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

SUNDERBANS WATERWAYS

RIVER: THAKURRAN RIVER (STATE OF WEST BENGAL)

GOBARDHANPUR TO BHUVANKHALI (63.865 KM)

(Volume – I: Main Report)

(Volume – II: Drawings)

Submission Date: 21/01/2021

Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 1

JANUARY 2021

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Submission Date: 21/01/2021

Project: Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of Cluster 3 National Waterways

Owner: IWAI, Ministry of Shipping

Consultant: Egis India Consulting Engineers

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1	For Acceptance	Jan 2021	Team	A Khullar	JK Panigrahi
0	For Approval	Sep 2020	Team	A Khullar	JK Panigrahi
Revision	**Description**	**Date**	**Prepared By**	**Checked By**	**Approved By**
Final DPR **Volume-I Main Report** **Volume-II Drawings**			**Classification**: Restricted		
Distribution IWAI			**Digital**	**Number of copies** 3	

LIST OF VOLUMES

ACKNOWLEDGEMENT

Egis India Consulting Engineers Pvt Ltd (EIPL) expresses their gratitude to ***Dr. Amita Prasad, IAS, Chairperson,*** *for spending her valuable time and guidance for completing this "Final Detailed Project Report (DPR) of Thakurran River, Sunderbans Waterways (National Waterway 97)". EIPL would also like to thank* ***Shri Pravir Pandey, IA&AS, Vice Chairman, Shri Rajesh Kumar Pathak, IP&TAFS, Member (Finance), Shri S.K. Gangwar, Member (Technical)*** *for their valuable support during the execution of project.*

EIPL wishes to express their gratitude to ***Sh. S.V.K Reddy, Chief Engineer-I (I/c Hydrographic Chief), IWAI*** *for his guidance and inspiration for this project. EIPL would also like to thank* ***Sh. Rajiv Singhal, S.H.S., IWAI*** *for their invaluable support and suggestions provided throughout the project duration. EIPL is pleased to place on record their sincere thanks to other staff and officers of IWAI for their excellent support and co-operation throughout the project duration.*

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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.
IMO	International Maritime Organisation
VHF	Very High Frequency
RIS	River Information System

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

Sr. No.	Particulars	Details						
A.	**GENERAL**							
1.	***Location***							
a)	Cluster	3						
b)	State(s)	West Bengal						
c)	Co-ordinates & Name of Place	**Start**			**End**			
	Place	Bisalakshmipur			Kastala			
	Latitude	21°33'31.78"N			22° 2'52.46"N			
	Longitude	88°27'45.28"E			88°33'27.97"E			
B.	**TECHNICAL**							
1.	***Waterway***							
a)	National Waterway Number	97						
b)	Class	VII						
c)	Type (Tidal/Non-Tidal)	Tidal						
	Length (Km.)	**Total**		**Tidal**		**Non-Tidal**		
		63.865 kms		63.865 kms		0 Km		
d)	Sounding Datum							
	Description/Basis	Sounding Datum was transferred at all the newly established BM's using Sagar values. Standard method was adopted for transfer of datum for tidal reaches areas as per Admiralty Manual.						
	Value w.r.t MSL (m)	**0 – 10 Km**	**10.1 to 20.0 KM**	**20.1 to 30.0 KM**	**30.1 to 40.0 KM**	**40.1 to 50.0 KM**	**50.1 to 60.0 KM**	**60.1 to 63.8KM**
		-2.82	-2.82	-2.82	-2.82	-2.82	-2.82	-2.82
e)	LAD Status (w.r.t. SD)							
	Stretch Km (From……To……)	**0-10**	**10 to 20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-63.865**
	Length with LAD < 1.2 m	0	0	0	2.079	5.481	8.645	3.865
	With LAD from 1.2-1.4 m	0	0	0	1.014	0.356	0.22	0

Sr. No.	Particulars	Details						
	With LAD from 1.5-1.7 m	0	0	0	0.237	0.28	0.211	0
	With LAD from 1.8-2.0 m	0	0	0	0	0.53	0.803	0
	With LAD > 2.0 m	10	10	10	6.67	3.353	0.121	0
f)	Target Depth of Proposed Fairway (m)	2.75 m for Class VII waterway						
g)	Conservancy Works Required							
	Type of Work	**0-10 Km**	**10 to 20 Km**	**20-30 KM**	**30-40 Km**	**40-50 Km**	**50-63.865 Km**	**Total (Km)**
	Dredging Required (M. Cum.)	Nil	Nil	0.007	0.782	1.771	1.752	4.313
	Bandalling	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	River Training (Km.)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	Bank Protection (Km.)	Nil	Nil	Nil	Nil	Nil	Nil	Nil
h)	Existing Cross Structures							
	Name of Structure	**Type**	**Nos.**	**Range of Horizontal Clearance**	**Range of Vertical Clearance w.r.t. MHWS**			
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil			
	Bridges	Nil	Nil	Nil	Nil			
	HT/Tele-communication lines	Nil	Nil	Nil	Nil			
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil			
2.	***Traffic***							
a)	Present IWT Operations (type of services)	Indo Bangladesh Protocol route crosses Thakurran river near Sripatinagar. Locally operated passenger ferry services are operational all along the waterway.						
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	Not Available						
c)	Connectivity of major industries with Rail/Road network	The left river bank of the Thakurran River has Raidihgi to Kuyemuri road in the vicinity. SH 1 and the nearest rail head are at Canning						

Sr. No.	Particulars	Details				
	(Distances/Nearest Railway Stations etc.)	which is 32 Km away. Private vehicles are not easily available in the nearby area. The public transport buses are operated by West Bengal state and the area is well connected with nearby cities				
d)	Commodities	**In-bound**		**Out-bound**		
		Passenger		Passenger		
e)	Existing and Future Potential					
	Name of Commodity	**Existing**	**5 years**	**10 years**	**15 years**	**20 years**
	Passengers with 8% growth rate (nos. per day)	1,500	2,571	3,777	5,550	8,155
3.	***Terminals/Jetties***					
a)	Terminal/Jetty - 1	Ganga Ferry Terminal				
	Location	Right Bank				
	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, Parking, Passenger waiting and ticketing area, Office complex				
	Approach	River bank road				
	Land Ownership	Government				
	Area (sq.m.)	1200				
b)	Terminal/Jetty - 2	Debipur Ferry Terminal				
	Location	Right Bank				
	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, Parking, Passenger waiting and ticketing area, Office complex				
	Approach	River bank road				
	Land Ownership	Government				
	Area (sq.m.)	1200				

Sr. No.	Particulars	Details	
c)	Terminal/Jetty - 3	Dhaki Ferry Terminal	
	Location	Left Bank	
	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, Parking, Passenger waiting and ticketing area, Office complex	
	Approach	State Highway	
	Land Ownership	Government	
	Area (sq.m.)	1200	
4.	***Design Vessel***		
a)	Type	Steel ferry vessel	
b)	No. & Size	5 Nos. (20.0m L x 4.0m B x 1.70mD) from start date of operation, additional 8 vessels in 10th year of operation and additional 14 vessels in 20th year of operation.	
c)	Loaded Draft	1.0 m	
d)	Capacity	50 passengers	
5.	***Navigation Aids***		
a)	Type	Marking buoys	
b)	Nos.	20	
c)	Communication Facilities	1.0 no. RIS system	
C.	**FINANCIAL**		
1.	***Cost***	***Capital Cost*** (INR Lakhs)	***O&M Cost*** (INR Lakhs)
	Fairway Development	8,625.19	862.52
	Terminal Structures	1,187.82	93.17
	Vessels	400.00	179.30
	Total Cost including Vessel	10,670.69	1,319.49

Sr. No.	Particulars	Details		
	Total Cost without Vessel cost	10,270.69	1,194.94	
2.	***User Charges***	INR 12.50 per passenger per Km (for proposed 2 OD pairs of Ganga-Debipur Jetty and Dhaki-Debipur jetty)		
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
		1.57%	3.94%	104.33%
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
		2.13%	4.45%	118.62%

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. Thakurran river is one of the 13 rivers clubbed in Cluster 3.

This detailed project report of 63.865 kms km stretch of Thakurran 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 63.865 kms stretch of Thakurran river National waterway proposed for DPR study lies from G-Plot at Lat 21°33'31.78"N, Long 88°27'45.28"E to Madhabpur at Lat 22° 2'52.46"N, Long 88°33'27.97"E. Whole stretch of Thakurran river waterway is having tidal influence with a maximum tidal variation of 5.05 m to a minimum tidal variation of 2.28 m.

River width in the waterway stretch varies from 0.03 Km to 6.85 Km. Average flow velocity in the waterway varies from 0.49 m/sec to 1.99m/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 63.865 km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation. The waterway is proposed to be developed as Class VII, and for this classification 43,12,593 cum of dreding is required to be done. The total capital and O&M cost of fairway development works out to INR 8,625.19 Lakh and INR 862.52 Lakh respectively.

4.0 TRAFFIC STUDY

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

a) Proposed Thakurran waterway is connected with Indo Bangladesh waterway protocol route.

b) Large cargo vessels navigating along Indo Bangladesh Protocol Route navigates through Thakurran river at a Chainage of 28.365 Km near Sripatinagar.

c) There are no big industries near the survey area, however few brick kilns are found along the river banks.

d) Passenger ferries are proposed to be operated in 19.20 Km waterway stretch from proposed Ganga jetty to proposed Dhaki jetty.

In view of existing passenger traffic per day and connectivity of Thakurran river with major waterways, 3 passenger ferry ghats, Ganga, Debipur and Dhaki are recommended to be developed for IWT services.

5.0 TERMINALS

Number of existing ferry terminals are located along Thakurran river. The existing ferry terminals lack facilities like embarking/disembarking of vessels, basic amenieties for passengers etc. In this DPR, following terminals are proposed to be developed with floating pontoons, gangway and necessary terminal facilities:

a) Ganga,
b) Debipur, and
c) Dhaki.

Ganga ferry terminal is also proposed to be developed to provide support and related services to vessels operating along Indo Bangladesh Protocol route. 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 Terminals excluding land cost	1,187.82
2.0	O&M cost for Terminals	93.17

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 terminal structures:

- Floating Pontoon
- Gangway
- Approach Platform
- Parking Facilities
- Terminal Building

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

7.0 VESSEL DESIGN

Steel ferry vessels developed by West Bengal Transport Infrastructure Development Corporation (WBTIDC) or other local manufacturers, with carrying capacity of 50 passengers are proposed to be operated on Thakurran 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 5 vessels initially and after 10 year of services on the basis of growing passenger traffic additional 8 vessels shall be incorporated in the existing fleet. In 20th year of operation additional 14 vessels shall be incorporated to cater the growing traffic demand. The procurement and O&M cost of ferry vessels works out to INR 400.00 lakh and INR 124.55 lakh in phase 1. Additional procurement and O&M cost of ferry vessels in phase 2 works out to INR 640.00 lakh and INR 199.28 lakh & in phase 3 works out to INR 1200.00 lakh and INR 348.74 lakh respectively.

8.0 NAVIGATION & COMMUNICATION SYSTEM

Aids to Navigation like RIS system and marking buoys are proposed along the channel alignment. Capital and maintenance cost for the same works out to INR 316.33 Lakh and INR 179.30 Lakh respectively.

9.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Thakurran 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 Lat 21°33'31.78"N, Long 88°27'45.28"E to Madhabpur at Lat 22° 2'52.46"N, Long 88°33'27.97"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) 2002/2016 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

The proposed development of passenger ferry services in Thakurran waterway shall be developed and maintained by a separate Project Management Unit (PMU) under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata.

About 4 permanent project staff and 4 additional support staff is envisaged to be engaged on contract/outsourcing basis. The total cost for Institutional set up (one time cost) works out to INR 39.00/- Lacs and total cost for manpower and training/capacity building (annual expenses) works out to INR 34.08 Lacs.

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) Approved DPR's of National Waterways by IWAI.

Thakurran waterway is proposed to be developed as Class VII waterway for a total stretch of 54.0 Km. Passenger ferries are proposed to be operated in 19.20 Km waterway stretch from proposed Ganga jetty (Chainage 34.5 Km) to proposed Dhaki jetty (Chainage 53.4 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 3 passenger terminals and 5 passenger ferry vessels at the inception stage. The ferry ghats proposed to be developed for Passenger ferry services in this DPR are Ganga, Debipur and Dhaki. The capital cost for development of the system components of the project viz., development of the designed waterway, construction of IWT terminals and purchasing of vessels has been worked out as INR 10,670.69 Lakh with 5 vessels. In 10th year of operation capital cost of purchasing additional 8 vessels is INR 640.00 Lakh and in 20th year of operation capital cost of purchasing additional 14 vessels is INR 1,120.00 Lakh. The additional vessels shall be purchased on the basis of growing traffic demand. Correspondingly O&M cost for Thakurran waterway works out to INR 1,319.49 Lakh from inception stage and additional INR 199.28 Lakh from 11th year of operation due to to procurement of additional vessels.

12.0 IMPLEMENTATION SCHEDULE

The project is scheduled to be completed in 24 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	Not Calculable	Not Calculable	7.93%	17.94%
3	3.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	21.22%	30.45%
4	4.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	30.68%	40.55%
5	5.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	39.30%	50.00%
6	7.50	-12.51%	-10.90%	-5.51%	-4.55%	60.50%	72.95%
7	10.00	-3.01%	-2.25%	0.33%	0.96%	82.19%	95.76%
8	12.50	1.57%	2.13%	3.94%	4.45%	104.33%	118.62%
9	15.00	4.70%	5.17%	6.63%	7.08%	126.76%	141.53%
10	20.00	9.16%	9.54%	10.69%	11.06%	172.07%	187.44%
	Not Calculable	All/majorly negative cash-flows					

From the above table, it is concluded that the proposed IWT operation along Thakurran waterway is financially and economically viable for all the three options with a tarrif of INR 12.50 per passenger per Km and above for proposed 2 OD pairs of Ganga-Debipur Jetties and Dhaki-Debipur jetties.

Project life cycle cost analysis is also done for Thakurran waterway DPR and for 20 years of project life cycle with a tariff of INR 12.50 per passenger per Km for proposed OD pairs, the results concluded are as below:

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

With project life cycle cost of INR 62,068 Lacs, the breakeven occurs during 19th year of operation.

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

With project life cycle cost of INR 52,953 Lacs, the breakeven occurs during 17th year of operation.

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

With project life cycle cost of INR 9,115 Lacs, the breakeven occurs during 0th year of operation.

14.0 CONCLUSION

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

a) Proposed Thakurran waterway is connected with Indo Bangladesh waterway protocol route.
b) By taking into advantage of tidal window, sufficient LAD is available in the complete 63.865 Km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation
c) Large cargo vessels navigating along Indo Bangladesh Protocol Route crosses Thakurran river at a Chainage of 28.365 Km near Sripatinagar.
d) There are no major industries near the survey area, however few brick kilns are found along the river banks.
e) Passenger ferries are proposed to be operated in 19.2 Km waterway stretch from proposed Ganga jetty to proposed Dhaki jetty.

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 12.50 per passenger per Km and above for proposed 2 OD pairs of Ganga-Debipur Jetties and Dhaki-Debipur jetties, 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 existing 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. Thakurran River was clubbed under Cluster -3 for the two stage DPR studies.

This detailed project report of 63.865 kms stretch of Thakurran River 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

Thakurran 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 Thakurran River) was covered in the Sunderbans waterways (NW-97). Following section of the Thakurran 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
63.865 kms	21°33'31.78"N,	G-Plot	22°2'52.46"N	Madhabpur
	88°27'45.28"E		88°33'27.97" E	

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

Based on the above conclusions/observations done during feasibility studies i.e. first stage of the studies, IWAI recommended following stretch of Thakurran 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
63.865 kms	21°33'31.78"N, 88°27'45.28"E	G-Plot	22°2'52.46”N 88°33'27.97" E	Madhabpur

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 63.865 Km stretch of Thakurran River 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.

Thakurran River project location as per DPR is shown in **Figure 1**. The detailed layout map of waterway is provided in drawing PT/EIPTIWB002/2018/DPR/001 attached as **Volume-II**.

Figure 1: Thakurran River 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.

Indo Bangladesh Protocol route crosses Thakurran River waterway near Sripatinagar.

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;

Stage-2:
Field Survey & Investigations

- Benchmark Establishment
- Hydrographic survey & Topographic details
- Water level (Guage Measurement)
- Current & Discharge Measurement
- Water & Soil samples
- Traffic Surveys

Stage-2:
Project Studies

- Analysis of Hydrographic survey data & existing infrastructure
- Traffic studies, Vessel analysis & dredging
- Proposed location for terminals/ports loading and unloading terminals
- Environmental Impact studies
- Fairway design, Navigational Aids and communication facilities
- River training, shore/bank protection measures
- Preliminary design of proposed facilities & infrastructure, alternatives
- BOQ and Cost Estimation
- Financial & Economic analysis

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:

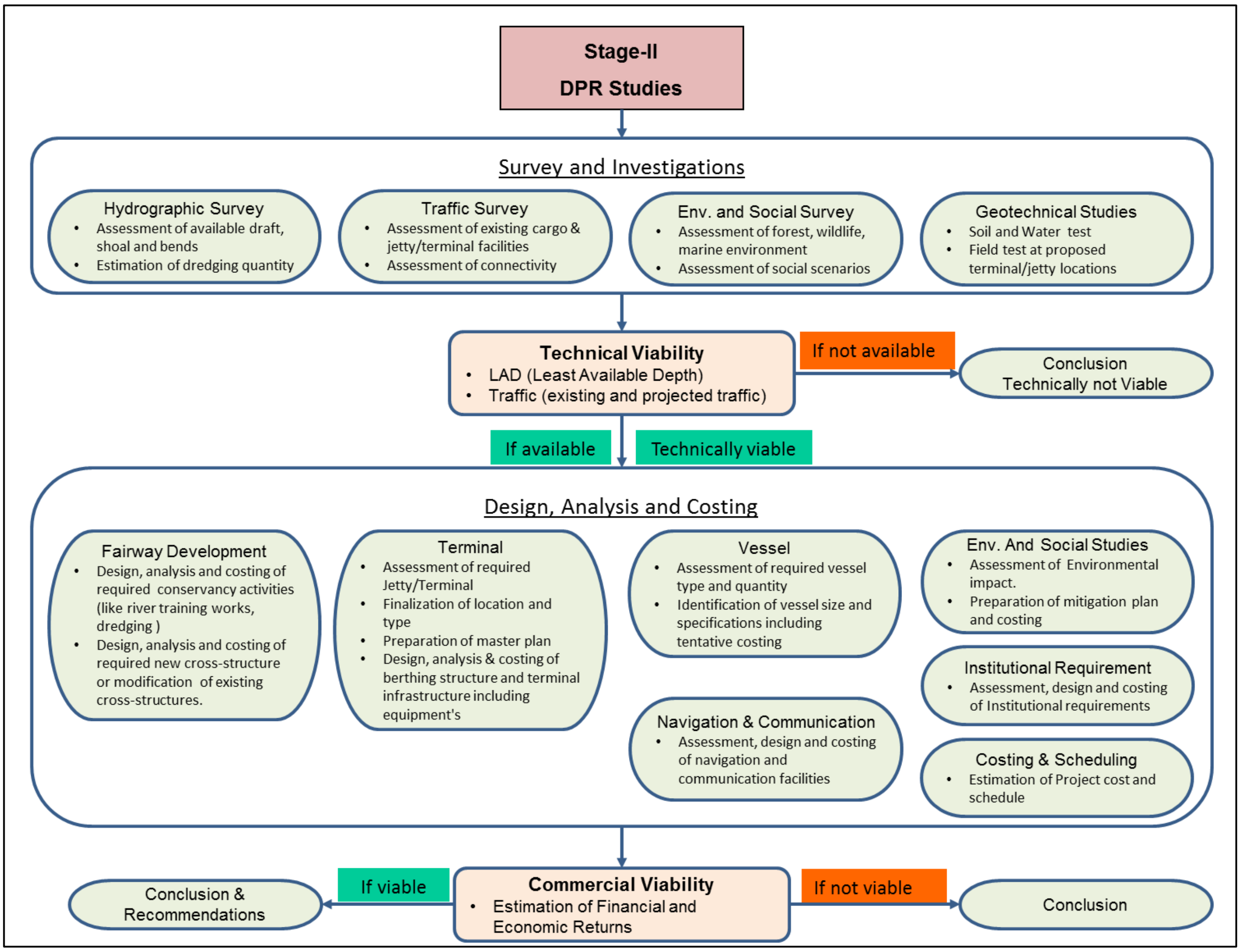

Figure 2: DPR Approach and Methodology Flow Chart

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 Thakurran River under DPR study is from G-Plot at Lat 21°33'31.78"N, Long 88°27'45.28"E to Madhabpur at Lat 22° 2'52.46"N, Long 88°33'27.97"E. The total length of this stretch is about 63.865 kms. The scope of the work to conduct hydrographic and topographic survey of this stretch of Thakurran River 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 Thakurran River is a tidal estuarine river that forms a wide estuary in and around the Sunderbans in South 24 Parganas district West Bengal, India. The river originates near Jaynagar and has a number of connections with Saptamukhi and forms the boundary between Mathurapur and Jaynagar blocks. To assess the feasibility of navigation over this stretch of river a bathymetric survey and topographic survey was carried out by Egis India Consulting Engineers Pvt Ltd.

The proposed 63.865 km stretch of waterway is located in the South 24 Parganas district of West Bengal. Whole stretch of Thakurran River waterway is having tidal influence with a maximum tidal variation of 5.045 m to a minimum tidal variation of 2.28 m.

Average flow velocity in the waterway varies from 0.49 m/sec to 1.99m/sec. Reduced depth at every 1 Km intervals for full stretch of the river is provided in **Chapter 3**.

2.1.2 Existing Hydrological / Topographical Reference levels

There was no GTS Station available near the survey area. As per IWAI guidelines, a 24 hour observation was carried out at TR 06 and data was post processed through Auspos. Simultaneously 4 hour observations were carried out at newly established BM, TR-07, TR -05, TR-04, TR-03, TR-02 & TR-01. All 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 Sagar. Thakurran river was divided into 10 km stretches for ease of applying Tidal level corrections to the collected bathymetric data. The values of BM's TR-03, TR-04, TR-05, TR-06 & TR-07 w.r.t sounding datum were established by using few hour observation methods in accordance with Admiralty Manual of Hydrographic Surveying Vol 2 and SD value of TR-01 & TR-02 was transferred by base line processing method. Total seven in number BM pillars (named TR-01, TR-02, TR-03, TR-04, TR-05, TR-06 & TR-07) were constructed and erected along the river from G-Plot to Madhabpur.

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

Table 2: Description of Bench Marks

BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above MSL (m)	Height above SD (m)
TR-01	Gobardhanpur, G-Plot	5.5 KP	21°36'30.26	88°24'03.47	645013.102	2390137.099	4.129	6.949
TR-02	Taltala Ghat, Indrapur G-Plot	11.8 KP	21°39'44.07	88°24'36.58	645911.126	2396105.588	4.187	7.007
TR-03	Hatyshivda ghat (Upendra nagar)	26 KP	21°47'17.93	88°27'45.96	651223.159	2410113.497	3.553	6.373
TR-04	Bhamun ghat ,Sripatinagar	31.5 KP	21°50'01.14	88°29'05.70	653465.14	2415154.533	3.694	6.514

BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above MSL (m)	Height above SD (m)
TR-05	Purbha shridhapur	41.8 KP	21°54'49.37	88°29'35.28	654228.328	2424026.702	4.561	7.381
TR-06	Majher kheya	50.8 KP	21°58'33.72	88°29'48.78	654548.353	2430930.025	4.276	7.096
TR-07	Bhuvankhali	59.4 KP	22°00'23.25	88°32'57.57	659929.587	2434352.463	4.641	7.461

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 wrt SD (m)
	A	B	C	D (+ve indicates above MSL, -ve indicates below MSL)	E	F = (E-WL data in MSL)	G = ((E-topo levels in MSL)
1	Gobardhanpur , G-Plot	5.5	0.0 to 10.0	-2.82	-2.82	Tide Applied w.r.t SD	-2.82
2	Taltala Ghat, Indrapur G-Plot	11.8	10.1 to 20.0	-2.82	-2.82		-2.82
3	Hatyshivda ghat (Upendra nagar)	26	20.1 to 30.0	-2.82	-2.82		-2.82

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 wrt SD (m)
	A	B	C	D (+ve indicates above MSL, -ve indicates below MSL)	E	F = (E-WL data in MSL)	G = ((E-topo levels in MSL)
4	Bhamun ghat, Sripatinagar	31.5	30.1 to 40.0	-2.82	-2.82		-2.82
5	Purbha Shridhapur	41.8	40.1 to 50.0	-2.82	-2.82		-2.82
6	Majher Kheya	50.8	50.1 to 60.0	-2.82	-2.82		-2.82
7	Bhuvankhali	59.4	60.1 to 63.865	-2.82	-2.82		-2.82

2.2 EXISTING CROSS STRUCTURES

2.2.1 Bridges

There are no bridges located along the waterway.

2.2.2 Electric Lines / Communication Lines

There is no High tension line crossing the Thakurran River.

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

Bends located along the Thakurran waterway is provided as below:

Table 4: Details of Bends along Thakurran River

Sl. No.	Start Chainage (Km)	End Chainage (Km)	Bend Radius (m)
1.0	37.94	44.39	4582.21
2.0	45.76	50.14	3334.34
3.0	51.35	56.52	1920.63
4.0	58.85	59.72	1049.38
5.0	59.72	63.19	1175.47

2.4 VELOCITY AND DISCHARGE DETAILS

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

Table 5: Current Meter and Discharge Details

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area(Sq m)	Discharge (Cu.m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
1	5	21°36'35.182"N	88°26'03.470"E	648462.37	2390319.76	3.8	1.20	1.03	0.98	1.99	57108	113835.28

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			
2	17	21°42'07.085"N	88°27'39.274"E	651121.33	2400552.13	8.5	1.25	1.00	0.94	1.06	74153	78849.36
3	29	21°48'51.6304"N	088°30'02.4272"E	655114.6	2413032.4	4.4	1.04	0.92	0.72	0.89	18524	16548.11
4	42	21°54'51.9051"N	088°31'20.1812"E	657237.8	2424134.0	9.45	0.83	0.77	0.59	0.73	598	436.54
5	51	21°58'35.7293"N	088°29'58.1039"E	654815.1	2430994.2	5.8	0.80	0.64	0.58	0.67	111	74.74
6	63.5	22°02'34.7780"N	088°33'16.6386"E	660435.2	2438402.8	3.70	0.57	0.49	0.42	0.49	185	91.26

2.5 WATERWAY DESCRIPTION

The total 63.865 Km stretch of Thakurran River Waterway under DPR study, can be broadly divided in to six (6) stretches. **Table 6** below provides the details of sub-stretches of Thakurran River waterway.

Table 6: Sub-Stretches of Thakurran River Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Gobardhanpur	Chainage 10.0	0 Km	10 Km
2	Chainage 10.0	L Block	10 Km	20 Km
3	L Block	Purba Sripatinagar	20 Km	30 Km
4	Purba Sripatinagar	Baikuntapur	30 Km	40 Km
5	Baikuntapur	Bagdimari Mulo	40 Km	50 Km
6	Bagdimari Mulo	Madhabpur	50 Km	63.865 Km

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

2.5.1 Sub Stretch 1: From Gobardhanpur to Chainage 10.0 (Chainage 0 Km to 10 Km)

Bathymetric Survey was carried out for this stretch between 0 to 10 km chainage of the Thakurran River. It is the downstream portion of the Thakurran River where it falls into sea. The left bank of the river is sparsely populated, with fishing and farming being the main occupation of the people. This stretch is about 9.2 KM wide with some portion of the river bank protected. Since sufficient depth is available in this stretch Dredging is not required in this stretch. Fishermen extensively use the natural slope of the ground for landing the boats. The details of current and discharge at different depths is placed at **Table 5.**

Following are the observations made during survey of Sub-stretch 1: From Gobardhanpur to Chainage 10.0 (Chainage 0 Km to 10 Km)

- There are no overhead obstructions/crossovers.
- There are no prominent dams & barrage available in this stretch.
- There is no hindrance or encroachment in this stretch. However right bank is completely under sundarban Tiger Reserve.

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 10.0 Km) of Thakurran River Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 7**. **Figure 4** shows the observed and reduced bed profile of sub-stretch 1.

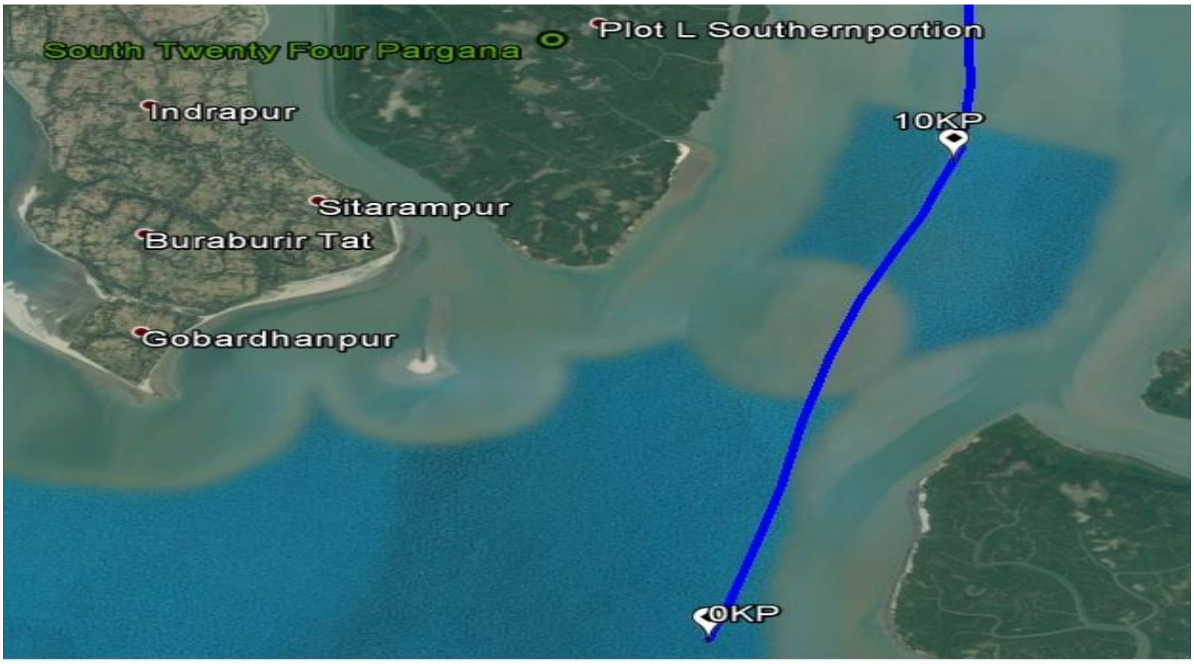

Figure 3: Google Image showing Sub-Stretch -1 of Thakurran River Waterway

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	0	10	Not Applicable (Tidal Zone)				7.92	17.19	0	0.00
II	0	10					7.90	17.19	0	0.00
III	0	10					7.90	17.19	0	0.00
IV	0	10					7.88	17.19	0	0.00
V	0	10					7.55	17.53	0	0.00
VI	0	10					7.44	17.53	0	0.00
VII	0	10					7.23	17.53	0	0.00

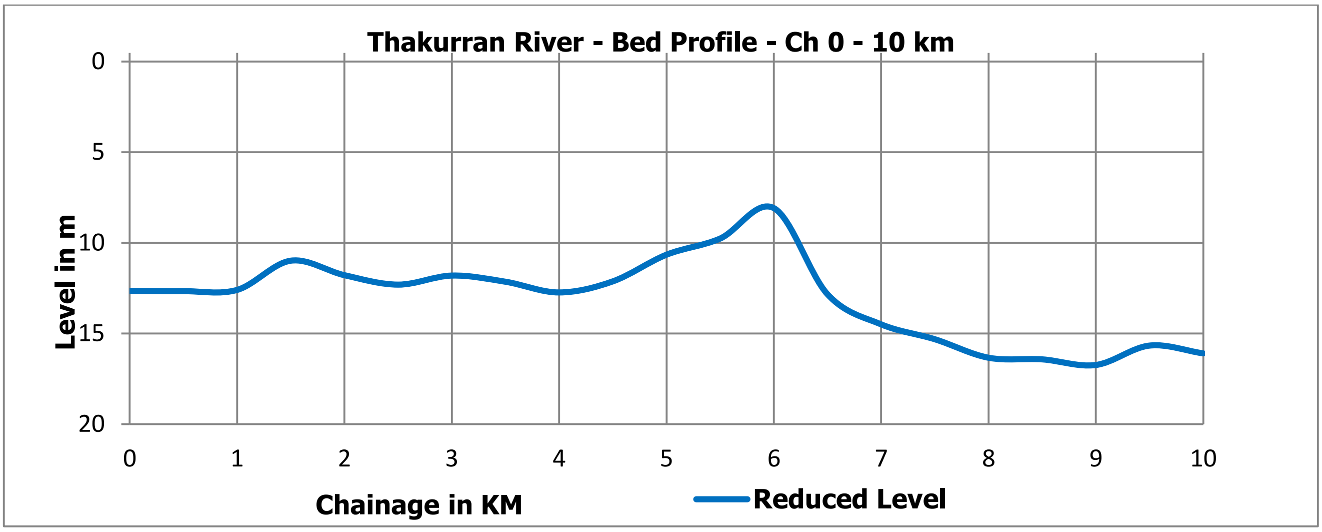

Figure 4: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

Figure 5: Photographs of Sub-Stretch 1

2.5.2 Sub Stretch 2: From Chainage 10.0 to L Block (10km to 20km)

Bathymetric Survey was carried out for this stretch between 10 to 20 km chainage of the Thakurran River. The area is sparsely populated on the left bank, with fishing and farming being the main occupation of the people & the fields in the area are dependent on the rainfall. This stretch is about 3.5 KM wide with no portion of the river bank protected. Since sufficient depth is available for all time navigation no Dredging would be required in this stretch. Fishermen extensively use the natural slope of the ground for landing the boats.

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

Following are the observations made during survey of Sub-stretch 1: From Chainage 10.0 to L Block (10km to 20km)

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no dams & Barrage available in this stretch.
- The tidal range is about 3.61 m in this stretch as we move from downstream to upstream.

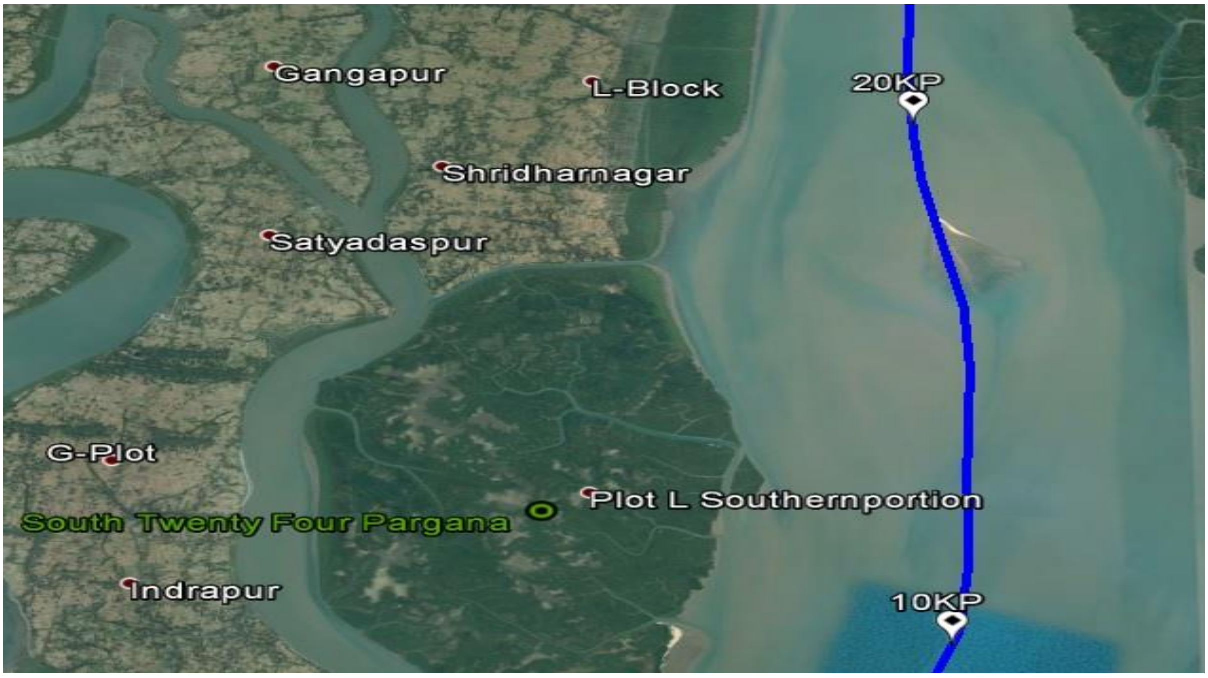

Figure 6: Google Image showing Sub-Stretch -2 of Waterway

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

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	10	20	Not Applicable (Tidal Zone)				12.47	17.86	0	0.00
II	10	20					12.47	17.88	0	0.00
III	10	20					12.47	18.04	0	0.00
IV	10	20					12.47	18.04	0	0.00
V	10	20					12.39	18.11	0	0.00
VI	10	20					12.39	18.11	0	0.00
VII	10	20					12.39	18.11	0	0.00

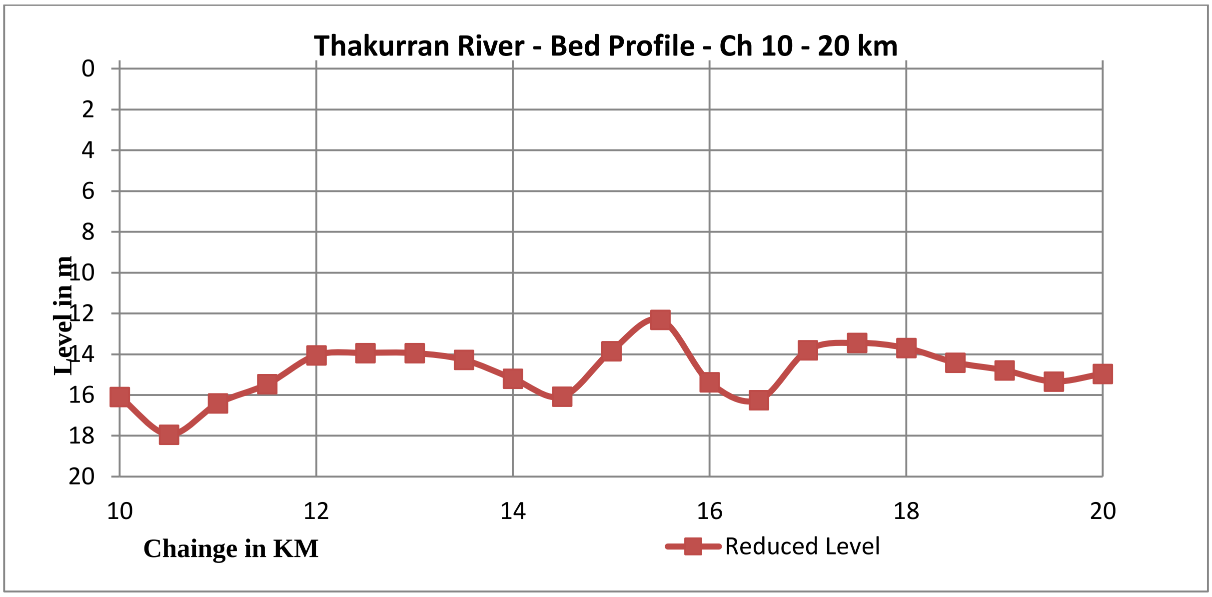

Figure 7: Bed Profile of Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

Figure 8: Photographs of Sub-stretch 2

2.5.3 Sub Stretch 3: From L Block to Purba Sripatinagar (20 km to 30 km)

Bathymetric and Topographic Survey was carried out for this stretch between 20 to 30 km chainage of the Thakurran River. The area is sparsely populated on the left bank. Fishing and farming are the main occupation of the people & the fields in the area are dependent on the rainfall. River banks are partially protected. This stretch width is about 3 KM. Since sufficient depth are available for all time Navigation, no dredging is required in this stretch. The details of current and discharge at different depths is placed at **Table 5**.

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no dams & Barrage available in this stretch.
- The tidal range is 5.05 m in this stretch as we move from downstream to upstream.

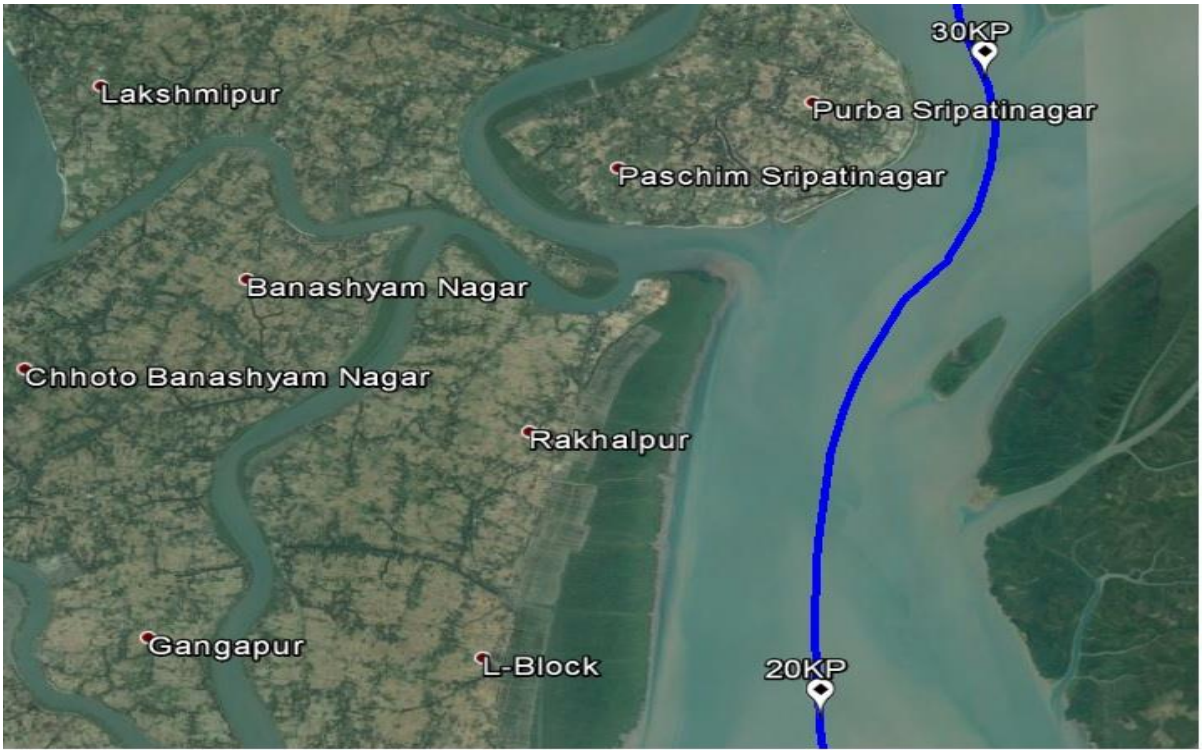

Figure 9: Google Image showing Sub-Stretch -3 of Waterway

Figure 9 above shows the alignment of sub-stretch 3 (Ch. 20.0 Km to 30 Km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 9**. **Figure 10** shows the observed and reduced bed profile of sub-stretch 3.

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	20	28.414	Not Applicable (Tidal Zone)				1.74	23.62	0	0.00
II	20	28.414					1.61	23.62	0	0.00
III	20	28.414					1.58	24.18	0	0.28
IV	20	28.414					1.58	24.18	0	310.80
V	20	28.414					1.39	24.29	0	931.17
VI	20	28.414					1.33	24.29	0	5825.90
VII	20	28.414					1.33	24.29	0	7388.76

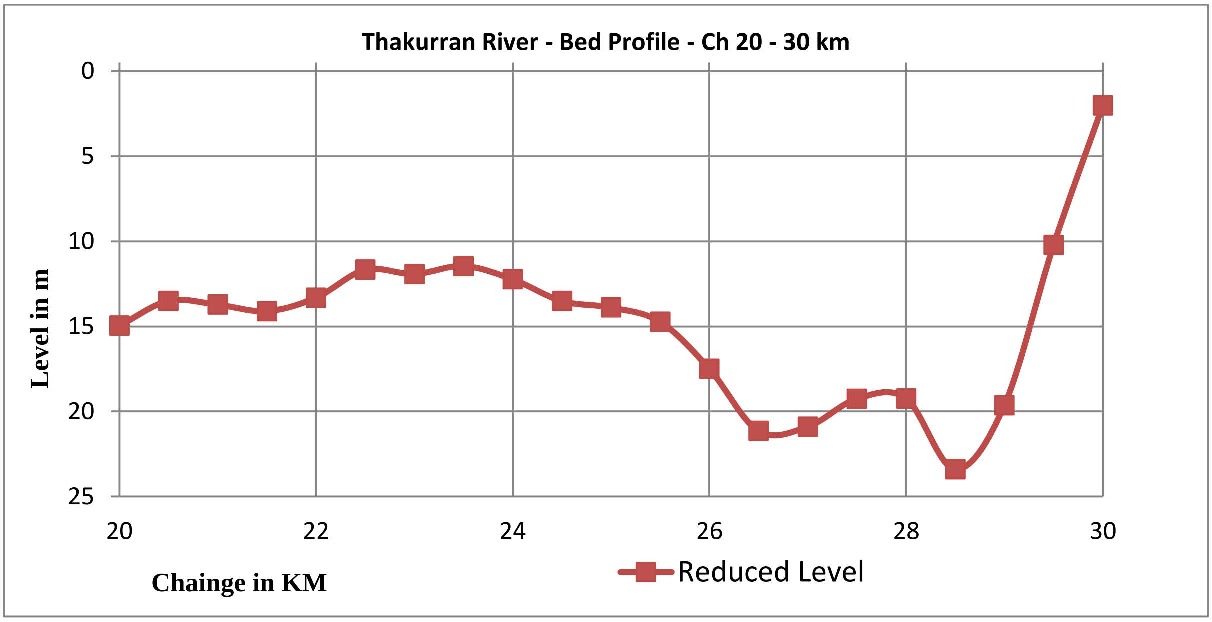

Figure 10: Bed Profile of Waterway Sub-stretch 3 (Chainage 20Km – 30 Km)

Figure 11: Photograph along Sub-Stretch 3

2.5.4 Sub Stretch 4: From Purba Sripatinagar to Baikuntapur (30 km to 40 km)

Bathymetric and Topographic Survey was carried out for this stretch between 30 to 40 km chainage of the Thakurran River. The area is sparsely populated. Fishing and farming are the main occupation of the people & the fields in the area are dependent on the rainfall. River banks are partially protected. Dredging would be required at some places for all time navigation. This stretch is narrow and average width is about 600 meters.

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

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 2.41 m in this stretch as we move from downstream to upstream.

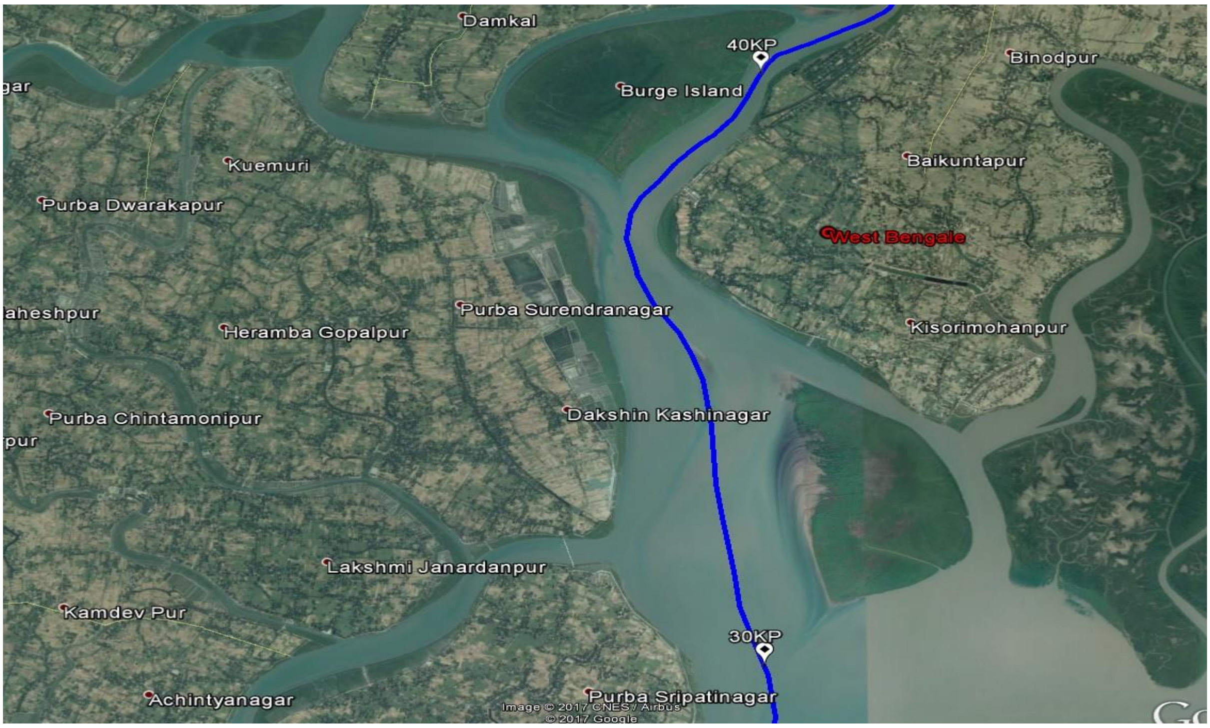

Figure 12: Google Image showing Sub-Stretch -4 of Waterway

Figure 12 above shows the alignment of sub-stretch 3 (Ch. 30 Km to 40 Km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 10.** **Figure 13** shows the observed and reduced bed profile of sub-stretch 4.

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
I	30	40	Not Applicable (Tidal Zone)				-1.14	20.38	600	24937.84
II	30	40					-1.14	20.38	600	73843.13
III	30	40					-1.14	20.87	600	133737.85
IV	30	40					-1.14	21.85	600	186768.52
V	30	40					-1.28	21.85	1600	310846.32
VI	30	40					-1.28	21.97	1600	610458.66
VII	30	40					-1.28	21.97	5400	781997.64

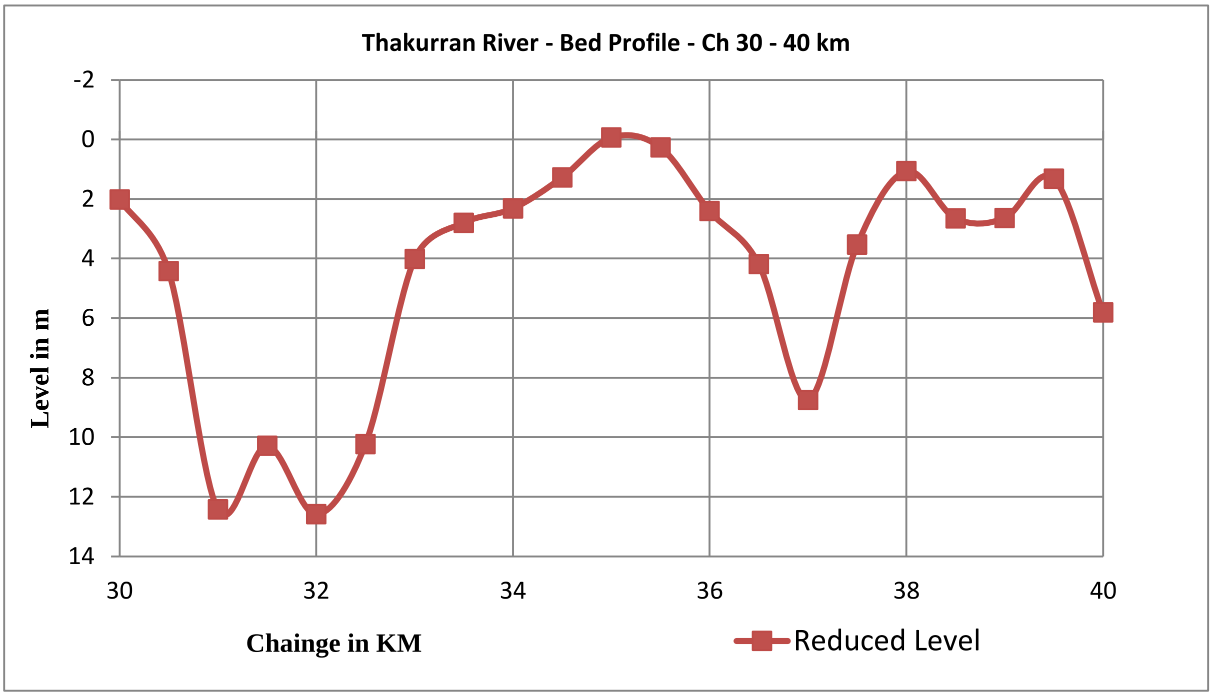

Figure 13: Bed Profile of Waterway Sub-stretch 4 (Chainage 30Km – 40 Km)

Figure 14: Photograph along Sub-Stretch 4

2.5.5 Sub Stretch 5: From Baikuntapur to Bagdimari Mulo (40 km to 50 km)

Bathymetric and Topographic Survey was carried out for this stretch between 40 to 50 km chainage of the Thakurran River. The area is sparsely populated .Fishing and farming are the main occupation of the people & the fields in the area are dependent on the rainfall. River banks are partially protected. This stretch is narrow and average width is about 250 meters. Dredging is required at some places for all time navigation.

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

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 3.32 m in this stretch as we move from downstream to upstream.

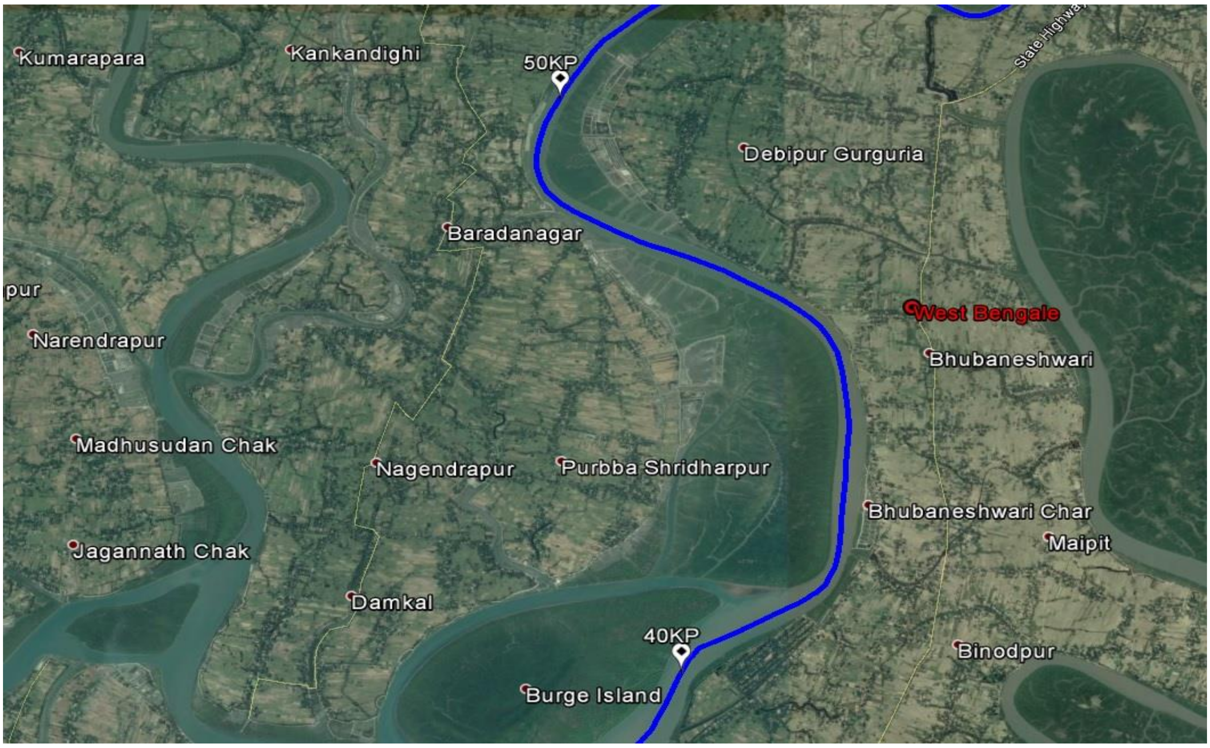

Figure 15: Google Image showing Sub-Stretch -5 of Waterway

Figure 15 above shows the alignment of sub-stretch 3 (Ch. 40 Km to 50 Km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 11**. **Figure 16** shows the observed and reduced bed profile of sub-stretch 5.

Table 11: 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)				-3.53	9.10	2400	60571.03
II	40	50					-3.75	9.27	2600	185589.21
III	40	50					-4.00	9.27	2800	330161.28
IV	40	50					-4.05	9.27	2800	442185.83
V	40	50					-5.59	10.84	3800	760533.94
VI	40	50					-7.05	10.85	4200	1317867.23
VII	40	50					-8.30	10.85	9600	1771223.05

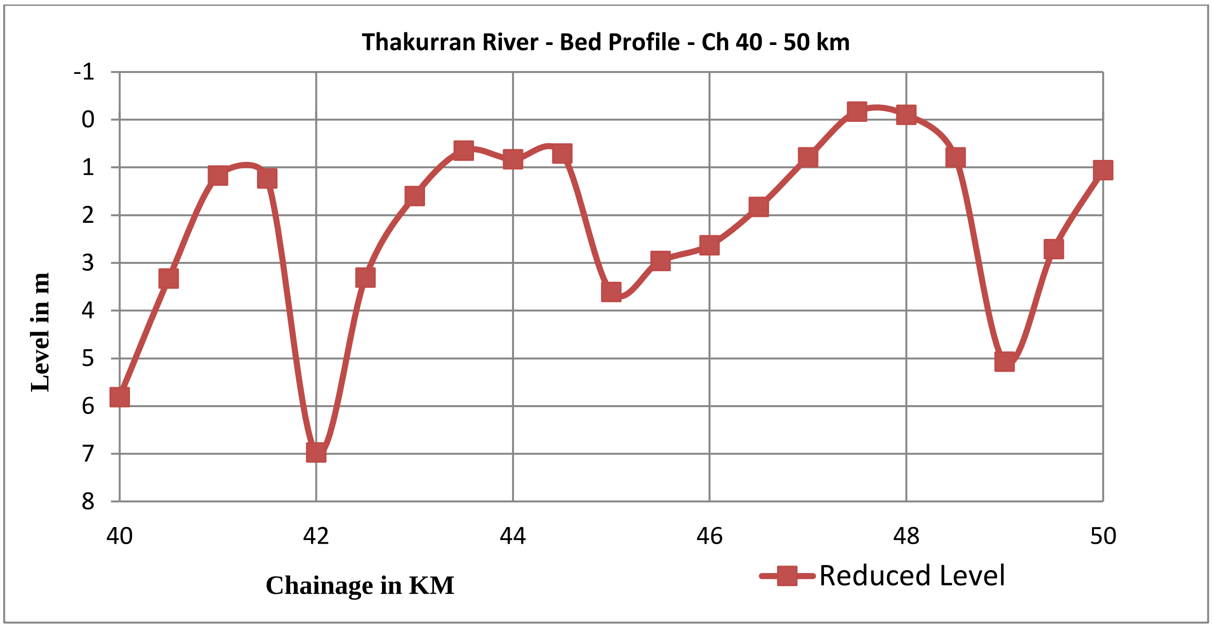

Figure 16: Bed Profile of Waterway Sub-stretch 5 (Chainage 40Km – 50 Km)

Figure 17: Photograph along Sub-Stretch 5

2.5.6 Sub Stretch 6: From Bagdimari Mulo to Madhabpur (50 km to 63.865 km)

Bathymetric and Topographic Survey was carried out for this stretch between 50 to 63.865 km chainage of the Thakurran River. The area sparsely populated. Fishing and farming are the main occupation of the people & the fields in the area are dependent on the rainfall. River banks are partially protected. This stretch is narrow and average width is about 80 meters. Dredging is required in this stretch for all time navigation.

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

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no prominent dams & Barrage available in this stretch.
- The tidal range is 3.9 m in this stretch as we move from downstream to upstream.

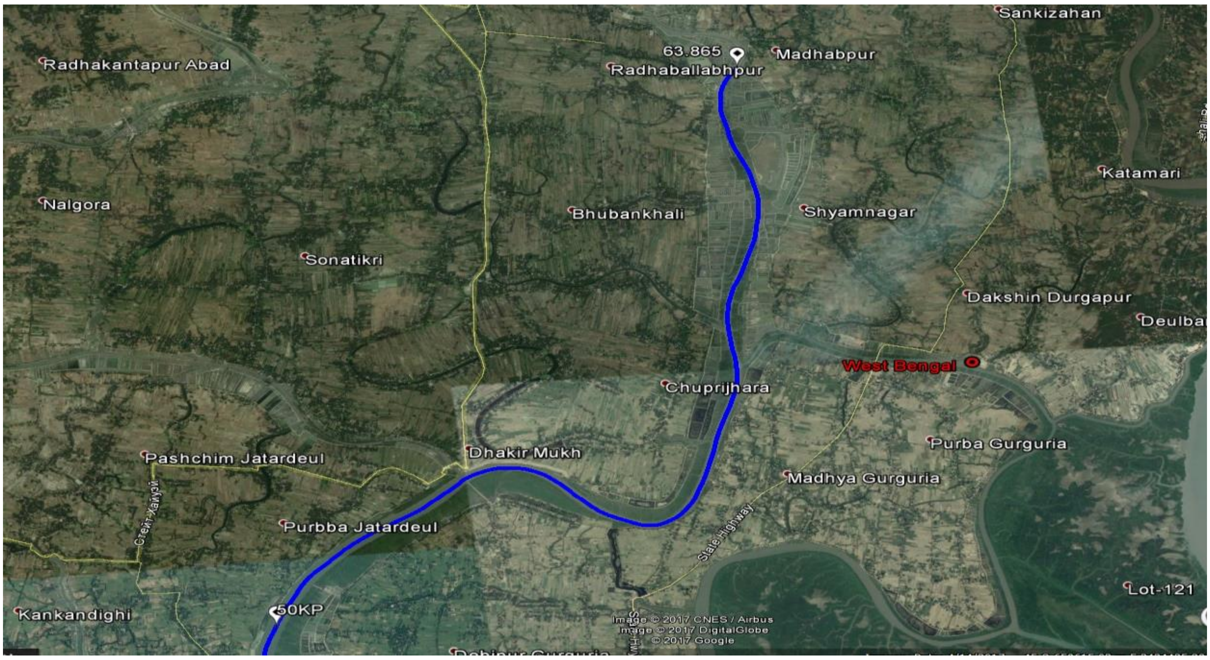

Figure 18: Google Image showing Sub-Stretch -6 of Waterway

Figure 9 above shows the alignment of sub-stretch 6 (Ch. 50 Km to 63.865 Km) of Waterway. The quantity of dredging required for all classes of waterways for this stretch is provided in **Table 9**. **Figure 19** shows the observed and reduced bed profile of sub-stretch 4.

Table 12: 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	63.865	Not Applicable (Tidal Zone)				-4.14	4.63	12560	762090.8
II	50	63.865					-4.14	4.63	12620	1118107
III	50	63.865					-4.14	4.63	13095	1569694
IV	50	63.865					-4.14	4.63	13500	1829345

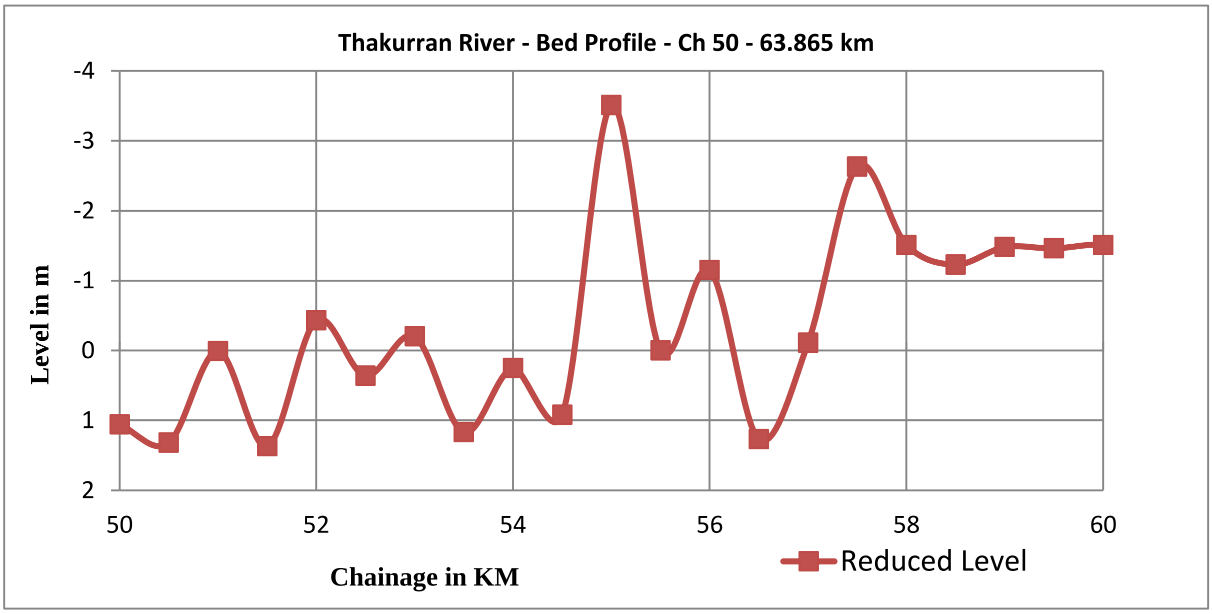

Figure 19: Bed Profile of Waterway Sub-stretch 6 (Chainage 50Km – 63.865 Km)

Figure 20: Photograph along Sub-Stretch 6

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 13.**

Table 13: Soil and Water Sample Locations

Sample No	Chainage (Km)	Latitude	Longitude	Easting (m)	Northing (m)	Samplings Depth (m)	
						Soil	Water
1	5	21°36'35.182"N	88°26'03.470"E	648462.37	2390319.76	3.8	1.9
2	17	21°42'07.085"N	88°27'39.274"E	651121.33	2400552.13	8.5	4.25
3	29	21°48'51.6304"N	88°30'02.4272"E	655114.6	2413032.4	4.4	2.2
4	42	21°54'51.9051"N	88°31'20.1812"E	657237.8	2424134.0	9.45	4.725
5	51	21°58'35.7293"N	88°29'58.1039"E	654815.1	2430994.2	5.8	2.9
6	63.5	22°02'34.7780"N	88°33'16.6386"E	660435.2	2438402.8	3.7	1.85

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

Soil Samples

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

Water samples

- Sediment Concentration

Results of the test are provided in **Figure 21.**

Drilltech Consultant 54A, Pratapaditya Road, Kolkata - 700026				CERTIFICATE OF ANALYSIS ON SOIL & WATER SAMPLES								TABLE NO. :	1
Project	Laboratory Analysis of Soil & Water Samples					River:		Thakurran				Job No:	6154 G
Sample Reference					Test Results on SOIL SAMPLES							Test Results for 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	TR-1	Soil	5	3.80	0	92	8		2.61	7.61	2.01	0.98	
2	TR-2	Soil	17	8.50	0	94	6		2.64	7.71	1.98	0.97	
3	TR-3	Soil	29	4.40	0	98	2		2.68	7.54	1.57	0.96	
4	TR-4	Soil	42	9.45	0	3	59	38	2.63	7.62	6.00	1.50	-
5	TR-5	Soil	51	5.80	0	1	60	39	2.61	8.88	6.00	1.50	-
6	TR-6	Soil	63.50	3.70	0	3	59	38	2.64	8.17	6.00	1.50	-
7	TR-1	Water	5	3.80	-	-	-	-	-	-	-	-	28739
8	TR-2	Water	17	8.50	-	-	-	-	-	-	-	-	29315
9	TR-3	Water	29	4.40	-	-	-	-	-	-	-	-	30244
10	TR-4	Water	42	9.45	-	-	-	-	-	-	-	-	26908
11	TR-5	Water	51	5.80	-	-	-	-	-	-	-	-	29462
12	TR-6	Water	63.50	3.70	-	-	-	-	-	-	-	-	31390

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Figure 21: 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 -8.30 m to 24.29 m w.r.t sounding datum for Class VII waterway.
c) Tidal variation varies from 2.28 to 5.045 m.
d) Width of river varies from 0.03 Km to 6.85 Km.

Figure 22 shows the proposed alignment of Thakurran River waterway.

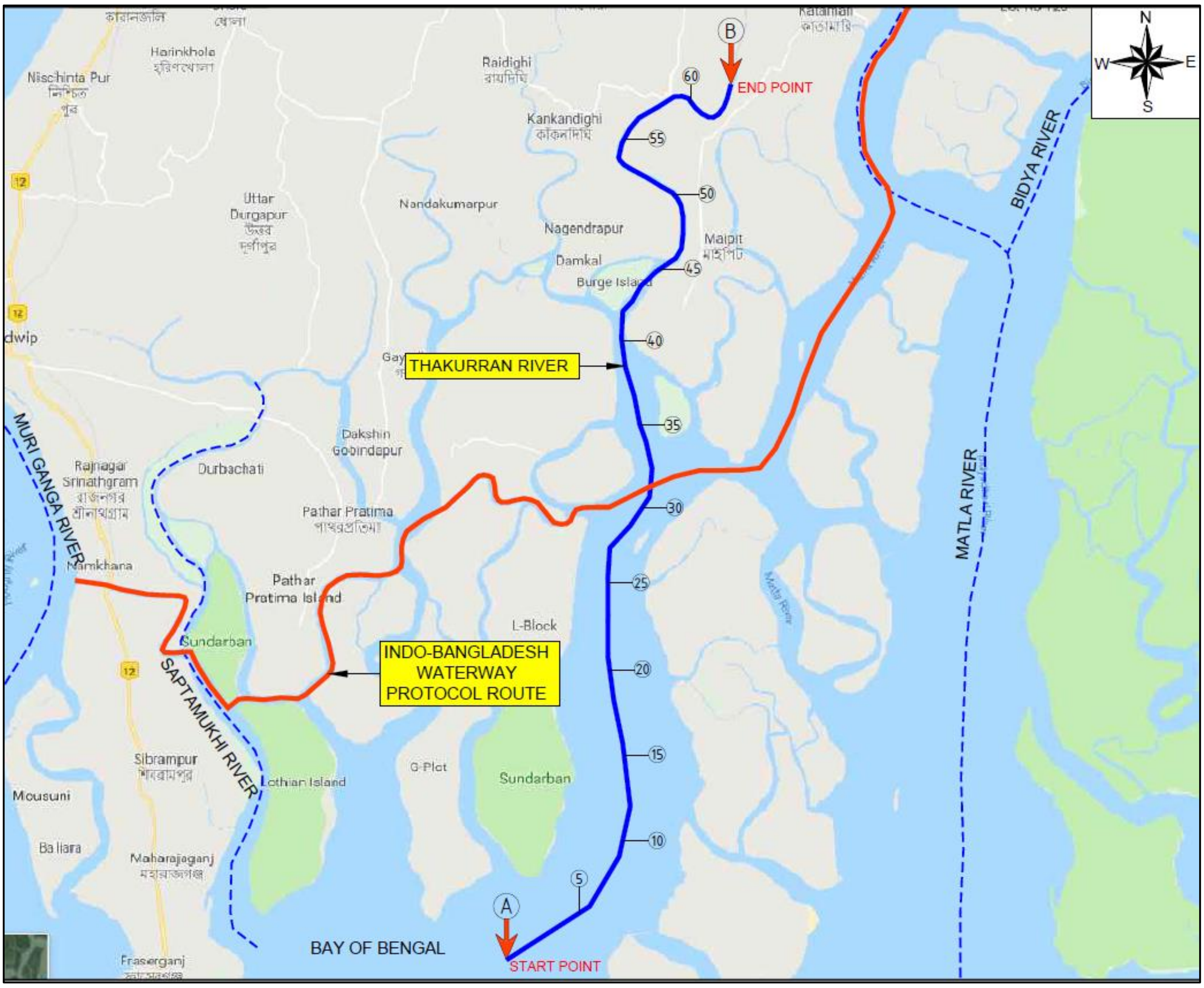


Figure 22: Proposed alignment of Thakurran Waterway

In addition to above features, Thakurran waterway is also connected with Indo-Bngladesgh Protocol Route at Chainage 28.365, which is already being maintained by IWAI

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 63.865 km stretch of waterway, which suggest that waterway is viable for throughout the year navigation. It is principally decided by IWAI to develop Sunderbans waterways as per Class VII only.

3.2 DETAILS OF SHOALS

Due consideration was given for shoals identified during the survey. As shown in **Table 14** shoals are located along the proposed waterway, hence dredging is required as detailed below.

3.3 PROPOSED CONSERVANCY ACTIVITIES

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

3.3.1 Dredging

A defined waterway is required to make throughout the year navigation in the IWT stretch of Thakurran 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 23**. The dredging quantity obtained from Hypack software for 63.865 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:

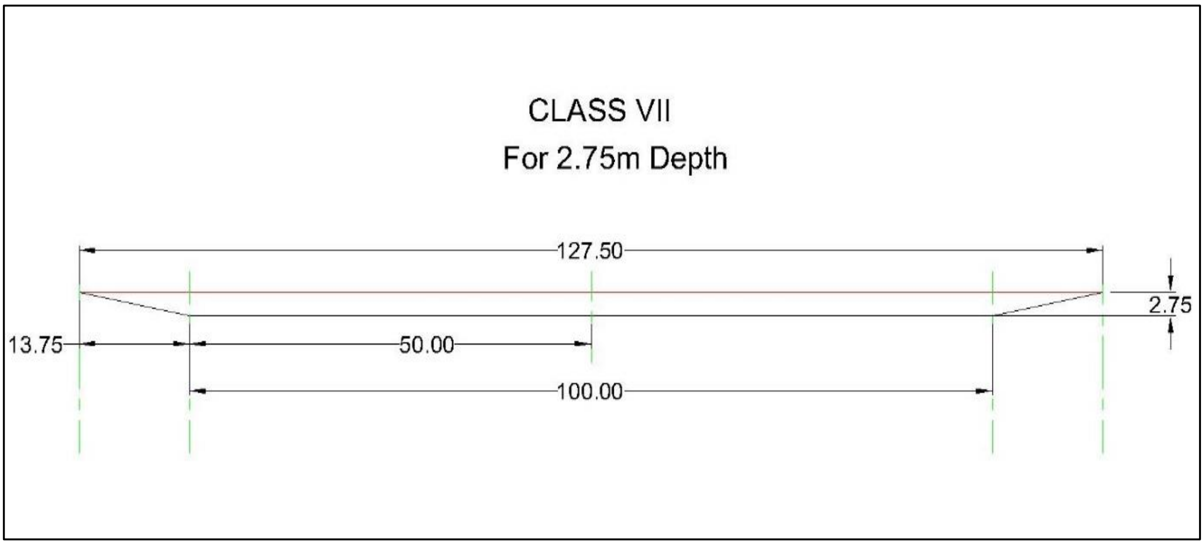


Figure 23: Fairway Dimension Class VII

Table 14: Dredging Quantity for Class VII Waterway

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
0	1	Not Applicable (Tidal Zone)				11.93	12.84	0	0.00	0.00
1	2					10.61	12.80	0	0.00	0.00
2	3					11.32	12.43	0	0.00	0.00
3	4					11.51	12.82	0	0.00	0.00
4	5					10.61	12.72	0	0.00	0.00
5	6					7.23	10.47	0	0.00	0.00
6	7					8.73	15.00	0	0.00	0.00
7	8					14.61	16.46	0	0.00	0.00
8	9					15.06	17.53	0	0.00	0.00
9	10					15.10	17.25	0	0.00	0.00
10	11					15.09	18.11	0	0.00	0.00
11	12					14.27	16.68	0	0.00	0.00
12	13					13.46	15.09	0	0.00	0.00
13	14					13.65	15.14	0	0.00	0.00
14	15					14.64	16.73	0	0.00	0.00
15	16					12.47	15.05	0	0.00	0.00
16	17					12.39	17.53	0	0.00	0.00
17	18					12.77	14.50	0	0.00	0.00
18	19					13.56	14.97	0	0.00	0.00
19	20					14.06	15.76	0	0.00	0.00
20	21					12.25	15.25	0	0.00	0.00
21	22					12.67	14.72	0	0.00	0.00
22	23					11.11	13.18	0	0.00	0.00
23	24					11.18	12.05	0	0.00	0.00
24	25					12.11	14.85	0	0.00	0.00
25	26					14.00	17.32	0	0.00	0.00
26	27					16.20	22.60	0	0.00	0.00
27	28					18.37	20.98	0	0.00	0.00
28	29					18.42	24.29	0	0.00	0.00
29	30					1.33	17.38	0	7389	7389
30	31					1.25	14.06	0	19320	26708
31	32					5.48	15.19	0	0	26708
32	33					3.69	21.97	0	0	26708
33	34					0.76	3.32	0	19292	46001
34	35					-0.07	2.18	800	100316	146316
35	36					-1.28	3.02	1200	293436	439753

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.
36	37					1.25	12.34	0	14866	454619
37	38					-0.20	14.96	1000	59127	513746
38	39					-0.73	4.28	1200	164211	677957
39	40					-0.97	6.57	1200	111429	789386
40	41	Not Applicable (Tidal Zone)				1.13	4.98	0	23644	813030
41	42					-0.37	10.85	1200	171153	984183
42	43					-1.08	6.61	1000	67312	1051495
43	44					-0.27	1.72	1200	163380	1214876
44	45					-6.28	5.07	1200	162434	1377309
45	46					-3.57	5.09	1000	190360	1567670
46	47					-1.99	3.04	1000	166229	1733898
47	48					-1.42	1.39	1000	236709	1970608
48	49					-3.55	5.07	1000	189995	2160603
49	50					-8.30	2.70	1000	400006	2560609
50	51					-4.98	1.36	1000	455608	3016217
51	52					-8.13	2.14	1000	396369	3412586
52	53					-2.16	1.20	1000	339056	3751643
53	54					-7.32	0.50	1000	560950	4312593
54	55					-7.63	1.70	1000	608273	4920866
55	56					-4.86	0.57	1000	368992	5289858
56	57					-6.67	0.51	1000	445073	5734931
57	58					-5.01	0.25	1000	341085	6076017
58	59					-5.36	1.08	1000	360519	6436536
59	60					-5.36	0.62	1000	416619	6853155
60	61					-3.69	-0.58	1000	244476	7097631
61	62					-3.60	-0.26	1000	240271	7337902
62	63					-6.40	-0.98	1000	285473	7623374
63	63.87					-7.76	-1.03	1200	681645	8305020

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 83,05,020 cum.

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

a) Indo-Bangladesh Waterway protocol route crosses Thakurran waterway at Chainage 28.365 Km. This stretch requires no dredging.

b) 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 34.5 Km, 50.8 Km and 53.4 Km respectively).

Accordingly, on the basis of above criterias, Thakurran waterway is proposed to be developed from Chainage 0 Km to Chainage 54.0 Km. The total dredging quanity for developing this 54.0 Km stretch of waterway in Class VII, works out to 43,12,593 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. Sufficient low lying area is available along the river bank specially on upstream and downstream of proposed Debipur jetty for dumping of dredged material. 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 24: 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.

For the Thakurran waterway, cutter suction dredger is recommended.

3.3.2 River Training

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

3.4 BANK PROTECTION / EMBANKMENT STRENGTHENING

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

3.5 NAVIGATION MARKINGS / NAVIGATION AIDS

The seasonal change in river morphology plays an important role for maintaining the navigation channel. The navigation channel generally goes on shifting due to changes in river morphology depending on seasonal rainfall and runoff. On this kind of waterway, one of main concern is safety and ease of traffic. This can be achieved by providing proper navigation aids like marker buoys, lights. The channel marking indicators is also very important for the safety and speed of navigation since the current velocity is much lower in the inner bends of a curved channel than the outer bend. If proper markings are provided, ships/vessel sailing upstream will take the inner bends with relatively less head current, thus making better speed. The ship sailing downstream in the outer bend will get the advantage of current. The main approach of the problem of making of shifting nature of navigable channel is to have the simple marks which could be shifted easily with less manpower and equipment.

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

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

No cross structure is located along the waterway.

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

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

3.8 LAND ACQUISITION

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

3.9 FAIRWAY COSTING

The cost estimate for fairway development of Thakurran 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 Capital Cost

The cost of initial dredging is as below:

Dredging cost @ INR 200/cum for 43,12,593 cum = INR 86,25,18,526/- (INR **8,625.19** Lakh).

3.9.2 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 43,12,593 cum = INR 8,62,51,852.6 /- **(INR 862.52 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.

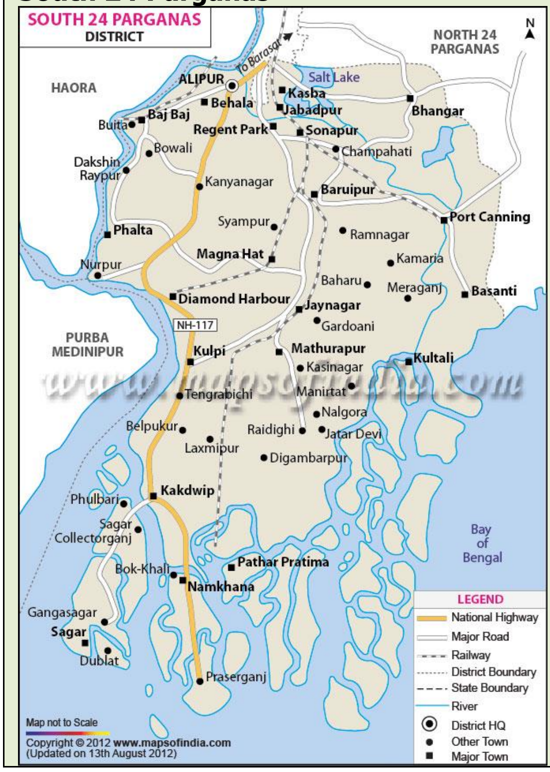
4.2 INFLUENCE AREA / HINTERLAND

Thakurran river flows through three (3) CD blocks of South 24 Parganas disctrict, namely, Kultali, Patharpratima and Mathurapur - II. The Project Influence Area (PIA), considering existing and

[1] District Census Handbook, 2011

projected traffic for passenger ferry services, comprises of the following CD blocks and districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 15**.

Table 15: Project Influence Area/ Hinterland

<table>
<tr><th>District</th><th>Area (Km²)</th><th>C.D. Block</th><th>Area (Km²)</th><th>Total Hinterland area (Km²)</th></tr>
<tr><td rowspan="3">South 24 Parganas

</td><td rowspan="3">9,960</td><td>Kultali</td><td>306.18</td><td rowspan="3">1018.1</td></tr>
<tr><td>Patharpratima</td><td>484.48</td></tr>
<tr><td>Mathurapur - II</td><td>227.44</td></tr>
</table>

4.2.1 Population of Hinterland area

Population of hinterland area for proposed IWT in Thakurran waterway is provided in **Table 16** below:

Table 16: Population of Hinterland[2]

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
West	South 24	81,61,961	Kultali	2,29,053	7,81,715

[2] District Census Handbook, 2011

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
Bengal	Parganas		Patharpratima	3,31,823	
			Mathurapur - II	2,20,839	

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Thakurran 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 17** and **Table 18** as below:

Table 17: 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 18: 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.

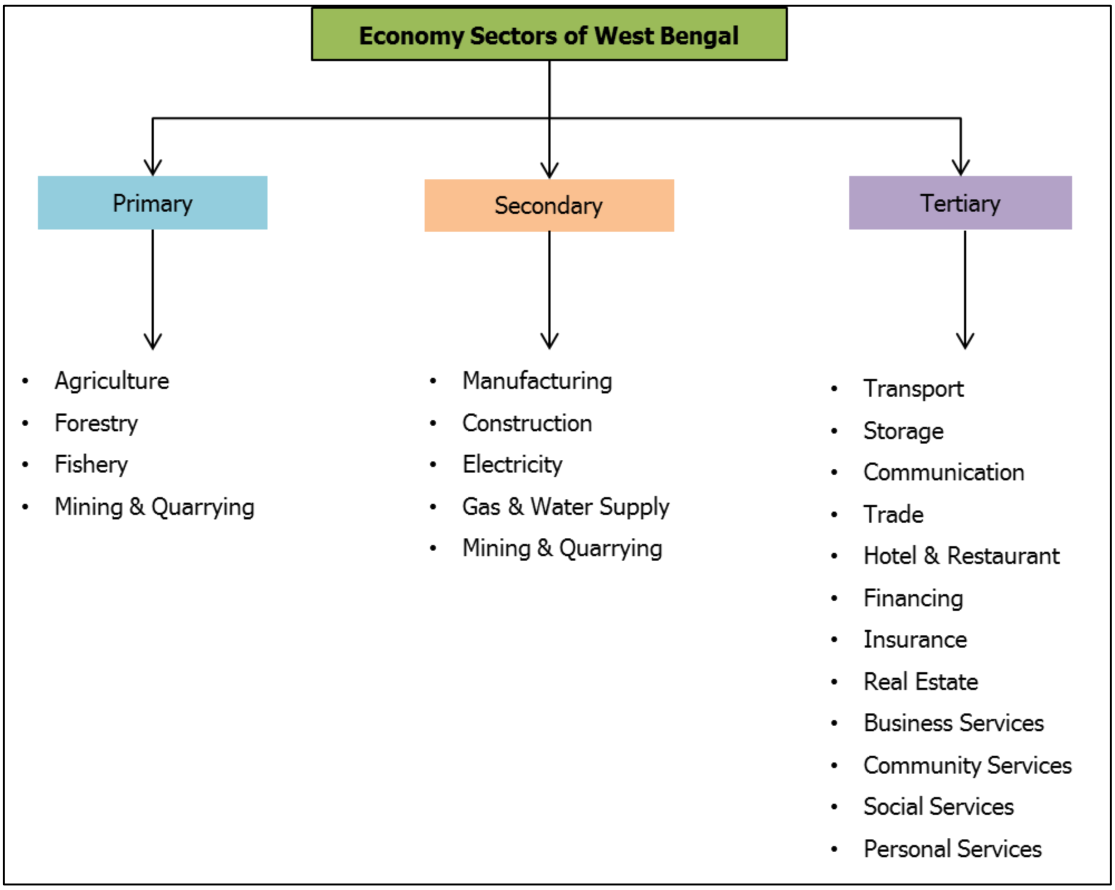


Figure 25: Sectors of West Bengal

Figure 26 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 27** 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.

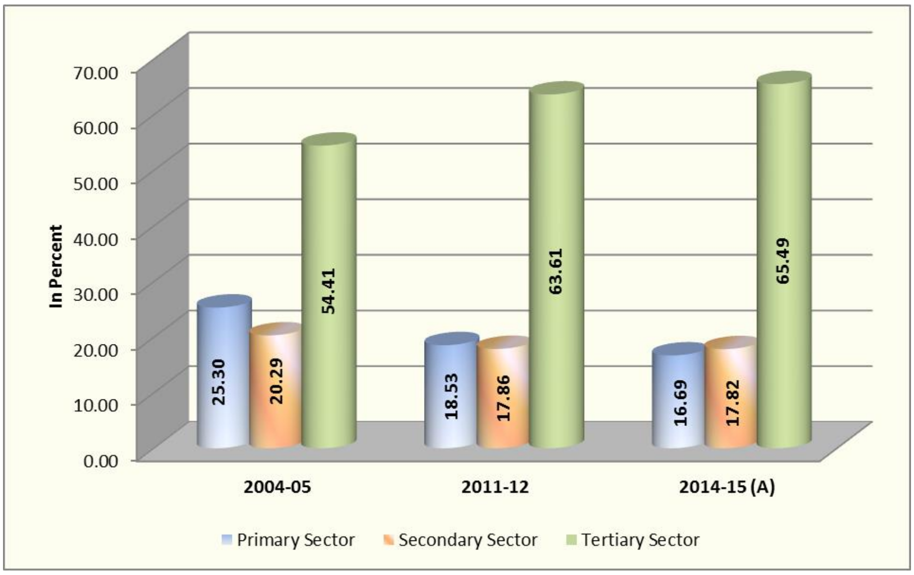


Figure 26: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

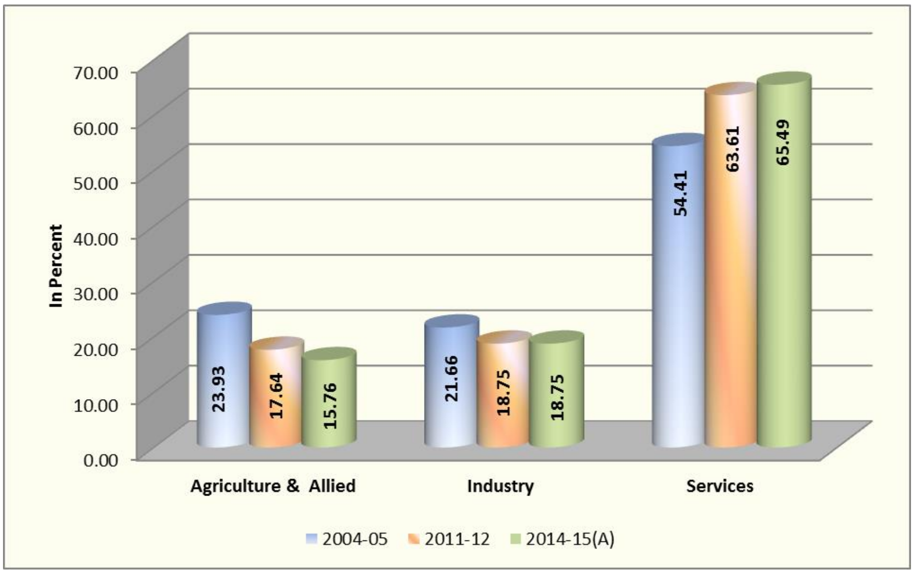


Figure 27: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

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 19** and the same is presented in **Figure 28** as below:

Table 19: 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

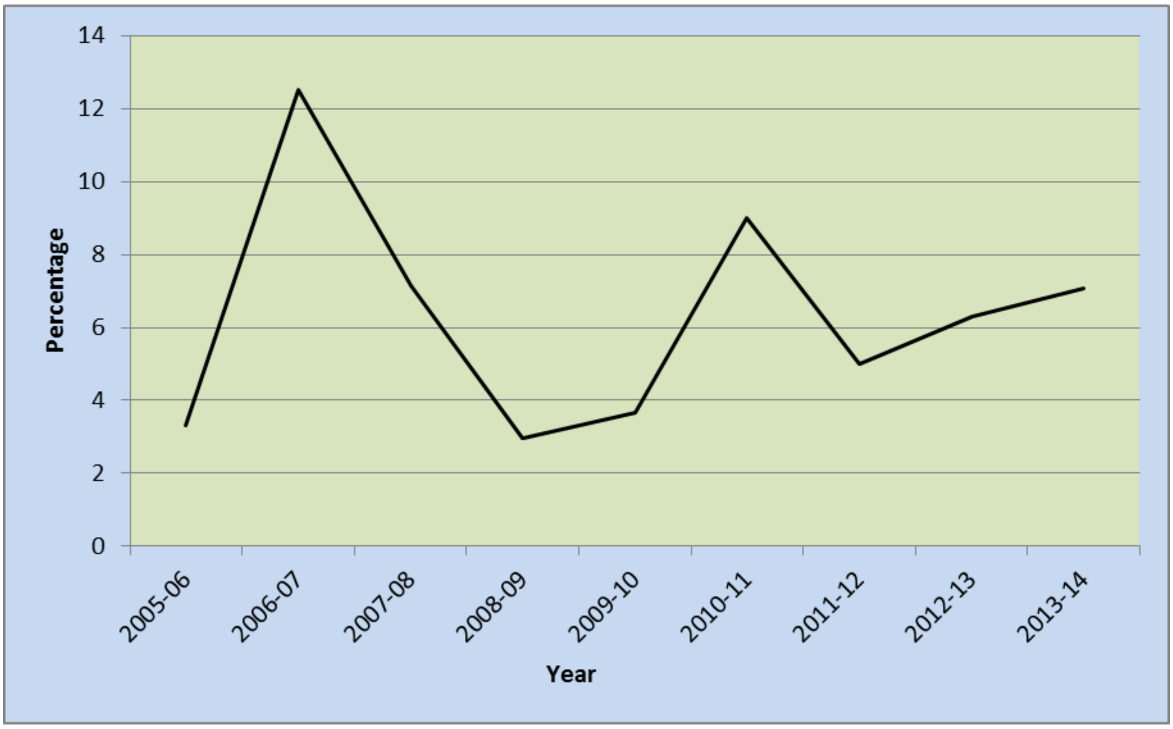


Figure 28: Annual Growth Rates of Gross District Domestic Product

Table 20: 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 20,** 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 29** as below:

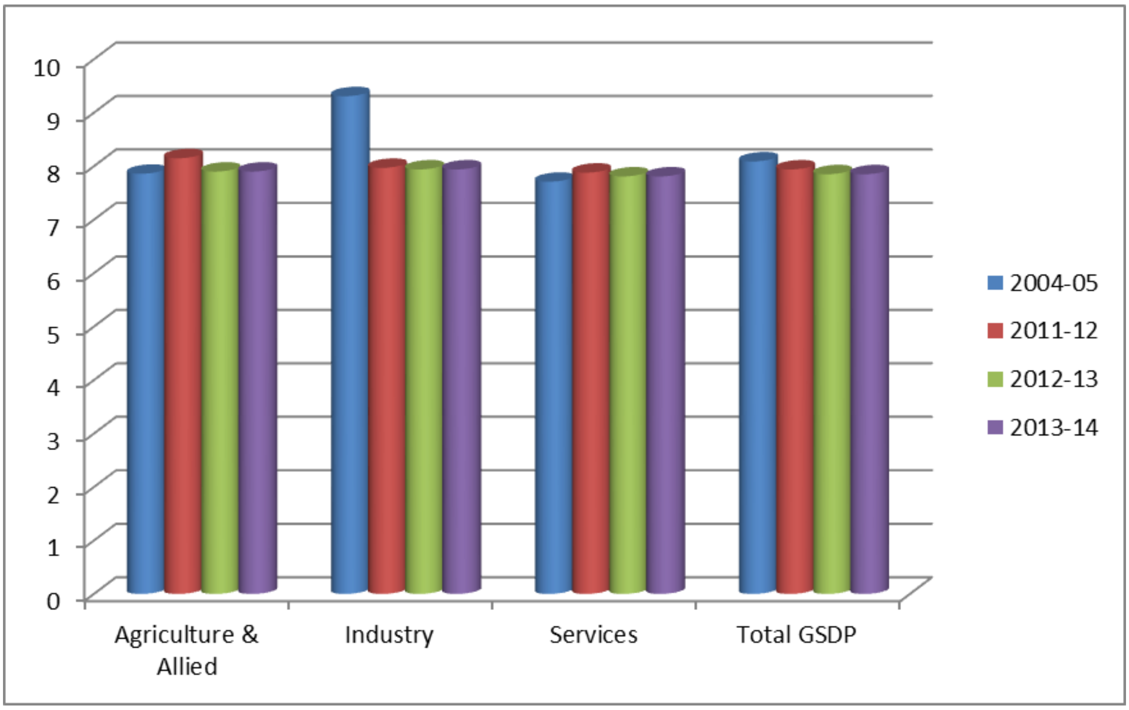


Figure 29: Contribution of South 24 Parganas in GSDP of Broad Sectors of Economy

4.2.3 Existing and Proposed Industries

Brick kilns are located all along the river stretch on both sides of banks. These brick kilns mostly uses fuel wood, saw dust, rice husks and agricultural residues along with coal for firing their kilns. All these are locally arranged and transported through roads/local boats by owners directly to their kilns.

However, no major industry or any other commercial establishment is located and proposed in the hinterland area, hence O-D pairing of cargo traffic is not applicable.

4.2.4 Hinterland Connectivity

The left river bank of the Thakurran River has Raidihgi to Kuyemuri road in the vicinity. SH 1 and the nearest rail head are at Canning which is 32 Km away. Private vehicles are not easily available in the nearby area. The public transport buses are operated by West Bengal state and the area is well connected with nearby cities. Mobile network is available in the area. Ferry services run at various places all along the waterway stretch.

4.2.5 Connectivity with Other Wateways

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

Table 21: Connectivity with other Waterways

Sl. No.	Waterway Name	Chainage at merging location (Km)
1.0	Indo Bangladesh waterway protocol Route	28.365 Km

4.3 COMMODITY COMPOSITION / CATEGORIZATION

Detailed traffic survey was done by the consultant along the study stretch of Thakurran 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 Thakurran waterway can be categorized as follows:

a) Cargo Vessels and Oil Tankers
b) Agricultural Products
c) Construction Material
d) Passengers

4.3.1 Cargo Vessels and Oil Tankers

As Thakurran river is part of the Indo Bangladesh Protocol Route, cargo vessels and Oil tankers originated/designated to/from Kolkata/Bangladesh navigates through Thakurran River near

Sripatinagar at chaiange 28.365 Km. Location Map of National Waterways and Indo-Bangladesh Protocol Route are shown in **Figure 30**.

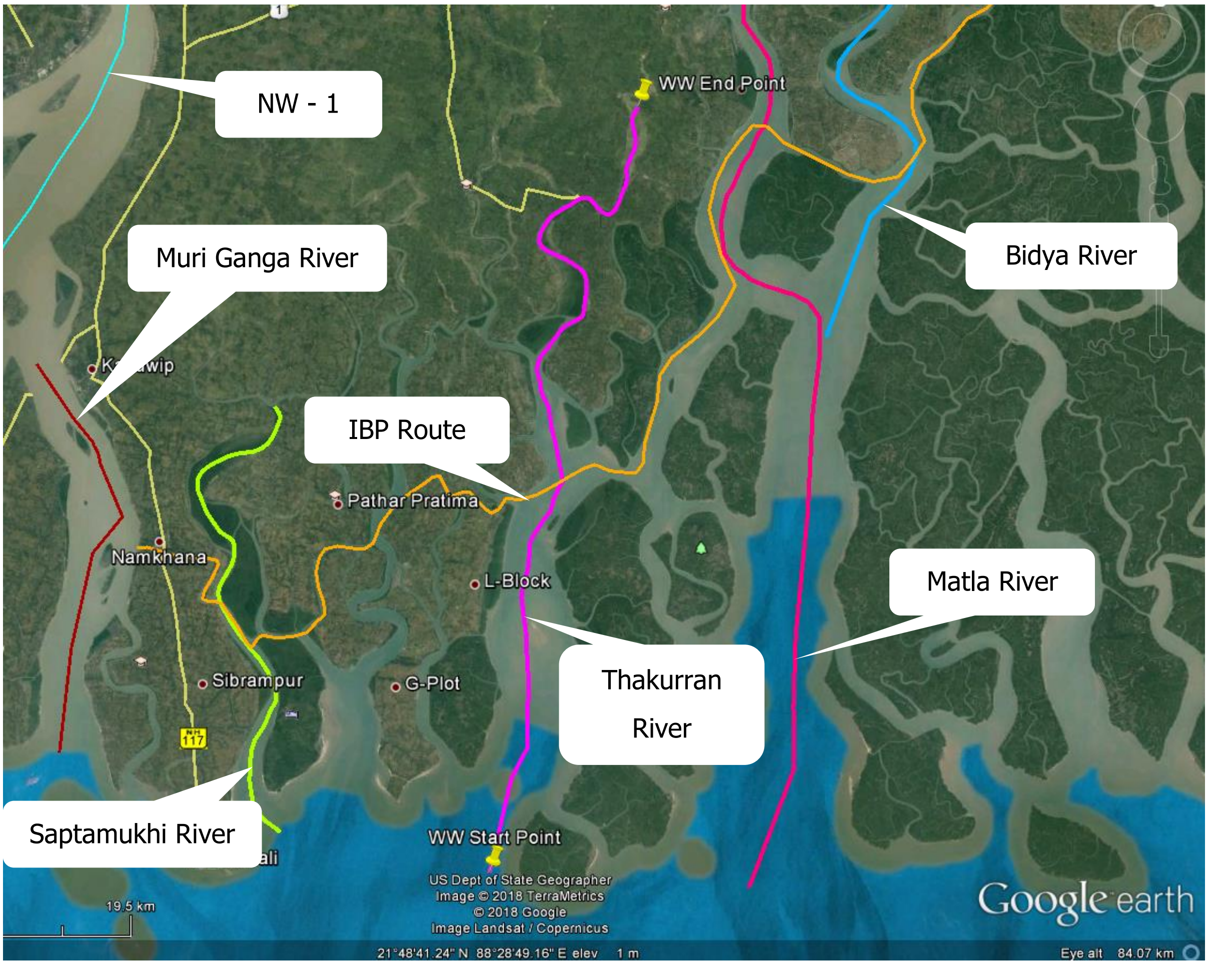


Figure 30: Location Map of National Waterways and Indo-Bangladesh Protocol Route

Though large cargo vessels and oil tankers navigates from Thakurran waterway, none of the cargo is designated or originated to/from Thakurran River 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 Thakurran waterway.

4.3.4 Passenger Traffic

Passenger ferry services are available at various locations along the 63.865 km stretch of Thakurran River. Traffic survey was carried out from 25th Mar 2017 to 04th Apr 2017. The details of passenger ferry services are provided in **Table 22**.

Table 22: Existing Passenger Ferry Services in Thakurran River

<table>
<tr><th rowspan="2">Ferry Route No.</th><th colspan="2">Passenger Ferry Services</th><th rowspan="2">Passengers using Jetty per day</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Bhumun</td><td>Dakshin Kashinagar</td><td rowspan="2">50</td></tr>
<tr><td>Raidighi</td></tr>
<tr><td rowspan="4">2</td><td rowspan="4">Ganga</td><td>K-PLOT</td><td rowspan="4">400</td></tr>
<tr><td>Koimudi</td></tr>
<tr><td>Raidighi</td></tr>
<tr><td>Ramganga</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Nandi</td><td>Kuimodi village</td><td rowspan="2">600</td></tr>
<tr><td>Raidighi</td></tr>
</table>

Ferry Route No.	Passenger Ferry Services		Passengers using Jetty per day
	From	To	
4	Baikunthpur	Raidighi	350
		Koimudi	
		Damkal	
5	Sahebghat no.1	Raidighi	60
6	Bhuvneshwari	Raidighi	20
7	Bhuvneshwari	Raydira	100
8	Dhaki	Debipur ghat	1500
		Joto	
9	Dhaki	Vasar	100
10	Vasar	Dhaki	100
11	Bhubonkhali	Shyamnagar	100
12	Shyamnagar	Bhubonkhali	100
13	Vasar	Dhaki	100
14	Bhubonkhali	Shyamnagar	100
15	Shyamnagar	Bhubonkhali	100

All the above listed ferry services are locally operated. **Annexure 5** presents the photographs of ferry services, jetties and vessels operated along the Thakurran 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 tourist or historical place is located along the waterway.

4.6 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.

With the base traffic of about 1500 passengers, the growth trend for passenger traffic in Thakurran River waterway for 20 years (from 2020 to 2040) is shown in **Figure 31**.

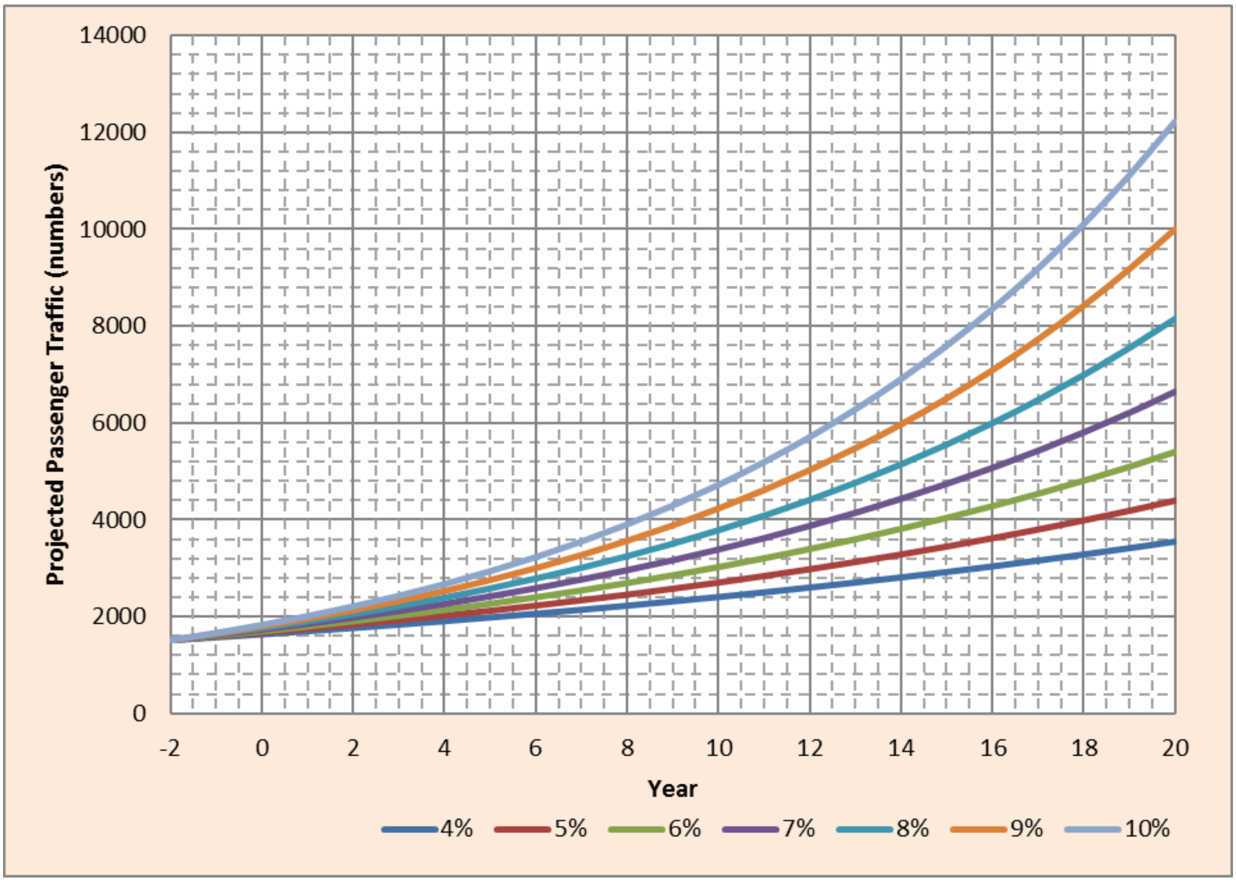


Figure 31: Projected Passenger Traffic of Thakurran River

With assumed growth rate of 8%, the passenger traffic considered for design is estimated as about 3,777 pax per day for 10th year and 8,155 pax per day for 20th year.

4.7 CONSLUSION

Following conclusions are made from the traffic studies done above:

a) Proposed Thakurran waterway is connected with Indo Bangladesh waterway protocol route at chainage 28.365 Km.

b) Large cargo vessels navigating along Indo Bangladesh Protocol Route navigates through Thakurran river at a Chainage of 28.365 Km near Sripatinagar.
c) There are no big industries near the survey area and hence O-D pairing for cargo traffic is not applicable in this DPR.
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 and connectivity of Thakurran river with major waterways, 3 passenger ferry ghats, Ganga, Debipur and Dhaki are recommended to be developed for IWT services as detailed in following chapters of DPR. Accordingly, the potential O-D pairs for passenger ferries are identified as below:

a) Link 1 – Ganga Jetty to Debipur Jetty (Reach Length = 16.6 Km)
b) Link 2 – Debipur Jetty to Dhaki Jetty (Reach Length = 2.6 Km)

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

Thakurran river is having potential for Inland Water Transport due to its topography, location and connectivity with 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 Thakurran River. The list of existing terminals located is provided in **Table 23** as below

Table 23: List of Existing Jetties

Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Bhuman	21°50'3.87"N 88°29'5.05"E	31.5 Km	1.3m	Ridighi-Kuyemuri road	Purba-Sripatinagar, Paschim-Sripatinagar
Ganga	21°51'53.36"N 88°30'39.57"E	34.5 km	1.4m	Maipitraod	Kishorimohpur, Maipit, Baikunthpur, Binodpur
Nandi ghat	21°53'16.65"N 88°29'51.10"E	38 Km	1.0m	Maipit road	Maipit, Baikunthpur, Binodpur, Kishorimohnpur.
Baikunthpur	21°53'47.08"N 88°30'16.88"E	39.3 Km	1.4m	Maipit Road	Baikunthpur, Maipath, Binodpur, Kishorimohpur,
Sahebghat no. 1	21°54'21.11"N 88°30'37.60"E	40.5 Km	1.2m	Maipit Road	Maipit, Baikunthpur, Binodpur, Kishorimohnpur
Bhubaneshwari no. 1	21°54'36.02"N 88°31'5.21"E	41.5 km	1.4m	Maipit road	Bhubaneshwari, Maipit, Debipur, Binodpur
Bhubaneshwari no. 2	21°55'50.54"N 88°31'32.94"E	43.8 Km	1.3m	Maipitraod	Bhubaneshwari, Maipit, Debipur, Binodpur
Paschimdevipur	21°57'12.49"N 88°30'14.65"E	47.4 km	1.2m	Maipitraod	Maipit, Debipur, Bhubaneshwari
Aamtola	21°57'7.37"N 88°30'1.61"E	47.6Km	1.2m	Raidighi-Kuyemuri road	Bardanagar, Devipur-Guruguriya, Purba-Shridharpur, Nagendrapur,
MajherKheya	21°58'30.16"N 88°29'47.00"E	50.7 Km	1.1m	Raidighi state highway road	Majher, Purba-Jatardeul, Baradanagar,Dhaki

Terminal Name	Co-ordinates	Approx. Chainage from starting point	Draft Available	Connecting Road	Connecting Village/District
Debipur	21°58'30.16"N 88°29'47.00"E	50.8 Km	1.4m	Maipit road	Debipur, Maipit, Bhubaneshwari
Dhaki	21°59'19.55"N 88°31'3.58"E	53.4 Km	1.2m	Raidighi state highway road	Dhaki, Chuprijhara, Purba-Jatardeul, Raidighi, Paschim-jatardeul
Vasar	21°59'6.16"N 88°32'41.85"E	56.8 Km	1.2m	Maipit Road	Madhyagurguria, Purba-Gurguria, Debipur, Maipath
Bhubonkhali	22° 0'22.51"N 88°32'59.63"E	59.4 Km	1.5m	Raidighi state highway road	Bhubonkhali, Chuprijhara
Shaymnagar	22° 0'22.95"N 88°33'2.71"E	59.4 Km	1.2m	Maipit Road	Maipit, Shyamnagar, Dakshin-Duragpur

Location map of all the above ferry ghats are provided in Volume 2 of the DPR. Photographs of some ferry ghats are provided in **Figure 32** 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 three (3) ferry ghats:

1) Ganga,
2) Debipur, and
3) Dhaki

It is proposed to develop the terminal complex area and provide inland water transport facilities like Gangway and Pontoon at the above three ferry ghat locations for passenger embarking and disembarking.

Ganga ferry terminal is also proposed to be developed to provide support and related services to vessels operating along Indo Bangladesh Protocol route.

Figure 32: Photographs of Jetties located along Thakurran River Waterway

5.3.1 Location Map of Proposed Ferry Ghats

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

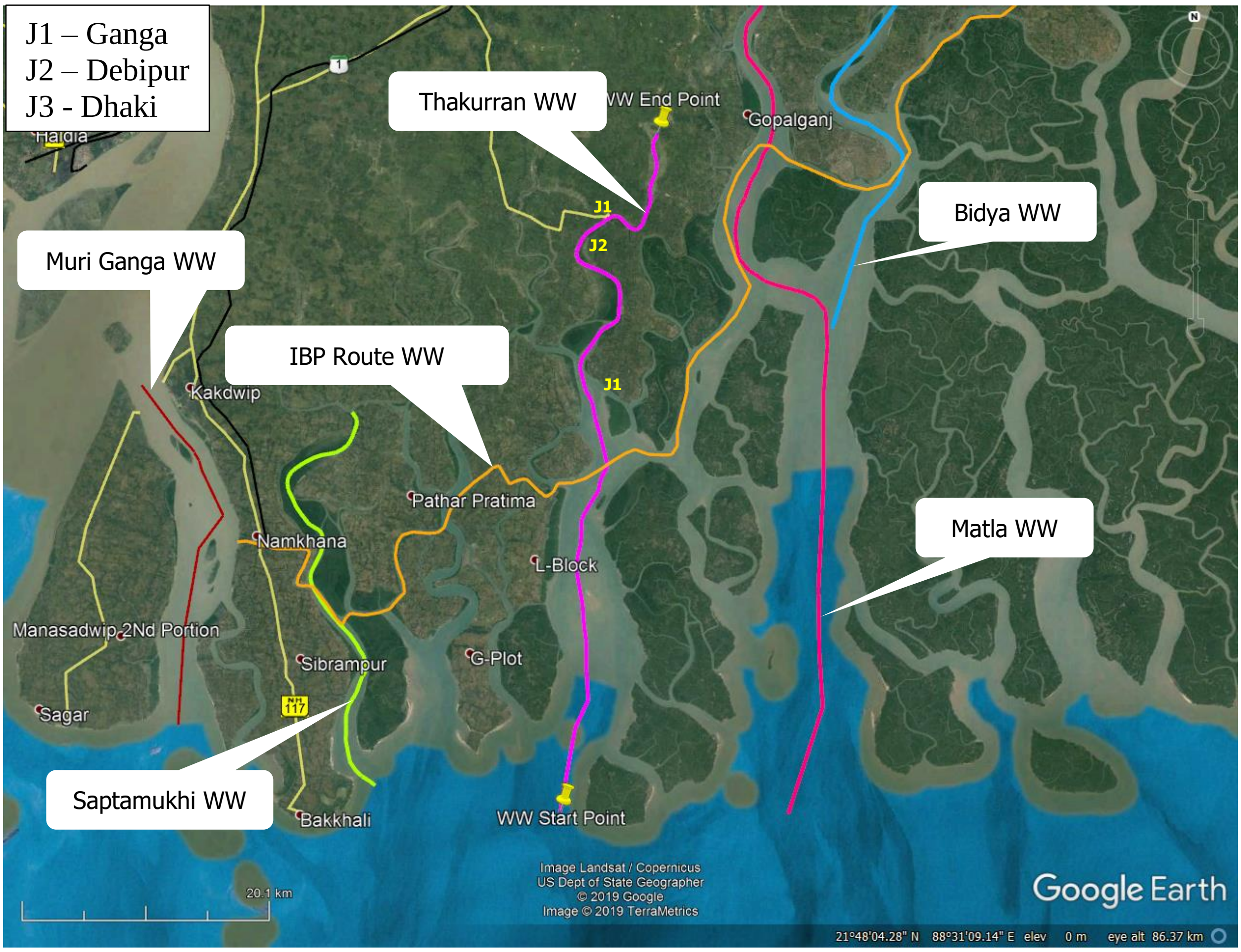


Figure 33: Location map of terminals proposed for development

5.3.2 IWT Facilities

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

1) Pontoon
2) Gangway
3) Terminal complex

A. <u>LAYOUT</u>

The passenger terminal at proposed locations is designed to facilitate the efficient operation of passenger ferries. 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. SAFETY

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.

Navigation at night is not foreseen/ recommended from the proposed pontoon facilities.

E. SERVICES

There will be a small operations, maintenance and storage room within the ticketing complex area. This room will contain equipment necessary for operation and maintenance of the Gangway and Pontoon.

The electricity supply to the pontoon will be sufficient for power requirements of the operating equipment as well as flood lighting and lighting and a standby generator will be installed in the terminal complex providing sufficient power for basic lighting and operation of the terminal infrastructure. A wireless telephone connection will be there in ferries for direct communication with the shore.

Facilities for reception of wastes from the ferries will be installed adjacent to the berth. A fuel supply will also be installed close to the berth to enable fuelling of ferries from storage tanks on shore.

F. TERMINAL COMPLEX

The various facilities to be developed on the shore is provided as below:

i) Ticketing room/window
ii) Embarking and disembarking ares,
iii) Electrical Panel & Generator Room,
iv) Workshop, emergency medical centre,
v) Staff room/secutity cabin

These are support requirements for buildings with a high functional priority and they are listed below.

i) Roads and parking facilities;
ii) Water supply system;
iii) Storm water disposal system;
iv) Sewage disposal system;
v) Electricity, including emergency power system;
vi) Fuel storage and supply system (for ferries);
vii) Telecommunication system including wireless network and PA system;
viii) Fire protection arrangements

Certain basic services such as power, water supply, etc. which are sourced from the public supply outside the terminal may need upgrading to satisfy the additional demand imposed by the IWT facilities.

5.4 LAND DETAILS

The tentative quantity of land required (excluding area required for future development) for construction of terminal complex area and other passenger amenieties is about 1200 m^2 for each ferry ghat. However, 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.

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 North 24 Parganas of West Bengal, India, lies in the southern part of the Bengal Basin. The basin is actually a peri-cratonic basin and comprises of Ganga-Brahmaputra delta in the southern part. It had broken from the Gondowana land along the margin of the Indian plate and then moved northerly in the early Cretaceous (125Myr ago) period. The collision of the Indian plate and European plate began in the early Eocene (40–41 Myrs ago) period and resulted in the formation of the Himalayas. Due to this, the two sediments from the Ganga and the Brahmaputra Basin got merged subsequently. Relatively recent folding and uplifting (Quaternary epoch) of the Brahmaputra sediments close to the intraplate boundary have redirected the course of the Brahmaputra to its present configuration.

The Ganga-Brahmaputra delta thickens towards the south and has three stratigraphic sequences–the proto - Ganges delta, the transitional delta and the modern delta (created 11Myrs ago) with a successive sequence of sand, sandy mud, silt and mud which were deposited under a major eustatic sea level about 11 Myrs ago. The modern delta has been formed primarily from alluvial sediments transported by the rivers originating from the Chotanagpur Uplands in the west e.g. the Mayurakshi, the Ajoy, the Damodar etc. and subsequently by the rivers flowing from the Himalayan foredeep basin from the north e.g. the Ganges, the Padma, the Bhagirathi, the Brahmaputra etc. when a gap named as the Garo -Rajmahal gap, was created due to tectonic movements. Arsenic contaminated groundwater occurs in the modern deltaic sediments.

In the present study area, the main water bearing formations are Quaternary formations which chiefly comprises of Recent and Pleistocene alluvial deposits and aquifer materials comprising of sand of varying grades and gravels. Thus ground water occurs within water table and in semi confined to confined conditions.

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 of Basirhat sub-division.

5.6 TERMINAL INFRASTRUCTURE INCLUDING EQUIPMENT

IWT Terminals proposed to be constructed with the following infrastructure facilities for operation.

a) Floating Pontoon
b) Gangway,
c) Approach platform,
d) Operation cum Administration Building,
e) Passenger car Parking area.

As per the scope of work mentioned in ToR preliminary engineering design is done in the DPR. The detailed engineering & design of terminals shall be carried out during the construction stage. The preliminary layout shown in **Volume-II** drawing is proposed for the DPR purposes only.

Major facilities provided at proposed terminals for safe and efficient terminal operation are discussed in detail as below:

5.6.1 Terminal Building

The following terminal buildings are proposed for the IWT terminal:

1. <u>Terminal Operation cum Administration Building</u>

It will be single building housing the following:

- Administration wing of the terminal including documentation
- Terminal operations wing

It is assessed that the terminal operation cum administration building shall be of size 20m X 27m (including exit corridor) and will have a total floor area of 540 sqm.

2. Security Office

This will be a single storied building/office for security personnel at the entrance of terminal premises of size 4.5m X 5m.

3. Electrical Sub-station

The electrical panel cum control room of suitable size 5m X 4m shall be located inside admin building preferably at the ground floor.

4. Overhead water tank

The overhead water tank above terminal building to cater need of the daily water demand required for terminal staff and passengers. The minimum capacity of the overhead tank shall be 60 m^3 or the two days requirement whichever is higher.

5.6.2 Boundary Wall / Fencing

It is proposed to provide boundary wall of 2.4 m height using brick masonry with barbed wire fencing. The boundary wall shall be provided along the periphery of the terminal area.

5.6.3 Sewerage System

Sewerage system for the IWT has been proposed considering the requirement of the proposed terminal vis-à-vis the development control regulation. An independent system has been proposed for the terminal considering the new CRZ regulation.

SYSTEM PROPOSAL

With the above, proposed sewerage system for the terminal area has been prepared. Features of the system are as below:

- A fab based package STP of 12 KLD or 12 cum/day are proposed for the sewage generated from the terminal building, etc., capacity of 12 KLD is draft only and may vary during detailed engineering as per the requirements of the system.
- Sewage from the independent building unit to STP will be conveyed through underground conduit;
- Conveyance of flow will be through gravity only;
- Inspection chamber of each building unit will collect the sewage of that unit. Thereafter the same will be conveyed to the nearest sewage collection pit/ manhole connected to the main sewer line of STP. Manhole will be proposed when the length of individual sewer line is more than 30m;
- The treated effluent from STP will be collected in a treated effluent tank. The same will then be utilized for gardening and in case of any surplus that will be discharged to the drainage network along the access road outside the western side of terminal boundary;
- The sludge coming out from the treatment plant will be taken to centrifuge and converted into sludge cake, which may be used as manure.

5.6.4 Firefighting System

For terminal building, Electrical room and other building Dry type fire extinguishers will be provided. Beside above, a continuous back up support will be provided by fire tenders round the clock are envisaged for the firefighting system.

The complete firefighting system shall be designed as per standard guidelines & codes. The system provided shall cater to the terminal area. However, for future developments, separate dedicated firefighting system may be required based in the future requirements.

Portable Fire Extinguishers (PFE)

Portable Fire extinguishers (PFE) are small hand held appliances that are used to put out fires in the very early stage of their inception. There are different types of extinguishers in use and their classification is based on the types of fires on which they are effective. Hence an understanding of the types of fire is very essential in selecting the appropriate type of extinguisher for use in a particular location.

Quantity

As per TAC (Tariff Advisory Committee) at least two extinguishers are to be provided in every area/ room. The appliances are to be so distributed over the entire floor such that a person has to travel not more than 15 metres to reach the nearest appliance.

As per TAC Guidelines - For any property, basic protection shall be appliances suitable for class A fires, since class A fires are of universal character.

Where class B fires are anticipated, a suitable number of appliances as determined above shall be replaced with appliances suitable for B class fires.

As a thumb rule the requirements specified above would mean approximately 2 extinguishers for every 600 m^2 of floor area or part thereof which would however be slightly less in case of light hazard occupancies having larger than 600 m^2 floor area in a single fire compartment.

In rooms containing only electrical equipment such as electrical transformers, switch gears, motors or other electrical apparatus, not less than 2 KG Dry Powder or carbon Dioxide type extinguishers are to be provided within 15 metres of the apparatus.

In rooms containing motors and/or other electric equipment along with other machineries or facilities one 5 Kg. DCP or Carbon Dioxide extinguisher is to be installed within 15 metres of the equipment in addition to the requirements that were earlier specified.

Location

Generally Portable Fire Extinguishers (PFE) are to be placed (wall mounted) as near as possible to exits or staircase landings by also taking into consideration (wherever possible) the normal routes of escape of persons. Placed PFE in such positions will enable these to be seen by persons following the natural impulse to get out of danger.

Standards further prescribe that PFE's be so located that the top of the extinguisher is located at a height of 1.5 metres from the finished floor level or that the bottom of the extinguisher is located at a height of 1 metre from the finished floor level.

Based upon the above the Selection of Fire Extinguishers shall be as follows

A. For Terminal Operation cum Administrative Building

a. Ground Floor:

Type of Fire Extinguishers Selected : 2 X 5kg, CO_2 (Type ABC) inside office Area
(ii) 1 X 5kg, DCP (Dry Chemical powder) Type C inside Electrical panel /Control room

B. Car/Vehicle Parking Area

Type of Fire Extinguishers Selected : 2 X 5kg, DCP (Dry Chemical powder) Type C

5.7 BERTHING STRUCTURE (FLOATING PONTOON)

The berthing structure for Ferry terminal proposed for waterway should have:

- Berthing facility for ferries,
- Facilities boarding/de-boarding of passengers,
- Land based facilities for passenger's movement, ticketing, waiting, etc.
- Scope for future development.

In order to work out the pontoon requirements to meet the projected requirement, it is necessary to define the following governing parameters:

- Ferry Size
- Passenger traffic
- Number of operational days per year
- Number of ferry trips per day
- Effective working hours per day
- Time required for peripheral/other activities

All the proposed facility shall connect terminal area to pontoon platform as shown in Layout drawing.

5.8 TERMINAL 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		
8.	Chhota Kalagachi waterway	Bhandarkhali Jetty	Sahibkhali waterway
9.	Raimangal waterway		
10.	Sahibkhali waterway		
11.	Katakhali waterway		
12.	Kalindi waterway		

Hence, for Thakurran waterway, the Operating Building and corresponding mannings proposed at Dhaki Jetty along Thakurran waterway is recommended to support the operational activities of all the ferry terminals proposed in Thakurran 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)

5.8.1 Capital Cost

Capital cost for proposed ferry terminals are provided in **Table 24** respectively

Table 24: Capital Cost of 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

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lakh)
3	Passenger Approach Area/ Bus Car Drop Off Area (12m X 22 m)	m²	264	40,000	105.60
4	Control Room Equipment's including navigation control equipment's	No.	1	50,000	0.50
5	Telecomm. Room Equipment's	lot	...	LSM	1.00
6	Ticket vending Machine & installation cost	No.	1	4,00,000	4.00
7	Automatic Fare collection gates (set of 2 nos. at Entry gates +Set of 1 no. at Exit Gate)	Per set	3	3,00,000	9.00
8	Passengers Arrival Area facility	-	...	LSM	5.00
9	Visitors parking Area (15m X 10 m)	m²	150	18,000	27.00
10	Passengers Waiting Chairs @ 50 per terminal	No.	50	2,500	1.25
11	Substation	No.	1	10,00,000	10.00
12	Fire Fighting System (dry type)	lot	...	LSM	2.50
13	Electrical, Water& Utility	lot	...	LSM	12.50
14	Security Office (4.5m X 5m)	m²	22.5	18,000	4.05
15	Sewage Treatment System	No.	1	25,00,000	25.00
16	Approach Platform (3m X 7 m)	m²	21	75000	15.75
Total					**290.65**
17	Cost of Detail Engineering and construction supervision			6%	17.44
Total					**308.09**
18	Contingency			3%	9.24
	Capital cost of each ferry terminal with Pontoon and Gangway				**317.33**

	Number of proposed Terminal/Jetties	3
	Capital cost of proposed ferry terminals with Pontoon and Gangway	**952.00**

19	Cost of Operating Building (20m X27m) (single storey) proposed in Dhaki Jetty	m²	540	40,000	216.00
20	Cost of Detail Engineering and construction supervision			6%	12.96
	Total				**228.96**
21	Contingency			3%	6.87
	Capital cost of Operating Building				**235.83**

	Total Capital Cost of proposed ferry terminals with Ponton and Gangway including one Operating Building	**1,187.82**

Hence, total capital cost of proposed ferry terminals in Thakurran waterway works out as **INR 1,187.82/- Lakh**.

5.8.2 O&M Cost

Operation and Maintenance cost to be incurred for running terminal facilities for ferry terminals are provided as below.

a) Manning

The efficient IWT operation requires a substantial number of staff. These include: -

- The operating staff comprising Terminal Manager, traffic marshals etc;
- Security Staff comprising the Security Chief and security officers
- Maintenance Engineering Staff comprising the maintenance engineer, his deputy, mechanical, electrical and civil engineers, foremen, fitters, welders, electricians, plumbers, joiners, painters, riggers and their mates and labourers;
- Administration staff comprising administrators, personnel, property managers, their assistants, secretaries and cleaning staff.

The total number of staff required to operate the terminal on a single shift basis (excluding critical staff) is estimated as provided in **Table 25.**

Table 25: Manpower Requirement for IWT Terminal Operation of all Terminals

Sl. No	Manpower	No./ Shift	No. of Shift required	Location of Posting	Total no. of Personnel required for proposed Jetties/Terminals
1	Terminal Manager	1	1	Operating Building	1
2	Operating staff/Executives	3	1		3
4	Accountant	2	2		4
5	Control Room Operator	2	1	All 3 Jetties/ Terminals	6
6	Plumper & Electrician	1	2		6
3	Security Guards	2	2		12
7	Misc. for Field Works	1	2		6
	Total				**36**

Table 26: Manpower Cost per annum

Sl. No.	Manpower	Category/ Level	Reference	Min Gross Salary (INR/ month)	Annual Gross Salary (INR)	Cost (INR) in Lakh
1	Terminal Manager	L-8	7th pay commission pay matrix	47600	5,71,200	5.71
2	Operating staff/ Executives	Highly Skilled	West Bengal Minimum rates of wages w.e.f July 2020	11380	1,36,560	4.10
3	Accountant	Skilled		10347	1,24,164	2.48
4	Control Room Operator	Skilled		10347	1,24,164	7.45
5	Plumper & Electrician	Skilled		10347	1,24,164	7.45
6	Security Guards	Unskilled		8550	1,02,600	12.31
7	Misc. for Field Works	Unskilled		8550	1,02,600	6.16
	Total					**45.66**

From the above table, the total annual manpower cost required for running the all the proposed 3 jetties/terminal facilities in Thakurran waterway works out to INR **45.66/- Lakh** annually.

b) Utilities and Services

The annual cost of providing water, electricity and other services is considered as about 1.0% of the capital cost. Thus, the annual cost for providing Utilities and Services for proposed three teminals works out as **INR 11.88/- Lakh annually.**

c) Maintenance

To ensure that the terminals 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.

In the first four years, the maintenance staff might consist only of fitters, electricians and plumbers together with their mates all under the control of a general trades foreman. Their duties would be to deal with breakdowns in the mechanical and electrical equipment as well as the water supply system. In the fourth year, it would be advisable to provide a fully equipped workshop where equipment can be repaired and serviced. The workshops would provide storage space for spare parts and would provide a base for all maintenance staff.

The annual cost of maintaining terminal structures including all civil, mechanical and electrical components is considered to be about 3% of the capital cost. Thus, the annual maintenance cost for three terminals works out as **INR 35.63/- Lakh**.

The total O&M cost of proposed terminals are provided in terminal **Table 27** below:

Table 27: Annual O&M cost of terminals

Sl. No	Item	O&M Cost for three terminals (INR) Lakh
1.	Manpower	45.66/-
2.	Utilities and Services	11.88/-
3.	Maintenance	35.63/-
Total annual O&M cost		**93.17/-**

6.0 PRELIMINARY ENGINEERING DESIGNS

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

6.1 RIVER TRAINING

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

6.2 BANK PROTECTION

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

6.3 NAVIGATION AIDS

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

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

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

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

6.4 FERRY TERMINAL AND JETTIES

Preliminary engineering design required for DPR level costing and analysis for jetty, terminal structures and access infrastructure is done and provided as below for ferry terminals.

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
- IS 875 (Part 3): Code of Practice for Design Loads for Building and Structures-Wind Load
- 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 passenger terminal. The following are the main facilities required for operation of the terminal:

- Approach Platform
- Gangway
- Pontoon Platform
- Terminal Building & parking facilities

A. STRUCTURAL SYSTEM

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

The approach platform is a piled structure, 7 m long and 3 m wide. The pile spacing of 0.75 m dia pile is 2.5m in longitudinal direction and mono-pile configuration is adopted. Beams of 0.9m wide and 1.2m deep connect the piles. The deck slab is 0.35 m thick.

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

A terminal building is provided with all facilities like ticketing room, waiting area, operations control centre, pantry and toilets

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.

C. DESIGN CRITERIA

LOADING DATA

The principal loads considered for design of various components are listed as below:

1) Dead Load
2) Live Load
3) Seismic Loads

Since it is a completely landside piled structure with no berthing and mooring operation, loads due to the same is not considered. Further, no effects due to wave and current are considered as they are insignificant because of their location. The values of intensities of the above loads considered in design are detailed in the following sections

1) Dead Load:

The following unit weights are used in design

Reinforced Cement Concrete	2.5 T/m^3
Structural Steel	7.85 T/ m^3
Density of sea Water (Tidal section)	1.025 T/ m^3

2) Live Load:

Live load on the jetty and approach structure is as per relevant Indian standards and the same is given below.

Load	Intensity
UDL – Jetty	25 kN/m^2
UDL – Terminal Building	5 kN/m^2
Load due to Gangway on approach platform	90 kN

3) Seismic Load:

The site falls in Zone 3 as per seismic map of India presented in IS 1893 (Part I) – 2002. Design horizontal seismic coefficient is evaluated as per provisions mentioned in code for the following parameters

Zone Factor	0.16
Importance Factor	1.5
Response	3

LOAD COMBINATIONS

The structure will be analysed as per load combinations presented in IS 4651 (Part IV) – 2014 for ultimate limit state and serviceability limit state.

SL.No	Loading	Partial Load factor					
		Serviceability Limit State			Ultimate Limit State		
		Short Term	Long Term	Normal	Extreme/ Survival	Temporary	Reverse
1	Dead Load (DL)	1.0	1.0	1.5	1.2	1.2	0.9
2	Live Load –Dynamic (DyL)	1.1	0.5	1.5	1.2	1.2	0.9
3	Live Load –Static (LL)	1.0	0.5	1.5	1.2	1.2	0.9
4	Seismic Load (SL)	1.0	-	-	1.2	-	1.5

SERVICEABILITY CRITERIA

1) Deflection Limit

Deflection of Pile at Pile cut-off level shall be L/350 under operating condition and L/250 under extreme condition, where L is the length of the pile from pile fixity to cut-off level.

2) Crack width Limit

Crack width in structural elements shall be maintained as per IS 4651 (Part IV) – 2014. The same has been reproduced here for ready reference.

Sl. No:	Exposure Zone	Maximum Crack width	
		Sustained	Transient
1	Atmospheric Zone (Above Splash Zone)	0.2 mm	0.3 mm
2	Splash Zone (Between CD & MHWS)	0.1 mm	0.2 mm
3	Continuous sea water immersion Zone (Below Splash Zone	0.2 mm	0.3 mm
4	Below Seabed Level	0.3 mm	0.3 mm

MATERIAL PROPERTIES

All reinforced cement concrete works shall be carried out with M40 grade concrete and reinforcement steel shall be of Fe500 grade. Clear cover to reinforcement shall be as per IS 4651 (Part IV) – 2014 which is as shown below.

Sl. No:	Exposure Zone	Clear Cover
1	Atmospheric Zone (Above Splash Zone)	50 mm
2	Splash Zone (Between CD & MHWS)	75 mm
3	Continuous sea water immersion Zone (Below Splash Zone upto sea	75 mm
4	Below Seabed Level	75 mm

DESIGN LIFE

The jetty and associated structure shall be designed for the following design life

Sl. No:	Structural Element	Design life
1	RCC Pile and deck superstructure	50 Years

DESIGN METHODOLOGY

The structure shall be idealized in STAAD Pro with all mentioned loads and design criteria to analyse and design the structural elements. Fixity method shall be adopted in modelling of piles. All design is based on IS 456-2000 and IS 2911 (Part 1/Section 2) – 2010.

D. METHOD OF ANALYSIS

The following software have been used in design

- STAAD Pro V8i

STRUCTURAL STAAD MODEL

3-dimensional STAAD model has been idealized for each of the structure envisaged. Piles and beams have been modelled as beam elements while deck slab is idealized as plate elements. Length of the pile has been assessed based on sea bed level as presented in available data. The following figures give an in-sight of the modelling undertaken for analysis.

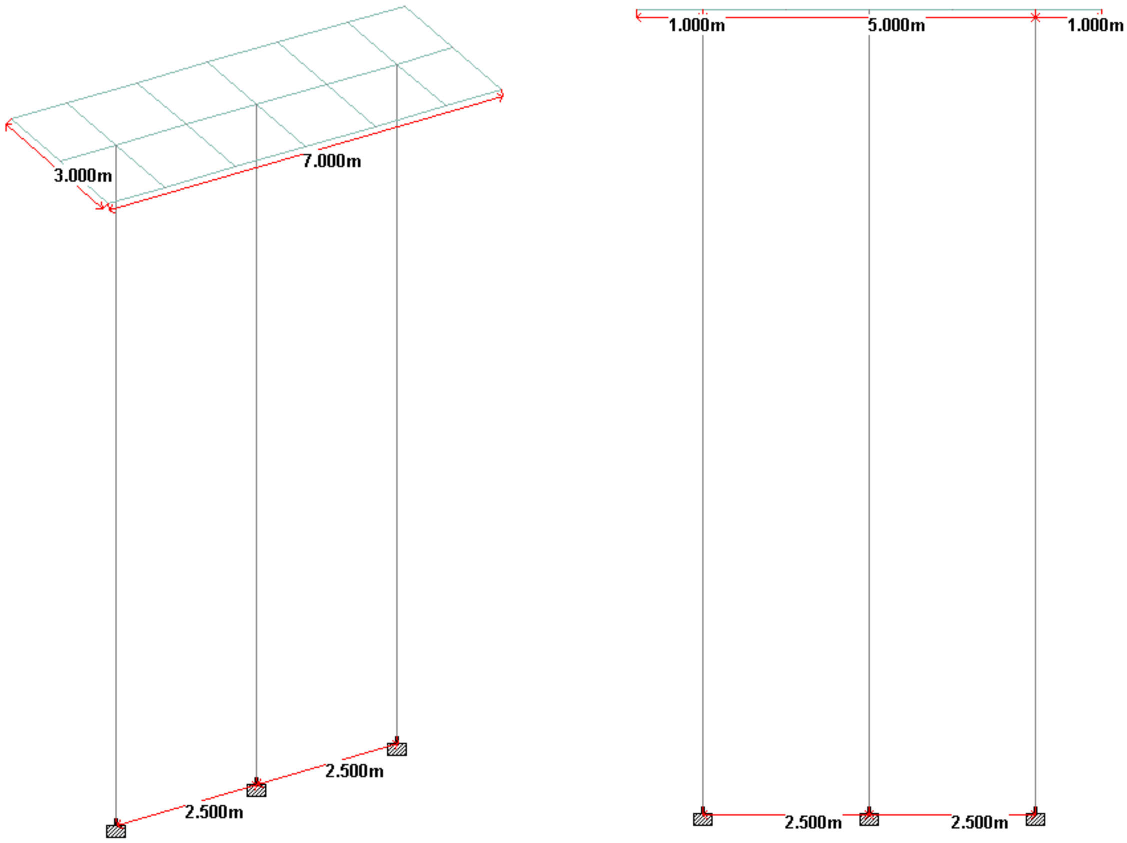
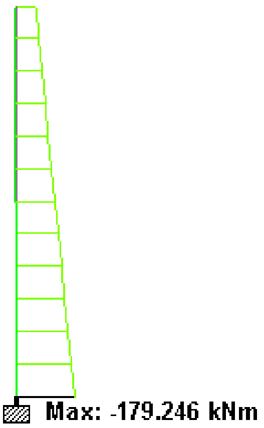


Figure 34: 2D View of STAAD Model – Approach Platform

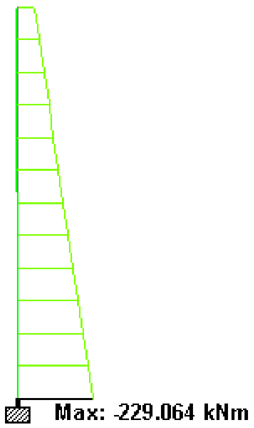
P-Δ analysis is carried out on the idealized model to include secondary effects. All possible loads and load combinations as per IS4651 (Part 4): 2014 is considered and applied in a logical way to analyse the structure to determine the design forces.

Limit State Design Method is used for design of structural components. All possible limit states are checked which includes serviceability and collapse limit states.

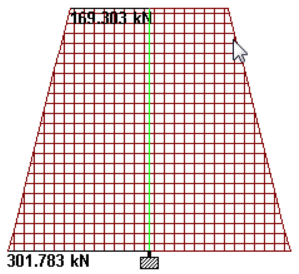
ANALYSIS RESULTS



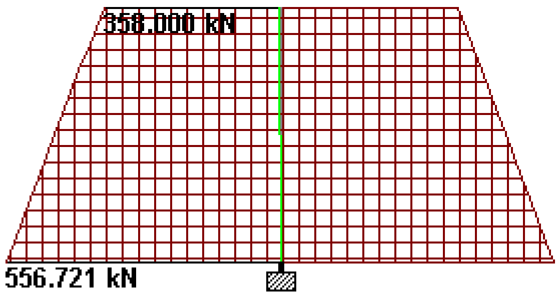
Max. Bending Moment My (SLS)



Max. Bending Moment My (ULS)



Min. Axial force Fx (SLS)



Max. Axial force Fx (ULS)

Design of piles

Design of longitudinal and helical reinforcement of pile is done as per IS:456-2000 & SP 16. Pile are checked for all possible severe combination of resultant forces and design for governing forces.

Development length (Refer IS: 456-2000, Cl. 26.2.1)

Development length, L_d $= \Phi\, \sigma_s / 4\, \tau_{bd}$

Bond stress, τ_{bd} = 1.9 MPa

60% increase in bond stress for deformed bars (Refer IS: 456-2000, Cl. 26.2.1.1)

Hence, Design Bond Stress = 3.04 MPa

Stress in bar, $\sigma s = 0.87\ f_y$ = 435 MPa

L_d = 35.8 Φ

Say = 36 Φ

6.5 Construction Schedule

The time schedule for construction activities of the project is considered as two (2) years. The proposed project schedule is provided in **Figure 35.**

Sl. No.	Activities	1st Year	2nd Year
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/Upgrdation of terminal building, landside facilities		
6	Upgrading existing road to terminals		

Figure 35: 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. India has about 14,500 km of navigable waterways which comprise rivers, canals, backwaters, creeks, etc. Currently, inland water transport is restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the Brahmaputra, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai and the deltaic regions of the Godavari-Krishna rivers. Besides the organised operations by mechanised vessels, country boats of various capacities also operate in various rivers and canals. Data of cargo and passenger movement in unorganised sector (i.e. by country boats, etc.) has not been compiled (for which efforts are on) but it is a fact that substantial quantum of cargo and passengers are transported in the unorganised sector as well. Considering the inherent advantages of this mode in terms of fuel efficiency, environment friendliness and cost effectiveness, the Govt. of India is trying to develop this mode to make it an effect supplementary mode of transportation vis-a-vis rail and road modes.

7.2 CURRENT SCENARIO

Ferry and small cargo vessels are already operational in Thakurran river. The photographs of existing vessels plying along the waterway are provided in **Figure 36.** Ferry boats having approximate dimensions of about 16.0 m long, 2.5 m breadth and 1.0 m depth are used for movement of passenger and small cargos. The existing vessels lack the basic safety gears and communication equipments. Hence, vessels with required safety and communication equiments are proposed along the waterway.

Figure 36: Vessels plying on Thakurran Waterway

7.3 PASSENGER TRAFFIC AT PROPOSED LOCATIONS

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

Table 28: Passenger Traffic at Proposed Locations

Sl. No	Proposed Ferry Ghat	Average daily passenger traffic
1.	Ganga	400
2.	Debipur	800
3.	Dhaki	1500

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

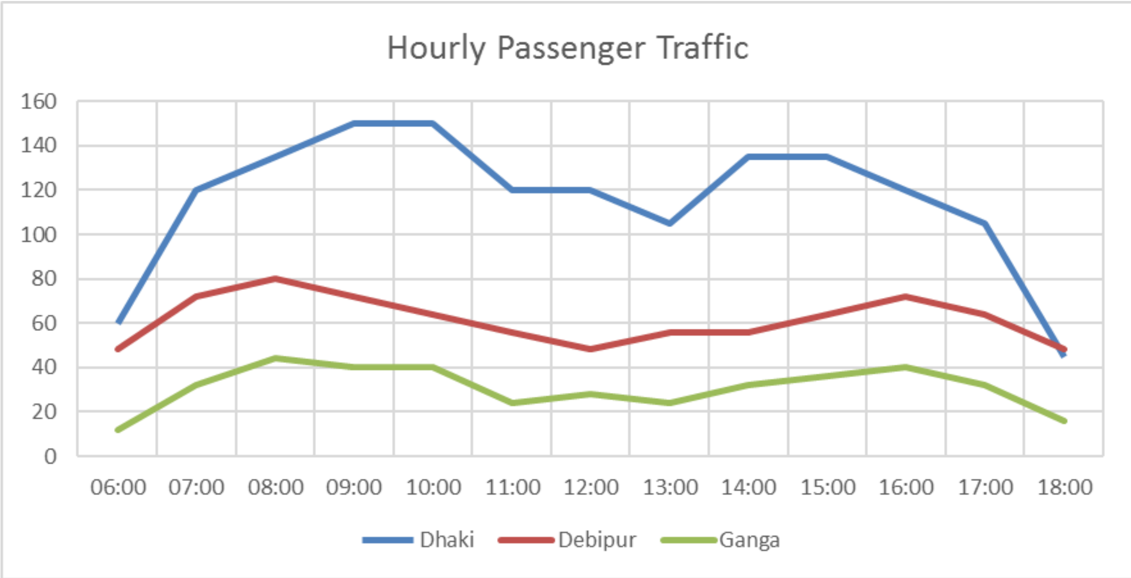


Figure 37: Hourly Passenger Traffic

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.

- 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 -8.30 m to 24.29 m w.r.t sounding datum for Class VII waterway.

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 ferry boats shall be equipped with an Intelligent Transport and Navigation System. The ferry boats 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 the 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 29: 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
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 38**.

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 38: Ferry Services in the river Hooghly between Kolkata and Howrah[3]

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.

The time taken by Passenger ferry vessel for loading and unloading of passengers is considered as 5 minutes.

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

As Thakurran waterway is connected with Indo-Bangladesh waterway protocol route and thereby with other National Waterways, the vessels may also ply on these waterways. However, for calculating turnaround time, it is presumed that the ferry vessels will operate between the proposed teminals only along Thakurran waterway, located in the stretch from Chainage 34.5 Km to Chaiange 53.4 Km only.

7.7 NUMBER OF VESSEL REQUIRED

Number of vessel required to ply on route is estimated and provided in **Table 30** as below.

Table 30: Estimate of No. of vessel required for Passenger Ferry Service

Sl. No.	Description	Unit	Value
A	Crusing Speed	Knot	6
B	Length of the waterway considered for development	Km	19.2
C	Time required by vessel to travel in proposed waterway stretch	minutes	103.67
D	Embarking and Dis-embarking time considered for 3 terminals	minutes	15
E	Trip duration (sl. no. C + sl. no. D)	hours	1.98
F	Operating hours per day (as per information collected on site)	hours	12
G	No. of trips allowed during 12 hours operational time per day per vessel (sl. no. F / sl. no. E)	trips	6.07
H	Considering passenger ferry vessels with capacity of	pax/vessel	50
I	Present passenger's traffic	pax/day	1500
J	Required no. of trips per day for current passenger traffic (sl. no. I/ sl. no. H)	trips	30.00
K	Number of Ferry vessel required for current passenger traffic demand (sl. no. J/ sl. no. G)	numbers	4.94
L	Design passenger traffic in 20th year	pax/day	8155
M	Required no. of trips per day for design passenger traffic (sl. no. L/ sl. no. H)	trips	163.10
N	Number of Ferry vessel required for design passenger traffic (sl. no. M/ sl. no. G)	numbers	26.88
O	Proposed number of ferry vessels for present passenger traffic	numbers	5.00
P	Proposed number of ferry vessels for design passenger traffic of 20th year	numbers	27.00

Accordingly, for Thakurran waterway, it is proposed to provide ferry vessel of 50 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, five (5) numbers of vessels are proposed at inception stage. In 10th year of operation additional eight (8) vessels are proposed and in 20th year of operation additional fouteen (14) vessels are proposed for IWT operations as per required passenger traffic, making total fleet to twenty-seven (27) vessels to cater the projected traffic demand from 20th year onwards.

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 50 passenger capacity for Thakurran waterway are as below:

a. Type – Fibre Boat
b. Length – 20.0 m
c. Breadth – 4.0 m
d. Depth – 1.70 m
e. Draft – 1.0 m
f. Engine capacity – As per design with conventional propulsion
g. Crusing Speed – 6 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 39** shows the range of purchase prices found for new vessels in each vessel category.

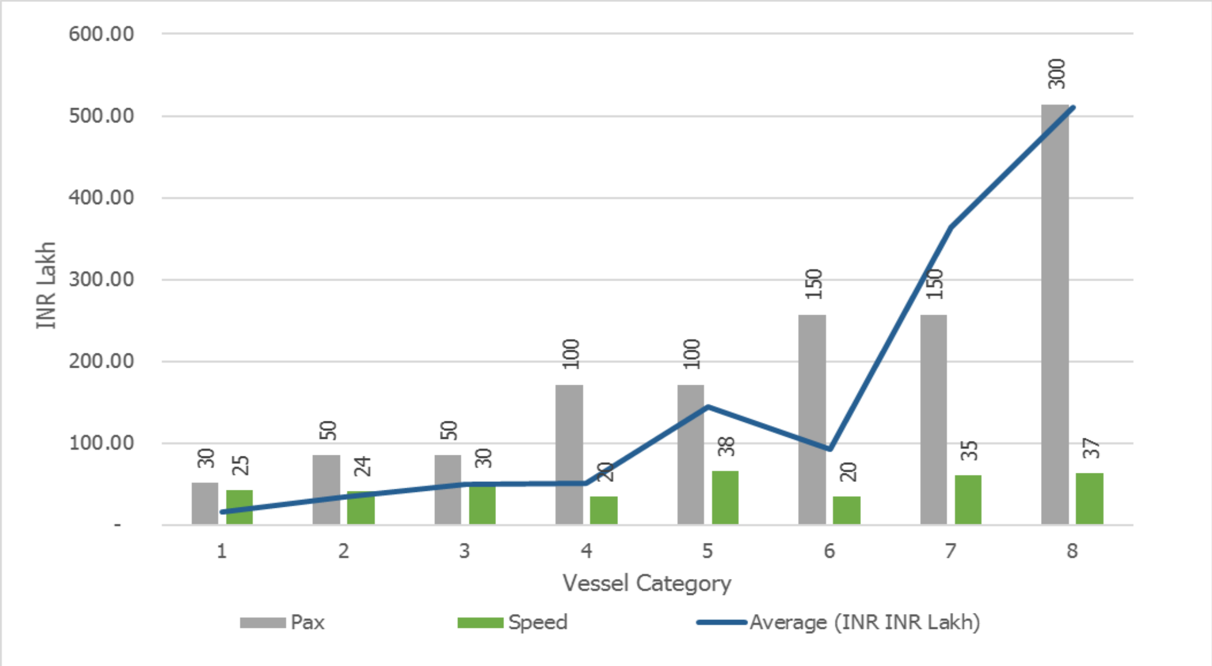


Figure 39: Graph showing variation in Vessel cost w.r.t passenger capacity and speed

Accordingly, for passenger ferry vessel of 50 pax capacity, the capital cost considered is provided in table below:

Table 31: 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	80.00	5 (from start date of operation)	400.00

Sl. No.	Description	Rate per Vessel (INR Lakh)	No. of Vessels	Total Cost for vessels (INR Lakh)
2.			8 (from 10th year of operation)	640.00
3.			14 (from 20th year of operation)	1120.00

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 latest Inland Vessel (IV) Act. Total nos. of crew members proposed is provided as below:

Table 32: Manning Cost per Vessel

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	2	2.05/-
Total						**3**	**4.44/-**

Hence, for each vessel 3 crew members are required with annual cost of INR 4.44/- Lakh.

b) Consumables and Repair/Maintenance Cost

Tentative maintenance cost of 2% per annum of capital cost is considered under this head. Hence, annual consumables and repair/maintenance cost works out to INR 1.60 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
Number of trips in a day per vessel	= 6.07 trips
Mobility time per trip	= 103.67 minutes
Approximate rate of fuel per litre	= 75 INR per litre
Fuel cost per trip per vessel	= INR 2,073.43
Fuel cost per annum for each vessel	= INR 18.87 Lakh per Annum

Table 33: Annual O&M cost of Vessels

Sl. No	Item	Annual O&M Cost for each vessel (INR Lakh)	Annual O&M Cost for 5 vessels (INR Lakh)	Annual O&M Cost for 8 vessels (INR Lakh)	Annual O&M Cost for 14 vessels (INR Lakh)
1.	Officer and Crew Costs	4.44	22.20	35.52	62.16
2.	Consumables and Repair/Maintenance Cost	1.60	8.00	12.80	22.40
3.	Fuel Cost	18.87	94.35	150.96	264.18
	Total	**24.91**	**124.55**	**199.28**	**348.74**

Hence, total O&M cost for running five (5) vessels is INR 124.55 Lakh per year. For additional eight vessels, the additional O&M cost works out to INR 199.28 Laks per year respectively.

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 40** below. As shown in figure below, all 13 waterways prpopsed under NW-97 fall under the radial coverage of proposed DGPS at Canning. Radial distance of canning from farthest point in Thakurran waterway is about 86 Km. The capital and O&M cost of proposed DGPS system at Canning is considered in DPR of Matla waterway.

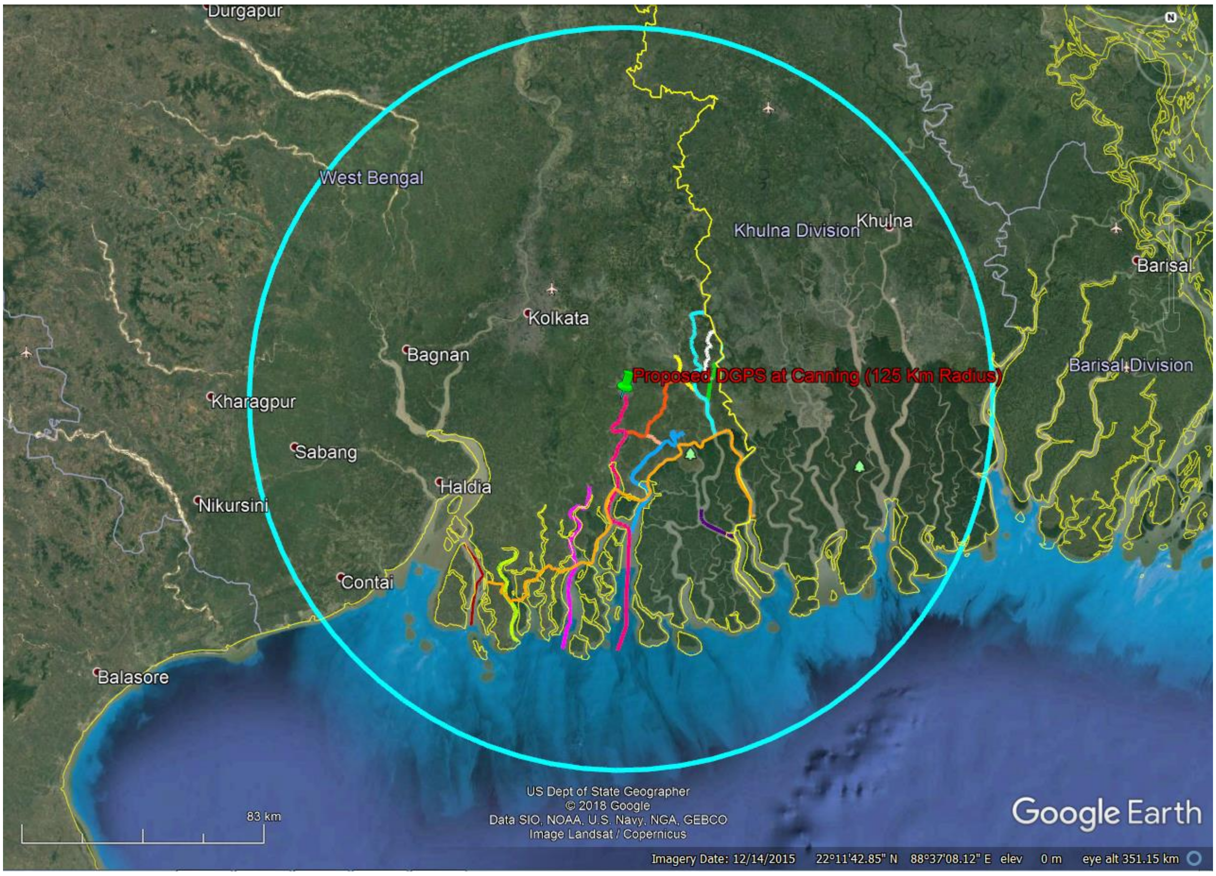


Figure 40: Google Earth image showing location map of proposed DGPS and effective coverage

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 34: 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**
				Saptamukhi	37.163	0.00	37.163	
				Thakurran	**36.4**	**0.00**	**36.4**	
2	**21°59'19.55"N, 88°31'3.58"E**	**Dhaki Jetty**	**Thakurran WW**	**Thakurran**	**40.865**	**23.0**	**63.865**	**Thakurran**
				Matla	45.0	30.0	75.0	
				Bidya	28.50	0.00	28.50	
3	22°10'5.76"N, 88°47'14.07"E	Godkhali Jetty	Gomar WW	Matla	43.731	55.0	98.731	Gomar WW
				Bidya	49.623	6.20	55.823	
				Gomar	6.711	0.00	6.711	
				Hogla	37.202	0.00	37.202	
				Raimangal	21.50	0.00	21.50	
				Chhota Kalagachi	8.324	0.00	8.324	
4	22°23'17.49"N, 88°53'59.43"E	Bolakhali Jetty	Raimangal WW	Hogla	27.702	10.0	37.202	Raimangal WW
				Raimangal	53.381	0.00	53.381	
				Chhota Kalagachi	15.324	0.00	15.324	
				Sahibkhali	14.392	0.00	14.392	
				Katakhali	22.465	0.00	22.465	
				Kalindi	8.513	0.00	8.513	

Hence, the proposed RIS stations at Bhagabatpur along Saptamukhi waterway and Dhaki Jetty along Thakurran waterway will cover the complete stretch of proposed Thakurran waterway as shown in **Figure 41** below. The capital and O&M cost of proposed RIS at Bhagabatpur is considered in the DPR of Saptamukhi waterway. The capital and O&M cost of proposed RIS at Dhaki Jetty is considered in this DPR of Thakurran waterway.

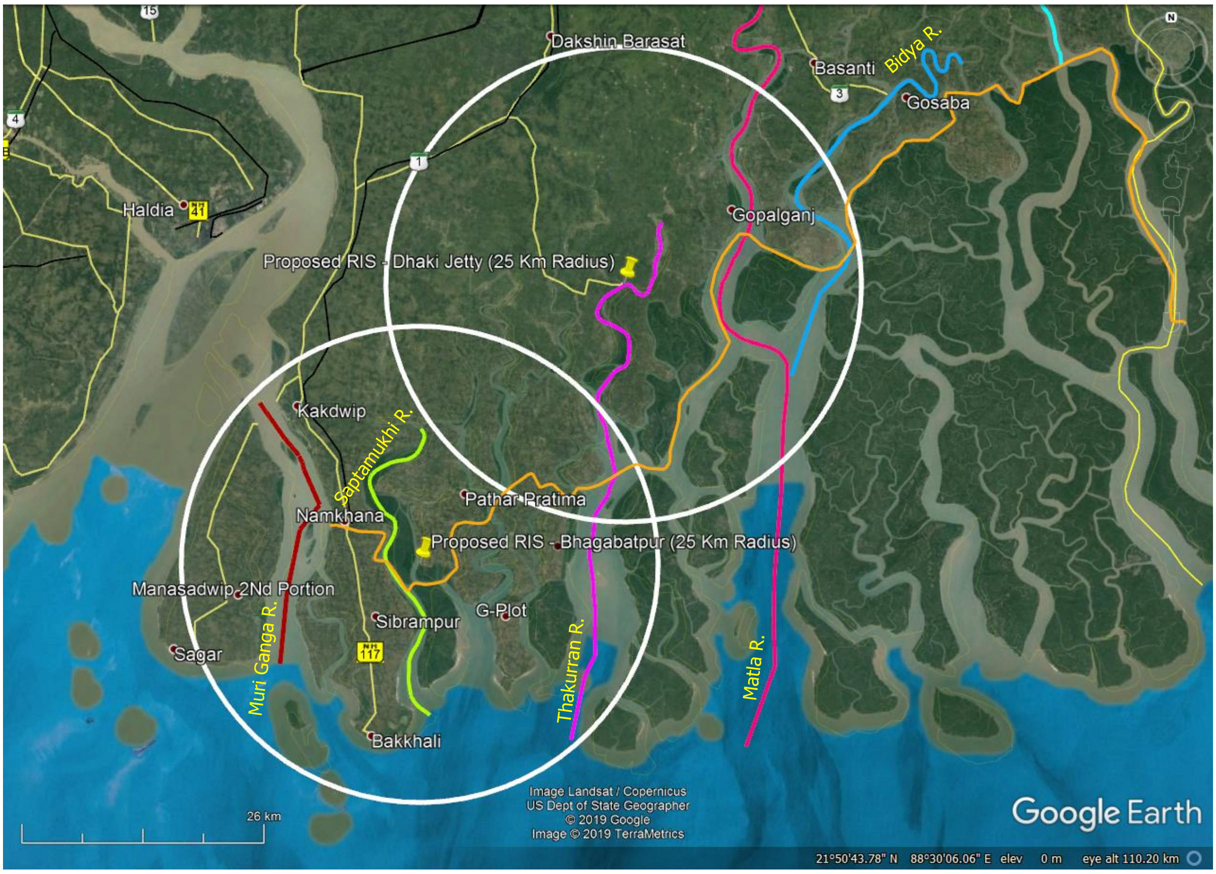


Figure 41: Google Earth image showing location map of proposed RIS and effective coverage

8.2 NIGHT NAVIGATION FACILITIES

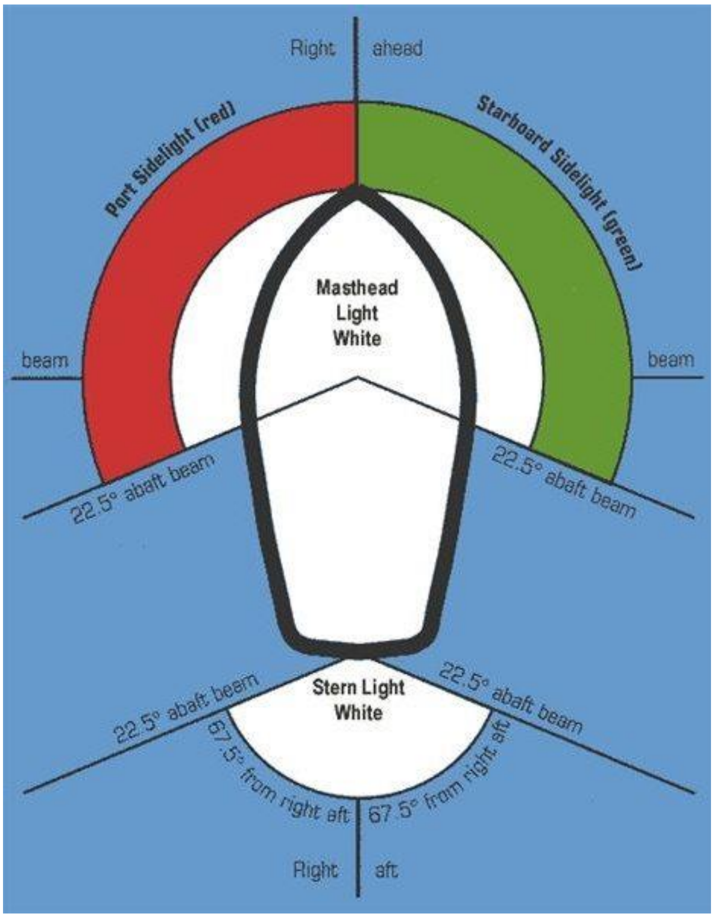
On sectors of the river where there is day and night navigation, forks, junctions and the axis of the fairway, along with obstacles to navigation lying within the fairway, shall be marked by light buoys or bank marks and lights. Floating signs shall be installed at such a depth and at such a distance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

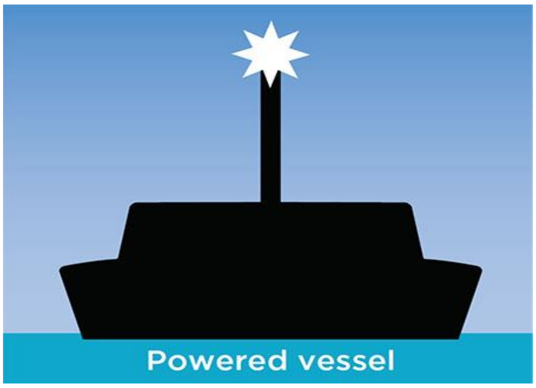
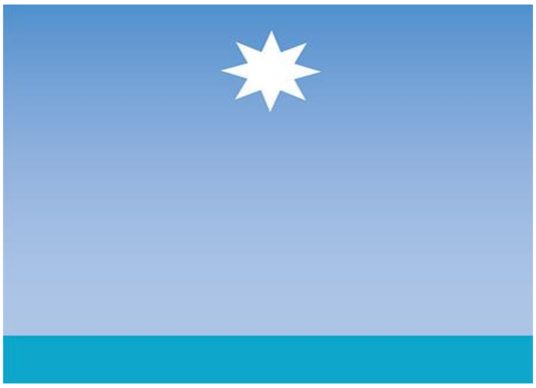


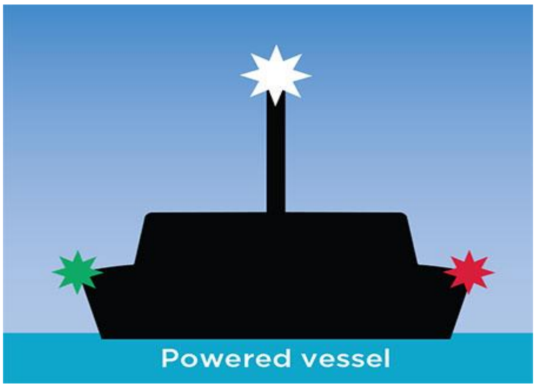
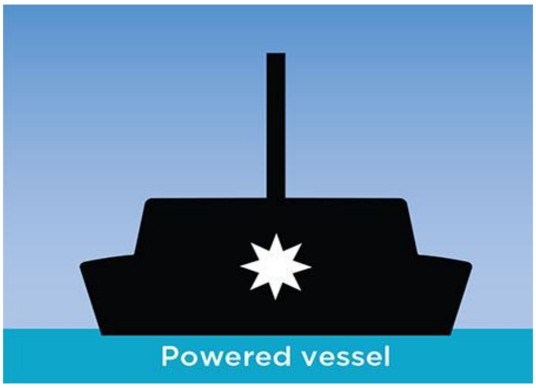
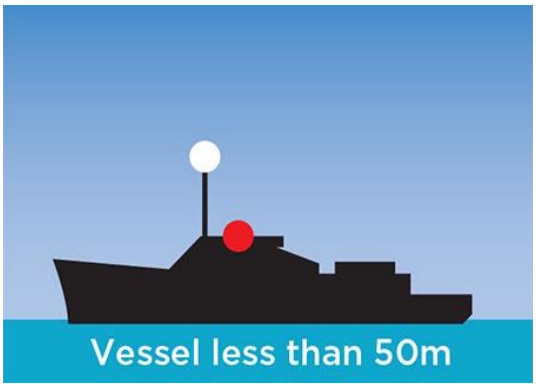
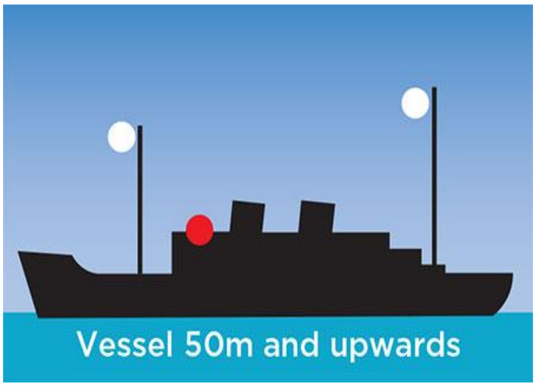
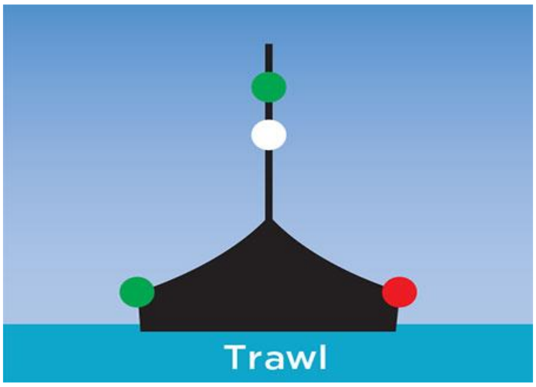
- There is a light at the right-hand side of the boat (right side when facing the bow of the vessel known as the starboard side) which is green in colour.
- There is a light at the left-hand side of the boat (left side when facing the bow of the vessel is known as the port side) which is red in colour.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

Thakurran waterway is proposed to be developed for ferry services from Chainage 34.5 Km to Chaiange 53.4 Km. Presently, passenger ferry services operational along the river are operated by locals and no safety, aids to navigation and communication system exists 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 42** 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 42: Relation between Services and RI Systems

8.5 COSTING

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

i) Quantity of the equipment/s has been decided depending on the distance of the river to be covered.

ii) To operate the system, proper certified operators are to be deployed at site along with the security guards.

iii) CAMC for minimum three years has been considered after one year warranty from the date of commissioning.

iv) As Thakurran waterway is constituent of NW-97 comprising 13 rivers, required quantity of DGPS and RIS condering their effective coverage to avoid duplicity of Instrument proposed and cost over runs is considered.

Capital cost of purchase & installation and O&M cost of DGPS is considered in submitted Matla DPR. Capital cost of purchase & installation and O&M cost of one RIS proposed at Bhagabatpur is considered in submitted Saptamukhi waterway. And capital cost of purchase & installation and O&M cost of one RIS proposed at Dhaki jetty and Marine lanterns/bouys provided in Thakurran Waterway works out as below.

8.5.1 Capital Cost

Table 35: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lakh)
A	**RIS System**			
1	AIS Base Station	1	30,00,000.00	30.00
2	RADAR	1	100,00,000.00	100.00
3	Meteo Sensor	1	7,00,000.00	7.00
4	ATG	1	9,00,000.00	9.00
5	VHF	1	5,00,000.00	5.00
6	DG Set 10 KVA	1	7,00,000.00	7.00
7	UPS	1	5,00,000.00	5.00
8	RIS Software	1	35,00,000.00	35.00
9	Installation Testing & Commissioning	1	20,00,000.00	20.00
10	Porta cabin	2	12,00,000.00	24.00
11	Trestle Tower	1	10,00,000.00	10.00
	Total cost of one RIS system			252.00
12	Construction Supervision, Design and Engineering charges		6%	15.12

	Capital cost per RIS system			**267.12**
B	Marine Lantern/Buoys of 1.25 m dia	20	2,00,000	**40.00**
	Capital Cost in Lakh			**307.12**
13	Contingencies Charges		3%	9.21
D	**Total Navigation & Communication Cost in Lakh**			**316.33**

8.5.2 O&M Cost

The operation and maintenance cost works out to as below:

Table 36: O&M Cost for Aids to Navigation and Communication

Sr. No.	Manpower	Qty	Unit Price (INR)	Total (INR Lakh)
1	Engineer 1 * Site 1 * Months 12 per year	12	35,000.00	4.20
	Operator 3 * Site 1 * Months 12 per year	36	20,000.00	7.20
	Security 3 * Site 1 * Months 12 per year	36	15,000.00	5.40
2	Second Year			17.98
3	Third Year			19.23
4	Fourth Year			20.58
			Total	**74.59**
	CAMC for 4 Years			
1	1st Year	1		31.63
2	2nd Year	1		34.80
3	3rd Year	1		38.28
			Total	**104.71**
	Overall O&M Cost in INR Lakh			**179.30**

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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 Thakurran River from Km 0.000 to Km 63.865 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).

The Thakurran River is a tidal estuarine river that forms a wide estuary in and around the Sunderbans in South 24 Parganas district West Bengal, India. The river originates near Jaynagar and has a number of connections with Saptamukhi and forms the boundary between Mathurapur and Jaynagar blocks.

Thakurran River has two (2) tributaries/creeks along the bank. The details of the creeks is given in **Table 37.**

Table 37: List of Creeks

Sl No	Creek	Chainage	Length(Km)
1	Dhakir Mukh	40.1	6.87
2	Burge Island	53.301	22.10

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.

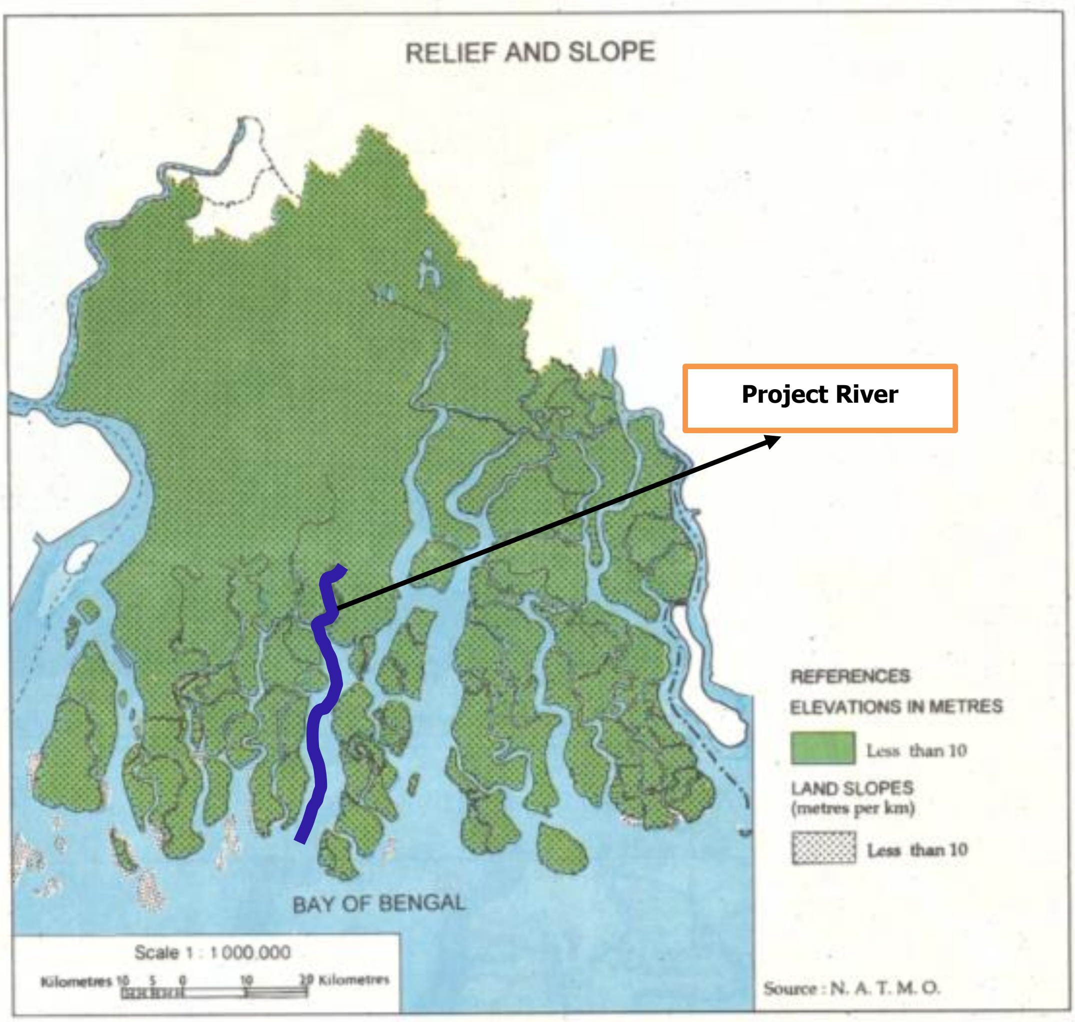
South Hugli Flats: From the northern boundary of the district (Kolkata) to Diamond Harbour in the south, this is a narrow flat alluvial land along the river of Hooghly which also forms the district boundary in the west. Flowing south-west, Hooghly receives the Rupnarayan River in the Hugli point and 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 43**.



Source : NATMO

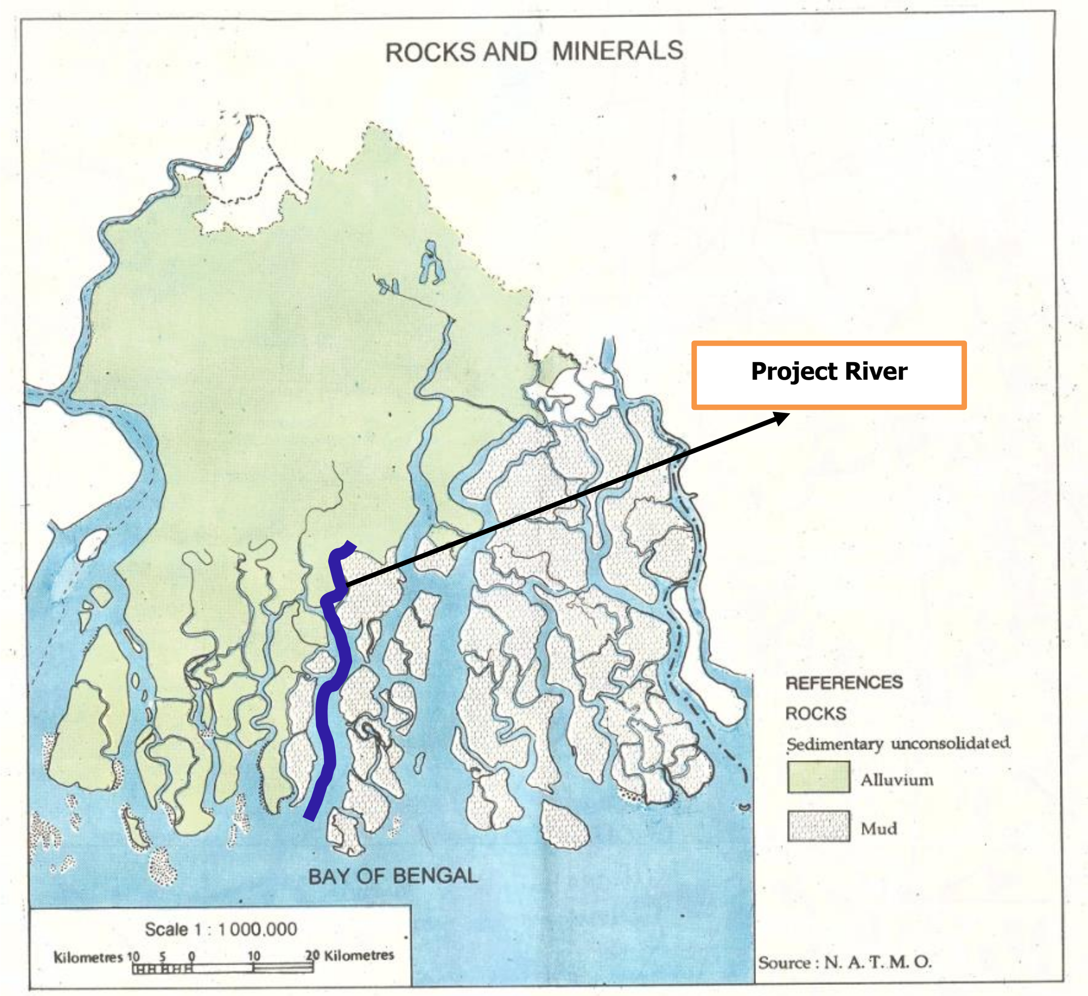
Figure 43: Relief and Slope Map of South 24 Parganas District

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 44**.

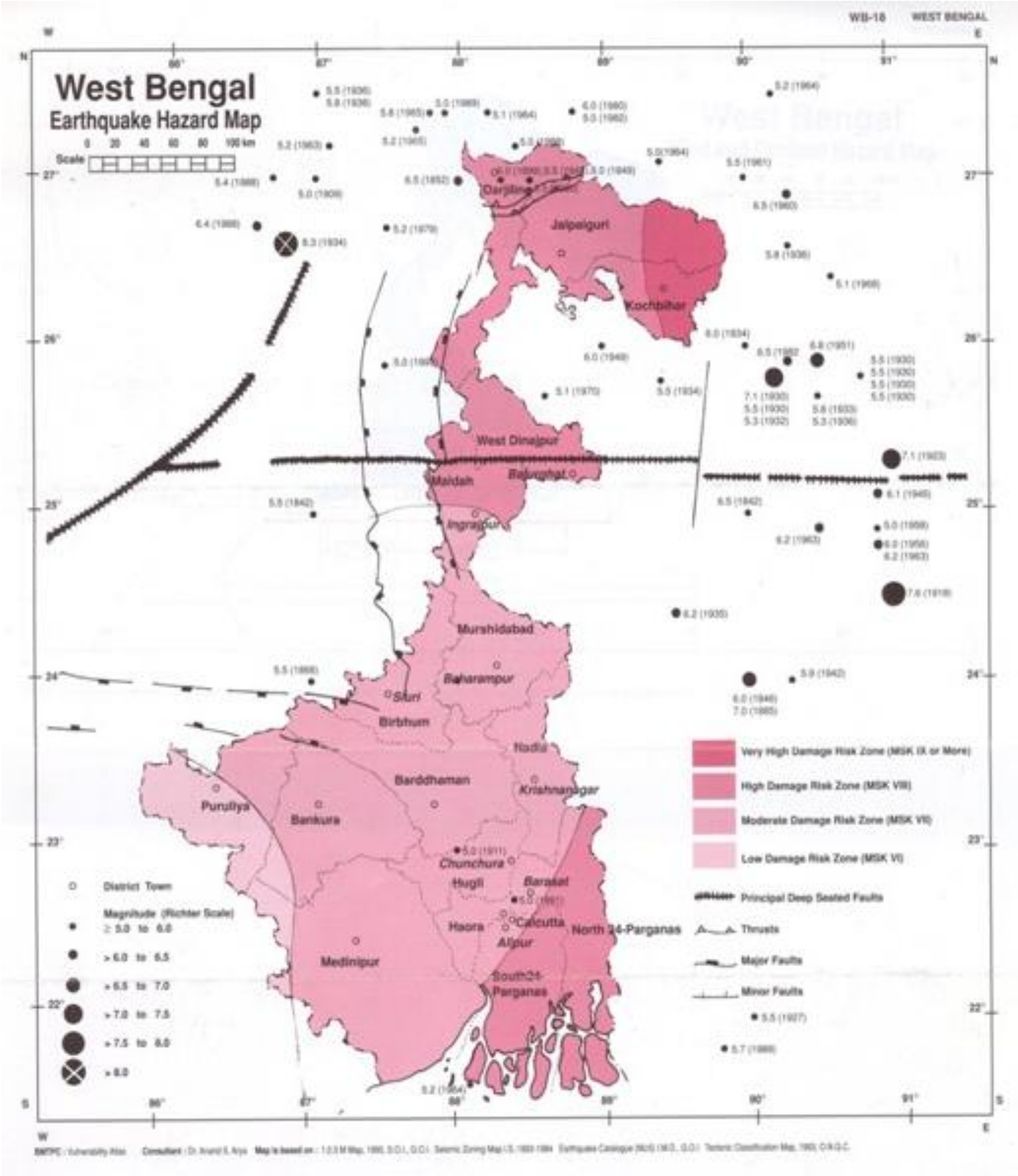


Source : NATMO

Figure 44: 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 45**.



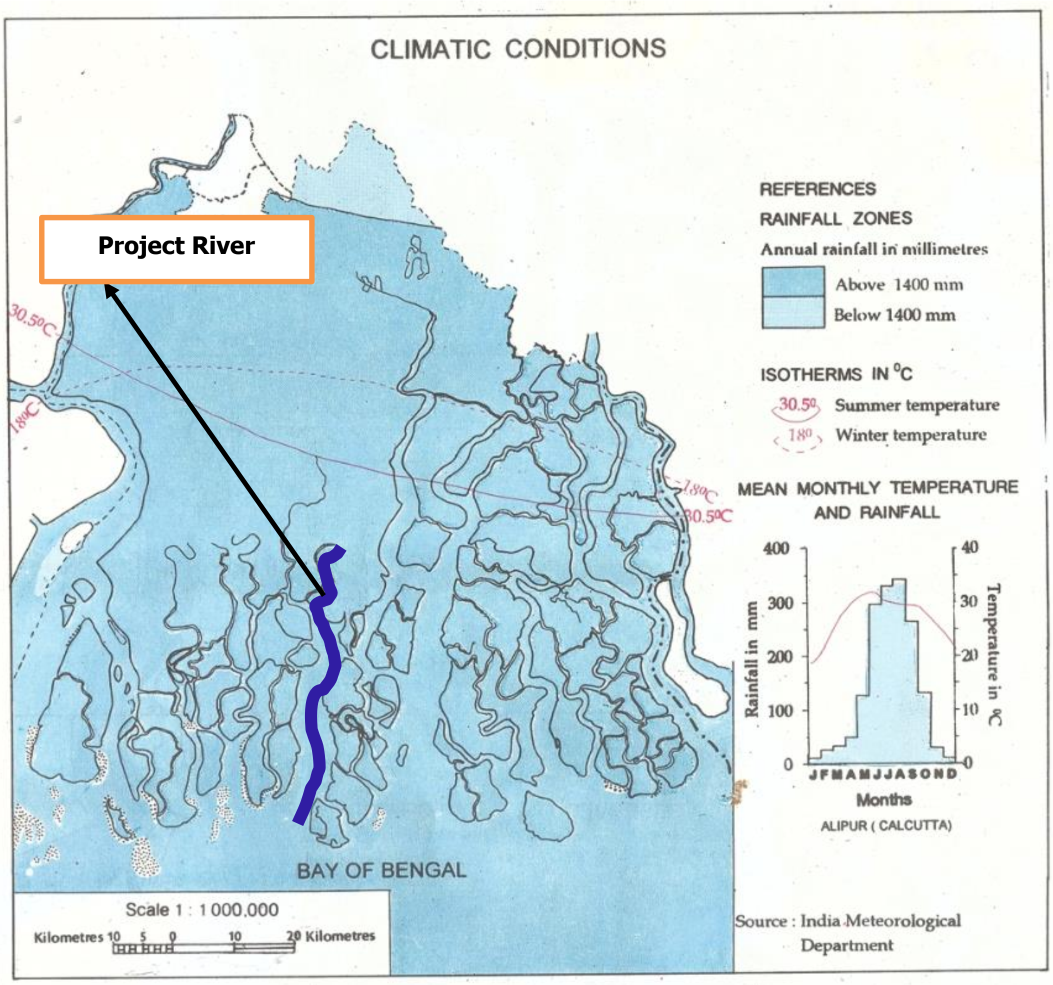
Source : West Bengal Disaster Management Department

Figure 45: 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 46**.



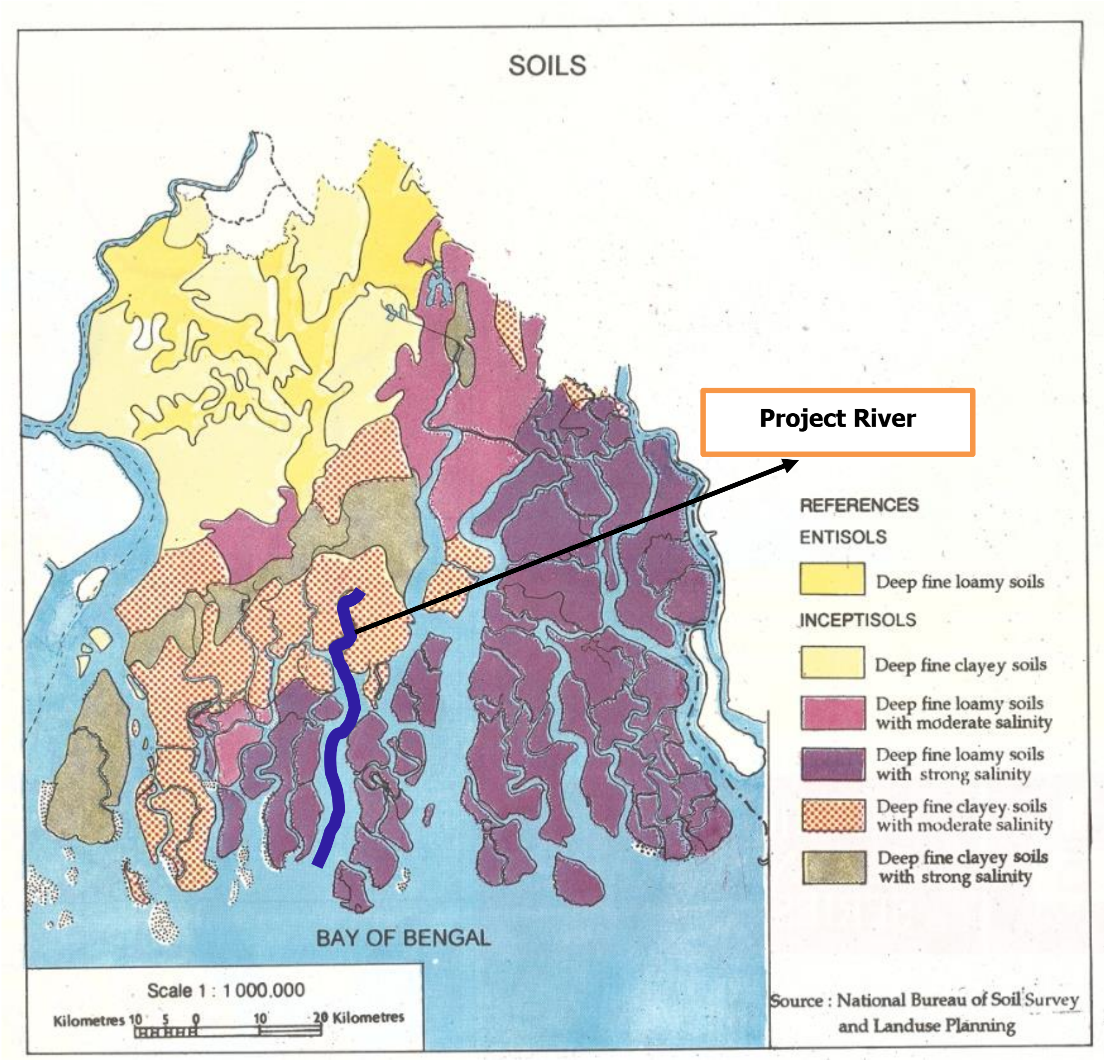
Source : NATMO

Figure 46: 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 47**.



Source : NATMO

Figure 47: 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 38**.

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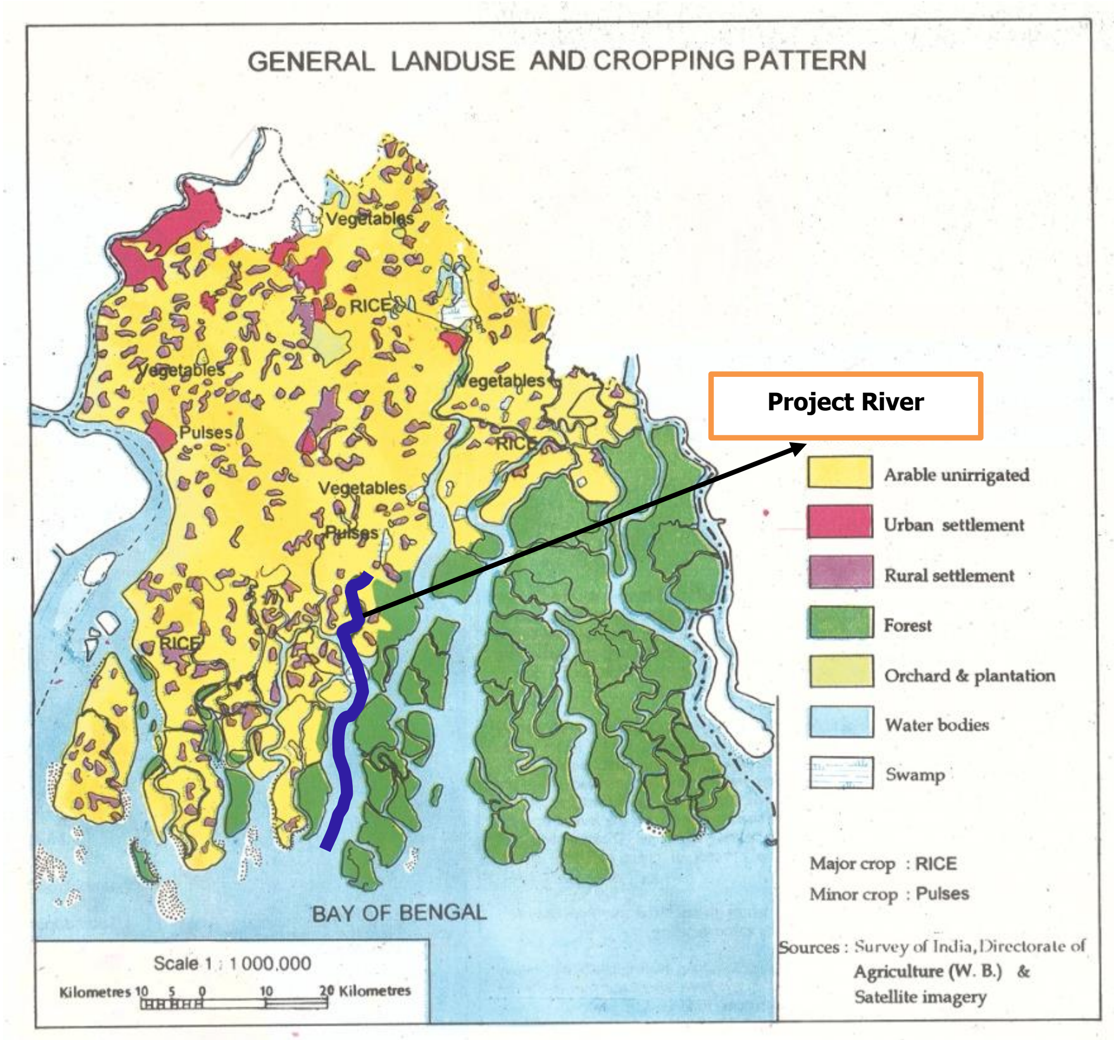
Table 38: Land Utilization Pattern of the South 24-Parganas district (Area in '000 ha.)

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 48**.



Source: NATMO

Figure 48 : 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 Thakurran River was free from dust. However, it was also confirmed from the local villagers that there is no problem of Air pollution, as there is less commercial activities and movements of human beings. Also there is no major industrial development along the waterway stretch. The nearest Ambient Air quality at Kakdwip Area is given in **Table 39**.

Table 39: 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

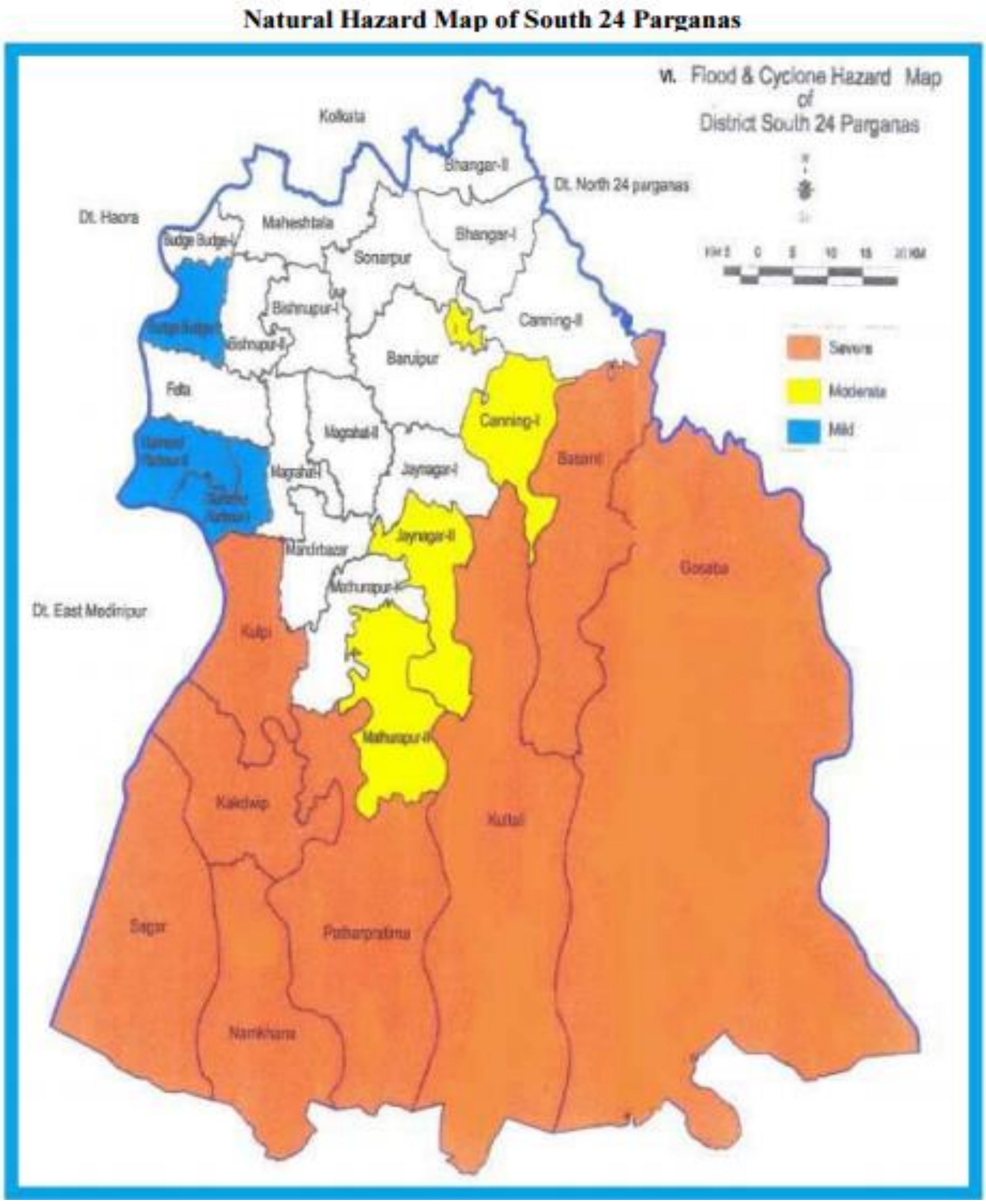
During the reconnaissance survey, it was the found Noise is not big issues in the surrounding areas of Thakurran River. There are not any noises generating sources in the nearby areas.

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 49: 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 40**.

Table 40: **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 about 1.5 km from the projevt river.

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

9.2.11 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.

9.2.12 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 (*Chamaeleonidae*), king cobras (*Naja naja*), salvator lizards (*Varanus salvator*), hard shelled batgun terrapins (*Melanochelys trijuga*), Russels vipers (*Daboia russelii*), monitor lizards (*Varanus bengalensis*), hawks bill turtles (*Eretmochelys imbricata*), pythons (*Python molurus*), common kraits (*Bungarus caeruleus*), green vine snake (*Ahaetulla nasuta*), checkered keelbacks (*Xenochrophis sp*) and rat snakes. The river terrapin (*Batagur baska*), Indian flap-shelled turtles (*Lissemys punctata*), peacock soft-shelled turtles (*Trionyx hurum*), yellow monitors (*Varanus flavescens*), water monitors (*Varanus salvator*) and Indian pythons (*Python molurus*) are some of the resident species.

The details lists of flora and fauna are given in **Annexure 3.**

9.2.13 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 41**. 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 41: 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

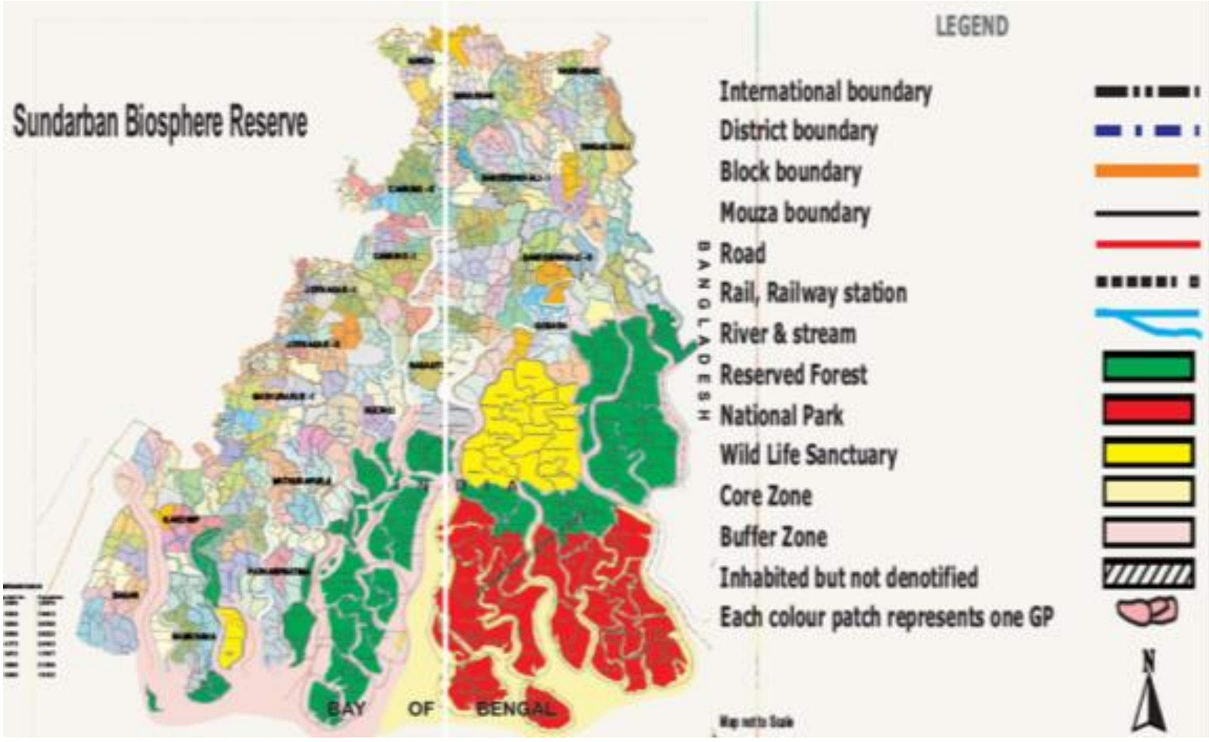
There are forest patches available along the proposed waterway stretch.

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 km^2 with 1437.4 km^2 consisting of populated areas and forest covering 1474 km^2. 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.

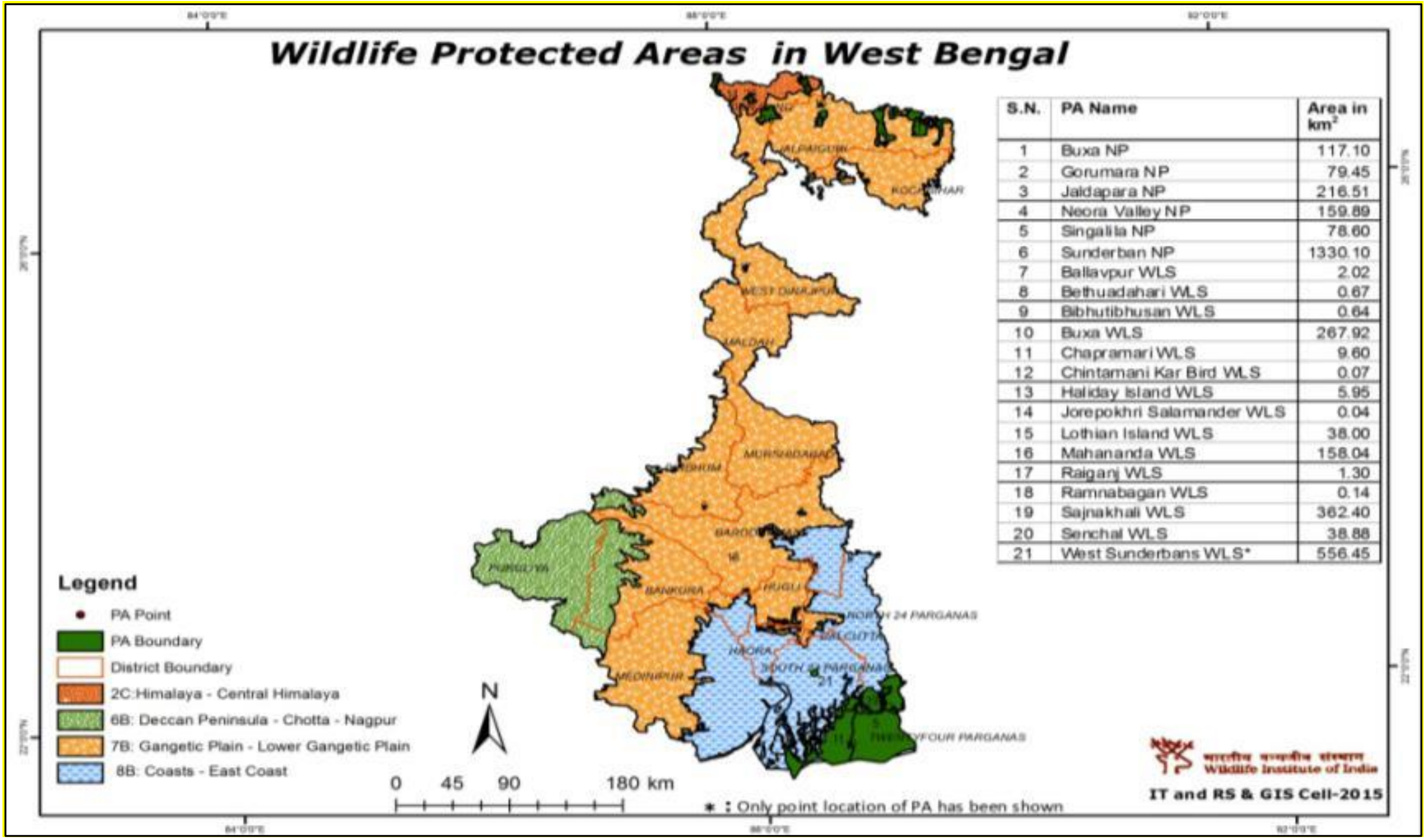
The Map of Sunderban Biosphere Reserve is furnished in **Figure 50**.



Source : WWF-India

Figure 50: 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 51**.



Source: Wildlife Institute of India

Figure 51: Wildlife Protected Area of West Bengal

9.2.14 Socio-Economic Profile

Social Profile

The distribution of population in rural and urban area in the district as per 2011 census shows that majority of the population i.e. 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 42**.

Table 42: **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 Thakurran River has been listed in the **Table 43** along with population details as per Census of India Data, 2011.

Table 43: **Major settlements/village along the project stretch of Thakurran River**

S. No.	Village/ Town name	Population (nos.)
1	Madhabpur	2,478
2	Binodpur	2,367
3	Debipur	9,967

Source : Census of India, 2011

Economic Profile

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. <u>IMPACTS DUE TO EXCESS SOIL/ DREDGING MATERIAL/ WASTE</u>

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 43,12,593 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:

  There are three Ferry ghat along the river located at Ganga, Debipur and Dhaki. These ghats are locally maintained and opearated. It is proposed to develop the terminal complex area and provide inland water transport facilities like Gangway and Pontoon at these three ferry ghats for passenger embarking and disembarking. About 1200 m^2 of area will required for passenger ferry terminal complex area. 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. IMPACTS ON SOIL

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

Contamination of Soil: Contamination of soil is primarily due to construction and allied activities. The sites where construction vehicles are parked and serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. Refuse and solid waste from labour camps can also contaminate the soil. Contamination of soil during construction might be a major long-term residual negative impact. Unwarranted disposal of construction spoil and debris will add to soil contamination. This contamination is likely to be carried over to 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. <u>IMPACTS ON AMBIENT NOISE AND VIBRATION</u>

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. IMPACTS ON ECOLOGY AND BIODIVERSITY

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

Mitigation Measures:

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

G. IMPACTS ON RIVER WATER

The impact on water arises due to the following:

- Discharge of sewage and wastewaters from construction sites and camps to surface waters
- 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. <u>IMPACTS DUE TO LABOUR CAMP</u>

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

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

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

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

Mitigation Measures:

- ✓ The Construction/labour camps will be established only on approved area.
- ✓ The worker's/labour camp will be located away from water bodies, schools and residential areas. The camp will be constructed with proper accommodation facilities.
- ✓ The workers camp will be provided with drinking water supply system so that local water sources are not disturbed.

- ✓ The camp should be provided with fuel for cooking like kerosene and /or LPG to avoid any cutting of trees for fuel wood.
- ✓ All camps will be provided with proper sanitation facilities, separate toilets and bathrooms for female and male workers, septic tanks with soak pits of sufficient size, dust bins etc.
- ✓ Waste water from domestic uses and solid wastes will be disposed of without violating environmental norms. The measures will be site specific.
- ✓ The labour camps will be provided with crèche, first aid facilities, etc as required under Factory Act.
- ✓ After completion of construction, the contractor will dismantle the camp and restore it to the original condition of the area before handing over the site to the land owner.

I. SOCIAL IMPACTS

- Impacts on Socio-economic environment

No impact will be envisaged on socio-economic environment

- Impacts on the Regional Economy

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

- Health and Safety

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

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

Mitigation Measures:

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

- ✓ Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate.
- ✓ Safe working techniques will be followed up and all the workers will be trained
- ✓ Proper caution signage, barricading, delineators etc. will be installed at Construction zone and temporary diversions
- ✓ Proper traffic management will be ensured at the Construction zone as per IRC.
- ✓ An Emergency Response system in case of any incidence will be developed and implemented
- ✓ Periodical health check facility will be provided at camp sites.

- Aesthetics

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

Mitigation Measures:

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

- Employment Generation

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

Mitigation Measures:

- ✓ Employing local labour
- ✓ Training of labour to benefit individuals beyond completion of the project.
- ✓ Ensure recruitment of labors will take place offsite.
- ✓ Ensure at least 50% of all labor is from surrounding communities in the contractual documentation.

9.3.2 Impacts during Operation Phase

A. <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. <u>IMPACTS ON WATER</u>

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 44** 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 44: Environmental Management Plan (EMP)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

9.5 APPLICABLE LEGAL AND REGULATORY FRAMEWORK

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

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

The laws and regulation applicable under the progamme:

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

9.5.1 Key Environmental Laws and Regulations

The relevant Acts and Rules are given in the **Table 45.**

Table 45: Key Environmental Laws and Regulations

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

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

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

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

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

9.6 NEED FOR ENVIRONMENTAL CLEARANCE

The proposed project will not require Environmental Clearance as per MoEFCC letter No. F. No. 14-9/2016-IA-III dated 21st December 2017. The letter is enclosed as **Annexure 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 46.**

Table 46: Other Statutory Clearances required for the Project

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

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
	Labour Commissioner Office		(Prior to initiation of any work)	
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 47**.

Table 47: 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 48)**	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 48: 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, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Grab Sampling	No.	2	8000	0.16
3.	Ground Water Quality Monitoring		Grab Sampling	No.	2	8000	0.16
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

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
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 49: 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 50**	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 50: 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
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

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
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 51: 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 52**	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 52: 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

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
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 53**.

Table 53: 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

The proposed development of Thakurran waterway shall be developed and maintained by a separate Project Management Unit (PMU) under the jurisdiction of Director, Inland Waterways Authority of India, Kolkata.

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

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

10.1 ORGANIZATIONAL SET UP / ESTABLISHMENT

The proposed PMU organisation structure is presented in **Figure 52**

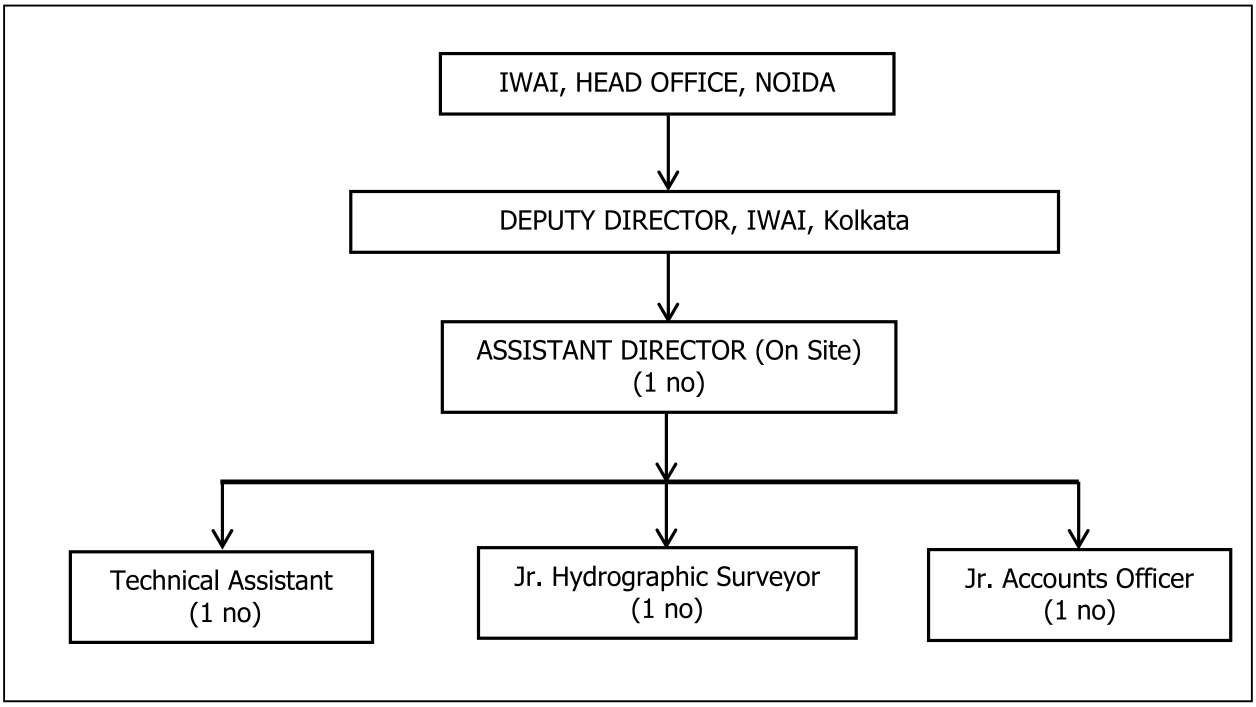


Figure 52: Organisation Structure of Project Monitoring Unit (PMU)

10.2 MAN POWER REQUIREMENT

Following man power is estimated to be required for efficient terminal operations:

a) Assistant Director (On Site) – 1 No
b) Technical Assistant – 1 No.
c) Jr. Hydrographic Surveyor – 1 No
d) Jr. Account Officer – 1 No

In addition to these 4 additional project/support staff are required to be engaged on contract/outsourcing basis. These support staff will work as a Multi-Purpose worker in PMU.

10.3 TRAINING REQUIREMENT / CAPACITY BUILDING

1 month of Training is proposed for all technical assistants and surveyors per year, at IWAI HO and other regional offices for skill development. The training to be provided is on latest software's, tools and plants, to upgrade technical skills and to increase awareness of Quality, Health, Safety and Environment (QHSE) policies.

10.4 INFRASTRUCTURE

Infrastructure required for running the organisational set up for Thakurran waterway is covered under this head. The basic infrastructure required for running the services are office complex, computers/laptos and printers/plotters, e-pbax facility, pantry, inspection vehicles etc.

10.4.1 Immovable

In order to optimise the cost to be incurred in purchasing/hiring land for office complex, it is proposed the required office complex including pantry/canteen and toilets will be housed in one of the terminal building.

10.4.2 Movable

Office stationary including computers/laptops, printers/plotters, inspection vehicles and other miscellaneous items are covered under movable assets. The detail list of movable assets required is as follows:

Sl. No.	Movable Asset	No.	Remark
1.	Computer/Laptop	4	For permanent Staff
		2	Additional for support staff
2.	Colour Printers & Scanner	2	
3.	Plotter	1	
4.	Air conditioners	7	
5.	Car	2	
6.	Inspection Vehicle (All wheel drive)	2	
7	Office stationery and other miscellaneous items		

10.5 COST IMPLICATIONS

Cost proposed to be incurred for organisational set up is divided in the following sub heads:

Capital Cost:

Infrastructure: As it is proposed that office complex for the staff shall be located in one of the terminal building, no expense is considered here for immovable infrastructure. Cost implication for purchasing/hiring movable assets is provided as below:

Table 54: Cost for developing infrastructural works for Institutional Setup

Sl. No.	Movable Asset	No.	Rate (INR)	Cost (INR)
1.	Computer/Laptop	6	50,000/-	3,00,000/-
2.	Colour Printers & Scanner	2	10,000/-	20,000/-
3.	Plotter	1	5,00,000/-	5,00,000/-
4.	Air conditioners	7	40,000/-	2,80,000/-
5.	Car	1	7,00,000/-	7,00,000/-
6.	Inspection Vehicle (All wheel drive)	1	20,00,000/-	20,00,000/-
7	Office stationery and other miscellaneous items		LS	1,00,000/-
	Total			**39,00,000/-**

Annual Cost:

Man power: The tentative manpower cost on the basis of 7th CPC is provided in **Table 55** as below:

Table 55: Manpower Cost

Sl. No.	Manpower	Level as per pay matrix	Min. gross salary (INR/month)	Numbers of staff	Annual Cost (INR Lakh)
1	Assistant Director	L-10	56,100	1	6.73
2	Technical Assistant	L-6	35,400	1	4.25
3	Jr. Hydrographic Surveyor	L-6	35,400	1	4.25
4	Jr. Accounts Officer	L-6	35,400	1	4.25
6	Project/support staff		20,000	4	9.60
	Total				**29.08**

The total manpower cost for Thakurran waterway project works out to **INR 29.08 Lakh** annually.

Training/ Capacity Building: An annual budget of INR 5,00,000/- (**INR 5.0 Lakh**) is considered for the same.

Hence total annual O&M cost works out to **INR 34.08 Lakh**.

11.0 PROJECT COSTING

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

11.1 BASIS OF COSTING

The basis of cost estimates worked out as per following:

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

11.2 DEVELOPMENT COST

Thakurran waterway is proposed to be developed as Class VII waterway for a total stretch of 54.0 Km. Passenger ferries are proposed to be operated in 19.20 Km waterway stretch from proposed Ganga jetty to proposed Dhaki jetty. 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.

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 56**.

Table 56: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	Capital cost for Fairway Development		8,625.19
2.0	Capital cost for three (3) Terminals	**Table 24**	1,187.82
3.0	Capital Cost for five (5) Passenger ferry Vessels	**Table 31**	400.00
4.0	Capital Cost for Aids to Navigation and Communication	**Table 35**	316.33
5.0	Cost allotted for EMP	**Table 53**	102.35
6.0	Cost for Institutional setup works	**Table 54**	39.00
	Total Capital Cost		**10,670.69**
	After 10 years of IWT operations on the basis of actual traffic growth		
7.0	Capital Cost for additional eight (8) Passenger ferry Vessels		**640.00**
	After 20 years of IWT operations on the basis of actual traffic growth		
8.0	Capital Cost for additional fourteen (14) Passenger ferry Vessels		**1120.00**

11.4 OPERATIONAL AND MAINTENANCE EXPENDITURE

The detail O&M cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies are provided in **Table 57** as below:

Table 57: Summary of annual O & M Cost of Project

Sl. No.	Item	Reference Table	Amount in Lakh (INR)
1.0	O&M cost for Fairway Development		862.52
2.0	O&M cost for Terminals	**Table 27**	93.17
3.0	O&M Cost for Vessels	**Table 33**	124.55
4.0	O&M Cost for Aids to Navigation and Communication	**Table 36**	179.30
5.0	EMP Cost during operation stage	**Table 53**	25.88
6.0	Operational cost under Institutional requirements		34.08
	Total O&M Cost		**1,319.49**
	After 10 years of IWT operations on the basis of actual traffic growth		
7.0	Additional O&M Cost for additional eight (8) Passenger ferry vessels		**199.28**

11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 2 years, the phasing of expenditures has been established during construction period. The detail of cost repartition during construction period is provided in **Table 58** and also shown in **Figure 53** below.

Table 58: Phasing of Expenditure

Months >	M1 – M6	M7 – M12	M13 – M18	M19 – M24
Total Cash Flow INR Lakh	1600.60	3201.21	3201.21	2667.67
% of Cash Flow	15%	30%	30%	25%

During construction stage 2 vessels are recommended for IWT development. Additional vessels shall be purchased in 10th & 20th year of operaton on the basis of traffic demand. Hence the same is not considerd to work out phasing of expenditure in 2 years of construction period.

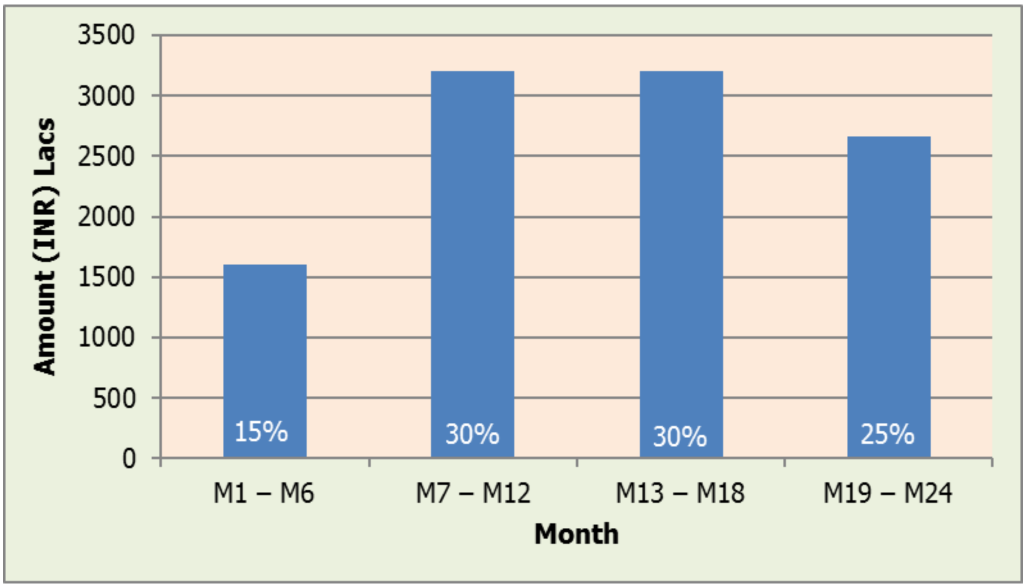


Figure 53: Phasing of Expenditure

12.0 IMPLEMENTATION SCHEDULE

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

12.1 TIME FRAME

The time schedule for construction activities of the project is considered as two (2) years. The proposed project schedule is provided in **Figure 54** as below.

Sl. No.	Activities	1st Year	2nd Year
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/Upgrdation of terminal building, landside facilities		
6	Upgrading existing road to terminals		

Figure 54: 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 Thakurran waterway include both the construction of offshore and onshore facilities, apart from installation of mechanical and electrical equipment's.

The offshore facilities include 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 Thakurran waterway project, which involves engineering, procurement, construction and commencement of operational activities.

Pre Construction activities:

- 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;

Construction activities:

- 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 Thakurran 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 50 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) - Dhaki Jetty to Debipur jetty, and
    2. OD pair 2) - Ganga Jetty to Dhaki/Debipur jetty
d) One-way trip length –
    1. OD pair 1) - 2.6 Km, and
    2. OD pair 2) - 16.6 Km.
e) For revenue estimation, present daily passenger traffic in the proposed OD pair are considered as below:
    1. OD pair 1) -1500 passengers, and
    2. OD pair 2) - 400 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 and in view of small capital cost, no loan has been considered. 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 59** to **Table 61.**

Table 59: 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 5.00 /pax/Km		Tafiff INR 10.00 /pax/Km		Tafiff INR 15.00 /pax/Km		Tafiff INR 20.00 /pax/Km	
-2	4802		4802	0	-4802	0	-4802	0	-4802	0	-4802	0	-4802
-1	5869		5869	0	-5869	0	-5869	0	-5869	0	-5869	0	-5869
0		1319	1319	37	-1283	184	-1135	369	-951	553	-766	738	-582
1		1385	1385	43	-1342	215	-1170	430	-955	645	-740	860	-525
2		1455	1455	50	-1405	251	-1204	502	-953	753	-702	1004	-451
3		1527	1527	59	-1469	293	-1235	585	-942	878	-650	1171	-357
4		1604	1604	68	-1536	341	-1263	683	-921	1024	-580	1365	-239
5		1684	1684	80	-1604	398	-1286	796	-888	1194	-490	1592	-92
6		1768	1768	93	-1675	464	-1304	929	-840	1393	-375	1857	89
7		1857	1857	108	-1748	542	-1315	1083	-773	1625	-232	2167	310
8		1949	1949	126	-1823	632	-1318	1264	-686	1895	-54	2527	578
9		2047	2047	147	-1900	737	-1310	1474	-573	2211	164	2948	901
10	640	2149	2789	172	-2617	860	-1930	1719	-1070	2579	-211	3438	649
11		2456	2456	201	-2256	1003	-1454	2005	-451	3008	552	4010	1554
12		2579	2579	234	-2345	1169	-1409	2339	-240	3508	929	4677	2099
13		2708	2708	273	-2435	1364	-1344	2728	20	4092	1384	5456	2748
14		2843	2843	318	-2525	1591	-1252	3182	339	4773	1930	6364	3520

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 5.00 /pax/Km		Tafiff INR 10.00 /pax/Km		Tafiff INR 15.00 /pax/Km		Tafiff INR 20.00 /pax/Km	
15		2985	2985	371	-2614	1856	-1130	3711	726	5567	2582	7423	4437
16		3135	3135	433	-2702	2164	-970	4329	1194	6493	3359	8658	5523
17		3291	3291	505	-2786	2525	-767	5049	1758	7574	4282	10098	6807
18		3456	3456	589	-2867	2945	-511	5889	2433	8834	5378	11779	8323
19		3629	3629	687	-2942	3435	-194	6869	3241	10304	6675	13739	10110
20	1120	3810	4930	801	-4129	4006	-924	8012	3082	12019	7088	16025	11095
FIRR (%)					**#NUM!**		**#NUM!**		**-3.01%**		**4.70%**		**9.16%**

Table 60: 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 5.00 /pax/Km		Tafiff INR 10.00 /pax/Km		Tafiff INR 15.00 /pax/Km		Tafiff INR 20.00 /pax/Km	
-2	4622		4622		-4622		-4622		-4622		-4622		-4622
-1	5649		5649		-5649		-5649		-5649		-5649		-5649
0		1195	1195	37	-1158	184	-1011	369	-826	553	-642	738	-457
1		1255	1255	43	-1212	215	-1040	430	-825	645	-609	860	-394
2		1317	1317	50	-1267	251	-1067	502	-816	753	-565	1004	-314
3		1383	1383	59	-1325	293	-1091	585	-798	878	-505	1171	-213
4		1452	1452	68	-1384	341	-1111	683	-770	1024	-428	1365	-87
5		1525	1525	80	-1445	398	-1127	796	-729	1194	-331	1592	67
6		1601	1601	93	-1508	464	-1137	929	-673	1393	-208	1857	256
7		1681	1681	108	-1573	542	-1140	1083	-598	1625	-56	2167	485
8		1765	1765	126	-1639	632	-1134	1264	-502	1895	130	2527	762
9		1854	1854	147	-1706	737	-1117	1474	-380	2211	357	2948	1094
10		1946	1946	172	-1775	860	-1087	1719	-227	2579	632	3438	1492
11		2044	2044	201	-1843	1003	-1041	2005	-39	3008	964	4010	1966
12		2146	2146	234	-1912	1169	-977	2339	193	3508	1362	4677	2532
13		2253	2253	273	-1980	1364	-889	2728	475	4092	1839	5456	3203

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 5.00 /pax/Km		Tafiff INR 10.00 /pax/Km		Tafiff INR 15.00 /pax/Km		Tafiff INR 20.00 /pax/Km	
14		2366	2366	318	-2048	1591	-775	3182	816	4773	2407	6364	3998
15		2484	2484	371	-2113	1856	-629	3711	1227	5567	3083	7423	4938
16		2608	2608	433	-2176	2164	-444	4329	1720	6493	3885	8658	6049
17		2739	2739	505	-2234	2525	-214	5049	2310	7574	4835	10098	7359
18		2876	2876	589	-2287	2945	69	5889	3014	8834	5958	11779	8903
19		3020	3020	687	-2333	3435	415	6869	3850	10304	7284	13739	10719
20		3171	3171	801	-2369	4006	836	8012	4842	12019	8848	16025	12854
FIRR (%)					**#NUM!**		**#NUM!**		**0.33%**		**6.63%**		**10.69%**

Table 61: 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 5.00 /pax/Km		Tafiff INR 10.00 /pax/Km		Tafiff INR 15.00 /pax/Km		Tafiff INR 20.00 /pax/Km	
-2	0		0.00		0		0		0		0		0
-1	400		400.00		-400		-400		-400		-400		-400
0		125	124.55	37	-88	184	60	369	244	553	429	738	613
1		131	130.78	43	-88	215	84	430	299	645	515	860	730
2		137	137.32	50	-87	251	114	502	364	753	615	1004	866
3		144	144.18	59	-86	293	148	585	441	878	734	1171	1026
4		151	151.39	68	-83	341	190	683	531	1024	873	1365	1214
5		159	158.96	80	-79	398	239	796	637	1194	1035	1592	1434
6		167	166.91	93	-74	464	297	929	762	1393	1226	1857	1691
7		175	175.25	108	-67	542	366	1083	908	1625	1450	2167	1991
8		184	184.02	126	-58	632	448	1264	1080	1895	1711	2527	2343
9		193	193.22	147	-46	737	544	1474	1281	2211	2017	2948	2754
10	640	203	842.88	172	-671	860	17	1719	876	2579	1736	3438	2595
11		412	412.30	201	-212	1003	590	2005	1593	3008	2595	4010	3598
12		433	432.92	234	-199	1169	736	2339	1906	3508	3075	4677	4245

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 5.00 /pax/Km		Tafiff INR 10.00 /pax/Km		Tafiff INR 15.00 /pax/Km		Tafiff INR 20.00 /pax/Km	
13		455	454.56	273	-182	1364	909	2728	2273	4092	3637	5456	5001
14		477	477.29	318	-159	1591	1114	3182	2705	4773	4295	6364	5886
15		501	501.16	371	-130	1856	1354	3711	3210	5567	5066	7423	6921
16		526	526.21	433	-93	2164	1638	4329	3803	6493	5967	8658	8131
17		553	552.53	505	-48	2525	1972	5049	4497	7574	7021	10098	9546
18		580	580.15	589	9	2945	2365	5889	5309	8834	8254	11779	11198
19		609	609.16	687	78	3435	2825	6869	6260	10304	9695	13739	13129
20	1120	640	1759.62	801	-958	4006	2247	8012	6253	12019	10259	16025	14265
FIRR (%)					**#NUM!**		**39.30%**		**82.19%**		**126.76%**		**172.07%**

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 15.0 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 Thakurran 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 15.0 per person per km for all the three (3) options is provided in **Table 62.**

Table 62: 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)
-2		-4802	-4802	-4622	-4622	0	0
-1		-5869	-5869	-5649	-5649	-400	-400
0	68	-766	-698	-642	-574	429	497
1	69	-740	-672	-609	-541	515	583
2	69	-702	-633	-565	-496	615	685
3	70	-650	-580	-505	-435	734	804
4	71	-580	-509	-428	-358	873	943
5	71	-490	-418	-331	-259	1035	1107
6	72	-375	-303	-208	-136	1226	1298
7	73	-232	-159	-56	16	1450	1522
8	73	-54	19	130	203	1711	1785
9	74	164	238	357	431	2017	2092
10	75	-211	-136	632	707	1736	1811
11	111	552	663	964	1075	2595	2707
12	112	929	1042	1362	1474	3075	3188
13	113	1384	1498	1839	1952	3637	3751
14	115	1930	2044	2407	2521	4295	4410
15	116	2582	2697	3083	3198	5066	5181
16	117	3359	3476	3885	4002	5967	6084
17	118	4282	4400	4835	4953	7021	7139
18	119	5378	5497	5958	6077	8254	8373
19	120	6675	6796	7284	7405	9695	9815
20	122	7088	7210	8848	8970	10259	10381
EIRR (%)			**5.17%**		**7.08%**		**141.53%**

From the the above table, it is concluded that Thakurran 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 63.**

Table 63: 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	Not Calculable	Not Calculable	7.93%	17.94%
3	3.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	21.22%	30.45%
4	4.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	30.68%	40.55%
5	5.00	Not Calculable	Not Calculable	Not Calculable	Not Calculable	39.30%	50.00%
6	7.50	-12.51%	-10.90%	-5.51%	-4.55%	60.50%	72.95%
7	10.00	-3.01%	-2.25%	0.33%	0.96%	82.19%	95.76%
8	12.50	1.57%	2.13%	3.94%	4.45%	104.33%	118.62%
9	15.00	4.70%	5.17%	6.63%	7.08%	126.76%	141.53%
10	20.00	9.16%	9.54%	10.69%	11.06%	172.07%	187.44%
	Not Calculable	All/majorly negative cash-flows					

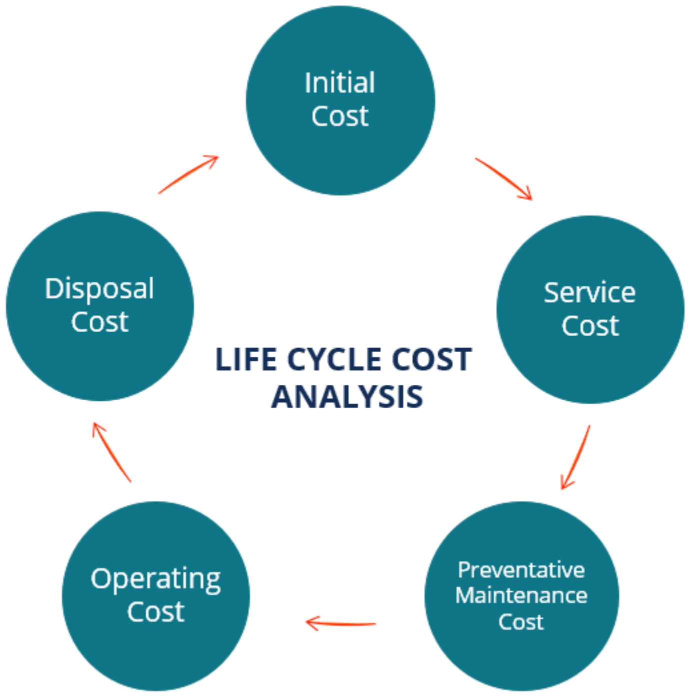
From the above table, it is concluded that the proposed IWT operation along Thakurran waterway is financially and economically viable for all the three options with a tarrif of INR 12.50 per passenger per Km and above for proposed OD pairs of Dhaki-Debipur jetty and Ganga-Debipur Jetty. In view of above, Internal Rate of Returns for proposed tarrif of INR 12.50 per passenger per Km is provided as below:

Table 64: IRR with proposed tarrif of INR 12.50 per passenger per Km

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)
-2		-4802	-4802	-4622	-4622	0	0
-1		-5869	-5869	-5649	-5649	-400	-400
0	68	-858	-791	-734	-666	336	404
1	69	-848	-779	-717	-648	407	475
2	69	-828	-758	-690	-621	490	559
3	70	-796	-726	-652	-582	587	657
4	71	-751	-680	-599	-529	702	773
5	71	-689	-617	-530	-458	836	908
6	72	-607	-535	-440	-368	994	1066
7	73	-503	-430	-327	-255	1179	1252
8	73	-370	-297	-186	-113	1395	1469
9	74	-205	-131	-12	63	1649	1723
10	75	-641	-566	202	277	1306	1381
11	111	50	162	463	574	2094	2205
12	112	345	457	777	890	2490	2603
13	113	702	816	1157	1270	2955	3069
14	115	1134	1249	1611	1726	3500	3615
15	116	1654	1769	2155	2271	4138	4254
16	117	2276	2393	2803	2920	4885	5002
17	118	3020	3138	3573	3691	5759	5877
18	119	3906	4025	4486	4605	6781	6901
19	120	4958	5078	5567	5688	7977	8098
20	122	5085	5207	6845	6967	8256	8377
		FIRR (%)	**EIRR (%)**	**FIRR (%)**	**EIRR (%)**	**FIRR (%)**	**EIRR (%)**
		1.57%	**2.13%**	**3.94%**	**4.45%**	**104.33%**	**118.62%**

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 Thakurran 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 12.50 per passenger per Km for proposed OD pairs 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 65**.

Table 65: 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)
-2	4,802	-	4,622	-	-	-
-1	5,869	-	5,649	-	400	-
0	1,319	529	1,195	529	125	529
1	1,385	606	1,255	606	131	606
2	1,455	696	1,317	696	137	696
3	1,527	801	1,383	801	144	801
4	1,604	924	1,452	924	151	924
5	1,684	1,067	1,525	1,067	159	1,067
6	1,768	1,233	1,601	1,233	167	1,233
7	1,857	1,427	1,681	1,427	175	1,427
8	1,949	1,653	1,765	1,653	184	1,653
9	2,047	1,916	1,854	1,916	193	1,916
10	2,789	2,224	1,946	2,224	843	2,224
11	2,456	2,618	2,044	2,618	412	2,618
12	2,579	3,036	2,146	3,036	433	3,036
13	2,708	3,523	2,253	3,523	455	3,523
14	2,843	4,092	2,366	4,092	477	4,092
15	2,985	4,755	2,484	4,755	501	4,755
16	3,135	5,528	2,608	5,528	526	5,528
17	3,291	6,429	2,739	6,429	553	6,429
18	3,456	7,481	2,876	7,481	580	7,481
19	3,629	8,707	3,020	8,707	609	8,707
20	4,930	10,137	3,171	10,137	1,760	10,137
Total	**62,068**	**69,382**	**52,953**	**69,382**	**9,115**	**69,382**

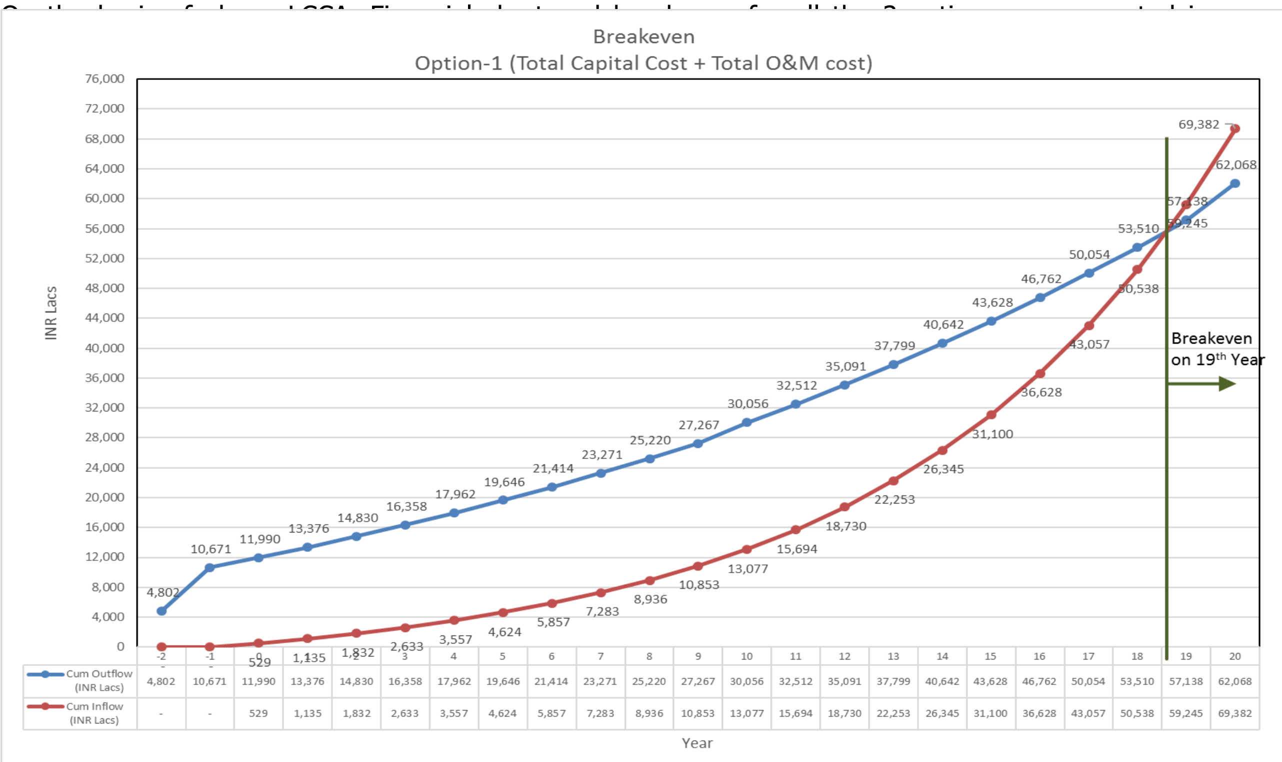


Figure 55 to **Figure 57**. For 20 years of project life cycle with a tariff of INR 12.50 per passenger per Km, following is concluded:

<u>Option 1: Total Capital Cost + Total O&M cost</u>

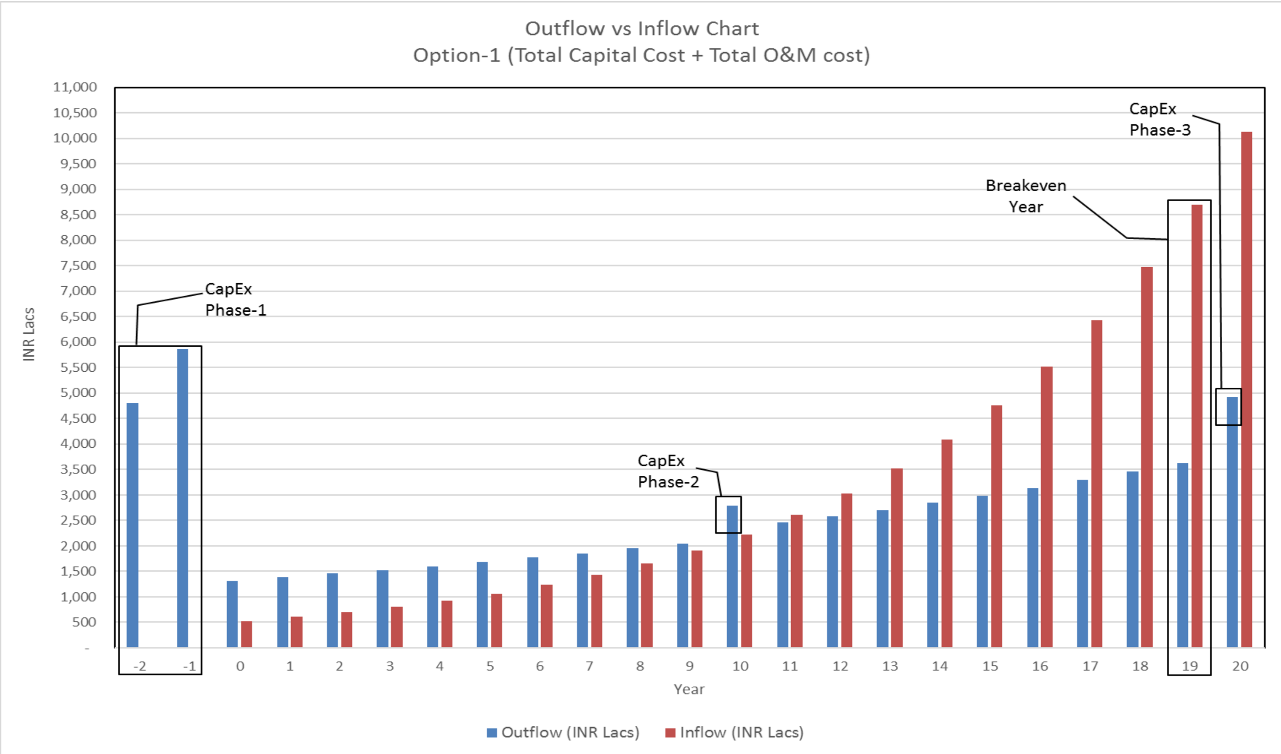
With project life cycle cost of INR 62,068 Lacs, the breakeven occurs during 19th year of operation.

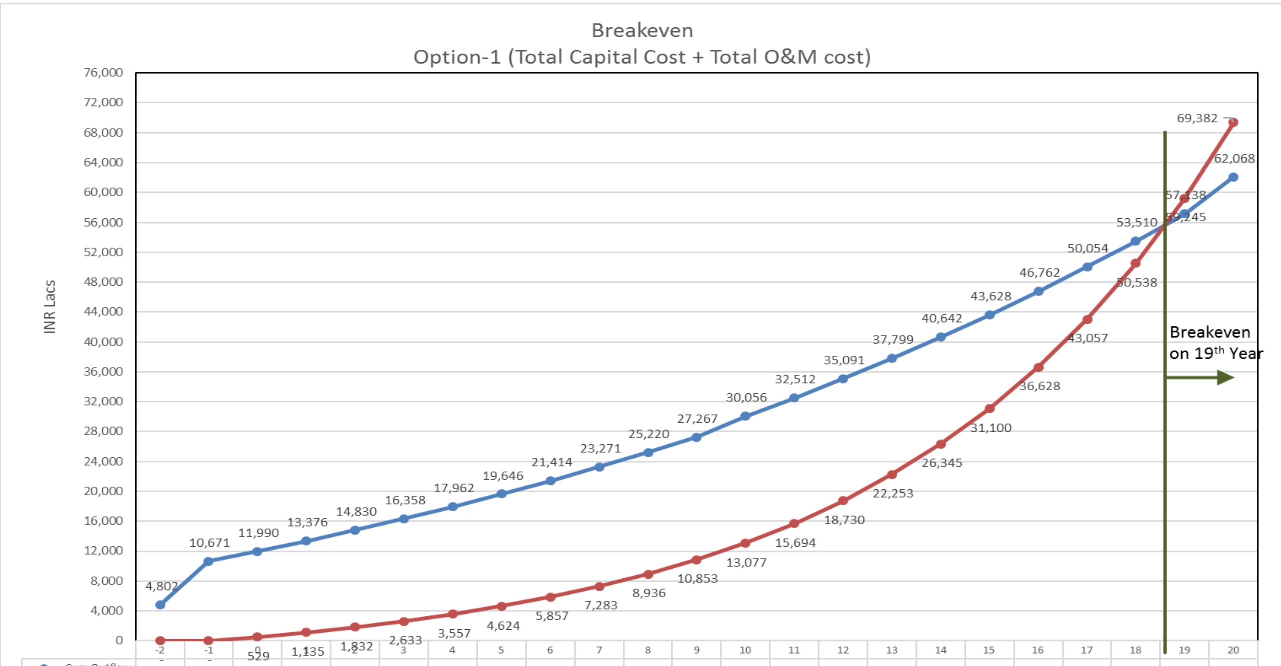
<u>Option 2: Option 1 - Vessel Capital & O&M cost</u>

With project life cycle cost of INR 52,953 Lacs, the breakeven occurs during 17th year of operation.

<u>Option 3: Vessel Capital Cost + Vessel O&M Cost</u>

With project life cycle cost of INR 9,115 Lacs, the breakeven occurs during 0th year of operation.

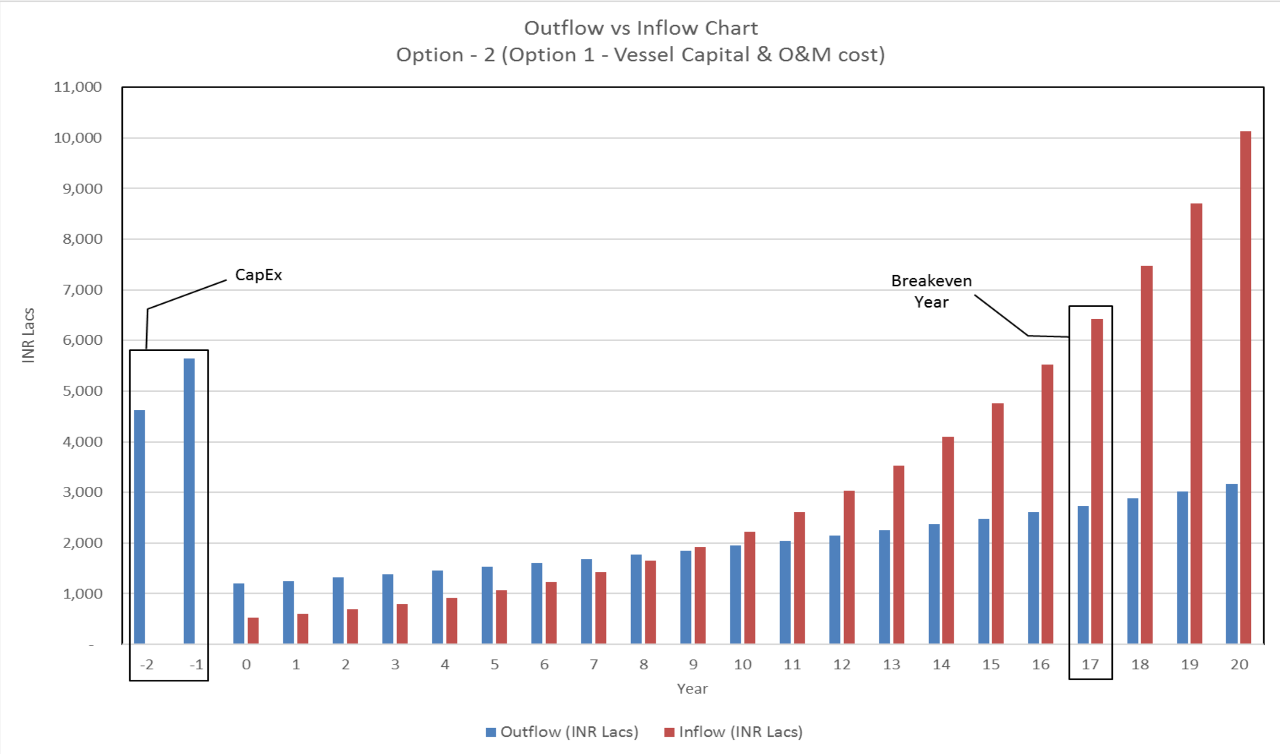


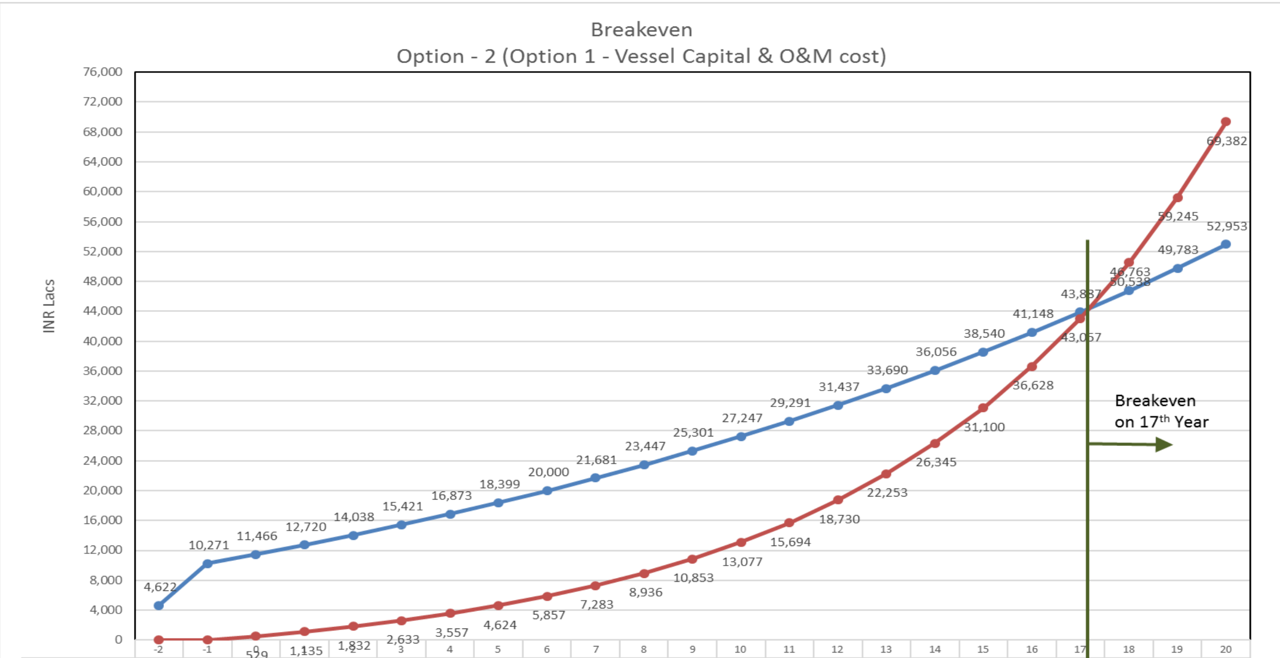


Year	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Cum Outflow (INR Lacs)	4,802	10,671	11,990	13,376	14,830	16,358	17,962	19,646	21,414	23,271	25,220	27,267	30,056	32,512	35,091	37,799	40,642	43,628	46,762	50,054	53,510	57,138	62,068
Cum Inflow (INR Lacs)	-	-	529	1,135	1,832	2,633	3,557	4,624	5,857	7,283	8,936	10,853	13,077	15,694	18,730	22,253	26,345	31,100	36,628	43,057	50,538	59,245	69,382

Year

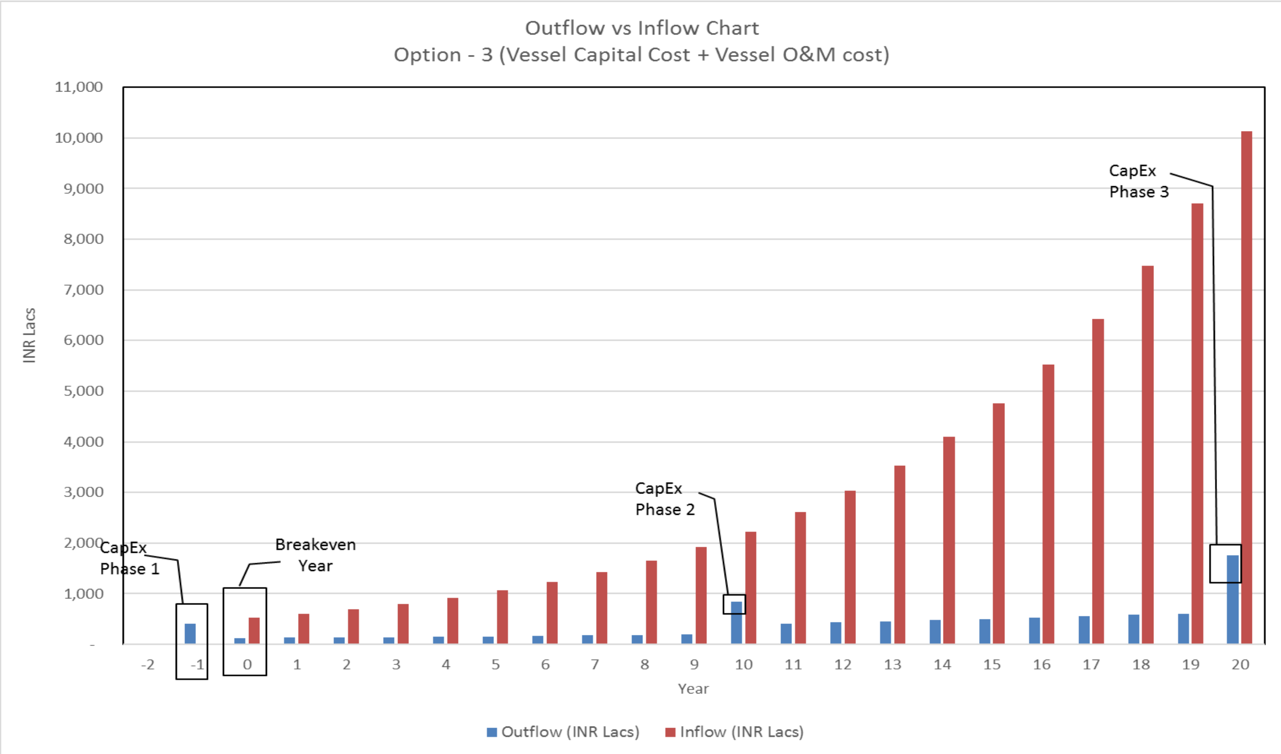
Figure 55: Financial (Outflow vs Inflow) Chart and Breakeven – Option 1





Year	-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)	4,622	10,271	11,466	12,720	14,038	15,421	16,873	18,399	20,000	21,681	23,447	25,301	27,247	29,291	31,437	33,690	36,056	38,540	41,148	43,887	46,763	49,783	52,953
Cum Inflow (INR Lacs)	-	-	529	1,135	1,832	2,633	3,557	4,624	5,857	7,283	8,936	10,853	13,077	15,694	18,730	22,253	26,345	31,100	36,628	43,057	50,538	59,245	69,382

Figure 56: Financial (Outflow vs Inflow) Chart and Breakeven – Option 2



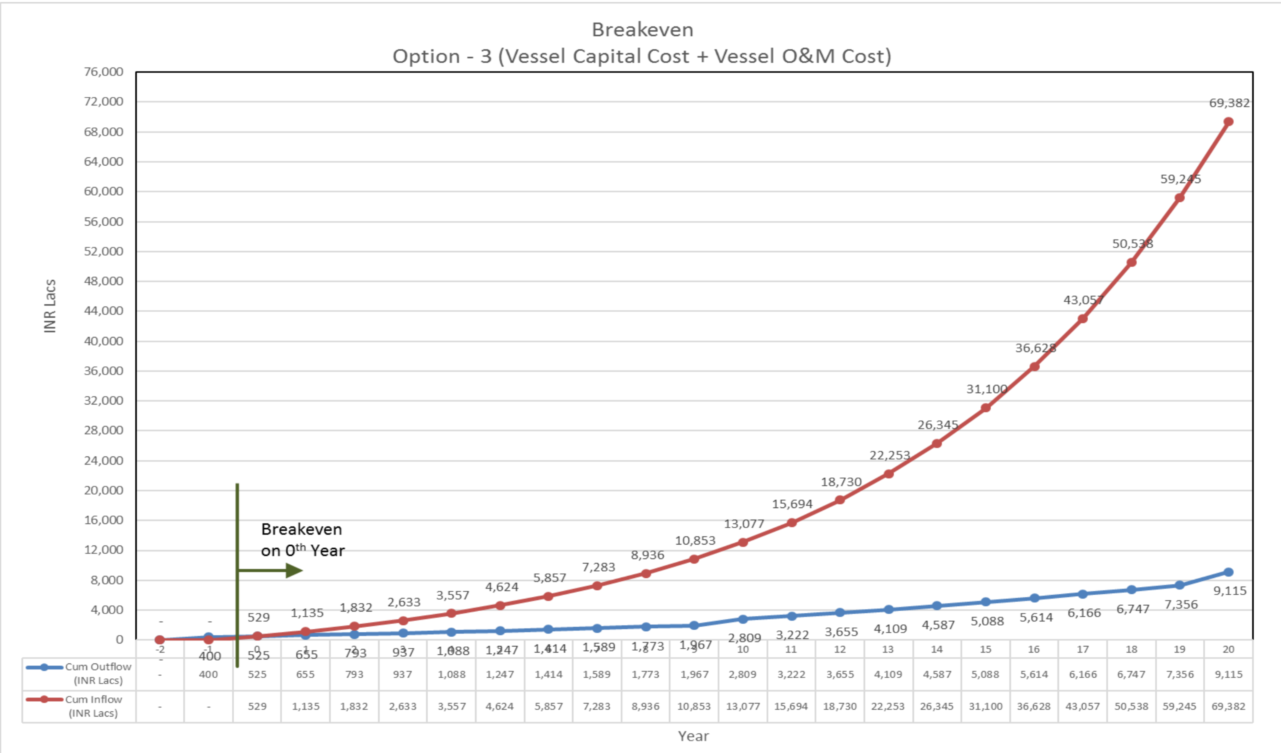


Figure 57: Financial (Outflow vs Inflow) Chart and Breakeven – Option 3

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

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

a) Proposed Thakurran waterway is connected with Indo Bangladesh waterway protocol route.
b) By taking into advantage of tidal window, sufficient LAD is available in the complete 63.865 Km stretch of waterway, which suggests that waterway, is viable for throughout the year navigation.
c) Large cargo vessels navigating along Indo Bangladesh Protocol Route crosses Thakurran river at a Chainage of 28.365 Km near Sripatinagar.
d) There are no major industries near the survey area, however few brick kilns are found along the river banks.
e) Passenger ferries are proposed to be operated in 19.20 Km waterway stretch from proposed Ganga jetty to proposed Dhaki jetty.

The waterway is proposed to be developed for Class VII, with 3 passenger terminals and 5 passenger ferry vessels at the inception stage. The ferry ghats proposed to be developed for Passenger ferry services in this DPR are Ganga, Debipur and Dhaki. The capital cost for development of the system components of the project viz., development of the designed waterway, construction of IWT terminals and purchasing of vessels has been worked out as INR 10,670.69 Lakh with 5 vessels. In 10th year of operation capital cost of purchasing additional 8 vessels is INR 640.00 Lakh and in 20th year of operation capital cost of purchasing additional 14 vessels is INR 1,120.00 Lakh. The additional vessels shall be purchased on the basis of growing traffic demand. Correspondingly O&M cost for Thakurran waterway works out to INR 1,319.49 Lakh from inception stage and additional INR 199.28 Lakh from 11th year of operation due to to procurement of additional vessels.

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 12.50 per passenger per Km and above for proposed 2 OD pairs of Ganga - Debipur Jetty and further Debipur - Dhaki jetty, 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	√		Prone to Flood, Cyclones and heavy winds

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

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

ANNEXURE 3: Checklist for Flora and Fauna of the District

Floral Community of Sundarban

Checklist for Flora

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

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

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

Source: West Bengal Forest Department

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

Faunal Community of Sundarban

Checklist for Mammals

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

Source: West Bengal Forest Department

Checklist for Reptiles

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

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

Source: West Bengal Forest Department

Checklist for Birds

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

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

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

Checklist for Birds	
168. Lesser Crested Tern - Sterna bengalensis 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	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
36	Asiatic milk fish	*Chanos chanos*	Least Concern

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

Source: West Bengal Forest Department

ANNEXURE 4: MoEF&CC Letter

Moef&CC Letter

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

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

Dated: 21st December, 2017.

OFFICE MEMORANDUM

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

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

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

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

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

Sharath Kumar 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 Palleria
Director

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ANNEXURE 5: PHOTOGRAPHS

River Bank Protection at Left Chainage 2.8

Land at Left Bank Chainage 3

River Bank at Left Chainage 3.1

Land at Left Bank Chainage 3.4

Path at Left Bank Chainage 3.5

River Bank at Left Chainage 3.6

Land at Left Bank Chainage 3.7

Pond at Left Bank Chainage 3.8

Pond at Left Bank Chainage 4

River Shore at Left Bank Chainage 4

River Shore at Left Bank Chainage 4

River Bank Protection at Left Chainage 4.1

River Bank at Left Chainage 4.2

River Shore at Left Bank Chainage 4.5

Fishing Net at Chainage 4.5

Fishing Net at Chainage 4.6

River Bank Protection at Left Chainage 5

River Shore at Left Chainage 5.1

River Shore at Left Chainage 5.2

Pond at Left Bank Chainage 5.5

Pond at Left Chainage 5.6

River Shore at Left Chainage 5.7

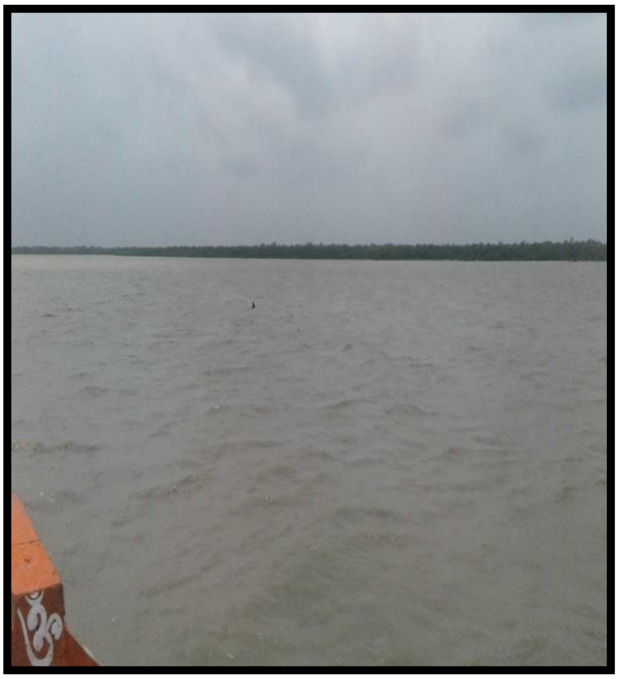
River Shore at Left Chainage 5.8

River Shore at Left Chainage 5.9

River Shore at Left Chainage 6

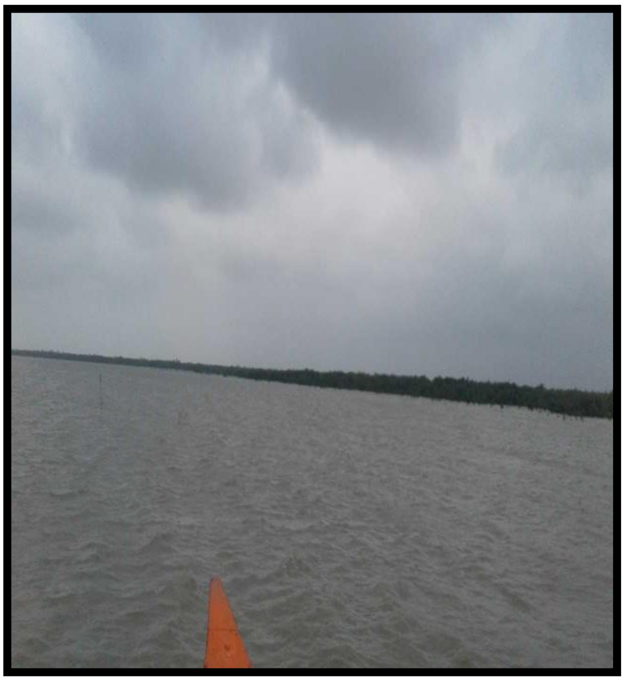
River Shore at Left Chainage 6.1

River Shore at Left Chainage 6.2



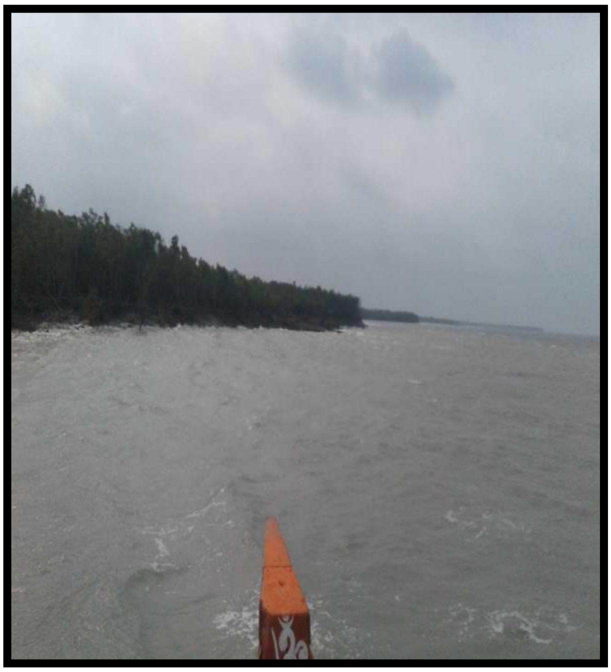
Fishing Stick at Chainage 18.5

Fishing Stick at Chainage 19.5

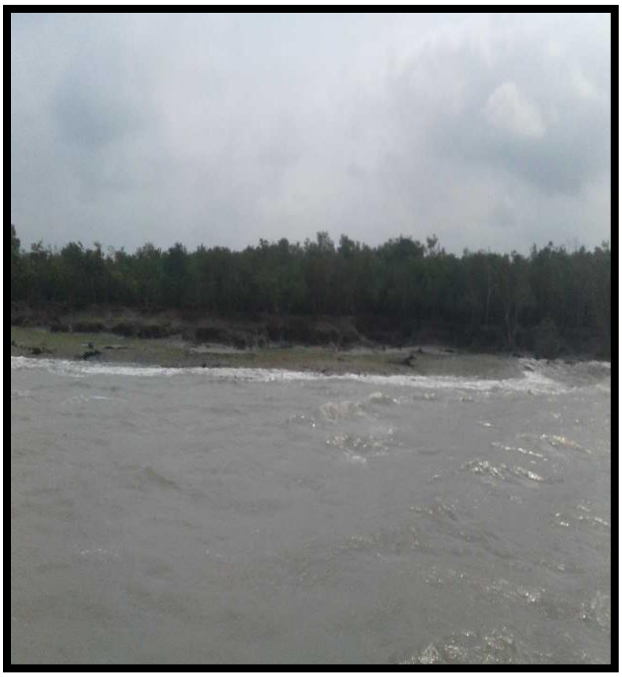


Mangroves at Chainage 19.5

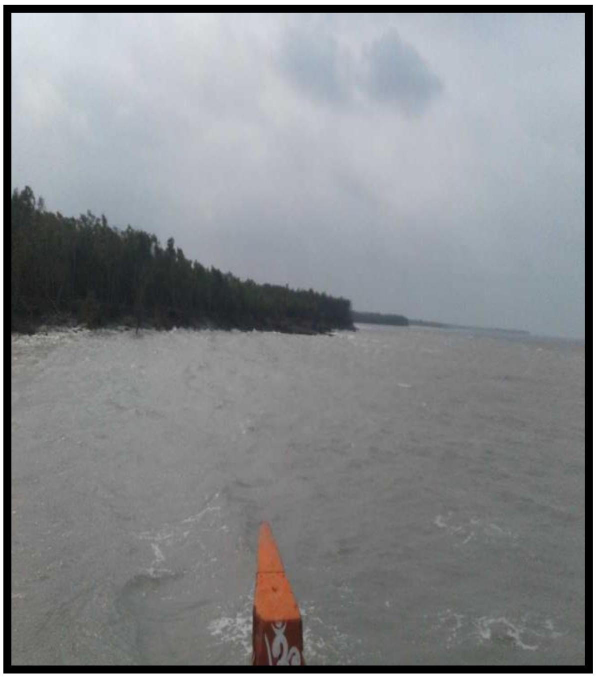
Mangroves at Chainage 20



Mangroves at Chainage 20.5



Mangroves at Chainage 20.7



Mangroves at Chainage 20.9

Right River Bank at Chainage 21

Left River Bank at Chainage 21.1

Left River Bank at Chainage 21.2

Left River Bank at Chainage 21.3

Right River Bank at Chainage 21.3

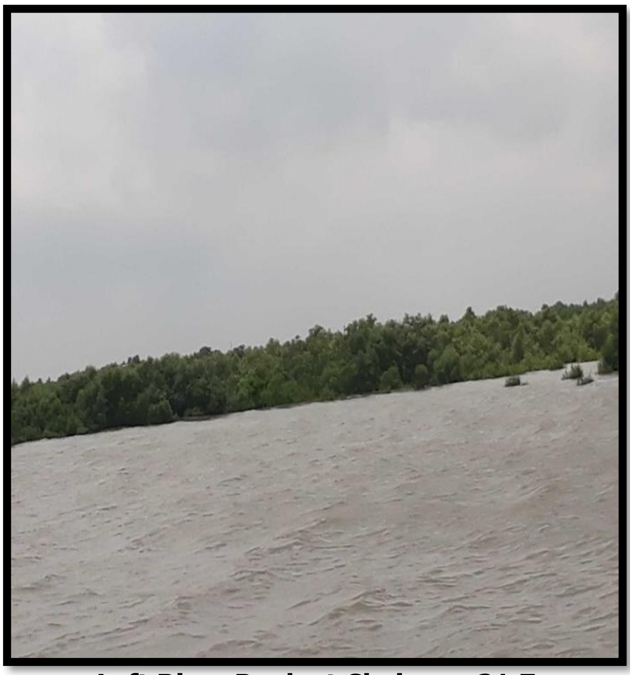
Left River Bank at Chainage 21.4

Right River Bank at Chainage 21.4

Right River Bank at Chainage 21.5

Right River Bank at Chainage 21.6

Right River Bank at Chainage 21.7



Left River Bank at Chainage 21.7

Left River Bank at Chainage 21.8

Left River Bank at Chainage 21.9

Right River Bank at Chainage 21.9

Right River Bank at Chainage 22

Right River Bank at Chainage 22.1

Mangroves at Left Bank Chainage 23.1

Right River Bank at Chainage 22.2

Mangroves at Left Bank Chainage 23.2

Right River Bank at Chainage 22.3

Fishing Net at Chainage 22.3

Fishing Boat at Chainage 22.3

Mangroves at Left Bank Chainage 23.3

Mangroves at Right Bank Chainage 22.4

Mangroves at Left Bank Chainage 23.4

Mangroves at Right Bank Chainage 22.5

Mangroves at Left Bank Chainage 24.5

Mangroves at Left Bank Chainage 24.6

Fishing Net at Left Bank Chainage 25

Fishing Net at Left Bank Chainage 25.2

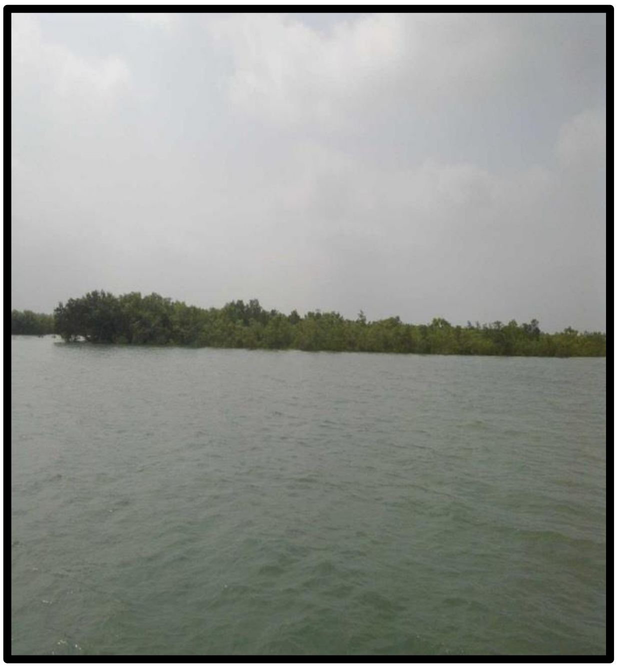
Island at Left Bank Chainage 25.5

angroves at Right Bank Chainage 26

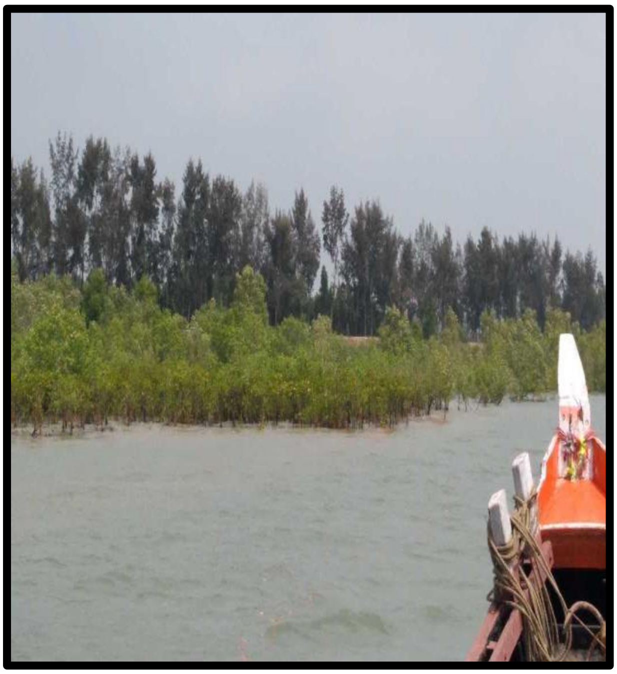
Mangroves at Right Bank Chainage 26.2

Left River Bank At Chainage 26.5

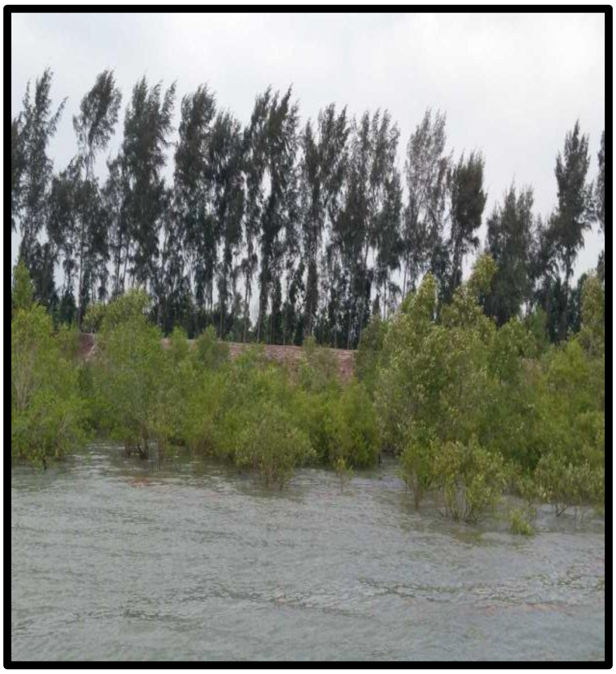
Mangroves at Right Bank Chainage 26.5



Mangroves at Right Bank Chainage 26.8



Mangroves at Left Bank Chainage 27

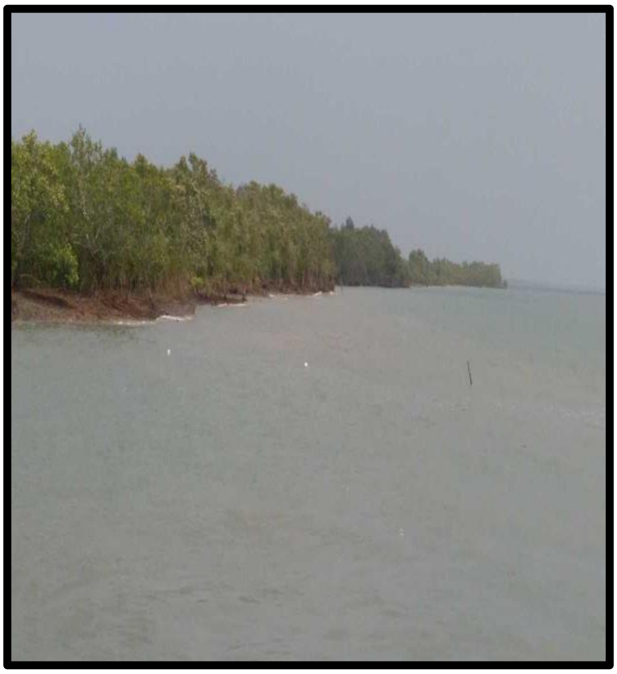


Left River Bank Protection at Chainage 27.1

Mangroves at Left Bank Chainage 27.2

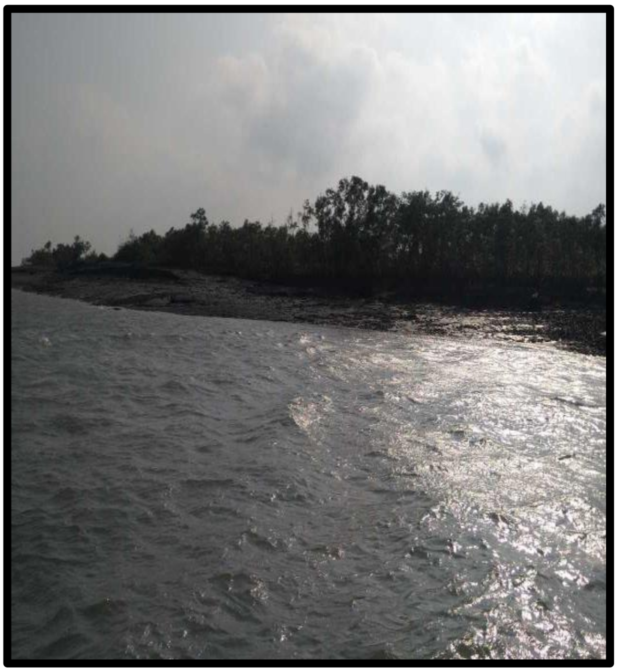
Mangroves at Left Bank Chainage 27.3

Mangroves at Left Bank Chainage 27.5



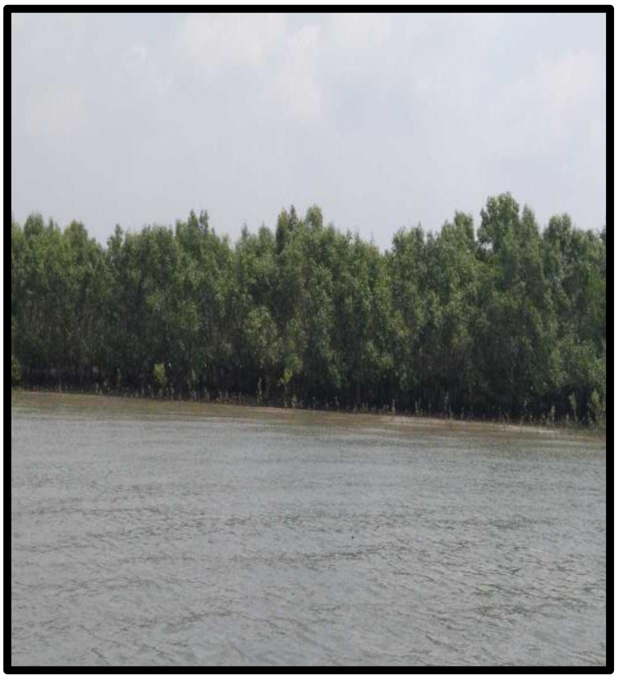
Mangroves at Left Bank Chainage 27.6

Mangroves at Left Bank Chainage 28



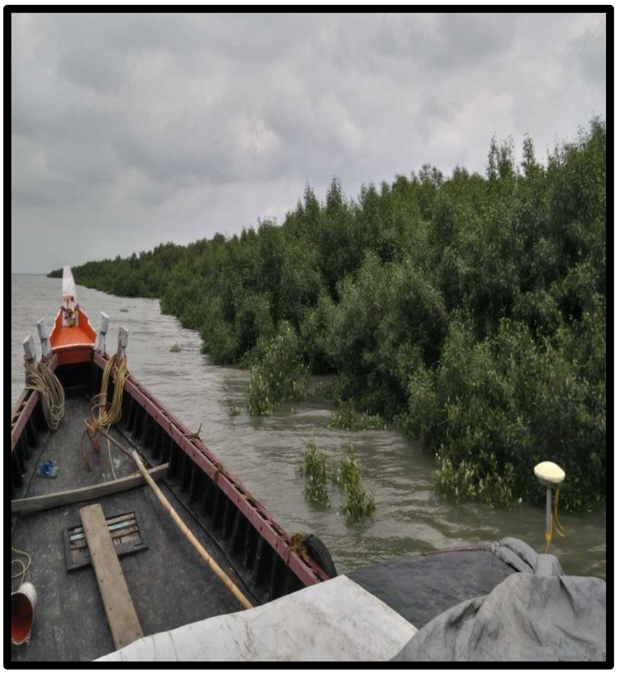
Left River Bank at Chainage 28.2

Left River Shore at Chainage 28.2



Mangroves at Right Bank Chainage 28

Mangroves at Left Bank Chainage 29

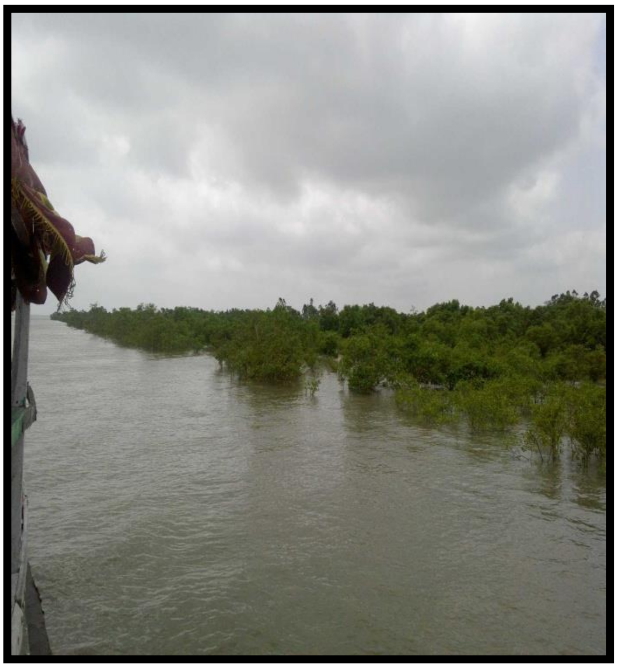


Mangroves at Left Bank Chainage 29.3

Mangroves at Right Bank Chainage 29.3

Mangroves at Right Bank Chainage 29.4

Mangroves at Left Bank Chainage 29.5

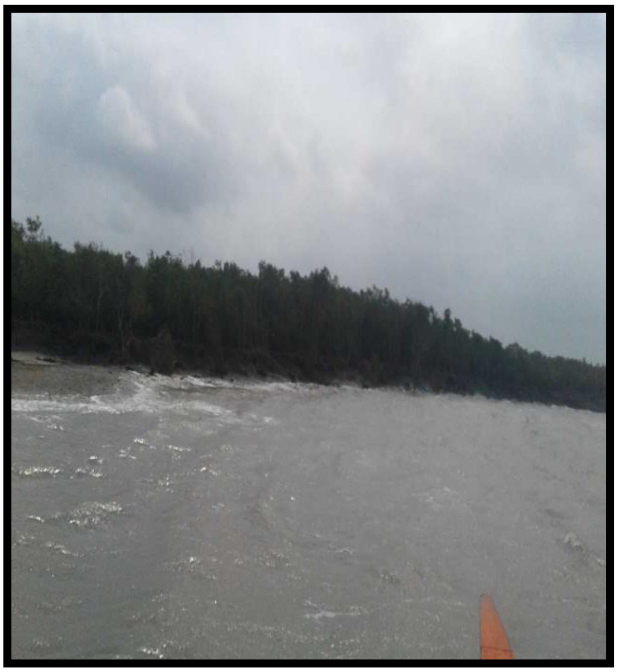


Mangroves at Left Bank Chainage 30

Mangroves at Left Bank Chainage 30.2

Mangroves at Right Bank Chainage 30.2

Right River Bank at Chainage 30.3



Mangrove at Right Bank Chainage 30.5

Mangroves at Left Bank Chainage 30.5

Right Bank at Chainage 30.6

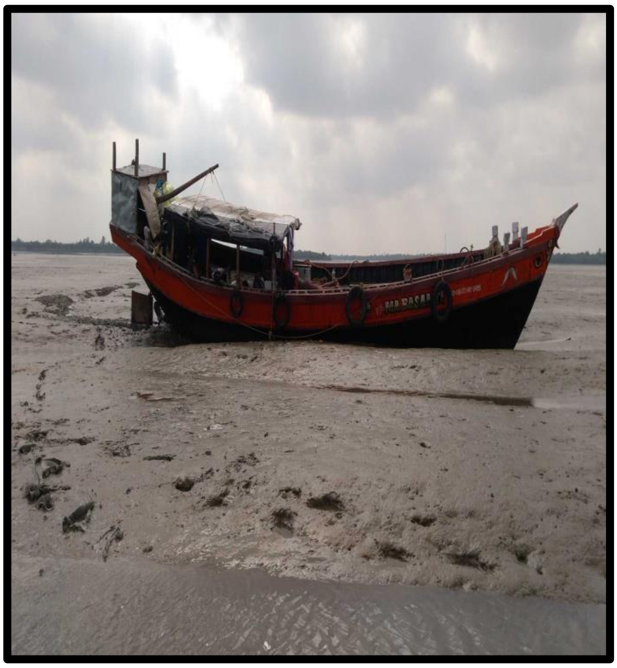
Right Bank at Chainage 30.7

Left Bank at Chainage 31

Left Bank at Chainage 31.2

Mangroves at Right Bank Chainage 31.2

Mangroves at Right Bank Chainage 31.4



Boat Grounded at Right Bank Chainage 31.5

Mangroves at Left Bank Chainage 31.5

Soil Erosion Area at Left Bank Chainage 31.6

Left Bank at Chainage 31.6

Mangroves at Left Bank Chainage 31.7

Mangroves at Right Bank Chainage 32

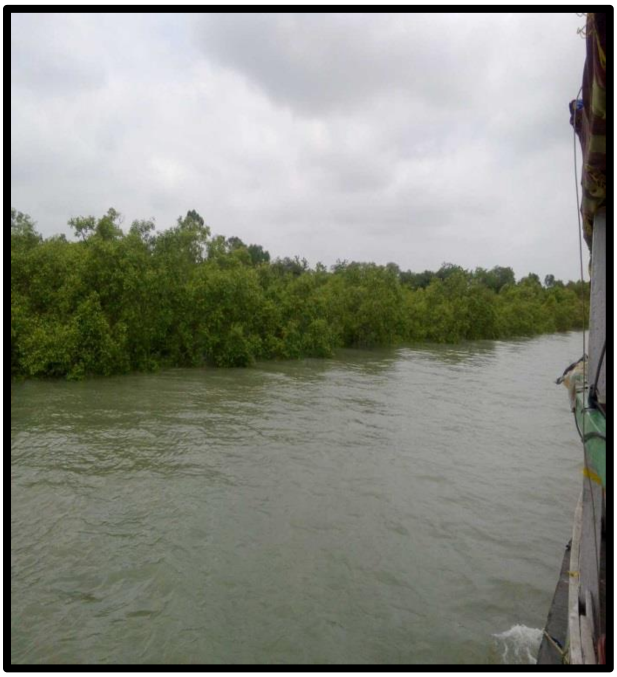
Mangroves at Left Bank Chainage 32

Mangroves at Left Bank Chainage 32.1

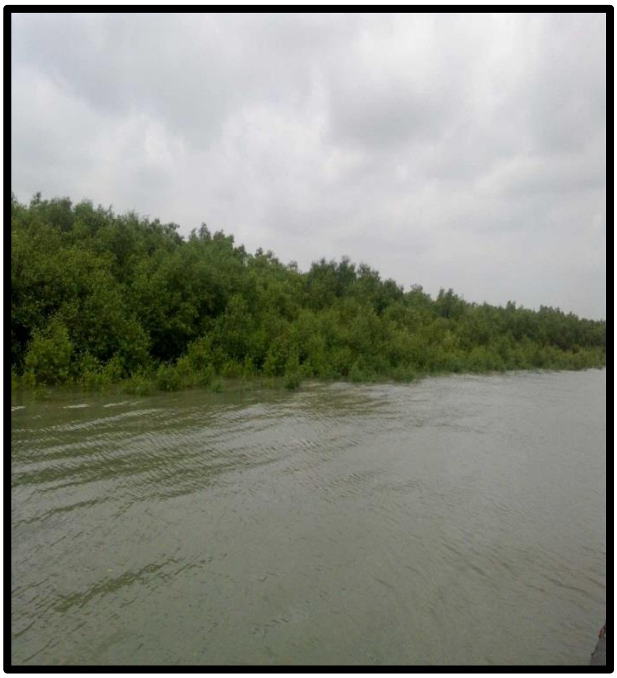
Mangroves at Left Bank Chainage 32.2

Mangroves at Right Bank Chainage 32.5

Mangroves at Left Bank Chainage 32

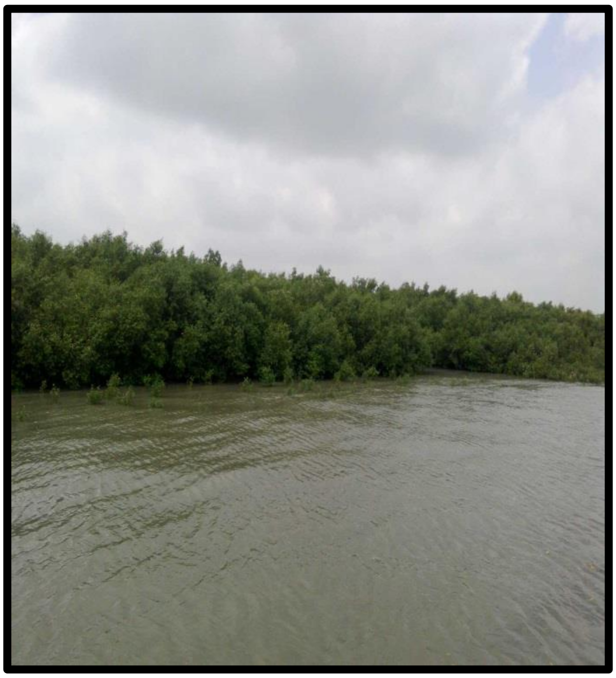


Mangroves at Left Bank Chainage 32.5



Mangroves at Left Bank Chainage 34

Fishing Boat With Net at Chainage 34



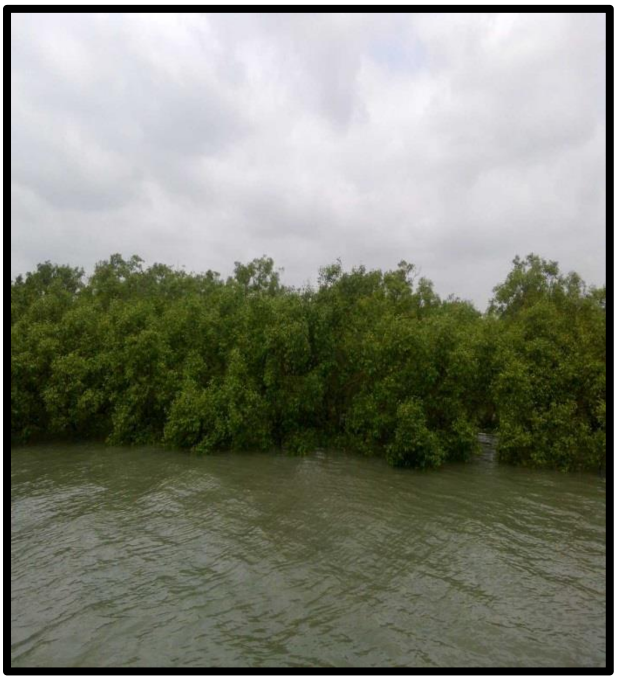
Mangroves At Chainage 34.1, Left Bank

Island at Right Bank Chainage 34.5

Island at Right Bank Chainage 34.5

Island at Right Bank Chainage 35

Mangroves at Left Bank Chainage 35.5



Mangroves at Left Bank Chainage 35.6

Mangroves at Right Bank Chainage 36.7

Mangroves at Right Bank Chainage 36.8

Mangroves at Right Bank Chainage 37

Mangroves at Right Bank Chainage 37.1

Mangroves at Left Bank Chainage 37.1

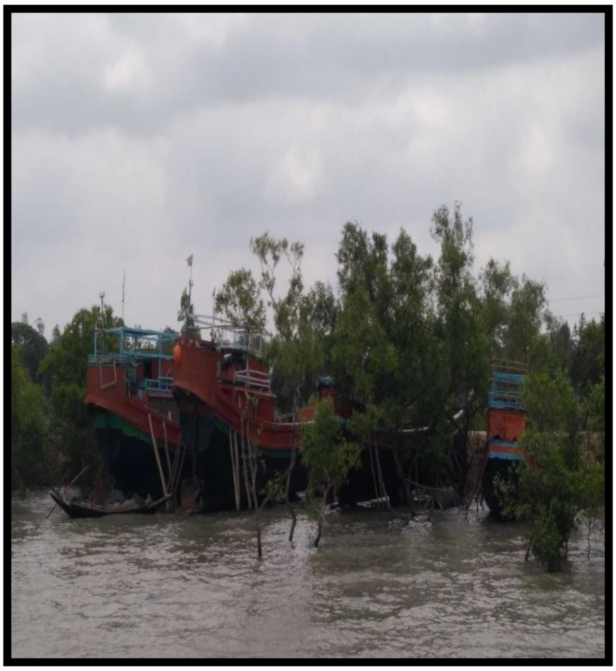
Mangroves at Left Bank Chainage 37.2

Left bank at Chainage 37. 3

Jetty at Right Bank Chainage 38

Residential Area at Right Bank Chainage 38.2

Mangroves at Left Bank Chainage 38.2

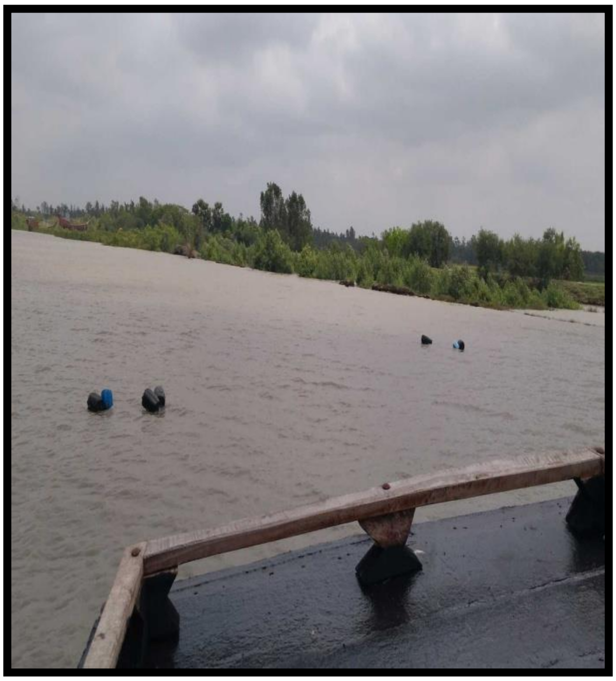


Right River Bank at Chainage 38.3

Mangroves at Left Bank Chainage 38.3

Right River Bank at Chainage 38.5

Mangroves at Left Bank Chainage 38.5



Fishing Net at Chainage 38.5

Mangroves at Left Bank Chainage 38.7

Left River Bank at Chainage 38.9

Jetty at Right Bank Chainage 39.2

Mangroves at Left Bank Chainage 39.2

Mangroves at Left Bank Chainage 39.3

Mangroves at Left Bank Chainage 39.5

Mangroves at Left Bank Chainage 39.8

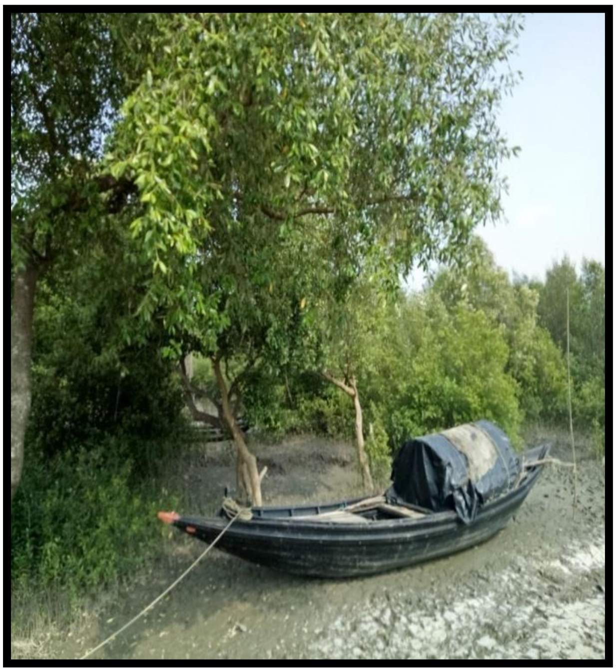
Cargo Boats at Chainage 40

GPS Observation at Left Bank TR-05 At Chainage 40

Road at Left Bank Chainage 40, Kurbha Shridhapur

Jetty Ghat at Left Bank Chainage 40, Kurbha Shridhapur

Mangroves at Left Bank Chainage 40, Kurbha Shridhapur

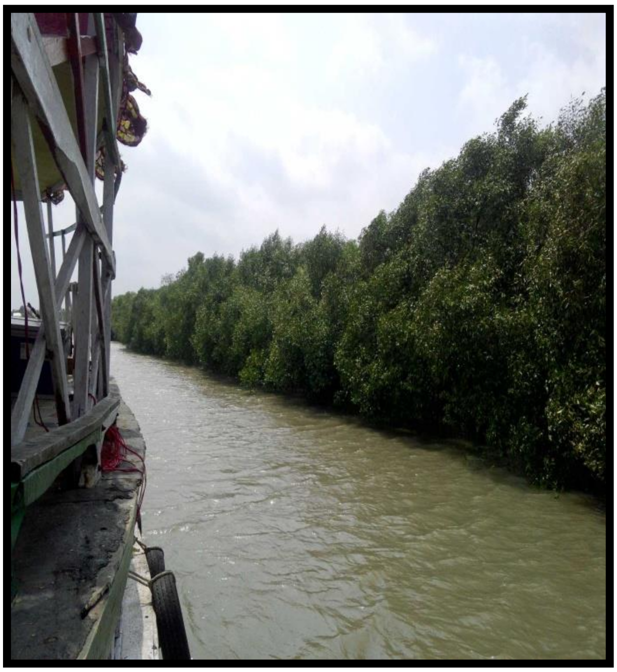


Mangroves at Left Bank Chainage 40, Kurbha Shridhapur

Mukti Head Office at Left Bank Chainage 40.1, Kurbha Shridhapur

Fishing Boat With Net at Chainage 40.5

Mangroves at Left Bank Chainage 40.5



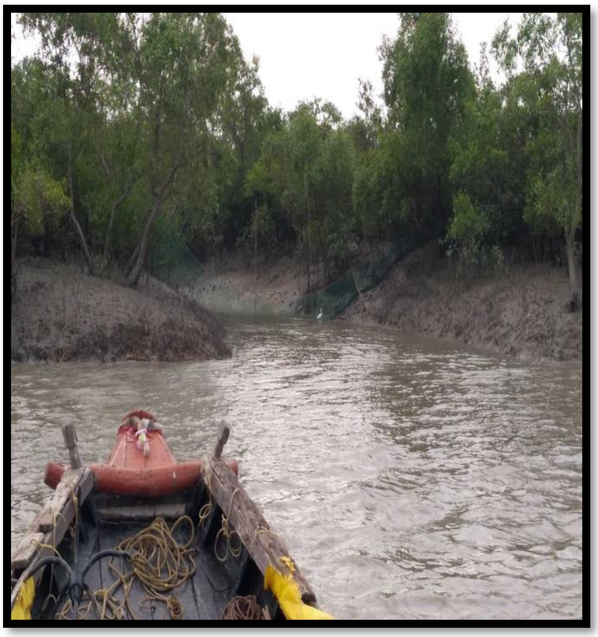
Mangroves at Right Bank Chainage 40.5

ishing Net at Chainage 40.5

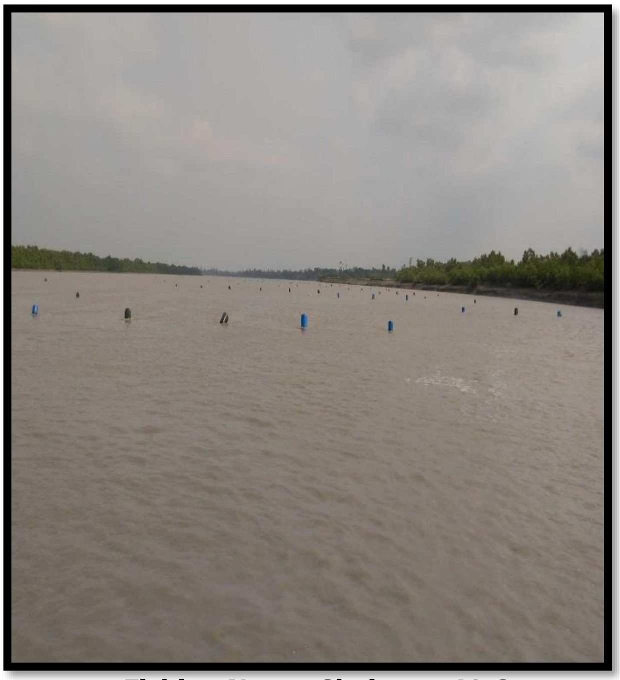
Right River Bank Bhunesvar Jetty at Chainage 41.4

Right River Bank Broken Bhunesvar Jetty at Chainage 41.4

Mangroves at Left Bank Chainage 41.5



Creek at Right Bank Chainage 41.5

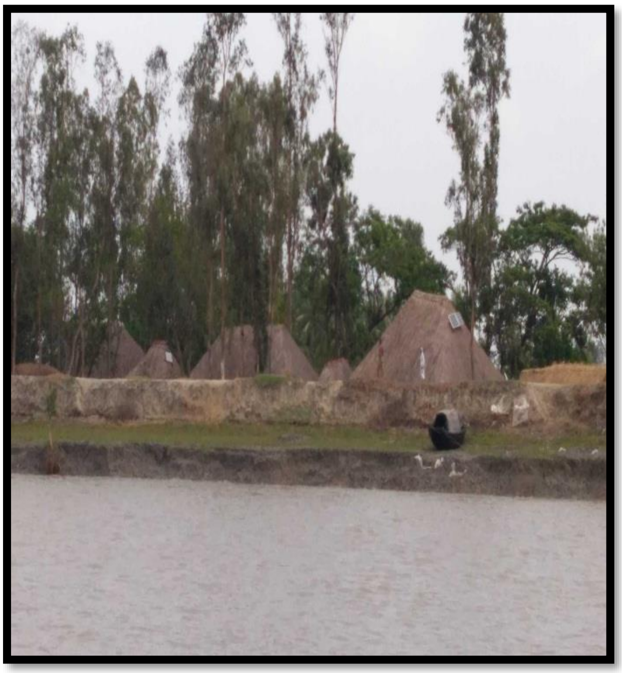


Fishing Net at Chainage 41.6

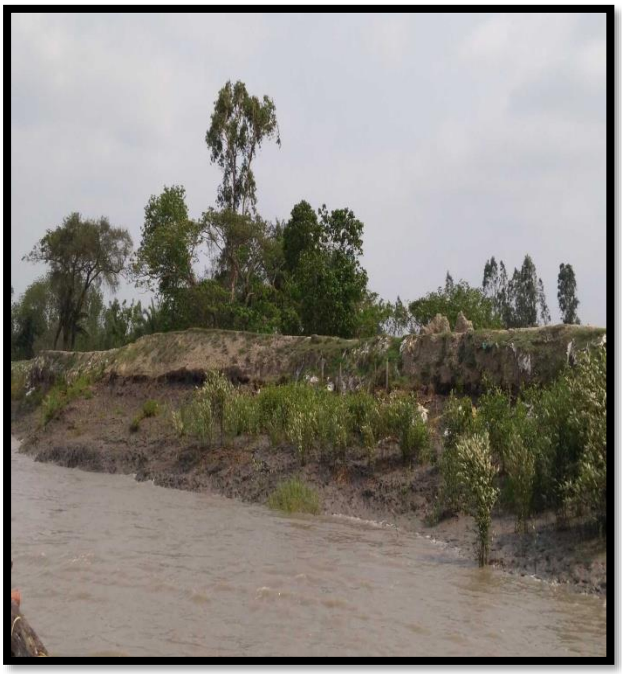
Mangroves at Right Bank Chainage 41.7

Temporary Right River Bank Protection at Chainage 44

Right River Bank at Chainage 45



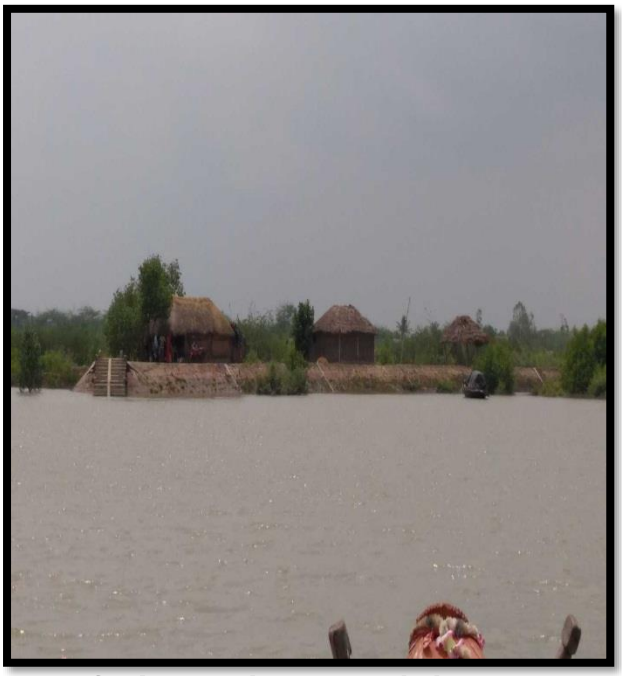
Right River Bank at Chainage 45.2



Right Bank at Chainage 44.6

Mangroves at Left River Bank Chainage 45.8

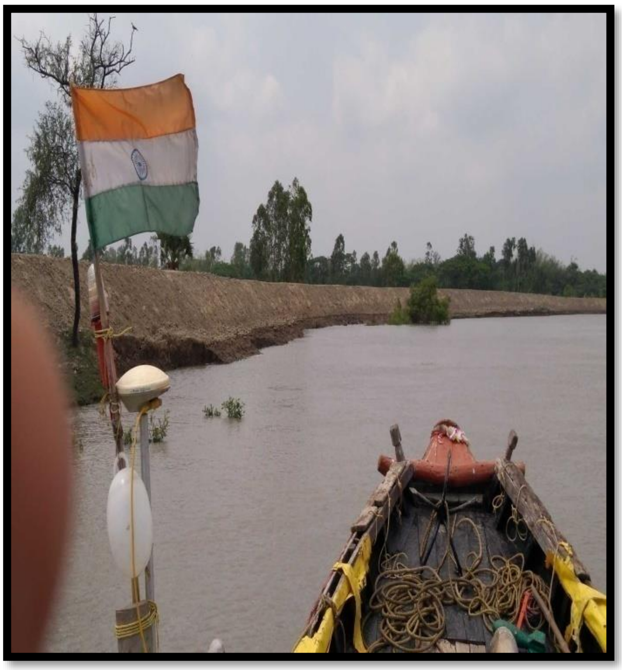
Left River Bank at Chainage 47



Left River Bank Jetty at Chainage 47.4

Right River Bank Jetty at Chainage 47.6

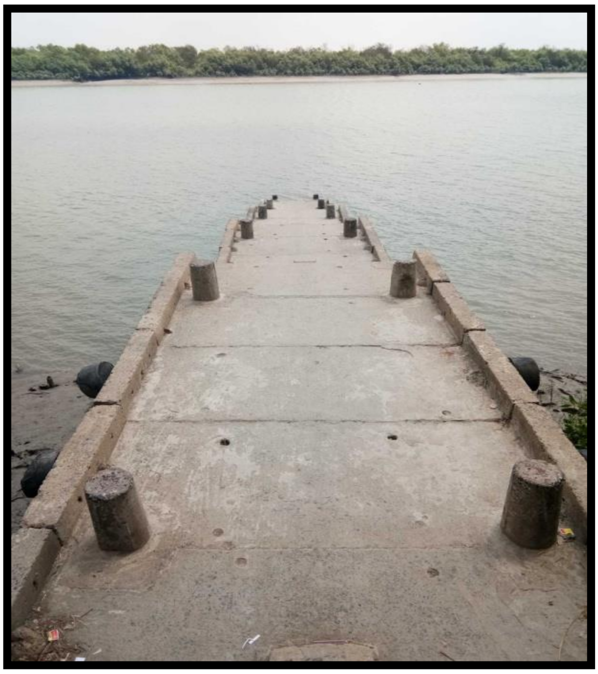
Left River Bank at Chainage 47.7



Left River Bank at Chainage 48.5

Mangroves at Chainage 49.5

Mangroves at Chainage 49.5



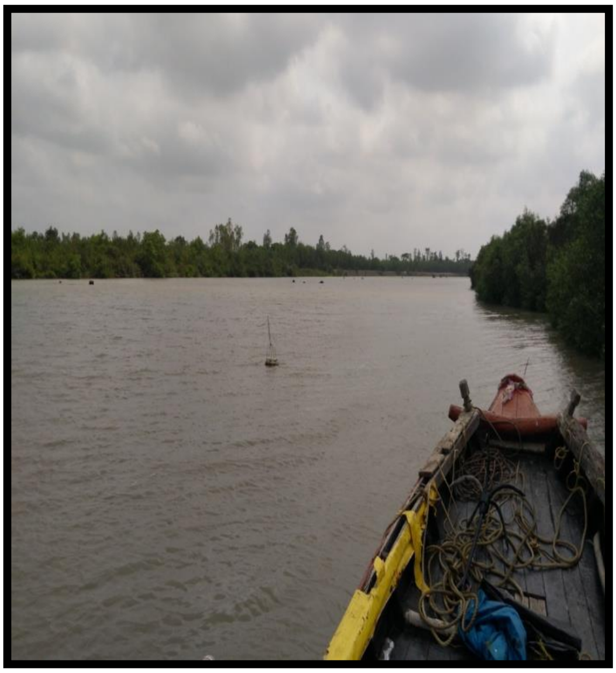
Majher Jetty Ghat at Left Bank Chainage 50.7

TR-06 At Left Bank Chainage 50.7

Majher Jetty Ghat at Left Bank Chainage 50.7

Majher Jetty Ghat at Left Bank Chainage 50.7

Mangrove at Left Bank Chainage 51



Fishing Net at Chainage 51

Mangrove at Left Bank Chainage 51.5

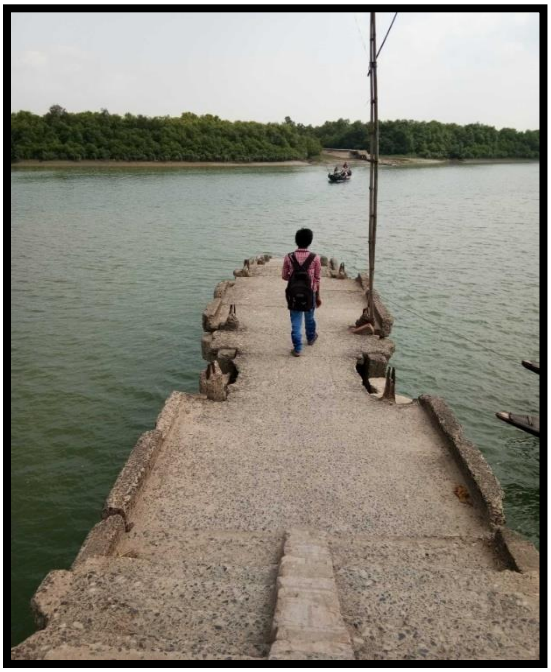
Mangrove at Left Bank Chainage 51.6

Bridge at Chainage 53.3

Under Construction Bridge at Left Bank Chainage 53.3

Debhipur Jetty Ghat at Right Bank Chainage 53.4

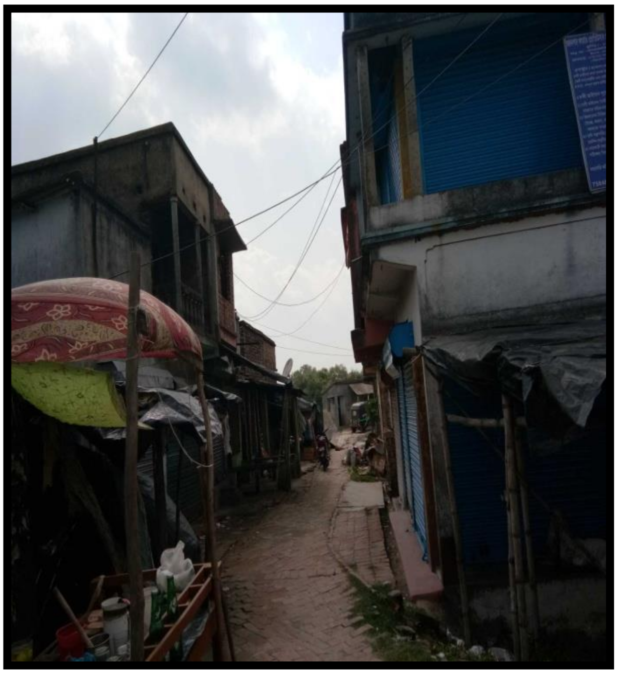
Debhipur Jety Ghat at Right Bank Chainage 53.4



Debhipur Jetty Ghat at Left Bank Chainage 53.4

Debhipur at Left Bank Chainage 53.3

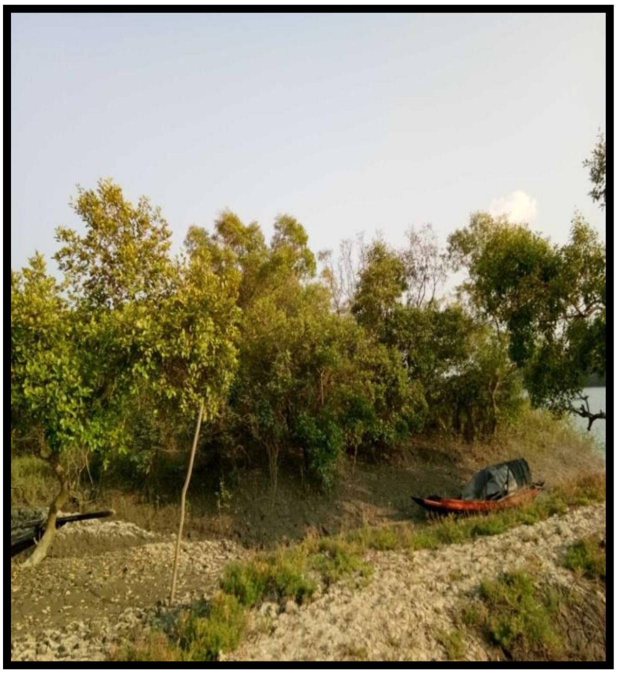
Road at Left Bank Chainage 53.3



Structure In Debhipur at Left Bank Chainage 53.3

Left River Bank Protection at Chainage 53.5

Left River Bank Protection at Chainage 53.6



Mangrove at Left Bank Chainage 54.7

Left River Bank Protection at Chainage 53.8

Mobile Tower at Left Bank Chainage 53.9

Left River Bank at Chainage 54

Mangroves at Right Bank Chainage 54.5

Fishing Net at Chainage 55.5,

Right River Bank at Chainage 56.5

Fishing Net at Chainage 56

Fishing Net at Chainage 57

ight River Bank at Chainage 58.5

Jetty at Right Bank Chainage 59.4

Mangroves at Left Bank Chainage 61

Fishing Net at Chainage 61

Left River Bank at Chainage 61.5

Mangroves at Right Bank Chainage 61.5

Mangroves at Chainage 62

Mangroves at Chainage 62.5

Fishing Net at Chainage 63

Left River Bank at Chainage 63

Left River Bank Protection at Chainage 63.2

Left River Bank at Chainage 63.5

Left River Bank at Chainage 64

VOLUME – II

DRAWINGS