FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 86

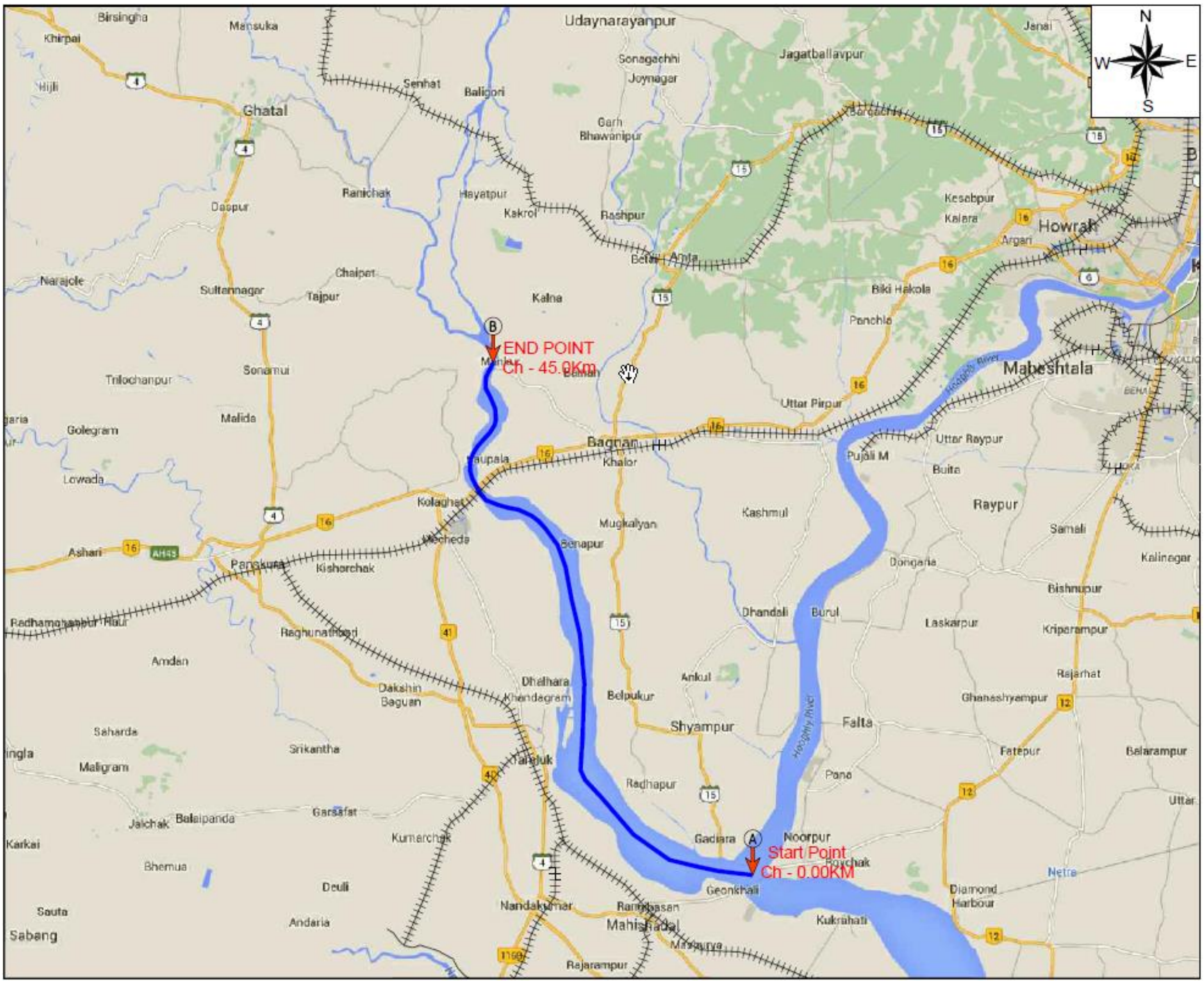
RIVER: RUPNARAYAN (STATE OF WEST BENGAL)

GEONKHALI TO MANKUR JETTY (45 KM LENGTH)

(VOLUME – I: MAIN REPORT)

(VOLUME – II: DRAWINGS)

SUBMISSION DATE: 10/12/2020



Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT

REVISION - 6

DECEMBER 2020

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Project:	Consultancy Services for preparation of Two Stage Detailed Project Report (DPR) of Cluster 1 National Waterways
Owner:	IWAI, Ministry of Shipping
Consultant:	Egis India Consulting Engineers

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Report No:
PT/EIPTIWB003/2017/DPR/001

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

SALIENT FEATURES OF RUPNARAYAN WATERWAY (NW 86)

Sr. No.	Particulars	Details					
A.	**GENERAL**						
1.	***Location***						
a)	Cluster	1					
b)	State(s)	West Bengal					
c)	Co-ordinates & Name of Place	**Start**	**End**				
	Place	Geonkhali	Mankur				
	Latitude	22°12'42.08"N	22°30'34.37"N				
	Longitude	88° 3'0.79"E	87°53'31.37"E				
B.	**TECHNICAL**						
1.	***Waterway***						
a)	National Waterway Number	86					
b)	Class	Special Purpose Vehicle (SPV) Class with 2.5 m depth below Sounding Datum and 30 m bottom Width					
c)	Type (Tidal/Non-Tidal)	Tidal					
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**			
		45 Km	45 Km	0 Km			
d)	Sounding Datum of Tide gauge						
	Description/Basis	Transferred from Diamond Harbour as per Admiralty Manual					
	Value w.r.t MSL (m)						
		0 –5Km	5.1 -15Km	15.1 -25Km	25.1 -35Km	35.1 -45Km	
		-1.983	-1.969	-1.546	-1.515	-0.181	
e)	LAD Status (w.r.t. CD)						
		Stretch-1	**Stretch-2**	**Stretch-3**	**Stretch-4**	**Stretch-5**	**Total (Km)**
	Stretch (From......To......)	0–10 Km	10-20Km	20-30Km	30-40Km	40-45Km	
	Length with LAD < 1.2 m	5.6	4.123	7.0	6.535	4.64	27.898
	With LAD from 1.2-1.4 m	0.0	0.742	0.436	0.466	0.081	1.679
	With LAD from 1.5-1.7 m	0.425	1.743	0.01	0.242	0.174	2.597
	With LAD from 1.8-2.0 m	0.331	1.276	2.4	0.651	0.105	4.763
	With LAD > 2.0 m	3.644	2.113	0.2	2.106	0.0	8.063

Sr. No.	Particulars	Details					
f)	Target Depth of Proposed Fairway (m)	2.5 m below Sounding Datum					
g)	Conservancy Works Required						
	Type of Work	**Stretch-1**	**Stretch-2**	**Stretch-3**	**Stretch-4**	**Stretch-5**	**Total**
	Stretch (From…...To……)	0–10 Km	10-20Km	20-30Km	30-35Km	35-45Km	
	Dredging Required (cum.)	3,47,127	3,87,500	4,87,734	4,22,141	4,54,094	
	Bandalling	Nil	Nil	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil	Nil	Nil
	River Training (Km.)	Nil	Nil	Nil	Nil	Nil	Nil
	Bank Protection (Km.)	Nil	Nil	Nil	Nil	Nil	Nil

Sr. No.	Particulars	Type	Chainage (Km)	Range of Horizontal Clearance (m)	Range of Vertical Clearance (m) w.r.t. MHWS
h)	Existing Cross Structures				
	Name of Structure	**Type**	**Chainage (Km)**	**Range of Horizontal Clearance (m)**	**Range of Vertical Clearance (m) w.r.t. MHWS**
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil
	Bridges	Rail Bridge	35.3	34.0	4.955
		Rail Bridge	35.5	34	4.075
		Road Bridge	35.721	54	4.306
		Road Bridge	35.743	18	6.63
		Road Bridge	35.762	54	3.67
	HT/Tele-communication lines	HT Line	34.40	417.844	36.378
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil
2.	***Traffic***				
a)	Present IWT Operations (type of services)	Passenger Ferry			
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	1) Kolaghat Thermal Power Plant 2) The Ramco Cement Ltd.			

<table>
<tr><th>Sr. No.</th><th>Particulars</th><th colspan="6">Details</th></tr>
<tr><td>c)</td><td>Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)</td><td colspan="6">• NH – 41 (within 2 Km from both the industries)
• Mecheda Railway Station (within 2-3 Km from both the industries)
• Kolaghat Railway Station (with 5 Km from both the industries)</td></tr>
<tr><td>d)</td><td>Commodities</td><td colspan="2">In-bound</td><td colspan="4">Out-bound</td></tr>
<tr><td></td><td></td><td colspan="2">• Clinker
• Gypsum
• Construction Material
• Passenger
• RO-RO vehicles</td><td colspan="4">• Fly Ash
• Cement
• Construction Material
• Passenger
• RO-RO vehicles</td></tr>
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<tr><td></td><td>Name of Commodity</td><td>Existing Potential</td><td colspan="2">5 years</td><td>10 years</td><td>15 years</td><td>20 years</td></tr>
<tr><td></td><td>Dry Bulk Cargo (MT/month)</td><td>10.0 Lakh</td><td colspan="5">14.80 Lakh</td></tr>
<tr><td></td><td>Passengers (nos./day)</td><td>4000</td><td colspan="2">5800</td><td>8600</td><td>12600</td><td>18600</td></tr>
<tr><td></td><td>RO-RO vehicles (nos./day)</td><td>Nil</td><td colspan="2">8 trucks</td><td>12 trucks</td><td>18 trucks</td><td>25 trucks</td></tr>
<tr><td></td><td></td><td colspan="6"></td></tr>
<tr><td>3.</td><td>Terminals/Jetties</td><td colspan="6"></td></tr>
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<tr><td>a)</td><td>Terminal/Jetty – 1</td><td colspan="6"></td></tr>
<tr><td></td><td>Location (Bank/city/district)</td><td colspan="6">(Right Bank/ Jamitya /Purba Medinipur)</td></tr>
<tr><td></td><td>Type/Services</td><td colspan="3">Existing
Nil (Cargo is operated from Haldia Jetty)</td><td colspan="3">Proposed
Dry Bulk Cargo Terminal</td></tr>
<tr><td></td><td>Existing Infrastructure</td><td colspan="6">Nil</td></tr>
<tr><td></td><td>Proposed Infrastructure</td><td colspan="6">Platform, RCC Jetty, Parking area, Open storage area and terminal complex.</td></tr>
<tr><td></td><td>Approach</td><td colspan="6">River Bank Road</td></tr>
</table>

Sr. No.	Particulars	Details	
	Land Ownership		
	Area (ha.)	**Govt.**	**Private**
		2.00	
b)	Terminal/Jetty - 2		
	Location (Bank/city/district)	(Right Bank/Noorpur/South 24 Parganas)	
	Type/Services	**Existing** Passenger Ferry	**Proposed** RO-RO, Passenger Ferry
	Existing Infrastructure	Wooden Jetty, Ticketing area	
	Proposed Infrastructure	RCC Jetty, Linkspan, Gangway, Pontoon Platform, Parking, Passenger waiting and ticketing area, Office complex	
	Approach	Noorpur Road	
	Land Ownership		
	Area (ha.)	**Govt.**	**Private**
		0.40	
c)	Terminal/Jetty – 3		
	Location (Bank/city/district)	(Right Bank/ Gadiara /Haora)	
	Type/Services	**Existing** Passenger Ferry	**Proposed** RO-RO, Passenger Ferry
	Existing Infrastructure	Wooden Jetty, Ticketing area	
	Proposed Infrastructure	RCC Jetty, Linkspan, Gangway, Pontoon Platform, Parking, Passenger waiting and ticketing area, Office complex	
	Approach	State Highway 15	
	Land Ownership		
	Area (ha.)	**Govt.**	**Private**
		0.40	
d)	Terminal/Jetty – 4		
	Location (Bank/city/district)	(Right Bank/ Geonkhali /Purba Medinipur)	
	Type/Services	**Existing** Passenger Ferry	**Proposed** RO-RO, Passenger Ferry
	Existing Infrastructure	Wooden Jetty, Ticketing area	
	Proposed Infrastructure	RCC Jetty, Linkspan, Gangway, Pontoon Platform, Parking, Passenger waiting and ticketing area, Office complex	

Sr. No.	Particulars	Details			
	Approach	Mahishadal Geonkhali Road			
	Land Ownership				
	Area (ha.)	**Govt.**		**Private**	
		0.40			
4.	***Design Vessel***				
		Cargo	***RO-RO***	***Passenger***	
a)	Type	Bulk Carrier (Self-propelled)	Double ended Roll-on- Roll-Off (RO-RO) ferry vessels	Steel ferry vessel	
b)	No. & Size	2 No. (95L x 15B)	1 No. (62.4L x 4.5B)	3 No. (62.4L x 4.5B)	
c)	Loaded Draft	2.5 m	2.3 m	2.3 m	
d)	Capacity	2000 T	8 trucks & 50 pax.	150 passengers	
5.	***Navigation Aids***				
a)	Type	Marking Buoys			
b)	Nos.	41			
c)	Communication Facilities	• RIS – 1 Station			
C.	**FINANCIAL**				
1.	***Project Cost***				
	Cost (INR Lacs) - Excluding Land Cost	**Total Cost**		**Cost without Vessel**	
		Phase 1	**Phase 2**	**Phase 1**	**Phase 2**
a)	Capital Cost	Cargo vessel cost not considered	9,806.32	5,814.65	9,150.33
b)	O & M Cost		817.38	1,069.52	463.58
	Cost (INR Lacs) - Including Land Cost	**Total Cost**		**Cost without Vessel**	
		Phase 1	**Phase 2**	**Phase 1**	**Phase 2**
a)	Capital Cost	Cargo vessel cost not considered	10,225.42	6,513.15	9,569.43
b)	O & M Cost		817.38	1,069.52	463.58

<table>
<tr><th>Sr. No.</th><th>Particulars</th><th colspan="3">Details</th></tr>
<tr><td></td><td></td><td colspan="3"></td></tr>
<tr><td>2.</td><td>User Charges</td><td colspan="3"></td></tr>
<tr><td>a)</td><td>For IWAI</td><td>Cargo</td><td>RO-RO</td><td>Passenger</td></tr>
<tr><td></td><td></td><td>INR 2.50 /ton/km</td><td>INR 200/truck</td><td>INR 8.0/ pax./ trip</td></tr>
<tr><td></td><td></td><td colspan="3"></td></tr>
<tr><td rowspan="11">3.</td><td rowspan="11">Financial Internal Rate of Return (%)</td><td colspan="3">Phase – 1 Excluding Land Cost</td></tr>
<tr><td colspan="2">Scenario - 1
a) Capital cost incurred in Phase – 1
b) O&M cost incurred in Phase – 1
c) Revenue generated from Cargo operations only</td><td>6.30% for tariff of INR 2.50 per ton per km</td></tr>
<tr><td colspan="2">Scenario - 2
a) O&M cost incurred in Phase – 1
b) Revenue generated from Cargo operations only</td><td>30.49% for tariff of INR 2.50 per ton per km</td></tr>
<tr><td colspan="3">Phase – 1 Including Land Cost</td></tr>
<tr><td colspan="2">Scenario - 1
a) Capital cost incurred in Phase – 1
b) O&M cost incurred in Phase – 1
c) Revenue generated from Cargo operations only</td><td>5.64% for tariff of INR 2.50 per ton per km</td></tr>
<tr><td colspan="2">Scenario - 2
a) O&M cost incurred in Phase – 1
b) Revenue generated from Cargo operations only</td><td>30.49% for tariff of INR 2.50 per ton per km</td></tr>
<tr><td colspan="3">Phase - 2 Excluding Land Cost</td></tr>
<tr><td colspan="2">Scenario - 1
a) Capital cost incurred in Phase – 2
b) O&M cost incurred in Phase – 2
c) Revenue generated from RO-RO/Ferry operations</td><td>-ve
(not calculable)</td></tr>
<tr><td colspan="2">Scenario - 2
a) O&M cost incurred in Phase – 2
b) Revenue generated from RO-RO/Ferry operations</td><td>-ve
(not calculable)</td></tr>
<tr><td colspan="3">Phase - 2 Including Land Cost</td></tr>
<tr><td colspan="2">Scenario - 1
a) Capital cost incurred in Phase – 2 (including vessel cost)
b) O&M cost incurred in Phase – 2 (including vessel cost)
c) Revenue generated from RO-RO/Ferry</td><td>-ve
(not calculable)</td></tr>
</table>

Sr. No.	Particulars	Details	
		operations	
		Scenario - 2 a) O&M cost incurred in Phase – 2 (including vessel cost) b) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)
4.	**Economic Internal Rate of Return (%)**	**Phase - 1 Excluding Land Cost**	
		Scenario - 1 a) Capital cost incurred in Phase – 1 b) O&M cost incurred in Phase – 1 c) Revenue generated from Cargo operations only	20.40% for tariff of INR 2.50 per ton per km
		Scenario - 2 a) O&M cost incurred in Phase – 1 b) Revenue generated from Cargo operations only	+ve (not calculable)
		Phase - 1 Including Land Cost	
		Scenario - 1 a) Capital cost incurred in Phase – 1 b) O&M cost incurred in Phase – 1 c) Revenue generated from Cargo operations only	18.76% for tariff of INR 2.50 per ton per km
		Scenario - 2 a) O&M cost incurred in Phase – 1 b) Revenue generated from Cargo operations only	+ve (not calculable)
		Phase - 2 Excluding Land Cost	
		Scenario - 1 a) Capital cost incurred in Phase – 2 b) O&M cost incurred in Phase – 2 c) Revenue generated from RO-RO/Ferry operations	6.55%
		Scenario - 2 a) O&M cost incurred in Phase – 2 b) Revenue generated from RO-RO/Ferry operations	+ve (not calculable)
		Phase - 2 Including Land Cost	
		Scenario - 1 d) Capital cost incurred in Phase – 2 e) O&M cost incurred in Phase – 2 f) Revenue generated from RO-RO/Ferry	6.09%

Sr. No.	Particulars	Details	
		operations	
		Scenario - 2 c) O&M cost incurred in Phase – 2 d) Revenue generated from RO-RO/Ferry operations	+ve (not calculable)

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 1 National Waterways. Rupnarayan waterway is one of the 4 rivers clubbed in Cluster 1.

This draft detailed project report of 45 km stretch of Rupnarayan 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 45 Km stretch of Rupnarayan National waterway proposed for DPR study lies from Geonkhali (22°12'42.08"N, 88° 3'0.79"E) to Mankur (22°30'34.46"N, 87°53'31.43"E). Whole stretch of Rupnarayan waterway from Geonkhali to Mankur Jetty is having tidal influence with a maximum tidal variation of 4.03 m near starting point of the waterway (i.e. Geonkhali Jetty) to a minimum tidal variation of 0.91 m at Chainage of 45.0 Km near Mankur Jetty. River width in the waterway stretch varies from 3.3 Km near Tamluk and Ghadiara Jetty to about 400 m near Mankur Jetty. Average flow velocity in the waterway varies from 1.243 m/sec to 0.173 m/sec.

Two railway and three road bridges are located along the waterway stretch crossing waterway near Kolaghat from Chainage 35.3Km to 35.762Km.

3.0 FAIRWAY DEVELOPMENT

On the basis of traffic study, it is proposed to develop only 35.0 Km out of total 45.0 Km of waterway stretch from Geonkhali to Jamitya Jetty (near Kolaghat). The waterway is proposed to be developed as a SPV waterway class with 2.5m depth below sounding datum and 30.0 m bed width.

It is proposed to develop IWT in Rupnarayan waterway in two (2) phases as below:

In Phase-1:

- Develop waterway from Geonkhali to Jamitya Jetty, Kolaghat and Jamity Jetty/terminal for Dry Bulk Cargo Transportation

In Phase-2:

- Develop Noorpur, Gadiara, Geonkhali Jetty/Terminal for RO-RO/Passenger ferry services

The total capital and O&M cost of fairway development is considered as INR 1960.0 Lacs and INR 196.0 Lacs respectively.

4.0 TRAFFIC STUDY

On the basis of detailed traffic survey and study done during this stage, following is concluded:

Type of Traffic	Existing Scenarios	Proposed Scenarios
Cargo	Light Cargo like Bricks, construction material, vegetables etc.	Fly Ash, Cement Clinker and Gypsum to/from proposed Kolaghat jetty.
Ro-Ro	Not Available	Proposed to connect existing Noorpur, Gadiara and Geonkhali Jetties/ferry ghats
Passenger Ferry Services	Available (locally operated without any proper infrastructure)	To be developed and operated as economical and safe mode of transport.

Sl. No.	Proposed Terminal	Type of Terminal	Proposed RO-RO/Ferry Traffic per day	Proposed Cargo Traffic per Annum
1.	Noorpur	RO-RO/Ferry	4000 pax, Cycles, bikes, cars, trucks requiring RO-RO vessel of about 5-6 truck capacity	
2.	Gadiara	RO-RO/Ferry	2500 pax, Cycles, bikes, cars, trucks requiring RO-RO vessel of about 4-5 truck capacity	
3.	Geonkhali	RO-RO/Ferry	3500 pax, Cycles, bikes, cars, trucks requiring RO-RO vessel of about 5-6 truck capacity	
4.	Jamitya	Dry Bulk Cargo Captive Jetty		10.0 Lac tonne

5.0 TERMINALS

On the basis of detailed bathymetric and traffic survey done during DPR studies on the 45 Km stretch of Rupnarayan river from Geonkhali (Chainage 0.0 Km) to Mankur Jetty (Chainage 45 Km), following locations are identified for development and construction of terminals:

a) Jamitya – Dry Bulk Cargo Terminal in Phase-1
b) Noorpur – RO-RO/Ferry Terminal in Phase-2
c) Gadiara – RO-RO/ Ferry Terminal in Phase-2
d) Geonkhali – RO-RO/ Ferry Terminal in Phase-2

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

Sl. No.	Item	Amount in Lacs (INR)
1.0	Capital cost for Terminals Excluding Land Cost	
	a) Dry Bulk Cargo Terminal at Jamitya (Kolaghat)	2,117.72
	b) RO-RO/Ferry Terminal at Noorpur, Geonkhali and Gadiara	9150.33
2.0	Capital cost for Terminals Including Land Cost	
	a) Dry Bulk Cargo Terminal at Jamitya (Kolaghat)	2,816.26
	b) RO-RO/Ferry Terminal at Noorpur, Geonkhali and Gadiara	9,569.43
3.0	O&M cost for Terminals	
	a) Dry Bulk Cargo Terminal	516.51
	b) RO-RO/Ferry Terminals	463.58

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 the terminal structures:

Dry Bulk Cargo Terminal

- Cargo Berth
- Approach jetty

- Substation
- Weigh bridge
- Administrative Building
- Internal road
- Security office
- Boundary Wall

RO-RO Ferry Terminal

- Approach Jetty & Jetty Platform
- Link Span Bridge
- Parking Facilities
- Terminal Building

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

7.0 VESSEL DESIGN

Following types of vessels are proposed to be operated in Rupnarayan waterway:

a) Self-propelled bulk carrier of 2000 DWT for cargo transportation.
b) Double ended RO-RO vessel having carrying capacity of 8 trucks including 50 passengers.
c) Steel ferry vessel with carrying capacity of 150 passengers.

It is proposed that vessels operated by traders for transporting Fly ash and other cargo, originated or destined to Kolaghat, to and fro Haldia terminal will come directly to Jamitya Jetty. Hence the capital and O&M cost of cargo vessels are not considered in the analysis. The total cost for vessels works out to:

Sl. No.	Item	Amount in Lacs (INR)
1.0	Capital Cost for Vessels	
	a) RO-RO/Ferry Vessel (1 No.)	380.00
	b) Passenger Ferry Vessels (3 Nos.)	275.99
2.0	O&M Cost for Vessels	353.80

8.0 NAVIGATION & COMMUNICATION SYSTEM

Aids to Navigation like DGPS, VTMS and marking buoys are proposed along the channel alignment. Capital and maintenance cost for the same is estimate to INR 442.20 Lakhs and INR 207.65 Lakhs respectively.

9.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Rupnarayan 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
- To identify the requirement of various regulatory clearances, NoCs

Asessment of impact on environment including social considerations are done in the DPR. The total environmental estimated cost for the project is INR 120.105 Lacs.

10.0 INSTITUTIONAL REQUIREMENTS

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

About 7 permanent project staff and 6 additional support staff is required to be engaged on contract/outsourcing basis. The total cost for Institutional set up works out to INR 123.98/- Lacs.

11.0 PROJECT COSTING

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates 2015-16 of PWD, Govt. of West; Corrigenda & Addenda regarding updated rates for 2017 of various items
b) "Unified Schedule of Rates" prepared by Irrigation and Waterways department, Government of West Bengal.
c) The consultant's references from various projects/sites proximity to the project area.
d) Local enquiries at the time of conducting surveys.
e) Market surveys and enquires
f) Judgement based on Consultant's Experience
g) https://www.wbidc.com/industrial_parks/available_land.htm

The development cost for waterway comprises of:

a) Cost for fairway development comprising dredging and navigation & communication system
b) Cost of floating pontoons, gangway and terminal buildings
c) Vessel Cost
d) Cost of Aids to Navigations
e) EMP cost.

The total capital cost for development of waterway, construction of terminals, and procurement of vessels including other expenses works out to as below:

Sl. No.	Description	Excluding Land Cost	Including Land Cost
1.	Phase 1 Capital Cost (in INR Lacs)	5,814.65	6,513.15
2.	Phase 1 O&M Cost (in INR Lacs)	1,069.52	
3.	Phase 2 Capital Cost (in INR Lacs)	9,806.32	10,225.42
4.	Phase 2 O&M Cost (in INR Lacs)	817.38	

12.0 IMPLEMENTATION SCHEDULE

The project is scheduled to be completed in 36 months from the start date of construction for each phase of development.

13.0 ECONOMIC & FINANCIAL ANALYSIS

The techno-economic model has been run with the various assumptions as stated below:

a) Dry Bulk Cargo Terminal
   i. 10 Lacs MT/annum dry bulk cargo through 2000 DWT vessel from Jamitya jetty.RO-RO/ Ferry

b) Terminal
   i. 1 RO-RO vessel having 12 cars + 4 trucks or 18 cars or 8 trucks with 50 passenger loading capacity operating 7:00 AM to 7:00 PM at every 4 hour interval on Noorpur – Geonkhali – Gadiara – Noorpur route.
   ii. 3 passenger ferry vessels of 150 pax capacity operating 7:00 AM to 7:00 PM at every 30 minute interval from each jetty.

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 revenue for RO-RO & passenger ferry services have been worked out by considering the tariff of INR 200/- per truck & INR 100/- per car for RO-RO services and INR 8/- per person per trip for passenger ferry services. Different tariffs from INR 0.50 to 3.25 per ton per km. have been considered for Cargo operations, accordingly FIRR and EIRR have been worked out

The financial and economic analysis for the river stretches of IWT system is worked for following different scenarios:

Excluding Land Cost

IWT Operation	FIRR	EIRR
Phase -1		
Scenario - 1 a) Capital cost incurred in Phase – 1 b) O&M cost incurred in Phase – 1 c) Revenue generated from Cargo operations only	6.30% for tariff of INR 2.50 per ton per km	20.40% for tariff of INR 2.50 per ton per km

IWT Operation	FIRR	EIRR
Scenario - 2 a) O&M cost incurred in Phase – 1 b) Revenue generated from Cargo operations only	30.49% for tariff of INR 2.50 per ton per km	+ve (not calculable)
Phase – 2		
Scenario - 1 a) Capital cost incurred in Phase – 2 (including vessel cost) b) O&M cost incurred in Phase – 2 (including vessel cost) c) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	6.55%
Scenario - 2 a) O&M cost incurred in Phase – 2 (including vessel cost) b) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	+ve (not calculable)

<u>Including Land Cost</u>

IWT Operation	FIRR	EIRR
Phase -1		
Scenario - 1 a) Capital cost incurred in Phase – 1 b) O&M cost incurred in Phase – 1 c) Revenue generated from Cargo operations only	5.64% for tariff of INR 2.50 per ton per km	18.76% for tariff of INR 2.50 per ton per km
Scenario - 2 a) O&M cost incurred in Phase – 1 b) Revenue generated from Cargo operations only	30.49% for tariff of INR 2.50 per ton per km	+ve (not calculable)
Phase – 2		
Scenario - 1 a) Capital cost incurred in Phase – 2 (including vessel cost) b) O&M cost incurred in Phase – 2 (including vessel cost) c) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	6.09%
Scenario - 2 a) O&M cost incurred in Phase – 2 (including vessel cost) b) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	+ve (not calculable)

From the above table, it is concluded that the project is economically viable for both the phases. With tariff of INR 2.5 per ton per km phase 1 is financially viable also.

14.0 CONCLUSIONS & RECOMMENDATIONS

From the estimated FIRR and EIRR, it is concluded that the investment on development of IWT on Rupnarayan River will be economically viable

In the light of the above, it is recommended that Rupnarayan waterway should be developed for IWT operations in consultation/association with West Bengal state government to provide integrated transport connectivity between IWT ands road transportation. The integrated Rupnarayan waterway with National waterway -1 from Allahabad to Haldia may further enhance its viability.

Given the above, it is recommended that the IWT systems, hitherto a neglected mode of transport, should be taken up for development of local/regional economy as this mode has great potential in terms of employment generation and other related developments.

With a view to completing the works strictly as per approved scope of works and time schedule, the Project Monitoring Group Including representatives of IWAI should be formulated by the competent Administrative Authority who, in turn, will regularly monitor the progress of the works, help the engineers in mobilizing physical and financial resources and removing procedural bottlenecks.

1.0 INTRODUCTION

Inland Waterways Authority of India (IWAI), Ministry of Shipping, Government of India intends planning to develop 106 new National Waterways in addition to the exiting 5 National Waterways. The National waterways are proposed to be developed as a multimodal 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) has been awarded the work for two stage DPR studies for cluster 1 and cluster 3. The present report on Rupnarayan River comes under Cluster -1.

This draft detailed project report of 45 km stretch of Rupnarayan waterway is prepared on the basis of recommendations from feasibility report, detailed survey & investigations, preliminary engineering and design and suggestions from IWAI during several meetings. 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

Rupnarayan Waterway is declared as National Waterway-86 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, following section of the 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
72 Km	22°12'41.58"N 88° 3'13.99"E	Confluence with Hooghly River at Geonkhali	22°40'16.94"N 87°46'42.57"E	Confluence with Dwarakeswar and Silabati Rivers at Pratappur

Following conclusions were drawn in the stage-1 feasibility study for 72 km stretch of Rupnarayan waterway:

- Tidal variation of 1.7 m is observed throughout the 72.0 km stretch of Rupnarayan waterway.
- The horizontal and vertical clearance of existing cross-structures is in the range of 80m – 100m and 8m respectively.
- On the basis of reduced water depth calculated from the bathy data observed during single line river survey, LAD of > 2.0 m is available for 18.28 km length of the waterway, 1.5 m to 2.0 m is available for 14.12 km length, 1.5 to 1.0 m is available for 14.31 km and <1.0 of LAD is available for 25.30 km of the waterway stretch respectively with respect to chart datum;
- Considering the length of the river and availability of numerous minor and major industries 5km reach across the bank, the river has huge economic potential.
- The waterway will be an alternated mode of connectivity to the existing and proposed Ports coming up in and nearby Rupnarayan waterway.
- Availability of Kolaghat Thermal power plant gives an additional economic advantage to the waterway, as the waterway can be used for coal transportation to the power plant located about 2.5 Km from the waterway. Coal can be easily transported by conveyor belt directly from waterway to the site.

All the above conclusions were made on the basis of single line (longitudinal) survey done on the proposed waterway during the feasibility study stage. To validate above conclusions and to identify the development works required for making a techno-economically viable IWT in Rupnarayan NW, detailed survey and investigations including basic engineering studies, are done, as per the scope of work for Stage-II, defined in the ToR.

Based on the above conclusions/observations done during feasibility studies IWAI selected following stretch of Rupnarayan river for second stage of the studies i.e. for preparation of DPR

Length	Co-ordinate at Start	Start Location	End Location
45 Km	22°12'42.08"N 88° 3'0.79"E	Confluence with Hooghly River at Geonkhali	Near Mankur

1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Rupnarayan waterway is located between Purba Medinipur and Haora districts of West Bengal. The waterway is proposed for the 45 Km of river stretch towards upstream from its confluence with Hugli River at Geonkhali. As observed during the feasibility studies, complete stretch of waterway is having tidal influence. Locally operated jetties are also available at Geonkhali, Gadiara and Noorpur for passenger and small cargo movement across the river. A Thermal power plant, namely Kolaghat Thermal Power Plant is located at about 35.0 km upstream of Geonkhali at about 2.5 km from the left bank of waterway.

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

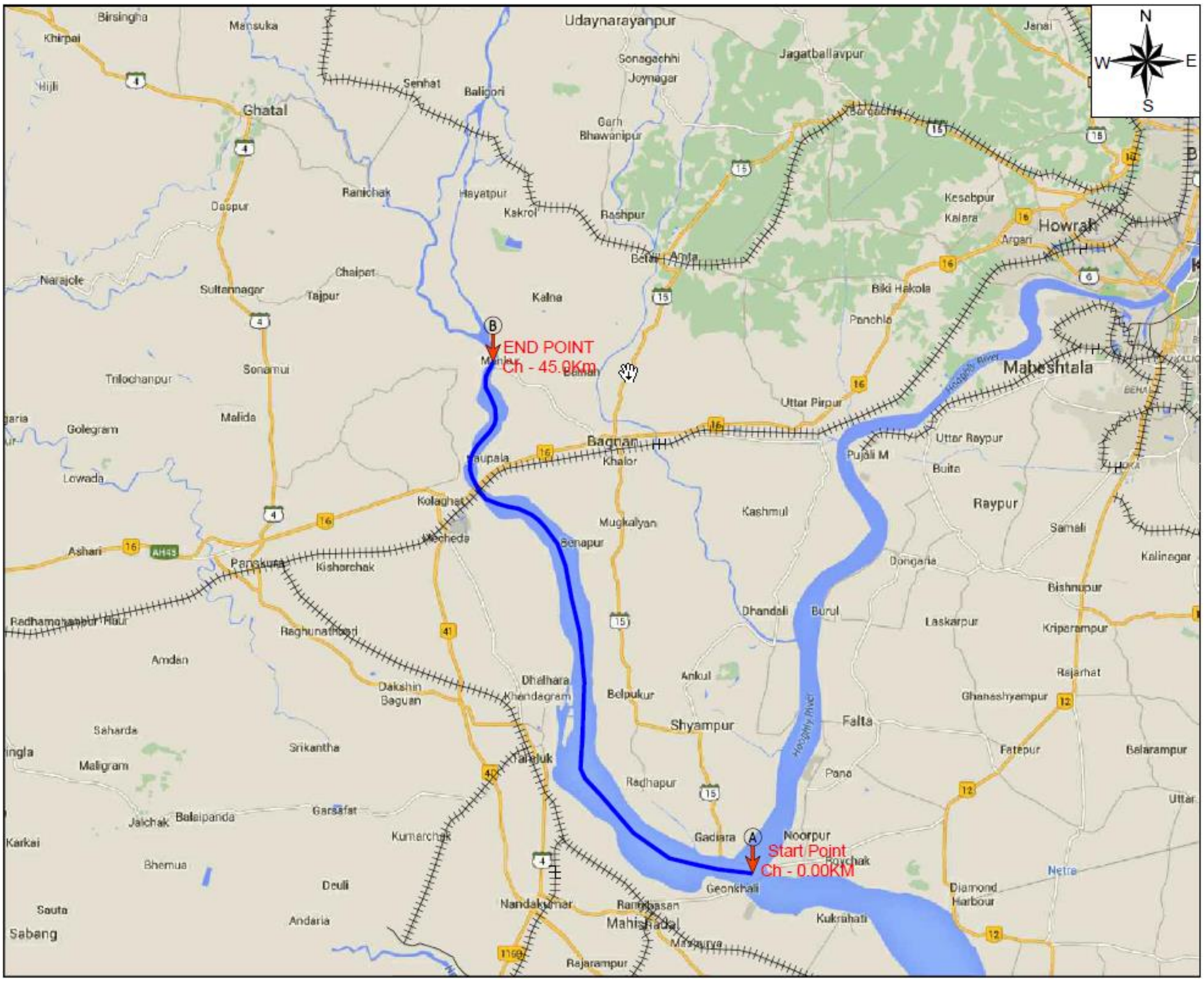


Figure 1: Rupnarayan National Waterway Project Location

1.3 BRIEF SCOPE OF WORK AND COMPLIANCE STATEMENT

The brief scope of work comprises of:

a) Hydrographic and Hydomorphological 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 and discharge measurements
   v. Collection of water & bottom samples and analysis as per TOR

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 hydromorphological survey was covered in the Hydrographic Survey Charts and Report, submitted as part of first deliverable under Stage-II of the project and attached as **Volume-IIIA & IIIB** of the DPR. The compliance statement of Draft 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 & Volume –IV: Geotechnical Investigation Report
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 in **Figure 2.0** below;

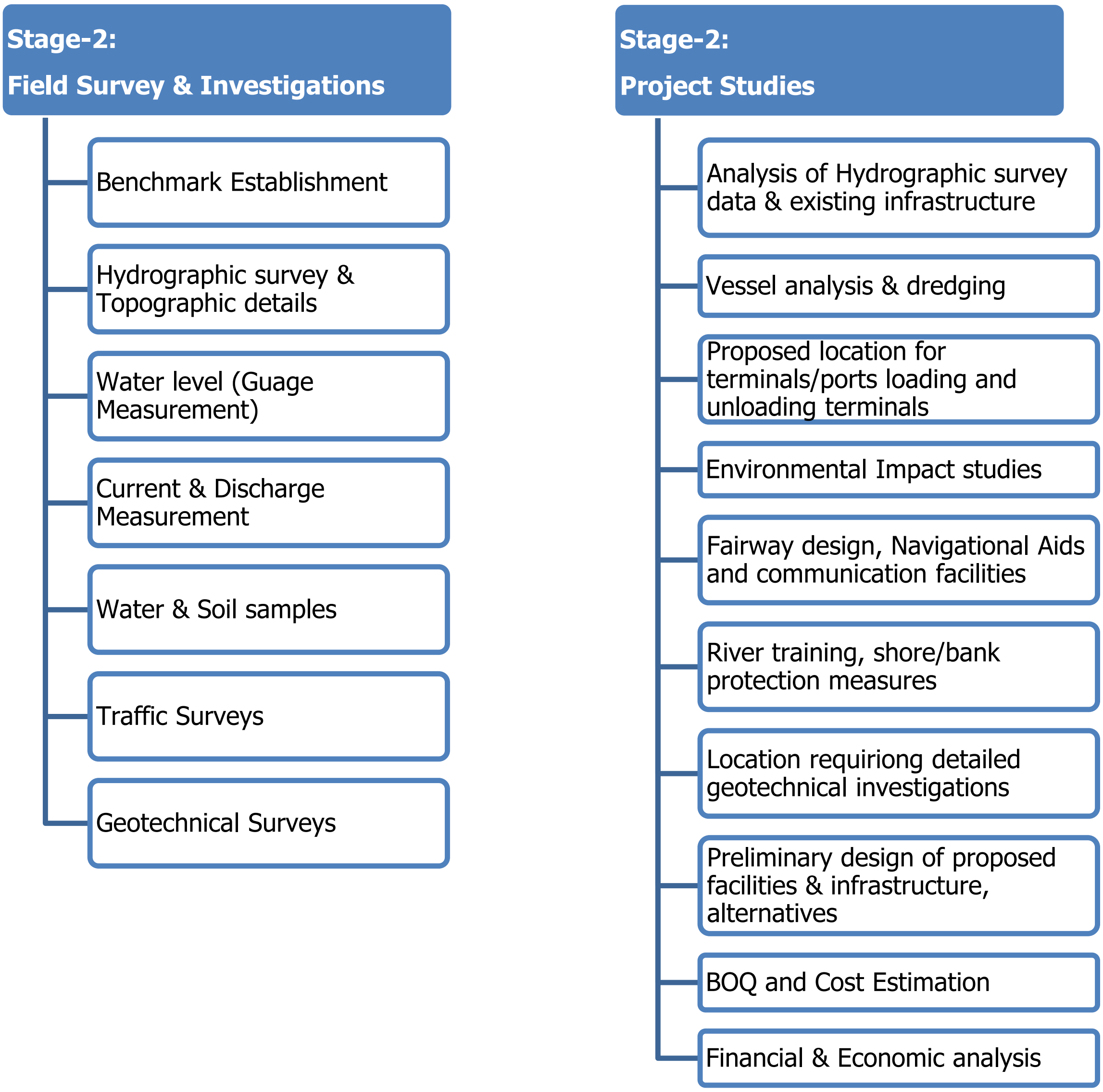


Figure 2: Framework of Studies

1.4 BRIEF METHODOLOGY & APPROACH

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

Detailed hydrographic, hydro morphological survey and investigations, traffic, environment and social survey is done along the stretch. The data collected from survey is further analysed indetail 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.

A detailed DPR methodology and the expected outcome in fulfilling the assignment is presented as below.

1.4.1 Classification of Waterways

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

Table 1: Classification of National Waterway -Rivers

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

Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self Propelled Vessel Carrying Capacity
						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 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-	2.75	100	900	10	100	2000 tonne Dead Weight

Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self Propelled Vessel Carrying Capacity
VII						Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 8000 tonne Dead Weight Tonnage (approx. size 210m overall length, 28m moulded breadth and 2.5m loaded draft or with higher dims).

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

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

Also:

a) Waterway side slopes should be kept as 1(V): 5(H);

b) Minimum depth of channel should normally be available for about 330 days of the year;

c) Vertical clearance at cross structure over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway;

d) For rivers, vertical clearance should be kept over Navigational High Flood Level (NHFL), which is the highest flood level at a frequency of 5% in any year over a period of last twenty years.

1.4.2 Measures to Improve the Depth

The basic parameters considered for the fairway design are:

- Depth
- Width
- Side slopes
- Bends

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

Fairway Design

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

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

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

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

Width of a Channel

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

W = BM + BM1 + C + 2C1

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

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

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

C = Width of separating zone.

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

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

BM = 1.3 B to 3.0 B

BM = BM1

C = 0.5 B to 1.0 B

C1 = 0.3 B to 1.5 B

Where, B = Beam of a design vessel.

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

BM = 1.8 B

BM = BM1

C = 0.5 B

C1 = 0.5 B

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

Slopes

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

Width Allowance at Bends

In bends, the width of the fairway should be more than the width of the canal that is designed for a straight reach to allow for a drift of the vessel in a curved portion of the waterway. It means that the vessel occupies a greater width in bends than in a straight stretch of the waterway. The drift of the vessel depends on the radius of the bend, the speed of the vessel, wind forces, the flow pattern and the loading of the vessel. The drift angle is larger for vessels traveling in the downstream than the upstream direction. The drift angle is inversely proportional to the bend radius 'R', that is, the larger the radius the smaller the value of drift angle. Unloaded ships normally subjected to more drift and consequently take up a greater width in bends than loaded ships and therefore the proposed allowance at the keel level of the unloaded ships is larger than the loaded ships.

Dredging of Navigational Channel

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

- Lateral marks, to mark the left and right sides of the navigation route to be followed by navigator;
- Bifurcation marks, to mark the middle ground between the navigation channel, bifurcated channel and isolated dangers in the middle of the navigational channel;

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

1.4.3 IWT Terminal Planning

The terminal planning and design includes selection of suitable sites in the vicinity of cargo potential considering all the relevant technical variables such as choosing the type of berthing facility and providing of covered/open storage facility, cargo handling systems and other ancillary facilities required for efficient terminal operation. Based on the projected traffic, the selection of various facilities shall be planned. The cost estimate including capital and operating costs shall be estimated for each of the proposed system considering the design. These above aspects are briefly explained in the following subsequent sections.

Planning Considerations

The terminal facilities proposed for this project shall include the following:

i) Berthing Facilities for vessels;
ii) Cargo Storage Facilities;
iii) Cargo Handling Facilities;
iv) Other ancillary Facilities.

Terminal Facilities

The type of cargo handling system required at the terminal is generally dependent on the type of cargo, the annual volume required to be handled and the size of the vessels.

The various type of cargo foreseen to be handled at the proposed IWT Terminals are primarily grouped into:

i) Incoming Cargo, and
ii) Outgoing Cargo.

These above two groups are further subdivided into bulk, bagged and other miscellaneous general cargo for the purpose of planning the cargo handling equipment. The quantum and other cargo compositions shall be based on the traffic study. The same may be classified as below:

- Bulk Cargo - Construction materials such as Sand, stone, bricks, Marble, Iron steel, Machinery – Light, Heavy and ODC, Mineral Ore such as coal, lime stone, iron, fly ash, copper ore etc., bamboo, etc.
- Bagged Cargo - Cement, Fertilizer, wine and beverages, acids, cereals, cash crops, wheat, rice, Bajra, gram, pulses, cotton, etc.
- Misc. General Cargo – Consumer goods, animals, oil cake, edible oil, refined oil, paper products, jute products, etc
- Ferry – Passenger vessels for Tourists

1.4.4 Identification of IWT Terminals

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

- Water availability near the terminal land throughout the year especially during lean season;
- Stable river channel with sufficient depth;
- Favourable hydraulic conditions for berthing and cargo handling;
- Availability of terminal land for infrastructure, cargo storage and handling;
- Traffic potential and cargo characteristics; and
- Navigational safety.

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

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

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

Other Alternatives to Improve for Navigation

Based on our earlier study for Ganga River between the reach from Allahabad to Ghazipur, there are many methods available to improve river navigation. Bandalling work – it has to follow closely falling stage of river, closing minor channels and diverting river flow in single channel to increase depth in the navigable channel in mainly due done by bandalling. In some reaches this method becomes successful but some river stretches remain shallow and need other training measures including dredging. Channelization of river and Construction of barrages at suitable locations, creating ponding conditions with required depth and navigational locks for ships and vessel movement shall be studied. The examination of various options/measures to improve the water depth shall be studied. The most suitable method for development shall be identified with consideration on the likely morphological, sediment transport, and dredging aspects of different options. This task is expected to be fed back into from the financial and economic analysis providing refinement to the proposed development until a recommended solution is reached. The most appropriate type of river development including drudging option along the river shall be identified and likely impacts of these developments on river flow depths as well as sedimentation and morphology shall be investigated. This analysis will constitute an iterative process in which problems relating to LAD will be addressed to find more successful solutions where necessary. This will however, not be an open-ended process as the assessment of techno-economic feasibility updation only requires an indication of the likely costs of building and maintaining the structures which are shown to support achievement of LAD as intended.

1.4.5 Rapid EIA

Suitable Rapid Environmental Impact Assessment shall be performed and report shall be included in final DPR. The Rapid EIA Studies can be broadly divided in to three phases.

- The first phase involves identification of significant environmental components in the area where the project is located and assessing their baseline (pre-project or existing) status within the study zone. In case of existing projects, environmental performance of existing manufacturing / pollution control plants is also required to be covered.
- The second phase involves prediction of impacts on various identified significant environmental parameters due to proposed project.
- The third phase includes the evaluation of final impacts and delineation of an Environmental Management Plan to mitigate adverse impacts on the quality of surrounding environment.

1.4.6 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. Floating Pontoon platforms, Gangway, jetty, approach to jetty, bank protection, covered and open storage, roads, office, sentry hut, boundary wall, bank protection, bunkering facility, water facility, turning circle for IWT vessels location of depth contours of 2m and 2.5m in the river near the terminal sites. Preliminary engineering design and drawings for setting up of terminals with related facilities including mechanical loading/ unloading at the proposed sites shall be prepared. Also inter modal cargo transfer facilities required at these terminals shall be indicated.

1.4.7 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. The Net Present Value (NPV) with interest and depreciation, IRR and preliminary expenses shall be suitably considered and estimated. Break-even analysis shall be performed and presented in the report.

1.4.8 Implementation & Monitoring Mechanism

Project financial structuring shall be worked out in detail which will examine the sources and composition of funding for the project. The Project financial structuring can involve a combination of equity, grant, debt and finance from private participation (and in some cases, contribution from user communities). The scope and options for possible debt and private sector financing shall be reviewed elaborately and presented in the report. The suitable monitoring mechanism shall be evolved

2.0 WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1 HYDROGRAPHIC SURVEY

As detailed above, the National Waterway stretch of Rupnarayan river under DPR study is from Geonkhali at Lat 22°12'42.08"N, Long 88° 3'0.79"E to Mankur at Lat 22°30'27.84"N, Long 87°53'28.58"E. The total length of this stretch is about 45 Km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Rupnarayan waterway comprises of:

- 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 Jetty/ Terminal locations.

2.1.1 Waterway in General and Hydro-Morphological Characteristics

The 45 Km stretch of Rupnarayan National waterway proposed for DPR study lies from Geonkhali (22°12'42.08"N, 88° 3'0.79"E) to Mankur (22°30'34.46"N, 87°53'31.43"E). Whole stretch of Rupnarayan waterway from Geonkhali to Mankur Jetty is having tidal influence with a maximum tidal variation of 4.03 m near starting point of the waterway (i.e. Geonkhali Jetty) to a minimum tidal variation of 0.91 m at Chainage of 45.0 Km near Mankur Jetty.

River width in the waterway stretch varies from 3.3 Km near Tamluk and Ghadiara Jetty to about 400 m near Mankur Jetty. Reduced depth at every 1 Km intervals are provided in **Annexure 2**.

Average flow velocity in the waterway varies from 1.243 m/sec at Chainage 2.75 Km to about 0.173 m/sec at Chainage 39.04 Km.

Two railway and three road bridges are located along the waterway stretch crossing waterway near Kolaghat from Chainage 35.3Km to 35.762Km. The horizontal clearance (clear distance between piers) of the bridges varies from 18 m to 54 m and vertical clearance from 3.67 m to 4.955 m w.r.t MHWS (m).

The Rupnarayan river network are bordered by Hooghly district in the East, Purulia and Bankura in the West and East, West Midnapore district in the south and Bardhaman district in the North. The detail of its catchment is follows:

Rupnarayan River is a combination of number of streams. The tidal reach below confluence of Dwarakeswar and Shilabati Rivers is known as Rupnarayan. It outfalls into Hooghly near Geonkhali of Purba Medinipur (Gadiara of Howrah) after receiving main flow of Damodar through Mundeswari and that of Kangsabati though Durbachaty and Polashpai rivers. Apart from those, there are various local drainage channels and khals which directly outfall into Rupnarayan from its both banks in the district of Purba Medinipur (Chandreswar, Dehaty, Soadighi, Shankrara, Pratapkhali etc.) and Howrah (Bakshi khal). The river is tidal throughout its entire course. The catchment area of this Sub-basin is 9,525 sq.km (catchment area of Silabati 4088 sq.km + Dwarakeswar 4292 sq.km + Rupnarayan 1145 sq.km).

Significance of the River: Rupnarayan River is an important source of fishing in West Bengal and is one of the major sources of the famous Hilsa fish which is used as a delicacy in Bengali cuisine. The West Bengal Power Development Corporation also hosts a thermal power plant on the banks of this river in Kolaghat. Most of the people inhabiting this river basin depend on agriculture for their source of livelihood. At the confluence of the Rupnarayan River with the Hoogly River, several industries like chemical and oil factories are located on the banks of this river.

Geography, Habitat and Eco-system: The Rupnarayan River flows through primarily three types of topography the Purulia High Plains in its upper reaches, the Rarh Upland in its middle reaches and finally the riverine deltaic region in its lower course. The Rupnarayan River basin usually receives regular and heavy rainfall over a large section of its course with the exception of the Dwarakeswar River which receives scanty rainfall even during the monsoons. The Rupnarayan River flows through large areas of densely populated lands and agricultural fields with very little surviving native vegetation.

Geomorphological Features: The Physiographic zones through which Rupnarayan and its tributaries has flowed includes the Purulia High Plains, The Rarh Upland and the Riverine Delta.

Meteorological Characteristics: The entire basins of Rupnarayan fall within the sub humid west. Heavy and regular rainfall is observed in the Rupnarayan basin though in the banks of Dwarakeswar, the climate is dry and occasional rainfall is received even during the monsoon season.

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 newly established BM, RN-01 and simultaneously 4 hour observation were carried out at RN -2, RN -03, RN-04 & RN-05 BM's and data was logged in rinex format which was post processed in Auspos and Spectra software and value of BMs w.r.t. MSL were obtained.

Also sounding datum was transferred from Diamond Harbor. The 45 Km stretch of Rupnarayan waterway was divided into 10 km stretches for ease of applying Tidal level corrections to the collected bathymetric data. The values of BM's w.r.t sounding datum were established by using few hour observation methods in accordance with Admiralty Manual of Hydrographic Surveying Vol 2. However, 48 hours observation has been undertaken and result found to be approx same. The calculation are given in the para 2.6.1 of **Volume-IIIA (Hydrographic Survey Report).** Total Five (5) number of BM's pillars (naming RN-01, RN-02, RN-03, RN-04 & RN-05) were constructed and erected along the river from Geonkhali to Panitras.

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 SD (m)	Height above MSL (m)
RN-01	Geonkhali (Natsal)	0.47	22°12'23.001"	88°02'41.677"	607704.065	2456042.842	6.856	4.873
RN-02	Tutabedria	12.00	22°15'15.720"	87°56'48.906"	597569.618	2461287.582	6.598	4.629
RN-03	Anantpur	19.27	22°19'21.558"	87°57'28.306"	598649.480	2468854.273	6.036	4.490
RN-04	Gopinathpur	26.77	22°23'30.434	87°56'56.456"	597690.017	2476501.578	5.820	4.305

BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above SD (m)	Height above MSL (m)
RN-05	Panitras	41.00	22°28'33.923	87°54'19.116	593134.513	2485806.25(	4.931	4.750

2.1.3 Chart Datum / Sounding Datum

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

Table 3: Chart Datum/Sounding Datum and Reduction Details

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. (+ve indicates above MSL, -ve indicates below MSL)	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	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
1	Geonkhali (Natsal)	0.47	0.0 to 5.0	-1.983	-1.983	Tide Applied w.r.t SD	1.983
2	Tutabedria	12.00	5.1 to 15.0	-1.969	-1.969		1.969
3	Anantpur	19.27	15.1 to 25.0	- 1.546	- 1.546		1.546
4	Gopinathpur	26.77	25.1 to 35.1	-1.515	-1.515		1.515
5	Panitras	41.00	35.1 to 45.0	-0.181	-0.181		0.181

2.2 EXISTING CROSS STRUCTURES

2.2.1 Bridges

Table 4: Details of Bridges along the Waterway

Sr. No.	Structure Name and for road / rail	Chainage (KM)	Type of Structure (RCC / Iron/ Wooden)	Location	Position (Lat/Long)		Position (UT M)		Length (m)	Width (m)	No of Pillars	Horizontal clearance (clear distance Between pillars) (m)	Vertical clearance w.r.t. MHWS (m)	Remarks (complete/ under- construction),in use or not, condition
					Left Bank	Right Bank	Left Bank	Right Bank						
1	Railway Bridge	37.7	Iron	Kolaghat	22° 26’ 05.21 087° 53’ 00.09	22° 26’ 23.25 087° 53’ 20.33	2 481 220N 590 903E	2 481 778N 591 478.5E	800	6.22	10	34	4.955	In Use
2	Railway Bridge	37.9	Iron	Kolaghat	22° 26’09.68 087° 52’ 55.44	22° 26’ 28.04 087° 53’ 15.40	2 481 357N 590 769.4E	2 481 924N 591336.8E	800	12.4	10	34	4.071	In Use
3	Road Bridge	38.2	RCC	Kolaghat	22° 26’09.40 087° 52’ 42.6	22° 26’ 32.55 087° 53’ 08.57	2481346N 590404.3E	2 482 062N 591 140.7E	1027	14	18	54	4.306	In Use
4	Road Bridge	38.25	RCC	Kolaghat	22° 26’09.95 087° 52’42.13	22°26’32.84 087° 53’07.28	2481363N 590388.9E	2 482 071N 591 119.2E	1017	11	24	18	4.63	Not in Use (Old)
5	Road Bridge	38.3	RCC	Kolaghat	22° 26’10.75 087° 52’41.43	22° 26’32.88 087° 53’ 08.22	2481387N 590368.9E	2 482 072N 248 2072E	1015	12.9	18	54	3.67	In Use

Note: - From field observation Bridge clearance over MSL has been worked out. The value of MHWS and Mean Sea Level was taken from KPT Tide book and the difference has been taken as correction. Our field observations thereby arrived at clearance under the bridge over MHWS level in those locations. Photographs of existing bridges are provided in **Annexure 5.**

2.2.2 Electric Lines / Communication Lines

One (1) no. of high tension line is located along the waterway. The detail of this high tension line is provided in **Table 5** below.

Table 5: Detail of High Tension Lines

Sr. No.	Type of Line	Chainage (KM)	Location	Position (Lat/Long)		Position (UT M)		No. of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. MHWS (m)	Remarks (complete/ under-construction)
				Left Bank	Right Bank	Left Bank	Right Bank				
1	High Tension Line	34.40	Orphuli	22°26'05.145 087°53'41.315	22°26'05.845 087°53'42.070	2481224.794 592081.512	2481246.431 592102.966	4	417.844	36.378	Complete

2.2.3 Pipe Lines / Cables

No cross-structures, pipe lines, underwater cables are located along the 45 Km stretch of Rupnarayan waterway.

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

No Dam, Barrage, Weir or any other cross structure was located along the 45 Km stretch of waterway. All Water Lock gates are on the water drains/ tributaries/inflows into the rivers of Rupnarayan River. No lock gates were observed across the waterway.

2.3 BENDS

No sharp bend is located along the waterway during bathymetric survey. However, gentle bends are proposed for the navigational channel.

2.3.1 Radius of Curvatures

Average radius of curvature along the fairway is 800.0 m.

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 6**.

Table 6: Current Meter and Discharge Details

Stretch No.	Chainage (Km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area (sq. m.)	Discharge (cu. m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
1	2.75	22°13'12.181"	88°01'27.202"	605 561.300	2 4575 40.600	8.7	1.39	1.26	1.08	1.243	3440.8	4276.91

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	11.82	22°15'13.547"	87°56'59.172"	597 863.900	2 461 222.600	10.7	1.14	1.05	0.92	1.037	1002.7	1039.79
3	23.04	22°21'26.839"	87°57'22.660"	598 463.500	2 472 705.700	3.5	0.79	0.46	0.38	0.543	394.5	214.21
4	34.59	22°25'50.393"	87°53'20.365"	591 485.300	2 480 767.600	5.9	0.83	0.78	0.64	0.75	385.1	288.82
5	39.04	22°28'02.269"	87°53'07.591"	591 096.200	2 484 820.700	3.5	0.19	0.17	0.16	0.173	461.2	79.79

2.5 WATERWAY DESCRIPTION

The total 45 Km stretch of Rupnarayan Waterway under DPR study, can be broadly divided in to four (4) stretches in accordance with the river gradient. **Table 7** below provides the details of sub-stretches of Rupnarayan waterway.

Table 7: Sub-Stretches of Rupnarayan Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Geonkhali	Tutabedria	0 Km	10 Km
2	Tutabedria	Anantpur	10 Km	20 Km

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
3	Anantpur	Gopinathpur	20 Km	30 Km
4	Gopinathpur	Mankur	30 Km	45 Km

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

2.5.1 Sub Stretch 1: From Geonkhali to Tutabedria (Chainage 0 Km to 10 Km)

Bathymetric and Topographic Survey was carried out for Sub-Stretch 1 (Chainage 0 Km to 10 km) of Rupnarayan river. The starting Chainage of waterway is at the confluence point of River Rupnarayan with Hooghly River. This sub-stretch of waterway is considerably wide with bank to bank clear distance of approximately 3 Km at some sections. Also, the river bank is protected at some sections in this sub-stretch.

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

- No overhead obstructions/crossovers located in this section.
- No Prominent dams & Barrage available in this stretch.
- The tidal range is 4.0 m to 3.5 m in this stretch from Chainage 0.0Km to 10Km.
- There is no hindrance or encroachment in this stretch.

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

Figure 3 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 10.0 Km) of Rupnarayan Waterway. The quantity of dredging required for this stretch is provided in **Table 8**. **Figure 4** shows the observed and reduced bed profile of sub-stretch 1.

Table 8: Dredging Quantity (cum) for Sub-Stretch 1

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
I	0	10	Not Applicable (Tidal Zone)				-0.22	10.9	5666	66258
II	0	10					-0.22	10.95	5676	131860.3
III	0	10					-0.22	10.95	5866	258707.5

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
IV	0	10					-0.22	10.95	6300	353066.5
2.5 draft x 30m bottom width	0	10					-0.22	10.95	6900	347127.5
VI	0	10					-0.22	11.04	6900	934545.88
VII	0	10					-0.22	11.04	6900	1152064.9

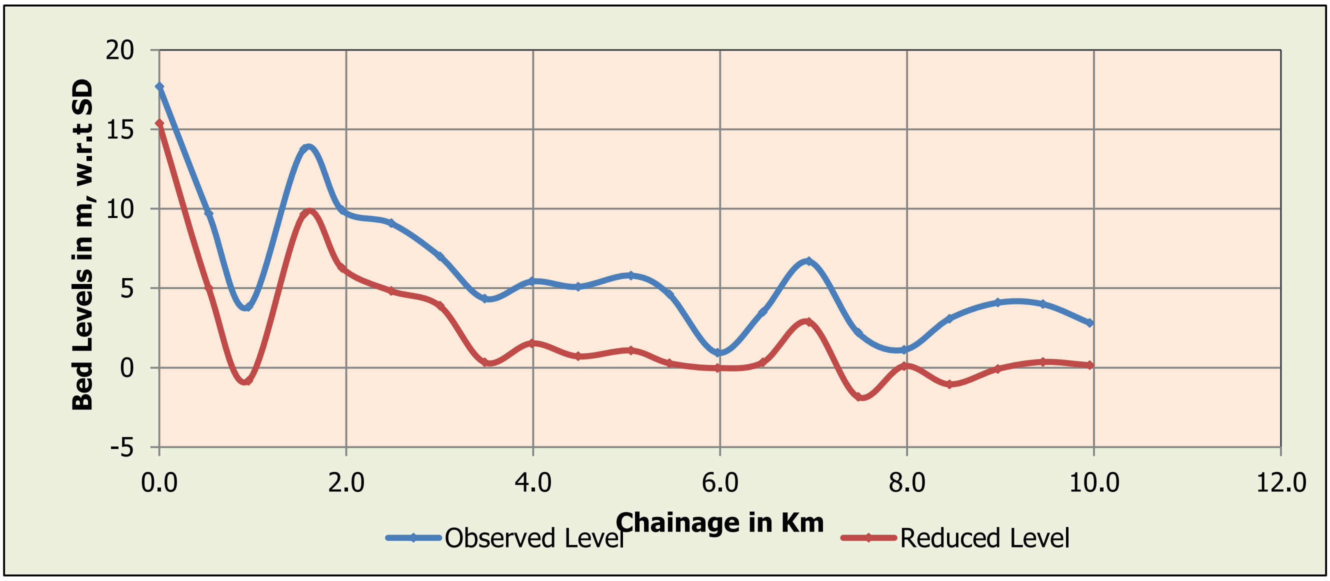


Figure 4: Bed Profile of Rupnarayan Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

	
Geonkhali Ferry Ghat	Gadiara Ferry Ghat

Figure 5: Photographs of Ferry Ghats located in sub-stretch 1

2.5.2 Sub Stretch 2: From Tutabedria to Anantpur (Chainage 10 Km to 20 Km)

Both Bathymetric and Topographic Survey was carried out for this sub-stretch 2 (Chainage 10 Km to 20 Km) of the Rupnarayan waterway. The water depth is less as compare to sub-stretch 1. There is a shallow patch of approximately 3.0 Km length, where bathymetric survey was not possible during normal flow conditions, however, navigation is possible during high tide near to the river left bank considering available tidal variation of maximum 3.5 m to minimum 2.2 m between low and high tides. There are also many brick factories on both the banks in this sub-stretch 2. Fishing and rice farming are main source of livelihood & the fields in this area are dependent on the rainfall. This stretch is considerably wide to about 2.0 Km with some portion of the river bank as protected. The details of current and discharge at different depths are provided in Table 6.

Figure 6 below shows the alignment of Sub-stretch 2 (Ch. 10.0 Km to 20.0 Km) of Rupnarayan Waterway.

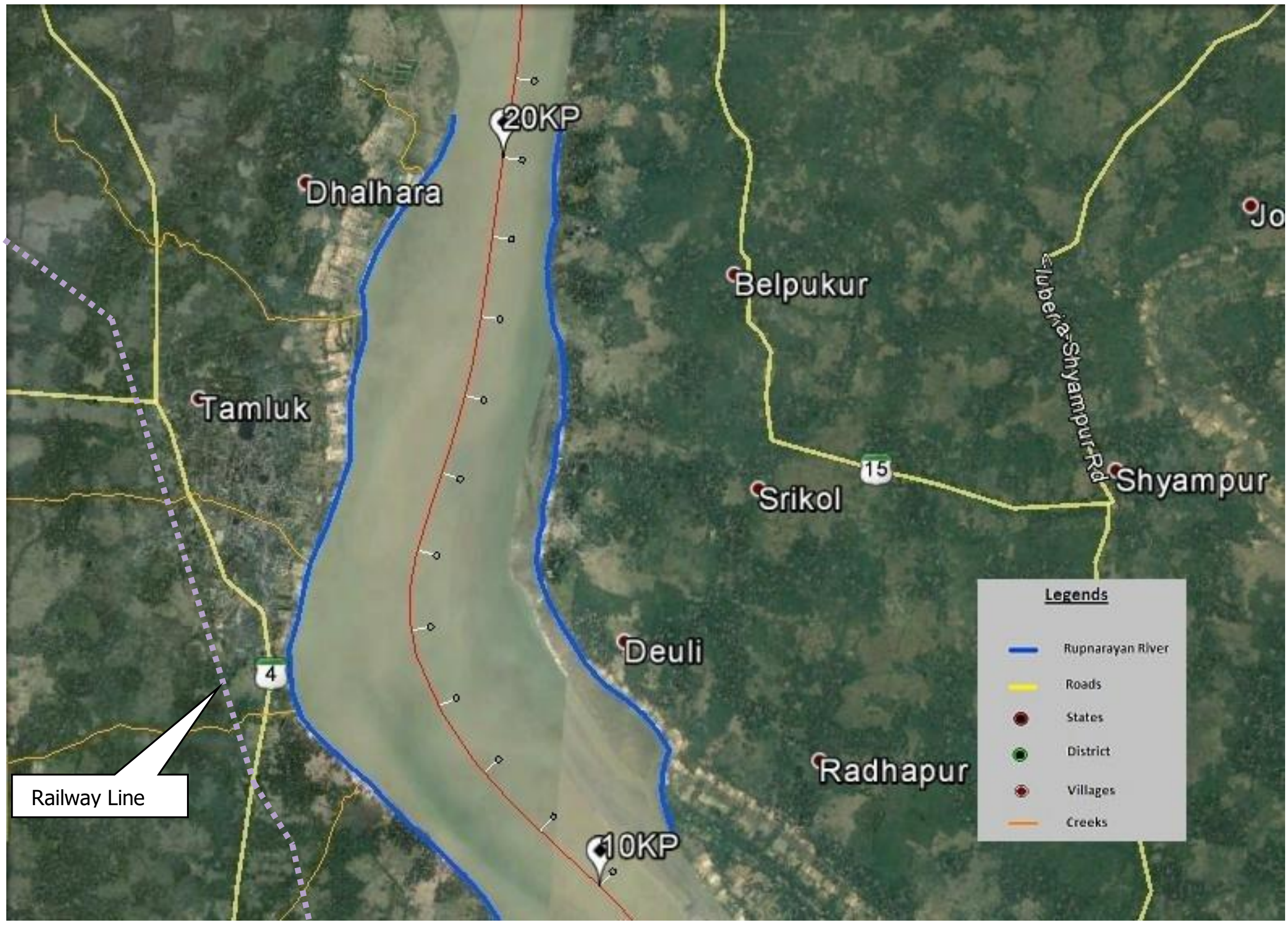


Figure 6: Google Image showing Sub-Stretch -2 of Rupnarayan Waterway

Following are the observations made during survey of Sub-stretch 2: From Tutabedria to Anantpur (Chainage 10 Km to 20 Km):

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no cross-structures like dams, barrage, weirs etc. available in this stretch.
- The tidal range is 3.5 m to 2.2 m in this stretch from Chainage 10.0Km to 20Km.
- There are ferry services between Tamluk to Amberia on this stretch of Rupnarayan River.

The quantity of dredging required for this stretch is provided in **Table 9** . **Figure 7** shows the observed and reduced bed profile of sub-stretch 2.

Table 9: Dredging Quantity (cum) for Sub-Stretch 2

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
I	10	20	Not Applicable (Tidal Zone)				-0.75	6.46	3966	91099.7
II	10	20					-0.77	6.46	4400	116190.3
III	10	20					-0.77	6.46	6220	259329.7
IV	10	20					-0.77	6.46	7700	375166.5
2.5 draft x 30m bottom width	10	20					-0.77	4.82	8850	387500.3
VI	10	20					-0.77	6.46	9320	1115646.12
VII	10	20					-0.77	6.46	9320	1335237.3

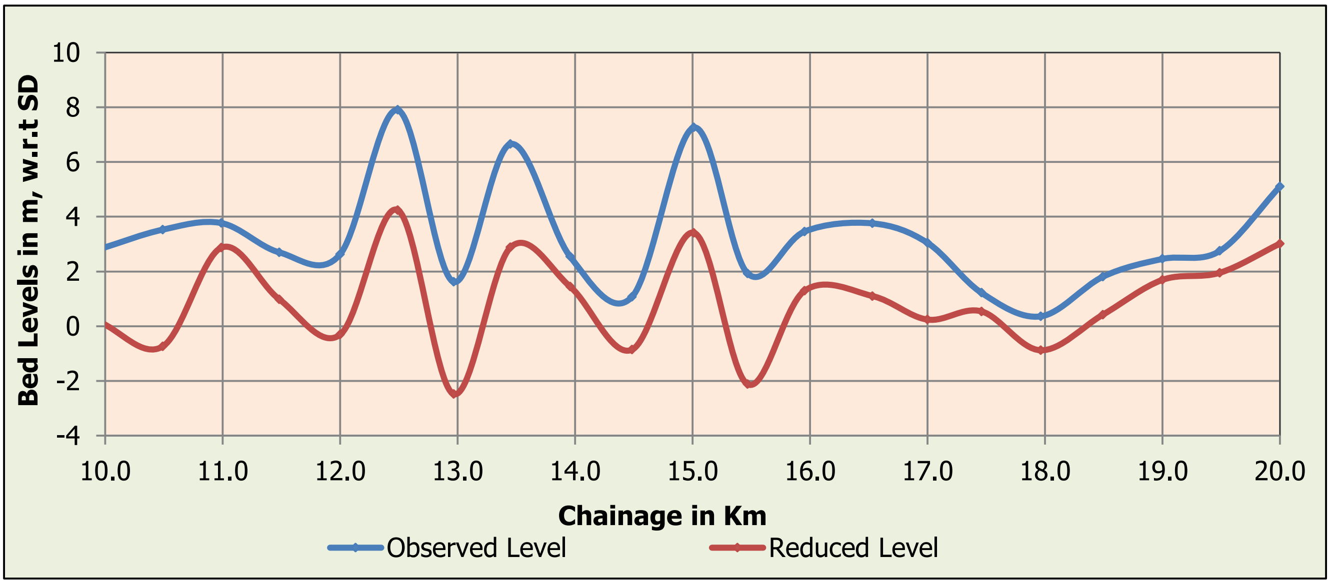


Figure 7: Bed Profile of Rupnarayan Waterway Sub-stretch 2 (Chainage 10Km – 20Km)

	
Tamluk Ferry Ghat	Bank Protections

Figure 8: Photographs of Sub-stretch 2

2.5.3 Sub Stretch 3: From Anantpur to Gopinathpur (Chainage 20 Km to 30 Km)

Bathymetric and Topographic Survey was carried out for this sub-stretch 3 (Chainage 20 Km to 30 Km) of Rupnarayan river. The water depth is also less as compare to stretch 2. Navigation is possible during high tide near to the river Right bank considering available tidal variation of maximum 2.2 m to minimum 1.5 m between low and high tides. River banks are partially protected. Soil erosion found at some areas. There are also many brick factories on both the banks. Fishing and rice farming are main source of livelihood & the fields in the area are dependent on the rainfall .This stretch is considerably wide to about 2.0 Km with some portion of the river bank as protected.

Following are the observations made during survey of Sub-stretch 3: From Anantpur to Gopinathpur (Chainage 20 Km to 30 Km):

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no cross-structures like dams, barrage, weirs etc. available in this stretch.
- The tidal range is 2.2 m to 1.5 m in this stretch from Chainage 20Km to 30Km.
- There are no ferry jetties available in this stretch however fishermen use the natural slope of the ground for landing the boats.

Figure 9 above shows the alignment of sub-stretch 2 (Ch. 20.0 Km to 30.0 Km) of Rupnarayan Waterway. The quantity of dredging required for this stretch is provided in **Table 10**. **Figure 10** shows the observed and reduced bed profile of sub-stretch 3.

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

Table 10: Dredging Quantity (cum) for Sub-Stretch 3

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
I	20	30	Not Applicable (Tidal Zone)				-0.78	3.33	6112	124757.1
II	20	30					-0.78	3.33	6350	244057.6
III	20	30					-0.78	3.37	7862	386499.1
IV	20	30					-0.78	3.37	9656	466094.4
2.5 draft x 30m bottom width	20	30					0.16	3.37	10000	487734.1

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
VI	20	30					-0.107	3.39	10000	1364698.96
VII	20	30					-0.107	3.39	10000	1715151.73

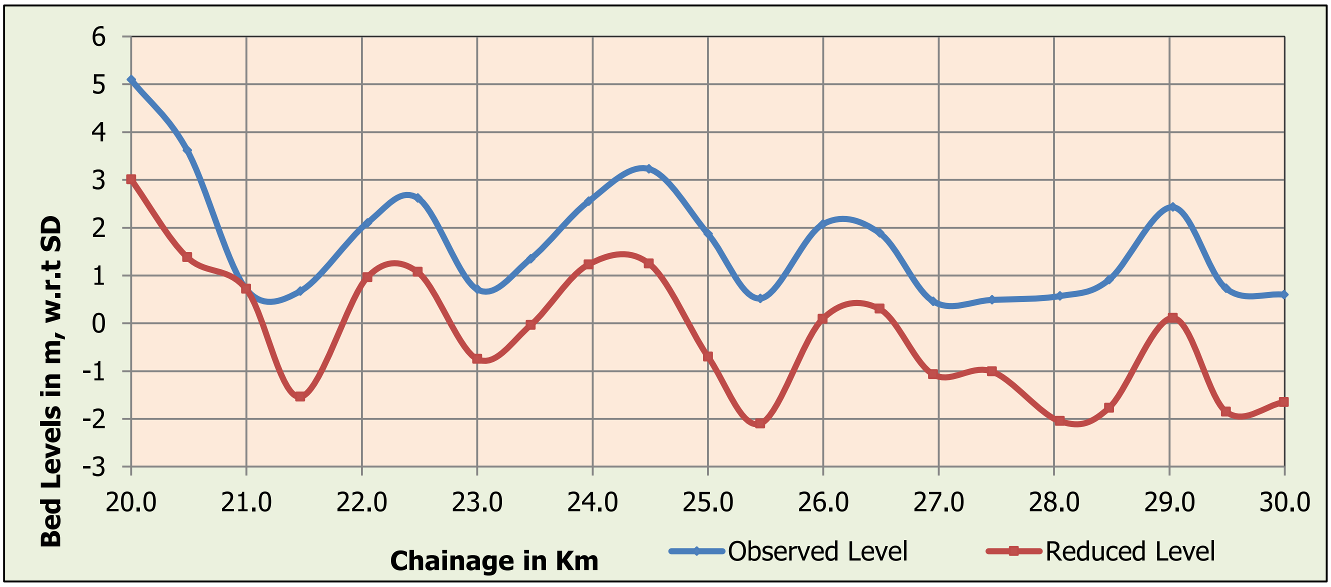


Figure 10: Bed Profile of Rupnarayan Waterway Sub-stretch 3 (Chainage 20Km – 30Km)

Brick Kiln

Soil Erosion

Figure 11: Photographs along Sub-Stretch 3

2.5.4 Sub Stretch 4: From Gopinathpur to Mankur (Chainage 30 Km to 45 Km)

Bathymetric and Topographic Survey was carried out for this sub stretch 4 of Rupnarayan River from Chainage 30 Km to 45 Km. The water depth in this sub-stretch is less as compare to sub-stretch 3. Navigation is possible during high tide considering available tidal variation of maximum 2.2 m to minimum 1.5 m between low and high tides. There is shoal of approximately 8Km in this stretch. There are also many brick kilns located on both the banks of this sub-stretch. Fishing and rice farming are main source of livelihood & the fields in the area are dependent on the rainfall.

This stretch is considerably wide to about 2.0 Km with some portion of the river bank as protected. The details of current and discharge at different depths is provided in **Table 6**.

There are three Road bridges, two Rail Bridges and one High Tension wire line located across the river from Chainage 32.0 Km to 36.0 Km near Kolaghat. A telecommunication tower is also located at a Chainage 34.50 Km on the right bank of this stretch.

Following are the observations made during survey of Sub-stretch 4: From Gopinathpur to Mankur (Chainage 30 Km to 45 Km):

- There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.
- There are no cross-structures like dams, barrage, weirs etc. available in this stretch.
- The tidal range is 2.2 m to 1.5 m in this stretch from Chainage 30 Km to 45 Km.
- There are no ferry jetties available in this stretch however fishermen use the natural slope of the ground for landing the boats

Figure 12 above shows the alignment of sub-stretch 4 (Ch. 30.0 Km to 45.0 Km) of Rupnarayan Waterway. The quantity of dredging required for this stretch is provided in **Table 11**. **Figure 13** shows the observed and reduced bed profile of sub-stretch 4.

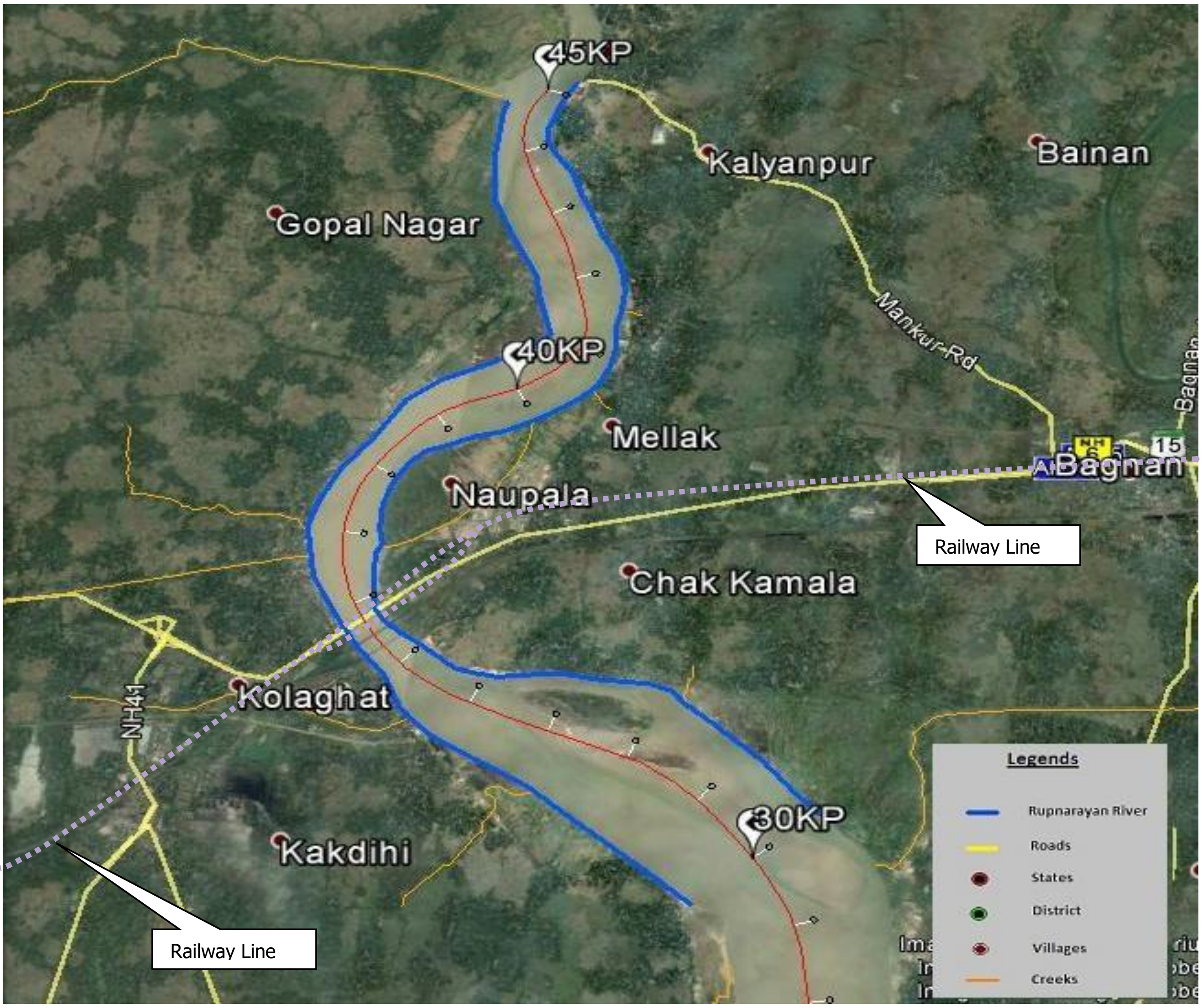


Figure 12: Google Image showing Sub-Stretch -4 of Rupnarayan Waterway

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
I	30	45	Not Applicable (Tidal Zone)				-1.19	5.91	9440	241662.7
II	30	45					-1.19	5.93	10600	415017.6
III	30	45					-1.19	6.22	10800	653908.1

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cum)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cum)
IV	30	45					-1.19	6.22	10800	859987.7
2.5 draft x 30m bottom width	30	45					-1.19	6.22	10600	876235.6
VI	30	45					-1.19	6.22	10700	2392343.88
VII	30	45					-1.19	6.22	10700	2923415.8

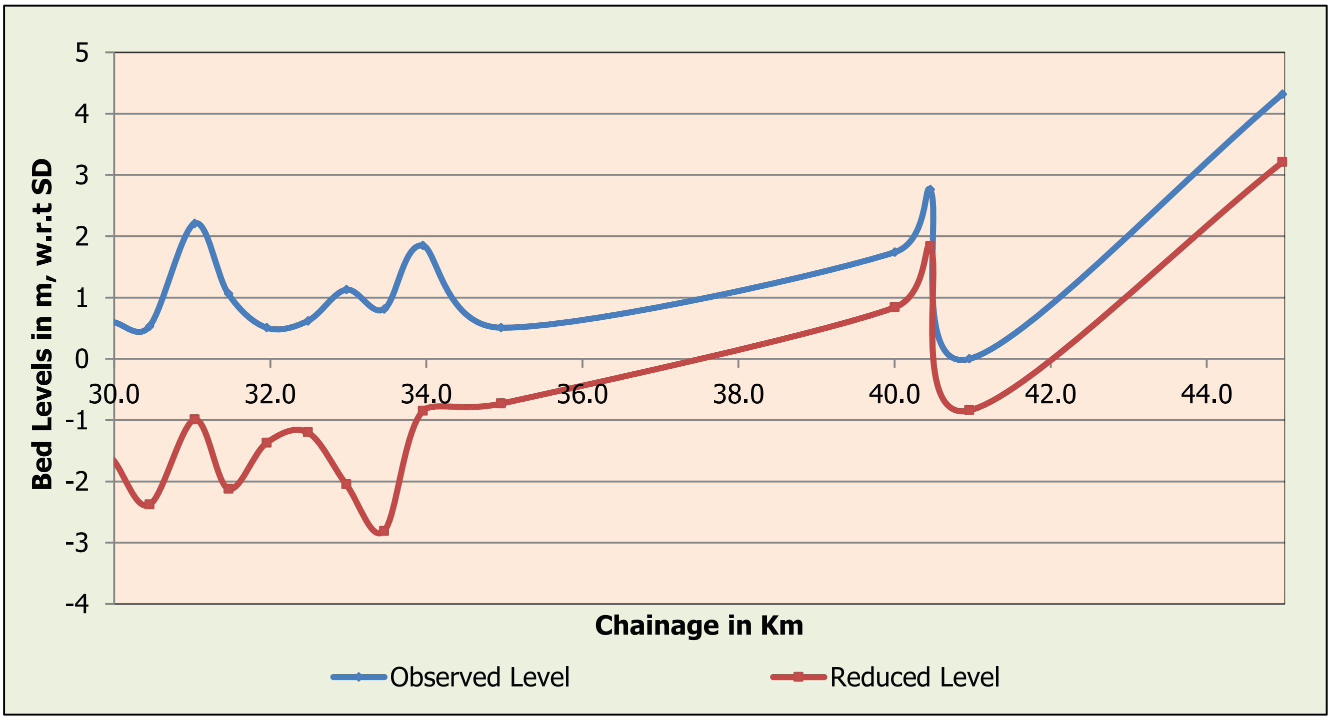


Figure 13: Bed Profile of Rupnarayan Waterway Sub-stretch 4 (Chainage 30Km – 45Km)

	
Rupsai Rupnarayan Resort	Overhead water tank

Figure 14: Photographs along sub-stretch 4

2.6 WATER AND SOIL SAMPLES ANALYSIS AND RESULTS

River bed Soil and water samples were collected using Vanveen Grab & Niskin type sampler at respective locations. The samples were collected at one location each in the river stretches. The location and depth of the collected samples are appended in **Table 12.**

Table 12: Soil Sample Locations

Sample No	Chainage (Km)	Latitude	Longitude	Easting (m)	Northing (m)	Soil Sampling Depth (m)	Water Sampling Depth (m)
1	6.91	22°13'10.55"	87°58'41.69"	600822.8	2457459.0	2.82	1.41
2	15.84	22°17'29.09"	87°57'02.75"	597940.1	2465391.1	2.9	1.45
3	23.03	22°21'26.72"	87°57'22.43"	598457.0	2472701.9	3.4	1.70
4	32.90	22°29'27.88"	87°54'02.96"	592662.8	2487462.7	3.3	1.65
5	42.52	22°26'06.67"	87°54'54.53"	594174.2	2481284.3	1.7	0.85

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

Soil Samples

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

Water samples

- Sediment Concentration

Test result of samples is provided in **Table 13** and **Table 14**.

Table 13: Soil Sample Test Results

Sample No.	Chainage Range (Km)	Observed Depth (m)	Description	Particle Size Analysis				Specific Gravity	pH Value	Cohesive Strength of Uniformity (Cu)	Cohesive Strength of Curvature (Cc)
				By Sieve Analysis		By Hydrometer Analysis					
				Gravel (%)	Sand (%)	Silt (%)	Clay (%)				
1	6.91	1.41	Silty Sand with Clay	0	31	47	22	2.65	8.40	6.00	1.50
2	15.84	1.45	Sandy Silt	0	61	34	5	2.67	8.65	6.05	1.49
3	23.03	1.70	Silty Clay	0	6	48	46	2.63	8.59	6.00	1.50
4	32.90	1.65	Sandy Silt	0	48	43	9	2.66	8.73	6.79	1.33
5	42.52	0.85	Silty Clay	0	7	52	41	2.64	8.63	6.00	1.50

Table 14: Water Sample Test Results

Sample No.	Chainage (Km)	Observed Depth (m)	Sediment Concentration Test			
			Total Solid (mg/lit)		Suspended Solid (mg/lit)	
1	6.91	2.82	0	31	47	22
2	15.84	2.9	0	61	34	5
3	23.03	3.4	0	6	48	46
4	32.90	3.3	0	48	43	9
5	42.52	1.7	0	7	52	41

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 words 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 **1.4.1** and **Table 1** above.

From the detailed hydrographic survey, following observations are made:

a) No dams, barrage and any other cross-structure is located along the waterway.
b) No bridge and high tension line is located from Geonkhali to Kolaghat.
c) Depth of waterway varies from -1.19 m to 11.04 m w.r.t sounding datum in the waterway stretch.
d) Maximum and Minimum tidal variation is 4.03 m to 0.91 m in the waterway stretch.
e) Width of waterway varies from 3.3 km to 400 m.

As per the discussions with IWAI, Rupnarayan waterway from Geonkhali to Kolaghat is classified as Special Purpose Vehicle class of waterway with 2.5m depth w.r.t Sounding datum and 30.0 m bed width.

3.2 DETAILS OF SHOALS

Due consideration was given for shoals identified during the survey. **Table 15** below provides the details of shoals available along the Rupnarayan waterway during survey period.

Table 15: Details of Shoals

Chainage (km)		Length of Shoal (m)
From	To	
0	1	0
1	2	0
2	3	0
3	4	900
4	5	1000
5	6	1000
6	7	1000
7	8	1000
8	9	1000
9	10	1000
10	11	800
11	12	150
12	13	900
13	14	1000
14	15	1000
15	16	1000
16	17	1000
17	18	1000
18	19	1000
19	20	1000
20	21	1000
21	22	1000
22	23	1000
23	24	1000
24	25	1000
25	26	1000
26	27	1000
27	28	1000
28	29	1000
29	30	1000
30	31	1000
31	32	1000
32	33	1000
33	34	1000
34	35	800

The aids to navigation have to be provided at various shoals present in Rupnarayan waterway which creates hazards to safe navigation to vessel/ship plying in the river. The details of some prominent shoals that are encountered during navigation in the navigation channel of river have to be property marked for early warning to the navigator. It is also recommended to do capital and maintenance dredging for removing shoals made up of siltation in river bed for safe navigation.

3.3 PROPOSED CONSERVANCY ACTIVITIES

The complete 45 Km stretch of Rupnarayan waterway is under tidal influence zone. No major sharp curves or turns are located along the waterway path, thereby making development of a fairway easier. The river bed along the entire stretch is sandy/ clay in nature with isolated incident of small scale and conventional sand mining by the local peoples.

From Geonkhali to Kolaghat, waterway is navigable taking advantage of the tidal window with available draft of 2.5 m for vessel movement. However, as per IWAI requirement through-out the year 24 hour vessel operation dredging is required. Hence capital and maintenance dredging is recommended for achieving and maintaining the desired depth of 2.55m below SD from Geonkhali to Kolaghat.

3.3.1 Dredging

In order to make the waterway year round navigable the 45 Km stretch of Rupnarayan waterway dredging is a plausible solution. Design improvement measures and increase of channel depth by capital dredging is required in the first phase of the fairway development. Thereby, regular maintenance of waterway banks by adopting suitable bank protection measures and maintenance of fairway depth by maintenance dredging is required in the waterway.

Fairway Dimensions

Refer DPR Volume 3B: Hydrographic survey report for detailed calculation of dredging quantity.

As per discussion with IWAI, the waterway shall be developed as SPECIAL PURPOSE VEHICLE (SPV) from Geonkhali to Jamitya Jetty, Kolaghat, considering the river profile, channel condition, existing waterway traffic and anticipated vessel manoeuvring conditions. It is proposed to carry out the DPR studies on the basis of channel dimension with water depth of 2.5m below sounding datum and 30 m bottom width.

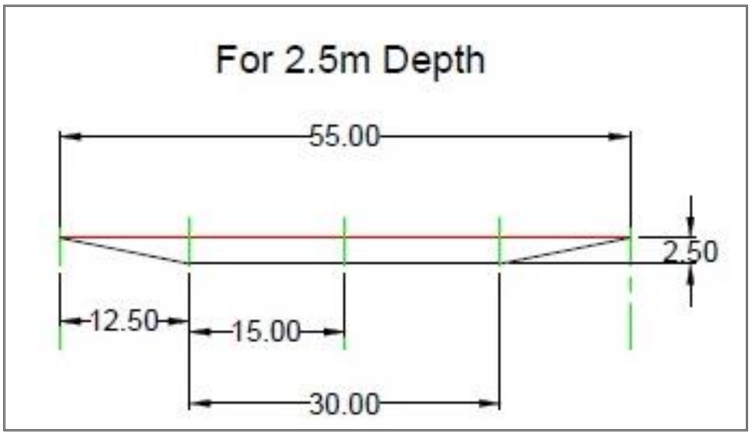


Figure 15: Fairway Dimension for Rupnarayan Waterway (2.5 m depth and 30m bottom width)

Figure 15 shows the channel dimensions proposed for Rupnarayan waterway. Dredging quantity estimated for above channel dimension is shown in below:

Table 16: Dredging Quantity of Rupnarayan Waterway for Proposed SPV channel dimensions

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				5.1	10.95	0	0	0.00
1	2					4.64	6.13	0	0	0.00
2	3	Tidal Zone				3.94	6.65	0	0	0.00
3	4					0.11	2.87	900	7513.06	7513.06
4	5					-0.22	0.88	1000	21171.78	28684.84
5	6					0.47	1.39	1000	87441.7	116126.54
6	7					0.72	1.36	1000	57976.27	174102.81
7	8					0.63	1.1	1000	53047.72	227150.53
8	9					0.44	3.1	1000	62159.4	289309.93
9	10					0.9	4.71	1000	57817.59	347127.52
10	11					1.23	4.82	800	11991.85	359119.37
11	12					1.3	6.46	150	15433.85	374553.22
12	13					0.39	4.04	900	1076.08	375629.30
13	14					-0.77	0.44	1000	15888.99	391518.29
14	15					-0.36	0.9	1000	76218.45	467736.74

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.
15	16					0.55	1.37	1000	107502.75	575239.49
16	17					0.98	2.93	1000	72624.64	647864.13
17	18					1.42	2.68	1000	53484.23	701348.36
18	19					1.43	2.46	1000	9457.49	710805.85
19	20					0.99	3.25	1000	23821.94	734627.79
20	21					1	3.37	1000	22143.08	756770.87
21	22					1.43	2.47	1000	14668.86	771439.73
22	23					1.46	2.36	1000	14105.09	785544.82
23	24					0.43	2.22	1000	13730.01	799274.83
24	25					-0.16	1.1	1000	13596.87	812871.70
25	26					-0.7	1.38	1000	50264.28	863135.98
26	27					-0.78	2.31	1000	86371.69	949507.67
27	28					-0.74	2.37	1000	107346.18	1056853.85
28	29					-0.7	1.22	1000	76934.25	1133788.10
29	30					-0.57	0.85	1000	88573.78	1222361.88
30	31					-0.89	1.51	1000	92945.86	1315307.74
31	32					0.56	1.81	1000	83934.27	1399242.01
32	33					0.6	1.24	1000	122379.37	1521621.38
33	34					0.76	1.4	1000	67073.58	1588694.96
34	35					0.43	3.92	800	55808.2	1644503.16

From the above table, the total dredging quantity for proposed waterway class and dimensions works out to 16,44,503.16 cum.

It is proposed to develop IWT in Rupnarayan waterway in two (2) phases as below:

In Phase-1:

- Dredging of 16,44,503.16 cum from Geonkhali to Jamitya Jetty, Kolaghat.
- Develop waterway Geonkhali to Jamitya Jetty, Kolaghat and Jamity Jetty/terminal for Dry Bulk Cargo Transportation

In Phase-2:

- Develop Noorpur, Gadiara, Geonkhali Jetty/Terminal for RO-RO/Passenger ferry services.

Disposal of Dredging Material

The dredged material is proposed to be dumped on low lying areas located on both sides of the river bank all along the waterway. The dredge material should be dumped providing gabion walls. The gabion walls should be adequately provided to prevent the dredged material to fall back in the waterway. **Figure 16** below shows the proposed location for dumping of dredged material. The proposed area has dumping capacity of about 25,83,000 cum with 1 m dumping height, which more than the required capacity of 16,44,503.16 cum.

Figure 16: Gogle imagery showing proposed dumping location for dredged material

Figure 17: Photograph showing arrangement of Gabion Wall along River Bank

Selection of dredging equipment

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 suit 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. Specifications of typical dredging equipment suitable to the waterway are indicated below:

- Length overall 20 m
- Width 4.1 m
- Dredging depth 6m
- Suction pipe 325 mm
- Discharge pipe 300 mm
- Installed capacity 350 kw
- Cutter power 50 kw
- H.P 500 BHP
- Draft 1 m
- Rated output with 500 m pipe line 200 cu m / hour

Number of dredgers Required

Considering cutter suction dredger with rated output of 200cum/hour, to be used for dredging in Rupnarayan waterway, following number of dredgers are required for dredging of 20,98,597.5 cum.

Sl. No.	Description	Quantity	Unit
1.0	Quantity of dredge material	16,44,503.16	cum
2.0	Output rate of CSD	200	cum/hr
3.0	Number of working hours per day	12	hr/day
4.0	Number of working days per month	30	days/month
5.0	Number of working month per year	12	months/year
6.0	Number of years considered for dredging	2	years

Sl. No.	Description	Quantity	Unit
7.0	Required numbers of dredgers	0.95	
	Proposed no. of dredgers	**1**	

3.3.2 River Training

No river training works is required in the Rupnarayan waterway stretch.

3.4 BANK PROTECTION / EMBANKMENT STRENGTHENING

Banks along the Rupnarayan waterway is mostly unprotected but stable. No bank protection measures are recommended for development of IWT in Rupnarayan WW.

3.5 NAVIGATION MARKINGS / NAVIGATION AIDS

The seasonal change in river morphology plays an important role for maintaining the navigation channel. As the navigation channel goes on shifting due to changes in river morphology depending on seasonal rainfall and runoff, specially untrained river like rupnarayan. 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.

3.5.1 Aids to Navigation for Inland Waterways

Aids to navigation and other communication facilities proposed along Rupnarayan waterway is provided in detail in Chapter 8 of the DPR.

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

As detailed in **Section 2.2** above, no dams, barrages, locks, weirs, anicuts or aqueducts are located along the waterway stretch from Geonkhali to Jamitya Jetty.

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

No dam/ barrage/ locks/ weirs is proposed.

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 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). The fairway development cost is estimated for development of Phase-1 and 2 separately.

3.9.1 BASIS OF COST

The basis of cost estimates worked out as per following:

a) Standard Schedule of Rates 2015-2016 of PWD, Govt. of West Bengal considered for various works;
b) Market surveys and enquires
c) Judgement based on Consultant's Experience

3.9.2 Capital Cost

As per IWAI tender no. IWAI/NW-86/1/2017-18 published on March, 2018, the total estimated cost for dredging along Rupnarayan waterway (NW-86) is INR 19.6 Crores. In view of this the total capital cost for dredging is considered as 19.6 Crore (INR 1960.00 Lacs) in this DPR.

3.9.3 O&M Cost

O&M cost for deredging is considered as 10% of capital cost. Thus O&M is taken as INR 1.96 Crore (INR 196.0 Lacs).

4.0 TRAFFIC STUDY

4.1 GENERAL

West Bengal is an Indian state, located in Eastern India on the Bay of Bengal. It is India's fourth-most populous state, with over 91 million inhabitants (as of 2011). It has an area of 34,267 sq mi (88,750 km^2). A part of the ethno-linguistic Bengal region, it borders Bangladesh in the east, and Nepal and Bhutan in the north; it borders five Indian states, Odisha, Jharkhand, Bihar, Sikkim and Assam. The state capital is Kolkata (Calcutta), the seventh-largest city in India. The geography of West Bengal includes the Darjeeling Himalayan hill region in its extreme north, the Ganges delta, the Rarh region and the coastal Sundarbans. The main ethnic group are the Bengalis, with Bengali Hindus forming the demographic majority.

According to the provisional results of the 2011 national census, West Bengal is the fourth most populous state in India with a population of 91,347,736 (7.55% of India's population). As of 2011, the total length of surface road in West Bengal is over 92,023 km (57,180 mi); national highways comprise 2,578 km (1,602 mi) and state highways 2,393 km (1,487 mi). As of 2006, the road density of the state is 103.69 km per 100 km^2 (166.92 mi per 100 sq mi), higher than the national average of 74.7 km per 100 km^2 (120 mi per 100 sq mi).

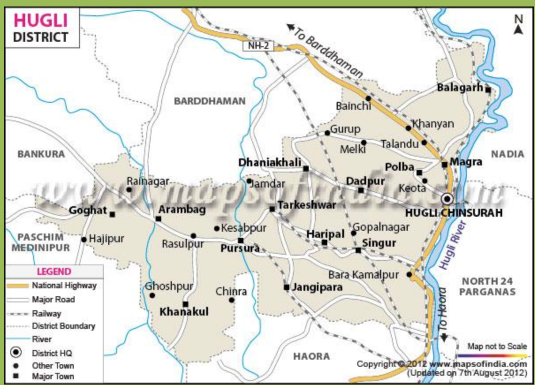
As of 2011, the total railway route length is around 4,481 km (2,784 mi). Kolkata is a major river-port in eastern India. The Kolkata Port Trust manages the Kolkata and the Haldia docks. There is passenger service to Port Blair on the Andaman and Nicobar Islands and cargo ship service to ports in India and abroad, operated by the Shipping Corporation of India. Ferry is a principal mode of transport in the southern part of the state, especially in the Sundarbans area. Kolkata is the only city in India to have trams as a mode of transport and these are operated by the Calcutta Tramways Company.

4.2 INFLUENCE AREA / HINTERLAND (WITHIN 25KM ON EITHER SIDE OF THE WATERWAY)

Rupnarayan River is one of the main rivers of West Bengal State. The Rupnarayan River has a length of nearly 72 km from Geonkhali (confluence of Rupnarayan and Hughli River) to Bondar (confluence of Dwarekeswar, Silabati and Rupnarayan River). The waterway stretch, recommended by IWAI for DPR study is from Geonkhali to Mankur Jetty having a length of 45 Km. However, on the basis of detailed survey and investigations and discussion with IWAI, 35 Km stretch of Rupnarayan waterway from Geonkhali to Kolaghat is considered for DPR studies.

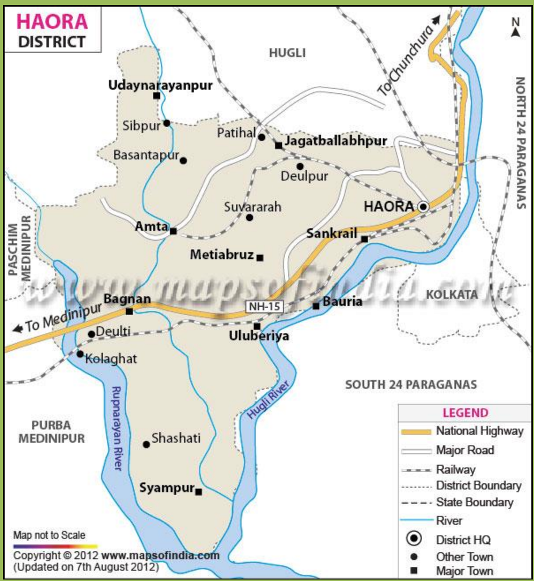
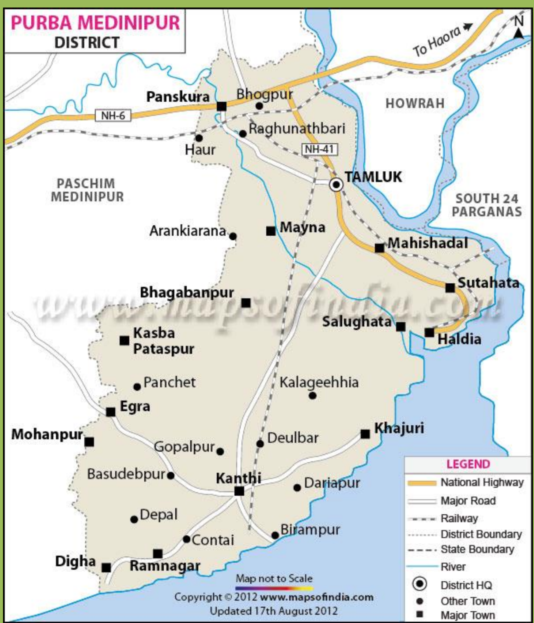
The Project Influence Area (PIA) (considering 25 Km stretch on either side of waterway) of the proposed development of Rupnarayan River stretches to five districts namely Paschim Medinipur, Purba Medinipur, Haora, Hughli and South twenty four Parganas. Total influence area/hinterland extending upto 25 Km on either side of waterway is provided in **Table 17**.

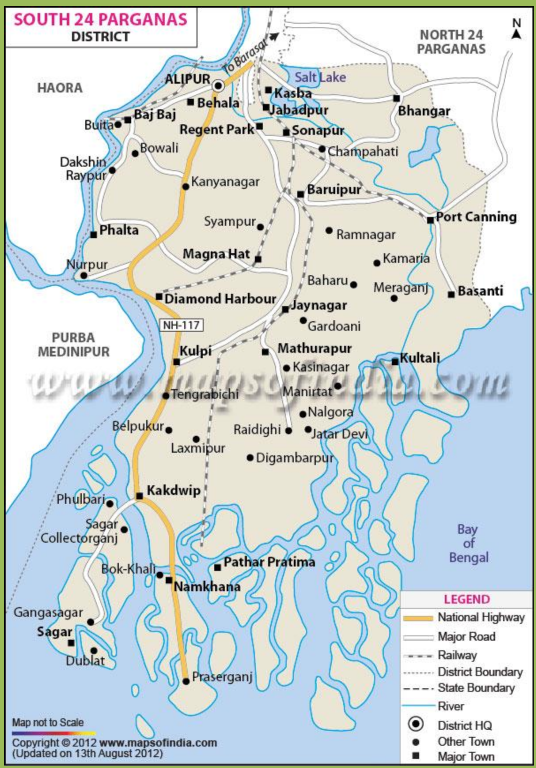
Table 17: Project Influence Area/ Hinterland (within 25 Km on either side of waterway)[1]

<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>Hughli

</td><td>3,149</td><td>Khanakul - II</td><td>121.84</td><td>121.84</td></tr>
<tr><td rowspan="2">Paschim Medinipur

</td><td rowspan="2">9,345</td><td>Daspur I</td><td>168.29</td><td rowspan="2">333.74</td></tr>
<tr><td>Daspur II</td><td>165.46</td></tr>
</table>

[1] District Census Handbook, 2011

District	Area (Km^2)	C.D. Block	Area (Km^2)	Total Hinterland area (Km^2)
Haora 	1,467	Amta - I	118.54	868.40
		Amta - II	137.46	
		Panchla	71.03	
		Bagnan - I	79.74	
		Bagnan - II	75.87	
		Uluberia - I	96.86	
		Uluberia - II	70.47	
		Shyampur - I	17.12	
		Shyampur - II	101.32	
Purba Medinipur 	4,736	Panskura	227.14	1,337.25
		Kolaghat	145.79	
		Moyna	158.69	
		Sahid Matangini	97.82	
		Tamluk	113.07	
		Nanda Kumar	165.70	
		Chandipur	137.58	
		Mahisadal	146.48	
		Sutahata	79.54	
		Haldia	65.44	
South 24 Parganas	9,960	Budge Budge - I	26.56	399.96
		Budge Budge - II	78.01	



District	Area (Km²)	C.D. Block	Area (Km²)	Total Hinterland area (Km²)
		Falta	130.68	
		Diamond Harbour - I	70.25	
		Diamond Harbour - II	94.47	
Total	**28,657**		**3,061**	**3,061**

4.2.1 Population of Hinterland area

Population of hinterland area of Rupnarayan waterway, within 25 Km on either side of waterway is provided in **Table 18** below:

Table 18: Population of Hinterland[2]

District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
Hughli	55,19,145	Khanakul - II	1,84,734	1,84,734
Paschim	59,13,457	Daspur I	2,03,987	4,42,516

[2] District Census Handbook, 2011

District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
Medinipur		Daspur II	2,38,529	
Haora	48,50,029	Amta - I	2,23,218	18,78,189
		Amta - II	2,08,132	
		Panchla	2,51,930	
		Bagnan - I	2,21,500	
		Bagnan - II	1,64,405	
		Uluberia - I	2,15,392	
		Uluberia - II	1,91,599	
		Shyampur - I	2,05,849	
		Shyampur - II	1,96,164	
Purba Medinipur	50,95,875	Panskura	2,83,303	20,96,510
		Kolaghat	2,90,124	
		Moyna	2,26,927	
		Sahid Matangini	1,99,210	
		Tamluk	2,17,776	
		Nanda Kumar	2,62,998	
		Chandipur	1,88,119	
		Mahisadal	2,06,277	
		Sutahata	1,23,784	
		Haldia	97,992	
South 24 Parganas	81,61,961	Budge Budge - I	1,12,908	9,01,570
		Budge Budge - II	1,92,134	
		Falta	2,49,561	
		Diamond Harbour - I	1,56,166	
		Diamond Harbour - II	1,90,801	
Total	**2,95,40,467**		**55,03,519**	**55,03,519**

4.2.2 Economic Profile of Hinterland

The hinterland of proposed stretch of Rupnarayan waterway includes Hughli, Paschim Medinipur, Haora, Purba Medinipur and South 24 Parganas disctricts of West Bnagal. Gross State Domestic Product (GSDP) prices of West Bengal and growth rate in percentage are provided in **Table 19** and **Table 20** as below:

Table 19: 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 20: 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

Year	Primary	Secondary	Teritary	GSDP
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.

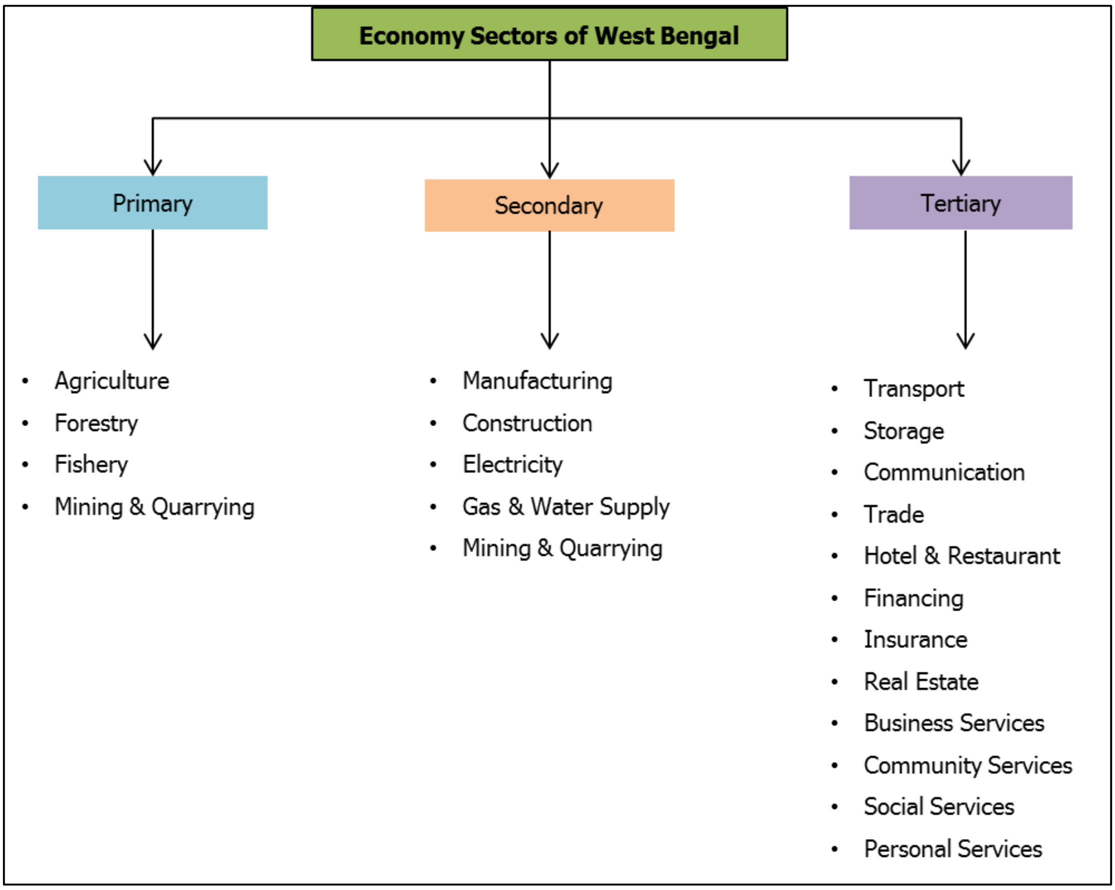


Figure 18: Sectors of West Bengal

Figure 19 below shows the percentage share of GSDP by primary, secondary and tertiary sectors at constant price level of 2004-05. **Figure 20** 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.

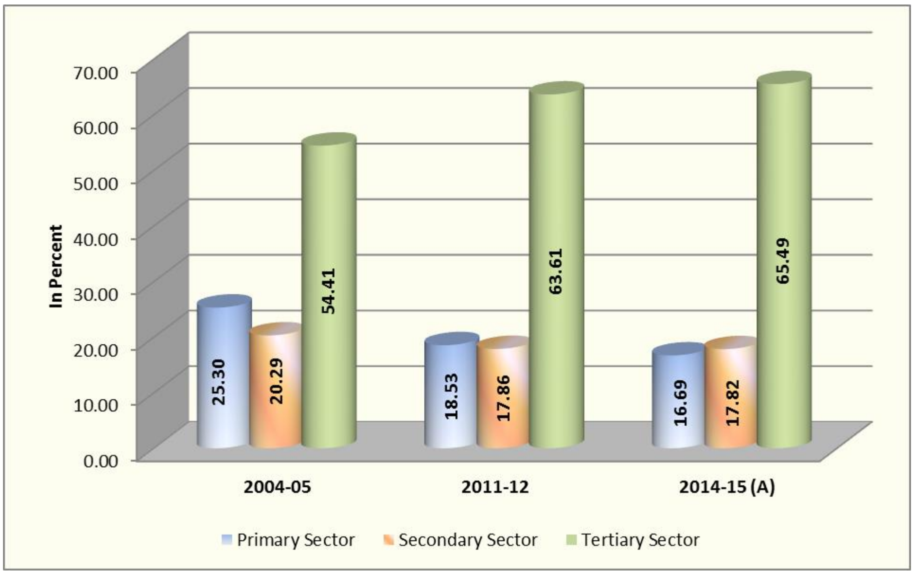


Figure 19: Percentage Share of GSDP by different Sectors of West Bengal Economy at Constant (2004-05) Prices

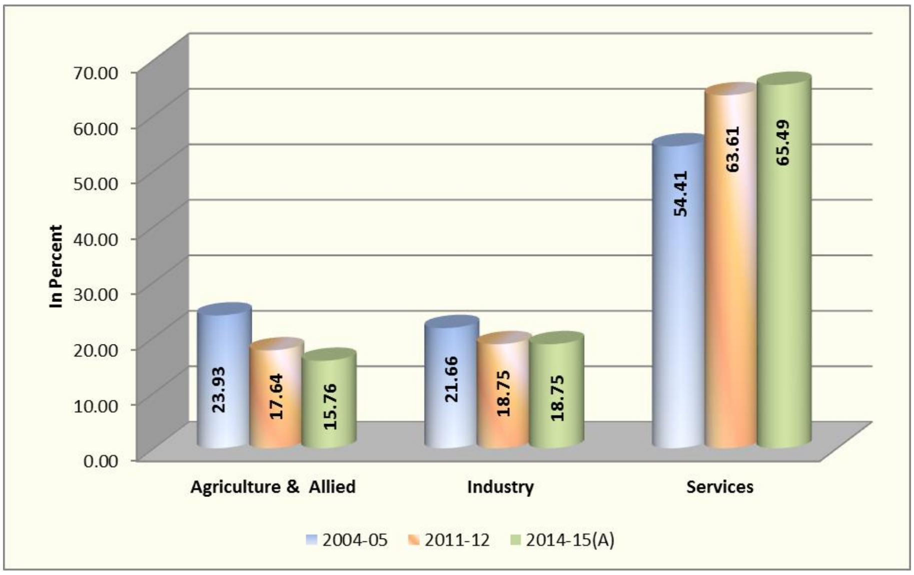


Figure 20: Sectoral Composition of GSDP by Broad Sectors of the Economy of West Bengal at Constant (2004-05) Prices

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 disctricts are provided in **Table 21** & **Table 22** and the same is presented in **Figure 21** as below:

Table 21: Gross District Domestic Product of Hinterland Districts

(at 2004-05 Constant Prices, INR Crores)

Year	Hughli	Paschim Medinipur	Haora	Purba Medinipur	South 24 Parganas
2004-05	13613.00	10889.9	11614.02	16728.73	16884.94
2005-06	14673.07	11506.06	12286.07	16672.62	17443.65
2006-07	14965.27	12359.28	13591.92	18089.79	19623.98
2007-08	16604.91	13502.63	14575.03	19169.64	21026.4
2008-09	17488.49	13638.37	15255.97	20441.05	21652.35
2009-10	19702.00	15211.87	17187.44	21010.13	22442.53
2010-11	20753.25	15625.54	19433.37	24134.15	24465.14
2011-12	21217.67	15992.07	19887.54	24232.58	25688.00
2012-13	22808.85	17845.15	21336.43	25895.81	27306.29
2013-14	24371.33	18930.11	22817.15	26978.96	29238.58

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

Table 22: Annual Growth Rates of Gross District Domestic Product of Hinterland Districts

(at 2004-05 Constant Prices, Percentage Change over Previous Year)

Year	Hughli	Paschim Medinipur	Haora	Purba Medinipur	South 24 Parganas
2005-06	7.79	5.66	5.79	-0.34	3.31
2006-07	1.99	7.42	10.63	8.5	12.5
2007-08	10.96	9.25	7.23	5.97	7.15
2008-09	5.32	1.01	4.67	6.63	2.98
2009-10	12.66	11.54	12.66	2.78	3.65
2010-11	5.34	2.72	13.07	14.87	9.01

Year	Hughli	Paschim Medinipur	Haora	Purba Medinipur	South 24 Parganas
2011-12	2.24	2.35	2.34	0.41	5
2012-13	7.50	11.59	7.29	6.86	6.3
2013-14	6.85	6.08	6.94	4.18	7.08
Average	**6.74**	**6.40**	**7.85**	**5.54**	**6.33**

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

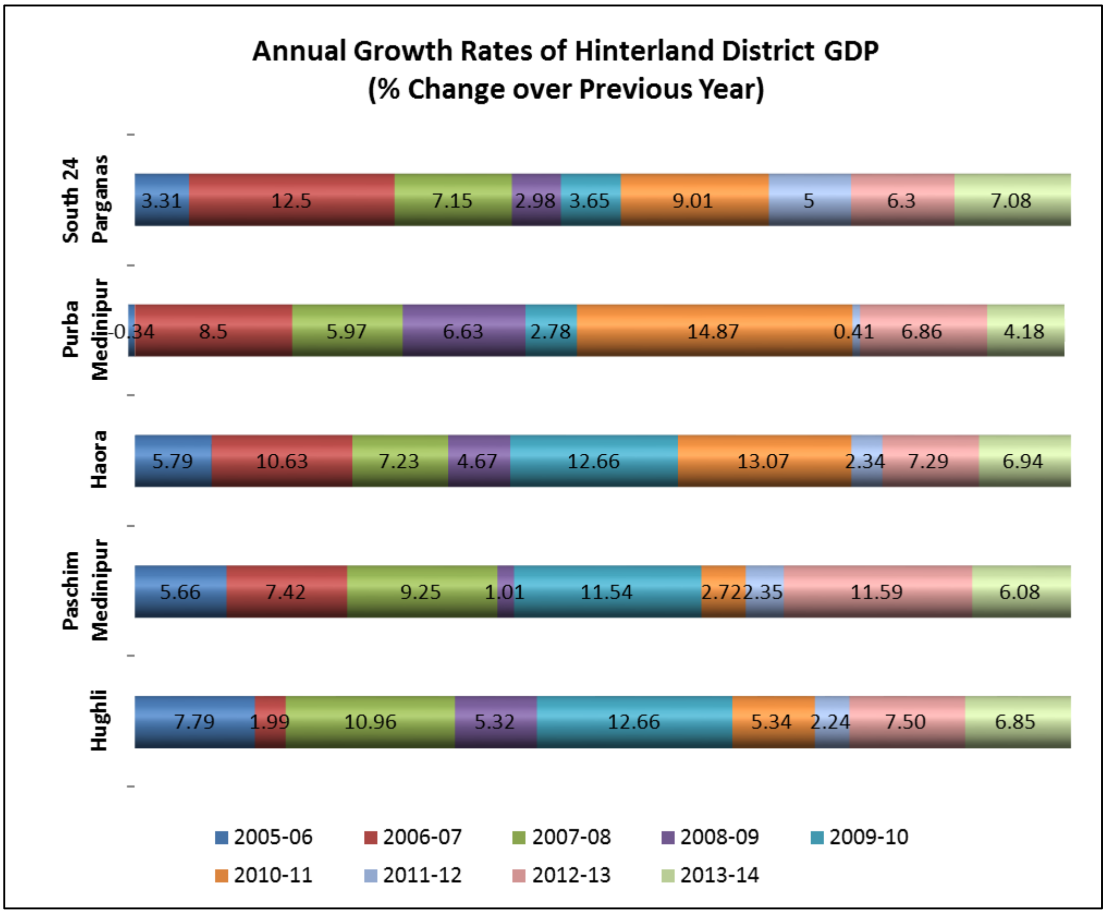


Figure 21: Annual Growth Rates of Gross District Domestic Product of Hinterland Districts

Table 23: Contribution of Hinterland Districts in GSDP of Broad Sectors of Economy in West Bengal

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

Year	Sectors	Hughli	Paschim Medinipur	Haora	Purba Medinipur	South 24 Parganas
2004-05	Agriculture & Allied	6.31	7.12	2.51	8.29	7.86
	Industry	6.9	4.08	6.77	9.99	9.31
	Services	6.47	4.84	6.43	7.11	7.71
	Total GSDP	**6.52**	**5.22**	**5.57**	**8.02**	**8.09**
2011-12	Agriculture & Allied	6.16	7.23	2.02	8.02	8.15
	Industry	6.71	4.13	8.4	8.59	7.97
	Services	6.63	4.55	6.63	7.03	7.88
	Total GSDP	**6.56**	**4.94**	**6.15**	**7.49**	**7.94**
2012-13	Agriculture & Allied	6.28	7.15	2.11	7.73	7.9
	Industry	6.64	4.09	8.11	8.3	7.94
	Services	6.61	4.91	6.61	7.11	7.81
	Total GSDP	**6.56**	**5.13**	**6.14**	**7.45**	**7.85**
2013-14	Agriculture & Allied	6.28	7.15	2.11	7.73	7.9
	Industry	6.64	4.09	8.11	8.3	7.94
	Services	6.61	4.91	6.61	7.11	7.81
	Total GSDP	**6.56**	**5.13**	**6.14**	**7.45**	**7.85**

From Table 23**,** it is concluded that, Purba Medinipur and South 24 Parganas have major share of agricultural products and Haldia contributes majorly in Industrial sector. However, services are the main governing sector in all hinterland disctricts. Contribution of Hinterland Districts in GSDP of Broad Sectors of Economy in West Bengal is also presented in **Figure 22**, **Figure 23** and **Figure 24** as below:

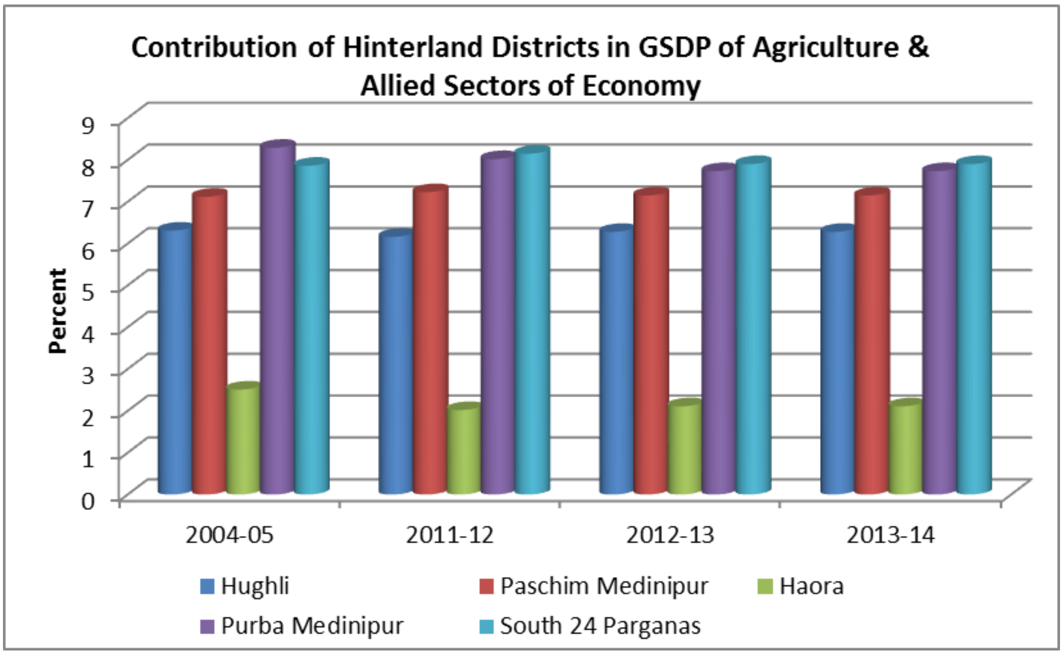


Figure 22: Contribution of Hinterland Disctricts in GSDP of Agriculture & Allied Sectors of Economy

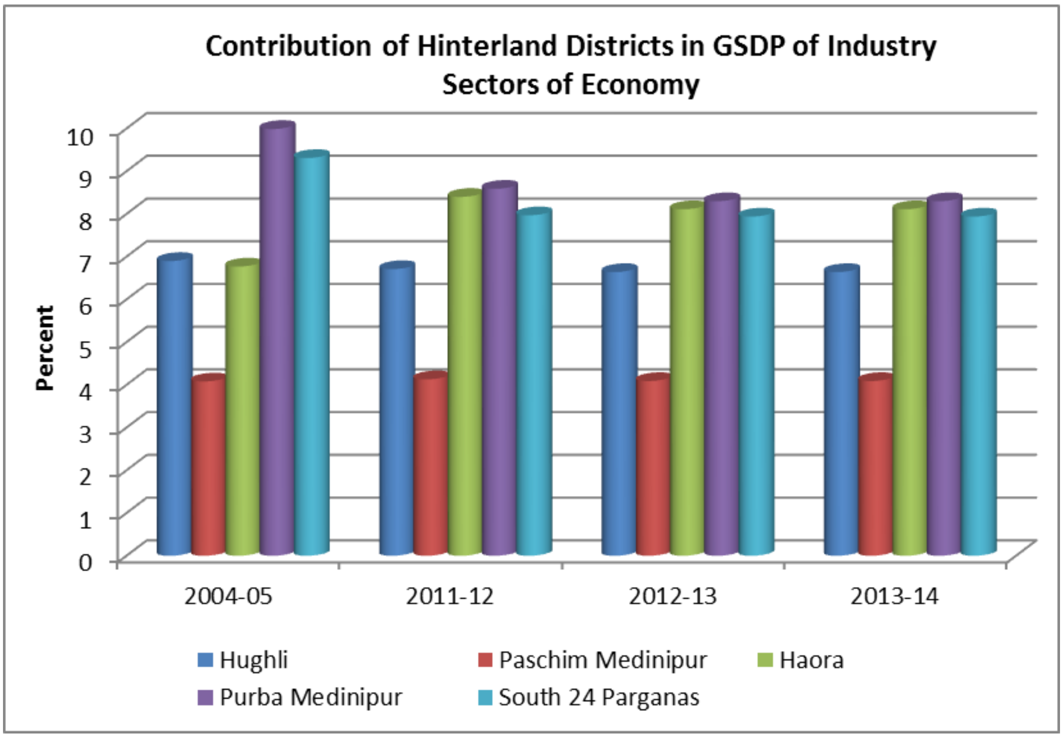


Figure 23: Contribution of Hinterland Disctricts in GSDP of Industry Sectors of Economy

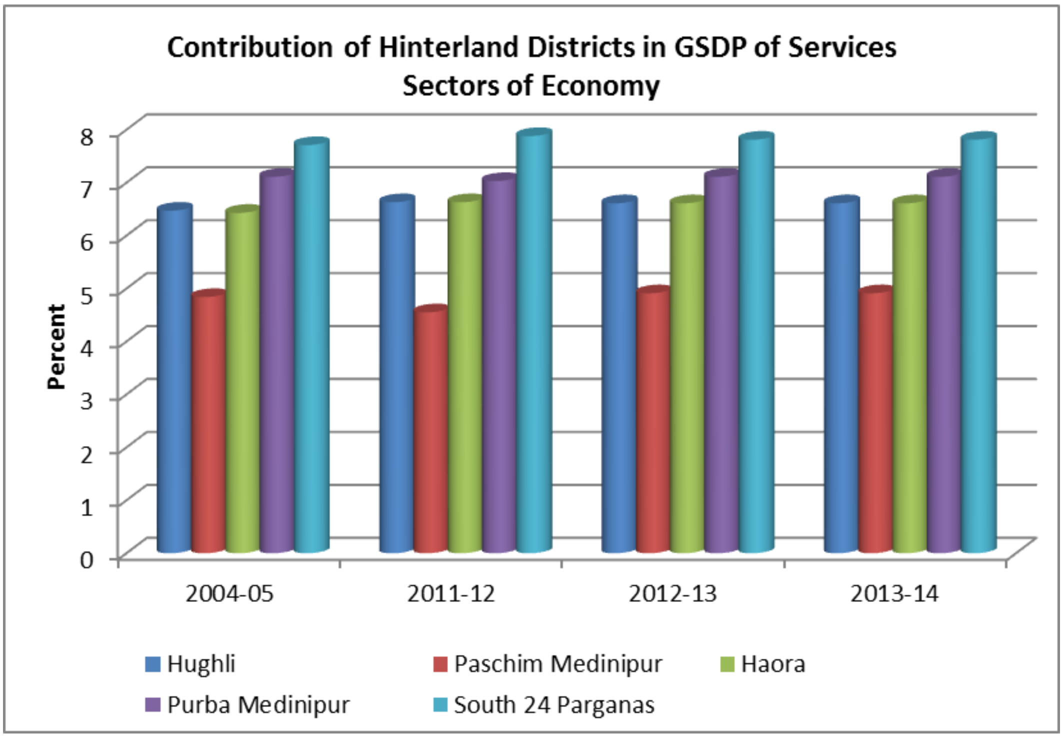


Figure 24: Contribution of Hinterland Disctricts in GSDP of Services Sectors of Economy

4.3 EXISTING AND PROPOSED INDUSTRIES

There are number of Industries exists along the bank of Rupnarayan River study area. Kolaghat Thermal Power Station, which is the largest power sector in the state and managed by West Bengal Power Development Corporation Limited (WBPDCL), a department of the State Government of West Bengal, is also located along the waterway. The waterway has an excellent transport and communication network of national highways and railways. A major existing industrial base at Kolaghat, due to availability of skilled man power at comparative low rates, abundance of electric power and a business environment conducive for industrial growth both from the labour and political fronts are few plus points for promotion and development of industries along the waterway. Aquaculture and shrimp farming has been taken up in a big way in the coastal belt of the waterway and floriculture and horticultural activities are concentrated in a major portion of Tamluk Sub-division. There are several number of Brick kiln are also present along the Rupnarayan waterway.

The major industries existing along the study stretch of Rupnarayan waterway are:

a) Kolaghat Thermal Power Plant.
b) The Ramco Cement Ltd.

A detailed site survey was conducted by consultant team during DPR studies for assessment of cargo traffic existing along the Rupnarayan river. Possibility for transfer of cargo traffic from road/rail to waterways is also assessed by the team during site visit.

During the interactions with officials of Kolaghat Thermal Power plant it was communicated that coal for thermal power plant is transported through rails via Mecheda, SE Railway station located about 1.0 Km from the power plant. Fly ash is transported by roads to nearby cement industries and brick klins. Fly ash from the power plant is also transported to Bangladesh from Haldia Jetty by private companies like M/s Interminable Commodity Management (India) Pvt. Ltd (ICM) and M/s Novel Engineering.

Inbound and outbound cargo for Ramco Cement is also transported to/fro Haldia Jetty. The details of commodity proposed to be transported through Rupnarayan waterway using proposed Kolaghat Jetty is provided in following sections. Kolaghat Jetty is proposed to be developed for Captive cargo originated/terminated to/from Kolaghat Thermal Power Plant and Ramco Cement Industries.

4.4 COMMODITY COMPOSITION / CATEGORIZATION

Detailed traffic survey was done by the consultant along the study stretch of Rupnarayan Waterway. During the survey, it was observed that the river is currently used for transporting local commodities in small scale. However, the waterway needs to be developed for accommodating largo cargo vessels to transport bulk commodities. Existing and proposed commodities planned for Rupnarayan waterway can be categorized as follows:

a) Passenger/Ro-Ro Traffic
b) Tourism Traffic
c) Agricultural Products
d) Construction Material
e) Dry Bulk Cargo

4.5 PASSENGER/ RO-RO TRAFFIC

In the whole 45 Km study stretch of Rupnarayan waterway, Road Bridge connecting both banks of river is located at Kolaghat only. Ferry ghats are located at Geonkhali, Noorpur, Gadiara, Tamluk and Amberia for river crossings. The daily passenger traffic from these jetties is provided in **Table 24**.

Table 24: Passenger Traffic

Sl. No	Embarking Jetty	Disembarking Jetty	No. of Passengers per day
1.0	Noorpur	Geonkhali, Gadiara	4000
2.0	Geonkhali	Gadiara, Noorpur	3500
3.0	Gadiara	Geonkhali, Noorpur	2500
4.0	Tamluk	Amberia	200
5.0	Amberia	Tamluk	200
6.0	Mankur Jetty	Not-operational	

Except Gadiara, all the above jetties are locally operated and lack the basic infrastructure for berthing/mooring of big vessels to carry four wheelers/ trucks. However, currently, passengers carry their cycles and bikes in the boat. As per the information obtained from locals during site visit, growth in traffic data is approximately stagnant and fixed in the last decade. As such, exiting terminal facilities are proposed to be developed for current traffic at this stage of DPR and provision of further development is provided.

4.6 TOURISM TRAFFIC

No tourism traffic is available along the study stretch of Rupnarayan waterway.

4.7 AGRICULTURAL PRODUCTS

West Bengal is predominantly an agrarian State. Comprising of only 2.7% of India's geographical area, it supports nearly 8% of its population. There are 71.23 lakh farm families of whom 96% are small and marginal farmers. The average size of land holding is only 0.77 ha. However, the State is bestowed with diverse natural resources and varied agro-climatic conditions which support cultivation of a wide range of crops. West Bengal ranks first in paddy and vegetable production in the country. It stands second in potato production (after Uttar Pradesh). It is also the leading producer of jute, pineapple, litchi, mango and loose flowers. Cultivation of pulses, oilseeds and maize is also picking up fast.

The net cropped area of West Bengal is 52.05 lakh ha which comprises 68% of the geographical area and 92% of arable land. The cropping intensity is 184%. The agricultural area and production capacity of hinterland of Rupnarayan waterway stretch under DPR study is provided in **Table 25** below.

Table 25: Agricultural Area and Production Capacity[3]

District	Net Sown Area (Km^2)	Production Capacity (MT)	C.D. Block	Net Sown Area (Km^2)	Production Capacity (MT)	Total Hinterland Net Sown Area (Km^2)	Total Hinterland Production Capacity (MT)
Hughli	2,119.70	4,972.90	Khanakul - II	124.92	38.63	124.92	38.63
Paschim Medinipur	5,170.00	4,590.80	Daspur I	183.60	129.59	373.92	183.68
			Daspur II	190.32	54.09		
Haora	829.78	672.10	Amta - I	110.01	39.16	818.82	243.76
			Amta - II	139.31	59.22		
			Panchla	41.33	7.73		
			Bagnan - I	43.36	9.43		
			Bagnan - II	44.79	11.21		
			Uluberia - I	71.49	18.35		
			Uluberia - II	76.39	19.75		
			Shyampur - I	148.99	42.04		
			Shyampur - II	143.15	36.86		
Purba Medinipur	2,884.87	1,296.80	Panskura	175.88	93.28	1011.42	316.79
			Kolaghat	114.68	32.82		
			Moyna	116.59	42.16		
			Sahid Matangini	73.21	22.58		
			Tamluk	68.96	20.28		
			Nanda Kumar	118.95	36.42		
			Chandipur	89.22	18.11		
			Mahisadal	166.31	37.65		
			Sutahata	60.44	10.40		
			Haldia	27.18	3.09		
South 24 Paraganas	3,618.76	1,121.80	Budge Budge - I	24.92	6.25	437.61	110.14
			Budge Budge - II	76.90	21.22		
			Falta	150.78	37.86		

[3] State Statistical Handbook, 2015 and District Statistical Handbook, 2013-2014

District	Net Sown Area (Km^2)	Production Capacity (MT)	C.D. Block	Net Sown Area (Km^2)	Production Capacity (MT)	Total Hinterland Net Sown Area (Km^2)	Total Hinterland Production Capacity (MT)
			Diamond Harbour - I	79.97	19.70		
			Diamond Harbour - II	105.04	25.12		
Total	**14,623.1**	**12,654.40**		**2,766.69**	**893.00**	**2766.69**	**893.00**

From the table, it is concluded that the total agricultural production capacity of the hinterland of stretch under DPR study of Rupnarayan waterway is 893.0 thousand tonnes. From this, the total foodgrain production capacity is 591.90 thousand tonnes (66.28%), Oilseeds production capacity is 25.61 thousand tonnes (2.87%), Jute production capacity is 23.32 thousand tonnes (2.61%) and Potato production capacity is 252.18 thousand tonnes (28.24%)[4]. It is envisaged that, in future once Rupnarayan waterway will be fully developed for IWT, foodgrains can be shifted to waterway mode of transport.

4.8 CONSTRUCTION MATERIAL

As stated above, M/s The Ramco Cement Limited is operating a Cement Grinding unit at Kolaghat (0.95 MTPA). In addition to this, numerous brick kilns are also located along both the banks of waterwa. As per the data/information collected during traffic survey, weekly about 600 - 700 bricks are transported from Mankur Jetty to Tejlipur (Medinipur) on local passenger boats. This is insignificant for proposing any development along the above jetties.

4.9 DRY BULK CARGO

The dry bulk cargos proposed for IWT are:

a) Fly Ash
b) Gypsum
c) Clinker
d) Slag

[4] State Statistical Handbook, 2015, published by "Bureau of Applied Economics & Statistics Department of Statistics & Programme Implementation Government of West Bengal".

West Bengal Power Development Corporation Limited (WBPDCL), a Government of West Bengal Undertaking, is operating its Kolaghat Thermal Power Station (6x210 MW) at Macheda, District Purba Medinipur, West Bengal since 1983 with production of significant quantity of Fly Ash.

The power plant has six units, 3 units each in Phase I and Phase II. In Phase I, all the units are of 210 MW capacity and are equipped with ESPs having single pass with 16 fields. In Phase II, all the units are of 210 MW capacity and are equipped with ESPs having two passes with 20 fields. Power plant is using coal from the mines of BCCL, ECL, MCL and Bengal Mines. Total coal consumption is about 15,000 MT per day. Ash content in the coal is 33 to 34% and fly ash generation is 5000 MT/day of which 80% is dry fly ash and 20% is bottom ash.

Fly ash from ESP hopper goes to intermediate silos by pneumatic pressure system, where as bottom ash and some part of the fly ash is being dumped into ash pond in the form of slurry.

As per mail from ICM (India) Pvt. Ltd. dated 30.08.2018[5], total quantity of fly ash cargo approved, to be exported to Bangladesh is 40,000 MT per month (approx.). It is about 33% of total fly ash generating from Kolaghat Thermal Power plant. Remaining fly ash will be supplied to Ramco Cement and other local cement manufacturing units.

As per mail from M/s The Ramco Cements Limited, dated 01.07.2016[6], total quantity of cargo movement from proposed Kolaghat jetty, indicated by M/s Ramco is 1 Million tons per annum (7 lakh MTs of clinker & 3 lakh MTs of Cement) which can improve to 1.50 million tons per annum within the nest 2 years.

Hence, the total anticipated quantity of dry bulk cargo for IWT through Rupnarayan waterway is considered as follows:

- Fly Ash = 40,000 MT/month (approx.)
- Clinker, Gypsum= 700,000 MT/annum (~58,000 MT/month approx.)
- Cement = 300,000 MT/annum (~ 25,000 MT/month approx.)

[5] As per mail from Mr. Sharan Singh Chauhan, Director M/s ICM (India) Pvt. Ltd dated 31st August 2019.

[6] As per mail from Mr. R. Sundar, Sr. Manager-Logistics M/s The Ramco Cements Limited, dated 01st July 2016.

Hence, a total of about 1.23 lakh MT/month (14.8 lakh MT/Annum) of cargo is anticiptated to be transported through proposed jetty in Rupanarayan Waterway. However, adopting a conservative approach about 10.0 lakh MT/Annum of cargo quantity is considered for financial and economic anyalis in this DPR.

4.10 ORIGINATING / TERMINATING POINTS OF DRY BULK CARGO

Large scale industries are located along the study stretch of Rupnarayan waterway. These industries procure raw materials from all over India, including the coastal areas of Southern states. Also the outputs from these industries are supplied in India as well as International markets.

The originating and terminating location of major commodities, anticipated to be used by waterway and Jamitya Jetty proposed at Kolaghat are provided in **Table 26**.

Table 26: Originating/ Terminating Points of major commodities anticipated for IWT[7,8]

Sl. No.	Commodity	Originating Point	Terminating Point
1.	Fly Ash	Jamitya Jetty, Kolaghat Thermal Power Plant	a) Bangladesh via. Haldia Jetty b) Bhagalpur, Sagardwip/Kakdwip/ Namkhana
2.	Gypsum	Haldia, Vishakhapatnam, Thailand, Indonesia	Jamitya Jetty The Ramco Cement Limited, Cement Grinding unit at Kolaghat
3.	Clinker	Jayanthipuram (Vijayawada), Ariyalur and Alathiyur in Tamil Nadu	Jamitya Jetty The Ramco Cement Limited, Cement Grinding unit at Kolaghat
4.	Cement	Jamitya Jetty, Kolaghat Thermal Power Plant	Various markets in West Bengal using NW-1

4.11 COMPETITIVENESS OF ROAD AND INLAND WATER TRANSPORT FOR DRY BULK CARGO

Inland water transport is justified on the grounds of being cheap and environment friendly. It offers significant cost advantages in terms of fuel costs at least. However, these cost advantages are not

[7] As per Future expansion plan of M/s Novel Engineering, provided by Letter No. NE/GRSL/015/17, dated 25/04/2017

[8] As per mail from Mr. R. Sundar, Sr. Manager-Logistics M/s The Ramco Cements Limited, dated 01st July 2016

always available, but depend on the circumstances, particularly on whether the entire transport chain is only through water or other modes of transport are also involved. Further, the costs and cost-advantages of water transport also depend significantly on the waterway itself, its depth availability (LAD), and several other factors. Thus, the viability of waterways needs to be worked out on a case by case basis for each of the waterways. We look at the various factors that determine the viability of Rupnarayan waterway for transporting dry bulk cargo.

4.11.1 Fly Ash

About 33% of fly ash, that is 40,000 MT per month produced at Kolaghat Thermal Power Plant (TPP) is proposed to be exported to Bangladesh using waterways. The existing and proposed route for exporting fly ash to Bangladesh is provided in details as below:

Existing and Proposed route for exporting Fly Ash

Sl. No.	Existing route	Proposed route
1.	Fly ash collected in bulk trucks from Kolaghat TPP	Fly ash collected in bulk trucks from Kolaghat TPP
2.	Bulk trucks bring fly ash to Haldia Port, covering road distance of about 56.0 Km	Bring fly ash to proposed Jamitya jetty in bulker trucks covering road distance of about 3.0 Km
3.	Trucks unloaded in silos, pnuematically by pumps	Unload trucks and load silos pnuematically by pumps
4.	Fly ash is loaded to fixed barge loaders using pipe conveyors at Haldia.	Bring fly ash to the berth by pipe conveyors and feed it to a fixed barge loader
5.	Fly ash cargo leave for their respective destination from Haldia port	Fly ash cargo leave for their respective destination from Jamitya jetty

Cost Comparison

Expenses incurred for transporting fly ash dependes on various factors, following assumptions are made for comparing cost for transporting fly ash through existing and proposed routes from Kolaghat TPP to Haldia port:

a) Loading/unloading charges to be same at both jetties
b) Considering no other economic benefits
c) Vessel and terminal realted charges to be same at both Jetties

Input Data		
Fly Ash quantity for IWT	40,000.00	MT/month
Road Haulage Cost	2.00	INR/TKm
Composite charge for unloading truck and loading vessel	45	INR/MT
Days of Operation per year	300	days
Waterway usage charges	0.02	INR/TKm
IWT distance from Jamity jetty to Haldia	72	Km
Vessel running cost through IWT	1.00	INR/TKM
Days of Operation per year	300	days

Cost through Existing route		
Road Distance from Kolaghat to Haldia Port	56.00	KM
Cost of Transporting Fly Ash by Road to Haldia Port	44,80,000	INR/month
Total expenses for transporting Fly Ash from Kolaghat to Haldia by existing route	44,80,000	INR/month
	4,48,00,000	**INR /year**

Cost through Proposed route		
Road Distance from Kolaghat to Jamitya Jetty	3.00	KM
Waterway usage cost from Jamitya Jetty to Haldia	57,600	INR/month
Vessel running cost through IWT	28,80,000	INR/month
Total expenses for transporting Fly Ash from Kolaghat to Haldia by proposed route	29,37,600	INR/month
	2,93,76,000	**INR /year**

Saving in transporting Fly Ash to IWT	1,54,24,000	INR /year
	154.24	INR Lacs/year

4.11.2 Clinker, Gypsum & Others

Clinker, Gypsum & Others cargo are being brought by M/s Ramco Cement Unit partly by rail up to Panskura Railway station and then by road transport up to Kolaghat. Remaning about 58,000 MT per month are brought through ship delivered at Haldia port and transported up to Kolaghat using bulk trucks. The existing and prosposed secanrios for transporting Clinker and gysum from Haldia port to M/s Ramco Cement Unit is prodived in detail as below:

Existing and Proposed route for importing Clinker and Gypsum

Sl. No.	Existing Scenario	Proposed Scenario
1.	Clinker and Gypsum destined for M/s Ramco cement reaches Haldia Port through ship	Clinker, Gypsum destined for M/s Ramco cement reaches Haldia Port through ship
2.	Cargo unloaded from ships and loaded on trucks at Haldia port	Cargo unloaded from ships and loaded on inland water barges at Haldia port
3.	Trucks delivered to M/s Ramco Cement units located in Kolaghat covering road distance of about 56.0 Km	Loaded barges transported to proposed Jamitya jetty through Rupnayaran waterway covering total waterway distance of about 72.0 Km
4.		Cargo unloaded from Barges and loaded on bulk trucks using pnuematic system
5.		Bulk trucks bring Clinker and Gypsum to M/s Ramco Cement unit through raod covering distance of about 3.3 Km

Cost Comparison

Following assumptions are made in cost comparison for transporting Clinker and Gypsum from Haldia port to M/s Ramco Cement unit:

a) Unloading/loading charges of Clinker & Gypsum from sea vessels to barges or trucks is same at Haldia port.
b) Considering no other economic benefits
c) Vessel and terminal realted charges to be same at both Jetties

Input Data		
Clinker and Gypsum quantity for IWT	58,000	MT/month
Road Distance from M/s Ramco Cement unit to Haldia Port	56.00	KM
Road Distance from M/s Ramco Cement unit to Jamitya Jetty	3.30	KM
Road Haulage Cost	2.00	INR/TKm
Composite charge for loading/unloading to/from truck or barges	45	INR/MT
Waterway usage charges	0.02	INR/TKm
IWT distance from Jamity jetty to Haldia	72	Km

Vessel running cost through IWT	1.00	INR/TKM
Days of Operation per year	300	days

Cost through Existing route		
Cost of Transporting Clinker & Gypsum by Road to M/s Ramco Cement Unit from Haldia Port	64,96,000	INR/month
Total expenses for transporting Clinker & Gypsum from Haldia to Kolaghat by existing route	64,96,000	INR/month
	6,49,60,000	**INR /year**

Cost through Proposed route		
Barges running cost from Haldia to Jamitya Jetty by IWT	41,76,000	INR/month
Waterway usage charges from Haldia to Jamitya Jetty	83,520	INR/month
Unloading/loading cost of Clinker & Gypsum from Barges to trucks at Jamitya Jetty	26,10,000	INR/month
Total expenses for transporting Clinker & Gypsum from Haldia to Kolaghat by proposed IWT route	68,69,520	INR/month
	6,86,95,200	**INR /year**

Saving in transporting Clinker & Gypsum to IWT	-37,35,200	INR /year
	-37.35	INR Lacs/year

4.11.3 Packed Cement and other Finished products

As communicated by M/s ICM (India) Pvt. Ltd.[9] cement companies are also keen to move their Packed Cement Cargo from proposed Jamitya Jetty. The existing and proposed route for the same is provided in detail as below:

Existing and Proposed route for exporting Packed Cement

Sl. No.	Existing Scenario	Proposed Scenario
1.	Packed cement collected in bulk trucks from M/s Ramco Cement	Packed cement collected in bulk trucks from M/s Ramco Cement

[9] As per mail from Mr. Sharan Singh Chauhan, Director M/s ICM (India) Pvt. Ltd dated 31st August 2019.

Sl. No.	Existing Scenario	Proposed Scenario
2.	Bulk trucks bring packed cement to Haldia Port, covering road distance of about 56.0 Km	Bring packaged cement to proposed Jamitya jetty in bulk by trucks covering road distance of about 3.3 Km
3.	Trucks unloaded at Haldia port and loaded on ships	Unload trucks and load fixed barge loaders with packed cement at Jamitya jetty
4.	Packed cement leave for their respective destination from Haldia port	Packed cement leave for their respective destination from Jamitya jetty

Cost Comparison

Following assumptions are made for comparing cost in transporting packed cement from M/s Ramco Cement unit:

a) Unloading/loading charges of Packed cement from trucks to barges/sea vessels is same at both the jetties.
b) Considering no other economic benefits
c) Vessel and terminal realted charges to be same at both Jetties

Input Data		
Packed cement quantity for IWT	25,000.00	MT/month
Road Distance from M/s Ramco Cement unit to Haldia Port	56.00	KM
Road Distance from M/s Ramco Cement unit to Jamitya Jetty	3.30	KM
Road Haulage Cost	2.00	INR/TKm
Waterway usage charges	0.02	INR/TKm
IWT distance from Jamity jetty to Haldia	72	Km
Vessel running cost through IWT	1.00	INR/TKM
Days of Operation per year	300	days

Cost through Existing route		
Cost of transporting Packed cement by Road from M/s Ramco Cement Unit to Haldia Port	28,00,000	INR/month
Total expenses for transporting Packed cement from M/s Ramco Cement Unit to Haldia by existing route	28,00,000	INR/month
	2,80,00,000	**INR /year**

Cost through Proposed route		
Barges running cost from Jamitya Jetty to Haldia by IWT	18,00,000	INR/month
Waterway usage charges from Jamitya Jetty to Haldia	36,000	INR/month
Total expenses for transporting Packed cement from Kolaghat to Haldia by proposed route	18,36,000	INR/month
	1,83,60,000	**INR /year**

Saving in transporting Packed cement to IWT	96,40,000	INR /year
	96.40	INR Lacs/year

4.12 GROWTH TREND

The availability of good road and rail infrastructure and lack of political will for developing inland waterway transport network results in low IWT traffic till date. However, last few years have seen considerable initiatives taken up by both Central and State governments to develop IWT sector for clean, green and cheap mode of transportation.

Cargo traffic handled by India's major ports increased 5.1 per cent year-on-year to 315.4 million tonnes (MT) during April-September 2016. In terms of composition of cargo traffic, the largest commodity was P.O.L. (37.1 per cent), followed by coal (23.4 per cent), container traffic (19.6 per cent), other cargo (11.9 per cent), iron ore (5.66 per cent) and Fertilizer and FRM (2.5 per cent).

The country's major ports handled a combined traffic volume of 586.29 million tonnes during April 2016-February 2017, up from 550.45 million tonnes during same period last year, while containerised cargo tonnage rose 3.7 per cent to 10.5 MT during August 2016. During April-June 2016, the ports had handled a combined volume of 2.12 million TEUs, which is roughly around 70 per cent of the country's overall container trade.

The government has taken several measures to improve operational efficiency through mechanisation, deepening the draft and speedy evacuations. In FY 2015-16, the Indian Port sector witnessed capacity addition of 94 Million Tonnes Per Annum (MTPA), which is the highest in the history of major ports.

The Department of Industrial Policy and Promotion (DIPP), Ministry of Commerce and Industry, reported that the Indian ports sector received FDI worth US$ 1.64 billion between April 2000 and December 2016. [10]

In West Bengal, the proposed multi-modal terminal at Haldia on NW-1 is expected to become the hub for transportation of cargo to the North-East and West Bengal. The Terminal has already received a commitment of 5.92 MMTPA of cargo volume by the year 2018 (the year the Terminal is ready for operation) from the Industry, indicating huge cargo potential of the proposed terminal and region. Fly ash is expected to be the major cargo with a commitment of 3.8 MT followed by vegetable oil (0.63 MT), cement (0.36 MT), among others. Other than the Haldia terminal, IWAI plans to develop GR Jetty-I, GR Jetty-II & BISN under the public-private partnership mode.[11]

Earlier this year, an IWAI vessel MV Zakir Hussain had transported 350 tonnes of cement consignment from Haldia to Patna.[12] However, due to lack of basic infrastructure/terminal facilities and connectivity with existing road network, no major cargo movement exist in the past along the study stretch of Rupnarayan waterway.

MV V. V. Giri, a vessel of the Inland Waterways Authority of India (IWAI) began a landmark pilot movement on April 23rd 2017 from Kolaghat in East Midnapore district of West Bengal to Bhagalpur in Bihar with a cement consignment of 240 tonnes. The vessel's journey commenced from Kolaghat on Rupnarayan river (National Waterway- 86) to reach Bhagalpur via river Ganga (NW-1). This marks the beginning of an integrated cargo movement involving two different NWs - NW-86 and NW-1. Rupnarayan river (NW-86) connects with river Ganga (NW-1) at Geonkhali near Haldia. On its return trip, the vessel will bring fly ash/pet coke.

As the waterway have no currently IWT traffic, the anticipated traffic volume is proposed on the basis of discussions and information's available from IWAI, local authorities, traders and industries located along the waterway. Hence growth rate of commodities depends on development of proposed IWT infrastructure, industrial growth and political will, which cannot be assessed at this stage. However, provision of future expansion is provided in the proposed terminal complexes to cater future demand.

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[10] https://www.ibef.org/industry/ports-india-shipping.aspx

[11] http://pib.nic.in/newsite/PrintRelease.aspx?relid=151948

[12] https://english.kolkata24x7.com/west-bengal/govt-starts-cargo-ferrying-along-multiple-waterways

4.13 TERMINAL WISE IWT TRAFFIC ANALYSIS

It is proposed to develop the 35 Km stretch of Rupnarayan waterway from Geonkhali to Kolaghat by upgrading the three existing ferry ghats into RO-RO/Ferry terminal and constructing a new dry bulk cargo terminal at Jamitya near Kolaghat. The terminal wise IWT traffic is provided in **Table 27** below

Table 27: Terminal Wise IWT Traffic

Sl. No.	Terminal	Type of Terminal	RO-RO/Ferry Traffic per day	Cargo Traffic per Annum
1.	Noorpur	RO-RO/Ferry	4000 pax, Cycles, bikes, cars, trucks requiring RO-RO vessel of about 5-6 truck capacity	
2.	Gadiara	RO-RO/Ferry	2500 pax, Cycles, bikes, cars, trucks requiring RO-RO vessel of about 4-5 truck capacity	
3.	Geonkhali	RO-RO/Ferry	3500 pax, Cycles, bikes, cars, trucks requiring RO-RO vessel of about 5-6 truck capacity	
4.	Jamitya	Dry Bulk Cargo Captive Jetty		10.0 Lakh tonne

5.0 TERMINALS

The terminal planning and design includes selection of suitable sites in the vicinity of cargo potential considering all the relevant technical variables such as choosing the type of berthing facility and providing of covered/open storage facility, cargo handling systems and other ancillary facilities required for efficient terminal operation. Based on the projected traffic, the selection of various facilities was planned. The cost estimate including capital and operating costs was 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

Rupnarayan waterway is having huge potential for Inland Water Transport due to its topography, location and connectivity with Hooghly River (National waterway 1). Both central and state governments are investing hugely for developing the basic infrastructure required for safe, convenient and sustained shipping operations in the region. Transport Department, Government of West Bengal prepared a 15 year master plan for development of Inland waterway transport sector in the state, as provided in **Table 28.**

Table 28: IWT Development plan of West Bengal[13]

State Objectives relevant to the Goals & Targets	Components of each objective	Goals & Targets for the next 5 years	Goals & Targets for the next 10 years	Goals & Targets for the next 15 years
Development of IWT Infrastructure	Setting up/development of ferry ghats/Jetties.	All the major ferry ghats catering more than 5000 passengers per day will be developed and modernized	All the major ferry ghats catering more than 2500 passengers per day will be developed and modernized.	All the major ferry ghats catering more than 1000 passengers per day will be developed and modernized.
	Commissioning of RO-RO vessels / Pontoons to facilitate cross ferry services;	Barge/ pontoon/RO-RO vessels for facilitating goods transport will be provided in 10	Barge/ pontoon/RO-RO vessels for facilitating goods transport will be provided 1n 10 more	Barge/ pontoon/RO-RO vessels for facilitating goods transport will be provided in 10 more

[13] http://transport.wb.gov.in/about-us/past-present-future/ (Transport Department, Government of West Bengal)

State Objectives relevant to the Goals & Targets	Components of each objective	Goals & Targets for the next 5 years	Goals & Targets for the next 10 years	Goals & Targets for the next 15 years
		locations across never Hooghly and Sundarban areas.	locations in Sundarban and other areas	locations in Sundarban and other areas.
Expansion of IWT Services	Commissioning of new vessels/ launch;	Cross ferry service and long distance ferry service will be intensified through induction of high speed / larger capacity vessels within KMA and Sundarban areas.	Cross ferry service and long distance ferry service will be intensified through induction of high speed / larger capacity vessels in other districts across river Hooghly.	More and more cross ferry service and long distance ferry service will be provided through induction of high speed / larger capacity vessels in coastal areas also.
	Commissioning of luxury cruise vessel services for promotion of tourism.	Luxury cruise vessels will be introduced through WBSTC to connect places of tourism along the course of river Hooghly within KMA area.	WBSTC to connect places of tourism along the course of river Hooghly upstream of KMA.	Improvement of service of Luxury cruise vessels introduced through WBSTC to connect places of tourism along the course of river Hooghly downstream of KMA.

In the process of IWT development, West Bengal state transport department constructed/developed jetties along the Hooghly River as shown in **Figure 25.** Rupnarayan waterway has huge potential for IWT development; however no jetty or terminal is located along the waterway, except a Gangway Pontoon Jetty by WBTIDC, as shown in **Figure 25**.

During the DPR stage, detailed bathymetric and topographic survey was done to assess the basic infrastructure, needs to be developed at proposed terminal locations. Connectivity of proposed locations with major roads and nearest railway stations, anticipated cargo potential was also assessed in detail during the DPR phase.

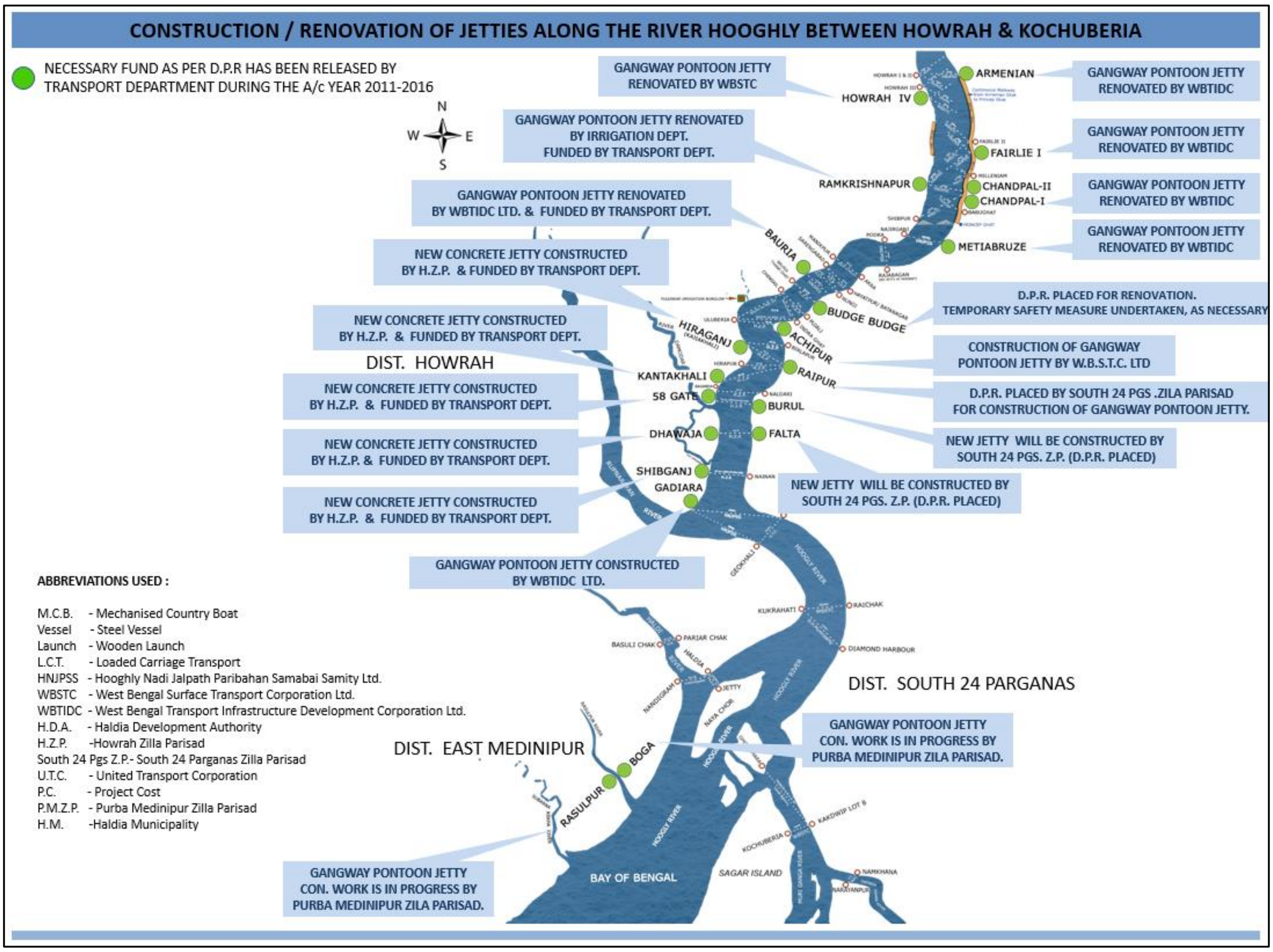

Figure 25: Location of Jetty Structures along Hooghly River[14]

5.2 IDENTIFICATION AND SITE LOCATION

Site selection is the 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,

[14] http://transport.wb.gov.in/infrastructure/jetties/constructionrenovation-of-jetties/ (Transport Department, Government of West Bengal)

- 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.

On the basis of detailed bathymetric and traffic survey done during DPR studies on the 45 Km stretch of Rupnarayan river from Geonkhali (Chainage 0.0 Km) to Mankur Jetty (Chainage 45 Km), following locations are identified for development and construction of terminals in two (2) phases:

Sl. No	Name	Type	Latitude	Longitude
Phase-1				
1.	Jamitya	Dry Bulk Cargo Terminal	22°25′32.99″ N	87°53′34.67″ E
Phase-2				
2.	Noorpur	RO-RO, Passenger Ferry Terminal	22°12′39.89″ N	88°4′17.26″ E
3.	Gadiara		22°13′12.32″ N	88°2′42.52″ E
4.	Geonkhali		22°12′18.33″ N	88°2′54.77″ E

5.3 TERMINAL LAYOUT / MASTER PLANNING INCLUDING PHASES OF DEVELOPMENT

Terminal facilities need to be developed according to an adequate Master Plan providing development concept and framework indicating the phased developmental solutions to meet the ultimate requirements. The Master Plan will include solutions for the actual planning periods as well as point out possibilities for further expansions in the more distant future. Normally, a master plan is developed for a time horizon of 10-20 years as any prediction of cargo throughput and the matching development requirements, in terms of port operational needs. Beyond this period may not be very accurate. Hence a master plan need to allow development in stages to meet the demands as they come and grow and also be flexible to incorporate mid-course modifications and to be responsive to emerging scenarios as time goes on. At this stage, based on the traffic, land and water front availability two concept layouts were presented for the proposed terminals.

IWT terminal layout for cargo and RO-RO/Ferry facility is proposed for base year 2017-18 traffic data collected during DPR study.

The following simple basic assumptions were considered for the purpose of IWT terminal planning:

a) Terminal facilities are planned for the initial traffic projected for base year 2017-18 and shall be expanded in the subsequent development phase up to the planned year 2027-28. System is planned that any additions to the facility will be possible for handling future traffic. Terminal facilities are planned and can be expanded to the ultimate traffic projected for the year 2027-28.
b) Based on the water level data analysis, the designed master plan has been considered available for berth operation of 300 days per year.
c) Average time required for to and fro movement from anchorage to berth, berthing time and other formalities is considered as 1 to 2 hour per vessel.
d) Storage capacities provided at the facility will be adequate to guarantee loading and unloading of cargo during disruption of traffic.
e) Maximum truck size assumed is 10 Tonnes pay load.
f) All bulk cargo which is not affected by weather will be stored in open stock pile.
g) The storm water drain proposed at the terminal shall discharge into the river.

The terminal facilities proposed for this project shall include the following:

For Dry Bulk Cargo terminal

- Berthing Facilities for vessels
- Admin/Operating Building
- Other ancillary Facilities

For RO-RO/Ferry terminal

- Berthing Facilities for vessels
- RO-RO vessels parking facilities
- Passenger ticket, waiting and parking area
- Other ancillary Facilities

5.3.1 Dry Bulk Cargo Terminal Facilities

A single barge can carry cargo equivalent to 15 rail wagons or 60 trucks and the operating cost of transportation via rail is 2.5 times, as per a study by National Council for Applied Economic Research. This section details the layout plan development options and facilities considered for dry bulk cargo terminal proposed at Jamitya. These options have been evolved with due consideration to various parameters like environmental aspects, geotechnical data, navigational aspects, adequacy of back up area, operational efficiency, the number of berths along the water area and development phasing strategy of power plant and industries in and around Kolagaht.

One no. of jetty has been envisaged at cargo terminal. The Jetty at proposed cargo termoinal shall be able to handle 2 nos. of vessels per day. If required to handle additional vessels local/temporary arrangements with the help of dump barges, hoses, etc. may be used.

The terminal layout is presented in Drawing PT/EIPTIWB003/2017/DPR/0010. The various waterside and land side facilities are presented in the mentioned drawing.

1. <u>LAND AVAILABILITY</u>

The multi-cargo Inland Water Transport (IWT) terminal is proposed adjacent to Jamitya, near Kolaghat. Terminal is proposed on the land protruded from river due to siltation on the banks.

2. <u>WATERFRONT FACILITIES</u>

The waterfront facilities for various berths and jetty are presented in above attached drawing. The dry bulk berth & pontoon platform is planned for handling fly ash. Also, handling of gypsum, clinker, construction materials and other clean cargo is envisaged in future planning.

3. <u>BACK UP AREA DEVELOPMENT</u>

In order to make the terminal functional and subsequently making the terminal capable of running with increasing efficiency and transportation between terminal/jetty site to Kolaghat Power plant and M/s The Ramco Cement Limited plant site, etc., location of each facility should be such that it becomes as a whole highly interactive making the terminal performance most efficient with minimum cargo transportation cost. These land side facilities are enumerated as follows.

- 1 No. Jetty & jetty approach for berthing of vessels of 2000 DWT
- Administration building

4. <u>Security office</u>

<u>Facility Requirement</u>

The IWT marine infrastructure and shore based infrastructure shall be planned and developed to cater to the cargo forecast. Development of the terminal infrastructure shall also be suitably planned in such as a way that the required/projected capacity can be handled efficiently with minimum transportation cost.

Marine Infrastructure

The marine infrastructure comprises of jetty & jetty approach and manoeuvring areas like approach channels, turning circle, holding area, etc.

Navigational and Operational requirements

The basic navigational and operational requirements to service the vessels calling at a terminal are:

- Sufficient depth in manoeuvring area and at the jetty
- Sufficient depth and width in approach/navigational channel
- Adequate berthing infrastructure including berth fixtures like fenders
- Mooring system
- Navigational aids

Vessels Proposed for Dry Bulk Cargo

The dimensions of manoeuvring areas are dependent on the design vessels arriving at the terminal and details of the same is presented in table below.

Vessel Type	Vessel Size (DWT)	LOA (m)	Beam (m)	Loaded Draft (m)
Barges	2,000	95	15	2.5

The detail design and proposed vessel specifications are provided in **Chapter 7: Vessel Design.**

5.3.2 RO-RO/ Ferry Terminal Facilities

A. MARINE FACILITIES

1. LAYOUT

The ferry terminals at proposed locations have been designed to facilitate the efficient operation of both roll-on, roll-off (ro-ro) and passenger ferries. A single ferry berth is provided at each site capable of handling all types of ferry vessels, but principally the combined RO-RO and passenger vessels which are expected to be the first vessels to use the terminals. An approach jetty is provided linking the berths to the shore allowing vehicular and pedestrian transfer between the shore terminal and the ferries. The layouts and designs that are shown in this and following chapters take account of the consultants' accumulated experience and in particular draw on the recommendations given in international design manuals and review of works carried out at other similar terminals.

The ferry berths 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 should that be appropriate. However, in order to minimise their initial capital cost attributable to the ferry service, separate berths sharing the approach jetty with the ferry traffic may be provided for use by other shipping lines.

2. RO-RO BERTH

Where possible the RO-RO berths are positioned in sufficiently deep water (4m depth at low water) to allow RO-RO vessels to have safe access to and from navigation channels at all states of the tide. However, at the proposed terminal locations viz: Noorpur, Gadiara and Geonkhali, where the deep water is some 200 m from the shore, the cost of the approach jetty would be more.

In view of this, two options for layout of RO-RO berths are proposed as:

a) The terminal is sited on bank with approach jetty of about 200 m length with platform at end for embarking/disembarking of vessels.
b) The terminal is sited on bank with extended platform in shallower water with the acceptance of some tidal restriction on operation.

However, considering the cost implication and impact on operation ability due to varying alignment of Jetty structure along the river flow direction, Option a) is considered most feasible and optimum and proposed hereafter.

The berths are aligned at an optimum orientation to resist the prevailing sea generated loading conditions. The most significant in this respect will be current flow because this would be present, albeit at different velocities, for most of the time. It will also be necessary to consider storm wave attack. Since the berths are being constructed in the river, the effect of storm waves will be considerably less as compared to open sea conditions.

Each terminal provides a berth for a single RO-RO vessel either alongside a jetty structure or against discrete berthing dolphins. In all case fenders are being provided to enable berthing to take place in most conditions without damaging either the vessel or the berth. Bollards are being provided along the length of the berth for the vessel to tie up and remain safely during loading and unloading operations. The layout of the berth is planned to suit the operational requirements of a wide range of ferry types. However, the requirements of ferry operators vary considerably and the RO-RO facilities are designed to suit the needs of specific vessels where these have already been identified.

3. LINKSPAN

A link is necessary between the ferry and the fixed shore installation. In essence this is a bridge supported at one end on the fixed jetty structure and at the other on the ferry or some other structure allowing the level to vary with tide and ferry configuration. It is required to provide for a single lane of traffic and be capable of carrying the heaviest vehicles which are expected to use the ferry. The slope of the link will vary according to the state of the tide and the vessel configuration, and the length of the bridge is chosen so that the gradient under normal conditions does not exceed 1:10. A steeper slope will occur under rarely occurring extreme low water conditions and will generally be acceptable, but it is possible that operations could be suspended for short periods.

In practice, the ferry is not capable of supporting the weight of the bridge and the traffic on- it, and the seaward end of the bridge must therefore be supported by other means. Typically the bridge may float on a pontoon or inbuilt buoyancy, or be supported from a fixed gantry with some means of adjusting the level. The bridge itself will be steel to reduce weight and may take any form, but will usually be a truss or box girder.

Fixed support at the seaward end will result in the lightest bridge structure, but this will be at the expense of a complex hoist system for controlling the level of the bridge. In general such a system is only justified in the most intensively used facilities serving vessels without stern ramps, and we have therefore chosen a buoyant system of support. Such as system will require much less maintenance. Such a system has the additional advantage that there is considerable degree of natural level control, and the consequence of any mechanical or electrical failure is much less critical. It is possible to provide support either in the form of a separate pontoon, on which the outer end of the bridge rests, or provide buoyancy tanks within an enlarged structure at the outer end of the bridge itself: We have opted for this latter solution as being the most economic, the weight of the bridge with tank being significantly less than the combined weights of pontoon and simple bridge. The enlarged tank section, which will coincide with the wider section of the bridge needed to serve the ferry will also contain a system of pumps which will be used to control and adjust the level of the bridge to suit individual ferries and tide levels.

For the bridge structure itself, we have selected a box girder design. This is now a standard form of construction, resulting in a light and economical structure. It is particularly suited to the marine environment in that the clean lines allow for easy maintenance. The box girder form allows the width of the bridge to vary, allowing the ship end of the link to be wider, providing access across the full width of the ferry; it is designed to support a short ramp from the ship. The buoyancy tank, which is an integral part of the structure, will be of similar construction and will contain a machinery room housing the pumping system.

The inner end of the bridge is supported by a hinge system mounted on a part of the jetty structure. This hinge will allow principally for the rise and fall of the linkspan in response to tidal changes, but will also allow horizontal movement to the extent permitted by the restraining structures at the ship end. A buffer system between the linkspan and the hinge will absorb impact forces from ship contact. Design of the supports and bearings of the linkspan will be carried out to achieve robust fixity and degrees of freedom where necessary; - good inspection and maintenance will be necessary in use.

The same design is used at Noorpur, Gadiara and Geonkhali simplifying spares and maintenance; if necessary, linkspans could be interchanged. The ramp will require a power supply for level adjustment and a backup supply is provided; however the ramp itself is not at risk in the event of power failure.

4. PASSENGER BERTH

Berths for catamarans or small passenger ferries are provided alongside the main vehicle accesses. There is segregated access for passengers, although in practice it is unlikely that ro- ro vessels and the passenger ferries will berth simultaneously.

5. APPROACH JETTY

At all three terminal locations, the ferry berths are connected to the shore terminal by an approach jetty. The Jetty will support a two lane approach road with a 7.5m wide carriageway, 1.5m wide pedestrian access/walkway and a 1m wide strip for services such as electrical cables, water pipelines and telephone lines etc. This approach provides access to the RO-RO berth as well as any other berth constructed at the jetty head.

6. UTILISATION

It is intended that a regular service can be operated on a timetable without undue restriction by tidal conditions. Although the prevailing weather conditions are such that vessels will be able to operate for most of the year in the waterway stretch, it must be recognised that there will be some weather related downtime at all of the terminals. It would simply not be economic to construct the infrastructure to enable operation in all weather or tidal conditions. In the event of the most severe river/weather conditions, operations would cease at all terminals and storm control measures would have to be taken to ensure survivability of the structures.

The RO-RO berths have been designed to be as versatile as possible, permitting use by a wide range of vessels although the detailed design is be based on specific vessels. This will provide the opportunity for the operation of as many ferry services as possible. In common with most modern ferry terminals the berths will be designed to serve vessels with their own stern ramps. This covers the vast majority of RO-RO vessels currently in operation and will include provision for berthing of single and double door RO-RO vessels. It will not be possible to accommodate vessels without stern ramps without major modifications.

All roadways are designed to support road going trucks, buses and terminal trailer units. Suitable turning areas are provided for vehicles close to the berth with sufficient road space for vehicles to embark and disembark from the vessels. There will also be a setting down and picking up area for passenger buses alongside but clear of the main carriageway.

7. SAFETY

The berths and approach jetties are provided with appropriate safety equipment including lifesaving equipment, ladders and safety rails. The roads will be marked in lanes as appropriate and signs will be installed to direct traffic.

Navigation lights are located on the berth to mark its position and suitable ships to shore communications are provided for operational control of vessels at each terminal.

Pedestrian walkways are segregated from vehicle carriageways between the passenger shelter on the jetty and the ferries. The walkway along the jetty is marked by a kerb; this walkway is for general use by the public, and it is the intention that all foot passengers will use the walkway, to and from the ferry. Safety parapets or hand railings are provided along the edge of all roadways.

A detailed set of procedures will be prepared for the safe operation of the link between the ferry and the shore.

At all terminals, a fendering system will be incorporated to cater for both normal berthing impacts and abnormal accidental ship impact.

8. SERVICES

There will be a small operations, maintenance and storage room within the terminal building. This room will contain equipment necessary for operation of the link as well as spare parts and emergency equipment.

The electricity supply to the berth will be sufficient for power requirements of the operating equipment as well as flood lighting at the berth and lighting of the approach jetty and a standby generator will be installed in the terminal complex providing sufficient power for basic lighting and operation of the jetty and linkspan infrastructure. There will be a water supply piped to the berth to enable servicing of the vessel, cleaning and other incidental use. A telephone connection will be installed for direct communication with the shore terminal.

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 vessels from storage tanks on shore.

B. SHORE FACILITIES

The various facilities to be developed on the shore may be grouped in three major sections:

1. Building facilities;
2. Infrastructure (service) facilities;

1. BUILDING FACILITIES;

The following buildings are provided at each terminal:

i) Passenger terminal building (with embarking and disembarking facilities);
ii) Central administration and canteen building;
iii) Electrical sub-station and switch yard
iv) Service buildings such as: workshop, fire stat on, telephone exchange, emergency medical centre, etc;
v) Drivers'/terminal staff room
vi) Other buildings related to functional need of the onshore facilities such as: security cabins, compound wall etc.

2. INFRASTRUCTURE (SERVICE) FACILITIES

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 (not at every terminal);
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 terminal.

5.4 LAND DETAILS

Jamitya Jetty – Government Land

"Noorpur, Gadiara and Geonkhali Jetty – Government Land, additional land required around the existing jetties as per DPR is to be purchased from private owners.

Table 29 below provides the tentative quantity of land required for fairway development and upgradation/ construction of jetties.

Table 29: Land Required

Sl. No.	Jetty Name	Type of proposed Jetty	Land required
1.	Jamitya Jetty	Dry Bulk Cargo	20,000 m^2
2.	Noorpur Jetty	Ro-Ro	4,000 m^2
3.	Gadiara Jetty	Ro-Ro	4,000 m^2
4.	Geonkhali Jetty	Ro-Ro	4,000 m^2

Land Rate

As obtained from https://www.wbidc.com/industrial_parks/available_land.htm, the rate of land for the nearby locations from proposed jetty is about 3391.00 INR/sqm. The same is considered for estaimting the land cost for proposed terminals.

5.5 GEOTECHNICAL INVESTIGATIONS

Geological investigations are proposed at the proposed terminal locations to have a preliminary assessment of the foundation profile for proposed terminal infrastructures. Results of the investigations are used for preliminary engineering design of jetties and terminal buildings proposed in the DPR.

5.5.1 Regional Geology

Purba Medinipur:

The land of Purba Medinipur district is a quaternary alluvial deposition. As the district area is bounded by water bodies in two sides, it is a formation of fluvial-tidal deposition. Geologically the area is of recent origin. This region is 5-7 meters above mean sea level and average slope is 0-5 degree.

Pashim Medinipur:

The North and NW regions of Paschim Medinipur district area part of Chhota Nagpur Plateau in its eastern end and covered with hard laterite stone. The Plain of Silai land is found in the northern part of the district bordering Bankura district and is a portion of East Chhota Nagpur plateau. Most part of the region recent alluvium and laterite. Due to irregular alluvial deposition, the river bed causes floods in this area. Lower Kasai plain is located either sides of the Kasai river which is having alluvial deposition. Upland of Medinipur region is found in the north-western part of the Paschim Medinipur district and lies close to Odisha and Jharkhand, with sloping is from north-west to south-east. This is part of Chhota Nagpur Plateau which is formed with laterite. Some hills which are found in the extreme north are 82 meters to 223 meters in height.

Hugli:

This district is a part of Gangetic Delta which forms flat plains and there is remarkable topographical homogeneity. The district is broadly divided into two main natural divisions, the plains and the uplands. The flat alluvial plains being an extension of the Bankura terrain, the Western portion of the Dwarakeswar is upland and rocky. The Eastern portion is a plain area. The general slope is towards the South-East and in the low lying areas of this region some marshes are found. The region is practically a narrow strip of alluvial flat land which lies along the entire stretch of the district, its landform is characterised by the presence of many narrow silted valleys. The elevation of the district form the mean sea level is 15 metres.

South 24-Parganas:

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.

Howrah:

The geological predominance of the district as a whole is that it is a part of delta proper under the Lower Ganga Plain region. It occupies the western most portion of the great Ganga Delta. Its origin is a recent phenomenon dating back to middle Miocene period when the rivers from the Himalayas filled the 'Sag' or 'fore deep' caused by the Himalayan mountains building process. The pre-existing narrow neck of the Peninsular (Gondwana) landmass resulting in the formation of the Rajmahal-Garo gap ultimately diverts the waters of the ancient Siwalik river southward into the Bay of Bengal.

5.5.2 Physical Condition and Drainage[15]

West Bengal is the only state of India that extends from the Himalaya to the Bay of Bengal. A large portion of the state occupies the transitional zones between the Himalayas in the north and the Chhotanagpur plateau in the west to the plains of the Ganga-Brahmaputra delta (GBD) in the southern and eastern sections (**Figure 26**). Broadly, West Bengal has nine major physiographic units:

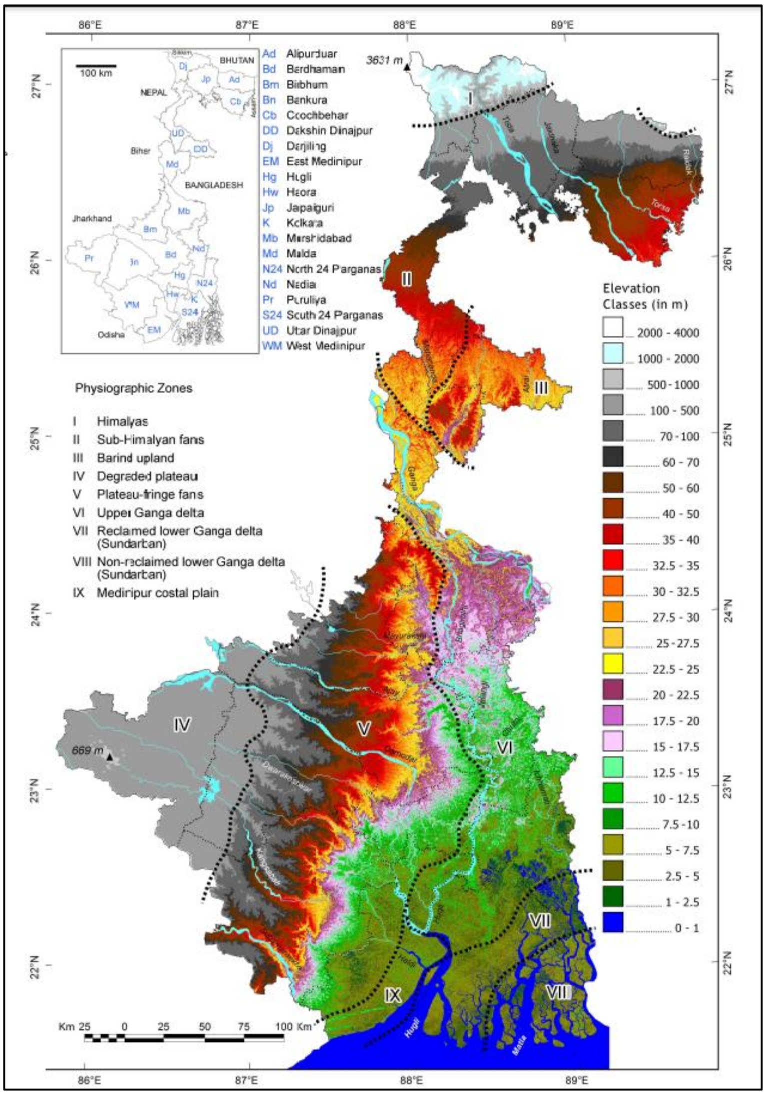

Figure 26: West Bengal: Physiographic divisions

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[15] Geological society of India special publication No. 3, 2014 "River Systems and Water Resources of West Bengal: A Review" by Sunando Bandyopadhyay, nabendu Shekar Kar, sayantan Das and Jayanta Sen

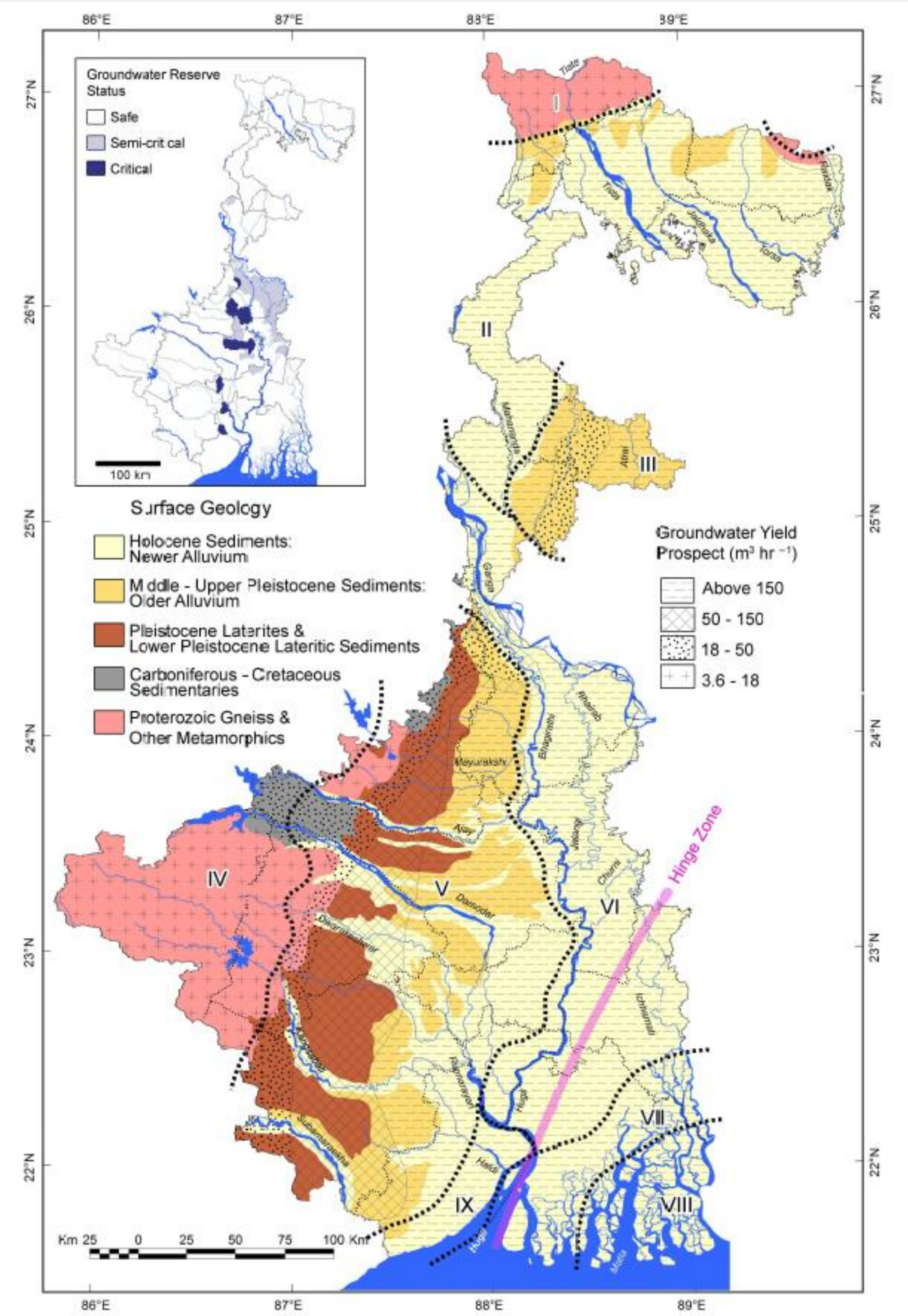


Figure 27: West Bengal: Geology and groundwater yield zones

(I) the Himalayas, (II) the sub-Himalayan alluvial fans, (III) the Barind uplands, (IV) the degenerated eastern fringes of the Chhotanagpur plateau, (V) the plateaufringe palaeodeltas resembling subdued fans at present, (VI) the primarily non-tidal upper Ganga delta, (VII) the tidal and reclaimed lower Ganga delta, (VIII) the tidally inundated lower Ganga delta occupied by the Sundarban mangroves and (IX) the Medinipur coastal plains primarily contributed by the Subarnarekha river. Each of these regions are represented by different sets of geological characteristics (**Figure 27**). The broad physiographic divisions coprising surface geology and drainage characteristics of regions along rupnarayan waterway is provided in **Table 30**.

Table 30: Broad physiographic divisions: Surface Geology and Drainage Characteristics

	Physiographic province		
	V. Plateau-fringe fans	**VI. Upper Ganga delta**	**IX Medinipur coastal plain**
Altitude range, average slope and area	5-115 m, 0.8°: 30,647 km^2	5-35 m, 0.4°: 15,905 km^2	0-15 m, 0.45°: 2,219 km^2
Physiography	Palaeodeltas developed at the eastern limit of Chhotanagpur plateau, merges with Ganga delta in the east. Badlands common on edges of laterites	Levees (with typical relief of 5-10m), floodplains, back-swamps and palaeo-channels	Chenier beach ridges in the west, partly obliterated by channels. Many small palaeo-channels with levees in the east.
Surface geology/ sediments	Pleistocene laterites (on highest levels in the west) and older alluvium; Holocene deltaic silt as flood deposit; sand in active channels; clay as paludal deposits	Holocene younger alluvium-flood sand, overbank deltaic silt, ponded clay and peat as paludal deposits; sand also occur in active channels	Holocene coastal deposits: tidal silt, beach and dune sand.
Principal drainage orientation	Tributaries to the Bhagirathi-Hughli: Flow east–southeast and south–south eastward.	Distributaries of Ganga, some of which turn into tributaries of the Bhagirathi-Hugli: Flow south and westward. Transforms into bidirectional tidal creeks and inlets at	Bidirectional south-east oriented tidal inlets.

	Physiographic province		
	V. Plateau-fringe fans	**VI. Upper Ganga delta**	**IX Medinipur coastal plain**
		coast.	
Surface drainage	Braided in the west and meandering in the east, channels and palaeochannels often radiate from an apex-resembling deltaic distributaries.	Meandering rivers with notable exception of the braided Ganga; cut-offs and palaeochannels in various states of decay omnipresent.	Embanked tidal inlets and regionally-fed short channels.
Surface storage	*Jor* tanks in the west; village pons and reservoirs of minor irrigation schemes; marshes and flood basins occur in the east.	Ox-bow lakes, channel cut-offs, decayed rivers and back-swamps; tanks associated with villages; aquaculture ponds.	Interdune marshes in the western part village tanks; aquaculture ponds.
Surface and ground water related hazards	Flooding in eastern sections, now largely controlled by river valley projects; annual flooding in some low-lying basins.	Occasionally flooded-mostly due to storm rainfalls and degenerated drainage network. Arsenic in ground water.	Coastal flooding due to breach in embankments during equinoctial tides and tropical storms; water-logging in the interiors.
Notable river projects	Mayurakshi Damodar valley and Kangsabati projects; drainage projects to reduce water-logging, river embankments.	Farraka barrage project; drainage projects to abate waterlogging; river embankments.	Medinipur canal project, coastal embankments.

5.5.3 Sub-surface Investigations

Soil Boring was carried out by Shell & Auger followed by Rotary Mud Circulation tools, operated by mechanical winch, to sink nominal 150 mm diameter boreholes. Auger was turned through auger pipes to cut soil at the bottom of the hole, which were in turn held in the auger & were drawn to the surface by pulling the auger out of the hole each time the auger was filled. In continuation to auger boring, Shell was used which is a 140 mm diameter heavy steel cylinder with a cutting edge under a hinged one-way flap valve, at the bottom. The borehole was advanced by raising the Shell upto desired height & allowing it to fall freely repeatedly till sufficient amount of soil enters in the Shell.

Geotechnical Laboratory tests on the soil samples were conducted as per the relevant provisions of different Sections of BIS Code. For proper identification and classification of the subsurface deposits and for deriving adequate information regarding the physical and engineering properties, the required laboratory tests pertaining to the soil types were conducted on the representative soil samples collected from boreholes.

Following laboratory tests have been conducted on the selected soil, rock & water Samples:

a) Natural Moisture Content
b) Grain Size Analysis (Sieve & Hydrometer)
c) Liquid Limit
d) Plastic Limit
e) Bulk Density
f) Vane Shear Test
g) Tri-axial Shear Test
h) Consolidation Test
i) Direct Shear Test
j) Specific Gravity
k) pH value, Sulphate content and Chloride content of soil samples & water samples

5.5.4 Geotechnical Results and Analysis

<u>Gadiara Site</u>

For geotechnical analysis purpose, the sub-soil at Gadiara site can be broadly distinguished in 3 (three) different strata upto the maximum depth of exploration of 25.0 m. At this jetty site, below the top 0.25 m thick, top soil, there exists a 'very soft', grey / bluish grey, silty Clay deposit (Stratum-I) continued upto a depth of 6.0 m from the Existing Ground Level (EGL), with SPT 'N' value as low as 1, followed by a, 'soft', bluish grey, organic, silty Clay deposit (Stratum-II) extended upto a design depth of 12.0 m. Below this & upto the maximum depth of exploration of 25.0 m, there exists a medium stiff, bluish grey, organic, silty Clay deposit (Stratum-III).

Geonkhali Site

The sub-soil at Geonkhali site can be broadly distinguished in 4 (four) different strata upto the maximum depth of exploration of 25.0 m. At this jetty site, below the top 0.30 m thick, top river deposit, there exists a soft, greyish brown / brownish grey, silty Clay deposit (Stratum-I) continued upto a depth of 4.2 m from the Existing Ground Level (EGL), followed by a very soft, bluish grey, organic, silty Clay deposit (Stratum-II) extended upto a depth of 11.0 m. Below this & upto 20.0 m depth, a soft, bluish grey, organic, silty Clay deposit (Stratum-III) has been encountered. This is followed by a medium stiff, bluish grey / brownish grey, sility Clay layer (Stratum-IV) continued upto maximum depth of exploration of 25.0 m.

Kolaghat Site

The sub-soil at this site can be broadly distinguished in 2 (two) different strata upto the maximum depth of exploration of 25.0 m. At this jetty site, below the top 0.40 m thick, top soil, there exists a soft to medium stiff, greyish brown / bluish grey, silty Clay deposit (Stratum-I) continued upto a depth of 20.4 m from the Existing Ground Level (EGL). Below this & upto the maximum depth of exploration of 25.0 m, there exists a medium stiff to hard, bluish grey / brownish grey, organic, silty Clay deposit (Stratum-II).

The details of Geotechnical Investigations, Lab Reports and pile design are provided in **Volume IV** of the DPR.

5.6 TERMINAL INFRASTRUCTURE INCLUDING EQUIPMENT

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

- **Phase – 1:** Cargo Terminal proposed at Jamitya to be constructed with the following infrastructure facilities for operation.

  a) 1 no. of 53 m length X 22.5 m wide RCC Jetty on Pile structure for dry bulk cargo (other cargo).
  b) 1 no. Jetty Approach 32m long X 8 m wide for the access to jetty no. 1.
  c) Cargo terminal should be optimally designed to utilise the tidal window maximum.
  d) Security office,
  e) Firefighting system (for Admin building only)

f) Weight bridge for weighing of the bulkers & trucks
g) Watch and ward, Compound wall, Electrical & PH Facilities including DG, etc.

- **Phase – 2:** Ro-Ro/ passenger Terminals at Noorpur, Gadiara and Geonkhali proposed to be constructed with the following infrastructure facilities for operation.

a) Link spans bridge approximately 12m wide and 25m in length for berthing of the passenger vessel RO-RO/Ferry vessel.
b) Pontoon Platform along with gangway for embarking/disembarking of the passengers.
c) Approach jetty and jetty platform for access to RO-RO/Ferry vessel.
d) Administration/Operational Building and Bank protection arrangement consisting of ticket office, Electrical & control room, terminal office, waiting area, approach platform, etc.
e) Vehicle Parking area,
f) Space for future development
g) Firefighting system

It is also proposed to provide Pontoon and Gangway facility at Ameria and Tamluk jetties. The detailed engineering & design of terminals shall be carried out during the construction stage. The preliminary layout shown in Volume 2 drawing is proposed for the DPR purposes only.

Major facilities provided at Jamitya cargo terminal for safe and efficient terminal operation are discussed in detail as below

5.6.1 Jetty and Jetty Approach

RCC jetty Platform of 53m X 22.5m has been proposed for ease and access of the respective vessels. The Jetty shall be connected to the terminal building via jetty approach of 8 m wide. Both Jetty Platform & approach shall be RCC structure on piles.

5.6.2 Terminal Buildings

The following terminal buildings are proposed for the Jamitya Cargo terminal:

1. Terminal Administration Building

It will be 2-storied building housing the following:

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

It is assessed that the terminal administration building shall be of size 20m X 15m and will have a total floor area of 600 sqm (300 sqm per floor).

2. Security Office

This will be a single storied building for security personnel of size 5m X 5m, and shall be provided near the terminal entrance.

3. Weigh Bridge Building

This will be a single storied weigh bridge cabin with operator’s space, and shall be provided near the terminal entrance for weighing of the trucks/bulker trucks. The weigh bridge structure shall be robust in construction with ample safety margin above the rated capacity. The lower structure of the platform shall comprise of wide flanged steel beams and high grade tested steel. The structure shall be suitably painted with special anti-corrosion epoxy based paint. The assembly shall be designed to compensate for expansion and contraction between the Weigh Bridge and foundation, caused by temperature variation.

The load cells shall be sealed and compression type suitable for pit less weigh bridge installation. Each load cells shall be of rated capacity having safe overload limit of 150% and breaking load of 300% of rated capacity. Each load cell shall have safe temperature range 0-65 degree Celsius and shall be weather proof IP-68 protection. Weigh bridge electronics shall be micro controller based with standard software capable of providing various kind of information on selectable basis.

The system shall be provided with communication facility with the main PIC in the control room and a real time clock to print date and time on the printouts. The system shall be provided with suitable PC with software and printer of latest technology.

4. Sub-station/Transformer Room

The electrical Substation cum Transformer room of size 6m X 20 m shall be located near approach jetty shall be utilised for installation on required transformer and HT/LT panels.

5. Overhead water tank

The overhead water tank above terminal administration building shall be provided to cater need of the daily water demand of the admin and worker amenities building. The minimum capacity of the overhead tank shall be 60 m3 A tubewell & submersible pump of suitable capacity shall be put near admin building to pump ground water into overhead tank. The potable water will be pumped into an overhead tank, from where the potable water shall be supplied to the desired located by gravity.

5.6.3 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.

5.6.4 Internal roads

Based on the traffic study, it is implicit that both the import and export cargoes will be carried to and from the hinder land through road only. Therefore, providing well-planned internal road from terminal entry gate upto the jetty approach is essential for effective functioning of the terminal. Accordingly, the internal roads shall be provided with the capacity to cater the proposed traffic.

Inside the terminal area, a 2-lane road (min. 8 m) is proposed for movement of the bulk carriers/trucks/maintenance trucks/office cars.

5.6.5 Sewerage System

Sewerage system for the terminal admin building 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

Preferably the Sewerage generated from the terminal admin building shall be dispose-off to the public / city sewerage system outside terminal boundary. In case public / city sewerage system is not available in nearby vicinity then the below STP system is envisaged inside terminal area. The required size STP shall be constructed in the available space. Features of the system are as below:

- A fab based package STP of 12KLD are proposed for the sewage generated from the terminal building. Final 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 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.

5.6.6 Firefighting System

Dry type fire fighting system has been envisaged for Terminal admin building. For terminal building Dry type fire extinguishers will be provided for tackling in care of fire.. Beside above, a continuous back up support will be provided by fire tenders round the clock. For future developments, separate dedicated firefighting system may be required based in the future requirements.

CLASS OF FIRE

Class A: Fires involving materials such as wood, paper, fibers and the like which are in a solid form.

Class B: Fires involving materials such as kerosene, petrol, paints, grease, solvents and the like which are in a liquid form.

Class C: Fires of an electrical nature involving electric equipment resulting from combustion of circuit breakers, wires, and other electric devices and equipment.

Class D: Fires involving materials such as magnesium, aluminium and the like which are reactive chemicals or active metals.

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.

<u>Quantity</u>

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 m2 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.

<u>Location</u>

Generally Portable Fire Extinguishers (PFE) are to be placed as near as possible to exits or staircase landings by also taking into consideration (wherever possible) the normal routes of escape of persons. Placing 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 Administrative Building

a. Ground Floor:

Area = 20m X 15m : 300 m^2

Type of Fire Extinguishers Selected : (i) 1 X 5kg, DCP (Dry Chemical powder) Type ABC inside Electrical panel /Control room

(ii) 1 X 5kg, CO_2 (Type ABC) inside office Area

b. First Floor:

Area = 20m X 15m : 300 m^2

Type of Fire Extinguishers Selected : 5kg, CO_2 (Type ABC)

Nos. of Fire Extinguishers Selected : 2 (wall mounted)

c. Terrace Floor (Inside Lift Room):

Type of Fire Extinguishers Selected : 5kg, CO_2 (Type ABC)

Nos. of Fire Extinguishers Selected : 1(wall mounted)

5.7 BERTHING STRUCTURE

The berthing structure for RO-RO/Ferry and dry bulk cargo terminal proposed for Rupnarayan waterway should have:

- Berthing facility for dry bulk cargo ships,
- Sufficient draft to have safe navigation of ships to and from the terminal,
- Land based facilities for transit storage of bulk cargos (open area only),
- Berth should be accessible for RO-RO vessels having adequate turn-around space,
- Scope for future development.

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

- Average Parcel Size
- Cargo handling arrangement
- Cargo handling rates
- Number of operational days per year
- Number of working hours per day
- Effective working hours per day
- Time required for peripheral activities

The jetty shall have utility trench/duct to pipe lines, cables etc., and it shall run all along the berth. The trench covers shall be seated properly and shall be intact with the trench side walls.

The jetty shall have all the required accessories/fixtures including but not limited to the following:

- Fenders including all its ancillaries
- Bollards
- Mooring rings on berth face
- Safety ladders
- Handrails
- Wooden / stainless steel rubbing strip for the protection of edges of berth from rubbing of mooring ropes.
- Drain pipes shall be embedded at regular intervals. The proposed jetty shall be provided with suitable slope to drain off storm water.
- Galvanized iron edge angles at various locations including on the sides of openings/pits.
- Marking on top of deck slab

The proposed RCC jetty shall be connected to terminal by approach jetty to respective berths/area shown in Layout drawing.

The approach jetty proposed to have a clear width of 8 m (6 m for movement of vehicles & 2m wide corridor for the placement of hoses, pipes, cables and other utilities.

Approach Jetty is designed to cater the movement of vehicular traffic in addition to the movement of maintenance cranes.

AVERAGE PARCEL SIZE

Though the design vessel size is the guiding parameter in arriving at the dimensions of the navigable water ways, in actual practice vessels of various sizes will arrive at the IWT terminal. For ascertaining the requirement of number of pontoon platform & berth, it is prudent to consider the average parcel size for each proposed commodity and details of the same are presented below.

Table 31: Average Parcel Size for proposed commodity

Commodity	Average Parcel Size (MT)	Inward/Outward
Flyash and Cement	2000	Outward
Gypsum and Clinker	2000	Inward

5.8 TERMINAL COSTING

The cost estimate for RO-RO/Ferry terminals proposed at Noorpur, Gadiara, and Geonkhali, Pontoon & Gangway facilities at Amaria & Tamluk and dry bulk cargo terminal proposed at Jamitya, 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 and Dry Bulk Cargo terminal and RO-RO/Ferry terminal proposed in Phase-1 and Phase 2 is provided in **Table 32** and **Table 33** respectively.

Table 32: Capital Cost for Dry Bulk Cargo Terminal

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lacs)
1	Berth / Jetty X 1 nos. (53m X 22.5m)	m^2	1192.5	75,000	894.38
2	Jetty Approach 8m wide (for Jetty no-1)	m^2	256	75,000	192.00
3	Supply & installation of Fenders	Nos	30	6,00,000	180.00

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lacs)
4	Admin /Operating Building (20m X 15 m), 2 floors	m^2	600	40,000	240.00
5	Fire Fighting System for admin building only	lot	lot	LSM	5.00
6	Electrical Substation / Transformer Room (20m X 6m) (excluding equipment cost)	m^2	120	30,000	36.00
7	Electrical, Water & Utility	lot	lot	LSM	30.00
8	Sewage Treatment Plant	No.	1	40,00,000	40.00
9	Road Weigh Bridge including installation	No.	1	20,00,000	20.00
10	Weigh Bridge Control room	m^2	25	18,000	4.50
11	Security Office (5 m X 5m)	m^2	25	18,000	4.50
12	Boundary Wall (185m X 105M- opening lengths = 555 (aaprox.))	m	555	17,000	94.35
13	Internal Roads (including land filling, levelling, compaction, etc. (For min 08m wide road)	m	184	60,000	110.40
14	Overhead Tank (above admin building)	No.	1	10,00,000	10.00
15	Submersible Pump including borehole digging, installation of pump, accessories, electrical & controls, pipes & laying etc. for potable water requirement	No.	1	8,00,000	8.00
Total					**1,869.13**

16	Cost of Detail Engineering	4%	74.8
17	Construction supervision	6%	112.1
	Total		**2,056.04**

18	Contingency @3%	61.68
	Total Capital Cost for Dry Bulk Cargo Terminal Excluding land cost	**2,117.72**

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lacs)
19	Land Cost for proposed terminal	m^2	20,000	3391	678.2
20	Contingency @3%				20.35
	Total Land Cost				**698.546**
	Total Capital Cost for Dry Bulk Cargo Terminal including Land Cost				**2,816.26**

Table 33: Capital Cost for RO-RO/Ferry Terminal

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lacs)
1	Jetty Platform (20m X 18m)	m^2	360	75,000	270
2	Jetty Approach 10m wide (150m X 10m)	m	150	75,000	112.5
3	Link Span Bridge Cost including Span Structural cost- INR 250 Lacs (approx.) Support Structure & Piling Cost- INR 450 Lacs (approx.) Hydraulic lifting mechanism cost - INR 250 Lacs (approx.) Equipment Cost-INR 50 Lacs (approx.)	no.	1	…	1,000.00
4	Passenger Approach Area/ Bus Car Drop Off Area (4m X 15 m)	m	15	40,000	6
5	Pontoon Platform (10m X 5M)	m^2	50	50,000	25
6	Gangway (15m long X 2.0 m wide) X 1 nos.	m^2	30	7,500	2.25
7	Telecomm Room Equipment's	lot	…	LSM	200
8	Gate Complex	No.	1	75,00,000	75
9	Admin /Operating Building (27m X 20. m), 2 floors	m^2	1080	40,000	432
10	Lift for Building	no.	1	10,00,000	10
11	Ticket vending Machine & installation cost	No.	1	4,00,000	4
12	Automatic Fare collection gates (4 X 2 at Entry gates + 4X1 at Exit Gate)	No.	3	3,00,000	9
13	Passengers Arrival / Exit Area (25m X 12 m)	m^2	300	35,000	105
14	Visitors parking Area (15m X 12 m)	m^2	180	18,000	32.4
15	Passengers Waiting Chairs	No.	50	2,500	1.25
16	Worker's Amenity Building including locker room, toilets, etc.	No.	1	10,00,000	10
17	Underground Water Reservoir including pump	No.	1	10,00,000	10
18	Fire Pump House Cost (5m X 10m)	m^2	50	25,000	12.5

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lacs)
19	Substation / Transformer Room (excluding equipment cost)	No.	1	10,00,000	10
20	Fire Pump House (including Fire Pumps, Pump Electrical & Controls, Maintenance cranes, etc.) (5m X 10m)	lot	…	LSM	40
21	Fire Fighting System (Other equipment cost such as Extinguishers, alarms, etc.)	lot	…	LSM	10
22	Electrical, Water & Utility	lot	…	LSM	75
23	Security Office (5m X 5m)	m^2	25	18,000	4.5
24	Truck / Car Parking Area for RO-RO Service (35m X 30m)	m^2	1050	15,000	157.5
25	Ro-Ro vehicle ticket/security area (5m x 5m)	m^2	25	20,000	5
26	Truck entry/exit gate to Ro-Ro vessel (including operator's cabin)	No.	1	5,00,000	5
27	Sewage Treatment Plant cost including Civil construction, equipment's, pumps, etc.	No.	1	50,00,000	50
Total					**2,673.90**

28	Cost of Detail Engineering	4%	106.96
29	Construction supervision	6%	160.43
	Total		**2,941.29**

30	Contingency@3%	88.24
	Total Capital Cost in INR Lacs for 1 terminal	**3,029.53**
	Total Capital Cost in INR Lacs for 3 terminal	**9,088.59**

31	Pontoon Platform (10m X 5M) X 2 nos. each for Amariya and Tamluk	m^2	100	50,000	50
32	Gangway (15m long X 2.0 m wide) X 2 nos. each for Amariya and Tamluk	m^2	60	7,500	4.5
	Total				**54.50**

33	Cost of Detail Engineering for Sl. no. 31 & 32.	4%	2.18
34	Construction supervision for Sl. no. 31 & 32.	6%	3.27
	Total		**59.95**

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lacs)
35	Contingency@3% for Sl. no. 31 & 32.				1.80
	Total Capital Cost in INR Lacs for for providing Pontoon and Gangway at Amariya and Tamluk				**61.75**

	Total cost of Passenger Terminals excluding Land cost	**9150.33**

36	Land Cost for proposed terminal	m^2	12,000	3391.00	406.89
37	Contingency @3%				12.21
	Total Land Cost				**419.10**

	Total Capital Cost for Passenger Terminals including Land Cost	**9,569.43**

5.8.2 O&M Cost

Operation and Maintenance including cost to be incurred for running terminal facilities for Dry bulk cargo and RO-RO terminals are provided as below.

Dry Bulk Cargo Terminal

a) Manning

The efficient operation of a Cargo terminal requires a substantial number of staff.

These include:-

- The Management comprising the operating Manager, the Operating Superintendent, Pontoon & Jetty Operators, deputies, etc.;
- The operating staff mainly comprises of Terminal Manager, pontoon & jetty Operators, Cargo Handling gangs, traffic marshals, etc.;
- The Accounts Department comprising the Financial Manager and clerical assistants;
- 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 three (3) shift basis is estimated as provided in **Table 34.**

Table 34: Manpower Requirement for Cargo Terminal Operation

Sl. No	Staff	Number for 1 Terminal
1	Management	6
2	Operating Staff	66
3	Accounts Staff	6
4	Security Staff	12
5	Maintenance Engineering Staff	15
6	Admin	19
7	Other/Misc. Staff for Field Works	6
	Total	**130**

Table 35: Manpower cost per Annum at Jamitya

Sl. No.	Location	No./Shift	No. of Shift required	Total no. of Personnel required	Rate (INR)	Cost (INR)
1	Berth @3 persons per berth	9	3	27	3,00,000	81,00,000
2	Security Office	4	3	12	3,00,000	36,00,000
3	Maintenance Shed / Work shop	3	3	9	4,00,000	36,00,000
4	Weigh Bridge	1	3	3	2,80,000	8,40,000
5	Fire pump house	1	3	3	3,00,000	9,00,000
6	Admin Building	5	3	15	4,50,000	67,50,000
7	Accounts	2	3	6	5,00,000	30,00,000
8	Designer /Draught men	2	2	4	4,00,000	16,00,000

Sl. No.	Location	No./Shift	No. of Shift required	Total no. of Personnel required	Rate (INR)	Cost (INR)
9	Senior Officers	3	2	6	5,00,000	90,00,000
10	Bulker unloading Area + Silo	3	3	9	3,50,000	31,50,000
11	Storage Shed / Area	3	3	9	2,80,000	25,20,000
12	Open Storage Area	3	3	9	2,80,000	25,20,000
13	Plumber	1	3	3	3,00,000	9,00,000
14	Electrician	1	3	3	3,00,000	9,00,000
15	Misc. for Field Works	2	3	6	3,00,000	18,00,000
	Total			**124**		**4,31,80,000**

From the above table, the total annual manpower cost required for running the facilities at Jamitya terminal works out to INR 4,31,80,000/- (**INR 431.80 Lacs** annually) considering round the clock operation at the terminal in three(3) shifts.

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 works out as **INR 21.18 Lacs.**

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 all the terminals from works out as **INR 63.53 Lacs.**

RO-RO/Ferry Terminal

a) Manning

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

- The Management comprising the Port Manager, the Operating Superintendent and their deputies;
- The operating staff comprising the Terminal Manager, the Linkspan Operators, Cargo Handling gangs, traffic marshals etc;
- The Accounts Department comprising the Financial Manager and clerical assistants;
- 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 each terminal on a two shift basis is estimated as provided in **Table 36.**

Table 36: Manpower Requirement for RO-RO/Ferry Terminal Operation

Sl. No	Staff	Number for 3 terminals
1	Management	3
2	Operating Staff	28
3	Accounts Staff	4
4	Security Staff	24
5	Maintenance Engineering Staff	10

Sl. No	Staff	Number for 3 terminals
6	Administration Staff	11
7	Misc. Staff for Field Works	20
	Total	**100**

Table 37: Manpower Cost per annum at RO-RO/Ferry terminals

Sl. No.	Location	No./Shift	No. of Shift required	Total no. of Personnel required	Rate (INR)	Cost (INR)
1	Terminal @3 persons per terminal	9	2	18	3,00,000	54,00,000
2	Security Office	12	2	24	3,00,000	72,00,000
3	Maintenance Shed / Work shop	3	2	6	4,00,000	24,00,000
4	Fire pump house	3	2	6	3,00,000	18,00,000
5	Admin Building	5	2	10	4,50,000	45,00,000
6	Accounts	2	2	4	5,00,000	20,00,000
7	Designer /Draught men	1	1	1	4,00,000	4,00,000
8	Senior Officers	3	1	3	15,00,000	45,00,000
9	Plumper	1	2	2	2,80,000	5,60,000
10	Electrician	1	2	2	2,80,000	5,60,000
11	Misc. for Field Works	10	2	20	2,80,000	56,00,000
	Total cost at all RO-RO terminals			**96**		**3,49,20,000**

From the above table, the total annual manpower cost required for running the facilities at Noorpur, Gadiara and Geonkhali terminals works out to INR 3, 49, 20, 000/- (INR **349.20 Lacs annually**).

b) Utilities and Services

The annual cost of providing water, electricity and other services is considered as about 0.25% of the capital cost. Thus, the annual cost for providing Utilities and Services works out as **INR 22.88 Lacs**

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 1% of the capital cost. Thus, the annual maintenance cost for all the terminals from fifth year onwards works out as **INR 91.50 Lacs.**

The total O&M cost of proposed terminals are provided in terminal **Table 38** below

Table 38: Annual O&M cost of terminals

Sl. No	Item	Cost (INR) Lacs
Dry Bulk Cargo Terminal at Jamitya (Kolaghat)		
1.	Manpower	431.80
2.	Utilities and Services	21.18
3.	Maintenance	63.53
Total annual O&M cost for Dry Bulk Cargo Terminal		**516.51**
RO-RO / Ferry terminal at Noorpur, Geonkhali and Gadiara		
4.	Manpower	349.20
5.	Utilities and Services	22.88
6.	Maintenance	91.50
Total annual O&M cost for Ro-RO / Ferry terminal		**463.58**
Grand Total		**980.09**

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 (INCLUDING BARRAGES AND LOCKS, IF PROPOSED)

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

6.2 BANK PROTECTION

As stated in the earlier sections, no bank protection works for IWT operation is proposed in 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 Jetty
- Preparation for berthing, including possible turning of the ship and pre-berthing procedures
- Berthing including mooring, etc. to the berth structure
- Loading and unloading operation while at berth
- Unberthing from the berth structure
- Departure from the Jetty

Navigation aids for the waterway and terminals are required to ensure safe and efficient navigation of ships navigating through the waterway and embarking/disembarking at terminals. It is required that that navigation will be carried out throughout the year, by day and night, except during cyclonic weather.

Aids to navigation and other communication facilities proposed along Rupnarayan waterway is provided in detail in Chapter 8 of the DPR.

6.4 CARGO TERMINALS AND RIVER PORTS

Preliminary engineering design required for DPR level costing and analysis for jetty, terminal structures and access infrastructure is done and provided as below for Dry bulk cargo and RO-RO 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 Design Levels

Maximum Water Level = +5.94 m (MHWS)

Minimum Water Level = -1.515 m (Sounding datum as obtained from Hydrographic Survey Report)

Deck Level = +6.50 m (MHWS + Freeboard of 0.5m = +6.44m ~ +6.50 m)

6.4.2 Dry Bulk Cargo Terminal

The objective of this chapter is to present design of marine & landside facilities required for development of Cargo terminal. The following are the main facilities required for operation of the terminal:

- Cargo Berth
- Approach jetty
- Weigh Bridge
- Substation
- Administrative Building
- Internal road

A. STRUCTURAL SYSTEM

The overall Layout showing location of facilities is shown in drawing PT/EIPTIWB003/2017/DPR/0010.

The approach jetty is an open piled structure, 32 m long and 8.5 m wide with a deck elevation of +6.50 m CD. The pile spacing of 0.750 m dia pile is 4.5m in longitudinal direction and 5 m in transverse direction. Beams of 1.0m wide and 1.2m deep in both directions connect the piles. The deck slab, which accommodates the deck furniture, is 0.35 m thick.

The cargo berth is 53m long and 22.5m wide piled structure. The structure is supported by 1.0m dia piles. The spacing in longitudinal direction and transverse direction is 5.0m. The deck slab is 0.35m thick and elevation of the same is +6.50m CD.

Administrative building is provided for efficient management of port operations.

B. CONSTRUCTION METHODS

The construction method proposed for jetty and jetty 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

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) Wind Load
4) Wave Load

5) Current Load
6) Berthing Load
7) Mooring Load
8) Seismic Loads
9) Temperature and Shrinkage Effects

The values of intensities of the above loads that have been considered in design are detailed in the following sections:

1) Dead Load:

The following unit weights are used in design

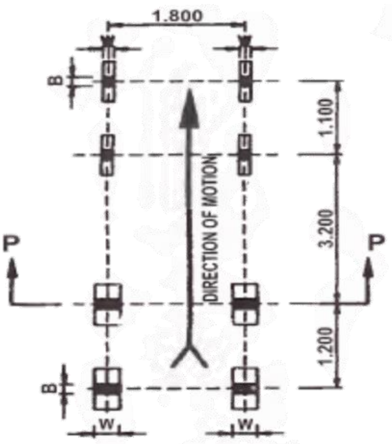
Reinforced Cement Concrete	2.5 T/m^3
Structural Steel	7.85 T/ m^3
Density of sea Water	1.025 T/ m^3

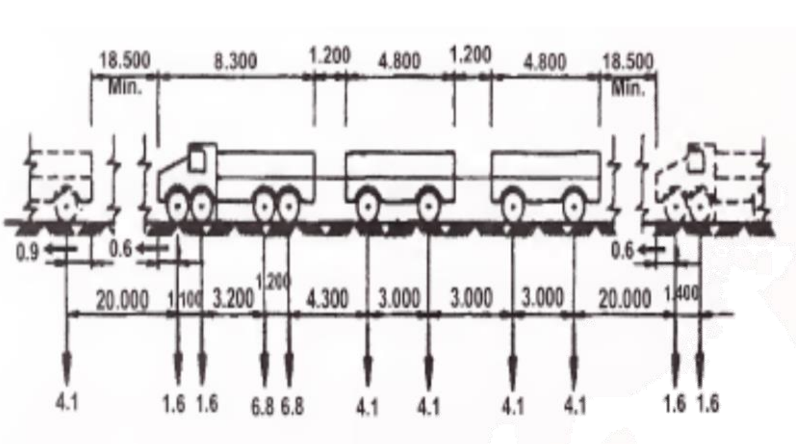
2) Live Load:

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

In addition to the above load the jetty and approach is also checked for Class B truck load as per IRC: 6-2014. The details of the same are presented below for ready reference





Driving Vehicle: Plan

Class B Train of Vehicles

3) Wind Load:

The basic Wind Speed in the region are as given below:

Operational Wind speed	24 m/s
Extreme Wind Speed	47 m/s

Based on the above parameters, the calculated wind pressures are as follows

Calculated Wind Pressure-Normal Condition	0.339 kN/m^2
Calculated Wind Pressure-Extreme Condition	1.3 kN/m^2

4) Wave Load:

Based on observed wave conditions, the effects of wave are found to be insignificant and hence not considered in design.

5) Current Load:

Design current velocity considered for calculation of current load is as given below:

Condition	Velocity
Operational	0.5 m/s
Extreme	1.5 m/s

Based on the above parameters, the calculated current force are as follows

Condition	Load
Operational	0.089 kN/m
Extreme	0.699 kN/m

6) Berthing Load

The details of proposed ship are summarized below:

Overall Length (LOA)	85 m
Length Between Perpendiculars (LBP)	75 m
Beam of the vessel (B)	15 m
Depth of the vessel (D)	5 m
Fully Laden Draught	2.5 m
Dead weight Tonnage (DWT)	2000 T
Berthing Velocity (V)	0.25 m/s

Based on parameters in design basis, Berthing load is calculated and the same is furnished below for ready reference.

Berthing Energy – Operational Condition	46.3 kNm
Berthing Energy – Extreme Condition	93 kNm
Recommended fender	Cylindrical 1000 x 500
Fender Reaction – Operational Condition	321 kN
Fender Reaction – Extreme Condition	500 kN
Spacing of fender	10 m

7) Mooring Load

Mooring load is calculated for the following conditions:

- Normal condition- Wind Speed at 18m/s & Current speed at 0.5m/s
- Extreme Condition- For full Capacity of Bollard (Recommended bollard Capacity is 75MT)

Based on parameters in design basis, mooring load is calculated and the same is furnished below for ready reference

Mooring Load – Operational Condition	71 kN
Mooring Load – Extreme Condition	538 kNm
Recommended Bollard	Pipe Bollard
Bollard Capacity	75 T

8) 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 Reduction Factor	3

9) Temperature and Shrinkage Effects

The maximum and minimum temperature in site location is 41° and 7.2° respectively as per IS -875 part 5. Hence the mean temperature is 24.1°. Temperature during construction is considered mean temperature +/- 10°. Shrinkage strain in reinforced concrete elements is taken as 0.0002 as per IRC 6: 2010. Effects of shrinkage are also converted into equivalent temperature

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	Earth Pressure (EP)	1.0	1.0	1.2	1.0	1.0	1.0
5	Hydrostatic Force (HyF)	1.0	-	1.0	1.0	1.0	1.0
6	Wave & Current Force (WL-CL)	1.0	-	1..2	1.0	1.0	1.0
7	Berthing Force (BF)	1.0	-	1.5	1.0	-	1.5
8	Mooring Force (MF)	1.0	-	1.5	-	-	1.5
9	Working Wind Force (WWiF)	1.0	-	1.0	-	-	
10	Extreme Wind Force (EWiF)	-	-	-	1.2	-	1.5
11	Shrinkage	-	1.0	-	-	-	-
12	Creep	-	1.0	-	-	-	-
13	Temperature Load (TempL)	-	1.0	-	-	-	-
14	Seismic Load (SL)	1.0	-	-	1.2	-	1.5
15	Tsunami Load (TL)	-	-	-	1.2	-	-
16	Secondary Stress (SS)	1.0	-	-	-	-	-

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
	Fender	8 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.

GEOTECHNICAL PARAMETERS

Based on geotechnical investigation and available bore holes data, the top layer of soil is identified as silt or silty clay upto a depth of maximum 1m. This layer is a result of siltation in river. Below this, it is soft to medium stiff clay.

The pile fixity level calculation has been carried out based on IS 2911-Part1-Section 2 (2010). Based on calculation, the fixity length is worked out to 1.80m below bed level. On a conservative side, the same is taken as 2m and hence final fixity level of pile is identified as -6m CD

Founding level of piles are provided in geotechnical report provided in Volume IV of the DPR.

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 the structure. Piles and beams has 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 and geotechnical data as presented. The following figures give an in-sight of the modelling undertaken for analysis.

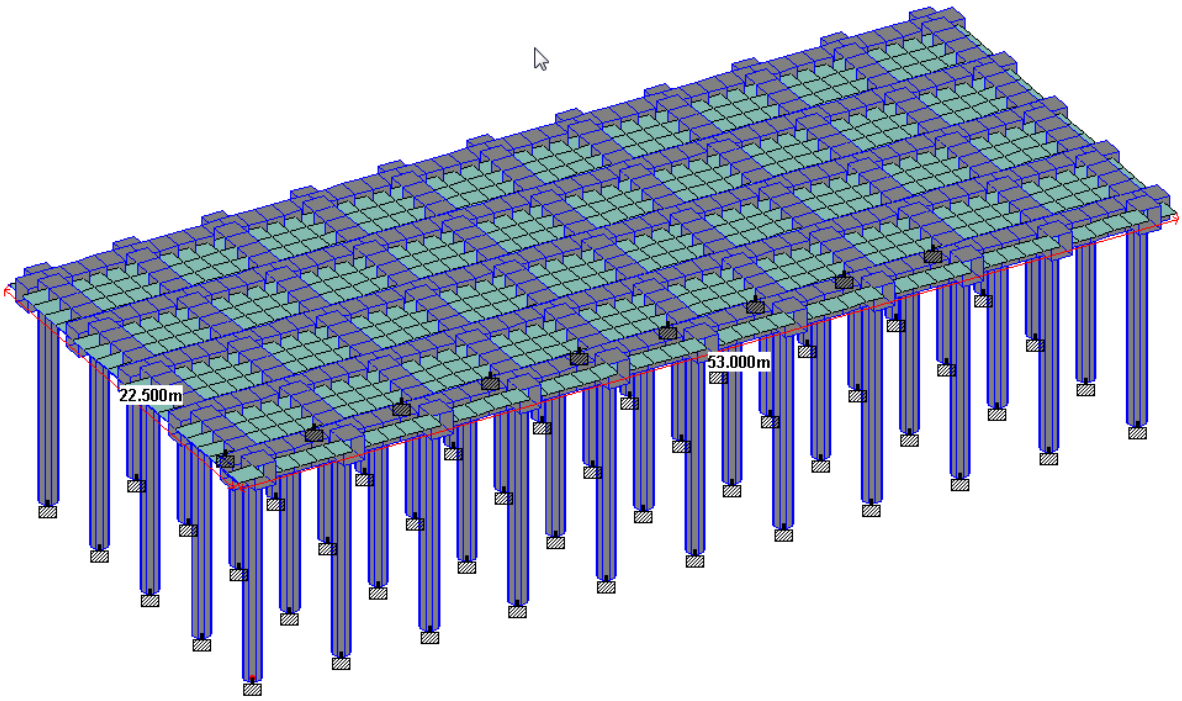


Figure 28: 3D View of STAAD Model – Cargo Berth

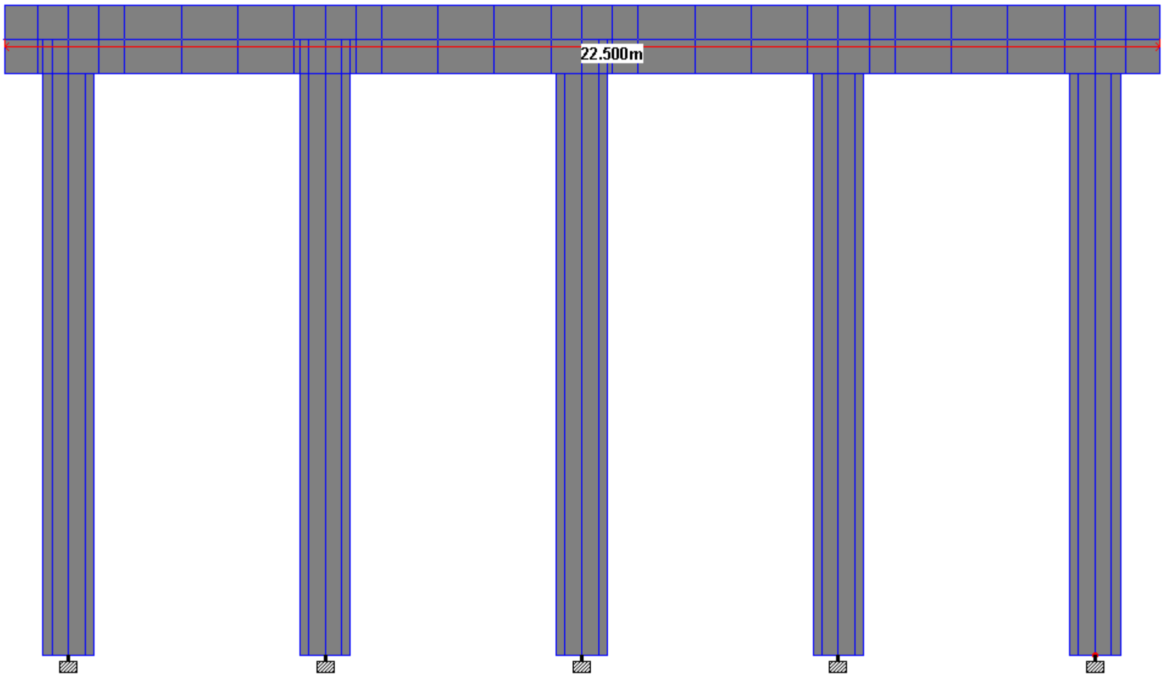


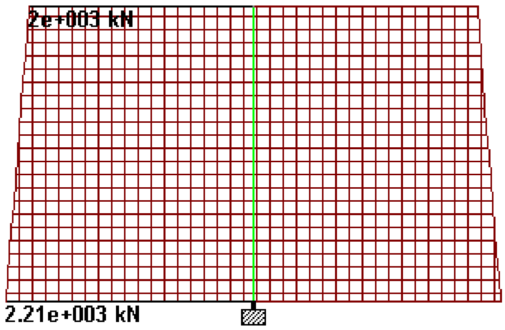
Figure 29: 2D View of STAAD Model – Approach Jetty

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.

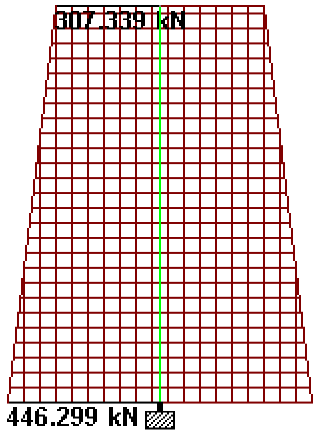
Limit State Design Method is used for design of structural components. All possible limit states are checked which includes serviceability and collapse limit states.

E. Analysis Results

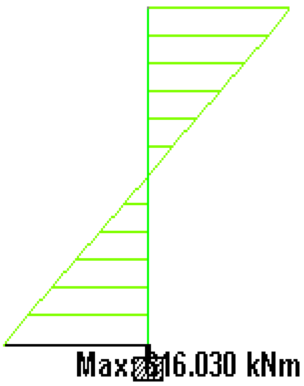
Results of the STAAD analysis for piles of the structure have been tabulated and given below



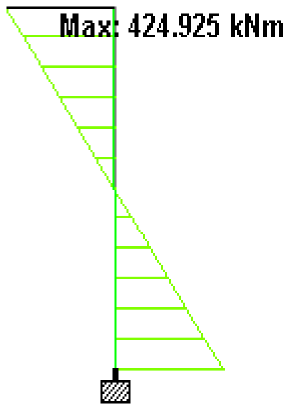
Max. Axial Force (ULS)



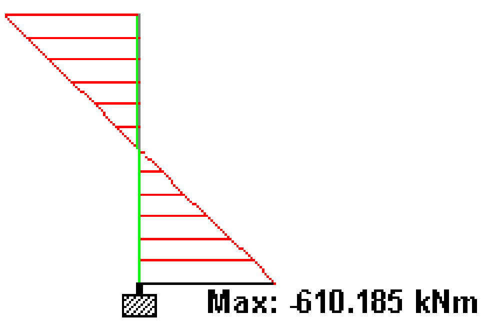
Min. Axial Force (SLS)

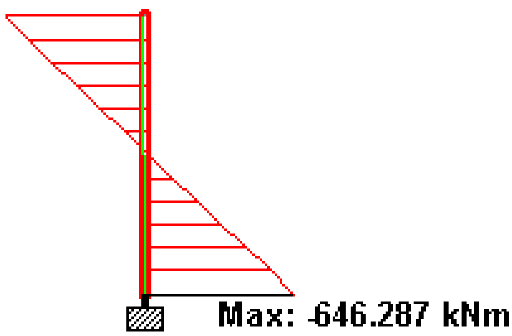


Max. Bending Moment My (ULS)



Max. Bending Moment My (SLS)





Max. Shear Force (ULS)   Max. Bending Shear Force (SLS)

Design of pile reinforcement

Design of longitudinal and helical reinforcement of pile is done as per IS:456-2000 & SP 16. Piles 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,	$L_d = \Phi\ \sigma_s / 4\ T_{bd}$	
Bond stress,	T_{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,	$\sigma s = 0.87\ fy$	= 435 MPa
	L_d	= 35.8 Φ
	Say	= 36 Φ

6.4.3 RO-RO and Passenger Ferry Terminal

The objective of this section is to present design of marine & land side facilities required for development of RO-RO and passenger ferry terminal. The following are the main facilities required for operation of the terminal:

- Approach Jetty & Jetty Platform
- Link Span Bridge
- Parking Facilities
- Terminal Building

A. STRUCTURAL SYSTEM

The overall Layout showing location of facilities is shown in drawing PT/EIPTIWB003/2017/DPR/0007.

The approach jetty is an open piled structure, 150 m long and 10 m wide with a deck elevation of +6.50 m CD. The pile spacing of 0.75 m dia pile is 4.5m in longitudinal direction and 4 m in transverse direction. Beams of 1.0m wide and 1.2m deep in both directions connect the piles. The deck slab, which accommodates the deck furniture, is 0.35 m thick. To accommodate the effects of berthing, arch fenders are proposed and the same is provided on fender wall of 0.2 m thick on either side of berth. Bollards are provided for safe mooring operations.

The jetty platform is 20m long and 18m wide piled structure. The structure is supported by 0.75m dia piles. The spacing in longitudinal direction is 4.5m and transverse direction is 4m. The deck slab is 0.35m thick and elevation of the same is +6.50m CD

The link span bridge is a steel platform hinged on the jetty platform and free on the other end. The free end rests on a hydraulic system which enables vertical movement of link span bridge according to the water levels for safe terminal Operation

Truck and car parking facilities are provided on land. 35m long and 30 m wide area is provided for the same. The facility is built upon a filling of average 2.5m thick. Parking facility is finished with interlocking cement concrete paver blocks.

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 jetty and jetty platform is as described below:

PILING

5) Drive steel liner up to refusal.
6) Bore inside the liner up to the founding level.
7) Lower Reinforcement cage and concrete the pile up to bottom of Pile muff.
8) Place sacrificial precast pile muff over the piles and concrete the annular space between the pile and pile muff.

ERECTION & CONCRETE WORK

6) 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.
7) Concrete inside the U beam upto the soffit level of bottom slab.
8) After the in-situ concrete attains strength place precast planks and precast Fender wall panel over the U beams.

9) Cast the in-situ portion of the bottom slab.
10) On completion of concrete works fixtures like fenders, bollards, pipes and cable support system shall be installed
11) 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) Wind Load
4) Wave Load
5) Current Load
6) Berthing Load
7) Mooring Load
8) Seismic Loads
9) Temperature and Shrinkage Effects

The values of intensities of the above loads that have been considered in design are detailed in the following sections.

1) Dead Load:

The following unit weights are used in design

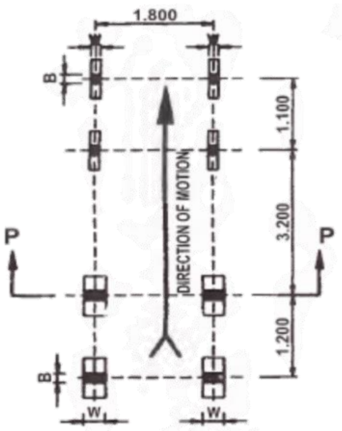
Reinforced Cement Concrete	2.5 T/m^3
Structural Steel	7.85 T/ m^3
Density of sea Water	1.025 T/ m^3

2) Live Load:

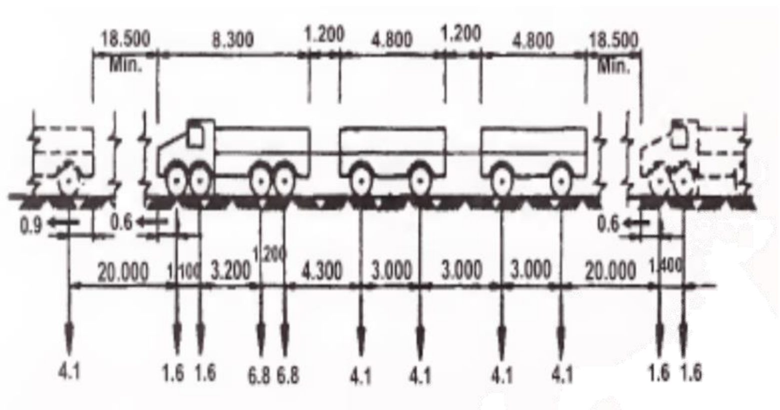
Live load on the jetty and approach structure is as per relevant Indian standards and the same is given below.

Load	Intensity
UDL – Jetty	25 kN/m^2
UDL – Terminal Building	5 kN/m^2

In addition to the above load the jetty and approach is also checked for Class B truck load as per IRC: 6-2014. The details of the same are presented below for ready reference



Driving Vehicle: Plan



Class B Train of Vehicles

3) Wind Load:

The basic Wind Speed in the region are as given below:

Operational Wind speed	24 m/s
Extreme Wind Speed	47 m/s

Based on the above parameters, the calculated wind pressures are as follows

Calculated Wind Pressure-Normal Condition	0.339 kN/m^2
Calculated Wind Pressure-Extreme Condition	1.3 kN/m^2

4) Wave Load:

Based on observed wave conditions, the effects of wave are found to be insignificant and hence not considered in design.

5) Current Load:

Design current velocity considered for calculation of current load is as given below:

Condition	Velocity
Operational	0.5 m/s
Extreme	1.5 m/s

Based on the above parameters, the calculated current force are as follows

Condition	Load
Operational	0.089 kN/m
Extreme	0.699 kN/m

6) Berthing Load:

The details of proposed ship are summarized below:

Overall Length (LOA)	62.4 m
Length Between Perpendiculars (LBP)	61 m
Beam of the vessel (B)	4.5 m
Depth of the vessel (D)	4.5 m
Fully Laden Draught	2.3 m
Displacement Tonnage (DT)	360 T
Berthing Velocity (V)	0.25 m/s

Based on parameters in design basis, Berthing load is calculated and the same is furnished below for ready reference.

Berthing Energy – Operational Condition	10.9 kNm
Berthing Energy – Extreme Condition	22 kNm
Recommended fender	Cylindrical 500 x 250
Fender Reaction – Operational Condition	136 kN
Fender Reaction – Extreme Condition	226 kN
Spacing of fender	10 m

7) Mooring Load:

Mooring load is calculated for the following conditions:

- Normal condition- Wind Speed at 18m/s & Current speed at 0.5m/s
- Extreme Condition- For full Capacity of Bollard (Recommended bollard Capacity is 50MT)

Based on parameters in design basis, mooring load is calculated and the same is furnished below for ready reference

Mooring Load – Operational Condition	56 kN
Mooring Load – Extreme Condition	431 kNm
Recommended Bollard	Pipe Bollard
Bollard Capacity	50 T

8) 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 Reduction Factor	3

9) Temperature and Shrinkage Effects

The maximum and minimum temperature in site location is 41° and 7.2° respectively as per IS -875 part 5. Hence the mean temperature is 24.1°. Temperature during construction is considered mean temperature +/- 10°. Shrinkage strain in reinforced concrete elements is taken as 0.0002 as per IRC 6: 2010. Effects of shrinkage are also converted into equivalent temperature

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	Earth Pressure (EP)	1.0	1.0	1.2	1.0	1.0	1.0
5	Hydrostatic Force (HyF)	1.0	-	1.0	1.0	1.0	1.0
6	Wave & Current Force (WL-CL)	1.0	-	1..2	1.0	1.0	1.0
7	Berthing Force (BF)	1.0	-	1.5	1.0	-	1.5
8	Mooring Force (MF)	1.0	-	1.5	-	-	1.5
9	Working Wind Force (WWiF)	1.0	-	1.0	-	-	
10	Extreme Wind Force (EWiF)	-	-	-	1.2	-	1.5
11	Shrinkage	-	1.0	-	-	-	-
12	Creep	-	1.0	-	-	-	-
13	Temperature Load (TempL)	-	1.0	-	-	-	-
14	Seismic Load (SL)	1.0	-	-	1.2	-	1.5
15	Tsunami Load (TL)	-	-	-	1.2	-	-
16	Secondary Stress (SS)	1.0	-	-	-	-	-

<u>SERVICEABILITY CRITERIA</u>

3) 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.

4) 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
	Fender	8 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.

GEOTECHNICAL PARAMETERS

Based on geotechnical investigation and available bore holes, the top layer of soil is identified as silt or silty clay upto a depth of maximum 1m. This layer is a result of siltation in river. Below this, it is soft to medium stiff clay.

The pile fixity level calculation has been carried out based on IS 2911-Part1-Section 2 (2010). Based on calculation , the fixity length is worked out to 1.74m below bed level. On a conservative side, the same is taken as 2m and hence final fixity level of pile is identified as -6m CD

Founding level of piles are provided in geotechnical report provided in Volume 4.

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 has 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.

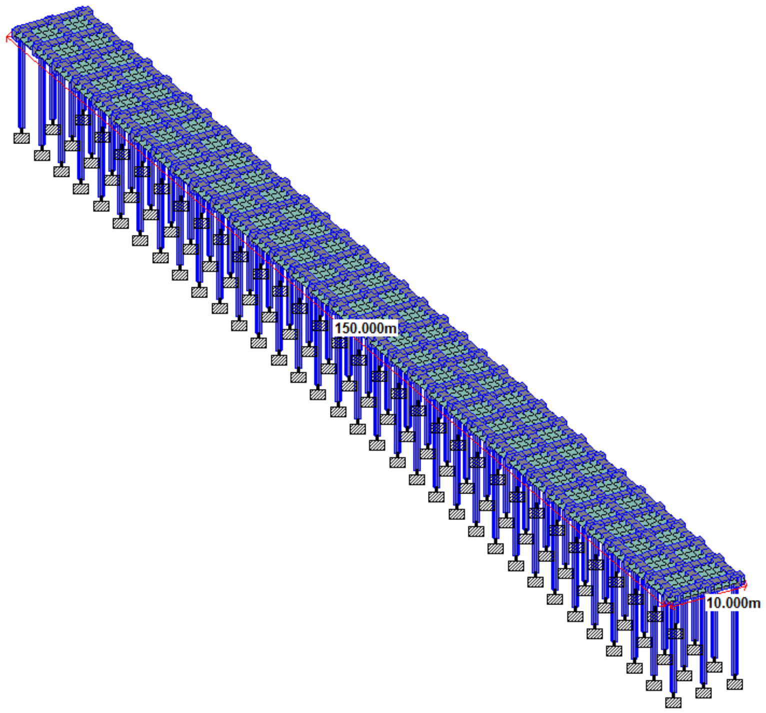


Figure 30: 3D View of STAAD Model – Approach Jetty

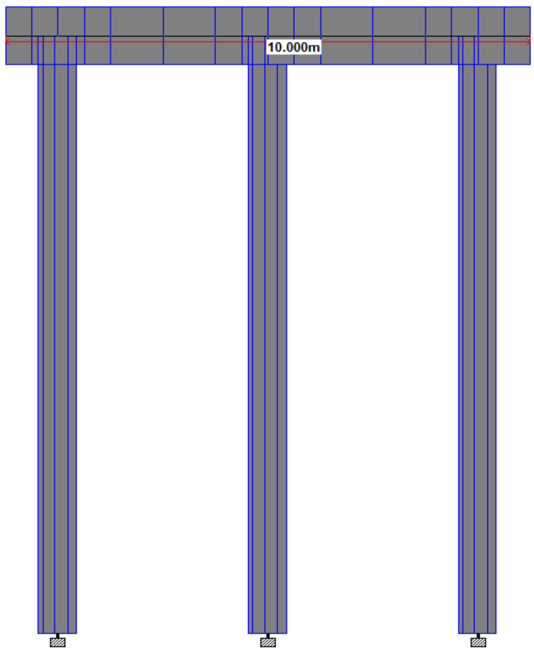


Figure 31: 2D View of STAAD Model – Approach Jetty

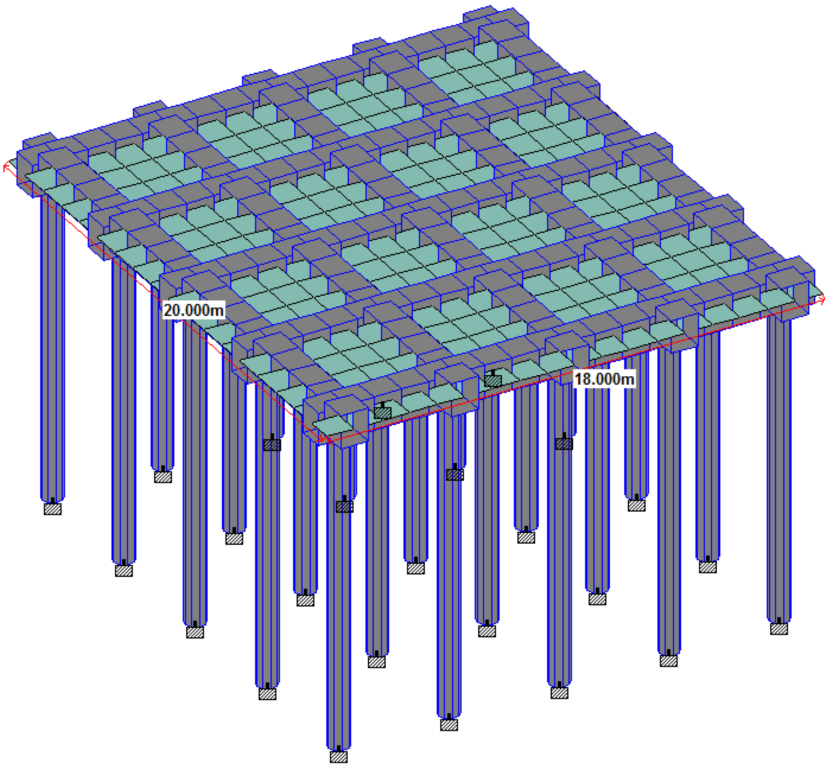


Figure 32: 3D View of STAAD Model –Jetty Platform

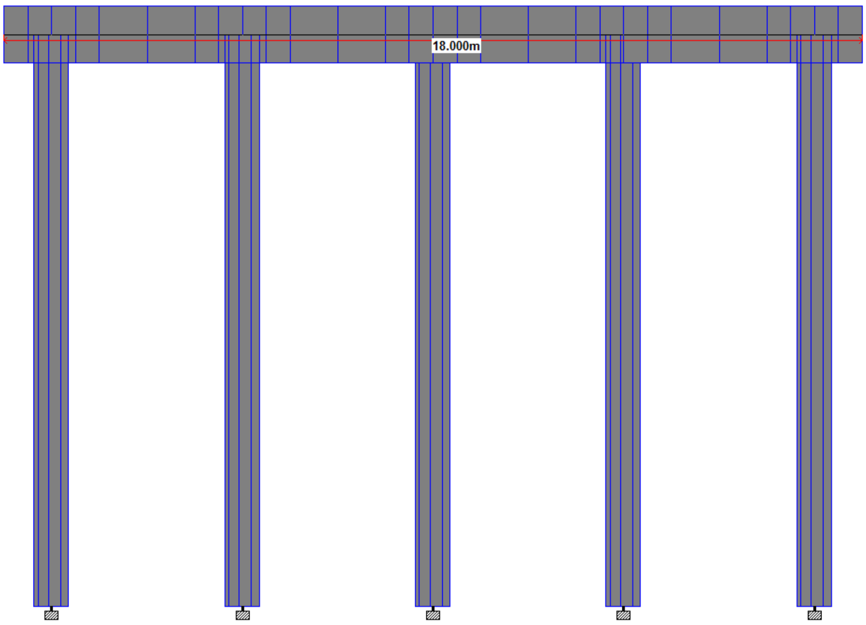


Figure 33: 2D View of STAAD Model – Jetty Platform

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.

6.5 CONSTRUCTION SCHEDULE

The time schedule for construction activities of the project is considered as three years. The proposed project schedule is provided in **Figure 34.**

Sl. No.	Activities	PHASE - 1			PHASE - 2		
		1st Year	2nd Year	3rd Year	1st Year	2nd Year	3rd 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 for Phase 1						
c)	Capital Dredging for Phase 2						
4	Procurement and installation of Aids to Navigation						
5	Setting up of IWT terminals						
a)	Land acquisition						
b)	Construction of terminal building, landside facilities and dry bulk cargo jetties at Jamtiya						
c)	Construction of terminal building, landside facilities and RO-RO jetty at Noorpur						
d)	Construction of terminal building, landside facilities and RO-RO jetty at Gadiara						
e)	Construction of terminal building, landside facilities and RO-RO jetty at Geonkhali						
6	Upgrading existing road to terminals						

Figure 34: Construction Schedule

7.0 VESSEL DESIGN

The major principal parameters governing Inland Waterway Fleet designs are:

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

7.1 GENERAL REVIEW

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

7.2 DESIGN BASIS

The type and size of vessel to be operated in inland waterways is designed on the basis of following factors:

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

7.2.1 Cargo Characteristics

The cargo consist of fly ash, clinker, gypsum, slag, construction material (cement, sand, stone, etc.), cereals/cash crops (wheat, rice, pulses, sugar, tea, etc.), livestock (animal, oil cake, etc.), others (consumer goods, Jute, bamboo products, kirana/perchun appliances, etc.), cars, trucks, bikes, cycles and passengers. The volume of total cargo originating and terminating from different terminal is shown in Traffic Studies chapter.

For quick movement of general cargo, it would be necessary that it stays for minimum time in the loading/unloading terminals and not wait long time for vessels.

7.2.2 Cargo Factors

The following cargo factors influence the design parameters:

- Volume and nature of cargo i.e. the cargo mix to be transported,
- Method of cargo handling facilities required or available,
- Average lot size and length of Haul,
- Balance of out and return cargo, and
- Requirement for protection against weather.

7.2.3 Waterway and Other Features

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

- No bridge is located along the proposed 35 Km of waterway stretch from Geonkhali to Jamitya (Kolaghat).
- River width all along the waterway available throughout the year. But width of waterway in few places may not be sufficient for turning of vessels/ two way operations during lean season. This could be achieved through periodical dredging.
- Shoals located along the waterway.
- Current velocities.

Hence, the waterway condition during lean season would dictate the selected vessel to have shallow draft to ensure navigation all around the year.

7.2.4 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 loading and unloading of cargo,
- Time lost in transit, change of pilot at beats, cargo transfer, crossing of state or International border,
- Number of unworkable days per year, and
- Susceptibility of vessel to damage and crew efficiency.

7.3 TYPE OF PROPOSED VESSELS

The selection of vessels shall also depend on the existing traffic in the waterway, available draft and other local conditions affecting the manoeuvring of vessels. For Inland Water Transportation, there are mainly two types of vessels namely self-propelled barges and dumb barges in tow. The two common vessels used for IWT are briefly discussed below.

7.3.1 Self Propelled Barge

Self-propelled cargo boats move under their own power and attain a higher speed than dumb barges in tow. These boats are also more effective against strong currents and are designed to meet particular requirement of traffic and route. In Shallow River, low draught vessels are designed with twin screws in tunnels. These vessels are not economical to run in deeper waters. Similarly vessel designed for deeper draft cannot be used in Shallow River. Costly cargoes which can stand a high freight rate like perishable goods requiring scheduled navigation are transported by self-propelled river vessel. These vessels have a low turnaround time in IWT ports (since no time is lost in anchoring and making up tows), are speedy and can call at many ports along the enroute. With proper scheduling of sailing of such vessels and full cargo availability, these can be an economic proposition inspite of the high cost of procurement.

7.3.2 Dumb Barge

Dumb barges are cheap and apart from being used for carriage of cargo, are also used for storing, as floating warehouses or even as pontoon jetties. These vessels require very little care and withstand rough handling. Small dumb barges do not normally have any permanent crew and lie unattended. Transportation of cargo in dumb barges is a slow process and there is normally no fixed schedule. Hence, bulk, unpacked and imperishable cargo is transported in such barges which offer a low freight rate. In Europe and USA. river transportation is normally carried in dumb barges in private sector.

7.3.3 Towing Arrangement

Dumb barges are grouped together to form flotilla which are towed by river tugs. Three methods of towing have been used internationally depending upon channel depth and width as well as the weather conditions experienced along the route. The following are the general methods.

- Towing astern,
- Towing alongside, and
- Push towing.

The first method, towing astern or pull towing has been used in European waters. A long towline is paid out from the river tug (moving in front) to the foremost barges of the flotilla. The flotilla may be made up of a number of rows of barges secured to each other or held together by a tie line passed from barge to barge. Sometimes, barges may be tied to the center barge alongside. In this system, the propeller race of the tug impinges on the front thus increasing the resistance of the barge flotilla. Due to this, there can be an augmentation of resistance as high as over 80% of the individual barge. To reduce this increase in resistance, a minimum length of towline equal to 1.25 times the length of the tug is recommended. This increases the total length of tow considerably. Further, when the tow is to take a turn, the radius of bend must be quite large. Therefore, this form of transportation is good where only long straight stretches of waterway are available.

In towing alongside or abreast, one barge is secured fast to one side of the tug or two barges are secured to either side of the tug. This is an efficient method of towing, the only disadvantages being that the width of the waterway required should be more to accommodate flotilla of twin barge width. The conventional method on the NW -1/river Ganga in India has been towing abreast or side towing.

In push towing, flotilla, consisting of a number of barges arranged abreast and in row, is formed by securing all the barges to one another tightly. The pusher tug pushes the flotilla from behind. The propeller race does not affect resistance. Since all the barges and tugs are close together, the incidence of increasing in resistance due to inference is minimum. This system is prevalent in USA and is now being adopted in Europe and elsewhere including India (eg. CIWTC) for its obvious advantages over pull towing. The individual units of barges are normally full with rectangular bilge with/without end shapes.

7.3.4 Towing Tug

River tugs are designed and built as per particular requirements. The designs are different for pull towing and push towing. In push towing, the foredeck is made square to facilitate matching of barge end. Bollards and fairleads are mostly in the forward. In pull towing, the mooring arrangements are astern and there is arrangement for paying out rope (winch or capstan). Either of the tugs can be used for side towing by suitable provision of bollards on their sides.

Various types of propulsion systems have been used on river/canals. The systems most extensively used are paddle wheel propulsion, propulsion with other sophistication such as multiple propellers and rudders, "Kort" nozzles, raised tunnels and rudder-propeller propulsions.

The paddle wheel propulsion has disappeared since quite long from most of world waterway although it offered good maneuverability, good stopping and backing abilities, easy repair without dry docking and its suitability of use in shallow water with efficient propulsion. The disadvantage which outweighed its advantages was heavier hull construction with associated problems, big reduction gear and overall low efficiency.

The propeller propulsion system consisting of propellers and complete rudder system comprising of normal rudder behind propellers and flanking rudder in the front of propellers for reverse and stopping maneuvers is being widely used. In number of shallow draft vessels, with this type of propulsion, Kort nozzles and raised tunnels have been provided with propeller of lower diameter to get better efficient and thrust, provide protection to waterway bottom and the banks and to protect the propeller from damage. However, construction is difficult in case of tugs provide with Kort nozzle or tunnel.

The third type i.e. rudder propeller system was initially developed for motorizing dumb barges and small vessels with ready-to-install unit but it has been developed for propelling even the bigger size vessels. The advantage of this type is its high maneuverability, simple installation without requiring floating dry docking facilities. The disadvantages are lower efficiency as compared with system of fixed propeller with nozzles, vulnerability of freely suspended propulsion arm and complicated machinery parts.

In pull towing, the propeller race of the tug impinges on the front barge thus increasing considerably the resistance of the barge fleet. Moreover, pull towing requires deployment of crew for steering the towed barges and has, in addition, the disadvantages of being less maneuverable.

7.3.5 Push Tug

The important parameter for selection of the tug is the power requirement which depends upon the displacement of tug and barges, the maximum dimension of the convoy, current velocity, the parameters of waterway and the speed. Out of these factors speed largely governs the power requirement. Researchers have suggested limiting value of speed in shallow and narrow canals. In shallow water of unrestricted width, the economic speed in m/s should be less than $2.5*\sqrt{h}$ where H is the depth of water. In narrow canals, economic speed should be less than $1.2*\sqrt{A/C}$ for a blockage ratio of 5 (The ratio of wet canal cross section to area of submerged mid ship section) where A and C are canal cross section area and canal perimeter respectively. The blockage ratio should not be less than 4.5 to prevent erosion of canal bed and slopes caused due to return currents and waves. Thus the mid ship cross section on this route should be less than 13.67 m^2. The vessel speed on the above consideration should not be higher than 8.0 knots/hr in waterway. The power requirement of push tug has been based on the speed in river section.

In push towing, barges are lashed together by wire ropes to form a single unit and this, in turn, is lashed rigidly to the towing knees of the pusher tug. The tug working at the rear can handle a fleet of barges at a greater speed and with greater control is possible in pull towing operation. The tug is equipped with a set of steering and flanking (backing) rudders which afford maximum control for forward, backward and sideward movements as are required in restricted channels. For this reason, push towing has been recognized as the most efficient. It requires 20% less power than pull towing for comparable loads.

7.3.6 Towed Flotilla v/s Self Propelled Vessel

The merits and demerits of both alternatives that will help in making final choice are:

a) In a towed flotilla, the cargo carrying unit and the engine unit are separate. Therefore, they can be scheduled independent of each other and thus ensure maximum transport efficiency. As the self-propelled vessels are expected to be more economical over long lead, both the alternatives have to be compared for cargo transportation.

b) In towing system when towing unit is down for engine survey, maintenance and repair, the cargo units need not be down and can be moved with another available towing unit, whereas in self-propelled barge system, one engine unit is always tied up with cargo unit.

c) Flotilla can be formed with varying units of barges. Therefore, this system can adjust to a fluctuating or uncertain transportation environment in an efficient manner. This system efficient is much higher since only limited numbers of barge that can be fully loaded are utilized. But this cannot be done for self-propelled vessels. If regular cargo is available in sufficient quantity, transport efficiency of self-propelled vessel can be more than flotilla.

d) Dumb barges are simply and less expensive to build and comparatively few towing tugs are required to operate the flotilla combination. Self-propelled barges are comparatively larger vessels and are more complex for building since the engine; supporting bunkers and crew accommodation are to be housed. The procurement price is generally 3 to 3.5 times that of a dumb vessel of same capacity.

e) It is well known in naval architecture that long slender vessels experience less resistance in motion. Well designed (ends properly shaped) dumb barges in flotilla experience proportionately less resistance than single vessels. Two single units in tandem experience 1.36 times the resistance of a single unit and a flotilla of 4 barges with two abreast in two rows experience 3.16 times the resistance of a single unit. The average resistance per single barges in a flotilla can be taken as 0.75 times that of a single barge on its own. With this resistance there would be net saving of 25% fuel, if barges are well designed and are moved in closely packed flotillas as against self-propelled barges.

f) A dumb barge can remain unattended in voyage and need not house any crew member. For a flotilla of 2 barges and one towing 4 crew members are sufficient. But for 2 independent self-propelled vessels at least 8 crew members would be required. Thus crew wage bill is reduced by half in case of towed system.

g) Maintenance for a flotilla system is easier and cheaper since barges are repaired separately from tugs. Downtime due to repair is also reduced.

7.4 PROPOSED VESSEL SIZE AND SPECIFICATIONS

The size of vessels calling at the proposed IWT terminal is restricted by the availability of draft in the navigation channel of National Waterway. It is proposed to ensure minimum LAD of 3.0 m in the 35 Km stretch of waterway for movement of vessels. Based on the LAD of 3.0 m in the navigational channel, IWAI recommended that self-propelled barges of sizes presented in **Table 39** below can ply in the inland waterways.

Table 39: Vessels that can Ply in Inland Waterways with LAD of 3.0 m

Tonnage (T)	Length (m)	Beam (m)	Draft (m)
650 - 1000	60 - 80	8.20	2.20
1000 - 1500	80 - 85	9.50	2.20
1500 - 3000	85 - 95	15.00	2.50

7.4.1 Vessel Sizes at Jamitya – Dry Bulk Cargo Terminal

The following main cargo commodities for proposed terminal at Jamitya have been identified:

- Fly ash
- Clinker (Future)
- Gypsum (Future)
- Slag (Future)

Vessel type proposed for Jamitya cargo terminal are:

Vessel Type	Vessel Capacity (DWT)	LOA (m)	Beam (m)	Loaded Draft (m)
Barges	2000	95	15	2.5

Generally, the depth in the manoeuvring areas is determined by:

- Vessel's loaded draft
- Water level and tidal variations
- Sedimentation pattern in the region

As per IS 4651 (Part V), under keel clearance to be provided is 20% in unsheltered areas. Considering the design vessels the required depths are as follows:

Table 40: Dredge depths required

Description	Barge
Draft (m)	2.5
Under keel clearance (@20%) (m)	0.5
Allowance for siltation (m)	1
Channel depth required (m)	4
Tidal window (MLWS) (m)	0.8
Dredge level below CD	3.2

The development at Jamitya terminal is planned for barges of 2000 DWT only. The barges are assumed to have a loaded draught of 2.5 m requiring a depth of 4 m on the berth for safe passage (including allowance for under keel clearance & siltation).

By considering the tidal advantage (MLWS) of 0.8 m, a draft of 3.2 m water level is required for the safe passage of barges and to ensure maximum terminal operation hours & minimum dredging requirements by using tidal window for berthing and de-berthing of the vessels.

7.4.2 Proposal of flat bottom and low capacity cargo vessels

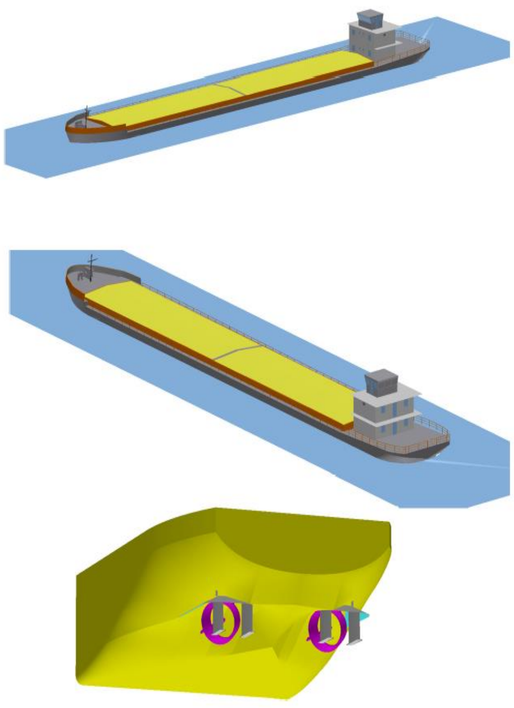
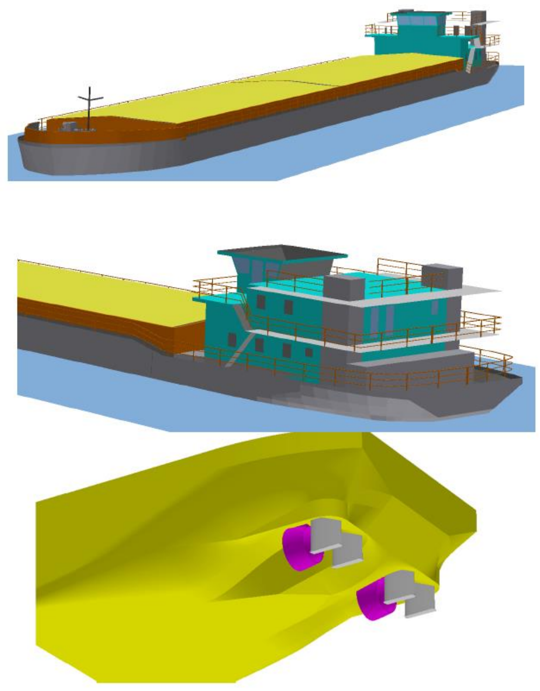
There was a meeting held at IWAI HO, regading approval of submitted Rupranayan DPR with higher authorities of IWAI, on 9th Dec. 2020. During the discussion, it was suggested to cater low capacity flat bottom vessels for deployment in rupnarayan waterway.

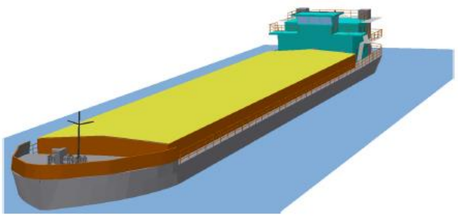
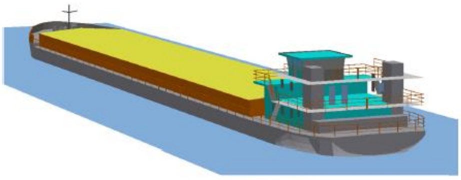
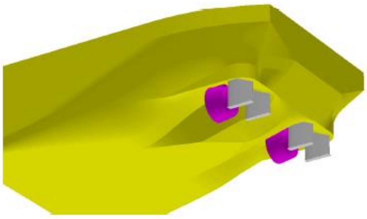
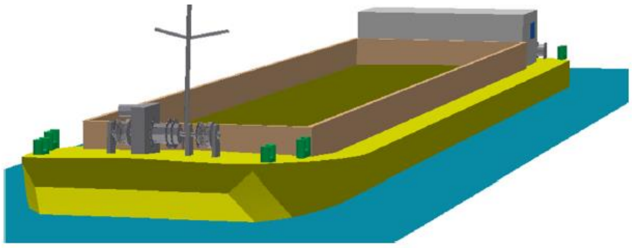
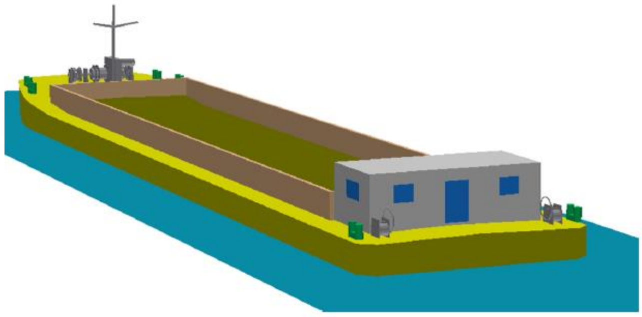
As, huge dredging is required to maintain the waterway depth of 2.5 m below sounding datum from chainage of 3.0 Km to 35 Km for movement of cargo vessels up to Jamitya jetty, as shown in Para 3.3.1. Accordingly, the proposal to consider deployment of low capacity and flat bottom cargo vessels (eg. Barges) will reduce the dredging requirement in the proposed waterway.

In this context, Inland Barges having flat bottom developed by Indian manufacturers can be considered. The inland barges are mostly I.V. class with authorization confined to Inland waters only. These barges are self propelled and can move at their own without tug assistance and with help of marine diesel motors. The payload/ convey limit of these barges is accessible between 500DWT to 2500DWT. The I.V Class Barges operates for short separation voyage.

As specified by IWAI following are the parameters for flat bottom barges/vessels in order to operate in inland waterways:

Cargo type	**Dry Bulk**	**Dry Bulk**	**Dry Bulk**	**Dumb Barge**
Hull Type	B1	B2	B3	DB
Length O.A. (L)	110.00 m	110.00 m	92.00 m	42.00 m
Breadth moulded (B)	12.00 m	12.00 m	12.00 m	8.00 m
Depth Main Deck (D)	3.70 m	4.30 m	3.70 m	2.80 m
Draught max. (T)	2.80 m	2.80 m	2.80 m	2.50 m
Lightweight estimate	827 t	880 t	680 t	180 t
Payload at Tmax	2526 t	2515 t	2105 t	585 t
Airdraft without cargo load			< 9.00 m	

Bulk Carrier B1	**Bulk Carrier B2**
	

Bulk Carrier B3	Dumb Barge DB
  	 

7.4.3 Vessel Sizes at Noorpur, Gadiara and Geonkhali – RO-RO and Ferry Terminal

RO-RO and Ferry services are proposed between Noorpur, Geonkhali and Gadira. As per the bathymetric survey, minimum draft available in this stretch of waterway is >6.0 m.

RO-RO/Ferry Vessel

Vehicular ferry services are need of the modern time integrated transport system for overall development of the region. The vessels used for these ferry services shall transport vehicles through waterway in this stretch such as - cars, busses, trucks, including passengers. These vehicles are rolled on to the vessel through a ramp and ferried across. On reaching the destination once again the vehicles drive out of the vessel. The ferry is necessary between these three banks, which do not have any road bridges connecting them.

To give examples of vessels that could be used for this Ro-Ro Ferry service, we have drawn together particulars of a range of vessels that are currently in operation in inland waterways in India. As per the data/information collected following, RO-RO ferry vessels/services are operational in inland waterways in India:

a) Vehicular ferry services in collaboration with West Bengal Surface Transport Corporation by M/s Vivada Inland Waterways Limited. The company is currently operating vehicular ferry services at Hasnabad, a remote village North 24 Parganas of West Bengal. The vessel used by the company for RO-RO ferry service is Megh Barna having length of about 150 meters or four 20 meter trucks[16].
b) Kochi Municipal Corporation also operates RO-RO ferry services in the inland waterways/creeks of Kochi[17].

Cochin Shipyard Limited ("CSL"), build two double ended Roll-on- Roll-Off (RO-RO) ferry vessels for the Kochi municipal corporation. The vessel was designed in-house and was built according to the rules of the Indian Register of Shipping (IRS), Classification rules and Kerala Inland Vessel (KIV) rules applicable for inland vessel in the state.

The vessel is designed to carry 12 cars and 4 trucks or 18 cars besides 50 passengers with an endurance of 5 days, enabling movement of lorry/passenger vehicles without entering the city. The vessels works like a floating bridge, with Ramps at both ends. The most important feature of the vessel is that the vehicles drive in and drive out on first in – first out basis i.e. no need to reverse the vehicles during loading of the vessel which drastically reduces loading/ unloading time. Hence special driving skills are not required for vehicle drivers to load the vehicles into the vessels. This would be a great advantage for senior citizens. Another special feature of the vessel is an Air Conditioned Wheel house for comfort of the operator. The vessel is also designed to withstand deck loading for trucks and heavy vehicles, with heavy duty Ramp and hinged flaps to ensure safe loading and unloading of vehicles.

The vessel is equipped with azimuth propulsion systems on both ends for easy manoeuvring, allowing the vessel to be operated without the need for turning around at the jetty during cast off, thereby reducing trip times. Two engines of 200 KW rating (1800 RPM) driving two azimuth propellers of 162 KW each also provide redundancy in case of failure of one system. The vessel can attain a speed of up to six knots and will take around twelve minutes to cross the 2400-meter distance between two stations.

[16] http://vivada.com/about.html

[17] http://www.cochinshipyard.com/press/RORO-10-JAN.pdf

The vehicles also had a number of inbuilt safety features. Structural tanks are designed to withstand flooding of engine/ thruster compartments ensuring safety of the vessel in case of structural damages in the event of a collision. Bilge safety alarms in all compartments are provided to detect flooding even in closed compartments. Fire alarm systems are provided for engine rooms. Apart from this, safety tips and alarms of the engine and thruster are displayed in the wheel house and echo sounder is also provided to know the depth of water.

Passenger Ferry Vessel

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 35**.

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 35: Ferry Services in the river Hooghly between Kolkata and Howrah[18]

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

West Bengal Transport Infrastructure Development Corporation (WBTIDC), (A govt. of West Bengal Undertaking) is constructing steel ferry vessels of capacity 150 passengers as per I.V Act for operating in the state. Some of its existing vessels with 150 passenger capacity are as follows[19]:

a) M. V. Shrishti (HAD) – Plying between Raichak – Kukrahati
b) M. V. Brishti (WBSTC) – Plying between Howrah – Kolkata
c) M. V. Krishti (WBSTC) – Plying between Belur – Dakshineswar
d) M. V. Drishti (HNJPSS) – Plying between Bauria – Budge Budge

For proposed RO-RO ferry services in Rupnarayan waterway to connect Noorpur, Geonkhali and Gadiara Jetties, a combination of RO-RO/ferry vessel built in-house by Cochin Shipyard Limited and passenger ferry vessels built in house by WBTIDC are proposed. We have only considered conventional vessels at this stage to keep the start-up risk to a minimum.

7.5 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.

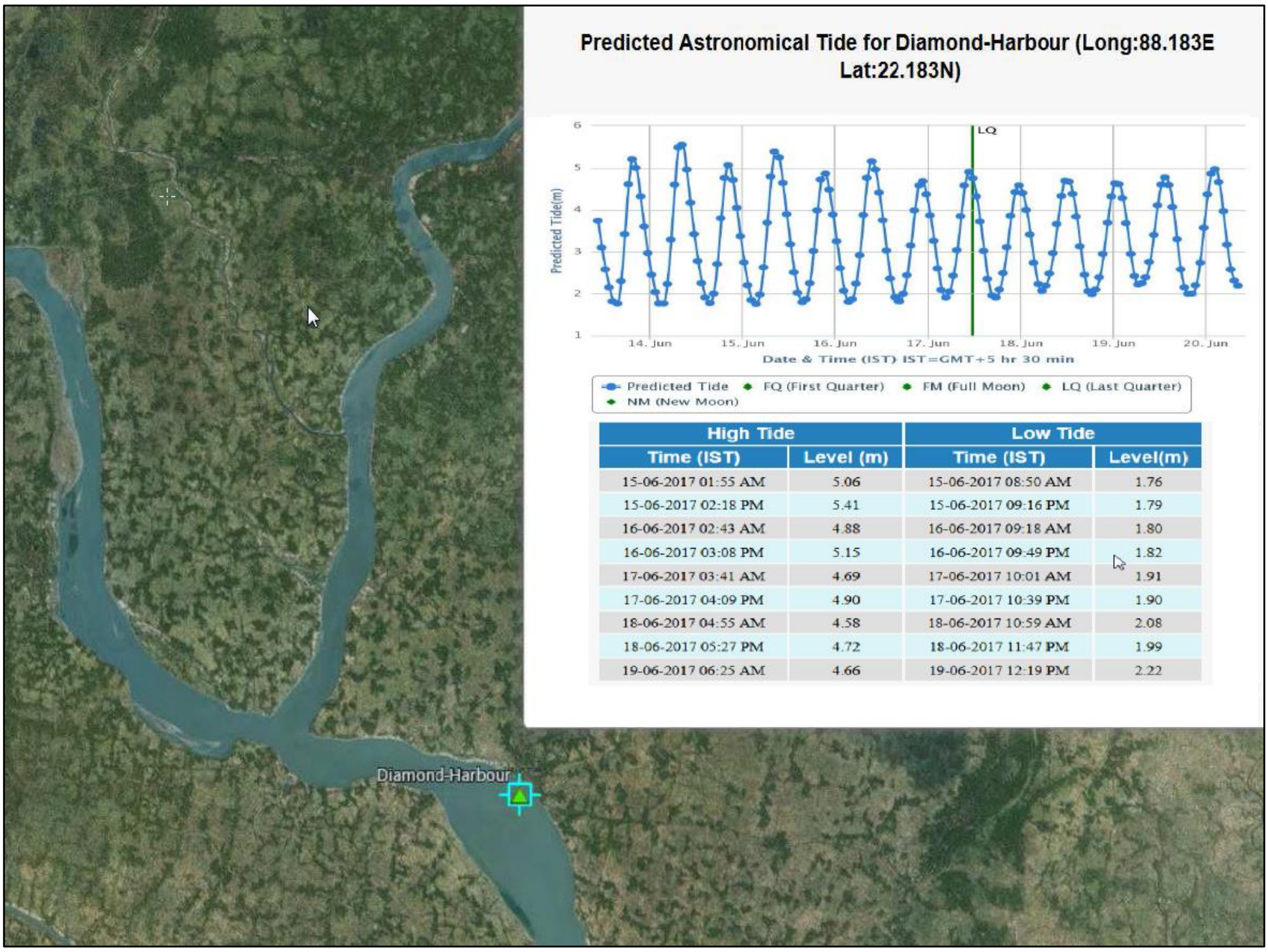
Turnaround time varies with type of vessel, efficiency of jetties and available cargo handling facilities on the jetties. Turnaround time for both dry bulk cargo vessel and RO-RO/ferry vessel are discussed in detail in following paragraphs.

7.5.1 Dry Bulk Cargo Vessel

Diamond harbour is the entry point of the Rupnarayan River and the tidal duration is more or same at diamond harbour and along Rupnarayan River. From **Figure 36**, it can be seen that the two high peaks occurs at the interval of 12-13 hours. So high tide above +3m water is available for around 3 - 4 hours.

It is proposed to utilize this available tidal window of 3 - 4 hours for sailing of vessel from Geonkhali to Jamitya Jetty.

[19] http://transport.wb.gov.in/infrastructure/jetties/constructionrenovation-of-jetties/



High Tide		Low Tide	
Time (IST)	Level (m)	Time (IST)	Level(m)
15-06-2017 01:55 AM	5.06	15-06-2017 08:50 AM	1.76
15-06-2017 02:18 PM	5.41	15-06-2017 09:16 PM	1.79
16-06-2017 02:43 AM	4.88	16-06-2017 09:18 AM	1.80
16-06-2017 03:08 PM	5.15	16-06-2017 09:49 PM	1.82
17-06-2017 03:41 AM	4.69	17-06-2017 10:01 AM	1.91
17-06-2017 04:09 PM	4.90	17-06-2017 10:39 PM	1.90
18-06-2017 04:55 AM	4.58	18-06-2017 10:59 AM	2.08
18-06-2017 05:27 PM	4.72	18-06-2017 11:47 PM	1.99
19-06-2017 06:25 AM	4.66	19-06-2017 12:19 PM	2.22

Figure 36: Location and Tidal graph of Diamond Harbour[20]

7.5.2 RO-RO Ferry Vessel

As detailed above, the proposed vessel, shall be equipped with azimuth propulsion systems on both ends for easy manoeuvring, allowing the vessel to be operated without the need for turning around at the jetty during cast off, thereby reducing trip times.

The time taken by RO-RO ferry vessel for loading and unloading for proposed number of vehicles and passengers, re-fuelling and re-arming is considered as 1 hour.

[20] *ESSO - Indian National Centre for Ocean Information Services, http://www.incois.gov.in/portal/osf/tide.jsp*

Similarly the time taken by Passenger ferry vessel for loading and unloading of passengers, re-fuelling and re-arming is considered as 30 minutes.

7.6 NUMBER OF VESSEL REQUIRED

7.6.1 RO-RO Ferry Vessel

It is proposed to provide a combination of RO-RO Ferry and passenger ferry vessels for optimised services. Number of vessel required to ply on Noorpur – Geonkhali – Gadiara – Noorpur route is estimated and provided in **Table 41** and **Table 42** as below.

Table 41: Estimate of No. of vessel required for RO-RO Ferry Service

Sl. No.	Description	Value
A	Speed of vessel considered	6 Knot
B	Average distance from each jetty	2400 m
C	Travel Time required to cover 2400 m one way	13 minutes
D	Turnaround time considered	60 minutes
E	Trip duration (sl. no. C + sl. no. D)	73 minutes
F	Capacity of RO-RO vessel per trip as per proposed vessel specification	12 cars and 4 trucks or 18 cars
G	Total no. of vehicles proposed to use the facility per day	100 cars
H	Required no. of trips per day (sl. no. G/ sl. no. F)	6 trips (approx)
I	Operating hours per day (assumed)	8 hours
J	No. of trips allowed during 8 hours operational time per day (sl. no. I / sl. no. E)	7 trips (approx)
K	Number of RO-RO Ferry vessel required (sl. no. H/ sl. no. J)	1

Table 42: Estimate of No. of vessel required for Passenger Ferry Service

Sl. No.	Description	Value
A	Speed of vessel considered	6 Knot
B	Average distance from each jetty	2400 m
C	Travel Time required to cover 2400 m one way	15 minutes
D	Turnaround time considered	15 minutes

Sl. No.	Description	Value
E	Trip duration (sl. no. C + sl. no. D)	30 minutes
F	Capacity of passenger ferry per trip as per proposed vessel specification	150
G	Total no. of passenger's currently using the jetty per day	4000
H	Total no. of passenger's proposed to use the jetty per day	6000
I	Required no. of trips per day (sl. no. H/ sl. no. F)	40 trips
J	Operating hours per day (as per information collected on site)	12 hours
K	No. of trips allowed during 12 hours operational time per day (sl. no. J / sl. no. E)	24 trips (approx)
L	Number of Passenger Ferry vessel required (sl. no. I/ sl. no. K)	2 (However proposing 3 vessels i.e 1 for each jetty)

7.7 VESSEL COSTING

The cost of operating a ferry is made up from a number of component parts. We have made an assessment of these costs considering fixed costs charged on a time basis and running costs charged on a distance basis.

7.7.1 Capital Cost

The cost to purchase the vessels, whether they are new or second hand, represents a significant commitment for the ferry/cargo operating company.

For vessels required to transport cargo from Jamitya jetty, it is assumed that existing vessels plying from Haldia jetty to transport cargo originated at Kolaghat will now come directly to Jamitya Jetty. Hence no additional procurement cost for Dry bulk cargo vessels is considered for the study. However, for RO-RO ferry and passenger ferry services, vessels need to be procured.

For the purpose of estimating a capital cost for vessels proposed to be operated in Rupnarayan waterway, manufacturing cost of vessels quoted in their websites are taken as a reference as shown in table below

Table 43: Capital Cost of Vessels

Sl. No.	Description	No. of Vessel	Rate per Vessel (INR Lacs)	Total Cost (INR Lacs)
1.	RO-RO Ferry Vessel	1	380[21]	**380**
2.	Passenger Ferry Vessel	3	91.998[22]	**275.994**

7.7.2 O&M Cost

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

Dry Bulk Cargo Vessel

No additional O&M cost is considered for cargo vessels.

RO-RO/Ferry and Passenger Ferry Vessel

a) Officers and Crew Costs

Two crews have been allocated for each vessel to enable continuous operation of vessels for 12 hours. Each crew comprise of 6 staff members for running/operating of vessel and on-board safety and security. Hence, for three vessels total staff requirement works out to 36. With annual salary of INR 4,00,000 /- per annum, the crew cost works out to INR 1,44,00,000/- (**INR 144.00 Lacs** annually)

b) Consumables and Repair/Maintenance Cost

Consumables such as oil and lubricants are generally used at a predictable rate and we have adopted a figure of INR 0.20 lacs per day derived for a vessel similar to those considered in this study. Similarly we have adopted a figure of INR 0.25 lacs per day for maintenance and repair of

[21] http://www.thehindu.com/news/cities/Kochi/Ro-ro-vessel-to-be-rolled-out-on-Vypeen-Fort-Kochi-route/article16439529.ece
[22] http://transport.wb.gov.in/infrastructure/jetties/constructionrenovation-of-jetties/

the vessels to cover the regular maintenance programme. Annual consumables and repair/maintenance cost works out to **INR 135.00 Lacs**.

c) Fuel Cost

Annual fuel cost is considered as 10% of the vessel cost. Annual fuel cost of vessels operating for ferry services works out to **INR 74.80 Lacs**.

Table 44: Annual O&M cost of Vessels

Sl. No	Item	Annual Cost (INR) Lacs
Ro-RO / Ferry and Passenger Ferry Vessel		
1.	Officer and Crew Costs	144.00
2.	Consumables and Repair/Maintenance Cost	135.00
3.	Fuel Cost	74.80
	Total	**353.80/-**

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, sate 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.

IWAI has one DGPS station at Swaroopganj and one DGPS station is proposed to be set up at Canning in Sunderbans waterways. The effective radial coverage of proposed DGPS station is about 125 Km. Proposed Rupnarayn waterway falls under the radial coverage of proposed DGPS station at Canning as shown in **Figure 37** below. Radial distance of canning from farthest point in Rupnarayan waterway is about 82 Km. The capital and O&M cost of proposed DGPS system at Canning is considered in DPR of Matla waterway (Sunderbans waterways).

Figure 37: 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 for Rupnarayan waterway, One RIS stations is proposed near Tamluk with a radial coverage of 25 Km. The proposed RIS station will cover the complete stretch of Rupnarayan waterway as shown in **Figure 38** below. The stations are proposed to be constructed during phase -1 of the project itself.

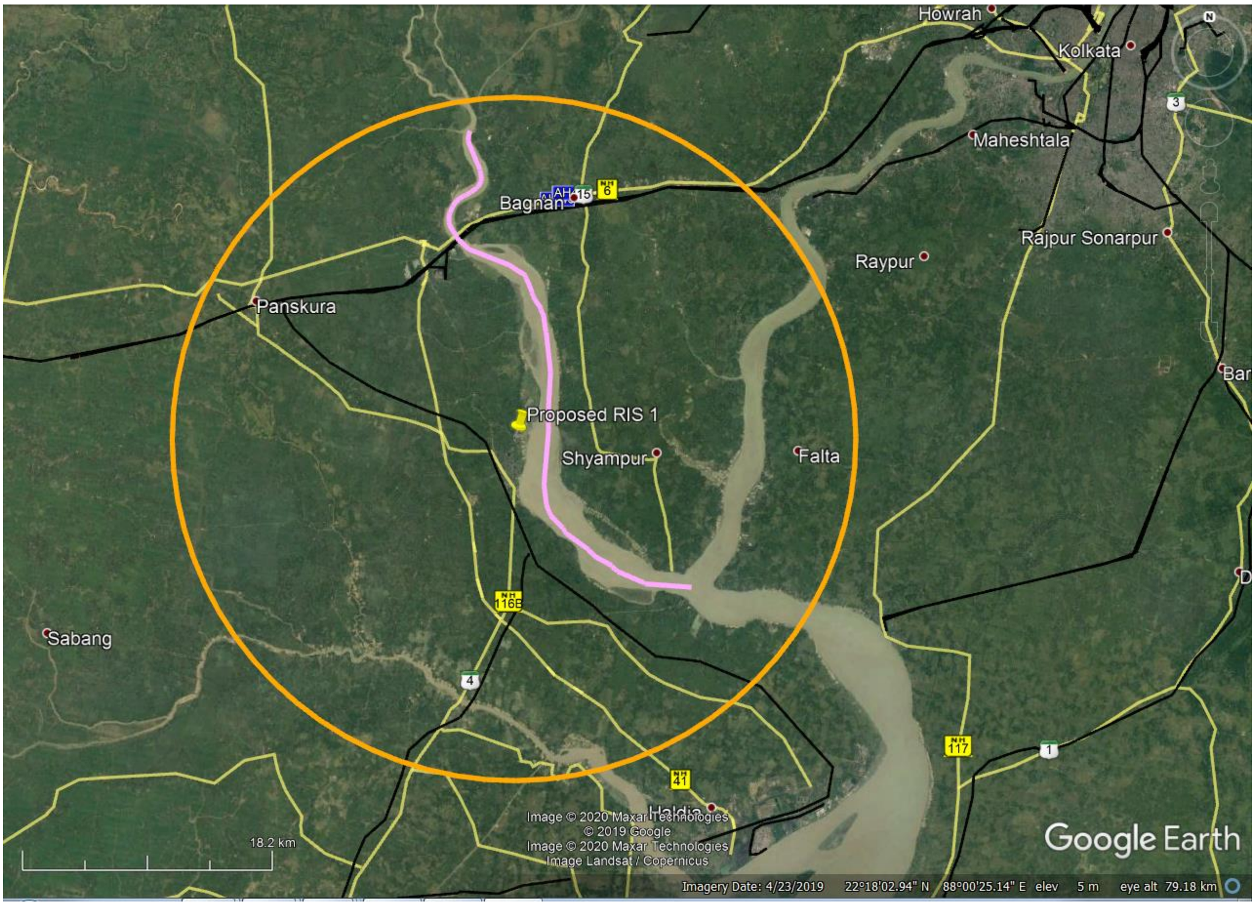


Figure 38: Google Earth image showing location map of proposed RIS and effective coverage

8.2 EXISTING SYSTEM

Though Rupnarayan waterway has water transport facility from Geonkhali, Noorpur and Gadiara. The existing infrastructure lacks the adequate navigation and communication system for safe and efficient transportation. The existing communication system consits of wireless communication system by mobiles only. Whole stretch of waterway is having mobile network connectivity.

8.3 ADDITIONAL REQUIREMENT

State-of-art navigation and communication system is required in Rupnarayan waterway. The details of River information systems and its applicability and relations to different services in navigation are provided in **Figure 39** 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 39: Relation between Services and RI Systems

8.4 COSTING

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

Capital cost of purchase & installation is INR 442.20 Lakhs.

Table 45: Capital Cost for Aids to Navigation and Communication

Sr. No.	Equipment	Qty	Unit Price (INR)	Total (INR Lacs)
A	**RIS System**			
1	AIS Base Station	1	30,00,000.00	30.00
2	RADAR	1	50,00,000.00	50.00
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	RIS Hardware	1	1,00,00,000.00	100.00
10	Installation Testing & Commissioning	1	20,00,000.00	20.00
11	Porta cabin	2	12,00,000.00	24.00
12	Trestle Tower	1	10,00,000.00	10.00
	Total cost of one RIS system			**302.00**
B	Marine Lantern/Buoys	50	2,00,000	100.00
	Total Cost in Lacs			**402.00**
C	3% Contingencies and 7% Supervision charges on Base cost			40.20
D	**Total Navigation & Communication Cost in Lacs**			**442.20**

8.4.1 O&M Cost

The operation and maintenance cost works out to as below:

Table 46: O&M Cost for Aids to Navigation and Communication

Sr. No.	Manpower	Qty	Unit Price (INR)	Total (INR Lacs)
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

Sr. No.	Manpower	Qty	Unit Price (INR)	Total (INR Lacs)
	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	40,20,000.00	40.20
2	2nd Year	1	44,22,000.00	44.22
3	3rd Year	1	48,64,200.00	48.64
			Total	**133.06**
	Overall O&M Cost in INR Lacs			**207.65**

9.0 ENVIRONMENTAL AND SOCIAL ASPECTS

9.1 OBJECTIVE OF ENVIRONMENTAL AND SOCIAL STUDIES

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

Among many rivers, the Rupnarayan River is also considered for waterway and declared as National Waterway No. 86 (NW-86). The Rupnarayan River begins at the Dhaleswari in the Chhota Nagpur plateau foothills northeast of the town of Purulia. It then follows a tortuous southeasterly course past the town of Bankura, where it is known as the Dwarakeswar River. Near the town of Ghatal it is joined by the Shilabati River, at Pratappur (Lat 22° 40′ 16.94″ N & Long 87° 46′ 42.57″) where it takes the name Rupnarayan. Finally, it joins the Hoogli River at Geonkhali (Lat 22o 12′ 41.58″ N & Long 88o 3′ 13.99″). The total catchment of the Rupnarayan water system is 1145 sq. Km. and having a total length of 72 kms. The river passes along Purba Medinipur, Pachim Medinipur, Hoogly, Howarah and South 24-Paragana districts in the state of West Bengal. The main tributaries of Rupnarayan River are Shilabati, Dwarakeswar, Mundeswari, Durbachati and Jamuna.

The major objective of this study is to establish present environmental condition along the project 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
- To identify the requirement of various regulatory clerances, NOCs

9.2 ENVIRONMENTAL SETTING IN THE PROJECT AREA

9.2.1 Physiographic

The study stretch passes through the following districts:

1) Purba Medinipur
2) Paschim Medinipur
3) Hooghly
4) South 24 Parganas
5) Howrah

The details are as follows:

Purba Mednipur:

Topographically, the Purba Medinipur district can be divided into two parts viz. (i) Flat plains on the East, West and Northern portion of the district, and (ii) The Contai Coastal plain at the Southern part. The land of Purba Medinipur district is a quaternary alluvial deposition. As the district area is bouned by water bodies in two sides, it is a formation of fluvial-tidal deposition. Geologically the area is of recent origin. This region is 5-7 meters above mean sea level and average slope is 0-5 degree.

The Rupnarayan, Kasai-Haldi, Keleghai, Rosulpur are important rivers of Purba Medinipur district. The soil of the district is alluvial type, as the district under coastal alluvium and its deposition. Soil of this region consists of different layers like sand, silt and clay. The district is situated on flood plains of the rivers Rupnarayan and river Haldi and therefore huge amount of clay is dominating in soil texture. Due to this specialty of soil, water logging in this region during monsoon is very common. Due to poor permeability, the soils are imperfect to poorly drain. Due to this physical quality of the soils, land use pattern of the area is also affected to a larger extent.

Pachim Medinipur:

Geographically, the north and north-west regions of Paschim Medinipur district are a part of Chhota Nagpur Plateau in its eastern end and covered with hard laterite stone. Geographically the district may be divided into three sub-micro regions:

Plain of Silai: This plain land is found in the northern part of the district bordering Bankura district and is a portion of East Chhota Nagpur plateau. Most part of the region recent alluvium and laterite. Due to irregular alluvial deposition, the river bed causes floods in this area. Alluvial and brown soil is found in southern parts of this plain area.

Lower Kasai Plain: Lower Kasai plain is located either sides of the Kasai river. Navigability of this river is negligible due to alluvial deposition. Huge depression is formed in the west and north-west area on the Kasai and Kaleghai rivers confluence and causes flood. This region is also known as 'Mayana Basin'.

Upland of Medinipur: This region is found in the north-western part of the Paschim Medinipur district and lies close to Odisha and Jharkhand. This upland is 2,029 sq. km. with sloping is from north-west to south-east. This is part of Chhota Nagpur Plateau which is formed with laterite. Some hills which are found in the extreme north are 82 meters to 223 meters in height. The Subarnarekha is the controlling river in this upland region. This River flows from the state of Jharkhand and flows towards south-east and empties at Bay of Bengal in Odisha.

Hugli:

Hugli district is a part of Gangetic Delta which forms flat plains and there is remarkable topographical homogeneity. The district is broadly divided into two main natural divisions, the plains and the uplands, the river Dwarakeswar forming the dividing line between the two. The flat alluvial plains may again be sub-divided into three regions, namely (i) the Dwarakeswar Plain (ii) the Hugli-Damodar Plain and (iii) the Hugli Flats. However, the human interferences in the forms of building railways and roadways, flood control measures have changed the topography of the region to a considerable extent. The process of urbanization and industrialization has contributed significantly in changing the land use pattern of the district. A number of important roads e.g. the National Highways etc. run along elevated surfaces. The changing topography and land use-pattern have their maximum impact in areas where urbanization is accompanied by large scale industrialization.

The major characteristics of the different plain lands of the district in described underneath in brief:

Dwarakeswar Plain: Starting from the Western part of the district, this region is extended upto the river Damodar in the East. Actually being an extension of the Bankura terrain, the Western portion of the Dwarakeswar is upland and rocky. The Eastern portion is a plain area which lies in between the Dwarakeswar and is called the Dwarakeswar-Damodar inter-riverine plain. Physically, the general slope is towards the South-East and in the low lying areas of this region some marshes are found.

Hugli-Damodar Plain: From the Damodar river to the West to the Saraswati River in the East, the plain area is referred as the Hugli-Damodar Plain land. Prominent rivers of this plain land are the Kana Nadi, the Kana Damodar and the Saraswati. They have natural embankment at various points. A continuous line of high embankments on the left bank of the Damodar River is found as a mark of topographic feature. The region has many depressions which receive water from the surrounding lands during the rainy season and discharge the water through small channels.

Hugli Flats: The region is practically a narrow strip of alluvial flat land which lies along the entire stretch of the district. The region has influenced by the course of the Hugli river and its landform is characterised by the presence of many narrow silted valleys. There are many oxbow lakes and river islands formed by the meandering of the Hugli River. In the North-Eastern parts, the region presents sand bars, marshy or silted lowlands. The Hugli River flows for about 80 km. along the district boundary from North to South.

South 24-Parganas:

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.

Sundarban Mangroves: This eco-region on the coast forms the seaward fringe of the delta and is the world's largest mangrove ecosystem, with 20,400 sq. km. (7,900 sq. mi.) of area covered. The dominant mangrove species *Heritiera fomes* is locally known as *sundri* or *sundari* from which the name of the forest had probably been derived. Twenty six of the fifty broad mangrove types found in the world grow well in the Sundarbans. Amongst them *Avicennia* spp., *Xylocarpus mekongensis*, *Xylocarpus Granatum*, *Sonneratia apetala, Bruguiera gymnorrhiza, Ceriops decandra, Aegiceras corniculatum, Rhizophora mucronata* are worth mentioning. The commonly identifiable vegetation that grow in the dense mangrove forests at the Sundarbans are salt water mixed forest, mangrove scrub, brackish water mixed forest, littoral forest, wet forest and wet alluvial grass forests.

Howrah:

With a gradual slope towards South-East direction, the district is a flat alluvial plain. It is seen that three tracts are formed in the district. The Eastern tract stretching amongst the Hooghly river and its branch Saraswati river, the central tract traversed by the Damodar river and its branch Kana Damodar or Kausiki river and the Western tract between the Damodar river and the Rupnarayan river. The average height of the areas for this district above the mean sea level ranges from 5 to 6 metres. Accordingly, on the basis of the physiographical factors, the district is divided into three sub-micro regions.

Rupnarayan-Damodar Plain: The region lying between the Damodar river on the East and the Rupnarayan river on the West represents the Western tract. The Northern part of the region is higher than Hugli and the other regions. The gradual slope is towards South and South-East, although the area is plain. The predominance of many swamps and water creeks, riverine landscape and embankments built along the river course used to be an observed feature. The Rupnarayan river does not intersect the district and flows along the district boundary. At the lower portion it becomes much wider and emerges and enters the Hooghly River at the Hugli point.

Hugli-Damodar Plain: The central low land areas between Damodar river on the West and Hooghly river on the East constitute this plain. The slope is gentle and as a result the rivers flow to the South. For this region there is a similarity with the physical landforms with that of the region falling under Rupnarayan-Damodar Plain. The region is drained by the Damodar river and its branch Kana Damodar river and the Saraswati river. Similar with Kana Damodar river, the old or deserted river channel of the Damodar river, the Saraswati river has also become a dead or dry river. Development of swamps and marshes has earmarked this region. The villages, surrounded by lush green vegetation, are situated on highlands and the paddy fields extend to the very fringes of the marshes.

Hugli Flats: The region is spread over the entire stretch of the alluvial flat area of Howrah district. Topographically, in due consideration of elevation, the Northern part is higher than the Southern part. The higher lands are relatively found replete with villages. The water bodies, mainly the swamps and their outlets, drain towards South-East to reach river Hooghly. There is a great influence of river Hooghly over this region. River Hooghly enters the district at the outfall of the Bally Khal (Canal) just north of the Vivekananda Bridge. The single meander near Malipanchghara between Vivekananda Bridge and the Howrah Bridge i.e. Rabindra Setu gradually starts deepening. The deep channel flowing in a meandering course from the Shalimar broadens at the lower stage. The lower Hooghly River is under the tidal forces and the biggest navigable river for the big streams to the open sea.

9.2.2 Geology and Seismicity

The details are as follows:

Purba Medinipur:

The land of Purba Medinipur district is a quaternary alluvial deposition. As the district area is bounded by water bodies in two sides, it is a formation of fluvial-tidal deposition. Geologically the area is of recent origin. This region is 5-7 meters above mean sea level and average slope is 0-5 degree.

Pashim Medinipur:

The North and NW regions of Paschim Medinipur district area part of Chhota Nagpur Plateau in its eastern end and covered with hard laterite stone. The Plain of Silai land is found in the northern part of the district bordering Bankura district and is a portion of East Chhota Nagpur plateau. Most part of the region recent alluvium and laterite. Due to irregular alluvial deposition, the river bed causes floods in this area. Lower Kasai plain is located either sides of the Kasai river which is having alluvial deposition. Upland of Medinipur region is found in the north-western part of the Paschim Medinipur district and lies close to Odisha and Jharkhand, with sloping is from north-west to south-east. This is part of Chhota Nagpur Plateau which is formed with laterite. Some hills which are found in the extreme north are 82 meters to 223 meters in height.

Hugli:

This district is a part of Gangetic Delta which forms flat plains and there is remarkable topographical homogeneity. The district is broadly divided into two main natural divisions, the plains and the uplands. The flat alluvial plains being an extension of the Bankura terrain, the Western portion of the Dwarakeswar is upland and rocky. The Eastern portion is a plain area. The general slope is towards the South-East and in the low lying areas of this region some marshes are found. The region is practically a narrow strip of alluvial flat land which lies along the entire stretch of the district, its landform is characterised by the presence of many narrow silted valleys. The elevation of the district form the mean sea level is 15 metres.

South 24-Parganas:

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.

Howrah:

The geological predominance of the district as a whole is that it is a part of delta proper under the Lower Ganga Plain region. It occupies the western most portion of the great Ganga Delta. Its origin is a recent phenomenon dating back to middle Miocene period when the rivers from the Himalayas filled the 'Sag' or 'fore deep' caused by the Himalayan mountains building process. The pre-existing narrow neck of the Peninsular (Gondwana) landmass resulting in the formation of the Rajmahal-Garo gap ultimately diverts the waters of the ancient Siwalik river southward into the Bay of Bengal.

Seismicity:

The project falls under the seismic zone III as defined by the Indian Standard (IS) 2002 seismic zoning classification system, i.e. a zone of relative stability. The horizontal seismic coefficient for zone III is 0.04 measured on a scale from II to V where zone II is most stable and Zone V is considered to be least stable. The seismic zone map of India is shown in **Figure 40**.

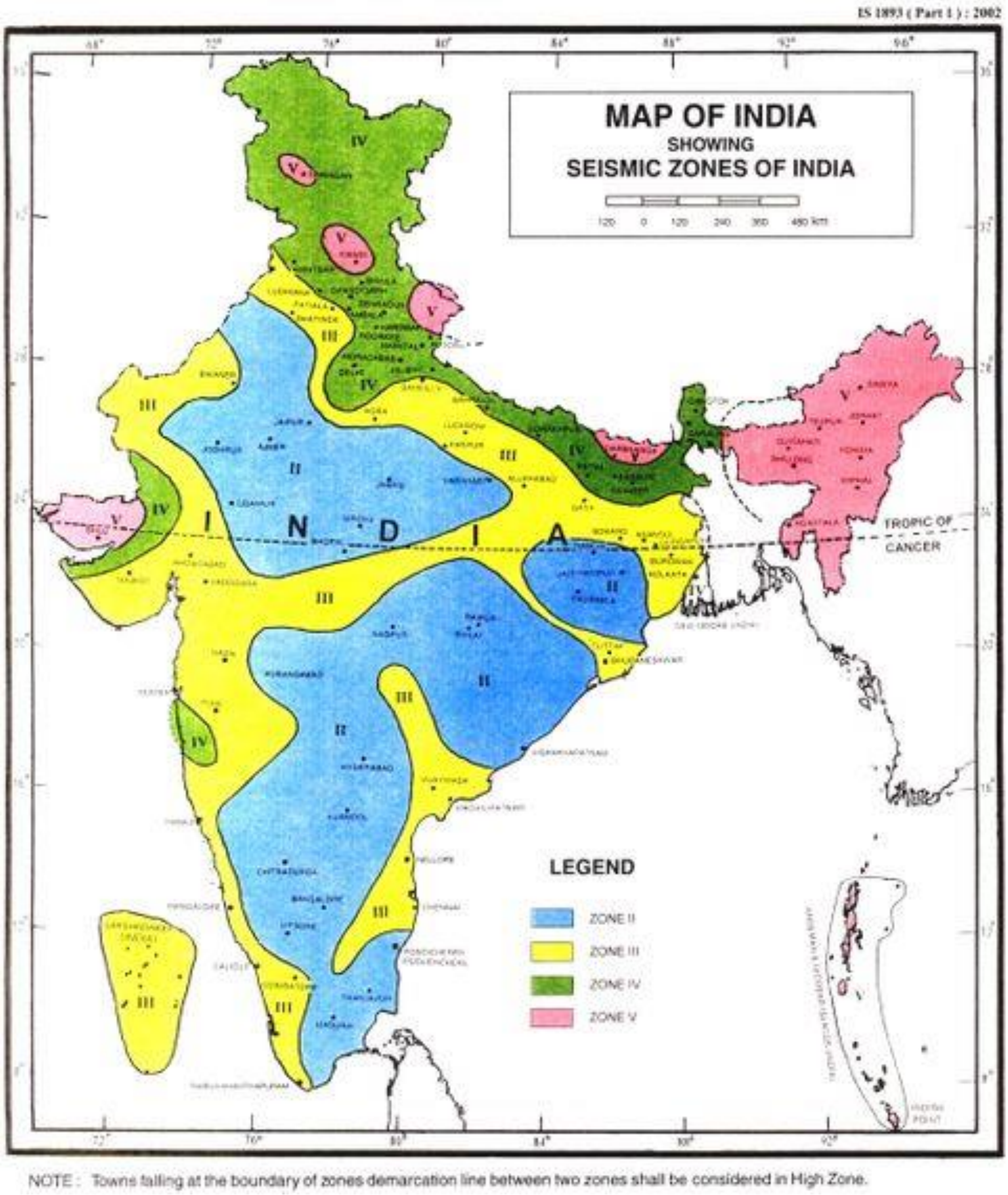


Figure 40: Seismic Zoning map of India

9.2.3 Climate

Purba Medinipur:

The climate of Purba Medinipur district is tropical in nature. Average temperature in the district varies from 25.5^{0}C to 38.6^{0}C. Rainfall occurs unevenly during monsoon season. Average rainfall is 1,752.6 mm. There are four marked seasons (a) Cold, dry weather from December to February (b) Hot, dry weather from March to May (c) Monsoon period lasts from June to September, and (d) Post monsoon period prevail in October and November. The district receives almost over 70 per cent of its annual rainfall between June to September. The climatic condition of the district is shown in **Figure 41**.

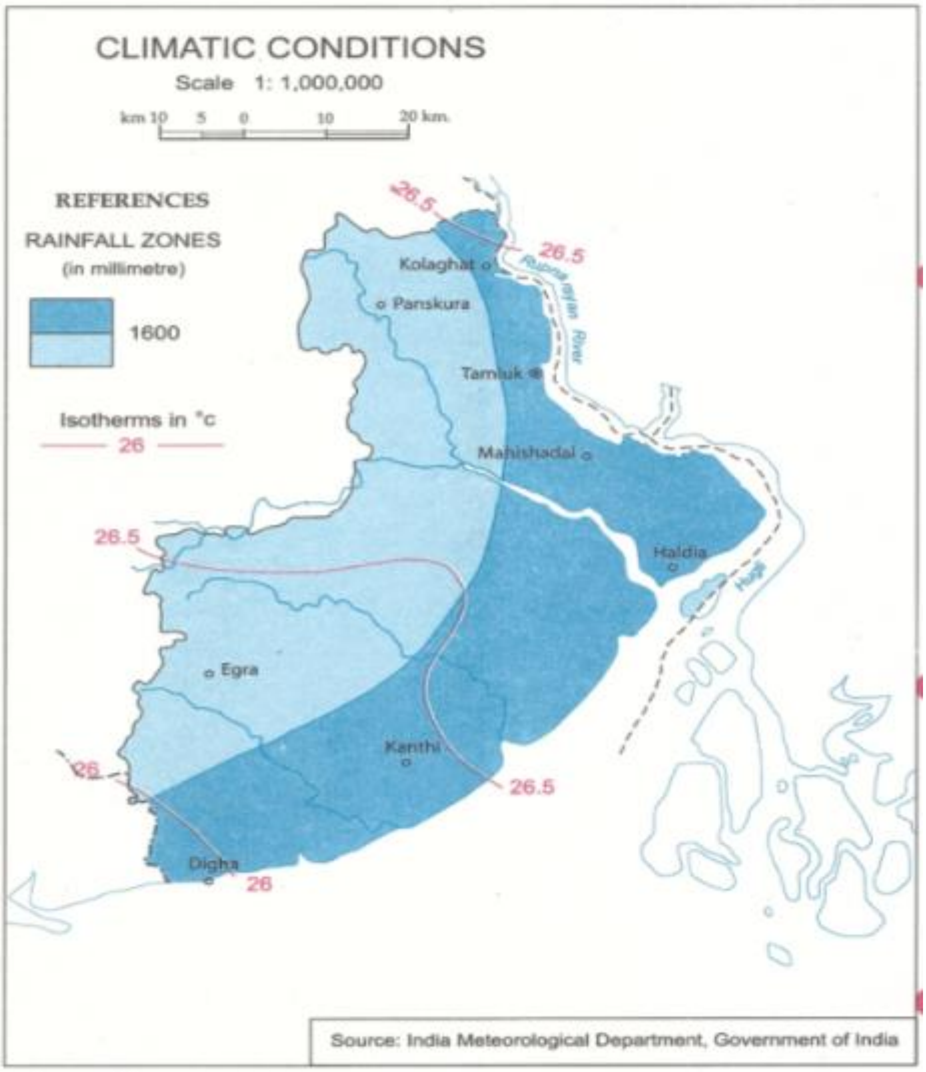


Figure 41 : Climatic Condition of Purba Medinīpur district

Paschim Medinipur:

The climate of the Pachim Medinipur district is tropical. The land surface is characterized by hard rock, lateritic covered area with flat alluvial and deltaic plains. The western part of the district is quite uneven and rolling topography is experienced in consisting of lateritic covered area. These rolling plains slowly merge in to flat alluvial and deltaic plains to the east and south east of the district. The soil is fairly fertile. The maximum temperature is 390C and minimum is 100C. The characteristic of the climate is hot summer, cold winter, humidity and sufficient rainfall. Average rainfall is in the district is around 1400-1500 mm. Paschim Medinipur district does not have a coastal line. The district is affected by cyclones during the months of October-November. The climatic condition of the district is shown in **Figure 42**.

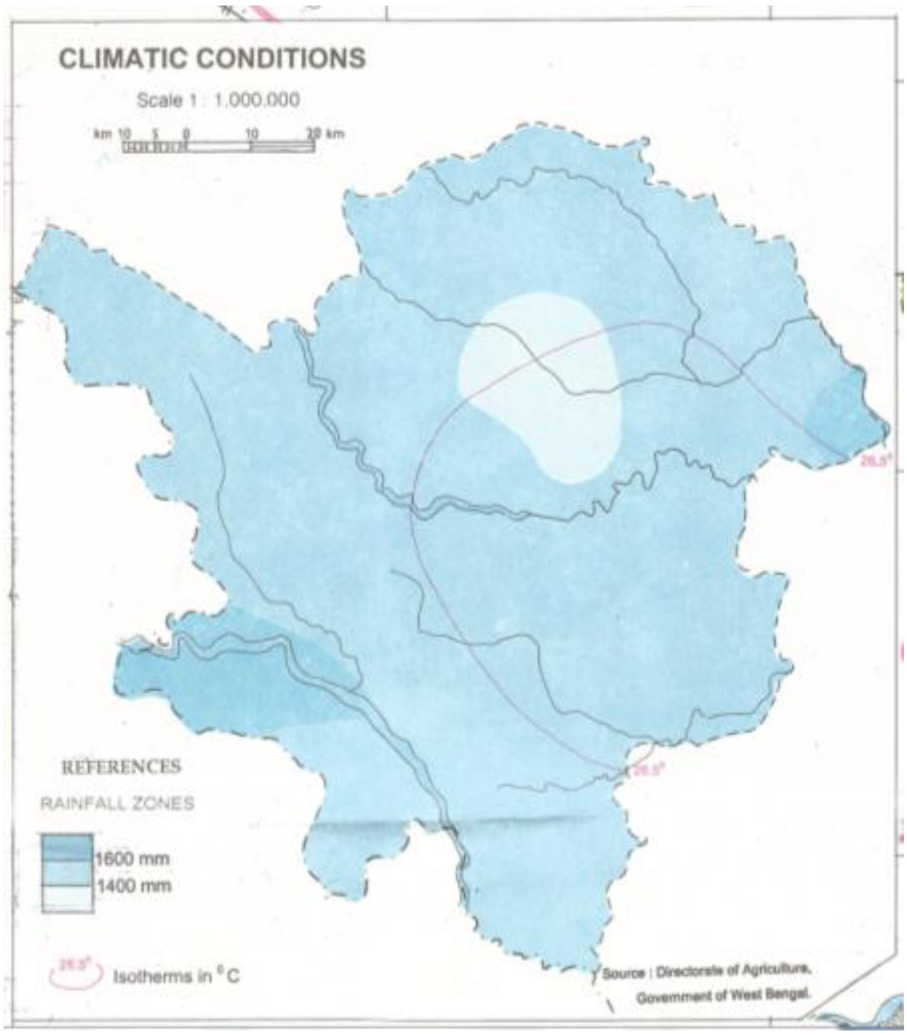


Figure 42: Climatic Condition of Paschim Medinīpur district

Hugli:

An oppressive summer season, profuse rains and high humidity all through the year are the main characteristic of the climate of the district. The hot season begins with strong Westerly winds from the middle of March and continues up to the middle of May. The weather is oppressively hot. Thunder storm commonly occurs in the afternoon in association with heavy rains with hails. The Kalbaisakhi or the North-Western storms are often violent and cause sharp drop in temperature. The post Monsoon season usually starts from middle of October and continues till the end of February with January being the coldest month.

In the month of May, storms and depressions from the Bay of Bengal reach the district which cause widespread heavy rains. The rain usually commences from the middle of June and uses to continue up to September with July and August are the rainiest months.

South 24-Parganas:

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 37^0C and the minimum is 9^0C.

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 43**.

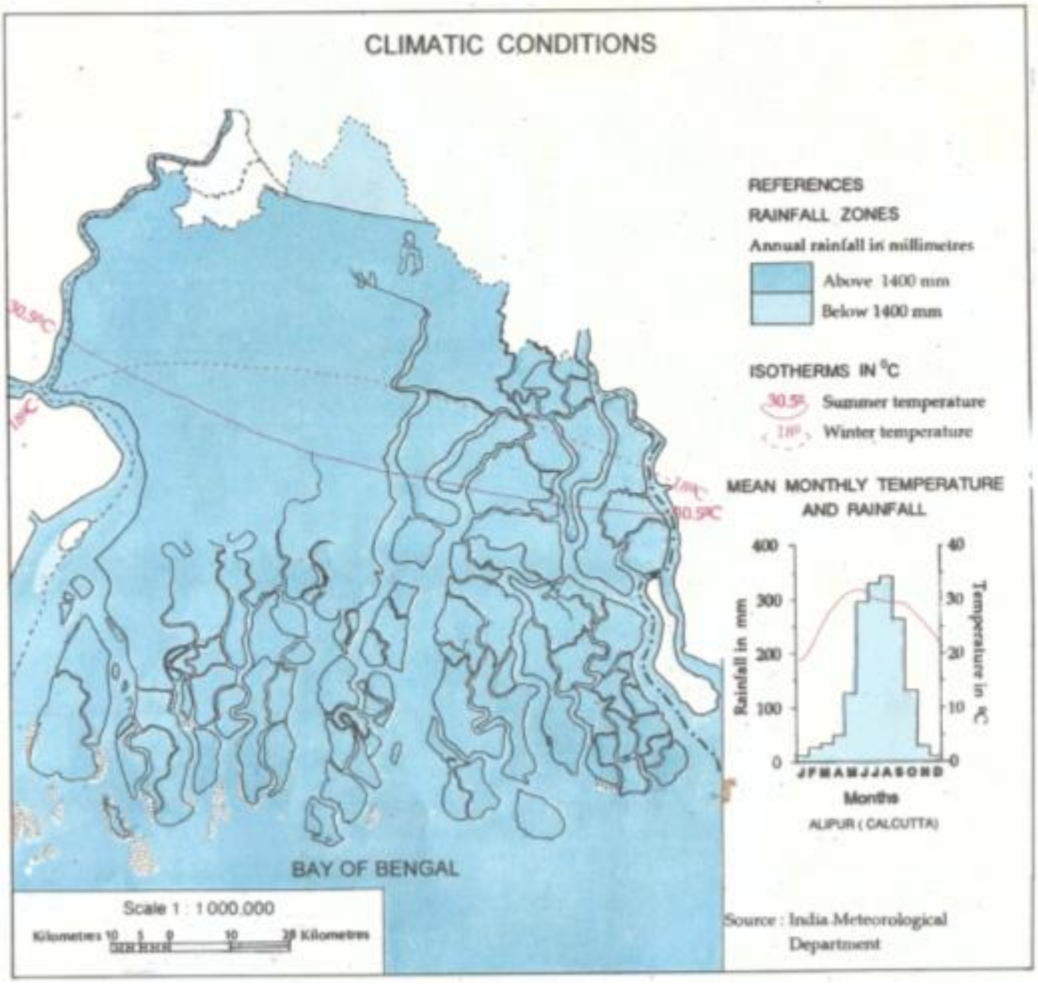


Figure 43: Climatic Condition of South 24-Pargana district

Howrah:

A moderate climatic condition prevails due to influences of the sea on the district's climate under the impact of the branch of the monsoon brought by Bay of Bengal. Three conventional seasons viz. the cold dry season, hot dry season and the rainy season earmark the climatic condition of the district.

The period falling between November to February is the cold dry season. January, the coldest month in the district, falls during this season. The summer season falls during the period from March to the middle of June when the weather remains hot dry. May is the hottest month in the district. The spell of monsoon starts from the middle of June ranging upto October. July and August are the months with the heaviest rain.

The mean daily temperature varies between 10ºC in the winter to 39ºC in the summer.

The normal annual rainfall during 2011 was 1,510 Millimetre. The Monsoon rainfall received during June to September constituted near to 75 to 80 per cent of the annual normal rainfall. In the district on an average there are 81 rainy days in a year. The Climatic condition of Howrah District is shown in **Figure 44**.

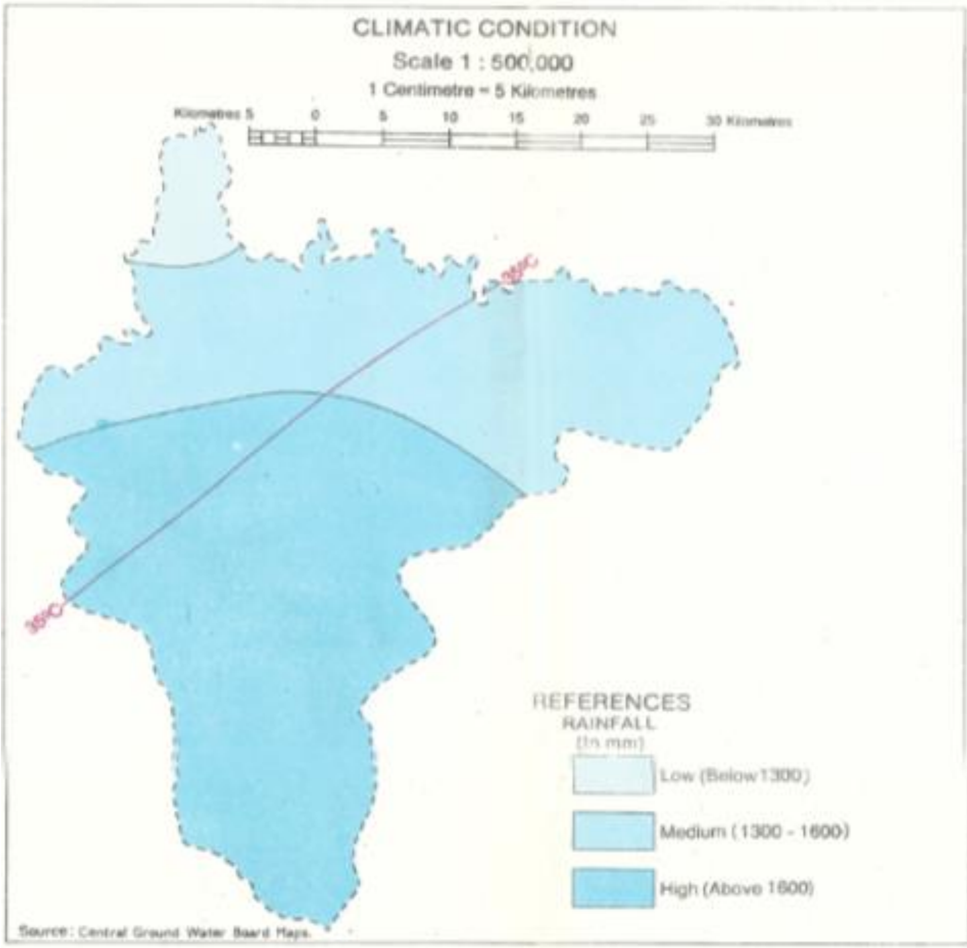


Figure 44: Climatic Condition of Howrah district

9.2.4 Soils

Purba Medinipur:

The soils of the Purba Medinipur district are alluvial types. The soils are deep to very deep. As the district is under coastal alluvium and has been formed by the recent alluvial deposition, the soils of this region are developed mostly on tertiary sediments comprising of sand, silt and clay. The district is situated on flood plains of the Rupnarayan and Haldi rivers. As a result, huge amount of clay particles dominates in soil texture. Due to the presence of high amount of clay content, this region is vulnerable to water logging during monsoon season. The soil map of the district is given in **Figure 45**.

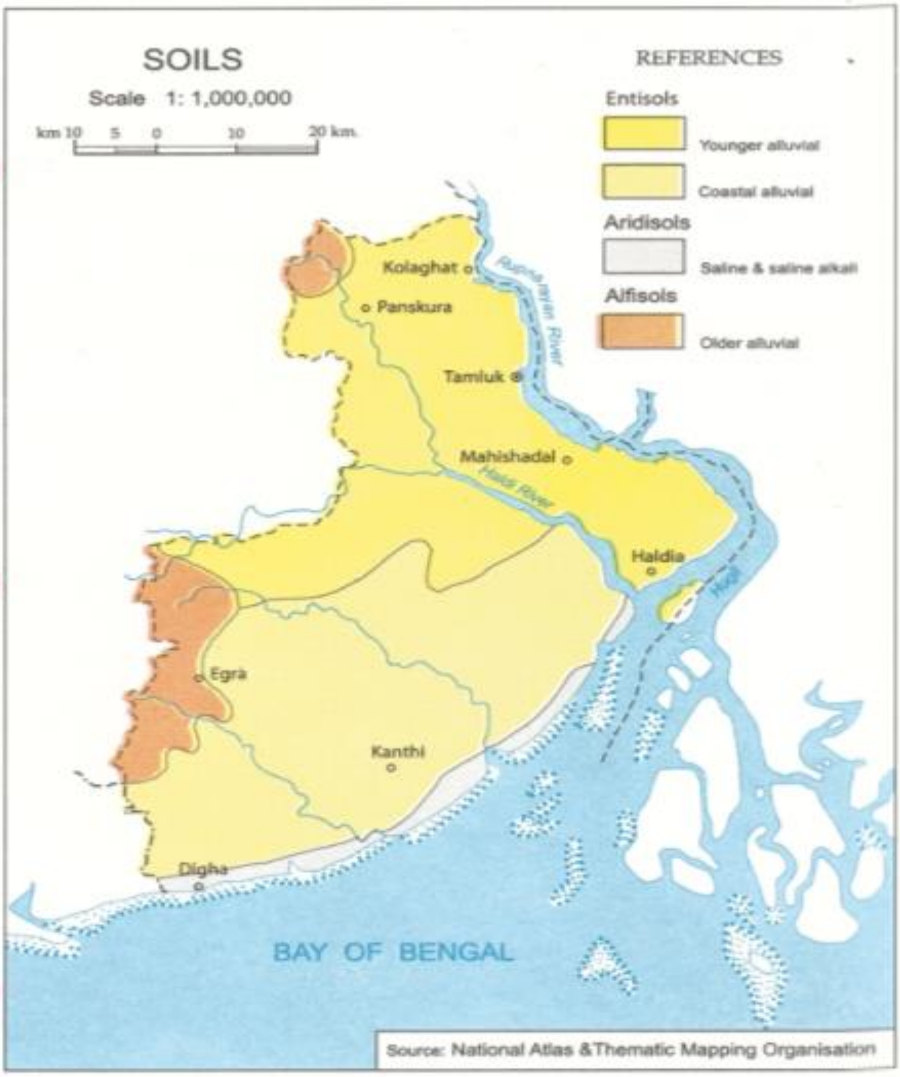


Figure 45: Soil Map of Purba Medinipur District

Paschim Medinipur:

The soil structure of the Paschim Medinipur district is found light and medium and in some places heavy types. North and north eastern part of the district is a part of Chhota Nagpur Plateau and covered with hard laterite stones. In western and eastern part, laterite alluvial soil persists. Geographically Paschim Medinipur district is divided into several sub-micro regions viz. Silai Plain, Lower Kasai Plain, and Upland Medinipur. Deferent types of soils are found in the district. Alluvial soils and brown soils are found in the southern part while brown and red sandy soils are found in the northern part of Paschim Medinipur district. This soil is good for the cultivation of oil seeds, millets and maize. In low land plain region paddy is being cultivated. In the lower Kasai Plain region alluvial soil is found which is highly suited for paddy cultivation. Besides, the river Kasai is flowing through this region which makes the soil more fertile and suitable for crop cultivation. Laterite rocks are also found in the north western part of this region.

The Upland Medinipur region is found in the north-west part of this district. This region is not ideal for cultivation. The Sandy soil found in the upper part of the district which is unproductive and therefore Sal trees and other jungle scrubs are found growing in this region. However in the southern part of this region, oil seeds and barley are rarely grown. The soil map of the district is given in **Figure 46**.

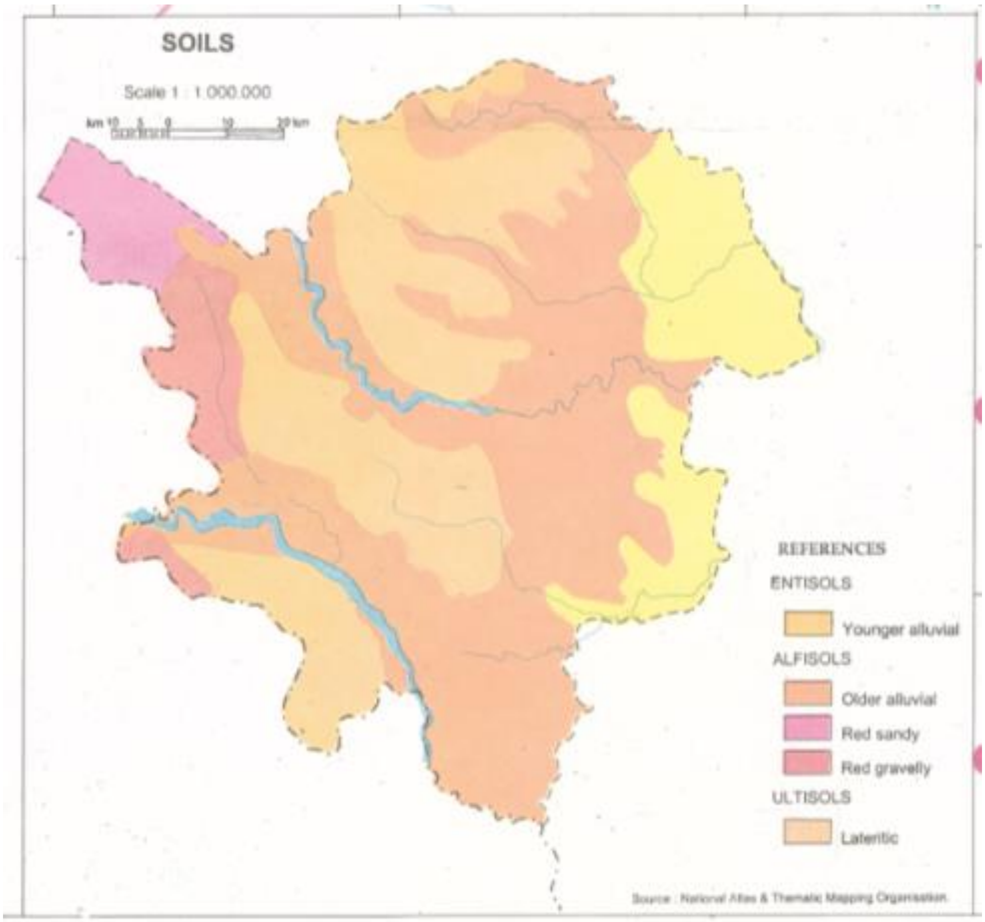


Figure 46: Soil Map of Paschim Medinipur District

South 24 Paraganas:

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. The soil map of the district is given in **Figure 47**.

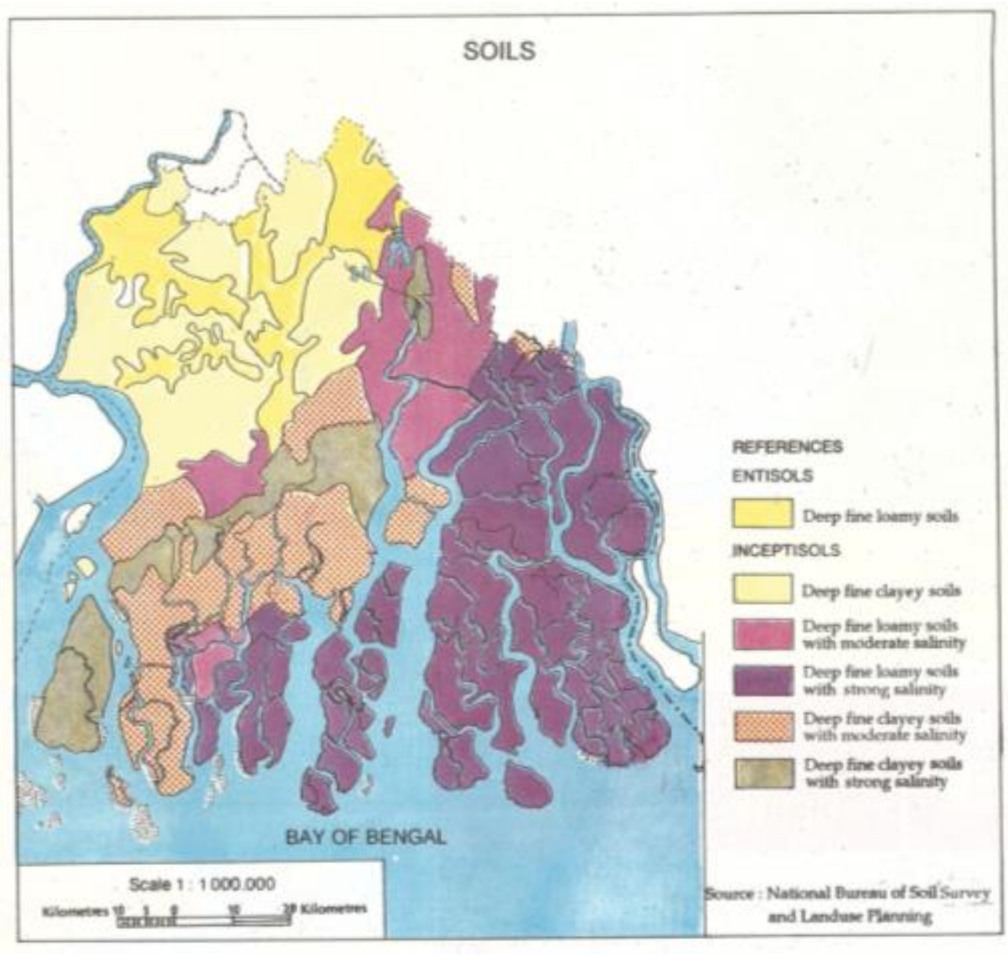


Figure 47: Soil Map of South 24-Pargana District

Hugli District:

Mainly alluvial soils are found in the region. The stretching in the Western part of the district has older alluvium soils with hard rocks. Laterite washing from the high lands of the Bankura district has made this district quite rich in laterite content.

The remaining part of the district is mainly alluvium. The sub-soil is mainly clay. In certain areas, silt deposition from the Hugli River and the once flourishing Saraswati River has developed surfaces with entel mati, whereas the deposition from the Damodar river and its branches has formed light and porous soil surface. But at places, the latter system has deposited reserves of sand. As such, in different places of district, layer of sands are found as sub-soil. The swampy areas have tough clay soil on surface. The local names of soil-clay as entel, clay loam as entel doash, loam as doash, sandy loam as bele doash and sand as bele, belemati.

Howrah District:

The soil in the entire district Howrah is alluvial and varies from sand in the river beds to sticky clay in the interior along the silted up streams and mud in the swamps. Clay soil and deep loamy soils prevail in the North and lighter loams in the South. These are comparatively recent deposits. In terms of composition, the soil may be leele or sandy, entel or clayey, penko or muddy, dhasa or marshey and similar types. The soil map of the district is given in **Figure 48**.

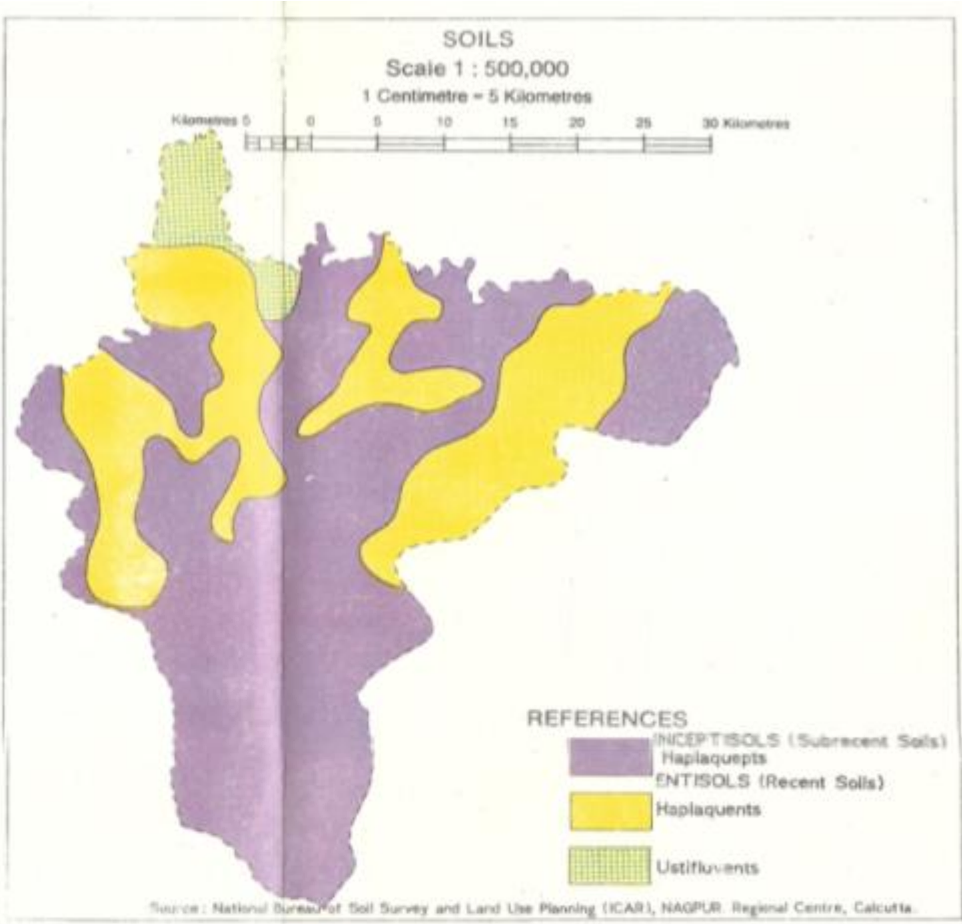


Figure 48: Soil Map of Howrah District

9.2.5 Land Use Pattern

The land use patterns of the project district are as follows:

Purba Medinipur:

Purba Medinipur district is one of the most varied districts in West Bengal with respect to physical aspects. The distribution of the particular types of land use in Purba Medinipur district depends largely on natural factors like the distribution of water and soil. It also depends on the traditional preferences and Government policies of zoning and land use planning decisions. Around 73 percent of the total reported area of the district is under cultivation Out of which 78 percent cultivation land has been occupied by food crops. Among food crops, paddy is the most widespread crop. The land use pattern of the district is given in **Figure 49**.

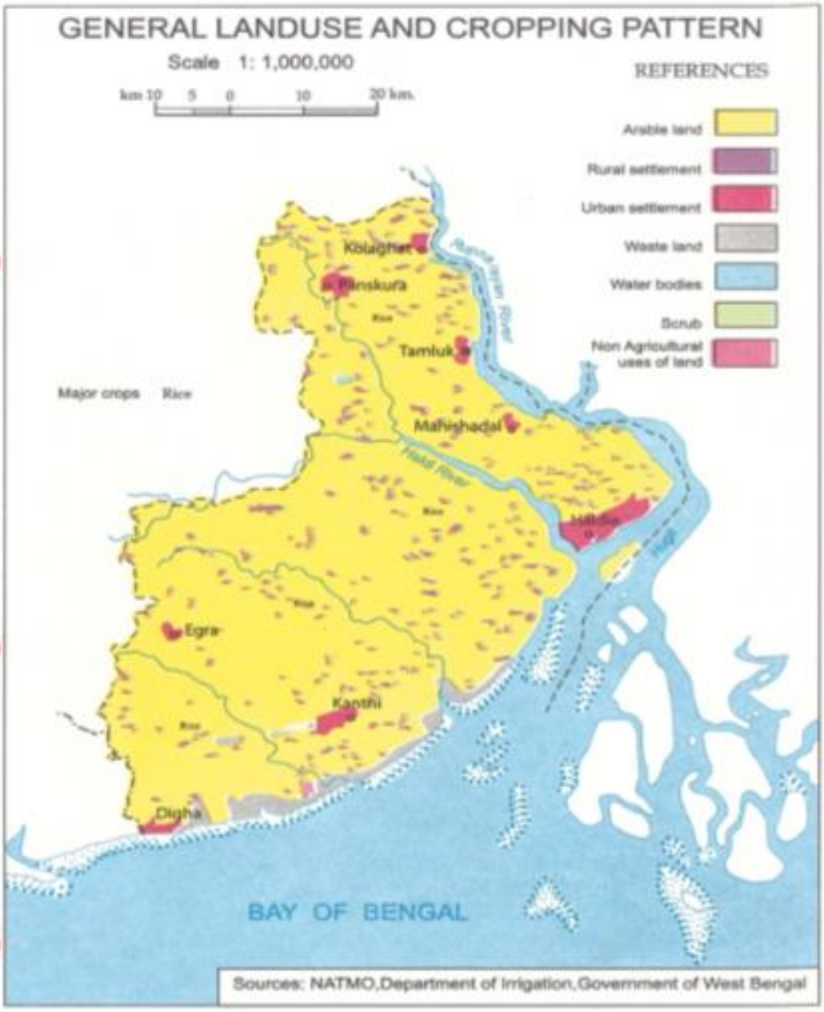


Figure 49: Land Use Map of Purba Medinipur

Paschim Medinipur:

Land is the most significant of all the natural resources and its use varies with the man's activity on land. Land may be used for shelter, food production, and recreation and processing of materials etc. Land use and land cover information are important for planning purposes. The land use pattern of the district is given in **Figure 50**.

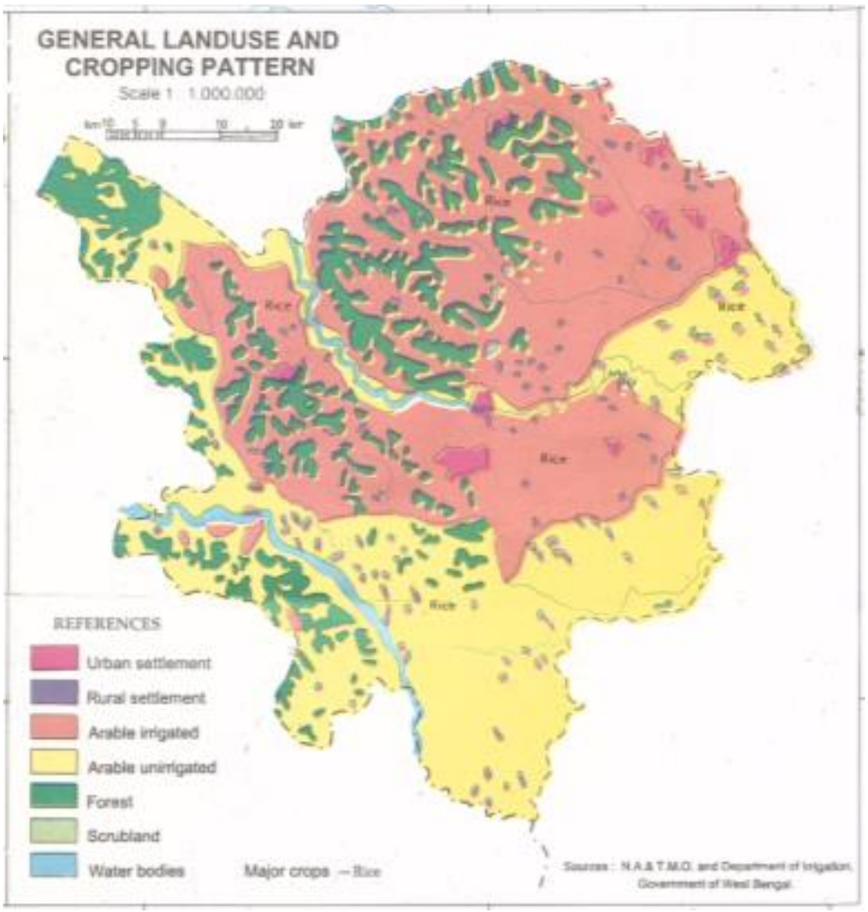


Figure 50: Land Use Map of Paschim Medinipur

South 24 Paraganas:

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 51.**

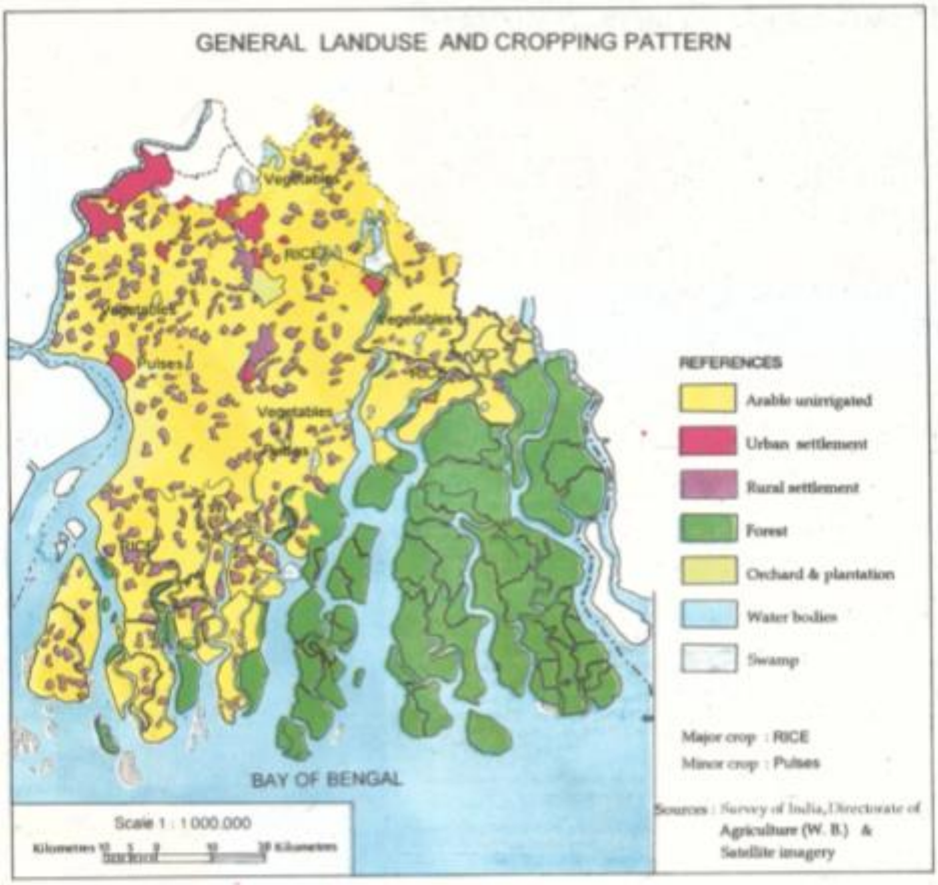


Figure 51: Land Use Map of South 24-Pargana District

Hugli district:

Hugli is a predominantly industrial district but the land is extremely fertile for agricultural production as well. In fact varieties of crops are grown in the district.

Howrah district:

Howrah is a district dependent on agriculture for the support of its population. The city of Howrah is inhabited by a vast share of the total population of the district which is mainly employed in non-agricultural fields. The land use pattern of the district is given in **Figure 52**.

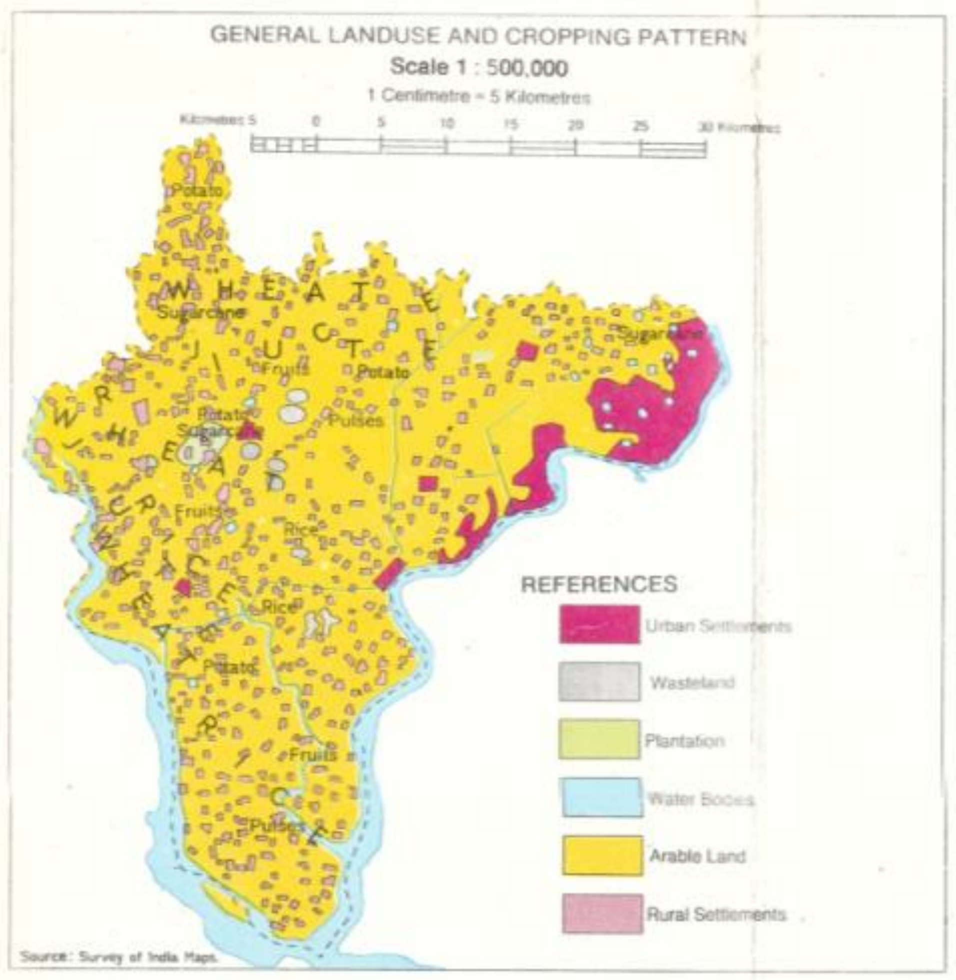


Figure 52: Land Use Map of Howrah

As per the Agricultural Contingency Plan for districts, the land use pattern for the project districts are given in **Table 47**.

Table 47: Land Use pattern of districts located along the Waterway[23]

S. No.	Land Use	District / Area ('000 ha.)				
		Purba Medinipur	Paschim Medinipur	South 24-Parganas	Hugli	Howrah
1	Geographical Area	396.59	928.53	953.37	317.09	138.67

[23] Agriculture Contingency Plan for districts

S. No.	Land Use	District / Area ('000 ha.)				
		Purba Medinipur	Paschim Medinipur	South 24-Parganas	Hugli	Howrah
2	Cultivable Area	295.67	597.39	380.46	220.35	85.57
3	Forest Area	0.90	171.94	426.30	0.530	-
4	Land under non-agricultural use	96.69	157.55	138.30	89.12	51.24
5	Permanent pasture	0.04	1.13	0.05	0.05	-
6	Cultivable wasteland	0.14	5.46	0.14	1.33	0.21
7	Land under miscellaneous tree crops and groves	2.78	9.26	2.94	1.89	1.20
8	Barren and uncultivable land	0.37	1.70	0.44	0.11	1.00
9	Current fallows	2.75	18.74	8.17	0.34	4.6
10	Other fallows	0.19	4.10	-	0.10	0.24

As per the reconnaissance survey, the land use along the Rupnarayan River is predominantly agricultural land, also numerous brick kiln are located along the banks.

9.2.6 Ambient Air Quality

During the reconnaissance survey, it was the found that the Air quality along the study area of Rupnarayan River was free from dust. However, it was also confirmed from the local people that there is no problem with Air pollution. **Table 48** shows the Ambient air quality of some locations along the Rupnarayan River.

Table 48: Ambient Air Quality along Project locations

S. No.	Location	Parameters (µg/m^3)		
		SO_2	NO_2	PM_{10}
1.	Bagnan (Howrah District)	4.40	35.73	41.53
2.	Amta (Howrah District)	3.32	29.37	34.367
3.	Tamluk (Purba Medinipur)	40.27	34.04	118.08

Source: West Bengal Pollution Control Board

9.2.7 Ambient Noise Level

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

9.2.8 Susceptibility to Natural Hazards

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.

In some places flooding is caused by excessive monsoons, while in others flooding is caused downstream from dams when reservoirs, which normally help to prevent downstream areas of rivers from flooding, are opened due to unusually high levels of rain to prevent the reservoir from overflowing the dam. Dam breaks are also a cause of catastrophic flooding. West Bengal has 37,660 sq. km flood prone area spread over 111 blocks where the total geographical area of the state is 88,752 sq. km. An analysis of the statistics of flood that occurred during last 41 years (from 1960 - 2000) shows that only on 5 occasions the state has not faced any severe flood. The total devastated area crossed 20,000 sq. km in 4 different years and the flood of medium magnitude i.e. between 2,000 to 10,000 sq.km. occurred on 10 occasions.

The State of West Bengal has been devastated frequently by different natural disasters mainly flood, cyclone and earthquake in the past causing huge losses of life and property. Approximately, 55.8% of the total land area of West Bengal is prone to flood. Past history of cyclones in West Bengal reveals that the state especially the coastal region has been one of the most cyclone affected territory in India. The hilly terrains of Darjeeling district in West Bengal are vulnerable to landslide. The state experienced earthquakes at a relatively moderate frequency. Subsidence hazards occurred in underground coal mining areas of West Bengal, e.g. Raniganj and Asansol.

Brief History of Natural Disaster

An earthquake in Kolkata in 1737 is said to be responsible for the loss of 0.3 million lives, thus illustrating it one of the three most disastrous earthquakes in history. But it was actually a storm surge that flooded the northern coast of the Bay of Bengal which resulted in numerous deaths. In 1787, due to heavy flood and devastating earthquake Teesta that was originally a river of Ganges basin shifted its course to Brahmaputra basin. Over ten thousand people perished in the cyclone that hit Medinipur district on October 14-15, 1942. A devastating tropical cyclone, Bhola struck West Bengal on November 12th 1970. It was the deadliest tropical cyclone ever recorded, and one of the deadliest natural disasters in modern times. Nearly to 0.5 million people lost their lives in the storm. It was due to the storm surge that flooded much of the low-lying islands of the Ganges Delta. This cyclone was the sixth cyclonic storm of the Nineteen-seventy's North Indian Ocean cyclone season. Floods in 1978 inundated one third of the state causing nearly billion damages. Flash flood in September 1991 caused damages of thirty five thousand houses. In 1995 flooding triggered by heavy rains caused erosion, severe agricultural damage and outbreak of diseases.

Table 49 summarizes the occurrences of extreme events and their consequences in the project districts.

Table 49: Natural Hazards and their damage vulnerability of Project District

Year	Types	Places	Description
1942	Cyclone	Medinipur	Over 10,000 people perished
1970	Cyclone Bhola	Some area of project district	Up to 50000 people lost their lives in the storm, primarily as a result of the storm surge that flooded much of the low-lying islands of the Ganges Delta
1978	Flood	Some area of project district	The places was inundated and caused nearly billion damaged
1985	Flood	Some area of project district	Caused by tropical cyclones
1986	Flood	Some area of Hugli, Howrah and Medinipur	Flooding due to heavy rain
1990	Flood	Some area of project district	Flooding due to monsoonal rain
2006	Cyclone	Some area of project district	Monsoonal rains and tropical cyclone-driven storms in the Bay of Bengal
2007	Flood	Some area of project district	10.8 million people in 10,173 villages were affected. Heavy

Year	Types	Places	Description
			rain from tropical depression in the Bay of Bengal caused flooding leading to 51 deaths, and affecting 3.2 million people
2009	Cyclone Aila	Some area of project district	Many people were killed and isolated

Source: Disaster in West Bengal: An Interdisciplinary Study

9.2.9 Estuary and Coastal Zone

Hooghly estuary is located in the confluence of river Hooghly in the Bay of Bengal, one of the major estuaries of the Ganges, the largest as well as longest river of Indian subcontinent. This estuary receives 4 small rivers, River Damodar and Rupnarayan at its head, and River Haldi and Rasulpur at the middle. The approximate area of the estuary is almost 4000 Sq.Km. Geographically this area is located in between latitude $22^0$11' 25'' N & $21^0$30' 51'' N and longitude $87^0$56' 08'' E and $88^0$24' 39'' E. It is a well mixed coastal plain estuary. Part of the world's largest delta is the Ganges-Brahmaputra delta, which lies partly in Bangladesh and partly in India. This low-lying fertile plain is one of the world's most densely populated areas. Navigable waterway for major port like Kolkata and Haldia.

The estuary is funnel shaped. The estuary consists of several bars, islands and a delta. Mixing zones of the estuary extends up to Diamond harbour, about 80 km upstream. This estuary is very shallow, depth is only 6m on the average and nowhere deeper than 20 m. Geomorphologically, it can be classified as coastal plain estuary. The important morphotypes are tidal island, tidal bars, beaches, mudflats, sand flats, coastal dunes, creeks, inlets and mangrove swamp. This delta is ornamented with large number of tidal bars and tidal islands of which Sagar Island, Lower Long Sand, and Nayachara are important. Sagar Island, the largest of the Sundarbans biosphere positioned at the mouth of the estuary and bifurcates it into two channels, the western channel is retained as Hooghly and eastern is named as Mooriganga. Semidiurnal tide (M2) type. The overall spring tide ranges were of the order of 4.27 m to 4.57 m and ranges of the neap tides were about 1.83 m to 2.83 m. Tidal influence is felt up to distance 300km Tide exhibits a positive asymmetry, which became stronger as it propagates along the channel. In the Tidal cycle flood tide is of short duration, 3 to 4 hours, while the ebb flows remaining 8 to 9 hours.

9.2.10 Archaeological and Heritage Locations

Following important historical and tourist place are located along the Rupnarayan River waterway:

Kolaghat: Kolaghat is a census town situated on the banks of the Rupnarayan River in the Midnapore East district of West Bengal. The riverside has become a popular picnic spot and is often crowded with people, particularly during the Christmas and New Year holidays. The town is notable for its Hilsa fish. The flower market is one of the biggest in the state.

Tamluk: Tamluk is the district headquarters of Purba Medinipur district of West Bengal, India. Though there is some controversy, scholars have generally agreed that present day Tamluk is the site of the ancient city variously known as Tamralipta or Tamralipti. The present town is located on the banks of the Rupnarayan River close to the Bay of Bengal. Archaeological remains show continuous settlement from about the 3rd century BC. It was a seaport, now buried under river silt. For this reason, Tamluk has many ponds and lakes remaining today.

9.2.11 Flora and Fauna

Purba Medinipur:

Flora: Purba Medinipur district has a visible coastline of approximately 60 km with Bay of Bengal and the coastal area is geographically contiguous with the Mangrove forests under Sundarban Reserve Forests lying towards East. The Forest area under district Purba Medinipur is characterised by coastal sand dunes, high salinity of the soil, low turbidity and thinner vegetative coverage affected by shore currents. The coastal tract extending from the estuary of river Hugli (Hooghly) to the North-East and Junput to the South-West; is enriched with a rich ecological diversity. There are fifty seven species of Mangroves found in this area including *Avicennia officinalis*, *Avicennia alba, Exococaria agallocha*, *Acanthus ilicifolius*, *Sueda maritima*, *Salicornia brachiate*, *Rizophora mucronata*, *Ipomea pescaprae*. Twenty eight species of benthic algae providing an opulent source of food, energy and cover for many organisms; eight species of phytoplanktons and many plant varieties associated with Mangroves have been identified so far in the district.

Along the beachfront seashore grows *Spinifex littoreus* (Ravan's Moustache), which is a perennial grass with stolon-forming stems.This species is an efficient sand binder, forming large colonies and stabilizing dunes. At the mobile dunes, grows Ipomoea pes-caprae (Goat's foot/Beach Morning Glory flower) which is also a salt-tolerant plant and being associated with Spinifex, helps in binding the dunes. In the more stabilised dunes tall evergreen shrubs and trees of Casuarina species grows abundantly. Most famous species among them is known as Jhau in colloquial Bengali. Shrubs and bushes of species Pandanus (known as Keora/Keya or Ketaki in Bengali language) which is a small branched tree or shrub with fragrant flowers, also grows copiously in this region. The distillate water generated from this plant has a powerful aroma and is used widely for medicinal and culinary purposes. The large ever green tree of Cashew nut is also grown in the coastal areas of the district, both commercially and in natural habitat. The plant species grown around the seashore acts as the major contributor for stabilising the tender coastline and creates buffer against the soil erosion caused by natural as well as human induced forces. Mat-reeds (*Cyperus corymbosus*) known as Madur Kathi in Bengali grows in abundance in the low lying water-logged areas, swamps and marshy lands in the mouth of rivers Hooghly and Haldi.

Fauna: Due to pressure of expanding population forces, the availability of natural diversity of wild fauna in the district Purba Medinipur is limited to the coastal region only. Despite having a small expansion, there is still significant diversification of animal species in the coastal areas of the district. The major types fauna observed in the coastal Purba Medinipur are Hare (*Lepus nigricollis*), Crabs, Horseshoe Crabs (*Limulus sp)*, Rats (*Rattus sp)*, different types of Snakes like Cobra (*Naja naja*), Krait (*Bungarus caeruleus*), Banded Krait (*Bungarus fasciatus*); Snails, Oysters, Clams, Starfish, Jellyfish, Limpets (*Patella vulgata*), large predatorysea-snails like Shankha or Conch (*Turbinella pyrum*), Sea-Urchins etc.

Zoological classification of the large varieties of fauna of district Purba Medinipur depicts that there are about 68 species of Arthropods including 12 types of Crabs, varieties of Prawns and 21 varieties of Shrimps living nearby the seacoast. A total of 51 species of Fish variety has been reported so far by fishermen folks and the zoologists. Among the smaller animals living inside the sea waters are 17 species of Zooplanktons – including Copepoda (small crustaceans), Chaetognatha (predatory Marine-Worm), Rotifera(microscopic and near-microscopic pseudo-coelomate animals), larvae of Blue Shrimp (Meen); 22 species of polychaete (paraphyletic class of annelid marine worms), 12 species of Actinaria (Sea Animones - a group of water-dwelling, predatory animals). Sea- Cucumber (Holothuroida), Sea-pen (Cnidaria), Lingula (Brachyopoda) is found in the coastal islands of Talsari, Sankarpur, Junputand Nayachar islands. Around forty eight species of Mollusca have also been reported so far along the sea coast of district Purba Medinipur.

Paschim Medinipur:

Flora: The flora of district Paschim Medinipur comprises of lush green forests and plantation, shrub jungles and bushes. The deeper forests of this district fall under Northern Tropical Dry Forests and Tropical Deciduous Forests category. The trees mostly found in this area are Sal (*Shorea robusta*), Peasal (*Pterocarpus marsupium*), Kend (*Diospyrosmelanoxylon*), Mahul (*Madhukalatifolia*), Kusum (*Schleicheratrijuga*), Karam (*Adina cordifolia*), Asan (*Terminalia tomentosa*), Bahera (*Terminalia *belerica*), Rahara (*Soyamidafebrifuga*), Dhaw (*Anogeissuslatifolia*), etc. The lesser forests include Eucalyptus (*Eucalyptus sp*), Akashmoni (*Acacia auriculiformis*), Bamboo groves, Cashew nut trees (*Anacardium sp*) etc.

Fauna: The availability of wild fauna has reduced considerably in the forests during in the last Century. However, consequent upon implementation of wildlife protection schemes by the Government as well as different international organizations, the condition of the forests is gradually improving and is becoming favourable for wildlife habitat. In recent years jungle cats (*Felis chaus)*, Monkeys (*Macaca mulatta)*, pythons (*Python molurus***)**, wild boar (*Sus scrofa*), Chitals (Axis axis), other deers and many variants of avifauna are increasingly being reported. Birds like ducks, storks, teals etc. are found in plenty. Jungle fowls are not many in numbers. Beside many non-venomous varieties, venomous snakes like Cobra (*Naja naja*), Krait (*Bungarus caeruleus*), Banded Krait (*Bungarus fasciatus*), Russel Vipers (*Daboia russelii*) etc. are common habitants of the jungles. Wild elephants (*Elephas maximus indicus*) from forests in Jhargram, Garbeta or Jamboni often visit to the nearby human habitations in search of crops and other foods. However, human-animal conflicts are rare due to scattered location of the jungles.

Hugli:

Flora: In the territory between the Damodar and Hugli plains, both cultivated and wild plants are found viz. reeds, sedges and aquatic plants in the marshes and swampy rice field, weeds, shrubs and smaller plants a little higher up; belts of bamboo, coconut (*Cocos nucifera*), palm (*Borassus flabellifer*), Mango (*Mangifera indica*), fig (*Ficus carica)*, jack fruit (*Artocarpus heterophyllus*) and other trees around the high village site. The river banks are lined with bamboos, figs, tamarinds (*Tamarindus indica)* and date-palms (*Phoenix sp*) with thick undergrowth.

Fauna: The domestic animals of the district include cows (*Bos indicus)*, dogs (*Canis lupus familiaris*), fowls, ducks and pigeons. No wild animals are found in the district. Monkeys abound all over the district. Other common mammals are rat (*Rattus sp)*, mouse (*Mus sp*), squirrel (*Funambulus palmarum*), civet cat (*Viverra zibetha*) and mongoose (*Herpestes edwardsii*).

South 24-Parganas:

Flora: It is easily understood that from the above discussion that this area is rich in flora. Practically the whole district is covered with mature and active parts of Gangetic Delta. The southern plains surround the mature delta, the Sundarbans surrounds the active parts of Gangetic Delta. In the mature delta, cultivated crops have replaced the natural cover. Various kinds of vegetables, cereals, pulses, fibre plants, oil seed crops and other food accessories are found in the region. Rice is the most important cereal of the district. Exotic varieties of fruit trees, bamboo groves, flowers and scrubs are also found.

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

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

Apart from tiger, there is much more wild life. 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 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, the saltwater crocodile (*Crocodylus porosus*) and mugger crocodile (*Crocodylus palustris*), as well as the gharial (*Gavialis gangeticus*) and the water monitor lizards (*Varanus salvator*), all of which hunt on both land and water. Sharks and the Gangetic dolphins (*Platanista gangetica*) roam the waterways.

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

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

Reptiles: An excellent number of reptiles are also found in Sundarbans. Some of the common ones are olive ridley turtles (*Lepidochelys olivacea*), sea snakes, dog faced water snakes (*Cerberus rynchops*), green turtles (*Chelonia mydas*), estuarine crocodiles (*Crocodylus porosus*), chameleons, king cobras (*Naja naja*), salvator lizards (*Varanus salvator*), hard shelled batgun terrapins (*Melanochelys trijuga*), Russels vipers (*Daboia russelii*), monitor lizards (*Varanus bengalensis*), hawks bill turtles (*Eretmochelys imbricata*), pythons (*Python molurus*), common kraits (*Bungarus caeruleus*), green vine snake (*Ahaetulla nasuta*), checkered keelbacks (*Xenochrophis sp*) and rat snakes. The river terrapin (*Batagur baska*), Indian flap-shelled turtles (*Lissemys punctata*), peacock soft-shelled turtles (*Trionyx hurum*), yellow monitors (*Varanus flavescens*), water monitors (*Varanus salvator*) and Indian pythons (*Python molurus*) are some of the resident species.

Howrah:

Flora: There is a high degree of composition of vegetation of the district Howrah almost exclusively having aquatic or palustrine plants such as *Hydrilla*, *Utricularia*, *Caesulia* in view of the predominance of low-lying swampy land laid out in rice fields in the entire region. There are semi-spontaneous plants that form the village shrubberies of Central Bengal, such as *Glycosmis*, *Trema*, *Urena*, *Solanum*, *Datura*, *Leonotis* and the like. The weedy vegetation of the waste places, one of the striking features of the district as it occurs in these places in exotic extent. Many of these weeds are actually the natives of America, such as *Scoparia*, *Ageratum*, *Evolvulus*, *Nummularius* and *Peperomia pellucida*.

Fauna: As there is no extensive forest area and the district is fringed with factories and under cultivation elsewhere, wild animals have always been scarce in the district. The mammals that occur in the district include some fox-type animals, some types of cat, otters (Lutrogale sp), civets (Viverra sp), mongooses (Herpestes edwardsi), hare, porcupine (*Hystrix indica*), rhesus macaque (*Macaca mulatta*) and langur (in the vicinity of Sibpur Botanical Garden), flying fox (*Badur*), Indian False Vampire (*Chamchika*) and Gangetic Dolphin (*Platanista gangetica*). There are some 66 species of bird in the district. During winter season it has been observed that Snipe of two or three varieties are fairly numerous in the paddy fields in the Domjur, Sankrail and Jagatballavpur Police Stations in the Howrah Sadar Sub-division and also in the Uluberia Sub-division. The principal varieties of river fish netted in the Hooghly river are hilsa (*Tenualosa ilisha*), bhetki (*Lates calcarifer sp*), tengra (*Mystus tengara*), topse fish (*Sarotherodon melanotheron heudelotii*).

9.2.12 National Parks, Forests, Wildlife Sanctuaries and Reserves

National Parks and Wildlife sanctuaries play a vital role in protecting the wildlife of a particular area and providing them their natural habitat. There are no national parks, forests, wildlife sanctuaries and reserves adjacent to the Rupnarayan River. The nearest protected area is Sunderbans which is located more than 38 Km away from the river section. The various wildlife and protected areas in West Bengal is given in **Figure 53**.

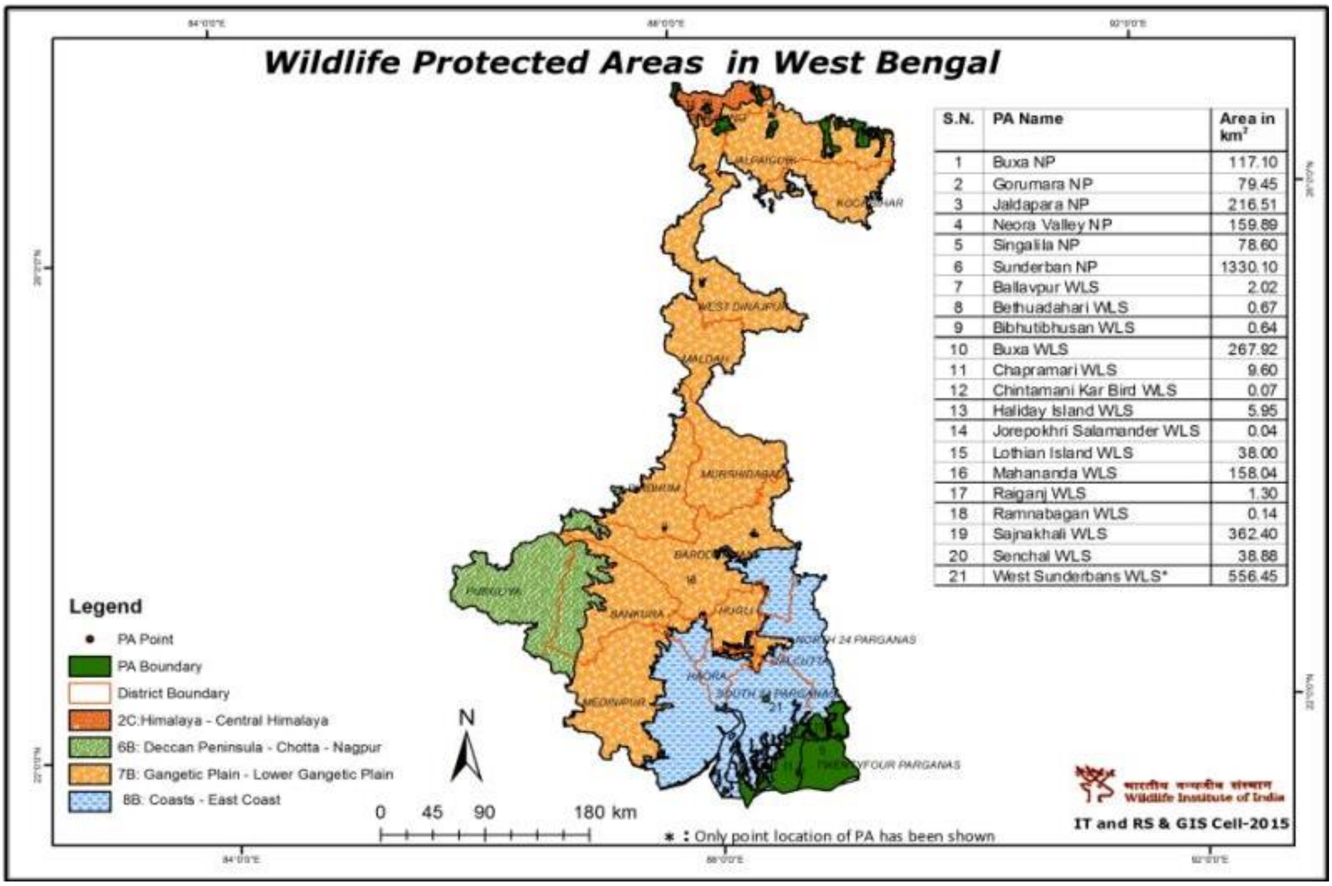


Figure 53: Wildlife Protected Area of West Bengal

9.2.13 Socio - Economic Profile

A) Demography

Purba Medinipur: According to the 2011 census of India, Purba Medinipur district has a population of 5,094,238. This gives it a ranking of 20th in India (out of a total of 640). The district has a population density of 1,076 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 15.32%. Purba Medinipur has a sex ratio of 936 females for every 1000 males and the district has a literacy rate of 87.66%

Paschim Medinipur: According to the 2011 census of India, Paschim Medinipur district has a population of 5,943,300. This gives it a ranking of 14th in India (out of a total of 640). The district has a population density of 636 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 14.44%. Paschim Medinipur has a sex ratio of 960 females for every 1000 males, and a literacy rate of 79.04%.

South 24-Parganas: According to the 2011 census of India, South 24-Parganas district has a population of 8,153,176. This gave it a ranking of 6th among the districts in India (out of a total of 640). The district had a population density of 819 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 18.05%. In 2011 South Twenty Four Parganas had a sex ratio of 949 females for every 1000 males, and a literacy rate of 78.57%.

Hugli: According to the 2011 census of India, Hugli district has a population of 5,520,389. This gives it a ranking of 16th in India (out of a total of 640). The district has a population density of 1,753 inhabitants per square kilometer. Its population growth rate over the decade 2001-2011 was 9.49%. Hugli has a sex ratio of 958 females for every 1000 males and a literacy rate of 82.55%

Howrah: According to the 2011 census of India, Howrah district has a population of 4,841,638. This gives it a ranking of 23rd in India (out of a total of 640). The district has a population density of 3,300 inhabitants per square kilometre. Its population growth rate over the decade 2001-2011 was 13.31%. Howrah has a sex ratio of 935 females for every 1000 males and a literacy rate of 83.85%.

The brief of demographic details of various project districts has been presented in **Table 50**.

Table 50: Demographic Profile of Project Districts

Total Population	Population	Population Density (/km^2)	Literary Rate (%)	Sex Ratio
Purba Medinipur	5,094,238	1,076	87.66	936
Paschim Medinipur	5,943,300	636	79.04	960
South 24-Parganas	8,153,176	819	78.57	949
Hugli	5,520,389	1,753	82.55	958
Howrah	4,841,638	3,300	83.85	935

However, the following tows/village given in **Table 51** are along the study stretches of Rupnarayan River. As per Census of India Report, 2011, these towns/villages comprises of population of 847949 persons

Table 51: Population along the project stretch of Rupnarayan River

S. No.	Village/ Town name	Population (nos.)
1	Anantapur	5,532
2	Deora	6,715

S. No.	Village/ Town name	Population (nos.)
3	Deulgram	6,517
4	Dihimandalghat	7,910
5	Dinga Khola	5,271
6	GarhKamalpur	6,664
7	Jallabad	5,381
8	Jaynagar	6,977
9	Kakdihi	5,477
10	Kalyanpur	8,914
11	Kanpur	6,069
12	Kesabpur	12,073
13	Kolaghat	2,90,124
14	Mahisadal	2,06,277
15	Mirjapur	5,114
16	Naul	5,865
17	Naupala	7,856
18	Noorpur (Nurpur)	7,257
19	Osmanpur	5,289
20	Radhapur	4,623
21	Shashati	6,914
22	Shyampur	7,354
23	Tamluk	2,17,776
Total		**8,47,949**

B) <u>Economic Profile</u>

<u>Purba Medinipur:</u>

Agriculture: Agriculture is an important part of the economy of Purba Medinipur district. Agricultural land is their asset, their capital and most importantly their means of sustenance as well as survival. Agriculture has the largest share in their income; it is the source of livelihood for major portion of the people. A very high percentage of working population in Purba Medinipur district is engaged in agriculture.

Land and water resources are inseparable, as water is indispensable to agriculture. A regular, abundant and continuous supply of water is essential for increase in agricultural production. Purba Medinipur district is one of those districts which are blessed with rainfall and perennial rivers. The area receives more than 1,800-2,250 milimetres. of rainfall during rainy season. As the district is low lying flat surface characterized with clay to silty clay type of soils, water logging during kharif seasons is a major threat to exploitation of land potentiality. The major crop grown in the district are Paddy, (*Aus, Aman and Boro*), Wheat, Potato, Oilseed, Vegetables, Pulses, Jute, Betel vine, Mat stick etc. The experience of draught and flood are common in the district. Normal rain fall of this district is 1,683 mm. and average rainfall is 1,752 mm.

Irrigation: Purba Medinipur district is well endowed with rivers and canals. Land and water resources are inseparable as water is indispensable to agriculture. Purba Medinipur district has a special position in West Bengal with a large area being covered with irrigation facilities. Paddy cultivation dominates in the district where irrigation facility is utilised extensively. Various sources of irrigation like river, canal, tank etc. are available in the district. The main rivers of the district are Rupnarayan, Kangsabati, Keleghai, Haldi, Rosulpur, Hugli (Hooghly) etc.

The major canal in the district is the Medinipur Canal whose construction started during the British period, in the year 1866 by the East India Irrigation and Canal Company. Out of four sections of this canal, two sections of the canal lye inside present day Purba Medinipur district. The first section starts near river Kasai and terminates in Panskura, spanning about 40 km. The second section extends from Panskura to Dainan on the Rupnarayan spanning about 20 km. During earlier periods, Medinipur Canal has been a major source of irrigation for the predominantly non-deltaic region. The Hijli Tidal Canal extended from Geokhalai near the junction of the Rupnarayan and Hooghly River to the Haldi River and thereafter to the Rosulpur River at Kalinagar. The total length is 47 km. Construction of the Canal started in 1868 and completed in 1873. Numerous drainage canals are linked with these major canals, Kanthi Canal and Masuria Canal are among them which allow river waters to come inwards at times of tides and floods and this helps in the irrigation of the respective C.D. Blocks without much maintenance cost. This is known as tidal irrigation in Purba Medinipur district and is really the meaning of Canal irrigation there. Irrigation sources like Deep Tube well, Shallow Tube Well, Lift Irrigation, Ponds, and other sources are also made available in the district.

Animal Husbandry: With regard to animal husbandry, Purba Medinipur district occupies a moderate position in the State. Major problem relating to milk production and meat are shortage of green fodder and inadequate supply of improved breed of animals. By promoting fodder cultivation, encouraging farmers towards crop diversification for fodder cultivation, increasing awareness through exposure visits and conducting health camps, the above problem could be overcome.

Dairy development is one of the major economic activities in the district. However, the district is unable to meet the requirement of milk and meat at the present level of production.

Fishery: Purba Medinipur district has 26,962.52 hectares of water area in the form of small, medium and large tanks, canals and others. Besides, there are also some riverine resources. There is ample scope for fish production both in fresh water, brackish water as for its marine variety. During last three decades the Fisheries Department, Government of West Bengal has made efforts in the field of seed and table fish production by motivating people with training and financial assistance through F.F.D.A. This has resulted in employment generation and uplifted socio-economic condition of the fishermen community.

Industry: Though agriculture is the main occupation of Purba Medinipur district, Micro, Small and Medium Enterprises (MSME) have also gained momentum recently. District Industries Centre has been initiating all positive efforts to present entrepreneurship. The district has an excellent transport and communication network of the national highways and railways. In Purba Medinipur district major industrial base are located at Haldia and Kolaghat. Haldia Petro Chemical Complex is one of the largest petro chemical units in India. The fast developing port at Haldia is an alternative to Kolkata port, where big ships are not able to anchor. Kolaghat Thermal Power Station at Mecheda is a major thermal power station in West Bengal. Large number of heavy engineering, chemical, small-scale cluster are growing up in Haldia. In coastal areas aquaculture and shrimp farming has been taken up. Besides, floriculture and horticultural activities are also found in the district. Handloom weaving is a traditional activity of the people in the district. The district is enriched in handicrafts activities. A large number of families are engaged in handicraft activities throughout the district.

Trade & Commerce: The chief commodity produced in the district is rice and therefore the principal trade is rice which is mainly exported to Kolkata. Other important commodities for export are sugar and molasses, jute, gram, pulses, brass and bell metal ware, silk and cotton clothes, poultry and vegetables. The important import items include kerosene oil, cotton goods, salt, tobacco etc. The principal trade markets are Tamluk, Haldia etc. A commercial transaction in the district is mainly carried out through trade in the markets. However, a huge quality of goods and articles are being sold out through fairs and festivals where large number of people assembled together.

Transport: The district has an excellent transport and communication network of National Highways and Railways. Two important National Highways are passing through this district. NH-6, which connects Panskura and Kolaghat, is a well maintained highway passing through the district. NH-41 at Kolaghat connecting Tamluk and Haldia is another National Highway in the district. The Tamluk-Contai road connects the Southern parts of the district. The Belda-Contai road is also an important road connecting with the Contai-Digha road. Nandigram-Mahishadal road and Basudebpur-Mahishadal-Sutahata coast roads are equally important roads in the district.

A large portion of the district Purba Medinipur is connected with well-defined railway network with State capital Kolkata and other places. The railway line from the busiest Sea Beach in West Bengal at Digha is connected with Kolkata through Ramnagar and Contai-I C. D. Block. Panskura is another important railway station catering large volume of trade of locally produced flowers to the outside world. Haldia Sub-division is connected to Sealdah (in Kolkata) through Panskura - Haldia railway line.

Due to typical geo-morphological compositions, the small stretch of river Hugli (Hooghly) flowing along the Eastern boundary of Purba Medinipur is navigable and well maintained ferry service is functional in these area. Haldia Township located at the estuary of river Haldi, is well connected through inland water transport services. Nandigram is connected to Haldia Town by ferry service and there are two popular ferry ghats in Haldia, one in the Township and another is Paria Chak Ghat. This ferry service plays as an important mode of transport for farmers and small traders of Nadigram who uses this service to reach Haldia Market. There is a ferry service from Geonkhali of C. D. Block Mahishadal to Nurpur in district South 24 Parganas (Geonkhali – Nurpur Ferry Service) across river Hugli (Hooghly). Kukrahati is another Ferry Ghat connected to Raichak in district South 24 Parganas across river Hugli (Hooghly). These two acts as the trade route as well as tourist destinations. Haldia Town is well connected with Sagardeep (Mythological Sagar Island) in district South 24 Parganas through ferry service, which also acts as trade route and route for contemplating religious journeys.

Paschim Medinipur:

Agriculture: Agriculture is the most important occupation of the people of Paschim Medinipur district. The economy of the district is based on agriculture. The principal crop of the district is paddy though other crops like pulses, oilseeds, potatoes and sugarcane also grows in the district.

Irrigation: Medinipur Canal is the most important source of irrigation in the district. The water supply is derived from the river Kangsabati at Mohanpur where there is a regulating weir with head works and the Canal extends to Uluberia on the river Hugli. Besides Medinipur Canal, number of Deep Tube Wells, River Lift Irrigation and Shallow Tube wells are also used for irrigation.

Animal Husbandry: The Directorate of Animal Husbandry maintains a breeding farm at Salboni in Paschim Medinipur and poultry farm in other places in the district.

Fishery: Paschim Medinipur district has 23,175.57 hectares water area in the form of small, medium and large tank. The eastern part of the district is rich in fisheries potential. The Fisheries department during the last three decades has made strenuous effort in the field of seed fish production. The total area under effective pisciculture in the district is 16,017.42hectares and the supply is 6,20,498 quintal. The number of persons engaged in this profession was 64,033.

Industry: West Bengal State Industrial Development Corporation (WBSIDC) is setting up Godapiasal Industrial Park for Cement industry in Paschim Medinipur district. It has also setup a unit for manufacturing Iron and Steel at Salbani in the district. The district is industrially backward with agriculture being the major source of occupation. Handicraft and paper industry are found in the district. Railway terminal workshop is setup at Kharagpur. Handicrafts of Medinipur are famous for time immemorial. Stone wares and Dokra work are well known to the rest of the world. The articles like thala (plate), rekab, ashtray, lamp etc. are being manufactured in home. Soft stone are used for the manufacture of house hold articles.

Trade & Commerce: The prime agricultural produce of Paschim Medinipur district is rice and therefore the main trade of the district is rice. The other important trading commodities are sugar, pulses, mats, vegetables and poultry products. Other commodities needed being imported from the neighboring districts for consumption. The most important among them are cotton goods, kerosene oil, salt, tobacco, potatoes etc. There are permanent market places for buying and selling of goods. The major market places of the district are Medinipur Sadar Regulated Market, Ghatal Regulated Market and Jhargram Regulated Market.

Transport: The most common transport system in Paschim Medinipur district is road transport. Water transport and Railways are also available in the district. The district is well networked with other part of the State through roadways. National Highway (NH-6) passes through the district connects other cities like Surat in Gujarat; Dhule, Amravati and Nagpur in Maharashtra; Durg and Raipur in Chhattishgarh; Sambhalpur in Odisha. The district is well connected with other districts like Purba

Medinipur, Bankura, Birbhum and Murshidabad through National Highway (NH-6). Besides the National Highway, few other State Highways also passes through the district. State Highway (SH)-4 connects Sarenga, Goaltore, Chandrakona, Ghatal and Panskura. SH-5 connects Banspahan, Narayanpur, Silda, Lodhasuli, Kharagpur (via NH-6), Keshiary and Belda.

South 24 Parganas:

Agriculture: South 24 Parganas is mainly an agricultural district. The main source of livelihood of the people is cultivation, but most of the agricultural lands in the district are mono-cropped owing to poor irrigation facilities and high salinity in water. Besides, the district being coastal the agriculture of the district periodically suffers from setbacks like Storm, Cyclone, and Depression etc. The crops are also often subjected to attacks by various diseases, insects and pests owing to relatively high humidity (85.0 per cent). Rice is the most important food crop of the district. All the three well-known types of rice, Aus, Aman and Boro are cultivated in the district with Aman occupying the first place and outstripping the other two in both area of cultivation and production of grain.

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

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

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

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

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

Fishery: South 24 Parganas is extremely rich in fish fauna, courtesy Sundarbans By virtue of presence of numerous intertwined river channels, creeks and riverine estuaries of Sundarbans, fishery has always been an important economic activity of the district of South Twenty Four 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, bills 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 Twenty Four Parganas district. The presence of dense jungle of Sundarbans, numerous islands and rivers, khals and bills 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 Twenty Four 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 lighten 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, thanks 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.

Hugli:

Agriculture: Hugli is an agriculturally prosperous district of West Bengal. The land use pattern of the district demonstrates a high proportion of net sown area as percentage of total reported area. About 70% of its population depend on agriculture and represents an important and remarkable place in the field of agriculture in West Bengal.

Due to massive population explosion and continuous increase of pressure on land, the farmers of this district are engaged in cultivation of all the major crops utilising the fullest potentiality of land and natural resources. Though rice is the prime crop of the district, the agricultural economy largely depends on potato, jute, vegetables and orchard and the cropping intensity of the district has been escalated to 220%.

Vegetable is a price crop in the blocks of Haripal, Singur, Chanditala, Polba and Dhaniakhali being grown in a relay system throughout the year. Though potato is cultivated in all the blocks of this district in Dhaniakhali, Arambagh, Goghat, Pursurah, Haripal, Polba-Dadpur, Tarakeswar, Pandua and Singur contributed much of its production of this district.

Irrigation: Paddy is the primary crop and rice is the principal cereal of this district which accounts for 69 % of total area and 96% of total production of rice. Potato cultivation also plays very important role in the agriculture-based econany of the district. This district is a major producer of potato in West Bengal. Jute, vegetables, oilseeds anu fruits are the other major crops of the district. Entire Arambagh Sub-division, Jangipara, Pandua, Haripal, Polba and Dhaniakhali blocks comprise an area where rice is the principal crop, while Tarakeswar, Pursurah and Balagarh blocks form a potato, jute, oilseeds pulses and vegetable-producing belt. A huge number of landless agricultural labourers, pattadars, bargadars and poor farmers most of whom live below the poverty line are engaged directly and indirectly in such agricultural and allied activities.

Industry: The foreign investors have come to this district since ages and their Trade flourished here. The Portuguese, the Dutch, the French, the Danes and the English dominated the district's industry, trade and commerce for more than two centuries. As a result, the district has been very rich in industry. In no other district in West Bengal, except Howrah, where the proportion of persons engaged in industrial occupations is as high as in Hugli. The old-time industries of the district are silk and cotton handloom weaving, chikan embroidery, brass and bell metal manufacture, bricks and tiles and rural oil pressing.

From the border of Howrah district i.e. from Uttarpara to Tribeni, along the bank of river Bhagirathi, the area is well served by road, rail and river transport connecting it with the great market and port city of Kolkata. Other factors contributing to the industrial growth of this region are supply of electricity by the Calcutta Electric Supply Corporation up to Bhadreswar at a low price and abundance of cheap labour.

Besides Bandel Thermal Power Plant, the district has got heavy industries in form of jute and cotton mills, heavy chemicals, rubber, auto mobile, steel, rayon etc. Hindustan Motors Limited at Uttarpara is one of the largest automobile manufacturing units in the country. The Dunlop Rubber Co. India Ltd., at Sahaganj, is the biggest of its kind in Asia producing rubber tyres, tubes and various other rubber products. The Alkali and Chemical Corporation of India Ltd. at Rishra is the first in India to produce polythene. The Shree Textile and Industries Ltd. at Rishra are manufacturing textile goods, especially flax goods. Kesoram Rayon at Bansberia produces rayon grade pulp. J.K. Steel Ltd. at Rishra is producing jute baling loops etc.

Among the small scale industries rice mills, cold storage, automobile servicing, printing presses, distilleries, power looms, iron foundries, manufacture of automobile parts and plastic moulding, non-ferrous and alloy casting, machine component, jute spiral needles, fencing wires, flooring tiles, brass locks, chemicals and pharmaceuticals, G.I. Pipes, soap, perfumes, optical lenses, dry stuff and pigments etc. are worth mentioning.

Due to globalization, foreign products have got a way in Indian market. Political turmoil, especially in the matter of land acquisition, has a negative impact not only in this district but in most parts of the country. Once referred as the industrial hub of West Bengal, the district has lost much of its past glory. In order to check any further decline, the Hugli District Collectorate has constituted a Single Window Cell in order to discuss the grievances/applications of the entrepreneurs and to assist them who still come forward to set up industries, small scale as well as large and medium scale, in the district considering its advantage of raw materials, skilled labour, easy finance, power, having proximity to Kolkata and having a congenial industrial atmosphere. The Cell functions under the Chairmanship of the Additional District Magistrate (General) and Additional District Magistrate & District Land & Land Reforms Officer, Additional District Magistrate (Land Acquisition), representative of WBSEB/CESC, General Manager, District Industries Centre are the other members. Officials of other departments as per necessity are also invited. The cases related to land, electricity, tree felling permission, bank finance, administrative clearance etc. are sorted out and to the possible extent solved by this Cell.

Trade & Commerce: The agricultural produce and agro-based industry products of the district are exported in different states of India. Industrial products like nylon ropes, bricks, medicine, plastics and synthetics produced in the district are exported to different parts of the country as well as in outside India.

Transport: Except an airport, the district has got every other means of transport. The Airport, i.e. Netaji Subhas Chandra Bose International Airport, is maximum a half an hour drive from the district border of Uttarpara-Kotrang Municipality. Both from Howrah and Sealdah Railway Station, trains frequently ply within the district. It may be mentioned here that after railway was introduced in India on 16th April 1853, the first train from Howrah Railway Station ran to Pandua in Hugli on 28th June 1854.

The Grand Trunk Road passes through Bali, Serampur, Bandel and Mogra before entering Burdwan district and connects with a number of State Highways. The district is well managed by the extensive road and rail connections with all the important places of the States. There are both Public and Private Communication systems, connecting different parts of the district and States.

Before the railway was constructed, water-borne traffic was almost the only means of transit in the district and Bhagirathi River was the main artery. It is recorded that during 19th Century there were at least 15 ferry services within and outside the district. The system still exists though no longer in extensive scale.

Howrah:

Agriculture: Topographically, there are three land situations namely up, medium and low and different farming systems are adopted accordingly. Frequent inundation of low lying areas result in stagnation of water for certain times of the year affecting some parts of the district. The soils of this sub-region have high nutrient content and mineral resource with a high potential for a large variety of agricultural and horticultural crops. Paddy (Aus, Aman and Boro), jute and potato are the major crops while pulses like gram, lentil etc., oilseeds like mustard, sesame, groundnut etc. and various kinds of vegetables are grown under varying physiographic situations of the district. Water chest nut, madur kathi, water lilly and lotus are also cultivated in some low lying marshy land areas of the district.

Irrigation: About 45,060 hectares of land in the district was under irrigation. Out of the total irrigated area, 29,630 hectares of land was irrigated by Government canals, 8,130 hectares by tanks and rest of the areas by tube wells and by other sources. Sources of minor irrigation included deep tube wells, river lift irrigations and large number of shallow tube wells.

Industry: District Howrah is famous for its small-scale and large-scale industries. The traditional Cottage industries also deserve a special mention. It was since 18th and 19th centuries, silk-industry thrived in the district, mulberry cultivation rose and the raising of domesticated silk-worms used to be carried out in certain areas of the district. Handloom weaving of cotton fabrics was an important cottage industry of the district at a certain point of time. It was during late twenties and the early thirties of the past century, the main handloom weaving centres started functioning in the Northern parts of the district. Village pottery is another important cottage industry of the district. The plenty availability of principal raw materials like river silt, common clay and a little sand helps to flourish the industries like manufacturing and preparing images, toys and numerous earthen wares in the hands of the hereditary artisans. Other cottage industries such as hookah, chikon, jari, fishing nets, solapith, handmade paper, bamboo and cane work, brassware, coir etc. also occupy an important place in this regard, except zari work which has survived the fate no other commodities has off late made considerable progress. Now a day the application of of women participate in the production at present. There are a few unique and unusual old cottage industries once famous but now almost dead, viz. manufacture of polo balls, football and shuttle cocks, hair wig and lock. At Baragachhia, since 1955, the State Government has been running a Central Lock Factory which produces padlocks and locks components for the rural artisans. Number of registered small scale industries with the number of employment during 2007-08 to 2010-11 of the district is given below to get an idea of the scenario of small scale industrialization in the district of Howrah. Due to connectivity of electricity in the rural belt which is now being much facilitated by means of governance and also in terms of good communication links with the city, many villages of the Howrah Sadar Sub-division flourished in small semi-urban industries such as repair of automobiles, bicycles and watches, manufacture of furniture and cutlery, textile printing and tailoring etc. Some small scale agro based industries of the district are viz. rice, flour and oil mills. Besides, there are both small and medium scale engineering establishments which form the bulk of the industries of Howrah district. These industries serve as feeders and ancillaries of the giant industrial machinery in the district.

Howrah got an important railway terminus since 1854. The railway lines got extended upto Mughalsarai within the next eight years. It had positively influenced the growth of large-scale industries in the district. Another important event was opening of the Howrah Pontoon Bridge in 1874 which also accelerated the growth of large-scale industries. The influences of Swadeshi movements having its impetus of 1905, helped to establish a number of large-scale industries such as jute, iron, steel and engineering factories as well as small-scale units in the district. The large-scale heavy industry of ship building and ship repairing dates back to 1706 A.D. Betor was well-known as the place of anchorage in the areas furthest up the river in case of large sea-going vessels, particularly of the Portuguese. This is as per information of historical chronicles. Though now a day there is no forest in the district there was a point of time when abundance of forests in this part of Bengal used to supply the needs of the boat-building industries which thrived well in the riverside area near the Hooghly town in the 17th century. In this context Howrah had been famous from the 14th century for the overseas trade. Another large-scale industry for production of rope was fairly well-established in the district towards the end of 18th century. The expansion of these kinds of trades depended on the crew visiting the various dockyards on the Howrah side of the river. Other than the above stated industries, twine and cordage also began to be manufactured in most of these establishments. Eventually in 1925 all the important rope industries in India, excepting a minor unit in Rawalpindi, were situated in Howrah. In 1965 there were nine rope industries in the district. Before 1825 there were other industries like textiles and paints. The successive industries are paper, canvas, distillery and jute factories which followed in quick succession. It was during in 1874-75 when large jute products manufacturing factories like the Howrah Jute Mills and the Ganges Jute Mills were started the operations. Simultaneously with the establishment of chemicals, wood, oil and printing firms the industrial base expanded. It was due to the partition of India in 1947 the richest jute producing area went to Bangladesh, resulting in closure of most of the jute mills in Haora district and sickness being a long-lasting symptom in the jute industry.

Trade and Commerce: For locally produced paddy, betel leaf, vegetables and cattle, Uluberia Sub-division forms the main trade centre, while Howrah Sadar Sub-division caters as a trade centre for imported jute, vegetables, dry coconut, betel leaf, rice, pulses, oil seeds and fish. Few decades back the district was highly deficit in rice. The situation since then has somewhat improved. It was all due to the reclamation of waste lands. The supply of rice for the district still continues across the Rupnarayan river from the neighbouring district, Purba Medinipur. Though comparatively less in volume, locally produced rice passes in small quantities from the producers to the stockiest in the assembling markets and then to the consumers through retailers. Wholesale transaction in rice or paddy is not done on a large scale in the market. At present the marketing of jute controlled by the Jute Corporation of India. One important cash crop of the district is betel leaf. The same is carried in Uluberia Sub-division by the producers to the assembling markets, where there are two sets of intermediaries, who are responsible for assembling and marketing of the commodity. There are distant buyers of this commodity who belong to the States of Bihar, Uttar Pradesh, Madhya Pradesh, Assam and other areas. The buyers do not present themselves and purchase is done through the chalandars. In Howrah Sadar Sub-division, the producers also sell their produce to the buyers and there are no intermediaries between them. The functioning of the market for pulses and oil-seeds is housed in a small railway shed opposite to Howrah Goods Shed. The supply of pulse and oilseed is mainly received from outside States, viz. Bihar, Punjab, Madhya Pradesh, Uttar Pradesh, Rajasthan and Tamil Nadu. The commonly known Howrah Bridge Market hoists a large fish market. The same is located near the Howrah Railway Station and the supply of fish is received mainly from Uttar Pradesh, Delhi, Orissa, Punjab, Rajasthan, Maharashtra, Andhra Pradesh, Tamil Nadu, Bihar and Uttar Pradesh by rail chiefly.

Transport: Having a few arterial waterways and feeder highways in old time as a hinterland of Tamralipti, the famous sea port of Eastern India, the location of the district is important. It was only after the British Rule the roads in the modern sense of the word were developed in the district. As because the land portions of the district are intersected by rivers, creeks and channels, the waterways, then as now, it has always furnished a natural and easy means of transit. The river Hooghly forming the great highway of commerce, used by boats and small ships, had on its banks several important hats or markets. The network of channels among which the Saraswati, the Kana Damodar, the Damodar and the Rupnarayan served as tributaries to the Hooghly remains important for the same and the small creeks serve as their sub-tributaries.

It was during the British period, the work of construction of modern roads started. In the middle of the 19th century there were four roads known as imperial roads, the oldest one is known as the Old Benaras Road or Ahalyabai Road or New Military Road. The other three, namely the Grand Trunk Road, the Orissa Trunk Road and a branch of Grand Tank Road (G.T. Road) from Salkia to Bally Khal are worth mentioning. The Grand Trunk Road which starts from Shibpur joins the main branch near Ghireti at Chandannagore in Hugli district. The construction began in 1804 and got completed during the time of Lord William Bentinck. Besides imperial and municipal roads there were six local roads during that time. As per District Statistical Hand Book, Howrah, 2011, in the district 553 km. of road are maintained by PWD and 1,338.2 km. of road are maintained by Zilla Parishad and 3,767.4 km. of road are maintained by Gram Panchayat and Panchayat Samity.

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, design, 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, maintenance dredging and operation of barges. 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 construction of new cargo terminal at Jamatiya. Dredging may changes 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 16,44,503.16 cum. It is proposed that the muck will be used for ground improvement, levelling, to raise the foundation level and to fill the low lying areas in and around the project area.

B. IMPACTS ON LAND

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

- Loss of land / land acquisition: The total land required to be acquired for the project is 3.20 ha. The land shall be acquired for construction of new 3 Ro-Ro Cum Passenger Ferry and 1 Cargo Terminal at the following locations
    - Jamitya : Cargo Terminal
    - Nurpoor : Ro-Ro Cum Passenger Ferry Terminal
    - Gadiara : Ro-Ro Cum Passenger Ferry Terminal
    - Gneokhali : Ro-Ro Cum Passenger Ferry Terminal
- 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 jetties and terminals, 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 Rupnarayan 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 suspended particulate matters (SPM), Particulate matters of size less than 10µ (PM10), Particulate matters of size less than 2.5µ (PM2.5), Sulphur dioxide (SO_2), Nitrogen oxides (NO_x), 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 proposed terminal 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 Rupnarayan 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 at one cargo terminal cum jetty location at Jamitya. About 350 m length dregding will take place along the Rupanarayan River near Jamitya. Some trees may also affected due to construction of terminal. Likely impact on population of phytoplankton, zooplankton, benthic communities and fishes are envisaged due to capital and maintenance dredging, but temporary in nature.

Mitigation Measures:

- ✓ Permission will be obtained from Competent Authority for the cutting/felling of trees prior to start of civil works.
- ✓ 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. IMPACTS DUE TO LABOUR CAMP

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

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

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

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

Mitigation Measures:

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

I. SOCIAL IMPACTS

- Impacts on Socio-economic environment

Land may be acquired due to Construction of cargo Terminal and jetties. The total amount of land will be affected is 3.11 Ha. The affected land should be compensated by proper compensation as per Government of West Bengal.

- 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. Air pollution may generate at jetty/terminal area during transportation and storage activities of material, loading and unloading of material.

Exhaust gases from moving vessel are source of air pollution. However, vessels emit least air emissions compared to the road and railway modes. The impact on air quality due to vessel movement is anticipated insignificant considering the emission levels and projected vessel traffic.

Mitigation Measures:

- ✓ Ensure compliance with the Air Act.
- ✓ Ensure compliance with emission standards
- ✓ Regularly service vehicles off-site in order to limit gaseous emissions

- ✓ Material generating dust should be transported under covered condition
- ✓ Uses of cleaner fuel
- ✓ Material should be stored under cover sheds
- ✓ Water sprinkling should be carried out during all loading and unloading activities and storage period.

B. IMPACTS DUE NOISE AND VIBRATION

Noise generated during operation phase are primarily loading and unloading of material at site and vessel/barges, movement of dumpers & vessel, operation of backup power generators, pumps and other equipment. However, the main effect on the environmental noise level will be from increased transportation of goods entering and leaving the terminal site. Sensitive receptors and nearby habitation areas may also be affected temporarily by increased traffic and related impacts. Disturbance from afterhours work

Improper handling and irregular maintenance of operating machines 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 in the Terminal/Jetty area.
- ✓ Use of DG set with acoustic enclosure.

C. IMPACTS DUE TO OIL SPILLAGE FROM BARGES AND VESSELS

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

Mitigation Measures:

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

D. IMPACTS ON WATER

During operation phase water will be required at terminal/jetties sites for purpose of consumption, dust suppression, cleaning, washing, cooling and landscaping, etc. Water can be used from ground water resources by taking prior permission from the concerned authority. It is proposed to treat the wastewater generated at site in STP. Hence, the impact on water resources is anticipated to be low.

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

Mitigation Measures:

- ✓ STP to be provided to treat the waste water generated
- ✓ No wastewater should be received from vessels and vessels should not be allowed to discharge their wastewater and solid waste in river
- ✓ No waste/wastewater should be discharged in river or dumped into the ground
- ✓ Fuelling of vessels is not proposed at terminal facility
- ✓ Toilets to be provided with running water facility to prevent open defecation.

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 arises 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. <u>IMPACTS ON REGIONAL ECONOMY</u>

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 52** 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 52: Environmental Management Plan (EMP)

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
A.	**DESIGN AND DEVELOPMENT/ PRE-CONSTRUCTION PHASE**			

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
1.	Loss of Land	• Land acquisition will be marginal. The acquisition of land will be carried out in accordance with the entitlement framework for the project. • Early identification of entitlement for Compensation of the Losses. • All the affected people will be compensated as per Rules and Regulation of Government of West Bengal before commencement of Construction works and the cost of compensation will be finalized by the Competent Authority and the Project Proponent will pay the compensation at all the entitles persons through the Competent Authority.	IWAI	IWAI
2.	Tree cutting	• The statutory permission for tree felling will be obtained prior to cutting of trees. • All efforts will be made to preserve trees. Special attention will be given for protecting giant trees, and locally important trees (having cultural importance). • The tree will be compensated in the ratio of at least 1:3	IWAI/Contractor	IWAI
3.	Arrangements for temporary land for Establishing	• The Contractor as per prevalent rules will carry out negotiations with the landowners for obtaining their consent	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	Camps/Plants/ Temporary diversions	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.		
4.	Establishment of Construction Camp	• The locations of construction camp to be identified by the Contractor. Construction camps will not be proposed within 500 m from the nearest settlements to avoid conflicts and stress over the infrastructure facilities with the local community. Location for stockyards for construction materials will be identified at least 1000m from water sources / and 10 Km from Wildlife Sanctuary boundary. • The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• The Camp site will be provided with all the necessary facilities as per norms.		
5.	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 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.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
6.	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 drains, etc, will be carried out.	Contractor	Supervision Consultants, IWAI
(ii)	Loss of Topsoil	• The topsoil from all areas of cutting and all areas to be permanently covered will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• 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.		
(iii)	Compaction of soil	• Construction vehicles, machinery and equipment will move, or be stationed in the designated area, to avoid compaction of soil. • If operating from temporarily hired land, it will be ensured that the topsoil for agriculture remains preserved & not destroyed by storage, material handling or any other construction related activities.	Contractor	Supervision Consultants, IWAI
(iv)	Contamination of land from fuel and lubricants	• Impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform will be appropriately provided at construction	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		camp, servicing area and liquid fuel and lubes at storage areas.		
(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 be covered • Mixing equipment will be well sealed and equipped as per PCB norms.	Contractor	Supervision Consultants, IWAI
(ii)	Emission from Construction Vehicles,	• Contractor will ensure that all vehicles, equipment and machinery used for construction are regularly maintained and	Contractor	Supervision Consultants,

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

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

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

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• 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		
5.	Safety			
(i)	Accidents due to construction activities	• To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed. • Traffic rules and regulations will be strictly adhered to. • Safety of workers undertaking various operations during construction will be ensured by providing helmets, masks, safety goggles, etc • The electrical equipment will be checked regularly • At every camp site, a readily available first aid unit including an adequate supply of dressing materials, a mode of transport (ambulance), para medical staff and an attending doctor will be provided.	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken. • Adequate signage, barriers and persons with flags during construction to control the traffic will be provided.		
(ii)	Occupation Health and Safety	• The Contractor will provide adequate good quality Personal Protective Equipments (PPE) to all the workers working at construction zones and Plant sites and will ensure that these PPEs are used by workers at all time during works. • Adequate drainage, sanitation and waste disposal will be provided at workplaces. • Proper drainage will be maintained around sites to avoid water logging leading to various diseases • Adequate sanitation and waste disposal facilities will be provided at construction 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		all the work sites and should be regularly maintained.		
6.	Wastes	• Ensure that no litter, refuse, wastes, rubbish, rubble, debris and builders wastes generated on the premises must be collected in rubbish bins and disposed of weekly at registered refuse facility sites. • Toilet facility must be provided at construction site and should be maintained properly. Toilets must be emptied regularly at treatment plants and every effort must be made to prevent the contamination of surface or sub-surface water • Muck generated due to dredging should be disposed as per the proposal of disposing around the proposed terminal area for flood protection	Contractor	Supervision Consultants, IWAI
7.	Camp Site 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	Contractor	Supervision Consultants, IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		submitted to the Engineer and IWAI prior to their construction. • The construction will commence only upon the written approval of the Engineer. • The contractor will maintain necessary living accommodation and ancillary facilities in • Functional and hygienic manner and as approved by the Engineer. • Periodical medical check up will be ensured for all the workers • The Contractor will provide potable water facilities within the precincts of every workplace in an accessible place. • The sewage system for the camp will be designed, built and operated in such a fashion that it should not pollute the ground water or nearby surface water. • Separate toilets/bathrooms, will be 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		

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of SC.		
8.	Monitoring of Air, Water & Noise Quality Pollution Monitoring	• The periodic monitoring of the ambient air quality, noise level, water (both ground and surface water) quality, soil pollution/contamination in the selected locations as suggested in environmental monitoring plan will be the responsibility of Contractor	Contractor	Supervision Consultants, IWAI
C.	**OPERATION PHASE**			
1.	Monitoring of Operation Performance	• The IWAI will monitor the operational performance of the various mitigation/enhancement measures carried out as a part of the project.	Contractor	IWAI
2.	Air	• Ensure compliance with the Air Act. • Ensure compliance with emission standards • Regularly service vehicles off-site in order 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	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		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 in the Terminal/Jetty area. • Use of DG set with acoustic enclosure	IWAI	IWAI
4.	Water and Waste water	• STP to be provided to treat the waste water generated • No wastewater should be received from vessels and vessels should not be allowed to discharge their wastewater and solid waste in river • No waste/wastewater should be discharged in river or dumped into the ground • Fuelling of vessels is not proposed at terminal facility	IWAI	IWAI

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		• Toilets to be provided with running water facility to prevent open defecation		
5.	Oil Spillage from Vessel/barges	• 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.	IWAI	IWAI

9.5 APPLICABLE LEGAL AND REGULATORY FRAMEWORK

The increase of environmental concern also necessitated appropriate tools/actions to protect environment. During Stockholm Conference, first exclusive Environmental Protection Act was enacted in India in 1986. Prior to this umbrella act, Water (Pollution Prevention and Control) Act was enacted in India in 1974 & Air Pollution act, 1981. In accordance with EPA act (1986) Central and State Boards for Prevention and Control of Water Pollution were set up. Later these boards were renamed into Central Pollution Control Board and respective State Pollution Control Boards. Department of Environment was set up in 1980. Subsequently in 1985, it was upgraded to a full-fledged Ministry of

Environment and Forests and Climate Change (MoEFCC) under Government of India to serve as the focal point in the administrative structure for the planning, promotion and coordination of environmental and forestry programmes. The name of MoEF has been revised in the year 2014 to Ministry of Environment, Forests and Climate Change (MOEFCC). This ministry has overall authority for the administration and implementation of government policies, laws and regulations related to the environment, including conservation, environmental assessment, sustainable development, forest conservation and pollution control. MOEFCC identifies the need to enact new laws and amend existing environmental legislation when required, in order to continue to conserve and protect the environment. At the state level, the MOEFCC authority is implemented by the Department of the Environment and the Department of Forests.

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

The laws and regulation applicable under the progamme:

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

9.5.1 Key Environmental Laws and Regulations

The relevant Acts and Rules are given in the **Table 53.**

Table 53: 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	√	..	This act is applicable to all environmental notifications, rules and schedules are

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
			Board			issued under this act.
Environment Impact Assessment Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	MOEFCC	--	√	Environment Impact Assessment Notification has been issued for requirement of EIA and activities requiring clearance from Central Government in the Ministry of Environment and Forests (MoEFCC). The proposed project does not require environmental clearance as per MoEFCC letter No. F. No. 14-9/2016-IA-III dated 21st December 2017
Municipal Solid Waste (Management and Handling) Rules	2000	To manage collection transportation, segregation, treatment and disposal of 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)	1927 1980 1981	To check deforestation by restricting	Forest Department, Govt. of West	..	√	No diversion of Forest land required for this project

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Act The Forest (Conservation) Rules		conversion of forested areas into non forested areas.	Bengal, MOEFCC, Regional Office and MOEFCC.			
Wildlife (Protection) Act	1972	To protect wildlife through certain of National Parks and Sanctuaries.	Chief Conservator. Wildlife, Wildlife Wing, Forest Department, Gov. of West Bengal and National Board For Wildlife, GoI.	--	√	This act will not be applicable
Water (Prevention and Control of Pollution) Act	1974	To control water pollution by controlling discharge of pollutants as per the prescribed standards.	West Bengal State Pollution Control	√	..	Applicable during construction stage
Air (Prevention and Control of Pollution) Act	1981	To control air pollution by controlling emission of air pollutants as per the prescribed standards.	West Bengal State Pollution Control	√	..	Applicable during construction stage
Noise Pollution (Regulation and Control) Rules The Noise Pollution (Regulation and	2000 2006	To regulate and control noise producing and generating sources with the objective of maintaining the	CPCB; MPCB & Transport Department; Govt. of West Bengal	√	..	This act will be applicable during construction phase of the project.

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Control) Amendment Rules		ambient air quality standards in respect of noise				
Central Motor Vehicle Act Central Motor Vehicle Rules	1988 1989	To check vehicular air and noise pollution.	Transport Department and West Bengal State Pollution Control Board	√	..	For construction vehicles (Construction Stage) – Pollution Under Control Certificate
Ancient Monuments and Archaeological Sites and Remains Act	1958	These Acts are applicable in case any development activity is undertaken in close vicinity of any archaeological site or any are discovered during the construction stage. The Act requires prior authorization of the Archaeological Survey of India (ASI) for development within 300 m of a Protected Property	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	--	√	This act will not be applicable
Wetland Conservation and Management Rules	2010	The rule specifies the activities which are harmful and prohibited in the wetlands such as	Central Wetland Regulatory Authority; MOEFCC	…	√	Not applicable

Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		industrialization, construction, dumping of untreated waste and effluents and reclamation.				
CRZ Notification	2011	To ensure livelihood security to the fisher communities and other local communities, living in the coastal areas, to conserve and protect coastal stretches, its unique environment and its marine area and to promote development through sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas, sea level rise due to global warming.	West Bengal State Coastal Zone Management Authority and MoEF&CC	√	..	CRZ Notification issued for To regulate development activities within the 500m of high tide line in coastal zone and 100 m of tidal influence rivers.

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 2011.

The other clearances and permits required for project at different stages is given in **Table 54.**

Table 54: 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	Extraction of ground	Construction stage	Contractor

S. No.	Type of Clearances / Permits	Applicability	Project Stage	Responsibility
	of ground water for use in road construction activities from State Ground Water board.	water	(Prior to initiation of installation of Bore wells and abstraction of water from such source)	
7	Permission for use of water for construction purpose from irrigation department	Use of surface water for construction	Construction stage (Prior to initiation of abstraction of water from such source)	Contractor
8	Labour license from Labour Commissioner Office	Engagement of Labour	Construction stage (Prior to initiation of any work)	Contractor

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 55**.

Table 55: Summary of Estimated Cost of EMP and SIA studies

Sl. No.	Particulars	Unit	Amount (Lacs 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 55)	8.35
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	Lump Sum	2.00

Sl. No.	Particulars	Unit	Amount (Lacs INR)
	information like Maps etc.		
	Total		**55.35**

Table 56: 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.	2 (Twice a week for twelve week): 48 Nos.	10000	4.8
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.	2	4000	0.08
5.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical	Composite sample shall be prepared based on at		2	7500	0.15

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (INR)	Amount (Lakh INR)
		Conductivity, N, P, K *etc.*	least 3 replicates from each location.				
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						**8.35**

b) Estimated cost at construction Stage:

Table 57: 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 58**	18.38
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			**39.38**

Table 58: 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 3 months for 2 years except monsoon) **Break up: 3 Locations X 3 Seasons X 2 Years = 6**	No.	18	10,000	1.8
2.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (2 locations in the interval of 3 months for 2 year except monsoon) **Break up: 3 Locations X 3 Seasons X 2 Years = 18**	No.	18	4,000	0.32
3.	Monitoring of River water Quality (2 locations in the interval of 3 months for 2 years during HFL and LFL except monsoon) **Break up: 2 Locations X 3 Seasons X 2 Years X 2 (HFL&LFL) = 6**	No.	24	8000	1.92
4.	Monitoring of ground water (2 locations in the interval of 3 months for 2 year except monsoon) **Break up: 2 Locations X 3 Seasons X 2 Year = 12**	No.	12	8000	0.96
5.	Soil Quality monitoring (1 location along the Bank of River and 1 location at Construction site for three season for 2 year except monsoon) **Break up: 2 Locations X 3 Seasons X 2 Year = 12**	No.	12	7,500	0.90
6.	Monitoring of drinking water quality at construction camp (1 location in the interval of 3 months for 2 year except monsoon) **Break up: 1 Locations X 3 Seasons X2 Years = 6**	No.	6	8,000	0.48

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
7.	Study of Acquatic and terrestrial fauna (2 location twice a year for two year) **Break up: 2 Locations X 2 Seasons X 2 Years = 8**	No	8	150000	12.0
Sub-Total					**18.38**

c) **Estimated cost during operation Stage**

Table 59: 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 60**	4.375
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			**25.375**

Table 60: 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 locations once in a year for 1 year except monsoon **Break up: 1 Location X 1 Season X 1 Year =6**	No.	1	12000	0.12
2.	Monitoring of River water Quality (2 locations interval of 3 month for 1 year during HFL and LFL except monsoon) **Break up: 2 Locations X 3 Season X 1 Years X 2 (HFL&LFL) = 12**	No.	12	10000	1.2
3.	Monitoring of drinking water (1 location in a interval of 3 month except monsoon for 1 year) **Break up: 1 Locations X 3 Season X 1 Year = 3**	No.	3	10000	0.30

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 3 year) **Break up: 1 Locations X 1 Season 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 except monsoon) **Break up: 1 Locations X 1 Season 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 Season X 1 Years = 1**	No.	1	175000	1.75
Sub-Total					**4.375**

The total estimated Environmental cost for the project is given in **Table 61**.

Table 61: Estimated Environmental and Social Costfor the Project

Sl. No.	Project Stages	Cost (Lakh INR.)
1.	Pre-Construction Stage	55.35
2.	Construction Stage	39.38
3.	Operational Stage	25.375
Total Estimated Budget (*Except Statutory Fee, Land Acquisition & R&R Costs*)		**120.105**

10.0 INSTITUTIONAL REQUIREMENTS

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

10.1 ORGANIZATIONAL SET UP / ESTABLISHMENT

The proposed PMU organisation structure is presented in **Figure 54**.

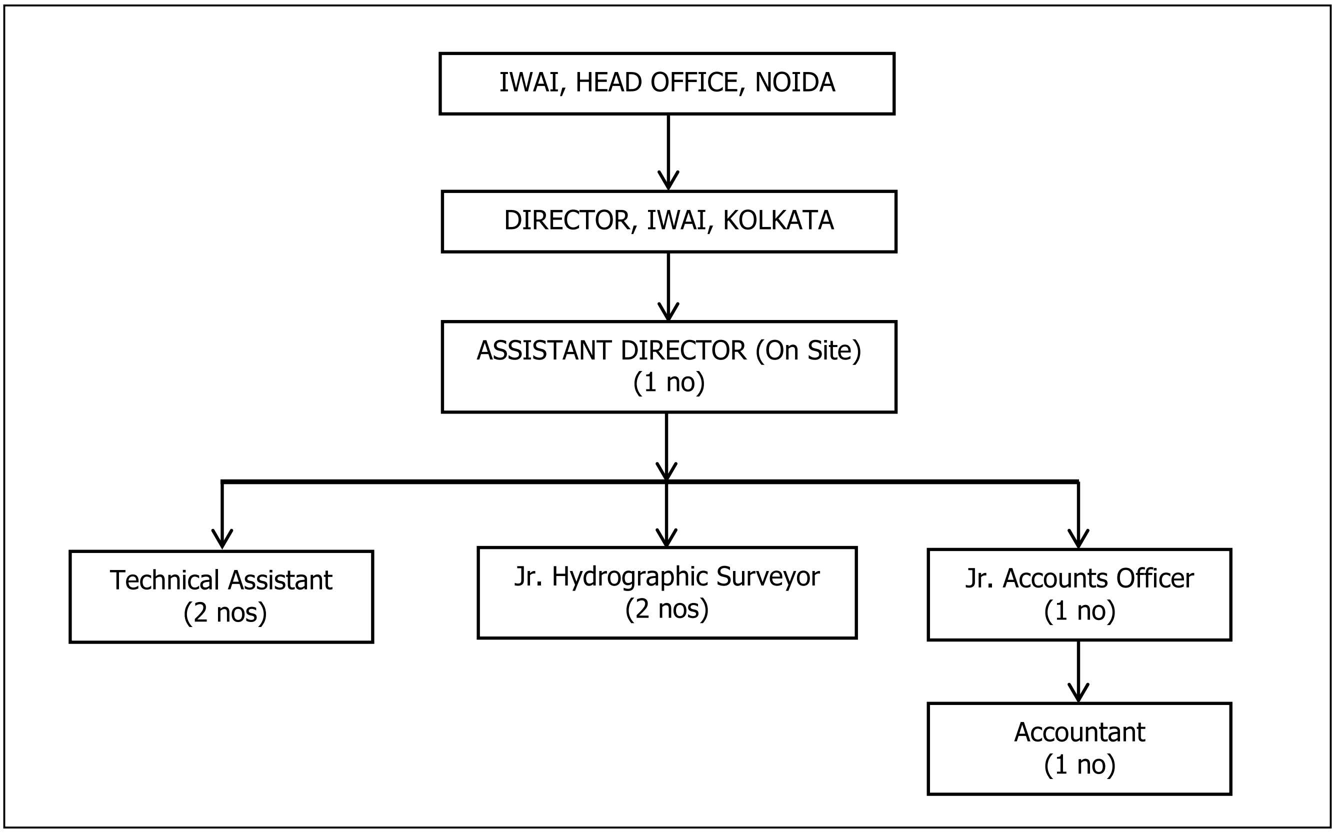


Figure 54: Organisation Structure of Project Monitoring Unit (PMU)

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 – 2 Nos.

c) Jr. Hydrographic Surveyor – 2 Nos
d) Jr. Account Officer – 1 No
e) Accountant – 1 no

In addition to these 6 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

Infrastructe required for running the organisational set up for Rupnarayan waterway is covered under this head. The basic infrastructre 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 miscellanous items are covered under movable assest. The detail list of movable assets required is as follows:

Sl. No.	Movable Asset	No.	Remark
1.	Computer/Laptop	12	For permanent Staff
		8	Additional for support staff
2.	Colour Printers & Scanner	3	

Sl. No.	Movable Asset	No.	Remark
3.	Plotter	1	
4.	Air conditioners	7	
5.	Car	2	
6.	Inspection Vehicle (All wheel drive)	2	
7	Office stationery and other miscellenous items		

10.5 COST IMPLICATIONS

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

Man power: The tentative manpower cost on the basis of 7th CPC is provided in **Table 62** as below:

Table 62: Manpower Cost

Sl. No.	Manpower	Level as per pay matrix	Min. gross salary (INR/month)	Numbers of staff	Annual Cost (INR Lacs)
1	Assistant Director	L-10	56,100	1	6.73
2	Technical Assistant	L-6	35,400	2	8.50
3	Jr. Hydrographic Surveyor	L-6	35,400	2	8.50
4	Jr. Accounts Officer	L-6	35,400	1	4.25
5	Accountant	L-5	29,200	1	3.50
6	Project/support staff		20,000	6	14.40
	Total				**45.88**

The total manpower cost for Rupnarayan waterway project works out to **INR 45.88 Lacs** annually.

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

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 63: Cost for developing infrastructural works for Institutional Setup

Sl. No.	Movable Asset	No.	Rate (INR)	Cost (INR)
1.	Computer/Laptop	20	50,000/-	10,00,000/-
2.	Colour Printers & Scanner	3	10,000/-	30,000/-
3.	Plotter	1	5,00,000/-	5,00,000/-
4.	Air conditioners	7	40,000/-	2,80,000/-
5.	Car	2	7,00,000/-	14,00,000/-
6.	Inspection Vehicle (All wheel drive)	2	20,00,000/-	40,00,000/-
7	Office stationery and other miscellaneous items		LS	1,00,000/-
	Total			**73,10,000/-**

Hence, total cost envisaged under Institutional Requirements is provided in **Table 64;**

Table 64: Cost under Institutional Requirements

Sl. No.	Item	Cost (INR) Lacs
1.	Manpower	45.88
2.	Training/ Capacity Building	5.00
3.	Infrastructure	73.10
	Total	**123.98/-**

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 2015-16 of PWD, Govt. of West; Corrigenda & Addenda regarding updated rates for 2017 of various items
b) "Unified Schedule of Rates" prepared by Irrigation and Waterways department, Government of West Bengal.
c) The consultant's references from various projects/sites proximity to the project area.
d) Local enquiries at the time of conducting surveys.
e) Market surveys and enquires
f) Judgement based on Consultant's Experience
g) https://www.wbidc.com/industrial_parks/available_land.htm

11.2 DEVELOPMENT COST

Rupnarayan waterway is proposed to be developed in two phases viz:

Phase 1: Immediate Development plan

- Development of Dry Bulk Cargo terminal at Jamitya (Kolaghat).

Phase 2: Future Development plan

- Development of RO-RO/ ferry terminals at Noorpur, Geonkhali and Gadiara and pontoon & gangway at Amariya and Tamluk.

Dredging is envisaged for round the clock IWT operations. Besides, the waterway is also to be marked and provided with aids to navigation for smooth and safe sailing of the vessels.

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. For vessels required to transport cargo from Jamitya jetty, it is assumed that existing vessels plying from Haldia jetty to transport cargo originated at Kolaghat will now come directly to Jamitya Jetty. Hence no additional procurement cost for Dry bulk cargo vessels is considered for the study. Development cost for external road from Kolaghat TPP and Ramco Cement industries to Jamitya jetty is also considered in estimation of capital cost of project. The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies are provided in **Table 65** as below:

Table 65: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lacs (INR)
PHASE - 1			
1.0	Cost of initial dredging		1960.00
2.0	Capital cost for construction of Dry Bulk Cargo terminal	**Table 32**	2,117.72
3.0	Capital cost for Navigation and Communication System	**Table 45**	442.20
4.0	Cost for EMP	**Table 55**	94.73
5.0	Development cost for External Road		1200.00
	Total Capital Cost for Phase – 1 excluding Land Cost		**5,814.64**
5.0	Land Cost for Cargo Terminal		698.50
	Total Capital Cost for Phase – 1 including Land Cost		**6,513.15**
PHASE – 2			
1.0	Capital cost for construction of RO-RO/Ferry terminal (3 nos.)	**Table 33**	9150.33

Sl. No.	Item	Reference Table	Amount in Lacs (INR)
2.0	Capital cost for RO-RO/Ferry Vessels (1 no)	**Table 43**	380.00
3.0	Capital cost for Passenger Ferry Vessels (3 nos.)		275.994
	Total Capital Cost for Phase – 2 excluding Land Cost		**9,806.32**
5.0	Land Cost for Passenger Terminals		419.10
	Total Capital Cost for Phase – 2 including Land Cost		**10,225.42**

11.4 OPERATIONAL AND MAINTENANCE EXPENDITURE

The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies are provided in **Table 66** as below:

Table 66: Summary of annual O & M Cost of Project

Sl. No.	Item	Reference Table	Amount in Lacs (INR)
	PHASE - 1		
1.0	O&M cost for Fairway Development		196.00
2.0	O&M cost for Dry Bulk Cargo Terminal	**Table 38**	516.51
3.0	O&M Cost for Navigation and Communication System	**Table 46**	207.65
4.0	O &M cost for EMP	**Table 55**	25.375
5.0	Operational cost under Institutional requirements	**Table 64**	123.98
	Total O&M Cost for Phase - 1		**1,069.52**

	PHASE – 2		
1.0	O&M cost for RO-RO/Ferry terminal (3 nos.)	**Table 38**	463.58
2.0	O&M cost for Vessels (including crew cost)		353.80
	Total O&M Cost for Phase - 2		**817.38**

11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 3 years for phase 1 and 2 development plans, the phasing of capital cost expenditures has been established. The detail of cost repartition during construction period is provided in **Table 67** and also shown in **Figure 55** to **Figure 58** below.

Table 67: Phasing of Expenditure

% of Cash Flow	5%	15%	20%	25%	25%	10%
Months >	M1 – M6	M7 – M12	M13 – M18	M19 – M24	M25 – M30	M31 – M36
Total Cash Flow INR Lacs - Phase 1 (excluding land cost)	290.73	872.20	1162.93	1453.66	1453.66	581.46
Total Cash Flow INR Lacs - Phase 1 (including land cost)	325.66	976.97	1302.63	1628.29	1628.29	651.31

Months >	M37 – M42	M43 – M48	M49 – M54	M55 – M60	M61 – M66	M67 – M72
Total Cash Flow INR Lacs - Phase 2 (excluding land cost)	490.32	1470.95	1961.26	2451.58	2451.58	980.63
Total Cash Flow INR Lacs - Phase 2 (including land cost)	511.27	1533.81	2045.08	2556.36	2556.36	1022.54

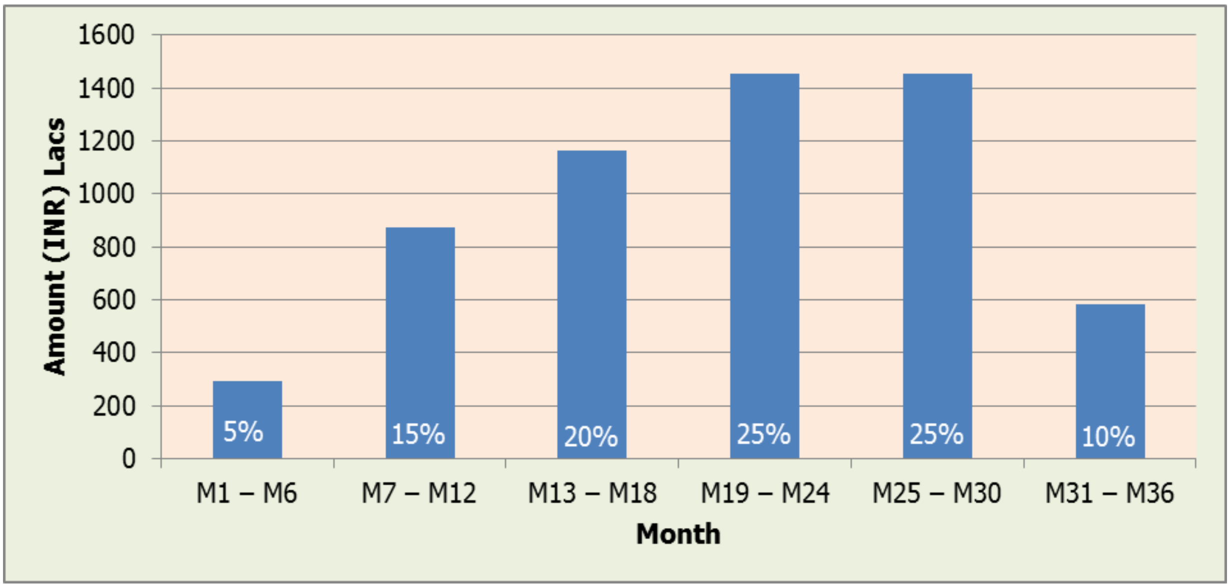


Figure 55: Phasing of Expenditure for Phase – 1 Development Excluding Land Cost

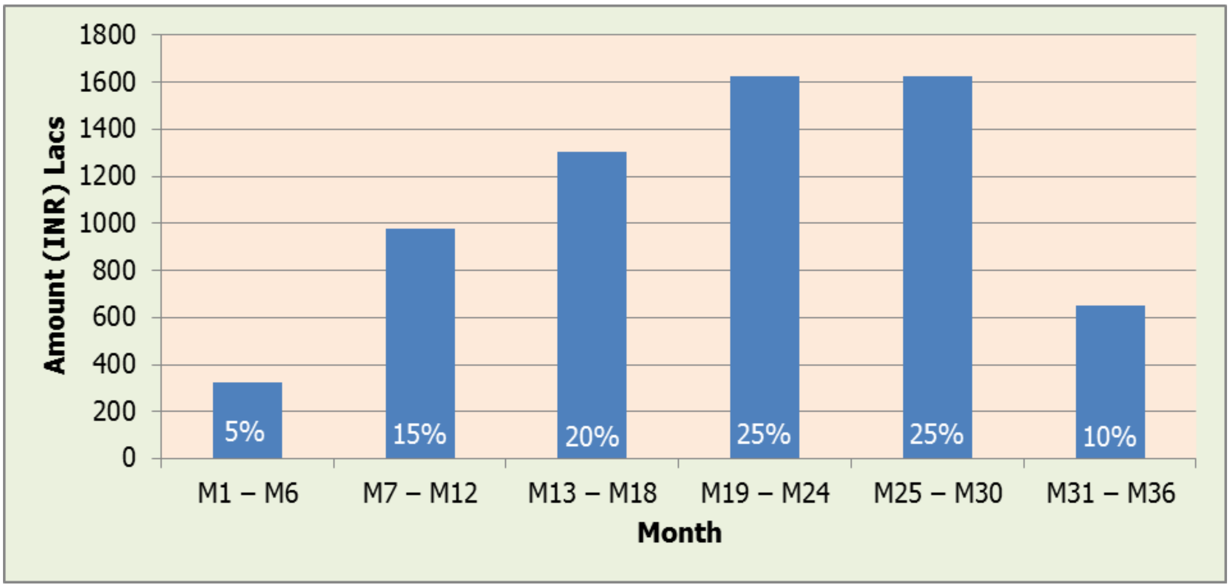


Figure 56: Phasing of Expenditure for Phase – 1 Development Including Land Cost

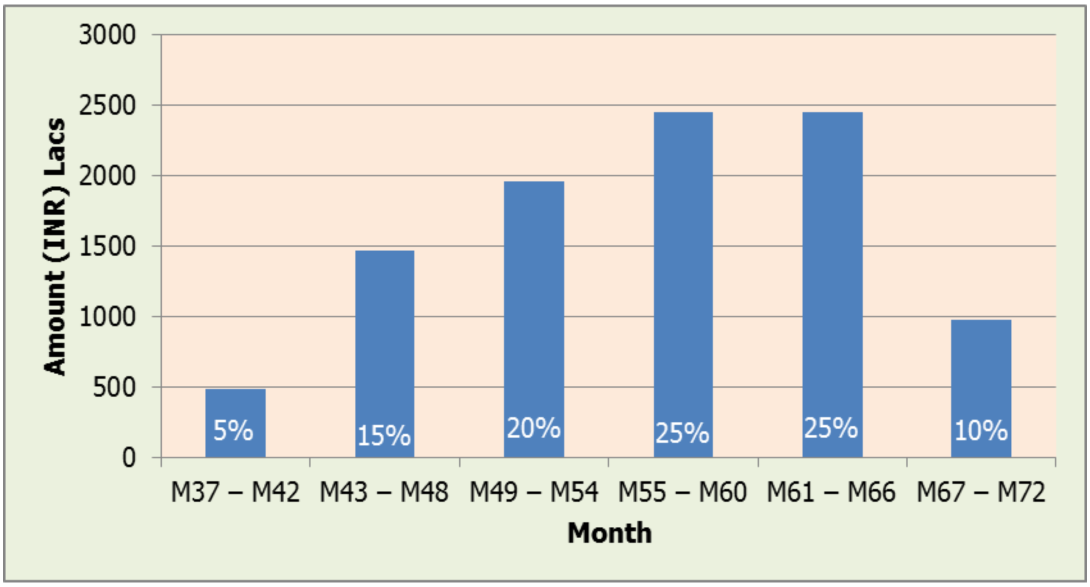


Figure 57: Phasing of Expenditure for Phase – 2 Development Excluding Land Cost

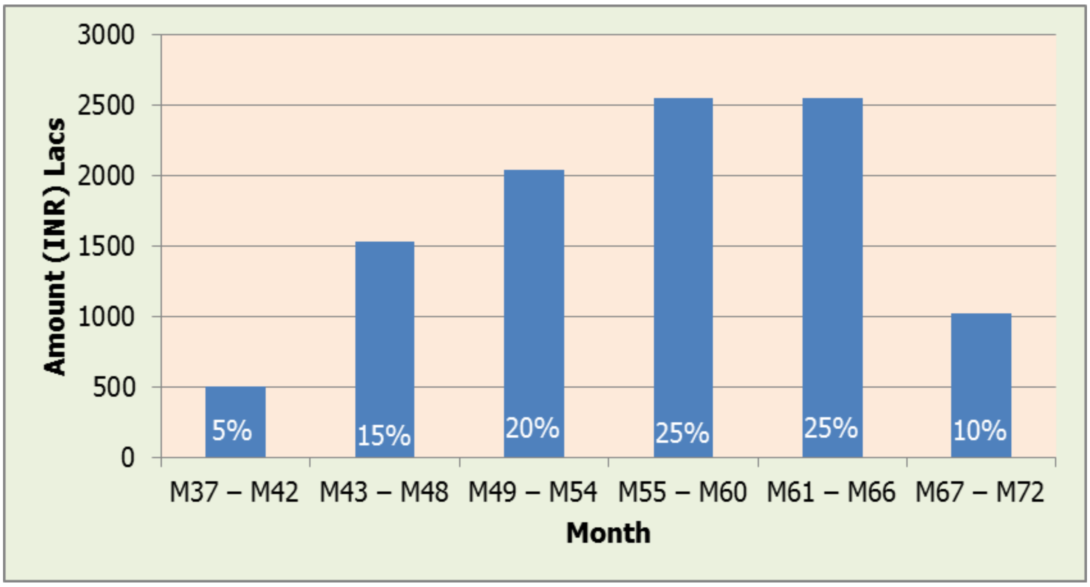


Figure 58: Phasing of Expenditure for Phase – 2 Development Including Land Cost

12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of 35 Km stretch of Rupnarayan waterway and its associated facilities are presented in this chapter. The probable time schedule for various activities from onset to completion of the project and commencement of operation are also discussed in this chapter.

12.1 TIME FRAME

The total project is scheduled to be completed in 36 months from the start date of construction.

12.2 PHASING

For timely completion of the project, identification of major project components and sequential planning of various modules is very important for any project. The major components of Rupnarayan waterway include both the construction of offshore and onshore facilities, apart from installation of mechanical and electrical equipment's.

The offshore facilities includes development of berth, approach jetties, linkspan for RO-RO terminal and dredging whereas the development of onshore facilities includes site development, construction of buildings, storage shed, silos, development of internal roads, 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 two (2) phases through EPC contract, as below:

Phase 1: Immediate Development plan

- Development of Dry Bulk Cargo terminal at Jamitya (Kolaghat).

Phase 2: Future Development plan

- Development of RO-RO/ ferry terminals at Noorpur, Geonkhali and Gadiara.

12.3 SUGGESTED IMPLEMENTATION MECHANISM

The various activities to be carried out prior to commencement of construction, includes selection of site, preparation of Detailed Project Report, surveys 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 carrying 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 Rupnarayan waterway project, which involves engineering, procurement, construction and commencement of operational activities.

- Detailed Engineering;
- Environmental clearance;
- Financial closure and Statutory approvals from all concerned authorities;
- Land acquisition and site development;
- Construction of onshore facilities for cargo terminal;
- Construction of offshore facilities for cargo terminal;
- Construction of onshore facilities for RO-RO ferry terminal;
- Construction of offshore facilities for RO-RO ferry terminal;
- Procurement of vessels;
- Up gradation/construction of access roads;
- Supply, installation and commission of electrical and mechanical equipment's.

13.0 ECONOMIC AND FINANCIAL ANALYSIS

Financial feasibility is a key determinant in an infrastructureinvestment 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 Rupnarayan 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.

The techno-economic model has been run with the various assumptions as stated below:

a) Dry Bulk Cargo Terminal
   i. 10 Lacs MT/annum dry bulk cargo through 2000 DWT vessel from Jamitya jetty.

b) RO-RO/ Ferry Terminal
   i. 1 RO-RO vessel having 12 cars + 4 trucks or 18 cars or 8 trucks with 50 passenger loading capacity operating 7:00 AM to 7:00 PM at every 4 hour interval on Noorpur – Geonkhali – Gadiara – Noorpur route.
   ii. 3 passenger ferry vessels of 150 pax capacity operating 7:00 AM to 7:00 PM at every 30 minute interval from each jetty.

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 revenue for RO-RO & passenger ferry services have been worked out by considering the tariff of INR 200/- per truck & INR 100/- per car for RO-RO services and INR 8/- per person per trip for passenger ferry services. Different tariffs from INR 0.50 to 3.5 per ton per km. have been considered for Cargo operations; accordingly FIRR and EIRR have been worked out.

On the basis of above assumptions, the revenue that could be generated from cargo, RO-RO and passenger ferry operations along 35 Km stretch of Rupnarayan waterway from Geonkahli to Jamitya jetty near Kolaghat is provided in **Table 68.**

Table 68: Annual Revenue Generation

a) Cargo		
Quantity of Cargo proposed to be shifted to IWT =	10,00,000	MT/Annum
Length of waterway =	35	Km
IWAI Tariff =	Varying from 0.50 to 3.25	INR/Ton/Km
No. of Days per year =	300	days
b) RO-RO		
Number of vehicles per vessel =	8	trucks
Number of trips per vessel per day =	4	trips
Number of vessel =	1	vessel
Number of vehicles per day =	32	trucks
IWAI Tariff =	200	INR/trucks/trip
No. of Days per year =	300	days
Annual revenue from RO-RO operations =	960,000	INR
c) Passenger Ferry		
Number of passengers per vessel =	84	nos.
Number of trips per vessel per day =	24	trips
Number of vessel =	3	vessel
Number of passengers per day =	6048	passengers
IWAI Tariff =	8	INR/passenger/trip
No. of Days per year =	300	days
Annual revenue from Passenger ferry operations =	14,515,200	INR
Annual revenue generation from RO-RO/Ferry in Lacs =	**154.752**	**INR Lacs**

13.2 FINANCIAL ANALYSIS

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.

Financial analysis for the river stretches of IWT system is worked for following different scenarios:

For Phase -1:

Scenario 1

a) Capital cost incurred in Phase – 1
b) O&M cost incurred in Phase – 1
c) Revenue generated from Cargo operations only

Scenario 2

a) O&M cost incurred in Phase – 1
b) Revenue generated from Cargo operations only

For Phase -2:

Scenario 1

a) Capital cost incurred in Phase – 2 (including vessel cost)
b) O&M cost incurred in Phase – 2 (including vessel cost)
c) Revenue generated from RO-RO/Ferry operations

Scenario 2

a) O&M cost incurred in Phase – 2 (including vessel cost)
b) Revenue generated from RO-RO/Ferry operations

13.3 ECONOMIC ANALYSIS

The economic analysis for proposed IWT in Rupnarayan 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, job creation, reduction in accidents, carbon savings are 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%

An assessment of economic benefit expected from IWT as compared to Road transport for Phase 1 and Phase 2 are provided in **Table 69** and **Table 70** respectively**.**

Table 69: Economic benefit from IWT (PHASE-1) as compared to Road Transport

Road distance from Kolaghat to Haldia =	56	Km
Cargo proposed to be diverted from road to IWT daily =	3333.33	MT/day
Road haulage cost =	2.0	INR/MT/Km
For economic analysis, considering IWT haulage charges =	1.0	INR/MT/Km
Hence, haulage benefit by shifting of cargo to IWT =	1.0	INR/MT/Km
Saving in Cargo transportion by IWT =	186667	INR per day
No of days service is operation per year =	300	days
Saving in Cargo transportion by IWT annually=	56000000	INR per year
	560.0	INR Lacs per year
Carbon saving INR 0.1/tons-km tranferred from road =	18667	INR daily
	5600000	INR per year
	56.0	INR Lacs per year
Road accident costs saving INR 0.2/tons-km tranferred from road =	37333	INR daily
	11200000	INR per year
	112.0	INR Lacs per year

Job creation per year =	130	numbers
Average annual salary =	400000	INR
Annual earning by Job creation =	52000000	INR per year
	520.0	INR Lacs per year
Total Economic benefits in Phase -1 by using IWT =	**1248.0**	**INR Lacs per year**

Table 70: Economic benefit from IWT (PHASE-2) as compared to Road Transport

Saving in haulage cost by shifting of cargo to IWT from roads=	1.0	INR/MT/Km
No of days service is operation per year =	300	days
Road distance saved by trucks using IWT RO-RO services =	50	KM
Trucks transported by RO-RO per day =	32	trucks
Cargo carrying capacity of each truck =	45	MT
Total quantity of cargo transported by RO-RO =	1440	MT
Saving in Cargo transportion by IWT RO-RO service=	72000	INR per day
Saving in Cargo transportion by IWT RO-RO annually=	21600000	INR per year
	216	INR Lacs per year
Passenger by IWT per day =	6048	nos.
Assuming Minimum cost difference between bus and ferry ticket =	50	INR
Cost saving per day by IWT =	302400	INR per day
Cost saving per year by IWT passenger ferry service =	90720000	INR per year
	907.2	INR Lacs per year
Carbon saving INR 0.1/tons-km tranferred from road =	7200	INR daily
	2160000	INR per year
	21.6	INR Lacs per year
Road accident costs saving INR 0.2/tons-km tranferred from road =	14400	INR daily
	4320000	INR per year
	43.2	INR Lacs per year

Job creation per year =	110	numbers
Average annual salary =	400000	INR
Annual earning by Job creation =	44000000	INR per year
	440	INR Lacs per year
Total savings by using IWT from road transport =	**1628.00**	**INR Lacs per year**

13.4 INTERNAL RATE OF RETURNS

Financial and Economic internal rate of returns are calculated for 20 years project design life and provided for Phase 1 and Phase 2 IWT development plans in **Table 71** to **Table 74** below:

Table 71: IRR for IWT (PHASE -1) in Rupnarayan Waterway Excluding Land Cost

Sr. No.	Cargo Tariff	FIRR (%)		EIRR (%)	
	(per ton per km.)	Scenario-1	Scenario-2	Scenario-1	Scenario-2
1	0.50	Not Calculable	Not Calculable	Not Calculable	-10.50
2	1.00	Not Calculable	Not Calculable	7.22	Not Calculable
3	1.50	-11.83	-9.73	12.97	Not Calculable
4	2.00	0.52	10.13	17.05	Not Calculable
5	2.50	6.30	30.49	20.40	Not Calculable
6	3.00	10.43	279.00	23.33	Not Calculable
7	3.50	13.81	Not Calculable	25.99	Not Calculable
	Not Calculable	All negative cash-flows			
	Not Calculable	All positive cash-flows			

Table 72: IRR for IWT (PHASE -1) in Rupnarayan Waterway Including Land Cost

Sr. No.	Cargo Tariff	FIRR (%)		EIRR (%)	
	(per ton per km.)	Scenario-1	Scenario-2	Scenario-1	Scenario-2
1	0.50	Not Calculable	Not Calculable	Not Calculable	-10.50
2	1.00	Not Calculable	Not Calculable	6.08	Not Calculable
3	1.50	-12.01	-9.73	11.66	Not Calculable
4	2.00	0.05	10.13	15.57	Not Calculable

Sr. No.	Cargo Tariff	FIRR (%)		EIRR (%)	
	(per ton per km.)	Scenario-1	Scenario-2	Scenario-1	Scenario-2
5	2.50	5.64	30.49	18.76	Not Calculable
6	3.00	9.61	279.00	21.54	Not Calculable
7	3.50	12.84	Not Calculable	24.04	Not Calculable
	Not Calculable	All negative cash-flows			
	Not Calculable	All positive cash-flows			

Table 73: IRR for IWT (PHASE -2) in Rupnarayan Waterway Excluding Land Cost

	FIRR (%)	EIRR (%)
Scenario-1	Not Calculable	6.55
Scenario-2	Not Calculable	Not Calculable
Not Calculable	All negative cash-flows	
Not Calculable	All positive cash-flows	

Table 74: IRR for IWT (PHASE -2) in Rupnarayan Waterway Including Land Cost

	FIRR (%)	EIRR (%)
Scenario-1	Not Calculable	6.09
Scenario-2	Not Calculable	Not Calculable
Not Calculable	All negative cash-flows	
Not Calculable	All positive cash-flows	

Year wise IRR for Cargo Tariff of INR 2.50 per ton per Km is provided from **Table 75** to **Table 86**.

Table 75: Year wise FIRR for Phase 1 Scenario 1 Excluding Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021	1162.93		1162.93		-1,162.93
-2	2021-2022	2616.59		2616.59		-2,616.59
-1	2022-2023	2035.13		2035.13		-2,035.13
0	2023-2024		1069.52	1069.52	875.00	-194.52

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
1	2024-2025		1122.99	1122.99	962.50	-160.49
2	2025-2026		1179.14	1179.14	1,058.75	-120.39
3	2026-2027		1238.10	1238.10	1,164.63	-73.47
4	2027-2028		1300.00	1300.00	1,281.09	-18.92
5	2028-2029		1365.00	1365.00	1,409.20	44.19
6	2029-2030		1433.25	1433.25	1,550.12	116.86
7	2030-2031		1504.92	1504.92	1,705.13	200.21
8	2031-2032		1580.16	1580.16	1,875.64	295.48
9	2032-2033		1659.17	1659.17	2,063.20	404.03
10	2033-2034		1742.13	1742.13	2,269.52	527.39
11	2034-2035		1829.24	1829.24	2,496.48	667.24
12	2035-2036		1920.70	1920.70	2,746.12	825.43
13	2036-2037		2016.73	2016.73	3,020.74	1,004.00
14	2037-2038		2117.57	2117.57	3,322.81	1,205.24
15	2038-2039		2223.45	2223.45	3,655.09	1,431.64
16	2039-2040		2334.62	2334.62	4,020.60	1,685.98
17	2040-2041		2451.35	2451.35	4,422.66	1,971.31
18	2041-2042		2573.92	2573.92	4,864.93	2,291.01
19	2042-2043		2702.62	2702.62	5,351.42	2,648.80
20	2043-2044		2837.75	2837.75	5,886.56	3,048.82
					FIRR	**6.30%**

Table 76: Year wise FIRR for Phase 1 Scenario 2 Excluding Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021			0.00		-
-2	2021-2022			0.00		-
-1	2022-2023			0.00		-
0	2023-2024		1069.52	1069.52	875.00	-194.52
1	2024-2025		1122.99	1122.99	962.50	-160.49

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
2	2025-2026		1179.14	1179.14	1,058.75	-120.39
3	2026-2027		1238.10	1238.10	1,164.63	-73.47
4	2027-2028		1300.00	1300.00	1,281.09	-18.92
5	2028-2029		1365.00	1365.00	1,409.20	44.19
6	2029-2030		1433.25	1433.25	1,550.12	116.86
7	2030-2031		1504.92	1504.92	1,705.13	200.21
8	2031-2032		1580.16	1580.16	1,875.64	295.48
9	2032-2033		1659.17	1659.17	2,063.20	404.03
10	2033-2034		1742.13	1742.13	2,269.52	527.39
11	2034-2035		1829.24	1829.24	2,496.48	667.24
12	2035-2036		1920.70	1920.70	2,746.12	825.43
13	2036-2037		2016.73	2016.73	3,020.74	1,004.00
14	2037-2038		2117.57	2117.57	3,322.81	1,205.24
15	2038-2039		2223.45	2223.45	3,655.09	1,431.64
16	2039-2040		2334.62	2334.62	4,020.60	1,685.98
17	2040-2041		2451.35	2451.35	4,422.66	1,971.31
18	2041-2042		2573.92	2573.92	4,864.93	2,291.01
19	2042-2043		2702.62	2702.62	5,351.42	2,648.80
20	2043-2044		2837.75	2837.75	5,886.56	3,048.82
					FIRR	**30.49%**

Table 77: Year wise FIRR for Phase 2 Scenario 1 Excluding Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021	1961.26		1961.26		-1,961.26
-2	2021-2022	4412.85		4412.85		-4,412.85
-1	2022-2023	3432.21		3432.21		-3,432.21

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
0	2023-2024		817.38	817.38	164.35	-653.03
1	2024-2025		858.25	858.25	180.79	-677.46
2	2025-2026		901.16	901.16	198.87	-702.30
3	2026-2027		946.22	946.22	218.75	-727.47
4	2027-2028		993.53	993.53	240.63	-752.90
5	2028-2029		1043.21	1043.21	264.69	-778.52
6	2029-2030		1095.37	1095.37	291.16	-804.21
7	2030-2031		1150.14	1150.14	320.28	-829.86
8	2031-2032		1207.64	1207.64	352.30	-855.34
9	2032-2033		1268.02	1268.02	387.53	-880.49
10	2033-2034		1331.43	1331.43	426.29	-905.14
11	2034-2035		1398.00	1398.00	468.92	-929.08
12	2035-2036		1467.90	1467.90	515.81	-952.09
13	2036-2037		1541.29	1541.29	567.39	-973.90
14	2037-2038		1618.36	1618.36	624.13	-994.23
15	2038-2039		1699.27	1699.27	686.54	-1,012.74
16	2039-2040		1784.24	1784.24	755.19	-1,029.05
17	2040-2041		1873.45	1873.45	830.71	-1,042.74
18	2041-2042		1967.12	1967.12	913.78	-1,053.34
19	2042-2043		2065.48	2065.48	1,005.16	-1,060.32
20	2043-2044		2168.75	2168.75	1,105.68	-1,063.07
					FIRR	**#NUM!**

Table 78: Year wise FIRR for Phase 2 Scenario 2 Excluding Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021			0.00		-
-2	2021-2022			0.00		-
-1	2022-2023			0.00		-
0	2023-2024		817.38	817.38	164.35	-653.03
1	2024-2025		858.25	858.25	180.79	-677.46
2	2025-2026		901.16	901.16	198.87	-702.30
3	2026-2027		946.22	946.22	218.75	-727.47
4	2027-2028		993.53	993.53	240.63	-752.90
5	2028-2029		1043.21	1043.21	264.69	-778.52
6	2029-2030		1095.37	1095.37	291.16	-804.21
7	2030-2031		1150.14	1150.14	320.28	-829.86
8	2031-2032		1207.64	1207.64	352.30	-855.34
9	2032-2033		1268.02	1268.02	387.53	-880.49
10	2033-2034		1331.43	1331.43	426.29	-905.14
11	2034-2035		1398.00	1398.00	468.92	-929.08
12	2035-2036		1467.90	1467.90	515.81	-952.09
13	2036-2037		1541.29	1541.29	567.39	-973.90
14	2037-2038		1618.36	1618.36	624.13	-994.23
15	2038-2039		1699.27	1699.27	686.54	-1,012.74
16	2039-2040		1784.24	1784.24	755.19	-1,029.05
17	2040-2041		1873.45	1873.45	830.71	-1,042.74
18	2041-2042		1967.12	1967.12	913.78	-1,053.34
19	2042-2043		2065.48	2065.48	1,005.16	-1,060.32
20	2043-2044		2168.75	2168.75	1,105.68	-1,063.07
					FIRR	**#NUM!**

Table 79: Year wise FIRR for Phase 1 Scenario 1 Including Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021	1302.63		1302.63		-1,302.63
-2	2021-2022	2930.92		2930.92		-2,930.92
-1	2022-2023	2279.60		2279.60		-2,279.60
0	2023-2024		1069.52	1069.52	875.00	-194.52
1	2024-2025		1122.99	1122.99	962.50	-160.49
2	2025-2026		1179.14	1179.14	1,058.75	-120.39
3	2026-2027		1238.10	1238.10	1,164.63	-73.47
4	2027-2028		1300.00	1300.00	1,281.09	-18.92
5	2028-2029		1365.00	1365.00	1,409.20	44.19
6	2029-2030		1433.25	1433.25	1,550.12	116.86
7	2030-2031		1504.92	1504.92	1,705.13	200.21
8	2031-2032		1580.16	1580.16	1,875.64	295.48
9	2032-2033		1659.17	1659.17	2,063.20	404.03
10	2033-2034		1742.13	1742.13	2,269.52	527.39
11	2034-2035		1829.24	1829.24	2,496.48	667.24
12	2035-2036		1920.70	1920.70	2,746.12	825.43
13	2036-2037		2016.73	2016.73	3,020.74	1,004.00
14	2037-2038		2117.57	2117.57	3,322.81	1,205.24
15	2038-2039		2223.45	2223.45	3,655.09	1,431.64
16	2039-2040		2334.62	2334.62	4,020.60	1,685.98
17	2040-2041		2451.35	2451.35	4,422.66	1,971.31
18	2041-2042		2573.92	2573.92	4,864.93	2,291.01
19	2042-2043		2702.62	2702.62	5,351.42	2,648.80
20	2043-2044		2837.75	2837.75	5,886.56	3,048.82
					FIRR	**5.64%**

Table 80: Year wise FIRR for Phase 1 Scenario 2 Including Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021			0.00		-
-2	2021-2022			0.00		-
-1	2022-2023			0.00		-
0	2023-2024		1069.52	1069.52	875.00	-194.52
1	2024-2025		1122.99	1122.99	962.50	-160.49
2	2025-2026		1179.14	1179.14	1,058.75	-120.39
3	2026-2027		1238.10	1238.10	1,164.63	-73.47
4	2027-2028		1300.00	1300.00	1,281.09	-18.92
5	2028-2029		1365.00	1365.00	1,409.20	44.19
6	2029-2030		1433.25	1433.25	1,550.12	116.86
7	2030-2031		1504.92	1504.92	1,705.13	200.21
8	2031-2032		1580.16	1580.16	1,875.64	295.48
9	2032-2033		1659.17	1659.17	2,063.20	404.03
10	2033-2034		1742.13	1742.13	2,269.52	527.39
11	2034-2035		1829.24	1829.24	2,496.48	667.24
12	2035-2036		1920.70	1920.70	2,746.12	825.43
13	2036-2037		2016.73	2016.73	3,020.74	1,004.00
14	2037-2038		2117.57	2117.57	3,322.81	1,205.24
15	2038-2039		2223.45	2223.45	3,655.09	1,431.64
16	2039-2040		2334.62	2334.62	4,020.60	1,685.98
17	2040-2041		2451.35	2451.35	4,422.66	1,971.31
18	2041-2042		2573.92	2573.92	4,864.93	2,291.01
19	2042-2043		2702.62	2702.62	5,351.42	2,648.80
20	2043-2044		2837.75	2837.75	5,886.56	3,048.82
					FIRR	**30.49%**

Table 81: Year wise FIRR for Phase 2 Scenario 1 Including Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021	2045.08		2045.08		-2,045.08
-2	2021-2022	4601.44		4601.44		-4,601.44
-1	2022-2023	3578.90		3578.90		-3,578.90
0	2023-2024		817.38	817.38	164.35	-653.03
1	2024-2025		858.25	858.25	180.79	-677.46
2	2025-2026		901.16	901.16	198.87	-702.30
3	2026-2027		946.22	946.22	218.75	-727.47
4	2027-2028		993.53	993.53	240.63	-752.90
5	2028-2029		1043.21	1043.21	264.69	-778.52
6	2029-2030		1095.37	1095.37	291.16	-804.21
7	2030-2031		1150.14	1150.14	320.28	-829.86
8	2031-2032		1207.64	1207.64	352.30	-855.34
9	2032-2033		1268.02	1268.02	387.53	-880.49
10	2033-2034		1331.43	1331.43	426.29	-905.14
11	2034-2035		1398.00	1398.00	468.92	-929.08
12	2035-2036		1467.90	1467.90	515.81	-952.09
13	2036-2037		1541.29	1541.29	567.39	-973.90
14	2037-2038		1618.36	1618.36	624.13	-994.23
15	2038-2039		1699.27	1699.27	686.54	-1,012.74
16	2039-2040		1784.24	1784.24	755.19	-1,029.05
17	2040-2041		1873.45	1873.45	830.71	-1,042.74
18	2041-2042		1967.12	1967.12	913.78	-1,053.34
19	2042-2043		2065.48	2065.48	1,005.16	-1,060.32
20	2043-2044		2168.75	2168.75	1,105.68	-1,063.07
					FIRR	**#NUM!**

Table 82: Year wise FIRR for Phase 2 Scenario 2 Including Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-3	2020-2021			0.00		-
-2	2021-2022			0.00		-
-1	2022-2023			0.00		-
0	2023-2024		817.38	817.38	164.35	-653.03
1	2024-2025		858.25	858.25	180.79	-677.46
2	2025-2026		901.16	901.16	198.87	-702.30
3	2026-2027		946.22	946.22	218.75	-727.47
4	2027-2028		993.53	993.53	240.63	-752.90
5	2028-2029		1043.21	1043.21	264.69	-778.52
6	2029-2030		1095.37	1095.37	291.16	-804.21
7	2030-2031		1150.14	1150.14	320.28	-829.86
8	2031-2032		1207.64	1207.64	352.30	-855.34
9	2032-2033		1268.02	1268.02	387.53	-880.49
10	2033-2034		1331.43	1331.43	426.29	-905.14
11	2034-2035		1398.00	1398.00	468.92	-929.08
12	2035-2036		1467.90	1467.90	515.81	-952.09
13	2036-2037		1541.29	1541.29	567.39	-973.90
14	2037-2038		1618.36	1618.36	624.13	-994.23
15	2038-2039		1699.27	1699.27	686.54	-1,012.74
16	2039-2040		1784.24	1784.24	755.19	-1,029.05
17	2040-2041		1873.45	1873.45	830.71	-1,042.74
18	2041-2042		1967.12	1967.12	913.78	-1,053.34
19	2042-2043		2065.48	2065.48	1,005.16	-1,060.32
20	2043-2044		2168.75	2168.75	1,105.68	-1,063.07
					FIRR	**#NUM!**

Table 83: Year wise EIRR for Phase 1 Excluding Land Cost

Sl. No	Year	Economic Benefit (INR lacs)	Scenario 1		Scenario 2	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
-3	2020-2021		-1162.93	-1162.93	-	0.00
-2	2021-2022		-2616.59	-2616.59	-	0.00
-1	2022-2023		-2035.13	-2035.13	-	0.00
0	2023-2024	1248.00	-194.52	1053.48	-194.52	1053.48
1	2024-2025	1260.48	-160.49	1099.99	-160.49	1099.99
2	2025-2026	1273.08	-120.39	1152.69	-120.39	1152.69
3	2026-2027	1285.82	-73.47	1212.34	-73.47	1212.34
4	2027-2028	1298.67	-18.92	1279.76	-18.92	1279.76
5	2028-2029	1311.66	44.19	1355.85	44.19	1355.85
6	2029-2030	1324.78	116.86	1441.64	116.86	1441.64
7	2030-2031	1338.02	200.21	1538.23	200.21	1538.23
8	2031-2032	1351.41	295.48	1646.88	295.48	1646.88
9	2032-2033	1364.92	404.03	1768.95	404.03	1768.95
10	2033-2034	1378.57	527.39	1905.96	527.39	1905.96
11	2034-2035	1392.35	667.24	2059.59	667.24	2059.59
12	2035-2036	1406.28	825.43	2231.70	825.43	2231.70
13	2036-2037	1420.34	1004.00	2424.34	1,004.00	2424.34
14	2037-2038	1434.54	1205.24	2639.78	1,205.24	2639.78
15	2038-2039	1448.89	1431.64	2880.53	1,431.64	2880.53
16	2039-2040	1463.38	1685.98	3149.36	1,685.98	3149.36
17	2040-2041	1478.01	1971.31	3449.32	1,971.31	3449.32
18	2041-2042	1492.79	2291.01	3783.80	2,291.01	3783.80
19	2042-2043	1507.72	2648.80	4156.52	2,648.80	4156.52
20	2043-2044	1522.80	3048.82	4571.61	3,048.82	4571.61
	Internal Rate of Return (IRR)		**6.30%**	**20.40%**	**30.49%**	**#NUM!**

Table 84: Year wise EIRR for Phase 2 Excluding Land Cost

Sl. No	Year	Economic Benefit (INR lacs)	Scenario 1		Scenario 2	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
-3	2020-2021		-1961.26	-1961.26	-	0.00
-2	2021-2022		-4412.85	-4412.85	-	0.00
-1	2022-2023		-3432.21	-3432.21	-	0.00
0	2023-2024	1628.00	-653.03	974.97	-653.03	974.97
1	2024-2025	1644.28	-677.46	966.82	-677.46	966.82
2	2025-2026	1660.72	-702.30	958.43	-702.30	958.43
3	2026-2027	1677.33	-727.47	949.86	-727.47	949.86
4	2027-2028	1694.10	-752.90	941.20	-752.90	941.20
5	2028-2029	1711.04	-778.52	932.53	-778.52	932.53
6	2029-2030	1728.15	-804.21	923.95	-804.21	923.95
7	2030-2031	1745.44	-829.86	915.58	-829.86	915.58
8	2031-2032	1762.89	-855.34	907.55	-855.34	907.55
9	2032-2033	1780.52	-880.49	900.03	-880.49	900.03
10	2033-2034	1798.32	-905.14	893.19	-905.14	893.19
11	2034-2035	1816.31	-929.08	887.23	-929.08	887.23
12	2035-2036	1834.47	-952.09	882.38	-952.09	882.38
13	2036-2037	1852.82	-973.90	878.91	-973.90	878.91
14	2037-2038	1871.34	-994.23	877.11	-994.23	877.11
15	2038-2039	1890.06	-1012.74	877.32	-1,012.74	877.32
16	2039-2040	1908.96	-1029.05	879.91	-1,029.05	879.91
17	2040-2041	1928.05	-1042.74	885.31	-1,042.74	885.31
18	2041-2042	1947.33	-1053.34	893.99	-1,053.34	893.99
19	2042-2043	1966.80	-1060.32	906.48	-1,060.32	906.48
20	2043-2044	1986.47	-1063.07	923.39	-1,063.07	923.39
	Internal Rate of Return (IRR)		**#NUM!**	**6.55%**	**#NUM!**	**#NUM!**

Table 85: Year wise EIRR for Phase 1 Including Land Cost

Sl. No	Year	Economic Benefit (INR lacs)	Scenario 1		Scenario 2	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
-3	2020-2021		-1302.63	-1302.63	-	0.00
-2	2021-2022		-2930.92	-2930.92	-	0.00
-1	2022-2023		-2279.60	-2279.60	-	0.00
0	2023-2024	1248.00	-194.52	1053.48	-194.52	1053.48
1	2024-2025	1260.48	-160.49	1099.99	-160.49	1099.99
2	2025-2026	1273.08	-120.39	1152.69	-120.39	1152.69
3	2026-2027	1285.82	-73.47	1212.34	-73.47	1212.34
4	2027-2028	1298.67	-18.92	1279.76	-18.92	1279.76
5	2028-2029	1311.66	44.19	1355.85	44.19	1355.85
6	2029-2030	1324.78	116.86	1441.64	116.86	1441.64
7	2030-2031	1338.02	200.21	1538.23	200.21	1538.23
8	2031-2032	1351.41	295.48	1646.88	295.48	1646.88
9	2032-2033	1364.92	404.03	1768.95	404.03	1768.95
10	2033-2034	1378.57	527.39	1905.96	527.39	1905.96
11	2034-2035	1392.35	667.24	2059.59	667.24	2059.59
12	2035-2036	1406.28	825.43	2231.70	825.43	2231.70
13	2036-2037	1420.34	1004.00	2424.34	1,004.00	2424.34
14	2037-2038	1434.54	1205.24	2639.78	1,205.24	2639.78
15	2038-2039	1448.89	1431.64	2880.53	1,431.64	2880.53
16	2039-2040	1463.38	1685.98	3149.36	1,685.98	3149.36
17	2040-2041	1478.01	1971.31	3449.32	1,971.31	3449.32
18	2041-2042	1492.79	2291.01	3783.80	2,291.01	3783.80
19	2042-2043	1507.72	2648.80	4156.52	2,648.80	4156.52
20	2043-2044	1522.80	3048.82	4571.61	3,048.82	4571.61
	Internal Rate of Return (IRR)		**5.64%**	**18.76%**	**30.49%**	**#NUM!**

Table 86: Year wise EIRR for Phase 2 Including Land Cost

Sl. No	Year	Economic Benefit (INR lacs)	Scenario 1		Scenario 2	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
-3	2020-2021		-2045.08	-2045.08	-	0.00
-2	2021-2022		-4601.44	-4601.44	-	0.00
-1	2022-2023		-3578.90	-3578.90	-	0.00
0	2023-2024	1628.00	-653.03	974.97	-653.03	974.97
1	2024-2025	1644.28	-677.46	966.82	-677.46	966.82
2	2025-2026	1660.72	-702.30	958.43	-702.30	958.43
3	2026-2027	1677.33	-727.47	949.86	-727.47	949.86
4	2027-2028	1694.10	-752.90	941.20	-752.90	941.20
5	2028-2029	1711.04	-778.52	932.53	-778.52	932.53
6	2029-2030	1728.15	-804.21	923.95	-804.21	923.95
7	2030-2031	1745.44	-829.86	915.58	-829.86	915.58
8	2031-2032	1762.89	-855.34	907.55	-855.34	907.55
9	2032-2033	1780.52	-880.49	900.03	-880.49	900.03
10	2033-2034	1798.32	-905.14	893.19	-905.14	893.19
11	2034-2035	1816.31	-929.08	887.23	-929.08	887.23
12	2035-2036	1834.47	-952.09	882.38	-952.09	882.38
13	2036-2037	1852.82	-973.90	878.91	-973.90	878.91
14	2037-2038	1871.34	-994.23	877.11	-994.23	877.11
15	2038-2039	1890.06	-1012.74	877.32	-1,012.74	877.32
16	2039-2040	1908.96	-1029.05	879.91	-1,029.05	879.91
17	2040-2041	1928.05	-1042.74	885.31	-1,042.74	885.31
18	2041-2042	1947.33	-1053.34	893.99	-1,053.34	893.99
19	2042-2043	1966.80	-1060.32	906.48	-1,060.32	906.48
20	2043-2044	1986.47	-1063.07	923.39	-1,063.07	923.39
	Internal Rate of Return (IRR)		**#NUM!**	**6.09%**	**#NUM!**	**#NUM!**

13.5 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 Rupnarayan 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. A detailed sensitivity analysis has not been carried out for each of the constituent cost elements.

Sensitivity analysis of IWT on Rupnarayan waterway is carried out for varying operational scenarios considering the basic operational and serviceability conditions as same. The FIRR and EIRR obtained from varying operational scenarios are shown in **Table 87** and **Table 88.**

Table 87: Sensitivity Analysis for varying scenarios (Excluding land Cost)

IWT Operation	FIRR	EIRR
Phase -1		
Scenario - 1 d) Capital cost incurred in Phase – 1 e) O&M cost incurred in Phase – 1 f) Revenue generated from Cargo operations only	6.30% for tariff of INR 2.50 per ton per km	20.40% for tariff of INR 2.50 per ton per km
Scenario - 2 c) O&M cost incurred in Phase – 1 d) Revenue generated from Cargo operations only	30.49% for tariff of INR 2.50 per ton per km	+ve (not calculable)
Phase – 2		
Scenario - 1 d) Capital cost incurred in Phase – 2 (including vessel cost) e) O&M cost incurred in Phase – 2 (including vessel cost) f) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	6.55%
Scenario - 2 c) O&M cost incurred in Phase – 2 (including vessel cost) d) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	+ve (not calculable)

Table 88: Sensitivity Analysis for varying scenarios (Including land Cost)

IWT Operation	FIRR	EIRR
Phase -1		
Scenario - 1 d) Capital cost incurred in Phase – 1 e) O&M cost incurred in Phase – 1 f) Revenue generated from Cargo operations only	5.64% for tariff of INR 2.50 per ton per km	18.76% for tariff of INR 2.50 per ton per km
Scenario - 2 c) O&M cost incurred in Phase – 1 d) Revenue generated from Cargo operations only	30.49% for tariff of INR 2.50 per ton per km	+ve (not calculable)
Phase – 2		
Scenario - 1 d) Capital cost incurred in Phase – 2 (including vessel cost) e) O&M cost incurred in Phase – 2 (including vessel cost) f) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	6.09%
Scenario - 2 c) O&M cost incurred in Phase – 2 (including vessel cost) d) Revenue generated from RO-RO/Ferry operations	-ve (not calculable)	+ve (not calculable)

From the above table, it is concluded that the project is economically viable for both the phases. With tariff of INR 2.5 per ton per km phase 1 is financially viable also.

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) Dredging –

Maintenance dredging is required throughout the year for uninterrupted IWT operations.

b) Dependency on inter-modality –

Integrated road transport connectivity is required for RO-RO and passenger ferry services.

13.7 PROJECT FINANCING ASPECTS / TRANSACTION STRUCTURING

It is proposed that the waterway and terminal facilities will be developed by IWAI with support from state government.

13.8 NECESSITY OF GOVT. SUPPORT

The consultant is of the view that the present trend in infrastructure sector with public-private partnerships (PPP) can be adopted for implementing the project. The initial investment and initiative being taken by IWAI in association with state government would give start to the project. Since private sector would not able to take the initiative of provision of infrastructure and operate the services on its own. The IWAI should take investment decision with support from State and Central government to develop the said facility. Then private sector could be expected to take participation in the project. Once the proposed services are operated by private sector, the FIRR may further improve because they would undertake intensive marketing efforts and relate it to utilizations of vessels and terminal facilities. Private participation in operating the IWT services may be considered in detail after investment decision is taken by IWAI to implement the project.

14.0 CONCLUSIONS AND RECOMMENDATIONS

The viability of Rupnarayan River for development of Inland Waterway and Transport is evaluated both technically and commercially. The technical viability of the project has been assessed based on availability of discharges to maintain navigable depth in a design channel suitable to ply design vessel. The commercial viability of the project have been assessed based on traffic potential and 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 etc. The recommendation for implementation of the project is decided based on the trade-off between costs to be incurred and benefits derived.

The capital cost for development of the system components of the project viz., development of the designed waterway and construction of IWT terminals has been worked out as below:

Sl. No.	Description	Excluding Land Cost	Including Land Cost
1.	Phase 1 Capital Cost (in INR Lacs)	5,814.65	6,513.15
2.	Phase 1 O&M Cost (in INR Lacs)	1,069.52	
3.	Phase 2 Capital Cost (in INR Lacs)	9,806.32	10,225.42
4.	Phase 2 O&M Cost (in INR Lacs)	817.38	

IWT operations in Rupnarayan WW are economically viable in all scenarios for both the development phases.

The project is financially viable for phases 1 with a tarrif of INR 2.5 per ton per Km.

The consideration of the project for implementation may be viewed as investments are made in the development of IWT-a fuel efficient mode, the associated cost of moving the projected traffic volumes by IWT instead of road transport would cost less to the economy. The following advantages of IWT need to be given due weightage while taking appropriate investment decisions:

a) Higher unit capacity per unit fuel consumption of IWT vis-à-vis road.
b) Pollution levels created by IWT for moving a unit quantity are much less when compared to road.
c) IWT is almost accident free.

Further the waterway is connected with National water – 1 (Ganga-Bhagirathi-Hooghly river system), which gives additional economic advantages for growth in trade and development of the region as a whole.

In the context of ever increasing fuel demand in the transport sector, mainly road transport which is least fuel efficient, there is need to promote fuel efficient modes like IWT and recommended measures to increase its share in the total freight movement. In long term it will help in saving energy demand and foreign exchange reserves.

In the light of the above, it is recommended that Rupnarayan waterway should be developed for IWT operations in consultation/association with West Bengal state government to provide integrated transport connectivity between IWT and road transportation. The integrated Rupnarayan waterway with National waterway -1 from Allahabad to Haldia may further enhance its viability. Also it will enhance the local/regional economy contributing towards employment generation and allied developments.

Given the above, Consultants recommend that the IWT for Rupnarayan waterway, should be taken up for development.

ANNEXURES

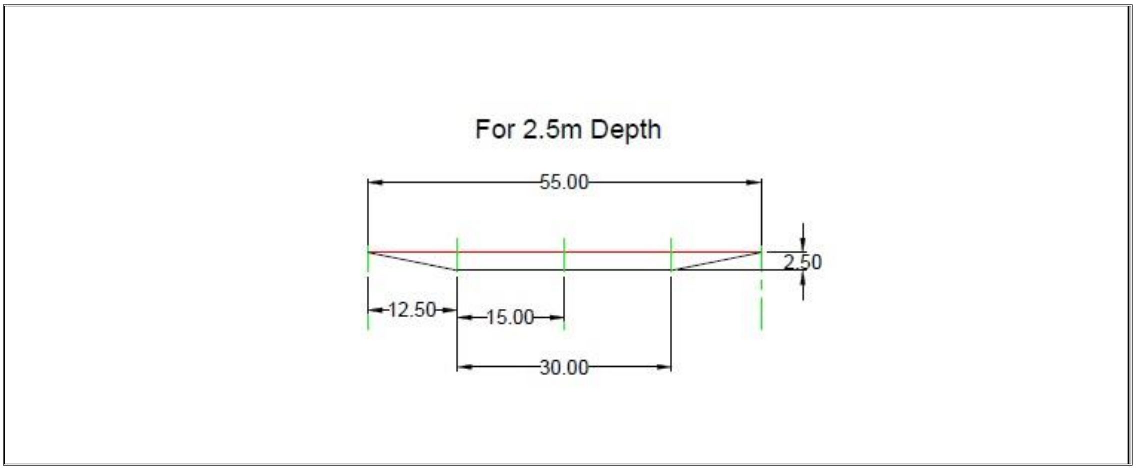
ANNEXURE – 1

ToR OF THE AGREEMENT

ANNEXURES – 2

MINIMUM AND MAXIMUM DEPTH W.R.T CD

(FOR SPV CLASS WW 2.5 M DEPTH 30 M BED WIDTH)



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				5.1	10.95	0	0	0.00
1	2					4.64	6.13	0	0	0.00
2	3	Tidal Zone				3.94	6.65	0	0	0.00
3	4					0.11	2.87	900	7513.06	7513.06
4	5					-0.22	0.88	1000	21171.78	28684.84
5	6					0.47	1.39	1000	87441.7	116126.54
6	7					0.72	1.36	1000	57976.27	174102.81
7	8					0.63	1.1	1000	53047.72	227150.53
8	9					0.44	3.1	1000	62159.4	289309.93
9	10					0.9	4.71	1000	57817.59	347127.52
10	11					1.23	4.82	800	11991.85	359119.37
11	12					1.3	6.46	150	15433.85	374553.22
12	13					0.39	4.04	900	1076.08	375629.30
13	14					-0.77	0.44	1000	15888.99	391518.29
14	15					-0.36	0.9	1000	76218.45	467736.74
15	16					0.55	1.37	1000	107502.75	575239.49
16	17					0.98	2.93	1000	72624.64	647864.13
17	18					1.42	2.68	1000	53484.23	701348.36
18	19					1.43	2.46	1000	9457.49	710805.85
19	20					0.99	3.25	1000	23821.94	734627.79
20	21					1	3.37	1000	22143.08	756770.87
21	22					1.43	2.47	1000	14668.86	771439.73
22	23					1.46	2.36	1000	14105.09	785544.82
23	24					0.43	2.22	1000	13730.01	799274.83
24	25					-0.16	1.1	1000	13596.87	812871.70
25	26					-0.7	1.38	1000	50264.28	863135.98
26	27					-0.78	2.31	1000	86371.69	949507.67
27	28					-0.74	2.37	1000	107346.18	1056853.85
28	29					-0.7	1.22	1000	76934.25	1133788.10
29	30					-0.57	0.85	1000	88573.78	1222361.88
30	31					-0.89	1.51	1000	92945.86	1315307.74

Chainage (km)		Observed				Reduced w.r.t. Sounding Datum				
From	**To**	**Min. depth (m)**	**Max. depth (m)**	**Length of Shoal (m)**	**Dredging Qty. (cu.m.)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty. (cu.m.)**	**Accumulative Dredging Qty.**
31	32					0.56	1.81	1000	83934.27	1399242.01
32	33					0.6	1.24	1000	122379.37	1521621.38
33	34					0.76	1.4	1000	67073.58	1588694.96
34	35					0.43	3.92	800	55808.2	1644503.16
35	36					2.79	6.22	0	0	1644503.16
36	37					1.67	5.65	1000	34529.43	1679032.59
37	38					1.79	5.49	600	23452.28	1702484.87
38	39					1.71	5.32	600	15264.22	1717749.09
39	40					0.05	3.2	600	5243.14	1722992.23
40	41					-0.45	1.12	600	23452	1746444.23
41	42					-0.77	1.59	600	16563.8	1763008.03
42	43					-0.3	3.84	600	49197.38	1812205.41
43	44					0.01	4.65	600	71314.5	1883519.91
44	45					-1.19	3.47	600	215077.6	2098597.50
				Total					2098597.5	

ANNEXURES – 3

ENVIRONMENT AND SOCIAL SCREENING TEMPLATE

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site.			
a) National Park		√	
b) Wildlife/ Bird Sanctuary		√	
c) Tiger or Elephant Reserve		√	
d) Biosphere Reserve		√	
e) Reserved / Protected Forest		√	
f) Wetland		√	
g) Important Bird Areas		√	
h) Mangroves Areas	√		Near the confluence (with Hoogly River) on the right bank of Rupnarayan River a Mangrove Swamp Patch (namely *Natshaler Char*) is present. Forest Dept. carried out plantation activity in the area. However, the ownership of land doesn't belong to Forest Dept.
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		√	
l) Archeological monuments/ sites (under ASI's Central / State list)		√	
2. Is the project located in whole or part in /near any Critically Polluted Areas identified by CPCB?		√	
3. Is, there any defense installations near the project site?		√	
4. Whether there is any Government Order/ Policy relevant / relating to the site?		√	
5. Is the project involved clearance of existing land, vegetation and buildings?	√		
6. Is the project involved dredging?	√		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)	√		Prone to Flood, Cyclones and heavy winds
8. Is the project located in whole or part within the Coastal Regulation Zone?	√		
9. Is the project involved any demolition of existing structure?	√		Deconstruction of existing infrastructure including Jetties may be requiring.

Screening Question	Yes	No	Details / Remarks
10. Is the project activity requires acquisition of private land?		√	Type of land to be verified at later stage during detailed SIA study
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. Since the project site is located in designated CRZ area
3	Environmental Clearance is Required	No
4	Forest Clearance is required	No
5	Wildlife Clearance is required	No
6	NOC from SPCB is required	Yes
7	Social Impact Assessment is Required	Yes
8	Abbreviated RAP is required	No
9	Full RAP is required	Yes
10	Any other clearance is required	Various NoCs for construction activities

ANNEXURES – 4

MoEFCC Memorandum

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

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

Dated: 21st December, 2017.

OFFICE MEMORANDUM

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

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

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

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

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

Sharath Kumar Pallerla
Director

To

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

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ANNEXURE

Environmental safety measures to be implemented

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

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

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

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

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

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

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

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

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

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

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

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

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

Sharath Kumar Pallerla
Director

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ANNEXURES – 5

PHOTOGRAPHS

Topographic Survey at Chainage 0.0

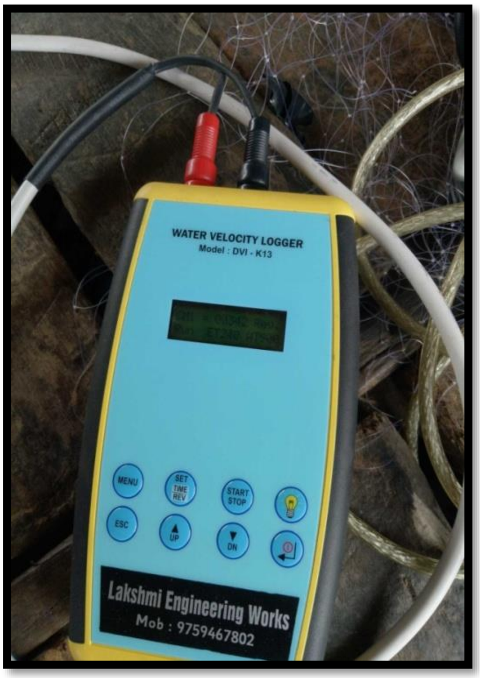
River Bank at Chainage 1.0

Data Logging system in Boat

BM RN- 2

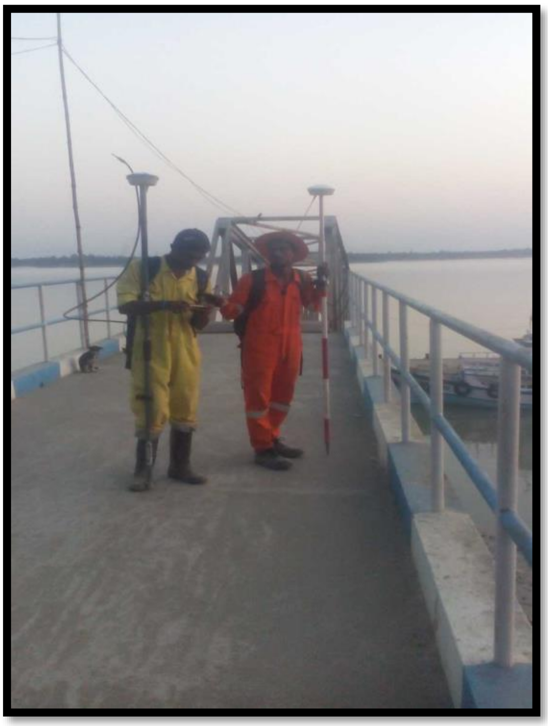
RN02,Tide Reading

Tide Pole near RN-2



Current meter Observation

TBM2 Boat Preaparing



Gadiara Ferry Ghat 1 Chainage 0.8

Tide Pole Erection At Chainage 0.28

River Bank At Chainage 1.2

Erection of Tide Pole at Geonkhali

Tide Poles at Geonkhali

Mangroves at Chainage 1.6

Jetty area near Geonkhali Village

River bank at Chainage 2.8

Creek at Chaiange 3.0

DGPS Observation at BM RN-02

NADSAL Creek

Bathymetric Survey

Base Station At Gadhiara

Brickline at Chaiange 4.6

Chainange 5.8

River Bank At Chainage 8.3

Bathymetric Survey

Brickline At Chainage 8.5

Data Acquisition

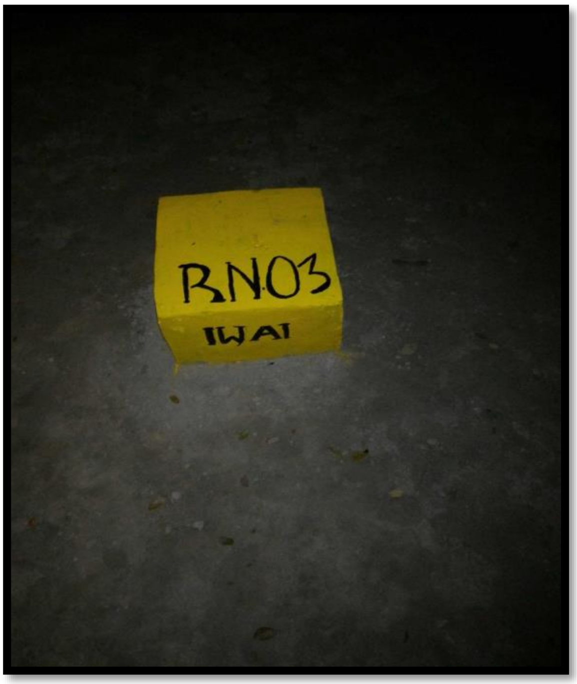
Culvert at Natshal

Current meter observation

Gathering Topo Points at Low Water Level

Shallow Patch during Low Water

Shallow Patch during Low Water



BM RN 3

Protected River Bank at Chainage 9.4

BM RN 4 at Gopinathpur

Rupasi Rupnarayan Resort

Brick Factory At Chainage 9.5

Brick Kline At Bykandapur Chainage 9.5

Brick Factory At Chainage 19.0

Survey Boat Aqua Marina

Soil Erosion Area At Chainage 14.0

Creek at Chainage 19.65

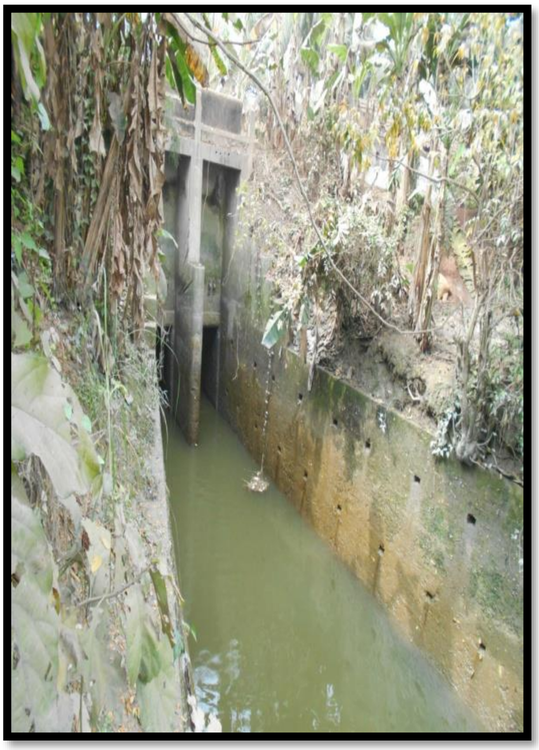
Creek on left bank at chainage 19.7

RN-4 Base

Creek at Mednapur

Creek at Bonsala

Canal At Nanpur Village



Aqudates at Nanpur Village

Topographic Survey at Nakudia using RTK

River Bank At Chainage 22.7

River Bank At Chainage 22.7

Soil Erosion On River Bank At Chainage 23.4

Water Sampler

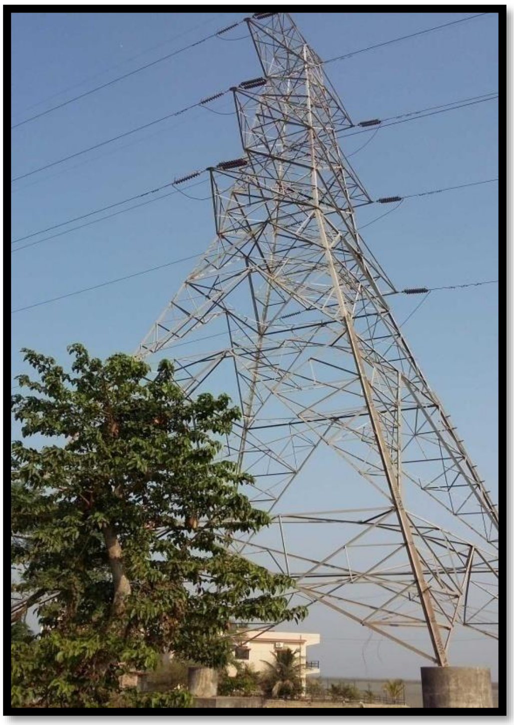
Dredger At Chainage 30.6

Canal Outlet Gate at RN-04

Water Locks At Near RN-4

Chainage 31.4

Chainage 32.1



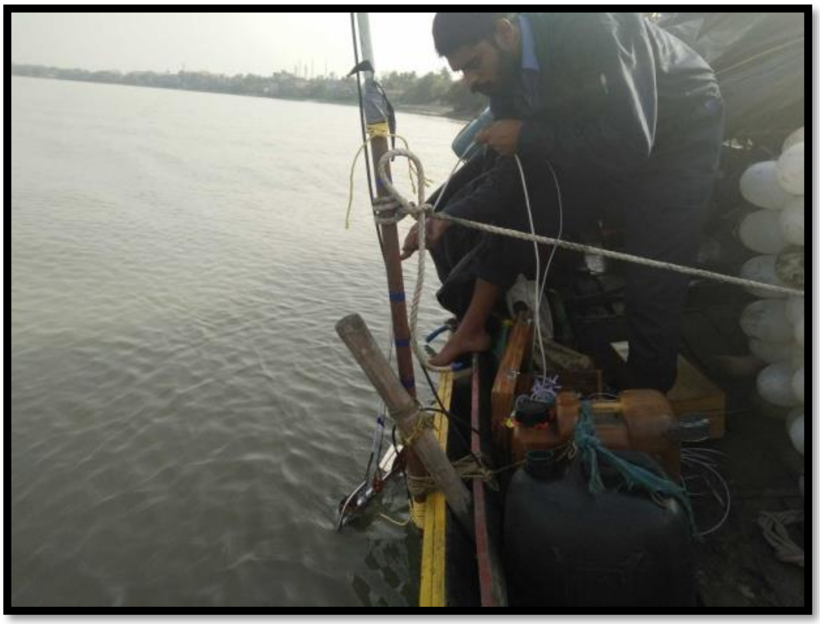
High Tension Line At Orphuli Chainage 34.4   **High Tentional Line At Chainage 34.4**

High Tension Line At Orphuli Chainage 34.4

Mobile Tower At Chainage 34.5

Creek at Halora

High Transmission Tower at Chainage 34.42



Current Meter Observation

Railway Bridge At Kolghat Chainage 35.2

Water Locks At Nadsal Village

Wooden Bridge A Chainage 35.5

Kolaghat Road Bridge at Chainage 35.76

Kolaghat Bridge at Chainage 35.76

Kolaghat Railway Bridge NO.1

Kolaghat Railway Over Bridge

Fixing Of Tide Ploe At Chainge 40.0

Railway Bridge 2 Kolaghat

Railway Bridge no. 1 Kolaghat

Road Bridge No 3-Kolaghat

Old Temple at Ululu vilage

Sea wall at Orphuli

Levelling at RN 5

Compound wall fishery department at chainage 37.5

Water Tank at Orphuli

Creek crossing at Chainage 39.1

Base Station RN 5-Kolaghat

Locks At Benipur Bajar

Locks At Botsala

Locks At Orphuli 1

VOLUME – II

DRAWINGS