FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 97
SUNDERBANS WATERWAYS
RIVER: KALINDI (KALANDI) RIVER (STATE OF WEST BENGAL)
AMBARIA TO HINGALGANJ (8.513 KMS)

(Volume – I: Main Report)

(Volume – II: Drawings)

Submission Date: 27/01/2021




Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 2

JANUARY 2021

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(Volume – I: Main Report)
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Submission Date: 27/01/2021

Project: Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of Cluster 1 National Waterways

Owner: IWAI, Ministry of Shipping

Consultant: Egis India Consulting Engineers

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LIST OF VOLUMES

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LIST OF ABBREVIATIONS

IWAI	Inland Waterways Authority of India
IWT	Inland Water Transportation
MOS	Ministry of Shipping
NW	National Waterway
DPR	Detailed Project Report
WW	Waterway
AtoN	Aid to Navigation
VC	Vertical Clearance
HC	Horizontal Clearance
CD	Chart Datum
SD	Sounding Datum
MSL	Mean Sea Level
DGPS	Differential Global Positioning System
RTK	Real Time Kinematic
GPS	Global Positioning System
SBES	Single Beam Echo Sounder
TS	Total Station
CRP	Common Reference Point
SBAS	Satellite-based augmentation systems
DGLL	Directorate General of Light House & Light ships
UTM	Universal Transverse Mercator
WGS	World Geodetic System
MT	Metric Ton
GNSS	Global Navigation Satellite System
BM	Bench Mark
TBM	Temporary Bench Mark
HAD	Haldia Development Authority
WBSTC	West Bengal Surface Transport Corporation Ltd.
WBTIDC	West Bengal Transport Infrastructre Development Corporation Ltd.
IMO	International Maritime Organisation
VHF	Very High Frequency
RIS	River Information System

SALIENT FEATURES OF KALINDI RIVER (SUNDERBANS WATERWAYS (NW 97)

Sr. No.	Particulars	Details			
A.	**GENERAL**				
1.	***Location***				
a)	Cluster	3			
b)	State(s)	West Bengal			
c)	Co-ordinates & Name of Place	**Start**		**End**	
	Place	Ambaria		Hingalganj	
	Latitude	22°24'41.40"N		22°28'8.84"N	
	Longitude	88°58'20.68"E		88°59'47.35"E	
B.	**TECHNICAL**				
1.	***Waterway***				
a)	National Waterway Number	97			
b)	Class	IV			
c)	Type (Tidal/Non-Tidal)	Tidal			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		8.513 km	8.513 km	0 Km	
d)	Sounding Datum				
	Description/Basis	Sounding Datum was transferred at all the newly established BM's using Garden Reach values. Standard method was adopted for transfer of datum for tidal reaches areas as per Admiralty Manual.			
	Value w.r.t MSL (m)	0 – 2 km	2 – 4 km	4 – 6 km	6 – 8.513 km
		-2.82	-2.82	-2.82	-2.82
e)	LAD Status (w.r.t. SD)				
		Sub - Stretch 1	**Sub - Stretch 2**	**Sub - Stretch 3**	**Sub - Stretch 4**
	Stretch Km (From……To……)	**0 – 2**	**2 – 4**	**4 – 6**	**6 – 8.513**
	Length with LAD < 1.2 m	0	0	0	0
	With LAD from 1.2-1.4 m	0	0	0	0
	With LAD from 1.5-1.7 m	0	0	0	0
	With LAD from 1.8-2.0 m	0	0	0	0

Sr. No.	Particulars	Details				
	With LAD > 2.0 m	2	2	2	2.513	
	Total	2	2	2	2.513	
f)	Target Depth of Proposed Fairway (m)	2.75 m for Class VII waterway				
g)	Conservancy Works Required					
	Type of Work	**0 – 2 km**	**2 – 4 km**	**4 – 6 km**	**6 – 8.513 km**	**Total (km)**
	Dredging Required (M. Cum.)	0.019	0.022	0.122	0.107	0.271
	Bandalling					Nil
	Barrages & Locks					Nil
	River Training (Km.)					Nil
	Bank Protection (Km.)					Nil
h)	Existing Cross Structures					
	Name of Structure	**Type**	**Nos.**	**Range of Horizontal Clearance**	**Range of Vertical Clearance w.r.t. MHWS**	
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil	
	Bridges	Nil	Nil	Nil	Nil	
	HT/Tele-communication lines	Nil	Nil	Nil	Nil	
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil	
2.	***Traffic***					
a)	Present IWT Operations (type of services)	Not available				
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	Not Available				
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	The stretch is moderately connected with road and rail network. Nearest rail head is at Hasnabad which is 15 km away. SH 2 passes at Hasnabad. Ferry services runs from the small jetties in the area. Mobile network is generally available in the area. The international boundary between India and Bangladesh passes				

Sr. No.	Particulars	Details				
		through the waters of the Kalindi River with the left bank belonging to India. The river has dense mangroves at a few locations.				
d)	Commodities	**In-bound**			**Out-bound**	
		Not Available			Not Available	
e)	Existing and Future Potential					
	Name of Commodity	**Existing**	**5 years**	**10 years**	**15 years**	**20 years**
	Passengers (nos. per day)	Not Available				
3.	***Terminals/Jetties***	Not Recommended				
4.	***Design Vessel***	Not Recommended				
5.	***Navigation Aids***					
a)	Type	Marking buoys				
b)	Nos.	8				
C.	**FINANCIAL**					
1.	***Cost***	***Capital Cost*** (INR Lakhs)			***O&M Cost*** (INR Lakhs)	
	Fairway Development	541.24			54.12	
	Total Cost	**641.76**			**80.85**	
2.	***User Charges***	Not applicable				
3.	***Financial Internal Rate of Return (%)***	Not applicable				
4.	***Economic Internal Rate of Return (%)***	Not applicable				

EXECUTIVE SUMMARY

1.0 INTRODUCTION

Inland Waterways Authority of India appointed M/s Egis India for providing Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of Cluster 3 National Waterways. Kalindi River is one of the 13 rivers clubbed in Cluster 3.

This detailed project report of 8.513 km stretch of Kalindi River waterway is prepared on the basis of recommendations from feasibility report, detailed survey & investigations, preliminary engineering and design and suggestions from IWAI.

2.0 WATERWAY/DETAILED HYDROGRAPHIC SURVEY

The 8.513 km stretch of Kalindi National waterway proposed for DPR study lies from Ambaria at Lat 22°24'41.40"N, Long 088°58'20.68"E to Hingalganj at Lat 22°28'8.84"N, Long 88°59'47.35"E. Whole stretch of Kalindi waterway is having tidal influence with a maximum tidal variation of 0.9 m to a minimum tidal variation of 0.875 m.

River width in the waterway stretch varies from 0.3 km to 0.85 km. Average flow velocity in the waterway varies from 0.543 m/sec to 0.56 m/sec.

3.0 FAIRWAY DEVELOPMENT

As obtained from the results of hydrographic survey, by taking into advantage of tidal window, sufficient LAD is available in the complete 8.513 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation. The waterway is proposed to be developed as Class VII, and for this classification 2,70,620.67 cum of dreding is required to be done. The total capital and O&M cost of fairway development works out to INR 541.24 Lakh and INR 54.12 Lakh respectively.

4.0 TRAFFIC STUDY

On the basis of detailed traffic survey and study done during DPR stage, following conclusions are made:

a) Proposed Kalindi waterway is directly connected with Sahibkhali.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) International Border of India Bangladesh falls along the Kalindi river, with left bank along the Indian side.
e) Three numbers of Border Security Force (BSF) jetties are located along the left bank of river.
f) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
g) 8.513 Km stretch of Kalindi River has no major passenger or cargo traffic.

In view of the above observations, the waterway is recommended to be developed as part of collective development of NW-97 (Sunderbans waterways) for providing an uninterrupted connectivity between proposed waterways. However, no additional jetty/terminal and vessels are proposed in this DPR.

5.0 TERMINALS

There are existing ferry terminals operated by BSF are located along the Kalindi river. The list of existing terminals located is provided as below:

List of Existing Jetties

Terminal Name	Approx. Chainage from starting point
Khoshbash jetty (BSF)	0.6 km
Singherkati (BSF)	3.5 km
Hingalganj (BSF)	8.4 km

In the absence of cargo and passenger traffic, further development of existing jetty/terminal structure or construction of new structure is not recommended at this stage of DPR.

6.0 NAVIGATION & COMMUNICATION SYSTEM

Aids to Navigation like marking buoys are proposed along the channel alignment. Capital and maintenance cost for the same works out to INR 16.48 Lakh and INR 1.65 Lakh respectively.

7.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Kalindi River through available data /information supported by field studies to evaluate the impacts on relevant environmental attributes due to the construction & operation of the proposed project; to recommend adequate mitigation measures to minimize / reduce adverse impacts and to prepare an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to make the project environmentally sound and sustainable. The study basically includes:

- Establishment of the present environmental scenario
- Study of the specific activities related to the project
- Evaluation of the probable environmental impacts
- Recommendations of necessary environmental control measures.
- Preparation of Environmental Management Plan

The study stretch passes through North 24 Parganas District of West Bengal State. North 24 Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends from latitude 22º11'6" North to 23º15'2" North and from longitude 88º20' East to 89º5' East. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west. Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district. It is also the tenth-largest district in the State by area.

The project falls under the lies in Earthquake high damage risk zone-IV as defined by the Indian Standard (IS) 2002 seismic zoning classification system, i.e. a zone of relative stability. The maximum temperature as recorded is 41°C and the minimum is 10°C.

Assessments of impact on environment including social considerations are done in the DPR. The total environmental estimated cost for the project is Rs. 109.11 lakh.

8.0 INSTITUTIONAL REQUIREMENTS

The proposed development of Kalindi waterway is recommended to be handled by the Project Management Unit (PMU) proposed for development of Sahibkhali waterway, under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata.

9.0 PROJECT COSTING

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates of PWD, Govt. of West Bengal.
b) "Unified Schedule of Rates" prepared by Irrigation and Waterways department, Government of West Bengal.
c) The consultants experience on various projects sites proximity to the project area.
d) Local enquiries at the time of conducting surveys.
e) Market surveys and enquires
f) Approved DPR's of National Waterways by IWAI.

Kalindi waterway is proposed to be developed as Class VII waterway for a stretch of 8.513 Km. The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) EMP cost

The capital cost for development of the waterway worked out as INR 641.76 Lakh and O&M cost worked out as INR 80.85 Lakh.

10.0 IMPLEMENTATION SCHEDULE

The project is scheduled to be completed in 12 months from the start date of construction.

11.0 ECONOMIC & FINANCIAL ANALYSIS

As presently Kalindi waterway neither have its own passenger and cargo traffic nor the same is foreseen for project duration, no jetty/ terminal structure and vessels are proposed in this DPR. Accordngly, in the absence of traffic and projected revenues to be generated from Kalindi waterway, the internal rate of returns can not be ascertained.

12.0 CONCLUSION

On the basis of studies done in this DPR following conclusions are made:

a) Proposed Kalindi waterway is directly connected with Sahibkhali.

b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) International Border of India Bangladesh falls along the Kalindi river, with left bank along the Indian side.
e) Three numbers of Border Security Force (BSF) jetties are located along the left bank of river.
f) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
g) 8.513 Km stretch of Kalindi River has no major passenger or cargo traffic.

As mentioned above, Kalindi waterway neither have its own passenger and cargo traffic nor the same is foreseen for project duration, accordingly no jetty/ terminal structure and vessels are proposed in this DPR.

However, in order to provide an uninterrupted connectivity between other proposed national waterways and as part of collective development of NW-97, Sunderban waterways, Kalindi waterway is proposed to be developed as Class VII waterway as per IWAI guidelines. Accordingly, Dredging and Navigation & Communication Aids are proposed for the development of Kalindi waterway. The capital and O&M cost for the waterway development works out as INR 641.76 Lakh and INR 80.85 Lakh respectively.

In the absence of traffic and projected revenues to be generated from Kalindi waterway, the internal rate of returns can not be ascertained.

1.0 INTRODUCTION

Inland Waterways Authority of India (IWAI), an undertaking of Ministry of Shipping, Government of India intends to develop 106 new National Waterways in addition to the exiting 5 National waterways. The National waterways are proposed to be developed as a composite and integrated water transport system with the existing rail and road infrastructure across the country.

In view of this, IWAI invited online bids for "Consultancy Services for preparation of Two Stage Detailed Project Report of the 106 National Waterways in a set of eight clusters. Each waterway is to be explored for the potential of year round commercial navigation during Stage-1 (Feasibility Studies) of the project. The second stage comprises of preparation of techno-commercial detailed project report of the river/stretches approved by IWAI for stage -2 studies. Egis India Consulting Engineers Pvt. Ltd (EICEPL) was awarded the work for two stage DPR studies of two out of eight clusters respectively. Kalindi River was clubbed under Cluster -3 for the two stage DPR studies.

This detailed project report of 8.513 km stretch of Kalindi waterway is prepared on the basis of recommendations from feasibility report, detailed survey & investigations, preliminary engineering and design and suggestions from IWAI. The report is prepared in accordance with detailed ToR as per the agreement **(Refer Annexure 1)**.

1.1 PROJECT BACKGROUND AND SUMMARY OF PREVIOUS STUDY

Kalindi River (under Sunderbans Waterways) is declared as National Waterway-97 as per "The National Waterway Act, 2016", No. 17 of 2016, published in the Gazette of India, Part – II- Section 1 no. 18, New Delhi, Saturday, March 26/2016/Chaitra 6, 1938 (Saka), by Ministry of Law and Justice (Legislative Department).

As per the Gazette notification, total 13 rivers (including Kalindi River) was covered in the Sunderbans waterways (NW-97). Following section of the Kalindi River is declared as National Waterway and recommended for feasibility studies by IWAI:

Length	Co-ordinate at Start	Start Location	Co-ordinate at End	End Location
8.513 Km	22°24'41.40"N 88°58'20.68"E	Ambaria	22°28'8.84"N 88°59'47.35"E	Hingalganj

A single feasibility report was prepared for all the 13 rivers covered under Sunderbans Waterways. Following conclusions were made for Kalindi River in the feasibility report.

- The waterway is a tidal river having year round navigational possibility.
- The river can be recommended for DPR studies.

The above conclusions were made on the basis of findings during the feasibility study stage. Detailed survey and investigations are done including preliminary engineering studies as per the scope of work defined in the ToR to validate above conclusions and to identify the development works required for making a techno-economically viable IWT in Kalindi WW.

Based on the above conclusions/observations done during feasibility studies i.e. first stage of the studies, IWAI recommended following stretch of Kalindi River for second stage of the studies i.e. for detailed project report.

Length	Co-ordinate at Start	Start Location	Co-ordinate at End	End Location
8.513 Km	22°24'41.40"N 88°58'20.68"E	Ambaria	22°28'8.84"N 88°59'47.35"E	Hingalganj

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 8.513 km stretch of Kalindi waterway is located in North 24 Parganas district of West Bengal. As observed during the feasibility studies, complete stretch of waterway is having tidal influence. Locally operated jetties/ferry ghats are also available at various locations all along the river stretch.

Kalindi waterway project location as per DPR is shown in **Figure 1**. The detailed layout plan of waterway is provided in Drawing attached as **Volume-II**.

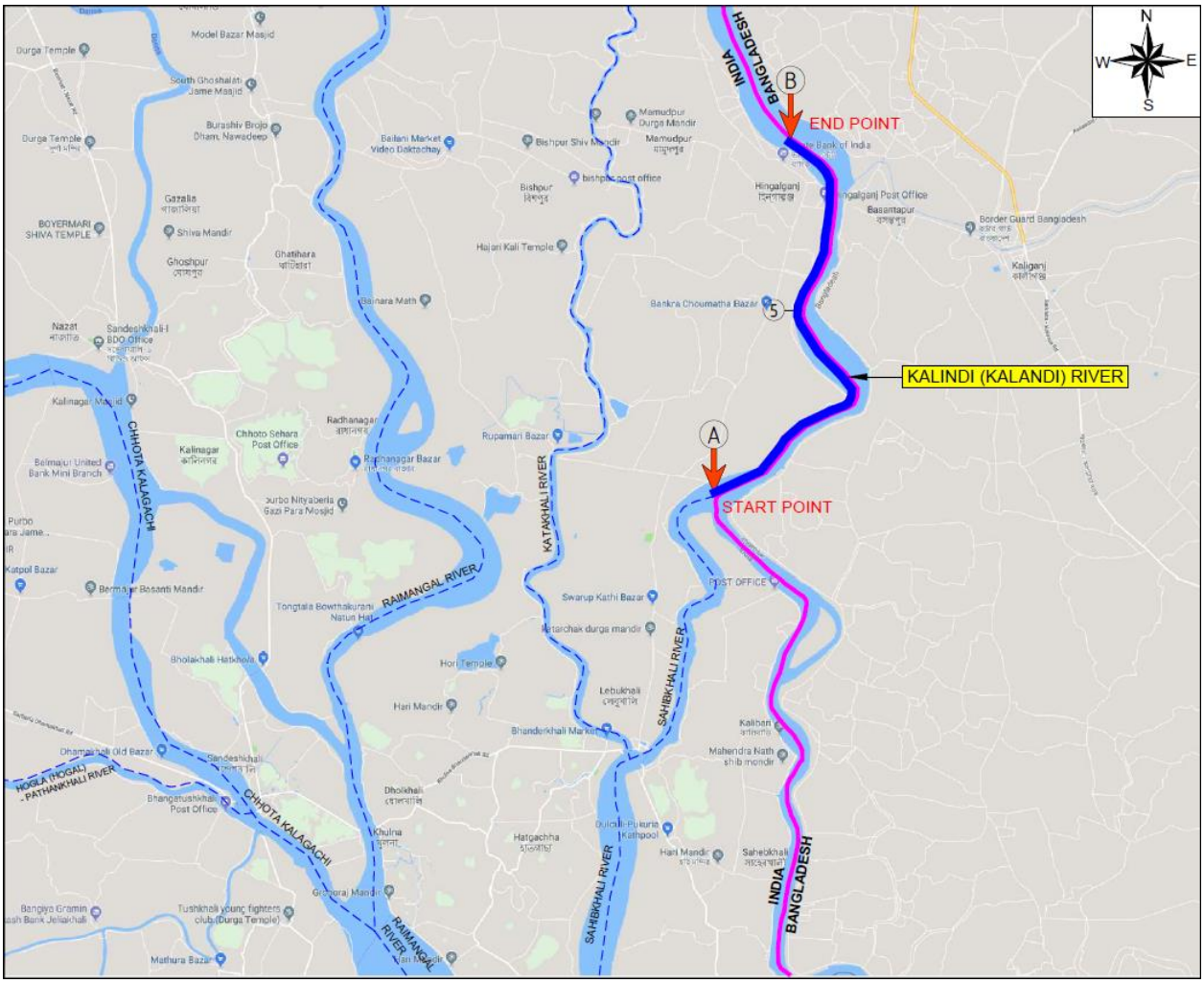


Figure 1: Kalindi National Waterway Project Location

1.3 BRIEF SCOPE OF WORK AND COMPLIANCE STATEMENT

The brief scope of work for the project comprises of:

a) Hydrographic and Hydro-morphological Survey and Investigations

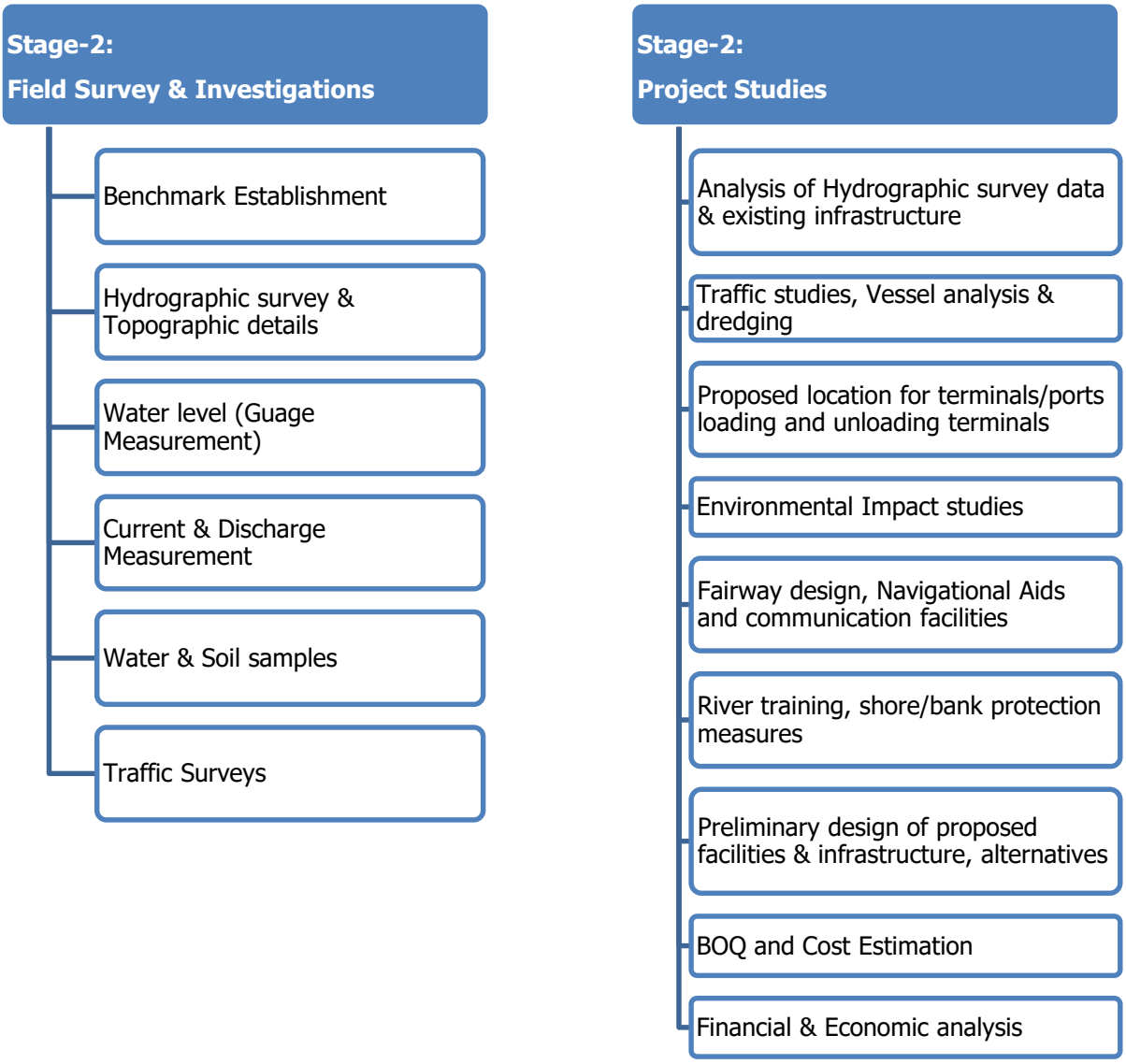
i. Installation of bench mark pillars
ii. Installation of water level gauges and observations as per TOR
iii. Bathymetric & Topographic Survey
iv. Current velocity and discharge measurements
v. Collection of water & bottom samples and analysis as per TOR
vi. Collection of Topographical features.
vii. Survey chart preparation

b) Traffic Survey
c) Geotechnical investigations
d) Environmental & social impact assessment
e) Analysis of collected data and preliminary engineering design
f) Scheduling and costing
g) Economic & Financial analysis for assessment of techno economic feasibility
h) Conclusion and recommendations.

The scope of work mentioned above, under Hydrographic and hydro-morphological survey was covered in the Hydrographic Survey Charts and Report, submitted as part of first deliverable under Stage-II of the project. The compliance statement of detailed project report covering the remaining scope of work as per TOR is provided as below:

Sr. No.	Section – 6 Terms of Reference Clause No. 1.2	Covered under Chapter No./ Title
1.0	Assessment of Hydrographic Survey Report	Chapter 2: Waterway/Detailed Hydrographic Survey
2.0	Traffic Survey	Chapter 4: Traffic Study
3.0	Geotechnical investigations	Chapter 5: Terminals
4.0	Environmental & Social impact assessment	Chapter 9: Environmental and Social Aspects
5.0	Analysis of collected data and preliminary engineering design	Chapter 6: Preliminary engineering Designs
6.0	Scheduling and costing	Chapter 11: Project Costing Chapter 12: Implementation Schedule
7.0	Economic & Financial analysis for assessment of techno economic feasibility	Chapter 13: Economic and Financial Analysis
8.0	Conclusion and recommendations.	Chapter 14: Conclusion and Recommendations

The above scope of works shall be executed as per the framework shown below;



1.4 BRIEF METHODOLOGY & APPROACH

The stretch of waterway, recommended for DPR studies is surveyed and studied in detail for techno-economic development of IWT along the proposed stretch.

Detailed hydrographic, hydro-morphological survey and investigations, traffic, environment and social survey is done out along the stretch. The data collected from survey is further analysed in detail for design of waterway, estimating of dredging quantity and finalising location and type of jetties/terminals required along the waterway. On the basis of DPR level design and drawings, cost estimate, financial and economic evaluation is done. The techno-economic viability of IWT development along the proposed stretch is assessed and concluded in the report.

DPR studies have been construed as a means to establish the techno-commercial viability of the development of waterway, and accordingly have been taken–up in two stages:

Stage-I: Establishment of Technical Viability

Stage-II: Assessment of Financial/Economic viability, in case the technical viability is established.

A detailed DPR methodology and the expected outcome in fulfilling the assignment are presented as below:

Stage-I: Establishment of Technical Viability

Technical viability has been established on the survey & investigations, as per Volume-III of this report. Following of two major parameters have been considered to establish the technical viability:

- Availability of LAD (Least Available Depth) & dredging quantity for proposed Class of waterway
- Availability of Traffic (cargo/RO-RO/passenger)

In case, the traffic is available, all technical possibilities shall be explored to ensure the required LAD and further studies for assessment of financial viability (Stage-II) shall be performed to assess the complete techno-commercial viability.

However, in case, no traffic is available, the development of waterway in the specific reach of the river shall be considered as "Technically Not-Viable" and stage –II studies are not warranted.

Stage-II: Assessment of Financial/Economic Viability

Stage-II studies shall comprise of the following:

a) Design, Analysis and Costing

- Fairway Development
- Terminal
- Vessel
- Environmental and Social Studies

- Navigation and Communication Facilities
- Institutional Requirement
- Project Costing
- Implementation Schedule

b) <u>Commercial Viability</u>

- Estimation of economic and financial Returns

For Commercially viable project, the DPR will be concluded with providing recommendations for development.

For Commercially non-viable project, the DPR will be concluded declaring the project as commercially non-viable.

Above methodology is also presented as a flow chart in **Figure 2** as below:

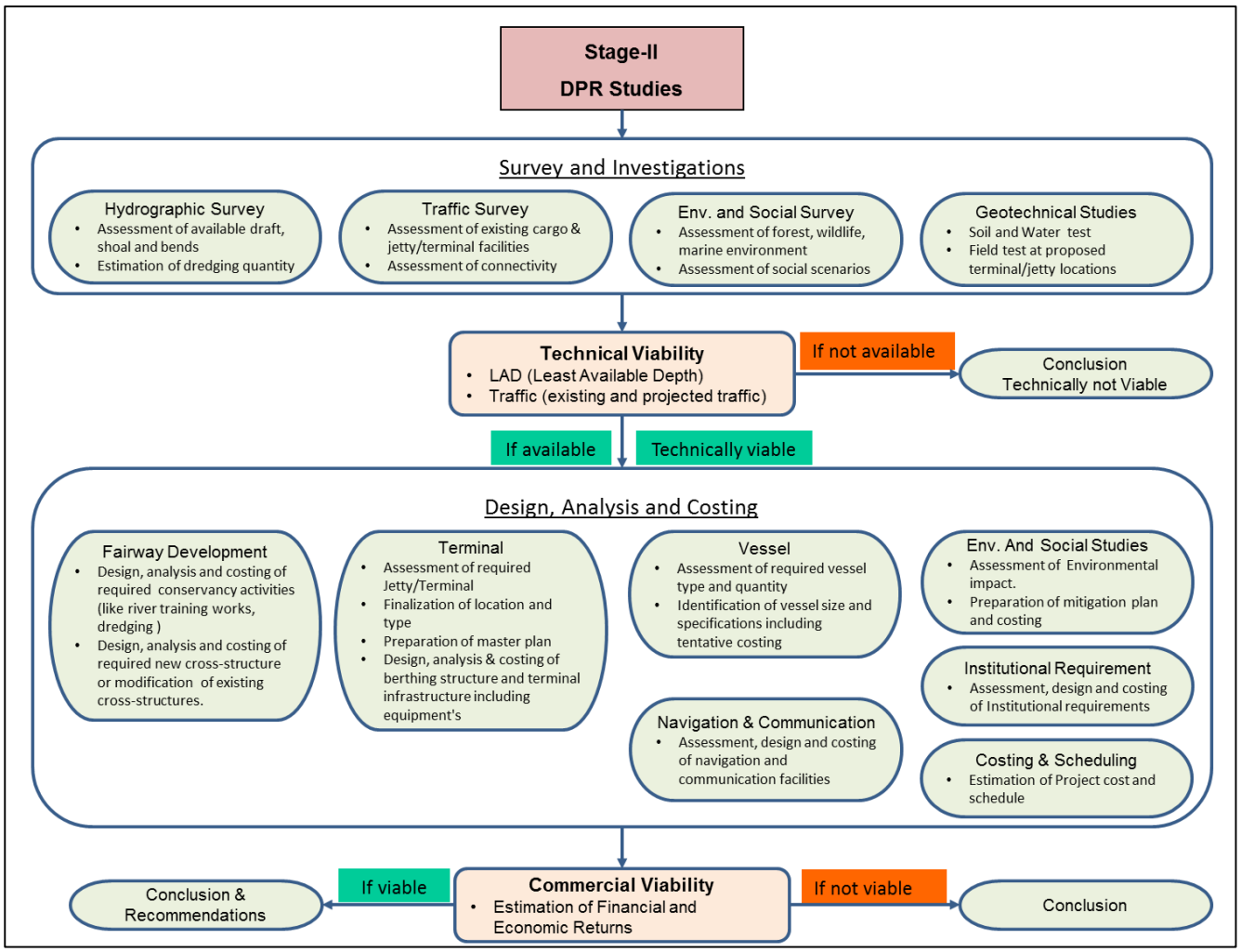


Figure 2: DPR Approach and Methodology Flow Chart

1.4.1 Classification of Waterways

For safe plying of self- propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in push tow units of carrying capacity up to 8000 tonne, National waterways can be classified in the following categories as suggested by IWAI:

Table 1: Classification of National Waterway -Rivers

Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self propelled vessel Carrying Capacity
CLASS-I	1.2	30	300	4	30	100 tonne Dead Weight Tonnage (approx. size 32m overall length, 5m moulded breadth and 1.0m loaded draft or one tug and two barges combination of 200 tonne Dead Weight Tonnage (approx. size 80m overall length, 5m moulded breadth and 1.0m loaded draft).
CLASS-II	1.4	40	500	5	40	300 tonne Dead Weight Tonnage (approx. size 45m overall length, 8m moulded breadth and 1.2m loaded draft or one tug and two barges combination of 600 tonne Dead Weight Tonnage (approx. size 110m overall length, 8m moulded breadth and 1.2m loaded draft).
CLASS-III	1.7	50	700	6	50	500 tonne Dead Weight Tonnage (approx. size 58m overall length, 9m moulded breadth and 1.5m loaded draft or one tug and two barges combination of 1000 tonne Dead Weight Tonnage (approx. size 141m overall length, 9m moulded breadth and 1.5m loaded draft).
CLASS-IV	2.0	50	800	8	50	1000 tonne Dead Weight Tonnage (approx. size 70m overall length, 12m moulded

Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self propelled vessel Carrying Capacity
						breadth and 1.8m loaded draft or one tug and two barges combination of 2000 tonne Dead Weight Tonnage (approx. size 170m overall length, 12m moulded breadth and 1.8m loaded draft).
CLASS-V	2.0	80	800	8	80	1000 tonne Dead Weight Tonnage (approx. size 70m overall length, 12m moulded breadth and 1.8m loaded draft or one tug and two barges combination of 4000 tonne Dead Weight Tonnage (approx. size 170m overall length, 24m moulded breadth and 1.8m loaded draft).
CLASS-VI	2.75	80	900	10	80	2000 tonne Dead Weight Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 4000 tonne Dead Weight Tonnage (approx. size 210m overall length, 14m moulded breadth and 2.5m loaded draft).
CLASS-VII	2.75	100	900	10	100	2000 tonne Dead Weight Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 8000 tonne Dead Weight Tonnage (approx. size 210m overall length, 28m moulded breadth and 2.5m loaded draft or with higher dims).

In addition to the above, IWAI also given guidelines regarding vertical clearances with respect to transmission lines for National waterways as below:

Type of Transmission Lines	Vertical Clearance
Low voltage transmission lines including telephone lines	16.5
High voltage transmission lines, not exceeding 110 kilo volt	19.0
High voltage transmission lines, exceeding 110 kilo volt	19.0
	+1 centimetres extra for each additional 1 kilovolt

Also:

a) Waterway side slopes should be kept as 1(V): 5(H);
b) Minimum depth of channel should normally be available for about 330 days of the year;
c) Vertical clearance at cross structure over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway;
d) For rivers, vertical clearance should be kept over Navigational High Flood Level (NHFL), which is the highest flood level at a frequency of 5% in any year over a period of last twenty years.

1.4.2 Measures to Improve the Depth

The basic parameters considered for the fairway design are:

- Depth
- Width
- Side slopes
- Bends

As explained above, as the classification of waterways in India is based on the experience gained in various waterways, the characteristic features of the design waterways based on studies carried out by IWAI are furnished below and the same shall be followed.

Fairway Design

The fairway depth should be good enough to ensure steerability of the vessel and to prevent bottom feel. To meet this requirement, the minimum depth that is needed in a channel would commonly be the sum of the draught (draft) of the vessel and other tolerance factors. The tolerance factors to be considered are listed as:

- Factor of keel clearance to avoid touching of the vessel to the ground and minimum free water below the keel for maintaining control on manoeuvring,
- Wave tolerance for the heaving and pitching of the vessel due to wave motion,
- Squat, increase of draft due to ship motion,
- Tolerance for siltation and dredging,
- Increase of draught due to trim and heaving due to unequal loading and steering manoeuvre respectively, and
- Tolerance for the change of draught during the transition from salt water to fresh water.

The keel clearance factor is the prime concern of the all tolerance factors considered. As per the standards laid down by German Code of practice (EAU 80), a 0.3 m layer of water column below the keel of the loaded ship is sufficient for free manoeuvrability of the vessel.

IWAI's experience in inland waterways in India and sub-continent (Bangladesh and Myanmar) shows that the under keel clearance for free manoeuvrability of the vessel varies between 0.2 and 0.5 m depending upon the soil characteristics of the channel bed and other parameters.

Width of a Channel

The total width of a navigation waterway (W) in general is expressed in terms of a beam of a vessel (B). The design width for the proposed two-way navigation can be obtained as:

$$W = BM + BM1 + C + 2C1$$

Where: W = Navigation channel width for two-way navigation.

BM = Maneuvering zone for the design vessel which takes into account the directional stability of vessel.

BM1 = Maneuvering zone for the upcoming vessel which takes into account the directional stability of vessel.

C = Width of separating zone.

C1 = Width of the security area, between the maneuvering zone and the channel side which is accounted for environmental and human factors including bank suction.

Values recommended by various authorities for the above equation vary within wide limits. Some of the recommended values are presented here:

BM = 1.3 B to 3.0 B
BM = BM1
C = 0.5 B to 1.0 B
C1 = 0.3 B to 1.5 B
Where, B = Beam of a design vessel.

Based on the experience and recommendations of experts on Inland Waterways, the factors considered for the present design are:

BM = 1.8 B
BM = BM1
C = 0.5 B
C1 = 0.5 B

The designed channel width = 1.8B+1.8B+0.5B+2x0.5B for two way navigation at draft level = 5.1B. The bottom width of the channel for two-way navigation for the design vessel can generally be considered as 5 x B.

Slopes

The selection of slope is in accordance with the soil characteristics of the bed and banks, width of the waterway etc. The adopted channel slope shall be 1:5

Width Allowance at Bends

In bends, the width of the fairway should be more than the width of the canal that is designed for a straight reach to allow for a drift of the vessel in a curved portion of the waterway. It means that the vessel occupies a greater width in bends than in a straight stretch of the waterway. The drift of the vessel depends on the radius of the bend, the speed of the vessel, wind forces, the flow pattern and the loading of the vessel. The drift angle is larger for vessels traveling in the downstream than the

upstream direction. The drift angle is inversely proportional to the bend radius 'R', that is, the larger the radius the smaller the value of drift angle. Unloaded ships normally subjected to more drift and consequently take up a greater width in bends than loaded ships and therefore the proposed allowance at the keel level of the unloaded ships is larger than the loaded ships.

Dredging of Navigational Channel

The dredging quantities for the above design channel shall be worked out based on the bathymetric surveys carried out. The system and different type of navigation marks shall be proposed in the DPR are given as follows:

- Lateral marks, to mark the left and right sides of the navigation route to be followed by navigator;
- Bifurcation marks, to mark the middle ground between the navigation channel, bifurcated channel and isolated dangers in the middle of the navigational channel;
- Shore marks;
- Bank wise marks, to indicate the channel at point where it approaches a bank;
- Crossing marks, to indicated crossing and alignment of the channel from one bank to another;
- Marks of prohibited areas, to indicate no permission of entry;
- Sound signal marks, to indicate use of horning or other sound signals;
- Marks for traffic control, to control up bound or down bound vessel in one way or sequence passage or to prohibit navigation;
- Marks on bridges, to indicate the passage through bridges;
- Depth indicator marks, to indicate shallow areas ahead in the navigation channel;
- Width indicator marks, to indicate the narrow stretches ahead in the navigational channel;
- River training marks, to indicate the ongoing river training works in the river to the navigators.

1.4.3 Identification of IWT Terminals

Site selection is the most important as it decides the investment for establishing the terminal facilities. Hence, proper consideration has to be given to select the most optimum location which will minimise the capital investment and other recurring cost during operation. The selection of suitable site shall be carried out with the view of following considerations:

- Water availability near the terminal land throughout the year especially during lean season;
- Stable river channel with sufficient depth;

- Favourable hydraulic conditions for berthing and cargo handling;
- Availability of terminal land for infrastructure, cargo storage and handling;
- Traffic potential and cargo characteristics; and
- Navigational safety.

The proposed IWT Terminals shall be planned with the following infrastructure facilities for operation:

i) Steel Gangway resting on a floating pontoon. The detailed engineering & design of gangway arrangement shall be carried out during the construction stage. The preliminary layout drawing shall be proposed in the DPR;
ii) Administration Building and Bank protection arrangement;
iii) Covered Storage Shed/Transit Shed;
iv) Open storage area;
v) Security Shed;
vi) Forklift Trucks, Pay loaders & Dumper tracks; and
vii) Weigh Bridge, Watch and ward, Compound wall, Firefighting arrangement, Electrical & PH Facilities including DG.

The terminal shall be proposed with suitable mooring facilities, firefighting water line, water supply pipeline, power line for shore connection to barges, fenders etc. Preliminary planning and master plan shall be prepared in the DPR stage as per the relevant IS codes. It is envisaged and proposed that to the extent possible, all shore/river bank based buildings / godown are prefabricated, pre-engineered type conforming to the best standards in vogue in logistic / supply chain industry.

Other Alternatives to Improve for Navigation

Based on our earlier study for Ganga River between the reach from Allahabad to Ghazipur, there are many methods available to improve river navigation. Bandalling work – it has to follow closely falling stage of river, closing minor channels and diverting river flow in single channel to increase depth in the navigable channel in mainly due done by bandalling. In some reaches this method becomes successful but some river stretches remain shallow and need other training measures including dredging. Channelization of river and Construction of barrages at suitable locations, creating ponding conditions with required depth and navigational locks for ships and vessel movement shall be studied. The examination of various options/measures to improve the water depth shall be studied. The most suitable method for development shall be identified with consideration on the likely morphological, sediment transport, and dredging aspects of different options. This task is expected to be fed back

into from the financial and economic analysis providing refinement to the proposed development until a recommended solution is reached. The most appropriate type of river development including drudging option along the river shall be identified and likely impacts of these developments on river flow depths as well as sedimentation and morphology shall be investigated. This analysis will constitute an iterative process in which problems relating to LAD will be addressed to find more successful solutions where necessary. This will however, not be an open-ended process as the assessment of techno-economic feasibility updation only requires an indication of the likely costs of building and maintaining the structures which are shown to support achievement of LAD as intended.

1.4.4 Concept Design and Cost Estimates

Preliminary Design shall be performed for all the structures /developmental works proposed as per the above analysis and mathematical model studies carried out conforming to relevant IS Codes. Design drawings shall be prepared and submitted based on the preliminary design. Bill of quantities and cost estimates shall be prepared for all the proposed structures / developmental works. Based on the cargo potential and other considerations necessary for locating an IWT terminal, extent of land required for setting up of IWT terminals and other suitable locations shall be identified. Preliminary topographic survey shall be carried out and layout plan for all suggested locations shall be prepared clearly indicating all facilities e.g. jetty, approach to jetty, bank protection, covered and open storage, roads, office, sentry hut, boundary wall, bank protection, bunkering facility, water facility, turning circle for IWT vessels location of depth contours of 2m and 2.5m in the river near the terminal sites. Preliminary engineering design and drawings for setting up of terminals with related facilities including mechanical loading/ unloading at the proposed sites shall be prepared. Also inter modal cargo transfer facilities required at these terminals shall be indicated.

1.4.5 Financial and Economic Analysis

Financial and economic analysis through FIRR and EIRR of the project including SWOT analysis shall be carried out for the project. For the Financial Internal Rate of Return shall be computed as follows:

- Costs shall be calculated as total capital investment for the Project components, net rate of interest charges during construction and operations & maintenance costs for the Project;
- Income flows shall be calculated based on gross revenues of projected goods to be transported through private operators with permissible assumptions such as project life etc.;
- Economic Internal Rate of Return shall be computed taking into account the following factors;
- The assumed life of the project as per norms;

- Costs shall be calculated as Government contribution and other sources. A standard conversion factor shall be used to reduce financial costs to economic costs;
- Benefits shall be estimated as Government revenues, calculated as net profit share, royalties and tax;
- Social Benefits like fuel saving, reduction in environment pollution and carbon emission, accident reduction, decongestion of rail and roads, etc.

The financial viability and sustainability of this project depend upon the adaptation to the prevailing context in which they operate. In working out the Financial Viability and sustainability, the following factors shall be considered.

- budgeting and cost accounting systems,
- resource mobilization for capital investments,
- cost recovery and operational financing,
- cost reduction and control.

The Profitability projections and financial analysis for each of the project components shall be worked out in detail and presented in the report. The financial statements shall be prepared on the basis of the suitable assumptions. The cost benefit analysis for the proposed project shall be calculated. IRR and preliminary expenses shall be suitably considered and estimated. Break-even analysis shall be performed and presented in the report.

2.0 WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1 HYDROGRAPHIC SURVEY

As detailed above, the National Waterway stretch of Kalindi river under DPR study is from Ambaria at Lat 22°24'41.40"N, Long 88°58'20.68"E to Hingalganj at Lat 22°28'8.84"N, Long 88°59'47.35"E. The total length of this stretch is about 8.513 km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Kalindi waterway comprises of:

- Undertake bathymetric and topographic survey of proposed waterway
- Establishing horizontal and vertical control stations.
- Construction of benchmark pillars and establishing its reduced level w.r.to Mean Sea Level.
- Transfer of sounding Datum.
- Setting up and deployment of water level gauges.
- Current velocity and discharge measurements.
- Collection and analysis of water and bottom samples.
- Collection of topographic features including existing cross structures.
- Preparation of inventory of industries in the project influence area (PIA).
- Analysis of survey data, including assessment of water availability for navigation.
- Preparation of survey charts and report.

2.1.1 Waterway in General and Hydro-Morphological Characteristics

The Kalindi River is a tidal estuarine river in and around the Sundarbans in North 24 Parganas district West Bengal, India, bordering on Satkhira District of Bangladesh. The river has a connection with the Ichhamati River in the North and with Sahibkhali River in the south. The combined river flow falls in to the Bay of Bengal with a wide mouth after traversing about 80 kilometers. There are a couple of sharp curves in the river stream.

The proposed 8.513 Km stretch of waterway is located in the North 24 Parganas district of West Bengal. Whole stretch of Kalindi waterway is having tidal influence with a maximum tidal variation of 0.875m to a minimum tidal variation of 0.90 m.

Average flow velocity in the waterway varies from 0.543m/sec to 0.56 m/sec. Reduced depth at every 1 Km intervals for full stretch of the river is provided in **Chapter 3**.

2.1.2 Existing Hydrological / Topographical Reference levels

There was no GTS Station available near the survey area. As per IWAI guidelines, simultaneous 4 hour observation was carried out at newly established BM KD-01& KD-02 and KK-01 of Kathakali River. Data was logged in rinex format which was post processed in Auspos and Spectra software and value of BMs w.r.t. MSL were obtained.

Value of sounding datum was obtained as 2.36 m w.r.t MSL from Garden Reach as per IWAI guidelines. Kalindi River was divided into 02 km stretches for ease of applying tidal level corrections to the collected bathymetric data. Total two in number BM pillars (naming KD-01 and KD-02 were constructed and erected along the river from Ambaria to Hingalganj.

The final accepted WGS 84 coordinates and details of Benchmarks established during the conduct of survey are provided in **Table 2**.

Table 2: Description of Bench Marks

IWAI BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above MSL (m)	SD W.R.T MSL	Height above SD (m)
KD-01	Boltala, Khosbash	0.65	22°24'59.86"	88°58'36.73"	703481.60	2480282.120	7.0	-2.36	9.36
KD-02	Hingalganj	8.4	22°28'01.86"	88°59'41.62"	705263.17	2485905.301	5.402	-2.36	7.762

2.1.3 Sounding Datum and Reduction details

Sounding Datum was transferred at all the newly established BM's using Garden Reach values. Standard method was adopted for transfer of datum for tidal reaches areas as per Admiralty Manual. Details of Sounding Datum (SD) and reduction details are provided in **Table 3** as below:

Table 3: Details of Sounding Datum

Sl No	Location of Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topolevels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey(m)	Topo level data to be converted as depth for volume calculation wrt SD (m)
	A	B	C	D +ve indicates above MSL -ve indicates below MSL	E	F= (E- WL data in MSL)	G = (E- topo levels in MSL)
KD-01	Boltala, Khosbash.	0.65	0.0 to 4.0	-2.36	-2.36	Tide Applied w.r.t SD	2.36
KD-02	Hingalganj	8.4	4.1 to 8.513	-2.36	-2.36		2.36

2.2 EXISTING CROSS STRUCTURES

2.2.1 Bridges

No Bridges are located across the entire stretch of waterway.

2.2.2 Electric Lines / Communication Lines

No High Tension lines are located along/across the entire stretch of waterway.

2.2.3 Pipe Lines / Cables

No cross-structures, pipe lines, underwater cables are located along the entire stretch of waterway.

2.2.4 Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

No dams, barrage, weir or any other cross structure are located along the entire stretch of waterway.

2.3 BENDS

Details of bends located along the entire stretch of waterway are provided in **Table 4**:

Table 4: List of Bends

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
1.0	1.43	2.30	1,492
2.0	2.96	3.35	235
3.0	4.60	5.34	539
4.0	7.09	7.96	644

2.4 VELOCITY AND DISCHARGE DETAILS

Current meter observations were carried out at each location at required depths using virtual ware Current meter. The observations were carried out at the deepest route of the channels. Discharge calculations are from the observed data. The current meter and discharge details are provided in **Table 5**.

Table 5: Current Meter and Discharge Details

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area(Sq m)	Discharge (Cu.m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
1	0.5	22°24'56.9337"N	088°58'37.0538"E	703492	2480192.09	7.2	0.65	0.58	0.40	0.543	3630.27	1971.24
2	8	22°27'58.1824"N	088°59'43.2771"E	705311.86	2485792.54	7.3	0.60	0.64	0.44	0.56	2357.08	1319.96

2.5 WATERWAY DESCRIPTION

The total 8.513 km stretch of Kalindi Waterway under DPR study, can be broadly divided in to four (4) stretches. **Table 6** below provides the details of sub-stretches of Kalindi waterway.

Table 6: Sub-Stretches of Kalindi Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Ambaria	Khosbash	0 Km	2 km
2	Khosbash	Singherkati	2 km	4 km
3	Singherkati	Bankra Dobar	4 km	6 km
4	Bankra Dobar	Hingalganj	6 km	8.513 km

Detail descriptions of each sub-stretch are provided in below sections.

2.5.1 Sub Stretch 1: From Ambaria to Khosbash (0 km to 2 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 0 to 2 km chainage of the Kalindi River. It is the downstream portion of the Kalindi River. The area is sparsely populated, with fishing and farming being the main occupation of the people. A few brick kiln are also seen in the area. Hingalganj- Lebukhali road is in the vicinity of the river bank and there is a BSF camp and jetty at Khosbash. The river is approx 150-200m wide as only that much width falls within the Indian boundary. The remaining river width falls into the Bangladesh territory. Some portion of the left bank that is in India's territory is protected. Fishermen extensively use the natural slope of the ground for landing the boats. Following are the observations made during survey of Sub-stretch 1: From Ambaria to Khosbash (0 km to 2 km). The details of current and discharge at different depths is placed at **Table 5**.

- There are no overhead obstructions/crossovers.
- There are no prominent dams & barrage available in this stretch.
- The tidal range is 0.875 m in this Stretch.
- There is no hindrance or encroachment in this stretch.
- Since sufficient depth is available for all time navigation dredging is not required at this stretch.

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 2.0 Km) of Kaliindi Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 7**. **Figure 4** shows the observed and reduced bed profile of sub-stretch 1.

Figure 3: Google Image showing Sub-Stretch -1 Ambaria to Khosbash

Table 7: Dredging Quantity (cum) for Sub-Stretch 1

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	0	2	Not Applicable (Tidal Zone)				6.6	28.2	0	0
II	0	2					6.09	28.2	0	0
III	0	2					2.89	32.33	0	0
IV	0	2					2.84	32.65	0	0
V	0	2					0.26	29.73	200	882.77
VI	0	2					0.26	29.63	200	17345.23
VII	0	2					0.26	29.63	200	19039.31

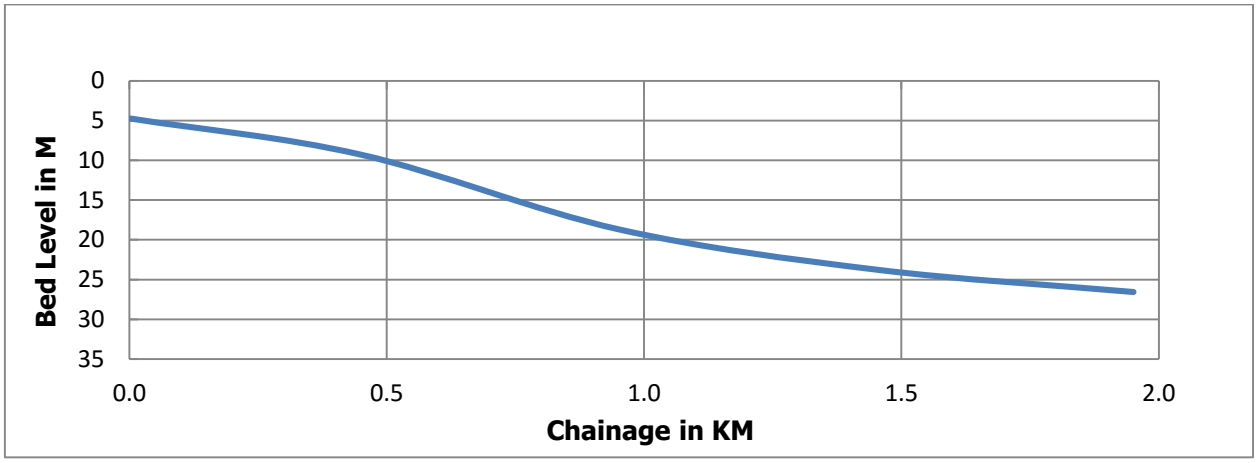


Figure 4: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

Figure 5: Photographs of Sub-Stretch 1

2.5.2 Sub Stretch 2: From Khosbash- Singherkati (2 km to 4 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 02 to 04 km chainage of the Kalindi River. There is dense mangrove forestation, at some places, on the left river bank. The area is not very densely populated, with fishing and farming being the main occupation of the people & the fields in the area are dependent on the rainfall. The river is approx. 150 m wide as only that much width falls within the Indian boundary. The remaining river width falls into the Bangladesh territory. Some portion of the left bank that is in India's territory is protected. The details of current and discharge at different depths is placed at **Table 5**. Following are the observations made during survey of Sub-stretch 1: From Khosbash- Singherkati (2 km to 4 km)

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & barrage available in this stretch.
- The tidal range is 0.875 m in this stretch as we move from downstream to upstream.
- Since sufficient depth is available for all time navigation dredging is not considered a requirement at this stretch.

Figure 6: Google Image showing Sub-Stretch -2 of Waterway

The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 8**. **Figure 7** shows the observed and reduced bed profile of sub-stretch 2.

Table 8: Dredging Quantity (cum) for Sub-Stretch 2

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	2	4	Not Applicable (Tidal Zone)				11.77	33.78	0	0
II	2	4					3.18	34.57	0	0
III	2	4					5.97	34.31	0	0
IV	2	4					5.92	34.43	0	0
V	2	4					0.26	32.53	0	912.5
VI	2	4					0.26	32.6	200	17127.54
VII	2	4					0.26	33.1	200	21966.7

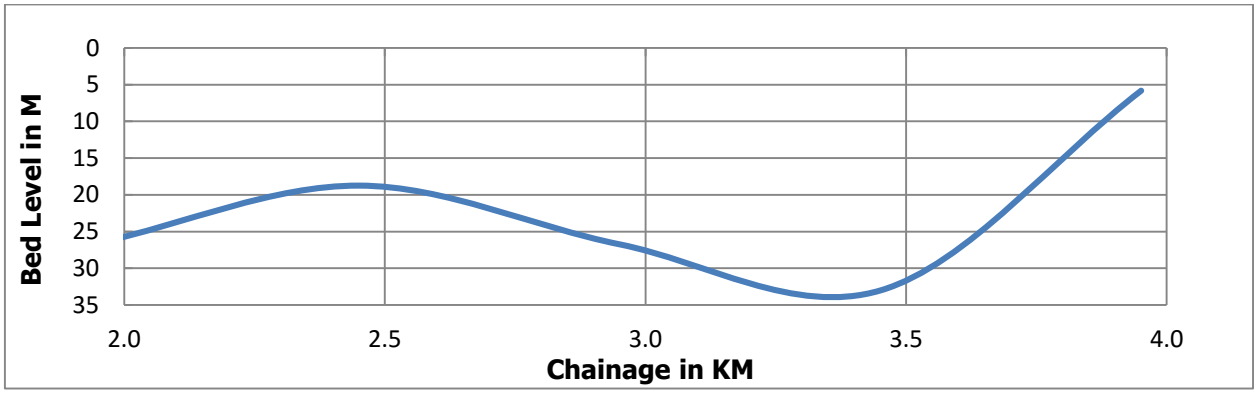


Figure 7: Bed Profile of Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

Figure 8: Photographs of Sub-stretch 2

2.5.3 Sub Stretch 3: From Singherkati to BankraDobar (4 km to 6 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 4 to 6 km chainage of the Kalindi River. The area is not densely populated and has dense mangroves on the left bank at a few places. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is comparatively wider than the other two stretch with the average width being about 200-250 mtrs on the Indian side of the boundary. Large portion of the river bank is unprotected. The details of current and discharge at different depths is placed at **Table 5**.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch. There are no prominent dams & Barrage available in this stretch.
- The tidal range is 0.9 m in this stretch.

- Since sufficient depth is available for all time navigation dredging is not considered a requirement at this stretch.

Figure 9: Google Image showing Sub-Stretch -3 of Waterway

Figure 9 above shows the alignment of sub-stretch 3 (Ch. 4 km to 6 km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 9**. **Figure 10** shows the observed and reduced bed profile of sub-stretch 3.

Table 9: Dredging Quantity (cum) for Sub-Stretch 3

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	4	6	Not Applicable (Tidal Zone)				1.34	26.76	0	0
II	4	6					1.34	15.51	0	25.32
III	4	6					4.33	24.29	0	1246.70
IV	4	6					4..3	24.36	0	6267.94
V	4	6					0.79	25.12	0	9951.94

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
VI	4	6					0.79	25.12	400	94911.35
VII	4	6					0.79	25.12	400	122167.31

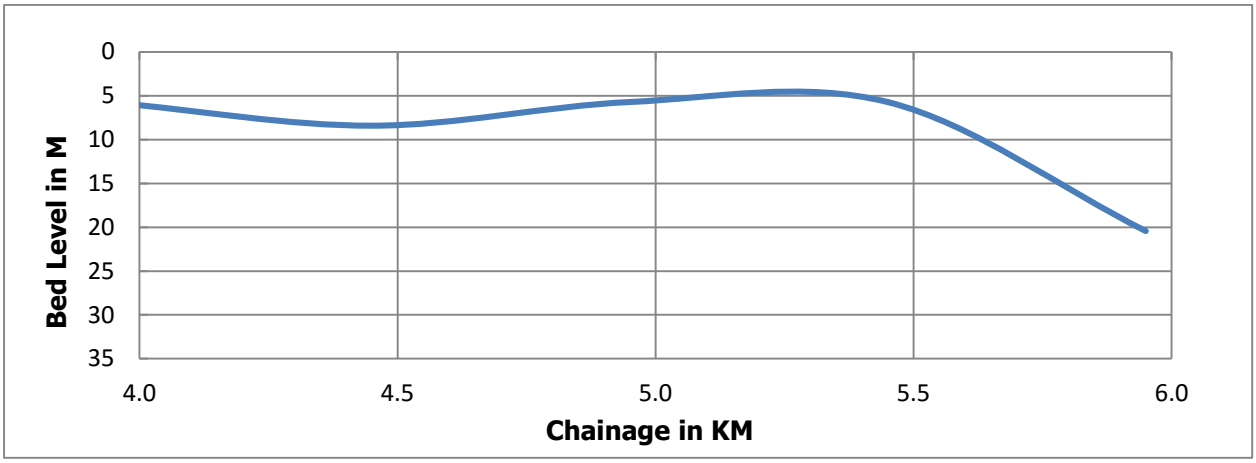


Figure 10: Bed Profile of Waterway Sub-stretch 3 (Chainage 20 km – 30 km)

Figure 11: Photograph along Sub-Stretch 3

2.5.4 Sub Stretch 4: From BankraDobar to Hingalganj (06 km to 8.513 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 6 to 8.513 km chainage of the Kalindi River. It is the upstream portion of the river and is moderately populated as it is closer to the town of Hasnabad which is about 13 Km away as the rail head for this area. Mangroves are present on the left bank which is in India's territory. Brick making, fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. The average width in this stretch is about 200-250 meters on the Indian side of the boundary. Hingalganj Jetty is used by small boats to ferry passengers. The details of current and discharge at different depths is placed at **Table 5**.

- There no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 0.9 m in this stretch.
- Since sufficient depth is available for all time navigation dredging is not considered a requirement at this stretch.

Figure 12: Google Image showing Sub-Stretch -4 of Waterway

Figure 12 above shows the alignment of sub-stretch 4 (Ch. 6 km to 8.513 km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 10**. **Figure 13** shows the observed and reduced bed profile of sub-stretch 4.

Table 10: Dredging Quantity (cum) for Sub-Stretch 4

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	6	8.513	Not Applicable (Tidal Zone)				5.53	37.06	0	0
II	6	8.513					4.44	37.06	0	0
III	6	8.513					8.27	33.29	0	0
IV	6	8.513					7.95	33.4	0	0
V	6	8.513					4.03	35.18	0	0
VI	6	8.513					3.98	35.21	0	95550.57
VII	6	8.513					1.72	35.21	0	107447.35

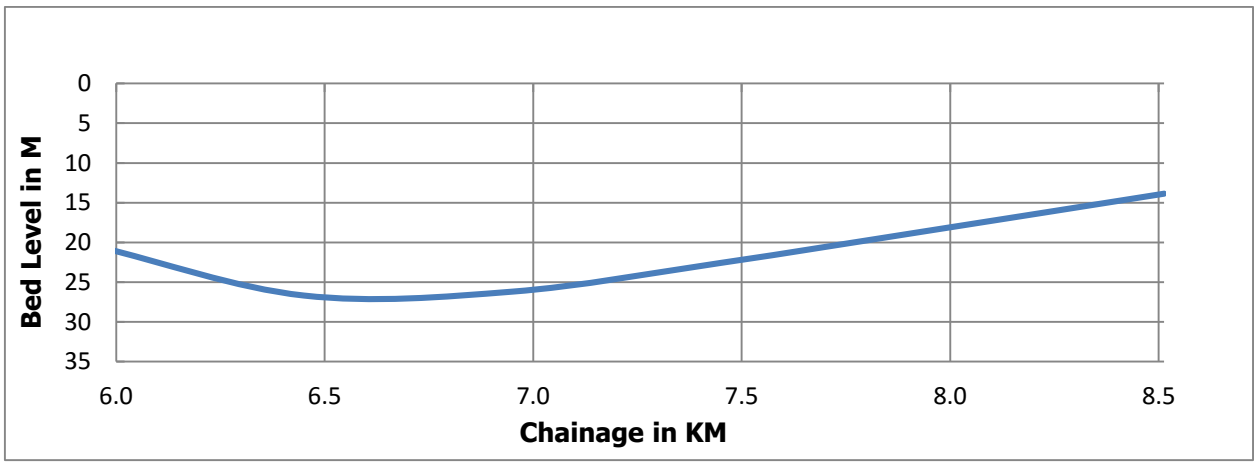


Figure 13: Bed Profile of Waterway Sub-stretch 4 (Chainage 30 km – 37.163 km)

Figure 14: Photograph along Sub-Stretch 4

2.6 SOIL AND WATER SAMPLES ANALYSIS AND RESULTS

Waterway bed soil and water samples were collected using Vanveen Grab & Niskin type water sampler at respective locations. One sample were collected at each location in the river stretches. The location and depth of the collected samples are appended in **Table 11.**

Table 11: Soil & Water Sample Locations

Sample No	Chainage (Km)	Latitude	Longitude	Easting(m)	Northing (m)	Depth (m)
1	0.5	22°24'56.9337"N	088°58'37.0538"E	703492	2480192.09	7.2
2	8	22°27'58.1824"N	088°59'43.2771"E	705311.86	2485792.54	7.3

The collected soil & water samples were analyzed for the following properties:-

Soil Samples

- Grain size
- Specific gravity
- PH Value
- Cu, Cc
- Clay Silt percentage

Water samples

- Sediment Concentration

Test result of samples is provided in **Figure 15**.

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CERTIFICATE OF ANALYSIS ON SOIL & WATER SAMPLES

Table No. : 7

Project : Laboratory Analysis of Soil & Water Samples

River : Kalindi

Job No. : 6154 H

Sample Reference				Test Results on SOIL SAMPLES							Test Results on WATER SAMPLES	
				Particle Size Analysis							Sediment Concentration Test	
				By Sieve Analysis		By Hydrometer Analysis						
Serial No.	Sample Ref. No.	Name of Sample	Chainage	Observed Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Specific Gravity	pH Value	Cohesive Strength of Uniformity (Cu)	Cohesive Strength of Curvature (Cc)	Total Solid (mg/lit)
1	KD-01	Soil	0.50	7.20	0	3	50	47	2.62	8.03	6.00	1.50	-
2	KD-02	Soil	8.00	7.30	0	5	52	43	2.61	8.84	6.00	1.50	-
3	KD-01	Water	0.50	7.20	-	-	-	-	-	-	-	-	22804
4	KD-02	Water	8.00	7.30	-	-	-	-	-	-	-	-	19198

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Figure 15: Soil and Water Sample Test Results

3.0 FAIRWAY DEVELOPMENT

In most of the countries where inland navigation is developed, such as in Europe, China, Russia etc., the waterways have been classified in different classes depending on their physical characteristics and development potential in future. Generally, with larger waterway dimensions bigger IWT vessels can operate resulting in lower shipping cost per tonne of cargo as compared to the shipping cost of smaller vessels. One of the important factors contributing to lower shipping cost by operation of bigger vessels is the improvement in power to load ratio, i.e. capacity of cargo carrying per unit of engine power. Hence, every waterway should be developed to larger dimensions (depth and width of navigation channel) subject to the physical characteristics of the waterway. However, for developing a waterway to larger dimensions (in other wards waterway of higher class) additional investment would be required. Therefore, there would be an optimum waterway class for a particular waterway whereby total cost to the system (i.e., increase in cost due to development work vis-a-vis reduction in shipping cost) is minimum. This optimum solution is required for each waterway and for this purpose classification of waterways would facilitate planning for the optimum class of the waterway and its development.

3.1 PROPOSED CLASS / TYPE OF WATERWAY

IWAI gives a classification of waterways on the basis of width and depth of rivers/canals, radius of bends, vertical clearance, horizontal clearance between bridge piers and self-propelled vessel carrying capacity of vessels. On the basis of these criteria's, classification of waterways was done by IWAI as detailed in Paragraph **1.1.1** and **Table 1**.

From the detailed hydrographic survey, following observations are made on the proposed fairway:

a) No dams, barrage and any other cross-structure is located along the proposed fairway stretch.
b) Reduced depth of waterway varies from 0.26 m to 35.21 m w.r.t sounding datum for Class VII waterway.
c) Tidal variation varies from 0.875 m to 0.9 m.
d) Width of river varies from 0.3 km to 0.85 km.

Figure 16 shows the proposed alignment of Kalindi waterway.

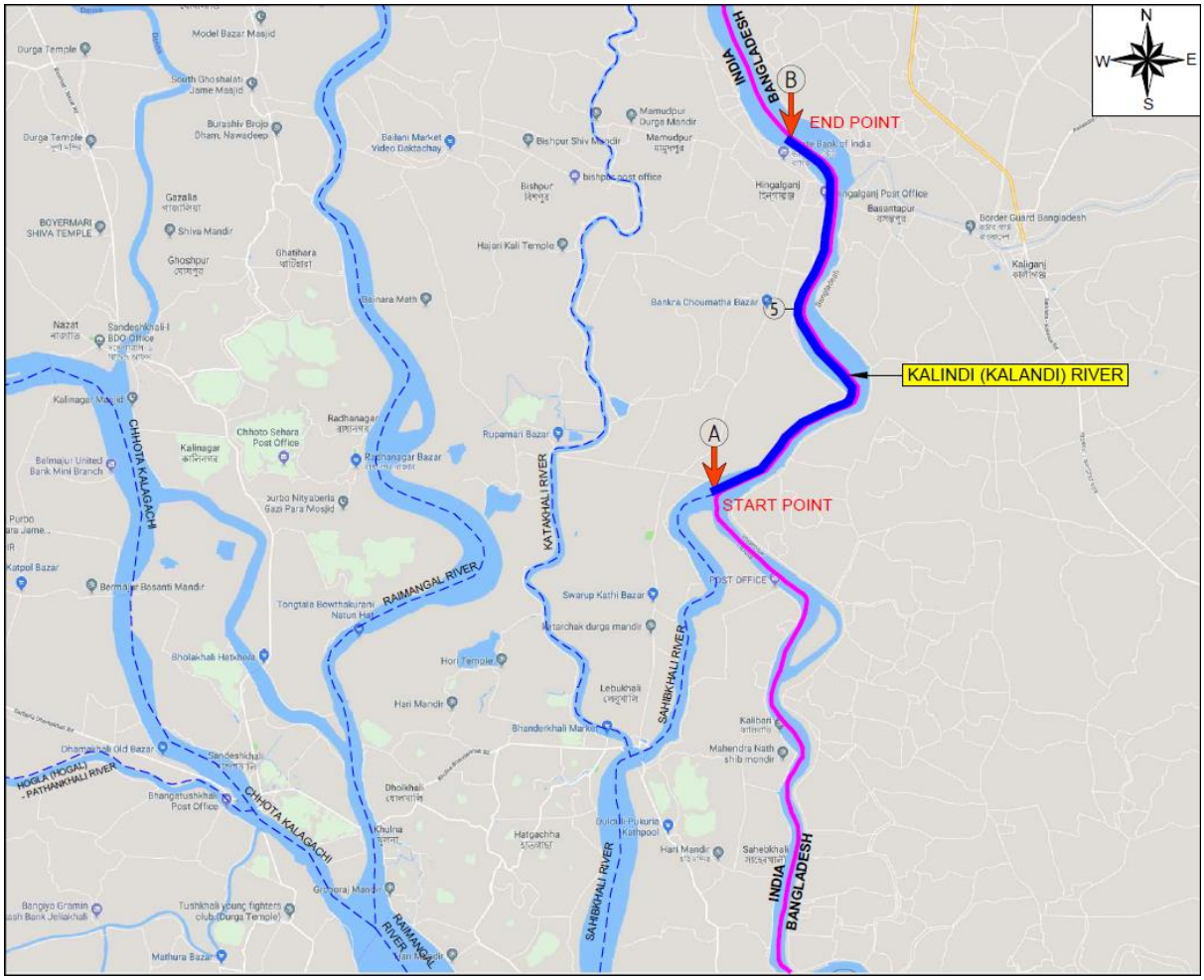


Figure 16: Proposed alignment of Kalindi Waterway

In addition to above features, Kalindi waterway is also connected with Sahibkhali and Katakhali river which is futher connected to other National Waterways and Indo-Bngladesh Protocol Route.

The classification of waterway and its type is based on the availability of LAD and Vessel proposed to be deployed for the required traffic. As per the hydro-graphic studies, as per Volume-III of this report, by taking into advantage of tidal window, sufficient LAD is available in the complete 8.513 km stretch of waterway, which suggest that waterway is viable for throughout the year navigation. It is principally decided by IWAI to develop Sunderbans waterways as per Class VII only.

3.2 DETAILS OF SHOALS

Due consideration was given for shoals identified during the survey. As shown in **Table 12**, shoals are located along the proposed waterway; hence dredging is required as detailed below.

3.3 PROPOSED CONSERVANCY ACTIVITIES

Dredging is proposed under conservancy works for the proposed fairway stretch.

3.3.1 Dredging

A defined waterway is required to make throughout the year navigation in the IWT stretch of Kalindi waterway. Design improvement measures and increase of channel depth by dredging is required in the first phase of the fairway development. Thereby, regular maintenance of fairway depth by dredging is required in the navigable route.

Fairway Dimensions

As per IWAI guidelines, fairway dimensions for river classified as Class-VII waterway should have required dimensions of 100m bottom width; 2.75m depth and side slop of 5:1 as shown in **Figure 17**. The dredging quantity obtained from Hypack software for 8.513 Km stretch of waterway for Class I to VII is provided in Volume 3A – Hydrographic Survey Report and Data. For waterway Class VII, the estimated dredging quantity is provided as below:

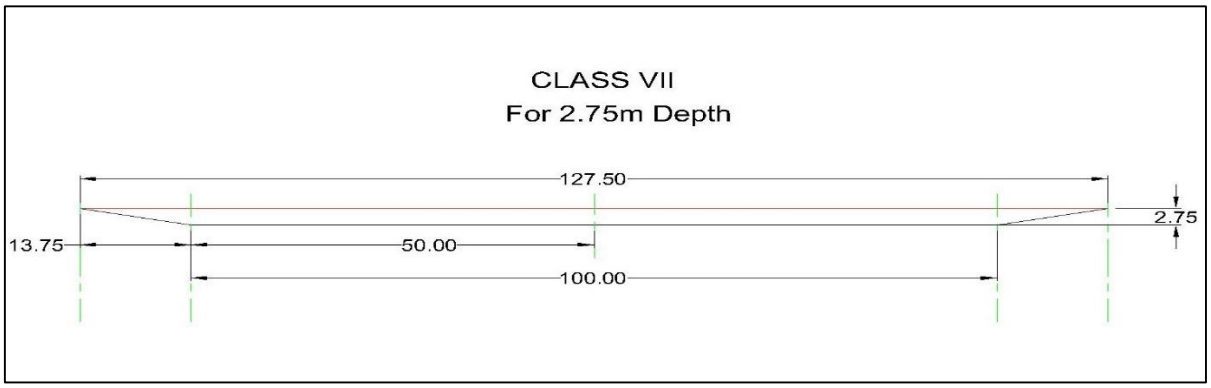


Figure 17: Fairway Dimension Class VII

Table 12: Dredging Quantity for Class VII Waterway

Chainage (km)	Observed	Reduced w.r.t. Sounding Datum

From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
0	1	Not Applicable Tidal Zone				5.94	22.55	0	0.00	1430.84
1	2					0.26	29.63	200	19039.31	20470.15
2	3					0.26	24.53	200	11508.53	31978.68
3	4					10.17	33.1	0	10458.17	4243.85
4	5					0.79	12.97	400	102894.7	107138.6
5	6					1.67	25.12	0	19272.61	126411.2
6	7					1.72	35.21	0	36390.23	162801.4
7	8					7.11	35.21	0	51286.19	214087.6
8	8.513					3.98	20.05	0	19770.93	233858.5
				Total				**Total**	**270620.67**	

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 2,70,620.67 cum.

Disposal of Dredging Material

The dredged material is proposed to be dumped on low lying areas located at left bank of the Kalindi river. The dredge material should be dumped providing gabion walls. The gabion walls should be adequately provided to prevent the dredged material to fall back in the waterway. **Figure 18** below shows the proposed location for dumping of dredged material. The proposed area has dumping capacity of about 3,22,372 cum with average 2 m dumping height, which is more than the required capacity of 2,70,620.67 cum.

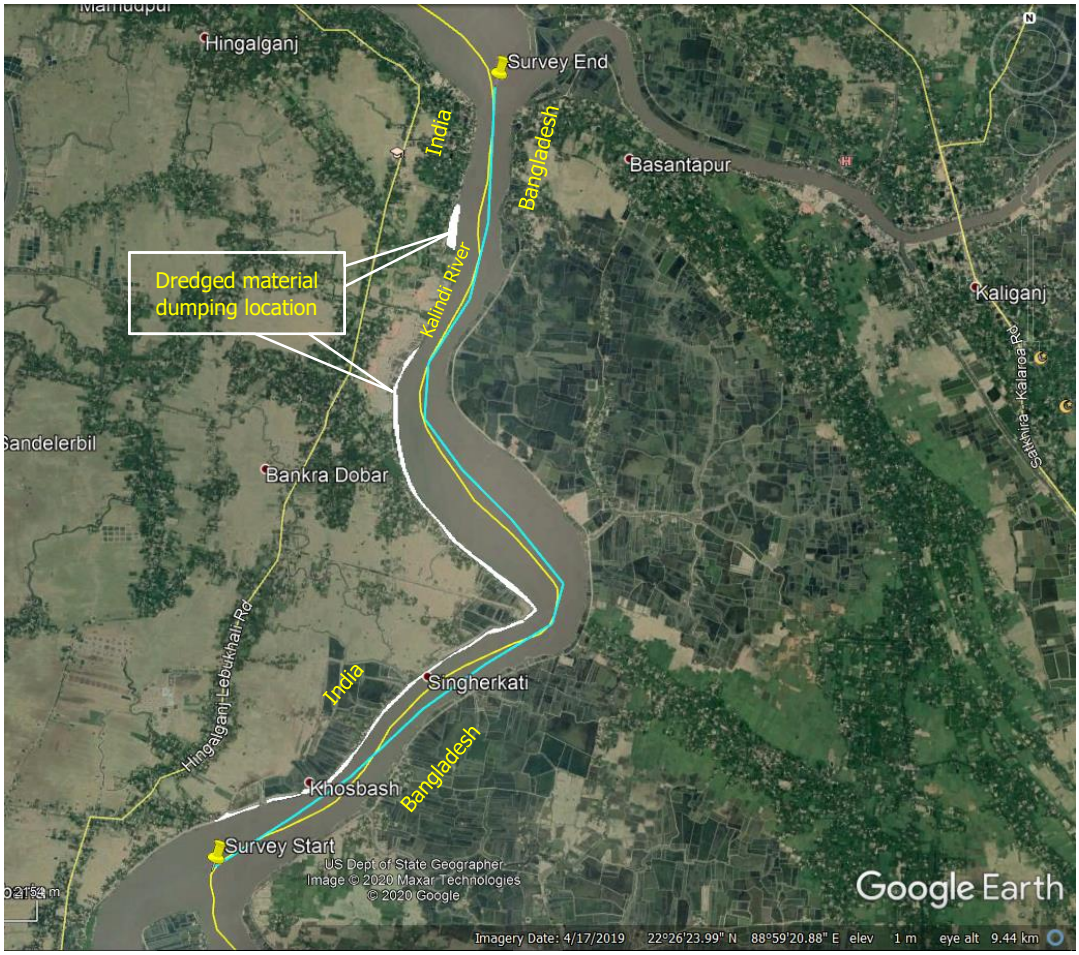


Figure 18: Proposed location for dumping of dredged material

Figure 19: Photograph showing arrangement of Gabion Wall along River Bank

Selection of dredging equipment

The dredging is usually carried out with a cutter-suction dredger whereas maintenance dredging will be carried out with a trailing suction hopper dredger. There are various types of dredgers available in the market viz., suction dredger, bucket dredger, grab dredger, backhoe / dipper dredger, water injection dredger, pneumatic dredger etc. While most of these dredgers are ideally suited for sea conditions to dredge harbour and approach channels, the selection of a dredger for inland waterway is rather critical due to various mobility factors, seasonal variation of water levels (floods/dry season) and shallow depths.

The cutter suction dredgers having conventional centrifugal pumps or modern jet pumps will be more effective to dredge out the material. In a cutter-suction dredger or CSD, the suction tube has a cutter head at the suction inlet, to loosen the bed and transport it to the suction mouth. The cutter can also be used for hard consolidated type of bed. The dredged soil is usually sucked up by a wear resistant centrifugal pump and discharged through a pipe line or to barge.

Alternately the modern amphibious cutter suction dredger is also suitable for the waterway. The amphibious dredger can be road transportable, able to unload itself from the truck/lorry and can dredge rivers/canals having depths of 2.0 to 3.0 m. These dredgers can walk into the river and even in dry portions of the river during lean period. The dredgers can also be disassembled for transportation to other locations. These dredgers are indigenously available in India.

3.3.2 River Training

No river training works is required in the proposed navigable waterway stretch.

3.4 BANK PROTECTION / EMBANKMENT STRENGTHENING

The river bank in the proposed fairway stretch is fairly stable with mild slope. No bank protection works is envisaged in the proposed fairway stretch.

3.5 NAVIGATION MARKINGS / NAVIGATION AIDS

The seasonal change in river morphology plays an important role for maintaining the navigation channel. The navigation channel generally goes on shifting due to changes in river morphology depending on seasonal rainfall and runoff. On this kind of waterway, one of main concern is safety and ease of traffic. This can be achieved by providing proper navigation aids like marker buoys, lights.

The channel marking indicators is also very important for the safety and speed of navigation since the current velocity is much lower in the inner bends of a curved channel than the outer bend. If proper markings are provided, ships/vessel sailing upstream will take the inner bends with relatively less head current, thus making better speed. The ship sailing downstream in the outer bend will get the advantage of current. The main approach of the problem of making of shifting nature of navigable channel is to have the simple marks which could be shifted easily with less manpower and equipment.

As per the international convention, the aids to navigation are a device external to a craft, designed to assist in determination of position of the craft or a safe course or to warn of dangers. Whereas, navigational aids are the equipment on board a ship. Navigation markings/aids, proposed for safe navigation along the proposed fairway stretch are discussed in detail in Chapter 8.

3.6 MODIFICATION REQUIREMENT IN EXISTING BRIDGES / CABLES / DAMS / BARRAGES / LOCKS / WEIRS / ANICUTS / AQUEDUCTS

No bridge, cable, dam, barrage, lock, weir, anicut or aqueduct is located in the waterway.

3.7 PROPOSED DAMS / BARRAGES / LOCKS / WEIRS TO IMPROVE DEPTH

No dam/ barrage/ locks/ weirs are proposed to improve depth.

3.8 LAND ACQUISITION

No additional land is required to be acquired for fairway development.

3.9 FAIRWAY COSTING

The cost estimate for fairway development of Kalindi waterway as per Class VII for IWT system including O&M of the system has been worked out. The cost estimates for development of the system are considered as Capital cost while for operation of the system is termed as maintenance or operating cost (O & M cost).

3.9.1 Basis of Cost

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates of PWD, Govt. of West Bengal considered for various works;
b) Market surveys and enquires

c) Judgement based on Consultant's Experience

3.9.2 Capital Cost

The cost of initial dredging is as below:

Dredging cost @ INR 200/cum for 2,70,620.67 cum = INR 5,41,24,134/- (INR **541.24 Lakh**).

3.9.3 O&M Cost

Operation and Maintenance of fairway comprises of dredging cost only. Actual quantity of dredging required during operation stage can be worked out from model studies only. For DPR studies, it is assumed that 10% of dredging is required annually for smooth and safe navigation. Hence O&M cost works out as:

Dredging cost @ INR 200/cum for 10% of 2,70,620.67 cum = INR 54,12,413.4/- **(INR 54.12 Lakh**).

4.0 TRAFFIC STUDY

4.1 GENERAL

North 24 Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends in the tropical zone from latitude 22º11'6" north to 23º15'2" north and from longitude 88º20' east to 89º5' east. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west. Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district and (following the splitting of the Thane district of Maharashtra in 2014) the most populated district in the whole of India. It is also the tenth-largest district in the State by area

The district of North Twenty Four Parganas has five Sub-divisions namely (i)Bongaon (ii)Barasat (iii)Barackpur (iv)Bidhannagar and (v)Basirhat. North 24 Parganas district highlights as per 2011 census[1]

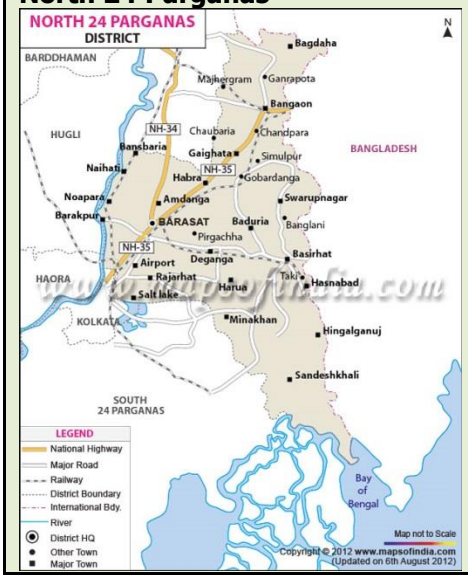
- North 24 Parganas District comprises of 22 C.D. Blocks and 29 Statutory Towns.
- There are total 1527 Villages and 78 Census Towns in the District.
- North 24 Parganas is the most populated district of the State.
- The percentage of urban share of Population of North 24 ParganasDistrict has expanded from 54.3% (2001 Census) to 57.3% (2011 Census) of total Population of respective Census.
- North 24 Parganas District ranks 14th in decadal Population growth rate among the Districts with 12.0%.
- The density of Population (Population per square km) of the District is 2,445 per square km which makes its rank 3rd in the State.
- North 24 Parganas District stands 10th in terms of area (4094.00 sq km) in the State.
- There are 9 uninhabited Villages in the District.

4.2 INFLUENCE AREA / HINTERLAND

Kalindi River flows through one (1) CD blocks of North 24 Parganas disctrict, namely, Hingalganj. The Project Influence Area (PIA), considering existing and projected traffic for passenger ferry services, comprises of the following CD blocks and districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 13**.

[1] District Census Handbook, 2011

Table 13: Project Influence Area/ Hinterland

District	Area (Km^2)	C.D. Block	Area (Km^2)	Total Hinterland area (Km^2)
North 24 Parganas 	9,960	Hingalganj	238.80	238.80

4.2.1 Population of Hinterland area

Population of hinterland area for proposed IWT in Kalindi waterway is provided in **Table 14** below:

Table 14: Population of Hinterland[2]

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
West Bengal	North 24 Parganas	81,61,961	Hingalganj	1,74,545	1,74,545

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Kalindi waterway includes North 24 Parganas disctrict of West Bengal. Gross State Domestic Product (GSDP) prices of West Bengal and growth rate in percentage are provided in **Table 15** and **Table 16** as below:

[2] District Census Handbook, 2011

Table 15: Historic GSDP of West Bengal

(at Constant Prices, INR Crores)

Year	Primary	Secondary	Teritary	GSDP
2004-2005 Series				
2004-05	52784.73	42345.24	113526.39	208656.36
2005-06	53904.43	43826.65	124058.38	221789.46
2006-07	55115.99	47764.33	136196.80	239077.12
2007-08	57961.17	51632.77	148038.24	257632.18
2008-09	56736.53	50607.84	162903.89	270248.26
2009-10	60482.83	55770.42	175701.71	291954.96
2010-11	59139.82	59303.48	190393.75	308837.05
2011-12	59933.06	57737.05	205746.87	323416.98
2012-13	62050.56	63944.59	221778.68	347773.83
2013-14	64042.77	67798.65	239953.62	371795.04
2014-15	66450.64	70992.85	260943.02	398386.51
2011-2012 Series				
2015-16	135884.08	141319.53	315478.40	612789.26
2016-17	141107.12	153276.84	247527.53	661714.69
2017-18	145213.53	170683.87	401788.08	737568.48

Source: Department of Statistics and Programm implementation, Government of West Bengal

Table 16: Annual Growth Rate of GSDP of West Bengal

(at Constant Prices, Per cent %)

Year	Primary	Secondary	Teritary	GSDP
2004-2005 Series				
2004-05	-	-	-	-
2005-06	2.22	3.30	9.28	6.29
2006-07	2.12	8.71	9.78	7.79
2007-08	6.21	6.85	8.69	7.76
2008-09	-2.35	-1.75	10.04	4.90
2009-10	6.94	9.68	7.86	8.03
2010-11	-2.10	5.82	8.36	5.78
2011-12	0.81	-1.99	8.06	4.72
2012-13	3.33	10.60	7.79	7.53
2013-14	3.01	6.07	8.20	6.91
2014-15	3.31	5.05	8.75	7.15

Year	Primary	Secondary	Teritary	GSDP
Average	**2.35**	**5.23**	**8.68**	**6.69**
2011-2012 Series				
2015-16	0.48	9.15	6.37	5.85
2016-17	3.84	8.46	10.16	7.98
2017-18	2.91	11.36	15.61	11.46
Average	**2.41**	**9.66**	**10.71**	**8.43**

Source: Department of Statistics and Programm implementation, Government of West Bengal

The below chart show the Primary, Secondary and Teritary sectors of West Bengal state. As depicted in the chart, Primary sector consists of Agriculture, Forestry, Fishery, Mining & Quarrying. Whereas Secondary sector includes different types of manufacturing industries, Construction, Elecrical, Gas & Water supply sectors. Services based industries comes under Tertiary sector.

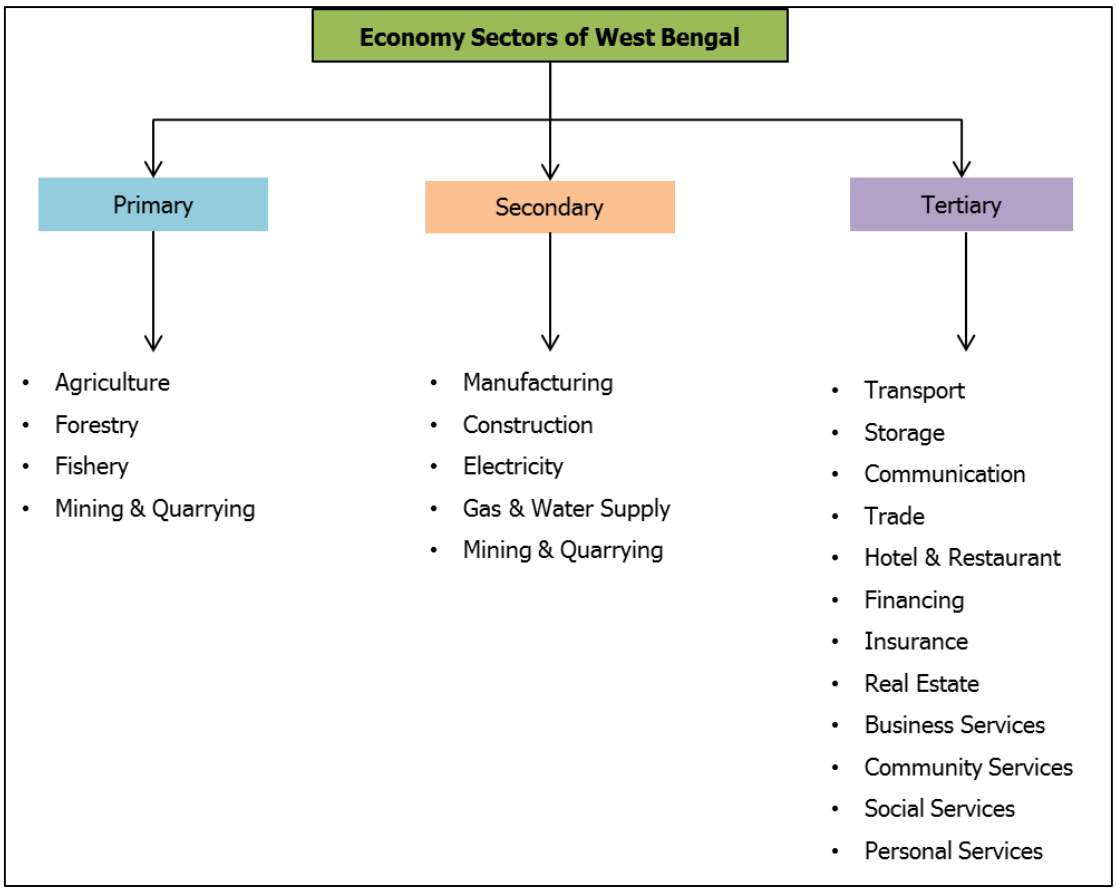


Figure 20: Sectors of West Bengal

Figure 21 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 22** below shows the sectoral composition of GSDP by broad sectors of agricultaural & allied, industry and services at constant price level of 2004-05. Input data sourced from Department of Statistics and Programm implementation, Government of West Bengal.

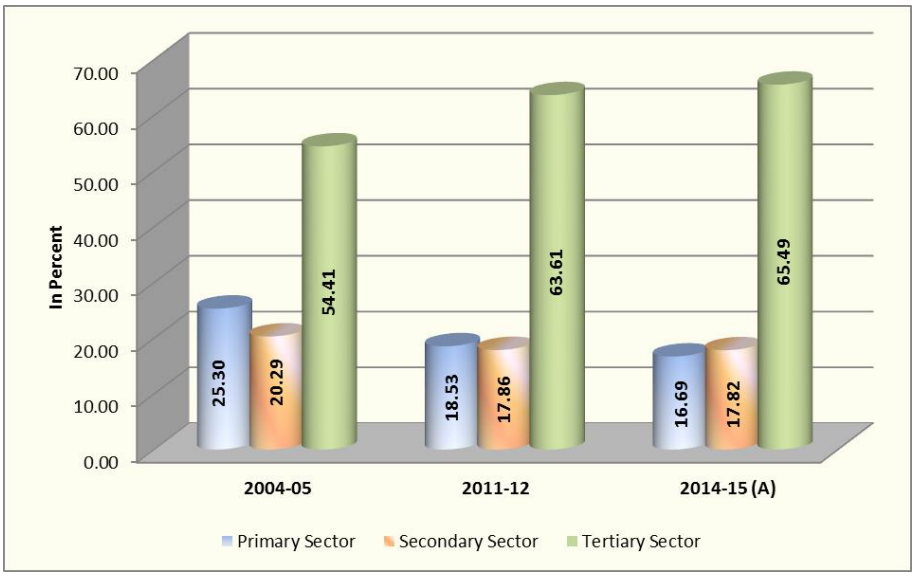


Figure 21: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

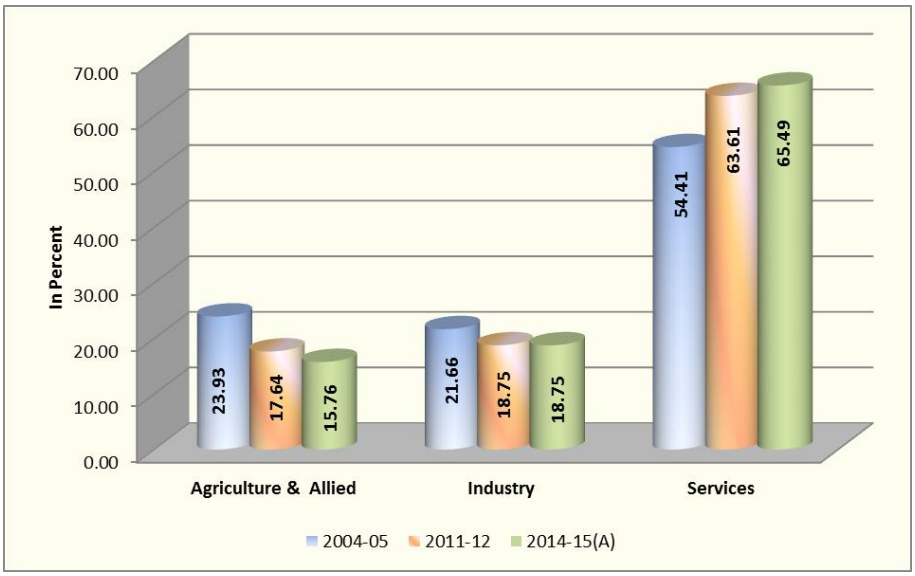


Figure 22: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

From the above charts, it is evaluated that the Services contributes more than 50% to GSDP and is shown considerable decadal growth rate. Contrary to this, the contribution of agricultural and industial sectors in GSDP is declining throughout the decade.

Economic profile of hinterland disctrict i.e. North 24 Parganas are provided in **Table 17** and the same is presented in **Figure 23** as below:

Table 17: Gross District Domestic Product and Annual Growth Rate of North 24 Parganas

(at 2004-05 Constant Prices,)

Year	Gross District Domestic Product *(INR Crores)*	Annual Growth Rate *(Percentage Change over Previous Year)*
2004-05	24416.69	-
2005-06	27157.76	11.23
2006-07	29049.04	6.96
2007-08	32131.75	10.61
2008-09	34747.1	8.14
2009-10	36706.81	5.64
2010-11	38989.62	6.22
2011-12	41335.35	6.02
2012-13	44949.67	8.74
2013-14	48035.5	6.87
Average	-	7.83

Source: Department of Statistics and Programm implementation, Government of West Bengal

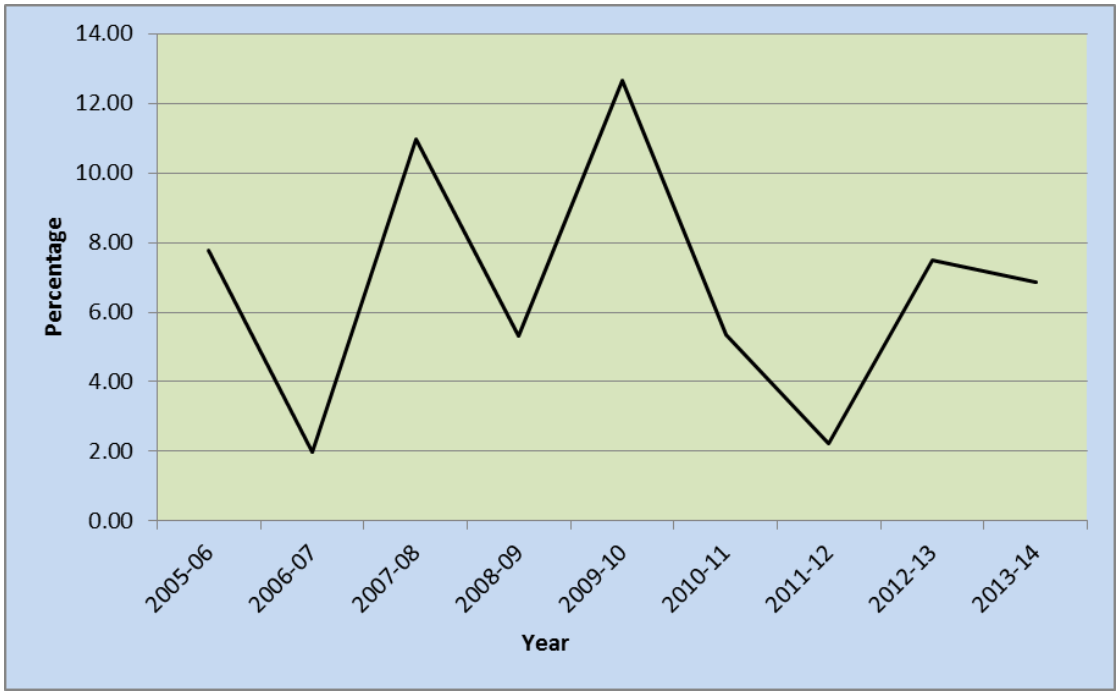


Figure 23: Annual Growth Rates of Gross District Domestic Product

Table 18: Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy in West Bengal

(at 2004-05 Constant Prices, Per cent %)

Sectors	2004-05	2011-12	2012-13	2013-14
Agriculture & Allied	8.83	8.63	8.54	8.54
Industry	11.7	12.4	12.43	12.43
Services	12.96	14.04	14.24	14.24
Total GSDP	11.7	12.78	12.91	12.91

From **Table 18,** it is concluded that, North 24 Parganas have major contribution in services sector and shows descent decadle growth. Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy in West Bengal is also presented in **Figure 24** as below:

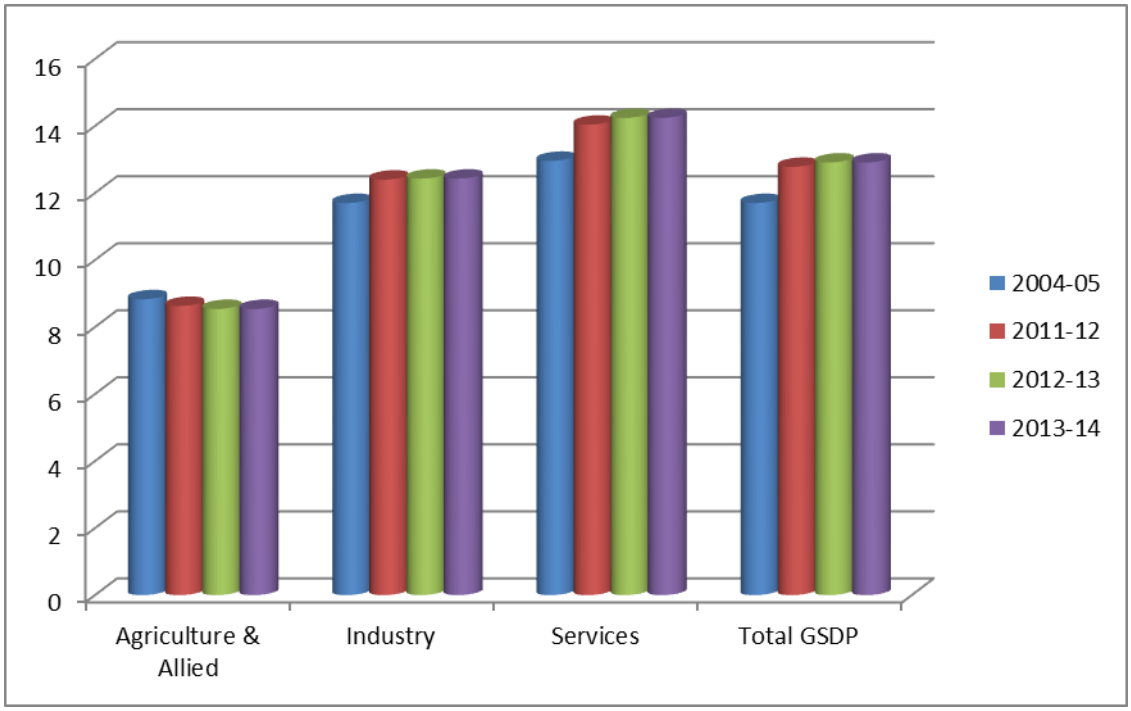


Figure 24: Contribution of North 24 Parganas in GSDP of Broad Sectors of Economy

4.2.3 Existing and proposed Industries

There are 5 Brick kilns located along the river stretch. These brick kilns mostly use fuel wood, saw dust, rice husks and agricultural residues along with coal for firing their kilns. Most of these raw materials are locally arranged and transported through roads/local boats by owners directly to their kilns. Coal is procured from Raniganj mines. On the basis of data collected during survey done in May 2017, the total quantity of coal used by 5 fire Kilns located along and near Kalindi waterway is about 6,000 Tons per year. However, coal is transferred through roads only and river route is neither used nor proposed for this purpose on the basis of location of mines and connectivity challanges. No major industry or any other commercial establishment is located or proposed in the hinterland area.

4.2.4 Hinterland Connectivity

The stretch is moderately connected with road and rail network. Nearest rail head is at Hasnabad which is 15 km away. SH 2 passes at Hasnabad. Ferry services runs from the small jetties in the area. Mobile network is generally available in the area.

The international boundary between India and Bangladesh passes through the waters of the Kalindi River with the left bank belonging to India.

4.2.5 Connectivity with Other Wateways

Kalindi waterway is also connected with other declared waterways of Sunderbans as shown below:

Table 19: Connectivity with other Waterways

Sl. No.	Waterway Name	Chainage at merging location (Km)
1.0	Sahibkhali Waterway	0.0 Km

In addition to this, Katakhali waterway is also connected with Kalindi river at about 5.0 Km upstream of end chainage of Kalindi waterway.

4.3 COMMODITY COMPOSITION / CATEGORIZATION

Detailed traffic survey was done by the consultant along the study stretch of Kalindi Waterway. During the survey, it was observed that, small boats act as passenger ferry services from the few jetties in the project area.

Existing and proposed commodities planned for Kalindi waterway can be categorized as follows:

a) Agricultural Products
b) Construction Material
c) Passengers

4.3.1 Agricultural Products

Agriculture and allied sectors are the main-stay of the economy in districts comprising hinterland area. It provides both direct and indirect employment to the majority of the workforce. Agriculture is the main source of livelihood of the population supplemented by livestock rearing, fishery and horticulture. The district lack mineral resources and so also major and medium industries. Hence, the rural population of the district mainly depends on agriculture, fishery and other activities allied to agriculture for their livelihood.

The major crop in this area is Paddy which is dependent on seasonal rainfall and local water supply. Fishing and boat building is the main core business of locals and they earn their lively hood from this resource.

4.3.2 Construction Material

All construction materials are available and transported along the project hinterland by roads. Smaller quanitities of construction material to be used for local construction activities along the river are transported through river. As per the traffic survey done in May 2017, majority of the materials are procured from Kolkata and destined for remote areas of South and North 24 Parganas as well as to Bangladesh. As the material is neither procured nor destined for the areas along or around proposed waterway, the quantity is not ascertained. Accordingly, there is no potential for movement of construction material in the Kalindi waterway.

4.3.3 Passenger Traffic

No major passenger traffic is available along the waterway.

4.4 TOURISM TRAFFIC

No tourist spots are available along the waterway.

4.5 PROTECTED AREA

There is a BSF camp and jetties located along waterway, to carry out patrolling along the water boundary between India and Bangladesh.

4.6 CONSLUSION

Following conclusions are made from the traffic studies done above:

a) Proposed Kalindi waterway is directly connected with Sahibkhali.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) International Border of India Bangladesh falls along the Kalindi river, with left bank along the Indian side.
e) Three numbers of Border Security Force (BSF) jetties are located along the left bank of river.
f) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.

g) 8.513 Km stretch of Kalindi River has no passenger or cargo traffic and accordingly O-D pairing is not applicable.

In view of the above observations, the waterway is recommended to be developed as part of collective development of NW-97 (Sunderbans waterways) for providing an uninterrupted connectivity between proposed waterways. However, no additional jetty/terminal and vessels are proposed in this DPR.

5.0 TERMINALS

The terminal planning and design includes selection of suitable sites in the vicinity of traffic potential considering all the relevant technical variables such as choosing the type of berthing facility and providing of waiting and parking areas and other ancillary facilities required for efficient terminal operation. Based on the projected traffic, the selection of various facilities will be planned.

There are three (3) number of BSF ferry terminals located all along the Kalindi River. The list of existing terminals located is provided as below:

Table 20: List of Existing Jetties

Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Khoshbash jetty(BSF)	22°24'57.70"N 88°58'36.20"E	0.6 km	1.3m	Hingalganj – Lebukhali Road	Khoshbash jetty(BSF)
Singherkati (BSF)	22°25'45.33"N 88°59'51.59"E	3.5 km	1.0m	Hingalganj – Lebukhali Road	Singherkati (BSF)
Hingalganj (BSF)	22°28'3.08"N 88°59'41.79"E	8.4 km	1.2m	Hingalganj ghat road	Hingalganj (BSF)

In the absence of cargo and passenger traffic, further development of existing jetty/terminal structure or construction of new structure is not recommended at this stage of DPR.

6.0 PRELIMINARY ENGINEERING DESIGNS

The main objective of preliminary engineering is to ascertain quantitatively the feasibility of engineering works. Preliminary engineering is carried out to arrive at the preliminary sizing of all major facilities required at the terminal and waterway for safe navigation. The preliminary sizing, design and engineering of the facilities are presented in following sections.

6.1 RIVER TRAINING

As stated in the earlier sections, no river training works including barrages, weirs or locks is required for the waterway.

6.2 BANK PROTECTION

As stated in the earlier sections, no bank protection works is required for the waterway.

6.3 NAVIGATION AIDS

The total navigation operation, ranging from arrival to departure, can be subdivided in to the following operations,

- Navigation through the waterway
- Arrival at berthing location
- Preparation for berthing, including possible turning of the vessel and pre-berthing procedures
- Berthing including mooring, etc. to the berth structure
- Loading and unloading operation while at berth
- Departure

Navigation aids for the waterway and terminals are required to ensure safe and efficient navigation of vessels navigating through the waterway and berthing/un-berthing at terminals.

These aids are proposed to be installed on land or in water for guidance to all vessels for safe and regulated navigation in channels, basin, berths and docks. The various types of aids to navigation proposed for IWT operation on proposed waterway is provided in detail in Chapter 8.

6.4 FERRY TERMINAL AND JETTIES

The main objective of preliminary engineering is to ascertain quantitatively the feasibility of engineering works. Preliminary engineering is carried out to arrive at the preliminary sizing of all major facilities required at the terminal and waterway for safe navigation. As concluded in Chapters 3 and 4, no development activity is proposed in the Kalindi Waterway in this DPR.

7.0 VESSEL DESIGN

The major principal parameters governing Inland Waterway Fleet designs are:

- Terminal facilities and obstructions enroute,
- Waterway characteristic like river course, depth of water, radius of bends, current/velocities of water etc.,
- Navigational aspects and improvements to navigation,
- Cargo characteristic like type of cargo, quantum of cargo and distance of transportation,
- The vessel dimension like length, beam, moulded depth, minimum and maximum draft,
- Haulage distance
- Physical constrains like clearance under bridges, navigation locks size etc., and
- Capital, operation and maintenance cost.

7.1 GENERAL REVIEW

India has a long history of river based water transport. India has about 14,500 km of navigable waterways which comprise rivers, canals, backwaters, creeks, etc. Currently, inland water transport is restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the Brahmaputra, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai and the deltaic regions of the Godavari-Krishna rivers. Besides the organised operations by mechanised vessels, country boats of various capacities also operate in various rivers and canals. Data of cargo and passenger movement in unorganised sector (i.e. by country boats, etc.) has not been compiled (for which efforts are on) but it is a fact that substantial quantum of cargo and passengers are transported in the unorganised sector as well. Considering the inherent advantages of this mode in terms of fuel efficiency, environment friendliness and cost effectiveness, the Govt. of India is trying to develop this mode to make it an effect supplementary mode of transportation vis-a-vis rail and road modes.

7.2 CURRENT SCENARIO

Small ferry vessels are operational in Kalindi river by locals. The photographs of existing vessels plying along the waterway are provided in **Figure 25**. Existing ferry boats located in the waterway have approximate dimensions of about 16.0 m long, 2.5 m breadth and 1.0 m depth and are majorly used for local fishing activities.

Figure 25: Vessels plying on Kalindi Waterway

However, as the waterway does not have its own passenger and cargo traffic, no additional vessels are proposed in this DPR of Kalindi Waterway. It is considered, that the vessels operating along other connecting waterways will commute along Kalindi Waterway also.

For any upcoming passenger services in future, the vessel of following specifications may be provided on the basis of passenger traffic:

a) Passenger capacity – 25-30 pax
b) Type – Fibre boat
c) Length – 18.0 m
d) Breadth – 3.0 m
e) Depth –1.58 m
f) Draft – 0.80 m
g) Engine capacity – as per design with conventional propulsion
h) Cruising Speed – 5.0 knot

8.0 NAVIGATION AND COMMUNICATION SYSTEM

In SOLAS-V/13 ("Safety of navigation" IMO, 1974), IMO established that each State shall provide the aids to navigation appropriate to the level of traffic and the degree of risk. International Association of Lighthouse Authorities (IALA) defines aids to navigation as systems external to the ship capable of helping determine its position and course, warning about dangers and obstacles and indicating the best route to follow.

As defined by IMO, the absolute horizontal accuracy of aids to navigation regarding vessel position on inland waterways should be 10 metres, with a probability of 95%. The accuracy of nautical charts is also very important. The national authority responsible for their publication must work in coordination with the body responsible for aids to navigation. In the particular case of restricted waters, the nautical chart scale is 1:10 000, requiring an accuracy of 10 m (IALA-AISM, 2014).

Aids to navigation include visual aids (lighthouses, beacons, buoys and leading lines), electronic navigation (AIS, DGPS, VTMS etc.), a pilotage service and traffic organisation boats.

The objectives of e-navigation are: to facilitate the safe navigation of vessels with regard to hydrographical, meteorological and navigation information, facilitate maritime traffic management, facilitate communication and provide opportunities to improve the efficiency of transport and logistics. E-navigation is a concept that incorporates systems and services.

8.1 GENERAL REQUIREMENTS

The information system for navigation and communication aims to improve the navigational capability and safety in the inland waterways, key points of River Information System are:

- The information system will help to track the real time position of ships plying on the inland waterways
- The system will also provide real time weather reports and help in building communication among the vessels
- Under the project, radars and sensors will be installed in boats and river ports
- The information will be sent via Very High Frequency (VHF) wireless communication between the operators and the user

For safe navigation of the ships throught the waterway, state of the art navigation and communication system are to be provided in the waterway stretch. These services should be supported by currently available technical systems like:

- Mobile radio communication systems for inland navigation (VHF radio)
- Ship and shore based radar
- Mobile data communication systems
- Global navigation satellite system (GNSS)
- Internet
- Electronic chart and display and information system for inland navigation (Inland ECDIS)
- Automatic identification system for inland navigation (Inland AIS)
- Ship reporting systems.

8.1.1 VHF / HF

One of the main characteristics of the River Information Service is efficient and reliable flow of information. It can be effectively achieved in real time through VHF communication, which is of key importance in maritime navigation and has been implemented to meet the requirements of inland waterway shipping services.

VHF communication is in use in inland navigation to ensure safe flow of information among vessels and services coordinating SAR operations within the RIS operation range.

The RIS operating centre is proposed to be located in one of the terminal building. Within a usable floor area of 200 sq. m, a room shall be arranged for the maintenance of constant radio watch by three system operators who can control the system modules. The foreground item of the equipment's will be a display consisting of six LCD screens.

It will display a view of the AIS and views from CCTV cameras, which, combined, support real time view of the situation on the waterway. The RIS Centre shall also provide electronic charts for the purposes of the Inland ECDIS, transmits Notices to Skippers (NtS), receives ERI messages and ensures system users reliable VHF radio communication. Signals received by VHF radio stations are transmitted directly to the RIS Operating Centre via a relay network.

8.1.2 DGPS

The Differential Global Positioning System (DGPS) is an enhancement to GPS that improves accuracy to under 3 metres, by means of a ground-based network of reference stations. It is proposed that all vessels should be equipped with latest DGPS equipment's to track the time positional accuracy of vessels.

One DGPS station is proposed at Canning with an effective radial coverage of about 125 km, as part of development of Sunderbans waterways and to cater all the 13 national wateways proposed under Sunderbans waterways (NW 97) as shown in **Figure 26** below. As shown in figure below, all 13 waterways prpopsed under NW-97 fall under the radial coverage of proposed DGPS at Canning. Radial distance of canning from farthest point in Kalindi waterway is about 40.0 Km. The capital and O&M cost of proposed DGPS system at Canning is considered in DPR of Matla waterway.

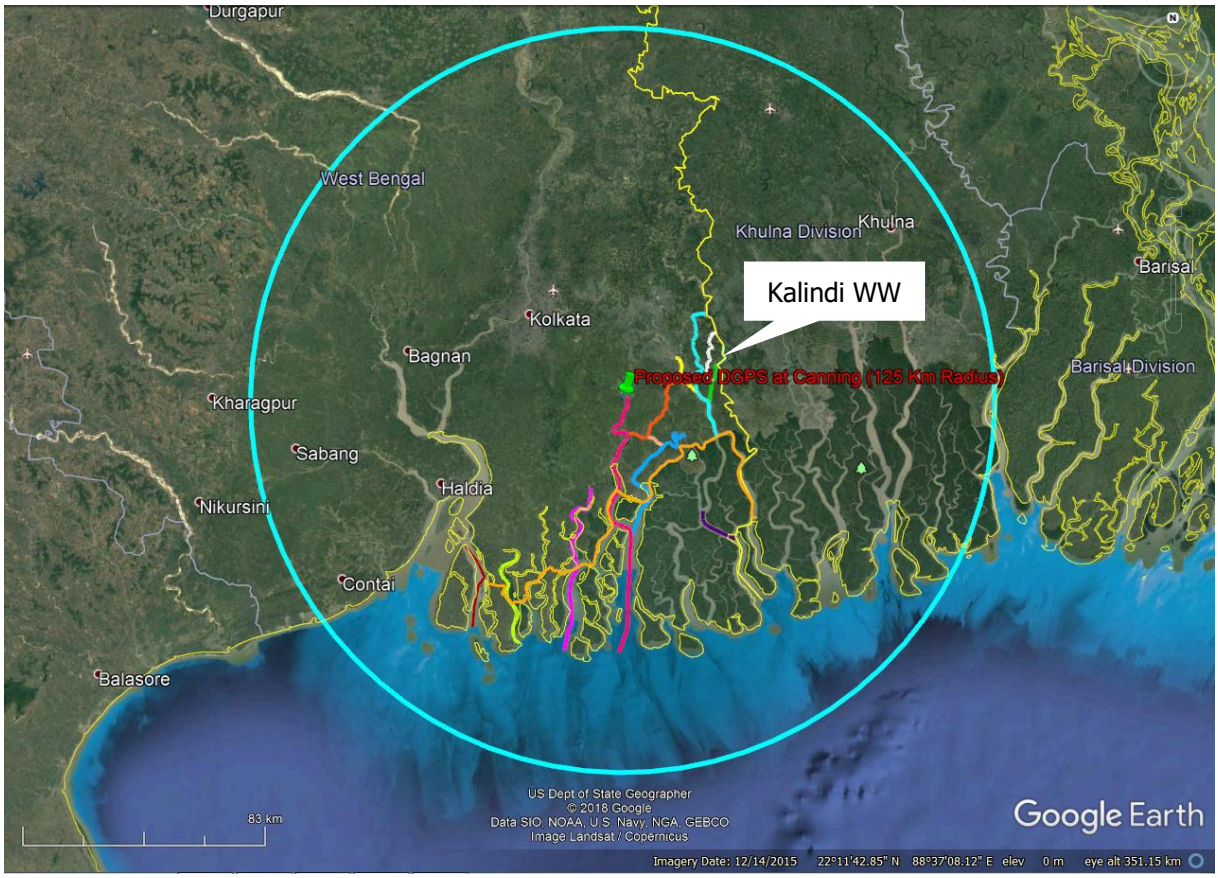


Figure 26: Google Earth image showing location map of proposed DGPS and effective coverage

8.1.3 RIS / AIS / Radar / VTMS

An objective is the description of intention. The objective may also be called the goal or aim. RIS have three main objectives:

1) Transport should be *safe*:

- Minimise injuries
- Minimise fatalities
- Minimise voyage incidents

2) Transport should be *efficient*:

- Maximise throughput or effective capacity of waterways
- Maximise the carrying capacity of vessels (length, width, draught and height)
- Reduce travel time
- Reduce workload of RIS users
- Reduce transport costs
- Reduce fuel consumption
- Provide efficient and economical link between transport modes
- Provide efficient harbours and terminals

3) Transport should be *environmentally friendly*:

- Reduce environmental hazard
- Reduce polluting emissions and spills due to accidents, illegal actions or normal operations

These objectives should be met under the constraints that all RIS are supplied in a manner that is reliable, cost efficient and legally sound.

As part of collective development of NW-97, Sunderbans waterways, following RIS stations are proposed with radial coverage of 25 Km. The proposed RIS stations will serve following waterways as shown in table below and accordingly the cost is considered in the waterway as provided below:

Table 21: Details of RIS stations proposed in NW-97, Sunderbans waterways

RIS Station No.	Proposed location of RIS station			Waterway name covered by proposed RIS	Reach length in Km	Chainage from Km	Chainage to Km	Waterway incoporating cost of proposed RIS
	Co-ordinates	Location Name	Waterway Name					
1	21°43'31.48"N, 88°18'33.06"E	Bhagabatpur	Saptamukhi WW	Muri Ganga	28.418	0.00	28.418	Saptamukhi
				Saptamukhi	37.163	0.00	37.163	
				Thakurran	36.4	0.00	36.4	
2	21°59'19.55"N, 88°31'3.58"E	Dhaki Jetty	Thakurran WW	Thakurran	40.865	23.0	63.865	Thakurran
				Matla	45.0	30.0	75.0	
				Bidya	28.50	0.00	28.50	
3	22°10'5.76"N, 88°47'14.07"E	Godkhali Jetty	Gomar WW	Matla	43.731	55.0	98.731	Gomar WW
				Bidya	49.623	6.20	55.823	
				Gomar	6.711	0.00	6.711	
				Hogla	37.202	0.00	37.202	
				Raimangal	21.50	0.00	21.50	
				Chhota Kalagachi	8.324	0.00	8.324	
4	**22°23'17.49"N, 88°53'59.43"E**	**Bolakhali Jetty**	**Raimangal WW**	Hogla	27.702	10.0	37.202	**Raimangal WW**
				Raimangal	53.381	0.00	53.381	
				Chhota Kalagachi	15.324	0.00	15.324	
				Sahibkhali	14.392	0.00	14.392	
				Katakhali	22.465	0.00	22.465	
				Kalindi	**8.513**	**0.00**	**8.513**	

Hence, the proposed RIS station to be set up near Bolakhali Jetty along Raimangal waterway will cover the complete stretch of Kalindi waterway as shown in **Figure 27**.

The capital and O&M cost of proposed RIS at Bolakhali Jetty is considered in DPR of Raimangal waterway.

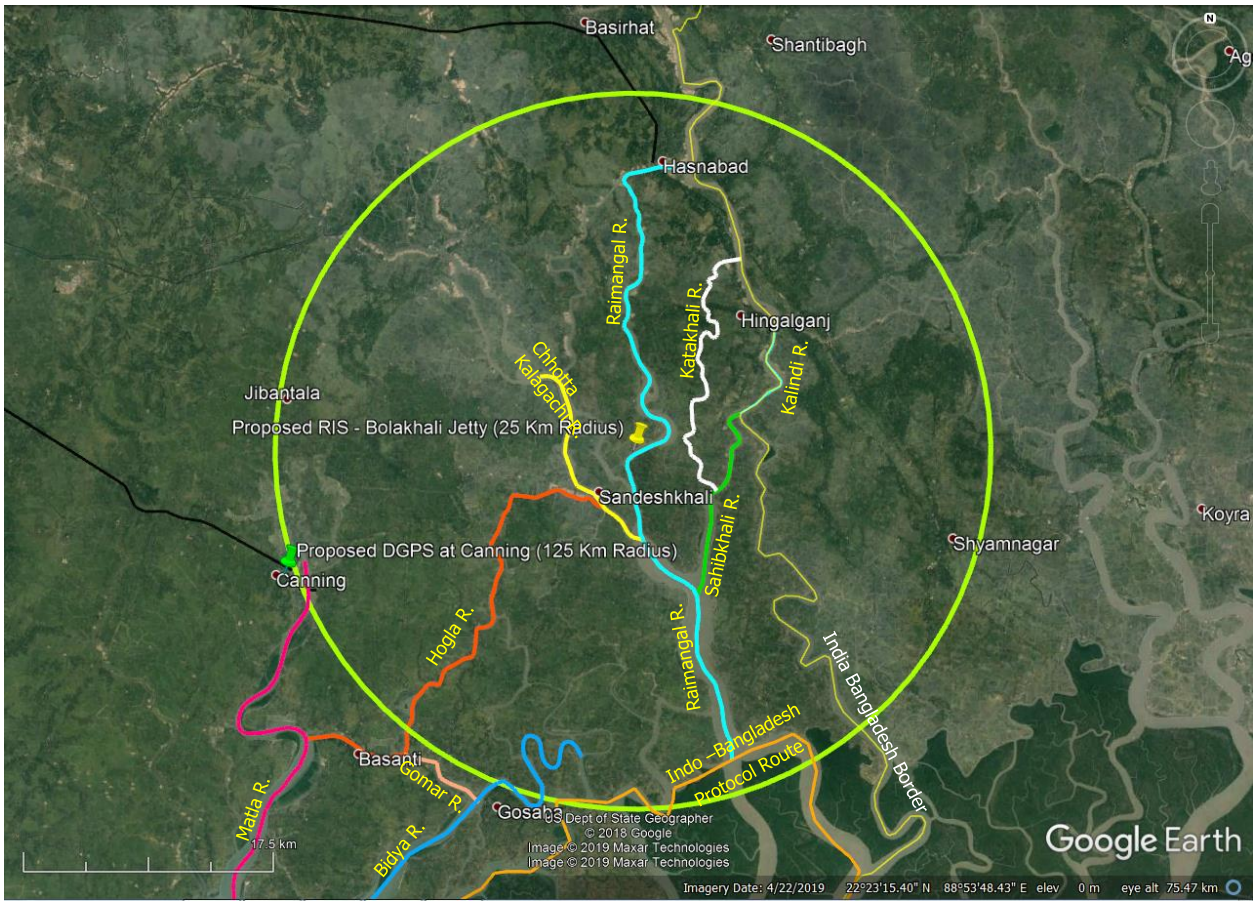


Figure 27: Google Earth image showing location map of proposed RIS and effective coverage

8.2 NIGHT NAVIGATION FACILITIES

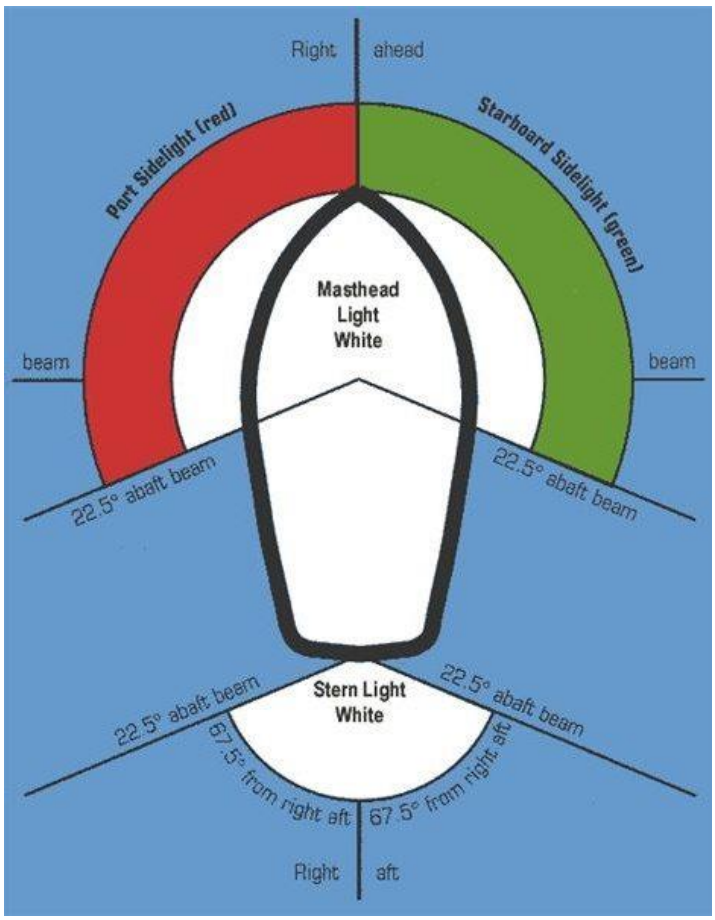
On sectors of the river where there is day and night navigation, forks, junctions and the axis of the fairway, along with obstacles to navigation lying within the fairway, shall be marked by light buoys or bank marks and lights. Floating signs shall be installed at such a depth and at such a distance from the obstacle that the safety and ease of movement of vessels shall be guaranteed at night and in poor visibility. The marking shall be in operation continuously (by day and by night) all along the navigable section of the river.

The visibility of signs regulating navigation on the waterway shall be ensured at night by lighting them with fixed directional white lights, operating uninterruptedly and so positioned that the light does not incommode the boatmasters. If electric lighting cannot be used, the sign boards shall be covered with reflective material of a corresponding colour on which the symbol shall be clearly visible to vessels. At night, for proposed waterway terminals, it shall be sufficient to illuminate the day markings described above. If lights are considered necessary, the entrance shall be marked:

- To port of a vessel entering: by a red light, preferably rhythmic;
- To starboard of a vessel entering: by a green light, preferably rhythmic.

In the case of a narrow or specially shaped entrance, one of these lights may be sufficient to help a boatmaster to enter the harbour. Such a single light shall be rhythmic.

On the vessels there is a pattern in which these lights are set in conjunction with the International Association of Lighthouse Authorities (IALA) Buoyage Systems. The pattern is explained below:

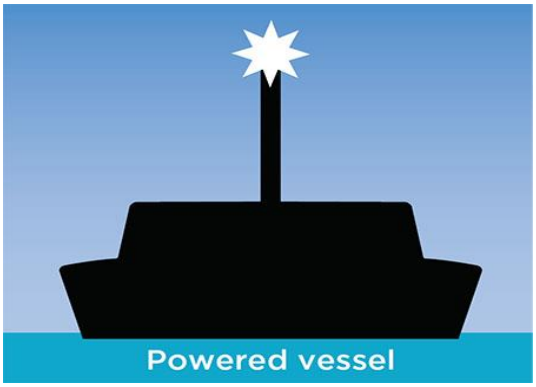


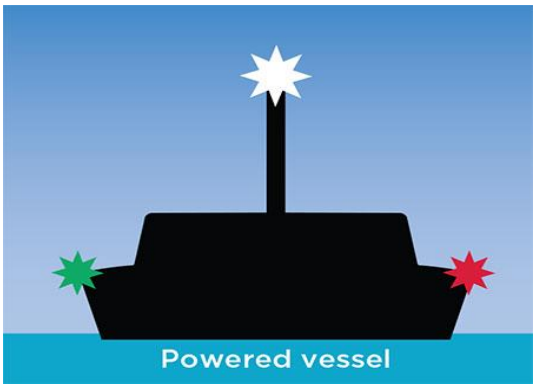
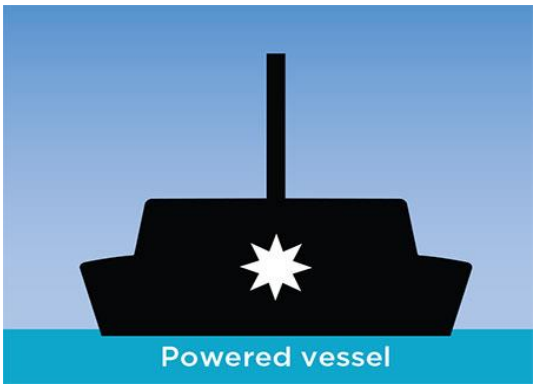
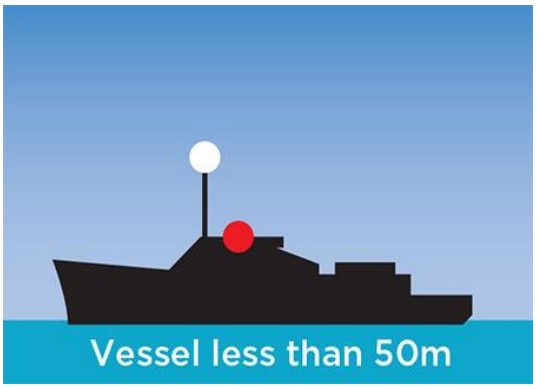
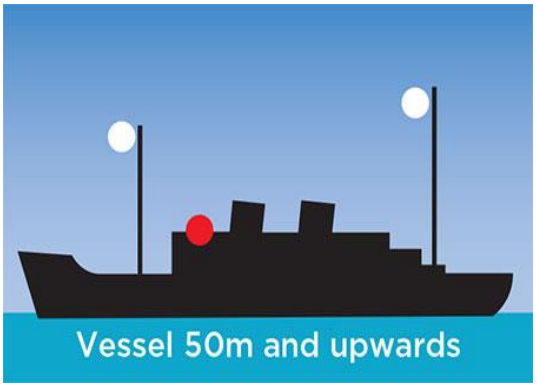
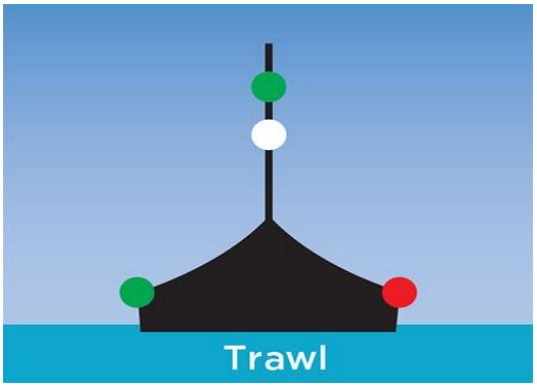
- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.
- Both the sidelights show an unbroken light over an arc of the horizon of 112.5 degrees such that from right ahead it can be viewed to 22.5 degrees shaft on either side.
- A white light is also placed at the back of the boat (known as the stern side). This shows an unbroken light over an arc of horizon of 135 degrees and fixed to show the light 67.5 degrees from right aft on each side
- The mast of the boat also has to have night lights. The colour of this light is white. Two mastheads lights are in place, with the second one shaft of and higher than the first, when the length of the vessel is greater than 50 metres. Shows an unbroken light over an arc of the horizon of 225 degrees and so fixed to show the light from right ahead to 22.5 degrees abaft on either side.

To stay safe on the water at night or at times of restricted visibility, the vessel operator also need to be able to recognise lights on other vessels. These lights help prevent collisions. A vessel's navigation lights tell the master/serang:

- whether it's at anchor or underway
- the direction it's travelling
- the vessel type and size.

Some examples of navigation lights used during night navigation are as below:

	
All round white light on any vessel up to 50m long at anchor	All round white light or torch light on any vessel up to 7m long going in any direction – moving towards, moving away, crossing left or right – or it may be at anchor

	
Green light to your port (left) and red light to starboard (right) on Sailing boat coming.	Powerboats and sailing boats using their engine up to 50m long coming also display a masthead light.
	
Powerboat or sailing boat using its engine up to 50m long travelling away.	A powerboat or sailing boat using its engine also displays a masthead light. Powerboat or sailing boat using its engine up to 50m long crossing path
	
Ships or other large vessels over 50m long display 2 masthead lights. Ship over 50m long crossing path	Displays special lights when its activity – such as trawling – restricts its manoeuvrability.

8.3 EXISTING SYSTEM

Full length of 8.513 Km of Kalindi River is proposed for development as national waterway. Presently, the vessels operated by BSf and local fishermen are using the Kalindi waterway. No aids to navigation and communication system exists currently along the waterway.

8.4 ADDITIONAL REQUIREMENT

State-of-art navigation and communication system is required in the proposed waterway. The details of River information systems and its applicability and relations to different services in navigation are provided in **Figure 28** as below.

SYSTEM	SERVICE													
		Traffic information		Traffic management				Information for transport logistics						
	Fairway information	Tactical	Strategic	Vessel traffic services	Navigational support	Lock and bridge management	Calamity abatement support	Voyage planning	Transport management	Inter-modal port and terminal management	Fleet and cargo management	Information for law enforcement	Statistics	Waterway charges and harbour dues
Visual aids to navigation	x													
Radar reflecting aids to navigation	x			x										
Light signals	x			x		x								
Mobile phone (voice and data)	x				x	x	x	x	x	x	x	x		x
GNSS for vessel positioning		x	x				x	x	x	x				
VHF radio	x	x	x	x	x	x	x	x		x		x		
Internet	x				x		x	x	x	x	x			x
Vessel based radar	x	x					x							
Shore based radar		x		x		x	x							
Shore based CCTV cameras		x		x		x								
Electronic navigational chart	x	x		x		x	x	x						
Vessel tracking and tracing system		x	x	x		x	x	x	x	x	x	x		x
Ship reporting system			x				x	x	x	x	x	x	x	x

Figure 28: Relation between Services and RI Systems

8.5 COSTING

The following criteria is adopted for estimating the quantity and cost of navigational aids, proposed for waterway.

i) Quantity of the equipment/s has been decided depending on the distance of the river to be covered.
ii) To operate the system, proper certified operators are to be deployed at site along with the security guards.
iii) As Kalindi waterway is constituent of NW-97 comprising 13 rivers, required quantity of DGPS and RIS condering their effective coverage to avoid duplicity of Instrument proposed and cost over runs is considered.

Capital cost of purchase & installation and O&M cost of DGPS and RIS are provided in respective Matla and Raimangal DPR's. In addition to DGPS and RIS, Marine lanterns/bouys are provided in Kalindi waterway for providing safe navigational facilities to BSF vessels and vessels plying from other connected waterways. The corresponding cost works out as below.

8.5.1 Capital Cost

Table 22: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lakh)
A	Marine Lantern/Buoys	8	2,00,000	16.00
			Total Cost in Lakh	**16.00**
C	3% Contingencies charges			0.48
D	**Total Navigation & Communication Cost in Lakh**			**16.48**

8.5.2 O&M Cost

The O&M cost is considered as 10% of the capital cost for Marine Lanter/Bouys. Accordingly, O&M cost for providing Aids to Navigation and Communication facilities at Kalindi waterway works out to **INR 1.65 Lakh**.

9.0 ENVIRONMENTAL AND SOCIAL ASPECTS

9.1 OBJECTIVE OF ENVIRONMENTAL AND SOCIAL STUDIES

Inland Waterway Authority of India (IWAI), Ministry of Shipping, Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, and recommending the possibility of Composite and Integrated development of National waterways to achieve navigation and to develop water transport facilities across India.

Among many rivers, the section of Kalindi River from Km 0.000 to Km 8.513 falling in North 24 Parganas District of West Bengal State is also considered for Sunderban waterways and declared as National Waterway No. 97 (NW-97).

The Kalindi River is a tidal estuarine river in and around the Sundarbans in North 24 Parganas district West Bengal, India, bordering on Satkhira District of Bangladesh. The river has a connection with the Ichhamati River in the North and with Sahibkhali River in the south. The combined river flow falls in to the Bay of Bengal with a wide mouth after traversing about 80 kilometers. There are a couple of sharp curves in the river stream.

Kalindi River has three tributaries/creeks along the bank, one in India and other two are in Bangladesh. The details of the creeks are given in **Table 23**

Table 23: List of Creeks

Sl No	Creek	Chainage	Length(Km)
1	Bagdariala (Bangladesh)	1.29	1.8
2	Singherkati(India)	2.28	2.9
3	Probajpur(Bangladesh)	4.01	1.3

The major objective of this study is to establish present environmental condition along the project corridor through available data /information supported by field studies to evaluate the impacts on relevant environmental attributes due to the construction & operation of the proposed project; to recommend adequate mitigation measures to minimize / reduce adverse impacts and to prepare an Environmental Management Plan (EMP) for timely implementation of the mitigation measures to make the project environmentally sound and sustainable. The study basically includes:

- Establishment of the present environmental and social scenario
- Study of the specific activities related to the project

- Evaluation of the probable environmental and social impacts
- Recommendations of necessary environmental control measures.
- Preparation of Environmental Management Plan
- To identify the requirement of various regulatory clearances, NoCs

9.2 ENVIRONMENTAL SETTING IN THE PROJECT AREA

9.2.1 Physiographic

The study stretch passes through North 24 Parganas District of West Bengal State. North 24 Parganas is a district in southern West Bengal, of eastern India. North 24 Parganas extends from latitude 22º11'6" North to 23º15'2" North and from longitude 88º20' East to 89º5' East. It is bordered to Nadia by north, to Bangladesh (Khulna Division) by north and east, to South 24 Parganas and Kolkata by south and to Kolkata, Howrah and Hoogly by west.

Barasat is the district headquarters of North 24 Parganas. North 24 Parganas is West Bengal's most populous district. It is also the tenth-largest district in the State by area.

The district, North 24-parganas, has been divided geographically into three parts,

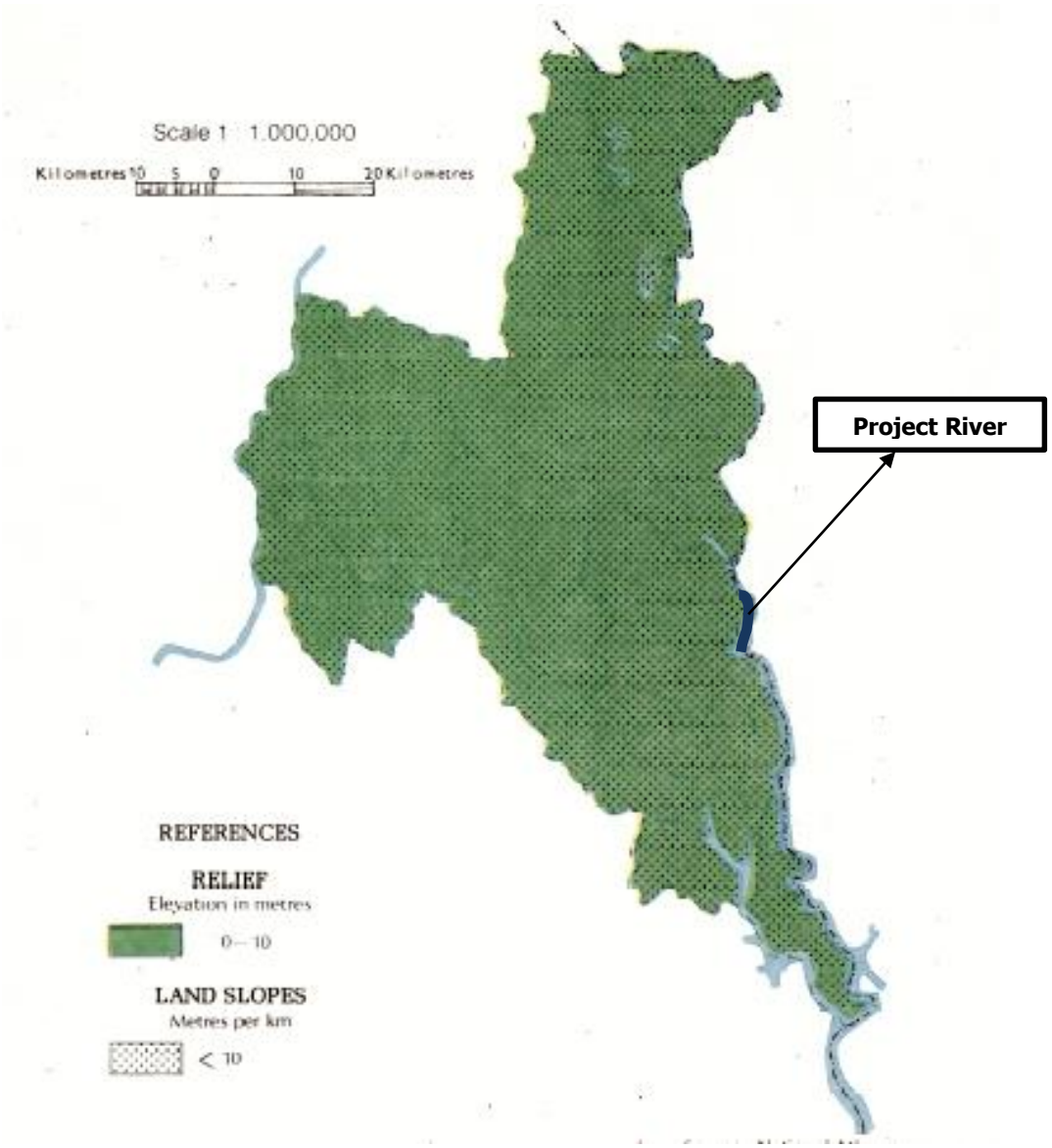
a) Vast reverine belt in the Southern part of Basirhat Sub-Division. (Sundarban area),
b) The industrial and urbanized zone of Bidhannagar and Barrackpore Sub-division
c) Vast cultivating plain land in the Bongaon Sub-division and adjoining part of Barrackpore, Barasat & Northern part of Basirhat Sub-Divisions.

The physiography of the region is that of a typical alluvial plain with gentle ups and downs. The terrain is essentially composed of Soft River borne sediments deposited under fluviatile environment. The general slope is from north west to south east. As the area is situated very near to the out fall, the dominant slope of the land is towards south with average elevation varying from 3.5 m to 2.5 m above MSL. The region is criss-crossed by a network of small streams and rivulets with out falls either at river Hooghly or Haldi. Since these rivers are connected to the sea, the channels suffer daily fluctuations in water level due to tidal influence. Hence, estuarine conditions prevail here with problems of salinity and coastal hazards especially along the banks and river fronts.

The district lies within the Ganges-Brahmaputra delta. The river Ganges flows along the western border of the district. The main rivers of the district of North 24-Parganas are Ichhamati, Kalindi, Raimangal, Dansa, Borokalagachi, Benti, Haribhanga, Gourchrar, Bidyadhari, Hooghly, etc. Ichhamati is the longest among these rivers. It enters the district through Bagdah block in the north of the

district from Nadia and flows south through Bangaon, Swarupnagar, Baduria, Bashirhat-I, Hasnabad and Hingalganj. This river flows into river Kalindi and Kalindi in turn flows into Raimangal. It indicates the borderline between India and Bangladesh during its course of flow from Bashirhat to Hingalganj. River Hooghly lies between Hooghly and North 24-Parganas district. Besides, Sunderban deltas make many rivers flow in this region due to high tidal water entering from Bay of Bengal

Relief and Slope Map of North 24 Parganas District is furnished in **Figure 29**.



Source : NATMO

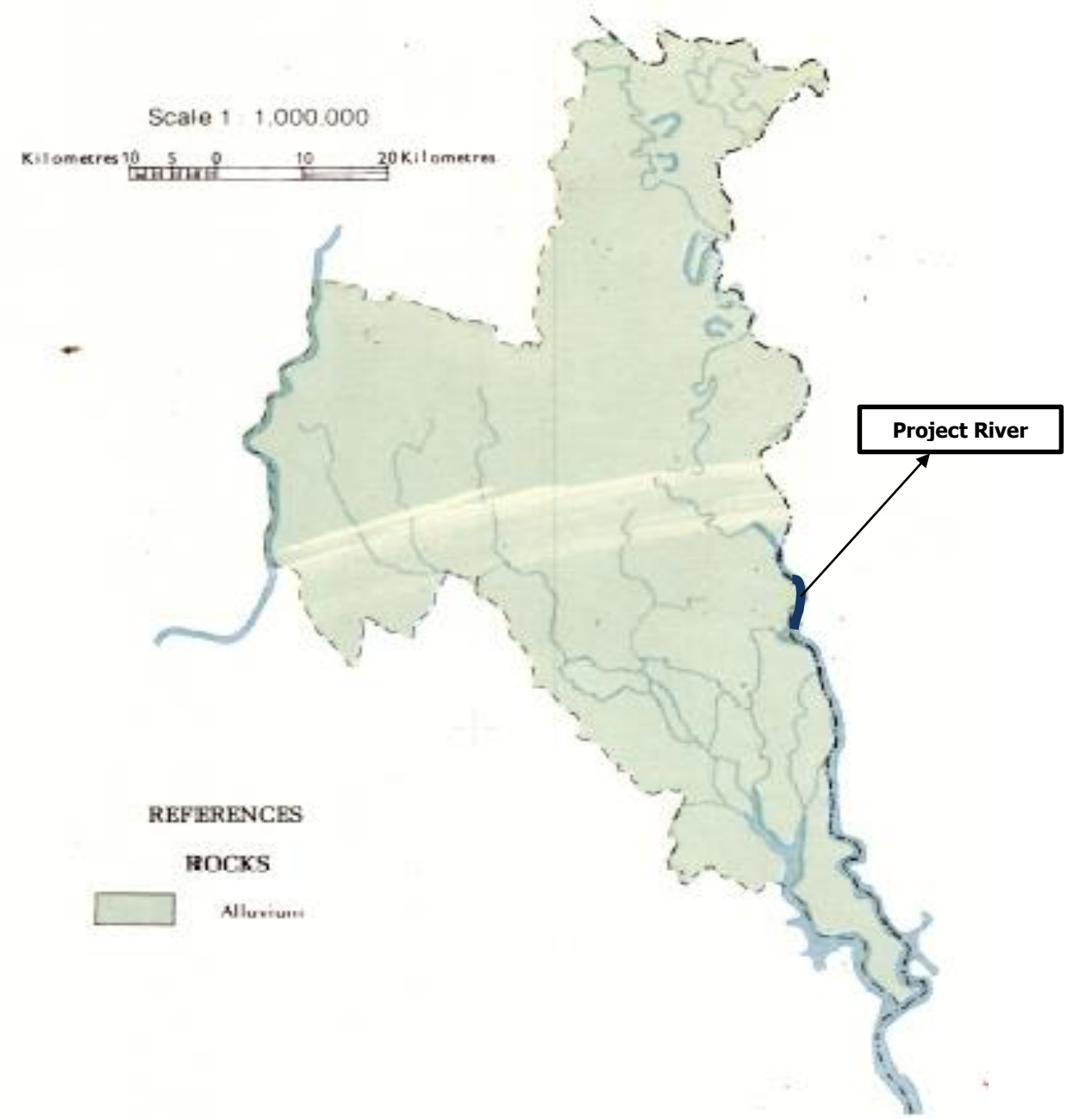
Figure 29: Relief and Slope Map of North 24 Parganas District

9.2.2 Geology and Seismicity

Geology:

The district lies within the Ganges-Brahmaputra delta. The river Ganges flows along the western border of the district. There are many other rivers, which include the Ichhamati, Jamuna, and Bidyadhari. The entire landmass of Sundarbans is of very recent in origin and is the result of extensive fluvial-marine deposits of the river Ganges and Bay of Bengal. This stretch of coastal landmass exhibits varied geomorphologic features like sandstones, beach ridge, intertidal sandy flats, tidal shoals etc. These structures are evolved out of dynamic and varied interactions of marine agencies like waves, tides and littoral currents combined with fluvial components. The silt, clay and sand particles have been deposited layer by layer by the river Ganges and its tributaries in the sea board. These rapid delta formations have resulted in uneven thickness and width of the horizons in the estuarine mouths by facing the Bay of Bengal. Lithological logs of the boreholes of Sundarbans include thick clay blanket (15.24 m to 76.20 m) at the topand is underlain by the presence of very coarse sediment containing medium to small gravels of rock fragments and quartz of Quaternary age.

The Rock and Mineral Map of North 24 Parganas District is presented in **Figure 30**.

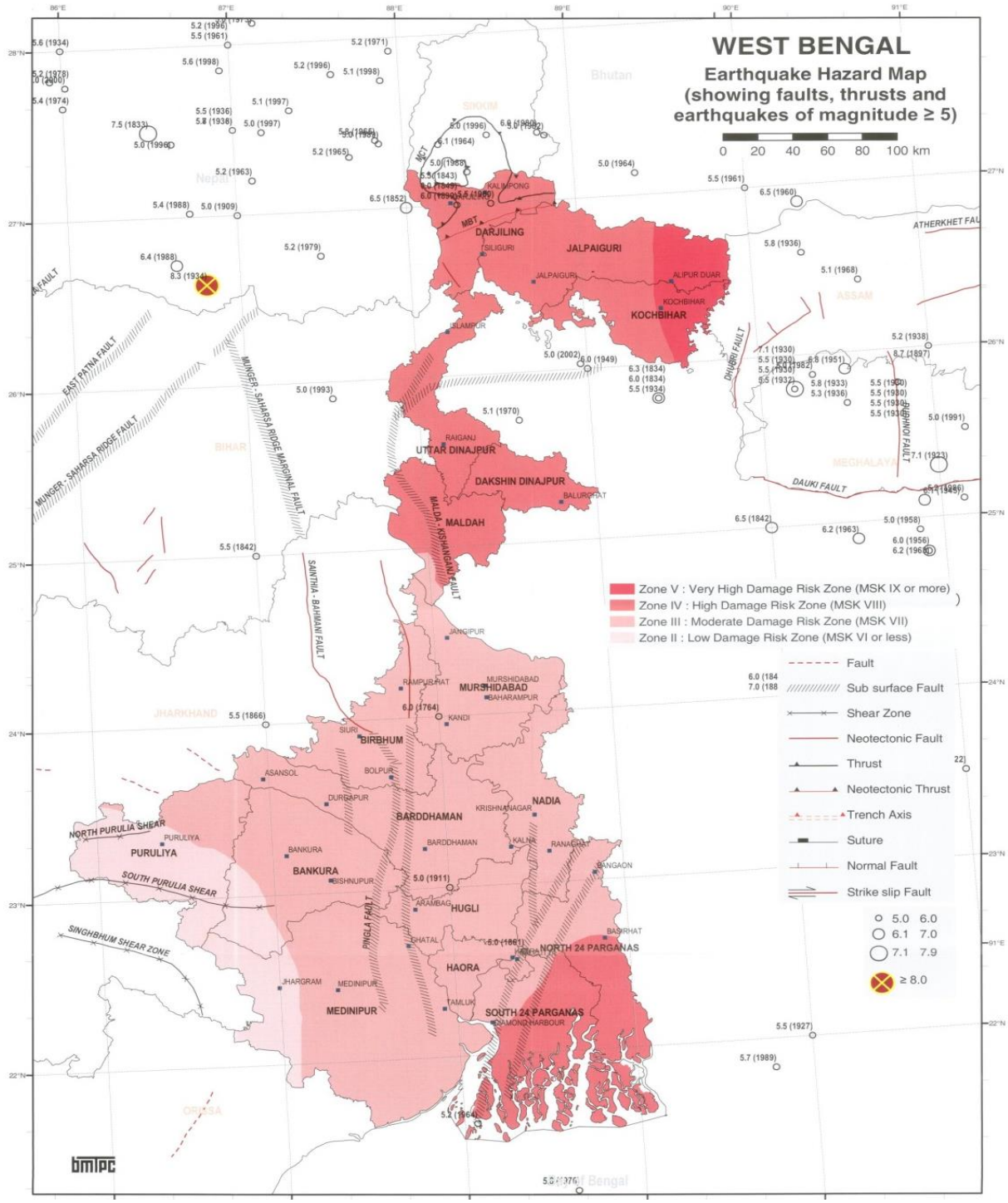


Source : NATMO

Figure 30: Rock and Mineral Map of North 24 Parganas District

Seismicity:

As defined by the Indian Standard (IS) 2002 seismic zoning classification system, the seismicity is measured on a scale from II to V where zone II is most stable and Zone V is considered to be least stable. According to West Bengal Disaster Management Department (WBDMD) western sections of the northern districts of Jalpaiguri and Kooch Bihar lie in Zone V. The remaining parts of these two districts, along with the districts of Darjeeling, Uttar Dinajpur, Dakshin Dinajpur, Maldah, 24 North Parganas and 24 South Parganas lie in Zone IV. The rest of the state along with the city of Kolkata lies in Zone III. The project stretch lies in Earthquake high damage risk zone-IV. The Eartquake zoning map of West Bengal state is shown in **Figure 31**.



Source : West Bengal Disaster Management Department

Figure 31: Earthquake Zoning map of West Bengal

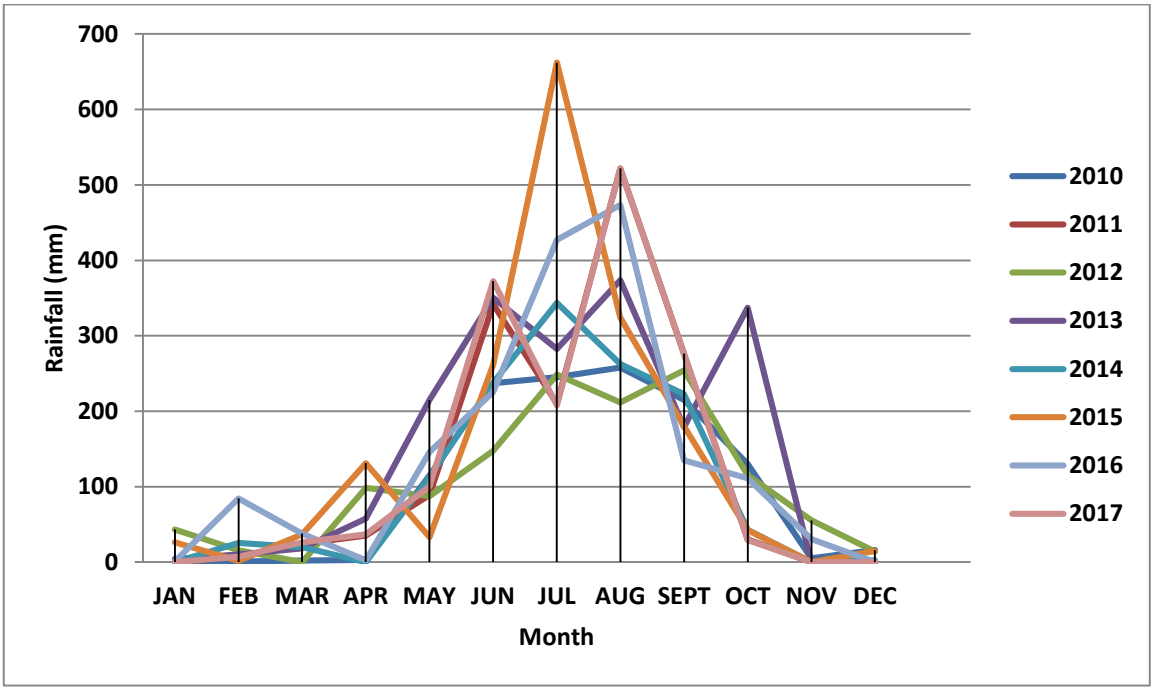
9.2.3 Climate

The district North 24 Parganas is characterized by humid, subtropical climate. It receives adequate rainfall from South-West Monsoon, which sets in the later half of June and continues upto middle of October. Premonsoon torrential downpour received during March-May. The average annual rainfall is 1579mm. The temperature ranges between 41 °C in May (Max) to 10°C in January (Min) and Relative Humidity ranges between 50% in March & 90% in July. The pattern of Rainfall in North 24 Paraganas District is furnished in below table and figure.

Table 24: Rainfall pattern of North 24 Paraganas District

Year	Month wise Rainfall Pattern (mm)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
2010	0	1	2	3	115	237	245	258	215	130	5	16
2011	0	7	24	35	89	342	210	522	276	30	0	0
2012	43.3	15.6	0	98.5	87.2	147.6	248.7	211.8	254.2	115.2	55.5	14
2013	4.3	10.1	18.2	57.6	214.9	350.3	282.5	373.7	178.8	337.4	0	0
2014	0	25.3	19.9	0	112.6	237.9	343.4	262.6	222.8	42.7	0	2.5
2015	26.3	1.8	36.7	131.2	33.2	261.9	662.1	324.1	180.2	42.5	0	15
2016	0.7	84.4	37.8	2.5	146	225.8	427.1	473.4	135	111.3	30.7	0
2017	0	7.27	26.10	36.78	100.35	372.47	207.66	521.81	276.36	29.28	0	0

Source: India Meteorological Department



Source: India Meteorological Department

Figure 32: Rainfall Pattern of North 24 Pargana District

The observatory of Indian Meteorology Department is located in Dumdum (Kolkata). Based on observations between 1971-2000 the temperature profile of the project area is furnished in below table. April is the warmest month of the year. The maximum temperature in April averages 35.5 °C. The lowest average temperatures in the year occur in January, when it is around 12.9 °C (minimum).

Table 25: Daily (Mean) Maximum and Minimum temperature by month in the Project Area (1981-2007)

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
January	25.8	12.9
February	28.7	16.2
March	33.3	21.0
April	35.5	24.5
May	35.4	25.6
June	34.0	26.3
July	32.6	26.0

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
August	32.3	26.1
September	32.5	25.7
October	32.2	23.8
November	29.9	19.1
December	26.7	13.8

Source: India Meteorological Department

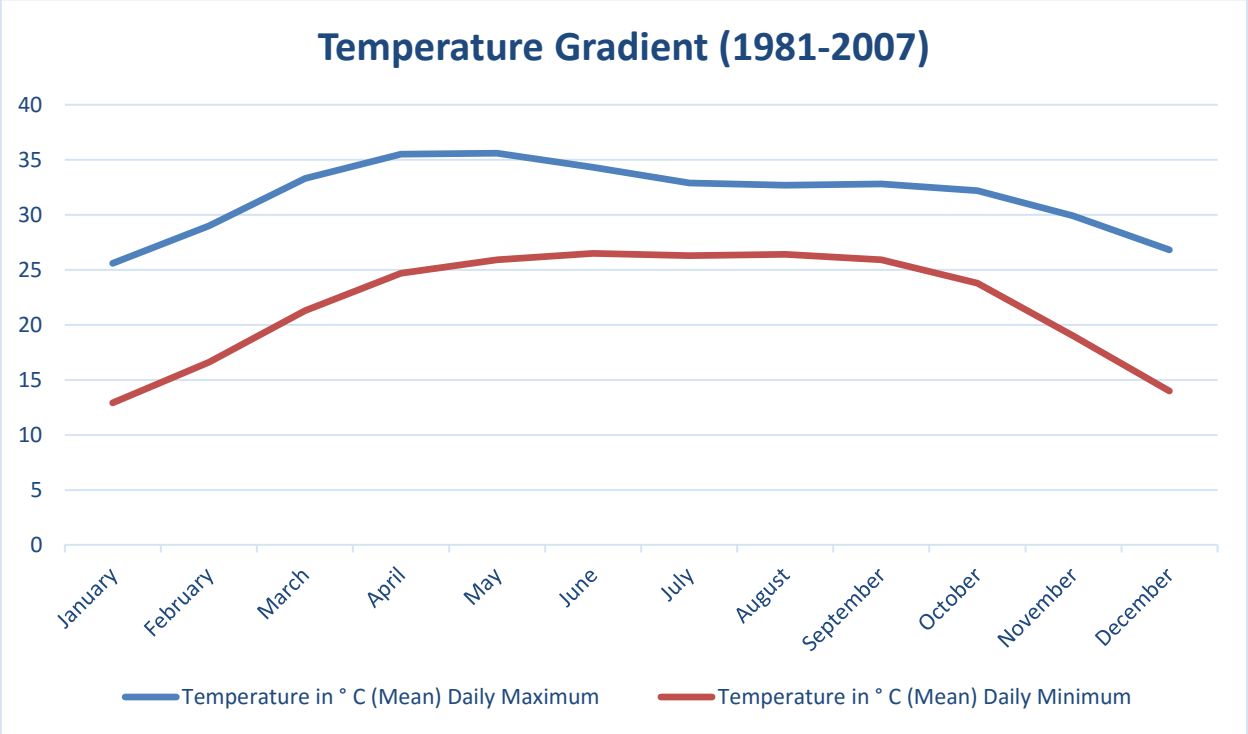
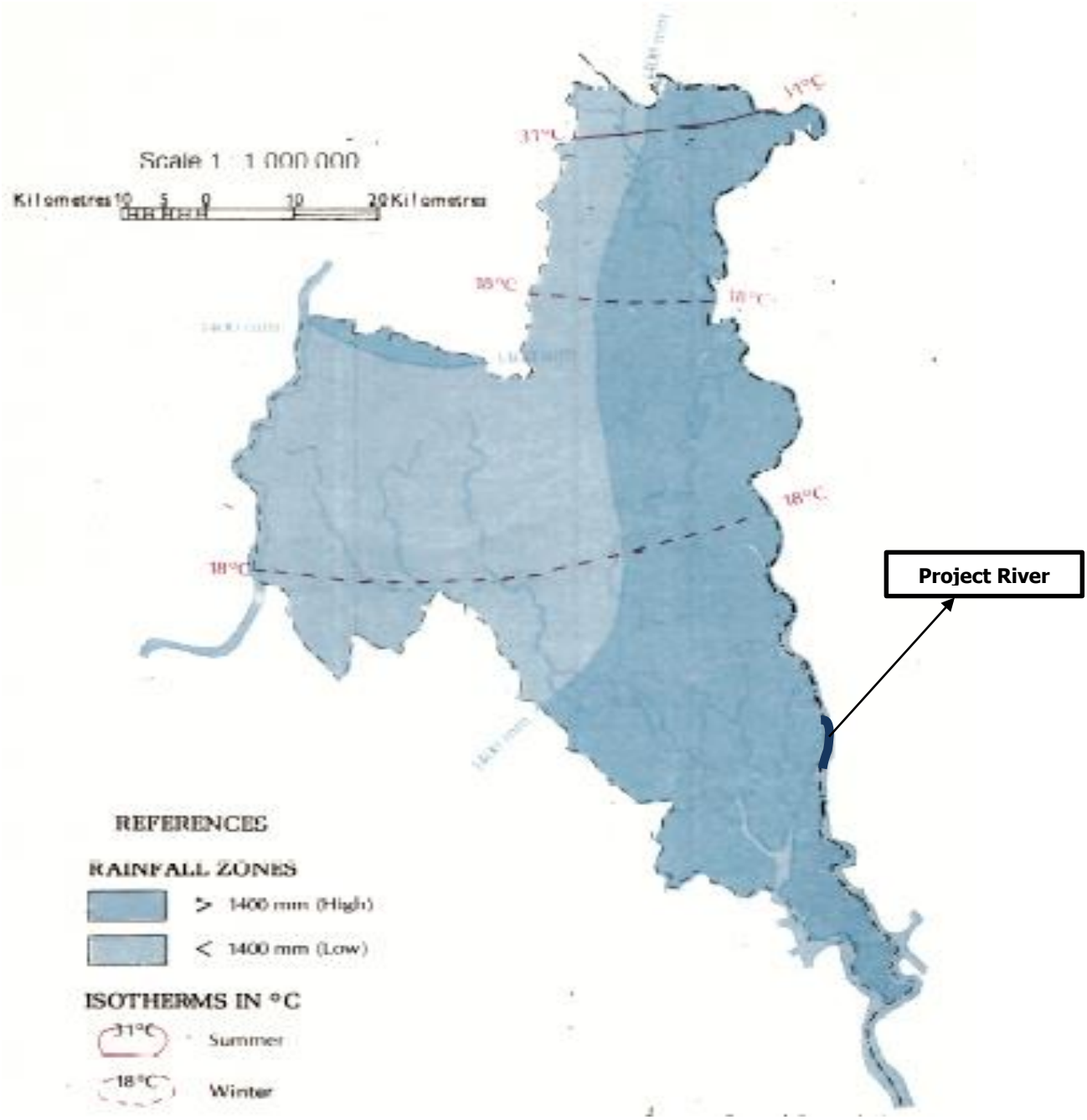


Figure 33: Graphical representation of Temperature Gradient for the year 1981-2007



Source : NATMO

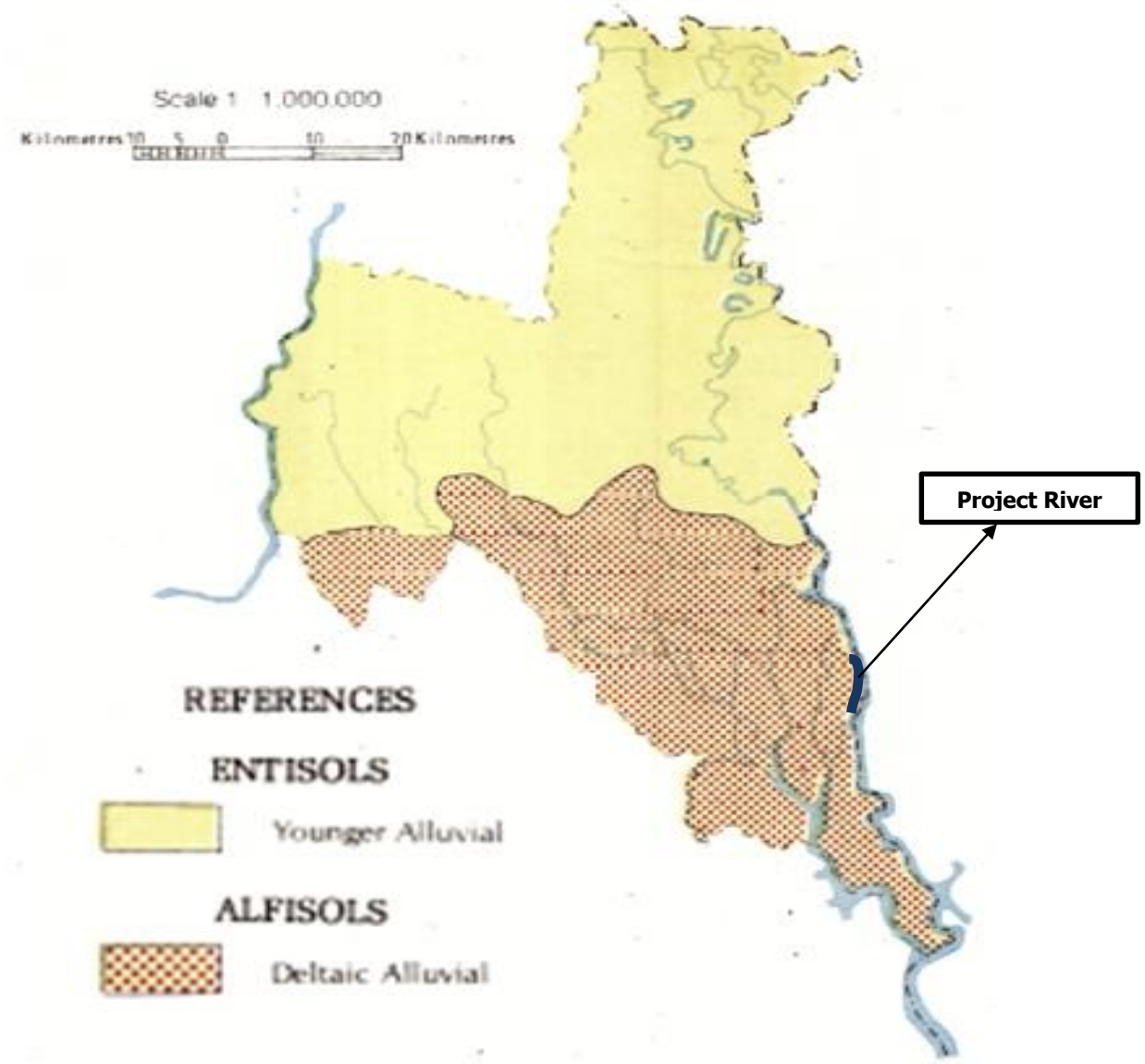
Figure 34: Climatic condition of North 24 Parganas District

9.2.4 Soil

North 24 Parganas district is underlain by Quaternary sediments consisting of clay, silt and various grades of sand gravel and pebble. No hard rock geological formation is found here. Lithological log

indicates the presence of a clay bed at the top of the geological succession with thickness varying from 10- 40 m. Alternate clay and sand bed exists further in the downward direction. A group of granular aquifer is found between 250-650 m below ground level. These layers are being tapped as groundwater sources. The unconsolidated alluvial sediments of Quaternary age have over laid the older deposits of Tertiary age as noticed in this pile of alluvium. The top most sediment, belonging to recent alluvium which contains mostly of clay. The type of soil varies widely from Sandy, alluvial to clay loam. As the district falls within the Gangetic delta, the soil of the district is very favourable for cultivation. Shallow black and brown soils are also found. The presence of good number of rivers, creeks, khals etc. also favours the cropping pattern of the district. The soil of northern part of the district is sandy, in the central middle part it is sandy with clay loam and in southern side it is clay loam. The physiography of the district is mostly plain. Most of the soils derived from alluvial deposits are azonal with little or no profile development. Clay loam is the predominating type. Clays with or without muck soils occur in swamps and alluvial lakes. These soils have been formed from deposits brought by tidal currents. The active delta still growing southwards is a system of innumerable tidal rivers, canals and creeks, saline soils, swamps and marshes. A part of this active delta contains forests. Known as Sunderbans, this part of the active delta region is under reserve forests. Quite a large part of Sunderbans has been brought under cultivation. Even then the area of Sunderbans spread over 24 Parganas (north and south) is 0.42 million hectares (1629 sq. km.). Sunderbans is a mangrove forest. All the mangroves protect the shore from erosion and aid in accumulation of deposit of peat and mud.

The soil map of the district is given in below Figure.



Source : NATMO

Figure 35: Soil Map of North 24 Parganas District

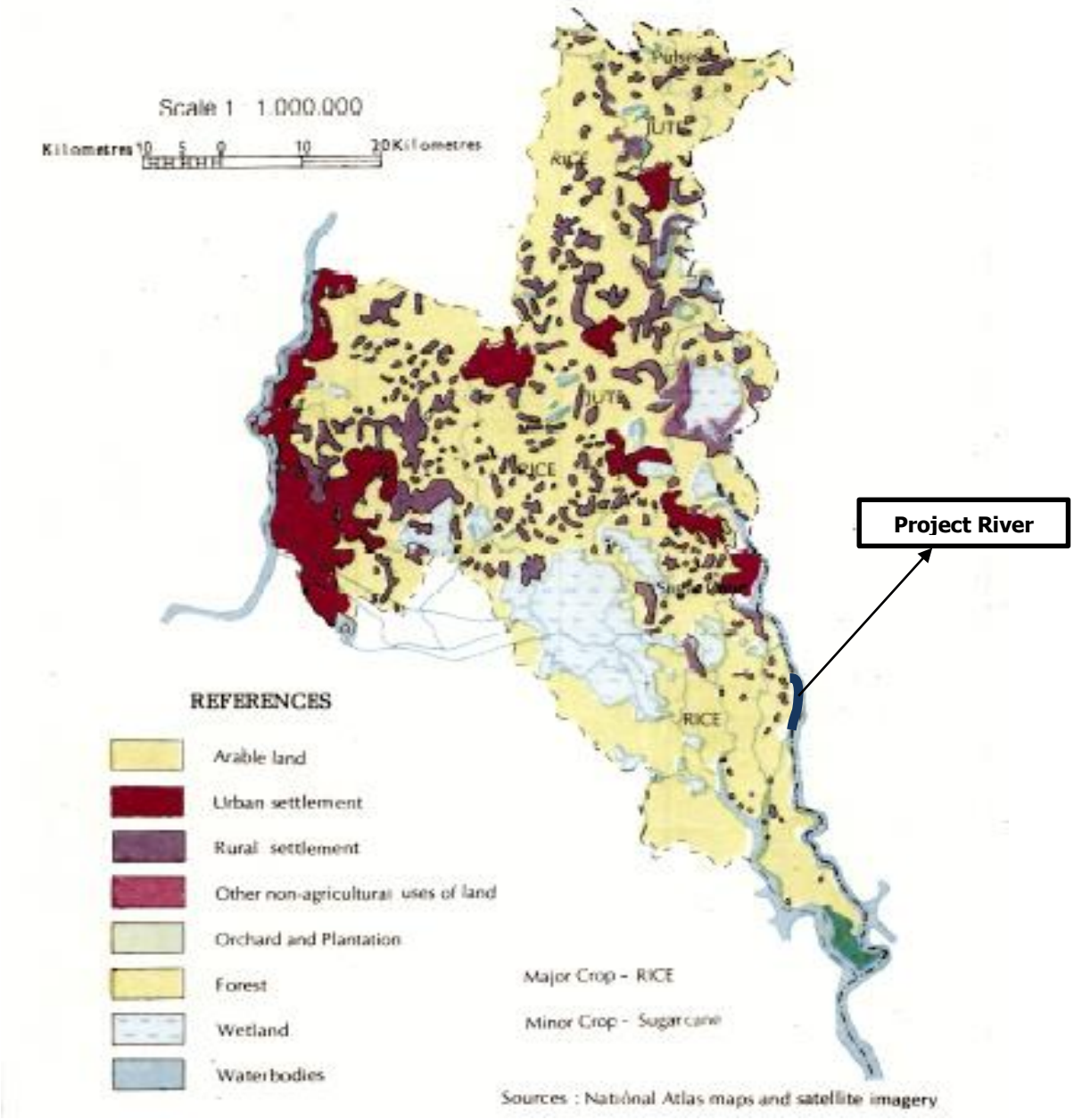
9.2.5 Land Use Pattern

The land use along the project waterway is predominantly agricultural land. There are a number of brick klins located along the waterway. Land use pattern of the project influenced district is presented in **Table 26**.

Table 26: Land Utilization Pattern of the Project district (Area in '000 ha.)

Year	Reporting Area	Area under Non-agricultural use	Barren & un-agriculturable land	Permanent pastures & other grazing lands	Land under misc. tree groves not included in Net area sown	Culturable waste land	Fallow other than current fallow	Current fallow	Net area sown
2006-07	386.52	119.70	0	0	4.44	0	0	2.4	259.98
2007-08	386.52	121.92	0	0	3.39	0.17	0	1.82	259.23
2008-09	386.52	122.37	0	0	4.85	0	0	1.89	257.41
2009-10	386.52	123.23	0.06	0	4.48	0	0	39.12	219.63
2010-11	386.52	124.78	0	0	4.81	0	0	33.91	223.02
2011-12	386.52	124.36	0.04	0	4.45	0.25	0.63	26.73	230.06
2012-13	386.52	125.30	0.03	0	4.00	0.21	0.59	25.12	231.27

Source: - District Statistical Hand Book, North 24 Parganas, 2010-11



Source: NATMO

Figure 36 : Land Use Map of North 24 Parganas District

9.2.6 Ambient Air Quality

During the reconnaissance survey, it was the found that the Air quality along the study area of Kalindi River was free from dust. However, it was also confirmed from the local people that there is no problem caused due to Air pollution. Also there is no major industrial development along the waterway stretch except some good number brick klins.

9.2.7 Ambient Noise Level

During the reconnaissance survey, it was the found Noise is not big issues in the surrounding areas of Kalindi River. There are not any noises generating sources in the nearby areas.

9.2.8 Susceptibility to Natural Hazards

West Bengal is vulnerable to multiple disasters. Due to its sub-tropical littoral location, the state is prone to tropical cyclones, storm surges and tsunamis. In past, this district was hit by natural hazards in many occasions. The hazards include Cyclone, Storm Surge, Flood, Earthquake etc. of medium to large intensities. Susceptibility to various kinds of Natural Hazards are elaborated in the following sections-

- **Susceptibility to floods**

19.16% of the population lives in flood-prone areas. Most flood-prone Blocks are Hingalganj, Hasnabad, Sandeshkhali- I/II, Minakhan, Horoa, Baduria, Swarupnagar, Bagdah, Bongaon, Gaighata, Deganga, Habra-I/II. There are 18 rivers running through the district and as it is situated at the downstream of these rivers. Embankments of all the rivers are made of Soil and the river beds are getting high day by day due to Siltation. All inhabitants are situated in the area comparatively at the lower level than the water level of river, so they face a water logging in almost every year due to heavy rainfall. In the year 2015 rainfall has occurred in 2491.50 mm. Due to heavy rainfall and breach of embankment maximum area of this district was water logged. As a result huge nos. of houses are damaged, agricultural crop, fishery, and other infrastructure like roads, tube wells & schools etc. are also damaged.

Source: West Bengal Disaster Management Department

Figure 37: Flood Prone Zones of West Bengal

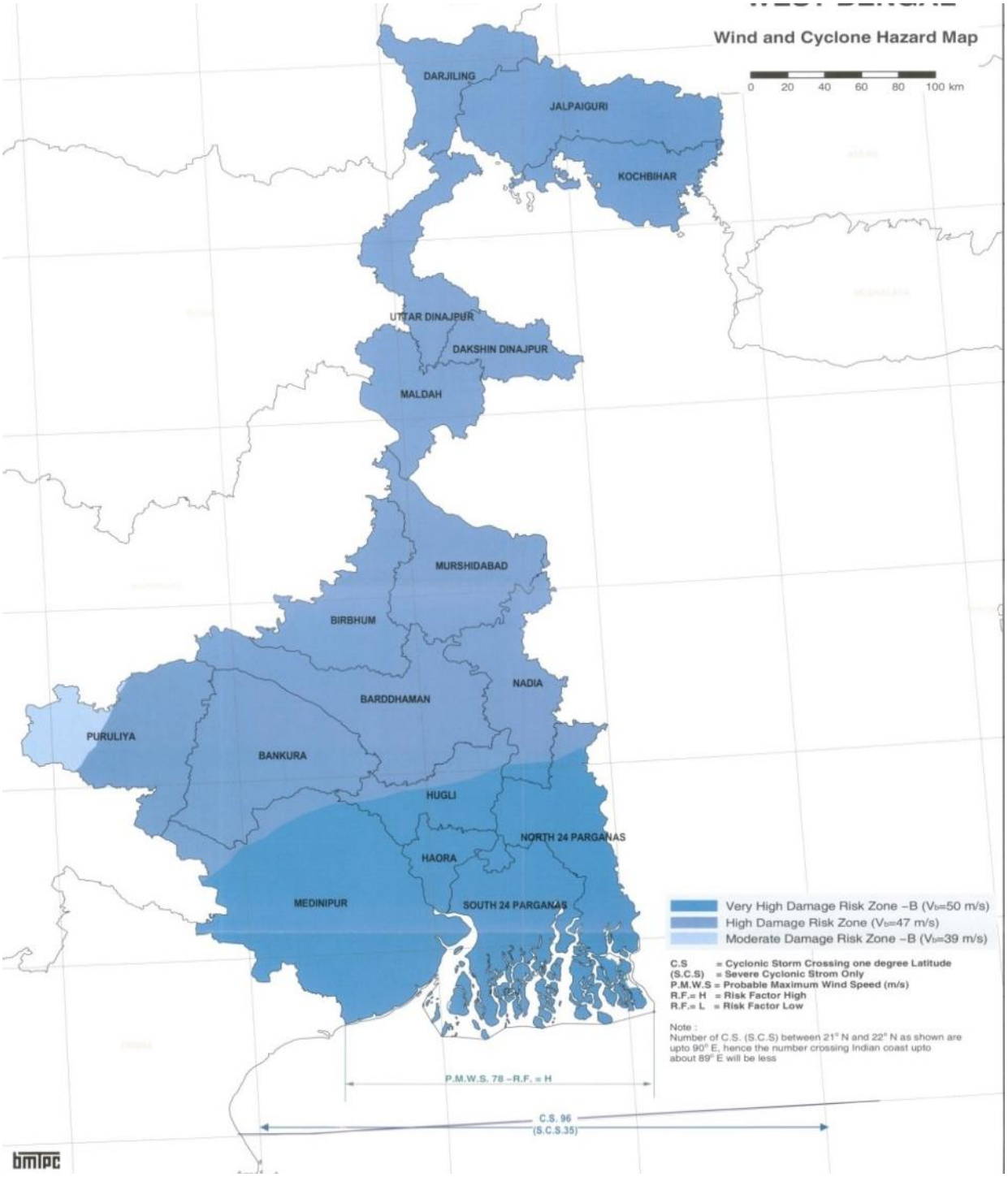
- **Susceptibility to Earth Quake**

73 % of the total area comes under High Damage Risk Zone (Zone IV) and 27 % of the total area comes under Moderate Damage Risk Zone (Zone III). Part of Bangaon, Barasat and Barrackpore Sub

divisions come under Zone IV. Entire Basirhat Subdivision containing the entire Sunderban area under this district is highly vulnerable to Earth Quake and Tsunami.

- **Susceptibility to Wind and Cyclones**

Cyclone and High tide has been commonly found in the reverine belts of Basirhat sub-division. Strangely, several focal areas of Gaighata Block of Bongaon sub-division had been found to be hit by tornado several times in the past. The East Coast of India is one of the six most cyclone-prone areas in the world. One of the Cyclone AILA which hit coastal West Bengal on 25 May, 2009 is described as one of the worst storms to hit the state in many years. Over 5.1 million people have been affected in 16 districts of West Bengal. Over 500,000 houses were damaged either fully or partially. The storm was especially devastating for farmers who were preparing to harvest rice and other crops. According to media sources, the Sundarbans national reserve forest was worst-hit, as many as three million people lived in the forests. All the coastal districts are vulnerable to cyclones.



Source : West Bengal Disaster Management Department

Figure 38: Wind and Cyclone Map of West Bengal

- **Susceptibility to Drought**

Draught is Occasional in North 24 Parganas. The district recently experienced draught in 2010 owing to less rainfall (857 mm) in Monsoon Season against normal rainfall (1579 mm). Probability of Draught is increasing with increasing water Scarcity.

- **Susceptibility to Tornadoes**

Tornado hits at Gaighata Block in the year 1983, 2001 under Bongaon Sub-Div. Tornado hits at Asoknagar – Kalyangar Municipality, Habra-I Block Deganga Block in the year 2015 (29.7.15).

9.2.9 Estuary and Coastal Zone

Estuaries form a transition zone between riverine and maritime environments. They are subject to both to marine influences—such as tides, waves, and the influx of saline water—and to riverine influences—such as flows of fresh water and sediment. The inflows of both sea water and fresh water provide high levels of nutrients both in the water column and in sediment, making estuaries among the most productive natural habitats in the world.

9.2.10 Archaeological and Heritage Locations

Chandraketugarh is an archaeological site located beside the Bidyadhari river, about 40 km west of proposed waterway near the township of Berachampa. The history of Chandraketugarh dates back to almost the 3rd century BC, during the pre-Mauryan era. Artefacts suggest that the site was continuously inhabited and flourished through the Shunga-Kushana period.

Sunderban Biosphere Reserve, a World Heritage Site declared by UNESCO in 1987 and International Biosphere Reserve declared by UNESCO in 2001 are located in the disctrict.

9.2.11 Flora

The floral environment in the study area is quite similar with Gangetice West Bengal. Identified flora in the area are *Mangifera indica* (Mango), *Syzygium cumini* (Jaam), *Phoenix sylvestris* (Date Plam), *Musa sapientum* (Banana), *Carica papaya* (papya), *Psidium guajava* (Guava), *Artocarpus heterophyllus* (Jackfruit), common shrubs and herbs like *Abutilon indicum* (*Potari*), *Achyranthes aspera* (*Latjira*), *Adhatoda vasica* (Basak), *Ageratum conyzoides* (Uchunti), *Amaranthus viridis* (Kata Note), *Amorphophallus paeoniifolius* (Oal/Gandira), *Andrographis paniculata* (Kalmegh), *Bambusa bambos*

(Bamboo), *Blumea lacera* (Kukurmuta), *Bryophyllum pinnatum* (Patharkuchi), *Calotropis gigantean* (Akanda), *Catharanthus roseus* (Nayantara), *Centella asiatica* (Thankuni), *Cestrum diurnum* (Day jasmine), *Clerodendrum infortunatum* (Ghentu), *Clitoria ternatea* (Aparajita), *Coccinia grandis* (Telakucha), *Commelina benghalensis* (Bengal Day flower/Kanchira), *Cynodon dactylon* (Doobghas),*Datura metel* (Dhutura), *Dentella repens* (Creeping Dentella), *Dryopteris filixmas* (Fern), *Euphorbia neriifolia* (Mansa), *Grangea maderaspatana* (Namuti), *Grewia hirsuta* (Kukurbicha), *Hibiscus rosa sinensis* (Joba), *Leucas aspera* (Swet Dron/ Ghal),*Mimosa pudica* (Lajjabati),*Musa paradisiaca* (Kachkola), *Nerium oleander* (Raktakarabi),*Ocimum basilicum* (Bantulsi), *Ocimum sanctum* (Tulshi), *Parthenium hysterophorus* (Parthenium), *Solanum surattense* (Kanta Begun), *Tragia involucrata* (Bichuti), *Vitex negundo* (Nishinda).

Climbers trees are *Abrus precatorius* (Gunch), *Asparagus racemosus* (Shatamuli), *Bougainvillea spectabilis* (Baganbilas), *Gymnema sylvestre* (Gurmar/ Chhotadudhilata), *Ichnocarpus frutescens* (Kalidudhi), *Luffa aegyptiaca* (Purulgach), *Paederiascandens* (Gandal*)*, *Tinospora cordifolia* (Nimgilo/ Gulancha).

9.2.12 Fauna

In the study area common mammals, birds, reptiles and amphibians area recorded. This is similar with gangetic West Bengal. Notable common mammals are *Canis aureus* (Fox), *Presbytis entellus*(Common Langur), *Rattus rattus* (House rat), *Mus musculus* (House Mouse), *Bandicota bengalensis* (Indian mole rat), *Suncus murinus* (Indian Shrew), *Felis domesticus* (Domestic Cat), *Rousettus Leschenaulti* (Fruit bat), *Pipistrellus coromandra* (Chamchika), *Canis lupus familiaris* (Indian Street Dog), *Herpestes edwardsii* (Indian grey Mongoose), *Funambulus palmarum* (Three stripped squirrel), *Funambulus pennantii* (Five-striped palmsquirrel) etc.

Common birds are *Corvus splendens* (House Crow), *Eudynamys scolopacea* (Koel), *Columba livia* (Pegion), *Passer domesticus indicus* (Sparrow),*Psittacula krameri* (Parrot), *Acridotheres tristis* (Myna), *Athene brama* (Spotted owl), *Alcedo atthis* (Common Kingfisher), *Bubulcus ibis* (Cattle Egret), *Ardeola grayii* (Pond Heron), *Streptopelia orientalis* (Oriental turtle dove), *Spilopelia chinensis* (Spotted Dove), *Arachnothera longirostra* (Little spiderhunter), *Ardea purpurea* (Purple heron), *Egretta garzetta* (Little egret), *Coracias benghalensis* (Indian roller), *Orthotomus sutorius* (Common tailorbird), *Halcyon smyrnensis* (White-throated kingfisher), *Haliastur indus* (Brahminy kite), *Nycticorax nycticorax* (Night Heron), *Lanius cristatus* (Brown shrike).

Numbers of reptiles are recorded, those are *Hemidactylus flaviviridis* (House gecko), *Typhlops acutus* (Blind snake), *Xenochrophis piscator* (Checkered keelback), *Enhydris enhydris* (Rainbow water snake), *Naja naj* (Cobra),Common retiles like *Ptyas mucosa* (indian rat snake), *Vipera russelii* (Russells vipers), *Dendrelaphis tristis* (Bronz Back Trees snake), *Bungarus caeruleus* (Indian Krait), *Amphiesma stolatum* (Streeped Kill back)etc.

In the study area common amphibians noted are Rana tigrina (*Indian bull frog*), Bufo melanostictus (Common Indian toad), *Hyla sp.* (Tree Frog), *Euphlyctis hexadactylus* (Indian green frog) etc.

Part of Sundarban Biosphere Reserve and Sundarban National Park area is annexed to the District of North 24-Parganas which are in the South-East portion of the district. It covers 6 (six) Blocks viz Sandeshkhali-I, Sandeshkhali-II, Hingalganj, Haroa, Minakhan and Hasnabad. Sunderban area harbours many endangered/rare/vulnerable species like *Panthera tigris* (Royal Bengal Tiger), *Prionailurus viverrinus (Fishing Cat), Neomeris phocaenoides (Finless Porpoise), Platanista gangetica (Gangetic Dolphin), Orcaella brevirostris* (*Irawady Dolphin), Lutrogale perspicillata (Smooth coated otter).*

There is no forest land along the bank of the waterway, however some sporadic growth of mangrove and mangrove associated vegetaion like Ceriops sp (Goran), Heritiera fomes (Sundari), Avicennia sp (Baen), Porteresia coarctata (Dhani Grass), Barringtonia sp (Hijal) are present.

9.2.13 National Parks, Forests, Wildlife Sanctuaries and Reserves

According to Forest Survey of India Report, 2015 the total forest cover of North 24 parganas district is 724 Km^2 which is about 17.68 % of the district's total geographical area (4094 Km^2).

Out of 724 Km^2, 13 Km^2 falls under very dense forest area category; whereas Moderately Dense Forest and Open Forest area covers 185 Km^2 and 526 Km^2 areas respectively. The comparative statement showing forest cover of North 24 Parganas District and West Bengal state is presented in **Table 27**. It is observed from the table that district's Forest Cover percentage in respect to total geographical area is little less than state's overall coverage.

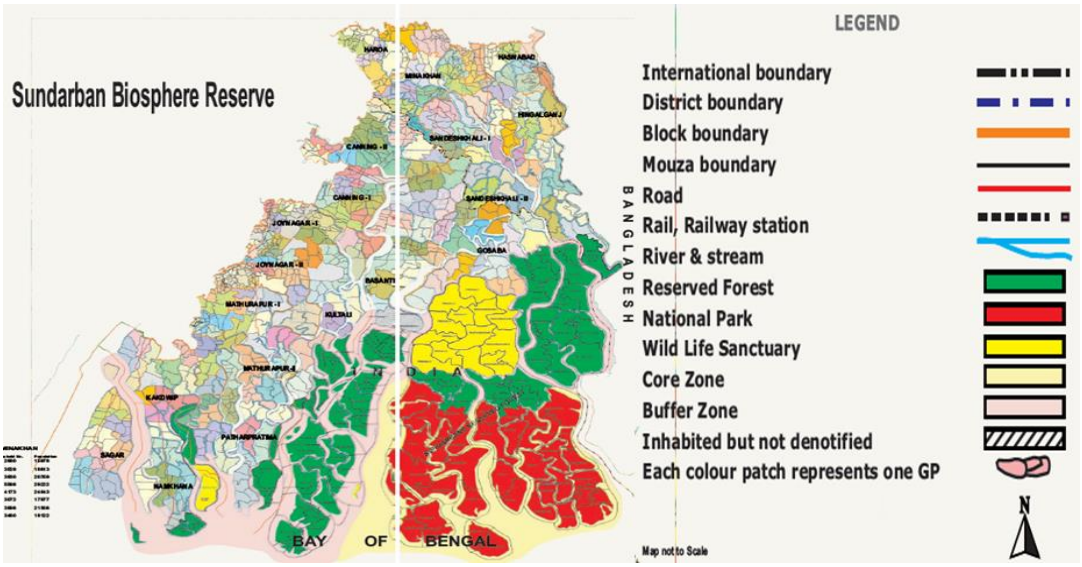
Table 27: Forest Cover of North 24 Parganas District and West Bengal State

District / State	Forest Cover in Sq. Km					
	Geographical Area (GA)	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	Percentage of GA
North 24 Parganas	4094	13	185	526	724	17.68
West Bengal	**88752**	**2948**	**4172**	**9708**	**16828**	**18.96**

Source : Forest Survey of India, 2015

National Parks, Wildlife sanctuaries, Biosphere Reserve play a vital role in protecting the wildlife of a particular area and providing them their natural habitat.

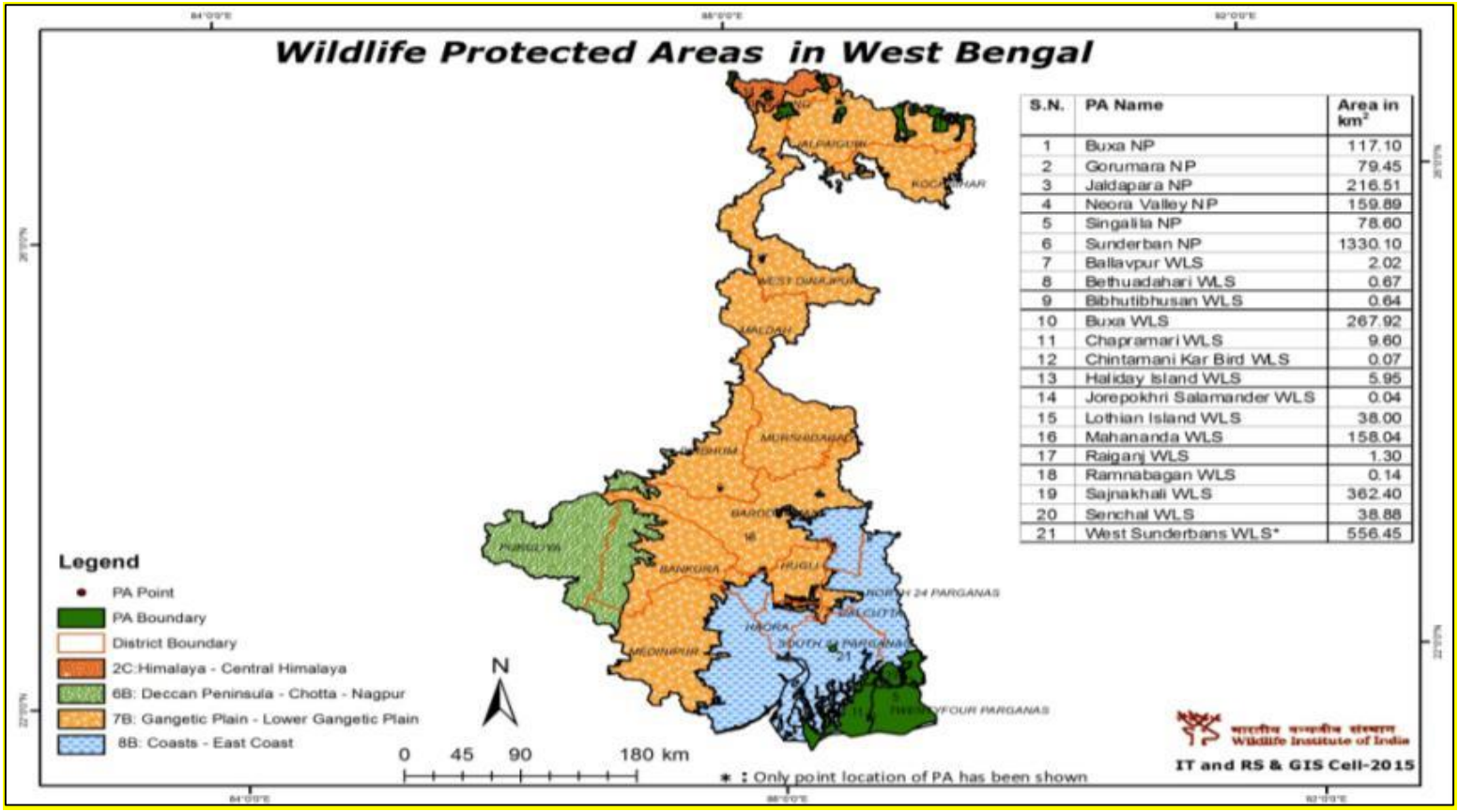
Part of Sundarban Biosphere Reserve and Sundarban National Park area is annexed to the District of North 24-Parganas which are in the South-East portion of the district. Which covers 6 (six) Blocks viz Sandeshkhali-I, Sandeshkhali-II, Hingalganj, Haroa, Minakhan and Hasnabad. These blocks are surrounded by tidal rivers such as the Ichhamati, Bidyadhari, Kulti, Dansa, Raymangal etc. besides being crisscrossed by numerous creeks and channels. Sundarban have been declared a National Park, a Biosphere Reserve by Indian Government and World Heritage Site and "An International Biosphere Reserve" by UNESCO during the 1980s and special measures were taken to reduce further deforestation and human induced destruction of forest. The Sunderban Biosphere Reserve is located at a distance of 4.5 Km from the end point of waterways section. The Map of Sunderban Biosphere Reserve is furnished in **Figure 39**.



Source : WWF-India

Figure 39: Map of Sundarban Biosphere Reserve

Besides Sundarban, the other notified Protected Area (under Willdlife Act, 1972) in the district is situated in Bongaon sub-division and is known as Bibhutibhusan Wildlife Sanctuary (formerly Parmadan Forest). The details of various protected areas in West Bengal covered under purview of Wildlife Act, 1972 is given in **Figure 40**



Source : Wildlife Institute of India

Figure 40: Wildlife Protected Area of West Bengal

9.2.14 Socio-Economic Profile

Social Profile

The distribution of population in rural and urban area in the district as per 2011 census shows that majority of the population i.e. 57.3% live in urbn areas. The percentage of rural population on the other hand is gradually decreasing from 57.1% in 1951 cencus to 42.7% in 2011 census. The total population of the district is 1,00,09,781 (Male- 5,119,389; Female – 4,890,392). The literary rate and sex ratio being 84.06% and 955 respectively, the percentage of SC and ST was 21.67 and 2.64 in the district. The district comprises of 27 municipalities along with 78 Census Towns and 1,527 villages. The demographic profile of the project district is presented in **Table 28**.

Table 28: **Demographic Profile of North 24 Parganas District**

Total Population	Male Population	Female Population	Literary Rate (%)	Sex Ratio	SC (%)	ST (%)
1,00,09,781	5,119,389	4,890,392	84.06	955	21.67	2.64

Source : Census of India, 2011

Major settlements/village located along the section of Kalindi River has been listed in the **Table 29** along with population details as per Census of India Data, 2011.

Table 29: **Major settlements/village along the project stretch of River**

Sl. No.	Village/ Town name	Population (nos.)
1	Khosbash	400
2	Singerkhati	300
3	Bankra Dobar	550
4	Hingalganj	880

Source : Hydrogrpahic Survey Report

Economic Profile

Agriculture: Abundance of fertile lands supported by handful rainfall had made the district an agricultural paradise. Total area used for production of Total Food Grains in the district is 239.1

thousand hectares during 2010-11. Oil seeds are grown in 45.6 thousand hectares of land and fibers are grown in 50.6 thousand hectares of land.

Irrigation: As already stated, economy of the district depends on agriculture andtherefore irrigation plays a major role. Water is drained into the field through various canals. The presence of abundant rivers, creeks etc. help the cultivators a lot.

Animal Husbandry: The district has plenty of live stocks. As per District Statistical Hand Book, North Twenty Four Parganas, 2010-11 data of Aminal Husbandary had shown up to 2007. There were total cattle population accounts for 9,48,260, total Buffalo population accounts for 38,071, total live-stock population is 20,55,617, total poultry 79,36,844 in the District.

Fishery: Because of abundant rivers, creeks, khals (manmade water channels) and bils, a fishery of the district has flourished. Many people earn their livelihood by catching fishes. Fishes are not only distributed among various parts of the state but also are exported to the other parts of the country.

Industry: Industrial development in the district of North Twenty Four Parganas is noteworthy. It is one of the top most districts in the state in terms of industrialization. Industries like cotton handloom, leather tanning, manufacturing of cutlery, brass and bell-metal industries, pottery, embroidery and lace works (chikan) etc. flourished in the district during the last century. Later large scale industries like jute manufacturing, engineering, rubber, textile, paper, chemical, etc. have been established. Cotton handloom textile industries and jute manufacturing industries plays an important role in the district's economy. Due to its geographical advantages, the riverside of Hooghly was developed as a centre of jute manufacturing mills by the British Government. The major jute mills of India are situated here. Cotton handloom textile industry centers are located mainly at Baduria, Barasat, Taki and Basirhat though there are other centers also. Huge qualities of handloom products are being exported from the district. There are several power loom centres found in the district. There are many large scale industries in the district also. The most notable of them is the Andrew Yule Company Ltd. which was established in 1863 with Japanese collaboration. Other important large scale industries are Chloride Industries Ltd. At Shyamnagar, India Foils Ltd. at Kamarhati, India Paper Pulp at Naihati, Titagarh Paper Mills Ltd., The Locomotive Carriages and Wagon Workshop at Kanchrapara, Kalyani Spinning Mills Ltd., West Bengal Ceramic Development Corporation, Sree Saraswati Press Ltd. etc.

The Information Technology hub of Kolkata is situated in this district, which is the centre of some of the reputed IT/ITES Indian and multinational companies. Around 1.2 Lakh people are employed in

Sector V and Sector III at Salt Lake City. The area is administered by Naba Diganta Industrial Township Authority (NDITA).

Trade and Commerce: Due to improved industrialization as well as growth ofagricultural products along with fisheries, the district has a good trade and commerce setup. International trade towards Bangladesh is made through the international boarder of Bongaon. The most important export items are engineering, chemical, jute, cereals, vegetables, poultry, bamboo etc. On the other hand coal, petroleum products, sugar etc.are imported in the district.

Transport: Transport and communication in the district is quite developed. Without adequate transport facilities, industries and agriculture could not be as developed as it is in this district. Summary of the length of roads maintained by different Government bodies(as per 2011 census); P.W.D road is 1391.00 km, Zilla Parishad road is 670 km, Gram Panchayat & Panchayat Samity road is 6711.48 km & road under Prime Minister's Gramin Sarak Yojana is 91.20 km. A good number of vehicles are registered with the Regional Transport Authority. There are numerous non-registered vehicles as hand pulled rickshaw, batteryoperated e-rickshaw etc. which is also used for human as well as material transport.

The district has good railway connectivity also. It falls under the Sealdah Division of the Eastern Railways. Four important section viz. (1) Sealdah-Dankuni, (2) Sealdah- Ranaghat, (3) Sealdah-Bongaon, and (4) Sealdah-Barasat-Hasnabad connects different parts of the district. The only international airport of entire Eastern India is located at Dum Dum named The Netaji Subhash Chandra Bose International Airport.

9.3 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS AND THEIR MITIGATION MEASURES

Environmental assessment helps in identifying the likely impacts due to project activities for all stages of the project viz, construction and operation stage on the physical, biological and social environment.

The three major activities involved in the project development which may have impacts on environment at different stages are capital and maintenance dredging and operation of vessels. These activities may impact different environmental components at different stages of project life cycle. The details are follows:

9.3.1 Impacts during Construction / Dredging Phase

A. IMPACTS DUE TO EXCESS SOIL/ DREDGING MATERIAL/ WASTE

The excess soil and muck generated from various construction activities, waste from construction vehicles, fuel lubricants, machinery & maintenance equipment needs to be properly disposed, so as to avoid adverse impacts. The impacts however, shall be marginal. The solid waste generated due to various construction activities should be disposed off at designated disposal ground.

Capital and Maintenance dredging is proposed for Class VII waterways. Dredging may change the water quality, river bed topography and benthos if not prevented. These activities must not occur in sites protected for drinking water supply and fish spawning.

The total quantity of muck generated due to dredging will be 2,70,620.67 cum. It is proposed that the muck will be used for dumping in low lying area located on both sides of the river bank all along the waterway. The dredge material should be dumped providing gabion walls. The gabion walls should be adequately provided to prevent the dredged material to fall back in the waterway

B. IMPACTS ON LAND

The impacts on land may occur due to the accumulation of fine silt during the dredging operation in the flood period. The dredging activity shall affect the intertidal zone and course of the water body to some extent. Disposal of the dredged material will have a significant impact on the land environment as the area in which the dredged material is disposed will considerably lead to change in the quality of top soil. The disposal of the dredge material at the selected site may pose impacts due to increase in organic load, destruction of the existing nutrient profile as well as due to the change in land elevation and land contamination due to inland water runoff channelsLoss of land / land acquisition:

- Change in topography
- Change in land use
- Deterioration of soil quality due to spillage of fuel, disposal of muck and any other construction material.

Mitigation Measures:

- ✓ Excavation and filling tasks should be carried out simultaneously so as to minimize the soil erosion. Unusable debris material should be suitably disposed off at designated site with prior approval from concerned authority
- ✓ Compaction of soil should be undertaken by controlled sprinkling the water to minimize the surface runoff and erosion.
- ✓ Agricultural land should be avoided for setting up construction camps, plant site or any other construction purpose
- ✓ Dredging soil should be proper utilized as proposed for flood protection measures around the terminal area.

C. IMPACTS ON SOIL

The site clearance process includes excavation and vegetation clearance for development activities, which ultimately induces vegetation loss as well as loss of top soil. Since, the vegetation clearance shall be confined to the minimum area; the area affected would be very less. The activities associated with the site preparation and excavation plus movement of vehicles and equipments can disturb the surrounding lands

Contamination of Soil: Contamination of soil is primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Refuse and solid waste from labour camps can also contaminate the soil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to Gomar River in case of dumping being done near River locations. However, by following mitigation measures such as maintenance of vehicles and machines and fuel refilling is carried out in a confined area can avoid contamination of soil to a great extend. The provision for oil interception chamber is suggested in EMP for treating the waste water generated from vehicle washing, refilling and maintenance areas. Fuel storage and refilling sites should be kept away from cross drainage structures and important water bodies. All spoils shall be disposed off as desired and the site shall be fully cleaned before handing over. These measures are expected to minimise the impact on soil contamination.

Compaction of Soil: Compaction of soil may anticipate due to the movement of construction vehicles and heavy machines. Thus regulation of movement of heavy equipments and vehicles shall be essential to prevent this.

Mitigation Measures:

- ✓ Rehabilitate all sites during construction including construction camps, stockpile area, temporary access and hauling routes, as soon as possible after the disturbance has ceased.
- ✓ Contractor to exercise strict care in the disposal of construction waste, with proof of disposal at an approved site provided after offloading each waste load and this logged/registered.
- ✓ Contain contaminated water and dispose off site at an approved disposal site in consultation with State Pollution Control Board.
- ✓ Dispose of waste from the oil interceptors only through suitable waste-handling contractor and request for safe disposal certificates.
- ✓ The movement of construction vehicles and equipments will be restricted to only designated route.
- ✓ Mix cement, concrete and chemicals on a concrete plinth and contain spillages or overflows into the soil.
- ✓ Vehicle maintenance are not allowed on site.
- ✓ If oil spills occur, disposing contaminated soil at a disposal site in consultation with State Pollution Control Board.
- ✓ Stockpiling of subsoil and overburden in all construction and lay down areas.

D. IMPACTS ON AIR

The air quality parameter is the most common environmental feature, which is being affected by any infrastructure improvement projects at different stages i.e. during constructional as well as operational phase. The major indicators of Ambient Air Quality relevant to the project are the concentration of Particulate matters of size less than 10µ (PM_{10}), Particulate matters of size less than 2.5µ ($PM_{2.5}$), Sulphur dioxide (SO_2), Nitrogen oxides (NOx), Carbon monoxide (CO) in the atmosphere.

The impacts on air environment will be due to emission from the dredger and barges during the dredging operation. The dredger/barges halting in and around the dredging area/channel for an unusually long period is mainly due to unmanaged traffic. This is happening mainly due to the lack of adequate infrastructures for the work, which is not capable of handling much of the operation in the operational area. In addition to these, the hindered movement of the boats also gives rise to the

condition of frequent acceleration of the engines, which may increase the emission rate to a higher level than that of the normal movement. Besides these, there will not be any considerable impact on the air environment due to the proposed project

Sensitive receptors and nearby habitation area may be affected temporarily by increased of traffic due to movement of construction vehicles and transportation of material. Fugitive dust can also impact on air quality due to various construction activities. Exhaust fumes from construction machinery, and potential smoke from cooking fires, burning of waste and cleared vegetation also affect the air quality. The improper sanitation at worker camps and waste disposal usually lead to odour problem. The problems related to the deterioration of air quality, however, will temporal in nature till the construction period only.

Mitigation Measures:

- ✓ All the Construction vehicles and machineries will be regularly maintained to conform to the emission standards stipulated under Environment (Protection) Rules, 1986.
- ✓ All the DG sets will conform to the emission standards as stipulated under Environment (Protection) Rules, 1986.
- ✓ Undertaking monitoring of air pollution levels as per monitoring plan in potential problem areas.
- ✓ Avoid dust generating construction activities during strong winds.
- ✓ Cover soil loads in transit.
- ✓ Cover stockpiles of soil or apply suitable dust palliative such as water or commercial dust suppressants.
- ✓ Regularly service vehicles off-site in order to limit gaseous emissions.
- ✓ No open fires permitted on site
- ✓ Water will be sprayed in construction area and other excavation areas for suppressing fugitive dust.
- ✓ Transportation material should be Water sprinkled and covered with tarpaulin.
- ✓ Dust emission from stock piles of excavated material will be controlled either by covering the stockpiled materials or water spraying over it.
- ✓ Special attention will be given when working near educational institutions and health centers and settlement areas.

E. IMPACTS ON AMBIENT NOISE AND VIBRATION

The noise level generated during day time will depend on the number & types of equipment deployed dredging ships and disposal barge and percentages of distances from receiver to site. The noise impact will be relatively more on construction workers during their duty hours. Occupational health issues associated with high noise level may be observed. Considering the adverse impacts on personnel engaged in construction works and due to construction equipment's, efficient mitigation measures shall be planned & implemented. The most efficient mitigation shall include the provision of PPEs like earmuffs/earplug to avoid adverse effects of noise on occupational health and hearing capacity of workers as well as planning of working hours and shift of workers. The machinery used for construction shall be of the high standard of reputed make and shall adhere to International Standards. These Standards itself take care of noise pollution control, vibration control, and air emission control. The noise level of the machinery/equipment shall be minimized by proper lubrication, modernization, maintenance, muffling and provision of silencers wherever possible. Further to minimize the above potential impacts, major construction activities would be scheduled during normal daylight working hours and would be implemented consistent with the applicable standards

Sensitive receptors and nearby habitation may be affected temporarily by increased traffic due to movement of heavy construction vehicle and equipments, which may generate high levels of noise.

Vibrations resulting from bulk earthworks, micro-tunneling and compaction may create significant disturbances to nearby area.

Mitigation Measures:

- ✓ All noise generating equipment's and construction camps will be installed sufficiently away from settlement and sensitive areas.
- ✓ Restrict construction activities to reasonable working hours where near sensitive receptors.
- ✓ The main stationary noise producing sources such as generator sets shall be provided with noise shields around them. The noise shields can either be a brick masonry structure or any other physical barrier which is effective in adequate attenuation of noise levels.
- ✓ The plants and equipment used for construction will strictly conform to CPCB noise standards and ensures that machinery in a good state of maintenance
- ✓ Vehicles and equipments used will be fitted with silencer and maintained accordingly.

- ✓ Noise to be monitored as per monitoring plan and if the noise level at any time found to be higher than immediate measure to reduce noise in that area will be ensured.
- ✓ An awareness programme may be organized for drivers and equipment operators to make them aware of the consequences of noise and to act properly at site.

F. IMPACTS ON ECOLOGY AND BIODIVERSITY

The proposed development is for Kalindi River. No such significant ecologically diverse area occurs within the proposed project location. Hence no major impact on ecology is anticipated. However capital and maintenance dredging is proposed for Class VII waterways, which may have likely impact on population of phytoplankton, zooplankton, benthic communities and fishes, but temporary in nature.

Mitigation Measures:

- ✓ Ensure any landscaping to be undertaken will be done with locally indigenous species and low maintenance requirements.
- ✓ Capital and maintenance dredging should avoidable during breeding season of aquatic fauna.
- ✓ The generated muck due capital and maintenance dredging should not be disposed off in the waterway.

G. IMPACTS ON RIVER WATER

The impact on water arises due to the following:

- Discharge of sewage and wastewaters from construction sites and camps to surface waters
- Risk of accidental spillages of oils, fuels, and other materials
- The dredging activities can lead to direct and indirect impacts on the water body and ecosystem. It has high potential to increase the turbidity due to an increased rate of dispersal of fine-grained sediment in the water column.

Mitigation Measures:

- ✓ The site surface has been engineered and shaped in such a way that rapid and efficient evacuation of runoff is achieved.
- ✓ Provide containment areas for potential pollutants at construction camps, refueling, depots, asphalt plants and concrete batching plants.

- ✓ Implement waste management practices.
- ✓ Control and manage transport, storage, handling and disposal of hazardous substances.

H. IMPACTS DUE TO LABOUR CAMP

Construction workers are neglected group in the country. Unless the workers are provided proper amenities to live at the construction site the environmental issues of project cannot be properly met. Location of the Construction camp also has certain impacts on surrounding environment if not properly managed.

At labour and construction camps lot of wastes are generated. These wastes are refuge from the plants, and equipments, waste water and other domestic waste. These wastes are solid as well as liquid waste mainly refuse water and kitchen waste. The disposal of such waste material to the surrounding land can potentially damage the land and would generate health risk to not only surrounding area but within the premises itself. Improper drainages system within the premises also creates insanitation condition thereby enhancing health risk.

Maximum labour to be employed in the project shall come from nearby areas. Some labour is expected to be migrated from other areas and is likely to put some stress on account of the following:

- Generation of sewage from labour colony.
- Generation of solid waste from labour colony.

Mitigation Measures:

- ✓ The Construction/labour camps will be established only on approved area.
- ✓ The worker's/labour camp will be located away from water bodies, schools and residential areas. The camp will be constructed with proper accommodation facilities.
- ✓ The workers camp will be provided with drinking water supply system so that local water sources are not disturbed.
- ✓ The camp should be provided with fuel for cooking like kerosene and /or LPG to avoid any cutting of trees for fuel wood.
- ✓ All camps will be provided with proper sanitation facilities, separate toilets and bathrooms for female and male workers, septic tanks with soak pits of sufficient size, dust bins etc.
- ✓ Waste water from domestic uses and solid wastes will be disposed of without violating environmental norms. The measures will be site specific.

- ✓ The labour camps will be provided with crèche, first aid facilities, etc as required under Factory Act.
- ✓ After completion of construction, the contractor will dismantle the camp and restore it to the original condition of the area before handing over the site to the land owner.

I. SOCIAL IMPACTS

- Impacts on Socio-economic environment

No impact will be envisaged on socio-economic environment

- Impacts on the Regional Economy

There would be benefits to the local and regional economy through the direct demand for construction goods and services associated with construction activities.

- Health and Safety

One of the potential impacts of the proposed project will be on the air quality due to the dust generated during construction. The amount of dust generated will depend upon the level of digging and the prevailing weather conditions. Based on past experience, the air pollution due to entrainment of fugitive emission is marginal in nature and is observed up to a distance of 100 to 200 m from the point of entrainment. Thus, it is expected to lead to marginal impact on ambient air quality. No major health related issues due to air pollution during construction phase of the proposed project are anticipated.

Construction related activities may lead to injuries. Open fires in construction camp can result in accidents. Safety of workers and general public may be compromised due to difficult site conditions. Poor waste management practices and unhygienic conditions at temporary ablution facilities can breed diseases. Standing water due to inadequate storm water drainage systems, inadequate waste management practices, pose a health hazard to providing breeding grounds for disease vectors such as mosquitoes, flies and snails. The use of hazardous chemicals in the micro-tunneling and restoration of roads can pose potential environmental, health and safety risks. Road safety may be affected during construction, especially when traffic is detoured.

Mitigation Measures:

- ✓ Implement good housekeeping practices at the construction camp.
- ✓ Strictly implement health and safety measures and audit on a regular basis.
- ✓ Secure enclosed construction site.
- ✓ Use reputable contractors.
- ✓ Provide warning signs of hazardous working areas.
- ✓ The plants and equipments will be installed sufficiently away from the settlement.
- ✓ All the construction equipments and vehicles will conform to the emission standards stipulated by the CPCB.
- ✓ Clearly demarcate excavations and provide barriers (not just danger tape) to protect pedestrians from open trenches.
- ✓ Thoroughly train workers assigned to dangerous equipment.
- ✓ Workers have the right to refuse work in unsafe conditions.
- ✓ Undertake waste management practices (Planned disposal of sludge from pumping stations within surrounding areas of PS) particularly for Pumping Station
- ✓ Control speed and movement of construction vehicles
- ✓ Exclude public from the site
- ✓ Ensure all workers are provided with and use Personal Protective Equipment.
- ✓ Ensure the visibility of workers through their use of high visibility vests when working in or walking through heavy equipment operating areas
- ✓ Ensure that qualified first-aid can be provided at all times. Ensure equipped first-aid stations are easily accessible throughout the site;
- ✓ Provide medical insurance coverage for workers.
- ✓ Provide clean eating areas where workers are not exposed to hazardous or noxious substances;
- ✓ Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted;
- ✓ Ensure moving equipment is outfitted with audible back-up alarms;
- ✓ Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate.
- ✓ Safe working techniques will be followed up and all the workers will be trained

- ✓ Proper caution signage, barricading, delineators etc. will be installed at Construction zone and temporary diversions
- ✓ Proper traffic management will be ensured at the Construction zone as per IRC.
- ✓ An Emergency Response system in case of any incidence will be developed and implemented
- ✓ Periodical health check facility will be provided at camp sites.

- Aesthetics

The presence of heavy duty vehicles and equipment, temporary structures at construction camps, stockpiles, may result in impacts on aesthetics and landscape character.

Mitigation Measures:

- ✓ Properly fence off storage areas.
- ✓ Collection of all domestic solid waste central point of disposal and feed into the city waste collection system.
- ✓ Contractor to exercise strict care in disposing construction waste.
- ✓ Identifying suitable waste disposal site with enough capacity to hold additional waste to be generated by the construction activities.
- ✓ Retaining mature trees on and around the site where possible.
- ✓ Removing unwanted material and litter on a frequent basis.
- ✓ Reinstate pathways and other local infrastructure immediately to at least their pre-project condition upon completion of construction.

- Employment Generation

The project will provide employment opportunities for local people during construction. Expectations regarding new employment will be high especially among the unemployed individuals in the area. Labor gathering at the site for work can be a safety and security issue, and must be avoided. The training of unskilled or previously unemployed persons will add to the skills base of the area.

Mitigation Measures:

- ✓ Employing local labour
- ✓ Training of labour to benefit individuals beyond completion of the project.
- ✓ Ensure recruitment of labors will take place offsite.

- ✓ Ensure at least 50% of all labor is from surrounding communities in the contractual documentation.

9.3.2 Impacts during Operation Phase

A. IMPACTS ON AIR

Sensitive receptors and nearby habitation area may be affected temporarily by increased traffic and other related impacts.

Exhaust gases from moving vessel are source of air pollution. 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.

Mitigation Measures:

- ✓ Ensure compliance with the Air Act.
- ✓ Ensure compliance with emission standards
- ✓ Regularly service vehicles off-site in order to limit gaseous emissions
- ✓ Material generating dust should be transported under covered condition
- ✓ Uses of cleaner fuel
- ✓ Material should be stored under cover sheds
- ✓ Water sprinkling should be carried out during all loading and unloading activities and storage period.

B. IMPACTS DUE NOISE AND VIBRATION

Noise generated during operation phase are improper handling and irregular maintenance of operating machines, which may lead to increased noise pollution during operation phases, which would affect the daily life of the surrounding neighborhoods. However, impacts on this account are expected to be marginal.

Mitigation Measures:

- ✓ Restrict maintenance activities to reasonable working hours where near sensitive receptors.
- ✓ Keep adjacent landowners informed of unusually noisy activities planned.
- ✓ Fit and maintain silencers to all machinery on site.

- ✓ Monitor noise levels in potential problem areas
- ✓ Personal Protective Equipment (PPE) should be provided to the worker working.
- ✓ Use of DG set with acoustic enclosure.

C. IMPACTS DUE TO OIL SPILLAGE FROM BARGES AND VESSELS

There may be possibility of oil spillage from barges/vessels during oil transportation. This affects the water quality and aquatic ecology of the river.

Mitigation Measures:

- ✓ All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only.
- ✓ The wastewater from vessels can be sent to STP for treatment and the treated water can be used for landscaping and dust suppression at terminal sites
- ✓ Vessels also may have some facilities for treatment of the waste generated
- ✓ Provision of oil water interceptors
- ✓ Vessels should not be washed or cleaned at terminal/jetty facility and washings should not be discharge at the terminal/jetty location. Washing should be undertaken only at the maintenance facility only.

D. IMPACTS ON WATER

Maintenance dredging & on-shore dumping of dredged material is the sources which may impact the water quality of river.

Mitigation Measures:

- ✓ Dredging material should be disposed to the designated area.

E. IMPACTS ON FLORA AND FAUNA

The proposed development is unlikely to have any significant impact on biodiversity. However, maintenance dredging may impact the growth of aquatic life. Impacts may also arise during the movement of vessel/barges.

F. IMPACTS ON HEALTH AND SAFETY

- Danger of operations and maintenance-related injuries.
- Safety of workers and general public must be ensured.
- Poor waste management practices and unhygienic conditions at the improved facilities can breed diseases.
- Standing water due to inadequate storm water drainage systems, inadequate waste management practices, pose a health hazard to providing breeding grounds for disease vectors such as mosquitoes, flies and snails.
- Fire and electrocution hazards in the pumping stations.

Mitigation Measures:

- ✓ Implement good housekeeping practices at terminal and jetty area.
- ✓ Strictly implement health and safety measures and audit on a regular basis.
- ✓ Provision of warning signs of hazardous working areas.
- ✓ Training of workers assigned to dangerous equipment.
- ✓ Undertaking waste management practices- specifically periodic removal of sludge from pumping stations.
- ✓ Ensuring all workers are provided with Personal Protective Equipment.
- ✓ Provision of medical insurance coverage for workers

G. IMPACTS ON REGIONAL ECONOMY

The project is expected to bring the economic benefits of the region directly through expansion of regional trade, increase new business opportunity, development of new industries. It will also decrease the travel time for crossing one bank to another through ferry facilities.

9.4 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The main aim of the Environmental Management Plan (EMP) is to ensure that the various adverse impacts are mitigated and the positive impacts are enhanced. The EMP identifies the potential issues of various activities that are anticipated in the design and development, construction, and operation phases of the proposed project. The EMP ensures to suggest appropriate mitigation measures against the issues/ concerns identified during the environmental study.

9.4.1 Implementation of EMP

A copy of the EMP must be kept on site during the construction period at all times. The EMP will be made binding on all contractors operating on the site and will be included within the Contractual Clauses. Non-compliance with, or any deviation from, the conditions set out in this document constitutes a failure in compliance.

The contractor shall be responsible to implement the EMP primarily in assistance with the Supervision Consultant team. The Environmental Specialist from the Supervision Consultant shall monitor the compliance of the EMP.

9.4.2 Environmental Management Action Plan

This section describes the Environmental Management Action Plan for the proposed project during different stages of project. The Environmental mitigation measures have been incorporated at all the stages of the project right from Designing phase to Construction and Operational Phase. The Management Plan has been formulated for implementation of environmental mitigation measures to be carried out and to ensure that the provisions of the EMP are strictly followed and implemented by strengthening implementation arrangements to prevent and minimize the adverse environmental impacts during Construction phase of the project. EMP has also addressed certain environmental measures to be taken to prevent further deterioration of environment components for various stages of the project.

Appropriate measures have also been identified for action during various stages of the project, viz, Design and Pre-Construction, Construction and Operational phases. The measures identified for all three phases, are tabulated in **Table 30** which describes the nature of the potential environmental impact, the measures, which have or will be taken, the timeframe in which they are taken, the implementing agency and responsible organization.

Table 30: Environmental Management Plan (EMP)

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
A. DESIGN AND DEVELOPMENT/ PRE-CONSTRUCTION PHASE				
1.	Arrangements for temporary land for Establishing Camps/Plants/ Temporary diversions	• The Contractor as per prevalent rules will carry out negotiations with the landowners for obtaining their consent for temporary use of lands for workers camp, construction sites/hot mix plants/traffic detours etc. • The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner. • The Contractor will ensure that the site is properly restored to the satisfaction of the land owner prior to handling over to the owner and shall submit satisfactory certificate from the Land Owner.	Contractor	Supervision Consultants, IWAI
2.	Establishment of Construction Camp	• The locations of construction camp to be identified by the Contractor. Construction camps will not be proposed within 500 m from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. Location for stockyards for construction materials will be identified at least 1000m from water sources / and 10	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		Km from Wildlife Sanctuary boundary. • The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner. • The Camp site will be provided with all the necessary facilities as per norms.		
3.	Establishment of Stone crushers, hot-mix plants, WMM Plant, Concrete Batching plants etc.	• Stone crushers, Hot mix plants, WMM Plants and Concrete Batching plants will be sited sufficiently away from settlements, agricultural operations and any commercial establishments. Such plants will be located at least 500 m away from the boundary of the nearest village/settlement preferably in the predominant downwind side. • The Contractor shall submit a detailed layout plan for all such sites and approval of the Environmental Expert of Supervision Consultants shall be necessary prior to their establishment. • All plants will be fitted with adequate dust suppression and emission control equipments and facilities. • Specifications of crushers and hot mix plants will comply with the requirements of the relevant current emission control	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		legislations and Consent/NOC for all such plants shall be obtained from the State Pollution Control Board. • The Contractor shall not operate the plants till the required legal clearance, permits are obtained and submitted.		
4.	Material Sources	• Finalization of material sourcing and all logistic arrangements are well as compliance to environmental requirements, as applicable, will be the sole responsibility of the Contractor	Contractor	Supervision Consultants, IWAI
B. CONSTRUCTION / DREDGING PHASE				
1.	Impact on Soil			
(i)	Soil Erosion	• Maintaining the excavation by Shoring trench sides by placing sheeting, timber shores, trench jacks, bracing, sheet piling materials to resist pressures surrounding the excavation • Exposed surface will be resurfaced and stabilized by making the sloping sides of trench to the angle of repose at which the soil will remain safely at rest • Proper stock piling of excavated soil and must be bordered by berms • Soil erosion checking measures as the formation of sediment basins, slope	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		drains, etc, will be carried out.		
(ii)	Loss of Topsoil	• The topsoil from all areas of cutting and all areas to be permanently covered will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m. • The stored topsoil will be spread back to maintain the soil physico-chemical and biological activity. The preserved top soil will be used for restoration of sites, in landscaping and avenue plantation • To prevent excessive disturbance of natural vegetation, the top soil excavated should be stored and utilized for re-vegetation after completion of work. • Topsoil and subsoil must be placed on opposite sides of the trench and must be kept separate throughout construction and rehabilitation.	Contractor	Supervision Consultants, IWAI
(iii)	Compaction of soil	• Construction vehicles, machinery and equipment will move, or be stationed in the designated area, to avoid compaction of soil. • If operating from temporarily hired land, it will be ensured that the topsoil for agriculture remains preserved & not destroyed by storage, material handling or any other construction related	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		activities.		
(iv)	Contamination of land from fuel and lubricants	• Impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform will be appropriately provided at construction camp, servicing area and liquid fuel and lubes at storage areas.	Contractor	Supervision Consultants, IWAI
(v)	Contamination of land from construction wastes and spoils	• All spoils will be disposed off as desired and the site will be fully cleaned before handing over. The non-usable bitumen spoils will be disposed off in a deep trench providing clay lining at the bottom and filled with soil at the top (for at least 0.5m)	Contractor	Supervision Consultants, IWAI
2.	Impact on Air			
(i)	Emission from construction vehicles and machinery	• All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. • The asphalt plants, crushers and the batching plants will be sited at least 500 m in the downwind direction from the nearest human settlement (Boundary of town/village). • Vehicles transporting earth materials will	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		be covered • Mixing equipment will be well sealed and equipped as per PCB norms.		
(ii)	Emission from Construction Vehicles, Equipment and Machineries	• Contractor will ensure that all vehicles, equipment and machinery used for construction are regularly maintained and confirm that pollution emission levels comply with the relevant requirements of SPCB. • The Contractor will submit PUC certificates for all vehicles/ equipment/machinery used for the project. Monitoring results will also be submitted to 'PIU' through the 'Engineer'. • Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carrier out as per Environmental Monitoring Plan. • Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of dust	Contractor	Supervision Consultants, IWAI
(iii)	Dust Pollution	• The Contractor will take every precaution to control dust nuisance at all the construction zones and allied sites where works are under progress. • Every equipments and machinery will be	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		fitted with dust suppression devices such as water sprinklers, dust bags, cyclone etc. as appropriate. • The Contractor will provide necessary certificates to confirm that all crushers used in construction conform to relevant dust emission control legislation. • At all the construction zones and unpaved lead roads, earthen temporary diversions and plant premises periodical water sprinkling will be carried out to suppress dust. • Transportation of loose earth, sand will be done in covered vehicles. • All equipments and machineries will be maintained properly. • Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carried out as per Environmental Monitoring Plan. • Workers at mixing sites will wear masks to reduce the chances of exposure to fugitive dusts.		
3.	Impact on Noise Pollution			
(i)	Noise from vehicles and construction equipments	The Contractor will confirm the following: • All plants and equipments used in construction shall strictly conform to the	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		MoEFCC/CPCB/WBPCB noise standards. • All vehicles and equipment used in construction will be fitted with exhaust silencers. • Servicing of all construction vehicles and machinery will be done for exhaust silences and will be checked and if found defective will be replaced. • All the construction sites within 150m of the nearest habitation, noisy construction work such as crushing, concrete mixing will be stopped during the night time between 10.00 pm to 6.00 am. • No noisy construction activities will be permitted around educational institutions/health centers (silence zones) up to a distance of 100 m from the sensitive receptors. • Monitoring shall be carried out at the construction sites as per the monitoring schedule and results will be submitted to Supervision Consultants (SC) and IWAI. • Environmental Expert of SC will be required to inspect regularly to ensure the compliance of EMP.		
4.	Impact on Flora and Fauna	• If required, Vegetation will be removed from the construction zone before	Contractor	Supervision Consultants,

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		commencement of construction • Construction vehicles, machinery and equipment will move or be stationed in the designated area only to prevent compaction of vegetation • Construction workers will be directed not to disrupt or damage the fauna. • Capital and maintenance dredging should avoidable during breeding season of aquatic fauna. • The generated muck due capital and maintenance dredging should not be disposed off in the waterway • Construction vehicles will run along specified access to avoid accidents to cattle		IWAI
5.	Safety			
(i)	Accidents due to construction activities	• To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed. • Traffic rules and regulations will be strictly adhered to. • Safety of workers undertaking various operations during construction will be ensured by providing helmets, masks,	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		safety goggles, etc • The electrical equipment will be checked regularly • At every camp site, a readily available first aid unit including an adequate supply of dressing materials, a mode of transport (ambulance), para medical staff and an attending doctor will be provided. • Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken. • Adequate signage, barriers and persons with flags during construction to control the traffic will be provided.		
(ii)	Occupation Health and Safety	• The Contractor will provide adequate good quality Personal Protective Equipments (PPE) to all the workers working at construction zones and Plant sites and will ensure that these PPEs are used by workers at all time during works. • Adequate drainage, sanitation and waste disposal will be provided at workplaces. • Proper drainage will be maintained around sites to avoid water logging leading to various diseases • Adequate sanitation and waste disposal	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		facilities will be provided at construction camps by means of septic tanks, soakage pits etc. • A health care system will be maintained at construction camp for routine check up of workers and avoidance of spread of any communicable disease • Readily available First Aid kit bearing all necessary first aid items will be proved at all the work sites and should be regularly maintained.		
6.	Wastes	• Ensure that no litter, refuse, wastes, rubbish, rubble, debris and builders wastes generated on the premises must be collected in rubbish bins and disposed of weekly at registered refuse facility sites. • Toilet facility must be provided at construction site and should be maintained properly. Toilets must be emptied regularly at treatment plants and every effort must be made to prevent the contamination of surface or sub-surface water • Muck generated due to dredging should be disposed as per the proposal of disposing around the proposed terminal area for flood protection	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
7.	Camp Site management	• Contractor will follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. • The location, layout and basic facility provision of each labour camp will be submitted to the Engineer and IWAI prior to their construction. • The construction will commence only upon the written approval of the Engineer. • The contractor will maintain necessary living accommodation and ancillary facilities in • Functional and hygienic manner and as approved by the Engineer. • Periodical medical check up will be ensured for all the workers • The Contractor will provide potable water facilities within the precincts of every workplace in an accessible place. • The sewage system for the camp will be designed, built and operated in such a fashion that it should not pollute the	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		ground water or nearby surface water. • Separate toilets/bathrooms, will be arranged for men and women • Adequate water supply is to be provided in all toilets and urinals • The Contractor will provide segregated garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of SC.		
8.	Monitoring of Air, Water & Noise Quality Pollution Monitoring	• The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil pollution/contamination in the selected locations as suggested in environmental monitoring plan will be the responsibility of Contractor	Contractor	Supervision Consultants, IWAI
C. OPERATION PHASE				
1.	Monitoring of Operation Performance	• The IWAI will monitor the operational performance of the various mitigation/enhancement measures carried out as a part of the project.	Contractor	IWAI
2.	Air	• Ensure compliance with the Air Act. • Ensure compliance with emission	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		standards • Regularly service vehicles off-site in order to limit gaseous emissions • Material generating dust should be transported under covered condition • Uses of cleaner fuel • Material should be stored under cover sheds • Water sprinkling should be carried out during all loading and unloading activities and storage period		
3.	Noise	• Restrict maintenance activities to reasonable working hours where near sensitive receptors. • Keep adjacent landowners informed of unusually noisy activities planned. • Fit and maintain silencers to all machinery on site. • Monitor noise levels in potential problem areas • Pernonal Protective Equipment (PPE) should be provided to the worker working. • Use of DG set with acoustic enclosure	IWAI	IWAI
4.	Oil Spillage from	• All waste water and solid waste or maintenance waste should be disposed at	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Vessel/barges	the designated barge maintenance facility only. • Vessels also may have some facilities for treatment of the waste generated • Provision of oil water interceptors • Vessels should not be washed or cleaned at terminal/jetty facility and washings should not be discharge at the terminal/jetty location. Washing should be undertaken only at the maintenance facility only.		

9.5 APPLICABLE LEGAL AND REGULATORY FRAMEWORK

The increase of environmental concern also necessitated appropriate tools/actions to protect environment. During Stockholm Conference, first exclusive Environmental Protection Act was enacted in India in 1986. Prior to this umbrella act, Water (Pollution Prevention and Control) Act was enacted in India in 1974 & Air Pollution act, 1981. In accordance with EPA act (1986) Central and State Boards for Prevention and Control of Water Pollution were set up. Later these boards were renamed into Central Pollution Control Board and respective State Pollution Control Boards. Department of Environment was set up in 1980. Subsequently in 1985, it was upgraded to a full-fledged Ministry of Environment and Forests and Climate Change (MoEFCC) under Government of India to serve as the focal point in the administrative structure for the planning, promotion and coordination of environmental and forestry programmes. The name of MoEF has been revised in the year 2014 to Ministry of Environment, Forests and Climate Change (MOEFCC). This ministry has overall authority for the administration and implementation of government policies, laws and regulations related to the environment, including conservation, environmental assessment, sustainable development, forest conservation and pollution control. MOEFCC identifies the need to enact new laws and amend existing environmental legislation when required, in order to continue to conserve and protect the

environment. At the state level, the MOEFCC authority is implemented by the Department of the Environment and the Department of Forests.

In 1976, the 42nd Constitutional Amendment created Article 48A and 51A, placing an obligation on every citizen of the country to attempt to conserve the environment. As a result, a number of laws related to environmental conservation were passed to strengthen existing legislation. Environment (Protection) Act, 1986 is the landmark legislation as it provides for the protection of environment and aims at plugging the loopholes in the other related acts and this Act is called as umbrella Act. Under this Umbrella Act all the environmental acts and rules have been formed.

The laws and regulation applicable under the progamme:

- Policy and Regulatory Framework of Government of India
- Environmental Policy of respective State Government
- Legislation applicable to construction activities

9.5.1 Key Environmental Laws and Regulations

The relevant Acts and Rules are given in the **Table 31.**

Table 31: Key Environmental Laws and Regulations

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Environmental (Protection) Act	1986	To protect and improve the overall environment.	MOEFCC. GoI; CPCB, West Bengal State Pollution Control Board	√	¨	This act is applicable to all environmental notifications, rules and schedules are issued under this act.
Environment Impact Assessment Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	MOEFCC	--	√	Environment Impact Assessment Notification has been issued for requirement of EIA and activities requiring clearance

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
						from Central Government in the Ministry of Environment and Forests (MoEFCC). The proposed project does not require environmental clearance as per MoEFCC letter No. F. No. 14-9/2016-IA-III dated 21st December 2017 (Copy enclosed as **Annexure 3**)
Municipal Solid Waste (Management and Handling) Rules	2000	To manage collection transportation, segregation, treatment and disposal of municipal solid waste	MOEFCC, GoI, West Bengal State Pollution Control Board	√	..	Applicable for the project for the management of Solid waste
Indian Forest Act The Forest (Conservation) Act The Forest (Conservation) Rules	1927 1980 1981	To check deforestation by restricting conversion of forested areas into non forested areas.	Forest Department, Govt. of West Bengal, MOEFCC, Regional Office and MOEFCC.	..	√	No diversion of Forest land required for this project
Wildlife (Protection) Act	1972	To protect wildlife through certain of National Parks and	Chief Conservator. Wildlife, Wildlife	√	..	Applicable,as the project require Wildlife clearance

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		Sanctuaries.	Wing, Forest Department, Gov. of West Bengal and National Board For Wildlife, GoI.			
Water (Prevention and Control of Pollution) Act	1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards.	West Bengal State Pollution Control	√	..	Applicable during construction stage
Air (Prevention and Control of Pollution) Act	1981	To control air pollution by controlling emission of air pollutants as per the prescribed standards.	West Bengal State Pollution Control	√	..	Applicable during construction stage
Noise Pollution (Regulation and Control) Rules The Noise Pollution (Regulation and Control) Amendment Rules	2000 2006	To regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise	CPCB; WBSPCB & Transport Department; Govt. of West Bengal	√	..	This act will be applicable during construction phase of the project.
Central Motor Vehicle Act Central Motor Vehicle Rules	1988 1989	To check vehicular air and noise pollution.	Transport Department and West Bengal State Pollution	√	..	For construction vehicles (Construction Stage) – Pollution Under

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
			Control Board			Control Certificate
Ancient Monuments and Archaeological Sites and Remains Act	1958	These Acts are applicable in case any development activity is undertaken in close vicinity of any archaeological site or any are discovered during the construction stage. The Act requires prior authorization of the Archaeological Survey of India (ASI) for development within 300 m of a Protected Property	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	--	√	This act will not be applicable
Wetland Conservation and Management Rules	2010	The rule specifies the activities which are harmful and prohibited in the wetlands such as industrialization, construction, dumping of untreated waste and effluents and reclamation.	Central Wetland Regulatory Authority; MOEFCC	√	…	Not applicable
CRZ Notification	2019	To ensure	West Bengal	√	¨	CRZ Notification

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		livelihood security to the fisher communities and other local communities, living in the coastal areas, to conserve and protect coastal stretches, its unique environment and its marine area and to promote development through sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas, sea level rise due to global warming.	State Coastal Zone Management Authority and MoEF&CC			issued for to regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.

9.6 NEED FOR ENVIRONMENTAL CLEARANCE

The proposed project will not require Environmental Clearance as per MoEFCC letter No. F. No. 14-9/2016-IA-III dated 21st December 2017. The letter is enclosed as **Annexure 3**.

9.7 OTHER MAJOR CLEARANCES / APPROVALS / PERMITS APPLICABLE TO THE PROJECT

The CRZ Clearances will be applicable as per the CRZ Notification 2019.

The other clearances and permits required for project at different stages is given in **Table 32.**

Table 32: Other Statutory Clearances required for the Project

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
1	NOC and consents under Air & Water Act	For development of Waterway	Pre-construction Stage	IWAI
2	NOC (Consent to Establish and Consent to Operate) under Air and Water Act from SPCB	For siting, erection and operation of stone crusher, Hot Mix Plant, batching plant, WMM Plant etc.	Construction Stage	Contractor
3	Explosive License from Chief Controller of Explosives,	For storing fuel oil, lubricants, diesel etc.	Construction stage (Prior to storing fuel, lubricants and Diesel, etc.)	Contractor
4	Labour license from Labour Commissioner Office	Engagement of Labour	Construction stage (Prior to initiation of any work)	Contractor
5	Authorization of Hazaradous Waste Storage	Storage of Hazardous Waste	Construction stage (Prior to storge of Hazardous waste)	Contractor

9.8 COST IMPLICATIONS

The estimated environment cost is as follows:

a) Estimated cost as Pre-construction stage:

The estimated cost for EIA-EMP & SIA studies have been summarized in **Table 33**.

Table 33: Summary of Estimated Cost of EMP and SIA studies

Sl. No.	Particulars	Unit	Amount (Lakh INR)
1.	Man Power Cost (13 nos of Experts: 1 no. EC and 12 noc FAE)	Lump sum	30.00
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	One season cost (**Table**	4.215

Sl. No.	Particulars	Unit	Amount (Lakh INR)
		34)	
3.	Public consultation meeting (PCM)	Lump Sum	2.00
4.	Surveys/ Reports / Document Printing	Lump Sum	5.00
5.	Travelling Cost for Site Visits	Lump Sum	3.00
6.	Lodging & Boarding Cost	Lump Sum	5.00
7.	Cost for collection of metrological data and other information like Maps etc.	Lump Sum	2.00
	Total		**51.215**

Table 34: Estimated cost for Baseline data generation

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
1.	Ambient Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO_2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	No.	1 (Twice a week for twelve week): 24 Nos.	10000	2.4
2.	Surface Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Grab Sampling	No.	1	8000	0.08
3.	Ground Water Quality Monitoring		Grab Sampling	No.	1	8000	0.08

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
4.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	No.	2	4000	0.08
5.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	No.	1	7500	0.075
6.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study	No.	1	150000	1.5
	Sub-Total						**4.215**

b) Estimated cost at construction Stage:

Table 35: Estimated Cost during Construction Stage

Sl. No.	Particulars of Estimated Budget	Unit	Amount (Lakh INR)
1.	Environmental Monitoring Cost at Construction Stage for two year	**Table 36**	11.82
2.	Greenbelt Development nearby terminal Premises by Contractor	Lump sum	7.00
3.	Solid Waste Management	Lump sum	5.00
4.	Sanitary facilities at labour camps	Lump sum	5.00

Sl. No.	Particulars of Estimated Budget	Unit	Amount (Lakh INR)
5.	Disaster Management Plan	Lump sum	2.00
6.	Environmental Training	Lump sum	2.00
Total			**32.82**

Table 36: Environmental Monitoring Cost during Construction Phase

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
1.	Ambient Air Quality monitoring of PM_{10}, $PM_{2.5}$, CO, SO_2 & NO_2 (1 locations in the interval of once in two month for 2 years) **Break up: 1 Locations X 6 times X 2 Years = 12**	No.	12	10,000	1.2
2.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (1 locations in the interval of once in two month for 2 years) **Break up: 1 Locations X 6 times X 2 Years = 12**	No.	12	4,000	0.48
3.	Monitoring of River water Quality (1 locations in the interval of once in two months for 2 years during HFL and LFL) **Break up: 1 Locations X 6 times X 2 Years X 2 (HFL&LFL) = 24**	No.	24	8000	1.92
4.	Monitoring of ground water (1 locations in the interval of of once in two months for 2 year) **Break up: 1 Locations X 6 times X 2 Year = 12**	No.	12	8000	0.96
5.	Soil Quality monitoring (1 location along the Bank of River for once in six month for 2 year) **Break up: 1 Locations X 2 times X 2 Year = 4**	No.	4	7,500	0.30
6.	Monitoring of drinking water quality at construction camp (1 location in the interval of once in two months for 2 year) **Break up: 1 Locations X 6 times X2 Years = 12**	No.	12	8,000	0.96
7.	Study of Acquatic and terrestrial fauna (1 locations in the interval of once in six month for two year) **Break up: 1 Locations X 2 times X 2 Years = 4**	No	4	150000	6.0

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
Sub-Total					**11.82**

c) Estimated cost during operation Stage

Table 37: Estimated Cost during Opertaion Stage

S. No.	Particulars of Estimated Budget	Unit	Amount (Lakh INR)
1.	Environmental Monitoring Cost at Operational Stage for one year	**Table 38**	4.075
2.	Maintenance & Supervision of Greenbelt Developed	Lump sum	6.00
3.	Solid Waste Management	Lump sum	5.00
4.	Sanitary facilities nearby terminals	Lump sum	5.00
5.	Miscellaneous	Lump sum	5.00
Total			**25.075**

Table 38: Environmental Monitoring cost during operation stage

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
1.	Ambient Air Quality monitoring of PM_{10}, $PM_{2.5}$, CO, SO_2 & NO_2 (1 location once in a year for 1 year) **Break up: 1 Location X 1 time X 1 Year =1**	No.	1	12000	0.12
2.	Monitoring of River Water Quality (1 locations interval of 3 months for 1 year during HFL and LFL) **Break up: 1 Locations X 4 times X 1 Years X 2 (HFL&LFL) = 8**	No.	8	10000	0.8
3.	Monitoring of drinking water (1 location in a interval of 3 month for 1 year) **Break up: 1 Locations X 4 times X 1 Year = 4**	No.	4	10000	0.40
4.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (1 location once in a year for 1 year) **Break up: 1 Locations X 1 time X 1 Years = 1**	No.	1	5,500	0.055
5.	Soil Quality monitoring (1 locations along the Bank of River once in a year for 1 year) **Break up: 1 Locations X 1 time X 1 Years = 1**	No.	1	9,500	0.95

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
6.	Study of Acquatic and terrestrial fauna (1 location once in a year for 1 year) **Break up: 1 Location X 1 time X 1 Years = 1**	No.	1	175000	1.75
Sub-Total					**4.075**

The total estimated Environmental cost for the project is given in **Table 39**.

Table 39: Estimated Environmental and Social Cost for the Project

Sl. No.	Project Stages	Cost (Lakh INR.)
1.	Pre-Construction Stage	51.215
2.	Construction Stage	32.82
3.	Operational Stage	25.075
Total Estimated Budget (*Except Statutory Fee*)		**109.11**

10.0 INSTITUTIONAL REQUIREMENTS

The proposed development of Kalindi waterway is limited to fairway development and provision of marking bouys only. In view of above, as part of cumulative development of NW-97 (Sunderbans waterways), it is recommended that the development of Kalindi waterway shall be handled by Project Management Unit (PMU) proposed for development of Sahibkhali waterway, under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata.

The Institutional facilities proposed in all 13 rivers of NW-97 and the names of waterways supported by them are provided as below:

Sl. No.	Name of waterway supported by proposed Institutional facility	Name of Jetty/Terminal where Institutional facility is proposed to be set up	Name of waterway in which cost of Institutional facility is considered
1.	Muri Ganga waterway	Dhaki Jetty	Thakurran waterway
2.	Saptamukhi waterway		
3.	Thakurran waterway		
4.	Matla waterway	Basanti Jetty	Hogla waterway
5.	Bidya waterway		
6.	Gomar waterway		
7.	Hogla waterway		
8.	Chhota Kalagachi waterway	**Bhandarkhali Jetty**	**Sahibkhali waterway**
9.	Raimangal waterway		
10.	Sahibkhali waterway		
11.	Katakhali waterway		
12.	**Kalindi waterway**		

11.0 PROJECT COSTING

The project cost estimates for development of the Inland Water Transport system as well as for maintenance of the system have been worked out. The cost estimates for development of the system are termed as capital cost while for operation of the system is termed as maintenance or operating cost.

11.1 BASIS OF COSTING

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates of PWD, Govt. of West Bengal.
b) "Unified Schedule of Rates" prepared by Irrigation and Waterways department, Government of West Bengal.
c) The consultants experience on various projects sites proximity to the project area.
d) Local enquiries at the time of conducting surveys.
e) Market surveys and enquires.
f) Approved DPR's of National Waterways by IWAI.

11.2 DEVELOPMENT COST

Kalindi waterway is proposed to be developed as Class VII waterway for a total stretch of 8.513 Km. The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) EMP cost.

11.3 CAPITAL EXPENDITURE

The expenses expected to be incurred in development of the waterway are considered as capital expenditure. The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies is provided in **Table 40**.

Table 40: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	Capital cost for Fairway Development		541.24
2.0	Capital Cost for Aids to Navigation and Communication	**Table 22**	16.48
3.0	Cost allotted for EMP	**Table 39**	84.04
	Total Capital Cost		**641.76**

11.4 OPERATIONAL AND MAINTENANCE EXPENDITURE

The detail O&M cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies are provided in **Table 41** as below:

Table 41: Summary of annual O & M Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	O&M cost for Fairway Development		54.12
2.0	O&M Cost for Aids to Navigation and Communication		1.65
3.0	EMP Cost during operation stage	**Table 39**	25.08
	Total O&M Cost		**80.85**

11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 1 year, the phasing of expenditures has been established during construction period. The detail of cost repartition during construction period is provided in **Table 42** and also shown in **Figure 41** below.

Table 42: Phasing of Expenditure

Months >	M1 – M3	M4 – M6	M6 – M9	M9 – M12
Total Cash Flow INR Lakh	96.26	192.53	192.53	160.44
% of Cash Flow	15%	30%	30%	25%

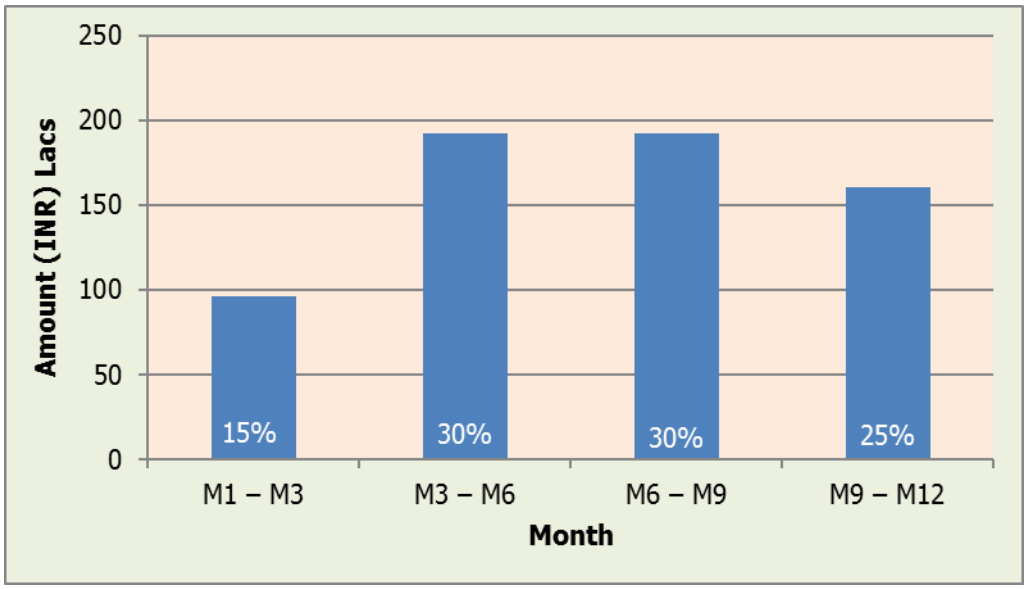


Figure 41: Phasing of Expenditure.

12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of Kalindi waterway and its associated facilities are presented in this chapter. The probable time schedule for various activities from onset to completion of the project and commencement of operation are also discussed in this chapter.

12.1 TIME FRAME

The total project is scheduled to be completed in 12 months from the start date of construction.

12.2 PHASING

For timely completion of the project, identification of major project components and sequential planning of various modules is very important for any project. The major components of Kalindi waterway include dredging and installation of navigational aids and communication facilities.

The schedule has been prepared with the presumption that IWAI will be developing the project in single phase through EPC contract.

12.3 SUGGESTED IMPLEMENTATION MECHANISM

The various activities to be carried out for development of waterway includes selection of site, preparation of detail engineering drawings & Report, survey and investigation, Social and Environmental Impact Assessment, preparation of tender document, Bid process management, selection of EPC contractor and award of work to the selected contractor. It is assessed that the lead time required to carry out the bid process management and selection of EPC contractor would be 3 months.

The schedule for the project also depends on the schedule of various Statutory Clearances required from different Statutory Agencies for the development of the project and therefore, all the requirement clearances need to be in place before the start of the construction activities.

The following are the major activities involved for effective completion of Kalindi waterway project, which involves engineering, procurement, construction and commencement of operational activities.

- Detailed Engineering;
- Environmental clearance;

- Financial closure and Statutory approvals from all concerned authorities;
- Supply, installation and commission of navigational aids and communication equipment's.

12.4 CONSTRUCTION SCHEDULE

Sl. No.	Activities	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Approval of DPR and Project Financial Closure				
2	Fairway development				
a)	Procurement of Hardware and other equipment's				
b)	Dredging				
3	Procurement and installation of Aids to Navigation				

Figure 42: Construction Schedule

13.0 ECONOMIC AND FINANCIAL ANALYSIS

Financial feasibility is a key determinant in a business oriented investment decision. In case of the projects of public/national interest like development of Inland Water Terminals, the viability of the project depends on the economic feasibility which acts as the deciding factor.

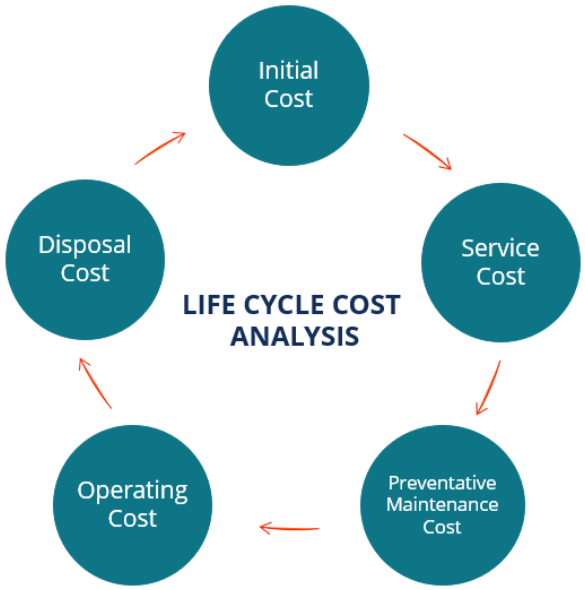
As detailed in previous chapters of this DPR, Kalindi waterway is proposed to be developed to provide an uninterrupted connectivity between other proposed waterways as part of cumulative development of NW-97, Sunderbans waterways.

Also, as presently Kalindi waterway neither have its own passenger and cargo traffic nor the same is foreseen for project duration, no jetty/ terminal structure and vessels are proposed in this DPR. Accordingly, in the absence of traffic and projected revenues to be generated from Kalindi waterway, the internal rate of returns can not be ascertained.

The Capital and O&M expenses estimated to be incurred for development of Kalindi waterway is considered as part of collective development of NW-97, Sunderbans waterways.

13.1 LIFE CYCLE COST ANALYSIS

Life cycle cost analysis (LCCA) is an approach used to assess the total cost of owning a facility or running a project. LCCA considers all the costs associated with obtaining, owning, and disposing of an investment.



Life cycle cost analysis is especially useful where a project comes with multiple alternatives and all of them meet performance necessities, but they differ with regards to the initial, as well as the operating, cost. In this case, the alternatives are compared to find one that can maximize savings.

Life cycle cost analysis used to assess infrastructural projects make use of:

- capital expenditure, which is the initial cost involved when constructing or delivering an infrastructural asset.
- operating expense, which consists of a number of costs, including utility, manpower, insurance, equipment, health, and routine and planned repairs.
- Replacement costs, incurred every cycle based on the predefined age of replacement for different assets and the manufacturer's preference, and
- disposal cost.

LCCA of Kalindi Inland waterway project is done for 20 years of project life cycle, considering the Capital and O&M expnses to be incurred in project phases and presented in below **Table 43**.

Table 43: Project Life Cycle Cost

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)
-1	642		642
0		81	81
1		85	85
2		89	89
3		94	94
4		98	98
5		103	103
6		108	108
7		114	114
8		119	119
9		125	125
10		132	132
11		138	138
12		145	145

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)
13		152	152
14		160	160
15		168	168
16		176	176
17		185	185
18		195	195
19		204	204
20		215	215
		Total	**3,529**

On the basis of above LCCA, the project life cycle cost for 20 years of project life cycle works out as INR 3,529/- Lakh.

13.2 RISK FACTORS AND MITIGATION

Environmental and social risk involved in construction (compring dredging and installation of RIS and Marine Bouys only) and operational stage of the project including their mitigation measures are discussed and provided in detail in Chapter 9.0 above.

13.3 NECESSITY OF GOVT. SUPPORT (VGF/PPP)

The guide lines were notified by the ministry of finance, department of economic affairs for financial support to infrastructure project that are to be undertaken through Public Private Partnerships (PPP).

Proposal is to be made under this scheme shall be considered for providing Viability Gap Funding (GAF), one time or deferred with the objective of making a PPP project commercially viable.

The proposal shall relate to a public private partnership (PPP) project which is based on a contract or concession agreement between a Government or statutory entity (Inland Waterways Authority of India) on the one side and a private sector company on the other side, for delivering an infrastructure service on payment of user charges.

This scheme will apply only if the contract/concession is awarded in favour of a private company in which 51% or more of the subscribed and paid up equity is owned and controlled by a private entity.

A private sector company shall be eligible for VGF only if it is selected on the basis of open competitive bidding and is responsible for financing, construction, maintenance and operation of the project during concession period.

The proposal for seeking clearance of the Empowered Institution shall be sent (in six copies, both in hard and soft form) to the PPP cell of the Department of Economic Affairs in the prescribed format. The proposal should include copies of all project agreements (such as concession agreement, state support agreement etc.) and the project report.

Once cleared by Empowered Institution, the project is eligible for financial support financial bids shall be invited by the concerned ministry, state Government or statutory entity, as the case may be, for the award of the project within four months of the approval of the Empowered Institution. This period may be extended by the Department of Economic Affairs.

The private sector company shall be selected through a transparent and open competitive bidding process. The criterion for bidding shall be the amount of VGF required by a private sector company where all other parameters are comparable.

14.0 CONCLUSION

The viability of Inland Water Transport project for introduction of navigation on any waterway can be judged by both technically and commercially. The technical viability of the project can be assessed based on availability of discharges to maintain navigable depth in a design channel suitable to ply design vessel and the availability of traffic (either existing or forecasted). The commercial viability of the project can be gauged based on its growth over the project period and return on investment made besides several others socio-economic benefits such as employment generation, poverty alleviation in rural areas and so on. The recommendation for implementation of the project is based on the trade-off between costs to be incurred and benefits derived.

On the basis of studies done in this DPR following conclusions are made:

a) Proposed Kalindi waterway is directly connected with Sahibkhali.
b) Katakhali waterway is also connected with Indo-Bangladesh Protocol route through Sahibkhali and Raimangal waterways.
c) Further, Katakhali waterway ends up in Kalindi river at about 5.0 Km upstream of end point of Kalindi waterway.
d) International Border of India Bangladesh falls along the Kalindi river, with left bank along the Indian side.
e) Three numbers of Border Security Force (BSF) jetties are located along the left bank of river.
f) There are no big industries in the project hinterland, however few brick kilns are found along the river banks.
g) 8.513 Km stretch of Kalindi River has no major passenger or cargo traffic.

As mentioned above, Kalindi waterway neither have its own passenger and cargo traffic nor the same is foreseen for project duration, accordingly no jetty/ terminal structure and vessels are proposed in this DPR.

However, in order to provide an uninterrupted connectivity between other proposed national waterways and as part of collective development of NW-97, Sunderban waterways, Kalindi waterway is proposed to be developed as Class VII waterway as per IWAI guidelines. Accordingly, Dredging and Navigation & Communication Aids are proposed for the development of Kalindi waterway. The capital and O&M cost for the waterway development works out as INR 641.76 Lakh and INR 80.85 Lakh respectively.

In the absence of traffic and projected revenues to be generated from Kalindi waterway, the internal rate of returns can not be ascertained.

ANNEXURES

ANNEXURE 1: TOR OF THE AGREEMENT

ANNEXURE 2: ENVIRONMENTAL AND SOCIAL SCREENING TEMPLATE

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site.			
a) National Park		√	
b) Wildlife/ Bird Sanctuary		√	
c) Tiger or Elephant Reserve		√	
d) Biosphere Reserve	√		The entire river stretch is located within Sundarban Biosphere Reserve
e) Reserved / Protected Forest		√	
f) Wetland	√		
g) Important Bird Areas		√	
h) Mangroves Areas	√		Within the stretch mangrove species are present
i) Estuary with Mangroves	√		
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration	√		
k) World Heritage Sites	√		Sundarbans World Heritage site
l) Archeological monuments/ sites (under ASI's Central / State list)		√	
2. Is the project located in whole or part in /near any Critically Polluted Areas identified by CPCB?		√	
3. Is, there any defense installations near the project site?		√	
4. Whether there is any Government Order/ Policy relevant / relating to the site?		√	
5. Is the project involved clearance of existing land, vegetation and buildings?		√	
6. Is the project involved dredging?	√		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)	√		Prone to Flood, Cyclones and heavy winds

Screening Question	Yes	No	Details / Remarks
8. Is the project located in whole or part within the Coastal Regulation Zone?	√		
9. Is the project involved any demolition of existing structure?		√	
10. Is the project activity requires acquisition of private land?		√	
11. Is the proposed project activity result in loss of direct livelihood / employment?		√	
12. Is the proposed project activity affect schedule tribe/ caste communities?		√	

S. N.	Result of Screening Exercise	(Yes / No)
1	Environment Impact Assessment is Required	Yes
2	CRZ Clearance is Required	Yes
3	Environmental Clearance is Required	No
4	Forest Clearance is required	No
5	Wildlife Clearance is required	Yes
6	NOC from SPCB is required	Yes
7	Social Impact Assessment is Required	No
8	Abbreviated RAP is required	No
9	Full RAP is required	No
10	Any other clearance is required	Yes

ANNEXURE 3: MoEF&CC Letter

No. F.No.14-9/2016-IA-III
Government of India
Ministry of Environment, Forest and Climate Change
(Impact Assessment Division)

Indira Paryavaran Bhawan
Jor Bagh Road, Aliganj
New Delhi-110003

Dated: 21st December, 2017.

OFFICE MEMORANDUM

Subject: Non-requirement of environment clearance for maintenance dredging in rivers for the purpose of navigation - regarding.

This has reference to your Office Memorandum IWT-11011/89/2016-IWT-(Vol.II) dated 7th December 2017 on the above mentioned subject.

2. The minutes of the meeting held under chairmanship of Hon'ble Minister, Road Transport & Highways, Shipping and Water Resources, River Development & Ganga Rejuvenation held on 24.10.2017 concluded that as per the extant legal position, no prior EC is required for maintenance dredging for navigational channel for Inland Waterways.

3. In view of the above the Ministry of Shipping may like to go ahead with the decision taken during the meeting held under chairmanship of Hon'ble Minister, Road Transport & Highways, Shipping held on 24.10.2017 subject to the implementation of the environmental safety measures as enclosed as annexure.

4. This issues with the approval of the competent authority.

Sharath Kumar Pallerla
Director

To

The Secretary,
Ministry of Shipping,
Parivahan Bhawan, 1, Parliament Street,
New Delhi - 110 001

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ANNEXURE

Environmental safety measures to be implemented

i. 'Consent to Establish' and 'Consent to Oparate' shall be obtained from State Pollution Control Board under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.
ii. The project authority shall ensure that no rivers or tributaries are blocked due to any activities at the project site and free flow of water is maintained.
iii. Shoreline shall not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary.
iv. Dredging shall not be carried out during the fish/turtle breeding seasons.
v. All vessels used in the river will be fitted with noise control and animal exclusion devices so that aquatic life is not unduly disturbed.
vi. Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts aquatic life, particularly benthos. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.
vii. Construction waste including debris shall be disposed safely in the designated areas and in no case shall be disposed in the aquatic environment.
viii. Vessels shall not discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil.
ix. The project authority shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.
x. All vessels will also have to comply with 'zero discharge' standards to prevent solid or liquid waste from flowing into the river and affecting its biodiversity.
xi. The dredging shall be carried by integrated and systematic planning by selective grid method by allowing migratory movement of Benthic fauna.
xii. All required Noise and vibration control measures are to be adopted in Dredgers. Cutter section Dredgers should be avoided as much as possible which produces more noise and vibration. No Drilling and Blasting is to be carried out.
xiii. Pre geo-tectonic studies has to be completed and the strata to be dredged is predetermined with complete data pertaining to hardness, compressive and tensile strengths.
xiv. Dredger type and other strata loosening methods shall be preconceived.
xv. Staggered dredging shall be carried based on turbidity monitoring to minimise the impact of turbidity.
xvi. Threshold level of turbidity, which has a minimal effect on fauna, has to be predetermined and Dredging planned accordingly.
xvii. Further silt screens needs to be used for minimising the spread of Turbidity.

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xviii. Disposal places of Dredged sediments needs to be predetermined, along the shore by assessment of suitability, which will not affect the shoreline (erosion) and also causing impacts during monsoon and flooding.

xix. As much as possible, it shall not be disposed off in the river itself, and the site should be such that the dispersion is quicker by undertaking modelling studies.

xx. Ballast water control and management measures shall be implemented.

xxi. Waste and waste water reception facilities in Jetty shall be implemented.

xxii. The Risk and Disaster management plan has been prepared in consonance with the manual of terminals and harbours issued by the Ministry of Environment and Forests dated 5th May 2010.

xxiii. Standard Operating Procedures (SOP) and Emergency Response Plan (ERP) for onsite and offsite emergencies shall be prepared and implemented based on Hazard Identification and Risk Assessment to handle, process, store and transport of hazardous substances.

xxiv. Oil spill contingency plan shall be prepared and part of DMP to tackle emergencies. The equipment and recovery of oil from a spill shall be assessed. Guidelines given in MARPOL and Shipping Acts for oil spill management shall be followed.

xxv. No diversion of the natural course of the river shall be made without prior permission from the Ministry of Water resources.

xxvi. All the erosion control measures shall be taken at water front facilities.

xxvii. Necessary Air Pollution Control measures shall be taken during loading, unloading, handling, transport of the material at the berthing and water front facilities.

xxviii. The Vessels shall comply the emission norms prescribed from time to time.

xxix. All safety measures are to be implemented in coordination with the respective state government departments such as State Forest Department, Public Works Department, State Pollution Control Board etc.

Sharath Kumar Pallerla
Director

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ANNEXURE 4: PHOTOGRAPHS

Left river bank at chainage 0.5

DGPS Observation on KD-01 BM at chainage 0.65

Unprotected Right bank at chainage 0.7

Unprotected Left bank at chainage 1.0

Unprotected Right bank at chainage 1.3

Unprotected Left bank at chainage 1.5

Unprotected Left bank at chainage 2.5

Unprotected Right bank at chainage 2.5

River Bank Condition at Chainage 3.0

Bank Condition at Chainage 3.4

Bank Condition at Chainage 3.5

Pond at Chainage 3.5

River Bank at Chainage 3.6

Lock gate on Right Bank at Chainage 4.0

Bank Condition Left bank at Chainage 4.2

Brick factory on Right Bank at Chainage 4.4

Fishing Nets at Chainage 4.6

Lock gate at Chainage 4.7

Unprotected Bank at Chainage 4.8

Fishing Nets at Chainage 5.0

Brick Factory on Laft Bank at Chainage 5.0

Carrying out Bathymetric Survey

Protected Left bank at Chainage 5.0

View of Brick Chimneys at Chainage 5.2

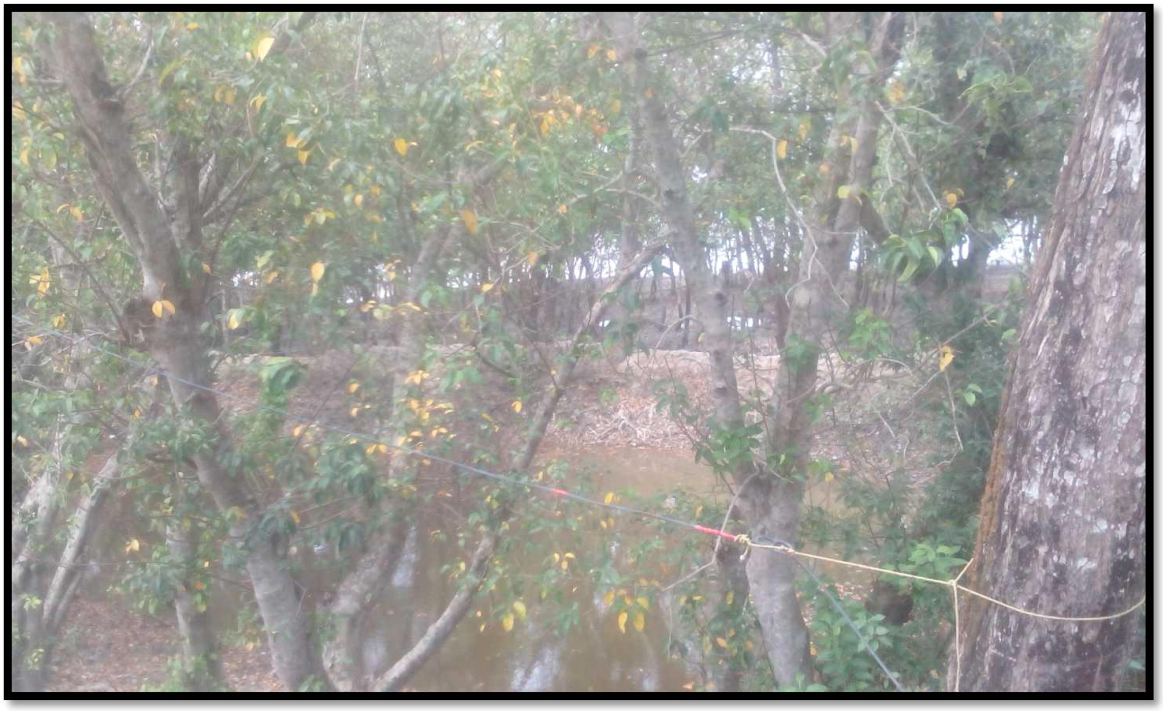
Right Bank at Chainage 6.0

Brick Factory at Chainage 6.0

Brick Factory at Chainage 6.2

River Bank at Chainage 6.3

Pond at Chainage 6.5



Dense trees and bushes at Chainage 7.0

Dense trees and bushes at Chainage 7.0

Bank Protection at Chainage 7.6

Transformer at Chainage 7.8

Local Ferry Ghat at Chainage 8.0

DGPS Observation at BM-KD-02

Tide Pole at Chainage 8.0

Govt School at Chainage 8.0

View at Chainage 8.4

Bank Protection at Chainage 8.4

VOLUME – II

DRAWINGS