FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 97

SUNDERBANS WATERWAYS

RIVER: GOMAR RIVER (STATE OF WEST BENGAL)

GOSABA TO RAMCHANDRAKHALI (6.711 KMS)

(Volume – I: Main Report)

(Volume – II: Drawings)

Submission Date: 21/01/2021

Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 1

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GOSABA TO RAMCHANDRAKHALI (6.711 KMS)
(Volume – I: Main Report)
(Volume – II: Drawings)
Submission Date: 21/01/2021

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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Final DPR
Volume-I Main Report
Volume-II Drawings

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LIST OF VOLUMES

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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.
HNJPSS	Hooghly Nadi Jalpath Paribahan Samabai Samity Ltd.
IMO	International Maritime Organisation
VHF	Very High Frequency
RIS	River Information System

SALIENT FEATURES OF GOMAR 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	Gosaba	Ramchandrakhali	
	Latitude	22°10'3.98"N	22°11'53.32"N	
	Longitude	88°47'38.61"E	88°44'41.29"E	
B.	**TECHNICAL**			
1.	***Waterway***			
a)	National Waterway Number	97		
b)	Class	VII		
c)	Type (Tidal/Non-Tidal)	Tidal		
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**
		6.711 Km	6.711 Km	0 Km
d)	Sounding Datum			
	Description/Basis	Sounding Datum was transferred at all the newly established BM's using Sagar 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 - 6.711 km
		-2.82	-2.82	-2.82
e)	LAD Status (w.r.t. SD)			
	Sub -Stretch 1			
	Stretch Km (From……To……)	**LAD (m)**	**0-6.796**	
	Length with LAD < 1.2 m	< 1.2	4.4	
	With LAD from 1.2-1.4 m	1.2 - 1.4	0.4	
	With LAD from 1.5-1.7 m	1.5 - 1.7	0.4	
	With LAD from 1.8-2.0 m	1.8 - 2.0	0.4	

Sr. No.	Particulars	Details			
	With LAD > 2.0 m	> 2		1.196	
	Total	**Total**		6.796	
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 - 6.711 km**	**Total (km)**
	Dredging Required (M. Cum.)	0.484	0.493	0.414	1.391
	Bandalling	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil
	River Training (Km.)	Nil	Nil	Nil	Nil
	Bank Protection (Km.)	Nil	Nil	Nil	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)	Passenger ferry services and movement of small cargo vessels are operational all along the waterway to/fro the jetties/ferry ghats located in Bidya and Hogla waterway.			
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 nearest major rail head is at Canning about 25 Km away from Gomar. State highway SH 3 runs all along the left bank of waterway.			
d)	Commodities	**In-bound**		**Out-bound**	

Sr. No.	Particulars	Details				
		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 (Waterway does not have own passenger traffic, however, Gomar river provides connectivity for traffic originating/terminating on Bidya and Hogla waterway				
3.	***Terminals/Jetties***	Not Recommended				
4.	***Design Vessel***	Not Recommended				
5.	***Navigation Aids***					
a)	Type	Marking buoys				
b)	Nos.	5				
c)	Communication Facilities	1.0 nos. RIS system				
C.	**FINANCIAL**					
1.	***Cost***	***Capital Cost*** (INR Lakhs)			***O&M Cost*** (INR Lakhs)	
	Fairway Development	2,782.59			278.26	
	Total Cost	**3,152.06**			**472.40**	
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. Gomar River is one of the 13 rivers clubbed in Cluster 3.

This detailed project report of 6.711 km stretch of Gomar 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 6.711 km stretch of Gomar National waterway proposed for DPR study lies from Gosaba at Lat 22°10'3.98"N, Long 088°47'38.61"E to Ramchandrakhali at Lat 22°11'53.32"N, Long 88°44'41.29"E. Whole stretch of Gomar waterway is having tidal influence with a tidal variation of 2.16 m.

River width in the waterway stretch varies from 0.14 km to 0.72 km. Average flow velocity in the waterway is 0.86m/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 6.711 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 13,91,295.67 cum of dreding is required to be done. The total capital and O&M cost of fairway development works out to INR 2,782.59 Lakh and INR 278.26 Lakh respectively.

4.0 TRAFFIC STUDY

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

a) There are no big industries located in project hinterland, however a few brick kilns are found along the river banks.

b) Gomar river has no passenger and cargo traffic of its own.
c) Gomar river provides an interconnectivity between Hogla and Bidya waterways.
d) Vessels operated from Hogla and Bidya ferry ghats uses Gomar waterway also.

In view of the above observations, the waterway is recommended to be developed for providing an uninterrupted connectivity between Bidya and Hogla waterway. However, no additional jetty/terminal and vessels are proposed in this DPR.

5.0 NAVIGATION & COMMUNICATION SYSTEM

As part of collective development of NW-97, Sunderbans waterways, one RIS station with radial coverage of 25 Km is proposed to be set up near Godkhali Jetty. It is also proposed to provide 5 numbers of Marine Lantern/Buoys along the channel alignment for safe navigation. Capital and maintenance cost for the same works out to INR 285.43 Lakh and INR 169.07 Lakh respectively

6.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Gomar 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 entire study stretch is in South 24-Parganas district. South 24 Parganas district lies between $22^0$12’13”N and $22^0$46’55”N latitude and its longitudes are $87^0$58’45”E and $88^0$22’10”E covering an area of 9,960 sq. km. Alipore is the district headquarters of South 24 Parganas. It is the largest district of West Bengal in terms of area with a very small proportion of urban settlements. A large portion of the district is included in the Forests of Sundarbans

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 37°C and the minimum is 9°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.

7.0 INSTITUTIONAL REQUIREMENTS

The proposed development of Gomar waterway comprises of; a) fairway development of full 6.711 Km stretch of waterway involving 13,91,295.67 cum of dredging and b) provision of Navigational & Communication equipment as part of collective development of all 13 rivers of NW-97.

Accordingly, it is recommended that the Project Management Unit (PMU) proposed in the Hogla Waterway DPR will provide operational support in the development of Gomar waterway. Further no additional institutional setup is recommended in the Gomar Waterway DPR.

8.0 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) Judgement based on Consultant's Experience

Gomar waterway is proposed to be developed for passenger ferry services for a stretch of 6.711 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 3,152.06 Lakh and O&M cost worked out as INR 472.40 Lakh.

9.0 IMPLEMENTATION SCHEDULE

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

10.0 ECONOMIC & FINANCIAL ANALYSIS

As presently Gomar 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 Gomar waterway, the internal rate of returns can not be ascertained.

11.0 CONCLUSION

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

a) There are no big industries located in project hinterland, however a few brick kilns are found along the river banks.
b) Gomar river has no passenger and cargo traffic of its own.
c) Gomar river provides an interconnectivity between Hogla and Bidya waterways.
d) Vessels operated from Hogla and Bidya ferry ghats uses Gomar waterway also.

As mentioned above, Gomar 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.

However, in order to provide an uninterrupted connectivity between Bidya and Hogla waterway and as part of collective development of NW-97, Sunderban waterways, Gomar 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 Gomar waterway. The capital and O&M cost for the waterway development works out as INR 3,152.06 Lakh and INR 472.40 respectively.

In the absence of traffic and projected revenues to be generated from Gomar 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. Gomar River was clubbed under Cluster -3 for the two stage DPR studies.

This detailed project report of 6.711 km stretch of Gomar 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

Gomar 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 Gomar River) was covered in the Sunderbans waterways (NW-97). Following section of the Gomar 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
6.711 Km	22°10'3.98" N 88°47'38.6" E	Gosaba	22°11'53.32" N 88°44'41.29" E	Ramchandrakhali

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

Based on the above conclusions/observations done during feasibility studies i.e. first stage of the studies, IWAI recommended following stretch of Gomar 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
6.711 Km	22°10'3.98" N 88°47'38.6" E	Gosaba	22°11'53.32" N 88°44'41.29" E	Ramchandrakhali

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 6.711 km stretch of Gomar waterway is located in South 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.

Gomar 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**.

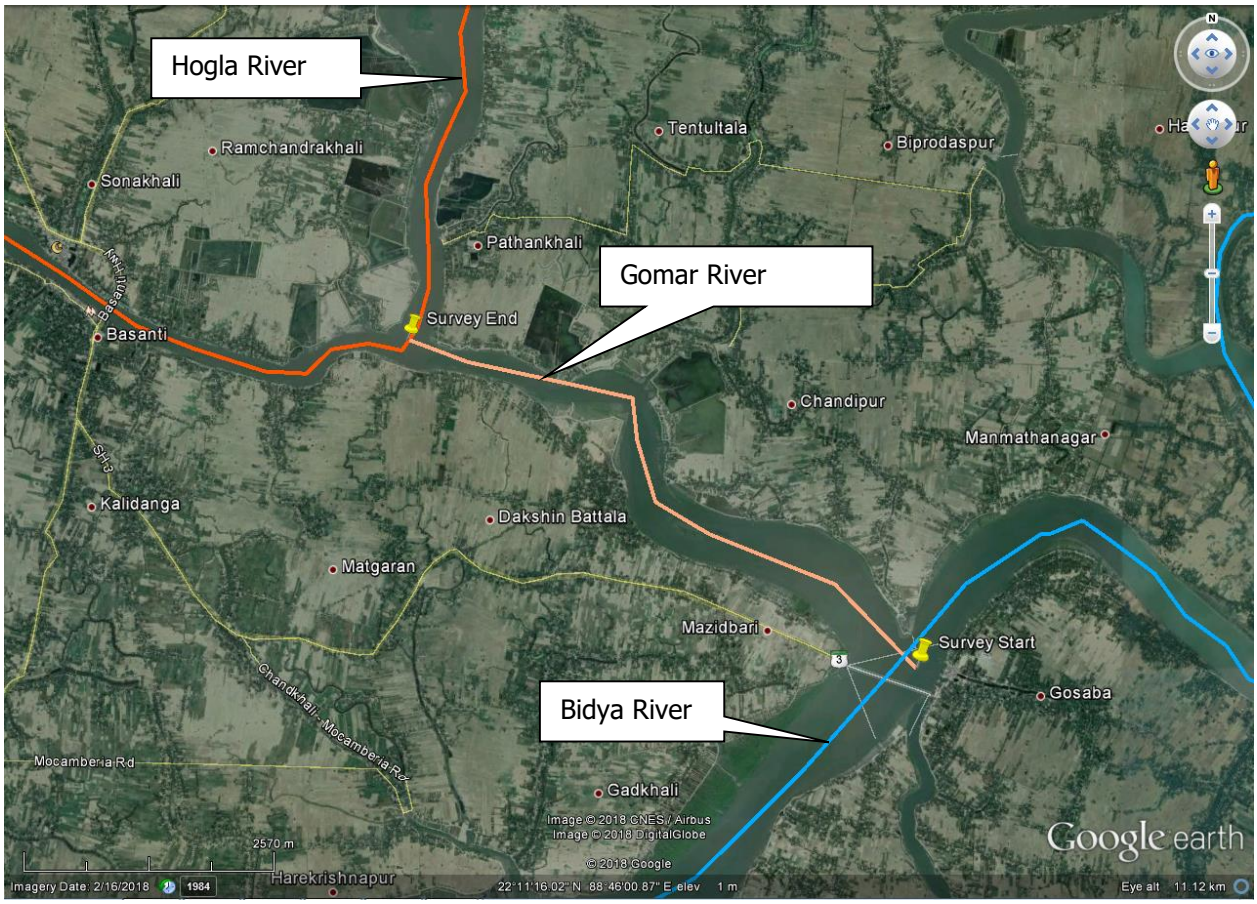


Figure 1: Gomar National Waterway Project Location

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

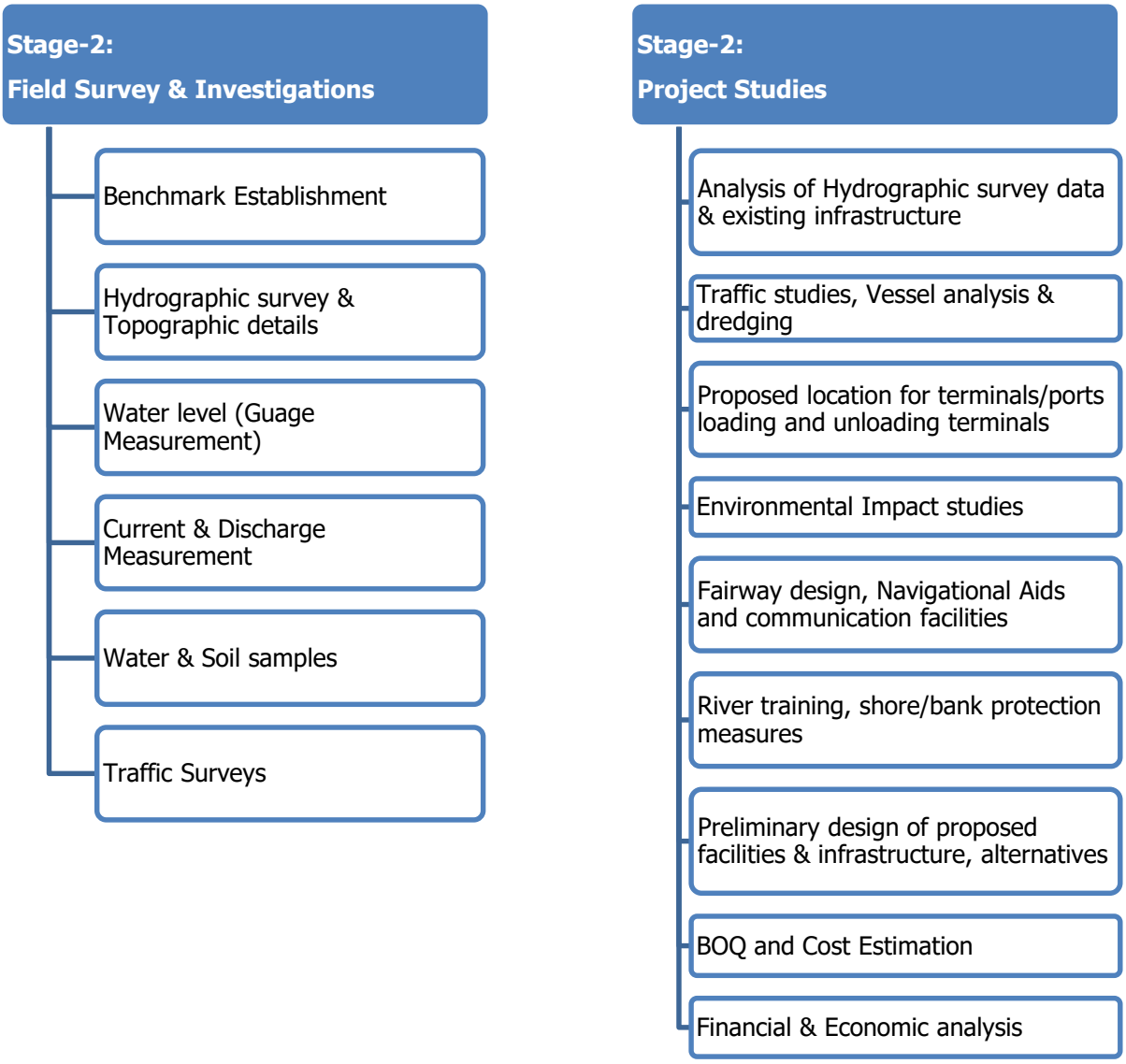
c) Geotechnical investigations

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:

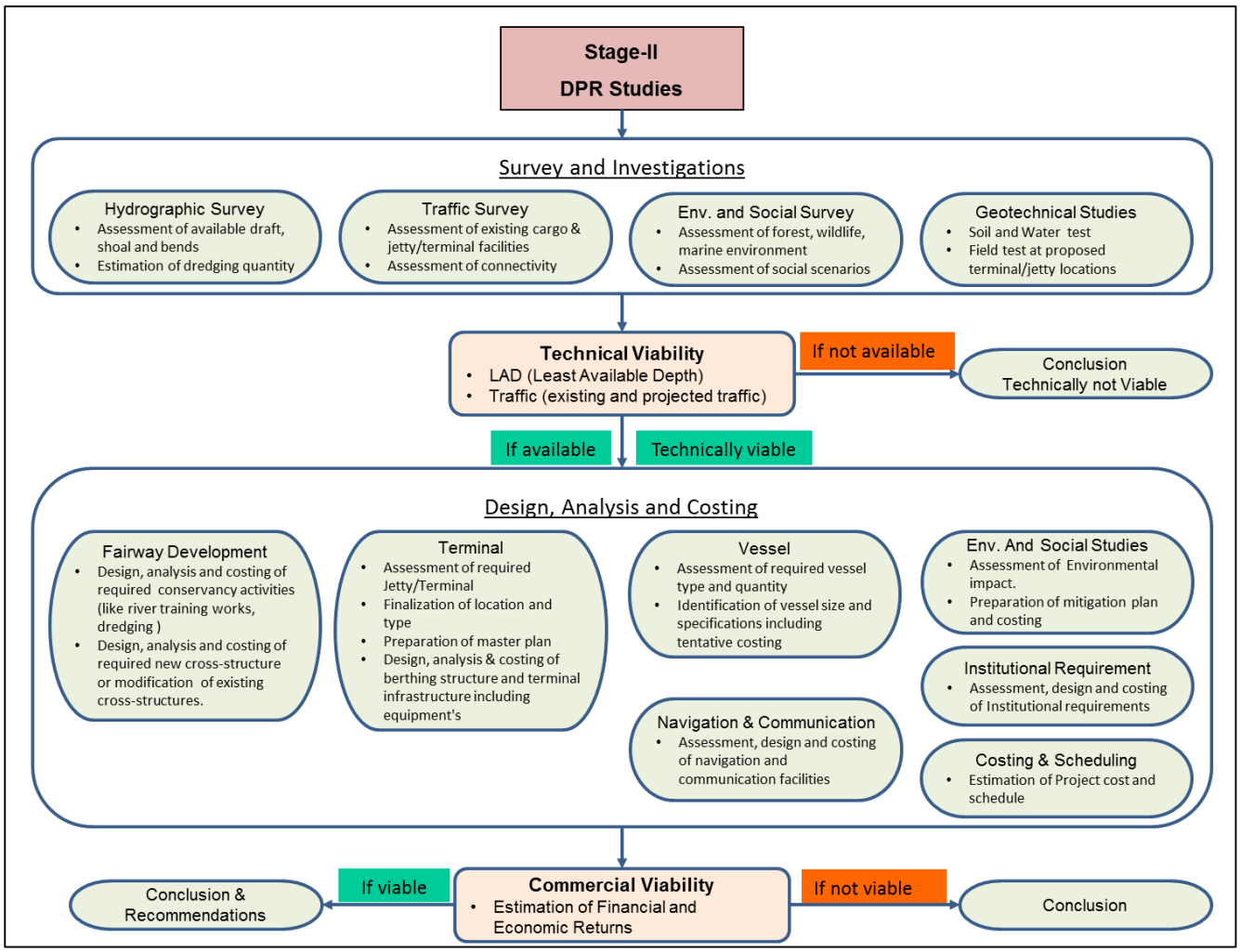


Figure 2: DPR Approach and Methodology Flow Chart

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 Gomar river under DPR study is from Gosaba at Lat 22°10'3.98"N, Long 88°47'38.61"E to Ramchandrakhali at Lat 22°11'53.32"N, Long 88°44'41.29"E. The total length of this stretch is about 6.711 Km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Gomar 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

Gomar is a tidal estuarine river in South 24 Parganas district West Bengal, India. The river is basically an interlinking river between Bidya and Hogla rivers. Gomar river meets Bidya river at Gosaba and meets Hogla at Ramchandrakhali.

The proposed 6.711 km stretch of waterway is located in the South 24 Parganas district of West Bengal. Whole stretch of Gomar waterway is having tidal influence of 2.16 m.

Average flow velocity in the waterway is 0.86m/sec. Reduced depth at every 1 Km intervals for full stretch of the river are 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, simultaneously 4 hour observation was carried out at newly established BM, GM-01and ML-03 (Malta River BM-03) data

was logged in rinex format which was post processed in Auspos and Spectra software and value of BMs w.r.t. MSL and SD were obtained.

Gomar River was divided into 2 km stretches for ease of applying tidal level corrections to the collected bathymetric data. Total one in number BM pillar (naming GM-01) was constructed and erected along the river from Gosaba to Ramchandrakhali.

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

BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above MSL (m)	Height above SD (m)
GM-01	Chandipur Bazar	4.3 KP	22°11'34.16"	88°46'10.08"	682419.03	2455234.3	4.5	7.32

2.1.3 Sounding Datum and Reduction details

Sounding Datum was transferred at newly established BM's using ML-03 values. Standard method of baseline processing was adopted for transfer of datum for tidal reaches areas. 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 BenchMark / tidegauges	Chainage (km)	Stretch for corrected soundings and topolevels (km)	Established SoundingDatum w.r.t. MSL(m) at col. A.	Sounding Datum ofTide Gaugew.r.t. MSL (m)	Correction inWL data for Bathymetric survey(m)	Topolevel datato beconverted as depth forvolume calculation wrt SD (m)
	A	B	C	D +ve indicates above MSL -ve indicates below MSL	E	F= (E- WL datainMSL)	G = ((E- topo levelsinMSL)
GM-01	Chandipur Bazar	4.3 KP	0.0 to 6.711	-2.82	-2.82	Tide Applied w.r.t SD	2.82

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 Electric lines are located 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 waterway stretch are provided in **Table 4**:

Table 4: Details of Bends along the waterway

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
1.0	0.78	1.97	1,068
2.0	2.53	3.74	681
3.0	4.02	4.70	308
4.0	4.81	5.31	540

2.4 VELOCITY AND DISCHARGE DETAILS

Current meter observation was 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	4.0	22°11'25.1724"N	088°46'01.6811"E	682181.42	2454954.90	5.0	0.92	0.89	0.77	0.860	253.5	218.01

2.5 WATERWAY DESCRIPTION

The total 6.711 km stretch of Gomar Waterway under DPR study, can be broadly divided in to three (3) stretches.

Table 6 below provides the details of sub-stretches of Gomar waterway.

Table 6: Sub-Stretches of Gomar Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Gosabato	Chandipur	0 km	2 km
2	Chandipur	Ramkrishnapur	2 km	4 km
3	Ramkrishnapur	Ramchandrakhali	4 km	6.711 km

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

2.5.1 Sub Stretch 1: From Gosaba to Chandipur (Chainage 0 Km to 2 Km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 0 to 2 km chainage of the Gomar River. It is the downstream portion of the Gomar River. The area is sparsely populated, with fishing and farming being the main occupation of the people. SH 3 is in the vicinity and the nearest town is Mazidbari on the left bank. The average width of the river in this stretch is about 400mtr with some portion of the river bank protected. Fishermen extensively use the natural slope of the ground for landing the boats and there are small jetties on either side of the river the main one being at creek North of Godkhali and at Gosabafrom where small boats ply.

Following are the observations made during survey of Sub-stretch 1: From Gosaba to Chandipur (Chainage 0 Km to 2 Km)

- There are no overhead obstructions/crossovers.
- There are no prominent dams & barrage available in this stretch.
- The tidal range is 2.16 m in this Stretch.
- There is no hindrance or encroachment in this stretch.
- Dredging would be required for all time navigation in this stretch of the river.

The details of current and discharge at different depths is placed at **Table 5.**

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 2.0 Km) of Gomar 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.

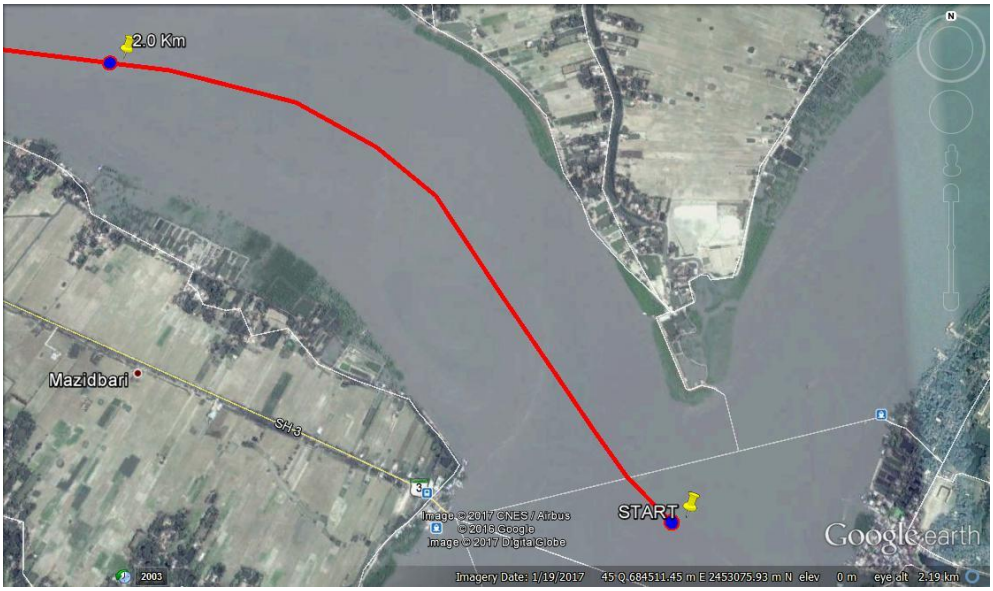


Figure 3: Google Image showing Sub-Stretch -1 of Gomar Waterway

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)				-1.00	2.23	600	54642.63
II	0	2					-1.00	2.25	800	85672.80
III	0	2					-1.04	2.25	800	133959.95
IV	0	2					-1.07	2.25	800	166705.06
V	0	2					-1.19	2.25	1200	256810.02
VI	0	2					-1.19	2.25	1200	392483.42
VII	0	2					-1.19	2.25	1600	484276.30

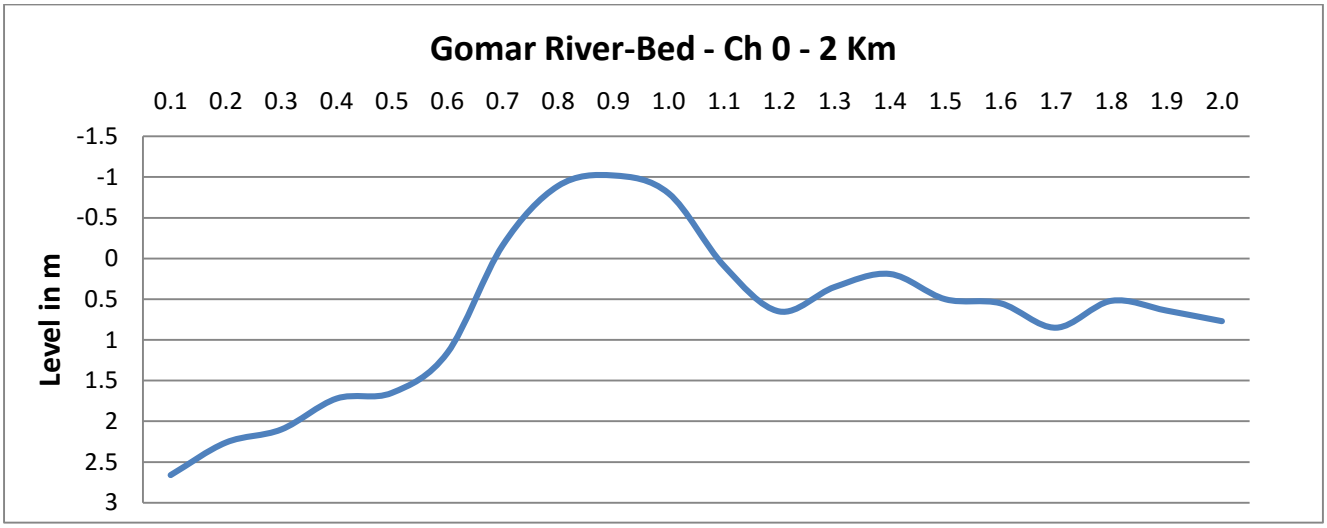


Figure 4: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 2Km)

Figure 5: Photographs of Sub-Stretch 1

2.5.2 Sub Stretch 2: From Chandipur to Ramkrishnapur (2 km to 4 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 2 to 4 km chainage of the Gomar River. There is mangrove forestation on both sides of the river at some locations in this stretch. The area is not densely populated, with fishing and farming being the main occupation of the people & the fields in the area are dependent on the rainfall. This stretch is not very wide and average width is about 400 mtrs with some portion of the river bank 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 Kalas Island to Unnamed Island (Chainage 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 2.16 m in this stretch as we move from downstream to upstream.
- Dredging would be required for all time navigation in this stretch of the river.

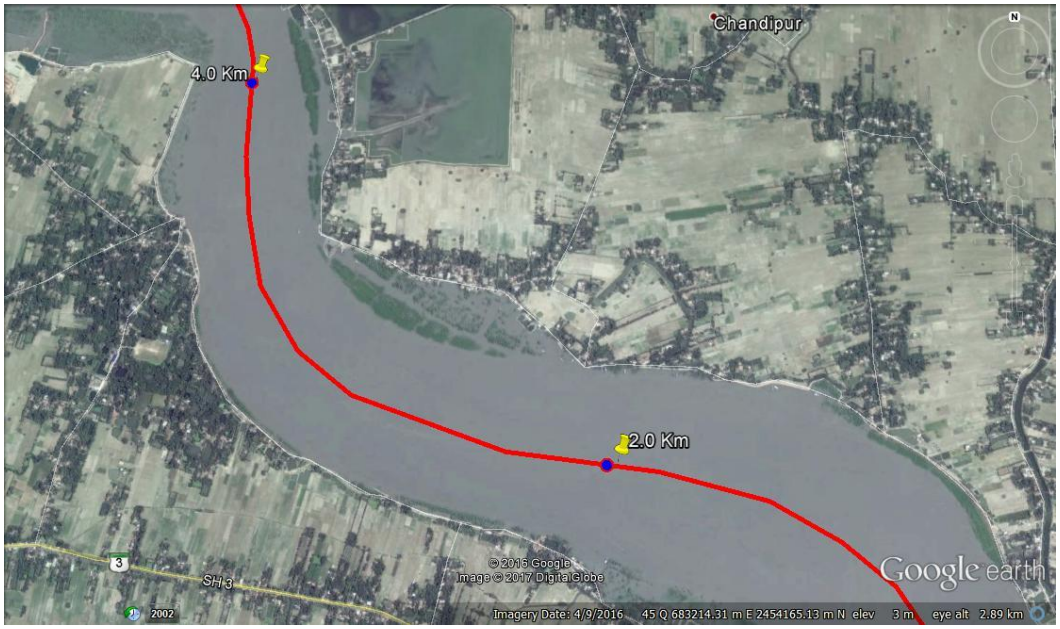


Figure 6: Google Image showing Sub-Stretch -2 of Waterway

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)				-0.76	5.42	600	34507.44
II	2	4					-1.03	6.23	600	59521.93
III	2	4					-1.12	7.59	800	104869.94
IV	2	4					-1.12	7.84	800	138642.76
V	2	4					-1.73	7.76	1600	235852.77
VI	2	4					-2.02	7.82	1800	381731.73
VII	2	4					-2.81	7.82	1800	492980.97

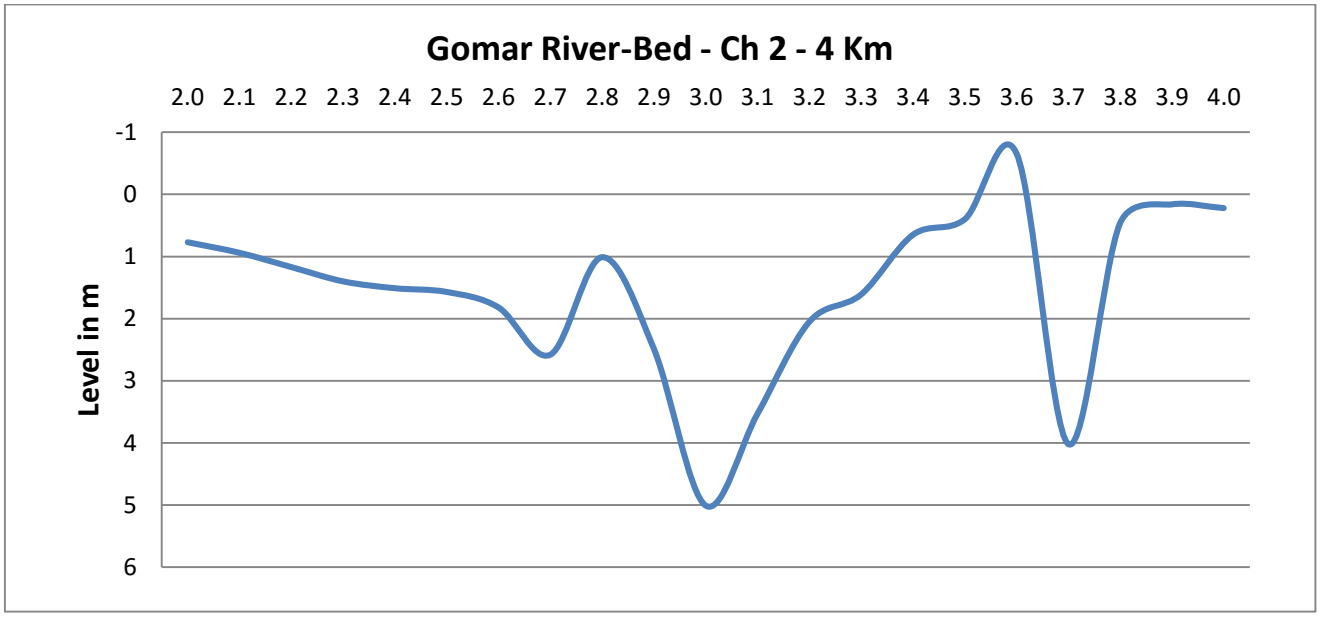


Figure 7: Bed Profile of Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

Figure 8: Photographs of Sub-Stretch 2

2.5.3 Sub Stretch 3: From Ramkrishnapur to Ramchandrakhali (4km to 6.711km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 4 to 6.711 km chainage of the GomarRiver.The area is very moderatelypopulated and has dense mangroves at some locations of the river. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is comparatively narrower at an average width of about 250 meters. Someportion of the river bank is protected. There is a small jetty at Chandipur Bazar ghat. 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 2.16 m in this stretch.
- Dredging would be required for all time navigation in this stretch of the river.

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

Figure 9 above shows the alignment of sub-stretch 3 (Ch. 4.0 km to 6.711 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	6.711	Not Applicable (Tidal Zone)				-0.37	11.09	600	32064.24
II	4	6.711					-0.47	11.10	600	49706.07
III	4	6.711					-0.56	11.11	600	78576.61
IV	4	6.711					-0.61	11.11	600	101643.67
V	4	6.711					-4.76	11.11	1200	183812.29
VI	4	6.711					-4.94	11.11	1400	306984.85
VII	4	6.711					-5.32	11.22	1800	414038.40

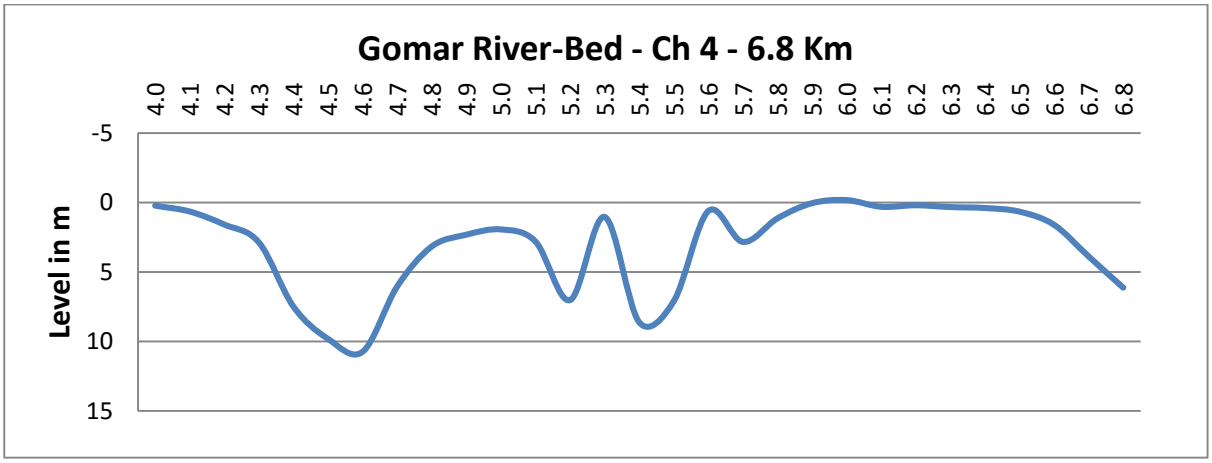


Figure 10: Bed Profile of Waterway Sub-stretch 3 (Chainage 20Km – 30 Km)

Figure 11: Photographs of Sub-Stretch 3

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 10.**

Table 10: Soil & Water Sample Locations

Sample No.	Chainage (km)	Latitude	Longitude	Easting (m)	Northing (m)	Depth (m)
1	4.021	22°11'25.17"N	088°46'01.68"E	682181.42	2454954.90	5

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

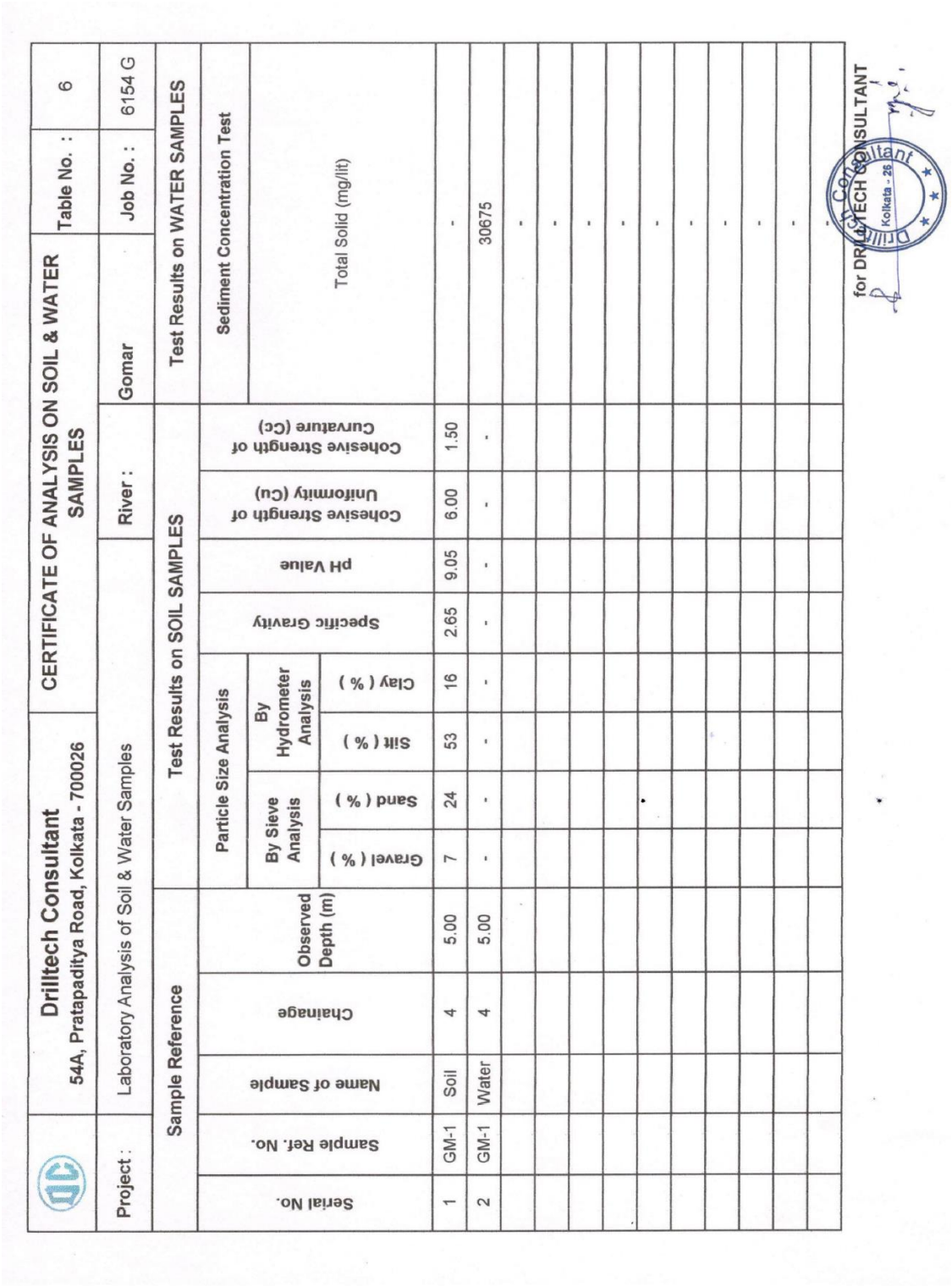
Soil Samples

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

Water samples

- Sediment Concentration

Test result of samples is provided in **Figure 12**.



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CERTIFICATE OF ANALYSIS ON SOIL & WATER SAMPLES

Table No. : 6

Project : Laboratory Analysis of Soil & Water Samples

River : Gomar

Job No. : 6154 G

Test Results on WATER SAMPLES

Sample Reference				Test Results on SOIL SAMPLES										Sediment Concentration Test	
				Particle Size Analysis						Specific Gravity	pH Value	Cohesive Strength of Uniformity (Cu)	Cohesive Strength of Curvature (Cc)	Total Solid (mg/lit)	
				By Sieve Analysis		By Hydrometer Analysis									
Serial No.	Sample Ref. No.	Name of Sample	Chainage	Observed Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)							
1	GM-1	Soil	4	5.00	7	24	53	16		2.65	9.05	6.00	1.50	-	
2	GM-1	Water	4	5.00	-	-	-	-		-	-	-	-	30675	
														-	
														-	
														-	
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														-	
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Figure 12: 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 **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 -5.32 m to 11.22 m w.r.t sounding datum for Class VII waterway.
c) Tidal variation varies of 2.16 m.
d) Width of river varies from 0.14 km to 0.72 km.

Figure 13 shows the proposed alignment of Gomar waterway.

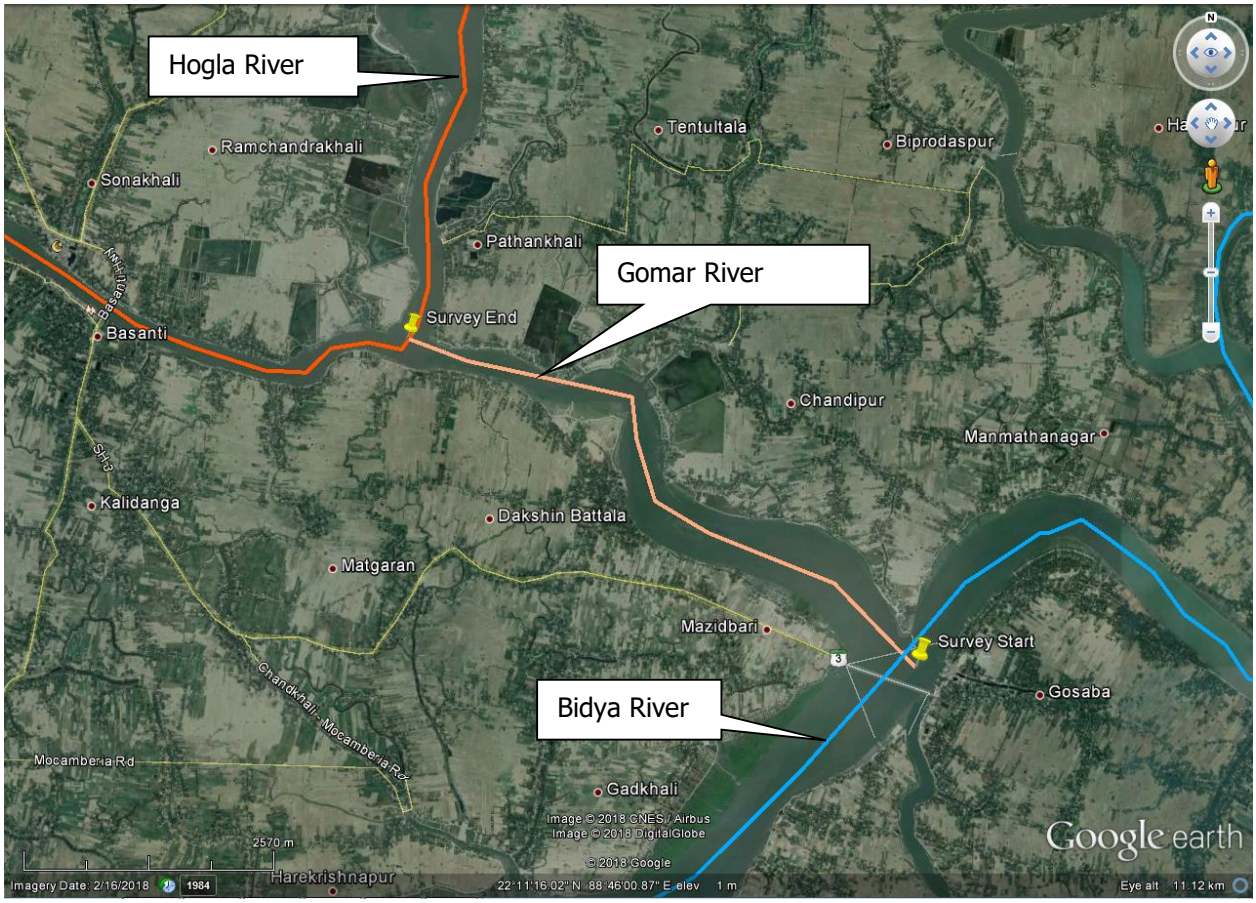


Figure 13: Proposed alignment of Gomar Waterway

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 6.711 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 11** shoals are located along the complete 6.711 Km stretch of Gomar river, 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 Gomar 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 14**. The dredging quantity obtained from Hypack software for 6.711 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:

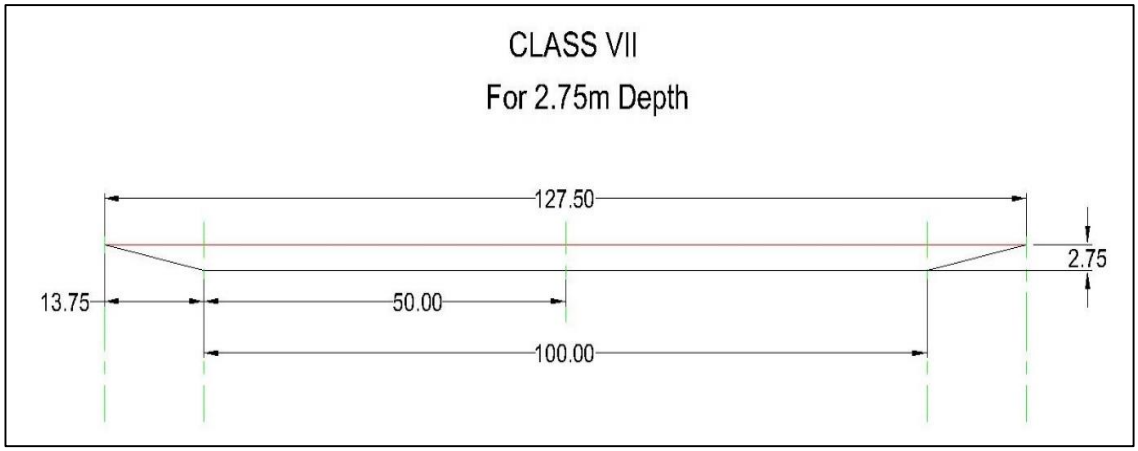


Figure 14: Fairway Dimension Class VII

Table 11: Dredging Quantity for Class VII Waterway

Chainage		Observed				Reduced w.r.t. Sounding Datum				
From (Km)	To (Km)	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				-1.19	2.25	600	200247.74	200247.74
1	2					-0.46	0.91	1000	284028.56	484276.30

Chainage		Observed				Reduced w.r.t. Sounding Datum				
From (Km)	To (Km)	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.
2	3	(Tidal Zone)				-2.71	2.41	800	227560.59	711836.89
3	4					-2.81	7.82	1000	265420.38	977257.27
4	5					-3.74	11.22	600	106404.20	1083661.47
5	6					-5.32	10.77	800	147345.79	1231007.26
6	6.711					-2.60	4.73	400	160288.41	1391295.67
								Total	**1391295.67**	

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 13,91,295.67 cum.

Total stretch for dredging along the proposed waterway is recommended on the basis of following points:

a) Stretch of Gomar river connecting proposed Bidya waterway at Chainage 0.0 Km and Hogla waterway at Chaiange 6.711 Km.
b) Available traffic as per the traffic studies done in this DPR.

Accordingly, on the basis of above criterias, Gomar waterway is proposed to be developed for full stretch from Chainage 0.0 Km to Chainage 6.711 Km, providing uninterrupted connectivtiy between Bidya and Hogla waterway.

Hence, the total dredging quanity estimated for developing this 6.711 Km stretch of waterway in Class VII is 13,91,295.67 cum.

Disposal of Dredging Material

The dredged material is proposed to be dumped on low lying areas 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.

Figure 15: 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 cross – structure is located along 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 Gomar 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 capital dredging is as below:

Dredging cost @ INR 200/cum for 13,91,295.67 cum = INR 27,82,59,134/- **(INR 2,782.59 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 13,91,295.67 cum = INR 2,78,25,913.4/- **(INR 278.26 Lakh)**.

4.0 TRAFFIC STUDY

4.1 GENERAL

South 24 Parganas is a district in the Indian State of West Bengal, headquartered in Alipore. It is the largest district of West Bengal state by area and second largest by population. It is the sixth most populous district in India (out of 640). On one side is the urban fringe of Kolkata and on the other, the remote riverine villages in the Sundarbans.

The district has 5 Sub-divisions namely (i) Alipore Sadar (ii) Baruipur (iii) Canning (iv) Diamond Harbour, and (v) Kakdwip. The South 24 Parganas district highlights as per 2011 census[1]

- South 24 Parganas District comprises of 29 C.D. Blocks and 7 Statutory Towns.
- There are total 2,042 villages and 111 Census Towns in the District.
- South 24 Parganas District 2nd most populated district.
- The percentage of urban share of Population of South 24 Parganas District has expanded from 15.7% (2001 Census) to 25.6% (2011 Census) of total Population of respective Census.
- South 24 Parganas District ranks 4th in decadal Population growth rate among the Districts with 18.2%.
- The density of Population (Population per square km) of the district is 819 per square km which makes its rank 12th in the State.
- There are 75 (seventy five) Villages having Population 10,000 and above.
- South 24 Parganas District has the highest area (9960.00 sq km) in the State.
- A large portion in the southern part of the district is covered with thick Mangrove forests of created in the riverine delta created in the confluence of the rivers Ganga, Brahmaputra, Padma known as the Sundarban Reserve Forest which is included in the UNESCO World Heritage Site. Sundarban is a prominent National Park, Tiger Reserve and Biosphere Reserve in the country and in the world.

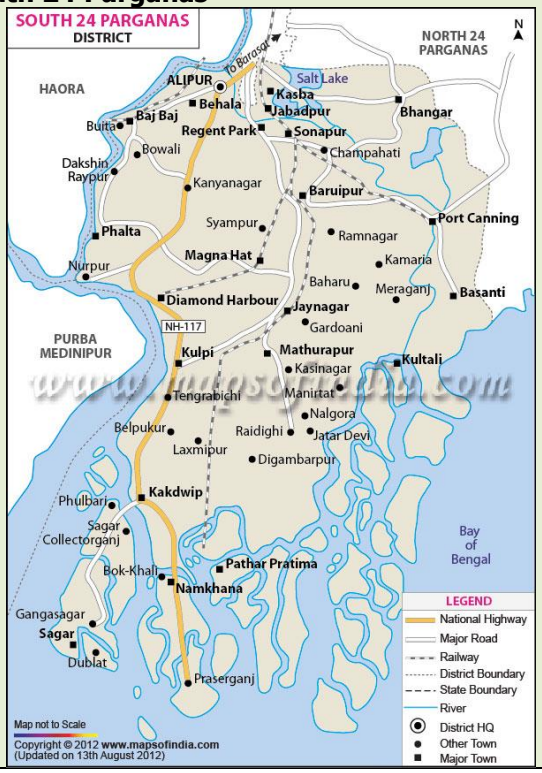
4.2 INFLUENCE AREA / HINTERLAND

Gomar river flows through two (2) CD blocks of South 24 Parganas disctrict, namely, Basanti and Gosaba. The Project Influence Area (PIA), considering existing and projected traffic for passenger

[1] District Census Handbook, 2011

ferry services, comprises of the following CD blocks and districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 12**.

Table 12: Project Influence Area/ Hinterland

District	Area (Km^2)	C.D. Block	Area (Km^2)	Total Hinterland area (Km^2)
South 24 Parganas 	9,960	Basanti	404.2	700.92
		Gosaba	296.72	

4.2.1 Population of Hinterland area

Population of hinterland area for proposed IWT in Gomar waterway is provided in **Table 13** below:

Table 13: Population of Hinterland[2]

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
West Bengal	South 24 Parganas	81,61,961	Basanti	3,36,717	5,83,315
			Gosaba	2,46,598	

[2] District Census Handbook, 2011

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Gomar waterway includes South 24 Parganas disctrict of West Bengal. Gross State Domestic Product (GSDP) prices of West Bengal and growth rate in percentage are provided in **Table 14** and **Table 15** as below:

Table 14: 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 15: 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

Year	Primary	Secondary	Teritary	GSDP
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
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 Tertiary 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.

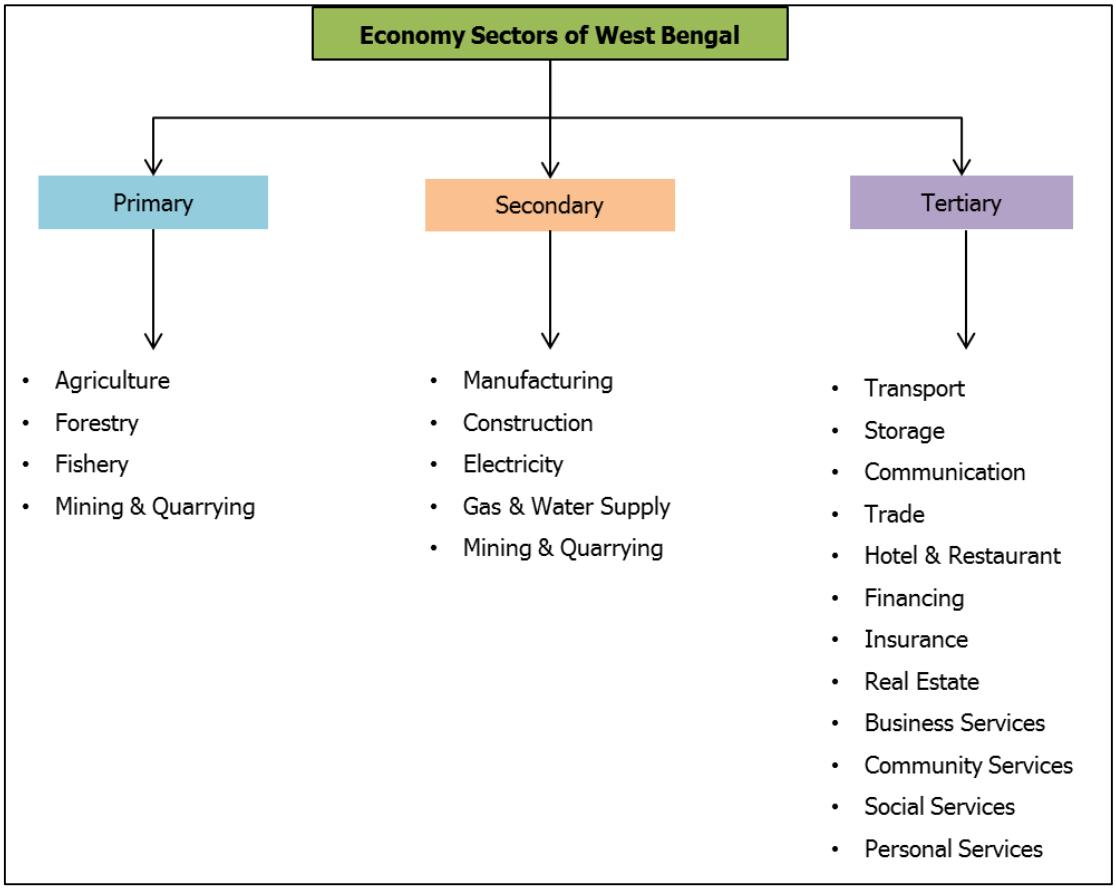


Figure 16: Sectors of West Bengal

Figure 17 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 18** 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.

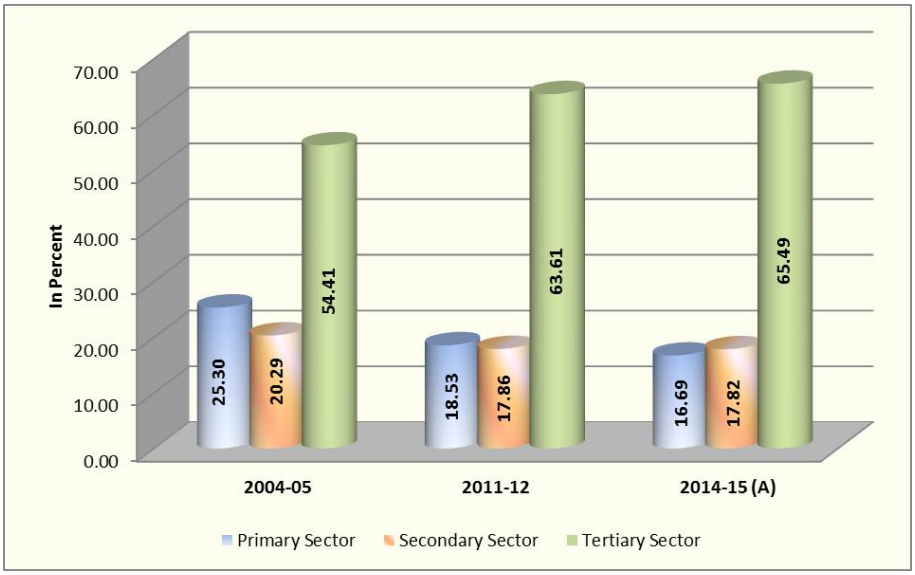


Figure 17: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

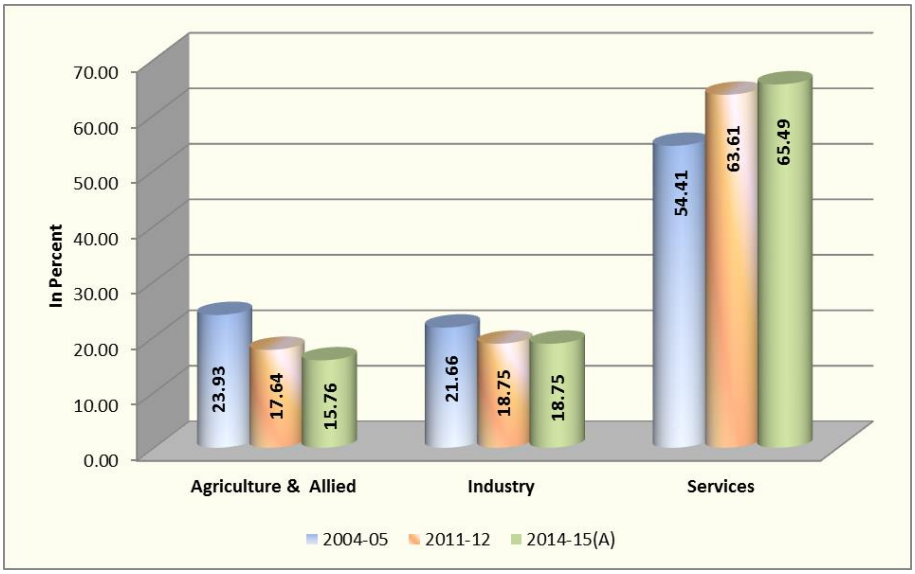


Figure 18: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

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. South 24 Parganas are provided in **Table 16** and the same is presented in **Figure 19** as below:

Table 16: Gross District Domestic Product and Annual Growth Rate of South 24 Parganas

(at 2004-05 Constant Prices,)

Year	Gross District Domestic Product *(INR Crores)*	Annual Growth Rate *(Percentage Change over Previous Year)*
2004-05	16884.94	-
2005-06	17443.65	3.31
2006-07	19623.98	12.5
2007-08	21026.4	7.15
2008-09	21652.35	2.98
2009-10	22442.53	3.65
2010-11	24465.14	9.01
2011-12	25688.00	5
2012-13	27306.29	6.3
2013-14	29238.58	7.08
Average	-	**6.33**

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

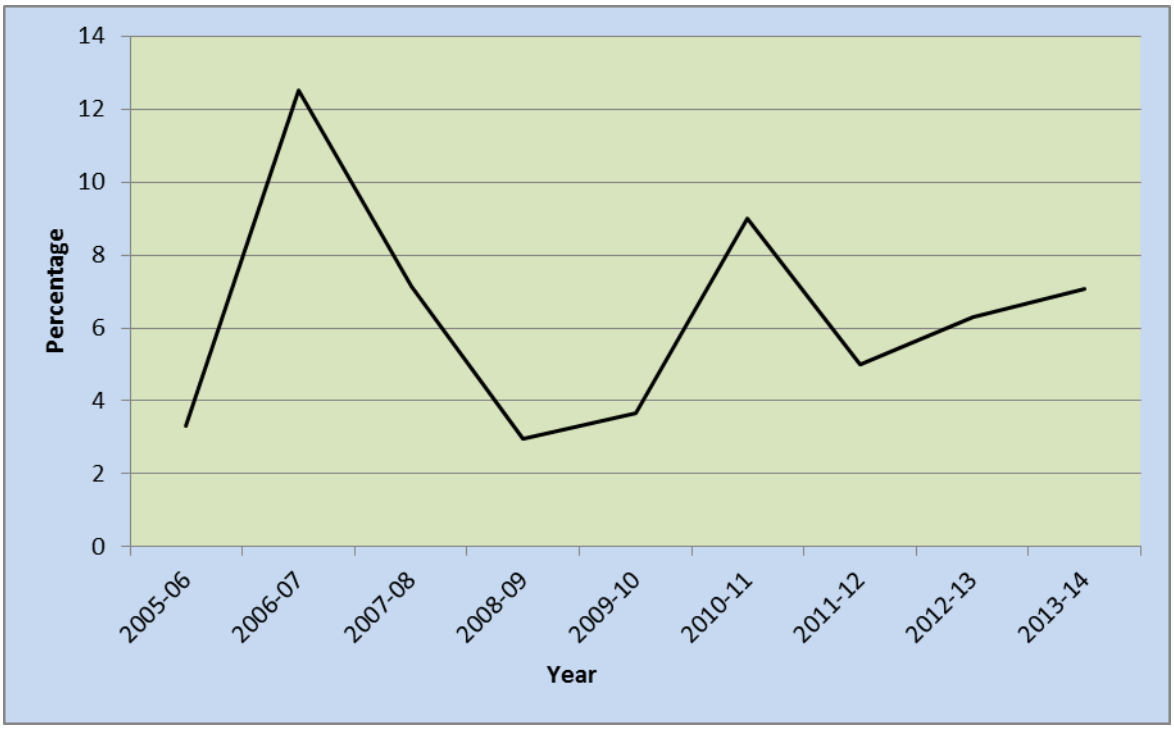


Figure 19: Annual Growth Rates of Gross District Domestic Product

Table 17: Contribution of South 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	7.86	8.15	7.9	7.9
Industry	9.31	7.97	7.94	7.94
Services	7.71	7.88	7.81	7.81
Total GSDP	8.09	7.94	7.85	7.85

From **Table 17,** it is concluded that, South 24 Parganas has major contribution in services sector and shows descent decadle growth. Contribution of South 24 Parganas in GSDP of Broad Sectors of Economy in West Bengal is also presented in **Figure 20** as below:

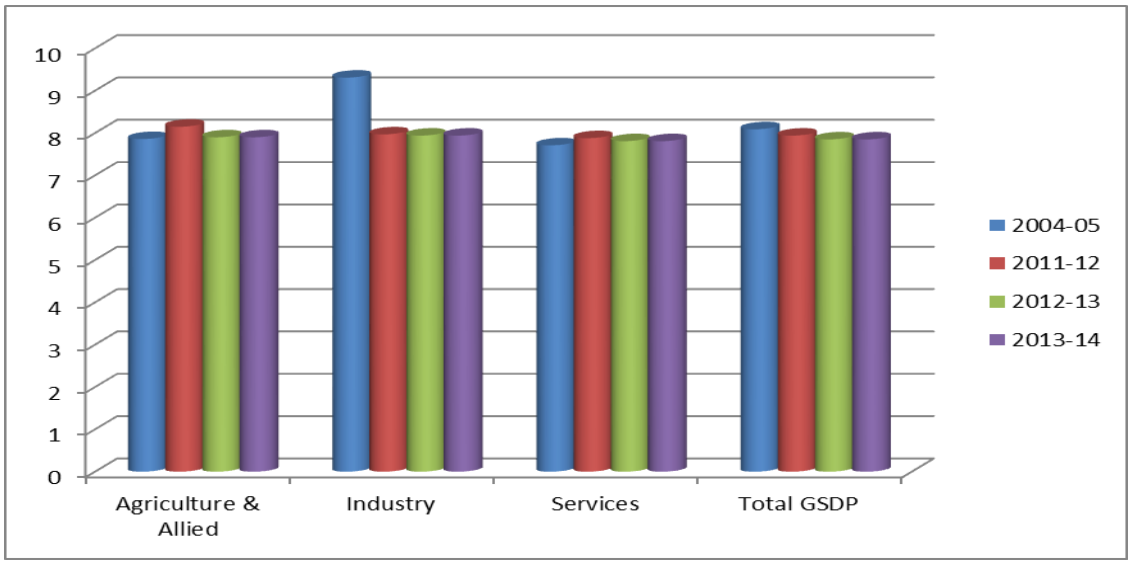


Figure 20: Contribution of South 24 Parganas in GSDP of Broad Sectors of Economy

4.2.3 Existing and proposed Industries

There is 1 Brick kiln located along the river stretch. The brick kiln mostly use fuel wood, saw dust, rice husks and agricultural residues along with coal for firing. Most of these raw materials are locally arranged and transported through roads/local boats by owner directly to the kiln. Coal is procured from Raniganj mines and transported through roads. On the basis of data collected during survey done in April 2017, the total quantity of coal used by fire Kiln is about 1,500 Tons per year. 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. The nearest major rail head is at Canning about 25 Km away from Gomar. State highway SH 3 runs all along the left bank of waterway. Passenger ferries and small cargo boats uses Gomar river to reach jetties/ferry ghats located in Bidya and Hogla waterways. Mobile network is intermittently available in the area.

4.2.5 Connectivity with Other Wateways

Gomar waterway is connected at both ends with other declared waterways of Sunderbans as shown below:

Table 18: Connectivity with other Waterways

Sl. No.	Waterway Name	Chainage at merging location (Km)
1.0	Bidya waterway	0.00 Km
2.0	Hogla Waterway	6.711 Km

4.3 COMMODITY COMPOSITION / CATEGORIZATION

Existing and proposed commodities planned for Gomar 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 April 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 Gomar waterway.

4.3.3 Passenger Traffic

No passenger traffic is available of its own along the Gomar river. However, passenger ferry services are operational all along the waterway to/fro the jetties/ferry ghats located in Bidya and Hogla waterway.

4.4 ORIGINATING / TERMINATING COMMODITIES

Only passenger traffic with small cargo like agricultural products, fish, bricks, construction materials and two wheelers are located along the waterway.

4.5 TOURISM TRAFFIC

No tourism traffic is located along the waterway.

4.6 CONCLUSION

Following conclusions are made from the traffic studies done above:

a) There are no big industries located in project hinterland, however a few brick kilns are found along the river banks.
b) Gomar river has no passenger and cargo traffic of its own.
c) Gomar river provides an interconnectivity between Hogla and Bidya waterways.
d) Vessels operated from Hogla and Bidya ferry ghats uses Gomar waterway also.

In view of the above observations, the waterway is recommended to be developed for providing an uninterrupted connectivity between Bidya and Hogla waterway. 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 no existing jetties/terminals located all along the Gomar River. Also, as the waterway does not have its own passenger and cargo traffic, no jetty or terminal structure is proposed in this DPR of Gomar Waterway.

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. As detailed in above chapters, no jetty or terminal structure is proposed in the Gomar 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

Ferry and small cargo vessels operational in Bidya and Hogla rivers are also plying in Gomar waterway. The photographs of existing vessels plying along the waterway are provided in **Figure 21**. Ferry boats having approximate dimensions of about 16.0 m long, 2.5 m breadth and 1.0 m depth are used for movement of passenger and small cargos. The existing vessels lack the basic safety gears and communication equipments.

Figure 21: Vessels plying on Bidya Waterway

However, as the waterway does not have its own passenger and cargo traffic, no additional vessels are proposed in this DPR of Gomar Waterway. It is considered, that the vessels operating along Bidya and Hogla waterway will continue to commute along Gomar Waterway also.

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.

Though, no terminal infrastructure and vessels are proposed in Gomar waterway, the waterway is recommended to be developed as class VII waterway to cater the traffic movement between Hogla and Bidya National Waterways. Accordinly, Navigation and Communication system is also recommended in Gomar waterway.

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 22**. The capital and O&M cost of proposed DGPS system at canning is considered in DPR of Matla waterway. Radial distance of canning from farthest point in Gomar waterway is about 21 Km.

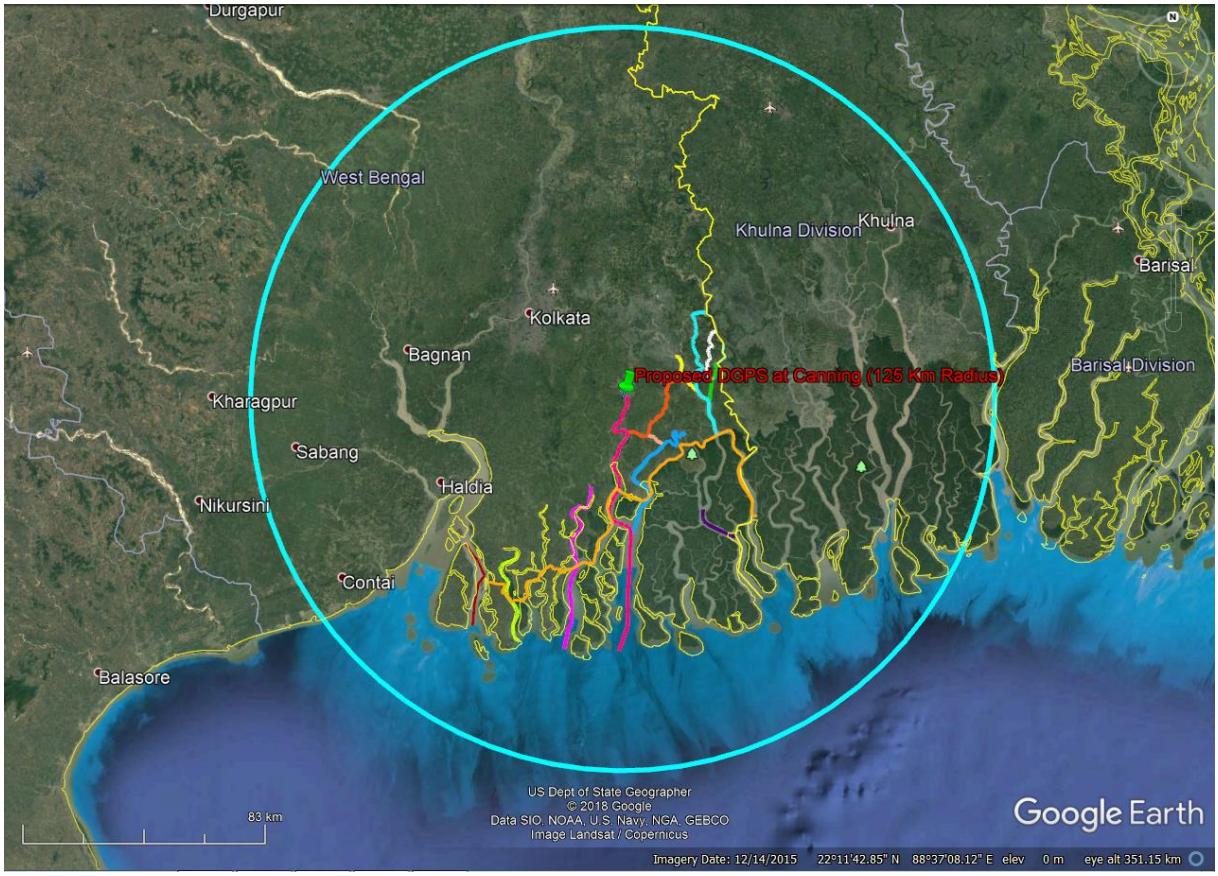


Figure 22: Google Earth image showing location map of proposed DGPS and effective coverage

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 19: 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 at Godkhali Jetty in Gomar Waterway will cover the complete stretch of Gomar waterway as shown in **Figure 23** below. The capital and O&M cost of proposed RIS station is provided in this Gomar waterway DPR.

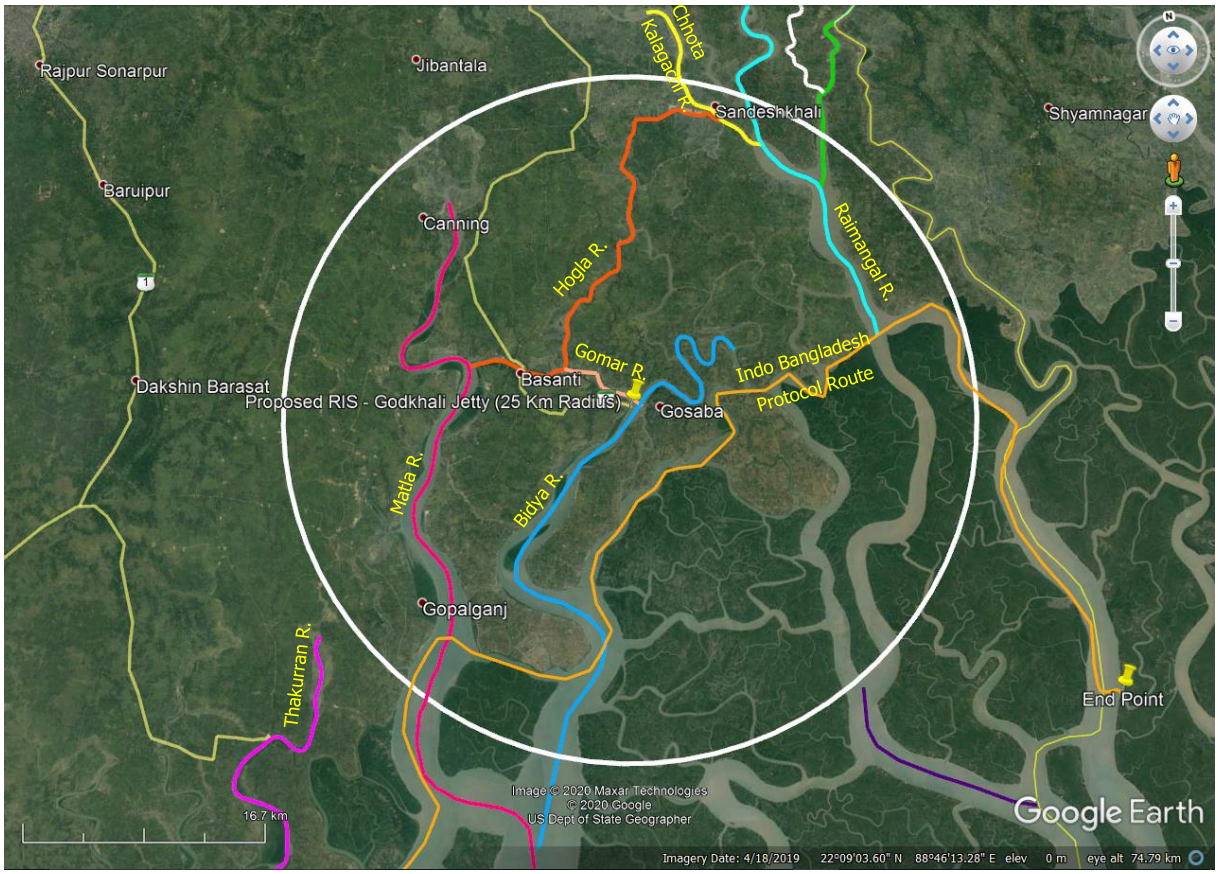


Figure 23: Google Earth image showing location map of proposed RIS and effective coverage

8.2 NIGHT NAVIGATION FACILITIES

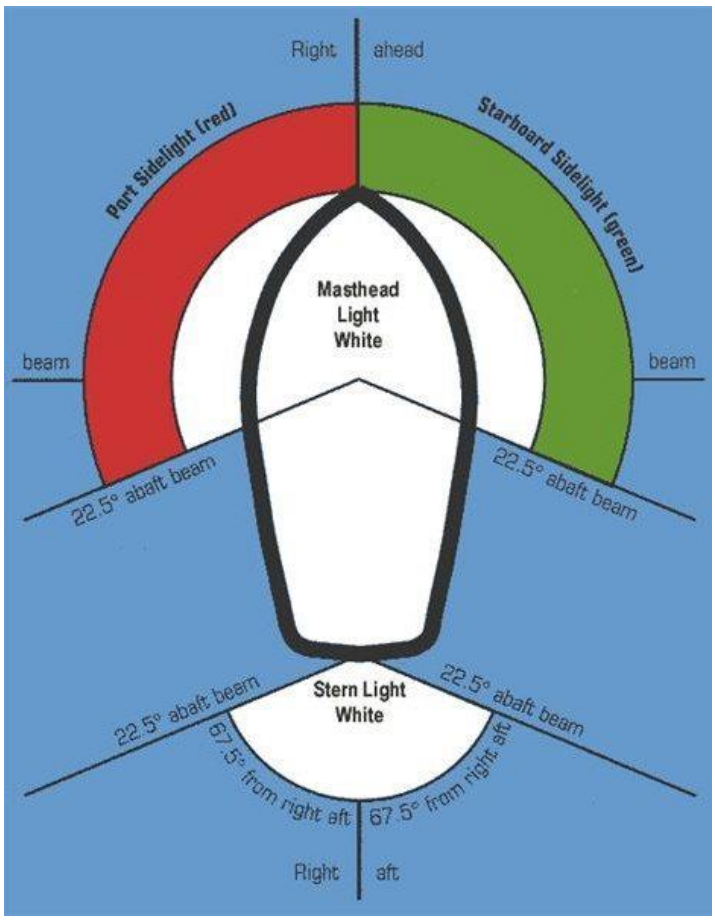
On sectors of the river where there is day and night navigation, forks, junctions and the axis of the fairway, along with obstacles to navigation lying within the fairway, shall be marked by light buoys or bank marks and lights. Floating signs shall be installed at such a depth and at such a distance 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:

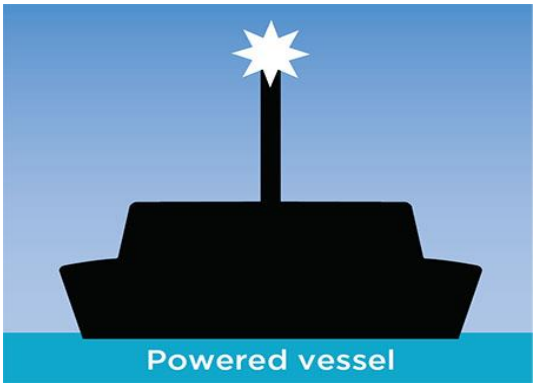


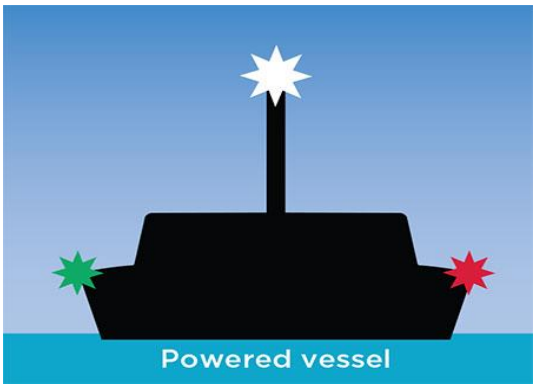
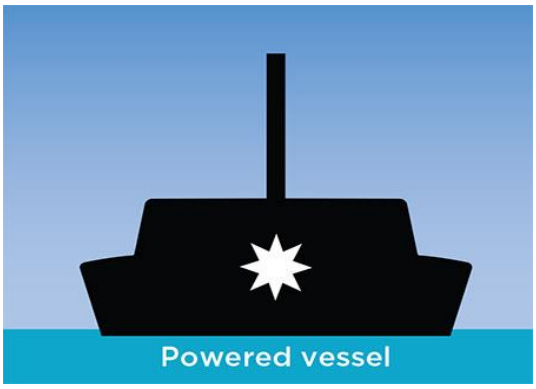
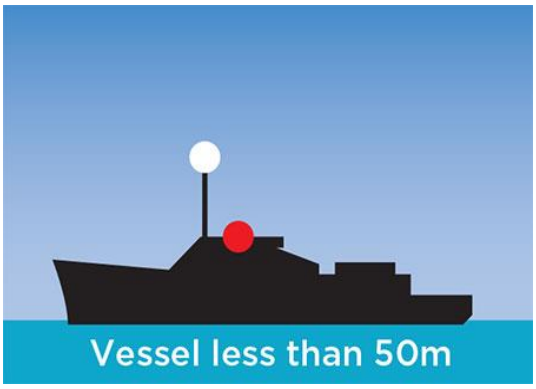
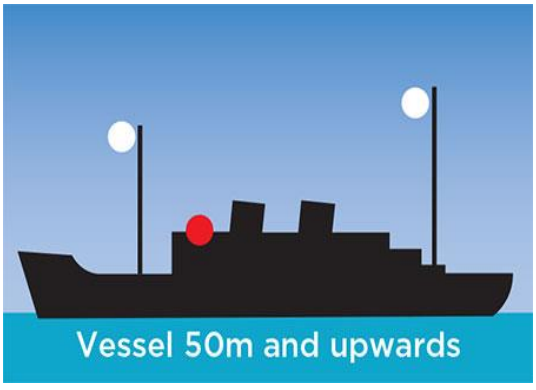
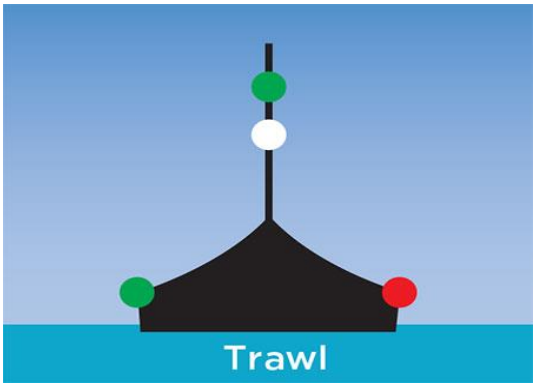
- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.
- 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 6.711 Km of Gomar River is proposed for development as national waterway. Presently, ferry services are operational along the river. The ferry services are operated by locals and no safety, 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 24** 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 24: Relation between Services and RI Systems

8.5 COSTING

The following criteria have been 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) CAMC for minimum three years has been considered after one year warranty from the date of commissioning.

iv) As Gomar 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.

8.5.1 Capital Cost

Table 20: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lakh)
A	**RIS System**			
1	AIS Base Station	1	30,00,000.00	30.00
2	RADAR	1	100,00,000.00	100.00
3	Meteo Sensor	1	7,00,000.00	7.00
4	ATG	1	9,00,000.00	9.00
5	VHF	1	5,00,000.00	5.00
6	DG Set 10 KVA	1	7,00,000.00	7.00
7	UPS	1	5,00,000.00	5.00
8	RIS Software	1	35,00,000.00	35.00
9	Installation Testing & Commissioning	1	20,00,000.00	20.00
10	Porta cabin	2	12,00,000.00	24.00
11	Trestle Tower	1	10,00,000.00	10.00
			Total cost of one RIS system	252.00
12	Construction Supervision, Design and Engineering charges		6%	15.12
			Capital cost per RIS system	**267.12**
B	Marine Lantern/Buoys of 1.25 m dia	5	2,00,000	**10.00**
			Capital Cost in Lakh	**277.12**
13	Contingencies Charges		3%	8.31
D	**Total Navigation & Communication Cost in Lakh**			**285.43**

8.5.2 O&M Cost

The operation and maintenance cost works out to as below:

Table 21: O&M Cost for Aids to Navigation and Communication

Sr. No.	Manpower	Qty	Unit Price (INR)	Total (INR Lakh)
1	Engineer 1 * Site 1 * Months 12 per year	12	35,000.00	4.20
	Operator 3 * Site 1 * Months 12 per year	36	20,000.00	7.20
	Security 3 * Site 1 * Months 12 per year	36	15,000.00	5.40
2	Second Year			17.98
3	Third Year			19.23
4	Fourth Year			20.58
			Total	**74.59**
	CAMC for 4 Years			
1	1st Year	1		28.54
2	2nd Year	1		31.40
3	3rd Year	1		34.54
			Total	**94.48**
	Overall O&M Cost in INR Lakh			**169.07**

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.

The section of Gomar River from Km 0.000 to Km 6.711 falling in South 24 Parganas District of West Bengal State is also considered for Sunderban waterways and declared as National Waterway No. 97 (NW-97).

Gomar is a tidal estuarine river in South 24 Parganas district West Bengal, India. The river is basically an interlinking river between Bidya and Hogla rivers. Gomar river meets Bidya river at Gosaba and meets Hogla at Ramchandrakhali

Gomar River has two tributaries/creeks on its banks. Details of the creeks are given in **Table 22.**

Table 22: List of Creeks

Sl No	Creek	Chainage	Length(Km)
1	Ramkrishnapur	3.37	1.316
2	Tentultala	5.84	7.74

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 entire study stretch is in South 24-Parganas district. South 24 Parganas district lies between $22^0$12'13"N and $22^0$46'55"N latitude and its longitudes are $87^0$58'45"E and $88^0$22'10"E covering an area of 9,960 sq. km. Alipore is the district headquarters of South 24 Parganas. It is the largest district of West Bengal in terms of area with a very small proportion of urban settlements. A large portion of the district is included in the Forests of Sundarbans.

Geographically, district South 24 Parganas lies in the lowest course of river Ganga at the Southern-most part of Gangetic West Bengal. The entire drainage pattern of the district is heavily incumbent upon the tidal forces of Bay of Bengal. There are numerous mudflats, coastal wetlands, lagoons, creeks and estuaries of large rivers in the district. The most important rivers of the district are Hooghly (the final course of Ganga), Bidyadhari, Matla, Piyali, Raymangal, Thakuran, Raidighi, Bidya, Saptamukhi (owing to its seven channels), Hataniya-Doaniya etc. There are many streams and rivulets known as Khal and forested Swamps and marshy wetlands known as Bil (also spelt asBeel). Most of the rivers are joined with each other through these channels, naturally or erected by human, and forms a web like river-network spread over the larger share of the district. Due to tidal activity in the Bay of Bengal, most of these rivers changes theirs paths often and forms small water bodies through-out the district. The sea water can enter as far as 100 km. from the coastal lines through these river streams. There are many other small rivers passing through the district, most of them are directly connected to the Bay of Bengal and are influenced by the Tidal waves.

The physiograhiy of the entire district is situated in the Gangetic delta. A large every area in the southern part of the district is covered with the dense jungle of Sundarban with numerous rivers and its tributaries in between. Numerous islands are thus found in this area. Some of these islands remain totally sub-merged under water. In the northern part of the district we find the Baruipur-Jaynagar Plain and Kulpi-Diamond Harbour Plain which is 5-6 meters above the sea level. Here the process of land making process is still going on.The district could be divided into 4 sub-micro regions viz. (a) South Hugli Flats (b) South Bidyadhari Plain (c) Hooghly Delta, and (d) Sundarbans.

South Hugli Flats: From the northern boundary of the district (Kolkata) to Diamond Harbour in the south, this is a narrow flat alluvial land along the river of Hooghly which also forms the district boundary in the west. Flowing south-west, Hooghly receives the Rupnarayan River in the Hugli point and then turns east for about 12 km. until it reach Diamond Harbour. From there it again turns

southwards and falls into Bay of Bengal. The Hugli is a navigable river and ships reach Kolkata Port through this river during high tides.

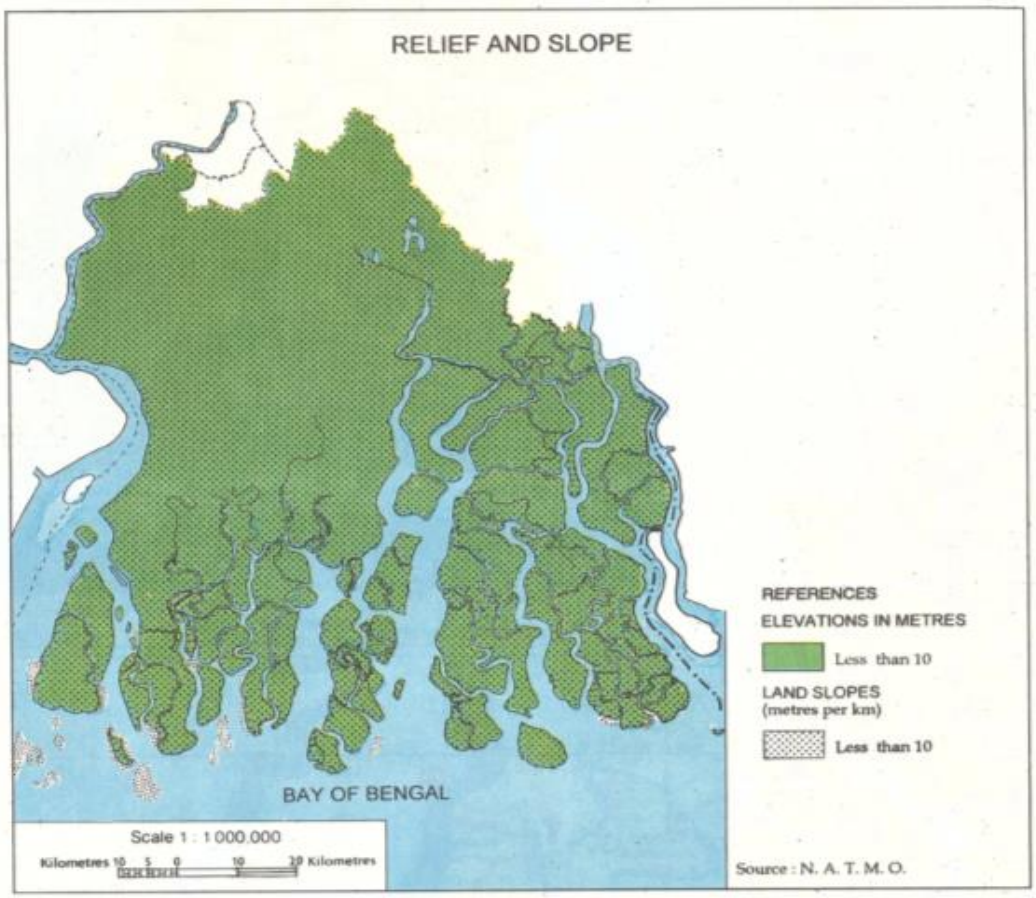
South Bidyadhari Plain: This plain area has its general slope towards the south. Situated in the northern part of the district, river Matla is the most prominent river of this plain. There are many streams and water channels which are locally known as khals.

Hooghly Delta: Lying in the south-western part of the district, the Hooghly river forms the district boundary in the west. The river falls into the Bay of Bengal and has a southern slop. Before falling into Bay of Bengal, it bifurcates into two channels. The main channel is passing to the west and the other called Baratala to the east of Sagar Island. The southern part of the Hugli Delta has numerous channels and islands of which Henry's Island, Sagar Island, Frederick Island and Fraserganj Island are some of the worth mentioning islands. It is a land of strong tides and tides sometimes reaches a height of 3 to 5 metres.

Sundarbans: Almost the entire area under Indian part of Sundarban is contained in district South Twenty Four Parganas. A dense mangrove forest amongst numerous rivers and streams, thousands of islands, rich flora and fauna along with human presence has made Sundarbans world famous. The area is known for the Royal Bengal Tiger (Pantheratigris tigris), as well as numerous fauna including species of birds, spotted deer, crocodiles and snakes. The fertile soil of Sundarbans helps intensive agriculture. Rightly designated as among the 'new seven wonders of nature', Sundarbans functions as a protective barrier for millions of inhabitants living in the southern part of the district.

Sundarbans is stretched between India and Bangladesh with India's share is only 19 percent. The Bay of Bengal lies in the southern part of Sundarbans and the rivers of the region falls there. Thus it has become a region of transition between the fresh water of the rivers and the saline water of the Bay of Bengal.

Relief and Slope Map of South 24 Parganas District are furnished in **Figure 25**.



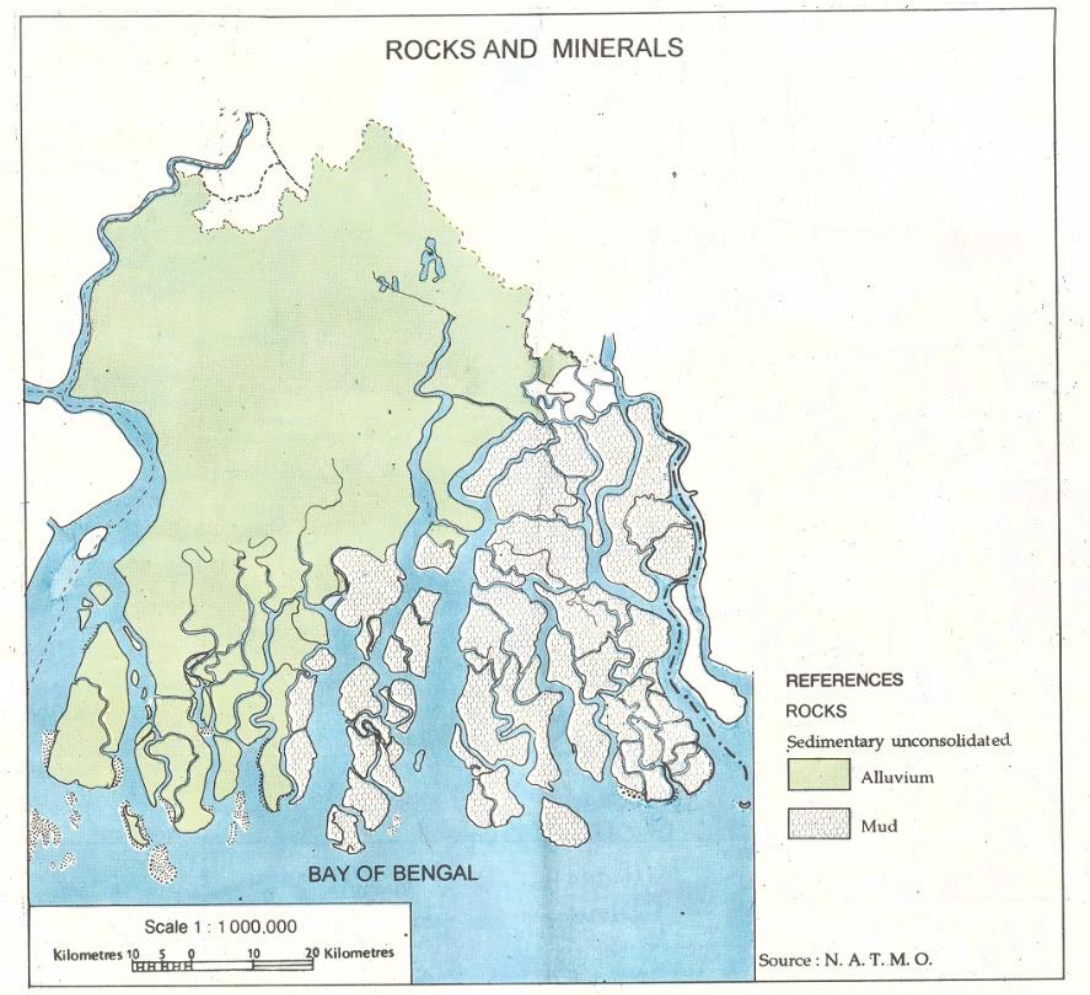
Source : NATMO

Figure 25: Relief and Slope Map of South 24 Parganas District

9.2.2 Geology and Seismicity

Geology:

The district of South 24-Parganas is covered with recent alluvium, which is of great depth. Once a boring was conducted near Akra Road, Garden Reach which found no signs of rocky bottom or marine beds even when dug at a depth of 1,306 feet. In the eastern and central parts, the surface soil is chiefly a clayey loam with some peaty patches in the marshy areas. Surface soil in the Sundarbans area is heavy clay impregnated with salt. The borings conducted in the region indicate that the alluvium of the area consists of alterations of clay, sand and silt. Kankar (very tiny pieces of stone) is mixed with sands and clays. Even the stumps of sundri trees have been found at Sealdah in Kolkata at various levels down to a depth of thirty feet. The Rock and Mineral Map of South 24 Parganas District is presented in **Figure 26**.

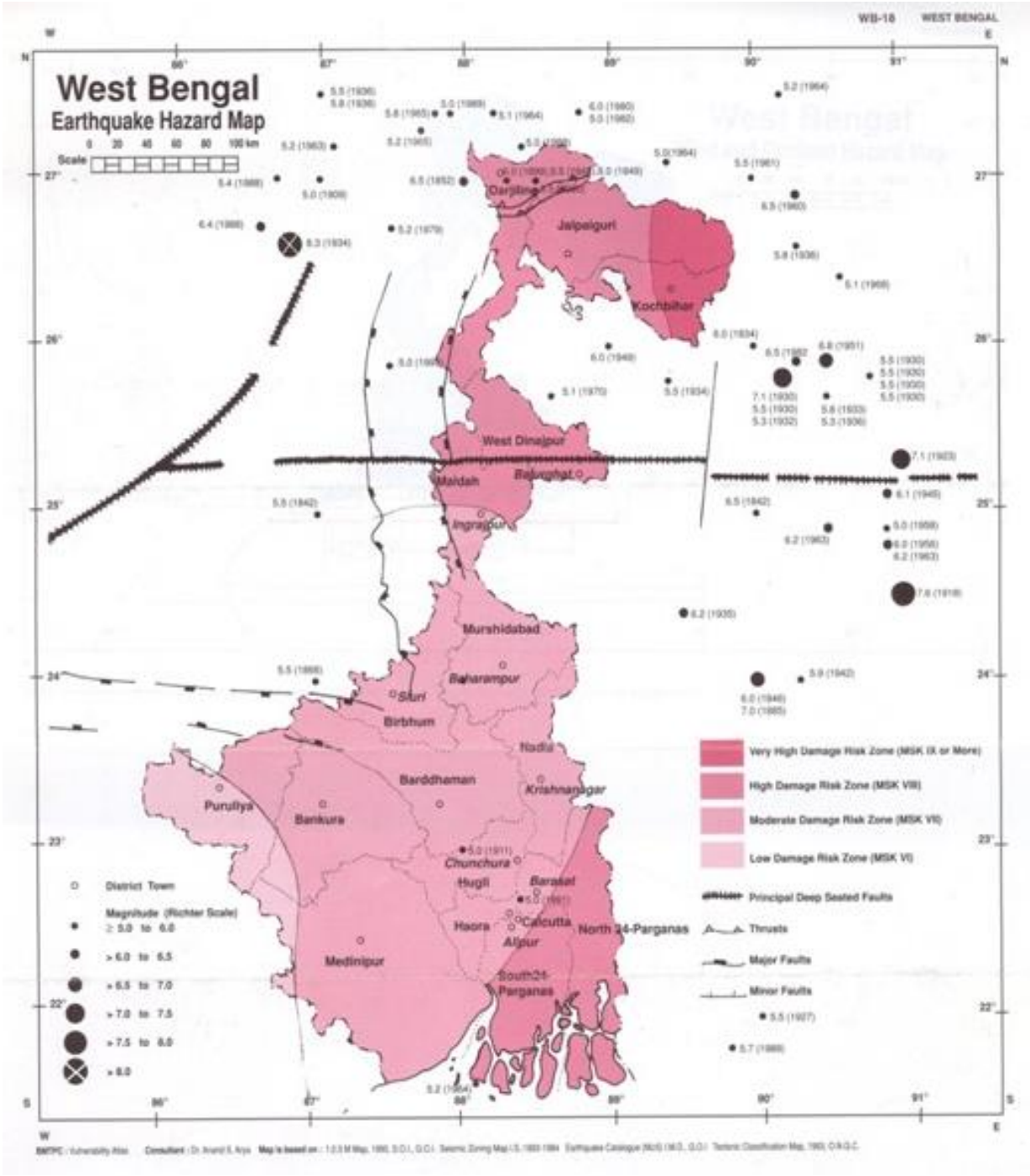


Source : NATMO

Figure 26: Rock and Mineral Map of South 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 27**.



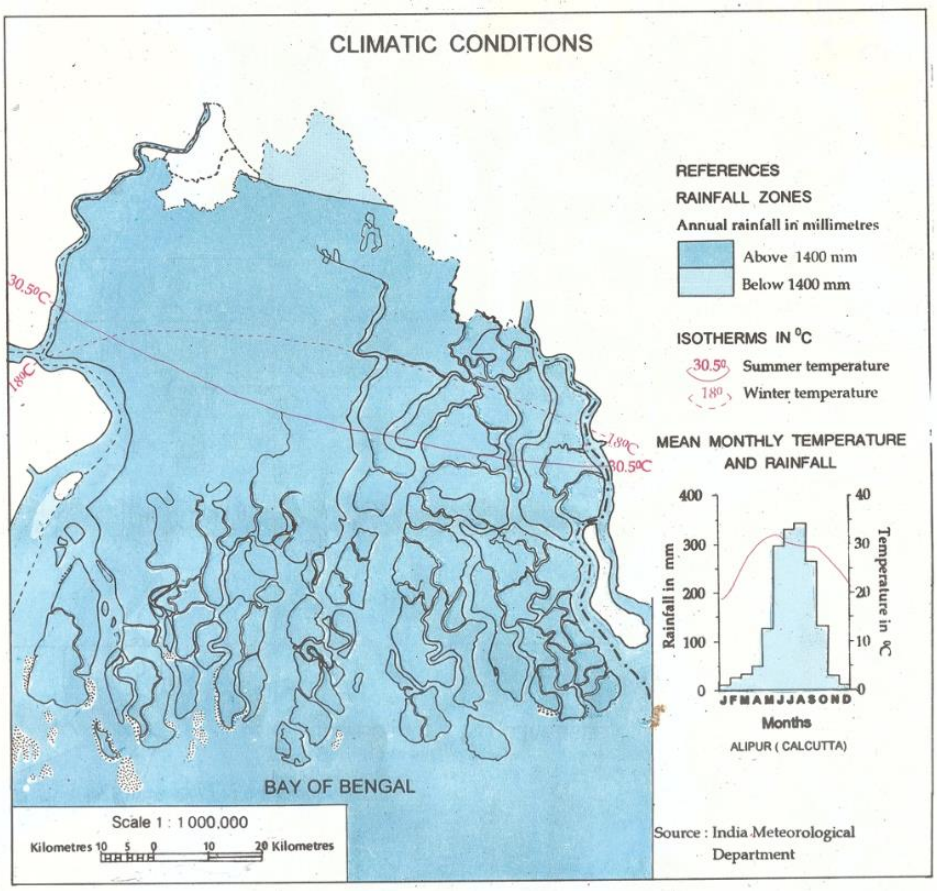
Source : West Bengal Disaster Management Department

Figure 27: Earthquake Zoning map of West Bengal

9.2.3 Climate

The normal climate of the district is hot and humid throughout the year with well distributed rainfall during the monsoon season. The maximum temperature as recorded is 37°C and the minimum is 9°C.

It may be noted that the skies are moderately clouded in May, heavily clouded in monsoon season and clear or lightly clouded during rest of the year. Winds are generally stronger in Sundarbans and its surroundings. Nor'westers from March to May and the Bay cyclones during the monsoon ravage the land every year. The climatic condition of the district is shown in **Figure 28**.



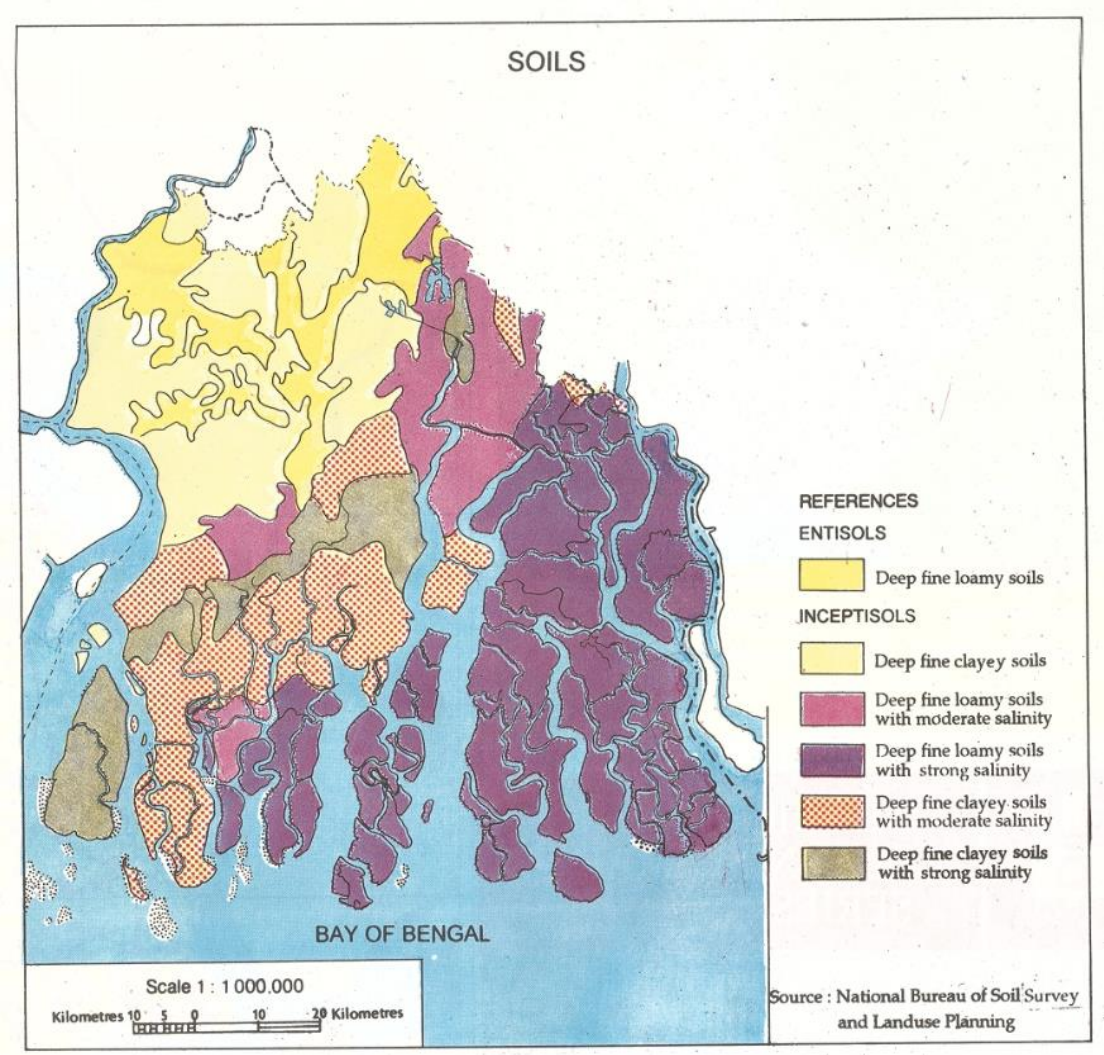
Source : NATMO

Figure 28: Climatic condition of South 24 Parganas District

9.2.4 Soil

The presence of numerous rivers, khals and bils with Bay of Bengal covering almost the whole of the south has divided the soil of the district into two broad categories viz. non-saline soils and coastal soils of tidal origin. The direct deposits of Ganga alluvium is salt free and rich in calcium or magnesium and thus rich in nutrients. The indirect deposits of Ganga alluvium is formed by the water going to sea, getting salty and re-entering the main land through tides.

Costal soils in the district of south 24 parganas are distributed over the police sation of Gosaba, basanti, Canning, Bhangar, Mograhat, Diamond Harbour, Falta, Mandir Bazar, Joymagar, Kultali, Mathurapur, Kulpi, Patharpratima, Namkhana and Sagar. Considering the trends in the soil salinity fluctuations, ground water table condition, natural vegetation, cropping practices, watershed areas draining into costal water and other features relevant to costal agro ecosystem. The soil map of the district is given in **Figure 29**.



Source : NATMO

Figure 29: Soil Map of South 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 also located along the waterway. There are a large number of small guest houses, ashrams, hotels etc. to cater for tourists.

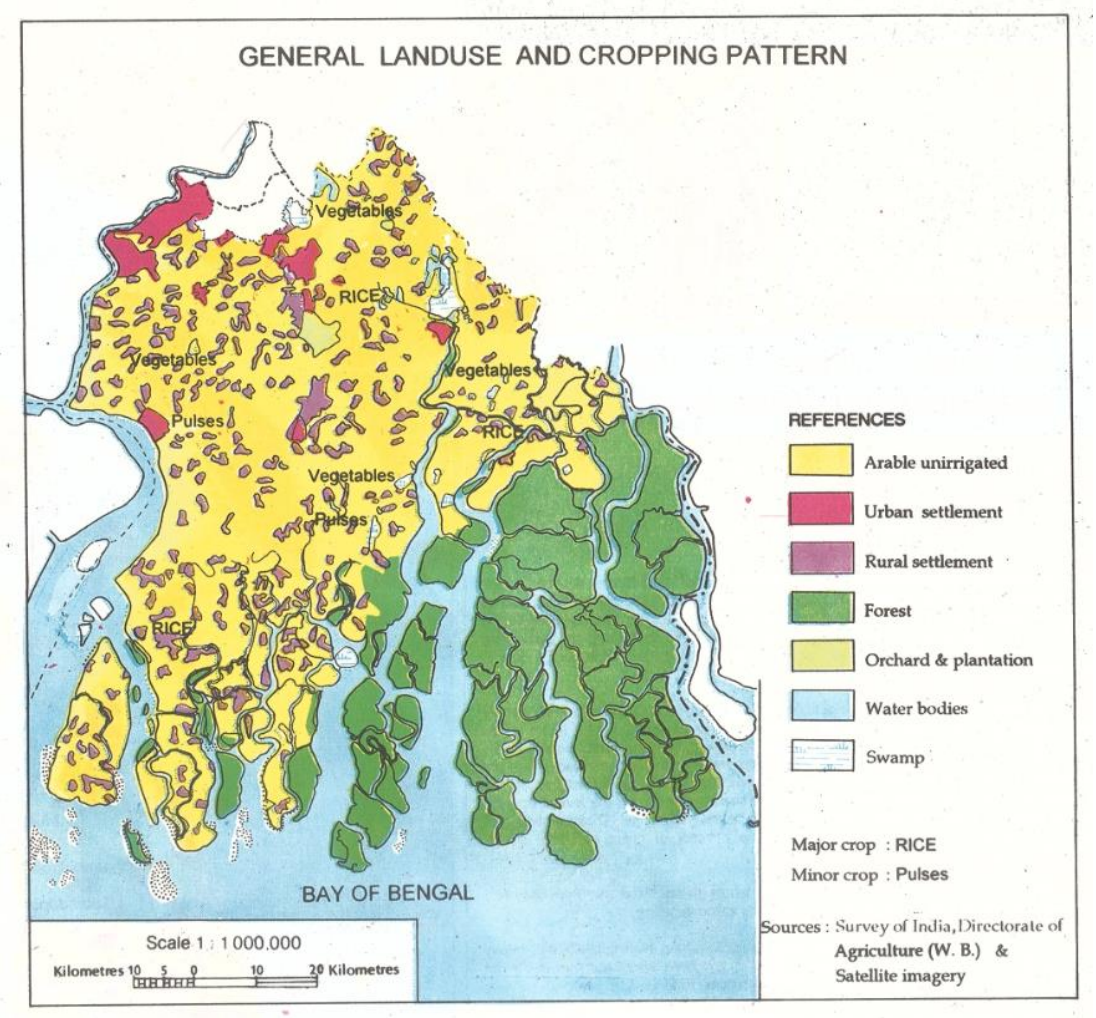
Land use pattern of the project influenced district is presented in **Table 23**.

Table 23: Land Utilization Pattern of the South 24-Parganas district (Area in '000 ha.)

Year	Reporting Area	Forest Area (C)	Area under Non-agricultural use	Barren & unculturable land	Permanent pastures & other grazing land	Land under misc. tree groves not included in Net area sown	Culturable waste land	Fallow land other than current fallow	Current fallow	Net area sown
2006-07	948.71	426.36	136.15	0.40	0.01	2.09	0.74	0.09	10.08	372.79
2007-08	948.71	426.30	138.30	0.44	0.05	2.94	0.04	0.18	8.16	372.30
2008-09	948.71	426.30	140.06	0.44	0.04	2.86	0.50	0.20	4.63	373.66
2009-10	948.71	426.30	141.30	0.47	-	2.69	1.47	0.03	18.91	357.54
2010-11	948.71	426.30	143.32	0.07	0.02	2.56	1.34	0.01	16.69	358.40

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

The district is situated in the Proper Delta of Lower Ganga Plain. It is little higher above the flood level and the physical features are similar to deltaic land of the country. The northern inland tract is fairly well raised delta and the southern portion is a low lying Sundarbans towards the seaboard. The Sundarbans are a network of tidal channels, river creeks and islands. There are some swampy marshes covered with low forest and scrub wood. The low land gradually declines towards the coast. The land use pattern of the district is given in **Figure 30**.



Source: NATMO

Figure 30 : Land Use Map of South 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 Gomar River was free from dust. However, it was also confirmed from the local villagers that there is no problem of Air pollution, as there is less commercial activities and movements of human beings. Also there is no major industrial development along the waterway stretch. The nearest ambient air quality at Kakdwip Area is given in **Table 24**.

Table 24: Ambient Air Quality near Kakdwip Area

Location	Parameters				
	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
Kakdwip Area, near KoPT Jetty	73.88	38.13	7.02	25.11	0.29

Source : EIA STUDY OF BSL'S MARINE INDUSTRIAL CLUSTER AT KULPI, August 2017

9.2.7 Ambient Noise Level

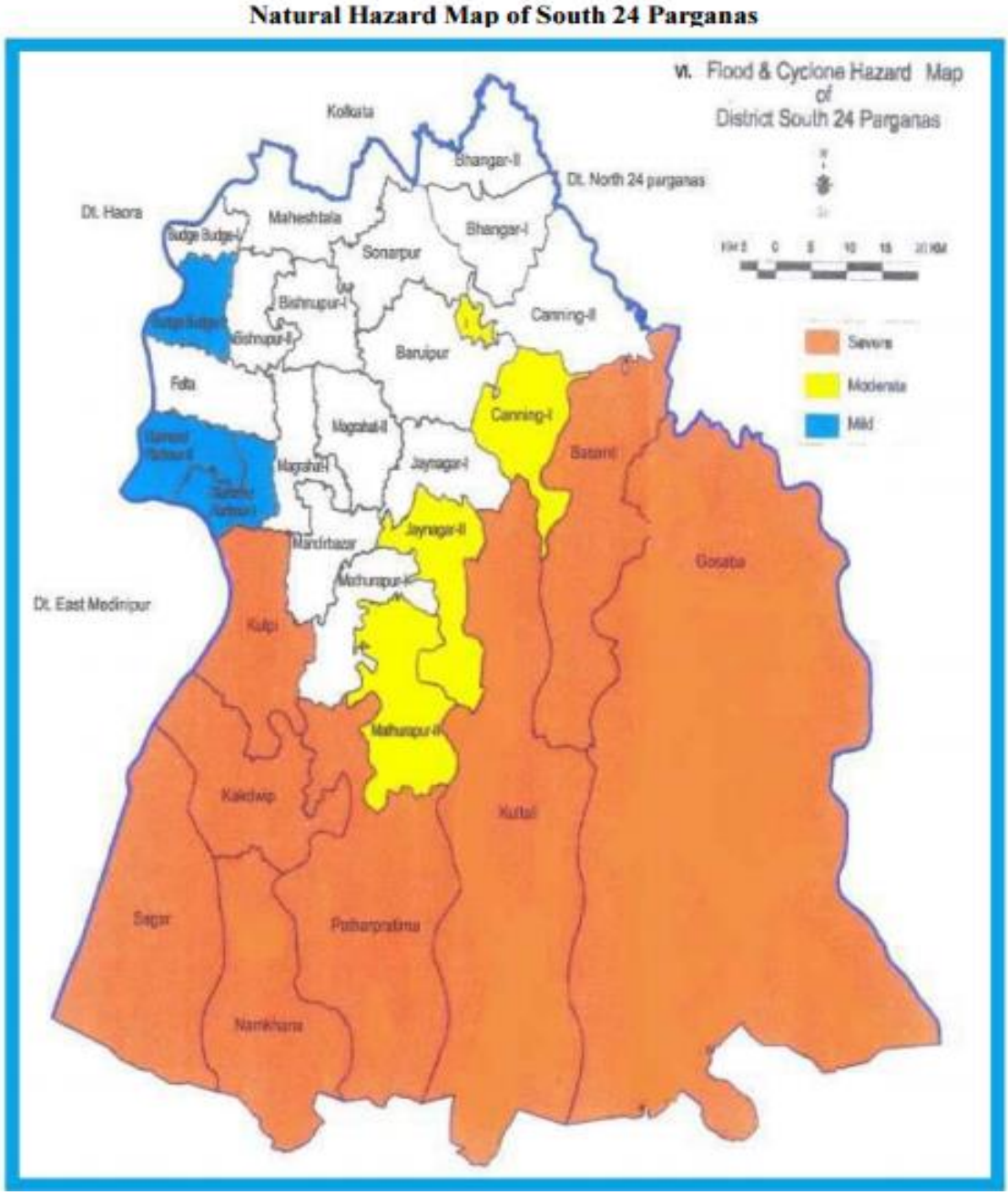
During the reconnaissance survey, it was the found Noise is not big issues in the surrounding areas of Gomar River. There are not any noises generating sources in the nearby areas.

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**

River and coastal flooding are the most frequently occurring natural disaster and are increasing in occurrence more rapidly than any other disaster. Urbanization and deforestation reduce the capability of the earth to hold excess water. As asphalt- and concrete-covered surfaces expand and open spaces disappear at the edges of metropolitan areas, it takes less rain to flood communities as water running over the pavement collects quickly and easily disrupts storm drain systems. Those areas which are most at risk for floods include low-lying areas, coastal regions and communities on rivers downstream from dams. Flood waters are extremely dangerous; a mere six inches of swiftly moving water can knock people off their feet.



Source: District Disaster Management Plan, South 24 Parganas 2017

Figure 31: Natural Hazard Map of South 24 Parganas

- **Susceptibility to Earth Quake**

Earthquakes are one of the most powerful natural forces on earth and regularly affect people around the world. Earthquakes can have a range of magnitudes with the strongest having devastating

consequences for the areas where they are centered, nearby areas, and even some far away in the case of earthquake-generated tsunamis.

Most earthquakes are quite small but are not readily felt. Larger and more violent earthquakes are those that occur in a release of energy as the plates slide past or collide into one another.

Large earthquakes can focus on the boundaries where two plates meet, but they are not limited to these areas. As the plates move, fractures in the earth's crust develop and earthquakes are often located on them. These fractures are referred to as faults, and all generate earthquakes when they move.

The impacts of earthquakes vary based on their energy and intensity. The strongest earthquakes that occur can result in ground rupture, causing damage to bridges, dams, roads, railroad tracks, and the foundations of buildings. They can also cause landslides and avalanches as a result of the shaking. Intense shaking can also cause liquification of ground built on landfill when water mains break. The shaking of an earthquake is increased in areas of landfill.

South 24 Parganas fall under Zone IV of the Seismic Zone of India. On 15th April 1964, largest instrumented Earthquake occurred in Sagar Island with Magnitude 5.2.

- **Susceptibility to Wind and Cyclones**

Cyclones are natural events, which cannot be prevented. Cyclones form in certain favourable atmospheric and oceanic conditions. There are marked seasonal variations in their places of origin, tracks and attainment of intensities. These behaviours help in predicting their movements. Pre and Post monsoon storms are more violent than the storms of the monsoon season. The coastal stretch of West Bengal, especially in South 24 Parganas is necessarily highly vulnerable to cyclone. The phenomenal storm surge in coastal West Bengal is due to its peculiar bathymetry and nature of coastal belt. As a result when a very severe cyclonic storm or a hurricane approaches the coast, the enormous storm surge generated by the wind pressure submerges the coastal belt at the time of the storm crossing the belt. The frequency of storms crossing this belt is also high. Another peculiar characteristic of this coast is that it is crisscrossed by innumerable rivers and rivulets, with the elevation of the islands about 4 to 5 meters. The seadykes and embankment are not strong enough to resist strong wind-driven waves and naturally cave in during depression / cyclonic storm situation.

A heavy cyclone accompanied by a sea wave, is the worst kind of disaster which may occur in this delta. Disasters of this kind have caused appalling mortality in the past and will possibly do so again.

Practically, nothing can be done to avoid them but fortunately they are not frequent. They are most likely to occur at the beginning or at the end of rains, i.e., either before the winter paddy is planted or at a time when it is almost ripe. Under such circumstances the damage to crops may be small in comparison with the mortality among men and cattle which may be enormous. The maritime districts of West Bengal are liable to storm waves but South 24 Parganas has suffered most severely.

The district experiences two Cyclone seasons – pre-monsoon and post-monsoon cyclone during April-May and Nov-Dec, respectively. Pre-monsoon cyclone, which causes wide spread hailstorm and it is traditionally called as Kalbaishaki. The district is located in very high damage risk zone (V=50m/s) with respect to Cyclone. The historical Records of devastating cyclone are given in **Table 25**.

Table 25: **Historical records of most devastating cyclones in South 24-Pargana district**

S. No.	Date	Cyclone	Description
1.	**7-12 October, 1737**	Super Cyclone*	Crossed West Bengal coast over Sunderbans **Surge height:** 12 m **Loss of life:** 300,000
2.	**2-5 October, 1864**	Very Severe Cyclonic Storm	Cross the coast near Contai, West Bengal Surge Height: The wave in many places rose to 9 m The Maximum height of the waves reached 12 m. At Sagar Island it was 5 m above land level. At Diamond Harbour, the wave was 3 m **Loss and Damage:** People Killed=**50,000** (mostly due to drowning), and **30,000** (due to diseases as a result of inundation)
3.	**23-26 May, 2009**	Severe Cyclonic Storm	Crossed close to the east of Sagar Island **Surge Height:** 3-5 m **Loss and Damage:** People Killed=137, Cattle heads Killed= 50,000

9.2.9 Estuary and Coastal Zone

The District is interspersed with innumerable drainage channelsincluding some important rivers, creeks, cross - channels and several man-made drainage-cum-irrigation canals. More particularly in the south and south-eastern parts of the District, this drainage network has attained a complex

pattern due to the presence of numerous crosschannels which ultimately join the major tidal creeks. They have given rise to a large number of islands of various shapes and sizes. These deltaic and tidal streams have their off-take points further upstream either in the Ganga or in the Padma River. To the west of the District, the Bhagirathi - Hooghly is the most important stream of this system. The lower tidal portion of this stream is called as the Hooghly, while the upper non-tidal portion is known as the Bhagirathi.

Coastal ecosystem" includes estuaries and coastal waters and lands located at the lower end of drainage basins, where streams and river systems meet the sea and are mixed by tides. The coastal ecosystem includes saline, brackish (mixed saline and fresh) and fresh waters, as well as coastlines and the adjacent lands. All these water and landforms interact as integrated ecological units. Shore-lands, dunes, sandbars, offshore islands, headlands, and freshwater wetlands within estuarine drainages are included in the definition since these interrelated features are crucial to coastal fish and wildlife and their habitats. Mangroves are located all along estuarine areas, deltas, tidal creeks, mud flats, salt marshes and extend over 4871 sq. km (about 7% of world's mangrove areas). Impact of global warming- induced sea level rise due to thermal expansion is more pronounced in the Bay of Bengal due to the shallowness of the waters. The entire coastal ecosystem in general and the eastern coast in particular are highly vulnerable due to flat and low terrain, high population density, over exploitation of natural resources, high rate of environmental degradation on account of pollution and non-sustainable development. On many occasions, the livelihood requirements of people are detrimental to maintaining the delicate balance of the fragile coastal ecosystem. Degradation of the eco-system not only affects the environment adversely, but also makes the people living in the coastal areas more vulnerable.

In general, these rivers show a north-south trend, but some of them maintain south-easterly course as well. Besides variations in local slopes, existence of pockets of depressions or raised grounds also influences the alignments of local drainage system. These channels ultimately find their ways to the Bay of Bengal through any one of the principal estuaries, starting from the Hooghly estuary forming the western-most boundary of the District to the Raimangal in the east. Other principal estuaries are the Baratala (a distributary of the Hooghly), the Saptamukhi, the Thakuran, the Matla and the Gosaba. Amongst these, the Hooghly in the extreme west and the Ichamati - Kalindi- Raimangal system receive some fresh water supply from their upstream zones. The supply of fresh water increases during monsoon rain. All other estuaries are beheaded and have become entirely tidal. These estuaries were the lower courses of the Ganga off-shoots in different phases of recent past. Though the upper courses of these rivers are totally disconnected from fresh water supply due to

heavy siltation in their feeder channels, their lower courses still remain active owing to regular tidal flow. All these estuaries are inter-connected by intricate network of cross-channels which are generally developed at right angles to the main estuaries.

The estuaries in the western part of the District with the exception of the Hooghly are smaller in length compared to those in the eastern part. The Muriganga or Baratala estuary along Namkhana - Kakdwip area is only 15 Kms. long while the Raimangal stretches via the Kalindi and the Ichamati for about 60 Kms. near Hasnabad - Hingalganj area. The inland extensions of active cross channels are rather constricted in the western part than in the east.

The drainage regime can be divided distinctly into two parts taking the Matla River as the axis. The Matla is a very wide estuary comparable with the Hooghly near the sea face. It becomes very turbulent during the monsoon months. But the upper course of the Matla from Canning to Basanti is seriously affected by excessive silt deposition. The Bidyadhari, the Karati and the Atrabeki have drained into the Matla at Canning. This section has been completely silted up. The Atrabeki, which was once a connecting channel between Matla and the north-western channel of Raimangal has now ceased to be active. The upper courses of Harinbhanga – Jhilla - Raimangal have become hydrologically more efficient due to increased tidal activities. Even in the Haroagang, flow tides are progressing via Jhilla-Raimangal creek. The tract lying in between Saptamukhi and Harinbhanga, to the south of the embanked area is truely in active phase where continuous deposition is in progress.

9.2.10 Archaeological and Heritage Locations

Jatar deul temple is an archaeological site located in the stony alluvial and bushy landscape of the western Sundarbans, which is about 35 km from the project river.

Sunderbans Biosphere Reserve, a World Heritage Site and International Biosphere Reserve declared by UNESCO is located in the district.

9.2.11 Flora and Fauna

Flora

It is easily understood that from the above discussion that this area is rich in flora. Practically the whole district is covered with mature and active parts of Gangetic Delta. The southern plains surround the mature delta, the Sundarbans surrounds the active parts of Gangetic Delta. In the mature delta, cultivated crops have replaced the natural cover. Various kinds of vegetables, cereals, pulses, fibre

plants, oil seed crops and other food accessories are found in the region. Rice is the most important cereal of the district. Exotic varieties of fruit trees, bamboo groves, flowers and scrubs are also found.

In a comprehensive study performed by David Prain in 1903 it is seen that Sundarbans have a total of 245 genera and 334 plant species. The Sundarbans flora is characterised by the abundance of Sundari (*Heritiera fomes*), gewa (*Excoecaria agallocha*), goran (*Ceriops decandra*) and keora (*Sonneratia apetala*) all of which occur prominently throughout the area. There is abundance of dhundul or passur (*Xylocarpus granatum*) and kankra (*Bruguiera gymnorrhiza*) though distribution is discontinuous. Among palms *Poresia coaractata*, *Myriostachya wightiana* and golpata (*Nypa fruticans*), and among grasses spear grass (*Imperata cylindrica*) and khagra (*Phragmites karka*) are well distributed.

Fauna

The Sundarbans provides a unique ecosystem and a rich wildlife habitat. According to the latest Tiger Census, the Sundarbans have about 270 tigers (*Panthera tigris tigris*). But the encouraging fact is that the number of this endangered species is increasing. The Royal Bengal Tiger (*Panthera tigris tigris*) of Sundarban is one of the most majestic animals of the world.

Apart from tiger, there is much more wildlife. Most importantly, mangroves are a transition from the marine to freshwater and terrestrial systems and provide critical habitat for numerous species of small fish, crabs, shrimps and other crustaceans that adapt to feed and shelter, and reproduce among the tangled mass of roots, known as *pneumatophores*, which grow upward from the anaerobic mud to get the supply of oxygen. Animals like leopard (*Panthera pardus fusca*) and several other smaller predators such as the jungle cats (*Felis chaus*), fishing cats (*Prionailurus viverrinus*) and leopard cats (*Prionailurus bengalensis*) are also found in this jungle. Also chital deer (*axis axis*), Indian muntjacs (*Muntiacus muntjak*), wild boars (*Sus scrofa*), rhesus macaque (*Macaca mulatta*) and about 30,000 spotted deer (*axis axis*) are found in the area. Sundarbans supports diverse biological resources which include at least 150 species of commercially important fish, 270 species of birds, 42 species of mammals, 35 reptiles and 8 amphibian species. This region is an important wintering area for migrant water birds also and is an area suitable for watching and studying avifauna. Some of the reptiles are predators too, including two species of crocodiles (*Crocodylina*e), the saltwater crocodile (*Crocodylus porosus*) and mugger crocodile (*Crocodylus palustris*), as well as the gharial (*Gavialis gangeticus*) and the water monitor lizards (*Varanus salvator*), all of which hunt on both land and water. Sharks and the Gangetic dolphins (*Platanista gangetica*) roam the waterways.

Avifauna

Sundarbans is the home of 170 species of bird life including the endemic brown-winged kingfishers (*Pelargopsis amauroptera*) and the globally threatened lesser adjutants (*Leptoptilos javanicus*) and masked finfoots (*Heliopais personata*) and birds of prey such as the ospreys (*Pandion haliaetus*), white-bellied sea eagles (*Haliaeetus leucogaster*) and grey-headed fish eagles (*Ichthyophaga ichthyaetus*). Other noteworthy birds found in this area are open billed storks (*Anastomus oscitans*), black-headed ibis (*Threskiornis melanocephalus*), water hens (*Amaurornis sp*), coots (*Fulica sp*), pheasant-tailed jacanas (*Hydrophasianus sp*), pariah kites (*Milvus migrans*), brahminy kites (*Haliastur indus*), marsh harriers (*Circus aeruginosus*), swamp partridges (*Francolinus gularis*), red jungle fowls, spotted doves(*Spilopelia chinensis*), common mynahs (*Acridotheres tristis*), jungle babblers (*Turdoides sp*), herring gulls (*Larus sp*), caspian terns (*Hydroprogne caspia*), gray herons (*Ardea cinerea*), brahminy ducks (*Tadorna ferruginea*), spot-billed pelicans (*Pelecanus philippensis*), great egrets (*Ardea alba*), night herons (*Nycticorax nycticorax*), common snipes (*Gallinago gallinago*), wood sandpipers (*Tringa glareola*), green pigeons (*Treron phoenicoptera*), rose-ringed parakeets (*Psittacula krameri*), paradise flycatchers (*Terpsiphone paradisi*), cormorants (*Phalacrocorax sp*), white-bellied sea eagles (*Haliaeetus leucogaster*), common kingfishers (*Alcedo atthis*), peregrine falcons (*Falco peregrinus*),various woodpeckers, whimbrels (*Numenius phaeopus*), black-tailed godwits (*Limosa limosa*), little stints (*Calidris minuta*), curlews (*Numenius sp*), golden plovers (*Pluvialis fulva*), pintails (*Anas acuta*), white-eyed pochards (*Aythya nyroca*), lesser whistling ducks (*Dendrocygna javanica*)etc.

Aqua fauna

Regarding the aqua fauna of the region silver carp (*Hypophthalmichthys molitrix*), barbs, river eels, starfish, king crab, fiddler crab (*Uca sp*), hermit crab, prawn, shrimps, Gangetic dolphins (*Platanista gangetica*), skipping frogs (*Euphlyctis sp*), common toads and tree frogs are found in abundance. One particularly interesting fish is the mudskipper.

Reptiles

An excellent number of reptiles are also found in Sundarbans. Some of the common ones are olive ridley turtles (*Lepidochelys olivacea*), sea snakes, dog faced water snakes (*Cerberus rynchops*), green turtles (*Chelonia mydas*), estuarine crocodiles (*Crocodylus porosus*), chameleons, king cobras (*Naja naja*), salvator lizards (*Varanus salvator*), hard shelled batgun terrapins (*Melanochelys trijuga*), Russels vipers (*Daboia russelii*), monitor lizards (*Varanus bengalensis*), hawks bill turtles (*Eretmochelys imbricata*), pythons (*Python molurus*), common kraits (*Bungarus caeruleus*), green vine

snake (*Ahaetulla nasuta*), checkered keelbacks (*Xenochrophis sp*) and rat snakes. The river terrapin (*Batagur baska*), Indian flap-shelled turtles (*Lissemys punctata*), peacock soft-shelled turtles (*Trionyx hurum*), yellow monitors (*Varanus flavescens*), water monitors (*Varanus salvator*) and Indian pythons (*Python molurus*) are some of the resident species. The details lists of flora and fauna are given in **Annexure 3.**

9.2.12 National Parks, Forests, Wildlife Sanctuaries and Reserves

According to India State Forest Report, 2015 the total forest cover of South 24 parganas district is 2782 Km^2 which is about 27.93 % of the district's total geographical area (9960 Km^2).

Out of 2782 Km^2, 977 Km^2 falls under very dense forest area category; whereas Moderately Dense Forest and Open Forest area covers 753 Km^2 and 1052 Km^2 areas respectively. The comparative statement showing forest cover of South 24 Parganas District and West Bengal state is presented in below **Table 26**. It is observed from the table that district's Forest Cover percentage in respect to total geographical area is higher than state's overall coverage.

Table 26: Forest Cover of South 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
South 24 Parganas	9960	977	753	1052	2782	27.93
West Bengal	**88752**	**2948**	**4172**	**9708**	**16828**	**18.96**

Source: India State Forest Report, 2015

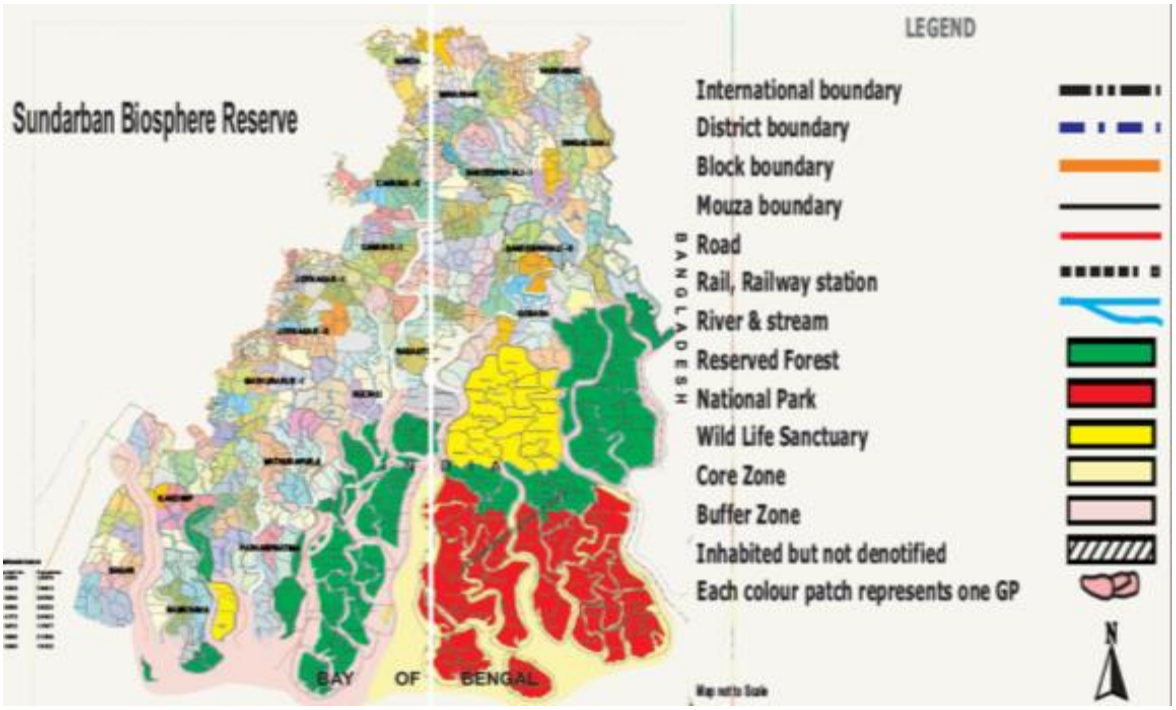
There are forest patches available along the proposed waterway stretch. National Parks, Wildlife sanctuaries, Biosphere Reserve play a vital role in protecting the wildlife of a particular area and providing them their natural habitat.

The Sunderban Tiger Reserve is located in South 24 Paraganas, West Bengal and has a total geographical area of 2585 km2 with 1437.4 km2 consisting of populated areas and forest covering 1474 km2. The Sundarbans National Park is a National Park, Tiger Reserve, and a Biosphere Reserve in West Bengal, India. It is part of the Sundarbans on the Ganges Delta, and adjacent to the Sundarban Reserve Forest in Bangladesh. The delta is densely covered by mangrove forests, and is

one of the largest reserves for the Bengal tiger. It is also home to a variety of bird, reptile and invertebrate species, including the salt-water crocodile. The present Sundarban National Park was declared as the core area of Sundarban Tiger Reserve in 1973 and a wildlife sanctuary in 1977. On 4th May 1984 it was declared a National Park. It is a UNESCO world heritage site inscripted in 1987. It is considered as a World Network of Biosphere Reserve (Man and Biosphere Reserve) in 2001.

Seven main rivers and innumerable watercourses form a network of channels at this estuarine delta. All the rivers have a southward course towards the sea. The eco-geography of this area is totally dependent on the tidal effect of two flow tides and two ebb tides occurring within 24 hours with a tidal range of 3–5 m and up to 8 m in normal spring tide, inundating the whole of Sunderban in varying depths. The tidal action deposits silt back on the channels and raising the bed, it forms new islands and creeks contributing to uncertain geomorphology. There is a great natural depression called "Swatch of No Ground" in the Bay of Bengal between 21°00' to 21°22' latitude where, the depth of water changes suddenly from 20 m to 500 m. This mysterious depression pushes back the silts towards south and/or further east to form new islands.

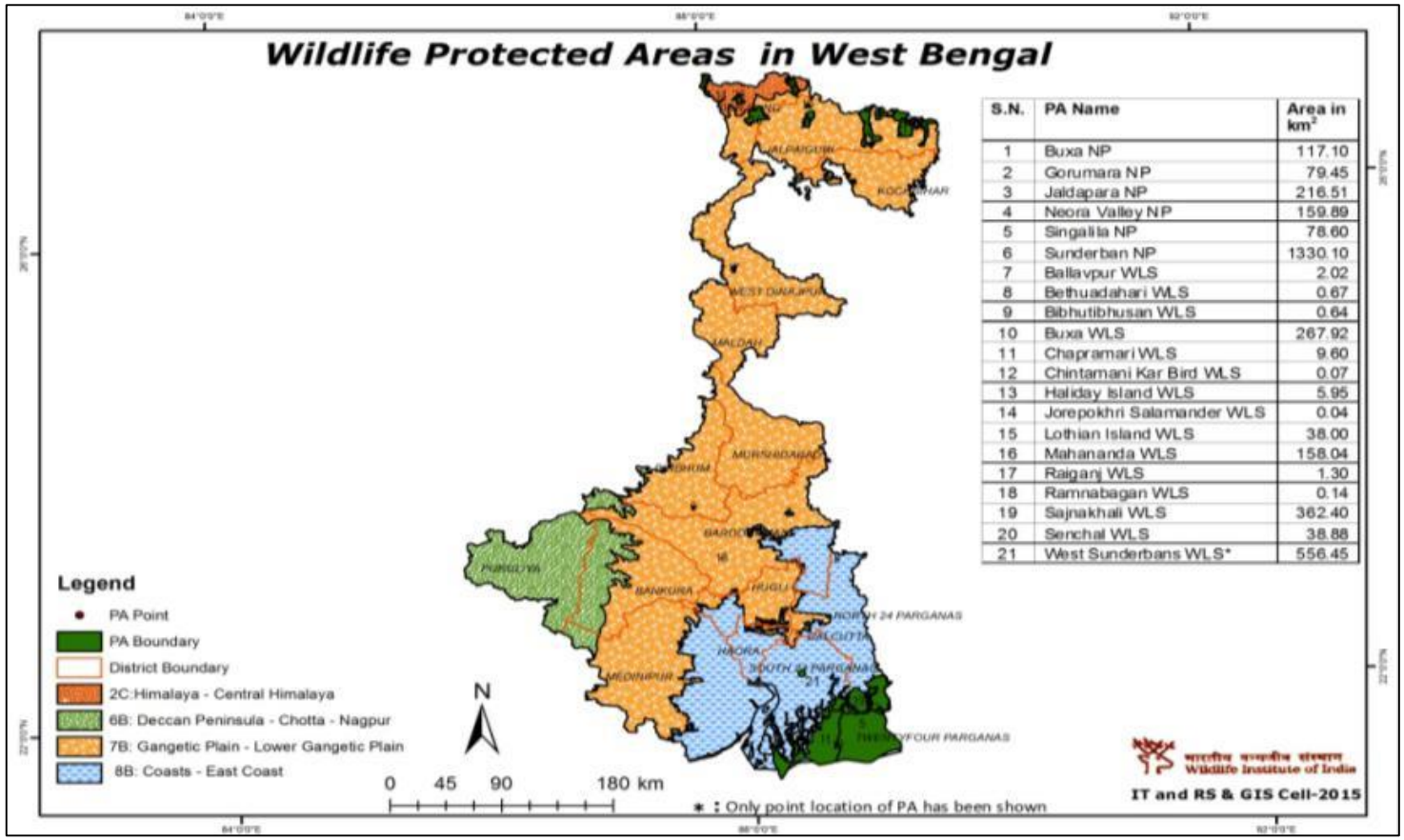
The Sunderban Biosphere Reserve is located at a distance of 30 Km from the start point of Waterway section. The Map of Sunderban Biosphere Reserve is furnished in **Figure 32**.



Source : WWF-India

Figure 32: Map of Sundarban Biosphere Reserve

Besides Sundarban, the other notified Protected Area (under Willdlife Act, 1972) in the district is also home to four wildlife sanctuaries. These are Haliday Island, Lothian Island, Narendrapur, and Sajnekhali. The details of various protected areas in West Bengal covered under purview of Wildlife Act, 1972 is given in **Figure 33**.



Source : Wildlife Institute of India

Figure 33: Wildlife Protected Area of West Bengal

9.2.13 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. 74.42% lives in rural areas of the district. The total population of the district is 81,61,961 (Male- 41,73,778; Female – 39,88,183). The literary rate and sex ratio being 77.51% and 956 respectively, the percentage of SC and ST was 30.19 and 1.19 respectively in the district. The district comprises of 5 nos. of sub-divisions, 7 nos. of municipalities along with 111 Census Towns and 2,042 villages. The demographic profile of the project district is presented in **Table 27**.

Table 27: **Demographic Profile of South 24 Parganas District**

Total Population	Male Population	Female Population	Literary Rate (%)	Sex Ratio	SC (%)	ST (%)
81,61,961	41,73,778	39,88,183	77.51	956	30.19	1.19

Source: Census of India, 2011

Major settlements/village located along the section of Gomar River has been listed in the **Table 28** along with population details as per Census of India Data, 2011.

Table 28: **Major settlements/village along the project stretch of Gomar River**

S. No.	Village/ Town name	Population (nos.)
1	Ramkrishnapur	2213

Source: Census of India, 2011

Economic Profile

South 24 Parganas

Agriculture: South 24 Parganas is mainly an agricultural district. The main source of livelihood of the people is cultivation, but most of the agricultural lands in the district are mono-cropped owing to poor irrigation facilities and high salinity in water. Besides, the district being coastal, the agriculture of the district periodically suffers from setbacks like Storm, Cyclone, and Depression etc. The crops are also

often subjected to attacks by various diseases, insects and pests owing to relatively high humidity (85.0 per cent). Rice is the most important food crop of the district. All the three well-known types of rice, Aus, Aman and Boro are cultivated in the district with Aman occupying the first place and outstripping the other two in both area of cultivation and production of grain.

Rice is the most important food crop in South 24 Parganas. Apart from rice, potato, pulses, gram, chilli etc. are also important food crops of the district. Jute is the most important cash crop. The topography of the Ganga riverine lands is plain with a mild slope towards the south and as such only rabi crops like potato, wheat and vegetables are irrigated from tanks and *bils*. The topography of the Ganga low lands is basin shaped and it gets submerged partially by accumulated rain water. Crops are usually irrigated from *bils* in Ganga low lands. The clayey soil of the Ganga low lands is very good for Aman paddy. With the first rain, Jute is sown. In July and August Jute is harvested and is allowed to lie on the plots to shed their stems for rotting. The topography of the saline soils is plain and its characteristic is the constant interaction between Ganga alluvium and saline soils. During rainy season the area of saline soils goes under Aman paddy. Except in the bheris and fisheries the entire area presents a landscape of Aman paddy. The nature of saline alkaline soil being silty it contains lower organic matter and nitrogen content and is not suitable for growing of crop as the salt concentration increases in such type of soils. Non-saline alkaline soil undergoes such a natural process that it becomes salt and calcium carbonate free and becomes favourable for growing of jute and rabi pulses. Degraded saline soil is highly unfit for growing of paddy and cultivation is often considered uneconomical on this soil and thus abandoned.

Irrigation: Although excessive rainfall in the district South 24 Parganas is certainly a boon for cultivation of the Aman paddy, it is harmful for other crops, because, with the exception of the high land along the banks of the rivers, the country is low and swampy and tends to become water-logged whenever there is excessive rainfall. Irrigation from rivers, dams and canals too does not help much as the water in winter is saline.

Despite such constraints, the Irrigation Department in last two decades has constructed some sluice gates and dams. They resist inflow of the saline water to certain extent, though cyclones and high tides often damage them. Excavation of tanks and sinking of shallow tube wells in some areas and use of transported water of the Hooghly river through back-feeding process has enabled the district to gain some more cropped areas.

Incidentally, irrigation by private canals is the most important source of irrigation covering almost 85 per cent of the total irrigated area in the district.

Animal Husbandry: South 24 Parganas doesn't occupy any significant place in animal husbandry. There is very little pasturage and cattle usually graze in the fields after the crops have been reaped, having very little to eat in the open. The local cattle are usually of non-descript type, ill-fed in most cases. There is also a crisis of the land for raising fodder crops and the villages try to overcome the crisis by cultivating seasonal fodders.

Fishery: South 24 Parganas is extremely rich in fish fauna, courtesy Sundarbans by virtue of presence of numerous intertwined river channels, creeks and riverine estuaries of Sundarbans, fishery has always been an important economic activity of the district of South 24 Parganas. Fresh water fishes as well as saline water fishes – both are available due to presence of rivers and sea. They are plentiful and found at all times of the year. While this is so, the supplies in the market are regrettably poor, still today there is no adequate arrangement for the preservation of fish. Thus the fishermen are compelled to sell their fishes in open market and naturally they do not receive adequate amount as they have to sell all the fishes afresh nor those will be wasted. Apart from rivers and seas, fishes are also available in ponds, lakes, *khals*, *bils* and *bheris*. Small fishermen use boats and to keep the fishes fresh and alive they keep their catches in bamboo cage in water tied to their boats. Big fishermen use motor boats and motor launches and use ice for preservation. The wholesale fish market is at Canning though there are a total eleven landing centres in South Twenty-Four Parganas. They are Basanti, Kultali, Gosaba, Sandeshkhali, Namkhana, Kakdwip, Diamond Harbour, Kalinagar (P.S. Nadakhali), Raidighi and Port Canning.

Industry: Though the district shares common boundary with the State Capital of Kolkata, still the industrial sector is not much developed in South 24 Parganas district. The presence of dense jungle of Sundarbans, numerous islands and rivers, *khals* and *bils* had made a large part of the area non-accessible for development of industry. One serious reason may be lack of adequate electricity.

The industries found in the district are mainly of house hold industry type. The centres for manufacturing of cutlery and agricultural implements are located in some places. The pottery industry is located at Jaynagar, Baruipur and Budge Budge. The manufacture of *gur* (molasses) is mainly carried on in Jaynagar and also throughout the Diamond Harbour Sub-division. Areas nearer to Kolkata have few button making and manufacture of steel trunks units. Cotton handloom weaving, which is an old time industry, still manages to survive with the help of the co-operatives in Bhangar, Begampur, Deara, Kanyanagar etc.

The handicrafts of the district deserve special mention. The mats and asans (small sitting mats), earthen dolls and images, cane and bamboo products etc. are famous. Undivided South 24 Parganas

were the home of jute industry. After the bifurcation of the district the jute industries that fall on this side are still running. But the market of jute is narrowed due to its high costing and launching of plastic bags as its substitute.

The industrialization of the district got a big blow during the last decade with the closer of big unit like Bata Shoe Industry. The only notable industry of the district is the Garden Reach Ship Builder & Engineers Ltd. which is a Government of India enterprise under the Ministry of Defence since 1960.

Solar energy is used in electrifying the areas of Sundarbans. The State Government has appointed West Bengal Renewable Energy Development Agency (WBREDA) for installing and utilizing solar power to illumine the area. They are acting as the nodal agency for its solar power project for the Sundarbans. West Bengal Electronics Industry Development Corporation Limited (WBEIDC) a Government of West Bengal enterprise has undertaken the challenging task of providing non-traditional electricity to the district. They have installed one SPV Power Plant in Gangasagar which is capable of generating 26 Kilowatts of power. Wind Farm at Bakkhali-Fraserganj produces 2 megawatts of electricity. Homes in various parts of Sundarbans receive this non- traditional electricity. Streets are lightened with solar lamps also. Besides Webel, some other private companies such as Agni Power, Tata, BP Solar, Geetanjali Solar, Exide etc. have also come forward and have installed their own Power Plants.

Trade and Commerce: Paddy, rice, jute, wheat, pulses, chillies, watermelon, coconut, varieties of vegetable etc. grows in the district due to the presence of abandon sweet water rivers. These are marketed at different points of the district. Presently paddy and rice marketing is done through Government run authorized agent i.e. the Food Corporation of India. Another Government run agency, the Jute Corporation of India controls raw jute trade. As for Government intervention, the farmers are ensured with minimum support price as fixed by the Government of India.

Among the vegetables, the most commonly grown and marketed vegetables are cabbage, cauliflower, tomato, radish, brinjal, patal, jhinga, ladies finger, sweet pumpkin, battle gourd, bitter gourd, papaya, spinach, carrot, beet and potato. The most important wholesale markets for vegetables in the district are Baruipur and Bhangar.Chilli and coconut are the most important cash crops of the districts. Chilli is marketed from Chhoto Mollakhali and Kakdwip while coconut is marketed from Amtala and Bhangar. Kakdwip, Diamond Harbour, Kolkata and its suburbs are assembling markets of Watermelon which is grown in Sundarbans in rotation with paddy and chillies. Pulses, sugar, gur (molasses), mustard seeds and oil, fruits, potato and onion are imported agricultural produce of the district. Both fresh water and salt water fishes are exported from the district in great qualities. The fish is also being sold locally.

Imported agricultural produce in the district are Pulses, Sugar, Gur, Mustard seeds and oil, Fruits, Potato and Onion. Export trade of the district mainly consists of jute and mesta, vegetables, chillis, fruits (especially guava, watermelon and coconut), fish and gur.

Transport: Due to abundance of waterways, the district got water transport from a very old time. Early trade and commerce of the district were performed by waterways only.

Road transport of the district is only a recent development. The total length of roads maintained by PWD is divided into four categories – National Highways, State Highways, District Roads and Village Roads.

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 13,91,295.67 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 Gomar 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.
- ✓ Quality of river water will be periodically monitored as per the monitoring plan.

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. <u>SOCIAL IMPACTS</u>

- 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.
- ✓ Quality of river water should be periodically monitored as per monitoring plan.

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 29** 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 29: 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		equipments and facilities. • Specifications of crushers and hot mix plants will comply with the requirements of the relevant current emission control 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		must be bordered by berms • Soil erosion checking measures as the formation of sediment basins, slope 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		agriculture remains preserved & not destroyed by storage, material handling or any other construction related 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		town/village). • Vehicles transporting earth materials will 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		works are under progress. • Every equipments and machinery will be 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	The Contractor will confirm the following:	Contractor	Supervision

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	and construction equipments	• All plants and equipments used in construction shall strictly conform to the 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.		Consultants, IWAI
4.	Impact on Flora	• If required, Vegetation will be removed	Contractor	Supervision

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	and Fauna	from the construction zone before 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		Consultants, 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 facilities will be provided at construction	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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
7.	Camp Site	• Contractor will follow all relevant	Contractor	Supervision

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	management	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 ground water or nearby surface water. • Separate toilets/bathrooms, will be		Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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 standards • Regularly service vehicles off-site in order	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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 Vessel/barges	• All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only.	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• 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 30.**

Table 30: 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 from Central Government in the Ministry of

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
						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 4**)
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 Sanctuaries.	Chief Conservator. Wildlife, Wildlife Wing, Forest Department, Gov. of West	√	..	Applicable,as the project require Wildlife clearance

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
			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 Control Board	√	..	For construction vehicles (Construction Stage) – Pollution Under Control Certificate
Ancient Monuments and	1958	These Acts are applicable in case	Archaeological Dept. GOI,	--	√	This act will not be applicable

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Archaeological Sites and Remains Act		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	Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).			
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	√	…	
CRZ Notification	2019	To ensure livelihood security to the fisher communities and	West Bengal State Coastal Zone Management	√	..	CRZ Notification issued for to regulate development activities within the

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		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.	Authority and MoEF&CC			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 4**.

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 31.**

Table 31: 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 32**.

Table 32: 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 33)	4.215
3.	Public consultation meeting (PCM)	Lump Sum	2.00
4.	Surveys/ Reports / Document Printing	Lump Sum	5.00

Sl. No.	Particulars	Unit	Amount (Lakh INR)
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 33: 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
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

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
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 34: 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 35	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
5.	Disaster Management Plan	Lump sum	2.00
6.	Environmental Training	Lump sum	2.00
Total			**32.82**

Table 35: 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
Sub-Total					**11.82**

c) Estimated cost during operation Stage

Table 36: 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 37	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 37: 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
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 38**.

Table 38: 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 Gomar waterway comprises of; a) fairway development of full 6.711 Km stretch of waterway involving 13,91,295.67 cum of dredging and b) provision of Navigational & Communication equipment as part of collective development of all 13 rivers of NW-97.

Accordingly, it is recommended that the Project Management Unit (PMU) proposed in the Hogla Waterway DPR will provide operational support in the development of Gomar waterway. Further no additional institutional setup is recommended in the Gomar Waterway DPR.

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 AND ECONOMIC & FINANCIAL ANALYSIS

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) Judgement based on Consultant's Experience

11.2 DEVELOPMENT COST

Gomar waterway is proposed to be developed as class VII waterway for a total stretch of 6.711 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 construction and development of the waterway is 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 39**.

Table 39: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	Capital cost for Fairway Development		2,782.59
4.0	Capital Cost for Aids to Navigation and Communication	**Table 20**	285.43
5.0	Cost allotted for EMP	**Table 38**	84.04
	Total Capital Cost		**3,152.06**

11.4 OPERATIONAL AND MAINTENANCE EXPENDITURE

The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies are provided in **Table 40** as below:

Table 40: 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		278.26
4.0	O&M Cost for Aids to Navigation and Communication	**Table 21**	169.07
5.0	EMP Cost during operation stage	**Table 38**	25.08
	Total Capital Cost		**472.40**

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 41** and also shown in **Figure 34** below.

Table 41: Phasing of Expenditure

Months >	M1 – M3	M4 – M6	M7 – M9	M10 – M12
Total Cash Flow INR Lakh	472.83	945.66	945.66	788.05
% of Cash Flow	15%	30%	30%	25%

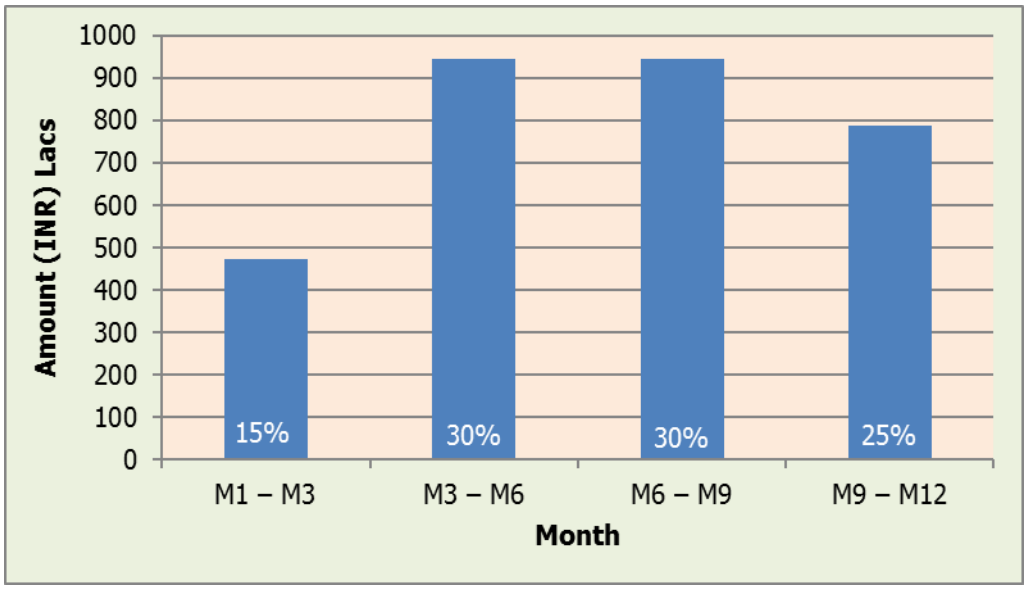


Figure 34: Phasing of Expenditure

12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of Gomar fairway 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.

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 35: Construction Schedule

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 Gomar waterway include development of waterway, navigation and communication facilitites.

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 prior to commencement, 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 Gomar 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;

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 act as the deciding factor.

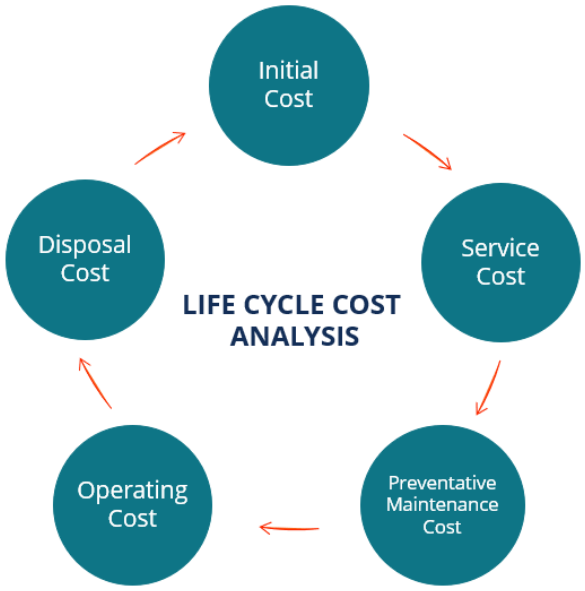
As detailed in previous chapters of this DPR, Gomar waterway is proposed to be developed to provide an uninterrupted connectivity between Bidya and Hogla waterway as part of collective development of NW-97, Sunderbans waterways.

Also, as presently Gomar 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 Gomar waterway, the internal rate of returns can not be ascertained.

The Capital and O&M expenses estimated to be incurred for development of Gomar 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 Gomar 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 42**.

Table 42: Project Life Cycle Cost

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)
-1	3152		3152
0		465	465
1		488	488
2		512	512
3		538	538
4		565	565
5		593	593
6		623	623
7		654	654
8		686	686
9		721	721
10		757	757
11		795	795
12		834	834

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)
13		876	876
14		920	920
15		966	966
16		1014	1014
17		1065	1065
18		1118	1118
19		1174	1174
20		1233	1233
		Total	**19,749**

On the basis of above LCCA, the project life cycle cost for 20 years of project life cycle works out as INR 19,749/- 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 project should provide a service against payment of a predetermined tariff or user charge from the vessels commuting in the Gomar waterway limit.

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) There are no big industries located in project hinterland, however a few brick kilns are found along the river banks.
b) Gomar river has no passenger and cargo traffic of its own.
c) Gomar river provides an interconnectivity between Hogla and Bidya waterways.
d) Vessels operated from Hogla and Bidya ferry ghats uses Gomar waterway also.

As mentioned above, Gomar 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.

However, in order to provide an uninterrupted connectivity between Bidya and Hogla waterway and as part of collective development of NW-97, Sunderban waterways, Gomar 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 Gomar waterway. The capital and O&M cost for the waterway development works out as INR 3,152.06 Lakh and INR 472.40 respectively.

In the absence of traffic and projected revenues to be generated from Gomar 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	√		Within 5 km from the Project River
b) Wildlife/ Bird Sanctuary	√		Within 5 km from the Project River
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?		√	No Activities are proposed
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, during the Construction / Dedging phase

ANNEXURE 3: Checklist for Flora and Fauna of the District

Floral Community of Sundarban

Checklist for Flora

Mangroves and associates			
Sl. no.	**Scientific name**	**Local name**	**Remarks**
1	*Nypa fruiticans*	Golpata	Mangrove
2	*Avicennia officinalis*	Jat baen	Mangrove
3	*Avicennia alba*	Kalo baen	Mangrove
4	*Avicennia marina*	Pyara baen	Mangrove
5	*Lumnitzera racemosa*	Kripa	Mangrove
6	*Exocoecaria agallocha*	Genwa	Mangrove
7	*Xylocarpus granatum*	Dhundul	Mangrove
8	*Xylocarpus mekongensis*	Passur	Mangrove
9	*Aegiceras corniculatum*	Khalsi	Mangrove
10	*Aegialitis rotundifolia*	Tora	Mangrove
11	*Rhizophora mucronata*	Garjan	Mangrove
12	*Rhizophora apiculata*	Garjan	Mangrove
13	*Bruguiera gymnorrhiza*	Kankra	Mangrove
14	*Bruguiera sexangula*	Kankra	Mangrove
15	*Bruguiera cylindrica*	Bakul kankra	Mangrove
16	*Bruguiera parviflora*	Bakul kankra	Mangrove
17	*Ceriops decandra*	Jhamti goran	Mangrove
18	*Ceriops tagal*	Math goran	Mangrove
19	*Kandelia candel*	Garia	Mangrove
20	*Scyphiphora hydrophyllacea*	Tagri bani	Mangrove
21	*Sonneratia apetala*	Keora	Mangrove
22	*Sonneratia griffithii*	Ora	Mangrove
23	*Sonneratia caseolaris*	Chak keora	Mangrove
24	*Sonneratia alba*		Mangrove
25	*Heritiera fomes*	Sundari	Mangrove associate
26	*Acanthus ilicifolius*	Hargoja	Mangrove associate
27	*Acanthus volubilis*	Lata hargoja	Mangrove associate
28	*Phoenix paludosa*	Hental	Mangrove associate
29	*Cynometra ramiflora*		Mangrove associate
30	*Caesalpinia bonduc*	Nata	Mangrove associate
31	*Caesalpinia crista*	Shingri lata	Mangrove associate
32	*Hibiscus tiliaceous*	Bhola	Mangrove associate
33	*Hibiscus tortuosus*	Bhola	Mangrove associate

Mangroves and associates			
Sl. no.	**Scientific name**	**Local name**	**Remarks**
34	*Thespesia populnea*	Paras	Mangrove associate
35	*Dalbergia spinosa*	Chulia kanta	Mangrove associate
36	*Derris scandens*	Noa lata	Mangrove associate
37	*Derris trifoliata*	Pan lata	Mangrove associate
38	*Derris indica*	Karanja	Mangrove associate
39	*Atalantia correa*	Ban Lebu	Mangrove associate
40	*Brownlowia tersa*	Lata Sundari	Mangrove associate
41	*Crinum defixum*	Sukha Darsan	Halophytes
42	*Cryptocorne ciliata*	Kerali	Halophytes
43	*Sesuvium portulacastrum*	Gada Bani	Halophytes
44	*Sarcolobus globosus*	Caw Phal	Halophytes
45	*Sarcolobus carinatus*	Baole Lata	Halophytes
46	*Pentatropis capensis*	Dudhi Lata	Halophytes
47	*Heliotropium curassavicum*	Nona Hatisnur	Halophytes
48	*Ipomoea pes-caprae*	Chhagal Knuri	Halophytes
49	*Hydrophylax maritima*		Halophytes
50	*Clerodendrum inerme*	Ban Jhampi	Halophytes
51	*Viscum orientale*	Manda	Halophytes
52	*Dendrophthoe falcata*	Bara Manda	Halophytes
53	*Porteresia coarctata*	Dhani Ghas	Halophytes
54	*Tamarix dioica*	Lal Jhau	Xerophytes
55	*Tamarix aphylla*	Lal Jhau	Xerophytes
56	*Tamarix troupii*	Nona Jhau	Xerophytes
57	*Solanum trilobatum*	Lala Gurbegun	Xerophytes
58	*Opuntia dillenii*	Fani mansa	Xerophytes
59	*Casuarina equisetifolia*		
60	*Viscum monoicum*	Manda	Epiphyte
61	*Dendrophthoe falcata*	Bara Manda	Epiphyte
62	*Premna corymbosa*		
63	*Holarrhana antidysenterica*		
64	*Cerbera manghas*	Dabur	Mangrove associate
65	*Launaea sermentosa*		
66	*Trianthema portulacastrum*		
67	*Ammannia baccifera*		
68	*Barringtonia asiatica*	Hijal	Fresh water Mangrove

Mangroves and associates			
Sl. no.	**Scientific name**	**Local name**	**Remarks**
69	*Barringtonia racemosa*	Hijal	Fresh water Mangrove
70	*Thespesia populneoides*	Paras	Mangrove associate

Source: West Bengal Forest Department

Bryophytes recorded from Sundarban		Pteridophytes Recorded from Sundarban	
S. No.	**Scientific name**	**S. No.**	**Scientific name**
1	*Pogonatum sp.*	1	*Acrostichum aureum*
2	*Polytrichum sp.*	2	*Adiantum caudatum*
3	*Porella sp.*	3	*Azolla pinnata*
4	*Marchantia sp*	4	*Ceratopteris thalictroides*
5	*Pogonatum sp.*	5	*Marsilea minuta*
		6	*Pteris vittata*
		7	*Salvinia cucullata*
		8	*Salvinia natans*

Faunal Community of Sundarban

Checklist for Mammals

Sl. No.	Name	Scientific Name	IUCN Status
1	Tiger	*Panthera tigris*	*Endangered*
2	Fishing Cat	*Prionailurus viverrinus*	*Vulnerable*
3	Rhesus Macaque	*Macaca mulatta*	*Least Concern*
4	Spotted Deer or Chita	*Axis axix*	*Least Concern*
5	Wild Pig	*Sus scrofa*	*Least Concern*
6	Finless Porpoise	*Neomeris phocaenoides*	*Vulnerable*
7	Gangetic Dolphin	*Platanista gangetica*	*Endangered*
8	Irrawady Dolphin	*Orcaella brevirostris*	*Vulnerable*
9	Smooth coated otter	*Lutrogale perspicillata*	*Vulnerable*
10	House Shrew	*Suncus marinua*	*Least Concern*
11	Common Jungle Cat	*Felis chaus*	*Least Concern*
12	Leopard Cat	*Prionailurus bengalensis*	*Least Concern*
13	Jackal	*Canis aureus*	*Least Concern*
14	Indian Fox	*Vulpes bengalensis*	*Least Concern*
15	Small Indian Civet	*Viverricula indica*	*Least Concern*
16	Common Grey Mongoose	*Herpestes edwardsii*	*Least Concern*
17	Five-striped Squirrel	*Funumbulas pennanti*	*Least Concern*
18	Field Mouse	*Mus booduga*	*Least Concern*
19	Large Bandicoot Rat	*Bandicota indica*	*Least Concern*
20	House Rat	*Rattus rattus*	*Least Concern*
21	House Mouse	*Mus musculus*	*Least Concern*
22	Indian Flying Fox	*Pteropus giganteus*	*Least Concern*
23	Short-nosed Fruit Bat	*Cynopterus sphinx*	*Least Concern*
24	Lesser Yellow Bat	*Scotophilus temmincki*	*Least Concern*
25	Greater False Vampire	*Megaderma lyra*	*Least Concern*
26	Lesser Rat-tailed Bat	*Rhinopoma hardwickli*	*Least Concern*
27	Bicoloured Leaf-nosed Bat	*Hipposideros bicolor*	*Least Concern*
28	Indian Pygmy Bat	*Pipistrellus tenuis*	*Least Concern*
29	Small clawed otter	*Amblonyx cinereus*	*Vulnerable*

Source: West Bengal Forest Department

Checklist for Reptiles

Sl. No.	Name	Scientific Name	IUCN Status
Order : Chelonia			
1	Common Batagur or river Terrapin	*Batagur baska*	*Critically Endangered*
2	Flap shell turtle	*Lissemys punctata*	*Least Concern*
3	Chitra Turtle	*Chitra indica*	*Endangered*
4	Indian roofed turtle	*Kachuga tecta*	*Least Concern*
5	Olive Ridley Turtle	*Lepidochelys olivacea*	*Vulnerable*
6	Green Turtle	*Chelonia mydas*	*Endangered*
7	Hawksbill Turtle	*Eretmochelys imbricata*	*Critically Endangered*
Order : Squamata			
8	Common Checkered Keelback	*Xenochrophis piscator*	*Least Concern*
9	Common smooth water snake	*Enhydris enhydris*	*Least Concern*
10	Dog faced Water Snake	*Cerberus rhynchops*	*Least Concern*
11	Wart Snake or file snake	*Acrochordus granulatus*	*Least Concern*
12	Glossy Marsh snake	*Gerarda prevostiana*	*Least Concern*
13	Sea-snake	*Enhylrina schistose*	*Least Concern*
14	Estuarine Sea-snake	*Hydrophis obscurus*	*Least Concern*
15	Black banded Sea-snake	*Hydrophis nigrocintus*	*Data Deficient*
16	Blue Sea-snake	*Hydrophis caerulescens*	*Least Concern*
17	Sea-snake	*Microcephalophis gracilis*	*Least Concern*
18	Sea-snake	*Microcephalophis cantoris*	*Data Deficient*
19	Estuarine Crocodile	*Crocodylus porosus*	*Least Concern*
20	Tokay gecko	*Gekko gecko*	-
21	Mouse Gecko	*Hemidactylus frinatas*	*Least Concern*
22	House Gecko	*Hemidactylus flaviridis*	*Least Concern*
23	Brook's House Gecko	*Hemidactylus brookii*	-
24	Indian Garden Lizard	*Calotes versicolor*	*Least Concern*
25	Indian Chameleon	*Chamaeleo zeylanicus*	*Least Concern*
26	Common Dotted Garden Skink	*Riopa punctata*	-
27	Water Monitor	*Varanus salavator*	*Least Concern*
28	Monitor Lizard	*Varanus flavescens*	*Least Concern*
29	Ornate Flying Snake or Gliding Snake	*Chrysopelea ornata*	-
30	Blind Snake	*Typhlops porrectus*	*Data Deficient*
31	Common Blind snake	*Typhlops braminus*	-
32	Indian Rock Python	*Python molurus*	*Vulnerable*

Sl. No.	Name	Scientific Name	IUCN Status
33	Common Sand Boa	*Gongylophis conicus*	-
34	Trinket Snake	*Elaphe helena*	-
35	Indian Rat Snake	*Ptyas mucosa*	-
36	Banded kukri Snake	*Oligodon arnensis*	-
38	Common vine snake	*Ahaetulla nasuta*	-
38	Common wolf snake	*Lycodon aulicus*	*Least Concern*
39	Striped Keelback	*Amphiesma stolatum*	-
40	Olivaceous Keelback	*Atretium schistosum*	*Least Concern*
41	Bronze-back	*Derdreluphis ahactulla*	-
42	Common Indian Bronzeback	*Dendrelaphis tristis*	*Data Deficient*
43	Common Indian Krait	*Bungarus caeruleus*	-
44	Banded Krait	*Bungarus fasciatus*	*Least Concern*
45	Indian Cobra	*Naja naja*	*Least Concern*
46	King Cobra	*Ophiophagus hannah*	*Vulnerable*
47	Rusell's viper	*Daboia russelli*	*Least Concern*
48	Spot tailed Pit Viper	*Trimeresurus erythrurus*	*Least Concern*

Source: West Bengal Forest Department

Checklist for Birds

Checklist for Birds	
1. Swamp Francolin - Francolinus gularis	183. Slender-billed Vulture - Gyps tenuirostris
2. Common Quail - Coturnix coturnix	184. Short-toed Eagle - Circaetus gallicus
3. Rain Quail - Coturnix coromandelica	185. Crested Serpent Eagle - Spilornis cheela
4. Blue-breasted Quail - Coturnix chinensis	186. Eurasian Marsh Harrier - Circus aeruginosus
5. Red Junglefowl - Gallus gallus	187. Pied Harrier - Circus melanoleucos
6. Lesser Whistling-duck - Dendrocygna javanica	188. Hen Harrier - Circus cyaneus
7. White-headed Duck - Oxyura leucocephala	189. Pallid Harrier - Circus macrourus
8. Greylag Goose - Anser anser	190. Crested Goshawk - Accipiter trivirgatus
9. Bar-headed Goose - Anser indicus	191. Shikra - Accipiter badius
10. Ruddy Shelduck - Tadorna ferruginea	192. Oriental Honey-Buzzard - Pernis ptilorhyncus
11. Common Shelduck - Tadorna tadorna	193. Greater Spotted Eagle - Aquila clanga
12. Comb Duck - Sarkidiornis melanotos	194. Indian Spotted Eagle - Pomarina hastata
13. Cotton Pygmy-goose - Nettapus coromandelianus	195. Bonelli's Eagle - Hieraaetus fasciatus
14. Gadwall - Anas strepera	196. Booted Eagle - Hieraaetus pennatus
15. Falcated Duck - Anas falcata	197. Changeable Hawk Eagle - Spizaetus cirrhatus
16. Eurasian Wigeon - Anas penelope	198. Common Kestrel - Falco tinnunculus
17. Mallard - Anas platyrhynchos	199. Red-necked Falcon - Falco chicquera
18. Spot-billed Duck - Anas poecilorhyncha	200. Amur Falcon - Falco amurensis
19. Common Teal - Anas crecca	201. Eurasian Hobby - Falco subbuteo
20. Garganey - Anas querquedula	202. Oriental Hobby - Falco severus
21. Northern Pintail - Anas acuta	203. Peregrine Falcon - Falco peregrinus
22. Northern Shoveler - Anas clypeata	204. Little Grebe - Tachybaptus ruficollis
23. Red-crested Pochard - Rhodonessa rufina	205. Darter - Anhinga melanogaster
24. Common Pochard - Aythya ferina	206. Little Cormorant - Phalacrocorax niger
25. Ferruginous Pochard - Aythya nyroca	207. Indian Cormorant - Phalacrocorax fuscicollis
26. Baer's Pochard - Aythya baeri	208. Great Cormorant - Phalacrocorax carbo
27. Tufted Duck - Aythya fuligula	209. Little Egret - Egretta garzetta
28. Greater Scaup - Aythya marila	210. Great Egret - Casmerodius albus
29. Red-breasted Merganser - Mergus serrator	211. Intermediate Egret - Mesophoyx intermedia
30. Eurasian Wryneck - Jynx torquilla	212. Cattle Egret - Bubulcus ibis
31. Speckled Piculet - Picumnus innominatus	213. Indian Pond Heron - Ardeola grayii
32. Rufous Woodpecker - Celeus brachyurus	214. Grey Heron - Ardea cinerea
33. Brown-capped Pygmy Woodpecker - Dendrocopos nanus	215. Goliath Heron - Ardea goliath
34. Fulvous-breasted Woodpecker - Dendrocopos macei	216. Purple Heron - Ardea purpurea
35. Yellow-crowned Woodpecker - Dendrocopos mahrattensis	217. Little Heron - Butorides striatus
36. Lesser Yellownape - Picus chlorolophus	218. Black-crowned Night Heron - Nycticorax nycticorax
37. Streak-throated Woodpecker - Picus xanthopygaeus	219. Yellow Bittern - Ixobrychus sinensis
38. Grey-headed Woodpecker - Picus canus	220. Cinnamon Bittern - Ixobrychus cinnamomeus
39. Common Flameback - Dinopium javanense	221. Black Bittern - Dupetor flavicollis
40. Black-rumped Flameback - Dinopium benghalense	222. Glossy Ibis - Plegadis falcinellus
41. Greater Flameback - Chrysocolaptes lucidus	223. Black-headed Ibis - Threskiornis melanocephalus
42. White-naped Woodpecker - Chrysocolaptes festivus	224. Eurasian Spoonbill - Platalea leucorodia
43. Brown-headed Barbet - Megalaima zeylanica	225. Great White Pelican - Pelecanus onocrotalus
44. Lineated Barbet - Megalaima lineata	226. Spot-billed Pelican - Pelecanus philippensis
45. Blue-throated Barbet - Megalaima asiatica	227. Painted Stork - Mycteria leucocephala
46. Coppersmith Barbet - Megalaima haemacephala	228. Asian Openbill - Anastomus oscitans
47. Common Hoopoe - Upupa epops	229. Black-necked Stork - Ephippiorhynchus asiaticus
48. Indian Roller - Coracias benghalensis	230. Lesser Adjutant - Leptoptilos javanicus
49. Dollarbird - Eurstomus orientalis	231. Greater Adjutant - Leptoptilos dubius
50. Common Kingfisher - Alcedo atthis	232. Christmas Island Frigatebird - Fregata andrewsi
51. Blue-eared Kingfisher - Alcedo meninting	233. Wilson's Storm-petrel - Oceanites oceanicus
52. Brown-winged Kingfisher - Halcyon amauroptera	234. Indian Pitta - Pitta brachyura
53. Stork-billed Kingfisher - Halcyon capensis	235. Mangrove Pitta - Pitta megarhyncha
	236. Golden-fronted Leafbird - Chloropsis aurifrons
	237. Brown Shrike - Lanius cristatus

Checklist for Birds

54. Ruddy Kingfisher - Halcyon coromanda
55. White-throated Kingfisher - Halcyon smyrnensis
56. Black-capped Kingfisher - Halcyon pileata
57. Collared Kingfisher - Todiramphus chloris
58. Pied Kingfisher - Ceryle rudis
59. Green Bee-eater -Merops orientalis
60. Blue-tailed Bee-eater - Merops philippinus
61. Chestnut-headed Bee-eater - Merops leschenaulti
62. Pied Cuckoo - Clamator jacobinus
63. Chestnut-winged Cuckoo - Clamator coromandus
64. Common Hawk Cuckoo - Hierococcyx varius
65. Indian Cuckoo - Cuculus micropterus
66. Eurasian Cuckoo - Cuculus canorus
67. Oriental Cuckoo - Cuculus saturatus
68. Lesser Cuckoo - Cuculus poliocephalus
69. Grey-bellied Cuckoo - Cacomantis passerinus
70. Plaintive Cuckoo - Cacomantis merulinus
71. Asian Koel - Eudynamys scolopacea
72. Green-billed Malkoha - Phaenicophaeus tristis
73. Greater Coucal - Centropus sinensis
74. Lesser Coucal - Centropus bengalensis
75. Rose-ringed Parakeet - Psittacula krameri
76. Asian Palm Swift - Cypsiurus balasiensis
77. House Swift - Apus affinis
78. Fork-tailed Swift - Apus pacificus
79. Barn Owl - Tyto alba
80. Oriental Scops Owl - Otus sunia
81. Indian Scops Owl - Otus bakkamoena
82. Brown Fish Owl - Ketupa zeylonensis
83. Buffy Fish Owl - Ketupa ketupu
84. Spotted Owlet - Athene brama
85. Short-eared Owl - Asio flammeus
86. Large-tailed Nightjar - Caprimulgus macrurus
87. Indian Nightjar - Caprimulgus asiaticus
88. Savanna Nightjar - Caprimulgus affinis
89. Rock Pigeon - Columba livia
90. Laughing Dove - Streptopelia senegalensis
91. Spotted Dove - Streptopelia chinensis
92. Red Collared Dove - Streptopelia tranquebarica
93. Eurasian Collared Dove - Streptopelia decaocto
94. Emerald Dove - Chalcophaps indica
95. Orange-breasted Green Pigeon - Treron bicincta
96. Yellow-footed Green Pigeon - Treron phoenicoptera
97. Masked Finfoot - Heliopais personata
98. Slaty-legged Crake - Rallina eurizonoides
99. Slaty-breasted Rail - Gallirallus striatus
100. Water Rail - Rallus aquaticus
101. White-breasted Waterhen - Amaurornis phoenicurus
102. Baillon's Crake - Porzana pusilla
103. Ruddy-breasted Crake - Porzana fusca
104. Watercock - Gallicrex cinerea
105. Purple Swamphen - Porphyrio porphyrio
106. Common Moorhen - Gallinula chloropus
107. Common Coot - Fulica atra
108. Eurasian Woodcock - Scolopax rusticola
109. Wood Snipe - Gallinago nemoricola
110. Pintail Snipe - Gallinago stenura
238. Bay-backed Shrike - Lanius vittatus
239. Long-tailed Shrike - Lanius schach tricolor
240. Grey-backed Shrike - Lanius tephronotus
241. Southern Grey Shrike - Lanius meridionalis
242. Mangrove Whistler - Pachycephala grisola
243. Rufous Treepie - Dendrocitta vagabunda
244. House Crow - Corvus splendens
245. Large-billed Crow - Corvus macrorhynchos
246. Ashy Woodswallow - Artamus fuscus
247. Eurasian Golden Oriole - Oriolus oriolus
248. Black-naped Oriole - Oriolus chinensis
249. Black-hooded Oriole - Oriolus xanthornus
250. Large Cuckooshrike - Coracina macei
251. Black-winged Cuckooshrike - Coracina melaschistos
252. Black-headed Cuckooshrike - Coracina melanoptera
253. Rosy Minivet - Pericrocotus roseus
254. Small Minivet - Pericrocotus cinnamomeus
255. Scarlet Minivet - Pericrocotus flammeus
256. Bar-winged Flycatcher-shrike - Hemipus picatus
257. White-throated Fantail - Rhipidura albicollis
258. Black Drongo - Dicrurus macrocercus
259. Ashy Drongo - Dicrurus leucocephalus
260. White-bellied Drongo - Dicrurus caerulescens
261. Bronzed Drongo - Dicrurus aeneus
262. Spangled Drongo - Dicrurus hottentottus
263. Greater Racket-tailed Drongo - Dicrurus paradiseus
264. Black-naped Monarch - Hypothymis azurea
265. Asian Paradise-flycatcher - Terpsiphone paradisi
266. Common Iora - Aegithina tiphia
267. Blue Rock Thrush - Monticola solitarius
268. Orange-headed Thrush - Zoothera citrina
269. Scaly Thrush - Zoothera dauma
270. Tickell's Thrush - Turdus unicolor
271. Red-throated Flycatcher - Ficedula parva
272. Little Pied Flycatcher - Ficedula westermanni
273. Verditer Flycatcher - Eumyias thalassina
274. Pale-chinned Flycatcher - Cyornis unicolor
275. Blue-throated Flycatcher - Cyornis rubeculoides
276. Tickell's Blue Flycatcher - Cyornis tickelliae
277. Grey-headed Canary Flycatcher - Culicicapa ceylonensis
278. Siberian Rubythroat - Luscinia calliope
279. Bluethroat - Luscinia svecica
280. Oriental Magpie Robin - Copsychus saularis
281. Indian Robin - Saxicoloides fulicata
282. Black Redstart - Phoenicurus ochruros
283. Siberian Stonechat - Saxicola torquata
284. White-tailed Stonechat - Saxicola leucura
285. Pied Bushchat - Saxicola caprata
286. Chestnut-tailed Starling - Sturnus malabaricus
287. Brahminy Starling - Sturnus pagodarum
288. Common Starling - Sturnus vulgaris
289. Asian Pied Starling - Sturnus contra
290. Common Myna - Acridotheres tristis
291. Bank Myna - Acridotheres ginginianus
292. Jungle Myna - Acridotheres fuscus
293. Chestnut-bellied Nuthatch - Sitta castanea

Checklist for Birds

111. Swinhoe's Snipe - Gallinago megala
112. Common Snipe - Gallinago gallinago
113. Jack Snipe - Lymnocryptes minimus
114. Black-tailed Godwit - Limosa limosa
115. Bar-tailed Godwit - Limosa lapponica
116. Whimbrel - Numenius phaeopus
117. Eurasian Curlew - Numenius arquata
118. Spotted Redshank - Tringa erythropus
119. Common Redshank - Tringa tetanus
120. Marsh Sandpiper - Tringa stagnatilis
121. Common Greenshank - Tringa nebularia
122. Green Sandpiper - Tringa ochropus
123. Wood Sandpiper - Tringa glareola
124. Terek Sandpiper - Xenus cinereus
125. Common Sandpiper - Actitis hypoleucos
126. Ruddy Turnstone - Arenaria interpres
127. Asian Dowitcher - Limnodromus semipalmatus
128. Great Knot - Calidris tenuirostris
129. Sanderling - Calidris alba
130. Little Stint - Calidris minuta
131. Red-necked Stint - Calidris ruficollis
132. Temminck's Stint - Calidris temminckii
133. Long-toed Stint - Calidris subminuta
134. Dunlin - Calidris alpine
135. Curlew Sandpiper - Calidris ferruginea
136. Spoon-billed Sandpiper - Calidris pygmeus
137. Broad-billed Sandpiper - Calidris falcinellus
138. Ruff - Philomachus pugnax
139. Red Phalarope - Phalaropus fulicaria
140. Greater Painted Snipe - Rostratula benghalensis
141. Pheasant-tailed Jacana - Hydrophasianus chirurgus
142. Bronze-winged Jacana - Metopidius indicus
143. Eurasian Thick-knee - Burhinus oedicnemus
144. Great Thick-knee - Esacus recurvirostris
145. Eurasian Oystercatcher - Haematopus ostralegus
146. Black-winged Stilt - Himantopus himantopus
147. Pied Avocet - Recurvirostra avosetta
148. Pacific Golden Plover - Pluvialis fulva
149. Grey Plover - Pluvialis squatarola
150. Common Ringed Plover - Charadrius hiaticula
151. Little Ringed Plover - Charadrius dubius
152. Kentish Plover - Charadrius alexandrinus
153. Lesser Sand Plover - Charadrius mongolus
154. Greater Sand Plover - Charadrius leschenaultii
155. River Lapwing - Vanellus duvaucelii
156. Grey-headed Lapwing - Vanellus cinereus
157. Red-wattled Lapwing - Vanellus indicus
158. White-tailed Lapwing - Vanellus leucurus
159. Oriental Pratincole - Glareola maldivarum
160. Small Pratincole - Glareola lactea
161. Heuglin's Gull - Larus heuglini
162. Pallas's Gull - Larus ichthyaetus
163. Brown-headed Gull - Larus brunnicephalus
164. Black-headed Gull - Larus ridibundus
165. Gull-billed Tern - Gelochelidon nilotica
166. Caspian Tern - Sterna caspia
167. River Tern - Sterna aurantia
294. Velvet-fronted Nuthatch - Sitta frontalis
295. Great Tit - Parus major
296. Sand Martin - Riparia riparia
297. Barn Swallow - Hirundo rustica
298. Red-rumped Swallow - Hirundo daurica
299. Streak-throated Swallow - Hirundo fluvicola
300. Red-whiskered Bulbul - Pycnonotus jocosus
301. Red-vented Bulbul - Pycnonotus cafer
302. Zitting Cisticola - Cisticola juncidis
303. Grey-breasted Prinia - Prinia hodgsonii
304. Yellow-bellied Prinia - Prinia flaviventris
305. Ashy Prinia - Prinia socialis
306. Plain Prinia - Prinia inornata
307. Oriental White-eye - Zosterops palpebrosus
308. Rusty-rumped Warbler - Locustella certhiola
309. Blyth's Reed Warbler - Acrocephalus dumetorum
310. Large-billed Reed Warbler - Acrocephalus orinus
311. Clamorous Reed Warbler - Acrocephalus stentoreus
312. Thick-billed Warbler - Acrocephalus aedon
313. Common Tailorbird - Orthotomus sutorius
314. Common Chiffchaff - Phylloscopus collybita
315. Dusky Warbler - Phylloscopus fuscatus
316. Tickell's Leaf Warbler - Phylloscopus affinis
317. Lemon-rumped Warbler - Phylloscopus chloronotus
318. Yellow-browed Warbler - Phylloscopus inornatus
319. Hume's Warbler - Phylloscopus humei
320. Greenish Warbler - Phylloscopus trochiloides
321. Large-billed Leaf Warbler - Phylloscopus magnirostris
322. Blyth's Leaf Warbler - Phylloscopus reguloides
323. Golden-spectacled Warbler - Seicercus burkii
324. Striated Grassbird - Megalurus palustris
325. Puff-throated Babbler - Pellorneum ruficeps
326. White-browed Scimitar Babbler - Pomatorhinus schisticeps
327. Striped Tit-Babbler - Macronous gularis
328. Chestnut-capped Babbler - Timalia pileata
329. Yellow-eyed Babbler - Chrysomma sinense
330. Striated Babbler - Turdoides earlei
331. Jungle Babbler - Turdoides striatus
332. Bengal Bushlark - Mirafra assamica
333. Ashy-crowned Sparrow Lark - Eremopterix nigriceps
334. Oriental Skylark - Alauda gulgula
335. Thick-billed Flowerpecker - Dicaeum agile
336. Orange-bellied Flowerpecker - Dicaeum trigonostigma
337. Pale-billed Flowerpecker - Dicaeum erythrorynchos
338. Scarlet-backed Flowerpecker - Dicaeum cruentatum
339. Purple-rumped Sunbird - Nectarinia zeylonica
340. Purple Sunbird - Nectarinia asiatica
341. Loten's Sunbird - Nectarinia lotenia
342. Crimson Sunbird - Aethopyga siparaja
343. Little Spiderhunter - Arachnothera longirostra
344. House Sparrow - Passer domesticus
345. Forest Wagtail - Dendronanthus indicus
346. White Wagtail - Motacilla alba
347. Citrine Wagtail - Motacilla citreola
348. Yellow Wagtail - Motacilla flava
349. Grey Wagtail - Motacilla cinerea

Checklist for Birds	
168. Lesser Crested Tern - Sterna bengalensis	350. Richard's Pipit - Anthus richardi
169. Great Crested Tern - Sterna bergii	351. Paddyfield Pipit - Anthus rufulus
170. Common Tern - Sterna hirundo	352. Tawny Pipit - Anthus campestris
171. Little Tern - Sterna albifrons	353. Tree Pipit - Anthus trivialis
172. Whiskered Tern - Chlidonias hybridus	354. Olive-backed Pipit - Anthus hodgsoni
173. White-winged Tern - Chlidonias leucopterus	355. Black-breasted Weaver - Ploceus benghalensis
174. Black Noddy - Anous minutus	356. Streaked Weaver - Ploceus manyar
175. Osprey - Pandion haliaetus	357. Baya Weaver - Ploceus philippinus
176. Black-shouldered Kite - Elanus caeruleus	358. Finn's Weaver - Ploceus megarhynchus
177. Black Kite - Milvus migrans	359. Red Avadavat - Amandava amandava
178. Brahminy Kite - Haliastur indus	360. Indian Silverbill - Lonchura malabarica
179. White-bellied Sea Eagle - Haliaeetus leucogaster	361. Scaly-breasted Munia - Lonchura punctulata
180. Pallas's Fish Eagle - Haliaeetus leucoryphus	362. Black-headed Munia - Lonchura malacca
181. Grey-headed Fish Eagle - Haliaeetus ichthyaetus	363. Common Rosefinch - Carpodacus erythrinus
182. White-rumped Vulture - Gyps bengalensis	364. Chestnut-eared Bunting - Emberiza fucata

Source: West Bengal Forest Department

Checklist for Fishes

Sl. No.	Name	Scientific Name	IUCN Status
1	Indian Dog Shark	*Scoliodon laticaudus*	Near Threatened
2	White cheeked shark	*Carcharhinus dussumieri*	Near Threatened
3	Blacktip shark	*Carcharhinus limbatus*	Near Threatened
4	Arrow headed hammer headed shark	*Sphryna blochii*	Endangered
5	Hammer headed shark	*Sphyrna zygaena*	vulnerable
6	River shark	*Glyphis gangeticus*	Critically Endangered
7	Sharpteeth shark	*Glyphis glyphis*	Endangered
8	Irrawady river shark	*Glyphis siamensis*	Critically Endangered
9	Tiger shark	*Galeocerdo cuvier*	Near Threatened
10	Bull shark	*Carcharhinus leucus*	Near Threatened
11	Bengal's snake eel	*Pisodonophis boro*	Least Concern
12	White sardine	*Escualosa thoracata*	-
13	Long finned eel, locally called Baan mach	*Anguilla bengalensis*	Near Threatened
14	Toli shad, locally called Kajli ilish	*Tenualosa toli*	-
15	Hilsa, locally called Ilish	*Tenualosa ilisha*	Least Concern
16	Elongate ilisha	*Ilisha elongata*	-
17	Indian ilish	*Ilisha melastoma*	-
18	Gold-spotted grenadier anchovy	*Coilia dussumeri*	-
19	Tapertail anchovy	*Coilia ramcarati*	-
20	Gangetic anchovy, locally called Phasa	*Setipinna phasa*	Least Concern
21	Hairfin anchovy	*Setipinna taty*	-
22	Spined anchovy	*Stolephorus baganensis*	-
23	Anchovy	*Stolephorus commersonii*	-
24	Dussumier's thryssa	*Thryssa dussumieri*	-
25	Hamilton's thryssa	*Thryssa hamiltonii*	-
26	Small-eye catfish	*Arius jella*	-
27	Hamilton's catfish	*Arius arius*	Least Concern
28	Bombay duck	*Harpadon nehereus*	-
29	Bhetki or Giant sea perch	*Lates calcarifer*	-
30	Silver sillago	*Sillago sihama*	Least Concern
31		*Sillago soringa*	-
32	Gangetic whiting	*Sillaginopsis panijus*	-
33	Spotted butterfish, locally called Pyra mach	*Scatophagus argus*	Least Concern
34	John's snapper	*Lutjanus johni*	Least Concern
35	Blotched grunt	*Pomadasys argenteus*	Least Concern
36	Asiatic milk fish	*Chanos chanos*	Least Concern

Sl. No.	Name	Scientific Name	IUCN Status
37		*Mystus gulio*	Least Concern
38	Half beck	*Zenarchopterus ectuntio*	-
39	Bloch's ponyfish	*Leiognathus blochii*	-
40	Common ponyfish	*Leiognathus equulus*	Least Concern
41	Parse	*Liza parsia*	-
42	Bhangone	*Liza tade*	Data Deficient
43	Corsula mullet, corsula	*Rhinomugil corsula*	Least Concern
44	Flathead grey mullet	*Mugil cephalus*	Least Concern
45	Paradise threadfin, locally called Topse	*Polynemus paradiseus*	-
46	Small-headed ribbonfish	*Lepturacanthus savala*	-
47	Gangetic ribbon fish	*Lepturacanthus pantuli*	-
48	Large head ribbon fish	*Trichiurus lepturus*	Least Concern

Source: West Bengal Forest Department

Annexure 4: MoEF&CC Letter

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 Operate' 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 5: PHOTOGRAPHS

Ferry Jetty at Chainage 0.5 (in Bidya waterway)

Protected Right Bank at Chainage 0.5

Protected Right Bank at Chainage 1.0

Unprotected Left Bank at Chainage 1.0

Mangroves on Left Bank at Chainage 1.4

Protected Right Bank at Chainage 1.5

View of Left bank at Chainage 1.5

Island at Chainage 2.0

View at Chainage 2.6

Island at Chainage 3.0

View of Left bank at Chainage 3.0

View of Right bank at Chainage 3.0

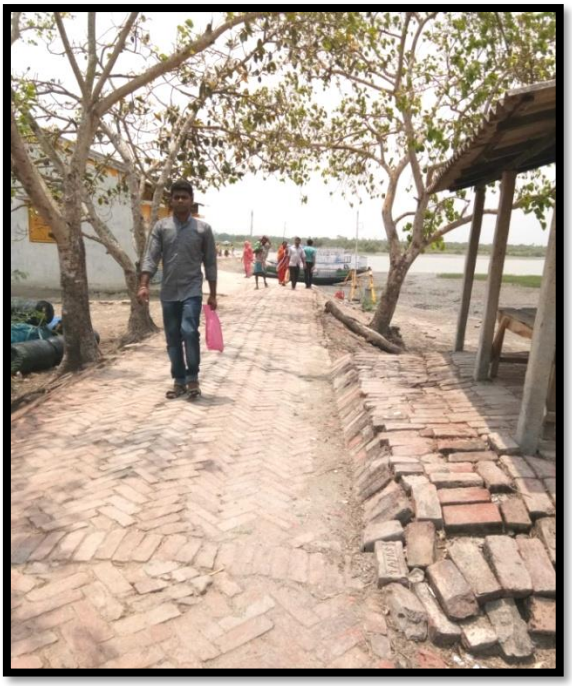
Base station at Masidbari at chainage 3.4

View on left bank at Chainage 3.4

Jetty at Masidbari at chainage 3.5

River bank at Chainage 3.6

Ferry Jetty at Chainage 4.0



Road leading to Chandipur Ghat at Chainage 4.2

Jetty at Chandipur Chainage 4.2

Road on right bank of river at chainage 4.4

Hindu Cemetery at chainage 4.5

Tide observation at chainage 4.5

Water lock at chainage 4.5

Pond along the river bank at chainage 5.0

Bushes along the river bank at chainage 5.0

Brick factory at Chainage 5.3

Mangroves at Chainage 5.3

Hutments at chainage 5.7

Transformer at Chainage 5.8

Water lock at chainage 5.8

VOLUME – II

DRAWINGS