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 - 3A:
DESCRIPTION OF ENVIRONMENT
(Baseline Part of Volume 3)

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

DEM	Digital Elevation Model
DFO	District Forests Officer
DFR	Detailed Feasibility Report
DG	Diesel Generators
DGPS	Differential Global Positioning System
DO	Dissolved Oxygen
DWT	Dry Weight Tonnage
DWT	Dead Weight Tonnage
E	East
EC	Electrical Conductivity
EIA	Environmental Impact Assessment
EMoP	Environmental Monitoring Plan
EMP	Environment Management Plan
EPC	Engineering Procurement Contractor
ESAs	Ecologically Sensitive Areas
ESC	Environment and Social Cell
ESS	Electrical Sub stations
FBP	Farakka Barrage Project
GHG	Green House Gases
GIS	Geographical Information Systems
gm	Gram
GoI	Government of India
GPS	Global Positioning System
GRB	Ganga River Basin
GW	Ground Water
ha	Hectare
HAD	Haldia Development Authority
HC	Horizontal Clearance
HDC	Haldia Dock Complex
HDPE	High Density Poly Ethylene
HFL	Highest Flood Level
hpa	Hectopascal
HPC	Name of a Consultant
hrs	hours
HSD	Hydraulic Surface Dredger
IARI	Indian Agricultural Research Institute
IBA	Important Bird Areas
IESWM	Institute of Environmental Studies & Wetland Management
IITs	Indian Institute of Technology
IMD	India Meteorological Department
IMDG-code	International Maritime Dangerous Goods Code
IMO	International Maritime Organization

INTACH	Indian National Trust for Art and Cultural Heritage
IRS	Indian Remote Sensing Satellite
IS	Indian Standards Published by Bureau of Indian Standards
ISRO	Indian Space Research Organization
IUCN	International Union for Conservation of Nature
IWAI	Inland Waterways Authority of India
IWC	International Whaling Commission
IWT	Inland Waterway Transport
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
kgs	Kilograms
KLD	Kilolitre per Day
km	kilometre
KMC	Kolkata Municipal Corporation
kmph	Kilometre per Hour
KoPT	Kolkatta Port Trust
KoPT	Kolkata Port Trust
KW	Kilo watt
LAD	Least Available Draft
LC	Level Crossing
Leq	Equivalent continuous sound pressure level in dB
LPG	Liquid Petroleum Gas
m	Metre
MARPOL	International Convention for the Prevention of Pollution from Ships
meq	Milli equivalent
mg/l	Milligram per litre
mg/l	Milligram per litre
□ill^3	Microgram per cubic metre
mL	Millilitre
MLD	Millions of Litres Per Day
mmhos/cm	Mili mho/ centimetre
MoEF&CC	Ministry of Environment & Forests & Climate Change
mpn/100 ml	Most Probable Number/100 millilitre
MSIHC	Manufacture Storage import of Hazardous Chemicals
MSW	Municipal Solid Waste
MSW	Municipal solid Waste
MT	Metric Tonnes
MTPA	Million Tonne Per Annum
N	North
NAAQS	National Ambient Air Quality Standards
NABL	National Accreditation Board for Testing and Calibration Laboratories
NCAER	National Council of Applied Economic Research
NGBRA	National Ganga Basin River Authority

NGO	Non-Government Organization
NH	National Highway
NMCG	National Mission for Clean Ganga
NOC	No Objection Certificate
Nox	Oxides of Nitrogen
NRCD	National River Conservation Directorate
NTPC	National Transport Policy Committee
NTU	Nephelometric Turbidity Unit
NW	National Waterways
NW	North West
ºC	Degree Celsius
PCC	Portland Cement Concrete
PCCF	Principle Chief Conservator of Forests
PIANC	World Association for Waterborne Transport Infrastructure
PM	Particulate Matter
PMC	Patna Municipal Corporation
PMU	Project Management Unit
ppb	parts per billion
ppm	parts per million
PPP	Public Private Partnership
PWD	Public Works Department
QA/QC	Quality Assurance/Quality Check
RCC	Reinforced Cement Concrete
RET	Rare Endangered and Threatened Species
RIS	River Information System
RITES	Name of Govt. Consultancy Organisation
ROB	Rail Over Bridge
RO-RO	Roll on and Roll Over
RWH	Rain Water Harvesting
S	South
SAV	Submerged Aquatic Vegetation
SC	Schedule Caste
SE	South East
SEAC	State Expert Appraisal Committee
SEIAA	State Environmental Impact Assessment Authority
SH	State Highway
SO2	Sulphur Dioxide
SPCB	State Pollution Control Board
Sq.km	Square kilometre
ST	Schedule Tribe
STP	Sewage Treatment Plant
SW	Surface Water

SWDS	Solid Waste Disposal Site
TDS	Total Dissolved Solids
TKM	Tonne Kilometres
TPD	Tonnes per Day
TPP	Thermal Power Plant
TSDF	Treatment Storage and Disposal Facilities
TSHDs	Trailer Suction Hopper Dredger
UNDP	United Nations Development Programme
UP	Uttar Pradesh
USA	United States of America
USDA	United States Department of Agriculture
USEPA	United State Environment Protection Authority
VBREC	Vikramshila Biodiversity Research and Education Centre
VC	Vertical Clearance
VMC	Varanasi Municipal Corporation
W	West
WB CZMA	West Bengal Coastal Zone Management Authority
WDSC	Whale and Dolphin Conservation Society
WHC	Water Holding Capacity
WNW	West North West
WWF	World Wide Fund for NGO

CHAPTER 1. INTRODUCTION

1.1. Project Background

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

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

1.2. Brief Project Description

Inland Waterway Transport (IWT) offers a comparatively low cost and environmentally sound alternative to road and rail transportation especially for bulk and containerized cargo. Infrastructure requirements of IWT in comparison to road and rail transport are also relatively low, although some investments are essential such as in port/terminal facilities, connecting road/rail infrastructure, navigation aid and dredging facilities etc.

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 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 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 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.

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

Cargo being transported in NW-1 includes cement, fly ash, iron ore, iron ore fines, coal, steel shed, tyres, iron fines, iron ingots, Galvanized steel plain sheets, stone chips, furnace oil, high Speed diesel, lube oil, boulders, pulses, aluminium block, sand, chips, ship block, food grains, Manganese ore, Petroleum, Coke, Cooking coal, Rock Phosphate, Timber, Peas, Slag oil, and Non-cooking coal. Traffic projections for the planned infrastructure site are given at **Table 1.1.** The terminals cargo handling capacity are being designed considering these traffic projections.

Table 1.1 : 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	0.54	1.22	1.22

	Terminal (with current land)			
3	Haldia Terminal	3.18 MTPA		

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 1.2.** Map showing location of NW-1 stretch from Haldia to Allahabad is shown in **Figure 1.1** below.

Table 1.2 : 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
• 5 ro-ro crossings
• Barge repair and maintenance facility
• 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-64m
LAD-3 m from Haldia to Barh, 2.5 m from Barh to Buxar and 2.2 m from Buxar to Varanasi at present</td></tr>
<tr><td>Design Vessel Specifications</td><td>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</td></tr>
<tr><td>Size of Vessels</td><td>1500-2000 dWT</td></tr>
<tr><td>River Slope</td><td>Haldia to Farakka-1 in 11000
Farakka downstream-1 in 18000
Farakka to Allahabad-1 in 17,000</td></tr>
<tr><td>Maintenance Dredging</td><td>Navigation Channel-15,765,596 cum/year*</td></tr>
<tr><td>Type of Dredgers</td><td>CSD, Agitation dredgers/plough dredgers and back hoe dredgers</td></tr>
</table>

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

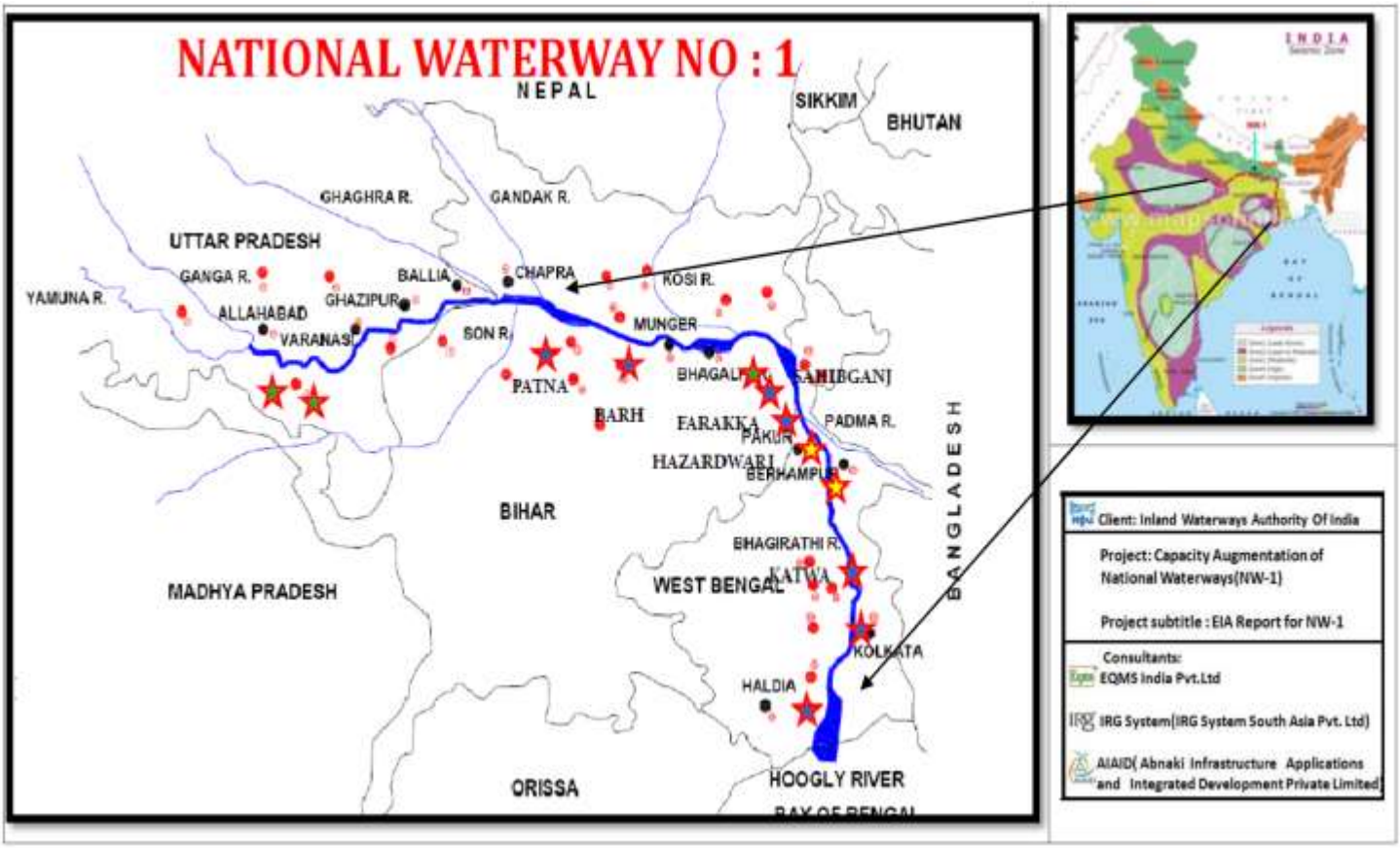


Figure 1.1 : Location Map of NW-1

1.3. 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. As per EIA Notification, 2006 as amended at present the project components like development of terminals & jetties does not requires environment clearance but environment clearance may be required for the activities like borrowing of earth as may be required for development of project. However detailed environmental clearance 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 the MoEF & CC Guidelines for EIA study for ports & harbours, IFC General guidelines for EHS and IFC Guidelines for EHS for Ports, Harbors and Terminals, World Bank

[1]The w orld 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 Waterw ays (OP/BP 7.5)

Operational Policies, Findings of CIA and Standalone EIA studies carried out for civil interventions.

1.4. 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, 2.5 m 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 assessed both qualitatively and quantitatively and are given in detail in the **Volume 1.**

1.5. Environment 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. EMP includes the environment management plans for the various activities, 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 budge. Detailed EMP is given in chapter 6 of the Volume 1.

However, the detailed intervention and activity specific plans for Maintenance dredging, barge operations, civil interventions are presented in this report. Standalone EMPs are prepared for each of the planned civil intervention, i.e. Sahibganj, Varanasi & Haldia Terminals and Farakka Navigational lock and are presented in this report as well.

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 shall be communicated to all stakeholders including workers and shall be freely available to them on demand.

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 shall include use of posters, bill boards/glow boards around project site and barge NW-1 alignment in Hindi, English & Regional language so as the workforce and community can understand it 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 shall evolve its environmental, Occupational health and safety guidelines and performance protocol. Budgetary provision has been made under environmental budget. The same shall be developed with the help of reputed institutions and organisation of repute. It should also follow the system of emergency response and suggested emergency response and management plan is included in the report.

Responsible Carrier Programme of IWAI[2]: It is proposed that IWAI develops Indian Waterways Operations Responsible Carrier Programme which should be developed as

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

part of its EHS Management System and Emergency Response Plan and Protocols Development. The programme shall 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 shall 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 shoreside personnel
- Addition of document control procedures
- Tracking of number and volume of spills in performance measurement requirements
- Internal and external audit procedures and frequency

1.6. 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 implementation stage: The respective contractors shall 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-Operation Phase and Emergency Situations: IWAI shall be solely responsible for implementation of the EMP and emergency response. IWAI shall be liable to ensure that suggestive mitigation measures are taken up by the shippers, dredgers and other stakeholders in time and adequately. IWAI shall 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 equippedwith speed 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.

1.7. Reporting requirement

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

1.8. Training and 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.

1.9. Conclusion

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

Chapter 2. DESCRIPTION OF THE ENVIRONMENT

2.1. General

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

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

2.2. Baseline Analysis, Study Area and Salient Environmental Features

2.2.1. *Baseline Data Collection and Study Area*

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

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

The primary data generation was carried out from 15th September, 2015 to 28thFebruary, 2016 for different period and frequency at different locations covering the entire stretch of NW-1, finalised intervention areas[3], likely intervention areas, likely maintenance dredging areas[4], select existing RO-RO jetty locations, selected existing passenger ferry locations and environmental sensitive areas. Being a linear project, the 500m radius[5] on either side of the bank is considered as core zone; 2 Km radius as immediate influence zone and 10 Km radius as extended buffer zone all along the NW-1 stretch and intervention areas. (refer **Figure 2.1** for study area map).

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

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

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

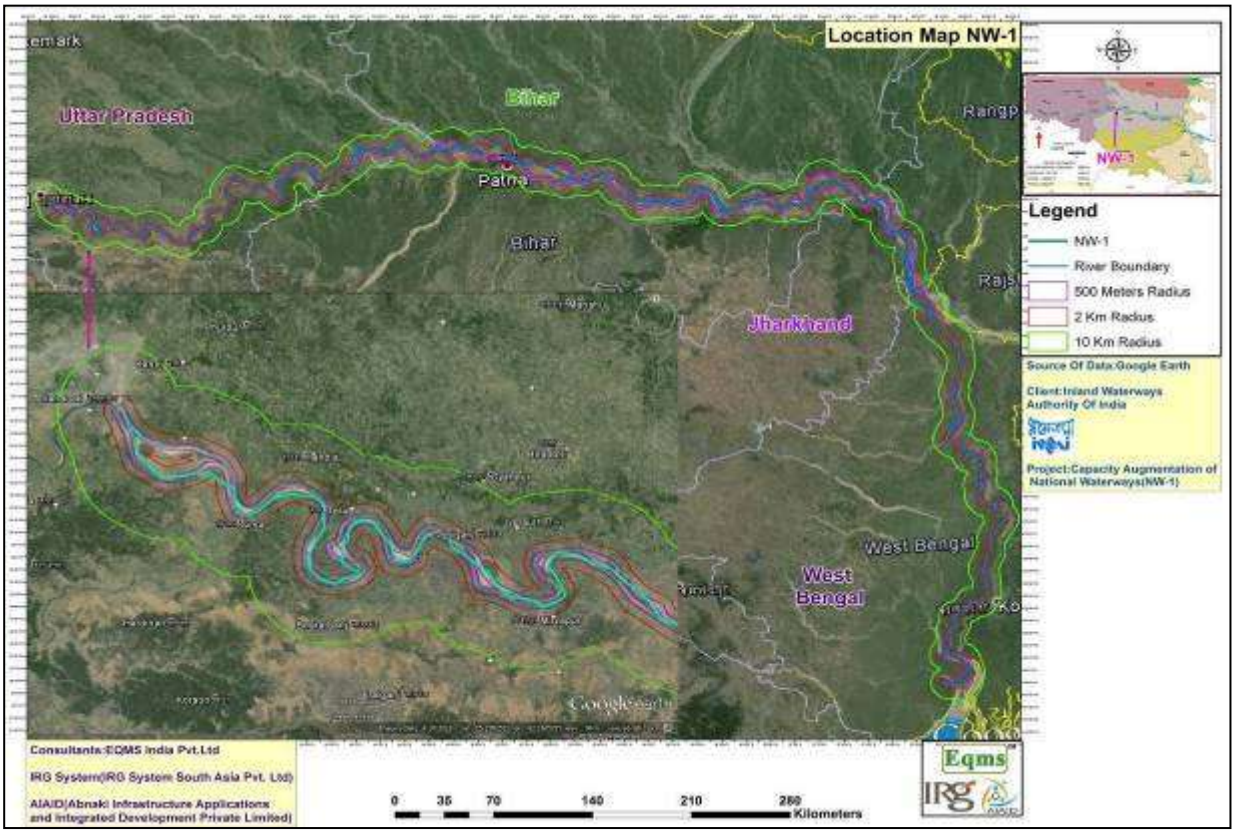


Figure 2.1 : Study Area Map (NW-1)

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

The NW-1 stretch starts from Haldia to Allahabad (1620 KM long) on Ganga - Bhagirathi - Hooghly river system. The Hooghly river portion of the waterway from Haldia to Nabadwip is under tidal influence. From Nabadwip to Jangipur the NW1 stretch is formed by Bhagirathi river. Bhagirathi river flow is regulated through barges at Farakka and Jangipur. From Farakka upstream the navigable route depends upon the main Ganga river flow. The Feeder Canal and the navigation lock at Farakka become the link between the Bhagirathi and main Ganga upstream of Farakka Barrage. NW-1 is passing through four states namely UP, Bihar, Jharkhand and West Bengal. Location map, alignment map of NW-1 is showing in **Figure 2.1.**

The salient environmental features around NW-1 within, 500m, 2km and 10km stretches are summarised in **Table 2.1**.

Table 2.1 : 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
	Presence of Wildlife Sanctuary	Yes 1. Kashi Turtle Sanctuary at Varanasi	None	Yes Udhwa lake sanctuary in Jharkhand (about 9

		2. Vikramshila Dolphin Sanctuary Kahalgaon to Sultanganj 3. Hilsa Sanctuary stretch in west Bengal		km away from NW-1
B	Reserved /Protected Forests	None	None	Yes (Bethuadahari RF, Bahadurpur RF & RF near Rajmahal Hills)
C	Wetland of state and national interest	None	None	Yes (Udhwa Bird sanctuary)
D	Migratory route for wild terrestrial animals	None	None	None
E	Presence of Schedule-I Terrestrial Fauna	None	Yes Migratory birds near Farakka Barrage and surrounding	Yes Migratory birds at important birds' areas
F	Presence of Schedule-I Aquatic Fauna	Yes Dolphin, and Turtle	None	None
G	Important Bird Area	Vikramshila sanctuary area	Yes 1. Danapur Cantonment area 2. Mokama tal 3. Kurseala river course and diyara floodplain. 4. Farakka Barrage and surround area	Yes Udhwa lake sanctuary
H	Seismicity	NW-1 falls in Zone-III (moderate risk) and zone IV (high damage risk zone) as per Seismic Zoning Map of India		
B.	**Social Environment**			
I	Physical Setting	Rural, Industrial and Urban		
	Densely populated area	Allahabad, Sirsa, Mirzapur, Chunar, Varanasi, Zamania, Ghazipur, Gahmar, Buxar, Ballia, Chappra, Patna, Barh, Bihat, Munger, Bhgalpur, Kahalgaon, Sahibganj, Farakka, Berhampore, Katwa, Kalna, Kolkatta and Haldia are densely populated areas.		
J	Physical Sensitive Receptors	Yes Ghats, Temples, Schools, Colleges and Hospitals are present all along the NW-1. Details are provided at section 4.7		
K	Archaeological Monuments	Yes There are 9 archaeological sites located within 300 m area of the NW-1 and these are Kardmeshwar Mahadeva Mandir, Ramnagar fort, archaeological excavation site, Varanasi, Manmahal and observatory, St. John's Church, Temple of Gour Chandra and Krishnachandra at Chatra (Gaur Chandra Ghat), Hazardwari Palace, Sindhi Dalan and Jami Masjid		

		Details provided in Section 4.7.

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

The study period and methodology for primary data collection is followed as per the monitoring plan approved by IWAI and World Bank. Summary of monitoring plan and sampling, testing methodology followed is shown in**Table 2.2**.

Table 2.2 : Summary of Monitoring Plan and Methodologies Adopted for Primary Data Collection

Parameters	No. Of sampling locations	Frequency	Remark
Ambient Air Quality			
PM_{10}, $PM_{2.5}$, SO_2, NOx and CO	3 locations and 8 sample per terminal and lock One location and 2 samples per Ro-Ro jetty	Twice a Week (within 2 km area)	AAQ monitoring was carried out representing upwind, downwind and crosswind directions of the site. 24 hours sampling at each location was carried out as per CPCB guidelines (CPCB Gazette notification dated 18.11.2009 on AAQ).
Meteorology			
Temperature, Humidity, Wind speed, Direction, storm, barometric pressure, Strom, Rainfall etc.	-	--	Meteorological status of the project influence area had been establishing through analysing the IMD secondary data for 30 years' period.
Ground Water Quality			
pH, Temp., Conductivity, Turbidity, TSS, TDS, DO, BOD, COD, oil & grease, chloride, NO_3, PO_4, Cl, SO_4, Na, K, Ca, Mg, Silica, Hg, Pb, Cd, Total Cr, Cu, Zn, Se, Fe, Total Coliform (MPN/100 mL), Presence and absence of pesticides in water samples	3 locations per terminal, lock One location per Ro-Ro jetty	Once	Samples were preserved, transported and analysed for different parameters based on APHA methods. Temperature, conductivity and pH were measured instantly at site itself.
Surface Water Quality			
pH, Temperature, Conductivity, Turbidity, TDS, Aluminium, Calcium, Chlorides, Copper, Fluoride, Free residual chlorine, Iron, Magnesium, Manganese, Nitrate, Phenolic compounds, Sulphate, Sulphide, Total Alkalinity, Total Hardness, Zinc, Cadmium, Cyanide, Lead, Mercury, Nickel, Total Arsenic, Total Chromium **Biological Parameter:** Total coliform Fecal Coliform	2 locations per terminals, lock, 3 locations in Sensitive Ecosystem and one location per Ro-Ro jetty	Once	Samples were preserved, transported and analysed for different parameters based on APHA methods. Temperature, conductivity and pH, DO which were measured instantly at site itself.
Soil Analysis			

Texture, bulk density, pH, conductivity, cation exchange capacity, organic matter, Total N, P, K, and Heavy metals etc.	2 locations per terminal/lock One location per Ro-Ro jetty	Once	Soil samples were collected at two locations and analysed as per IARI method
River bed Sampling			
Texture, bulk density, pH, conductivity, cation exchange capacity, organic matter, Chromium, Arsenic, Mercury, Lead, Zinc, Iron, Cupper, ∞, β- γ- Endosulphan, Methyl Parathion, and Lindane	34 dredge sampling location (total 102 nos. of sample at different depth) along NW-1	Once in season	Top layer, (composite sample of 0 to 1.0 m depth), Middle Layer (composite sample 1.0 to 2.0 m depth) & Bottom layer (composite sample of 2.0 to 2.5 m depth) at each proposed dredging and borehole location. For the sampling location of first seven locations sampling of 2.5 to 3 m sample will also be drawn and tested. Sedimentation sampling was collected and analysed as per IARI method.
Noise Environment			
Noise profiling for 24 hrs	3 locations per terminal and lock One location per Ro-Ro jetty and six locations per sensitive ecosystem	Once in season	Noise monitoring was conducted within 2 km area of terminal/lock/ ROo-RO jetty and sensitive ecosystem for noise profiling for 24 hrs using integrated sound level meter, as per CPCB guidelines.
Aquatic Ecology			
Phytoplankton, Zooplankton, benthos	3 locations per terminal and lock/sensitive ecosystem One location per Ro-Ro jetty	Once in season	River water sampling was also carried out for aquatic ecology and analysed as per APHA method.
Terrestrial Ecology			
Flora & Fauna	Along NW-1	Once	Primary survey/ Secondary sources
Terrestrial Ecology			
Demography & Socioeconomic	Along NW-1	Once	Primary survey/ Secondary sources

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

2.3. Physical Environment

2.3.1. *Topography*

The whole NW-1 (Allahabad to Haldia) falls within a relatively flat terrain. Physiographically, it constitutes a part of the Indo-Gangatic plain, which is largely flat, featureless and is formedof recentalluvial deposits of the river Ganga and its tributaries. River erosion, change in course of rivers and human activities of recent times has played an important role in shaping the relief of the river terrain. Based on the contour of the NW-1, the Digital Elevation Model has been prepared for 10 km area around the NW-1. The Nearest Neighbour method has been used to interpolate the elevation data to develop the elevation model. The elevation within this stretch ranges between 321 m to 1 m. Highest elevation

was observed at Sahibganj area (Jharkhand), because of presence of hillocks in this area. The map shown below depicts clearly that the elevation of waterways declines from western to eastern part towards Haldia. Digital Elevation Model of study area is shown in **Figure 2.2.**

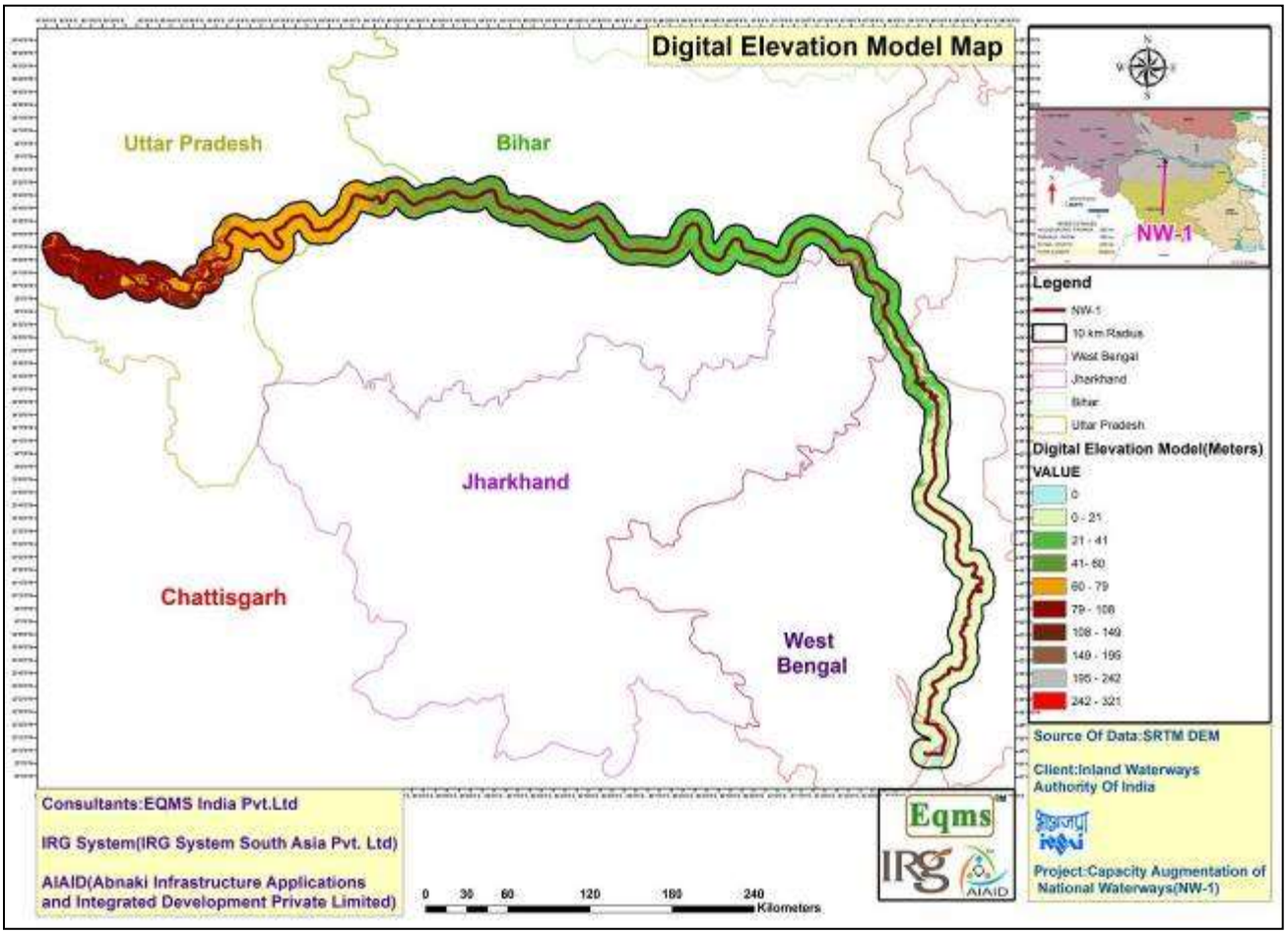


Figure 2.2 : DEM of NW-1

2.3.2. *Drainage Pattern (Ganga River)*

The Ganga River (about 2525 km long) is fed by runoff from a vast catchment area bounded by the snow peaks of the Himalaya on one side in the north and the peninsular highlands and the Vindhya Range on the other side in the south. The basin encompasses an area of more than a million square kilometres (1,186,000 Sq. km) spread over four countries: India, Nepal, Bangladesh and China. With 861,404 Sq.km within India itself, the Ganga basin is the largest river basin in India and covers approximately 25 percent of India's total geographical area. The catchment area, length, total utilizable water of Ganga river basins within India and the states that they cover is shown in **Table 2.3.** State wise distribution of drainage area of Ganga river is mentioned in **Table 2.4**.

Table 2.3 : Ganga river Basin Catchment Area

S. No.	Length (km.)	Catchment Area (Sq. km.)	Total utilizable water
1	2525	861404 (1186000)	420.99

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

Table 2.4 Distribution of the Drainage Area of Ganga River in India

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

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

2.3.3. *Drainage pattern NW-1*

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

The Padma, carries the majority of Ganga river flow, eventually turns south-eastwards into Bangladesh, while the Bhagirathi (Ganga) winds southwards down the deltaic plain of West Bengal and ultimately empties into the Bay of Bengal under the name of Hugli. Nearly halfway between Farakka and Sagar Island, the hydraulic character of the Bhagirathi (Ganga) changes upon its entry into the tidal zone of the Gangetic delta. The speed and direction of water in the estuarine streams and creeks are in continual flux due to the ebb and flow of the tides. Drainage Map of Ganga River in NW-1 stretch is shown in **Figure 2.3.** Line diagram of the River Ganga and its major tributaries meeting in NW-1is shown in **Figure 2.4**.

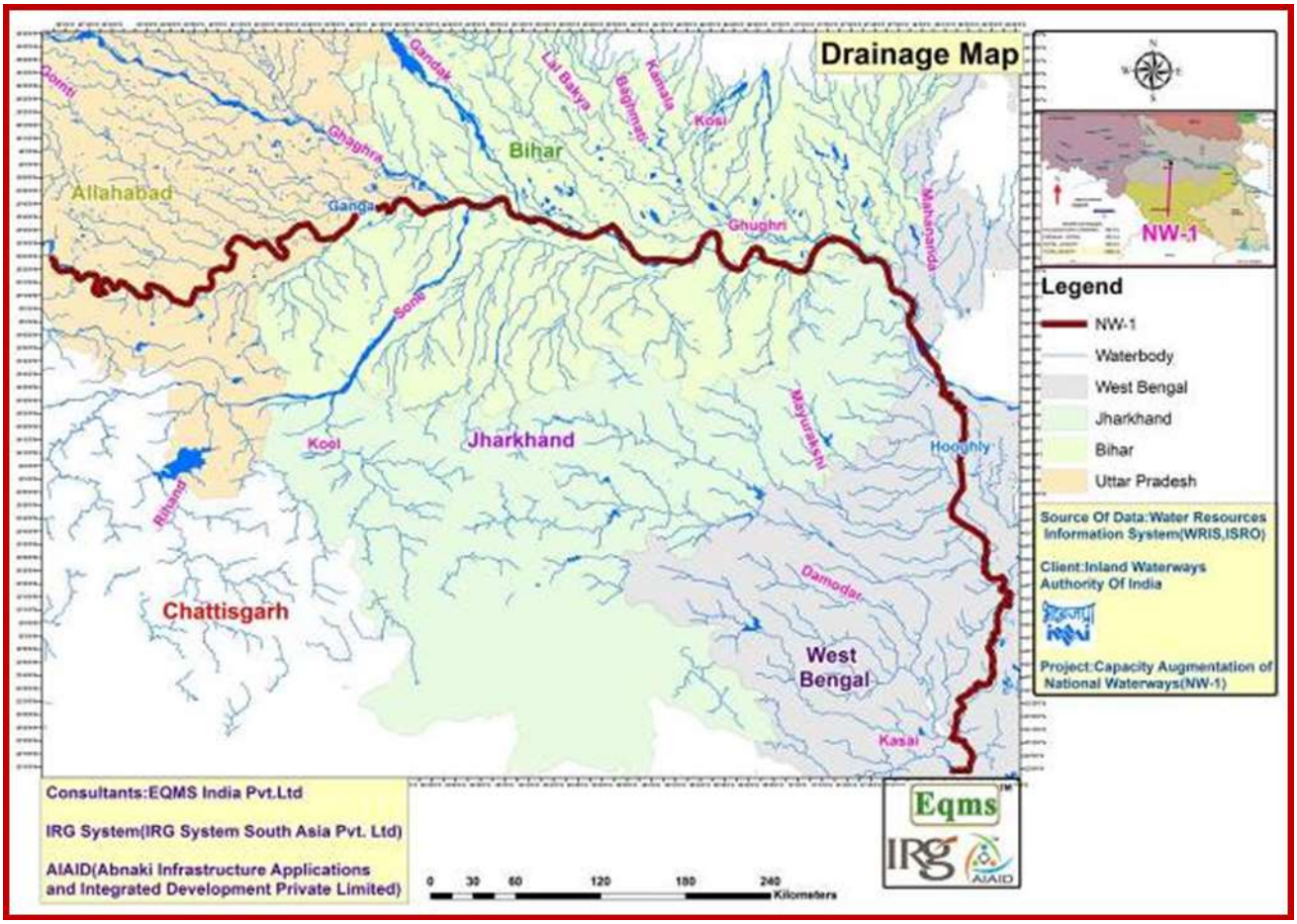
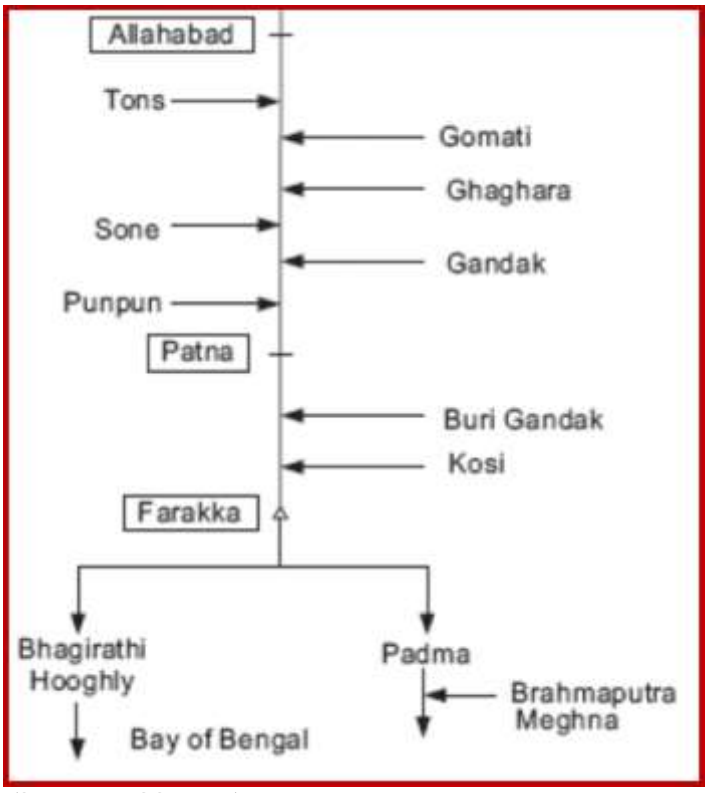


Figure 2.3 : Drainage Map of 2 Km radius of NW-1



(Source: NMCG report)

Figure 2.4 : Line Diagram of Ganga and its tributaries

2.3.4. *Land use Pattern*

NW-1 passes through states of Uttar Pradesh, Bihar, Jharkhand and West Bengalwhichare extensively cultivated, constituting about 10 per cent of the total area of the India. About 11 per cent of total land of NW-1 states is fallow land and 52% percent as net sown area. The cropping intensity is highest in west Bengal with 184.1 per cent followed by Jharkhand, Uttar Pradesh and Bihar. The overview of land use pattern of the sates traversed by NW-1 is shown in **Table 2.5**.

Table 2.5 : Overview of Land use in the States traversed by NW-1

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

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

2.3.5. *Land use pattern along NW-1*

The land use analysis of study area (10 km area around NW-1) was carried out using remote sensing data. Systematic interpretation was carried out using a set of digitized images with color-coding for delineating the land use classes. By integrating the areas demarcated under different land use/land cover as different coloursare assigned to different land use/land cover types of satellite imagery[6] .

The land use classes in 10 km area of the NW-1 are agricultural land, settlement, water body, forest, barren land and vegetation. Land use within the 10 km Radius of the NW-1 is majorly dominated by agricultural land. Both sides of the NW-1 are occupied by Agricultural land and about 78.9 % of the land is under cultivation. NW-1 also passes through many urban areas. About 7.18% of the land is under settlement. As per the land use data analysis about 7.21% of the land is under water bodies, about 3.59% of the land is under vegetation, 2.82% of the land is under dry river bed and rest of the land falls under other uses (refer **Table 2.6**).

Table 2.6 : Land use of the Study Area

Sl. No.	Class	Area(KM^2)	Percent (%)
1	Agricultural Land	19767.57	78.90
2	Water body	1805.8	7.21

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

3	Vegetation	899.94	3.59
4	Settlement	1799.93	7.18
5	Dry River Bed	705.76	2.82
6	Open Land (Non Agri. Land)	76.01	0.30
Total		**25055.01**	100.00

Source: Satellite Image Analysis

The land use map of different sections of NW-1 is shown in **Figure 2.5 to 2.7**.

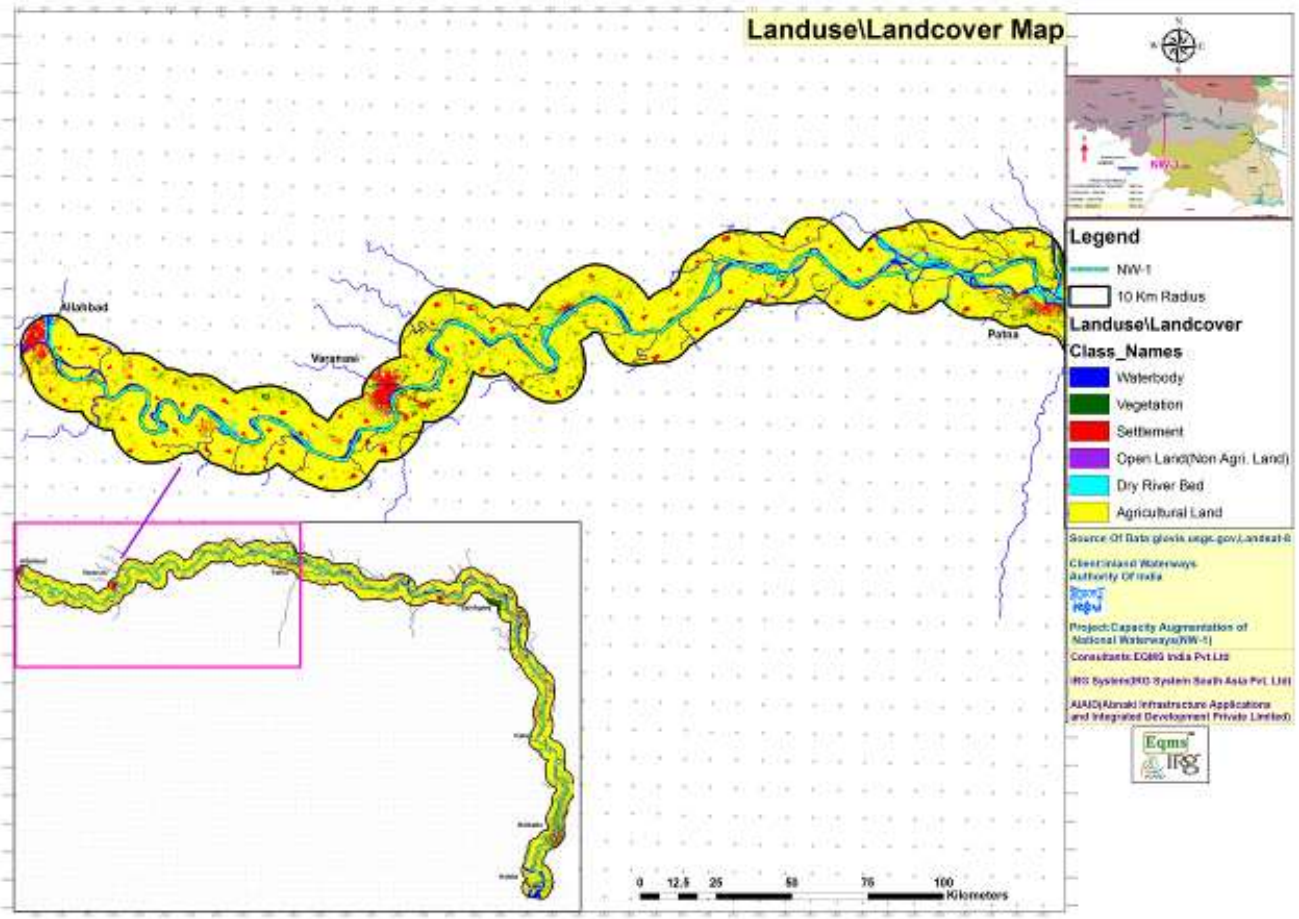


Figure 2.5 : Land use Map (Allahabad to Patna)

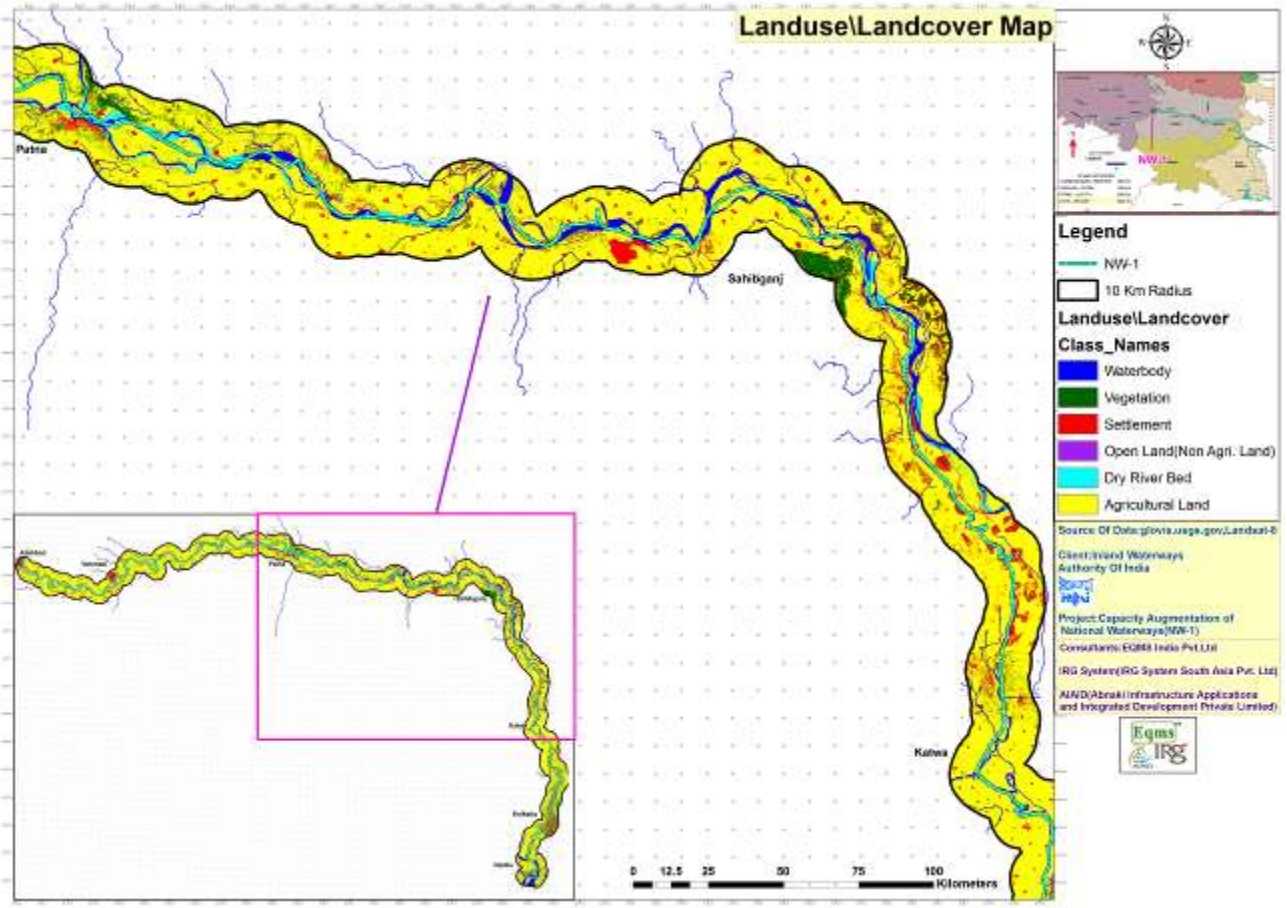


Figure 2.6 : Land use Map (Patna to Katwa)

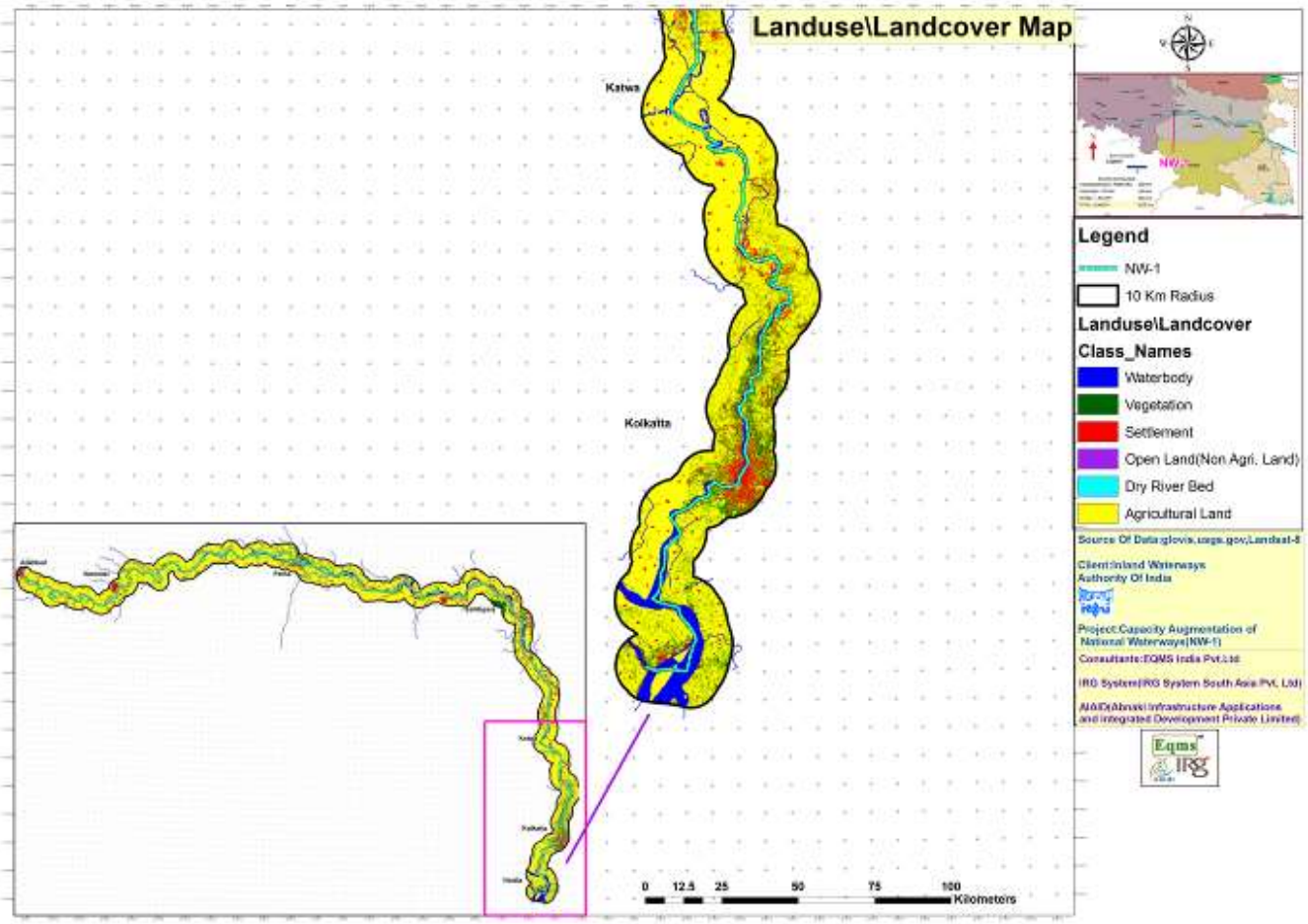


Figure 2.7 : Land use Map (Katwa to Haldia)

2.3.6. *Cropping Pattern*

The Ganga River with its fertile soil have 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.

2.3.7. *Major Habitation along the NW-1*

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

2.3.8. *Geology*

Ganga river basinis part of the tectonically active foreland basin of the Himalayan mountain range formed by collision of the Indian tectonic plate with the Eurasian plate more than fifty million years ago. Thus, most of the area of NW-1 consists of alluvial plains formed during the Tertiary and Quaternary periods by flood deposits of Himalayan rivers. The Ganga river network not only conveys water, but also transfers enormous amount of eroded Himalayan sediments to the sea. The alluvial deposits on the plain area constitute large and highly productive multi-aquifer systems in the area, which are a major storehouse of ground water.

The soils of the area are also largely alluvial. Geological map of NW-1 is shown in **Figure 2.8.**

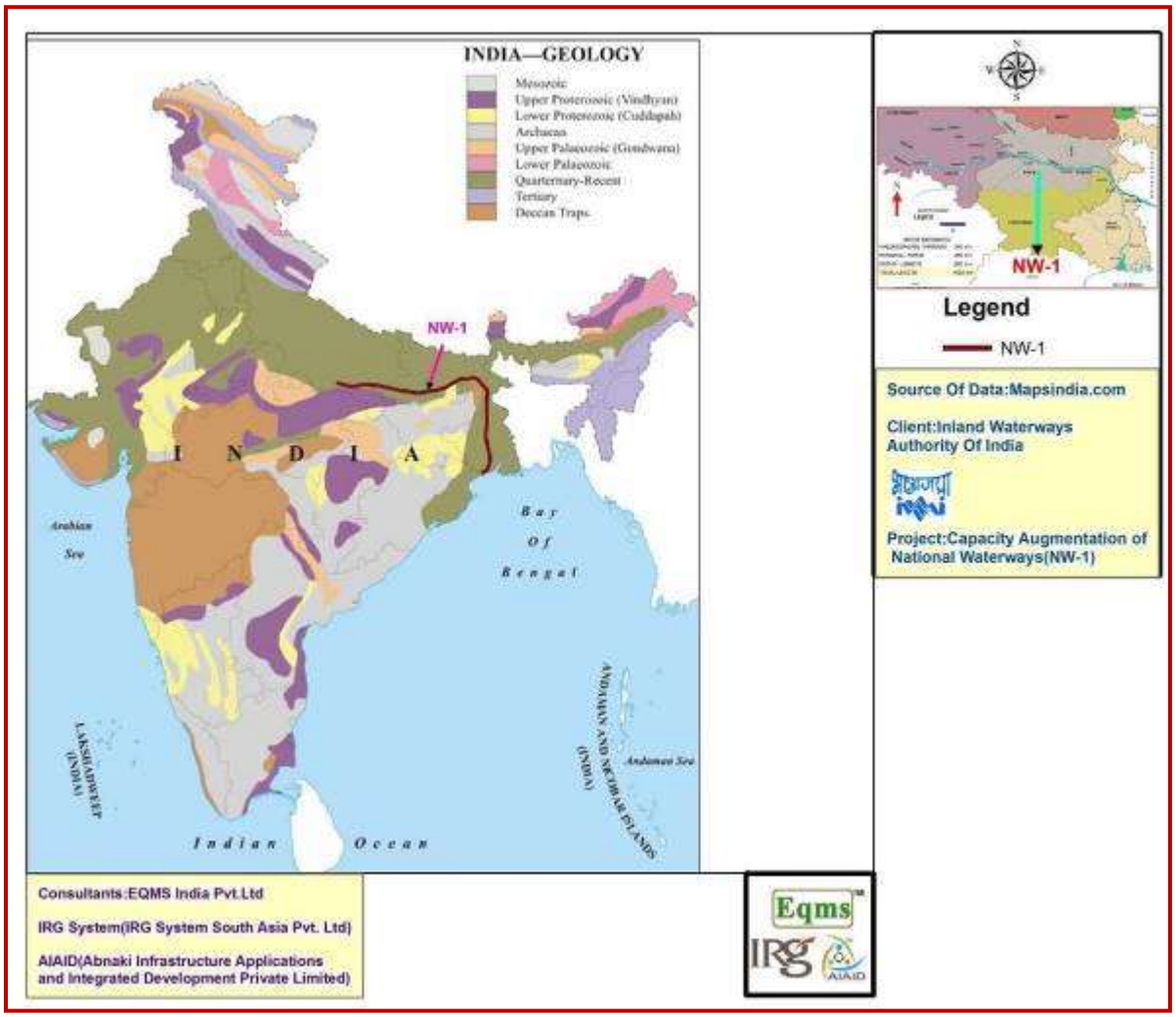


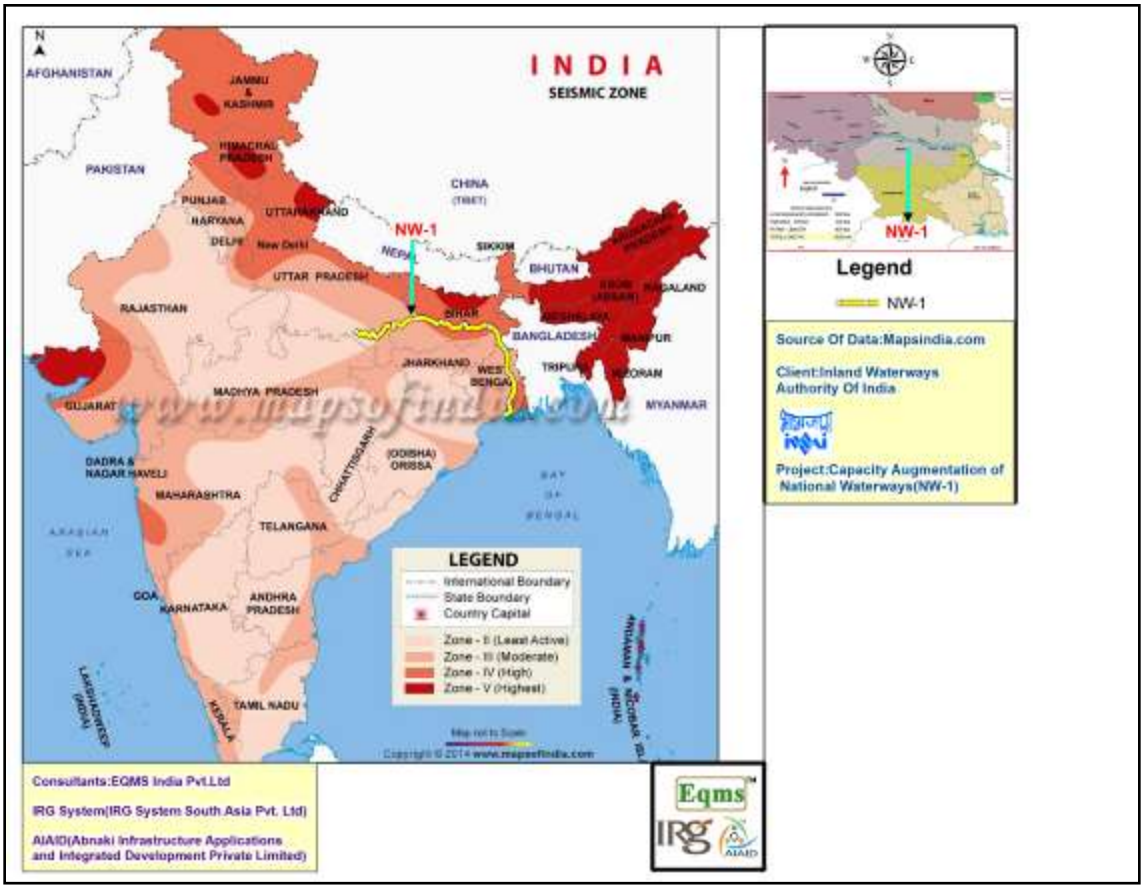
Figure 2.8 : Geological Map of India

2.3.9. *Volcanic activity*

There areno records of any volcanic eruption in NW-1 region or even in its surrounding areas.

2.3.10. *Seismicity*

As per seismic classification of India, most of the NW-1stretch falls under zone-IIIwhich means moderate seismic risk. Some stretch in Bihar state falls under zone IV which means high seismic risk. The seismic zoning map of India is showing **Figure 2.9**.



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

Figure 2.9 : Seismic of Zones Map of India

2.3.11. *Soil*

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

A. Regional Soil Types

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

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

B. Study, Sampling and Analysis

The physicochemical characteristics of soils within the study area, soil sample were also collected from proposed interventions along the NW-1. The physicochemical characteristics of the soils in the study area, as established from the analysis of the soil samples are presented in **Table 2.7** and **2.8.**

Table 2.7 : Soil Quality along NW-1 (near Proposed Terminal Locations)

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

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

Table 2.8 : Soil Quality along NW-1 (Near Existing Ro-Ro / Jetty / Floating Terminal Locations)

S. No.	Parameter	Unit	West Bengal						Jharkhand	Bihar		
			Diamond Harbor	Howrah	Shantipur Ghat	Hazardwari	Katwa	Pakur	Mangal Hat	Munger	Patna	Buxer
Physical Characteristics												
1.	Texture	USDA System	Sandy Clay	Clay Loam	Sandy Clay	Sandy Clay	Clay Loam	Sandy Clay	Sandy Clay	Sandy Loam	Sandy Loam	Clay Loam
2.	Water Holding Capacity (WHC)	%	32.6	30.5	31.8	30.5	29.7	30.5	29.4	28.9	29.6	33.8
3.	Bulk Density (BD)	gm/cc	1.37	1.28	1.35	1.39	1.36	1.35	1.30	1.42	1.48	1.25
4.	Porosity	%	48.3	51.7	49.1	47.6	48.7	49.1	50.9	46.4	44.2	52.8
Chemical Characteristics												
5.	pH	20 % Slurry	7.66	7.01	7.72	7.35	6.62	7.56	7.08	7.68	7.46	7.36
6.	Conductivity (EC)	µmhos/cm	224.4	235.6	298.5	228.3	261.5	278.5	220.6	244.8	224.2	272.9
7.	CEC	meq /100-gm	18.8	16.5	20.6	22.8	24.4	18.2	21.5	10.5	9.6	18.5
8.	Organic Matter (OM)	%	1.17	1.34	1.07	1.24	1.66	0.88	1.02	1.10	1.12	0.83
9.	Organic Carbon (OC)	%	0.68	0.78	0.62	0.72	0.96	0.51	0.59	0.64	0.65	0.48
10.	**Primary Nutrients**											
i)	Nitrogen as N	Kg/ha	245.8	264.3	278.5	229.7	272.8	255.4	226.4	238.5	227.5	255.1
ii)	Phosphorous as P	Kg/ha	22.5	29.7	26.2	20.6	32.4	28.5	25.6	28.2	26.8	31.5
iii)	Potassium as K	Kg/ha	128.5	124.9	123.4	246.6	185.5	142.6	252.8	267.9	252.7	236.8
Micronutrients												
11.	Manganese as Mn	mg/kg	10.2	18.7	16.8	15.9	18.6	16.2	19.6	15.8	17.1	13.7
12.	Chromium as Cr	mg/kg	32.4	17.6	6.58	20.3	8.4	14.8	22.8	<0.01	<0.01	<0.01
13.	Arsenic as	mg/kg	1.22	1.12	0.95	<0.01	<0.01	8.5	<0.01	<0.01	<0.01	<0.01
14.	Mercury as Hg	mg/kg	0.16	0.12	0.27	<0.01	<0.01	0.85	<0.01	<0.01	<0.01	<0.01
15.	Lead as Pb	mg/kg	14.2	16.8	11.6	5.2	6.8	4.6	6.5	<0.01	<0.01	<0.01
16.	Zinc as Zn	mg/kg	24.5	1.88	1.15	0.76	0.44	0.95	0.82	2.62	2.06	1.16
17.	Iron as Fe	mg/kg	2.45	28.4	30.8	28.5	33.8	24.8	37.5	24.2	32.4	28.2
18.	Copper as Cu	mg/kg	12.8	8.6	12.4	2.25	2.66	2.55	1.95	2.11	2.07	2.15
19.	Cadmium as Cd	mg/kg	0.67	<0.01	<0.01	1.18	<0.01	0.24	1.14	<0.01	<0.01	<0.01
20.	Nickel as Ni	mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01	12.8	<0.01	<0.01	<0.01	<0.01

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

C. Soil Characteristics

Physical Properties

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

Chemical Characteristics

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

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

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

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

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

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

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

The main climatic factors of concern are temperature, sunlight and precipitation. In India, there are four-temperature zones namely tropical, sub-tropical, temperate and alpine. Among these, the tropical zone (Humid, sub-tropical and Tropical wet and dry) is most predominant in the entire NW-1 stretch.

The meteorological parameters also play a vital role in transport and dispersion of pollutants in the atmosphere. Historical meteorological data were obtained from climatological tables pertaining to different IMD stations all along the NW-1. The met data of the nearest representative IMD stations all along the NW-1(period 1961-1990) is summarized in **Table 2.9 and 2.10**.

Table 2.9 : Meteorological Data (Period 1961-1990)

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

(Source-IMD)

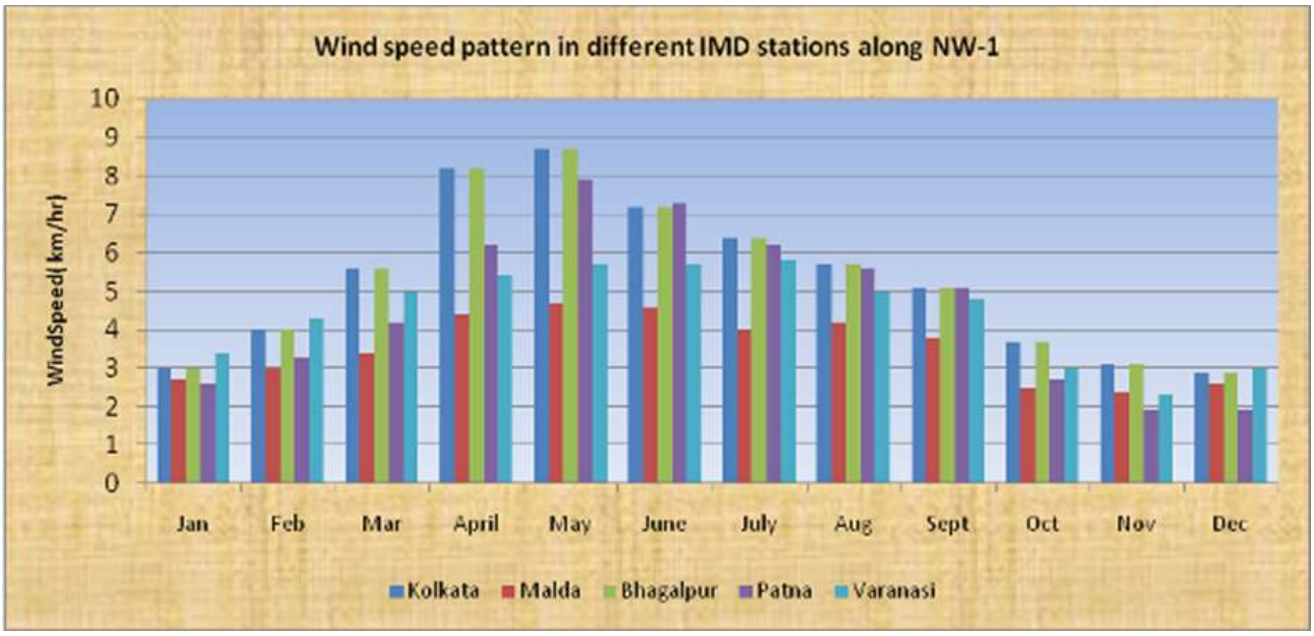
Table 2.10 : Meteorological Data (Period 1961-1990)

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

(Source-IMD)

A. Wind Speed and Direction

The wind speed in the area was mostly between 1.9 km/hour at Patna IMD and maximum of 8.7 km/hour at Kolkata IMD for all the months of a year (**Figure 2.10**). The predominant wind direction is from North and Northwest direction in winters and South and Southeast direction during rest of the season.

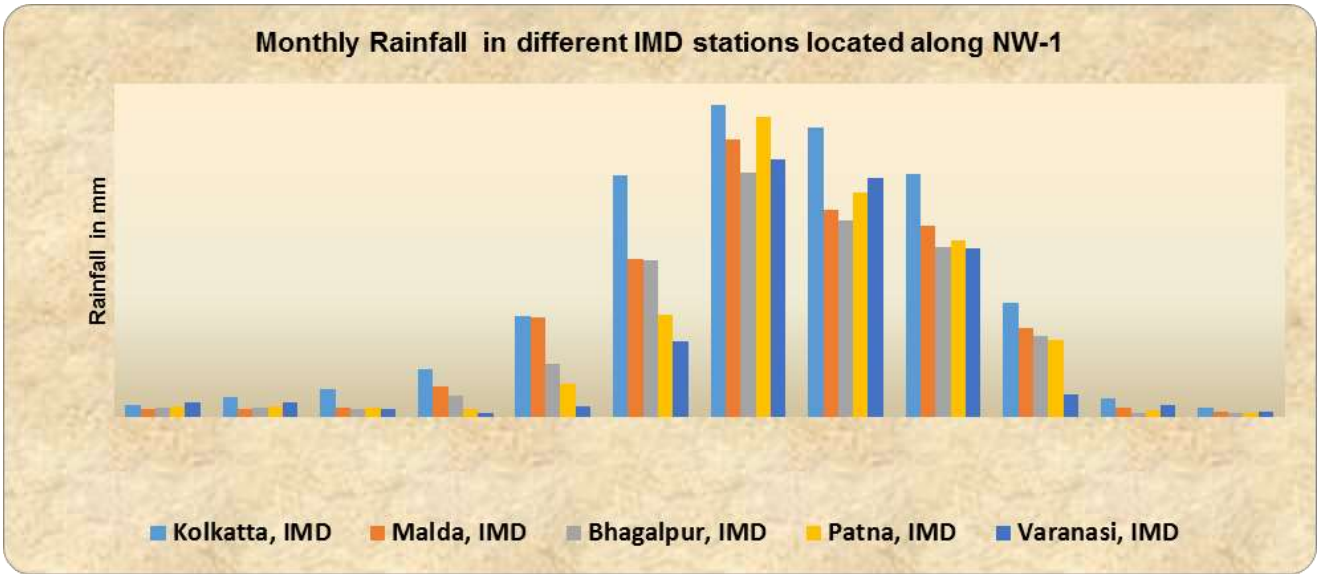


(Source: Analysis of IMD data)

Figure 2.10 : Wind Speed at different IMD stations along NW-1

B. Rainfall

The annual total rainfall in all IMD stations (representing respective city/towns) ranges between 1000.3mm at Varanasi and 1728.5 mm at Kolkata. Over 80% of the total annual rainfall at all locations is received during the monsoon period between June to September (**Figure 2.11**).

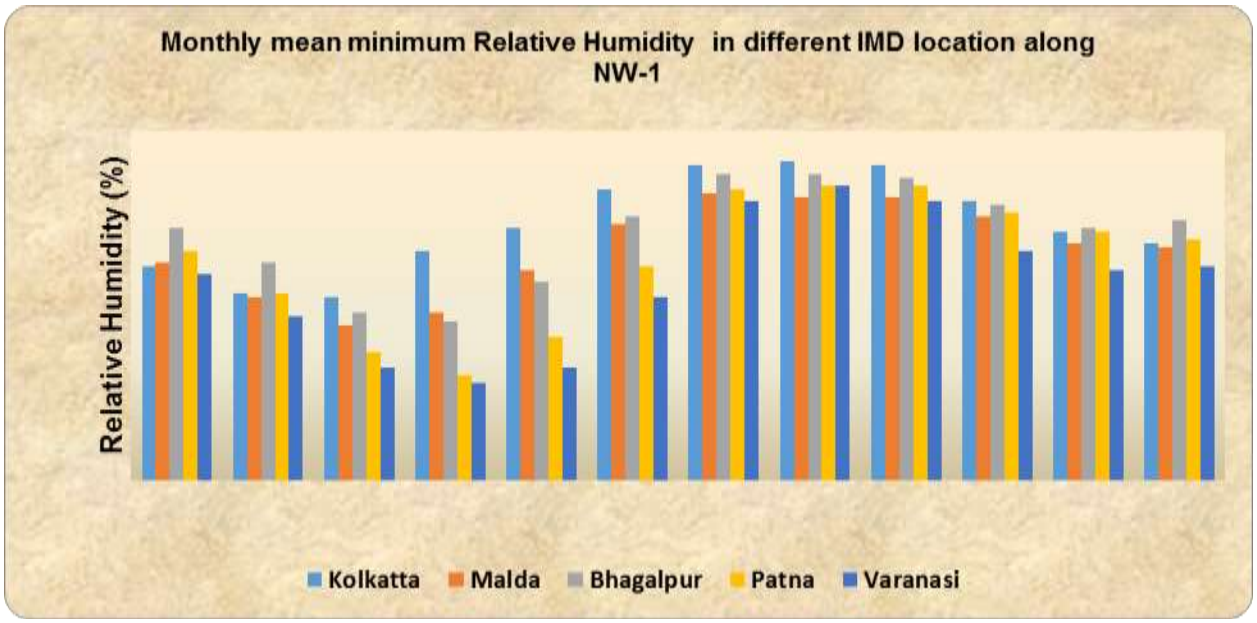


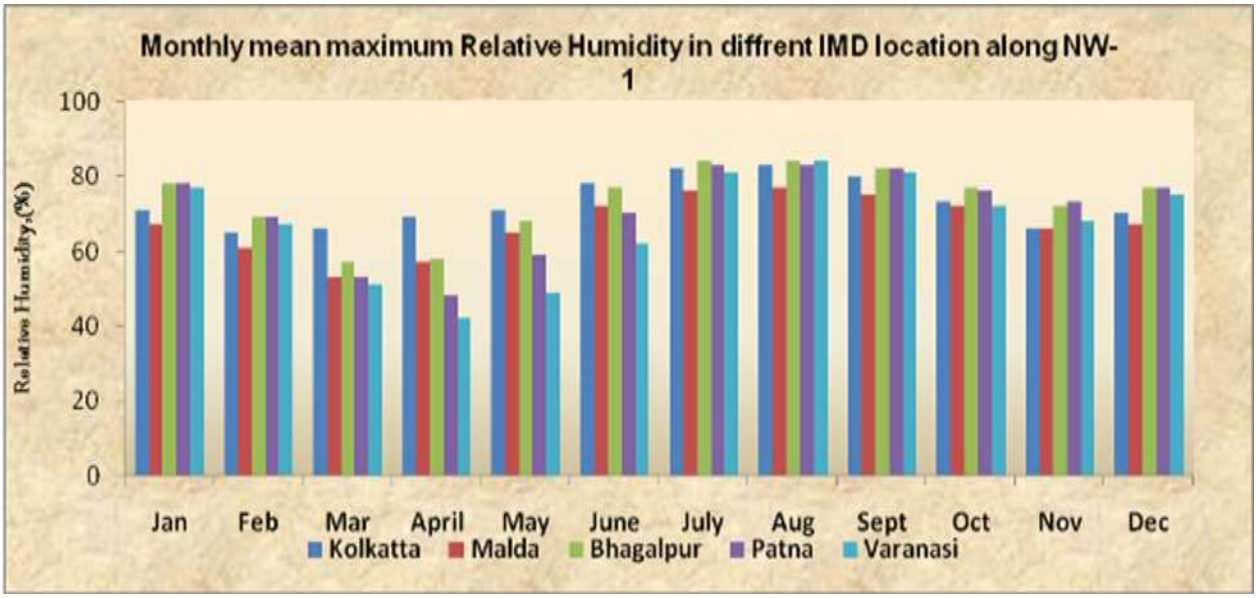
(Source: Analysis of IMD data)

Figure 2.11 : Monthly Rainfall

C. Relative Humidity

The air is generally dry in the region except during monsoon. March and April are the driest months with relative humidity ranging between 25-84%. Lowest humidity was observed in Varanasi (as per IMD records) which slightly increased with decreasing altitude. The maximum humidity was observed during rainy season as reflected in database of all IMD stations along NW1 **(Figure 2.12)**.



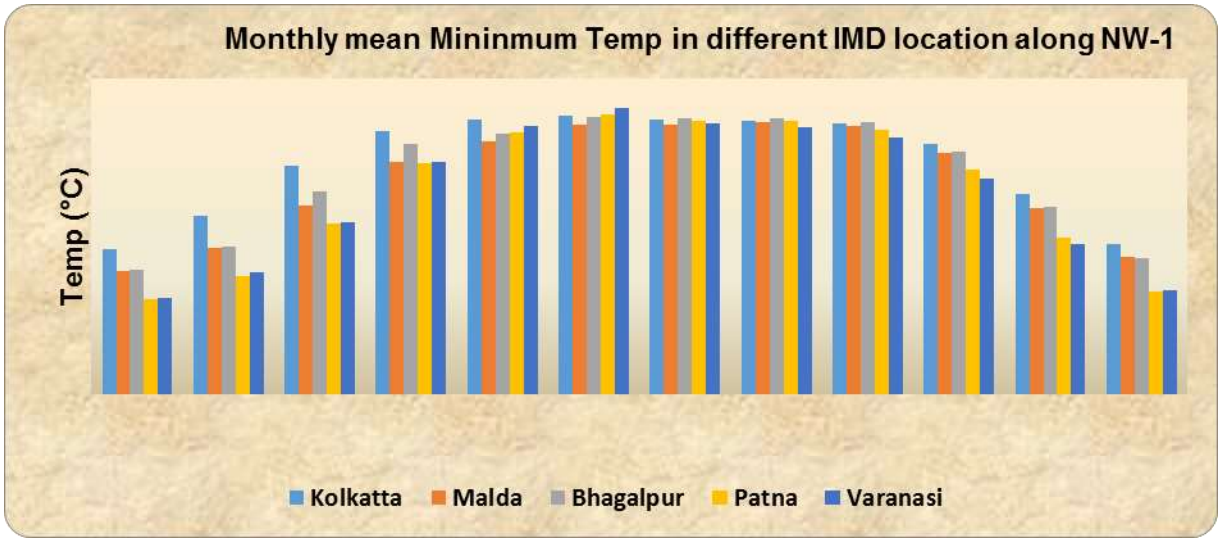


(Source: Analysis of IMD data)

Figure 2.12 : Monthly Relative Humidity

D. Temperature

December and January constitutes winter months with daily mean minimum temperature of around 9.1°C at Patna (IMD Station) and daily mean maximum temperature of around 26.9°C at Kolkata. April and May are the hottest months with daily mean maximum temperature varying around 40.4°C at Varanasi and daily mean minimum temperature around 24°C at Malda (IMD records) **(Figure 2.13)**.



(Source: Analysis of IMD data)

Figure 2.13 : Monthly Temperature

E. Barometric Pressures

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

F. Day Time Length:

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

G. Visibility

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

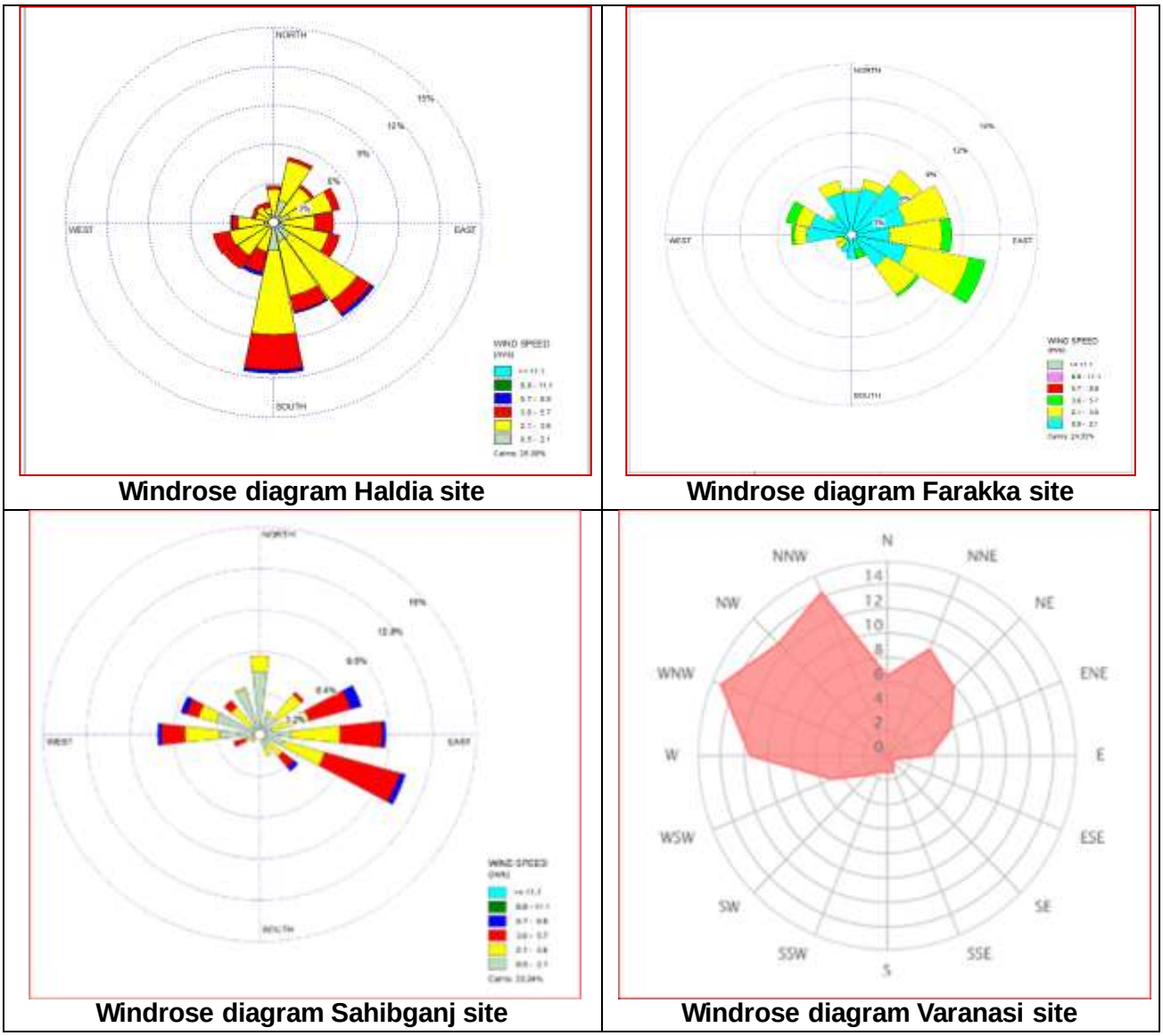
H. Site specific Met Data at proposed terminals

Secondary one-month data was collated for terminal and Lock locations at Haldia, Farakka lock, Sahibganj and Varanasi. The analysis reflected that predominant wind direction all along NW-1 is from NW, WNW, E, S and SE direction. The prevalence of calm period ranges between 26 to 31%. Site specific met data and wind roses are givenin **Table 2.11** and **Figure 2.14**.

Table 2.11 : Meteorological Data

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

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



Windrose diagram Haldia site | **Windrose diagram Farakka site**

Windrose diagram Sahibganj site | **Windrose diagram Varanasi site**

Figure 2.14 : Wind Rose Diagram

I. History of Cyclones:

As per Cyclone Hazard Prone Map of India, some stretch of NW-1 close to Haldia in West Bengal (nearer to sea) fallsin Cyclone prone area. Cyclone hazard prone areas of NW-1 are shown at **Figure 2.15.**

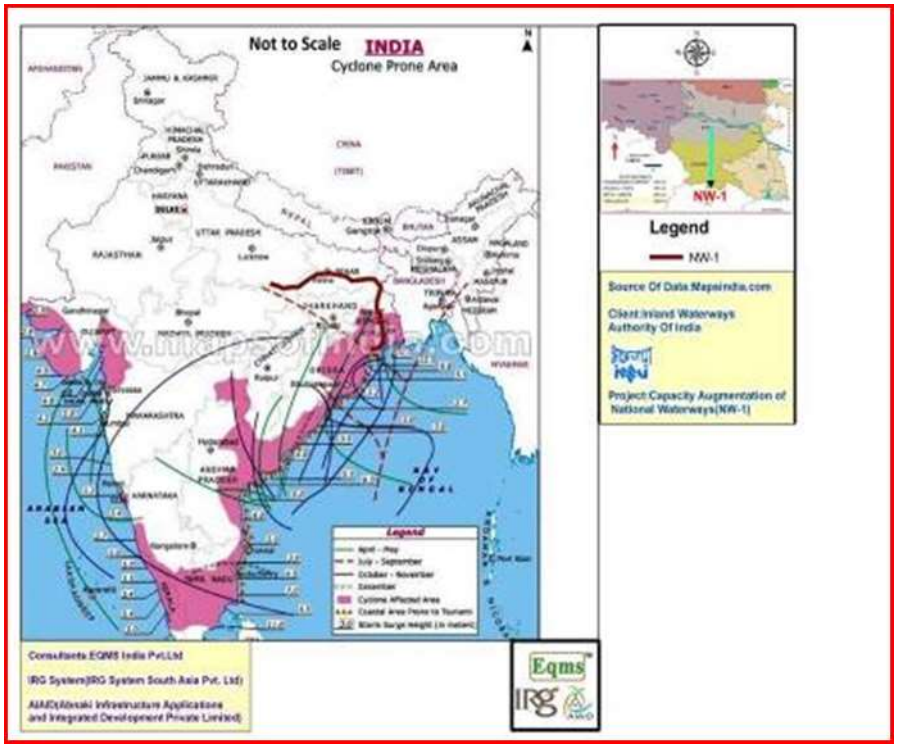


Figure 2.15 : Cyclone Prone Area Map of India showing NW-1

J. Tidal Surges

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

2.3.13. *Water Environment*

A. Ground Water Use pattern

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

The groundwater usage pattern in the states traversed by NW-1is given in **Table 2.12.** The extent of groundwater utilization for irrigation is highest in Uttar Pradesh (45.36 BCM per year), followed by West Bengal (10.84 BCM per year), Bihar (9.39 BCM per year) and Jharkhand (0.7 BCM per year).

Table 2.12 : Overview of Ground water uses Pattern in States Traversed by NW-1

S. No.	State	Annual Groundwater Draft (BCM per year)	Net annual Groundwater availability (BCM/year)	Projected Demand for Domestic and Industrial uses up to 2025 (BCM per Year)

		irrigation	Domestic and Industrial uses	Total		
1	Uttar Pradesh	45.36	3.42	48.78	70.18	5.30
2	Bihar	9.39	1.37	10.77	27.42	2.14
3	Jharkhand	0.7	0.38	1.06	5.25	0.56
4	West Bengal	10.84	0.81	11.65	27.46	1.24

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

Apart from irrigation, groundwater resources are also being heavily tapped for industrial and domestic activities in urban as well as in rural areas. Throughout the alluvial area of the NW-1, most of the urban water supply schemes are dependent upon groundwater resources. Similarly, large number of industries also withdraw significant amounts of groundwater, especially from the easily accessible aquifers in the alluvial zone. State wise ground water resources in NW-1 state are given in **Table 2.13.**

Table 2.13 : State wise Ground water resources in NW-1 (2008)

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

Source: CWC 2008

B. Ground Water Quality

Ground water samples were collected from intervention locations and stretches close to populated zones all along the NW-1[7]. The water samples were examined for physico-chemical parameters as well as for bacteriological parameters. The details of sampling locations arepresented in **Table 2.14** and **Figure 2.16.** The Analysis results are presentedin**Table 2.15 and Table 2.16.**

Table 2.14 : Ground Water Sampling Locations along NW-1

S. No.	Terminal Location	Ground water sampling Location	Location Code	Source
Proposed and Planned Terminals				
1	Haldia Terminal, WB	Patikhali	GW-1	Hand pump
		Near terminal site	GW-2	Borewell
		Durgachak	GW-3	Borewell
2	Tribeni Terminal, WB	Near Terminal site, Tap water	GW-4	Borewell
		Tribeni, Tap Market	GW-5	Tap water
5.	Farakka Lock, WB	Near Farakka lock site	GW-6	Borewell
		Goraipara Village	GW-7	Hand pump

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

		Farakka Town	GW-8	Hand pump
6.	Sahibganj Terminal, Kharkhand	Samda Nala Village	GW-9	Hand pump
		Rampur Village	GW-10	Hand pump
		Sakrigali	GW-11	Hand pump
7.	Gazipur Terminal, Uttar Pradesh	Tarighat, Ghazipur	GW-12	Hand pump
			GW-13	Handpump
		Kalupur	GW-14	Handpump
8.	Varanasi Terminal, Uttar Pradesh	Terminal Site	GW-15	Borewell
		Milkipur	GW-16	Hand pump
		Ralhupur	GW-17	Hand pump
		Tahirpur	GW-18	Hand pump
		Bhitti	GW-19	Hand pump
		Madarwa	GW-20	Hand pump
Populated areas along NW-1				
1	West Bengal	Diamond Harbour	GW-21	Hand pump
2	West Bengal	Howrah	GW-22	Hand pump
3	West Bengal	Katwa	GW-23	Hand pump
4	Jharkhand	Magalhat	GW-24	Hand pump
5	Bihar	Bhagalpur	GW-25	Hand pump
6	Bihar	Buxar	GW-26	Hand pump
7	Bihar	Munger,	GW-27	Hand pump
8	Bihar	Patna	GW-28	Hand pump

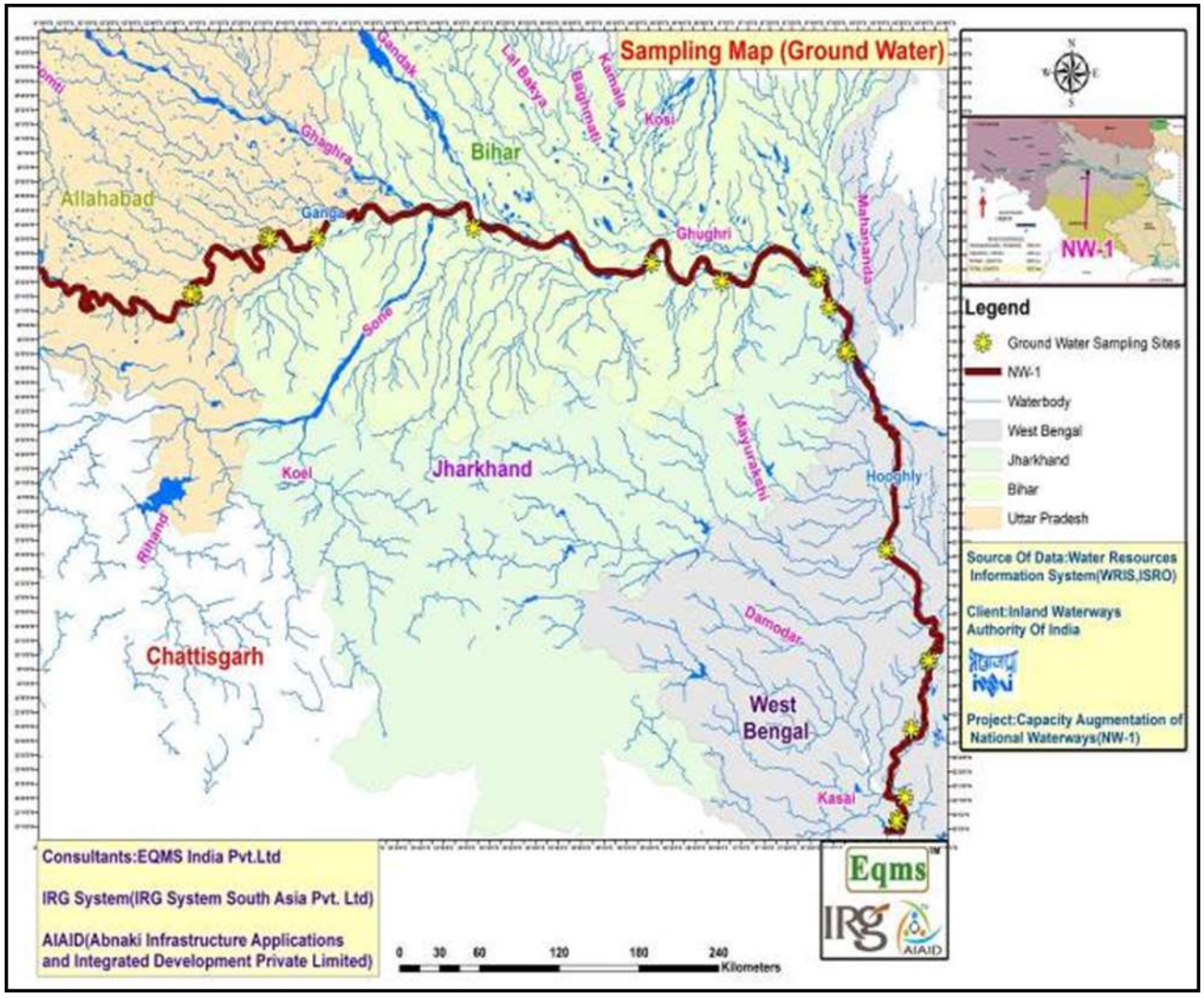


Figure 2.16 : Ground Water Sampling Locations

Table 2.15 : Ground Water Quality at Proposed Terminals/Lock area

S.N.	Parameters	Desirable Limit IS: 10500	Permissible Limit IS: 10500	Haldia Terminal (WB)			Triveni Terminal		Farakka Lock (WB)			Sahibganj Terminal		
				GW-1	GW-2	GW-3	GW4	GW5	GW-6	GW-7	GW-8	GW-9	GW-10	GW-11
1	pH	6.5-8.5	No relaxation	7.24	8.04	7.67	7.38	7.31	6.79	6.96	6.71	7.1	6.85	6.91
2	Temp. ^{0}C	-	-	24	24	24	27.4	26.5	24.6	25	24.8	27	26	27
3	Conductivity, mmhos/cm	-	-	950	1982	1164	474	314	551	549	558	316	632	1303
4	Turbidity,NTU	5	10	0.1	0.1	0.2	0.1	0.4	0.1	0.1	0.2	0.1	0.2	0.2
5	TDS, mg/l	500	2000	612	1372	744	299	201	356	369	377	212	429	886
6	TSS, mg/l	-	-	2	1	1	Nil	Nil	1	2	2	2	1	4
7	T Hardness as $CaCO_3$, mg/l	300	600	268	345	279	264	152	244	252	264	132	225	756
8	Chloride asCl, mg/l	250	1000	236	456	276	26	16	18	20	26	18	39	171
9	Alkalinity, mg/l	200	600	186	268	226	95	75	112	126	116	126	167	133
10	Sulphates as, SO_4, mg/l	200	400	8.2	3.98	3.34	15	5	6	9	11	8	13	75
11	Nitrates as NO_3, mg/l	45	100	2.9	0.06	0.08	0.9	0.6	0.6	0.8	0.9	0.9	1.2	1.48
12	Fluoride as F, mg/l	1	1.5	0.38	0.46	0.49	0.28	0.22	0.4	0.5	0.23	0.3	0.24	0.19
13	Iron as Fe, mg/l	0.3	1	0.46	0.35	0.32	0.56	0.41	0.22	0.34	0.44	0.12	0.44	0.32
14	Zinc as Zn, mg/l	5	15	0.08	0.7	0.9	1.1	1.0	0.6	0.9	0.9	0.8	1	0.9
15	Calcium as Ca	75	200	72	114	68	53	30	50	51	53	27	70	152
16	Magnesium as Mg	30	100	21	14	28	32	19	29	30	32	16	11	91
17	Cadmium as Cd, mg/l	0.01	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Copper as Cu, mg/l	0.05	1.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Nickel as Ni, mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead as Pb, mg/l	0.05	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Mercury as Hg, mg/l	0.001	No relaxation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Chromium (Total as Cr, mg/l	0.05	No relaxation	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Arsenic as As, mg/l	0.05	No relaxation	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
24	Phenolic compound	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
25	Total coliform MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
26	Fecal Coliform, MPN/100ml	-	-	Nil	Nil	NI	Nil	Nil	Nil	Nil	NI	Nil	Nil	NI

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

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

S.N.	Parameters	Desirable Limit IS: 10500	Permissible Limit IS: 10500	Ghazipur Terminal				Varanasi Terminal				
				GW-12	GW-13	GW-14	GW-15	GW-16	GW-17	GW-18	GW-19	GW-20
1	pH	6.5-8.5	No relaxation	7.11	7.11	7.34	7.4	7.14	1.17	7.25	7.5	7.4
2	Temp. ^{0}C	-	-	24.6	25.2	25.0	-	-	-	-	-	-
3	Conductivity, mmhos/cm	-	-	749	648	472	462	490	575	887	493	711
4	Turbidity,NTU	5	10	0.1	0.2	0.3	0.5	0.5	0.6	0.8	1.8	1.6
5	TDS, mg/l	500	2000	472	428	320	318	253	274	501	316	440
6	TSS, mg/l	-	-	2	4	1	2	3	4	4	4	4
7	T Hardness as $CaCO_3$, mg/l	300	600	392	310	168	272	212	220	284	172	312
8	Chloride as Cl, mg/l	250	1000	30	28	14	14	7	10	50	16	68
9	Alkalinity, mg/l	200	600	143	124	110	NA	NA	NA	NA	NA	NA
10	Sulphates as, SO_4, mg/l	200	400	17	15	8.7	15	13	29	35	5	46
11	Nitrates as NO_3, mg/l	45	100	0.84	0.78	1.23	0.95	0.07	0.08	0.75	0.7	0.6
12	Fluoride as F, mg/l	1	1.5	0.46	0.38	0.34	0.4	0.03	0.31	0.64	0.34	0.13
13	Iron as Fe, mg/l	0.3	1	0.48	0.38	0.60	0.12	0.02	0.11	0.012	0.12	0.12
14	Zinc as Zn, mg/l	5	15	1.21	1.21	0.87	1	1	0.9	1.1	0.9	0.8
15	Calcium as Ca	75	200	78	62	32	32	39	35	37	44	50
16	Magnesium as Mg	30	100	48	45	21	47	27	32	47	12.2	46
17	Cadmium as Cd, mg/l	0.01	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Copper as Cu, mg/l	0.05	1.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Nickel as Ni, mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead as Pb, mg/l	0.05	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Mercury as Hg, mg/l	0.001	No relaxation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Chromium (Total as Cr, mg/l	0.05	No relaxation	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Arsenic as As, mg/l	0.05	No relaxation	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
24	Phenolic compound	0.001	0.002	<0.001	<0.001	<0.001	-	-	-	-	-	-
25	Total coliform MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
26	Fecal Coliform, MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

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

Table 2.16 : Ground Water Quality at Major Habitation area along NW-1

S.N.	Parameters	Desirable Limit IS: 10500	Permissible Limit IS: 10500	Daimond Harbour	Hoorah	Katwa	Mangalhat	Bhagalpur	Buxer	Munger	Patna
1	pH			7.50	7.36	7.29	7.67	7.56	7.34	6.94	7.23
2	Temp. ^{0}C	-	-	24.0	24.2	24.5	24.8	24.8	23.6	23.8	25.1
3	Conductivity, mmhos/cm	-	-	1148	1240	322	626	637	342	862	674
4	Turbidity,NTU	5	10	1.0	2	1	Nil	2	1	3	1
5	TDS, mg/l	500	2000	754	794	232	420	408	220	646	425
6	TSS, mg/l	-	-	1.1	0.5	0.7	0.8	Nil	0.4	1.2	Nil
7	T Hardness as $CaCO_3$, mg/l	300	600	258	304	100	220	376	138	288	348
8	Chloride as Cl, mg/l	250	1000	270	230	12	38	64	20	42	50
9	Alkalinity, mg/l	200	600	236	252	90	164	180	118	160	187
10	Sulphates as, SO_4, mg/l	200	400	2.86	1.87	15	18	24	12	16.8	28
11	Nitrates as NO_3, mg/l	45	100	2.1	4.2	7.8	1.8	1.13	1.22	11.2	8.4
12	Fluoride as F, mg/l	1	1.5	0.50	0.48	0.53	0.45	0.35	0.43	0.56	0.81
13	Iron as Fe, mg/l	0.3	1	1.20	0.89	0.46	0.87	0.61	0.92	0.046	0.51
14	Zinc as Zn, mg/l	5	15	1.10	0.92	0.74	1.34	1.23	1.10	1.26	1.29
15	Calcium as Ca	75	200	74	102	24	64	75	32	48	70
16	Magnesium as Mg	30	100	18	20.3	9.7	14	46	14	41	42
17	Cadmium as Cd, mg/l	0.01	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
18	Copper as Cu, mg/l	0.05	1.5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	Nickel as Ni, mg/l	-	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	Lead as Pb, mg/l	0.05	No relaxation	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Mercury as Hg, mg/l	0.001	No relaxation	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
22	Chromium (Total as Cr, mg/l	0.05	No relaxation	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
23	Arsenic as As, mg/l	0.05	No relaxation	<0.025	<0.025	<0.025	<0.025	0.03	<0.025	0.04	<0.025
24	Phenolic compound	0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		<0.001
25	Total coliform MPN/100ml	-	-	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
26	Fecal Coliform, MPN/100ml	-	-	NI	NI	NI	Nil	NI	Nil	Nil	Nil

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

Observation on Ground Water Quality

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

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

C. Secondary Data Analysis

Ganga river quality data monitored by CPCB at different locations along NW-1 are shown in **Table 2.18** and graphic representation of selected parameters is shown in **Figure 2.17 and Figure 2.18.** CPCB guidelines are available to evaluate the quality of river for its Best Designated Use (BDU). Water can be classified in five classes depending upon its chemical properties as per Indian BDU Criteria Standard prescribed by CPCB. (Refer **Table 2.17** for standards).

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

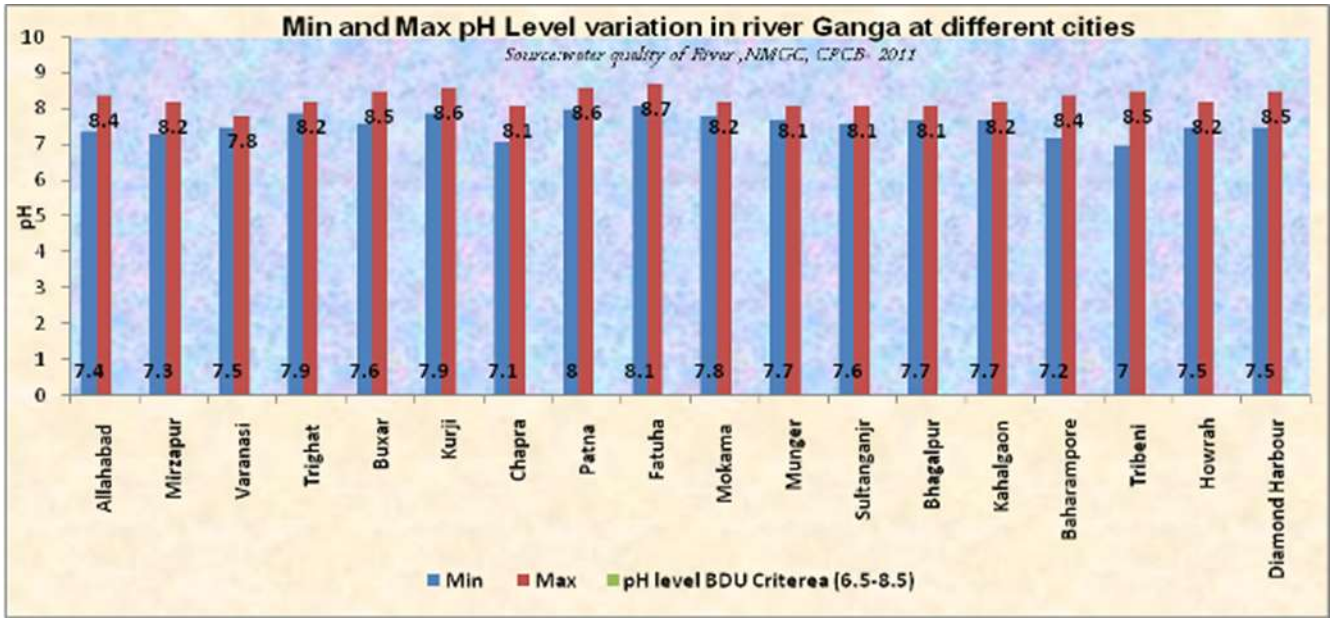
Table 2.17 : CPCB Best Designated Use Standard (source: CPCB)

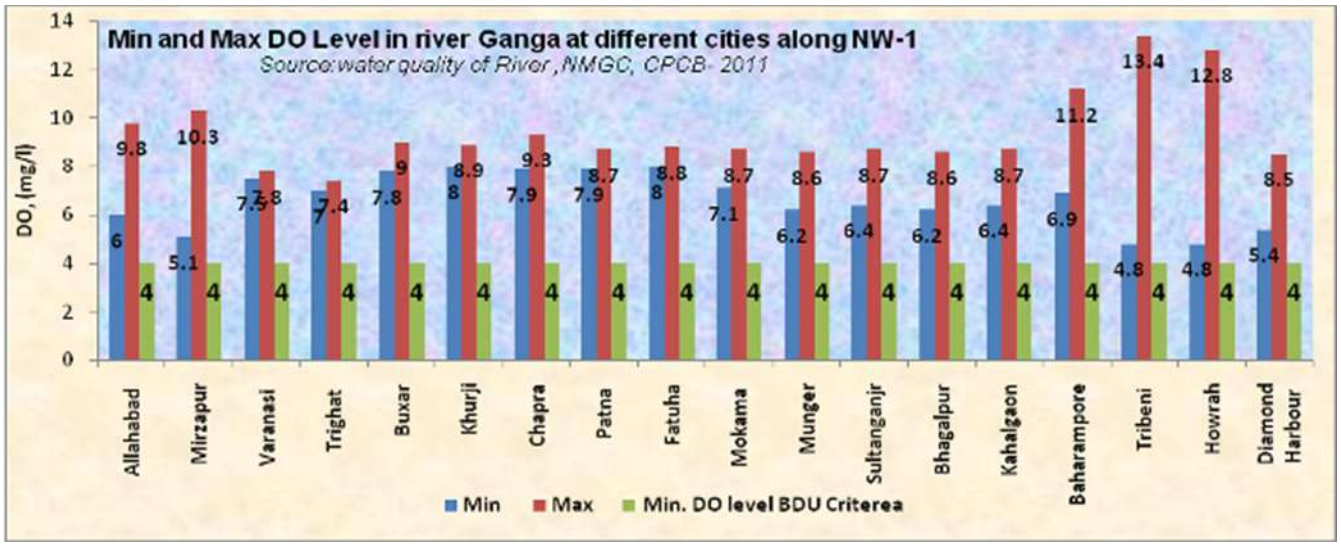
Designed Best Use	Class of Water	Criteria
Drinking Water Source without conventional treatment but after disinfection	**A**	• Total Coliforms Organism MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more • Biochemical Oxygen Demand 5 days 20°C 2mg/l or less
Outdoor bathing (Organized)	**B**	• Total Coliforms Organism MPN/100ml shall be 500 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	**C**	1 Total Coliforms Organism MPN/100ml shall be 5000 or less 2 pH between 6 to 9 3 Dissolved Oxygen 4mg/l or more 4 Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	**D**	5 pH between 6.5 to 8.5 6 Dissolved Oxygen 4mg/l or more 7 Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	**E**	8 pH between 6.0 to 8.5 9 Electrical Conductivity at 25°C micro mhos/cm Max.2250 10 Sodium absorption Ratio Max.26and Boron Max. 2mg/l

Table 2.18 : River Water Quality at Different cities along NW-1

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

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





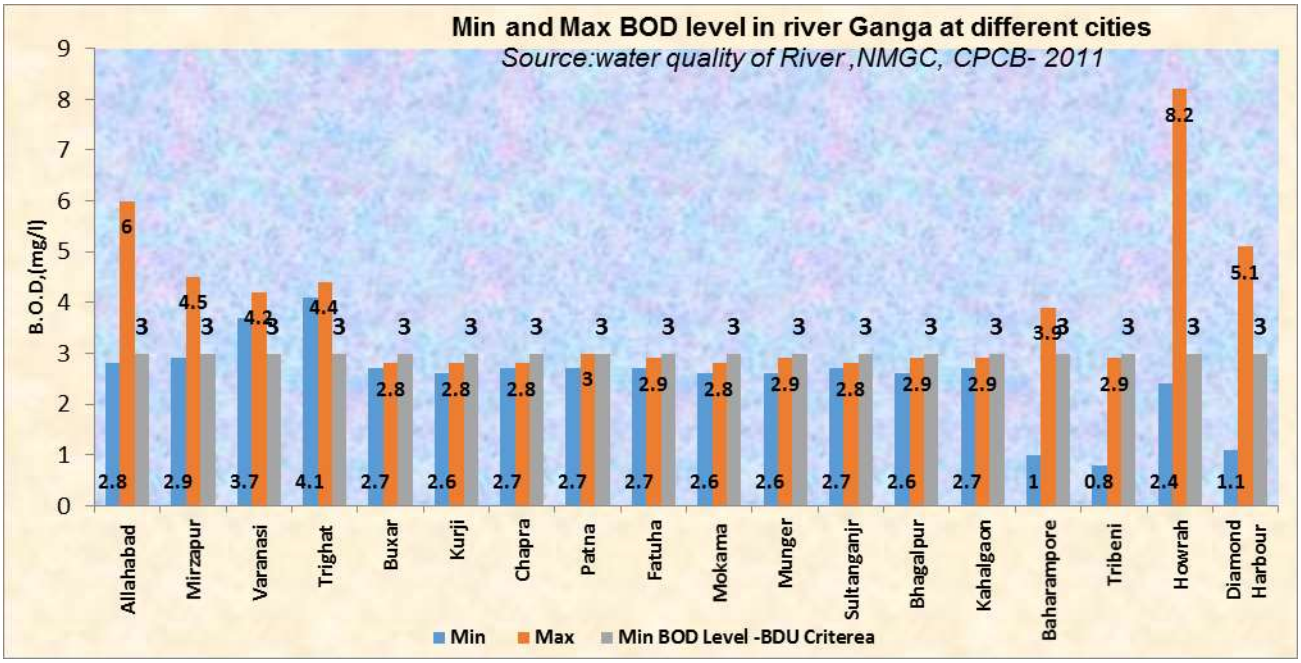
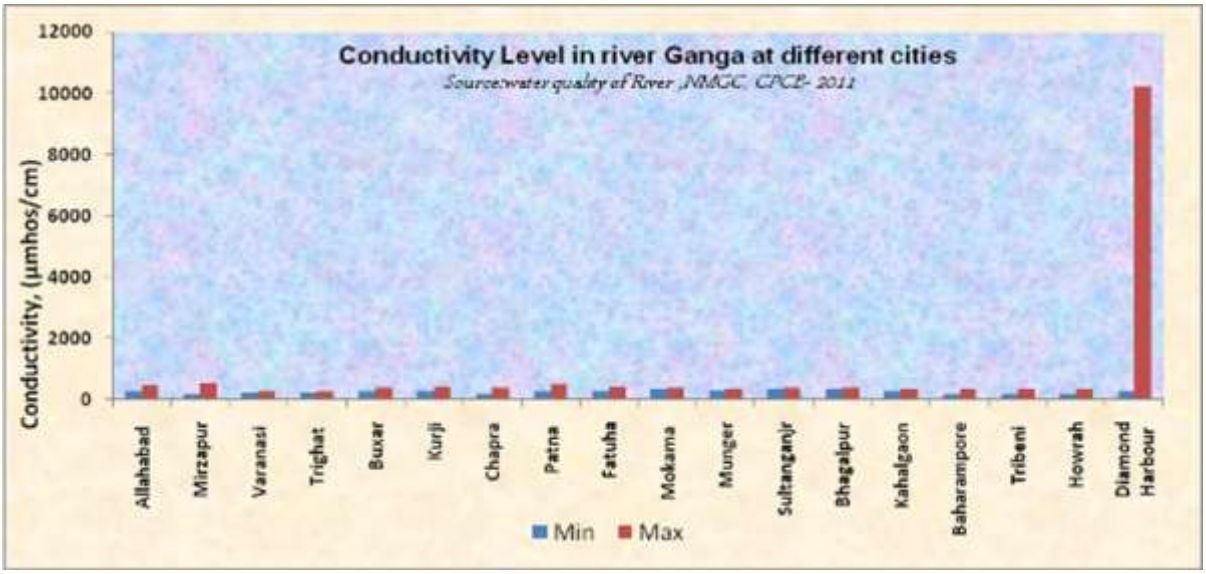
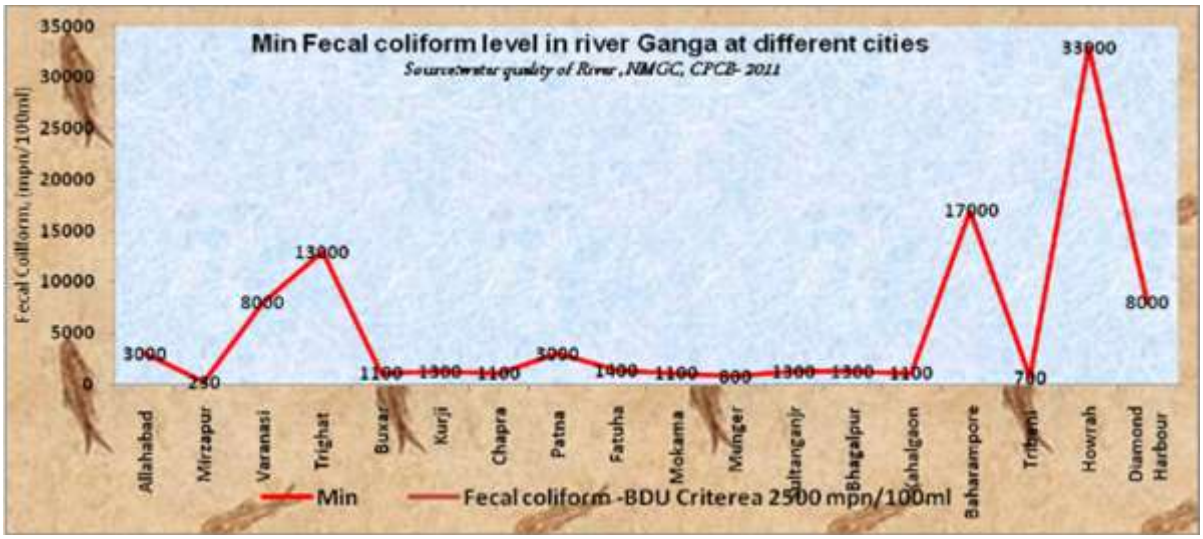


Figure 2.17 : Graphical representation of Ganga River water quality at Different Locations





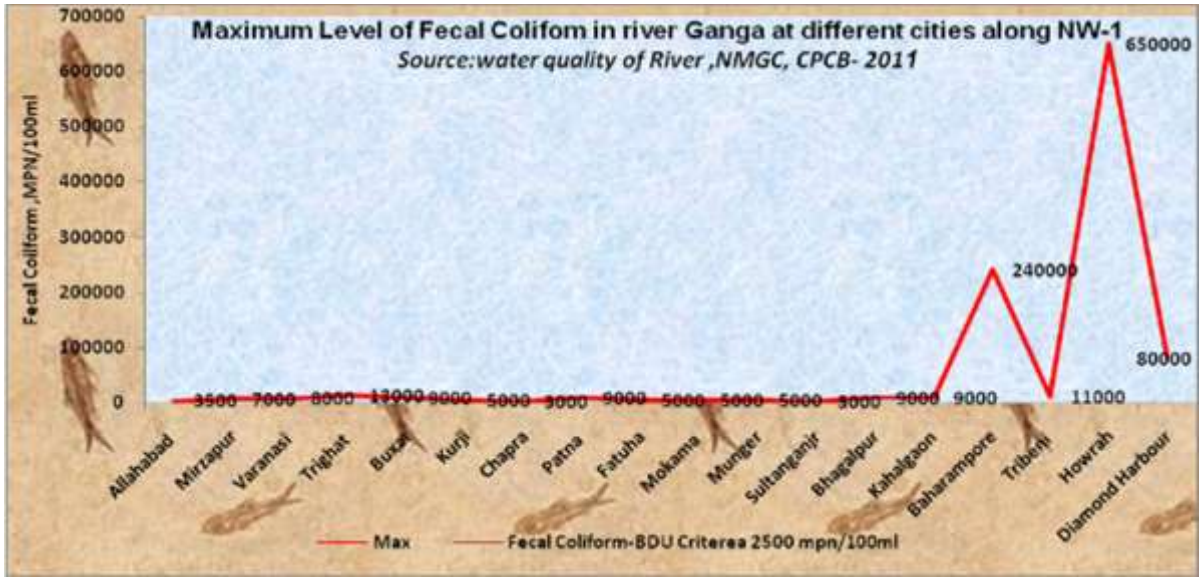


Figure 2.18 : Graphical representation of Ganga Water Quality at Different Cities along NW-1

D. Primary Data Analysis

Surface water sample were collected[8] from the upstream and downstream of the proposed and planned terminals/ lock locations and environmental sensitive receptors present all along the NW-1. One sample each was also collected from existing ro-ro/jetty/floating terminals. The water samples were examined for physico-chemical parameters as well as for bacteriological parameters. Samples were analysed for various parameters using the CPCB's BDU Criteria. The name of water sampling locations is given in **Table 2.19** and shown in **Figure 2.19**. The analysis results of surface water are presented in **Table 2.20 to 2.22.** Photograph of water sampling is provided in **Figure 2.20**.

Table 2.19 : Name of Surface Water Sampling Locations

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

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

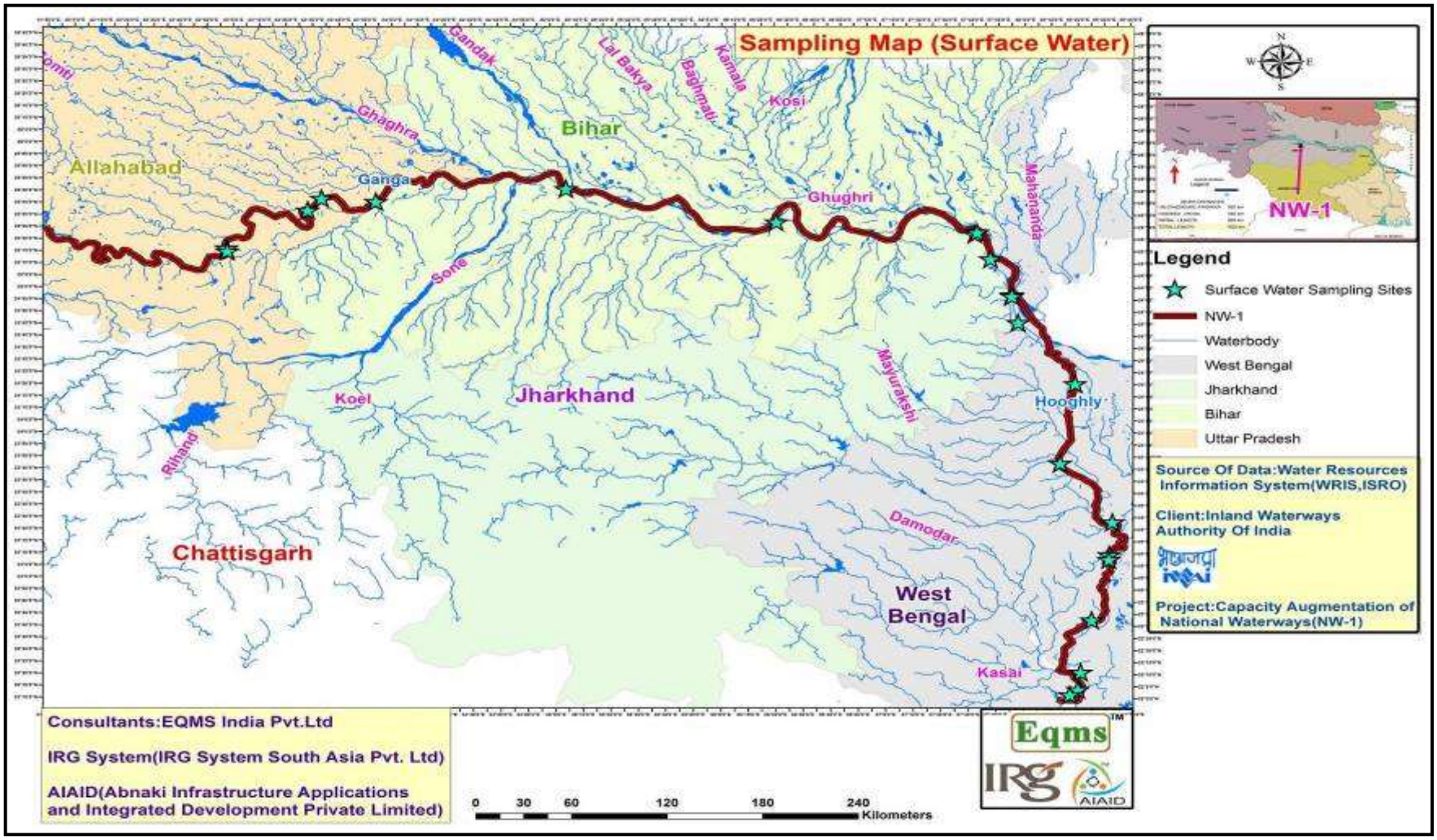


Figure 2.19 : Surface Water Sampling Locations

Table 2.20 : Ganga Water Quality NW-1 (near proposed and planned Terminal Site location)

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

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

Table 2.21 : Ganga Water Quality Along NW-1 (near Existing Ro-Ro/Jetty/Floating Terminal sites)

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

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

Table 2.22 : Ganga Water Quality near sensitive locations along NW-1

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

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

Primary Data Analysis and Observation on Surface Water Quality

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

2.3.15. *River Water Quality at dredging locations*

IWAI undertakes dredging to maintain the LAD for effective navigation. To analyse the effect of dredging activity on water quality, water samples in upstream and downstream of the river at different distance from the operating dredger were taken during study period. During site visit, dredging was in operation only in Farakka navigational lock channel. The details of Farakka sampling locations and analysis results are presented in **Table 2.23.** Photographs of dredging operation is provided at **Figure 2.20**:

Water samples were taken again at Gaighat Patna during monsoon season (July 2016). Due to monsoon the Ganga River carried high sedimentation load which added to the Turbidity and TSS and thus the values of Turbidity and TSS are found very high in the sample. Test results of the same are given in **Table 2.24 and 2.25.**

Figure 2.20 : View of Dredging Operations at Farakka

Table 2.23 : Ganga Water Quality NW-1 (U/S and D/S of the Dredging Machine at Farakka Location)

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

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

Table 2.24 : Ganga Water Quality NW-1 (U/S and D/S of the Dredging Machine at Gaighat Patna Dredger No-1)

		Ganga water Gaighat at Patna	Location: Ganga riverGaighat at Patana Upstream of the Dredger No.-1			Location: Ganga River Gaighat at Patna (Downstream of the Dredger No-1)			
Sl.No.	**Parameters**	**When no dredging is operational**	**200 m u/s of Dredger**	**300 m u/s of Dredger**	**500 m u/s of Dredger**	**200 m d/s of Dredger**	**500 m d/s of Dredger**	**700 m d/s of Dredger**	**1000 m d/s of Dredger**
1	pH Value	7.60	7.87	7.41	7.80	7.47	7.95	7.98	7.94
2	Temperature ^{0}C	26.0	26.4	26.6	26.8	26.7	26.8	26.7	26.8
3	Conductivity, µmhos/cm	404	412	393	398	416	382	408	410
4	Turbidity (NTU)	20.2	30.5	25.6	22.2	40.2	34.4	24.8	21.0
5	Total Dissolved solids	268	276	258	266	278	254	274	276
6	Total Suspended solids	48	64	57	47	87	74	53	45
7	Dissolved Oxygen (mg/litre)	7.2	7.6	6.8	7.0	6.2	7.0	6.6	6.2
8	BOD, (for 3 days at 27^{0}C) (mg/litre)	2.2	2.3	2.6	2.4	3.0	2.8	2.6	2.7
9	Chemical Oxygen Demand, (mg/litre)	7.2	7.8	8.0	7.6	9.8	9.4	8.8	9.0
10	Total Hardness, mg/l	178.4	184	172	178	186	168	182	185
11	Oil & grease, mg/l	0.2	0.3	0.1	0.3	0.3	0.2	0.2	0.2
12	Chloride, mg. l	32	34	30	32.6	34.6	30	34	33
13	Nitrates as NO_3, mg/l	1.34	1.42	1.36	1.35	1.68	1.58	1.49	1.35
14	Iron as Fe, mg/l	1.23	1.36	1.30	1.24	1.48	1.44	1.32	1.28
15	Zinc as Zn, mg/l	0.56	0.66	0.62	0.58	0.72	0.68	0.62	0.64
16	Calcium as Ca, mg/l	54	44	41	42	44.6	40	43.6	44.4
17	Magnesium as Mg, mg/l	10.2	17.9	17	18	18	16.5	17.8	18.2
18	Cadmium as Cd, mg/l	<0.01	0.03	0.02	<0.01	0.09	0.05	0.03	<0.01
19	Copper as Cu, mg/l	<0.01	0.04	0.02	<0.01	0.06	0.04	0.03	<0.01
20	Nickel as Ni, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Lead as Pb, mg/l	<0.01	0.06	0.03	<0.01	0.12	0.09	0.04	<0.01
22	Mercury as Hg, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Total Chromium (Total as Cr), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
24	Arsenic as As, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
25	Silica, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Fecal coliform MPN/100ml	2458	2480	2472	2466	2510	2492	2484	2472
27	Total coliform MPN/100ml	6880	6912	6888	6876	6914	6904	6896	6890
28	Pesticides (Present /Absence)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Table 2.25 Ganga Water Quality NW-1 (U/S and D/S of the Dredging Machine at Gaighat Patna Dredger No-2)

		Ganga water Gaighat at Patna	Location: Ganga riverGaighat at Patana Upstream of the Dredger-No. 2			Location: Ganga River Gaighat at Patna (Downstream of the Dredger) No 2			
Sl.No.	**Parameters**	**When no dredging is operational**	**200 m u/s of Dredger**	**300 m u/s of Dredger**	**500 m u/s of Dredger**	**200 m d/s of Dredger**	**500 m d/s of Dredger**	**700 m d/s of Dredger**	**1000 m d/s of Dredger**
1	pH Value	7.82	7.73	7.78	7.99	7.91	8.01	7.88	7.99
2	Temperature ^{0}C	26.2	26.6	26.8	26.7	26.9	26.7	26.8	26.6
3	Conductivity, µmhos/cm	396	416	386	418	422.0	399	398	382
4	Turbidity (NTU)	19.8	28.0	23.4	20.0	41.8	36.8	28.3	24
5	Total Dissolved solids	266	280	260	282	284	268	267	256
6	Total Suspended solids	42	63	52	45	94	82	64	52
7	Dissolved Oxygen (mg/litre)	7.6	7.4	7.1	7.0	7.2	6.8	7.2	6.8
8	BOD, (for 3 days at 27^{0}C) (mg/litre)	2.0	2.2	2.3	2.3	2.1	2.7	2.4	2.6
9	Chemical Oxygen Demand, (mg/litre)	7.0	7.4	7.6	7.2	9.6	9.0	8.2	8.6
10	Total Hardness, mg/l	178	189	174	192	193	182	181	172
11	Oil & grease, mg/l	0.4	0.6	0.4	0.5	0.9	0.8	0.6	0.5
12	Chloride, mg/ l	33.2	34	32.4	35	35.5	33.4	33.2	32
13	Nitrates as NO_3, mg/l	1.28	1.36	1.32	1.29	1.44	1.41	1.39	1.34
14	Iron as Fe, mg/l	1.30	1.43	1.38	1.32	1.54	1.44	1.36	1.32
15	Zinc as Zn, mg/l	0.60	0.72	0.65	0.62	0.79	0. 72	0.70	0.66
16	Calcium as Ca, mg/l	42.7	45	41.8	46	46.2	43.7	43.4	41
17	Magnesium as Mg, mg/l	17.4	18.2	17	18.4	18.6	18	17.6	17
18	Cadmium as Cd, mg/l	<0.01	0.04	<0.01	<0.01	0.10	0.07	0.04	0.02
19	Copper as Cu, mg/l	<0.01	0.05	0.03	<0.01	0.08	0.05	0.02	<0.01
20	Nickel as Ni, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
21	Lead as Pb, mg/l	<0.01	0.08	0.03	<0.01	0.14	0.08	0.06	0.03
22	Mercury as Hg, mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
23	Total Chromium (Total as Cr), mg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
24	Arsenic as As, mg/l	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
25	Silica, mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
26	Fecal coliform MPN/100ml	2466	2486	2475	2469	2516	2496	2488	2476
27	Total coliform MPN/100ml	6896	6914	6892	6880	6916	6908	6900	6888
28	Pesticides (Present /Absence)	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absent

Observation of Surface Water Quality during Dredging operation:

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

Patna Location: Due to monsoon, the Ganga River carried high sedimentation load hence the Turbidity and TSS found very high in Ganga water when no dredging was in operation. Further, the test results of the sample collected in up and down stream of the operating dredger reflect that the parameters like turbidity and total suspended solid increases in downstream of the dredging location up to 700 m, which gradually normalised at a distance of 1000 m from the dredging location. In upstream side of the river there were no major changes observed in these parameter. However, the metals like iron, copper, cadmium and lead were also detected in traces in water sample close to the dredging location in downstream. No variations observed in other water quality parameter.

2.3.16. River Sediment Analysis.

For mapping the river bed sediment quality, about 110 river bed sediment samples were collected (average 3 samples per location upto the depth of 3m) spread across the NW-1 and analysed for various parameters/contaminants. (Refer **Figure 2.21**). The summary of the test results of river bed sediment sample at different stretches of the NW-1 is given in **Table 2.26** and graphically presented in **Figure 2.22 to Figure 2.25.**

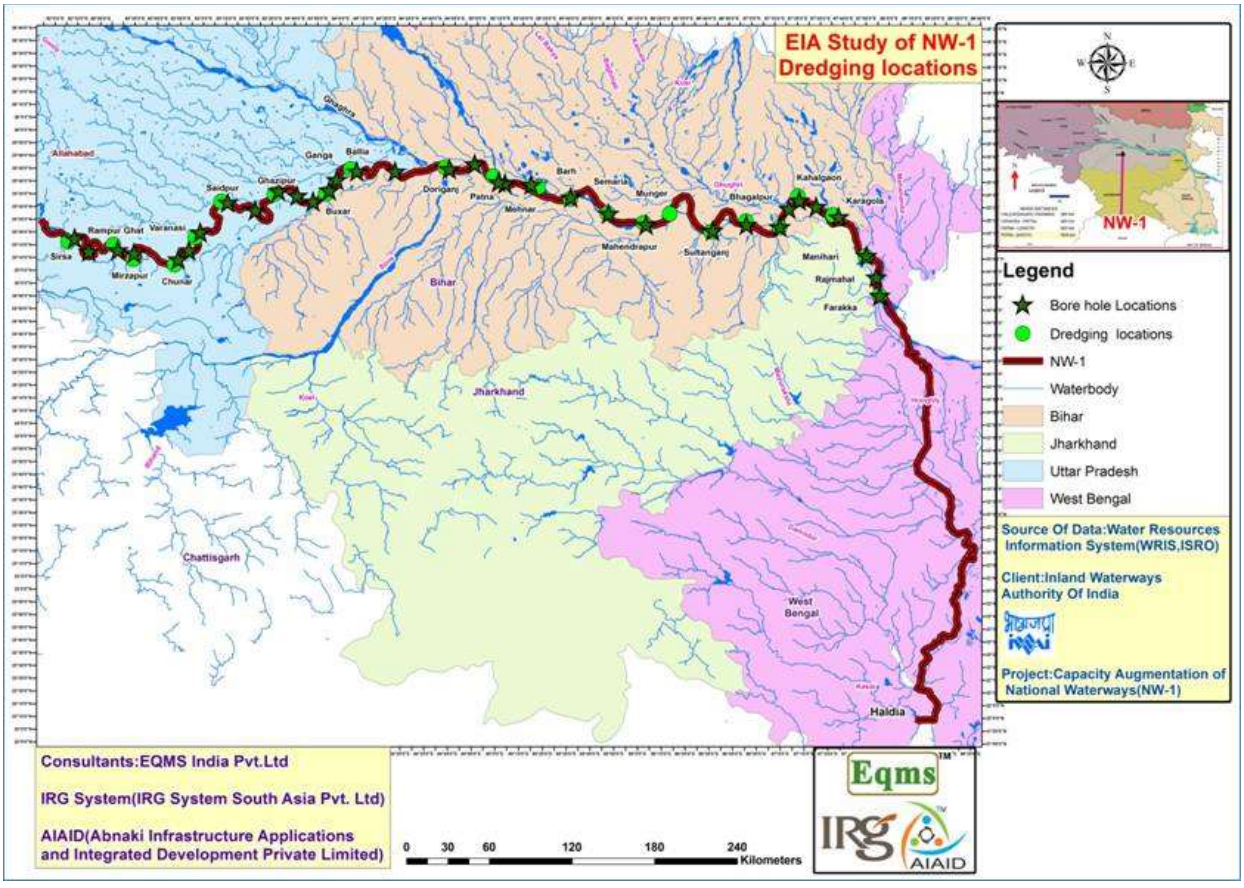
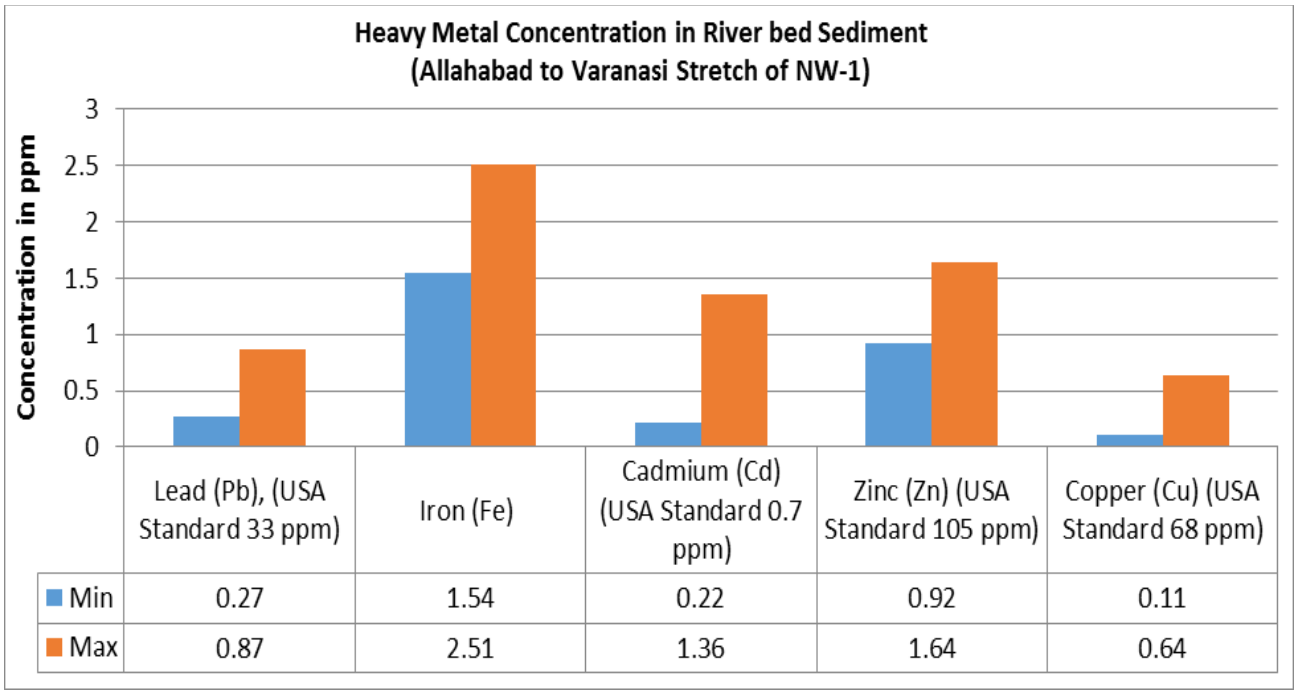
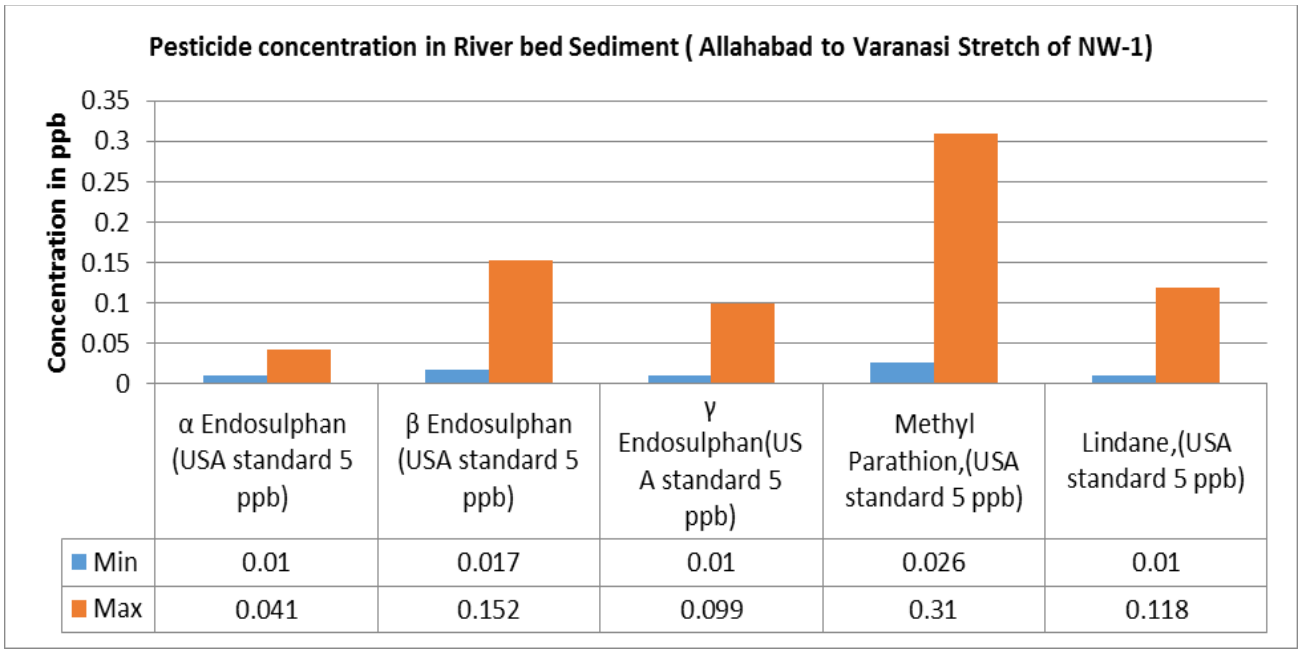


Figure 2.21 : Dredging and Bore hole locations along NW-1

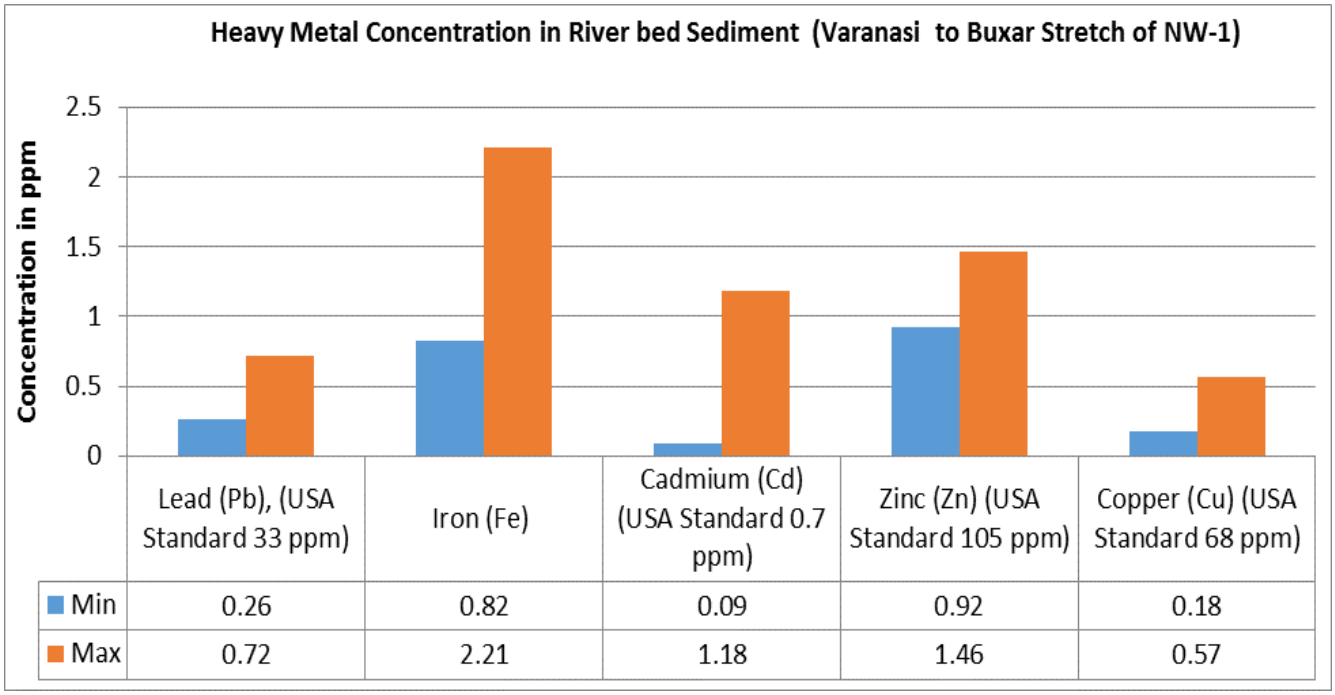


	Lead (Pb), (USA Standard 33 ppm)	Iron (Fe)	Cadmium (Cd) (USA Standard 0.7 ppm)	Zinc (Zn) (USA Standard 105 ppm)	Copper (Cu) (USA Standard 68 ppm)
Min	0.27	1.54	0.22	0.92	0.11
Max	0.87	2.51	1.36	1.64	0.64

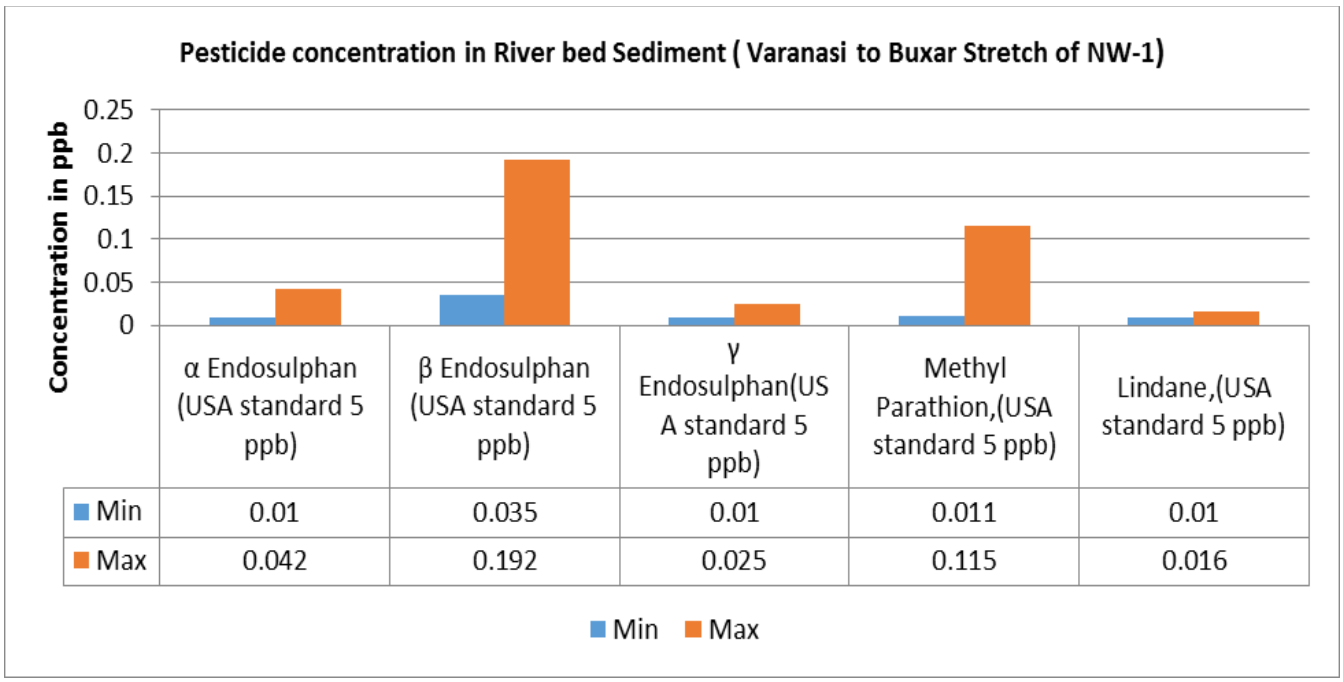


	α Endosulphan (USA standard 5 ppb)	β Endosulphan (USA standard 5 ppb)	γ Endosulphan(USA standard 5 ppb)	Methyl Parathion,(USA standard 5 ppb)	Lindane,(USA standard 5 ppb)
Min	0.01	0.017	0.01	0.026	0.01
Max	0.041	0.152	0.099	0.31	0.118

Figure 2.22 : River Bed Sediment Analysis between Allahabad to Varanasi Stretch

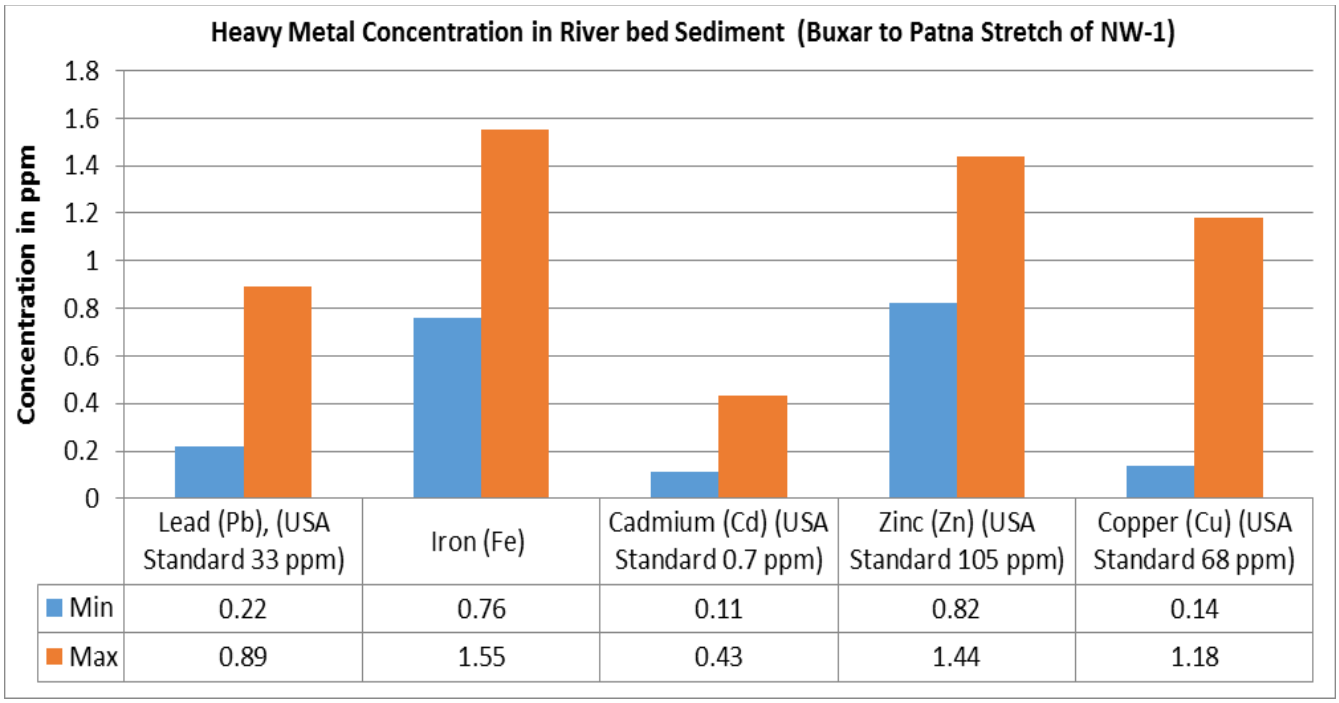


	Lead (Pb), (USA Standard 33 ppm)	Iron (Fe)	Cadmium (Cd) (USA Standard 0.7 ppm)	Zinc (Zn) (USA Standard 105 ppm)	Copper (Cu) (USA Standard 68 ppm)
Min	0.26	0.82	0.09	0.92	0.18
Max	0.72	2.21	1.18	1.46	0.57



	α Endosulphan (USA standard 5 ppb)	β Endosulphan (USA standard 5 ppb)	γ Endosulphan(USA standard 5 ppb)	Methyl Parathion,(USA standard 5 ppb)	Lindane,(USA standard 5 ppb)
Min	0.01	0.035	0.01	0.011	0.01
Max	0.042	0.192	0.025	0.115	0.016

Figure 2.23 : River Bed Sediment Analysis between Varanasi to Buxar Stretch



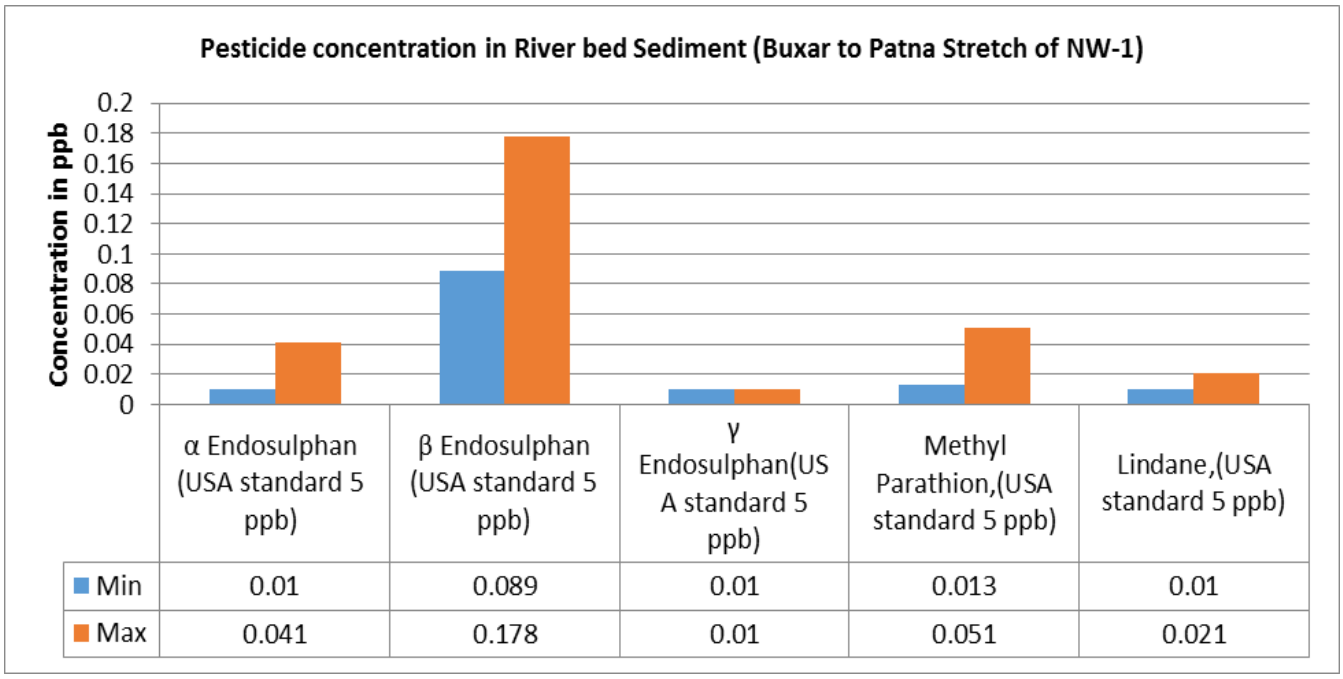
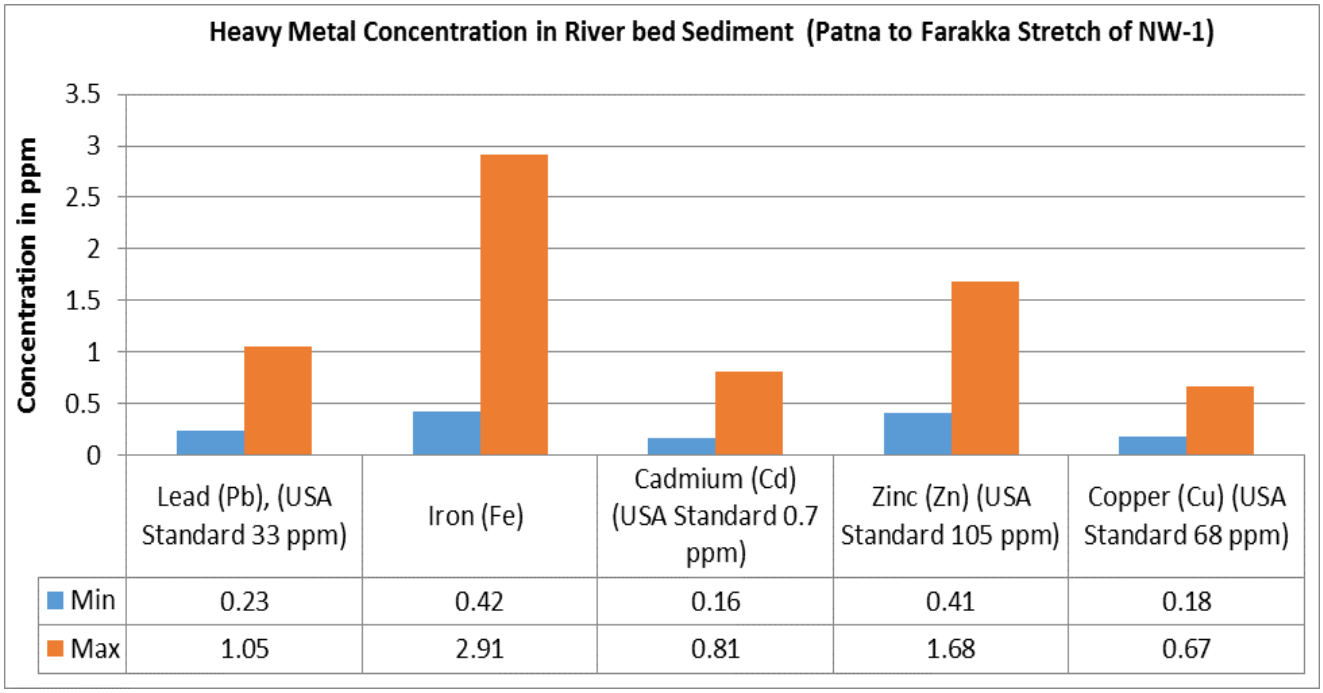


Figure 2.24 : River Bed Sediment Analysis between Buxar to Patna Stretch



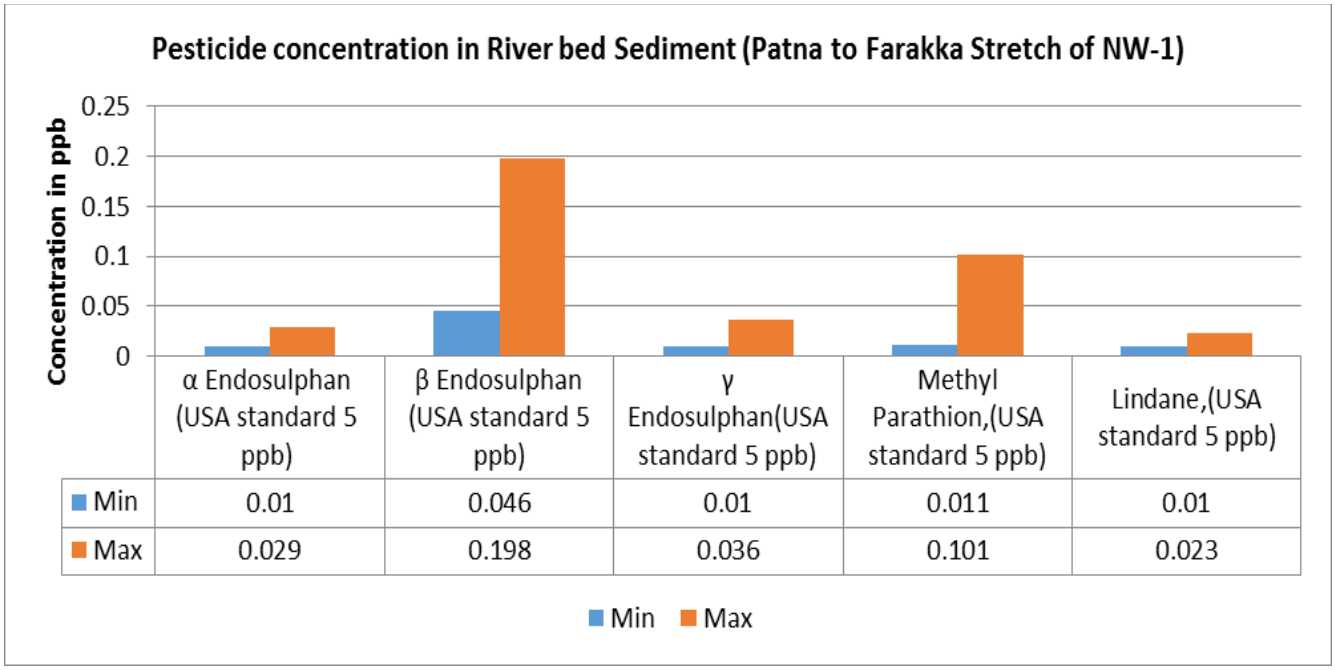


Figure 2.25 : River Bed Sediment Analysis between Patna to Farakka Stretch

Table 2.26 : Summary of River Bed Sediment Quality

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

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

Summary of River Bed Sediment Quality (cont..)

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

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

Summary of River Bed Sediment Quality (cont..)

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

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

Summary of River Bed Sediment Quality (cont..)

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

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

Observations on River Bed-Dredge Material Quality

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

Figure 2.26 : Surface and Ground Water Sampling (in- situ testing) at Different Locations along NW-1

Figure 2.27 Surface and Ground Water Sampling at Different Locations along NW-1

2.3.17. Air Environment

The ambient air quality has been monitored at all proposed terminal/ lock, RO-RO jetty, floating terminal locations along NW-1. Additional baseline monitoring was carried out around proposed terminals/lock site areas. The locations of the monitoring stations were selected based on frequency of wind directions, presence of sensitive receptor (habitation, eco sensitive receptor) located within the influence area of 2 km. Three monitoring station was setup (One station close to the terminal/lock site, one location in downwind direction and other location was near to the existing air pollution source (if any) such as industrial area, crushers or mining areas. Ambient air quality monitoring was carried out between 16th September to 28th February 2016 with the frequency of weekly two samples of 24 hourly average each (8 hrs. averaging for CO) at each monitoring location. There are 5 terminals, one lock[9] and 5 nos. of existing Ro-Ro crossings/ floating terminal of NW-1 to get representative data along NW-1. Air sampling location map is projected in **Figure 2.28.**

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

The AAQ data of NW-1 are summarised in **Table 2.27** to **Table 2.30**. Graphical representations of the AAQ data are given at **Figure 2.29 and Figure 2.30.**

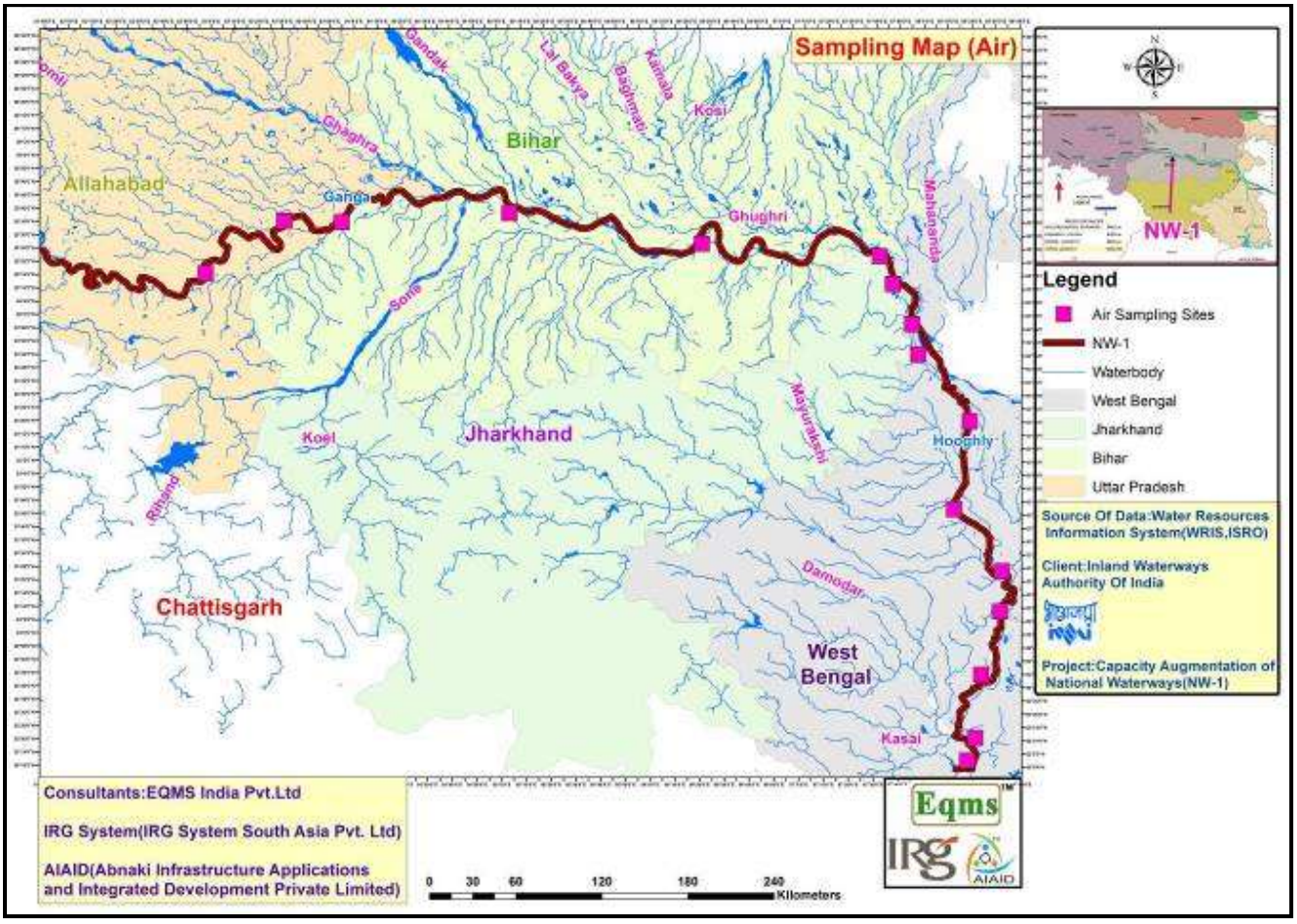


Figure 2.28 : AAQ Monitoring Location Map

Table 2.27 : Ambient Air Quality results for PM2.5 and PM10 (24-hour average) along NW-1 (at Proposed Terminal Locations)

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

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

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

Table 2.28 : Ambient Air Quality Monitoring Results for SOx, NOx (24-h avg.) along NW-1 (at Proposed Terminal Locations)

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

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

Table 2.29 : Ambient Air Quality results for PM2.5 and PM10 (24-hour average)along NW-1 (at RO-RO Jetty/ Floating Terminals)

RO-RO Jetty/ Floating Terminal Location	$PM_{2.5}$, µg/m³		PM_{10} (µg/m³)	
	Min	Max	Min	Max
Diamond Harbour	24	47	53	89
Howrah	31	56	68	125
Shantipur	21	34	43	70
Katwa	18	30	39	64
Hazardwari	19	32	41	67
Pakur	19	32	40	68
Magalhat	16	29	39	62
Buxar	21	36	46	78
Munger	18	32	43	71

Patna	29	56	72	138

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

Table 2.30 : Ambient Air Quality Monitoring Results for SOx, NOx and CO (24-h avg.) along NW-1(at RO-RO Jetty/ Floating Terminals)

Terminal Location	SO_2, µg/m³		NO_2, µg/m³		CO(mg/m³) 8 hrs avg.	
	Min	Max	Min	Max	Min	Max
Diamond Harbour	5.2	12.3	9.4	18.6	0.2	0.4
Howrah	6.8	17.6	13.6	32.4	0.3	0.9
Shantipur	4.8	7.4	9.0	11.2	<0.1	<0.1
Katwa	5.2	8.7	9.2	14.3	<0.1	<0.1
Hazardwari	4.7	7.8	9.1	13.2	<0.1	<0.1
Pakur	5.1	8.6	9.0	14.3	<0.1	<0.1
Magalhal	4.4	6.7	9.0	11.2	<0.1	<0.1
Buxar	5.2	9.4	9.3	13.2	<0.1	<0.1
Munger	5.0	8.3	9.1	15.5	<0.1	<0.1
Patna	6.3	14.6	13.2	22.3	0.20	0.45

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

B. Observation on Ambient Air Quality

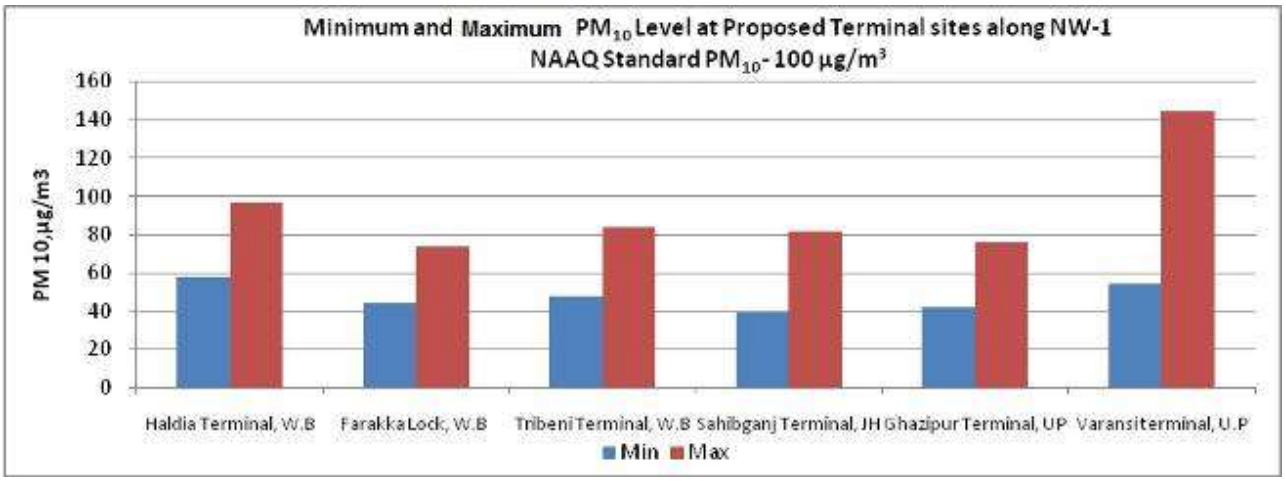
Particulate Matter (PM_{10}): Particulate Matter PM_{10} level at proposed and planned terminal and existing jetty locations along NW-1 varied from 39 to 145µg/m³.PM_{10} values in all locations were within the specified limit of 100 µg/m³ as per NAAQS except at Varanasi, Patna and Howrah. The higher concentration of PM_{10} i.e.145 µg/m³ was observed at Ramnagar area of Varanasi followed by Patna and Howrah. The higher dust levels are because of industrial activities, heavy vehicular pollution and domestic burning in these large urban agglomerations.

Particulate Matter ($PM_{2.5}$): $PM_{2.5}$ levels were found ranging from 16 to 58µg/m³. All value of $PM_{2.5}$were within the specified limit of 60 µg/m³ as per NAAQS but high values with respect to $PM_{2.5}$ were recorded in Varanasi, Patna and Howrah locations. The higher fine respirable dust levels are because of various industrial and domestic combustions (coal and biomass burning) and heavy construction activities in these areas.

Sulphur Dioxide (SO_2):SO_2 levels were universally foundlow with respect to particulate matter. Background level of SO_2 ranged from 4.4 to 35.6 µg/m³. The highest levels of SO_2were found at Varanasi, Howrah and Patna location that may be due to heavy vehicular movement and industrial activities in these locations.

Oxides of Nitrogen (NO_x): High NOx was observed in those locations that lie in city area like Varanasi, Patna, Howrah and Haldia. The NO_x levels were found ranges between 9.0 to 48µg/m³. The observed NO_x level was found within the national Ambient Air Quality Standard. Again, the highest levels of NO_xwere found at Haldia followed by Varanasi, Patna, Howrah, Tribeni and Diamond Harbour location. Predominant sources contributing to high level of NOx in the study area are industrial pollution arising out from industries and vehicle/motorboats operating in the area.

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



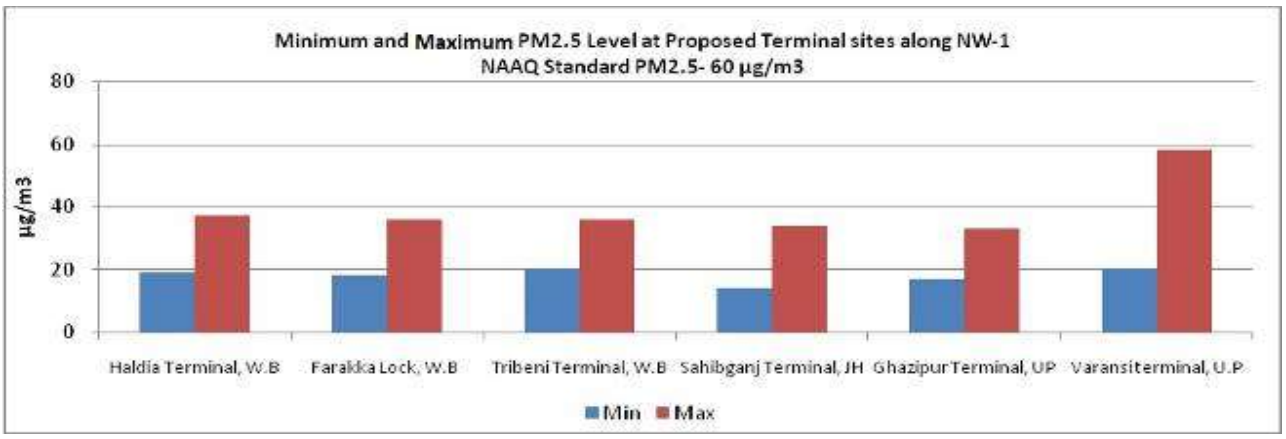
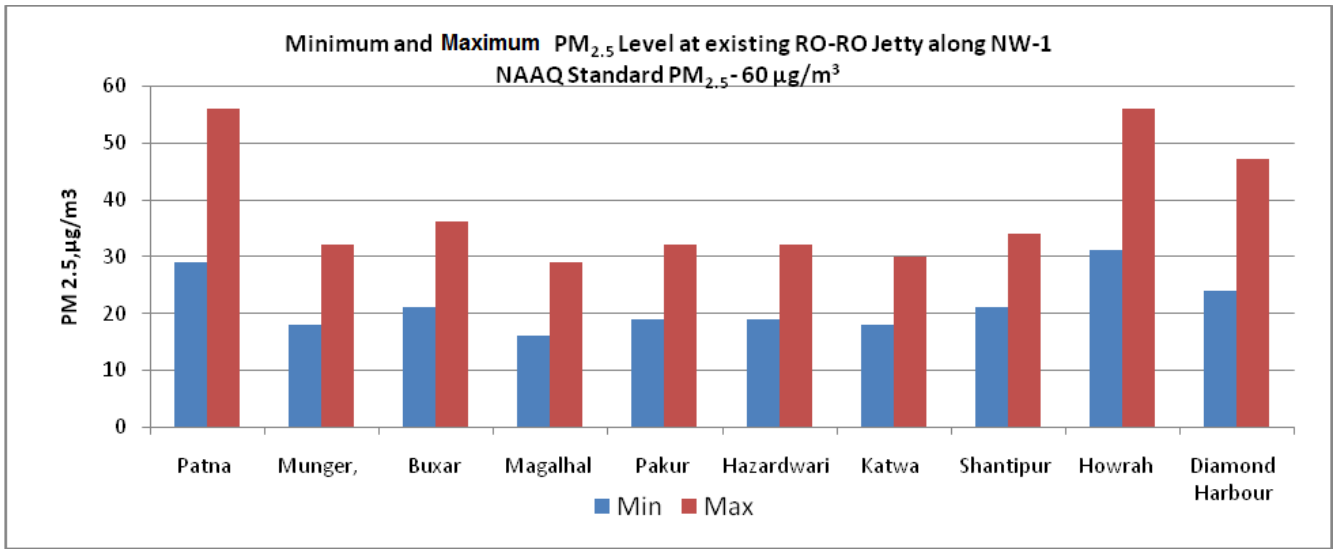
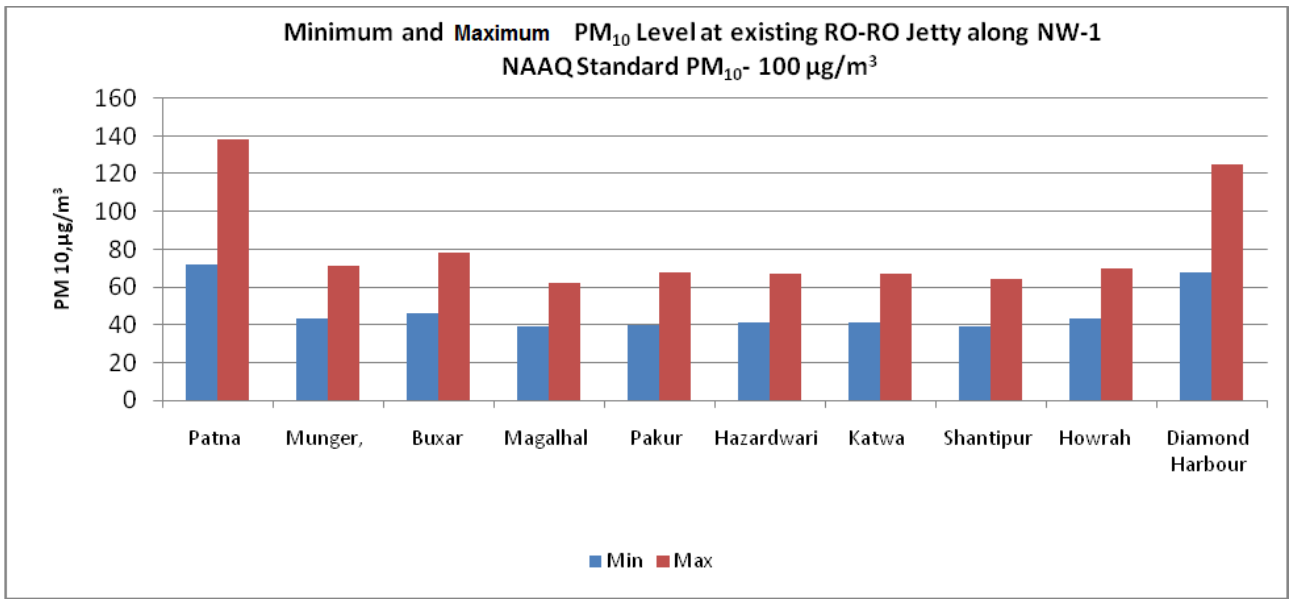
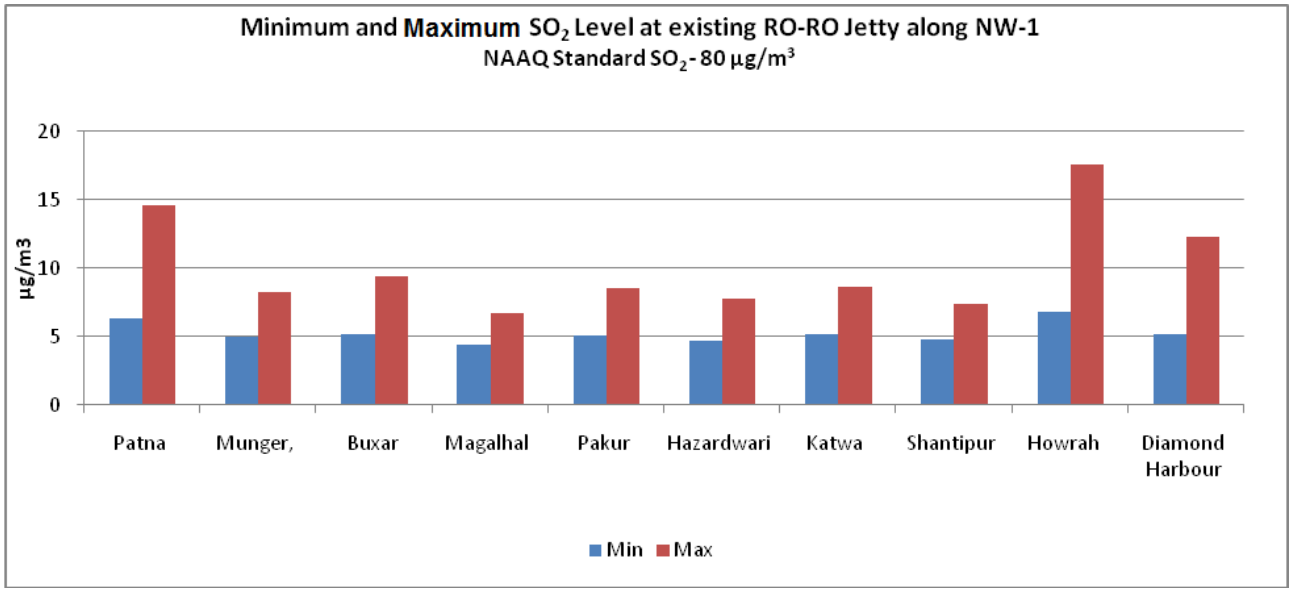


Figure 2.29 : Graphical Representation of AAQ monitoring results around Proposed Terminal and Lock Locations







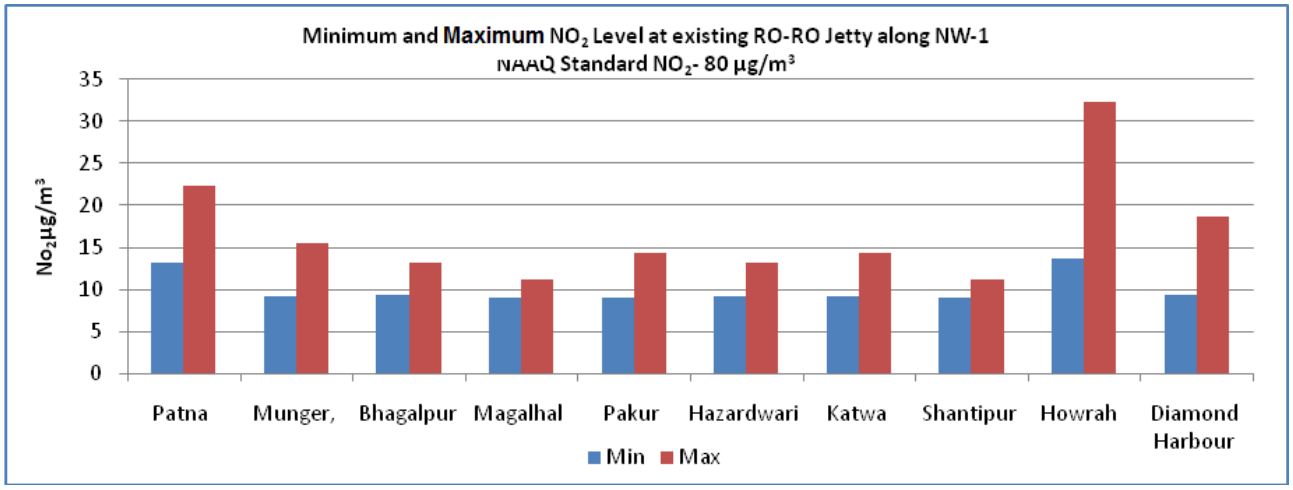


Figure 2.30 : Graphical Representation of AAQ Monitoring Results at RO-RO and Floating Jetty Locations

Figure 2.31 : Photographs of AAQ Monitoring Along NW-1

2.3.18. Ambient Noise Quality

The noise level was measured as per the monitoring plan approved by IWAI/world bank at proposed terminals/locks, around sensitive receptors and existing Ro-Ro/jetty along the NW-1. At each location, readings were taken at uniform interval of 5 seconds over a period of 10 minutes per hour for each of twenty-four hours' period, with further divisions of day and night noise as per CPCB guidelines (between 6.00 A.M. to 10.00 P.M. and between 10.01 P.M. to 5.59 A.M. representing day and night period noise levels)[10]. Ambient noise monitoring was carried out at 3 locations at each terminal, five locations around each sensitive ecosystem and one location each at ro-ro jetty locations. Noise monitoring locations mapis shown in **Figure 2.32.**

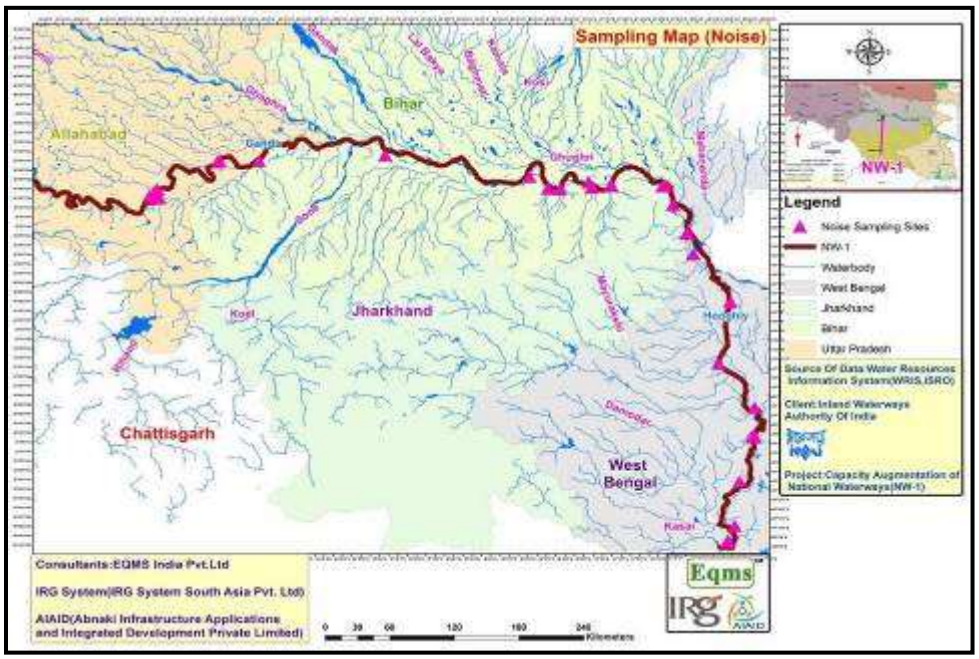


Figure 2.32 : Noise Monitoring Location Map

A. Noise Levels in the Study Area

Noise monitoring results (min, max and Leq at all monitoring stations) for day time and night time are presented in **Table 2.31 and Table 2.32.**

Table 2.31 : Ambient Noise level along NW-1 and proposed intervention locations

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

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

Termin	Location Name	Present Category	Day time Leq dB(A)			National Standard Day time	Night time Leq; dB(A)			National Standard Night time
Tribeni terminal	Kalyani Town	Mixed use	47.8	64.6	58.5	65	42.1	52.3	51.2	55
	Near terminal site	Residential	41.6	56.3	52.6	55	40.3	46.8	42.6	45
	NH-6 connecting site	Industrial	53.6	68.9	64.8.	75	44.3	62.5	58.5	65
Farakka Lock	Lock gate site	Residential	39.8	51.2	45.6	55	37.0	42.0	38.5	45
	Road connecting to site	Road	44.6	62.6	58.7	65	40.2	58.6	52.7	45
	Ghoraipara village	Residential	40.4	53.2	46.8	55	38.3	44.5	40.1	45
Sahibganj Terminal	Samda nala near Terminal Site	Residential	38.0	54.3	46.2	55	35.1	41.2	38.4	45
	Road connecting to Terminal site	Commercial	50.9	65.5	61.1	65	42.4	55.6	49.6	55
	Rampur village	Residential	39.5	54.5	47.6	55	35.0	42.2	38.7	45
Ghazipur Terminal	Tarighat Near Terminal site	Residential	40.1	52.3	46.5	55	37.4	43.2	39.0	45
	Saraiya village	Residential	40.8	53.2	47.2	55	38.2	43.0	38.6	45
	Village road connecting site to NH-97	Mixed use	43.6	61.8	54.3	65	39.0	54.3		55
Varanasi Terminal	Terminal Site	Industrial	_	_	43.5	75	_	_	40.2	65
	Ramnagar (NH-7)	Commercial	_	_	64.5	65	_	_	54.8	55
	Ralhupur	Residential	_	_	45.8	55	_	_	41.3	45
	Tahirpur	Residential	_	_	46.5	55	_	_	42.0	45
	Bhitti	Residential	_	_	46.8	55	_	_	42.5	45
	Madarwa	Residential	_	_	48.8	55	_	_	43.0	45
	Sultanpur	Residential	_	_	47.3	55	_	_	42.9	45
	Milkipur	Residential	_	_	46.4	55	_	_	42.5	45
Existing Ro-Ro/ Floating terminals	Diamond Harbour	Commercial	45.6	57.2	50.4	65	41.6	46.5	43.6	55
	Howrah	Commercial	47.8	62.3	58.5	65	43.0	54.2	51.6	55
	Shantipur	Residential	42.5	54.4	50.1	55	39.6	46.5	42.6	45
	Katwa	Residential	41.2	54.3	48.5	55	38.2	45.8	43.0	45
	Hazardwari	Residential	40.3	51.2	46.4	55	37.6	43.2	41.5	45
	Pakur	Residential	40.2	48.6	45.0	55	38.1	44.3	41.7	45
	Magalhal	Residential	39.1	47.3	42.8	55	37.2	44.6	40.1	45
	Buxar	Residential	41.3	52.3	47.4	55	40.1	46.4	42.3	45
	Munger	Residential	42.4	54.7	50.1	55	41.2	47.8	43.5	45
	Patna	Commercial	46.7	62.1	57.8	65	43.5	53.4	51.2	55

(Source: Monitored by JV)

Table 2.32 : Ambient Noise level along NW-1 near Sensitive Ecosystems

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

(Source: Monitored by JV)

IFC general EHS Guidelines[11] for Noise

Sl.No.	Receptor	Noise Level, Leq; dB(A)	
		Day Time (07:00 to 22:00)	Night Time (22:00 to 07:00)
1	Residential; institutional; educational	55	45
2	Industrial, commercial	70	70

B. Observation of Ambient Noise Quality

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

[11]Guidelines values are for noise levels measured out of doors.
Source: Guidelines for Community Noise, World Health Organization (WHO), 1999.

Figure 2.33 : Photographs of Noise Monitoring along NW-1

2.4. Biological Environment (NW-1)

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

2.4.1. *Ecological Profile - Biogeographic Zone*

Biogeographic zone indicates area of animal and plant distribution having similar or shared characteristics throughout. NW-1 falls largely under Gangetic Plain Biogeographic zone (7) [12] and small section under Coast Biogeographic Zone (8) (**Figure 2.34).** Biogeographically the NW-1 falls in Gangetic plain. Biogeographic zoneis dividedin two biotic provinces namely Upper Gangetic plain (7A) and Lower Gangetic plain (7B)[13].Part of NW-1 near Haldia falls under East Coast (8B) area. Details of the biogeographical zone i.e. Zone 7 and zone 8(B) is briefly discussed below:

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

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

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

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

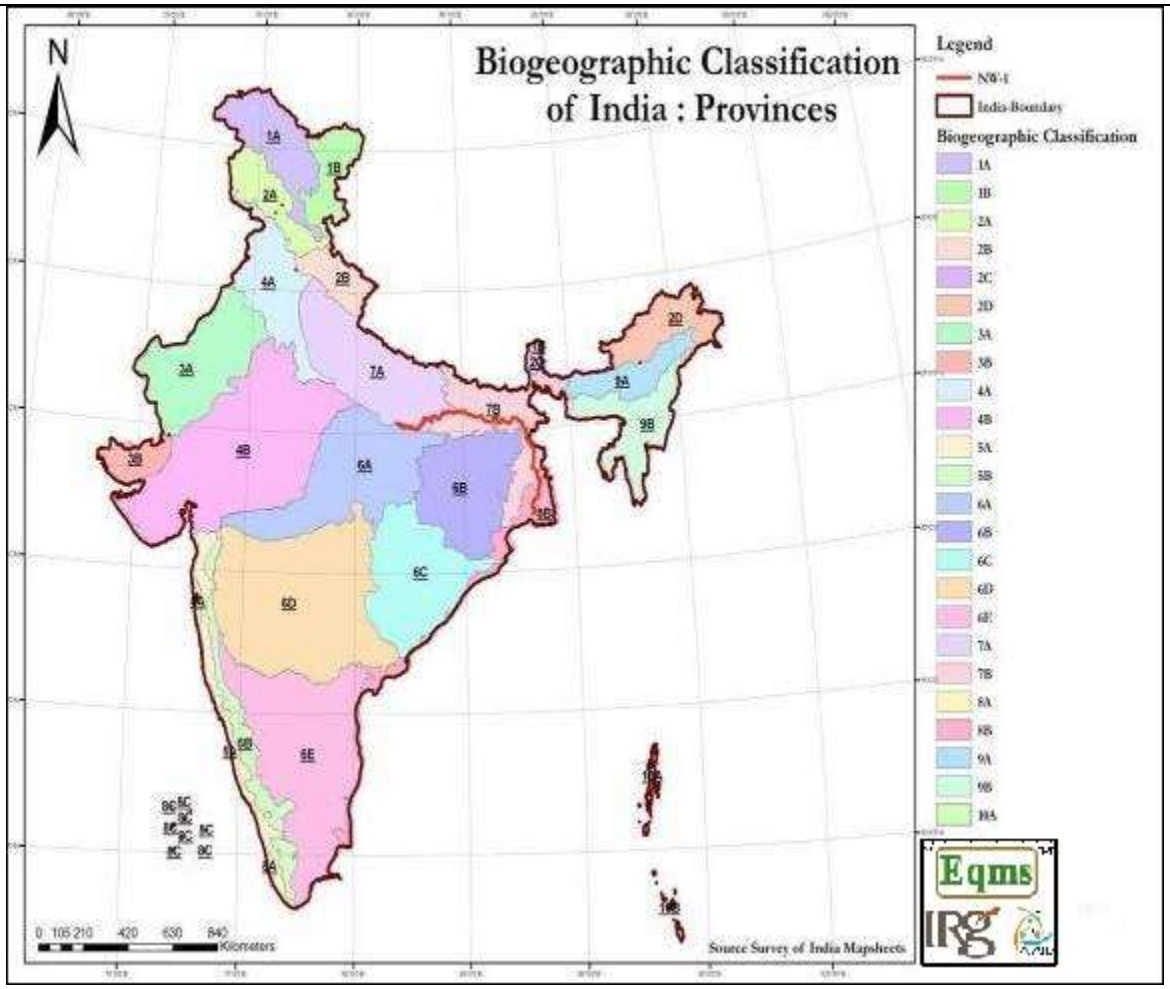


Figure 2.34 : Biogeographic zone and provinces falling in NW-1

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

2.4.2. *Forest type*

Data on forest and tree cover in states[14]traversed by NW-1 indicates that forest and tree cover is highest in Jharkhand (32.74% of total geographical area) followed by West Bengal (21.35%), Bihar (10.04%) and Uttar Pradesh (8.82%) as mentioned in **Table 2.34.** Reserved forest map in the state traversed by NW-1 is shown in **Figure 2.35**. No portion of NW-1 and intervention areas falls under any reserved forest or protected forests area.

[14]*State of Forest Report, 2013*

Table 2.33 : State-wise Forest and Tree Cover in study area and State Traversed by NW-1

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

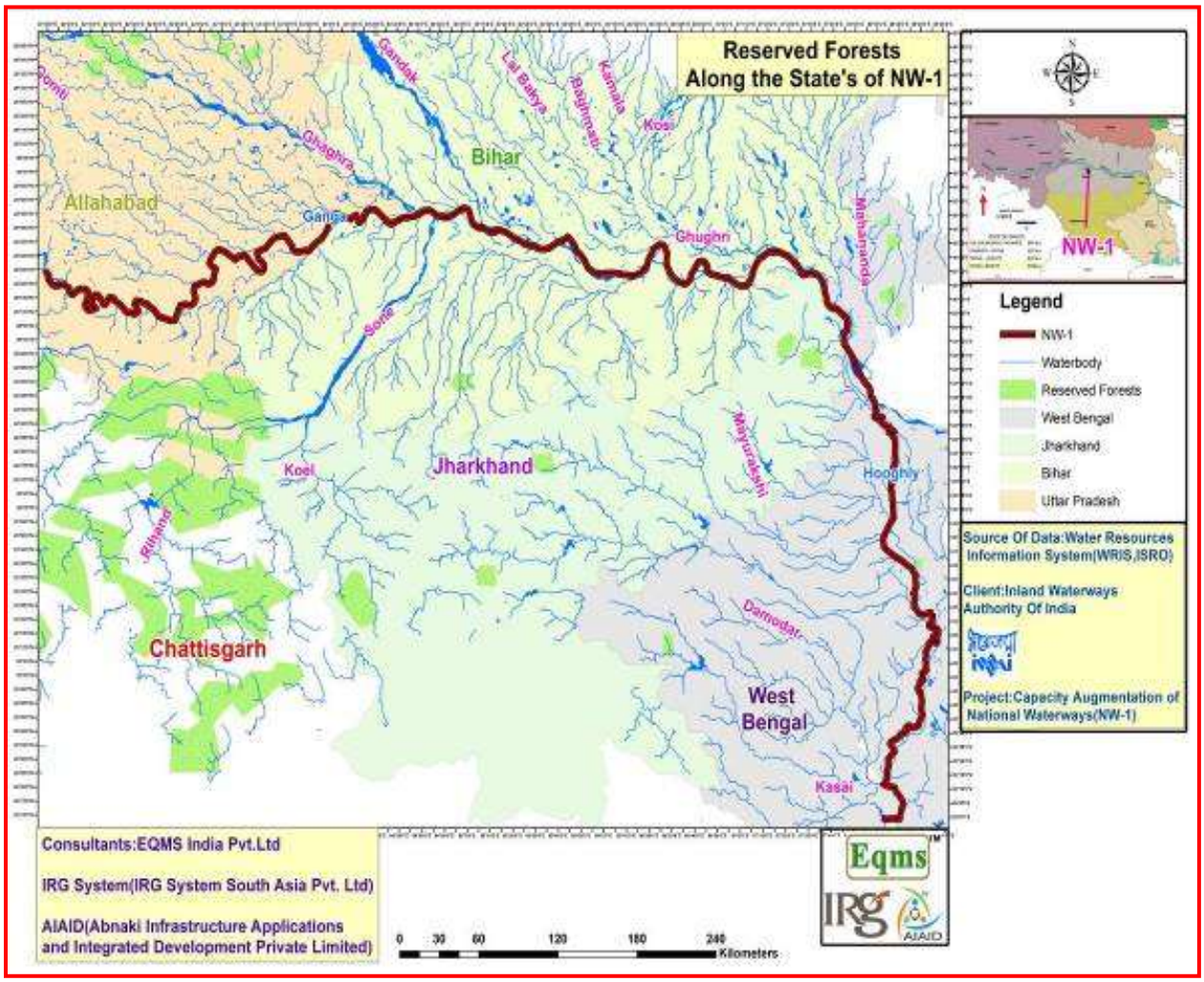


Figure 2.35 : Reserve Forest Map of States Traversed by NW-1

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

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

Wildlife Sanctuaries within NW-1

There are two notified wild life sanctuaries namely Kashi Turtle Sanctuary and Vikramshila, Dolphin Sanctuary and Hilsa Sanctuary Stretches) located within the NW-1. Hilsa Sanctuary is not notified under Wild Life (Protection) Act. It is notified only to propagate Hilsa Fish production. Salient features of the wild life sanctuaries (refer **Table 2.35**) along with flora and fauna details is described in following sections.

Table 2.34 : Salient features of Wild life Sanctuaries present within NW-1

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

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

A. Kashi Turtle Sanctuary, Varanasi, UP

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

diversity inhabiting this stretches are also protected. The Sanctuary also forms the part of Ganga Action Plan. Location of Kashi Turtle sanctuary in NW-1 is shownat **Figure 3.36**.

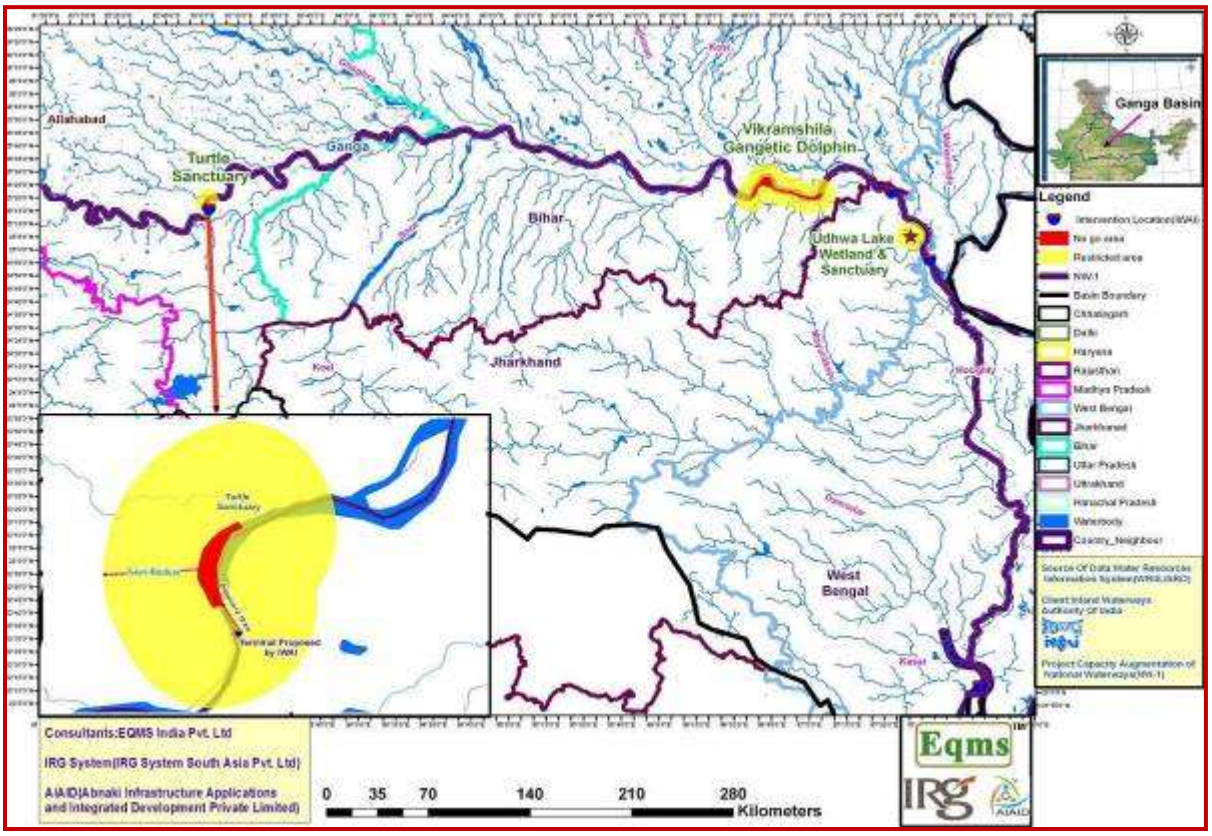


Figure 2.36 : Location of Kashi Turtle Sanctuary in NW-1

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

Turtle: As reported in literature freshwater turtles are major biodiversity components of the aquatic ecosystem, often serves keystone species benefiting other animals and plants. They participate in the web of interacting and co-dependent species that constitute a healthy functioning of ecosystem. In Kashi Turtle Sanctuary mainly *Aspederites Gangetic* (self-shell turtles), *Geoclamis, Hamiltonai, ChitraIndica* and *Lasimous* which are carnivorous species and hardshell herbivorous tortoise- Pechra Kachhua, Sundri Kachhua, TentoriaKachhua, Tongoka are in abundance. The list of Turtle species with their IUCN threatened status is provided in following **Table 2.36.** A tortoise-breeding centre is also set up at Sarnath to propagate its population where tortoise (both herbivores and Carnivores) are hatched and reared for one to two year and then are left into Kashi Turtle sanctuary.

Table 2.35 : Turtle species in Sanctuary Area

S.N	Common name	Species	IUCN Classification
1	Self-shell turtle	*Aspederetes gangeticus*	Vulnerable
2	Indian flap shell turtle	Lissemys punctata	Low risk

3	Narrow headed soft shell turtle	*Chitra indica*	Endangered
4	Spotted pond turtle	*Geoclemy shamiltonii*	Vulnerable
5	Crowned river turtle	*Hardella thurjii*	Vulnerable
6	Indian roofed turtle	*Pangshura tecta*	Lower risk
7	Indian tent turtle	*Pangshura tentoria*	Lower risk
8	Tongoka	*Balagur dhongoka*	Endangered

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

Fishes: In sanctuary area major carps like, Rohu (*Labeo rohita*) mrigal (*cirrhinus mrigala*), katla (*catla catla*), kalbasu (*labeo calbasu*), and cat fishes like padhan (*walla goattu*) tengras (*Mystus teengara*) and Magur (*Clarias batrachus*), Singhi (*Heteropneutes fossilis*), Tilapia (*Oreocromis sps*.), Kavai (*Anabas testudineus*), Mahfish (*Barbus sps*) are present.

B. Vikramshila Dolphin Sanctuary, Bihar

Vikramshila Gangetic Dolphin Sanctuary (VGDS) was notified on 7th August, 1991 as Wildlife Sanctuary under Wildlife Protection Act, 1972 for the protection of Dolphin[15].which is categorized as endangered species on the IUCN Red List. VGDS is the only riverine protected area for conservation of Gangetic Dolphin in the eastern Gangetic Plain. The sanctuary includes middle of Ganges between Sultanganj and Kahalgaon Hills (25.254°N to 25.282°N[16]and 86.738°E to 87.229°E) in Bhagalpur district-. 10 km area around VGDS is the default Eco Sensitive Zone at present. The proposed nearest Terminal at Sahibganj is located about 48 km from VGDS. The location of VGDS in NW-1 and proposed terminal at Sahibganj is shown in **Figure 2.37.**

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

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

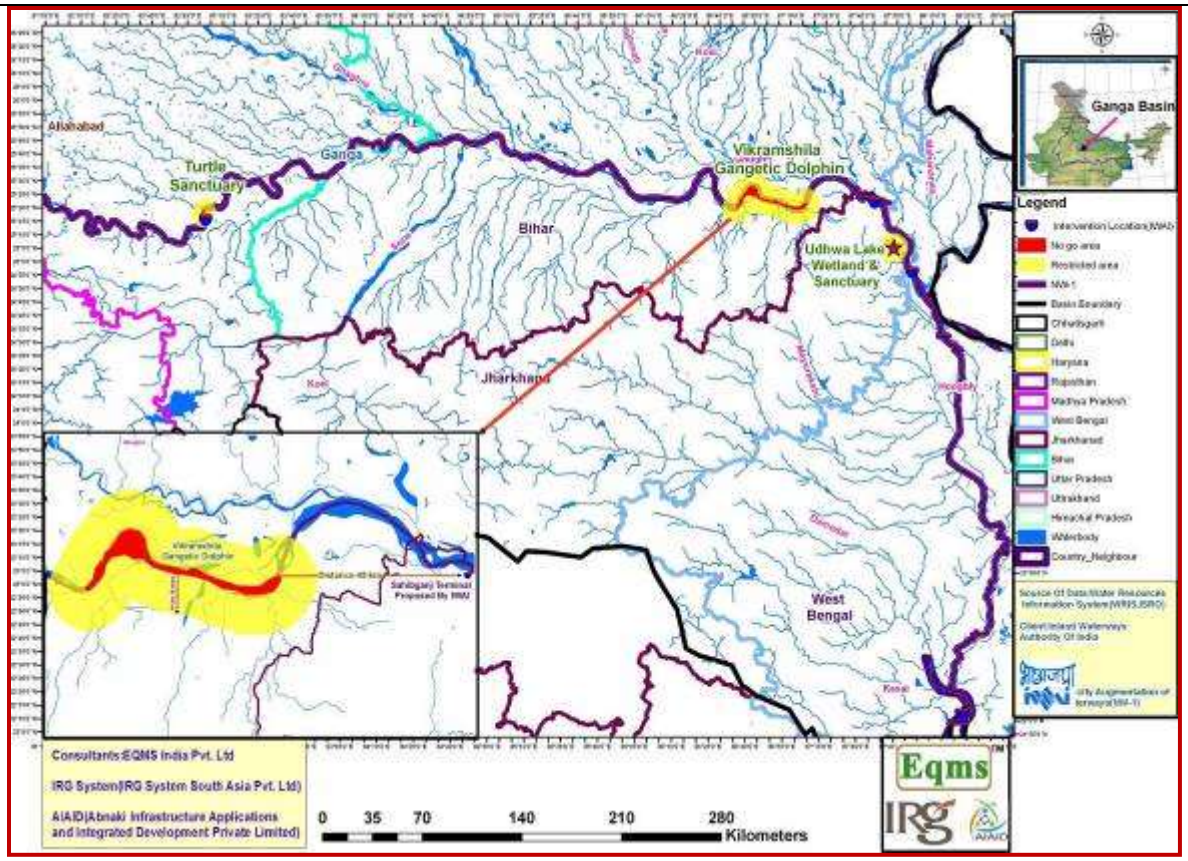


Figure 2.37 : Location of VGDS in NW-1

Various aquatic species of flora and fauna are found in Vikramshila Gangetic Dolphin Sanctuary. Besides Dolphins, other species of freshwater shrimps, fish and crustaceans can be observed. The area of the sanctuary is also an important bird area and the species such as the Greater Adjutant (*Leptoptilos dubius*) and Lesser Adjutant (*L. javanicus*) are present. Other storks present are the *Ciconia nigra*, Black-necked strok (*Ephippiorhynchus asiaticus*), White-necked (*Ciconia episcopus*), and the Asian Openbill (*Anastomus oscitans*). The Sanctuary is rich in waders. Common Crane (*Grus grus*), *Eurasian Spoonbill* (Platalea leucorodia) and various ducks are also seen here. Themajor carps like, Rohu (*Labeo rohita*) mrigal (*cirrhinus mrigala*), katla (*catla catla*), kalbasu (*labeo calbasu*), and cat fishes like padhan (*wallagoattu*) tengras (*Mystus teengara*) and Magur (*Clarias batrachus*), Singhi (*Heteropneutes fossilis*), Tilapia (*Oreocromis sps*.), Kavai (*Anabas testudineus*), Mahfish (*Barbus sps*) etc. are present in the sanctuary area.

C. Hilsa Sanctuary

Hilsa (*Tenualosa ilisha*) is assessed as Least Concern species as per IUCN's threatened category (version 3.1) but its population is declining due to over fishing and fragmentation of migratory routes along Farakka barrage. This sanctuary is notified[17] mainly with objective of enhancing Hilsa production. In order to facilitate spawning, all types of fish catching are banned in the Hilsa Sanctuaries during June to August and October to December every year in Hilsa Sanctuary areas (Refer **Table 2.37** and **Figure 2.38)**. Fishing of Hilsa is prohibited within 5 square kilometre of the Farakka Barrage (the notified sanctuary area) round the year to protect the Hilsa species and facilitate breeding and spawning in this area.

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

Table 2.36 : Location of the Hilsa Sanctuary and their stretch

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

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

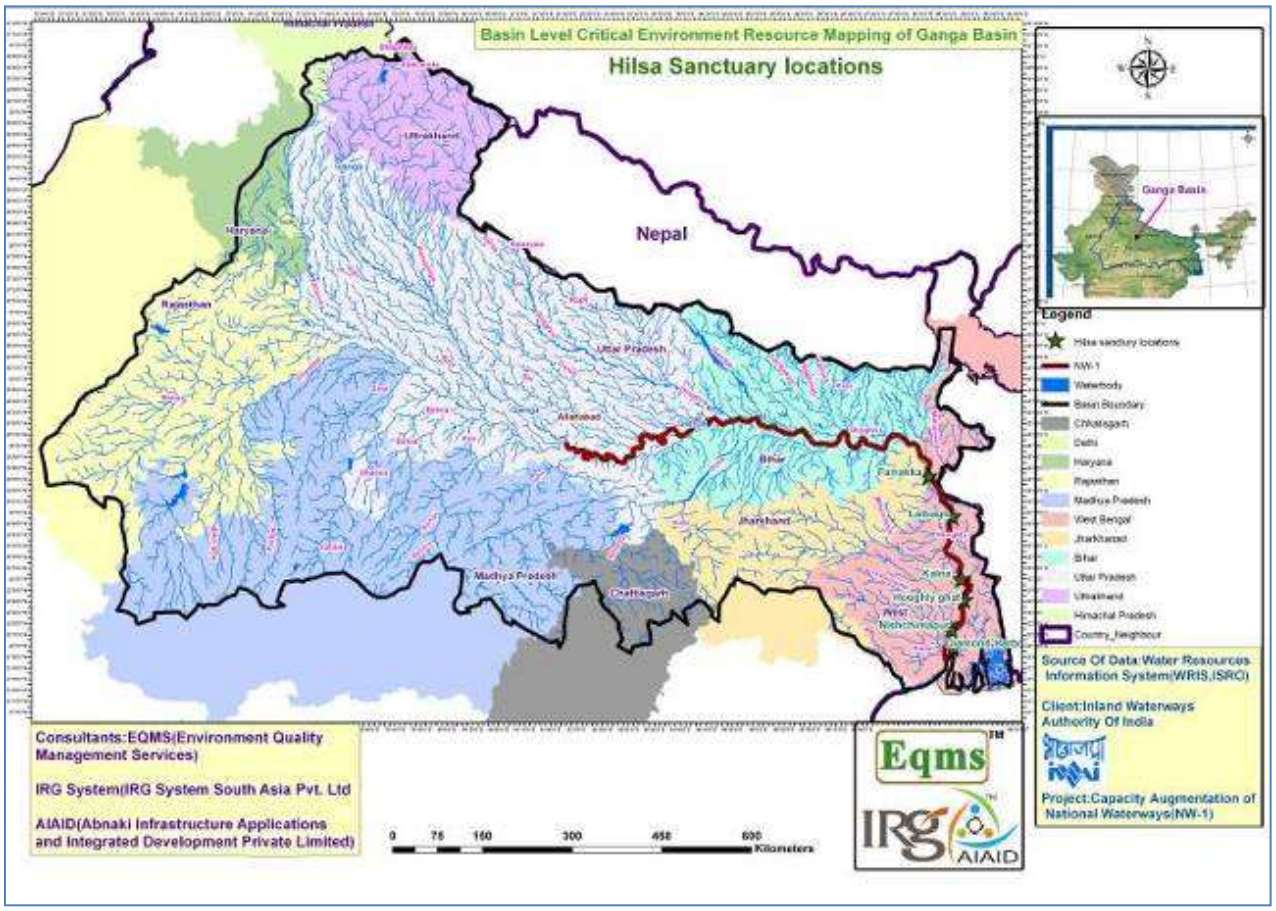


Figure 2.38 : Location of Hilsa Sanctuaries in NW-1

2.4.4. *Important Bird Area within 10 km area of the NW-1*

Six Important Bird Areas (IBAs)[18] have been identified along NW-1 stretch because they support important congregations of water birds (**Table 2.38**). None of these areas are protected except Vikramshila Gangetic Dolphin Sanctuary and Udhwa Lake Bird Sanctuary areas.

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

Table 2.37 : Important Bird Area within 10 km area of the NW-1

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

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

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

Mokama Taal (Barah) Wetlands: Mokama Taal wetlands cover more than 1,000 ha of shallow water bodies, situated in Patna, Samastipur and Begusarai districts of Bihar. Mokama tal bird area is located along the NW-1. Mokama Taal exhibits enormous biodiversity. Kawar (Kabar) Lake, another IBA site is close to Mokama, and when the birds get disturbed at Kawar, they fly to Mokama. About 149 species and over 20,000 breeding and migratory water birds reportedly are found in this IBA. The Black Ibis (Pseudibis papillosa), Glossy Ibis (Plegadis falcinellus), Eurasian Spoonbill (Platalea leucorodia), Greylag Goose (Anser anser) and Barheaded Goose (A. indicus) are some of the species

reported from the area. Ten globally threatened and Near Threatened species are also found here.

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

Udhwa Lake Bird Sanctuary: Udhuwa lake Bird Sanctuary is located along NW-1 at about 9 km southeast of Rajmahal in Jharkhand State. Two water bodies, namely Pataura and Barhale constitutes the 5.65 km2 of Udhuwa lake bird sanctuary. Pataura Lake is perennial and the average depth is about 2 meter. Total area of the sanctuary is 1605 ha and coordinates of the lake is 87° 48' 55.500" E, 24° 58' 6.400" N. Location Map of Udhwa Lake Sanctuary and photographs are shown in **Figure 2.39** and **Figure 2.40**.

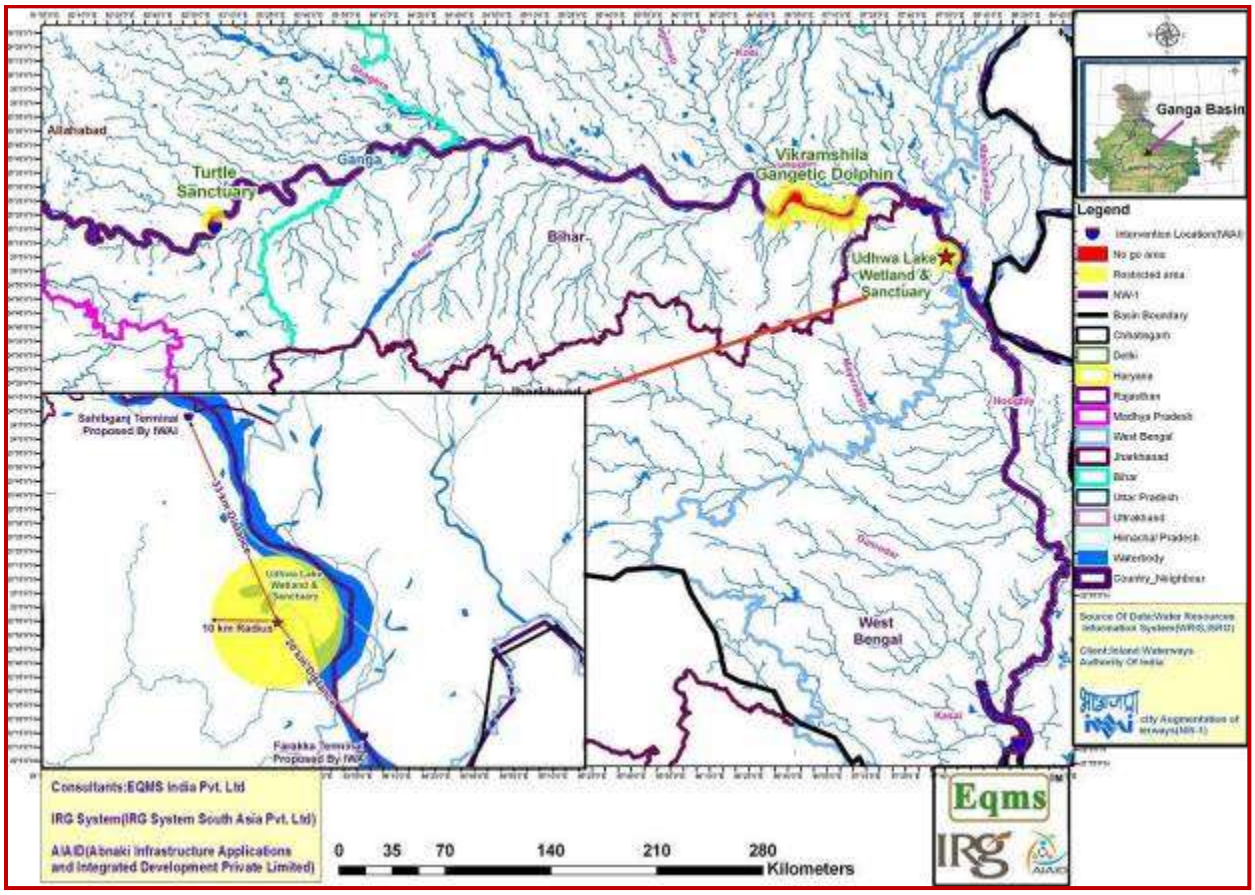


Figure 2.39 : Location of Udhwa Bird Sanctuaries

Figure 2.40 : Photographs of Udhwa Lake Sanctuary

Many migratory birds come to this sanctuary every winter from several parts of the world, including Siberia and Europe. The main birds include the pratincole, egret, wagtail, plover, lapwing, stork, ibis and heron. It is a home to a variety of birds including different mynas, brahminy kites, Cattel Egret, Pond Heron, Purple Heron, Egret, Open Billed stock, White Ibis, Dab chick or little Grebe, fishing eagles, hose swifts and palm swifts flying at dizzying speeds (Refer **Table 2.39**). Complete list of birds visiting the Udhwa lake and surroundings with their conservation status is highlighted in **Table 2.34.** The lake is infested with aquatic macrophytes comprising emergent, free floating and submerged forms. Water hyacinth was found to be the dominant form. Over all 50% of the lake surface was covered with aquatic weeds. Udhwa lake is also rich in fish and fish spawn. Some common fishes of the lake are Rohu (*Labeo rohita*), Catla (*Catla catla*), Tengra, (*Mystus cavasius*) Bata (*L. bata*), Reba (*C. retra*), and Mirka (*Cirrihinus mrigala*).

Table 2.38 : List of the Birds Visiting Udhwa Lake sanctuary

S. No.	Hindi Name	English Name	Scientific Name	Habitat	IUCN status
1	Pandubbi	Dab Chick of little grebe	*Tachybaptus ruficollis*	R	LC
2	Pankauba	Little cormorant	*Microcarbo niger*	R	LC
3	Pankauba	Large cormorant	*Phalacrocorax carbo*	R	LC
4	Bambi	Snake- bird Darter	Plotus anhinga	R	LC
5	Bagula	Little Egret	*Egretta garzetta*	R	LC
6	Bagula	Median Egret	*Mesophoyx intermedia*	R	
7	Bada Bagula	Large Egret	*Ardea alba*	R	LC
8	Gay Bagula	Cattle Egret	*Bubulcus ibis*	R	LC
9	Andha Bagula	Pond Heron	*Ardeola grayii*	R	LC
10	Anjan	Grey Heron	*Ardea cinerea*	R	LC
11	Ghoghil	Open- billed stork	*Anastomus oscitans*	R,LM	LC
12	Lalag	White-necked stork	*Ciconia episcopus*	R,LM	VU
13	Garud	Lesser adjutant	*Leptoptilos javanicus*	R,LM	VU
14	Girja Billi	Blanck Ibis	*Pseudibis papillosa*	LM	LC
15	Silli	Cotton Teal	*Nettapus coromandelianus*	LM	LC
16	Malki	Gadwall	*Anas strepera*	M	LC
17	Chhoti Lalsar	Wigeon	*Anas americana*	M	LC
18	Chaita	Garganey	*Anas querquedula*	M	LC
19	Tidari	Shoveller	*Anas clypeata*	M	LC
20	Nilsar	Mallard	*Anas platyrhynchos*	M	LC
21	Lalsar	Red- crested pochard	*Netta rufina*	M	LC

22	Giddha	Bengal vulture	*Gyps bengalensis*	R	CR
23	Karan	Purple Moorhen	*Porphyrio coeruleus*	R,LM	LC
24	Sagyar	Coot	*Fulica alai*	R,LM	VU
25	Kaltoyi	Bronze Winged Jacana	*Metopidius indicus*	R	LC
26	Tithari	Lapwing	*Vanellus armatus*	M	LC
27	Chaha	Fantail Snipe	*Gallinago gallinago*	M	LC
28	Tehri	Indian River Tern	*Sterna aurantia*	M	NT
29	Panduk	Ring Dove	*Streptopelia capicola*	R,M	LC
30	Hariyal	Bengal Green Pigeon	*Treron phoenicoptera*	R	LC
31	Kabutar	Blue Rock Pigeon	*Columba livia*	R	LC
32	Kilkila	Pied kingfisher	*Ceryle rudis*	R	LC
33	Kilkila	White breads kingfisher	*Alcedo atthis*	R	LC
34	Chhota Kilkila	Small blue kingfisher	*Alcedo atthis*	R	LC
35	Patinga	Small Green Bee-eater	*Merops orientalis*	R	LC
36	Nilkantha	Indian Roller, Blue Jay	*Coracias benghalensis*	R	LC
37	Bara	Bee-eater	*Merops leschenaulti*	R,LM	LC
38	Hud-hud	Hoopoe	*Upupa epops*	R	LC
39	Koel	Koel	Eudynamys	R	LC
40	Khanjan	Largepled wagtail	*Motacilla maderaspatensis*	M	LC
41	Charchari	Indian pipit	*Anthus rufulus*	R	LC
42	Mahalat	Indian Tree pie	*Dendrocitta vagabunda*	R	LC
43	Bulbul	Red-vented Bulbul	*Pycnonotus cafer*	R	LC
44	Kachbachiya	Common Babbler	*Turdoides caudata*	R	LC
45	Nilkanthi	Bluethroat	*Luscinia svecica*	M	LC
46	Baya	Weaver Bird	*Ploceidae*	R,LM	LC

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

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

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

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

In Uttar Pradesh, Allahabad to Gazipur area is relatively sparsely occupied with variety of trees that are equally well present up to Farakka belt. However, the density of flora is relatively thin in U.P. & Bihar areas as compared to Jharkhand and West Bengal region. The Allahabad to Balia region comprises about 41 varieties of macrophytes in which some species like *Ruellia prostrata*, Amaranthus *spinosus*, Calotropis *procera* and Polygonum *plebeium* are present along the bank of river. Tree cover is formed by the Sal (*Shorea robusta*), Teak (*Tectona grandis*), Sheesham (*Dalbergia sissoo*), Mango (*Mangifera indica*), Neem (*Tamarindus indica*), Banyan (*Ficus* sp.), Peepal (*Ficus religiosa*), Jamun (*Syzygium cumini*), Mahua (*Madhuca longifolia*) and Semal (*Bombax ceiba*).

The riparian flora in Bihar, region is comprising of 7 shrubs species, 41 herbs species, 6 grasses and sedges species, besides these a number of tree species along the banks of

river is reported. The tree species in the stretch is mainly composed of *Shorea robusta, Diospyros melanoxylon, Boswellia serrata, Dalbergia sisoo, Tamarindus indica, Terminalia tomentosa, Terminalia bellirica, Terminalia arjuna, Pterocarpus marsupium, and Madhuca indica*. 23 families comprising of 48 species in Diara land of Ganga and its tributaries are reported. The important species of this land are *Justicia peploides, Rauwolfia serpentina, Eclipta prostrata, Leucas aspera, Desmodium gangeticum, Lippia javanica and Scoparia dulcis.*

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

From Bendel to Haldia the tree species is mainly comprised of Semal (*Bombax ceiba*), Mango (*Magnifera indica*), Peepal (*Ficus religiosa*), Neem (*Tamarindus indica*), Jackfruit (*Artocarpus heterophyllus*) and Pakur (*Ficus lacor*). Other macrophytes (aquatic and semi aquatic) is *Alternanthera philoxeoroides, Amaranthus spinosus, Blumea lacera, Eclipta alba, Grangea maderaspatana, Tridax procumbens, Veronia cinerea, Xanthium strumarium, Nasturtium indicum, Chenopodium indicum, Juncellus sp., Cyperus sp., Sida rhombifolia, Chrozophora plicata, Croton bonpandianum, Boerhavia repens, Polygonum sp* and *Chrozophora plicata* species. The list of riparian flora observed during study along NW-1 stretch is given in **Annexure 3.1**.

2.4.6. *Aquatic Biodiversity in NW-1*

The aquatic fauna of NW-1 stretch comprises of phytoplankton, zooplankton, zoo-benthos, fish, and higher aquatic vertebrates. The higher aquatic vertebrates mammalian fauna present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanista gangetica gangetica*) and the Smooth Coated Otter (*Lutrogale perspicillata*) which are categorized as endangered species (Schedule-I). The reptile fauna found in Gangetic system are variety of fresh water turtle species, water snake (*Xenochrophis pistator*), Mugger Crocodile (*Crocodilus Paluspris*), estuarine (East Coast) Crocodile (*C. porosus*) and Indian Gharial (*Gavilialis Gangeticus*). The Mugger, Crocodile and Indian Gharial are observed rarely in NW-1 stretch. Details provided below:

Mammalian Fauna in NW-1 strech of Ganga River: In this class there are only two species found in river Ganga. These are the Gangetic Dolphin (*Platanista gangeticus*) and the smmoth coated Otter (*Lutrogale perspicillata*).

The most common one and most important one is the Gangetic Dolphin (*Platanista gangetica*) which is a schedule-I species. As mentioned earlier this species is found

routinely moving between Allahabad to Farakka and occurs in the post Farkka region and other tributaries of Brahmaputra River system. It is among the rarest one since this Genus is reported to be present in few rivers of Pakistan, China and India only. It is under critically endangered category of IUCN. However, it is not sighted during site visits but as per consultation with local fishermen along the NW-1 strech, Dolphin are rarely seen in Allahbad to Varanasi stretch however Patana Bhagalpur and Sultanpur stretch has indicated its presence.

The presence of Indian Smooth-coated Otter (*Lutrogale perspicillata*) in NW-1 strech has been repoted in litratures. Smooth Coated Otter (*Lutrogale perspicillata*) is categorized as endangered species (Schedule-I). As per the literature and available secondary information it is mostly found in the upper Ganga Region (primarily above Narora Barage area and around Hastinapur Wild Life Sanctuary and Garmukteshwar area)[19]. These animals are also reported in (Vikramshila Dolphine Sanctuary area) specially in side channel of river Ganga in near Bhagalpur[20]. These animals preffer the wet land area, seasonal swamps, lakes and rice paddies. As per consultation with local fishermen and local people this mammal is rarely seen in NW-1 stretch.

Reptilian Fauna: Among the reptilian (the rarest of reptiles found) fauna mugger crocodile (*Crocodylus palustris*), and the estuarine (east coast) crocodile (*C. porosus*) and Indian Gharial (*Gavialis gangeticus*) has been reported from NW-1 strech of Ganga river. However, these species were not sighted during the study period. Mugger crocodile (*Crocodylus palustris*), and Indian Gharial (*Gavialis gangeticus*) has been reported in upper stretch of Ganga (near Narora barrage) and distributaries of Ganga like Chambal etc. while crocodile which (*C. Porosus*) is reported near estuarine part of Hooghly river.

IUCN in its report of 2006[21] has reported presence of Gharial only in upper Ganga region (above Narora Barage) and in three of its tributaries (Chambal, Son, and Gandak). It is reported that construction of Narora Barage has fragmented these species. During flood some of Juveline of these sepcies are sighted even at far areas from their Habitate like Allahabad and Varansi due to to its stray movement in high water.

[19] Habitate Use pattern and Conservation of Smooth Coated otters by Mr M S Khan in 2006.

[20] Protection of a Smooth Coated Otter den site in Vikramshila Gangetic Dolphin Sanctuary in Bihar by Bhagalpur University, 2013.

[21] IUCN has reported its presence in upper Ganga and four of its tributaries as indicated in figure below.

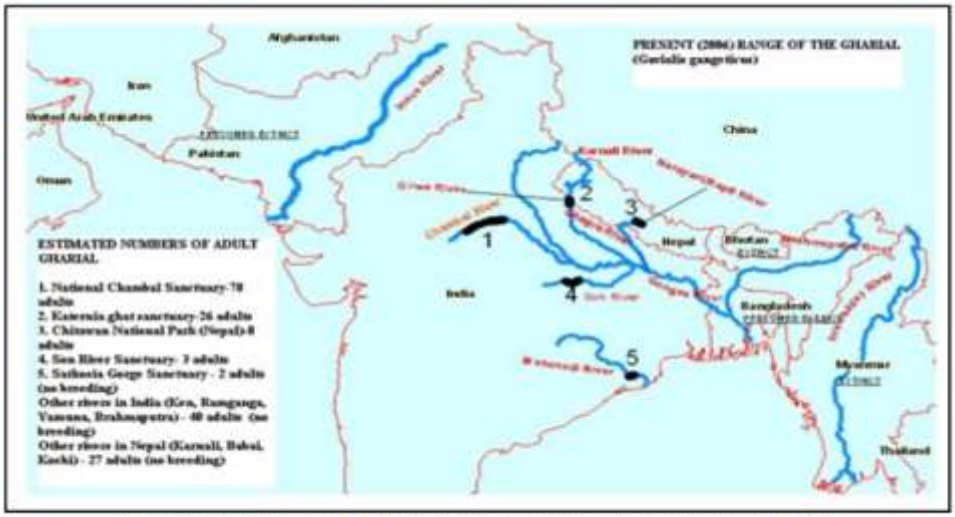


Figure 1: Current distribution of the Gharial (Source: IUCN)

Turtles: Freshwater turtles are major biodiversity components of the aquatic ecosystem, often serves keystone species benefiting other animals and plants. They participate in the web of interacting and co-dependent species that constitute a healthy functioning of ecosystem. *Aspederites Gangetic* (self-shell turtles), *Geoclamis, Hamiltonai, ChitraIndica, Lasimous Pechra Kachhua, Sundri Kachhua, Tentoria Kachhua, Tongoka* present in in the NW-1 strech of Ganga river.

Water Snakes: Water snakes (*Xenochrophis piscator*) are frequently seen in the river. But found very low in numbers (never more than 3-10 other wise just one or two flowing with the water current or swimming around bank) were encountered by few fishermen or bathers in river Ganga children or the adults at various places was shared with us at Allahabad, Varanasi, Bhagalpuer, Sultanganj Ghazipur and Farakka. These snakes are piscivorous though can feed on the eggs of reptiles if find along the riverbanks or amphibians.

About the Ganges Shark [Glyphis gangeticus]

As detailed in Cumulative Impact Assessment Report that Ganges Shark (a critically endangered species) does not exists in river Ganga. There is only unconfirmed report of its presence in this river[22]. Considering doubbtfull presence focus of impact assessment has been made on prominently found endengerad species.

Fishes: Though there are more than 176 species of freshwater fishes reported from different places between Allahabad to Haldia. The major commercial fish species found in the stretch are Rohu (*Labeo rohita*), mrigal (*cirrhinus mrigala*), katla (*catla catla*), kalbasu (*labeo calbasu*), Magur (*Clarias batrachus*), Singhi (*Heteropneutes fossilis*), Tilapia (O*reo cromissps*.), Kavai (*Anabas testudineus*), Mahfish (*Barbus sps*), padhan (*walla goattu)* also called as freshwater shark) and tengras (Mystus teengara).

Phytoplanktons, Zooplanktons and Bentos: The Allahabad to Farakka segment of River Ganga (LG-A) comprises of fresh water zone of 701 km.The floral and faunal diversity comprise of phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher vertebrates. As per the secondary source[23], the Phytoplankton in Ganga river from Allahabad to Farakka segment is represented by total of 270 taxa (91 sp. of Chlorophyceae, 81 sp. of Bacillariophyceae, 78 sp. of Cyanophyceae, 8 sp. of Euglenophyceae, 3 sp. of Chrysophyceae, 3 sp. of Xanthophyceae, 2 sp. of Dinophyceae, 2 sp. of Rhodophyceae, 1 sp. of Cryptophyceae, 1 sp. of Synurophyceae). Zooplankton comprises of Protozoans (8 sp.), Rotifers (26 sp.) and Crustaceans (5 sp. of Copepods and 13 sp. of Cladocerans). In this stretch, all groups are represented though are low in specific composition. The stretch supports the zoobenthos i.e. Insects (43%), Annelids (21%) and Molluscs (36%). Nematodes are also reported in the stretch. Fish in the stretch is represented by total of 121 species belonging to 35 families. Thirty-five commercially important fishes are included in the taxa along with six invasive species. Beside the preponderance of fish species in this zone, an aquatic mammal, Gangetic dolphinis also present in the Bihar stretch.

[22] R.K. Sinha (2014), and WWF has reported the presence of this in the lower stretch of Ganga (Hoogly River Region). However, no additional secondary information or literature available confirming its presence in Ganga river.

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

286 km of stretch of Lower Ganga downstream of Farakka up to Haldiaconsist of Phytoplankton, Zooplankton, Macrobenthos, Nekton, Macrofauna. As per the secondary data analysis Phytoplankton distribution in this stretch is represented by 641 algal species (Cyanophyceae 280 taxa; Chlorophyceae 206 taxa; Bacillariophyceae 115 taxa; Rhodophyceae 17 taxa; Dinophyceae 14 taxa; Xanthophyceae 4 taxa; Euglenophyceae 3 taxa; Phaeophyceae 2 taxa) under 169 genera. The dominant algal species in lower Ganga is Cyanophyceae followed by Chlorophyceae. The zooplankton communities in lower Ganga basin are represented by members of Cnidaria (25 taxa), Rotifera (102 taxa), Copepod (26 taxa), Cladocerans (53 taxa) and larval forms of Decapods and Cyclopods. Macrobenthos and Macro-invertebrates constitute Annelida (90 taxa), Arthropoda (Total 476 taxa;240 species of Crustaceans, 33 species of Arachnids, 201 species of insects and 2 species of Merostomata), Mollusca (Total 68 taxa) and Echinodermata (17 taxa). The Ichthyo-fauna is represented by 175 species, out of which 103 species, under 69 genera and 37 families are strictly estuarine in nature. Detail list of flora and Fauna along NW-1 strech are presented in **Annexure 3.1.**

2.4.7. *Primary Data analysis*

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

A. Phytoplanktons & Zoplanktons Observed in Sanctuary Area along NW-1

Aquatic biodiversity depends on quality of water and nutrients present in the water. The variety of zooplankton in any aquatic system reflects the primary productivity status of the system. However, the population of phytoplankton's in riverine system is a sort of moving crop. The phytoplankton originates in shallow water levels of low velocity, in streams, pools and zones of shallow meandering of rivers. The submerged aquatic vegetation along riparian areas developed due to accumulation of soil in the course of river serves as good feeding grounds for fishes and their juveniles and zooplanktons. The site observations and

literature review shows that the Ganga river system has a rich diversity of both types of planktons i.e. phyto-plankton and the Zooplankton, though the diversity varies because of local anthropogenic impacts from station to station. The diversity of planktons is slightly high in Hilsa Sanctuary than Kashi sanctuary and Vikramshila dolphin sanctuary areas. The list of phytoplankton and zooplanktons, observed in Kashi Turtle sanctuary, Vikramshila Dolphin Sanctuary and Hilsa Sanctuary areas along NW-1 is given in **Table-2.40** and **Table 2.41**.

Table 2.39 : Phytoplankton observed at Sanctuary Area along NW-1

S.N.	***Taxa***	**Kashi Turtle Sanctuary Area**	**Dolphin Sanctuary Area**	**Hilsa Sanctuary area**
Phytoplankton				
Bacillariophyceae				
1.	*Amphora sp.*	+	+	+
2.	*Amphipleura*	+	+	+
3.	*Achnanthes sp.*	-	+	+
4.	*Asterionella sp.*	+	+	+
5.	*Bacillaria sp.*	-	+	+
6.	*Biddulphia sp.*	+	+	+
7.	*Brebissonia sp.*	-	+	+
8.	*Caloneis sp.*	+	+	+
9.	*Ceratoneis sp.*	-	+	+
10.	*Coconeis sp.*	-	-	+
11.	*Chaetoceros sp.*	+	+	+
12.	*Cosinodiscus sp.*	-	+	+
13.	*Cyclotella sp.*	+	-	+
14.	*Cymatopleura sp.*	-	+	+
15.	*Cymbella sp.*	+	+	+
16.	*Diatoma sp.*	+	+	+
17.	*Diatomella sp.*	-	+	+
18.	*Epithelmia sp.*	-	+	+
19.	*Fragilaria sp.*	+	+	+
20.	*Frustulia sp.*	+	-	+
21.	*Gomphoneis sp.*	-	+	+
22.	*Gyrosigma sp.*	+	+	+
23.	*Hantzchia sp.*	-	+	+
24.	*Melosira sp.*	+	+	+
25.	*Meridian sp.*	-	+	+
26.	*Navicula sp.*	+	+	+
27.	*Nedium sp.*	-	+	+
28.	*Pinnularia sp.*	+	-	+
29.	*Pleurosigma sp.*	+	+	+
30.	*Rhicosphenia sp.*	-	+	+
31.	*Stephanodiscus sp.*	-	+	+
32.	*Surirella sp.*	-	+	+
33.	*Tabellariasp*	-	+	+

34.	*Tetracylus sp.*	+	-	+
Chlorophyceae				
35.	*Actinastrum sp.*	+	+	+
36.	*Chlamydomonas sp.*	-	+	+
37.	*Chlorella* sp	+	+	+
38.	*Chlorococium sp.*	-	+	+
39.	*Cladophora sp.*	+	+	+
40.	*Closterium sp.*	+	+	+
41.	*Coelastrum sp.*	+	+	+
42.	*Conococcus sp.*	+	-	+
43.	*Cosmarium sp.*	_	+	+
44.	*Desmidium sp.*	-	+	+
45.	*Eudorina sp.*	+	+	+
46.	*Gonatozygon sp.*	-	+	+
47.	*Gonium* sp	+	+	+
48.	*Hormidium*sp	+	+	+
49.	*Hydrodictyon sp.*	-	+	+
50.	*Microspora sp*	+	+	+
51.	*Oedogonium sp.*	+	+	+
52.	*Pandorina sp.*	+	+	+
53.	*Pediastrum sp.*	+	+	+
54.	*Spirogyra sp.*	+	+	+
55.	*Tetraspora sp.*	-	-	+
56.	*Ulothrix sp.*	+	+	+
57.	*Zygnema sp*	-	+	+
58.	*Debarya*sp	-	+	+
59.	*Mesotaenium*sp	-	+	+
60.	*Stigeclonium*sp	-	+	+
61.	*Tetradesmus*sp	-	-	+
62.	*Rhizoclonium*sp	-	+	+
Cyanophyceae				
63.	*Spirulina sp*	+	+	+
64.	*Rivularia sp.*	+	+	+
65.	*Schizothrix sp.*	+	+	+
66.	*Phormidium sp.*	+	+	+
67.	*Oscillatoria sp.*	-	+	+
68.	*Anabaena* sp .	+	-	+
69.	*Calothrix sp.*	+	+	+
Xanthophyceae				
70.	Bumillaria sp.	+	+	+
71.	Chlorobotrys sp.	+	+	+
72.	Tribonema sp.	-	-	+
73.	T. bombycinum	-	+	+
74.	Voucheria sp.	-	-	+
Euglenophyceae				
75.	Astasis sp.	+	+	+
76.	Euglena sp.	+	+	+

77.	Peronia sp.	+	+	+
78.	Phacus sp.	+	+	+
Rhodophyceae				
79.	*Bostrychia radicans*	-	-	+
80.	*Catenella impudica*	-	+	+
81.	*Ceramium elegans*	-	-	+

Table 2.40 : Zooplanktons observed at Sanctuary Area along NW-1

Zooplankton Group/Species		Kashi Turtle Sanctuary Area	Dolphin Sanctuary Area	Hilsa Sanctuary area
Protozoa				
1.	*Arcella sp*.	+	+	+
2.	*Chilodonella*sp.	+	+	+
3.	*Difflugiia*sp.	+	+	+
4.	*Globigerina* sp.	+	+	+
5.	*Holophrya*sp.	+	+	+
6.	*Noctiluca*sp.	+	+	+
7.	*Paramecium* sp.	-	+	+
8.	*Spathidium*sp.	+	+	+
9.	*Sphenoderia*sp	+	+	-
10.	*Tintinnopsis*sp.	+	-	+
11.	*Vorticella* sp	-	+	+
Rotifera				
12.	*Anura*sp.	+	+	+
13.	*Asplanchna* sp.	+	+	+
14.	*Brachionus* sp.	+	+	+
15.	*Filinia* sp.	+	+	+
16.	*Horaella* sp.	+	+	+
17.	*Keratella* sp .	+	+	+
18.	*Lecane* sp.	-	+	+
19.	*Notholca* sp.	+	+	-
20.	*Rotaria* sp.	+	+	+
21.	*Testudinella sp*	-	+	+
Copepoda				
22.	*Cyclops sp.*	+	+	+
23.	*Diaptomus*	+	+	+
24.	*Nauplii*	-	+	+
Cladocera				
25.	*Bosmina* sp	+	+	+
26.	*Ceriodaphnia* sp.	+	-	+
27.	*Cydorus* sp.	+	+	-
28.	*Daphnia* sp.	-	+	+
29.	*Diphanosoma* sp.	-	+	+
30.	*Moina* sp	-	+	+
31.	*Simocephalus* sp	+	+	+

Phytoplankton group reported from the above sampled locations are Basillariophyceae, Chlorophyceae, Cyanophyceae, Xanthophyceae and Euglenophyceae members. Dominance of Bacillariophyceae members followed by Chrophyceae and Cyanophyceae observed in studied sampling locations. However, the diversity of the phytoplankton group is high in Hilsa sanctuary area followed by Dolphin Sanctuary and Kashi sanctuary area. Among zooplankton group, Brachionous sps. (Rotifera) had highest percentage composition and the lowest percentage composition was of Asplanchana sps.

2.4.8. *Breeding and Spawning*

Fish Breeding and Spawning: Generally, fish breeding and spawning is most frequent in monsoon season (July to September). Therefore, field studies were conducted overlapping rainy season during mid-June 2015 to September 2015. It was found that spawning grounds of fishes are generally located in shallow parts of river meandering sites where water current is slow and depth is around 5-10 cm. The fishes of cat fish families like Mystus, Wallago, clarioas make a nest type breeding niche, which is looked after by male and where after a little time courtship female lays its spawn followed by the release of milt leading to fertilization. As per the situation, a small exploratory assessment was done to know the availability of fish spawn/ larvae along the study stretch using spawn collection nets during study period. The cone shaped spawn collection nets were fixed against the water flow along the right and left edges of the NW-1 at each selected sampling site, for a duration of half an hour. The mass of spawn/larvae collected varied from site to site and were a mixture of different species of fishes distributed in the particular sites and the study indicated that fishes were breeding throughout the river stretch and the larvae and the spawns were abundant near river meandering points and shallow zones. The map showing likely breeding and spawning grounds at different stretch along the NW-1 is given in Figure 2**.41 to Figure 2.44.**

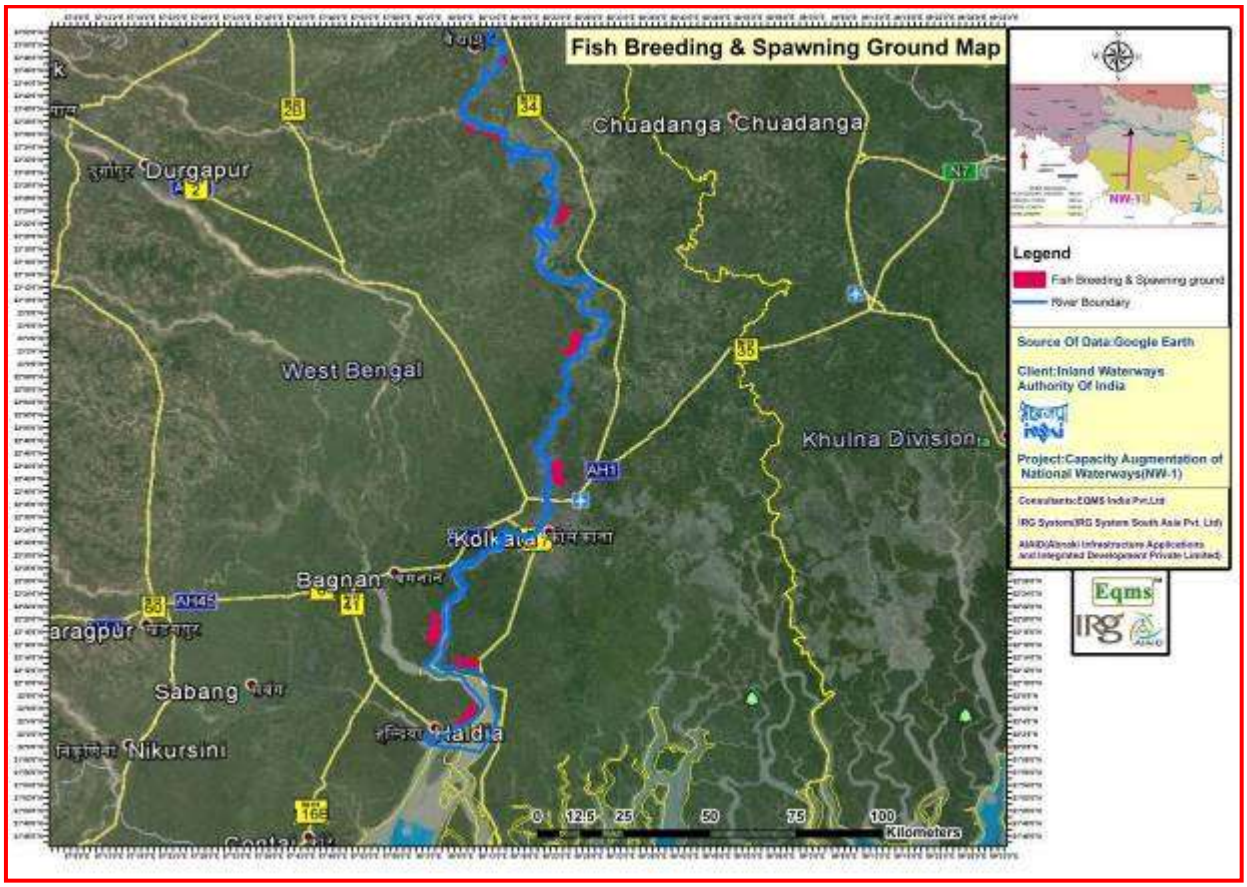


Figure 2.41 : Fish Breeding and Spawning Grounds along NW-1 (Haldia to Baidyapur Stretch)

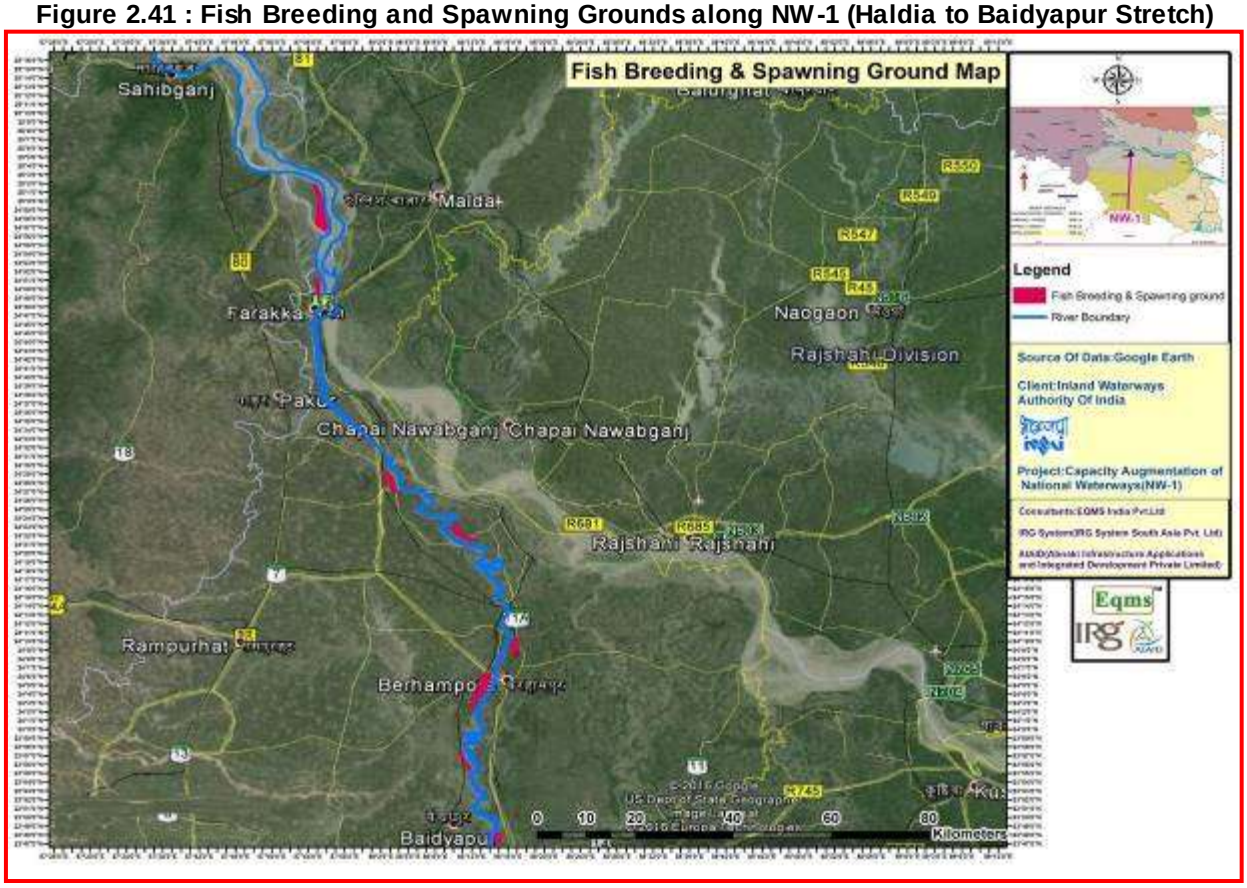


Figure 2.42 : Fish Breeding and Spawning Grounds along NW-1 (Baidyapur to Sahibganj Stretch)

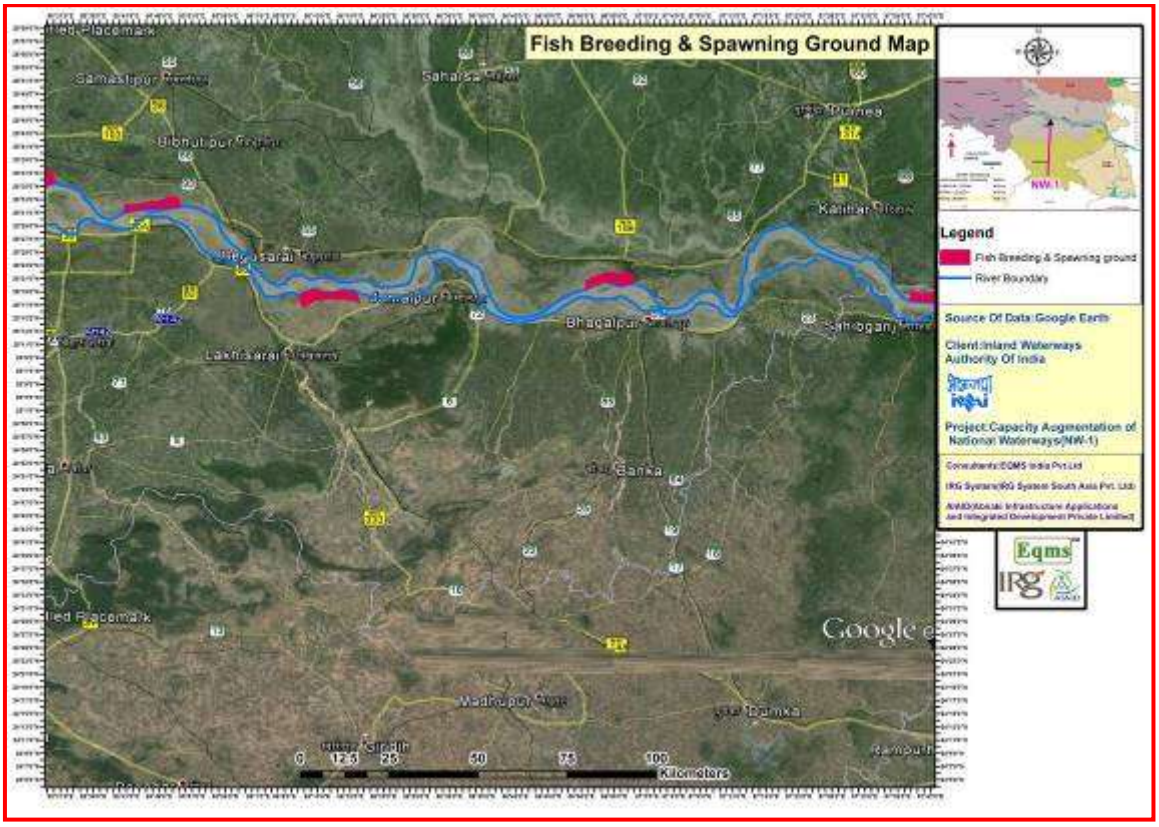


Figure 2.43 : Fish Breeding and Spawning Grounds along NW-1 (Sahibganj to Patna Stretch)

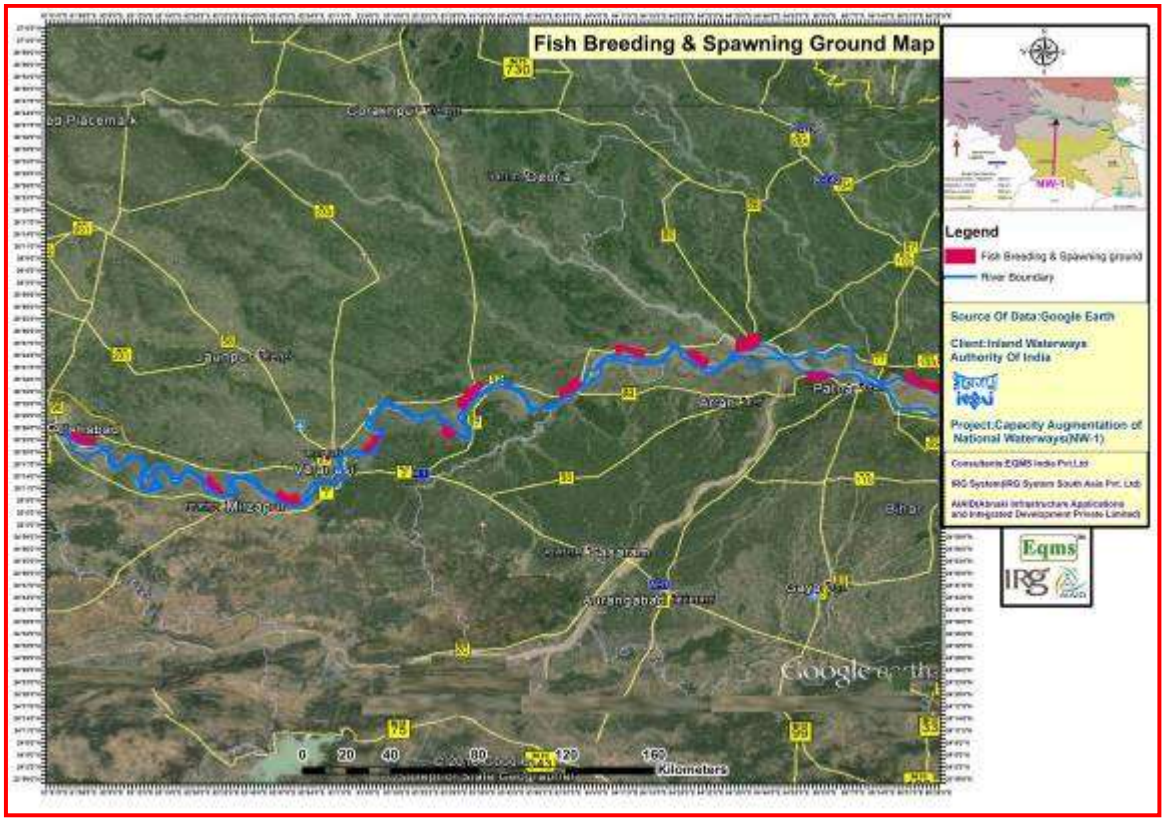


Figure 2.44 : Fish Breeding and Spawning Grounds along NW-1 (Patna to Allahabad Stretch)

Hilsa Fish Breeding: The Bengal Hilsa (*Tenualosa ilisha*) occurs in marine environment but migrates to fresh water for breeding. It tolerates variations in salinity and travels over 1200 km in inland water for breeding up to Farakka. The Hilsa fish is heterosexual. Breeding starts with start of monsoon in July and peaks in September-December. Hilsa primarily restricted to the estuarine zone only and its migration has been stopped in fresh water zone beyond Farakka.

Dolphin Breeding (reproduction): Calving of Gangetic Dolphin generally occurs in December to January and March to May, though it can occur any time of the year. New-born calves are observed mainly in April and May[24].

Turtle Breeding: Turtle nesting season vary depending on the species. Its hatching period normally confined between May to October. The nesting and hatching season of fresh water turtle vary from May to October. The Nesting and hatching season of fresh water turtle in NW-1 is given in **Table 2.42**

Table 2.41 : Nesting and hatching season of turtle species

S. No.	Species	Nesting season	Hatching season
1	*Batagur dhongoka*	December-February-April	May
2	*Batagur kachuga*	December-February-April	May

[24]Dolphin reproduction start with the copulation of group of dolphins.Dolphin mothers usually go to shallow waters to deliver the calves. Usually a single calf is born, which is nursed for around 18 months with milk from the mother.Calves live close to their mothers for around 6 years.

3	*Pangshura smithii*	October-December	May
4	*Pangshura tentoria*	September-February	May
5	*Pangshura tecta*	October-December	May
6	*Lissemys punctata*	July-October	July
7	*Chitra indica*	September	October
8	*Nilssonia gangeticus*	August-October	June/July

Reference: Status of Higher Aquatic Vertebrates in the Ganga River GRB EMP: Ganga River Basin Environment Management Plan by consortium of 7 Indian Institute of Technology.

2.4.9. *Terrestrial and Aquatic biodiversity around Finalised intervention sites of NW-1*

IWAI has finalized four interventions namely Haldia Terminal, Sahibganj Terminal, Varanasi Terminal and Farakka Lock. Separate ecological assessment has been carried out around these identified sites and same is summarized in the following sections:

A. Haldia Terminal, Haldia Dock Complex, West Bengal

Terrestrial biodiversity: The proposed site is located in Haldia Dock Complex (HDC) and the vegetation is restricted to road side plantation, open spaces and plantation done by the HDC under green belt development programme. The dominant vegetation type in core zone comprises of trees like *Albizzia lebbeck, Casuarina equisetifolia, Phoenix sylvestris, Delonix regia, Acacia spp, Azadirachta indica,* and *Dalbergia sissoo.*

Terrestrial flora in 10 km includes open scrub land, crop land having agrarian ecosystem and road side plantation. Most of the land within the 10 km area of the proposed Haldia terminal site is under water bodies.

Threatened floral and Faunal species: No threatened floral, faunal or schedule I species as per Wildlife Protection Act, 1972, amended till date is recorded in the study area.

Protected Area: No Reserved Forest/National Park/Sanctuary is present within 10 km radius of the Haldia terminal site.

Aquatic biodiversity: Aquatic biodiversity of Hooghly River at Haldia includes plankton diversity, fishes, benthos and mammals. Phytoplankton is dominant group of aquatic flora in the study area. It includes Bacillariophyceae, Chlorophyceae and Cyanophyceae. Bacillariophyaceae also known as diatoms are dominant over the Cyanophyaceae and Chlorophyceae. Abundant species are *Amphora, Bacillaria, Cymbella, Denticula, Diatoma, Gomphonema,* and *Navicula.*

The aquatic fauna includes protozoa, cladocera, annelids, mollusca, larvae of insects, copepods, rotifers, fishes, amphibians, reptiles, mammals. Protozoans and rotifer are dominant over other groups of zooplankton.

Most important fish species of Hooghly River at Haldia are *Rita, Catla, Mystus, mastacembelus, Labeo spp.* Zooplankton includes Protozoa, Rotifera, Copepoda and Cladocera. Rotifera and Porifera are dominant group of Zooplankton in the study area. The most common species of benthos are insects viz. May fly, Odonata, Hemiptera, Coleoptera. Molluscs includes Pelecypoda, Bellamya sp., Gabbia sp., Lymnaea sp. and Thiaria sp.

Fish species are represented by species of Mystus, Puntius, Rita, Wallago, Channa, Labeo and Tenualosa ilisha (Hilsa). Hilsa fisheries in on decline and is assessed as Least Concern

as per IUCN's threatened category (version 3.1)[25]. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Haldia terminal.

B. Farakka Navigation lock, Farakka, Murshidabad district, West Bengal:

Terrestrial biodiversity: The vegetation in the study area of the proposed navigation lock is primarily agriculture related. The prevailing vegetation found in study area represents the trees and river riparian vegetation with dominance of agricultural fields. Major tree species found are *Azadirachta indica, Dalbergia sissoo, Albizia lebbeack*, Taad (*Borassus flabellifer*), Krishnachuda (*Caesalpinia pulcherrima*), Aam (*Mangifera indica L*), *Ficus religiosa, Ficus benghalensis* etc, Mango and Litchi orchards. No forest is present within the study area.

Threatened flora & Fauna: No threatened floral, faunal or schedule I species as per Wildlife Protection Act, 1972, amended till date is recorded in the study area. However, being an important bird area few migratory birds' area found in the study area. The details of Avi fauna of the area is described under IBA section before.

Aquatic biodiversity: Gangetic Dolphin's (*Platanista gangetica*) presence was reported in this region prior to the construction of Farakka Barrage. No Gangetic Dolphins were found in the proposed lock site area. No other endangered aquatic faunal species were found in the study area.

Fish fauna in the study area includes *Labeo sp., Catla, Notopterus sp., Hilsa sp., Rita, Clarias sp., Mystus sp., Osteobrama sp., Chanda nama, Puntius sp., Heteropneustes fossilis, Cyprinus carpio, Cirrhinus mrigala,* and *Wallago attu*.

Phytoplankton found at Farakka Lock are *Achnathes, Bacillaria, Caratoneis, Fragillaria, Navicula, Frustulia, Diatoma, Diatomella, Cymbella, Actinastrum, Chlamydomonas, Chlorella, Closterium, Tetracylus, Anabaeana, Ocillatoria,* and *Microcystis.*

Zooplankton of Ganga River at Farakka Lock comprises Protozoa, Rotifera, Copepda, Cladocera. It includes species of Arcella, Difflugia, Noctiluca, Paramecium, Vorticella, Brachionus, Filinia, Keratella, Lecane, Nothlca, Rotaria, Cyclops, Bosmia, Chydorus, Daphnia, and Moina.

Benthos of Ganga River canal at Farakka Lock are *Gabbia sp. Bellamya sp. Lymnaea sp, Belostoma indica* and *Cybister confuses.*

In order to facilitate spawning, all types of fish catching are banned in the Hilsa Sanctuaries located within 10 Km of this site, during June to August and October to December every year. Fishing of Hilsa is prohibited within 5 square kilometre of the Farakka Barrage and between Lalbagh in Farakka, Murshidabad district round the year to protect the Hilsa species and facilitate brooders spawning in the area[26]. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Farakka Lock.

[25] http://www.iucnredlist.org/details/166442/0

[26] *Notification of Fisheries Department, Government of West Bengal dated Tuesday, April 09, 2013 published in The Kolkata Gazette.*

C. Sahibganj Terminal, Samdaghat, Sahibganj district, Jharkhand

Terrestrial biodiversity: The ecology of 10 km zone around the proposed Sahibganj terminal site included protected forest ecosystem, agrarian ecosystem as well as aquatic ecosystem of Ganga river. The vegetation around the 2 km area of the terminal is agriculture ecosystem. There is no forest present within 2 km area of the proposed terminal site. The dominant vegetation comprises Acacia spp., Mangifera indica, Azadirachta indica, and Dalbergia sissoo. However, the southern part of the study area is hilly and fall under forest ecosystem. The forest is classified as protected forest and falls in the jurisdiction of Sahibganj Forest Division. Forests types of the Sahibganj district of Jharkhand are mainly considered as tropical dry deciduous forest (Group 5B/C2) 27 according to the revised classification of forests types of India by Champion and Seth 1968. The natural vegetation in this type of forest is pure formations of Boswellia sp., Acacia sp, Butea sp, Tectona sp, Azadirachta sp, Lannea sp and Flacourtia sp.

Threatened flora and Fauna: No rare, vulnerable and threatened species of flora and fauna were recorded in the study area.

Protected Area: There is no National Park, wild life Sanctuary; Biosphere reserve, wetland and elephant/tiger reserve present within 10-km of the proposed project area.

Aquatic biodiversity: Dolphin (*Platanista gangetica gangetica*) commonly known as Susu as is one of the endangered species found in lower stretch of Ganga River. Very few dolphins were reported at Sahibganj Terminal area in its 500-meter radius. However, during field studies no dolphins were observed in the stretch of Sahibganj terminal.

Aquatic ecology of Ganga river at Samda Ghat includes variety of plankton, fishes and benthos. Phytoplanktons are represented by Bacillariophyceae (diatoms) which is dominant in comparison to Cholrophyceae and Cyanophyceae group. The zooplanktons are represented by Protozoa, Rotifera, Copepoda and Cladocera group. Benthos is represented by Oligochaeta, Insecta, etc.

Fish are represented by Chanda *nama, Channa spp., Chela labuca. Cirrhinus mrigala, Cyprinus carpio, Labeo spp., Mastacembelus armatus, Monopterus spp. Mystus spp., Osteobrama cotio, Puntius spp., Rhinomugil corsula, Rita, Wallago attu and Xenentodon cancila*. Detailed list of flora and fauna around this terminal is detailed in separate EIA of Sahibganh terminal.

[27] Divisional Forest Working Plan of Sahibganj District.Jharkhand

D. Ramnagar Terminal, Varanasi, Uttar Pradesh

Terrestrial biodiversity: The proposed terminal site at Ralhupur, Ramnagar is devoid of any forest. The current land is a fallow land. Total 8-9 trees of Khajur Phoenix sylvestris and Acacia sp. are present on the site and around the site.

Threatened species: No threatened floral, faunal or schedule I species as per Wildlife Protection Act, 1972, amended till date is recorded in the study area.

Protected areas: Turtle Wildlife Sanctuary (TWS)- Kachua Vanyajeev Vihar- is located about 1.95 km in north direction from the proposed terminal at Ramnagar (**Figure 2.45**).

Aquatic Fauna: Gangetic dolphin is reported in river Ganga but not in 10 Km of this terminal site. Turtle are also found in the study area as Kashi Turtle Wild Life sanctuary is located within 10 Km radius study area (refer **Figure 2.45**) to this terminal. Species details have already been presented in earlier section on Kashi Wild Life Sanctuary.

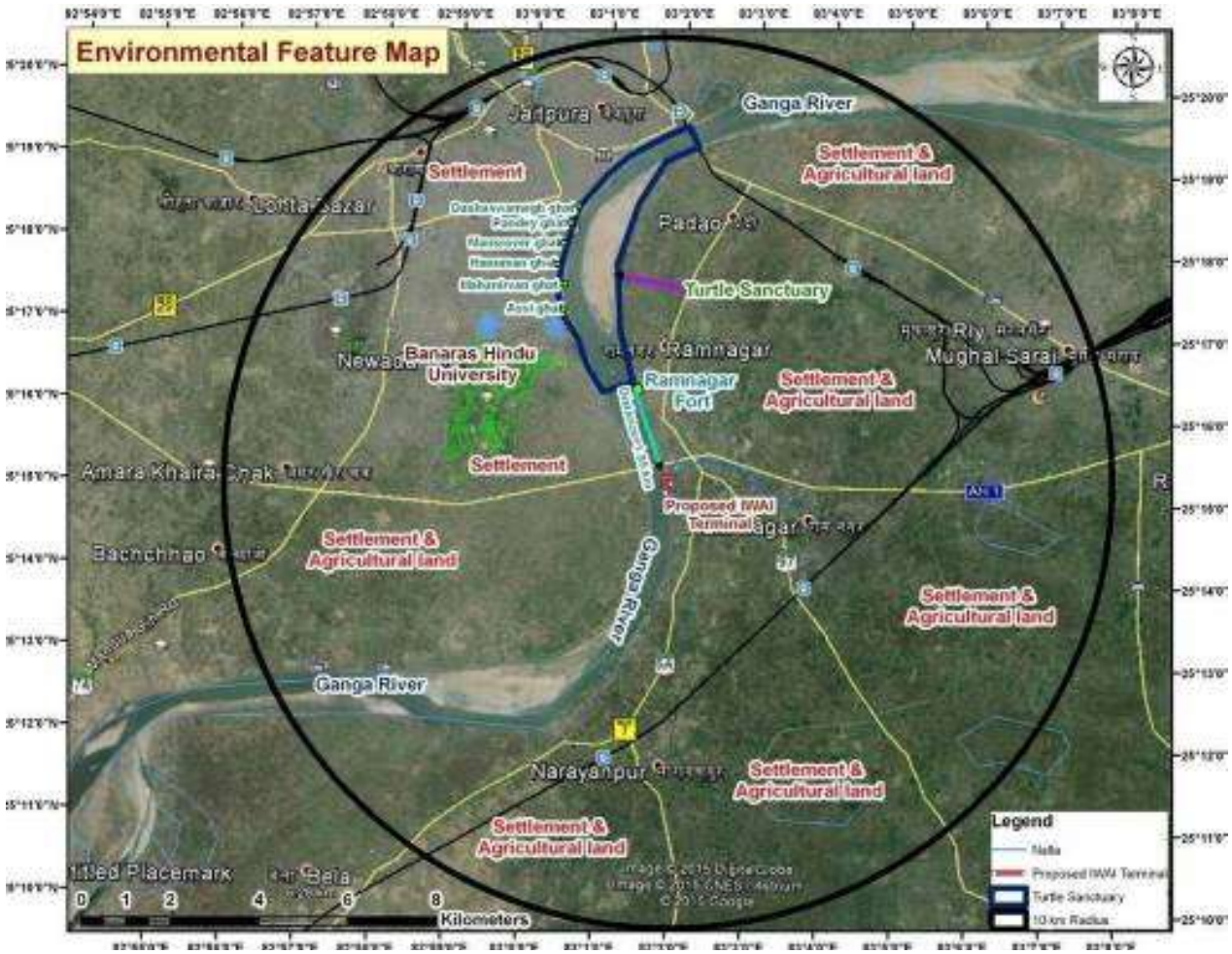


Figure 2.45 : Location of proposed terminal, TWS and study area/NW-1

Phytoplankton group reported from the sampled locations are Bacillariophyceae, Chlorophyceae, Cyanophyceae, Xanthophyceae and Euglenophyceae members. Bacillariophyceae is dominant followed by Chrophyceae and Cyanophyceae observed in studied samples.

Among the zooplankton group, Brachionos sp. (Rotifera) had highest percentage composition and the lowest percentage composition was of Asplanchna sp. The zooplankton Cypris sp and Gastrocypris sp. are also reported.

Zoobenthos in the study area include Gastropods, Annelids and Insects. Gastropods Bellamya sp., Gabbia sp. Lymnaea sp.AndThiaria sp, while annelds are represented by Oligochaetes, and Polychaetes. Insects are represented by Argia sp., Caenis sp. Cloen sp and Enallagma sp.

Fishes include species of major carps like Rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*), katla (*Catla catla*), kalbasu (*Labeo calbasu*),cat fishes like padhan (*Walla go attu*) tengras (*Mystus teengara*) and Magur (*Clarias batrachus*), Singhi (*Heteropneustes fossilis*), Tilapia (*Oreochromis sp*.), Kavai (*Anabas testudineus*), Mahfish (*Barbus sp.*), are recorded in the Ramnagar area of Ganga river. Carnivore fishes namely Walla goattu, Bagarius sp. Mystus sp. and few other minor cat fishes like Clarias, Mystus vittatus etc are also reported.

Ilish fish (Hilsa sp).are no more visible around, which used to migrate up to Allahabad prior to construction of barrage on Ganga river at Farakka, coupled with a high rate of pollution along its course.Detailed list of flora and fauna around this terminal is detailed in separate EIA of Sahibganj terminal.

2.5. Socio-economic Environment

NW-1 passes through four Indian states namely Uttar Pradesh, Bihar, Jharkhand, and West Bengal. Each of the state has distinct socio-economic profile. The socio-economic profile of districts/cities/towns of these states falling along NW-1 are analysed to understand overall socio-economic environment around NW-1 project areas.

2.5.1. *Demography*

Demography is one of the important indicators of environmental health of an area. It includes population, number of households, literacy, population density, etc. Demographic profile of the area was analysed based on 2011 census data.

2.5.2. *Population Distribution in Major Cities along NW-1*

There are many cities, towns and villages located along the NW-1. As per the Census Record of India 2011, the population of major cities/ town located along the Ganga river in NW-1 section was recorded as 12875343 comprising 6782150 male and 6093193 females. Total number of 'Households' was also recorded as 2562165 and 0-6-year age population was also recorded as 1308682. City/town wise Population distribution in study area (NW-1 section) is shown in **Table 2.43** and **Figure 2.46**.

Table 2.42 : Population of Major City & Towns along with NW-1

Sl. No.	Name of Town/City	No of Household	Total Population	Male	Female	Population 0-6-year age
1	Allahabad	205529	1168385	630577	537808	120620
2	Sirasa	1867	12686	6637	6049	1826
3	Gyanpur	2906	19058	10029	9029	2662
4	Mirzapur-cum-Vindhyachal	38185	234871	125601	109270	30340
5	Chunar	5951	37185	19647	17538	4926
6	Varanasi	190835	1198491	635140	563351	135677
7	Saidpur	3505	24338	12716	11622	3578
8	Zamania	4863	33243	17322	15921	5226
9	Gahmar	4365	25994	13367	12627	3650
10	Ballia	15772	104424	55459	48965	11623
11	Ghazipur	19556	121020	63513	57507	15139
12	Buxar	16710	102861	54277	48584	14165
13	Chhapra	31501	202352	106501	95851	29100
14	Fathua	8225	50961	26953	24008	8499
15	Hajipur	24033	147688	78047	69641	20899
16	Patna	294631	1684297	893445	790852	203047
17	Barauni	12964	71660	37858	33802	12723
18	Sonepur	6383	37776	19995	17781	5273
19	Bakhtiarpur	7295	47897	25168	22729	8653
20	Kahagaria	9123	49406	26594	22812	7273
21	Begusarai	48620	261384	138519	122865	41560
22	Barh	9310	61470	32823	28647	9627
23	Bihat	12958	67952	35965	31987	10694
24	Munger	38921	213303	113291	100012	30484
25	Sultanganj	9410	52892	28240	24652	8741
26	Bhagalpur	69984	400146	212813	187333	54818
27	Sahibganj	17076	88214	46449	41765	12262
28	Farakka Barrage Township	4786	20126	10430	9696	1882
29	Pakaur	9333	45840	23653	22187	6352
30	Berhampore	43075	195223	100247	94976	13881
31	Katwa	19382	81615	41350	40265	6799
32	Santipur	36506	151777	77011	74766	13573
33	Hugli-Chinsurah	45005	179931	90217	89714	12604
34	Haora	244135	1077075	561220	515855	91315
35	Kolkata	1024928	4496694	2356766	2139928	339323
36	Diamond Harbour	10048	41802	21050	20752	3688
37	Tamluk	14489	65306	33260	32046	6180
38	Haldia	44065	200827	104841	95986	21945
Total		**2562165**	**12875343**	**6782150**	**6093193**	**1308682**

Source: Primary Census of India 2011

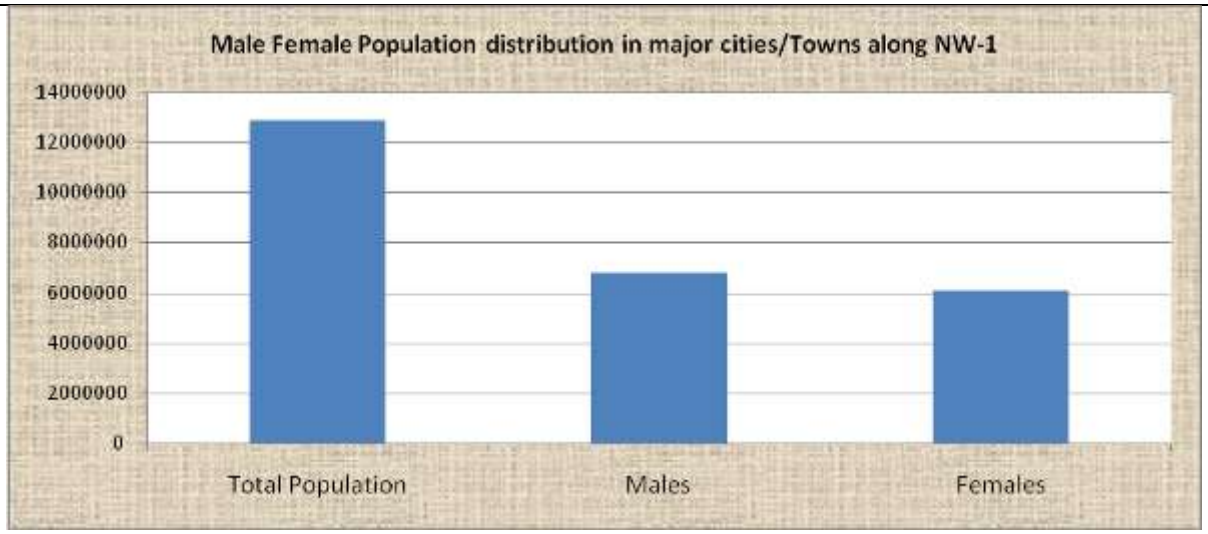


Figure 2.46 : Graphical Presentation of Male-Female Wise Population

2.5.3. *Scheduled Caste and Schedule Tribe Population in Major cities/Town along NW-1*

The schedule Caste (SC) and Schedule Tribe (ST) community are considered as socially weak who are supported by Government through various welfare schemes. Scheduled Caste population consists of 544284 males and 483706 females respectively in major city/towns along the study area and accounts for 7.9% of the total population. The 'Scheduled Tribe' population consist of 27576 males and 25244 females respectively and accounts for 0.41% of the total population (12875343). It implies that 91.6% of total population belong to the general category and other backward classes. SC & ST population profile is given in **Table 2.44** and **Figure 2.47.**

Table 2.43 : Caste wise (SC & ST) Population breakup in cities/towns along NW-1

Sl. No.	Name	SC Population	SC Male	SC Female	ST Population	ST Male	ST Female
1	Allahabad	148794	80023	68771	2694	1494	1200
2	Sirasa	1799	965	834	21	14	7
3	Gyanpur	911	486	425	0	0	0
4	Mirzapur-cum-Vindhyachal	26700	14495	12205	391	204	187
5	Chunar	5657	3053	2604	119	68	51
6	Varanasi	82190	44058	38132	6595	3558	3037
7	Saidpur	6194	3256	2938	28	13	15
8	Zamania	3359	1758	1601	220	118	102
9	Gahmar	3295	1774	1521	327	168	159
10	Ballia	8703	4637	4066	3942	2088	1854
11	Ghazipur	9548	4965	4583	881	464	417
12	Buxar	8619	4612	4007	1800	961	839
13	Chhapra	16629	8739	7890	566	291	275
14	Fathua	7991	4198	3793	29	12	17
15	Hajipur	24908	13132	11776	97	57	40
16	Patna	151924	80521	71403	5139	2527	2612
17	Barauni	5540	2898	2642	195	103	92

18	Sonepur	5158	2721	2437	138	81	57
19	Bakhtiarpur	7122	3676	3446	50	21	29
20	Kahagaria	3782	2029	1753	89	44	45
21	Begusarai	31227	16668	14559	279	138	141
22	Barh	8578	4575	4003	37	22	15
23	Bihat	8540	4556	3984	274	150	124
24	Munger	14562	7632	6930	406	215	191
25	Sultanganj	4839	2552	2287	19	11	8
26	Bhagalpur	32681	17453	15228	1061	493	568
27	Sahibganj	11105	5848	5257	5306	2688	2618
28	Farakka Barrage Township	6604	3423	3181	274	138	136
29	Pakaur	3224	1625	1599	2557	1258	1299
30	Berhampore	19349	9952	9397	1104	625	479
31	Katwa	12189	6146	6043	209	101	108
32	Santipur	33493	17174	16319	2371	1194	1177
33	Hugli-Chinsurah	26157	13353	12804	1306	658	648
34	Haora	35025	18289	16736	3339	1735	1604
35	Kolkata	241932	128053	113879	10684	5729	4955
36	Diamond Harbour	5221	2677	2544	72	34	38
37	Tamluk	4441	2312	2129	201	101	100
38	Haldia	36946	19342	17604	1560	838	722
		1027990	**544284**	**483706**	**52820**	**27576**	**25244**

Source: Primary Census of India 2011

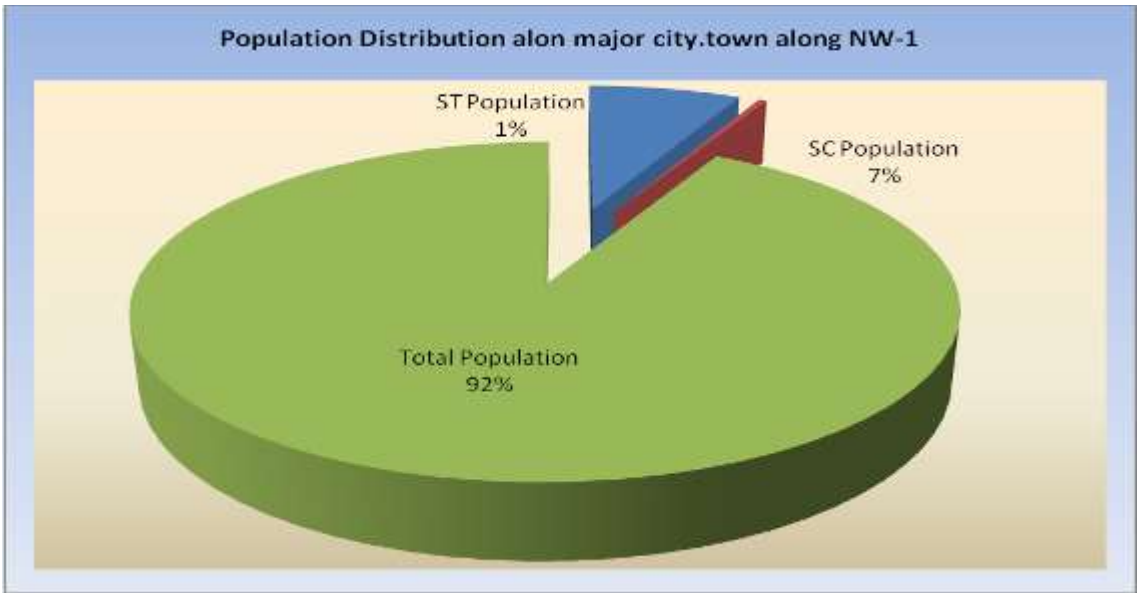


Figure 2.47 : Graphical representation of SC, ST and General Population

2.5.4. *Literacy Level in Major cities/towns along NW-1*

Literacy level is quantifiable indicator to assess the development status of an area or region. The statistic of literate and illiterate male and female population is presented in **Table 2.45 and Figure 2.48**. About 75.4% of the population is literate and 23.6% is illiterate in cities/town located along the NW-1. Male population is more literate than female.

Table 2.44 : Literate and Illiterate Population breakup in cities/towns along NW-1

Sl. No.	Name	Population literate	Male Literate	Male Literate	Population Illiterate	Male Illiterate	Female Illiterate
1	Allahabad	887136	499842	387294	281249	130735	150514
2	Sirasa	8715	5004	3711	3971	1633	2338
3	Gyanpur	13004	7362	5642	6054	2667	3387
4	Mirzapur-cum-Vindhyachal	156408	89938	66470	78463	35663	42800
5	Chunar	24674	14442	10232	12511	5205	7306
6	Varanasi	842497	469653	372844	355994	165487	190507
7	Saidpur	15898	9138	6760	8440	3578	4862
8	Zamania	21462	12473	8989	11781	4849	6932
9	Gahmar	17108	9897	7211	8886	3470	5416
10	Ballia	77331	43298	34033	27093	12161	14932
11	Ghazipur	88656	49359	39297	32364	14154	18210
12	Buxar	74344	41701	32643	28517	12576	15941
13	Chhapra	135951	76783	59168	66401	29718	36683
14	Fathua	29803	17248	12555	21158	9705	11453
15	Hajipur	97372	55206	42166	50316	22841	27475
16	Patna	1234991	685885	549106	449306	207560	241746
17	Barauni	40529	23456	17073	31131	14402	16729
18	Sonepur	25893	14909	10984	11883	5086	6797
19	Bakhtiarpur	27477	16117	11360	20420	9051	11369
20	Kahagaria	35124	19853	15271	14282	6741	7541
21	Begusarai	167178	95014	72164	94206	43505	50701
22	Barh	39168	22578	16590	22302	10245	12057
23	Bihat	44350	25534	18816	23602	10431	13171
24	Munger	146507	82590	63917	66796	30701	36095
25	Sultanganj	31327	18466	12861	21565	9774	11791
26	Bhagalpur	273695	153821	119874	126451	58992	67459
27	Sahibganj	60164	34053	26111	28050	12396	15654
28	Farakka Barrage Township	14394	7907	6487	5732	2523	3209
29	Pakaur	30641	16640	14001	15199	7013	8186
30	Berhampore	163312	85970	77342	31911	14277	17634
31	Katwa	65187	34159	31028	16428	7191	9237
32	Santipur	111806	59588	52218	39971	17423	22548
33	Hugli-Chinsurah	152333	78617	73716	27598	11600	15998
34	Haora	874491	468026	406465	202584	93194	109390
35	Kolkata	3588137	1926915	1661222	908557	429851	478706
36	Diamond Harbour	32753	17193	15560	9049	3857	5192
37	Tamluk	53318	28282	25036	11988	4978	7010
38	Haldia	158380	87334	71046	42447	17507	24940
Total		**9703134**	**5316917**	**4386217**	**3172209**	**1465233**	**1706976**

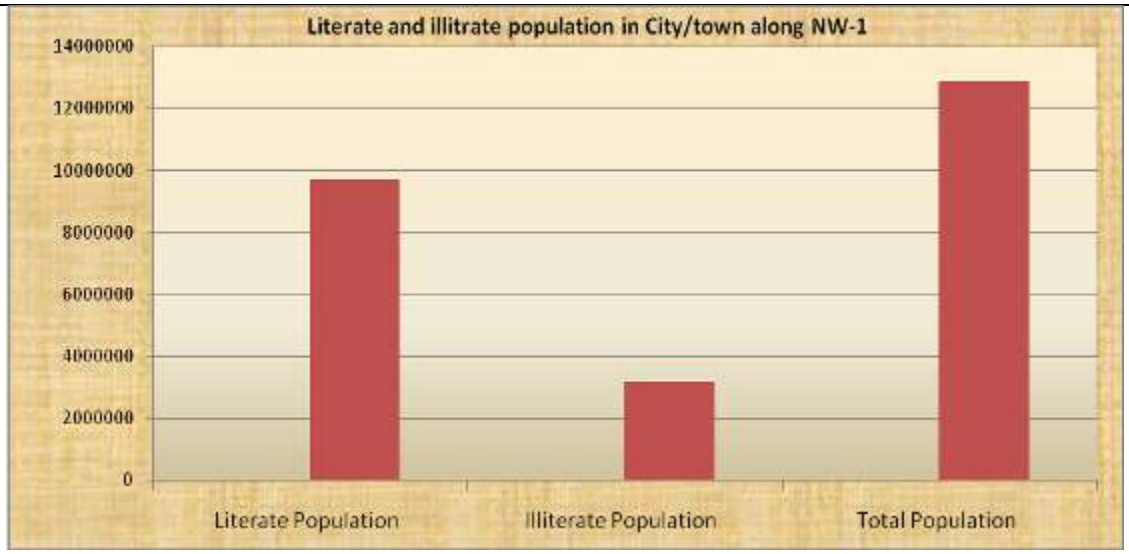


Figure 2.48 : Graphical representation of literate and Illiterate Population

2.5.5. *Workers Scenario and Livelihood Pattern of the community along NW-1*

In cities and town along NW-1 area, the main and marginal workers[28] are 14% and 29% respectively while the remaining 57% of total population constitutes non-workers. The main occupation is agriculture, labour class and trading activities. The workers' scenario is given in the cities and town along "NW-1" presented in **Table 2.46** and **Figure 2.49**. The occupation-based bifurcation of population in study area is provided in **Figure 2.50**.

Table 2.45 : Working and Non-Working Population breakup in cities/towns along NW-1

Sl. No.	Name	Total Workers	Main worker	Marginal Workers	Non workers
1	Allahabad	390202	281443	108759	778183
2	Sirasa	4365	2959	1406	8321
3	Gyanpur	5105	4255	850	13953
4	Mirzapur-cum-Vindhyachal	77247	56326	20921	157624
5	Chunar	11901	7986	3915	25284
6	Varanasi	402122	339305	62817	796369
7	Saidpur	7015	5368	1647	17323
8	Zamania	8459	6527	1932	24784
9	Gahmar	7058	4399	2659	18936
10	Ballia	35256	23069	12187	69168
11	Ghazipur	33464	26881	6583	87556
12	Buxar	26652	23493	3159	76209
13	Chhapra	53479	40896	12583	148873
14	Fathua	13540	11832	1708	37421
15	Hajipur	39836	33596	6240	107852
16	Patna	509839	426086	83753	1174458
17	Barauni	18923	16144	2779	52737
18	Sonepur	9197	7329	1868	28579
19	Bakhtiarpur	12978	8896	4082	34919

[28] A person who has worked for more than 183 days in a year is called the main worker. Marginal workers are those who have worked any time in the year preceding the census but have not worked for major part, which is not more than 183 days, of the year

20	Kahagaria	12925	10808	2117	36481
21	Begusarai	75740	54680	21060	185644
22	Barh (Nagar Parishad)	17152	14417	2735	44318
23	Bihat (Nagar Parishad)	18862	13707	5155	49090
24	Munger	57185	43389	13796	156118
25	Sultanganj(Town)	15403	10520	4883	37489
26	Bhagalpur	119346	95077	24269	280800
27	Sahibganj (Nagar Parishad)	25443	20498	4945	62771
28	Farakka Barrage Township	7174	6153	1021	12952
29	Pakaur	14906	13171	1735	30934
30	Berhampore	73145	68515	4630	122078
31	Katwa	28718	25283	3435	52897
32	Santipur	72023	63783	8240	79754
33	Hugli-Chinsurah	68994	61730	7264	110937
34	Haora	397048	358922	38126	680027
35	Kolkata	1795740	1576419	219321	2700954
36	Diamond Harbour	14808	13178	1630	26994
37	Tamluk	22929	19230	3699	42377
38	Haldia	61216	50792	10424	139611
Total		**4565395**	**3847062**	**718333**	**8510775**

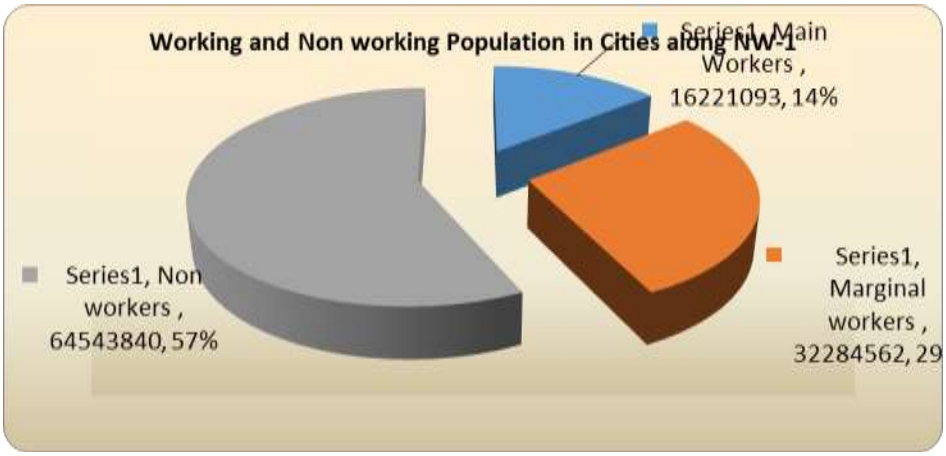


Figure 2.49 : Graphical representation of Working and Non-working Population

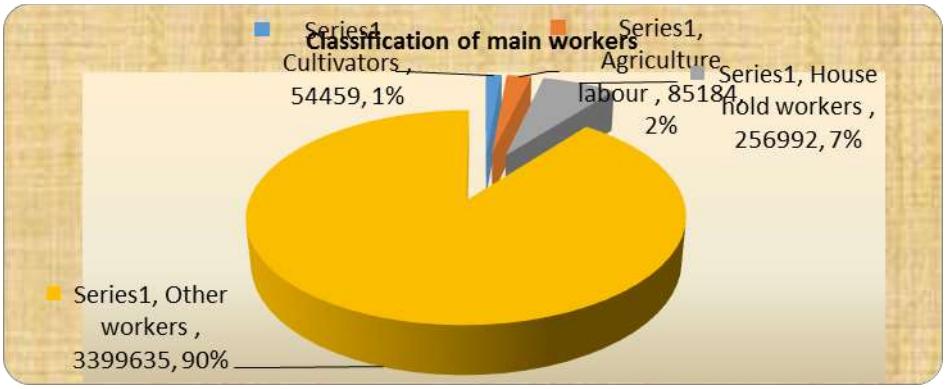


Figure 2.50 : Classification of Main Working Population in cities/town along NW-1

2.5.6. *Livelihood Pattern of the community Depending on the river*

Ganga along the NW-1 state is intrinsically linked to the economy of the area. It provides the necessary silt in much of the land around it, increasing its fertility. Paddy is the greatest crop of the region. Agriculture is the main source of the livelihood generation for the people residing along the NW-1 area. Many towns in the area are primarily industrial. Ganga provides the necessary infrastructure for the factories to perform. Commercial fisheries in the Ganga River System are important source of livelihood for the people residing along the Ganga river. The Ganga in Allahabad and Varanasi is also considered to be most auspicious. Thousands of devotee Hindus comes to the Ghats to pray for their ancestors. Pilgrimage and the associated tourism it brings along is a major source of revenue for this religious town and its people.

2.5.7. *Fishing and Livelihood Generation along NW-1*

Ganga is the most important river and source of livelihood for countless fishers inhabiting on its bank. The fishery in the potamon zone of the river is mainly represented by the species belonging to Cyprinidae and Siluridae families. There is substantial decline in major carps fish catch in Allahabad to Farakka stretch over past few years. In recent period, the fishery showed some improvement due to emergence of exotic species, specifically C. carpio and O. niloticus. Buxer hilsa was the main fishery and with the commissioning of Farakka barrage the fishery declined sharply between 1972-80. Fishery improved during 1981-86 due to improvement in landings of other species. Patna centre also showed drastic decline in major carp landings and as compared to sixties, it was almost half during 1986-93. Decline at Bhagalpur was not as severe as at other centres. Gupta and Tyagi (1991) have discussed the fishery of Ganga with an analytical approach and showed that the fishery is harvested at a level higher than the optimum fishing level and efforts should be made to reduce the fishing pressure to obtain a sustainable fishery from the system.

Fishermen Population and Fishing pattern: It is very important to know the total number of fishers involved in capture fisheries in the NW-1 stretch. It is reported that almost every village along both sides of the river are having some fishermen who earn their livelihood by fishing in the Ganga river. There are no census data available regarding fishers specifically involved in capture fisheries in the whole NW-1 stretch. Generally, one member of the family is engaged in fishing in lower stretch of NW-1(Farakka to Haldia), sometimes two, the average comes to be 1.5. However, in upper stretch (Allahabad to Farakka) the average person engaged in fishing is 1.2 that is mainly due to low fish catch in this stretch. The fishermen do fishing for 5-12 hours daily, depending upon the season. Fishing activities is very less during monsoon season. Fishing is the main occupation to 90% of the fishers, which contribute to more than 80% of their household income. Other major occupation includes fish vending, ferry service, tourism, driving and daily labour. Most of the fisherman does not have agricultural land and small amount of income comes from labour wage, service, and petty business. In the season of less catch, the youth generally engage themselves in labour works or rickshaw van pulling to earn their livelihood.

Fishing Income: The monthly average income of the fisherman ranged from Rs.4000 to 7000 per month in Allahabad to Patna stretch. However, in Varanasi stretch, most of the fisherman are engaged in boating and ferry services now and earning more than fishing. In lower zone (Farakka to Haldia) the average income of fisherman is slightly high and ranging between 7000 to Rs. 10,000 per month because of higher catch and high value fish (mainly hilsa) in the catch.

Fishing Crafts: For fishing purpose, mainly small or medium sized boats are being used. As compared to sixties, the availability of boats per fishermen shows an increase, this may be due to change in fishing pattern. As in past mainly dragnets were used for fishing involving only two boats and more than 10 fishers in a fishing unit. With the passage of time dragnets have lost their place and fishers have switched over to gill nets involving maximum 2-3 persons and a boat. Single piece tin made fishing craft dingi are mostly found in Farakka and surrounding stretch and whereas the wooden boats/ big crafts are mostly found in the lower zone near Haldia.

Nets & Gears: Dragnets, dip net, gill nets, traps, bag nets are commonly used by the fisherman along the NW-1 stretch. Gill nets availability was highest in Patna, Munger and Bhagalpur stretch of NW-1 and lower in Allahabad and Mirzapur stretch of NW-1. Availability of dragnets was low in almost Allahabad to Farakka stretches. Large dragnets were not present at all. Use of hook and lines were

mainly in the Allahabad and Mirzapur stretches of NW-1 whereas traps were more in district Ballia and Bihar stretches. Small scoop nets were available in the entire stretch but large size was available only in lower stretches down to Farakka. Dip nets were observed in Allahabad and Mirzapur districts.

Various forms of gill nets and bag nets are found to be operated by the fishers. Among them gill nets are most prevalent throughout the NW-1 stretch. Around 80% of the fishers were using the gear. The gill nets have different local names like Current jal, Nagin jal, Kajli jal, Phasa jal, Bhola jal, Vacha jal, Ghero jal, Dhoali jal, Gule jal, Pungus jal, etc. A number of variations in material and mesh size in gill nets are observeddepending upon the targeted fishes. However, drift gill nets are the major nets used to catch hilsa, the main migratory fish of Bhagirathi- Hooghly river system. All different types of gill nets have their distinct seasonality in operation depending upon the availability of the target species.

Fishing sites and Jal/net operation in river: Most of the gears, bigger nets are operated inside the river for quite long time. Few bigger nets like Khelpa jal / Bachari jal and hooks can operate from river bank. Gears, bigger nets are more frequently used by the fisherman near Farakka and downstream of Farakka to Haldia. However, the use of Gears and bigger nets is not so common in upper reach from Rajmahal to Allahabad.

2.5.8. *Infrastructure Facilities along NW-1*

The cities and towns along NW-1 has most of required infrastructure facilities. Infrastructural facilities namely Industries/industrial areas, transmission line, national highways, other roads, railways, settlement, cultural sites and archaeological site located within 500 either side of NW-1 is mapped using satellite imageries and limited physical verifications. These are presented in **Figure 2.51 to 2.66**.

A. Transport Network (Road/Rail/Water and Airways)

All the towns and cities along the NW-1 are well connected with national highways, state highways, district roads, railways. Cities like Varanasi, Patna, Kolkata are also connected with airways. Some of cities located along the NW-1 are also connected with localised ferry services as well.

B. **Thermal Power plants along NW-1**

Eleven thermal power plants are located in close proximity of river Ganga between Haldia and Allahabad and 10 more are reportedly proposed to be set up in close proximity of the river. These thermal power plants have boosted the prospect of the waterway like never before for transportation of imported coal to these power stations. Transportation of coal to NTPC power plant at Farakka is already operational through NW-1.

C. Current Pollution Load from Point Sources and its flow at Different Segment of NW-1

There are 30 class I cities and 8 class II towns along the mainstream of river Ganga at NW-1 segment. These cities are discharging 2173.8 MLD wastewater out of which only 959.6 MLD has the treatment Capacity. The City sewage discharge is major source of pollution to river ganga which is another cause of declining fish catch in the river. Status of wastewater generation and treatment capacity in these cities is summarized in **Table: 2.47** and detailed in**Table 2.48.**

Table 2.46 : Wastewater Generation and Treatment Capacity

Category	Wastewater Generation, MLD	Treatment Capacity, MLD
Class-I (30)	2110.4	957.6
Class-II (8)	63.4	2
Total	**2173.8**	**959.6**

Source: CPCB report Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities Class-II Towns of India

Table 2.47 : Sewage Generation of class Cities-I in River Ganga

State	City/Town	Sewage Generation (MLD)	Treatment Capacity (MLD)
Uttar Pradesh	Allahabad	208	89
	Mirzapur	27.5	14
	Varanasi	187.1	141
	Sub-Total	**422.6**	**244**
Bihar	Patna	249.2	109
	Munger	34	13.5
	Bhagalpur	61.6	11
	Katihar	31.7	31.7

	Sub-Total	**376.5**	**165.2**
West Bengal	Kolkata	618.4	172
	Haldia	24.5	24.5
	santipur	18.7	18.7
	Nabadwip	15.5	10
	Basirhat	15.3	--
	Bangaon	13.8	--
	South dumdum	53	52.9
	Rajpur sonarpur	33.6	45.4
	Kamarhati	48.8	40
	North Dumdum	29.7	--
	Naihati	20.5	--
	Ulberia	27.3	--
	Kanchrapara	17	--
	Halisahar	16.8	--
	North Barrackpur	19.2	16.7
	Rishra	13.5	15.3
	Ashoknagar Kalyangarh	17.3	15
	Haora	136.2	63.9
	Bhatpara	59.7	28.5
	Maheshtala	52.5	3.9
	Serampore	26.7	18.9
	Chandannagar	16.1	22.7
	Habra	17.2	--
	Sub-Total	**1311.3**	**548.4**
	Total	**2110.4**	**957.6**

Source: CPCB report Status of Water Supply, Wastewater Generation and Treatment in Class-I Cities Class-II Towns of India

Waste water generation from cities and towns along NW-1 in Uttar Pradesh segment generated is 422.6 MLD i.e. 26% of total wastewater generation. Waste water generation from cities and towns along NW-1 in Biharsegments is 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.

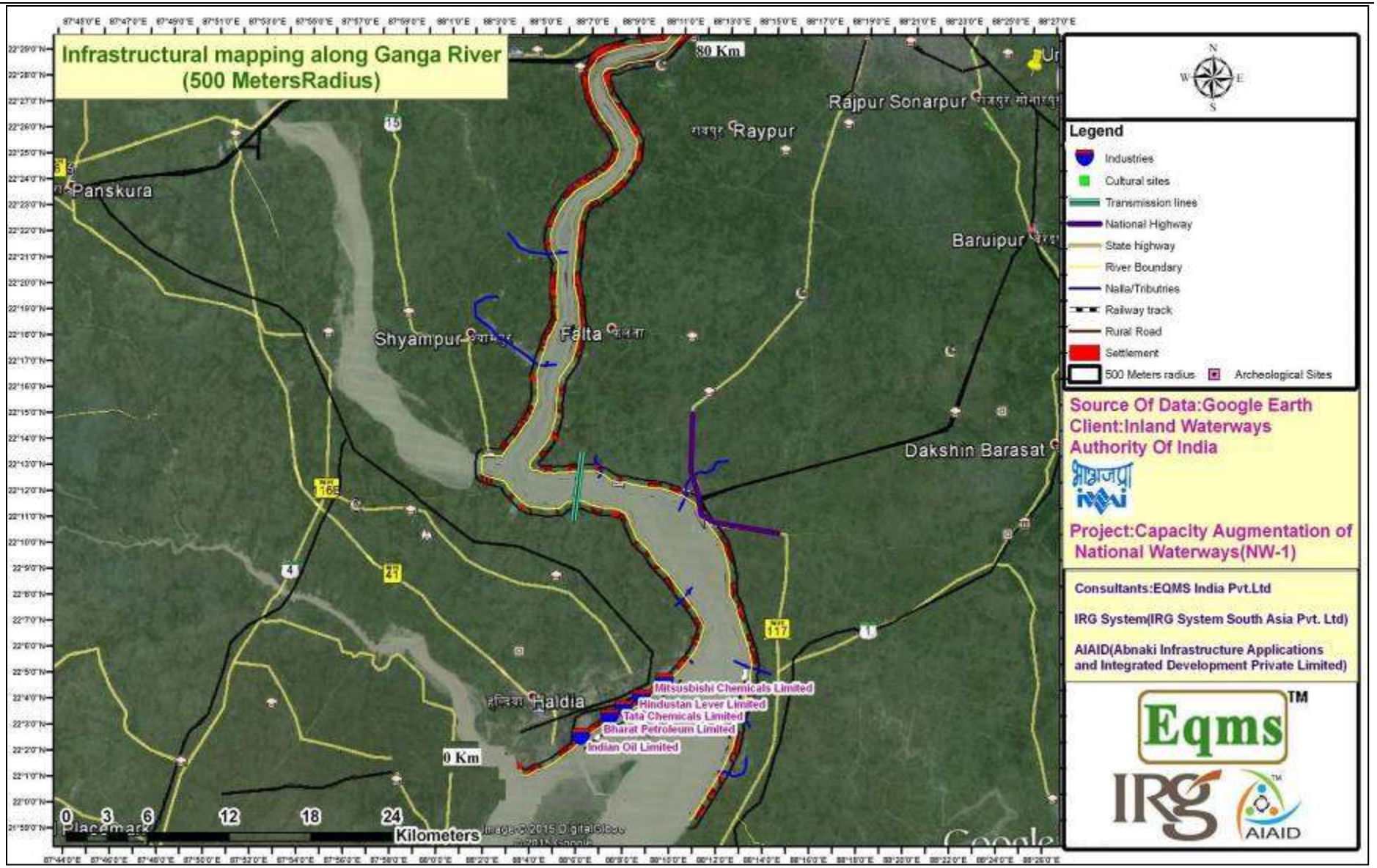


Figure 2.51 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 0-80 km)

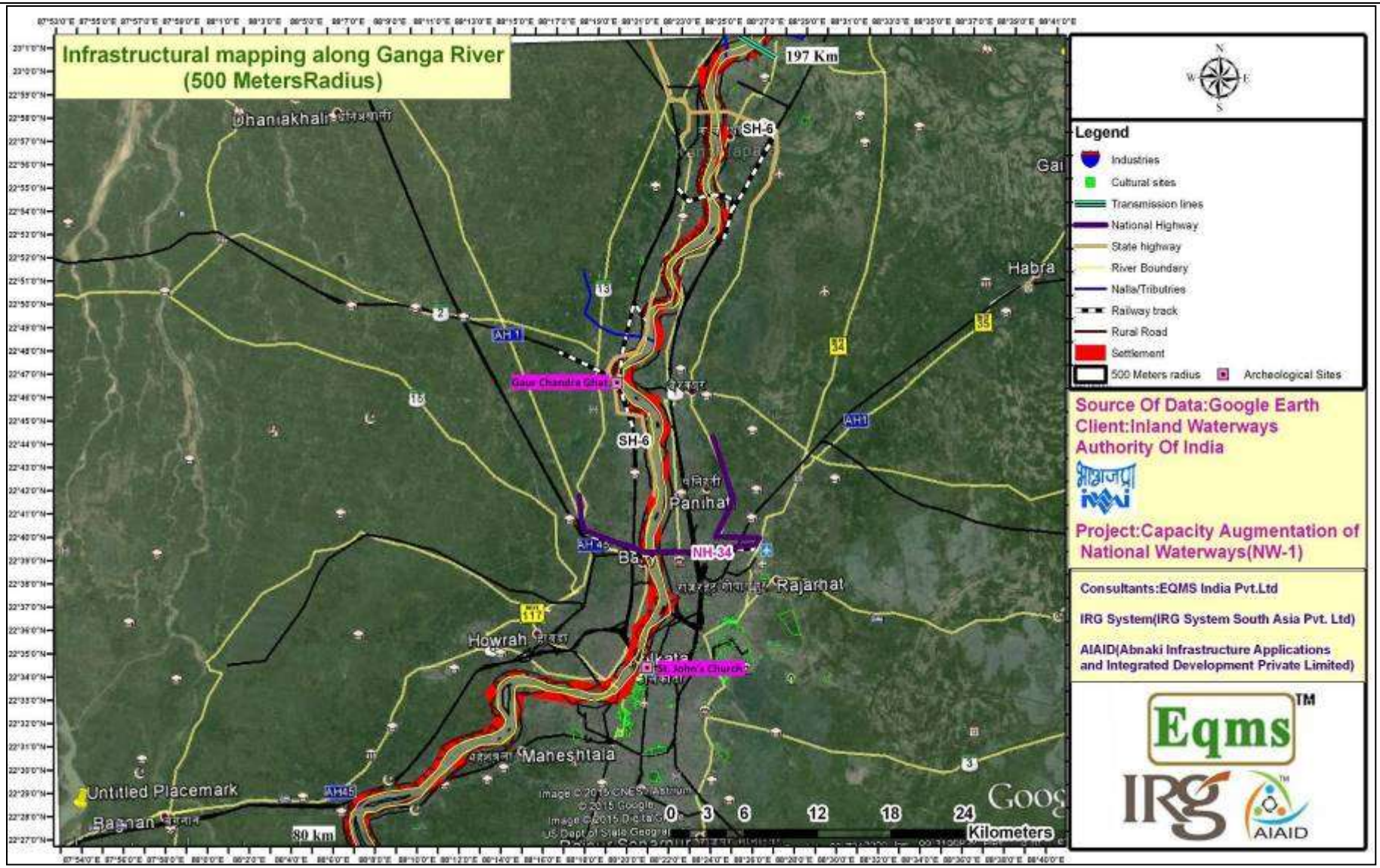


Figure 2.52 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 80-197 km)

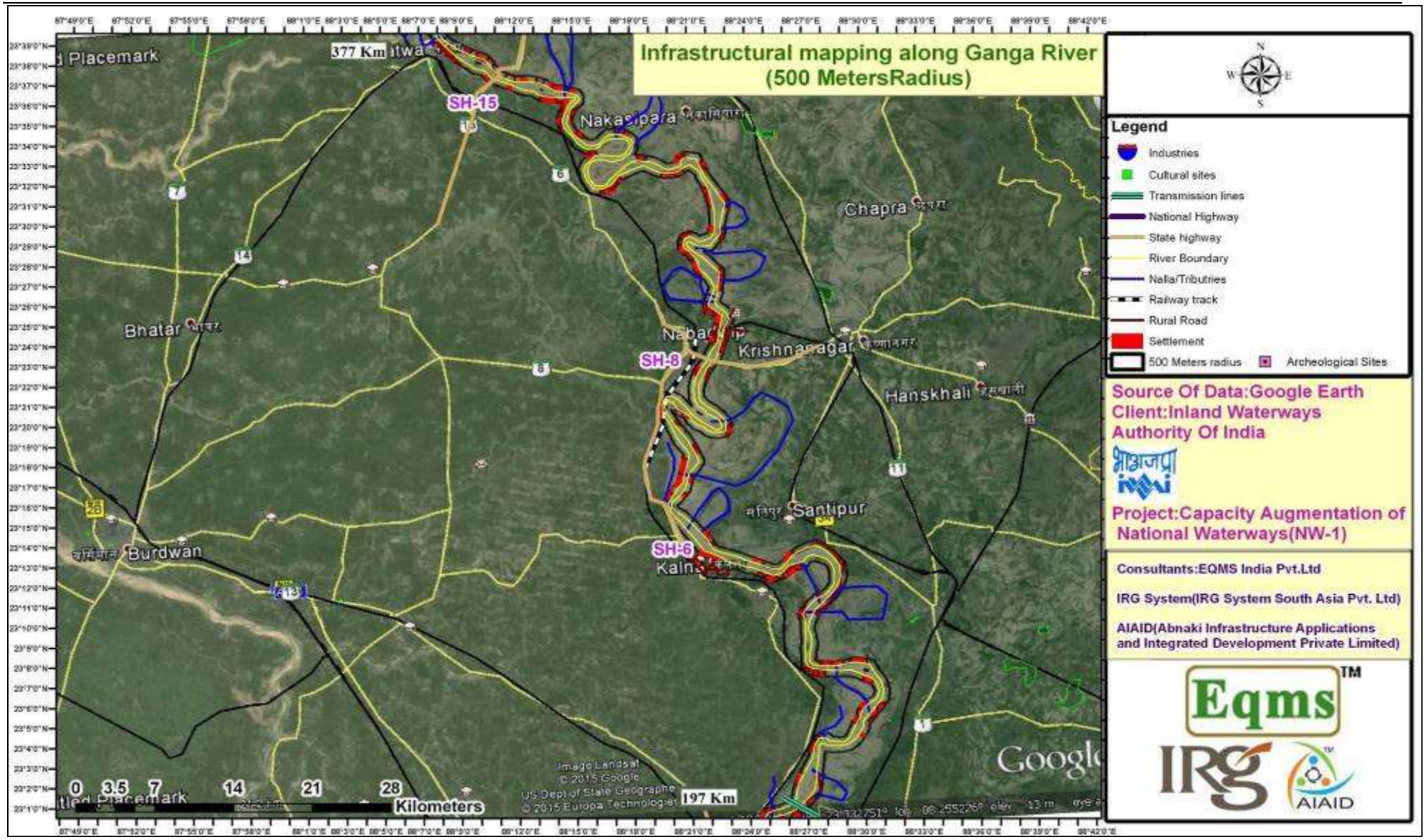


Figure 2.53 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 197-377 km)

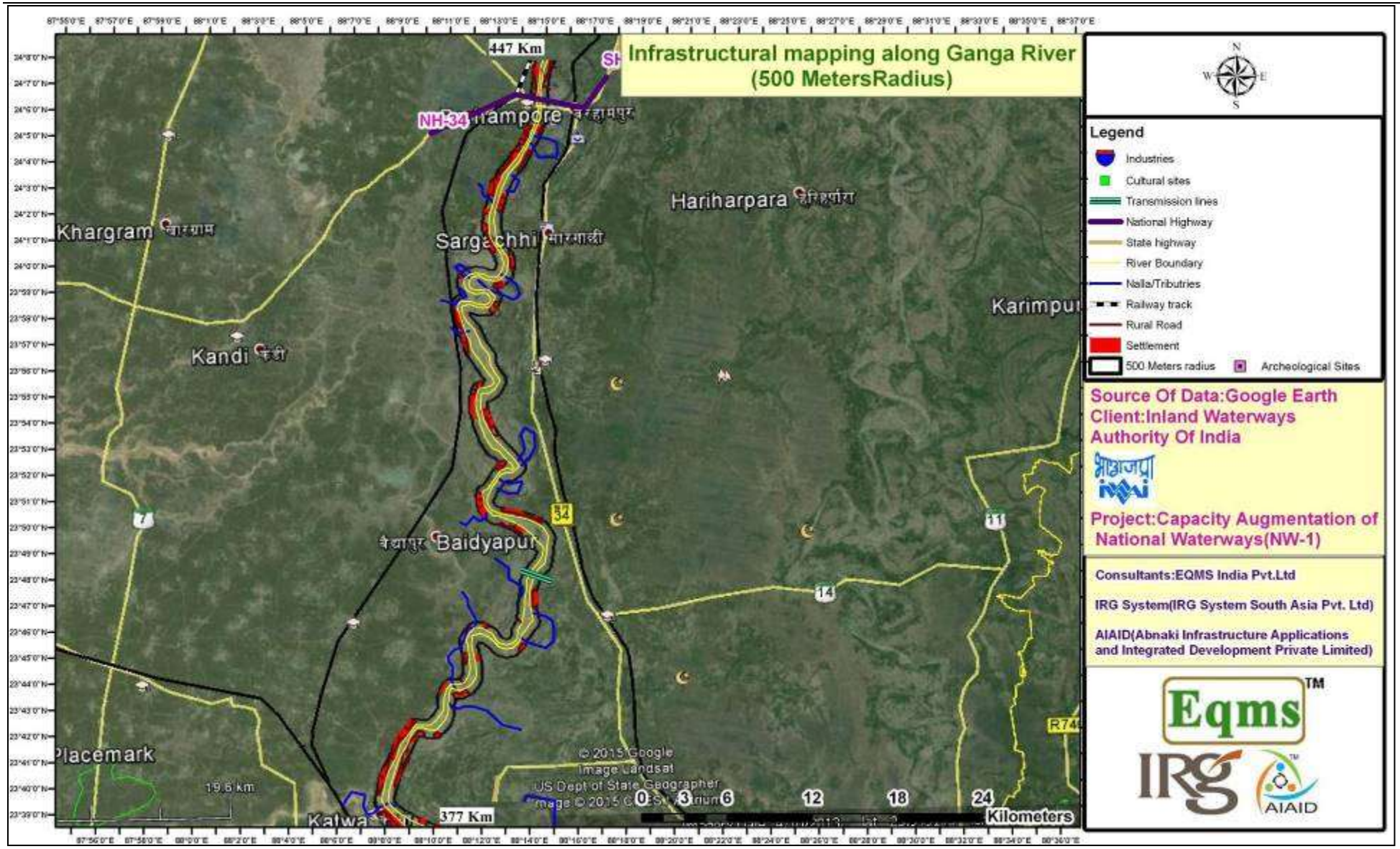


Figure 2.54 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 377- 447 km**)**

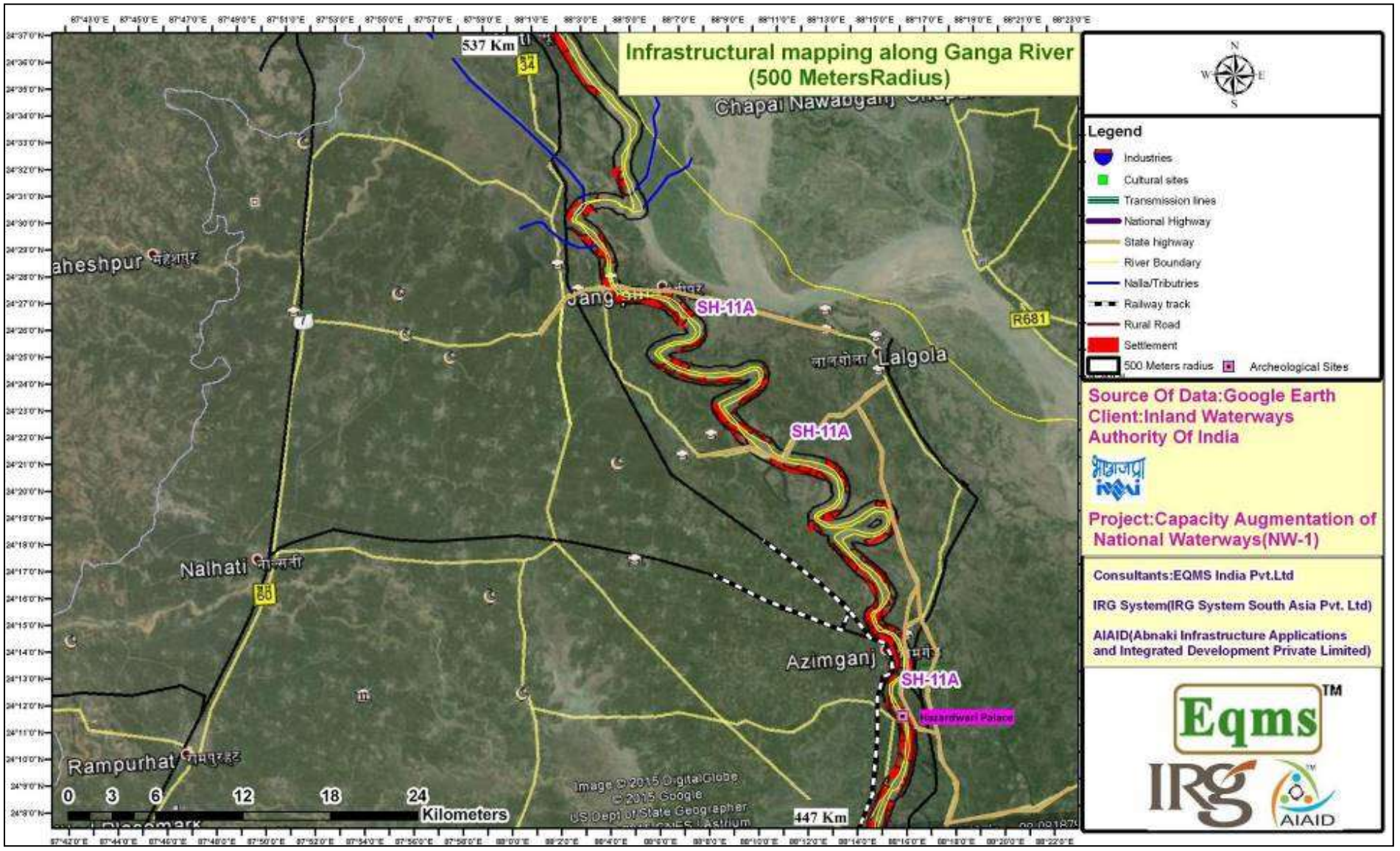


Figure 2.55 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 447-553 km**)**

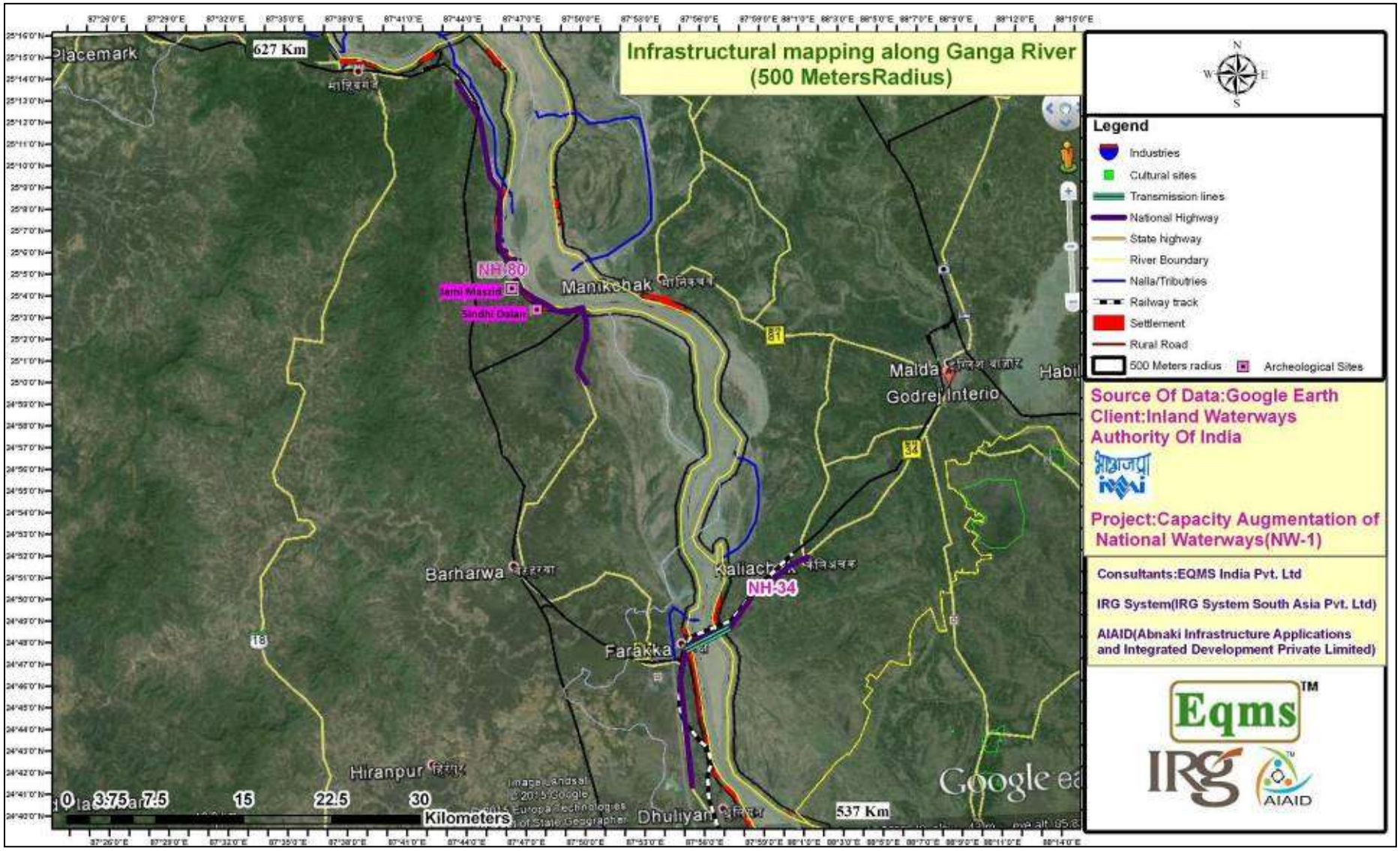


Figure 2.56 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 553-627 km**)**

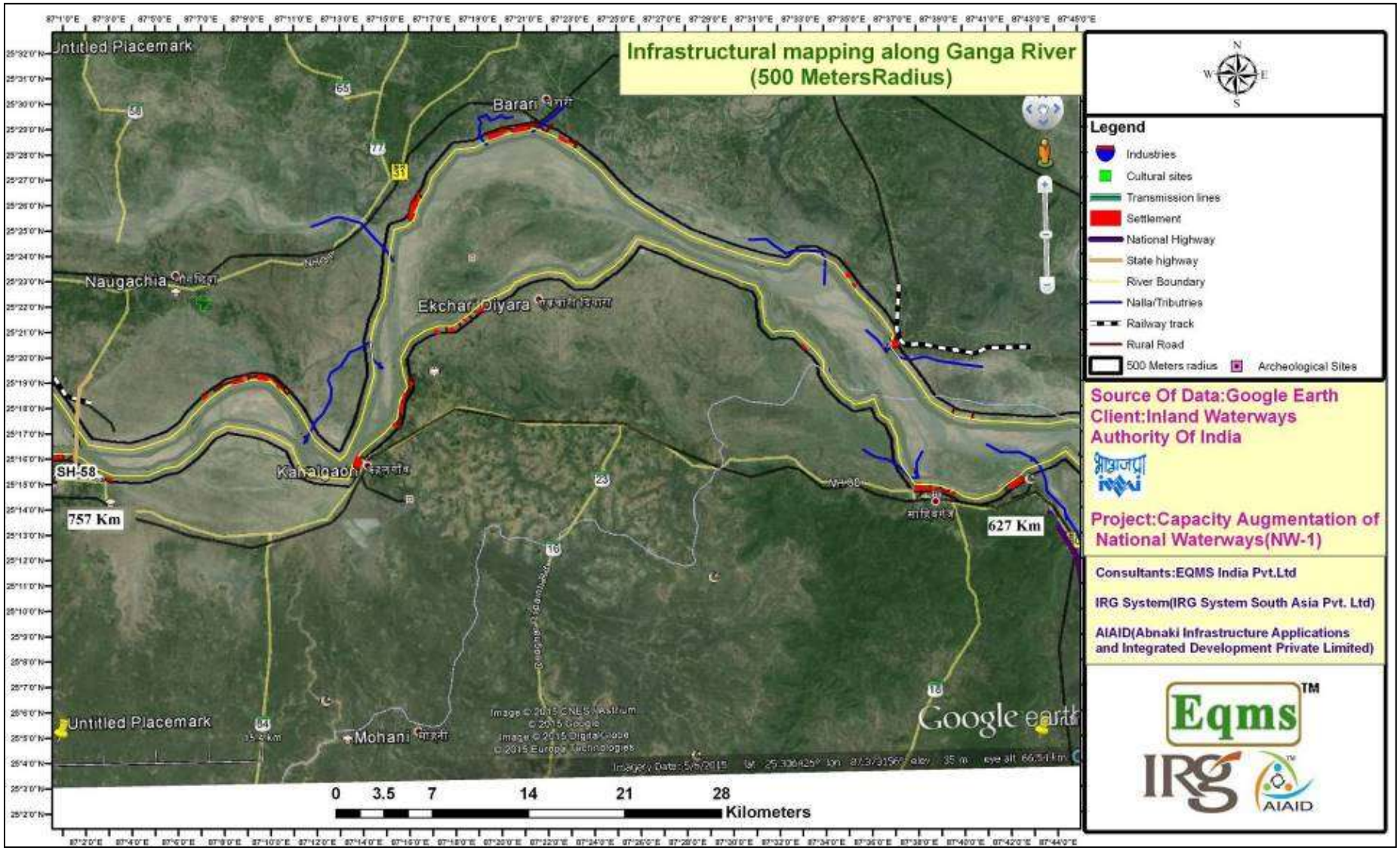


Figure 2.57 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 627-750 km**)**

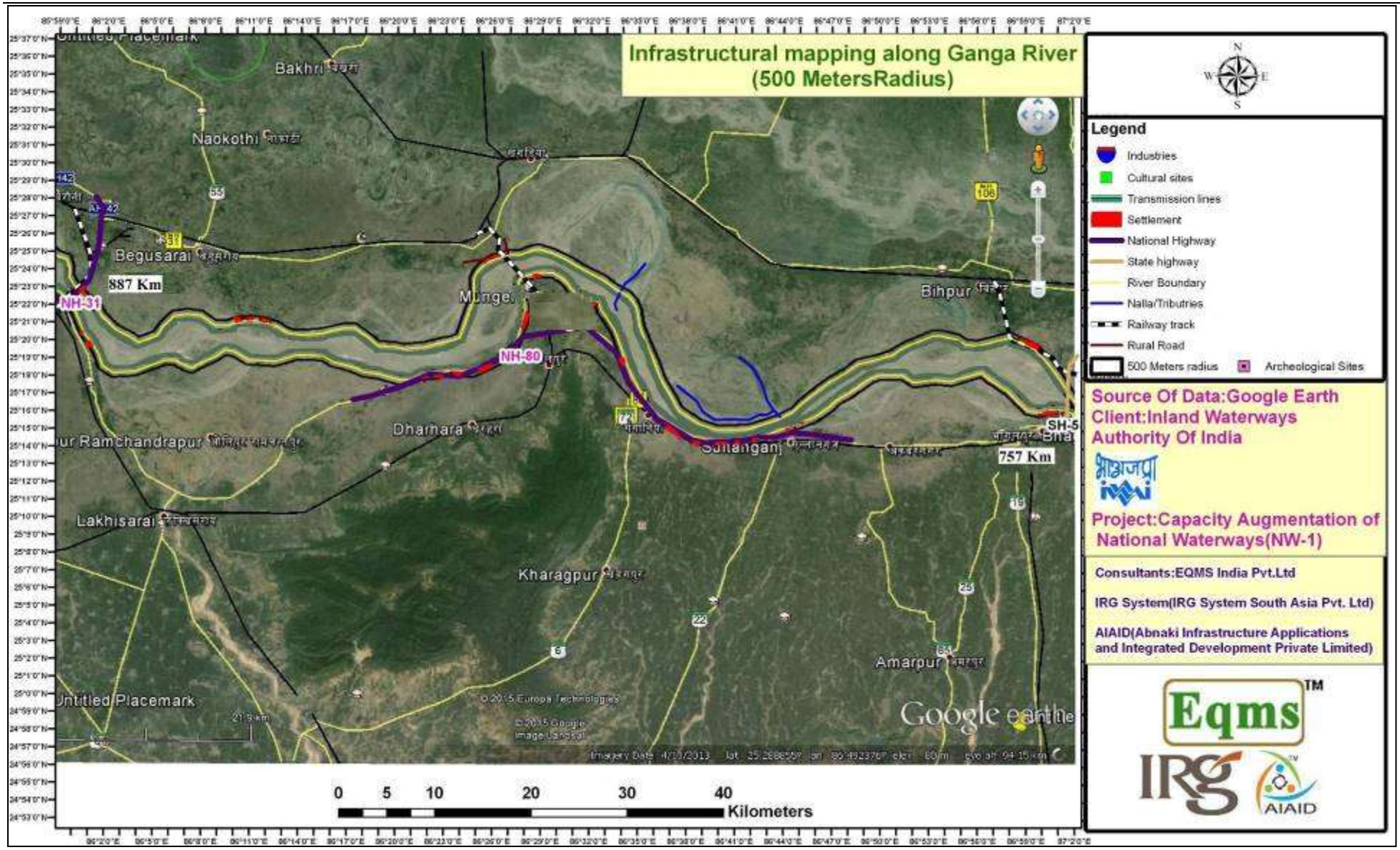


Figure 2.58 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 750-887 km**)**

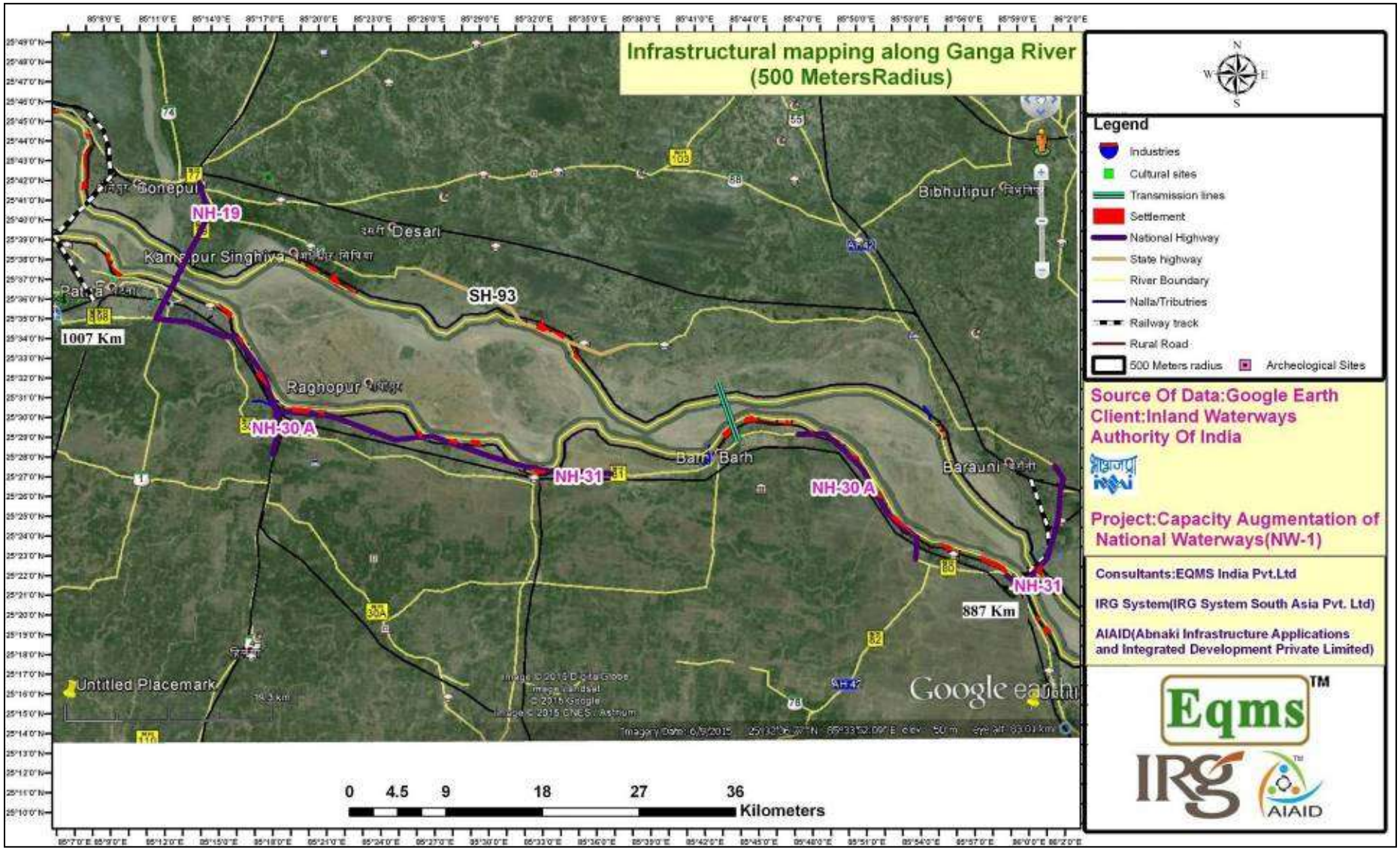


Figure 2.59 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 887-1007 km)

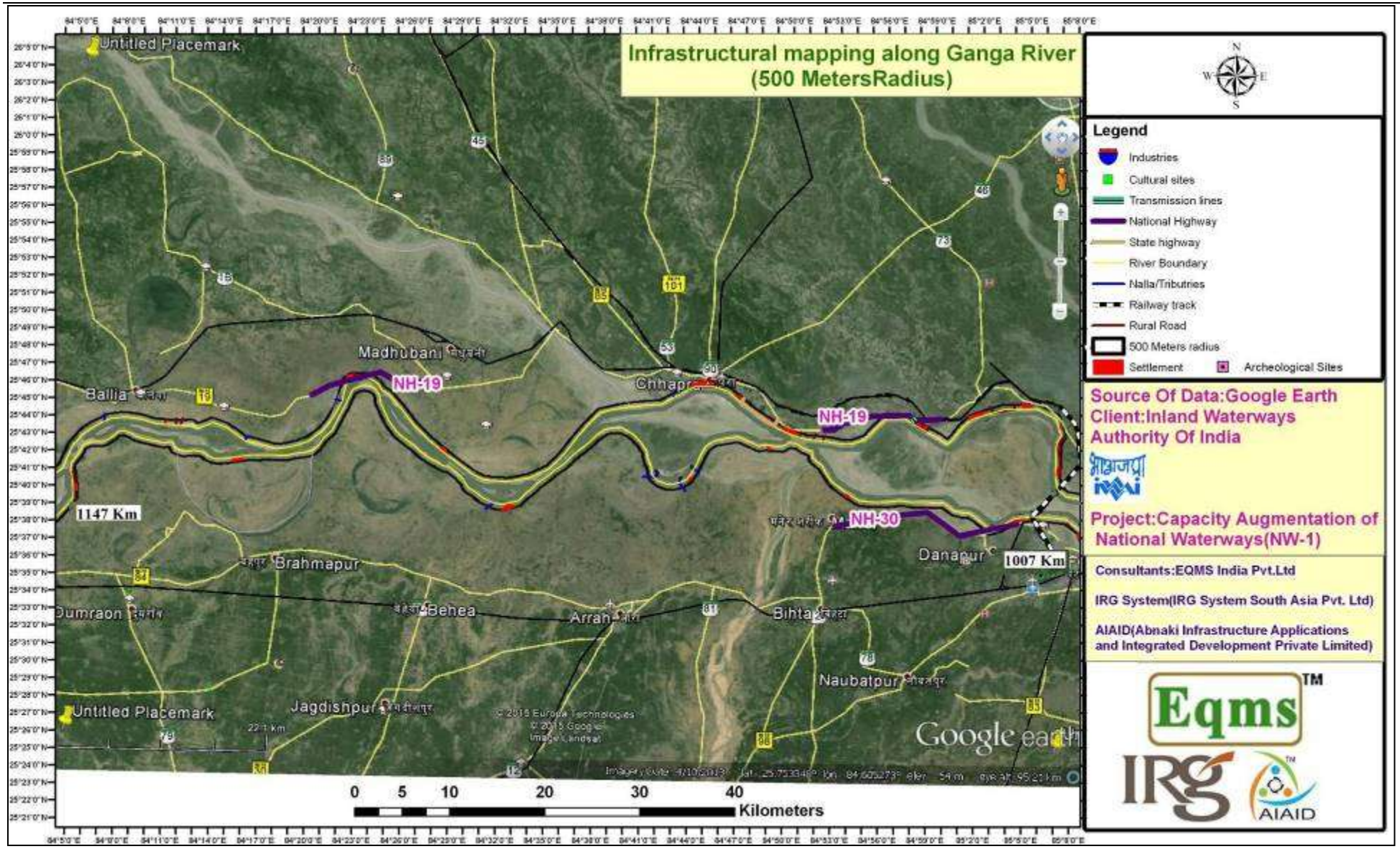


Figure 2.60 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1007-1147 km)

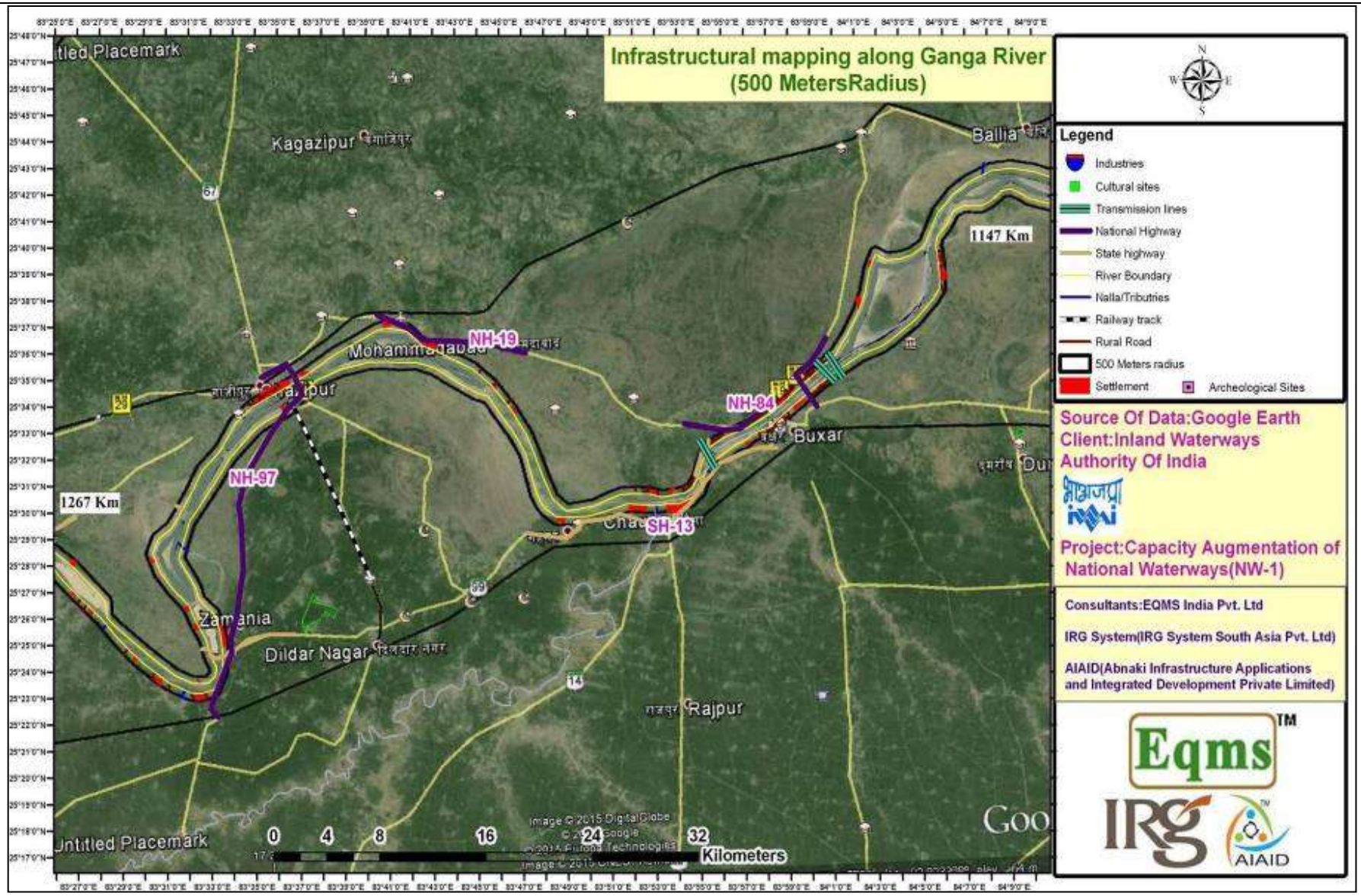


Figure 2.61 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1147-1267 km)

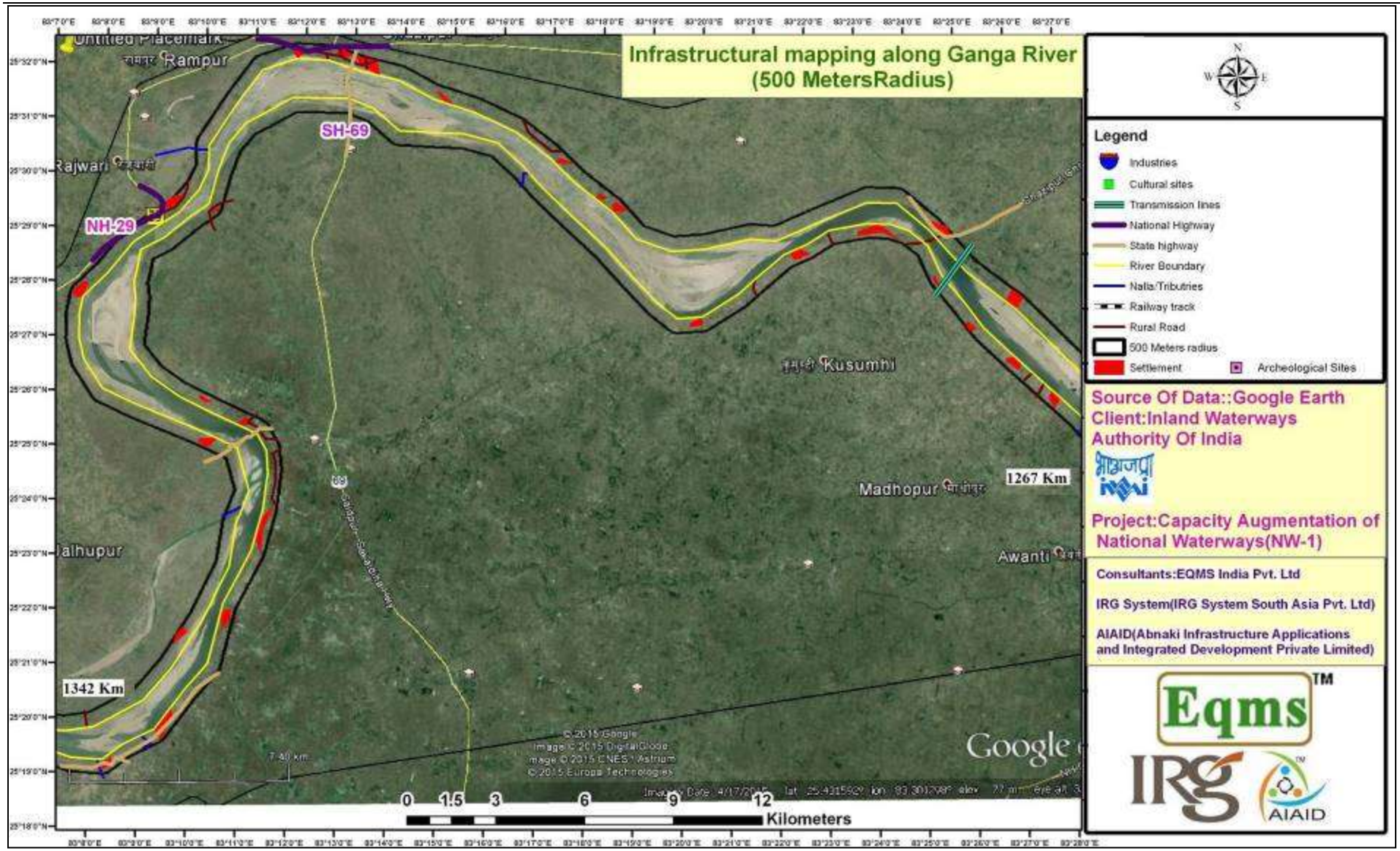


Figure 2.62 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1267-1342 km)

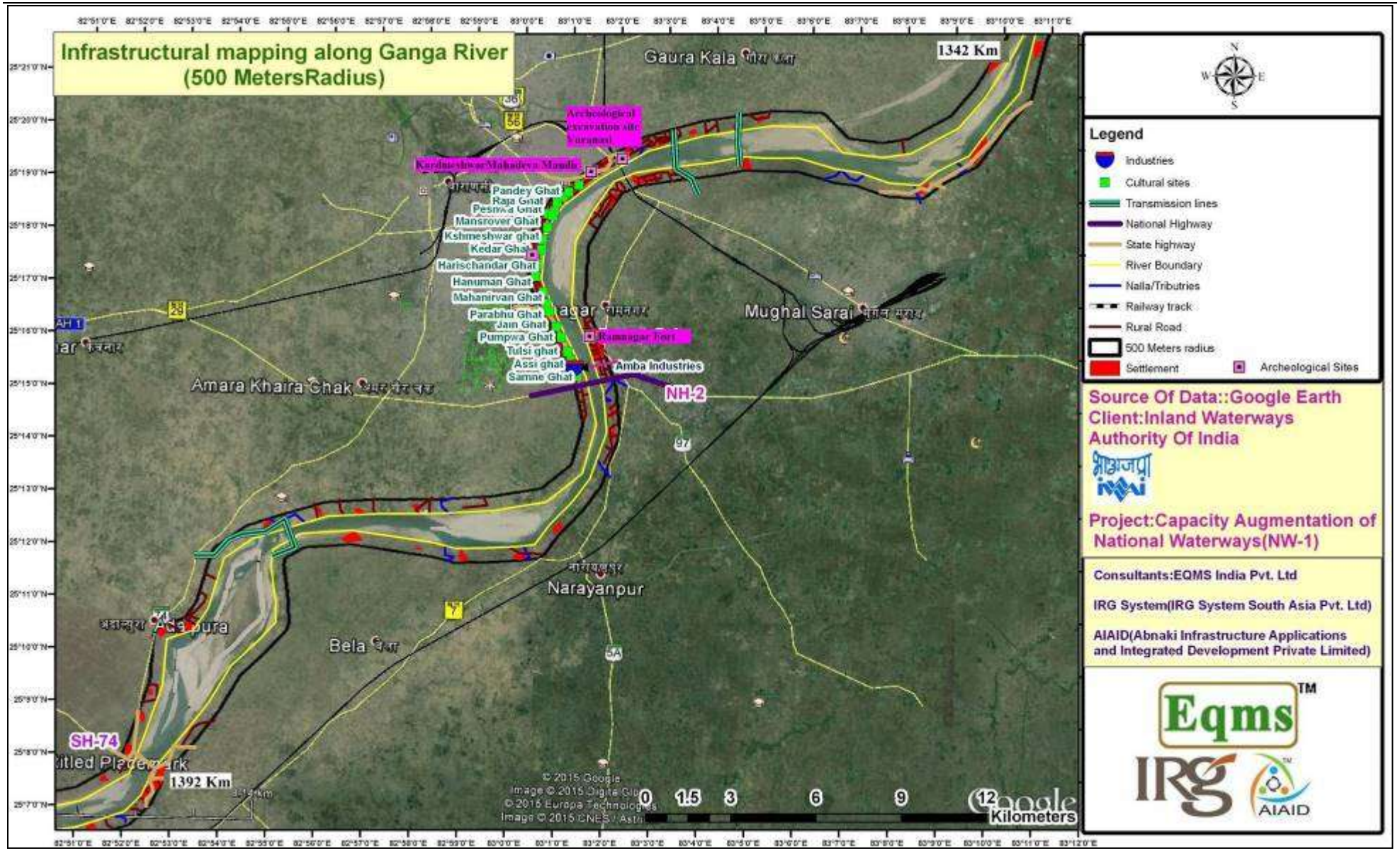


Figure 2.63 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1342-1392 km)

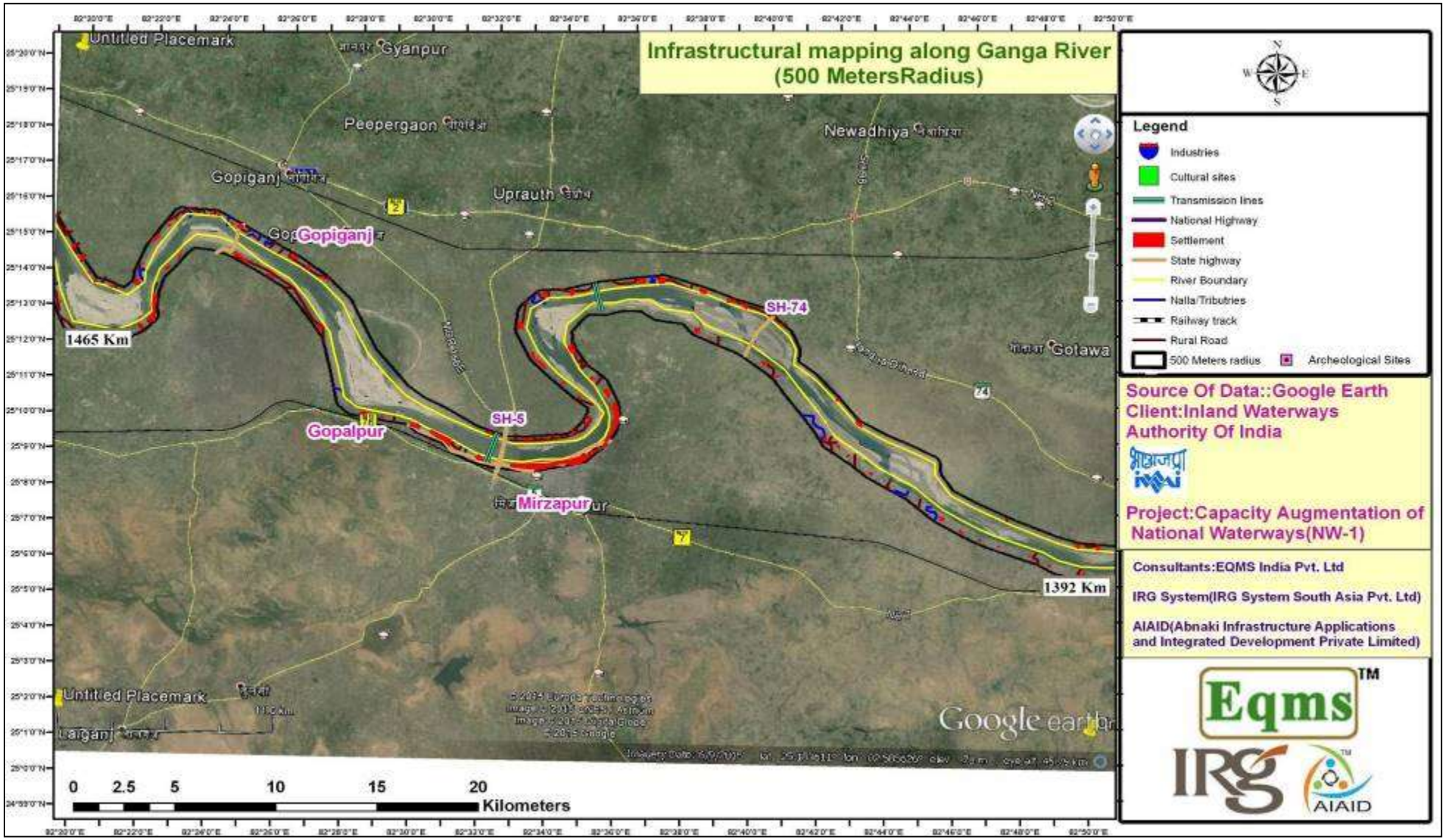


Figure 2.64 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1392-1465 km)

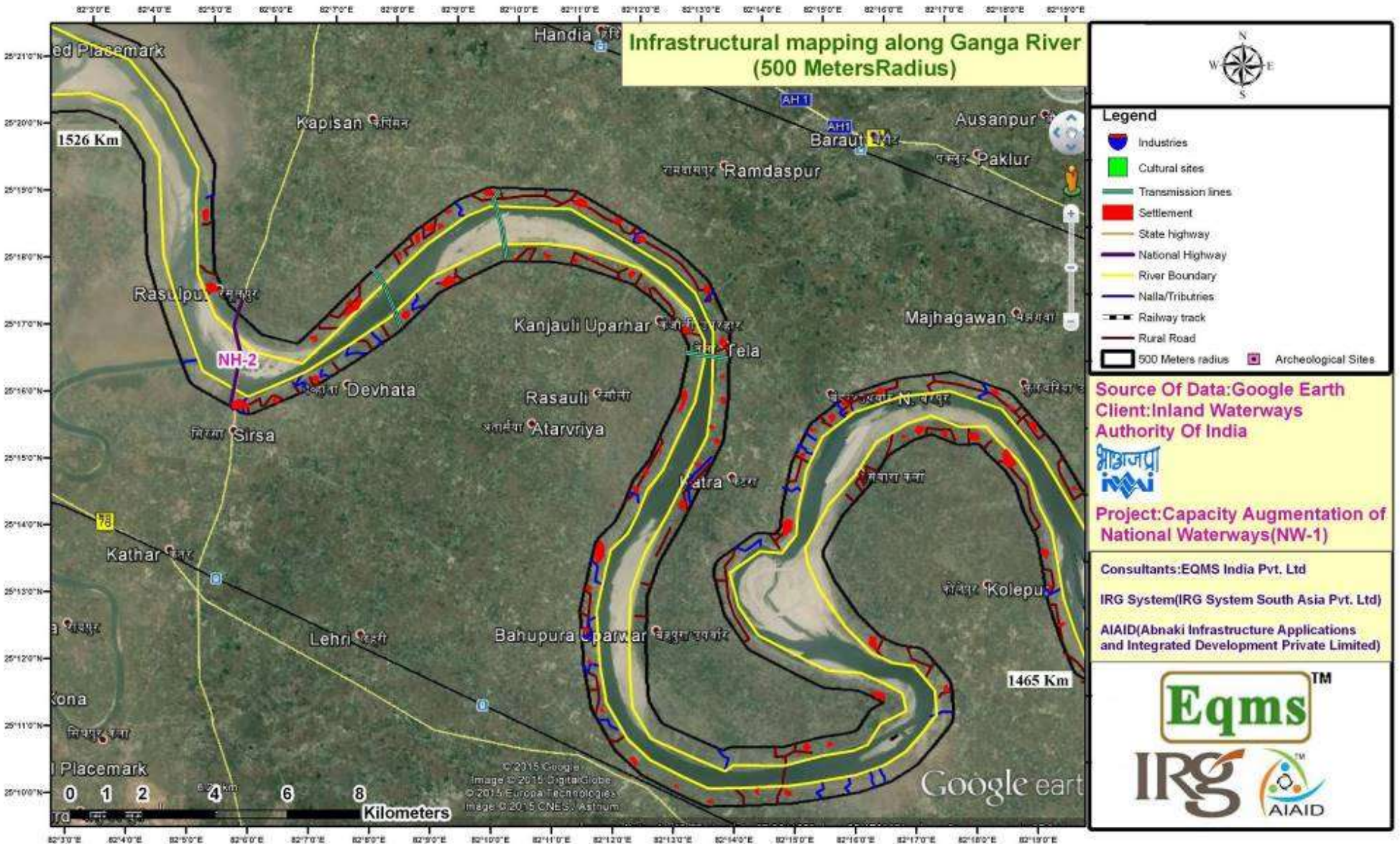


Figure 2.65 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1465-1526 km)

Figure 2.66 : Infrastructural Mapping along 500 m area of NW-1 (Chainage 1526- km)

2.5.9. *Cultural Activities and Religiously Important Places along NW-1and Important Festivals*

Ganga river is worshipped in India and holds an important place as it is considered sacred and holy river in Hindu religion. Hindu people believe that holy dip in river Ganga washes their sins. This dip is considered more important at religious places at Allahabad and Varanasi located along NW-1. Hindus also believes that bathing in the river on certain special occasions and periods causes the forgiveness of sins and helps attain salvation. People also travel from distant places to immerse the ashes of their kin in the water of the Ganga. This immersion is also believed to send the ashes to heaven. Various festivals are organised on the bank of rivers at different places and different period. These festivals attract very large crowds and may have bearing even on movement of barges in NW-1 during festival periods. The list of culturally and religiously important places with its festivals along the NW-1 is givenat **Table 2.49**.

Table 2.48 : Culturally and Religiously Important Places with Fair and Festivals

S.No.	City	Place	Fairs & Festivals
1	Allahabad	Sangam	**Kumbh Mela:** The confluence of the 3 rivers Ganga, Jamuna and the sacred and mythological river Saraswati at Sangam is considered to be quite auspicious for the Hindu community. It is said that when Lord Vishnu carried a pot or Kumbha of Nectar or Amrita, a fight broke out among the gods. In the milieu, four nectar drops fell on the earth at the four place which are known as the Tirthas and include Nasik, Haridwar, Prayad and Ujjain. These places are  therefore,considered as place where the mortal humans can pass on to a celestial world form the human world. In each of these locations, there is a kumbha mela held but on the 12th year, the mela is organized in Allahabad as it is considered as the most sacred of the Tirthas. The Greatest Kumbha Mela is held in Allahabad which is also known as Maha Kumbha Mela and is the biggest fair related to religious practices. **Magh Mela:** Apart from the Maha Kumbh and another Kumbh mela by the name of Ardh Kumbh, there is the Magh Mela. Maha Kumbh is held every 12th year in the city of Allahabad which is a sacred city in the state of Uttar Pradesh. As because

			the Magh Mela falls during the period of Magh months of Jan and Feb, so the name has been given. During this period, the devotees take a holy bath at the confluence of the 3 rivers believing that the waters will wash away their sins.
2	Varanasi	Ghats	 There are more than 100 Ghats along the Ganga river at Varanasi (steps leading to the water of the Ganges). The banks of the Holy River at Varanasi are the most preferred cremation grounds.
		Ghats	**Panch Koshi Parikrama:** This parikrama starts and finishes at Manikarnika Ghat and has the great importance in ancient Parikrama of India. The devotee will pass through the five great places that's why it has named so behind this. The five places of which the devotees have to round up and complete his Panch Koshi Parikrama are Kardmeshwar, Shivpur, Rameshwar, Bhimchandi and Kapildhara. **Ganga Mahotsav**: This festival is being celebrated in the months of October and November which is the tourism festival of Varanasi that is being celebrated from Prabodhani Ekadashi to Kartik Purnima (November month) ending by a dance presentation at Ganga Mahotsav. The rich cultural heritage of Varanasi is being reflected by this festival. Besides various cultural programs and the boat racing the martial arts are also presented. This festival also corresponds with another traditional festival of Dev Deepavali in which all the Ghats of Varanasi are enlightened by thousands of Diyas. **Dhrupad Mela:** This mela is basically a music festival that is organized on the Tusli Ghat for five days (Feb or March month) in which the renowned artists of the area give their performances. This mela is especially famous among the foreign tourists.
3.	Bihar & Jharkhand	Ghats	**Chatth Puja:** Chhath is an ancient Hindu festival dedicated to the worship of the Lord Sun in November month and is mainly celebrated in Bihar and Jharkhand on the banks of Ganga.

2.5.10. *Tourism*

The river is of great cultural and religious significance for all Indians. All of this makes the Ganges a must for all tourists who wish to encounter all of India's diverse beauty in terms of both culture and nature. There are many cities along the banks of NW-1 specially Allahabad, Varanasi and Kolkata which are important from tourism prospective and attract thousands of religious and non-religious tourists every year. Varanasi, a pilgrim place for Hindus and Buddhists alone attracts over one million pilgrims every year followed by Allahabad.

2.5.11. *Existing Waste Management Facilities along NW-1*

The municipal and bio-medical waste management facility is available at select cities only along the entire stretch of NW-1. Common Hazardous waste facility is available only at Haldia in NW-1 area. The status of these facilities in select cities along the NW-1 is described below:

Allahabad (Uttar Pradesh): Currently, the local body of Allahabad Municipal Corporation collects and dispose its municipal solid waste through Allahabad Waste Processing Company Pvt. Ltd (AWPCPL at Solid Waste Disposal Site (SWDS) located near Kareli which is about 4 km away from the Allahabad railway station and functions on composting technology. The compost that is generated from this plant will be supplied to local agricultural farms.

Municipal solid waste treatment facilities in Varanasi (Uttar Pradesh): Varanasi Municipal Corporation (VMC) currently collects municipal waste and dispose to unorganized dumping site located 20 Km away from the city in Karsada. Construction of a treatment plant and organized landfill site is planned under JNNURM.

Bio-medical waste treatment facilities in Varanasi (Uttar Pradesh): Varanasi Nagar Nigam has established Common Bio Medical Waste Treatment Facility (CBWTF) at 310-Mohan Sarai, National Highway and is well managed.

Solid waste disposal Facilities in Patna (Bihar): Solid waste management is an overall responsibility of the Municipal Corporation as per Bihar Municipal act 2007 and MSW (management & Handling) rules 2000. Patna Municipal Corporation (PMC) is responsible for development of municipal waste land fill sites but it is yet to develop an organized land fill site. At present municipal waste is dumped in identified unorganized dumping sites. Bihar Urban infrastructure development Corporation Ltd (BUIDCO) has also initiated the process of an integrated Solid Waste Management process plant at Patna on PPP mode with power generation capacity of 8 MW electricity.

Solid waste Disposal in Bhagalpur (Bihar): No organized or bio medical waste disposal facility is available in this city.

Solid waste disposal facilities in Kolkata (West Bengal): About 95% of total waste generated in Kolkata Municipal Corporation (KMC) area is disposed at Dhapa landfill site and the rest at Garden Reach dumping ground. 700 TPD compost plant is set up by M/s. Eastern Organic Fertilizer Ltd. with technical back up of Excel Industry, Mumbai. Plant was set up and commissioned in the year 2000 and operated at 200 – 250 TPD

capacity till 2003. Since 2003, Eastern Organic Fertilizer has stopped operating the plant because they are unable to sell the compost with reasonable profit margin and failed to meet their commitments towards KMC.

Haldia (West Bengal): The first Common Storage, Treatment and Disposal Facility (CSTDF) for hazardous waste under the Public Private Partnership (PPP) have been developed at Haldia. It is a joint venture project of Haldia Development Authority (HDA) and M/s Ramky Enviro Engineers Limited. In April 2003, the HDA and M/s Ramky Enviro Engineers Limited formed a joined venture company under the name and style as M/s West Bengal Waste Management Limited to develop and operate the integrated waste management complex for taking care of the industrial hazardous wastes of West Bengal. Apart from these, the facility will also deal with the biomedical waste as well as municipal solid wastes for the adjacent municipal areas.

2.5.12. *Water Born Diseases*

Waterborne diseases increase where standards of water, sanitation and personal hygiene are low. Contaminated drinking-water is a frequent cause of diseases such as cholera, typhoid, viral hepatitis A and dysentery, malaria, dengue. The extent and effect of water born diseases in the states traversed by NW-1 are given in **Table 2.50** to **Table 2.53**.

Table 2.49 : Epidemiological status of Malaria in 2010 and 2011 in the States Traversed by NW-1

States	Year	Population	Cases	Deaths
West Bengal	2010	84908	134795	47
	2011	98922	66368	19
Jharkhand	2010	32187	199842	16
	2011	32928	160653	17
Bihar	2010	103230	1908	1
	2011	103483	2643	0
Uttar Pradesh	2010	188015	64606	0
	2011	194373	56968	0

Sources: National Vector Borne Disease Control Programme

Table 2.50 : State-Wise Dengue Cases and Deaths in the States Traversed by NW-1

No. Sl.	State	2008		2009		2010		2011	
		Case	Death	Case	Death	Case	Death	Case	Death
1	West Bengal	1038	7	399	0	805	1	510	0
2	Jharkhand	0	0	0	0	27	0	36	0
3	Bihar	1	0	1	0	510	0	21	0
4	Uttar Pradesh	51	2	168	2	960	8	155	5

Sources: National Vector Borne Disease Control Programme

Table 2.51 : Kala-azar cases and deaths in the States Traversed by NW-1

State	2007		2008		2009		2010		2011	
	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
West Bengal	1817	9	1256	3	756	0	1482	4	1962	0
Jharkhand	4803	20	3690	5	2875	12	4305	5	5960	3
Bihar	37819	172	28489	142	20519	80	23084	95	25222	76
UP	69	1	26	0	17	1	14	0	11	1

Sources: National Vector Borne Disease Control Programme

Table 2.52 : AES/JE (Viral) Cases and Deaths (2006 – 2011) in the States Traversed by NW-1

Sl. No.	Affected States/UTs	2006		2007		2008		2009		2010		2011	
		Case	Death	Case	Death	Case	Death	Case	Death	Case	Death	Case	Death
1	Uttar Pradesh	2320	528	3024	645	3012	537	3073	556	3540	494	3490	579
2	Bihar	21	3	336	164	203	45	325	95	50	7	821	197
3	Jharkhand	0	0	0	0	0	0	0	0	18	2	303	19
4	West Bengal	0	0	16	2	58	0	0	0	70	0	714	58
	Total (India)	2871	663	4110	995	3855	684	4521	774	5167	679	8247	1169

Sources: National Vector Borne Disease Control Programme
(Japanese Encephalitis (JE), Acute Encephalitis Syndrome (AES)

2.5.13. *Archeologically Protected structures (within 300 m of NW-1)*

The archeologically protected structures/monument[29] located within 300 m of NW-1 is listed in **Table 2.54** and **Figure 2.67**.

Table 2.53 : Archeologically Protected area around 300 m of NW-1

No.	Name	Latitude& Longitude	Place	Distance from NW-1 km	Direction from NW-1
1	KardmeshwarMahadevaMandir	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	Rajmahal,	0.3	West

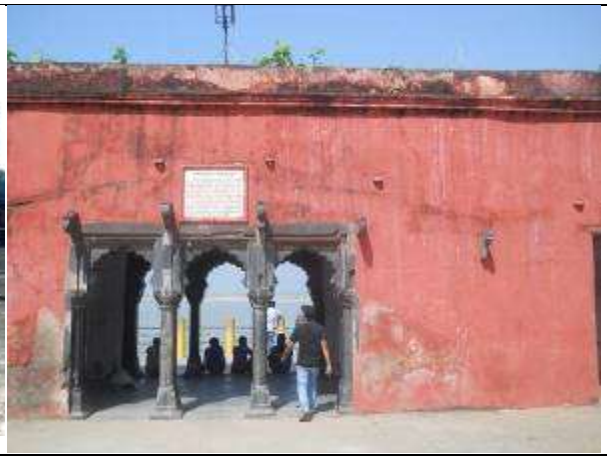
[29]As per Indian regulation no construction activity can take place within 300 m of archeologically protected monuments/ structures/site without written permission from archeological department.

		87°49'51.17"E	Jharkhand		
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	Hooghly, WB	0	West
9	Hazardwari Palace	24°11'10.27"N 88°16'5.73"E	Murshidabad, WB	0.03	East

St. John's Church Kolkatta

Hazardwari Palace Murshidabad

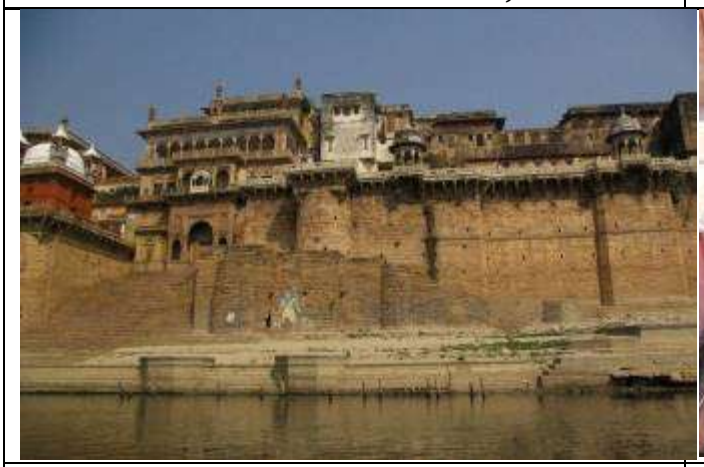
Jami masjid Mangalhat, Rajmahal



Sindhi Dalan, Rajmahal

Kardmeshwar Mahadeva Mandir, Varanasi

Archaeological excavation site, Varanasi



Ramangar Fort, Varanasi

Manmahal and observatory

Figure 2.67 : Photographs of Archaeological& Cultural sites within 300 m of NW-1

ANNEXURE

Annexure 3.1: List Flora and Fauna observed Along NW-1 (Allahabad to Haldia)

Table-1: Riparian Flora Observed/Reported along the NW-1 stretch (Allahabad to Haldia)

S. No.	Scientific Name	Local Name	Family
Trees			
1.	Acacia arabica	Babul	Fabaceae
2.	Acacia catechu	Khair	Fabaceae
3.	Adina cordifolia	Karam	Rubiaceae
4.	Aegle marmelos	Bel	Rutaceae
5.	Ailanthus excelsa	Ghorkaranj/Ghorkaram	Simaroubaceae
6.	Alangium Lamarckii	Dhela	Cornaceae
7.	Albizzia lebbeck	Black Siris	Fabaceae
8.	Albizzia odoratissima	Jang Siris	Fabaceae
9.	Albizzia procera	Safed Siris	Fabaceae
10.	Alstonia scholaris	Chatni	Apocynaceae
11.	Anogeissus latifolia	Dhatura	Combretaceae
12.	Artocarpus intigrifolia	Kathal	Moraceae
13.	Azadirachta indica	Neem	Meliaceae
14.	Bauhinia retusa	Kathul	Caesalpiniaceae.
15.	Bauhinia purpurea	Koenar	Fabaceae
16.	Bauhinia racemosa	Katmauli	Fabaceae
17.	Bauhinia variegata	Kachnar	Fabaceae
18.	Bombax ceiba	Semal	Malvaceae
19.	Boswellia serrata	Salia	Burseraceae
20.	Buchanania lanzan	Piar	Anacardiaceae
21.	Butea frondosa	Palas	Fabaceae
22.	Careya arborea	Kumbhi	Lecythidaceae
23.	Cassia fistula	Dhanraj/Amaltas	Fabaceae
24.	Dalbergia lanceolaria	Hardi	Fabaceae
25.	Dalbergia latifolia	Kala Shisham	Fabaceae
26.	Dalbergia sissoo	Shisham	Fabaceae
27.	Diospyros melanoxylon	Tend/Kend/Tiril	Ebenaceae
28.	Delenia pentagyna	Rai	Dilleniaceae
29.	Emblica officinalis	Amla	Phylanthaceae
30.	Ficus benghalensis	Barh	Moraceae
31.	Ficus religiosa	Pipal	Moraceae
32.	Ficus tomentosa	Barun	Moraceae
33.	Gardenia latifolia	Papra	Rubiaceae
34.	Gmelina arborea	Gamhar	Lamiaceae
36.	Grewia asiatica	Patdhaman	Malvaceae
37.	Holarrhena antidysentrica	Koreya	Apocynaceae
38.	Lagerostroemia parviflora	Sidha	Lythraceae
39.	Litchi chinensis	Litchi	Sapindaceae
40.	Madhuca latifolia	Mahua	Sapotaceae
41.	Mallotus philippinensis	Rohan	Euphorbiaceae
42.	Mangifera indica	Aam (Mango)	Anacardiaceae
43.	Melia azadirach	Bakain	Meliaceae
44.	Michelia champaca	Champa	Magnoliaceae
45.	Mitrgyna parviflora	Guri/Gurikaram	Rubiaceae
46.	Morus alba.	Tut	Moraceae
47.	Murraya exotica	Kamini/Otel	Rutaceae
48.	Oroxylum indicum	Sonapatta	Bignoniaceae
49.	Ougeinia oojenesis	Sandam	Fabaceae

50.	Pongamia glabra	Karanj	Fabaceae
51.	Pterocarpus marsupium	Bia/Paisar	Fabaceae
52.	*Randia uliginosa*	Piurar	Rubiaceae
54.	*Rubia cordifolia*	Jotsingh	Rubiaceae
55.	*Sapindus mukorossi*	Ritha	Sapindaceae
56.	*Schleichera oleosa*	Kusum	Sapindaceae
57.	*Semecarpus anacardium*	Bhelwa	Anacardiaceae
58.	*Shorea robusta*	Sal/Sakhua	Dipterocarpaceae
59.	*Soymida febrifuga*	Rohena	Meliaceae
60.	*Spondias mangifera*	Amra	Anacardiaceae
61.	*Sterculia urens*	Keonjhi	Malvaceae
62.	*Stereospermum suaveolens*	Padar	
63.	*Tamarindus indica*	Imli/Jojo	Fabaceae
67.	*Tectona grandis*	Sagwan/Teak	Lamiaceae
68.	*Terminalia arjuna*	Arjun	Combretaceae
69.	*Terminalia belerica*	Bahera	Combretaceae
70.	*Terminalia chebula*	Harra	Combretaceae
71.	*Terminalia tomentosa*	Asan	
72.	*Zizyphus mauritiana*	Ber	Rhamnaceae
73.	*Zizyphus xylopyra*	Katber	Rhamnaceae

Table-2: Riparian Flora (Herbs and Shrubs) Observed/Reported along the NW-1 stretch (Allahabad to Haldia)

S. No.	Name of the Plant	Medicinal Importance	Name of the Plant	Medicinal Importance	Name of the Plant	Medicinal Importance
Shrubs						
1	*Abelmoschus esculentus*	-	Calotropis gigantean	M	Mallotus repandus	-
2	*Abutilon indicum*	M	C. procera	M	Polyalthia suberosa	-
3	*Acanthus ilicifolius*	-	Clerodendrum inerme	M	Plumbago zeylanica	M
4	*Adhatoda zeylanica*	M	Datura sp.	-	Rouwolfia serpentina	M
5	*Barleria spp.*	-	Glycosmis arborea	-	Solanum khasianum	M
6	*B. cristata*	-	Hibiscus rosasinensis	-	S. indicum	M
7	*B. prionitis*	-	Jatropha curcus	M	S. torvum	-
8	*Caesalpinia crista*	-	J. gossypifolia	-	S. erianthum	-
9	*Casearia tomentosa*	-	Kirganelia reticulate	-	Urena lobata	-
10	*Cassia occidentalis*	M	Lantana camara	-	Vernonia anthelmintica	M
11	*C. sophera*	M	Leonurus sibiricus	-	Withania somnifera	M
Herbs						
12	*Acalypha indica*	-	Desmodium gangeticum	M	Parthenium hysterophorus	-
13	*Achyranthes aspera*	M	D. trifolia	-	Pedalium murex	M
14	*Ageratum conyzoides*	M	Digera muricata	-	Phaseolus trilobus	-
15	*Alhagi pseudoalhagi*	-	Echinops echinatus	-	Phyla	-

					nodiflora	
16	*Alternanthera pungens*	-	Eclipta prostrate	M	P. simplex	-
17	*Alternanthera sessilis*	-	Erigeron asteroids	-	Physalis minima	-
18	*Alternanthus spinosus*	-	E. thymifolia	-	Polygonum glabrum	-
19	*Amaranthus spinosus*	-	Evolvulus plumbaginifolia	-	P. hydropiper	-
20	*A. spirtosus*	-	E. alsinoides	-	P. plebeium	-
21	*A. viridis*	-	Glinus lotoides	M	Portulaca oleracea	-
22	*Ammannia baccifera*	-	Gomphrena celosiodes	-	P. quadrifida	--
23	*Anagallis arvenis*	-	Grangea maderasptana	-	Potentilla supine	-
24	*Anisomeles indica*	-	Heliotropium hirsutum	-	Primula umbellata	-
25	*Argemone mexicana*	-	H. indicum	-	Psoralea corylifolia	M
26	*Asphodelus tenuifolius*	-	Hibiscus vitifolius	-	Ranunculus sceleratus	-
27	*Bergia ammannioides*	-	Hygrophila auriculata	-	Ricinus communis	-
28	*Blainvillea acmella*	-	Indigofera linifolia	-	Rumex dentatus	-
29	*Boerhavia diffusa*	M	I. linnaei	-	Rungia pectnata	-
30	*Caesulia axillaris*	-	Justicia peploides	-	Salvia plebeian	-
31	*Callicarpa nudiflora*	-	Lathyrus sativus	-	Scirpus articulates	-
32	*Cannabis sativa*	-	Launaea asplenifolia	-	Scoparia dulcis	-
33	*Canscora decussate*	-	Leucas aspera	-	Sida acuta	-
34	*Cassia tora*	-	Lindenbergia indica	-	S. cordata	M
35	*Catharanthus roseus*	M	Lindernia crustacean	-	S. obovata	-
36	*Celosia argentea*	-	Malvastrum	-	S. rhombiolia	-
37	*Centella asiatica*	M	Mazus pumilus	-	Solanum nigarum	-
38	*Chenopodium album*	-	Mecardonia procumbens	-	S. surattense	-
39	*Chrozosphora rottleri*	-	Medicago polymorpha	-	Trianthema portulacastrum	-
40	*Cleome gynandra*	-	Melilotus alba	--	Tribulus terrestris	M
41	*C. viscose*	-	M. indica	-	Tridax procumbens	-
42	*Commelina bengalensis*	-	Murdannia nudiflora	-	Ureria picta	M
43	*Convolvulus arvensis*	-	Nasturtium indicum	-	Verascum chinense	-
44	*C. microphyllus*	-	Nepeta hindostana	-	V. thaspus	-
45	*Costus speciosus*	--	Nicotiana plumbaginifolia	-	Vernonia cinerea	-
46	*Crotalaria medicaginea*	-	Ocimum canum	-	Vicia sativa	-

47	*Croton bonplandianum*	-	O. sanctum	M	Volutarella divaricata	-
48	*Cyanotis axillaris*	-	Oldenlandia corymbosa	M	Wedelia calendulacea	-
49	*Cynoglossum lancelatum*	-	O. paniculata	-	Xanthium strumarium	-
50	*Depteracanthus prostrates*	-	Oxalis comiculata	-		
Climbers						
51	*Asparagus spp.*	M	Derris trifoliate	-	I. sepiaria	-
52	*Bryonopsis laciniosa*	-	Dioscorea bulbifera	M	Leptadenia reticulate	-
53	*Celastrus paniculatus*	-	Hemidesmus indicus	M	Mikania cordata	-
54	*Cissampelos pareira*	M	Ichnocarpus fructescens	M	Pueraria tuberose	M
55	*Cuscuta reflexa*	M	Ipomoea cairica	-	Tinospora cordifolia	-
56	*Dalbergia spinosa*	-	-	-	Tylophora indica	M
Grasses						
57	*Cynodon dactylon*	-	Imperata cylindrica	-	Saccharum spontaneum	-
58	*Dichanthium annulatum*	-	Panicum repens	-	Setaria verticillata	-
59	*Hygroryza aristata*	-	Paspalum distichum	-	-	-

Table-3: Aquatic faunal diversity of NW-1 strech of Ganga River (Allahabad to Haldia)

Sl.No.	Local name	Scientific name
1	Dolphin	*Platanista gangeticus*
2	Smooth Coated Otter	*Lutrogale perspicillata*
3	Maggar	*Crocodylus palustris*
4	Gharial	*Gavialis gangeticus*
5	Crocodiel	*C. porosus*
6	Self-shell turtle	*Aspederitesgangeticus*
7	Indian flap shell turtle	*Lissemyspunctata*
8	Narrow headed soft shell turtle	*Chitraindica*
9	Spotted pond turtle	*Geoclemyshamiltonii*
10	Crowned river turtle	*Hardellathurjii*
11	Indian roofed turtle	*Pangshura tectum*
12	Indian tent turtle	*Pangshura tentoria*
13	Tongoka	*Balagurdhongoka*
14	Water snakes	*Xenochrophis piscator*

able-4: Ichthyo-faunal diversity of Ganga River at different locations from Allahabad to Haldia

S.No.	Name of Fishes	Local Name	Famiy	All.	Vara.	Pat.	Bha.	Sah.	Fara.	Hald.
1	*Acanthocobitis botia* (Hamilton)		Balitoridae	-	-	+	-	-	-	-
2	*Ailia coila* (Hamilton)		Siluridae	+	+	+	+	+	+	+
3	*Amblypharyngodon gora* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
4	*Amblypharyngodon microlepis*(Bleeker)		Cyprinidae	+	+	+	+			

5	Amblypharyngodon mola (Hamilton-Buchanan)	Marwa	Cyprinidae	+	+	+				
6	*Anabas testudineus* (Bloch)	Kawai		+	+	+				
7	*Anguila bengalensis*(Gray)	Bamach		+	+	+				
8	*Aspidoparia jaya* (Hamilton)			+	+	+				
9	*Aspidoparia morar* (Hamilton)	Pehora		+	+	+				
10	*Bagarius bagarius* (Hamilton)	Baghar, Padhan	Siluridae	+	+	+	+	+	+	+
11	*Bagarius yarellii* (Sykes)				+	+				
12	*Barilius bendelisis* (Hamilton)		Cyprinidae	+	+	+				
13	*Botia dario* (Hamilton)	Baghi	Balitoridae	+	+	+	+	+	+	+
14	Botia lohachata (Hamilton)		Cobitidae	+	+	+				
15	*Cabdia morar* (Hamilton)			+	+	+	+	+	+	+
16	*Catla catla* (Hamilton)	Catla	Cyprinidae	+	+	+	+	+	+	+
17	*Chaca chaca* (Hamilton)		Chacidae	+	+	+	+	+	+	+
18	*Chagunius chagunio* (Hamilton)		Cyprinidae	+	+	+				
19	*Chanda nama*	Chanda	Ambassidae	+	+	+	+	+	+	+
20	*Channa gachua* (Hamilton)	Chenga	Channidae	+	+	+	+	+	+	+
21	*Channa marulius* (Hamilton)	Gajal	Channidae	+	+	+	+	+	+	+
22	*Channa orientalis* (Hamilton)		Channidae	+	+	+	+	+	+	+
23	Channa punctatus (Bloch)	Garai	Channidae	+	+	+	+	+	+	+
24	*Channa striatus* (Bloch)	Sauri	Channidae	+	+	+	+	+	+	+
25	*Chela atpar* (Hamilton)		Cyprinidae	+	+	+	+	+		
26	*Chela labuca* (Hamilton)		Cyprinidae	+	+	+	+	+		
27	*Cirrhinus mrigala* (Hamilton)	Nain, Mirka	Cyprinidae	+	+	+	+	+	+	+
28	*Cirrhinus reba* (Hamilton)	Mirka	Cyprinidae	+	+	+	+	+	+	+
29	*Clarias batrachus* (Linnaeus)	Mangur	Clariidae	+	+	+				
30	Clupisoma garua (Hamilton)	Charnakwa		+	+	+	+	+	+	+
31	*Colisa fasciatus* (Bloch & Schneider)	Khesra	Osphronemidae	+	+	+	+	+	+	+
32	*Crosocheillus latius latius* (Hamilton)		Cyprinidae		+	+	+	+		
33	*Cyprinus carpio* (Linnaeus)		Cyprinidae	+	+	+	+	+	+	+
34	*Devario devario* (Hamilton)		Cyprinidae	+	+	+				
35	*Esomus danricus* (Hamilton)		Cyprinidae	+	+	+				
36	*Eutropiichthys murius* (Hamilton)	Sugwa	Siluridae	+	+	+				
37	*Eutropiichthys vach* a(Hamilton)	Sugwa		+	+	+				
38	*Gadusa chapra* (Hamilton)			+	+	+	+	+		
39	*Gagata cenia* (Hamilton)		Siluridae	+	+	+	+	+	+	+
40	*Garra gotyla* (Gray)		Cyprinidae	+	+	+				
41	*Glossogobius giuris* (Hamilton)			+	+	+	+	+	+	+
42	*Glyptothorax botia* (Hamilton)		Siluridae	+	+	+				
43	*Glyptothorax cavia* (Hamilton)		Siluridae	+	+					
44	*Glyptothorax telchitta* (Hamilton)		Siluridae	+	+					

45	*Gogangra viridescense* (Hamilton)				+	+	+	+		
46	*Gonialosa manmina* (Hamilton)				+	+	+	+		
47	*Hemibagarus menoda* (Hamilton)		Bagridae	+	+	+	+			
48	*Heteropneustus fossilis* (Bloch)	Singhi	Clariidae	+	+	+	+	+	+	+
49	*Hypopthalmichthys nobilis* (Valenciennes)		Cyprinidae	+	+					
50	*Hyporamphus limbatus* (Valenciennes)			+	+	+				
51	*Johnius coitor* (Hamilton)		Sciaenidae	+	+	+	+			
52	*Labeo bata* (Hamilton)		Cyprinidae	+	+	+	+			
53	*Labeo boga* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
54	*Labeo calbasu* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
55	*Labeo gonius* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
56	*Labeo pangusia* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
57	*Labeo rohita* (Hamilton)	Rohu	Cyprinidae	+	+					
58	*Leiodon cutcutia* (Hamilton)			+	+	+	+	+	+	+
59	*Lepidocephalichthys guntea* (Hamilton)		Cobitidae	+	+	+	+	+	+	+
60	*Macrognathus aral* (Bloch and Schneider)	Gainchi		+	+	+	+	+	+	+
61	*Mastacembelus pancalus* (Hamilton)	Gainchi	Mastacembelidae	+	+	+	+	+	+	+
62	*Mastacembelus armatus* (Lacepede)	Baam, baami	Mastacembelidae	+	+	+	+	+	+	+
63	*Monopterus albus* (Zuiew)				+	+	+			
64	*Monopterus cuchia* (Hamilton)				+	+	+			
65	*Mystus aor* (Hamilton)		Bagridae	+	+	+	+	+	+	+
66	*Mystus bleekery* (Day)		Bagridae	+	+	+	+	+	+	+
67	*Mystus carcio* (Bloch)		Bagridae	+	+	+	+	+	+	+
68	*Mystus cavasius* (Hamilton)	Palwa	Bagridae	+	+	+	+	+	+	+
69	*Mystus tengara* (Hamilton)	Sonipalwa	Bagridae	+	+	+	+	+	+	+
70	*Mystus vittatus* (Bloch)	Hadda	Bagridae	+	+	+	+	+	+	+
71	*Nandus nandus* (Hamilton)	Dhalo	Nandidae	+	+	+	+	+	+	+
72	*Nangra nangra* (Hamilton)			+	+	+	+	+	+	+
73	*Nangra punctata* (Hamilton)			+	+	+	+	+	+	+
74	*Neotropius antherinoides* (Bloch)			+	+	+	+	+	+	+
75	*Notopterus chitala* (Hamilton)	Chital, Moi	Notopteridae	+	+	+	+	+	+	+
76	*Ompok bimaculatus* (Bloch)			+	+	+	+	+	+	+
77	*Ompok pabda* (Hamilton)		Siluridae	+	+	+	+	+	+	+
78	*Ompok Pabo* (Hamilton)	Papta		+	+	+	+	+	+	+
79	*Oriochromis mossambicus* (Peters)			+	+	+	+	+	+	+
80	*Osteobramacotio* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
81	*Pangasius pangasius* (Hamilton)	Pangas	Pangasiidae	+	+	+	+	+	+	+
82	*Pangio pangia* (Hamilton-			+	+	+	+	+	+	

	Buchanan)									
83	*Panna microdon* (Hamilton)			+	+	+	+	+	+	
84	*Pterigoplichthys anisitsi* (Jonathan Armbruster)			+	+	+	+	+	+	
85	*Puntius chola* (Hamilton)		Cyprinidae	+	+	+	+	+	+	+
86	*Puntius conchonius* (Hamilton-Buchanan)		Cyprinidae	+	+	+	+	+	+	+
87	*Puntius sarana* (Hamilton)			+	+	+	+	+	+	+
88	*Puntius sophore* (Hamilton-Buchanan)	Potia	Cyprinidae	+	+	+	+	+	+	+
89	*Puntius ticto* (Hamilton-Buchanan)		Cyprinidae	+	+	+	+	+	+	+
90	*Rhinomugil corsula* (Hamilton)	Arwari, Harwari		+	+	+	+	+	+	+
91	*Rita rita* (Hamilton)	Rita	Bagridae	+	+	+	+	+	+	+
92	*Salmostoma bacaila* (Hamilton)	Chelwa	Cyprinidae	+	+	+	+			
93	*Salmostoma phulo* (Hamilton)			+	+	+	+			
94	*Securicula gora* (Hamilton)		Cyprinidae	+	+	+	+			
95	*Setipinna brevifilis* (Hamilton)			+	+	+	+			
96	*Setipinna phasa* (Hamilton)			+	+	+	+			
97	*Sicamugil cascasia* (Hamilton)	Khaksi		+	+	+	+			
98	*Silonia silondia* (Hamilton)	Silan		+	+	+	+	+	+	+
99	Sisorrab dophorus (Hamilton)		Sisoridae	+	+	+	+	+	+	+
100	*Somileptes gongota* (Hamilton)		Cobitidae	+	+	+	+	+	+	+
101	*Systomus sarana* (Hamilton-Buchanan)		Cyprinidae	+	+	+	+	+	+	+
102	*Tenualosa ilisha* (Hamilton)		Clupeidae	+	+	+	+	+	+	+
103	*Tetraodon fluviatalis* (Hamilton-Buchanan)			+	+	+	+	+	+	+
104	*Trichogaster fasciatus* (Bloch & Schneider)			+	+	+	+	+	+	+
105	*Walla goattu* (Schneider)	Lachi, Buari	Siluridae	+	+	+	+	+	+	+
106	*Xenentodon cancila* (Hamilton)	Kawa	Belonidae	+	+	+	+	+	+	+

Table-4: Phyto-planktonic diversity of Ganga River at different locations from Allahabad to Haldia

S.No.	Taxa	All.	Vara.	Pat.	Bha.	Sah.	Fark	Hal.
Bacillariophyceae								
1	*Amphora sp.*	+	+	+	+	+	+	+
2	*Amphipleura*	+	+	+	+	+	+	+
3	*Achnanthes sp.*	+	+	+	+	+	+	+
4	*Asterionella sp.*	+	+	+	+	+	+	+
5	*Bacillaria sp.*	+	+	+	+	+	+	+
6	*Biddulphia sp.*	+	+	+	+	+	+	+
7	*Brebissonia sp.*	+	+	+	+	+	+	+
8	*Caloneis sp.*	+	+	+	+	+	+	+
9	*Ceratoneis sp.*	+	+	+	+	+	+	+
10	*Coconeis sp.*	+		+	+	+	+	+
11	*Chaetoceros sp.*	+	+	+	+	+	+	+

12	*Cosinodiscus sp.*	+	+	+	+	+	+	+
13	*Cyclotella sp.*	+	+	+	+		+	+
14	*Cymatopleura sp.*	+	+	+	+	+	+	+
15	*Cymbella sp.*	+	+	+	+	+	+	+
16	*Denticula sp.*	+	+	+	+	+	+	+
17	*Diatoma sp.*	+	+	+	+	+	+	+
18	*Diatomella sp.*	+	+	+	+	+	+	+
19	*Epithelmia sp.*	+	+	+	+	+	+	+
20	*Fragilaria sp.*	+	+		+	+	+	+
21	*Frustulia sp.*	+	+	+	+	+	+	+
22	*Gomphoneis sp.*	+	+	+	+	+	+	+
23	*Gomphonema sp.*		+	+	+	+		+
24	*Gyrosigma sp.*	+	+	+	+	+	+	+
25	*Hantzchia sp.*	+	+	+	+	+	+	+
26	*Melosira sp.*	+	+		+	+	+	+
27	*Meridian sp.*	+	+	+	+	+	+	+
28	*Navicula sp.*	+	+	+	+	+	+	+
29	*Nedium sp.*	+	+	+	+	+	+	+
30	*Nitzschia sp.*	+	+	+	+	+	+	+
31	*Opephora sp.*	+	+	+	+	+	+	+
32	*Pinnularia sp.*	+	+	+	+	+	+	+
33	*Pleurosigma sp.*	+	+	+	+	+	+	+
34	*Rhicosphenia sp.*	+	+	+	+	+	+	+
35	*Stephanodiscus sp.*	+		+	+	+	+	+
36	*Surirella sp.*	+	+	+	+	+		+
37	*Synedra sp.*	+	+		+	+	+	+
38	*Tabellariasp*	+	+	+	+	+	+	+
39	*Tetracylus sp.*	+	+	+	+	+	+	+
Chlorophyceae								
40	*Actinastrum sp.*	+	+	+	+	+	+	+
41	*Chlamydomonas sp.*	+	+	+	+	+	+	+
42	*Chlorella sp*	+	+	+	+	+	+	+
43	*Chlorococium sp.*	+	+	+	+	+	+	+
44	*Cladophora sp.*	+	+	+	+	+	+	+
45	*Closterium sp.*	+	+	+	+	+	+	+
46	*Coelastrum sp.*	+	+	+	+	+	+	+
47	*Conococcus sp.*	+	+	+	+	+	+	+
48	*Cosmarium sp.*	+	+	+	+	+	+	+
49	*Desmidium sp.*	+	+	+	+	+	+	+
50	*Eudorina sp.*	+	+	+	+	+	+	+
51	*Gonatozygon sp.*	+	+	+	+	+	+	+
52	*Gonium sp*	+	+	+	+	+	+	+
53	*Hormidiumsp*	+	+	+	+	+	+	+
54	*Hydrodictyon sp.*	+	+	+	+	+	+	+
55	*Microsporasp*	+	+	+	+	+	+	+
56	*Oedogonium sp.*	+	+	+	+	+	+	+
57	*Pandorina sp.*	+	+	+	+	+	+	+
58	*Pediastrum sp.*	+	+	+	+	+	+	+
59	*Spirogyra sp.*	+	+	+	+	+	+	+
60	*Tetraspor sp.*	+	+	+	+	+	+	+
61	*Ulothrix sp.*	+	+	+	+	+	+	+
62	*Zygnema sp*	+	+	+	+	+	+	+
63	*Debarya sp*	+	+	+	+	+	+	+
64	*Mesotaenium sp*	+	+	+	+	+	+	+

65	*Stigeclonium sp*	+	+	+	+	+	+	+
66	*Tetradesmus sp*	+	+	+	+	+	+	+
67	*Rhizoclonium sp*	+	+	+	+	+	+	+
Cyanophyceae								
68	*Spirulinasp*	+	+	+	+	+	+	+
69	*Rivularia sp.*	+	+	+	+	+	+	+
70	*Schizothrix sp.*	+	-	+	+	+	+	+
71	*Phormidium sp.*	-	+	+	+	+	+	+
72	*Oscillatoria sp.*	+	+	+	+	+	+	+
73	*Anabaena sp .*	+	+	+	+	+	+	+
74	*Calothrix sp.*	+	+	+	+	+	+	+
75	*Microcystis sp.*	+	+	+	+	+	+	+
Xanthophyceae								
76	*Bumillaria sp.*	-	+	+	+	+	+	+
77	*Chlorobotrys sp.*	+	-	+	-	+	+	+
78	*Tribonema sp.*	-	+	+	+	-	+	+
79	*T. bombycinum*	-	+	+	+	+	+	+
80	*Voucheria sp.*	+	+	+	+	+	+	+
Euglenophyceae								
81	*Astasis sp.*	+	+	+	+	+	+	+
82	*Euglena sp.*	+	+	+	+	+	+	+
83	*Peronia sp.*	-	+	+	+	+	+	+
84	*Phacus sp.*	+	+	+	+	+	+	+
Rhodophyceae								
85	*Bostrychia radicans*	-	-	-	+	-	+	+
86	*Catenella impudica*	-	-	-	-	+	-	+
87	*Ceramium elegans*	+	+	+	+	-	+	+

Table-5:- Zooplankton diversity of Ganga River at different locations from Allahabad to Haldia

S.No.	Taxa	All.	Vara.	Pat.	Bha.	Sah.	Fark	Hal.
Protozoa								
1	*Arcella sp .*	+	+	+	+	+	+	+
2	*Chilodonella sp .*	+	+	+	+	+	+	+
3	*Difflugiia sp.*	+	+	+	+	+	+	+
4	*Globigerina sp .*	+	+	+	+	+	+	+
5	*Holophrya sp .*	+	+	+	+	+	+	+
6	*Noctiluca sp .*	+	+	+	+	+	+	+
7	*Paramecium sp .*	+	+	+	+	+	+	+
8	*Spathidium sp .*	+	+	+	+	+	+	+
9	*Sphenoderia sp*	+	+	+	+	+	+	+
10	*Tintinnopsis sp.*	+	+	+	+	+	+	+
11	*Vorticella sp*	+	+	+	+	+	+	+
Rotifera								
12	*Anura sp*	+	+	+	+	+	+	+
13	*Asplanchna sp*	+	+	+	+	+	+	+
14	*Brachionus sp.*	+	+	+	+	+	+	+
15	*Filinia sp.*	+	+	+	+	+	+	+
16	*Horaella sp.*	+	+	+	+	+	+	+
17	*Keratella sp .*	+	+	+	+	+	+	+
18	*Lecane sp.*	+	+	+	+	+	+	+
19	*Notholca sp.*	+	+	+	+	+	+	+
20	*Rotaria sp.*	+	+	+	+	+	+	+
21	*Testudinella sp*	+	+	+	+	+	+	+

Copepoda								
22	*Cyclops sp.*	+	+	+	+	+	+	+
23	*Diaptomus*	+	+	+	+	+	+	+
24	*Nauplii*	+	+	+	+	+	+	+
Cladocera								
25	*Bosmina sp*	+	+	+	+	+	+	+
26	*Ceriodaphnia sp.*	+	+	+	+	+	+	+
27	*Cydorus sp.*	+	+	+	+	+	+	+
28	*Daphnia sp .*	+	+	+	+	+	+	+
29	*Diphanosoma sp.*	+	+	+	+	+	+	+
30	*Moina sp*	+	+	+	+	+	+	+
31	*Simocephalus sp*	+	+	+	+	+	+	+

Table-6:- Macro-benthos of Ganga River at different locations from Allahabad to Haldia

S.No.	Taxa	All.	Vara.	Pat.	Bha.	Sah.	Fark	Hal.
Gastropoda								
1	*Bellamya sp .*	+	+	+	+	+	+	+
2	*Gabbia sp .*	+	+	+	+	+	+	+
3	*Lymnaea sp .*	+	+	+	+	+	+	+
4	*Thiaria sp.*	+	+	+	+	+	+	+
Annelids								
5	*Polychaetes*	+	+	+	+	+	+	+
6	*Oligochaetes*	+	+	+	+	+	+	+
Insects								
7	*Argia sp .*	+	+	+	+	+	+	+
8	*Caenis sp .*	+	+	+	+	+	+	+
9	*Cloeon sp .,*	+	+	+	+	+	+	+
10	*Enallgma sp*	+	+	+	+	+	+	+
11	*Nepa sp.*	+	+	+	+	+	+	+

Table-7:- List of Avi-fauna diversity along the periphery of River Ganga

S.No.	Scientific Name	Common Name	Family
1	*Ardea pupurea*	Purple Heron	Ardeidae
2	*Nycticorax nycticorax*	Black crowned Night-Heron	Ardeidae
3	*Pelecanus onocrotalus*	Great White Pelican	Pelecanidae
4	*Ephippiorhynchus asiaticus*	Black necked stork	Ciconiidae
5	*Leptoptilos javanicus*	Lesser Adjutant	Ciconiidae
6	*Leptoptilos dubius*	Greater Adjutant	Ciconiidae
7	*Threskiornis melanocephalus*	Black headed Ibis	Threskiornithidae
8	*Pseudibis papillosa*	Black Ibis	Threskiornithidae
9	*Dendrocygna javanica*	Lesser Whistling Duck	Anatidae
10	*Anas platyrhynchos*	Mallard	Anatidae
11	*Anas acuta*	Northern pintail	Anatidae
12	*Anas crecca*	Common teal	Anatidae
13	*Aythyacnyroca*	Ferruginous pochard	Anatidae
14	*Aythya fuligula*	Tufted Duck	Anatidae
15	*Milvus migrans*	Black kitell	Accipitridae
16	*Elanus caeruleus*	Black shouldered kite	Accipitridae
17	*Heliastur indus*	Brahminy kite	Accipitridae
18	*Circus aeruginosus*	Eurasian Marsh	Accipitridae
19	*Buteo rufinus*	Long legged Buzzard	Accipitridae
20	*Aquila clanga*	Greater Spotted Eagle	Accipitridae
21	*Hieraaetus pennatus*	Booted Eagle	Accipitridae

22	*Falco tinnunculus*	Common Kestrel	Falconidae
23	*Falco peregrines*	Peregrine Falcon II	Falconidae
24	*Grus grus*	Common crane	Gruidae
25	*Amaurornis phoenicurus*	White Breasted Waterhen	Rallidae
26	*Fulica atra*	Common cootll	Rallidae
27	*Charadrius dubius*	Little Ringed Plover II	Charadriidae
28	*Charadrius alexandrines*	Kentish Plover	Charadriidae
29	*Limosa limosa*	Black-tailed Godwit	Scolopacidae
30	*Tringa tetanus*	Common Redshank	Scolopacidae
31	*Tringa stagnatilis*	Marsh Sandpiper	Scolopacidae
32	*Tringa ochropus*	Green Sandpiper	Scolopacidae
33	*Calidris temminckii*	Temminck's Stint	Scolopacidae
34	*Recurvirostra avosetta*	Pied Avocet	Recurvirostridae
35	*Glareola lacteal*	Small Prantincole	Lasreolidae
36	*Larus ichthyaetus*	Pallas's Gull	Laridae
37	*Larus brunnicephalus*	Brown Headed Gull	Laridae
38	*Larus ridibundus*	Black Headed Gull	Laridae
39	*Sterna caspia*	Caspian tern	Laridae
40	*Sterna hirundo*	Common tern	Laridae
41	*Columba livia*	Rock Pigeon	Columbidae
42	*Riparia paludicola*	Plain Martin	Hirundinidae
43	*Hirundo rustica*	Barn Swallow	Hirundinidae
44	*Motacilla flava*	Yellow wagtail	Motacillaidae
45	*Anthus rufulus*	Paddy Field Pipit	Motacillaidae
46	*Saxicola torquata*	Common Stonechat	Turdinae
47	*Passer domesticus*	House sparrow	Passerinae
48	*Sturnus contra*	Asian pied Starling	Sturnidae
49	*Acridotheres tristis*	Common Myna	Sturnidae
50	*Acridotheres ginginianus*	Bank Myna	Sturnidae
51	*Dendrocitta vagabunda*	RufousTreepie	Corvidae
52	*Tachybaptus ruficollis*	Dab Chick of little grebe	Podicipedidae
53	*Microcarbo niger*	Little cormorant	Phalacrocoracidae
54	*Phalacrocorax carbo*	Large cormorant	Phalacrocoracidae
55	Plotus anhinga	Snake- bird Darter	Anhingidae
56	*Egretta garzetta*	Little Egret	Ardeidae
57	*Mesophoyx intermedia*	Median Egret	Ardeidae
58	*Ardea alba*	Large Egret	Ardeidae
59	*Bubulcus ibis*	Cattle Egret	Ardeidae
60	*Ardeola grayii*	Pond Heron	Ardeidae
61	*Ardea cinerea*	Grey Heron	Ardeidae
62	*Anastomus oscitans*	Open- billed stork	Ciconiidae
63	*Ciconia episcopus*	White-necked stork	Ciconiidae
64	*Leptoptilos javanicus*	Lesser adjutant	Ciconiidae
65	*Pseudibis papillosa*	Blanck Ibis	Threskiornithidae
66	*Nettapus coromandelianus*	Cotton Teal	Anatidae
67	*Anas strepera*	Gadwall	Anatidae
68	*Anas americana*	Wigeon	Anatidae
69	*Anas querquedula*	Garganey	Anatidae
70	*Anas clypeata*	Shoveller	Anatidae
71	*Netta rufina*	Red- crested pochard	Anatidae
72	*Gyps bengalensis*	Bengal vulture	Accipitridae
73	*Porphyrio coeruleus*	Purple Moorhen	Rallidae
74	*Fulica alai*	Coot	Rallidae
75	*Metopidius indicus*	Bronze Winged Jacana	Jacanidae

76	*Vanellus armatus*	Lapwing	Charadriidae
77	*Gallinago gallinago*	Fantail Snipe	Scolopacidae
78	*Sterna aurantia*	Indian River Tern	Sternidae
79	*Streptopelia capicola*	Ring Dove	Columbidae
80	*Treron phoenicoptera*	Bengal Green Pigeon	Columbidae
81	*Ceryle rudis*	Pied kingfisher	Alcedinidae
82	*Alcedo atthis*	Small blue kingfisher	Meropidae
83	*Merops orientalis*	Small Green Bee-eater	Meropidae
84	*Coracias benghalensis*	Indian Roller, Blue Jay	Coraciidae
85	*Merops leschenaulti*	Bee-eater	Meropidae
86	*Upupa epops*	Hoopoe	Upupidae
87	Eudynamys	Koel	Cuculidae
88	*Motacilla maderaspatensis*	Largepled wagtail	Motacillidae
89	*Pycnonotus cafer*	Red-vented Bulbul	Pycnonotidae
90	*Turdoides caudata*	Common Babbler	Leiothrichidae
91	*Luscinia svecica*	Bluethroat	Muscicapidae
92	*Ploceidae*	Weaver Bird	Ploceidae