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

SUNDERBANS WATERWAYS

RIVER: MATLA RIVER (STATE OF WEST BENGAL)

BALUCHERY ISLAND TO CANNING (98.731 KMS)

(Volume – I: Main Report)

(Volume – II: Drawings)

Submission Date: 04/08/2021

Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 4

AUGUST 2021

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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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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 MATLA RIVER (SUNDERBANS WATERWAYS (NW 97)

<table>
<tr><th>Sr. No.</th><th>Particulars</th><th colspan="10">Details</th></tr>
<tr><td>A.</td><td>GENERAL</td><td colspan="10"></td></tr>
<tr><td>1.</td><td>Location</td><td colspan="10"></td></tr>
<tr><td>a)</td><td>Cluster</td><td colspan="10">3</td></tr>
<tr><td>b)</td><td>State(s)</td><td colspan="10">West Bengal</td></tr>
<tr><td>c)</td><td>Co-ordinates & Name of Place</td><td colspan="5">Start</td><td colspan="5">End</td></tr>
<tr><td></td><td>Place</td><td colspan="5">Baluchery Island</td><td colspan="5">Canning</td></tr>
<tr><td></td><td>Latitude</td><td colspan="5">21°33'04.06"N</td><td colspan="5">22°19'8.92" N</td></tr>
<tr><td></td><td>Longitude</td><td colspan="5">88°38'25.63"E</td><td colspan="5">88°40'38.76"E</td></tr>
<tr><td>B.</td><td>TECHNICAL</td><td colspan="10"></td></tr>
<tr><td>1.</td><td>Waterway</td><td colspan="10"></td></tr>
<tr><td>a)</td><td>National Waterway Number</td><td colspan="10">97</td></tr>
<tr><td>b)</td><td>Class</td><td colspan="10">VII</td></tr>
<tr><td>c)</td><td>Type (Tidal/Non-Tidal)</td><td colspan="10">Tidal</td></tr>
<tr><td></td><td>Length (Km.)</td><td colspan="3">Total</td><td colspan="4">Tidal</td><td colspan="3">Non-Tidal</td></tr>
<tr><td></td><td></td><td colspan="3">98.731 Km</td><td colspan="4">98.731 Km</td><td colspan="3">0 Km</td></tr>
<tr><td>d)</td><td>Sounding Datum</td><td colspan="10"></td></tr>
<tr><td></td><td>Description/Basis</td><td colspan="10">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.</td></tr>
<tr><td></td><td>Value w.r.t MSL (m)</td><td>0-10 km</td><td>10-20 km</td><td>20-30 km</td><td>30-40 km</td><td>40-50 km</td><td>50-60 km</td><td>60-70 km</td><td>70-80 km</td><td>80-90 km</td><td>90-98.73 km</td></tr>
<tr><td></td><td></td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td><td>-2.82</td></tr>
<tr><td>e)</td><td>LAD Status (w.r.t. SD)</td><td colspan="10"></td></tr>
</table>

Sr. No.	Particulars	Details										
		Sub - Stretch 1	Sub - Stretch 2	Sub - Stretch 3	Sub - Stretch 4	Sub - Stretch 5	Sub - Stretch 6	Sub - Stretch 7	Sub - Stretch 8	Sub - Stretch 9	Sub - Stretch 10	
	Stretch Km (From......To......)	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-98.73	
	Length with LAD < 1.2 m	0	0	0	0	1.6	0	0	0	0	4.13	
	With LAD from 1.2-1.4 m	0	0	0	0	0.2	0	0	0	0	0.2	
	With LAD from 1.5-1.7 m	0	0	0	0	0	0	0	0	0	0.2	
	With LAD from 1.8-2.0 m	0	0	0	0	0.8	0	0	0	0	0	
	With LAD > 2.0 m	10	10	10	10	7.4	10	10	10	10	4.2	
	Total	10	10	10	10	10	10	10	10	10	8.73	
f)	Target Depth of Proposed Fairway (m)	2.75 m for Class VII waterway										
g)	Conservancy Works Required for 45.0 Km (from Chainage 41.0 Km to chaiange 86.0 Km) stretch proposed to be developed											
	Type of Work (km)	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-98.73	Total
	Dredging Required (M. Cum.)	Nil	Nil	Nil	Nil	0.22	Nil	Nil	Nil	0.03	Nil	0.25
	Bandalling	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NIL
	Barrages & Locks	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NIL
	River Training (Km.)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NIL
	Bank Protection (Km.)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	NIL
h)	Existing Cross Structures											
	Name of Structure for 45.0 Km (from Chainage 41.0 Km to chaiange 86.0 Km) stretch proposed to be developed	Type	Nos.	Range of Horizontal Clearance	Range of Vertical Clearance w.r.t. MHWS							

Sr. No.	Particulars	Details				
	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)	Ferry services and small boats run from Jharkhali, Basanti ferry ghat, Garan Bose No 1 and 3 ghat, Golabari ferry ghat, Haribhangi ferry ghat, Kaikhali ghat, Madhukhali Jetty and Sonakhali ferry ghat. About 11.5 km of Matla river stretch (Lot No. 121 to Kaikhali) lies in the Indo Bangladesh Waterway Protocol Route				
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.)	Nearest Railway station is Canning which is 1.5 Km away from the end point near canning bridge. Canning Railway station is about 0.9km from the river bank. The mainland side of the Matla is connected with good road transport network and private vehicles are also available in the nearby area. State highway SH-3, runs through the eastern side of the river				
d)	Commodities	**In-bound**		**Out-bound**		
		Not Available		Not Available		
e)	Existing and Future Potential					
	Name of Commodity	**Existing**	**5 years**	**10 years**	**15 years**	**20 years**
	Passengers with 8% growth rate (nos/day)	250	428	630	925	1359
3.	***Terminals/Jetties***					
a)	Terminal/Jetty - 1	Kaikhali Ferry Terminal				
	Location	(Left Bank/Kaikhali)				
	Type/Services	Passenger Ferry, Tourism and IWT support to Indo Bangladesh protocol route.				

Sr. No.	Particulars	Details
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform
	Approach	Kaikhali Road
	Land Ownership	Government
b)	Terminal/Jetty - 2	Garan Bose No. 1 Ferry Terminal
	Location	(Right Bank/ Garan Bose)
	Type/Services	Passenger Ferry
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform
	Approach	River Bank Road
	Land Ownership	Government
c)	Terminal/Jetty - 3	Madhukhali
	Location	(Right Bank/ Madhukhali)
	Type/Services	Passenger Ferry
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform
	Approach	River Bank Road
	Land Ownership	Government
d)	Terminal/Jetty - 4	Golabari Ferry Terminal
	Location	(Left Bank/Golabari)
	Type/Services	Passenger Ferry
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform
	Approach	Village road
	Land Ownership	Government

Sr. No.	Particulars	Details		
4.	***Design Vessel***			
a)	Type	Fibre boat		
b)	No. & Size	3 Nos. (18.0m L x 3.0m B x 1.58m D) from start date of operation, additional 1 vessels in 10th year of operation and additional 5 vessels in 20th year of operation.		
c)	Loaded Draft	0.80 m		
d)	Capacity	25 passengers		
5.	***Navigation Aids***			
a)	DGPS	1 no.		
b)	Type	Marking buoys		
c)	Nos.	20		
C.	**FINANCIAL**			
1.	***Cost***	***Capital Cost*** (INR Lakhs)	***O&M Cost*** (INR Lakhs)	
	Fairway Development	490.08	49.01	
	Ferry Service facilities	294.79	8.84	
	Vessels (3 nos.)	105.00	52.23	
	Total Cost including Vessel	**1,048.86**	**141.62**	
	Total Cost without Vessel cost	**943.86**	**89.39**	
2.	***User Charges***	INR 5.0 per passenger per KM		
3.	***Financial Internal Rate of Return (%)***	**Option 1** Total Capital Cost + Total O&M cost	**Option 2** Option 1 - Vessel Capital & O&M cost	**Option 3** Vessel Capital Cost + Vessel O&M Cost
		3.18%	9.06%	33.85%
4.	***Economic Internal Rate of Return (%)***	**Option 1** Total Capital Cost + Total O&M cost	**Option 2** Option 1 - Vessel Capital & O&M cost	**Option 3** Vessel Capital Cost + Vessel O&M Cost
		3.91%	9.77%	38.31%

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. Matla River is one of the 13 rivers clubbed in Cluster 3.

This draft detailed project report of 98.731 km stretch of Matla 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 98.731 km stretch of Matla National waterway proposed for DPR study lies from Baluchery Island at Lat 21°33'04.06"N, Long 88°38'25.63"E to Canning at Lat 22°19'8.92" N, Long 88°40'38.76"E. Whole stretch of Matla waterway is having tidal influence with a maximum tidal variation of 4.79 m to a minimum tidal variation of 4.52 m.

River width in the waterway stretch varies from 0.05 km to 7.0 km. Average flow velocity in the waterway varies from 0.208 m/sec to 0.887 m/sec.

3.0 FAIRWAY DEVELOPMENT

As obtained from the results of hydrographic survey, by taking into advantage of tidal window, sufficient LAD is available in the complete 98.731 km stretch of waterway, which suggests that waterway is technically viable for throughout the year navigation. However, on the basis of traffic studies done in this DPR, 45.0 Km stretch of waterway from Chainage 41.0 Km to chainage 86.0 Km is recommended to be developed as per Class VII. The dredging quantity estimated for Class VII waterway is 2,45,038.17 cum. The total capital and O&M cost of fairway development works out to INR 490.09 Lakh and INR 49.01 Lakh respectively.

4.0 TRAFFIC STUDY

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

a) Proposed Matla waterway is connected with Indo Bangladesh waterway protocol route, Bidya and Hogla National waterways.
b) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Matla river from Lot No. 121 to Kaikhali (for a length of about 11 Km).
c) There are no big industries near the survey area, however a few brick kilns are found along the river banks.
d) Passenger ferry services are operated privately all along the waterway, however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking.

In view of existing passenger traffic per day (though small) and connectivity of Matla river with major waterways, 4 passenger ferry ghats, namely, Kaikhali, Garan Bose no. 1, Madhukhali and Golabari are recommended to be developed for IWT services as detailed in following chapters of DPR.

Pontoon and Gangway facilities only are proposed at Garan Bose no. 1, Madhukhali and Golabari ferry ghats for providing ferry service link to Basanti and Sonakhali ferry ghats, for the limited traffic as provided in traffic chapter above and as such it is recommended that all basic anemities of terminal structure like parking, ticketing etc. shall be locally handled. Similarly, the Pontoon and Gangway facility at Kaikhali are proposed to provide additional support to vessels plying along India Bangladesh protocol route and for tourism traffic to sunderbans reserve forest.

5.0 TERMINALS

Number of existing ferry terminals is located along the Matla river. The existing ferry terminals are operated by locals and lacks facilities like embarking/disembarking of vessels, basic amenieties for passengers etc. In this DPR, following ferry ghats are proposed to be developed with floating pontoons and gangway facilities:

a) Kaikhali,
b) Garan Bose no. 1,
c) Madhukhali and
d) Golabari

The total cost of terminals works out on the basis of preliminary engineering design is provided as below:

Sl. No.	Item	Amount in Lakh (INR)
1.0	Capital cost for proposed facilities excluding land cost	294.79
2.0	O&M cost for Terminals	8.84

6.0 PRELIMINARY ENGINEERING DESIGNS

Preliminary engineering design is done for terminal structures and necessary infrastructure required for waterway development. Following basic facilities are provided for both the passenger ferry facilities:

- Floating Pontoon
- Gangway

Relevant Indian and International codes are used for preliminary design of all structures.

7.0 VESSEL DESIGN

Ferry vessels developed by West Bengal Transport Infrastructure Development Corporation (WBTIDC) or other local operators, with carrying capacity of 25 passengers are proposed to be operated in Matla waterway for passenger ferry services. On the basis of traffic studies done in DPR, it is recommended that the ferry services shall be started with 3 vessels initially and after 10 years of service additional 1 vessel and after 20 years of service additional 5 vessels shall be incorporated in the existing fleet on the basis of growing passenger traffic. The procurement and O&M cost of two ferry vessel in inception phase works out to INR 105.00 lakh and INR 52.23 lakh respectively and in phase 2 for additional 1 ferry vessel works out to INR 35.00 lakh and INR 17.27 lakh respectively. In phase 3 for additional 5 ferry vessel works out to INR 175.00 lakh and INR 86.76 lakh respectively

8.0 NAVIGATION & COMMUNICATION SYSTEM

Aids to Navigation like DGPS (for all Sunderbans Waterways), and marking buoys are proposed along the channel alignment. Capital and maintenance cost for the same works out to INR 56.65 Lakh and INR 5.67 Lakh respectively.

9.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Matla 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. 128.225 lakh.

10.0 INSTITUTIONAL REQUIREMENTS

In view of collective development of NW-97 (Sunderbans waterways), and the proposed infrastructure development along Matla waterway, it is recommended that the development of Matla waterway shall be handled by Project Management Unit (PMU) proposed for development of Hogla waterway, under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata. Accordingly, the cost of development of Institutional requirement is considered in Hogla waterway DPR.

11.0 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

Matla waterway is proposed to be developed for passenger ferry services for a stretch of 45.0 Km from 98.731 Km. The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) Cost of jetties and terminal buildings
c) Vessel Cost
d) EMP cost

The waterway is proposed to be developed for Class VII, with 4 ferry ghats with Pontoon and Gangway facilities and 3 passenger ferry vessels at the inception stage. Garan Bose no. 1, Madhukhali and Golabari ferry ghats are proposed to be developed for providing ferry service link to Basanti and Sonakhali ferry ghats. Kaikhali ferry ghat is proposed to provide additional support to vessels plying along India Bangladesh protocol route and to support tourism traffic for Sunderbans Reserve Forest area. The capital cost for development of the system components of the project viz., development of the designed waterway, construction of facilities for passenger ferry services and purchasing of vessels has been worked out as INR 1,048.86 Lakh with 3 vessels. In 10th year of operation, capital cost of purchasing additional 1 vessel is INR 35.00 Lakh and in 20th year of operation, capital cost of purchasing additional 5 vessels are INR 175.00 Lakh. The additional vessels shall be purchased on the basis of growing traffic demand. Corespondignly O&M cost for Matla waterway works out to INR 141.62 Lakh from inception stage. For additional vessel, O&M cost from 11th year onwards works out to INR 17.27 Lakh.

12.0 IMPLEMENTATION SCHEDULE

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

13.0 ECONOMIC & FINANCIAL ANALYSIS

An attempt has been made to estimate the possible revenue available from this service. Although this has been calculated in a thorough and logical manner the study is based on many assumptions and it should therefore be taken as a guide to the magnitude of possible revenue.

A downtime of about 2 months is assumed, which could be occurred due to weather, operational or other factors. Hence, it is assumed that the full service is operating for 300 days annually. The calculated FIRR and EIRR for varying fare are shown as below:

Sr. No.	Fare (INR) per passenger per KM	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
		FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)
1	1.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable
2	2.00	Not Calculable	Not Calculable	-5.68%	-4.07%	7.74%	11.18%
3	3.00	-9.78%	-8.05%	1.78%	2.75%	18.20%	21.61%
4	4.00	-1.27%	-0.34%	5.99%	6.78%	26.27%	30.12%
5	5.00	3.18%	3.91%	9.06%	9.77%	33.85%	38.31%
6	6.00	6.33%	6.96%	11.56%	12.21%	41.51%	46.62%
7	7.00	8.83%	9.41%	13.70%	14.33%	49.47%	55.22%
8	8.00	10.95%	11.50%	15.61%	16.21%	57.78%	64.09%
9	9.00	12.81%	13.34%	17.35%	17.94%	66.42%	73.19%
10	10.00	14.49%	15.01%	18.96%	19.55%	75.33%	82.48%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the proposed IWT operation along Matla waterway is financially and economically viable for all the three options with a tariff of INR 5.00 per passenger per Km and above for proposed OD pairs.

Project life cycle cost analysis is also done for Matla waterway DPR and for 20 years of project life cycle with a tariff of INR 5.00 per passenger per Km the results concluded are as below:

Option 1: Total Capital Cost + Total O&M cost:

With project life cycle cost of INR 6,535 Lacs, the breakeven occurs during 18th year of operation.

Option 2: Option 1 - Vessel Capital & O&M cost

With project life cycle cost of INR 4,137 Lacs, the breakeven occurs during 13th year of operation.

Option 3: Vessel Capital Cost + Vessel O&M Cost

With project life cycle cost of INR 2,398 Lacs, the breakeven occurs during 3rd year of operation.

14.0 CONCLUSION

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

a) By taking into advantage of tidal window, sufficient LAD is available in the complete 98.731 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation.
b) About 11.50 km stretch of Matla river from Lot No. 121 to Kaikhali lies in the Indo Bangladesh Waterway Protocol Route and is also located near to Sanderbans reserve forest area.
c) Proposed Matla waterway is also connected with Bidya and Hogla national waterways.
d) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Matla river from Lot No. 121 to Kaikhali.
e) There are no big industries ocated along the hinterland, however a few brick kilns are found along the river banks.
f) Passenger ferry vessels are operational along the waterway by locals.
g) 45 Km stretch of Matla waterway is recommended for development as per Class VII, serving the proposed terminals, Indo-Bangladesh Waterway protocol route, Bidya and Hogla national waterways.

The cost benefit analysis, calculations done for financial internal rate of return (FIRR) and Economic internal rate of return (EIRR) concludes that the project is financially and economically viable with a tariff of INR 5.0 per passenger per Km and above for the proposed OD pairs, in case the project is implemented in a single package. However, in case the project is implemented in separate packages as shown below, the tariff can be reduced accordingly.

Package – 1 : Construction, Operation & Maintenance of fairway and jetties

Package – 2 : Procurement, operation & maintenance of Ferry Vessel

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. Matla River is clubbed under Cluster -3 for the two stage DPR studies.

This draft detailed project report of 98.731 km stretch of Matla 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

Matla 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 Matla River) was covered in the Sunderbans waterways (NW-97). Following section of the Matla 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
98.731 Km	21°33'04.06"N 88°38'25.63"E	Baluchery	22°19'8.92" N 88°40'38.76"E	Canning

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

Based on the above conclusions/observations done during feasibility studies i.e. first stage of the studies, IWAI recommended following stretch of Matla 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
98.731 Km	21°33'04.06"N	Baluchery	22°19'8.92” N	Canning
	88°38'25.63"E		88°40'38.76"E	

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 98.731 km stretch of Matla 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.

Matla waterway project location as per DPR is shown in **Figure 1**. The detailed layout plan of waterway and terminal structures are provided in Drawings PT/EIPTIWB003/2017/DPR/0001 to 0003 attached as **Volume-II**.

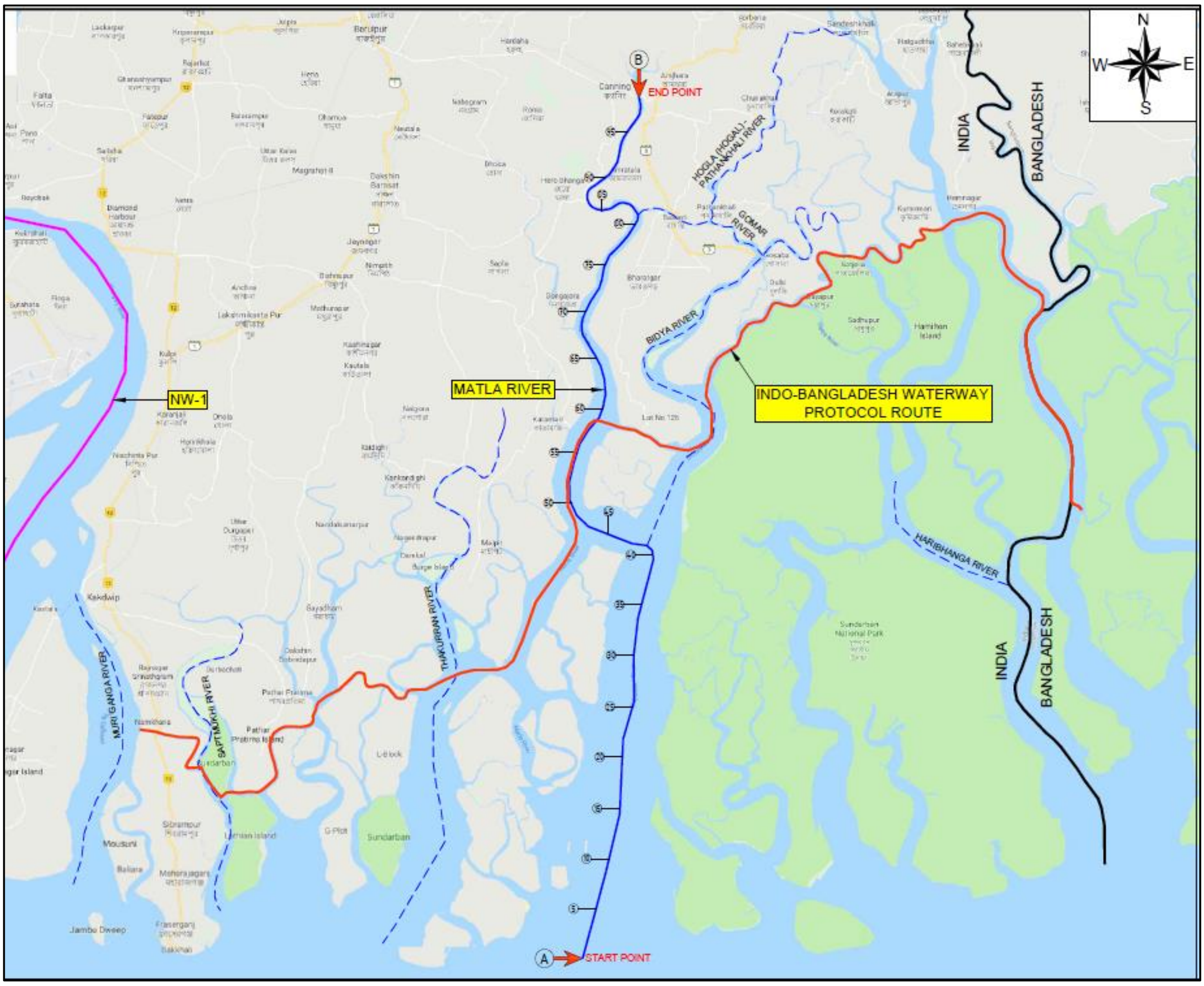


Figure 1: Matla National Waterway Project Location

1.3 INDO–BANGLADESH WATERWAY PROTOCOL ROUTE

An Inland water transit and trade protocol exists between India and Bangladesh under which inland vessels of one country can transit through the specified routes of the other country. The existing protocol routes are (i) Kolkata-Pandu-Kolkata, (ii) Kolkata-Karimganj - Kolkata, (iii) Rajshahi-Dhulian-Rajshahi and (iv) Pandu-Karimganj-Pandu. For inter-country trade, four ports of call have been designated in each country namely; Haldia, Kolkata, Pandu and Karimganj in India and Narayanganj, Khulna, Mongla and Sirajganj in Bangladesh. Under the Protocol, 50:50 cargo sharing by Indian and Bangladeshi vessels is permitted both for transit and inter country trade.

IWAI is the Competent Authority on Indian side w.e.f. 8th September 2003 vide Ministry's Order No. WTC-15014/2/2001-IWT dated 29.08.03 and is responsible for maintenance of routes including conservancy and pilotage.

About 11.45 km stretch of Matla waterway, from Lot No 121 to Kaikhali lies along this Indo Bangladesh Protocol Routes maintained by IWAI.

1.4 BRIEF SCOPE OF WORK AND COMPLIANCE STATEMENT

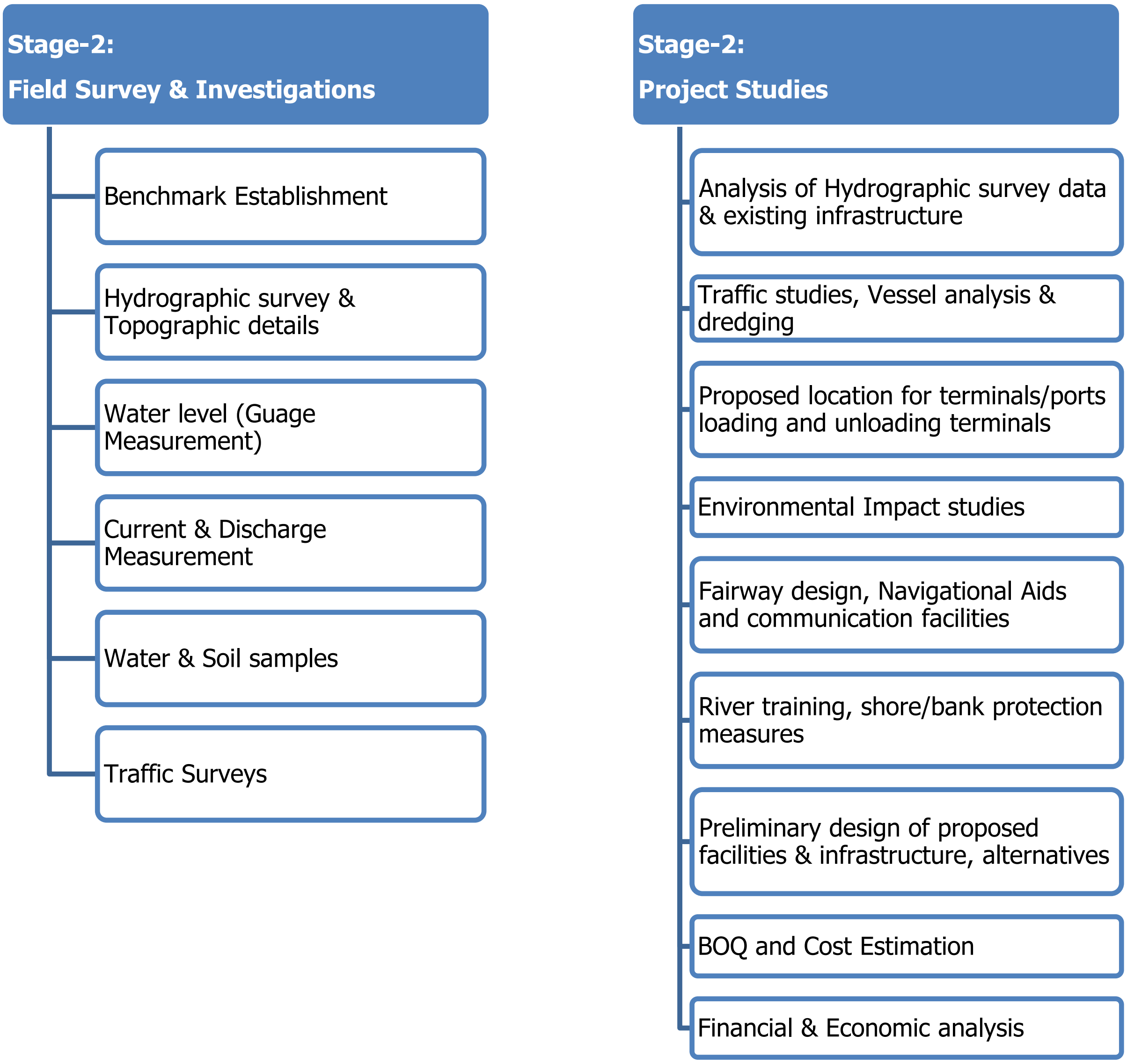
The brief scope of work for the project comprises of:

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;



1.5 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:

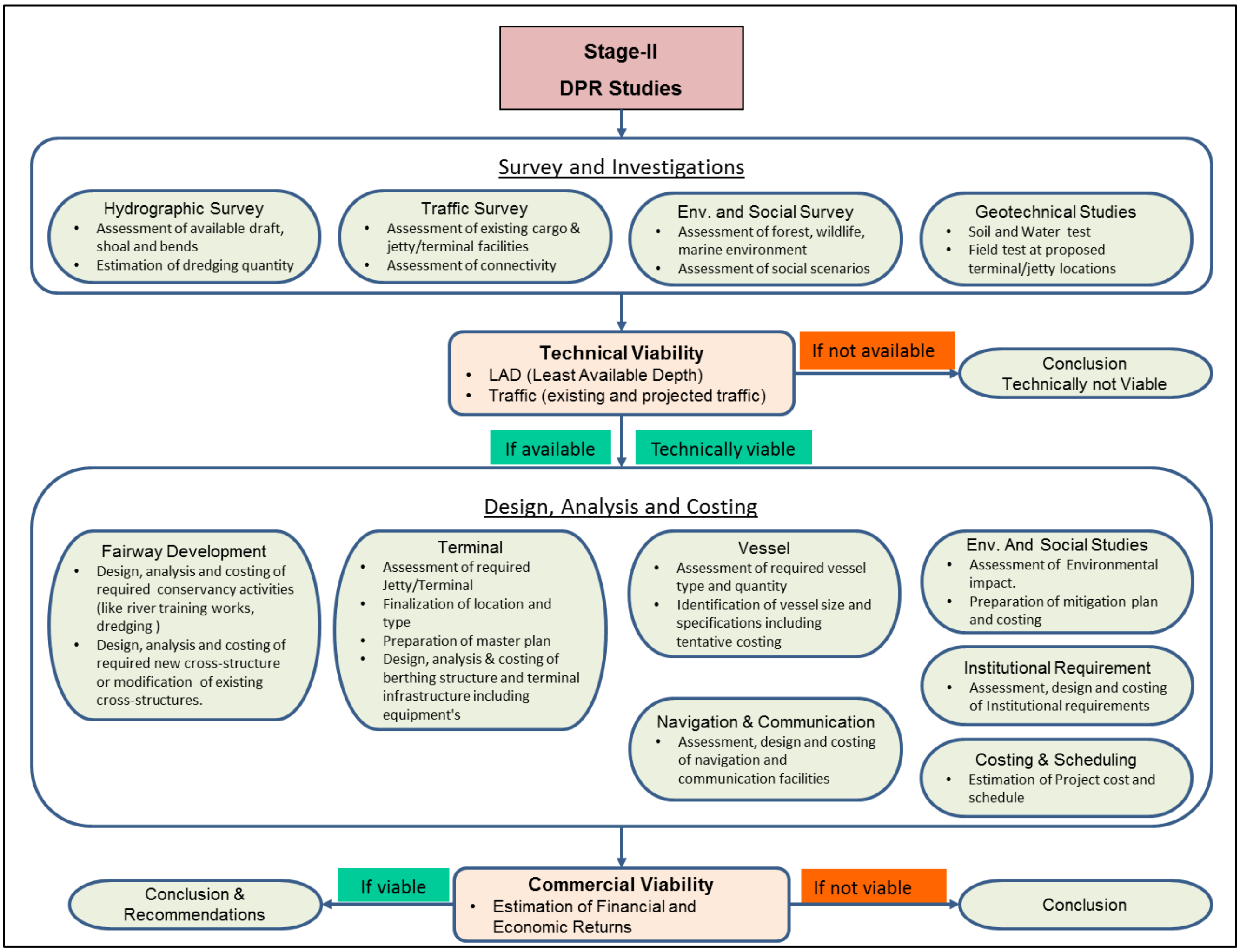


Figure 2: DPR Approach and Methodology Flow Chart

1.5.1 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.

1.5.2 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.

1.5.3 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.

1.5.4 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.

1.5.5 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 Matla river under DPR study is from Baluchery Island at Lat 21°33'04.0612"N, Long 88°38'25.6352"E to Canning at Lat 22°19'8.92" N, Long 88°40'38.76"E. The total length of this stretch is about 98.731 Km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Matla 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.
- Geotechnical Investigations at proposed new Jetty/ Terminal locations.

2.1.1 Waterway in General and Hydro-Morphological Characteristics

The Matla River is a tidal estuarine river in and around the Sundarbans in South 24 Parganas district West Bengal, India. The main streme of the the river is divided into two arms near Purandar. One passes through Kultali-Garanbose and then passes through the Sunderban. The other passes through Basanti, Patankhali, Surjyaberia, Masjidbati and then meets the Bidyadhari river.

The proposed 98.731 Km stretch of waterway is located in the South 24 Parganas district of West Bengal. Whole stretch of Matla waterway is having tidal influence with a maximum tidal variation of 4.79 m to a minimum tidal variation of 4.52 m.

Average flow velocity in the waterway varies from 0.208 m/sec to 0.887 m/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, a 4 hour observation was carried out at TR-06 of Thakuran River and newly established BM, ML-05 to transfer the MSL value from TR-06. Also 4 hour observation were carried out at ML-01, ML-02 & ML-03 and ML-04 BM's and data was logged in rinex format which was post processed in Auspos and Spectra software and value of BMs w.r.t. MSL were obtained.

Sounding datum was transferred from Haldiya, Diamond Harbour and Mayapur. Matla River was divided into 10 km stretches for ease of applying Tidal level corrections to the collected bathymetric data. Total five in number BM's pillars (naming ML-01, ML-02, ML-03, ML-04 & ML-05) were constructed and erected along the river from Jharkhali to Canning.

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	Height above SD (m)
ML-01	Jharkhali	58.3 KP	21°57'12.87"	88°30'15.27"	673966.30	2436208.29	4.873	7.693
ML-02	Dongajora	69.7 KP	22°07'08.01"	88°37'13.22"	667129.11	2446876.68	3.623	6.443
ML-03	Basanti	80.8 KP	22°12'15.19	88°42'29.01"	676072.553	2456423.668	3.845	6.665
ML-04	Amratala	91 KP	22°14'34.29	88°39'38.02"	671128.418	2460647.286	4.795	7.615
ML-05	Canning	98.5 KP	22°18'17.32	88°40 '58.50"	673356.418	2467532.658	2.408	4.768

2.1.3 Sounding Datum and Reduction details

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. Details of Sounding Datum (SD) and reduction details are provided in

Table 3 as below:

Table 3: Details of Sounding Datum

Sl No	Location of Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation
	A	B	C	D +ve indicates above MSL -ve	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
ML-01	Jharkhali	58.3 KP	0.0 to 64	-2.82	-2.82	Tide Applied w.r.t SD	2.82
ML-02	Dongajora	69.7 KP	64.1 to 75	-2.82	-2.82		2.82
ML-03	Basanti	80.8 KP	75.1 to 86	-2.82	-2.82		2.82
ML-04	Amratala	91 KP	86.1 to 95	-2.82	-2.82		2.82
ML-05	Canning	98.5 KP	95.1 to 98.731	-2.36	-2.36		2.36

2.2 EXISTING CROSS STRUCTURES

2.2.1 Bridges

The value of MHWS and Mean Sea Level was taken from KPT Tide book for the Standard Port i.e Sagar Roads and same was applied at the site. The details of MHWS values for all cross structures are provided **Table 4** in below.

Table 4: Detail of Cross Structure

Sl. No.	Location	Cross-structure Details	Chainage (km)	Established MHWS w.r.t. MSL (m)	Computed MHWS at Cross-Structures w.r.t. MSL (m)
1	Canning	Road Bridge	98.6	5.938	5.938

2	Canning	Rail Bridge	98.0	Under Construction

2.2.2 Electric Lines / Communication Lines

No Electric lines are loacated across the entire stretch of waterway.

2.2.3 Pipe Lines / Cables

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

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

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

2.3 BENDS

Details of bends located along the entire stretch of waterway are provided in **Table 5**.

Table 5: Details of Bends located along the waterway

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
1.0	38.94	42.20	1,355
2.0	47.03	52.05	4,282
3.0	58.25	65.90	5,663
4.0	67.12	70.00	2,860
5.0	79.80	83.30	1,418
6.0	85.01	88.40	1,283

As listed above, no sharp bend is located along the entire waterway stretch.

2.4 VELOCITY AND DISCHARGE DETAILS

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

Table 6.

Table 6: 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	97.652	22°17'47.7806"N	088°40'59.6564"E	673399.50	2466624.20	0.66	0.49	0.41	0.34	0.496	276.5	137.144
2	90	22°14'11.4432"N	088°39'03.3170"E	670142.40	2459933.70	5.38	0.44	0.11	0.08	0.21	1123	235.83
3	80	22°11'51.4692"N	088°40'37.3347"E	672882.10	2455658.20	7.56	0.54	0.43	0.17	0.380	3500	1330

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			
4	70	22°07'17.7320"N	088°38'07.7189"E	668687.60	2447192.40	1.14	0.23	0.205	0.19	0.208	8679	1805.232
5	60	22°01'52.7763"N	088°39'32.2795"E	671219.60	2437224.40	3.7	.58	.51	.48	0.523	13125	6864.375
6	50	21°57'15.1749"N	088°37'10.0704"E	667232.20	24286430	6.3	.62	.57	.54	.577	18096.6	10441.738
7	40	21°54'26.1449"N	088°40'53.6234"E	673703.00	2423513.50	11.2	.87	.83	.78	.827	51680.8	42740.022
8	30	21°49'6.4862"N	088°40'6.7716"E	672465.00	2413667.70	8	.76	.72	.69	.723	17585.5	12714.317

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			
9	20	21°43'42.8860"N	088°39'31.0201"E	671545.20	2403704.40	19.4	1.05	.87	.69	.87	47314.1	41163.27
10	10	21°38'23.3512"N	088°38'37.3200"E	670106.30	2393860.90	11.5	.83	.79	.76	.793	79943.3	63395.037
11	0.6	21°33'13.899"N	88°38'48.138"E	670518.04	2384347.33	16.3	.97	.88	.81	.887	67507.4	59879.064

2.5 WATERWAY DESCRIPTION

The total 98.731 Km stretch of Matla Waterway under DPR study, can be broadly divided in to ten (10) stretches. **Table 7** below provides the details of sub-stretches of Matla waterway.

Table 7: Sub-Stretches of Matla Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Baluchery Island	Kalas Island	0 km	10 km
2	Kalas Island	Unnamed Island	10 km	20 km
3	Unnamed Island	Bonnie camp	20 km	30 km

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
4	Bonnie camp	Unnamed Island	30 km	40 km
5	Unnamed Island	Purba Gurguria	40 km	50 km
6	Purba Gurguria	Gopalganj	50 km	60 km
7	Gopalganj	Andheria	60 km	70 km
8	Andheria	Budh Khali	70 km	80 km
9	Budh Khali	Amratala	80 km	90 km
10	Amratala	Katalberia	90 km	98.731 km

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

2.5.1 Sub Stretch 1: From Baluchery Island to Kalas Island (Chainage 0 Km to 10 Km)

Only Bathymetric Survey was carried out for this stretch between 0 to 10 km chainage of the Matla river. It is the downstream portion of the river where it confluence with the Bay of Bengal. The area is covered with dense forest and is declared as the protected area for Tigers. Hence no civilisation is seen along the bank except one watch tower naming Chulkathi Camp. This river stretch is very wide approx 15 Km at the point where the river joins the Bay of Bengal and remains approx 13 km as we move upstream. The river banks on both the sides are unprotected. There is a small jetty near Chulkathi camp. Fishing is prohibited in this region.

Following are the observations made during survey of Sub-stretch 1: From Baluchery Island to Kalas Island (Chainage 0 Km to 10 Km)

- There are no overhead obstructions/crossovers.
- There are no prominent dams & barrage available in this stretch.
- The tidal range is 4.644 m in this Stretch.
- There is no hindrance or encroachment in this stretch.
- Since sufficient depth is available for all time navigation, dredging is not required at this stretch.

The details of current and discharge at different depths is placed at

Table 6.

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 10.0 Km) of Matla Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 8**. **Figure 4** shows the observed and reduced bed profile of sub-stretch 1.

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

Table 8: 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	10	Not Applicable (Tidal Zone)				5.63	16.43	0	0
II	0	10					5.63	16.54	0	0
III	0	10					5.63	16.54	0	0
IV	0	10					5.63	16.54	0	0

V	0	10		5.63	16.54	0	0
VI	0	10		5.63	16.54	0	0
VII	0	10		5.63	16.67	0	0

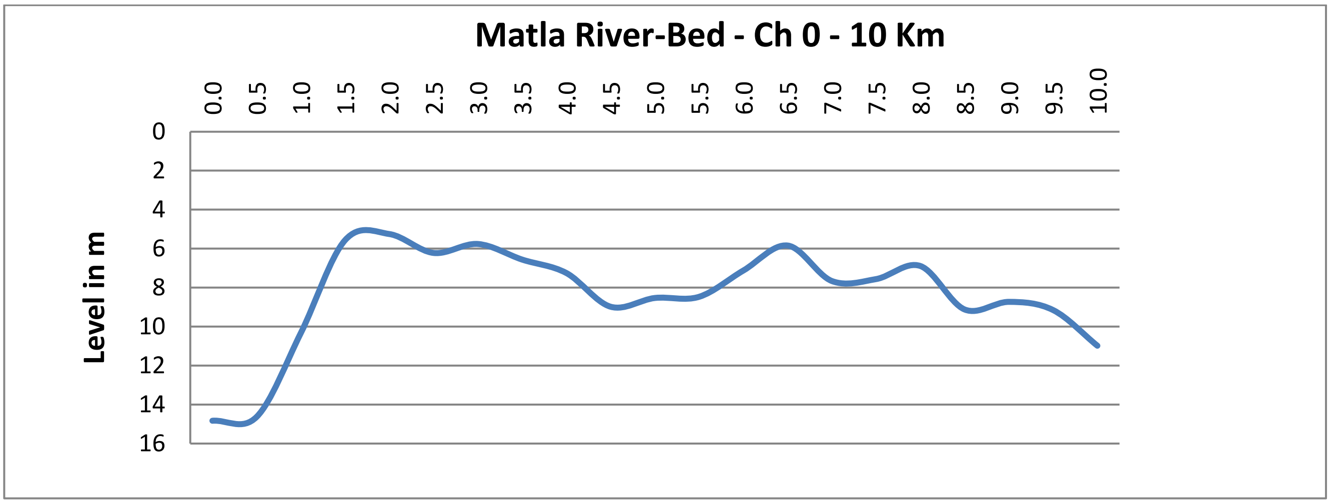


Figure 4: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

2.5.2 Sub Stretch 2: From Kalas Island to Unnamed Island (Chainage 10 Km to 20 Km)

Only Bathymetric Survey was carried out for this stretch between 10 to 20 km chainage of the Matla River. There is dense mangrove forestation on both sides of the river in this stretch. A 800 mtr long island covered with mangroves is also present in the river. The area falls in core region. This stretch is also very wide and average width is about 7 km with unprotected river bank at both the sides.

The details of current and discharge at different depths is placed at

Table 6**.**

Following are the observations made during survey of Sub-stretch 1: From Kalas Island to Unnamed Island (Chainage 10 Km to 20 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 4.644m in this stretch as we move from downstream to upstream.
- Since sufficient depth is available for all time navigation, dredging is not required at this stretch.

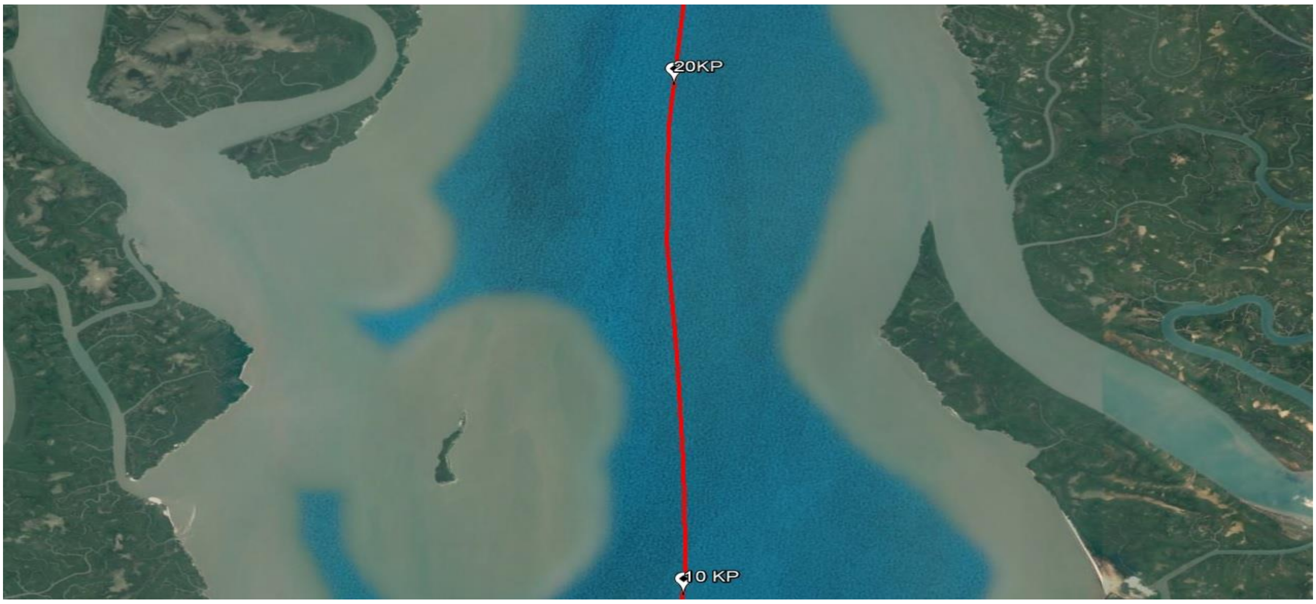


Figure 5: Google Image showing Sub-Stretch -2 of Waterway

The quantity of dredging required for Class I, II, III and IV type of WW for this stretch is provided in **Table 9**. **Figure 6** shows the observed and reduced bed profile of sub-stretch 2

Table 9: 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	10	20	Not Applicable (Tidal Zone)				7.28	20.59	0	0
II	10	20					7.28	21.17	0	0
III	10	20					7.21	21.17	0	0
IV	10	20					7.19	21.17	0	0
V	10	20					7.03	21.17	0	0
VI	10	20					7.03	21.17	0	0
VII	10	20					6.90	21.17	0	0

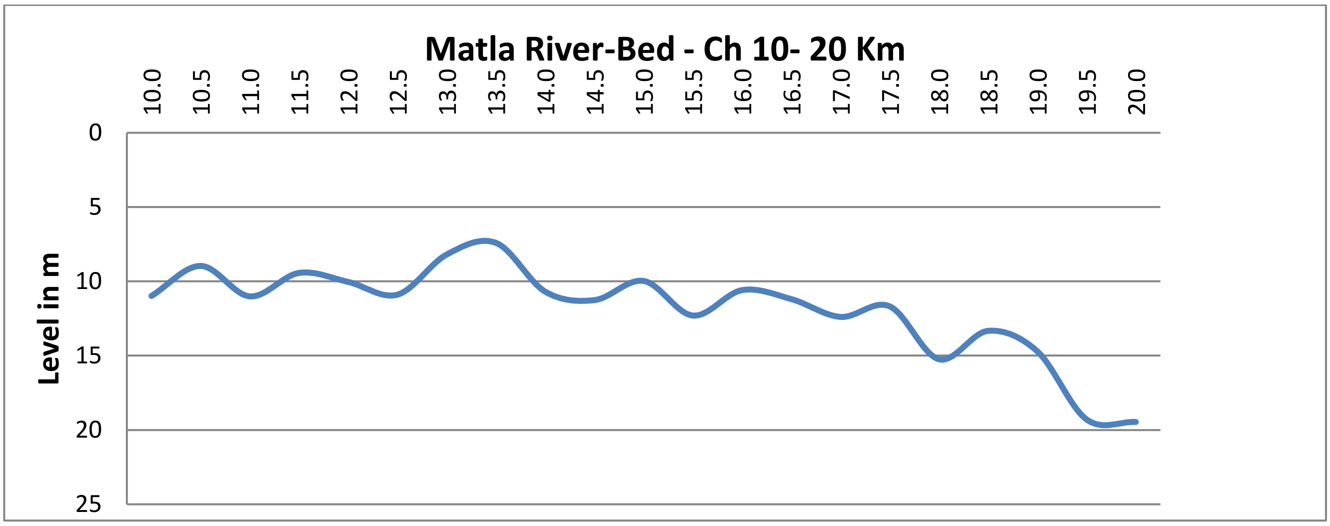


Figure 6: Bed Profile of Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

2.5.3 Sub Stretch 3: Unnamed Island to Bonnie camp (Chainage 20 Km to 30 Km)

Only Bathymetric Survey was carried out for this stretch between 20 to 30 km chainage of the Matla River. The area is covered with dense mangroves on either side of the river. This area also comes under the restricted area. This stretch is also quite wide with the approx width about 7 Km. The river banks on both the sides are unprotected. The details of current and discharge at different depths is placed at

Table 6.

There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch. There is no road bridge and HT wire connectivity in this strech. There is no hindrance or encroachment in this stretch.

- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 4.644 m in this stretch.
- Since sufficient depth is available for all time navigation dredging is not required at this stretch.

Figure 7: Google Image showing Sub-Stretch -3 of Waterway

Figure 7 above shows the alignment of sub-stretch 3 (Ch. 20.0 Km to 30 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 10**. **Figure 8** shows the observed and reduced bed profile of sub-stretch 3.

Table 10: 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	20	30	Not Applicable (Tidal Zone)				5.19	20.86	0	0
II	20	30					5.19	20.86	0	0
III	20	30					5.17	20.86	0	0
IV	20	30					5.17	20.86	0	0
V	20	30					5.07	20.86	0	0
VI	20	30					5.01	20.86	0	0
VII	20	30					4.78	20.86	0	0

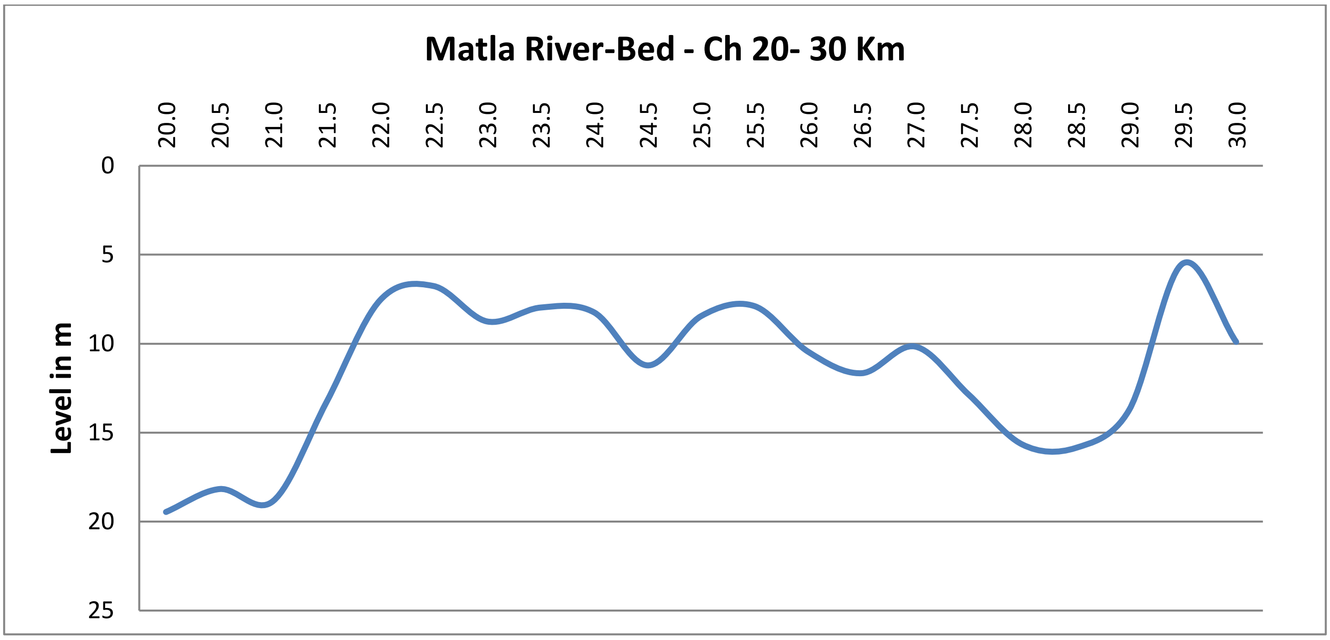


Figure 8: Bed Profile of Waterway Sub-stretch 3 (Chainage 20Km – 30 Km)

2.5.4 Sub Stretch 4: From Bonie Camp to Unnamed Island (30 km to 40 km)

Only Bathymetric Survey was carried out for this stretch between 30 to 40 km chainage of the Matla River. The area is covered with dense mangroves on either side of the river. This area also comes under the restricted area. This stretch is also quite wide with the approx width about 7 Km. The river banks on both the sides are unprotected. The details of current and discharge at different depths is placed at

Table 6.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch. There is no road bridge and HT wire connectivity in this stretch.
- There is no hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 4.644 m in this stretch.
- Since sufficient depth is available for all time navigation dredging is not required at this stretch.

Figure 9: Google Image showing Sub-Stretch -4 of Waterway

Figure 9 above shows the alignment of sub-stretch 4 (Ch. 30.0 Km to 40 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 11**. **Figure 10** shows the observed and reduced bed profile of sub-stretch 4.

Table 11: Dredging Quantity (cum) for Sub-Stretch 4

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	30	40	Not Applicable (Tidal Zone)				2.99	10.98	0	0
II	30	40					2.99	10.98	0	0
III	30	40					2.99	10.98	0	0
IV	30	40					2.99	10.98	0	0
V	30	40					2.99	11.14	0	0
VI	30	40					2.99	11.14	0	0
VII	30	40					2.99	11.14	0	0

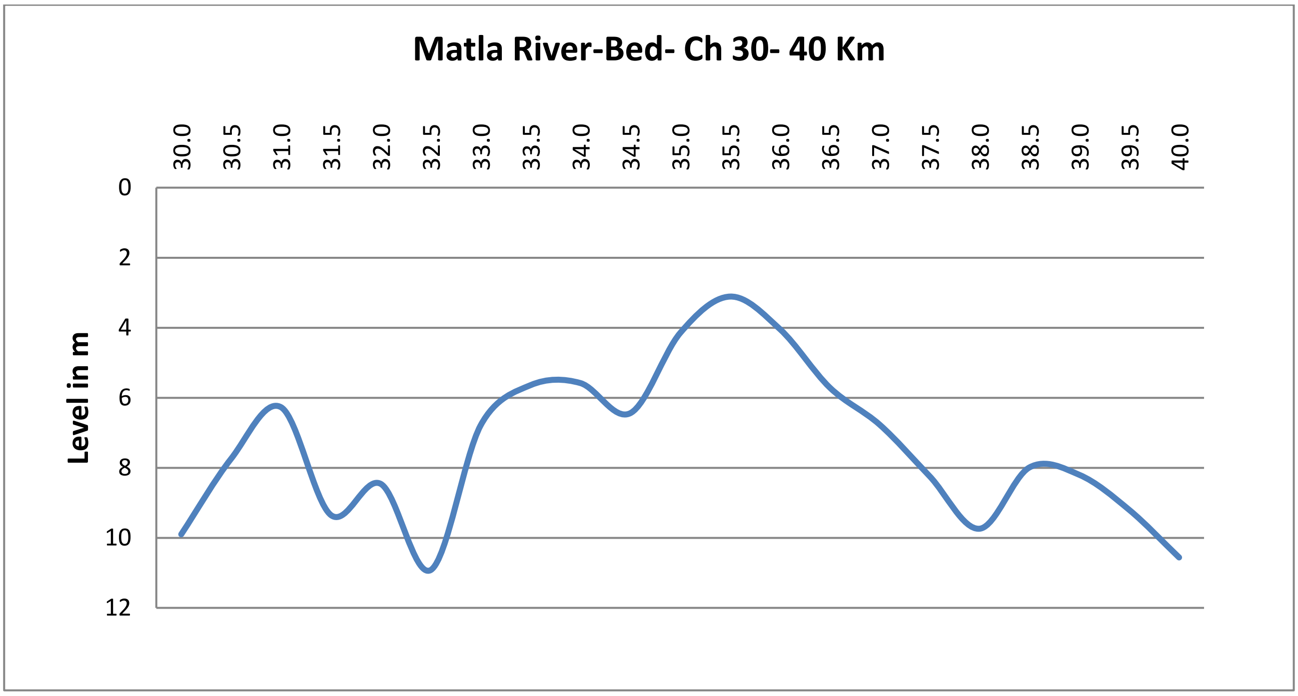


Figure 10: Bed Profile of Waterway Sub-stretch 4 (Chainage 30Km – 40 Km)

2.5.5 Sub Stretch 5: From Unnamed Island to Purba Gurguria (40 km to 50 km)

Only Bathymetric Survey was carried out for this stretch between 40 to 50 km chainage of the Matla River. The area is covered with dense mangroves on both the banks. In this area the Bidya river merges into the Matla. This stretch is narrow than the earlier with the width being reduced to about 4 to 5 KM. The whole stretch is having unprotected river bank. The details of current and discharge at different depths is placed at

Table 6.

- 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 4.644 m in this stretch.
- This stretch needs dredging waterway feasibility.

Figure 11: Google Image showing Sub-Stretch -5 of Waterway

Figure 11 above shows the alignment of sub-stretch 5 (Ch. 40.0 Km to 50 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 12**. **Figure 12** shows the observed and reduced bed profile of sub-stretch 5.

Table 12: Dredging Quantity (cum) for Sub-Stretch 5

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	40	50	Not Applicable (Tidal Zone)				1.55	18.45	0.00	0.00
II	40	50					1.55	18.45	0.00	0.00
III	40	50					1.55	18.45	0.00	1689.81
IV	40	50					1.55	18.45	0.00	23853.59
V	40	50					1.55	19.19	0.00	38081.98
VI	40	50					1.53	19.19	0.00	177326.61
VII	40	50					1.53	19.22	0.00	219756.56

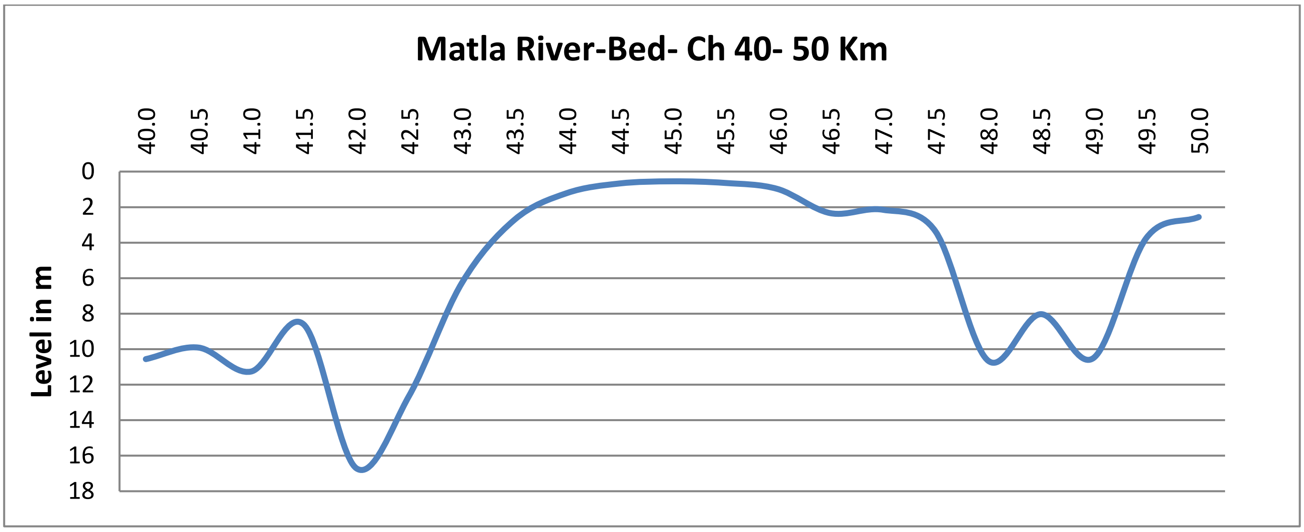


Figure 12: Bed Profile of Waterway Sub-stretch 5 (Chainage 40 Km – 50 Km)

2.5.6 Sub Stretch 6: From Purba Gurguria to Gopalganj (50 km to 60 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 50 to 60 km chainage of the Matla River. The area is very sparsely populated and has dense mangroves on left bank. The right bank is fairly populated as we move upstream towards Sankijahan. Mangroves are present on left sides in the river. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow with the width being about 3 to 4 KM. Some portion of the right river bank is protected. The details of current and discharge at different depths is placed at

Table 6.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There is no road bridge and HT wire connectivity in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 4.644 m in this stretch.
- Since sufficient depth is available for all time navigation dredging is not required at this stretch.

Figure 13: Google Image showing Sub-Stretch -6 of Waterway

Figure 13 above shows the alignment of sub-stretch 6 (Ch. 50 Km to 60 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 13**. **Figure 14** shows the observed and reduced bed profile of sub-stretch 6.

Table 13: Dredging Quantity (cum) for Sub-Stretch 6

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	50	60	Not Applicable (Tidal Zone)				5.48	21.81	0	0
II	50	60					5.40	21.81	0	0
III	50	60					5.40	21.81	0	0
IV	50	60					5.40	21.81	0	0
V	50	60					5.32	21.81	0	0
VI	50	60					5.26	21.81	0	0
VII	50	60					5.21	21.81	0	0

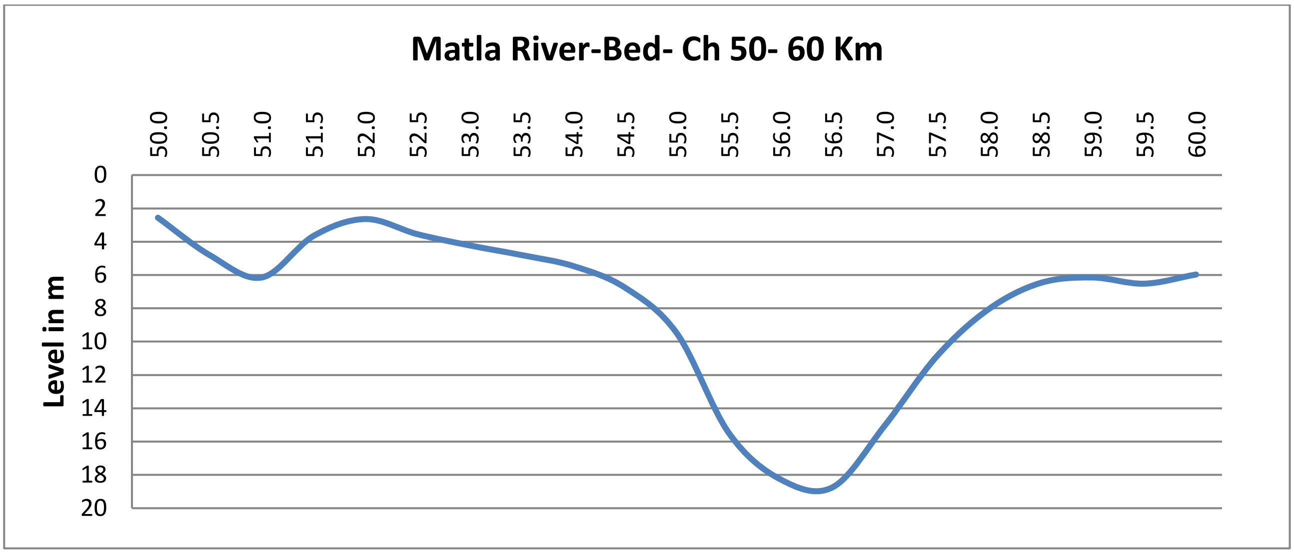


Figure 14: Bed Profile of Waterway Sub-stretch 6 (Chainage 50Km – 60 Km)

2.5.7 Sub Stretch 7: From Gopalganj to Andheria (60 km to 70 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 60 to 70 km chainage of the Matla River. The area is very sparsely populated and has dense mangroves on right bank. The left bank is fairly populated as we move upstream. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow with the width being about 1.5 km to 3 Km. Some portion of the river bank is protected. The details of current and discharge at different depths is placed at

Table 6.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There is no road bridge and HT wire connectivity.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 4.52 m in this stretch.
- Since sufficient depth is available for all time navigation dredging is not required at this stretch.

Figure 15: Google Image showing Sub-Stretch -7 of Waterway

Figure 15 above shows the alignment of sub-stretch 7 (Ch. 60 Km to 70 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 14**. **Figure 16** shows the observed and reduced bed profile of sub-stretch 7.

Table 14: Dredging Quantity (cum) for Sub-Stretch 7

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	60	70	Not Applicable (Tidal Zone)				6.76	25.21	0	0
II	60	70					6.76	26.18	0	0
III	60	70					6.63	26.18	0	0
IV	60	70					6.63	26.18	0	0
V	60	70					6.63	26.36		
VI	60	70					6.61	26.36		
VII	60	70					6.57	26.36		

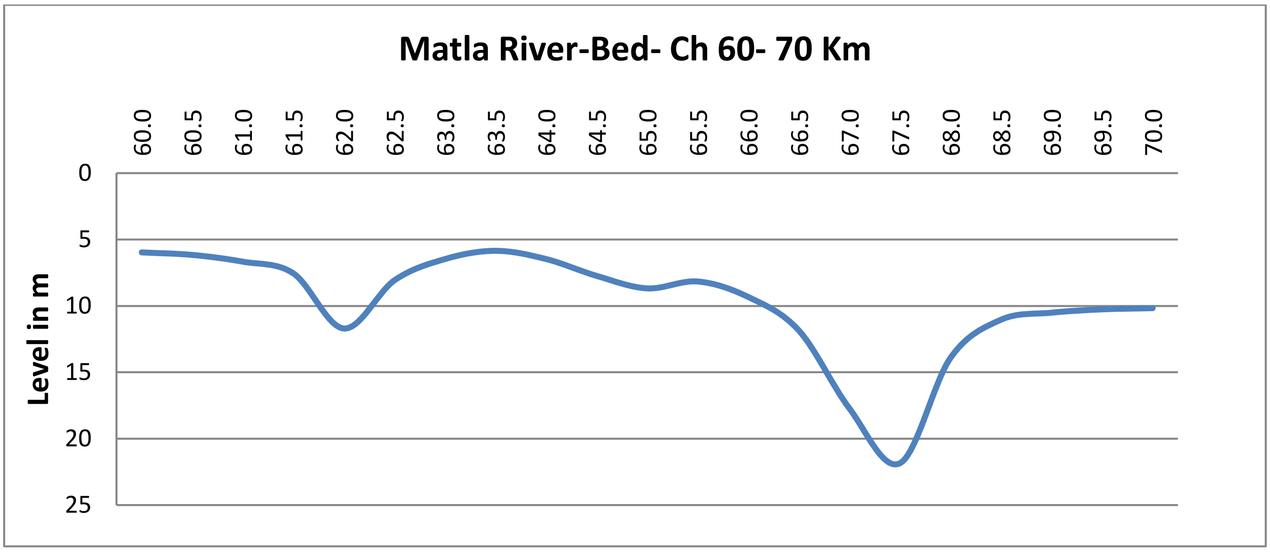


Figure 16: Bed Profile of Waterway Sub-stretch 7 (Chainage 60Km – 70 Km)

2.5.8 Sub Stretch 8: From Andharia to Budh Khali (70 km to 80 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 70 to 80 km chainage of the Matla River. The area is very well populated and has dense mangroves on both the banks. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow with the width being about 500 m to 1 Km. Some portion of the river bank is protected. The details of current and discharge at different depths is placed at

Table 6.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There is no road bridge and HT wire connectivity in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 4.78 m in this stretch.
- Since sufficient depth is available for all time navigation dredging is not required at this stretch.

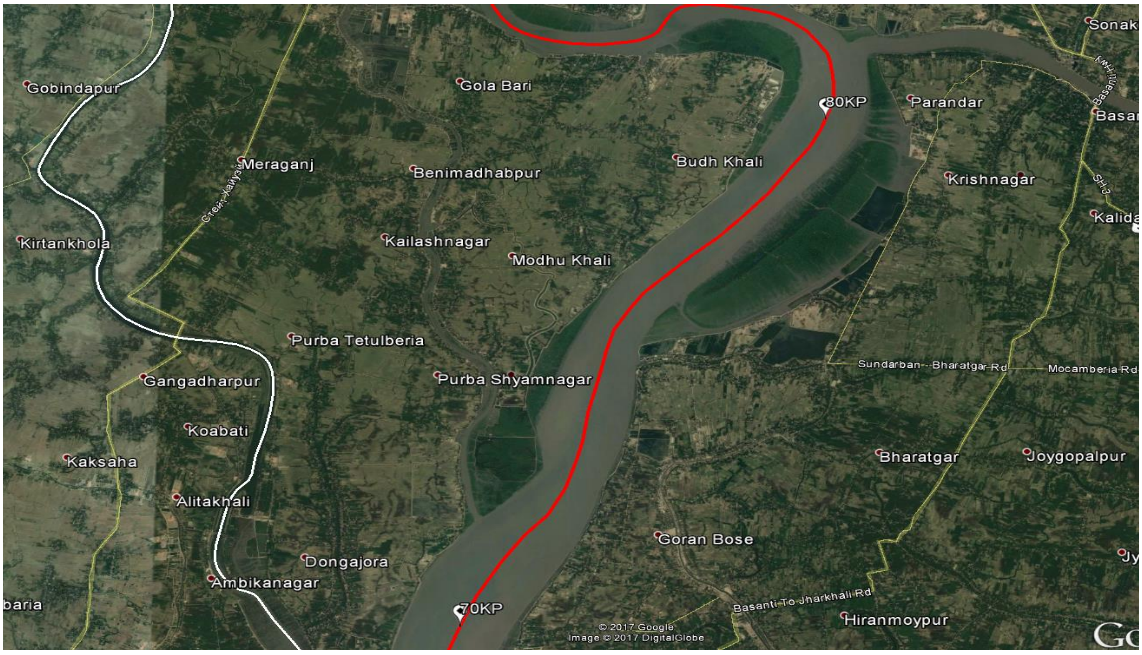


Figure 17: Google Image showing Sub-Stretch -8 of Waterway

Figure 17 above shows the alignment of sub-stretch 8 (Ch. 70 Km to 80 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 15**. **Figure 18** shows the observed and reduced bed profile of sub-stretch 8.

Table 15: Dredging Quantity (cum) for Sub-Stretch 8

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	70	80	Not Applicable (Tidal Zone)				6.05	17.87	0	0
II	70	80					5.98	17.87	0	0
III	70	80					5.71	18.90	0	0
IV	70	80					5.55	18.90	0	0
V	70	80					4.07	19.01	0	0
VI	70	80					3.70	19.03	0	0
VII	70	80					2.69	19.03	0	0

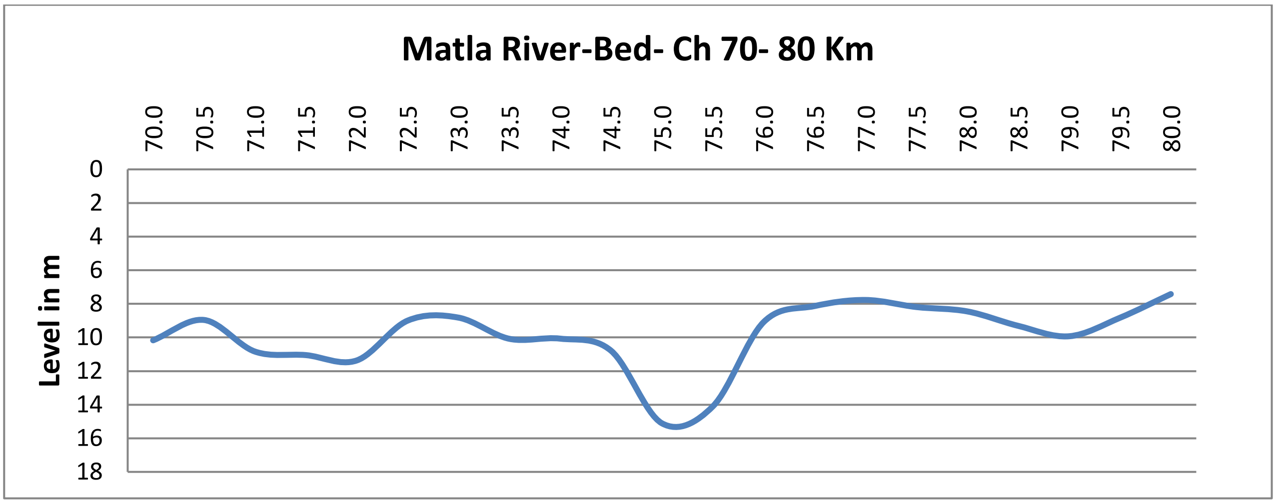


Figure 18: Bed Profile of Waterway Sub-stretch 8 (Chainage 70 Km – 80 Km)

2.5.9 Sub Stretch 9: From Budh Khali to Amratala (80 km to 90 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 80 to 90 km chainage of the Matla River. The area is very well populated and has dense mangroves on both the banks. Both the banks are fairly populated. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow with the width being about 500 m. Some portion of the river bank is protected. The details of current and discharge at different depths is placed at

Table 6.

- 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 4.78 m in this stretch.
- Since sufficient depth is available thereafter dredging would not be required except near 86 Kp for all time navigation at this stretch.

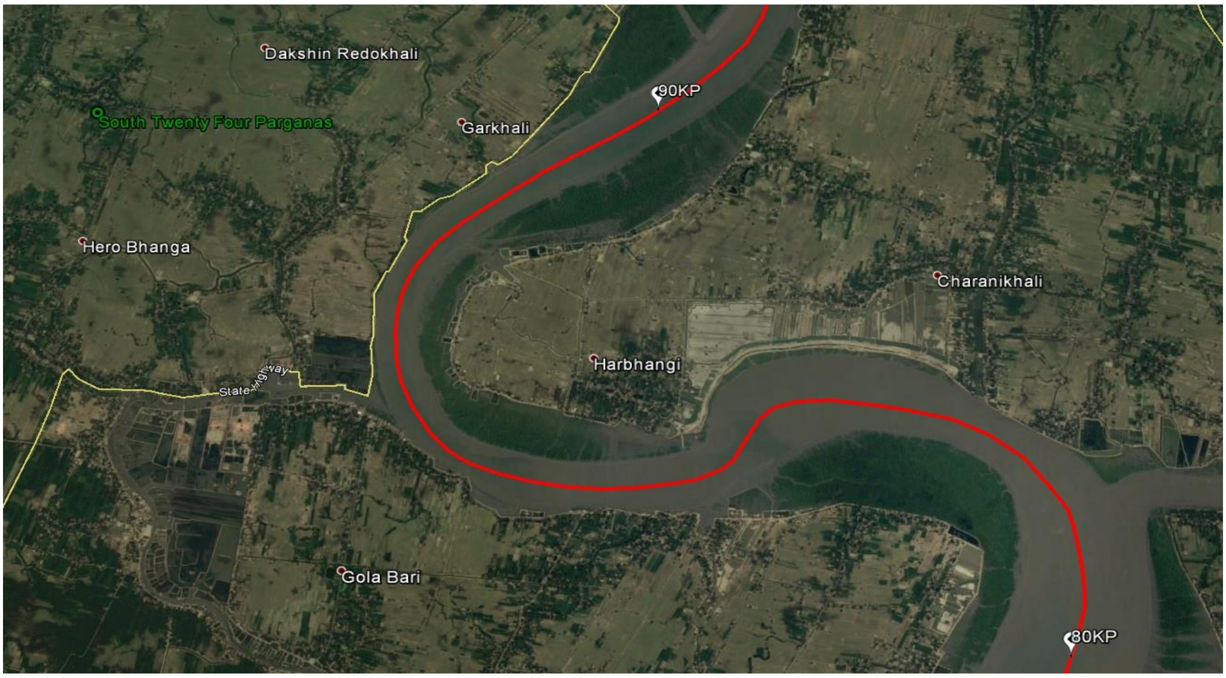


Figure 19: Google Image showing Sub-Stretch -9 of Waterway

Figure 19 above shows the alignment of sub-stretch 8 (Ch. 80 Km to 90 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 16**. **Figure 20** shows the observed and reduced bed profile of sub-stretch 9.

Table 16: Dredging Quantity (cum) for Sub-Stretch 9

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	80	90	Not Applicable (Tidal Zone)				0.12	21.27	0.00	6339.33
II	80	90					0.09	21.27	0.00	10183.05
III	80	90					0.05	23.69	0.00	16821.27
IV	80	90					0.02	23.69	0.00	22610.20
V	80	90					-0.07	23.69	200.00	35309.56
VI	80	90					-0.10	23.69	200.00	66406.82
VII	80	90					-0.67	23.69	1000.00	95284.20

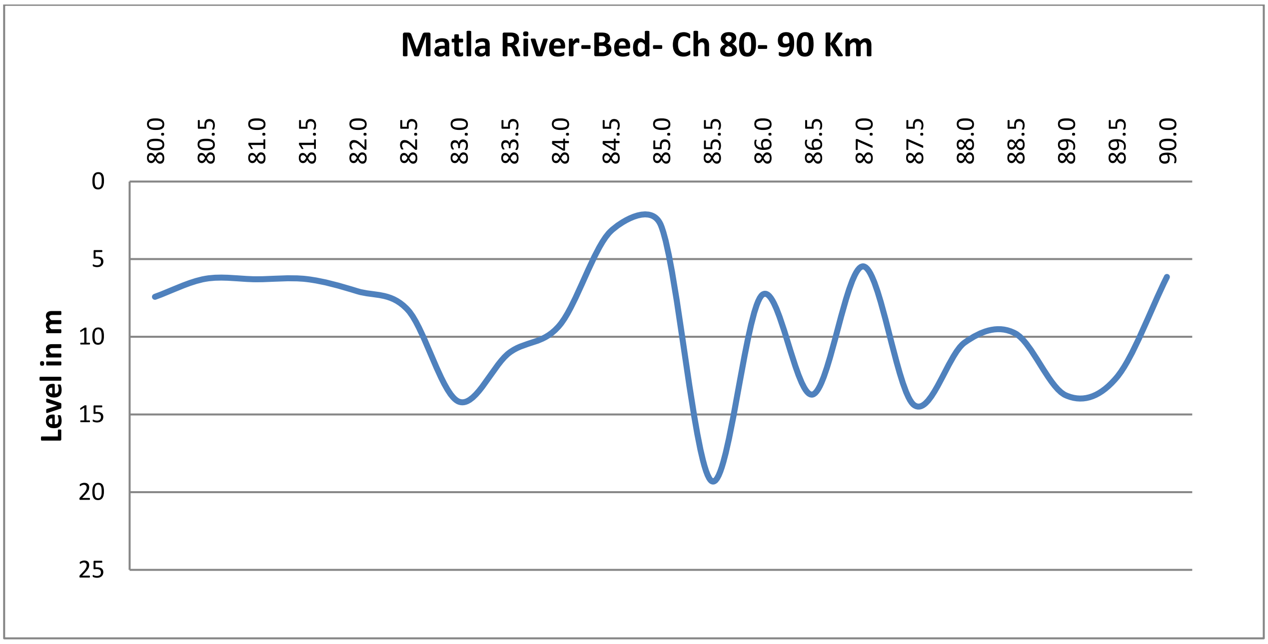


Figure 20: Bed Profile of Waterway Sub-stretch 9 (Chainage 80 Km – 90 Km)

2.5.10 Sub Stretch 10: From Amratala to Katalberia (90 km to 98.731 km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 90 to 98.731 km chainage of the Matla River. The area is very well populated and has dense mangroves on both the banks. Both banks are fairly populated as we move upstream towards Canning. Mangroves are present on both sides in the river. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably narrow with the width being about 450 m. Some portion of the river bank is protected. The details of current and discharge at different depths is placed at

Table 6.

- 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 4.79 m in this stretch.

- The area is full of shoal depths therefore a large amount of dredging is required in this stretch

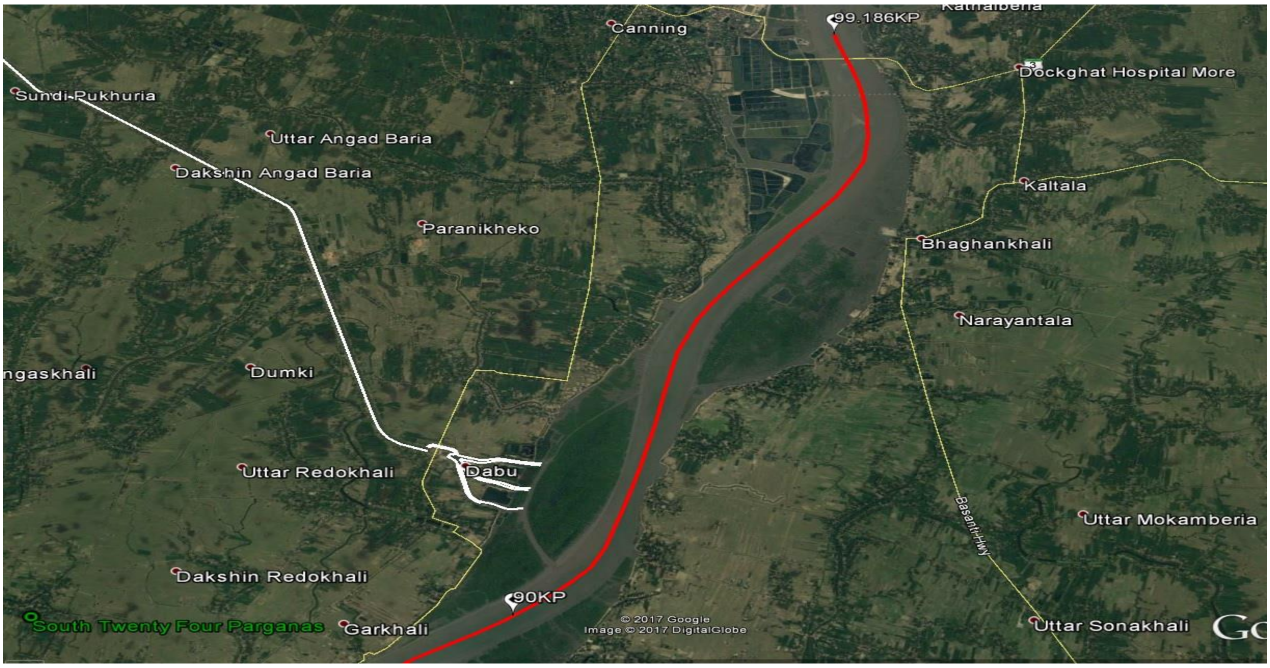


Figure 21: Google Image showing Sub-Stretch -10 of Waterway

Figure 21 above shows the alignment of sub-stretch 10 (Ch. 90 Km to 98.731 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 17**. **Figure 22** shows the observed and reduced bed profile of sub-stretch 10.

Table 17: Dredging Quantity (cum) for Sub-Stretch 10

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	90	98.731	Not Applicable (Tidal Zone)				-4.28	7.76	2800.00	215557.51
II	90	98.731					-4.98	8.07	2800.00	315259.65
III	90	98.731					-5.73	8.07	2800.00	455734.57
IV	90	98.731					-5.90	8.07	2800.00	538966.46

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.)
V	90	98.731					-7.65	8.07	3800.00	817928.82
VI	90	98.731					-7.90	8.07	4200.00	1210348.31
VII	90	98.731					-8.13	8.07	5000.00	1494480.01

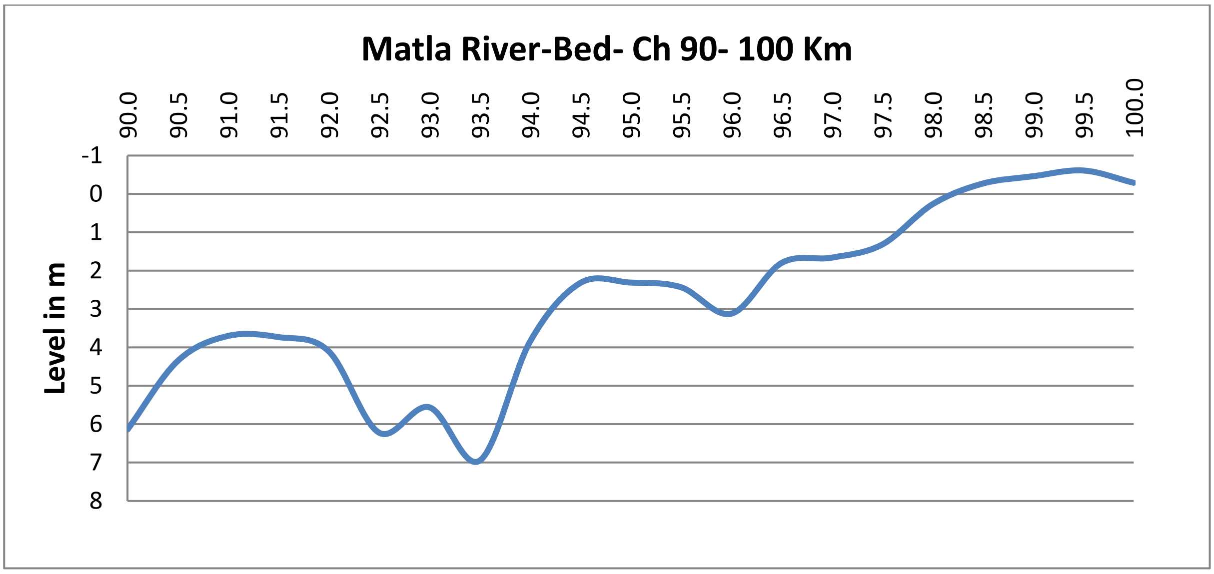


Figure 22: Bed Profile of Waterway Sub-stretch 10 (Chainage 90Km – 98.731 Km)

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 18.**

Table 18: Soil & Water Sample Locations

Sample	Chainage	Latitude	Longitude	Easting	Northing (m)	Depth (m)
1	98.5	22°18'16.0470"N	88°40'55.3882"E	673267.65	2467492.22	1

Sample	Chainage	Latitude	Longitude	Easting	Northing (m)	Depth (m)
2	90.2	22°14'13.9773"N	88°39'8.6626"E	670294.61	2460013.31	9.3
3	79.8	22°11'44.6034"N	88°40'35.3649"E	672828.02	2455446.41	9.4
4	70.2	22°07'25.3539N	88°37'40.1145"E	667894.05	2447418.33	12.6
5	60.6	22°02'26.502"N	88°38'52.4443"E	670066.14	2438249.28	10.3
6	49.8	21°57'05.1223"N	88°37'03.9539"E	667059.981	2428331.981	7.1
7	39.6	21°54'05.2189"N	88°41'26.9510"E	674666.592	2422880.418	12.3
8	30.1	21°49'08.5978"N	088.40'09.9764"E	672556.329	2413733.639	12.8
9	19.40	21°43'25.7755"N	88°38'55.3723"E	670526.450	2403167.230	16.4
10	10.1	21°38'18.9345"N	88°39'31.2771"E	671659.18	2393741.56	9.3
11	0.3	21°33'15.1797"N	88°38'05.0702"E	669278.58	2384373.67	10.8

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 23**.

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CERTIFICATE OF ANALYSIS ON SOIL & WATER SAMPLES

Table No. : 8

Project : Laboratory Analysis of Soil & Water Samples | River : Saptamukhi | Job No. : 6154 G

Sample Reference					Test Results on SOIL SAMPLES								Test Results on WATER SAMPLES
					Particle Size Analysis								Sediment Concentration Test
					By Sieve Analysis		By Hydrometer Analysis						
Serial No.	Sample Ref. No.	Name of Sample	Chainage	Observed Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Specific Gravity	pH Value	Cohesive Strength of Uniformity (Cu)	Cohesive Strength of Curvature (Cc)	Total Solid (mg/lit)
1	SM-01	Soil	3.50	3.50	0	91	9		2.69	7.99	2.79	1.33	-
2	SM-02	Soil	10	3.40	0	99	1		2.69	8.03	1.67	0.96	-
3	SM-03	Soil	18	7.20	0	74	20	6	2.67	8.57	4.00	1.88	-
4	SM-04	Soil	30.50	2.90	2	11	49	38	2.65	8.36	6.00	1.50	-
5	SM-05	Soil	37	4.60	0	45	25	30	2.66	8.61	7.04	1.28	-
6	SM-01	Water	3.50	3.50	-	-	-	-	-	-	-	-	12108
7	SM-02	Water	10	3.40	-	-	-	-	-	-	-	-	19172
8	SM-03	Water	18	7.20	-	-	-	-	-	-	-	-	11648
9	SM-04	Water	30.50	2.90	-	-	-	-	-	-	-	-	15765
10	SM-05	Water	37	4.60	-	-	-	-	-	-	-	-	24773

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Figure 23: Soil and Water Sample Test Results

3.0 FAIRWAY DEVELOPMENT

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

3.1 PROPOSED CLASS / TYPE OF WATERWAY

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

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

a) No dams, barrage and any other cross-structure is located along the proposed fairway stretch.
b) Reduced depth of waterway varies from -8.13m to 26.36 m w.r.t sounding datum for Class VII waterway.
c) Tidal variation varies from 4.52 to 4.79 m.
d) Width of river varies from 0.50 km to 13.0 km.

Figure 24 shows the proposed alignment of Matla waterway.

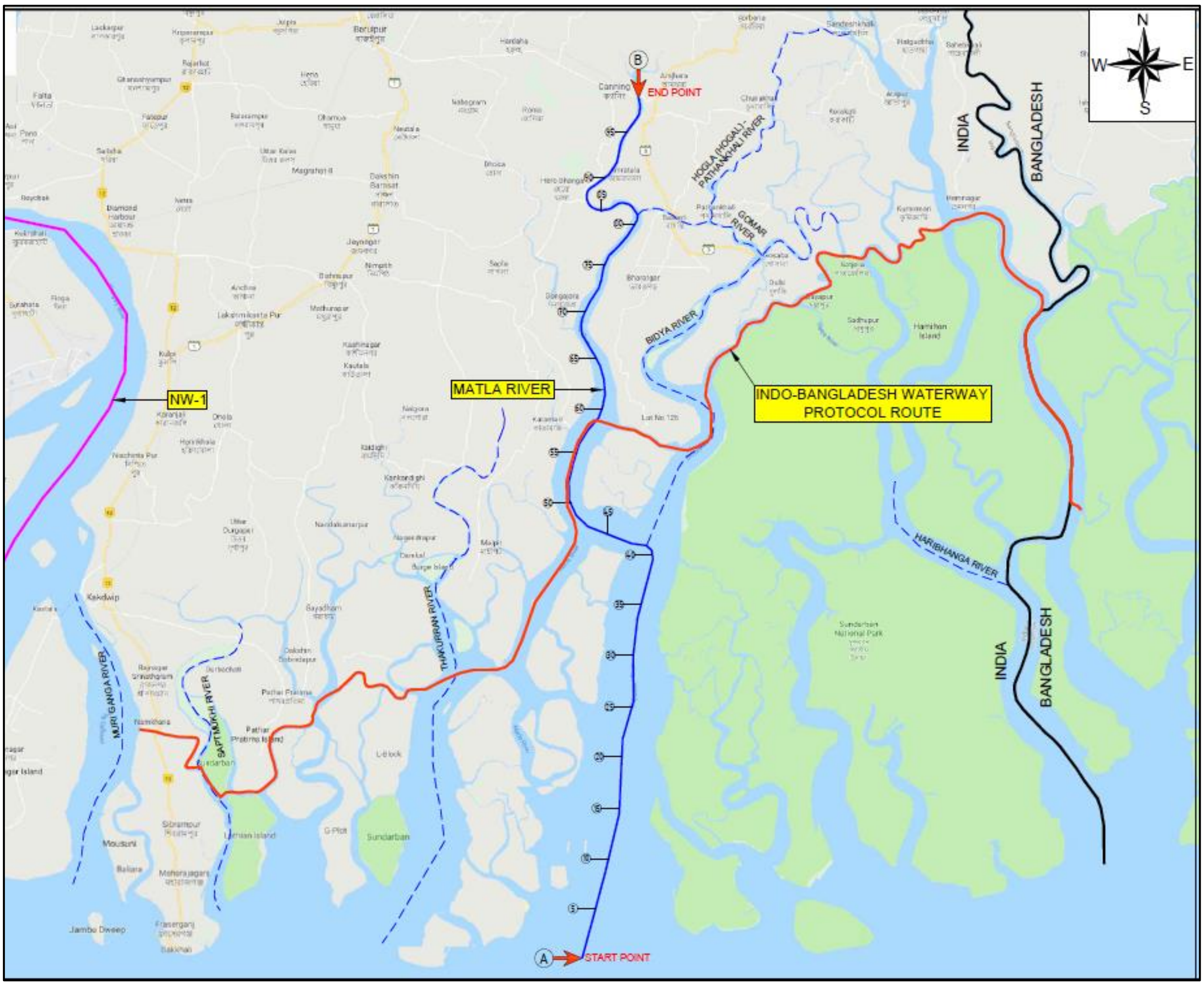


Figure 24: Proposed alignment of Matla Waterway

In addition to above features, about 11.50km stretch of Matla river from Lot No. 121 (Chainage 48.615 Km)to Kaikhali (Chainage 59.052 Km) lies in the Indo Bangladesh Waterway Protocol Route, which is already being maintained by IWAI. The proposed Matla waterway is also connected with proposed Bidya and Hogla waterways at Chainage 41.081 KM and 80.928 Km respectively.

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 98.731 km stretch of waterway, which suggest that waterway is viable for throughout the year navigation. It was 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 19** shoals are located along the upstream reaches of proposed waterway stretch of Matla river.

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 Matla 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 25** The dredging quantity obtained from Hypack software for 98.731 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.

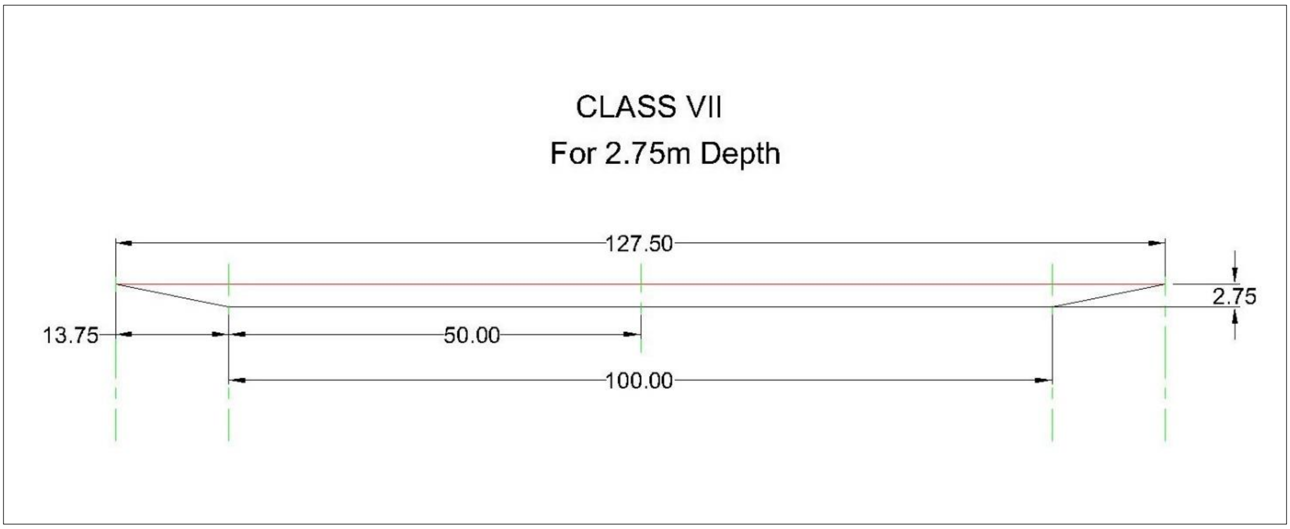


Figure 25: Fairway Dimension Class VII

Table 19: Dredging Quanitity for Class VII Waterway

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
0	1	Not Applicable (Tidal Zone)				10.64	16.67	0	0.00	0.00
1	2					5.88	9.05	0	0.00	0.00
2	3					6.42	7.30	0	0.00	0.00
3	4					6.82	8.15	0	0.00	0.00
4	5					7.53	9.47	0	0.00	0.00
5	6					6.84	8.98	0	0.00	0.00
6	7					5.63	7.86	0	0.00	0.00
7	8					5.78	7.98	0	0.00	0.00
8	9					6.61	10.38	0	0.00	0.00
9	10					7.17	10.35	0	0.00	0.00
10	11					8.77	11.36	0	0.00	0.00
11	12					7.96	11.43	0	0.00	0.00
12	13					8.81	12.43	0	0.00	0.00
13	14					6.90	8.56	0	0.00	0.00
14	15					9.36	12.09	0	0.00	0.00
15	16					9.17	13.28	0	0.00	0.00
16	17					10.09	12.64	0	0.00	0.00
17	18					9.56	15.55	0	0.00	0.00
18	19					12.31	15.44	0	0.00	0.00
19	20	Not Applicable (Tidal Zone)				14.56	21.17	0	0.00	0.00
20	21					14.73	20.86	0	0.00	0.00
21	22					6.48	13.53	0	0.00	0.00
22	23					6.21	9.00	0	0.00	0.00
23	24					7.80	9.22	0	0.00	0.00
24	25					7.48	11.44	0	0.00	0.00
25	26					7.07	11.69	0	0.00	0.00
26	27					8.73	12.77	0	0.00	0.00
27	28					12.61	17.82	0	0.00	0.00
28	29					7.26	16.04	0	0.00	0.00
29	30					4.78	11.15	0	0.00	0.00
30	31					5.92	9.25	0	0.00	0.00

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
31	32					7.65	9.86	0	0.00	0.00
32	33					6.48	10.98	0	0.00	0.00
33	34					4.96	5.88	0	0.00	0.00
34	35					3.31	7.26	0	0.00	0.00
35	36					2.99	5.53	0	0.00	0.00
36	37					6.05	8.01	0	0.00	0.00
37	38					7.92	10.84	0	0.00	0.00
38	39					7.86	9.19	0	0.00	0.00
39	40					9.59	11.14	0	0.00	0.00
40	41					9.02	12.38	0	0.00	0.00
41	42					7.55	13.86	0	0.00	0.00
42	43					13.02	18.45	0	0.00	0.00
43	44					2.97	12.71	0	0.00	0.00
44	45					1.53	2.67	0	154093.17	154093.17
45	46					1.67	3.51	0	65663.39	219756.56
46	47					2.86	3.69	0	0.00	219756.56
47	48					3.42	13.14	0	0.00	219756.56
48	49					6.32	19.22	0	0.00	219756.56
49	50					3.16	6.13	0	0.00	219756.56
50	51					5.38	7.82	0	0.00	219756.56
51	52					5.21	6.86	0	0.00	219756.56
52	53					5.38	6.84	0	0.00	219756.56
53	54					5.96	7.11	0	0.00	219756.56
54	55					7.44	17.07	0	0.00	219756.56
55	56					13.98	21.81	0	0.00	219756.56
56	57					9.30	19.87	0	0.00	219756.56
57	58					7.00	9.18	0	0.00	219756.56
58	59					6.76	7.19	0	0.00	219756.56
59	60	Not Applicable (Tidal Zone)				6.65	7.38	0	0.00	219756.56
60	61					7.36	8.68	0	0.00	219756.56
61	62					8.13	13.67	0	0.00	219756.56
62	63					6.57	8.84	0	0.00	219756.56
63	64					7.05	11.25	0	0.00	219756.56

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
64	65					7.94	12.75	0	0.00	219756.56
65	66					10.61	17.55	0	0.00	219756.56
66	67					16.36	26.36	0	0.00	219756.56
67	68					12.09	15.63	0	0.00	219756.56
68	69					11.52	12.68	0	0.00	219756.56
69	70					10.55	13.03	0	0.00	219756.56
70	71					10.51	15.30	0	0.00	219756.56
71	72					9.73	11.77	0	0.00	219756.56
72	73					10.21	13.10	0	0.00	219756.56
73	74					10.65	19.03	0	0.00	219756.56
74	75					7.76	18.27	0	0.00	219756.56
75	76					7.61	10.18	0	0.00	219756.56
76	77					2.69	9.27	0	0.00	219756.56
77	78					5.67	10.71	0	0.00	219756.56
78	79					6.90	9.61	0	0.00	219756.56
79	80					5.19	7.15	0	0.00	219756.56
80	81					3.05	9.01	0	0.00	219756.56
81	82					2.77	18.78	0	0.00	219756.56
82	83					-0.01	16.25	0	3640.10	223396.66
83	84					1.45	23.69	0	21641.51	245038.17
84	85					2.80	23.69	0	0.00	245038.17
85	86					2.47	19.59	0	0.00	245038.17
86	87					1.11	15.30	0	0.00	245038.17
87	88					-0.17	17.18	400	57860.39	302898.56
88	89					-0.67	16.12	600	9546.64	312445.20
89	90					1.24	4.84	0	2595.56	315040.76
90	91					1.50	6.88	0	4855.94	319896.70
91	92					1.16	8.07	0	419.44	320316.14
92	93					2.08	6.96	0	92.87	320409.01
93	94	Not Applicable (Tidal Zone)				1.09	2.41	0	89420.24	409829.25
94	95					-0.28	3.75	1000	66461.22	476290.47
95	96					-0.50	2.38	1000	191234.21	667524.68
96	97					-1.01	0.21	1000	356546.86	1024071.54

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
97	98					-1.69	-1.06	1000	440714.80	1464786.34
98	98.731					-8.13	-0.58	1000	344734.43	1809520.77
				Total				Total	**1809520.77**	

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 18,09,520.77 cum.

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

a) Waterway stretch falling along Indo-Bangladesh Waterway protocol route from chaiange 48.615 Km to Chainage 59.052 Km requires no dredging.

b) Stretch of Matla river connecting proposed Hogla and Bidya waterways from Chainage 41.081 Km to Chainage 80.928 Km requires dredging of about 2,19,756.56 cum between Chainage 44 Km to 46 Km.

c) Location of proposed terminals to be developed in this DPR (as detailed in subsequent chapters 3 ferry terminals are proposed to be developed at chaiange 57.5 Km, 74.8 Km and 85.3 Km respectively).

Accordingly, on the basis of above criterias, Matla waterway is proposed to be developed from Chainage 41.0 Km to Chainage 86.0 Km. The total dredging quanity for developing this 45.0 Km stretch of waterway in Class VII, works out to 2,45,038.17 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 26: 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. 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

One underconstrucion bridge and one road bridge are located at Chainage 98.0 Km and 98.6 Km respectively.

However, no Bridge / Cables / Dam / Barrage / Lock / Weir / Anicut / Aqueduct are located along the proposed 45 Km stretch of navigation channel from Chainage 41.0 Km to chaiange 86.0 Km.

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 Matla 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 PWD, Govt. of West Bengal considered for various works;
b) Market surveys and enquires
c) Judgement based on Consultant's Experience

3.9.2 Capital Cost

The cost of initial dredging is as below:

Dredging cost @ INR 200/cum for 2,45,038.17 cum = INR 4,90,07,634.00 /- **(INR 490.08 Lakh).**

3.9.3 O&M Cost

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

Dredging cost @ INR 200/cum for 10% of 2,45,038.17 cum = INR 49,00,763.40 /- **(INR 49.01 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.

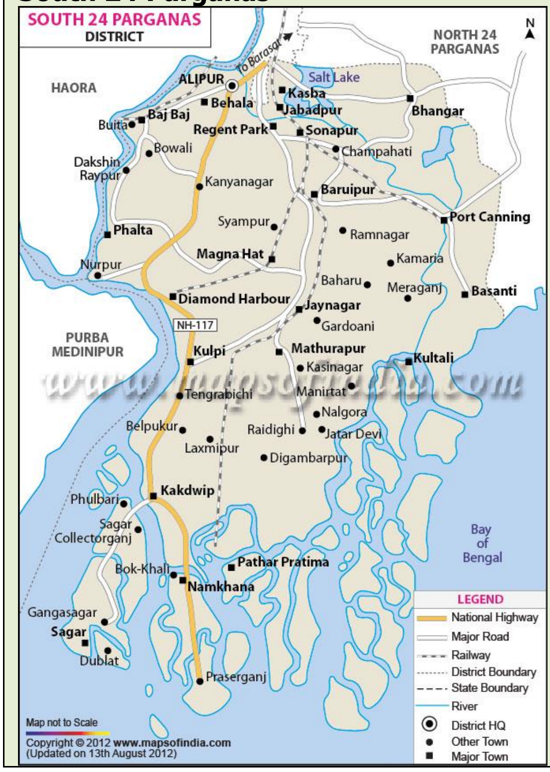
4.2 INFLUENCE AREA / HINTERLAND

Matla river flows through four (4) CD blocks of South 24 Parganas disctrict, namely, Gosaba, Kultali, Basanti and Canning I. The Project Influence Area (PIA), considering existing and projected traffic for

[1] District Census Handbook, 2011

passenger ferry services, comprises of the following CD blocks and districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 20**.

Table 20: Project Influence Area/ Hinterland

District	Area (Km²)	C.D. Block	Area (Km²)	Total Hinterland area (Km²)
South 24 Parganas  	9,960	Gosaba	296.73	1,194.99
		Kultali	306.18	
		Basanti	404.21	
		Canning I	187.87	

4.2.1 Population of Hinterland area

Population of hinterland area for proposed IWT in Matla waterway is provided in **Table 21** below:

Table 21: 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	Gosaba	2,46,598	11,14,092
			Kultali	2,29,053	

[2] District Census Handbook, 2011

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
			Basanti	3,36,717	
			Canning I	3,04,724	

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Matla 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 22** and **Table 23** as below:

Table 22: 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 23: Annual Growth Rate of GSDP of West Bengal

(at Constant Prices, Per cent %)

Year	Primary	Secondary	Teritary	GSDP
2004-2005 Series				
2004-05	-	-	-	-
2005-06	2.22	3.30	9.28	6.29
2006-07	2.12	8.71	9.78	7.79
2007-08	6.21	6.85	8.69	7.76
2008-09	-2.35	-1.75	10.04	4.90
2009-10	6.94	9.68	7.86	8.03
2010-11	-2.10	5.82	8.36	5.78
2011-12	0.81	-1.99	8.06	4.72
2012-13	3.33	10.60	7.79	7.53
2013-14	3.01	6.07	8.20	6.91
2014-15	3.31	5.05	8.75	7.15
Average	**2.35**	**5.23**	**8.68**	**6.69**
2011-2012 Series				
2015-16	0.48	9.15	6.37	5.85
2016-17	3.84	8.46	10.16	7.98
2017-18	2.91	11.36	15.61	11.46
Average	**2.41**	**9.66**	**10.71**	**8.43**

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

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

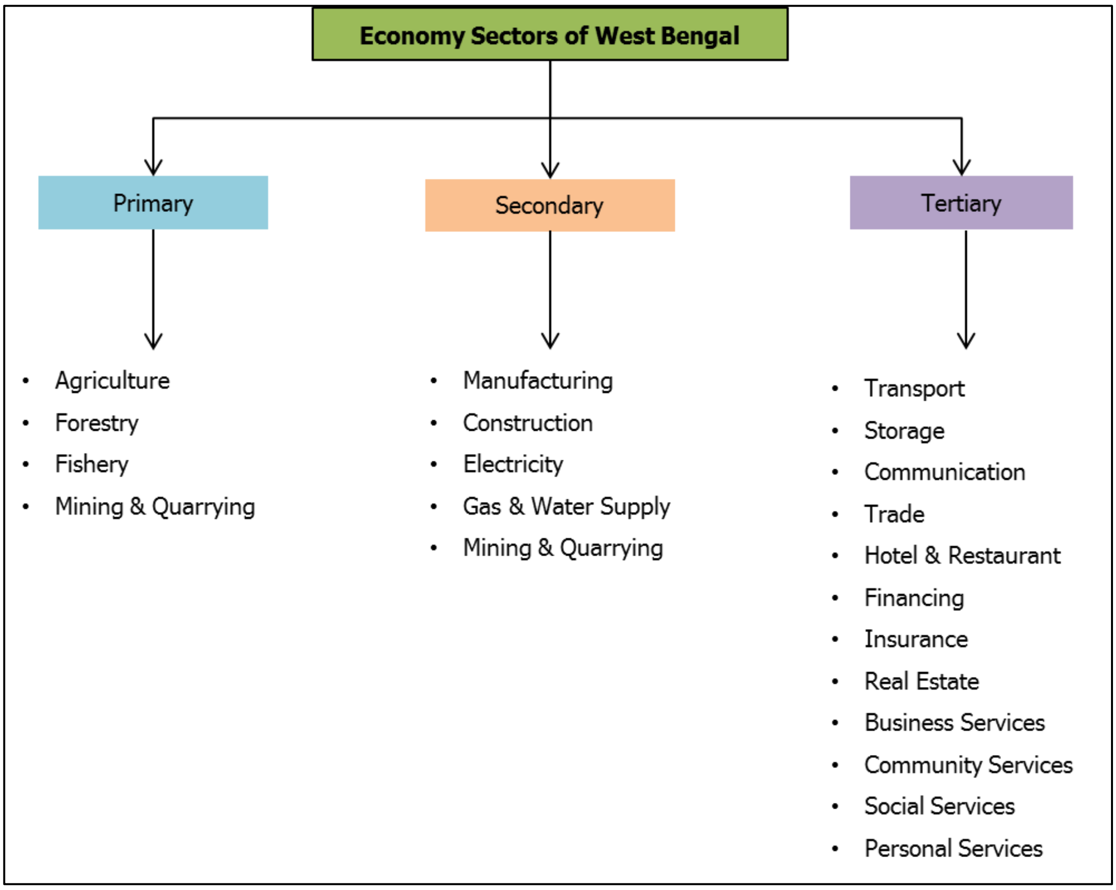


Figure 27: Sectors of West Bengal

Figure 28 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 29** 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.

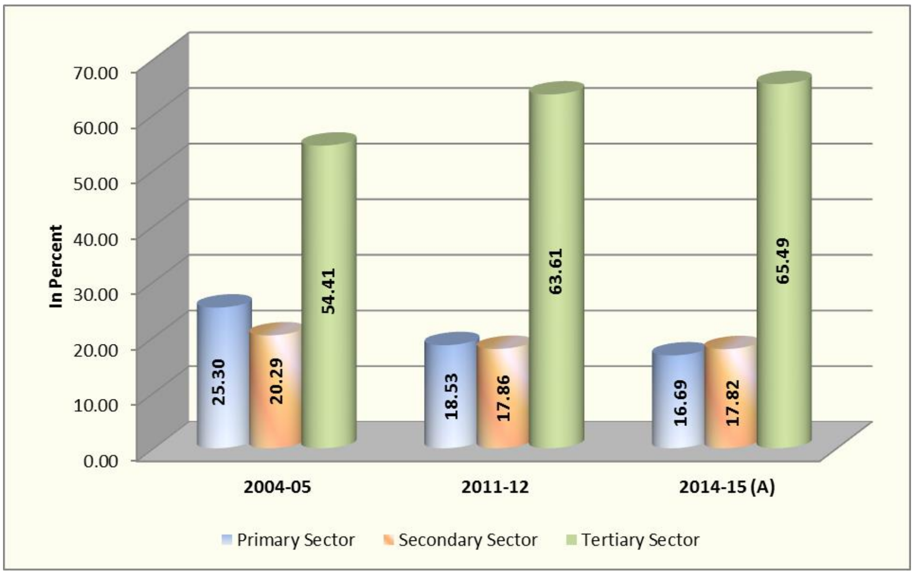


Figure 28: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

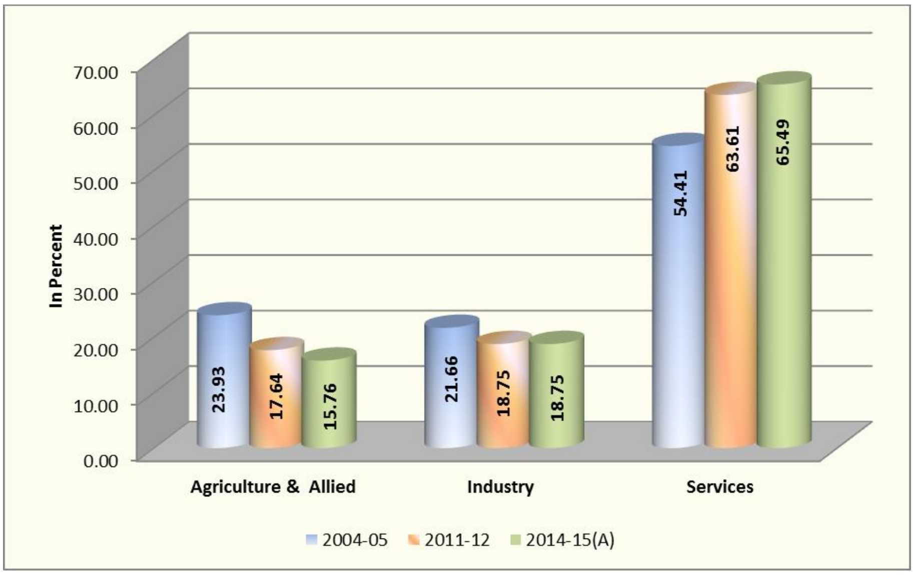


Figure 29: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

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 24** and the same is presented in **Figure 30** as below:

Table 24: 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

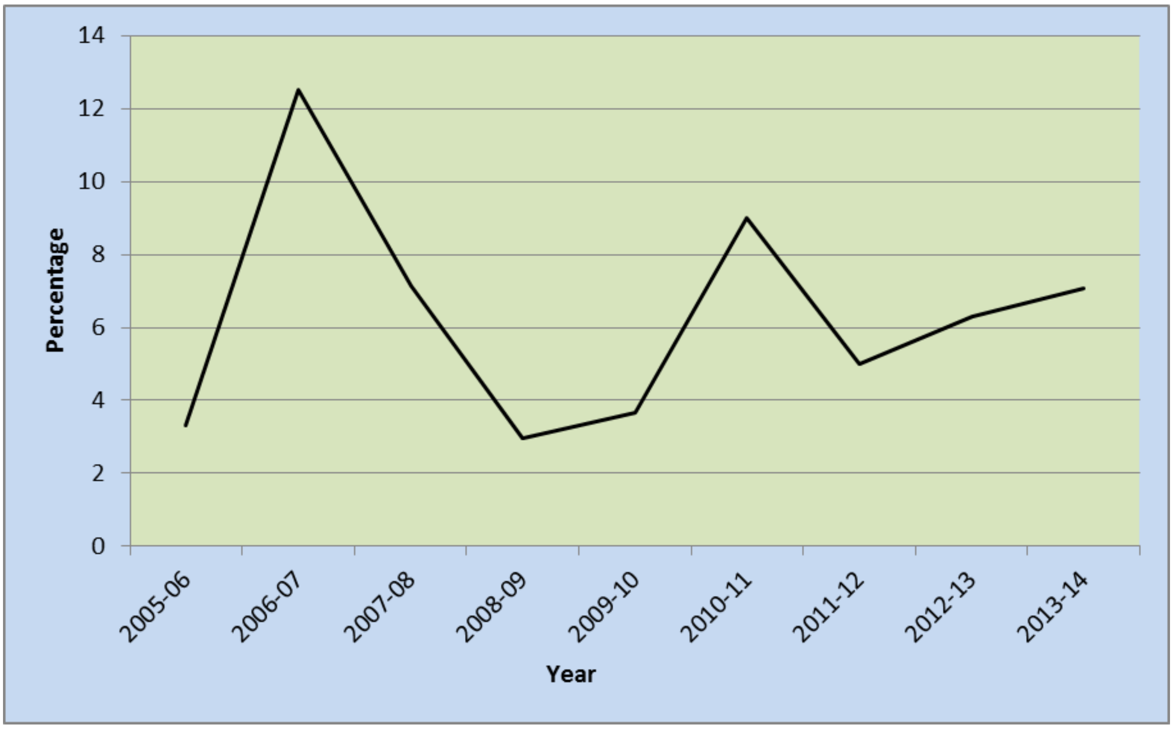


Figure 30: Annual Growth Rates of Gross District Domestic Product

Table 25: 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 25,** 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 31** as below:

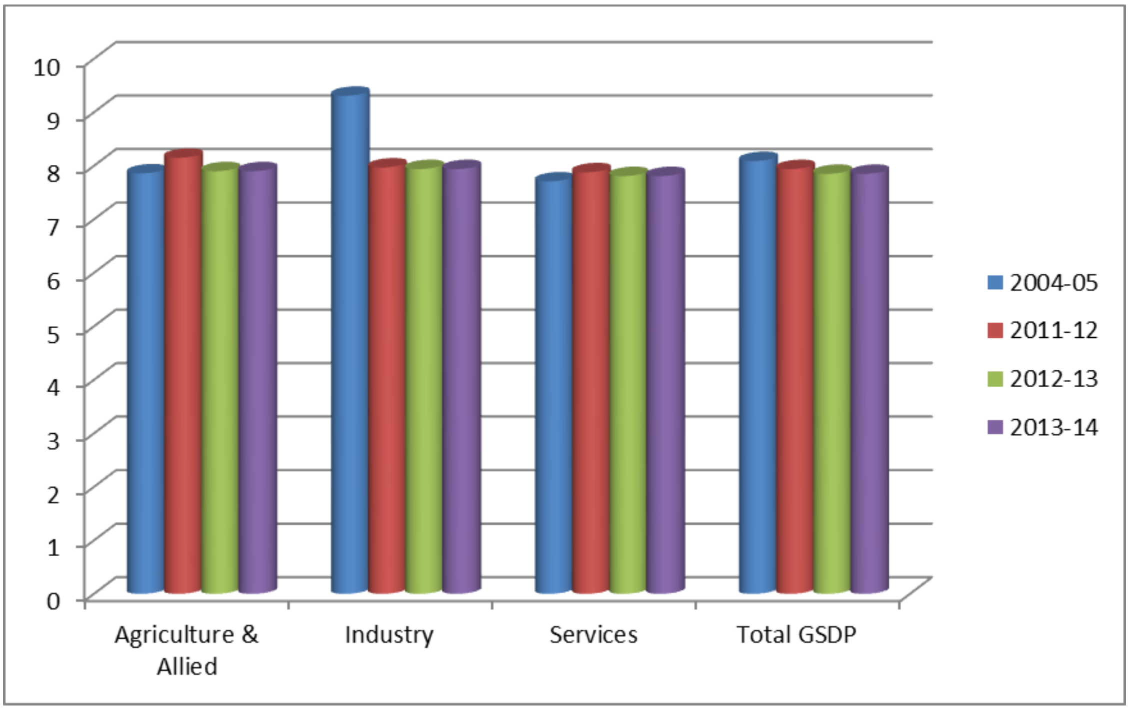


Figure 31: Contribution of South 24 Parganas in GSDP of Broad Sectors of Economy

4.2.3 Existing and proposed Industries

There are about 7 Brick kilns located along the river stretch. These brick kilns mostly use fuel wood, saw dust, rice husks and agricultural residues along with coal for firing their kilns. Most of these are locally arranged and transported through roads/local boats by owners directly to their kilns. 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 7 fire Kilns located along and near Matla waterway is about 9,000 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 project area starting from 0 kp to 55 kp is located in core area. This area is strictly protected as Tiger reserve. From 55 to 98.731 Kp is moderately connected with road. The nearest railway station is Canning located near 98.731 KP. State Highway runs on the both sides of the river from 55 Kp to 98.731 Kp. Ferry services runs from Jharkhali, Kaikhali, Garan Bose, Madhukhali, Haribhangi and Golabari Ferry ghats. Mobile network is intermittently available in the area. The both sides of the river have dense mangroves.

4.2.5 Connectivity with Other Wateways

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

Table 26: Connectivity with other Waterways

Sl. No.	Waterway Name	Chainage at merging location (Km)
1.0	Indo Bangladesh waterway protocol Route	From 48.62 Km to 59.05 Km
1.0	Bidya Waterway	41.08 Km
2.0	Hogla Waterway	80.93 Km

4.3 COMMODITY COMPOSITION / CATEGORIZATION

Detailed traffic survey was done by the consultant along the study stretch of Matla Waterway. During the survey, it was observed that, ferry services are operational along the waterway to transport passengers and small cargo. The ferry sevices are operated by local private bodies.

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

a) Cargo Vessels through Indo Bangladesh Protocol Route
b) Agricultural Products
c) Construction Material
d) Passengers

4.3.1 Cargo Vessels

As Matla river is part of the Indo Bangladesh Protocol Route, cargo vessels originated/designated to/from Kolkata/Bangladesh navigates through Matla river from Lot No. 121 to Kaikhali. Location Map of Indo-Bangladesh Protocol Route and connecting National Waterways is shown in **Figure 32**.

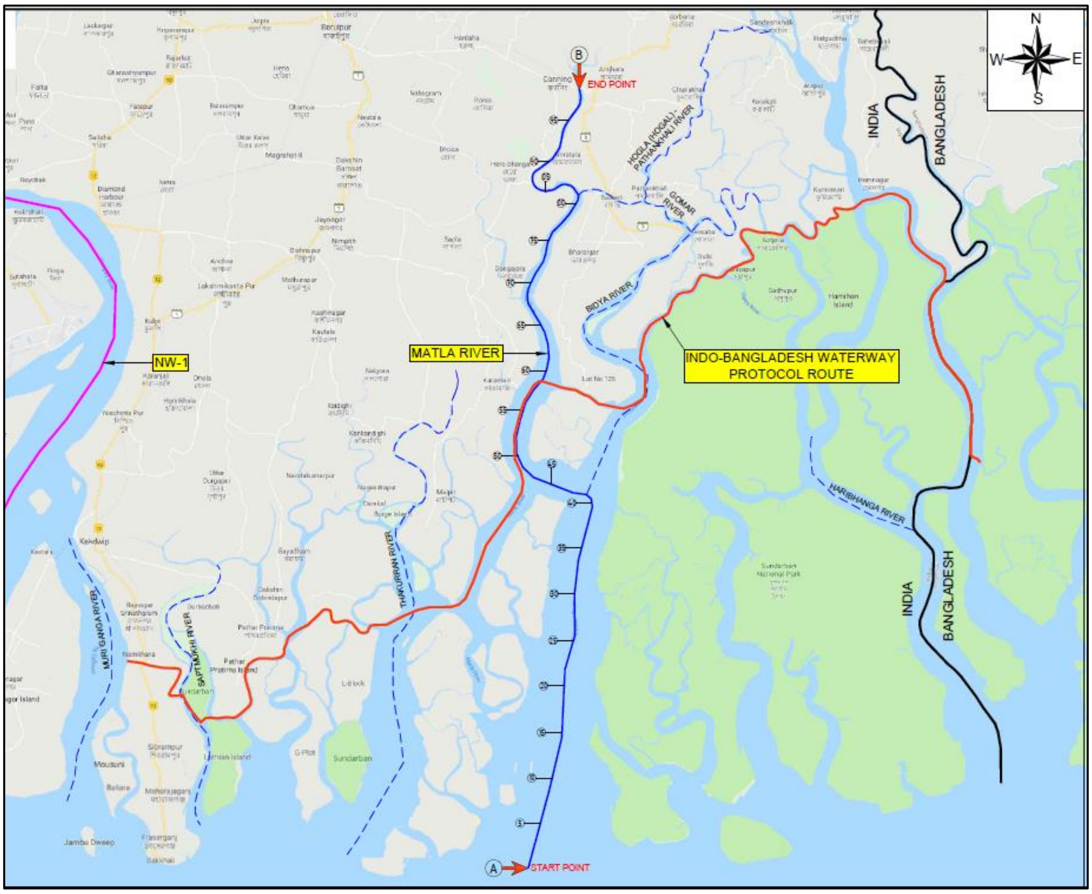


Figure 32: Location Map of National Waterways and Indo-Bangladesh Protocol Route

Though Matla River is used for navigating the large cargo vessels, none of the cargo is designated or originated to/from Matla hinterland.

4.3.2 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.

4.3.3 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 March & 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 Matla waterway.

4.3.4 Passenger Traffic

Passenger ferry services are available at various locations along the 98.731 km stretch of Matla river. The details of passenger ferry services on the basis of traffic survey done in April 2017 are provided in **Table 27**.

Table 27: Existing Passenger Ferry Services in Matla River

Ferry Route No.	Passenger Ferry Services		Passengers using Jetty per day
	From	To	
1	Kaikhali	Jharkhali	150
2	Madhukhali	Garan Bose, Basanti, Sonakhali	200
3	Garan Bose	Basanti, Sonakhali, Madhukhali	250
4	Golabari	Harbhangi, Basanti, Sonakhali	100

All the above listed ferry services are locally operated.

ANNEXURE 5 shows the photographs of ferry services, jetties and vessels operated along the Matla river.

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 related traffic is located along the waterway. Howerver, Kaikhali is located very near to Sunderbans reserve forest area.

4.6 IBP ROUTE TRAFFIC AND ITS POTENTIAL MOVEMENT

An Inland water transit and trade protocol exists between India and Bangladesh under which inland vessels of one country can transit through the specified routes of the other country. The existing protocol routes are (i) Kolkata-Pandu-Kolkata, (ii) Kolkata-Karimganj - Kolkata, (iii) Rajshahi-Dhulian-Rajshahi and (iv) Pandu-Karimganj-Pandu. For inter-country trade, six ports of call have been declared in each country under the PIWT&T[3]. The Ports of call in India are Haldia (West Bengal), Kolkata (West Bengal), Dhubri (Assam), Pandu (Assam), Karimganj (Assam) and Silghat (Assam). The Ports of call in Bangladesh are Narayanganj, Khulna, Mongla, Sirajganj, Ashuganj and Pangaon as shown in **Figure 33** below. Under the Protocol, 50:50 cargo sharing by Indian and Bangladeshi vessels is permitted both for transit and inter country trade.

[3] Annual Report on Traffic on National Waterways: FY 2019-20, by IWAI

Figure 33: The Indo Bangladesh Protocol (IBP) routes under PIWT&T

IWAI is the Competent Authority on Indian side w.e.f. 8th September 2003 vide Ministry's Order No. WTC-15014/2/2001-IWT dated 29.08.03 and is responsible for maintenance of routes including conservancy and pilotage. The stretch of IBP route along proposed 13 rivers of National waterway 97, Sunderbans waterways is shown in **Figure 34** below.

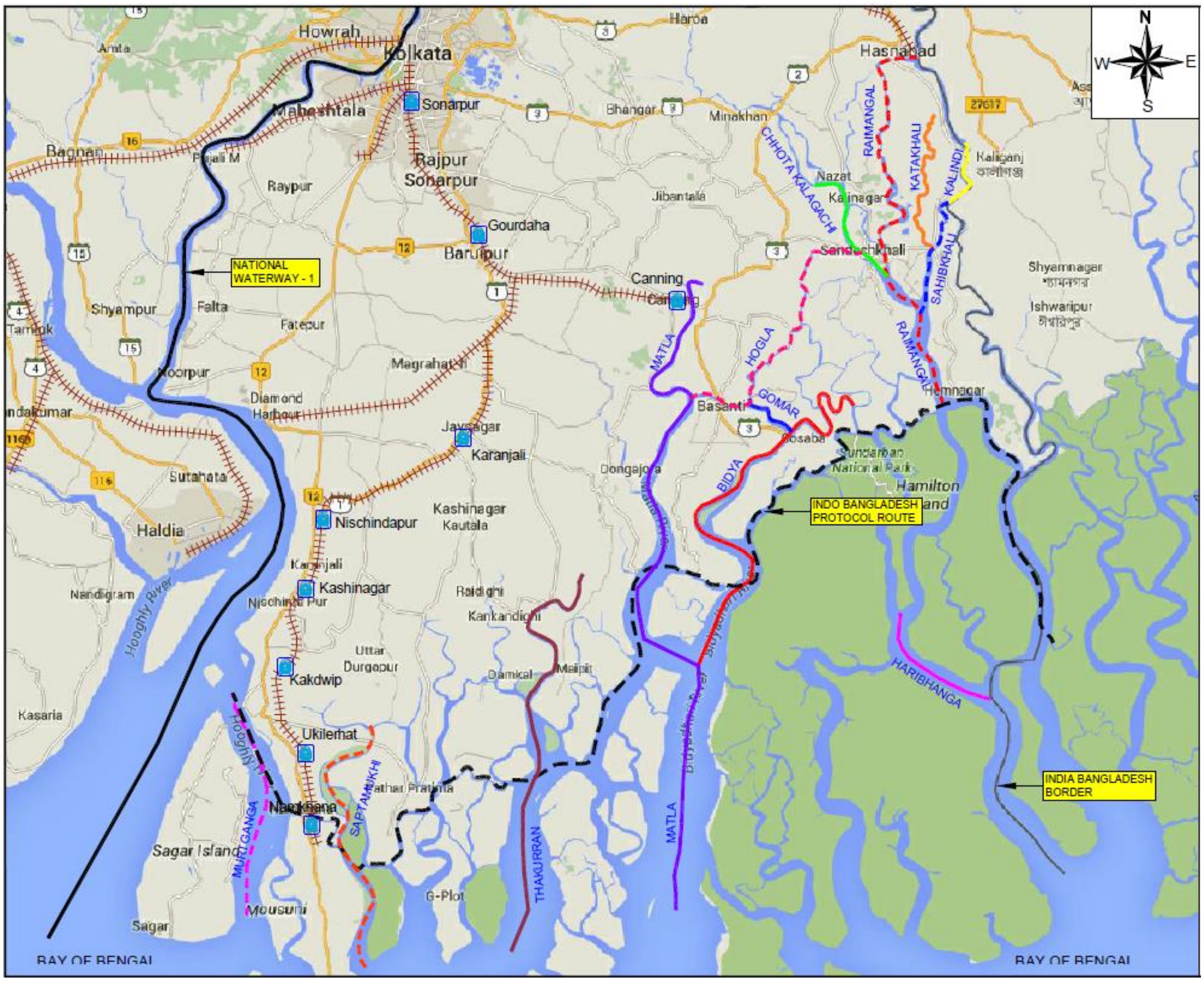


Figure 34: Location map of IBP route along NW97 (Sunderbans Waterways)

Traffic on the IBP route predominantly consists of fly ash movement from Kolkata/Haldia to destinations based in Bangladesh. Fly ash movement to Bangladesh is driven by the requirement of Cement plants. M/s Feedback Infra (P) Limited had conducted the Technical, Economic and Financial (TEF) feasibility studies for development of Sunderbans Inland Waterways in the IBP route[4]. The final report was submitted to IWAI on 30th March 2017. As per the report, the Indo-Bangladesh protocol route is the major contributor towards Indo-Bangladesh trade through waterways.

According to the TEF studies, majority of the cargo in the IBP route constitute of Fly ash, Slag, Clinkers and Gypsum. These products are raw materials to Cement industries and other manufacturing

[4] Final Technical, Economic & Financial Feasibility Report on Development of Sunderbans Inland Waterways, 2017, by IWAI

industries in Bangladesh. The cargo movement in IBP route is majorly from the Kolkata cluster to various river ports in Bangladesh.

Some of indicative long-standing linkages between industries in the region are as follows.

- Fly ash – from Kolaghat and Bandal coal-fired power plants (West Bengal Power Development Corporation Limited)
- Gypsum – from chemical industries cluster in Haldia
- Clinker – from cement industries (Ambuja, ACC Cement, etc.)
- Granulated slag – from steel plants in Kolkata cluster

The protocol route was also used for transportation of commodities including fuel (diesel and petrol), food grains (rice and pulses), iron rods, etc. to Tripura and other north-eastern states. The commodities are majorly transshipped through Ashuganj port (on Kolkata-Karimganj route) and moved through road to the north-eastern states.

Based on the commodity flows and industrial assessment, the traffic along the protocol route were broadly classified into three categories in the TEF studies, as shown below:

a) Trade traffic – includes commodity movement between Kolkata (via Petrapole Land Port, Kolkata Sea and waterways) and Bangladesh.
b) Transit traffic – includes commodity movement between the hinterland and North-Eastern states such as Assam, Tripura, Manipur, Mizoram, Meghalaya and Arunachal Pradesh.
c) Traffic within Sunderbans – Includes the passenger and commodity movement between major population nodes of Sunderbans.

It was concluded from the feasibility studies that, major component of traffic in sunderban waterways along IBP route comprises trade and transit traffic only. Traffic within sunderbans comprises of passenger movement only because of tourism and work. This movement is by ferry across rivers, on short stretches along rivers and tourism based passenger traffic. On the bais of estimated traffic, IBP route was proposed for development in the TEF feasibility report along with terminal infrastructure facilities at 3 locations i.e. Kolkata, Haldia and Hemnagar. The Hemnagar Terminal is proposed as a Customs check-point and no loading or unloading of material/cargo is envisaged at the terminal.

The results concluded from this TEF studies are also supported by the IBP route traffic presented in the Annual Report on Traffic on National Waterways of FY 2019-20, published by IWAI.

As per the Annual Report on Traffic on National Waterways of FY 2019-20, published by IWAI, approx. 3.5 million tonne of traffic moved on the IBP route in FY-20 and displayed a growth of approx. 7% over FY-19 as shown in **Figure 35**. Vessels plying on IBP route for fly ash movement are shown in **Figure 36**.

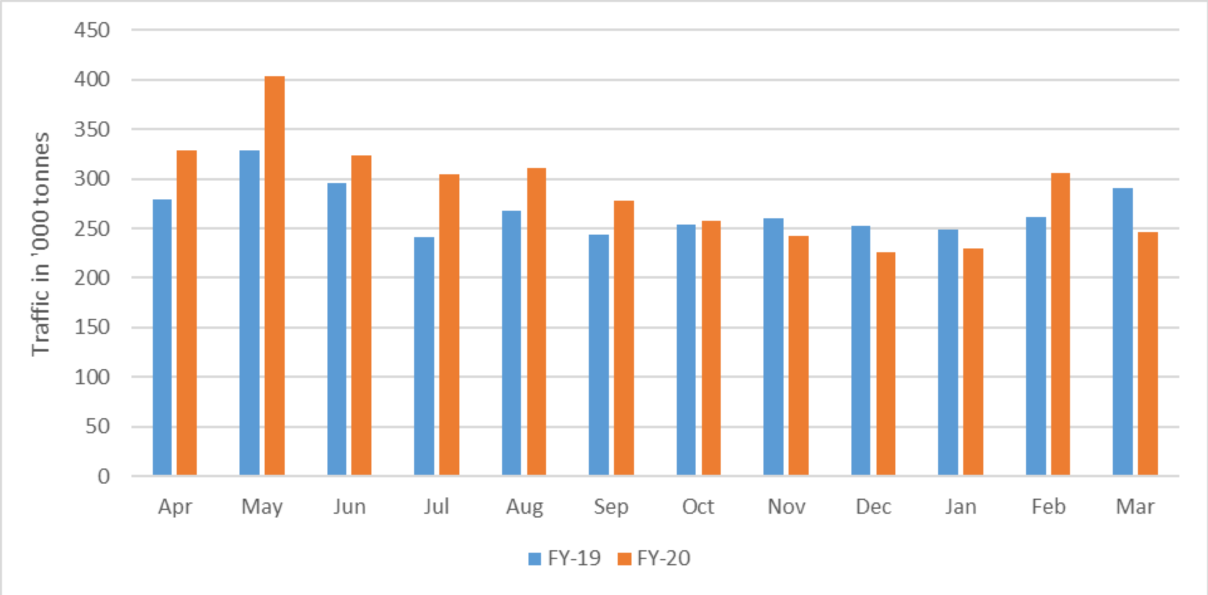


Figure 35: IBP route: Month-wise traffic (FY-19 & FY-20)

Figure 36: Vessels plying on the IBP route

Figure 37 below shows the commodity profile of the traffic handled on the IBP route in FY-20. It can be observed that almost 97% of the traffic on the IBP route is fly ash. The jetties at the origin locations handling fly ash are IWAI Haldia Jetty (30%), Budge Budge, Kolkata (24%), T.T Shed (18%) and G.R Jetty 2 (14%). Among the jetties at the destination locations, Narayanganj receives 84% of this fly ash followed by Khulna which receives the remaining 16%.

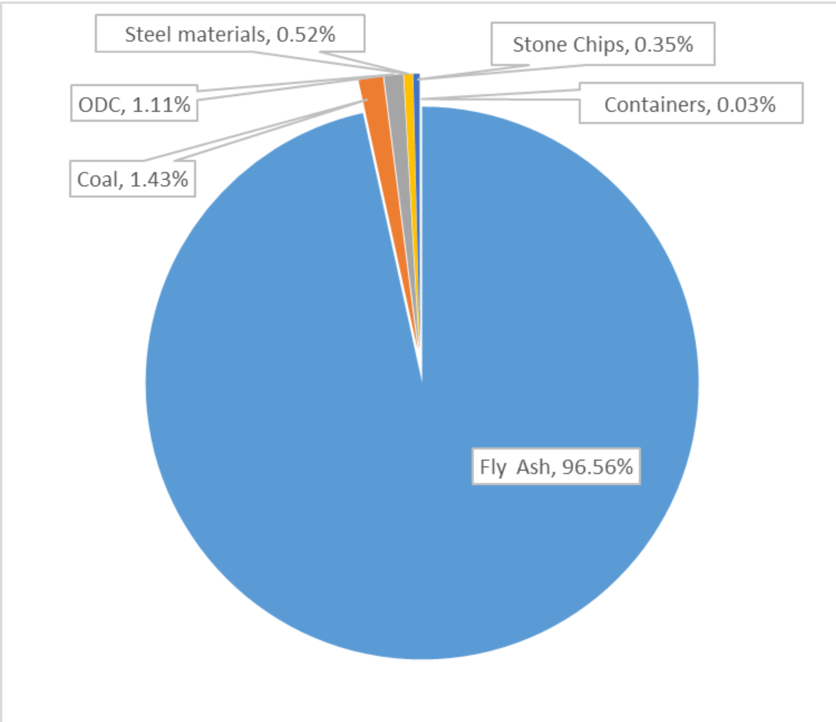


Figure 37: IBP route: Commodity profile of traffic (FY-20)

Commodities other than fly ash constitute approx. 3% of traffic on the IBP route, of which coal is the highest (1.4%) followed by Over Dimensional Cargo (ODC) (1.11%). Steel materials, Stone chips and Containers constitute less than 1% of the traffic.

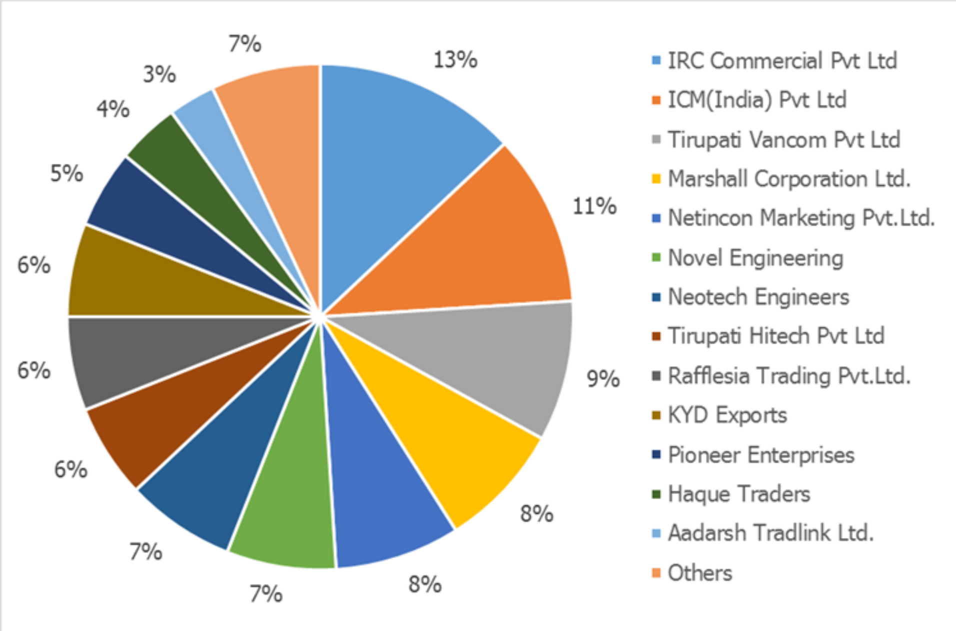
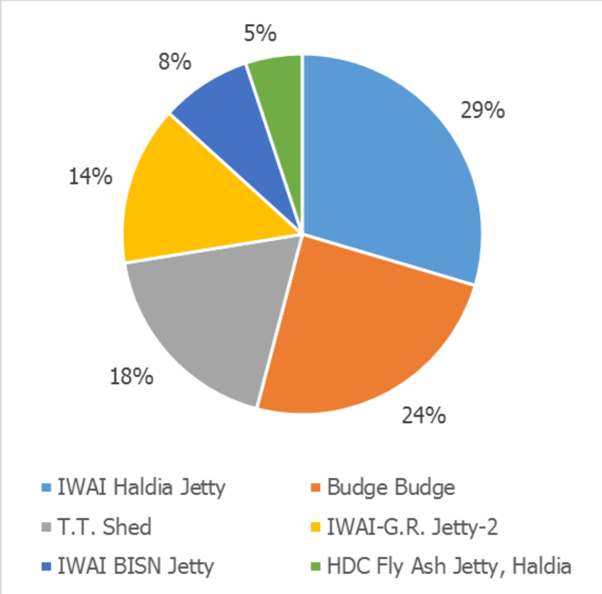
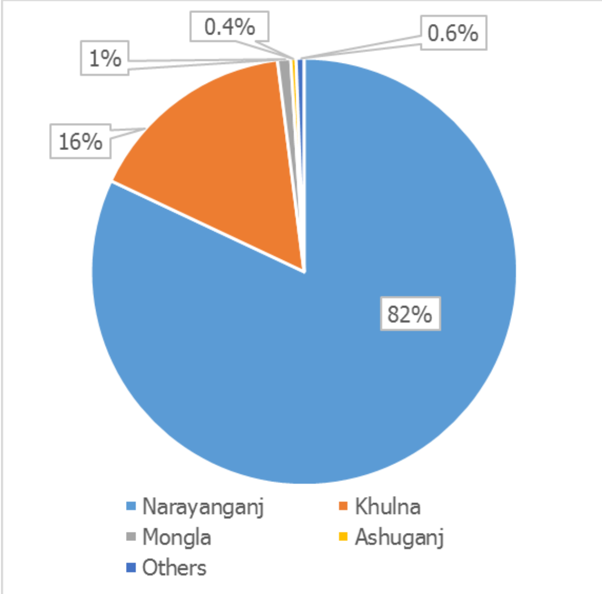


Figure 38: IBP route: Shipper-wise traffic (FY-20)

Figure 38 above shows the key shippers who used the IBP route for movement in FY-20. It can be observed that there are multiple shippers who move their cargo using the IBP route. Most of these shippers are exporters of fly ash. There are close to 39 shippers on the IBP route of which the top 13 constitute 93% of the traffic. The balance 25 shippers also include large scale companies like Bharat Heavy Electricals Limited (ODC, Steam Turbine & Steel), Jindal Steel & Power (Steel materials) and Tata Steel (Hot rolled steel coils).



Jetty-wise share of traffic at origin (FY-20)



Jetty-wise share of traffic at destination (FY-20)

Figure 39: IBP route: Jetty-wise share of traffic at origin & destination (FY-20)

Figure 39 above shows the jetty wise share of cargo handled both at the origin and the destination on the IBP Route in FY-20.

It can be observed that among the origin jetties/ports (India Ports of call), 85% of the traffic on the IBP route is handled at 4 jetties namely IWAI Haldia Jetty, Budge Budge-Kolkata, T.T Shed-Kolkata and G.R Jetty 2-Kolkata. Of these 4, the top 2 jetties, IWAI's Haldia Jetty and Budge Budge Jetty only handled fly ash and steam coal. T. T Shed primarily handled fly ash along with a small quantity of ODC and steam coal, whereas IWAI's G.R. Jetty 2 handled a variety of commodities. Of the remaining jetties, HDC fly ash Jetty and IWAI's BISN Jetty constituted 13% of the traffic. HDC fly ash jetty and IWAI BISN Jetty handled fly ash. The other jetties such as KPD, Kolkata, NS Dock, Kolkata and HDC, Kolkata jetties handled 2 % of the traffic mainly consisting of project cargo and steel materials.

In terms of the destination jetties/ports (Bangladesh Ports of call), Narayanganj and Khulna handled more than 98% of the traffic. Both these jetties predominantly unload fly ash along with small quantities of project cargo, steel material and stone chips.

A total of 12 jetties on NW-1 loaded traffic for the IBP route in FY-20, of which 6 jetties loaded 98% of the traffic.

About 11.45 km stretch of Matla waterway, from Lot No 121 to Kaikhali lies along this Indo Bangladesh Protocol Routes maintained by IWAI as shown in **Figure 40**.

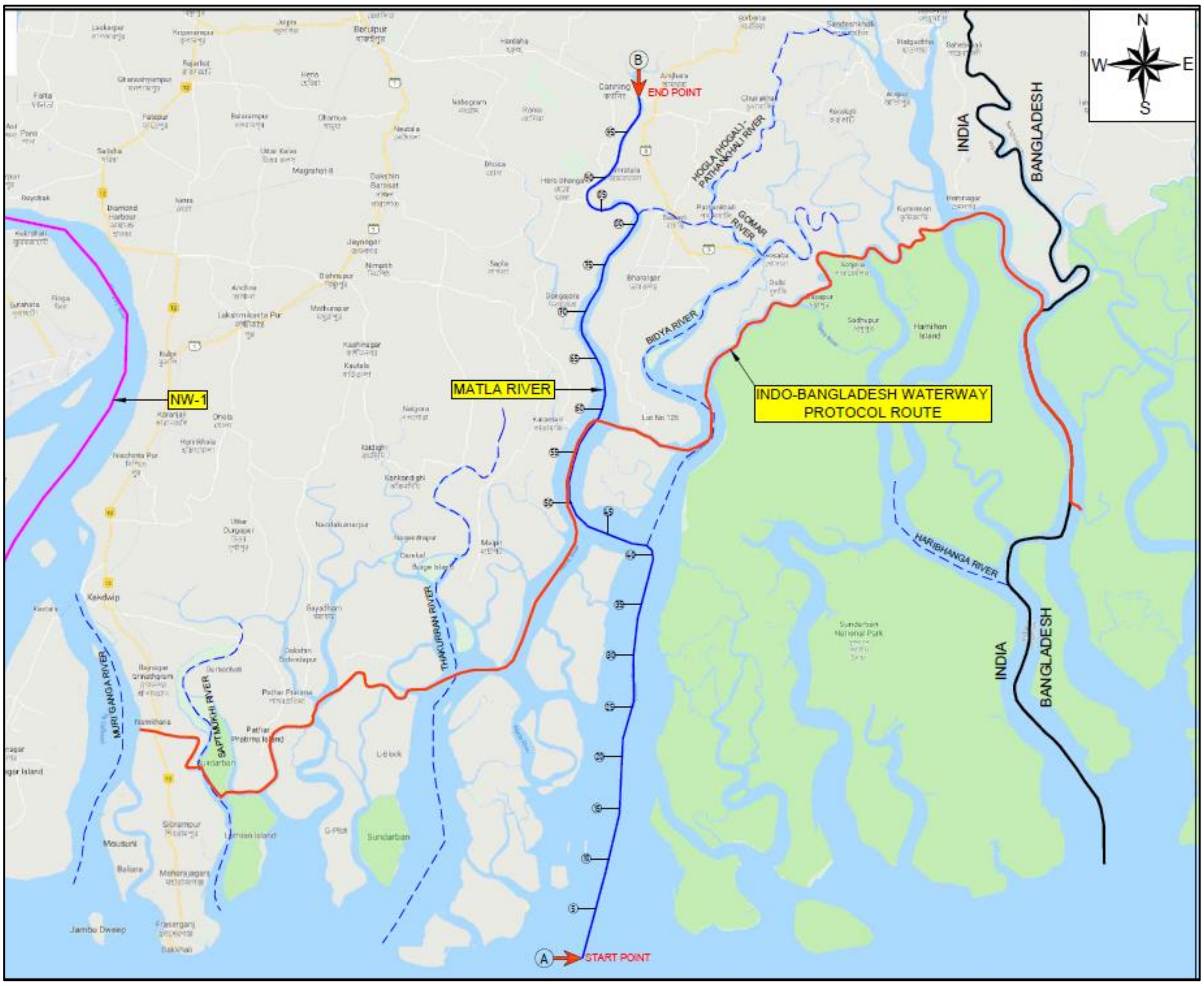


Figure 40: Matla Waterway route along IBP route

As per the traffic studies done in this DPR, TEF report for development of Sunderbans waterways in the IBP route and IBP traffic data provided in annual Report on Traffic on National Waterways (FY 2019-20) preparaed by IWAI, potential of cargo movement is not envisaged from/to Matla waterway to/from IBP route.

4.7 GROWTH TREND

As per district census statistics, the decadal population growth rate of South 24 Parganas is 18.2% and average Gross District GDP growth rate is 6.33%. In the absence of any historical data, 8% of growth trend for passenger traffic is considered on the basis of discussion done with local boat operators during site visit. In discussions with local boat operators during traffic survey done in April 2017, following information were acquired:

a) Ferries are operated by locals.
b) Local ferries are only means of transport to cross the river.
c) Two wheelers are also carried by passengers on ferry boats.
d) Large number of people uses ferry boats to cross rivers for work, school and other livelihood stuff.
e) With no plan of construction of any bridge or cross-structure across the river by Government in near future, the dependency on local ferries will increase with growth in local population.

With the base traffic of about 250 passengers per day, the growth trend for passenger traffic in Matla waterway for 20 years is shown in **Figure 41**.

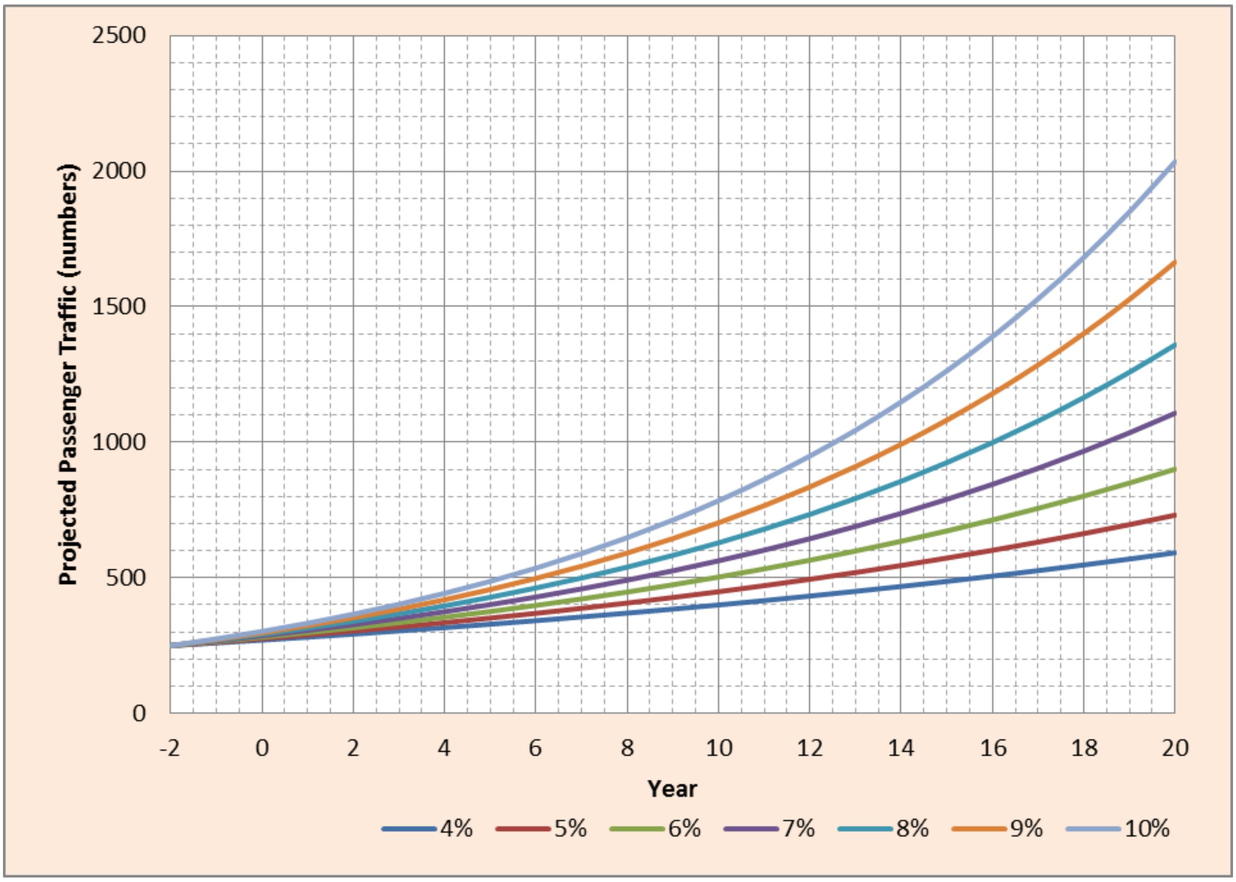


Figure 41: Projected Passenger Traffic of Matla River

With assumed growth rate of 8%, the passenger traffic considered for design is estimated as about 1400 pax per day for 20th year.

4.8 CONSLUSION

Following conclusions are made from the traffic studies done above:

a) Proposed Matla waterway is connected with Indo Bangladesh waterway protocol route, Bidya and Hogla National waterways.
b) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Matla river from Lot No. 121 to Kaikhali (for a length of about 11 Km).
c) There are no big industries near the survey area, however a few brick kilns are found along the river banks.

d) Passenger ferry services are operated privately all along the waterway, however, the services lack basic inland water transport infrastructure facilities for safe navigation, embarking and disembarking.

In view of existing passenger traffic per day (though small) and connectivity of Matla river with major waterways, 4 passenger ferry ghats, namely, Kaikhali, Garan Bose no. 1, Madhukhali and Golabari are recommended to be developed for IWT services as detailed in following chapters of DPR.

Pontoon and Gangway facilities only are proposed at Garan Bose no. 1, Madhukhali and Golabari ferry ghats for providing ferry service link to Basanti and Sonakhali ferry ghats, for the limited traffic as provided in traffic chapter above and as such it is recommended that all basic anemities of terminal structure like parking, ticketing etc. shall be locally handled. Similarly, the Pontoon and Gangway facility at Kaikhali are proposed to provide additional support to vessels plying along India Bangladesh protocol route and to support torism traffic to Sunderbans Reserve Forest area.

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. The cost estimate including capital and operating costs is planned for each of the proposed system considering the design. These above aspects are briefly explained in the following subsequent sections.

5.1 GENERAL REVIEW

Matla river is having potential for Inland Water Transport due to its topography, location and connectivity with other declared national waterways including Indo Bangladesh protocol (IBP) Route.

As detailed in traffic study, the project area and connecting hinterland doed not have any major commercial or industrial unit. However, the waterway is used for passenger ferry services and to transport small cargo along the stretch.

In view of the above, it is recommended to develop the waterway and ferry ghats to provide required inland water transport infrastructure facilities for safe and secure commuting.

5.2 IDENTIFICATION AND SITE LOCATION

Site selection is most important as it decides the investment for establishing the terminal facilities. Hence proper consideration has been given to select the most optimum location which will minimise the capital investment and other recurring cost during operation. The selection of suitable site was 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,
- Availability of land for terminal infrastructure,
- Traffic potential, and
- Navigational safety.

5.3 EXISTING AND PROPOSED FACILITIES

There are number of existing ferry ghats located along the Matla River. The list of existing terminals located is provided in **Table 28** as below:

Table 28: List of Existing Ferry Ghats

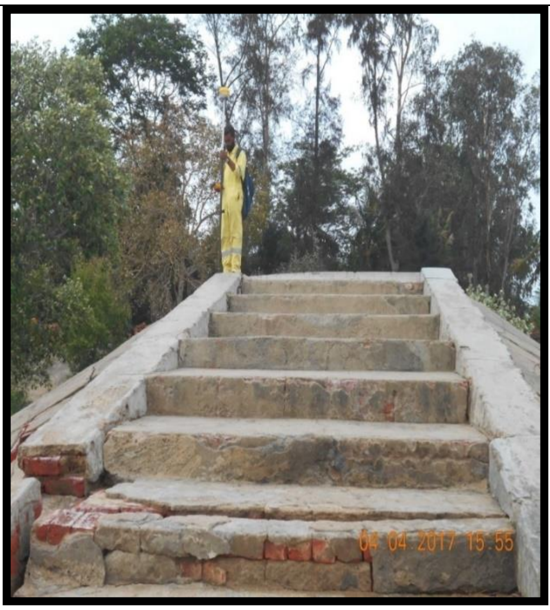
Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Kaikhali	22° 1'17.21"N 88°36'56.26"E	57.5km	1.6m	Kaikhali road	Kaikhali, Gopalganj
Garan bose no.3	22° 7'18.83"N 88°38'15.74"E	70.5km	1.4m	Basanti-jharkhali road	Garan bose, Bharatgar, Joygopalpur,Hiranmoypur
Garan bose no.1	22° 9'33.69"N 88°39'9.55"E	74.8km	1.4m	Sundarban bharatgar road	Garan bose, Bharatgar, Maheshpur
Madhukhali	22°10'27.39"N 88°39'7.09"E	76.4km	1.6m	Sundarban-bharatgar road	Madhukhali, budhkhali, Golabari
Haribhangi	22°12'41.86"N 88°39'7.31"E	84.4km	1.3m	Caning-Basanti road	Haribhangi, Charanikhali, Uttar battala
Golabari	22°12'26.09"N 88°38'39.31"E	85.3km	1.2m	Caning-basanti road	Golabari, Budh khali

Location map of all the above ferry ghats are provided in Volume 2 of the DPR. Photographs of ferry ghats are provided in **Figure 42** below.

These ferry ghats are locally maintained and operated. On the basis of faiway and traffic studies done in this DPR, it is recommended to develop following four ferry ghats:

1) Kaikhali,
2) Garan Bose no. 1,
3) Madhukhali and
4) Golabari,

Pontoon and Gangway facilities only are proposed at Garan Bose no. 1, Madhukhali and Golabari ferry ghats for providing ferry service link to Basanti and Sonakhali ferry ghats, for the limited traffic as provided in traffic chapter and as such it is recommended that all basic anemities of terminal structure like parking, ticketing etc. shall be locally handled. Similarly, the Pontoon and Gangway facility at Kaikhali are proposed to provide additional support to vessels plying along India Bangladesh protocol route and to support torism traffic to Sunderbans Reserve Forest area.



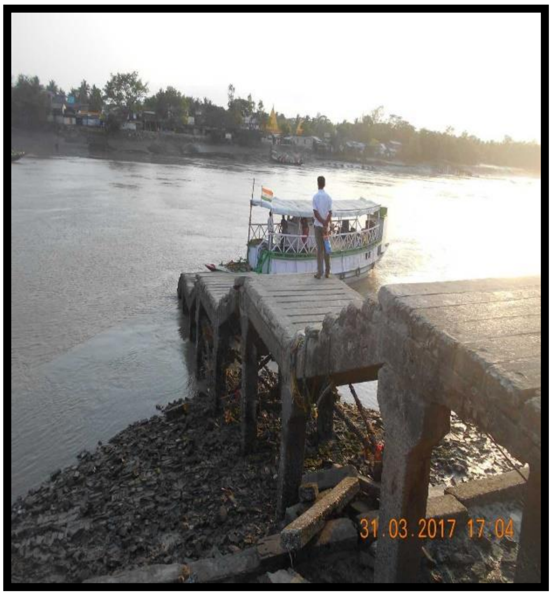


Figure 42: Photographs of Jetties located along Matla Waterway

5.3.1 Location Map of Proposed Ferry Ghats

Location of the above proposed three ferry ghats, is presented in the Google earth image below:

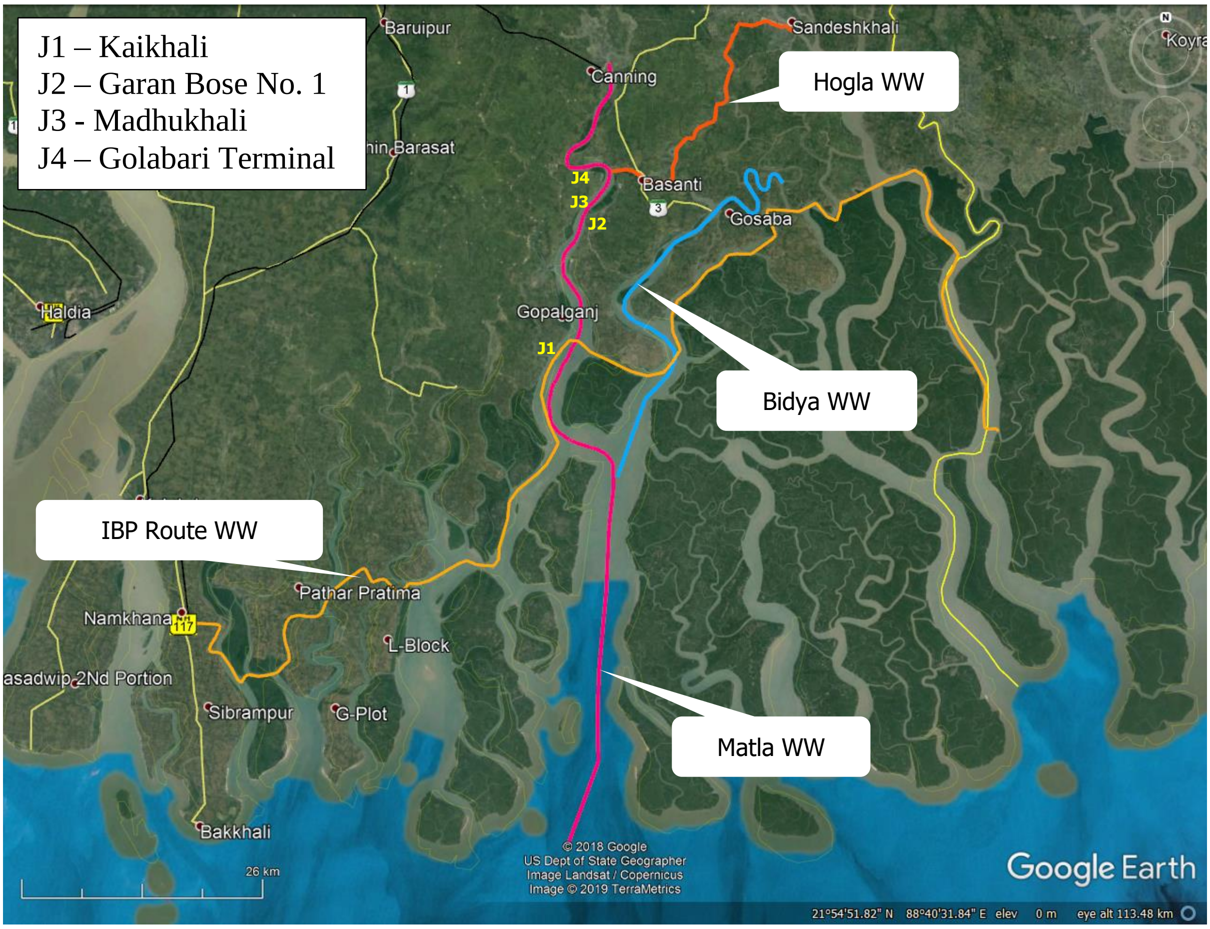


Figure 43: Location map of proposed terminals

5.3.2 IWT Facilities

It is proposed to provide following facilities at the proposed ferry ghat loactions:

1) Pontoon
2) Gangway

A. LAYOUT

A single floating pontoon platform is provided for berthing of ferries at each site capable of handling all types of proposed ferry vessels. A gangway is also provided linking the berthing pontoon to the shore, allowing pedestrian transfer between the shore terminal and the ferries.

The ferry platform are intended for use by vessels operating on regular ferry services to other terminals along the waterway and further afield, but the designs do not preclude use by other vessels.

B. Gangway

16 m long x 2.2m wide Gangway is proposed to provide necessary link between the pontoon platform and the shore platform.

C. PONTOON

A pontoon also known as a floating bridge/platform uses floats or shallow-draft boats to support a continuous deck for pedestrian and vehicle travel. The buoyancy of the supports limits the maximum load they can carry. The level of the pontoon will vary as per the tide variations. Floating pontoon shall provide the support to the other end of the approach bridge and also provide berthing to the passenger ferries. The pontoon is to be stationed at proposed terminal locations along river. The pontoon will be moored at site via sets of catenary and anchors. The pontoon shall be suitably chained anchored to the river bed for the horizontal & vertical stability.

The pontoons shall be as per Indian Register of Shipping rules / regulations for dumb barge / pontoon applicable to inland waters. The pontoon shall be designed and built in accordance with the requirements of the rules and regulations of:

- IRS (Indian Register of Shipping) or any Classification Society who is member of International Association of Classification Society (IACS)
- The Inland Vessel Act 1917 and as amended in 2007.

The Pontoon shall comply with IMO's stability requirements. The Pontoons shall not have any trim by fore in any of the operating conditions at terminal. The pontoon shall be shaped with rounded corners and swims ends. The hull shall be divided into watertight subdivisions for the stability.

The steel to be used for the construction of the pontoon shall comply with IS 2062 Grade B or equivalent. The welding works shall be of excellent quality and using high quality electrodes and shall be done by certified welders. Necessary hull preservation and painting shall be done for the prevention of corrosion. Draft marks shall be suitably placed on pontoon of 3 mm in welded steel plate and painted with at least two coats. They shall be located at intervals of 200 mm vertical (P&S) and at forward aft and amidships. The accuracy of these marking will be checked & verified.

Pontoon of 10m x 20m size is considered DPR design and costing. It is envisaged that pontoon will used for berthing of ferry vessels, to support one end of gangway and to provide passage for passengers from terminal building to ferry through gangway.

No waiting/halting of passengers is recommended on pontoon. The pontoon shall be designed to encounter current of maximum 2m/sec during flood. Suitable mooring arrangements along with anchors shall to be provided along the sides. The winches, anchor chain, mooring ropes, shackles etc. shall be as per the class requirement.

The Steel fenders shall be of min. 300 mm dia (6 mm thick) shall be placed on either sides for 95 percent of the length of pontoon. Tyre fenders of sufficient size shall also to be provided on both sides in such a manner that the spacing between them does not exceed 1250 mm. Lugs of not less than 16 mm to tie up these tyres shall be welded to the sides.

D. <u>SAFETY</u>

The Pontoon and Gangway are provided with appropriate safety equipment including lifesaving equipment, ladders and safety rails. The passenger’s walkway will be marked in lanes as appropriate and signs will be installed to direct. A detailed set of procedures will be prepared for the safe operation of the link between the ferry and the shore. A fendering system on pontoon will be incorporated to cater for both normal berthing impacts and abnormal accidental ferry impact.

5.4 LAND DETAILS

No additional land is required to be acquired for construction or installation of Pontoon and Gangway, as the ferry ghats are already operational at the proposed locations.

5.5 GEOTECHNICAL INVESTIGATIONS

For preliminary engineering design, the data about soil characteristics is collected from the local sources based on the basis of structure constructed near by. On the basis of visual inspection as observed during site visit the top layer of the area (around 2.5 m depth) is covered with fine river sand. During project execution, detail geotechnical investigation may be done for detail engineering.

5.5.1 Regional 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.

5.5.2 Physical Condition and Drainage

The drainage capabilities of the canals, rivers etc. located in the district have been reduced due to unplanned manmade activities and some ecological changes like silting of the rivers etc. So, the flood/heavy water logging has been common occurrence every year in the most parts of the aforesaid sub-divisions. Similarly, Cyclone and High tide has been commonly found in the riverine belts.

5.6 COSTING

As part of collective development of NW-97, an optimised approach for infrastructure development is proposed herewith. Accordingly, operating buildings and corresponding mannings proposed in NW-97 are provided as below:

Sl. No.	Name of waterway supported by proposed operating building and corresponding Manning	Name of Jetty/Terminal where Operating Building and corresponding Manning is proposed	Name of waterway in which cost of operating building and corresponding Manning 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		

Sl. No.	Name of waterway supported by proposed operating building and corresponding Manning	Name of Jetty/Terminal where Operating Building and corresponding Manning is proposed	Name of waterway in which cost of operating building and corresponding Manning is considered
8.	Chhota Kalagachi waterway	Bhandarkhali Jetty	Sahibkhali waterway
9.	Raimangal waterway		
10.	Sahibkhali waterway		
11.	Katakhali waterway		
12.	Kalindi waterway		

Hence, for Matla waterway, the Operating Building and corresponding mannings proposed at Basanti Jetty along Hogla waterway is recommended to support the operational activities of all the ferry terminals proposed in Matla waterway. The cost estimate for proposed ferry terminals 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).

5.6.1 Capital Cost

Pontoon and Gangway facilities only are proposed at Garan Bose no. 1, Madhukhali and Golabari ferry ghats for providing ferry service link to Basanti and Sonakhali ferry ghats, for the limited traffic as provided in traffic chapter and as such it is recommended that all basic anemities of terminal structure like parking, ticketing etc. shall be locally handled. Similarly, the Pontoon and Gangway facility at Kaikhali are proposed to provide additional support to vessels plying along India Bangladesh protocol route and to support torism traffic to Sunderbans Reserve Forest area. Capital cost for proposed ferry terminal is provided in **Table 29** respectively.

Table 29: Capital Cost for Ferry Terminal

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lakh)
1	Pontoon Platform with all required accessories	No.	1	50,00,000	50.00
2	Gangway (Including Maintenance)	No.	1	17,50,000	17.50
				Total	**67.50**
3	Cost of Detail Engineering and construction supervision			6%	4.05

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lakh)
				Total	**71.55**
4	Contingency			3%	2.15
	Capital cost of each Pontoon and Gangway system				**73.70**

5	Number of Jetties proposed to be developed	4
	Total Capital cost of proposed Pontoon and Gangway system for all ferry ghats	**294.79**

Hence, total capital cost for facilities proposed to be developed at all ferry ghats works out as **INR 294.79/- Lakh**.

5.6.2 O&M Cost

Operation and Maintenance cost to be incurred for running Pontoon and Gangway facilities for ferry ghats are provided as below.

a) Maintenance

To ensure that the Pontoon and Gangway facilities are kept in an efficient and safe condition, it will be necessary to ensure that money is set aside for annual maintenance. In the first four years of operation, maintenance costs are comparatively low but would then build up as structures and equipment begin to be affected by wear and tear.

The annual cost of maintaining Pontoon and Gangway including all civil, mechanical and electrical works is considered to be about 3% of the capital cost. Thus, the annual maintenance cost for proposed facilities works out as INR **8.84/- Lakh**.

6.0 PRELIMINARY ENGINEERING DESIGNS

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

6.1 RIVER TRAINING

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

6.2 BANK PROTECTION

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

6.3 NAVIGATION AIDS

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

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

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

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

6.4 FERRY TERMINAL AND JETTIES

Preliminary engineering design required for DPR level costing and analysis for Pontoon and Gangway are done and provided as below. Following codes and standards are used for preliminary design of structures.

Civil Works:

- IS 4651 (Part 1-5): Codes of Practice for Planning and Design of Ports and Harbors
- IS 456 - 2000: Code of Practice for Plain and Reinforced Concrete
- IS 800 – 1984: Code of Practice for General Construction of Steel
- IS 2911: Code of Practice for Design and Construction of Pile Foundations
- IS 1893 – 2002 (Part 1): Criteria for Earthquake resistant design of Structures
- IS 9527 (Part 3): Code of Practice for Design and Construction of Port and Harbor Structures
- IRC-6: Standard Specifications and code of Practice for Road Bridges, Section 2 Loads and Stresses

Geotechnical

- IS 2991 (Part 1 – Sec 2) 2010: Code of Practice for Design and Construction of Pile Foundations – Bored Cast in-situ Piles
- IS 14593 - 1998: Design and Construction of Bored Cast in-situ Piles founded on Rocks-Guidelines

Where applicable the following International Standards are referred

- BS 6349 Maritime Structures
- BS 8110 & 5400 Reinforced Concrete Structures
- BS 449 & API-RP 2A-WSD Offshore Platforms-Working Stress Design
- BS 5950 Structural Steel Work
- BS 8004 & 8000 Foundations
- MJ Tomlinson: Pile Design and Construction Practice, Fourth edition
- Joseph E Bowles: Foundation Analysis and Design, Fifth edition.

6.4.1 Ferry Terminal

The objective of this chapter is to present design of river & landside facilities required for development of Pontoon and Gangway. The following are the main facilities required for operation of the terminal:

- Gangway
- Pontoon Platform

A. STRUCTURAL SYSTEM

The overall Layout showing location of facilities is shown in drawings provided in Volume 2 of the DPR.

The gangway is aluminium/steel platform hinged on the approach platform and pontoon platform on the other end.

B. CONSTRUCTION METHOD

The construction method proposed for approach platform is as described below:

PILING

1) Drive steel liner up to refusal.
2) Bore inside the liner up to the founding level.
3) Lower Reinforcement cage and concrete the pile up to bottom of Pile muff.
4) Place sacrificial precast pile muff over the piles and concrete the annular space between the pile and pile muff.

ERECTION & CONCRETE WORK

1) After the in-situ concrete attains strength, place the precast pile cap U beams over the Pile muffs. Note that the Precast U beams are designed as part of permanent structure.
2) Concrete inside the U beam upto the soffit level of bottom slab.
3) After the in-situ concrete attains strength place precast planks and precast Fender wall panel over the U beams.
4) Cast the in-situ portion of the bottom slab.
5) On completion of concrete works fixtures like fenders, bollards, pipes and cable support system shall be installed

6) All equipment, pipes, cables, light poles shall be installed at the end.

6.5 CONSTRUCTION SCHEDULE

The time schedule for construction activities of the project is considered as one (1) years. The proposed project schedule is provided in **Figure 44.**

Sl. No.	Activities	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Approval of DPR and Project Financial Closure				
2	Environmental, Forest and CRZ clearances				
3	Fairway development				
a)	Procurement of Hardware and other equipment's				
b)	Capital Dredging				
4	Procurement and installation of Aids to Navigation				
5	Construction/ Installation of Pontoon and Gangway				
6	Upgrading existing road to terminals				

Figure 44: Construction Schedule

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. Among operators, the government owned CIWTC (Central Inland Water Transport Corporation) is the largest owner of vessels and barges. Private operators have a substantial fleet, but have not been investing in new vessels in the last decade. In fact, there has been scrapping vessels of late, and all operators may require some help in reviving them and investing in new vessels.

7.2 CURRENT SCENARIO

Ferry and small cargo vessels are already operational in Matla river by locals for river crossing. Also, in the waterway stretch falling in IBP route, major cargo vessels are operational. The photographs of existing vessels plying along the waterway are provided in **Figure 45**. Ferry boats having approximate dimensions of about 14.0 m long, 2.25 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. Hence, vessels with required safety and communication equiments are proposed along the waterway.

Figure 45: Vessels plying on Matla Waterway

7.3 PASSENGER TRAFFIC AT PROPOSED LOCATIONS

Pontoon and Gangway facilities only are proposed at Garan Bose no. 1, Madhukhali and Golabari ferry ghats for providing ferry service link to Basanti and Sonakhali ferry ghats, for the limited traffic as provided in traffic chapter above and as such it is recommended that all basic anemities of terminal structure like parking, ticketing etc. shall be locally handled. Similarly, the Pontoon and Gangway facility at Kaikhali are proposed to provide additional support to vessels plying along India Bangladesh protocol route and to support torism traffic to Sunderbans Reserve Forest area.

Accordingly, following OD pair is proposed for Matla waterway:

a) Link 1: Garan Bose no.1 – Madhukhali – Basanti/Sonakhali (Trip Length 9.8 Km)
b) Link 2: Golabari – Basanti/Sonakhali (Trip Length 8.0 Km)

As detailed in chapter 4, the passenger traffic at proposed loactions as obtained from traffic survey done in March & April 2017 are provided as below:

Table 30: Passenger Traffic at Proposed Locations

Sl. No	Proposed Ferry Ghat	Average daily passenger traffic
1.	Madhukhali	200
2.	Garan Bose Jetty 1	250
3.	Golabari	100

The tentative hourly variation of passenger traffic at proposed loaction for 12-hour waterway operations from 6:00 AM to 6:00 PM, on the basis of collected data are presented as below:

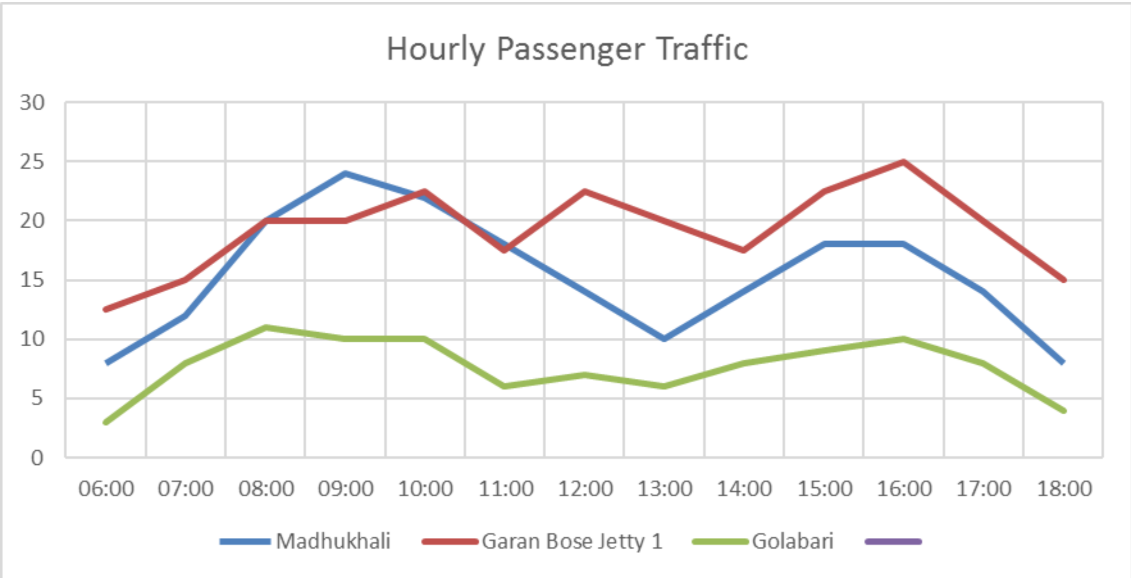


Figure 46: Hourly Passenger Traffic

7.4 DESIGN BASIS

The type and size of vessels proposed to be operated in the waterway is designed on the basis of following factors:

a) Cargo Characteristics
b) Cargo Factors
c) Waterway and Other Features
d) Operational Factors

7.4.1 Cargo Characteristics

Cargo considered for DPR design of the proposed waterway consists of passengers including small cargo like bikes, cycles and agricultural goods. The total volume of cargo originating and terminating from different terminal is shown in Traffic Studies chapter.

7.4.2 Waterway and Other Features

Field investigations done in the total stretch of the river bring out the following characteristic of the waterway which shall influence selection of the vessel for transportation.

- No bridge is located along the proposed fairway.
- Shoals located along the waterway.
- Complete stretch of waterway is tidal.

Hence, the waterway condition during low tide would dictate the selected vessel to have shallow draft to ensure un-interrupted navigation.

7.4.3 Operational Factors

The following factors are generally considered as operational factors in the process of study on vessels for IWT.

- Speed of vessel under varying hydraulic condition,
- Relation between speed, propulsive power and energy consumption,
- Rate of embarkment and dis-embarkment of passengers.
- Number of unworkable days per year, and
- Susceptibility of vessel to damage and crew efficiency.

7.5 PROPOSED VESSEL SIZE AND SPECIFICATIONS

Passenger ferry services are proposed along the waterway at locations detailed above. As per the bathymetric survey, draft available in proposed stretch of waterway is in the range of -8.13 m to 26.36 m w.r.t sounding datum for Class VII.

The ferry boats shall be of a design combining reliability, fuel efficiency, low environmental impact (low wash), safety and comfort. The vessels should be based on environmental and climatic change friendly designs to improve energy efficiency and reduce the environmental footprint. Possible features could include, but not limited to, using alternate clean fuels, use of solar modules for ancillary energy needs (lights) on ferries.

The ferryboats shall be equipped with an Intelligent Transport and Navigation System. The ferryboats shall be compliant with the rules and contents of a member of the International Association of Classification Societies (IACS) and the Inland Vessels Rules of State as well as Central Authorities.

The major parameters, considered for proposing sutiable and optimized passenger ferry vessel for Matla waterway are hull material, hull form, propulsions system, steering system Shipboard Systems, Environmental Friendliness, etc. The brief charateristics of vessels categories applicable for Inland waterways are presented in below table:

Table 31: Characterisctics of Vessel Categories

Vessel Type	Category	Pax Capacity	Vehicle Capacity	Max Speed (knots (nautical miles/hour))	Horsepower	Hull Type
Passengery Ferry	1	12-30		16-25	115-375	Mono
Passengery Ferry	2	31-50		8-24	180-700	Pontoon
Passengery Ferry	3	31-50		12-30	180-850	Mono or Cat
Passengery Ferry	4	51-100		8-20	230-900	Mono or Cat
Passengery Ferry	5	51-100		21-38	525-2100	Mono or Cat
Passengery Ferry	6	101-150		10-20	225-1800	Mono
Passengery Ferry	7	101-150		21-35	900-4000	Cat
Passengery Ferry	8	151-300		8-37	400-7200	Mono

Vessel Type	Category	Pax Capacity	Vehicle Capacity	Max Speed (knots (nautical miles/hour))	Horsepower	Hull Type
Passengery Ferry & RORO	9	25-100	2-15	5-15	100-1000	Mono
Passengery Ferry & RORO	10	100-500	2-10	9-15	500-3000	Mono
Passengery Ferry & RORO	11	100-500	10-50	9-15	285-4500	Mono
Passengery Ferry & RORO	12	250-500	50-100	39-42	19300-22600	Mono

The above types of vessels generally have one of three hull types – monohull, catamaran, or pontoon. Monohulls are a traditional hull design that are often used for slower speed services. Monohulls can be designed for high speeds, but generally more engine power is required to reach the same top speed with a monohull than with a catamaran hull. RORO ferries are almost always monohulls. Catamarans are often used for higher speed services. They require less power, and thus less fuel to travel at the same speed as a monohull, and provide a more stable ride for passenger comfort. Pontoons are more affordable than other hull types, but generally only carry 30-50 passengers and cannot travel at high speeds.

Transport department of Government of West Bengal is operating regular ferry services in the state, to provide, clean, safe and faster mode of transport system. The list of various ferry service operators and number of water crafts for the ferry trips operating by Government of West Bengal (excluding private operators) in the Hooghly River are provided in **Figure 47**.

List of various Ferry Service Operators and number of water crafts for the ferry trips :

1. WBSTC Ltd. *(A Govt. of West Bengal undertaking).*
2. HNJPSS (Hooghly Nadi Jalapath Paribahan Samabay Samity Limited).
3. Ghatal Steam Navigation Company (private operator).
4. Indo Swiss Waterways Company (private operator).

Name of operator	Number of steel vessel with capacity of passengers
WBSTC Ltd.	16 steel vessels of capacity for 400 passengers 2 steel vessels of capacity for 250 passengers 2 Steel vessels of capacity for 150 passengers
HNJPSS	14 steel vessels of capacity for 400 passengers 6 steel vessels of capacity for 250 passengers 4 steel vessels of capacity for 150 passengers 10 wooden vessels of capacity for 100 passengers
Ghatal Steam Navigation Company	1 steel body vessel of capacity for 150 passengers 1 wooden vessel of capacity for 100 passengers
Indo Swiss Waterways Company	2 steel vessels of capacity for 150 passengers

Note – It has been decided that the jetties at Bandhaghat in Howrah and Ahiritala in Kolkata will be renovated by Kolkata Port Trust. Ghatal Steam Navigation Company & Indo Swiss Waterways Company are operating the ferry service at these ferry ghats on contact basis from the Kolkata Port Trust. Kolkata Port Trust has been informed

Figure 47: Ferry Services in the river Hooghly between Kolkata and Howrah[5]

7.6 TURNAROUND TIME

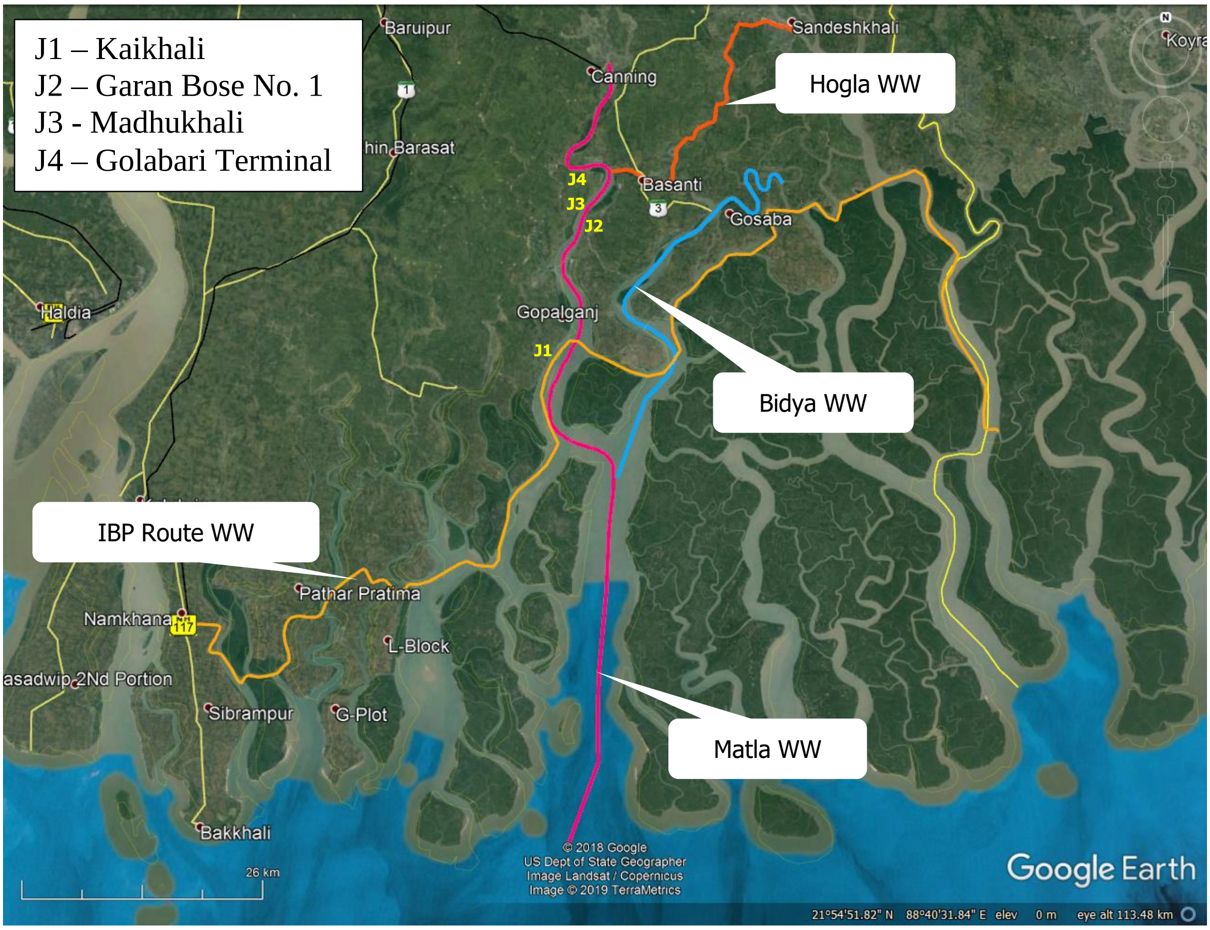
Turnaround time for ships is defined as the length of time between arriving at a point and being ready to depart from that point. It is used in this sense for the loading, unloading, re-fuelling, and re-arming of vessels.

Turnaround time varies with type of vessel, efficiency of jetties and available cargo handling facilities on the jetties. Turnaround time for passenger ferry vessel is discussed in detail in following paragraphs.

For Matla waterway, following OD pairs are proposed:

a) Link 1: Garan Bose no.1 – Madhukhali – Basanti/Sonakhali (Trip Length 9.8 Km)
b) Link 2: Golabari – Basanti/Sonakhali (Trip Length 8.0 Km)

[5] http://transport.wb.gov.in/transport-services/ferry-services/passenger-ferry-services/



7.7 NUMBER OF VESSEL REQUIRED

Number of vessel required to ply on route is estimated and provided in **Table 32** as below.

Table 32: Estimate of No. of vessel required for Passenger Ferry Service

Sl. No.	Description	Unit	Values for OD pair 1	Values for OD pair 2
A	Cruising Speed of vessel	Knot	5	5
B	Length of the waterway considered for ferry services	Km	10.0	8.0
C	Time required by vessel to travel in proposed waterway stretch	minutes	64.79	51.84
D	Embarking and Dis-embarking time considered	minutes	15	10
E	Trip duration (sl. no. C + sl. no. D)	hours	1.33	1.03
F	Operating hours per day (as per information collected on site)	hours	12	12

Sl. No.	Description	Unit	Values for OD pair 1	Values for OD pair 2
G	No. of trips allowed during 12 hours operational time per day per vessel (sl. no. F / sl. no. E)	trips	9.02	11.64
H	Considering Passenger ferry vessels with capacity as	pax/vessel	25	25
I	Present passenger's traffic	pax/day	250	100
J	Required no. of trips per day for current passenger traffic (sl. no. I/ sl. no. H)	trips	10	4
K	Number of Ferry vessel required for current passenger traffic demand (sl. no. J/ sl. no. G)	numbers	1.11	0.34
L	Design passenger traffic in 20th year	pax/day	1359	544
M	Required no. of trips per day for design passenger traffic (sl. no. L/ sl. no. H)	trips	54.37	21.75
N	Number of Ferry vessel required for design passenger traffic (sl. no. M/ sl. no. G)	numbers	6.03	1.87
O	Proposed number of ferry vessels for present passenger traffic	numbers	2	1
P	Proposed number of ferry vessels for design passenger traffic of 10th year	numbers	3	1
Q	Proposed number of ferry vessels for design passenger traffic of 20th year	numbers	7	2

Accordingly, for Matla waterway, it is proposed to provide ferry vessel of 25 passenger capacity. The vessels shall be provided in phase wise manner as per traffic demand. For DPR purpose, it is considered that for present traffic demand, two (2) numbers of vessels are proposed for OD pair-1 and one (1) number of vessel is proposed for OD pair-2 initially from the start date of operation. In 10th year of operation additional one (1) vessel is proposed for OD pair-1 and in 20th year of operation additional four (4) vessels are proposed for OD pair-1 and additional one (1) vessel is proposed for OD pair-2 for IWT operations as per required passenger traffic, making total fleet of nine (9) vessels to cater the projected traffic demand in 20th year of operation.

The required numbers of smaller capacity ferry vessels are proposed to cater the daily hourly traffic fluctuation at the proposed terminals. The tentative technical details for the proposed vessels of 25 passenger capacity for Matla waterway are as below:

a) Type – Fibre boat
b) Length – 18.0 m

c) Breadth – 3.0 m
d) Depth – 1.58 m
e) Draft – 0.8 m
f) Engine capacity – as per design with conventional propulsion
g) Crusing Speed – 5 knot

For proposed passenger ferry services in the waterway, passenger ferry vessels built in house by WBTIDC or other local vessel manufacturer are proposed. DPR consultant has only considered conventional vessels at this stage to keep the start-up risk to a minimum.

7.8 VESSEL COSTING

The cost of operating a ferry is made up from a number of component parts. In keeping with generally accepted principals and methods for the financial analysis of transportation business entities, total expenses (cash outflows) are classified into three mutually exclusive categories of capital costs, direct operating costs and indirect operating costs. Vessel debt repayment includes principal and interest payments on the portion of the vessel purchase price not funded by the equity investment of the owners. Direct operating costs are defined here as vessel direct operating costs, which include crew costs (in this case deck and engine crew only, excluding passenger service crew), fuel and lubricant costs, and vessel maintenance. Indirect operating costs are defined here as including insurance, marketing, advertising, and general administration.

7.8.1 Capital Cost

The cost to purchase the vessels, whether they are new or second hand, represents a significant commitment for the ferry operating company. For passenger ferry services, vessels need to be procured. For the purpose of estimating a capital cost for vessels proposed to be operated in the waterway, the price data were compiled from a variety of sources including newspaper archives, marine industry magazines, other ferry cost studies, and discussions with ferry operators. Vessel purchase prices vary greatly, and many vessels are built to meet particular specifications, which are not always made clear when prices are reported. **Figure 48** shows the range of purchase prices found for new vessels in each vessel category.

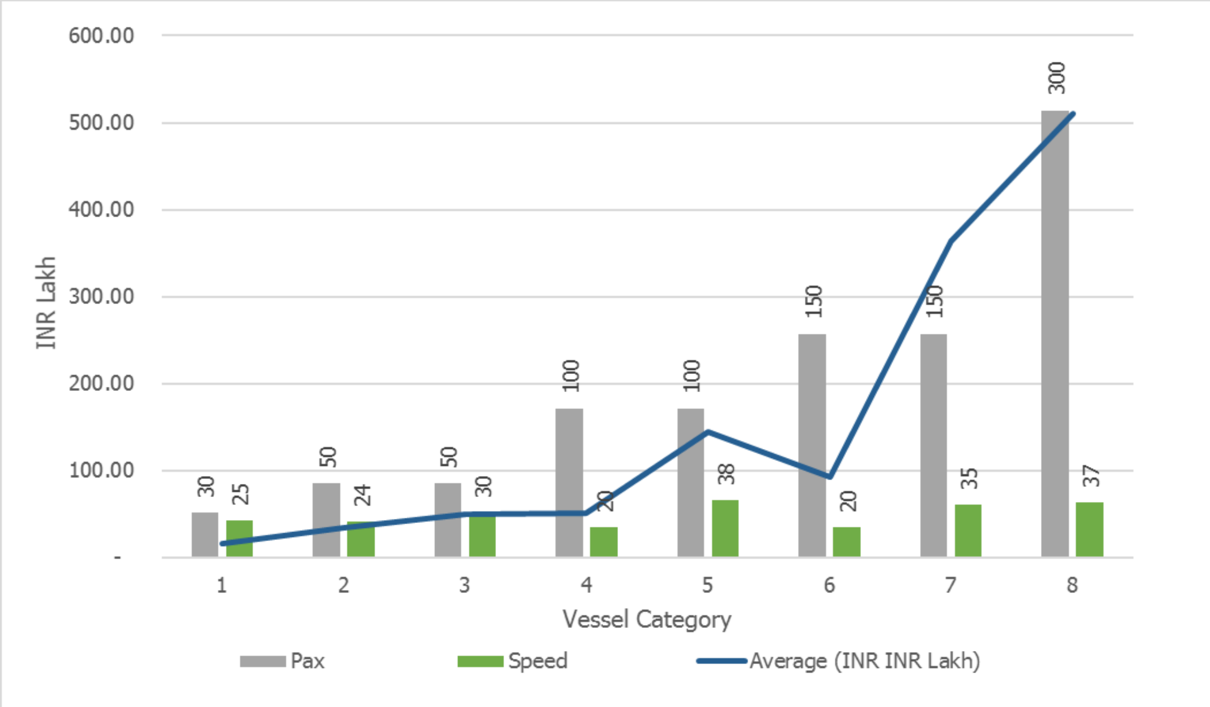


Figure 48: Graph showing variation in Vessel cost w.r.t passenger capacity and speed

Accordingly, for passenger ferry vessel of 25 pax capacity, the capital cost considered is provided in table below:

Table 33: Capital Cost of Vessels

Sl. No.	Description	Rate per Vessel (INR Lakh)	No. of Vessels	Total Cost for vessels (INR Lakh)
1.	Passenger Ferry Vessel	35.00	3 (from start date of operation)	105.00
2.			1 (from 10th year of operation)	35.00
3.			5 (from 20th year of operation)	175.00

7.8.2 O&M Cost

The O&M cost of vessels are estimated as below:

a) Officers and Crew Costs

One team has been allocated for each vessel to enable continuous operation of vessels for 12 hours depending upon traffic flow. Each crew team comprise of members for running/operating of vessel and on-board safety and security in accordance with the Inland Vessel (IV) Act, 1917. Total nos. of crew members proposed is provided as below:

Table 34: Manning Cost

Sl. no.	Type of Crew	Level/ Classification	Reference	Min Gross Salary (INR/ month)	Annual Gross Salary (INR)	Number	Annual Cost (INR Lakh)
1.	One master with Master Class 3 / Serang certificate	L-2	7th pay commission pay matrix	19900	2,38,800	1	2.39/-
3.	General Purpose Ratings for attending duties of deck hands & engine hands	Unskilled	West Bengal Minimum rates of wages w.e.f July 2020	8550	1,02,600	1	1.03/-
Total						**2**	**3.41/-**

Hence, for each vessel 2 crew members are required with annual cost of INR 3.41/- Lakh.

b) Consumables and Repair/Maintenance Cost

Maintenance cost of about 2% per annum of capital cost is considered under this head. Hence, annual consumables and repair/maintenance cost works out to INR 0.70 Lakh for each vessel.

c) Fuel Cost

Fuel expenses for running passenger ferry vessels in the proposed fairway is estimated as below:

Number of days of operation in a year = 300 days
Fuel cost per round trip for each vessel for OD pair 1 = INR 971.92/-
Fuel cost per round trip for each vessel for OD pair 2 = INR 777.54/-
Fuel cost per annum for each vessel for OD pair 1 = INR 13.15 Lakh per Annum
Fuel cost per annum for each vessel for OD pair 2 = INR 13.58 Lakh per Annum

Table 35: Annual O&M cost of Vessels

Sl. No	Item	Annual O&M Cost for OD pair 1 (INR Lakh)	Annual O&M Cost for OD pair 2 (INR Lakh)	Annual O&M Cost for proposed vessels (INR Lakh)
1.	For each vessel in INR Lacs per annum	17.27	17.69	
2.	For proposed 3 vessels from inception stage	34.54	17.69	52.23
3.	Additional cost for proposed 1 vessels from 11th year onwards	17.27	0.00	17.27
4.	Additional cost for proposed 5 vessels from 20th year onwards	69.07	17.69	86.76

8.0 NAVIGATION AND COMMUNICATION SYSTEM

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

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

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

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

8.1 GENERAL REQUIREMENTS

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

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

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

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

8.1.1 VHF / HF

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

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

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

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

8.1.2 DGPS

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

One DGPS station is proposed at Canning with an effective radial coverage of about 125 km, as part of development of Sunderbans waterways and to cater all the 13 national wateways proposed under Sunderbans waterways (NW 97) as shown in **Figure 49** below. As shown in figure below, all 13 waterways prpopsed under NW-97 fall under the radial coverage of proposed DGPS at Canning. The capital and O&M cost of proposed DGPS system at Canning is considered in this DPR of Matla waterway.

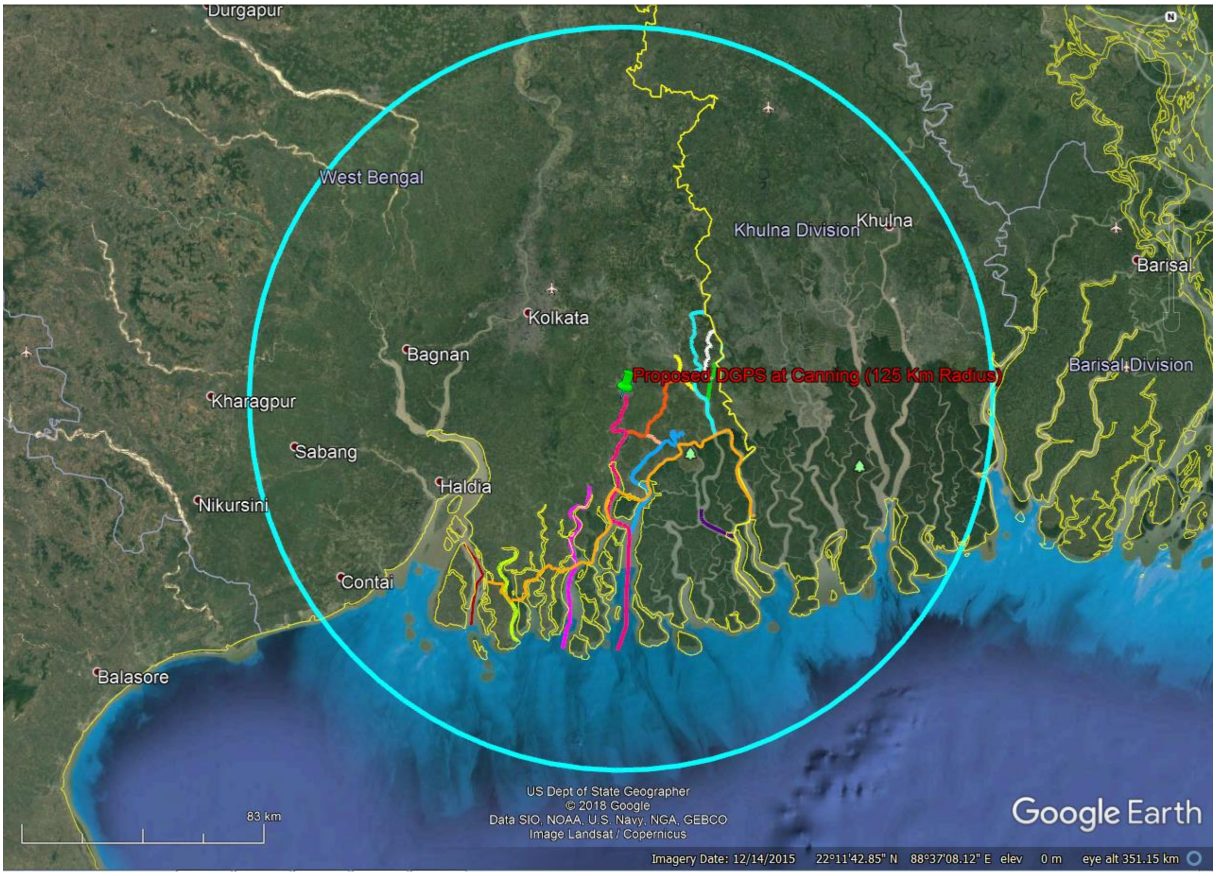


Figure 49: Google Earth image showing location map of proposed DGPS and effective coverage

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

RIS Station No.	Proposed location of RIS station			Waterway 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 WW
				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 WW**
				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 stations to be set up near Dhaki Jetty (21°59'19.55"N, 88°31'3.58"E) along Thakurran waterway and near Godkhali Jetty (22°10'5.76"N, 88°47'14.07"E) along the confluence of Gomar & Bidya WW will cover the complete stretch of proposed Matla waterway as shown in **Figure 50**.

Hence, the proposed RIS stations will cover the Matla Waterway from chainage 30.0 Km to 98.731 Km covering the proposed waterway stretch of 45 Km from Chainage 41.0 Km to 86.0 Km.

The capital and O&M cost of proposed RIS at Dhaki Jetty is considered in the DPR of Thakurran waterway. The capital and O&M cost of proposed RIS at Godkhali Jetty is considered in the DPR of Gomar waterway

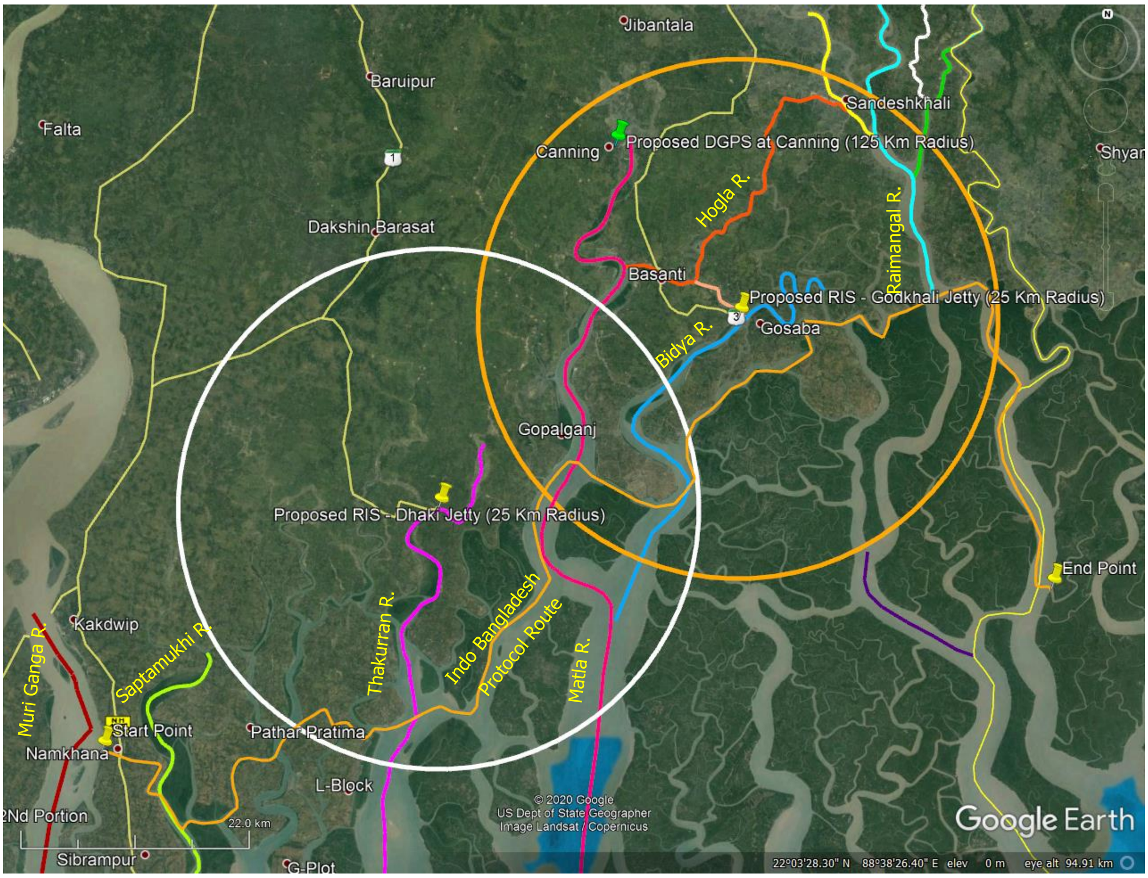


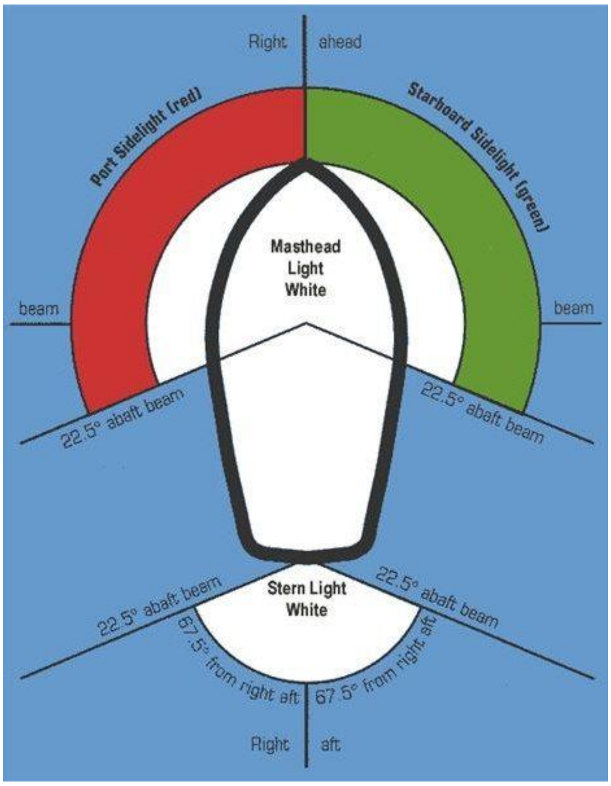
Figure 50: Google Earth image showing location map of proposed RIS and effective coverage

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.

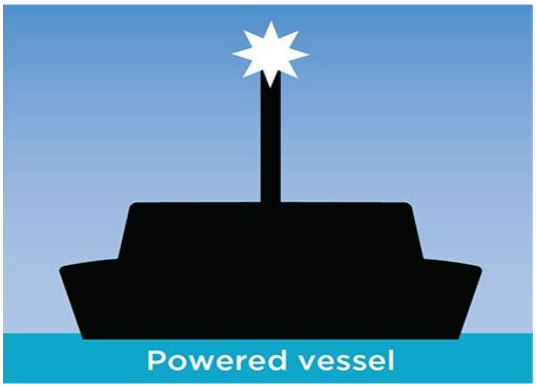
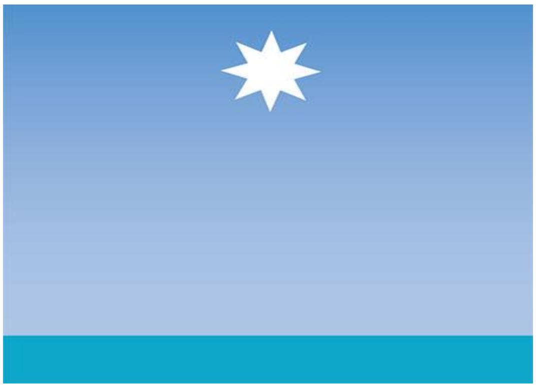
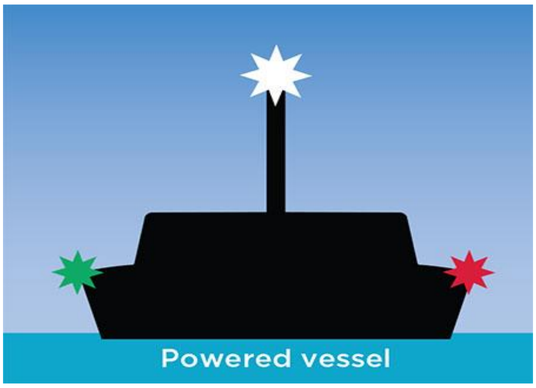
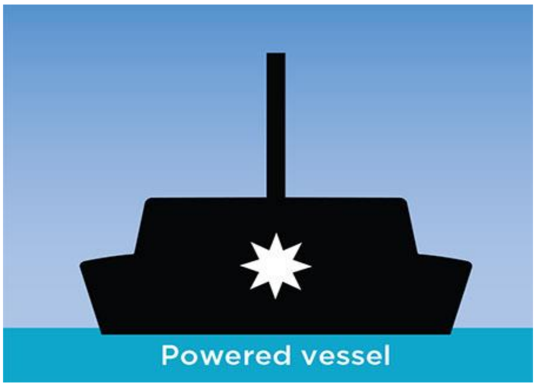
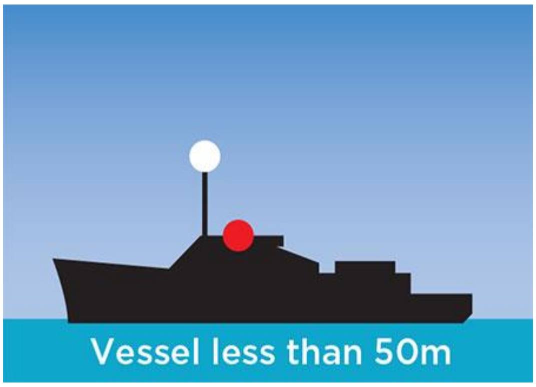
On the vessels there is a pattern in which these lights are set in conjunction with the International Association of Lighthouse Authorities (IALA) Buoyage Systems. The pattern is explained below:

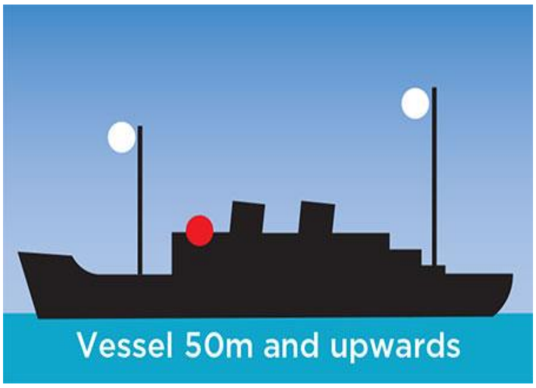
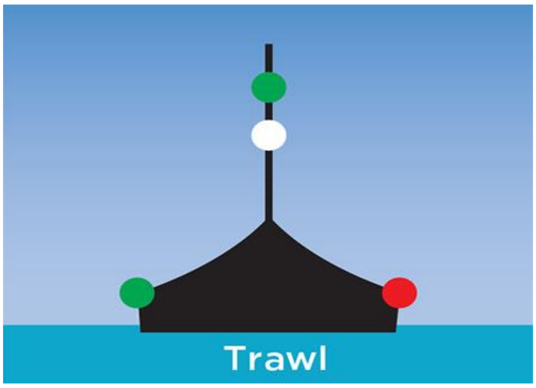
- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.
- 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

Presently, passenger ferry services are operational along the river and cargo vessels are operated in IBP route. 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 51** 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 51: 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) As Matla 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.

Capital cost of purchase & installation and O&M cost of proposed RIS are provided in respective Gomar and Thakurran DPR's. Capital cost of purchase & installation and O&M cost of proposed DGPS and Marine lanterns/bouys provided in Matla Waterway are worked out as below.

8.5.1 Capital Cost

Table 37: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lakh)
A	DGPS	1	15,00,000.00	15.00
B	Marine Lantern/Buoys of 1.25 m dia	20	2,00,000.00	40.00
	Total Cost in Lakh			**55.00**
C	3% Contingencies charges			1.65
D	**Total Navigation & Communication Cost in Lakh**			**56.65**

8.5.2 O&M Cost

The O&M cost is considered as 10% of the capital cost. Accordingly, O&M cost for providing Aids to Navigation and Communication facilities at Matla waterway works out to **INR 5.67 Lakh**.

9.0 ENVIRONMENTAL AND SOCIAL ASPECTS

9.1 OBJECTIVE OF ENVIRONMENTAL AND SOCIAL STUDIES

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

The section of Matla River from Km 0.000 to Km 98.731 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).

Matla River is a tidal estuarine river in and around the Sundarbans in South 24 Parganas district West Bengal, India. The main streme of the the river is divided into two arms near Purandar. One passes through Kultali-Garanbose and then passes through the Sunderban. The other passes through Basanti, Patankhali, Surjyaberia, Masjidbati and then meets the Bidyadhari river

Matla River has several tributaries/creeks along the banks. The details of the creeks are given in **Table 38.**

Table 38: List of Creeks

Sl No	Creek	Chainage	Length(Km)
1	Deulbari Debipur	54.5	7.21
2	Katamari	57.0	10.5
3	Jharkhali	59.0	4.64
4	Dongajora	68.5	22.9
5	Kripa Khali	71.5	8.22
6	Modhu Khali	74.1	3.22
7	Gola Bari	86.6	2.1
8	Nikariaghat	96.6	1.82
9	Kathalberia	99.0	3.0

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.

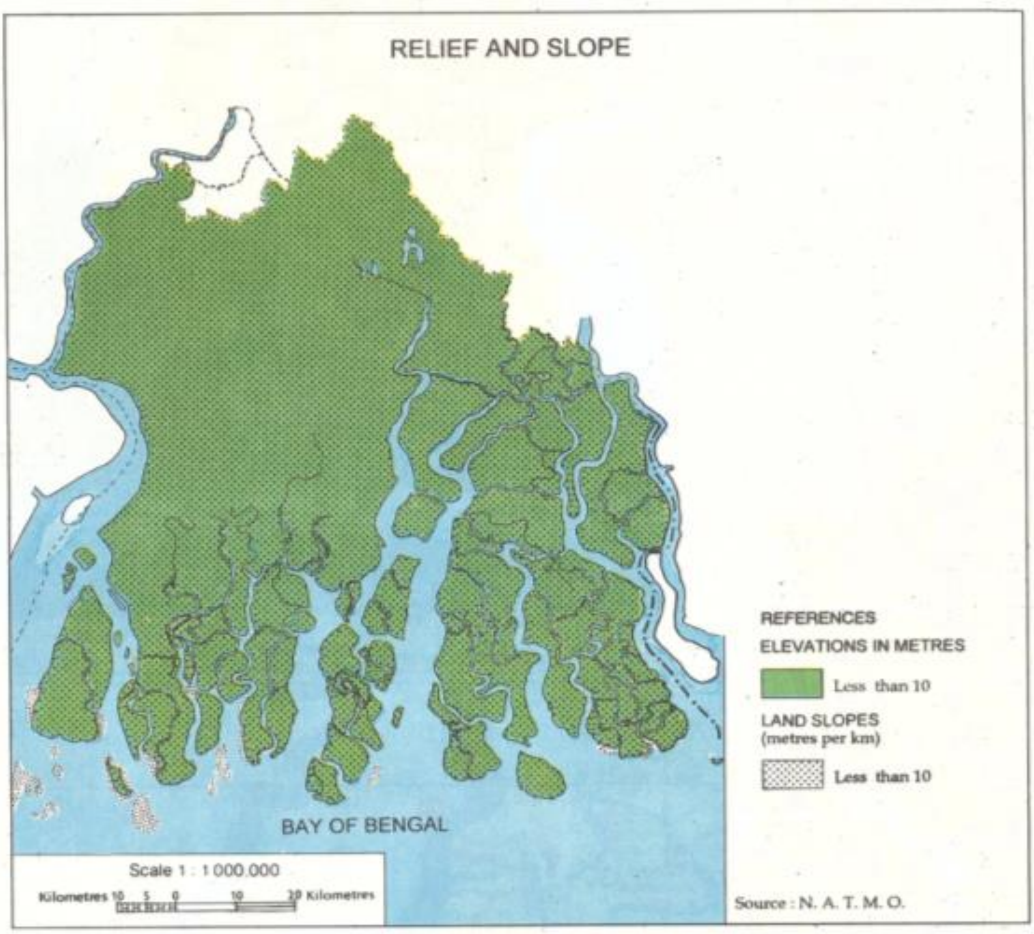
South Bidyadhari Plain: This plain area has its general slope towards the south. Situated in the northern part of the district, river Matla is the most prominent river of this plain. There are many streams and water channels which are locally known as khals.

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 52**.



Source : NATMO

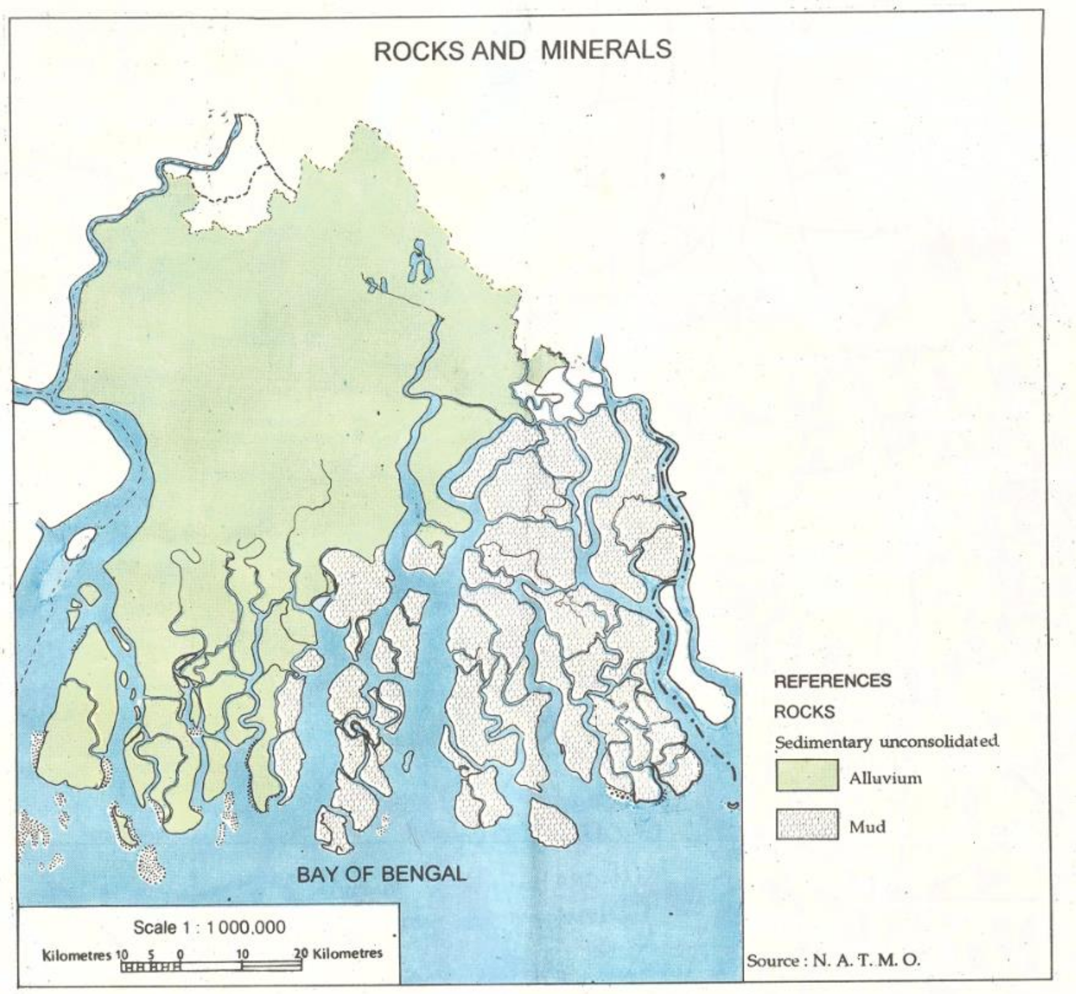
Figure 52: Relief and Slope Map of South 24 Parganas District

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 53**.

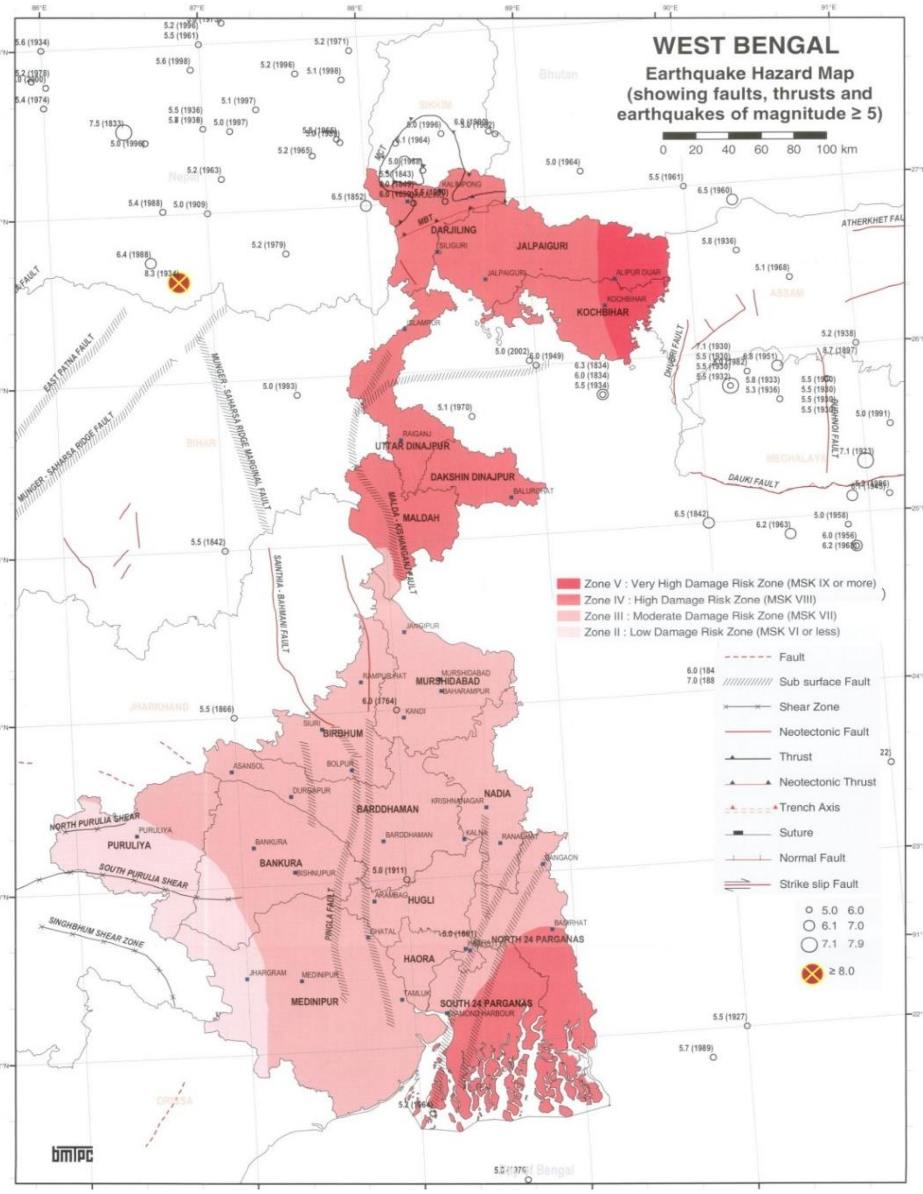


Source : NATMO

Figure 53: 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 54**.



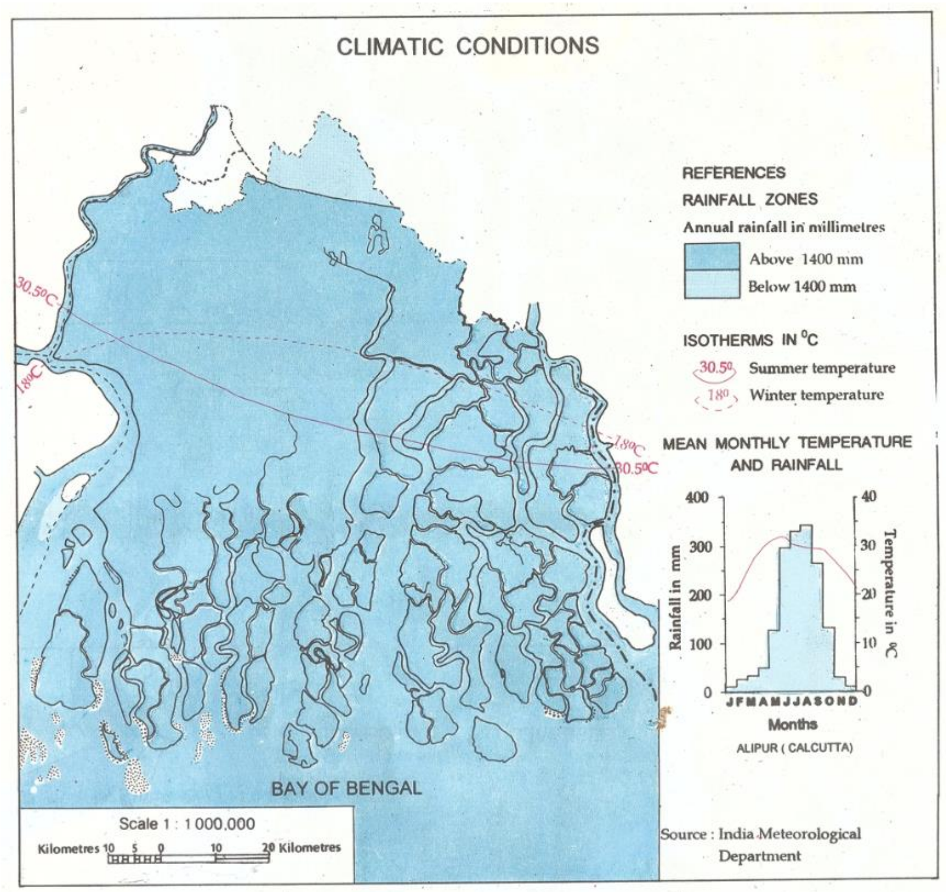
Source : West Bengal Disaster Management Department

Figure 54: 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 55**.



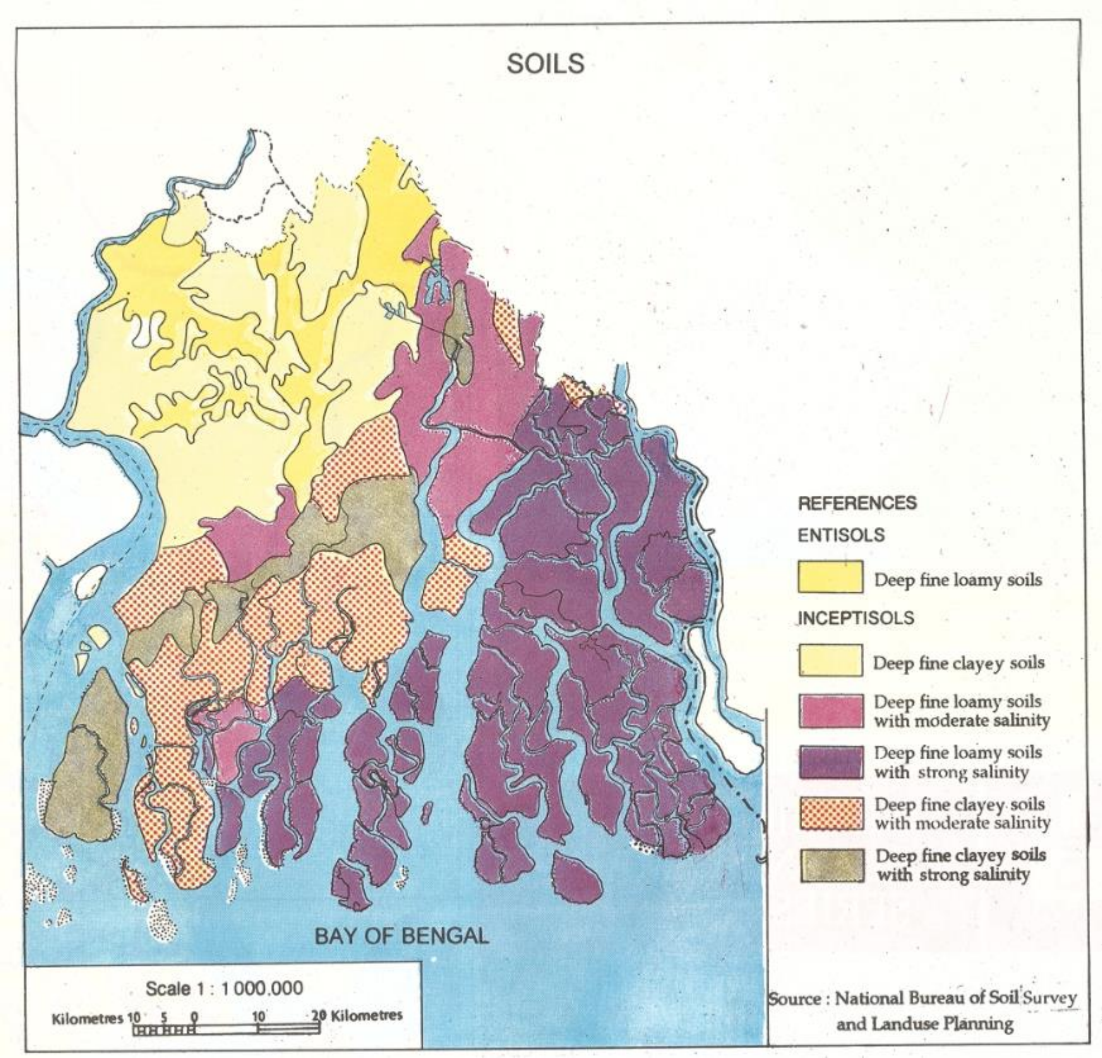
Source : NATMO

Figure 55: 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 56**.



Source : NATMO

Figure 56: 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.

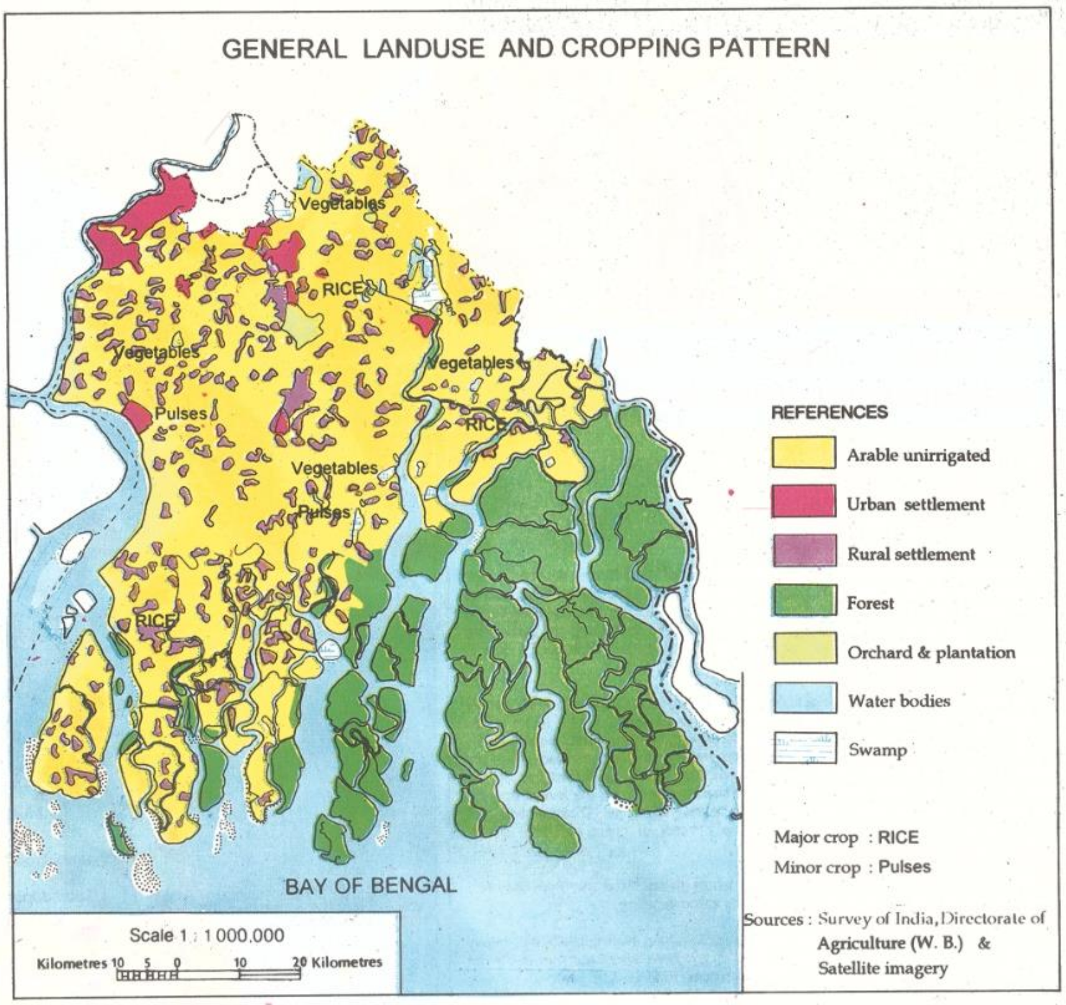
Land use pattern of the project influenced district is presented in **Table 39**.

Table 39: 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 57**.



Source: NATMO

Figure 57 : 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 Matla 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 movement 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 40**.

Table 40: 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

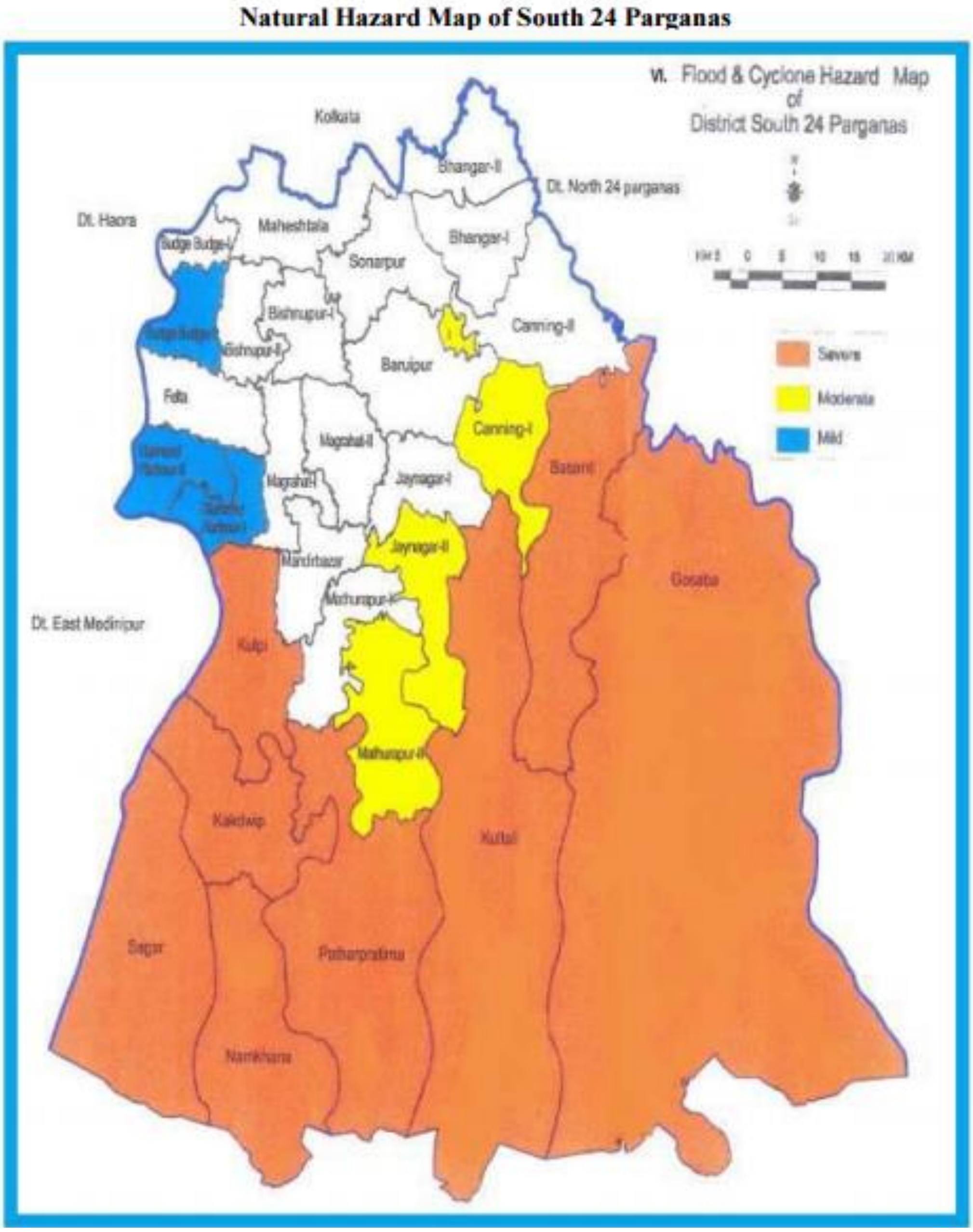
During the reconnaissance survey, it was the found Noise is not big issues in the surrounding areas of Matla River. There are not any noises generating sources in the nearby areas.

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 58: 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 41**.

Table 41: 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.

The section of waterway starts near Kakdwip at Lat 22°39'6.71"N, Long 88°55'33.35"E and ends at Kalanchi at Lat 22°53'53.79"N, Long 88°53'53.94"E. The start point is nearest to Dampier-Hodges Line and located at a distance of 4.5 km north from the Dampier-Hodges Line. It is an imaginary line, passing through 24 Parganas South and North districts, which roughly indicates the northern-most limits of estuarine zone affected by tidal fluctuations. However, tidal influence is observed in the stretch of waterway.

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 11.5 km from Matla 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 III.**

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 42**. 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 42: 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

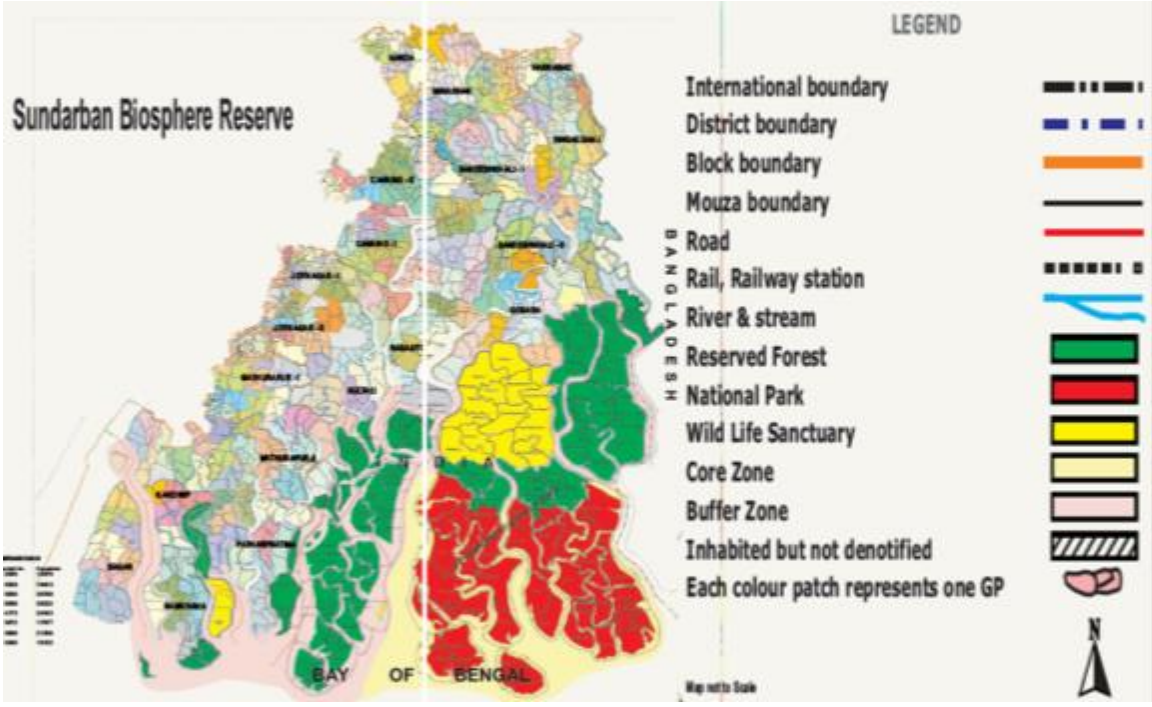
There are forest patches available along the proposed waterway stretch.

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 silts 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.

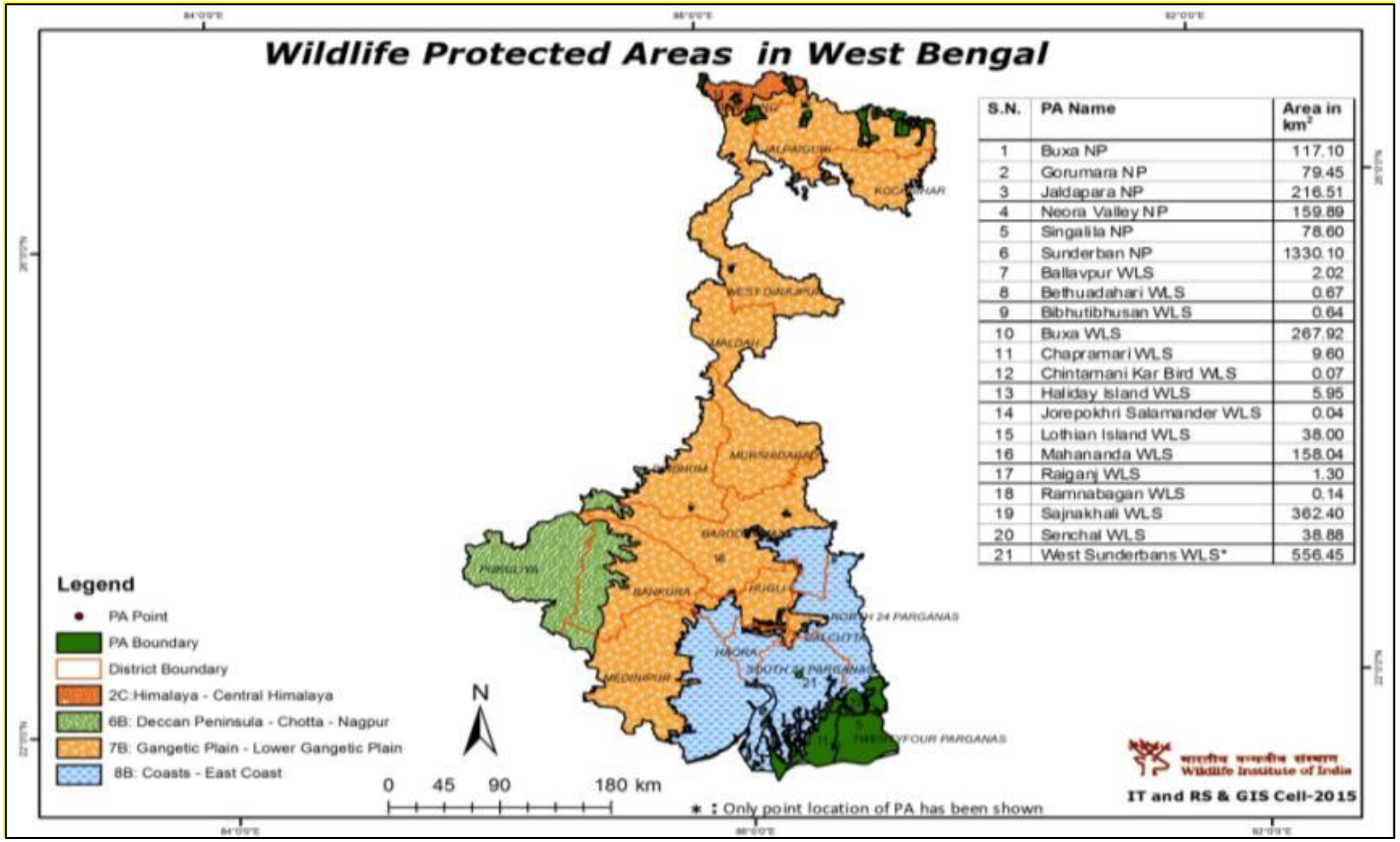
The Sunderban Biosphere Reserve is located at a distance of 30 Km from the start point of Waterway section. The Map of Sunderban Biosphere Reserve is furnished in **Figure 59**.



Source : WWF-India

Figure 59: 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 60**.



Source : Wildlife Institute of India

Figure 60: 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 43**.

Table 43: 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 Matla River has been listed in the **Table 44** along with population details as per Census of India Data, 2011.

Table 44: Major settlements/village along the project stretch of Matla River

S. No.	Village/ Town name	Population (nos.)
1	Deulbari Durgapur	7315
2	Kaikhali	6030
3	Gopalganj	7853
4	Laskarpur	2600
5	Kripakhali	614
6	Ananda Abad	3422
7	Modhu Khali	5546
8	Budh Khali	8908
9	Golabari	4896
10	Parandar	2693
11	Garkhali	7339

S. No.	Village/ Town name	Population (nos.)
12	Charanikhali	2316
13	Harbhangi	3023
14	Dabu	3036
15	Uttar Battala	724
16	Amratala	1962
17	Tetultala	446
18	Banibadabela	4930
19	Hincha Khali	3106
20	Naliakhali	1114
21	Nikarighata	3419
22	Dakshin Narayantala	1992
23	Bhagankhali	15127
24	Kathalberia	14113
25	Canning	31320

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 construction and operation of civil interventions, 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 Phase

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

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

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

The total quantity of muck generated due to dredging will be 2,45,038.17 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.

B. IMPACTS ON LAND

The impact associated with the land environment during design and construction phases are as follows:

- Loss of land / land acquisition:

Four ferry ghats along the river located at Kaikhali, Garan Bose No. 1, Madhukhali and at Golabari are proposed for development. These ghats are locally maintained and opearated. It is proposed to develop the area and provide inland water transport facilities like Gangway and Pontoon at these three ferry ghats for passenger embarking and disembarking. No additional land is required to be acquired for terminal construction as the ferry ghats are already operational at the proposed locations. Only upgradation works are required to be done for terminal development.

- 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
- ✓ Water sprinkling to be carried out for dust suppress
- ✓ Dredging soil should be proper utilized as proposed for flood protection measures around the terminal area.

C. <u>IMPACTS ON SOIL</u>

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 Matla 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. <u>IMPACTS ON AIR</u>

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 (PM10), Particulate matters of size less than 2.5µ (PM2.5), Sulphur dioxide (SO_2), Nitrogen oxides (NOx), Carbon monoxide (CO) in the atmosphere.

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.

Vegetations existing at terminal development site will be removed. Bare & loose soil after vegetation uprooting/removal will be exposed to wind and will add on to the concentration of ambient dust levels. Air quality will also be affected in case tree cutting is undertaken at site as the tree act as air purifiers

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
- ✓ Place portable toilets on-site and maintain on a daily basis.
- ✓ 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.
- ✓ As soon as construction is over all the surplus earth will be utilized properly and all loose earth will be removed from the site.
- ✓ Compensatory plantation of trees having adequate canopy should be implemented.

E. IMPACTS ON AMBIENT NOISE AND VIBRATION

The proposed construction activities are expected to increase the noise levels mainly due to plying of construction vehicles, pumping machines, use of portable generators, mechanical machinery etc. These activities will occur round the clock and the noise pollution thus created may affect human habitations, particularly during the night time. Increase of noise level at night may cause discomforts to population in the vicinity of the site in case construction activity is extended into the night hours.

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.
- ✓ Keep adjacent landowners informed of unusually noisy activities planned.
- ✓ 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. <u>IMPACTS ON ECOLOGY AND BIODIVERSITY</u>

The proposed development is situated along the Matla 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. <u>IMPACTS ON RIVER WATER</u>

The impact on water arises due to the following:

- Discharge of sewage and wastewaters from construction sites and camps to surface waters
- Re-suspension of sediments contaminated with heavy metals during the construction of the terminal.
- Risk of accidental spillages of oils, fuels, and other materials

Mitigation Measures:

- ✓ The site surface has been engineered and shaped in such a way that rapid and efficient evacuation of runoff is achieved.
- ✓ Provide containment areas for potential pollutants at construction camps, refueling, depots, asphalt plants and concrete batching plants.
- ✓ Implement waste management practices.
- ✓ Control and manage transport, storage, handling and disposal of hazardous substances.

H. IMPACTS DUE TO LABOUR CAMP

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

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

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

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

Mitigation Measures:

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

- ✓ After completion of construction, the contractor will dismantle the camp and restore it to the original condition of the area before handing over the site to the land owner.

I. <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. <u>IMPACTS ON AIR</u>

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. <u>IMPACTS DUE NOISE AND VIBRATION</u>

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. <u>IMPACTS DUE TO OIL SPILLAGE FROM BARGES AND VESSELS</u>

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

Mitigation Measures:

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

D. IMPACTS ON WATER

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

Mitigation Measures:

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

E. IMPACTS ON FLORA AND FAUNA

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

F. IMPACTS ON HEALTH AND SAFETY

- Danger of operations and maintenance-related injuries.
- Safety of workers and general public must be ensured.
- Poor waste management practices and unhygienic conditions at the improved facilities can breed diseases.

- Standing water due to inadequate storm water drainage systems, inadequate waste management practices, pose a health hazard to providing breeding grounds for disease vectors such as mosquitoes, flies and snails.
- Fire and electrocution hazards in the pumping stations.

Mitigation Measures:

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

G. IMPACTS ON REGIONAL ECONOMY

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

9.4 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

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

9.4.1 Implementation of EMP

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

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

9.4.2 Environmental Management Action Plan

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

Appropriate measures have also been identified for action during various stages of the project, viz, Design and Pre-Construction, Construction and Operational phases. The measures identified for all three phases, are tabulated in **Table 45** 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 45: 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.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• 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.		
2.	Establishment of Construction Camp	• The locations of construction camp to be identified by the Contractor. Construction camps will not be proposed within 500 m from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. Location for stockyards for construction materials will be identified at least 1000m from water sources / and 10 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.	Contractor	Supervision Consultants, IWAI
3.	Establishment of	• Stone crushers, Hot mix plants, WMM	Contractor	Supervision

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Stone crushers, hot-mix plants, WMM Plant, Concrete Batching plants etc.	Plants and Concrete Batching plants will be sited sufficiently away from settlements, agricultural operations and any commercial establishments. Such plants will be located at least 500 m away from the boundary of the nearest village/settlement preferably in the predominant downwind side. • The Contractor shall submit a detailed layout plan for all such sites and approval of the Environmental Expert of Supervision Consultants shall be necessary prior to their establishment. • All plants will be fitted with adequate dust suppression and emission control equipments and facilities. • Specifications of crushers and hot mix plants will comply with the requirements of the relevant current emission control 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.		Consultants, IWAI
4.	Material Sources	• Finalization of material sourcing and all logistic arrangements are well as compliance to environmental requirements, as applicable, will be the	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		sole responsibility of the Contractor		
B.	**CONSTRUCTION PHASE**			
1.	Impact on Soil			
(i)	Soil Erosion	• Maintaining the excavation by Shoring trench sides by placing sheeting, timber shores, trench jacks, bracing, sheet piling materials to resist pressures surrounding the excavation • Exposed surface will be resurfaced and stabilized by making the sloping sides of trench to the angle of repose at which the soil will remain safely at rest • Proper stock piling of excavated soil and must be bordered by berms • Soil erosion checking measures as the formation of sediment basins, slope drains, etc, will be carried out.	Contractor	Supervision Consultants, IWAI
(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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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.		
(iii)	Compaction of soil	• Construction vehicles, machinery and equipment will move, or be stationed in the designated area, to avoid compaction of soil. • If operating from temporarily hired land, it will be ensured that the topsoil for agriculture remains preserved & not destroyed by storage, material handling or any other construction related activities.	Contractor	Supervision Consultants, IWAI
(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	• All spoils will be disposed off as desired and the site will be fully cleaned before	Contractor	Supervision Consultants,

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	construction wastes and spoils	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)		IWAI
2.	Impact on Air			
(i)	Emission from construction vehicles and machinery	• All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms. • The asphalt plants, crushers and the batching plants will be sited at least 500 m in the downwind direction from the nearest human settlement (Boundary of town/village). • Vehicles transporting earth materials will be covered • Mixing equipment will be well sealed and equipped as per PCB norms.	Contractor	Supervision Consultants, IWAI
(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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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		
(iii)	Dust Pollution	• The Contractor will take every precaution to control dust nuisance at all the construction zones and allied sites where works are under progress. • Every equipments and machinery will be 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		dust. • Transportation of loose earth, sand will be done in covered vehicles. • All equipments and machineries will be maintained properly. • Periodical monitoring of fine Particulate Matters (PM_{10} and $PM_{2.5}$) will be carried out as per Environmental Monitoring Plan. • Workers at mixing sites will wear masks to reduce the chances of exposure to fugitive dusts.		
3.	Impact on Noise Pollution			
(i)	Noise from vehicles and construction equipments	The Contractor will confirm the following: • All plants and equipments used in construction shall strictly conform to the 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		will be stopped during the night time between 10.00 pm to 6.00 am. • No noisy construction activities will be permitted around educational institutions/health centers (silence zones) up to a distance of 100 m from the sensitive receptors. • Monitoring shall be carried out at the construction sites as per the monitoring schedule and results will be submitted to Supervision Consultants (SC) and IWAI. • Environmental Expert of SC will be required to inspect regularly to ensure the compliance of EMP.		
4.	Impact on Flora and Fauna	• If required, Vegetation will be removed from the construction zone before 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		disposed off in the waterway • Construction vehicles will run along specified access to avoid accidents to cattle		
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, 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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 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.	Contractor	Supervision Consultants, IWAI
6.	Wastes	• Ensure that no litter, refuse, wastes, rubbish, rubble, debris and builders wastes generated on the premises must	Contractor	Supervision Consultants,

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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		IWAI
7.	Camp Site management	• Contractor will follow all relevant provisions of the Factories Act, 1948 and the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction and maintenance of labour camp. • The location, layout and basic facility provision of each labour camp will be submitted to the Engineer and IWAI prior to their construction. • The construction will commence only upon the written approval of the Engineer.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• 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 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	• The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil	Contractor	Supervision Consultants,

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Monitoring	pollution/contamination in the selected locations as suggested in environmental monitoring plan will be the responsibility of Contractor		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 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	IWAI	IWAI
3.	Noise	• Restrict maintenance activities to reasonable working hours where near sensitive receptors. • Keep adjacent landowners informed of	IWAI	IWAI

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

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 46.**

Table 46: 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 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
Municipal Solid Waste (Management and Handling) Rules	2000	To manage collection transportation, segregation, treatment and disposal of	MOEFCC, GoI, West Bengal State Pollution Control Board	√	..	Applicable for the project for the management of Solid waste

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		municipal 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 Bengal and National Board For Wildlife, GoI.	..	√	This act will not be applicable
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	2000	To regulate and	CPCB; WBSPCB	√	..	This act will be

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
(Regulation and Control) Rules The Noise Pollution (Regulation and Control) Amendment Rules	2006	control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise	& Transport Department; Govt. of West Bengal			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 Archaeological Sites and Remains Act	1958	These Acts are applicable in case any development activity is undertaken in close vicinity of any archaeological site or any are discovered during the construction stage. The Act requires prior authorization of the Archaeological Survey of India (ASI) for development within 300 m of a Protected Property	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	--	√	This act will not be applicable

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
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 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	West Bengal State Coastal Zone Management Authority and MoEF&CC	√	..	CRZ Notification issued for to regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		the coastal areas, sea level rise due to global warming.				

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 47.**

Table 47: 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

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
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	Quarry Lease Deed and Quarry License from State Department of Mines and Geology	Quarry operation	Construction stage (Prior to initiation of Quarrying)	Contractor
5	Environmental Clearance for stone quarry from District Level environmental Impact Assessment Authority,	Opening of new Quarry and Borrow area for earth material	Construction stage (Prior to initiation of Quarrying)	Contractor
6	Permission for extraction of ground water for use in road construction activities from State Ground Water board.	Extraction of ground water	Construction stage (Prior to initiation of installation of Bore wells and abstraction of water from such source)	Contractor
7	Permission for use of water for construction purpose from irrigation department	Use of surface water for construction	Construction stage (Prior to initiation of abstraction of water from such source)	Contractor
8	Labour license from Labour Commissioner Office	Engagement of Labour	Construction stage (Prior to initiation of any work)	Contractor
10	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 48**.

Table 48: 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
2.0	Cost of one Time Baseline Data Generation at Pre-Construction Stage	One season cost (**Table 49**)	10.79
3.	Public consultation meeting (PCM)	Lump Sum	2.00
4.	Surveys/ Reports / Document Printing	Lump Sum	5.00
5.	Travelling Cost for Site Visits	Lump Sum	3.00
6.	Lodging & Boarding Cost	Lump Sum	5.00
7.	Cost for collection of metrological data and other information like Maps etc.	Lump Sum	2.00
	Total		**57.79**

Table 49: 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.	3 (Twice a week for twelve week): 72 Nos.	10000	7.2
2.	Surface Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K,	Grab Sampling	No.	2	8000	0.16
3.	Ground Water Quality Monitoring		Grab Sampling	No.	2	8000	0.16

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
		Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.					
4.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	No.	3	4000	0.12
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.		2	7500	0.15
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.	2	150000	3.0
	Sub-Total						**10.79**

b) Estimated cost at construction Stage:

Table 50: 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 51**	23.56
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			**44.56**

Table 51: 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 (3 locations in the interval of once in two month for 2 years) **Break up: 3 Locations X 6 times X 2 Years = 36**	No.	36	10,000	3.6
2.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (3 locations in the interval of once in two month for 2 years) **Break up: 3 Locations X 6 times X 2 Years = 36**	No.	36	4,000	0.64
3.	Monitoring of River water Quality (2 locations in the interval of once in two months for 2 years during HFL and LFL) **Break up: 2 Locations X 6 times X 2 Years X 2 (HFL&LFL) = 48**	No.	48	8000	3.84
4.	Monitoring of ground water (2 locations in the interval of of once in two months for 2 year) **Break up: 2 Locations X 6 times X 2 Year = 24**	No.	24	8000	1.92

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
5.	Soil Quality monitoring (1 location along the Bank of River and 1 location at Construction site for once in six month for 2 year) **Break up: 2 Locations X 2 times X 2 Year = 8**	No.	8	7,500	0.60
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 (2 locations in the interval of once in six month for two year) **Break up: 2 Locations X 2 times X 2 Years = 8**	No	8	150000	12.0
Sub-Total					**23.56**

c) **Estimated cost during operation Stage**

Table 52: 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 53**	4.875
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			**25.875**

Table 53: 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 (2 locations interval of 3 months for 1 year during HFL and LFL) **Break up: 2 Locations X 4 times X 1 Years X 2 (HFL&LFL) = 16**	No.	16	10000	1.6
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					**4.875**

The total estimated Environmental cost for the project is given in **Table 54**.

Table 54: Estimated Environmental and Social Cost for the Project

Sl. No.	Project Stages	Cost (Lakh INR.)
1.	Pre-Construction Stage	57.79
2.	Construction Stage	44.56
3.	Operational Stage	25.875
Total Estimated Budget (*Except Statutory Fee*)		**128.225**

10.0 INSTITUTIONAL REQUIREMENTS

In view of collective development of NW-97 (Sunderbans waterways), and the proposed infrastructure development along Matla waterway, it is recommended that the development of Matla waterway shall be handled by Project Management Unit (PMU) proposed for development of Hogla waterway, under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata. Accordingly, the cost of development of Institutional requirement is considered in Hogla 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:

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

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

Matla waterway is proposed to be developed as Class VII. The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) Cost of jetties and proposed facilities
c) Vessel Cost
d) EMP cost.

11.3 CAPITAL EXPENDITURE

The expenses expected to be incurred in construction and development of the waterway, terminal structures including jetties and procurement of vessels are considered as capital expenditure. The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies is provided in **Table 55**.

Table 55: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
	Phase - 1		
1.0	Capital cost for Fairway Development		490.08
2.0	Capital cost for ferry service facilities	**Table 29**	294.79
3.0	Capital Cost for 3 Passenger ferry Vessels	**Table 33**	105.00
4.0	Capital Cost for Aids to Navigation and Communication	**Table 37**	56.65
5.0	Cost allotted for EMP	**Table 54**	102.35
	Total Capital Cost – Phase 1		**1,048.86**
	Phase – 2 (In 10th year of IWT operations on the basis of actual traffic growth)		
6.0	Capital Cost for additional One (1) Passenger ferry Vessels		**35.00**
	Phase – 3 (In 20th year of IWT operations on the basis of actual traffic growth)		
7.0	Capital Cost for additional five (5) Passenger ferry Vessels		**175.00**

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 56** as below:

Table 56: Summary of annual O & M Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
	Phase - 1		
1.0	O&M cost for Fairway Development		49.01
2.0	O&M cost for Terminals		8.84
3.0	O&M Cost for Vessels	**Table 35**	52.23
4.0	O&M Cost for Aids to Navigation and Communication		5.67
5.0	EMP Cost during operation stage	**Table 54**	25.88
	Total Capital Cost – Phase 1		**141.62**

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
	Phase – 2 (From 10th year onwards)		
6.0	O&M Cost for additional One (1) Passenger ferry Vessel		**17.27**

11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 1 years, the phasing of expenditures has been established during construction period. The detail of cost repartition during construction period is provided in **Table 57** and also shown in **Figure 61** below.

Table 57: Phasing of Expenditure

Months >	M1 – M3	M4 – M6	M7 – M9	M10 – M12
Total Cash Flow INR Lakh	157.33	314.66	314.66	262.22
% of Cash Flow	15%	30%	30%	25%

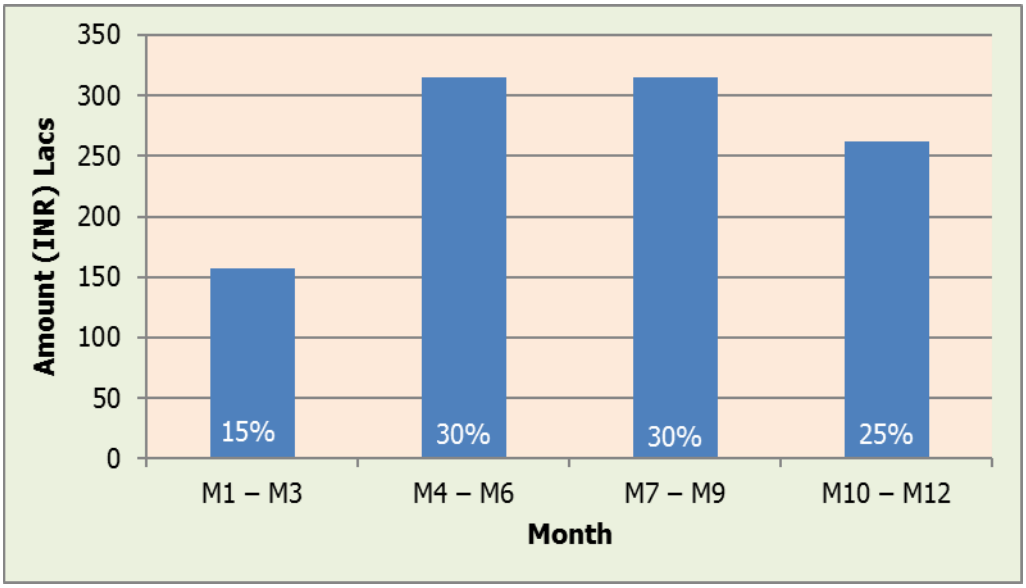


Figure 61: Phasing of Expenditure

12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of Matla 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 time schedule for construction activities of the project is considered as one (1) year. The proposed project schedule is provided in **Figure 62** as below**.**

Sl. No.	Activities	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
1	Approval of DPR and Project Financial Closure				
2	Environmental, Forest and CRZ clearances				
3	Fairway development				
a)	Procurement of Hardware and other equipment's				
b)	Capital Dredging				
4	Procurement and installation of Aids to Navigation				
5	Construction/ Installation of Pontoon and Gangway				
6	Upgrading existing road to terminals				

Figure 62: 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 Matla waterway include both the construction of offshore and onshore facilities, apart from installation of mechanical and electrical equipment's.

The offshore facilities includes development of pontoon, gangway, approach platform and dredging whereas the development of onshore facilities includes site development, construction of terminal building and providing utilities like water supply system, sewerage system, storm water drainage system and firefighting facility.

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 of construction, 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 Matla waterway project, which involves engineering, procurement, construction and commencement of operational activities.

<u>Pre Construction activities:</u>

- Detailed Engineering;
- Environmental clearance (if any);
- Financial closure and Statutory approvals from all concerned authorities as per Para 9.5;
- Land acquisition and site development;

<u>Construction activities</u>:

- Construction of onshore facilities for ferry terminal;
- Construction of offshore facilities for ferry terminal;
- Procurement of vessels;
- Up gradation/construction of access roads;

- Supply, installation and commission of electrical and mechanical equipment's.

Post Construction activities:

Defect Liability period.

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. In this chapter, the financial and economic viability for development of Matla Waterway is worked out.

13.1 REVENUE

An attempt has been made to estimate the possible revenue available from this service. Although this has been calculated in a thorough and logical manner the study is based on many assumptions and it should therefore be taken as a guide to the magnitude of possible revenue. Downtime of 2 months is considered, which could be occurred due to weather, operational or other factors. Hence, it is assumed that the full service is operating for 300 days annually. The techno-economic model has been run with the following considerations as stated below:

a) Passenger Ferry services - passenger ferry vessels of 25 pax capacity operating 6:00 AM to 6:00 PM.
b) Number of days of operation – 300 days.
c) OD pair links -
    1. OD pair 1) - Garan Bose no.1 – Madhukhali – Basanti/Sonakhali, and
    2. OD pair 2) - Golabari – Basanti/Sonakhali
d) One-way trip length –
    1. OD pair 1) – 9.8 Km, and
    2. OD pair 2) – 8.0 Km
e) For revenue estimation, present daily passenger traffic in the proposed OD pair are considered as below:
    1. OD pair 1) - 250 passengers, and
    2. OD pair 2) - 100 passengers

The revenue for passenger ferry services for both the OD pairs has been worked out by considering the variable tariff from INR 1.00 per person per Km onwards as per following formula:

$$\text{Revenue (INR)} = T \times L \times (1+R)^{Y} \times P \times D$$

where;

T = Proposed tariff in INR/Km/pax

L = OD Pair length in Km

R = Incremental rate of tariff in %, assuming at 8% per year on the basis of CPI Index of last 2 years
Y = Year of service from start date of operation
P = Peak Passenger traffic per day in a year
D = Days of operation per year, considering as 300 days per year.

13.2 FINANCIAL ANALYSIS/ FIRR

The introduction of the IWT will yield tangible and non-tangible saving due to equivalent reduction in road traffic and certain socio-economic benefits. These include saving in road construction and maintenance, vehicle operation costs, travel time and other socio-economic benefits of travel time, better accessibility, better comfort and quantity of life, increase in mobility etc. The direct and indirect benefits of the project are following:

- Reduced road stress.
- Better accessibility to facilities in the influence area.
- Economic stimulation in the micro region of the infrastructure.
- Increased business opportunities.
- Overall increased mobility.
- Facilitating better planning and up-gradation of influence area.
- Saving in vehicle operating costs of buses and other vehicles that are using the existing transport network after the IWT is introducing due to decongestion effect on road stress.
- Saving in time of passenger of existing modes, because of reduced congestion on road.
- Saving on account of reduction of vehicular pollution.

The financial analysis of the project is done on the basis of estimated cost proposed to be incurred for construction/development of fairway, terminal and procurement of vessels including other miscellaneous expenses, O& M cost proposed to be incurred during proposed project life cycle of 20 years and revenue that could be generated. The implementation of this project has been conceptualized as Government funded project. However, the FIRR for proposed waterway is done with following options:

Option 1: Total Capital Cost + Total O&M cost
Option 2: Option 1 - Vessel Capital & O&M cost
Option 3: Vessel Capital Cost + Vessel O&M Cost.

The Financial analysis for all the above options are worked out and provided in **Table 58** to **Table 60.**

Table 58: FIRR (Option 1: Total Capital Cost + Total O&M cost)

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
-1	1049		1049	0	-1049	0	-1049	0	-1049	0	-1049	0	-1049
0		142	142	11	-131	32	-110	53	-89	74	-68	95	-47
1		149	149	12	-136	37	-112	61	-87	86	-63	111	-38
2		156	156	14	-142	43	-113	72	-85	100	-56	129	-27
3		164	164	17	-147	50	-114	84	-80	117	-47	150	-14
4		172	172	19	-153	58	-114	97	-75	136	-36	175	3
5		181	181	23	-158	68	-113	114	-67	159	-22	205	24
6		190	190	27	-163	80	-110	133	-57	186	-4	239	49
7		199	199	31	-168	93	-106	155	-45	217	17	278	79
8		209	209	36	-173	108	-101	180	-29	253	43	325	115
9		220	220	42	-178	126	-93	210	-9	295	75	379	159
10	35	231	266	49	-217	147	-118	245	-20	344	78	442	176
11		259	259	57	-202	172	-88	286	27	401	141	515	256
12		272	272	67	-206	200	-72	334	61	467	195	601	328
13		286	286	78	-208	234	-52	389	103	545	259	701	415
14		300	300	91	-210	273	-28	454	154	636	336	818	517
15		315	315	106	-209	318	2	530	214	742	426	954	638

Year	Capital Cost (INR Lakh)	O&M (INR Lakh)	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
16		331	331	124	-208	371	40	618	287	865	534	1112	781
17		348	348	144	-204	432	85	721	373	1009	661	1297	950
18		365	365	168	-197	504	139	841	476	1177	812	1513	1148
19		383	383	196	-187	588	205	981	597	1373	989	1765	1382
20	175	403	578	229	-349	686	109	1144	566	1601	1024	2059	1481
FIRR					**#NUM!**		**-9.78%**		**3.18%**		**8.83%**		**12.81%**

Table 59: FIRR (Option 2: Option 1 - Vessel Capital & O&M cost)

Year	Capital Cost	O&M	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
-1	944		944		-944		-944		-944		-944		-944
0		89	89	11	-79	32	-58	53	-37	74	-16	95	5
1		94	94	12	-82	37	-57	61	-32	86	-8	111	17
2		99	99	14	-84	43	-56	72	-27	100	2	129	30
3		103	103	17	-87	50	-53	84	-20	117	13	150	47
4		109	109	19	-89	58	-50	97	-11	136	28	175	67
5		114	114	23	-91	68	-46	114	0	159	45	205	91
6		120	120	27	-93	80	-40	133	13	186	66	239	119
7		126	126	31	-95	93	-33	155	29	217	91	278	153
8		132	132	36	-96	108	-24	180	48	253	120	325	193
9		139	139	42	-97	126	-12	210	72	295	156	379	240
10		146	146	49	-97	147	2	245	100	344	198	442	296
11		153	153	57	-96	172	19	286	133	401	248	515	362
12		161	161	67	-94	200	40	334	173	467	307	601	440
13		169	169	78	-91	234	65	389	221	545	377	701	532
14		177	177	91	-86	273	96	454	277	636	459	818	641
15		186	186	106	-80	318	132	530	344	742	556	954	768

Year	Capital Cost	O&M	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
16		195	195	124	-72	371	176	618	423	865	670	1112	917
17		205	205	144	-61	432	228	721	516	1009	804	1297	1093
18		215	215	168	-47	504	289	841	626	1177	962	1513	1298
19		226	226	196	-30	588	362	981	755	1373	1147	1765	1539
20		237	237	229	-8	686	449	1144	907	1601	1364	2059	1822
FIRR					**#NUM!**		**1.78%**		**9.06%**		**13.70%**		**17.35%**

Table 60: FIRR (Option 3: Vessel Capital Cost + Vessel O&M Cost)

Year	Capital Cost	O&M	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
-1	105		105.00		-105		-105		-105		-105		-105
0		52	52.23	11	-42	32	-21	53	0	74	21	95	43
1		55	54.84	12	-43	37	-18	61	7	86	31	111	56
2		58	57.58	14	-43	43	-15	72	14	100	43	129	71
3		60	60.46	17	-44	50	-10	84	23	117	57	150	90
4		63	63.49	19	-44	58	-5	97	34	136	73	175	112
5		67	66.66	23	-44	68	2	114	47	159	92	205	138
6		70	69.99	27	-43	80	10	133	63	186	116	239	169
7		73	73.49	31	-43	93	19	155	81	217	143	278	205
8		77	77.17	36	-41	108	31	180	103	253	175	325	248
9		81	81.03	42	-39	126	45	210	129	295	214	379	298
10	35	85	120.08	49	-71	147	27	245	125	344	223	442	322
11		107	106.60	57	-49	172	65	286	180	401	294	515	409
12		112	111.93	67	-45	200	88	334	222	467	355	601	489
13		118	117.53	78	-40	234	116	389	272	545	428	701	583

Year	Capital Cost	O&M	Total Outflow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)	Total Revenue (INR Lakh)	Net Cash Flow (INR Lakh)
				Tafiff INR 1.00 /pax/Km		Tafiff INR 3.00 /pax/Km		Tafiff INR 5.00 /pax/Km		Tafiff INR 7.00 /pax/Km		Tafiff INR 9.00 /pax/Km	
14		123	123.40	91	-33	273	149	454	331	636	513	818	694
15		130	129.57	106	-24	318	188	530	400	742	612	954	824
16		136	136.05	124	-12	371	235	618	482	865	729	1112	976
17		143	142.86	144	1	432	290	721	578	1009	866	1297	1155
18		150	150.00	168	18	504	354	841	691	1177	1027	1513	1363
19		157	157.50	196	39	588	431	981	823	1373	1215	1765	1608
20	175	165	340.37	229	-112	686	346	1144	803	1601	1261	2059	1718
FIRR					**#NUM!**		**18.20%**		**33.85%**		**49.47%**		**66.42%**

From the above analysis with various options it is concluded that the passenger ferry services in the waterway is financially viable in all cases for fare of INR 5.0 per passenger per Km and above for proposed OD pairs. However, it would be better that the implementation of the whole project may be taken up as two packages:

Package – 1 : Construction, Operation & Maintenance of fairway and jetties
Package – 2 : Procurement, operation & maintenance of Ferry Vessel

13.3 ECONOMIC ANALYSIS / EIRR

The economic analysis for proposed IWT in Matla waterway is done on all the above scenarios discussed in financial analysis section.

In addition to above, economic benefit foreseen due to factors like reduction in pollution and accidents, carbon savings is considered for economic analysis. For the analysis following assumptions were made:

a) Road haulage cost: INR 2.0/Ton-Km
b) Road accident cost saving: INR 0.2/Ton-Km
c) Carbon savings: INR 0.1/Ton-Km transferred from road
d) Annual incremental economic benefit: 1%

Passenger ferry services are already operational from above proposed jetty locations, however a proposal for safe and efficient ferry services along with necessary infrastructure services are made in this DPR. Hence economic benefit due to road and rail haulage cost saving, road accident cost savings and carbon savings is not considered for economic evaluation for passenger ferry services. Also, as the ferry operations are currently active along the proposed fairway route, saving in fuel cost due to IWT operation is not foreseen. Benefit due to job creation is only considered for economic analysis of passenger ferry services. The economic benefit analysis with tariff of INR 5.0 per person per km for proposed OD pairs for all the three (3) options is provided in **Table 61**.

Table 61: EIRR from IWT

Year	Economic Benefit (INR Lakh)	Option-1		Option-2		Option-3	
		Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)	Financial Income (INR Lakh)	Total Income (INR Lakh)
-1		-1049	-1049	-944	-944	-105	-105
0	10	-89	-79	-37	-26	0	11
1	10	-87	-77	-32	-22	7	17
2	10	-85	-74	-27	-16	14	24
3	11	-80	-70	-20	-9	23	34
4	11	-75	-64	-11	-1	34	45
5	11	-67	-56	0	10	47	58
6	11	-57	-46	13	24	63	73
7	11	-45	-34	29	40	81	92
8	11	-29	-18	48	59	103	114
9	11	-9	2	72	83	129	141
10	11	-20	-9	100	111	125	137
11	15	27	42	133	148	180	194
12	15	61	76	173	188	222	237
13	15	103	118	221	236	272	287
14	15	154	169	277	293	331	346
15	15	214	230	344	359	400	416
16	16	287	302	423	438	482	498
17	16	373	389	516	532	578	594
18	16	476	492	626	642	691	707
19	16	597	613	755	771	823	839
20	16	566	582	907	923	803	820
EIRR			**3.91%**		**9.77%**		**38.31%**

From the the above table, it is concluded that Matla waterway is economically viable for all the three options.

13.4 SENSITIVITY ANALYSIS

Sensitivity analysis shows the uncertainty in the output values for different sources of uncertainty in its inputs. The financial and economic evaluation of proposed IWT operations in waterway depends on factors like, fuel cost, demand ratio of IWT, serviceability and operational days in a year. These fluctuations will have a dramatic effect on the profitability of IWT.

Sensitivity analysis of IWT on proposed waterway is carried out for varying fare for passenger ferry services and considering the basic operational and serviceability conditions as same. For varying fare for passenger ferry services, the change in FIRR and EIRR is shown in **Table 62.**

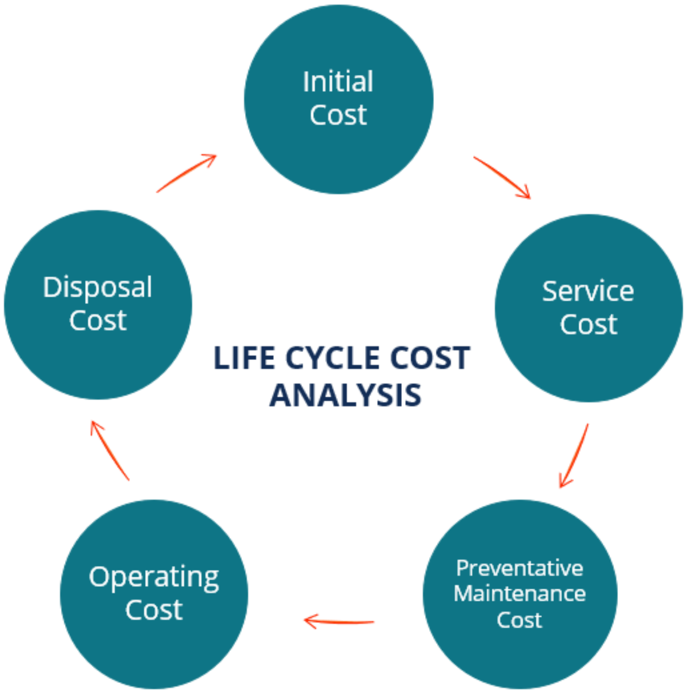
Table 62: Sensitivity Analysis w.r.t to varying IWT fare

Sr. No.	Fare (INR) per passenger per KM	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
		FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)	FIRR (%)	EIRR (%)
1	1.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable	Not Calculable
2	2.00	Not Calculable	Not Calculable	-5.68%	-4.07%	7.74%	11.18%
3	3.00	-9.78%	-8.05%	1.78%	2.75%	18.20%	21.61%
4	4.00	-1.27%	-0.34%	5.99%	6.78%	26.27%	30.12%
5	5.00	3.18%	3.91%	9.06%	9.77%	33.85%	38.31%
6	6.00	6.33%	6.96%	11.56%	12.21%	41.51%	46.62%
7	7.00	8.83%	9.41%	13.70%	14.33%	49.47%	55.22%
8	8.00	10.95%	11.50%	15.61%	16.21%	57.78%	64.09%
9	9.00	12.81%	13.34%	17.35%	17.94%	66.42%	73.19%
10	10.00	14.49%	15.01%	18.96%	19.55%	75.33%	82.48%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the proposed IWT operation along Matla waterway is financially and economically viable for all the three options with a tariff of INR 5.0 per passenger per Km and above for the proposed OD pairs.

13.5 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 Matla 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. Revenue generated with proposed tariff of INR 5.0 per passenger per Km has been considered in the analysis.

Comparative analysis of life cycle cost for the three options as stated in financial and economical analysis is done and presented in below **Table 63**.

Table 63: Project Life Cycle Cost

Year	Option-1: Total Capital Cost + Total O&M cost		Option-2: Option 1 - Vessel Capital & O&M cost		Option-3: Vessel Capital Cost + Vessel O&M Cost	
	Outflow (INR Lacs)	Inflow (INR Lacs)	Outflow (INR Lacs)	Inflow (INR Lacs)	Outflow (INR Lacs)	Inflow (INR Lacs)
-1	1,049	-	944	-	105	-
0	142	63	89	63	52	63
1	149	72	94	72	55	72
2	156	82	99	82	58	82
3	164	94	103	94	60	94
4	172	108	109	108	63	108
5	181	124	114	124	67	124
6	190	143	120	143	70	143
7	199	166	126	166	73	166
8	209	191	132	191	77	191
9	220	222	139	222	81	222
10	266	257	146	257	120	257
11	259	301	153	301	107	301
12	272	349	161	349	112	349
13	286	405	169	405	118	405
14	300	470	177	470	123	470
15	315	545	186	545	130	545
16	331	634	195	634	136	634
17	348	737	205	737	143	737
18	365	857	215	857	150	857
19	383	997	226	997	157	997
20	578	1,160	237	1,160	340	1,160
Total	**6,535**	**7,975**	**4,137**	**7,975**	**2,398**	**7,975**

On the basis of above LCCA, Financial chart and breakeven for all the 3 options are presented in **Figure 63** to **Figure 65**. For 20 years of project life cycle with a tariff of INR 5.0 per passenger per Km, following is concluded:

Option 1: Total Capital Cost + Total O&M cost

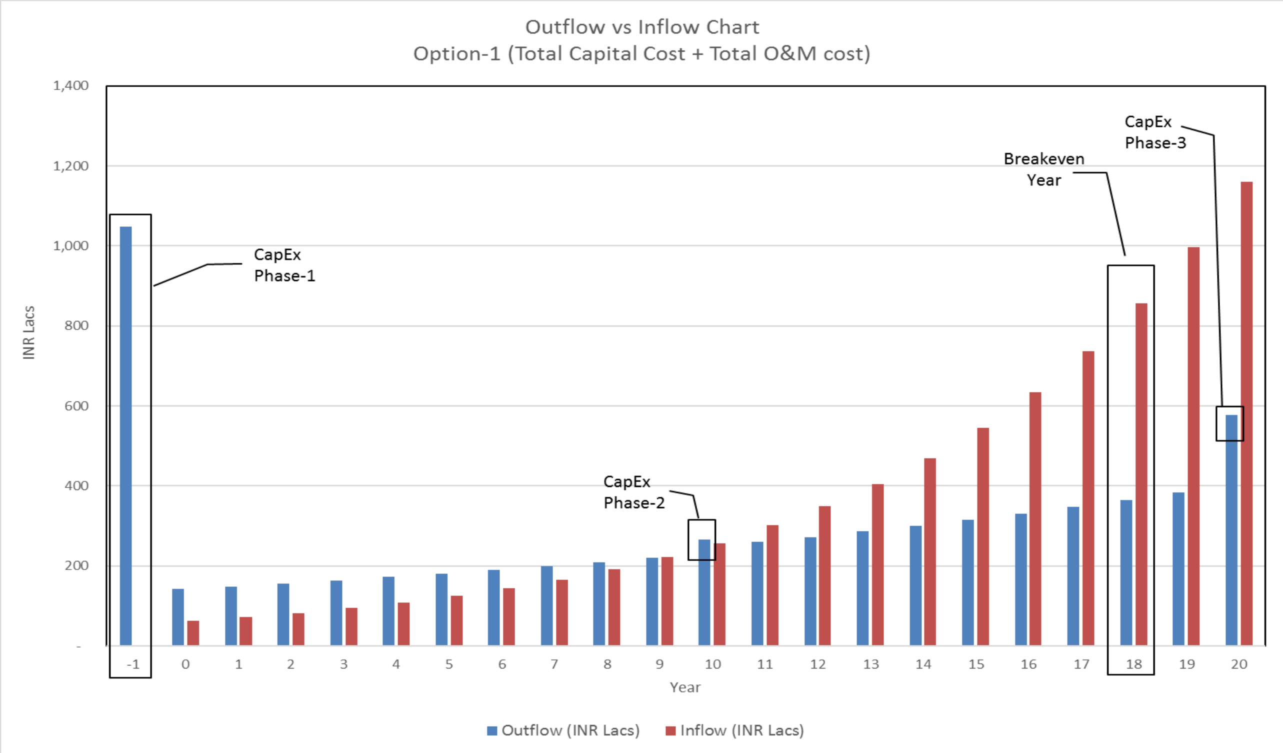
With project life cycle cost of INR 6,535 Lacs, the breakeven occurs during 18th year of operation.

Option 2: Option 1 - Vessel Capital & O&M cost

With project life cycle cost of INR 4,137 Lacs, the breakeven occurs during 13th year of operation.

Option 3: Vessel Capital Cost + Vessel O&M Cost

With project life cycle cost of INR 2,398 Lacs, the breakeven occurs during 3rd year of operation.



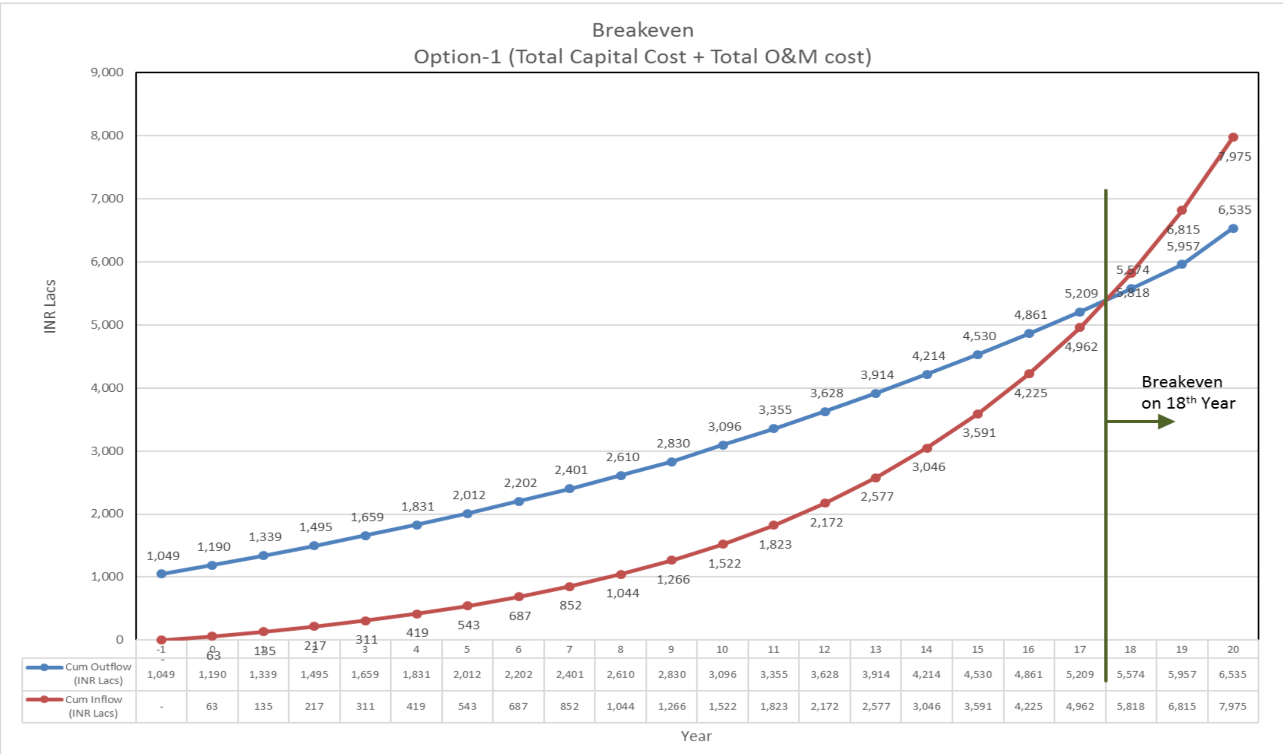
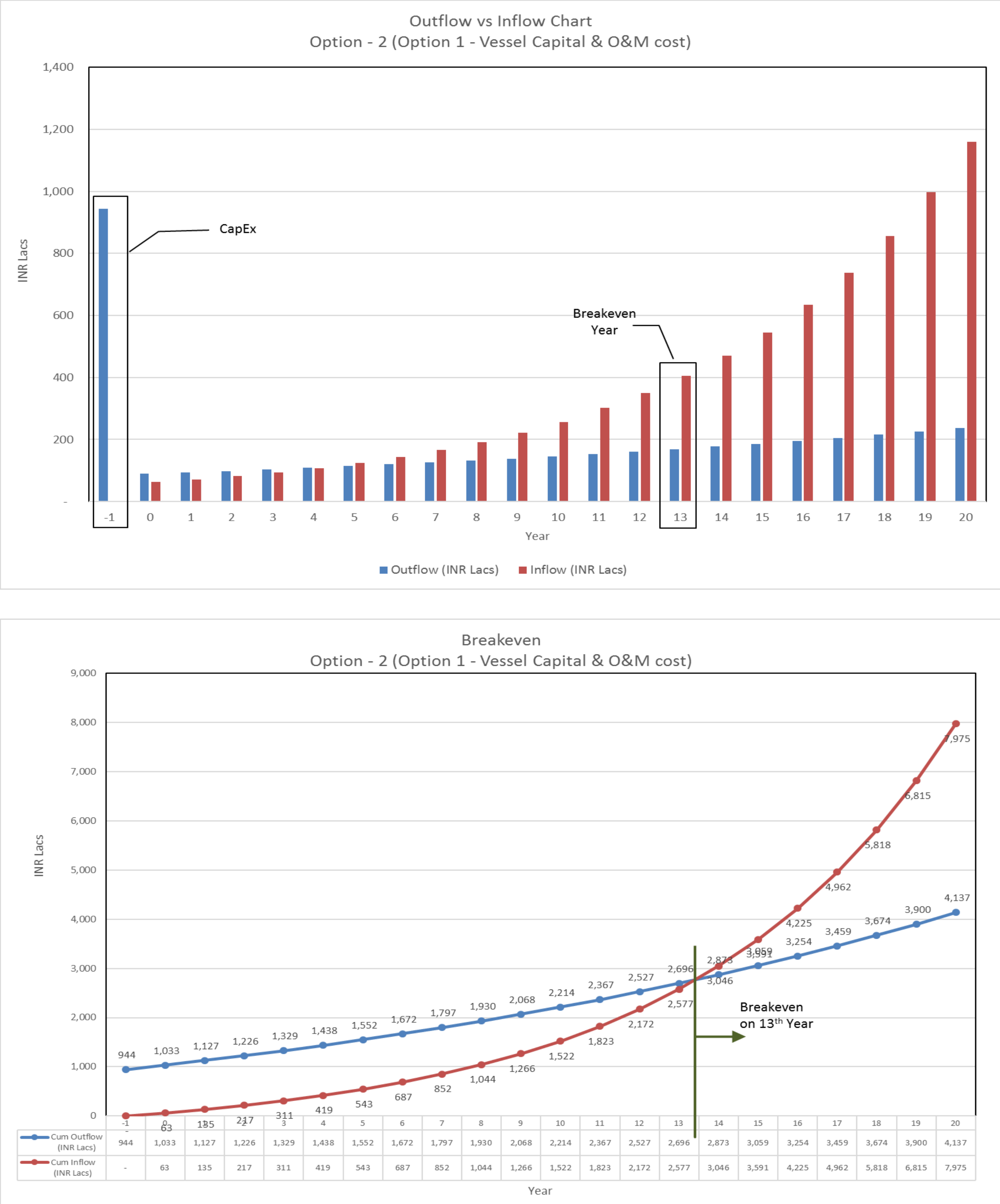
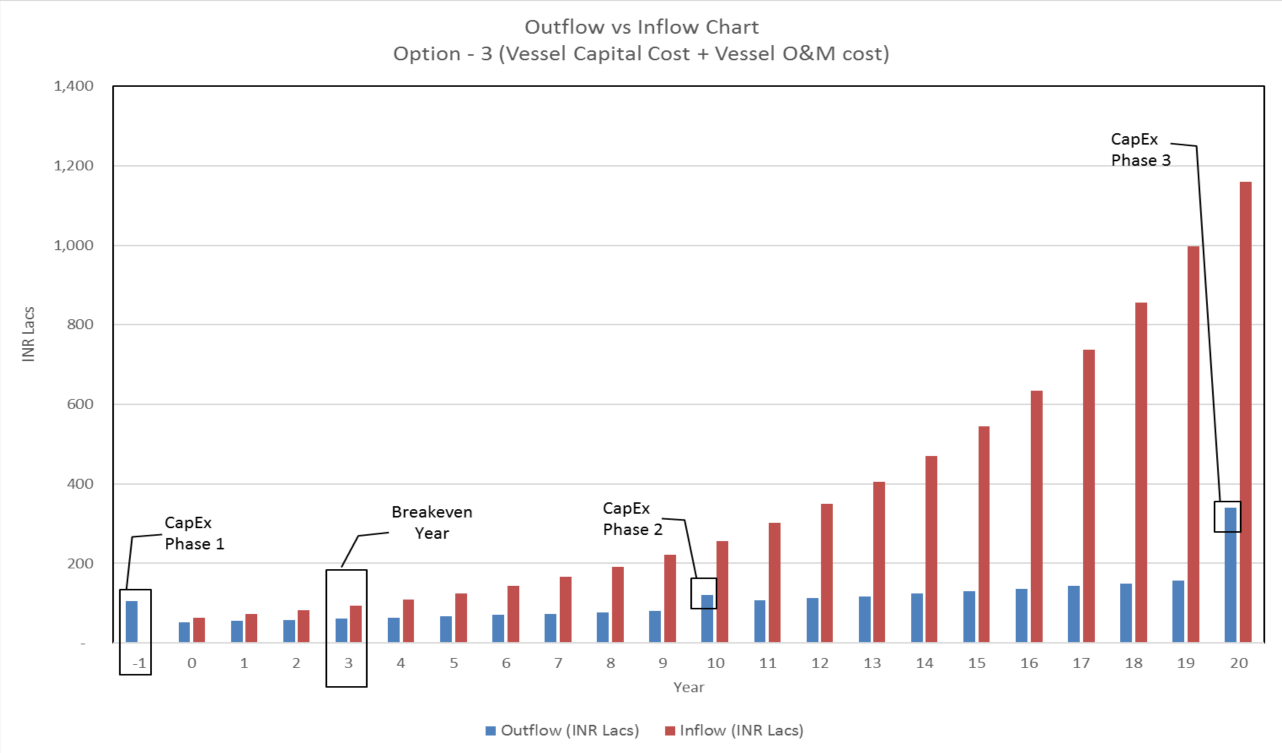


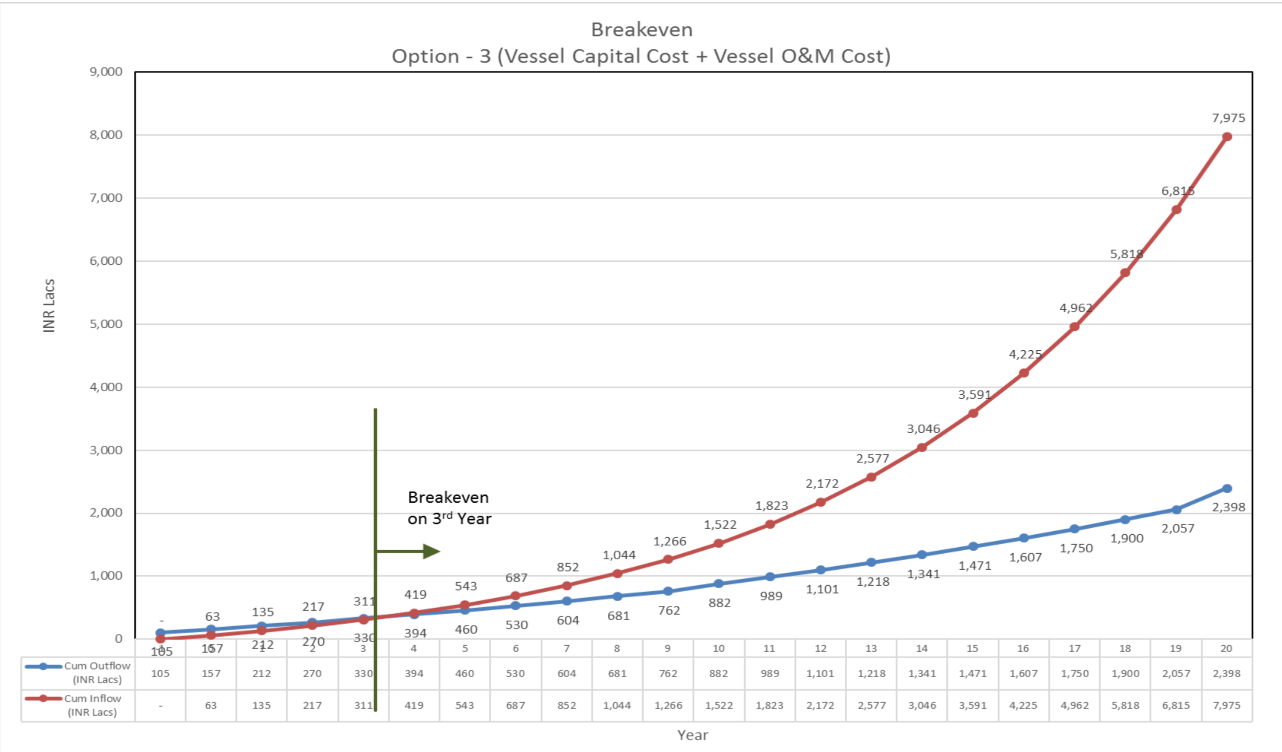
Figure 63: Financial (Outflow vs Inflow) Chart and Breakeven – Option 1



Year	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cum Outflow (INR Lacs)	944	1,033	1,127	1,226	1,329	1,438	1,552	1,672	1,797	1,930	2,068	2,214	2,367	2,527	2,696	2,873	3,059	3,254	3,459	3,674	3,900	4,137
Cum Inflow (INR Lacs)	-	63	135	217	311	419	543	687	852	1,044	1,266	1,522	1,823	2,172	2,577	3,046	3,591	4,225	4,962	5,818	6,815	7,975

Figure 64: Financial (Outflow vs Inflow) Chart and Breakeven – Option 2





	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cum Outflow (INR Lacs)	105	157	212	270	330	394	460	530	604	681	762	882	989	1,101	1,218	1,341	1,471	1,607	1,750	1,900	2,057	2,398
Cum Inflow (INR Lacs)	-	63	135	217	311	419	543	687	852	1,044	1,266	1,522	1,823	2,172	2,577	3,046	3,591	4,225	4,962	5,818	6,815	7,975

Figure 65: Financial (Outflow vs Inflow) Chart and Breakeven – Option 3

13.6 RISK FACTORS AND MITIGATION

Environmental and social risk involved in construction and operational stage of the project including their mitigation measures are discussed and provided in detail in Chapter 9.0 above. Other minor risks foreseen at this stage of the project for successful implementation and execution of the project are provided as below:

a) Dependency on inter-modality –

Integrated road transport connectivity is required for passenger ferry services.

13.7 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.

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) By taking into advantage of tidal window, sufficient LAD is available in the complete 98.731 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation.
b) About 11.50 km stretch of Matla river from Lot No. 121 to Kaikhali lies in the Indo Bangladesh Waterway Protocol Route.
c) Proposed Matla waterway is also connected with Bidya and Hogla national waterways.
d) Large cargo vessels navigating along Indo Bangladesh Protocol Route uses Matla river from Lot No. 121 to Kaikhali.
e) There are no big industries ocated along the hinterland, however a few brick kilns are found along the river banks.
f) Passenger ferry vessels are operational along the waterway by locals.
g) 45 Km stretch of Matla waterway is recommended for development as per Class VII, serving the proposed terminals, Indo-Bangladesh Waterway protocol route, Bidya and Hogla national waterways.

The waterway is proposed to be developed for Class VII, with 4 ferry ghats with Pontoon and Gangway facilities and 3 passenger ferry vessels at the inception stage. Garan Bose no. 1, Madhukhali and Golabari ferry ghats are proposed to be developed for providing ferry service link to Basanti and Sonakhali ferry ghats. Kaikhali ferry ghat is proposed to provide additional support to vessels plying along India Bangladesh protocol route and to support tourism traffic for Sunderbans Reserve Forest area. The capital cost for development of the system components of the project viz., development of the designed waterway, construction of facilities for passenger ferry services and purchasing of vessels has been worked out as INR 1,048.86 Lakh with 3 vessels. In 10th year of operation, capital cost of purchasing additional 1 vessel is INR 35.00 Lakh and in 20th year of operation, capital cost of purchasing additional 5 vessels are INR 175.00 Lakh. The additional vessels shall be purchased on the basis of growing traffic demand. Corespondignly O&M cost for Matla waterway works out to INR 141.62 Lakh from inception stage. For additional vessel, O&M cost from 11th year onwards works out to INR 17.27 Lakh.

The cost benefit analysis, calculations done for financial internal rate of return (FIRR) and Economic internal rate of return (EIRR) concludes that the project is financially and economically viable with a tariff of INR 5.00 per passenger per Km and above for the proposed OD pairs, in case the project is implemented in a single package. However, in case the project is implemented in separate packages as shown below, the tariff can be reduced accordingly.

Package – 1 : Construction, Operation & Maintenance of fairway and jetties

Package – 2 : Procurement, operation & maintenance of Ferry Vessel

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	√		It is along the Project River
b) Wildlife/ Bird Sanctuary	√		It is along 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	√		Forest patches are available along the study stretch of the river
f) Wetland		√	
g) Important Bird Areas		√	
h) Mangroves Areas	√		Within the stretch mangrove species are present
i) Estuary with Mangroves	√		
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration	√		
k) World Heritage Sites	√		Sundarbans World Heritage site
l) Archeological monuments/ sites (under ASI's Central / State list)		√	
2. Is the project located in whole or part in /near any Critically Polluted Areas identified by CPCB?		√	
3. Is, there any defense installations near the project site?		√	
4. Whether there is any Government Order/ Policy relevant / relating to the site?		√	
5. Is the project involved clearance of existing land, vegetation and buildings?	√		
6. Is the project involved dredging?	√		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)	√		Prone to Flood, Cyclones and heavy winds

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	No
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	No
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 costruction period

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
34	*Thespesia populnea*	Paras	Mangrove associate

Mangroves and associates			
Sl. no.	**Scientific name**	**Local name**	**Remarks**
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
69	*Barringtonia racemosa*	Hijal	Fresh water Mangrove

Mangroves and associates			
Sl. no.	**Scientific name**	**Local name**	**Remarks**
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*

Sl. No.	Name	Scientific Name	IUCN Status
31	Common Blind snake	*Typhlops braminus*	-
32	Indian Rock Python	*Python molurus*	*Vulnerable*
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 2. Common Quail - Coturnix coturnix 3. Rain Quail - Coturnix coromandelica 4. Blue-breasted Quail - Coturnix chinensis 5. Red Junglefowl - Gallus gallus 6. Lesser Whistling-duck - Dendrocygna javanica 7. White-headed Duck - Oxyura leucocephala 8. Greylag Goose - Anser anser 9. Bar-headed Goose - Anser indicus 10. Ruddy Shelduck - Tadorna ferruginea 11. Common Shelduck - Tadorna tadorna 12. Comb Duck - Sarkidiornis melanotos 13. Cotton Pygmy-goose - Nettapus coromandelianus 14. Gadwall - Anas strepera 15. Falcated Duck - Anas falcata 16. Eurasian Wigeon - Anas penelope 17. Mallard - Anas platyrhynchos 18. Spot-billed Duck - Anas poecilorhyncha 19. Common Teal - Anas crecca 20. Garganey - Anas querquedula 21. Northern Pintail - Anas acuta 22. Northern Shoveler - Anas clypeata 23. Red-crested Pochard - Rhodonessa rufina 24. Common Pochard - Aythya ferina 25. Ferruginous Pochard - Aythya nyroca 26. Baer's Pochard - Aythya baeri 27. Tufted Duck - Aythya fuligula 28. Greater Scaup - Aythya marila 29. Red-breasted Merganser - Mergus serrator 30. Eurasian Wryneck - Jynx torquilla 31. Speckled Piculet - Picumnus innominatus 32. Rufous Woodpecker - Celeus brachyurus 33. Brown-capped Pygmy Woodpecker - Dendrocopos nanus 34. Fulvous-breasted Woodpecker - Dendrocopos macei 35. Yellow-crowned Woodpecker - Dendrocopos mahrattensis 36. Lesser Yellownape - Picus chlorolophus 37. Streak-throated Woodpecker - Picus xanthopygaeus 38. Grey-headed Woodpecker - Picus canus 39. Common Flameback - Dinopium javanense 40. Black-rumped Flameback - Dinopium benghalense 41. Greater Flameback - Chrysocolaptes lucidus 42. White-naped Woodpecker - Chrysocolaptes festivus 43. Brown-headed Barbet - Megalaima zeylanica 44. Lineated Barbet - Megalaima lineata 45. Blue-throated Barbet - Megalaima asiatica 46. Coppersmith Barbet - Megalaima haemacephala 47. Common Hoopoe - Upupa epops 48. Indian Roller - Coracias benghalensis 49. Dollarbird - Eurstomus orientalis 50. Common Kingfisher - Alcedo atthis	183. Slender-billed Vulture - Gyps tenuirostris 184. Short-toed Eagle - Circaetus gallicus 185. Crested Serpent Eagle - Spilornis cheela 186. Eurasian Marsh Harrier - Circus aeruginosus 187. Pied Harrier - Circus melanoleucos 188. Hen Harrier - Circus cyaneus 189. Pallid Harrier - Circus macrourus 190. Crested Goshawk - Accipiter trivirgatus 191. Shikra - Accipiter badius 192. Oriental Honey-Buzzard - Pernis ptilorhyncus 193. Greater Spotted Eagle - Aquila clanga 194. Indian Spotted Eagle - Pomarina hastata 195. Bonelli's Eagle - Hieraaetus fasciatus 196. Booted Eagle - Hieraaetus pennatus 197. Changeable Hawk Eagle - Spizaetus cirrhatus 198. Common Kestrel - Falco tinnunculus 199. Red-necked Falcon - Falco chicquera 200. Amur Falcon - Falco amurensis 201. Eurasian Hobby - Falco subbuteo 202. Oriental Hobby - Falco severus 203. Peregrine Falcon - Falco peregrinus 204. Little Grebe - Tachybaptus ruficollis 205. Darter - Anhinga melanogaster 206. Little Cormorant - Phalacrocorax niger 207. Indian Cormorant - Phalacrocorax fuscicollis 208. Great Cormorant - Phalacrocorax carbo 209. Little Egret - Egretta garzetta 210. Great Egret - Casmerodius albus 211. Intermediate Egret - Mesophoyx intermedia 212. Cattle Egret - Bubulcus ibis 213. Indian Pond Heron - Ardeola grayii 214. Grey Heron - Ardea cinerea 215. Goliath Heron - Ardea goliath 216. Purple Heron - Ardea purpurea 217. Little Heron - Butorides striatus 218. Black-crowned Night Heron - Nycticorax nycticorax 219. Yellow Bittern - Ixobrychus sinensis 220. Cinnamon Bittern - Ixobrychus cinnamomeus 221. Black Bittern - Dupetor flavicollis 222. Glossy Ibis - Plegadis falcinellus 223. Black-headed Ibis - Threskiornis melanocephalus 224. Eurasian Spoonbill - Platalea leucorodia 225. Great White Pelican - Pelecanus onocrotalus 226. Spot-billed Pelican - Pelecanus philippensis 227. Painted Stork - Mycteria leucocephala 228. Asian Openbill - Anastomus oscitans 229. Black-necked Stork - Ephippiorhynchus asiaticus 230. Lesser Adjutant - Leptoptilos javanicus 231. Greater Adjutant - Leptoptilos dubius 232. Christmas Island Frigatebird - Fregata andrewsi 233. Wilson's Storm-petrel - Oceanites oceanicus 234. Indian Pitta - Pitta brachyura

Checklist for Birds	
51. Blue-eared Kingfisher - Alcedo meninting 52. Brown-winged Kingfisher - Halcyon amauroptera 53. Stork-billed Kingfisher - Halcyon capensis 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	235. Mangrove Pitta - Pitta megarhyncha 236. Golden-fronted Leafbird - Chloropsis aurifrons 237. Brown Shrike - Lanius cristatus 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

Checklist for Birds	
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 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	290. Common Myna - Acridotheres tristis 291. Bank Myna - Acridotheres ginginianus 292. Jungle Myna - Acridotheres fuscus 293. Chestnut-bellied Nuthatch - Sitta castanea 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

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

Sl. No.	Name	Scientific Name	IUCN Status
36	Asiatic milk fish	*Chanos chanos*	Least Concern
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

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 Palleria
Director

To

The Secretary,
Ministry of Shipping,
Parivahan Bhavan, 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.

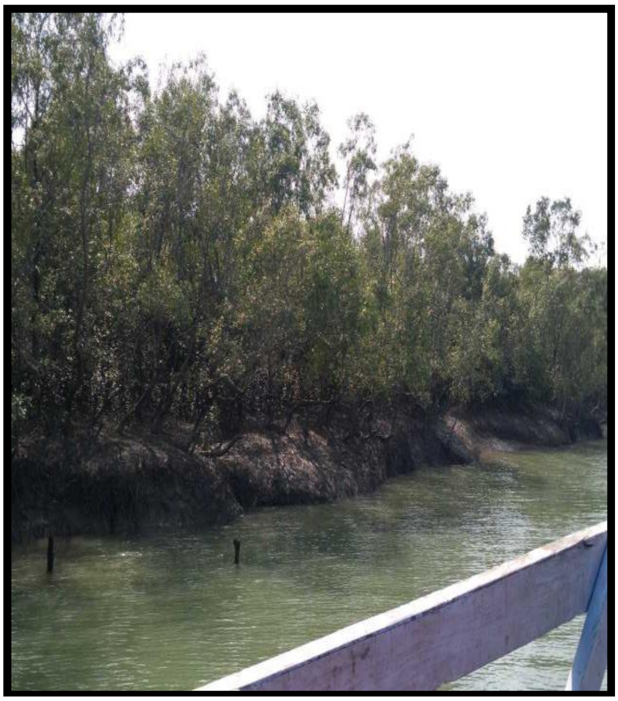
Sharath Kumar Pallerla
Director

ANNEXURE 5: PHOTOGRAPHS


Mangroves at Chainage 0.0

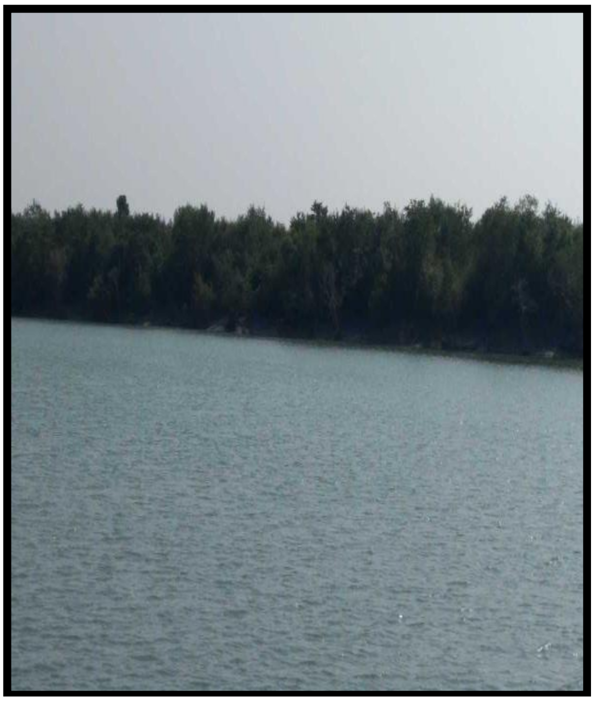

Mangroves at Chainage 2.0


Mangroves at Chainage 5.0


Mangroves at Chainage 7.0

Mangroves at Chainage 10.0

Mangroves at Chainage15.0



Mangroves at Chainage 20.0

Mangroves at Chainage 27.0

Mangroves at Chainage 32.0

Mangroves at Chainage35.0

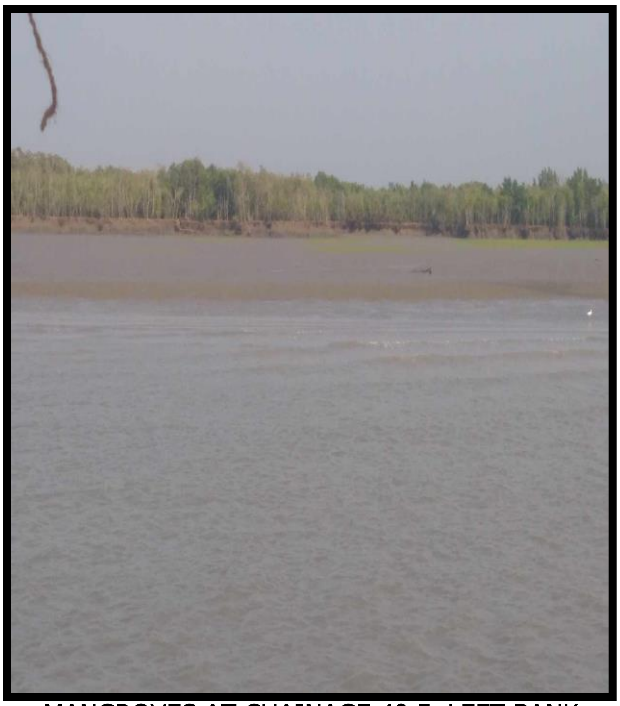
Mangroves at Chainage 37.0

Mangroves at Chainage 39.0

ANCHORED MERCHANT VESSEL AT CHAINAGE 40

FISHING NET AT CHAINAGE 40.5, RIGHT BANK

MANGROVES AT CHAINAGE 40.5, RIGHT BANK

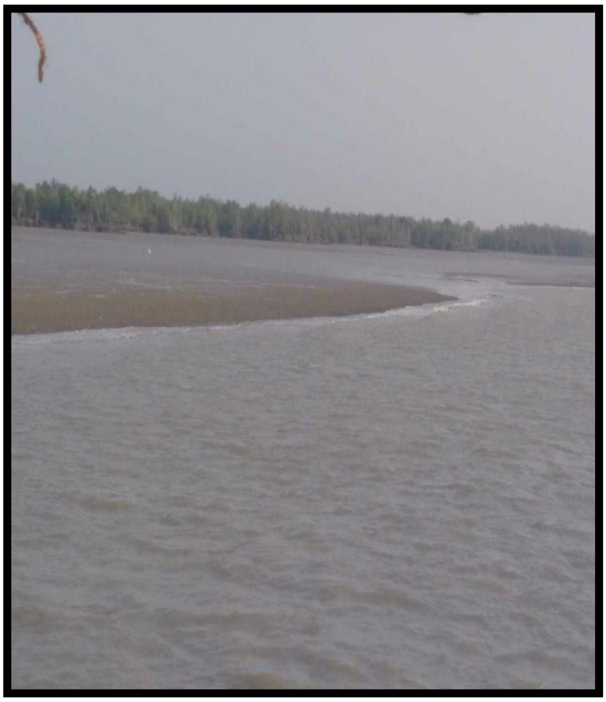


MANGROVES AT CHAINAGE 40.5, LEFT BANK

MANGROVES AT CHAINAGE 40.5, LEFT BANK

MANGROVES AT CHAINAGE 40.5, RIGHT BANK

MERCHANT VESSEL



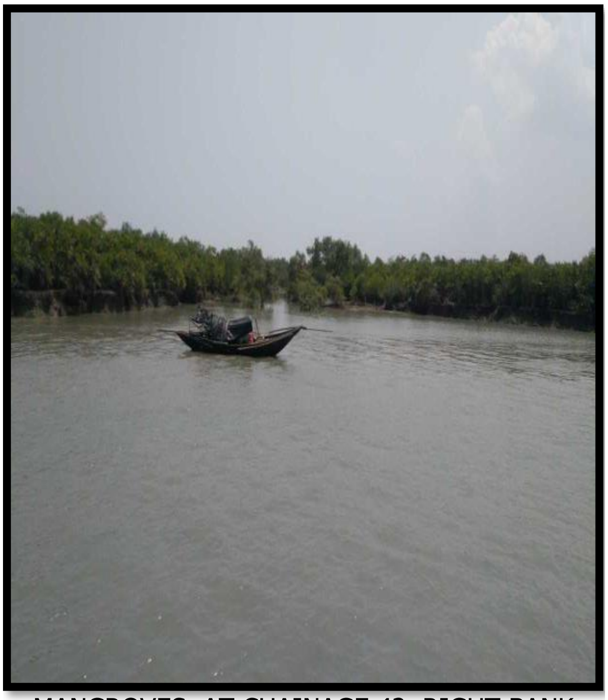
SHALLOW PATCH AT CHAINAGE 40.5, RIGHT BANK

SWELL AT CHAINAGE 40.5

LEFT RIVER BANK MANGROVES AT CHAINAGE 42

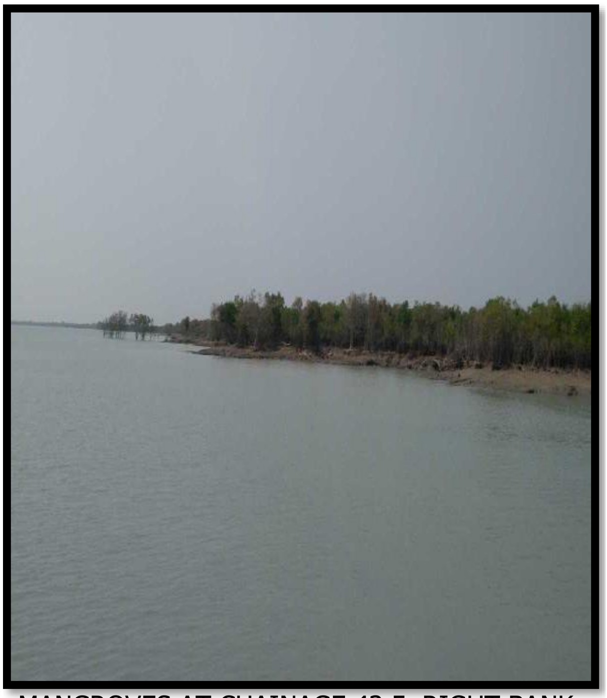
LEFT RIVER BANK MANGROVES AT CHAINAGE 42

SHIP ROUTE AT CHAINAGE 42



MANGROVES AT CHAINAGE 42, RIGHT BANK

MANGROVES AT CHAINAGE 43.5, LEFT BANK



MANGROVES AT CHAINAGE 43.5, RIGHT BANK

MANGROVES AT CHAINAGE 43.5, RIGHT BANK

SHIP ROUTE AT CHAINAGE 43.5

SHIP ROUTE AT CHAINAGE 43.5

SHIP ANCHORED AT CHAINAGE 43.5

SHIP ANCHORED AT CHAINAGE 43.5

RIVER BANK AT CHAINAGE 44.5, RIGHT BANK

SHOLE PATCH CHAINAGE 45, RIGHT BANK

SHOLE PATCH AT CHAINAGE 45, RIGHT BANK

RIVER BANK AT CHAINAGE 45, RIGHT BANK

RIVER BANK AT CHAINAGE 45.5, RIGHT BANK

RIVER BANK AT CHAINAGE 45.5, RIGHT BANK

RIVER BANK AT CHAINAGE 45.5, RIGHT BANK

RIVER BANK AT CHAINAGE 46, RIGHT BANK


RIVER BANK AT CHAINAGE 46, RIGHT BANK


RIVER BANK AT CHAINAGE 46, RIGHT BANK


MANGROVES AT CHAINAGE 46.5, RIGHT BANK


MANGROVES AT CHAINAGE 46.5, RIGHT BANK

MANGROVES AT CHAINAGE 47, RIGHT BANK

MANGROVES AT CHAINAGE 47,

RIGHT BANK

MANGROVES AT CHAINAGE 47,

RIGHT BANK

FISHING NET AT CHAINAGE 47, RIGHT BANK

MANGROVES AT CHAINAGE 47.5, RIGHT BANK

MANGROVES AT CHAINAGE 47.5, RIGHT BANK

MANGROVES AT CHAINAGE 47.5, RIGHT BANK

MANGROVES AT CHAINAGE 48 RIGHT BANK


MANGROVES AT CHAINAGE 48 RIGHT BANK


MANGROVES AT CHAINAGE 48.5 RIGHT BANK


MANGROVES AT CHAINAGE 48.5 RIGHT BANK


MANGROVES AT CHAINAGE 48.5 RIGHT BANK

SHOLE PATCH AT CHAINAGE 48.5

SHOLE PATCH AT CHAINAGE 48.5

BANGLADESH SHIP MOVEMANT THROUGH MATLA RIVER

BANGLADESH SHIP MOVEMANT THROUGH MATLA RIVER

BANGLADESH SHIP MOVEMANT THROUGH MATLA RIVER

BANGLADESH SHIP MOVEMANT THROUGH MATLA RIVER

MANGROVES AT CHAINAGE 49, LEFT BANK

MANGROVES AT CHAINAGE 49, LEFT BANK


MANGROVES AT CHAINAGE 49, LEFT BANK


MANGROVES AT CHAINAGE 49, RIGHT BANK


MANGROVES AT CHAINAGE 49, RIGHT BANK


MANGROVES AT CHAINAGE 49, RIGHT BANK


MANGROVES AT CHAINAGE 49.5, LEFT BANK


MANGROVES AT CHAINAGE 49.5, LEFT BANK


MANGROVES AT CHAINAGE 49.5, LEFT BANK


MANGROVES AT CHAINAGE 49.5, RIGHT BANK


MANGROVES AT CHAINAGE 49.5, RIGHT BANK


MANGROVES AT CHAINAGE 49.5, RIGHT BANK


MANGROVES AT CHAINAGE 50, LEFT BANK


MANGROVES AT CHAINAGE 50, LEFT BANK

MANGROVES AT CHAINAGE 50, RIGHT BANK

MANGROVES AT CHAINAGE 50, RIGHT BANK

RIVER BANK AT CHAINAGE 50, RIGHT BANK

MANGROVES AT CHAINAGE 50.5, LEFT BANK

MANGROVES AT CHAINAGE 50.5, LEFT BANK

MANGROVES AT CHAINAGE 50.5, RIGHT BANK

MANGROVES AT CHAINAGE 50.5, RIGHT BANK

MANGROVES AT CHAINAGE 51, LEFT BANK

MANGROVES AT CHAINAGE 51, RIGHT BANK

MANGROVES AT CHAINAGE 51.5, LEFT BANK

MANGROVES AT CHAINAGE 51.5, RIGHT BANK

MANGROVES AT CHAINAGE 51.5, RIGHT BANK

MANGROVES AT CHAINAGE 51.7, RIGHT BANK

FISHING BOAT AT CHAINAGE 51.7, RIGHT BANK

MANGROVES AT CHAINAGE 52, LEFT BANK

MANGROVES AT CHAINAGE 52, RIGHT BANK


MANGROVES AT CHAINAGE 52.5, RIGHT BANK


MANGROVES AT CHAINAGE 53, LEFT BANK


MANGROVES AT CHAINAGE 53, LEFT BANK


MANGROVES AT CHAINAGE 53, LEFT BANK

MANGROVES AT CHAINAGE 53, RIGHT BANK

MANGROVES AT CHAINAGE 53.5, LEFT BANK

MANGROVES AT CHAINAGE 53.5, LEFT BANK

MANGROVES AT CHAINAGE 53.5, LEFT BANK


MANGROVES AT CHAINAGE 54, LEFT BANK


MANGROVES AT CHAINAGE 54, LEFT BANK


MANGROVES AT CHAINAGE 54.2, LEFT BANK


MANGROVES AT CHAINAGE 54.2, LEFT BANK

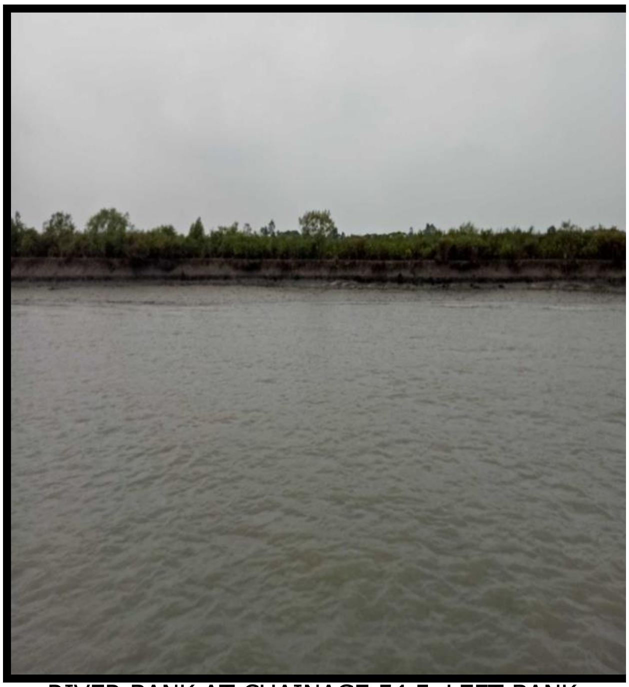

CREEK AT CHAINAGE 54.3, RIGHT BANK


MANGROVES AT CHAINAGE 54.5, RIGHT BANK


MANGROVES AT CHAINAGE 54.5, RIGHT BANK


MANGROVES AT CHAINAGE 54.5, RIGHT BANK

MANGROVES AT CHAINAGE 54.5, RIGHT BANK

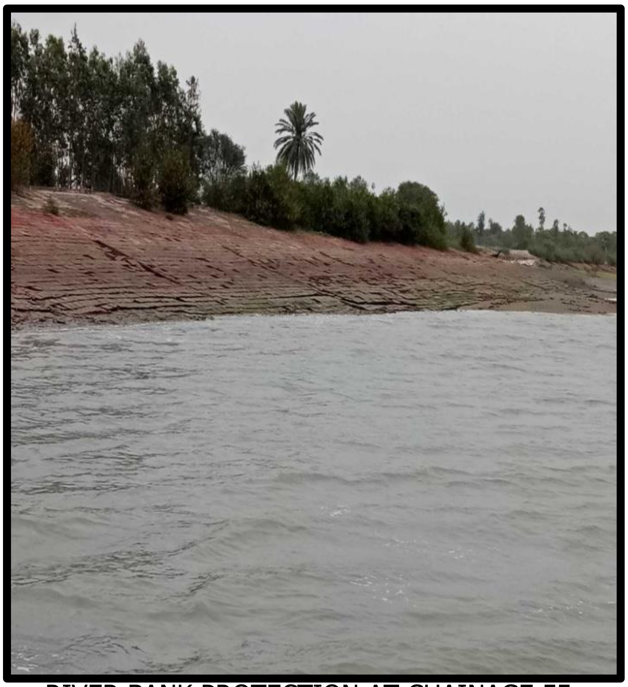


RIVER BANK AT CHAINAGE 54.5, LEFT BANK

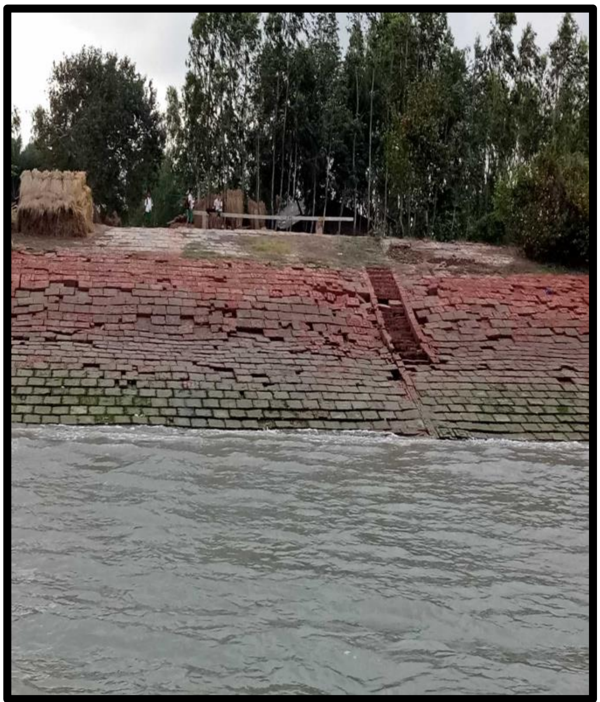
RIVER BANK PROTECTION AT CHAINAGE 54.7, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 54.7, LEFT BANK

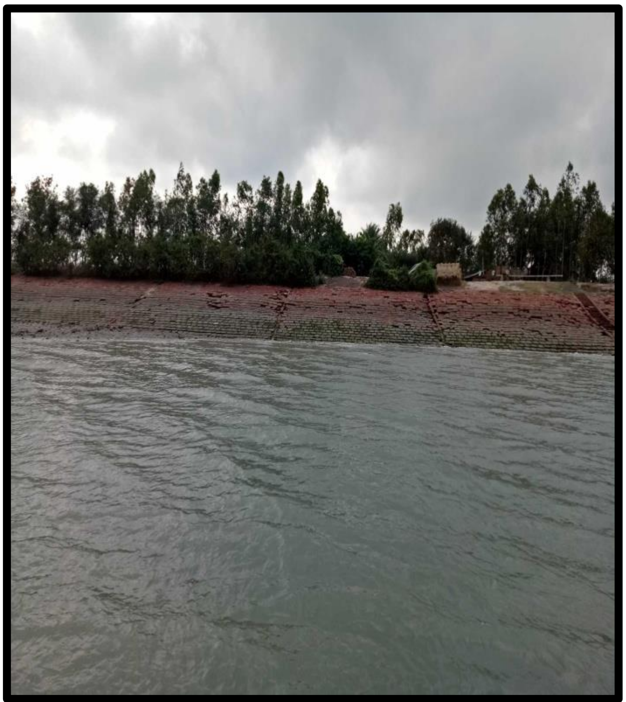
RIVER BANK PROTECTION AT CHAINAGE 55, LEFT BANK



RIVER BANK PROTECTION AT CHAINAGE 55, LEFT BANK



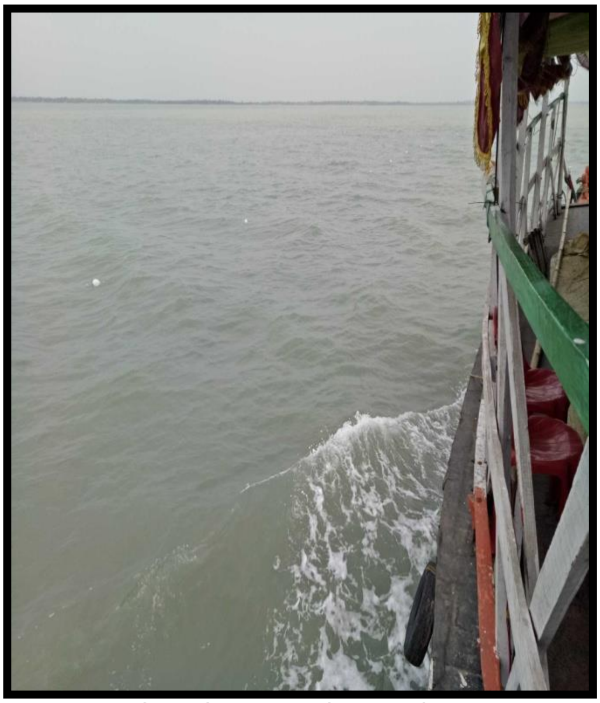
RIVER BANK PROTECTION AT CHAINAGE 55.7, LEFT BANK



RIVER BANK PROTECTION AT CHAINAGE 55.7, LEFT BANK

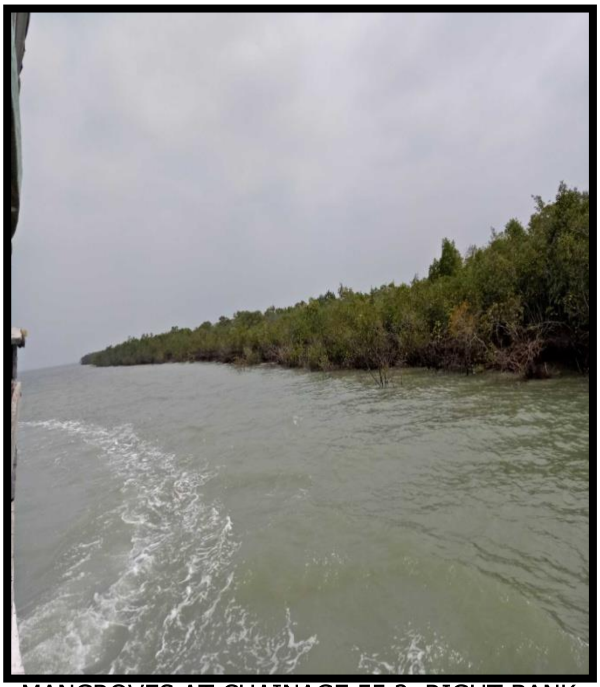
MANGROVES AT CHAINAGE 55, RIGHT BANK

MANGROVES AT CHAINAGE 55, RIGHT BANK



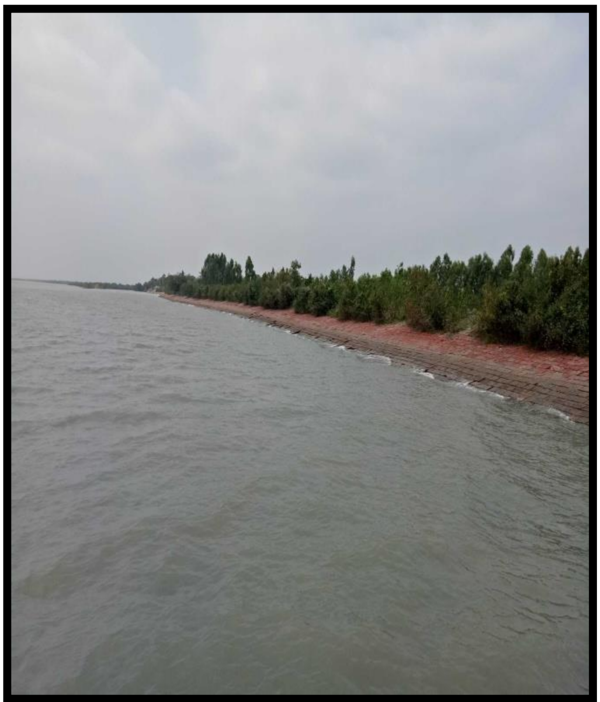
FISHING NET AT CHAINAGE 55

MANGROVES AT CHAINAGE 55.2 RIGHT BANK

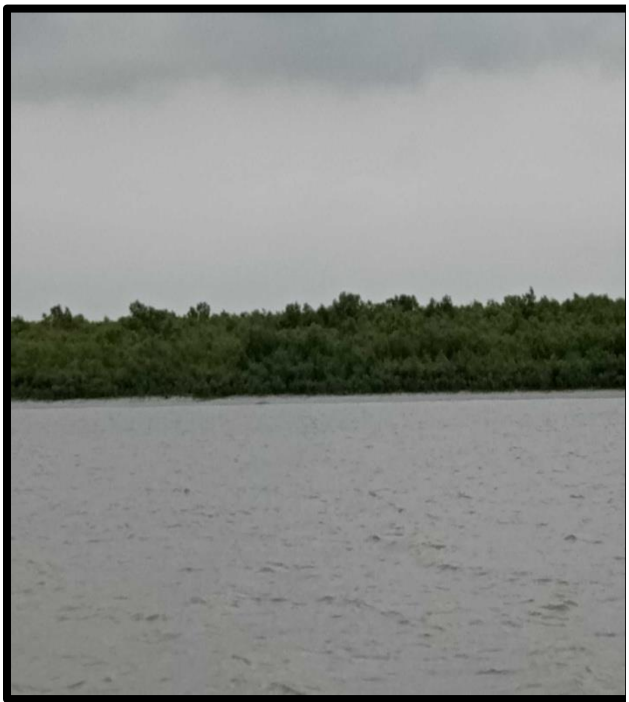


MANGROVES AT CHAINAGE 55.2, RIGHT BANK

RIVER BANK PROTECTION CHAINAGE 55.5, LEFT BANK

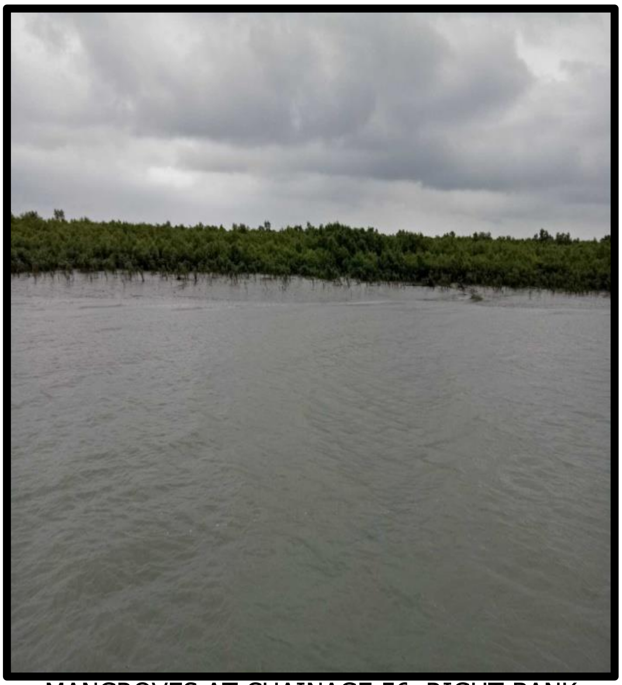


RIVER BANK PROTECTION AT CHAINAGE 55.5, LEFT BANK

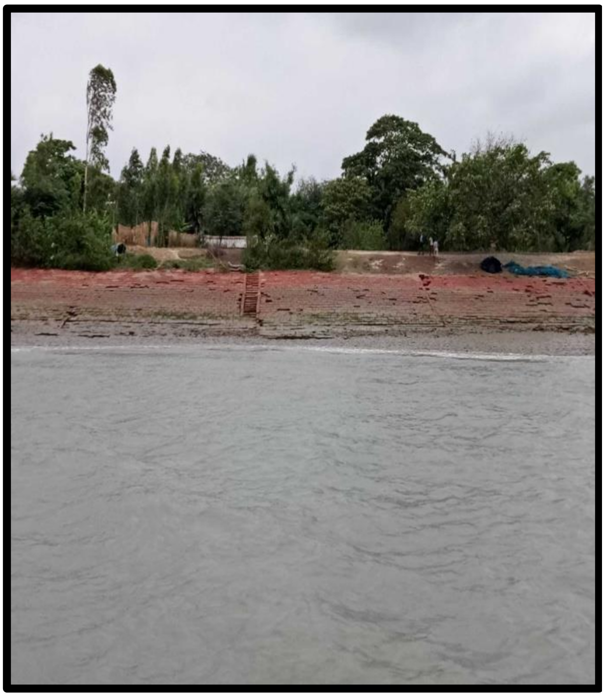


MANGROVES AT CHAINAGE 55.5, RIGHT BANK

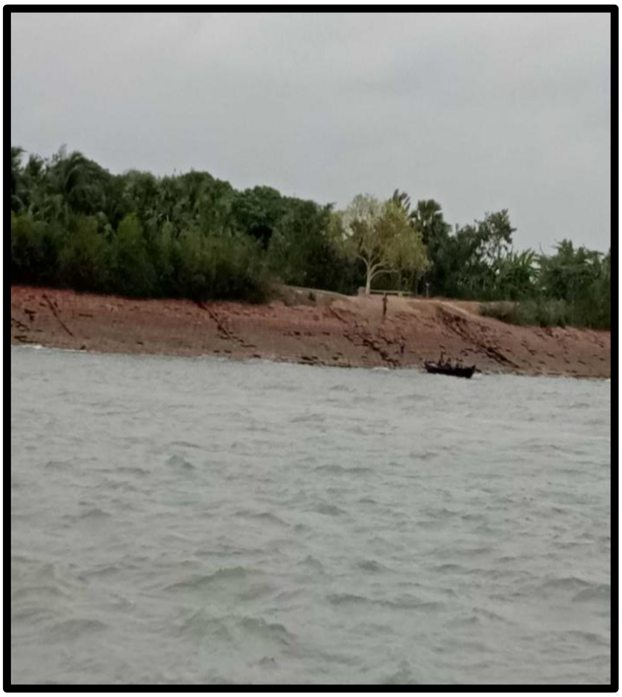
RIVER BANK PROTECTION AT CHAINAGE 55.7, LEFT BANK



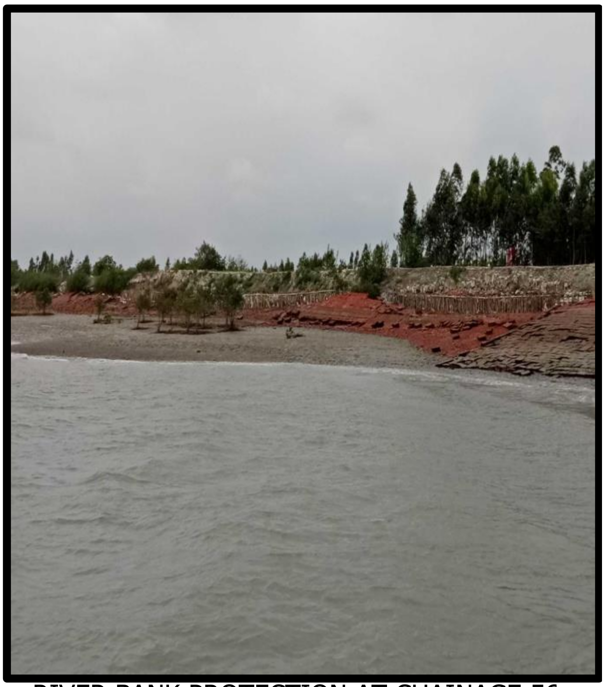
MANGROVES AT CHAINAGE 56, RIGHT BANK



RIVER BANK PROTECTION AT CHAINAGE 56, LEFT BANK



RIVER BANK PROTECTION AT CHAINAGE 56, LEFT BANK



RIVER BANK PROTECTION AT CHAINAGE 56, LEFT BANK

MANGROVES AT CHAINAGE 56, RIGHT BANK

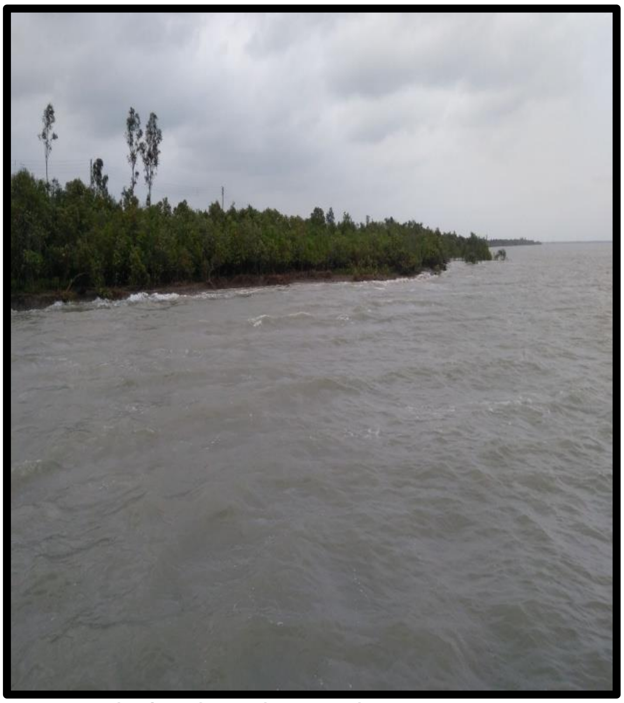
MANGROVES AT CHAINAGE 56, RIGHT BANK

MANGROVES AT CHAINAGE 56.5, LEFT BANK

MANGROVES AT CHAINAGE 56.5, RIGHT BANK

JETTY AT CHAINAGE 57, LEFT BANK

MANGROVES AT CHAINAGE 57, LEFT BANK



MANGROVES AT CHAINAGE 57, LEFT BANK

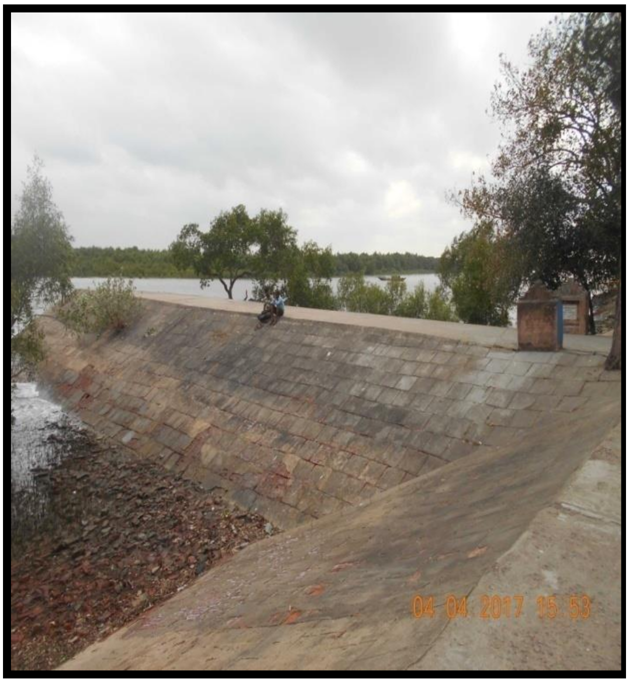
MANGROVES AT CHAINAGE 57, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 57, LEFT BANK

KAIKHALI GUEST HOUSE AT CHAINAGE 57.5, LEFT BANK

KAIKHALI GUEST HOUSE AT CHAINAGE 57.5, LEFT BANK

KAIKHALI GUEST HOUSE AT CHAINAGE 57.5, LEFT BANK

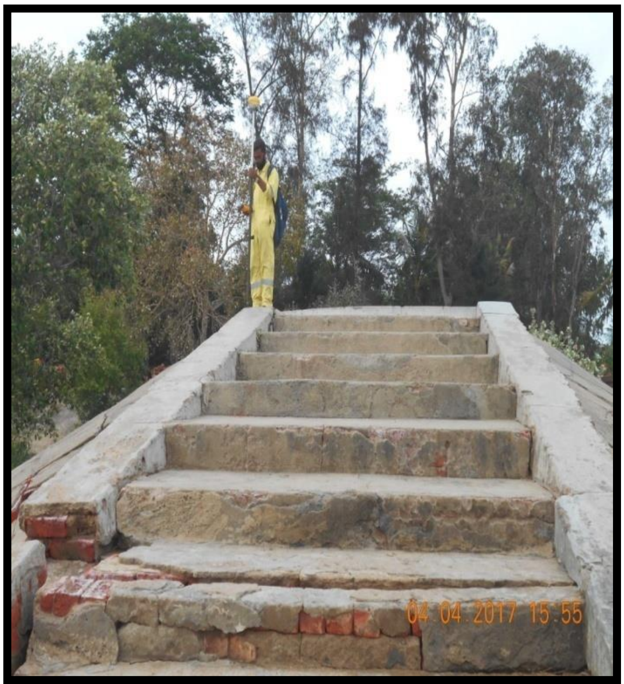


RIVER BANK PROTECTION AT CHAINAGE 57.5, LEFT BANK

KAIKHALI JETTY FOUNTATION STONE AT CHAINAGE 57.5, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 57.5, LEFT BANK

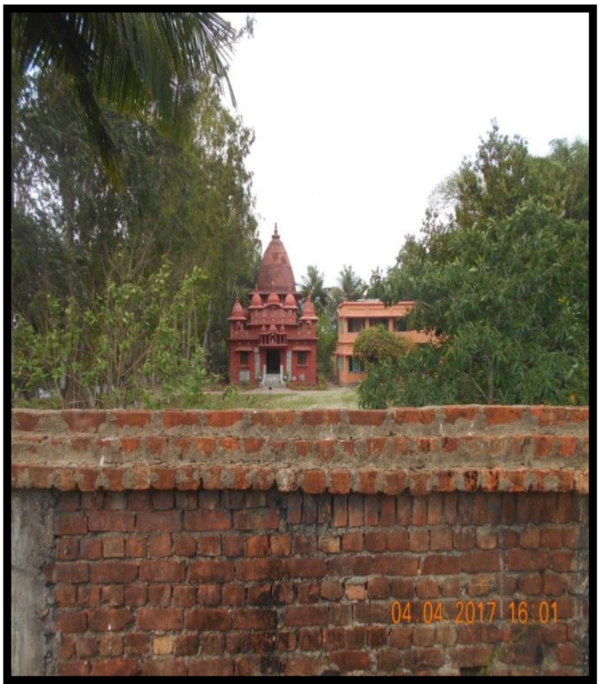
KAIKHALI JETTY AT CHAINAGE 57.5, LEFT BANK



KAIKHALI JETTY AT CHAINAGE 57.5, LEFT BANK

KAIKHALI JETTY FOUNTATION STONE AT CHAINAGE 57.5, LEFT BANK

RIVER BANK PROTECTION CHAINAGE 57.5, LEFT BANK



RAMKRISHNAN ASHRAM AT CHAINAGE 57.5, LEFT BANK

RAMKRISHNAN ASHRAM ENTRY AT CHAINAGE 57.5, LEFT BANK

ROAD OF KAIKHALI JETTY AT CHAINAGE 57.5, LEFT BANK

ROAD TOWARD KAIKHALI JETTY AT CHAINAGE 57.5, LEFT BANK

BASE STATION AT CHAINAGE 57.5 , LEFT BANK

MANGROVES AT CHAINAGE 58, RIGHT BANK

BM ML-01 AT CHAINAGE 58, RIGHT BANK

BOTANICAL GARDEN NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

BOTANICAL GARDEN NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

TICKET COUNTER BOTANICAL GARDEN NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

TEMPLE AT CHAINAGE 58, RIGHT BANK

POLICE STATION NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

ROAD NEAR TBM-01 AT CHAINAGE 58, RIGHT BANK

ROAD NEAR BM-01 AT CHAINAGE 58, RIGHT BANK

ECO TOURISM HUB AT CHAINAGE 58, RIGHT BANK

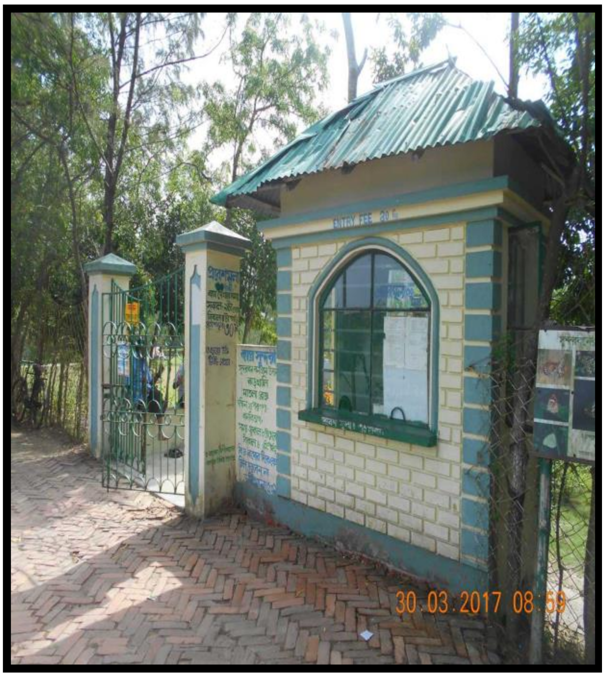
ECO TOURISM HUB ROAD AT CHAINAGE 58, RIGHT BANK

DEVELOPMENT OF CLIMATE-RESILIENT-AGRICULTURE STRATEGIES FOR SAGAR & BASANTI BLOCK OF INDIAN SUNDARBAN AT

DEVELOPMENT OF CLIMATE-RESILIENT-AGRICULTURE STRATEGIES FOR SAGAR & BASANTI BLOCK OF INDIAN SUNDARBAN AT

TIGER RESCUE CENTER AT CHAINAGE 58, RIGHT BANK

TIGER RESCUE CENTER AT CHAINAGE 58, RIGHT BANK



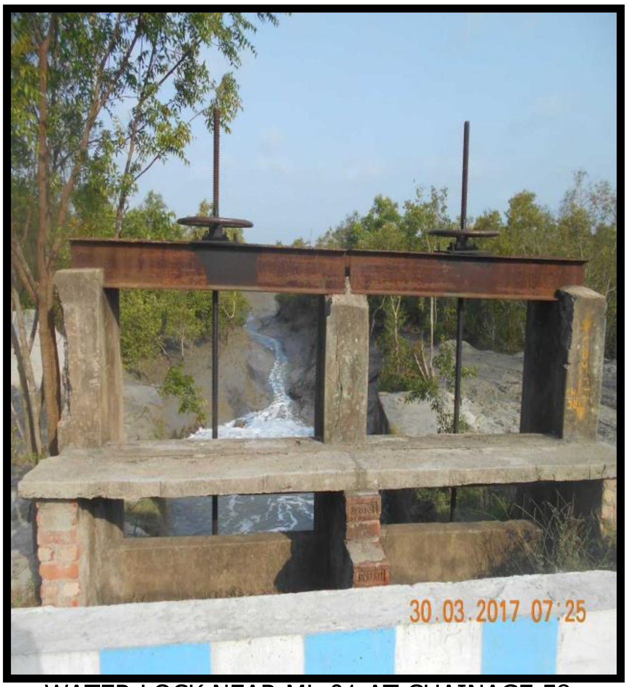
TIGER RESCUE CENTER AT CHAINAGE 58, RIGHT BANK

TIGER RESCUE CENTER AT CHAINAGE 58, RIGHT BANK

FOUNTATION STONE AT CHAINAGE 58, RIGHT BANK

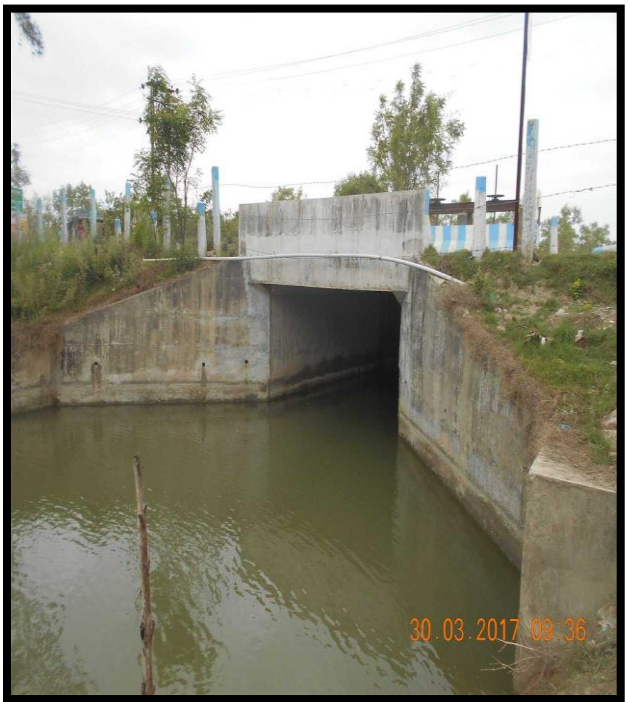
TIGER RESCUE CENTER ENTRY AT CHAINAGE 58, RIGHT BANK

TIGER RESCUE CENTER ENTRY AT CHAINAGE 58, RIGHT BANK



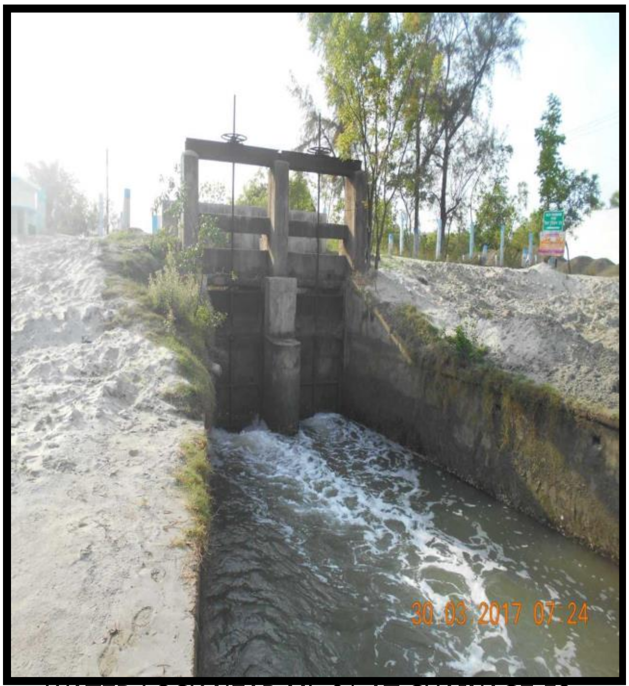
WATER LOCK NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

WATER LOCK NEAR ML-01 AT CHAINAGE 58, RIGHT BANK



WATER LOCK NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

WATER LOCK NEAR ML-01 AT CHAINAGE 58, RIGHT BANK



WATER LOCK NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

POND NEAR ML-01 AT CHAINAGE 58, RIGHT BANK

FISHERY PROJECT AND TRINING CENTER AT CHAINAGE 58, RIGHT BANK

FISHERY PROJECT AND TRINING CENTER AT CHAINAGE 58, RIGHT BANK

GONGAMALA TEMPLE AT CHAINAGE 58, RIGHT BANK

MANGROVES AT CHAINAGE 58.1, RIGHT BANK

FISHING NET AT CHAINAGE 58.5, RIGHT BANK

FISHING NET AT CHAINAGE 58.5, RIGHT BANK

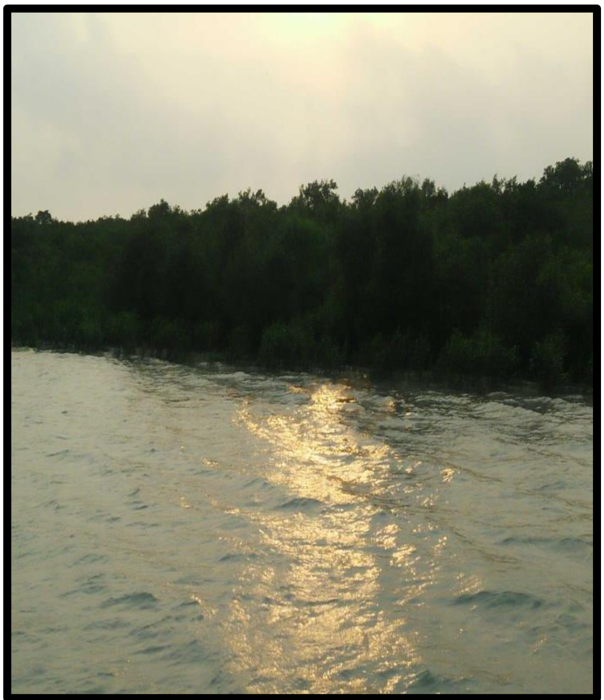
RIVER BANK AT CHAINAGE 58.5,LEFT BANK

RIVER BANK AT CHAINAGE 58.5,LEFT BANK

JETTY AT CHAINAGE 58.5, RIGHT BANK

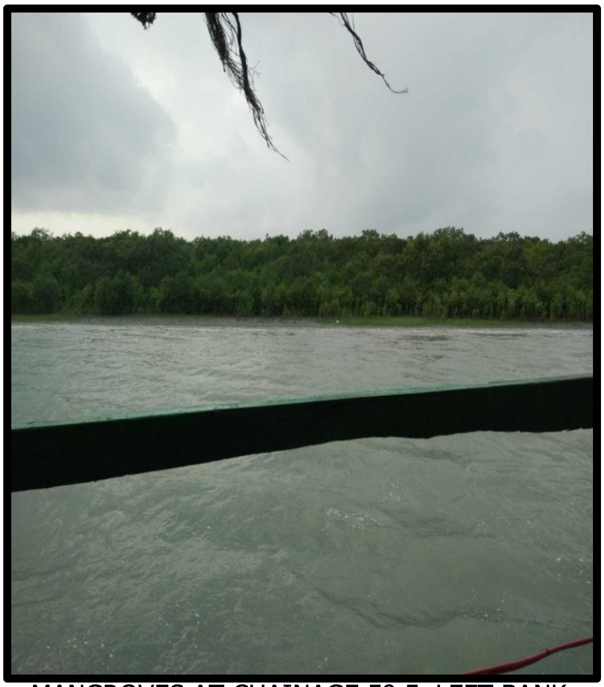
RIVER BANK AT CHAINAGE 59,LEFT BANK

RIVER BANK AT CHAINAGE 59,LEFT BANK



MANGROVES AT CHAINAGE 59.5, LEFT BANK

MANGROVES AT CHAINAGE 59.5, LEFT BANK


MANGROVES AT CHAINAGE 59.5, LEFT BANK


FISHING NET AT CHAINAGE 59.5, LEFT BANK


FISHING NET AT CHAINAGE 59.5, RIGHT BANK


MANGROVES AT CHAINAGE 60, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 60.5, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 60.5, LEFT BANK

JETTY UNDER CONSTRUCTION AND MANGROVES AT CHAINAGE 60, LEFT BANK

MANGROVES AT CHAINAGE 60.5, RIGHT BANK

MANGROVES AT CHAINAGE 60.5, LEFT BANK

MANGROVES AT CHAINAGE 61, RIGHT BANK

MANGROVES AT CHAINAGE 61.5, RIGHT BANK

MANGROVES AT CHAINAGE 61.5, LEFT BANK


MANGROVES AT CHAINAGE 62, LEFT BANK


MANGROVES AT CHAINAGE 62.3, LEFT BANK


MANGROVES AT CHAINAGE 62.5,LEFT BANK


MANGROVES AT CHAINAGE 62.5,LEFT BANK

MANGROVES AT CHAINAGE 62.5,RIGHT BANK

MANGROVES AT CHAINAGE 62.5,RIGHT BANK

MANGROVES AT CHAINAGE 63,LEFT BANK

MANGROVES AT CHAINAGE 63,LEFT BANK


FISHING NET AT CHAINAGE 63,LEFT BANK


MANGROVES AT CHAINAGE 63,RIGHT BANK


MANGROVES AT CHAINAGE 63,RIGHT BANK


MANGROVES AT CHAINAGE 63,RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 63,RIGHT BANK GONGAMALA

FENCE AT CHAINAGE 63, RIGHT BANK

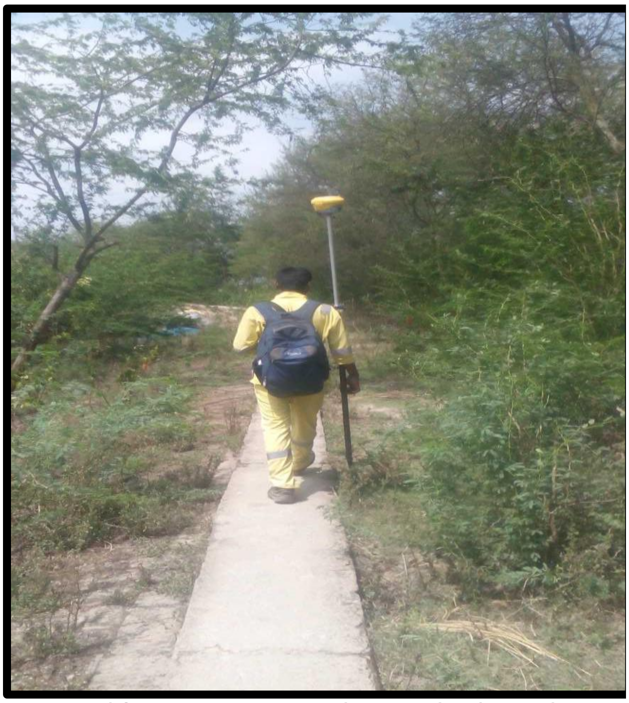
WATER LOCK AT CHAINAGE 63, RIGHT BANK

RIVER BANK AT CHAINAGE 63.5, RIGHT BANK

RIVER BANK AT CHAINAGE 63.5, RIGHT BANK

MANGROVES AT CHAINAGE 63.5, LEFT BANK

MANGROVES AT CHAINAGE 63.5, LEFT BANK

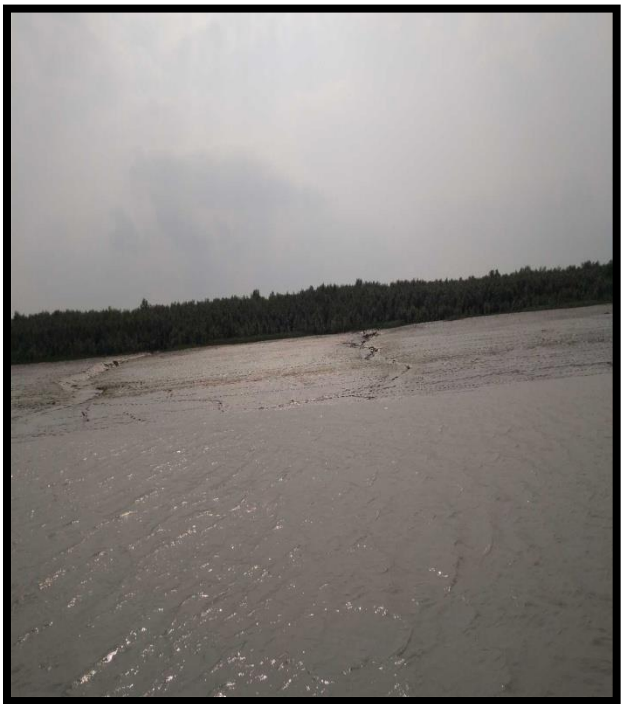


TREE COVERED AREA AT CHAINAGE 64, RIGHT BANK


FISHING NET AT CHAINAGE 64


MANGROVES AT CHAINAGE 64, RIGHT BANK


MANGROVES AT CHAINAGE 64, RIGHT BANK


MANGROVES AT CHAINAGE 64, LEFT BANK

MANGROVES AT CHAINAGE 64, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 64.5, RIGHT BANK

MANGROVES AT CHAINAGE 64.5, RIGHT BANK

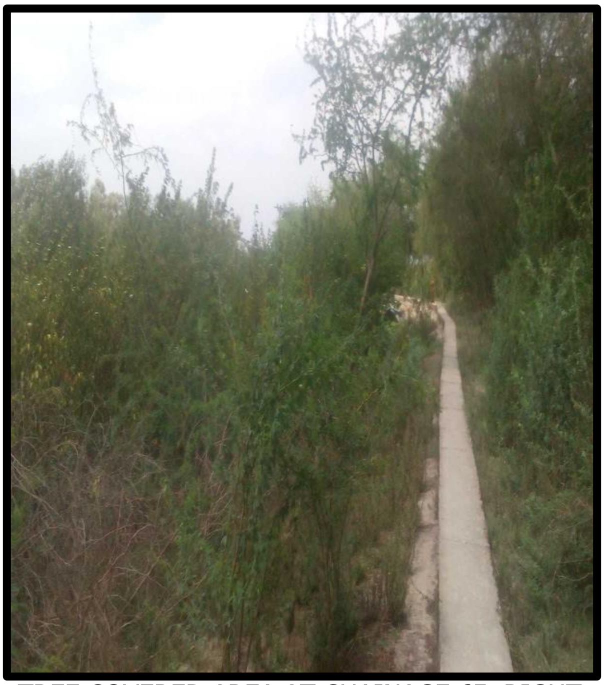
DESCRIPTION BOARD AT CHAINAGE 64.9, RIGHT BANK

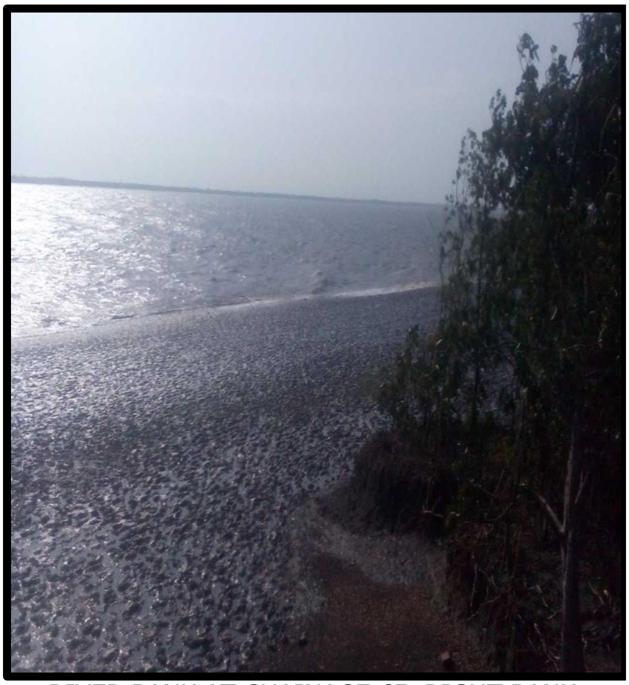
FISHING POND AT CHAINAGE 64.9, RIGHT BANK

MANGROVES AT CHAINAGE 65, LEFT BANK

MANGROVES AT CHAINAGE 65, LEFT BANK

RIVER BANK PROTECTION WALL AT CHAINAGE 65, RIGHT BANK


TREE COVERED AREA AT CHAINAGE 65, RIGHT BANK


RIVER BANK AT CHAINAGE 65, RIGHT BANK


RIVER BANK AT CHAINAGE 65, RIGHT BANK


MANGROVES AT CHAINAGE 65.5, RIGHT BANK

MANGROVES AT CHAINAGE 65.9, RIGHT BANK

Creek(LOW WATER TIME) AT CHAINAGE 65.9, RIGHT BANK

DAMAGED RIVER BANK AT CHAINAGE 65.9, RIGHT BANK

MANGROVES AT CHAINAGE 66, LEFT BANK


MANGROVES AT CHAINAGE 66, LEFT BANK


MANGROVES AT CHAINAGE 66, RIGHT BANK


MANGROVES AT CHAINAGE 66, RIGHT BANK


MANGROVES AT CHAINAGE 66, RIGHT BANK


MANGROVES AT CHAINAGE 66.5, RIGHT BANK


MANGROVES AT CHAINAGE 66.5, RIGHT BANK


FISHING NET AT CHAINAGE 66.5


MANGROVES AT CHAINAGE 66.5, LEFT BANK

FISHING NET AT CHAINAGE 67, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 67, RIGHT BANK

MANGROVES AT CHAINAGE 67.5, LEFT BANK

RIVER BANK AT CHAINAGE 67.5, RIGHT BANK

WATER LOCK AT CHAINAGE 67.5, RIGHT BANK

MANGROVE STARTED AT CHAINAGE 67.6, RIGHT BANK

MANGROVE AT CHAINAGE 67.6, RIGHT BANK

MANGROVES AT CHAINAGE 68, RIGHT BANK

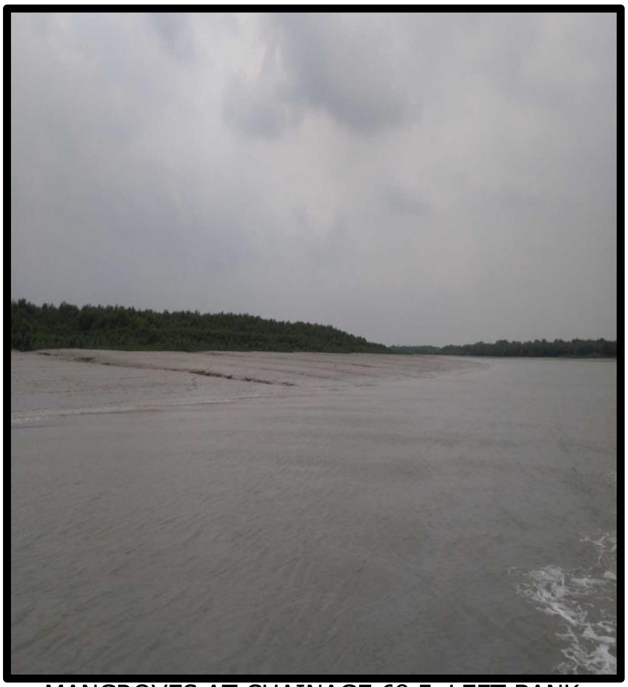

FISHING NET AT CHAINAGE 68, RIGHT BANK


MANGROVES AT CHAINAGE 68, RIGHT BANK


MANGROVES AT CHAINAGE 68, RIGHT BANK


MANGROVES AT CHAINAGE 68, LEFT BANK


MANGROVES AT CHAINAGE 68.5, RIGHT BANK


MANGROVES AT CHAINAGE 68.5, LEFT BANK


MANGROVES AT CHAINAGE 68.5, RIGHT BANK


MANGROVES AT CHAINAGE 69, LEFT BANK

FISHING NET AT CHAINAGE 69, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 69, RIGHT BANK

BASE OBSERVATION AT ML-02 AT CHAINAGE 69.7

BASE OBSERVATION AT ML-02 AT CHAINAGE 69.7

BASE OBSERVATION AT ML-02 AT CHAINAGE 69.7

BM ML-02 AT CHAINAGE 69.7

RIVER BANK PROTECTION AT CHAINAGE 70, RIGHT BANK

MANGROVES END AT CHAINAGE 70, RIGHT BANK

MANGROVES AT CHAINAGE 70, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 70.5, LEFT BANK

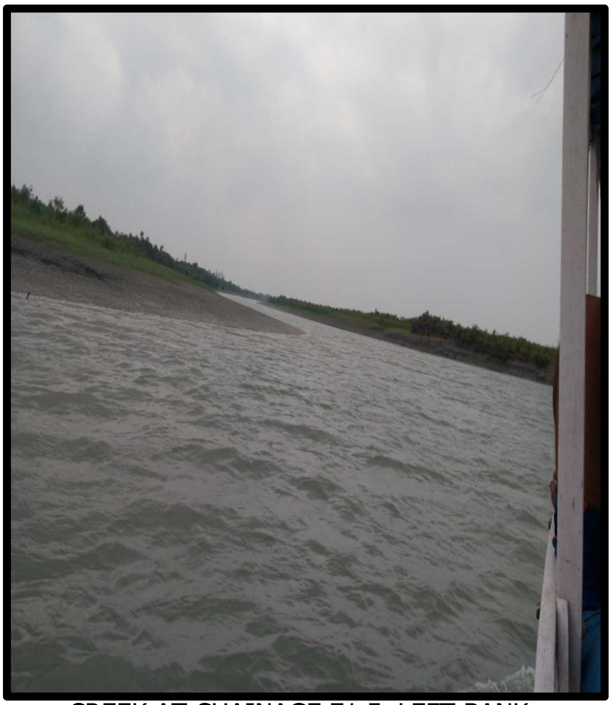
MANGROVES AT CHAINAGE 70.5, LEFT BANK

TEMPLE AT CHAINAGE 71, RIGHT BANK

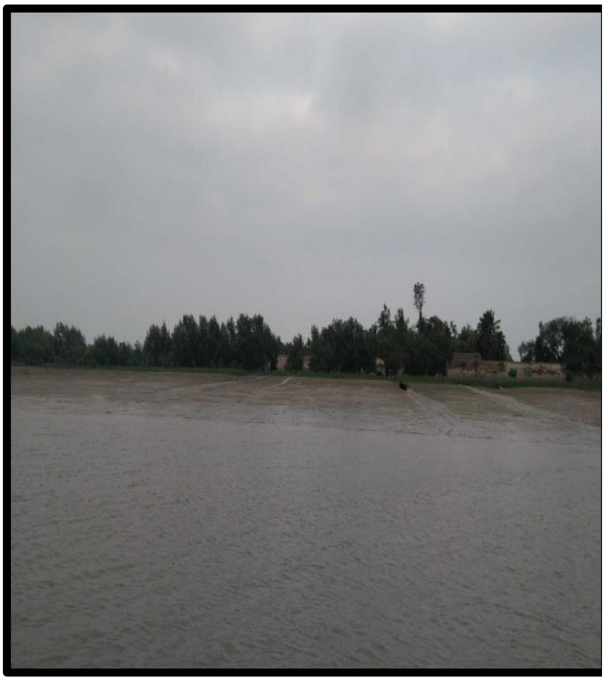
RIVER BANK AT CHAINAGE 71, RIGHT BANK

FISHING NET AT CHAINAGE 71, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 71, LEFT BANK



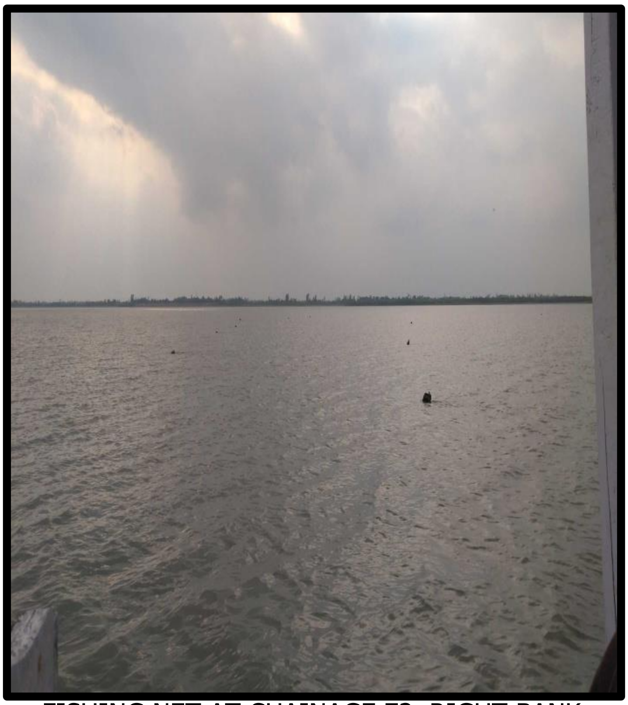
CREEK AT CHAINAGE 71.5, LEFT BANK



RIVER BANK AT CHAINAGE 71.5, LEFT BANK

RIVER BANK PROTECTION AT CHAINAGE 71.5, RIGHT BANK

JETTY AT CHAINAGE 72, RIGHT BANK



FISHING NET AT CHAINAGE 72, RIGHT BANK

FISHING NET AT CHAINAGE 72, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 72, RIGHT BANK

MANGROVES AT CHAINAGE 72.5, LEFT BANK

RIVER BANK AT CHAINAGE 72.5, RIGHT BANK

BANK PROTECTION AT CHAINAGE 73, LEFT BANK

MANGROVES AT CHAINAGE 73, LEFT BANK

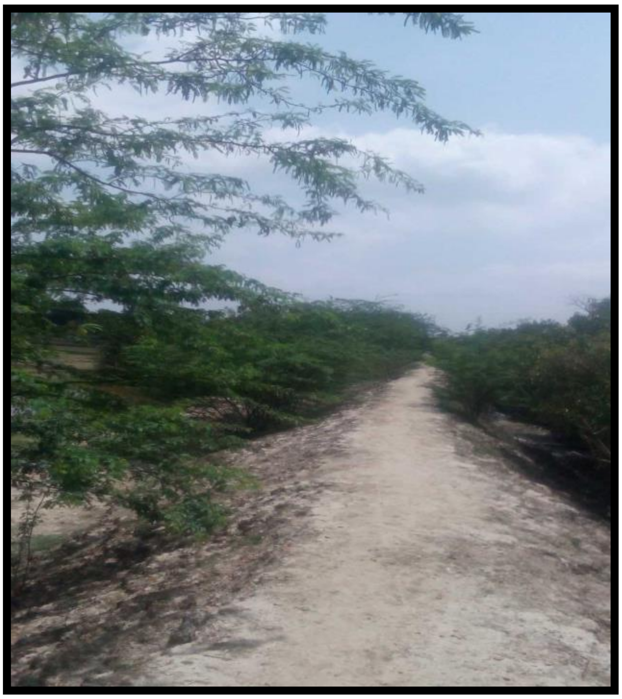
MANGROVES AT CHAINAGE 73, LEFT BANK

MANGROVES AT 73.5, LEFT BANK

MANGROVES AT CHAINAGE 73.5, LEFT BANK

MANGROVES AT CHAINAGE 73.5, LEFT BANK

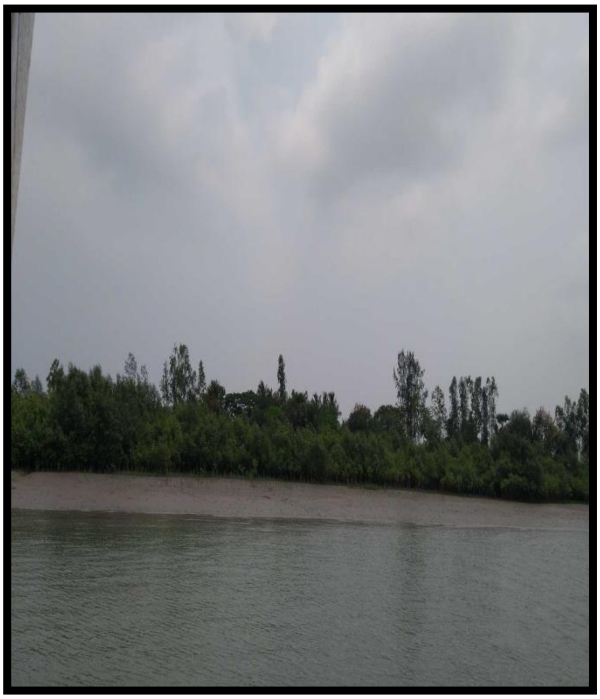
MANGROVES AT CHAINAGE 73.5, RIGHT BANK



TREE COVERED AREA AT CHAINAGE 73.8, RIGHT BANK

MANGROVES AT CHAINAGE 74, LEFT BANK

MANGROVES AT CHAINAGE 74, LEFT BANK



MANGROVES AT CHAINAGE 74, RIGHT BANK

BASE STATION AT CHAINAGE 74.5, RIGHT BANK

BASE STATION AT CHAINAGE 74.5, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 74.5, RIGHT BANK

TEMPLE AT CHAINAGE 74.5, RIGHT BANK

TEMPLE AUDITORIUM AT CHAINAGE 74.5, RIGHT BANK

ROAD TOWARDS GARANBOSE JETTY AT CHAINANGE 74.5, RIGHT BANK

ROAD TOWARDS GARANBOSE JETTY AT CHAINANGE 74.5, RIGHT BANK

GARANBOSE JETTY NO.1 AT CHAINANGE 74.5, RIGHT BANK

GARANBOSE JETTY NO.1 AT CHAINANGE 74.5, RIGHT BANK

GARANBOSE JETTY NO.1 AT CHAINANGE 74.5, RIGHT BANK

GARANBOSE JETTY NO.1 AT CHAINANGE 74.5, RIGHT BANK

MANGROVES AT CHAINAGE 74.5, LEFT BANK

MANGROVES AT CHAINAGE 74.5, LEFT BANK

MANGROVES START AT CHAINAGE 75, RIGHT BANK

FISHING NET AT CHAINAGE 75, LEFT BANK

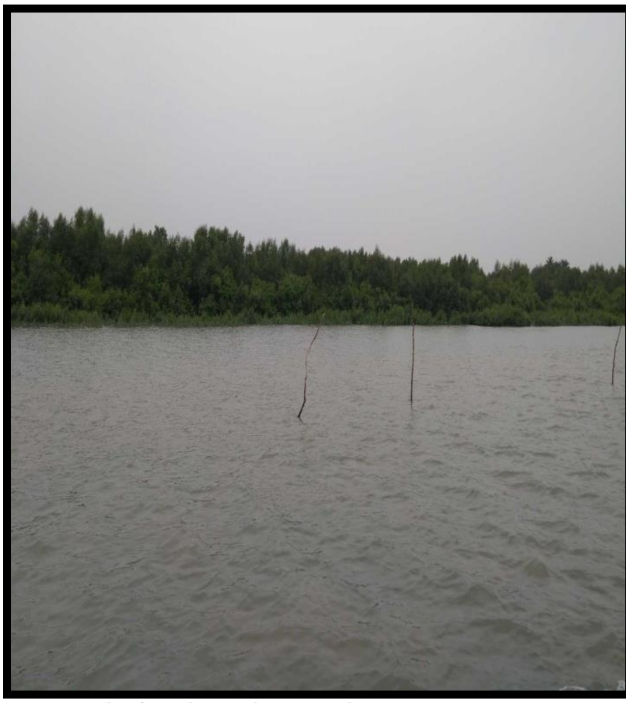
JETTY AT CHAINAGE 75, RIGHT BANK

MANGROVES AT CHAINAGE 75, LEFT BANK

MANGROVES AT CHAINAGE 75, RIGHT BANK

FISHING NET AT CHAINAGE 75.5

MANGROVES AT CHAINAGE 75.5, RIGHT BANK

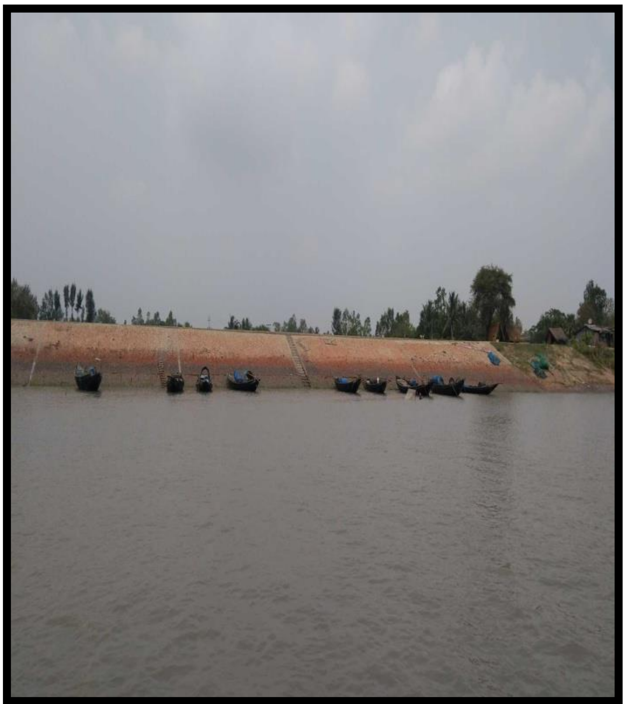


MANGROVES AT CHAINAGE 75.5, LEFT BANK

MANGROVES AT CHAINAGE 75.5, RIGHT BANK

FISHING NET AT CHAINAGE 75.5

MANGROVES AT CHAINAGE 76, LEFT BANK



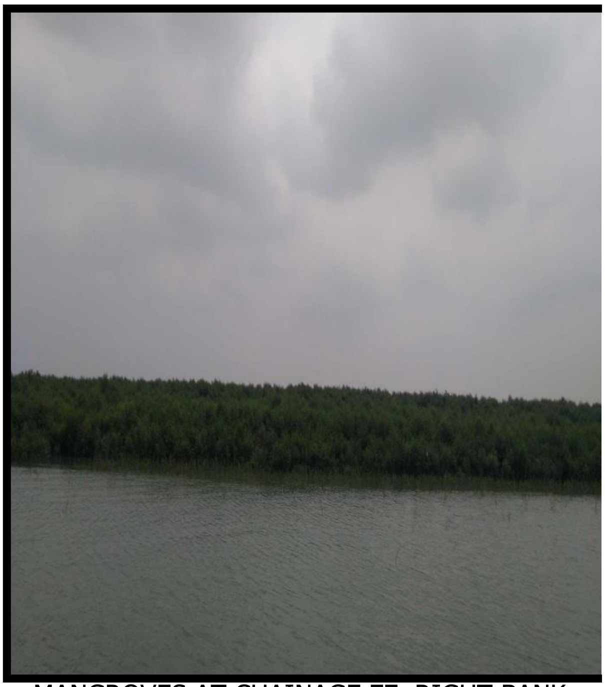
BANK PROTECTION WALL AT CHAINAGE 76.5, LEFT BANK

BANK PROTECTION WALL AT CHAINAGE 76.5, LEFT BANK

FISHING NET AT CHAINAGE 76.5

FISHING NET AT CHAINAGE 76.5,

JETTY AT CHAINAGE 76.5, LEFT BANK



MANGROVES AT CHAINAGE 77, RIGHT BANK

BANK PROTECTION WALL AT CHAINAGE 77.5, LEFT BANK

BANK PROTECTION AT CHAINAGE 77.5, LEFT BANK

MANGROVES AT CHAINAGR 77.5, RIGHT BANK

MANGROVES AT CHAINAGR 77.5, RIGHT BANK

MANGROVES AT CHAINAGE 78, LEFT BANK

MANGROVES AT CHAINAGE 78, LEFT BANK

MANGROVES AT CHAINAGE 78.5, RIGHT BANK


MANGROVES AT CHAINAGE 79, RIGHT BANK


MANGROVES AT CHAINAGE 79, RIGHT BANK


MANGROVES AT CHAINAGE 79, LEFT BANK


MANGROVES AT CHAINAGE79.5, RIGHT BANK

MANGROVES AT CHAINAGE 79.5, LEFT BANK

MANGROVES AT CHAINAGE 80, RIGHT BANK

MANGROVES AT CHAINAGE 80, LEFT BANK

MANGROVES AT CHAINAGE 80.5, RIGHT BANK

MANGROVES AT CHAINAGE 80.5, LEFT BANK

MANGROVES AT CHAINAGE 80.5, RIGHT BANK

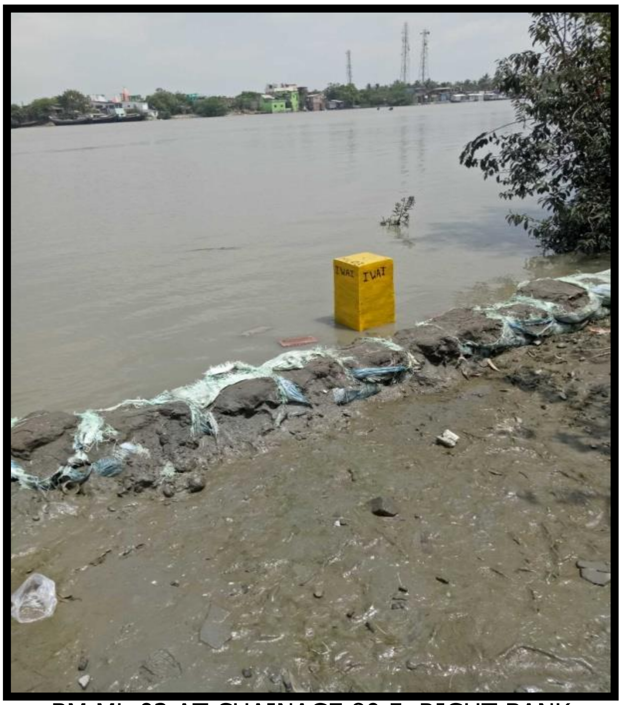
BASE OBSERVATION ML-03 AT CHAINAGE 80.5, RIGHT BANK

BASE OBSERVATION AT CHAINAGE 80.5, RIGHT BANK

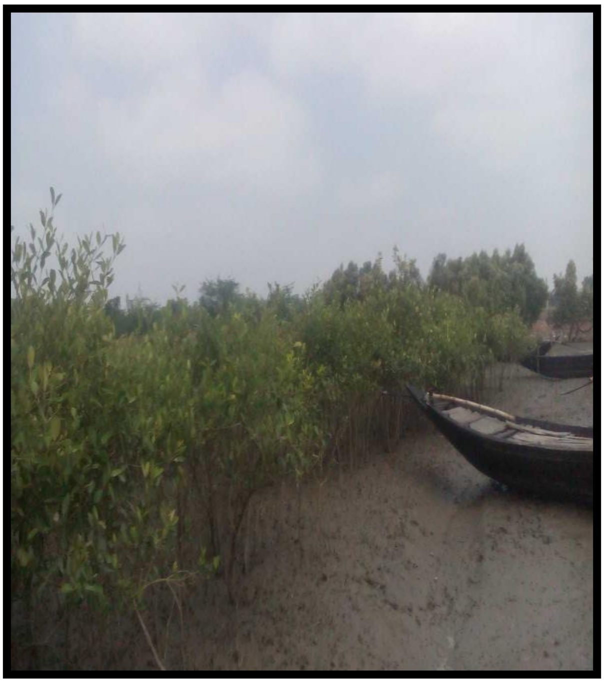
BASE STATION ML-03 AT CHAINAGE 80.5, RIGHT BANK

BASE STATION ML-03 AT CHAINAGE 80.5, RIGHT BANK

BM ML-03 AT CHAINAGE 80.5, RIGHT BANK



BM ML-03 AT CHAINAGE 80.5, RIGHT BANK



MANGROVE START AT CHAINAGE 81.5, LEFT BANK

MANGROVE START AT CHAINAGE 81.5, LEFT BANK

CREEK AT CHAINAGE 81.5, RIGHT BANK

FISHING NET AT CHAINAGE 81.5

MANGROVES AT CHAINAGE 81.5, LEFT BANK

FISHING NET AT CHAINAGE 81.5

BANK PROTECTION WALL AT CHAINAGE 82, RIGHT BANK

BANK PROTECTION WALL AT CHAINAGE 82.5, RIGHT BANK


MANGROVES AT CHAINAGE 82.5, LEFT BANK

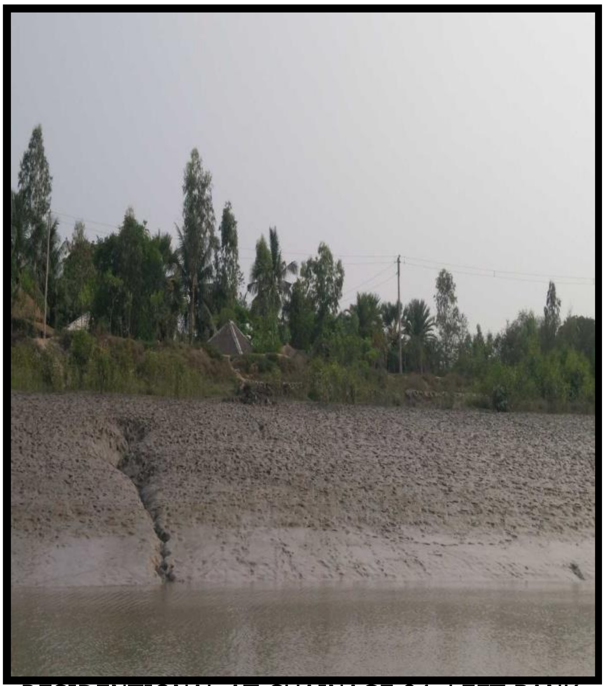

MANGROVES AT CHAINAGE 82.5, RIGHT BANK


MANGROVES AT CHAINAGE 83, LEFT BANK


MANGROVES AT CHAINAGE 83.5, LEFT BANK

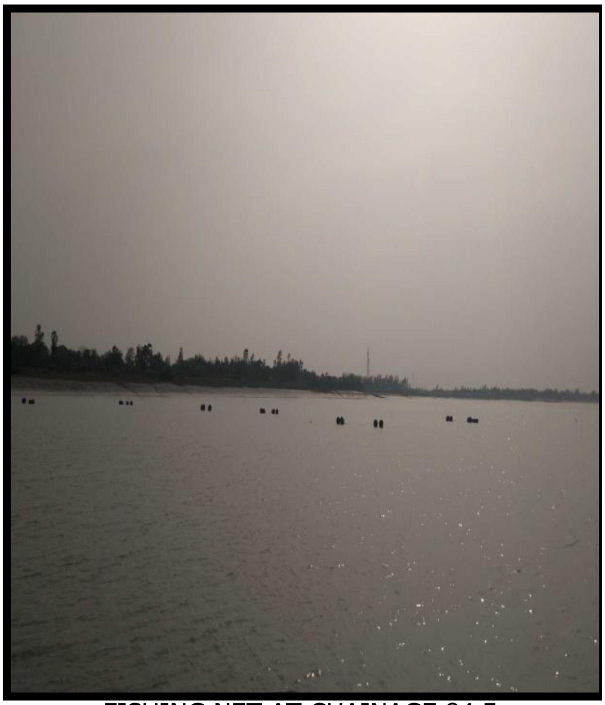
MANGROVES AT CHAINAGE 84, LEFT BANK

MANGROVES AT CHAINAGE 84, RIGHT BANK



RESIDENTIONAL AT CHAINAGE 84, LEFT BANK

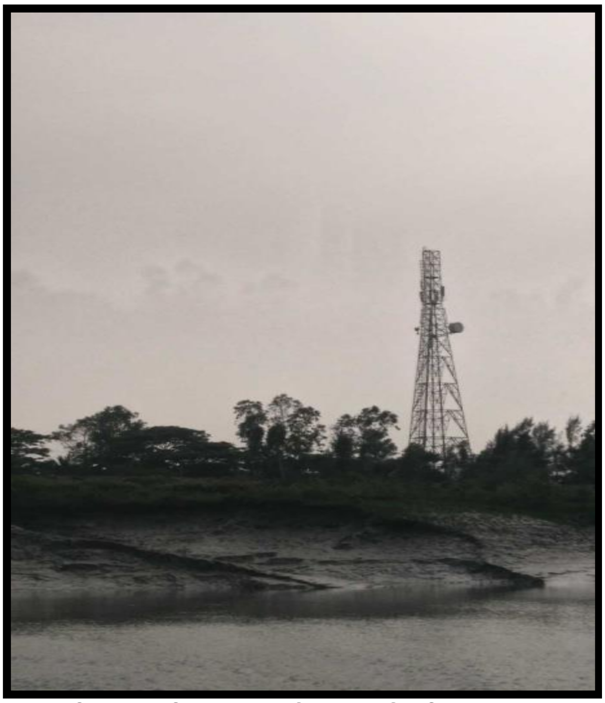
MANGROVES AT CHAIANGE 84.5, RIGHT BANK


FISHING NET AT CHAINAGE 84.5


JETTYAT CHAINAGE 84.5, RIGHT BANK

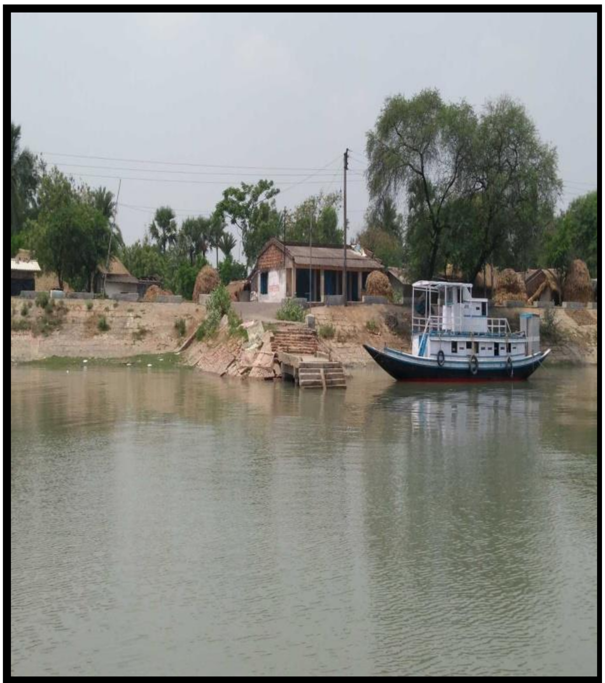

RIVER BANK AT CHAINAGE 85, RIGHT BANK


RESIDENTIONAL AT CHAINAGE 85, LEFT BANK



MOBILE TOWER AT CHAINAGE 85.5, LEFT BANK

MANGROVE END JETTY KOLABADI AT CHAINAGE 86.5, RIGHT BANK



JETTY AT CHAINAGE 86.5, LEFT BANK

MANGROVE END GARKHALI AT CHAINAGE 87.3, RIGHT BANK

NAVIGATION POLE AT CHAINAGE 87.5, RIGHT BANK

MANGROVES AT CHAINAGE 87.5, RIGHT BANK

MANGROVES AT CHAINAGE 87.5, RIGHT BANK

MANGROVES AT CHAINAGE 87.5, RIGHT BANK

MANGROVES AT CHAINAGE 88, LEFT BANK

MANGROVES AT CHAINAGE 88, RIGHT BANK

MANGROVES AT CHAINAGE 88, RIGHT BANK

FISHING NET AT CHAINAGE 88, LEFT BANK

FISHING NET AT CHAINAGE 88, LEFT BANK

MANGROVE START AT CHAINAGE 88.1, RIGHT BANK

MANGROVES AT CHAINAGE 88.5, LEFT BANK

MANGROVES AT CHAINAGE 88.5, LEFT BANK

MANGROVES AT CHAINAGE 88.5, RIGHT BANK

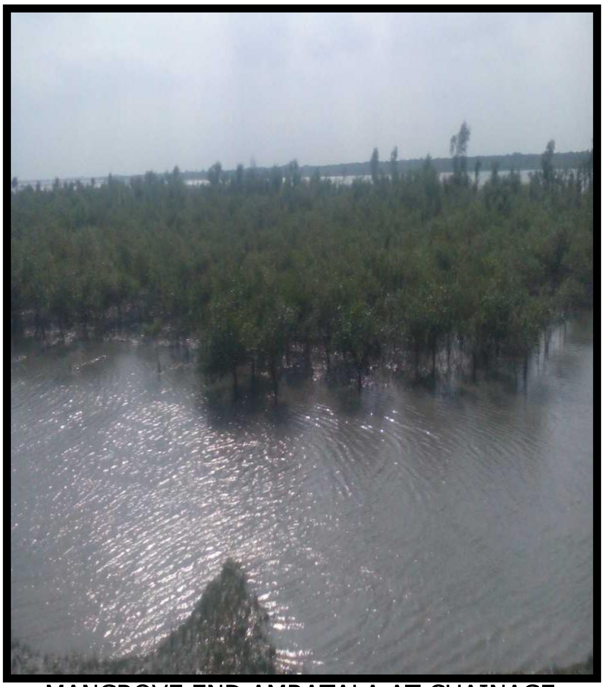
MANGROVES AT CHAINAGE 88.5, RIGHT BANK

FISHING NET AT CHAINAGE 89, LEFT BANK

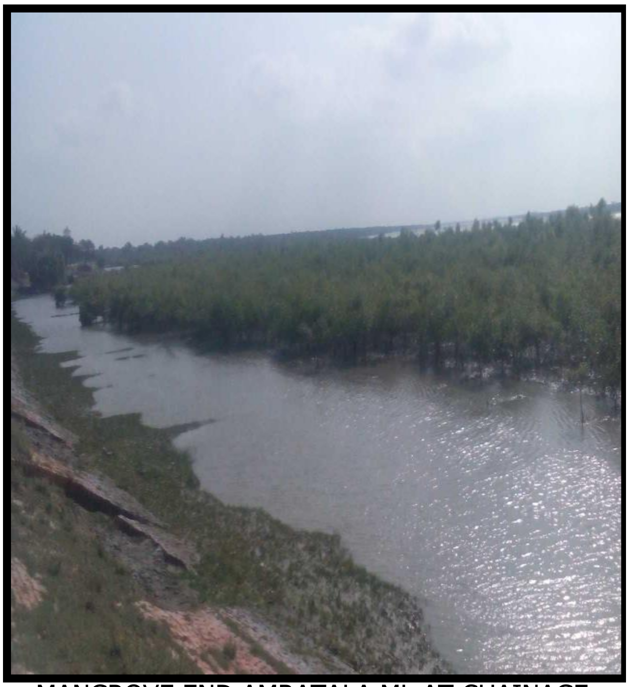
FISHING NET AT CHAINAGE 89, RIGHT BANK

MANGROVES AT CHAINAGE 89, RIGHT BANK

MANGROVES AT CHAINAGE 90, LEFT BANK



MANGROVE END AMRATALA AT CHAINAGE 90.3, LEFT BANK



MANGROVE END AMRATALA ML AT CHAINAGE 90.3, LEFT BANK

RIVER BANK PROTECTION AMRATALA 90.3, LEFT BANK

MANGROVES AT CHAINAGE 90.5, LEFT BANK

MANGROVES AT CHAINAGE 91, LEFT BANK

MANGROVES AT CHAINAGE 91, LEFT BANK


MANGROVES AT CHAINAGE 91, RIGHT BANK


MANGROVES AT CHAINAGE 91.5, LEFT BANK

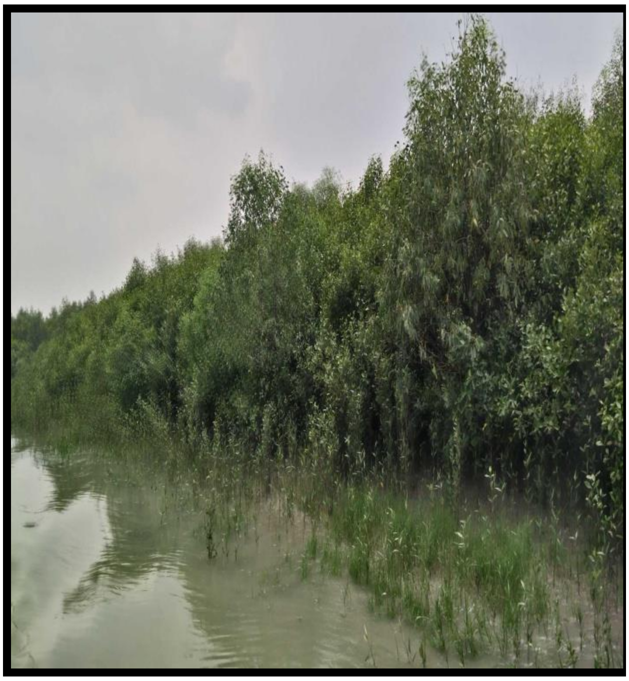

RIVER BANK AT CHAINAGE 91.5, RIGHT BANK


RIVER BANK AT CHAINAGE 92, RIGHT BANK

WATER LOCK NALIAKHALI AT CHAINAGE 92.2, LEFT BANK

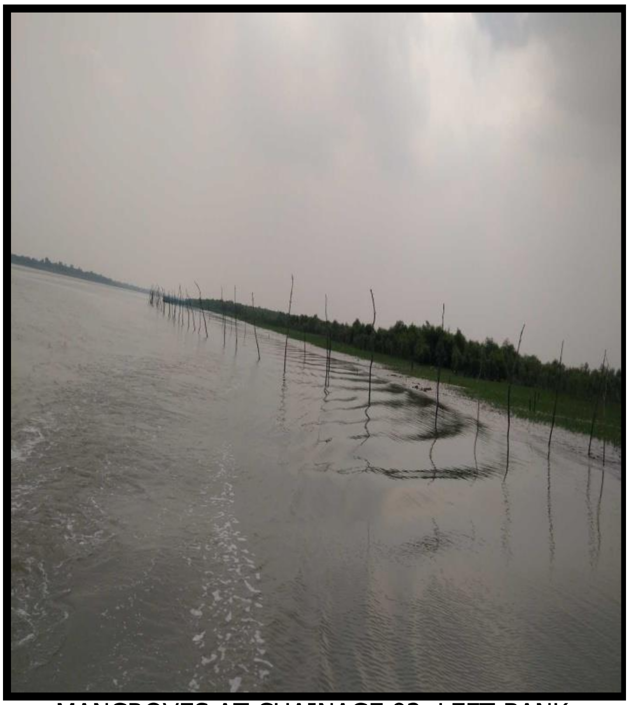
WATER LOCK NALIAKHALI AT CHAINAGE 92.3, LEFT BANK

FISHING NET AT CHAINAGE 92.5, LEFT BANK

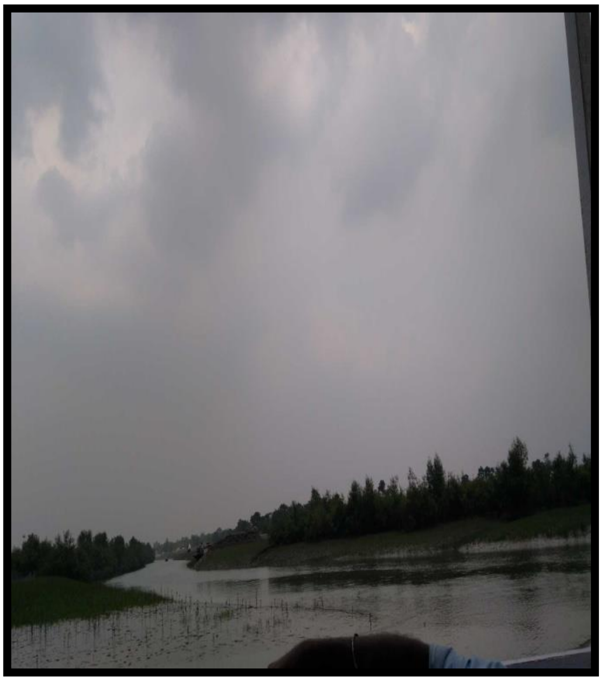


MANGROVES AT CHAINAGE 92.5, LEFT BANK

MANGROVES AT CHAINAGE 92.5, RIGHT BANK



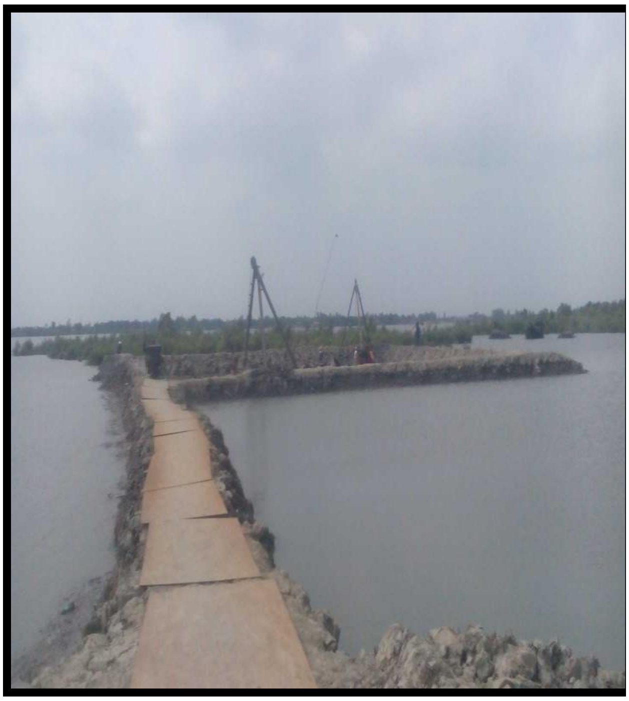
MANGROVES AT CHAINAGE 93, LEFT BANK



SHALLOW PATCH AT CHAINAGE 93, RIGHT BANK

PYLON NEW CONSTRUCTION SITE NALIAKHALI AT CHAINAGE 93.2, LEFT BANK

PYLON NEW CONSTRUCTION SITE NALIAKHALI AT CHAINAGE 93.2, LEFT BANK



PYLON NEW CONSTRUCTION SITE NALIAKHALI AT CHAINAGE 93.2, LEFT BANK

MANGROVE START NALIAKHALI AT CHAINAGE 93.2, LEFT BANK

MANGROVE START NALIAKHALI AT CHAINAGE 93.2, LEFT BANK

FISHING NET ON RIVER BANK AT CHAINAGE 93.5, RIGHT BANK

FISHING NET ON RIVER BANK AT CHAINAGE 94, RIGHT BANK

RIVER BANK AT CHAINAGE 94.5, LEFT BANK

RIVER BANK AT CHAINAGE 95, LEFT BANK


RIVER BANK PROTECTION AT CHAINAGE 95, LEFT BANK


MANGROVES AT CHAINAGE 95, LEFT BANK


MANGROVES AT CHAINAGE 95.5, RIGHT BANK


MANGROVES AT CHAINAGE 96, LEFT BANK

FISHING NET AT CHAINAGE 96.5, LEFT BANK

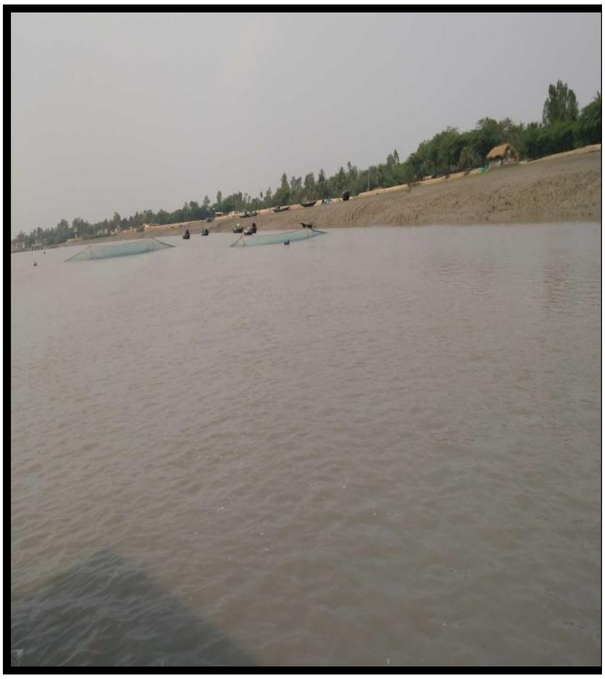
MANGROVES AT CHAINAGE 96.5, LEFT BANK

SHALLOW PATCH ON LOW WATER AT CHAINAGE 97, LEFT BANK

FISHING NET AT CHAINAGE 97, RIGHT BANK

FISHING NET AT CHAINAGE 97, RIGHT BANK

WATER LOCK AT CHAINAGE 97.5, RIGHT BANK



FISHING NET AT CHAINAGE 97.5, RIGHT BANK

FISHING NET AT CHAINAGE 97.5, RIGHT BANK

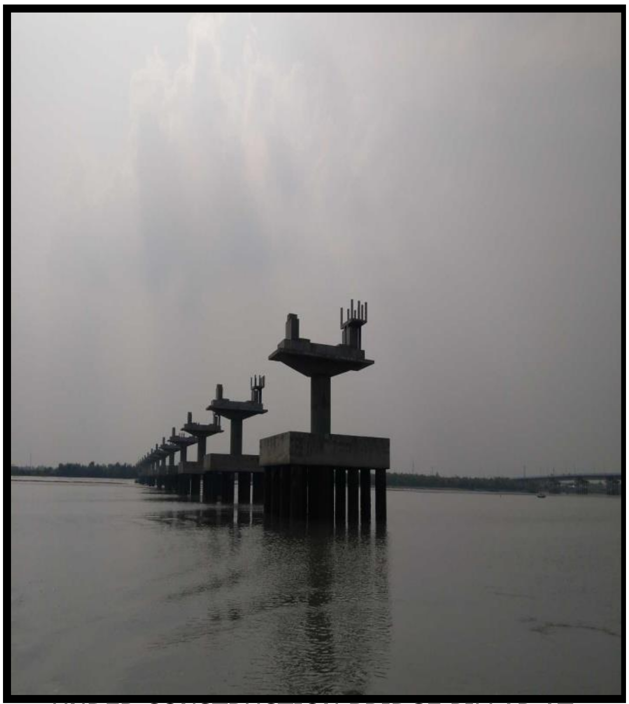
SHALLOW PATCH ON LOW WATER AT CHAINAGE 97.5, RIGHT BANK

CULVERT AT CHAINAGE 98, RIGHT BANK

UNDER CONSTRUCTION BRIDGE PILLAR AT CHAINAGE 98

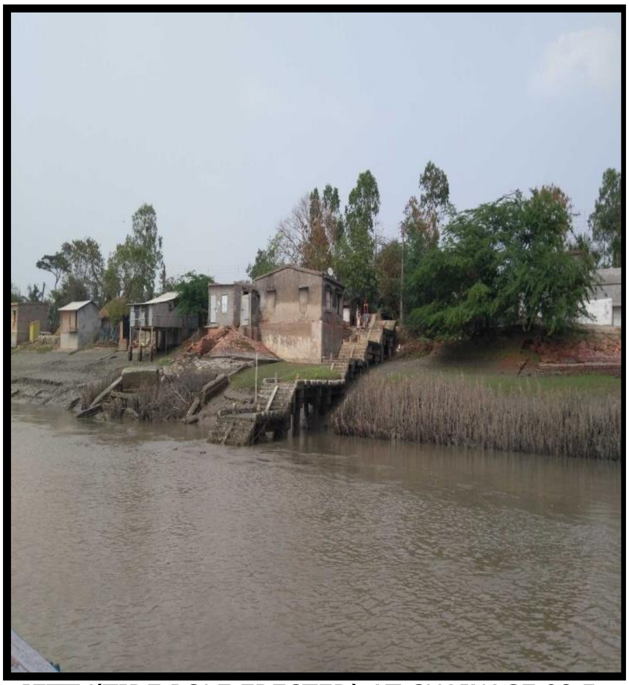
UNDER CONSTRUCTION BRIDGE PILLAR AT CHAINAGE 98

UNDER CONSTRUCTION BRIDGE PILLAR AT CHAINAGE 98



UNDER CONSTRUCTION BRIDGE PILLAR AT CHAINAGE 98

UNDER CONSTRUCTION BRIDGE PILLAR AT CHAINAGE 98

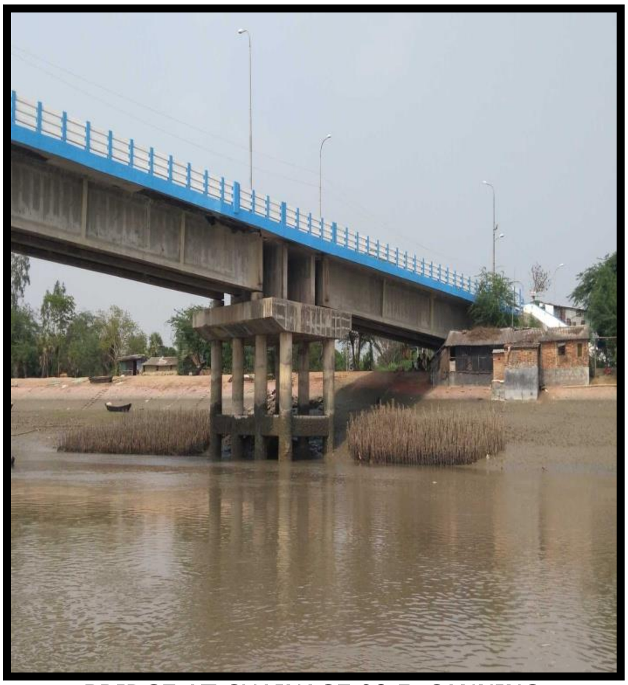


JETTY(TIDE POLE ERECTED) AT CHAINAGE 98.5, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 98.5, RIGHT BANK

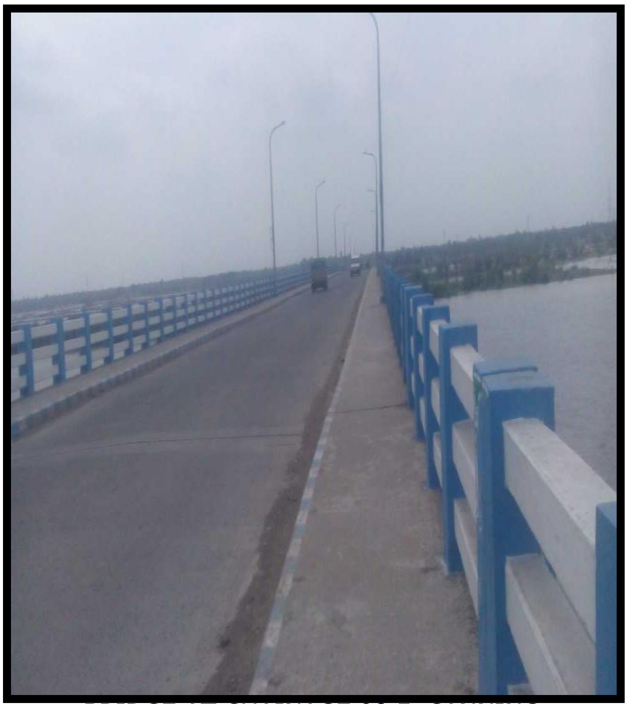
FISHING NET AT CHAINAGE 98.5, RIGHT BANK

BRIDGE AT CHAINAGE 98.5, CANNING



BRIDGE AT CHAINAGE 98.5, CANNING

BRIDGE AT CHAINAGE 98.5, CANNING



BRIDGE AT CHAINAGE 98.5, CANNING

BRIDGE AT CHAINAGE 98.5, CANNING

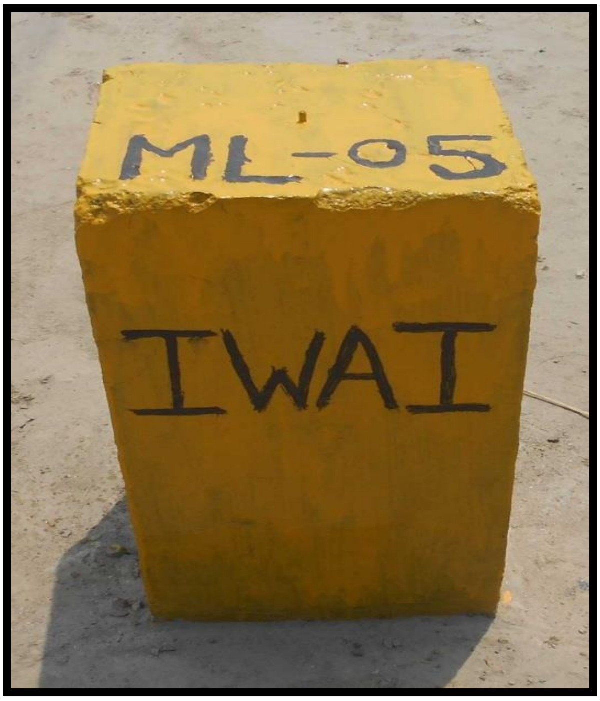
BRIDGE PILLAR AT CHAINAGE 98.5, CANNING

BRIDGE FOUNTATION STONE AT CHAINAGE 98.5

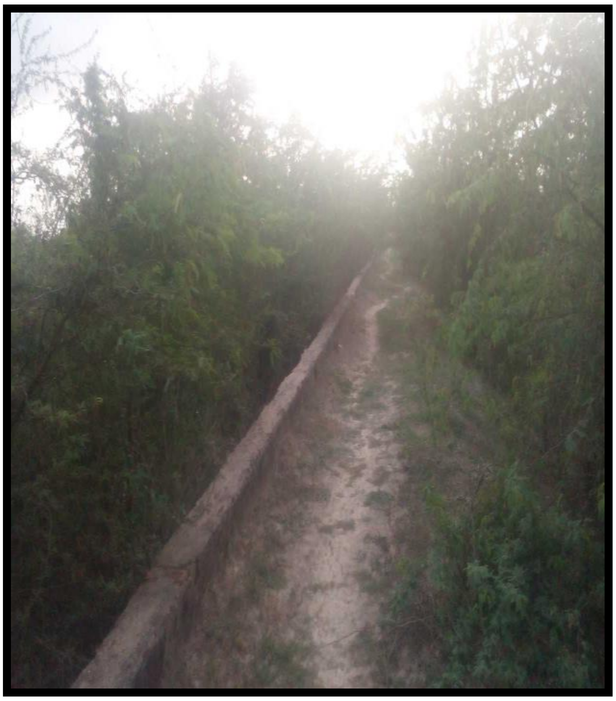
BASE OBSERVATION ON ML-05 AT CHAINAGE 98.5

BASE OBSERVATION ON ML-05 AT CHAINAGE 98.5

BASE OBSERVATION ON ML-05 AT CHAINAGE 98.5



BM ML-05



TREE COVERED AREA AT CHAINAGE 98.7, RIGHT BANK

RIVER BANK PROTECTION AT CHAINAGE 99, RIGHT BANK

VOLUME – II

DRAWINGS