SFG2388 REV

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-2: CUMULATIVE IMPACT ASSESMENT

May 2016

(Revised September 2016; Copy Edited November 2016)

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EXECUTIVE SUMMARY

Inland Waterways Authority of India (IWAI) is a statutory body under Ministry of Shipping, Govt. of India. IWAI is primarily responsible for development, maintenance and regulation of Inland Water Transport (IWT) in the country specifically on National waterways. In this context, the Ganga-Bhagirathi-Hooghly river system from Allahabad to Haldia has been declared as National Waterway-I (NW-I). It is a natural waterway of about 1620 km in length and passes through the states of Uttar Pradesh, Bihar, Jharkhand and West Bengal. One of the limitations on viable Inland waterway transport on NW-1 is a weak navigation infrastructure. Therefore, IWAI has proposed the Capacity Augmentation of navigational infrastructure of NW-1 between Allahabad to Haldia with technical and financial assistance from The World Bank.

In this regard, IWAI has commissioned Environmental and Social Impact Assessment (ESIA) studies to map and understand potential environmental and social impacts associated with navigation improvement of NW-I and to prepare plan for effective mitigation and management of the Impact associated with the project. This report is prepared for Cumulative Impact Assessment (CIA) study which is the part of the ESIA study.

ESIAs and Cumulative Impact Assessments (CIAs) share the same basic logical framework and analytical process and tools for a basic logic framework for a CIA. However, they take different perspectives. The perspectives can be characterized as project-centered (ESIA) or VEC-centered (CIA). In an ESIA the focus of analysis begins with the project. The area where the project will have environmental and social impacts is identified are the VECs that will be affected. The impacts on the VECs are identified and a mitigation hierarchy is applied to avoid them when possible and to minimize and mitigate them when avoidance is not possible. Where residual impacts remain, impacts and risks to workers, affected communities, and the environment are compensated or offset[1].

NW-1 is being fed by various tributaries at different locations. Major tributaries to NW-1 between Haldia to Allahabad are Tons, Gomti, Ghagra, Son, Gandak, Punpun and Kosi. 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

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[1] *Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, International Finance Corporation, World Bank Group*

development of terminals are identified at Ghazipur and Kalughat. These two sites are still under consideration for finalization and planning of design at initial stage only. One more terminal site along NW-1 is being identified.
    - Construction of one Navigation Lock at Farakka, West Bengal.
    - Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment. Development of low draught cargos.
    - Development of navigation aids along NW-I 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.

The main objectives of this study are:

- Assess the potential impacts and risks of a proposed and other developments over time on a chosen Valued Environment & Social Component (VECs)
- Verify that the proposed development's cumulative social and environmental impacts and risks will not exceed a threshold that could compromise the sustainability or viability of selected VECs;
- Confirm that the proposed development's value and feasibility are not limited by cumulative social and environmental effects;
- Support the development of governance structures for making decisions and managing cumulative impacts at the appropriate geographic scale (e.g., airshed, river catchment, town, regional landscape);
- Ensure that the VECs of affected communities about the cumulative impacts of a proposed development are identified, documented, and addressed; and
- Manage potential reputation risks

Approach & methodology based on Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, International Finance Corporation, World Bank Group for CIA study is given below.

Step 1: Identify VECs, and determine spatial and temporal Boundaries for CIA
Step 2: Identify other activities and developments affecting VECs
Step 3: Establish information on baseline status of VECs
Step 4: Assess cumulative impacts on VECs
Step 5: Assess significance of predicted cumulative impacts
Step 6: Management of cumulative impacts – design and implementation

Draft Cumulative Impact Assessment Report has been structured in seven chapters containing 1. Introduction and Background, 2. Project Description, 3. Delineation of CIA boundaries and VECs, 4. Stakeholders consultations, Other Development Proposals and finalization of VECs, 5. Cumulative Baseline Study, 6 Cumulative Impact Assessment and 7 Mitigation measure and management Plan.

Chapter 2 describes existing infrastructure & current traffic, components and salient features. At first, project description has been summarized. This is followed by summary of existing project components, proposed components, applicable policies of India and World Bank Operational Policies. NW-1 project offers potential opportunity for diversification of cargo movement from road & rail to waterways. In order to achieve this diversification, the existing infrastructure needs to be augmented with proposed project interventions. These proposed interventions consisting of both development & operation of navigation route require availability of water (depth) & its maintenance supported by new infrastructure. Further, these activities will trigger indirect & induced development in the influence area. Therefore, NW-1 development along with these existing, direct, indirect & induced developments will have cumulative impact in the influence area.

Chapter 3 describes spatial and temporal boundaries in order to assess the impacts of direct, indirect and induced activities due to proposed project. Process of delineation of boundary largely depends upon the type of development & its potential to exhibit direct & indirect impacts on the surrounding environment. The chapter describes the CIA boundary, the rationale & basis of its delineation, VECs within the delineated boundaries, and hot spots identified. Three levels of considerations have been taken into account for delineation of CIA boundary as described below.

Basin level hydrological & ecological considerations (First Level): It is important to consider the various hydrological and ecological functions of the river valley and floodplains at a basin level for purposes of CIA. Therefore, active floodplain of River Ganga pertaining to NW-1 has been considered.

Project Interventions (Second Level): IWAI's interventions/activities of non IWAI entities have been considered in relation to study area including active floodplain in the context of NW-1 for identification of influence area.

Overall (Third Level): In summary, based on active flood plain, basin level VECs report, IFC guidelines, stakeholders consultations, expert's consultation/ judgment, Indian regulations, ecosensitive zone, and abovesaid considerations, 10 km influence area (impact area) boundary has been considered to conduct the detailed CIA study of the project. Further considering hydrological & ecological functions of the river, basin level influence area downstream of Allahabad has been considered. This has been done in order to meet segment-wise approach and basin level approach (hydrological & ecological) as mentioned in ToR.

In this study all the natural as well as manmade features have been taken into account and plotted spatially to delineate the boundary of the CIA. The natural and manmade features mapped are Forests; National parks; Wildlife Sanctuaries; Tiger Reserves; Important Birds Areas; Archaeological sites; Water bodies; Wetlands; Roads; Railways; Urban Agglomerations; Industrial Areas; Thermal Power Plants and Critically Polluted Areas, identified by CPCB.

To conduct the detailed study of the project, 10 kms buffer boundary has been considered. The basis for delineating these buffer boundaries are based basin level VEC reports IFC guidelines and stakeholders consultations and the expert's consultation/judgment to determine the influence area for proposed CIA studies. In consideration of these 500 meters is taken as first level of influence, followed by 2 hour & 10 kms as second & third level of influence area. For EIA / EMP study area of 10 kms has been recommended.

Based on these considerations, the influence area for CIA is basin level (Hydrology & Ecology) and 10 kms. Further, overlay mapping and GIS have been used for identifying the spatial distribution of VECs. Based on the above approach, mapping method as per IFC guidelines for Cumulative Impact Assessment and Management, VECs have been classified as given below.

VEC	VEC Components
Cultural Aspects of Ganga	Maintain the cultural values
	Maintain cultural events and cultural functions
	Conserve heritage sites, structures and values
Ecosystem services	Terrestrial biodiversity values
	Aquatic biodiversity
	Environmental flows
Physical environmental services and natural processes	Land use and soil quality
	Water
	Air
	Noise
Socio-economic conditions	Socio-economic infrastructure and facilities
	Opportunity and access to improved and conserved livelihood

On the basis of the identified VECs, spatial analysis, literature review, hotspots have been identified. This list was further enhanced after addition of input from stakeholder consultations and baseline study of the VECs.

Assessment of Status of Identified VECs including the site visits, study of the project alignment through topographic maps & Google maps, review of existing studies and literature was carried out to assess the status of identified VECs within the CIA boundary of NW-1. Stakeholders comprising government organisations, non government organizations, research and development organizations, academia, experts, individuals, community based organizations, were identified in the study area encompassing four states (Uttar Pradesh, Bihar, Jharkhand and West Bengal) and outside these states for consultations with institutes of national repute like Wildlife Institute of India, Dehradun.. During the stakeholder consultations, the views were taken on various aspects of project development in NW-1 and their likely impacts in the influence area. The identified VECs were also discussed with the stakeholders for confirmation and finalization (Chapter 4: Public Consultations and Disclosures, Table 4.6). On the basis of the identified VECs, spatial analysis, literature review, hotspots have been identified. Identified hotspots and VECs in NW-1 have also been mapped.

The VECs are the ultimate recipient of impacts because they tend to be at the ends of ecological pathways considering water related proposed activities both in terms of availability & quality in NW-1. These VECs may be directly or indirectly affected by a specific development or by the cumulative effects of several developments.

Chapter 4 provides details of the public consultation and participation activities undertaken during the CIA study for the Project "Jal Marg Vikas". From CIA perspective, an effort was made by conducting consultations particularly in reference to confirmation of hotspots mentioned in Chapter 3 as well as to identify new hotspots, if any. The approach involved a mix of conventional as well as participatory/ rapid rural appraisal (PRA/RRA), focus group discussions (FGD) and one-to-one discussions with wide range of stakeholders encompassing government, non government organisations, local communities, research and development organisations, academia, media. Consultations have been carried out in line with World Bank Guidelines for conducting the public consultation. Finally, this chapter concludes with identification of hotspots based on preliminary assessment, baseline data and inputs from stakeholder consultations. The inputs of stakeholder consultations have been used in finalisation of hotspots.

During the consultations for 'Jal Marg Vikas Project', it is found that there is mix view of people about the project. Some people take it as positive development as the proposed project will benefit the economy of country. Whereas affected people, i.e. fishermen and land holders who will lose land are concerned about the restriction of fishing activity, reduction in fish yield, loss of land and livelihood and receipt of adequate compensation and alternate livelihood. Locals and experts are also concerned about the water pollution and impact on the aquatic fauna which may result due to the project. All the concerns were taken in consideration during assessment of impacts and the mitigation measures are proposed for all the concerns to minimize/mitigate the impact. Mitigation measures proposed are well addressed in management plan along with their period of implementation.

Chapter 5 provides details of baseline study which has been conducted to assess the existing condition or status of the identified VECs in the study area. Baseline study has been carried out on the basis of secondary information collected from EIA/SIA study of NW-1, data from pollution control boards, IMD, Agricultural departments and other Governmental Organization. Baseline study has provided the details of condition of identified VECs along the NW-1 and of the district through which NW-1 traverse. This data has helped to identify the significance of the impact on the VECs condition and has provided the basis of carrying out the impact assessment study. Baseline study indicates NW1 has flat terrain with vast catchment being drained by main river along with tributaries. Geological influence area has alluvial soil and falls in Zone III & IV. Land use is largely agricultural land followed by water body, settlements with only 3.59 %vegetation. Turtle sanctuary, Vikramshila

Gangetic Dolphin sanctuary & Hilsa sanctuary are major VECs. Udhwa bird sanctuary is a protected area. This area has diverse terrestrial & aquatic biodiversity with spawning & breeding grounds adjoining NW1. Flow analysis indicates that NW 1 has flow constraints in certain stretches considering CAD requirements.

Overall soil type / quality along the NW-1 area is of moderately fertile and not expected to be detrimental to the growth of agricultural and forest crops. It can be concluded that soils fall within medium fertility levels in the entire stretch of NW-1and forms the basis of agriculture resources / cropping pattern. Assessment of land resources indicates land use change particularly diversion of agriculture land for urbanization industries & infrastructure development. Though it is an ongoing phenomenon, any new infrastructure development intervention is expected to accelerate it. No portion of NW-1 and intervention areas falls under any reserved forest or normal forests area. Ecologically the area has important VECs.

Udhwa bird sanctuary and 5 other important bird areas are also located within 10 km radius of NW-1 stretch. However, project interventions like maintenance dredging with alleviate the flow constraints for smooth operation of the barges, water availability analysis also indicates the river water is good for propagation of wild life and fisheries.

Observations on River Bed-Dredge Material Quality indicate that the concentration level of heavy metal was found low 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 that may be due to industrial effluent discharge in this section. Pesticide concentration in all samples was found below the USA criteria. The pesticides presence is on expected line as these are predominantly used for various agriculture applications. The source of these pesticide parathion and endosulphan might be from applications of insecticides and pesticides for agriculture in the study area which has significant agriculture land use. Air quality in terms of PM_{10}, $PM_{2.5}$ NOx SO_2 has been found high in major urban centers.

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. Scheduled Caste population consisting of 544284 males and 483706 females respectively in major city/towns along the study area and accounts for 7.9% of the total population. The ‘Scheduled Tribe’ population consist of 27576 males and 25244 females respectively and accounts for 0.41% of the total population (12875343). About 75.4% of the population is literate and 23.6% is illiterate in cities/town located along the NW-1 is illiterate. Male population is more literate than female. In cities and town along NW-1 area the main and marginal workers[2] 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. Agriculture is the main source of the livelihood generation for the people residing along the NW-1 area. Many towns in the area are primarily industrial. Ganga provides the necessary infrastructure for the factories to perform. Commercial fisheries in the Ganga River System are an important source of livelihood for the people residing along the Ganga River. Pilgrimage and the

2A 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

associated tourism brings along a major source of revenue for religious towns and their people. There is substantial decline in major carps fish catch in Allahabad to Farakka stretch over past few years. At Buxar 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. It is reported that almost every village along the both sides of the river are having some fishermen who earn their livelihood by fishing in the Ganga river. Generally, one member of the family is engaged in fishing in lower stretch of NW-1(Allahabad 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. Fishing Income: The monthly average income of the fisherman ranged from Rs.4000 to 7000 per month in Allahabad to Patna stretch. 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.

All the towns and cities along the NW-1 are well connected with national highways, state highways, district roads, railways. Cities like Varanasi, Patna, and Kolkata are also connected with airways. Eleven thermal power plants are located in close proximity of river Ganga between Haldia and Allahabad and 10 more are reportedly are proposed to be set up in close proximity of the river. 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 above mentioned baseline data provides basis for identification, classification & quantification of impacts.

Chapter 6 provides Cumulative Impact Assessment of NW-1 from Haldia to Allahabad carried out for 10 km area in both sides along the entire stretch. For the purpose of CIA, VECs has been identified to assess their existing conditions so that probable impact & significance of the impacts on these VECs can be evaluated. Apart from direct interventions in NW-1, projects/activities of other agencies like EDFC, development of industries and industrial area, zones, parks, thermal power plant, urbanization, road development, irrigations/dams schemes have been identified and their impacts assessed as small scale impact and large scale impacts as cumulative impacts (Table 6.4)

For purpose of CIA study an influence zone is identified where cumulative impact due to NW-1 and other developments within this zone will be identified. Through preliminary desktop study, baseline study and stakeholder consultations the existing developments in influence area, baseline scenario of the influence area, pollution load in environmental area, planned and anticipated developments in influence area are identified. It is found that some zones are experiencing/will experience more of the above mentioned developments as compared to other zones. Such zones are demarcated on the basis of quantum and nature of developments the zone is experiencing or will experience in future. These zones are termed as hotspots as the impacts due to existing/planned development will be maximum/more in these zones as compared to other zones.

Type and nature of the cumulative impact has been evaluated on all VECs in each finalized hotspot as given below.

Finalized Hotspots Selected for CIA Study

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots
1.	Haldia	• Declared as critically polluted area but at present moratorium is lifted by MoEF&CC • Declared notified zone by CGWB • Operation of terminal would require dredging of 1,57,60,596 cum. • Existing floating terminal and proposed new terminal at Haldia • Shifting of ammonia pipeline of TATA chemicals and existing road to Mitsubishi Plant • Haldia Port & Shipping Activities • Haldia Dock Complex & Industrial Area • Celebration of Ganga Sagar Mela at Sagar • Urban areas: Haldia Town • Expected increased industrial development in existing industrial area and enhanced traffic movement • Indragachi TPP at Sangrampur & Haldia Energy Ltd. TPP
2.	Kolkata-Mahesthala	• Existing BISN jetty, GR-1 & GR-2 and Botanical Garden Jetty • Archaeological sites within 300 m: Temple of Gour Chandra and Krishnachandra at Chatra-Gaur Chandra Ghat (0 m, W) , St John Church • High PM_{10} concentration in Howrah • Urban areas: Mahesthala, Kolkata & Howrah
3.	Katwa to Hoogly Ghat	• Floating Terminal Katwa, Floating Terminal Swarupganj, Floating Terminal Shantipur, Floating Terminal Tribeni, BISN jetty • New proposed terminal at Tribeni • Hilsha Sanctuary (fishing restriction for larvae of Hilsha) • TPP at Bandel & Balagarh • Urban Areas: Katwa, Swaroopganj, Nabadwip, Kalna, Balagarh, Kanchrapara, Hoogly • Increased traffic volume due to newly proposed terminal
4.	Farakka to Murshidabad	• Floating Terminal at Hazardwari, Existing RCC Jetty Pakur, U/s & D/s jetty, feeder canal, RCC jetty and old lock at Farakka • Proposed New lock at Farakka • Archaeological Sites: Hazardwari Palace • Hilsha Sanctuary (fishing restriction for larvae of Hilsha) • IBA: Farakka and surrounding areas • Farakka feeder canal is prone to erosion • Sagardighi TPP, Farakka STPS • Urban Areas: Farakka, Murshidabad, Azimganj, Baranagar, Balia, Raghunathganj • Bagmari siphon
5.	Mangalghat (Rajmahal)	• Existing floating terminal • Archaeological sites within 300 m: Jama Maszid & Singhi Dalan • Chatt Pooja celebration Oct-Nov • Udhawa Lake Bird Sanctuary at app 6 km • Mining activities
6.	Sahibganj	• Existing Samdhaghat terminal and proposed Sahibganj terminal • Chatt Pooja celebration Oct-Nov • Construction of approach road to connect the terminal to NH-80 • Construction of railway siding to provide linkage with existing IR track

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots
		• Existing Fishing Activities • Acquisition of Land, R& R and shifting of community temple • Cutting of app. 500 trees
7.	Pirpanti-kahalgaon-Bhagalpur	• Chatt Pooja celebration Oct-Nov • Existing Bateshwarsthan Floating Terminal, Bhagalpur Terminal • Vikramshila Gangetic Dolphin Sanctuary • IBA: Kurseala River Course and Diyara Flood Plains • Bhagalpur TPP, Kahalgaon STPS, Pripanti TPP, Pripanti Power CESC • Presence of arsenic in ground water • Urban Area: Bhagalpur, Kahalgaon
8.	Munger	• Existing Floating Terminal at Munger • Chatt Pooja celebration Oct-Nov • Presence of arsenic in ground water • Urban Area: Munger
9.	Semaria-Begusarai-Barh	• Existing Floating Terminal at Semaria • Chatt Pooja celebration Oct-Nov • Urban Area: Semaria, Doraiganj, Begusarai, Barh • Barauni TPP, Barh TPP & Lakhisarai TPP • IBA: Mokama Taal
10.	Patna	• Low & High Level Jetty (Gaighat) • Proposed Terminal at Kalughat • Chatt Pooja celebration Oct-Nov • IBA: Danapur Cantonment Area • High PM_{10} concentration in Patna • Urban Area: Patna • Development of River Front at Patna
11.	Buxar	• Existing floating terminal at Buxar • Buxar TPP (under construction) • Chatt Pooja celebration Oct-Nov • Urban Area: Buxar
12.	Ghazipur	• Proposed Terminal • Urban Area: Ghazipur
13.	Varanasi	• Rajghat floating terminal • Proposed Varanasi Terminal • Archaeological Sites: Kardmeshwar Mahadeva Mandir, Ramnagar, fort, archaeological excavation site, Varanasi • Festival: Ganga Mahotsav at Varanasi (Oct-Nov) & Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March) • Kashi Turtle Sanctuary • DFCCIL Connectivity at Varanasi Terminal • Slightly high cadmium concentration in river bed sediments but below toxicity level of fishes • High PM_{10} levels in Varanasi • High noise level in Turtle sanctuary area
14.	Allahabad	• Festival: Kumbh Mela • Slightly high cadmium concentration in river bed sediments but below toxicity level of fishes

Cumulative impact assessment is carried out for the 14 hotspots identified as given above & the criteria for selection of them as hotspot above to assess the magnitude and significance of cumulative impact. It has been identified that nature of impact varied from low to moderately high. For example Varanasi, Patna and Howrah, air quality of the area is already impacted due to high PM_{10} concentration. Varanasi turtle sanctuary and Dolphin sanctuary are the eco-sensitive zones in NW-1 which are being impacted due to existing development and will be impacted due to development of NW-1 and other upcoming and planned development in the area. Other areas like Barh, Danapur, Bhagalpur etc are sensitive due to presence of important bird area. Varanasi will be the common station of upcoming EDFC and NW-1 and exchange of material will take place between these two points. Depending on the sensitivity of the area and nature of existing & upcoming developments in the area, certain zones are declared as hotspots. Total 14 zones are identified as hotspots. Rating is provided to impact of each identified activity on VECs and it is found that impact on these hotspots due to existing, planned and upcoming development varies from low to moderate. As per the impact assessment it is also found that the identified impacts can be mitigated by implementing the mitigation measures and management plan.

Chapter 7 provides strategic evaluation and recommendations to address cumulative impacts which are predicated on baseline status of identified VECs and impacts thereon. Identified VECs broadly are Physical environmental services and natural processes, Cultural Aspects of Ganga, Ecosystem services and Socio Economic Conditions. Components of VECs have been described in terms of its baseline status, possible impacts on VECs, strategic recommendations and responsibility for implementation.

Strategic recommendations are:

Water Availability:

a) Ganga basin suffers from stress on water resources. NRGB's present hydrological status is very inadequately known, especially in terms of water availability and usage. The hydrological status needs to be determined afresh both temporally and spatially. (2) NRGB's water resource management plan must adopt distributed water storage in the basin's groundwater, lakes, tanks and ponds, and promote wetlands and forests.(3) Increasing anthropogenic water usage needs to be checked by increased water use efficiency through realistic pricing of fresh water, incentives, technical assistance, allocation of water rights and entitlements to stakeholders, and promotion of water reuse and recycling. (4) A major policy shift in NRGB's water resource management should bring it under the ambit of natural resource management in the basin with emphasis on resource preservation before exploitation, decentralized stakeholder control, and expert guidance and regulation.(5) All existing and future dams/ barrages must ensure longitudinal river connectivity and **environmental flows** (of water, sediments and other natural constituents), and new projects should be approved or rejected on this basis. Efforts should be made to ensure environmental flows along the stretch of the river catering to environmental and social needs (ghats) of the basin (6) Increasing water withdrawals must be checked on a priority basis in critical regions.(7) The sediment resources of the Ganga river system need monitoring on a long-term basis and assessed comprehensibly in terms of both quantity and quality. The quantity and nutrient value of sediments trapped behind dams also need to be assessed, and nutrient-rich sediments need to be delivered to downstream river stretches and floodplains.(8) Some major research needs include the determination of ecological limits, thresholds and interconnections of water resources in NRGB, and river flow health assessments within the framework of ecohydrology.

b) Further, climate change scenarios with recommendations on adaptation & mitigation strategies should be made part of recommendation a).

Terrestrial biodiversity

a) Compensatory afforestation and green belt development. Translocation of trees proposed to be felled should be attempted, if feasible.

Aquatic Biodiversity

a) Delineation of Exclusion (No Go) areas in Ganga Basin and NW-1 (With respect to Protected Areas)
b) No-Go Areas- Ganga Main Stem other than NW-1 stretch
c) Restricted Areas
d) Propeller guards in vessels plying in NW-1

IWAI's vessels, cargo and tourist vessels plying in NW-1 through restricted and critical stretches as identified above should take adequate environment and social safeguards as described below.

a) Maintaining water depth of the navigation channel. This measure may reduce the disturbance to the migrating Hilsa, benthic habitat, facilitate escapement of fishes and aquatic mammals from direct impact of the barge/vessels, considering that the fully loaded barge draft is 2.7 m. This will also help Hilsa, which prefers more than 5 m depth for their migration.
b) The spawning & breeding grounds are not identified in the entire NW-1 stretches. Spawning areas normally have enough sand depth and water depth in general. Normally the spawning activity occurs in the rainy season. All care shall be given during construction & dredging activities to avoid any damage to spawning, breeding and nesting habitat of threatened aquatic species like Dolphin, Smooth Coated Otter, Gangetic Shark, Mugger, Gharial, Turtle, Hilsa, etc during spawning season which is from May to August.
c) Measures would also be required from aquatic perspective in terms of vessel movement speed, material handling (like coal dust spillages to river, oil spillages to river) and other operational aspects may have impact on aquatic life. Necessary design features to be included based on intervention specific environmental impact assessment and capital dredging impact assessment as well as mitigation measures proposed.

Landuse & Soil Quality

a) Land use change needs to be monitored in the short and the long term considering rapid urbanization in the influence area. Stress/ pressure and carrying capacity of the hotspots needs to be assessed in future for better local area and zonal planning.
b) Agriculture productivity and soil quality need to be monitored by agriculture department in the influence area.

c) Any future development/ intervention in NW needs to be well planned & designed, implemented and monitored from environmental perspective considering zero waste discharge approach, green buildings, access roads and railway infrastructure. These development/ interventions need to be follow the statutory requirements like EIA/ EMP but also designed on the principles of 3Rs (reduce, recover & recycle) and adaptation for climate change.

d) There is a need to monitor the economic activity particularly fishing activity and the sector in the entire NW 1 stretch to avoid its disruption

Air

a) Zonal planning and master planning of urban centers (hotspots) need to be upgraded in view of expected urbanization. These plans need to include developments related to NW 1 e.g. best locations for terminals, access, connectivity (roads & railways) and related infrastructure.

b) NW 1 operational strategy should aim for zero emissions. This should include alternate fuel e.g. CNG or renewable energy e.g. solar powered based barge/ vessel operations.

c) GHG accounting should be carried out especially for terminal and operation related movement of NW 1.This should also include GHG avoided & added vis a vis rail and road transport.

d) Air pollution monitoring infrastructure should be augmented in and around hotspots by state pollution control board.

Noise

OSHA guidelines shall be followed for exposure to specific noise levels for workers. Conducting hearing tests for workers also help in monitoring the impact of the higher noise level on workers' health.

Socio-economic Infrastructure Services & Facilities

a) Adequate compensation should be given to the people losing the land. People have sentiments associated with River Ganga so relocation of people should also be given near to River only as desired by them

b) Any utility or CPR like community temple, school, hospital, hand pump, well etc. if required to be shifted should be shifted immediately after the dismantling so as to minimize disturbance to people. Shifting should preferably be carried out on private land.

c) Non-productive lands, barren lands, raised lands; wastelands should be used for setting up labour camps, plant sites and debris disposal site. Agricultural land should be avoided. Land should be used for establishment of construction camps, debris disposal site and plant site only after obtaining consent from land owner.

d) Meetings should be conducted with nearby people six monthly to address the problems they are facing. A grievance redressal cell shall be set up at each intervention site. People should be communicated about the facility & system of grievance redressal so as they can launch their complaints, if any easily.

e) Fishing activity should not be restricted in the river. Alternate provision for fishermen should be given in case fishing activity is restricted.

Opportunity and access to improved and conserved livelihood

a) Barge/vessel movement will be restricted to the designated navigation route only. Maintenance of buoys, beacons, signs, gauges to mark the navigation channel
b) Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the damage to fishing gears and boats.
c) Marking of navigation channel through beacons and communicating information about the navigation channel monthly to fishermen and the expected timing or frequency of barges to fishing community so as they can be pre-informed and the damage to their boats and gears can be reduced. Barge movement schedule should be prepared in advance and should be shared with the fishermen
d) Regularizing the barge speed to 7-8 knots in bending areas so as bank erosion can be reduced due to barge movement resulting in lesser turbidity, enhanced planktonic growth and thus increased fish yield.
e) River training works should be carried out at the bank locations which are prone to erosion to reduce the turbidity in shallow areas and its impact on fish yield.
f) All measures to reduce the water quality pollution & to prevent damage to ecology due to barge movement as proposed above should be adequately addressed and implemented so as to minimise impact on fish yield due to the project.
g) In case of damage of fishing nets, fishing crafts and other gears of fishers, arising due to barge operation, appropriate and quick compensations may be given to the aggrieved fishers.
h) The barges may be fitted with powerful searchlight and may sound horn so that fishermen can realize arrival of barge at least from 500 m-1 km away to prevent damage to fishing nets
i) Regular consultations to be carried out with the fishing communities to get their feedback on the impact due to barge movement on fishing and problems they are facing
j) Support shall be extended in terms of supporting setting up fish nurseries for improving fish productivity and training awareness of fishermen for better fishing techniques through institute of repute like CIFRI.

Maintain the Cultural Values

a) Ensure availability of water including around the ghats and maintenance of water quality fit for bathing and performing rites and rituals.
b) No waste in any form shall be discharged by vessel in the river so as to improve and maintain the quality of water
c) Vessel movement shall be restricted or regularised during the identified major festival period as listed in section 2.0.
d) Support for establishment of small enclosed areas dedicated for female bathing in every village along the NW-1 to allow female maintain their privacy.
e) Support for improving cleanliness and at existing ghats at Varanasi and other locations
f) Provision for improving/restoring selected *Ghats, Kunds*, etc.

Maintain cultural events and cultural functions

a) Dredging operations should be restricted primarily to day time, i.e. 6:00 Am-10:00 Pm only to minimize noise impacts on the residents of nearby settlements. Dredgers should be equipped with the noise reduction/masking equipment to reduce the noise generation

b) Dredgers should be placed in consultation with the fishermen so as to minimize the impact on their equipment/gears and their fishing activities
c) Dredging should not be carried out in the areas close to Ghats in Varanasi and buffer of 2 km should be maintained for dredging during time of religious gatherings during Chat and Kumbh festivals.
d) Material to be disposed on land may create nuisance odour due to exposure of anaerobic sediments with air. Thus if land disposal is involved than disposal site should not be in upwind direction of any settlement area or sensitive locations like hospitals, schools etc.
e) Log book should be maintained for recording the accidents at site/mortality of the any aquatic mammal and other fauna should be maintained. Analysis shall be carried out to assess the reason for the accident/mortality and measures should be taken to prevent repetition of the event.
f) Dredging plan should be prepared by contractor and submitted to IWAI for approval prior to carrying out dredging operations. Dredging plan should be reviewed considering its location w.r.t environmental sensitive locations/archaeological locations/cultural festival/pollution influx in the area/dredged material quality & texture/available depth etc.

Conserve heritage sites, structures and values

a) Construction activities should avoid archeologically protected monuments/ structures/site as much as possible.
b) 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. Such permissions may necessarily be obtained from archeological department.

Other Benefits

Green Rating for Integrated Habitat Assessment (GRIHA)

It is recommended that the Green Rating for Integrated Habitat Assessment (GRIHA) is followed in proposed development of terminals, etc. by IWAI and by other developers on account of induced development spurred by NW-1 project particularly in the influence area.

Energy Conservation Building Code (ECBC)

It is recommended that ECBC is followed in proposed development of terminals, etc. by IWAI and by other developers on account of induced development spurred by NW-1 project particularly in the influence area.

Environmental Health & Safety Policy and EHS Management System

An effective environmental health and safety policy is essentially required to be prepared for the project and it should be communicated to the workforce through displaying posters/bill boards/posters/glow boards and campaigning around the work site. Posters should be in Hindi, English & Regional language so as it can be understood by the workforce. Verbal communication through campaigning also should be carried out. Some of the important days such as Environment Day (June 5), Red Cross Month (March), Emergency Preparedness Week (May 1-7), National safety day (4th April), National Health Day (7th April), Fire safety day (14th April), 20th April (Earth day) can be planned for spreading the awareness for Environment Protection, Cleanliness and safety among work force through campaigning.

For effective and systematic implementation of the project, it is desirable that IWAI (The EA) develops its Environmental and Social management systems which are 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.

Environmental Standards for operation and maintenance of Various Civil Interventions, Barge Movement and Dredging Operations

The abovesaid activities have potential to pose threat on the environmental quality. Regulatory Authorities of India and other countries have specified certain limits of pollutants which, if maintained, environmental pollution can be maintained. The Environmental standards applicable for the operation and maintenance stage of the project and that should be adhered to are listed below.

- Standards for discharged of effluent in inland surface water bodies and Marine Coastal Areas (Source: G.S.R 422 (E) dated 19.05.1993 and G.S.R 801 (E) dated 31.12.1993 issued under the provisions of E (P) Act 1986)
- Classification of Surface water Bodies on basis of Quality (Source: Guidelines for Water Quality Management-CPCB, 2008)
- Water Quality Standards for Coastal Waters, SW-IV & V-Harbour and Navigation & controlled waste disposal (EIA Guidance Manual for Ports & Harbours, MoEF&CC, GoI)
- Standards for permissible level of water quality indicators (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Permissible limit for off-shore dumping of dredged material (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Criteria for harmful bottom sediments (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Approximate Quantity of Suspended Sediments Generated by Dredging or Dumping Operations (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- MARPOL 73/78 for prevention of pollution from ships
- SOLAS (Safety of Life at Sea) as per latest amendments (Chapter I-XII)
- CPWD Norms for construction of off-shore works, river bank protection structure, carrying out dredging works, river training works

Zero discharge from vessels and proposed terminals

Zero discharge is recommended at all terminals site to minimize water pollution from the site and from plying vessels to address potential pollution.

Zero Emissions and reduction of GHG emissions

NW-1 operational strategy should aim for zero emissions. This should include alternate fuel e.g. CNG or renewable energy e.g. solar powered based barge/ vessel operations.

GHG accounting should be carried out especially for terminal and operation related movement of NW 1.This should also include GHG avoided & added vis a vis rail and road transport.

CHAPTER 1: INTRODUCTION & BACKGROUND

1.0 Introduction

From the beginning of history, human sensitivity has revealed an urge for mobility leading to a measure of Society's progress. The history of this mobility or transport is the history of civilization. For any country to develop with right momentum, modern and efficient, transport as a basic infrastructure is a must. It has been seen throughout the history of any nation that a proper, extensive and efficient road transport has played a major role. Where roads are considered as veins and arteries of a nation, passenger and goods transported are likened to blood in circulation, water transport is the cheapest and the oldest form of transport for heavy goods and bulk cargoes.

Inland Waterways Authority of India (IWAI) is a statutory body under Ministry of Shipping, Govt. of India. IWAI is primarily responsible for development, maintenance and regulation of Inland Water Transport (IWT) in the country specifically on National waterways. In this context, the Ganga-Bhagirathi-Hooghly river system from Allahabad to Haldia has been declared as National Waterway-I (NW-I). It is a natural waterway of about 1620 km in length and passes through the states of Uttar Pradesh, Bihar, Jharkhand and West Bengal. One of the limitations on viable Inland waterway transport on NW-1 is a weak navigation infrastructure. Therefore, 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.

In this regard, IWAI has commissioned Social & Environmental Impact Assessment (SEIA) studies to map and understand potential environmental and social impacts associated with navigation improvement of NW-I and to prepare plan for effective mitigation and management of the Impact associated with the project. This report is prepared for Cumulative Impact Assessment (CIA) study which is the part of the SEIA study.

1.1 Need for the CIA Study and Objectives

Need for the CIA Study: Over time, all the proposed projects in NW1 are expected to have direct and indirect environmental and social impacts in their immediate area of influence and beyond. Environmental and social impact assessment & mitigation plans will be prepared and will be implemented to mitigate, offset, reduce negative impacts and strengthen positive impacts on the environment and communities in the individual project areas. However, a need for a study to understand and analyse the incremental, induced and cumulative impacts of all the proposed in NW1 was identified. Other regional development, including potential development in infrastructure sectors such as roads, transport and storage, urban development, industry and tourism can also be triggered, as a result of development of inland navigation. These induced developments, if any, would also influence environment of the Ganga basin. Therefore the assessment of cumulative (direct, indirect, induced) impacts of all these developments, parallel or induced, will provide a holistic view of their magnitude and extent in the Ganga basin over a longer period of time. To this end, this CIA will assess the cumulative impacts expected due to planned projects over several time horizon, and will recommend measures to be implemented in planning and development of all future activities related to NW, including capacity augmentation of NW-1. The CIA study shall address the following components:

1: Quantity of flow
2. River Water Quality
3. Avoid or minimize impacts on valued environment and social component
4. Area level social impacts
5. Strategies for development and operation of the waterway

It will also serve as a guideline document for planned interventions in NW1 in future.

As per the need of the project, the main objectives of this study are as follows:

- Assess the potential impacts and risks of a proposed and other developments over time on a chosen VECs;
- Verify that the proposed development's cumulative social and environmental impacts and risks will not exceed a threshold that could compromise the sustainability or viability of selected VECs;
- Confirm that the proposed development's value and feasibility are not limited by cumulative social and environmental effects;
- Support the development of governance structures for making decisions and managing cumulative impacts at the appropriate geographic scale (e.g., airshed, river catchment, town, regional landscape);
- Ensure that the VECs of affected communities about the cumulative impacts of a proposed development are identified, documented, and addressed; and
- Manage potential reputation risks

These objectives will be achieved by carrying out activities viz. inception stage as wll as feasibility and design stage.
This includes cumulative environmental & social impacts assessment on the identified VECs and formulation of development and operational strategy of the waterway.
At the feasibility and design stage, this includes updation of the inception stage strategy considering feasibility and design of the interventions proposed in NW-1.

1.2 Study Area, Project Description

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

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 cargos.
    - Development of navigation aids along NW-1 for facilitation of day & night time navigation.
- Development of efficient River Information System with all hardware & software.
- Provision for bank protection / slope protection and river training works for critical locations.

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

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

Table 1.1: 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

S. No.	Infrastructural Facility	Projected Cargo-2015 (MTPA)	Projected Cargo-2030 (MTPA)	Projected Cargo-2045 (MTPA)
2	Varanasi Terminal (with current land)	0.54	1.22	1.22
3	Haldia Terminal	3.18 MTPA		

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

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

Table 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-45 m
LAD-3 m from Haldia to Barh, 2.5 m from Barh to Ghazipur and 2.2 m from Ghazipur to Varanasi at present</td></tr>
<tr><td>Design Vessel Specifications</td><td>Vessels of maximum length 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-14,850,000 cum/year*</td></tr>
<tr><td>Type of Dredgers</td><td>CSD, Agitation dredgers/plough dredgers and back hoe dredgers</td></tr>
<tr><td>Dredge disposal</td><td>Preferably off-shore, onshore only if sediments are found to be contaminated</td></tr>
</table>

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

Figure 1.1: Location and Alignment of the Project

1.3 Approach & Methodology

Stepwise Approach & Methodology (A&M) is based on the Good Practice Handbook: Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, International Finance Corporation, World Bank Group[3], is given below.

Step 1: Identify VECs*, and determine spatial and temporal Boundaries for CIA
Step 2: Identify other activities and developments affecting VECs
Step 3: Establish information on baseline status of VECs
Step 4: Assess cumulative impacts on VECs
Step 5: Assess significance of predicted cumulative impacts
Step 6: Management of cumulative impacts – design and implementation

The above step wise approach has been converted into activities and tasks as mentioned below & schematically shown in **Figure 1.2[4].**

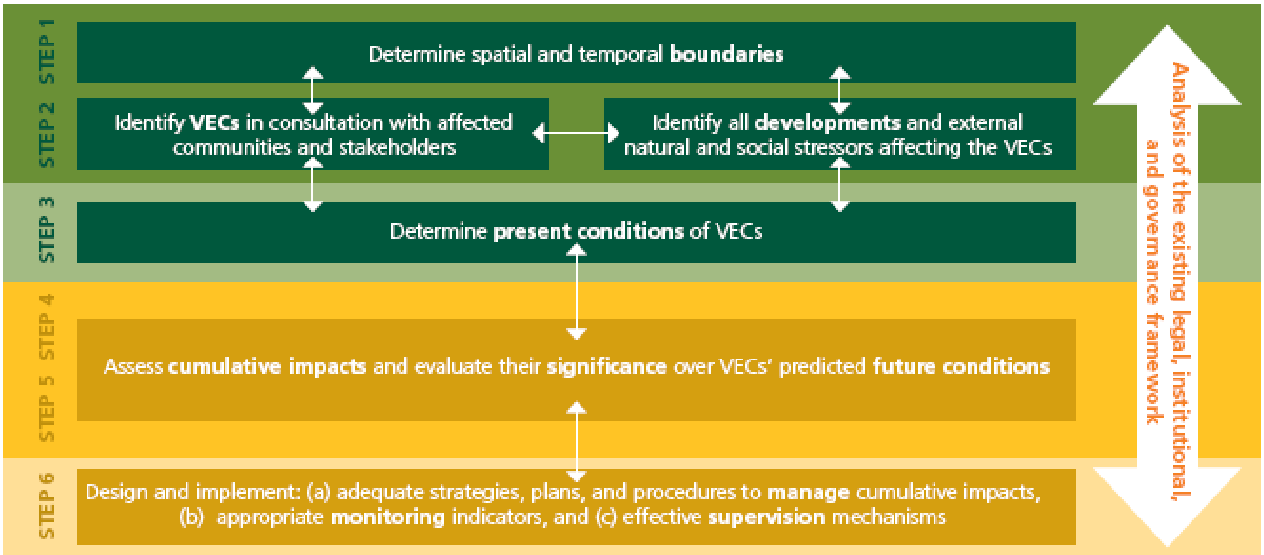


Figure 1.2: Schematic Representation of Proposed Approach & Methodology (A&M)

Activity 1: Scoping Phase I –VECs, Spatial and Temporal Boundaries

1. Identify the VECs to include in the CIA.
2. Identify the spatial boundaries of the CIA.
3. Identify the temporal extent of the CIA.

A&M: In the scoping phase, as per ToR, CIA will identify area of influence (impact area) which will be further assessed for its relevance, applicability, etc. for the purposes of EIA & EMP for

[3] http://www.ifc.org/wps/wcm/connect/3aebf50041c11f8383ba8700caa2aa08/IFC_GoodPracticeHandbook_CumulativeImpactAssessment.pdf?MOD=AJPERES
http://www.ifc.org/wps/wcm/connect/3aebf50041c11f8383ba8700caa2aa08/IFC_GoodPracticeHandbook_CumulativeImpactAssessment.pdf?MOD=AJPERES
[4]
*CERs/VECs correspond to the same terminology & hence the term VEC has been used in place of CER mentioned in ToR.

local interventions. These inputs and iterative process will form the basis of revised and updated CIA, if needed. The activities include (1) Determine spatial and temporal boundaries (Identification of Zone of Influence of NW-1 and Preparation of Base Map) Identify VECs in consultation with affected communities and stakeholders (2) Inventorization of VECs their zonation & sample consultations for verification.

Activity 2: Other Activities and Environmental Drivers

1. Identify other existing and reasonably predictable projects and human activities that do/would affect the VECs to be included in the CIA;
2. Identify natural environmental drivers that also impact the condition of VECs identified in Step 1.

A&M: Identify all developments and external natural and social stressors affecting the VECs Identification of direct, indirect & induced activities both natural & developmental & possible stresses.

Activity 3: Establish Information on Baseline Status of VECs

1. Collect available information on the impacts of the other activities and natural drivers on the condition of the VECs;
2. Collect available information on VECs trends;
3. Collect any available information on regional thresholds for VECs (e.g. air pollution).

A&M: (1) Identify all developments and external natural and social stressors affecting the VECs Identification of direct, indirect & induced activities both natural & developmental & possible stresses (2) Development Matrix of VECs Vs Activities.

Activity 4: Assess Cumulative Impact on VECs

1. Establish indicators for expression of VECs condition. This may already be reflected in the information collected on VECs baseline status (in Step 3 above). If not, then indicators may need to be established that can be estimated from the baseline information;
2. Estimate the "future baseline" for condition of the VECs — i.e., the condition of VECs as affected by the other projects, human activities, and natural drivers; and Estimate the project impact on VECs condition. This estimation is done with the effects of planned project mitigation included; and
3. Estimate the cumulative impact on VECs —the total impact on the VECs when the impacts of the development are combined with the future baseline.

A&M: Baseline data evaluation of NW-1 & Identification of critical elements of VECs, their prioritization & development of indicators.

Activity 5: Assess Significance of Anticipated Cumulative Impacts

1. Assess the significance of the foreseen cumulative impacts on the VECs;

Activity 6: Management of Cumulative Impacts: Design and Implementation

1. Identify, when necessary, additional project mitigation (beyond that identified in the project ESIA) to reduce an estimated unacceptable cumulative impact on a VECs to an acceptable level. This should represent effective application of the mitigation hierarchy in environmental and social management of the specific project contributions to the expected cumulative impacts;
2. If necessary, identify the potential, or need for, additional mitigation of other existing or reasonably predictable future projects;
3. Identify the potential for other regional strategies that could maintain VECs at acceptable conditions; and
4. Undertake best efforts to engage, enhance, and contribute to a multi-stakeholder collaborative approach for the implementation of management actions that are beyond the capacity of the project proponent.

A&M: (1) Assess cumulative impacts and evaluate their significance over VECs predicted future conditions (Predicted Scenarios Vs Impacts. Design and implement: (a) adequate strategies, plans, and procedures to manage cumulative impacts, (b) appropriate monitoring indicators, and (c) effective supervision mechanism (2) Strategic evaluation & recommendations & institutional mechanism)

Activity 7: Stakeholder Engagement

1. Identify the stakeholders getting affected during the construction phase and operational phase of the project and other developmental proposals along the alignment.
2. Consultation with stakeholders including public, line departments, infrastructure, service providers and experts.
3. Incorporate input from other people knowledgeable of the study area to inform conclusions about future land use and developments in the study area.
4. Identify and finalise the Hotspots / Pressure Points based on Consultations.

The entire A&M is iterative in nature and has been reviewed and refined considering field work, Basin Level Valued Environment & Social Component study.

1.4 Format of the Report

Cumulative Impact Assessment Report has been compiled in seven chapters. The table of contents of each chapter is given below.

Chapter 1 Introduction and Background: This chapter describes Introduction; Objective of the Study as per ToR; Study Area; Approach and Methodology and format of the report.

Chapter 2 Project Description: This chapter describes project description; components of NW-1 in an integrated manner; and applicable legislations and World Bank policies.

Chapter 3 Delineation of CIA boundaries and VECs. This chapter describes delineation of CIA boundary; VECs and Social components; Assessment of status of identified VECs; Preliminary Identification of Hotspots.

Chapter 4 Stakeholders consultations, Other Development Proposals and finalization of VECs: This chapter describes Basis and Strategy of Stakeholder's Selection; Methodology and the Tools Used; Proceedings of Stakeholder Consultations; Public Consultations; Summary of Output of the Stakeholders Consultations; and Identification of Hotspots based on Consultations.

Chapter 5: Cumulative Baseline Study: This chapter describes cumulative baseline including CIA of NW-1 in an integrated manner.

Chapter 6: Cumulative Impact Assessment: This chapter describes Finalization of Hotspots VECs for Cumulative Impact Assessment; Impact identification due to Proposed project; Interaction of VECs and proposed development; Assessment of Cumulative Impacts; Recommendation of Basin level VECs Study.

Chapter 7: Strategic Evaluation & Recommendations: This chapter describes baseline, predicted impacts & strategic evaluation of the impacts on VECs considering basin as well as project influence areas. Based on this evaluation, recommendations have been formulated considering short & long term environmental planning considering proposed / planned & anticipated developments with study area.

CHAPTER 2: DESCRIPTION OF THE PROJECT

2.0 Introduction

This chapter presents the details of the project, its existing infrastructure & current traffic, components and salient features. At first, project description has been summarized. This is followed by summary of existing project components, proposed components, applicable legislation considering initial & planning, Design and engineering. Further, applicable World Bank Guidelines have also been referred for their application. Finally, inferences have been drawn considering the scope & boundaries of CIA.

2.1 Project Description of NW-1

NW-1 which is natural waterway extends from Haldia (Sagar) to Allahabad and spans 1620 kms crossing the states of Bihar, Jharkhand, Uttar Pradesh & West Bengal. NW-1 falls in The Ganga - Bhagirathi - Hooghly river system between Haldia & Allahabad. It links the ports of Haldia and Kolkata to Bhagalpur, Patna, Ghazipur, Varanasi and Allahabad, their industrial hinterlands, and several industries located along the Ganga basin. Alignment of NW-1 is depicted in **Figure 2.1** below.

Figure 2.1: Alignment of NW-1

NW-1 is being fed by various tributaries at different locations. Major tributaries to NW-1 between Haldia to Allahabad are Tons, Gomti, Ghagra, Son, Gandak, Punpun and Kosi. Jal Marg Vikas project is aimed at augmentation of navigation in the waterway by maintaining the LAD in the waterway throughout the year for navigation, development of the navigational infrastructure and navigation aids, river training works at critical location, equipments like barges/dredgers/boats for navigation purpose and development of efficient River information system.

2.2 Components of the Existing Infrastructure & Current Cargo Movement

Navigation infrastructure existing at NW-1 which facilitates the cargo transportation consist of: Low & High level jetties at Patna; GR jetty in Kolkata; Fixed Jetty at Farakka & Pakur and floating terminals at Haldia, BISN & Botanical Garden in Kolkata, Tribeni, Shantipur, Swaroopganj, Katwa, Hazardwari, d/s Farakka, u/s Farakka, Manglahaat (Rajmahal), Samdaghat (sahebganj), Bateshwarsthan, Bhagalpur, Munger, Semaria, Buxar, Ghazipur, Ramnagar (Varanasi) and Allahabad. Details of the location, Chainage, capacity, area, facilities of these above mentioned existing facilities in NW-1 are given below in **Table 2.1**. Map showing location of the existing developments in NW-1 is given in **Figure 2.2** below.

Table 2.1: Details of Existing Infrastructure in NW-1

A. Floating Terminals										
Sl. No.	**Name of terminal with chainage (In km)**	**Land area (in ha)**	**Size of berth, water front (In metre)**	**No. of Pontoon Barge & Gangway**	**Cargo Handling equipment**	**Storage area**	**Link approach road**	**Security (in each shift)**	**Water/ Lighting facility**	**Remarks**
1	Allahabad (Ch. 1535)	8.759 Hectare Land	35 m berth & 300 WF	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land (0.5 ha)	Pucca Rasta (Concrete road)500 m and metalled road 2 kmconnected with NH 76	01 no. armed 01 no.unarmed	Drinking Water facility available	Generator could be provided for lighting if required
2	Ramnagar (Varanasi) (Ch. 1315)	5.586 Hectare Land	35 m berth & 300 WF	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land (0.2 ha)	Land acquisition in process for approach road of about 700m connecting with NH 07	01 no. armed 01 no. unarmed	-	Being developed under Jal Marg Vikas Project
3	Ghazipur (Ch. 1177 Km) / Rajghat (Varanasi)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon. Private land could be made available if required	KachchaRasta(Earthen Road) 100m and Pucca road 100 m connected with NH 19	-	Drinking Water facility available	Generator could be provided for lighting if required
4	Buxar (Ch. 1124 Km)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon. Private land could be made available if required	KachchaRasta100m and Pucca road 400 m connected with NH 84	-	Drinking Water facility available and Street Lights available as provided by Local Administration	
4	Semaria (Ch. 850 Km)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Crane on Pontoon available	To be stored on Pontoon. Private land could be made available if	Kachcha Rasta 200m and Pucca road 300 m connected with NH 31	-	Drinking Water facility available	

A. Floating Terminals										
Sl. No.	**Name of terminal with chainage (In km)**	**Land area (in ha)**	**Size of berth, water front (In metre)**	**No. of Pontoon Barge & Gangway**	**Cargo Handling equipment**	**Storage area**	**Link approach road**	**Security (in each shift)**	**Water/ Lighting facility**	**Remarks**
						required				
5	Munger (Ch.793Km.)	1.37 ha Land	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land (0.1 ha)	Pucca Rasta 100 m and metalled road 5 km connected with NH 80	01 no. armed 01 no. unarmed	Drinking Water facility available and Street Lights available provided by Local Administration	Generator could be provided for lighting whenever required
6	Bhagalpur (Ch715Km.)	1.56 ha Land	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon and open space of IWAI's land (0.1 ha)	Pucca Rasta 300 m and metalled road 2 km connected with NH 80	01 no. armed 02 nos unarmed	Drinking Water Sodium Vapour Lamps (Full Illumination)	DGPS Station is operational and being utilized since 2010.
7	Bateshwarsthan (Ch. 683Km.)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon.	Kachcha Rasta 200m and Pucca road 5km connected with NH 80	-	Drinking Water facility available	Generator could be provided for lighting whenever required
8	Samdaghat (Sahebganj) (Ch.617Km.)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Crane on pontoon	To be stored on Pontoon. Private land could be made available if required	Kachcha Rasta300m and Pucca road 1km connected with NH 80	-	Drinking Water facility available	Generator could be provided for lighting whenever required
9	Manglahat (Rajmahal) (Ch. 588Km.)	-	35 m berth	01 Pontoon Barge 01 Pontoon Gangway	Nil	To be stored on Pontoon. Private land could be made available if required	Kachcha Rasta 100m and connected with NH 80	-	Drinking Water facility available	Generator could be provided for lighting whenever required

A. Floating Terminals										
Sl. No.	**Name of terminal with chainage (In km)**	**Land area (in ha)**	**Size of berth, water front (In metre)**	**No. of Pontoon Barge & Gangway**	**Cargo Handling equipment**	**Storage area**	**Link approach road**	**Security (in each shift)**	**Water/ Lighting facility**	**Remarks**
10	U/s Farakka (Ch. 545.0)	0.48 ha land	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon & land of FBP	100 m	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps	Land belongs to FBP being used by IWAI.
11	D/s Farakka (Ch. 542.0)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon.	Along the road	NIL	Street Lights provided by Local Administration	Land not available pontoon placed on water front
12	Hazardwari (Ch. 439.0)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon.	100 m	NIL	Street Lights provided by Local Administration	Land not available pontoon placed on water front
13	Katwa (Ch. 334.50)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon.	1.5 km	NIL	NIL	Land not available pontoon placed on water front
14	Swaroopganj (Ch. 280)	0.23 ha land	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	One Godown of size 4.5 x 5 m and Open space (0.029 ha)	500 m	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps	Land taken from KoPT on lease basis
15	Shantipur (Ch. 241.0)	0.8 ha land	35 m berth & 100 WF	01 Pontoon 06 Modular Pontoons Gangway	NIL	To be stored on Pontoon and open space of IWAI's land (0.2 ha)	3 km	03 nos. unarmed	NIL	Land belongs to State Govt. of W.B. being used by IWAI.
16	Tribeni (Ch. 196.0)	-	35 m berth	01 Pontoon 01 Bamboo Gangway	NIL	To be stored on Pontoon	Along the road	01 nos. armed 02 no. unarmed	NIL	Land not available pontoon placed on water front
17	BISN Jetty	3.04 ha land	70 m	03 Pontoons	NIL	Open Space area	1 km	01 nos.	Sodium Vapour	Land taken from

Sl. No.	Name of terminal with chainage (In km)	Land area (in ha)	Size of berth, water front (In metre)	No. of Pontoon Barge & Gangway	Cargo Handling equipment	Storage area	Link approach road	Security (in each shift)	Water/ Lighting facility	Remarks
A. Floating Terminals										
	& G.R. Jetty-1 (Ch. 135.0)		berth & 100 WF	01 Steel Gangway		(0.6 ha)		armed 03 no. unarmed	Lamps (Full Illumination)	KoPT on lease basis
18	Botanical Garden Jetty (Ch. 134.5)	0.09 ha land	35 m berth & 50 m WF	01 Pontoon 01 Steel Gangway	NIL	To be stored on Pontoon	150 m	03 nos. unarmed	Sodium Vapour Lamps (Full Illumination)	Land belongs to KoPT being used by IWAI.
19	Haldia (Ch. 35.0)	1.09 ha land	70 m berth & 200 m WF	04 Pontoons 01 Gangway	NIL	One Godown of size 12 x 30 m and Open space (0.163 ha)	3.5 km via HDC	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps	Land taken from Haldia Dock Complex (HDC) on lease basis.
B. Fixed RCC Jetties										
1	G.R.Jetty -2 (Ch. 134.5)	1,4 ha land	70 m berth	-	-	One Transit shed of size 25 x 46 m and Open space (0.4 ha)	500 m.	01 nos. armed 03 no. unarmed	Drinking Water Sodium Vapour Lamps (Full Illumination)	Land taken from KoPT on long term lease basis. RCC Jetty completed and being operational since Nov., 2013.
2	Farakka RCC Jetty (Ch. 542 km)	-	115 m berth	-	-	-	Along the road	-	Drinking Water Sodium Vapour Lamps	Owned by FBP this can be used by the common users.
3	Pakur RCC Jetty (Ch. 522 km)	-	60 m berth	-	-	-	1 km	-	-	Owned by FBP this can be used by the common users.
4	Patna	1.18 ha land	46.0 m	Nil	Shore	45m x 14m	Pucca Rasta 500 m	01 no.	Drinking Water	Permanent High level

A. Floating Terminals										
Sl. No.	**Name of terminal with chainage (In km)**	**Land area (in ha)**	**Size of berth, water front (In metre)**	**No. of Pontoon Barge & Gangway**	**Cargo Handling equipment**	**Storage area**	**Link approach road**	**Security (in each shift)**	**Water/ Lighting facility**	**Remarks**
	(Gaighat) (Ch. 955Km.)		berth 100 m WF		Crane-2 with capacity of 01 - 20 tonnes subject to radius	Transit shed and open space of IWAI's land (0.1 ha)	and metalled road 2 km connected with NH 30	armed 03 no.unarmed	Sodium Vapour Lamps (Full Illumination)	Jetty and DGPS Station is operational and being utilised since 2012.

(Source: Howe Engineering -Detailed Feasibility Report)

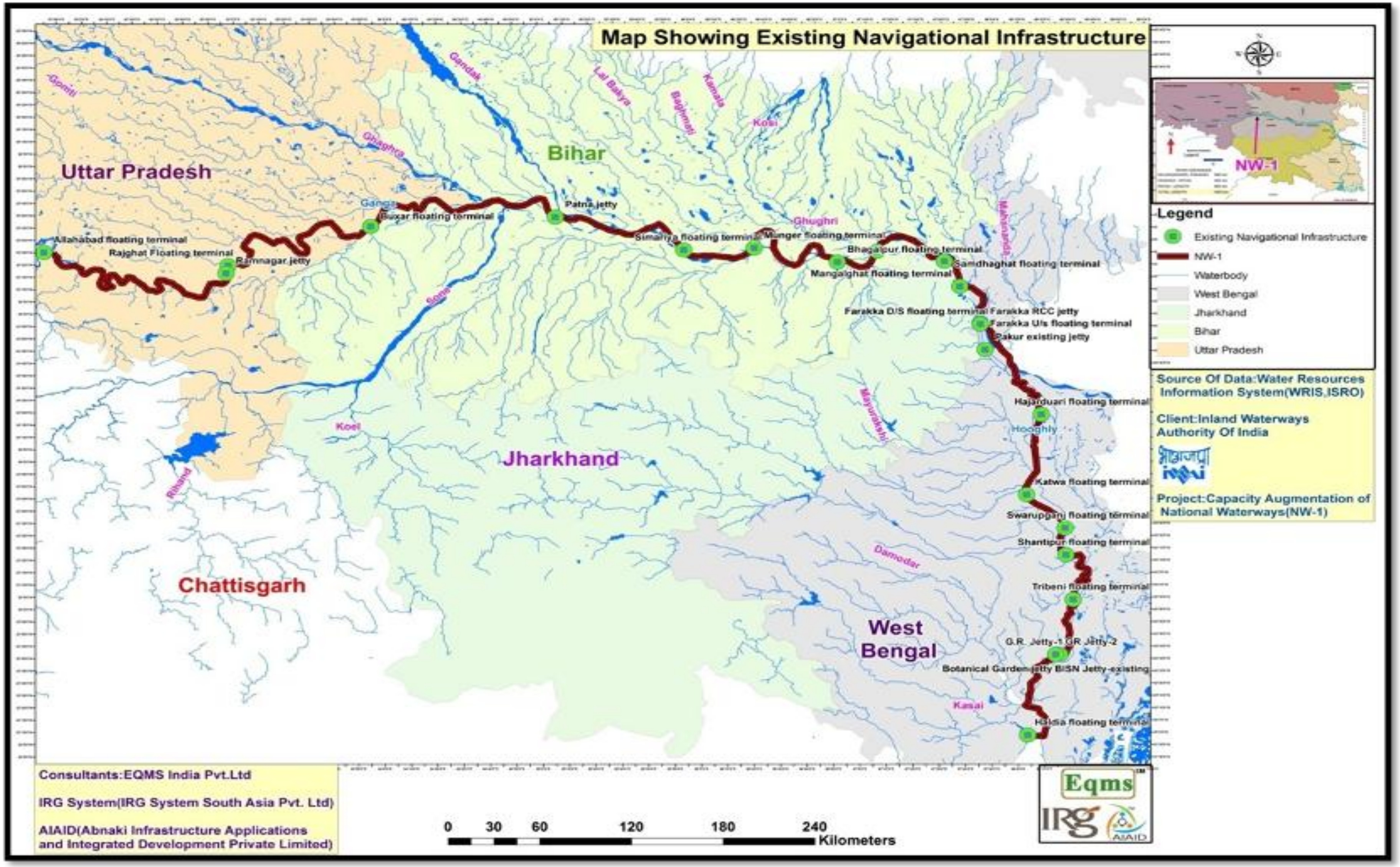


Figure 2.2: Existing Navigation Infrastructure Facilities in NW-1

2.2.1 Existing and Anticipated Cargo Movement at NW-1

The above infrastructure supported a cargo movement of 27,16,436 MT (15,11,961,380 TKM/1.512 BTKM) during 2012-2013 (IWAI). Cargo transported include cement, fly ash, iron ore, iron ore fines, coal, steel shed, tyres, iron fines, iron ingots, Galvanized steel plain sheets, stone chips, furnace oil, high Speed diesel, lube oil, boulders, pulses, aluminium block, sand, chips, ship block, log, pulses, Manganese ore, Petroleum, Coke, Cooking coal, Rock Phosphate, Timber, Peas, Slag oil, and Non-cooking coal. Cargo traffic and the commodities transported in NW-1 vary in different stretches. Cargo volume by rail & road mode along NW-1 stretch for year 2014 is given at **Table 2.2.**

Table 2.2: Current Traffic Along NW-1 Stretch (2014)

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

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

Table 2.2 indicates that the current potential along NW-1 vis a vis other modes is very high which can be shared by NW-1.

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

2.3 Traffic Projections & Components of Planned Project

Traffic projection study for 30 years has been undertaken by survey and marketing consultant HPC for growth of traffic under three scenarios, i.e. base scenario (in absence of Jal Marg Vikas Project), Medium Augmentation scenario (Jal Marg Vikas project with 3 m LAD upto Barh, 2.5 m until Ghazipur and 2 m upto Varanasi) and Full augmentation scenario (LAD of 3 m upto Patna and 2.5 m upto Varanasi). For the current study, HPC has considered scenario for medium augmentation. Since traffic will be generated for different stretches, the traffic projection is made for three different stretches, i.e. Haldia-Varanasi, Haldia-Patna & Patna-Varanasi. The traffic projection for these stretches as per medium augmentation scenario is given below in **Table 2.3, 2.4 & 2.5**.

Table 2.3: Traffic Forecast for Stretch-1 (Haldia-Varanasi)*

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

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

Table 2.4: Traffic Forecast for Stretch-2 (Patna-Varanasi)*

Cargo Type	Commodity	Forecast Medium Augmentation Case (tons)				
		Forecast MAC 2015 (t)	Forecast MAC 2020 (t)	Forecast MAC 2025 (t)	Forecast MAC 2035 (t)	Forecast MAC 2045 (t)
Dry bulk	Coal	0	2,51,993	2,46,256	2,68,992	2,71,067
Dry bulk	Sand stone	0	5,185	6,576	9,233	10,733
Dry bulk	Limestone	0	3,889	4,932	6,925	8,050
Bagged	Food & Foodstuff	0	3,32,723	4,35,396	5,94,442	6,28,316
Bagged	Textile	0	61,229	73,563	1,01,778	1,30,401
Bagged	Plastic granules	0	9,383	12,270	18,713	24,250
Bagged	Cement	0	8,13,646	11,93,886	20,03,696	25,23,702
Neo-Bulk	Paper	0	3,745	5,282	8,320	10,480
Neo-Bulk	Project	0	2,02,152	2,24,605	2,77,894	3,50,014

Cargo Type	Commodity	Forecast Medium Augmentation Case (tons)				
		Forecast MAC 2015 (t)	Forecast MAC 2020 (t)	Forecast MAC 2025 (t)	Forecast MAC 2035 (t)	Forecast MAC 2045 (t)
	cargo					
Neo-bulk	Steel products	0	4,81,730	5,77,518	7,69,196	9,68,820
Neo-bulk	Statues	0	1,07,208	1,21,296	1,37,339	1,37,339
Ro-Ro	Vehicles	0	47,863	65,484	1,09,045	1,45,370
Container	General cargo	0	17,43,011	25,91,191	45,32,781	59,07,393
Total		0	38,11,763	53,12,000	85,69,361	1,08,44,869

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

Table 2.5: Traffic Forecast for Stretch-3 (Haldia-Patna)*

Cargo Type	Commodity	Forecast Medium Augmentation Case (tons)				
		Forecast MAC 2015 (t)	Forecast MAC 2020 (t)	Forecast MAC 2025 (t)	Forecast MAC 2035 (t)	Forecast MAC 2045 (t)
Dry bulk	Stone chips	0	23,98,814	30,23,922	40,38,168	46,94,401
Dry bulk	Coal	32,82,875	69,39,211	79,69,586	98,53,827	1,10,56,473
Dry bulk	Iron ore	0	9,71,959	12,25,242	16,36,197	19,02,091
Dry bulk	Limestone	0	3,23,986	4,08,414	5,45,399	6,34,030
Dry bulk	Sand	0	68,652	84,513	1,12,091	1,41,182
Bagged	Food & Foodstuff	1,62,487	63,63,580	79,20,893	1,04,42,930	1,19,90,623
Bagged	Fertilizers	0	17,94,026	26,47,350	45,96,517	59,75,527
Bagged	Plastic granules	0	23,258	32,621	50,627	58,517
Bagged	Textile	0	2,22,364	3,02,610	4,71,792	5,99,523
Neo-Bulk	Logs and wood	0	6,47,972	8,16,828	10,90,798	12,68,061
Neo-bulk	Petroleum	2,62,460	14,63,318	18,43,599	24,76,593	28,74,916
Neo-Bulk	Project cargo	0	2,64,189	3,15,652	4,24,786	5,19,963
Neo-bulk	Steel products	0	9,39,231	11,52,032	15,42,578	19,02,495
Ro-Ro	Vehicles	0	25,886	30,543	41,522	53,199
Container	General cargo	0	2,17,457	2,95,933	4,65,037	5,85,405
Total		37,07,822	2,26,63,903	2,80,69,739	3,77,88,862	4,42,56,407

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

Though above traffic projection indicate sufficient traffic cargo potential till 2045, however design consultant has designed infrastructure facility as given in **Table 1.1** of Chapter 1.

2.3.1 Components of the Planned Project

Entire stretch measures 1620 kms and traverses through 4 states namely Jharkhand, Uttar Pradesh, Bihar and West Bengal. Developments planned under the Jal Marg Vikas project to support traffic forecasts as on date includes:

- Maintenance dredging to maintain the LAD in waterway/channel and the terminal facility
- Improved Navigation Infrastructure & Navigation Aids
  - Construction of 5 Nos. of Ro-Ro crossings & ferry passenger jetties. Location for these jetties is not yet identified.
  - Construction of 6 Nos. of terminals. Site identification and planning for 3 terminals sites at Sahibganj, Varanasi and Haldia is completed. 2 more potential sites for development of terminals are identified at Ghazipur and Kalughat. These two sites are still under consideration for finalization and planning is at initial stage only. One more terminal site is to be identified along NW-1.
  - Construction of Navigation Locks
  - Provision for tow barges, inland vessels, survey vessels including rescue boats and survey equipment. Development of low draught cargos
  - Development of navigation aids along NW-1 for facilitation of day & night time navigation
- Development of efficient River Information System with all hardware & software
- Provision for bank protection / slope protection and river training works for critical locations

2.3.2 Depth & Width of Navigation Channel & Size of Vessel / Ships

It is planned to maintain depth of 3 m from Haldia to Barh, 2.5 m from Barh to Ghazipur and 2.2 m from Ghazipur to Varanasi at present * [5]. Further, it is planned to maintain the channel width of 65 to 45 m and side slopes of 1:10 from section Haldia to Varanasi[6]. As per IWAI planning, Vessels of maximum length 110 m, beam 11.4 m, draught 2.5 m-2.8 m and air draught of 9 m will ply in the waterway. However, the vessel size will vary in different stretched as per the available LAD and type and quantity of cargo to be transported. Vessels of size 1500-2000 DWT is expected to ply in the waterway. Study for cargo estimation is under process and size of the vessels will be finalized accordingly.

2.3.3 Challenges for Project Development

Some of the major challenges include nature of the river, its morphology & related phenomena along NW-1. River Ganga (NW-1) is alluvial river with typical characteristic of braiding, meandering and large water level fluctuation between summer and monsoon months. Wide

[5] *Source of Data: (Detailed Feasibility Study for Jal Marg Vikas Project and Detailed Engineering for its Ancillary Works and Processes between Haldia to Allahabad by HAWE Engineering Projects (India) Pvt. Ltd). * quantities are tentative and subject to change with revision in planning*

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

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

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

1. Highly braiding and meandering river
2. Large water level fluctuation
3. Unavailability of LAD for navigation throughout NW-1 and unreliable water depths
4. Existence of sharp bends
5. High silt load & shoal/bar/island formation leading to splitting of main channel
6. Growing of bars reducing the available depth
7. Lateral migration of the river and change in navigation line
8. Existence of power line pylons at various locations
9. Existence of pontoon bridges. About 7 pontoon bridges are present between Buxar and Allahabad which are in use. Pontoon bridges are significant threat to navigation
10. Existence of siphon in the Farakka feeder canal for irrigation purpose which generates eddy currents, reduces water level by 0.1-0.2 m in immediate vicinity of the structure and reduction in buoyancy of vessel due to presence of air bubbles in water column above this siphon leading to increase in vessel draught
11. Existence of critical bridges (bridges with Horizontal Clearance (HC) & Vertical Clearance (VC) less than 70 m & 9 m respectively). Details of the critical bridges are given below in **Table 2.6** below.
12. Inadequate navigation infrastructure and aids like inadequate fairway width, channel marking, navigation lights, signals, RIS etc., lack of modern vessel based navigation aids, absence of effective waterway reporting & tracking system etc.

Table 2.6: Details of Critical Bridges on NW-1

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

9	Buxar Road Bridge	--	--	10.91-50%, 9.43-10% & 9.23-1%
10	Ghazipur Road Bridge	--	--	11.82-50%, 10.35%-10% & 10.12-1%

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

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

13. Some of the bends in the NW-1 are significant w.r.t. navigation. There are 10 significant bends in U.P. stretch, 1 bend at U/s of Farakka and 63 significant bends in West Bengal. Due to presence of these bends, additional channel width will be required. Details of the significant bends are given in **Table 2.7**.

Table 2.7: Details of Navigationally Significant Bends in UP stretch of NW-1

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

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

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

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

2.4 Physical Intervention

The components of the projects, during phase 1 mentioned in 2.3 which are required to be achieved have been described in the following sections. These include:

Planned Infrastructure

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

Infrastructure Facilities at Initial Planning Stage

1. Terminals at Ghazipur and Kalughat

Facilities yet to be planned

1. One similar terminal site (Kalyani at Tribeni)
2. 5 Nos. Ro-Ro Crossings and Passenger Ferry Jetties
3. Development of low draught cargo
4. River Training Works at Critical Locations like bends and civil interventions under planning
5. Bank/slope & scour protection works
6. Equipment of tow barges, inland vessels, survey vessels including rescue boats and survey equipment
7. Barge maintenance and repair facility

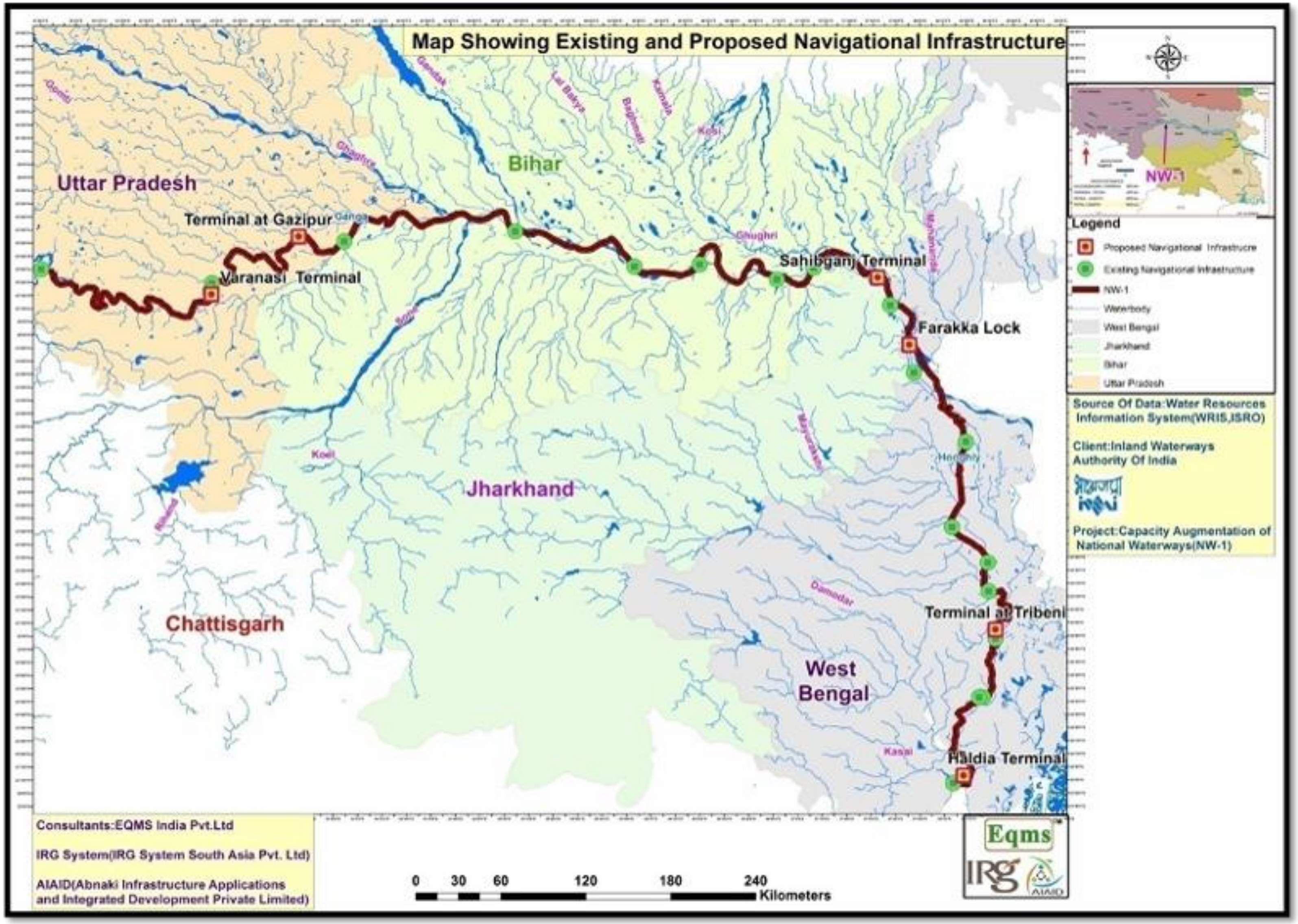


Figure 2.3: Planned Navigation Infrastructure Facilities in NW-1 Under Jal Marg Vikas project

2.4.8 Barge Maintenance & Repair Facility

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

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

2.4.9 Waste Mangement at Maintenance & Repair Facility

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

2.4.10 Material Handling, Transport and Storage

Material handling including transportation, storage, loading and unloading will be involved at terminals and jetty sites. Material handling at some planned site is manual, i.e. is through pay loaders, barge loaders, dumpers, trucks and at some sites is mechanical through conveyor belts and pneumatically depending on type and quantum of cargo to be transported. Considering the environmental effect, it is strongly suggested to adopt mechanical mode of material handling only for loading & unloading of barges and pneumatic transportation of the fly ash to minimize dust generation.

2.4.11 Construction material sourcing

Construction materials required majorly for the project development are bricks, steel, cement, timbers, sand etc. It is preferred that construction material will be sourced from nearby areas preferably. Details of likely construction material sourcing for the planned infrastructure under Jal Marg Vikas Project are given as a reference in **Table 2.8** below.

Table 2.8: Construction Material Sourcing for alreadyPlanned Interventions

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

2.4.12 Project Schedule

The NW-1 project activities will be developed in phases. The phase I development is likely tostarting inmid-2016 and expected to be completed in 5years period by 2019. The project life is considered as 30 years. Time required for construction of the various planned infrastructure inPhase-I is given below in **Table 2.9** below.

Table 2.9: Implementation Time for Planned Interventions under Jal Marg Vikas Project (Phase-1)

Component	Construction Time from Start (months)
Start	Mid 2016
Varanasi Terminal	26
Sahibganj Terminal	30
Haldia Terminal	30
Terminal-4* (Tribeni Terminal)	30
Terminal-5*	30
Terminal-6 * (Ghazipur terminal)	30
Farakka Navigation Lock	30
NW-1 Dredging	8
Shore Protection Works	18
River Training Works	24

Vessel Management System	12
Disaster Management System	12
Project Life Considered	30
End Date	Year 2045

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

2.5 Applicable Policy, Legislation and World Bank Operational Policies

There are four World Bank operational policies applicable to NW-1. These are listed at **Table 2.10.** Required mitigation measures have been incorporated in project design/Environmental management plans.

Table 2.10: Salient World Bank Safeguard Policies

Name	Key Requirement	Applicability	Remarks
OP 4.01 Environmental Assessment	Ensures sustainability and environmental feasibility of the project. Projects are classified into A, B & C category depending on the nature and extent of the impact.	Triggers	Project classified as Category A considering nature of activities and impacts
OP 4.04 Natural habitats	Ensures conservation of natural habitats and discourages disturbance of nay natural habitat due to project development by recommending adoption of alternative method/route/approach or adopting management measures	Triggered	Triggered for Sahibganj & Varanasi Terminal Projects. No other project is in close vicinity of such endangered or protected environment
OP 4.36 Forests	Ensures that project activities donot disturbs/interfere with the forest, forest dwellers activities, fauna and flora of the forest. Prevents and discourages deforestation and impacts on rights of forest dependent people.	Triggers	No diversion of forest land is involved however large number of tree cutting is involved. Permission will be required for felling these trees from forest department.
OP 4.12 Involuntary Resettlement	Ensures minimal involuntary resettlement by considering feasible alternatives project design, assisting displaced people to improve their former living standard.	Triggers	Applicable for facilities which involves land acquisition like Sahibganj terminal, Varanasi terminal etc.
OP 4.10 Indigenous people	Ensures protection of the dignity, right and cultural uniqueness of indigenous people and ensures they	Triggers	No indigenous group of people will be affected directly by project, however ST population is residing within 10 km radius area of the Sahibganj terminal.

Name	Key Requirement	Applicability	Remarks
	receive social and economic benefits		
OP 4.11 Physical Cultural Resources	Ensures preservation of property of cultural and religious importance, heritage and property of natural importance and enhancement of cultural properties	Triggers	Applicable for Sahibganj terminal project as it involves shifting of one of the community temple which exists at the site. It may be applicable for other sites for civil interventions which are under planning and identification
OP 7.5 Projects on International Waterways	Projects on international waterways may affect the relations between the World Bank and its borrowers, and between riparian states. Therefore, the Bank attaches great importance to the riparian making appropriate agreements or arrangements for the entire waterway, or parts thereof, and stands ready to assist in this regard. A borrower must notify other riparian of planned projects that could affect water quality or quantity, sufficiently far in advance to allow them to review the plans and raise any concerns or objections	Triggered	NW-1 traverse through Farakka canal to Hoogly River and does not affect or change the water treaty between India and Bangladesh in any way. However due to movement of vessels in River Ganga in Farakka area which is part of international riparian treaty between India & Bangladesh, this policy is considered triggered with a view to give advance intimation of NW-1 plans of this area to Bangladesh

World Bank's operational policy 4.01 (OP 4.01) categorize the project into Category A, B & C on the basis of nature and extent of the impacts anticipated from the project. Scope of Environmental assessment studies depends on the category in which the project falls and is defined below.
Category A - Projects with significant environmental impacts and requiring a full Environmental Assessment (EA),
Category B - Projects with moderate environmental impacts and requiring a lesser level of environmental assessment,
Category C - Projects which require no environmental analysis.

India has well defined environmental and social policy legislation framework. Applicability of these regulations depends on nature of project and activities. At a broad level India, has National Water Policy (2012), National Environment Policy (2006) and National Forest Policy 1988.

Extract of relevant sections of the National Water Policy (NWP) 2012 applicable to proposed development.

Section 3.1 states "Water is required for domestic, agricultural, hydro-power, thermal power, navigation, recreation, etc. Utilisation in all these diverse uses of water should be optimized and an awareness of water as a scarce resource should be fostered".

Section 3.3 states "Ecological needs of the River should be determined, through scientific study, recognizing that the natural River flows are characterized by low or no flows, small floods (freshets), large floods, etc., and should accommodate developmental needs. A portion of River flows should be kept aside to meet ecological needs ensuring that the low and high flow releases are proportional to the natural flow regime, including base flow contribution in the low flow season through regulated ground water use". Section 3.5 states "In the water rich eastern and north eastern regions of India, the water use infrastructure is weak and needs to be strengthened in the interest of food security"

Section 3.4 states "Rivers and other water bodies should be considered for development for navigation as far as possible and all multipurpose projects over water bodies should keep navigation in mind right from the planning stage".

Section 5.5 states "Inter-basin transfers are not merely for increasing production but also for meeting basic human need and achieving equity and social justice. Inter-basin transfers of water should be considered on the basis of merits of each case after evaluating the environmental, economic and social impacts of such transfers".

Section 6.2 states "The project appraisal and environment impact assessment for water uses, particularly for industrial projects, should, inter-alia, include the analysis of the water footprints for the use"

Section 8.1 states "Conservation of Rivers, River corridors, water bodies and infrastructure should be undertaken in a scientifically planned manner through community participation. The storage capacities of water bodies and water courses and/or associated wetlands, the flood plains, ecological buffer and areas required for specific aesthetic recreational and/or social needs may be managed to the extent possible in an integrated manner to balance the flooding, environment and social issues as per prevalent laws through planned development of urban areas, in particular"

Section 8.4 states "Environmental needs of Himalayan regions, aquatic eco-system, wet lands and embanked flood plains need to be recognized and taken into consideration while planning"

Section 9.2 states "Being inter-disciplinary in nature, water resources projects should be planned considering social and environmental aspects also in addition to techno-economic considerations in consultation with project affected and beneficiary families. The integrated water resources management with emphasis on finding reasonable and generally acceptable solutions for most of the stakeholders should be followed for planning and management of water resources projects"

Section 9.6 states "Local governing bodies like Panchayats, Municipalities, Corporations, etc., and Water Users Associations, wherever applicable, should be involved in planning of the projects. The unique needs and aspirations of the Scheduled caste and Scheduled Tribes, women and other weaker sections of the society should be given due consideration"

Section 9.7 states "All water resources projects, including hydro power projects, should be planned to the extent feasible as multi-purpose projects with provision of storage to derive maximum benefit from available topology and water resources"

Section 12.4 states "Integrated Water Resources Management (IWRM) taking River basin / sub-basin as a unit should be the main principle for planning, development and management of water resources. The departments / organizations at Centre / State Governments levels should be restructured and made multi-disciplinary accordingly"

National Environment Policy (2006)

National Environment Policy was adopted in 2006. It has a specific section on freshwater resources. The environment policy clearly states integrated approach for management of River basins with emphasis on water use efficiency and conservation, afforestation of banks, wetlands management, assessment and mitigation of impacts and reduction of pollution loads. The policy also emphasizes the need for research in glaciology and impacts of climate change.

a) Promote research in glaciology to evaluate the impacts of climate change on glaciers and River flows.

b) Promote integrated approaches to management of River basins by the concerned River authorities, considering upstream and downstream inflows and withdrawals by season, interface between land and water, pollution loads and natural regeneration capacities, to ensure maintenance of adequate flows, in particular for maintenance of in-stream ecological values, and adherence to water quality standards throughout their course in all seasons.

c) Consider and mitigate the impacts on River and estuarine flora and fauna, and the resulting change in the resource base for livelihoods, of multipurpose River valley projects, power plants, and industries.

d) Consider mandating the installation of water saving closets and taps in the building bye-laws of urban centres, and other available regulatory mechanisms.

e) Integrate conservation and wise use of wetlands into River basin management involving all relevant stakeholders, in particular local communities, to ensure maintenance of hydrological regimes and conservation of biodiversity.

f) Incorporate a special component in afforestation programmes for afforestation on the banks and catchments of Rivers and reservoirs to prevent soil erosion and improve green cover.

National Forest Policy Resolution of 1952 and National Forest Policy of 1988: The National Forest Policy (1988) establishes a principal aim 'to ensure environmental stability and ecological balance including atmosphere equilibrium which are vital for substances of all life forms, human, animal & plant, and directs that the domestic requirements of poor and marginalized forest users should be the first charge on forest produce. The policy calls for the enhancement of income and employment through improved and increased production of non-wood forest products (NWFPs), and proposes that a massive people's movement with the involvement of women should be launched to achieve the objectives.

The Government of India (GOI) has detailed legislative framework imposing various restrictions for developments of inland & water areas. The key legislations include Wildlife Protection Act, Forest Conservation Act, Environmental Protection Act and Ancient Monuments and Archaeological Sites and Remains Act.

Various national parks & sanctuaries are notified under above acts which impose ban of any activities without following a defined clearance process going up to Supreme Court level. Such areas have been considered as no go areas wherever applicable in the basin and project intervention areas. Other areas identified like reserve forest, Hilsa sanctuaries are also notified but with much lesser degree of restrictions.

2.5.1 International Conventions, Protocols and Agreements

International Maritime Organization Conventions: India is member state of the International Maritime Organization (IMO). Therefore, all activities relating to shipment through the port shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements. IMO Conventions/ Protocols related to environment & pollution are given in **Table 2.11** for reference purposes and inputs for design requirement.

The World Bank Operation Policies are also applicable to the project but are not summarized here as these would be followed while developing the mitigation measures in the EIA reports.

Table 2.11: International Maritime Conventions, Protocols and Agreements

Sr. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
1.	Maritime safety	SOLAS Convention, 1974	The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The 1974 version includes the tacit acceptance procedure - which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties. The Convention came into force on May 25, 1980
2.	Measurement of ships	Load Lines Convention,1966	It has long been recognized that limitations on the draught to which a ship may be loaded make a significant contribution to her safety. These limits are given in the form of freeboards, which constitute, besides external weather tight and watertight integrity, the main objective of the Convention.
3.	Preventing collisions at sea	Convention on International Regulations for Preventing Collisions at Sea (COLREG), 1972	The 1972 Convention was designed to update and replace the Collision Regulations of 1960 which were adopted at the same time as the 1960 SOLAS Convention. One of the most important innovations in the 1972 COLREGs was the recognition given to traffic separation schemes - Rule 10 gives guidance in determining safe speed, the risk of collision and the conduct of vessels operating in or near traffic separation schemes.
4.	Prevention of Pollution from Ships	International Convention for the Prevention of Pollution from Ships (MARPOL), 1973, as modified by the Protocol of 1978 relating thereto and by the Protocol of 1997(MARPOL)	The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and also includes the Protocol of 1997 (Annex VI). It has been updated by amendments through the years.
		Convention on Facilitation of International Maritime Traffic (FACILITATION), London, 1965	The Convention's main objectives are to prevent unnecessary delays in maritime traffic, to aid cooperation between Governments, and to secure the highest practicable degree of uniformity in formalities and other procedures. In particular, the Convention reduces the number of declarations which can be required by public authorities.
5.	Safety of maritime navigation	Convention for The Suppression of Unlawful Acts of Violence Against the Safety of Maritime	The main purpose of the convention is to ensure that appropriate action is taken against persons committing unlawful acts against ships. These include: • the seizure of ships by force;

Sr. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
		Navigation (SUA convention), 1988	• acts of violence against persons on board ships; and • the placing of devices on board a ship which are likely to destroy or damage it. The convention obliges Contracting Governments either to extradite or prosecute alleged offenders.
6.	Environmental Safety	Convention Relating to Intervention on the High Seas, 1969	Contracting States are empowered to act against ships of other countries which have been involved in an accident or have been damaged on the high seas if there is a grave risk of oil pollution occurring as a result.
7.	Standards of Training, Certification and Watch keeping for Seafarers	International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW) as amended, including the 1995 and 2010 Manila Amendments	The main purpose of the convention is to ensure the safety of seagoing personnel. Convention in explained in two codes A & B. Code A is mandatory while Code B is recommendation. It intends to help parties implement the convention.
8.	Safe containers	International Convention for Safe Containers (CSC) 72/77	The 1972 Convention for Safe Containers has two goals. • to maintain a high level of safety of human life in the transport and handling of containers by providing generally acceptable test procedures and related strength requirements • to facilitate the international transport of containers by providing uniform international safety regulations, equally applicable to all modes of surface transport to avoid proliferation of divergent national safety regulations The requirements of the Convention apply to the great majority of freight containers used internationally, except those designed especially for carriage by air. As it was not intended that all containers or reusable packing boxes should be affected, the scope of the Convention is limited to containers of a prescribed minimum size having corner fittings - devices which permit handling, securing or stacking.
9.	Safety of Fishing vessel	The Torremolinos International Convention for the Safety of Fishing Vessels (SFV),1977,	The Protocol applies to fishing vessels of 24 metres in length and over including those vessels also processing their catch. The general trend in modern designed fishing vessels, if they are to be economically profitable, must include improvements in machinery and fishing gear, improvements in safety features as a whole and better

Sr. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
		superseded by the The 1993 Torremolinos Protocol; Cape Town Agreement of 2012 on the Implementation of the Provisions of the 1993 Protocol relating to the Torremolinos International Convention for the Safety of Fishing Vessels	working conditions for fishermen. The safety provisions include automatically controlled machinery spaces, improved life-saving appliances, immersion suits and thermal protective aids, satellite communication systems and other components of the global maritime distress and safety system.
10.	Standards of Training, Certification and Watch keeping for Fishing Vessel Personnel	International Convention on Standards of Training, Certification and Watch keeping for Fishing Vessel Personnel (STCW-F), 1995	General Provisions & certifications of Safety of Skippers, Officers, Engineer Officers and Radio Operators.
11.	Space Requirements for Special Trade Passenger Ships, 1973	Special Trade Passenger Ships Agreement (STP), 1971 and Protocol on Space Requirements for Special Trade Passenger Ships, 1973	Following the International Conference on Special Trade Passenger Ships, 1971, IMO, in cooperation with other Organizations, particularly the World Health Organization (WHO), developed technical rules covering the safety aspects of carrying passengers on board in special trade passenger ships (ships carrying large nos. of unberthed passengers such as in pilgrim area)
12.	Prevention of Marine Pollution by Dumping of Wastes and Other Matter	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (LC), 1972 (and the 1996 London Protocol)	London Convention, one of the first international conventions for the protection of the marine environment from human activities, came into force on 30 August 1975. Since 1977, it has been administered by IMO. It contributes to the international control and prevention of marine pollution by prohibiting the dumping of certain hazardous materials. In addition, a special permit is required prior to dumping of a number of other identified materials and a general permit for other wastes or matter.
13.	Oil Pollution Preparedness, Response and Co operation	International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC), 1990	As per convention, Ships are required to carry a shipboard oil pollution emergency plan. Operators of offshore units under the jurisdiction of Parties are also required to have oil pollution emergency plans or similar arrangements which must be coordinated with national systems for responding promptly and effectively to oil pollution incidents. Ships are required to report incidents of pollution to coastal authorities and the convention details the actions that are then to be taken. The Convention calls for the

Sr. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
			establishment of stockpiles of oil spill combating equipment, the holding of oil spill combating exercises and the development of detailed plans for dealing with pollution incidents. Parties to the convention are required to provide assistance to others in the event of a pollution emergency and provision is made for the reimbursement of any assistance provided.
14.	Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances	Protocol on Preparedness, Response and Co-operation to pollution Incidents by Hazardous and Noxious Substances, 2000 (OPRC-HNS Protocol)	Convention aims to establish national systems for preparedness and response and to provide a global framework for international co-operation in combating major incidents or threats of marine pollution. Parties to the OPRC-HNS Protocol are required to establish measures for dealing with pollution incidents, either nationally or in co-operation with other countries. Ships are required to carry a shipboard pollution emergency plan to deal specifically with incidents involving hazardous and noxious substances. The OPRC-HNS Protocol ensures that ships carrying hazardous and noxious substances are covered by preparedness and response regimes similar to those already in existence for oil incidents.
15.	Control of Harmful Anti-fouling Systems	International Convention on the Control of Harmful Anti-fouling Systems on Ships (AFS), 2001	Under the terms of the AFS Convention, Parties to the Convention are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a Party. Anti-fouling paints are used to coat the bottoms of ships to prevent sealife such as algae and molluscs attaching themselves to the hull – thereby slowing down the ship and increasing fuel consumption. n the early days of sailing ships, lime and later arsenic were used to coat ships' hulls, until the modern chemicals industry developed effective anti-fouling paints using metallic compounds. These compounds slowly "leach" into the sea water, killing barnacles and other marine life that have attached to the ship. But studies have shown that these compounds persist in the water, killing sea-life, harming the environment and possibly entering the food chain. One of the most effective anti-fouling paints, developed in the 1960s, contains the organotin tributyltin (TBT), which has been proven to cause deformations in oysters and sex changes in whelks.

Sr. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
16.	Safe and Environmentally Sound Recycling of Ships	The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009	Convention aimed at ensuring that ships, when being recycled after reaching the end of their operational lives, do not pose any unnecessary risk to human health and safety or to the environment. It intends to address all the issues around ship recycling, including the fact that ships sold for scrapping may contain environmentally hazardous substances such as asbestos, heavy metals, hydrocarbons, ozone depleting substances and others. It will address concerns about working and environmental conditions in many of the world's ship recycling facilities. Regulations in the new Convention cover: the design, construction, operation and preparation of ships so as to facilitate safe and environmentally sound recycling, without compromising the safety and operational efficiency of ships; the operation of ship recycling facilities in a safe and environmentally sound manner; and the establishment of an appropriate enforcement mechanism for ship recycling, incorporating certification and reporting requirements. Ships to be sent for recycling will be required to carry an inventory of hazardous materials, which will be specific to each ship.
17.	Control and Management of Ships' Ballast Water and Sediments	International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004	Convention aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediment. Under the Convention, all ships in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. All ships will also have to carry a ballast water record book and an international ballast water management certificate. The ballast water management standards will be phased in over a period of time. As an intermediate solution, ships should exchange ballast water mid-ocean. However, eventually most ships will need to install an on-board ballast water treatment system
18.	Salvage Convention, 1989	International Convention on Salvage (SALVAGE), 1989	As per convention, "special compensation" to be paid to salvors who have failed to earn a reward in the normal way (i.e. by salving the ship and cargo). The compensation consists of the salvor's expenses, plus up to 30% of these expenses if, thanks to the efforts of the salvor, environmental damage has been minimized or prevented. The salvor's expenses are defined as "out-of-pocket expenses reasonably

Sr. No.	Issues	International Maritime Conventions, Protocols and Agreements	Remarks
			incurred by the salvor in the salvage operation and a fair rate for equipment and personnel actually and reasonably used".
19.	The United Provinces Fisheries Act, 1948	The Fisheries Act provides for the prohibition and licensing of fishing in selected waters.	Definition of fish is a broad one under the Act and includes a wide gamut of aquatic biodiversity including "turtles, dolphins, aquatic plants, fisheries, whale and fish in all states in its life history". For the purposes of regulating fishing, the rules made under this Act provides for selected waters where there is prohibition for fishing. However, this excludes 'private waters' 7and 'religious waters'8. The authority constituted under this Act has been vested with power of arrest without warrant, compound certain offences as well as prohibit the sale of fish in such area as may be specified.

[7] *Private waters are exclusive property of any person or religious body or institution where such persons or institution has exclusive right of fishery.*
[8] *Religious water means water belonging to a religious body or institutions and which have never been fished before on account of any restrictions on religious grounds.*

2.6 Conclusion

Project descriptions give a developmental perspective of NW-1 in a cumulative manner. NW-1 project offers potential opportunity not only for diversification of cargo movement from road & rail to waterways but also add additional capacity to the existing movement. In order to achieve this diversification, the existing infrastructure needs to be augmented with proposed project interventions. These proposed interventions consisting of both development & operation of navigation route require availability of water (depth) & its maintenance supported by new infrastructure. Traffic projection study for 30 years has been carried out & has been considered. Major challenges for navigation in NW-1 include: highly braiding and meandering river; large water level fluctuation; unavailability of LAD for navigation throughout NW-1 and unreliable water depths; existence of sharp bends; high silt load & shoal/bar/island formation leading to splitting of main channel; growing of bars reducing the available depth; lateral migration of the river and change in navigation line and existing bridges & other structures. Further, these activities will trigger indirect & induced development in the influence area not expected to exceed 10 kms within different segments of NW-1. Therefore, Phase -1, NW-1 development along with these existing, direct, indirect & induced developments will have cumulative impact in the influence area not exceeding 10 kms, considering all the segments of the stretch.

CHAPTER 3: DELINEATION OF CIA BOUNDARY AND VECs

3.0 Introduction

The proposed Jal Marg Vikas Project (JMVP) is expected to enhance the economic development of the country by augmentation of the freight transportation substantially. The JMVP will provide the accessibility to the areas through which it traverses as well as to the nearby areas leading to to development and growth of these areas. This necessitates that study area size should be based on the extent of the area where accessibility improvements could occur and may require some judgments about the extent of the influence of the project. Therefore, Cumulative Impact Assessment (CIA) requires fixation of spatial and temporal boundaries in order to assess the impacts of direct, indirect and induced activities due to proposed project. Process of delineation of boundary largely depends upon the type of development & its potential to exhibit direct & indirect impacts on the surrounding environment. The following sections describe the CIA boundary, the rationale & basis of its delineation, VECs within the delineated boundaries, and hot spots identified.

3.1 Delineation of the CIA Boundary

Important factors which need to be considered for proposed assessment of indirect and cumulative impacts and impact interactions is the setting of the geographical or 'spatial' boundary and the temporal or 'time frame' boundary. Indirect and direct impacts as well as impact interactions may well extend beyond the geographical site boundaries of the project. Therefore preferred methodology for detailed analysis is a combination of collaborative judgment and GIS based allocation mode as described in chapter 1. Hence, mapping the geographical and time boundaries provides areas of potential overlap and therefore where indirect and cumulative impacts as well as impact interactions may occur. Three levels of considerations have been taken into account for delineation of CIA boundary described below.

Basin level hydrological & ecological considerations (First Level)

It is important to consider the various hydrological and ecological functions of the river valley and floodplains at a basin level for purposes of CIA. Therefore, active floodplain of River Ganga pertaining to NW-1 has been considered. Consideration of floodplains of River Ganga has been made to delineate the influence area (impact area). The geomorphic features with in active flood plain as mapped in Ganga River Basin Management Plan is considered[9]. Geomorphic features in the channel belt and active floodplain along the Ganga River pertaining to NW-1 stretch is given in **Annexure 3.1**.

It is observed that the mapping of valley margin and geomorphic features in the active floodplain along the Ganga river shows significant diversity in terms of valley width and geomorphic features in different reaches of the river. These differences have important implications for water resource management and ecological restoration. The stretches with wide valleys and active floodplains could provide sites for creating artificial recharge sites keeping in view the present-day landuse. The channel-belt and floodplain features should provide important insights to the possible habitats for aquatic and land biota. Valley margin of the Ganga River in NW-1 stretch is summarized in Table 3.1.

Table 3.1: Maximum and minimum width and major characteristics of valley margin in NW-1

Stretch	Maximum and minimum width, km	Major characteristics
Allahabad to Varanasi	14.2/1.8	Valley width quite variable and extends to both banks of the river, sinuous course of the river frequently swings from the right edge to the left edge of the valley.
Varanasi to Munger	36.1/7	Valley widens significantly downstream of Varanasi and is evenly distributed on left and right bank of the river; valley width reduces significantly downstream of Patna and also becomes asymmetric, mostly spread along the left bank.
Munger to Farakka	39.2/7.3	Large parts of the valley are spread towards the left bank and the river is flowing at the southern edge of the valley up to 95 km downstream of Munger after which it swings to the northern and southern edges alternately.

Table 3.1 shows that in NW-1 minimum valley margin width of 1.8 kms is observed in Allahabad-Varanasi stretch while maximum valley margin width of 39.2 kms is seen in Munger to Farakka stretch**. National Mission for Clean Ganga describes hydrology of Ganga as "Annual flooding is the characteristic of all rivers in the Ganga basin. The Ganga rises during the monsoon but the high banks restrict the flood water from spreading. The flood plain is usually 0.5 to 2 km wide. This active flood plain is flooded every year"[10].**

Project Interventions (Second Level)

[9] Active Floodplain Mapping: Defining the "River Space", Report Code: 005_GBP_IIT_FGM_DAT_01_Ver 1_Dec 2010, NGRBA

[10] http://nmcg.nic.in/hydrology.aspx

In the above background and context, the extent and scope of proposed JMVP project of IWAI and interventions/activities of non IWAI entities have been considered in relation to study area including active floodplain in the context of NW-1 for identification of influence area. Environment, socio-economic and project design and operations perpectives have been considered for delineation of influence area as described in **Table 3.2.**

Table 3.2: Criteria for delineation of influence area for CIA

Serial number	Parameters	Impact area/ particular
Criteria I: Environment, Ecological and Socio-cultural perspective		
1	Air pollutants	limited to 400 metres
2	Noise dispersion from piling and dredging	500 metres
3	Important Bird Areas (IBAs)	IBAs are connected to main river Ganga, located within 2 kms of river Ganga
4	Ecosensitive Zone	10 kms around notified protected areas
5	Major human settlements and school, hospitals etc	200 metres
6	Archeological monuments	300 metres is considered as regulated (buffer) area
7	Ghats	Located within 500 metres from main stem of River Ganga.
Criteria II: Project design and operation perspective:		
1	Project interventions for capacity augmentation of NW-1 (*e.g.* proposed terminals and associated infrastructure like road and rail connectivity), navigation locks, RORO terminals, *etc.*	These are located with in 10 kms from the main stem of River Ganga.
2	Dredging in Ganga.	Barge (9 metres) movement would be in the main stem of river Ganga and dredging would be confined within the banks of Ganga River.
3	Plying of vessels.	Restricted within the NW-1 (Ganga River)
4	Existing and proposed infrastructure development projects including multimodal terminal development with road and railway network (including DFCCIL's proposed alignment), urban conglomerations, irrigation schemes, dams, barrages, thermal power plants, *etc.*	These are located/proposed to be located within 10 kms of River Ganga.

Considering the abovesaid factors, 500 metres is taken as first level of influence area, followed by 2 kms and 10 kms as second and third levels of influence area respectively.

Overall (Third Level)

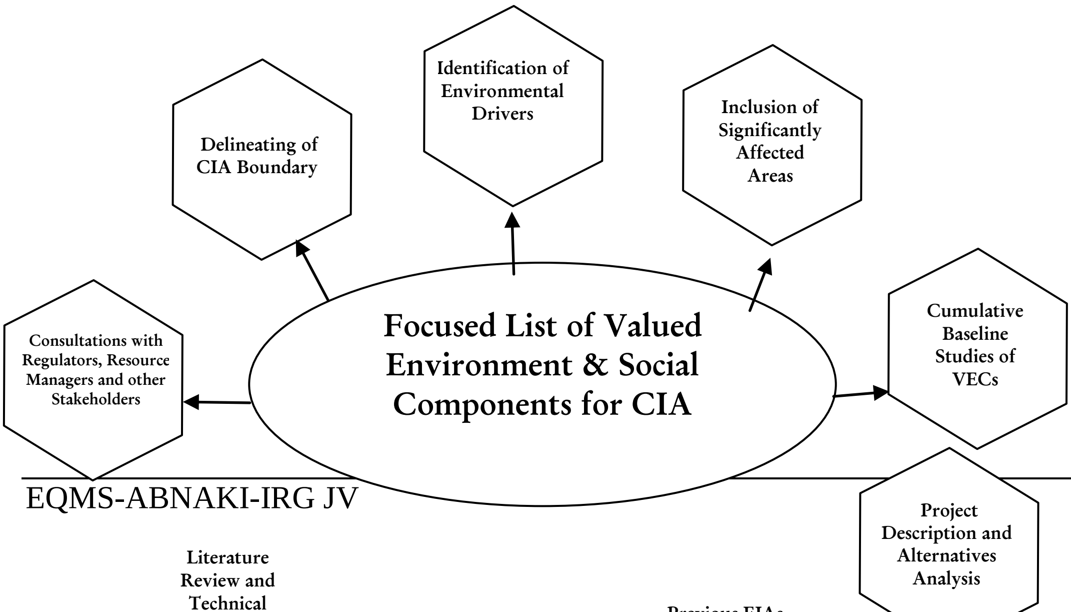
In summary, based on active flood plain, basin level VECs report, IFC guidelines, stakeholders consultations, expert's consultation/ judgment, Indian regulations, ecosensitive zone, and abovesaid considerations, 10 km influence area (impact area) boundary has been considered to conduct the detailed **CIA study of the project. Further considering hydrological & ecological functions of the river, basin level influence area downstream of Allahabad has been considered. This has been done in order to meet segment-wise approach and basin level approach (hydrological & ecolocial) as mentioned in ToR**.

3.2 Valued Environment & Social Components (VECs)

VECs are environmental attributes that are considered to be important in assessing risks. While VECs may be directly or indirectly affected by a specific development, they often are also affected by the cumulative effects of several developments. VECs are the ultimate recipient of impacts because they tend to be at the ends of ecological pathways. VECs in general refer to sensitive or valued receptors of impact whose desired future condition determines the assessment end points to be used in the CIA process.

3.2.1 Approaches for Identification of VECs

To identify the VECs for CIA study, it is possible to largely obtain cumulative opinions of various stakeholders which are directly & indirectly impacted due to proposed development, and extensive review of the existing environmental and social impact assessment studies of the proposed project. Approach followed to identify VECs for purpose of CIA study is shown in **Figure 3.1**.



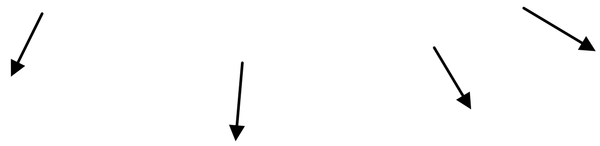


Figure 3.1: Approach for VECs Identification

Source: Derived from IFC Guideline

3.2.2 Classification of VECs

Further, overlay mapping and GIS have been used for identifying the spatial distribution of VECs. Based on the above approach, mapping method as per IFC guidelines for Cumulative Impact Assessment and Management, **VECs have been classified** as given below.

VEC	VEC Components
Cultural Aspects of Ganga	Maintain the cultural values
	Maintain cultural events and cultural functions
	Conserve heritage sites, structures and values
Ecosystem services	Terrestrial biodiversity values
	Aquatic biodiversity
	Environmental flows
Physical environmental services and natural processes	Land use and soil quality
	Water
	Air
	Noise
Socio-economic conditions	Socio-economic infrastructure and facilities
	Opportunity and access to improved and conserved livelihood
	Other benefits

3.2.3 Identification of Indicators to Assess Conditions of VECs

To analyze the conditions and impact on identified VECs various indicators have been identified & analyzed as given in **Table 3.3**. These indicators will help to identify the extent of impact on the identified VECs and assist in defining "Cause & Effect" relationship.

3.3 Assessment of Status of Identified VECs

An extensive study including the site visits, study of the project alignment through topographic maps & Google maps, review of existing studies and literature was carried out to assess the status of identified VECs within the CIA boundary of NW -1. The boundary delineation exercise identifies the potential impacts considered to be significant and which require further assessment. In this study all the natural as well as manmade features have been taken into account and plotted spatially to delineate the boundary of the CIA. The natural and manmade features mapped are as follows:

- Forests;
- National parks;
- Wild Life Sanctuaries;
- Tiger Reserves;
- Birds Areas;
- Archaeological sites;
- Water bodies;
- Wetlands;
- Roads;
- Railways;
- Urban Agglomerations;
- Industrial Areas;
- Thermal Power Plants
- Critically Polluted Areas, based on Comprehensive Environmental Pollution Index (CEPI)

Details are given in **Table 3.4** for NW-1.

Table 3.3: Indicators of VECs

Sr. No.	VEC	VEC Components	Indicators for the health of VECs
1	Cultural Aspects of Ganga	Maintain the cultural values	Water Availability (overall)
			Water availability at Ghats
			(Pure/healthy to support bathing and) Water Quality
		Maintain cultural events and cultural functions	*Ghats, kunds*, temples, shrines, festivals like *kumbh, chhath* and other related festivals
		Conserve heritage sites, structures and values	Protected buildings and sites, *Ghats, kunds*, temples, shrines, festivals
2	Ecosystem services	Terrestrial biodiversity values	National Parks, Sanctuaries, Biosphere Reserves, Forests, IBAs,RET species, wetlands, plantations/orchards
		Aquatic biodiversity	Sanctuaries, RET species (all impacts due to increased pollution, noise, activity, accidents and conflicts), Fish (same as RET species), Fish-based livelihood
		Environmental flows	Quality and quantity of flow (especially in the lean seasons)
3	Physical environmental services and natural processes	Land use and soil quality	Potential changes in land use; change in soil quality; river bank erosion
			Urbanization; degeneration of urban environment (pollution brought in by additional mode of transport, multi-modal exchanges, slum development, poor quality accommodation for migrant labourers); additional solid and liquid waste generation, reduction in open spaces
		Water	Changes in water flow regime, changes in sediment transport regime
			Access to water (if water is used by the project and the people brought in), water quality (due to additional pollution, due to reduction in availability and access)
			Incremental flood, inundation
			Incremental changes in water flow and sediment transport due to climate change
		Air	Air quality in urban areas; traffic congestion (including on associated facilities like roads, parking and railway sidings)
			Changes in micro-climate (due to GHG emission or reduction)

Sr. No.	VEC	VEC Components	Indicators for the health of VECs
		Noise	Increased noise levels for sensitive receptors (schools, hospitals, residential areas, urban open spaces, cultural heritages)
4	Socio-economic conditions	Socio-economic infrastructure and facilities	Induced impacts on roads (ODR, MDR, SH and NH); tourism sites, facilities and infrastructure; disturbance to and load on crematoria; waste handling facilities (solid and liquid); disturbance to bathing ghats and practices; passenger ferry facility (cheaper and direct mode of transport)
		Opportunity and access to improved and conserved livelihood	Benefits to consumers (directly or indirectly from cheaper transport of expected cargo); benefits to the transport industry; improvement in tourism; effect on fishing and related livelihood; new employment opportunities created
		Other benefits	Setting up standards for terminals, vessels, operations and EHS to be followed all over the country for waterways

Table 3.4: Details of VECs and their Status within the CIA boundary (NW1)

Sr. No.	VEC	VEC Components	Indicators for the health of VECs	Basin Level Below Allahabad within 10 kms	Basin Level Below Allahabad upto 10 kms
1	Cultural Aspects of Ganga	Maintain the cultural values	Water Availability (overall)		√
			Water availability at Ghats		
			(Pure/healthy to support bathing and) Water Quality		
		Maintain cultural events and cultural functions	*Ghats, kunds*, temples, shrines, festivals like *kumbh, chhath* and other related festivals		√
		Conserve heritage sites, structures and values	Protected buildings and sites, *Ghats, kunds*, temples, shrines, festivals		√
2	Ecosystem services	Terrestrial biodiversity values	National Parks, Sanctuaries, Biosphere Reserves, Forests, IBAs,RET species, wetlands, plantations/orchards	√	
		Aquatic biodiversity	Sanctuaries, RET species (all impacts due to increased pollution, noise, activity, accidents and conflicts), Fish (same as RET species), Fish-based livelihood	√	
		Environmental flows	Quality and quantity of flow (especially in the lean seasons)	√	
3	Physical environmental services and natural processes	Land use and soil quality	Potential changes in land use; change in soil quality; river bank erosion		√
			Urbanization; degeneration of urban environment (pollution brought in by additional mode of transport, multi-modal exchanges, slum development, poor quality accommodation for migrant labourers); additional solid and liquid waste generation, reduction in open spaces		√

Sr. No.	VEC	VEC Components	Indicators for the health of VECs	Basin Level Below Allahabad within 10 kms	Basin Level Below Allahabad upto 10 kms
		Water	Changes in water flow regime, changes in sediment transport regime	√	
			Access to water (if water is used by the project and the people brought in), water quality (due to additional pollution, due to reduction in availability and access)	√	
			Incremental flood, inundation	√	
			Incremental changes in water flow and sediment transport due to climate change	√	
		Air	Air quality in urban areas; traffic congestion (including on associated facilities like roads, parking and railway sidings)		√
			Changes in micro-climate (due to GHG emission or reduction)		√
		Noise	Increased noise levels for sensitive receptors (schools, hospitals, residential areas, urban open spaces, cultural heritages)		√
4	Socio-economic conditions	Socio-economic infrastructure and facilities	Induced impacts on roads (ODR, MDR, SH and NH); tourism sites, facilities and infrastructure; disturbance to and load on crematoria; waste handling facilities (solid and liquid); disturbance to bathing ghats and practices; passenger ferry facility (cheaper and direct mode of transport)		√
		Opportunity and access to improved and conserved	Benefits to consumers (directly or indirectly from cheaper transport of		√

Sr. No.	VEC	VEC Components	Indicators for the health of VECs	Basin Level Below Allahabad within 10 kms	Basin Level Below Allahabad upto 10 kms
		livelihood	expected cargo); benefits to the transport industry; improvement in tourism; effect on fishing and related livelihood; new employment opportunities created		
		Other benefits	Setting up standards for terminals, vessels, operations and EHS to be followed all over the country for waterways		√

3.4 Preliminary Identification of Hotspots

On the basis of the identified VECs, spatial analysis, literature review, hotspots have been identified. This list will be further enhanced after addition of input from stakeholder consultation and baseline study of the VECs. From the desktop study, it is obvious that these areas are significantly going to be impacted and this has helped focusing on these areas while carrying out stakeholder consultation. Identified hotspots and VECs in basin (below Allahabad) are given in **Annexure 3.2** and in NW-1 within 10 kms in **Table 3.5.** Floodplain and Active Floodplain of Ganges river (NW-1) showing VECs is shown in **Figure 3.2** and **Figure 3.3** respectively. Map of identified hotspots and VECs are given in **Figure 3.4 to 3.24.** Map of identified hotspots within basin is given in **Annexure 3.3**.

Table 3.5: Identified Major Hotspots

Sr. No.	Locations	VECs identified to be impacted majorly	Reasons for declaring Hotspot
1.	Allahabad	• Religious Value • River Bed Sediments	• Festival: Kumbh Mela
2.	Varanasi	• Land acquisition • Livelihood & Fishing Activities • Aquatic ecology • Terrestrial flora • Existing Infrastructure • Archaeological sites • Air Quality • River Bed Sediments • Noise level • Religious Value	• Rajghat floating terminal • Proposed Varanasi Terminal • Kashi Turtle Sanctuary • DFCCIL Connectivity at Varanasi Terminal
3.	Ghazipur	• Land acquisition • Livelihood • Aquatic ecology • Terrestrial flora • Existing Infrastructure • River Bed Sediments	• Proposed Terminal • Urban Area: Ghazipur
4.	Buxar	• Religious Values	• Existing floating terminal at Buxar • Urban Area: Buxar
5.	Patna	• Avifauna • Air Quality • Religious Value	• Low & High Level Jetty • Urban Area: Patna • Development of River Front
6.	Semaria	• Land acquisition • Livelihood • Aquatic ecology • Terrestrial flora • Existing Infrastructure • Religious value	• Existing Floating Terminal at Semaria • Proposed Terminal at Kalughat • Urban Area: Semaria, Doraiganj

7.	Munger	• Ground Water • Religious Values	• Existing Floating Terminal at Munger • Urban Area: Munger
8.	Bhagalpur	• Aquatic Ecology • Avifauna • Air Quality • Ground Water • Religious Values • Fishing Activities	• Existing Bhagalpur Terminal • Vikramshila Gangetic Dolphin Sanctuary • Urban Area: Bhagalpur
9.	Khalgaon	• Aquatic Ecology • Avifauna • Air Quality • Religious Values	• Existing Bateshwarsthan Floating Terminal • Urban Area: Kahalgaon
10.	Sahibganj	• Land Use • Livelihood & Fishing Activities • Socio-economy • Aquatic ecology • Terrestrial flora • Existing Infrastructure • Religious Values	• Existing Samdhaghat terminal and proposed Sahibganj terminal • Construction of approach road to connect the terminal to NH-80 • Construction of railway siding to provide linkage with existing IR track • Existing Fishing Activities • Acquisition of Land, R& R and shifting of community temple • Cutting of app. 500 trees
11.	Rajmahal	• Archaeological sites • Religious Values	• Mining activities
12.	Mangalghat		• Existing floating terminal
13.	Lalbagh in Farakka to Murshidabad*	• Bank erosion • Air Quality • Existing Infrastructure • Fishing Activities	• Floating Terminal, Hazardwari, Existing RCC Jetty Pakur, U/s & D/s jetty, feeder canal, RCC jetty and old lock at Farakka • New lock Farakka • Urban Areas: Farakka, Murshidabad, Azimganj, Baranagar, Balia, Raghunathganj • Bagmari siphon
14.	Katwa to HooglyGhat	• Traffic • Air Quality • Aquatic Ecology • Existing infrastructure • Fishing Activities	• Floating Terminal Katwa, Floating Terminal Swarupganj, Floating Terminal Shantipur, Floating Terminal Tribeni • New proposed terminal at Tribeni • Urban Areas: Katwa, Swaroopganj, Nabadwip, Kalna, Balagarh, Kanchrapara, Hoogly • Increased traffic volume due to newly proposed terminal
15.	Maheshthala		• Existing BISN jetty, GR-1 & GR-2 and Botanical Garden Jetty • Urban areas: Mahesthala
16.	Haldia	• Ground water • Traffic • Air Quality • Religious Values • Aquatic ecology • Existing infrastructure	• Declared as critically polluted area but at present moratorium is lifted by MoEFCC • Declared notified zone by CGWB • Presence of Industrial Zone of Haldia Dock Complex • Operation of terminal would require

	• Fishing Activities	dredging of 0.1-0.2 million cum • Existing floating terminal and proposed new terminal at Haldia • Shifting of ammonia pipeline of TATA chemicals and existing road to Mitsubishi Plant • Haldia Port & Shipping Activities • Haldia Dock Complex & Industrial Area • Urban areas: Haldia Town • Expected increased industrial development in existing industrial area and enhanced traffic movement

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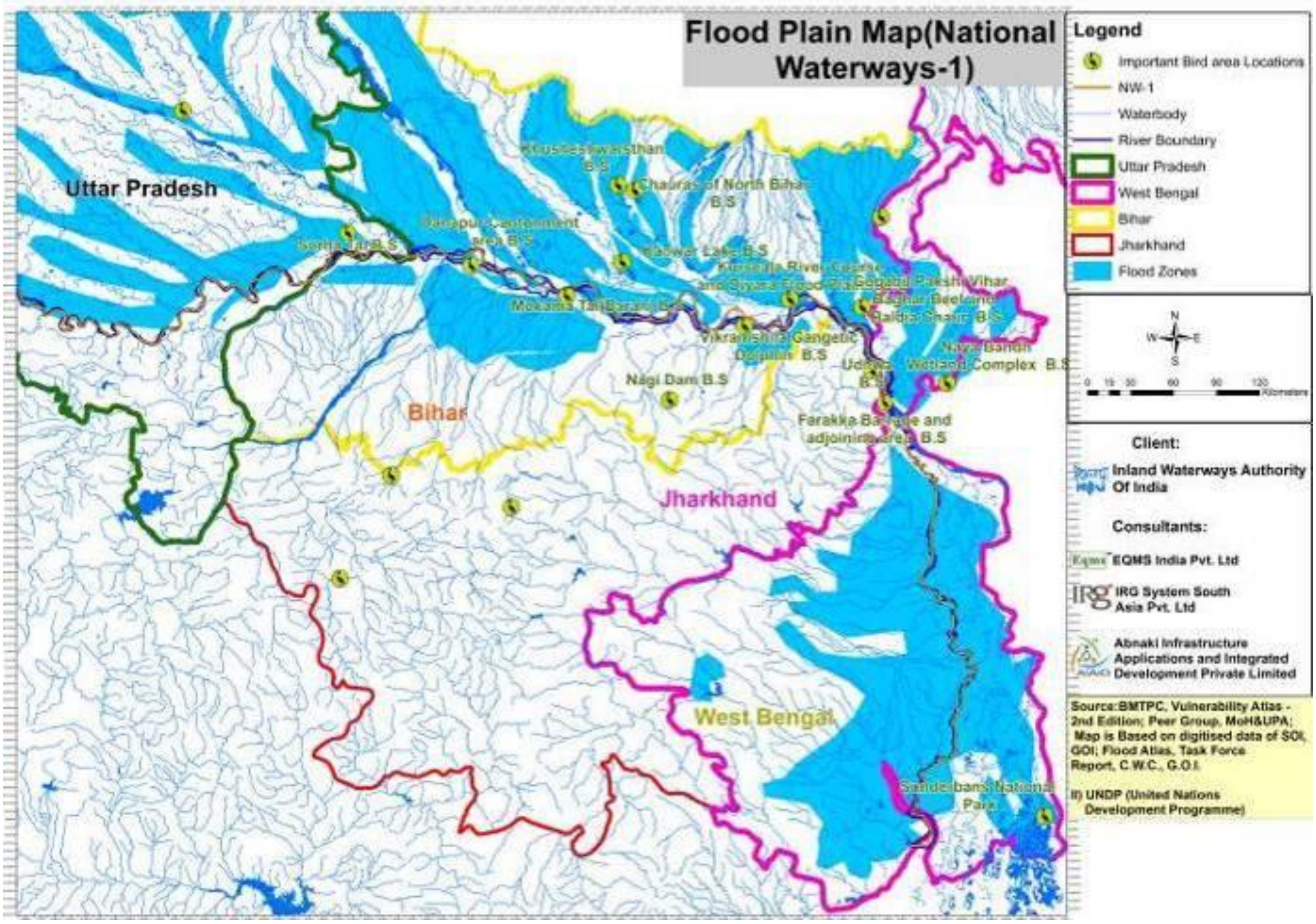


Figure 3.2: Floodplain of Ganges river (NW-1) showing VECs

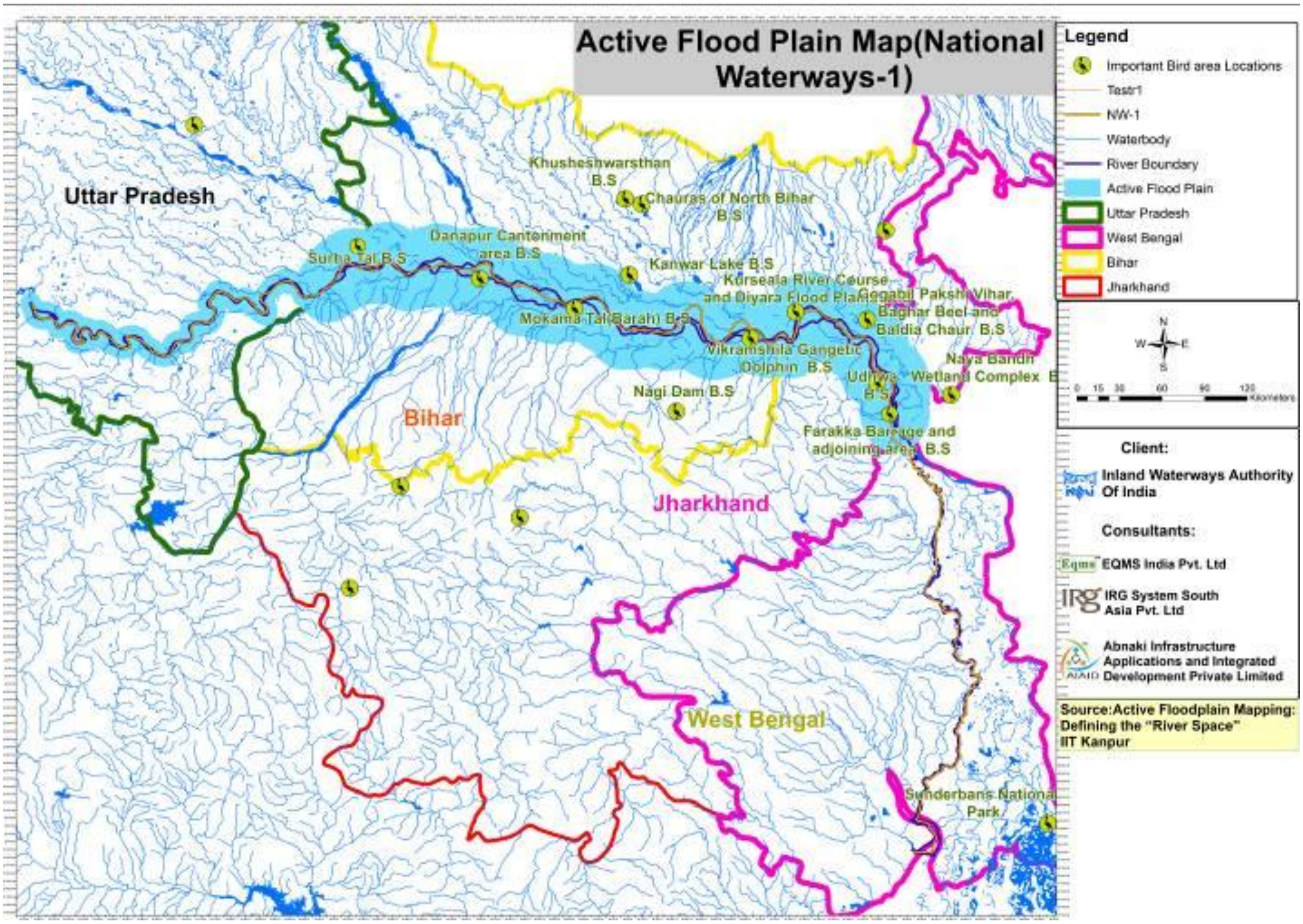


Figure 3.3: Active floodplain of Ganges river (NW-1) showing VECs

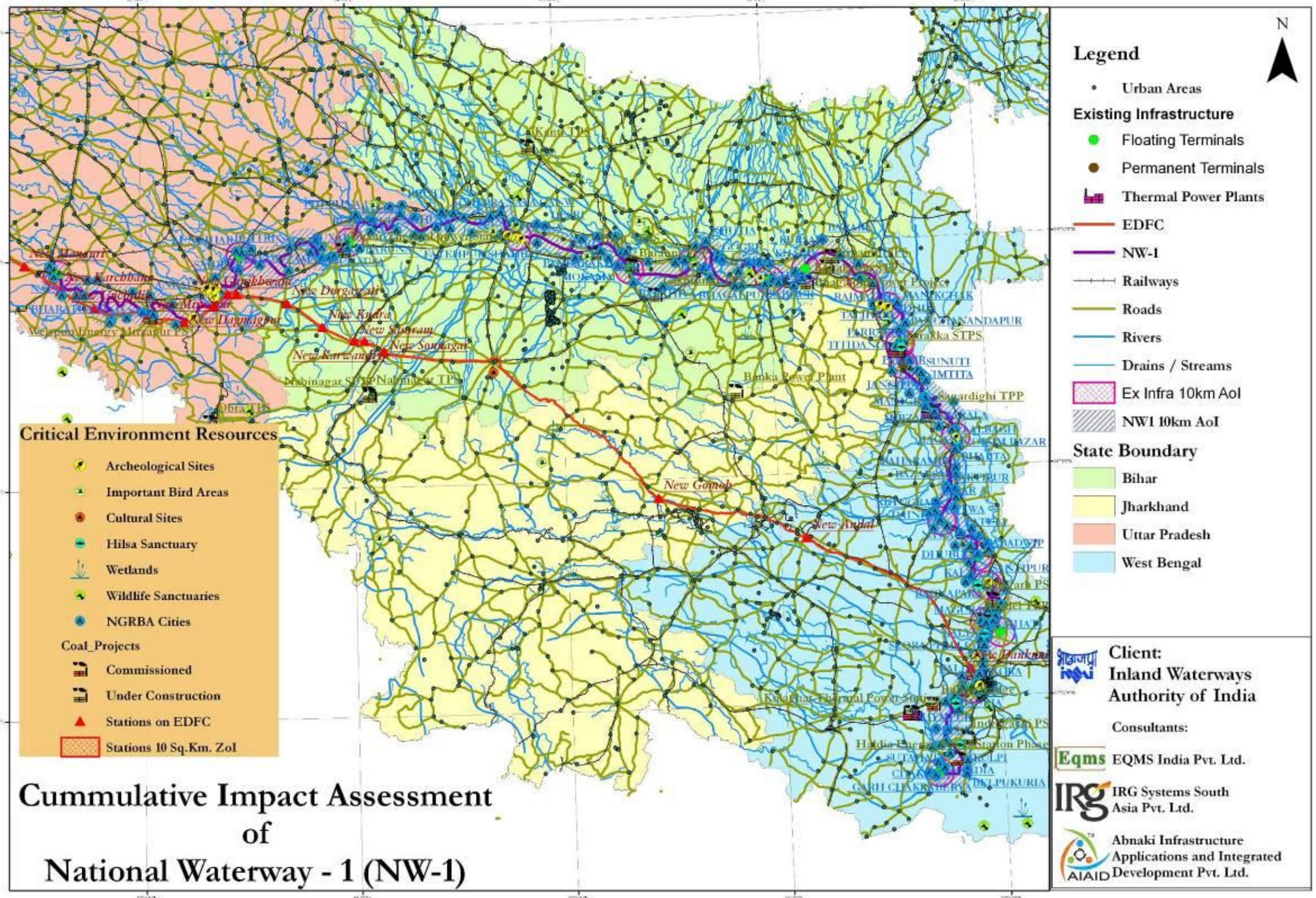


Figure 3.4: Base Map of VECs in UP

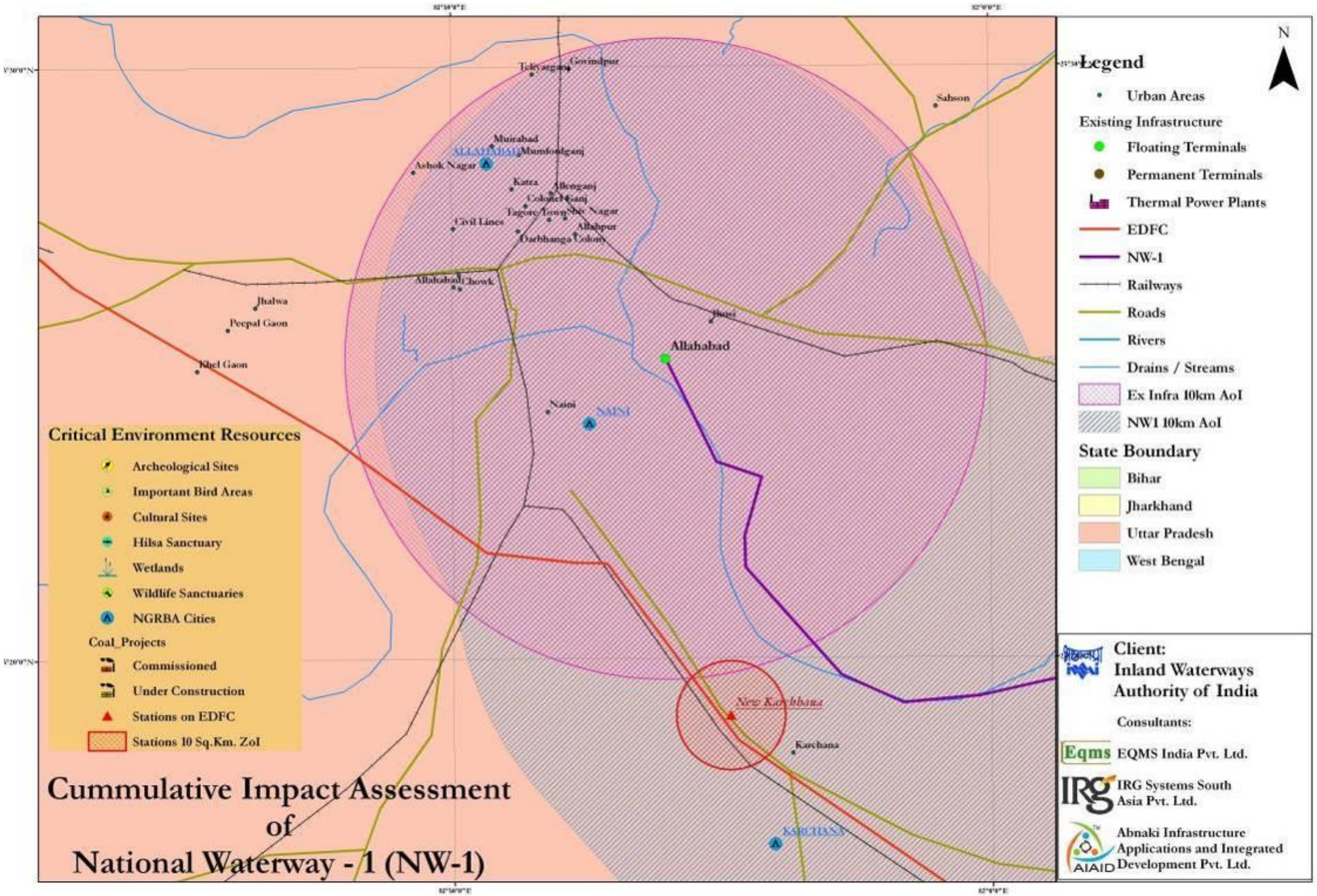


Figure 3.5: VECs in Allahabad

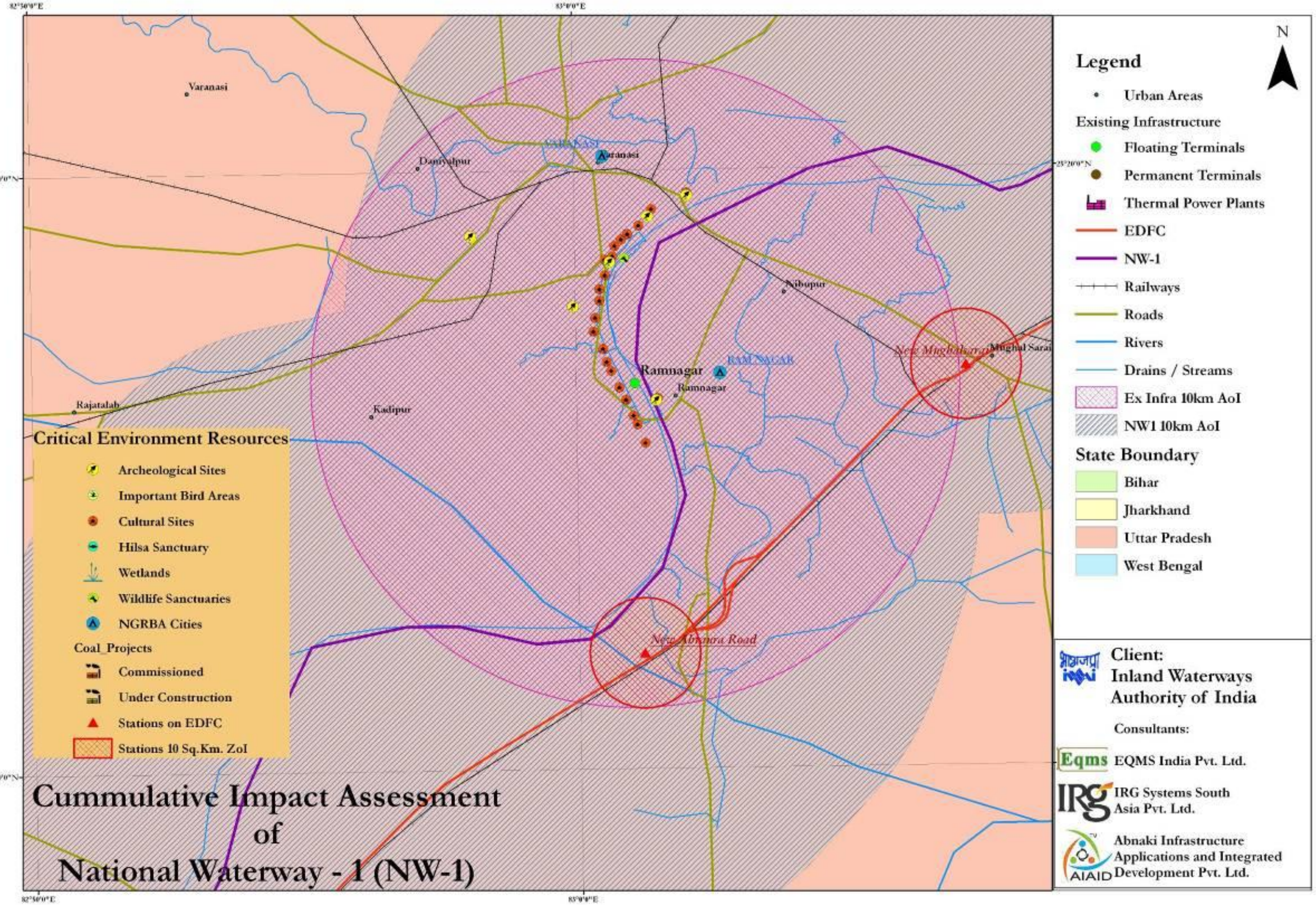


Figure 3.6: VECs in Varanasi

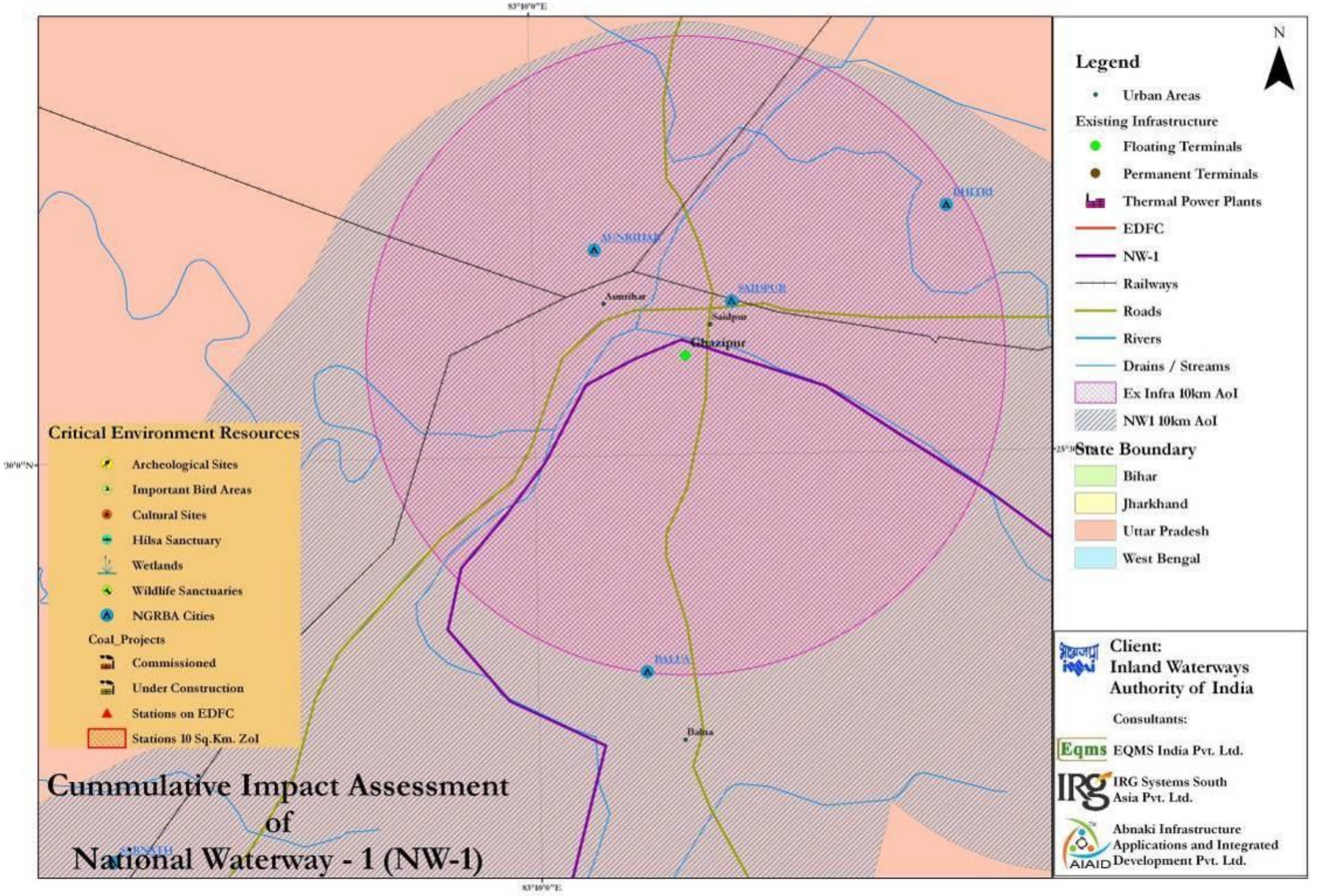


Figure 3.7: VECs in Ghazipur

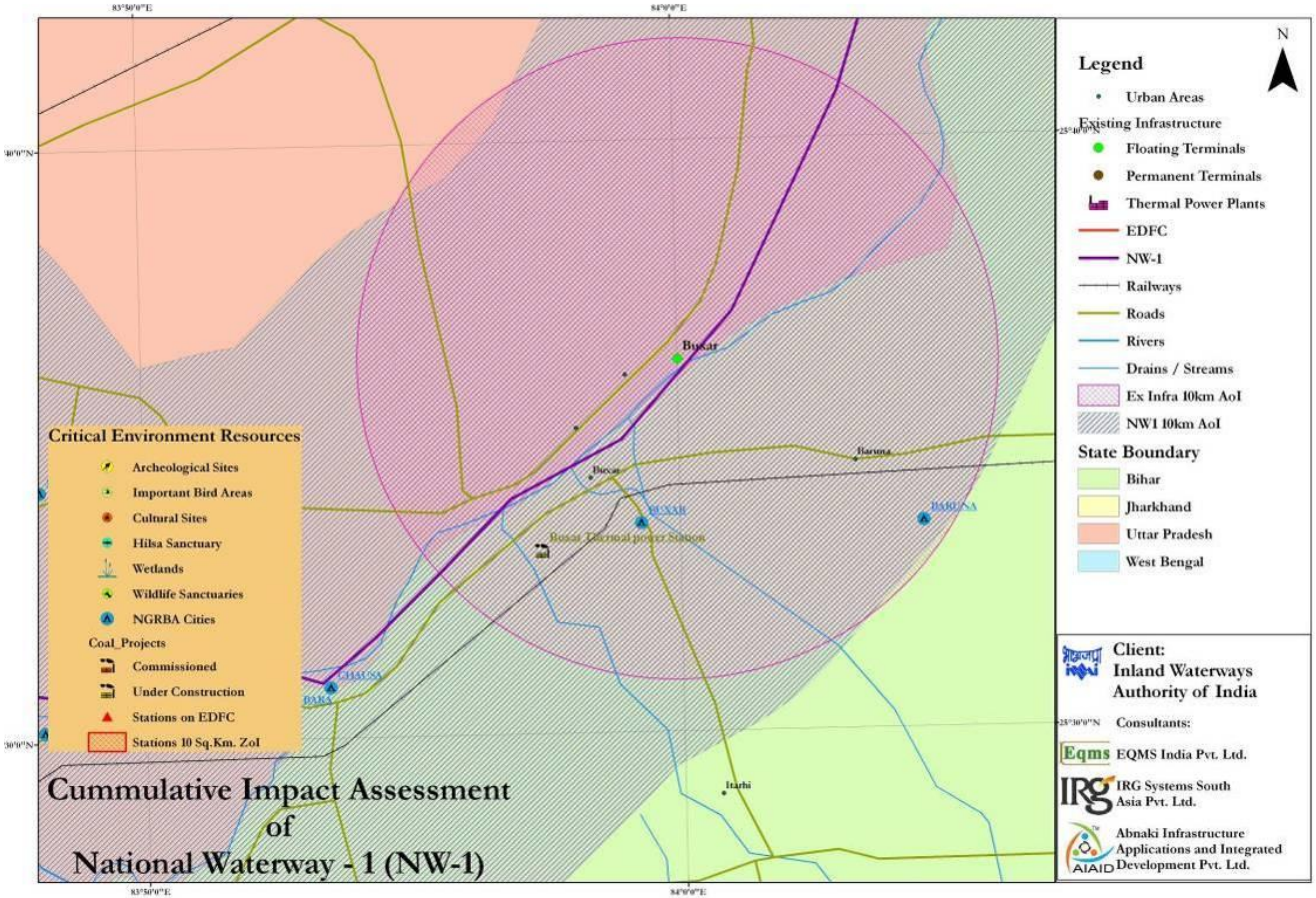


Figure 3.8: VECs in Buxar

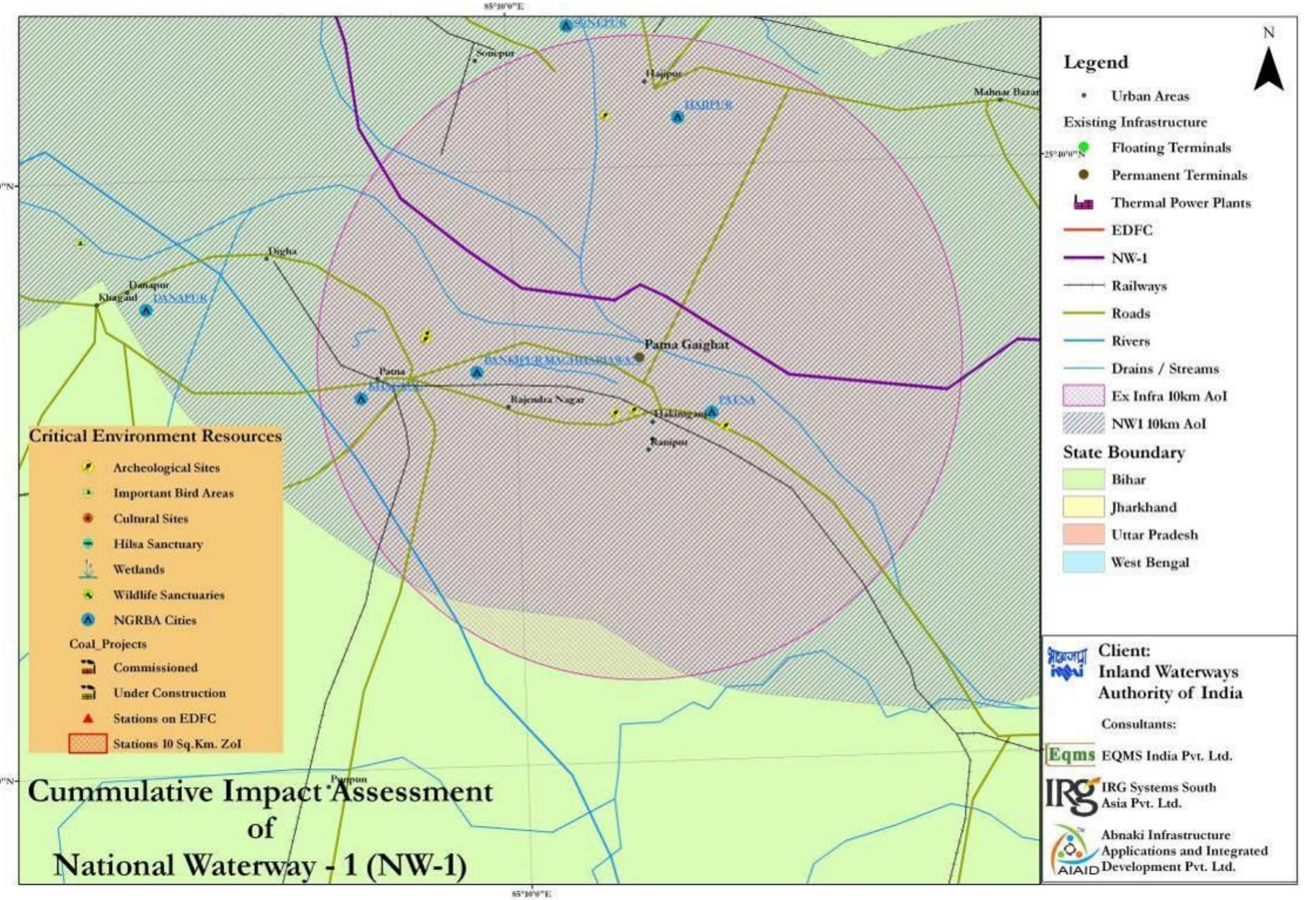


Figure 3.9: VECs in Patna Gaighat

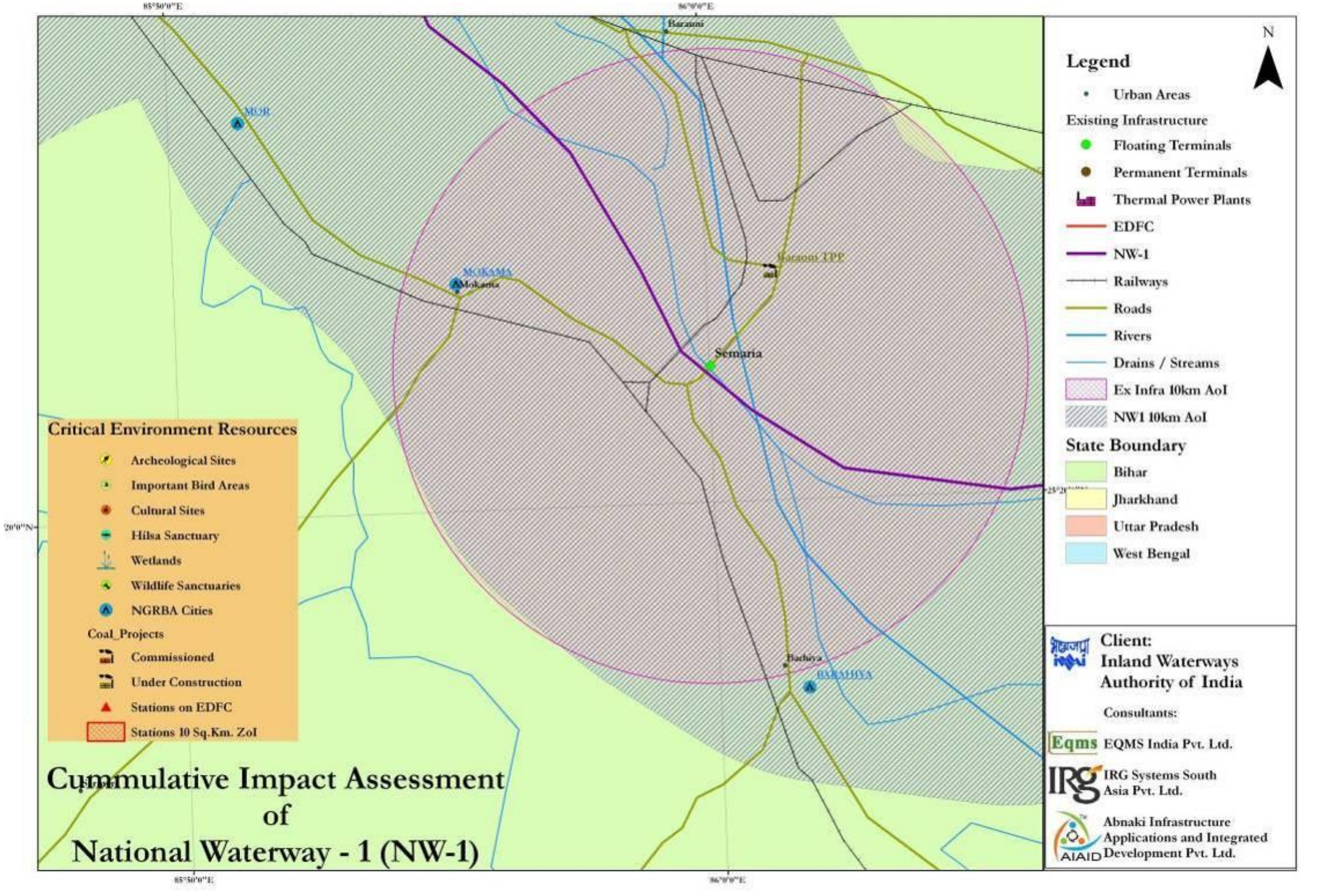


Figure 3.10: VECs in Semaria

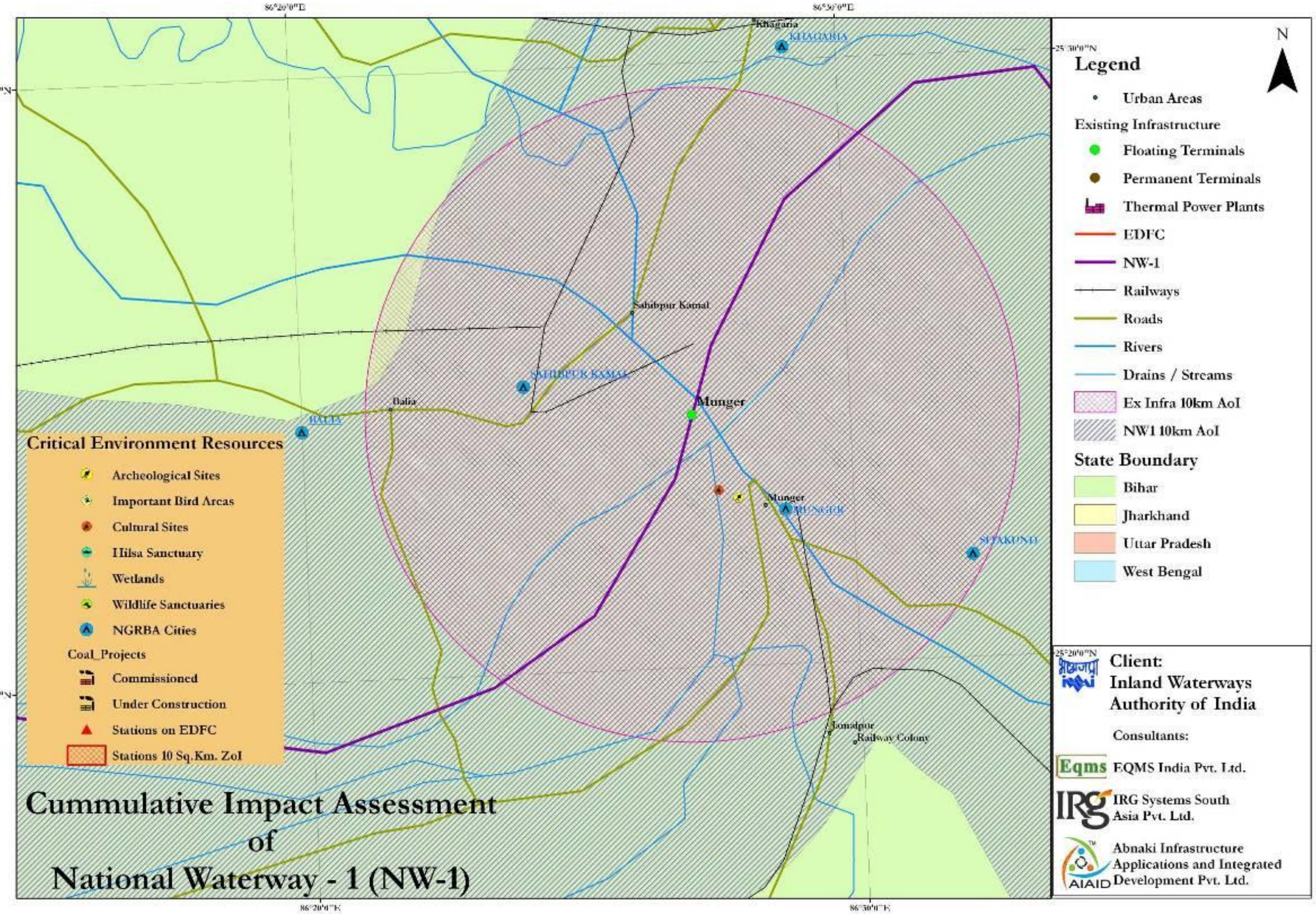


Figure 3.11: VECs in Munger

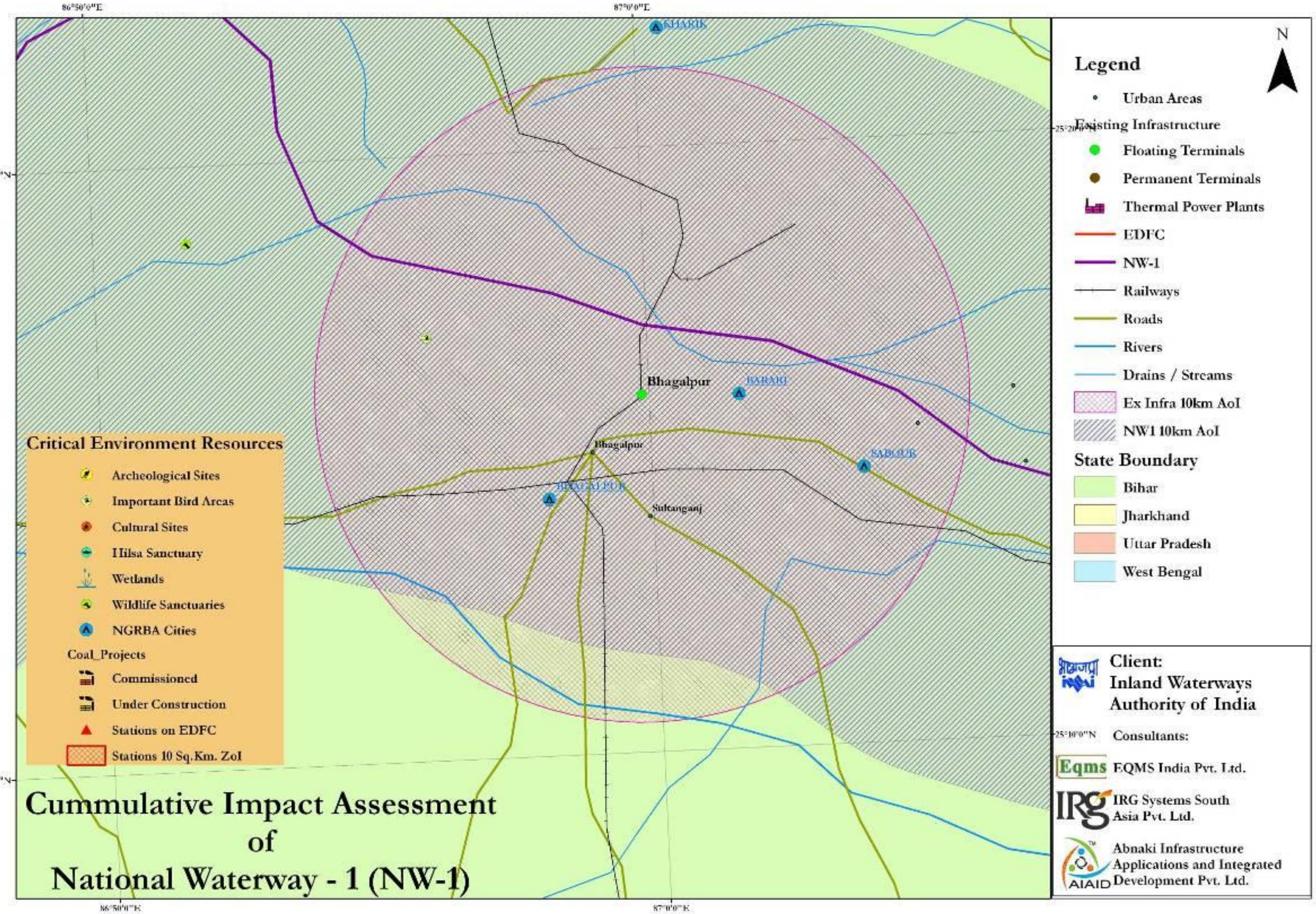


Figure 3.12: VECs in Bhagalpur

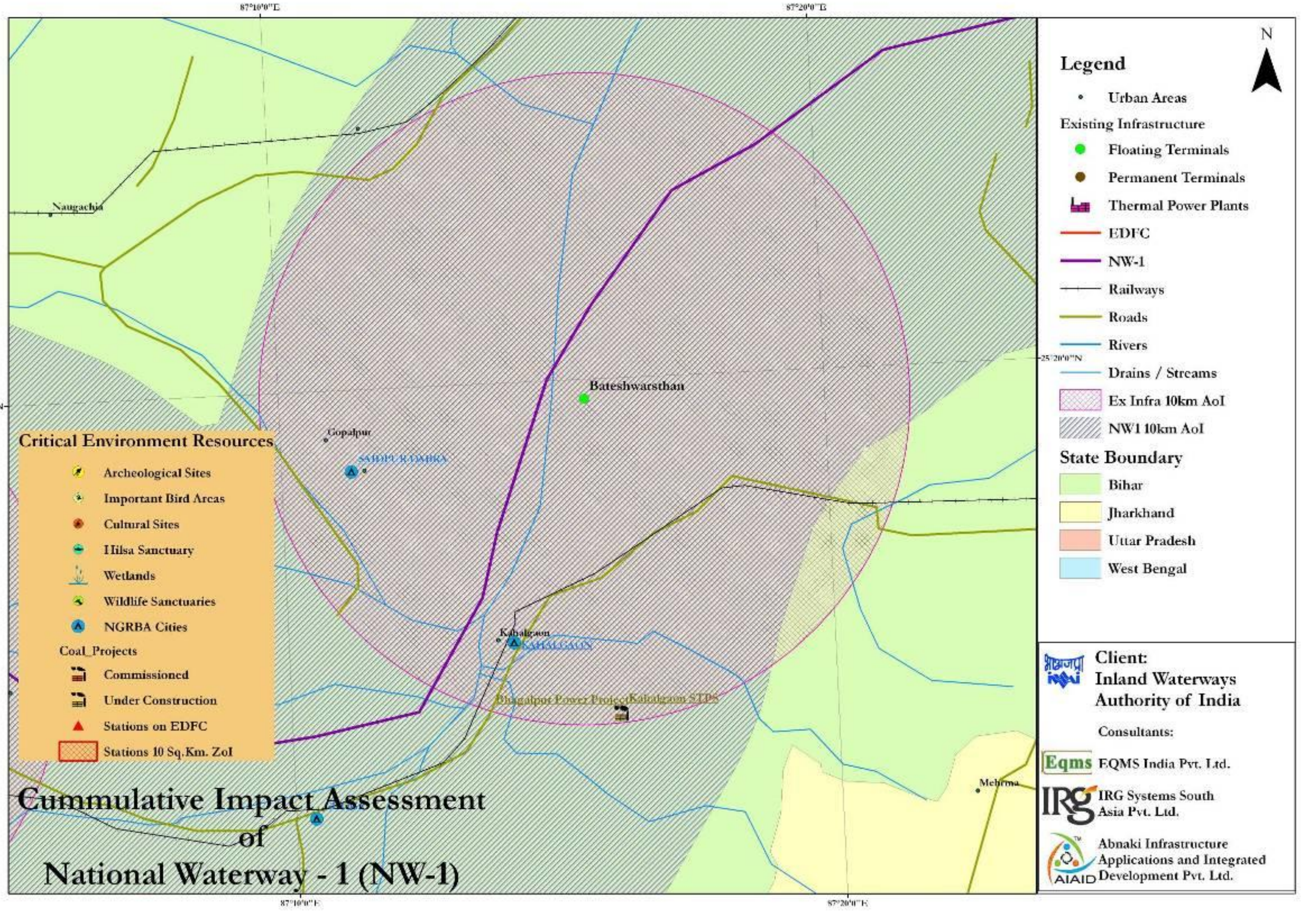


Figure 3.13: VECs in Bateshwarsthan

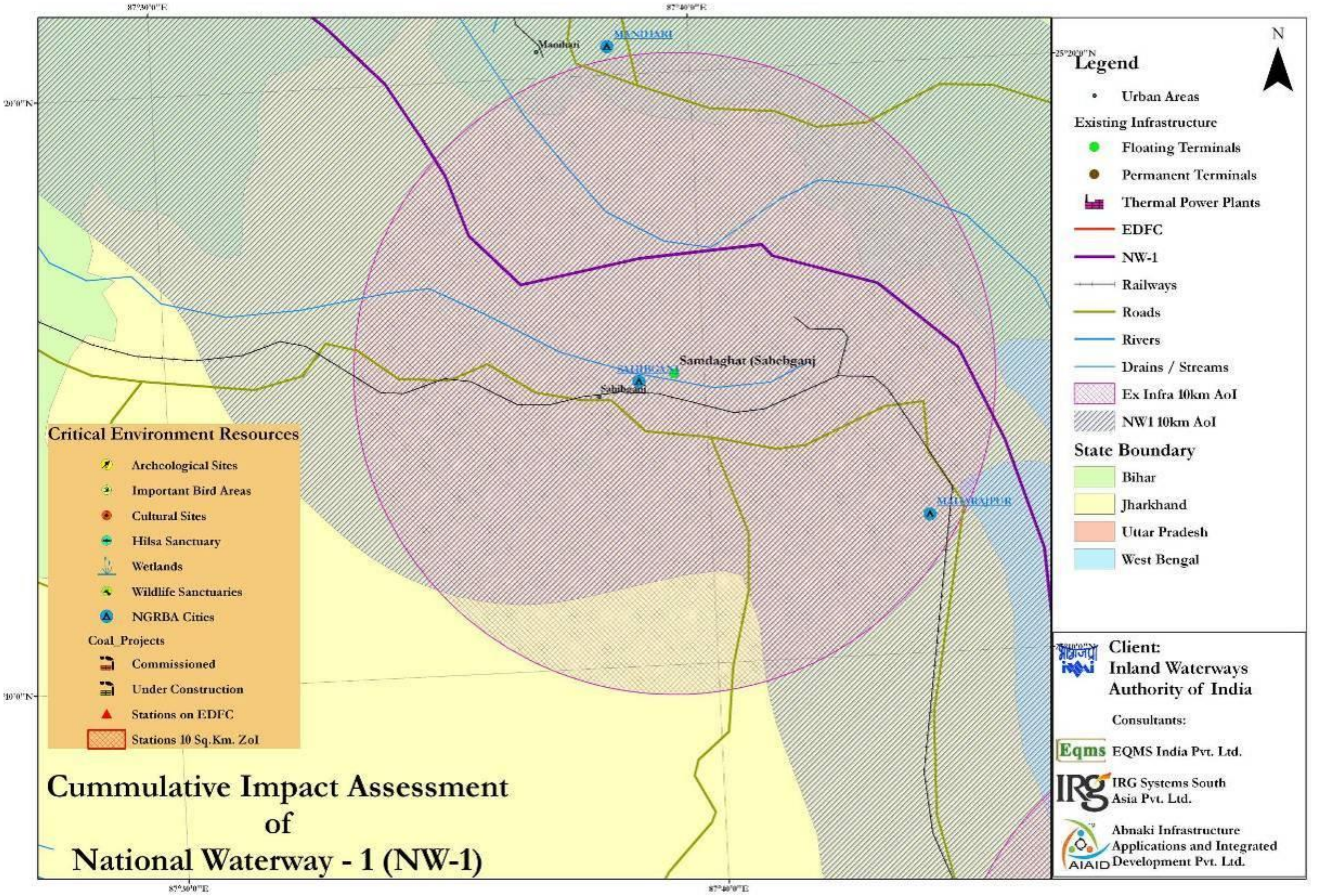


Figure 3.14: VECs in Samdhaghat (Sahebganj)

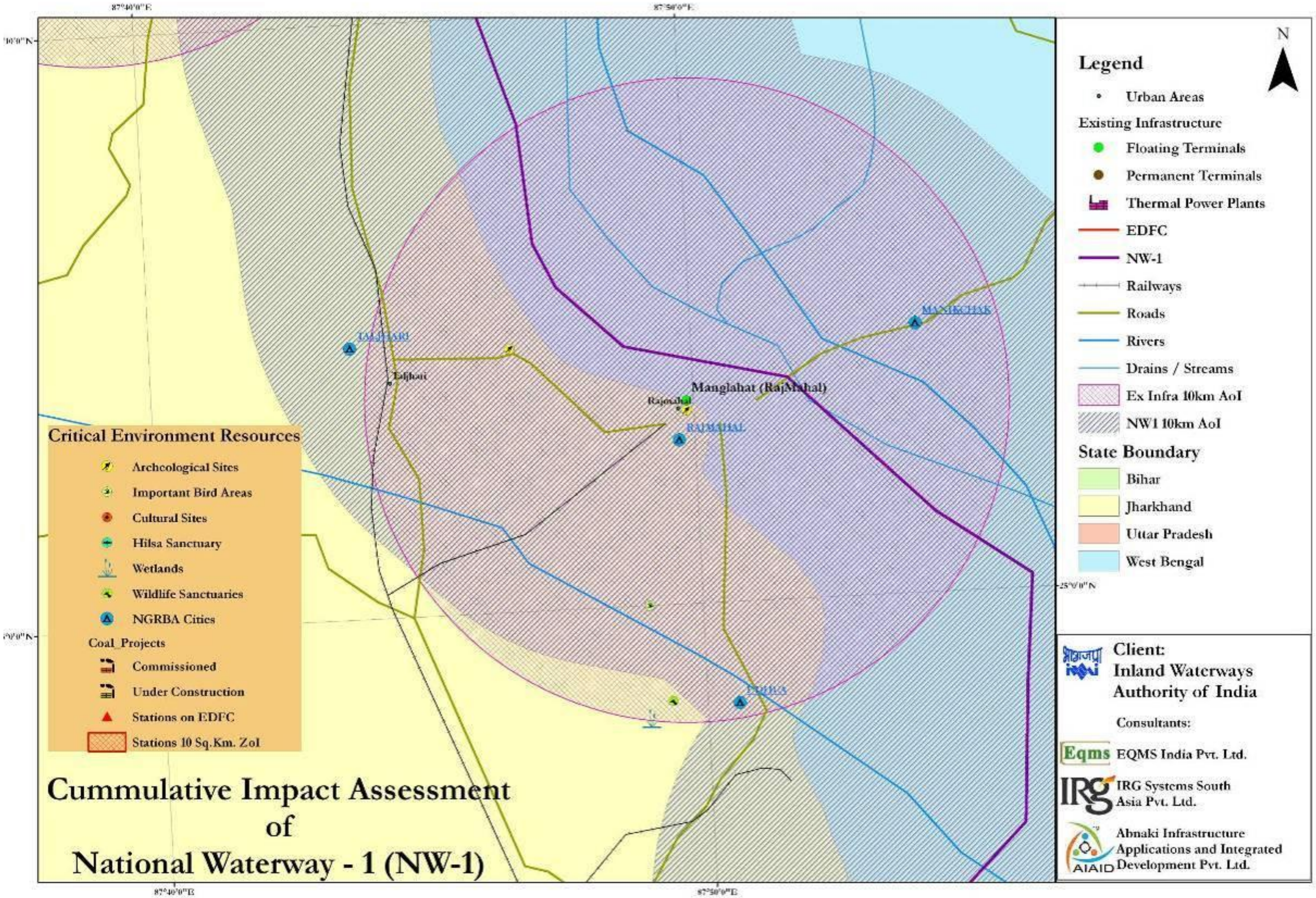


Figure 3.15: VECs in Manglahat (Rajmahal)

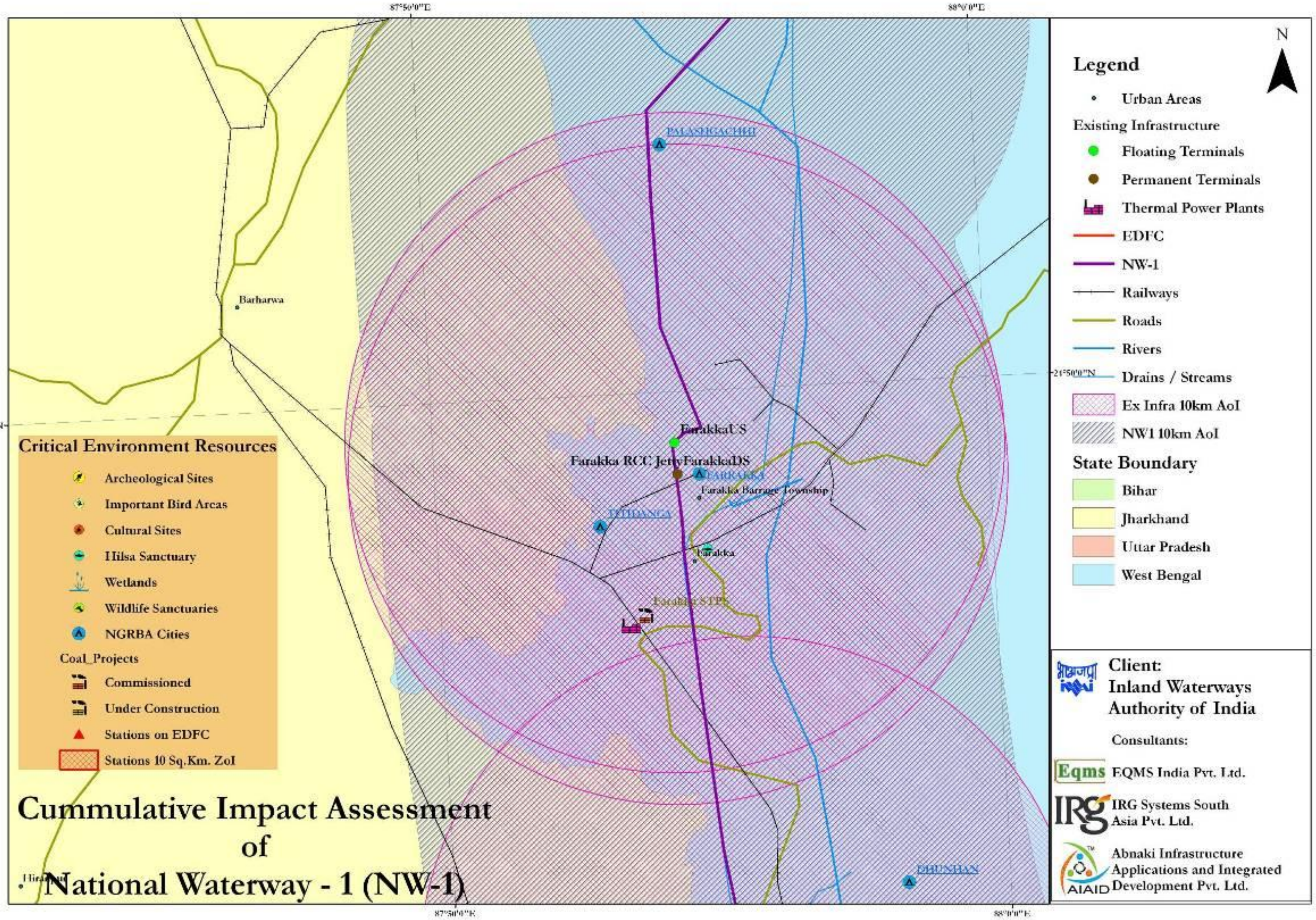


Figure 3.16: VECs in Farakka

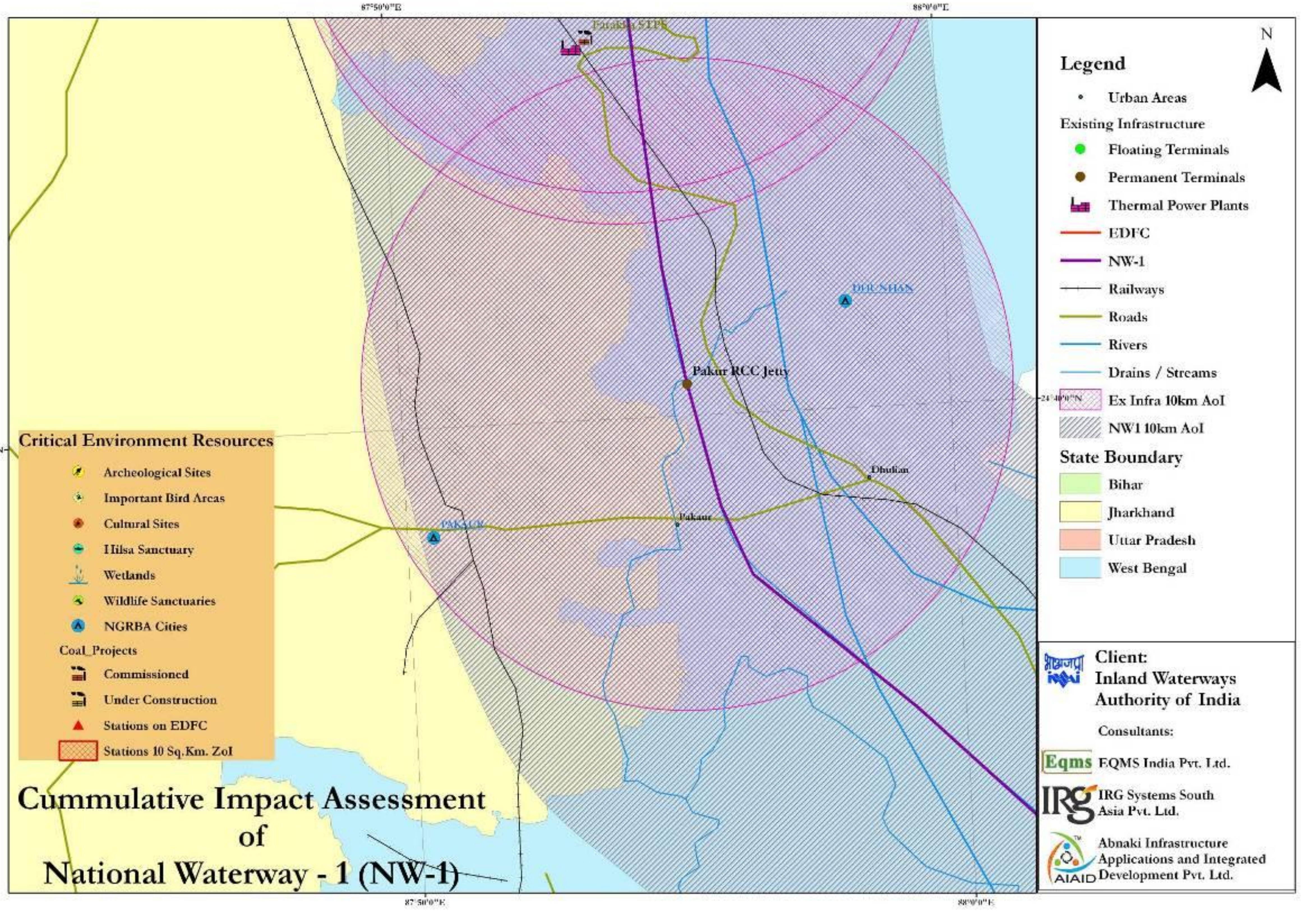


Figure 3.17: VECs in Pakur

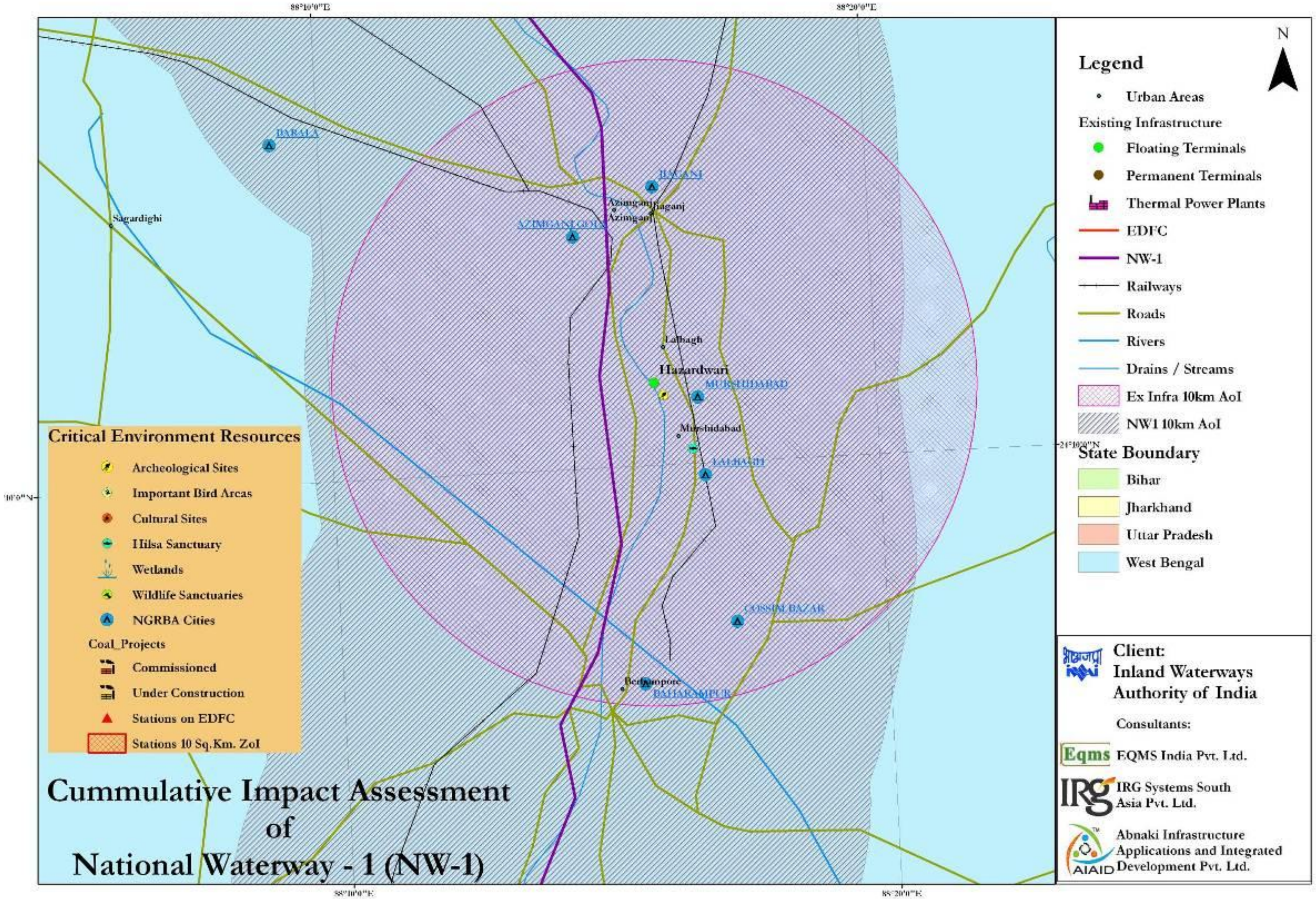


Figure 3.18: VECs in Hazardwari

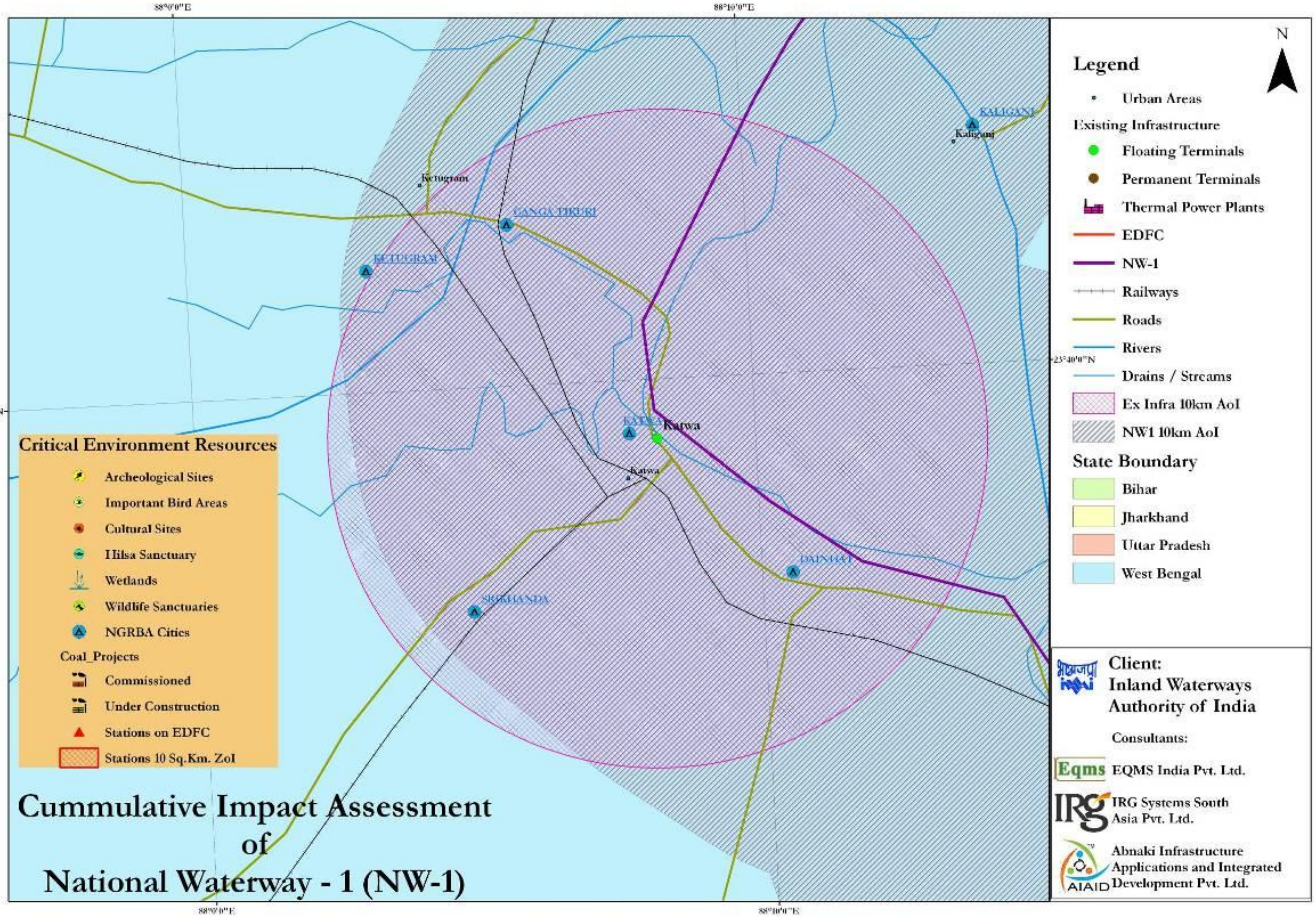


Figure 3.19: VECs in Katwa

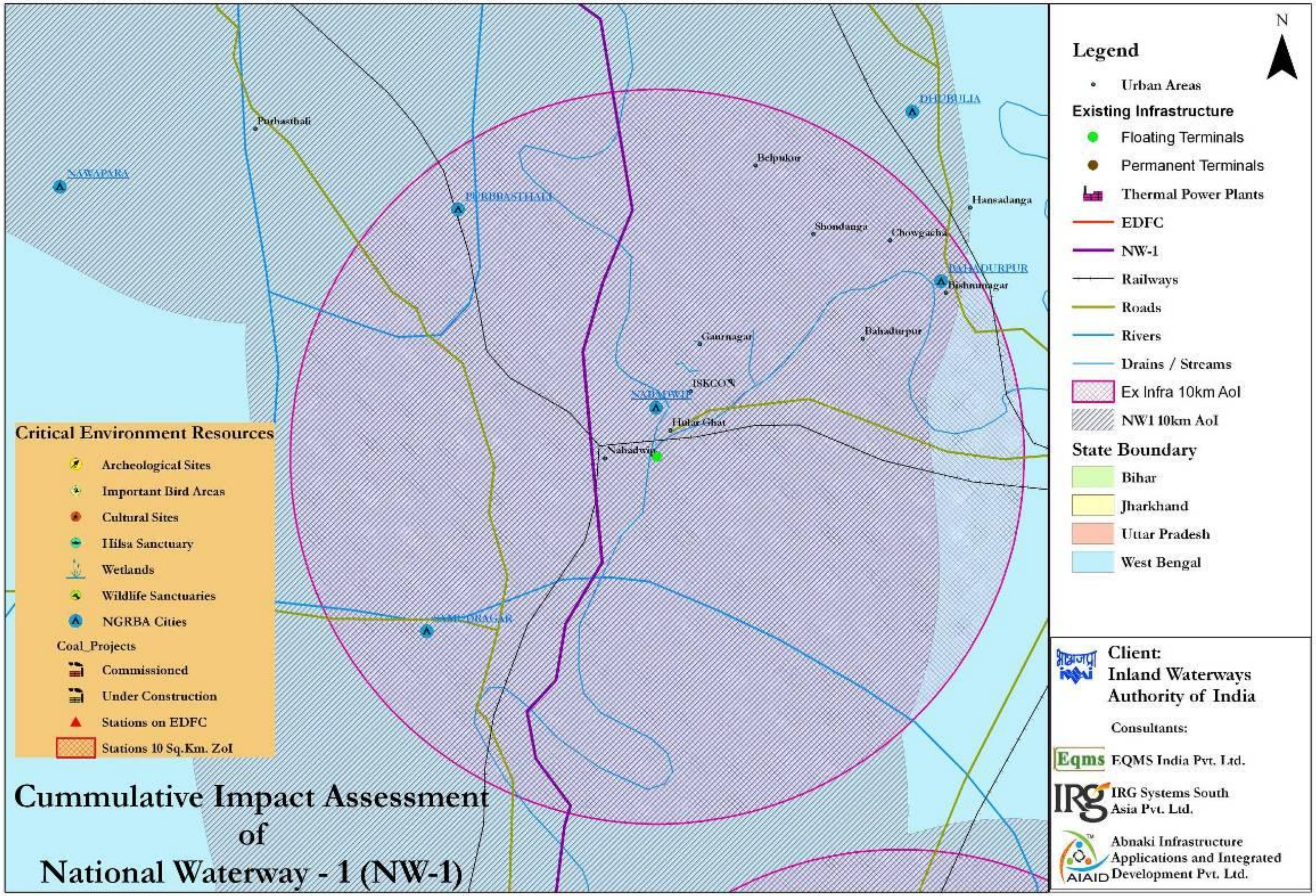


Figure 3.20: VECs in Swaroopganj

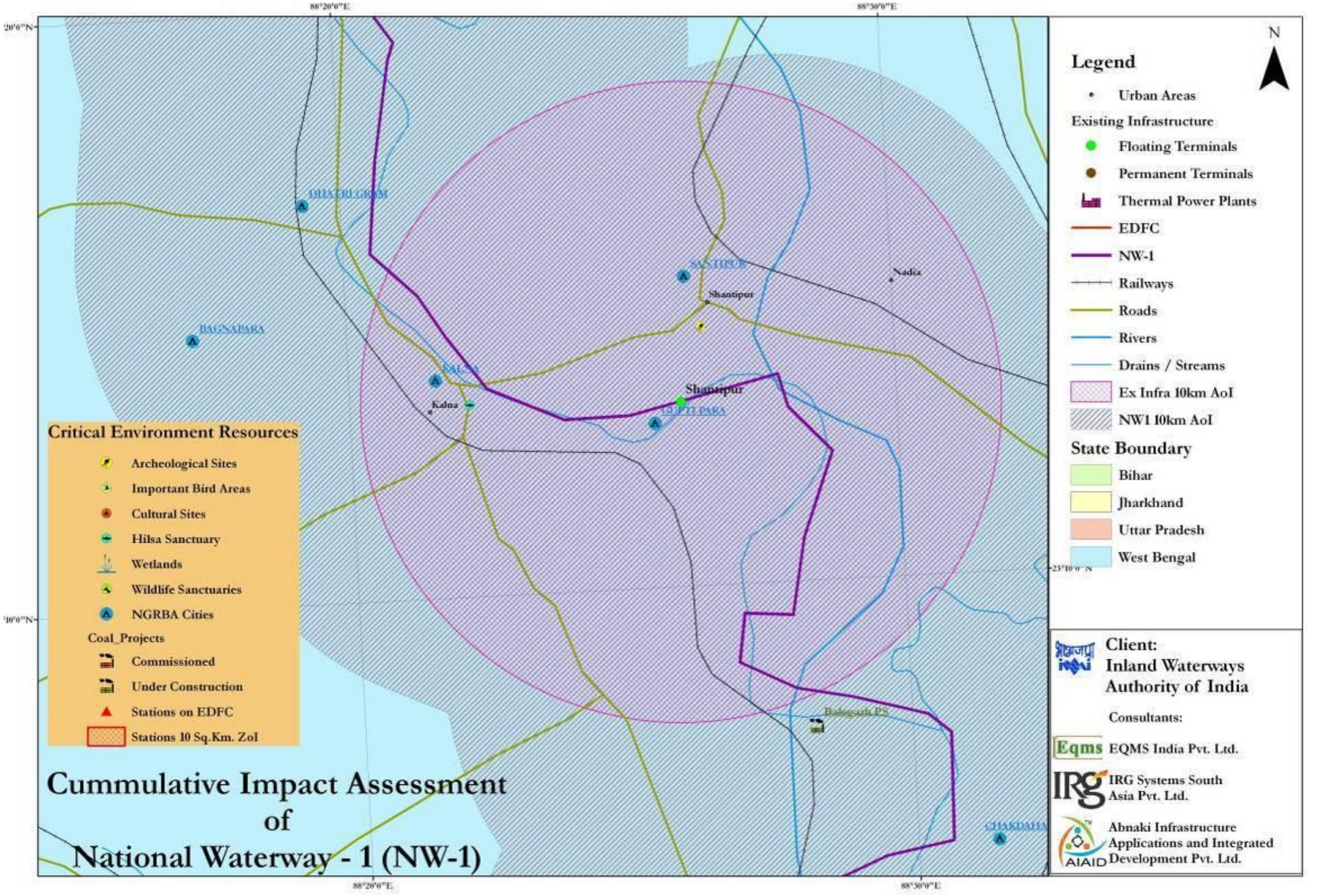


Figure 3.21: VECs in Shantipur

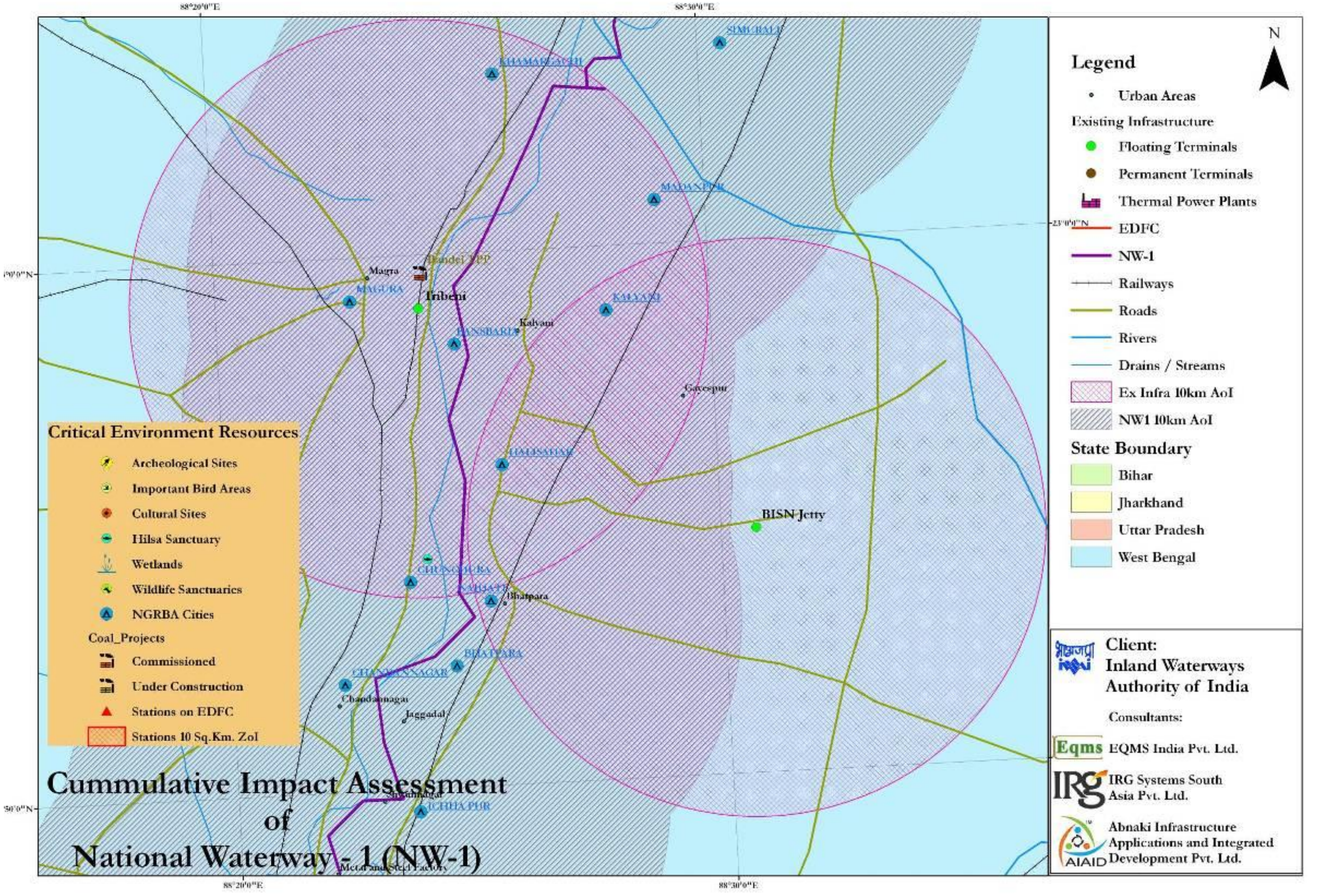


Figure 3.22: VECs in Tribeni

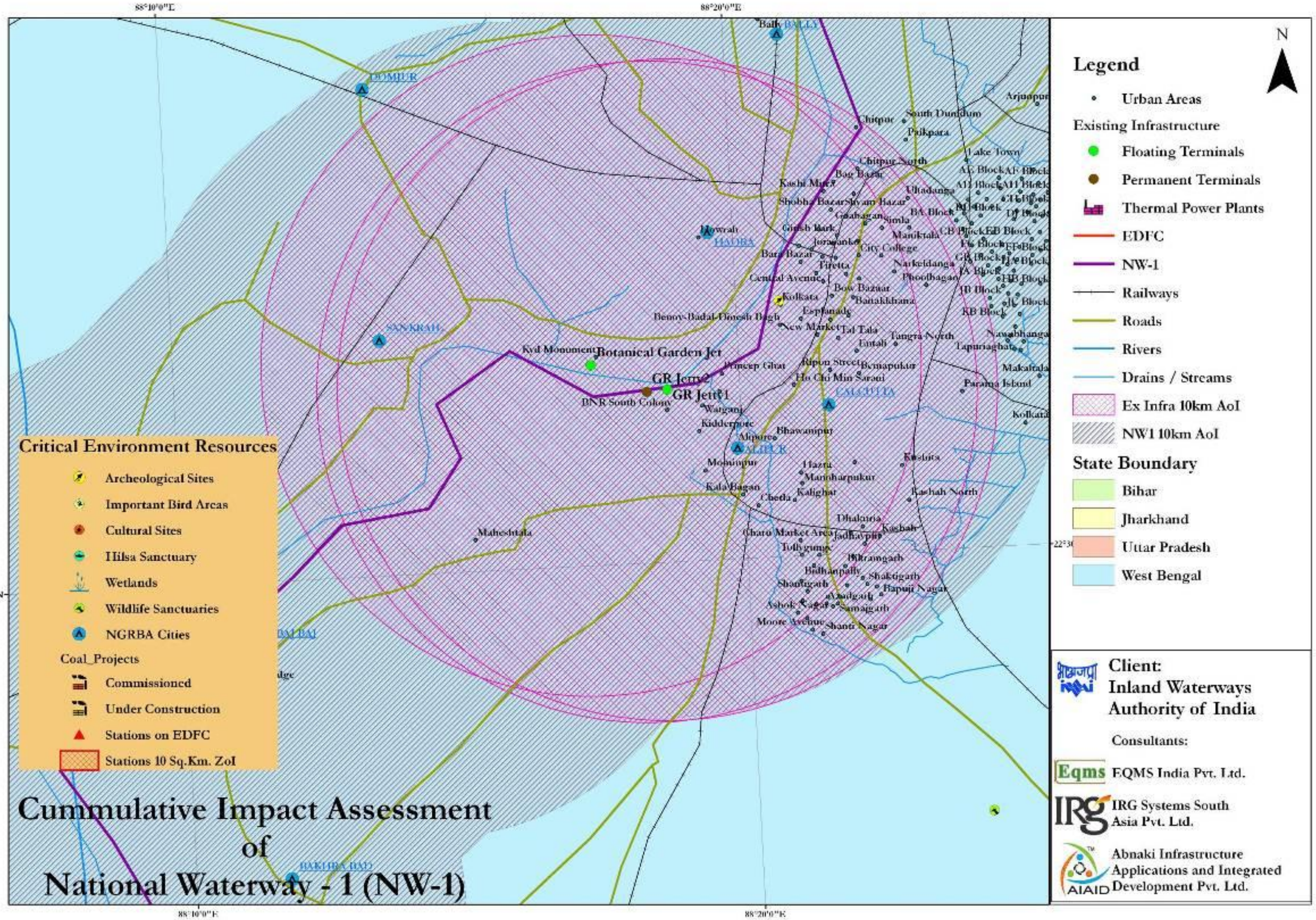


Figure 3.23: VECs in Botanical Garden / Garden Reach Jetty

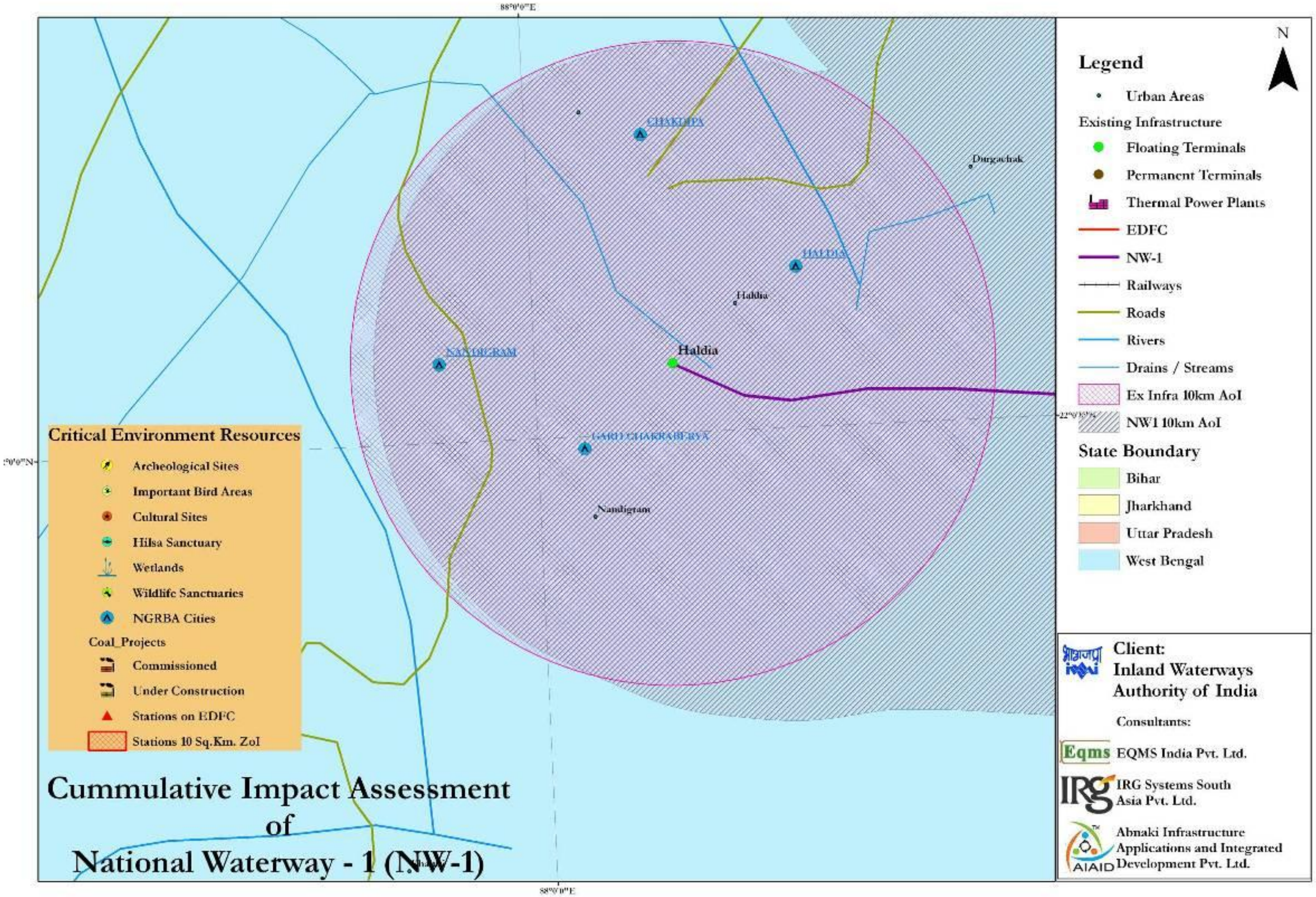


Figure 3.24: VECs in Haldia

3.5 Conclusion

Delineation of CIA boundaries has been carried out with reference to basin of river Ganga (NW-1), based on literature review including those of National Ganga River Basin Authority and National Mission for Clean Ganga, existing environmental, ecological, socio-economic conditions, project design and operations of JMVP perspectives. Based on these consideratons, the influence area for CIA is basin level (Hydrology & Ecology) and 10 kms. Further, VECs, their current status and hotspots in the NW-1 influence area have been identified. These VECs are the ultimate recipient of impacts because they tend to be at the ends of ecological pathways considering water related proposed activities both in terms of availability & quality in NW-1. These VECs may be directly or indirectly affected by a specific development or by the cumulative effects of several developments. Therefore, it is essential to carry out the stakeholders consultations (a kind of collaborative judgement) considering other proposed developmental work within the CIA influence area. This will give insight into type and extent of impacts and after finalization of hotspots, further baseline assessments of the VECs can be done.

CHAPTER 4: PUBLIC CONSULTATIONS AND DISCLOSURE

4.1 Introduction

Public consultation is one of the key components of the environmental assessment. The CIA/ESIA team conducted public consultations in project site area and study area. From CIA perspective, an effort was made by conducting consultations particularly in reference to confirmation of hotspots mentioned in Chapter 3 as well as to identify new hotspots, if any. The approach involved a mix of conventional as well as participatory consultations, focus group discussions (FGD) and one-to-one discussions with wide range of stakeholders encompassing government, non-government organisations, local communities, research and development organisations, academia, media. Prior consultations have been carried out in line with World Bank Guidelines for conducting the public consultation followed by summarising the findings. . Finally, this chapter concludes with identification of hotspots based on preliminary assessment, baseline data and inputs from stakeholder consultations.

This chapter provides details of the public consultation and participation activities undertaken during the CIA study for the Project “Jal Marg Vikas” extending from Allahabad to Haldia. During public consultation, emphasis was placed on a fully-inclusive, open and transparent public participation process in the transfer of information regarding the project and likely impacts from the project on each environment and social components. A number of stakeholders are involved in this project ranging from the local communities, local bodies, State & Central Level Government agencies and Non-Government Organizations.

4.2 Methods of Public Consultation

Consultations were conducted during and prior to the CIA study to obtain the views of people about the project and to ensure their involvement. Issues pertaining to both environment and social environment were discussed in depth during the consultations.
Consultations were carried, prior and during the CIA study of the different components of the Jal Marg Vikas project. Since the project comprises of various components like terminals, jetties etc., informal consultations were undertaken in reference to these proposed components at the respective locations. One to one and focused consultations were conducted on informal interview basis. No questionnaires/ brochures were supplied to the participants.
The discussions were primarily focused on receiving inputs from the participants regarding their acceptability and environmental concerns arising out of the project. Consultations were initiated with the short description of the upcoming project components under Jal Marg Vikas Project. The objectives, proposed developments and the possible impacts of the project components and the connectivity links of the study area with the project were

also explained. The survey team recorded their perceptions, demands and recommendations, about the project.

Consultations were carried out for different planned components at different time periods. The details of the same are given in **Table 4.1.**

Table 4.1: Detail of Developmental Activity and Period of Public Consultation

Sr. No.	Details of Developmental Activity	Period
1.	Haldia Terminal	Sep, 2015
2.	Farakka Lock	June, 2015
3.	Sahibganj Terminal	July-Nov, 2015
4.	Varanasi Terminal	Oct-Nov, 2015
5.	Patna	Sept 2015
6.	Movement of Barges in Buxar & Patna Area	Feb, 2016
7.	Proposed development in NW-1, Bihar & Jharkhand	April, 2016

Visits were made to the villages and offices of the local bodies, Government officials, Universities and NGOs to meet the stakeholders and obtain their views. Local people included the farmers, fishermen, boatmen, land owners, cultivators and students. Interaction with females was also done during the informal focused group discussions. During the consultations, it was found that people are generally aware about the IWAI planning for development of planned components, i.e. terminals and lock. Again a brief was provided to people prior consultation. People were then asked about their views, issues and expectation from the project. Focus on both environmental and social issues was given during the consultations.
Consultations were carried out for the interventions sites where acquisition of land involved has associated R & R issues and indirect impact. Two large scale consultations have been carried out for the project, one for Farakka Lock at Bewa Panchayat, Farakka and second for Sahibganj Terminal at Ashram, SamdaNala village, Sahibganj. Invitation letter were given through e-mail and through in person meeting to Local bodies, Government officials & NGOs for attending the public consultation, minimum a day before the formal public consultation meeting.

4.3 Objectives of Public Consultation

The public consultations were conducted with the following objectives:

- To spread awareness and generate understanding about the project among stakeholders, and to collect their opinion, suggestions for planning and designing of the project
- To assess positive as well as adverse socio economic and environmental impacts in the area through participatory methods such as walk through and focus group discussions.

- To identify the need and concern of the public
- To assess cultural patterns and behaviour of local communities towards the project
- To understand the environmental and social issues associated with the project through discussions
- To understand suggestions and opinions of the community, Government officials and NGOs on mitigation measures to counter and check the adverse and negative impact that threaten the socio economic environment in the area.
- To understand the satisfaction level of people with proposed mitigation and management measures proposed for the project

4.4 Outcome of Stakeholder Consultation

People and are supportive of the project in general. Extract of the public consultation meetings held are attached is given in **Annexure 4.1.** Main concerns raised during the consultation and redressal of the concerns is given at **Table 4.2.**

Table 4.2: Main Outcome of Consultation and Redressal of Concerns

Sr. No.	Outcomes/Concerns	Redressal
1.	Development of the project will ensure continuous water flow in the river.	✓ This will be positive to the fisher groups as regular flow in the river will have a increased fish availability throughout the year and will provide a sustainable income to the fisher group families.
2.	The project may lead to fish kill especially during construction and will affect the fishing business. The fisher groups expect the Government to provide them with some compensation for the loss of income during this period. The fishing activity may be affected adversely during the movement of the vessels along the corridor. This should be mitigated with measures as provided mentioned.	✓ Mitigation measures and management plan includes the measures for reduction of impacts of intervention construction &operation, maintenance dredging and barge movement on fish yield. Some of the measures are: ✓ Regulated/slow speed shipping ✓ Management of pollution by ships/vessels ✓ Intimation of dredging/piling plan to fisher groups prior carrying out any activity ✓ Enhancement of fishing in the area by boosting and funding fish nurseries and provision of better fishing aids and funding training of fishermen by CIFRI or organizing training program for fishermen through CIFRI ✓ Provision of sirens and strong search lights in vessels/barges so as fishermen would know the approach of ship/barge from minimum distance of 500 m
3.	Nearby roads to the terminal facilities should be strengthened and widened, as there may be substantial increase in traffic movement in the roads	✓ These roads being constructed as approaches to the terminals will require to large weight trucks and should be constructed accordingly. Presently the two locations that are being connected are Sahibganj terminal and Varanasi terminal.

Sr. No.	Outcomes/Concerns	Redressal
	connecting the terminal site after development of terminal.	
4.	Dredging activity will have an impact to the ghat sections which is called in-pits	✓ The river, scouring off the silt from under the concrete, has been catapulting their bodies into the deepening abyss on the fringes of the ghats. This could be an impact of the dredging activity. Thus such locations where people are utilizing the ghats for bathing/swimming or other activities should be warned or information of the dredging activity publicized so that causalities to life is minimized or avoided. There could also be sign boards displayed at prominent places for information.
5.	Turtle will get impacted due to regular movement of ships and vessels in river.	✓ Only 1-2 vessels per hour are expected to move in the sanctuary area. Speed of vessels will be maintained to 5 kmph/2.7 knots in turtle sanctuary area. Such speed barges generate noise in order of 11-140 dB. Threshold noise level of turtles for change in behavioural response is 150 dB which is above the noise expected to be generated by moving barges and the impact on turtles behaviour responses is insignificant. Other measures are also being proposed in the EMP to minimize impact of barge movement on turtle.
6.	Oil spillage from ships during accident may impact the aquatic flora, fauna and water quality	✓ Safety measures to be taken by vessels are given in the EMP. This will minimize the chances of accidents and will facilitate the quick clean-up operations in case of spillage
7.	Concerns regarding the water quality issues which may be there due to construction of terminal facility and operation of cargos, spillage in case of accidents, discharge of waste and sewage, oil leakage and other related activities	✓ Environment management plan has incorporated the measures for barges and terminal facilities to be taken up to minimize the water pollution
8.	Adequate compensation should be provided for the land which will be acquired	✓ SIA has been carried out for Sahibganj terminal site and RAP/LA/compensation plan has been prepared as per the R & R Act, 2013 and R & R policy for the project
9.	Demand for livelihood by the people who will lose their land	✓ Engagement of NGO can be taken up to find them alternative livelihood.
10.	At Sahibganj, locals expressed that they were keen on being relocated near the River Ganga	✓ It was informed that a relocation site has been identified by the District Officials near the current habitation in the Diyara land

Sr. No.	Outcomes/Concerns	Redressal
11.	Large number of tree cutting is involved at Sahibganj site which may impact the climate.	✓ Compensatory plantation is proposed to be undertaken. At all the terminal/jetty sites green belt will be developed to the extent possible. This will help in minimizing the impact and will lead to reduced impact of CO_2.
12.	Impact of barge movement on dolphins	✓ Regulated speed of barge movement in dolphin sanctuary area. Provision of propeller guards to prevent entangling of dolphins. Other measures are also proposed in management plan to reduce the impact on dolphins
13.	Plying vessels at present get stuck in lean season and this enhances the impact	✓ LAD is proposed to be maintained in stretch between Haldia to Varanasi during entire lean period
14.	Dredging may have significant impact on breeding and spawning season	✓ Dredging is proposed to be regulated during this season
15.	Erosion occurs along the bank of feeder canal and that is creating problem. Ship movement has further enhanced erosion	✓ River training works of 39 km are proposed to be undertaken on banks of feeder canal
16.	As part of social development, the local immersion Ghat at Durgachak(near project site) should be expanded by the project sponsors to overcome the current congestion especially during the local festival.	✓ Proposal is made to undertake expansion of ghat and budgetary provisions are also kept.
17.	The access road of Haldia terminal needs to be carpeted as present road is not in good condition.	✓ Shall be carried out as part of project development
18.	Provision for appropriate parking facilities inside the proposed terminal for better management of container carrying vehicles.	✓ Provision of parking area is made at each terminal site
19.	Sanjana Chemicals near Haldia terminal site suggested that no water logging should take place at terminal site and nearby areas after development of terminal	✓ Adequate storm water drainage is provided at the site to drain the storm water and fire-fighting facility is also proposed at the site.

Sr. No.	Outcomes/Concerns	Redressal
	and firefighting measures should be provided at the site	

4.5 Formal Public Consultation Meetings

Formal public consultation was conducted for Terminal at Sahibganj & Lock at Farakka. Formal consultation at Sahibganj was conducted at Ashram, Samda Nala village, Sahibganj. Formal consultation at Haldia was conducted at Bewa Panchayat, Farakka. Request for support and participation in public consultation meeting was sent to stakeholder, Gram Panchayat, other locals such as fishermen and Local Administrations. Some of the stakeholders were invited by giving invitations personally. Villagers were invited through Gram Sarpanch and also by giving door to door invitations.

4.5.1 Formal Consultation in Sahibganj and Farakka

Meeting was started with brief introduction about the project by Mr. Ravi Kant, Director IWAI, Patna. At the community meetings information on the socio-economic studies, environment impact studies and other engineering related to the proposed terminal of IWAI were discussed. He requested stakeholders to cooperate and provide information to these teams for facilitating their studies. The stakeholders and community members were then given an opportunity to raise their concerns regarding the proposed project. About 700 people participated in the PCM. Meeting was attended by Government officials, PAF's, World Bank Officials, IWAI Official, CIA team and General public. The consultation at Farakka was kicked off by Mr. Madhusudan Hanumappa (Social Expert), part of EQMS-AIAID-IRGSSA JV by welcoming all the dignitaries and participants. In his address, he emphasized on the proposed project i.e. "Capacity Augmentation of Navigational Infrastructure on NW-1 between Allahabad to Farakka". He also explained the objective of the ESIA/CIA for managing environmental and social issues for sustainable development. At the community meetings information on the socio-economic studies, environment impact studies and other engineering aspects related to the proposed lock gate of IWAI were discussed. He requested stakeholders to cooperate and provide information to these teams for facilitating their studies. The stakeholders and community members were then given an opportunity to raise their concerns regarding the proposed project. The summary of the key concerns/views and observations of the different stakeholders are presented in **Table 4.3**.

Table 4.3: Summary of Formal Public Consultation Meeting at Sahibganj

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
1	**Person/ Organization:** Shri K.K. Tiwari **Designation:** Divisional Forest Officer ,Sahibganj	Shri K.K. Tiwari told that the area behind the terminal site is protected forest. He told that forest department has plans to carry out afforestation

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
	E mail: sbgforest@gmail.com **Phone:** 09431306331 **Address:** Divisional Forest Office, Sahibganj, Jharkhand	and grasses/shrubs in 5 km area of the Ganga River and along the Railway lines in Udhwa Region for benefit of livelihoods of local communities. Also forest department has planned to develop wetland. His concerns about the project development are: 1. Dolphins will be impacted due to the movement of cargo so mitigation measures should be taken to minimize the accidents 2. Water pollution may result due to disposal of sewage from terminal and from vessels and disposal of solid and other waste in River Water. Thus mitigation measures and management plan should be prepared to prevent water pollution. 3. Surveys should be carried out to identify the breeding and spawning grounds of fishes and project activities should not be undertaken in those regions 4. Construction activities should not be carried out during spawning and breeding seasons 5. Piling and construction within water should be carried out during low flow period 6. Measures should be taken to minimize the impact of the project on aquatic organism
21	**Person/ Organization Consulted:** Shri Jayant Ranjan **Designation:** District Fisheries officer **Phone:** 09835031630 **Email:**jayant.ranjan21@gmail.com **Address:** Department of Fisheries, Sahibganj	Shri Jayant Ranjan raised the following concerns: 1. About 5000 fishermen depend on River for their livelihood 2. Major fish species in the area are Indian Major carps, singhi, shrimps, *Mystus* sp. catfishes, tengra etc. These are commercially important species. Project development may affect the production of fishes in the River and will affect the livelihood of people 3. Breeding and spawning grounds of the fishes should be identified and care should be taken that no development should be carried out in these regions 4. Dolphins are very sensitive and care should be taken that minimum disturbance should be caused to dolphins

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		5. Mechanism should be developed for river clean up during accidents, oil spills, spillage etc. 6. Dredged material should be disposed in safe places and dumping should not be carried out on banks as these are habitat to various important species. 7. Fish catch may reduce due to increase in water pollution due to project development 8. Project may increase the export of frozen fishes and also there is potential for growth of commercial fisheries
4.	**Person/ Organization:** Mrs Munni Gaud **Phone:** 07808789116, 7070603324	Mrs. Munni Gaud raised the following concerns: 1. Appropriate compensation should be given to the land owners 2. Alternate employment options should be provided to people who are losing their complete land 3. Developments should be carried out in the nearby areas also for development of villages 4. Fishing activity should not be restricted after development of terminals 5. Farmers practising river terrace agriculture should not be stopped
5.	**Person/ Organization:** Mrs Usha Khalkoo **Phone:** 9801018326,9801352024 **Address:** Gram Panchyat Head, Hathigarhi	Mrs. Usha Khalkoo raised the following concerns: 1. Villagers are opposing the project as they are losing their land and they do not have any alternate employment option and are completely dependent on agriculture for their livelihood 2. Compensation should be given to villagers as per prevailing market rate, then they may get interested in selling their land 3. Alternate livelihood options should be provided to affected people 4. Pollution should not increase at the site and nearby areas due to project development
6.	**Person/ Organization:**MrNiranjan Kumar **Designation:** Additional Deputy Collector + Land Acquisition officer, Sahibganj	Mr. Niranjan Kumar informed the survey of land is under process and some more time is required to finalize the award list and land details.

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
	Phone: 09431306331 **Location/ Address: District Collectorate Office** Sahibganj, Jharkhand	
7.	**Person/ Organisation:** Mr Vishal Chandra **Address:** Jharkhand RajyaVidutVitran Nigam Ltd Sahibganj Jharkhand	Mr Vishal Chandra raised the following points: 1. He was in favour of project and said that the project is good for betterment of the area 2. This project will increase the development opportunities in the area 3. Shifting of LT line may be required from village which will be a challenging task 4. IWAI should be responsible to compensate for shift of the utilities
8.	**Person/ Organization:**Mr Sushil Kumar Executive Engineer PWD **Address:** Public works Department Sahibganj, Jharkhand	Mr Sushil Kumar said that project is good for development of the area and raised the following points: 1. Land acquisition will be the major hurdle for project development as one of the PWD project of road is also on hold due to difficulties in land acquisition 2. No paved public road connects the site to the highway or other road. Also it is expected that traffic will increase in the area, thus to prevent dust generation and traffic congestion, it is required to construct minimum 4 lane road to connect site to NH-80. 3. ROB should also be constructed above the railway line to allow smooth flow of traffic 4. Green belt should be maintained along the approach road to suppress the dust generation 5. Assessment of increase in traffic should also be carried out on existing roads so as expansion can be planned when required
9.	**Person/ Organization :** Dr. Bhagwant Marandi **Designation:** Chief Medical Officer **Address:** CMO,Health Department, Sahibganj, Sahibganj, Jharkhand	Dr. Bhagwant said that in his point of view, project will lead to overall development of the area. Healthcare facilities will also increase in the area after development of project.

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
10	**Person/ Organization** : Mr Safaij Reiz, **Address:** Ganga pump Canal Nahar Pariyojna (Irrigation Department, Sahibganj, Jharkhand	He supported the project and said that project is beneficial for overall development of area and improvement of living standards of people.
11.	**Person/ Organization** : Mr Faiku Ram **Address:** District Mining Officer , Sahibganj, Jharkhand	He supported the project and said that project is beneficial for overall development of area and improvement of living standards of people. He is ready to extend his support to IWAI, if required
12	**Person/ Organization** : Mr Vinay Kumar Mishra and (5 staff members) **Address:** District Land Acquisition Officer Sahibganj, Sahibganj, Jharkhand	He said that land acquisition is under process and they are trying to identify land near the village for relocation and resettlement of displaced families and facilities
13.	**Person/ Organization :** Mr Prasant Kumar Additional Director, IWAI and (6 staff members) **Address:** IWAI, Bhagalpur, Jharkhand	He gave confirmation to villagers that no additional land will be acquired for terminal construction. Land will be acquired as per law of land. He explained about the project to villagers and clarified the queries of people during meeting.
14.	**Person/ Organization:** Villagers of Samda Nala and Rampur village (Direct and Indirect Affected Persons)	Villagers were highly concerned and raised following points 1. They said that land should be acquired as per prevailing market rates 2. Alternate employment options should be provided to people who are losing their land 3. Land should be provided to affected people within or near village for relocation and resettlement 4. Fishing should not be restricted in the River due to project development 5. Employment opportunity should be provided preferably to local people
15.	**Other Participant** Mrs. Abha Singal Joshi, Consultant World Bank Mrs. Mridula Singh, World Bank Mr Pranay Kumar +2 persons from social team of IWAI Consultant Mr Krishna + 2 persons from Environment team of IWAI Consultant Media: Dainik Jagaran, Hindustan	

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
16.	Kesang Dhendup Bhutia BDO & Block Executive Officer Farakka Block Development Office, Farakka, Murshidabad	• BDO, Farakka, welcomed the project development and assured his and local administration cooperation for the project implementation. • Also mentioned that without addressing environmental and social concern/impact in a structured manner no project can be completed on time successfully. • Any kind of toxic pollution by the vessel like oil spillage and chemicals in the river water, transport emissions, needs to be considered. • The project implementing agency should be careful about river erosion during the vessels movement. River bank erosion has a permanent effect upon the socio-economic conditions and demographic dislocation. • As Farakka BDO, he appealed to the authority that they should provide jobs to the local unemployed youth based on their skill and should give business opportunities to the local people. • The access road needs to widened and upgraded to ensure smooth traffic movement because it has an important link with NH-34. A traffic management plan needs to be in place. • He suggested that the project should employ local people in the proposed location on a priority basis provided they have the required skills. • The health safety and protection of labour and other community members should be considered on project site as well as nearest locality of the villages during the operation phase. • Also suggested for adequate mitigation measures in ESIA/CIA to address to erosion issue because due to

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		river bank erosion Farakka block is one of the worse affected area and many people have lost their homes/properties since 1975 when Farakka barrage was commissioned. • The public consultation meeting should be held at different places for awareness of the people and Grievance Redressal Committees should be active with timely conflict resolution. • The Interviewee was optimistic that implementation of this project would change the current socio-economic scenario of the local communities.
17.	Mr. Arnab Chakraborty Journalist(Malda & Murshidabad Division) Uttarbanga Samgbad Farakka, Murshidabad	• He suggested that the project should employ local people in the proposed location on a priority basis provided they have the required skills. • The health safety and protection of labour and other community members should be considered on project site as well as nearest locality of the villages during the operation phase. • Also suggested for adequate mitigation measures in ESIA/CIA to address to erosion issue because due to river bank erosion Farakka block is one of the worse affected area and many people have lost their homes/properties since 1975 when Farakka barrage was commissioned. • The public consultation meeting should be held at different places for awareness of the people and Grievance Redressal Committees should be active with timely conflict resolution. • The Interviewee was optimistic that implementation of this

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		project would change the current socio-economic scenario of the local communities.
18.	Mr. Jahid Hussain Director, Mahadevnagar Rural Welfare Society, Farakka, Murshidabad	• The authority can support them through livelihood restoration programmes. • Also suggested for safety and protection from the construction site near the locality of the villages and • The consensus described as during the construction period authority should consider the vulnerable health issues like HIV/AIDS because Murshidabad is one of the vulnerable health related district in West Bengal.
19.	Mr. Rana Dutta,IFS DFO Divisional Forest Office, Nadia & Murshidabad Range Institutional Stakeholders consultation through KII (key informant interview)	• There is no forest conservation around the Farakka area. • The continuous turbulence and waves from plying vessel movement can cause river bank erosion. This is problem that is difficult to resolve in entire downstream • As a DFO gave the assurances that DFO range will give all help for smooth operation of the project activities.
20.	Community members of local Villages at PCM	• The villagers also informed that there is no forest area. Further, they did not anticipate any adverse impacts on their livelihood due to construction works. • They further opined that there would be positive impacts on the sources of livelihood due to increased economic opportunities which will provide good earning sources to the local families due to the project implementation. It was also informed that there is no Schedule Tribe (ST) population in the project area. • Representatives from Beoa Panchayat extended their support during the construction and operational

Sr. No.	Person Name/organization, Phone, Address	Outcome (concerns and suggestions) / Views
		phase of the proposed project. -They also suggested that public consultation meetings should be held at different places for awareness of the people and Grievance Redressal Committee should be active with timely conflict resolution.

Table 4.4: Hotspots Identified based on Stakeholder Consultations

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
1.	Haldia	• Celebration of Ganga Sagar Mela at Sagar • Urban areas: Haldia Town	• Religious Values
2.	Farakka to Murshidabad	• Farakka feeder canal is prone to erosion • Urban Areas: Farakka, Murshidabad, Azimganj, Baranagar, Balia, Raghunathganj	• Bank/Soil erosion
3.	Rajmahal	• Chatt Pooja celebration Oct-Nov • Mining activities	• Religious Values • Air Quality
4.	Sahibganj	• Chatt Pooja celebration Oct-Nov • Acquisition of Land, R& R and shifting of community temple • Cutting of app. 500 trees	• Land Use • Livelihood & Fishing Activities • Socio-economic • Air Quality • Terrestrial flora • Religious Values • New infrastructure development
5.	Pirpanti	• Chatt Pooja celebration Oct-Nov	• Religious Values
6.	Kahalgaon	• Chatt Pooja celebration Oct-Nov • Urban Area: Kahalgaon	• Religious Values
7.	Bhagalpur	• Chatt Pooja celebration Oct-Nov • Urban Area: Bhagalpur	• Religious Values
8.	Munger	• Chatt Pooja celebration Oct-Nov •	• Religious Values
9.	Semaria	• Chatt Pooja celebration Oct-Nov • Urban Area: Semaria, Doraiganj	• Religious Values
10.	Begusarai	• Chatt Pooja celebration Oct-Nov • Urban Area: Begusarai	• Religious Values
11.	Barh	• Chatt Pooja celebration Oct-Nov • Urban Area: Barh	• Religious Values
12.	Patna	• Chatt Pooja celebration Oct-Nov • Urban Area: Patna • Development of River Front	• Religious Values • Water Quality • Land Use • Soil Erosion
13.	Buxar	• Chatt Pooja celebration Oct-Nov	• Religious Values

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
		• Urban Area: Buxar	
14.	Varanasi	• Festival: Ganga Mahotsav at Varanasi (Oct-Nov) & Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March)	• Religious Values
15.	Allahabad	• Festival: Kumbh Mela	• Religious Values

4.6 Conclusion

Stakeholder's view and perception was assessed through public consultation meetings.. This ensures involvement of public, NGO, experts in the project's pre-planning stage itself and addressal of their problems and expectation from the projects. The inputs of stakeholder consultations have been used in finalisation of hotspots.

During the consultations for 'Jal Marg Vikas Project', it is found that there is mix view of people about the project. Some people take it as positive development as the proposed project will benefit the economy of country. Whereas affected people, i.e. fishermen and land holders who will lose land are concerned about the restriction of fishing activity, reduction in fish yield, loss of land and livelihood and receipt of adequate compensation and alternate livelihood. Locals and experts are also concerned about the water pollution and impact on the aquatic fauna which may result due to the project. All the concerns were taken in consideration during assessment of impacts and the mitigation measures are proposed for all the concerns to minimize/mitigate the impact. Mitigation measures proposed are well addressed in management plan along with their period of implementation.

CHAPTER 5: BASELINE ENVIRONMENTAL PROFILE OF THE CUMULATIVE IMPACT INFLUENCE AREA

5.0 Introduction

Baseline study is an essential component of cumulative impact assessment of any project. Baseline study aims at collecting & collating the data on the VECs and their indicators. This data provides the basis on which an impact assessment can be carried out. It not only helps to determine the existing scenario of the study area in terms of environment and social conditions but also helps in identification of external environment and social drivers which may have an impact on the identified VECs due to future developments within the area. This will further assist in identifying & redefining hotspots. Baseline study also provides an insight into both existing & future condition of the area within the boundary for which CIA study has to be carried out.

5.1 Influence Area

Baseline study area coverage includes NW-1 & area within 10 km on either side of NW-1 to study the sites declared by ASI as heritage & cultural sites; to study eco-sensitive areas like national park, wild life sanctuaries, bird migratory routes etc. and major development area / critical zone having potential to be impacted by NW-1 which may further impact the surrounding environment. Map showing the study area for baseline study of the NW-1 is given below in **Figure 5.1.** List of the districts through which NW-1 passes is given in **Table 5.1** below.

Table 5.1: State and Districts through which the NW-1 corridor is traversing

Sr. No.	Name of Districts	State
1.	Allahabad	Uttar Pradesh
2.	Ravidas Nagar	
3.	Mirzapur	
4.	Varanasi	
5.	Chandauli	
6.	Ghazipur	
7.	Balia	
8.	Buxar	Bihar
9.	Bhojpur	
10.	Saran	
11.	Patna	
12.	VAishali	
13.	Samastipur	
14.	Begusarai	

Sr. No.	Name of Districts	State
15.	Munger	
16.	Khagaria	
17.	Bhagalpur	
18.	Kathihar	
19.	Sahibganj	Jharkhand
20.	Pakur	
21.	Malda	West Bengal
22.	Murshidabad	
23.	Vardhman	
24.	Nadia	
25.	Hugli	
26.	North – 24 Pargnas	
27.	South – 24 Pargnas	
28.	Kolkata	
29.	Howrah	
30.	Mednipur	

It may be noted that since the study area boundaries extends up to 10 Kms for major development area/critical zone, the baseline data collection & collation gives a range of observations near vicinity of alignment, up to observations at district level.

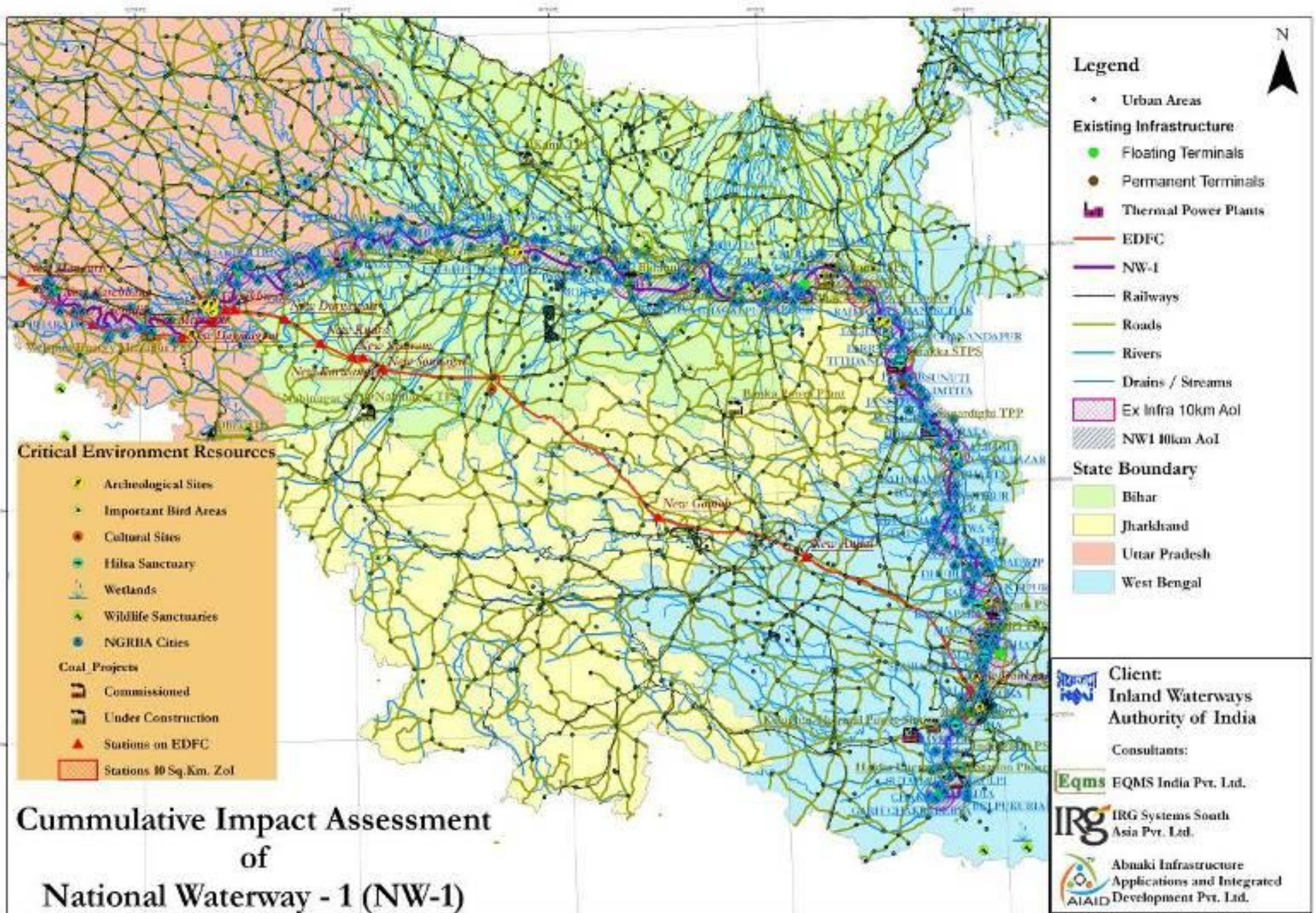


Figure 5.1: Map Showing Baseline Study Area for NW-1

5.2 Baseline Data

Baseline data has been collected from secondary sources like existing studies, reports, and consultation with Government Departments etc. Detail of sources of the baseline study for the CIA study is listed in the **Table 5.2** below:

Table 5.2: Sources of Data for Baseline Study for the CIA Study

Source Organization	Report/Source Name	Type of Data
CPCB & MOEF	CPCB Gazette notification dated 18.11.2009 on AAQ, Noise Notification, and BDU criteria	AAQ Standards BDU Criteria Standards Noise Standards
	Water Quality Assessment River Ganga 2013	Water Quality of NW-1 stretch
MOEF & CC	Endangered Species Brochure, 2009	Endangered Species
Indian Meteorological department	Climatological Normal 1961-1990	Met Data
	First order seismic micro zonation IMD	Seismicity and seismic map and Cyclone Hazard Prone Map
MOEF & CC	Jharkhand Wetland Atlas, Prepared by Space Applications Centre (ISRO), Ahmedabad and Institute of Environmental Studies & Wetland Management (IESWM), Kolkata)	Wetland information
MOEF & CC	Information on Wetlands	Wetland information
Central Ground Water Board	Ground Water Boucher of Project Districts	Geology, Ground water related information
Botanical Survey of India	Red Data Book of Indian Plants	RET species
Zoological Survey of India	Red data book on Indian Animal	RET species
IUCN (International Union for Conservation of Nature) 1980	Gland, Switzerland: International Union for Conservation of Nature. IUCN (International Union for Conservation of Nature) 1980.World Conservation Strategy: Regional strategies for international river basins and seas.	RET species
IWC (International Whaling Commission) 2000	Report of the standing sub-committee on small cetaceans. Journal of Cetacean Research and Management 1 (Supplement),	Cetacean fauna
Mohan, R. S. L. and Kunhi, K. V. M. 1996.	Fish oil as alternative to river dolphin, *Platanista gangetica* (Lebeck) oil for fishing catfish *Clupisoma garua* in the River Gangetic, India.Journal of the Bombay Natural History Society 93, 86-88.	Oil impact on Aquatic fauna
Gland, Switzerland: IUCN. Perrin, W.F. 1999.	Selected examples of small cetaceans at risk. Pp. 296-310 in: Conservation and Management of Marine Mammals (eds. J.R. Twiss, Jr. and R.R. Reeves) Smithsonian Institution Press, Washington, DC.	Aquatic fauna
NGBRA (Indian Institutes of Technology)	GRB EMP: Ganga River Basin Environment Management Plan	Flora & Fauna
NGBRA (IIT Consortium)	Main Plan Document by Consortium of 7 Indian Institute of Technology's (IITs)	Ganga basin
NGBRA (Indian Institutes of Technology)	Status of Higher aquatic vertebrates in Ganga river (Ganga River Basin Management Plan) By	Higher aquatic vertebrates

Source Organization	Report/Source Name	Type of Data
	Consortium of India's IIT Institutes	
NGBRA	Hilsa an assessment of in lower ganga basin (Ganga River Basin Management Plan) By Consortium of India's IIT Institutes	Fish
NGBRA (Indian Institutes of Technology)	Status of fish and fisheries in Ganga river (Ganga River Basin Management Plan) By Consortium of India's IIT Institutes	Fish
NGBRA	River Ganga at a Glance: Identification of Issues and Priority Actions for Restoration	Waterways quality
NGBRA (IIT Consortium)	Main Plan Document by Consortium of 7 Indian Institute of Technology's (IITs)	Ganga basin
Publication of BHU university	Flora of BHU	Flora
Kashi Turtle Sanctuary	Management Plan of Kashi turtle sanctuary	Turtle
Kalpavriksha	India's Notified Ecologically Sensitive Areas (ESAs)	Sensitive ecosystem
Chaudhary, S. K., Smith, B.D., Dye, S., Dye, S. And Prakash, S. 2006.	Conservation and Biomonitoring in the Vikramshila Gangetic Dolphin Sanctuary, Bihar, India. Oryx, 40 (2), 189-197	Dolphin
Quaritich. Braulik, G. 2000.	Entrapment of Indus dolphins (*Platanista minor*) in irrigation canals: incidence, implications and solutions. International Whaling Commission, Scientific Committee Document SC/52/SM9, Cambridge, UK.	Dolphin
Harison, R. J. 1972.	Reproduction and reproductive organs in *Platanista indi* and *Platanista gangetica*. Invest Cetacea.	Dolphin
Hua, Y., Zhao, Q., & Zhang G. 1989.The habitat and behavior of *Lipotes vexillifer*. In W. F. Perrin, R. L. Jr. Brownell, K. Zhou & J. Liu (Eds.)	Biology and conservation of the river dolphins Occasional Paper of the IUCN Species Survival Commission (No.3., pp. 92-98).	Conservation Dolphin
Kannan, K. Sinha, R.K., Tanabe, S., Ichihashi, H. and Tatsukawa, R. 1993	Heavy metals and organochlorine residues in Gangetic Dolphin from India. Marine Pollution Bulletin Vol. 26 No. 3 pp 159-162 Pergamon press U.K.	Heavy metal impact on Dolphin
Kannan, K., Tanabe, S., and Tatsukawa, R. And Sinha R.K. 1994.	Biodegradation capacity and residue pattern of organochlorines in Gangetic Dolphins from India. Toxicological and Environmental Chemistry.	Dolphin toxicology
Kasuya, T. 1972.	Some information on the growth of the Gangetic Dolphin with a comment on the Indus dolphin. The Scientific Reports of the Whales Research Institute	Morphology of dolphin
Mohan, R. S. L. and Kunhi, K. V. M. 1996.	Fish oil as alternative to river dolphin, *Platanista gangetica* (Lebeck) oil for fishing catfish *Clupisoma garua* in the River Gangetic, India. Journal of the Bombay Natural History Society 93, 86-88.	Oil impact on Aquatic fauna
KK Vass, S K Mandal, S Samanta, V R Suresh and P K Katiha, (CIFRI)	The Environment and Fishery status of River Ganges	Fish
Srivastava, P. And M.P. Singh,	Phenology and Biodiversity of Riparian Plant	Flora

Source Organization	Report/Source Name	Type of Data
M.P. (2013)	Species of Ganga River Bank at Bharwari (Kaushambi), U.P., India. Indian J.Sci.Res. 4(1)	
Sahibganj Forest Division	Forest Working Plan of Sahibganj Forest Division	Flora and Fauna
Kalpavriksha	India's Notified Ecologically Sensitive Areas (ESAs)	Sensitive ecosystem
R.J. Rao Conservation Biology Lab School of Studies in Zoology Jiwaji University, Gwalior	The Diversity, Ecology and Conservation Management of Freshwater turtles in Ganges River System	Ecology & Turtles
Agriculture Department	Agriculture plans	Cropping pattern
Census of India, Govt. Of India	Census of India 2011	Census data
Census of India, Govt. Of India	District Statistics Hand Book & Village Profile of the Project Districts	Basic Amenities
Kelkar, N., Krishnamurthy J., Choudhary, S., and Sutaria, D. 2010.	Coexistence of fisheries with River Dolphin Conservation. Conservation Biology, Vol. 24 (4): 1130-1140.	Dolphin conservation
WWF-Nepal. 2006	Conservation and Management of river dolphins in Asia. Proceedings of the regional meeting on conservation and management of river dolphins. 26-27 May, Kathmandu, Nepal.	Dolphin
Forest Division	Forest Working Plan of Kashi Forest Division, Farakka Division	Flora and Fauna
Guideline, Standard and recommendations as published by Environmental Committee of PIANC	• Initial Assessment of Environmental Effect of Navigation and Infrastructure Project (WG 143-2014) • Sustainable waterway within the context of Navigation and Flood Management (WG 107-2009) • Climate Change and Navigation (TG3-2008) • Dredging Management Practices for the Environment (WG 100-2009) • Dredging Material as a Resources (WG 104-2009) • Environmental Impact Assessments of Dredging and Disposal Operation (WG 10-2006) • Biological Assessment Guidance for Dredged Material (WG 8-2006) • Ecological and Engineering Guidelines for Wetland Restoration in relation to the Development, Operation and Maintenance of Navigational Infrastructure (WG 7-2003) • Management of Aquatic Disposal of dredged material (WG 1-1998) • Dredged Material Management Guide 1997. • Guidelines for sustainable Inland Waterways and Navigation WG 6-2003 • Environmental guidelines for aquatic, near shore and upland confined disposal facilities for contaminated dredged material WG 5-2002 • Dredging the environmental facts-where to find what you need to know? PIANC-IADC-WODA brochure-2001 • Environmental management framework for ports and related industries WG 4-1999 • Dredging: the fact WODA brochure-PIANC-IADC-CEDA-IAPH1999	

5.3 Cumulative Environmental Baseline

Cumulative Environmental Baseline has been described below in terms of identified VECs, Physical features, Ecological Profile, Physical Environment Profile, Socio-economic & Archaeological / Heritage sites.

5.3.1 Physical Features

Physical features have been described in terms of land environment consisting of topography, geology, land use, soil type, soil quality and agriculture resources.

5.3.3.1 Topography

The whole NW-1 (Allahabad to Haldia) falls within a relatively flat terrain. Physiographically, it constitutes a part of the Indo-Gangetic plain, which is largely flat, featureless and is formed of recent alluvial deposits of the river Ganga and its tributaries. River erosions, change in course of rivers and human activities of recent times have played an important role in shaping the relief of the river terrain. Based on the contour of the NW-1, the Digital Elevation Model has been prepared for 10 km area around the NW-1. The Nearest Neighbour method has been used to interpolate the elevation data to develop the elevation model. The elevation within this stretch ranges between 321 m to 1 m. Highest elevation was observed at Sahibganj area (Jharkhand), because of presence of hillocks in this area. This map depicts clearly that the elevation of waterways declines from western to eastern part towards Haldia. Digital Elevation Model of study area is shown in **Figure 5.2**.

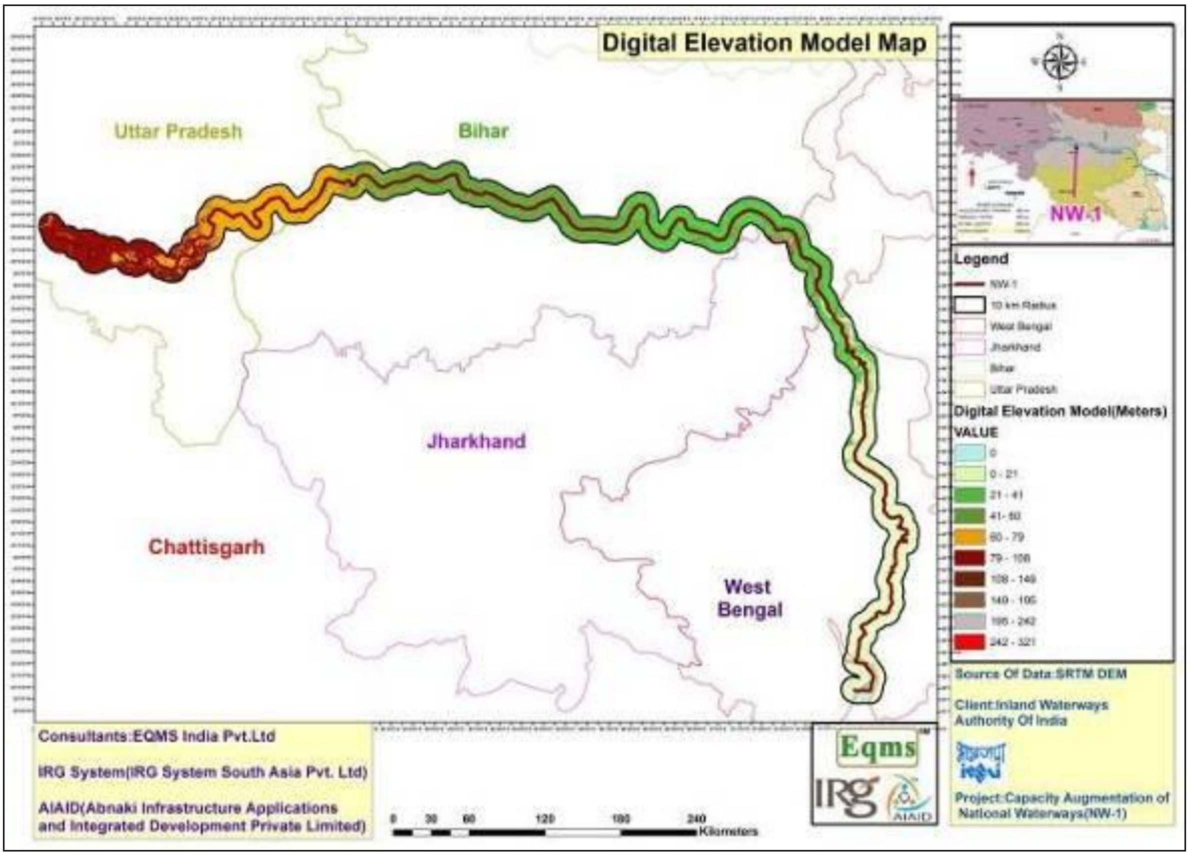


Figure 5.2: DEM of NW-1

5.3.3.2 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 per cent of India's total geographical area. The catchment area, length, total utilizable water of Ganga river basins within India and the states that they cover is given in **Table 5.3**. State wise distribution of drainage area of Ganga River is given in **Table 5.4**.

Table 5.3: Ganga river Basin Catchment Area

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

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

Table 5.4: Distribution of the Drainage Area of Ganga River in India

Sl. 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

5.3.3.3 Drainage pattern NW-1

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

The Padma carries the majority of Ganga's 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 NW-1 is shown in **Figure 5.3**. Line diagram of the NW-1and its major tributaries is shown in **Figure 5.4**.

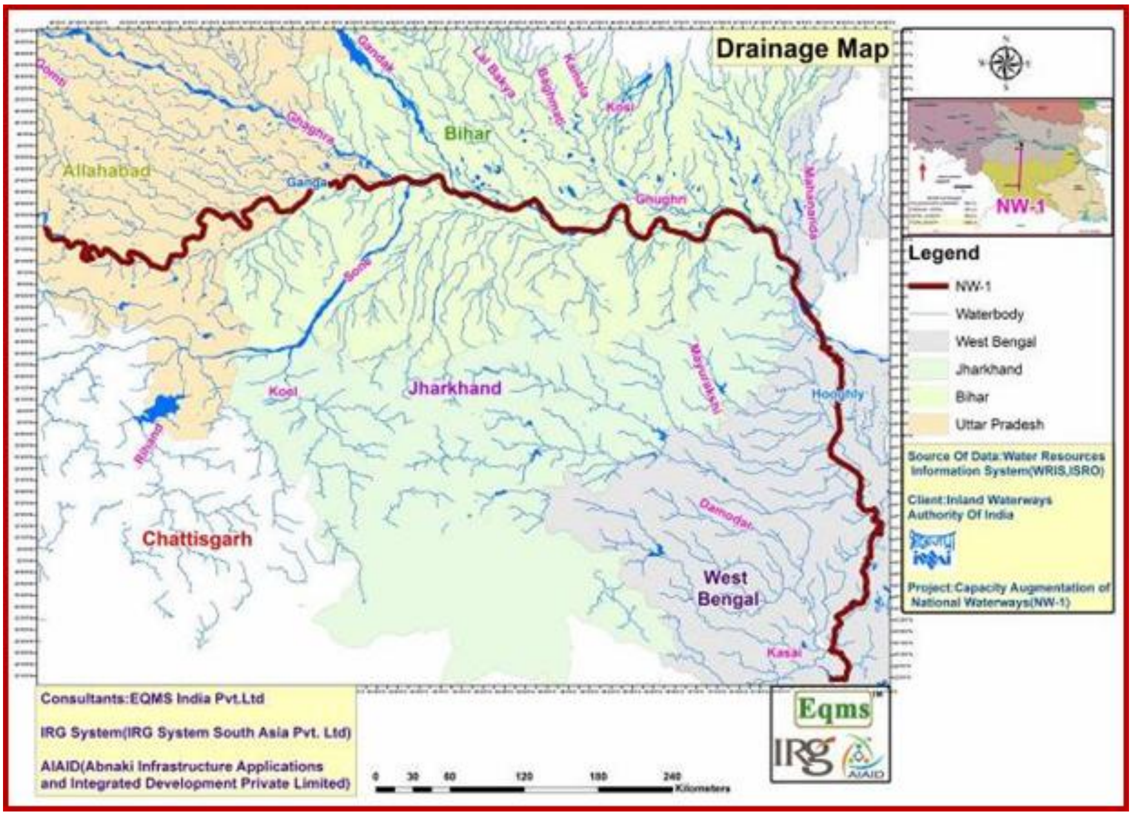
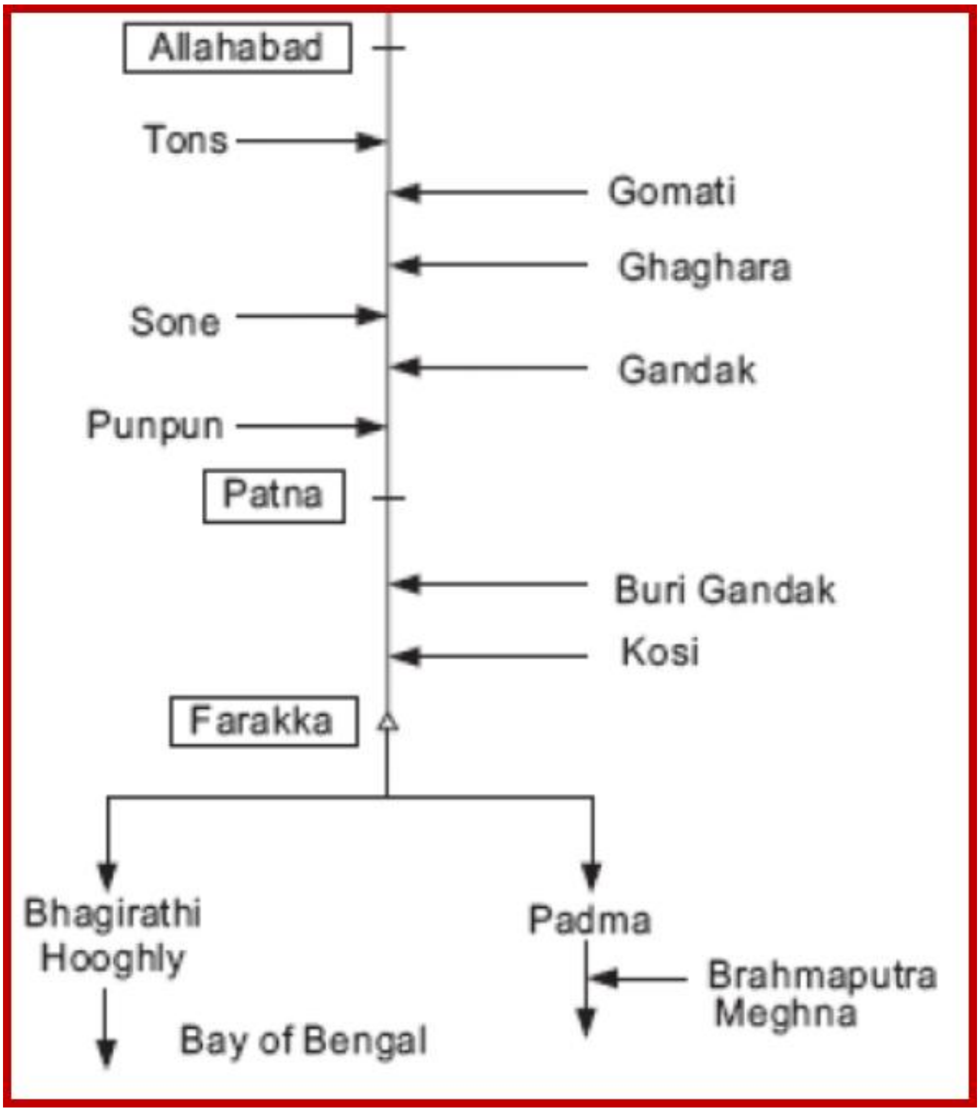


Figure 5.3: Drainage Map of 2 Km radius of NW-1



Source: NMGC report

Figure 5.4: Line Diagram of Ganga and its tributaries

5.3.3.4 Geology

Ganga river basin is part of the tectonically active foreland basin of the Himalayan mountain range formed by collision of the Indian tectonic plate with the Eurasian plate more than fifty million years ago. Thus, most of the area of NW-1 consists of alluvial plains formed during the Tertiary and Quaternary periods by flood deposits of Himalayan Rivers. The Ganga River network not only conveys water, but also transfers enormous amounts of eroded Himalayan sediments to the sea. The alluvial deposits on the plain area constitute large and highly productive multi-aquifer systems in the area, which are a major storehouse of ground water. The soils of the area are also largely alluvial. Geological map of NW-1 is provided in **Figure 5.5**.

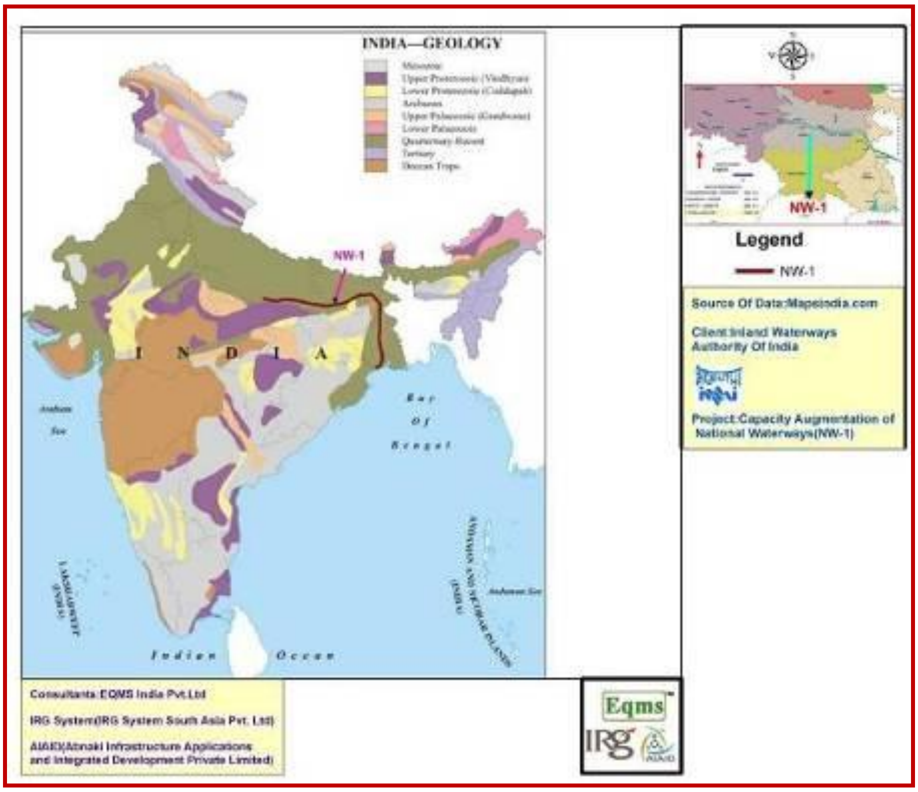


Figure 5.5: Geological Map of India

5.3.3.5 Seismicity

As per seismic classification of India most of the NW-1stretch falls under zone-III which mean moderate seismic risk. Some stretch in Bihar state falls under zone IV which means high seismic risk. The seismic zoning map of India is shown at **Figure 5.6**.

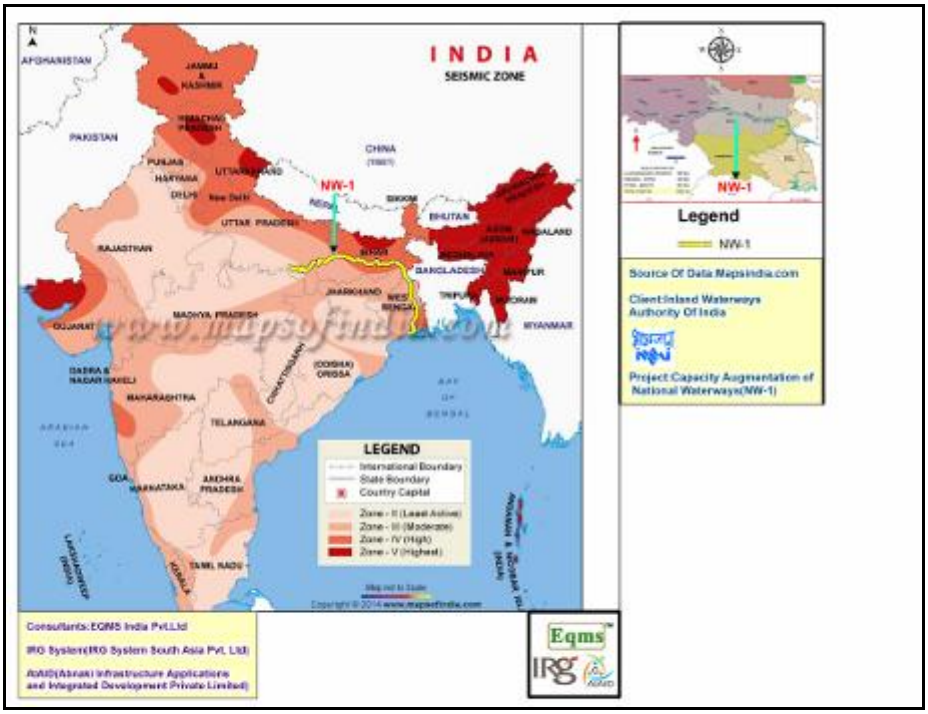


Figure 5.6: Seismic of Zones Map of India

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

5.3.3.6 Land use Pattern

NW-1 passes through states of Uttar Pradesh, Bihar, Jharkhand and West Bengal which are extensively cultivated, constituting about 10 per cent of the total area of the India. About 11 per cent of total land of NW-1 states are fallow land and 52% percent as net sown area. The cropping intensity is highest in west Bengal with 184.1 per cent followed by Jharkhand, Uttar Pradesh and Bihar. The overview of land use pattern of the sates traversed by NW-1 is given in **Table 5.5**.

Table 5.5: 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

5.3.3.7 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 colors are assigned to different land use/land cover types of satellite imagery[11] .

The land use classes in 10 km area of the NW-1 are agricultural land, settlement, water body, forest, barren land and vegetation. It is majorly dominated by agricultural land about 78.9 % of the land is under cultivation. NW-1 also passes through many urban areas. About 7.18% land is under settlement. As per the land use data analysis about 7.21% of the land is under water bodies, about 3.59% land is under vegetation, 2.82% land is under dry river bed and rest of the land falls under other uses (refer **Table 5.6**).

Table 5.6: Land use of the Study Area

Sl. No.	Class	Area(KM^2)	Percent (%)

11: 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

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

Source: Satellite Image Analysis

The land use map of different sections of the NW-1 is shown in **Figure 5.7** to **5.9**.

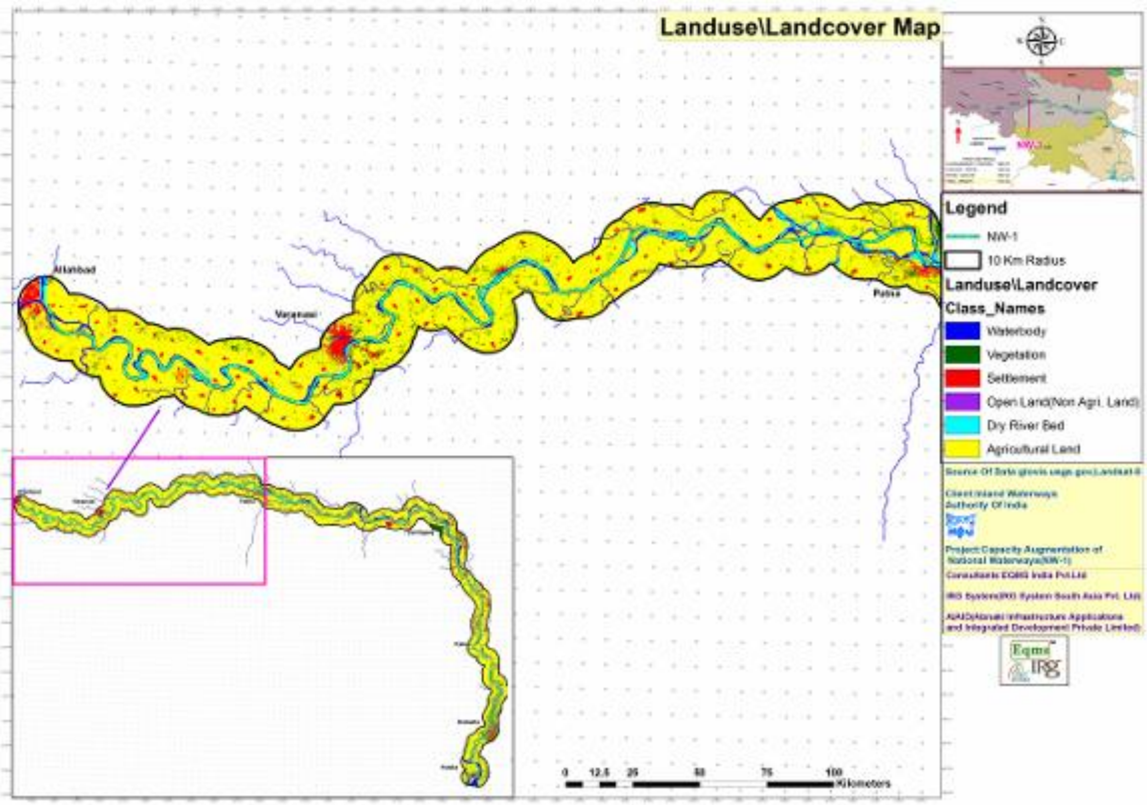


Figure 5.7: Land use Map (Allahabad to Patna)

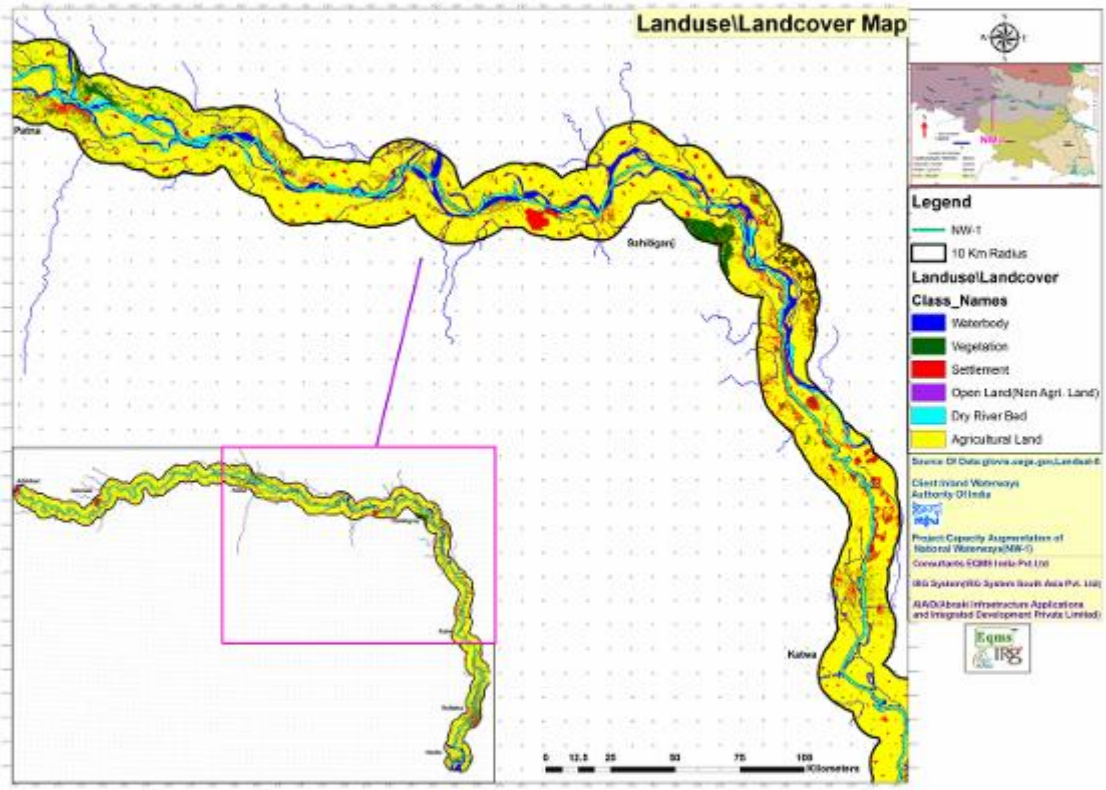


Figure 5.8: Land use Map (Patna to Katwa)

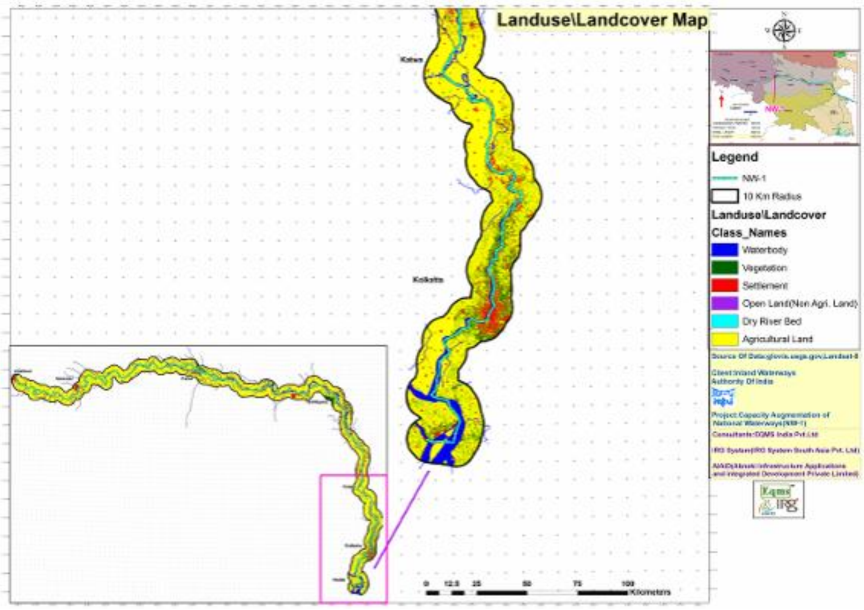


Figure 5.9: Land use Map (Katwa to Haldia)

5.3.3.8 Soil Type / Quality

The soil along the NW-1 is alluvial type. As per 'USDA' Triangular Classification System, overall soils of along NW-1 can be described as Sandy Clay and Clay Loam type. Soil quality has to anaysed in detail during EIA studies.

5.3.3.9 Cropping Pattern

The Ganga River with its fertile soil is having a great influence to the agriculture based 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, chillies, sesame, mustard, sugarcane, and jute.

5.3.3.10 Major Habitation along the NW-1

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

Assessment of land resources indicates land use change particularly diversion of agriculture land for urbanization industries & infrastructure development. Though it is an ongoing phenomena, any new infrastructure development intervention is expected to accelerate it.

5.4 Ecological Profile

5.4.1 Biological Environment (NW-1)

This Section provides detail of terrestrial and aquatic environment along NW-1, and influence area around NW-1. Ecological profile of the area has been described in terms of biogeographic zone followed by terrestrial & aquatic flora & fauna and the valued environment & social component.

5.4.1.1 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). Biogeographically, the NW-1 falls in Gangetic plain Biogeographic zone which is divided in two biotic provinces namely Upper Gangetic plain (7A) and Lower Gangetic plain (7B)[13].

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

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 Pl ain 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.

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

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 Valued Environment & Social Component. The river's biodiversity comprises periphytons, phytoplanktons and macrophytes which are consumers in the trophic level of energy pyramid and thus the real commercial products at tertiary level of food chain.

5.4.1.2 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 given in **Table 5.7**. Reserved forest map in the state traversed by NW-1 is provided in **Figure 5.10**. **No portion of NW-1 and intervention areas falls under any reserved forest or normal forests area.**

Table 5.7: 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		

14State of Forest Report, 2013

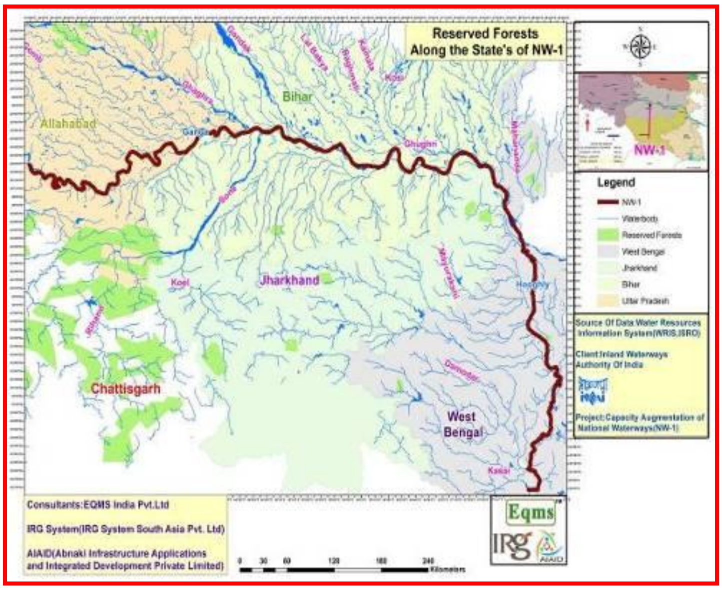


Figure 5.10: Reserve Forest Map of States Traversed by NW-1

The forest cover directly and indirectly impacts the quality as well as quantity of waters of the rivers in the whole Indo-gangetic plain, besides the sedimentation patterns through soil erosion levels.

Therefore, within 10 km of influence area, forest cover (if any) need to be conserved.

5.4.1.3 Valued Environment & Social Component in Project Area (NW-1)

The Valued Environment & Social Component (VECs) namely Biosphere Reserves, Wildlife Sanctuaries, National Parks, wetlands, Tiger Reserves, Important bird areas, and Breeding and nesting grounds for aquatic species (Schedule-I species) are identified and mapped for entire NW-1 stretch due their importance for providing suitable habitats for wildlife, humans, and their role in sustaining ecological functions. There are 2 wildlife Sanctuaries, and four Hilsa Fish sanctuaries 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. Details of VEC's along NW-1 are described below.**

5.4.1.4 Wildlife Sanctuaries within NW-1

There are two notified wildlife sanctuaries namely Kashi Turtle Sanctuary and Vikramshila, Dolphin Sanctuary under Wildlife Protection Act, 1972 (amended as on date) and 4 Hilsa Sanctuaries located within the NW-1. Hilsa Sanctuaries have been notified under West Bengal inland Fisheries Rules, 1985 to propagate Hilsa Fish production. Salient features of the wildlife sanctuaries (refer **Table 5.8**) along with flora and fauna details is described in following sections.

Table 5.8: 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,	Protected	Yes	No	10

Sr. No.	State	Wildlife Sanctuary	Protection status	Applicability of Wild life act for NW-1 operations	Applicability of Forest act for NW-1 operations	Regulated buffer Zone (Km radius)
		Varanasi	under Wildlife Protection Act, 1972 (amended as on date)			
2	Bihar	Vikramshila Gangetic Dolphin, Sultanganj to Kahalgaon pahad	Protected under Wildlife Protection Act, 1972 (amended as on date)	Yes	No	10
3	West Bengal	Hilsa Sanctuary	West Bengal inland Fisheries Rules, 1985 to facilitate spawning of Hilsa,	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)

Description of each wildlife sanctuary is given in **Annexure 5.1**.

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

Seven Important Bird Areas (IBAs)[15] have been identified along NW-1 stretch because they support important congregations of water birds (**Table 5.9**). None of these areas are protected area except Vikramshila Gangetic Dolphin Sanctuary and Udhwa Lake Bird Sanctuary areas.

Table 5.9: Important Bird Area within 10 km area of the NW-1

Sr. No.	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	25°17'N 86°56'E	Protected as Wildlife Sanctuary under Wildlife Protection	Winter	Within NW-1

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

Sr. No.	Name of State	Important Bird Area in Ganga Basin	Coordinates	Protection status	Migration period for Birds	Distance from NW-1 (km)
				Act, 1972 (as amended till date).		
5	Jharkhand	Udhwa Lake Bird Sanctuary	25°0'N 87°49'E	Protected as Wildlife Sanctuary under Wildlife Protection Act, 1972 (as amended till date).	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

Description of important bird areas is given in **Annexure 5.1**.

5.4.2 Terrestrial biodiversity along NW-1 stretch of River Ganga

Terrestrial Biodiversity describing riparian flora of the Ganga for NW-1 has been reported state wise into two main stretches of Allahabad to Farakka stretch and Berhampur to Haldia stretch.

In Uttar Pradesh, the Allahabad belt up to Gazipur is relatively sparsely occupied with variety of trees which are equally well present up to Farakka belt. However, the density of flora is relatively thin in U.P. & Bihar areas as compared to Jharkhand and West Bengal region. The Allahabad to Balia region comprises 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 comprises 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 sissoo, 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*.

From Munger to Farakka about 212 macrophytes have been reported along the river Ganga. From Bally to Bandel about 32 species of macrophytes have been reported which includes 7 species of Asteraceae, 4 species of Euphorbiaceae, 2 of Amaranthaceae and 3 of Cyperaceae, 2 of Polygonaceae and 1 of Poaceae. Tree species is mainly comprises of Semal (*Bombax ceiba*), Mango (*Mangifera indica*), Peepal (*Ficus religiosa*), Neem (*Tamarindus indica*), Jackfruit (*Artocarpus heterophyllus*) and Pakur (*Ficus lacor*). Other macrophytes comprises *Adhatoda zeylanica, Barleria prionitis, B. cristata, Dipteracanthus prostratus, Hygrophila auriculata, Achyranthes aspera, Alternanthera pungens, A. sessilis, Amaranthus spp, Chenopodium album, Centella asiatica, Rauvolfia* *serpentina, Calotropis procera, Leptadenia reticulata, Asparagus spp., Oroxylum indicum, Cannabis sativa, Cyperus rotundus, Hydrilla verticillata, Marsilea minuta.*

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 as it is freshwater flora zone. After Nawadip the salinity increase in river water due to estuarine affect the change in riparian flora is noticed. The tree species is mainly comprised of Semal (*Bombax ceiba*), Mango (*Mangifera 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,Vernonia cinerea, Xanthium strumarium, Nasturtium indicum, Chenopodium indicum, Juncellus sp., Cyperus sp., Sida rhombifolia, Chrozophora plicata, Croton bonpandianum, Boerhavia repens, Polygonum sp and Chrozophora plicata.*

5.4.2.1 Aquatic Biodiversity in NW-1

The Allahabad to Farakka segment of River Ganga (LG-A) comprises a fresh water zone of 701 km. The floral and faunal diversity comprises phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher vertebrates. Phytoplankton 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 dolphin is also present in the Bihar stretch. Fresh water turtle were also reported in Kashi turtle sanctuary area.

286 km of stretch of Lower Ganga downstream of Farakka up to Haldia consist of Phytoplankton, Zooplankton, Macrobenthos, Nekton, Macrofauna and Angiosperms. 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. The higher aquatic vertebrates observed in this stretch during study period are represented by turtles and dolphins.

The higher aquatic vertebrates present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanista gangetica gangetica*), an endangered species **smooth coated Otter** (*Lutrogale perspicillata*), **vulnerable species. Among the reptilian fauna, water snake** (*Xenochrophis piscator*)**, mugger crocodile *(Crocodylus palustris*)**, **and the estuarine (east coast) crocodile *(C. porosus)* and Indian Gharial *(Gavialis gangeticus)* and variety of turtle species. Among the threatened species, Ganges Shark (*Glyphis gangeticus*), a critically endangered species** is known only from the lower reaches of the Ganges-Hooghli river system, West Bengal, India. It possibly occurs in other river systems in the area. It could also occur in shallow marine estuaries although there are no verified marine records of this species to date[16]. Crocodile is found in upper Ganga region and in tributaries of Ganga river. Stray instances have been reported about presence of crocodile in Allahabad and Varansi area during rainy season. These animals have got fragmented due to construction of Narora Barrrage. Ganges Shark presence has been reported in 18th sanctuary but its presence is doubtful in the river. Smmoth Coatted Otter is also reported to be found in upper Ganga reaches above Naraora Barage. It prefers wetland, rice paddy fileds and lake. Its presence has been reported in side channel of river Ganga near Bhagalpur. The prime species for further assessment is considered for Dolphin and Turtle which are largely found in NW-1 stretch and are of endangered category. Mitigation measures likely to be proposed for these animals will be suitable for Crocodile and Smooth coated otter as well to a larger extent.

5.4.2.2 Phytoplanktons & Zooplanktons Observed in Sanctuary Area along NW-1

Observations and existing literature cites 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 on account of local anthropogenic impacts from station to station. The diversity of planktons is slightly high in Hilsa Sanctuary than Kashi Turtle sanctuary and Vikramshila dolphin sanctuary area. The list of phytoplankton and zooplanktons, observed in Kashi Turtle sanctuary, Vikramshila Dolphin Sanctuary and Hilsa Sanctuary area along NW-1 is given in **Table 5.10** and **Table 5.11**.

Table 5.10: Phytoplankton observed at Sanctuary Area along NW-1

Sr. No.	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.*	+	-	+

[16] *http://www.iucnredlist.org/details/9281/0*

Sr. No.	Taxa	Kashi Turtle Sanctuary Area	Dolphin Sanctuary Area	Hilsa Sanctuary area
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	*Gyrosigma sp.*	+	+	+
24	*Hantzchia sp.*	-	+	+
25	*Melosira sp.*	+	+	+
26	*Meridian sp.*	-	+	+
27	*Navicula sp.*	+	+	+
28	*Nedium sp.*	-	+	+
29	*Opephora sp.*	-	-	-
30	*Pinnularia sp.*	+	-	+
31	*Pleurosigma sp.*	+	+	+
32	*Rhicosphenia sp.*	-	+	+
33	*Stephanodiscus sp.*	-	+	+
34	*Surirella sp.*	-	+	+
35	*Tabellariasp*	-	+	+
36	*Tetracylus sp.*	+	-	+
Chlorophyceae				
37	*Actinastrum sp.*	+	+	+
38	*Chlamydomonas sp.*	-	+	+
39	*Chlorella sp*	+	+	+
40	*Chlorococium sp.*	-	+	+
41	*Cladophora sp.*	+	+	+
42	*Closterium sp.*	+	+	+
43	*Coelastrum sp.*	+	+	+
44	*Conococcus sp.*	+	-	+
45	*Cosmarium sp.*	_	+	+
46	*Desmidium sp.*	-	+	+
47	*Eudorina sp.*	+	+	+
48	*Gonatozygon sp.*	-	+	+
49	*Gonium sp*	+	+	+
50	*Hormidiumsp*	+	+	+
51	*Hydrodictyon sp.*	-	+	+
52	*Microspora sp*	+	+	+
53	*Oedogonium sp.*	+	+	+
54	*Pandorina sp.*	+	+	+
55	*Pediastrum sp.*	+	+	+
56	*Spirogyra sp.*	+	+	+
57	*Tetraspora sp.*	-	-	+
58	*Ulothrix sp.*	+	+	+
59	*Zygnema sp*	-	+	+
60	*Debaryasp*	-	+	+
61	*Mesotaeniumsp*	-	+	+
62	*Stigecloniumsp*	-	+	+
63	*Tetradesmussp*	-	-	+

Sr. No.	Taxa	Kashi Turtle Sanctuary Area	Dolphin Sanctuary Area	Hilsa Sanctuary area
64	*Rhizocloniumsp*	-	+	+
Cyanophyceae				
65	*Spirulina sp*	+	+	+
66	*Rivularia sp.*	+	+	+
67	*Schizothrix sp.*	+	+	+
68	*Phormidium sp.*	+	+	+
69	*Oscillatoria sp.*	-	+	+
70	*Anabaena sp.*	+	-	+
71	*Calothrix sp.*	+	+	+
Xanthophyceae				
72	*Bumillaria sp.*	+	+	+
73	*Chlorobotrys sp.*	+	+	+
74	*Tribonema sp.*	-	-	+
75	*T. bombycinum*	-	+	+
76	*Voucheria sp.*	-	-	+
Euglenophyceae				
77	*Astasis sp.*	+	+	+
78	*Euglena sp.*	+	+	+
79	*Peronia sp.*	+	+	+
80	*Phacus sp.*	+	+	+
Rhodophyceae				
81	*Bostrychia radicans*	-	-	+
82	*Catenella impudica*	-	+	+
83	*Ceramium elegans*	-	-	+

Table 5.11: Zooplanktons observed at Sanctuary Area along NW-1

Sr. No.	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*	-	+	+
12	*Rotifera*			
13	*Anura sp.*	+	+	+
14	*Asplanchna sp.*	+	+	+
15	*Brachionus sp.*	+	+	+
16	*Filinia sp.*	+	+	+
17	*Horaella sp.*	+	+	+
18	*Keratella sp.*	+	+	+
19	*Lecane sp.*	-	+	+
20	*Notholca sp.*	+	+	-
21	*Rotaria sp.*	+	+	+

Sr. No.	Zooplankton Group/Species	Kashi Turtle Sanctuary Area	Dolphin Sanctuary Area	Hilsa Sanctuary area
22	*Testudinella sp*	-	+	+
Copepoda				
23	*Cyclops sp.*	+	+	+
24	*Diaptomus*	+	+	+
25	*Nauplii*	-	+	+
Cladocera				
26	*Bosmina sp*	+	+	+
27	*Ceriodaphnia sp.*	+	-	+
28	*Cydorus sp.*	+	+	-
29	*Daphnia sp.*	-	+	+
30	*Diphanosoma sp.*	-	+	+
31	*Moina sp*	-	+	+
32	*Simocephalus sp*	+	+	+

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

5.4.2.3 Breeding and Spawning

Fish Breeding and Spawning: Generally, fish breeding and spawning is most frequent in monsoon season (July to September).. 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 genera of cat fish families like Mystus, Wallago and Clarias 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 5.11** to **Figure 5.14**.

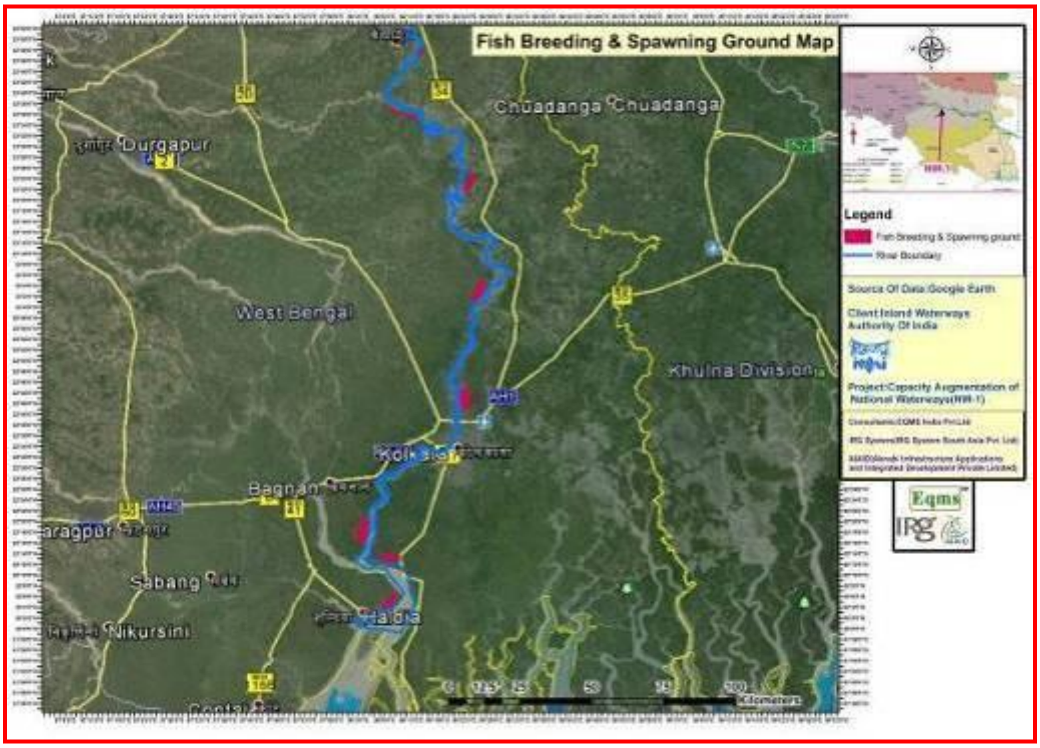


Figure 5.11: Fish Breeding and Spawning Grounds along NW-1 (Haldia to Baidyapur Stretch)

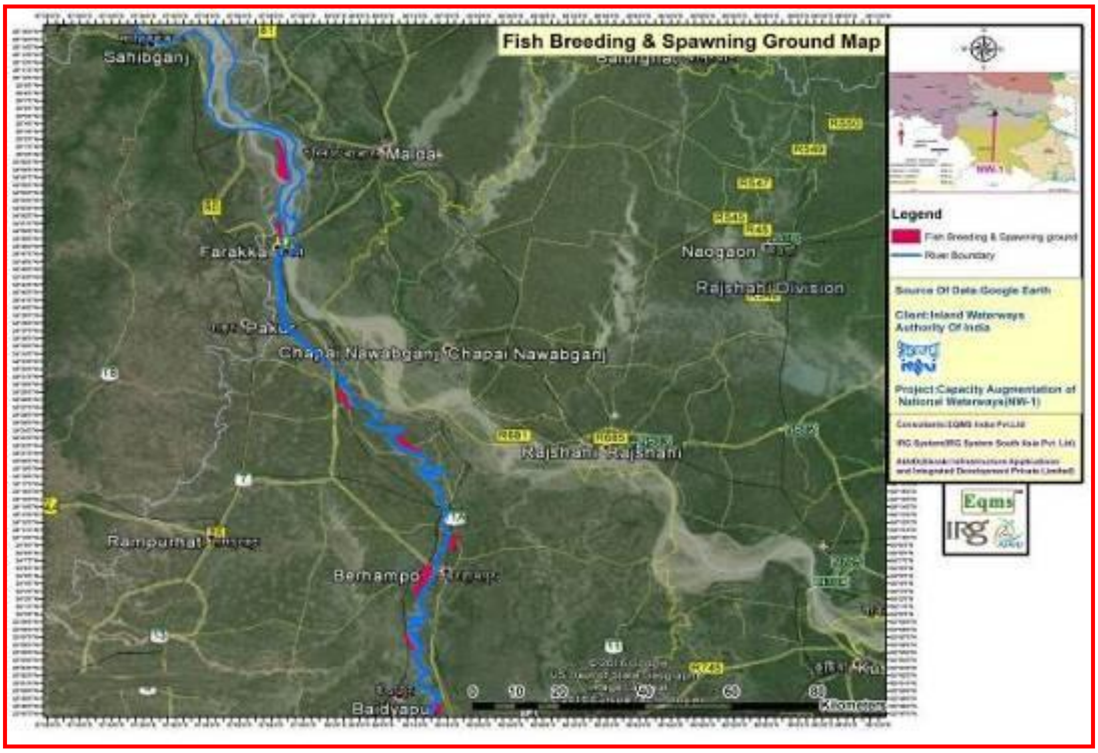


Figure 5.12: Fish Breeding and Spawning Grounds along NW-1 (Baidyapur to Sahibganj Stretch)

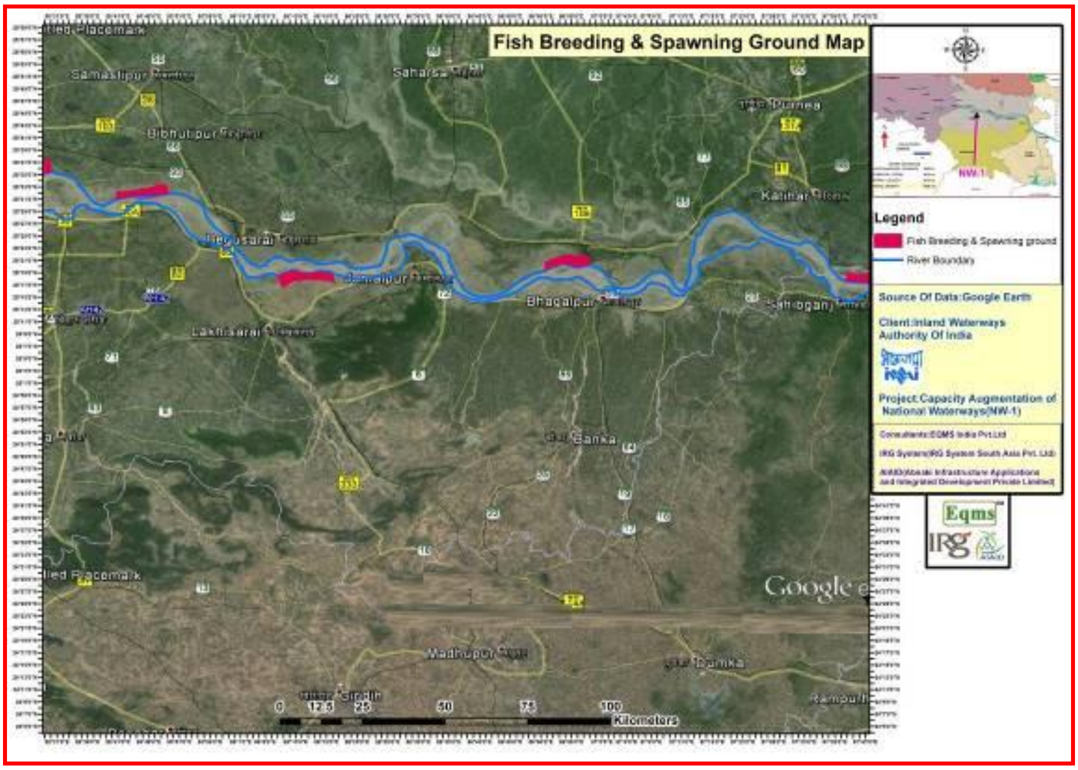


Figure 5.13: Fish Breeding and Spawning Grounds along NW-1 (Sahibganj to Patna Stretch)

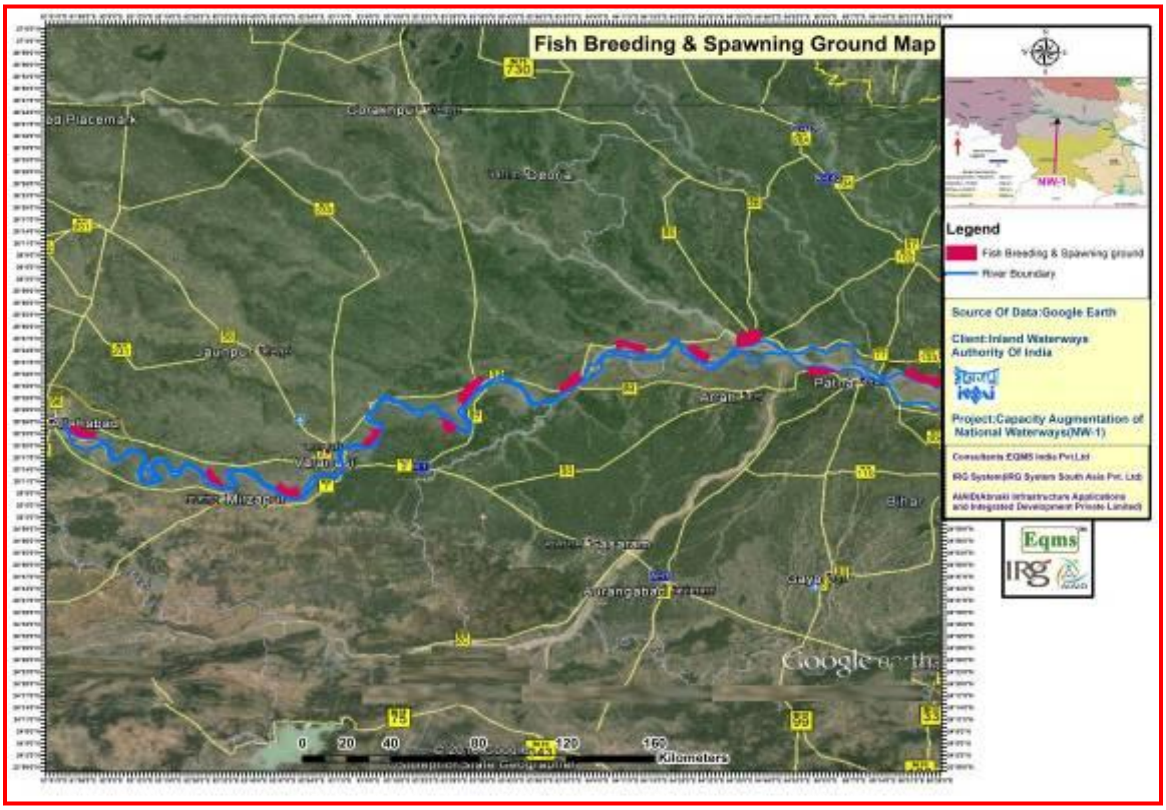


Figure 5.14: Fish Breeding and Spawning Grounds along NW-1 (Patna to Allahabad Stretch)

Hilsha Fish Breeding: The Bengal Hilsa (*Tenualosa ilisha*) occurs in marine environment but migrates to fresh water for breeding and is anadromous in nature. It tolerates variations in salinity and travels over 1200 km in inland water for breeding upto Farakka. The Hilsa fish is heterosexual. Breeding starts with start of monsoon in July and peaks in September-December. Hilsa is 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. Newborn calves have been observed mainly in April and May[17].

Smooth-coated Otter (*Lutrogale perspicillata*) is dependent on monsoons. It mostly breed between August and December. The gestation period is 61-65 days. Smooth-coated otters give birth to and raise their young in a burrow or shelter near water, which they excavate, or they assume an abandoned one. Two to five cubs are born in a litter, blind and helpless. At thirty days, the cub's eyes open, and by sixty days, they can swim. The cubs disperse at about 1 year of age. Sexual maturity is reached at two years

Turtle Breeding: Turtle nesting season vary depending on the species. It's hatching period normally confined between May to October. The nesting and hatching season of fresh water turtle vary from May to October. The Nesting and hatching season of fresh water turtle in NW-1 is given at **Table 5.12**.

Table 5.12: Nesting and hatching season of turtle species

S1. No.	Species	Nesting season	Hatching season
1	*Batagur dhongoka*	December-February-April	May
2	*Batagur kachuga*	December-February-April	May
3	*Pangshura smithii*	October-December	May
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.

5.5 Environmental Profile

Environmental profile has been described in terms of water environment, air environment, meteorology, noise environment and other climatic / meteorological parameters.

5.5.1 Water Environment

17Dolphin reproduction starts 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.

Basin level and project level water environment has been described in terms of hydrological status, river mobility, flow availability, water levels, sediment load, tributaries flow & their sediment load and least available depth for navigation. Each of these items have been described below both in terms of basin and project. Further, summary of surface and ground water quality have also been described below.

5.5.1.1 River Mobility

River Ganga is significantly mobile and changes flow pattern from one season to another. As per ganga river basin management plan – 2015 mission 1 avrial dhara hydrological status of NRGP is given in **Table 5.13 & Table 5.14**.

Table 5.13: Water Resources Potential (in Billion Cubic Metres) in Indian River Basins

River Basin	Catchment Area (km²)	Total Water Resource Potential (BCM)	Total Utilizable Water Resource Potential (BCM)	
			Replenishable Ground Water Potential (BCM)	Utilisable Surface Water Resources (BCM)
Ganga	861452	525	171	250
Total Indian	3290000	1869	433	690

Table 5.14: Projected Water Demand in BCM (i.e., Billion Cubic Metres)

Sector	Standing Sub-Committee of MoWR			NCIWRD		
Year	*2010*	*2025*	*2050*	*2010*	*2025*	*2050*
Irrigation	688	910	1072	557	611	807
Drinking Water	56	73	102	43	62	111
Industry	12	23	63	37	67	81
Energy	5	15	130	19	33	70
Others	52	72	80	54	70	111
Total	**813**	**1093**	**1447**	**710**	**843**	**1180**

The major observations based on this assessment are given below.

1. Water resources potential of the basin is very approximate.

The above data give an indication of the critical status of water resources in India (and in the NRGB), especially when water demands are compared with the water resource potentials. The following points, however, are pertinent with regard to these data:

a) How Approximate are the Water Resources Potential
b) The above water estimates are for very large regions, and spatial variations of water resources potentials cannot be gauged from the above data.
c) While clarity on these data and their interpretations are needed, it seems certain, however, that NRGB (like much of the country) is under increasing water stress, which calls for major changes in how NRGB's water resources are managed.
d) The projected water demands are for human use only, and do not give any indication of the water needed to sustain healthy functioning of the basin.
e) Dams and barrages often help to meet several anthropogenic needs such as water supply, hydropower generation, flood control and navigation. But these obstructions have divided National River Ganga and her tributaries into small segments, thereby interrupting the flow of water, nutrient, sediments and aquatic species in the rivers. However, these are observed more in the upper reaches of ganga river.
f) Streamflow and evapotranspiration are the two main components of water outgo. It may be noted that, on an annual basis, the average ratio of evapotranspiration to precipitation is found to be about 41-42%, which is much higher than the government norm of 23% for the Ganga basin but much lower than 60%.
g) The flow health scores had significantly altered in several stretches of National River Ganga and her tributaries due to the present system of river water management.

However, the analysis does not cover many aspects of river health such as functional needs of ecosystems and habitats.

2. Modelling results indicate that, while the changes in flow volumes are very small in the headstreams of National River Ganga, river flows are considerably reduced in her major tributaries such as Yamuna, Ghaghra, Gandak, Kosi, Chambal, Sone, etc., thereby reducing the flow in the main Ganga river through most of her reach.

3. The river's suspended sediment load – generally estimated at between 500 to 800 million T/yr. Most of the long-term sediment load in the Ganga river system derives from the Himalaya mountain range (especially from the High Himalayas), with probably less than 10% coming from the Siwaliks, plains and peninsular regions of the basin.

4. Many of the Himalayan tributaries of National River Ganga (such as the Kosi, Ghaghra, and Gandak) are known to carry enormous sediment loads, some of which tend to deposit on the plains during floods.

Flooding is one of the most disastrous natural lphenomena in alluvial plains of Ganges system particularly in the eastern parts, which are presently regarded as one of the worst flood-affected regions in the world (Agrawal and Narain, 1996). The plains of north Bihar have the dublous distinction of recording the highest number of floods in India in the last 30 years (Kale, 1997). The Kosi river is an important tributary is an important tributary of the Ganga in the eastern India and one of the most distinctive hydrological characteristics of this river is a very high sediment yield (0.43 $mt/y/km^2$. The 'avulsive' shifts of the Kosi river have been well documented and a preferentially westward movement of 150 kms in the last 200 years has been recorded. Unlike the previous westward shifts, the August 18, 2008 avulsion of the Kosi River recorded an eastward shift of ~120 km which is an order of magnitude larger than any single avulsive shift recorded in historical times.

Data Analysis and Observation on Water Availability is given in Annexure 5.3.

In the upper stretches of NW 1, from Allahabad to Doriaganj, the river is meandering or sinuous with minor secondary branches and several chutes. The river shows a clear change of plan form typology at area around Patna to Munger. The change is from a meandering to an ana branching typology, with multiple channels. Change in planform is due to confluence of various tributaries namely Ghagra & Gandak in left bank and Son & Punpun in the right bank. The river typology changes again, downstream of Munger where the channel shows a sinuous channel with a certain degree of braiding. Bars are common in this area. Between Kahalgaon and Manihari the main channel clearly splits in two, with a certain degree of braiding in each channel. The contribution of the Kosi River takes place near Kahalgaon. From Manihari to Farakka there is one main sinuous channel and several sinuous secondary channels. Downstream stretches of Farakka to Farakka lock and Farakka lock to Jangipur lock is an artificial canal. Reaches downstream of Jangipur Lock show a meandering channel with different degrees of sinuosity, from tortuous to irregular meanders. From Jangipur Lock to Tribeni the presence of oxbow Lakes is common, and cut-offs meanders[18]. Detailed morphology of the river in different reaches is given in **Annexure 5.2**.

5.5.1.2 Available Flow in NW-1

The Ganga River is characterised by high flows during the monsoon season, approximately from July until October, and low flows during the rest of the year. Annual minimum discharges provided by IWAI at Allahabad, Mirzapur and Varanasi during the last 3 years are given below in **Table 5.15 & Figure 5.15.**

Table 5.15: Annual minimum discharges obtained from statistical analysis

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

Source: IWAI

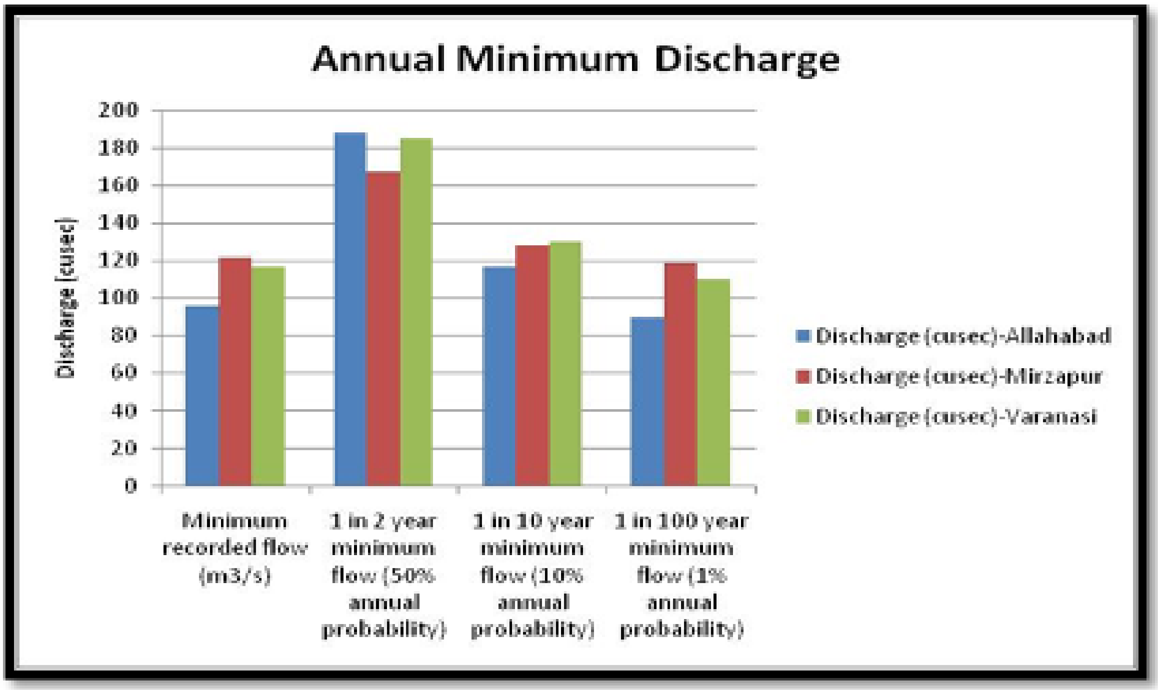


Figure 5.15: Annual minimum discharges obtained from statistical analysis
Source: IWAI

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

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

As per the data available in the report "Status on River Ganga: State of the Environment and Water Quality" by the National River Conservation Directorate (2009), discharges with a probability of exceeding 50%, 10% and 90% of times at 6 stations namely Allahabad, Mirzapur, Varanasi, Buxar, Patna and Azamabad during low flow season are given in **Table 5.16 & Figure 5.16** below.

Table 5.16: Annual Minimum Discharges at Different Locations in NW-1

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

Source: National River Conservation Directorate

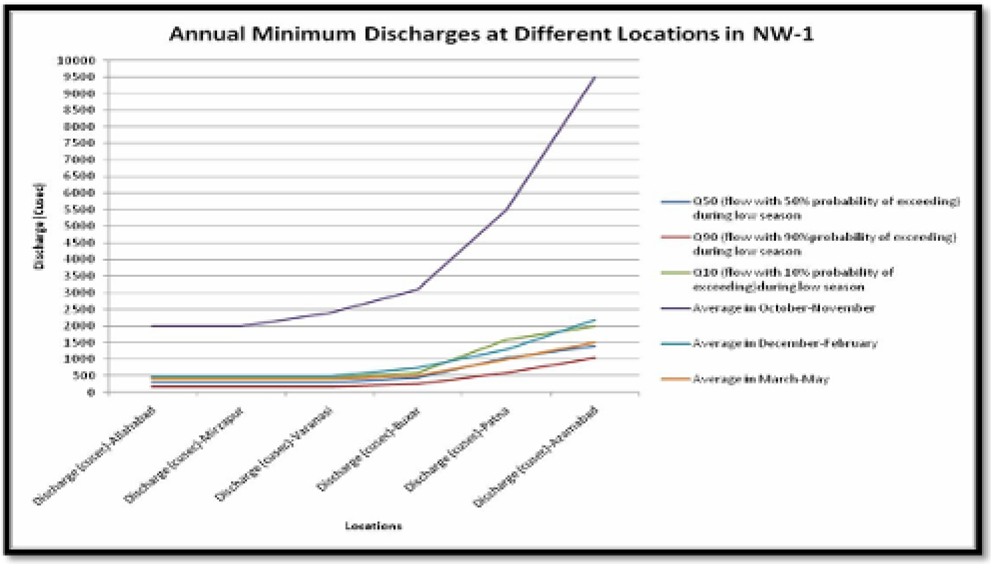


Figure 5.16: Annual Minimum Discharges at Different Locations in NW-1
Source: National River Conservation Directorate

5.5.1.3 Water Level of NW-1

NW-1 experiences high water level variations, i.e. of order of 10 m during high season. In general, water levels are at their highest in August-September and sharply decrease in October-November. In general, they continue to decrease during the whole low flow season, from December to May, and start to rise again in June-July. The variability of water levels during the dry season is lower than during the high season, with variations of the order of 2-3m. The period of the year in which the minimum water level can occur varies with location along the river. In the upstream reaches from Allahabad to Ghazipur the minimum water levels occur from April to July. Downstream of the three major tributaries, Ghagra, Son and Gandak that join the river near Patna, the minimum water levels can occur between February and June as a result of the influence of snow melt. Minimum & Maximum surface water levels at 7 gauging stations between Allahabad and Farakka for 3 annual probability of occurrence is given in **Table 5.17 & 5.18 & Figures 5.17 & 5.18** below.

Table 5.17: Minimum Water Levels for a Range of Annual Probabilities

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

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

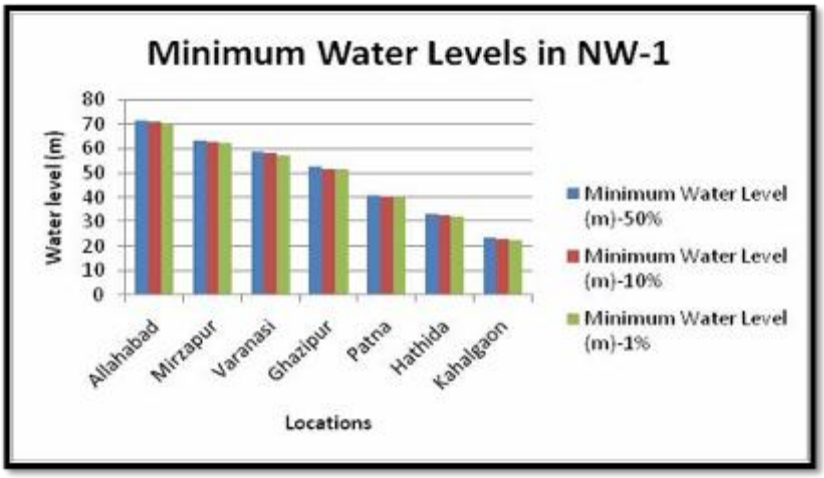


Figure 5.17: Minimum Water Levels for a Range of Annual Probabilities

Table 5.18: Maximum Water Levels for a Range of Annual Probabilities

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

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

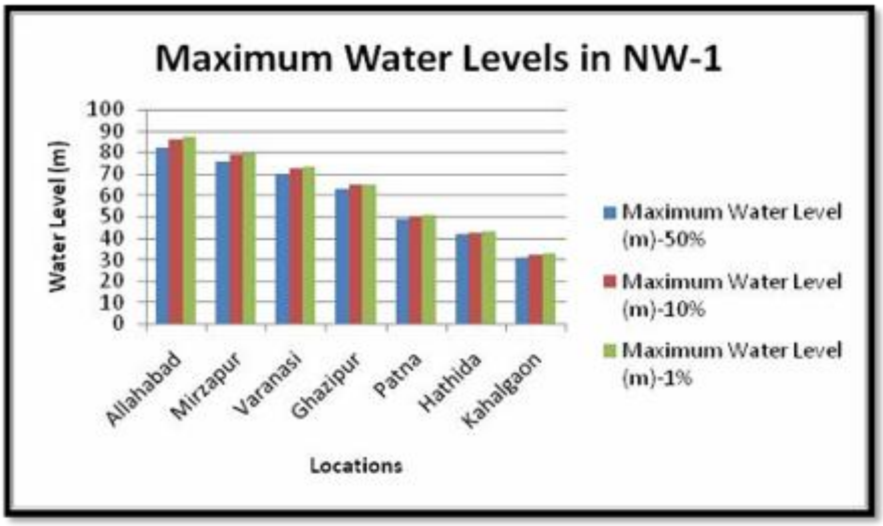


Figure 5.18: Maximum Water Levels for a Range of Annual Probabilities

5.5.1.4 Tidal Variation in NW-1

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

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

5.5.1.5 Sediment Load in NW-1

NW-1 comprises of the River Ganga and the tributaries system between Haldia and Allahabad. Rivers originating from the Himalaya region (Ganga, Ghaghara and Gandak) are characterized by a predominance of fine and very fine sand. The rivers draining from the Indian craton region (Tons, Son and Yamuna) bring much coarser sediments with higher contents of coarse and medium sand. Sediments are classified into suspended and bed load depending on the size of the particles. Sediments of diameter smaller than 125μm are transported in suspension and can be deposited during the low flow period. Sediment size decreases from Allahabad to Farakka. Sediment load at different locations and tributaries of NW-1 is given below in **Table 5.19**.

Table 5.19: Sediment Load at Different Locations and Tributaries of NW-1

Locations	Sediment Load (MT/Year)		
	From CWC (available online)	From Abbas and Subramanian (1984)	From Jain and Sinha (2003)
Ganges at			

Allahabad	-	228	-
Farakka	-	729	729
Kolkata	-	328	-
Gomati	-	6	6
Ghaghara	-	125	125
Son	22	50	-
Gandak	33	24	82
Kosi	73	-	193

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

5.5.2 Tributaries

Ganga River originates in the Gangotri Glacier at about 4,000 m above sea level in the Indian state of Uttarakand. Its major tributaries include the Himalayan rivers of the Yamuna, Mahakali, Karnali, Gandak, Kosi and Mahananda rivers flowing south from the Himalaya. These northern Himalayan tributaries rise primarily in Nepal and India, with some portions of the Kosi rising in China. From the south, the tributaries of the Yamuna and the Tons and Son Rivers flow north from the Deccan Plateau into the main stem of the Ganga. The Deccan Plateau in the south of the Basin is generally at low elevation with hills up to 1,200 m. Other important tributaries are Gomati, Ghaghara and Gandak from the North and Punpun from the south. **Figure 5.19** shows the main tributaries along the River Ganga between Allahabad and Farakka.

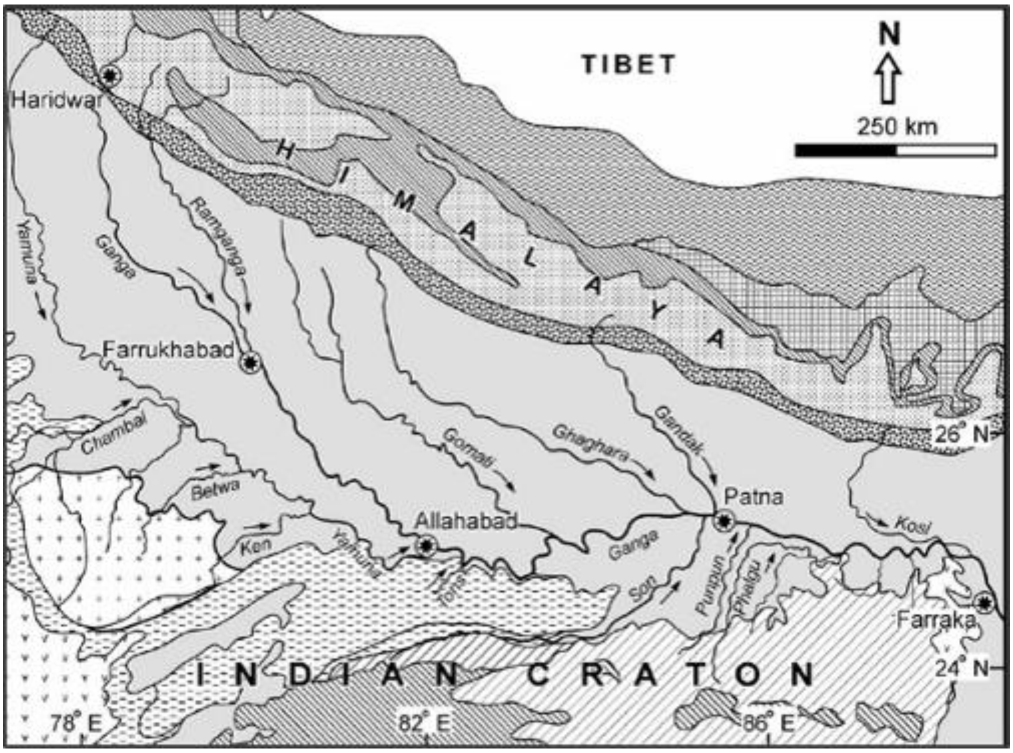


Figure 5.19: River Ganga and its tributaries in the region between Allahabad and Farraka. Extracted from Singh et al (2007)

Catchment areas and annual water yield for some of the main tributaries in the Allahabad – Farakka reach are provided in **Table 5.20**.

Table 5.20: Information about main tributaries between Allahabad and Farakka

Tributaries	Catchment area1(Km2)	Mean Annual Flow2(BCM)
Tons	17,000	10.6
Gomati	30,000	113.5**
Ghaghara	85,000	
Son	71,000	44.1
Gandak	57,000	59
Punpun	8,500*	-
Kosi	72,000	81.8

*Source: [1]Catchment areas from the River basin Atlas of India except Punpun * from Singh and Pandey (2014); [2]From the report "Status on River Ganga: State of the Environment and Water Quality" from the National River Conservation Directorate (2009); ** value for the system Gomati-Ghaghara*

Tributaries also contribute sediment to the River Ganga. Singh et al (2007) reports that floods occur almost simultaneously in the River Ganga and its tributaries due to the concurrent monsoon conditions over the alluvial plain for a long period and the simultaneous heavy rainfall over the Himalaya. Tributaries may increase sediment concentration in the main river because of their sediment load or decrease it because of the dilution due to the increase in water discharge. Percentages of sediment in different tributaries of Ganga is given in **Table 5.21**.

Table 5.21: Percentages of Sediment in Different Tributaries

River	Very coarse sand (2000-1000μm)	Coarse sand (1000-500μm)	Medium sand (500-1000μm)	Fine sand (250-125μm)	Very fine sand (125-63μm)	Silt & clay (<63μm)
Yamuna	-	2.5	22.5	22.5	45	7.5
Ganga	-	-	1.5	63.5	27.5	7.5
Ghaghara	-	-	2.5	59.5	28	10
Gandak	-	-	1	54	40	5
Gomti	-	-	1	11	58	30
Tons	-	-	25	70	4	1
Son	2	8	50	37	2	1

5.5.2.1 Least Available Depth for Navigation in NW-1

It is essential that minimum depth of the water is maintained in the river all the time of navigation. As per the surveys carried out by IWAI, depths available in NW-1 naturally are given below.

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

IWAI is currently maintaining LAD for managing the navigation in NW-1 through dredging and bandalling. Depths maintained by IWAI in different stretches currently is given below.

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

5.5.2.2 Ganga River Water Quality in NW-1 Stretch

The basin level water quality status of river Ganga and its tributaries indicate that the pollution status of the river and its tributaries show marked variation. This variation is very significant near riparian urban centres. As per "Ganga River Basin Management Plan 2015, Mission 2-Nirmal Dhara", pollutant ingress into the Ganga river system occurs in three ways, 1) by direct discharge of pollutants, 2) discharge of polluted surface runoff into rivers, and 3) seepage of polluted subsurface flows into rivers. Direct discharge of pollutants into rivers occur due to, i) discharge of liquid wastes generated from point sources into rivers, ii) dumping of municipal and industrial solid waste, devotional offerings, animal carcasses, un- burned/partially burned human bodies, etc. into rivers, and iii) non-ritual bathing with the intention of cleaning body dirt, direct defecation, washing of clothes, washing of vehicles, washing/wallowing of animals, etc. The origin of polluted non-point surface discharge into the Ganga river system are two fold, i) surface runoff containing leached fertilizers and pesticides applied on agricultural fields and ii) surface runoff containing entrained solid waste, i.e., garbage, industrial waste, human and animal feces, etc. Some portion of the liquid waste generated from both point and non-point sources described above infiltrates into the subsurface and pollute the groundwater. Seepage of this polluted ground water also results in pollution of the Ganga river system.

Examination of Ganga water quality data indicates that at Dev Prayag (confluence of rivers Bhagirathi and Alaknanda) and further downstream, the fecal coliform numbers in Ganga River are on an average, 100 times more than the levels acceptable for bathing. Finally, it is estimated that approximately 70 % of the volumetric pollution load on the Ganga river system is from domestic/commercial sources, i.e., from human urine/feces and solid waste. Major polluting industries along river Ganga are pulp and paper, sugar and distillery, tannery, textiles, etc. together with agricultural pollution contribute the remaining 30 % pollution load to the river. **The same trend has been observed in the basin downstream of Allahabad.** Further detailed status of water quality is given in **Annexure 5.4.**

Water can be classified in five classes of best designated use (BDU) depending upon its chemical properties. CPCB's BDU Criteria Standard in India is given in **Table 5.22**. Ganga river quality data monitored by CPCB at different locations along NW-1 are shown in **Table 5.23** and shown in **Figure 5.20**.

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 Mirzpur to 85,0000 at Howrah. It is mostly above 5000 MPN/100ml/coliform limit for category 'C' -designated best use requirement.

Table 5.22: CPCB Best Designated Use Standard (source: CPCB)

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

Table 5.23: 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: (NMCG / CPCB Ganga Water Quality Assessment -2011)

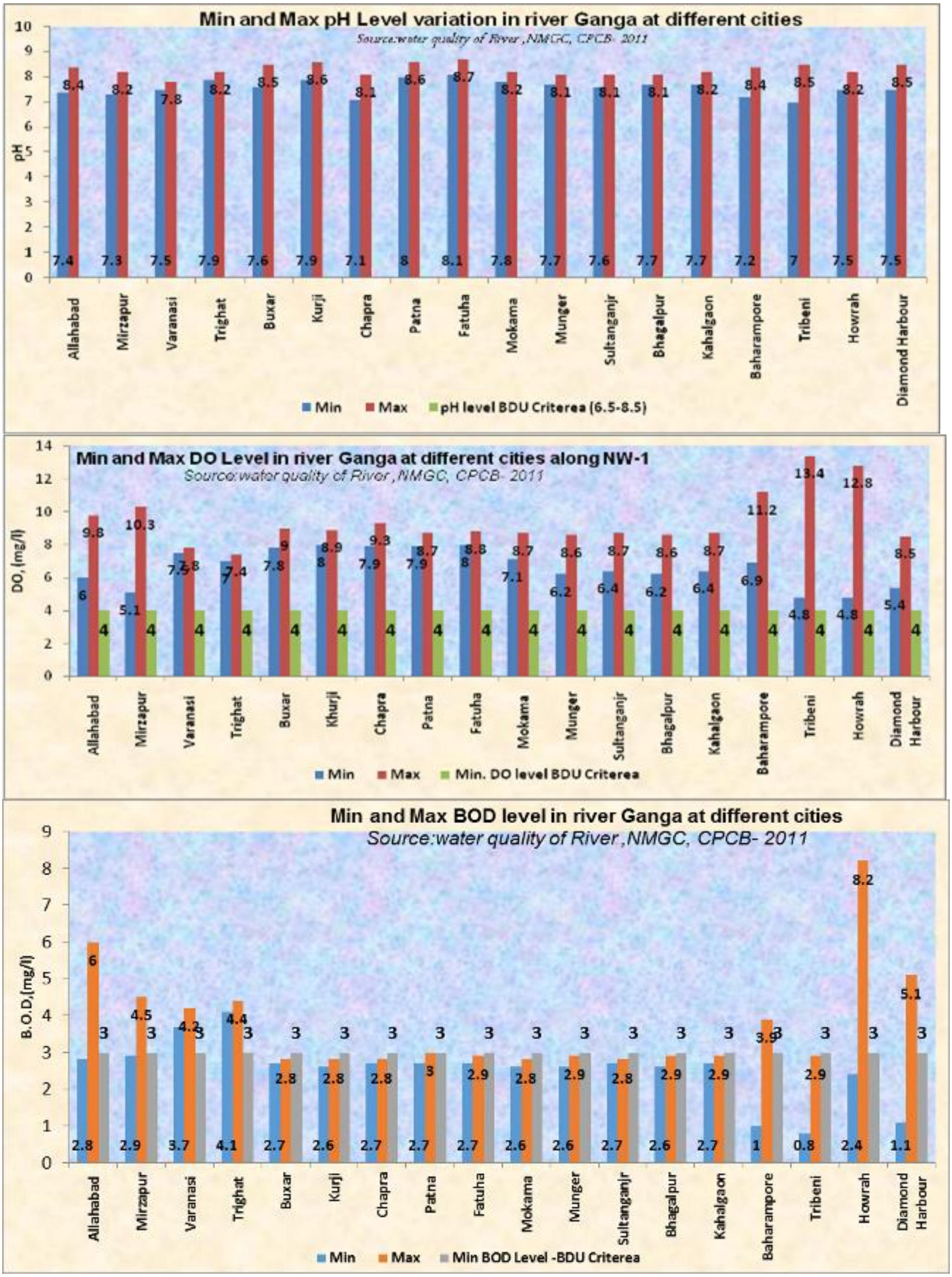


Figure 5.20: Graphical representation of Ganga River water quality at Different Locations

The analysis concludes that the river water is good for propagation of Wildlife and fisheries.

5.5.2.6 Ground Water

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

Details of Ground Water quality is not available in detail across the NW-1 stretch and the same shall be analysed in detail during EIA studies.

5.6 Air Environment

The ambient air quality data is not available for NW-1 stretch. Some data is available for certain cities. The Ambient air quality genrally is expected to be within the prescribed limits. However baseline air quality shall be monitoried and base level to be established for future references.

5.7 Meteorology & Other Climatic Parameter

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

The meteorological parameters also play a vital role in transport and dispersion of pollutants in the atmosphere. Historical meteorological data were obtained from climatological tables pertaining to different IMD stations all along the NW-1. The met data of the nearest representative IMD stations all along the NW-1(period 1961-1990) is summarized in **Table 5.24** and **Table 5.25**.

Table 5.24: Meteorological Data (Period 1961-1990)

Month	Kolkata, IMD					Malda, IMD					Bhagalpur, IMD					Patna, IMD					Varanasi, IMD				
	Temp (OC) daily		Relative Humidity, %		Rain Fall	Temp (OC) daily		Relative Humidity %		Rain fall	Temp (OC) daily		Relative Humidity, %		Rain Fall	Temp (OC) daily		Relative Humidity, %		Rain fall	Temp (OC) daily		Relative Humidity, %		Rain fall
	Max	Min	Max	Max	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 5.25: Meteorological Data (Period 1961-1990)

Month	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)

5.7.1 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. The predominant wind direction is from North and Northwest direction in winters and South and Southeast direction during rest of the season.

5.7.2 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.

5.7.3 Relative Humidity

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

5.7.4 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).

5.7.5 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.

5.7.6 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.

5.7.7 Visibility

Visibility is of key concern for safe navigation all along NW1. A review of climate date 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 potentialinland 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.

Site specific Met Data at proposed terminals.

Secondary one-month data was collated for terminal and Lock locations at Haldia, Farakka lock, Sahibganj and Varanasi. The analysis reflected that predominant wind direction all along NW-1 is from NW, WNW, E, S and SE direction. The prevalence of calm period ranges between 26 to 31%. Site specific met data and wind roses are given at **Table 5.30** and **Figure 5.21**.

Table 5.26: 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)

5.7.8 History of Cyclones

As per Cyclone Hazard Prone Map of India some stretch of NW-1 close to Haldia in West Bengal (nearer to sea) falls high Cyclone prone area. Cyclone hazard prone areas of NW-1 are shown at **Figure 5.21**.

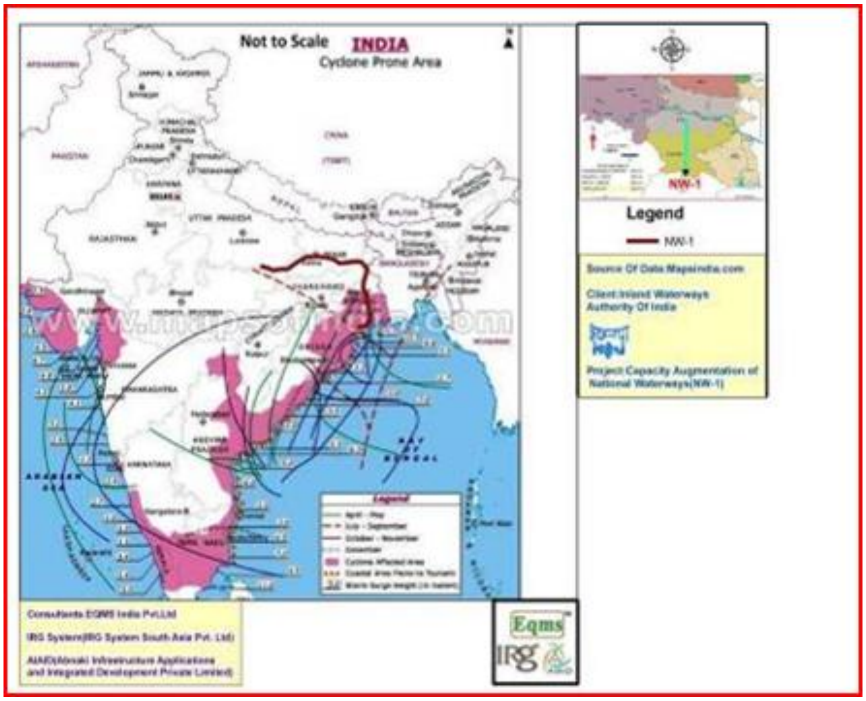


Figure 5.21: Cyclone Prone Area Map of India showing NW-1

5.7.9 Tidal Surges

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

5.8 Socio-Economic Environment

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.

5.8.1 Demography

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

5.8.1.1 Population Distribution in Major Cities along NW-1

There are many cities, towns and villages located along the NW-1. As per the Census Record of India 2011, **the population of major cities/ town located along the Ganga River in NW-1 section was recorded as 12875343 comprising 6782150 male and 6093193 females.** Total number of 'Households' was also recorded as 2562165 and 0-6-year age population was also recorded as 1308682. City/town wise Population distribution in study area (NW-1 section) is shown in **Table 5.27** and **Figure 5.22**.

Table 5.27: 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

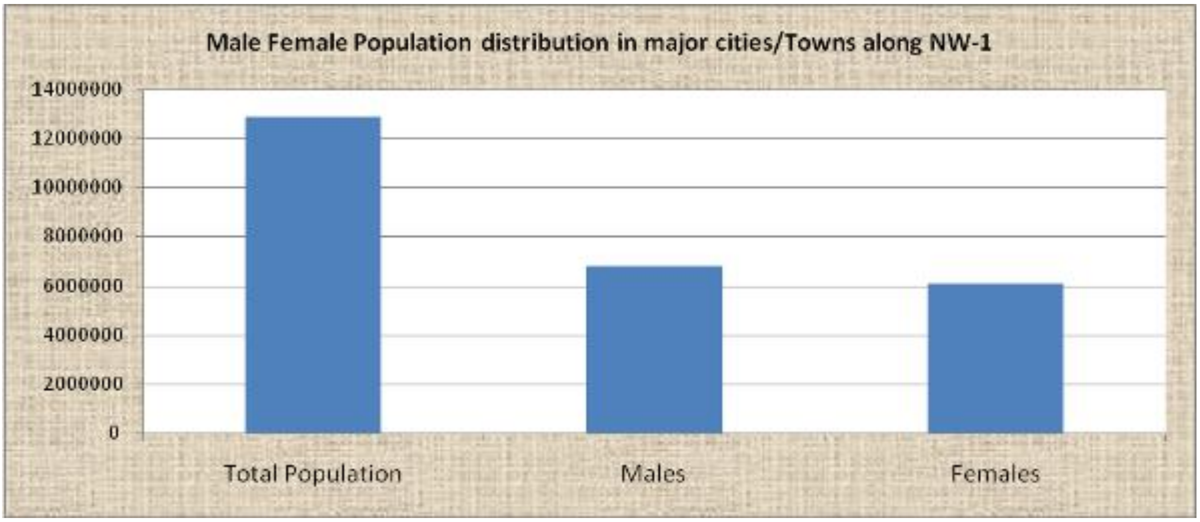


Figure 5.22: Graphical Presentation of Male-Female wise Population

5.8.1.2 Scheduled Caste and Schedule Tribe Population in Major cities/Town along NW-1

The Scheduled Caste (SC) and Scheduled Tribe (ST) communities are considered as socially weak who are supported by Government through various welfare schemes. **Scheduled Caste population consisting of 544284 males and 483706 females respectively in major city/towns along the study area and accounts for 7.9% of the total population. The 'Scheduled Tribe' population consist of 27576 males and 25244 females respectively and accounts for 0.41% of the total population (12875343).** It implies that 91.6% of total population belong to the general category and other backward classes. SC & ST population profile is given at **Table 5.28** and **Figure 5.23**.

Table 5.28: Caste wise (SC & ST) Population breakup in cities/towns along NW-1

Sr. 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

Sr. No.	Name	SC Population	SC Male	SC Female	ST Population	ST Male	ST Female
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
Total		1027990	544284	483706	52820	27576	25244

Source: Primary Census of India 2011

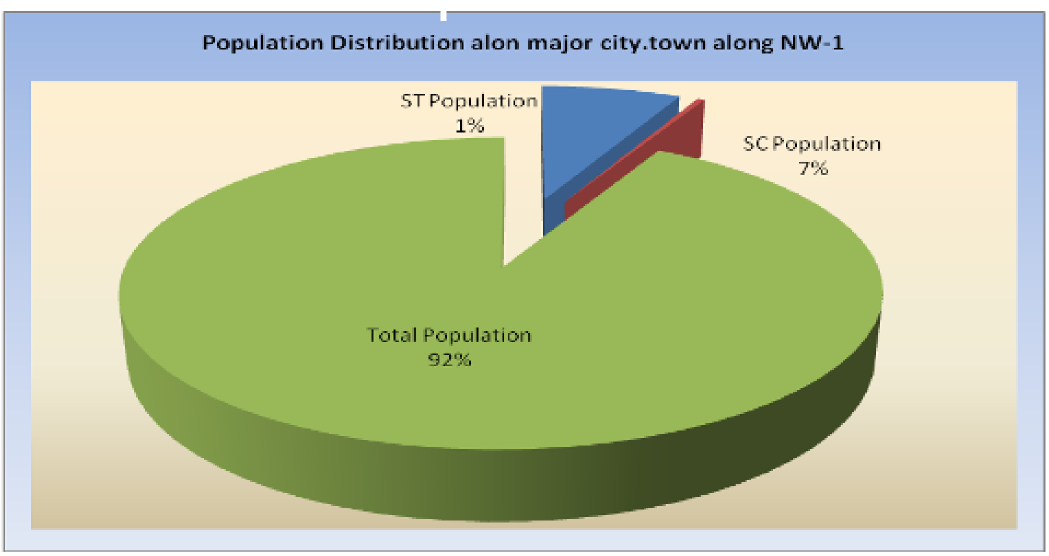


Figure 5.23: Graphical representation of SC, ST and General Population

5.8.2 Literacy Level in Major cities/towns along NW-1

Literacy level is quantifiable indicator to assess the development status of an area or region. The statistic of literate and illiterate male and female population is presented in **Table 5.29** and **Figure 5.24. About 75.4% of the population is literate and 23.6% is illiterate in cities/town located along the NW-1 is illiterate. Male population is more literate than female.**

Table 5.29: 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

Sl. No.	Name	Population literate	Male Literate	Male Literate	Population Illiterate	Male Illiterate	Female Illiterate
38	Haldia	158380	87334	71046	42447	17507	24940
Total		9703134	5316917	4386217	3172209	1465233	1706976

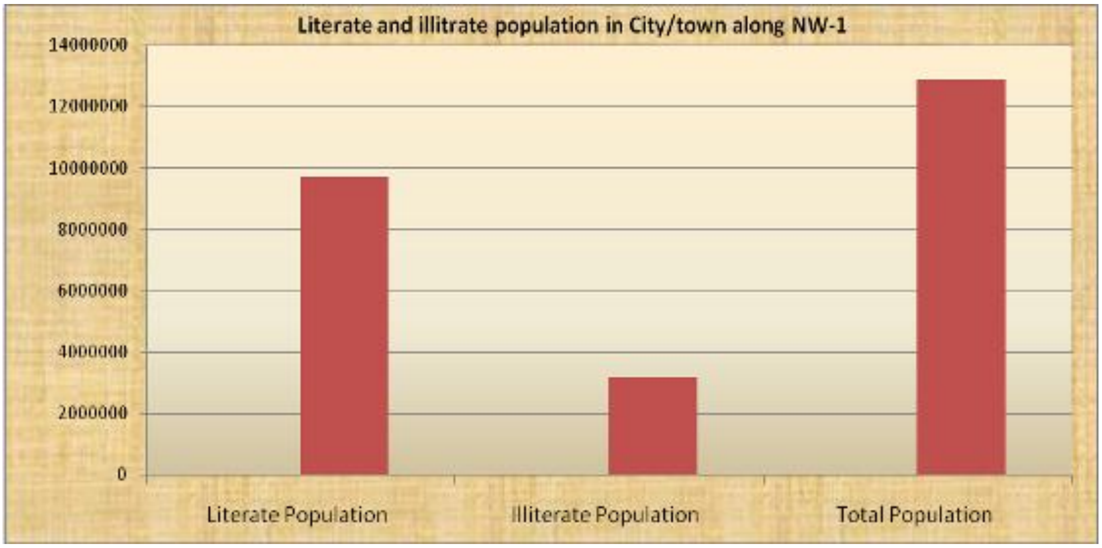


Figure 5.24: Graphical representation of literate and Illiterate Population

5.8.3 Workers Scenario and Livelihood Pattern of the community along NW-1

In cities and town along NW-1 area the main and marginal workers[19] are 14% and 29% respectively while the remaining 57% of total population constitutes non-workers. The main occupation is agriculture, labour class and trading activities. The workers' scenario is given in the cities and town along "NW-1" is presented in the **Table 5.30** and **Figure 5.25**. The occupation based bifurcation of population in study area is provided in **Figure 5.26**.

Table 5.30: Working and Non-Working Population breakup in cities/towns along NW-1

Sr. No.	Name	Total Workers	Main worker	Marginal Workers	Non workers
1	Allahabad (M Corp. + OG)	390202	281443	108759	778183
2	Sirasa	4365	2959	1406	8321
3	Gyanpur	5105	4255	850	13953
4	Mirzapur-cum-Vindhyachal (NPP)	77247	56326	20921	157624
5	Chunar (NPP)	11901	7986	3915	25284
6	Varanasi (M Corp.)	402122	339305	62817	796369
7	Saidpur (NP)	7015	5368	1647	17323

19A 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

Sr. No .	Name	Total Workers	Main worker	Marginal Workers	Non workers
8	Zamania (NPP)	8459	6527	1932	24784
9	Gahmar	7058	4399	2659	18936
10	Ballia (NPP)	35256	23069	12187	69168
11	Ghazipur (NPP + OG)	33464	26881	6583	87556
12	Buxar (Nagar Parishad)	26652	23493	3159	76209
13	Chhapra	53479	40896	12583	148873
14	Fathua	13540	11832	1708	37421
15	Hajipur	39836	33596	6240	107852
16	Patna (M Corp. + OG)	509839	426086	83753	1174458
17	Barauni	18923	16144	2779	52737
18	Sonepur	9197	7329	1868	28579
19	Bakhtiarpur	12978	8896	4082	34919
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 (M Corp.)	57185	43389	13796	156118
25	Sultanganj(Town)	15403	10520	4883	37489
26	Bhagalpur (M Corp.)	119346	95077	24269	280800
27	Sahibganj (Nagar Parishad)	25443	20498	4945	62771
28	Farakka Barrage Township (CT)	7174	6153	1021	12952
29	Pakaur (NP)	14906	13171	1735	30934
30	Berhampore (M)	73145	68515	4630	122078
31	Katwa (M)	28718	25283	3435	52897
32	Santipur (M)	72023	63783	8240	79754
33	Hugli-Chinsurah (M + OG)	68994	61730	7264	110937
34	Haora (M Corp)	397048	358922	38126	680027
35	Kolkata (M Corp.)	1795740	1576419	219321	2700954
36	Diamond Harbour (M)	14808	13178	1630	26994
37	Tamluk (M)	22929	19230	3699	42377
38	Haldia (M)	61216	50792	10424	139611
Total		4565395	3847062	718333	8510775

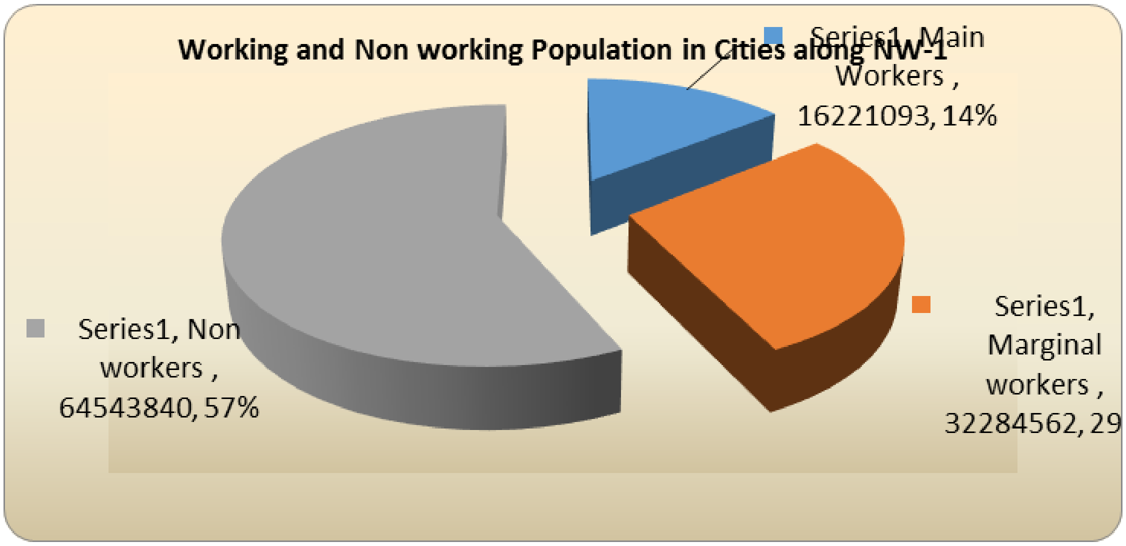


Figure 5.25: Graphical representation of Working and Non-working Population

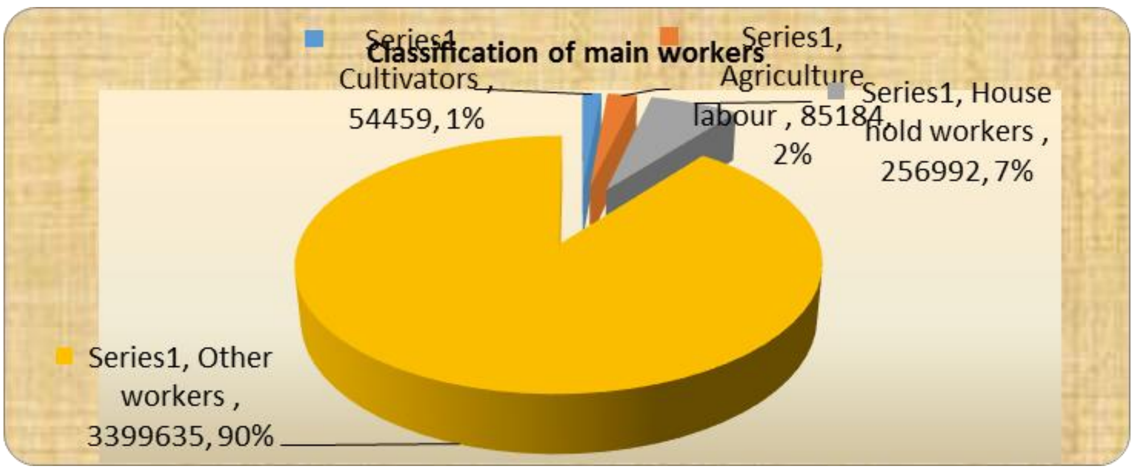


Figure 5.26: Classification of Main Working Population in cities/town along NW-1

5.8.4 Livelihood Pattern of the community Depending on the river

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

5.8.4.1 Fishing and Livelihood Generation along NW-1

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

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

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

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

Nets & Gears: Dragnets, dip net, gill nets, traps, bag nets are commonly used by the fisherman along the NW-1 stretch. Gill nets availability was highest in Patna, Munger and Bhagalpur stretch of NW-1 and lower in Allahabad and Mirzapur stretch of NW-1. Availability of dragnets was low in almost Allahabad to Farakka stretches. Large dragnets were not present at all. Use of hook and lines were mainly in the Allahabad and Mirzapur stretches of NW-1 whereas traps were more in district Ballia and Bihar stretches. Small scoop nets were available in the entire stretch but large size was available only in lower stretches down to Farakka. Dip nets were observed in Allahabad and Mirzapur districts.
Various forms of gill nets and bag nets are found to be operated by the fishers. Among them gill nets are most prevalent throughout the NW-1 stretch. Around 80% of the fishers were using the gear. The gill nets have different local names like Current jal, Nagin jal, Kajli jal, Phasa jal, Bhola jal, Vacha jal, Ghero jal, Dhoali jal, Gule jal, Pungus jal, etc. A number of variations in material and mesh size in gill nets are observed depending 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.

5.8.5 Infrastructure Facilities along NW-1

The cities and towns along NW-1 has most of required infrastructure facilities. Infrastructural facilities namely Industries/industrial areas, transmission line, national highways, other roads, railways, settlement, cultural sites and archaeological site located within 500 either side of NW-1 is mapped using satellite imageries and limited physical verifications. These are presented in **Annexure 5.5**.

5.8.5.1 Transport Network (Road/Rail/Water and Airways)

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

5.8.5.2 Thermal Power plants along NW-1

Eleven thermal power plants are located in close proximity of river Ganga between Haldia and Allahabad and 10 more are reportedly are proposed to be set up in close proximity of the river. These terminal 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.

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

There are 30 class I cities and 8 class II towns along the mainstream of river Ganga at NW-1 segment. These cities are discharging 2173.8 MLD wastewater out of which only 959.6 MLD has the treatment Capacity. The City sewage discharge is major source of pollution to river Ganga which is another cause of declining fish catch in the river. Status of wastewater generation and treatment capacity in these cities is summarized in **Table 5.31** and detailed at **Table 5.32**.

Table 5.31: 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 5.32: 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

State	City/Town	Sewage Generation (MLD)	Treatment Capacity (MLD)
	Rajpur sonarpur	33.6	45.4
	Kamarhati	48.8	40
	North Dumdum	29.7	--
	Naihati	20.5	--
	Ulberia	27.3	--
	Kanchrapara	17	--
	Halisahar	16.8	--
	North Barrackpur	19.2	16.7
	Rishra	13.5	15.3
	Ashoknagar Kalyangarh	17.3	15
	Haora	136.2	63.9
	Bhatpara	59.7	28.5
	Maheshtala	52.5	3.9
	Serampore	26.7	18.9
	Chandannagar	16.1	22.7
	Habra	17.2	--
	Sub-Total	1311.3	548.4
	Total	2110.4	957.6

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

Waste water generation from cities and towns along NW-1 in Uttar Pradesh segment generated 422.6 MLD i.e. 26. % of total wastewater generation. Waste water generation from cities and towns along NW-1 in Bihar segment 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 contributes47% and Howrah generates 10% of the total waste water generation of west Bengal stretch.

5.8.6 Cultural Activities and Religiously Important Places along NW-1 and 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 believe that bathing in the river on certain special occasions and periods causes the forgiveness of sins and helps attain salvation. People also travel from distant places to immerse the ashes of their kin in the waters of the Ganga. This immersion also is believed to send the ashes to heaven. Various festivals are organised on the bank of rivers at different places and different period. These festivals attract very large crowds and may have bearing even on movement of barges in NW-1 during festival periods. The list of culturally and religiously important places with its festivals along the NW-1 is given at **Table 5.33**.

Table 5.33: Culturally and Religiously Important Places with Fair and Festivals

Sl. 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 Hindus. It is said that when Lord Vishnu carried a pot or Kumbha of Nectar or Amrita, a fight broke out among the gods. In the milieu, four nectar drops fell on the earth at the four place which are known as the Tirthas and include Nasik, Haridwar, Prayad and Ujjain. These places are therefore considered as place where the mortal humans can pass on to a celestial world form the human world. In each of these locations, there is a kumbha mela held but on the 12th year, the mela is organized in Allahabad as it is considered the most sacred of the Tirthas. The Greatest Kumbha Mela is held in Allahabad which is also known as Maha Kumbha Mela and is the biggest fair related to religious practices. **Magh Mela:** Apart from the Maha Kumbh and another kumbh mela by the name of Ardh Kumbh, there is the Magh Mela. Maha kumbh is held every 12th year in the city of Allahabad which is a sacred city in the state of Uttar Pradesh. As because the Magh Mela falls during the period of Magh months of Jan and Feb, so the name has been given. During this period, the devotees take a holy bath at the confluence of the 3 rivers believing that the waters will wash away their sins.
2	Varanasi	Ghats	There are more than 100 ghats along the Ganga river at Varanasi (steps leading to the water of the Ganges). The banks of the Holy River at Varanasi are the most preferred cremation grounds.
		Ghats	**Panch Koshi Parikrama:** This parikrama starts and finishes at Manikarnika Ghat and has the great importance in ancient Parikrama of India. The devotee will pass through the five great places that's why it has named so behind this. The five places of which the devotees have to round up and complete his Panch Koshi Parikrama are Kardmeshwar, Shivpur, Rameshwar, Bhimchandi and Kapildhara. **Ganga Mahotsav:** This festival is being celebrated in the months of October and November which is the tourism festival of Varanasi that is being celebrated from Prabodhani Ekadashi to Kartik Purnima (November month) ending by a dance presentation at Ganga Mahotsav. The rich cultural heritage of Varanasi is being reflected by this festival. Besides various cultural programs and the boat racing the martial arts are also presented. This festival also corresponds with another traditional festival of Dev Deepavali in which all the ghats of Varanasi are enlightened by thousands of Diyas. **Dhrupad Mela:** This mela is basically a music festival that is organized on the Tusli Ghat for five days (Feb or March month) in which the renowned artists of the area give there 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.

5.8.7 Tourism

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

5.8.8 Existing Waste Management Facilities along NW-1

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

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

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

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

Solid waste disposal Facilities in Patna (Bihar): Solid waste management is an overall responsibility of the Municipal Corporation as per Bihar Municipal act 2007 and MSW (management & Handling) rules 2000. Patna Municipal Corporation (PMC) is responsible for development municipal waste land fill sites butit has yet to develop an organized land fill site. At present municipal waste is dumped to identify 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.

5.8.9 Water Borne Diseases

Waterborne diseases increase where standards of water, sanitation and personal hygiene are low. Contaminated drinking-water is a frequent cause of diseases such as cholera, typhoid, viral hepatitis A and dysentery, malaria, dengue. The extent and effect of water born diseases in the states traversed by NW-1 are given at **Table 5.34** to **Table 5.37**.

Table 5.34: 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 5.35: State-Wise Dengue Cases and Deaths in the States Traversed by NW-1

Sl.No.	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 5.36: 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 5.37: 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)

5.8.10 ArcheologicallyProtected structures (within 300 m of NW-1)

The archeologically protected structures/monument[20] located within 300 m of NW-1 is listed at **Table 5.38**.

Table 5.38: Archeologically Protected area around 300 m of NW-1

Sl. No.	Name	Latitude& Longitude	Place	Distance from NW-1 km	Direction from NW-1
1	Kardmeshwar Mahadeva Mandir	25°19'13.13"N 83° 1'20.91"E	Varanasi, UP	0.24	W
2	Ramnagar, fort,	25°16'9.17"N 83° 1'28.17"E	Varanasi, UP	0.04	East
3	Archaeological excavation site, Varanasi	25°19'33.72"N 83° 2'4.47"E	Varanasi, UP	0.13	North
4	Manmahal and observatory	25°18'27.83"N 83° 0'38.55"E	Varanasi, UP	0.04	West
5	Sindhi Dalan	25° 3'15.32"N 87°49'51.17"E	Rajmahal, Jharkhand	0.3	West

20As per Indian regulation no construction activity can take place within 300 m of archeologically protected monuments/ structures/site without written permission from archeological department.

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

5.9 External Environment & Social Drivers

External environment & social drivers includes the natural disasters like earthquake, cyclones, fires, forest fires, valconic eruptions, immigration, emigration etc. Some of the drivers which will affect the NW-1 development project or which will affect the surrounding areas are given below:

Earthquakes: As described in earlier section, area falls within seismic zone III & IV as per BIS classification. This zone has experienced various earthquakes in past and have recorded high causality & loss of property. Occurrence of earthquake has potential to disturb & disrupt infrastructure, transportation, industrial operations, connectivity, communication etc, if occurs with severe intensity

Flood: Area falls under ganga River water System. Ganga is Perenneial river. Ganga River has experienced and recorded several devastating floods. Similarly floods also have potential to disrupt all infrastructural, communication, industrial, electricity operations in the area:

Immigration & Emigration: Whenever there are some developments in part of the state or country, there is possibility of movement of population to the activity zone in search of employment. Thus the areas proposed and identified as major development area may experience high immigration. Thus for these areas, infrastructural development is essentially to be taken in phasec manner as per requirement. Young/Work force population from rural areas may migrate into these regions.

5.10 Identification of Hotspots on Basis of Baseline Study

From the above study, areas has been identified which are sensitive or the areas where status of VECs is critical. These areas are considered as hotspots which will experience maximum stress in future, i.e. post development of NW-1 and other identified developments. These identified Hotspots as per baseline study is given in **Table 5.39 below**.

Table 5.39: Identified Hotspots on Basis of Baseline Study

S. No.	Hotspots Strech/Location	Criteria For Selection of Hotspots	VECs
1.	Haldia	• Declared as critically polluted area but at present moratorium is lifted by MoEFCC • Declared notified zone by CGWB • Haldia Port & Shipping Activities • Haldia Dock Complex & Industrial Area • Haldia Energy Ltd. TPP • Urban areas: Haldia Town • Indragachi TPP at Sangrampur	• Ground Water Quality • River Water Quality • Traffic • GHG emissions (micro climate) • Air Quality • Aquatic ecology • Existing infrastructure • New infrastructure development • Fishing Activities • Quality of Life • Water Resources
2.	Kolkata	• Archaeological sites within 300 m: Temple of Gour Chandra and Krishnachandra at Chatra-Gaur Chandra Ghat (0 m, W) , St John Church • High PM_{10} concentration in Howrah • Urban areas: Kolkata & Howrah	• Archaeological sites • Air Quality • River Water Quality • Water resources • Surface Water Quality • Ground Water Quality
3.	Katwa to Hoogly Ghat	• Hisha Sanctuary (fishing restriction for larvae of Hilsha) • TPP at Bandel & Balagarh • Urban Areas: Katwa, Swaroopganj, Nabadwip, Kalna, Balagarh, Kanchrapara, Hoogly	• Traffic • GHG emissions (micro climate) • Air Quality • Aquatic Ecology • Existing infrastructure • Fishing Activities • New infrastructure development • River Water Quality
4.	Lalbagh in Farakka to Murshidabad*	• Floating Terminal, Hazardwari, Existing RCC Jetty Pakur, U/s & D/s jetty, feeder canal, RCC jetty and old lock at Farakka • New lock Farakka • Archaeological Site: Hazardwari Palace • Hilsha Sanctuary (fishing restriction for larvae of Hilsha) • IBA: Farakka and surrounding areas • Farakka feeder canal is prone to erosion • Sagardighi TPP, Farakka STPS • Urban Areas: Farakka, Murshidabad, Azimganj, Baranagar, Balia, Raghunathganj • Bagmari siphon	• Bank/Soil erosion • GHG emissions (micro climate) • Air Quality • River Water Quality • Existing Infrastructure • Fishing Activities • Archaeological Site
5.	Sahibganj	• Existing Samdhaghat terminal and	• Land Use

S. No.	Hotspots Strech/Location	Criteria For Selection of Hotspots	VECs
		proposed Sahibganj terminal • Existing Fishing Activities • Land Acquisition • Cutting of app. 500 trees • Archaeological sites within 300 m: Jama Maszid & Singhi Dalan • Udhawa Lake Bird Sanctuary at app 6 km • Mining activities	• Livelihood & Fishing Activities • Socio-economy • Air Quality • GHG emissions (micro climate) • Aquatic ecology • Terrestrial flora • Existing Infrastructure • Religious Values • New infrastructure development • River Water Quality • Bank/Soil erosion • Archaeological sites • River Water Quality
6.	Pirpanti	• Pripanti TPP, Pripanti Power CESC	• Air Quality • GHG emissions (micro climate)
7.	Kahalgaon	• Vikramshila Gangetic Dolphin Sanctuary • IBA: Kurseala River Course and Diyara Flood Plains • Kahalgaon STPS • Urban Area: Kahalgaon	• Aquatic Ecology • Avifauna • GHG emissions (micro climate)
8.	Bhagalpur	• Vikramshila Gangetic Dolphin Sanctuary • Bhagalpur TPP • Presence of arsenic in ground water • Urban Area: Bhagalpur	• Aquatic Ecology • Avifauna • Air Quality • GHG emissions (micro climate) • Ground Water • River Water Quality • Fishing Activities
9.	Munger	• Presence of arsenic in ground water • Urban Area: Munger	• Ground Water • Traffic • Air Quality
10.	Begusarai	• Barauni TPP & Lakhisarai TPP • Urban Area: Begusarai	• Air Quality • GHG emissions (micro climate)
11.	Barh	• IBA: Mokama Taal • Barh TPP • Urban Area: Barh	• Avifauna • Air Quality • GHG emissions (micro climate) • Ground Water
12.	Patna	• IBA: Danapur Cantonment Area • High PM_{10} concentration in Patna • Urban Area: Patna • Development of River Front	• Avifauna • Air Quality • River Water Qualit

S. No.	Hotspots Strech/Location	Criteria For Selection of Hotspots	VECs
13.	Varanasi	• Archaeological Sites: Kardmeshwar Mahadeva Mandir, Ramnagar, fort, archaeological excavation site, Varanasi • Kashi Turtle Sanctuary • Slightly high cadmium concentration in river bed sediments but below toxicity level of fishes • High PM_{10} levels in Varanasi • High noise level in Turtle sanctuary area	• Archaeological site • Aquatic ecology • Ground water quality • Air quality • Noise levels
14.	Allahabad	• Slightly high cadmium concentration in river bed sediments but below toxicity level of fishes	• River Bed Sediments Quality • River Water Quality

These zones have been already marked in Maps shown in either chapter 3 or chapter 4.

5.11 Conclusion

Baseline study has been conducted to assess the existing condition or status of the identified VECs in the study area. Baseline study has been carried out on the basis of secondary information collected from EIA/SIA study of NW-1, data from pollution control boards, IMD, Agricultural departments and other Governmental Organization. Baseline study has provided the details of condition of identified VECs along the NW-1 and of the district through which NW-1 traverse. This data has helped to identify the significance of the impact on the VECs condition and has provided the basis of carrying out the impact assessment study. Baseline study indicates NW1 has flat terrain with vast catchment being drained by main river along with tributaries. Geologivcal influence area has alluvial soil and falls in Zone III & IV. Land use is largely agricultural land followed by water body, stllements with only 3.59 %vegetation. Turtle sanctuary Vikramshila Gangetic Dolphin sanctuary & Hilsa sanctuary are major VECs with Vikramshila Gangetic Dolphin sanctuary & Udhwa bird sanctuary are protected areas. This area has diverse terrestrial & aquatic biodiversity with spawning & breeding grounds adjoining NW1. Flow analysis indicates that NW 1 has flow constraints in certain stretches considering CAD requirements.

Overall soil type / quality along the NW-1 area is of moderately fertile and not expected to be detrimental to the growth of agricultural and forest crops. It can be concluded that soils fall within medium fertility levels in the entire stretch of NW-1and forms the basis of agriculture resources / cropping pattern. Assessment of land resources indicates land use change particularly diversion of agriculture land for urbanization industries & infrastructure development. Though it is an ongoing phenomena, any new infrastructure development intervention is expected to accelerate it. No portion of NW-1 and intervention areas falls under any reserved forest or normal forests area. Ecologically the area has important VECs.

Udhwa bird sanctuary and 5 other important bird areas are also located within 10 km radius of NW-1 stretch. However, project interventions like maintenance dredging with alleviate the flow constraints for smooth operation of the barges, water availability analysis also indicates the river water is good for propogation of wild life and fesheries.

Observations on River Bed-Dredge Material Quality indicate that the concentration level of heavy metal was found low 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 that may be due to industrial effluent discharge in this section. Pesticide concentration in all samples were found below the USA criteria. The pesticides presence is on expected line as these are predominantly used for various agriculture applications. The source of these pesticide parathion and endosulphan might be from applications of insecticides and pesticides for agriculture in the study area which has significant agriculture land use. Air quality in terms of PM_{10}, $PM_{2.5}$ NOx SO_2 has been found high in major urban centers.

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. Scheduled Caste population consisting of 544284 males and 483706 females respectively in major city/towns along the study area and accounts for 7.9% of the total population. The 'Scheduled Tribe' population consist of 27576 males and 25244 females respectively and accounts for 0.41% of the total population (12875343). About 75.4% of the population is literate and 23.6% is illiterate in cities/town located along the NW-1 is illiterate. Male population is more literate than female. In cities and town along NW-1 area the main and marginal workers[21] 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. Agriculture is the main source of the livelihood generation for the people residing along the NW-1 area. Many towns in the area are primarily industrial. Ganga provides the necessary infrastructure for the factories to perform. Commercial fisheries in the Ganga River System are an important source of livelihood for the people residing along the Ganga River. Pilgrimage and the associated tourism brings along a major source of revenue for religious towns and their people. There is substantial decline in major carps fish catch in Allahabad to Farakka stretch over past few years. At Buxer hilsa was the main fishery and with the commissioning of Farakka barrage the fishery declined sharply between 1972-80. Fishery improved during 1981-86 due to improvement in landings of other species. Patna centre also showed drastic decline in major carp landings and as compared to sixties it was almost half during 1986-93. Decline at Bhagalpur was not as severe as at other centres. It is reported that almost every village along the both sides of the river are having some fishermen who earn their livelihood by fishing in the Ganga river. 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. Fishing Income: The monthly average income of the fisherman ranged from Rs.4000 to 7000 per month in Allahabad to Patna stretch. In lower zone

21A 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

(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.

All the towns and cities along the NW-1 are well connected with national highways, state highways, district roads, railways. Cities like Varanasi, Patna, and Kolkata are also connected with airways. Eleven thermal power plants are located in close proximity of river Ganga between Haldia and Allahabad and 10 more are reportedly are proposed to be set up in close proximity of the river. 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 above mentioned baseline features provides basis for identification, classification & quantification of impacts.

CHAPTER 6: CUMULATIVE IMPACT ASSESSMENT

6.1 Introduction

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity (collectively referred to in this document as "developments") when added to other existing, planned, and/or reasonably anticipated future ones. For practical reasons, the identification and management of cumulative impacts are limited to those effects generally recognized as important on the basis of scientific concerns and/or concerns of affected communities. Multiple and successive environmental and social impacts from existing developments, combined with the potential incremental impacts resulting from proposed and/or anticipated future developments, may result in significant cumulative impacts that would not be expected in the case of a stand-alone development.

Cumulative impacts are contextual and encompass a broad spectrum of impacts at different spatial and temporal scales. In this case, cumulative impacts occur because a series of projects of the same type and correlated to each other are being developed; for example, when several development projects are planned or constructed along the NW-1 or within the same stretch, when multiple roads projects and railway projects are developed in close proximity, or when a number of logistic hubs, industrial areas are constructed or planned within the same flyway or region.

Cumulative Impact Assessment study for NW-1 from Haldia to Allahabad has been carried out for basin (water environment & ecological environment) and 10 km area in both sides along the entire stretch. For the purpose of CIA, VECs has been identified to assess their existing conditions in previous chapter so as the probable impact & significance of the impacts on these VECs can be evaluated. Below sections provides details of anticipated cumulative impacts due to NW-1 development, existing/past developments and proposed/planned developments.

6.2 Basin Level Cumulative Impact Assessment for Water Environment and Eco-system Services

Based on the Baseline assessment of water environment & ecological services basin level cumulative impact assessment has been carried out some of the major impact has been carried out are described below.

Water availability in the Ganga river system is stressed. Further,the innumerable intercepts in the Ganga river network have fragmented the once unified river network into disjointed stretches of flowing and stagnant waters. Any further new intercepts will further stress as well fragment the river further. This will also lead to potential impact on the health of river and the associated ecosystem.

Improper disposal of 1) solid wastes and 2) liquid wastes adversely impact water quality of the Ganga system. Further, non availability of required flow also impacts water quality of Ganga system

6.3 Finalization of VECs Specific Hotspots

For purpose of CIA study an influence zone is identified where cumulative impact due to NW-1 and other developments within this zone will be identified. Through preliminary desktop study, baseline study and stakeholder consultations the existing developments in influence area, baseline scenario of the influence area, pollution load in environmental area, planned and anticipated developments in influence area are identified. It is found that some zones are experiencing/will experience more of the above mentioned developments as compared to other zones. Such zones are demarcated on the basis of quantam and nature of developments the zone is experiencing or will experience in future. These zones are termed as hotspots as the impacts due to existing/planned development will be maximum/more in these zones as compared to other zones. **Table 6.1** represents the hotspots demarcated on the basis of preliminary selection, baseline study and stakeholder consultations along with criteria for selection of hotspots and VECs to be impacted in each zone. These hotspots are also marked on the maps and are given in **Figures 6.1-6.13.** Cumulative impacts due to the identified developments will be assessed specifically in these hotspots.

Table 6.1: Finalized Hotspots Selected for CIA Study

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
1.	Haldia	• Declared as critically polluted area but at present moratorium is lifted by MoEF&CC • Declared notified zone by CGWB • Operation of terminal would require dredging of 1,57,60,596 cum • Existing floating terminal and proposed new terminal at Haldia • Shifting of ammonia pipeline of TATA chemicals and existing road to Mitsubishi Plant • Haldia Port & Shipping Activities • Haldia Dock Complex & Industrial Area • Celebration of Ganga Sagar Mela at Sagar • Urban areas: Haldia Town • Expected increased industrial	• Ground Water Quality • River Water Quality • Traffic • GHG emissions (micro climate) • Air Quality • Religious Values • Aquatic ecology • Existing infrastructure • New infrastructure development • Fishing Activities • Quality of Life • Water Resources • Drainage • Traffic • Noise • Soil Quality

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
		development in existing industrial area and enhanced traffic movement • Indragachi TPP at Sangrampur & Haldia Energy Ltd. TPP	
2.	Kolkata-Mahesthala	• Existing BISN jetty, GR-1 & GR-2 and Botanical Garden Jetty • Archaeological sites within 300 m: Temple of Gour Chandra and Krishnachandra at Chatra-Gaur Chandra Ghat (0 m, W) , St John Church • High PM_{10} concentration in Howrah • Urban areas: Mahesthala, Kolkata & Howrah	• Archaeological sites • Air Quality • Water resources • River Water Quality • Ground Water Quality • Traffic • Aquatic ecology • Quality of Life
3.	Katwa to Hoogly Ghat	• Floating Terminal Katwa, Floating Terminal Swarupganj, Floating Terminal Shantipur, Floating Terminal Tribeni, BISN jetty • New proposed terminal at Tribeni • Hisha Sanctuary (fishing restriction for larvae of Hilsha) • TPP at Bandel & Balagarh • Urban Areas: Katwa, Swaroopganj, Nabadwip, Kalna, Balagarh, Kanchrapara, Hoogly • Increased traffic volume due to newly proposed terminal	• Traffic • GHG emissions (micro climate) • Air Quality • Aquatic Ecology • Terrestrial ecology • Existing infrastructure • Fishing Activities & Livelihood (Agriculture Land Acquisition) • New infrastructure development • Water resources • River Water Quality • Ground Water Quality • Drainage • Noise • Terrestrial ecology • Soil Quality • Quality of Life • Land Use
4.	Farakka to Murshidabad	• Floating Terminal at Hazardwari, Existing RCC Jetty Pakur, U/s & D/s jetty, feeder canal, RCC jetty and old lock at Farakka • Proposed New lock at Farakka • Archaeological Sites: Hazardwari Palace • Hilsha Sanctuary (fishing restriction for larvae of Hilsha) • IBA: Farakka and surrounding areas • Farakka feeder canal is prone to erosion • Sagardighi TPP, Farakka STPS	• Bank/Soil erosion • GHG emissions (micro climate) • Air Quality • Water resources • River Water Quality • Ground Water Quality • Existing Infrastructure • New Infrastructure Development • Fishing Activities • Traffic • Noise

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
		• Urban Areas: Farakka, Murshidabad, Azimganj, Baranagar, Balia, Raghunathganj • Bagmari siphon	• Drainage • Aquatic ecology • Terrestrial Ecology • Soil Quality • Quality of Life • Land Use • Archaeological Sites
5.	Mangalghat (Rajmahal)	• Existing floating terminal • Archaeological sites within 300 m: Jama Maszid & Singhi Dalan • Chatt Pooja celebration Oct-Nov • Udhawa Lake Bird Sanctuary at app 6 km • Mining activities	• Traffic • Air Quality • Archaeological sites • Religious Values • River Water Quality • Aquatic ecology
6.	Sahibganj	• Existing Samdhaghat terminal and proposed Sahibganj terminal • Chatt Pooja celebration Oct-Nov • Construction of approach road to connect the terminal to NH-80 • Construction of railway siding to provide linkage with existing IR track • Existing Fishing Activities • Acquisition of Land, R& R and shifting of community temple • Cutting of app. 500 trees	• Land Use • Livelihood (agriculture land acquisition) & Fishing Activities • Socio-economy • Air Quality • GHG emissions (micro climate) • Aquatic ecology • Terrestrial Ecology • Existing Infrastructure • Religious Values • New infrastructure development • Water resources • River Water Quality • Ground Water Quality • Bank/Soil erosion • Traffic • Noise • Drainage • Quality of Life • Land Use

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
7.	Pirpanti-kahalgaon-Bhagalpur	• Chatt Pooja celebration Oct-Nov • Existing Bateshwarsthan Floating Terminal, Bhagalpur Terminal • Vikramshila Gangetic Dolphin Sanctuary • IBA: Kurseala River Course and Diyara Flood Plains • Bhagalpur TPP, Kahalgaon STPS, Pripanti TPP, Pripanti Power CESC • Presence of arsenic in ground water • Urban Area: Bhagalpur, Kahalgaon	• Air Quality • GHG emissions (micro climate) • Religious Values • Aquatic Ecology • Avifauna • Water resources • River Water Quality • Ground Water Quality • Traffic • Soil Quality • Quality of Life
8.	Munger	• Existing Floating Terminal at Munger • Chatt Pooja celebration Oct-Nov • Presence of arsenic in ground water • Urban Area: Munger	• Ground Water Quality • Religious Values • Traffic • Aquatic ecology
9.	Semaria-Begusarai-Barh	• Existing Floating Terminal at Semaria • Chatt Pooja celebration Oct-Nov • Urban Area: Semaria, Doraiganj, Begusarai, Barh • Barauni TPP, Barh TPP & Lakhisarai TPP • IBA: Mokama Taal	• Air Quality • GHG emissions (micro climate) • Aquatic ecology • Terrestrial flora • Religious value • Water resources • River Water Quality • Ground Water Quality • Avifauna • Soil Quality • Quality of Life
10.	Patna	• Low & High Level Jetty (Gaighat) • Proposed Terminal at Kalughat • Chatt Pooja celebration Oct-Nov • IBA: Danapur Cantonment Area • High PM_{10} concentration in Patna • Urban Area: Patna • Development of River Front at Patna	• Avifauna • Air Quality • River Water Quality • Religious Value • Traffic • Noise • Water resources • Drainage • Aquatic ecology • Terrestrial Ecology • Bank/soil erosion • Quality of Life • Land Use
11.	Buxar	• Existing floating terminal at Buxar	• Religious Values

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
		• Buxar TPP (under construction) • Chatt Pooja celebration Oct-Nov • Urban Area: Buxar	• Traffic • Air Quality • Water resources • River Water Quality • Ground Water Quality • Aquatic ecology • Soil Quality • Quality of Life
12.	Ghazipur	• Proposed Terminal • Urban Area: Ghazipur	• Land Use • Livelihood (agriculture land acquisition) • Air Quality • GHG emissions (micro climate) • Aquatic ecology • Terrestrial Ecology • Existing Infrastructure • River Bed Sediments Quality • New infrastructure development • Water resources • River Water Quality • Ground Water Quality • Bank/Soil erosion • Drainage • Traffic • Noise • Quality of Life
13.	Varanasi	• Rajghat floating terminal • Proposed Varanasi Terminal • Archaeological Sites: Kardmeshwar Mahadeva Mandir, Ramnagar, fort, archaeological excavation site, Varanasi • Festival: Ganga Mahotsav at Varanasi (Oct-Nov) & Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March) • Kashi Turtle Sanctuary • DFCCIL Connectivity at Varanasi Terminal • Slightly high cadmium concentration in river bed sediments but below toxicity level of fishes • High PM_{10} levels in Varanasi • High noise level in Turtle sanctuary area	• Land use • Livelihood (agriculture land acquisition) & Fishing Activities • Aquatic ecology • Existing Infrastructure • New infrastructure development • Archaeological sites • Air Quality • GHG emissions (micro climate) • River Bed Sediments Quality • Bank/Soil erosion • Noise level • Religious Value • Vibrations • Water resources

S. No.	Hotspots Stretch/Location	Criteria For Selection of Hotspots	VECs
			• River Water Quality • Drainage • Traffic • Noise • Quality of Life
14.	Allahabad	• Festival: Kumbh Mela • Slightly high cadmium concentration in river bed sediments but below toxicity level of fishes	• Religious Value • River Bed Sediments Quality • River Water Quality • Aquatic ecology • Quality of Life

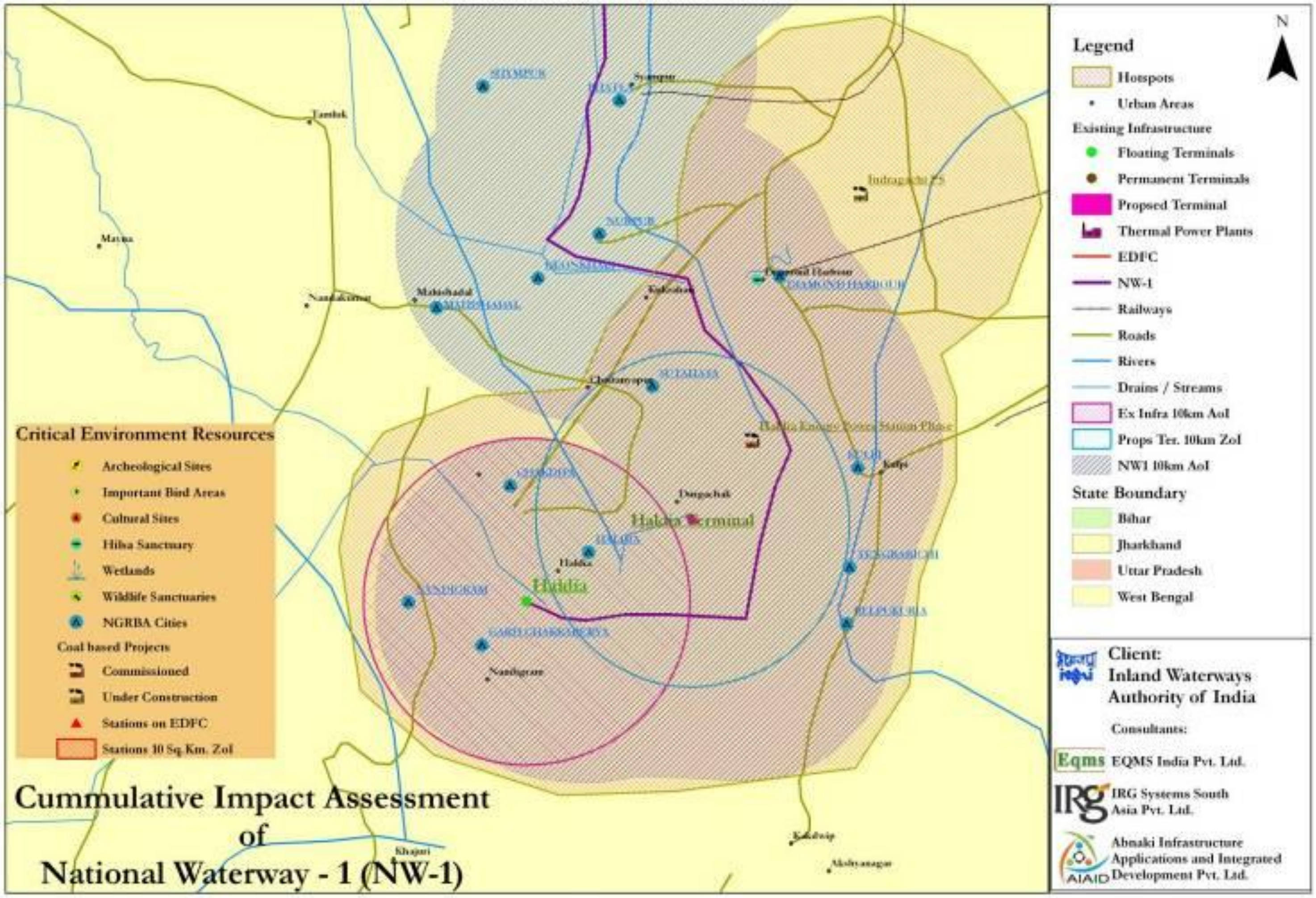


Figure 6.1: Map depicting Hotspot Haldia

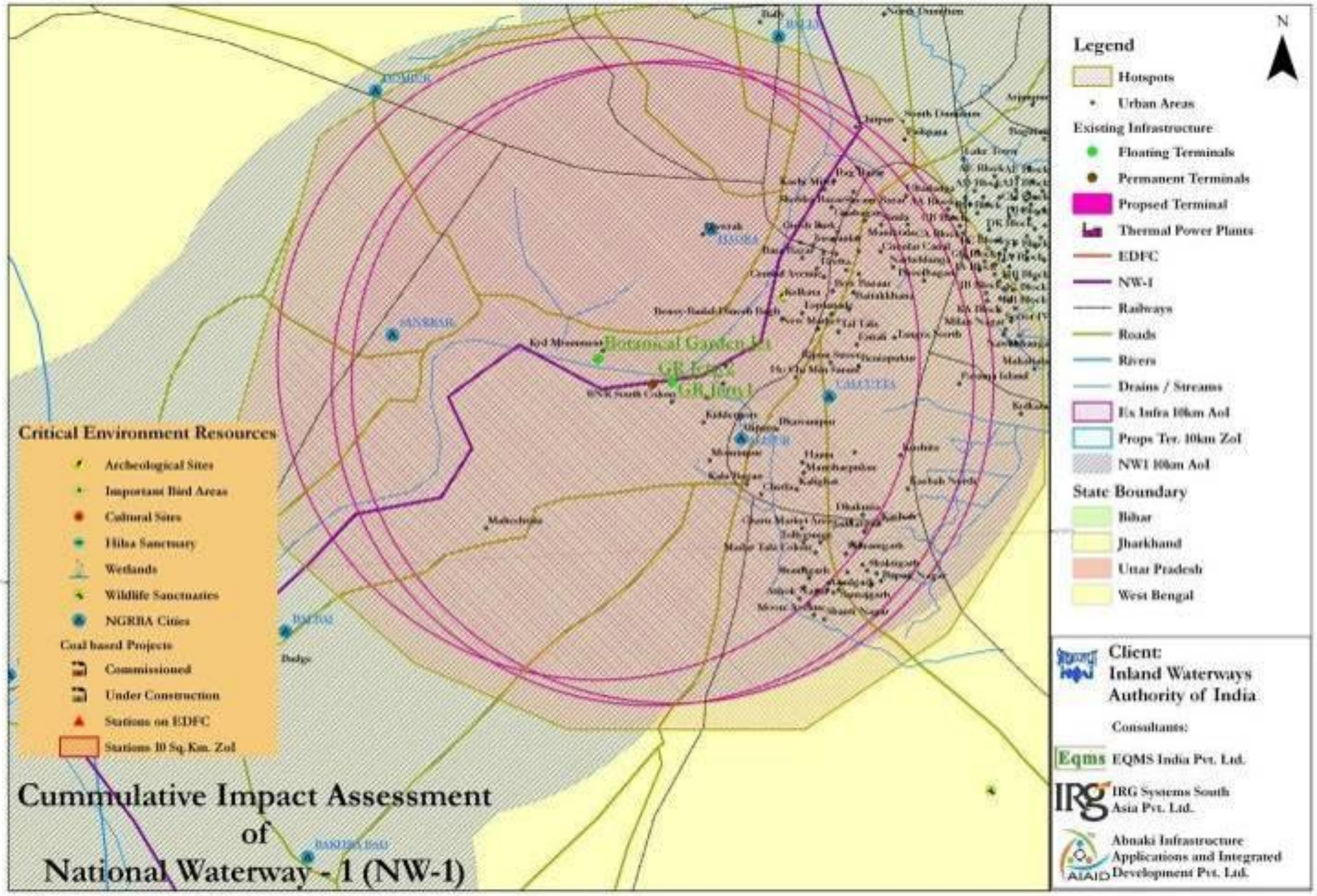


Figure 6.2: Map depicting Hotspot Kolkata- Mahesthala

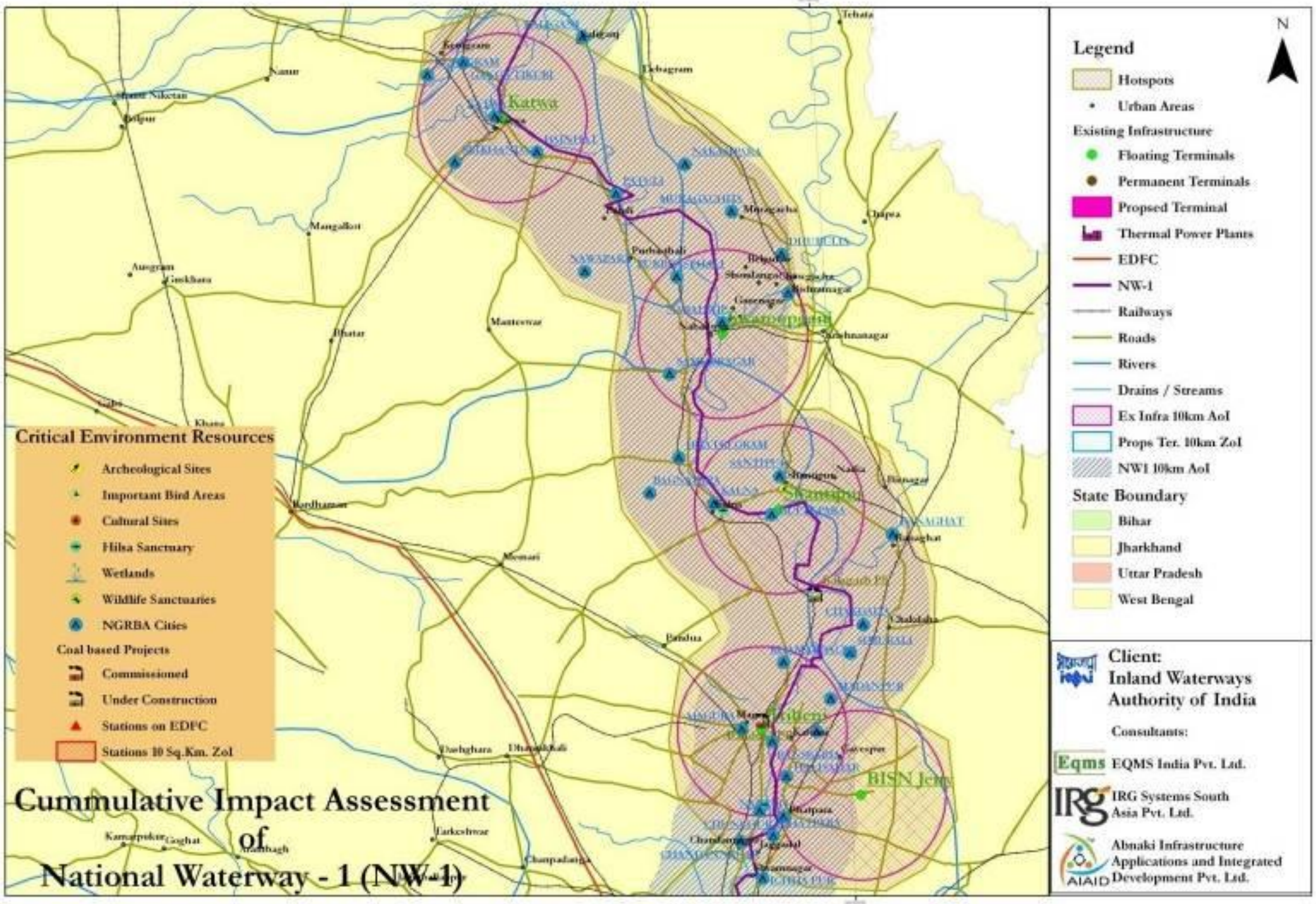


Figure 6.3: Map depicting Hotspot Katwa to Hoogly Ghat

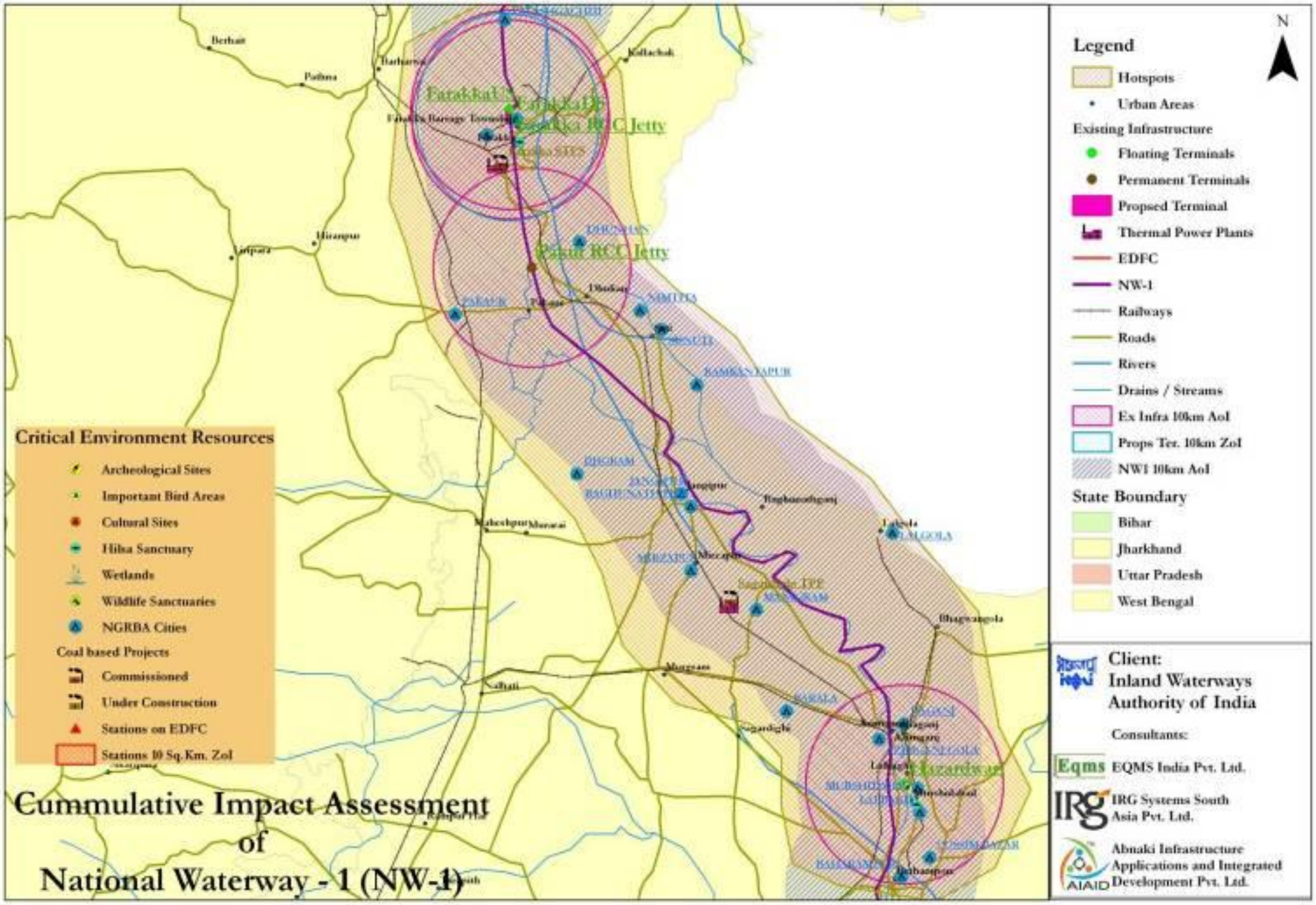


Figure 6.4: Map depicting Hotspot Farakka to Murshidabad

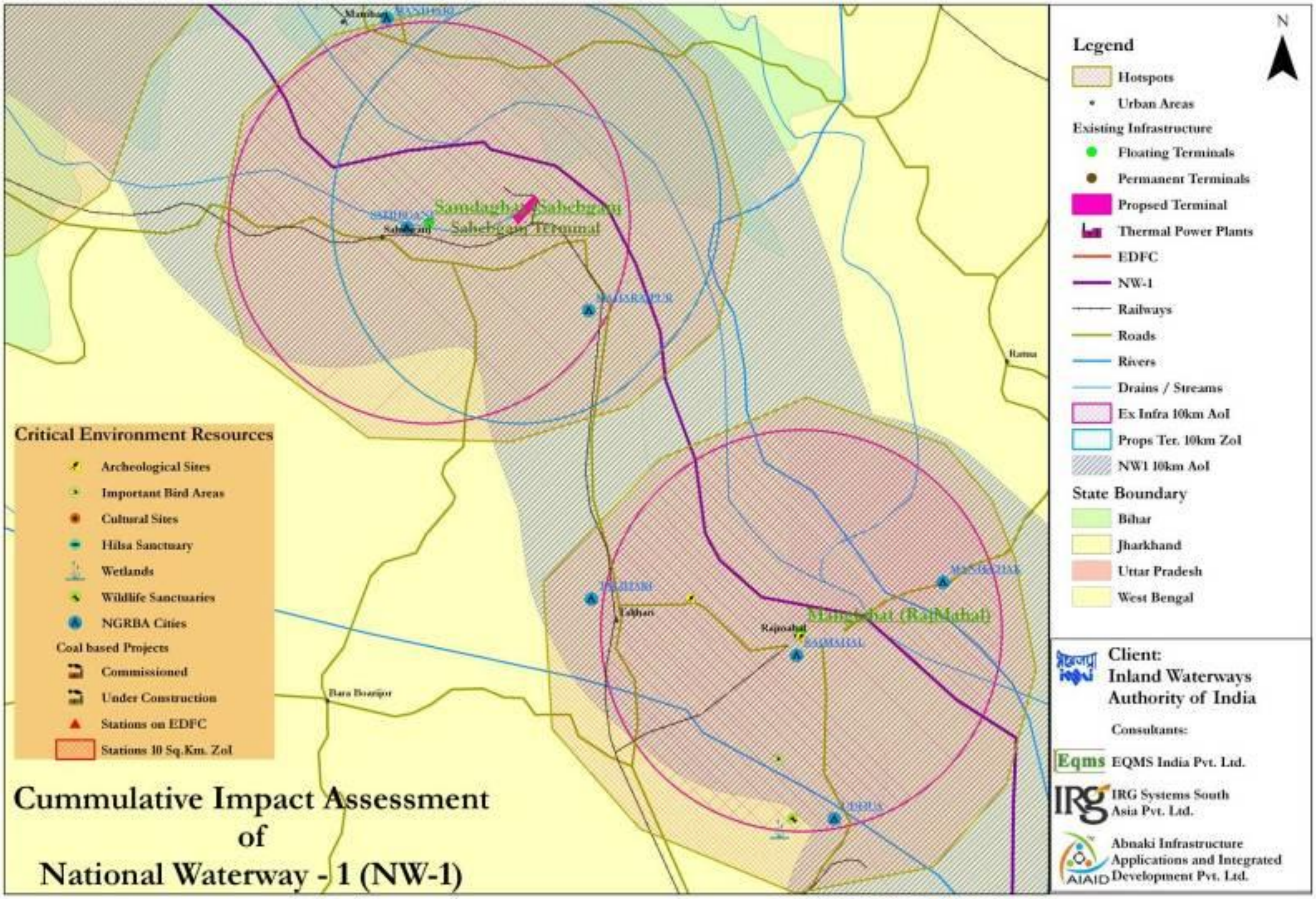

Legend
Hotspots
Urban Areas
Existing Infrastructure
Floating Terminals
Permanent Terminals
Propsed Terminal
Thermal Power Plants
EDFC
NW-1
Railways
Roads
Rivers
Drains / Streams
Ex Infra 10km AoI
Props Ter. 10km ZoI
NW1 10km AoI
State Boundary
Bihar
Jharkhand
Uttar Pradesh
West Bengal
Client:
Inland Waterways Authority of India
Consultants:
EQMS India Pvt. Ltd.
IRG Systems South Asia Pvt. Ltd.
Abnaki Infrastructure Applications and Integrated Development Pvt. Ltd.
Critical Environment Resources
Archeological Sites
Important Bird Areas
Cultural Sites
Hilsa Sanctuary
Wetlands
Wildlife Sanctuaries
NGRBA Cities
Coal based Projects
Commissioned
Under Construction
Stations on EDFC
Stations 10 Sq.Km. ZoI
Samdaghat Sahebganj
Sahebganj Terminal
Manighat (RajMahal)
Rajmahal
Taljhari
Bara Boarijor
Cummulative Impact Assessment
of
National Waterway - 1 (NW-1)

Figure 6.5: Map depicting Hotspot Mangalghat (Rajmahal) & Sahibganj

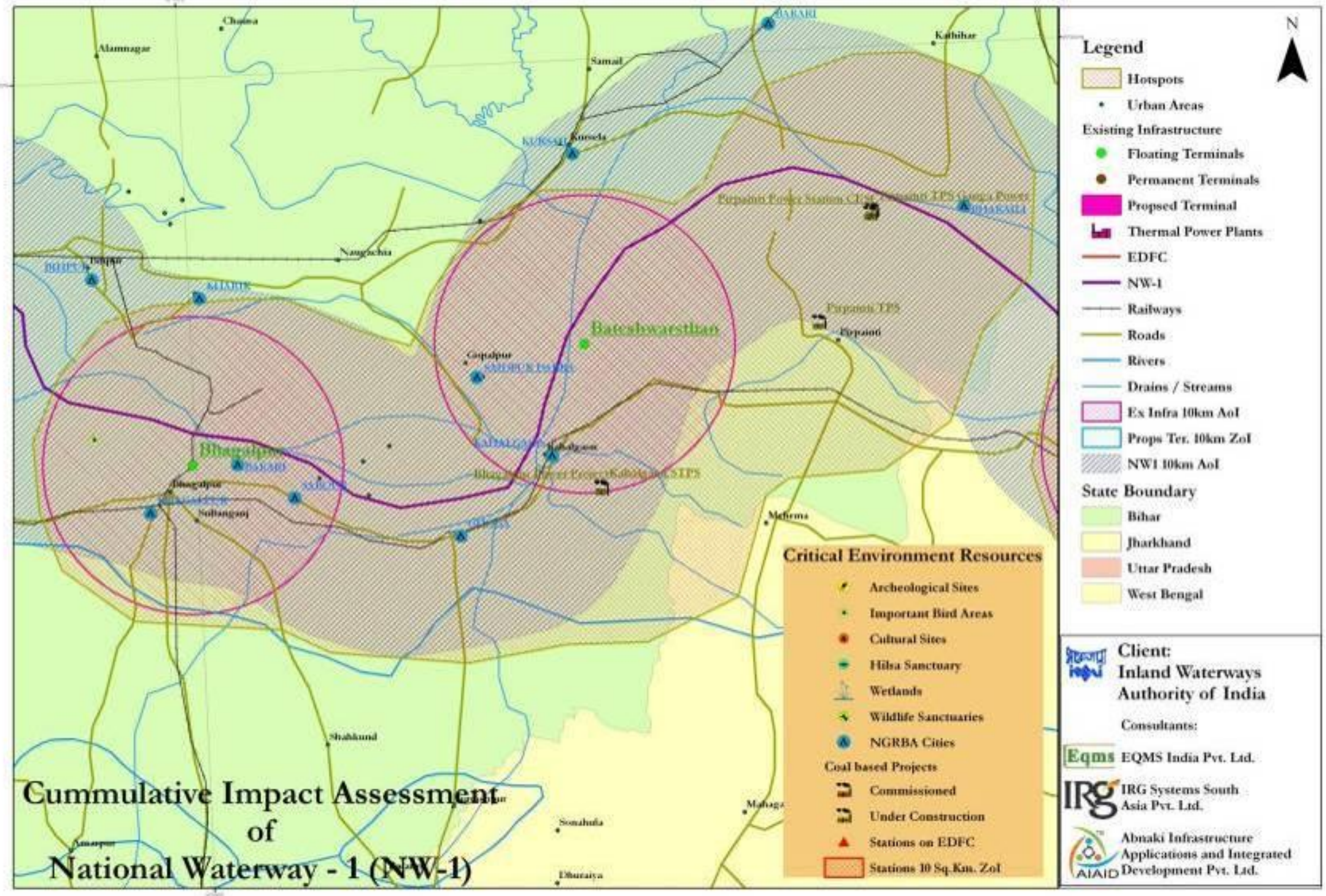


Figure 6.6: Map depicting Hotspot Pirpanti-kahalgaon-Bhagalpur

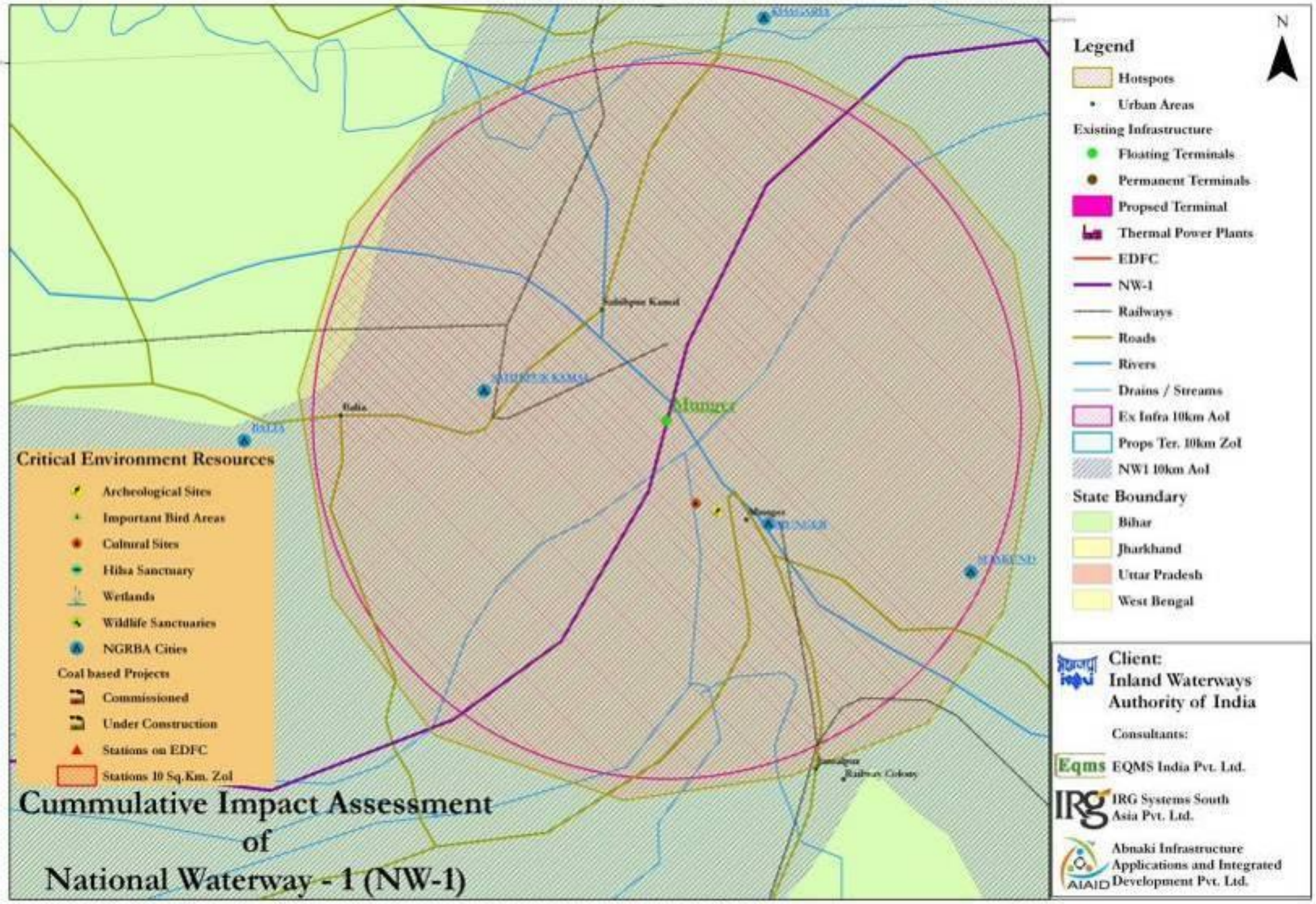


Figure 6.7: Map depicting Hotspot Munger

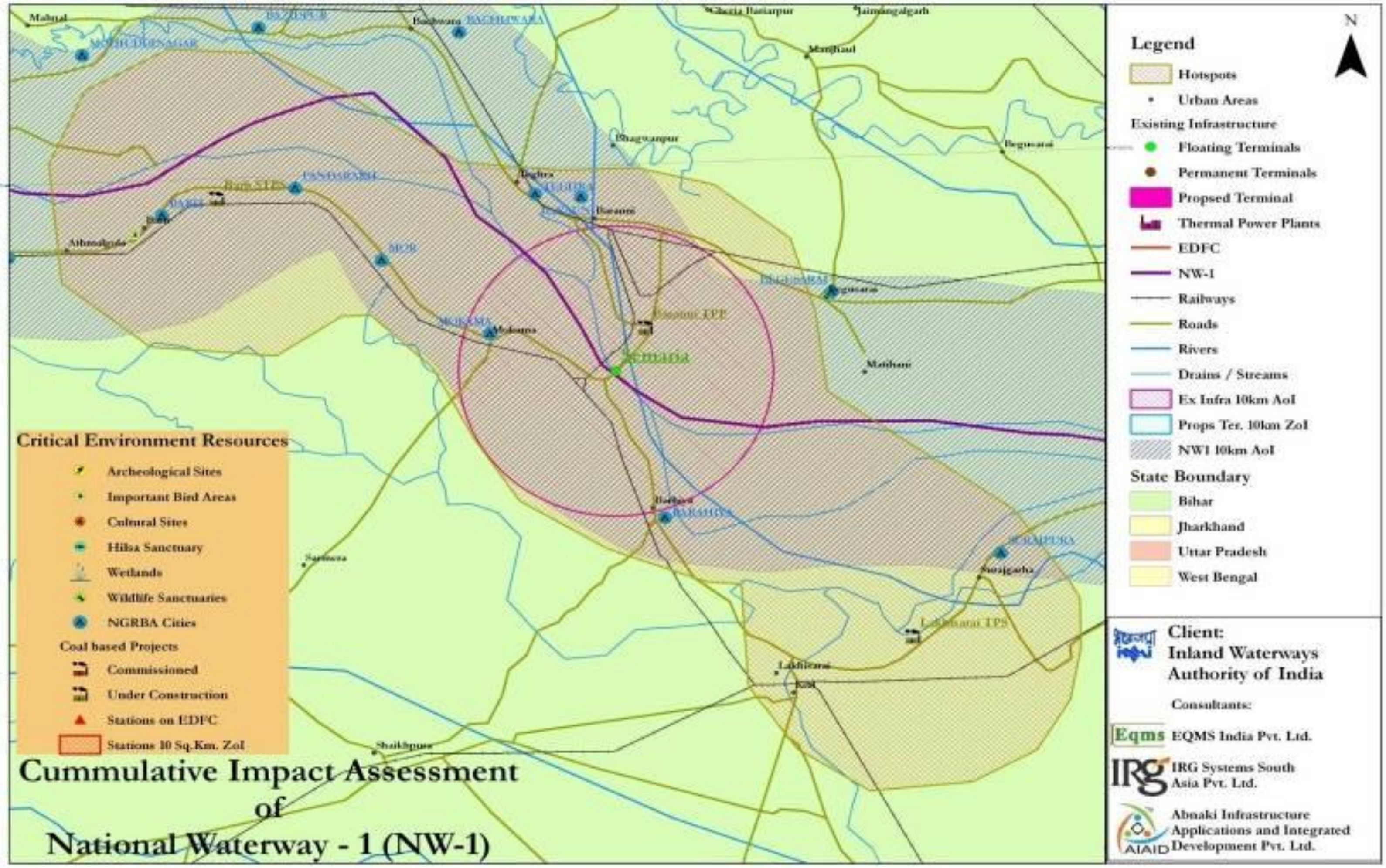


Figure 6.8: Map depicting Hotspot Semaria-Begusarai-Barh

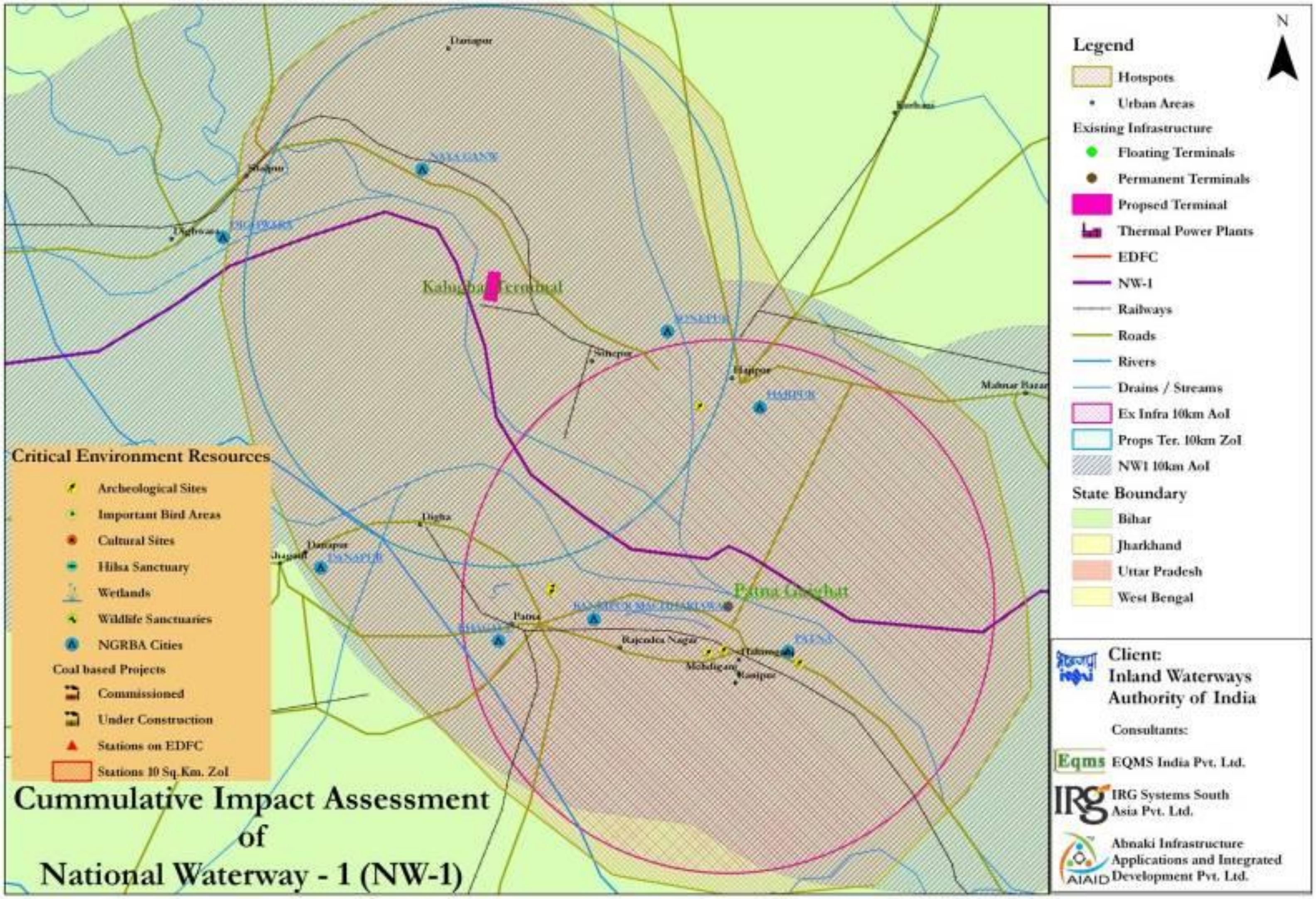


Figure 6.9: Map depicting Hotspot Patna

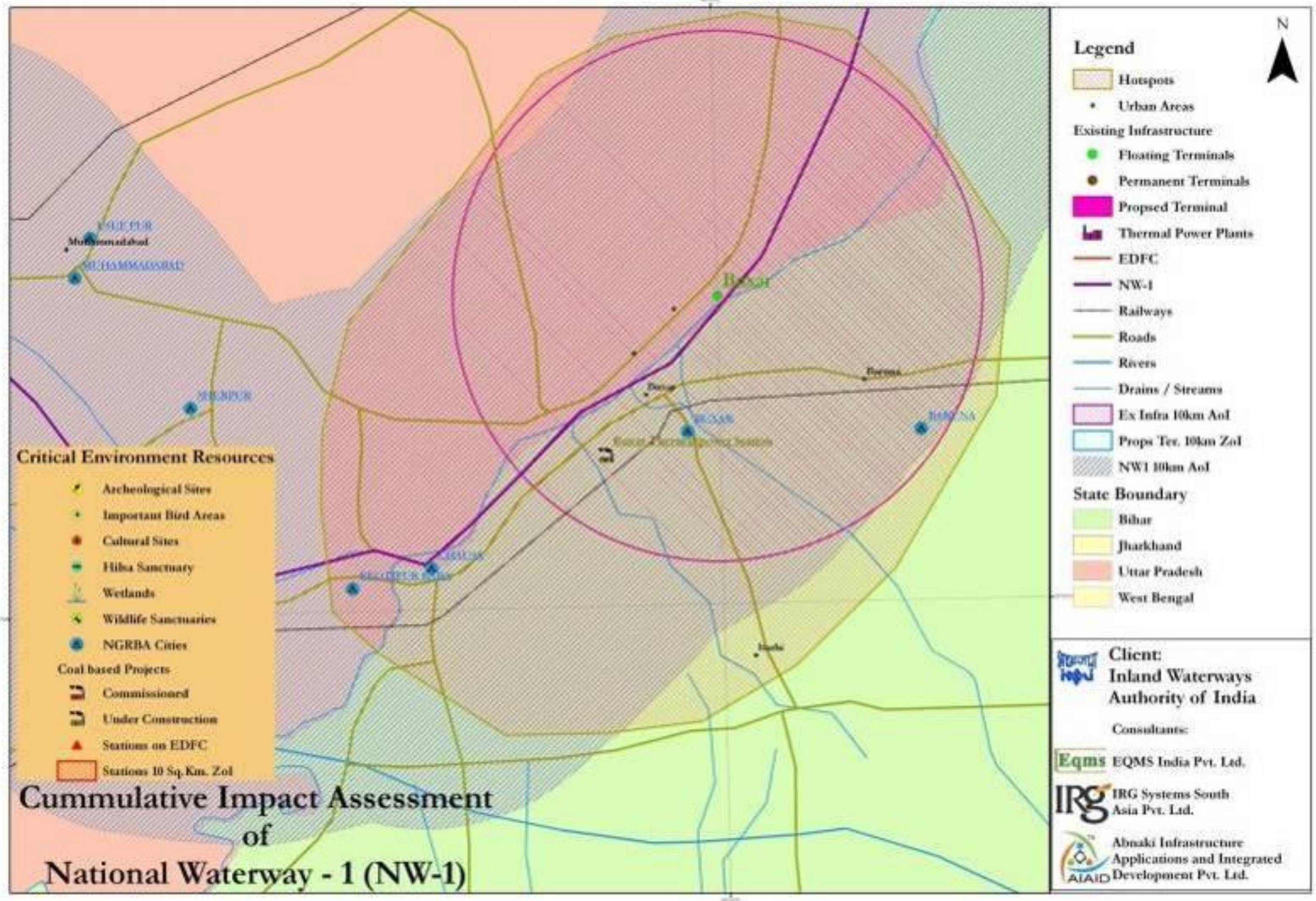


Figure 6.10: Map depicting Hotspot Buxar

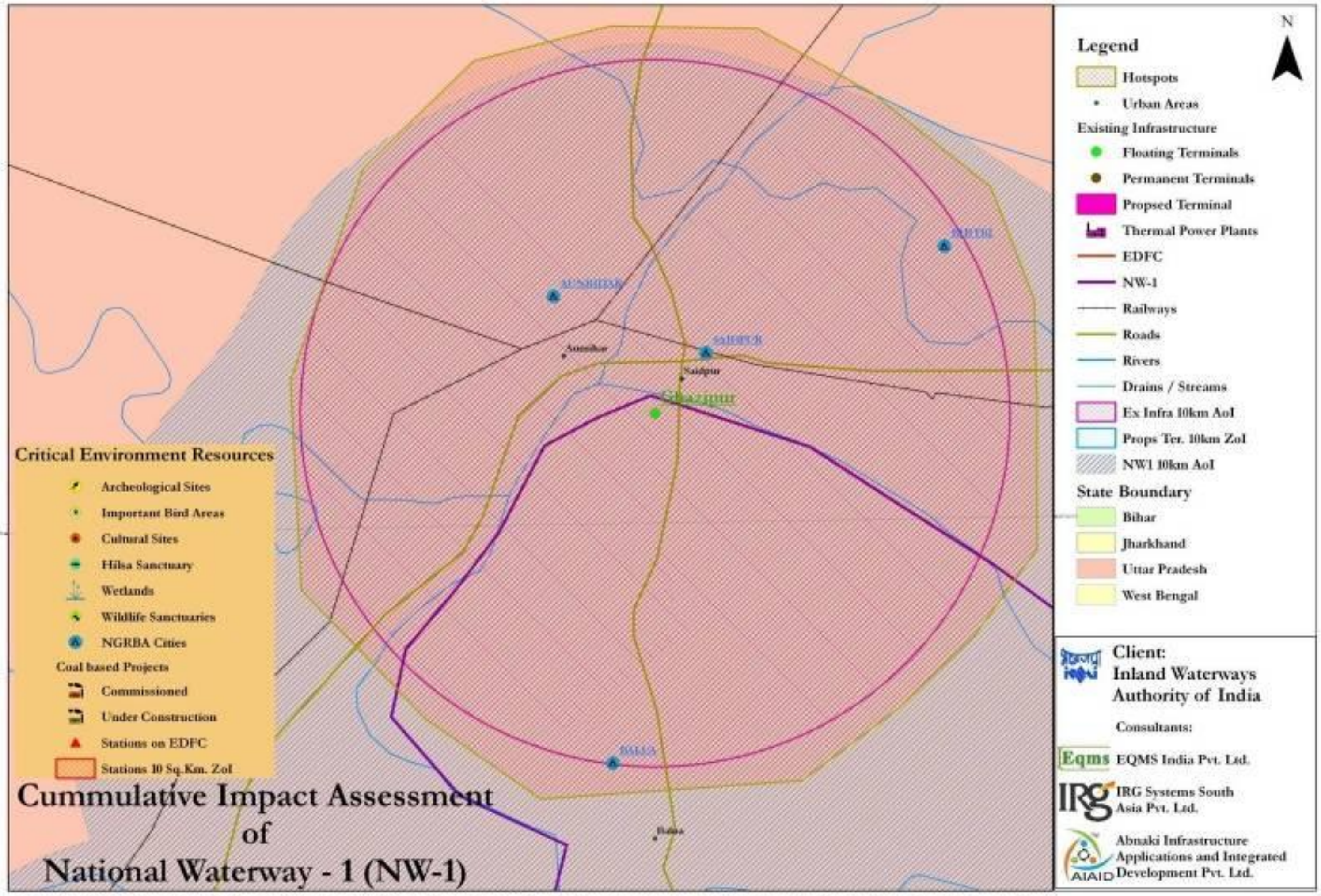


Figure 6.11: Map depicting Hotspot Ghazipur

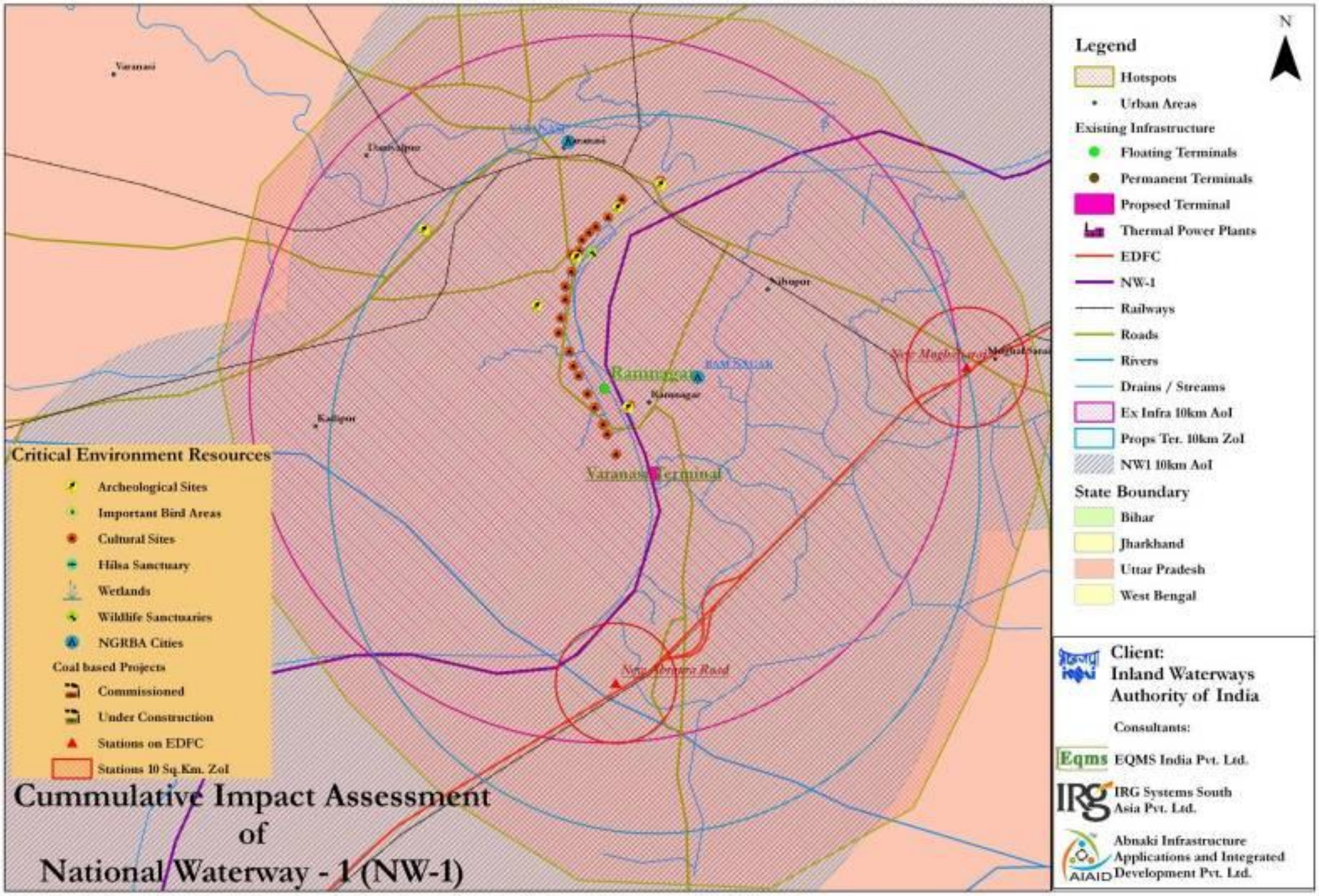


Figure 6.12: Map depicting Hotspot Varanasi

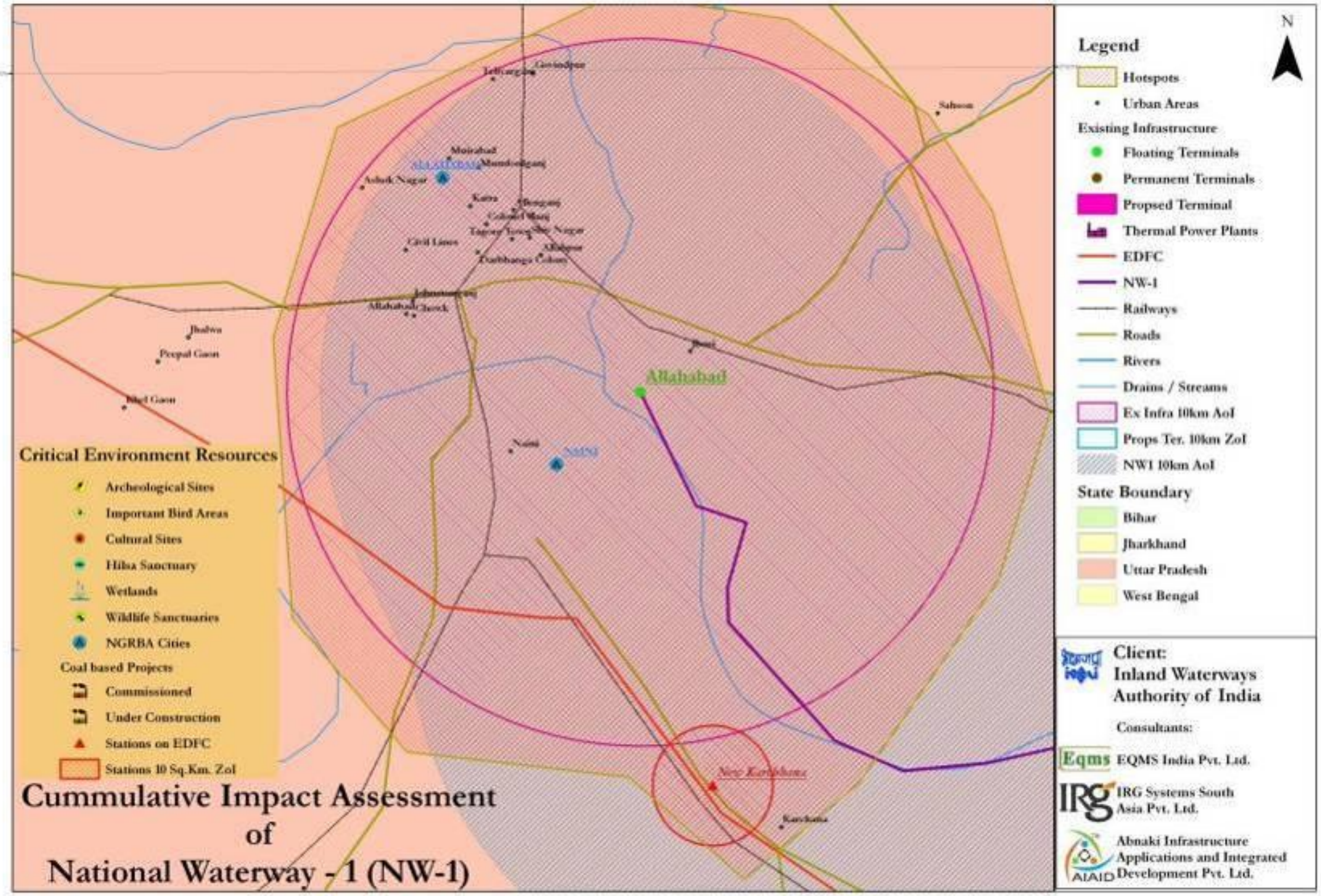


Figure 6.13: Map depicting Hotspot Allahabad

6.4 Impact identification

Planned Jal Marg Vikas Project is augmentation of navigation capacity of NW-1 through construction of new navigation infrastructure, maintaining LAD through dredging & bandalling, river training works, bank protection works and improvement of existing and development of new navigational aids. NW-1 traverses through major cities which are highly populated. Various festivals and religious rituals are associated with the River Ganga. Developments like TPPs & industrial areas also exist along the NW-1. Total 5 bird areas and 3 eco-sensitive zones, i.e. Kashi turtle sanctuary, dolphin sanctuary & Udhawa sanctuary exists within 10 km of the NW-1. As per the EIA/SIA studies carried out for the project, it is found that the project has potential to impact various VECs in its different stages.

As per the baseline study and stakeholder consultation carried out, it is found that there are already significant developments in the influence area of NW-1 and several other developments are planned. Those developments are and may be development of Eastern Dedicated freight Corridor (within influence area near Varanasi MMT), Industrial areas, TPPs, Roads, Indian Railways line/ROB/RUB, Expansion and development of and within urban areas and irrigation schemes/dams. All of these developments also have potential to impact VECs at different stages. The impacts due to proposed Jal Marg Vikas project and these mentioned developments is given in **Table 6.2** below. Also an attempt is made to assess the nature of the impact of each development on the VECs which will be impacted and is given in **Table 6.3.**

Table 6.2: Impact identification

S. No.	Existing/Planned and Proposed Development	Activities	Impacts	VECs Impacted
1.	Planned Development-NW-1	Civil Intervention Development	**Design & Construction Phase:** • Acquisition of land • Loss of livelihood • Impact on Fishing Activities • Tree Cutting • Impact on aquatic ecology due to piling & dredging during • Shifting of CPRs & utilities • Increased traffic and GHG near terminals & jetties • Unpleasant view during	• Land Use • Livelihood (R & R) • Religious Value • Terrestrial Flora • Aquatic Ecology • Traffic near terminal/jetty • Noise • Air Quality • Micro climate • Soil Quality (top soil loss) • River Water Quality

S. No.	Existing/Planned and Proposed Development	Activities	Impacts	VECs Impacted
			construction phase • Soil contamination due to spillage of oil **Operation Phase:** • Impact on aquatic ecology due to berthing & mooring of vessels during operation phase • Impact on Fishing Activities • Increased Traffic & GHG near terminals & jetties • Bank erosion near interventions • Surface water contamination • Change in drainage pattern	• Archaeological sites • Bank/soil erosion • Existing Infrastructure • New Infrastructure Development • Religious value • Archaeological sites • River Bed Sediments
		Maintenance Dredging	• Impact on Fishing Activities • Avifauna near important bird areas • Aquatic ecology (major impact in VGDS & turtle sanctuary) due to high underwater noise generation, dredging and dredge disposal • Water quality due to release of sediments • Increased noise level	
		Barge Movement	• Impact on Fishing Activities • Aquatic ecology (major impact in VGDS & turtle sanctuary) due to high underwater noise generation and collision	

S. No.	Existing/Planned and Proposed Development	Activities	Impacts	VECs Impacted
			with ships • River banks & bank structure	
2.	EDFC	Freight movement through railway	• Acquisition of land, R & R • Change in land use • Tree cutting any impact to eco-sensitive zone • Emissions due to material loading/unloading • Increased GHGs near stations • Change in drainage pattern • High noise and vibration • Shifting of Utilities	• Land use • Terrestrial Ecology • Noise • Vibration • Livelihood (R & R) • Air Quality • Drainage • Soil Quality • Soil Erosion • Existing Infrastructure • New Infrastructure & Industrial Development • Aquatic Ecology • Archaeological sites • Traffic near stations
3.	Roads	Vehicular Movement	• Acquisition of land, R & R • Change in land use • Tree cutting any impact to eco-sensitive zone • Emissions due to material loading/unloading • Increased GHGs • Change in drainage pattern • Reduction in Traffic jams and air/noise emissions due to traffic	• Land use • Terrestrial Ecology • Noise • Livelihood (R & R) • Air Quality • Drainage • Soil Quality • Soil Erosion • Existing Infrastructure • New Infrastructure &

S. No.	Existing/Planned and Proposed Development	Activities	Impacts	VECs Impacted
			jams/congestion • Enhanced connectivity • Shifting of Utilities	Industrial Development • Aquatic Ecology • Archaeological sites
4.	Existing and Planned Industrial Areas & TPPs	Industrial operations	• Traffic movement, Material transportation & increased GHG emissions • Increased air emissions • Increased water consumption and degradation of water quality • Soil quality contamination • Pressure on existing infrastructure	• Air Quality • Land Use • Terrestrial Ecology • Water resources • Ground & Surface Water Quality • Noise • Soil Quality
5.	Infrastructure Development and Urbanization	Increased population growth	• Increased water consumption and sewage generation • Increased air emission • Increased pressure on existing infrastructure • Increased waste generation (municipal, e-waste, bio-medical waste) • Change in land use	• Air Quality • Soil Quality • Land Use • Water resources • Ground & Surface Water Quality • Noise • Traffic
6.	Irrigation Scheme	Withdrawal of water from river	• Impact on water flow • Impact on surface & ground water quality due to contamination of pesticides/fertilizers • Water logging in area	• Water Resources • River water Quality • Ground Water Quality • Soil Quality • Drainage

Table 6.3: Type of Impact of Proposed/Planned/Anticipated Developments on VECs within Influence Area

VECs	Impact Due to development in Influence Area						
	NW-1	EDFC & Other Railways	Road Developments	Industrial development /TPP	Infrastructure development	Urbanization	Irrigation Schemes/Dams/Agriculture
Micro Climate	+ve	-ve	-ve	-ve	-ve	-ve	Nil
Air Quality	+ve	+ ve	+ve	-ve	-ve	-ve	Nil
Water Resources	Nil	Nil	Nil	-ve	-ve	-ve	-ve
Ground Water Quality	-ve	Nil	Nil	-ve	-ve	-ve	-ve
Surface Water Quality	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Natural Drainage Pattern	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Noise Levels	-ve (UW)	-ve	+ve	-ve	-ve	-ve	Nil
Vibrations	Nil	-ve	Nil	Nil	Nil	Nil	-ve
Terrestrial Ecology	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Aquatic Ecology	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Avifauna	-ve	-ve	-ve	-ve	-ve	-ve	Nil
Soil Quality	-ve	-ve	-ve	-ve	-ve	-ve	-ve
River Bed Sediments Quality	-ve	Nil	Nil	-ve	-ve	-ve	-ve
Soil Erosion	-ve	-ve	-ve	Nil	Nil	+ve	-ve
Quality of Life	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve
Existing Infrastructure	+ ve	+ ve	+ ve	-ve	-ve	-ve	Nil

VECs	Impact Due to development in Influence Area						
	NW-1	EDFC & Other Railways	Road Developments	Industrial development /TPP	Infrastructure development	Urbanization	Irrigation Schemes/Dams/Agriculture
New Infrastructure Development	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve	+ ve
Livelihood-Fishing Activity & loss of Agriculture land	-ve	-ve	-ve	-ve	-ve	-ve	+ve
Religious Values	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Traffic	-ve (NT) & +ve (OA)	-ve (NS) & +ve (OA)	+ve	-ve	-ve	-ve	Nil
Land Use	-ve	-ve	-ve	-ve	-ve	-ve	-ve
Archaeological sites	-ve	-ve	-ve	-ve	-ve	-ve	-ve

UW: Underwater, NT: Near Terminals, NS: Near Stations, OA: Overall

6.5 Interaction of the VECs and Developments (NW-1 & other developments in Influence Area)

In above sections, areas experiencing cumulative impacts, i.e hotspots are identified. Also assessment is made to identify the impact of the identified existing/planned developments in these hotspots. Attempt was also made to assess the nature of these impacts on the VECs to be impacted as identified in table 6.1 & 6.2.

Further a tabular representation is made showing assessment of impacts due to developments individually and cumulatively on each of the identified VECs. The table shows how these developments will interact with each of the VECs individually and cumulative impact due of each development is given in the last column. An attempt is also made to quantify the impact to the extent possible. Interaction Matrix of Individual & Cumulative Impacts of Development on VECs is given below in **Table 6.4.**

Table 6.4: Interaction Matrix of Developments and Identified VECs

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	**EDFC**	**Development of Industries & Industrial Area/zones/parks/TPPs**	**Urbanization**	**Road Development**	**Irrigation Schemes/Dams**	**Cumulative Impact**
Micro-Climate (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Ghazipur, Varanasi)	Will reduce GHG emissions due to shift of freight from road/rail to IWT thus positive impacts. GHG emissions may be high near terminals and jetties. GHG Emissions: In **"without project"** scenario GHG emissions associated with freight transportation through rail / road mode will continue to generate, thereby increasing overall GHG emissions associated for movement of cargo estimated to be transported through NW-1 (calculated for maximum terminal capacity as planned in phase 1) through from rail & road are 84 billion & 277 billion g/yr respectively. GHG Emissions: **"with project"** reduction in overall GHG emissions as IWT involves minimal fuel consumption thus minimal GHG emissions when compared to raod & rail. As per analysis carried out, it is estimated that CO2 (potential GHG) emissions associated with IWT for freight transportation (calculated for maximum terminal capacity as planned in phase I) from Haldia to Varanasi is 4.54	Will reduce GHG emissions due to shift of freight from road to Rail thus positive impacts. GHG emissions may be high near stations. GHG emission calculations for transportation of freight planned through Rail for phase I of NW-1 is given in **Annexure 6.1**	Will increase GHG emissions will impact negatively. List of TPPs along the NW-1 are given as **Annexure 6.2**	Will increase GHG emissions will impact negatively	Will reduce GHG emissions due to reduction in traffic jams and congestion and ultimately thus positive impacts. GHG emission calculations for transportation of freight planned through Road for phase I of NW-1 is given in **Annexure 6.1**	No significant impact	GHG emission will increase due to increase in developments in business as usual but GHG emission will cut down due to shift of freight from Road/Rail to IWT. Assessment of reduction of GHG emissions due to development of Jal Marg Vikas Project is given in **Annexure 6.1**

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
	million tones/yr). GHG emission calculations for transportation of freight planned through IWT mode for phase I of NW-1 is given in **Annexure 6.1.**						
Air Quality (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Patna, Buxar, Ghazipur, Varanasi)	Air quality will improve due to shift of freight from road/rail to IWT thus positive impacts. Air emissions may be high near terminals and jetties. Air emission calculations for transportation of freight planned through IWT mode for phase I of NW-1 is given in **Annexure 6.3.**	Will reduce Air emissions due to shift of freight from road to Rail thus positive impacts. Air emissions may be high near stations. Air emission calculations for transportation of freight planned through Rail mode for phase I of NW-1 is given in **Annexure 6.3.**	Air Quality will deteriorate significantly but can be controlled with adequate APCEs	Air Quality will deteriorate but can be controlled with imposing restrictions and development of green belts and avenue plantation	Air quality will improve due to reduction in traffic jams and congestion and ultimately thus positive impacts. Air emission calculations for transportation of freight planned through Road mode for phase I of NW-1 is given in **Annexure 6.3.**	No significant impact	Air Quality will deteriorate due to increased traffic, urbanization and industrial development in business as usual but the Air emission will cut down due to shift of freight from Road/Rail to IWT. Assessment of reduction of Air emissions due to development of Jal Marg Vikas Project is given in **Annexure 6.1**
Water Resources/Flow (Haldia, Kolkata-Mahesthala, Katwa to Hoogly Ghat, Farakka to Murshidabad, Mangalghat	No impact on water resources/flow as no consumption of water is involved. Nor any water storage and diversion structure is proposed on NW-1 which can impact the water resources/flow.	No impact on water resources. Water is required only during construction phase which is short term. No significant impact on water resources. Water	Depletion of water resources due to extraction of water for industrial consumption but can be controlled by using water efficient modern technologies	Depletion of water resources due to increased water consumption & change in life style but can be controlled by spreading awareness and	No impact on water resources. Water is required only during construction phase which is short term. No significant impact on water resources. Water	Water will required to be withdrawn from NW-1 or the tributaries of NW-1 along which the irrigation scheme will be developed. Dams and this scheme will affect	Water Resources will deplete due to continued urbanization, industrial development and infrastructure development. NW-1 will not have significant impact on

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
(Rajmahal), Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Patna, Buxar, Ghazipur, Varanasi)		flow may be impacted due to construction of bridge piers		making it mandatory to use only water efficient fixtures. Water requirement of the Districts through which NW-1 traverses is given in **Annexure 6.4**	flow may be impacted due to construction of bridge piers	the water flow available in these rivers and tributaries. List of the dams and irrigation schemes within the Ganga Basin is attached as **Annexure 6.5 & 6.6.** However impacts of these existing schemes and dams are considered while carrying out design study. Any new scheme or dam will impact the availability of flow in NW-1	water resources and flow. But coming up of new dams and irrigation schemes may impact the availability of flow in NW-1 significantly.
Ground Water Quality (Haldia, Kolkata-Mahesthala, Katwa to Hoogly Ghat, Farakka to Murshidabad, Mangalghat (Rajmahal), Sahibganj, Pirpanti-	No impact	No impact	Ground Water Pollution due to leaching of pollutants. However it is mandatory for industries to take pollution prevention measures	Ground Water Pollution due to leaching of pollutants. However it is mandatory for ULBS to take pollution prevention measures	No impact	Ground water may get polluted due to leaching of the fertilizers and pesticides used for agriculture	Ground water quality will continue to impacted due to increased developmental and industrial activities in the area

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
kahalgaon-Bhagalpur, Munger, Semaria-Begusarai-Barh, Buxar, Ghazipur)							
Surface/River Water Quality (Haldia,, Kolkata-Mahesthala, Katwa to Hoogly Ghat, Farakka to Murshidabad, Mangalghat (Rajmahal), Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Patna, Buxar, Ghazipur, Varanasi, Allahabad)	Surface Water quality will be deteriorated significantly due to dredging, barge operation and terminal activities	No significant impact, low impact due to increased run-off	Surface Water Pollution due to discharge of untreated/treated effluent in water bodies. However it is mandatory for industries to take pollution prevention measures	Surface Water Pollution due to discharge of untreated/treated sewage/contaminated run-off in water bodies. Sewage generation potential of the districts through which NW-1 traverses is attached as **Annexure 6.4** However it is mandatory for ULBS to take pollution prevention measures. No of the households in each district covered under sewage scheme is also given in **Annexure 6.4.**	No significant impact, low impact due to increased run-off	Surface water may get contaminated with the run-off from the agricultural land which may contain pesticides and fertilizers	Surface water pollution will continue to impact due to increased developmental and industrial activities in the area and religious rituals performed on Ganga by people and burning and immersion of bones/idols in the Ganga.. Surface water pollution will be aggravated due to NW-1 project

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
				Surface water quality gets also impacted due to religious rituals performed on Ganga by people and burning and immersion of bones/idols in the Ganga.			
Natural Drainage Pattern (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Patna, Ghazipur, Varanasi)	Construction of infrastructure and related facilities of waterways may impact the flow of the river and thus the drainage pattern of river	Natural drainage pattern will be disturbed as alignment crosses various streams, nallahs & rivers but effect can be minimized by providing cross-drainage structures	Effects the natural drainage pattern but impact is insignificant as storm water drainage system is provided to divert the storm water with each such development	Increased sealed surfaces and thus disturbs natural drainage pattern resulting into urban flooding and water lodging during monsoons. But it can be controlled by developing adequate storm water drainage system for the area	Natural drainage pattern will be disturbed as alignment crosses various streams, nallahs & rivers but effect can be minimized by providing cross-drainage structures	No significant impact	Natural Pattern will be altered significantly due to continued road & railway development but need of development of road/rail may reduce due to shift of freight from road/rail to IWT
Noise Level (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Patna, Ghazipur,	High underground noise due to dredging, pilling and barge movement and high ambient air noise due to dredging operation. Ambient air noise generation due to dredging varies from 80-85 dB(A).	Intermittent noise level will increase in areas along EDFC track. Noise levels vary from 75-90 dB (A) due to movement of trains.	Noise level will increase due to industrial operations but can be controlled using noise control technologies. Noise levels from	Noise level will increase due to increased traffic and commercial activities. Existing motorboat movement in the NW-1 also adds to the ambient &	Noise level will increase due to increased traffic movement but can be controlled by provision of noise barriers. But noise level will also reduce	No significant impact. Some noise may generate due to operation of pumps. Noise level from pumps varies from 100-120 dB(A)	Noise level will increase in the area due to continued developmental and industrial activities and plying of the motorboats. But noise level along the NW-1 may reduce

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
Varanasi)			various industries are as below: steel: 130 dB, plastic molding: 100 dB; TPP: 130 dB; casting: 120-129 dB; mining operations: 109 dB, food processing: 99 dB, Textile: 80-89 dB	underwater noise. As per CPCB data noise level of cities like Mumbai, Pune, Nashik, Aurangabad, Nagpur, Kohlapur etc are higher than the CPCB standards for both night & day time.	due to reduction in traffic jams. Noise levels due to various road transport varies from 65-90 dB (A)		due to shift if freight from road/rail to IWT.
Vibration (Varanasi)	No Impacts	Will increase along the proposed EDFC alignment. Vibration level varies from 75.9 to 79.1 dB at distance of 12.5 m from the track and 60.5 to 62.1 dB at distance of 25 m from track due to movement of train.	No Impacts	No Impacts	No Impacts	Some vibrations may result due to pumping of water.	Vibration will increase in area close vicinity of railway track, i.e. near Varanasi stretch. Impact of these vibrations are analyzed during EDFC study and it is assessed that vibrations impact will dissipate within 100 m.
Terrestrial Ecology (Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj,	May require tree cutting for development of civil interventions like involve cutting of 500 trees for development of Sahibganj terminals. NW-1 alignment is app. Udhawa Lake wildlife sanctuary but no significant impact is	Tree cutting may be required for development of track and other associated developments. Eco-sensitive	May require clearance of vegetation and cutting of trees. But it is mandatory to develop 30% area	Will disturb both flora & fauna due to increased human intervention. But ecology may improve due as	Tree cutting may be required for development of track and other associated developments. Eco-sensitive	Natural vegetation in irrigation scheme area will be removed for growing the required crops/plantation	Terrestrial ecology will continue o be impacted due to cutting of trees for development of infrastructure and industries. However

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
Semaria-Begusarai-Barh, Patna, Ghazipur)	anticipated on the sanctuary. Green belt will be developed around terminals. Compensatory plantation will be carried out as per state policy to reduce the impact	zones like sanctuaries/forest may also get disturb as the alignment may pass through these zones. Compensatory plantation will be carried out as per state policy to reduce the impact. For example 27556 will be cut for 222 km long EDFC section from Khurja to Pilkhani.	of industrial area/industry as green belt. Compensatory plantation will be carried out as per state policy to reduce the impact	urbanization involves development of avenue plantation and urban forests and parks.	zones like sanctuaries/forest may also get disturb as the alignment may pass through these zones. Compensatory plantation will be carried out as per state policy to reduce the impact		development of avenue plantations, compensatory plantation, urban forests may be positive impact on the terrestrial ecology
Aquatic Ecology (Haldia, Kolkata-Mahesthala, Katwa to Hoogly Ghat, Farakka to Murshidabad, Mangalghat (Rajmahal), Sahibganj, Pirpanti-kahalgaon-Bhagalpur,	High impact on aquatic flora & fauna including dolphins, turtles and fishes. May directly impact the primary productivity of water body. NW-1 includes 2 wildlife sanctuaries, i.e. Kashi Turtle Sanctuary & VGDS	May impact aquatic ecology due to construction of bridge piers	Aquatic ecology may be affected to discharge of pollutants in the water bodies but it is mandatory for all industries to treat the effluent to defined standards prior discharging into water body	Aquatic ecology may be impacted due to increased run-off and increase treated/untreated sewage disposal into the water bodies but is guidelines of CPCB for ULBs to treat the sewage to 100% before discharging into water bodies.	May impact aquatic ecology due to construction of bridge piers	Run-off from the irrigated area may contain pesticides, fertilizers/chemicals	Impact on aquatic ecology will continue to exists and will be escalated due to NW-1 development

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
Munger, Semaria-Begusarai-Barh, Patna, Buxar, Ghazipur, Varanasi, Allahabad)				Another development in the area is Patna River front development			
Avifauna (Farakka to Murshidabad, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Patna)	NW-1 traverses through 5 important bird areas. Dredging operations in these areas may impact the avifauna. Development of civil interventions may involve tree cutting which is habitat of avifauna thus again disturbing the avifauna. Compensatory plantation and green belt development may reduce the impact.	Tree cutting will impact habitat of avifauna. Compensatory plantation and green belt development may reduce the impact.	Tree cutting will impact habitat of avifauna. Compensatory plantation and green belt development may reduce the impact.	Tree cutting will impact habitat of avifauna. Urban forests and avenue plantation may reduce the impact.	Tree cutting will impact habitat of avifauna. Compensatory plantation and green belt development may reduce the impact.	Agriculture field may provide habitat to avifauna	Avifauna will continue to be impacted due to loss of habitat. Impact will increase due to NW-1 and other upcoming developments in the area
Soil Quality (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Buxar)	Loss of productive top soil for development of terminals or jetties but impact will be very less. Soil may be required for development of embankment o carrying out other bank protection work. This soil can be sourced from agriculture fields. Spillage of materials at site may contaminate the soil in the area	Large amount of soil required for construction of embankments	Soil pollution may occur, if appropriate measures for material & waste handling not taken	Soil pollution, soil compaction etc may increase due to improper waste disposal	Large amount of soil required for construction of embankments	Soil may become saline due to excess irrigation and use of fertilizers and pesticides	Soil quality, & fertility will continue to deteriorate due to upcoming developments in the area and will also be impacted due to Jal Marg Vikas Project
River Bed Sediment Quality	River bed sediments are disturbed due to dredging & piling. I contaminated may lead to release	Low Impact	May lead to pollution of river bed sediments	Low Impact	Low Impact	Pesticides/fertilizers may enter the water bodies and	River bed sediments will further pollute due to continued use

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
(Ghazipur, Varanasi, Allahabad)	of pollutants in the water. At present river sediments are not contaminated in the entire stretch except Ghazipur, Varanasi & Allahabad where pesticides were found in traces but they are below the level as per US standard for off-shore disposal. Cadmium levels are found higher in Allahabad, Varanasi & Ghazipur but concentration is below the toxicity level for fishes.		due to usage of heavy metals			ultimately to sediments along with the runoff from these areas	of fertilizers and pesticides
Soil/Bank Erosion (Farakka to Murshidabad, Sahibganj, Patna, Ghazipur, Varanasi)	Construction of terminals/jetties may lead to bank/soil erosion and bed scouring in upstream and downstream of the developed structure. But shore/bank protection measures & bed scouring protection measures are being taken by IWAI already. Erosion is expected in narrow stretches like feeder canal	Excavation of soil from borrow area may lead to significant soil erosion. Soil erosion may happen at embankments also during rains and storms	Soil quality may be polluted but can be taken care by taking adequate waste management techniques and mulching. Soil erosion may occur if areas left open without any paving or plantation	Soil erosion may increase due to construction of open areas without vegetation	Excavation of soil from borrow area may lead to significant soil erosion. Soil erosion may happen at embankments also during rains and storms	Soil erosion may occur during the rains from agricultural fields but can be controlled using various techniques	Soil erosion will increase in the influence area due to NW-1 and other identified development
Quality of Life-Health & Education (Haldia, Kolkata-Mahesthala, Katwa to Hoogly Ghat,	Increase employment opportunities, reduced transportation cost, reduced accident risk and reduced air emissions and GHG emissions as compared to road/rail thus positive impact on quality of life	Increase employment opportunities, reduced transportation cost, reduced accident risk and reduced air	Increase employment opportunities thus will improve quality of life but increased pollution may increase the	Increase employment opportunities, better infrastructure will improve quality of life	Increase employment opportunities and improved connectivity will improve quality of life but increased air and	Increased agriculture productivity & income thus improved quality of life	Quality of life will improve due to industrial and infrastructure development in the area but health and living conditions may deteriorate due

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
Farakka to Murshidabad, Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Semaria-Begusarai-Barh, Patna, Buxar, Ghazipur, Varanasi, Allahabad)		emissions and GHG emissions as compared to road thus positive impact on quality of life	health issues and pollution problems in the area		noise pollution will deteriorate the health of the people and living conditions		to increased pollution
Pressure on Existing Resources (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Ghazipur, Varanasi)	Will reduce pressure on railway and NH but may increase pressure on the feeder routes and nearby settlements/industrial towns due to induced growth options	Will reduce pressure on IR track and NH but will continue to pressurize the feeder routes and nearby settlements/industrial towns due to induced growth options	Will further increase pressure on all the resources significantly	Will further increase pressure on all the resources significantly	Pressure on existing infrastructure will reduce due to development of good road network	No significant impact	Pressure on existing resources will continue to increase due to continued industrial and other infrastructure development. Pressure on IR & road may reduce due to shift of freight to IWT with Jal Marg Vikas Project
New Infrastructure Development (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj,	Development of new infrastructure in terms of roads & railways is expected near the terminal/jetties location	Development of new infrastructure in terms of roads & railways is expected near the stations	Industrial developments always brings infrastructure development along with it	Urbanization will lead to development of new infrastructure	Infrastructure development will take place as soon as the area gets proper road connectivity	No significant impact	New infrastructure will continue to be developed with the industrial and infrastructure development.

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
Ghazipur, Varanasi)							
Livelihood- Fishing Activity & loss of Agriculture land (Haldia, Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Ghazipur, Varanasi)	Fishing activities may be disturbed due to barge operations and dredging activities. Agricultural land may be required to acquire for development of terminals and other facilities. This will lead to loss of livelihood	Agricultural land is required to acquire for development of track and associated facilities. This will lead to loss of livelihood	Acquisition of land for development of industrial areas or zone will lead to loss of livelihood	Change in land use of agricultural land into residential and commercial will lead to loss of productive agricultural land for urbanization purpose	Agricultural land is required to acquire for development of road. This will lead to loss of livelihood	Agriculture productivity will increase in the area which will enhance the livelihood of the people	Agricultural land will continue to be acquired for various industrial and infrastructural developments. NW-1 development will add to this and also may lead to impact on fishing due to dredging and barge movement
Religious Values (Haldia, Mangalghat (Rajmahal), Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Munger, Semaria-Begusarai-Barh, Patna, Buxar, Varanasi, Allahabad)	Religious sentiments and festivals are associated with River Ganga. Dredging, barge movement and terminal operation facilities impact the religious sentiments of the people	Religious places within the ROW may be required to be relocated or removed due to development of track	No significant impact	No significant impact	Religious places within the ROW may be required to be relocated or removed due to development of road	No significant impact	Religious places and values may be continued to be impacted due to development of rail/railway.
Traffic (Haldia, Kolkata-Mahesthala, Katwa to Hoogly Ghat,	Traffic volume on road/rail will reduce overall due to shift of the freight to the IWT mode. However traffic volume may increase on the roads connecting	Traffic volume on road will reduce overall due to shift of the freight to EDFC. However	Traffic volume will increase on the roads connected to industrial areas	Traffic volume will increase due to shift of population from rural area to urban	Traffic volume will increase but the increased road capacity will reduce the traffic	No significant impact. Some traffic may increase due to transportation of	Traffic volume will increase due to increased development but the traffic volume on

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
Farakka to Murshidabad, Mangalghat (Rajmahal), Sahibganj, Pirpanti-kahalgaon-Bhagalpur, Munger, Patna, Buxar, Ghazipur, Varanasi)	to the terminals/jetties	traffic volume may increase on the roads connecting to the stations	and highways due to transportation of raw material and products	areas	jams	crops/grains	road/rail will reduce due to shift of freight to IWT
Land Use (Katwa to Hoogly Ghat, Farakka to Murshidabad, Sahibganj, Patna, Ghazipur, Varanasi)	Land may required to be acquired for construction of various proposed civil interventions which will lead to change in land use.	Land use diversion for track construction from agricultural use. Soil from agricultural land being used for development of borrow areas	Land use may change from agricultural land use to industrial use	Expansion of the urban area may require diversion of agricultural land for urban area development	Land use diversion for road construction-significant for green field projects	No significant impact	More change of land use. Diversion of more agricultural and forest land for other uses
Archaeological Sites (Kolkata-Mahesthala, Farakka to Murshidabad, Mangalghat (Rajmahal), Varanasi)	No intervention planned close to archaeological sites at present thus minimal impact but may have impact if any activity is undertaken in future	EDFC alignment at Varanasi is not within 300 m of any of the archaeological site thus no major impact.	Industrial development is generally avoided in close vicinity of such site. If done permission is required from ASI/INTACH and measures are taken to prevent any damage to Archaeological	Construction in close vicinity of Archaeological sites is restricted thus no impacts. Pollution & public nuisance in urban area however may impact the aesthetics of these sites	Road construction activities close to these sites may impacts these sites. Measures should be taken to prevent any impact on these sites.	No significant impact	Impacts on Archaeological sites may continue to occur due to developments and the impact may increase if any development related to NW-1 will be undertaken within 300 m of such site

Developments /VECs (Hotspots)	Small Scale Impacts						Large Scale Impacts
	NW-1	EDFC	Development of Industries & Industrial Area/zones/parks/TPPs	Urbanization	Road Development	Irrigation Schemes/Dams	Cumulative Impact
			sites				

We can say that maximum interaction will take place in the zones experiencing the overlapping impacts due to above mentioned developments. These zones are the zones which are identified in table 6.1, i.e. hotspots, on basis of baseline study and stakeholder consultation as they are the ones which are experiencing or will experience developments. Due to these interactions, VECs in these zones will experience the cumulative impacts, i.e. impact due to these developments individually and impact due to other developments in the surrounding areas. Cumulative impacts anticipated on VECs are listed in the last column of **Table 6.4** above.

6.6 Assessment of Cumulative Impacts

In this section an attempt has been made to quantify the anticipated impact by assigning score to each impact and the development in scale of 1-5 and is defined in **Table 6.5** below. Cumulative impact assessment is carried out for the hotspots identified in Table 6.1 & the criteria for selection of them as hotspot above to assess the magnitude and significance of cumulative impact and is given in **Table 6.6 & Figures 6.14-6.32.**

Table 6.5: Rating Scale for Average Score

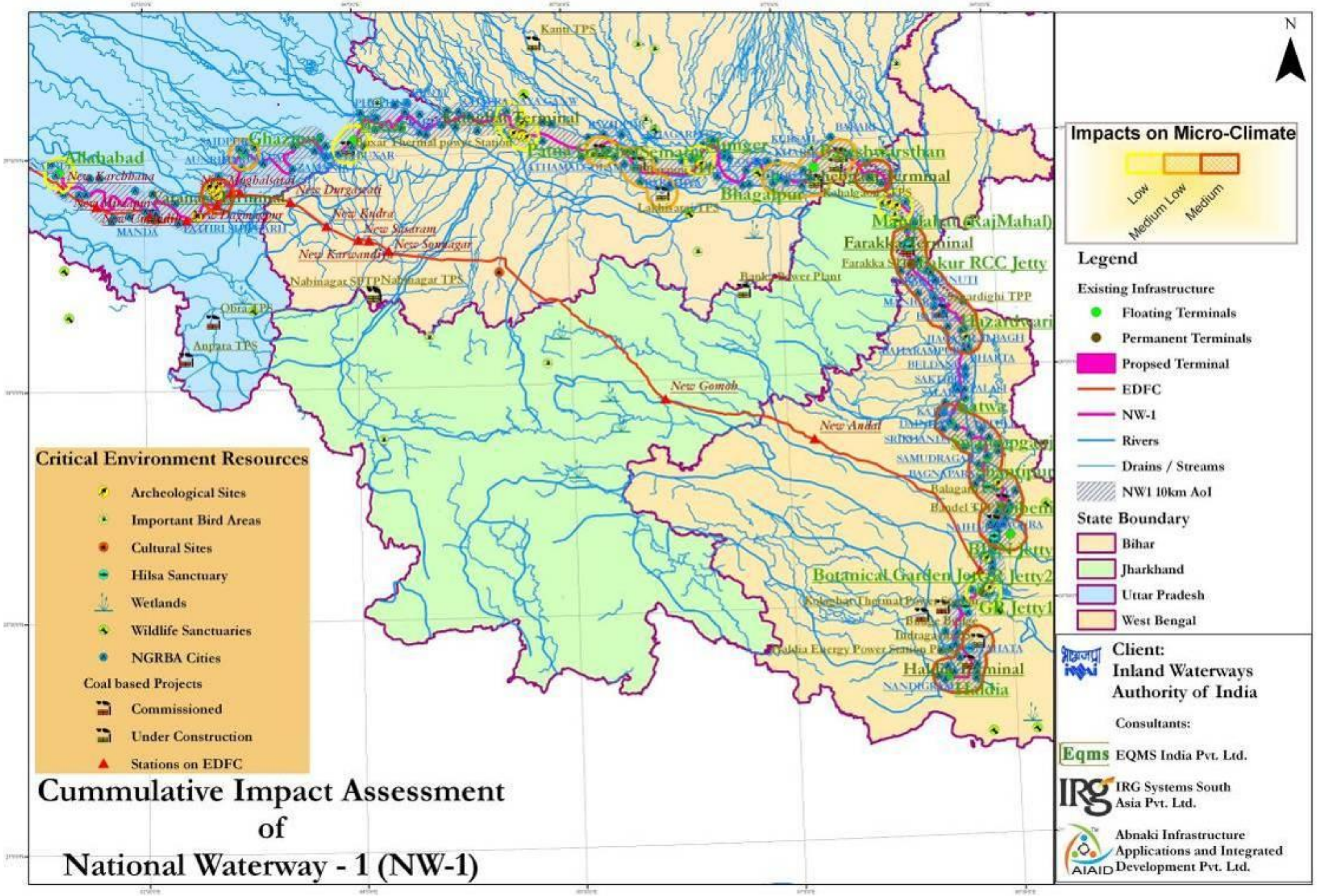
Range of Average Score	Type of Impact	Color Coding
0	Nil	
0.5-1.0	Low (L)	
1.0-1.5	Moderately Low (ML)	
1.5-2.0	Moderate (M)	
2.0-2.5	Moderately High (MH)	
2.5-3.0	High (H)	

Table 6.6: Cumulative Impacts Due to Existing, Planned and Proposed Developments on Hotspots

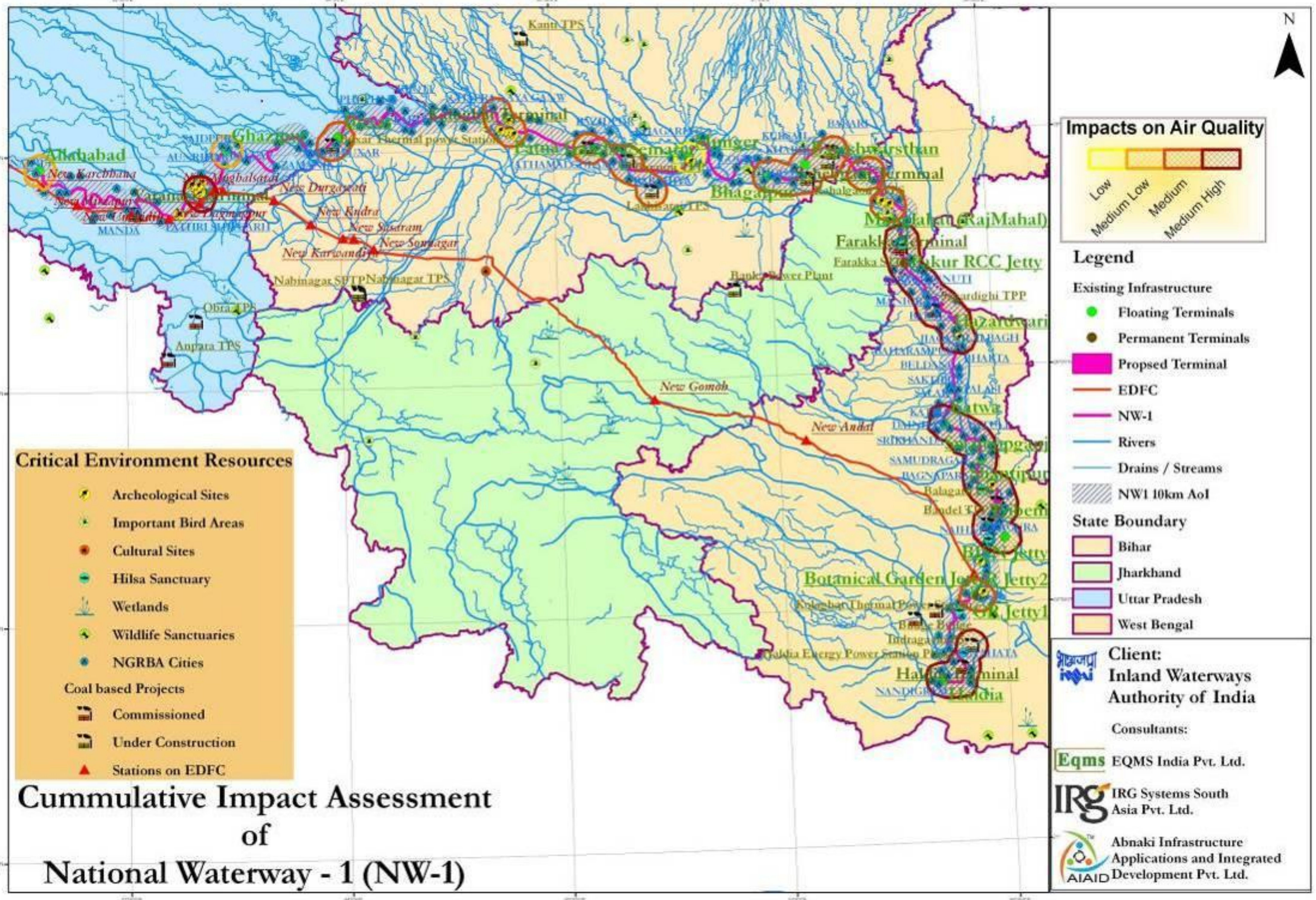
VECs/Hotspots	Haldia	Kolkata-Mahesthala	Katwa to Hoogly Ghat	Farakka to Murshidabad	Mangalghat (Rajmahal)	Sahibganj	Pirpanti-Kahalgaon-Bhagalpur	Munger	Semaria-Begusarai- Barh	Patna	Buxar	Ghazipur	Varanasi	Allahabad	Remarks
MC	2 M	1 L	2 M	2 M	1 L	2 M	1.5 ML	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	2 M	1 L	L-M
AQ	2.5 MH	2 M	2.5 MH	2.5 MH	2 M	2 M	2 M	1 L	2 M	2 M	2 M	1.5 ML	2.5 MH	1.5 ML	L-MH
WR/F	2.5 MH	1.5 ML	2 M	2 M	1 L	1.5 ML	1.5 ML	1 L	1.5 ML	1.5 ML	1.5 ML	1 L	1.5 ML	1 L	L-MH
GWQ	2.5 MH	1.5 ML	1.5 ML	1.5 ML	0.5 L	1.5 ML	1.5 ML	2 M	1.5 ML	2 M	1 L	0.5 L	1.5 ML	1.5 ML	L-MH
SWQ	2 M	1.5 ML	2 M	2 M	1.5 ML	1.5 ML	2 M	2 M	2 M	2 M	2 M	1.5 ML	2.5 MH	1 L	L-MH
D	1.5 ML	0.5 L	1.5 ML	1.5 ML	0.5 L	1 L	1 L	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	1.5 ML	1 L	L-ML
NL	2 M	1 L	1.5 ML	2 M	1.5 ML	1.5 ML	1.5 ML	1 L	1 L	1.5 ML	1.5 ML	1 L	2.5 MH	1.5 ML	L-MH
V	0	0	0	0	0	0	0	0	0	0	0	0	1.5 ML	1.5 ML	M
BD	1.5 ML	1.5 ML	2 M	2.5 MH	2 M	2 M	2.5 MH	0.5 L	1.5 ML	2 M	1 L	1.5 ML	2.5 MH	1.5 ML	L-MH
SQ	1.5 ML	0.5 L	1.5 ML	1.5 ML	1.5 ML	1.5 ML	1.5 ML	0.5 L	1 L	1.5 ML	0.5 L	1 L	2 M	2 M	L-M
SE	1 L	0.5 L	0.5 L	2.5 MH	1 L	2.5 MH	1 L	0.5 L	1.5 ML	1 L	1 L	1.5 ML	2 M	1 L	L-MH
QOL	2 M	1.5 ML	2 M	2 M	1.5 ML	1.5 ML	1.5 ML	1 L	1.5 ML	1 L	1 L	1.5 ML	2 M	1.5 ML	L-M
ER	2.5 MH	1 L	2.5 MH	2 M	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	0.5 L	0.5 L	1	2 M	1 L	L-MH
NI	1.5 ML	1 L	1.5 ML	1.5 ML	1 L	1.5 ML	0.5 L	1 L	1.5 ML	1.5 ML	0.5 L	1.5 ML	1.5 ML	1 L	L-ML
LI	1.5 ML	1.5 ML	1.5 ML	1.5 ML	1 L	1.5 ML	1.5 ML	1 L	1 L	1.5 ML	1.5 ML	1 L	1.5 ML	1 L	L-ML
RV	1.5 ML	0.5 L	1 L	1 L	1.5 ML	1.5 ML	1.5 ML	1.5 ML	1.5 ML	1.5 ML	1.5 ML	0.5 L	2 M	1.5 ML	L-M
TV	1.5 ML	0.5 L	1.5 ML	1.5 ML	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	1.5 ML	0.5 L	L-ML
LU	1 L	0.5 L	2 M	2 M	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	0.5 L	0.5 L	1.5 ML	1 L	0.5 L	L-M

AS	0	1.5 ML	0	0	2 M	0	0	0	0	0	0	0	2 M	0	ML-M

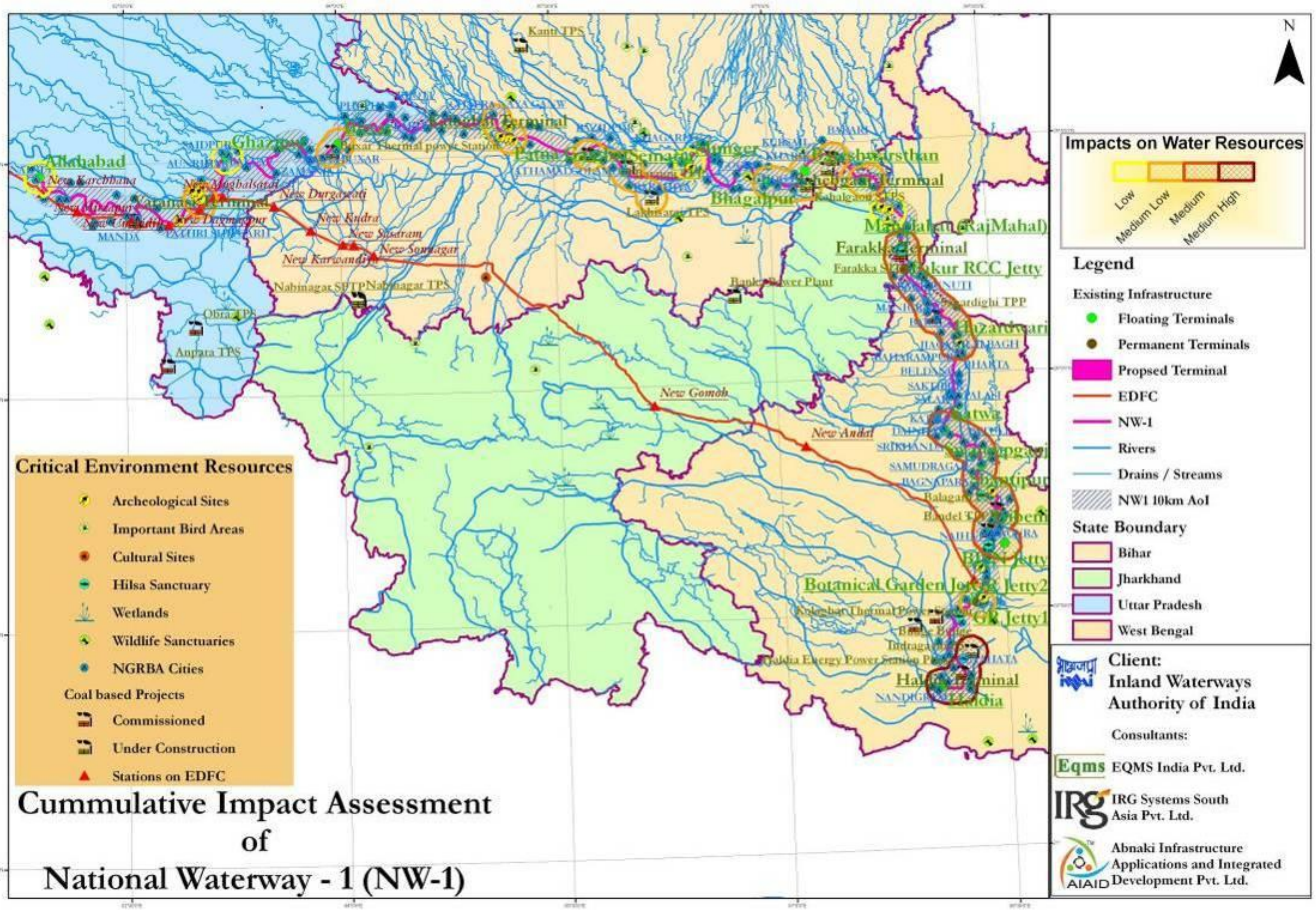
***MC-Micro climate, AQ-Air quality, WR/F-Water resources & flow, GWQ-Ground water quality, SWQ-Surface water quality, D-drainage, NL-noise level, V-Vibrations, BD-Bio-diversity (Aquatic +Terrestrial +Avifauna), SQ-Soil & River Bed Sediment quality, SE-soil/Bank erosion, QOL-Quality of life, ER-Pressure on existing resources, NI-New Infrastructure Development, LI-Livelihood (fishing & Agriculture), RV-Religious Values, TV-Traffic Volume, LU-land use, AS-Archaeological sites**



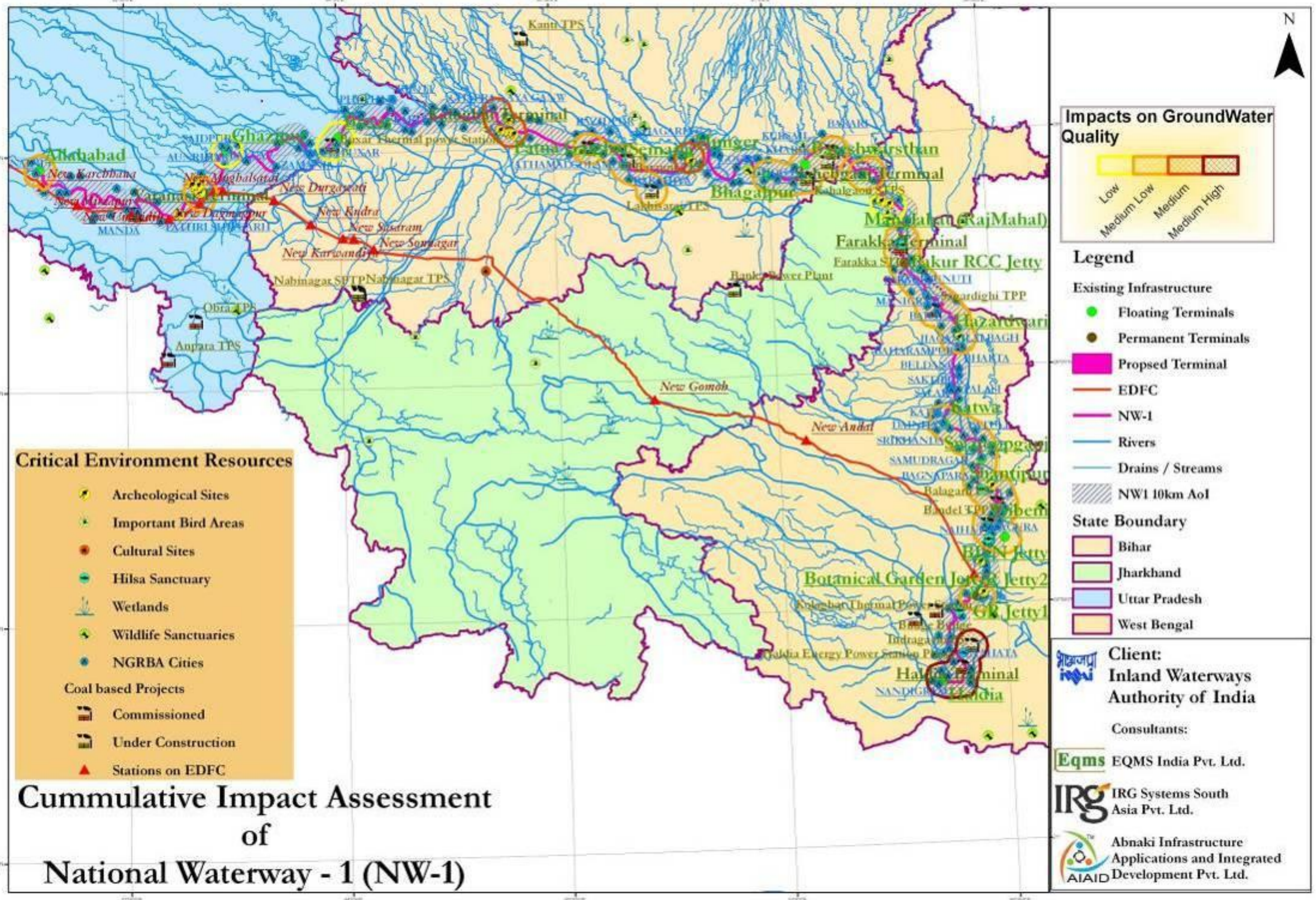
Figures 6.14: Map depicting Impacts on Micro Climate along NW – 1 Alignment



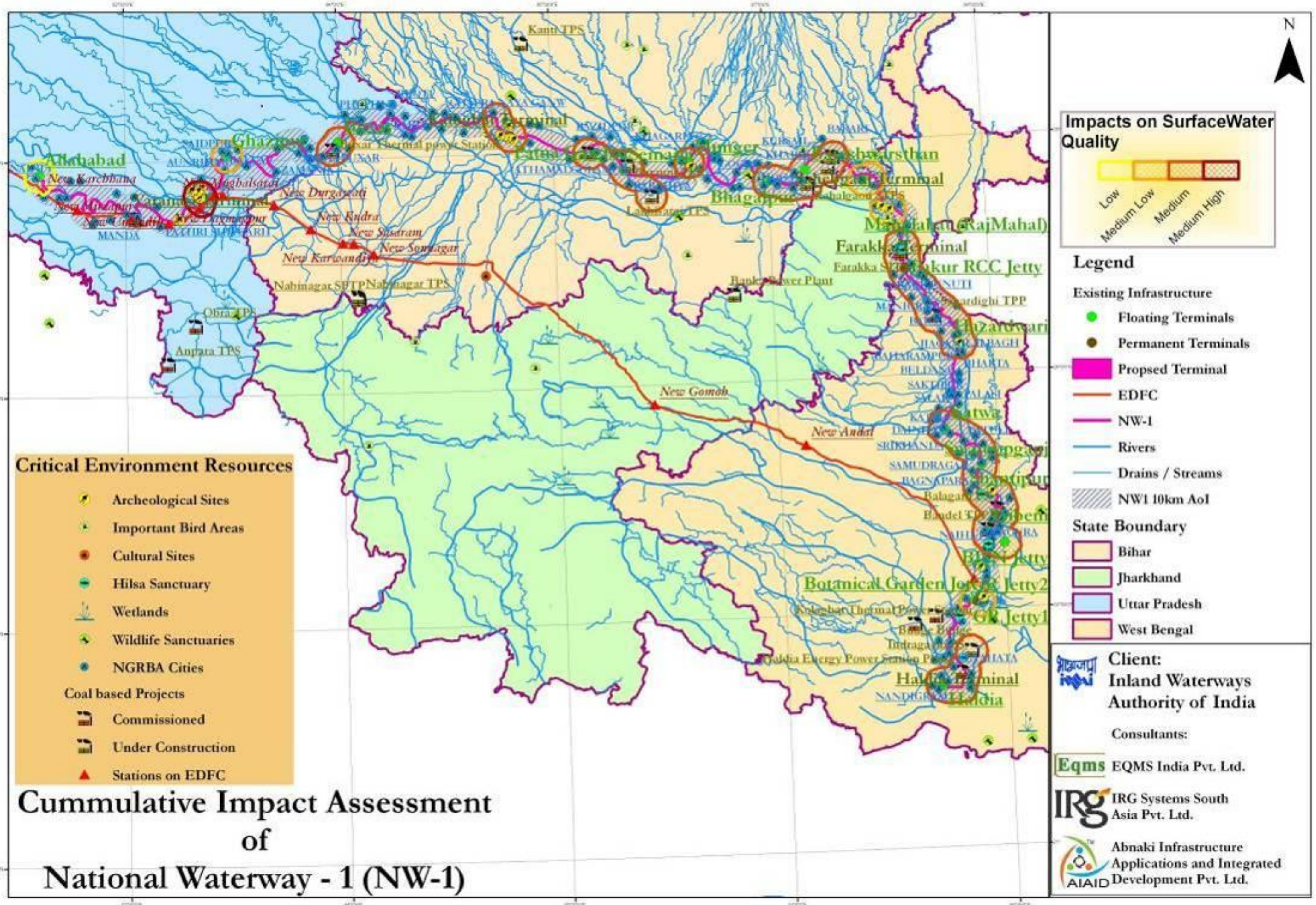
Figures 6.15: Map depicting Impacts on Air Quality along NW – 1 Alignment



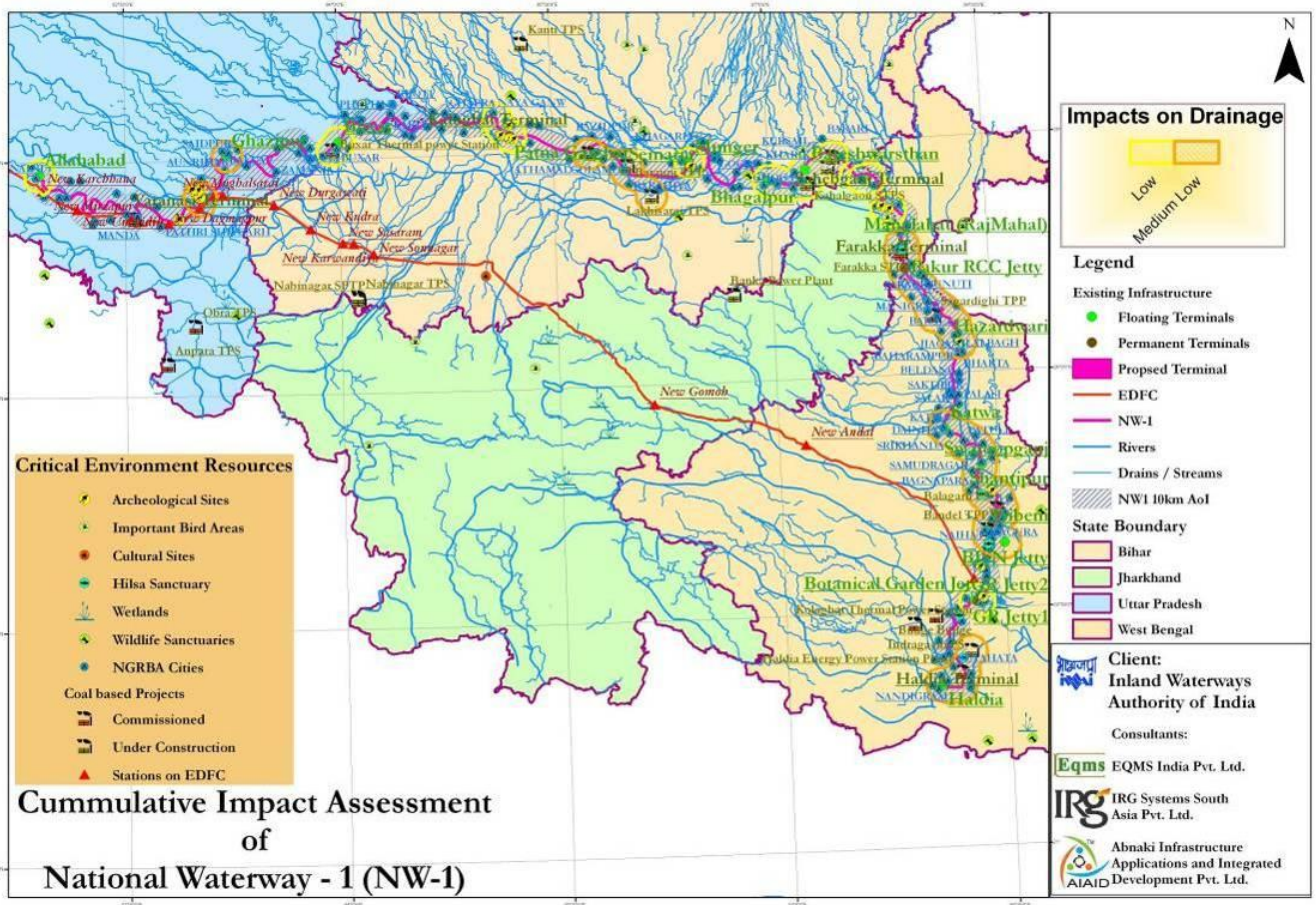
Figures 6.16: Map depicting Impacts on Water Resources & Flow along NW – 1 Alignment



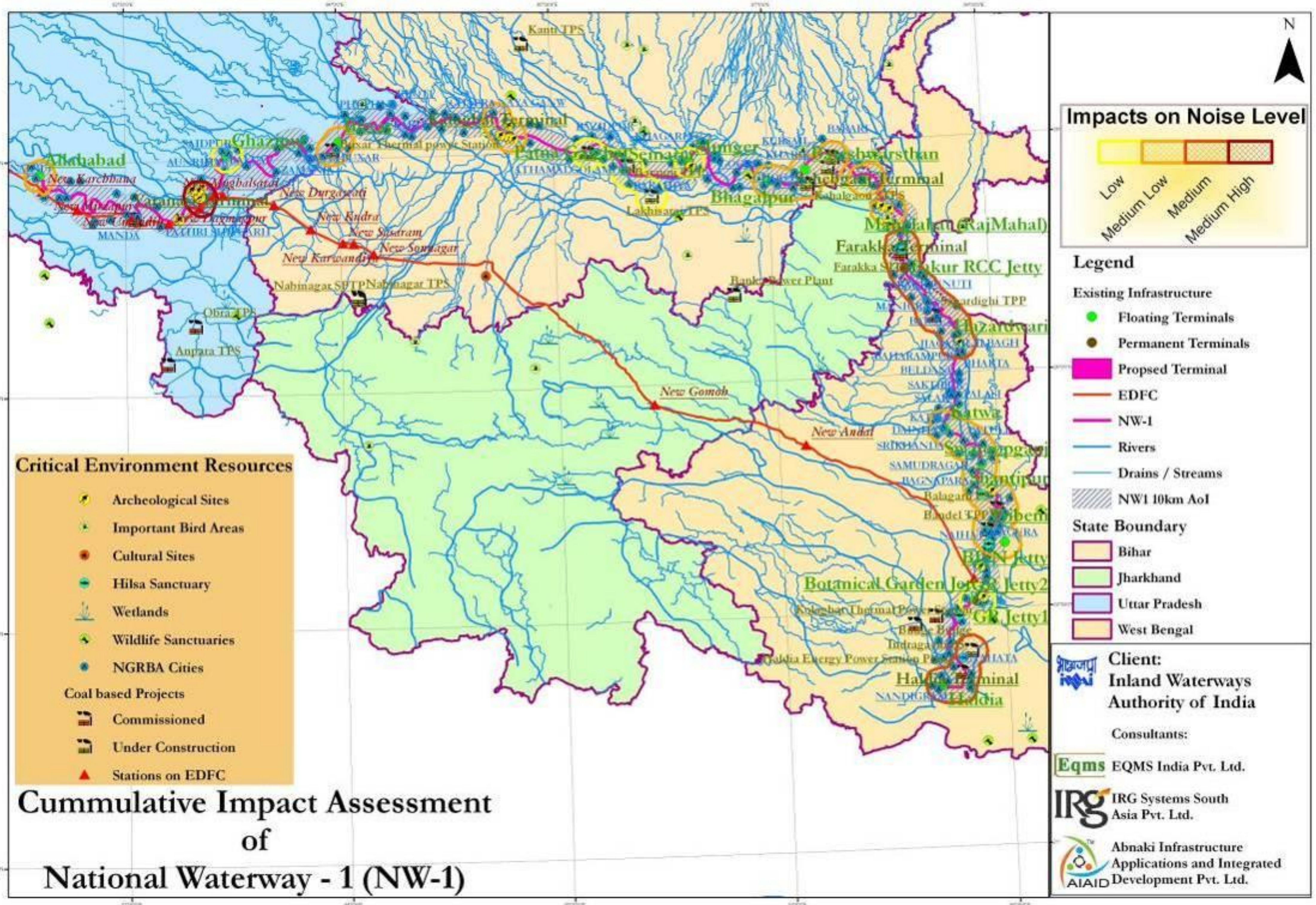
Figures 6.17: Map depicting Impacts on Ground Water Quality along NW – 1 Alignment



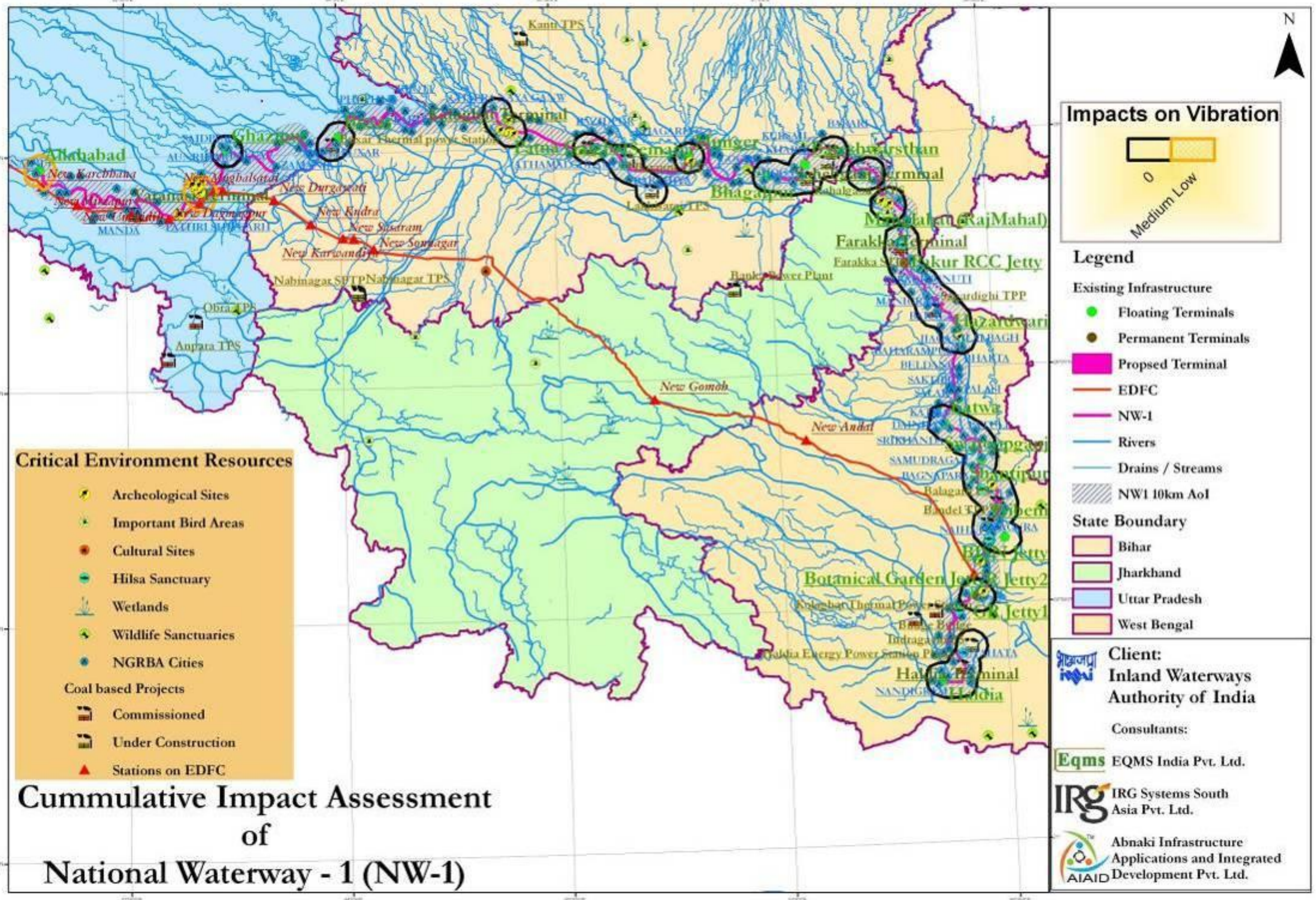
Figures 6.18: Map depicting Impacts on Surface Water Quality along NW – 1 Alignment



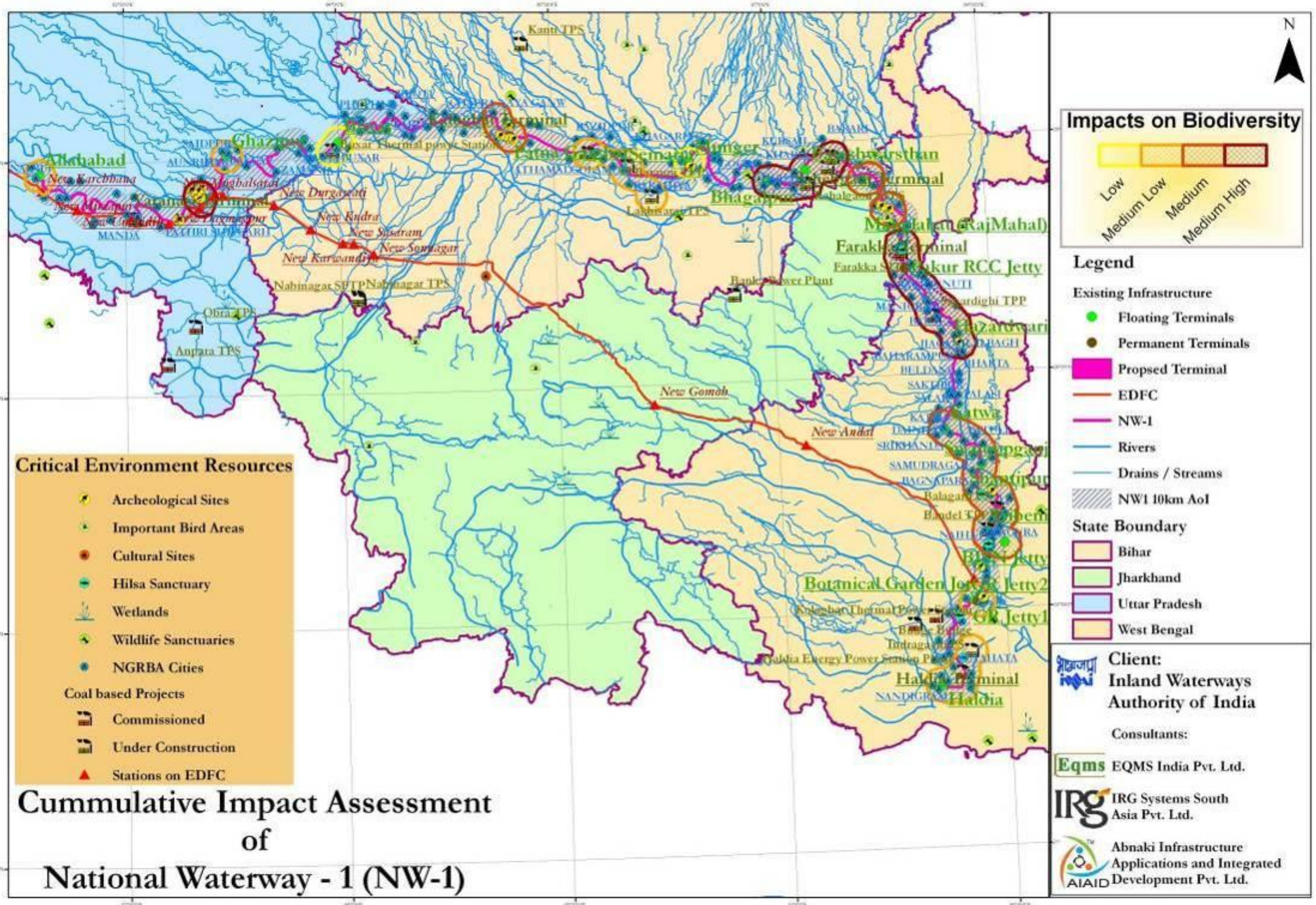
Figures 6.19: Map depicting Impacts on Drainage along NW – 1 Alignment



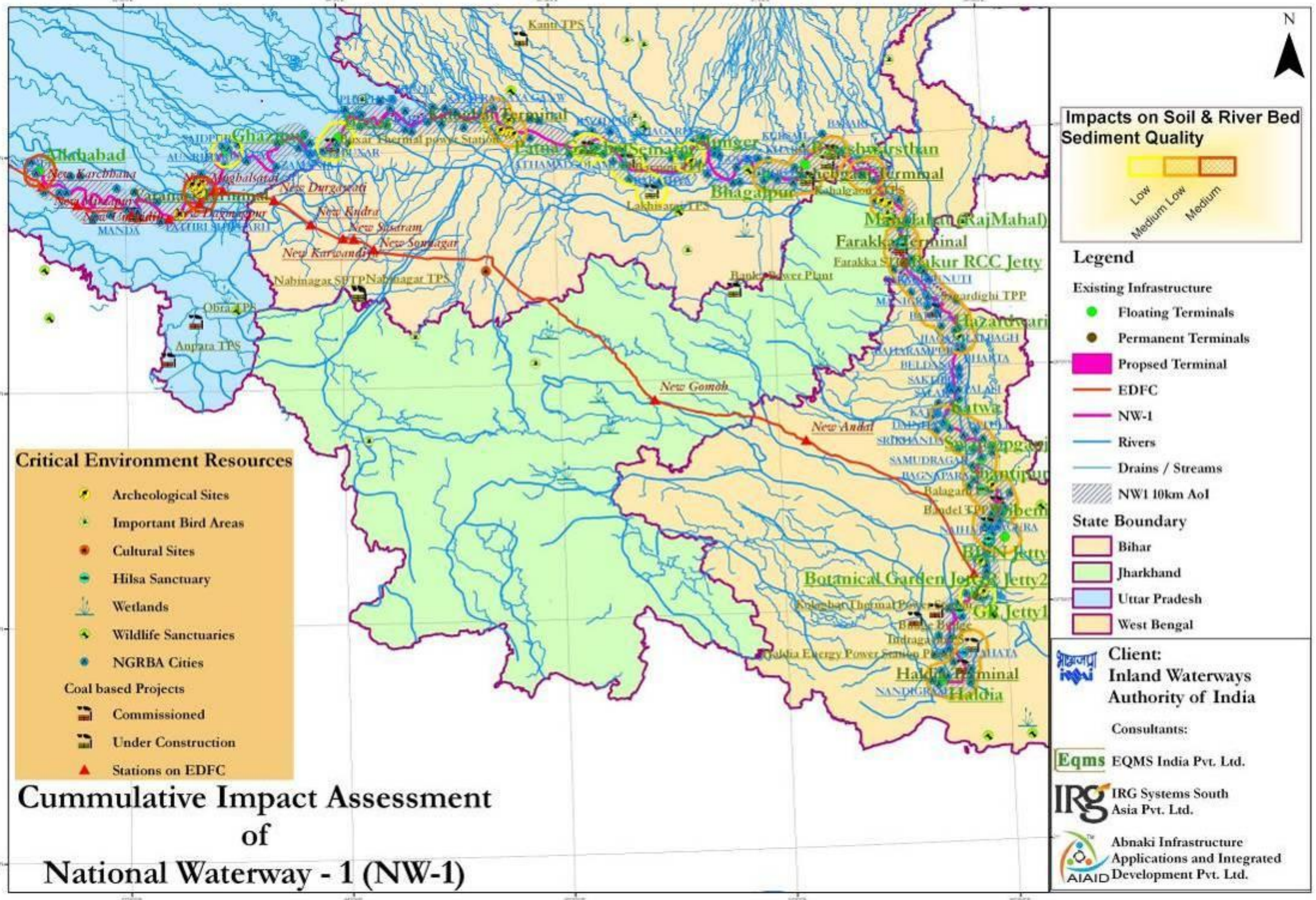
Figures 6.20: Map depicting Impacts on Noise Level along NW – 1 Alignment



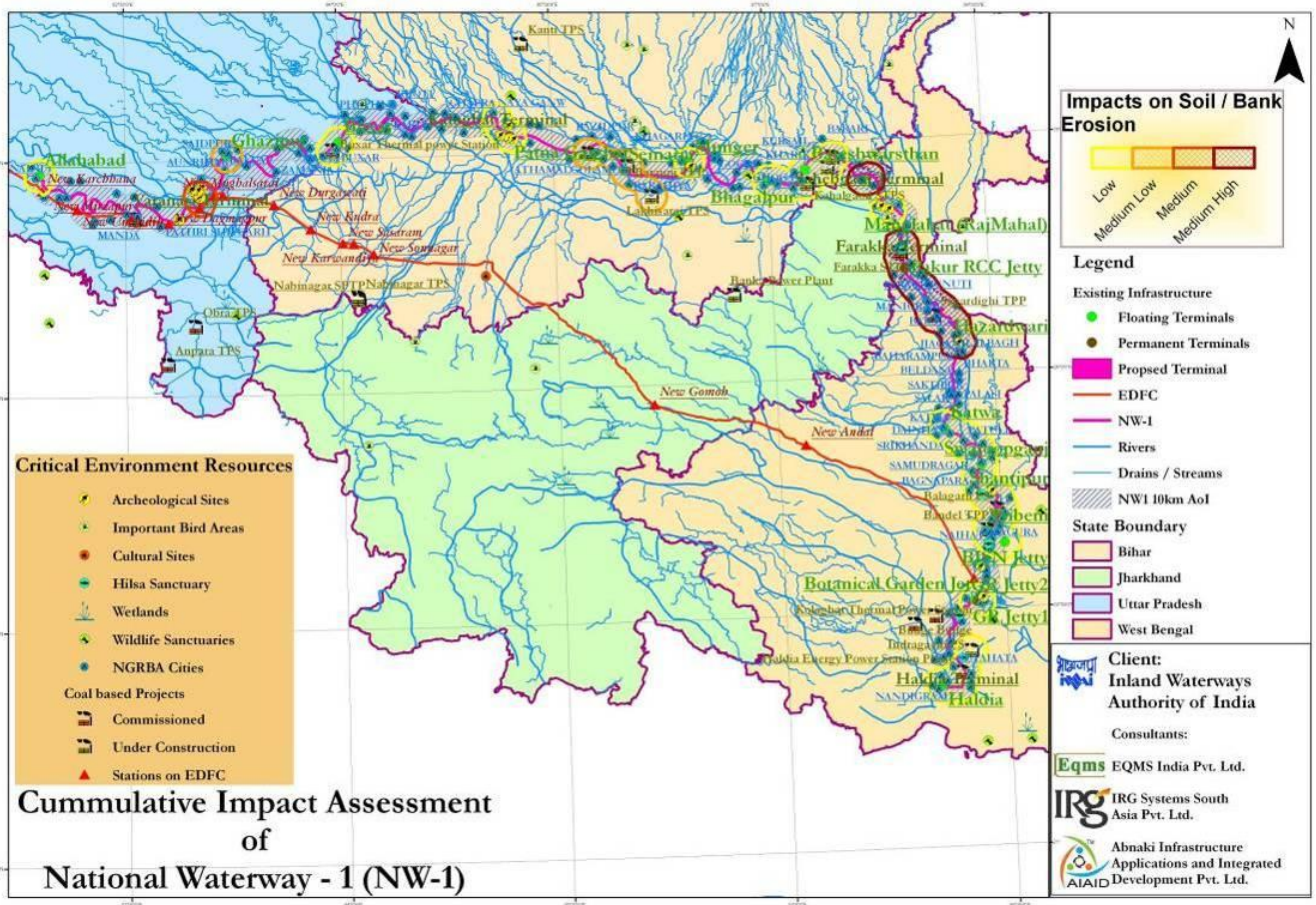
Figures 6.21: Map depicting Impacts on Vibration Level along NW – 1 Alignment



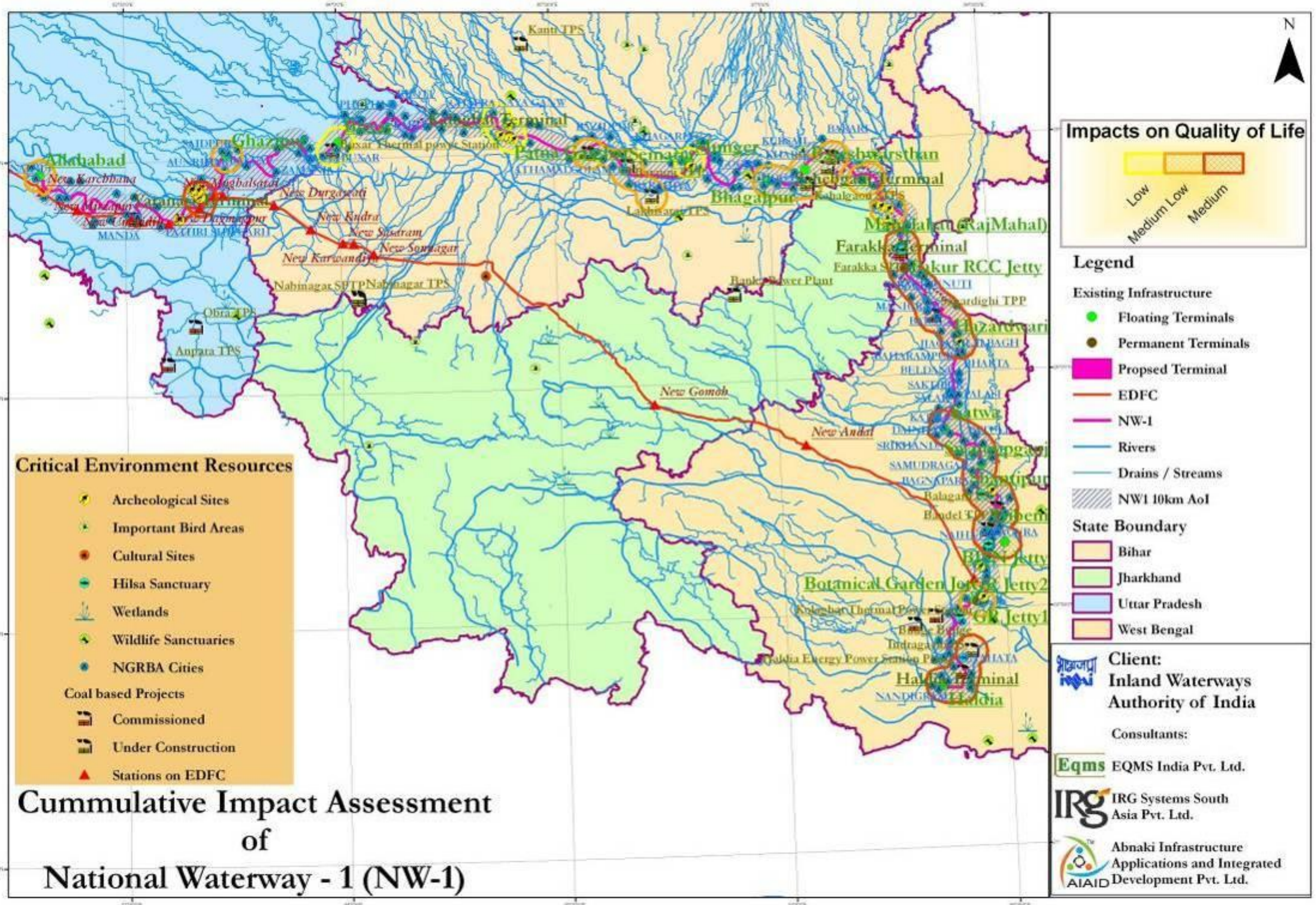
Figures 6.22: Map depicting Impacts on Biodiversity along NW – 1 Alignment



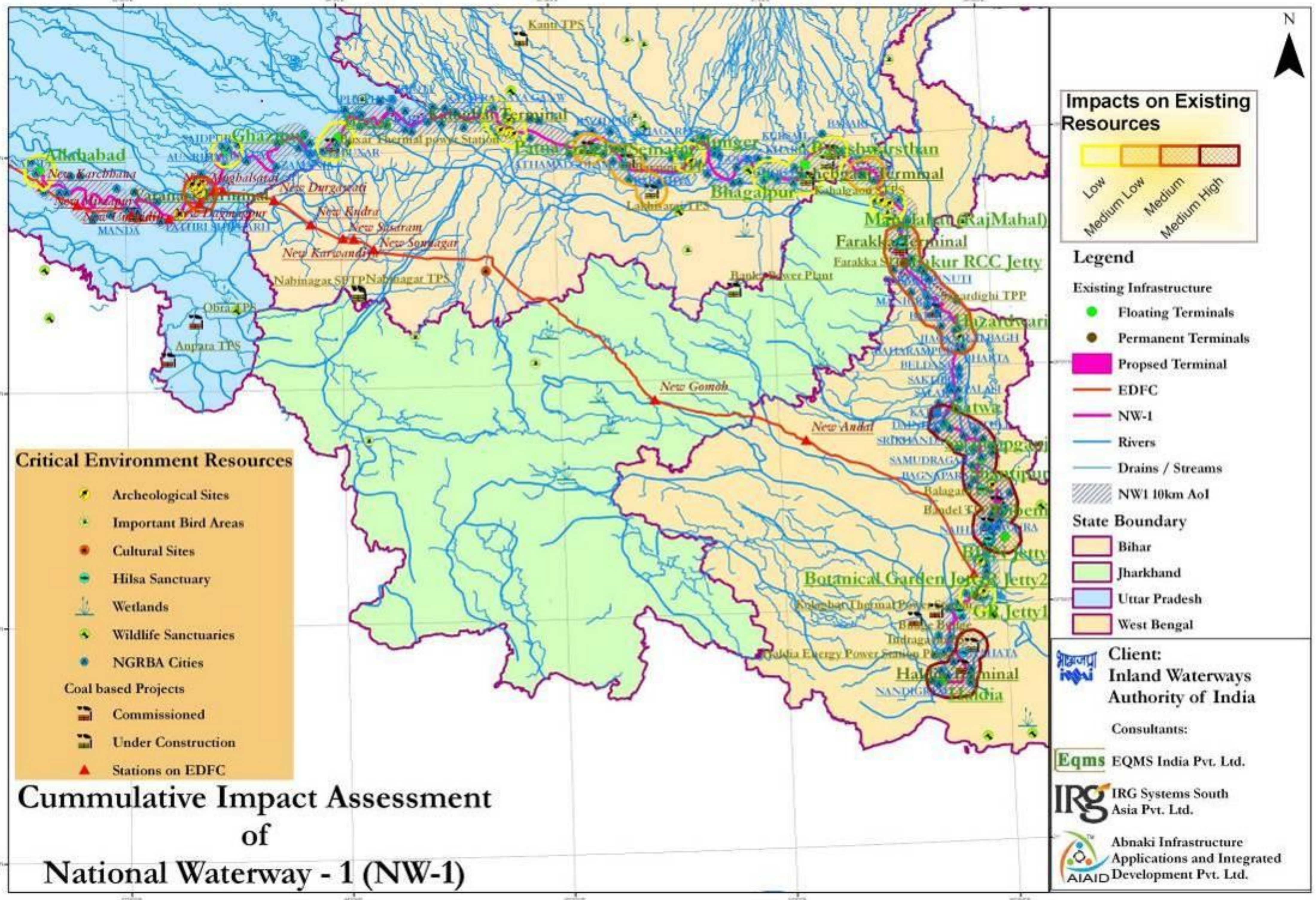
Figures 6.23: Map depicting Impacts on Soil & River Bed Sediment Quality along NW – 1 Alignment



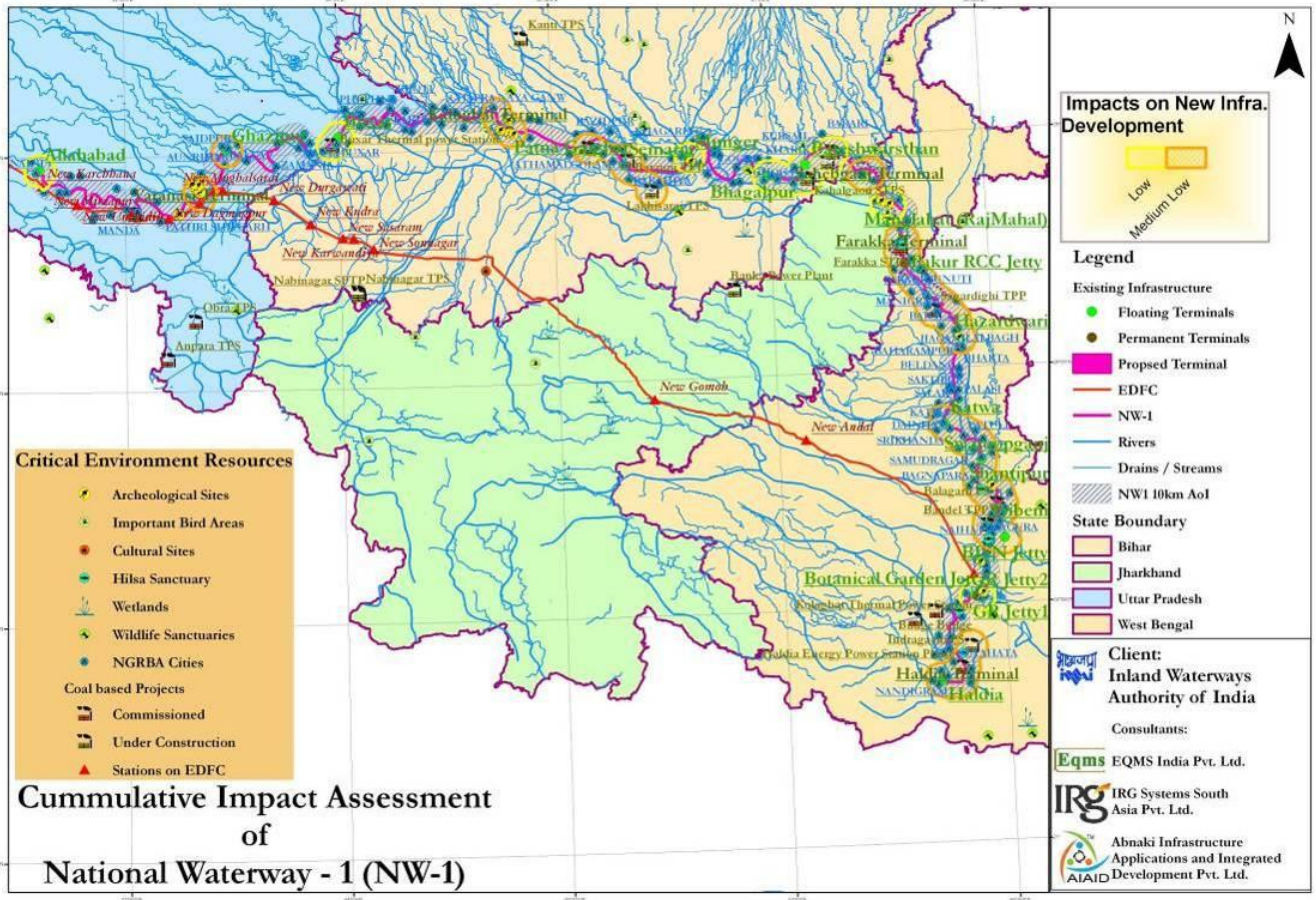
Figures 6.24: Map depicting Impacts on Soil / Bank Erosion along NW – 1 Alignment



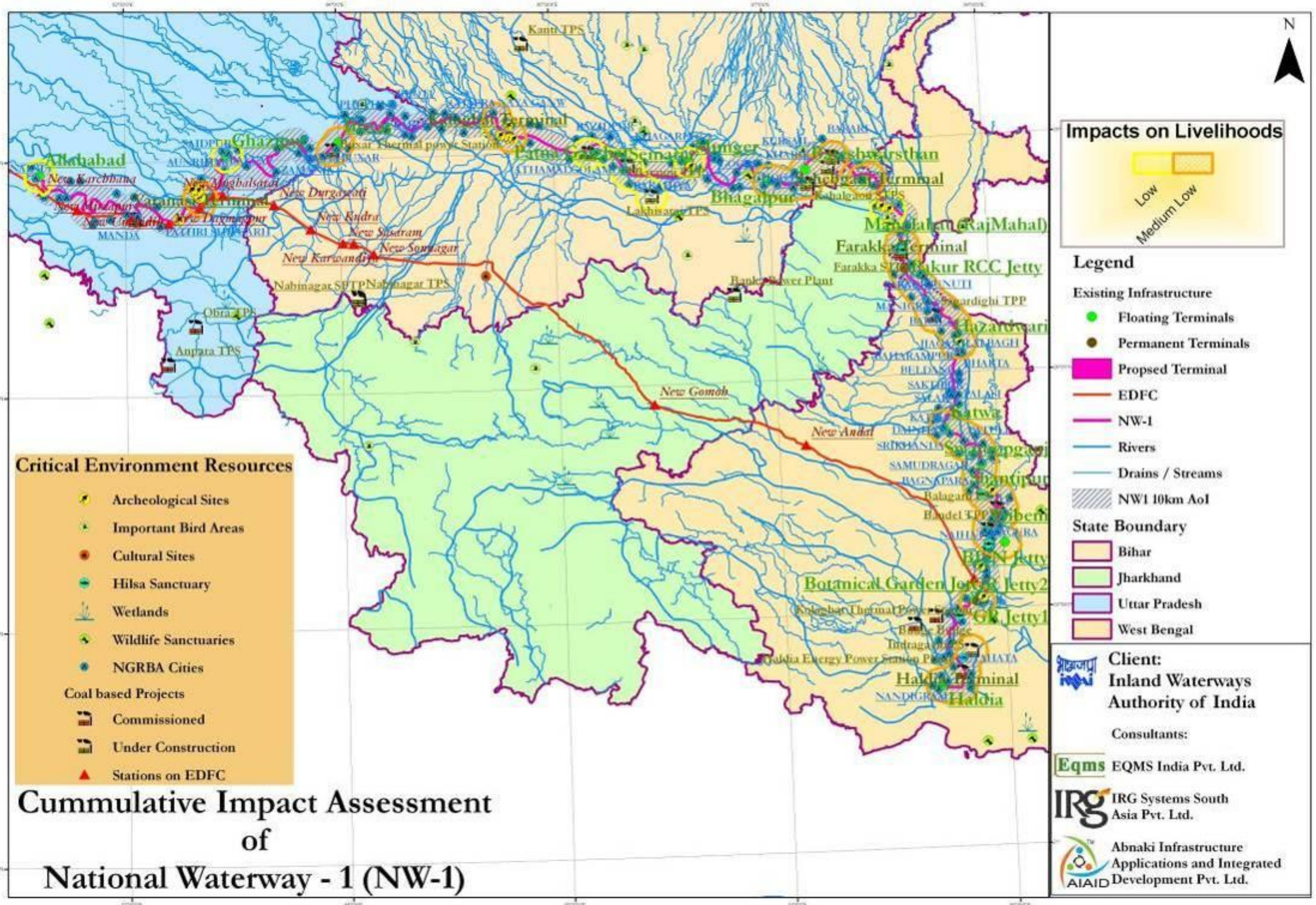
Figures 6.25: Map depicting Impacts on Quality of Life along NW – 1 Alignment



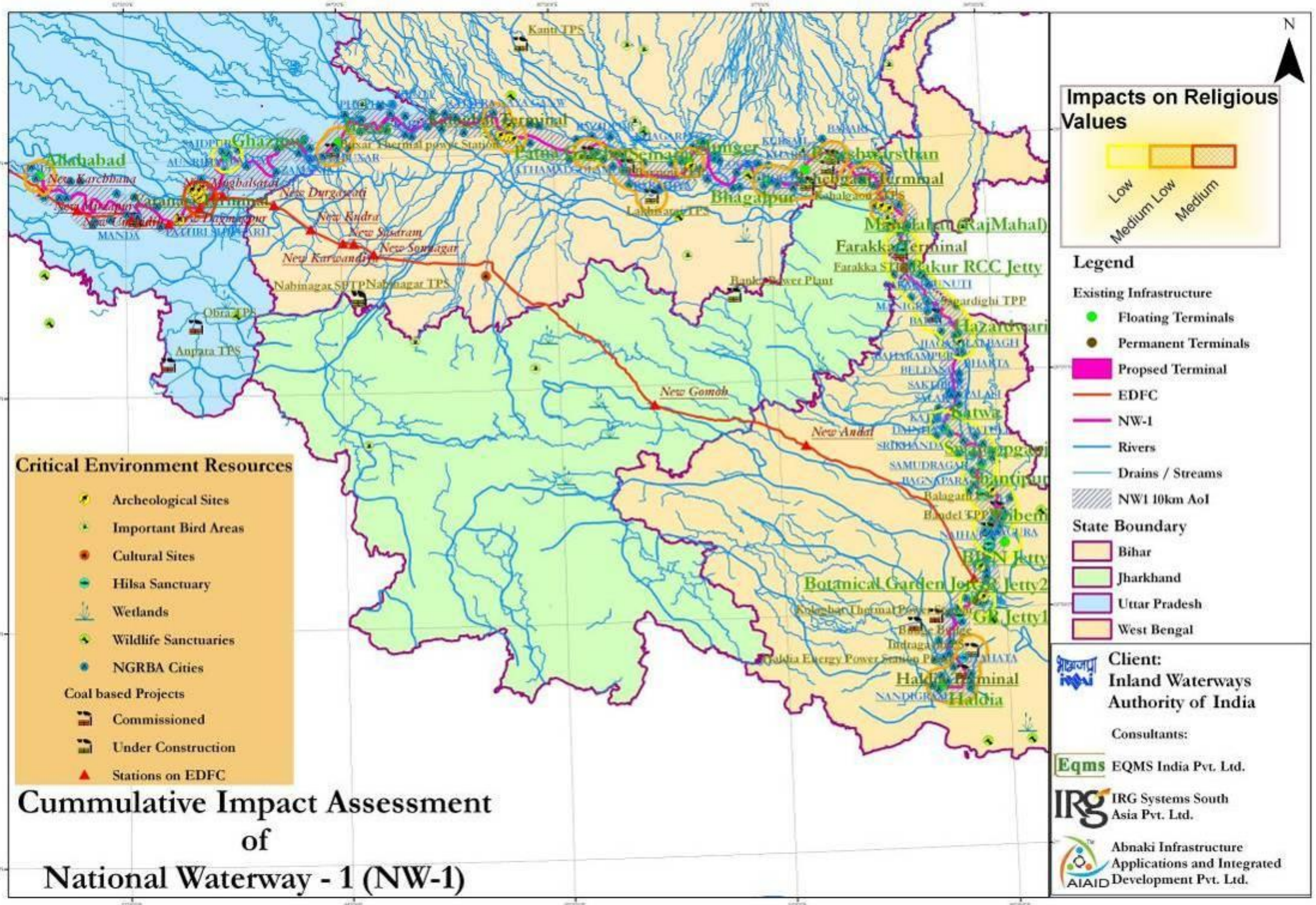
Figures 6.26: Map depicting Impacts on Pressure on Existing Resources along NW – 1 Alignment



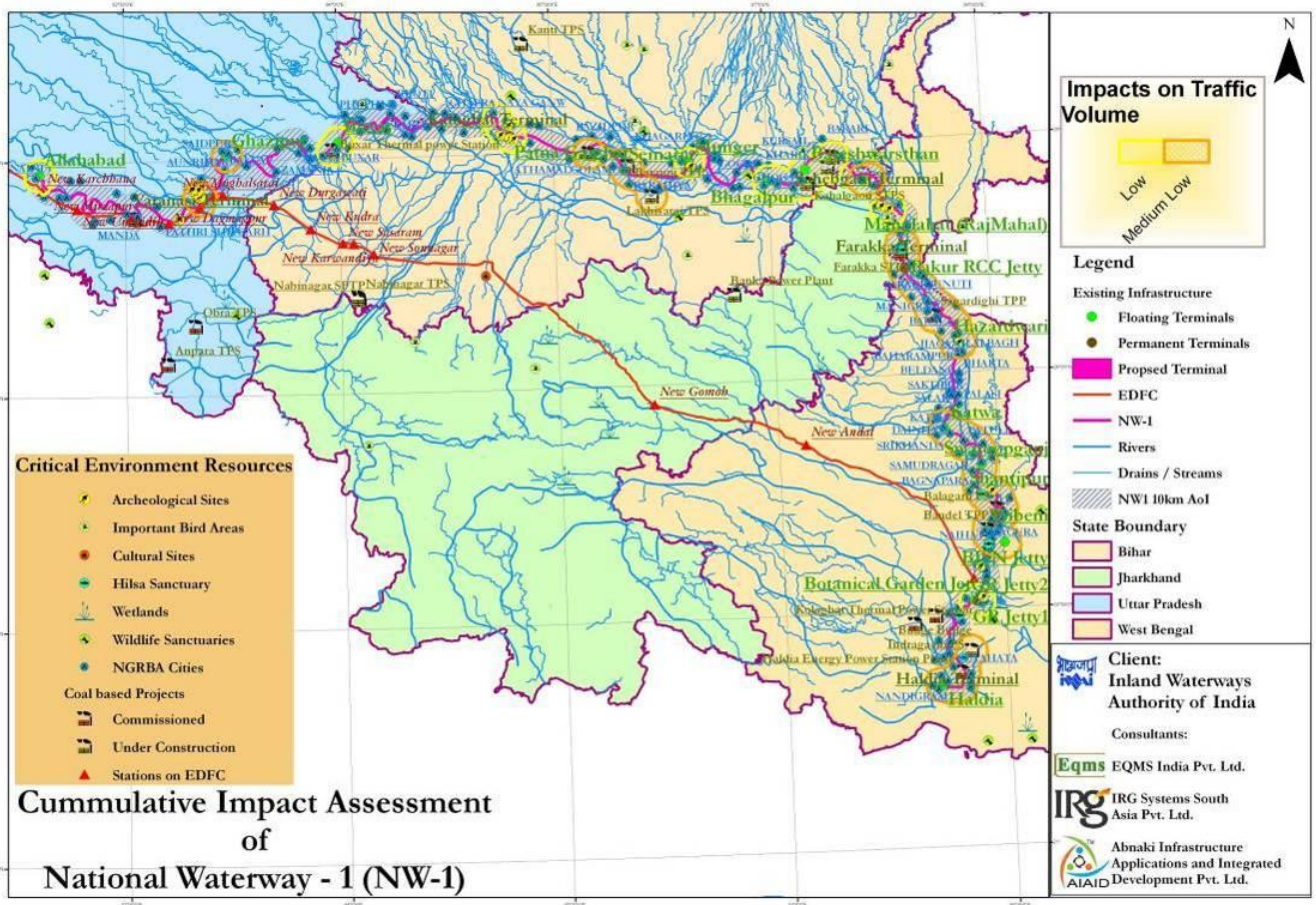
Figures 6.27: Map depicting Impacts on New Infrastructure Development along NW – 1 Alignment



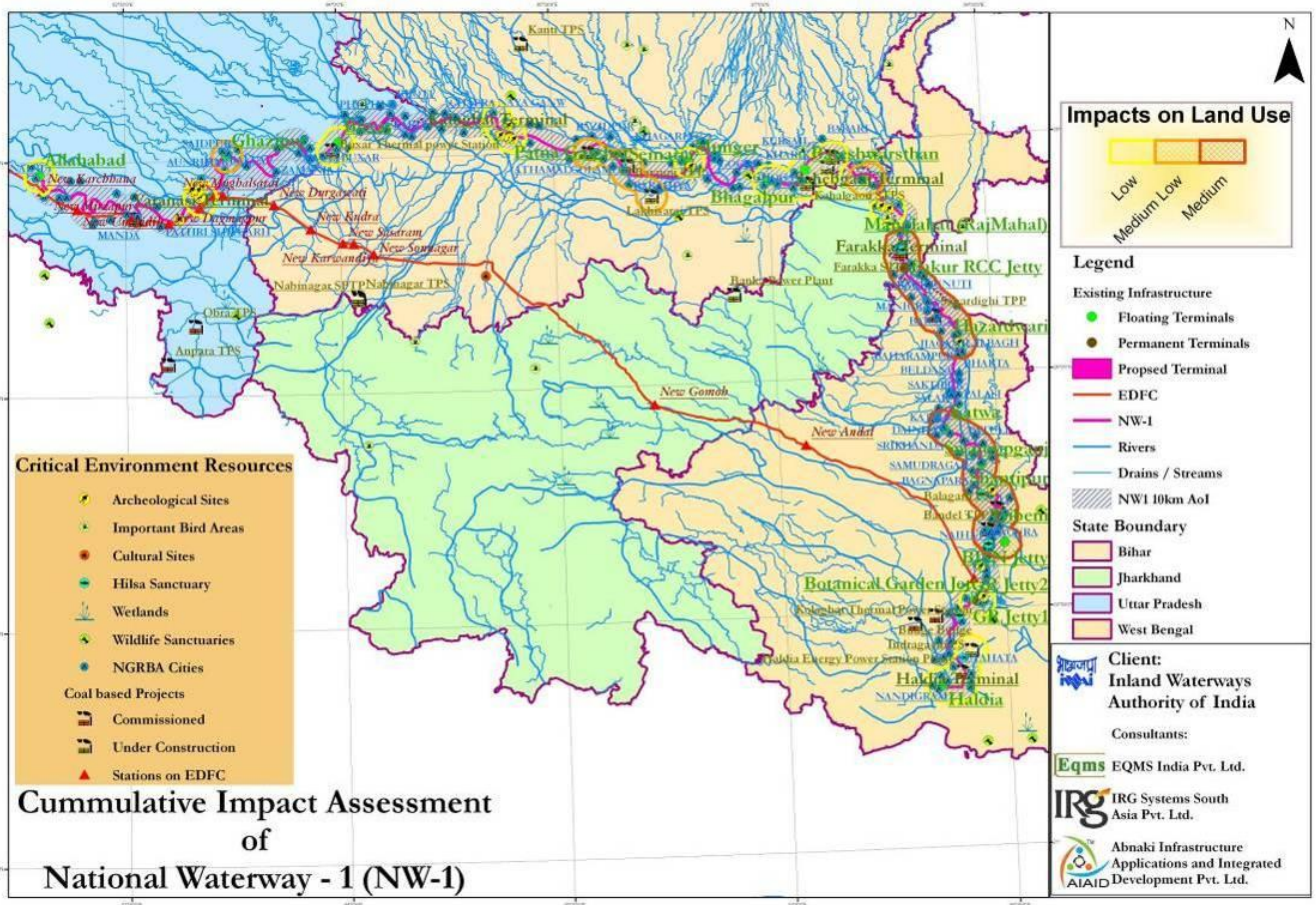
Figures 6.28: Map depicting Impacts on Livelihoods along NW – 1 Alignment



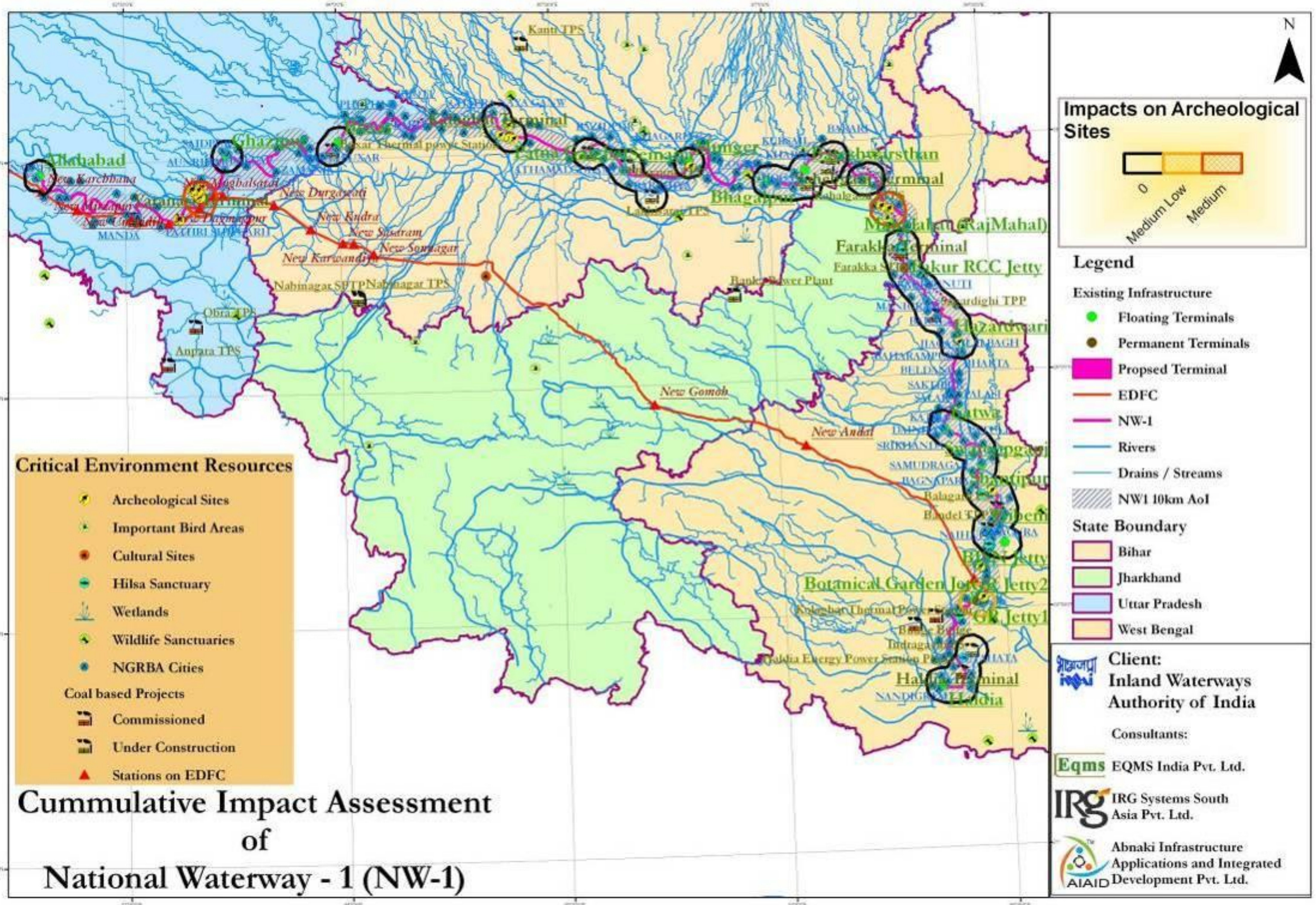
Figures 6.29: Map depicting Impacts on Religious Values along NW – 1 Alignment



Figures 6.30: Map depicting Impacts on Traffic Volume along NW – 1 Alignment



Figures 6.31: Map depicting Impacts on Land Use along NW – 1 Alignment



Figures 6.32: Map depicting Impacts on Archeological Site along NW – 1 Alignment

6.7 Summary of Cumulative Impact Assessment

Type and nature of the cumulative impact has been evaluated on all VECs in each hotspot. It has been identified that nature of impact varied from low to moderately high. For example Varanasi, Patna and Howrah, air quality of the area is already impacted due to high PM_{10} concentration. Varanasi turtle sanctuary and Dolphin sanctuary are the eco-sensitive zones in NW-1 which are being impacted due to existing development and will be impacted due to development of NW-1 and other upcoming and planned development in the area. Other areas like Barh, Danapur, Bhagalpur etc are sensitive due to presence of important bird area. Varanasi will be the common station of upcoming EDFC and NW-1 ad exchange of material will be taken place between these two points. Depending on the sensitivity of the area and nature of existing & upcoming developments in the area, certain zones are declared as hotspots. Total 14 zones are identified as hotspots. Rating is provided to impact of each identified activity on VECs and it is found that impact on these hotspots due to existing, planned and upcoming development varies from low to moderate. As per the impact assessment it is also found that the identified impacts can be mitigated and mitigation plan for the impacts is described in detail in **Chapter 7.**

CHAPTER 7: STRATEGIC EVALUATION & RECOMMENDATIONS

7.0 Introduction and Background

This chapter provides strategic evaluation and recommendations to address cumulative impacts which are predicated on baseline status of identified VECs and impacts thereon. Identified VECs broadly are Physical environmental services and natural processes, Cultural Aspects of Ganga, Ecosystem services and Socio Economic Conditions. Components of VECs have been described below in terms of its baseline status, possible impacts on VECs, strategic recommendations and responsibility for implementation.

7.1 Water (Physical Environment Services & Natural Processes)

7.1.1 Baseline Status of VECs

As per Ganga river basin management plan – 2015 mission 1 Aviral Dhara hydrological status of NRGB, the total water resources potential is 525 BCM with a replenish able ground water potential of 171 BCM and utilizable surface water resources of 250 BCM. These figures are very approximate. As described in section 5.5.1.1, Chapter 5, the critical status of water resources in India (and in the NRGB), especially when water demands are compared with the water resource potentials. The Ganga river basin is under increasing water stress, which calls for major changes in how NRGB's water resources are managed. The projected water demands are for human use only, and do not give any indication of the water needed to sustain healthy functioning of the basin. Other observations from NRGB report are summarized below.

a) Dams and barrages often help to meet several anthropogenic needs such as water supply, hydropower generation, flood control and navigation. But these obstructions have divided National River Ganga and her tributaries into small segments, thereby interrupting the flow of water, nutrient, sediments and aquatic species in the rivers. However, these are observed more in the upper reaches of Ganga river.
b) Stream flow and evapotranspiration are the two main components of water outgo. It may be noted that, on an annual basis, the average ratio of evapotranspiration to precipitation is found to be about 41-42%, which is much higher than the government norm of 23% for the Ganga basin but much lower than 60%.

c) The flow health scores had significantly altered in several stretches of National River Ganga and her tributaries due to the present system of river water management. However, the analysis does not cover many aspects of river health such as functional needs of ecosystems and habitats.
d) The changes in flow volumes are very small in the headstreams of National River Ganga, river flows are considerably reduced in her major tributaries such as Yamuna, Ghaghra, Gandak, Kosi, Chambal, Sone, etc., thereby reducing the flow in the main Ganga river through most of her reach. This is on account of the current practices of water management in the basin.

In the NW 1 stretch, rapid increase and fall of discharges has been observed during July and September-October at two locations: Varanasi (Chainage 1311) and Farakka (Chainage 583). Average discharge increase downstream during the high season (July to November). In addition to the significant seasonal variation within 7 years, there is also a great variability between years.

The report "Status on River Ganga: State of the Environment and Water Quality" from the National River Conservation Directorate (2009) provides useful information in terms of understanding water discharges along the upstream reaches of NW-1. Variability of monthly water levels, which can be of the order of 10 m during the high season. In general, water levels are at their highest in August-September and sharply decrease in October-November. In general, they continue to decrease during the whole low flow season, from December to May, and start to raise again in June-July. The variability to water levels during the dry season is lower than during the high season, with variations of the order of 2-3 m.

Many tributaries of Ganga namely, the Tons, Son, Gomati, Ghaghara, Gandak, Burhi Gandak and Kosi meets NW-1 after Allahabad. Drainage pattern of the NW-1 is controlled by these rivers. By the time Ganga reach the head of its delta at Farakka (after Rajmahal) in the state of Jharkhand, its water flow and volumes increases substantially due the contribution from these tributaries. Its water quality and sediment load also fluctuate depending on the composition of the contributing stream. Beyond Farakka, the Ganga River bifurcates into the Padma and the original channel of the Ganga, known as the Bhagirathi. Tributaries also contribute sediment to the river Ganga. Literature cites that floods occur almost simultaneously in the River Ganga and its tributaries due to the concurrent monsoon conditions over the alluvial plain for a long period and the simultaneous heavy rainfall over the Himalaya. Tributaries may increase sediment concentration in the main river because of their sediment load or decrease it because of the dilution due to the increase in water discharge. Details of sediment quantity has been discussed in **Annexure 5.3**.

The extent of ground water utilization for irrigation is highest in Uttar Pradesh (45.36 BMC per year), followed by West Bengal (10.84 BMC per year), Bihar (9.39 BMC per year) and Jharkhand (0.7 BMC per year). Ganga River has experienced and recorded several devastating floods. Similarly floods also have potential to disrupt all infrastructural, communication, industrial, electricity operations in the area.

Literature cites that flooding is one of the most disastrous natural phenomena in alluvial plains of the Ganges system particularly in the eastern parts, which are presently regarded as one of the worst flood-affected regions in the world. The Kosi river is an important tributary of the Ganga in the eastern India and one of the most distinctive hydrological characteristics of this river is a very high sediment yield (0.43 mt/y/km2) The 'avulsive' shifts of the Kosi river have been well documented and a preferentially westward movement of 150 kms in the last 200 years has been recorded. Unlike the previous westward shifts, the August 18, 2008 avulsion of the Kosi River recorded an eastward shift of ~120 km which is an order of magnitude larger than any single avulsive shift recorded in historical times.

Pollutant ingress into the Ganga river system occurs in three ways, 1) by direct discharge of pollutants, 2) discharge of polluted surface runoff into rivers, and 3) seepage of polluted subsurface flows into rivers. Direct discharge of pollutants into rivers occur due to, i) discharge of liquid wastes generated from point sources into rivers, ii) dumping of municipal and industrial solid waste, devotional offerings, animal carcasses, un- burned/partially burned human bodies, etc. into rivers, and iii) non-ritual bathing with the intention of cleaning body dirt, direct defecation, washing of clothes, washing of vehicles, washing/wallowing of animals, etc. As per NMCG's document, Mission 2, Nirmal Dhara, approximately 70% of the volumetric pollution load on the Ganga river system is from domestic/commercial sources, i.e., from human urine/feces and solid waste. Major polluting industries along river Ganga are pulp and paper, sugar and distillery, tannery, textiles, etc. together with agricultural pollution contribute the remaining 30% pollution load to the river. Basic water quality indicators indicators show spike in values near major urban centres. Details of water quality data in the Ganga basin has been described in **Annexure 5.4**.

Along the 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. 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 Mirzpur to 85,0000 at Howrah. It is mostly above 5000 MPN/100ml/coliform limit for category 'C' -designated best use requirement. Data analysis and observation on surface water quality at project intervention areas & sensitive location areas indicate that water quality meets with BDU Class D Criteria of CPCB barring few parameters PH, DO which meets A class criteria . Metallic and pesticide level is within prescribed limit of Drinking water standard. **The analysis concludes that the river water is good for propagation of Wildlife and fisheries.**

7.1.2 Possible Impact on VECs

Impacts described Chapter 6 indicates water availability to sustain short term and long term health of the river is a big challenge. Further, variation of climatic conditions due to climate change e.g. drought & flooding further aggravates the stress on available water resources in the basin.

Improper disposal of 1) solid wastes and 2) liquid wastes adversely impact water quality of the Ganga system. Further, non availability of required flow also impacts water quality of Ganga system.

7.1.3 Strategic Recommendations

As per Ganga River Basin Plan-2015, Mission 1: Aviral Dhara, the main recommendations include:

Water Availability:

c) Ganga basin suffers from stress on water resources. NRGB's present hydrological status is very inadequately known, especially in terms of water availability and usage. The hydrological status needs to be determined afresh both temporally and spatially. (2) NRGB's water resource management plan must adopt distributed water storage in the basin's groundwater, lakes, tanks and ponds, and promote wetlands and forests.(3) Increasing anthropogenic water usage needs to be checked by increased water use efficiency through realistic pricing of fresh water, incentives, technical assistance, allocation of water rights and entitlements to stakeholders, and promotion of water reuse and recycling. (4) A major policy shift in NRGB's water resource management should bring it under the ambit of natural resource management in the basin with emphasis on resource preservation before exploitation, decentralized stakeholder control, and expert guidance and regulation.(5) All existing and future dams/ barrages must ensure longitudinal river connectivity and **environmental flows** (of water, sediments and other natural constituents), and new projects should be approved or rejected on this basis. Efforts should be made to ensure environmental flows along the stretch of the river catering to environmental and social needs (ghats) of the basin (6) Increasing water withdrawals must be checked on a priority basis in critical regions.(7) The sediment resources of the Ganga river system need monitoring on a long-term basis and assessed comprehensibly in terms of both quantity and quality. The quantity and nutrient value of sediments trapped behind dams also need to be assessed, and nutrient-rich sediments need to be delivered to downstream river stretches and floodplains.(8) Some major research needs include the determination of ecological limits, thresholds and interconnections of water resources in NRGB, and river flow health assessments within the framework of ecohydrology.

d) Further, climate change scenarios with recommendations on adaptation & mitigation strategies should be made part of recommendation a)

These recommendations remain valid for NW 1 stretch downstream of Allahabad both at basin level segment wise distribution of main stem of the river as well as for tributaries. This is essential considering requirement of flow, minimum depth of water & water levels required for smooth operation of NW both present and in future. All options should be explored at the planning, design and engineering stage to minimize the requirement of storage structures on the main stem of the river as well as on tributaries downstream of Allahabad. Further, options should be explored to operate using vessels/ barges requiring least available depth as well as with least operational dredging requirements in line with international best practices. Further, continuous flow, depth and sediment monitoring is required along NW 1 and form part of the river monitoring framework

Water Quality:

e) As per Ganga River Basin Plan-2015, Mission 2:Nirmal Dhara, the list of activities to be prohibited in Ganga Basin include: 1) discharge of sewage (either treated or untreated) from Class I towns, either directly or indirectly, into any river; 2) discharge of industrial effluents (either treated or untreated) from any large, medium or cluster of small industries, either directly or indirectly, into any river; 3) direct injection of sewage and industrial effluents (either treated or untreated) into the subsurface; 4) disposal of un-burnt and partially burnt corpses and animal carcasses in any river or riverbank; 5) open defecation and dumping of municipal/industrial solid wastes or sludge in any river or its active flood plain; 6) Construction of new permanent structures in river flood plains for residential, commercial and industrial purposes, but excluding bridges and associated roads, jetties/ghats and hydraulic structures for storage/diversion/control/channelization of river waters.

f) Certain activities must be gradually restricted, i.e., permitted only with adequate safeguards or even prohibited in future. The list of restricted activities include, 1) discharge of sewage (either treated or untreated) from Class II town and smaller towns and villages, either directly or indirectly, into any river; 2) disposal of sludge derived through treatment of sewage and industrial effluents except in secure landfills/hazardous waste sites; 3) discharge of industrial effluents (either treated or untreated) from small scale industry into any river; 4) disposal and/or discharge of mining and construction debris in any river's flood plain, river bank or the river itself; 5) river bed farming and agricultural activities in the active flood plain of any river; 6) ritual immersion of idols, and floral and other offerings in any river; 7) wallowing of domestic animals, washing of clothes, vehicles, etc., in any river; 8) widespread use of chemical fertilizers and pesticides in agriculture, horticulture, aquaculture, animal husbandry, forestry, etc. in NRGB. Therefore, there is a need for urban river management plan for restoration of natural drains in Class I and Class II towns, sewage treatment in Class I and Class II towns using ZLD system, reuse/recycling of treated sewage in Class I and Class II towns, use of treated sewage for restoration/creation of surface water bodies, use of treated sewage for irrigation, sewage management in new/existing colonies, housing societies using ZLD system, zero-liquiddischarge (ZLD) systems for large/medium industries, including TDS management, prevention of disposal of corpses/human remains and animal carcasses in river, riverbank or river floodplain, prevention of open defecation in river, riverbank or river floodplain in Class I and Class II towns, Removal of stray (e.g., dogs) and domesticated animals (e.g., cows, buffaloes, pigs, etc.) from river, riverbank or river floodplain in Class I and Class II towns, prevention of disposal of municipal and industrial solid waste in river, riverbank or river floodplain in Class I and Class II towns, prevention of disposal of mining and construction debris in river, riverbank or river floodplain, control of activities such as immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles in Class I and Class II towns, river-frame restoration and development in Class I and Class II towns &river floodplain restoration in Class I and Class II town.

g) Water pollution monitoring capacity and capability of different agencies need to be augmented.

These recommendations are also applicable in the NW 1 river stretch from Allahabad to Farakka. Terminal locations should be selected to optimize construction requirements based on principles of 3Rs and zero waste discharge.

7.1.4 Responsibility for implementation

Recommendation a) is being implemented in a disintegrated manner at central level by agencies like CWC, MoEF, NMCG, IWAI and at a state level by irrigation/ water resources department from time to time and limited to certain stretches of Ganga basin. Therefore, there is a need for adopting an integrated and holistic approach by synergizing efforts at central and state level. IWAI should augment and synergize its design and engineering capacity and capability for their operational requirements in line with recommendation a).

Recommendations b) and c) are being already implemented by NMCG both at central and state government level under NMCG, Clean India Mission (Swach Bharat Urban/ Rural & AMRUT), Smart City Program by a number of agencies. IWAI can synergize with these agencies by adopting ZLD approach from their vessels and terminal buildings. Further, they can monitor ZLD and 3R based approaches by using innovative approaches e.g. how much tariff the barges/ vessels have paid for their liquid and solid waste discharge at terminal sites.

Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) monitor pollution related data for Ganga river system. However, all the tributaries are not covered under their monitoring programs. There is a need to augment capacity and capability of these agencies. Further, IWAI can compliment this effort by monitoring river water quality both upstream and downstream of their terminal locations as well in critical stretches/ restricted stretches identified in basin level report. This monitoring can be institutionalized by integrating environmental and social indicators as part of their information system.

7.2 Terrestrial Biodiversity Values

7.2.1 Baseline Status of VECs

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) [22] and small section under Coast Biogeographic Zone (8). Biogeographically, the NW-1 falls in Gangetic plain Biogeographic zone which is divided in two biotic provinces namely Upper Gangetic plain (7A) and Lower Gangetic plain (7B)[23].

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

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

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 Valued Environment & Social Component. The river's biodiversity comprises periphytons, phytoplanktons and macrophytes which are consumers in the trophic level of energy pyramid and thus the real commercial products at tertiary level of food chain.

Forest type

Data on forest and tree cover in states[24] 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%**).** No portion of NW-1 and intervention areas falls under any reserved forest or normal forests area.

Reserved Forest

The vegetation type of the Ganga basin is largely tropical moist and dry deciduous types of forest, but also includes sub-tropical coniferous, Himalayan dry temperate and Himalayan moist temperate forests types.

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

23: 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.
24State of Forest Report, 2013

Terrestrial Biodiversity

Terrestrial Biodiversity describing riparian flora of the Ganga for NW-1 has been reported state wise into two main stretches of Allahabad to Farakka stretch and Berhampur to Haldia stretch.

In Uttar Pradesh, the Allahabad belt up to Gazipur is relatively sparsely occupied with variety of trees which are equally well present up to Farakka belt. However, the density of flora is relatively thin in U.P. & Bihar areas as compared to Jharkhand and West Bengal region. The Allahabad to Balia region comprises 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 comprises 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 sissoo*, *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*.

From Munger to Farakka about 212 macrophytes have been reported along the river Ganga. From Bally to Bandel about 32 species of macrophytes have been reported which includes 7 species of Asteraceae, 4 species of Euphorbiaceae, 2 of Amaranthaceae and 3 of Cyperaceae, 2 of Polygonaceae and 1 of Poaceae. Tree species is mainly comprises of Semal (Bombax ceiba), Mango (*Mangifera indica*), Peepal (*Ficus religiosa*), Neem (*Tamarindus indica*), Jackfruit (*Artocarpus heterophyllus*) and Pakur (*Ficus lacor*). Other Macrophytes comprises *Adhatoda zeylanica*, *Barleria prionitis*, *B. cristata*, *Dipteracanthus prostratus*, *Hygrophila auriculata*, *Achyranthes aspera*, *Alternanthera pungens*, *A. sessilis*, *Amaranthus spp*, *Chenopodium album*, *Centella asiatica*, *Rauvolfia serpentina*, *Calotropis procera*, *Leptadenia reticulata*, *Asparagus spp.*, *Oroxylum indicum*, *Cannabis sativa*, *Cyperus rotundus*, *Hydrilla verticillata*, *Marsilea minuta*.

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 as it is freshwater flora zone. After Nawadip the salinity increase in river water due to estuarine affect the change in riparian flora is noticed. The tree species is mainly comprised of Semal (*Bombax ceiba*), Mango (*Mangifera 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,Vernonia cinerea, Xanthium strumarium, Nasturtium indicum, Chenopodium indicum, Juncellus* sp., *Cyperus* sp., *Sida rhombifolia, Chrozophora plicata, Croton bonpandianum, Boerhavia repens, Polygonum* sp, and *Chrozophora plicata*.

Valued Environment & Social Component in Project Area (NW-1)

The Valued Environment & Social Component (VECs) namely Biosphere Reserves, Wildlife Sanctuaries, National Parks, wetlands, Tiger Reserves, Important bird areas, and Breeding and nesting grounds for aquatic species (Schedule-I species) are identified and mapped for entire NW-1 stretch due their importance for providing suitable habitats for wildlife, humans, and their role in sustaining ecological functions. There are 2 wildlife Sanctuaries, and four Hilsa Fish sanctuaries 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. Details of VEC's along NW-1 are described below.**

Wildlife Sanctuaries within NW-1

There are two notified wildlife sanctuaries namely Kashi Turtle Sanctuary and Vikramshila, Dolphin Sanctuary under Wildlife Protection Act, 1972 (amended as on date) and 4 Hilsa Sanctuaries located within the NW-1. Hilsa Sanctuaries have been notified under West Bengal inland Fisheries Rules, 1985 to propagate Hilsa Fish production. Salient features of the wildlife sanctuaries along with flora and fauna details are described in following sections.

Table 7.1: Salient features of Wildlife 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	Protected under Wildlife Protection Act, 1972 (amended as on date)	Yes	No	10
2	Bihar	Vikramshila Gangetic Dolphin, Sultanganj to Kahalgaon pahad	Protected under Wildlife Protection Act, 1972 (amended as on date)	Yes	No	10
3	West Bengal	Hilsa Sanctuary	West Bengal inland Fisheries Rules, 1985 to facilitate	No	No	10

Sr. No.	State	Wildlife Sanctuary	Protection status	Applicability of Wild life act for NW-1 operations	Applicability of Forest act for NW-1 operations	Regulated buffer Zone (Km radius)
			spawning of Hilsa,			

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)

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

Seven Important Bird Areas (IBAs)[25] have been identified along NW-1 stretch because they support important congregations of water birds (**Table 7.2**). None of these areas are protected area except Vikramshila Gangetic Dolphin Sanctuary and Udhwa Lake Bird Sanctuary areas.

Table 7.2: Important Bird Area within 10 km area of the NW-1

Sr. No.	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	25°17'N 86°56'E	Protected as Wildlife Sanctuary under Wildlife Protection Act, 1972 (as amended till date).	Winter	Within NW-1
5	Jharkhand	Udhwa Lake Bird Sanctuary	25°0'N 87°49'E	Protected as Wildlife Sanctuary under Wildlife Protection Act, 1972 (as amended till date).	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

7.2.2 Possible Impact on VECs

The forest cover directly and indirectly impacts the quality as well as quantity of waters of the rivers in the whole Indo-gangetic plain, besides the sedimentation patterns through soil erosion levels. Therefore, within 10 km of influence area, forest cover (if any) need to be conserved.

7.2.3 Strategic Recommendations

25 These IBAs have been identified by Bird Life International under its BirdLife Important Bird and Biodiversity Area (IBA) Programme

Pre-Construction/Design and Construction Stage

Development of the civil interventions will require clearing of the vegetation from the proposed site. No significant vegetation is present at Farakka lock, Haldia terminal and Varanasi terminal site. But app.500 trees are present at identified terminal site in Sahibganj. Mango orchards are present at the planned terminal site at Sahibganj. No wildlife is reported or observed during the visit at the proposed sites. Thus no impact on wildlife is anticipated during construction phase of the project. However, avifauna of the area may be impacted due to loss of their habitat (trees), majorly at Sahibganj site. But the site is surrounded by agricultural land and mango orchards thus sufficient habitat is present for the avifauna. Large number of tree may require felling. It is recomonded to plant 7 trees against every trees to be cut. Translocation of trees proposed to be felled should be attempted as per the feasibility. Trees after growing up will provide excellent habitat to avifauna and insects. Also it is proposed to develop thick peripheral green belt and avenue plantation at each of proposed civil intervention site. This will help in improving the ecology of the area.

For development of the project, project site may be required to excavated and filled which may impact the micro-fauna & flora residing within the soil. Also riparian fauna/flora is also likely to be affected due to project development but since construction phase is temporary and short term thus it is likely for vegetation to recover after removal of disturbance or completion of construction activities. Thus the impact anticipated due to project design & construction on terrestrial ecology are low-moderate.

Also during the construction of project the transportation of heavy vehicle carrying the construction material will move in the project area. It will generate dust and noise during movement. The dust will be settled on the nearby flora of the roads and adjoining area, and covering the leaf and hence reducing the photosynthetic activity. Noise created due to increased traffic will have impact on the nearby fauna, it may have impact on the nocturnal animals/birds also. However, impact is anticipated to be short term and temporary and will be restricted to construction phase only.

None of the planned intervention site is proposed within eco-sensitive zone. Eco-sensitive zones within 10 km radius of the NW-1 alignment are Udhwa lake bird sanctuary, Farakka barrage & surrounding areas, Mokama Taal Wetlands and Kurseala River Course, Diyara Flood Plains and Danapur cantonment area. No impacts are anticipated on flora/fauna of these areas during construction & design phase as no construction activities are proposed within the river stretch along these areas.

Operation Stage

Positive impact on ecology is anticipated during the operation stage of planned interventions majorly. Thick peripheral green belt will be developed and avenue plantation will be carried out at all the proposed intervention sites. Green belt will provide excellent habitat to avifauna, insects, small animals like squirrels, lizards, chameleons etc. But as the interventions like terminals and jetties involve movement of vehicles at and around the site, dust level may increase in the area. This dust when settles on the leaves of the trees will hamper the photosynthesis activity.

7.2.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility for effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities.

7.3 Aquatic Biodiversity

7.3.1 Baseline Status of VECs

The Allahabad to Farakka segment of River Ganga (LG-A) comprises a fresh water zone of 701 km. The floral and faunal diversity comprises phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher vertebrates. Phytoplankton 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 dolphin is also present in the Bihar stretch. Fresh water turtle were also reported in Kashi turtle sanctuary area.

286 km of stretch of Lower Ganga downstream of Farakka up to Haldia consist of Phytoplankton, Zooplankton, Macrobenthos, Nekton, Macrofauna and Angiosperms. 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. The higher aquatic vertebrates observed in this stretch during study period are represented by turtles and dolphins.

The higher aquatic vertebrates (mammals) present in NW-1 stretch (Allahabad to Haldia area are Gangetic dolphin (*Platanista gangetica gangetica*), an endangered species and smooth coated Otter (*Lutrogale perspicillata*), vulnerable species. Among the reptilian fauna, water snake (*Xenochrophis piscator*), mugger crocodile *(Crocodylus palustris*), and the estuarine (east coast) crocodile *(C. porosus)* and Indian Gharial *(Gavialis gangeticus)* and variety of turtle species. Among the threatened species, Ganges Shark (*Glyphis gangeticus*), a critically endangered species is known only from the lower reaches of the Ganges-Hooghli river system, West Bengal, India. It possibly occurs in other river systems in the area. It could also occur in shallow marine estuaries although there are no verified marine records of this species to date[26]. However, this species and its fingerling or yearling stages have not been recorded during the surveys under this project conducted between July to November 2015.

Field observations and existing literature cites 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 on account of local anthropogenic impacts from station to station. The diversity of planktons is slightly high in Hilsa Sanctuary than Kashi Turtle sanctuary and Vikramshila dolphin sanctuary area.

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

There are several aquatic floral species present in the riparian zone and in aquatic habitat along the whole NW-1 stretch. The floral and faunal diversity comprises phytoplankton, zooplankton, zoo-benthos including macro-invertebrates, fish and higher vertebrates. In Ganga river from Allahabad to Haldia, NW-1 segment total of 90 taxa (28 sp. of Chlorophyceae, 39 sp. of Bacillariophyceae, 11 sp. of Cyanophyceae, 5 sp. of Euglenophyceae, 5 sp. of Rhodophyceae were observed. Bacillariophyceae (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

[26] http://www.iucnredlist.org/details/9281/0

throughout the NW-1 stretch. The most common Benthos observed in Ganga River was *Gabbia* sp.*Bellamya* sp. *Lymnaea* sp., *Belostomaindica* and *Cybister confuses*.

The higher aquatic vertebrates observed in this stretch during study period are represented by turtles and dolphins. The Ichthyo-fauna is represented by 106 species, out of which 103 species belonging to family Balilooridae, Siluridae, Cyrinidea, Channidaea, Cobitidaea, Osplronemidae and Nandidae. The higher aquatic vertebrates present in NW-1 stretch (Allahabad to Haldia area are only Gangetic dolphin (*Platanista gangetica gangetica*) and turtle species.

RET Species

Gangetic dolphin (Schedule-1) and fresh water turtle species (endangered and vulnerable species) are present in the river stretch of the NW-1 primarily. Some of the vulnerable and endangered species of migratory birds also visit the IBAs located along the NW-1. EIA shall focus on species generally found in NW-1.

Breeding and Spawning

Fish Breeding and Spawning: Generally, fish breeding and spawning is most frequent in monsoon season (July to September). A field study was conducted 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 genera of cat fish families like *Mystus*, *Wallago* and *Clarias* 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. 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.

Hilsha Fish Breeding: The Bengal Hilsa (*Tenualosa ilisha*) occurs in marine environment but migrates to fresh water for breeding and is anadromous in nature. It tolerates variations in salinity and travels over 1200 km in inland water for breeding upto Farakka. The Hilsa fish is heterosexual. Breeding starts with start of monsoon in July and peaks in September-December. Hilsa is 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. Newborn calves have been observed mainly in April and May[27].

Smooth-coated Otter (*Lutrogale perspicillata*) is dependent on monsoons. It mostly breeds between August and December. The gestation period is 61-65 days. Smooth-coated otters give birth to and raise their young in a burrow or shelter near water, which they excavate, or they assume an abandoned one. Two to five cubs are born in a litter, blind and helpless. At thirty days, the cub's eyes open, and by sixty days, they can swim. The cubs disperse at about 1 year of age. Sexual maturity is reached at two years

Turtle Breeding: Turtle nesting season vary depending on the species. It's hatching period normally confined between May to October. The nesting and hatching season of fresh water turtle vary from May to October.

Fish based livelihood

Fishing is major occupation of the people. The monthly average income of the fisherman ranged from Rs.4000 to 7000 in Allahabad to Patna stretch. However, in Varanasi stretch the most of the fisherman is engaging in boating and ferry services and earning more than fishing. In lower zone (Farakka to Haldia) the average income of fisherman is slightly high and ranging between 7000 to Rs. 10,000. The income is higher in lower zone (Farakka to Haldia) because of higher catch and high value fish (mainly Hilsa) in the catch.

7.3.2 Possible Impact on VECs

Impact on Aquatic Ecology

Impacts due to maintenance dredging are anticipated largely on aquatic ecology. Impacts are assessed for different scenarios as given in the following section:

A. Changes in Diversity of Benthic Habitat

The impacts on diversity may range from abundance of certain species of the prevailing community or even habitat community itself. Such changes in diversity may be caused due to change occurring in river hydrodynamics and chemical or physical characteristics of river bed sediments of the impacted area. As during dredging the settled sediments are dredged thereby impacting the whole range of flora and fauna which dwells in the river bed sediments. Once the sediment organisms are dredged and removed along with the sediments the dredging process may even cause mortality of benthic organisms. However, recolonization of habitats after dredging at the site may initiate soon after dredging but it may take significant rehabilitation time though the benthic organisms are essential components for river health as

27Dolphin reproduction starts 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.

being ingredients of the aquatic food chain. Rate of rehabilitation of fresh colonies is highly variable as it is governed by characteristics of remaining sediment portions. Faster recoveries have been observed in finer sizes sediments and of less saline character. Diversity rich and stable benthic habitat is most unlikely wherever regular maintenance dredging is required (which is the case here as suspended solids get quickly settled on the bed) of the river beds in the stretches such as adjoining the terminal berths and river bed of navigation channel having lower LAD warranting regular maintenance dredging. However, it may be pertinent to point out that the habitat loss caused may not significantly impact the river ecological health because the maintenance dredging is confined to navigational channel of 45 m width in comparison to the total width of the Ganga River on such locations. Dredging activity will not have significant impact on the larger mobile faunal species such as fishes, dolphins, and turtles. The impact assessments carried out based on under water modelling of dredging noise indicated that the noise impacts on these species for their behavioural changes may not be significant. Because these organisms normally move away from the dredging spots resulting in high underwater noise generation. In any case mortality of these aquatic species due to dredging is not anticipated. Besides, in case minimum LAD is maintained in the channel, then it also facilitates the movement of these aquatic species as enough space is available to avoid any injury from barge movements[28].

B. Increased Noise Levels

Noise generation due to dredging operations also disturb the aquatic life either leading to behavioural changes, tissue/gill injury, temporary loss of habitat for the dredging period or mortality (rarely) due to dredging operations. Noise generation during dredging operations is of order of 160-180 d(B) for CSD category of dredgers. Behavioural disturbance criteria for Dolphins & turtles from any continuous noise exposures are 177 d(B) and 150 d(B) respectively[29] . In addition, no dredging operations are proposed within or in vicinity of Kashi Turtle Sanctuary and Vikramshila Dolphin Sanctuary that minimise the possibility of the impact of dredging on such vital sensitive organisms. However, in addition various mitigation measures are still proposed to further minimize the impact of dredging on aquatic species. As per U.S. Fish and Wildlife Service (USFWS), sensitivity level for injury in fishes is 186 dB for fish size of >2gm and 183 dB for <2gm. Thus the dredging operations noise will not lead to any injury to the fishes. Also it is likely that fishes and other moving organisms will move away from the source of disturbance and since the dredging activity is short term, the aquatic fauna will move back after the disturbance is removed.

C. Increased Sediment Load/Turbidity

Both dredging as well as in-stream (dumping) disposal of dredged sediments have potential to increase the sediments or turbidity load of river water due to generation of sediment plumes

[28]Impact Analysis on "Ecology, Flora and Fauna including Fish and Fisheries due to Movement of Barges Carrying Coal Through National Waterway-1, Sagar to Farakka, ICAR-CIFRI

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

during the dredging and disposal operations. Increased suspended sediments can affect filter feeding organisms, such as shellfish, through clogging and damaging feeding and breathing equipment (Brehmer 1965; Parr et al 1998). Similarly, young fish can be damaged if suspended sediments become trapped in their gills and increased fatalities of young fish which have been observed in heavily turbid water (Wilbur 1971). Adult fish are likely to move away from or avoid areas of high suspended solids, such as dredging sites, unless food supplies are increased as a result of increases in organic material (ABP Research R701 1997). Suspended sediment due to dredging operations in the water column blocks available light for photosynthesis, reducing benthic primary productivity and inhibiting the ability of benthic plants to recover from dredging impacts. However, the effect of suspended sediments and turbidity in open environment like river are generally short term (<1 week after activity) and near field (<1km from activity)[30]. There is only need to be concern if sensitive species are located in the vicinity of the maintained channel. Since river width is wide enough compare to 45 m wide navigational channel, it is anticipated that aquatic life will get accustomed fast to regular activity phenomenon of the river and adjust their behaviour accordingly.

D. Release of Locked Pollutants in Bed Sediments

Sediments settled on the bed may have trapped toxins, chemicals and pollutants which are trapped in them and are not affecting the water quality. The most important among the toxic pollutants are pesticides, and heavy metals. However as per analysis carried out for river bed sediments, sediments are not contaminated as covered in previous section. Therefore, any significant impacts on water quality/habitat-health of aquatic species are not anticipated.

E. Disposal of Dredged Material in Aquatic Environment

Disposal of dredged material may lead to burial of existing benthic community at the location of disposal and Submerged Aquatic Vegetation (SAV) on the river bed, leading to mortality of buried community. In case of high turbidity and disposal heap is below the photosynthetic depth (adequate light penetration) then SAV cannot recover. However as discussed above, impact of suspended sediments and increased turbidity is of temporary being confined to disposal location besides of short term in nature.

F. Increased Depth During Dredging

In shallow waters, the light necessary for photosynthesis penetrates to the bottom of the water column. The LAD proposed is 3 m so the availability of sun light at bottom for clean river water will supports the growth of SAV and algae. SAV at the bottom provides shelter and food for young fish and helps reduce turbidity by resisting water flow and thus, allow sediment generated during dumping to settle out. The benthic algae are an important component of food chain and serve as a food source for some fish species. When the water

[30].As per UK Marine SACs Projects assessments

gets too deep (below 6 feet/1.8 m) the available sun light decreases and plants growth is restricted as it can no longer photosynthesize in the deep channel area.

Impacts on Avifauna

Dredging and dredge Sediment disposal activities may also have certain impact on the avifauna having its habitats identified as Important Bird Area (IBA) located close to or along shallow waters areas of the river (Refers Chapter for IBA locations). However, the dredging impact will be localized and will be confined within the impact zone (may be of 500 m or less) and duration of dredging only. Avifauna is disturbed during dredging periods due to high noise levels, reduction in availability of aquatic food such a fishes in dredging stretches and increase in various human activity at dredging sites. Noise level of the order 80 dB(A) is expected to be generated from dredging operations. Apart from dredging effect, disposal of dredged material in mud flats and reed land which are habitat of the migratory and other water birds, may also impact the aquatic birds. The most impacts will be confined to initial period only as on later stage avifauna will gets acclimatized to the situation.

Impact Due to Vessel Speed and Movement on Aquatic Organisms

Aquatic mammals are subjected to threat of collision by vessel speeds causing injury and death. Dolphins, fishes moving in river can collide with the moving vessels which may cause them injury and even mortality. To minimise the chances of collision, restricted vessel speed of 2.7 knots (5 kmph) is proposed within VSGDS and in Kashi turtle sanctuary. Even in low speed danger still exists for juveniles of dolphins and other fishes which can get trapped / entangled with propeller's blades leading to injury or death. Propeller guards in ships could reduce mortality.

Impact Due to Ballast Water Discharges on Aquatic Organisms

Ballast water discharges by vessel can have a negative impact on the aquatic environment. Bulk cargo carriers use a huge amount of ballast water, which is often taken in from the coastal waters from one region and may be discharged at the next location. Such Ballast water typically contains a variety of biological materials, including plants, animals, viruses, and bacteria from the sea water intake location. As ballast water may have various non-native, nuisance, invasive, exotic species that can cause ecological imbalance and economic damage to the receiving aquatic ecosystems besides certain human health problems. Since NW1 is an inland waterway transport project with movement of vessel only within same aquatic river environment no impacts due to ballast water discharges are anticipated. Though coastal vessel arrive at Haldia Terminal but loaded with coal and thus will not be required to discharge any ballast water. Therefore, no impact due to ballast water discharge is anticipated

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

Materials like coal, oil, building construction material, textiles, fertilizers etc. are proposed to be transported through the waterway. In case of accidents these materials can spill in the River and may pollute the water quality and may have significant impact on aquatic ecology. Oil spills are well known to cause significant harmful impacts on sea aquatic ecology as the oil leaks form a thin film floating over the sea water and thereby breaking contact between seawater & air (DO reaeration). This floating oil enters the gills of fishes and other organism and block the gills, skin pores and may impact the normal functioning of the aquatic organisms. Impact of oil spills on various aquatic organisms is summarised below:

- **Plankton:** Oil spills can lead to plankton kills. The recovery of plankton will be however quicker through repopulation of the community by fresh planktons from adjacent areas not affected by oil. Eggs and larvae of fishes, crustaceans and molluscs which are highly sensitive to even low concentrations of PHc (10-100 µg/l) and aromatics (1 - 5 µg/l) in particular will be severely affected. However, it is unlikely that any localised losses of fish eggs and larvae caused by a spill will have discernible effect on the size or health of future adult populations.
- **Benthos:** These organisms have limited movements and hence, are more vulnerable to oil spills. If the thick weathered oily mass spread on intertidal areas, immediate mortalities of organisms in the zones of physical contact are expected. Sub-tidal benthos of shallow waters might also be killed or tainted if the sinking residue affects their habitats. If the residue persists for longer time in the sub-tidal or intertidal segments due to poor circulation, the recovery will be delayed. Thus, the benthic organisms near to the berth area will recover slower than the organism away from berth area due to poor water circulation near the berthing area.
- **Fishes:** A large oil spill can temporarily reduce the fish catch from the area as fish might migrate from the affected zone. Limited mortality may also occur particularly when the oil concentrations in water go abnormally high. Fishes are sensitive to oil and tend to avoid petroleum. Often fishes get tainted and unpalatable but become normal when the ambient PHC level approaches the baseline which is expected within a few days. The area which is the breeding and nursery grounds for a variety of fish and shell fish, large scale mortality of eggs and larval stages of several economically important groups may occur if oil is transported to these habitats during major accidental oil spill. Local fishermen may get affected by getting either contaminated fishes/crabs/larvae etc. or poor catch.

Impact Due to High Noise Generation During Movement on Aquatic Organisms

Cargo vessels generate substantial broadband underwater noise from their propellers, motors, auxiliary machinery, gear boxes and shafts, plus their hull wake and turbulence. Diesel motors produce more noise than steam or gas turbines, but most long distance (low frequency) noise is generated by the 'hissing' cavitation of spinning propellers. Noise generation from the ship movement is continuous type of noise generation. Noise generation from ship movement (1500-2000 DWT) vary from 110-140 d(B). This order of noise generation may have impact on behaviour of various aquatic organisms and may lead to other injuries like tissue injury, temporary & permanent hearing loss. However physical impact on aquatic species is not anticipated as the aquatic species moves away from the source of disturbance (barge) and usually do not come close. But impacts of this level of noise can be on behavioural responses and audiometry of aquatic species, turtles and dolphins in particular.

A. Impacts on Behavioural Response of Aquatic Organisms and on Auditory System of Dolphins Due to Noise Generation from Moving Barges

This assessment has been carried out considering the outputs of various studies vs noise and using mathematical techniques (underground noise modelling) to assess the expected noise from vessel movement in IWT in NW-1. Based on above studies it is established that bulk vessels moving at a speed of 2.7 knots (5 kmph) generates noise of range 130-140 d(B). However, considering the variation upper limit of 160 d9B) is also considered underwater noise modelling assessment.

Output of Underwater Noise Modelling: An estimation is carried out to assess distance of achieving the safe threshold noise level of 150 d(B) for turtle and 177 d(B) Dolphin from behavioural consideration perspective as per EIA Study of "South of Embley Project" sited above. It is concluded that noise level of 150 d(B) can be achieved at distance less than 4.6 m from centre of the ship for turtle. However, the maximum beam of ship which will ply in waterway is 11.4 m. *Thus possibility of occurrence of organism at 4.6 m is comparatively less.*

B. Impact on Auditory System of Dolphins Due to Noise Generation from Moving Barges

When the dolphin 's auditory system is exposed to a high level of sound for a specific duration, the sensory hair cells begin to fatigue and do not immediately return to their normal shape (NRC 2005)[31]. This causes a reduction in the hearing sensitivity, or an increase in hearing threshold. If the noise exposure is below some critical sound energy level, the hair cells will eventually return to their normal shape. This effect is called a temporary threshold shift (TTS) as the hearing loss is temporary. If the noise exposure exceeds the critical sound energy level, the hair cells become permanently damaged and the effect is called permanent threshold shift (PTS).

C. Impact Due to Masking of Biological Important Noise of Aquatic organism by Noise Generated from Moving Barges

Another impact of high noise level generated from moving barges is masking of biologically important sounds. These sounds may interfere with communication and social interaction and cause changes in behaviour as well. The zone of masking impact will be highly variable and depends on many factors including the distance between the listener and sources of the signal and masking noise, the level of the signal and masking noise, and the propagation of noise from the signal and masking source to the listener. It is however important to note that masking of communication and echolocation signals naturally occurs by the ambient noise environment. Man-made noise causes additional masking of a signal only when it is of a higher

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

level than the ambient environment within the species 'critical hearing bandwidth at the signal's dominant frequencies. Echolocation clicks produced by the Ganges River Dolphin have dominant energy around 65 kHz (Sugimatsu et al., 2011)[32]. This is well above the dominant frequency range of most man-made noise, including pump noise. Masking of echolocation signals is therefore not a significant issue for most man-made sources (Richardson et al., 1995). ***Thus it can be concluded that noise generation due to barge movement is not anticipated to interfere with echolocation ability of Ganges Dolphins***. The Ganges River Dolphin is likely to produce communication signals, such as whistles, squeals or clicks, based on communication signals produced by other river dolphins. These signals generally have energy at much lower frequencies than the echolocation clicks, i.e. as low as 1-6 kHz. **Communication signals are therefore more likely to be masked by man-made noise than echolocation clicks**. Noise reduction measures will help in minimizing the noise generation from barge movement and will minimize masking of communication signals generated by dolphins.

Impacts Due to Physical Interventions on Aquatic Ecology

Pre-Construction/Design and Construction Stage

Eco-sensitive aquatic habitats identified within NW-1 are Vikramshila Dolphin sanctuary (Sultanpur-Kahalgaon) and Kashi Turtle Sanctuary at Varanasi. No civil intervention is proposed within these locations. Also it is proposed no dredging/dredge disposal will be carried out within this stretch. Thus impacts anticipated on these eco-sensitive zones during design & construction phase are minimal. However, construction activities like dredging/piling is proposed to be carried out in river stretch along the planned terminal/jetties site. Piling & dredging activities have potential to impact aquatic ecology of the area. Anticipated impacts during construction phase on aquatic ecology for the project are given below:

Impact of Piling/Dredging Activity due to sound Generation on Aquatic ecology:

Piling & dredging activities will be carried out for construction of proposed off-site facilities like jetties & berths. For the purpose, dredger will be placed in the River which will occupy some physical space in the River. This space was being used by the biotic components of the river. As a behavioural response, instinctively animals at the first encounter avoid approaching the site of unknown object. This is done using echolocation, olfaction or chemo-reception, if the object is not making any sound. If object / machine starts making sound / noise, then all vertebrates through auditory acoustic sense avoid the area which has disturbing range of sound and hampers to the natural acoustic behaviour and physiology of these vertebrate fauna from fishes to dolphins.

[32] Sugimatsu et al. (2011). Annual Behavioral Changes of the Ganges River Dolphins (Platanista gangetica) Based on the Three Long-Term Monitoring Seasons using 6-Hydrophone Array System. IEEE Symposium on and 2011 Workshop on Scientific Use of Submarine Cables and Related Technologies, (pp. 1-7). Tokyo

Apart from occupying the physical space, dredging and pilling activity will generate significant noise. Exposure to low levels of sound for a relatively long period of time, or exposure to higher levels of sound for shorter periods of time, may result in auditory tissue damage in fish, though recovery is generally possible within 24 hrs (Popper et al. 2005). Oscillations induced by high sound pressure levels can cause swim bladders in fishes to tear or rupture (Hastings and Popper 2005). Whereas it is possible that some (although not all) species of fish would swim away from a sound source, thereby decreasing exposure to sound, larvae and eggs of fish are often at the mercy of currents or move very slowly. Movement of the fishes and dolphins away from these places makes the place unused for foraging, spawning and local movement. This would cause crowding of organisms at other places and enhanced struggle for space and other requirements, till the disturbance has not ceased/completed.

Impact of Piling/Dredging Activity: loss of habitat

Large amount of river bed sediment (dredged Material) will be removed for carrying out bank & bed scouring and erosion protection. Bed and bank erosion/scour prevention works involve stone pitching of banks upstream & downstream, concreting of banks, construction of retaining walls/embankments along the river banks, construction of aprons across the river along the length of the proposed terminal/jetty, construction of guide walls in case of Farakka lock etc. These sediments are in habituated by various benthos (molluscs, arthropods, juvenile fishes, amphibians and reptiles etc.). Removal of these sediments will lead to mortality of these communities. Also the actual habitat will be lost permanently in the activity area due to bed and bank erosion/scour prevention works. Impact on the moving aquatic species is however anticipated to be low as they disperse when any activity is being carried out in the river.

The major impact on larger organism is that the movement routes, spawning activities and foraging grounds of these organisms may be affected. These animals would also struggle for normal conditions due to increased turbidity and increased sedimentation during the dredging activity. Increased sediments and turbidity can impact the aquatic life by reducing visibility, making water coarse, choking gills of fishes etc. Thus measures should be taken to quicken up the dredging and piling activities, minimizing the noise level and controlling the sediments generation. Among the floral components rooted plants will be uprooted and destroyed totally. The primary productivity by phytoplankton will be lowered, on account of lowered transparency for light.

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

The riparian area soil are loose and sticky/clayey. Release of these sediments would cause high increase in turbidity of water during and sometime after the dredging/oiling activity. Such soil has a tendency of sticking over the skin and gills and blocking the pores and is hence harmful. Suspended sediment due to dredging operations in the water column blocks available light for photosynthesis, reducing benthic primary productivity and inhibiting the ability of benthic plants to recover from dredging impacts. But the effect of suspended sediments and turbidity in open environment like river are generally short term (<1 week after activity) and near field

(<1km from activity). There is only need to be concern if sensitive species are located in the vicinity of the maintained channel.

Some pollutants such as insecticides, pesticides, fertilizers may be unlocked from sediments when dredged. But soon it will be washed away along the flow. The test results show very low concentration of pesticide. Even then there are chances that it may enter the food chain.

Construction activities to be undertaken involves storage of raw material, debris, fuel, paints etc. There are likely chances that, the run-off from the site may get contaminated with these materials and when it will enter the water body may also degrade the water quality of the river.

Operation Stage

Impact due to operation of any project is of main concern as it always persists. Construction of berths, jetties and other off-shore structure will consume physical space in water reducing the available space for the aquatic organism. Planktonic population at berth area and nearby area will reduce or will decrease drastically which will impact the primary productivity of the water body. Planktons is feed for various big fishes, thus reduce in plankton population will affect the aquatic food chain. However, area to be covered by berth is very less as compared to width of the river. Thus reduction of this much space will not have significant impact. Also it is possible that aquatic organisms may collide with these newly constructed structures. But as behavioural response, instinctively aquatic animals at the first encounter avoid approaching the site of unknown object. This is done using echolocation, olfaction or chemo-reception, if the object is not making any sound. Thus the space occupied by unknown structures will be avoided by aquatic organisms thereby reducing the chances of collisions and injury to aquatic organisms.

During rains, run-off from the stockyards at jetty/terminal sites may enter the river and may contain the contaminants. This contaminated run-off may pollute river water quality, if discharged in river. Thus proper storm water collection and management system is required so as water from stockyards do not enter the river directly. Sewage & waste will be generated at intervention sites (terminal/jetties/locks) and in vessel. If this waste is disposed on the land or in river, then this waste can pollute the soil impacting the terrestrial ecology and can pollute the water impacting aquatic ecology. Release of coal dust during coal transhipment and may settle on surface of the river and will have a negative impact aquatic life.

Other activities at the sites of civil interventions which may have impact on aquatic ecology are berthing & mooring of vessel, oil/material spillage, dust generation from material transportation, barge movement and maintenance dredging for keeping the berth area navigable. Berthing & mooring of the vessel at terminal/jetties reduces the circulation of water in the area thereby reducing the air flow in the water and self-assimilative capacity of river in that stretch. If vessel is berthed for longer duration at terminal/jetty sites, then there are increased chances of release of toxins from anti-fouling coating of vessel or leakage of some oil from bilge tank into the river. All these may pollute the river water quality near the terminal/jetty sites. Movement of barges in the civil intervention area will increase after development of the proposed interventions and thus the transportation of commodities will also increase. Some of the commodities to be transported include building & construction material, and coal which may generate the dust and this dust can settle over the surface of the river. This dust will increase turbidity of water and may reduce the visibility of the water there by impacting the SAV, planktonic communities and other aquatic fauna. This dust if consumed by aquatic organisms may cause respiratory and other related problems in organisms. Thus it is required for transportation of dust generating material under covered conditions. Also coal should be kept moist so as to reduce the dust generation potential during transportation. It is proposed to transport edible oil/POL at Haldia terminal site so there are likely chances of accidental oil spillage near the terminal site or in the waterway. Oil spillages are threat to aquatic organisms and can lead to mass mortality also. Oil spills can affect all planktons, benthos and Fishes.

Maintenance dredging and disposal of dredged material will also be required to be undertaken at the proposed intervention sites so as make them navigable throughout the year. As per the planning, insignificant quantity of dredging will require to be carried out at Sahibganj & Varanasi terminal site. Dolphins are found in the river stretch along Sahibganj terminal. Terminal site is located in the secondary channel so impact of dredging near terminal site on the dolphins is nil.

Dredging of 30-60 lakh cum will be required at Haldia Terminal site but no dolphins are observed in that stretch of river. Quantity of dredging will depend on the duration for which terminal will be kept navigable and nos. of berths to be kept navigable. Dredging operations generate high noise levels, increased turbidity of the water, and removal of benthic community thus impacting aquatic ecology, reduce DO level in water thus reducing available oxygen for aquatic organisms, may unlock toxins trapped in the sediments etc. All these impact the aquatic environment and organisms

From the above discussion, it is evident that physical interventions development can affect both the terrestrial and aquatic ecology however barge operations and maintenance dredging operations will majorly affect the aquatic ecology. Significance of the impacts of physical interventions will be different in different phases on both the component however the impact on aquatic ecology due to dredging and barge operations is anticipated majorly during operation phase. The impacts are significant and can be severe. Mitigation measures as proposed are essentially required to be implemented to prevent the impact on the terrestrial and aquatic ecology.

7.3.3 Strategic Recommendations

Based on the inventorying and mapping of VECs, exclusion (No Go areas) and restricted areas have been identified and given in "**Basin level Critical Environment Resources study for Project Capacity Augmentation of National Waterway -1**" which is summarized below.

Exclusion (No Go) areas in Ganga Basin and NW-1 (With respect to Wildlife protected Areas)

Exclusion (No Go areas) has been defined with respect to location of proposed project interventions of IWAI location of critical environment resources in Ganga Basin and along main stem of Ganga in NW-1.

No-Go Areas- Ganga Main Stem Other than NW-1 stretch

Upper Ganga River (Brijghat to Narora Stretch) is declared as a Ramsar Site. Moreover, Ganges Dolphin Conservation Zone Garhmukteshwar – Narora Barrage has been recommended to be declared as "No Go area" for which detailed studies have been done by WWF- India. Given the recognition of Upper Ganga River as a Ramsar site and in line with finding of previous studies and recommendations, this stretch is further recommended to be Exclusion (No go area). Since, this river stretch is outside the purview of NW-1, it would not be directly impacted by plying of IWAI's vessels. However, hydrological interventions for augmenting flow in the NW-1 should avoid this area for planning any hydrological interventions.

No-Go Areas- NW-1 stretch

Two notified wildlife sanctuaries are located within the main stem of river Ganga in NW-1 namely:

1. Turtle WLS, Varanasi
2. Vikaramshila Gangetic Dolphin Sanctuary, Bhagalpur

The entire notified stretches of river are considered as No Go area. The Turtle Wildlife Sanctuary stretch (the 7 Km long river stretch) at Varanasi the Vikramshila Gangetic Dolphin Sanctuary stretch located in Bihar State (starting from Sultanganj to Kahalgaon pahad, about 50 km stretch, is recommended to be exclusion (No Go area) in NW-1 from the point of IWAI's interventions.

Restricted Areas

The restricted areas are identified as per the criteria defined. As per this criteria the buffer zone of two sanctuaries located in NW-1 (the No Go areas) and one sanctuary located about 9 Km away from NW-1 is identified as restricted areas.

Determination of Areas Having Minimum Impacts

Areas other than those marked as exclusion (No Go area) and restricted areas are of least environmental sensitivity and environmental impacts.

IWAI's vessels, cargo and tourist vessels plying in NW-1 through restricted and critical stretches as identified above should take adequate environment and social safeguards as described below.

1. Maintaining water depth of the navigation channel (at least 6 m)[33]. This measure may reduce the disturbance to the migrating Hilsa, benthic habitat, facilitate escapement of fishes and aquatic mammals from direct impact of the barge/vessels, considering that the fully loaded barge draft is 2.7 m. This will also help Hilsa, which prefers more than 5 m depth for their migration.
2. The spawning & breeding grounds are not identified in the entire NW-1 stretches. Spawning areas normally have enough sand depth and water depth in general. Normally the spawning activity occurs in the rainy season. All care shall be given during construction & dredging activities to avoid any damage to spawning, breeding and nesting habitat of threatened aquatic species like Dolphin, Smooth Coated Otter, Gangetic Shark, Mugger, Gharial, Turtle, Hilsa, etc during spawning season which is from May to August.
3. Measures would also be required from aquatic perspective in terms of vessel movement speed, material handling (like coal dust spillages to river, oil spillages to river) and other operational aspects may have impact on aquatic life. Necessary design features to be included based on intervention specific environmental impact assessment and capital dredging impact assessment as well as mitigation measures proposed.

7.3.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. Vessel owners, cargo operators, dredge operators, tourist operators and other users of NW-1 shall comply with conditions set out in EMP and implement mitigation measures.

7.4 Landuse & Soil Quality

7.4.1 Baseline Status

[33] *Impact Analysis on "Ecology, Flora and Fauna including Fish and Fisheries due to Movement of Barges Carrying Coal through National Waterway No.1 (Sagar to Farakka) Final Report ICAR – Central Inland Fisheries Research Institute (Indian Council of Agricultural Research) Barrackpore, West Bengal*

At basin level, NW 1 passes through the states of Uttar Pradesh, Bihar, Jharkhand and West Bengal which are extensively cultivated, constituting about 10 % of the total area of the India. About 11 % of total land of NW-1 states are fallow land and 52% percent as net sown area. The cropping intensity is highest in west Bengal with 184.1 % followed by Jharkhand, Uttar Pradesh and Bihar. The land use classes in 10 km area of the NW-1 are agricultural land, settlement, water body, forest, barren land and vegetation. It is majorly dominated by agricultural land. About 78.9 % of the land is under cultivation, 7.18% land is under settlement, 7.21% of the land is under water bodies, 3.59 % land is under vegetation, 2.82% land is under dry river bed and rest of the land falls under other uses.

Soil along NW-1 can be described as Sandy Clay and Clay Loam type. Overall soil type / quality along the NW-1 area is of moderately fertile and not expected to be detrimental to the growth of agricultural and forest crops and forms the basis of agriculture resources / cropping pattern. The Ganga River with its fertile soil is having a great influence to the agriculture based economies of adjoining district 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, chillies, sesame, mustard, sugarcane, and jute. The major habitation located along NW-1 are Allahabad, Sirsa, Mirzapur, Chunar, Varanasi, Zamania, Ghazipur, Gahmar, Buxar, Ballia, Chapra, Patna, Barh, Bihat, Munger, Bhagalpur, Kahalgaon, Sahibganj, Farakka, Berhampore, Katwa, Kalna, Kolkata and Haldia.

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. Commercial fisheries in the Ganga River System are an important source of livelihood for the people residing along the Ganga River. Pilgrimage and the associated tourism brings along a major source of revenue for religious towns and their people. In cities and town along NW-1 area, the main and marginal workers[34] are 14% and 2% respectively while the remaining 57% of total population constitutes non-workers. The main occupation is agriculture, farm labor, factory workers and workers in trade related activities.

A number of programs both at central & state government level are being implemented particularly for agriculture improvement/ farm productivity/ cropping intensity, soil quality and irrigation improvement & coverage. Further, urbanization is being regulated by master plans and building bye laws. Urban sanitation services are being covered under AMRUT, Clean India Mission and NMCG programs of Government of India.

7.4.2 Possible Impact on VECs

34A 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

NW 1 is going to improve the accessibility and transportation in a climate friendly way (lesser GHG emissions) of agriculture produce as well as other items like finished products like automobiles, steel, coal, cement etc. Therefore, direct, indirect & induced impacts are being anticipated in the ten km area during implementation of phase 1. Assessment of land resources indicates land use change particularly diversion of agriculture land for urbanization, industries & infrastructure development. This also indicates loss of top soil as well its quality considering requirement for infrastructure development as well as serving as a sink for discharges. Though urbanization is an ongoing phenomenon with an average increase in urban population around 1% annually, any new or associated infrastructure development like NW 1 and intervention is expected to accelerate it. Population concentration around hotspots along NW 1is going have additional stress on the land as well as civic amenities water supply, solid waste management, sewage and other utilities. Further, soil erosion, which is already an ongoing phenomena in the basin as well as in the influence area, NW1infrastrucure on the banks may further accelerate it at the point of intervention. Earlier data indicates that there is substantial decline in major carps fish catch in Allahabad to Farakka stretch over past few years.

7.4.3 Strategic Recommendations

1. Land use change needs to be monitored in the short and the long term considering rapid urbanization in the influence area. Stress/ pressure and carrying capacity of the hotspots needs to be assessed in future for better local area and zonal planning.
2. Agriculture productivity and soil quality need to be monitored by agriculture department in the influence area.
3. Any future development/ intervention in NW needs to be well planned & designed, implemented and monitored from environmental perspective considering zero waste discharge approach, green buildings, access roads and railway infrastructure. These development/ interventions need to be follow the statutory requirements like EIA/EMP but also designed on the principles of 3Rs (reduce, recover & recycle) and adaptation for climate change.
4. There is a need to monitor the economic activity particularly fishing activity and the sector in the entire NW 1 stretch to avoid its disruption.

7.4.4 Responsibility for implementation

1. Recommendation 1 needs to be carried out by state level town planning, urban development industrial infrastructure development department & environment department. Part of recommendation 2 especially for agriculture productivity and soil quality need to be monitored by state agriculture department. Part of recommendation 3 especially for road and railway infrastructure should be implemented by state road department/ PWD and Indian railways/ DFCCIL.
2. Recommendation 3 and recommendation 4 related to NW 1 infrastructure development should be carried out by IWAI. This not only includes EIA/EMP

preparation and implementation from perspective of environmental planning but also based on alternative/ option analysis related to location but also on the principles of 3Rs (reduce, recover and recycle) and climate change. Economic activity and livelihoods directly related to NW1 need to be monitored by IWAI. This monitoring can be institutionalized by integrating environmental and social indicators as part of their information system.

7.5 Air

7.5.1 Baseline Status of VECs

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%. 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. The predominant wind direction is from North and Northwest direction in winters and South and Southeast direction during rest of the season. 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. The air environment in the influence area is critical especially at the hotspots. This is due to traffic and industrial areas in and around the hotspots. PM_{10} values in all locations are within the specified limit of 100 µg/m^3 as per NAAQS except at Varanasi, Patna and Howrah. High values with respect to $PM_{2.5}$ were recorded in Varanasi, Patna and Howrah locations. The highest levels of SO_2 were found at Varanasi, Howrah and Patna location that may be due to heavy vehicular movement and industrial activities in these locations. High NOx was observed in those locations that lie in city area like Varanasi, Patna, Howrah and Haldia. Carbon Mono-oxides (CO): CO was detected in few locations i.e. Haldia, Howrah, Patna and Varanasi.

7.5.2 Possible Impact on VECs

Data analysis at the hotspots and other urban centers in the influence areas indicate increasing air pollution both at temporal and geographical scale due to increased urbanization, traffic, construction and industrial activities. Therefore, air pollution footprint is gradually increasing around hotspots. This is also contributing to greater GHG emissions and climate change. Activities in and around NW 1 terminals catalyzing urbanization and also including connectivity to major national/ state highways and railways will add incremental air pollution load both during construction and operation of the project. Further, vessel movement along NW1 will also add to air pollution along the stretch.

7.5.3 Strategic Recommendations

1. Zonal planning and master planning of urban centers (hotspots) need to be upgraded in view of expected urbanization. These plans need to include developments related to NW 1 e.g. best locations for terminals, access, connectivity (roads & railways) and related infrastructure.
2. NW 1 operational strategy should aim for zero emissions. This should include alternate fuel e.g. CNG or renewable energy e.g. solar powered based barge/ vessel operations.
3. GHG accounting should be carried out especially for terminal and operation related movement of NW 1.This should also include GHG avoided & added vis a vis rail and road transport.
4. Air pollution monitoring infrastructure should be augmented in and around hotspots by state pollution control board.

7.5.4 Responsibility for implementation

1. Recommendations 1 & 2 needs to be carried out by state level town planning, urban development industrial infrastructure development department & environment department. Part of recommendation 1 especially for road and railway infrastructure should be implemented by state road department/ PWD and Indian railways/ DFCCIL. This not only includes EIA/EMP preparation and implementation from perspective of environmental planning but also based on alternative/ option analysis related to location but also on the principles of 3Rs (reduce, recover and recycle) and climate change.
2. Recommendation 2 and 3 related to GHG accounting for NW 1 infrastructure development and operations should be carried out by IWAI.

3. Central Pollution Control Board (CPCB) and State Pollution Control Board (SPCB) monitor pollution related data for major urban and industrial centers. However, all the hotspots need to be covered under their monitoring programs. There is a need to augment capacity and capability of these agencies. Further, IWAI can compliment this effort by monitoring air quality both upstream and downstream of their terminal locations as well in critical hotspots. This monitoring can be institutionalized by integrating environmental and social indicators as part of their information system.

7.6 Noise

7.6.1 Baseline Status of VECs

Ambient noise levels show variation on account of anthropogenic activities in the influence area particularly near the urban centres. 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 religious shrines is the another source of noise in the sanctuary area.

7.6.2 Possible Impact on VECs

Ambient noise levels are expected to rise above baseline on account of increased anthropogenic activities in the influence area particularly near the urban centres. Along NW 1 noise levels are expected to rise due to maintenance dredging, barge operations and activities around terminal sites. Dredging operations generates noise levels of app. 85-90 dB(A). This noise level adds to the aerial noise levels of the area thereby exceeding the baseline noise levels. High noise level has serious impacts on human health and the flora & fauna residing in the area. But the noise significantly reduces and dissipates with distance. Dredging will be carried out within the river thus the noise levels due to dredging operation will reduce by the time it reaches the habitation area. Through noise modelling study, it is seen that noise levels reduce to 56 dB(A) at distance of 500 m from source which is equivalent to baseline noise levels of the area. Also dredging is carried out intermittently thus impact will not be continuous type. Thus impact due to dredging operations on noise environment is low and can be further managed by adoption of recommendations. Barge movement does not involves significant aerial noise generation, however significant underwater noise is generated. The ambient noise level generation dissipates with the noise of the currents.

Source of noise pollution in NW 1 during the design and construction phase at the proposed intervention sites are site clearing, operation of excavators/earth moving equipment and leveller, operation of heavy machinery and equipment for construction purpose, loading & unloading of construction material and piling & dredging activities.

Operation of abovementioned equipments will generate high noise and will lead to increase in ambient noise level at the site and nearby areas and may impact the health of construction labour and nearby residents. Impact on nearby residents due to the noise generated is low in case of all presently planned site as habitations are located at more than 100 m at all the presently planned sites. Apart from above activities piling and dredging activities are to be carried out in river for construction of berths. These activities also generate significant level of noise ranging from 85-90 dB(A). However, this will also be confined to the piling and dredging period. No piling and dredging activity shall be carried out at night time.

Noise generation sources during operation phase are primarily loading and unloading of material at site and cargo vessel, movement of dumpers, cargo vessel, operation of backup power generators, pumps and other equipment. However, the main effect on the environmental noise level will be from increased transportation of goods entering and leaving the terminal site. Land use of the site is industrial and permissible noise levels at present are well within the CPCB standards that is 70 dB(A) for night time and 75 dB(A) for day time. During operation stage these levels are expected to increase due to above mentioned activities.Impact due to underwater noise generation, including dredging and barge operations on aquatic ecology is given in the section on VEC related to aquatic biodiversity.

7.6.3 Strategic Recommendations

1. Zonal planning and master planning of urban centers (hotspots) need to be upgraded in view of expected urbanization. These plans need to include developments related to NW 1 e.g. best locations for terminals, access, connectivity (roads & railways) and related infrastructure as well as sensitive receptors.

2. NW 1 operational strategy should aim for activities with reduced noise generation.

Recommendations to address impacts due to Maintenance Dredging for maintaining minimum LAD in navigation channel.

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

By provision of earplugs to the workers engaged in high noise generating activities, impact due to noise pollution can be managed. As per occupation standards, workers' exposure to 90 dB(A) noise level shall not be more than 8 hours. OSHA guidelines shall be followed for exposure to specific noise levels for workers. Conducting hearing tests for workers also help in monitoring the impact of the higher noise level on workers' health.

Provision shall be made for:

- Barricading (Temporary noise barrier) the construction site to minimize the noise level outside the site boundary
- Restriction on Honking at the project site
- Hearing test for the workers prior to deployment at site and high noise areas followed by periodic testing every six months.
- Job rotations systems for workers, working in high noise level areas
- Restriction of high noise generating activity between 6:00 AM to 10:00 PM.
- Periodic monitoring (monthly level) of noise levels to check the level of pollutants and effectiveness of proposed EMP
- Protection devices (earplugs or earmuffs) shall be provided to the workers operating near high noise generating machines. Construction equipment and

machinery shall be fitted with silencers and maintained properly. Noise measurements should be carried out to ensure the effectiveness of mitigation measures and develop a mechanism to record and respond to complaints on noise.

- All equipment shall be fitted with silencers/noise mufflers and will be properly maintained to minimize its operational noise. Noise level will be one of the considerations in equipment selection, which will favour lower sound power levels.

Operation stage

- Site boundary should be provided which can act as noise barrier
- Earplugs should be provided to workers involved in unloading operations
- Provision of thick green belt along the boundary and roads which will act as noise buffer
- Timely maintenance and servicing of transportation vehicles and the machinery/pumps to be used during operation phase to reduce the noise generation due to friction and abrasion
- Honking shall be prohibited at the project site
- Hearing test for the workers shall be undertaken before employing them and thereafter shall be done after every six months
- Job rotations should be practised for people, working in high noise level areas
- Noise generating activity should be restricted between 6:00 am to 10:00 pm.
- DG sets shall be provided with acoustic enclosure
- Monitoring of Noise levels shall be carried out on monthly basis to check the level of pollutants and effectiveness of proposed EMP

Strategic recommendations to address underwater noise generation, including dredging and barge operations on aquatic ecology is given in VEC related to aquatic biodiversity.

7.6.4 Responsibility for implementation

Recommendations 1 needs to be carried out by state level town planning, urban development industrial infrastructure development department & environment department. Part of recommendation 1 especially for road and railway infrastructure should be implemented by state road department/ PWD and Indian railways/ DFCCIL. This not only includes EIA/EMP preparation and implementation from perspective of environmental planning.

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. NHAI, PWD, DFFCIL, Indian Railways, vessel owners, cargo operators, dredge operators, tourist operators and other developers of infrastructure and users of NW-1 shall comply with conditions set out in EMP and implement mitigation measures.

7.7 Socio-economic Infrastructure Services & Facilities

7.7.1 Baseline Status of VECs

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.**

About 75.4% of the population is literate and 23.6% is illiterate in cities/town located along the NW-1 is illiterate. Male population is more literate than female.

The cities and towns along NW-1 have most of required infrastructure facilities. Infrastructural facilities namely Industries/industrial areas, transmission line, national highways, other roads, railways, settlement, cultural sites and archaeological sites. **All the towns and cities along the NW-1 are well connected with national highways, state highways, district roads, railways. Cities like Varanasi, Patna, and Kolkata are also connected with airways.** Some of cities located along the NW-1 are connected with localised ferry services as well.

Eleven thermal power plants are located in close proximity of river Ganga between Haldia and Allahabad and 10 more are reportedly are proposed to be set up in close proximity of the river. These terminal 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.

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.

Waste water generation from cities and towns along NW-1 in Uttar Pradesh segment generated 422.6 MLD i.e. 26% of total wastewater generation. Waste water generation from cities and towns along NW-1 in Bihar segment 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 contributes47% and Howrah generates 10% of the total waste water generation of west Bengal stretch.

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.

7.7.2 Possible Impact on VECs

Induced impacts are anticipated on existing land resources due to development of NW-1 project like development of terminals with multimodal connectivity, RoRo jetties and associated infrastructure. These are likely to have impact on existing infrastructure like roads (ODR, MDR, SH and NH), tourism sites and facilities and infrastructure. It would increase pressure on natural resources, existing solid and liquid waste handling facilities, disturbance to ghats and practices. However, development of NW-1 will provide facilities for improved passenger ferry services and connectivity. These impacts are described below.

Pre-Construction/Design and Construction Stage
Land is one of the major requirements for project development. At some of the proposed site it is also required to acquire private land or common public land. For the planned civil interventions under Jal Marg Vikas Project, it is required to acquire the land. At present acquisition of private land is required for Sahibganj & Varanasi terminal. However, in case of Haldia terminal and Farakka lock land belongs to Haldia Dock Complex and no acquisition of land will be required. Private land area of 5.685 ha and area of 61.38 ha/151.71 acres (44.92 ha/111 acres in phase I) will be acquired for Varanasi terminal and Sahibganj terminal respectively. Apart from private land area, 19 acres of Government land will also be required for development of the Sahibganj terminal. Land at Varanasi is agricultural land but is not being used for agricultural purpose by people. However, land at Sahibganj site is being used by farmers for carrying out agricultural activities for earning livelihood. Also there are few household and community temples located at terminal site. Acquisition of land will disturb their livelihood & living and will make them landless. However, it is proposed to provide them adequate compensation as per R & R Act, 2013 and resettlement & rehabilitation of the displaced population should be as per R & R Plan. Further land may be required for setting up labour camps, batching plant etc. But the land will be required temporarily for construction phase. Adequate compensation should be given for the land to be used for these activities and then the land should be rehabilitated in its original condition before handing back to the owner. Any utility or CPR like community temple, school, hospital, hand pump, well etc. if required to be shifted should be shifted immediately after the dismantling so as to minimize disturbance to people. Shifting should preferably be carried out on private land.

Construction activities at sites of civil intervention involves excavation, filling, parking of machinery/equipment etc. which may be threat to the population and can lead to any accident. Thus it is required that site should be barricaded and entry to the site should be strictly restricted to authorized personnel only. Construction of the terminal will require transportation of raw material to the site and debris from the site. Transportation of material may increase pressure on the roads which are used by villagers. Thus the haul roads should be well maintained and in case any diversion of traffic is required on these land alternate arrangements should be made. Traffic management is utmost required so as to prevent the congestion &accidents on these roads during peak hours.

Construction activities will generate high dust and noise levels which can be uncomfortable for nearby residing population. However, no habitation is within 100 m of all planned site but to mitigate this impact measures for controlling air and noise pollution are proposed to be taken during construction phase. These measures will significantly reduce the emissions and noise level.

Development of the project will generate employment options for local people as construction worker, supervisors etc. thereby improving the quality of life of people.

Operation Stage

Civil intervention works will involve development of terminals, jetties, locks, river training work, bank and bed erosion/scour protection works etc. These developments will lead to further development of infrastructure like roads to connect these sites to the existing roads, water supply system, power supply system etc. All these facilities will also be beneficial for nearby residing population. River bank protection works, construction of bunds/levees etc. will help in controlling the floods in area thus will be beneficial for people. Development of NW-1 project does not involve extraction of water from the river, thus no impact is anticipated on existing irrigational schemes set up on the NW-1.

All the civil intervention works are components of Jal Marg Vikas project which aims at enhancing the IWT mode of freight transportation. IWT is most environment friendly, cost efficient and safest mode of transportation. Transportation of material through waterway will reduce the risk of accidents, cost of transportation and GHG emissions associated with transportation. Reduced cost of transportation will reduce the ultimate cost of the goods to be manufactured thereby benefiting the consumers. Increased freight movement and low transportation cost will boost the economy of the country. Shift of freight from road or railway to waterway will also reduce the GHG emissions & other associated pollutants with the project. Also this will reduce the pressure on existing roads and railways there by reducing the need of further land acquisition for expansion or development of new roads.

Project will also generate large scale direct and indirect employment for unskilled, semiskilled and skilled workers. Employment opportunity will improve the quality of life of people in the area. Project may also induce development of various other facilities like warehouses, industries, roads, power supply etc. in the area. Thus project will lead to overall development of the whole area.

However, there are some negative impacts of the project at sites of proposed interventions. Traffic movement near these sites will increase due to increased nos. of vehicles carrying goods to & fro from these sites. Increased traffic involves generation of increased air emissions, increased pollution, increased noise level and increased risks of accidents in the area. Increased traffic will exert the pressure on the existing roads near the site. All these may increase the pollution level in the area and quality of life of people in nearby area may get affected. Thus it is required to upgrade the infrastructure like roads which will be used for project during operation phase and adoption of proposed pollution control measures to minimize the negative impact of project on society. Development of these civil interventions also may impact the quality of River Ganga. People are spiritually attached with the river thus impact on the quality of water of River Ganga will impact the sentiment and spiritual value of people. Increased cargo movement may also hamper fishing movement or damage the fishing gear of fishermen. Also there may be chances of reduction of fish yield in the river due to increased barge movement and increased pollution thereby impacting livelihood of farmers. Mitigation measures are required to be taken to prevent the impact on socio-economic environment

7.7.3 Strategic Recommendations

Pre-Construction/Design and Construction Stage

- Separate SIA, LA and RAP are being prepared for the sites which involves land acquisition. Adequate compensation should be given to the people losing the land
- People have sentiments associated with River Ganga so relocation of people should also be given near to River only as desired by them
- Shifting of utilities/CPRs if any shall be done immediately so as to minimize disturbance to the people or owner of the utility. Shifting should preferably be carried out at private land. The location proposed for shifting should also be acceptable by people.
- Skill training and assistance should be given to people so as they can get other jobs or get into other business. NGOs should be hired for this purpose
- Small loans should be given to the farmers losing the land and wishing to start new business
- Infrastructure development in form of small school, hospital, library etc. can be undertaken in the village as compensation to the disturbance caused
- Rest area should be provided at site in which workers can rest after the lunch hours and should not lie at site in open. This will help in preventing the accidents at site
- Adequate illumination should be provided at site during evening and night time till the work is being carried out
- Site should be barricaded and should have entry guarded by security guard. Register should be maintained for entry of outsiders. No unauthorized person should be allowed to enter the site especially village children
- A board should be displayed at entrance of site displaying name of project, area and hazards associated with the site on entrance and activities prohibited within and near site area in local language
- Workers should wear the personal protective equipment like helmet, gum boots, safety shoes, safety jackets, ear plugs, gloves etc. while working

- Noise level in the work zone should be maintained and followed as per OSHAS norms.
- Non-productive lands, barren lands, raised lands; wastelands should be used for setting up labour camps, plant sites and debris disposal site. Agricultural land should be avoided. Land should be used for establishment of construction camps, debris disposal site and plant site only after obtaining consent from land owner.
- Fishermen should be consulted prior restricting fishing activity in the activity area
- Necessary permits should be obtained by contractor from concerned authorities for setting up any batching plant or hot mix plant.
- Labour camps, plant sites and debris disposal site should not be located close to habitations, schools, hospitals, religious places and other community places. A minimum distance of 500 m should be maintained for setting up such facilities.
- Management, rehabilitation and closure of these sites should be as per the Management plans proposed for these sites. Records for starting, maintaining and closure should be maintained and should be approved by site engineers
- Contractors should adopt and maintain safe working practices. SOPs should be prepared for each and every activity and all activities should be undertaken as per SOPs under supervision of site engineer
- Training should be given to workers to handle the heavy equipment so as to prevent accidents
- Training should be given to workers to handle emergency situation like fire, earth quake and flood
- Complete medical check-up should be done for workers prior to joining and after six months of joining
- First aid facilities, first aid room, first aid trained personnel and ambulance should be provided at the site 24 X 7. Also tie-ups with local hospital should be done to handle emergency case, if any
- List of emergency nos., hospital contacts, ambulance contacts and doctors contacts should be displayed in first aid room, rest area and at all required location
- Working hours of labour should not exceed than standard norms as per state factory law
- Labour camps should be located at neat and clean location with no water logging issues and should be well ventilated with adequate illumination, kitchen and safe drinking water facility
- Construction labour camps and site should be properly cleaned and hygiene should be maintained
- Proper sanitation facility like toilet and bathing facility should be provided at site and labour camps. Wastewater generated from these facilities should be disposed through septic tanks and soak pit

- LPG should be provided as fuel for cooking to workers and open burning of fuel should not be allowed
- Wastewater from construction site should not be allowed to accumulate at site as standing water may lead to breeding of mosquitoes. Septic tanks/soak pits should be provided for its disposal
- Sprinkling of water should be carried out at site and haul roads, so as to minimize dust generation due to movement of construction vehicles and its impact on nearby residing population
- Temporary storm water drainage system should also be provided at camp site and construction site so as to drain the storm water and prevent accumulation of storm water at site and thus breeding of mosquitoes/flies
- Safety officers should be appointed at site so as to ensure all safety measures are taken at the site
- All construction workers should be provided with personal protective equipment like helmet, gloves, gumboots, safety jackets etc. and fines should be imposed if found not wearing
- Job rotation should be carried out for workers exposed to high noise and dust areas
- Activity like smoking and consuming liquor should be prohibited at the site
- Awareness on AIDS should be spread among the workers
- Traffic manager should be present at the site all the time to manage incoming and outgoing traffic to prevent accidents
- Crèche facility should be provided for kids if female workers are employed
- Regular inspection for hygiene and safety in labour camps should be done
- Provision of cautionary and guiding signage in local and English language indicating the hazard associated with the site & activities. Usage of fluorescent signage, in local language at the construction sites
- Speed limit of vehicles should be restricted at site to prevent any accidents and fines should be imposed on vehicles if same is not maintained. All construction vehicles should follow the designated routes & timings only.
- Construction vehicle movement should be restricted to non-peak hours, i.e. late evening (7-12:00 pm) only. Villagers should also be given intimation of these timings.
- Noise level in the work zone should be maintained and followed as per OSHA norm
- Employment should be provided preferable to local & affected people
- Dustbins should be provided at labour camps for collection of waste and waste should be regularly disposed through the concerned agency
- Arrangement of fire-fighting should be made at site and workers should be trained to use the system in case of fire
- All construction vehicles should be regularly serviced and maintained and carry pollution under control certificate

- All proposed environmental pollution measures should be taken during construction of phase of terminal to minimize the harm to existing environmental quality of the area, which is being enjoyed by the residents of that area

Operation stage

- Traffic management should be carried out at site so as to reduce the congestion and accident risk. Roads to be used for material transportation should be maintained. Routes and time for material transportation should be fixed. All vehicles carrying the material should be green tagged and should carry PUC certificate. All vehicles carrying transportation material should be properly serviced and maintained. All vehicles carrying material should have some restricted speed limits and should not be overloaded. Monitoring of these vehicles should be done through GPS.
- Separation of people from vehicles and making vehicle passageways one-way, to the extent practical
- Regular maintenance of plantation along the roadside should be done. No invasive plantation near the road. Plantation along the road side should be maintained and trimmed timely to prevent accidents. Proper street lighting should be given at site and at approach road to prevent accidents
- Traffic managers should be deputed at haul roads, approach roads and within the site
- All the workers at site involved in material handling, traffic management and other such operations should wear the safety equipment like helmets, gum boots, safety shoes etc.
- Honking within the site should be prohibited
- Existence of spill prevention and control and emergency responsive system at the site. Preparation of spill control and management plan for the terminal facilities & jetties
- Locating means of access to ensure suspended loads do not pass overhead, to the extent practical
- Constructing the surface of terminal areas to be: of adequate strength to support the heaviest expected loads; level, or with only a slight slope; free from holes, cracks, depressions, unnecessary curbs, or other raised objects; continuous; and skid resistant
- Providing safe access arrangements suitable for the sizes and types of vessels calling at their facilities. These access arrangements should include guard rails and / or properly secured safety nets to prevent workers from falling into the water between the ship's side and the adjacent quay
- Inspecting and approving all slings before use
- Clearly marking (indicating its own weight) all lifting beams and frames, vacuum lifting, or magnetic lifting device which does not form an integral part

of a lifting appliance and every other item of loose gear weighing more than 100 kilograms (kg)

- Inspecting disposable pallets and similar disposable devices before use and avoiding re-use of such disposable devices o Equipping lifting appliances with means of emergency escape from the driver's cabin and a safe means for the removal of an injured or ill driver
- Risk of free fall of materials should be minimized by installing telescoping arm loaders and conveyors
- Materials handling operations should follow a simple, linear layout to reduce the need for multiple transfer points
- Emergency plan for vehicles carrying hazardous material should be in place
- Implementation of the environment management plan as proposed to prevent the environmental pollution during operation phase
- Vessel should comply with safety norms and should maintain the speed so as to prevent the accidents. In case of accidents, ship owner should be responsible for clean-up operations
- Employment should preferably be given to local people. Women should be given equal opportunity for work.
- Emergency preparedness and response plan should be available at the site for all the natural and occupational hazards associated with the site. The plan should be approved by health & safety officer. The plan should be implemented by EHS cell at the site.
- Safety training should be given to the terminal staff for managing the floods, earthquake, fire, ship accidents like situation. Emergency collection area should be designated at the site which is safe. All workers should be directed to collect at this area in case of emergency.
- Fire-fighting facility should be provided at site and trained personnel should be available at site who can operate the fire extinguishers and other fire-fighting equipment.
- Development activities as CSR should be carried out in the village and nearby areas for development of area
- Meetings should be conducted with nearby people six monthly to address the problems they are facing. A grievance redressal cell shall be set up at each intervention site. People should be communicated about the facility & system of grievance redressal so as they can launch their complaints, if any easily.
- Fishing activity should not be restricted in the river. Alternate provision for fishermen should be given in case fishing activity is restricted.

7.7.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. NHAI, PWD, DFFCIL, Indian Railways, vessel owners, cargo operators, dredge operators, tourist operators and other developers of infrastructure and users of NW-1 shall comply with conditions set out in EMP and implement mitigation measures.

7.8 Opportunity and Access to Improved and Conserved Livelihood

7.8.1 Baseline Status of VECs

Ganga along the NW-1 state is intrinsically linked to the economy of the area. It provides the necessary silt in much of the land around it, increasing its fertility. Paddy is the greatest crop of the region. Agriculture is the main source of the livelihood generation for the people residing along the NW-1 area. Many towns in the area are primarily industrial. Ganga provides the necessary infrastructure for the factories to perform. Commercial fisheries in the Ganga River System are an important source of livelihood for the people residing along the Ganga River.

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

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

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

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

Nets & Gears: Dragnets, dip net, gill nets, traps, bag nets are commonly used by the fisherman along the NW-1 stretch. Gill nets availability was highest in Patna, Munger and Bhagalpur stretch of NW-1 and lower in Allahabad and Mirzapur stretch of NW-1. Availability of dragnets was low in almost Allahabad to Farakka stretches. Large dragnets were not present at all. Use of hook and lines were mainly in the Allahabad and Mirzapur stretches of NW-1 whereas traps were more in district Ballia and Bihar stretches. Small scoop nets were available in the entire stretch but large size was available only in lower stretches down to Farakka. Dip nets were observed in Allahabad and Mirzapur districts.

Various forms of gill nets and bag nets are found to be operated by the fishers. Among them gill nets are most prevalent throughout the NW-1 stretch. Around 80% of the fishers were using the gear. The gill nets have different local names like Current jal, Nagin jal, Kajli jal, Phasa jal, Bhola jal, Vacha jal, Ghero jal, Dhoali jal, Gule jal, Pungus jal, etc. A number of variations in material and mesh size in gill nets are observed depending 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.

7.8.2 Possible Impact on VECs

As per study carried out by CIFRI "Impact analysis on Ecology, Flora and Fauna including Fish and Fisheries due to movement of Barges carrying coal through National waterway no. 1 (Sagar to Farakka)", it is found that barge movement significantly impact the fishing operations in that stretch resulting in reduction in their income. Thus similar nature impacts are anticipated due to the project. Stretch downstream of Farakka is already impacted due to existing barge movement. Impacts on stretch upstream of Farakka are anticipated to be comparatively lower than the stretch downstream. Fishing is done using large nets placed across the river in areas near Farakka and downstream of Farakka, whereas in areas upstream Farakka fishing is done near the bank areas using small size mesh gill net, traps and hooks and lines. However, increased plying of vessels is likely to disrupt/ come in conflict with the current fishing activities/ practices, small boat/ferry services operators which will impact associated livelihoods.

On the other hand, due to operationalisation of NW-1 Project, increased opportunities of inland water transportation and availability of commodities will directly or indirectly benefit consumers due to cheaper transport of variety of commodities. Cargo and logistic operators will be benefited which will create direct/ indirect livelihood and income generating activities. Tourism sector will receive a boost since diversification of inland waterways tourism and related activities will generate direct/ indirect livelihood and income generating activities

7.8.3 Strategic Recommendations

- Barge/vessel movement will be restricted to the designated navigation route only. Maintenance of buoys, beacons, signs, gauges to mark the navigation channel
- Crew of the vessel carrying especially oil should be competent and experienced so as they can prevent the damage to fishing gears and boats.
- Marking of navigation channel through beacons and communicating information about the navigation channel monthly to fishermen and the expected timing or frequency of barges to fishing community so as they can be pre-informed and the damage to their boats and gears can be reduced. Barge movement schedule should be prepared in advance and should be shared with the fishermen
- Regularizing the barge speed to 7-8 knots in bending areas so as bank erosion can be reduced due to barge movement resulting in lesser turbidity, enhanced planktonic growth and thus increased fish yield.
- River training works should be carried out at the bank locations which are prone to erosion to reduce the turbidity in shallow areas and its impact on fish yield.
- All measures to reduce the water quality pollution & to prevent damage to ecology due to barge movement as proposed above should be adequately addressed and implemented so as to minimise impact on fish yield due to the project.

- In case of damage of fishing nets, fishing crafts and other gears of fishers, arising due to barge operation, appropriate and quick compensations may be given to the aggrieved fishers.
- The barges may be fitted with powerful searchlight and may sound horn so that fishermen can realize arrival of barge at least from 500 m-1 km away to prevent damage to fishing nets
- Regular consultations to be carried out with the fishing communities to get their feedback on the impact due to barge movement on fishing and problems they are facing
- Support shall be extended in terms of supporting setting up fish nurseries for improving fish productivity and training awareness of fishermen for better fishing techniques through institute of repute like CIFRI.

7.8.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment and social management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. Vessel owners, cargo operators, dredge operators, tourist operators and other users of NW-1 shall comply with conditions set out in EMP and implement mitigation measures. Research and development agencies, e.g. CIFRI, Fisheries departments, socio–economic and livelihood development agencies and experts may be brought on board, as deemed necessary.

7.9 Maintain the Cultural Values

7.9.1 Baseline Status of VECS

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 believe that bathing in the river on certain special occasions and periods causes the forgiveness of sins and helps attain salvation. People also travel from distant places to immerse the ashes of their kin in the waters of the Ganga. This immersion also is believed to send the ashes to heaven. Various festivals are organised on the bank of rivers at different places and different period. These festivals attract very large crowds and may have bearing even on movement of barges in NW-1 during festival periods. The list of culturally and religiously important places with its festivals along the NW-1 is given at **Table 7.3**.

Table 7.3: Culturally and Religiously Important Places with Fair and Festivals

Sl. 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

Sl. No.	City	Place	Fairs & Festivals
			the Hindus. It is said that when Lord Vishnu carried a pot or Kumbha of Nectar or Amrita, a fight broke out among the gods. In the milieu, four nectar drops fell on the earth at the four place which are known as the Tirthas and include Nasik, Haridwar, Prayad and Ujjain. These places are therefore considered as place where the mortal humans can pass on to a celestial world form the human world. In each of these locations, there is a kumbha mela held but on the 12th year, the mela is organized in Allahabad as it is considered the most sacred of the Tirthas. The Greatest Kumbha Mela is held in Allahabad which is also known as Maha Kumbha Mela and is the biggest fair related to religious practices. **Magh Mela:** Apart from the Maha Kumbh and another kumbh mela by the name of Ardh Kumbh, there is the Magh Mela. Maha kumbh is held every 12th year in the city of Allahabad which is a sacred city in the state of Uttar Pradesh. As because the Magh Mela falls during the period of Magh months of Jan and Feb, so the name has been given. During this period, the devotees take a holy bath at the confluence of the 3 rivers believing that the waters will wash away their sins.
2	Varanasi	Ghats	There are more than 100 ghats along the Ganga river at Varanasi (steps leading to the water of the Ganges). The banks of the Holy River at Varanasi are the most preferred cremation grounds.
		Ghats	**Panch Koshi Parikrama:** This parikrama starts and finishes at Manikarnika Ghat and has the great importance in ancient Parikrama of India. The devotee will pass through the five great places that's why it has named so behind this. The five places of which the devotees have to round up and complete his Panch Koshi Parikrama are Kardmeshwar, Shivpur, Rameshwar, Bhimchandi and Kapildhara. **Ganga Mahotsav:** This festival is being celebrated in the months of October and November which is the tourism festival of Varanasi that is being celebrated from Prabodhani Ekadashi to Kartik Purnima (November month) ending by a dance presentation at Ganga Mahotsav. The rich cultural heritage of Varanasi is being reflected by this festival. Besides various cultural programs and the boat racing the martial arts are also presented. This festival also corresponds with another traditional festival of Dev Deepavali in which all the ghats of Varanasi are enlightened by thousands of Diyas. **Dhrupad Mela:** This mela is basically a music festival that is organized on the Tusli Ghat for five days (Feb or March month) in which the renowned artists of the area give their performances. This mela is especially famous among the foreign tourists.
3.	Bihar & Jharkhand	Ghats	**Chatth Puja:** Chhath is an ancient Hindu festival dedicated to the worship of the Lord Sun in November month and is mainly celebrated in Bihar and Jharkhand on the banks of Ganga.

7.9.2 Possible Impact on VECs

Barge movement though restricted to the defined navigation channel but have potential to impact and interrupt the fest and festivals and other day to day activities being carried out or performed at river by the people. There are several festivals which are being celebrated at River Ganga and several rituals being performed at River by people. These activities are also likely to be impacted due to increased barge movement. Some of the important festivals are Kumbh at Allahabad (Jan-Feb), Ganga Mahotsav at Varanasi (Oct-Nov), Dhrupad Mela at Tulsi Ghat of Varanasi (Feb to March), Chatt at Bihar & Jharkhand (Oct-Nov) and Ganga Sagar Mela at Sagar (January). Thus, it is essential that barge movement should be regularized at these locations during these festivals so as to prevent social conflicts. Apart from this, there are about 100 ghats at Varanasi used for various purposes like bathing, idol immersion and performing last rites (*asthi visarjan)* and other rituals. Cremation ceremony is performed at several locations along the bank of river. Also locals of nearby villagers (both males and females) bath in river. Barge movement could be uncomforting for the female bathing in the river. Barge movement may bring certain social conflict if appropriate and timely measures are not put in place.

7.9.3 Strategic Recommendations

- Ensure availability of water including around the ghats and maintenance of water quality fit for bathing and performing rites and rituals.
- No waste in any form shall be discharged by vessel in the river so as to improve and maintain the quality of water
- Vessel movement shall be restricted or regularised during the identified major festival period as listed in section 2.0.
- Support for establishment of small enclosed areas dedicated for female bathing in every village along the NW-1 to allow female maintain their privacy.
- Support for improving cleanliness and at existing ghats at Varanasi and other locations
- Provision for improving/restoring selected *Ghats, Kunds*, etc.

7.9.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. Vessel owners, cargo operators, dredge operators, tourist operators and other users of NW-1 shall comply with conditions set out in EMP and implement mitigation measures.

7.10 Maintain Cultural Events and Cultural Functions

7.10.1 Baseline Status of VECs

River Ganga is of great cultural and religious significance for the 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 Buddhist alone attracts over one million pilgrims every year followed by Allahabad. Pilgrimage and the associated tourism brings along a major source of revenue for religious towns and their people. There are several ghats, kunds, temples, shrines, etc. *Kumbh, chhath* constitutes cultural events and functions in and around Ganga.

7.10.2 Possible Impact on VECs

As per analysis and planning no dredging is proposed near the important cultural areas/Ghat. Placement of dredgers in river may disrupt the fishing activities, however dredging activities at any particular location will be for short duration and thus the impacts will not be significant. Dredging operations generate noise of 80 dB(A) which can create discomfort for the population residing on the banks specially in the night time. Dredging operations required manpower for carrying and controlling dredging operations. Thus generation of employment for skilled, semi-skilled and unskilled labour can be taken as positive impact of dredging operations. Dredging operations will enable navigation of the barges in the waterway throughout the year thereby increasing the IWT mode of transportation. This will have positive socio-economic impact in terms of employment generation.

7.10.3 Strategic Recommendations

- Dredging operations should be restricted primarily to day time, i.e. 6:00 Am-10:00 Pm only to minimize noise impacts on the residents of nearby settlements. Dredgers should be equipped with the noise reduction/masking equipment to reduce the noise generation
- Dredgers should be placed in consultation with the fishermen so as to minimize the impact on their equipment/gears and their fishing activities
- Dredging should not be carried out in the areas close to Ghats in Varanasi and buffer of 2 km should be maintained for dredging during time of religious gatherings during Chhat and Kumbh festivals.
- In case contaminated dredged material is disposed on land, then it should be disposed at approved TSDF sites to prevent any harm to community residing in nearby areas. One of such approved TSDF site is located Sagar (Haldia Dock Complex site)
- Material to be disposed on land may create nuisance odour due to exposure of anaerobic sediments with air. Thus if land disposal is involved than disposal site should not be in upwind direction of any settlement area or sensitive locations like hospitals, schools etc.
- Log book should be maintained for recording the accidents at site/mortality of the any aquatic mammal and other fauna should be maintained. Analysis shall be carried out to assess the reason for the accident/mortality and measures should be taken to prevent repetition of the event.
- Contractors having experience of dredging and well trained staff should only be allowed to carry out dredging. This will help in prevention of spillage of dredged material or any accidents during the dredging operations.
- Dredging plan should be prepared by contractor and submitted to IWAI for approval prior to carrying out dredging operations. Dredging plan should be reviewed considering its location w.r.t environmental sensitive locations/archaeological locations/cultural festival/pollution influx in the area/dredged material quality & texture/available depth etc.
- Contractors should submit method statement & risk assessment plan prior to carrying out any dredging work. Dredger should follow the defined safety procedures to avoid

accidents and spills, and IWAI should ensure that other vessel users are provided with adequate information and instruction to avoid conflict with the dredgers.

- Post-dredging monitoring of the sediment nature, rate of sedimentation shall be made part of contractor's job as best dredging practise. This will provide information which can be taken into consideration before the next maintenance dredge is carried out.
- Re-use of dredged material should be explored if dredged material is not contaminated. Economically and environmentally feasible options can be adopted to minimize the dredge spoil burdens. Some of such measures include
  - Dredged sediment can be used for beach nourishment/ development of artificial beach/deposition on shoal & thus enrichment of habitat
  - Dredged material can be explored for its usage for coast/bank protection purpose/flood protection
  - Use of dredged material can be explored for land filling, as construction material for road foundations, dikes, mounds, noise/wind barriers.

7.10.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. Vessel owners, cargo operators, dredge operators, tourist operators and other users of NW-1 will comply with conditions set out in EMP and implement mitigation measures.

7.11 Conserve Heritage Sites, Structures and Values

7.11.1 Baseline Status of VECs

Archeological Survey of India has notified monuments as archeologically protected. 77 monuments falling in the districts through which NW-1 is passing is listed at **Table 7.4.**

Table 7.4: List of Archeologically Protected Monuments in the Districts located in NW-1 route

Sr. No.	West Bengal	Districts
1	Abandoned Gopal temple at Amdpur	Burdwan(WB)
2	Majlish Saheb or Id-Baqrid mosque at Kalna town	Burdwan
3	Panchratna brick temple at Baidyapur	Burdwan
4	Radha Gobunda temple at Jagadanandapur	Burdwan
5	Three Siva temple at Sribati	Burdwan
6	Badsahi or Hussain Shai mosque at Nutanhat	Burdwan
7	Siva temple at Honpas – Kamarpura	Burdwan
8	Hussain Shah mosque at Kulutia	Burdwan
9	Excavated monument at Goswamikhanda	Burdwan

Sr. No.	West Bengal	Districts
10	Bijoy - Toran at Burdwan town	Burdwan
11	Temple of Kashinath Siva at Ajhapur	Burdwan
12	Temple of Madan Gopal at Kulingram	Burdwan
13	South Park street Cemetery in Park street	Calcutta
14	The tomb of Admiral Charles Watson, the Mausoleum of Job Charnak and The Tomb of BegunJohnson within the compound of St. John's Church at Council house street, Calcutta	Calcutta
15	Henry martin's Pagoda at Serampore	Hooghly
16	Raj Rajeswar temple at Dwarahatta	Hooghly
17	Chandi temple at Deulpara	Hooghly
18	Siva temple at Bakharpur	Hooghly
19	Temple of Gour Chandra and Krishnachandra at Chatra	Hooghly
20	Jorbangla temple at Parul	Hooghly
21	Raghunandan temple at Parul	Hooghly
22	Jorbangla temple of Durga with Navaratna tower at Bally dewangunj	Hooghly
23	Mosque at Village bajua	Hooghly
24	Radha Govinda temle at Satpur	Hooghly
25	Siva temple at Harirampur	Hooghly
26	Raj Rajeswar temple at Kotalpur	Hooghly
27	Temple of Sri Sri Nandadulal Jew at Gurap	Hooghly
28	The mast of a Portuguese ship at bandal	Hooghly
29	Kanakeswar Shiva temple, Byra Kanpur	Hooghly
30	Temple of Dadhimadhab of the Roy family at Amraguri	Howrah
31	Temple of Gopal Jew at Mellock	Howrah
32	Jami mosque in Old Malda municipality	Malda
33	Ruins of the fortified city of Pandua	Malda
34	Ruins of Pathan palace at Adian	Malda
35	Ancient ruins at Ratnagarh at Wari	Malda
36	Ancient ruin site at Gagjibanpur	Malda
37	Tomb of Nawab Sharfaraz Khan at Naginabagh	Murshidabad
38	Temple of Gangeswar Siva at Baranagar	Murshidabad
39	Siva temple at Yugwara	Murshidabad
40	Ravratna temple at Sibarambati	Murshidabad
41	Ratneshwar Siva temple at Bilbari	Murshidabad
42	The house, temples and ruins associated with memory of Jagat Sett's house at Mahimapur	Murshidabad
43	Temple of Raghabeswar Siva at Dignagar	Nadia
44	Temple of Shyamchand at Santipur town	Nadia
	Jharkhand	
1	Ancient Fort and Sangeet Dalan	Shobhabgunj(Sahibganj)

	Bihar	

Sr. No.	West Bengal	Districts
1	Archaeological Site, Kheri, Shahkund	Bhagalpur
2	Tomb of Mahmudshah, Kahalgaon	Bhagalpur
3	Fort of Munger	Munger
4	Golghar	Patna
5	Agamkuan Gulzarbagh, Patna City	Patna
6	Beguhjam Masjid, Patna City	Patna
7	Jain Temple, Kamaldah, Gulzarbagh	Patna
8	Do Ruikhi Pratima, Kumrahar	Patna
9	Choti Patandevi, Patna city	Patna
10	Nepali Temple, Hazipur	Vaishali
	Uttar Pradesh	
1	Ancient mound at Koldihwa	Allahabad (36)
2	Ancient mound at Mahagara	Allahabad
3	Ancient mound at Chopani Mando	Allahabad
4	Purana Mandir	Chandauli
5	Chunar firt	Mirzapur
6	Ancient site of Bhuili	Mirzapur
7	Sarnath Temple	Mirzapur
8	Siddhanath ki Dari	Mirzapur
9	Lekhnia Pahar	Mirzapur
10	Painted rock- shelter	Mirzapur
11	Megalithic Remains	Mirzapur
12	Painted rockshelter at Lekhnia Pahar	Mirzapur
13	Megalithic remains of Kotwar Pahar	Mirzapur
14	Bhaldria Painted rockshelter	Mirzapur
15	Lekhnia Painted Rockshelter	Mirzapur
16	Samadhi and Mausoleum od Sant Kabirdas	Sant Kabir Nagar
17	Ancient of Kopia or Anupia	Sant Kabir Nagar
18	Battis Khamba	Varanasi
19	Battis Khamba	Varanasi
20	Lahartara Talab	Varanasi
21	Kardmeshwar Mahadeva Mandir	Varanasi
22	Guradham Mandir	Varanasi

Nine archeologically protected structures/monument[35] located within 300 m of NW-1 is listed at **Table 7.5**.

Table 7.5: Archeologically Protected area around 300 m of NW-1

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

35As per Indian regulation no construction activity can take place within 300 m of archeologically protected monuments/ structures/site without written permission from archeological department.

Sl. No.	Name	Latitude & Longitude	Place	Distance from NW-1 km	Direction from NW-1
1	Kardmeshwar Mahadeva Mandir	25°19'13.13"N 83° 1'20.91"E	Varanasi, UP	0.24	W
2	Ramnagar, fort	25°16'9.17"N 83° 1'28.17"E	Varanasi, UP	0.04	East
3	Archaeological excavation site, Varanasi	25°19'33.72"N 83° 2'4.47"E	Varanasi, UP	0.13	North
4	Manmahal and observatory	25°18'27.83"N 83° 0'38.55"E	Varanasi, UP	0.04	West
5	Sindhi Dalan	25° 3'15.32"N 87°49'51.17"E	Rajmahal, Jharkhand	0.3	West
6	Jami masjid	25° 4'25.73"N 87°46'39.01"E	Mangalhat, Jharkhand	0.14	West
7	St. John's Church	22°34'11.38"N 88°20'45.27"E	Council house street, Kolkata, WB	0.3	East
8	Temple of Gour Chandra and Krishnachandra at Chatra (Gaur Chandra Ghat)	22°45'48.96"N 88°20'13.76"E	Hooghly, WB	0	West
9	Hazardwari Palace	24°11'10.27"N 88°16'5.73"E	Murshidabad, WB	0.03	East

7.11.2 Possible Impact on VECs

Construction activity within 300 m of archeologically protected monuments/ structures/site can impact them and associated values.

7.11.3 Strategic Recommendations

Construction activities should avoid archeologically protected monuments/ structures/site as much as possible.
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. Such permissions may necessarily be obtained from archeological department.

7.11.4 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities.

7.12 Other Benefits

7.12.1 Strategic Recommendations

Green Rating for Integrated Habitat Assessment (GRIHA)

Green Rating for Integrated Habitat Assessment (GRIHA) Council, is mandated to promote development of buildings and habitats in India through GRIHA. It is recommended that the GRIHA is followed in proposed development of terminals, etc. by IWAI and by other developers on account of induced development spurred by NW-1 project particularly in the influence area.

Energy Conservation Building Code (ECBC)

ECBC was developed by the Govt. of India for new commercial buildings on 27th May 2007. ECBC sets minimum energy standards for commercial buildings having a connected load of 100kW or contract demand of 120 KVA and above. the ECBC has been integrated in other rating & compliance systems being followed in the country such as EIA (Environmental Impact Assessment) for large area development under MoEFCC, Green Rating for Integrated Habitat Assessment (GRIHA) rating system of ADARSH and Leadership in Energy & Environmental Design (LEED) rating system of the Indian Green Building Council (IGBC).

It is recommended that ECBC is followed in proposed development of terminals, etc. by IWAI and by other developers on account of induced development spurred by NW-1 project particularly in the influence area.

Environmental Health & Safety Policy and EHS Management System

An effective environmental health and safety policy is essentially required to be prepared for the project and it should be communicated to the workforce through displaying posters/bill boards/posters/glow boards and campaigning around the work site. Posters should be in Hindi, English & Regional language so as it can be understood by the workforce. Verbal communication through campaigning also should be carried out. Some of the important days such as Environment Day (June 5), Red Cross Month (March), Emergency Preparedness Week (May 1-7), National safety day (4th April), National Health Day (7th April), Fire safety day (14th April), 20th April (Earth day) can be planned for spreading the awareness for Environment Protection, Cleanliness and safety among work force through campaigning.

For effective and systematic implementation of the project, it is desirable that IWAI (The EA) develops its Environmental and Social management systems which is auditable and effectively enforceable. Parallel can be drawn from the experience of National Highway Authority of India or Delhi Metro Rail Corporation and adopt EHS system on the similar lines. Each contractor should be contractually bound to follow such system and must have EHS management system in line with EA's management system. IWAI should also develop its standard technical guidelines for Environmental Assessment, Management and Reporting.

Environmental Standards for operation and maintenance of Various Civil Interventions, Barge Movement and Dredging Operations

Mentioned activities have potential to pose threat on the environmental quality. Regulatory Authorities of India and other countries have specified certain limits of pollutants which, if maintained, environmental pollution can be maintained. The Environmental standards applicable for the operation and maintenance stage of the project and that should be adhered to are listed below.

- Standards for discharged of effluent in inland surface water bodies and Marine Coastal Areas (Source: G.S.R 422 (E) dated 19.05.1993 and G.S.R 801 (E) dated 31.12.1993 issued under the provisions of E (P) Act 1986)
- Classification of Surface water Bodies on basis of Quality (Source: Guidelines for Water Quality Management-CPCB, 2008)
- Water Quality Standards for Coastal Waters, SW-IV & V-Harbour and Navigation & controlled waste disposal (EIA Guidance Manual for Ports & Harbours, MoEF&CC, GoI)
- Standards for permissible level of water quality indicators (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Permissible limit for off-shore dumping of dredged material (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Criteria for harmful bottom sediments (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- Approximate Quantity of Suspended Sediments Generated by Dredging or Dumping Operations (Source: Assessment of the Environmental Impact of Port Development, United Nations, New York, 1992)
- MARPOL 73/78 for prevention of pollution from ships
- SOLAS (Safety of Life at Sea) as per latest amendments (Chapter I-XII)
- CPWD Norms for construction of off-shore works, river bank protection structure, carrying out dredging works, river training works

Zero discharge from vessels and proposed terminals

Zero discharge is recommended at all terminals site to minimize water pollution from the site and from plying vessels to address potential pollution.

Zero Emissions and reduction of GHG emissions

NW-1 operational strategy should aim for zero emissions. This should include alternate fuel e.g. CNG or renewable energy e.g. solar powered based barge/ vessel operations.

GHG accounting should be carried out especially for terminal and operation related movement of NW 1.This should also include GHG avoided & added vis a vis rail and road transport.

7.12.2 Responsibility for implementation

IWAI, PMU and Contractors will have direct responsibility in effective implementation and internal monitoring of environment management plan and mitigation measures. Compliance to conditions as set out by various regulatory authorities will be monitored by concerned regulatory authorities. NHAI, PWD, DFFCIL, Indian Railways, vessel owners, cargo operators, dredge operators, tourist operators and other developers of infrastructure and users of NW-1 shall comply with EHS Management System, Environment standards as well conditions set out in EMP and implement mitigation measures.

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ANNEXURE 3.1

Annexure 3.1: Geomorphic Features in the Channel Belt and Active Floodplaing along the Ganga River

The geomorphic features with in active flood plain as mapped in Ganga River Basin Management Plan is considered. Geomorphic features in the channel belt and active floodplain along the Ganga River pertaining to NW-1 stretch is described below.

Allahabad to Varanasi stretch:

The river stretch between Allahabad and Varanasi (Figure 3.1) over a length of 245 km is a unique segment of the Ganga River as it nearly approaches (~7 km; near Meja) the peninsular shield and exhibits a strong basement/tectonic control with a maximum sinistral shift of about 16 km towards SSE (Allahabad). In addition, these two cities are the most popular religious centers along the river course. The mapping of the river course based on remote sensing data with limited field checks has shown the various geomorphic units with their respective numbers and areal coverage which includes mid-channel bars (134.59 sq km), point bars (110.76 sq km), alluvial islands (56.17 sq km), lateral bars (245.34 sq km), meander scrolls (3.18 sq km), flood channels (9.42 sq km), and vegetation patches (69.17 sq km). The width of the flood plain varies between 1.4 (SE of Handia) and 8.4 km (near Mirjapur). The maximum (14.2 km) and minimum (1.8 km) valley margin width have noted ~63 km downstream of Allahabad and Varanasi, respectively. The distinctive feature of this stretch of the Ganga River is its partly confined valley fills (cratonic) nature between Chunar and Mirjapur and the remaining part is grouped under unconfined alluvial valley.

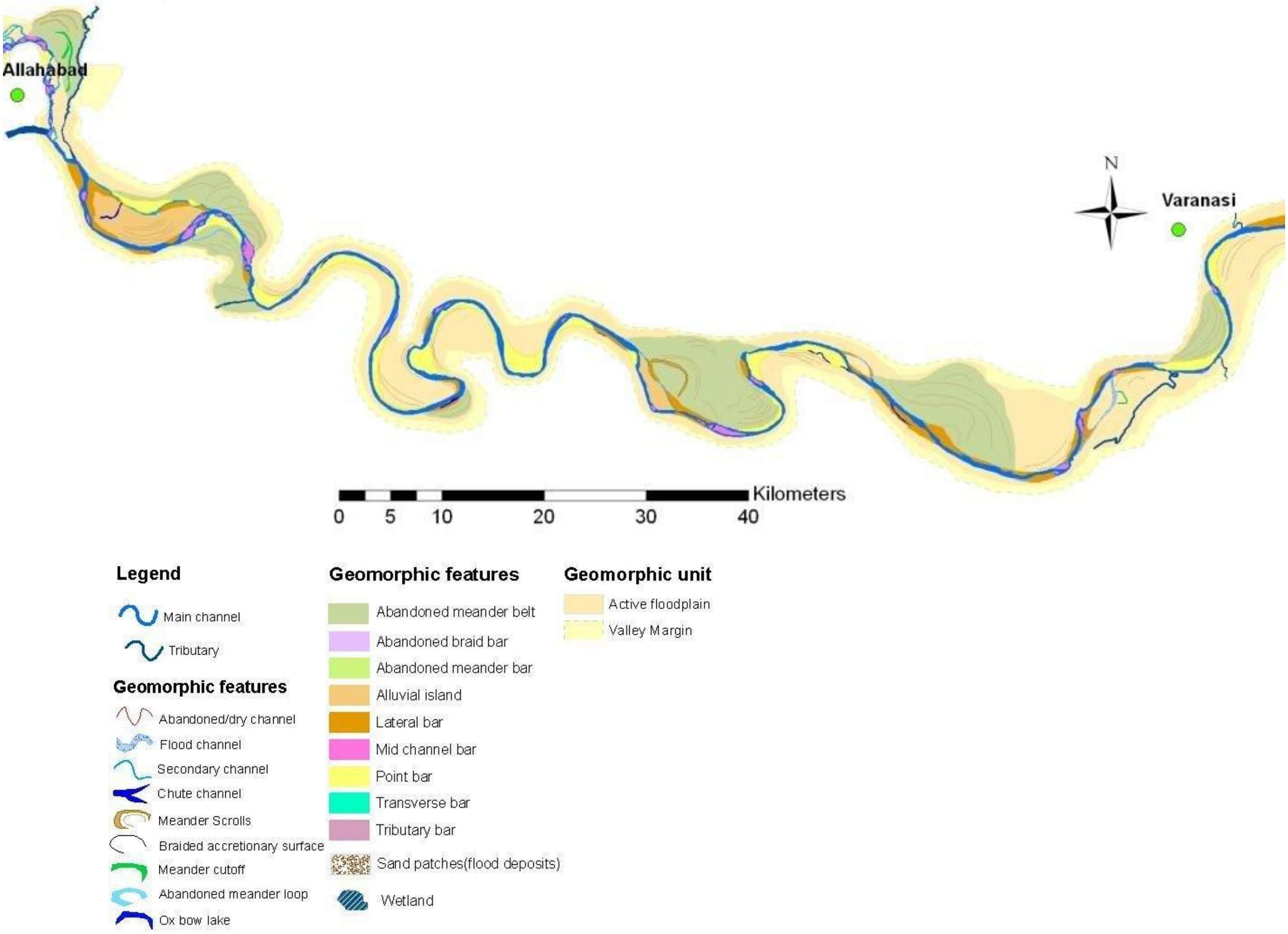

Figure 3.1 Geomorphic map of the Allahabad to Varanasi stretch

Varanasi to Munger stretch

The geomorphic map in this stretch has been presented into two parts, one from Varanasi to Madhubani (Figure. 3.2a) and then from Madhubani to Munger (Figure. 3.2b). The minimum width of floodplain in this stretch is 1.8 km downstream Varanasi, while the maximum width went up to 28 km near Ara. The minimum Valley margin width is 7 km d/s Varanasi, while the maximum Valley margin width increases to 36.1 km at the location 23 km d/s Buxar. Alluvial Islands are a significant geomorphic characteristic in this reach of Ganga river (Figure 8a, b). While the first island 30 km downstream of Buxar is only 3.0 km in width, 2 major islands of over 12 km. maximum width are present u/s and d/s Patna and there are 2 more islands further downstream -- between Barh-Mokama (5.5 km max. width) and upstream of Munger (2.0 km wide). Alluvial islands seem to gain prominence in width / area downstream of the confluence of Ghaghra and Gandak rivers from the North and Son river from the South, probably due to the contribution of a huge sediment load from the Himalayan terrain. Two major areas of meandering belts, one each on the northern and southern banks of Ganga river, d/s of Varanasi between Zamania and Buxar, have been identified. Another special stretch between Buxar and Ara (downstream) and confined only to the southern bank of river Ganga, is a zone of meander scrolls, meander scars and ox-bow lakes.

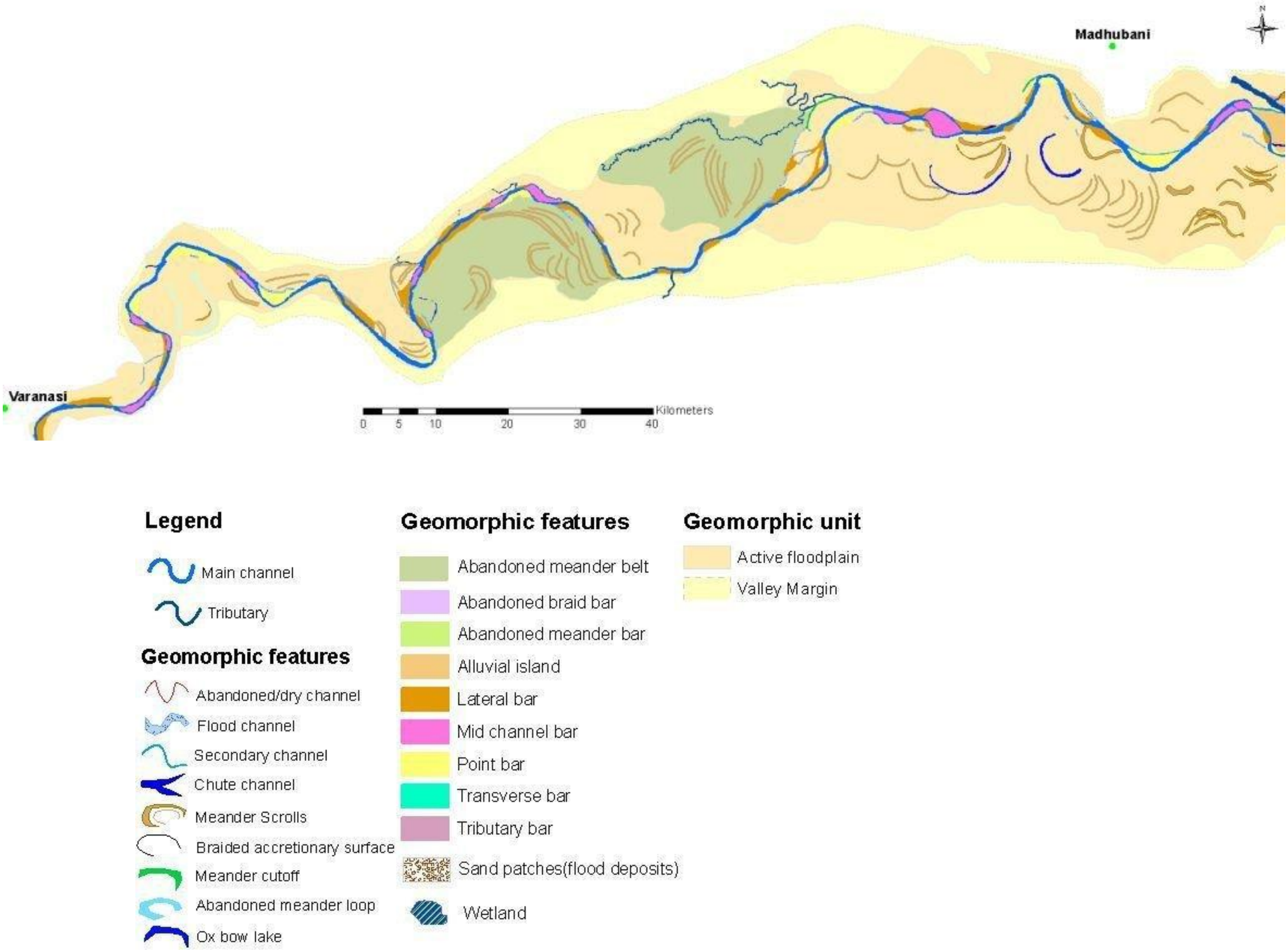

Figure 3.2(a): Geomorphic map of the Varanasi to Madhubani stretch

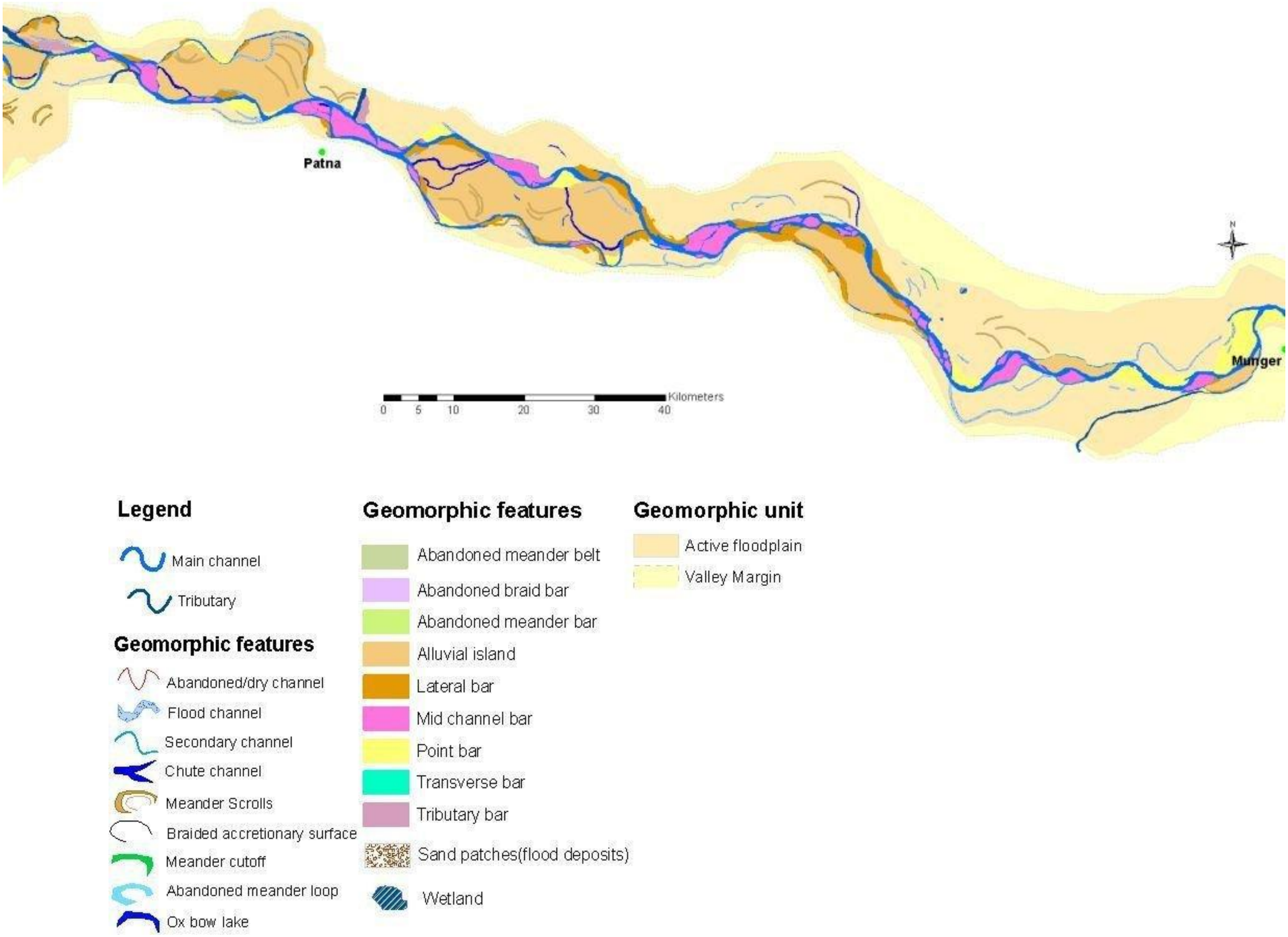

Figure 3.2(b) Geomorphic map of the Madhubani to Munger stretch

Munger to Farakka strtech

Total along channel length of the studied area is about 330 km and the valley setting is semi-confined (Figure 3.3). The southern margin is controlled by basement rocks of the craton whereas the northern valley margin is unconfined and merges with/bound by the alluvium of Kosi and Mahananda river. Maximum floodplain width in the study stretch is about 23.3 km and minimum width 7.2 km. The sinuosity of the stretch has increased a little bit as compared to the immediately upstream stretch, but the river is braided all through the sector with many mid-channel bar or large islands, lateral bar, etc. The increase in sinuosity is plausibly related to irregular configuration of the basement block on the southern margin of the valley (e.g. Munger-Bhagalpur-Sahibganj stretch).

The major geomorphic characteristic of the river in this stretch is the braided-sinuous pattern, with numerous fine-grained sandy bars in channel (Fig. 3.3). These channels are extremely mobile and the active channel is seen to migrate more than a km within a year. Active floodplain is marked by abandoned meander and braided bars. Abandoned channel and bar accretion surfaces at places marked fine clayey fine-grained sediment. Levees, newly grown bars and many abandoned slough channels (flood channels) over braid bars are marked by dry sandy patches. Most of these abandoned bars (now part of the floodplain) and in channel large islands are now agricultural fields.

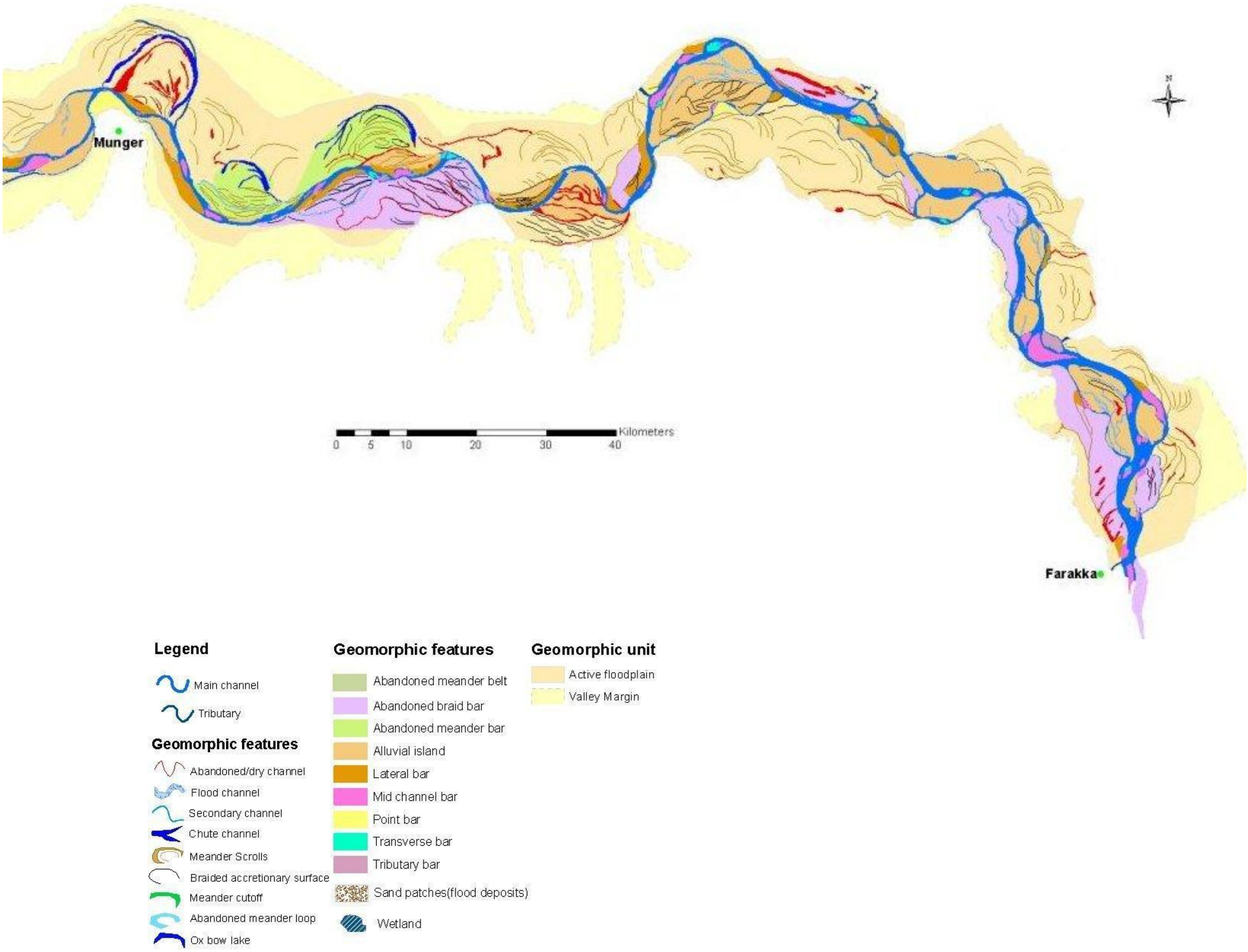

Figure 3.3: Geomorphic map of the Munger to Farakka stretch

ANNEXURE 3.2

Annexure 3.2: Identified Hotspots and VECs in Basin Below Allahabad

Table 3.1: Biosphere Reserves located in the Ganga Basin[1]

Name	Location details	Nearest Tributary	Type	Date of Notification	Area in Sq. Km	Co-ordinates	Distance from NW-1 (in km)
Sunderbans Tiger Reserve (West Bengal)	Part of delta of Ganges and Brahmaputra river system	Ganga	Gangetic Delta	29/03/1989	9630	22°02'17.34"N 88°51'03.59"E	70

[1] *Forest and Wildlife Statistics, India, 2014, MoEFCC*

National Parks

Table 3.2: National Parks in Ganga River Basin[2]

Sr. No	National Park	State	Location (District)	Nearest tributary	Nearest Settlement	Coordinates	Area (Sq.Km.)	Distance from NW-1 (in km)	Regulated buffer Zone Km radius
1.	Valmiki National Park	Bihar	West Champaran	Koshi	Narkatigang Bagha	*27°23'7.55"N 84°8'33.66"E*	335.65	195	10
2.	Betla National Park	Jharkhand	Palamau	Koel	Daltongani	*23°52'23.72"N 84°11'17.77"E*	231.67	196	10
3.	Sanjay National Park	Madhya Pradesh	Sidhi/Sarguja	Son	Sidhi	*23°55'36.72"N 81°48'36.59"E*	1938	148	10
4.	Panna National Park	Madhya Pradesh	Panna, Chatarpur	Son	Satna	*24°35'40.26"N 80°1'4.71"E*	543	208	10
5.	Bandhavgarh National Park	Madhya Pradesh	Shandol	Son	Katni	*23°37'55.31"N 81°0'19.69"E*	105.4	213	10
6.	Madhav National Park	Madhya Pradesh	Shivpuri	Chambal	Shivpuri	*25°26'53.15"N 77°42'59.33"E*	337	428	10
7.	Van Vihar National Park	Madhya Pradesh	Bhopal	Narmada	Bhopal	*23°14'4.93"N 77°22'1.04"E*	4.45	519	10
8.	Fossil National Park	Madhya Pradesh	Mandla	Son	Katni	*23°5'2.84"N 80°42'56.58"E*	0.27	283	10
9.	Dudhwa National Park	Uttar Pradesh	Lakhimpur-Kheri	Ganga, Sarda	Dhangadhi	*28°31'45.42"N 80°39'4.79"E*	490.29	375	10
10.	Sundarbans National Park	West Bengal	North and South Paraganas	Ganga	Haldia	*22°2'17.34"N 88°51'3.59"E*	1330.1	70	10

Note: Default area of 10 km from the boundary of PA will be the Eco-sensitive zone of such Protected area whose ESZ have not been notified.

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[2] *Source: NGRB Report (ESA volume-I), Forest Statistics India 2010. Indian Council of Forestry Research and Education, Respective State Forest Department Websites, Respective National Park Official Website*

Tiger Reserves

Table 3.3: Tiger Reserves located within the Ganga Basin[3]

Sr. No.	Name	State	Location (District)	Nearest Tributary	Nearest Settlement	Latitude	Core Area (Sq.Km.)	Distance from NW-1 (in km)	Regulated buffer Zone Km radius
1	Valmiki	Bihar	West Champaran	Koshi	NarkatigangBagha	*27°23'7.55"N 84°8'33.66"E*	880.76	188	10
2	Bandhavgarh	Madhya Pradesh	Shahdol and Jabalpur	Johilla and Son	Katni	*23°37'55.31"N 81°0'19.69"E*	716.9	214	10
3	Panna	Madhya Pradesh	Ken	Panna and Chhatarpur	Son	*24°35'40.26"N 80°1'4.71"E*	576.13	208	10
4	Dudhwa-Katerniaghat	Uttar Pradesh	Lakhimpur-Kheri	Ganga, Sarda	Dhangadhi	*28°31'45.42"N 80°39'4.79"E*	648	372	10
5	Sunderbans	West Bengal	North and South 24-Paraganas	Ganga	Haldia	*22°2'17.34"N 88°51'3.59"E*	1699.92	70	10

Note: Default area of 10 km from the boundary of PA will be the Eco-sensitive zone (ESZ) of such Protected area whose ESZ have not been notified.

[3]*Source: NGRB Report (ESA volume-I), Forest Statistics India 2010. Indian Council of Forestry Research and Education, Respective State Forest Department Websites, Respective National Park Official Website*

Wildlife Sanctuaries

Table 3.4: Wildlife Sanctuaries in Ganga River Basin[4]

Sr. No.	State	Wildlife Sanctuary	District	Coordinates	Area (Sq.Km.)	Distance from NW-1 (In Km.)	Regulated buffer Zone (Km radius)
1.	Bihar	Bhimbandh	Munger	*25°4'31.50"N 86°21'57.93"E*	681.99	22	10
2.	Bihar	Kanwarjheel	Begusarai	*25°36'55.05"N 86°8'43.84"E*	63.11	27	10
3.	Bihar	Valmiki	Pashchim Champaran	*27°23'7.55"N 84°8'33.66"E*	544.67	191	10
4.	Bihar	VikramshilaGangetic Dolphin	Bhagalpur	*25°18'43.31"N 86°51'41.88*	0.5	00	10
5.	Delhi	Indira Priyadarshani (Asola)	Delhi	*28°27'29.98"N 77°15'9.88"E*	13.2	574	10
6.	Jharkhand	Udhwa Lake Bird Sanctuary	Sahebganj	*24°58'23.02"N 87°49'20.30"E*	0.57	9	10
7.	MP	Bagdara	Sidhi	*24°47'5.55"N 81°55'52.36"E*	478	62	10
8.	MP	Gandhi Sagar	Mandsaur	*24°38'46.89"N 75°30'41.81"E*	368.62	644	10
9.	MP	Ghatigaon	Gwalior	*26°16'23.91"N 77°54'39.34"E*	511	407	10
10.	MP	Karera	Shivpuri	*25°46'47.67"N 77°49'33.21"E*	202.21	411	10
11.	MP	Ken Gharial	Panna, Chhatarpur	*24°35'40.26"N 80°1'4.71"E*	45.2	215	10
12.	MP	National Chambal	Morena, Bhind	*26°40'58.41"N 78°5'45.51"E*	435	408	10
13.	MP	Narsinhgarh	Raigarh	*23°39'21.03"N 77°6'31.01"E*	59.19	520	10
14.	MP	Nauradehi	Damoh, Sagar, Narsimhapur	*23°10'41.31"N 79°12'6.79"E*	1194.67	365	10
15.	MP	Orcha	Tikamgarh	*25°19'40.65"N 78°38'36.80"E*	44.91	330	10

[4] *Source:NGRB Report (ESA volume-I), Forest Statistics India 2010. Indian Council of Forestry Research and Education, Respective State Forest Department Websites, Respective National Park Official Website*

Sr. No.	State	Wildlife Sanctuary	District	Coordinates	Area (Sq.Km.)	Distance from NW-1 (In Km.)	Regulated buffer Zone (Km radius)
16.	MP	Palpur-Kuno	Morena	*25°42'8.04"N 77°16'23.38"E*	344.68	474	10
17.	MP	Panna (Gangau)	Panna	*24°38'8.19"N 79°38'34.67"E*	68.14	256	10
18.	MP	Panpatha	Shahdol	*23°52'41.63"N 81°3'51.01"E*	245.84	186	10
19.	MP	Ralamandal	Indore	*22°38'53.34"N; 75°55'20.87"E*	2.34	688	10
20.	MP	Sailana	Ratlam	*23°25'48.75"N 74°54'44.48"E*	12.96	737	10
21.	MP	Sanjay Dubri	Sidhi	*23°35'29.39"N 81°31'42.77"E*	364.59	210	10
22.	MP	Son Gharial	Sidhi, Shahdol,Satna	*24°28'40.82"N 81°57'50.43"E*	41.8	65	10
23.	MP	Veerangna Durgawati	Damoh	*23°31'55.35"N 79°43'46.80"E*	23.97	301	10
24.	Bihar	Kaimur	Mirzapur, Sonbhadra	*24°30'54.78"N 83°15'54.26"E*	500.73	80	2
25.	UP	Lakh Bahosi	Farrukhabad	*26°54'47.50"N 79°39'19.20"E*	80.24	281	10
26.	UP	Samaspur	Rae Bareli	*26°0'24.73"N 81°23'18.12"E*	7.99	89	10
27.	UP	Surha Tal	Ballia	*25°50'38.51"N 84°10'31.92"E*	34.32	12	10
28.	UP	Turtle	Varanasi	*25°18'32.04"N 83°0'54.62"E*	7	00	10
29.	WB	Bihutibhusan	North 24-Paraganas	*23°6'20.86"N 88°46'7.56"E*	0.64	27	10
30.	WB	Haliday Island	South 24-Paraganas	*21°39'50.24"N 88°37'56.64"E*	5.95	72	10
31.	WB	Lothian Island	South 24-Paraganas	*21°39'37.89"N 88°19'53.83"E*	38	50	10
32.	WB	Chintamani Kar Bird Sanctuary	South 24-Paraganas	22°25'41.01"N 88°24'7.10"E	0.1 (6.9 ha)	14	10
33.	WB	Sajnekhali	South 24-Paraganas	*22°7'27.89"N 88°49'51.18"E*	362.4	76	10

Note: Default area of 10 km from the boundary of PA will be the Eco-sensitive zone (ESZ) of such Protected area whose ESZ have not been notified.

Important Bird Areas

Table 3.5: List of Important Bird Areas in Ganga Basin

Sr. No.	Name of State	Important Bird Area in Ganga Basin	Coordinates	Distance(km)
1.	Madhya Pradesh	Bandhavgarh National Park	23°36'N 81°14'E	207
2.		Bhoj wetland	23°14'N 77°22'E	493
3.		Dihaila Jheel and other wetlands	25°42'N 78°10'E	374
4.		Gandhi Sagar Wildlife Sanctuary and reservoir	24°36'N 75°41'E	631
5.		Ghatigaon Bustard Sanctuary	26°2'N 77°52'E	413
6.		Halali Reservoir	23°30'N 77°30'E	490
7.		Madhav National Park	25°29'N 77°41'E	425
8.		Panna National Park	24°26'N 80°5'E	214
9.		Rangawa Reservoir	24°42'N 79°51'E	221
10.		Sailana Kharmor Sanctuary	23°24'N 74°58'E	728
11.		Sardarpur Wildlife Sanctuary	22°36'N 75°12'E	742
12.		Yeshwantsagar Reservoir	22°49'N 75°41'E	695
13.	Bihar	Chaurs of North Bihar	26°8'N 86°10'E	67
14.		Danapur cantonment area	25°39'N 85°2'E	7.12
15.		Gogabil Pakshi Vihar, Baghar Beel and Baldia Chaur	25°24'N 87°45'E	11
16.		Kawar or Kabar Lake Wildlife Sanctuary	25°41'N 86°5'E	33
17.		Kurseala River Course and Diyara Flood Plains	25°27'N 87°15'E	6
18.		Kusheshwarsthan	26°10'N 86°3'E	68
19.		Mokama Taal (Barah) Wetlands	25°28'N 85°42'E	2
20.		Nagi Dam and Nakti Dam Bird Sanctuary	24°49'N 86°25'E	53
21.		Reservoirs of Chotanagpur Plateau	24°10'N 84°31'E	160
22.		Valmiki Tiger Reserve and Saraiyaman Lake	27°19'N 84°9'E	186
23.		Vikramshila Gangetic Dolphin Sanctuary	25°17'N 86°56'E	00
24.	Jharkhand	Hazaribagh Wildlife Sanctuary and North Karanpur Valley	24°8'N 85°20'E	153
25.		Palamau Tiger Reserve	23°40'N 84°10'E	209
26.		Udhwa Lake Bird Sanctuary	25°0'N 87°49'E	9.00
27.	West Bengal	Farakka Barrage and adjoining area	25°6'N 87°48'E	00
28.		Kulik (Raiganj) Bird Sanctuary	25°58'N 87°53'E	77
29.		Mahananda Wildlife Sanctuary	26°52'N 88°25'E	190
30.		Naya Bandh Wetland Complex	24°55'N 88°20'E	37
31.		Sundarbans Biosphere Reserve (National Park)	22°11'N 88°58'E	80

(Source: http://www.birdlife.org/datazone/site)

Wetlands

Table 3.6: Important Wetlands in Ganga Basin [5]

Sr. No.	Wetland name	Type	Area	State	Latitude	Longitude	Regulated buffer Zone Km radius	Distance from NW-1, (in km)
1.	Khabartal	Natural lake	2680 ha	Begusarai, Bihar	25° 37' 00" N	86° 08' 00"E	10	29
2.	Mora Mahananda Tal (Mahananda Dhar)	Riverine wetland	68 ha	Katihar, Bihar	25° 26' 54" N,	87° 44' 36" E	10	19
3.	Bawlee Chaur	Natural waterlogged	68 ha	Bihar	26° 32' 15" N	84° 54' 16" E	10	88
4.	Kosi/Belasi Dam	Reservoir	520 ha	Banka, Bihar	24° 56' 54" N	86° 49' 15" E	10	37
5.	Getulsud	Reservoir	2302 ha	Jharkhand	23°26'38.601"N	85°31'17.874"E	10	215
6.	Konar	Reservoir	2149 ha	Jharkhand	23°55'50.85"N	85°45'50.731"E	10	180
7.	Tenughat	Reservoir	3814 ha	Jharkhand	23°43'51.677"N	85°50'1.091"E	10	202
8.	Massanjore	Reservoir	5027 ha	Jharkhand	24°6'29.9"N	87°18'39.3"E	10	92
9.	Tilaiya	Reservoir	4865 ha	Jharkhand	24°20'38.8"N	85°25'56.201"E	10	128
10.	Udhwa	Lake	1605 ha	Jharkhand	24° 58' 6.400" N	87° 48' 55.500" E	10	9.29
11.	East Kolkata Wetlands	Lake	12512 ha	West Bengal	20°25'00"N to 22°35'00"N;	88°20'00" E to 88°35'00" E.	10	14
12.	Sundarbans	Mangroves	209330 ha	West Bengal	21°56'00'' N	88°51'00'' E.	10	70
13.	Surha Tal	Lake	2357 ha	Uttar Pradesh	25°48' 58''and 25°52' 13' N;	84°08'15'' and 84°08'15'' E.	10	12
14.	Baghettal	Lake	1432 ha	Uttar Pradesh	27°22' 44''and 27°25' 36' N;	81°42'15'' and 81°46'16'' E.	10	218
15.	Bakhira Wildlife Sanctuary	Lake	3905 ha	Uttar Pradesh	26°52' 10''and 26°56' 38' N;	83°05'16'' and 83°12'18'' E.	10	154
16.	Ghaghar Reservoir	Reservoir	2165 ha	Uttar Pradesh	24°36' 01''and 24°38' 56' N	83°09'33'' and 83°15'03'' E.	10	63
17.	Samaspur Wildlife Sanctuary	Sanctuary	791 ha	Uttar Pradesh	25°55' 40''and 26°03' 47' N	81°18'33'' and 81°27'51'' E	10	80
18.	Dahar Lake (Sandi Wildlife Sanctuary)	Sanctuary	309 ha	Uttar Pradesh	27°17' 57''and 27°19' 42' N	79°57'47'' and 79°59'10'' E	10	290
19.	Keetham Reservoir	Reservoir	403 ha	Uttar Pradesh	27°14' 25''and	77°49'41'' and	10	447

[5] *Source: MOEF National Wetland Atlas: Prepared by Space Applications Centre (ISRO), Ahmedabadand Institute of Environmental Studies & Wetland Management (IESWM), Kolkata)*

Sr. No.	Wetland name	Type	Area	State	Latitude	Longitude	Regulated buffer Zone Km radius	Distance from NW-1, (in km)
					27°15′ 57' N	77°51′37'' E.		
20.	MinimataBango	Reservoir		Chhattisgarh	22° 41' 00" N	22° 41' 00" N	10	283
21.	Bhoj wetland	Reservoir	31 km^2	Madhya Pradesh	23°14' 46" N	77°20' 31" E	10	532

Note: Default area of 10 km from the boundary of PA will be the Eco-sensitive zone of such Protected area whose ESZ have not been notified.

Reserved Forest

Table 3.7: State-wise Forest and Tree Cover in Ganga Basin States

State	Geographical Area (Sq. km)	Forest and Tree Cover					% of Geographical Area of the State
		Very Dense Forest (Sq. km)	Moderately Dense Forest Cover (Sq. km)	Open Forest (Sq. km)	Tree Cover (Sq. km)	Total (Sq. km)	
Bihar	94,163	247	3380	3664	2164	9455	10.04
Jharkhand	79,714	2587	9667	11,219	2629	26,102	32.74
Madhya Pradesh	308,245	6632	34,921	35,969	7087	84609	27.45
Uttar Pradesh	240,928	1623	4550	8176	6895	21,244	8.82
West Bengal	88,752	2971	4146	9688	2144	18949	21.35
Chhattisgarh	135191	4153	34865	16603	3463	59, 084	43.7

Source: (State of Forest Report, 2013)

Aquatic Biodiversity Breeding and Nesting grounds of aquatic species (Schedule-I species)

Table 3.8: Population Status of Dolphins in the Ganga river and its tributaries

Name of the River	Length of the River Surveyed	Dolphin Number	Source
The Ganga main stem			
The Ganga (Haridwar to Bijnor Barrage)	100 km	Nil	Behera, 1995, Sinha *et al.* (2000)
The Ganga (Bijnor Barrage to Narora Barrage)	169 km	56	WWF-India Survey Report (pers. comm. S. Behera (2010)
The Ganga (Narora to Kanpur)	300 km	03	WWF-India Survey Report (pers. comm. S. Behera (2010)
Kanpur to Allahabad Survey Report	200 km	78	WWF-India Survey Report (pers. comm. S. Behera (2010)
The Ganga (Allahabad to Buxar)	425 km	172 (d/s survey)	Sinha *et al.* (2000)
The Ganga (Buxar to Maniharighat)	500 km	808 (u/s survey)	Sinha *et al.* (2000)
The Ganga (Maniharighat to Farakka)	100 km	24 (d/s survey)	unpublished data of Dec. 2004 (Sinha, 2004)
The Farakka Feeder canal	38 km	21 (d/s survey)	Sinha *et al.* (2000)
The Bhagirathi (Jangipur Barrage to Triveni)	320 km	119 (d/s survey)	Sinha *et al.* (2000)
The Hooghli (Triveni Ganga Sagar)	190 km	97 (d/s survey)	(pers. comm. G. Sharma 2008)
Tributaries of the Ganga			
The Yamuna (from Confluence of Chambal to Hamirpur)	350 km	60 (d/s survey)	WWF-India Survey Report (pers. comm. S. Behera 2010) Sinha *et al.* (2000)
The Kosi (Kosi Barrage to Kursela)	200 km	85 (discrete survey)	Sinha and Sharma (2003)
The Gandak (Gandak Barrage to confluence with Ganga at Patna)	320 km	290 (d/s survey)	multi-organizational survey 2010
The Gherua (India-Nepal border to Girijapuri Barrage)	20 km	23 (d/s survey)	Smith *et al.* (1994)
The Sarda (Sarda Barrage to Palya)	100 km	Nil	Sinha and Sharma (2003)
The Chambal (Pali to Pachhnada)	425 km	79	Singh (2010)
The Ken (from confluence of Yamuna at Chilla to Sindhan Kala village)	30 km	08 (d/s survey)	Sinha *et al.* (2000)
The Kumari (from confluence of Sind River)	100 km	Nil	Sinha *et al.* (2000)
The Betwa (from confluence of the Yamuna at Hamirpur to Orai	84 km	06 (d/s survey)	Sinha *et al.* (2000)
The Sind (from confluence with the Yamuna)	110 km	05 (d/s survey)	Sinha *et al.* (2000)
The Son	130 km	10 (d/s survey)	Sinha *et al.* (2000)

Name of the River	Length of the River Surveyed	Dolphin Number	Source
The Brahmaputra	600 km 856 km	400 (1996) 197 (2004-05)	Mohan (1997) pers. comm. A. Wakid
The Barak river	17 km	02 (1999), 08 (2004), 06 (2006)	Pers. comm. Paulan Singh
The river Subansiri	99 km	26	Wakid (2009)
The river Kulsi	76 km	27	Wakid (2009)

Table 3.9: Status and distribution and of freshwater Turtles in river Ganga

Sr. No.	Common name	Species	Threatened status (IUCN)
1	Three striped roof turtle	*Batagur dhongoka*	Endangered
2	Red crowned roof turtle	*Batagur kachuga*	Critically Endangered
3	Narrow headed soft shell turtle	*Chitra indica*	Endangered
4	Spotted pond turtle	*Geoclemys hamiltonii*	Vulnerable
5	Crowned river turtle	*Hardella thurjii*	Vulnerable
6	Indian flap shell turtle	*Lissemys punctata*	Lower risk
7	Indian black turtle	*Melanochelys trijuga*	NT
8	Indian soft shell turtle	*Nilssonia gangeticus*	Vulnerable
9	Indian peacock soft shell turtle	*Nilssonia hurum*	Vulnerable
10	Brown roofed turtle	*Pangshura smithii*	NT (lower risk)
11	Indian roofed turtle	*Pangshura tecta*	Lower risk
12	Indian tent turtle	*Pangshura tentoria*	Lower risk

Table 3.10: Nesting sites of turtles between Bijnor to Kanpur

Sr. No.	Place	Latitude	Latitude
1	Bijnor	29°34′214	78°05′971
2	Maqdoompur	29°08′743	78°04′546
3	Tighri ghat	28°79′329 (28.822482)	78°14′148 (78.157875)
4	Garh	28°74′214 (26.81019)	78°17′678 (80.11266)
5	Pooth	28°69′419 28.69352	78°18′50178.19308
6	Awantika Devi	28°40′066(28.450510)	78°28′274 (78.279008)
7	Anoopshehar	28°32′633 (28.354112)	78°29′149 78.267427
8	Rajghat	28°21′067 (28.240950)	78°19′228 (78.358984)

Table 3.11: Breeding status of fresh water Turtles occurs in the Ganga river between Rishikesh and Kanpur

S. No.	Species	Nesting season	Hatching season
1	*Geoclemys hamiltoni*	-	-
2	*Melanochelys trijuga*	-	-
3	*Batagur dhongoka*	December-February-April	May
4	*Batagur kachuga*	December-February-April	May
5	*Pangshura smithii*	October-December	May
6	*Pangshura tentoria*	September-February	May
7	*Pangshura tecta*	October-December	May
8	*Lissemys punctata*	July-October	July
9	*Chitra indica*	September	October
10	*Nilssonia gangeticus*	August-October	June/July

S. No.	Species	Nesting season	Hatching season
11	*Nilssonia hurum*	-	-
12	*Hardella thurjii*		-

Table 3.12: Characteristic vertebrate taxa (Turtles, Gharials and Dolphin) of Middle Ganga stretch

Characteristic Taxa	Dwelling Habitat	Feeding Habits	Breeding Ground
Turtles: Kachuga and *Aspideretes* sp.	Shallow waters on sandy banks	Adult turtles feed mainly on insect larvae and decomposing organic materials (Scavengers)	Breed on sand beds Nesting in Dec- Feb hatching in May
Gharials: *Gavialis gangeticus*	Less interrupted basking sites, prefer clayey islands from sand of banks	Juveniles feed on small crustaceans insects, frogs. Adults feed on small fish	Nesting in dry season preferred riverine sand banks
Dolphin *Platanista gangetica gangetica*	Mid channel depth approx 2- 4.5 m with bank depth greater than 1.5 m. Rocky and muddy substrates velocity 5-30 cm/sec.	Catfish, Small carps, Prawns, molluscs and turtles preferred food small fish.	No specific birth period move in pairs and give birth from Oct- March on sand bars

Table 3.13: Total number of fishes (taxa) in river Ganga

Categories	Species	Genus	Families
(a) Number of fish from fresh water	178	89	37
(b) Number of fish from brackish waters	103+72*	69	37
(c) Common cartilaginous fishes (Chondrichthyes)	13	9	7
Total	**294**	**167**	**81**

* Common in fresh water zone

Table 3.14: Critical Dolphin Stretches along Ganga River Basin

Sr. No.	State	Stretch	S.N.	State	Stretch
1	**Uttar Pradesh**	Middle Ganga Barrage at Bijnore to Lower Ganga Barrage at Narora (165 km)	**4**	**Bihar**	Gangi-Ganga Confluence near Sinha Ghat, Ara 20km upstream Ghaghara- Ganga confluence at Doriganj, Chhapra) to Fatuha (confluence of Ganga and Punpun (80 km).
2		Fatatehpur to Mirzapur (150 km)	**5**		Barh to Mokama to Maniharighat (Katihar) (210 km). This stretch includes the Vikramshila Gangetic Dolphin Sanctuary (60 km)

Sr. No.	State	Stretch	S.N.	State	Stretch
3		Chambal-Yamuna confluence near Etawah to Ganga-Yamuna confluence at Allahabad	**6**		5.River Gandak from Triveni Barrage at Indo-Nepal border to Ganga – Gandak confluence at Patna (332 km)

Table 3.15: Location of Hilsa Sanctuaries (Protected area for Hilsa) in River Bhagirathi, West Bengal

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 kilometers area around Farakka Barrage

Archeologically Protected Monuments, Heritage and Cultural sites

Table 3.16: List of Archeologically Protected Monuments in the Districts located in NW-1 route

Sr. No.	West Bengal	Districts
1	Abandoned Gopal temple at Amdpur	Burdwan(WB)
2	Majlish Saheb or Id-Baqrid mosque at Kalna town	Burdwan
3	Panchratna brick temple at Baidyapur	Burdwan
4	Radha Gobunda temple at Jagadanandapur	Burdwan
5	Three Siva temple at Sribati	Burdwan
6	Badsahi or Hussain Shai mosque at Nutanhat	Burdwan
7	Siva temple at Honpas – Kamarpura	Burdwan
8	Hussain Shah mosque at Kulutia	Burdwan
9	Excavated monument at Goswamikhanda	Burdwan
10	Bijoy - Toran at Burdwan town	Burdwan
11	Temple of Kashinath Siva at Ajhapur	Burdwan
12	Temple of Madan Gopal at Kulingram	Burdwan
13	South Park street Cemetery in Park street	Calcutta
14	The tomb of Admiral Charles Watson, the Mausoleum of Job Charnak and The Tomb of BegunJohnson within the compound of St. John's Church at Council house street, Calcutta	Calcutta
15	Henry martin's Pagoda at Serampore	Hooghly
16	Raj Rajeswar temple at Dwarahatta	Hooghly
17	Chandi temple at Deulpara	Hooghly
18	Siva temple at Bakharpur	Hooghly
19	Temple of Gour Chandra and Krishnachandra at Chatra	Hooghly
20	Jorbangla temple at Parul	Hooghly
21	Raghunandan temple at Parul	Hooghly

Sr. No.	West Bengal	Districts
22	Jorbangla temple of Durga with Navaratna tower at Bally dewangunj	Hooghly
23	Mosque at Village bajua	Hooghly
24	Radha Govinda temle at Satpur	Hooghly
25	Siva temple at Harirampur	Hooghly
26	Raj Rajeswar temple at Kotalpur	Hooghly
27	Temple of Sri Sri Nandadulal Jew at Gurap	Hooghly
28	The mast of a Portuguese ship at bandal	Hooghly
29	Kanakeswar Shiva temple, Byra Kanpur	Hooghly
30	Temple of Dadhimadhab of the Roy family at Amraguri	Howrah
31	Temple of Gopal Jew at Mellock	Howrah
32	Jami mosque in Old Malda municipality	Malda
33	Ruins of the fortified city of Pandua	Malda
34	Ruins of Pathan palace at Adian	Malda
35	Ancient ruins at Ratnagarh at Wari	Malda
36	Ancient ruin site at Gagjibanpur	Malda
37	Tomb of Nawab Sharfaraz Khan at Naginabagh	Murshidabad
38	Temple of Gangeswar Siva at Baranagar	Murshidabad
39	Siva temple at Yugwara	Murshidabad
40	Ravratna temple at Sibarambati	Murshidabad
41	Ratneshwar Siva temple at Bilbari	Murshidabad
42	The house, temples and ruins associated with memory of Jagat Sett's house at Mahimapur	Murshidabad
43	Temple of Raghabeswar Siva at Dignagar	Nadia
44	Temple of Shyamchand at Santipur town	Nadia
	JharKhand	
1	Ancient Fort and Sangeet Dalan	Shobhabgunj(Sahibganj)

	Bihar	
1	Archaeological Site, Kheri, Shahkund	Bhagalpur
2	Tomb of Mahmudshah, Kahalgaon	Bhagalpur
3	Fort of Munger	Munger
4	Golghar	Patna
5	Agamkuan Gulzarbagh, Patna City	Patna
6	Beguhjam Masjid, Patna City	Patna
7	Jain Temple, Kamaldah, Gulzarbagh	Patna
8	Do Ruikhi Pratima, Kumrahar	Patna
9	Choti Patandevi, Patna city	Patna
10	Nepali Temple, Hazipur	Vaishali
	Uttar Pradesh	
1	Ancient mound at Koldihwa	Allahabad(36)
2	Ancient mound at Mahagara	Allahabad

Sr. No.	West Bengal	Districts
3	Ancient mound at Chopani Mando	Allahabad
4	Purana Mandir	Chandauli
5	Chunar firt	Mirzapur
6	Ancient site of Bhuili	Mirzapur
7	Sarnath Temple	Mirzapur
8	Siddhanath ki Dari	Mirzapur
9	Lekhnia Pahar	Mirzapur
10	Painted rock- shelter	Mirzapur
11	Megalithic Remains	Mirzapur
12	Painted rockshelter at Lekhnia Pahar	Mirzapur
13	Megalithic remains of Kotwar Pahar	Mirzapur
14	Bhaldria Painted rockshelter	Mirzapur
15	Lekhnia Painted Rockshelter	Mirzapur
16	Samadhi and Mausoleum od Sant Kabirdas	Sant Kabir Nagar
17	Ancient of Kopia or Anupia	Sant Kabir Nagar
18	Battis Khamba	Varanasi
19	Battis Khamba	Varanasi
20	Lahartara Talab	Varanasi
21	Kardmeshwar Mahadeva Mandir	Varanasi
22	Guradham Mandir	Varanasi

Table 3.17: List of Archeologically Protected area/heritage sites in Basin Area

Sr. No.	Name and Location of Protected Site	Distance from NW-1 (in KM)
1	Agra - Fort- UP	434
2	Agra - Taj Mahal- UP	453
3	Fatehpur Sikri- UP	477
4	Khajuraho Group of Monuments- (MP)	202
5	Buddhist Monuments at Sanchi- MP	481
6	Humayun's Tomb- DELHI	600
7	Qutb Minar and its Monuments, Delhi	588
8	Mahabodhi Temple Complex at Bodh Gaya – BIHAR	102
9	Red Fort Complex, Delhi	585
10	The Jantar Mantar, Jaipur	635
11	Hill Forts of Rajasthan	641

ANNEXURE 3.3

Annexure 3.3: Map of Identified Hotspots with Basin

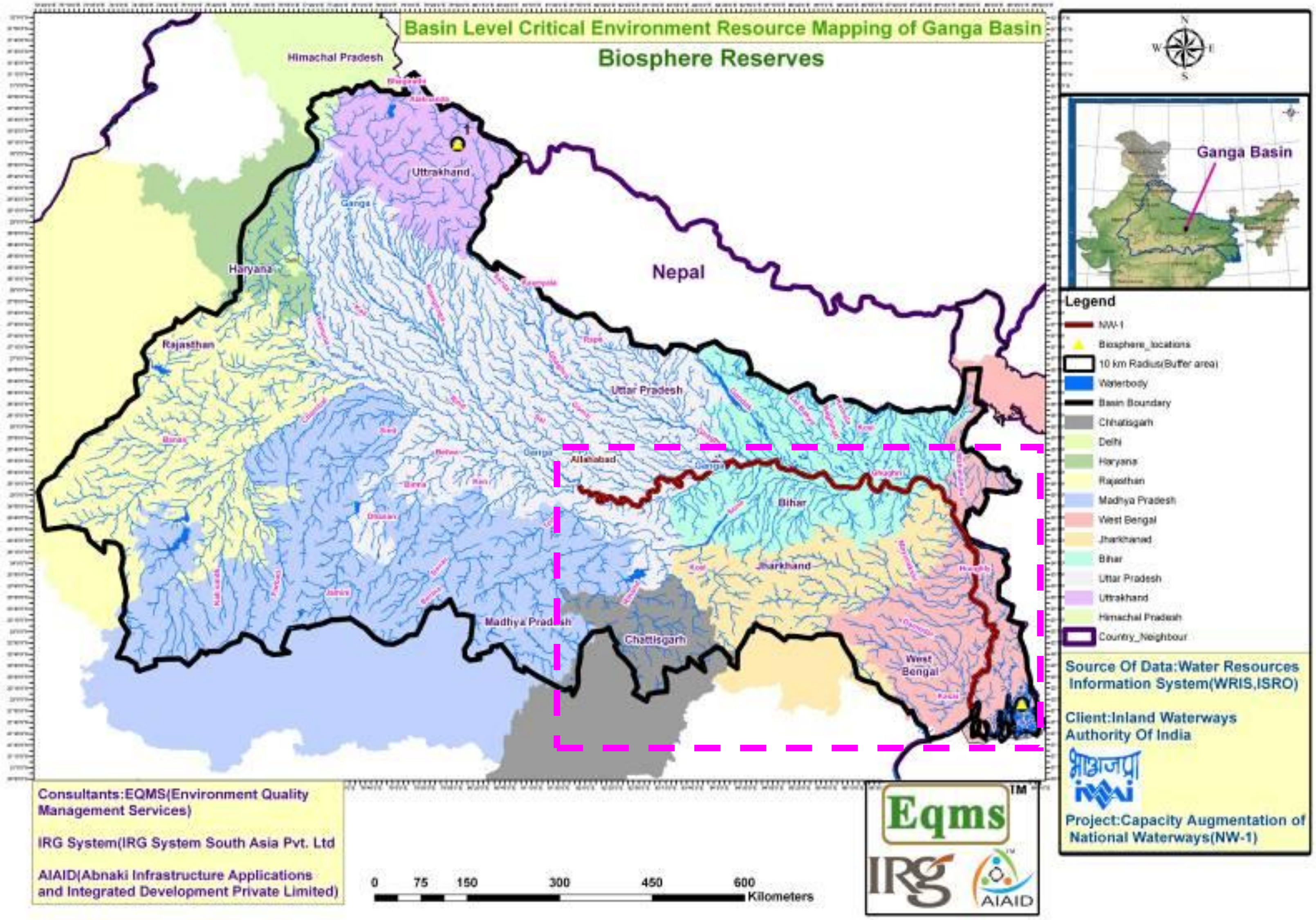

Figure 3.1: Location of Biosphere Reserves in Ganga River Basin

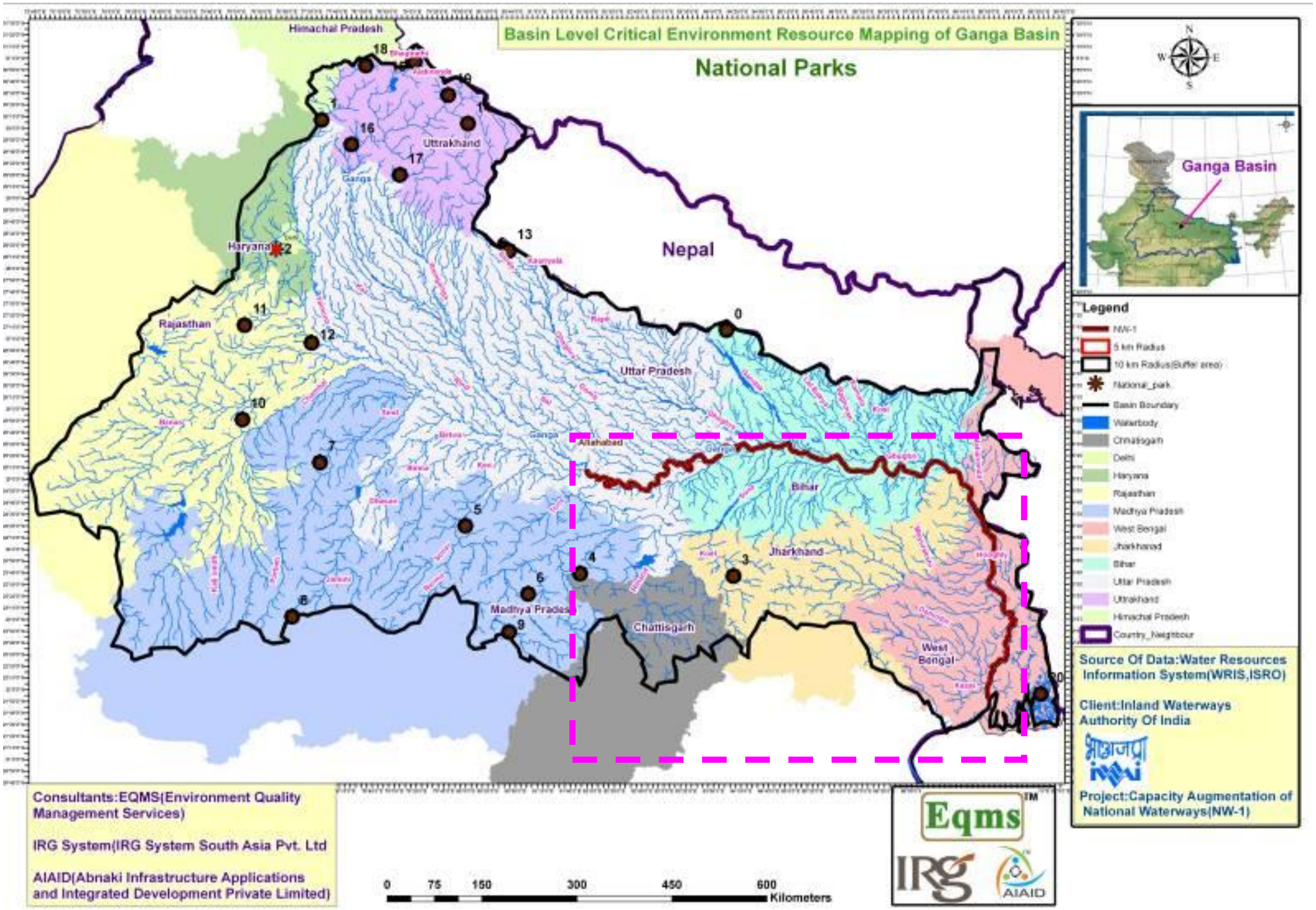

Figure 3.2: Location of National Parks in Ganga River Basin

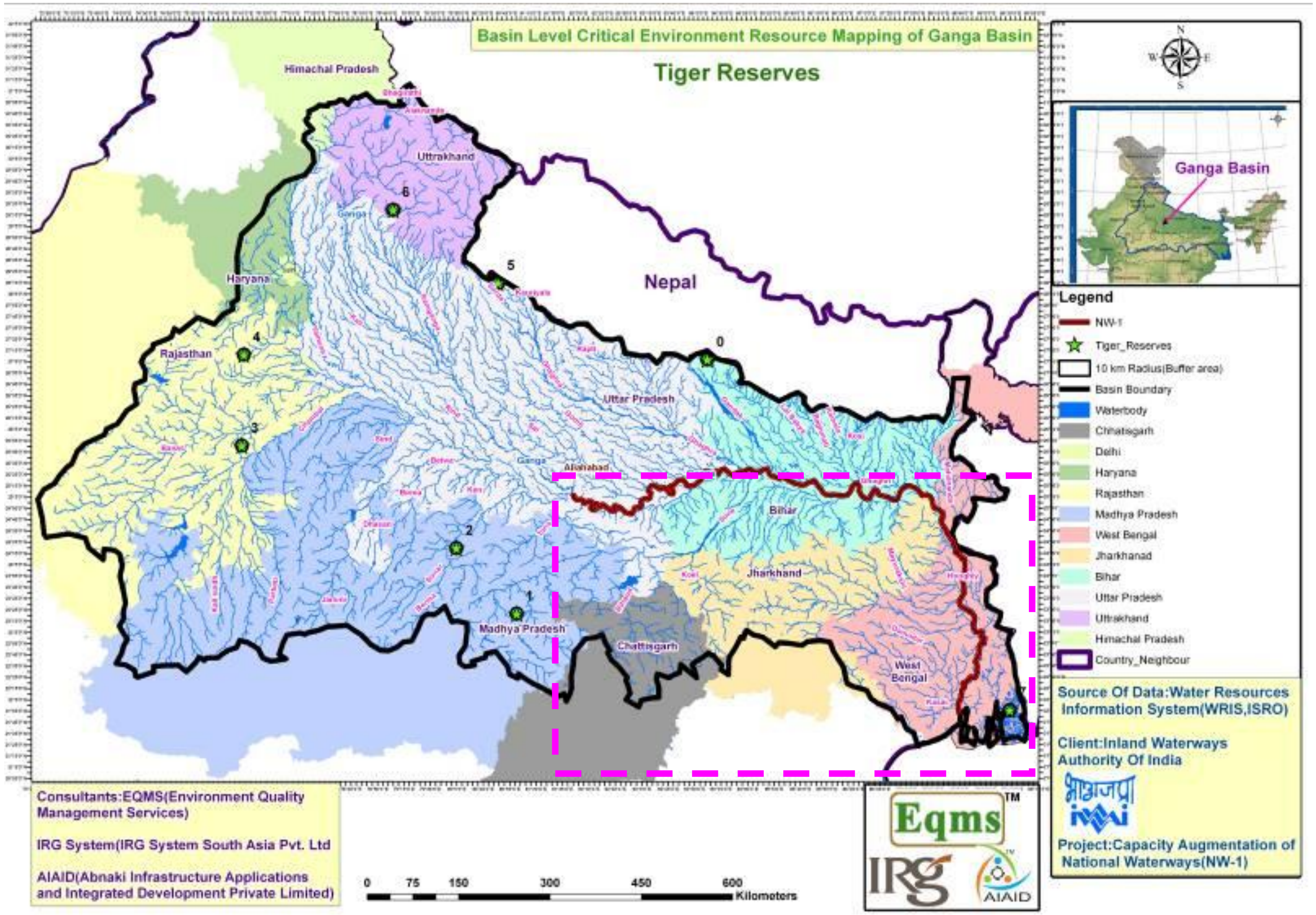

Figure 3.3: Location of Tiger Reserves in Ganga River Basin

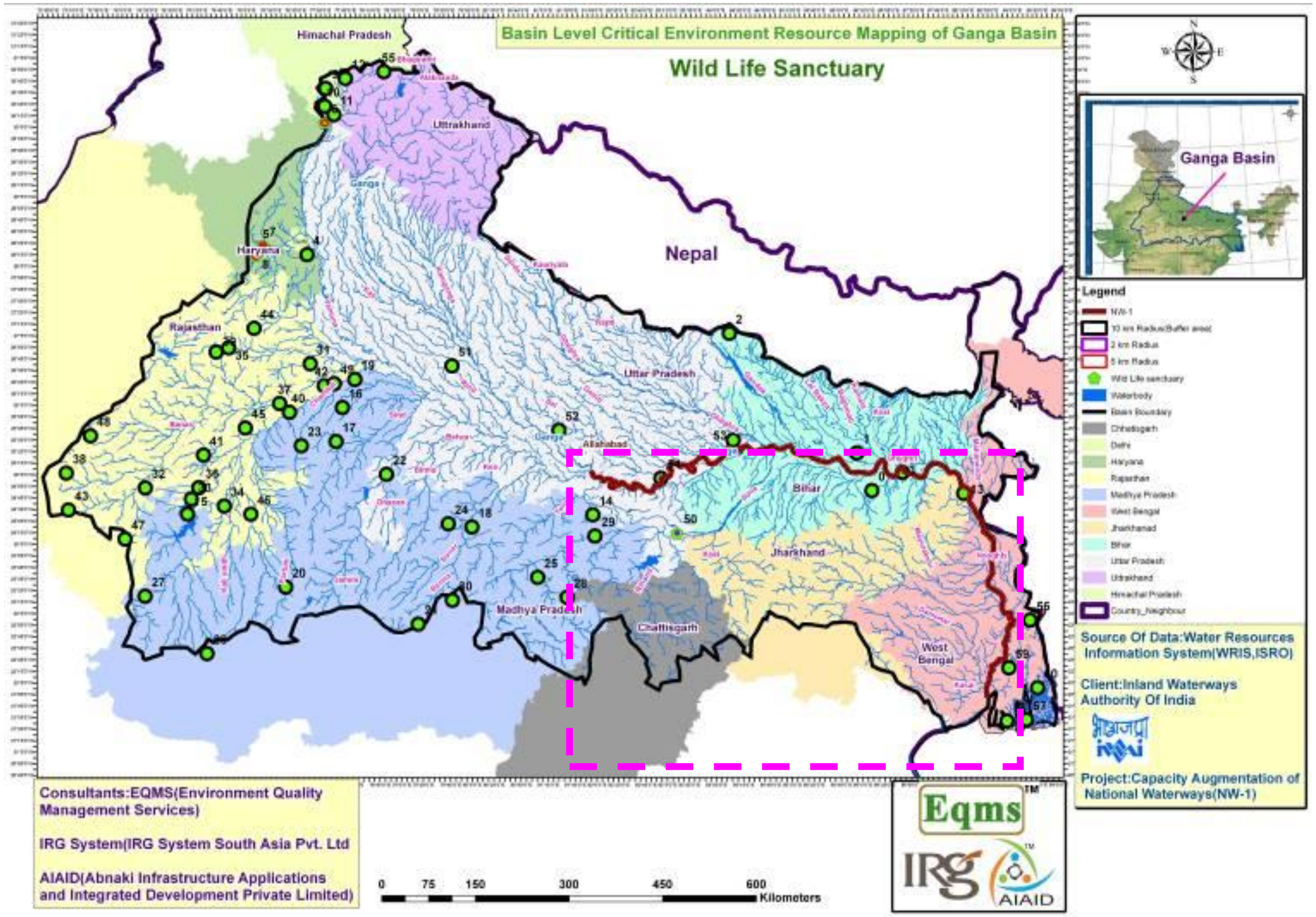

Figure 3.4 Location of Wildlife Sanctuaries in Ganga River Basin

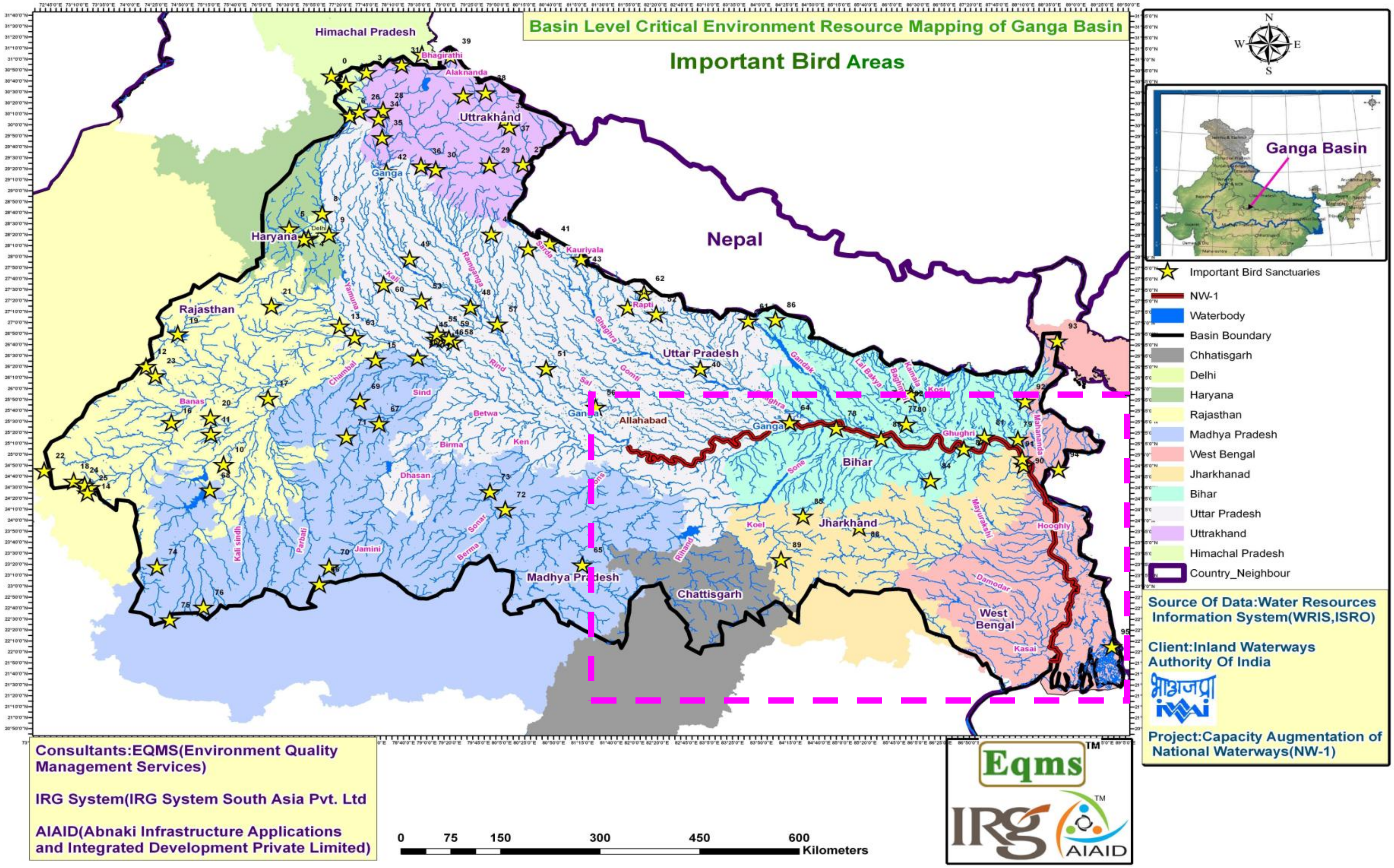

Figure 3.5 Location of Important Bird Area in Ganga Basin

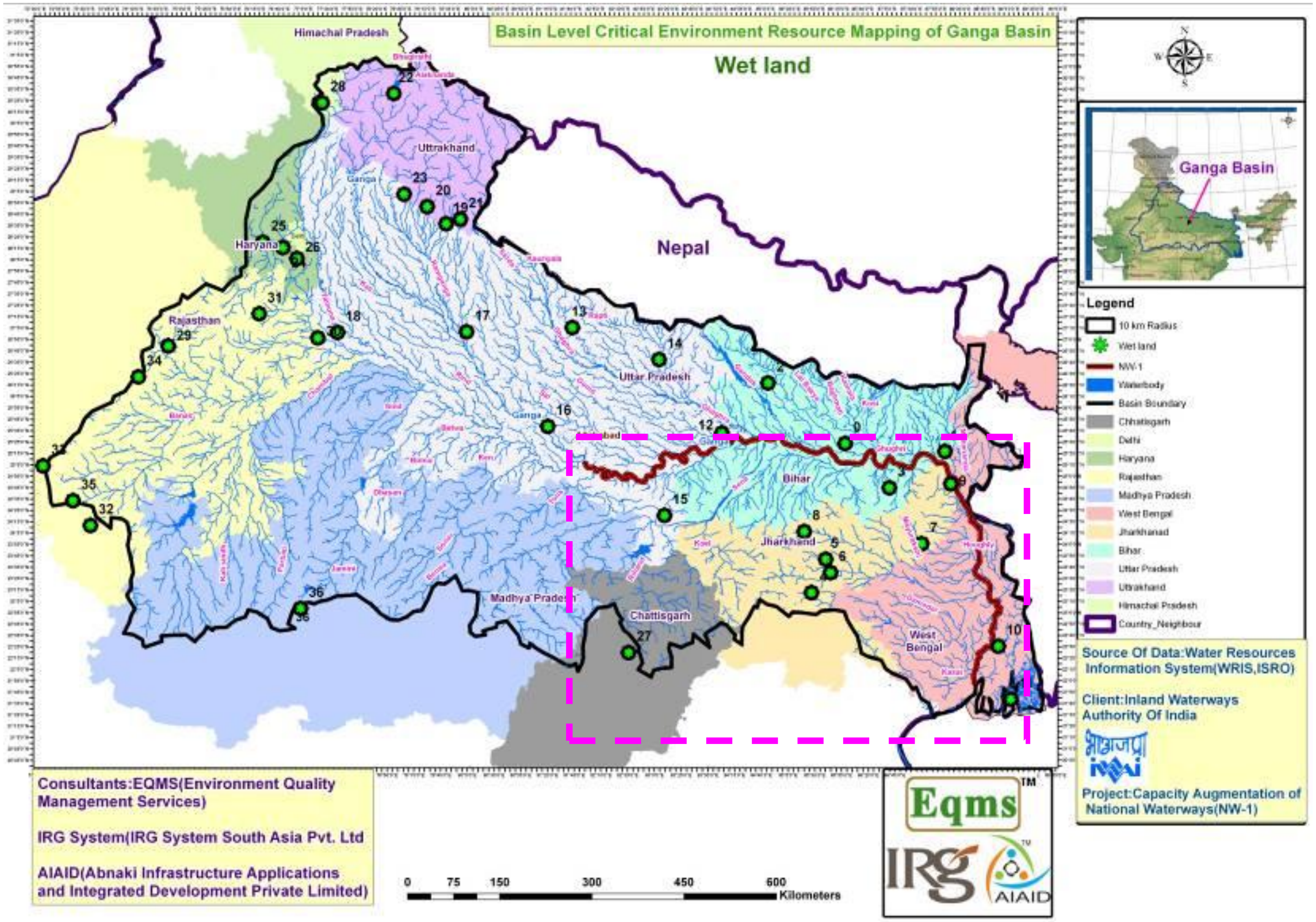

Figure 3.6: Location of Important Wetlands in Ganga Basin

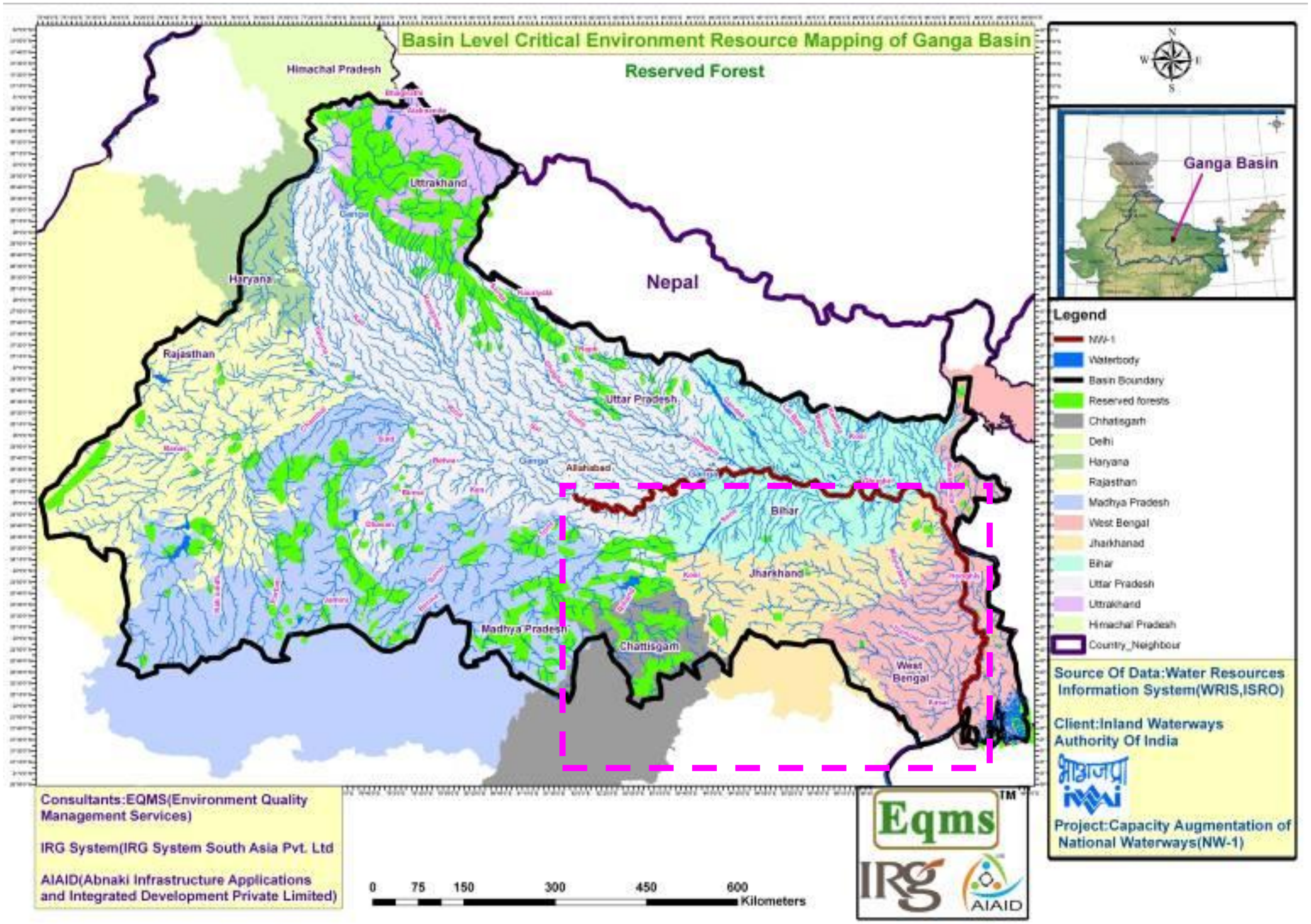

Figure 3.7: Reserved Forests in Ganga River Basin

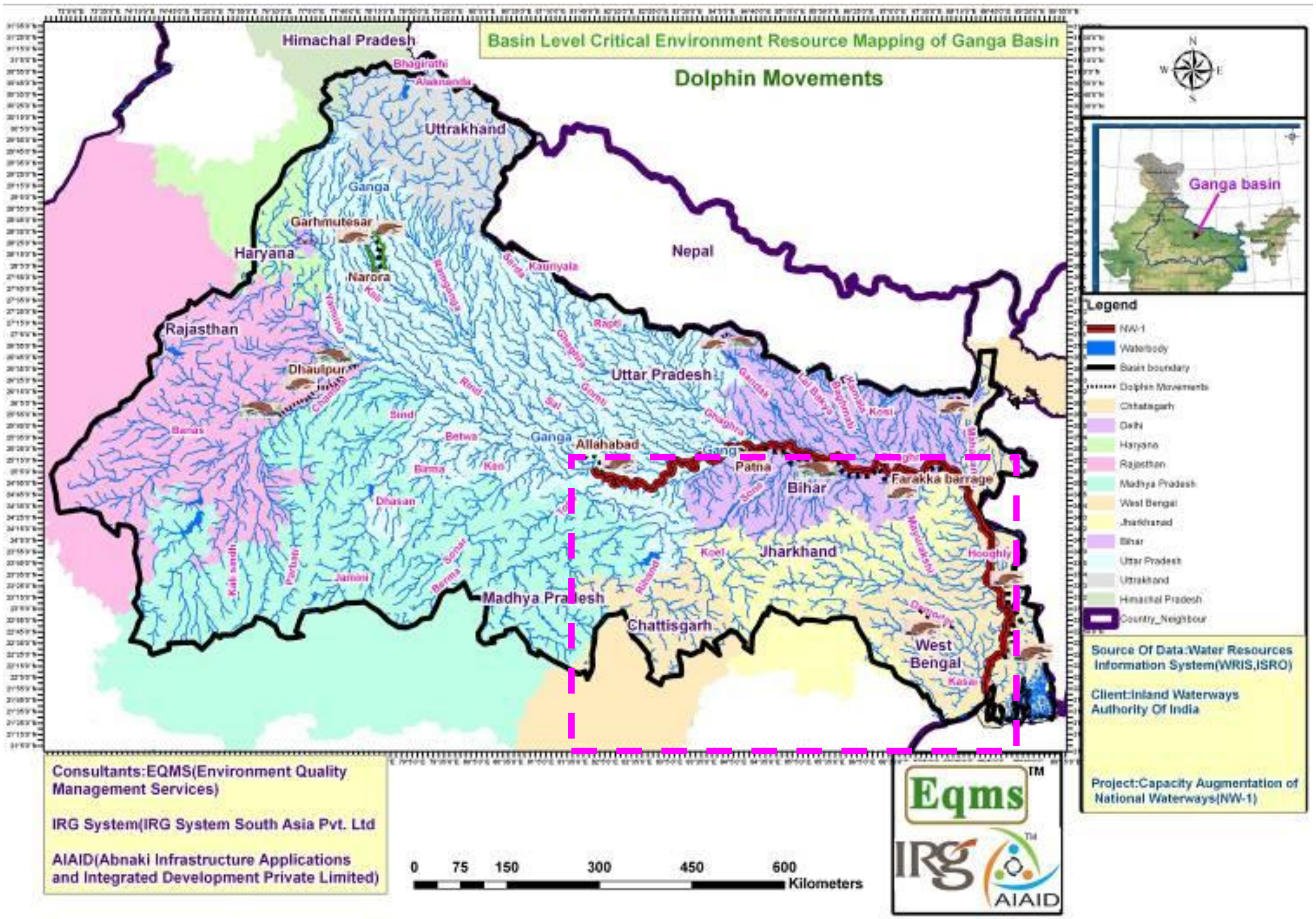

Figure 3.8: Critical Stretches of Dolphin Movement in Ganga River Basin

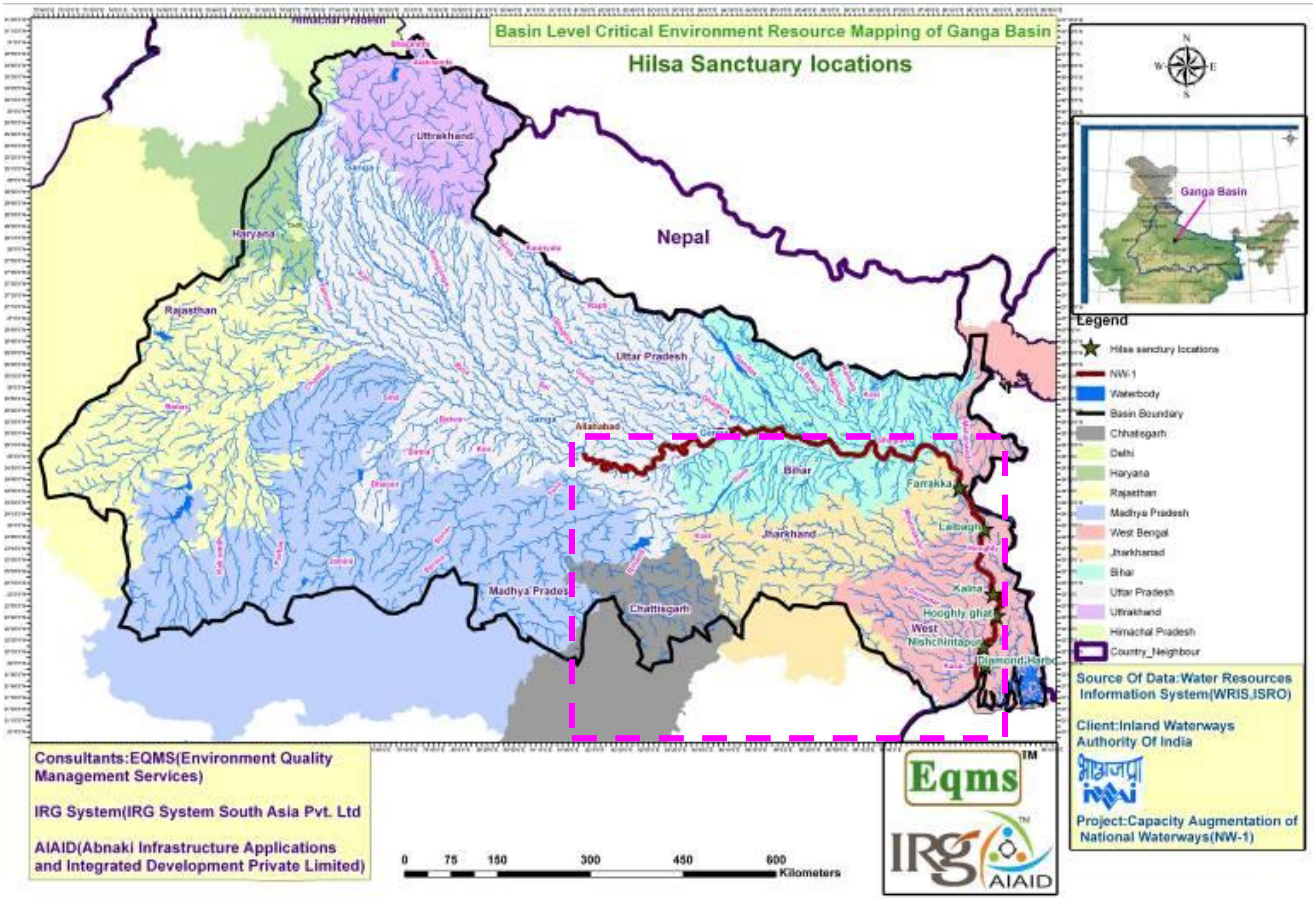

Figure 3.9: Location of Hilsa Sanctuaries

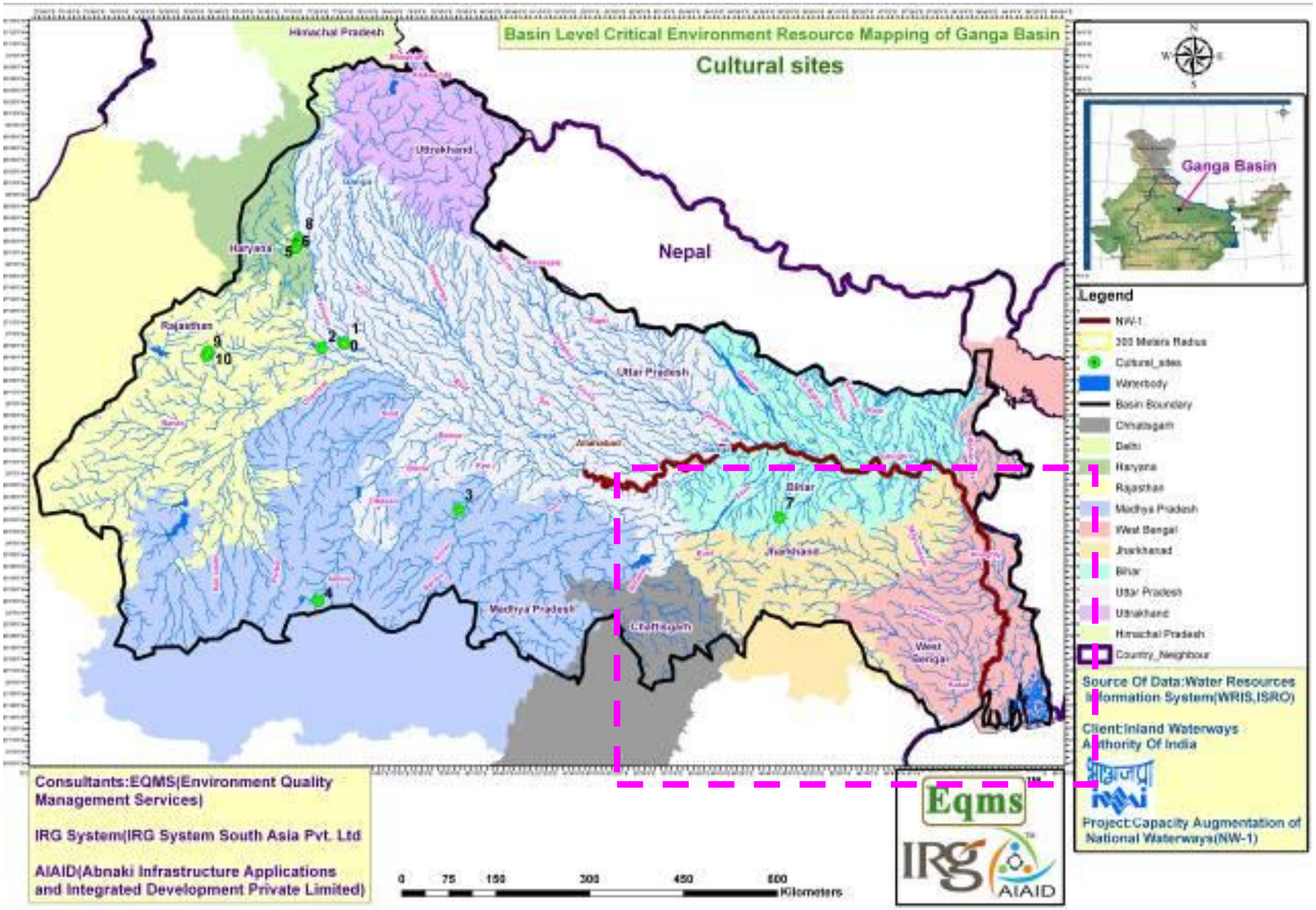

Figure 3.10: Important Protected /Heritage and cultural sites in Ganga Basin

ANNEXURE 4.1

Annexure 4.1: Proceedings of Consultations for NW-1

Proceedings of Consultations

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
Informal Consultation in Varanasi				
1.	IWAI, Varanasi & Date:20.06.2015	A.K.Mishra, Deputy Director, IWAI, Varanasi	1	According to him site location is suitable for development of terminal from HFL prospective. Other points he added are 1. Economic Feasibility 2. Reduced Air and noise pollution, 3. Increased Employment
2.	Varanasi & Date: 21-6-2015	Group Discussion with Locals, Fishermen and Boatmen, Baluaghat, Varanasi 1. Suresh Saki 2. Hariyan 3. Savajeet Sahni 4. Kashim Nishad 5. Rambabu Nishad 6. Syambabu nishad 7. Sidhunishad 8. Jaikishan 9. Bholusankar 10. Vishunnishad 11. Dablu Sahni 12. Takkan majhi 13. Ramnath Majhi 14. Gopal Nishad 15. Sidhu Sahni 16. Kashi	52	1. People consulted involved local resident of the area, fishermen and boatmen and squatters at Balua Ghat 2. People affected here are indirectly 3. Most of them are educated till higher secondary level. All of them are well aware about the project. 4. Some of them wants this project because more job opportunity will create in the area. 5. Some of the fishermen showed concern the development of project may lead to **fish** kill and in turn will affect the fishing businesses. They expect some allowances from the Government in lieu of their affected income.

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
		17. Dakhhi 18. Somnath 19. Hiralal 20. Shankar 21. Ramnahe 22. Visnu 23. Syambabu 24. Banarsilal 25. Seva lal 26. Manish 27. Gopal ji 28. Manish kumar 29. Vivek Chorasiya 30. Sankar Sahni 31. Bittu 32. Ramesh 33. Banarsi 34. Gaurisankar 35. Ranku Sahni 36. Pancham Mallah 37. Dilesh Sahni 38. Mirtu Kumari 39. Dhobelal 40. Bichanu 41. Sumeru 42. Bablu kumar 43. Chedi Sahni 44. Raju Sahni 45. Rajesh 46. Mohit 47. Anans Sahni 48. Mote Nath		

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
		49. Banarsi lal 50. Chote lal 51. Sri Ram 52. Gopal Ji		
3.	PWD, Varanasi & Date: 21-6-2015	M.P Singh (Administrative Office)	1	1. PWD officials are not aware about the project development 2. When the details were shared with him about the project, he presented a favourable view towards the project 3. He stated that development of waterways will reduce the freight load from highways, will reduce the air and noise pollution in area and will make transportation of goods cheaper. 4. However he suggested that the nearby roads to the terminal facility should be strengthened and widened, as there may be substantial increase in traffic movement in the roads connecting the terminal site after development of terminal. Thus IWAI should carry out traffic assessment due to project development and should coordinate with PWD in this regard.
4.	UPSIDC, Varanasi & Date-22-6-2015	Sushash Tripathi Ph-9935757014	1	1. Development of terminal site may generate necessity of development of industrial zone near the terminal site as industries will be willing to find a location close to terminal site. 2. Development of terminal will facilitate low cost transportation of goods which will enable industries to produce goods at low cost, however no such industry exist in the industrial area at present in the nearby industrial area which may avail the facility of raw material movement by waterways.
5.	Kashi Van Mandal, Kacchua sanctuary, Varanasi & Date: 23.06.2015	Ajay roy, DFO, Kashi Van Mandal, Kacchua sanctuary Varanasi	1	Discussion was carried out to identify environmental issues may associate with Turtle Sanctuary. Following are the main concerns of the officer: 1. There turtle will get impacted due to regular movement of ships and vessels in river. 2. Because the Turtle is very shy in nature the noise generated from the waterway transport will affect them. 3. Siltation during the construction period will create a problem to aquatic fauna.

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				4. Chance of oil spillage from the ships will contaminate the Ganga water quality. Solid waste generation management shall be done in scientific manner.
6.	District Industry Centre (DIC), Varanasi & Date: 23-6-2015	Umesh Kumar Singh (Joint Commissioner, Industry)-09838467078	1	1. They were not aware about the project development. 2. When project information was shared with them they said that there are 2 industrial areas in Chandauli District. These industries are generally agro based, small scale and non-polluting types. However, development of terminal may interest industrialist to develop industries in nearby areas. 3. He suggested waterways are cost effective and environment friendly mode of transportation. However, water pollution may occur, if wastewater is discharged by ships and terminal facility into river. This may also affect the aquatic life of the river and fishing activity.
7.	Banaras Hindu University & Date: 24.06.2015	Dr.B.D. Tripathi, UGC-BSR, BHU, Ganga pollution Research, NMCGA	1	Discussion was carried out with him regarding this project. Following are the main concerns of Dr. Tripathi was: 1. Ganga River has anti bacterial quality on itself. Execution of this project, Ganga will lose its anti bacterial property. 2. Aquatic flora and fauna will disturbs 3. Religious point of view he was not satisfied. 4. Overall he is not in favour of this project.
8.	Irrigation Department, Varanasi & Date: 24.06.2015	E.S.P. Srivastava, Sacchiv, Jal Nigam Irrigation Department, Varanasi	1	1. He is concerned about the vibration generated due to heavy traffic movement can disturb the strata of pump wells located in Ganga River for drinking water purposes.
9.	Ganga Pollution Unit at Varanasi & Date: 24-6-2015	Er. J.B Rai, General Manager	1	1. He was aware about the project development 2. He does not have any favour and opposition for the project development
10.	Public Health department (PHD), Varanasi & Date: 26.06.2015	Dr. M.P.Chaurasiya, (C.M.O), Public Health Department, Varanasi.	1	1. They are not aware about the project 2. They do not have any existing and upcoming health schemes in the area near to the site development. 3. They suggested IWAI should contact them for development of health.
11.	Vikas Bhawan at	R.k.sharma (DESTRO),	2	1. They are not aware about the project

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	Varanasi & Date: 26.06.2015	Contact:941525214 C.M.srivastava:9451890977, Statics Depatment		2. They do not have any upcoming development scheme in the area near to site. 3. They did not have any say about the project development.
12.	USPCB, Varanasi & Date: 27.06.2015	Dr. Mohd. Sikandar R.O, UPPCB Contact:7800006344	1	1. He was aware about the project development. 2. He was concerned regarding the water quality issues which may be there due to construction of terminal facility and operation of cargos, spillage in case of accidents, discharge of waste and sewage, oil leakage and other related activities. 3. He suggested environment management plan should be prepared for the construction and operation phase and that should be strictly followed by IWAI and cargo operators to ensure no pollution to occur due to them. 4. In case of accidents, cargo operator should be responsible to clean the spills.
13.	Ralhupur, Village, Varanasi & Date-8-7-2015	Project Affected Families: 1. Dinesh Singh 2. Ashok Singh 3. Santosh Kumar Singh 4. Alok Kumar Singh 5. Gopal Singh 6. NarenderBahadur Singh 7. Laxami Prased Rai and Family.	7	1. People are aware about the project development 2. Discussion was carried out with Farmers, students and PAF regarding the impact of this project. People are well aware about the project. The main issues of the villagers are: ▪ Most of them want this project because more job opportunity will create in the area. ▪ People were expecting permanent job in this project. ▪ Majority of people have positive attitude towards the project. ▪ People also expect infrastructure development such as good roads, water supply, power supply in their area after coming up of proposed terminal. ▪ People expects that the upcoming project is of less polluting industries so as no pollution related problems will observed in the area. ▪ They wished and expect from authority that their compensation should be on current market price. ▪ They got notification from government before

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				acquisition of their land. ▪ As per villagers, officers from block/anchal never talked to them regarding compensation and land acquisition. ▪ They have been growing crops like Jau, Pulse, Arhar, Masoor for a long time on their land but now they have been gradually losing their irrigation land. ▪ Villagers are requesting that compensation of their land should be as per prevailing market rate, if it is not feasible at least compensation should be disbursed to them on circle rate. 3. Some Project affected families have filed petitions in the court for higher compensation.
14.	Balwa Ghat Ramnagar Date:9.7.2015	Fishermen, Boatmen and Squatters at Ghat and local community. 1. Jaikishan 2. Ramlal 3. Kamlu 4. Roshan Lal 5. Majhi lal 6. Kamlulal 7. Sankar 8. Ramnahe 9. Vivek 10. Aman 11. Banarsi 12. Kamlesh	12	1. Yes, Supporting project 2. Fishermen, Boatmen Squatters at Ghat and local community were happy from the NW-1 3. The main concern of the local community is to provide them the livelihood based activities in the project works. 4. Second concern is to provide them skill based training which can help them to provide employment
15.	Land Owner (Local People), Dated-23.8.2015	Vieswar Dravin, Land owner for proposed access road to Terminal	1(The land belongs to one family of three	1. Mr. Vieswar has some issues. Total land to be acquired as per the Government notification dated 19th March 2015 is 0.592 ha. The land belongs to one family of three brothers. The owner of the land opined that the valuation of land is being done based on the circle

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			brothers)	rates and is not justified. He is requesting for the revision of the land value 2. Compensation amount and circle rates for the proposed land should be revised with the consent of the affected families in the meeting before finalization of the circle rates. 3. Loss of this land will lead to loss of livelihood to the family.
Informal Consultation in Sahibganj				
16.	Samda Nala Ghat, Near Project site, Sahibganj & Date: 16-09- 2015	General Public and Fisherman 1. Shiv ji maldar 2. Chanchal kumar yadav 3. Jawahar yadav 4. Rmaan 5. Narayan yadav 6. Shiv Shankar yadav 7. Rupan Mandal 8. Shivshankar yadav 9. Sudeshan Yadav 10. Sushila devi 11. Mahendra yadav 12. Kanhayia yadav 13. Bal Krishna Yadav	13	Participants included farmers, students, affected people, fishermen, Boatmen and females. Most of the people in the area are farmers and depend on agriculture for livelihood. Villagers are aware about the IWAI planning for construction of terminal. Following issues/concerns were raised by the participants. 1. Land owners are highly concerned as they depend on the agriculture and mango plantation for their livelihood 2. Students however see the project as positive development in the area in terms of infrastructure, power, roads and water supply facilities and employment generation 3. Fishermen stated that fish catch will reduce in the area after construction of terminal due to increase in water pollution and killing due to barge movement. 4. Farmer practice river terrace cultivation in the river bed area and they are worried that they will not be allowed to practice the same after construction of terminal due to restrictions by authority.
17.	Ashram, Samda Nala Village & Date: 9th -10-2015	Villagers from Rampur & SamdaNala village	10	Participants included farmers, students and females. Following issues/concerns were raised by the participants. 1. Loss of livelihood is major concern due to loss of agriculture land 2. Land owners were demanding compensation should be as per prevailing market rates 3. Local people only should be considered for provision of employment 4. Proper R & R should be done before displacement of affected

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				people. Affected people/land owners are worried about the loss of houses and place of relocation 5. Religious sentiments of locals are associated with River Ganga so they want place near to River Ganga for relocation 6. Employment and home should be provided to affected people before displacement/land acquisition and loss of livelihood 7. Project development will lead to increase in pollution in area and water. Water pollution may significantly impact the fish catch.
18.	Ashram, Samda Nala Village & Date: 9th -10-2015	Villagers from Rampur, Ashram, Samda Nala Village (8 Participants)	8	Participants included farmers, fishermen & students. Following issues/concerns were raised by the participants. 1. Land owners categorically said that land will be given only, if they will get appropriate compensation 2. Also they require employment, if complete land will be taken away from them 3. They mentioned large nos. of trees are planted in the land which is under planning to be acquired, cutting of large no. of trees will affect the environment of village thus equal nos. of trees should be planted before cutting the trees in nearby land areas 4. They said some dolphins are seen in the water, operation of barges may be danger to life of dolphin. 5. They are scared as they think fishing will be banned in the area after development of terminal which is major livelihood source of most of the people.
19.	Ashram, Samda Nala Village & Date:9th -10-2015	Ashram, Village Rampur	15	Participants included farmers, fishermen & students. Following issues/concerns were raised by the participants. 1. Land owners are expecting appropriate compensation for their land and also assistance in alternative livelihood of their land will be acquired 2. They demanded job for them and their children and they mentioned they should be given skill generation training for job

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				offered as they have practised only agriculture throughout their life 3. They insisted that they worship River Ganga and they will not bear addition of pollutants and waste in the River 4. They want to get assurance about that they can continue fishing activity in the river after construction of terminal. 5. They wanted to ask what other developments will be taken up by IWAI in village for betterment of villagers
20.	Naya Tola & Samda Nala Village & Date:5th-11-2015	Villagers from Naya Tola & Samdha Nala	10	Participants included farmers, students and females. Following issues/concerns were raised by the participants. 1. Farmers whose land will be acquired are worried due to loss of land and loss of livelihood as they are practising agriculture since generation 2. Land owners demanded alternate housing facility and employment prior to land acquisition and displacement 3. Fishing activity will be hampered in the river due to development of terminal and plying of large nos. of cargos 4. Cutting of large nos. of trees within the project site will impact the climate of the area 5. Local people should be considered for providing employment. 6. Community facility in the area, if any to be disturbed should be relocated at the accessible and appropriate location
21.	Asharam Ashram, Naya Tola & Samda Nala Village & Date:8th November, 2015	Villagers from Naya Tola & Samdha Nala	20	Participants included farmers, students and females. People are aware about the project. Following issues/concerns were raised by the participants. 1. Land owners are worried about the compensation rates and the loss of livelihood 2. They demanded provision of employment for the affected people. Authority committed for provision of employment to locals after coming up of project 3. Locals demanded compensation should be given as per market rates 4. Displaced population want the relocation near or inside the village

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				only 5. Assistance should be given for alternate livelihood for affected people 6. Water quality can be affected due to project development, this will affect the aquatic life in the area. 7. Air pollution in the area will increase due to increased movement of vehicles in the area.
22.	Department of Environment and Forest, Aranya Bhawan, ShahidPir Ali Khan Path (Riding Road), Shekhpura, Patna-14 & Date:15th September 2015	Dr. D K Shukla Designation: Principal Chief Conservator of Forest (PCCF) Phone: 0612-2545074 Department of Environment and Forest.	1	1. Dr. D.K. Shukla gave idea on extent of the dolphin sanctuary. VGDS boundary starts from Sultangunj block boundary and ends at Kahalgaon subdivision boundary. He also advised to meet Chief Wildlife Warden, Bihar for more information on VGDS. He raised the following concern 2. Dolphins will be impacted with barge & cargo movement especially the baby dolphins. 3. Development of terminal may increase the water pollution which will significantly affect the aquatic life 4. Strict norms and measures are required to be followed and taken towards the protection of habitat of the dolphins, if this project is being developed. 5. Discharge of waste in the river should be strictly prohibited by anybody (terminal/vessels/barges). Waste management facilities should be developed at site and waste should be treated and disposed off at other safe locations. 6. Mechanical movement of barges will impact the dolphins thus the speed of the cargos movement in these water should be regularized
23.	Department of Environment and Forest , Aranya Bhawan, ShahidPir Ali Khan Path (Riding Road), Shekhpura, Patna-14 & Date:15th-09-	Shri S S Chaudhary Designation: Additional Principal Chief Conservator of Forest (PCCF) and Chief Wildlife Warden, Bihar Phone: 09430919565	1	1. Shri S.S. Chaudhary was aware about the project development. He gave more information about the extent of VGDS. He told that river stretch between Sultanganj and Kahalgaon Pahar (50 kms) is declared as VGDS. Copy of notification for declaration of VGDS as Dolphin Sanctuary was provided by him. He raised the following concerns: 2. Project may have significant impact on dolphin thus proper measures should be taken during operation phase to minimize this impact. 3. It may be required to obtain Wildlife clearance for the project

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	2015			4. Interference in this zone should be minimized to the extent possible. 5. Minimal disturbance to the dolphin should be done as they are sensitive. 6. Waste management is key requirement. Waste disposal, disposal of coal ash and contaminated run-off to the river may pollute the river water quality significantly which in turn may affect the aquatic life.
24.	Gangetic Plains Regional Centre, Zoological Survey of India, 11-D Rajendra Nagar, Patna - 800 016, 0612-2360054 & Date: 15th-09- 2015	Dr. Gopal Sharma Designation: Scientist D and Officer-In-Charge at Gangetic Plains Regional Centre Phone: 09431221918	1	1. Dr. Gopal Sharma was aware about the IWAI Project. He opined that the project will have impact on Dolphins. He told that VGDS extends about 60-65 kms. Coordinates for starting and end points are as follows: ▪ Sultanganj (Ajgaivinath Temple) N 28°15.247' and E 86°44.758' ▪ Kahalgaon (3 hillocks in river) N 25°15.402' and E 87°13.246' 2. He told that this stretch is preferred habitat of the dolphin due to availability of confluence points, meandering locations and deep pools of river. About 127 dolphins have been recorded in VGDS. Other aquatic fauna of VGDS include Otter, gharial, turtle, etc. VGDS provides breeding ground of such species. He raised the following concerns: ▪ VGDS is rich in bio-diversity thus care should be taken that minimal or no disturbance should be caused to aquatic life ▪ Dredged material may contain toxic compounds so should not be dumped on river bank as river banks are habitat for otter, birds feeding on aquatic organisms and other species ▪ Dolphins are affected by the vibrations. Plying vessels create ripples which causes energy losses in dolphin for its movement and carrying out other functions. ▪ At present dolphins are distracted by vessels plying in NW-1. Mitigation measure for propellers to avoid dolphin getting hit should be considered, e.g. propeller guard. ▪ This leads to entanglement of dolphins in fishing nets in

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				Ganga causing mortality. ▪ In the current situation, plying vessels get stuck in lean season. In the event of larger vessels plying in NW-1, the situation will be aggravated. 3. Also there are various sites of socio-cultural importance like Ajgaivinath temple, Sultangunj, which should not be impacted due to project development.
25.	Department of Fisheries, Sahibganj & Date:16th September 2015	Shri Jayant Ranjan, Designation: District Fisheries officer Phone: 09835031630 Email:jayant.ranjan21@gmail.com	1	1. During the consultation, Mr. Jayant Ranjan made the following comments ▪ He appreciated the efforts to engage with local communities through public consultation. ▪ He said app. 5000 fishermen are dependent on fisheries for livelihood in this stretch and their livelihood may get impacted due to development of project ▪ Some of the commercial fisheries in the area are Indian Major carps, singhi, shrimps, Mystus sp. Catfishes &tengra ▪ The river banks at Bejlighar, Maharajpur, Mahadevganj, etc in Sahibganj are known as breeding and spawning grounds. Fish breeding takes place in shallow water. Fish seedlings are collected by fishermen in this region. ▪ During lean season, siltation is high and water current is low. Thus dredging will be required to carry out which will significantly impact the water quality ▪ Dredging may have significant impact on breeding and spawning season ▪ Impacts which may result due to project development are oil spills from barge vessels, cargo spillage, ballast water, anti-fouling paints etc ▪ Dredged material should not be disposed off on the bank of river as they are breeding and spawning grounds of fishes ▪ In Jharkhand District, decline in Rohu fish is recorded. ▪ Project will open up the opportunity for movement of frozen

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				fish in Sahibganj and will open up opportunity for livelihood of local communities 2. There is potential for growth of commercial fisheries including cage culture fisheries, which is being promoted in Jharkhand.
26.	District Forest officer, Bhagalpur, Patna & Date: 16th-09- 2015	Mr. S.K.Sinha, Designation: DFO, Bhagalpur Phone: 09835031630	1	1. Mr. S. K. Sinha made the following comments and suggestion ▪ He discussed that it may require to clear large nos. of trees for development of project ▪ He suggested permission should be taken from forest department before cutting any tree ▪ He also suggested that compensatory aforestation should be carried out in lieu of trees cut ▪ He suggested to consider impacts on aquatic life and terrestrial flora & fauna while designing the project and to include mitigation measures in environment management plan ▪ He suggested a thick green belt should be developed all around the boundary of the terminal site 2. He also suggested that terminal boundary should be high enough to prevent entry of cattle/animals
27.	Gram Panchayat, Samda Nala and Rampur village & Date: 9th -09- 2015	Mrs. Munni Gaud Designation: Gram Panchayat Head Phone: 07808789116, 7070603324 Gram Panchayat, Samda Nala and Rampur village	1	1. Mrs. Munni Gaud is aware about the project and she opined the following: ▪ She said the project will bring development in the area and will have positive socio-economic impact on large scale. However people who are losing land will lose their livelihood and their housing ▪ People are expecting employment generation from the project and also the infrastructure development ▪ Traffic may increase in the village and nearby area which will pollute the air so mitigation measures should be taken to minimize air pollution ▪ Villagers have emotional values attached with the River Ganga, thus terminal project should not cause water

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				pollution else there will be opposition from the villagers ▪ Adequate compensation should be given provided to the people. 2. Alternate employment options should be suggested for people who are completely losing their land.
28.	Gram Panchayat, Hathigarhi & Date: 9th-09-2015	Mrs. Usha Khalkoo Designation: Gram Panchayat Head, Gram Panchayat, Hathigarhi Phone:9801018326, 9801352024	1	1. Mrs. Usha Khalkoo is aware about the project and she told the following: ▪ Land owners are worried as some are losing their complete land and they will lose their livelihood, if land will be taken away from t hem ▪ Adequate compensation and assistance should be provided to land owners to find new livelihood options. ▪ Employment should b provided to local people preferably ▪ Tree cutting should be minimized and compensation should be provided to owners for all their assets as per law ▪ River water will be polluted due to construction of terminal and villagers may have concerns about this as they worship River Ganga 2. Traffic may increase in the area which may increase chances of accidents.
29.	District Collectorate Office Sahibganj, Jharkhand & Date: 7th-09-2015	Mr Niranjan Kumar Designation: Additional Deputy Collector + Land Acquisition officer, Sahibganj Phone: 09431306331, District Collectorate Office Sahibganj, Jharkhand	1	Meeting was held in the Collectorate office regarding the proposed terminal activities. In the meeting Mr Niranjan kumar ADC Sahibganj told that their office is carrying out the land acquisition which is in progress and it may take some more time to finalize the final individual award list. After completion of the work they can provide the final award list and land details to the IWAI. He also suggested to carry out the SIA activities and they can provide security for survey team as necessary.
Informal consultation in Farakka:				
30.	Bewa village– cognitive interview	Villagers of Bewa Panchayat 1. Ajay Mondal	21	Participants included farmers, non-title holder's farmer and community member. Following issues/concerns were raised by the participants.

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
	& Date:5/10/2015	2. Arun Ghosh 3. Ashoke Ghosh 4. Banu Ghosh 5. Bapan Ghosh 6. Binoy Ghosh 7. Bharat Ghosh 8. Bikash Ghosh 9. Biren Ghosh 10. Dukhu Sekh 11. Abddul Mannan 12. Barqat Sekh 13. Gani Sekh 14. Aftab Sekh 15. Hamsad Sekh 16. Ahmad Sekh 17. Tufani Sekh 18. Sarju Sekh 19. Gaju Sekh 20. Siraj Sekh 21. Abdul Sekh		1. People were aware about the project. 2. Some of them were doing agriculture on Farakka Barrage project land without any agreement and lease navigational lock to be constructed. 3. They had already given their land to FBP during Farakka barrage project installation in 1965 4. Most of them were disagree with the compensation provided by FBP. 5. All the non-title holders expecting proper compensation and re-settlement. 6. Erosion occurs along the bank of feeder canal and that is creating problem. Ship movement has further enhanced erosion.
31.	Near Primary school Ghoraipada village & Date:6/102015	Villagers of Ghoraipada village 1. Nikil ghosh 2. Pawan ghosh	9	Participants included farmer and small traders. Following issues/concerns were raised by the participants. 1. Non-Title holder are cultivating the land frost many years and

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
		3. Pappu ghosh 4. Ravi ghosh 5. Rakesh ghosh 6. Ram Chandra ghosh 7. Ratan Ghosh 8. Sadan Ghosh 9. Sanjay Ghosh.		dependent on the land. They are expecting appropriate compensation and also assistance in alternative lively hood. 2. They demanded job for them and their children and they mentioned they should be given skill generation training for job offered as they have practiced only agriculture throughout their life 3. Most of them were disagree with the compensation provided by FBP. 4. They need compensation for damage of fishing nets and other accessories due to barrage movement and project development (if any 5. They need employment during construction and operation phase of the proposed navigation lock.
32.	Central Inland Fisheries Research Institute ,Barrackpore, 700120, West Bengal & Date:1.07.2015	Director, Central Inland Fisheries Research Institute, Barrackpore,	1	They are aware about the project development. 1. They suggested project will have significant impact on aquatic life and sensitive species like dolphins and turtles 2. Water quality is already polluted and will be affected further due to project development. 3. Dredging activity have significant impact on the aquatic life 4. This will lead to disturbance of the sediments which may contain hazardous material, increase in turbidity which may impact the visibility and gills of the aquatic organisms etc.

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				5. Mechanical movement of barges will impact the fish and other aquatic animals thus the speed of the cargos movement in these water should be regularized.
33.	Department of Environment, Government of West Bengal & Date-31.06.2015	Mr. Siddhartha Roy, IFS, Senior Environment Officer, Government of West Bengal, Kolkata	1	He was aware about the project and they were highly concerned about the environment issues related with the project development. 1. Clearances and NOCs should be obtained as applicable for the project as per the laws and Acts of Govt. of India 2. Project will significantly reduce air emission, noise level & traffic loads from highways but may add to water pollution 3. Surface water quality may be degraded due to discharge o waste/sewage from ships and lock gate facility, increased human activities near river, accidental spillage, leakage of oils etc. 4. Ground water may also get polluted as this surface water seeps into ground water aquifers.
34.	State Warehousing Corporation, WB & Date -30.06. 2015	Mr. A.K. Sinh, Executive Secretary, WBSWC & Mr. Kaushik Mukherjee, Dy. Commercial Manager, WBSWC	2	The officials were aware about the project and added the following: 1. They have expressed positive attitude towards project development 2. Project will boost the freight movement, cheap raw material transportation and thus the industrial sector 3. With boost in freight transportation and industrial activity, need of warehouses will increase with time 4. Thus some projects may come near to lock gate sites. 5. Cost effective, energy efficient and environment friendly mode of transportation.
35.	Farakka Block Development Office, Farakka, Murshidabad & Date:8th October 2015	Mr Niranjan Kumar, Kesang Dhendup Bhutia, BDO & Block Executive Office Ph-9434770026 E-mail-bdo.farakka@gmail.com	1	BDO, Farakka was aware and happy with the project development and assured his and local administration cooperation for the project implementation. 1. He was also invited for public consultation meeting. 2. Any kind of toxic pollution by the vessel like oil spillage and chemicals in the river water, transport emissions, needs to be

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				considered.
36.	Divisional Forest Office, Nadia & Murshidabad Range & Date:15th October 2015	Mr. Rana Dutta,IFS, DFO PH: 9434053965 E-mail: dfomnd@rediffmail.com	1	He was aware about the project. He says that there is no reserve and protected forest in the area and also added that there is no sensitive ecosystem present in the area. He was highly concerned about river bank erosion.
37.	Coal India, Kolkata.	Mr. Niranjan Das, CGM (Env.), Coal India, Kolkata.	1	He was aware about the project he further added that the project is highly beneficial. Insufficient transportation facility available at present. 1. Project development will increase the transportation of coal to user agencies, especially NTPC thus enhancing the power generation capacity 2. IWT is environment friendly mode of transportation 3. Transportation of coal should be carried out only in covered cargo 4. However, project can impact the aquatic life by disturbing its habitat. 5. Environment management plan should be prepared and for all the stages of project and should be implemented as suggested to minimize environmental impacts of the project.
38.	Community members of local Villages at PCM	Community members of local Villages at PCM	50	1. The villagers also informed that there is no forest area. Further, they did not anticipate any adverse impacts on their livelihood due to construction works. 2. They further opined that there would be positive impacts on the sources of livelihood due to increased economic opportunities which will provide good earning sources to the local families due to the project implementation. It was also informed that there is no Schedule Tribe (ST) population in the project area. 3. Representatives from Beoa Panchayat extended their support during the construction and operational phase of the proposed project. - They also suggested that public consultation meetings should be held at different places for awareness of the people and Grievance Redressal Committee should be active with timely conflict resolution.

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
39.	Patna Aranya Bhawan, Shahid Pir Ali Khan Path (Riding Road), Shekhpura, Patna-14 Phone: 0612-2545074 Date: October 15, 2015	Dr. D K Shukla, Principal Chief Conservator of Forest (PCCF), Department of Environment and Forest	1	Wildlife Protection Act, 1972 will be applicable if the project intervention is within the boundary of Vikramshila Gangetic Dolphin Sanctuary (VGDS)
Informal Consultation in Haldia				
42.	Tamluk, East Medinipur & Date: September 21, 2015,	Mr. S K Chakraborty, DFO, East Medinipur Division	1	DFO sought directions from Headquarters of Department of Environment and Forest for providing relevant data.
43.	Tamluk, East Medinipur & Date: September 21, 2015	Mr. Satikanta Bairagi, Assistant Director of Fisheries (ADF) in Directorate of Fisheries and Fish Farmers Development Agency	1	Provided information on Nayachar and Nutanchar Islands in the project area of proposed Haldia Terminal.
44.	Tamluk, East Medinipur & Date: September 22, 2015,	Mr. Jay Sengupta, Director (Technical) and Mr. B D Saha, Manager (Process)	2	The officials of Sanjana Cryogenic Storages Ltd. were aware of the proposed terminal at Haldia in the neighbourhood of Sanjana Cryogenic Storages Ltd. The issue of over ground pipeline was raised which runs along the proposed site
45.	Kolkata, September 23, 2015,	Dr R P Saini, Special Additional PCCF and Chief Conservator of Forests (HQ) Department of Environment and Forests	1	Instructions were issued to DFOs in Nadia and East Medinipur Division for collection of relevant data
46.	Haldia Municipality,	Mr. Debopadsad Mondal Chairman of Haldia	1	Support the project. The main issues are:

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
	Haldia, Purba Medinipur & Date: 25th September, 2015	Municipality Cell No. 9434940619 Email: haldmuni@yahoo.com		1. Hooghly River which is very much close to the proposed terminal 2. Any kind of toxic pollution by the vessel like oil spillage and chemicals in the river water, transport emissions, needs to be considered. 3. He appealed to the authority that they should provide jobs to the local unemployed youth based on their skill and should give business opportunities to the local people. 4. As part of social development the local immersion Ghat at Durgachak (near project site) should be expanded by the project sponsors to overcome the current congestion especially during the local festival. 5. The access road needs to be carpeted as present road is not in good condition. 6. Our request is to develop the road as it will be needed for the proposed terminal access movement also. 7. He requested to make provisions for appropriate parking facilities inside the proposed terminal for better management of container carrying vehicles. 8. Finally he gave the assurances that local government (ULB) will give all help for smooth operation of the project activities.
47.	Haldia, P Haldia Development Authority(HDA), Haldia, Purba Medinipur. Date: 28th September 2015	Mr. Purnendu S. Naskar, WBCS Ph: 03224-255927, Email: ceo.hda@gmail.com	1	Support the project, The main issues discussed are: 1. The project sponsors should consider the fact that the vessel navigation should be planned appropriately as there could be an impact to the river bank which is adjacent to the proposed terminal. 2. Due to increased river cargo traffic management of incoming and outgoing vessels in terms of loading and unloading will have to be planned and executed appropriately. 3. During dry and winter season the river water depth is low, this will create issue of cargo movement from and to the terminal. Measures should be taken to address this problem either by ensuring minimum water flow in the river or provide appropriate warehousing facilities for storing the cargo material during the lean period. 4. Oil from vessel may flow into the river and pollute the water. This

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				pollution will affect the terrestrial flora and fauna. Their needs strict control to be imposed by the project sponsors. 5. The IWAI authority have to be prepared for any kind of accidents occurring with maximum preparedness like – having a rescue team on call, good communication with the civil volunteers, fire services and local administration contacts.
48.	Haldia Municipality, Haldia, Purba Medinipur & Date: 25th September, 2015	Mr. Gopal Chandra Das, Vice Chairman, Haldia Municipality Ph:09475038119,Email: haldiamunicipality@gmail.com	1	Support the project, The main issues discussed are: 1. The interviewee raised concerns about the existing high particulate matter concentration in the area and recommended that the proposed project should ensure that no further particulate matter is created by the proposed project. Concerns about oil spillage was raised and hoped that proper emergency response to tackle any accidental spillage would be in place. 2. The access road needs to be widened and upgraded to ensure smooth traffic movement. A traffic management plan needs to be in place. 3. The interviewee suggested that the project should employ local people in the proposed terminal on a priority basis provided they have the required skills.
49.	Haldia Block Development office, Brajlalchak, Haldia Purba Medinipur & Date: 23rd September 2015	Mr. Suman Kumar Sahoo, Fisheries Extension officer PH:-9434506729	1	Support the project, The main issues discussed are: 1. There is no fish sanctuary around the port site. Fish existence is found for three months during the rainy season. During the dry season the water quality is degraded and blackish which is not suitable for the fish. Thus production of fish reduces. 2. Turbulence and wave from plying vessel movement can be a cause of fish resource sheltering in safer waters. This is problem that is difficult to resolve as the waterway fish may migrate. 3. Considering terrestrial flora and fauna, the authority can prepare habitat by tree plantation. 4. There are some fishermen depending on the fishing activity in the Hooghly River for 3-4 months of the year; the authority can support

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				them through livelihood restoration programmes. 5. The authority can prohibit the discharge of oily water into the river during fish breeding period April- May. 6. IWAI authority can invest in fish breeding in the river or nearby water bodies and employ the fishermen who are without a livelihood for nine months in a year.
50.	Sanjana Cryogenic Storages Ltd., Durgachak, Haldia, Purba Medinipur. Cell No: 09332311334, Email: sanjana_haldia@rediffmail.com & Date: 21st September 2015	Mr. Joy Sengupta, Director Technical, Sanjana Cryogenic Storages Ltd	1	Support the project, The main issues discussed are: 1. The terminal will be a new addition for carrying the container and goods by the river at lower rate. Once the terminal is in operation they will use it to vessel their export goods which will be cheaper by road transport that they are currently using. ▪ Export import business will be improved for terminal installation. ▪ Employment opportunity will be increase. ▪ The only source of pollution from proposed terminal will be sound pollution. The project implementing agency needs to take steps to abate the noise pollution. 2. Our factory is close to the proposed terminal therefore, we will help IWAI authority to operate the terminal smoothly in term of existing pipe line shifting, etc. 3. Need to work in close cooperation with the IWAI to ensure that no water logging takes place due to the project by integrating the drainage systems in the area. 4. Fire team should be available on call to attend to and avoid any kind of disaster situations.
51.	Durgachak, Haldia, Purba Medinipur. Ph No.- 03224-253180, Date: 27th September 2015	Haldia Vigyan Parishad (NGO's, Ph No.- 03224-253180)	3	1. Support the project, The main issues discussed are: ▪ Meaningful community development for the people in the affected areas was demanded ▪ Oil water from vessel washes may pollute the river water which will affect the terrestrial flora and fauna. There needs to be strict control measures to be imposed by the project

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				authority. 2. The proper environment management plan should be prepared before the project operation phase.
52.	Community members living within 1.5km radius of the project location at Durgachawk & Date: 27th September 2015	Community members living within 1.5km radius of the project location at Durgachawk. 1. Sanjay Kumar Maji 2. Arindam Pramanik 3. Sadhan Sardar 4. Sibsankar Patra 5. Pralay Kr. Hazra 6. Atanu Bera 7. Prabir Pusti 8. Biswajit Rana 9. Arjun Metya 10. Kamal Jana	10	1. Interviewees highlighted that the consultation – adapting the company's operations to reflect the views heard – is typically missing. They underlined that if companies wish to conduct meaningful consultation, they should be willing to revise the project terms in response to the feedback received from the community. They noted that they view the objective of the consultation not as merely explaining the project, but revising it as needed to satisfy the affected communities. 2. Consider providing access to alternative methods of gaining adequate livelihoods, such as offering vocational training for specific jobs, in addition to providing monetary compensation for affected structure. 3. Compensation for affected structure payments should be transferred directly to the recipients through community-based organizations. The funds should not be transferred through local authorities, land registries or other entities that could be prone to corruption. 4. Put in place grievance mechanisms so that community members have a place to go to voice concerns and resolve the issue.
53.	Durgachak, Haldia, Purba Medinipur & Date -28th -06-2015	Santanu Ghosh, Local Auto Rickshaw Drivers at Durgachak, Haldia, Purba Medinipur	1	1. We are driving our vehicle in this road from dawn to dusk. 2. We earned and derive our 6-member family by this. 3. If traffic congestion becomes severe than our income will be reduced and will have to divert our profession.

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				4. We expect the authority will take measures.
54.	Fisherman group at Durgachak & Date: 29th-06, 2015	Sanatan Dinda and other fishermen	1	1. According to the team leader Md. Sanatan Dinda-we are fishing here only 3 to 4 month. 2. Another time we work in the brickfield and some of us pulling rickshaw and van. There are 7-8 people in our team, every day we get 2500 to 3000 rupees by fishing. 3. September is the peak time for high income. Our concern is that if the vessel comes during this time the fishing may be affected which will hamper our livelihood.
Informal Consultations for Barge Movement in Buxar & Patna				
55.	People gathered for Ganga bath & Date: 10th February 2016	Ram Rekha ghat, Buxar	10	1. People were given brief about the project and to be increased frequency of barge movement and large size barges movement in the stretch of River 2. People welcome the project and were interested to know about the employment generation potential for locals due to project 3. No objection was raised to project. 4. People said that if project will lead to congestion then infrastructure should be enhanced accordingly so as local people do not suffer.
56.	Local People gathered for bath in Ganga (Ganga Snan) & Date: 11th February 2016	Adi Nath Ghat, Buxar	6	1. People were not aware about the project and thus brief was given to people about the augmentation of entire NW-1 to enhance the navigation 2. People were told about the increased barge movement in the area 3. People raised their concerns regarding their day to day activity in the river. 4. They inquired if the barge movement will enhance the pollution. They asked for pollution free Ganga 5. They also expect that employment generation should be there due to project development in their area also
57.	Local people gathered for idol emersion. & Date: 14th February 2016	Gai Ghat, Patna	8	1. People were aware about the project as IWAI is nearby 2. Brief was given to people again about the augmentation of entire NW-1 to enhance the navigation 3. People were told about the increased barge movement in the

Sr. No	Date and place of consultation	Name and designation of person with organization name	No of people participated in the consultation	Major outcome: specifically : Have they supported the project or not. Major concern raised.
				area. 4. People were worried about the enhanced pollution in the river due to project

ANNEXURE 5.1

Annexure 5.1: List of Sanctuary

A. Kashi Turtle Sanctuary (KTS), 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 stretch is also protected. The Sanctuary also forms the part of Ganga Action Plan. Location of Kashi Turtle sanctuary in NW-1 is shown at **Figure 5.1.**

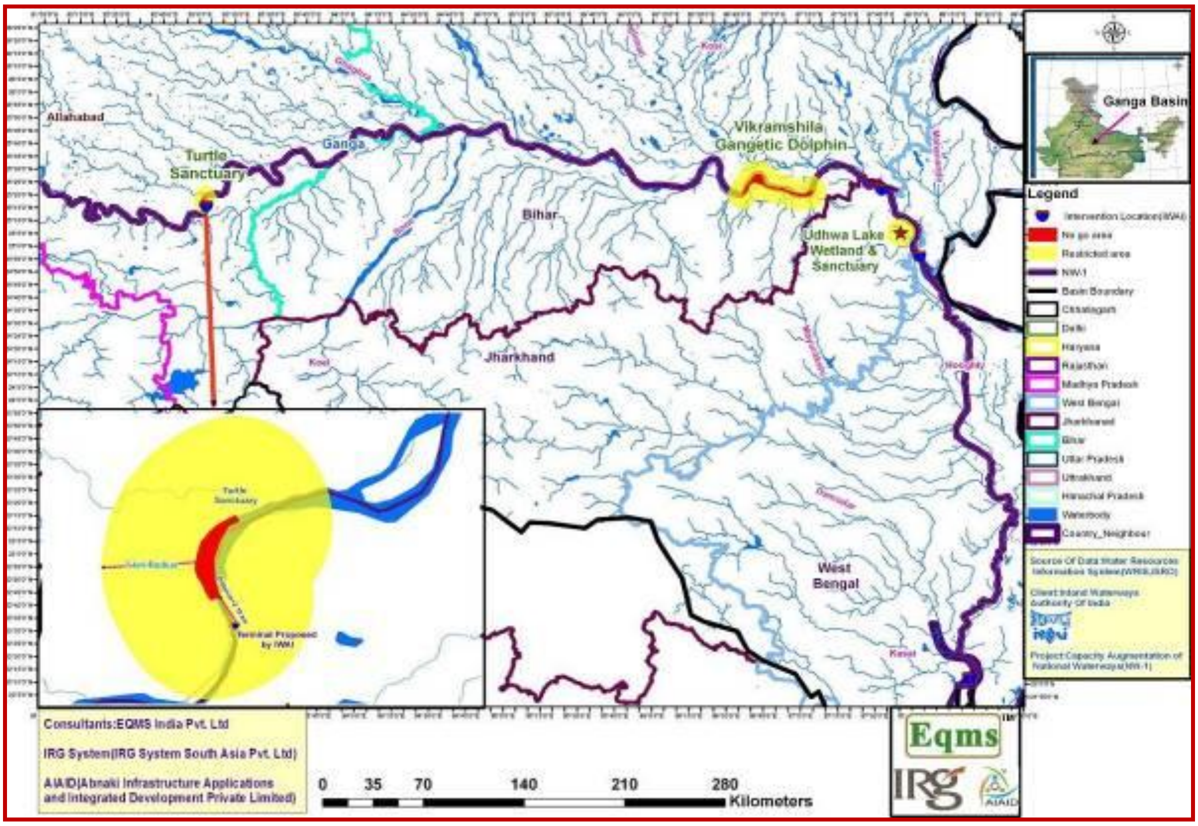

Figure 5.1: Location of Kashi Turtle Sanctuary in NW-1

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 in sanctuary area is completely prohibited. Sand mining in the sanctuary area is also prohibited. Biological resource of the sanctuary comprises of Turtle and fishes.

Gangetic Dolphin, Ganges Soft shelled turtle wintering birds, etc are reported in Kachua vanyajeev Vihar (Turtle WLS), Varanasi[6]. TWS, a notified protected area under Wildlife protected area is located about 2.27 km in north direction, downstream from the proposed

6 State of Environment Report- 2010, Uttar Pradesh, p.105, Directorate of Uttar Pradesh.

Ramnagar terminal in NW-1. Stretches of Varanasi downstream which was not surveyed in 2012 recorded 269 Gangetic Dolphins[7].

As reported in literature freshwater turtles are major biodiversity components of the aquatic ecosystem, often serve as 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 *Aspederetes gangetica* (self-shell turtles), Geoclemys hamiltonii, Chitra indica and Lissemys punctata which are carnivorous species and hard shelled herbivorous turtle - Pechra Kachhua, Sundri Kachhua, Tentoria Kachhua, and Tongoka are in abundance. The list of Turtle species with their IUCN's Threatened status is provided in following **Table 5.1**. A turtle breeding centre is also set up at Sarnath to propagate its population where turtle (both herbivorous and carnivorous) are hatched, reared for one to two year and then released into Kashi Turtle sanctuary.

Table 5.1: Turtle species in Sanctuary Area

Sl. No.	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	*Geoclemys hamiltonii*	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	*Batagur dhongoka*	Endangered

The right bank of the turtle sanctuary provides a perfect habitat for turtle to breed. However, during the site visit as well as literature records 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 (Wallago attu) tengras (Mystus tengara) and Magur (Clarias batrachus), Singhi (Heteropneutes fossilis), Tilapia (Oreocromis sp.), Kavai (Anabas testudineus) and Mahfish (Barbus sp.) are present.

B. Vikramshila Dolphin Sanctuary, Bihar

Vikramshila Gangetic Dolphin Sanctuary (VGDS) has been notified on 7th August, 1991as Wildlife Sanctuary under Wildlife Protection Act, 1972 for the protection of Dolphin[8].which

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7http://www.wwfindia.org/?14681/The-Ganga-Dolphin-Census-and-My-Ganga-My-Dolphin-campaign-2015-come-to-a-close-with-a-heartening-1263-in-the-surveyed-3350-km-stretch 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[9]and 86.738°E to 87.229°E)- in Bhagalpur district-. 10 kms area around VGDS is the default Eco Sensitive Zone at present. The proposed nearest Terminal at Sahibganj is located about 48 kms from VGDS. The location of VGDS in NW-1 and proposed terminal at Sahibganj is shown in **Figure 5.2**.

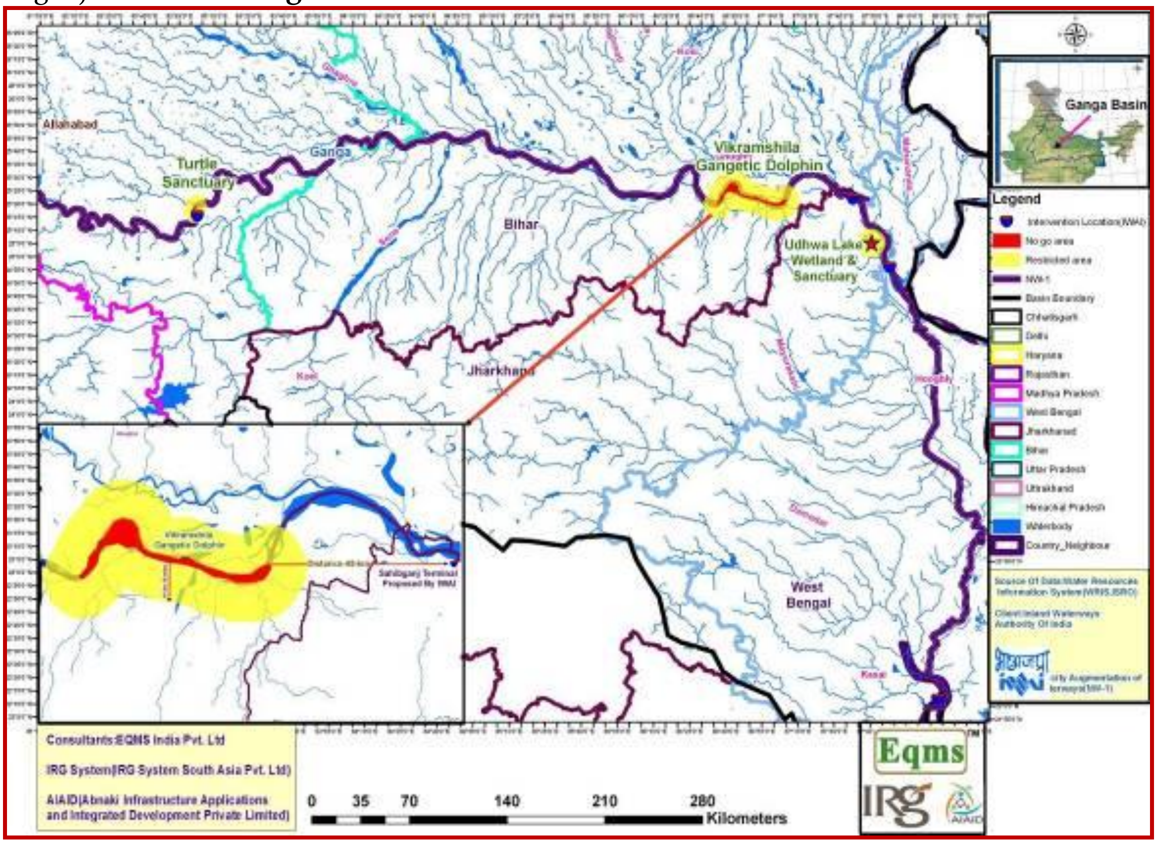


Figure 5.2: Location of VGDS in NW-1

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 stork (*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

8This 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.

9 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.

various ducks are also seen here. The major carps like, Rohu (*Labeo rohita*) mrigal (*Cirrhinus mrigala*), katla (*Catla catla*), kalbasu (*Labeo calbasu*) and cat fishes like padhan (*Wallago attu*), tengras (*Mystus tengara*) and Magur (*Clarias batrachus*), Singhi (*Heteropneutes fossilis*), Tilapia (*Oreocromis* sp.), Kavai (*Anabas testudineus*), Mahfish (*Barbus* sp.) 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[10] 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 5.2** and **Figure 5.3**). 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.

Table 5.2: Location of the Hilsa Sanctuary and their stretch

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

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

10Notification 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.

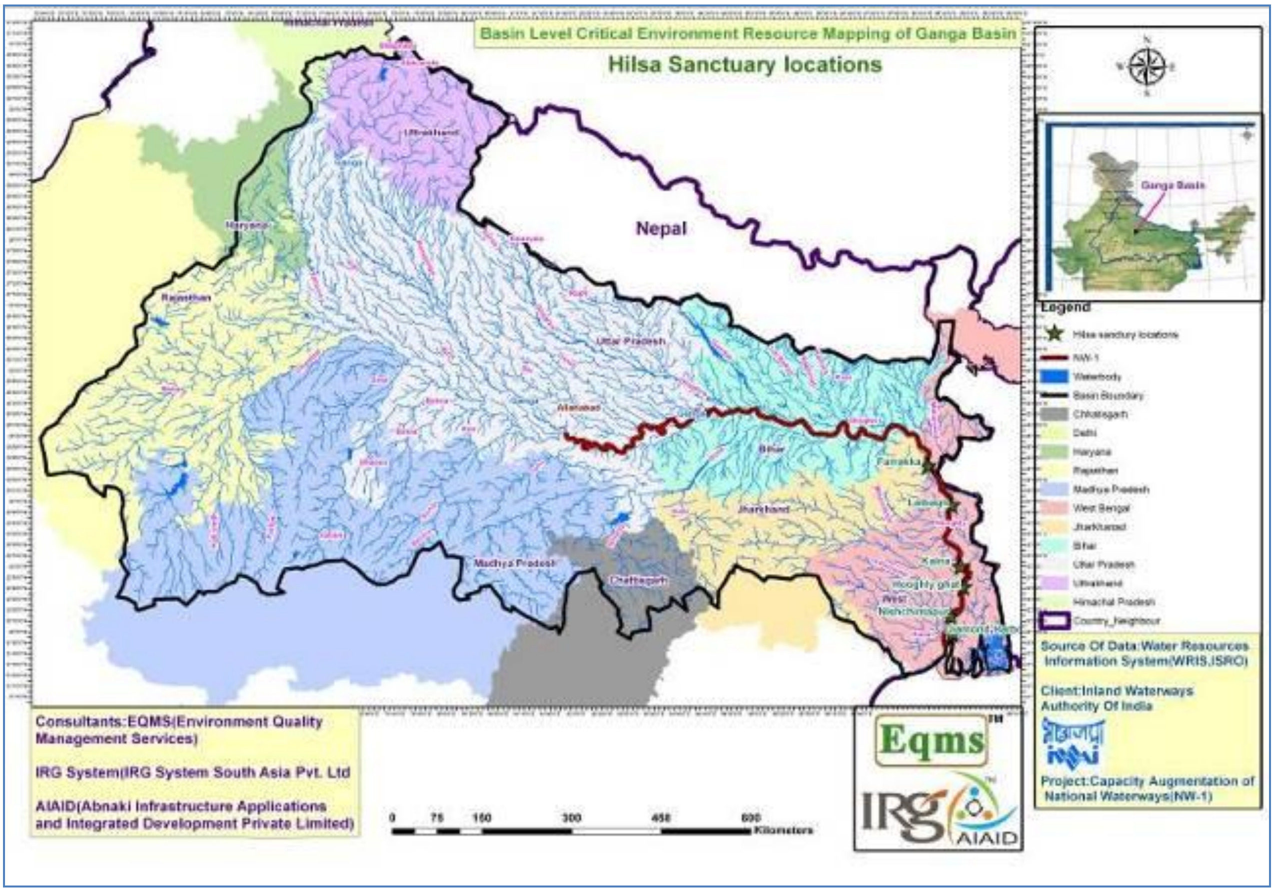


Figure 5.3: Location of Hilsa Sanctuaries in NW-1

ANNEXURE 5.2

Annexure 5.2: Morphology of River (NW-1) in different reaches

Table 5.3: Morphology of River (NW-1) in different reaches

S. No.	Reach/Stretch	Chainage	Morphology
1.	Sagar Road – Haldia	(0-35)	Split channel with central islands
2.	Haldia – Diamond Sand	(35-60)	Split channel with central islands
3.	Diamon Sand –Howrah Bridge	(60-145)	Sinuous channel
4.	Howrah Bridge -Tribeni	(145-193)	Irregular meandering channel with some sporadic central bars
5.	Tribeni-Balagarh	(193-221)	Irregular meandering channel with split channels and bars. Oxbow lakes and cut-offs visible
6.	Balagarh-Kalna	(221-245)	Tortuous meandering channel showing split channels at bends. Oxbow lakes and cut-offs visible
7.	Kalna-Samudragarh	(245-263)	Irregular meandering channel showing some degree of split at a few locations. Oxbow lakes and cut-offs visible
8.	Samudragarh-nabadweep	(263-280)	Tortuous meandering channel with bars at the near the inner bank of bends
9.	Nabadweep-Patuli	(280-322)	Tortuous meandering channel with chutes at bends and several split channels. Oxbow lakes and cut-offs visible
10.	Patuli-Katwa	(322-345)	Tortuous meandering channel with localised bars and chutes at bends and some degree of split channels. Oxbow lakes and cut-offs visible
11.	Katwa-Palassey	(345-371)	Meandering single channel, wider at bends with some chutes. Cut-offs visible
12.	Palassey-Chaurigacha	(371-400)	Irregular meandering channel showing chutes at bends and split of channels at particular locations. Oxbow lakes and cutoffs visible
13.	Chaurigacha-berhampur	(400-421)	Sinuous channel except for the approximately last 5 km of the reach. In that area the channel shows tortuous meanders and oxbow lakes. Cut-offs also visible
14.	Berhampur-mohammadpur	(421-449)	Irregular meandering single channel. Oxbow lakes visible
15.	Mohammadpur-nasirpur	(449-479)	Tortuous meandering single channel with central bars at certain locations. Oxbow lakes and abandoned meander channels visible
16.	Nasirpur-Jangipur Lock	(479-505)	Tortuous meandering single channel. Cut-off and abandoned meander channels visible
17.	Jangipur Lock-Farraka Lock	(505-544)	Artificial channel
18.	Farakka Lock Rajmahal	(544-583)	Composite river with one main sinuous channel with bars and islands and several sinuous secondary channels. Several oxbow lakes can be seen

S. No.	Reach/Stretch	Chainage	Morphology
19.	Rajmahal-Manihari	(583-633)	Composite river with one main channel with bars and islands and several sinuous side channels
20.	Manihari-Karagola	(633-660)	Split river with sinuous channels with a certain degree of braiding that converts in a single main sinuous channel with several side channels
21.	Karagola-Kahalgaon	(660-690)	Split river with sinuous channels with a certain degree of braiding
22.	Kahalgaon-Bhagalpur	(690-715)	Sinuous channel with a certain degree of braiding showing bars and islands
23.	Bhagalpur-sultanganj	(715-746)	Sinuous channel that shows some degree of braiding. The area shows clear oxbow lakes
24.	Sultanganj-Munger	(746-793)	Sinuous channel that shows some degree of braiding in a stretch of a few kilometres. It is a clear cut-off with the old bendy channel still showing some activity
25.	Munger-Mahendrapur	(793-820)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
26.	Mahendrapur-Semaria	(820-853)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
27.	Semaria-Barh	(853-891)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
28.	Barh-Mehnar	(891-925)	Anabranched river with channels with a certain degree of braiding showing bars, islands and side channels
29.	Mehnar-Patna	(925-955)	Anabranched river with channels with a certain degree of braiding showing bars and islands
30.	Patna-Doriganj	(955-1000)	Split sinuous channels with a high degree of anabranching
31.	Doriganj-Ballia	(1000-1063)	Meandering single channel, wider at bends with some chutes and several subparallel anabranches
32.	Ballia-Buxar	(1063-1124)	Sinuous single channel, wider at bends with some chutes and a sinuous side channel and certain degree of braiding
33.	Buxar-Ghazipur	(1124-1178)	Sinuous single channel, wider at bends with some chutes and a sinuous side channel
34.	Ghazipur-Saidpur	(1178-1254)	Sinuous channel that shows some degree of braiding in a stretch of around 10 kilometres
35.	Saidpur-Varanasi	(1254-1311)	Meandering single channel, wider at bends with some chutes and a side channel
36.	Varanasi-Chunar	(1311-1344)	Meandering single channel, wider at bends with some chutes and a side channel
37.	Chunar-Mirzapur	(1344-1398)	Meandering single channel, wider at bends with several chutes
38.	Mirzapur-Rampur Ghat	(1398-1419)	Sinuous channel that shows some degree of braiding in a stretch of a few kilometres
39.	Rampur Ghat-Sirsa	(1419-1506)	Meandering single channel, wider at bends with some chutes and a sinuous side channel; stretches of few kilometres with split of channels less than 200 m wide
40.	Sirsa-Allahabad	(1506-1547)	Meandering single channel, wider at bends with some chutes and a sinuous side ch

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

ANNEXURE 5.3

Annexure 5.3: Data Analysis and Observation on Water Availability

1. Dams and Barrages

Figure 1 shows major dams and barrages erected in the Ganga River Network [*MoWR, 2014*]. Dams and barrages often help to meet several anthropogenic needs such as water supply, hydropower generation, flood control and navigation. But these obstructions have divided National River Ganga and her tributaries into small segments, thereby interrupting the flow of water, nutrient, sediments and aquatic species in the rivers. In the Upper Ganga Basin, the obstructions include cascades of *run-of-the-river* (ROR) hydro- electric projects in the Bhagirathi and Alaknanda head streams. Many of these projects are constructed or planned end to end, i.e. the tail waters of one project are head waters of the next one, so that the river gets transformed into a series of reservoirs. Moreover, the water stored behind a dam is sent through tunnels to turbines and released as tail waters at downstream points of the rivers. Thus, long stretches of rivers between dams and tail-water releases are almost devoid of water. Overall, an estimated 86 km length of River Bhagirathi is thus without any flow whatsoever [IITC, 2014a]. Besides, sediments get trapped behind the dams, thereby disrupting the downstream river's water-sediment balance and affecting nutrient flow and fertility of the downstream river.

More than 70 hydropower projects (large and small dams) have been conceived in the Upper Ganga Basin, many of which are still in the planning stage. While there have been environmental impact studies of some individual dams, the only comprehensive study of their cumulative environmental impact in the river sub-basins was made by the Wildlife Institute of India [*Rajvanshi, 2012*]. However, the study was limited in scope. For instance, its focus did not extend beyond the Bhaghirathi and Alaknanda sub-basins, so that the impact of the dams over the downstream river's ecology remained unexplored. It may be also noted here that, while many of these dams are small, the common notion that small dams have relatively insignificant impacts on river ecosystems is a misconception. In some cases, the cumulative impact of small dams may be more damaging to river ecosystems than those of large dams of equivalent power generation capacity [*Kibler and Tullos, 2013*].

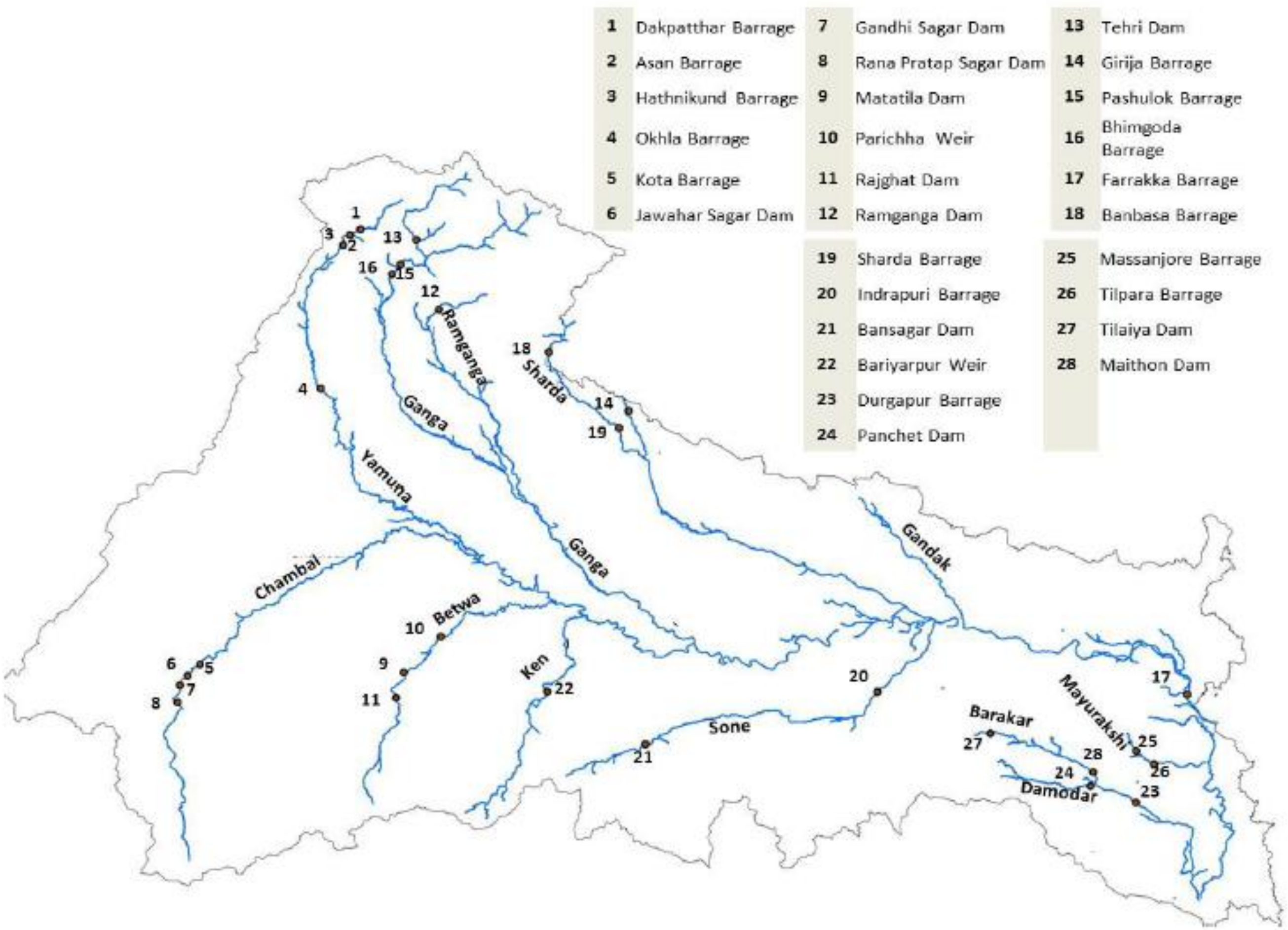


Figure 5.3.4: Major structural obstructions on River Ganga and her tributaries within India [*MoWR, 2014*]
7

Downstream of the hydroelectric projects in the Bhagirathi and Alaknanda basins, the Pashulok barrage on River Ganga near Rishikesh diverts nearly all the dry-weather flow of main Ganga river into the power channel of Chilla Power Station. The tail water of this power station joins the Ganga river near Bhoopatwala. Thus, a distance of about 15 km from Pashulok barrage to the junction of the tail waters with the river has essentially no flow. Further downstream, Bhimgauda Barrage, Madhya Ganga Barrage and Narora Barrage intersect the river successively to divert water to the Upper, Middle and Lower Ganga Canals. Further downstream, River Ganga is again clipped at Kanpur by the Lav-Kush Barrage. Finally, as the river heads for the estuarine reach, it is again bifurcated by the Farakka Barrage in West Bengal, which diverts part of the flow into a canal to feed the Bhagirathi-Hooghly river.

Besides the above operations on the main Ganga river, major dams and barrages on her tributaries include the Ramganga Dam on Ramganga river in Uttarakhand, the Asan Barrage, Dakpathar Barrage and Hathnikund Barrage (and the upcoming Lakhwar Dam) on River Yamuna, the Ichari Dam and Tons Barrage on River Tons, the Dhandhraul Dam on Ghaghra river, Gandhi Sagar Dam on Chambal river, the Rajghat, Parichha and Matatila Dams on Betwa river, the Rihand Dam on Rihand river in Uttar Pradesh, the Bansagar, Jawahar Sagar and Ruthai Dams on Kali Sindh, the Chandil, Tenughat, Maithon, Panchet and Tilayia dams on the Suvarnarekha and Damodar rivers in Jharkhand, and the Durgapur Barrage on River Damodar in West Bengal [*NIH, 2014*]. Needless to say, the innumerable intercepts in the Ganga river network have fragmented the once unified river network into disjointed stretches of flowing and stagnant waters.

Dams and barrages trap much of the river sediments, converting the downstream river water into what is called *hungry water* – "hungry water has sufficient energy to transport sediment but the sediment has been captured behind the dam. The hungry water gradually consumes the bed and banks of the river below the dam, resulting in entrenchment and armoring of the bed" [*Wampler, 2012*]. The long-term effects of this process significantly affect the morphology of rivers and their floodplains [*Graf, 2006; Gupta et al., 2012*].

In addition to the direct impacts of dams and barrages on river geomorphology, the sediments trapped behind these structures may contain many mineral nutrients, thereby depriving the downstream river stretches of essential nutrients. It may be noted that, apart from carbon, hydrogen and oxygen, at least twenty five (and probably many more) elements are essential for plants and animals (namely, N, P, K, Ca, Mg, S, Na, Cl, B, Zn, Cu, Mn, Fe, Co, Ni, Mo, Li, I, Se, Cr, V, Si, F, As, and Sn, vide *Graham, 2008*). While knowledge of the effects of micro-nutrient deprivation in river ecosystems may be limited, the effect of deprivation of essential macro-elements (like N and P) on river biota have been studied [*refer Elser et al., 2007*]. In this context, a report by Zhou et al. [*2013*] on the effects of the Three Gorges Dam on phosphorus depletion in MLY (i.e. Middle and Lower Yangtze river) deserves mention. Until major dam constructions begun on River Yangtze in the 1990s, the river discharged about 940 km^3/yr water and 478 Mt/yr of sediment into the East Sea, with the MLY stretch (about 2,000 km long below the Three Gorges Dam up to the estuary) getting little sediment added in the MLY reach. Zhou et al.'s study reveals that by 2011 (i.e. within 10 years of operation of the Three Gorges Project) the total sediment load in MLY reduced to only 6% of its previous long-term average, thereby resulting in extensive scouring of the river channel. Moreover, nutrient-rich fine sediment load reduced to only 8% of its long-term average. As a result, the Total P and Particulate P loads delivered to the MLY reduced to only 23% and 16.5% of their long-term values. Now P had already been a limiting nutrient for the Yangtze river's bioactivity before large dams came up on the river, hence its further reduction was critical for bioproductivity in MLY.

2. Hydrological Modeling of GRBMP and Inferences

In order to obtain a quantitative picture of the hydrological status of NRGB and its likely change under various scenarios, hydrological modeling was carried out for the surface water and ground water system of the combined Ganga basin area in India (i.e. NRGB) and Nepal covering 1,028,468,63 sq. km. area [IITC, 2014c]. The SWAT (Soil and Water Assessment Tool) Model was adopted to simulate the surface water response of the basin, the basin being subdivided into 1045 sub-basins for model computations. The model results were calibrated with observed river discharge data at 30 locations on the main stem and tributaries of the Ganga river network. The raw data used included static spatial data (digital elevation data, drainage network data, soil maps, soil characteristics, and land use data), dynamic hydro-meteorological data, and water demand and abstraction data. The model simulation was carried out for the period 1969–2006 (37 years) over the basin. The groundwater model was set up for the alluvium part of the basin (shown in Figure 5.3.5) using MODFLOW computer model.

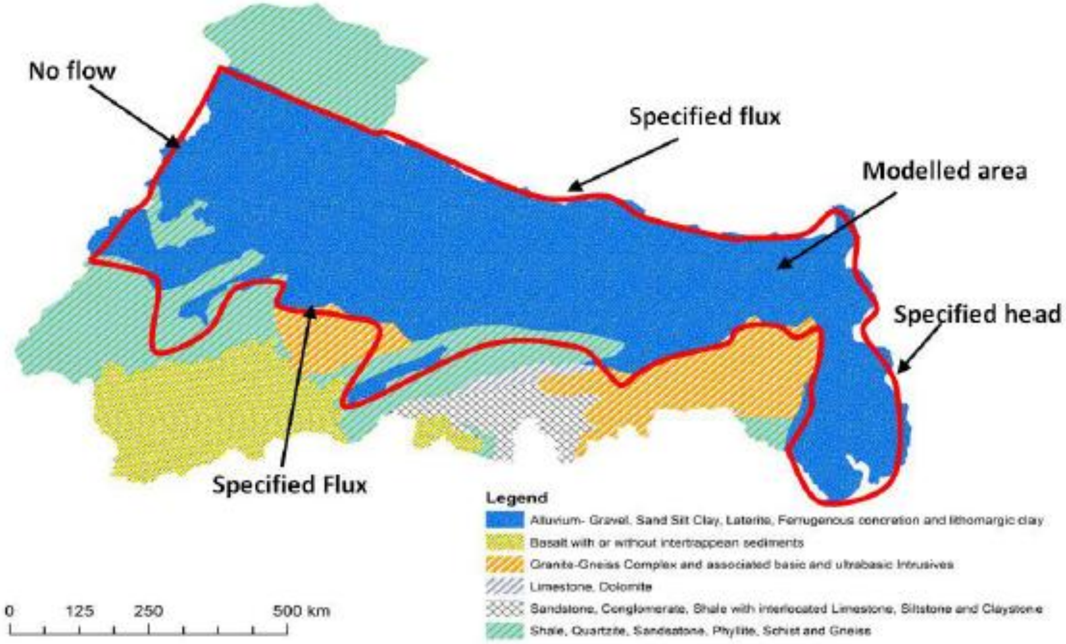


Figure 5.3.5: Groundwater Model Area of Ganga Basin [IITC, 2014c]

The modeling effort was constrained by data limitations such as absence of precipitation data for higher elevation areas, of canal water diversions, and of crop management (irrigation) practices. Besides, out of about 206 dams/ reservoirs in the basin, information was available on only 104 such structures, and canal command area information was also missing in some cases. Limitations are also likely on the quality of data used for other anthropogenic parameters such as land use and groundwater abstractions. Subject to such constraints, the computational model was calibrated and validated against observed streamflow data at about 24 flow measuring stations and groundwater data at about 100 observation wells. The summary outcome of surface water modeling is shown in Figure 5.3.6 in terms of the basin's 37-year average annual water balance components, viz.**:** (i) Total Streamflow (Water Yield) consisting of surface runoff, lateral and base flow, (ii) Precipitation, and (iii) Evapotranspiration. The monthly variation of the average water balance components are shown in Figure 5.3.7. As evident from the figures, streamflow and evapotranspiration are the two main components of water outgo from the modeled area. It may be noted that, on an annual basis, the average ratio of evapotranspiration to precipitation is found to be about 41-42%, which is much higher than the government norm of 23% for the Ganga basin but much lower than 60% suggested by Jain [*2012*] which were cited earlier in Section 4.

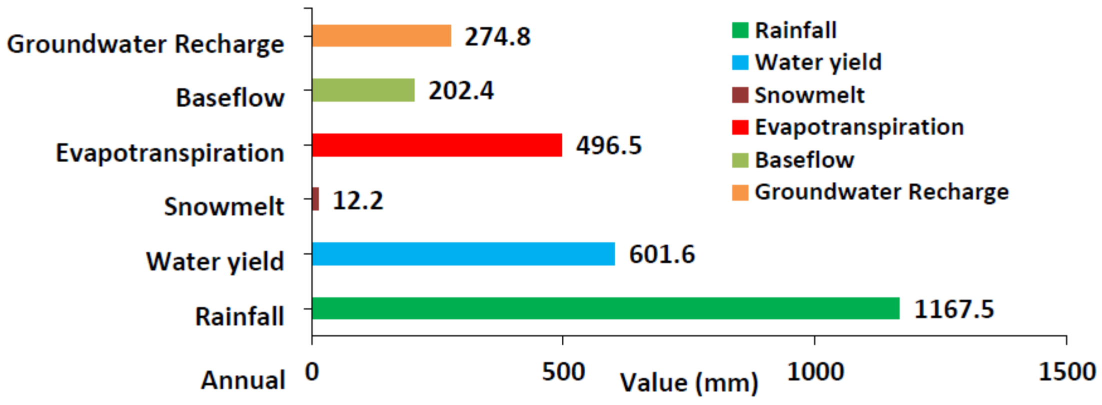


Figure 5.3.6: Average (1969-2006) Annual Water Balance of the Modeled Ganga Basin

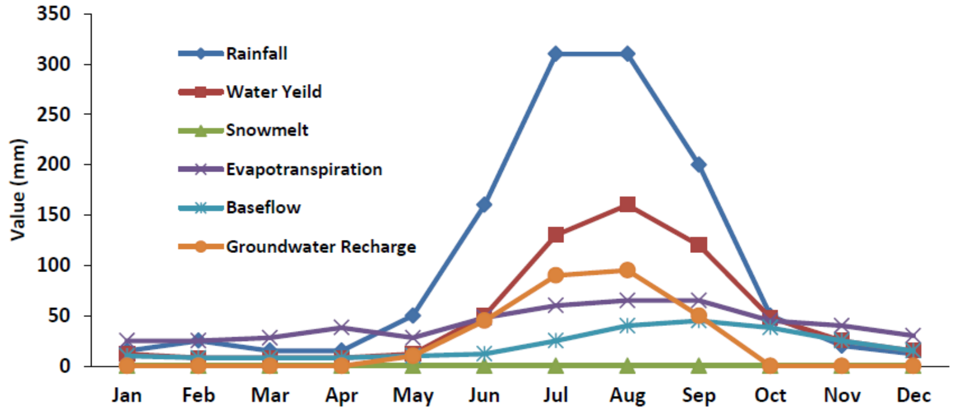


Figure 5.3.7: Average (1969-2006) Monthly Water Balance Components of the Basin.

Based on the above model results, an analysis of the hydrologic flow health of the Ganga river and its important tributaries had also been carried out to obtain annual "flow health scores" of the rivers [IITC, 2014b]. In general, the study showed that the flow health scores had significantly altered in several stretches of National River Ganga and her tributaries due to the present system of river water management. However, the analysis does not cover many aspects of river health such as functional needs of ecosystems and habitats. Considering this work as a first step to understand the significance of hydrology on the health of National River Ganga, it is envisaged that a more comprehensive assessment including ecological and geomorphological considerations of river health can be developed in future within the broader framework of ecohydrology.

The hydrological model was also run to simulate the hypothetical virgin river flows under the present climatic and land-use conditions by switching off all water resource projects and considering no groundwater abstraction in the basin. The “virgin flows” of different rivers of the network and their contributions to the main stem of the river were thus obtained for the hypothetical virgin conditions over a 30-year period of model run to enable quantitative comparison with actual flows over this period. The main tributaries of the Ganga river network (and some important flow and water quality measuring stations of CWC) are shown in the line diagram of Figure.5.8. Based on the model results, Figure 5.9 shows the estimated changes in annual flows of the major tributaries of the network. The results indicate that, while the changes in flow volumes are very small in the headstreams of National River Ganga, river flows are considerably reduced in her major tributaries such as Yamuna, Ghaghra, Gandak, Kosi, Chambal, Sone, etc., thereby reducing the flow in the main Ganga river through most of her reach. Figures 5.10 and 5.11 show the comparisons of average virgin flows and actual flows for the wet season (mid-June to mid-October) and dry season (mid-October to mid-June of following year), respectively. As evident from the figures, the differences between virgin and present flows in most rivers are much more pronounced in the dry season than the wet period, with dry season flows having drastically reduced in some rivers such as Ramganga, Chambal, Yamuna and Damodar. Thus, it can be definitively concluded that anthropogenic hydrological interventions have significantly curtailed the annual flows in the Ganga river network below the Himalayan Upper Ganga Region, especially in the dry season. Further anthropogenic uses must be immediately curtailed in critical sub-basins, and corrective measures applied where possible.

The model simulation results were also analysed in further detail to compare the average hydrographs of maximum 10-daily flows, average 10-daily flows and minimum 10-daily flows under virgin and present conditions, respectively in the major sub-basins. Appendix 1 presents figures showing the comparative changes, and their significance is self-evident from the figures.

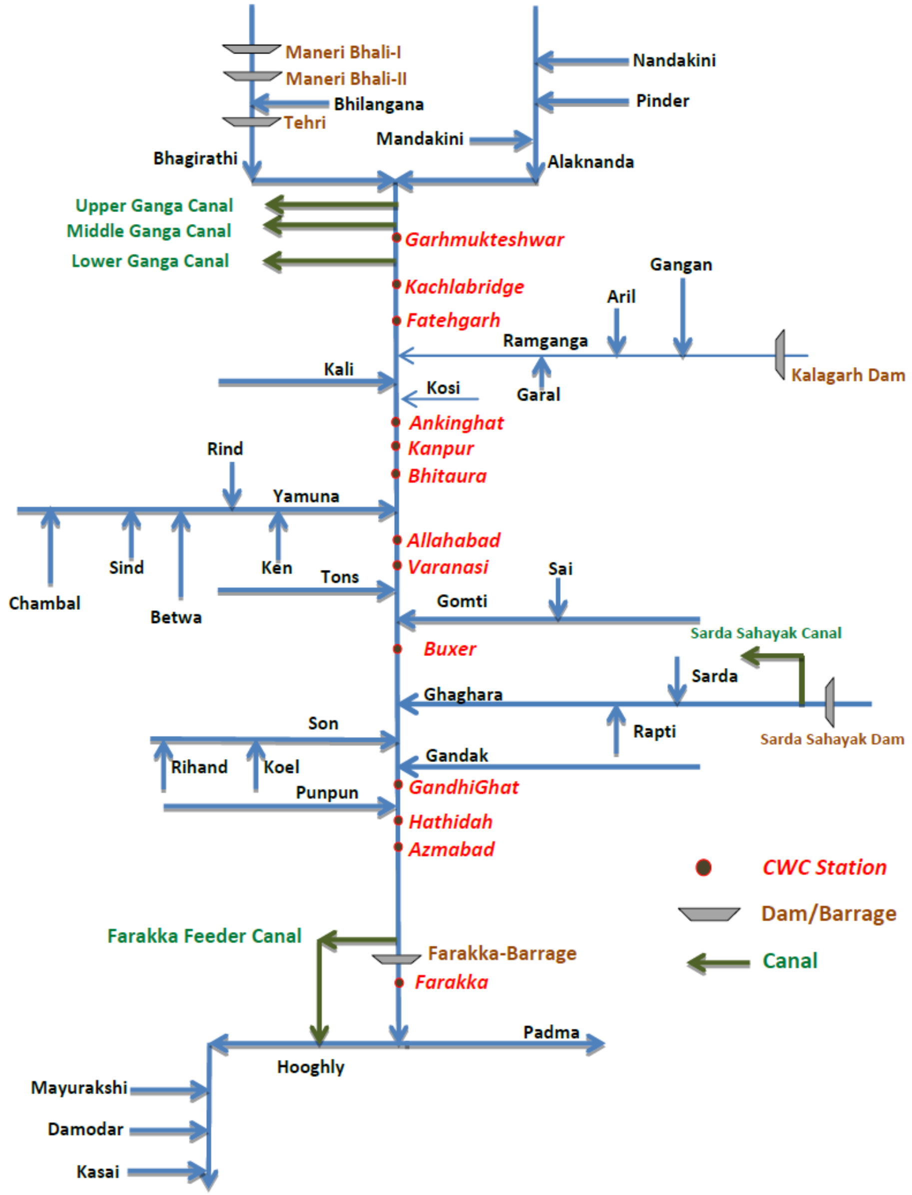


Figure 5.3.8: Line Diagram of Ganga River Network (with major dams/ barrages, canals, and flow and water quality measuring stations).

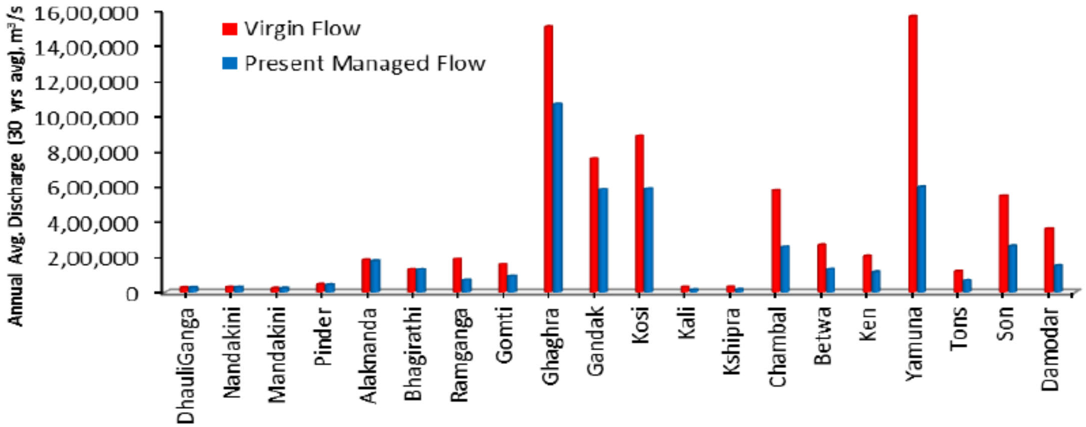


Figure 5.3.9: Annual Flow Contributions of Different Tributaries (sub-basins) to National River Ganga under Present Flow Conditions and under Virgin Flow Conditions

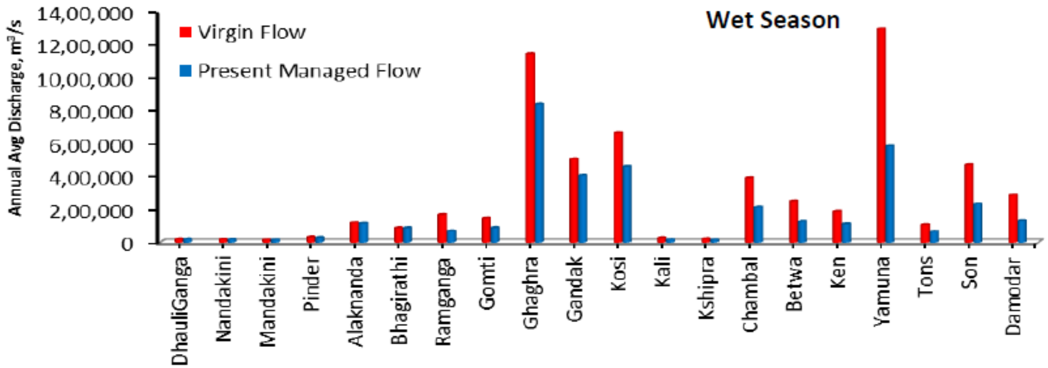


Figure 5.3.10: Wet Season Flow Contributions of Different Tributaries (sub- basins) to National River Ganga under Present Flow Conditions and under Virgin Flow Conditions

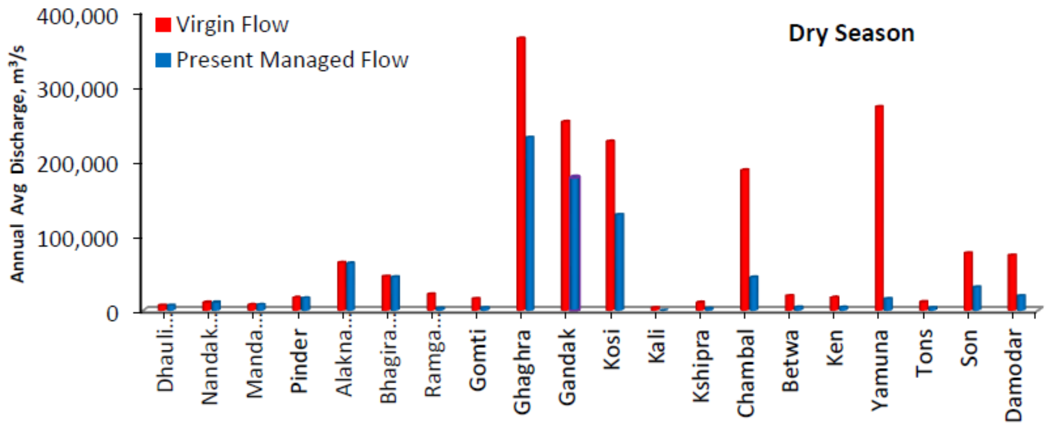


Figure 5.3.11: Dry Season Flow Contributions of Different Tributaries (sub-basins) to National River Ganga under Present Flow Conditions and under Virgin Flow Conditions

3. Sediment Resources of National River Ganga

Water-borne sediments play a vital role in the dynamics and ecology of the Ganga River Network. The river's suspended sediment load – generally estimated at between 500 to 800 million T/yr (e.g. 524 million T/yr vide *Tandon et al., 2008*; 729 million T/yr vide *Abbas & Subramanian, 1984*) – is probably the third highest among the world's rivers, after the Yellow and Amazon rivers' loads [*Milliman & Meade, 1983; Singh et al., 2003*]. The total sediment load estimated at 2400 million T/yr [IITC, 2012] is also very high for any river, but since bed load measurements are few in the river network, the figure is very uncertain. Wasson [*2003*] reasoned that the long-term average of total sediment load of the combined Ganga-Brahmaputra rivers is between 1600 to 3500 million T/yr, which suggests that the total sediment load of National River Ganga could be much less than 2400 million T/yr. Nonetheless, the sediment load is exceptionally high, and it evidently plays a key role in maintaining the network of rivers in dynamic equilibrium from their sources to the delta.

Apart from their geomorphological significance, river sediments deposited on plains during floods replenish soils lost from the plains through erosion. Besides, sediments are also a potentially major source of key nutrient elements such as phosphorous as well as most of the micro-nutrient elements discussed in Section 4.1. These elements provide long-term fertility to the rivers and the delta (for maintaining healthy biota) as well as to the plains by flood deposits [*Dixit et al., 2008*]. The possibility of heavy metals being present in harmful proportions in the sediments has also been studied in the field, but their concentrations in sediments from upland sources are generally found to be benign in the Ganga river network [*Jha et al., 1988; Purushothaman & Chakrapani, 2007; Singh et al., 2003*]. In fact, considering the sediment load at 744 million tons/ year, Singh et al.'s [*2003*] estimate includes significant annual transport of many sedimentary micro-nutrients to the Bay of Bengal (e.g. 1.3 X 10^6 tons Mn, 30.0 X 10^6 tons Fe, 110 X 10^3 tons Cr, 14 X 10^3 tons Co, 35 X 10^3 tons Ni, 41 X 10^3 tons Cu, and 78 X 10^3 tons Zn). Given the known deficiency of many of these micro-nutrients in agricultural soils in NRGB (vide Mission Report on Sustainable Agriculture), the sediments deposited on flood plains would be a natural mechanism to replenish such nutrients.

Wasson [*2003*] conducted a sediment budget analysis and estimated that most of the long-term sediment load in the Ganga river system derives from the Himalaya mountain range (especially from the High Himalayas), with probably less than 10% coming from the Siwaliks, plains and peninsular regions of the basin, vide Figure 5.12. While the exact figures may be uncertain, the Himalayas – on account of their litho-tectonic characteristics – undoubtedly contribute the major sediment load in the river network. Thus many of the Himalayan tributaries of National River Ganga (such as the Kosi, Ghaghra, and Gandak) are known to carry enormous sediment loads, some of which tend to deposit on the plains during floods. The Himalayan ranges are therefore important not only for the hydrological regime, but also for the geomorphological stability and fertility of the basin.

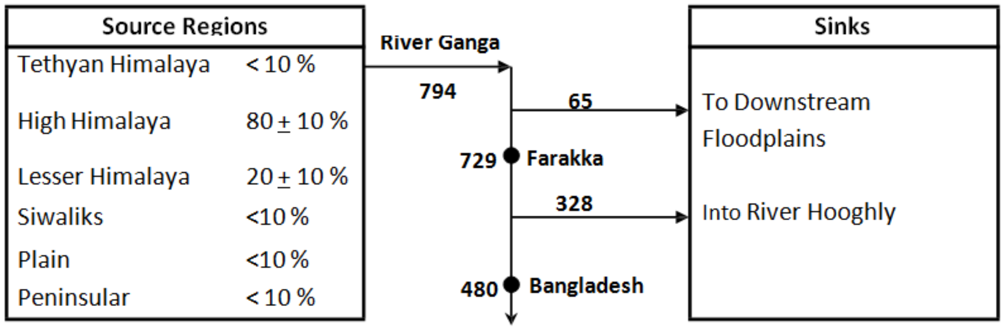


Figure 5.3.12: A Sediment Budget (in 10^6 ton/yr) for Ganga Rivver Basin [from Wasson, 2003]

In view of the above available information, it is first and foremost necessary to estimate the correct sediment loads in the Ganga River System. To this end, river discharges and suspended sediment concentrations measured continually at 13 measuring stations along the main stem of the National River Ganga for varying periods were availed from CWC. The said measuring stations and the period of sediment data availability are given in **Table 5.3.4** below. Data were also available for 3 measuring stations on tributaries, but these have not been used here since such stations are too few. Based on data of the preceding 13 stations, the average sediment loads at different stations for the common period of data availability (1999–2006) were computed for annual, wet season and dry season sediment loads respectively, and are shown in **Figures 5.3.13, 5.3.14** and **5.3.15**. However, it may be noted that at Garhmuketswar data were available only up to 2003, so the average of the 1999-2003 period was used for this station. For further reference, the annual sediment load data for different stations are shown in the Appendix 2.

Table 5.3.4: Sediment Measuring Stations and Periods of Data Availability

Station No.	1	2	3	4	5	6
Station Name	Garhmukteshwar	Kachlabridge	Fatehgarh	Ankinghat	Kanpur	Bhitaura
Data Period	1981–2003	1981–2010	1981–2010	1981–2010	1981–2010	1981–2010

Station No.	7	8	9	10	11	12	13
Station Name	Allahabad	Varanasi	Buxer	Gandhighat	Hathidah	Azimabad	Farakka
Data Period	1981–2010	1981–2010	2001–10	2001–10	2001–10	2001–10	1999-2006

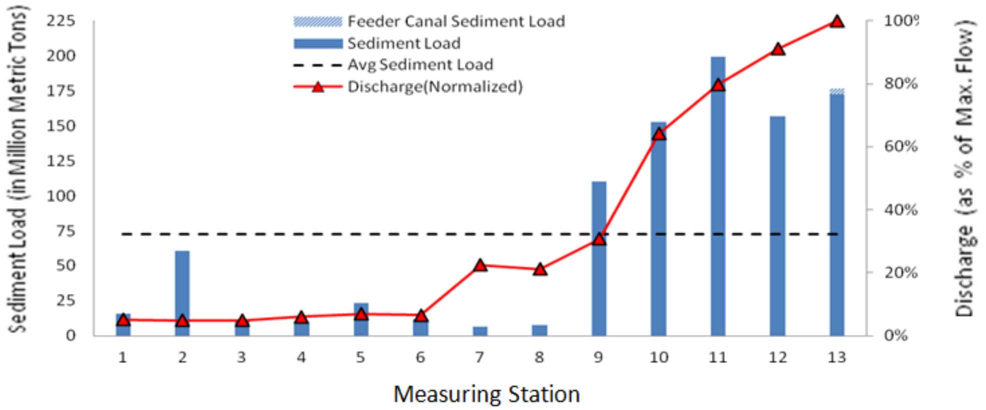
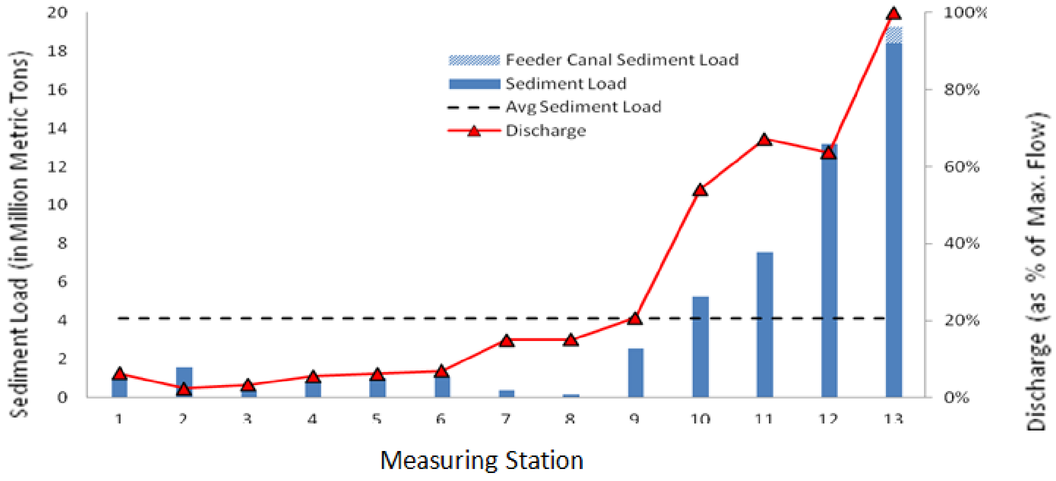


Figure 5.3.13: Comparison of the Annual Average Sediment Loads (for period 1999-2006) at Different Locations of National River Ganga

Discharge (as % of Max. Flow)

charge (as % of Max. Flow)



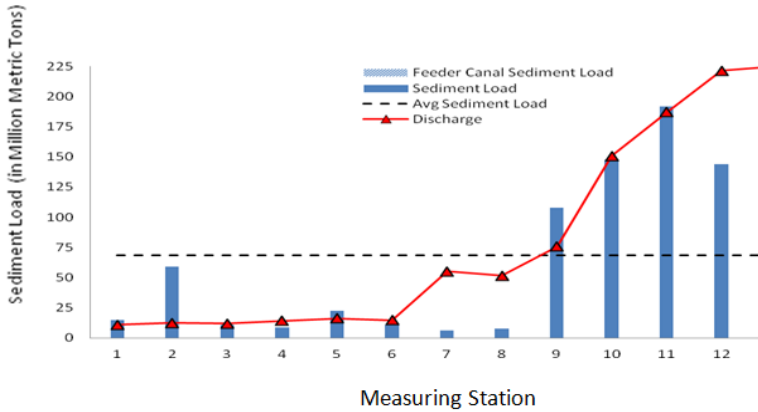


Figure 5.3.14: Comparison of the Average Wet Season Sediment Loads (for period 1999-2006) at Different Locations of National River Ganga

Figure 5.3.15: Comparison of the Average Dry Season Sediment Loads (for period 1999-2006) at Different Locations of National River Ganga

Overall, it may be noted that the common period of data availability is very limited, hence the computed results are of limited significance. But some provisional conclusions can be drawn from the figures. Firstly, the average suspended sediment load at Farakka (i.e. passing the Farakka Barrage into the Ganga/ Padma river as well as flowing into the canal feeding River Bhagirathi/Hooghly) during the period 1999–2006 is only about 177 million T/year which is much less than values between 500 to 800 million T/year commonly cited in literature. But, in consonance with observations cited in literature, most of the sediment load carried by the river occurs during the wet season.

Secondly, the sediment load variation along the main river stem is somewhat intriguing, and they suggest varying aggrading–degrading stretches along the length of the river. Generally the load increases downstream, but it jumps sharply between Garhmukteswar and Kachlabridge (despite the Lower Ganga Canal taking off in this zone) and drops at Fatehgarh, suggesting a degrading river stretch before Kachlabridge and an aggrading stretch after it. Between Kanpur and Varanasi, the river stretch again appears to aggrade to some extent with the sediment load reducing downstream (despite the Yamuna river joining below Allahabad). After Varanasi, the sediment load increases steeply at Buxar (probably due to significant sediment inflows from the Tons and Gomti rivers) and increases progressively up to Hathidah (with major tributaries like Ghaghra, Sone, Gandak and Punpun joining National River Ganga). But the sediment load decreases before Azimabad (except in the dry season), again suggesting channel aggradation in this zone. Finally there is some further increase in load at Farakka (presumably with sediment inputs from River Kosi.) It may be also seen that most of the sediment outflow from Farakka barrage carries over to the Ganga/Padma river, with only a very small fraction entering the feeder canal of the Bhagirathi-Hooghly river.

In summing up, the above discussions throw up many questions regarding National River Ganga's sediment resources. At the minimum, they underscore the need for long-term monitoring of sediment loads in the Ganga river system including all her major tributaries, sediment budget assessments of her major sub-basins, understanding the dynamics of sediment flow in the network, and sediment quality estimates.

4. Flow Discharges

The South Asian monsoon system largely defines the climate and hydrology of the Ganga River. The monsoon brings heavy rains three months a year therefore, the Ganga River is characterised by high flows during the monsoon season, approximately from July until October, and low flows during the rest of the year. April and May are in general, the lowest flow months with negligible rainfall and a low base flow into the system. Due to the climate variability the timing of the onset of the monsoon period is uncertain. Climate change predictions suggest that for the River Ganga the monsoon discharges will increase in the future (ref).

Figure 5.3.16 and **Figure 5.3.17** show the rapid increase and fall of discharges during July and September-October at two locations: Varanasi (chainage 1311) and Farakka (chainage 583). The average values during the low flow season can be of the order of 1 per cent of the discharge during the high flow season.

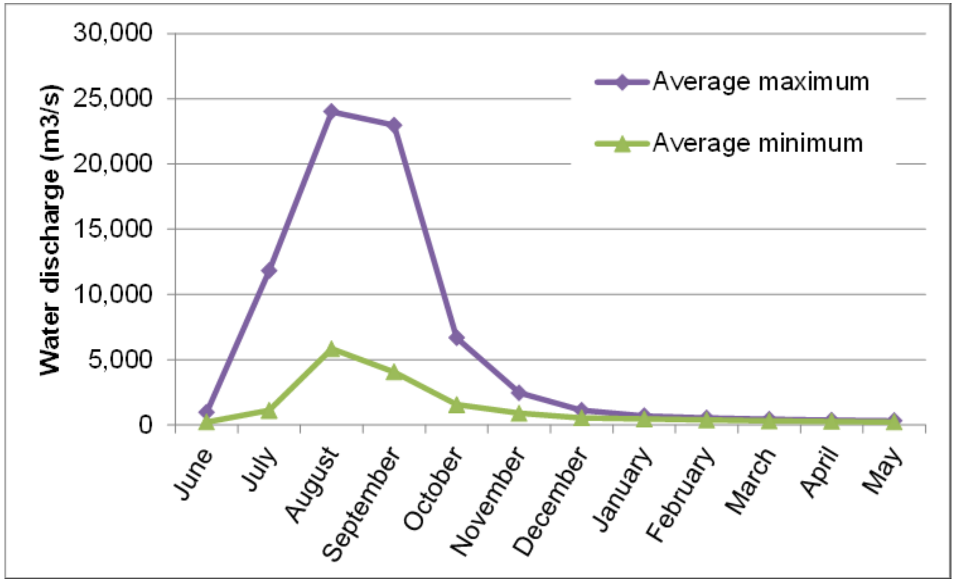


Figure 5.3.16: Average of maximum and minimum monthly discharges at Varanasi (chainage 1311)

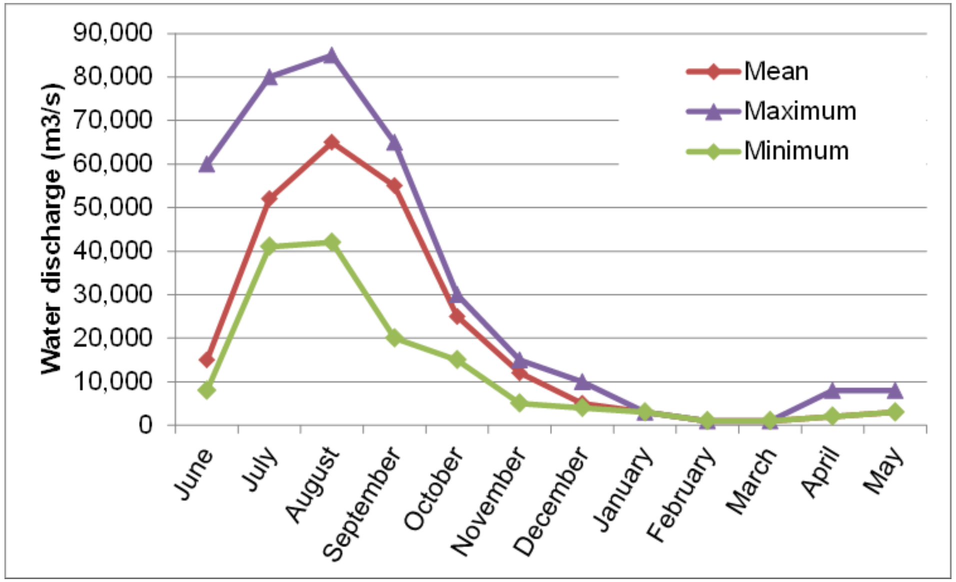


Figure 5.3.17: Mean, maximum and minimum monthly discharges at Farakka, chainage 583 (extracted from Jeuland et al, 2013)

Maximum and minimum discharges were provided by IWAI for different years at 3 locations: Allahabad (chainage 1547), Mirzapur (chainage 1398) and Varanasi (chainage 1311). Average monthly discharges for a range of years were provided at Buxar (chainage 1124) and Patna (chainage 955). When comparing this information it is clear (see **Figure 5.3.18**) that average discharges increase downstream during the high season (July to November).

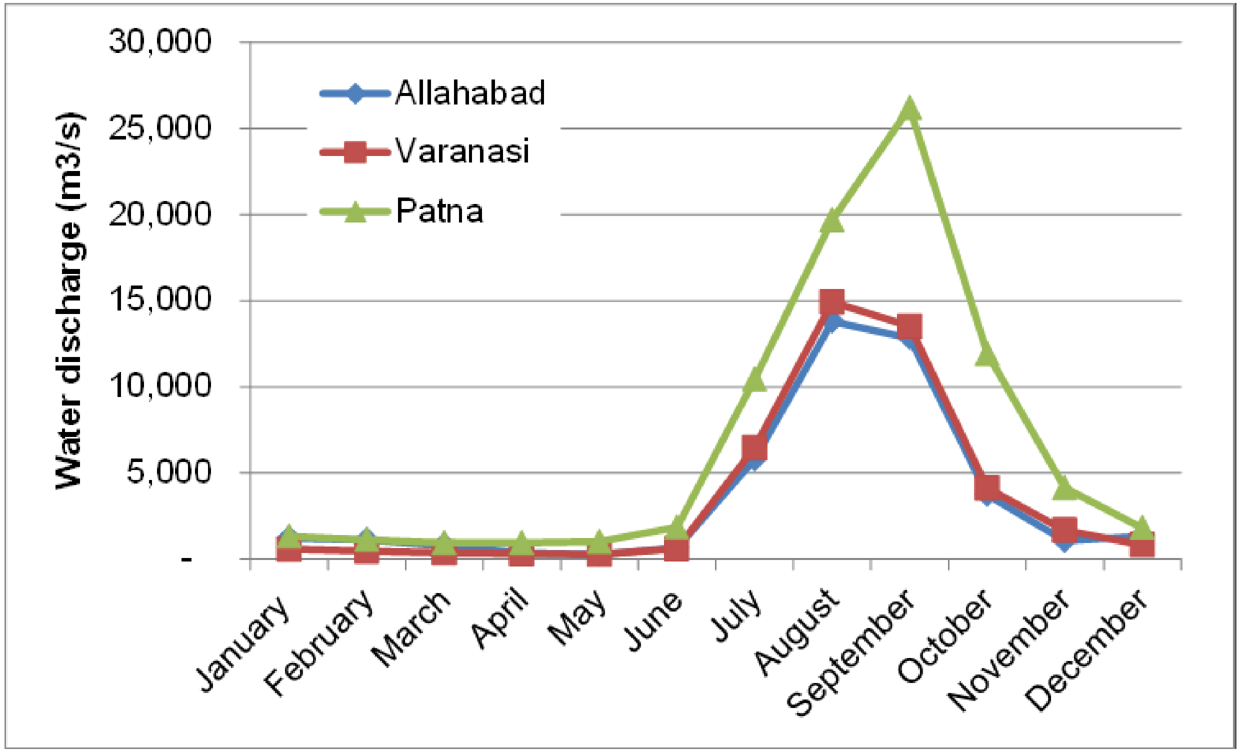


Figure 5.3.18: Monthly average discharges over the year at Allahabad, Varanasi and Patna

In addition to the significant seasonal variation within years, there is also a great variability between years. With the time series available at the three upstream gauging sections it is possible to perform a statistical analysis of the lowest flows. **Figure 5.3.19** shows, as an example, the extreme analysis performed at Allahabad considering the Generalized Extreme Value (GEV) distribution.

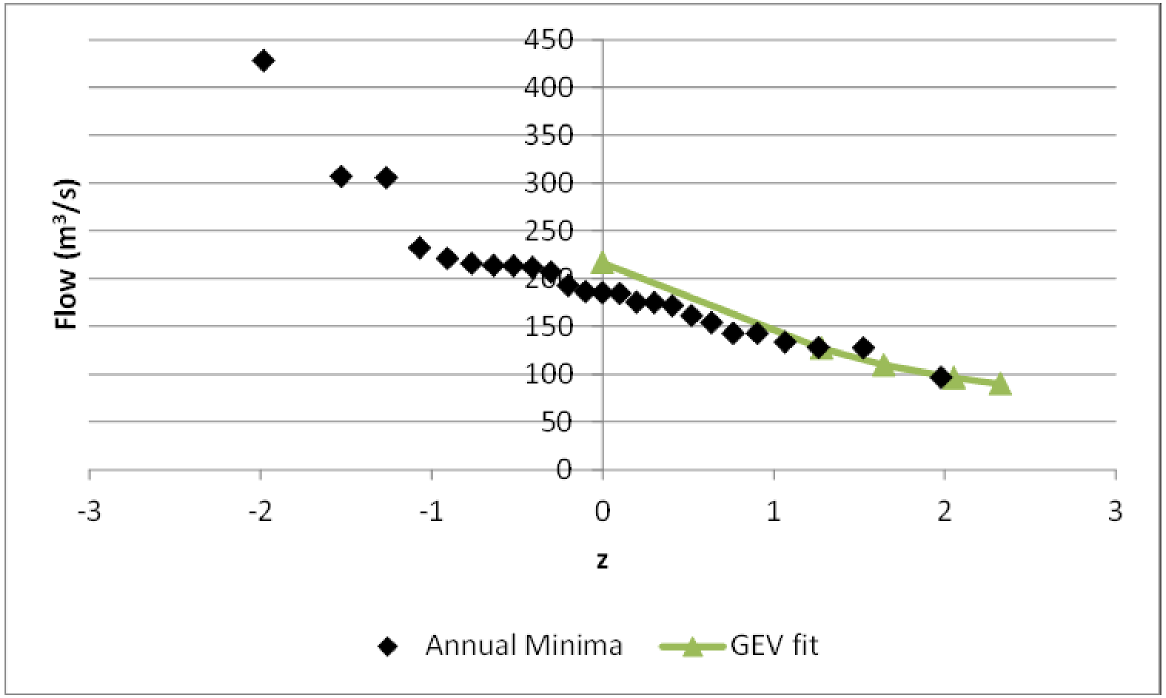


Figure 5.3.19: Extremes analysis on the annual minimum flow at Allahabad

The results of the statistical analysis are summarised in the following **Table 5.3.5**.

Table 5.3.5: Annual minimum discharges obtained from statistical analysis

Discharge (m^3/s) Parameter	Allahabad	Mirzapur	Varanasi
Minimum recorded flow (m^3/s)	96	122	117
1 in 2 year minimum flow (50% annual probability)	188	167	185
1 in 10 year minimum flow (10% annual probability)	117	128	130
1 in 100 year minimum flow (1% annual probability)	90	119	110

Despite data constraint at Buxar & Patna, the available data shows that the lowest flow recorded at Buxar was 225 m3/s and the lowest flow recorded at Patna was 689 m3/s. These flows are considerably lower than the averages for the dry season.

The report "Status on River Ganga: State of the Environment and Water Quality" from the National River Conservation Directorate (2009) provides useful information in terms of understanding water discharges along the upstream reaches of NW-1. The report presents water discharges with a probability of exceedance of 50%, 10% and 90% at 6 stations: Allahabad, Mirzapur, Varanasi, Buxar, Patna and Azamabad during the low flow season. It also presents average post-monsoon flows (in October-November), average flows in December-February and in March-May periods. These values are summarised in **Table 5.3.5.** They are generally higher than the values presented in **Table 5.3.6** obtained from the statistical (extremes) analysis of available data at the three gauging stations.

Table 5.3.6: Characteristic discharges obtained from the National River Conservation Directorate (2009) report

Flow regime Discharge (m^3/s)	Allahabad	Mizarpur	Varanasi	Buxar	Patna	Azamabad
Q50 (flow with 50% probability of exceedance) during low season	300	300	300	450	1050	1400
Q90 (flow with 90% probability of exceedance) during low season	175	175	175	250	600	1050
Q10 (flow with 10% probability of exceedance) during low season	450	450	450	600	1600	2000
Average in October-November	2000	2200	2400	3100	5500	9500
Average in December-February	500	500	500	750	1300	2200
Average in March-May	400	400	400	500	1000	1500

Source: The National River Conservation Directorate, Ministry of Environment and Forests, Government of India (2009)

Farakka Barrage, with a length of 2.2 km and about 15 km from the border with Bangladesh, regulates the flow of the River Ganga diverting some of the water into the 42 km long Feeder Canal linking with the Bhagirathi River downstream towards Kolkata. The design discharge for this channel is around 1,100 m3/s. The navigation lock at Farakka, as well as the Feeder Canal, are part of the Farakka Barrage Project and become the link between the Bhagirathi-Hugli system and the main River Ganga upstream of the Farakka Barrage.

The existing agreement between India and Bangladesh, includes specific water allocation rules during the low flow season. The treaty establishes that during the period January – May 35,000 cusecs (or approximately 425 m3/s) are shared alternatively through the Farakka Barrage on a 10 day cycle in each month by both countries.

Data extracted from Jeuland et al (2013) shows the historical flows at Farakka for the period 1969-2001 (**Figure 5.3.20**).

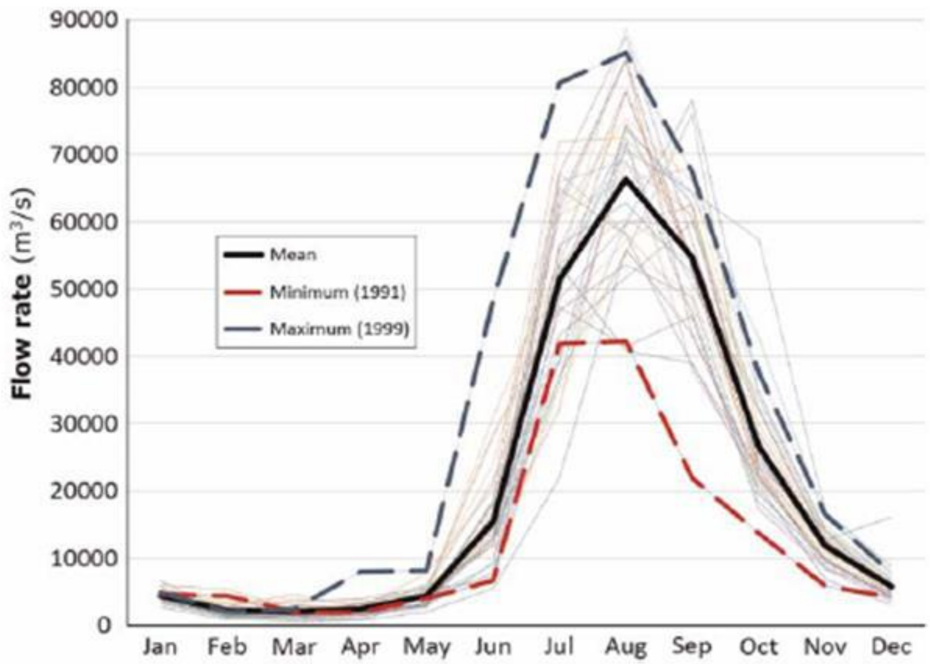


Figure 5.3.20: Historical flows at Farakka for the period 1969-2001 (extracted from Jeuland et al, 2013)

5. Water Levels

Temporal series of water levels have been provided for a number of locations along the waterway between Allahabad and Farakka. The following figures show the variability of monthly water levels, which can be of the order of 10 m during the high season. In general, water levels are at their highest in August-September and sharply decrease in October-November. In general, they continue to decrease during the whole low flow season, from December to May, and start to raise again in June-July. The variability of water levels during the dry season is lower than during the high season, with variations of the order of 2-3m. The following figures show the maximum and minimum monthly values with the black block representing where 50% of the values concentrate.

The period of the year in which the minimum water level can occur varies with location along the river. In the upstream reaches from Allahabad to Ghazipur the minimum water levels occur from April to July (**Figure 5.3.21** and **Figure 5.3.22**). Downstream of the three major tributaries, Ghagra, Son and Gandak that join the river near Patna, the minimum water levels can occur between February and June as a result of the influence of snow melt (**Figure 5.3.23** and **Figure 5.3.24**).

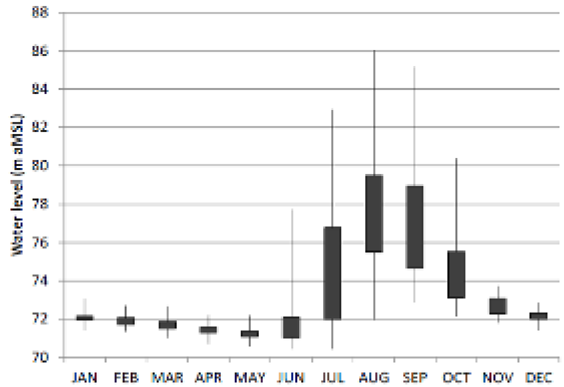


Figure 5.3.21: Monthly water levels at Allahabad (chainage 1,547)

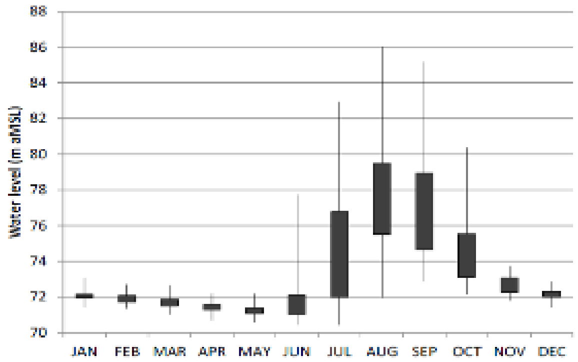


Figure 5.3.22: Monthly water levels at Ghazipur (chainage 1,178)

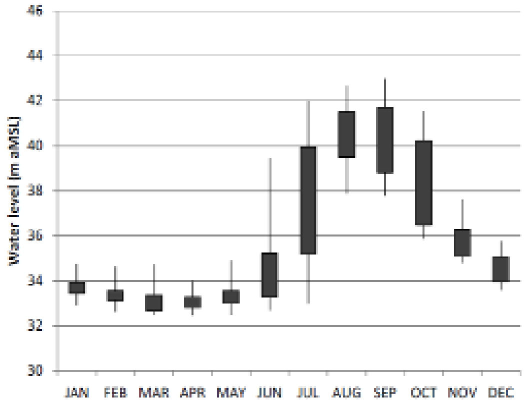
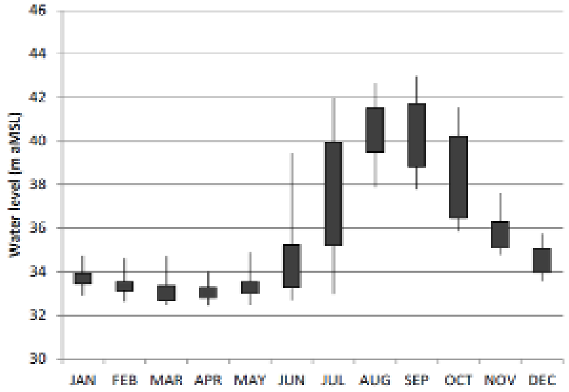
	

Figure 5.3.23: Monthly water levels at Hathida (chainage 850)	**Figure 5.3.24: Monthly water levels at Kahalgaon (chainage 690)**

Statistical analysis has been performed on the annual minimum and maximum water levels at 7 gauging stations between Allahabad and Farakka. These water levels at each location are given for 3 annual probabilities of occurrence (see **Table 5.3.7** and **Table 5.3.8**).

Table 5.3.7: Minimum water levels for a range of annual probabilities

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

Table 5.3.8: Maximum water levels for a range of annual probabilities

Location	Maximum water level (m)		
	50%	10%	1%
Allahabad	82.36	85.67	87.22

Mirzapur	75.65	78.77	79.89
Varanasi	70.00	72.48	73.37
Ghazipur	62.88	64.78	65.18
Patna	49.36	50.44	50.91
Hathida	41.78	42.85	43.01
Kahalgaon	30.99	32.70	32.90

6. Analysis of LAD

Least Available Data (LAD) available from Tribeni to Allahabad was analysed to get an understanding of the variations of water depths in NW-1. Data for the period April 2002 to June 2015 was used to build probability curves of LAD. As an example, two of them are shown in **Figure 5.3.25**.

The curves show the probability of having a LAD value lower than the value shown in the graph. For example, in IWAI Reach 20 the probability of having a value less than 6.30 m in August is 90% and the probability of having a value less than 3.60 m is only 10%. As a reference, horizontal lines at 3, 2.5 and 2.2 metres are also shown on the Figures. The graph corresponding to the IWAI Reach 32, Varanasi – Chunar, clearly shows that, based on the existing data, the probability of having depths less than 2.2 m for the period January-May and November-December is 90% or more.

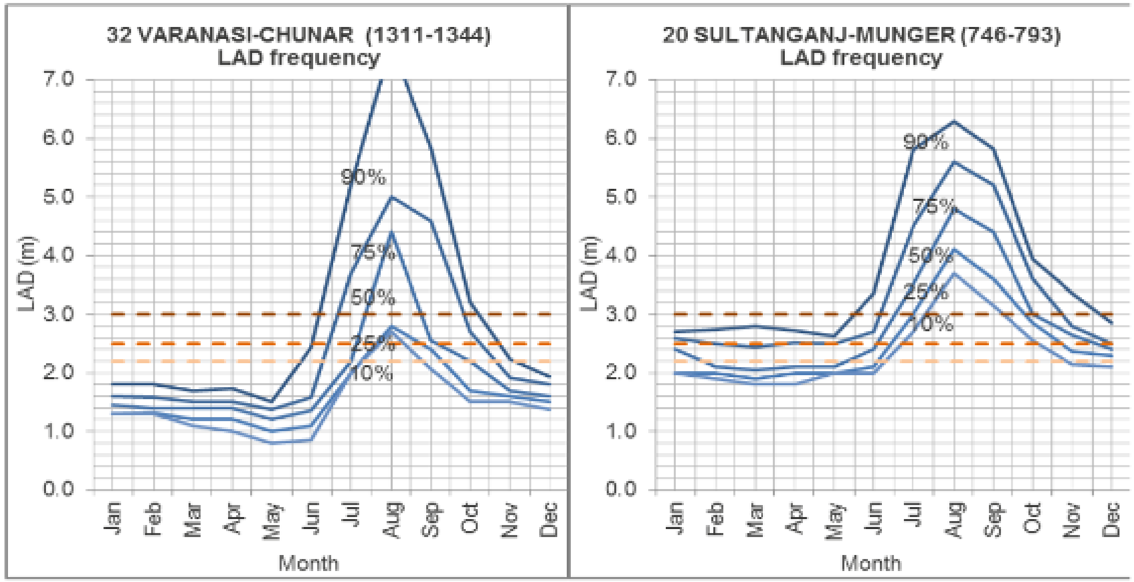


Figure 5.3.25: Probability curves of LAD for two different reaches

This statistical information has also been analysed to show the periods when available water depths have a 50% probability to be lower than a certain value (3m, 2.5m and 2.2m). The information is presented in **Table 5.3.9** below. It should be analysed in conjunction with other information presented in this report about the length and number of shoals to provide a full picture of the sedimentation processes occurring.

Table 5.3.9: LAD with 50% probability (in metres)

Sr. No.	Name	Chainage (km)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Tribeni – Balagarh	193-221	3.00	3.10	3.00	3.00	3.30	3.40	3.80	4.20	3.80	3.60	3.10	3.00
2	Balagarh – Kalna	221-245	3.00	2.90	2.80	2.90	3.00	3.30	3.50	3.95	3.90	3.60	3.05	3.05
3	Kalna - Samudragarh	245-263	3.00	2.80	2.75	2.80	2.90	3.20	3.60	4.00	3.80	3.50	3.20	3.10
4	Samudragarh - Nabadweep	263-280	3.00	2.90	2.80	2.80	2.95	3.25	3.40	4.20	4.20	3.70	3.20	3.10
5	Nabadweep – Patuli	280-322	2.80	2.85	2.85	2.75	2.80	3.10	3.30	3.50	3.70	3.50	3.10	3.00
6	Patuli – Katwa	322-345	3.10	2.90	2.90	2.85	2.90	3.10	3.20	3.40	3.50	3.30	3.00	3.05
7	Katwa – Palassey	345-371	2.80	2.65	2.50	2.50	2.70	3.00	3.00	3.50	3.40	3.10	2.80	2.80
8	Palassey - Chaurigacha	371-400	2.90	2.95	2.80	2.90	3.00	3.10	3.10	3.40	3.40	3.20	3.05	3.00
9	Chaurigacha - Berhampur	400-421	3.40	3.20	3.00	3.05	3.20	3.40	3.70	3.70	3.80	3.55	3.50	3.50
10	Berhampur – Mohammadpur	421-449	3.20	3.00	3.00	3.00	3.10	3.45	3.60	3.95	3.70	3.60	3.40	3.30
11	Mohammadpur - Nasirpur	449-479	3.30	3.20	3.15	3.00	3.20	3.50	3.70	3.80	3.50	3.70	3.50	3.50
12	Nasirpur – Jangipur Lock	479-505	3.75	3.50	3.30	3.40	3.50	4.15	4.30	4.50	4.20	3.95	4.00	4.00
13	Jangipur Lock – Farrakka Lock	505-544	2.70	2.50	2.50	2.30	2.50	2.85	2.80	2.80	2.70	2.75	3.00	2.80
14	Farrakka Lock - Rajmahal	544-583	2.00	2.00	2.00	2.05	2.10	2.20	2.35	2.20	2.10	1.95	2.00	2.00
15	Rajmahal – Manihari	583-633	2.60	2.30	2.35	2.20	2.40	2.65	3.50	4.20	3.90	3.00	2.80	2.85
16	Manihari – Karagola	633-660	2.60	2.40	2.20	2.20	2.45	2.80	3.90	4.60	3.70	3.20	2.95	2.85
17	Karagola - Kahalgaon	660-690	2.20	2.15	2.00	2.00	2.30	2.60	3.95	4.20	4.20	3.00	2.60	2.50
18	Kahalgaon - Bhagalpur	690-715	2.45	2.40	2.20	2.20	2.30	2.50	4.00	4.70	4.10	3.00	2.85	2.70
19	Bhagalpur - Sultanganj	715-746	2.35	2.10	2.10	2.10	2.15	2.50	3.50	4.60	4.10	2.90	2.50	2.35
20	Sultanganj - Munger	746-793	2.40	2.10	2.05	2.10	2.10	2.40	3.50	4.80	4.40	3.00	2.65	2.40
21	Munger - Mahendrapur	793-820	2.20	2.10	2.10	2.15	2.25	2.40	3.70	4.70	3.60	3.10	2.60	2.50
22	Mahendrapur - Semaria	820-853	2.20	2.10	2.10	2.15	2.20	2.45	3.50	5.20	3.90	2.90	2.40	2.30
23	Semaria – Barh	853-891	2.10	2.10	2.00	2.00	2.10	2.30	3.30	4.60	3.40	2.80	2.35	2.20
24	Barh – Mehnar	891-925	2.05	2.00	2.00	2.00	2.00	2.30	3.40	4.50	3.50	2.80	2.40	2.10
25	Mehnar – Patna	925-955	2.00	2.00	2.00	2.00	2.00	2.25	3.40	4.50	3.40	2.70	2.30	2.00
26	Patna – Doriganj	955-1000	2.00	2.00	1.95	1.90	2.00	2.10	3.20	4.30	4.20	2.40	2.10	2.00
27	Doriganj – Ballia	1000-1063	1.60	1.70	1.70	1.70	1.80	1.75	3.00	4.00	3.60	2.30	2.05	1.75
28	Ballia – Buxar	1063-1124	1.70	1.70	1.60	1.60	1.50	1.50	3.00	4.10	3.60	2.40	2.00	1.70
29	Buxar – Ghazipur	1124-1178	1.55	1.60	1.60	1.50	1.30	1.50	2.70	4.40	4.10	2.25	1.80	1.70
30	Ghazipur – Saidpur	1178-1254	1.40	1.30	1.25	1.30	1.10	1.15	2.10	4.40	3.35	2.00	1.65	1.40
31	Saidpur – Varanasi	1254-1311	1.50	1.50	1.30	1.30	1.10	1.20	2.20	4.30	3.10	2.20	1.75	1.45

Sr. No.	Name	Chainage (km)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
32	Varanasi – Chunar	1311-1344	1.45	1.40	1.40	1.40	1.20	1.35	2.20	4.40	2.55	2.20	1.70	1.60
33	Chunar – Mirzapur	1344-1398	1.40	1.30	1.20	1.05	0.95	1.00	2.10	3.10	2.75	2.15	1.60	1.40
34	Mirzapur – Rampur Ghat	1398-1419	1.40	1.40	1.30	1.30	1.00	1.10	2.10	3.10	2.70	2.10	1.80	1.40
35	Rampur Ghat - Sirsa	1419-1506	1.50	1.50	1.30	1.40	1.10	1.30	2.10	3.10	3.25	2.05	1.90	1.50
36	Sirsa – Allahabad	1506-1547	1.20	1.10	1.00	0.90	0.80	0.90	2.00	2.80	2.75	1.95	1.50	1.30

Key:

3.0m =< LAD	2.5m =< LAD < 3.0m	2.2m =< LAD < 2.5m	LAD < 2.2m

The different colours in Table 19 show the range of minimum depths available. Green corresponds to the months when available depths are larger than 3 m. The table clearly shows the different behaviour of water depths upstream of Farakka Barrage, where the waterway is not regulated and downstream of Farakka Barrage, where water discharges are regulated by the releases from the Barrage into the Hugli River.

Figure 5.3.26 summarises the information provided by the table for the dry season (November to June). It shows the available dry season LAD along the waterway.

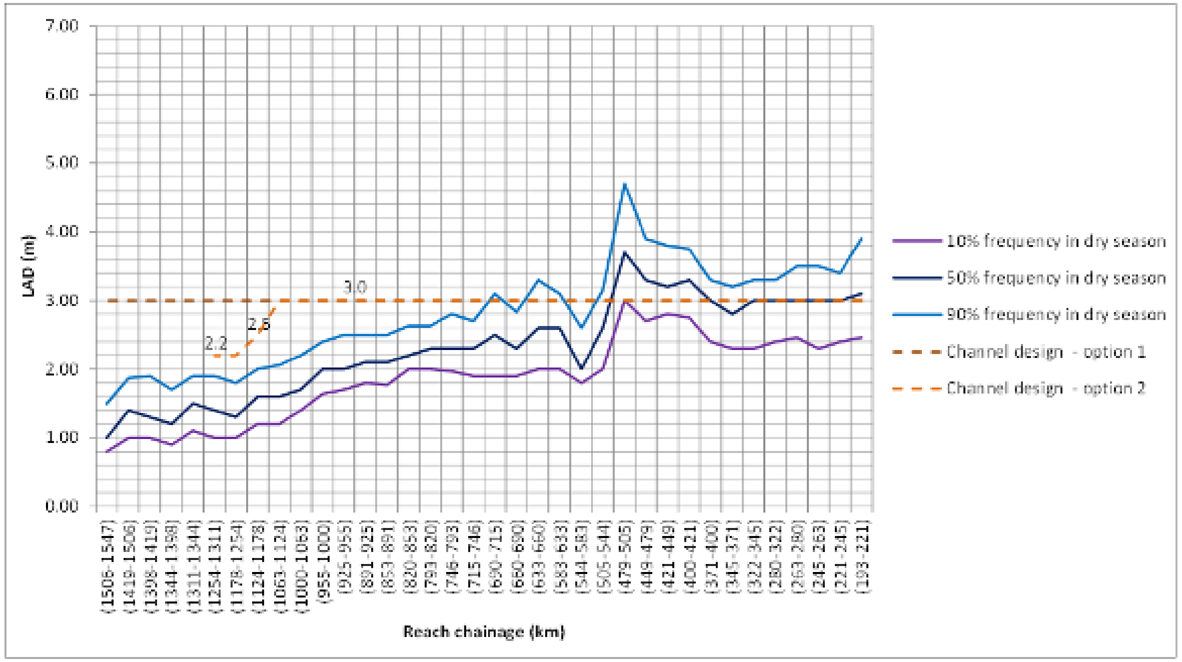


Figure 5.3.26: LAD along the waterway for the 10, 50 and 90 per cent frequency values

ANNEXURE 5.4

Annexure 5.4: Data Analysis and Observations on Water Quality

1. Ganga River System: Sources of Pollutants

Various types for waste generation in NRGB have been identified in Figure 5.4.1. Two broad types of wastes generated in the NGRB, whose improper disposal adversely impact water quality of the Ganga system are, 1) solid wastes and 2) liquid wastes.

Solid waste can be broadly classified as, 1) non-hazardous and 2) hazardous. Non-hazardous solid waste is generated mostly from domestic, commercial and agricultural sources. Industrial activity may result in the generation of both non-hazardous and hazardous solid waste.

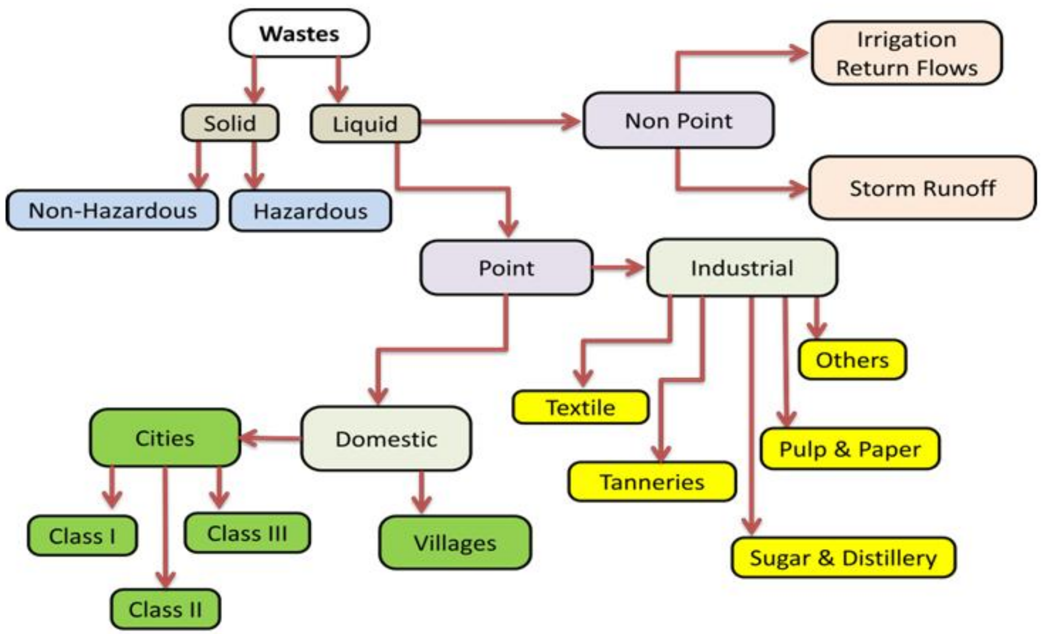


Figure 5.4.1: Various types for waste generation in NRGB

Liquid waste is produced when pollutants are intentionally dissolved or suspended in water for transport away from their point of generation. Such point sources of liquid waste generation are attributable to domestic, commercial and industrial activities. Thus all Class I, Class II, Class III towns and villages in the NRGB are point sources for liquid waste. Inaddition, the industries in NRGB including, sugar and distillery, pulp and paper, tannery, textiles and others are also major point sources of liquid waste.

Liquid waste is also generated from non-point (i.e., distributed) sources. The accumulation of garbage and the widespread practice of open defection results in the general accumulation of filth in the NRGB landmass. This is entrained in the surface runoff during rainy season and becomes a source for non-point pollution in the NRGB. The agricultural sector is also a major source for non- point pollution in NRGB. Fertilizers and pesticides applied on agricultural fields are leached into irrigation return flows or storm runoffs.

2. Ganga River System: Pollutant Ingress

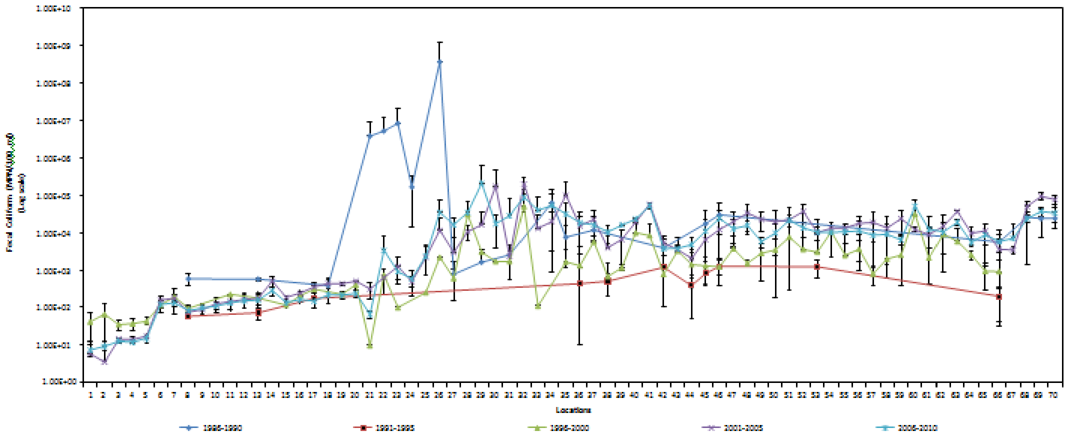
Pollutant ingress into the Ganga river system occurs in three ways, 1) by direct discharge of pollutants, 2) discharge of polluted surface runoff into rivers, and 3) seepage of polluted subsurface flows into rivers.

Direct discharge of pollutants into rivers occur due to, i) discharge of liquid wastes generated from point sources into rivers, ii) dumping of municipal and industrial solid waste, devotional offerings, animal carcasses, un- burned/partially burned human bodies, etc. into rivers, and iii) non-ritual bathing with the intention of cleaning body dirt, direct defecation, washing of clothes, washing of vehicles, washing/wallowing of animals, etc.

The origin of polluted non-point surface discharge into the Ganga river system are twofold, i) surface runoff containing leached fertilizers and pesticides applied on agricultural fields and ii) surface runoff containing entrained solid waste, i.e., garbage, industrial waste, human and animal feces, etc.
Some portion of the liquid waste generated from both point and non-point sources described above infiltrates into the subsurface and pollute the groundwater. Seepage of this polluted ground water also results in pollution of the Ganga river system.

3. Ganga River System: Pollution Status

Examination of Ganga water quality data indicates that at Dev Prayag (confluence of rivers Bhagirathi and Alaknanda) and further downstream, the fecal coliform numbers in Ganga River are on an average, 100 times more than the levels acceptable for bathing (Figure 5.4.2). Downstream of large cities like Kanpur, the fecal coliform numbers are 1000 times or more than acceptable levels. Fecal coliforms are bacteria normally found in human feces. Discharge of, i) untreated/partially treated domestic sewage into the river, and ii) storm runoff contaminated with human feces is mainly responsible for the high fecal coliform numbers observed.



1	Uttarkashi u/s (Bhagirathi)	15	Bijnore u/s (Ganga)	29	D/s Deehaghat	43	Hajipur u/s (River Gandak)	57	Sultanganj d/s
2	Uttarkashi d/s (Bhagirathi)	16	Bijnore d/s (Ganga)	30	Vindhyachal, PakkaGhat	44	Hajipur d/s (River Gandak)	58	Bhagalpur u/s
3	Devprayag u/s (Bhagirathi)	17	Garhmukteshwar u/s	31	Varanasi u/s	45	Patna u/s	59	Bhagalpur d/s
4	Devprayag u/s (Alaknanda)	18	Garhmukteshwar d/s	32	DashashawmedhGhat	46	Patna d/s	60	D/s Champanala
5	Devprayag d/s (Ganga)	19	Anoopshahr u/s (Ganga)	33	D/s at Kaithy	47	Fatuha u/s	61	Kahalgaon u/s
6	Ranipur u/s (Ganga)	20	Anoopshahr d/s (Ganga)	34	Near Malviya Bridge	48	Fatuha d/s	62	Kahalgaon d/s
7	Ranipur d/s (Ganga)	21	Fatehgarh u/s	35	Tarighat	49	Barh u/s	63	D/s NTPC Drain
8	Rishikesh u/s	22	Kannauj u/s (a/c with Ramganga & b/c with Kali)	36	Buxar u/s	50	Barh d/s	64	Sahebganj u/s
9	Rishikesh d/s	23	Kannauj d/s (a/c with Kali)	37	Buxar d/s	51	Mokama u/s	65	Sahebganj d/s
10	Haridwar u/s	24	Kanpur u/s (Bithoor)	38	Chapra u/s (Ghaghra)	52	Mokama d/s	66	Rajmahal d/s
11	Har-ki-Paudi	25	Kanpur d/s (Shuklaganj)	39	Chapra d/s (Chapra)	53	D/s Bata - McDowell	67	Berhampore (Middle)
12	Lalta Rao	26	Kanpur d/s (Jane Village)	40	Arrah u/s (River Gangi)	54	Munger u/s	68	Palta (Middle)
13	Dam Kothi	27	Allahbad u/s (Ujahni, Fatehpur)	41	Arrah d/s (River Gangi)	55	Munger d/s	69	Dakshineswar (Middle)
14	Mishrpur	28	Bathing Ghats at Sangam	42	Koliwar (River Sone)	56	Sultanganj u/s	70	Uluberia (Middle)

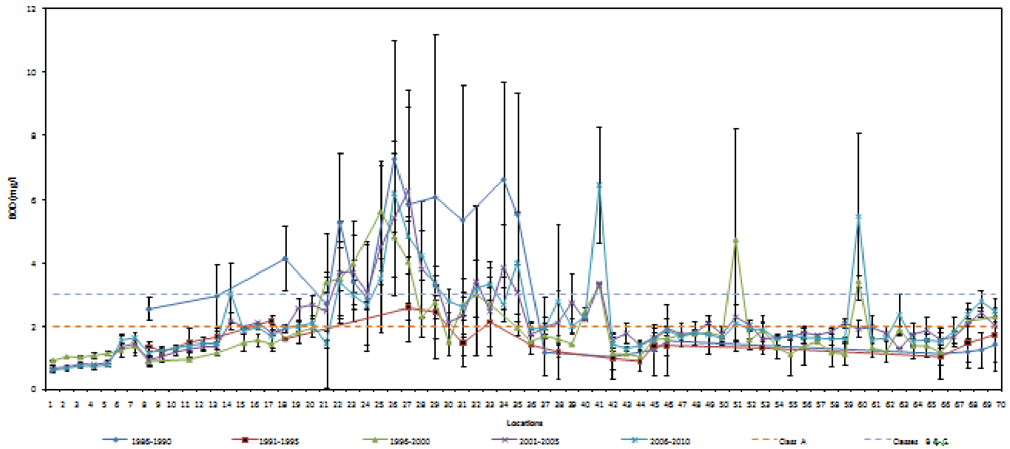
Figure 5.4.2: Variation in 5 year average Fecal Coliform at Various Locations along the Ganga River

The organic loading, as indicated by the Biochemical Oxygen Demand (BOD) is also high in some places of the Ganga river system (Figure 3). High BOD levels may result in low dissolved oxygen (DO) concentrations in water, which is injurious to the aquatic life in the rivers. The source of such pollution is mainly the point discharges of untreated/partially treated domestic sewage and industrial effluents into the rivers.

The nutrient, i.e., nitrogen and phosphorus loading are also high in some places in the middle and lower reaches of the Ganga river system. High nutrient loading leads eutrophication of the river, i.e., excessive growth of algae and aquatic plants, leading to the choking of the river. A glaring example of this can be seen at upstream of Okhla Barrage on river Yamuna in Delhi. The high nutrient loading is attributable to, i) point discharges of untreated/partially treated sewage and industrial effluents and ii) non-point loading of fertilizer, fecal and solid waste residues through surface runoff and seepage of groundwater. A ballpark estimation of pollutant load contributed through sewage generation in Class I and Class II towns (assuming that all sewage gets collected) in various NRGB states and NRGB Sub Basins is presented in Thematic Reports prepared by Consortium of 7 IITs [IITC, 2014a-k].

The issues of inorganic salt loading into the Ganga river system is mainly due to discharge of industrial effluents. Such loading is particularly high near tannery clusters in the Kanpur region. The data regarding loading of other pollutants i.e., pesticides and heavy metals into the Ganga river system is scanty [IITC, 2011b]. However, preliminary estimates indicate that concentration of pesticides and heavy metals in Ganga river system is low in most locations [IITC, 2011b].

Finally, it is estimated that approximately 70 percent of the volumetric pollution load on the Ganga river system is from domestic/commercial sources, i.e., from human urine/feces and solid waste. Major polluting industries along river Ganga are pulp and paper, sugar and distillery, tannery, textiles, etc. together with agricultural pollution contribute the remaining 30 percent pollution load to the river.

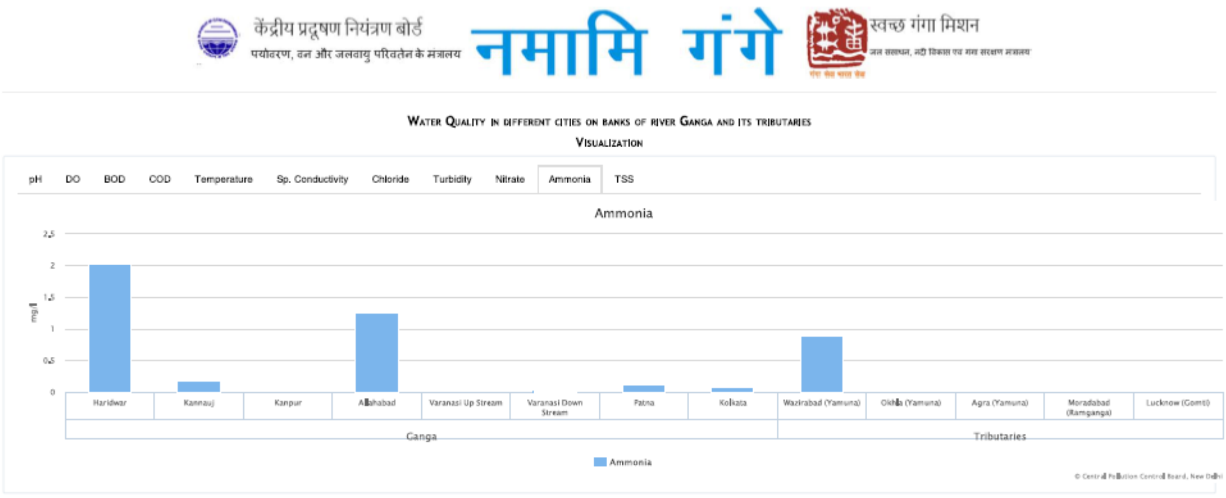


1	Uttarkashi u/s (Bhagirathi)	15	Bijnore u/s (Ganga)	29	D/s Deehaghat	43	Hajipur u/s (River Gandak)	57	Sultanganj d/s
2	Uttarkashi d/s (Bhagirathi)	16	Bijnore d/s (Ganga)	30	Vindhyachal, PakkaGhat	44	Hajipur d/s (River Gandak)	58	Bhagalpur u/s
3	Devprayag u/s (Bhagirathi)	17	Garhmukteshwar u/s	31	Varanasi u/s	45	Patna u/s	59	Bhagalpur d/s
4	Devprayag u/s (Alaknanda)	18	Garhmukteshwar d/s	32	DashashawmedhGhat	46	Patna d/s	60	D/s Champanala
5	Devprayag d/s (Ganga)	19	Anoopshahr u/s (Ganga)	33	D/s at Kaithy	47	Fatuha u/s	61	Kahalgaon u/s
6	Ranipur u/s (Ganga)	20	Anoopshahr d/s (Ganga)	34	Near Malviya Bridge	48	Fatuha d/s	62	Kahalgaon d/s
7	Ranipur d/s (Ganga)	21	Fatehgarh u/s	35	Tarighat	49	Barh u/s	63	D/s NTPC Drain
8	Rishikesh u/s	22	Kannauj u/s (a/c with Ramganga & b/c with Kali)	36	Buxar u/s	50	Barh d/s	64	Sahebganj u/s
9	Rishikesh d/s	23	Kannauj d/s (a/c with Kali)	37	Buxar d/s	51	Mokama u/s	65	Sahebganj d/s
10	Haridwar u/s	24	Kanpur u/s (Bithoor)	38	Chapra u/s (Ghaghra)	52	Mokama d/s	66	Rajmahal d/s
11	Har-ki-Paudi	25	Kanpur d/s (Shuklaganj)	39	Chapra d/s (Chapra)	53	D/s Bata - McDowell	67	Berhampore (Middle)
12	Lalta Rao	26	Kanpur d/s (Jane Village)	40	Arrah u/s (River Gangi)	54	Munger u/s	68	Palta (Middle)
13	Dam Kothi	27	Allahbad u/s (Ujahni, Fatehpur)	41	Arrah d/s (River Gangi)	55	Munger d/s	69	Dakshineswar (Middle)
14	Mishrpur	28	Bathing Ghats at Sangam	42	Koliwar (River Sone)	56	Sultangan/s	70	Uluberia (Middle)

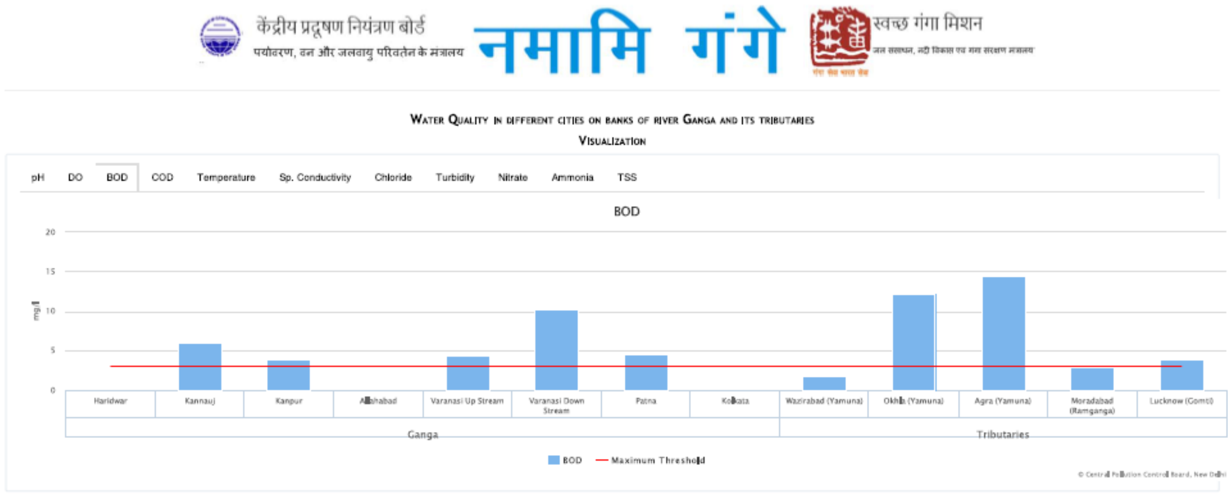
Figure 5.4.3: Variation in 5 year average BOD5 at various locations along the Ganga River

4. Water Quality in Different Cities on Bank of River Ganga

Ammonia



BOD



Chloride

COD


केंद्रीय प्रदूषण नियंत्रण बोर्ड
पर्यावरण, वन और जलवायु परिवर्तन के मंत्रालय
नमामि गंगे
स्वच्छ गंगा मिशन
Water Quality in different cities on banks of river Ganga and its tributaries
Visualization
pH DO BOD COD Temperature Sp. Conductivity Chloride Turbidity Nitrate Ammonia TSS
COD
400
300
200
100
0
mg/l
Haridwar
Kannauj
Kanpur
Allahabad
Varanasi Up Stream
Varanasi Down Stream
Patna
Kolkata
Wazirabad (Yamuna)
Okhla (Yamuna)
Agra (Yamuna)
Moradabad (Ramganga)
Lucknow (Gomti)
Ganga
Tributaries
COD
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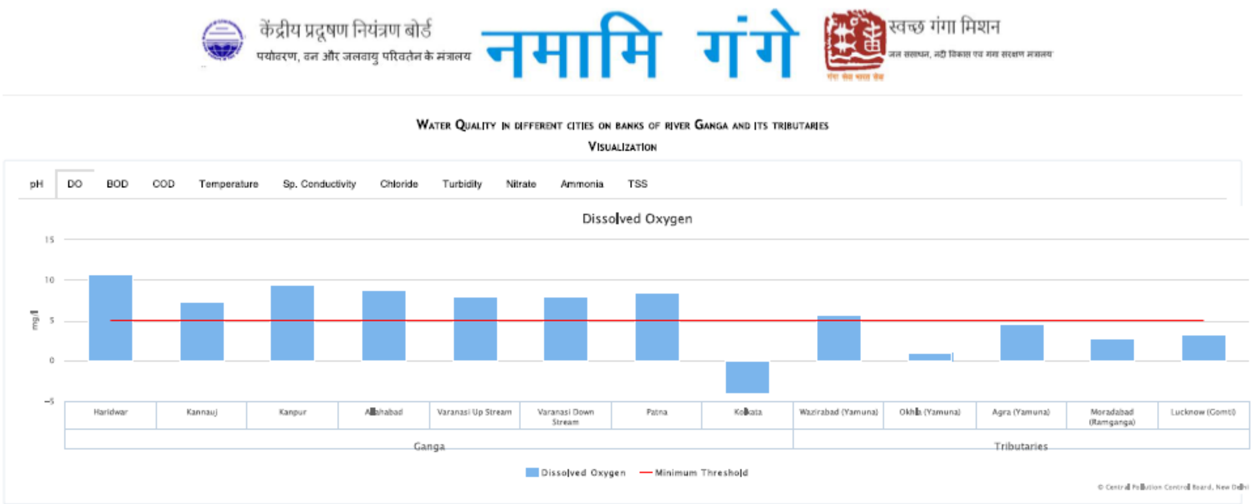
DO


केंद्रीय प्रदूषण नियंत्रण बोर्ड
पर्यावरण, वन और जलवायु परिवर्तन के मंत्रालय
नमामि गंगे
स्वच्छ गंगा मिशन
Water Quality in different cities on banks of river Ganga and its tributaries
Visualization
pH DO BOD COD Temperature Sp. Conductivity Chloride Turbidity Nitrate Ammonia TSS
Dissolved Oxygen
15
10
5
0
-5
mg/l
Haridwar
Kannauj
Kanpur
Allahabad
Varanasi Up Stream
Varanasi Down Stream
Patna
Kolkata
Wazirabad (Yamuna)
Okhla (Yamuna)
Agra (Yamuna)
Moradabad (Ramganga)
Lucknow (Gomti)
Ganga
Tributaries
Dissolved Oxygen
Minimum Threshold
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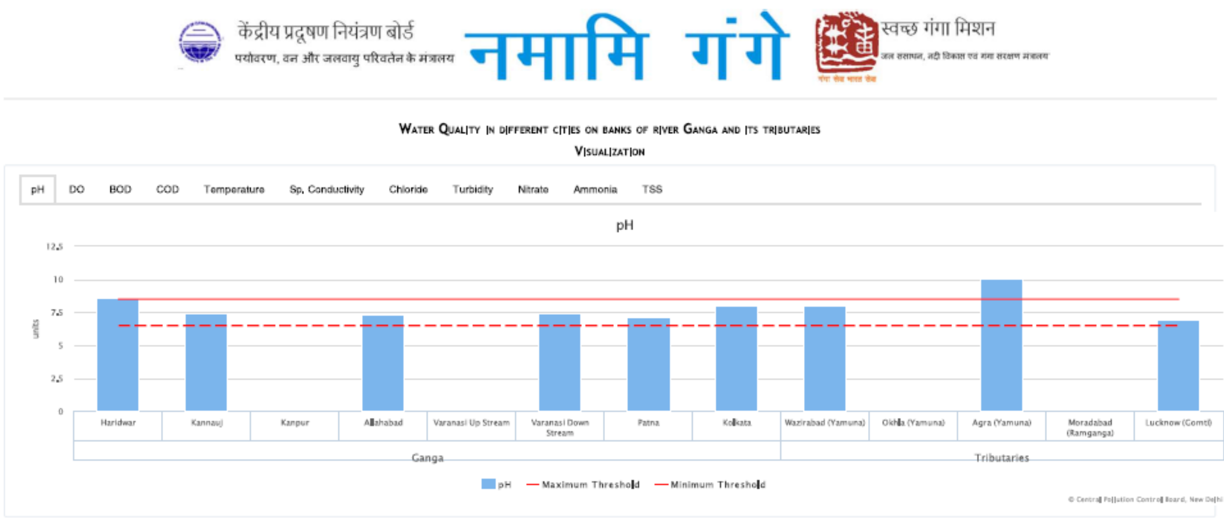
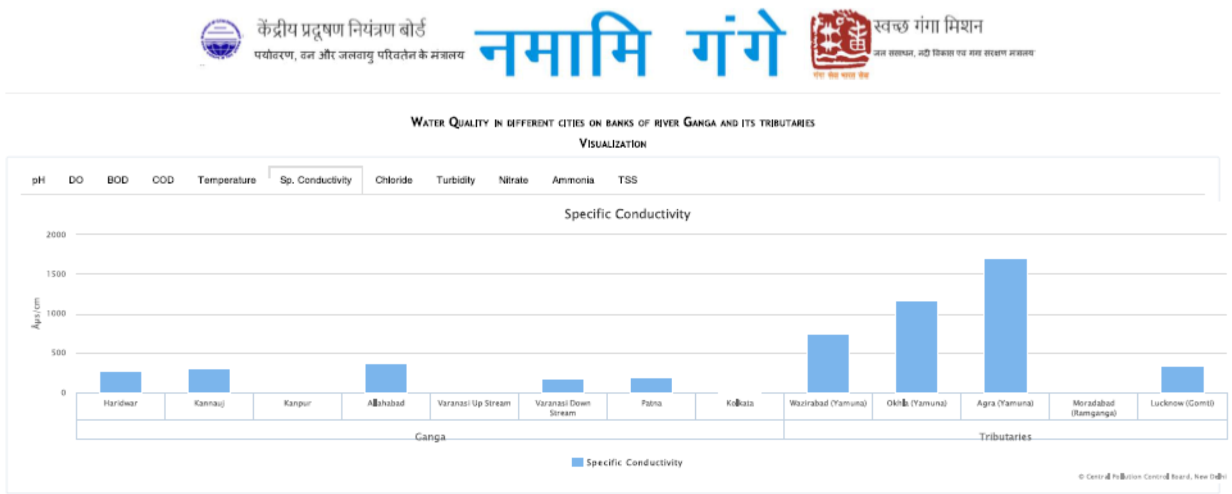
Nitrate


केंद्रीय प्रदूषण नियंत्रण बोर्ड
पर्यावरण, वन और जलवायु परिवर्तन के मंत्रालय
नमामि गंगे
स्वच्छ गंगा मिशन
Water Quality in different cities on banks of river Ganga and its tributaries
Visualization
pH DO BOD COD Temperature Sp. Conductivity Chloride Turbidity Nitrate Ammonia TSS
Nitrate
mg/l
Haridwar Kannauj Kanpur Allahabad Varanasi Up Stream Varanasi Down Stream Patna Kolkata Wazirabad (Yamuna) Okhla (Yamuna) Agra (Yamuna) Moradabad (Ramganga) Lucknow (Gomti)
Ganga
Tributaries
Nitrate

pH


केंद्रीय प्रदूषण नियंत्रण बोर्ड
पर्यावरण, वन और जलवायु परिवर्तन के मंत्रालय
नमामि गंगे
स्वच्छ गंगा मिशन
Water Quality in different cities on banks of river Ganga and its tributaries
Visualization
pH DO BOD COD Temperature Sp. Conductivity Chloride Turbidity Nitrate Ammonia TSS
pH
units
Haridwar Kannauj Kanpur Allahabad Varanasi Up Stream Varanasi Down Stream Patna Kolkata Wazirabad (Yamuna) Okhla (Yamuna) Agra (Yamuna) Moradabad (Ramganga) Lucknow (Gomti)
Ganga
Tributaries
pH
Maximum Threshold
Minimum Threshold

Sp.Conductivity



Temparature

TSS

Turbidity

5. Ground Water Use pattern

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

The groundwater usage pattern in the states traversed by NW-1 is given in **Table 5.4.1**-. 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 5.4.1: 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		
2	Uttar Pradesh	45.36	3.42	48.78	70.18	5.30
4	Bihar	9.39	1.37	10.77	27.42	2.14
5	Jharkhand	0.7	0.38	1.06	5.25	0.56
6	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, a large number of industries also withdraw significant amounts of groundwater, especially from the easily accessible aquifers in the alluvial zone. State wise ground water resources in NW-1 state is given in **Table 5.4.2**.

Table 5.4.2: 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 (%)
2	Uttar Pradesh	76.35	48.78	27.57	70
4	Bihar	29.19	10.77	18.42	39
5	Jharkhand	5.58	1.06	4.52	20
6	West Bengal	30.36	11.65	18.71	42

Source: CWC, 2008

ANNEXURE 5.5

Annexure 5.5: Infrastructural mapping along Ganga River

Infrastructural Mapping

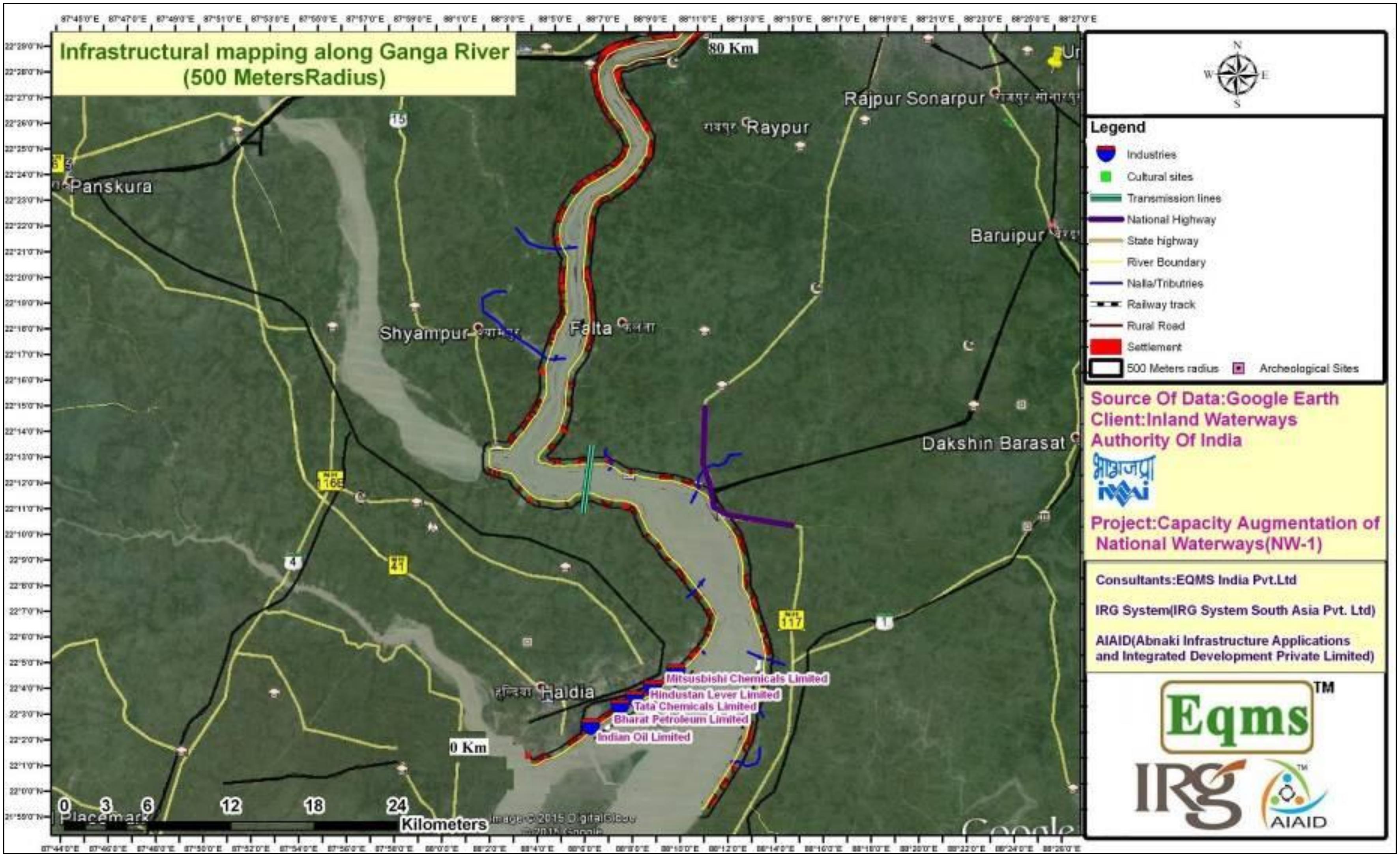


Figure 5.5.1: Infrastructural Mapping along 500 m area of NW-1 (Chainage 0-80 km)

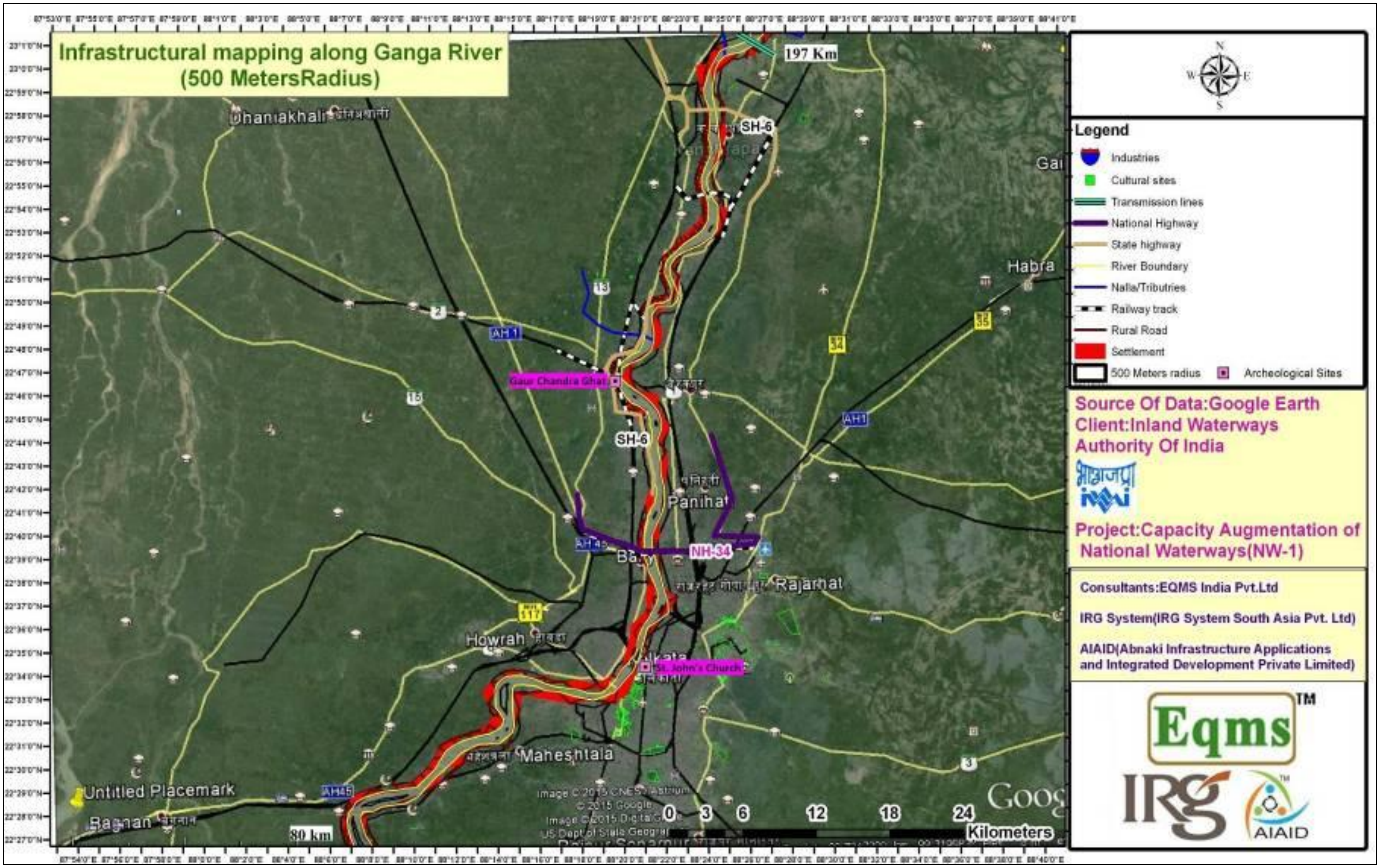


Figure 5.5.2: Infrastructural Mapping along 500 m area of NW-1 (Chainage 80-197 km)

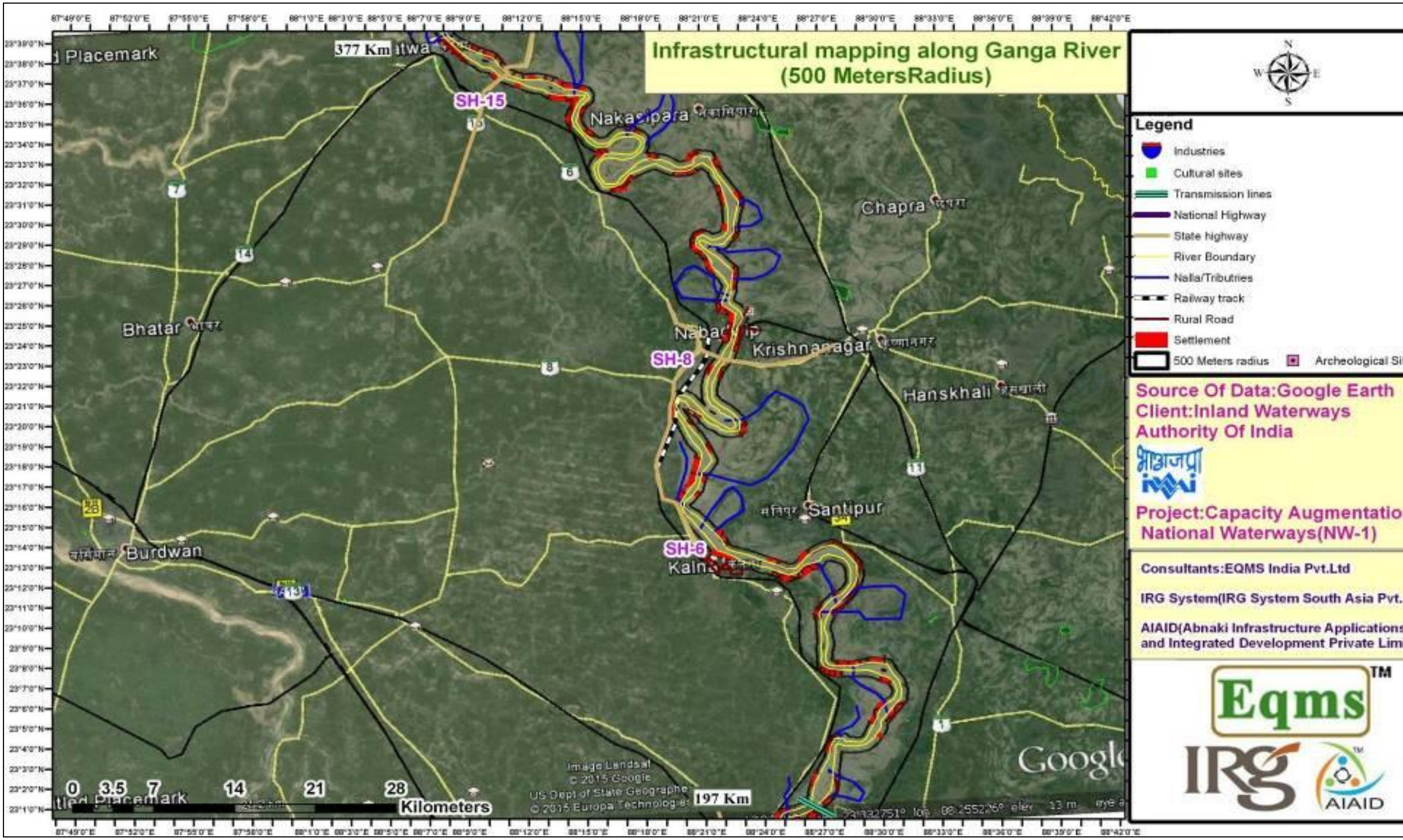


Figure 5.5.3: Infrastructural Mapping along 500 m area of NW-1 (Chainage 197-377 km)

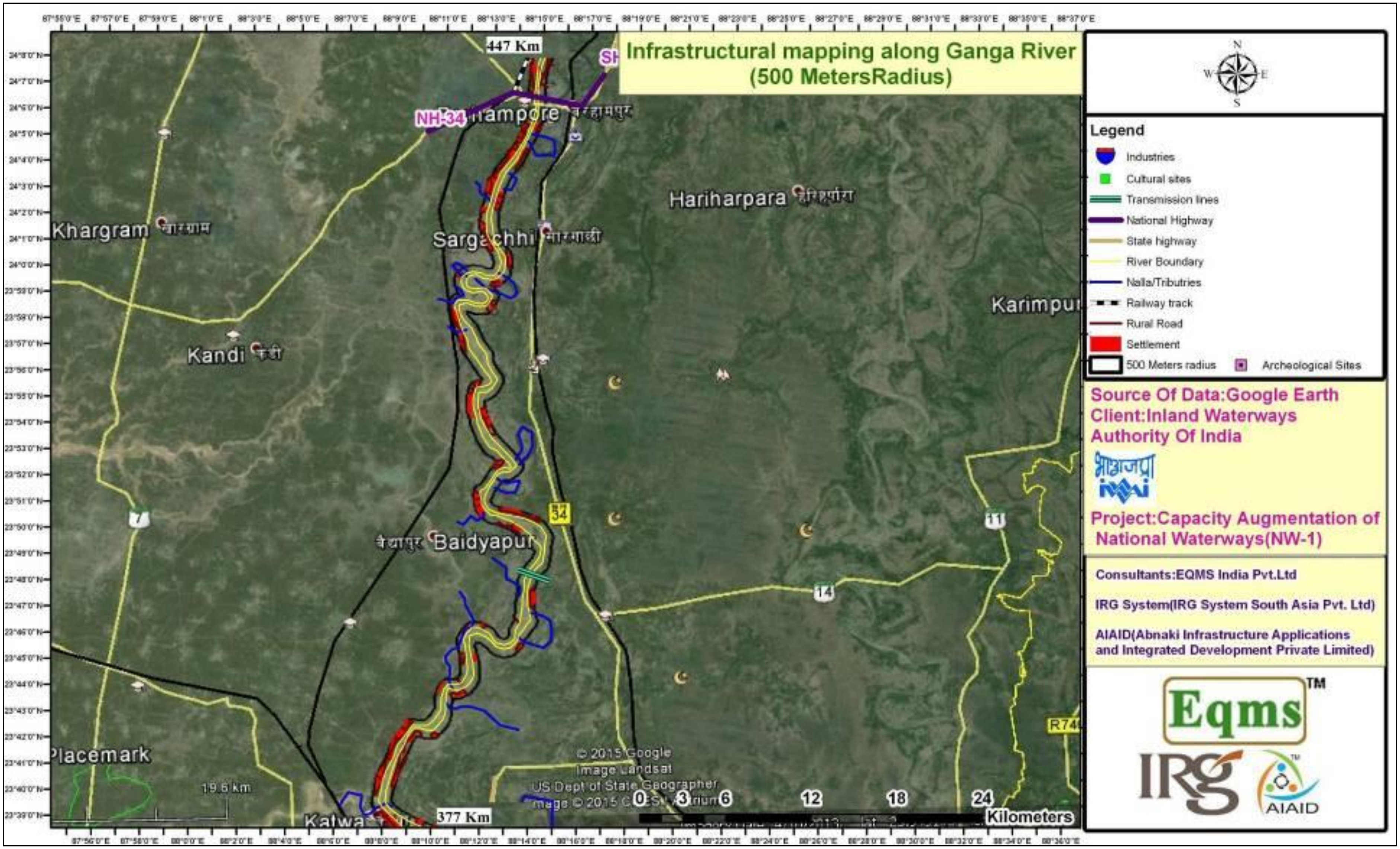


Figure 5.5.4: Infrastructural Mapping along 500 m area of NW-1 (Chainage 377- 447 km)

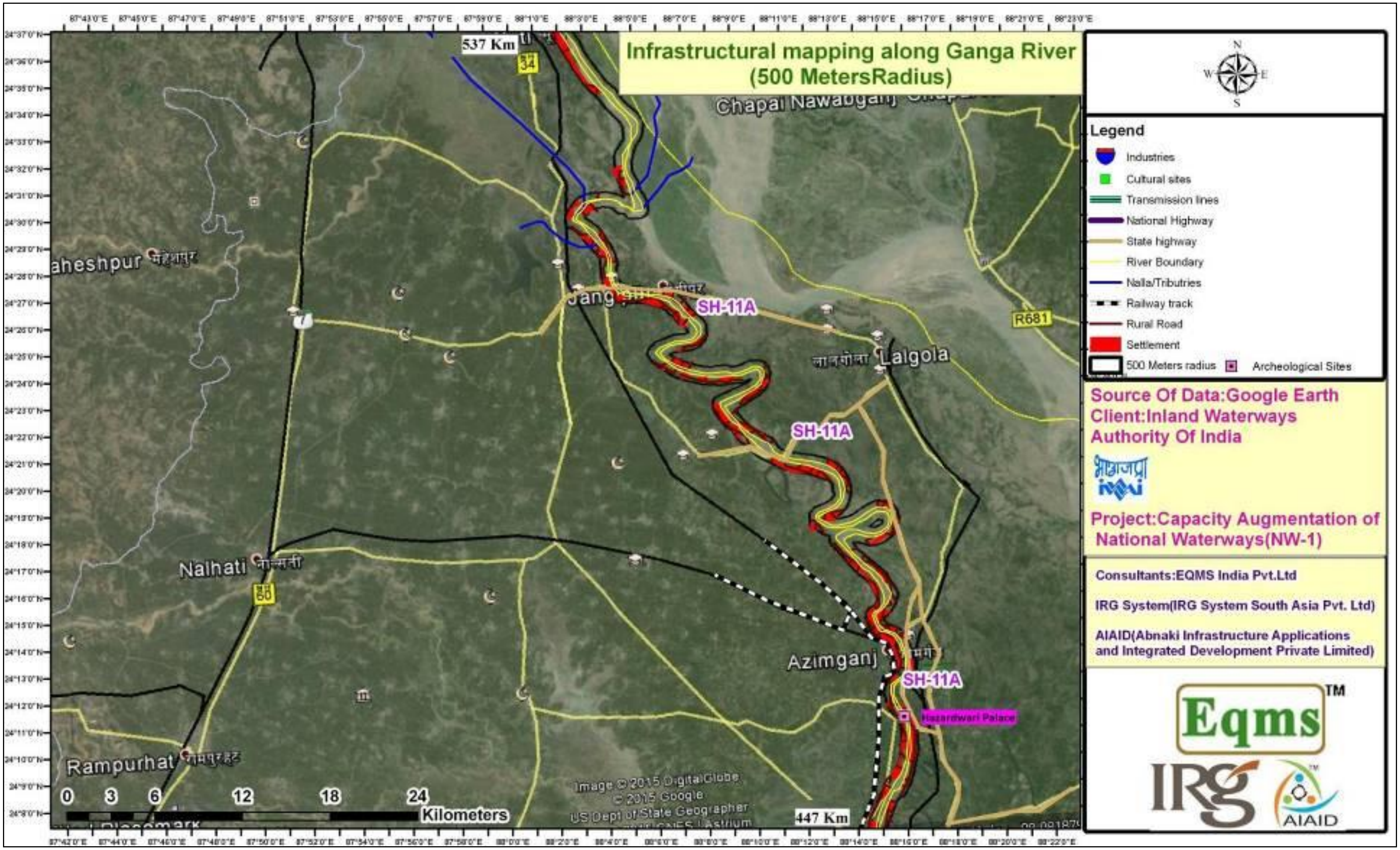


Figure 5.5.5: Infrastructural Mapping along 500 m area of NW-1 (Chainage 447-553 km)

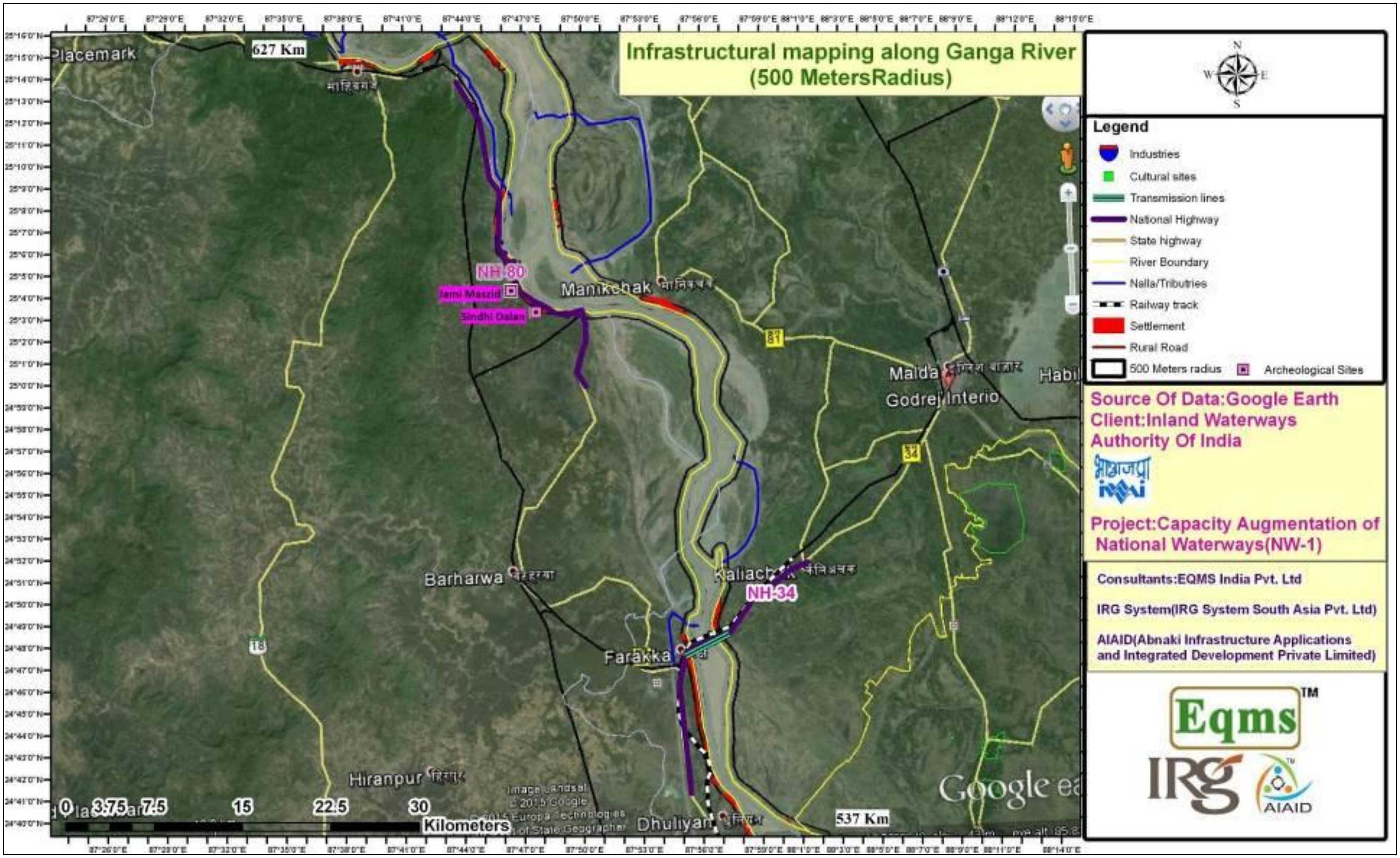


Figure 5.5.6: Infrastructural Mapping along 500 m area of NW-1 (Chainage 553-627 km)

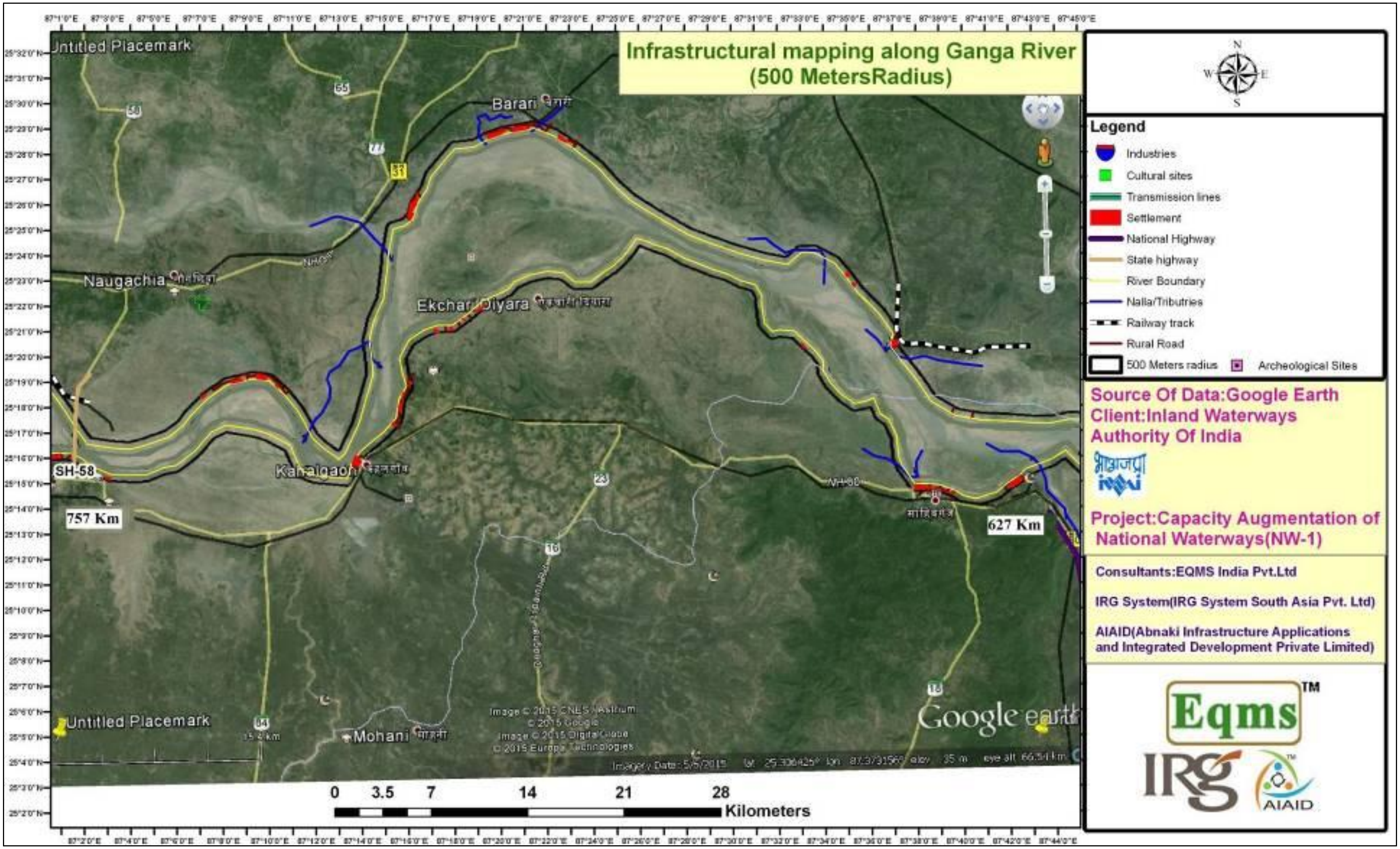


Figure 5.5.7: Infrastructural Mapping along 500 m area of NW-1 (Chainage 627-750 km)

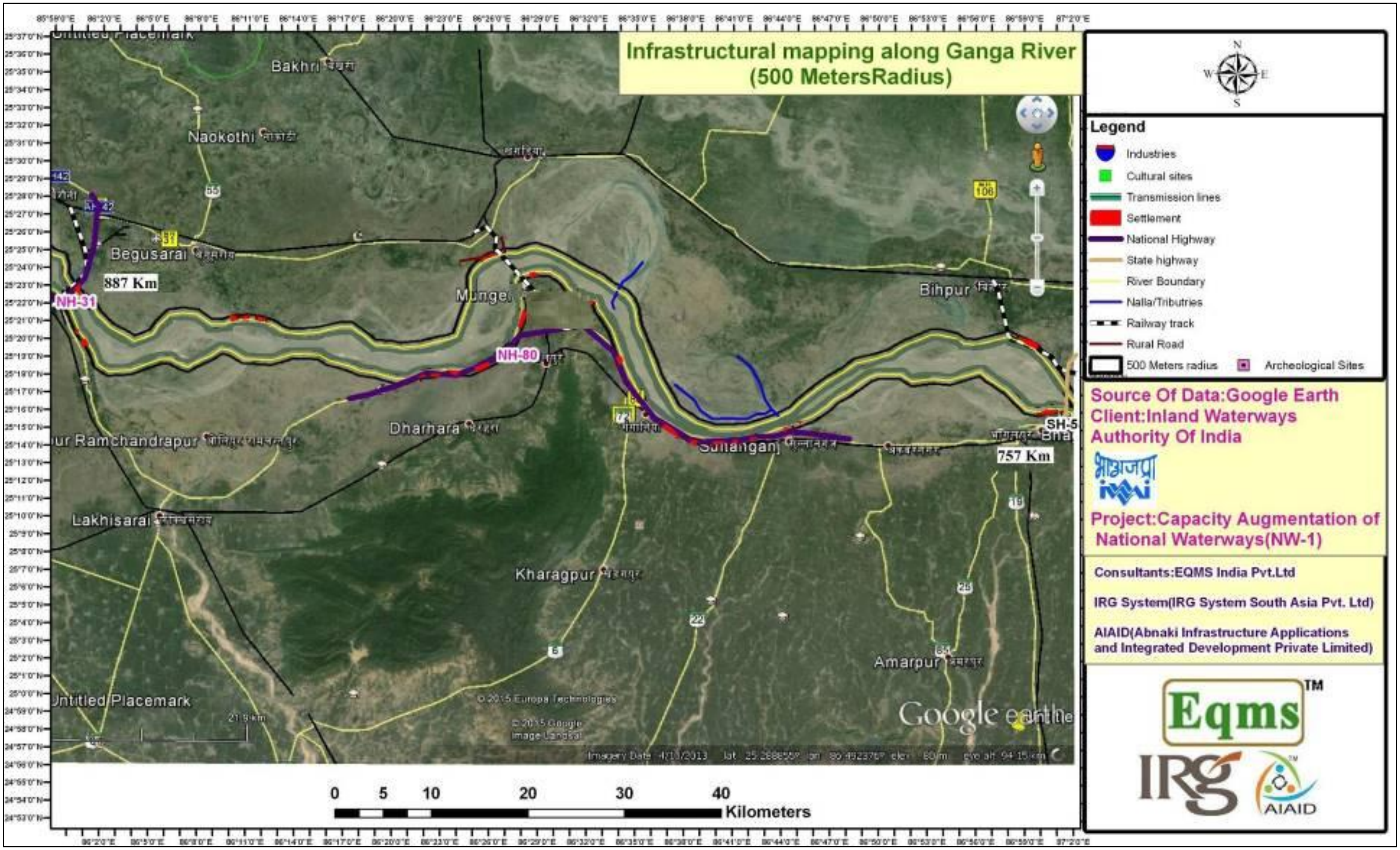


Figure 5.5.8: Infrastructural Mapping along 500 m area of NW-1 (Chainage 750-887 km)

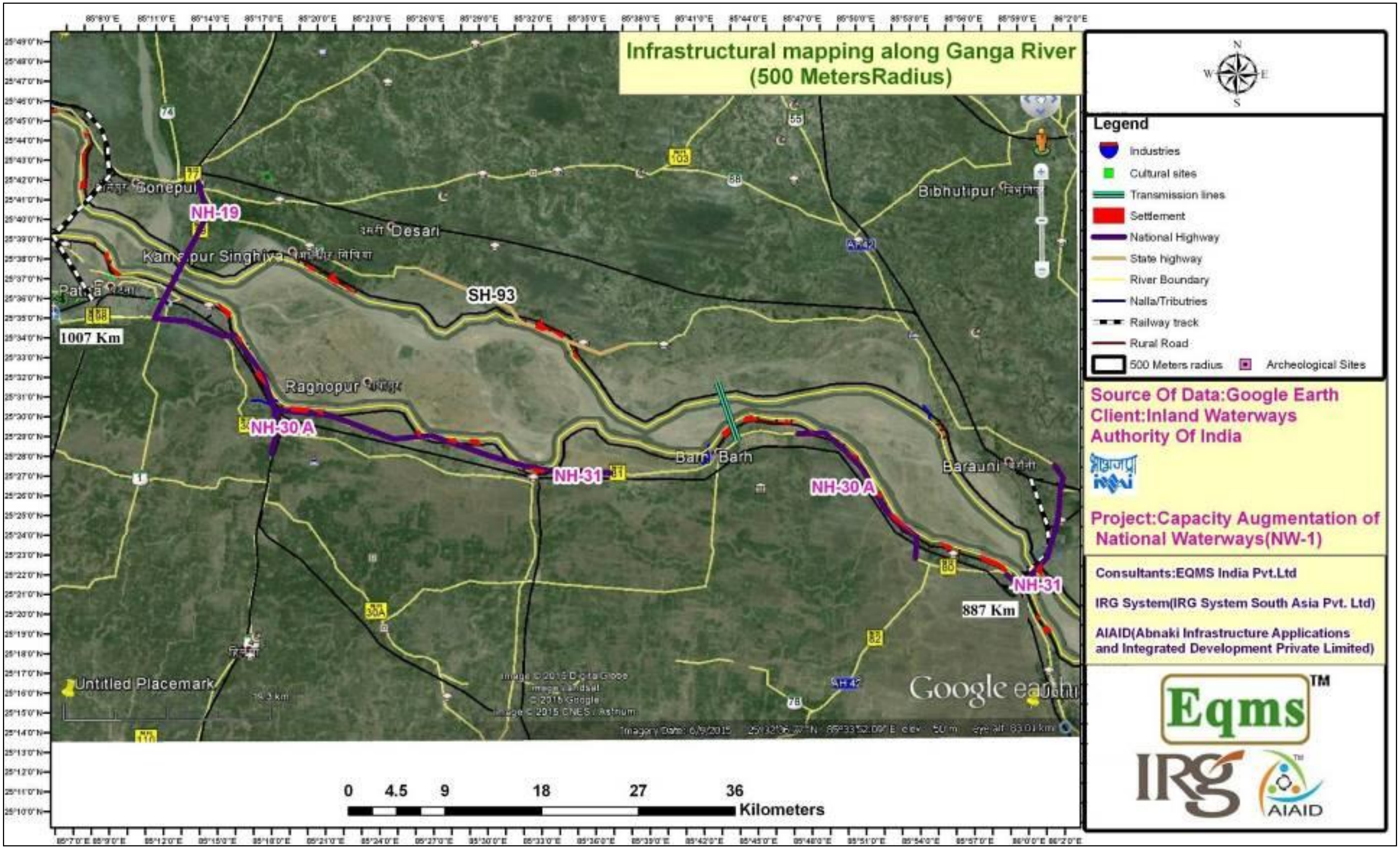


Figure 5.5.9: Infrastructural Mapping along 500 m area of NW-1 (Chainage 887-1007 km)

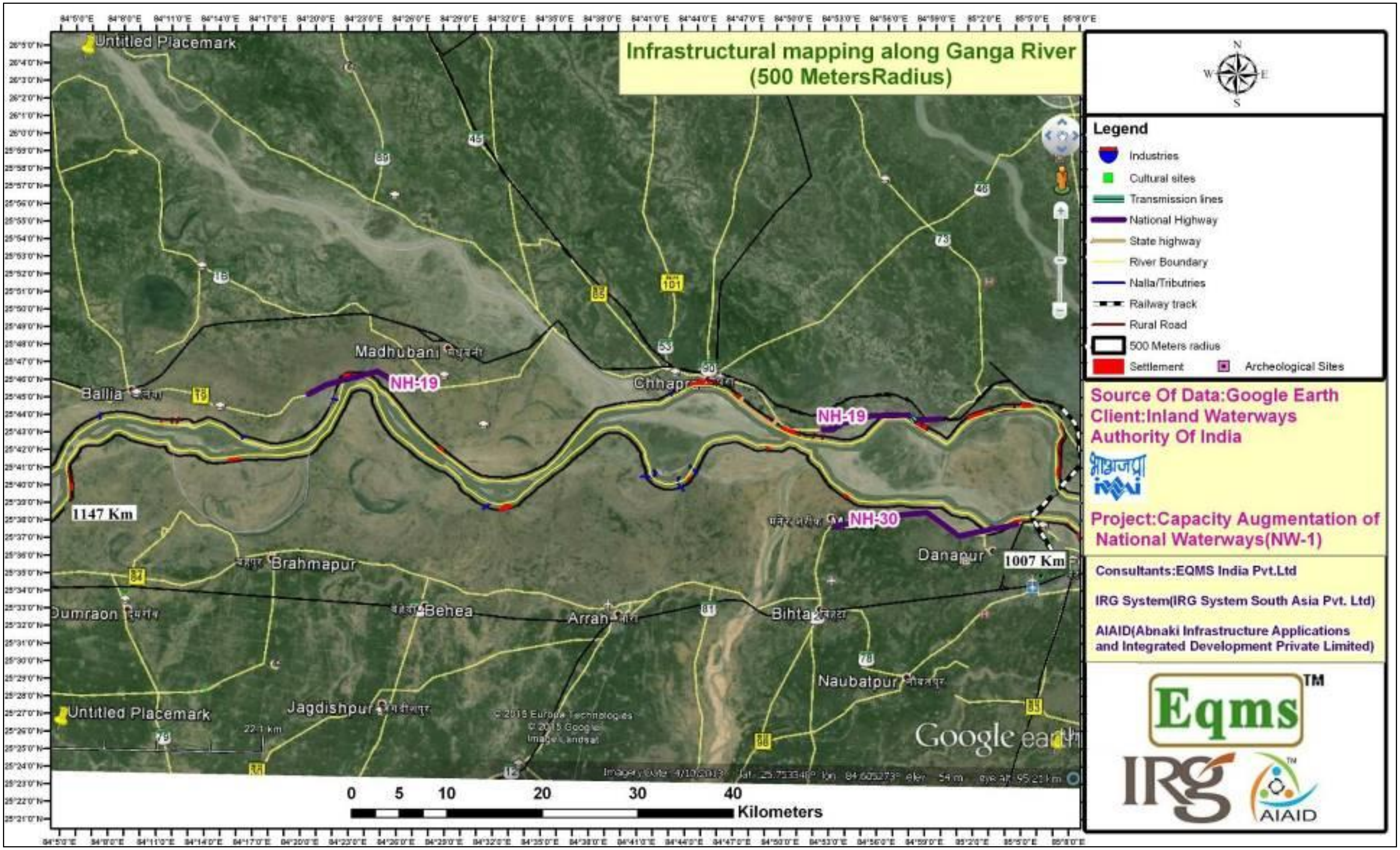


Figure 5.5.10: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1007-1147 km)

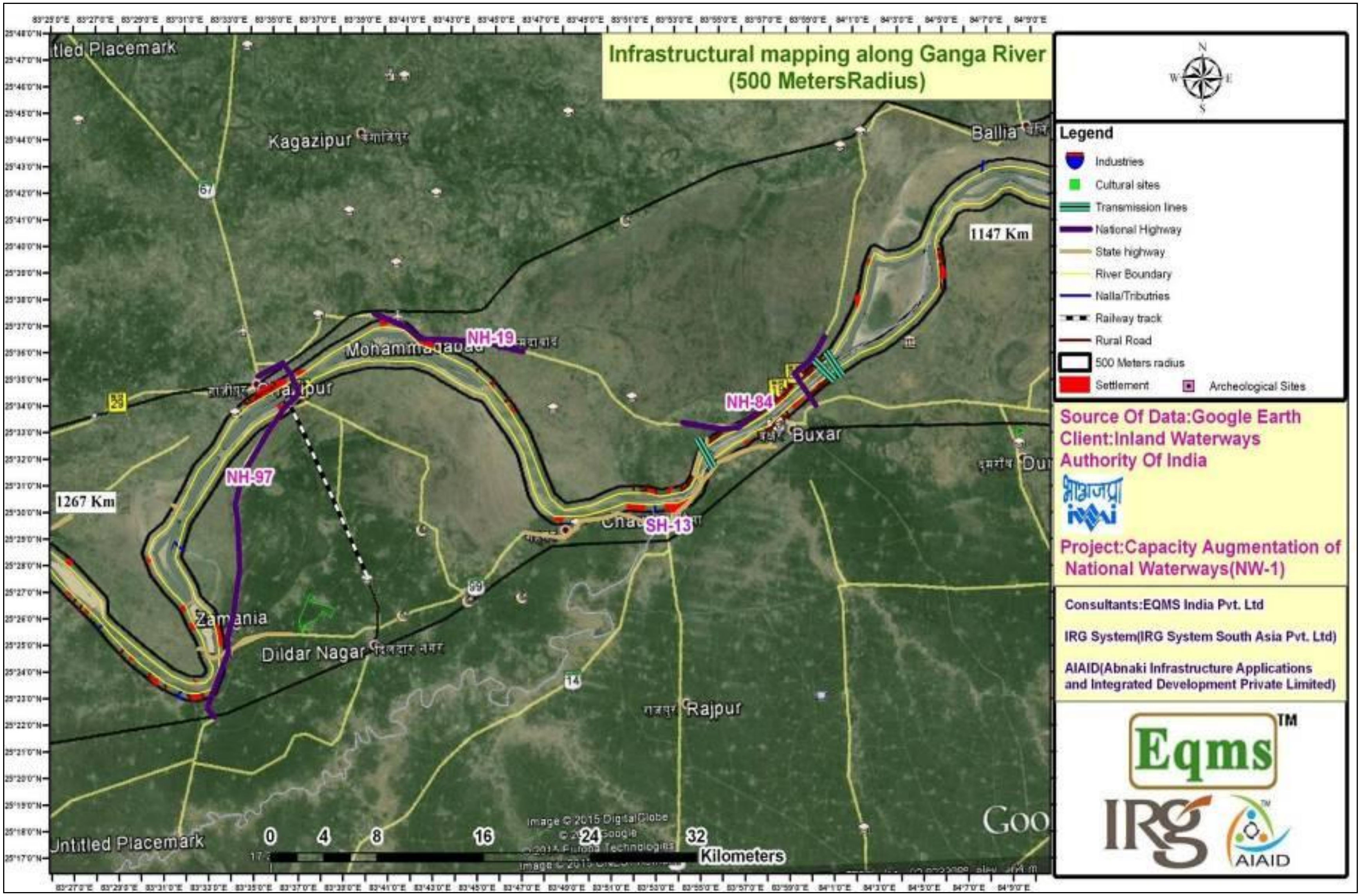


Figure 5.5.11: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1147-1267 km)

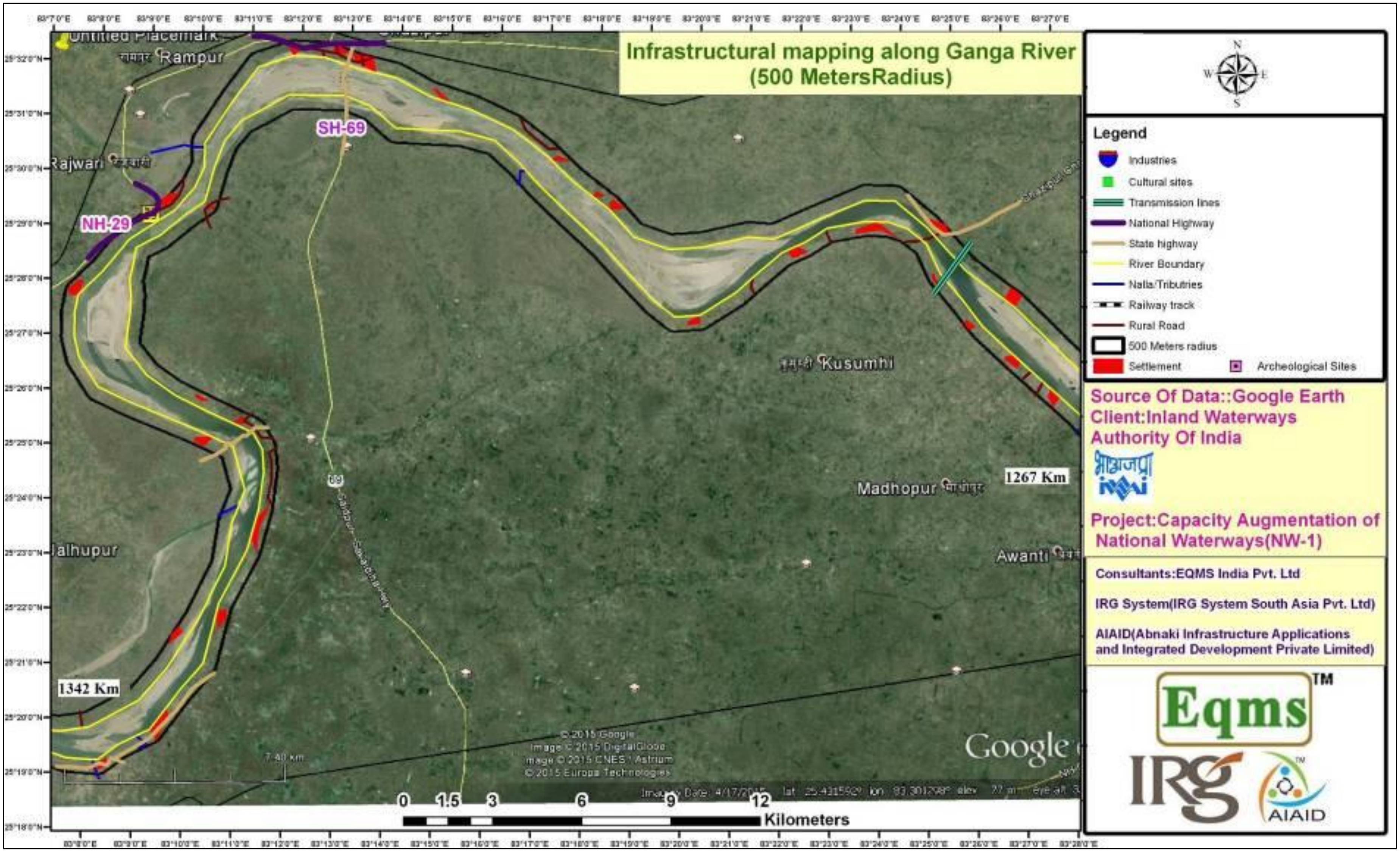


Figure 5.5.12: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1267-1342 km)

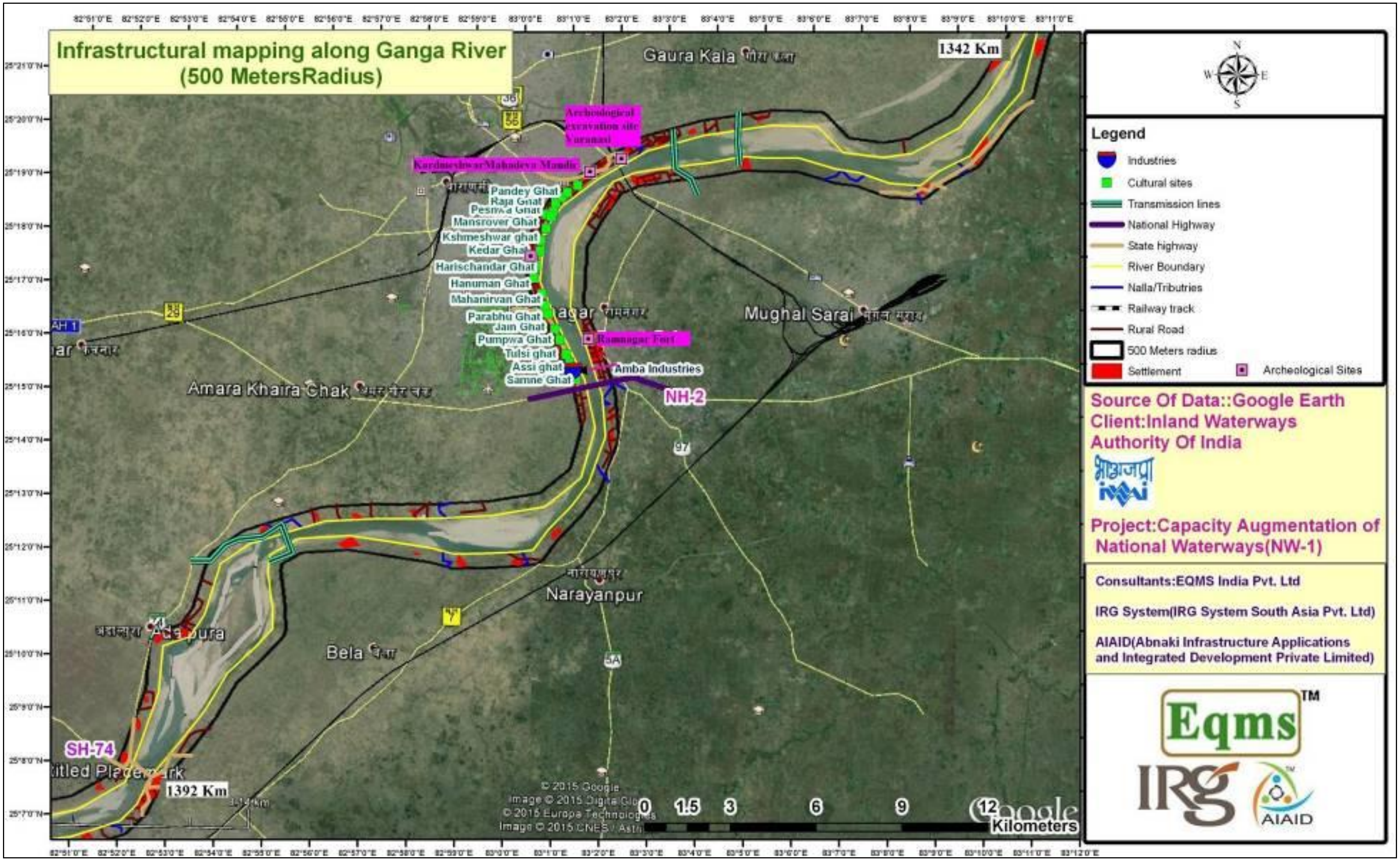


Figure 5.5.13: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1342-1392 km)

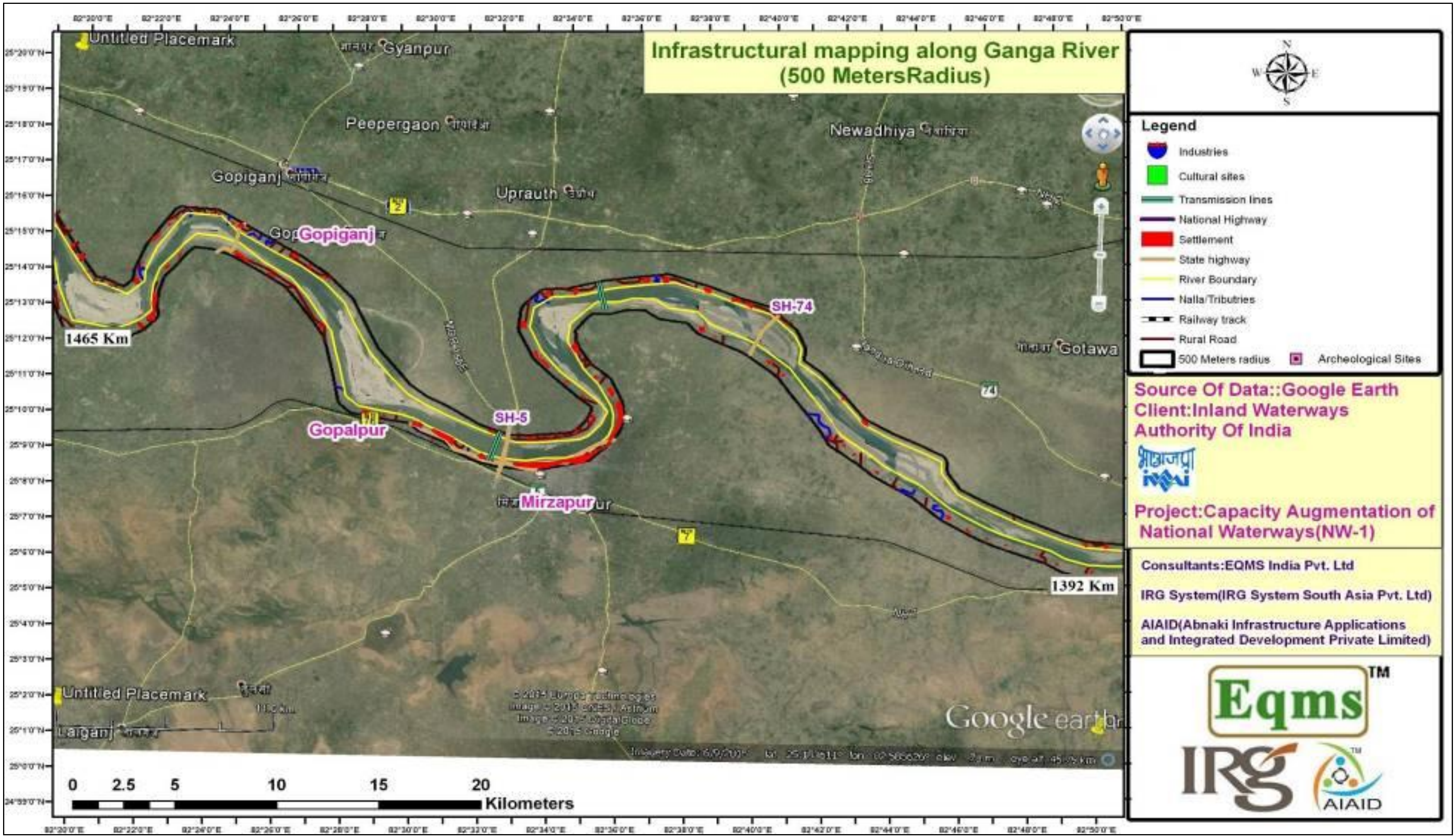


Figure 5.5.14: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1392-1465 km)

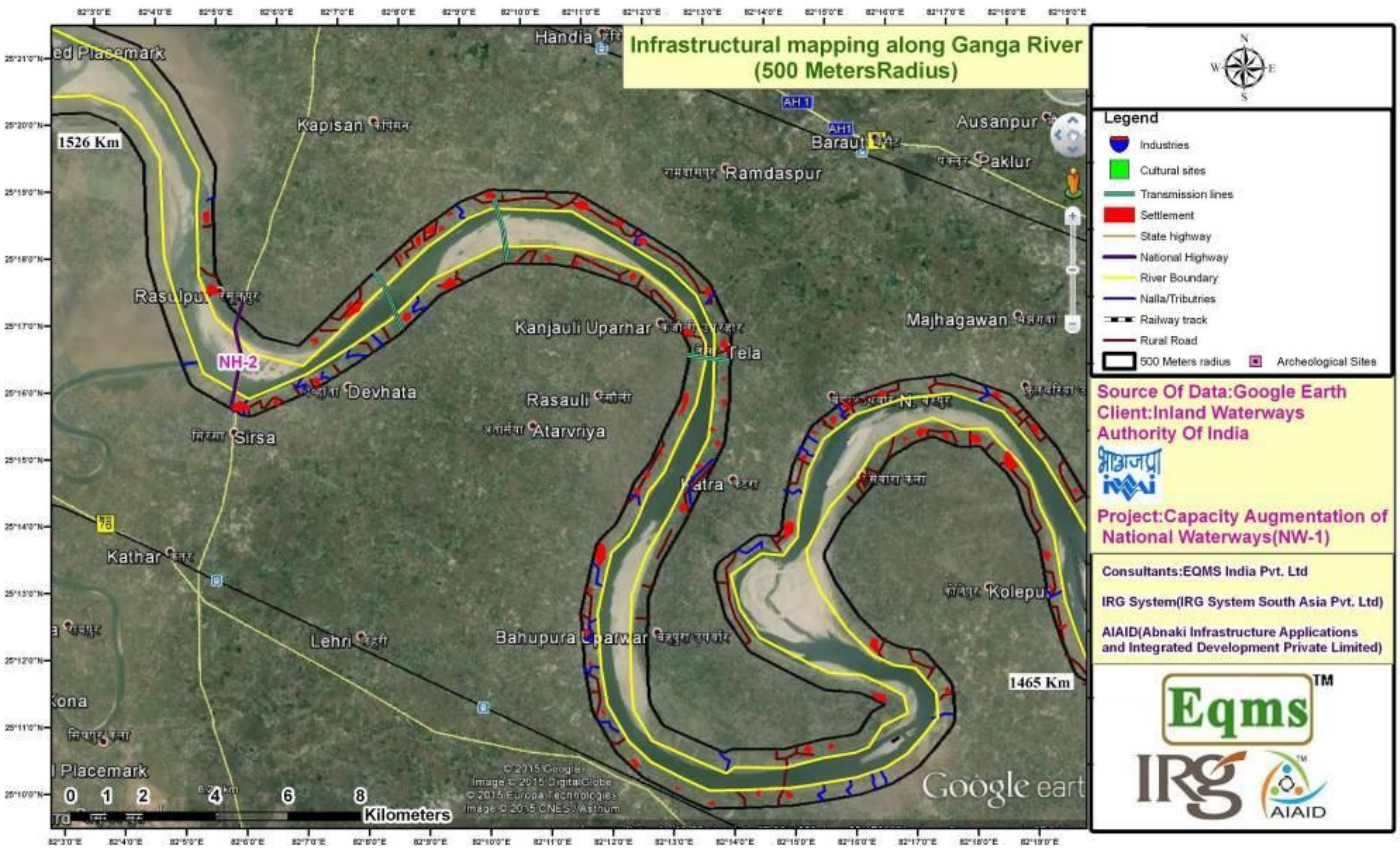


Figure 5.5.15: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1465-1526 km)

Figure 5.5.16: Infrastructural Mapping along 500 m area of NW-1 (Chainage 1526- km)

ANNEXURE 6.1

Annexure 6.1: GHG emission for transportation of freight

Climate Change Scenario in India:

Generally, IWT is considered more energy efficient and emit less CO_2 per ton-km performance compared to other two transport modes namely road or rail transport modes. The average emissions from IWT mode range from 25 gr CO_2/ton-km to 70 gr CO_2/ton-km. Whereas from road transport by truck it varies from 60-120 gr CO_2/ton-km and in the case of rail mode it varies from 20-80 gr CO_2/ton-km depending upon fuel use transport capacity etc. In the case of IWT the variations are due to fleet structure, age and engine of vessels, fuel use, market conditions etc. All these factors are associated with IWT system efficiency which can be planned and managed to make the IWT system more efficient. Besides, the impacts of climate change are required to be managed depending upon the events occurring due to the changes in climate taking place. This type of mitigation management is known as Adoption need in IWT facilities. For example, as per World Bank report on impacts of changes in climate in India are concerned, the erratic behaviour of Indian monsoon has become a reality and is considered to be the major manifestation of climate change impacts in India. The frequency of droughts or short spells of heavy rainfall events are now being experienced at much higher rate. It is pertinent to mention that agriculture productivity is life line of India. An abrupt change in the monsoon could precipitate a major crisis, triggering more frequent droughts as well as greater flooding in large parts of India. Droughts are expected to be more frequent in some areas, especially in north-western India, Jharkhand, Orissa and Chhattisgarh. At 2.5°C warming, melting glaciers and the loss of snow cover over the Himalayas are expected to threaten the stability and reliability of northern India's primarily all glacier-fed rivers, particularly the Indus and the Brahmaputra. The Ganges will be less dependent on melt water due to high annual rainfall downstream during the monsoon season. As per WB reports downward trend of river flow of the Indus, Ganges, and Brahmaputra rivers alone could significantly impact irrigation, affecting the amount of food that can be produced in their respective river basins thereby adversely impacting livelihoods of millions of people (209 million in the Indus basin, 478 million in the Ganges basin, and 62 million in the Brahmaputra basin in the year 2005). The Indus and the Ganges-Brahmaputra-Meghna Basins are the major trans-boundary rivers, and the increasing demand for water is already leading to tensions among countries over water sharing (World Bank).

Impact of Shift of Freight Movement to IWT Mode on Rate of Emissions of GHG:

GHG emissions will be generated in IWT mode during three stages, i.e. during transportation of material within the terminal site for loading and unloading of barges; during transportation of construction material for construction of navigational facilities (terminals & locks); during dredging and material transportation vide batges. GHG emissions during each of this stage is estimated and is given in sections below

A. GHG emissions due to Transportation of Materials within Terminal Site

The GHG emissions generated due to material transoportation within the terminal site is estimated by calculating the emission factors for GHG generation per tonne of cargo movement within the terminal site using the available data for three terminal sites (Sahibganj, Varanasi and Haldia). Details of emissions factor estimations for GHG emissions within terminal sites are given in Table 1 below.

Table 1: Emission Factor Calculation for GHG Emissions within Terminal Sites

Terminals	Per year material handling (MMT) at Terminals in phase I	Per year material handling (MT) at Terminals in phase I	No. of trucks (15 MT) required to carry the material-2 way movement	Distance to be travelled by trucks within terminal site for material transportation (km)	Standard for CO2 emission by trucks post 2000 of 6000 cc engine capacity (g/km)	Per Year GHG Emissions (Tones)	Per Year GHG Emissions (Kg)	GHG emission (kg) /MT
Varanasi	0.54	540000	198	0.5	762.39	27.549	27548.96	0.051016598
Haldia	3.18	3180000	1162	0.9		291.017	291017.2	0.091514850
Sahibganj	2.24	2240000	818	0.7		159.339	159338.7	0.071133369
Average GHG emissions/MT = 0.071221606 kg/MT								

As per above estimations, it is found that 0.071221606 kg of CO_2 will be generated while transportation of 1 MT of cargo. Using market survey data for cargo availability and projection data for IWT mode (with project scenario) by HPC consultant, GHG emissions to be generated due to transportation of material within terminal site every year (2016 to 2045) are given in Table 2 below

Table 2: GHG (CO2) emission generation within terminal due to material transportation

Year	Volume of Cargo to eb Trasported-IWT Mode (With Project Scenario)	GHG emissions (kgs)
2016	4767658	339698.5
2017	4767658	339698.5
2018	4767658	339698.5
2019	4767658	339698.5
2020	4958364.32	353286.4
2021	5156698.893	367417.9
2022	5413542.16	385718.1
2023	5628551.72	401037.6
2024	5851589.65	416929.2
2025	6027137.34	429437.1
2026	6147680.09	438025.8
2027	6270633.69	446786.4

2028	6396046.37	455722.1
2029	6523967.29	464836.5
2030	6654446.64	474133.3
2031	6787535.57	483615.9
2032	6923286.28	493288.2
2033	7061752.01	503154.0
2034	7202987.05	513217.1
2035	7347046.79	523481.4
2036	7493987.73	533951.1
2037	7568927.6	539290.6
2038	7078348.96	504336.6
2039	7149132.45	509379.9
2040	7220623.78	514473.7
2041	7292830.01	519618.5
2042	7365758.31	524814.6
2043	7439415.9	530062.8
2044	7513810.06	535363.4
2045	7588948.16	540717.1
Total Emissions (kg)		13760889.18
Total Emissions (Tonnes)		13760.9

B. GHG Emission Generation Due to Dredging

It is anticipated that annual dredging of 14850000 cum will required to be carried out for the project to maintain desired LAD in different stretches of NW-1. Type of dredgers to be used for the project will be Cutter Suction Dredgers. Specifications were available for CSD of Make "Qingzhou Xianke Mechanical Device Co., Ltd." & Model No. CSD-1. Taking reference of specification of this CSD, estimations are made how much fuel will be consumed for dredging 14850000 cum of sand from river. Details of specifications used and estimations made are given in Table 3 below:

Table 3: Specifications of CSD (CSD-1) and Estimation of Fuel Consumption For Dredging

Specifications of CSD (CSD-1) Used for Estimations	
Model No & Make of CSD	CSD-1 & Qingzhou Xianke Mechanical Device Co., Ltd.
Dredging Capacity	700 cum/hr at full capacity
Power rating	280 KW
Fuel Consumption	200g/KW
Estimations for Fuel Consumption	
Dredging Quantity/Year for project	14850000 cum
As per above specification, CSD of power rating 280 KW dredging capacity	700 cum of sand per hour at full capacity (it means at 280 KW 700 cum of sand can be dredged per hour)
Power Requirement for Dredging 14850000 cum of sand	14850000/700 *280 =21214.28*280 = 5939999.9 KW

Fuel Consumption for operating 5939999.9 KW	=5939999.9 X 200 = 1187999999.999 g of fuel =1187999.9 kg of fuel

As per IPCC default emission factors for European Ships and boats on Inland Waterways, Diesel Engine will generate 3140 g of CO_2 per kg of fuel consumed. It is assumed similar emissions will be made by diesel operated dredgers. Thus using this standard, CO_2 emission generation was estimated and are given below

Fuel Consumption (Table 4) = 1187999.9 kg for dredging 14850000 cum of sand as required for project annually.

CO_2 emissions will be = 1187999.9 X 3140 = 3730319686 g = 3730.3 Tonnes/Year

These emissions will remain same throughout project cycle as dredging quantity will remain more or less same every year as per assumptions.

C. GHG Emission Generation Due to Construction of Navigational Infrastructure

Broad estimates are taken from HOWE for requirement of construction material for construction of navigation infrastructure like terminals and jetties. Emission generation due to transportation of construction material for constructon of 6 nos of terminals and 1 no. lock is considered for estimation of GHGs. Construction of the terminals and lock is anticipated to occur between 2016 and 2017. Emissions estimated to be generated due to construction material transportation for 6 terminals and locks is given below in Table 4 below.

Table 4: Emissions estimated to be generated due to construction material transportation for 6 terminals and locks

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

D. GHG Emission Generation Due to Material Transportation Vide Barges (IWT Mode)

GHG emission generations for transportation of material by barges are also evaluated for material transportation vide barges (IWT Mode). It is well established that the GHG emission generation while bulk transportation of material is far less by IWT Mode if compared to Road & Rail due to minimal consumption of fuel in IWT mode. Thus it can be said that if the freight bulk movement is shifted from road/rail to IWT mode (with project scenario), GHG emission generation due to material transportation will be comparatively lesser than other modes, i.e. Rail & Road (Without project Scenario). Estimations of GHG emissions is made for both the project scenario for all the three modes i.e. road, rail & IWT. These estimations will not only help to evaluate the GHG generation due to material transportation vide barges but also will help us to know how much difference in GHG generation will be there in With project scenario.

For the comparative assessment cargo availability and Traffic Data (actual and projected) collected & generated by HPC consultant is used. GHG emissions were evaluated for all the three modes for actual and projected cargo & traffic data using the GHG emissions factor available for all the three modes (Road-0.00016 t/km, Rail-0.000029t/km & IWT-0.000031 t/km) and are given in Table 5 below. On comparing emissions of both the scenario (with & without project scenario), it is found that the GHG emissions are lesser in case of with project scenario which was already anticpated. Then GHG savings are also evaluated for the project (GHG emissions in Without Project Scenario-GHG emissions in with project scenario) and are also presented in Table 5 below. GHG savings estimated due to freight shift to IWT mode is 4875602 Tonnes.

GHG Emissions Generation Due to movement of Empty Barges

The barges carrying material may not always get the cargo while returning back or may not be loaded fully to the ultimate capacity. As per the current traffic data and projections made for different OD pairs, estimations are made to calculate the trips between the different ODs in which ship will return back in partially or totally unloaded conditions even if it is taking load intermitantly. It is also assumed that vessel will return more empty in the initial years which will reduce once movement and transportation with IWT increases in later years @ 1% less every year till 2045 (means about 50% empty return in 2016 to 21% empty return in 2045) . Emissions will also be generated due to the empty vessel movement which is also not accounted in GHG savings calculated above in Table 5. Emission generation due to movement of empty barges is given in Table 6 below. It is estimated that in empty conditions barges will carry some ballast water to maintain the balance. This ballast water volume is estimated to be 15% of the volume loaded and the emissions are calculated at 15% of net volume transport capacity of barges.

Net GHG Savings

Net savings will be equal to the GHG savings estimated due to shift of freight movement to IWT mode minus GHG emission generation due to movement of material within terminals, emission due to dredging operations, emissions due to transportation of construction material and emissions due to movement of empty barges. These calculations are given in Table 7 below. Net GHG savings for entire project lifecycle is estimated to be 4544037.4 Tonnes.

Current Data on cargo volume for all the three modes: rail, road & IWT along with the growth rates and projections are taken from Feasibility Study carried out by HPC consultant. For reference purpose current data on volume of cargo (tones & tkm) & growth factors are given in Table 8 below and Cargo Projection Data (tkm) from 2015-2045 is given in Table 9 below.

Table 5: GHG Emissions Generation Due to Material transportation Vide Rail, Road & Barges During With project & Without project Scenario and GHG Savings Estimations

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

2040	1,905,931	73,357	138,478	1,652,442	68,662	138,478	253488.84	4694.83	0.00	258183.67
2041	1,944,050	76,291	139,862	1,685,491	71,408	139,862	258558.62	4882.63	0.00	263441.24
2042	1,982,931	79,343	141,261	1,719,201	74,265	141,261	263729.79	5077.93	0.00	268807.72
2043	2,022,589	82,516	142,674	1,753,585	77,235	142,674	269004.39	5281.05	0.00	274285.43
2044	2,063,041	85,817	144,100	1,788,657	80,325	144,100	274384.47	5492.29	0.00	279876.76
2045	2,104,302	89,250	145,541	1,824,430	81,128	145,541	279872.16	8121.73	0.00	287993.89
Total GHG Savings (Tonnes)										**4875601.76 ~ 4.9 million tonnes**

Table 6: GHG Emissions Due to Empty Barge Movement

Year	GHG Emissions
2016	6,857.58
2017	6,720.43
2018	6,583.28
2019	6,446.13
2020	6,308.98
2021	6,418.70
2022	6,527.10
2023	6,696.47
2024	6,800.52
2025	6,901.66
2026	6,935.33
2027	6,897.19
2028	6,854.74
2029	6,807.84
2030	6,756.32
2031	6,700.02
2032	6,638.76
2033	6,572.37

2034	6,500.68
2035	6,423.48
2036	6,340.60
2037	6,251.83
2038	6,096.61
2039	5,497.84
2040	5,347.16
2041	5,192.91
2042	5,035.05
2043	4,873.50
2044	4,708.23
2045	4,539.16
Total	**187230.5**

Table 7: Net GHG Savings for the Project

S. No.	Year	GHG Savings (Tonnes) (Without project-Withproject) A Tonnes	GHG Emissions Within terminal B Tonnes	GHG Emissions Due to dredging C Tonnes	GHG Emissions Due to Empty barge Movement D Tonnes	GHG Emission in construction of terminals and locks E Tonnes	Net GHG savings A-B-C-D-E Tonnes
1.	2016	339.7	641.5	3730.3	6,857.58	3600	-68274.4
2.	2017	339.7	641.5	3730.3	6,720.43	5732	-74005.4
3.	2018	339.7	641.5	3730.3	6,583.28	0	-72133.5
4.	2019	339.7	641.5	3730.3	6,446.13	0	-76272.8
5.	2020	353.3	667.1	3730.3	6,308.98	0	95408.9
6.	2021	367.4	693.8	3730.3	6,418.70	0	100542.2
7.	2022	385.7	728.4	3730.3	6,527.10	0	104014.7
8.	2023	401.0	757.3	3730.3	6,696.47	0	108599.3
9.	2024	416.9	787.3	3730.3	6,800.52	3600	108227.5
10.	2025	429.4	810.9	3730.3	6,901.66	5732	134531.6
11.	2026	438.0	827.2	3730.3	6,935.33	0	144892.3
12.	2027	446.8	843.7	3730.3	6,897.19	0	149737.2

S. No.	Year	GHG Savings (Tonnes) (Without project-Withproject) A Tonnes	GHG Emissions Within terminal B Tonnes	GHG Emissions Due to dredging C Tonnes	GHG Emissions Due to Empty barge Movement D Tonnes	GHG Emission in construction of terminals and locks E Tonnes	Net GHG savings A-B-C-D-E Tonnes
13.	2028	455.7	860.6	3730.3	6,854.74	0	154735.4
14.	2029	464.8	877.8	3730.3	6,807.84	0	159891.6
15.	2030	474.1	895.3	3730.3	6,756.32	0	165210.9
16.	2031	483.6	913.2	3730.3	6,700.02	0	170698.4
17.	2032	493.3	931.5	3730.3	6,638.76	0	176359.4
18.	2033	503.2	950.1	3730.3	6,572.37	0	182199.5
19.	2034	513.2	969.1	3730.3	6,500.68	0	188224.2
20.	2035	523.5	988.5	3730.3	6,423.48	0	194439.6
21.	2036	534.0	1008.3	3730.3	6,340.60	0	216946.9
22.	2037	539.3	1018.4	3730.3	6,251.83	0	221768.1
23.	2038	504.3	952.4	3730.3	6,096.61	0	237655.0
24.	2039	509.4	961.9	3730.3	5,497.84	0	243295.2
25.	2040	514.5	971.5	3730.3	5,347.16	0	248591.7
26.	2041	519.6	981.2	3730.3	5,192.91	0	253998.4
27.	2042	524.8	991.0	3730.3	5,035.05	0	259517.6
28.	2043	530.1	1001.0	3730.3	4,873.50	0	265151.6
29.	2044	535.4	1011.0	3730.3	4,708.23	0	270902.9
30.	2045	540.7	1021.1	3730.3	4,539.16	0	279183.7
Total		**4875601.7**	**13760.9**	**111909.0**	**187230.5**	**18664**	**4544037.4**

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Table 8: Volume of Cargo Actual and Projected for All the Three Mode: Rail, Road & IWT (HPC Consultant)

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Coal	Dry bulk	IWT	Haldia	Begusarai		1		0	0	0	Haldia MMT	Semaria	0	818	18	1.00	1.00	1.00	1.00	1.00			56,344	45,075	36,060	0	0	46,089,348	36,871,479	29,497,183
Coal	Dry bulk	IWT	Haldia	Pirpainti		1		0	0	0	Haldia MMT	Sahibganj MMT	0	636	30	1.00	1.00	1.00	1.00	1.00		164,779	131,824	105,459	84,367	0	104,799,741	83,839,793	67,071,834	53,657,467
Coal	Dry bulk	IWT	Haldia	Buxar				0	0	0	Haldia MMT	Ghazipur	0	1142	54	1.00	1.00	1.00	1.00	1.00		166,108	132,887	106,309	85,047	0	189,695,717	151,756,573	121,405,259	97,124,207
Coal	Dry bulk	IWT	Haldia	Pirpainti				0	0	0	Haldia MMT	Sahibganj MMT	0	636	30	1.00	1.00	1.00	1.00	1.00		166,108	132,887	106,309	85,047	0	105,644,900	84,515,920	67,612,736	54,090,189
Coal	Dry bulk	IWT	Haldia	Pirpainti				0	0	0	Haldia MMT	Sahibganj MM	0	636	30	1.00	1.00	1.00	1.00	1.00		183,384	146,707	117,366	93,892	0	116,631,970	93,305,576	74,644,461	59,715,568

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
												T																		
Coal	Dry bulk	IWT	Haldia	Kahalgaon				0	0	0	Haldia MMT	Kahalgaon	0	648	5	1.00	1.00	1.00	1.00	1.00			223,250	178,600	142,880	0	0	144,665,741	115,732,593	92,586,074
Project Cargo	Neo-bulk	IWT	Kolkata	Narayanganj (Bangladesh)			1,350	0	0	1,248,750	Kolkata GRT	Sea/Other River	0	925	0	1.05	1.05	1.04	1.03	1.02	1,421	1,835	2,259	2,996	3,774	1,314,324	1,697,605	2,089,820	2,771,761	3,491,099
Project Cargo	Neo-bulk	IWT	Kolkata	Narayanganj (Bangladesh)			1,762	0	0	1,629,850	Kolkata GRT	Sea/Other River	0	925	0	1.05	1.05	1.04	1.03	1.02	1,855	2,395	2,949	3,911	4,926	1,715,436	2,215,689	2,727,602	3,617,662	4,556,531
Steel	Neo-bulk	IWT	Kolkata	Narayanganj (Bangladesh)			2,335	0	0	2,159,875	Kolkata GRT	Sea/Other River	0	925	0	1.06	1.06	1.04	1.03	1.02	2,464	3,227	4,000	5,312	6,690	2,279,568	2,985,194	3,700,105	4,913,419	6,188,569
Project Carg	Neo-bul	IWT	Kolkata	Narayanganj (Banglades			4,000	0	0	3,700,000	Kolkata GR	Sea/Other Rive	0	925	0	1.05	1.05	1.04	1.03	1.02	4,210	5,438	6,694	8,879	11,183	3,894,293	5,029,942	6,192,060	8,212,626	10,343,998

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
o	k			h)							T	r																		
Project Cargo	Neo-bulk	IWT	Haldia	Biswanath Charali (Assam)			4,600	0	0	7,714,200	Haldia MMT	Sea/Other River	0	1677	0	1.05	1.05	1.04	1.03	1.02	4,842	6,253	7,698	10,210	12,860	8,119,285	10,487,021	12,909,942	17,122,659	21,566,398
Project Cargo	Neo-bulk	IWT	Kolkata	Tezpur (Assam)			4,800	0	0	8,640,000	Kolkata GRT	Sea/Other River	0	1800	0	1.05	1.05	1.04	1.03	1.02	5,052	6,525	8,033	10,654	13,419	9,093,700	11,745,594	14,459,296	19,177,591	24,154,634
Project Cargo	Neo-bulk	IWT	Panihati (WB)	Ashuganj (Bangladesh)			7,300	0	0	7,285,400	Kolkata GRT	Sea/Other River	0	998	0	1.05	1.05	1.04	1.03	1.02	7,683	9,924	12,217	16,203	20,408	7,667,968	9,904,091	12,192,333	16,170,882	20,367,612
Natural Aggregates	Dry Bulk	IWT	Nalhati (WB)	Chittagong (Bangladesh)			7,500	0	0	6,150,000	Pakur	Sea/Other River	45	820	0	1.10	1.10	1.05	1.03	1.02	8,278	13,560	17,093	22,826	26,536	6,787,969	11,118,945	14,016,438	18,717,652	21,759,416
Logs & Woo	Neo-bul	IW	Sagar Island	Kolkata			60,0	0	0	8,400,	Sagar Islan	Kolkata GR	0	14	0	1.0	1.0	1.0	1.0	1.0	63,1	81,56	100,4	133,1	167,7	8,841,	11,419,32	14,057,6	18,644,8	23,483,6

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
d	k	T					00			000	d	T		0		5	5	4	3	2	51	7	12	78	41	097	7	49	80	72
Natural Aggregates	Dry Bulk	IWT	Farakka	Haldia			90,000	0	0	45,810,000	Farakka	Haldia MMT	0	509	0	1.10	1.10	1.05	1.03	1.02	99,336	162,716	205,119	273,917	318,430	50,562,092	82,822,583	104,405,368	139,423,682	162,081,113
Petroleum	Neo-bulk	IWT	Haldia	Kolkata			250,550	0	0	26,307,750	Haldia MMT	Kolkata GRT	0	105	0	1.05	1.05	1.04	1.03	1.01	262,460	331,060	402,795	523,613	605,218	27,558,305	34,761,336	42,293,456	54,979,399	63,547,900
Fly Ash	Dry Bulk	IWT	Budge Budge (WB)	Narayanganj (Bangladesh)			260,000	0	0	233,480,000	Budge Budge	Sea/Other River	0	898	0	1.04	1.04	1.04	1.03	1.02	271,154	334,528	402,579	529,913	656,110	243,496,534	300,405,779	361,516,322	475,862,092	589,186,763
Fly Ash	Dry Bulk	IWT	Kolaghat (WB)	Narayanganj (Bangladesh)			266,461	0	0	218,498,020	Haldia MMT	Sea/Other River	0	820	0	1.04	1.04	1.04	1.03	1.02	277,892	342,841	412,584	543,082	672,414	227,871,812	281,129,296	338,318,488	445,326,901	551,379,738
Fly Ash	Dry Bulk	IWT	Durgapur (WB)	Narayanganj (Banglades			807,00	0	0	746,475,0	Kolkata GR	Sea/Other Rive	0	925	0	1.04	1.04	1.04	1.03	1.02	841,62	1,038,32	1,249,54	1,644,76	2,036,46	778,499,5	960,448,0	1,155,828,75	1,521,411,49	1,883,729,60

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
				h)			0			00	T	r									1	2	5	9	4	52	21	0	2	8
Coal	Dry Bulk	IWT	Sagar Island	Farakka			3,000,000	0	0	1,632,000,000	Sagar Island	Farakka	0	544	0	1.09	1.09	1.03	1.02	1.01	3,282,875	5,151,334	6,063,753	7,537,952	8,619,278	1,785,883,916	2,802,325,535	3,298,681,830	4,100,645,981	4,688,887,144
Sub-total IWT																1.04	1.04	1.03	1.02	1.01	5,134,294	8,171,905	9,721,627	11,926,534	13,702,747	3,163,585,851	5,045,268,285	5,987,562,411	7,330,337,039	8,461,394,884
Fertilizer	Bagged	Rail	Kakinada Sea ports limited	Bhagalpur Railway Station		1,417	4,988	0	7,067,996	0	Haldia MMT	Kahalgaon	6	648	30	1.03	1.03	1.02	1.01	1.01			6,368	7,227	7,726			4,126,537	4,683,268	5,006,499
Fertilizer	Bagged	Rail	Paradip	Bhagalpur Railway Station		892	4,988	0	4,449,296	0	Haldia MMT	Kahalgaon	20	648	30	1.03	1.03	1.02	1.01	1.01			6,368	7,227	7,726			4,126,537	4,683,268	5,006,499
Petroleum	Neo-bulk	Rail	Barauni (Bihar)	Haldia	587	574	2,646	0	1,518,804	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.07	1.04	1.01			6,419	9,963	11,515			5,250,993	8,149,544	9,419,645

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Petroleum	Neo-bulk	Rail	Garhara Goods Marsh.Yard (Bihar)	Haldia	581	571	2,700	0	1,541,700	0	Semaria	Haldia MMT	7	818	5	1.10	1.09	1.07	1.04	1.01			6,550	10,166	11,750			5,358,156	8,315,861	9,611,883
Petroleum	Neo-bulk	Rail	Baad (UP)	Haldia	1,435	1,370	2,700	0	3,699,000	0	Semaria	Haldia MMT	540	818	5	1.10	1.09	1.07	1.04	1.01			6,550	10,166	11,750			5,358,156	8,315,861	9,611,883
Fertilizer	Bagged	Rail	Vishakapatnam	Katihar Railway Station		1,290	7,800	0	10,062,000	0	Haldia MMT	Manihari	5	598	25	1.03	1.03	1.02	1.01	1.01			9,958	11,302	12,082			5,954,976	6,758,391	7,224,844
Steel	Neo-bulk	Rail	Haldia	Raxaul (Bihar)	822	812	2,835	0	2,302,020	0	Haldia MMT	Patna	5	920	198	1.10	1.10	1.07	1.05	1.02				10,981	13,831				10,102,507	12,724,349
Coal	Dry bulk	Rail	Haldia	Vyas Nagar (Bihar)	681	742	3,944	0	2,926,448	0	Haldia MMT	Patna	5	920	5	1.10	1.10	1.07	1.04	1.01			9,619	14,445	16,517			8,849,385	13,289,479	15,195,866
Petroleum	Neo-bul	Rail	Numaligarh Siding (Assam)	Haldia	1,11	1,44	5,346	0	7,708,93	0	Sea/Other Rive	Haldia MM	19	163	5	1.10	1.09	1.07	1.04	1.01		9,247	12,970	20,129	23,266		15,155,92	21,257,206	32,991,197	38,132,853

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
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Petroleum	Neo-bulk	Rail	Gaziabad (UP)	Haldia	1,555	1,490	5,400	0	8,046,000	0	Semaria	Haldia MMT	661	818	5	1.10	1.09	1.07	1.04	1.01			13,101	20,332	23,501			10,716,312	16,631,723	19,223,765
Fertilizer	Bagged	Rail	Vishakapatnam	Katihar Railway Station		1,290	15,600	0	20,124,000	0	Haldia MMT	Manihari	5	598	25	1.03	1.03	1.02	1.01	1.01			19,916	22,603	24,163			11,909,953	13,516,782	14,449,687
Project Cargo	Neo-Bulk	Rail	Kolkata	Pratagarh		849	18,250	0	15,494,250	0	Kolkata GRT	Ramnagar MMT	0	1176	146	1.00	1.01	1.02	1.02	1.02			20,809	25,736	32,416			24,470,805	30,266,110	38,120,889
Iron Ore	Dry bulk	Rail	Barauni (Bihar)	Haldia	587	574	10,200	0	5,854,800	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.06	1.03	1.01				30,960	32,910				25,325,127	26,920,465
Food Grains	Bagged	Rail	Delhi	Haldia	1,561	1,661	10,521	0	17,475,381	0	Semaria	Haldia MMT	664	818	5	1.10	1.09	1.06	1.03	1.01				32,269	33,994				26,396,140	27,807,247

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Fertilizer	Bagged	Rail	Vishakapatnam	Katihar Railway Station		1,290	23,400	0	30,186,000	0	Haldia MMT	Manihari	5	598	25	1.03	1.03	1.02	1.01	1.01			29,874	33,905	36,245			17,864,929	20,275,173	21,674,531
Petroleum	Neo-bulk	Rail	Baad (UP)	Haldia	1,435	1,370	10,800	0	14,796,000	0	Semaria	Haldia MMT	540	818	5	1.10	1.09	1.07	1.04	1.01			26,201	40,664	47,002			21,432,623	33,263,445	38,447,530
Petroleum	Neo-bulk	Rail	Garhara Goods Marsh.Yard (Bihar)	Haldia	581	571	13,392	0	7,646,832	0	Semaria	Haldia MMT	7	818	5	1.10	1.09	1.07	1.04	1.01			32,490	50,424	58,282			26,576,453	41,246,672	47,674,937
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	13,446	0	19,389,132	0	Semaria	Haldia MMT	19	818	5	1.10	1.09	1.07	1.04	1.01			32,621	50,627	58,517			26,683,616	41,412,989	47,867,175
Petroleum	Neo-bulk	Rail	Indian Oil Refinary Siding, Barauni (Bihar)	Haldia	570	586	18,900	0	11,075,400	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.07	1.04	1.01			45,852	71,163	82,253			37,507,091	58,211,029	67,283,178
Coal	Dry bul	Rai	Haldia	Krishna Silao (Bihar)	71	82	24,0	0	19,779,2	0	Haldia MM	Patna	5	92	5	1.1	1.1	1.0	1.0	1.0			58,54	87,91	100,5			53,859,1	80,882,5	92,485,1

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	k	l		Khaja Bhandar	8	4	04		96		T			0		0	0	7	4	1			3	6	27			86	17	83
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	24,138	0	34,806,996	0	Semaria	Haldia MMT	19	818	5	1.10	1.09	1.07	1.04	1.01			58,560	90,885	105,049			47,901,913	74,343,800	85,930,230
Steel	Dry bulk	Rail	Haldia	Raxaul (Bihar)	822	812	22,806	0	18,518,472	0	Haldia MMT	Patna	5	920	198	1.10	1.10	1.07	1.05	1.02				88,336	111,261				81,269,057	102,360,319
Petroleum	Neo-bulk	Rail	Barauni (Bihar)	Haldia	587	574	28,890	0	16,582,860	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.07	1.04	1.01			70,088	108,777	125,730			57,332,268	88,979,716	102,847,143
Natural Aggregates	Dry Bulk	Rail	Sakrigali	Begusarai, Bihar		232	36,204	0	8,399,328	0	Sahibganj MMT	Semaria	3	235	20	1.10	1.10	1.05	1.03	1.02				110,188	128,094				25,894,091	30,102,082
Natural Aggregate	Dry Bulk	Rail	Sakrigali	Danapur, Bihar		313	36,204	0	11,331,852	0	Sahibganj MM	Patna	3	337	12	1.10	1.10	1.05	1.03	1.02				110,188	128,094				37,133,229	43,167,667

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
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Natural Aggregates	Dry Bulk	Rail	Sakrigali	Sonpur Junction, Bihar		313	36,204	0	11,331,852	0	Sahibganj MMT	Patna	3	337	26	1.10	1.10	1.05	1.03	1.02				110,188	128,094				37,133,229	43,167,667
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	75,384	0	108,703,728	0	Sea/Other River	Haldia MMT	19	1639	5	1.10	1.09	1.07	1.04	1.01		130,393	182,885	283,837	328,073		213,713,840	299,748,077	465,209,208	537,711,739
Coal	Dry bulk	Rail	Haldia	Barh Super Thermal Power Stn	627	600	79,832	0	47,899,200	0	Haldia MMT	Sahibganj MMT	5	636	5	1.10	1.10	1.07	1.04	1.01			194,700	292,388	334,332			123,829,028	185,959,057	212,635,042
Coal	Dry bulk	Rail	Haldia	NTPC Farakka	388	424	168,096	0	71,272,704	0	Haldia MMT	Farakka	5	509	5	1.10	1.10	1.07	1.04	1.01				615,660	703,976				313,370,688	358,323,981
Coal	Dry bulk	Rail	Haldia	NTPC Kahalgaon	501	518	224,19	0	116,133,52	0	Haldia MM	Kahalgaon	5	648	5	1.10	1.10	1.07	1.04	1.01			546,785	821,128	938,920			354,316,359	532,091,199	608,420,135

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
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Natural Aggregates	Dry Bulk	Rail	Pakur	Patna, Bihar		376	602,088	0	226,385,088	0	Pakur	Patna	20	426	10	1.10	1.10	1.05	1.03	1.02				1,832,467	2,130,257				780,631,058	907,489,669
Sub-total Rail																1.09	1.08	1.06	1.04	1.01	0	139,640	1,397,226	5,032,247	5,807,857	0	228,869,764	1,174,430,559	3,106,731,416	3,586,044,577
Iron Ore	Dry Bulk	Road	Gaya	Kolkata	450		5	2,250	0	0	Patna	Kolkata GRT	98	815	0	1.01	1.01	1.01	1.01	1.01			6	6	7			4,655	5,055	5,374
Project Cargo	Neo-Bulk	Road	Khadakpur (Patna)	Varanasi	420		5	2,100	0	0	Semaria	Ramnagar MMT	36	523	10	1.05	1.05	1.04	1.03	1.02			8	11	14			4,376	5,804	7,311
Food	General Cargo	Road	Purnea	Kolkata	494		58	28,652	0	0	Manihari	Kolkata GRT	57	493	10	1.02	1.02	1.01	1.01	1.01				74	78				36,594	38,550

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Fertilizer	Bagged	Road	Dankuni, Mogra (WB)	Tezpur, Jorhat, Tinsukia (Assam)			200	0	0	0	Sea/Other River	Sea/Other River	112	1588	9	1.03	1.03	1.02	1.01	1.01				290	310				460,180	491,941
Fertilizer	Bagged	Road	Dankuni, Mogra (WB)	Assam (Tezpur, Jorhat, Tinsukia)	1,090	1,020	171	186,857	0	0	Kolkata GRT	Sea/Other River	10	1800	15	1.05	1.05	1.03	1.02	1.01				335	358				602,725	644,324
Bleaching Powder	Bagged	Road	Gaya	Kolkata	450		500	225,000	0	0	Patna	Kolkata GRT	98	815	0	1.02	1.02	1.01	1.01	1.01			585	640	674			476,450	521,510	549,389
Rice	Bagged	Road	Kolkata	Mau	708		250	177,000	0	0	Kolkata GRT	Ballia	0	923	69	1.10	1.09	1.06	1.03	1.01			560	768	816			516,600	708,533	752,773
Project Cargo	Neo-Bulk	Road	Varanasi	Patna	269		360	96,840	0	0	Ramnagar MMT	Patna	5	361	5	1.05	1.05	1.05	1.03	1.02		483	605	846	1,065		174,367	218,569	305,295	384,526

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Project Cargo	Neo-Bulk	Road	Gaya	Kolkata	400		500	200,000	0	0	Patna	Kolkata GRT	98	815	0	1.05	1.05	1.04	1.03	1.02			837	1,110	1,398			681,963	904,499	1,139,238
Paper	Neo-bulk	Road	Varanasi	Patna	269		360	96,840	0	0	Ramnagar MMT	Patna	0	361	0	1.10	1.10	1.07	1.05	1.02		624	880	1,387	1,747		225,305	317,814	500,601	630,518
Food	General Cargo	Road	Kolkata	Varanasi	681		2,000	1,362,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	0	1.00	1.00	1.01	1.01	1.01			2,081	2,227	2,346			2,447,044	2,618,839	2,758,839
Coal	Dry Bulk	Road	Haldia HDC	Ballia	746		700	522,200	0	0	Haldia MMT	Ramnagar MMT	0	1281	0	1.10	1.10	1.07	1.04	1.01		1,237	1,707	2,564	2,932		1,584,441	2,186,933	3,284,206	3,755,328
Coal	Dry Bulk	Road	Haldia HDC	Ballia	746		800	596,800	0	0	Haldia MMT	Ramnagar MMT	0	1281	0	1.10	1.10	1.07	1.04	1.01		1,414	1,951	2,930	3,350		1,810,790	2,499,352	3,753,378	4,291,803

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Coal	Dry Bulk	Road	Haldia HDC	Varanasi	773		1,000	773,000	0	0	Haldia MMT	Ramnagar MMT	0	1281	0	1.10	1.10	1.07	1.04	1.01		1,767	2,439	3,663	4,188		2,263,487	3,124,190	4,691,723	5,364,754
Textiles	Neo-bulk	Road	Katihar	Hooghly, West Bengal	436		1,313	572,468	0	0	Manihari	Kolkata GRT	25	493	57	1.07	1.07	1.05	1.04	1.03			2,449	3,477	4,455			1,207,261	1,714,354	2,196,492
Flour	Bagged	Road	Lalgunj (UP)	Kolkata	960	816	3,200	3,072,000	0	0	Patna	Kolkata GRT	397	815	5	1.02	1.02	1.02	1.01	1.01			3,900	4,386	4,621			3,178,790	3,574,731	3,765,832
Cement	Bagged	Road	Varanasi	Patna	269		1,000	269,000	0	0	Ramnagar MMT	Patna	0	361	0	1.10	1.10	1.07	1.05	1.02		1,738	2,468	3,895	4,906		627,516	891,100	1,406,108	1,771,027
Lime Stone	Dry bulk	Road	Kolkata	Allahabad	800	816	2,571	2,057,143	0	0	Kolkata GRT	Allahabad	5	1480	5	1.05	1.06	1.05	1.03	1.02				6,295	7,318				9,316,721	10,830,760
Pape	Neo-	Ro	Kolkata	Varanasi	68		1,80	1,225,	0	0	Kolkata	Ramnaga	0	11	0	1.1	1.1	1.0	1.0	1.0			4,4	6,9	8,7			5,176,57	8,153,82	10,269,9

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
r	bulk	ad			1		0	800			GRT	r MMT		76		0	0	7	5	2			02	34	33			7	6	39
Food	General Cargo	Road	Patna	Ballia	141		1,800	253,800	0	0	Patna	Ballia	5	108	5	1.15	1.14	1.08	1.04	1.01			5,805	8,956	9,435			626,984	967,260	1,018,968
Sand	Dry bulk	Road	Kolkata	Allahabad	800	816	3,429	2,742,857	0	0	Kolkata GRT	Allahabad	5	1480	5	1.05	1.06	1.05	1.03	1.02				8,393	9,757				12,422,294	14,441,013
Food Grains	Bagged	Road	Katihar	Patna, Bihar	304		7,700	2,340,800	0	0	Manihari	Patna	25	322	10	1.02	1.02	1.01	1.01	1.01			9,003	9,854	10,381			2,898,923	3,173,085	3,342,714
Food Grains	Bagged	Road	Katihar	Kolkata	458		7,700	3,526,600	0	0	Manihari	Kolkata GRT	25	493	10	1.02	1.02	1.01	1.01	1.01			9,003	9,854	10,381			4,438,413	4,858,171	5,117,883
Textiles	Neo-bulk	Road	Varanasi	Kolkata	681		5,475	3,728,475	0	0	Ramnagar MMT	Kolkata GRT	0	1176	0	1.00	1.01	1.03	1.03	1.03		5,656	6,402	8,337	10,682		6,650,939	7,528,377	9,804,462	12,561,825

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
											T																			
Paper	Neo-bulk	Road	Karnataka	Kolkata	2,200	2,236	4,286	9,428,571	0	0	Sea/Other River	Kolkata GRT	1000	1200	5	1.05	1.05	1.05	1.03	1.02		5,750	7,208	10,068	12,681		6,900,167	8,649,342	12,081,310	15,216,699
Logs & Wood	Neo-bulk	Road	Faizabad	Kolkata	878		3,120	2,739,360	0	0	Ramnagar MMT	Kolkata GRT	200	1176	0	1.10	1.10	1.07	1.05	1.02				12,018	15,137				14,133,299	17,801,227
Food	General Cargo	Road	Kolkata	Allahabad	790		8,400	6,636,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	121	1.05	1.05	1.03	1.02	1.01			12,924	15,648	16,484			15,198,459	18,401,543	19,385,268
Wheat	Bagged	Road	Sk Nagar	Kolkata	941		3,840	3,613,440	0	0	Ramnagar MMT	Kolkata GRT	181	1176	0	1.13	1.12	1.07	1.04	1.01			10,925	16,490	17,628			12,848,175	19,392,359	20,730,787
Textiles	Neo-bul	Roa	Kolkata	Sultanpur	83		7,20	5,976,00	0	0	Kolkata GR	Ramnagar	0	117	15	1.0	1.0	1.0	1.0	1.0		8,745	10,64	14,90	19,10		10,283,75	12,517,4	17,532,5	22,463,2

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	k	d			0		0	0			T	MMT		6	2	3	3	4	3	3			4	9	1		0	07	24	92
LPG Gas	Liquid Bulk	Road	Kolkata	Uttar Pradesh	1,000		7,200	7,200,000	0	0	Kolkata GRT	Allahabad	5	1480	202	1.05	1.05	1.05	1.03	1.01				16,750	19,360				24,789,530	28,652,961
Textiles	Neo-bulk	Road	Kolkata	Varanasi	681		10,950	7,456,950	0	0	Kolkata GRT	Ramnagar MMT	0	1176	0	1.00	1.01	1.03	1.03	1.03		11,311	12,803	16,674	21,364		13,301,878	15,056,754	19,608,925	25,123,651
Plastic Granules	Bagged	Road	Kanpur (UP)	Kolkata	1,160		6,300	7,308,000	0	0	Ramnagar MMT	Kolkata GRT	337	1249	5	1.05	1.05	1.06	1.04	1.03				17,012	22,045				21,247,852	27,534,741
Rice	Bagged	Road	Purnia (Bihar)	Dhulagarh (WB)	475		12,000	5,700,000	0	0	Kahalgaon	Kolkata GRT	121	550	5	1.05	1.05	1.03	1.02	1.01				22,378	23,776				12,308,128	13,076,635
Food Grains	Bagged	Roa	Sultanpur	Kolkata	830		6,000	4,980,00	0	0	Ramnagar MM	Kolkata GR	152	117	0	1.13	1.12	1.07	1.04	1.01				24,643	25,961				28,980,327	30,529,581

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
		d						0			T	T		6																
Project Cargo	Neo-Bulk	Road	Kolkata	Sultanpur	830		16,200	13,446,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	152	1.00	1.01	1.02	1.02	1.02				22,846	28,775				26,866,355	33,838,816
Textiles	Neo-bulk	Road	Kolkata	Allahabad	790		12,000	9,480,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	121	1.03	1.03	1.04	1.03	1.03		14,574	17,740	24,848	31,836		17,139,583	20,862,345	29,220,873	37,438,819
Flour	Bagged	Road	Patna	Kolkata	620	534	16,800	10,416,000	0	0	Patna	Kolkata GRT	5	815	5	1.05	1.05	1.03	1.02	1.01				31,295	32,968				25,505,540	26,869,037
Textiles	Neo-bulk	Road	Haldia HDC	Chunar	784		7,200	5,644,800	0	0	Haldia MMT	Ramnagar MMT	31	1281	0	1.10	1.10	1.08	1.05	1.03		12,554	18,031	29,869	38,269		16,081,934	23,097,787	38,262,127	49,022,796
Cement	Bagged	Roa	Varanasi	Kolkata	681		8,000	5,448,00	0	0	Ramnagar MM	Kolkata GR	0	117	0	1.10	1.10	1.07	1.05	1.02			19,747	31,160	39,247			23,222,896	36,644,500	46,154,623

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
		d						0			T	T		6																
Rice	Bagged	Road	Naugarh (UP)	Kolkata	941		15,000	14,115,000	0	0	Ballia	Kolkata GRT	263	923	0	1.10	1.09	1.06	1.03	1.01			33,582	46,058	48,934			30,996,025	42,511,965	45,166,368
Food Grains	Bagged	Road	Allahabad	Kolkata	790		12,000	9,480,000	0	0	Ramnagar MMT	Kolkata GRT	121	1176	0	1.13	1.12	1.07	1.04	1.01				49,286	51,921				57,960,653	61,059,163
Textiles	Neo-bulk	Road	Kolkata	Partapgarh	849		21,900	18,593,100	0	0	Kolkata GRT	Ramnagar MMT	0	1176	146	1.03	1.03	1.04	1.03	1.03		26,598	32,376	45,347	58,100		31,279,738	38,073,779	53,328,093	68,325,846
Wheat	Bagged	Road	Fatuwa	Haldia	628		50,000	31,400,000	0	0	Patna	Haldia MMT	21	920	0	1.00	1.00	1.01	1.01	1.01		50,608	53,061	58,339	62,365		46,559,504	48,816,532	53,671,754	57,376,087
Statues	Neo-bulk	Road	Chunar	Kolkata	692		40,000	27,680,000	0	0	Ramnagar MM	Kolkata GRT	31	1176	0	1.05	1.05	1.03	1.01	1.00		53,604	60,648	68,670	68,670		63,038,099	71,321,823	80,755,620	80,755,620

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
											T																			
Statues	Neo-bulk	Road	Chunar	Patna	271		40,000	10,840,000	0	0	Ramnagar MMT	Patna	31	361	0	1.05	1.05	1.03	1.01	1.00		53,604	60,648	68,670	68,670		19,350,981	21,893,859	24,789,778	24,789,778
Coal	Dry Bulk	Road	Haldia HDC	Sultanpur	921		21,000	19,341,000	0	0	Haldia MMT	Ramnagar MMT	0	1281	152	1.08	1.08	1.06	1.04	1.01		33,545	44,171	63,217	72,285		42,971,703	56,583,086	80,980,757	92,597,516
Coal	Dry Bulk	Road	Haldia HDC	Partapgarh	941		30,000	28,230,000	0	0	Haldia MMT	Ramnagar MMT	0	1281	146	1.08	1.08	1.06	1.04	1.01		47,922	63,101	90,310	103,265		61,388,147	80,832,980	115,686,796	132,282,166
Vehicles	Ro-Ro	Road	Delhi	Kolkata	1,500	1,470	27,000	40,500,000	0	0	Allahabad	Kolkata GRT	730	1480	5	1.05	1.05	1.06	1.05	1.03				84,168	112,206				124,569,068	166,065,433
Wheat	Bagged	Roa	Shahganj (UP)	Patna	336		40,000	13,440,0	0	0	Ramnagar MM	Patna	83	361	5	1.10	1.09	1.06	1.03	1.01		68,455	91,397	128,337	137,194		24,712,11	32,994,407	46,329,553	49,527,140

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
		d						00			T																0			
Project Cargo	Neo-Bulk	Road	Gaya	Kolkata	450		50,000	22,500,000	0	0	Patna	Kolkata GRT	98	815	0	1.05	1.05	1.04	1.03	1.02				110,981	139,784				90,449,864	113,923,766
Steel	Neo-Bulk	Road	Baikhatopur	Kolkata	507		50,000	25,350,000	0	0	Patna	Kolkata GRT	115	815	0	1.06	1.06	1.04	1.03	1.02			85,656	113,743	143,262			69,809,268	92,700,661	116,758,698
Wheat	Bagged	Road	Jaunpur	Manihari	604		42,000	25,368,000	0	0	Ramnagar MMT	Manihari	63	683	0	1.10	1.09	1.06	1.03	1.01			95,967	134,754	140,054			65,545,538	92,036,673	98,388,888
Wheat	Bagged	Road	Jaunpur	Patna	290		42,000	12,180,000	0	0	Ramnagar MMT	Patna	63	361	0	1.10	1.09	1.06	1.03	1.01				134,754	140,054				48,646,031	52,003,497
Steel	Neo-Bulk	Road	Fatuwa	Kolkata	536		50,300	26,960,800	0	0	Patna	Kolkata GRT	21	815	0	1.06	1.06	1.04	1.03	1.02		69,520	86,169	114,426	144,122		56,659,090	70,228,123	93,256,865	117,459,250

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Wheat	Bagged	Road	Samastipur	Kolkata	565		101,000	57,065,000	0	0	Kahalgaon	Kolkata GRT	182	550	0	1.02	1.02	1.02	1.01	1.01			128,108	145,343	155,375			70,459,460	79,938,896	85,456,143
Cement	Bagged	Road	Chunar	Patna	271		36,500	9,891,500	0	0	Ramnagar MMT	Patna	31	361	0	1.10	1.10	1.07	1.05	1.02		63,447	90,097	142,169	179,065		22,904,316	32,525,138	51,322,943	64,642,474
Cement	Bagged	Road	Chunar	Kolkata	692		36,500	25,258,000	0	0	Ramnagar MMT	Kolkata GRT	31	1176	0	1.10	1.10	1.07	1.05	1.02		63,447	90,097	142,169	179,065		74,613,507	105,954,465	167,190,530	210,580,468
Fertilizer	Bagged	Road	Haldia	all Assam, Agartala (Tripura)	1,193	1,218	86,500	103,194,500	0	0	Haldia MMT	Sea/Other River	5	1588	150	1.05	1.05	1.03	1.02	1.01				168,958	180,620				268,305,922	286,823,940
Textiles	Neo-bulk	Road	Haldia HDC	Jaunpur	683		15,800	10,791,400	0	0	Haldia MMT	Ramnagar MMT	0	1281	63	1.20	1.19	1.13	1.08	1.03		44,586	80,379	168,407	215,769		57,114,368	102,964,934	215,729,714	276,400,569

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Project Cargo	Neo-Bulk	Road	Fatuwa	Kolkata	536		80,000	42,880,000	0	0	Patna	Kolkata GRT	21	815	0	1.05	1.05	1.04	1.03	1.02		108,755	133,882	177,570	223,654		88,635,729	109,114,133	144,719,783	182,278,025
Sand	Dry Bulk	Road	Mangalhat	Kolkata	352		73,500	25,872,000	0	0	Raj Mahal	Kolkata GRT	8	443	10	1.10	1.10	1.05	1.03	1.02			167,514	223,699	260,052			74,208,492	99,098,555	115,202,840
Project Cargo	Neo-Bulk	Road	Kolkata	Allahabad	790		162,000	127,980,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	121	1.00	1.01	1.02	1.02	1.02			184,711	228,455	287,745			217,220,294	268,663,552	338,388,164
Steel	Neo-Bulk	Road	Fatuwa	Kolkata	536		150,000	80,400,000	0	0	Patna	Kolkata GRT	21	815	0	1.06	1.06	1.04	1.03	1.02		207,317	256,967	341,229	429,787		168,963,488	209,427,803	278,101,984	350,276,094
Container	Container	Road	Haldia	Varanasi	774	692	72,000	55,728,000	0	0	Haldia MMT	Ramnagar MMT	5	1281	12	1.10	1.10	1.08	1.06	1.03				335,762	437,585				430,110,589	560,545,955
Steel	Neo-	Ro	Kolkata	Pratagarh	84		182,	154,9	0	0	Kolkata	Ramnaga	0	11	14	1.0	1.0	1.0	1.0	1.0			264,4	352,2	443,6			311,033,	414,265,	521,777,

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	Bulk	ad			9		500	42,500			GRT	r MMT		76	6	3	3	4	3	2			85	67	88			928	459	245
Steel	Neo-Bulk	Road	Kolkata	Sultanpur	830		216,000	179,280,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	152	1.03	1.03	1.04	1.03	1.02			313,034	416,929	525,132			368,127,827	490,308,708	617,555,533
Natural Aggregates	Dry Bulk	Road	Sakrigali	Karpurigram, Bihar	284		179,200	50,892,800	0	0	Sahibganj MMT	Patna	5	337	81	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sakrigali	Narayanpur Ananth, Bihar	320		179,200	57,344,000	0	0	Sahibganj MMT	Patna	5	337	72	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		109,183,343	137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sakrigali	Narkatiaganj, Bihar	506		179,200	90,675,200	0	0	Sahibganj MMT	Patna	5	337	224	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Natural Aggregates	Dry Bulk	Road	Sakrigali	Gauthamsthan, Bihar	389		179,200	69,708,800	0	0	Sahibganj MMT	Doriganj	5	382	25	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Sakrigali	Garhara, Bihar	223		179,200	39,961,600	0	0	Sahibganj MMT	Semaria	5	235	8	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Natural Aggregates	Dry Bulk	Road	Sakrigali	Kanti, Bihar	338		179,200	60,569,600	0	0	Sahibganj MMT	Patna	5	337	85	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		109,183,343	137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sakrigali	Siwan, Bihar	458		179,200	82,073,600	0	0	Sahibganj MMT	Doriganj	5	382	73	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregate	Dry Bulk	Road	Sakrigali	Chakia, Bihar	387		179,200	69,350,400	0	0	Sahibganj MM	Patna	5	337	113	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		109,183,343	137,635,494	183,799,431	213,668,266

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
s											T																			
Natural Aggregates	Dry Bulk	Road	Sakrigali	Sitamarhi, Bihar	380		179,200	68,096,000	0	0	Sahibganj MMT	Patna	5	337	139	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sakrigali	Barauni, Bihar	226		179,200	40,499,200	0	0	Sahibganj MMT	Semaria	5	235	10	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Natural Aggregates	Dry Bulk	Road	Sahibganj	Narayanpur Ananth, Bihar	305		179,200	54,656,000	0	0	Sahibganj MMT	Patna	10	337	72	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sahibganj	Narkatiaganj, Bihar	490		179,200	87,808,000	0	0	Sahibganj MMT	Patna	10	337	224	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggr	Dry Bul	Roa	Sahibganj	Gauthamsthan,	37		179,20	66,841,6	0	0	Sahibganj	Doriganj	10	38	25	1.1	1.1	1.0	1.0	1.0		323,9	408,4	545,3	634,0		123,762,7	156,014,	208,342,	242,199,

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
egates	k	d		Bihar	3		0	00			MMT			2		0	0	5	3	2		86	14	99	30		21	120	381	637
Natural Aggregates	Dry Bulk	Road	Sahibganj	Garhara, Bihar	207		179,200	37,094,400	0	0	Sahibganj MMT	Semaria	10	235	8	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Natural Aggregates	Dry Bulk	Road	Sahibganj	Kanti, Bihar	322		179,200	57,702,400	0	0	Sahibganj MMT	Patna	10	337	85	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sahibganj	Siwan, Bihar	434		179,200	77,772,800	0	0	Sahibganj MMT	Doriganj	10	382	73	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Sahibganj	Chakia, Bihar	371		179,200	66,483,200	0	0	Sahibganj MMT	Patna	10	337	113	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural	Dry Bul	Ro	Sahibganj	Sitamarhi,	36		179,	65,22	0	0	Sahibgan	Patn	1	33	13	1.1	1.1	1.0	1.0	1.0				545,3	634,0				183,799,	213,668,

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Aggregates	k	ad		Bihar	4		200	8,800			j MMT	a	0	7	9	0	0	5	3	2				99	30				431	266
Natural Aggregates	Dry Bulk	Road	Sahibganj	Barauni, Bihar	210		179,200	37,632,000	0	0	Sahibganj MMT	Semaria	10	235	10	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Narayanpur Ananth, Bihar	290		179,200	51,968,000	0	0	Sahibganj MMT	Patna	25	337	72	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Gauthamsthan, Bihar	359		179,200	64,332,800	0	0	Sahibganj MMT	Doriganj	25	382	25	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Garhara, Bihar	193		179,200	34,585,600	0	0	Sahibganj MMT	Semaria	25	235	8	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Kanti, Bihar	308		179,200	55,193,600	0	0	Sahibganj MMT	Patna	25	337	85	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Siwan, Bihar	420		179,200	75,264,000	0	0	Sahibganj MMT	Doriganj	25	382	73	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Chakia, Bihar	357		179,200	63,974,400	0	0	Sahibganj MMT	Patna	25	337	113	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Barauni, Bihar	196		179,200	35,123,200	0	0	Sahibganj MMT	Semaria	25	235	10	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Cement	Bagged	Road	Varanasi	Patna	269		300,000	80,700,000	0	0	Ramnagar MM	Patna	0	361	0	1.05	1.05	1.05	1.03	1.02		403,629	509,419	712,835	897,832		145,709,912	183,900,149	257,333,317	324,117,461

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
											T																			
Food	General Cargo	Road	Kushinagar (UP)	Haldia HDC	888		576,000	511,488,000	0	0	Doriganj	Haldia MMT	162	965	0	1.05	1.05	1.03	1.02	1.01				1,072,976	1,130,336				1,035,422,111	1,090,774,579
Cement	Bagged	Road	Jaunpur	Patna	290		100,000	29,000,000	0	0	Ramnagar MMT	Patna	63	361	0	1.20	1.19	1.12	1.07	1.02			501,804	1,002,628	1,262,834			181, 151, 369	361, 948, 788	455, 883, 147
Container	Container	Road	Kolkata	Birgunj (Nepal)	760	700	480,000	364,799,635	0	0	Kolkata GRT	Doriganj	5	860	182	1.10	1.10	1.08	1.06	1.03				2,238,408	2,917,228				1,925,031,157	2,508,816,233
Container	Container	Road	Kolkata	Varanasi	582	523	972,000	565,704,000	0	0	Kolkata GRT	Ramnagar MMT	5	1176	5	1.10	1.10	1.08	1.06	1.03				4,532,781	5,907,393				5,330,550,907	6,947,094,129
Sub-total							9,003,									1.0	1.0	1.0	1.0	1.0	0	3,952,78	11,760,6	28,287,8	34,081,4	0	1,927,308	5,336,093,25	17,926,740,9	22,051,598,7

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport	Origin	Destination	Road Distance	Rail Distance [km]	Volume 2014	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile"	Distance	"Last Mile"	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Growth Factor for	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Road							09 3									8	7	5	3	2		0	66	56	21		,48 2	6	64	61
Total all Modes							9, 00 3, 09 3														5, 13 4, 29 4	12, 26 4,3 25	22, 87 9,5 18	45, 24 6,6 37	53, 59 2,0 25	3,1 63, 585 ,85 1	7,2 01, 446 ,53 1	12,4 98,0 86,2 26	28,3 63,8 09,4 19	34,0 99,0 38,2 23

Table 9: Traffic Projections and Traffic Growth Rate For All Three modes: Rail, Road & IWT

				Road		Rail	IWT					
Average traffic growth rate				0.85		0.9	1					
Carrying capacity tonnes				18								
Average speed												
Fuel consumption l/km				0.0048		0.0313	0.0089					
CO_2 emission t/tkm				0.00016		0.000029	0.000031					
Forecasted Traffic Volume-Without Project (tkm)				Forecasted Traffic Volume-With Project (tkm)			Growth rate					
							Without project			With project		
Year	Road	Rail	IWT	Road	Rail	IWT	Road	Rail	IWT	Road	Rail	IWT
2015	4,441,316,039	882,508,895	2,949,498,845	4,441,316,039	882,508,895	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2016	4,752,208,161	900,159,073	2,949,498,845	5,084,862,733	918,162,254	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2017	5,084,862,733	918,162,254	2,949,498,845	5,440,803,124	936,525,499	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2018	5,440,803,124	936,525,499	2,949,498,845	5,821,659,343	955,256,009	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2019	5,821,659,343	955,256,009	2,949,498,845	6,229,175,497	974,361,130	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2020	6,229,175,497	974,361,130	2,949,498,845	5,559,539,131	894,463,517	3,067,478,799	1.05	1.02	1.04	0.8925	0.918	1.04
2021	6,540,634,272	993,848,352	3,067,478,799	5,837,516,087	912,352,787	3,190,177,951	1.05	1.02	1.03	0.8925	0.918	1.04
2022	6,867,665,985	1,013,725,319	3,159,503,163	6,129,391,892	930,599,843	3,349,073,353	1.05	1.02	1.03	0.8925	0.918	1.06
2023	7,211,049,284	1,033,999,826	3,254,288,258	6,435,861,486	949,211,840	3,482,088,436	1.05	1.02	1.03	0.8925	0.918	1.07
2024	7,571,601,749	1,054,679,822	3,351,916,905	6,757,654,561	1,025,148,787	3,620,070,258	1.05	1.08	1.03	0.8925	0.972	1.08
2025	7,950,181,836	1,139,054,208	3,452,474,413	6,960,384,198	1,086,657,714	3,728,672,366	1.03	1.06	1.02	0.8755	0.954	1.08
2026	8,188,687,291	1,207,397,460	3,521,523,901	7,169,195,723	1,151,857,177	3,803,245,813	1.03	1.06	1.02	0.8755	0.954	1.08

2027	8,434,347,910	1,279,841,308	3,591,954,379	7,384,271,595	1,220,968,608	3,879,310,729	1.03	1.06	1.02	0.8755	0.954	1.08
2028	8,687,378,347	1,356,631,787	3,663,793,466	7,605,799,743	1,294,226,724	3,956,896,944	1.03	1.06	1.02	0.8755	0.954	1.08
2029	8,947,999,698	1,438,029,694	3,737,069,336	7,833,973,735	1,371,880,328	4,036,034,883	1.03	1.06	1.02	0.8755	0.954	1.08
2030	9,216,439,689	1,524,311,475	3,811,810,722	8,068,992,947	1,454,193,147	4,116,755,580	1.03	1.06	1.02	0.8755	0.954	1.08
2031	9,492,932,879	1,615,770,164	3,888,046,937	8,311,062,736	1,541,444,736	4,199,090,692	1.03	1.06	1.02	0.8755	0.954	1.08
2032	9,777,720,866	1,712,716,374	3,965,807,876	8,560,394,618	1,633,931,420	4,283,072,506	1.03	1.06	1.02	0.8755	0.954	1.08
2033	10,071,052,492	1,815,479,356	4,045,124,033	8,817,206,456	1,731,967,306	4,368,733,956	1.03	1.06	1.02	0.8755	0.954	1.08
2034	10,373,184,066	1,924,408,117	4,126,026,514	9,081,722,650	1,835,885,344	4,456,108,635	1.03	1.06	1.02	0.8755	0.954	1.08
2035	10,684,379,588	2,039,872,605	4,208,547,044	9,354,174,330	1,946,038,465	4,545,230,808	1.03	1.06	1.02	0.8755	0.954	1.08
2036	11,004,910,976	2,162,264,961	4,292,717,985	9,541,257,816	2,023,880,003	4,636,135,424	1.02	1.04	1.01	0.867	0.936	1.08
2037	11,225,009,195	2,248,755,559	4,335,645,165	9,732,082,972	2,104,835,203	4,682,496,778	1.02	1.04	1.01	0.867	0.936	1.08
2038	11,449,509,379	2,338,705,782	4,379,001,616	9,926,724,632	2,189,028,612	4,379,001,616	1.02	1.04	1.01	0.867	0.936	1.00
2039	11,678,499,567	2,432,254,013	4,422,791,633	10,125,259,125	2,276,589,756	4,422,791,633	1.02	1.04	1.01	0.867	0.936	1.00
2040	11,912,069,558	2,529,544,173	4,467,019,549	10,327,764,307	2,367,653,346	4,467,019,549	1.02	1.04	1.01	0.867	0.936	1.00
2041	12,150,310,949	2,630,725,940	4,511,689,744	10,534,319,593	2,462,359,480	4,511,689,744	1.02	1.04	1.01	0.867	0.936	1.00
2042	12,393,317,168	2,735,954,978	4,556,806,642	10,745,005,985	2,560,853,859	4,556,806,642	1.02	1.04	1.01	0.867	0.936	1.00
2043	12,641,183,512	2,845,393,177	4,602,374,708	10,959,906,105	2,663,288,014	4,602,374,708	1.02	1.04	1.01	0.867	0.936	1.00
2044	12,894,007,182	2,959,208,904	4,648,398,455	11,179,104,227	2,769,819,534	4,648,398,455	1.02	1.04	1.01	0.867	0.936	1.00
2045	13,151,887,326	3,077,577,260	4,694,882,440	11,402,686,311	2,797,517,730	4,694,882,440	1.02	1.01	1.01	0.867	0.909	1.00

ANNEXURE 6.2

Annexure 6.2: List of Thermal Power Plants

SL. No.	Coal Projects	Latitude			Longitude		
		Degree	Min.	Sec.	Degree	Min.	Sec.
1	Kolaghat Thermal Power Station	22	25	5.56	87	52	19.78
2	Budge Budge	22	27	53.58	88	1	6.03
3	Bandel TPP	22	59	39.37	88	24	10.24
4	Sagardighi TPP	24	22	0.93	88	6	8.33
5	Farakka STPS	24	46	21.32	87	53	40.32
6	Kahalgaon STPS	25	14	26.98	87	16	0.77
7	Barauni TPP	25	23	54.58	86	1	12.05
8	Kanti TPS	26	11	49.36	85	18	5.36
9	Anpara TPS	24	12	12.11	82	47	17.36
10	Obra TPS	24	26	42.29	82	58	51.72
11	Haldia Energy Power Station Phase 1	22	6	8.93	88	10	46.04
12	Barh STPS	25	29	15.3	85	45	9.22
13	Banka Power Plant	24	33	11.62	86	43	44.89
14	Pirpainti TPS	25	20	5.06	87	24	55.95
15	Buxar Thermal power Station	25	33	5.56	83	57	24.46
16	Nabinagar SPTP	24	35	52.02	84	7	24.74
17	Nabinagar TPS	24	36	36.64	84	7	1.93
18	Lakhisarai TPS	25	12	1.64	86	10	49.74
19	Bhagalpur Power Project	25	14	25.48	87	16	0.3
20	Pirpainti Power Station CESC	25	23	56.47	87	27	10.83
21	Pirpainti TPS Ganga Power	25	24	3.15	87	27	15.13
22	Indragachi PS	22	14	8.92	88	15	2.76
23	Balagarh PS	23	7	32.59	88	28	13.6
24	Welspun Energy Mirzapur PS	25	8	12.08	82	33	43.72

ANNEXURE 6.3

Annexure 6.3.1: Air emissions for transportation of freight

Air Emissions for Transportation of Freight through IWT, Rail & Road mode Planned to be Transported through Phase I of IWT

Impact on Air Quality Du to Barge Movement

Exhaust gases from moving vessel are source of air pollution and GHG gases. However, vessels emit least air emissions compared to the road and railway modes. The impact on air quality due to vessel movement is anticipated insignificant considering the emission levels and projected vessel traffic. However, estimation is carried out to arrive at the total emission load from the movement of vessels and corresponding load for transportation of similar amount of cargo by rail and road. Emissions are calculated for transportation of cargo for entire project cycle through NW-1 between Haldia to Varanasi and detailed calculations. Emission factors considered for various transportation mode are given in **Table 1** below. Emissions savings for all the pollutants is given in **Table 1.2.** The analysis indicated that the emissions will be reduced overall due to modal shift and will have positive impact on micro climate. Traffic projections and emission generations estimations are given in **Table 3-9.**

Table 1: Emission Factors Considered for Gaseous Pollutants

Mode of Transportation	Emission Factor for NOx (t/tonne km)	Emission Factor for PM (t/tonne km)	Emission Factor for SO_2 (t/tonne km)	Emission Factor for HC (t/tonne km)	Emission Factor for CO (t/tonne km)
Railway (Diesel Engines)	0.0000004	0.00000007	0.00000018	0.00000007	0.00000015
Road	0.00000137	0.00000022	0.00000018	0.00000038	0.00000054
IWT (For inland vessels)	0.00000026	0.00000002	0.00000004	0.00000005	0.00000011

Table 2: Emission Savings in with Project Scenario

Year	SO_2 emissions (Tonne/Yr.)	NO_x emissions (Tonne/Yr.)	CO emissions (Tonne/Yr.)	HC emissions (Tonne/Yr.)	PM Emissions (Tonne/Yr)
2016	0	0	0	0	0
2017	0	0	0	0	0
2018	0	0	0	0	0
2019	0	0	0	0	0
2020	130.1969	918.6861	360.6105	254.1557	150.5532
2021	136.3225	963.9684	378.4112	266.7546	157.9367
2022	140.2691	995.3974	390.2841	276.8844	164.4477
2023	145.6836	1036.694	406.2616	289.1165	171.9205
2024	141.0999	1057.2	414.4643	297.9594	175.7725
2025	176.547	1305.17	511.9684	365.981	215.8993
2026	182.2369	1345.672	527.8671	377.2085	222.5415

2027	188.1166	1387.441	544.2629	388.7823	229.3908
2028	194.1929	1430.518	561.1718	400.7131	236.4536
2029	200.4729	1474.944	578.6102	413.012	243.7369
2030	206.9639	1520.764	596.5951	425.6908	251.2477
2031	213.6735	1568.021	615.1439	438.7612	258.9933
2032	220.6094	1616.762	634.2748	452.2357	266.9814
2033	227.7801	1667.035	654.0066	466.1268	275.2198
2034	235.1939	1718.89	674.3585	480.4478	283.7165
2035	242.8597	1772.377	695.3507	495.2122	292.4799
2036	274.6302	1971.27	773.3545	548.7043	324.8223
2037	280.7583	2012.696	789.6145	560.0438	331.5812
2038	301.0431	2146.086	844.7553	589.1356	345.49
2039	307.6028	2190.205	862.0995	601.1279	352.6094
2040	314.3153	2235.255	879.8085	613.3684	359.8795
2041	321.1844	2281.255	897.8903	625.8624	367.3038
2042	328.2142	2328.227	916.3532	638.6153	374.8855
2043	335.4089	2376.192	935.2056	651.6328	382.6284
2044	342.7726	2425.173	954.456	664.9204	390.5359
2045	365.2669	2508.429	986.5775	684.3006	404.4284
Savings Estimated (Tonnes)	5874.205	42201.2	16575.06	11700.31	6901.329

Table 3: Volume Of Cargo (Hpc Consultant)

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Coal	Dry bulk	IWT	Haldia	Begusarai		1		0	0	0	Haldia MMT	Semaria	0	818	18	1.00	1.00	1.00	1.00	1.00			56,344	45,075	36,060	0	0	46,089,348	36,871,479	29,497,183
Coal	Dry bulk	IWT	Haldia	Pirpainti		1		0	0	0	Haldia MMT	Sahibganj MMT	0	636	30	1.00	1.00	1.00	1.00	1.00		164,779	131,824	105,459	84,367	0	104,799,741	83,839,793	67,071,834	53,657,467
Coal	Dry bulk	IWT	Haldia	Buxar				0	0	0	Haldia MMT	Ghazipur	0	1142	54	1.00	1.00	1.00	1.00	1.00		166,108	132,887	106,309	85,047	0	189,695,717	151,756,573	121,405,259	97,124,207
Coal	Dry bulk	IWT	Haldia	Pirpainti				0	0	0	Haldia MMT	Sahibganj MMT	0	636	30	1.00	1.00	1.00	1.00	1.00		166,108	132,887	106,309	85,047	0	105,644,900	84,515,920	67,612,736	54,090,189

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Coal	Dry bulk	IWT	Haldia	Pirpainti				0	0	0	Haldia MMT	Sahibganj MMT	0	636	30	1.00	1.00	1.00	1.00	1.00		183,384	146,707	117,366	93,892	0	116,631,970	93,305,576	74,644,461	59,715,568
Coal	Dry bulk	IWT	Haldia	Kahalgaon				0	0	0	Haldia MMT	Kahalgaon	0	648	5	1.00	1.00	1.00	1.00	1.00			223,250	178,600	142,880	0	0	144,665,741	115,732,593	92,586,074
Project Cargo	Neo-bulk	IWT	Kolkata	Narayanganj (Bangladesh)			1,350	0	0	1,248,750	Kolkata GRT	Sea/Other River	0	925	0	1.05	1.05	1.04	1.03	1.02	1,421	1,835	2,259	2,996	3,774	1,314,324	1,697,605	2,089,820	2,771,761	3,491,099
Project Cargo	Neo-bulk	IWT	Kolkata	Narayanganj (Bangladesh)			1,762	0	0	1,629,850	Kolkata GRT	Sea/Other River	0	925	0	1.05	1.05	1.04	1.03	1.02	1,855	2,395	2,949	3,911	4,926	1,715,436	2,215,689	2,727,602	3,617,662	4,556,531
Steel	Neo-bul	IWT	Kolkata	Narayanganj (Banglade			2,335	0	0	2,159,875	Kolkata GR	Sea/Other	0	925	0	1.06	1.06	1.04	1.03	1.02	2,464	3,227	4,000	5,312	6,690	2,279,568	2,985,194	3,700,105	4,913,419	6,188,569

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	k			sh)							T	River																		
Project Cargo	Neo-bulk	IWT	Kolkata	Narayanganj (Bangladesh)			4,000	0	0	3,700,000	Kolkata GRT	Sea/Other River	0	925	0	1.05	1.05	1.04	1.03	1.02	4,210	5,438	6,694	8,879	11,183	3,894,293	5,029,942	6,192,060	8,212,626	10,343,998
Project Cargo	Neo-bulk	IWT	Haldia	Biswanath Charali (Assam)			4,600	0	0	7,714,200	Haldia MMT	Sea/Other River	0	1677	0	1.05	1.05	1.04	1.03	1.02	4,842	6,253	7,698	10,210	12,860	8,119,285	10,487,021	12,909,942	17,122,659	21,566,398
Project Cargo	Neo-bulk	IWT	Kolkata	Tezpur (Assam)			4,800	0	0	8,640,000	Kolkata GRT	Sea/Other River	0	1800	0	1.05	1.05	1.04	1.03	1.02	5,052	6,525	8,033	10,654	13,419	9,093,700	11,745,594	14,459,296	19,177,591	24,154,634
Project Cargo	Neo-bulk	IWT	Panihati (WB)	Ashuganj (Bangladesh)			7,300	0	0	7,285,400	Kolkata GRT	Sea/Other Riv	0	998	0	1.05	1.05	1.04	1.03	1.02	7,683	9,924	12,217	16,203	20,408	7,667,968	9,904,091	12,192,333	16,170,882	20,367,612

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
												er																		
Natural Aggregates	Dry Bulk	IWT	Nalhati (WB)	Chittagong (Bangladesh)			7,500	0	0	6,150,000	Pakur	Sea/Other River	45	820	0	1.10	1.10	1.05	1.03	1.02	8,278	13,560	17,093	22,826	26,536	6,787,969	11,118,945	14,016,438	18,717,652	21,759,416
Logs & Wood	Neo-bulk	IWT	Sagar Island	Kolkata			60,000	0	0	8,400,000	Sagar Island	Kolkata GRT	0	140	0	1.05	1.05	1.04	1.03	1.02	63,151	81,567	100,412	133,178	167,741	8,841,097	11,419,327	14,057,649	18,644,880	23,483,672
Natural Aggregates	Dry Bulk	IWT	Farakka	Haldia			90,000	0	0	45,810,000	Farakka	Haldia MMT	0	509	0	1.10	1.10	1.05	1.03	1.02	99,336	162,716	205,119	273,917	318,430	50,562,092	82,822,583	104,405,368	139,423,682	162,081,113
Petroleum	Neo-bulk	IWT	Haldia	Kolkata			250,550	0	0	26,307,750	Haldia MMT	Kolkata GRT	0	105	0	1.05	1.05	1.04	1.03	1.01	262,460	331,060	402,795	523,613	605,218	27,558,305	34,761,336	42,293,456	54,979,399	63,547,900
Fly Ash	Dry	IW	Budge Budge	Narayanganj			260,	0	0	233,48	Budge	Sea/Oth	0	898	0	1.0	1.0	1.0	1.0	1.0	271,	334,	402,	529,	656,	243,49	300,40	361,51	475,86	589,18

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	Bulk	T	(WB)	(Bangladesh)			000			0,000	Budge	er River				4	4	4	3	2	154	528	579	913	110	6,534	5,779	6,322	2,092	6,763
Fly Ash	Dry Bulk	IWT	Kolaghat (WB)	Narayanganj (Bangladesh)			266,461	0	0	218,498,020	Haldia MMT	Sea/Other River	0	820	0	1.04	1.04	1.04	1.03	1.02	277,892	342,841	412,584	543,082	672,414	227,871,812	281,129,296	338,318,488	445,326,901	551,379,738
Fly Ash	Dry Bulk	IWT	Durgapur (WB)	Narayanganj (Bangladesh)			807,000	0	0	746,475,000	Kolkata GRT	Sea/Other River	0	925	0	1.04	1.04	1.04	1.03	1.02	841,621	1,038,322	1,249,545	1,644,769	2,036,464	778,499,552	960,448,021	1,155,828,750	1,521,411,492	1,883,729,608
Coal	Dry Bulk	IWT	Sagar Island	Farakka			3,000,000	0	0	1,632,000,000	Sagar Island	Farakka	0	544	0	1.09	1.09	1.03	1.02	1.01	3,282,875	5,151,334	6,063,753	7,537,952	8,619,278	1,785,883,916	2,802,325,535	3,298,681,830	4,100,645,981	4,688,887,144
Sub-total IWT																1.04	1.04	1.03	1.02	1.01	5,134,29	8,171,90	9,721,62	11,926,5	13,702,7	3,163,585,85	5,045,268,28	5,987,562,41	7,330,337,03	8,461,394,88

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
																					4	5	7	34	47	1	5	1	9	4
Fertilizer	Bagged	Rail	Kakinada Sea ports limited	Bhagalpur Railway Station		1,417	4,988	0	7,067,996	0	Haldia MMT	Kahalgaon	6	648	30	1.03	1.03	1.02	1.01	1.01			6,368	7,227	7,726			4,126,537	4,683,268	5,006,499
Fertilizer	Bagged	Rail	Paradip	Bhagalpur Railway Station		892	4,988	0	4,449,296	0	Haldia MMT	Kahalgaon	20	648	30	1.03	1.03	1.02	1.01	1.01			6,368	7,227	7,726			4,126,537	4,683,268	5,006,499
Petroleum	Neo-bulk	Rail	Barauni (Bihar)	Haldia	587	574	2,646	0	1,518,804	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.07	1.04	1.01			6,419	9,963	11,515			5,250,993	8,149,544	9,419,645
Petroleum	Neo-bulk	Rail	Garhara Goods Marsh.Yard (Bihar)	Haldia	581	571	2,700	0	1,541,700	0	Semaria	Haldia MMT	7	818	5	1.10	1.09	1.07	1.04	1.01			6,550	10,166	11,750			5,358,156	8,315,861	9,611,883
Petroleum	Neo-bul	Rail	Baad (UP)	Haldia	1,435	1,370	2,700	0	3,699,00	0	Semaria	Haldia MM	540	818	5	1.10	1.09	1.07	1.04	1.01			6,550	10,166	11,750			5,358,156	8,315,861	9,611,883

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	k								0			T																		
Fertilizer	Bagged	Rail	Vishakapatnam	Katihar Railway Station		1,290	7,800	0	10,062,000	0	Haldia MMT	Maniharí	5	598	25	1.03	1.03	1.02	1.01	1.01			9,958	11,302	12,082			5,954,976	6,758,391	7,224,844
Steel	Neo-bulk	Rail	Haldia	Raxaul (Bihar)	822	812	2,835	0	2,302,020	0	Haldia MMT	Patna	5	920	198	1.10	1.10	1.07	1.05	1.02				10,981	13,831				10,102,507	12,724,349
Coal	Dry bulk	Rail	Haldia	Vyas Nagar (Bihar)	681	742	3,944	0	2,926,448	0	Haldia MMT	Patna	5	920	5	1.10	1.10	1.07	1.04	1.01			9,619	14,445	16,517			8,849,385	13,289,479	15,195,866
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	5,346	0	7,708,932	0	Sea/Other River	Haldia MMT	19	1639	5	1.10	1.09	1.07	1.04	1.01		9,247	12,970	20,129	23,266		15,155,924	21,257,206	32,991,197	38,132,853
Petroleum	Neo-	Rail	Gaziabad (UP)	Haldia	1,55	1,49	5,40	0	8,046,	0	Semaria	Haldia	661	818	5	1.1	1.0	1.0	1.0	1.0			13,1	20,3	23,5			10,716	16,631	19,223

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	bulk				5	0	0		000			MMT				0	9	7	4	1			01	32	01			,312	,723	,765
Fertilizer	Bagged	Rail	Vishakapatnam	Katihar Railway Station		1,290	15,600	0	20,124,000	0	Haldia MMT	Manihari	5	598	25	1.03	1.03	1.02	1.01	1.01			19,916	22,603	24,163			11,909,953	13,516,782	14,449,687
Project Cargo	Neo-Bulk	Rail	Kolkata	Pratagarh		849	18,250	0	15,494,250	0	Kolkata GRT	Ramnagar MMT	0	1176	146	1.00	1.01	1.02	1.02	1.02			20,809	25,736	32,416			24,470,805	30,266,110	38,120,889
Iron Ore	Dry bulk	Rail	Barauni (Bihar)	Haldia	587	574	10,200	0	5,854,800	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.06	1.03	1.01				30,960	32,910				25,325,127	26,920,465
Food Grains	Bagged	Rail	Delhi	Haldia	1,561	1,661	10,521	0	17,475,381	0	Semaria	Haldia MMT	664	818	5	1.10	1.09	1.06	1.03	1.01				32,269	33,994				26,396,140	27,807,247
Fertilizer	Bagged	Rail	Vishakapatnam	Katihar Railway		1,29	23,4	0	30,18	0	Haldia	Maniha	5	598	25	1.0	1.0	1.0	1.0	1.0			29,8	33,9	36,2			17,864	20,275	21,674

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
				Station		0	00		6,000		MMT	ri				3	3	2	1	1			74	05	45			,929	,173	,531
Petroleum	Neo-bulk	Rail	Baad (UP)	Haldia	1,435	1,370	10,800	0	14,796,000	0	Semaria	Haldia MMT	540	818	5	1.10	1.09	1.07	1.04	1.01			26,201	40,664	47,002			21,432,623	33,263,445	38,447,530
Petroleum	Neo-bulk	Rail	Garhara Goods Marsh.Yard (Bihar)	Haldia	581	571	13,392	0	7,646,832	0	Semaria	Haldia MMT	7	818	5	1.10	1.09	1.07	1.04	1.01			32,490	50,424	58,282			26,576,453	41,246,672	47,674,937
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	13,446	0	19,389,132	0	Semaria	Haldia MMT	19	818	5	1.10	1.09	1.07	1.04	1.01			32,621	50,627	58,517			26,683,616	41,412,989	47,867,175
Petroleum	Neo-bulk	Rail	Indian Oil Refinary Siding, Barauni (Bihar)	Haldia	570	586	18,900	0	11,075,400	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.07	1.04	1.01			45,852	71,163	82,253			37,507,091	58,211,029	67,283,178
Coal	Dry	Rail	Haldia	Krishna Silao	718	824	24,0	0	19,77	0	Haldia	Patna	5	920	5	1.1	1.1	1.0	1.0	1.0			58,5	87,9	100,			53,859	80,882	92,485

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	bulk			(Bihar) Khaja Bhandar			04		9,296		MMT					0	0	7	4	1			43	16	527			,186	,517	,183
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	24,138	0	34,806,996	0	Semaria	Haldia MMT	19	818	5	1.10	1.09	1.07	1.04	1.01			58,560	90,885	105,049			47,901,913	74,343,800	85,930,230
Steel	Dry bulk	Rail	Haldia	Raxaul (Bihar)	822	812	22,806	0	18,518,472	0	Haldia MMT	Patna	5	920	198	1.10	1.10	1.07	1.05	1.02				88,336	111,261				81,269,057	102,360,319
Petroleum	Neo-bulk	Rail	Barauni (Bihar)	Haldia	587	574	28,890	0	16,582,860	0	Semaria	Haldia MMT	12	818	5	1.10	1.09	1.07	1.04	1.01			70,088	108,777	125,730			57,332,268	88,979,716	102,847,143
Natural Aggregates	Dry Bulk	Rail	Sakrigali	Begusarai, Bihar		232	36,204	0	8,399,328	0	Sahibganj MMT	Semaria	3	235	20	1.10	1.10	1.05	1.03	1.02				110,188	128,094				25,894,091	30,102,082

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Natural Aggregates	Dry Bulk	Rail	Sakrigali	Danapur, Bihar		313	36,204	0	11,331,852	0	Sahibganj MMT	Patna	3	337	12	1.10	1.10	1.05	1.03	1.02				110,188	128,094				37,133,229	43,167,667
Natural Aggregates	Dry Bulk	Rail	Sakrigali	Sonpur Junction, Bihar		313	36,204	0	11,331,852	0	Sahibganj MMT	Patna	3	337	26	1.10	1.10	1.05	1.03	1.02				110,188	128,094				37,133,229	43,167,667
Petroleum	Neo-bulk	Rail	Numaligarh Siding (Assam)	Haldia	1,119	1,442	75,384	0	108,703,728	0	Sea/Other River	Haldia MMT	19	1639	5	1.10	1.09	1.07	1.04	1.01		130,393	182,885	283,837	328,073		213,713,840	299,748,077	465,209,208	537,711,739
Coal	Dry bulk	Rail	Haldia	Barh Super Thermal Power Stn	627	600	79,832	0	47,899,200	0	Haldia MMT	Sahibganj MMT	5	636	5	1.10	1.10	1.07	1.04	1.01			194,700	292,388	334,332			123,829,028	185,959,057	212,635,042

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Coal	Dry bulk	Rail	Haldia	NTPC Farakka	388	424	168,096	0	71,272,704	0	Haldia MMT	Farakka	5	509	5	1.10	1.10	1.07	1.04	1.01				615,660	703,976				313,370,688	358,323,981
Coal	Dry bulk	Rail	Haldia	NTPC Kahalgaon	501	518	224,196	0	116,133,528	0	Haldia MMT	Kahalgaon	5	648	5	1.10	1.10	1.07	1.04	1.01			546,785	821,128	938,920			354,316,359	532,091,199	608,420,135
Natural Aggregates	Dry Bulk	Rail	Pakur	Patna, Bihar		376	602,088	0	226,385,088	0	Pakur	Patna	20	426	10	1.10	1.10	1.05	1.03	1.02				1,832,467	2,130,257				780,631,058	907,489,669
Sub-total Rail																1.09	1.08	1.06	1.04	1.01	0	139,640	1,397,226	5,032,247	5,807,857	0	228,869,764	1,174,430,559	3,106,731,416	3,586,044,577
Iron Ore	Dry Bul	Road	Gaya	Kolkata	450		5	2,250	0	0	Patna	Kolkata GR	98	815	0	1.01	1.01	1.01	1.01	1.01			6	6	7			4,655	5,055	5,374

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	k											T																		
Project Cargo	Neo-Bulk	Road	Khadakpur (Patna)	Varanasi	420		5	2,100	0	0	Semaria	Ramnagar MMT	36	523	10	1.05	1.05	1.04	1.03	1.02			8	11	14			4,376	5,804	7,311
Food	General Cargo	Road	Purnea	Kolkata	494		58	28,652	0	0	Maniha ri	Kolkata GRT	57	493	10	1.02	1.02	1.01	1.01	1.01				74	78				36,594	38,550
Fertilizer	Bagged	Road	Dankuni, Mogra (WB)	Tezpur, Jorhat, Tinsukia (Assam)			200	0	0	0	Sea/Other River	Sea/Other River	112	1588	9	1.03	1.03	1.02	1.01	1.01				290	310				460,180	491,941
Fertilizer	Bagged	Road	Dankuni, Mogra (WB)	Assam (Tezpur, Jorhat, Tinsukia	1,090	1,020	171	186,857	0	0	Kolkata GRT	Sea/Other Riv	10	1800	15	1.05	1.05	1.03	1.02	1.01				335	358				602,725	644,324

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
				)								er																		
Bleaching Powder	Bagged	Road	Gaya	Kolkata	450		500	225,000	0	0	Patna	Kolkata GRT	98	815	0	1.02	1.02	1.01	1.01	1.01			585	640	674			476,450	521,510	549,389
Rice	Bagged	Road	Kolkata	Mau	708		250	177,000	0	0	Kolkata GRT	Ballia	0	923	69	1.10	1.09	1.06	1.03	1.01			560	768	816			516,600	708,533	752,773
Project Cargo	Neo-Bulk	Road	Varanasi	Patna	269		360	96,840	0	0	Ramnagar MMT	Patna	5	361	5	1.05	1.05	1.05	1.03	1.02		483	605	846	1,065		174,367	218,569	305,295	384,526
Project Cargo	Neo-Bulk	Road	Gaya	Kolkata	400		500	200,000	0	0	Patna	Kolkata GRT	98	815	0	1.05	1.05	1.04	1.03	1.02			837	1,110	1,398			681,963	904,499	1,139,238
Paper	Neo-	Roa	Varanasi	Patna	269		360	96,84	0	0	Ramna	Patna	0	361	0	1.1	1.1	1.0	1.0	1.0		624	880	1,38	1,74		225,30	317,81	500,60	630,51

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	bulk	d						0			garMMT					0	0	7	5	2				7	7		5	4	1	8
Food	General Cargo	Road	Kolkata	Varanasi	681		2,000	1,362,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	0	1.00	1.00	1.01	1.01	1.01			2,081	2,227	2,346			2,447,044	2,618,839	2,758,839
Coal	Dry Bulk	Road	Haldia HDC	Ballia	746		700	522,200	0	0	Haldia MMT	Ramnagar MMT	0	1281	0	1.10	1.10	1.07	1.04	1.01		1,237	1,707	2,564	2,932		1,584,441	2,186,933	3,284,206	3,755,328
Coal	Dry Bulk	Road	Haldia HDC	Ballia	746		800	596,800	0	0	Haldia MMT	Ramnagar MMT	0	1281	0	1.10	1.10	1.07	1.04	1.01		1,414	1,951	2,930	3,350		1,810,790	2,499,352	3,753,378	4,291,803
Coal	Dry Bulk	Road	Haldia HDC	Varanasi	773		1,000	773,000	0	0	Haldia MMT	Ramnagar MM	0	1281	0	1.10	1.10	1.07	1.04	1.01		1,767	2,439	3,663	4,188		2,263,487	3,124,190	4,691,723	5,364,754

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
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Textiles	Neo-bulk	Road	Katihar	Hooghly, West Bengal	436		1,313	572,468	0	0	Manihari	Kolkata GRT	25	493	57	1.07	1.07	1.05	1.04	1.03			2,449	3,477	4,455			1,207,261	1,714,354	2,196,492
Flour	Bagged	Road	Lalgunj (UP)	Kolkata	960	816	3,200	3,072,000	0	0	Patna	Kolkata GRT	397	815	5	1.02	1.02	1.02	1.01	1.01			3,900	4,386	4,621			3,178,790	3,574,731	3,765,832
Cement	Bagged	Road	Varanasi	Patna	269		1,000	269,000	0	0	Ramnagar MMT	Patna	0	361	0	1.10	1.10	1.07	1.05	1.02		1,738	2,468	3,895	4,906		627,516	891,100	1,406,108	1,771,027
Lime Stone	Dry bulk	Road	Kolkata	Allahabad	800	816	2,571	2,057,143	0	0	Kolkata GRT	Allahabad	5	1480	5	1.05	1.06	1.05	1.03	1.02				6,295	7,318				9,316,721	10,830,760
Paper	Neo-	Roa	Kolkata	Varanasi	681		1,80	1,225,	0	0	Kolkata	Ramna	0	1176	0	1.1	1.1	1.0	1.0	1.0			4,40	6,93	8,73			5,176,	8,153,	10,269

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	bulk	d					0	800			GRT	gar MMT				0	0	7	5	2			2	4	3			577	826	,939
Food	General Cargo	Road	Patna	Ballia	141		1,800	253,800	0	0	Patna	Ballia	5	108	5	1.15	1.14	1.08	1.04	1.01			5,805	8,956	9,435			626,984	967,260	1,018,968
Sand	Dry bulk	Road	Kolkata	Allahabad	800	816	3,429	2,742,857	0	0	Kolkata GRT	Allahabad	5	1480	5	1.05	1.06	1.05	1.03	1.02				8,393	9,757				12,422,294	14,441,013
Food Grains	Bagged	Road	Katihar	Patna, Bihar	304		7,700	2,340,800	0	0	Manihari	Patna	25	322	10	1.02	1.02	1.01	1.01	1.01			9,003	9,854	10,381			2,898,923	3,173,085	3,342,714
Food Grains	Bagged	Road	Katihar	Kolkata	458		7,700	3,526,600	0	0	Manihari	Kolkata GRT	25	493	10	1.02	1.02	1.01	1.01	1.01			9,003	9,854	10,381			4,438,413	4,858,171	5,117,883

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Textiles	Neo-bulk	Road	Varanasi	Kolkata	681		5,475	3,728,475	0	0	Ramnagar MMT	Kolkata GRT	0	1176	0	1.00	1.01	1.03	1.03	1.03		5,656	6,402	8,337	10,682		6,650,939	7,528,377	9,804,462	12,561,825
Paper	Neo-bulk	Road	Karnataka	Kolkata	2,200	2,236	4,286	9,428,571	0	0	Sea/Other River	Kolkata GRT	1000	1200	5	1.05	1.05	1.05	1.03	1.02		5,750	7,208	10,068	12,681		6,900,167	8,649,342	12,081,310	15,216,699
Logs & Wood	Neo-bulk	Road	Faizabad	Kolkata	878		3,120	2,739,360	0	0	Ramnagar MMT	Kolkata GRT	200	1176	0	1.10	1.10	1.07	1.05	1.02				12,018	15,137				14,133,299	17,801,227
Food	General Cargo	Road	Kolkata	Allahabad	790		8,400	6,636,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	121	1.05	1.05	1.03	1.02	1.01			12,924	15,648	16,484			15,198,459	18,401,543	19,385,268

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Wheat	Bagged	Road	Sk Nagar	Kolkata	941		3,840	3,613,440	0	0	Ramnagar MMT	Kolkata GRT	181	1176	0	1.13	1.12	1.07	1.04	1.01			10,925	16,490	17,628			12,848,175	19,392,359	20,730,787
Textiles	Neo-bulk	Road	Kolkata	Sultanpur	830		7,200	5,976,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	152	1.03	1.03	1.04	1.03	1.03		8,745	10,644	14,909	19,101		10,283,750	12,517,407	17,532,524	22,463,292
LPG Gas	Liquid Bulk	Road	Kolkata	Uttar Pradesh	1,000		7,200	7,200,000	0	0	Kolkata GRT	Allahabad	5	1480	202	1.05	1.05	1.05	1.03	1.01				16,750	19,360				24,789,530	28,652,961
Textiles	Neo-bulk	Road	Kolkata	Varanasi	681		10,950	7,456,950	0	0	Kolkata GRT	Ramnagar MMT	0	1176	0	1.00	1.01	1.03	1.03	1.03		11,311	12,803	16,674	21,364		13,301,878	15,056,754	19,608,925	25,123,651
Plastic Gra	Bagged	Road	Kanpur (UP)	Kolkata	1,160		6,300	7,308,00	0	0	Ramnagar	Kolkata GR	337	1249	5	1.05	1.05	1.06	1.04	1.03				17,012	22,045				21,247,85	27,534,74

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
nules								0			MMT	T																	2	1
Rice	Bagged	Road	Purnia (Bihar)	Dhulagarh (WB)	475		12,000	5,700,000	0	0	Kahalgaon	Kolkata GRT	121	550	5	1.05	1.05	1.03	1.02	1.01				22,378	23,776				12,308,128	13,076,635
Food Grains	Bagged	Road	Sultanpur	Kolkata	830		6,000	4,980,000	0	0	Ramnagar MMT	Kolkata GRT	152	1176	0	1.13	1.12	1.07	1.04	1.01				24,643	25,961				28,980,327	30,529,581
Project Cargo	Neo-Bulk	Road	Kolkata	Sultanpur	830		16,200	13,446,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	152	1.00	1.01	1.02	1.02	1.02				22,846	28,775				26,866,355	33,838,816
Textiles	Neo-bulk	Road	Kolkata	Allahabad	790		12,000	9,480,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	121	1.03	1.03	1.04	1.03	1.03		14,574	17,740	24,848	31,836		17,139,583	20,862,345	29,220,873	37,438,819

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Flour	Bagged	Road	Patna	Kolkata	620	534	16,800	10,416,000	0	0	Patna	Kolkata GRT	5	815	5	1.05	1.05	1.03	1.02	1.01				31,295	32,968				25,505,540	26,869,037
Textiles	Neo-bulk	Road	Haldia HDC	Chunar	784		7,200	5,644,800	0	0	Haldia MMT	Ramnagar MMT	31	1281	0	1.10	1.10	1.08	1.05	1.03		12,554	18,031	29,869	38,269		16,081,934	23,097,787	38,262,127	49,022,796
Cement	Bagged	Road	Varanasi	Kolkata	681		8,000	5,448,000	0	0	Ramnagar MMT	Kolkata GRT	0	1176	0	1.10	1.10	1.07	1.05	1.02			19,747	31,160	39,247			23,222,896	36,644,500	46,154,623
Rice	Bagged	Road	Naugarh (UP)	Kolkata	941		15,000	14,115,000	0	0	Ballia	Kolkata GRT	263	923	0	1.10	1.09	1.06	1.03	1.01			33,582	46,058	48,934			30,996,025	42,511,965	45,166,368
Food Grains	Bagged	Road	Allahabad	Kolkata	790		12,000	9,480,000	0	0	Ramnagar MM	Kolkata GRT	121	1176	0	1.13	1.12	1.07	1.04	1.01				49,286	51,921				57,960,653	61,059,163

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
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Textiles	Neo-bulk	Road	Kolkata	Partapgarh	849		21,900	18,593,100	0	0	Kolkata GRT	Ramnagar MMT	0	1176	146	1.03	1.03	1.04	1.03	1.03		26,598	32,376	45,347	58,100		31,279,738	38,073,779	53,328,093	68,325,846
Wheat	Bagged	Road	Fatuwa	Haldia	628		50,000	31,400,000	0	0	Patna	Haldia MMT	21	920	0	1.00	1.00	1.01	1.01	1.01		50,608	53,061	58,339	62,365		46,559,504	48,816,532	53,671,754	57,376,087
Statues	Neo-bulk	Road	Chunar	Kolkata	692		40,000	27,680,000	0	0	Ramnagar MMT	Kolkata GRT	31	1176	0	1.05	1.05	1.03	1.01	1.00		53,604	60,648	68,670	68,670		63,038,099	71,321,823	80,755,620	80,755,620
Statues	Neo-bulk	Road	Chunar	Patna	271		40,000	10,840,000	0	0	Ramnagar MMT	Patna	31	361	0	1.05	1.05	1.03	1.01	1.00		53,604	60,648	68,670	68,670		19,350,981	21,893,859	24,789,778	24,789,778

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Coal	Dry Bulk	Road	Haldia HDC	Sultanpur	921		21,000	19,341,000	0	0	Haldia MMT	Ramnagar MMT	0	1281	152	1.08	1.08	1.06	1.04	1.01		33,545	44,171	63,217	72,285		42,971,703	56,583,086	80,980,757	92,597,516
Coal	Dry Bulk	Road	Haldia HDC	Partapgarh	941		30,000	28,230,000	0	0	Haldia MMT	Ramnagar MMT	0	1281	146	1.08	1.08	1.06	1.04	1.01		47,922	63,101	90,310	103,265		61,388,147	80,832,980	115,686,796	132,282,166
Vehicles	Ro-Ro	Road	Delhi	Kolkata	1,500	1,470	27,000	40,500,000	0	0	Allahabad	Kolkata GRT	730	1480	5	1.05	1.05	1.06	1.05	1.03				84,168	112,206				124,569,068	166,065,433
Wheat	Bagged	Road	Shahganj (UP)	Patna	336		40,000	13,440,000	0	0	Ramnagar MMT	Patna	83	361	5	1.10	1.09	1.06	1.03	1.01		68,455	91,397	128,337	137,194		24,712,110	32,994,407	46,329,553	49,527,140
Project Car	Neo-Bul	Road	Gaya	Kolkata	450		50,000	22,500,0	0	0	Patna	Kolkata GR	98	815	0	1.05	1.05	1.04	1.03	1.02				110,98	139,78				90,449,86	113,923,7

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
go	k							00				T												1	4				4	66
Steel	Neo-Bulk	Road	Baikhatopur	Kolkata	507		50,000	25,350,000	0	0	Patna	Kolkata GRT	115	815	0	1.06	1.06	1.04	1.03	1.02			85,656	113,743	143,262			69,809,268	92,700,661	116,758,698
Wheat	Bagged	Road	Jaunpur	Manihari	604		42,000	25,368,000	0	0	Ramnagar MMT	Manihari	63	683	0	1.10	1.09	1.06	1.03	1.01			95,967	134,754	144,054			65,545,538	92,036,673	98,388,888
Wheat	Bagged	Road	Jaunpur	Patna	290		42,000	12,180,000	0	0	Ramnagar MMT	Patna	63	361	0	1.10	1.09	1.06	1.03	1.01				134,754	144,054				48,646,031	52,003,497
Steel	Neo-Bulk	Road	Fatuwa	Kolkata	536		50,300	26,960,800	0	0	Patna	Kolkata GRT	21	815	0	1.06	1.06	1.04	1.03	1.02		69,520	86,169	114,426	144,122		56,659,090	70,228,123	93,256,865	117,459,250

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
Wheat	Bagged	Road	Samastipur	Kolkata	565		101,000	57,065,000	0	0	Kahalgaon	Kolkata GRT	182	550	0	1.02	1.02	1.02	1.01	1.01			128,108	145,343	155,375			70,459,460	79,938,896	85,456,143
Cement	Bagged	Road	Chunar	Patna	271		36,500	9,891,500	0	0	Ramnagar MMT	Patna	31	361	0	1.10	1.10	1.07	1.05	1.02		63,447	90,097	142,169	179,065		22,904,316	32,525,138	51,322,943	64,642,474
Cement	Bagged	Road	Chunar	Kolkata	692		36,500	25,258,000	0	0	Ramnagar MMT	Kolkata GRT	31	1176	0	1.10	1.10	1.07	1.05	1.02		63,447	90,097	142,169	179,065		74,613,507	105,954,465	167,190,530	210,580,468
Fertilizer	Bagged	Road	Haldia	all Assam, Agartala (Tripura)	1,193	1,218	86,500	103,194,500	0	0	Haldia MMT	Sea/Other River	5	1588	150	1.05	1.05	1.03	1.02	1.01				168,958	180,620				268,305,922	286,823,940
Textiles	Neo-bul	Road	Haldia HDC	Jaunpur	683		15,800	10,791,4	0	0	Haldia MM	Ramnagar	0	1281	63	1.20	1.19	1.13	1.08	1.03		44,586	80,379	168,40	215,76		57,114,36	102,964,9	215,729,7	276,400,5

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
	k							00			T	MMT												7	9		8	34	14	69
Project Cargo	Neo-Bulk	Road	Fatuwa	Kolkata	536		80,000	42,880,000	0	0	Patna	Kolkata GRT	21	815	0	1.05	1.05	1.04	1.03	1.02		108,755	133,882	177,570	223,654		88,635,729	109,114,133	144,719,783	182,278,025
Sand	Dry Bulk	Road	Mangalhat	Kolkata	352		73,500	25,872,000	0	0	Raj Mahal	Kolkata GRT	8	443	10	1.10	1.10	1.05	1.03	1.02			167,514	223,699	260,052			74,208,492	99,098,555	115,202,840
Project Cargo	Neo-Bulk	Road	Kolkata	Allahabad	790		162,000	127,980,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	121	1.00	1.01	1.02	1.02	1.02			184,711	228,455	287,745			217,220,294	268,663,552	338,381,164
Steel	Neo-Bulk	Road	Fatuwa	Kolkata	536		150,000	80,400,000	0	0	Patna	Kolkata GRT	21	815	0	1.06	1.06	1.04	1.03	1.02		207,317	256,967	341,229	429,787		168,963,488	209,427,803	278,101,984	350,276,094
Contai	Contai	Roa	Haldia	Varanasi	774	692	72,0	55,72	0	0	Haldia	Ramna	5	1281	12	1.1	1.1	1.0	1.0	1.0				335,	437,				430,11	560,54

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
ner	ner	d					00	8,000			MMT	gar MMT				0	0	8	6	3				762	585				0,589	5,955
Steel	Neo-Bulk	Road	Kolkata	Pratagarh	849		182,500	154,942,500	0	0	Kolkata GRT	Ramnagar MMT	0	1176	146	1.03	1.03	1.04	1.03	1.02			264,485	352,267	443,688			311,033,928	414,265,459	521,777,245
Steel	Neo-Bulk	Road	Kolkata	Sultanpur	830		216,000	179,280,000	0	0	Kolkata GRT	Ramnagar MMT	0	1176	152	1.03	1.03	1.04	1.03	1.02			313,034	416,929	525,132			368,127,827	490,308,708	617,555,533
Natural Aggregates	Dry Bulk	Road	Sakrigali	Karpurigram, Bihar	284		179,200	50,892,800	0	0	Sahibganj MMT	Patna	5	337	81	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggrega	Dry Bulk	Road	Sakrigali	Narayanpur Ananth, Bihar	320		179,200	57,344,000	0	0	Sahibganj MM	Patna	5	337	72	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		109,183,343	137,635,494	183,799,431	213,668,266

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
tes											T																			
Natural Aggregates	Dry Bulk	Road	Sakrigali	Narkatiaganj, Bihar	506		179,200	90,675,200	0	0	Sahibganj MMT	Patna	5	337	224	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sakrigali	Gauthamsthan, Bihar	389		179,200	69,708,800	0	0	Sahibganj MMT	Doriganj	5	382	25	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Sakrigali	Garhara, Bihar	223		179,200	39,961,600	0	0	Sahibganj MMT	Semaria	5	235	8	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Natural Aggrega	Dry Bulk	Road	Sakrigali	Kanti, Bihar	338		179,200	60,569,600	0	0	Sahibganj MM	Patna	5	337	85	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		109,183,343	137,635,494	183,799,431	213,668,266

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW1	Exit Point NW1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
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Natural Aggregates	Dry Bulk	Road	Sakrigali	Siwan, Bihar	458		179,200	82,073,600	0	0	Sahibganj MMT	Doriganj	5	382	73	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Sakrigali	Chakia, Bihar	387		179,200	69,350,400	0	0	Sahibganj MMT	Patna	5	337	113	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		109,183,343	137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sakrigali	Sitamarhi, Bihar	380		179,200	68,096,000	0	0	Sahibganj MMT	Patna	5	337	139	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggrega	Dry Bulk	Road	Sakrigali	Barauni, Bihar	226		179,200	40,499,200	0	0	Sahibganj MM	Semaria	5	235	10	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
tes											T																			
Natural Aggregates	Dry Bulk	Road	Sahibganj	Narayanpur Ananth, Bihar	305		179,200	54,656,000	0	0	Sahibganj MMT	Patna	10	337	72	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sahibganj	Narkatiaganj, Bihar	490		179,200	87,808,000	0	0	Sahibganj MMT	Patna	10	337	224	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sahibganj	Gauthamsthan, Bihar	373		179,200	66,841,600	0	0	Sahibganj MMT	Doriganj	10	382	25	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggrega	Dry Bulk	Road	Sahibganj	Garhara, Bihar	207		179,200	37,094,400	0	0	Sahibganj MM	Semaria	10	235	8	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
tes											T																			
Natural Aggregates	Dry Bulk	Road	Sahibganj	Kanti, Bihar	322		179,200	57,702,400	0	0	Sahibganj MMT	Patna	10	337	85	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Sahibganj	Siwan, Bihar	434		179,200	77,772,800	0	0	Sahibganj MMT	Doriganj	10	382	73	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Sahibganj	Chakia, Bihar	371		179,200	66,483,200	0	0	Sahibganj MMT	Patna	10	337	113	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			137,635,494	183,799,431	213,668,266
Natural Aggrega	Dry Bulk	Road	Sahibganj	Sitamarhi, Bihar	364		179,200	65,228,800	0	0	Sahibganj MM	Patna	10	337	139	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
tes											T																			
Natural Aggregates	Dry Bulk	Road	Sahibganj	Barauni, Bihar	210		179,200	37,632,000	0	0	Sahibganj MMT	Semaria	10	235	10	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Narayanpur Ananth, Bihar	290		179,200	51,968,000	0	0	Sahibganj MMT	Patna	25	337	72	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Gauthamsthan, Bihar	359		179,200	64,332,800	0	0	Sahibganj MMT	Doriganj	25	382	25	1.10	1.10	1.05	1.03	1.02		323,986	408,414	545,399	634,030		123,762,721	156,014,120	208,342,381	242,199,637
Natural Aggrega	Dry Bulk	Road	Mirzachowk	Garhara, Bihar	193		179,200	34,585,600	0	0	Sahibganj MM	Semaria	25	235	8	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
tes											T																			
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Kanti, Bihar	308		179,200	55,193,600	0	0	Sahibganj MMT	Patna	25	337	85	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Siwan, Bihar	420		179,200	75,264,000	0	0	Sahibganj MMT	Doriganj	25	382	73	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			156,014,120	208,342,381	242,199,637
Natural Aggregates	Dry Bulk	Road	Mirzachowk	Chakia, Bihar	357		179,200	63,974,400	0	0	Sahibganj MMT	Patna	25	337	113	1.10	1.10	1.05	1.03	1.02				545,399	634,030				183,799,431	213,668,266
Natural Aggrega	Dry Bulk	Road	Mirzachowk	Barauni, Bihar	196		179,200	35,123,200	0	0	Sahibganj MM	Semaria	25	235	10	1.10	1.10	1.05	1.03	1.02			408,414	545,399	634,030			95,977,273	128,168,742	148,997,159

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
tes											T																			
Cement	Bagged	Road	Varanasi	Patna	269		300,000	80,700,000	0	0	Ramnagar MMT	Patna	0	361	0	1.05	1.05	1.05	1.03	1.02		403,629	509,419	712,835	897,832		145,709,912	183,900,149	257,333,317	324,117,461
Food	General Cargo	Road	Kushinagar (UP)	Haldia HDC	888		576,000	511,488,000	0	0	Doriganj	Haldia MMT	162	965	0	1.05	1.05	1.03	1.02	1.01				1,072,976	1,130,336				1,035,422,111	1,090,774,579
Cement	Bagged	Road	Jaunpur	Patna	290		100,000	29,000,000	0	0	Ramnagar MMT	Patna	63	361	0	1.20	1.19	1.12	1.07	1.02			501,804	1,002,628	1,262,834			181,151,369	361,948,788	455,883,147
Container	Container	Road	Kolkata	Birgunj (Nepal)	760	700	480,000	364,799,63	0	0	Kolkata GRT	Doriganj	5	860	182	1.10	1.10	1.08	1.06	1.03				2,238,40	2,917,22				1,925,031,15	2,508,816,23

Transport Case											Transport Case if shifted to IWT					Growth Rates					Forecast Medium Augmentation Case [tons]					Forecast Medium Augmentation Case [ton-km]				
Commodity Type	Cargo Type	Current Transport Mode	Origin	Destination	Road Distance [km]	Rail Distance [km]	Volume 2014 [tons]	Road tkm	Rail tkm	IWT tkm	Entry Point NW 1	Exit Point NW 1	"First Mile" Distance	Distance Waterway [km]	"Last Mile" Distance	Growth Factor for 2015	Growth Factor for 2016-2020	Growth Factor for 2021-2025	Growth Factor for 2026-2035	Growth Factor for 2036-2045	Forecast MAC 2015 [t]	Forecast MAC 2020 [t]	Forecast MAC 2025 [t]	Forecast MAC 2035 [t]	Forecast MAC 2045 [t]	Forecast MAC 2015 [t-km]	Forecast MAC 2020 [t-km]	Forecast MAC 2025 [t-km]	Forecast MAC 2035 [t-km]	Forecast MAC 2045 [t-km]
								5																8	8				7	3
Container	Container	Road	Kolkata	Varanasi	582	523	972,000	565,704,000	0	0	Kolkata GRT	Ramnagar MMT	5	1176	5	1.10	1.10	1.08	1.06	1.03				4,532,781	5,907,393				5,330,550,907	6,947,094,129
Sub-total Road							9,003,093									1.08	1.07	1.05	1.03	1.02	0	3,952,780	11,760,666	28,287,856	34,081,421	0	1,927,308,482	5,336,093,256	17,926,740,964	22,051,598,761
Total all Modes							9,003,093														5,134,294	12,264,325	22,879,518	45,246,637	53,592,025	3,163,585,851	7,201,446,531	12,498,086,226	28,363,809,419	34,099,038,223

Table 4: Traffic Projections

Forecasted Traffic Volume-Without Project				Road		Rail	IWT					
				Forecasted Traffic Volume-With Project			Growth rate					
							Without project			Without project		
Year	Road	Rail	IWT	Road	Rail	IWT	Road	Rail	IWT	Road	Rail	IWT
2015	4,441,316,039	882,508,895	2,949,498,845	4,441,316,039	882,508,895	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2016	4,752,208,161	900,159,073	2,949,498,845	5,084,862,733	918,162,254	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2017	5,084,862,733	918,162,254	2,949,498,845	5,440,803,124	936,525,499	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2018	5,440,803,124	936,525,499	2,949,498,845	5,821,659,343	955,256,009	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2019	5,821,659,343	955,256,009	2,949,498,845	6,229,175,497	974,361,130	2,949,498,845	1.07	1.02	1	1.07	1.02	1
2020	6,229,175,497	974,361,130	2,949,498,845	5,559,539,131	894,463,517	3,067,478,799	1.05	1.02	1.04	0.8925	0.918	1.04
2021	6,540,634,272	993,848,352	3,067,478,799	5,837,516,087	912,352,787	3,190,177,951	1.05	1.02	1.03	0.8925	0.918	1.04
2022	6,867,665,985	1,013,725,319	3,159,503,163	6,129,391,892	930,599,843	3,349,073,353	1.05	1.02	1.03	0.8925	0.918	1.06
2023	7,211,049,284	1,033,999,826	3,254,288,258	6,435,861,486	949,211,840	3,482,088,436	1.05	1.02	1.03	0.8925	0.918	1.07
2024	7,571,601,749	1,054,679,822	3,351,916,905	6,757,654,561	1,025,148,787	3,620,070,258	1.05	1.08	1.03	0.8925	0.972	1.08
2025	7,950,181,836	1,139,054,208	3,452,474,413	6,960,384,198	1,086,657,714	3,728,672,366	1.03	1.06	1.02	0.8755	0.954	1.08
2026	8,188,687,291	1,207,397,460	3,521,523,901	7,169,195,723	1,151,857,177	3,803,245,813	1.03	1.06	1.02	0.8755	0.954	1.08
2027	8,434,347,910	1,279,841,308	3,591,954,379	7,384,271,595	1,220,968,608	3,879,310,729	1.03	1.06	1.02	0.8755	0.954	1.08
2028	8,687,378,347	1,356,631,787	3,663,793,466	7,605,799,743	1,294,226,724	3,956,896,944	1.03	1.06	1.02	0.8755	0.954	1.08
2029	8,947,999,698	1,438,029,694	3,737,069,336	7,833,973,735	1,371,880,328	4,036,034,883	1.03	1.06	1.02	0.8755	0.954	1.08
2030	9,216,439,689	1,524,311,475	3,811,810,722	8,068,992,947	1,454,193,147	4,116,755,580	1.03	1.06	1.02	0.8755	0.954	1.08
2031	9,492,932,879	1,615,770,164	3,888,046,937	8,311,062,736	1,541,444,736	4,199,090,692	1.03	1.06	1.02	0.8755	0.954	1.08
2032	9,777,720,866	1,712,716,374	3,965,807,876	8,560,394,618	1,633,931,420	4,283,072,506	1.03	1.06	1.02	0.8755	0.954	1.08
2033							1.03	1.06	1.02	0.8755	0.954	1.08

	10,071,052,492	1,815,479,356	4,045,124,033	8,817,206,456	1,731,967,306	4,368,733,956						
2034	10,373,184,066	1,924,408,117	4,126,026,514	9,081,722,650	1,835,885,344	4,456,108,635	1.03	1.06	1.02	0.8755	0.954	1.08
2035	10,684,379,588	2,039,872,605	4,208,547,044	9,354,174,330	1,946,038,465	4,545,230,808	1.03	1.06	1.02	0.8755	0.954	1.08
2036	11,004,910,976	2,162,264,961	4,292,717,985	9,541,257,816	2,023,880,003	4,636,135,424	1.02	1.04	1.01	0.867	0.936	1.08
2037	11,225,009,195	2,248,755,559	4,335,645,165	9,732,082,972	2,104,835,203	4,682,496,778	1.02	1.04	1.01	0.867	0.936	1.08
2038	11,449,509,379	2,338,705,782	4,379,001,616	9,926,724,632	2,189,028,612	4,379,001,616	1.02	1.04	1.01	0.867	0.936	1.00
2039	11,678,499,567	2,432,254,013	4,422,791,633	10,125,259,125	2,276,589,756	4,422,791,633	1.02	1.04	1.01	0.867	0.936	1.00
2040	11,912,069,558	2,529,544,173	4,467,019,549	10,327,764,307	2,367,653,346	4,467,019,549	1.02	1.04	1.01	0.867	0.936	1.00
2041	12,150,310,949	2,630,725,940	4,511,689,744	10,534,319,593	2,462,359,480	4,511,689,744	1.02	1.04	1.01	0.867	0.936	1.00
2042	12,393,317,168	2,735,954,978	4,556,806,642	10,745,005,985	2,560,853,859	4,556,806,642	1.02	1.04	1.01	0.867	0.936	1.00
2043	12,641,183,512	2,845,393,177	4,602,374,708	10,959,906,105	2,663,288,014	4,602,374,708	1.02	1.04	1.01	0.867	0.936	1.00
2044	12,894,007,182	2,959,208,904	4,648,398,455	11,179,104,227	2,769,819,534	4,648,398,455	1.02	1.04	1.01	0.867	0.936	1.00
2045	13,151,887,326	3,077,577,260	4,694,882,440	11,402,686,311	2,797,517,730	4,694,882,440	1.02	1.01	1.01	0.867	0.909	1.00

Table 5: SO_2 Emissions Savings During Transportation

Emissions				Road			Rail			IWT
SO2 emissions (t/tkm)				0.00000018			0.00000018			0.00000004
Year	Without Project (Tonnes)			With Project (Tonnes)			Savings (With project-Without Project) Tonnes			Tonnes
	Road	Rail	IWT	Road	Rail	IWT	Road	Rail	IWT	Total

2015	799.436887	158.851601	117.9799538	799.4369	158.8516	117.98	0	0	0	0
2016	855.3974691	162.028633	117.9799538	915.2753	165.2692	117.98	-59.8778	-3.24057	0	-63.1184
2017	915.2752919	165.269206	117.9799538	979.3446	168.5746	117.98	-64.0693	-3.30538	0	-67.3747
2018	979.3445623	168.57459	117.9799538	1047.899	171.9461	117.98	-68.5541	-3.37149	0	-71.9256
2019	1047.898682	171.946082	117.9799538	1121.252	175.385	117.98	-73.3529	-3.43892	0	-76.7918
2020	1121.251589	175.385003	117.9799538	1000.717	161.0034	122.6992	120.5345	14.38157	-4.7192	130.1969
2021	1177.314169	178.892703	122.699152	1050.753	164.2235	127.6071	126.5613	14.6692	-4.90797	136.3225
2022	1236.179877	182.470557	126.3801265	1103.291	167.508	133.9629	132.8893	14.96259	-7.58281	140.2691
2023	1297.988871	186.119969	130.1715303	1158.455	170.8581	139.2835	139.5338	15.26184	-9.11201	145.6836
2024	1362.888315	189.842368	134.0766762	1216.378	184.5268	144.8028	146.5105	5.315586	-10.7261	141.0999
2025	1431.03273	205.029757	138.0989765	1252.869	195.5984	149.1469	178.1636	9.431369	-11.0479	176.547
2026	1473.963712	217.331543	140.860956	1290.455	207.3343	152.1298	183.5085	9.997251	-11.2689	182.2369
2027	1518.182624	230.371435	143.6781752	1329.169	219.7743	155.1724	189.0137	10.59709	-11.4943	188.1166
2028	1563.728102	244.193722	146.5517387	1369.044	232.9608	158.2759	194.6841	11.23291	-11.7241	194.1929
2029	1610.639946	258.845345	149.4827734	1410.115	246.9385	161.4414	200.5247	11.90689	-11.9586	200.4729
2030	1658.959144	274.376066	152.4724289	1452.419	261.7548	164.6702	206.5404	12.6213	-12.1978	206.9639
2031	1708.727918	290.838629	155.5218775	1495.991	277.4601	167.9636	212.7366	13.37858	-12.4418	213.6735
2032	1759.989756	308.288947	158.632315	1540.871	294.1077	171.3229	219.1187	14.18129	-12.6906	220.6094
2033	1812.789448	326.786284	161.8049613	1587.097	311.7541	174.7494	225.6923	15.03217	-12.9444	227.7801
2034	1867.173132	346.393461	165.0410606	1634.71	330.4594	178.2443	232.4631	15.9341	-13.2033	235.1939
2035	1923.188326	367.177069	168.3418818	1683.751	350.2869	181.8092	239.4369	16.89015	-13.4674	242.8597
2036	1980.883976	389.207693	171.7087194	1717.426	364.2984	185.4454	263.4576	24.90929	-13.7367	274.6302
2037	2020.501655	404.776001	173.4258066	1751.775	378.8703	187.2999	268.7267	25.90566	-13.8741	280.7583
2038	2060.911688	420.967041	175.1600647	1786.81	394.0252	175.1601	274.1013	26.94189	0	301.0431
2039	2102.129922	437.805722	176.9116653	1822.547	409.7862	176.9117	279.5833	28.01957	0	307.6028
2040	2144.17252	455.317951	178.680782	1858.998	426.1776	178.6808	285.1749	29.14035	0	314.3153
2041	2187.055971	473.530669	180.4675898	1896.178	443.2247	180.4676	290.8784	30.30596	0	321.1844
2042	2230.79709	492.471896	182.2722657	1934.101	460.9537	182.2723	296.696	31.5182	0	328.2142
2043	2275.413032	512.170772	184.0949883	1972.783	479.3918	184.095	302.6299	32.77893	0	335.4089

2044	2320.921293	532.657603	185.9359382	2012.239	498.5675	185.9359	308.6825	34.09009	0	342.7726
2045	2367.339719	553.963907	187.7952976	2052.484	503.5532	187.7953	314.8562	50.41072	0	365.2669
										5874.205

Table 6: NO_x Emissions Savings During Transportation

Emissions				Road			Rail			IWT
NOx emissions (t/tkm)				0.00000137			0.0000004			0.00000026
Year	Without Project (Tonnes)			With Project (Tonnes)			Savings (With project-Without Project) Tonnes			Tonnes
	Road	Rail	IWT	Road	Rail		Road	Rail	IWT	Total
2015	6084.602973	353.003558	766.8696997	6084.603	353.0036	766.8697	0	0	0	0
2016	6510.525181	360.063629	766.8696997	6966.262	367.2649	766.8697	-455.737	-7.20127	0	-462.938
2017	6966.261944	367.264902	766.8696997	7453.9	374.6102	766.8697	-487.638	-7.3453	0	-494.984
2018	7453.90028	374.6102	766.8696997	7975.673	382.1024	766.8697	-521.773	-7.4922	0	-529.265
2019	7975.6733	382.102404	766.8696997	8533.97	389.7445	766.8697	-558.297	-7.64205	0	-565.939
2020	8533.970431	389.744452	766.8696997	7616.569	357.7854	797.5445	917.4018	31.95905	-30.6748	918.6861
2021	8960.668952	397.539341	797.5444877	7997.397	364.9411	829.4463	963.2719	32.59823	-31.9018	963.9684
2022	9408.7024	405.490128	821.4708223	8397.267	372.2399	870.7591	1011.436	33.25019	-49.2882	995.3974
2023	9879.13752	413.59993	846.114947	8817.13	379.6847	905.343	1062.007	33.91519	-59.228	1036.694
2024	10373.0944	421.871929	871.4983954	9257.987	410.0595	941.2183	1115.108	11.81241	-69.7199	1057.2
2025	10891.74912	455.621683	897.6433473	9535.726	434.6631	969.4548	1356.023	20.9586	-71.8115	1305.17
2026	11218.50159	482.958984	915.5962142	9821.798	460.7429	988.8439	1396.703	22.21611	-73.2477	1345.672
2027	11555.05664	511.936523	933.9081385	10116.45	488.3874	1008.621	1438.605	23.54908	-74.7127	1387.441
2028	11901.70834	542.652715	952.5863013	10419.95	517.6907	1028.793	1481.763	24.96202	-76.2069	1430.518
2029	12258.75959	575.211877	971.6380273	10732.54	548.7521	1049.369	1526.216	26.45975	-77.731	1474.944
2030	12626.52237	609.72459	991.0707878	11054.52	581.6773	1070.356	1572.002	28.04733	-79.2857	1520.764
2031	13005.31804	646.308066	1010.892204	11386.16	616.5779	1091.764	1619.162	29.73017	-80.8714	1568.021
2032	13395.47759	685.086549	1031.110048	11727.74	653.5726	1113.599	1667.737	31.51398	-82.4888	1616.762

2033	13797.34191	726.191742	1051.732249	12079.57	692.7869	1135.871	1717.769	33.40482	-84.1386	1667.035
2034	14211.26217	769.763247	1072.766894	12441.96	734.3541	1158.588	1769.302	35.40911	-85.8214	1718.89
2035	14637.60004	815.949042	1094.222231	12815.22	778.4154	1181.76	1822.381	37.53366	-87.5378	1772.377
2036	15076.72804	864.905984	1116.106676	13071.52	809.552	1205.395	2005.205	55.35398	-89.2885	1971.27
2037	15378.2626	899.502224	1127.267743	13332.95	841.9341	1217.449	2045.309	57.56814	-90.1814	2012.696
2038	15685.82785	935.482313	1138.54042	13599.61	875.6114	1138.54	2086.215	59.87087	0	2146.086
2039	15999.54441	972.901605	1149.925824	13871.61	910.6359	1149.926	2127.939	62.2657	0	2190.205
2040	16319.53529	1011.81767	1161.425083	14149.04	947.0613	1161.425	2170.498	64.75633	0	2235.255
2041	16645.926	1052.29038	1173.039334	14432.02	984.9438	1173.039	2213.908	67.34658	0	2281.255
2042	16978.84452	1094.38199	1184.769727	14720.66	1024.342	1184.77	2258.186	70.04045	0	2328.227
2043	17318.42141	1138.15727	1196.617424	15015.07	1065.315	1196.617	2303.35	72.84207	0	2376.192
2044	17664.78984	1183.68356	1208.583598	15315.37	1107.928	1208.584	2349.417	75.75575	0	2425.173
2045	18018.08564	1231.0309	1220.669434	15621.68	1119.007	1220.669	2396.405	112.0238	0	2508.429

Table 7: CO Emissions Savings During Transportation

Emissions				Road			Rail			IWT
CO emissions (t/tkm)				0.00000054			0.00000015			0.00000011
Year	Without Project (Tonnes)			With Project (Tonnes)			Savings (With project-Without Project) Tonnes			Tonnes
	Road	Rail	IWT	Road	Rail		Road	Rail	IWT	Total
2015	2398.310661	132.376334	324.444873	2398.311	132.3763	324.4449	0	0	0	0
2016	2566.192407	135.023861	324.444873	2745.826	137.7243	324.4449	-179.633	-2.70048	0	-182.334
2017	2745.825876	137.724338	324.444873	2938.034	140.4788	324.4449	-192.208	-2.75449	0	-194.962
2018	2938.033687	140.478825	324.444873	3143.696	143.2884	324.4449	-205.662	-2.80958	0	-208.472
2019	3143.696045	143.288401	324.444873	3363.755	146.1542	324.4449	-220.059	-2.86577	0	-222.924
2020	3363.754768	146.154169	324.444873	3002.151	134.1695	337.4227	361.6036	11.98464	-12.9778	360.6105
2021	3531.942507	149.077253	337.4226679	3152.259	136.8529	350.9196	379.6838	12.22433	-13.4969	378.4112
2022	3708.539632	152.058798	347.5453479	3309.872	139.59	368.3981	398.668	12.46882	-20.8527	390.2841

2023	3893.966614	155.099974	357.9717083	3475.365	142.3818	383.0297	418.6014	12.7182	-25.058	406.2616
2024	4088.664944	158.201973	368.7108596	3649.133	153.7723	398.2077	439.5315	4.429655	-29.4969	414.4643
2025	4293.098191	170.858131	379.7721854	3758.607	162.9987	410.154	534.4907	7.859474	-30.3818	511.9684
2026	4421.891137	181.109619	387.3676291	3871.366	172.7786	418.357	550.5254	8.331042	-30.9894	527.8671
2027	4554.547871	191.976196	395.1149817	3987.507	183.1453	426.7242	567.0412	8.830905	-31.6092	544.2629
2028	4691.184307	203.494768	403.0172813	4107.132	194.134	435.2587	584.0524	9.360759	-32.2414	561.1718
2029	4831.919837	215.704454	411.0776269	4230.346	205.782	443.9638	601.574	9.922405	-32.8862	578.6102
2030	4976.877432	228.646721	419.2991795	4357.256	218.129	452.8431	619.6212	10.51775	-33.5439	596.5951
2031	5126.183755	242.365525	427.6851631	4487.974	231.2167	461.9	638.2099	11.14881	-34.2148	615.1439
2032	5279.969267	256.907456	436.2388663	4622.613	245.0897	471.138	657.3562	11.81774	-34.8991	634.2748
2033	5438.368345	272.321903	444.9636436	4761.291	259.7951	480.5607	677.0769	12.52681	-35.5971	654.0066
2034	5601.519396	288.661218	453.8629165	4904.13	275.3828	490.1719	697.3892	13.27842	-36.309	674.3585
2035	5769.564978	305.980891	462.9401748	5051.254	291.9058	499.9754	718.3108	14.07512	-37.0352	695.3507
2036	5942.651927	324.339744	472.1989783	5152.279	303.582	509.9749	790.3727	20.75774	-37.7759	773.3545
2037	6061.504966	337.313334	476.9209681	5255.325	315.7253	515.0746	806.1802	21.58805	-38.1537	789.6145
2038	6182.735065	350.805867	481.6901778	5360.431	328.3543	481.6902	822.3038	22.45158	0	844.7553
2039	6306.389766	364.838102	486.5070796	5467.64	341.4885	486.5071	838.7498	23.34964	0	862.0995
2040	6432.517561	379.431626	491.3721504	5576.993	355.148	491.3722	855.5248	24.28362	0	879.8085
2041	6561.167913	394.608891	496.2858719	5688.533	369.3539	496.2859	872.6353	25.25497	0	897.8903
2042	6692.391271	410.393247	501.2487306	5802.303	384.1281	501.2487	890.088	26.26517	0	916.3532
2043	6826.239096	426.808977	506.2612179	5918.349	399.4932	506.2612	907.8898	27.31577	0	935.2056
2044	6962.763878	443.881336	511.3238301	6036.716	415.4729	511.3238	926.0476	28.40841	0	954.456
2045	7102.019156	461.636589	516.4370684	6157.451	419.6277	516.4371	944.5685	42.00893	0	986.5775

Table 8: PM Emissions Savings During Transportation

Emissions		Road	Rail	IWT
PM emissions (t/tkm)		0.00000022	0.00000007	0.00000002
Year	Without Project (Tonnes)	With Project (Tonnes)	Savings (With project-Without Project) Tonnes	Tonnes

	Road	Rail	IWT	Road	Rail		Road	Rail	IWT	Total
2015	977.0895285	61.7756227	58.9899769	977.0895	61.77562	58.98998	0	0	0	0
2016	1045.485796	63.0111351	58.9899769	1118.67	64.27136	58.98998	-73.184	-1.26022	0	-74.4442
2017	1118.669801	64.2713578	58.9899769	1196.977	65.55678	58.98998	-78.3069	-1.28543	0	-79.5923
2018	1196.976687	65.556785	58.9899769	1280.765	66.86792	58.98998	-83.7884	-1.31114	0	-85.0995
2019	1280.765055	66.8679207	58.9899769	1370.419	68.20528	58.98998	-89.6536	-1.33736	0	-90.9909
2020	1370.418609	68.2052791	58.9899769	1223.099	62.61245	61.34958	147.32	5.592833	-2.3596	150.5532
2021	1438.93954	69.5693847	61.34957598	1284.254	63.8647	63.80356	154.686	5.70469	-2.45398	157.9367
2022	1510.886517	70.9607723	63.19006326	1348.466	65.14199	66.98147	162.4203	5.818783	-3.7914	164.4477
2023	1586.430843	72.3799878	65.08576515	1415.89	66.44483	69.64177	170.5413	5.935159	-4.556	171.9205
2024	1665.752385	73.8275876	67.03833811	1486.684	71.76042	72.40141	179.0684	2.067172	-5.36307	175.7725
2025	1749.040004	79.7337946	69.04948825	1531.285	76.06604	74.57345	217.7555	3.667755	-5.52396	215.8993
2026	1801.511204	84.5178222	70.43047802	1577.223	80.63	76.06492	224.2881	3.88782	-5.63444	222.5415
2027	1855.55654	89.5888916	71.83908758	1624.54	85.4678	77.58621	231.0168	4.121089	-5.74713	229.3908
2028	1911.223236	94.9642251	73.27586933	1673.276	90.59587	79.13794	237.9473	4.368354	-5.86207	236.4536
2029	1968.559933	100.662079	74.74138671	1723.474	96.03162	80.7207	245.0857	4.630456	-5.97931	243.7369
2030	2027.616731	106.701803	76.23621445	1775.178	101.7935	82.33511	252.4383	4.908283	-6.0989	251.2477
2031	2088.445233	113.103911	77.76093874	1828.434	107.9011	83.98181	260.0114	5.20278	-6.22088	258.9933
2032	2151.09859	119.890146	79.31615751	1883.287	114.3752	85.66145	267.8118	5.514947	-6.34529	266.9814
2033	2215.631548	127.083555	80.90248066	1939.785	121.2377	87.37468	275.8461	5.845844	-6.4722	275.2198
2034	2282.100495	134.708568	82.52053028	1997.979	128.512	89.12217	284.1215	6.196594	-6.60164	283.7165
2035	2350.563509	142.791082	84.17094088	2057.918	136.2227	90.90462	292.6452	6.56839	-6.73368	292.4799
2036	2421.080415	151.358547	85.8543597	2099.077	141.6716	92.72271	322.0037	9.686947	-6.86835	324.8223
2037	2469.502023	157.412889	86.7129033	2141.058	147.3385	93.64994	328.4438	10.07442	-6.93703	331.5812
2038	2518.892063	163.709405	87.58003233	2183.879	153.232	87.58003	335.0126	10.4774	0	345.49
2039	2569.269905	170.257781	88.45583265	2227.557	159.3613	88.45583	341.7129	10.8965	0	352.6094
2040	2620.655303	177.068092	89.34039098	2272.108	165.7357	89.34039	348.5472	11.33236	0	359.8795
2041	2673.068409	184.150816	90.23379489	2317.55	172.3652	90.23379	355.5181	11.78565	0	367.3038
2042	2726.529777	191.516848	91.13613284	2363.901	179.2598	91.13613	362.6285	12.25708	0	374.8855

2043	2781.060373	199.177522	92.04749417	2411.179	186.4302	92.04749	369.881	12.74736	0	382.6284
2044	2836.68158	207.144623	92.96796911	2459.403	193.8874	92.96797	377.2787	13.25726	0	390.5359
2045	2893.415212	215.430408	93.8976488	2508.591	195.8262	93.89765	384.8242	19.60417	0	404.4284

Table 9: HC Emissions Savings During Transportation

Emissions				Road			Rail			IWT
HC emissions (t/tkm)				0.00000038			0.00000007			0.00000005
Year	Without Project (Tonnes)			With Project (Tonnes)			Savings (With project-Without Project) Tonnes			Tonnes
	Road	Rail	IWT	Road	Rail		Road	Rail	IWT	Total
2015	1687.700095	61.7756227	147.4749423	1687.7	61.77562	147.4749	0	0	0	0
2016	1805.839101	63.0111351	147.4749423	1932.248	64.27136	147.4749	-126.409	-1.26022	0	-127.669
2017	1932.247838	64.2713578	147.4749423	2067.505	65.55678	147.4749	-135.257	-1.28543	0	-136.543
2018	2067.505187	65.556785	147.4749423	2212.231	66.86792	147.4749	-144.725	-1.31114	0	-146.036
2019	2212.23055	66.8679207	147.4749423	2367.087	68.20528	147.4749	-154.856	-1.33736	0	-156.193
2020	2367.086689	68.2052791	147.4749423	2112.625	62.61245	153.3739	254.4618	5.592833	-5.899	254.1557
2021	2485.441023	69.5693847	153.3739399	2218.256	63.8647	159.5089	267.1849	5.70469	-6.13496	266.7546
2022	2609.713074	70.9607723	157.9751581	2329.169	65.14199	167.4537	280.5442	5.818783	-9.47851	276.8844
2023	2740.198728	72.3799878	162.7144129	2445.627	66.44483	174.1044	294.5714	5.935159	-11.39	289.1165
2024	2877.208664	73.8275876	167.5958453	2567.909	71.76042	181.0035	309.2999	2.067172	-13.4077	297.9594
202	3021.06909	79.733794	172.623720	2644.94	76.0660	186.433	376.1231	3.667755	-	365.981

5	8	6	6	6	4	6			13.8099	
2026	3111.701171	84.5178222	176.076195	2724.294	80.63	190.1623	387.4068	3.88782	-14.0861	377.2085
2027	3205.052206	89.5888916	179.5977189	2806.023	85.4678	193.9655	399.029	4.121089	-14.3678	388.7823
2028	3301.203772	94.9642251	183.1896733	2890.204	90.59587	197.8448	410.9999	4.368354	-14.6552	400.7131
2029	3400.239885	100.662079	186.8534668	2976.91	96.03162	201.8017	423.3299	4.630456	-14.9483	413.012
2030	3502.247082	106.701803	190.5905361	3066.217	101.7935	205.8378	436.0298	4.908283	-15.2472	425.6908
2031	3607.314494	113.103911	194.4023468	3158.204	107.9011	209.9545	449.1107	5.20278	-15.5522	438.7612
2032	3715.533929	119.890146	198.2903938	3252.95	114.3752	214.1536	462.584	5.514947	-15.8632	452.2357
2033	3826.999947	127.083555	202.2562017	3350.538	121.2377	218.4367	476.4615	5.845844	-16.1805	466.1268
2034	3941.809945	134.708568	206.3013257	3451.055	128.512	222.8054	490.7553	6.196594	-16.5041	480.4478
2035	4060.064244	142.791082	210.4273522	3554.586	136.2227	227.2615	505.478	6.56839	-16.8342	495.2122
2036	4181.866171	151.358547	214.6358992	3625.678	141.6716	231.8068	556.1882	9.686947	-17.1709	548.7043
2037	4265.503494	157.412889	216.7822582	3698.192	147.3385	234.1248	567.312	10.07442	-17.3426	560.0438
2038	4350.813564	163.709405	218.9500808	3772.155	153.232	218.9501	578.6582	10.4774	0	589.1356
2039	4437.829835	170.257781	221.1395816	3847.598	159.3613	221.1396	590.2314	10.8965	0	601.1279
2040	4526.586432	177.068092	223.3509774	3924.55	165.7357	223.351	602.036	11.33236	0	613.3684
204	4617.11816	184.15081	225.584487	4003.04	172.365	225.584	614.0767	11.78565	0	625.8624

1	1	6	2	1	2	5				
2042	4709.460524	191.516848	227.8403321	4083.102	179.2598	227.8403	626.3582	12.25708	0	638.6153
2043	4803.649734	199.177522	230.1187354	4164.764	186.4302	230.1187	638.8854	12.74736	0	651.6328
2044	4899.722729	207.144623	232.4199228	4248.06	193.8874	232.4199	651.6631	13.25726	0	664.9204
2045	4997.717184	215.430408	234.744122	4333.021	195.8262	234.7441	664.6964	19.60417	0	684.3006

ANNEXURE 6.4

Annexure 6.4: Water demand

Table 1: Water Demand

S. No.	District	Number of Urban Households	Total Urban Population	Water Consumption	Effluent Discharge / Pollution Load	Number of Household Covered by Sewer Systems	% of Households Covered by Sewer Systems
1	Varanasi	253,184	1,597,051	30382080	24305664	167152	66.02
2	Ghazipur	41,569	274,360	4988280	3990624	3201	7.70
3	Mirzapur	55,602	3,47,567	6672240	2003006	16692	30.02
4	Buxar	26,483	164,499	3177960	2542368	1046	3.95
5	Munger	71,010	380,120	8521200	6816960	3188	4.49
6	Patna	429,424	2,514,590	51530880	41224704	72873	16.97
7	Lakhisarai	24,107	143,011	2892840	2314272	926	3.84
8	Bhagalpur	106,303	602,532	12756360	10205088	5868	5.52
9	Saran	55,873	353,202	6704760	5363808	2095	3.75
10	Katihar	53,564	273,822	6427680	5142144	2244	4.19
11	Sahibganj	30,967	159,666	3716040	2972832	511	1.65
12	Murshidabad	284,559	1,400,692	34147080	27317664	11212	3.94
13	Bardhwan	659,366	3,078,299	79123920	63299136	78267	11.87
14	Nadia	348,972	1,438,873	41876640	33501312	21566	6.18
15	Hugli	505,943	2,128,499	60713160	48570528	41791	8.26
16	Howrah	669,902	3,074,144	80388240	64310592	42874	6.40
17	North 24 Pgs	1,355,449	5,732,162	162653880	130123104	148286	10.94
18	South 24 Pgs	482962	2087773	57955440	46364352	21878	4.53
19	Purba Medinipur	125386	592714	15046320	12037056	6545	5.22

ANNEXURE 6.5

Annexure 6.5: List of Dams in Ganga basin and its tributaries

Table 6.5.1: Dams in Ganga basin and its tributaries

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
WEST BENGAL											
1	Bakreshwar Dam			Siuri	Ganga	Birbhum					
2	Bandhu Dam		Bandhu	Puruliya	Ganga	Puruliya	TE	16	1605	Irrigation	Completed
3	Bara Mandira Dam	1977	Baramandira	Asansol	Ganga	Barddhaman	TE	17	853	Irrigation	Completed
4	Barabhum Dam	1991	Nagasai, Barabhum	Puruliya	Ganga	Puruliya	TE	11	1529	Irrigation	Completed
5	Beko Dam	1990		Puruliya	Ganga	Puruliya	TE	16	914	Irrigation	Completed
6	Dangrajhore Dam	1982		Puruliya	Ganga	Puruliya	TE	10	580	Irrigation	
7	Futiary Dam			Puruliya	Ganga	Puruliya	TE	13.7	768	Irrigation	Completed
8	Golamarajore Dam	1989	Golamarajore	Puruliya	Ganga	Puruliya	TE	13		Irrigation	Completed
9	Hanumata Dam	2007	Hanumata	Puruliya	Ganga	Puruliya	TE	19	984.62	Irrigation	Completed
10	Hinglow Irrigation Scheme Dam	1976		Siuri	Ganga	Birbhum	TE	12	1158	Irrigation	Completed
11	Kangsabati Kumari Dam	1965	Kasai	Bankura	Ganga	Bankura		41	10400	Irrigation	Completed
12	Kanjan Dam			Bankura	Ganga	Bankura					
13	Kumari Dam	1984		Puruliya	Ganga	Puruliya	TE + PG	15	1068	Irrigation	Completed
14	Lipania Dam			Puruliya	Ganga	Puruliya	TE	15	750	Irrigation	Completed
15	Moutorejore Dam	1990		Puruliya	Ganga	Puruliya	TE	14	1151	Irrigation	Complete

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
							+ PG				d
16	Muruguma Dam	1982		Puruliya	Ganga	Puruliya	TE	19	328	Irrigation	Completed
17	Nachan Irri. Scheme Dam	1977		Durgapur	Ganga	Barddhaman	TE	14	853	Irrigation	Completed
18	Paraga Irri. Scheme Dam	1979		Puruliya	Ganga	Puruliya	TE	16	737	Irrigation	Completed
19	Patloi Dam	2012	Patloi	Puruliya	Ganga	Puruliya	TE	14	952.4	Irrigation	Completed
20	Ramchandrapur Dam	1991	Machkandajore	Puruliya	Ganga	Puruliya	TE	15	899	Irrigation	Completed
21	Saharajore Irri. Scheme Dam	1978		Bankura	Ganga	Bankura	TE	16	2682	Irrigation	Completed
22	Sali Dam	1985	Sali	Bankura	Ganga	Bankura	TE	12	1494	Irrigation	Completed
23	Taragonia Irri. Scheme Dam	1987		Puruliya	Ganga	Puruliya	TE	12	716	Irrigation	Completed
24	Tatko Dam	2013	Tatko	Puruliya	Ganga	Puruliya	TE	15	1468	Irrigation	Completed
JHARKHAND											
1	**Amanat Dam**		**Amanat**	**Daltenganj**	**Ganga**	**Palamu**	**TE**	**41**	**869**	**Irrigation**	**Under Construction**
2	Anjanwa Dam	1981	Anjanwa	Hazaribag	Ganga	Hazaribagh	TE	16.25	1341.46	Irrigation	Completed
3	Anraj Dam		Arraj	Garhwa	Ganga	Garhwa	TE	27.74	731.52	Irrigation	
4	Babhani Khand Dam		Banki	Garhwa	Ganga	Garhwa	TE	13.1	822.96	Irrigation	
5	Baranadi Dam	1967		Dumka	Ganga	Dumka	TE	19.51	220.98	Irrigation	Completed
6	Barhi Dam	1981	Mahuaghat	Hazaribag	Ganga	Hazariba	TE	12.8	1057.	Irrigation	Complete

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
						gh			66		d
8	Batane Dam	1990	Batane	Daltenganj	Ganga	Palamu	TE	24.08	2011.68	Irrigation	Completed
9	Batre Dam	1954	Batare	Daltenganj	Ganga	Palamu	TE	19.33	748.48	Irrigation	Completed
10	**Bhairwa Dam**		**Bhera**	**Hazaribag**	**Ganga**	**Ramgarh**	**TE**	**29.57**	**2469.5**	**Irrigation**	**Under Construction**
11	Boudha Dam	1978	Agrawa/ Konar	Hazaribag	Ganga	Hazaribagh	TE	15.85	609.26	Irrigation	Completed
12	Bucha Opa Dam	1957	Buchaopa Nala	Ranchi	Brahmani and Baitarni	Ranchi	TE	14.02	1067	Irrigation	Completed
13	Buksa Dam	1982	Baksa	Chatra	Ganga	Chatra	TE	18.78	2667.67	Irrigation	Completed
14	Burhai Dam		Pathro	Devghar	Ganga	Deoghar	TE	29.23	5760	Irrigation	
15	Butanduba Dam	1985		Daltenganj	Ganga	Palamu	TE	22.56	365.85	Irrigation	Completed
17	Chatania Ghat Dam	1980	Kuljhiri Nala	Garhwa	Ganga	Garhwa	TE	19.81	365.76	Irrigation	Completed
19	Chirka Dam	1985	Dhengura	Garhwa	Ganga	Garhwa	TE	22.13	1046.07	Irrigation	Completed
20	Danro Dam	1985	Danro	Garhwa	Ganga	Garhwa	TE	22.37	1371.6	Irrigation	Completed
21	Dhankai Dam	1979	Dhankai Nala	Daltenganj	Ganga	Palamu	TE	10.55	810.77	Irrigation	Completed
23	Diggalpahari Dam	1975	Ashabani River/Reshma Nala	Dumka	Ganga	Dumka	TE	10.37	426.72	Irrigation	

Sl. N o.	Dam Name	Complet ion Year	River	Nearest City	Basin	District	Ty pe	Height (m)	Leng th (m)	Purpose	Status
24	Dulaki Dam	1971	Lilajan	Chatra	Ganga	Chatra	TE	16.76	1067	Irrigation	Complete d
26	Getalsud Dam	1971	Subarnarekha	Ranchi	Subarnare kha	Ranchi	TE	36.1	3800	Hydroelectric,Irrigatio n,,Water Storage	
27	Ghaghra Dam	1957	Ghaghra	Hazaribag	Ganga	Hazariba gh	TE + PG	19.82	94.51	Irrigation	Complete d
28	Gonda Dam	1954	Gonda	Hazaribag	Ganga	Hazariba gh	TE	13.41	1006. 09	Irrigation	Complete d
29	Hatia Dam	1963	Subarnarekha	Ranchi	Subarnare kha	Ranchi	TE	24	4525	Irrigation	Complete d
30	Hiru Dam	1982	Hiroo	Chatra	Ganga	Chatra	TE	18.3	970.7 88	Irrigation	Complete d
33	Jamunia Dam	1954	Jamunia	Hazaribag	Ganga	Hazariba gh	TE	17.38	1067. 1	Irrigation	Complete d
38	Karawani Dam	1967	Dararika	Dumka	Ganga	Dumka	TE	18.59	295.6 6	Irrigation	Complet ed
40	**Kesho Dam**		**Kesho**	**Kodarma**	**Ganga**	**Kodarm a**	**TE**	**14.57**	**2052**	**Irrigation**	**Under Construc tion**
41	Khudia Dam	1971	Khudia River	Baghmara	Ganga	Dhanbad	TE		1227. 12	Irrigation	
42	Konar Dam	1955	Konar	Hazaribag	Ganga	Hazariba gh	TE + PG	48.77	3806. 65	Irrigation	Complete d
45	Left Banki Dam	1980	Left Banki	Garhwa	Ganga	Garhwa	TE	14.32	1499. 42	Irrigation	Complete d
47	Lotia Dam	1978	Chondhi	Hazaribag	Ganga	Hazariba gh	TE	19.74	762.2	Irrigation	Complete d
48	Maithon Dam	1957	Barakar	Asansol	Ganga		TE	56.08	4426	Hydroelectric,Water Storage	Complete d
49	Malay Dam	1985	North Koel	Daltenganj	Ganga	Palamu	TE	28.8	1684.	Irrigation	Complete

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
									15		d
50	Masanjor JH Dam	1955	Mayurakshi or Mor	Dumka	Ganga	Dumka	TE	36.9	630	Hydroelectric,Irrigation	Completed
54	Nalkari Dam	1968	Nalkari	Hazaribag	Ganga	Ramgarh	TE	36	3074	Irrigation	Completed
56	**North Koel Dam**		**North Koel**	**Garhwa**	**Ganga**	**Garhwa**	**TE**	**67.86**	**343**	**Hydroelectric,Irrigation**	**Under Construction**
58	Panchat Hill Dam	1959	Damodar	Dhanbad	Ganga	Dhanbad	TE + PG	48	6777	Hydroelectric,Irrigation,,Water Storage	Completed
59	**Panchkhero Dam**		**Panchkhero**	**Giridih**	**Ganga**	**Giridih**	**TE**	**19.33**	**2182**	**Irrigation**	**Under Construction**
60	Pandarwa Dam	1983	Pandarwa	Garhwa	Ganga	Garhwa	TE	21.8	193.55	Irrigation	Completed
62	**Punasi Dam**		**Ajoy**	**Devghar**	**Ganga**	**Deoghar**	**TE**	**21.54**	**2133.6**	**Irrigation**	**Under Construction**
65	**Salaiya Dam**		**Barsoti**	**Kodarma**	**Ganga**	**Hazaribagh**	**TE**	**18.6**	**990**	**Irrigation**	**Under Construction**
69	**Sudhari Nala Dam**		**Sudhari nala**	**Chatra**	**Ganga**	**Chatra**	**TE**	**16.46**	**396.34**	**Irrigation**	**Under Construction**
70	**Sugathan Dam**			**Godda**	**Ganga**	**Godda**	**TE**	**21.12**	**2040**	**Irrigation**	**Under Construction**
72	Sunder Dam	1976	Sunder	Godda	Ganga	Godda	TE	35.67	1554.48	Irrigation	Completed
74	Suryodi Dam	1974	Surjudi Nala	Pakaur	Ganga	Pakur	TE + PG	12.5	487.68	Irrigation	Completed

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
75	**Tahlay Dam**		**Tahlay**	**Daltenganj**	**Ganga**	**Palamu**	**TE**	**15**		**Irrigation**	**Under Construction**
78	Temrain Dam	1973		Daltenganj	Ganga	Palamu	TE	12.8	503.05	Irrigation	Completed
79	Tenughat Dam	1978	Damodar	Bermo	Ganga	Bokaro	TE	50.61	6492.24	Hydroelectric,Irrigation	Completed
80	Tilaiya Dam	1953	Barakar	Hazaribag	Ganga	Kodarma	PG	29.7	366	Hydroelectric,Irrigation	Completed
81	**Torai Dam**		**Torai**	**Pakaur**	**Ganga**	**Pakur**	**TE**	**24.4**	**647.7**	**Irrigation**	**Under Construction**
BIHAR											
1	Ajan Dam	1989	Ajan	Jamui	Ganga	Jamui	TE	39.02	518.3	Irrigation	Completed
2	Amrity Dam	1965		Jamui	Ganga	Jamui	TE	16.65	166.16	Irrigation	Completed
3	Badua Dam	1965	Badua	Banka	Ganga	Banka	TE	56.66	457.32	Irrigation	Completed
4	**Barnar Dam**			**Jamui**	**Ganga**	**Jamui**	**PG**	**76.75**	**282.7**	**Irrigation**	**Under Construction**
5	Baskund Dam	1984	Baskund	Lakhisarai	Ganga	Lakhisarai	TE	17.68	67.07	Irrigation	Completed
6	Belharna Dam	1987	Belharna	Banka	Ganga	Banka	TE	30.1	411.58	Irrigation	Completed
7	Bilasi Dam	2001	Bilasi	Banka	Ganga	Banka	TE	19.9797003	169.8	Irrigation	Completed
8	Chandan Dam	1968	Chandan	Banka	Ganga	Banka	TE	40.4	1555	Irrigation	Completed
9	**Durgawati Dam**		**Durgawati**	**Bhabhua**	**Ganga**	**Kaimur**	**TE**	**46.3**	**1615.**	**Irrigation**	**Under**

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
						(bhabua)			4		Construction
10	**Gaighat Dam**		**Baghara**	**Munger**	**Ganga**	**Munger**					**Proposed**
11	Jalkund Dam	1968	Jalkund	Munger	Ganga	Munger	TE	15.99	631.1	Irrigation	Completed
12	Job Dam	1977	JOB	Nawada	Ganga	Nawada	TE	18.9	1616	Irrigation	Completed
13	Kailash Ghati Dam	1980	Kailash Ghati	Jamui	Ganga	Jamui	TE	25.9	183	Irrigation	Completed
14	Khargpur Lake Dam	1876	Man	Munger	Ganga	Munger	TE	26.53	221.04	Irrigation	Completed
15	Kohira Dam	1962	Kohira	Bhabhua	Ganga	Kaimur (bhabua)	TE + PG	16	265.24	Irrigation	Completed
16	Kolmahadeo Dam	1966	Kolmahadev(bhusari)	Nawada	Ganga	Nawada	TE	19.2	157	Irrigation	Completed
17	Morwy Dam	1960	Morwe	Lakhisarai	Ganga	Lakhisarai	TE	25.56	533.53	Irrigation	Completed
18	Nagi Dam	1958	Nagi	Jamui	Ganga	Jamui	TE	113.5	1884	Irrigation	Completed
19	Nakti (Bihar) Dam	1980	Nakti	Jamui	Ganga	Jamui	TE	23.61	990.85	Irrigation	Completed
20	Orhni Dam	2000	Orni	Banka	Ganga	Banka	TE	23.774	686	Irrigation	Completed
21	Phulwaria Dam	1988	Tilaiya	Nawada	Ganga	Nawada	TE	25.66	1135	Irrigation	Completed
22	**Sindhwarni Dam**		**Man**	**Munger**	**Ganga**	**Munger**	**TE**	**21.34**	**125.76**	**Irrigation**	**Under Construction**
23	Srikhandi Dam	1965	Srikhandi	Jamui	Ganga	Jamui	TE	16.65	205.8	Irrigation	Completed
24	Upper Kiul Dam	2004	Kiul	Jamui	Ganga	Jamui	TE	30.48	3673	Irrigation	Completed

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
UTTAR PRADESH											
1	Adwa Dam	1978	Adwa	Mirzapur	Ganga	Mirzapur	TE	20.48	7906	Irrigation	Completed
2	Afzalgarh Dam			Bijnore	Ganga		TE			Irrigation	
3	Ahraura Dam	1955	GARAI	Chunar	Ganga	Mirzapur	TE	22.87	1219.5	Irrigation	Completed
4	Arjun Dam	1957	ARJUN River	Kulpahar	Ganga	Mahoba	TE	25.88	5200	Irrigation	Completed
5	Aunjhar Dam	1930	AUNJHAR	Mau	Ganga	Chitrakoot	PG	17.6	1056	Irrigation	Completed
6	Bachara Dam	1980		Meja	Ganga	Allahabad	TE	15	660	Irrigation	Completed
7	Baghel Khand Dam	1957	Jamunahwa	Balrampur	Ganga	Balrampur	TE	15.46	3200	Irrigation	Completed
8	**Balui Dam**		**LOCAL**	**Robertsganj**	**Ganga**	**Sonbhadra**	**TE**	**14.1**	**2900**	**Irrigation**	**Under Construction**
9	**Banjari Kalan Dam**		**LOCAL**	**Mirzapur**	**Ganga**	**Mirzapur**	**TE**	**14.1**	**1470**	**Irrigation**	**Under Construction**
10	Barkachha Dam	1975	LOCAL	Mirzapur	Ganga	Mirzapur	TE	19	570	Irrigation	Completed
11	Barwa Dam	1967		Jhansi	Ganga	Jhansi	TE	21.03	2815	Irrigation	Completed
12	Barwa Sagar Dam		Barwa Nala	Karwi	Ganga	Chitrakoot	TE	21.03	1067	Irrigation	Completed
13	Barwar Dam	1923	BORA NALA	Garautha	Ganga	Jhansi	TE	20.4	2233	Irrigation	Completed
14	Barwatola Dam	1957		Dudhi	Ganga	Sonbhadra	TE	16.77	1050	Irrigation	Completed
15	Bhagwan Pur Dam	1965		Balrampur	Ganga	Balrampur	TE	11.28	4400		Completed
16	Bhainsora Dam	1926	Marhwa Nala	Chakia	Ganga	Chandau	TE	11.26	1850.	Irrigation	Complete

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
						li			61		d
17	Bhonka Dam	1951	BHONKA	Mirzapur	Ganga	Mirzapur	TE	15.3	2012	Irrigation	Completed
18	Chandra Prabha Dam	1966	Chandraprabha	Chakia	Ganga	Chandauli	TE	22.25	1600	Irrigation	Completed
19	Chandrawal Dam	1973	Chandrawal	Charkhari	Ganga	Mahoba	TE	10	5765	Irrigation	Completed
20	Chittaurgarh Dam	1985		Balrampur	Ganga	Balrampur	TE	15.3	11000	Irrigation	Completed
21	Deori Dam	1978	LOCAL	Robertsganj	Ganga	Sonbhadra	TE	21	930	Irrigation	Completed
22	Dhandhraul Dam	1917		ROBERTSGANJ	Ganga		TE	21	7305	Irrigation	Completed
23	Dhenkwan Dam	1985		Chunar	Ganga	Mirzapur	TE	20.85	1700	Irrigation	Completed
24	Dongia Dam	1918	GARAI	Robertsganj	Ganga	Sonbhadra	TE	15.3	2012	Irrigation	Completed
25	Dongri Dam	1986	PAHUJ	Jhansi	Ganga	Jhansi	TE	15.3	2760	Irrigation	Completed
26	Ganeshpur Dam			Balrampur	Ganga	Balrampur					
27	Garhwa Dam	1975	GARHWA	Mau	Ganga	Chitrakoot	TE	13	980	Irrigation	Completed
28	Ghaghar Dam			Robertsganj	Ganga	Sonbhadra					
29	Ghooga Dam		LOCAL	Bahraich	Ganga	Shrawasti	TE	16	520	Irrigation	
30	Ghori Dam	1915		Mirzapur	Ganga	Mirzapur	TE	13.87	1584	Irrigation	Completed
31	Girgity Dam	1966		Balrampur	Ganga	Balrampur	TE	15.18	4800	Irrigation	Completed
32	Gointha Dam	1992	LOCAL	Ghazipur	Ganga	Ghazipur	TE	13.55	500	Irrigation	Completed

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
33	Govind Sagar Dam	1953	Shahzad River	Lalitpur	Ganga	Lalitpur	TE	18.29	3606	Irrigation	Completed
34	Gularia Dam	1966	GULARIA STREAM	Meja	Ganga	Allahabad	TE	11	3200	Irrigation	Completed
35	Gunta Dam	2003	GUNTA NALA (YAMUNA)	Karwi	Ganga	Chitrakoot	TE	29.5	5200	Irrigation	Completed
36	Hinauti Dam	1964	COL NALA	Mirzapur	Ganga	Mirzapur	TE	10.67	995	Irrigation	Completed
37	Jaiwanti Dam	1928		Mau	Ganga	Chitrakoot	TE	15	3352	Irrigation	Completed
38	Jamini Dam	1973	Jamni	Mahrauni	Ganga	Lalitpur	TE	26.22	6400	Irrigation	Completed
39	Jirgo Dam	1958	JIRGO	Chunar	Ganga	Mirzapur		29.88	6704	Irrigation	Completed
40	Jogendra Dam	1970	JOGENDRA	Mirzapur	Ganga	Mirzapur	TE	10.04	1313	Irrigation	Completed
41	Kabrai Dam	1955		Mahoba	Ganga	Mahoba	TE	18.24	2300.2	Irrigation	Completed
42	Kachnoda Dam	2012		Lalitpur	Ganga	Lalitpur	TE	18.9	4100	Irrigation	Completed
43	Kargara Dam	1978	LOCAL	Robertsganj	Ganga	Sonbhadra	TE	16.84	1410	Irrigation	Completed
44	Keolari Dam	1966		Kulpahar	Ganga	Mahoba	TE	11.73	2836.58	Irrigation	Completed
45	Khairman Dam	1958	HENGA NALA	Balrampur	Ganga	Balrampur	TE	10.6	3020	Irrigation	Completed
46	Khandeha Dam	1929	DASRATH NALA	Mau	Ganga	Chitrakoot	TE	19.9	1200	Irrigation	Completed
47	Khapatia Dam	1916	BORERA	Mau	Ganga	Chitrakoot	TE	16	806	Irrigation	Completed
48	Khirihata Dam	1992	LOCAL	Dudhi	Ganga	Sonbhadra	TE	10.77	178	Irrigation	Completed

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
49	Kohar Gaddi Dam	1930		Balrampur	Ganga	Balrampur	TE	10.5	2820	Irrigation	Completed
50	Kota Dam	1960	LOCAL	Robertsganj	Ganga	Sonbhadra	TE	14.63	549	Irrigation	Completed
51	Kotra Khambha Dam	1915		Mau	Ganga	Chitrakoot	TE	18	806	Irrigation	Completed
52	Kuba Khurd Dam	1988	LOCAL	Chunar	Ganga	Mirzapur	TE	10.33	1675	Irrigation	Completed
53	Lachura Dam	1910		Mau Ranipur	Ganga	Jhansi	TE + PG	14.94	542.3	Irrigation	Completed
54	Lower Khajuri Dam	1949		Mirzapur	Ganga	Mirzapur	TE + PG	18	640	Irrigation	Completed
55	Majhgawan Dam	1917	GUNCHI NALA	Kulpahar	Ganga	Mahoba	TE	19.43	1402	Irrigation	Completed
56	Matatila Dam	1958		Lalitpur	Ganga	Lalitpur	TE	45.72	6300	Hydroelectric,Irrigation	Completed
57	Maudaha (Swami Brahmanand) Dam	2003		Rath	Ganga	Hamirpur	TE	32.6	3480	Irrigation	Completed
58	Meja Dam	1987	Belan	Mirzapur	Ganga	Mirzapur	TE	40	2000	Irrigation	Completed
59	Moosakhand Dam	1967	KARMNASA	Chakia	Ganga	Chandauli	TE	33.53	2967	Irrigation	Completed
60	Muirpur Dam	1992	LOCAL	Dudhi	Ganga	Sonbhadra	TE	15.3	581	Irrigation	Completed
61	Murtia Dam	1977	LOCAL	Robertsganj	Ganga	Sonbhadra	TE	18.26	1135	Irrigation	Completed
62	Nagwa Dam	1950	KARMANASA RIVER	Robertsganj	Ganga	Sonbhadra	TE	20.31	2810.19	Irrigation	Completed
63	Nanauti Dam	1963	LOCAL	Chunar	Ganga	Mirzapur	TE	13.71	1400	Irrigation	Completed
64	Narson Dam	1988	NARSON	Robertsganj	Ganga	Sonbhad	TE	14.33	2340	Irrigation	Complete

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
						ra					d
65	Naugarh Dam	1956	KARMNASA	Chakia	Ganga	Chandauli	TE	18.9	5975	Irrigation	Completed
66	**Newari Dam**		**LOCAL**	**Robertsganj**	**Ganga**	**Sonbhadra**	**TE**	**15.44**	**1218**	**Irrigation**	**Under Construction**
67	Obra Dam	1970	RIHAND	Robertsganj	Ganga	Sonbhadra	TE + PG	29	2000	Hydroelectric,Irrigation	Completed
68	Ohen Dam	1961	Ohan	Karwi	Ganga	Chitrakoot	TE + PG	24.08	2527	Irrigation	Completed
69	Pachwara Lake Dam	1694	LOCAL	Mau Ranipur	Ganga	Jhansi	TE + PG	13.72	208	Irrigation	Completed
70	Pahari Dam	1912	Local Nalla	Mau Ranipur	Ganga	Jhansi	TE + PG	10	580.95	Irrigation	Completed
71	Pahuj Dam	1909	PAHUJ	Jhansi	Ganga	Jhansi	TE + PG	10.67	2040	Irrigation	Completed
72	Parichha Dam	1886	BETWA	Jhansi	Ganga	Jhansi	TE + PG	16.77	1174.59	Irrigation	Completed
73	Patharai Dam	2002	PATHARI AND SUKHNAI (TRIBUTARY OF DHASAN)	Mau Ranipur	Ganga	Jhansi	TE	18	3800	Irrigation	Completed
74	Pili Dam	1968	Pili	Nagina	Ganga	Bijnor	TE	19	1540	Irrigation	Completed
75	Ragura Dam	1976	Local	Tikamgarh	Ganga		PG	12.05	1189	Irrigation	Completed

Sl. No.	Dam Name	Completion Year	River	Nearest City	Basin	District	Type	Height (m)	Length (m)	Purpose	Status
76	Raipura Dam	1930		Mahoba	Ganga	Mahoba	TE	13	3509	Irrigation	Completed
77	Rajghat Dam	2000	Betwa	Lalitpur	Ganga	Lalitpur	TE + PG	43.5	11200	Hydroelectric,Irrigation,Water Storage	Completed
78	Rajkhar Dam	1957	LOCAL STREAM	Dudhi	Ganga	Sonbhadra	TE	14.94	970	Irrigation	Completed
79	Rampur Dam	1958	GOINGHAWA NALA	Bahraich	Ganga	Shrawasti	TE	10.5	3820	Irrigation	Completed
80	Rampur Kalyangarh Dam	1925	LOCAL	Karwi	Ganga	Chitrakoot	TE	13	1000	Irrigation	Completed
81	Rampur Pindaria Dam	1974	LOCAL	Mirzapur	Ganga	Mirzapur	TE	10.3	1260	Irrigation	Completed
82	Rihand Dam	1962	Rihand	Dudhi	Ganga	Sonbhadra	PG	91.46	932	Hydroelectric,Irrigation	Completed
83	Rohini Dam	1983	ROHINI	Mahrauni	Ganga	Lalitpur	TE	17.82	1647	Irrigation	Completed
84	Sajnam Dam	1990		Mahrauni	Ganga	Lalitpur	TE	22.34	4524	Irrigation	Completed
85	Saktesh Garh Dam	1989	LOCAL	Chunar	Ganga	Mirzapur	TE	15.66	880	Irrigation	Completed
86	Salarpur Dam	1960	KARDIA	Mahoba	Ganga	Mahoba	TE	11	2975	Irrigation	Completed
87	Saprar Dam	1952		JHANSI	Ganga		TE	16.76	3000	Irrigation	Completed
88	Sarai Garh Dam	1970	LOCAL	Robertsganj	Ganga	Sonbhadra	TE	10.82	735	Irrigation	Completed
89	Sarda Sagar Dam	1962	Sharda	Puranpur	Ganga	Pilibhit	TE	16.15	2220	Irrigation	Completed
90	Semri Dam	1989	LOCAL	Chunar	Ganga	Mirzapur	TE	14.8	666	Irrigation	Completed
91	Shahjad Dam	1992		Lalitpur	Ganga	Lalitpur	TE	18	4160	Irrigation	Completed

Sl. N o.	Dam Name	Complet ion Year	River	Nearest City	Basin	District	Ty pe	Height (m)	Leng th (m)	Purpose	Status
92	Siori Lake Dam	1911	Siori	Mau Ranipur	Ganga	Jhansi	TE	13.94	2306	Irrigation	Complete d
93	Sirsi Dam	1958	Bakhar Nala	Mirzapur	Ganga	Mirzapu r	TE	21.34	3808	Irrigation	Complete d
94	Sukhra Dam	1909	SUKHARA NALA	Mirzapur	Ganga	Mirzapu r	TE	12.2	1158	Irrigation	Complete d
95	**Suswar Dam**		**LOCAL**	**Mirzapur**	**Ganga**	**Mirzapu r**	**TE**	**14.03**	**1400**	**Irrigation**	**Under Construc tion**
96	Upper Khajuri Dam	1958	Chandauli and Shibati	Mirzapur	Ganga	Mirzapu r	TE	24.88	2313	Irrigation	Complete d
97	Urmil Dam	1994	Urmil	Mahoba	Ganga	Mahoba	TE	25.56	4799	Irrigation	Complete d
98	Vijaipur Dam	1983	LOCAL	Mirzapur	Ganga	Mirzapu r	TE	14.3	570	Irrigation	Complete d

(Source: **India-WRIS WebGIS**)

Table 6.5.2: Barrages in Ganga basin and its tributaries

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
WEST BENGAL										
1	Bakreswar Barrage	1950		Siuri	Ganga	Birbhum		91		Completed
2	Brahmani Barrage		Brahmani	Rampur Hat	Ganga	Birbhum		126		Completed
3	Dauk Barrage	1988		Islampur	Ganga	Uttar Dinajpur		68		Completed
4	Durgapur Barrage	1955	Damodar	Bankura	Ganga	Bankura	12	692.2		Completed
5	Dwaraka Barrage	1953	Dwaraka	Siuri	Ganga	Birbhum		83.82		Completed
6	Farakka Barrage	1975	Ganga	Jangipur	Ganga	Murshidabad		2240		Completed
9	Kopai Barrage	1955	Kopai	Siuri	Ganga	Birbhum		66		Completed
10	Mahananda Barrage	1986	Mahananda	Siliguri	Ganga	Darjiling		182.88		Completed
11	Sali Weir		Damodar	Bankura	Ganga	Bankura				Completed
12	Tarafeni Barrage	1972		Jhargram	Ganga	Pashchim Medinipur				Completed
14	Tilpara Barrage	1949	Mayurakahi	Siuri	Ganga	Birbhum		309		Completed
JHARKHAND										
1	Ajoy Barrage	2004	Ajoy/ Ajay	Devghar	Ganga	Deoghar		275		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
2	Amanat Barrage				Ganga					
3	Anraj Weir		Arraj	Garhwa	Ganga	Garhwa				Completed
5	Batane Pick-up Barrage		Batane	Daltenganj	Ganga	Palamu		95.12		Completed
6	Batre Weir		Batre	Daltenganj	Ganga	Palamu		32.004		Completed
7	Bhora Weir	1974	Jhamarla	Rajmahal	Ganga	Sahibganj		22.86		Completed
9	Birha Weir		Shankh	Latehar	Ganga	Latehar	3.05	48.77		Completed
10	Bishunpur Weir	1967	Phuljhar	Gumla	Ganga	Gumla	0.914	23.77		Completed
12	Chako Weir		Chako	Chatra	Ganga	Chatra		115.82		Completed
13	Chordana Weir				Ganga					
14	Daruwa Weir		Darhwa	Devghar	Ganga	Deoghar		60.96		Completed
16	Ghaghari Weir		Ghaghari	Latehar	Ganga	Latehar	0.46	40.84		Completed
17	Gobai Barrage	1983		Baghmara	Ganga	Bokaro		93.27		Completed
18	Golai Weir	1968		Chatra	Ganga	Chatra	1.2192	73.76		Completed
19	Gumani Barrage		Gumani	Rajmahal	Ganga	Sahibganj		79.55		Completed
20	Harhi Weir		Harhi	Daltengan	Gang	Palamu				Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
				j	a					
21	Harna North Weir		Harna	Godda	Ganga	Godda		43.28		Completed
22	Harna South Weir		Harna	Godda	Ganga	Godda		38.1		Completed
23	Jinjoy Weir		Jinjoy	Daltenganj	Ganga	Palamu		60.96		Completed
24	Jugra Weir	1952	Pakwa Nala	Hazaribag	Ganga	Hazaribagh	1.186	106.68		Completed
25	Kajhia Weir		Kajhia	Godda	Ganga	Godda		164.6		Completed
27	Karantola Weir		Domani	Rajmahal	Ganga	Sahibganj		24.38		Completed
28	Kawaldag Weir		Panda	Garhwa	Ganga	Garhwa	1.22	57.91		Completed
31	Khudia Weir	1971	Khudia River	Dhanbad	Ganga	Dhanbad		54.9		Completed
34	Kutipisi Weir	1963	Tributory of Kewta Nadi	Hazaribag	Ganga	Hazaribagh	4.57	46.65		Completed
36	Left Banki Weir		Banki	Garhwa	Ganga	Garhwa	2.44	72.54		Completed
37	Lilajan Weir	1958	Lilajan	Chatra	Ganga	Chatra		367.285108		Completed
38	Lower Kararbar Weir		Kararwar	Daltenganj	Ganga	Palamu		25.91		Completed
39	Mohamadganj Barrage		North Koel	Garhwa	Ganga	Garhwa		814.75		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
40	Nakti Nala Weir		Nakti Nallah	Latehar	Ganga	Latehar	1.52	25.6		Completed
41	Pagla Weir	1974	Pagla	Pakaur	Ganga	Pakur	1.62	79.25		Completed
43	Phulwariya Weir		Phulwaria	Garhwa	Ganga	Garhwa	1.52	25.6		Completed
44	Piri Weir		Piri Nala	Daltenganj	Ganga	Palamu		51.21		Completed
47	Ramghat Weir		North Koel	Latehar	Ganga	Latehar	1.83	45.72		Completed
49	Sadabah Weir		Jinjoy	Daltenganj	Ganga	Palamu	1.52	70.1		Completed
50	Sarswatia Weir		Sarswatia	Garhwa	Ganga	Garhwa		35.05		Completed
52	Sonepur Weir				Ganga					
53	Sonre Weir		Sonre	Daltenganj	Ganga	Palamu		51.82		Completed
57	Triveni / Tribeni Weir	1961		Godda	Ganga	Godda	0.7	121.92		Completed
58	Upper Kararbar Weir		Kararwar	Daltenganj	Ganga	Palamu				Completed
59	Usri Weir	1968	Usri	Giridih	Ganga	Giridih	1.51	40		Completed
60	Uttmahi Weir		Sarswatia	Garhwa	Gang	Garhwa		39.62		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
					a					
61	Yamuna Weir		Satbahini	Daltenganj	Ganga	Palamu				Completed
BIHAR										
1	Adri Weir		Adri	Aurangabad	Ganga	Aurangabad				Completed
2	Bagara Weir		Baghara	Munger	Ganga	Munger		43		Completed
3	Batane Weir		Batane	Aurangabad	Ganga	Aurangabad				Completed
4	Belharna Weir		Belharna		Ganga					Completed
5	Chanken Weir			Munger	Ganga	Munger				Proposed
6	Chhariyari Weir		Yamune River	Jahanabad	Ganga	Jehanabad		30.480092		Completed
7	Dakai Weir			Banka	Ganga	Banka				Completed
8	Dhadhar Barrage	2004	Dhadhar	Gaya	Ganga	Gaya	2.434	138		Completed
9	Dhawa Weir		Dhawa	Aurangabad	Ganga	Aurangabad				Completed
10	Durgawati Weir (Kudra)		Durgawati	Bhabhua	Ganga	Kaimur (bhabua)				Completed
11	Gandak Barrage	1968	Gandak	Bettiah	Ganga	Pashchim Champaran		739		Completed
12	Ghogha Weir		Chandan	Banka	Ganga	Banka		312.4		Completed
13	Gidheshwar Weir		Kiul	Jamui	Ganga	Jamui		396.24		Completed
14	Gokhula Weir	1975	Gokhula	Gaya	Ganga	Gaya				Completed
15	Ikoria Weir		Chandan	Banka	Gang	Banka		244		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
					a					
16	Kamla Weir		Kamla	Madhubani	Ganga	Madhubani	1.52	292.53		Completed
17	Kanakbigha Weir		Yamune River	Jahanabad	Ganga	Jehanabad		49.987351		Completed
18	Karihari Weir		Karihari	Nawada	Ganga	Nawada				Completed
19	Kohira Weir		Kohira	Bhabhua	Ganga	Kaimur (bhabua)		26.22		Completed
20	Kosi Barrage Bihar	1963	Kosi	Bhimnagar	Ganga	Bhimnagar		1149		Completed
21	Kulthi Weir			Bihar Sharif	Ganga	Nalanda				Completed
22	Kundghat Weir		Bahuar	Jamui	Ganga	Jamui		34.7		Completed
23	Libari / Bharthuanandan Weir		Bhutahi	Hilsa	Ganga	Nalanda		54.864		Proposed
24	Lokain Weir	1964	Lokain(Falgu)	Hilsa	Ganga	Nalanda		73.152221		Completed
25	Lower Kiul Weir	1965	Kiul	Lakhisarai	Ganga	Jamui		202.5		Completed
26	Lower Morhar Weir	1962	Morhar	Gaya	Ganga	Gaya		289.560873		Completed
27	Mandai Weir		Falgu	Jahanabad	Ganga	Jehanabad		305		Underconstruction
28	Morwe Weir		Morwe	Lakhisarai	Ganga	Lakhisarai				Completed
29	Munahra Weir	2007	Balan	Jhanjharpur	Ganga	Madhubani	2	114		Completed
30	Paimar Barrage		Paimar	Hilsa	Ganga	Nalanda				Completed
31	Panchane Weir		Panchana	Bihar Sharif	Ganga	Nalanda	1.21	230		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
32	Paura Weir (Sakri)		Sakri	Nawada	Ganga	Nawada				Completed
33	Punpun Barrage		Punpun	Aurangabad	Ganga	Aurangabad		178		Underconstruction
34	Sone Barrage	1968	sone	Sasaram	Ganga	Rohtas		1407		Completed
35	Sukhnia Weir		Sukhnia	Banka	Ganga	Banka				Completed
36	Surara Weir		Suar	Bhabhua	Ganga	Kaimur (bhabua)				Completed
37	Uderasthan Weir		Falgu	Jahanabad	Ganga	Jehanabad	1	336		Completed
38	Upper Jamuna /Yamuna Weir	1959	Yamune River	Gaya	Ganga	Gaya				Completed
39	Upper Morhar Diversion Weir	1961	Morhar	Gaya	Ganga	Gaya		195.07		Completed
UTTAR PRADESH										
1	Adwa Barrage	1978		Mirzapur	Ganga	Mirzapur		113.5		Completed
2	Banganga Barrage	1956	Banganga	Naugarh	Ganga	Siddharth Nagar	0.92	116		Completed
3	Dakpatthar Barrage	1965	Yamuna	Paonta	Ganga	Dehradun	18.38	516.92		Completed
4	Dhukwan Weir	1905	BETWA	Lalitpur	Ganga	Lalitpur	18.67	1171.9		Completed
5	Duni Barrage	1925		Pilibhit	Ganga	Pilibhit		157.26		Completed
6	Ghaghar Barrage		SONE	Robertsganj and Sonbhadra	Ganga					Completed
7	Girija Barrage	1976	GHAGHRA	Nanpara	Ganga	Bahraich		716		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
8	Gokul Barrage	2001		Mathura	Ganga	Mathura		555		Completed
9	Gomti Barrage	1979	GOMTI	Lucknow	Ganga	Lucknow		202.5		Completed
10	Hindan Barrage	1979		Dadri	Ganga	Gautam Buddha Nagar		162		Completed
11	Husainpur Weir		GARAI	Chunar	Ganga	Mirzapur				Completed
12	Kho Barrage	1975		Dhampur	Ganga	Bijnor		203		Completed
13	Lakhani Devi Diversion Weir				Ganga					Completed
14	Latifshah Weir		KARMANASA RIVER	Chakia	Ganga	Chandauli	14.33	217.68		Completed
15	Lower Khajuri Weir				Ganga					Completed
16	Lower Sarda Barrage	1974	SHARDA	Nighasan	Ganga	Kheri		408		Completed
17	Madhya Ganga Barrage (Chaudhary Charan Singh			Jansath	Ganga	Muzaffarnagar		621		Completed
18	Nagwa silhati Weir				Ganga					Completed
19	Narora Barrage	1966	GANGA	Anupshahr	Ganga	Bulandshahr		922.43		Completed
20	New Okhla Barrage		YAMUNA	Dadri	Ganga	Gautam Buddha Nagar		743.11		Completed
21	Parichha Weir	1886	BETWA	Moth	Ganga	Jhansi	16.77	1171.3		Completed
22	Ramganga Barrage	1975	RAMGANGA	Nagina	Ganga	Bijnor		408		Completed
23	Rapti Barrage		Rapti	Bahraich	Gang	Shrawasti		284.5		Completed

Sl. No.	BWA Name	Completion Year	River	Nearest city	Basin	District	Height (m)	Length (m)	Purpose	Status
					a					
24	Saryu Barrage			Nanpara	Ganga	Bahraich		243.5		Completed
25	Tons Weir			Meja	Ganga	Allahabad		500		Completed

ANNEXURE 6.6

Annexure 6.6: Major medium irrigation projects in Ganga basin and its tributaries

Major medium irrigation projects in Ganga basin and its tributaries

Sl. No.	Project Name		River	Basin	Purpose	Status
	WEST BENGAL					
1	Bandhu Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
2	Barabhum Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
3	Barrage And Irrigation System Of DVC		Damodar	Ganga	Irrigation	Completed
4	Beko Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
5	Berai Canal Medium Irrigation Project		Dwarkeswar	Ganga	Irrigation	Completed
6	Dimu Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
7	Futiary Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
8	Golamarajore Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
9	Hanumata Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
10	Hinglow Medium Irrigation Project		Ajoy	Ganga	Irrigation	Completed
11	Kangsabati Major Irrigation Project		Subernarekha	Ganga	Irrigation	Completed
12	Karatowa Medium Irrigation Project		Teesta	Brahmaputra	Irrigation	Completed
13	Karrior Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
14	Khairabera Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
15	Kumari Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
16	Lipaniajore Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
17	Mayurakshi Major Irrigation Project West Bengal			Ganga	Irrigation	Completed
18	Midnapur Canal Major Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
19	Moutorejore Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
20	Parga Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
21	Patloi Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
22	Ramchandrapur Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
23	Ranichak Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
24	Saharajore Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
25	Sali Medium Irrigation Project		Damodar	Ganga	Irrigation	Completed
26	Sali Reservoir Medium Irrigation Project		Damodar	Ganga	Irrigation	Completed
27	Subernarekha Barrage Major Irrigation Project			Ganga	Irrigation	Ongoing
28	Subernarekha Multipurpose Project West Bengal		Subernarekha	Subarnarekha	Irrigation	Ongoing
29	Suvankar Dangra Medium Irrigation Project		Damodar	Ganga	Irrigation	Completed
30	Taragonia Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
31	Tatko Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Ongoing
32	Teesta Barrage, Phase -I, St.I, Sub Stage I		Teesta	Ganga, Brahmaputra	Irrigation	Ongoing
33	Turga Medium Irrigation Project		Kangsabati	Ganga	Irrigation	Completed
	JHARKHAND					
1	Ajoy Barrage (Siktia) Major Irrigation Project		Ajoy	Ganga	Irrigation	Completed
2	Amanat Reservoir Project		Amanat	Ganga	Irrigation	Completed
3	Anjanwa Resevoir Medium Irrigation Project		Anjanwa	Ganga	Irrigation	Completed
4	Anraj Medium Irrigation Project		Arraj	Ganga	Irrigation	Completed
5	Aradih Weir Medium Irrigation Project			Subarnarekha	Irrigation	Completed
6	Auranga Major Irrigation Project		Auranga	Ganga	Irrigation	Ongoing
7	Babhanikhand Medium Irrigation Project		Banki	Ganga	Irrigation	Completed
8	Baranadi Medium Irrigation Project		Baranadi	Ganga	Irrigation	Completed
9	Barhi Medium Irrigation Project		Mahuaghat	Ganga	Irrigation	Completed
10	Basuki Medium Irrigation Project		South Koel	Subarnarekha	Irrigation	Proposed
11	Batane Major Irrigation Project Jharkhand		Batane	Ganga	Irrigation	Ongoing
12	Bateshwarsthan Pump Canal Major Irrigation		Ganga	Ganga	Irrigation	Ongoing
13	Batre Medium Irrigation Project Jharkhand		Batare	Ganga	Irrigation	Completed
14	Baudha Medium Irrigation Project		Agrawa/ Konar	Ganga	Irrigation	Completed
15	Bhairawa Medium Irrigation Project			Ganga	Irrigation	Ongoing
16	Bhoura Bandh Medium Irrigation Project		Jhamarla	Ganga	Irrigation	Completed
17	Birha Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
18	Bishunpur Medium Irrigation Project		Phuljhar	Ganga	Irrigation	Completed
19	Bishunpur Medium Irrigation Project			Ganga	Irrigation	Completed
20	Brahmani Medium Irrigation Project		Bamni	Subarnarekha	Irrigation	Completed
21	Buchaopa Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed
22	Buksa Medium Irrigation Project		Baksa	Ganga	Irrigation	Completed
23	Butanduba Medium Irrigation Project			Ganga	Irrigation	Completed
24	Chako Medium Irrigation Project		Chako	Ganga	Irrigation	Completed
25	Chandan Major Irrigation Project Jharkhand		Chandan\ Tribeni\ Harna	Ganga	Irrigation	Completed
26	Chataniyaghat Medium Irrigation Project			Ganga	Irrigation	Completed
27	Chinda Medium Irrigation Project		Chhinda	Brahmani and Baitarni	Irrigation	Completed
28	Chirka Medium Irrigation Project		Dhengura	Ganga	Irrigation	Completed
29	Chordanda Medium Irrigation Project		Surhar	Ganga	Irrigation	Completed
30	Danro Medium Irrigation Project		Danro	Ganga	Irrigation	Completed
31	Daruwa Medium Irrigation Project		Darhwa	Ganga	Irrigation	Completed
32	Desh Bandh Medium Irrigation Project			Subarnarekha	Irrigation	Completed
33	Dhankai Medium Irrigation Project			Ganga	Irrigation	Completed
34	Dhansinghtoli Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed
35	Dhauajore Medium Irrigation Project			Ganga	Irrigation	Completed
36	Diggalpahari Medium Irrigation Project			Ganga	Irrigation	Completed
37	Dulki Medium Irrigation Project			Ganga	Irrigation	Completed
38	Garhi Medium Irrigation Project		Garhi (Damodar)	Ganga	Irrigation	Ongoing
39	Ghaghari Medium Irrigation Project			Ganga	Irrigation	Completed
40	Ghaghra Medium Irrigation Project		Ghaghra	Ganga	Irrigation	Completed
41	Gobai Barrage Medium Irrigation Project		Gabai / Gowai	Ganga	Irrigation	Completed
42	Golai Medium Irrigation Project			Ganga	Irrigation	Completed
43	Gonda Medium Irrigation Project		Gonda	Ganga	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
44	Gumani Barrage Major Irrigation Project			Ganga	Irrigation	Ongoing
45	Harhi Medium Irrigation Project			Ganga	Irrigation	Completed
46	Harna Medium Irrigation Project		Harna	Ganga	Irrigation	Completed
47	Hiru Medium Irrigation Project		Hiru	Ganga	Irrigation	Completed
48	Jaipur Medium Irrigation Project		Nakti Nallah	Brahmani and Baitarni	Irrigation	Completed
49	Jamunia Medium Irrigation Project			Ganga	Irrigation	Completed
50	Jenasai Medium Irrigation Project		Karala	Subarnarekha	Irrigation	Completed
51	Jharjhara Medium Irrigation Project		Bamini Nalla	Subarnarekha	Irrigation	Ongoing
52	Jinjoy Weir Scheme Medium Irrigation Project		Jinjoy	Ganga	Irrigation	Completed
53	Jugra Medium Irrigation Project		Pakwa Nala	Ganga	Irrigation	Completed
54	Kajhia Medium Irrigation Project		Kajhia	Ganga	Irrigation	Completed
55	Kanchi Major Irrigation Project		Kanchi	Subarnarekha	Irrigation	Completed
56	Kans Medium Irrigation Project			Subarnarekha	Irrigation	Ongoing
57	Kansjore Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed
58	Karantola Medium Irrigation Project			Ganga	Irrigation	Completed
59	Karawani Medium Irrigation Project		Dwarika	Brahmani and Baitarni	Irrigation	Completed
60	Katri Medium Irrigation Project		South Koel	Brahmani and Baitarni	Irrigation	Ongoing
61	Kawaldag Medium Irrigation Project		Panda	Ganga	Irrigation	Completed
62	Kesho Medium Irrigation Project		Kesho	Ganga	Irrigation	Ongoing
63	Khatwa Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed
64	Khudia Irrigation Scheme Medium Irrigation		Khudia River	Ganga	Irrigation	Completed
65	Kita Medium Irrigation Project		Urangarha	Subarnarekha	Irrigation	Completed
66	Kitanala Medium Irrigation Project		Kita Nala	Subarnarekha	Irrigation	Completed
67	Kokro Irrigation Scheme Medium Irrigation Project		Raru	Subarnarekha	Irrigation	Completed
68	Konar Major Irrigation Project		Konar	Ganga	Irrigation	Ongoing

Sl. No.	Project Name		River	Basin	Purpose	Status
69	Kutipisi Medium Irrigation Project			Ganga	Irrigation	Completed
70	Lapasia Medium Irrigation Project			Subarnarekha	Irrigation	Completed
71	Larwa Medium Irrigation Project		Deo	Brahmani and Baitarni	Irrigation	Completed
72	Latratu Medium Irrigation Project		North Karo	Brahmani and Baitarni	Irrigation	Completed
73	Left Banki Weir Irrigation Project		Left Banki	Ganga	Irrigation	Completed
74	Left banki Reservoir Irrigation Project		Left Banki	Ganga	Irrigation	Completed
75	Lorgara Medium Irrigation Project		Kharkhai	Subarnarekha	Irrigation	Completed
76	Lotia Medium Irrigation Project		Chondhi	Ganga	Irrigation	Completed
77	Lower Karrabar Medium Irrigation Project		Kararbar	Ganga	Irrigation	Completed
78	Malay Medium Irrigation Project		North Koel	Ganga	Irrigation	Completed
79	Masaria Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed
80	Mayurakshi LBC Jharkhand		Mayuraraksh/ Mor	Ganga	Irrigation	Completed
81	Murahir Reservoir Scheme Medium Irrigation		Lokjheria Nala	Subarnarekha	Irrigation	Completed
82	Murumsona Irrigation Scheme Medium Irrigation		Sana	Subarnarekha	Irrigation	Completed
83	Nakti Medium Irrigation Project		Bijay	Subarnarekha	Irrigation	Ongoing
84	Nakti Nala Weir Scheme Medium Irrigation Project			Subarnarekha	Irrigation	Completed
85	Nandini Medium Irrigation Project		Nandini	Brahmani and Baitarni	Irrigation	Completed
86	North Koel Major Irrigation Project Jharkhand		North Koel	Ganga	Irrigation	Ongoing
87	Pagla Medium Irrigation Project		Pagla	Ganga	Irrigation	Completed
88	Palna Medium Irrigation Project		Ranka Jhuria	Subarnarekha	Irrigation	Completed
89	Panch Khero Medium Irrigation Project			Ganga	Irrigation	Ongoing
90	Pandarwa Medium Irrigation Project		Pandarwa	Ganga	Irrigation	Completed
91	Paras Medium Irrigation Project		Paras	Brahmani and Baitarni	Irrigation	Completed
92	Phuljhar Medium Irrigation Project		Phuljhar	Brahmani and Baitarni	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
93	Phulwaria Medium Irrigation Project		Phulwaria	Ganga	Irrigation	Completed
94	Piri Medium Irrigation Project		Piri Nala	Ganga	Irrigation	Completed
95	Punasi Major Irrigation Project		Ajoy	Ganga	Irrigation	Ongoing
96	Putunggara Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Completed
97	Raisa Medium Irrigation Project		Kanchi	Subarnarekha	Irrigation	Completed
98	Rajbhandh Medium Irrigation Project			Subarnarekha	Irrigation	Completed
99	Ramghat Medium Irrigation Project			Ganga	Irrigation	Completed
100	Ramrekha Medium Irrigation Project		Utial Nala	Brahmani and Baitarni	Irrigation	Ongoing
101	Roro Medium Irrigation Project		Roro Gara	Subarnarekha	Irrigation	Completed
102	Sadabah Medium Irrigation Project			Ganga	Irrigation	Completed
103	Sakrigali Pump Canal Medium Irrigation Project			Ganga	Irrigation	Completed
104	Salaiya Medium Irrigation Project			Ganga	Irrigation	Ongoing
105	Saraswatia Medium Irrigation Project			Ganga	Irrigation	Completed
106	Satpotka Medium Irrigation Project		Brahmani	Brahmani and Baitarni	Irrigation	Ongoing
107	Sona Medium Irrigation Project			Subarnarekha	Irrigation	Completed
108	Sonepur Medium Irrigation Project		Dhaulia	Ganga	Irrigation	Completed
109	Sonre Medium Irrigation Project			Ganga	Irrigation	Completed
110	Sonua Medium Irrigation Project			Subarnarekha	Irrigation	Ongoing
111	Sonua Medium Irrigation Project		Sanjay	Subarnarekha	Irrigation	Completed
112	Subernarekha Multipurpose Project Jharkhand		Subernarekha	Subarnarekha	Irrigation	Ongoing
113	Sunder Medium Irrigation Project		Sunder	Ganga	Irrigation	Completed
114	Surangi Medium Irrigation Project		Surangi Nala\ Karkari	Subarnarekha	Irrigation	Ongoing
115	Suru Medium Irrigation Project			Brahmani and Baitarni	Irrigation	Ongoing
116	Suryodi Medium Irrigation Project			Ganga	Irrigation	Completed
117	Tajna Barrage Medium Irrigation Project		Tajna	Subarnarekha	Irrigation	Completed
118	Tapkara Medium Irrigation Project		Kukurdoba	Brahmani and	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
				Baitarni		
119	Temrain Medium Irrigation Project			Ganga	Irrigation	Completed
120	Tenughat Medium Irrigation Project		Damodar	Ganga	Irrigation	Completed
121	Torlow Medium Irrigation Project		Torlow	Subarnarekha	Irrigation	Completed
122	Triveni Medium Irrigation Project		Triveni	Ganga	Irrigation	Completed
123	Upper Sankh Medium Irrigation Project		Shankh	Brahmani and Baitarni	Irrigation	Ongoing
124	Upri Karabar Medium Irrigation Project		Kakarbar	Ganga	Irrigation	Completed
125	Usri Medium Irrigation Project		Usri	Ganga	Irrigation	Completed
126	Uttmahi Medium Irrigation Project			Ganga	Irrigation	Completed
127	VIjay Medium Irrigation Project			Subarnarekha	Irrigation	Completed
128	Yamuna Medium Irrigation Project			Ganga	Irrigation	Completed
	BIHAR					
1	Adri Canal Medium Irrigation Project		Adri	Ganga	Irrigation	Completed
2	Ajan (Kukurjhap) Medium Irrigation Project		Ajan	Ganga	Irrigation	Completed
3	Badua Major Irrigation Project		Badua	Ganga	Irrigation	Completed
4	Bansagar Dam Major Irrigation Project Bihar		Sone	Ganga	Irrigation	Completed
5	Barnar Major Irrigation Project		Barnar	Ganga	Irrigation	Ongoing
6	Batane Canal Medium Irrigation Project		Batane	Ganga	Irrigation	Completed
7	Batane Major Irrigation Project Bihar		Batane	Ganga	Irrigation	Ongoing
8	Bateshwarasthan Pump Ph-I Major Irrigation		Ganga	Ganga	Irrigation	Ongoing
9	Belharna Medium Irrigation Project		Belharna	Ganga	Irrigation	Completed
10	Bharthu Nandna Medium Irrigation Project		River Bhutahi (Old Course Of Falgu)	Ganga	Irrigation	Ongoing
11	Bilasi Medium Irrigation Project		Bilasi	Ganga	Irrigation	Completed
12	Chandan Major Irrigation Project Bihar		Chandan	Ganga	Irrigation	Completed
13	Chausa Pump Canal Medium Irrigation Project		Ganga	Ganga	Irrigation	Completed
14	Chhariyari Medium Irrigation Project		Yamune River	Ganga	Irrigation	Completed
15	Dhakranalla Pump Ph - I Medium Project Medium		Dhakranalla	Ganga	Irrigation	OnGoing
16	Dhakranalla Pump Ph - II Medium Project Medium		Dhakranalla	Ganga	Irrigation	OnGoing

Sl. No.	Project Name		River	Basin	Purpose	Status
17	Dhuwa /Dhawa Medium Project Medium Irrigation		Dhawa	Ganga	Irrigation	Completed
18	Durgavati Major Irrigation Project		Durgawati	Ganga	Irrigation	Ongoing
19	Gandak Major Irrigation Project Bihar		Gandak	Ganga	Irrigation	Completed
20	Gokhula Medium Irrigation Project		Gokhula	Ganga	Irrigation	Completed
21	Job Medium Irrigation Project		JOB	Ganga	Irrigation	Completed
22	Kamla Major Irrigation Project		Kamla	Ganga	Irrigation	Completed
23	Kanak Bigha Medium Irrigation Project		Yamune River	Ganga	Irrigation	Completed
24	Karihari Medium Irrigation Project		Karihari	Ganga	Irrigation	Completed
25	Kohira Dam Major Irrigation Project		Kohira	Ganga	Irrigation	Completed
26	Kolmahadeo Medium Irrigation Project		Kolmahadev(bhusari)	Ganga	Irrigation	Completed
27	Kosi Barrage and Eastern Canal Major Irrigation		Kosi	Ganga	Irrigation	Completed
28	Kulthi Weir Medium Irrigation Project			Ganga	Irrigation	Completed
29	Kundghat Medium Irrigation Project		Bahuar	Ganga	Irrigation	Ongoing
30	Lilajan Major Irrigation Project		Lilajan	Ganga	Irrigation	Completed
31	Lokine Medium Irrigation Project		Lokain(Falgu)	Ganga	Irrigation	Completed
32	Lower Kiul Valley Major Irrigation Project		Kiul	Ganga	Irrigation	Completed
33	Lower Morhar Major Irrigation Project		Morhar	Ganga	Irrigation	Completed
34	Mahabodhi Medium Irrigation Project		Lilajan	Ganga	Irrigation	Completed
35	Mandai Medium Irrigation Project		Falgu	Ganga	Irrigation	Ongoing
36	Morwa Medium Irrigation Project		Morwe	Ganga	Irrigation	Completed
37	Munhara Barrage Medium Irrigation Project		Balan	Ganga	Irrigation	Ongoing
38	Musakhand Dam (Karmanasa Irrigation Project)		KARMANASA RIVER	Ganga	Irrigation	Completed
39	Nagi Medium Irrigation Project		Nagi	Ganga	Irrigation	Completed
40	North Koel Major Irrigation Project Bihar		North Koel	Ganga	Irrigation	Ongoing
41	Orni Medium Irrigation Project		Orni	Ganga	Irrigation	Completed
42	Paimar Barrage Medium Irrigation Project		Paimar	Ganga	Irrigation	Completed
43	Panchane Medium Irrigation Project		Panchana	Ganga	Irrigation	Completed
44	Phulwaria Medium Irrigation Project		Tilaiya	Ganga	Irrigation	Completed
45	Punpun Barrage Major Irrigation Project		Punpun	Ganga	Irrigation	Ongoing
46	Sakri Lower Valley Major Irrigation Project		Sakri	Ganga	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
47	Sindhwarni Medium Irrigation Project		Man	Ganga	Irrigation	Ongoing
48	Sone Canals Major Irrigation Project		Sone	Ganga	Irrigation	Completed
49	Sone High Level Canal Major Irrigation Project		Sone	Ganga	Irrigation	Completed
50	Suara Canal Medium Irrigation Project		Suar	Ganga	Irrigation	Completed
51	Surajgarh Pump Canal Medium Irrigation Project		Harohar	Ganga	Irrigation	Completed
52	Tilaiya - Dhadhar Major Irrigation Project		Dhadhar	Ganga	Irrigation	Ongoing
53	Uderasthan Major Irrigation Project		Falgu	Ganga	Irrigation	Completed
54	Upper Jamuna/Yamuna Medium Irrigation Project		Yamune River	Ganga	Irrigation	Completed
55	Upper Kiul Major Irrigation Project		Kiul	Ganga	Irrigation	Completed
56	Upper Morhar Major Irrigation Project		Morhar	Ganga	Irrigation	Completed
57	Western Kosi Canal Major Irrigation Project		Kosi	Ganga	Irrigation	Ongoing
58	Zamania Pump Scheme (Larma) Medium Irrigation		Karamnasa	Ganga	Irrigation	Ongoing
	UTTAR PRADESH					
1	Adwa Dam Project Major Irrigation Project		ADWA	Ganga	Irrigation	Completed
2	Afzalgarh Medium Irrigation Project			Ganga	Irrigation	Completed
3	Agra Canal Major Irrigation Project Uttar Pradesh		YAMUNA	Ganga	Irrigation	Completed
4	Ahraura Dam Medium Irrigation Project			Ganga	Irrigation	Completed
5	Aliganj Major Irrigation Project			Ganga	Irrigation	Completed
6	Arjun Dam Medium Irrigation Project		Arjuna	Ganga	Irrigation	Completed
7	Augasi Pump Canal Major Irrigation Project		YAMUNA RIVER	Ganga	Irrigation	Completed
8	Badaun Major Irrigation Project		RAMGANGA	Ganga	Irrigation	Ongoing
9	Bakhar Marihan Feeder Medium Irrigation Project			Ganga	Irrigation	Completed
10	Balmiki (Ohen) Sarovar Medium Irrigation Project			Ganga	Irrigation	Completed
11	Banganga Canal Major Irrigation Project			Ganga	Irrigation	Completed
12	Bansagar Canal (UP) Irrigation Project		Sone	Ganga	Irrigation	Ongoing
13	Bansagar Dam Major Irrigation Project Uttar			Ganga	Irrigation	Completed
14	Barwa Dam Medium Irrigation Project		BORA NALA	Ganga	Irrigation	Completed
15	Baur Medium Irrigation Project Uttar Pradesh			Ganga	Irrigation	Completed
16	Beewer Feeder Canal Medium Irrigation Project			Ganga	Irrigation	Completed
17	Belan - Tons Canal Major Irrigation Project		BELAN	Ganga	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
18	Belan Bhakhar Medium Irrigation Project		BELAN	Ganga	Irrigation	Completed
19	Bevar Feeder Canal Major Irrigation Project			Ganga	Irrigation	Completed
20	Bhaunrat Dam Medium Irrigation Project			Ganga	Irrigation	Ongoing
21	Bhopauli Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
22	Bijnore Canal Major Irrigation Project			Ganga	Irrigation	Completed
23	Chambal Lift Irrigation Project			Ganga	Irrigation	Completed
24	Chandra Prabha Dam Medium Irrigation Project			Ganga	Irrigation	Completed
25	Chandrawal Dam Medium Irrigation Project			Ganga	Irrigation	Completed
26	Chillimal Pump Canal Medium Irrigation Project		Yamuna	Ganga	Irrigation	Completed
27	Chittaurgarh Reservoir Major Irrigation Project			Ganga	Irrigation	Completed
28	Dalmau Pump Canal Stage - I and Stage - II Major			Ganga	Irrigation	Completed
29	Denkwa Dam Major Irrigation Project			Ganga	Irrigation	Completed
30	Deokali Pump Canal Stage - I Major Irrigation			Ganga	Irrigation	Completed
31	Dhasan Canal Major Irrigation Project			Ganga	Irrigation	Completed
32	Dhoba Pump Canal Medium Irrigation Project			Ganga	Irrigation	Completed
33	Dohrighat Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
34	Dohrighat Sahyak Major Irrigation Project			Ganga	Irrigation	Completed
35	Dongri Medium Irrigation Project			Ganga	Irrigation	Completed
36	East Baigul Major Irrigation Project Uttar			Ganga	Irrigation	Completed
37	Eastern Ganga Canal Major Irrigation Project		Ganga	Ganga	Irrigation	Completed
38	Eastern Yamuna Canal Major Irrigation Project			Ganga	Irrigation	Completed
39	Gandak Canal Major Irrigation Project Uttar		Gandak	Ganga	Irrigation	Completed
40	Ghaggar Canal Project		GHAGHAR	Ganga	Irrigation	Completed
41	Gularia Dam Medium Irrigation Project			Ganga	Irrigation	Completed
42	Gunta Nalla Medium Irrigation Project			Ganga	Irrigation	Completed
43	Gyanpur Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
44	Haripur Major Irrigation Project Uttar Pradesh			Ganga	Irrigation	Completed
45	Jahangirganj Branch Medium Irrigation Project			Ganga	Irrigation	Completed
46	Jamni Dam Medium Irrigation Project Uttar Pradesh		JAMINI RIVER	Ganga	Irrigation	Completed
47	Jamrani Multipurpose project Uttar Pradesh			Ganga	Irrigation	Ongoing

Sl. No.	Project Name		River	Basin	Purpose	Status
48	Jarauli Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
49	Jirgo Medium Irrigation Project			Ganga	Irrigation	Completed
50	Kabrai Lake Medium Irrigation Project		Arjun	Ganga	Irrigation	Completed
51	Kachnoda Dam Major Irrigation Project		Sajnam	Ganga	Irrigation	Completed
52	Kanhar Major Irrigation Project		PAGAN	Ganga	Irrigation	Ongoing
53	Ken Canal Major Irrigation Project		KEN	Ganga	Irrigation	Completed
54	Keolari Medium Irrigation Project			Ganga	Irrigation	Completed
55	Khara Canal Medium Irrigation Project		YAMUNA RIVER	Ganga	Irrigation	Completed
56	Kishanpur Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
57	Kosi Irrigation Medium Irrigation Project Uttar			Ganga	Irrigation	Completed
58	Lakhwar Multipurpose Project Uttar Pradesh		YAMUNA RIVER	Ganga	Irrigation	Ongoing
59	Lalitpur Dam Medium Irrigation Project Uttar			Ganga	Irrigation	Completed
60	Lower Ganga Canal Major Irrigation Project		Gnaga	Ganga	Irrigation	Completed
61	Madho Tanda Major Irrigation Project			Ganga	Irrigation	Completed
62	Madhya Ganga Canal Phase - II Major Irrigation		Ganga	Ganga	Irrigation	Completed
63	Madhya Ganga Canal Stage - I Major Irrigation		Ganga	Ganga	Irrigation	Completed
64	Matatila Dam Major Irrigation Project (including		BETWA RIVER	Ganga	Irrigation	Completed
65	Maudaha Dam Major Irrigation Project		BIRMA	Ganga	Irrigation	Completed
66	Meja Dam Major Irrigation Project			Ganga	Irrigation	Completed
67	Moosakhand Dam Major Irrigation Project Uttar		KARMANSA	Ganga	Irrigation	Completed
68	Nagwa Dam Major Irrigation Project		KARNASSA	Ganga	Irrigation	Completed
69	Nanak Sagar Major Irrigation Project Uttar		SARDA	Ganga	Irrigation	Completed
70	Narainpur Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
71	Naugarh Dam Major Irrigation Project		KARMANASA RIVER	Ganga	Irrigation	Completed
72	Parallel Lower Ganga Canal Major Irrigation			Ganga	Irrigation	Completed
73	Pathrai Dam Medium Irrigation Project		PATHRAI AND SUKHNAI	Ganga	Irrigation	Completed
74	Pili Dam Medium Irrigation Project Uttar Pradesh		Pili	Ganga	Irrigation	Completed
75	Providing Kharif Channel in Hindon Krishi Doab			Ganga	Irrigation	Completed
76	Rajghat Canal Major Irrigation Project		BETWA	Ganga	Irrigation	Completed

Sl. No.	Project Name		River	Basin	Purpose	Status
77	Rajghat Dam Irrigation Project Uttar Pradesh		Betwa	Ganga	Irrigation	Completed
78	Ramganga Major Irrigation Project		Ramganga	Ganga	Irrigation	Completed
79	Rampur Canal Major Irrigation Project			Ganga	Irrigation	Completed
80	Rangwan Dam Project Uttar Pradesh Major		Banne Nala	Ganga	Irrigation	Completed
81	Rohilkhand Canal Major Irrigation Project			Ganga	Irrigation	Completed
82	Rohini Project Medium Irrigation Project			Ganga	Irrigation	Completed
83	Sajnam Dam Medium Irrigation Project		SAJNAM	Ganga	Irrigation	Completed
84	Saprar Medium Irrigation Project			Ganga	Irrigation	Completed
85	Sarda Canal Major Irrigation Project Uttar			Ganga	Irrigation	Completed
86	Sarda Sagar Stage I Major Irrigation Project		SARDA	Ganga	Irrigation	Completed
87	Sarda Sagar Stage II Major Irrigation Project		SARDA	Ganga	Irrigation	Completed
88	Sarju Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
89	Saryu Nahar Pariyojana Major Irrigation Project		SARYU	Ganga	Irrigation	Completed
90	Shahganj Medium Irrigation Project			Ganga	Irrigation	Completed
91	Shahzad Major Irrigation Project			Ganga	Irrigation	Completed
92	Sharda Sahayak Major Irrigation Project		SHARDA	Ganga	Irrigation	Completed
93	Sirsi Barundha Feeder Medium Irrigation Project			Ganga	Irrigation	Completed
94	Sone Pump Canal Major Irrigation Project		Sone	Ganga	Irrigation	Completed
95	Suheli Major Irrigation Project			Ganga	Irrigation	Completed
96	Tanda Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
97	Tehri Dam (Irrigation Share) Irrigation Project		Bhagirathi	Ganga	Irrigation	Completed
98	Tons Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
99	Trans- Kalyani Medium Irrigation Project			Ganga	Irrigation	Completed
100	Tumaria Reservoir Medium Irrigation Project Uttar			Ganga	Irrigation	Completed
101	Umarahat Pump Canal Phase - I Medium Irrigation			Ganga	Irrigation	Completed
102	Upper Ganga Canal Major Irrigation Project		Ganga	Ganga	Irrigation	Completed
103	Upper Khajuri Medium Irrigation Project		Chandauli and Shibati	Ganga	Irrigation	Completed
104	Urmil Dam Major Irrigation Project Uttar Pradesh		KEN	Ganga	Irrigation	Completed
105	Yamuna Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed
106	Zamania Pump Canal Major Irrigation Project			Ganga	Irrigation	Completed

(Source: **India-WRIS WebGIS**)