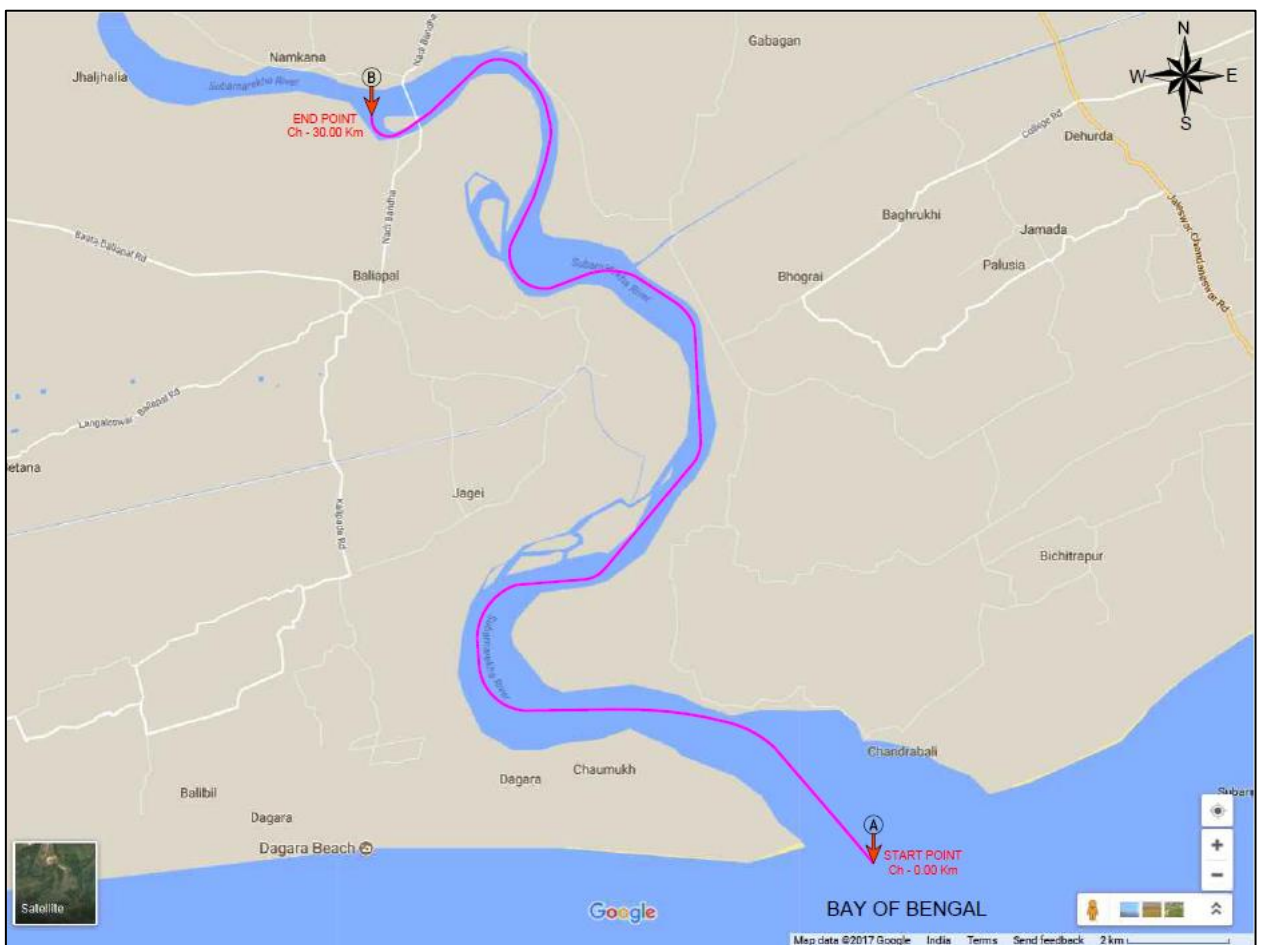


FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
RIVER: SUBARNREKHA (STATE OF ODISHA)
CHANDRABALI TO NAMKANA (30 KMS)
(Volume – I: Main Report)
(Volume – II: Drawings)
Submission Date: 24/05/2019



Inland Waterways Authority of India

FINAL DETAILED PROJECT REPORT
REVISION - 3
May 2019

FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
RIVER: SUBARNREKHA (STATE OF ODISHA)
CHANDRABALI TO NAMKANA (30 KMS)
(Volume – I: Main Report)
(Volume – II: Drawings)
Submission Date: 24/05/2019

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

Owner: IWAI, Ministry of Shipping

Consultant: Egis India Consulting Engineers

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**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

LIST OF VOLUMES

VOLUME – I : MAIN REPORT

VOLUME – II : DRAWINGS

VOLUME – III A : HYDROGRAPHIC SURVEY REPORT

VOLUME – III B : HYDROGRAPHIC SURVEY CHARTS

VOLUME – IV : GEO-TECHNICAL INVESTIGATION REPORT

FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96 SUBARNREKHA RIVER (30 KM)

ACKNOWLEDGEMENT

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SUBARNREKHA RIVER (30 KM)**

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FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96 SUBARNREKHA RIVER (30 KM)

LIST OF ABBREVIATIONS

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

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

SALIENT FEATURES OF SUBARNREKHA WATERWAY (NW 96)

Sr. No.	Particulars	Details			
A.	GENERAL				
1.	Location				
a)	Cluster	1			
b)	State(s)	Odisha (Orissa)			
c)	Co-ordinates & Name of Place	Start		End	
	Place	Chandrabali		Namkana	
	Latitude	21°33'28.75"N		21°40'57.17"N	
	Longitude	87°22'58.6"E		87°16'57.28"E	
B.	TECHNICAL				
1.	Waterway	Waterway is proposed for IWT on 640 m stretch for river crossing at Pantei Ghat near Chainage 17.0 Km			
a)	National Waterway Number	96			
b)	Class	III			
c)	Type (Tidal/Non-Tidal)	Tidal			
	Length (Km.)	Total	Tidal	Non-Tidal	
		30 Km	30 Km	0 Km	
d)	Sounding Datum				
	Description/Basis	Sounding Datum was transferred at all the newly established BM's using Sagar Road values. Standard method was adopted for transfer of datum for tidal reaches areas as per Admiralty Manual.			
	Value w.r.t MSL (m)	0 – 5.0 Km	5.1 – 15.0 Km	15.1 – 25.0 Km	25.1 – 30.0 Km
		-0.25	0.516	0.378	1.198
e)	LAD Status (w.r.t. SD)				
		Stretch -1	Stretch -2	Stretch -3	Total (Km)
	Stretch (From.....To.....)	0 - 10	10 - 20	20 – 30	
	Length with LAD < 1.2 m	0	2.09	2.52	4.61
	With LAD from 1.2-1.4 m	0.73	0.97	0.07	1.77
	With LAD from 1.5-1.7 m	0.32	0.83	0.29	1.44
	With LAD from 1.8-2.0 m	0.12	0.42	0.73	1.27
	With LAD > 2.0 m	8.83	5.69	6.39	20.91

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

Sr. No.	Particulars	Details			
f)	Target Depth of Proposed Fairway (m)	2.2 m (1.7m below SD level for Class III WW + 0.5 m additional clearance for siltation)			
g)	Conservancy Works Required (For proposed waterway stretch of 640 m at Pantei Ghat)				
	Type of Work	0 – 10 Km	10 – 20 Km	20 – 30 Km	Total (Km)
	Dredging Required (M. Cum.)	Nil	0.021	Nil	Nil
	Bandalling	Nil	Nil	Nil	Nil
	Barrages & Locks	Nil	Nil	Nil	Nil
	River Training (Km.)	Nil	Nil	Nil	Nil
	Bank Protection (Km.)	Nil	Nil	Nil	Nil
h)	Existing Cross Structures (For proposed waterway stretch of 640 m at Pantei Ghat)				
	Name of Structure	Type	Nos.	Range of Horizontal Clearance	Range of Vertical Clearance w.r.t. HFL/MHWS
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil
	Bridges	Nil	Nil	Nil	Nil
	HT/Tele-communication lines	Nil	Nil	Nil	Nil
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil
2.	Traffic				
a)	Present IWT Operations (type of services)	Passenger Ferry			
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	Not Available			
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	Not applicable			
d)	Commodities	In-bound		Out-bound	

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

Sr. No.	Particulars	Details				
		Not Available		Not Available		
e)	Existing and Future Potential					
	Name of Commodity	Existing	5 years	10 years	15 years	20 years
	Passengers (nos.)	2000	2814	3592	4584	5851
3.	<i>Terminals/Jetties</i>					
a)	Terminal/Jetty - 1					
	Location	(Right Bank/Pantei Ghat/Balasore district)				
	Type/Services	Passenger Ferry				
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.				
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform, Parking, Passenger waiting and ticketing area, Office complex				
	Approach	Baliapal village Road				
	Land Ownership					
	Area (sq.m.)	Govt.		Private		
				1195		
b)	Terminal/Jetty – 2					
	Location (Bank/city/district)	(Left Bank/Pantei Ghat/ Balasore district)				
	Type/Services	Passenger Ferry				
	Existing Infrastructure/Facilities	Vessels use river bank for berthing. No terminal structure or basic amenities for passengers are available.				
	Proposed Infrastructure/Facilities	Gangway, Pontoon Platform, Parking, Passenger waiting and ticketing area, Office complex				
	Approach	Vusudeswar village Road				
	Land Ownership					
	Area (sq.m.)	Govt.		Private		
				1195		
4.	<i>Design Vessel</i>					
a)	Type	Steel ferry vessel				
b)	No. & Size	2 No. (62.4L x 4.5B)				
c)	Loaded Draft	1.5 m				
d)	Capacity	150 passengers				

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

Sr. No.	Particulars	Details		
5.	Navigation Aids			
a)	Type	Marking buoys		
b)	Nos.	8		
c)	Communication Facilities	<ul style="list-style-type: none"> • DGPS • VTMS 		
C.	FINANCIAL			
1.	Cost	Capital Cost (INR Lakhs)	O&M Cost (INR Lakhs)	
	a) Fairway Development	42.00	4.20	
	b) Terminal Structure	1166.20	174.65	
	c) Vessels	183.996	86.16	
	d) Land	5.32	-	
	Total Cost including Vessel and Land Cost	1608.54/-	325.165/-	
	Total Cost including Vessel	1603.221/-	325.165/-	
	Total Cost without Vessel and Land cost	1419.225/-	239.005/-	
2.	User Charges	INR 6.00 per person per trip one way		
3.	Financial Internal Rate of Return (%)	Option 1	Option 2	Option 3
		Total Capital Cost + Total O&M cost	Option 1 - Vessel Capital & O&M cost	Vessel Capital Cost + Vessel O&M Cost
		-7.48	0.18	28.51
4.	Economic Internal Rate of Return (%)	Option 1	Option 2	Option 3
		Total Capital Cost + Total O&M cost	Option 1 - Vessel Capital & O&M cost	Vessel Capital Cost + Vessel O&M Cost
		0.08	6.82	79.68

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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. Subarnrekha waterway is one of the 4 rivers clubbed in Cluster 1.

This final detailed project report of 30 km stretch of Subarnrekha 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 30 Km stretch of Subarnrekha National waterway proposed for DPR study lies from the river confluence with Bay of Bengal (Lat 21°33'28.75"N, Long 87°22'58.6"E) to Baliapal - Kamarda Road Bridge (Lat 21°40'51.64"N, Long 87°17'27.71"E). Whole stretch of Subarnrekha waterway from Bay of Bengal to Baliapal - Kamarda Road Bridge is having tidal influence with a maximum tidal variation of 1.89 m to a minimum tidal variation of 0.86 m.

River width in the waterway stretch varies from 2.0 Km at estuarine portions to 250 m near the end. Maximum and minimum reduced depth of the waterway with respect to sounding datum are 10.7m at chainage 26.0 Km and -0.3m at chainage 21.0 Km respectively, for proposed waterway Class III. Average flow velocity in the waterway varies from 0.533 m/sec to 0.266 m/sec.

3.0 FAIRWAY DEVELOPMENT

Fairway for navigation is proposed at Pantei ghat (Chainage 17.0 Km) for river crossing. Dredging is proposed for 640 m fairway stretch across the river for obtaining desired depth of 1.7 m below sounding datum as per Class-III waterway classification and additional 0.5m for river siltation. The total capital and O&M cost of fairway development works out to INR 42.00 Lacs and INR 4.20 Lacs respectively.

4.0 TRAFFIC STUDY

On the basis of detailed traffic survey and study done during DPR stage, it is concluded that locally operated passenger ferry service is currently operational near Pantei Ghat for river crossing. Vehicular

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traffic use the Baliapal road bridge located about 10 Km upstream of Pantei ghat for river crossing. Existing passenger traffic as observed during field survey is about 2000 person per day. In the DPR, the techno-economical aspects to develop the ferry services and necessary infrastructure required for safe navigation, embarking and disembarking of passengers for projected traffic demand of about 6000 person per day in 2040 is studied.

5.0 TERMINALS

Floating pontoons with Gangway and necessary terminal structure is envisaged to be developed on both the banks Subarnrekha waterway at Pantei ghat.

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	1,166.20
2.0	Capital cost for Terminals including land cost	1,171.52
3.0	O&M cost for Terminals	174.65

6.0 PRELIMINARY ENGINEERING DESIGNS

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

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

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

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7.0 VESSEL DESIGN

Steel ferry vessels developed by West Bengal Transport Infrastructure Development Corporation (WBTIDC), with carrying capacity of 150 passengers are proposed to be operated in Subarnrekha waterway for passenger ferry services. The procurement and O&M cost of 2 vessels works out to INR 183.996 lakhs and INR 86.16 lakhs respectively.

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 95.90 Lakhs and INR 4.80 Lakhs respectively.

9.0 ENVIRONMENTAL & SOCIAL ASPECTS

The major objective of this study is to establish present environmental condition along the Subarnarekha 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

The study stretch passes through Baleswar District in the state of Odisha. The district Baleswar lies between 21° 03' and 21°59' North latitude and 86° 20' to 87°29' East longitude. The project falls under the seismic zone II as defined by the Indian Standard (IS) 2002 seismic zoning classification system, i.e. a zone of relative stability. Based on observations between 1973-2000 the temperature profile of the project area is furnished in below table. April is the warmest month of the year. The temperature in April averages 35.9 °C. The lowest average temperatures in the year occur in January, when it is around 14.4 °C

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Assessments of impact on environment including social considerations are done in the DPR. The total environmental estimated cost for the project is Rs. 97.40 lakhs.

10.0 INSTITUTIONAL REQUIREMENTS

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

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

11.0 PROJECT COSTING

The basis of cost estimates worked out as per following:

- a) Standard Schedule of Rates 2015-16 of PWD, Govt. of Odisha
- b) The consultants experience on various projects sites proximity to the project area.
- c) Local enquiries at the time of conducting surveys.
- d) Market surveys and enquires
- e) Judgement based on Consultant's Experience
- f) "Estimates of State Domestic Product, Odisha", report published by Directorate of Economics & Statistics, Odisha, Bhubaneswar, dated February 2019.
- g) Land Rate for Baliapal, Balasore District of Odisha state as obtained from Odisha Industrial Infrastructure Development Corporation website <http://www.idco.in/2009/landrate.aspx>.

Subarnrekha waterway is proposed to be developed for passenger ferry services at Pantei ghat. 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.

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The total capital cost for development of waterway, construction of terminals, and procurement of vessels including other expenses works out to INR 1603.221/- Lacs excluding land cost and INR 1608.54 Lacs including land cost. Annual operation and maintenance cost of Subarnrekha waterway including O&M expenses for terminal/ jetty structures works out to INR 325.165/- Lacs.

12.0 IMPLEMENTATION SCHEDULE

The project is scheduled to be completed in 24 months from the start date of construction.

13.0 ECONOMIC & FINANCIAL ANALYSIS

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

The techno-economic model has been run with the assumption that 2 passenger ferry vessels of 150 pax capacity will operate from 7:00 AM to 7:00 PM at every 30 minute interval between both the jetties.

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.

From the detailed financial analysis it is recommended that the project shall be implemented in two packages as below:

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

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

The calculated FIRR and EIRR for varying fare is shown as below:

Calculation excluding Land Cost

Sr. No.	Fare (INR) (per trip one way)	FIRR (%)			EIRR (%)		
		Option-1	Option-2	Option-3	Option-1	Option-2	Option-3
1	3.00	Not Calculable	Not Calculable	10.55	Not Calculable	-7.6	54.99

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Sr. No.	Fare (INR)	FIRR (%)			EIRR (%)		
	(per trip one way)	Option-1	Option-2	Option-3	Option-1	Option-2	Option-3
2	5.00	Not Calculable	-4.05	23.05	-4.48	3.93	71.71
3	6.00	-7.47	0.19	28.51	0.09	6.84	79.68
4	8.00	0.30	5.61	39.45	5.66	11.12	95.21
5	10.00	4.82	9.37	51.02	9.42	14.4	110.42
6	12.00	8.14	12.36	63.33	12.38	17.14	125.42
	Not Calculable	All/majorly negative cash-flows					

Calculation including Land Cost

Sr. No.	Fare (INR)	FIRR (%)			EIRR (%)		
	(per trip one way)	Option-1	Option-2	Option-3	Option-1	Option-2	Option-3
1	3.00	Not Calculable	Not Calculable	10.55	Not Calculable	-7.61	54.99
2	5.00	Not Calculable	4.06	23.05	-4.49	3.91	71.71
3	6.00	-7.48	0.18	28.51	0.08	6.82	79.68
4	8.00	0.29	5.59	39.45	5.64	11.1	95.21
5	10.00	4.81	9.35	51.02	9.4	14.37	110.42
6	12.00	8.13	12.34	63.33	12.36	17.1	125.42
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that the IWT operations in Subarnrekha waterway is financially and economically viable with a tariff of INR 6.00 per trip one way.

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1.0 INTRODUCTION

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

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

This final detailed project report of 30 km stretch of Subarnrekha waterway is prepared on the basis of recommendations from feasibility report, detailed survey & investigations, preliminary engineering and design and suggestions from IWAI. The report is prepared in accordance with detailed ToR as per the agreement (**Refer Annexure 1**).

1.1 PROJECT BACKGROUND AND SUMMARY OF PREVIOUS STUDY

Subarnrekha Waterway is declared as National Waterway-96 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
314 Km	22°33'28.75"N	Confluence of Subarnrekha River with Bay of Bengal	22°58'29.39"N	Downstream of Chandil Dam
	87°22'58.60"E		86°1'14.03"E	

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Following conclusions were made in the feasibility study for 314 km stretch of Subarnrekha waterway:

- The national waterway of 314 km of Subarnrekha River is feasible for navigation.
- The horizontal and vertical clearance of existing cross-structures along the 314 Km waterway stretch is in the range of 5m – 18m and 7m-12m respectively.
- On the basis of reduced water depth calculated from bathymetric survey done during feasibility stage of the studies, LAD of > 2.0 m is available for 172.19 km length of the waterway, 1.5 m to 2.0 m is available for 49.27 km length, 1.5 to 2.0 m is available for 42.12 km and <1.0 of LAD is available for 50.42 km of the waterway stretch respectively with respect to chart datum;
- Taking in to account the tide and CWC discharges, the LAD of 2m is available for most of the sections of the River over the year.
- 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 for Development of Waterway
- The waterway will be an alternated mode of connectivity to the proposed Port coming up at the confluence of Subarnrekha river with Bay of Bengal.
- Not only there is existing traffic but also the development of waterway will trigger new traffic.

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

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

Length	Co-ordinate at Start	Start Location	Co-ordinate at End	End Location
30 Km	21°33'28.75"N	Confluence of Subarnrekha River with Bay of Bengal at Chandrabali	21°40'57.17"N	Namkana
	87°22'58.6"E		87°16'57.28"E	

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1.2 PROJECT LOCATION / DETAILS OF STUDY AREA

Complete 30 Km stretch of Subarnrekha waterway is located in Balasore (also known as Baleshwar) district of Odisha. The waterway is proposed for the 30 Km of river stretch towards upstream from its confluence with Bay of Bengal at Chandrabali. As observed during the feasibility studies, complete stretch of waterway is having tidal influence. Locally operated jetties/ferry ghats are also available at Chandrabali (Chainage 0.0 Km) (used only by local fishermen) and on both the banks of river at Pantei Ghat (Chainage 17.0 Km) (for passenger and small cargo movement across the river).

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

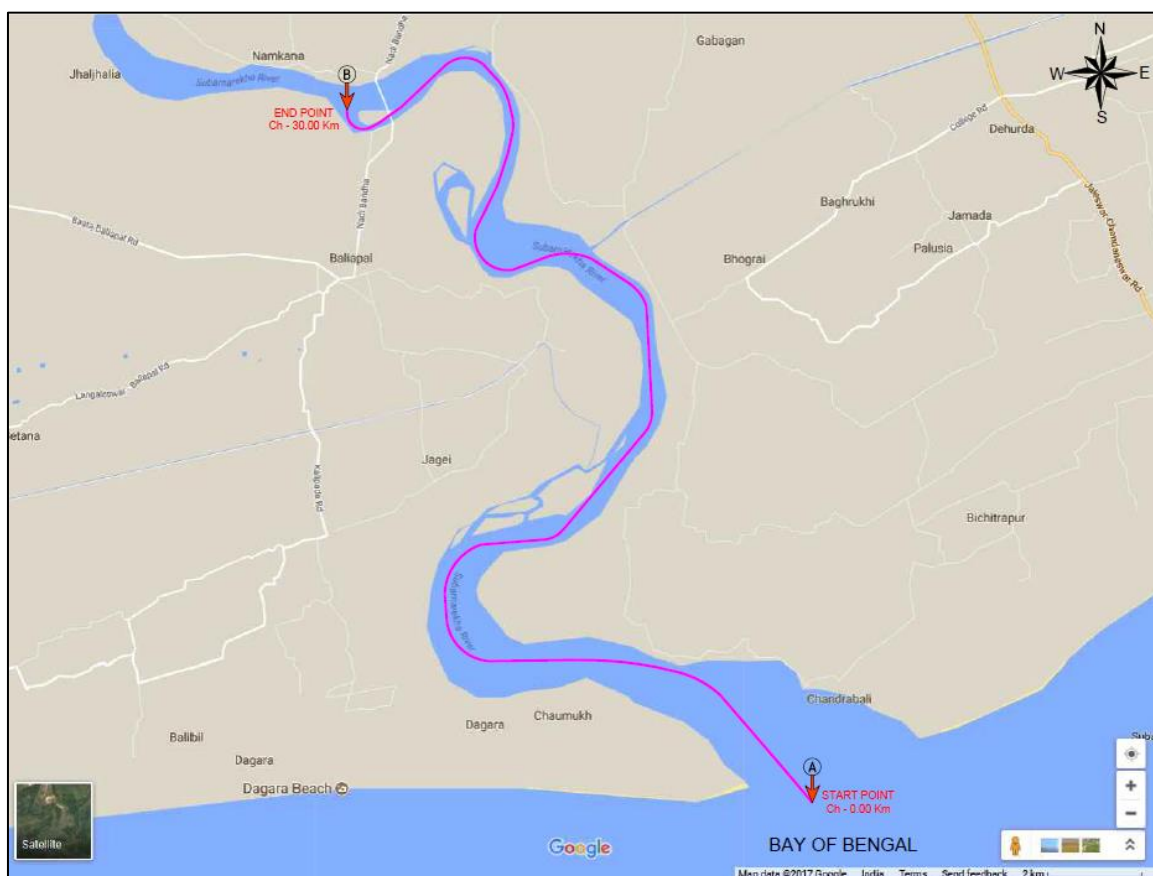


Figure 1: Subarnrekha National Waterway Project Location

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1.3 BRIEF SCOPE OF WORK AND COMPLIANCE STATEMENT

The brief scope of work for the project comprises of:

- a) Hydrographic and Hydromorphological Survey and Investigations
 - i. Installation of bench mark pillars
 - ii. Installation of water level gauges and observations as per TOR
 - iii. Bathymetric & Topographic Survey
 - iv. Current velocity and discharge measurements
 - v. Collection of water & bottom samples and analysis as per TOR
 - vi. Collection of Topographical features.
 - vii. Survey chart preparation
- b) Traffic Survey
- c) Geotechnical investigations
- d) Environmental & social impact assessment
- e) Analysis of collected data and preliminary engineering design
- f) Scheduling and costing
- g) Economic & Financial analysis for assessment of techno economic feasibility
- h) Conclusion and recommendations.

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

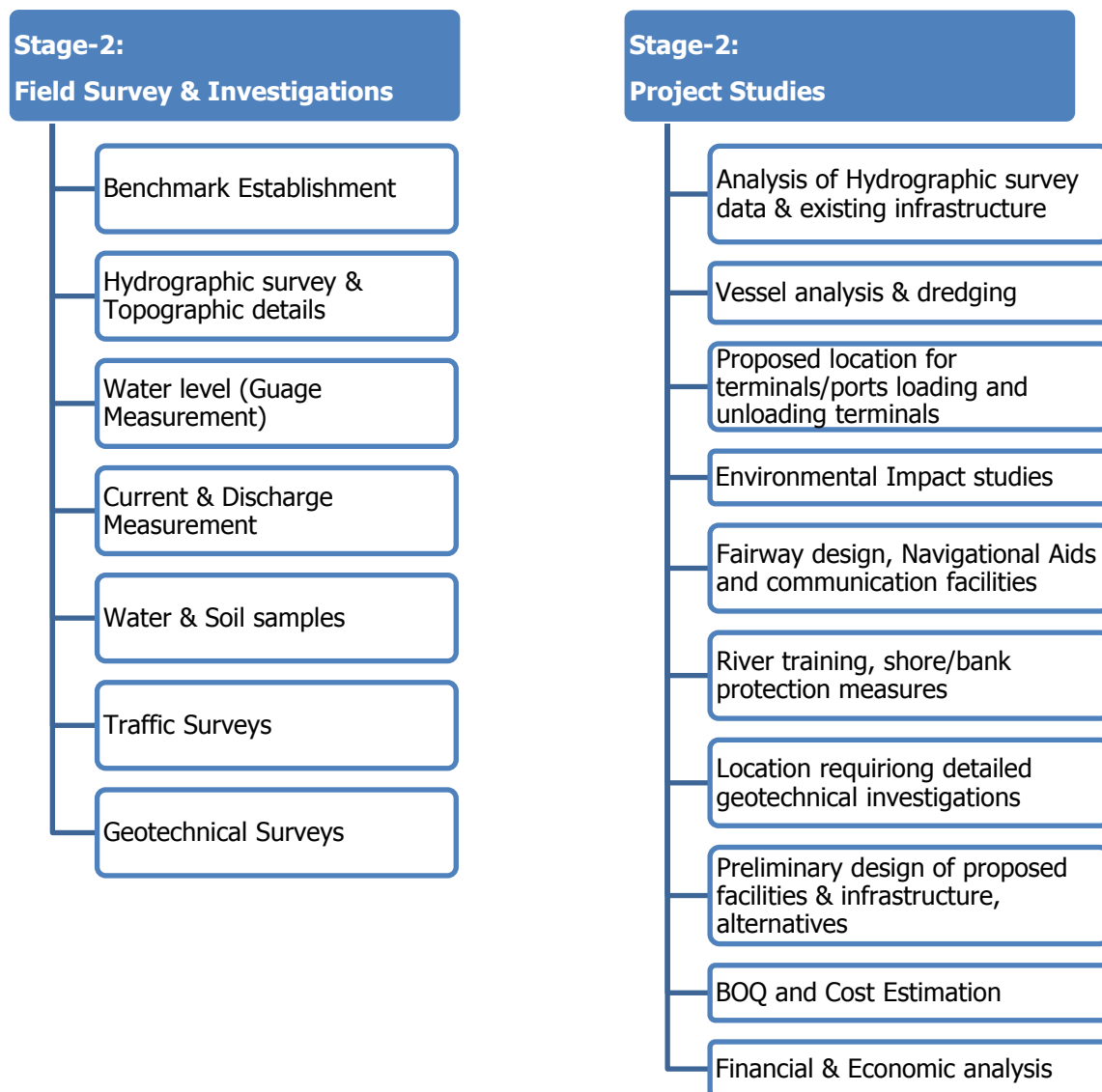
Sr. No.	Section – 6 Terms of Reference Clause No. 1.2	Covered under Chapter No./ Title
1.0	Assessment of Hydrographic Survey Report	Chapter 2: Waterway/Detailed Hydrographic Survey
2.0	Traffic Survey	Chapter 4: Traffic Study
3.0	Geotechnical investigations	Chapter 5: Terminals & Volume –IV: Geotechnical Investigation Report
4.0	Environmental & Social impact assessment	Chapter 9: Environmental and Social Aspects
5.0	Analysis of collected data and preliminary	Chapter 6: Preliminary engineering

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Sr. No.	Section – 6 Terms of Reference Clause No. 1.2	Covered under Chapter No./ Title
	engineering design	Designs
6.0	Scheduling and costing	Chapter 11: Project Costing Chapter 12: Implementation Schedule
7.0	Economic & Financial analysis for assessment of techno economic feasibility	Chapter 13: Economic and Financial Analysis
8.0	Conclusion and recommendations.	Chapter 14: Conclusion and Recommendations

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

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1.4 BRIEF METHODOLOGY & APPROACH

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

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

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A detailed DPR methodology and the expected outcome in fulfilling the assignment are 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

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Class of Waterway	Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance Between Piers (m)	Self propelled vessel Carrying Capacity
						draft).
CLASS-III	1.7	50	700	7	50	500 tonne Dead Weight Tonnage (approx. size 58m overall length, 9m moulded breadth and 1.5m loaded draft or one tug and two barges combination of 1000 tonne Dead Weight Tonnage (approx. size 141m overall length, 9m moulded breadth and 1.5m loaded draft).
CLASS-IV	2.0	50	800	10	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	10	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

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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, 24m moulded breadth and 1.8m loaded draft).
CLASS-VI	2.75	80	900	10	80	2000 tonne Dead Weight Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 4000 tonne Dead Weight Tonnage (approx. size 210m overall length, 14m moulded breadth and 2.5m loaded draft).
CLASS-VII	2.75	100	900	10	100	2000 tonne Dead Weight Tonnage (approx. size 86m overall length, 14m moulded breadth and 2.5m loaded draft or one tug and two barges combination of 8000 tonne Dead Weight Tonnage (approx. size 210m overall length, 28m moulded breadth and 2.5m loaded draft or with higher dims).

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

Type of Transmission Lines	Vertical Clearance
Low voltage transmission lines including	16.5

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Type of Transmission Lines	Vertical Clearance
telephone lines	
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

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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.

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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 = $1.8B+1.8B+0.5B+2\times 0.5B$ 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

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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 potential traffic, considering all the relevant technical variables such as choosing the type of berthing facility and providing embarking and disembarking facility, passenger 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

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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) Embarking and Disembarking arrangement;
- iii) Passenger handling area including waiting and ticketing area.

Terminal Facilities

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

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:

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- 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

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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. 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

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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

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proposed project shall be calculated. IRR and preliminary expenses shall be suitably considered and estimated. Break-even analysis shall be performed and presented in the report.

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2.0 WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1 HYDROGRAPHIC SURVEY

As detailed above, the National Waterway stretch of Subarnrekha river under DPR study is from the river confluence with Bay of Bengal near Chandrabali at Lat 21°33'28.75"N, Long 87°22'58.6"E to Namkana at Lat 21°40'57.17"N, Long 87°16'57.28"E. The total length of this stretch is about 30 Km. The scope of the work to conduct hydrographic and topographic survey of this stretch of Subarnrekha waterway comprises of:

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

2.1.1 Waterway in General and Hydro-Morphological Characteristics

Subarnrekha is one of the longest east flowing inter-state rivers. It covers large areas of Jharkhand and some parts of Orissa and West Bengal. The basin lies between north latitudes of 21°33' to 23°32' and east longitudes of 85°09' to 87°27' situated in the northeast corner of the peninsular India. It is bounded on the northwest by the Chhotanagpur Plateau, in the south west by Brahmani Basin, in the south by Burhabalang basin and in the south-east by the Bay of Bengal. This river originates near Nagri village in Ranchi district of Jharkhand at an elevation of 600 m. The total length of the river is about 395 km. Its principal tributaries are Kanchi, Kharkai, Karkari and Dulang. The basin is generally influenced by South-West monsoon, which breaks in the month of June and extended upto October.

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The proposed 30 Km stretch of Subarnrekha waterway is located in the Balasore (also known as Baleshwar) district of Odisha. Whole stretch of proposed Subarnrekha waterway from DPR study, from Bay of Bengal to Namkana is having tidal influence with a maximum and minimum tidal variation of 1.89 m and 0.86 m respectively, as observed during the survey period.

River width in the waterway stretch varies from 2.0 Km at estuarine portions to 250 m near the end. Maximum and minimum reduced depth of the waterway with respect to sounding datum are 10.7m at chainage 26.0 Km and -0.3m at chainage 21.0 Km respectively, for proposed waterway Class III. Reduced depth at every 1 Km intervals are provided in **Annexure 2**.

Average flow velocity in the waterway varies from 0.266 m/sec to 0.533 m/sec along the waterway.

One RCC road bridge is located along the waterway at Chainage 28.766 Km near Baliapal, about 10Km from the proposed passenger jetties at Pantei ghat.

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

Also sounding datum was transferred from Sagar. Subarnrekha River 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. Total four in number BM's pillars (naming SR-01, SR-02, SR-03 & SR-04) were constructed and erected along the river from Chandrabali to Namkana.

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

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Table 2: Description of Bench Marks

BM	Location	Chainage	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above MSL (m)	SD w.r.t MSL	Height above SD (m)
SR-01	Chandrabali	1.703	21°34'30.60"	87°22'28.14"	538768.97	2385851.90	5.402	-0.25	5.652
SR-02	Sarpunja	10.039	21°35'54.92"	87°17'26.56"	530091.48	2388425.81	3.544	0.516	3.028
SR-03	Nayabali	19.967	21°39'07.34"	87°19'38.27"	533865.96	2394349.07	3.464	0.378	3.086
SR-04	Namkana	31.150	21°41'22.27"	87°16'24.86"	528299.58	2398486.86	8.259	1.198	7.061

2.1.3 Sounding Datum and Reduction details

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

Table 3: Details of Sounding Datum

Sl. No	Location of Bench Mark / tide gauges	Chainage (Km)	Stretch for corrected soundings and topo levels (Km)	Established Sounding Datum w.r.t. MSL (m) at col. A. (+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	Chandrabali	1.703	0.0 to 5.0	-0.25	-0.25	Tide	0.25
2	Sarpunja	10.039	5.1 to 15.0	0.516	0.516		-0.516

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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)
3	Nayabali	19.967	15.1 to 25.0	0.378	0.378	Applied	-0.378
4	Namkana	31.150	25.1 to 30.0	1.198	1.198	w.r.t SD	-1.198

2.2 EXISTING CROSS STRUCTURES

2.2.1 Bridges

There is only one Road Bridge in the entire survey stretch of Subarnrekha River. The details of existing bridge are provided in **Table 4**.

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Table 4: Details of Bridge

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	Road Bridge	28.766	Concrete	Baliapal	21°40'48.54	87°17'29.12	2397453 N	530148 E	944	6.5	23	40	6.52	In use

Note: - The value of MHWS and Mean Sea Level was taken from KPT Tide book for the Standard Port i.e Sagar Roads and same was applied at the site. From field observation Bridge clearance over MSL was obtained and subtracted from the MHWS of the standard port. Thus vertical clearance over MHWS level in those locations was obtained.

2.2.2 Electric Lines / Communication Lines

There is no High tension line crossing in the Subarnarekha River.

2.2.3 Pipe Lines / Cables

No cross-structures, pipe lines, underwater cables are located along the 30 Km stretch of waterway.

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

No dams, barrage, weir or any other cross structure are located along the 30 Km stretch of waterway.

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2.3 BENDS

No sharp bend is located along the waterway

2.3.1 Radius of Curvatures

The proposed fairway on Subarnrekha for IWT is proposed to connect river banks at Pantei ghat. Hence, the fairway alignment is nearly a straight line.

2.4 VELOCITY AND DISCHARGE DETAILS

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

Table 5: Current Meter and Discharge Details

Stretch No.	Chainage (Km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area (sq. m.)	Discharge (cu. m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
1	1.8	21°33'55.05"	87°22'08.87"	538217.13	2384757.23	2.4	0.32	0.38	0.10	0.266	1994.156	530.4
2	7.2	21°34'34.89"	87°19'00.46"	532796.26	2385970.19	2.2	0.38	0.49	0.13	0.333	689.248	229.5
3	16.6	21°38'00.27"	087°20'38.60"	535604.5	2392290.7	3.1	0.35	0.44	0.06	0.283	73.4	20.8

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Stretch No.	Chainage (Km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area (sq. m.)	Discharge (cu. m)
		Latitude	Longitude	Easting (m)	Northing (m)		Surface	0.5 D	0.8 D			
4	27.8	21°41'10.19"	087°17'55.55"	530906.1	2398120.0	3.8	0.53	0.55	0.52	0.533	147.56	78.6

2.5 WATERWAY DESCRIPTION

The total 30 Km stretch of Subarnrekha Waterway under DPR study, can be broadly divided in to three (3) stretches in accordance with the river gradient. **Table 6** below provides the details of sub-stretches of Subarnrekha waterway.

Table 6: Sub-Stretches of Subarnrekha Waterway

Sub-Stretch No.	Location		Chainage	
	From	To	From	To
1	Chandrabali	Kathasagara	0 Km	10 Km
2	Kathasagara	Bishnupur	10 Km	20 Km
3	Bishnupur	Namkana	20 Km	30 Km

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

2.5.1 Sub Stretch 1: From Chandrabali to Kathasagara (Chainage 0 Km to 10 Km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 0 to 10 km chainage of the Subarnrekha river. It is the downstream portion of the Subarnrekha river where it confluence with the Bay of Bengal. This stretch is considerably wide approx 1.5 Km with some portion of the river bank is protected. A project for river bank protection is underway and which was scheduled to be completed in June 2017. A lot of fish ponds exist near to the river banks where fisherman uses these ponds for fish breeding purposes.

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There are no overhead obstructions/crossovers. There is a small Jetty at Chandrabali which is used for bigger boats and at numerous locations fishermen use the natural slope of land for boat landing.

There are no dams & barrage available in this stretch.

There is one hindrance found on the left bank with bushy area which has dense thorns/snakes/ scorpions and other unknown dangerous reptiles while carrying out Topographic Survey of the Subranrekha river from Chainage 7.5 to 8.5. Apart from this no other hindrance or encroachment is found in this stretch.

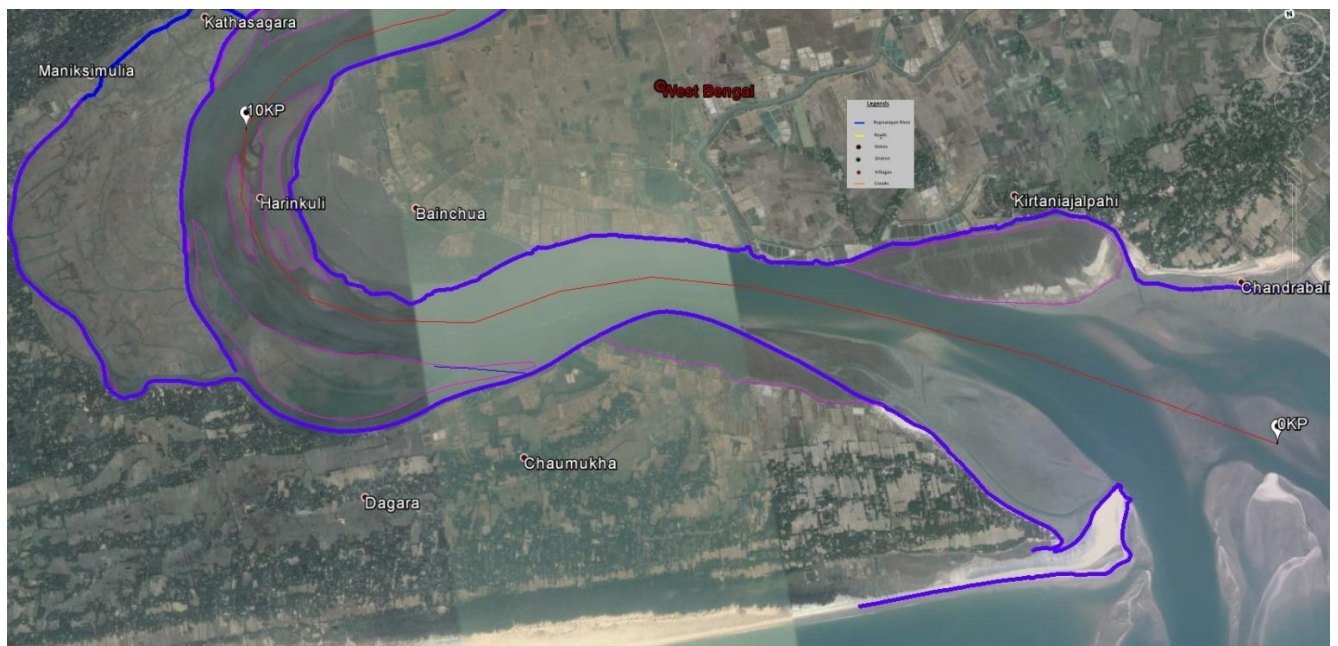


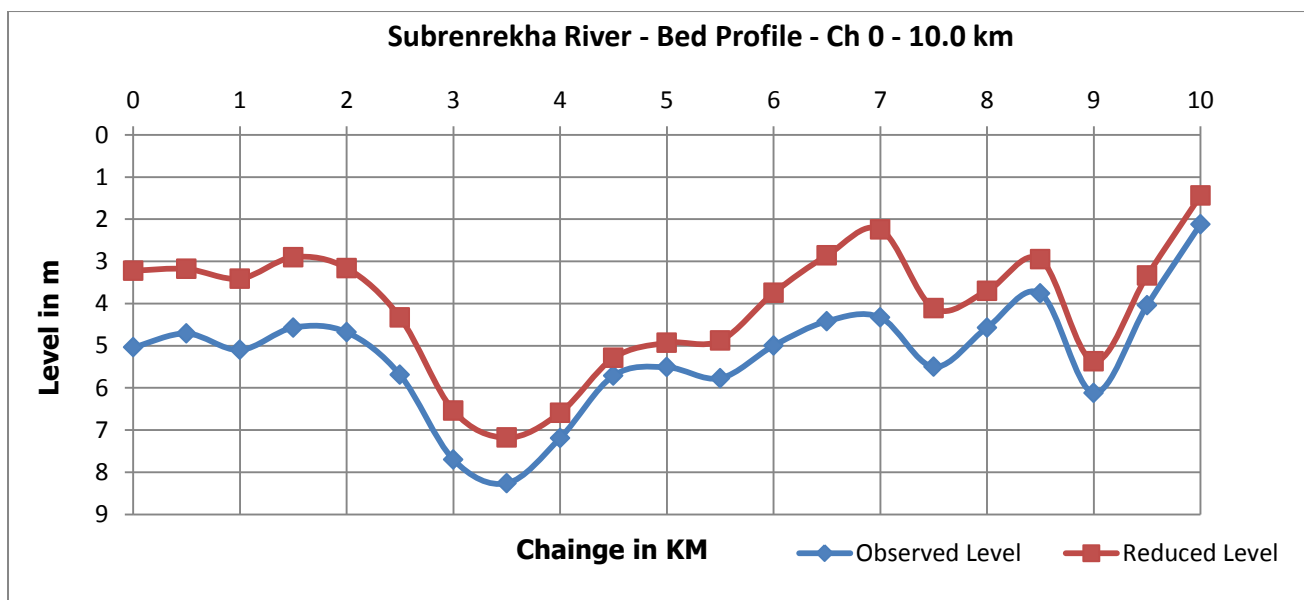
Figure 2: Google Image showing Sub-Stretch -1 of Subranrekha Waterway

Figure 2 above shows the alignment of Sub-stretch 1 (Ch. 0.0 Km to 10.0 Km) of Subranrekha Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 7**. **Figure 3** shows the observed and reduced bed profile of sub-stretch 1.

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum (Refer Table 3 for 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)				1.4	8.6	0	0
II	0	10					1.4	8.6	29	186.74
III	0	10					1.4	8.6	41	242.77
IV	0	10					1.4	8.6	324	2499.02



(Refer Table 3 for Sounding Datum)

Figure 3: Bed Profile of Waterway Sub-Stretch 1 (Chainage 0Km – 10Km)

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<p align="center">Signboard for Bank protection works in the stretch</p>	<p align="center">Thick bushes on left bank</p>
	
<p align="center">Ferry Jetty at Chandrabali</p>	<p align="center">Fishing farms at Chandrabali</p>

Figure 4: Photographs of Sub-Stretch 1

2.5.2 Sub Stretch 2: From Kathasagara to Bishnupur (Chainage 10 Km to 20 Km)

Both Bathymetric and Topographic Survey was carried out for this stretch between 10 to 20 km chainage of the Subarnrekha river. The water depth is much lesser as compare to stretch 1. There is shallow patch of approx 3.2 km where survey was carried out during high water. Navigation is possible during high tide near to the river left banks from chainage 10 to 20. There are many fish ponds on both the banks. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably wide approx 2 Km but the water was present only in about 400 m width with the remaining area being dry. Some portion of the river bank is protected.

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There are no overhead obstructions/crossovers or hindrance or encroachment in this stretch.

There are no dams & Barrage available in this stretch.

There is no suitable Jetty in this stretch but at Pantei Ghat, ferry services are located which uses natural slope of land for boat landing.

Figure 5 below shows the alignment of Sub-stretch 2 (Ch. 10.0 Km to 20.0 Km) of Waterway.

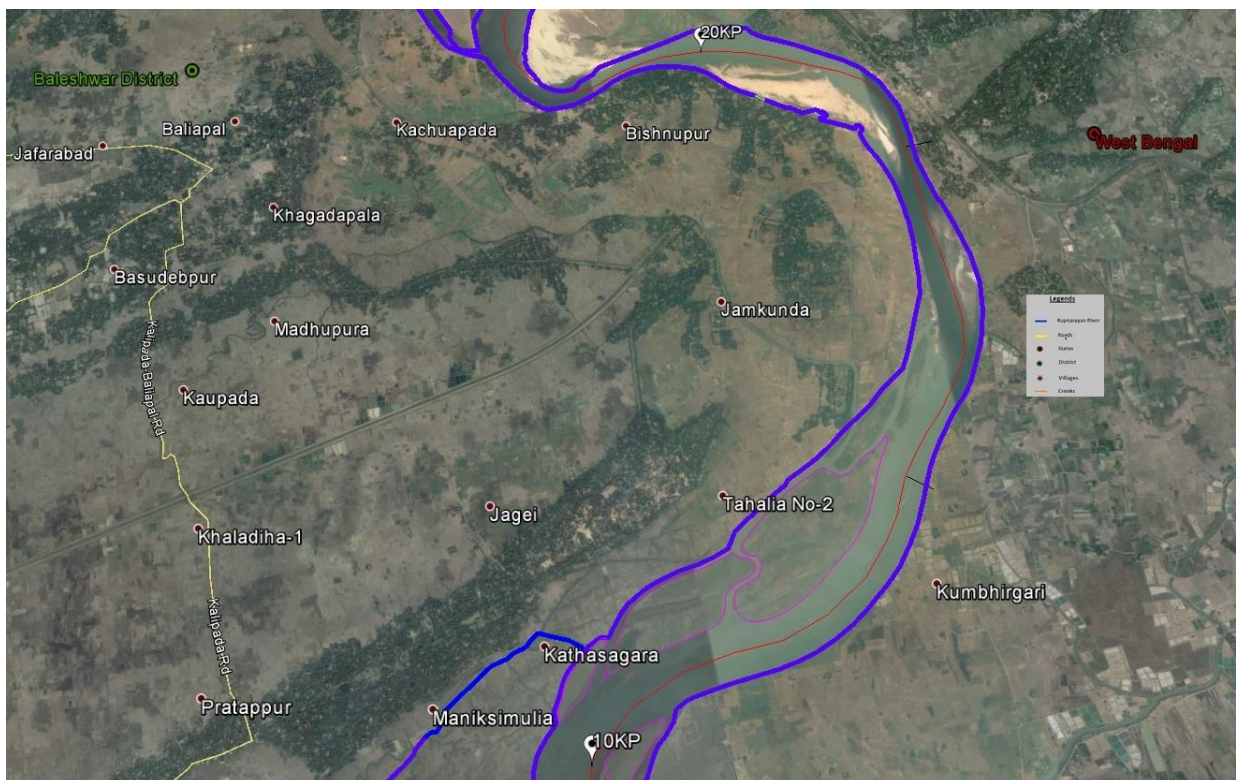


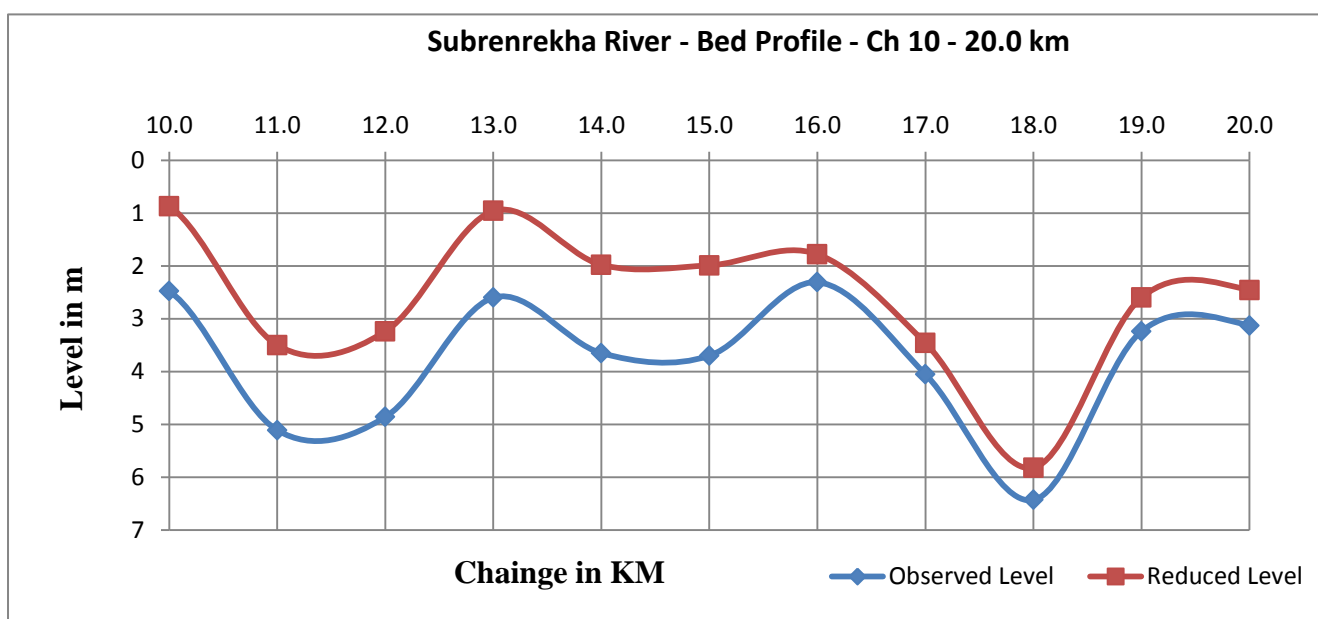
Figure 5: Google Image showing Sub-Stretch -2 of Waterway

The quantity of dredging required for Class I, II, III and IV type of WW for this stretch is provided in **Table 8** . **Figure 6** shows the observed and reduced bed profile of sub-stretch 2.

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum (Refer Table 3 for 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)				0.1	9.2	1593	20252.46
II	10	20					0.1	9.2	2100	40441.55
III	10	20					0.1	9.2	3020	87921.62
IV	10	20					0.1	9.2	4536	144129.88



(Refer Table 3 for Sounding Datum)

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

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Figure 7: 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 stretch between 20 to 30 km chainage of the Subarnrekha river. The water depth is significantly lesser as compare to stretch 1 & 2. Navigation is not possible even during high tide as range of tide is less than 0.9 meters. River banks are partially protected. Soil erosion found at some areas. Fishing and farming are main source of livelihood & the fields in the area are dependent on the rainfall. This stretch is considerably wide approx. 1 Km but the water was present only in about 150 m width with the remaining area being dry.

There is one bridge located at Baliapal used for crossovers. There is no hindrance or encroachment in this stretch.

There are no dams & Barrage available in this stretch.

There are no ferry jetties available in this stretch however fishermen use the natural slope of the ground for landing the boats.

Figure 8 above shows the alignment of sub-stretch 3 (Ch. 20.0 Km to 30.0 Km) of Waterway. The quantity of dredging required for Class I, II, III and IV type of WW, for this stretch is provided in **Table 9**. **Figure 9** shows the observed and reduced bed profile of sub-stretch 3.

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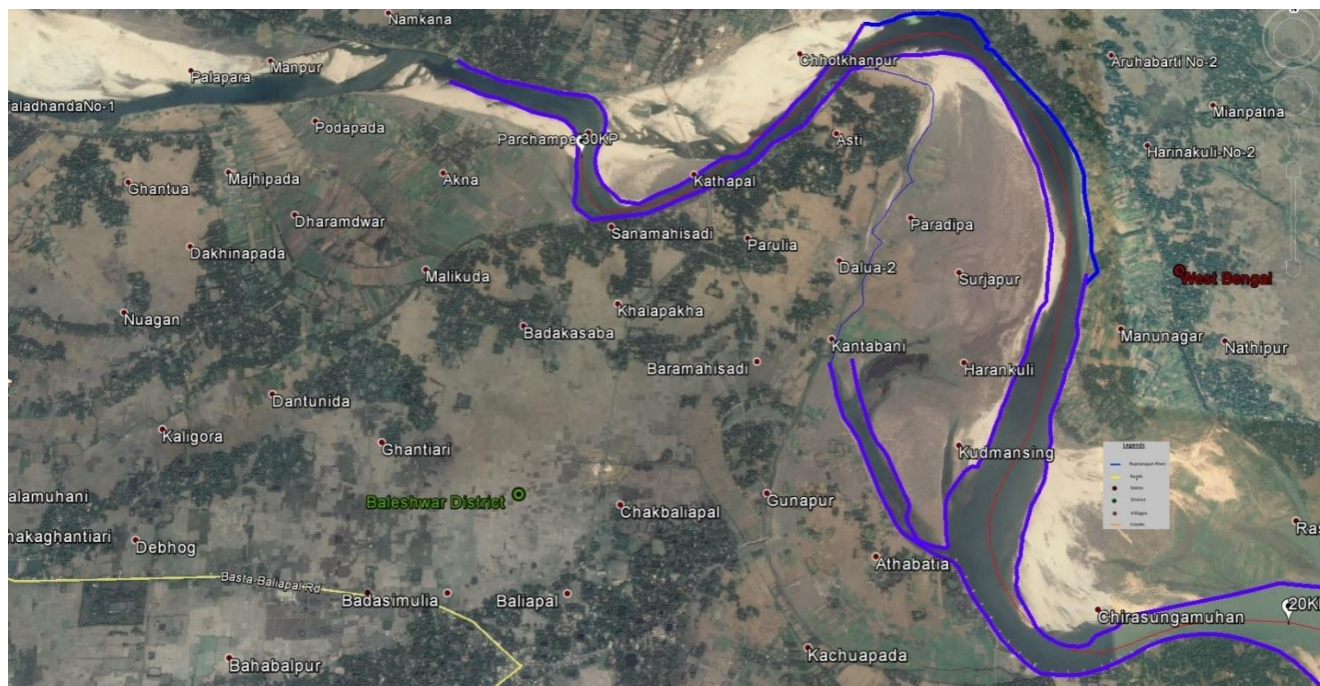
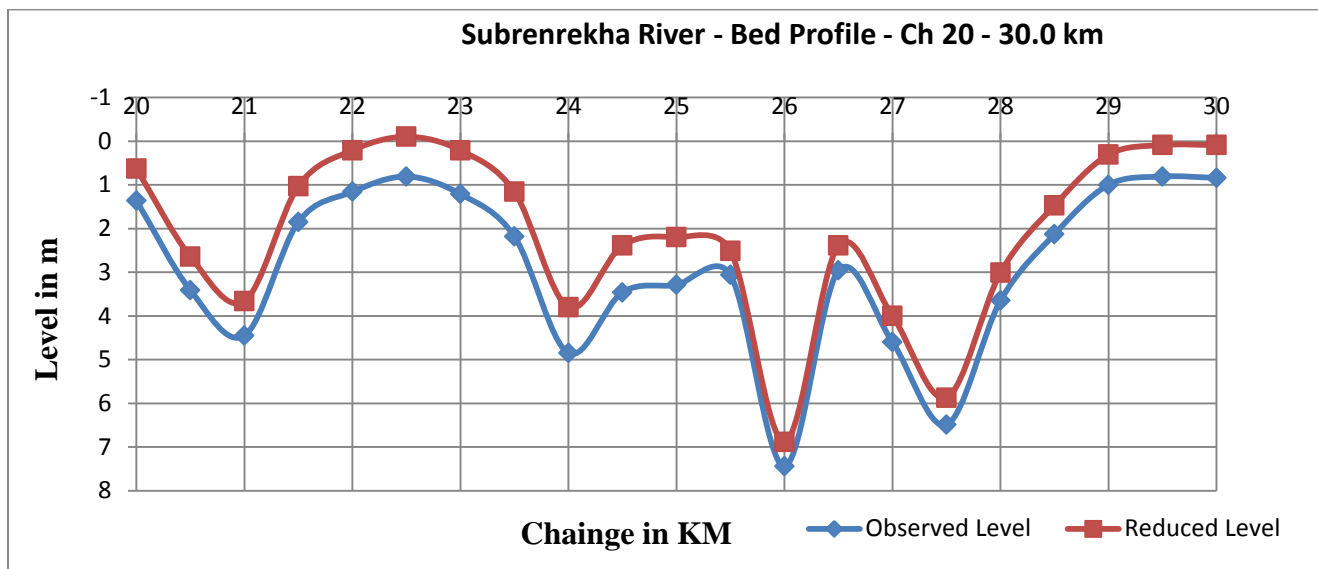


Figure 8: Google Image showing Sub-Stretch -3 of Waterway

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

Class	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum (Refer Table 3 for 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)				-0.7	10.7	4853	104183.8
II	20	30					-0.7	10.7	5672	196364.3
III	20	30					-0.7	10.7	7040	335752.4
IV	20	30					-0.7	10.7	7765	436193.6

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(Refer Table 3 for Sounding Datum)

Figure 9: Bed Profile of Waterway Sub-stretch 3 (Chainage 20Km – 30Km)



Baliapal Road Bridge

Figure 10: Photograph along Sub-Stretch 3

2.6 SOIL AND WATER 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 10**.

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Table 10: Soil & Water Sample Locations

Sample No	Chainage (Km)	Latitude	Longitude	Easting (m)	Northing (m)	Soil Sampling Depth (m)	Water Sampling at 0.5D Depth (m)
1	0.07	21°33'51.492"N	087°23'09.749"E	539968.3	2384652.2	2.5	1.25
2	8.40	21°34'46.271"N	087°18'21.786"E	531683.3	2386318.0	2.6	1.3
3	14.9	21°36'43.546"N	087°20'17.284"E	534996.8	2389930.5	1.5	0.75
4	26.4	21°41'30.442"N	087°18'33.002"E	531981.1	2398744.9	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 11** and **Table 12**.

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Table 11: Soil Sample Test Results

Sample No.	Chainage Range (Km)	Observed Depth (m)	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	0-0.5	2.50	0	74	15	11	2.68	7.97	4.02	1.88
2	9.5	2.60	0	10	54	36	2.62	8.03	6.00	1.50
3	20	1.50	0	99	1		2.67	7.26	1.72	1.27
4	30.5	1.70	5	58	19	18	2.66	7.49	6.91	1.30

Table 12: Water Sample Test Results

Sample No.	Chainage (Km)	Observed Depth (m)	Sediment Concentration Test
			Total Solid (mg/lit)
1	0-0.5	1.25	27949
2	9.5	1.3	1198
3	20	0.75	2972
4	30.5	0.85	3414

From the above analysis, it is observed that the river bed soil is sandy silt in nature, with water turbidity in the range of 27,949 mg/litre to 1,198 mg/litre.

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3.0 FAIRWAY DEVELOPMENT

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

3.1 PROPOSED CLASS / TYPE OF WATERWAY

IWAI gives a classification of waterways on the basis of width and depth of rivers/canals, radius of bends, vertical clearance, horizontal clearance between bridge piers and self-propelled vessel carrying capacity of vessels. On the basis of these criteria's, classification of waterways was done by IWAI as detailed in Paragraph **1.4.1** and **Table 1**.

On the basis of inputs from bathymetric and traffic survey, it is proposed to develop fairway stretch to connect both banks of Pantei ghat. The proposed fairway connects the passenger jetties proposed at both banks of Pantei ghat. Figure 11 shows the proposed alignment of fairway. The total length of proposed fairway is about 1.0 Km.

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

- a) No dams, barrage and any other cross-structure is located along the proposed fairway stretch.
- b) Reduced depth of waterway varies from 0.17 m to 2.85 m w.r.t sounding datum along the proposed fairway stretch of about 1.0 Km.

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- c) Tidal variation is about 2.0 m.
- d) Width of river is about 320 m at the proposed location.

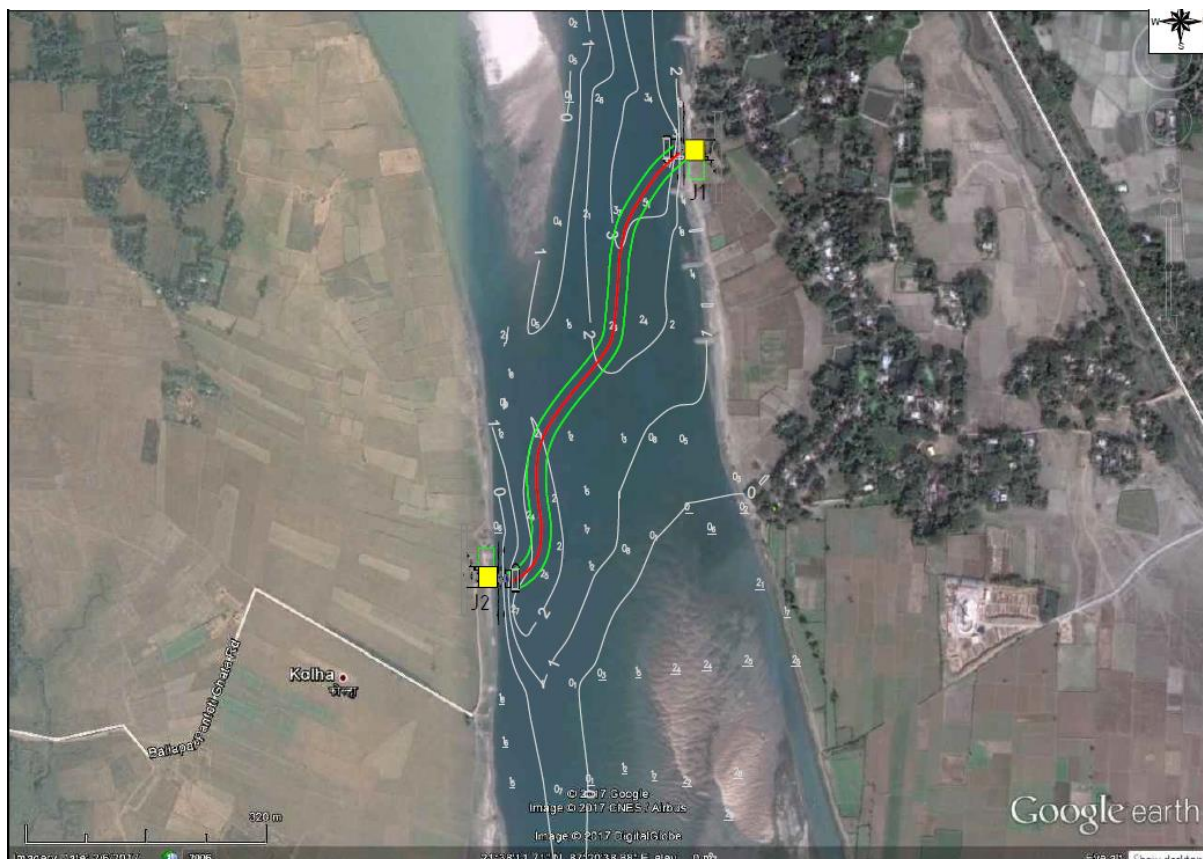


Figure 11: Proposed alignment of Fairway

On the basis of above inputs, and type of proposed vessel for estimated traffic as discussed in subsequent chapters, the fairway is classified as Class – III. All the development works, like dredging shall be proposed considering the fairway as Class-III waterway.

3.2 DETAILS OF SHOALS

Due consideration was given for shoals identified during the survey. The length of shoal located in the proposed fairway stretch (i.e. from chainage 16 Km to 18 Km) is about 150m for Class III WW. However, considering the alignment of channel along waterway and unstable channel bed, it is foreseen that the channel bed of proposed waterway alignment is at risk of continuous silting. In view of this, it is recommended to consider whole waterway stretch of 640 m for dredging.

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3.3 PROPOSED CONSERVANCY ACTIVITIES

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

3.3.1 Dredging

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

Fairway Dimensions

As per IWAI guidelines, fairway dimensions for river classified as Class-III waterway should have required dimensions of 50m bottom width; 1.7m depth and side slop of 5:1 as shown in **Figure 12**. The dredging quantity obtained from Hypack software for full length of the waterway is provided in Volume 3A – Hydrographic Survey Report and Data. For 640m stretch of fairway, the dredging quantity is estimated as below.

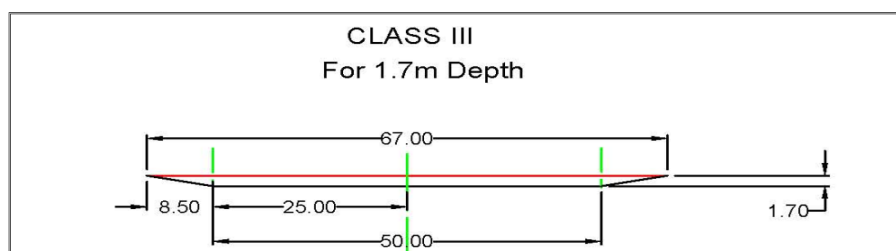


Figure 12: Fairway Dimension Class III

The dredging shall be calculated as below:

Length of channel to be dredged (L)	= 640 m
Reduced depth w.r.t Sounding datum	= 1.1 m from Chainage 16 to 17 Km = 2.2 m from Chainage 17 to 18 Km
Average reduced depth w.r.t SD	= $(1.1+2.2)/2 = 1.65$ m
Depth required for Class-III waterway	= 1.7 m
Additional clearance for siltation considering channel alignment and changing river bed behaviour	= 0.5 m
Required draft	= 1.70 m + 0.5 = 2.20 m
Hence, dredge depth of the channel	= 2.20 – 1.65 = 0.55 m

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$$\begin{aligned} \text{Area of channel to be dredged (A)} &= 0.5 \times (50\text{m} + 67\text{m}) \times 0.55\text{m} = 32.175 \text{ sqm} \\ \text{Dredging Quantity (Q)} &= (A) \times (L) = 32.175 \times 640 \\ &= 20,592 \text{ cum} \sim 21,000 \text{ cum} \end{aligned}$$

Disposal of Dredging Material

The 21,000 cum of dredged material is proposed to be dumped on low lying areas near Rasalpur, located at about 3.5 Km upstream of proposed Jetty location on right bank of waterway.

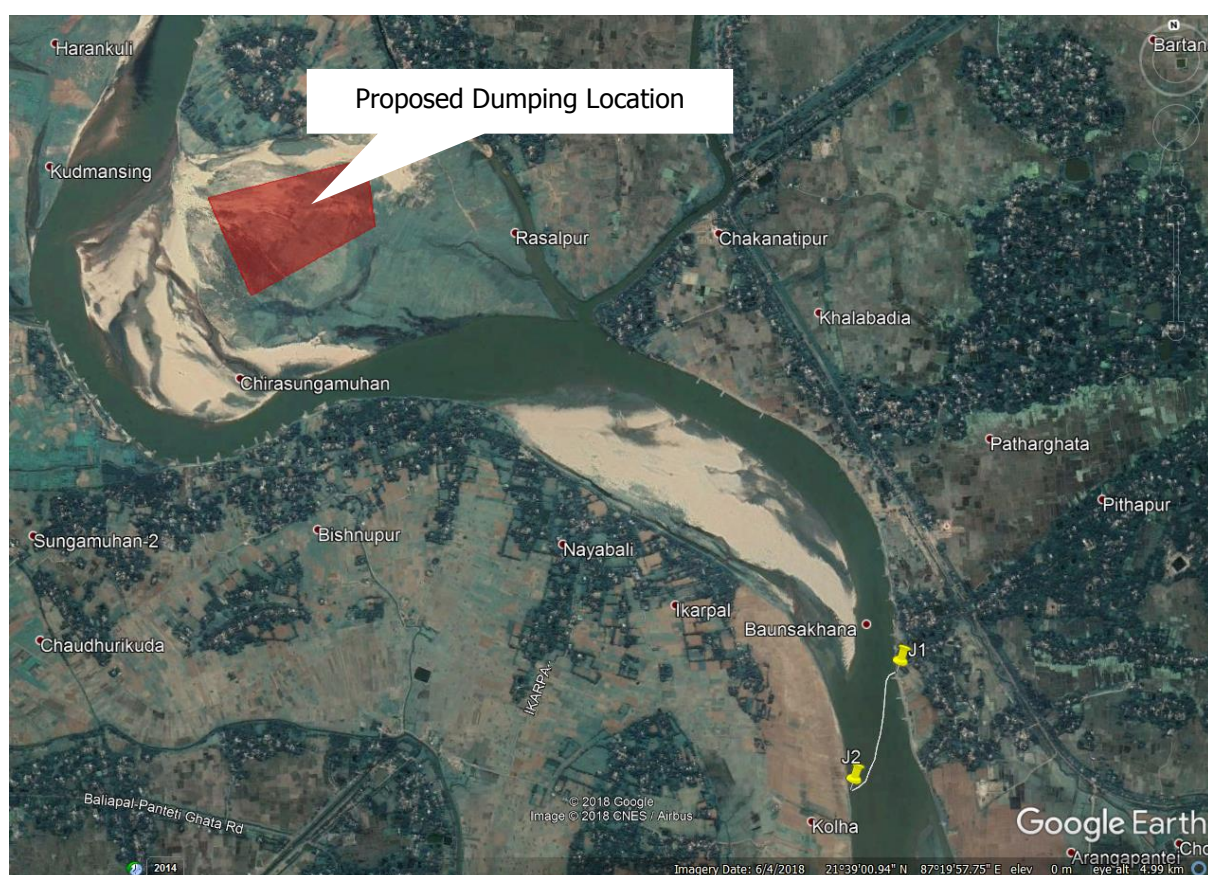


Figure 13: Photograph showing proposed location for dumping of dredged material

Selection of dredging equipment

The dredging is usually carried out with a cutter-suction dredger whereas maintenance dredging will be carried out with a trailing suction hopper dredger. There are various types of dredgers available in the market viz., suction dredger, bucket dredger, grab dredger, backhoe / dipper dredger, water injection dredger, pneumatic dredger etc. While most of

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these dredgers are ideally suited for sea conditions to dredge harbour and approach channels, the selection of a dredger for inland waterway is rather critical due to various mobility factors, seasonal variation of water levels (floods/dry season) and shallow depths.

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

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

The low draft amphibious dredgers with bucket arrangement to remove the material are also ideally suitable. Specifications of typical amphibious bucket dredger are given below:

- Length overall 9.5 m

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• Beam	2.5 m
• Dredging depth	2.75 m over stern
• Draft	0.5 m
• Weight	7.5 MT
• BHP	63 BHP
• Reach	7 m
• Bucket capacity	200 litres.

In the case of bucket dredger, hopper tugs/barges are required to transport the material to disposal grounds. The type of dredging effort (either floating or mobile shore based) will, however, depend on the detailed investigations on the availability of indigenous equipment, disposal area, and environmental impact.

3.3.2 River Training

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

3.4 BANK PROTECTION / EMBANKMENT STRENGTHENING

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

3.5 NAVIGATION MARKINGS / NAVIGATION AIDS

Navigation markings/aids, proposed for safe navigation along the proposed fairway stretch are discussed in detail in Chapter 8.

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

No Bridges / Cables / Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located along the navigation channel.

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

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

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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 navigation channel proposed in Subarnrekha waterway.

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 Odisha considered for various works;
- b) Market surveys and enquires
- c) Judgement based on Consultant's Experience

3.9.2 Capital Cost

Dredging is required for fairway development of Subarnrekha waterway. The cost of initial dredging is as below:

Dredging cost @ INR 200/cum for 21,000 cum = INR 42,00,000/- **(INR 42.00 Lacs)**.

3.9.3 O&M Cost

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

Dredging cost @ INR 200/cum for 10% of 21,000 cum = INR 4,20,000/- **(INR 4.20 Lacs)**.

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4.0 TRAFFIC STUDY

4.1 GENERAL

Balasore or Baleshwar is one of the north-eastern coastal districts of Orissa. The district lies in between latitude: 21° 03' to 21° 59' North latitude and 86° 20' to 87° 29' East Longitude. It is bounded by Bay of Bengal in the East, Mayurbhanj and Keonjhar districts in the West, Medinapore district of West Bengal in the North and Bhadrak district in the South. The geographical area of the district is 3806 Sq. km. Balasore, is crisscrossed with perennial and estuarine rivers because of its proximity to sea. Five important rivers of Orissa, namely Subarnarekha, Budhabalanga, Jalaka, Kansabansa and Sono have passed through this district from west to east before surging into the Bay of Bengal. The district head quarter, Balasore is 214 kms from the State Capital, Bhubaneswar.

Balasore is one of the most populous districts of the state. It occupies only 2.44% of the total land mass of the state but accommodates 5.53% of total population. The population density of the district (610) is very high; almost double that of Orissa State (270). The growth rate of population in the district is high (14.62%) as against 14.05% for the State during 2001-2011. As per 2011 census, the total population of the district is 23,20,529.¹

Out of the eleven development sectors, social services, transport, rural development, irrigation & flood control and agriculture are the lead sectors of the district. Transport is one of the important sectors in a district like Balasore. Because of its location in deltaic region, the land mass of the district is crisscrossed by a good number of rivers, rivulets, natural drainage channels, canals etc. Five major rivers flow through the district before entering the sea. These water bodies act as physical barriers and demand huge number of bridges, culverts to make all corners of the district accessible. Further, it is a densely populated district and people are educated, culturally active and socio economically developed. They require an efficient transport and communication system as an integral part of their daily needs.

¹ District Census Handbook 2011 Baleshwar (Balasore) District of Odisha

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4.2 INFLUENCE AREA / HINTERLAND

Subarnrekha River is one of the main rivers of Odisha State. The Subarnrekha River has a length of nearly 395.0 km from its source Piska/ Nagri (Rani Chuan) near Ranchi, Chota Nagpur Plateau to the mouth at Bay of Bengal. The waterway stretch, recommended by IWAI for DPR study is from Bay of Bengal near Chandrabali to Namkana having a length of 30 Km. However, on the basis of detailed survey and investigations, traffic analysis and demand assessment, it is recommended to develop Class-IV navigable channel at Pantei Ghat for providing a linkage for movement of passenger across the river.

The Project Influence Area (PIA), considering existing and projected traffic for passenger ferry services, comprises of the following CD blocks and districts. Total influence area/hinterland extending on either side of waterway is provided in **Table 13**.

Table 13: Project Influence Area/ Hinterland

State	District	Area (Km ²)	C.D. Block	Area (Km ²)	Total Hinterland area (Km ²)
Odisha	Balasore (Baleshwar)	3,806	Baliapal	235.65	561.13
			Bhograi	325.48	
West Bengal	Purba Medinipur	4,736	Ramnagar - 1	139.43	139.43
	Total	8542		700.56	700.56

4.2.1 Population of Hinterland area

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

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Table 14: Population of Hinterland²

State	District	Population (Nos.)	C.D. Block	Population (Nos.)	Total Hinterland Population (Nos)
Odisha	Balasore (Baleshwar)	23,20,529	Baliapal	1,97,259	4,80,845
			Bhograi	2,83,586	
West Bengal	Purba Medinipur	50,95,875	Ramnagar - 1	1,67,330	1,67,330
	Total	74,16,404			6,48,175

4.2.2 Existing and proposed Industries

About 99.7% of total hinterland area for proposed IWT of Subarnrekha waterway is Rural and only 0.3% is Urban. No major industry or any other commercial establishment is located/proposed in the hinterland area.

4.3 PROPOSED SUBARNREKHA PORT

The government of Odisha signed an MOU on 18th December 2006 and entered into a Concession Agreement on 11th January 2008 with the Creative Port Development Pvt. Ltd., Chennai to establish an all-weather multi-purpose port at Kirtania (Bhogarai block) on the Northern side of the mouth of River Subarnarekha on Build, Own, Operate, Share and Transfer (BOOST) basis. The location and detailed layout of the proposed port is as shown in **Figure 14** and **Figure 15**.

Important features of port and traffic are³:

- Port will have five (5) berths (Coking coal & limestone 1, Iron Ore 1, Thermal Coal 1, General Cargo 1, Containers 1)
- Round the clock port operation.
- First Phase Capacity – 25 Million Tons/Annum
- Cargo handling 5000 Tons/Hr balanced system.

² District Census Handbook, 2011

³ <http://subarnarekhaport.com/>

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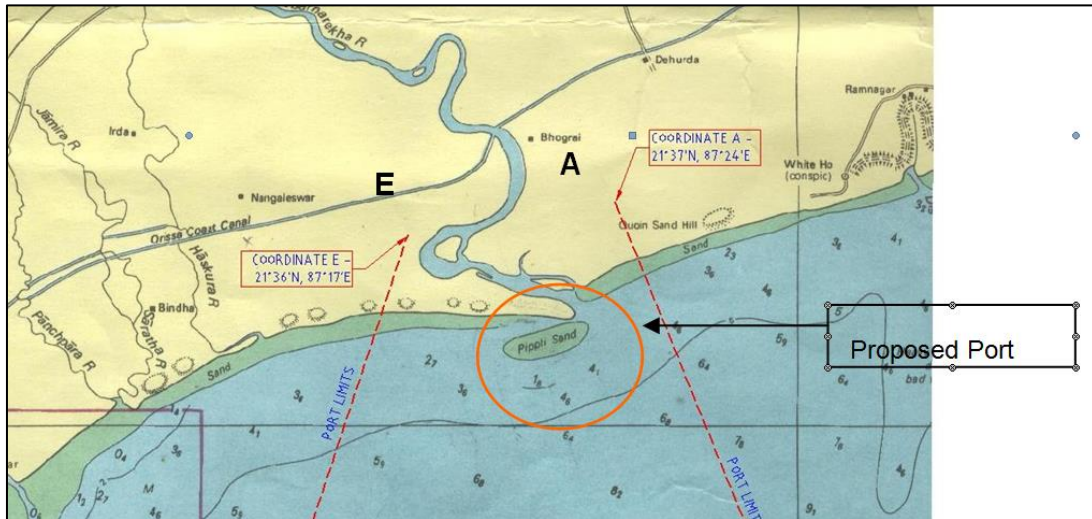


Figure 14: Location of Propose Subarnrekha Port

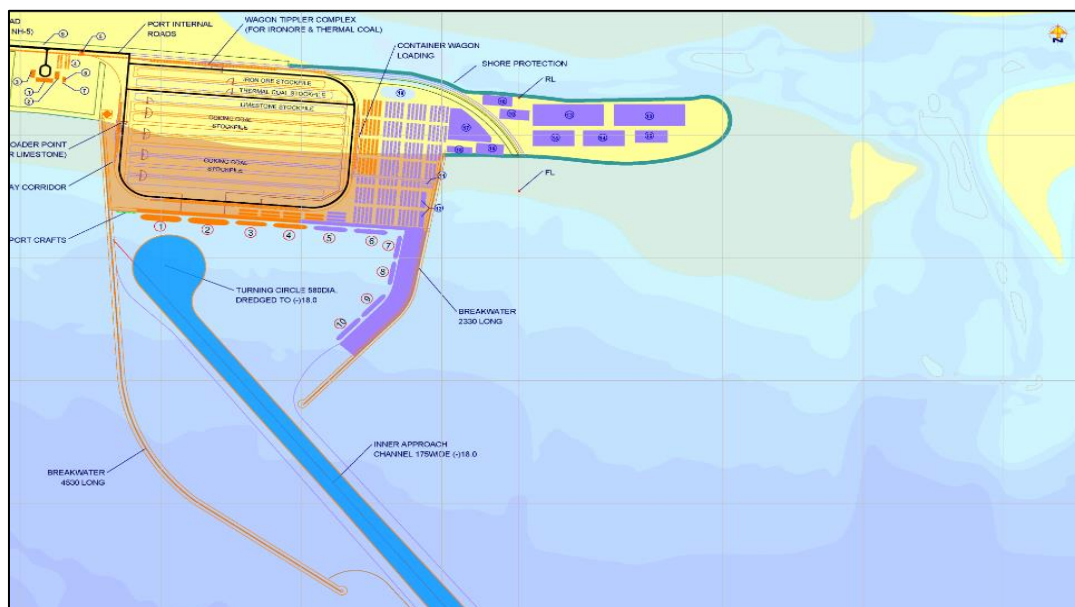


Figure 15: Layout Plan of Proposed Subarnrekha Port

4.3.1 Port Connectivity

Subarnarekha Port would be connected to Haldipada Station on Chennai - Howrah main line which is about 45 Kms from the site and Road would be connected to NH -60 which is 45 Kms from the port site. A detailed connectivity plan of existing and planned ports in Orissa with the existing and new integrated Steel Plants is shown as below

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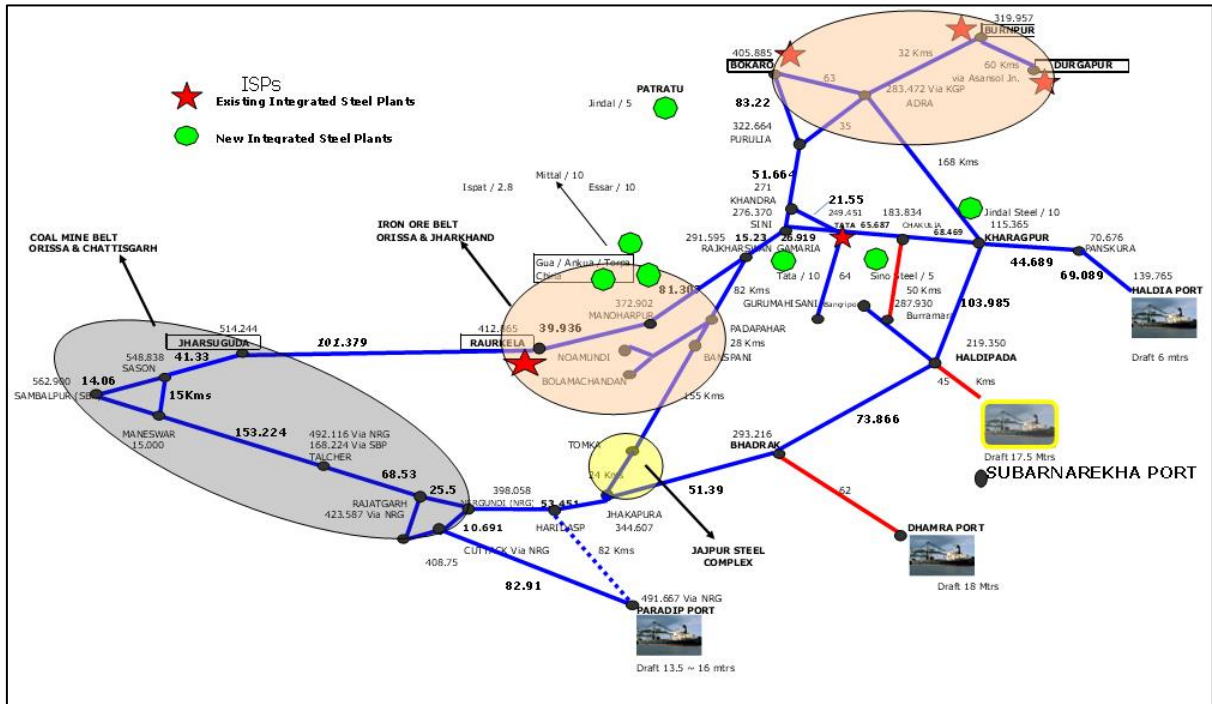


Figure 16: Port Connectivity ⁴

From the above, it is concluded that the Subarnrekha port is planned to be connected with well-developed Rail/Road network along the east coast.

However, with the availability of East Coast Canal crossing Subarnrekha river and the proposed development of Subarnrekha waterway, a new connectivity route through IWT up to the existing and new integrated Steel plants can be studied.

As the stretch of waterway, studied in this DPR is only 30 Km from the mouth of Subarnrekha river, the detailed study focusing on interlinking of Subarnrekha waterway with East coast canal and proving an end to end connectivity of Inbound/Outbound cargo to/from Subarnrekha Port is not assessed.

⁴ <http://subarnarekhaport.com/>

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4.4 COMMODITY COMPOSITION / CATEGORIZATION

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

4.4.1 Agricultural Products

Balasore district has the gross cropped area of 352839 ha (2015) and an area of 102289 ha is sown more than once. The cropping intensity of the district is estimated to be 140.83 %. Among the blocks Jaleswar has the highest gross cropped area of 45180 ha with maximum area sown more than once (17360 ha). The lowest gross cropped area is found in Oupada with 14695 ha. The cropping intensity is maximum in Baliapal (175.97 %), followed by Bhograi (169.07 %), Basta (167.09 %), Jaleswar (162.40 %) and is minimum in Nilagiri (108.82 %).

4.5 ORIGINATING / TERMINATING COMMODITIES

Number of Industries exists along the bank of Subarnrekha River. The well-known Industries are Tata Iron and Steel Company (TISCO) and Hindustan Copper Limited (HCL). Some important small scale industries in the basin are tobacco products in Chakradharpur, cement, asbestos sheets, glass and ceramics at Chaibasa. Locomotives and coaches, automobiles, agricultural equipment, wires and cables, iron and steel machinery, metal tubes and conduits, copper and brass, chemicals (acids) and caustics, fertilizers and Soaps at Jamshedpur. However, all these industries are located along the upper reaches of Subarnrekha river.

No major industry or commercial set up is located with 25 Km radius along the 30 Km stretch of Subarnrekha waterway.

4.6 PASSENGER/ RO-RO TRAFFIC

As detailed above, transportation is an important sector of growth in this region along the waterway. Only one bridge is located at Chainage 28.77 Km throughout the 30Km stretch of

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waterway for river crossing. The bridge is located about 11.77 Km upstream of existing ferry location at Pantei ghat. Due to this, no major cargo will shift towards waterways for river crossing. However, for local villagers and farmers, ferries are an important mode for river crossing.

Local ferry services are operational at Pantei Ghat (Chainage ~17.0 Km) to connect both banks of the river. As observed during traffic survey, the ferry services are used to transport passengers, two-wheelers and light cargo from one bank to other using country boats. Daily about 2000 persons use this ferry service to cross river at Pantei Ghat. The fare of existing ferry services are INR 3/- per person per trip, INR 5/- per bike per trip and INR 3/- per cycle per trip.

The ferry services are locally operated and lack the basic infrastructure for berthing/mooring of vessels, passenger waiting area including other basic amenities.



Figure 17: Ferry Service at Pantei ghat in Subarnrekha River

4.7 TOURISM TRAFFIC

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

4.8 GROWTH TREND

The population growth of hinterland districts is about 15%. About 5% of growth trend for passenger traffic is considered on the basis of discussion done with local boat operators during site visit. The growth trend for traffic at proposed passenger ferry service at Pantei Ghat for 20 years (from 2020 to 2040) is shown in **Figure 18**.

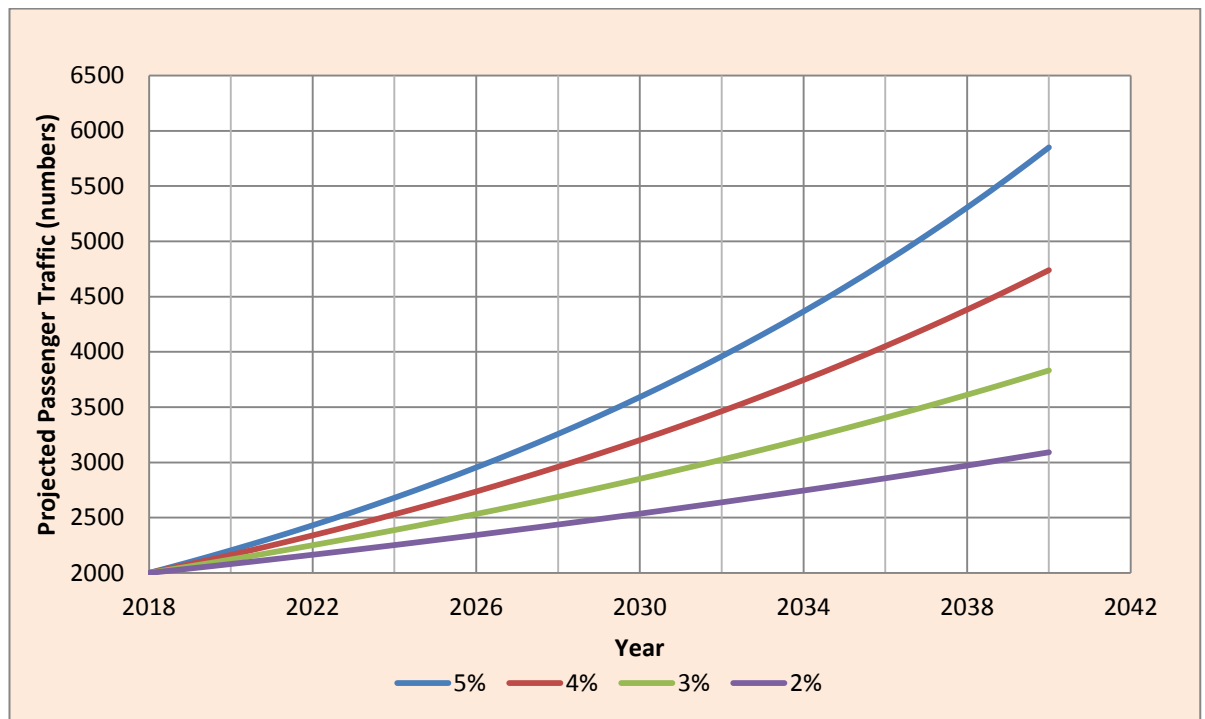


Figure 18: Projected Passenger Traffic at Pantei Ghat

Thus the proposed terminal infrastructure is planned for about 4000 passenger per day at this stage. Future expansion area is also proposed to cater the additional passengers projected in the design life.

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5.0 TERMINALS

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

5.1 GENERAL REVIEW

Subarnrekha river is having huge potential for Inland Water Transport due to its topography, location and availability of some of major industrial units on the river banks near Jamshedpur. However, the waterway section of 30 Km proposed for DPR studies lacks any commercial or industrial units throughout its length. In spite of this, the waterway is proposed to be developed for passenger ferry services at Pantei ghat on the basis of local demand and data collected during the course of studies.

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

5.2 IDENTIFICATION AND SITE LOCATION

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

- Water availability near the terminal land throughout the year especially during lean season,
- Stable river channel with sufficient depth,
- Favourable hydraulic conditions for berthing,
- Availability of land for terminal infrastructure,
- Traffic potential, and

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- Navigational safety.

On the basis of detailed bathymetric and traffic survey done during DPR studies on the 30 Km stretch of Subarnrekha waterway from Chandrabali (chainage 0.0 Km) to Namkana (chainage 30 Km), following location is identified for development and construction of terminals:

Sl. No	Name	Type	Latitude	Longitude
1.	Pantei Ghat (Chandeneswar Side)	Passenger Ferry Terminal	21°38'23.33"N	87°20'42.26"E
2.	Pantei Ghat (Baliapal Side)		21°38'5.70"N	87°20'33.33"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 20-25 years as any prediction of cargo throughput and the matching development requirements, in terms of terminal 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 following concept layout were presented for the proposed passenger terminals.

IWT terminal layout for passenger ferry services is proposed for base year 2017-18 traffic data collected during DPR study. Scope for future development for planned year 2037-38 is also considered in the terminal layouts.

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

- a) Terminal facilities are planned for the initial passenger traffic projected for base year 2017-18 and shall be expanded in the subsequent development phase upto the

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planned year 2037-38. System is planned that any additions to the facility will be possible for handling future traffic upto next 20 years. Terminal facilities are planned and can be expanded to the ultimate future traffic.

- 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 berthing time and other formalities is considered as 30 minutes per ferry.
- d) Passenger capacities provided at the terminals facility will be adequate to smooth operation during disruption of traffic.
- e) The storm water drain proposed at the terminals periphery shall discharge into the river.

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

- Floating Pontoon platform for Berthing Facilities
- Ferry parking facilities
- Passenger ticket, waiting and parking area
- Toilets & other utility area
- Terminal Operation building
- Other ancillary Facilities

5.3.1 Passenger Ferry Terminal Facilities

Steel ferry vessel of 150 passenger capacity is considered for deign of passenger ferry terminal.

A. RIVER SIDE FACILITIES

1. LAYOUT

The passenger terminal at proposed locations is designed to facilitate the efficient operation of passenger ferries. A single floating pontoon platform is provided for berthing of ferries at each site capable of handling all types of proposed ferry vessels. A gangway & approach platform is provided linking the berthing pontoon to the shore allowing pedestrian transfer between the shore terminal and the ferries.

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

2. Gangway

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

3. PONTOON

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

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

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

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

The steel to be used for the construction of the pontoon shall comply with IS 2062 Grade B or equivalent. The welding works shall be of excellent quality and using high quality electrodes and shall be done by certified welders. Necessary hull preservation and painting shall be done for the prevention of corrosion. Draft marks shall be suitably placed on

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pontoon of 3 mm in welded steel plate and painted with at least two coats. They shall be located at intervals of 200 mm vertical (P&S) and at forward aft and amidships. The accuracy of these marking will be checked & verified.

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

No waiting/halting of 150 passengers is recommended on pontoon. The pontoon shall be designed to encounter current of maximum 2m/sec during flood. Suitable mooring arrangements along with anchors shall to be provided along the sides. The winches, anchor chain, mooring ropes, shackles etc. shall be as per the class requirement.

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

4. APPROCAH PLATFORM

At all proposed terminals an approach platform shall be constructed (onshore) which shall connect the terminal building to the approach bridge and thus to the pontoon platform as shown in drawings provided in Volume-II.

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.

5. SAFETY

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The Pontoon, Gangway and approach platform are provided with appropriate safety equipment including lifesaving equipment, ladders and safety rails. The passenger's walkway will be marked in lanes as appropriate and signs will be installed to direct.

Navigation lights shall be placed at suitable locations for operation of the terminal in low lights.

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

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

6. 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 bridge as well as spare parts and emergency equipment's.

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

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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 station, telephone exchange, emergency medical centre, etc.;
- v) 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 (for ferries);
- vii) Telecommunication system including wireless network and PA system;
- viii) Fire protection arrangements

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

5.4 LAND DETAILS

The tentative quantity of land required (excluding area required for future development) for fairway development and construction of terminal is as follows for each terminal complex.

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Table 15: Land Details

S. No.	Description	Area (m ²)	Ownership	Status
1	Terminal Building (20m X 27 m)	540	Private	Agricultural land
2	Passenger Arrival / Exit Area (15m X 27m)	405		
3	Passenger Approach Towards approach Platform (5m x 20m)	100		
4	Visitor parking area (10m X 15m)	150		
	Total	1195		

Land Rate

Land Rate for Baliapal, Balasore is estimated on the basis of Gross State Domestic Product (GSDP) at current prices as below:

Sl. No.	Year	GSDP growth over previous year (in %) ⁵
1.	2012 - 2013	13.30
2.	2013 - 2014	13.29
3.	2014 - 2015	6.00
4.	2015 - 2016	4.56
5.	2016 - 2017	17.05
6.	2017 - 2018	13.01
7.	2018 - 2019	11.81
	Average (in %)	11.29

Now, as per Odisha Industrial Infrastructure Development Corporation, the Land rate per acre for Baliapal, Balasore district is INR 3.00 Lacs per acre (as on year 2009)⁶. By adopting an escalation factor of 11.29% on the basis of GSDP growth rate as calculated above, the land rate for the year 2019 works out to INR 8.74 Lacs per acre or INR 216.06 per sqm.

⁵ GSDP of Odisha state as obtained from report published by Directorate of Economics & Statistics, Odisha, Bhubaneswar, dated February 2019, titled "Estimates of State Domestic Product, Odisha"

⁶ Land Rate for Baliapal, Balasore District of Odisha state as obtained from Odisha Industrial Infrastructure Development Corporation website <http://www.idco.in/2009/landrate.aspx>.

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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

The geological formations of the district are ranging from Pleistocene laterite to the recent alluvium with a few areas bordering Mayurbhanj district covering Archean Unclassified Gneisses including Singhbhum Granite in Nilagiri upland. Only a limited number of rock types are met within the North Western hilly tract of the district, while the vast coastal tract in south east portion is devoid of any rock type. Thus the various formations exposed in the district of Baleshwar belong to Archean, middle Proterozoic, Pleistocene and recent groups.

5.5.2 Physical Condition and Drainage

The district is watered by a chain of rivers. Proceeding from North to South, these principal rivers are the Subarnarekha, the Budha Balanga, the Kansbans, the Haskura, the Saratha, the Jalaka and Panchapara. Small insignificant streams dotted here and there in the catchment areas of these rivers bring enormous mass of water from the hills in the rainy season, which flow down to the plains thus flooding the areas and bringing vast quantity of silt in suspension of delta. The result is that though in the cold and hot weathers they are small streams winding through long expanses of sand, in the rains they are formidable torrent, which often outflow their banks and flood the country far and wide.

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

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fall freely repeatedly till sufficient amount of soil enters in the Shell. The details of Geotechnical Investigations & Lab Reports are placed at **Volume-IV**.

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

Baliapal Site

For geotechnical analysis purpose, the sub-soil at Baliapal 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 1.1 m thick, top river deposit, there exists a loose, brownish grey/grayish brown, silty sand deposit (Stratum-I) continued upto a depth of 7.3 m from the Existing Ground Level (EGL), This is followed by a medium dense, brownish grey/greyish, silty sand (Stratum-II) extended upto a design depth of 11.4 m. Below this & upto the maximum depth of exploration of 25.0 m, there exists a dense to very dense, brownish grey/grayish silty sand deposit (Stratum-III).

Chandeneswar Side

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For geotechnical analysis purpose, the sub-soil at Chandeneswar 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, 1.2 m thick top river deposit, there exists a medium dense, brownish grey / greyish brown, silty Sand deposit (Stratum-I) continued upto a depth of 14.4 m from the Existing Ground Level (EGL), with increasing compactness. Below this & upto the maximum depth of exploration of 25.0 m, there exists a dense to very dense, brownish grey / greyish brown silty Sand deposit (Stratum-II).

From the geotechnical parameters revealed in the boreholes, it is evident that, open shallow foundation cannot be placed at both the terminal locations due to liquefiable loose silty Sand deposit (Stratum-I), which is also prone to scour. Thus, foundation in the form of Bored cast-in-situ concrete pile, is the optimal foundation solution here.

The detailed report on Geotechnical Investigation 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.

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

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

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

5.6.1 Terminal Building

The following terminal buildings are proposed for the IWT terminal:

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1. Terminal Operation cum Administration Building

It will be single building housing the following:

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

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

2. Security Office

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

3. Electrical Sub-station

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

4. Overhead water tank

The overhead water tank above terminal building to cater need of the daily water demand required for terminal staff and passengers. The minimum capacity of the overhead tank shall be 60 m³ or the two days requirement whichever is higher.

5.6.2 Boundary Wall / Fencing

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

5.6.3 Sewerage System

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

SYSTEM PROPOSAL

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

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

5.6.4 Firefighting System

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

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

Portable Fire Extinguishers (PFE)

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

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Quantity

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

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

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

As a thumb rule the requirements specified above would mean approximately 2 extinguishers for every 600 m² 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.

Location

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

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A. For Terminal Operation cum Administrative Building

a. Ground Floor:

Type of Fire Extinguishers Selected : 2 X 5kg, CO₂ (Type ABC) inside office Area
(ii) 1 X 5kg, DCP (Dry Chemical powder)
Type C inside Electrical panel /Control room

B. Car/Vehicle Parking Area

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

5.7 BERTHING STRUCTURE (FLOATING PONTOON)

The berthing structure for Ferry terminal proposed for Subarnarekha waterway on both the river banks at Pantei Ghats should have:

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

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

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

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

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5.8 TERMINAL COSTING

The cost estimate for proposed ferry terminals at both the banks of Pantei Ghat, including O&M of the system has been worked out. The cost estimates for development of the system are considered as Capital cost while for operation of the system is termed as maintenance or operating cost (O & M cost).

5.8.1 Capital Cost

Capital cost for proposed ferry terminal is provided in **Table 16** respectively.

Table 16: Capital Cost for Ferry Terminal

Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lakh)
1	Pontoon Platform with all required accessories	No.	2	50,00,000	100.00
2	Gangway (Including Maintenance)	No.	2	17,50,000	35.00
3	Passenger Approach Area/ Bus Car Drop Off Area (12m X 22 m)	m ²	528	40,000	211.20
4	Control Room Equipment's including navigation control equipment's	No.	2	50,000	1.00
5	Telecomm. Room Equipment's X 2 terminals	lot	...	LSM	2.00
6	Operating Building (20m X27m) (single storey) X 2 nos.	m ²	1080	40,000	432.00
7	Ticket vending Machine & installation cost	No.	2	4,00,000	8.00
8	Automatic Fare collection gates (set of 4 X 2 nos. at Entry gates +Set of 4 X1 no. at Exit Gate)	Per set	6	3,00,000	18.00
9	Passengers Arrival Area facility for two terminals	-	...	LSM	10.00
10	Visitors parking Area (15m X 10 m)	m ²	300	18,000	54.00
11	Passengers Waiting Chairs @ 50 per terminal	No.	100	2,500	2.50

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Sl. No.	Facilities	Unit	Quantity	Unit Rate (INR)	Cost (INR Lakh)
12	Substation X 2 nos.	No.	2	10,00,000	20.00
13	Fire Fighting System (dry type)	lot	...	LSM	5.00
14	Electrical, Water & Utility	lot	...	LSM	25.00
15	Security Office (4.5m X 5m) X 2 terminals	m ²	45	18,000	8.10
16	Sewage Treatment System X 2 terminals	No.	2	25,00,000	50.00
17	Approach Platform (3m X 7 m)	m ²	42	75000	31.50
18	Passenger Approach (5m X 20 m)	m ²	200	8000	16.00
Total					1,029.3
18	Cost of Detail Engineering		4%		41.17
19	Construction supervision		6%		61.76
	Total				1,132.23
20	Contingency		3%		33.97
	Capital Cost of two Ferry Terminals including Pontoon jetty and Gangway excluding Land cost				1,166.20
21	Land cost for two terminals	sqm	2390	216.06	5.16
	Contingency		3%		0.155
	Capital Cost of two Ferry Terminals including Pontoon jetty and Gangway including Land cost				1171.52

5.8.2 O&M Cost

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

a) Manning

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

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- The Management comprising the Terminal Manager, Operating Superintendent and their deputies;
- The operating staff comprising Terminal Manager, 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 both the terminals on a single shift basis (excluding critical staff) is estimated as provided in **Table 17**.

Table 17: Manpower Requirement for IWT Terminal Operation

Sl. No	Staff	Numbers
1	Management	1
2	Operating Staff	6
3	Accounts Staff	4
4	Security Staff	8
5	Maintenance Engineering Staff	4
6	Administration Staff	4
7	Misc. Staff for Field Works	4
	Total	31

Table 18: Manpower Cost per annum

Sl. No.	Location	No./Shift	No. of Shift required	Total no. of Personnel required	Rate (INR)	Cost (INR) in Lacs
1	Terminal Manager	1	1	1	10,00,000	10.00
2	Terminal Operational staff	6	1	6	5,00,000	30.00
3	Security Office	4	2	8	3,00,000	24.00
4	Accounts	4	1	4	5,00,000	20.00

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Sl. No.	Location	No./Shift	No. of Shift required	Total no. of Personnel required	Rate (INR)	Cost (INR) in Lacs
5	Control Room	4	1	4	4,00,000	16.00
6	Plumper & Electrician	2	2	4	4,00,000	16.00
7	Misc. for Field Works	4	1	4	3,00,000	12.00
	Total			31		128.00

From the above table, the total annual manpower cost required for running the terminal facilities at both the terminals of Pantei Ghat works out to INR 1,28, 00,000/- (**INR 128.00 Lacs annually**).

b) Utilities and Services

The annual cost of providing water, electricity and other services is considered as about 1.0% of the capital cost. Thus, the annual cost for providing Utilities and Services works out as **INR 11.66 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 fifth year onwards works out as **INR 34.98 Lacs**.

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The total O&M cost of proposed terminals are provided in terminal **Table 19** below

Table 19: Annual O&M cost of terminals

Sl. No	Item	Cost (INR) Lacs
1.	Manpower	128.00
2.	Utilities and Services	11.66
3.	Maintenance	34.98
Total annual O&M cost		174.65

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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 is required for the waterway.

6.3 NAVIGATION AIDS

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

- Navigation through the waterway
- Arrival at 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 berthing/un-berthing at terminals.

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

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The location proposed for installing various types of aids to navigation are provided in drawing PT/EIPTIWB003/2017/DPR/0014.

6.4 FERRY TERMINAL AND JETTIES

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

Following codes and standards are used for preliminary design of structures.

Civil Works:

- IS 4651 (Part 1-5): Codes of Practice for Planning and Design of Ports and Harbors
- IS 456 - 2000: Code of Practice for Plain and Reinforced Concrete
- IS 800 – 1984: Code of Practice for General Construction of Steel
- IS 2911: Code of Practice for Design and Construction of Pile Foundations
- IS 1893 – 2002 (Part 1): Criteria for Earthquake resistant design of Structures
- IS 9527 (Part 3): Code of Practice for Design and Construction of Port and Harbor Structures
- IS 875 (Part 3): Code of Practice for Design Loads for Building and Structures-Wind Load
- IRC-6: Standard Specifications and code of Practice for Road Bridges, Section 2 Loads and Stresses

Geotechnical

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

Where applicable the following International Standards are referred

- BS 6349 Maritime Structures
- BS 8110 & 5400 Reinforced Concrete Structures
- BS 449 & API-RP 2A-WSD Offshore Platforms-Working Stress Design
- BS 5950 Structural Steel Work
- BS 8004 & 8000 Foundations

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- MJ Tomlinson: Pile Design and Construction Practice, Fourth edition
- Joseph E Bowles: Foundation Analysis and Design, Fifth edition.

6.4.1 Ferry Terminal

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

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

A. STRUCTURAL SYSTEM

The overall Layout showing location of facilities is shown in drawing PT/EIPTIWB003/2017/DPR/0003.

The approach platform is a piled structure, 7 m long and 3 m wide with a deck elevation of +6.0 m CD. The pile spacing of 0.75 m dia pile is 2.5m in longitudinal direction and mono-pile configuration is adopted. Beams of 0.9m wide and 1.2m deep connect the piles. The deck slab is 0.35 m thick.

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

Truck and car parking facilities are provided on land. 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 approach platform is as described below:

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PILING

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

ERECTION & CONCRETE WORK

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

C. DESIGN CRITERIA

LOADING DATA

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

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

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

- 1) Dead Load:

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The following unit weights are used in design

Table 20: Dead Loads

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.

Table 21: Live Loads

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

3) Seismic Load:

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

Table 22: Seismic Load Factors

Zone Factor	0.16
Importance Factor	1.5
Response Reduction Factor	3

LOAD COMBINATIONS

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

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Table 23: Load Combinations

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

SERVICEABILITY CRITERIA

1) Deflection Limit

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

2) Crack width Limit

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

Table 24: Crack Width Limit

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)	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.

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Table 25: Clear Cover to Reinforcement

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)	75 mm
4	Below Seabed Level	75 mm

DESIGN LIFE

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

Table 26: Design Life

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

DESIGN METHODOLOGY

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

GEOTECHNICAL PARAMETERS

Geotechnical parameters of the soil are provided in related chapter. The pile fixity level calculation has been carried out based on IS 2911-Part1-Section 2 (2010) and is presented in geotechnical report.

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

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available data. The following figures give an in-sight of the modelling undertaken for analysis.

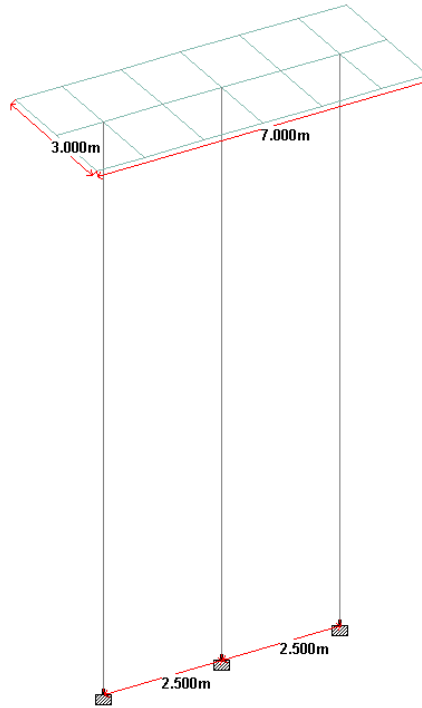


Figure 19: 3D View of STAAD Model – Approach Platform

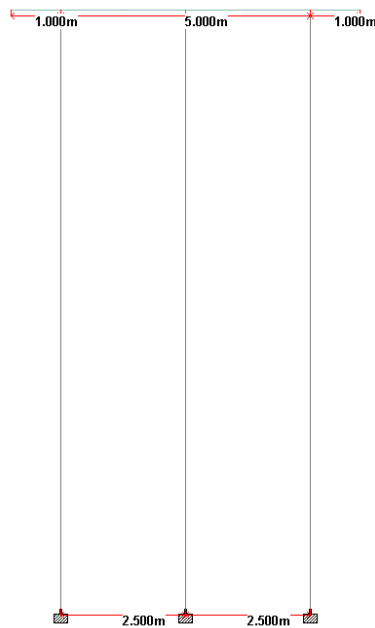


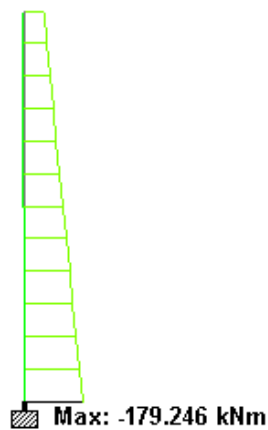
Figure 20: 2D View of STAAD Model – Approach Platform

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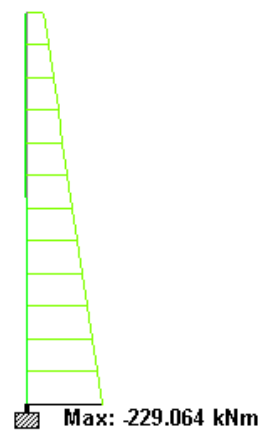
P-Δ analysis is carried out on the idealized model to include secondary effects. All possible loads and load combinations as per IS4651 (Part 4): 2014 is considered and applied in a logical way to analyse the structure to determine the design forces.

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

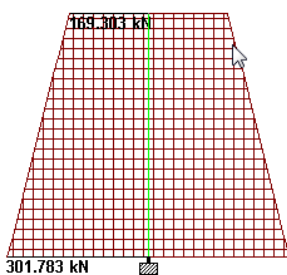
ANALYSIS RESULTS



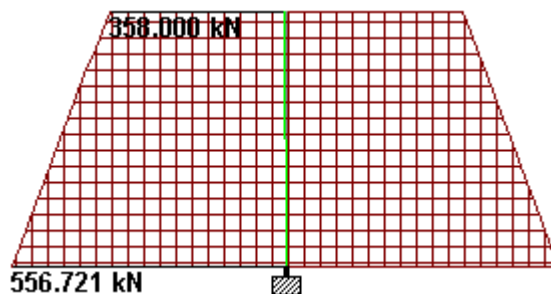
Max. Bending Moment My (SLS)



Max. Bending Moment My (ULS)



Min. Axial force Fx (SLS)



Max. Axial force Fx (ULS)

Design of piles

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

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

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

$$\text{Bond stress, } T_{bd} = 1.9 \text{ MPa}$$

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

$$\text{Hence, Design Bond Stress} = 3.04 \text{ MPa}$$

$$\text{Stress in bar, } \sigma_s = 0.87 f_y = 435 \text{ MPa}$$

$$L_d = 35.8 \Phi$$

$$\text{Say} = 36 \Phi$$

6.5 CONSTRUCTION SCHEDULE

The time schedule for construction activities of the project is considered as two (2) years.

The proposed project schedule is provided in **Figure 21**.

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Sl. No.	Activities	1 st Year												2 nd Year												
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	
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)	Dredging				■	■	■	■	■	■	■	■	■													
4	Procurement and installation of Aids to Navigation								■																	
5	Setting up of IWT terminals																									
a)	Land acquisition	■																								
b)	Construction of terminal building, landside facilities													■												
6	Upgrading existing road to terminals																							■		

Figure 21: Construction Schedule

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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 vessels proposed to be operated in Subarnrekha waterway is designed on the basis of following factors:

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

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7.2.1 Cargo Characteristics

The cargo consists of passengers including small cargo like bikes, cycles and agricultural goods. The volume of total cargo originating and terminating from different terminal is shown in Traffic Studies chapter.

7.2.2 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 fairway.
- Fairway is proposed for river crossing.
- 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.

7.2.3 Operational Factors

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

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

7.3 PROPOSED VESSEL SIZE AND SPECIFICATIONS

Passenger ferry services are proposed to connect both banks of Pantei ghat. As per the bathymetric survey, draft available in this stretch of waterway is 1.1 to 2.2 m w.r.t sounding datum. However, dredging is proposed to develop the fairway as per waterway classification for Class-III.

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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 22**.

List of various Ferry Service Operators and number of water crafts for the ferry trips :	
<ol style="list-style-type: none"> 1. WBSTC Ltd. (A Govt. 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 22: Ferry Services in the river Hooghly between Kolkata and Howrah⁷

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 follows⁸:

⁷ <http://transport.wb.gov.in/transport-services/ferry-services/passenger-ferry-services/>

⁸ <http://transport.wb.gov.in/infrastructure/jetties/constructionrenovation-of-jetties/>

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- 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 passenger ferry services in Subarnrekha waterway 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.

7.4 TURNAROUND TIME

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

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

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

7.5 NUMBER OF VESSEL REQUIRED

Number of vessel required to ply on route is estimated and provided in **Table 27** as below.

Table 27: Estimate of No. of vessel required for Passenger Ferry Service

Sl. No.	Description	Value
A	Speed of vessel considered	6 Knot
B	Average distance between terminals along navigational channel	640 m
C	Travel Time required to cover 640 m both ways	10 minutes
D	Embarking and Dis-embarking time considered (@10min/terminal)	20 minutes
E	Trip duration (sl. no. C + sl. no. D)	30 minutes

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Sl. No.	Description	Value
F	Capacity of passenger ferry per trip as per proposed vessel specification	150
G	Total no. of passenger's currently using the terminal per day	2000
H	Design passenger capacity for terminals per day	4000
I	Required no. of trips per day (sl. no. H/ sl. no. F)	26.67 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 Ferry vessel required (sl. no. I/ sl. no. K)	1.11 ~ 2 (i.e 1 for each jetty)

7.6 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.

7.6.1 Capital Cost

The cost to purchase the vessels, whether they are new or second hand, represents a significant commitment for the ferry operating company. For passenger ferry services, vessels need to be procured.

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

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Table 28: Capital Cost of Vessels

Sl. No.	Description	No. of Vessel	Rate per Vessel (INR Lacs)	Total Cost (INR Lacs)
1.	Passenger Ferry Vessel	2	91.998 ⁹	183.996

7.6.2 O&M Cost

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

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 4 staff members for running/operating of vessel and on-board safety and security. One Electrical & one mechanical engineer shall common for both vessels. Total nos. of crew members proposed is tentatively as below:

Sl. no.	Type of Crew	Number	Tentative Annual Rate (INR)	Annual Cost (INR)
1.	Pilot	2	5,00,000/-	10,00,000/-
2.	Electrical Engineer	1	4,00,000/-	4,00,000/-
3.	Mechanical Engineer	1	4,00,000/-	4,00,000/-
4.	Life Guards	6	3,00,000/-	18,00,000/-
Total		10		36,00,000/-

Hence, for two vessels total 10 crew members are required. The annual cost of crew works out to be INR 36,00,000/- (**INR 36.00 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 0.02 lacs per day derived for a vessel similar to those considered in this study. Similarly we have adopted a figure of INR 0.02 lacs per day for

⁹ <http://transport.wb.gov.in/infrastructure/jetties/constructionrenovation-of-jetties/>

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maintenance and repair of the vessels to cover the regular maintenance programme.
Annual consumables and repair/maintenance cost works out to **INR 12.00 Lacs**.

c) Fuel Cost

Fuel expenses for running two (2) passenger ferry vessels in the proposed fairway is estimated as below:

Number of days of operation in a year	= 300 days
Number of trips in a day	= 24 trips
Mobility time per trip	= 10 minutes
Approximate rate of fuel per litre	= 75 INR per litre
Vessel running cost per annum	= 300 days x (10/60) Hrs x 24 trips x {0.1 litre per hour x 2 Engines x 106 Bhp} x INR 75 per litre x 2 Vessel = INR 38,16,000 per Annum = (INR 38.16 Lacs)

Table 29: Annual O&M cost of Vessels

Sl. No	Item	Annual Cost (INR) Lacs
1.	Officer and Crew Costs	36.00
2.	Consumables and Repair/Maintenance Cost	12.00
3.	Fuel Cost	38.16
	Total	86.16

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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.

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

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For safe navigation of the ships through the waterway, state-of-the-art navigation and communication systems 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 buildings. 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.

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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.

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.

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A Vessel Traffic Management Systems will be installed for safe navigation efficient traffic flow and protection of the environment. The system has a radar for monitoring and controlling of vessels on real time basis with a state of the art RISC based Alpha Server. The VTMS will also be useful for dealing with incidents and emergency situations. It will also assist Coastguard in search and rescue operations. The system will be interfaced with the port management computer system to maintain the database of vessel movements, vessel related information and aid in the scheduling of arrival and departure of vessels at the terminals.

8.2 EXISTING SYSTEM

From the 30 Km length of Subarnrekha waterway, fairway is proposed for a stretch of 640 m only for river crossing near Pantei ghat. The navigable channel requires dredging initially and thereafter dredging is proposed for maintaining required draft. Jetties are proposed on both the banks. No safety, aids to navigation and communication system exists currently along the Subarnrekha waterway.

8.3 ADDITIONAL REQUIREMENT

Once the terminals on Subarnrekha River gets developed, all these basic safety norms need to be installed for safe navigation of vessels and to have complete control on traffic handled at terminal.

8.4 COSTING

The cost of Navigation and communication system comprises of equipment cost, cost of operation and maintenance.

8.4.1 Capital Cost

Capital cost of purchase & installation is INR 95.90 Lakhs.

Table 30: Capital Cost for Aids to Navigation and Communication

Navigation & Communication System	Cost in INR lakhs
DGPS	22.00
VTMS	50.00
Marine Lantern/Buoys (8 nos.)	16.00

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Navigation & Communication System	Cost in INR lakhs
Total Base Cost	88.00
3% Contingencies and 6% Supervision charges on Base cost	7.92
Total Navigation & Communication Cost	95.90

8.4.2 O&M Cost

For navigational aids 5% of the capital cost is kept as operation & maintenance cost i.e.
INR 4.80 lakhs.

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9.0 ENVIRONMENTAL AND SOCIAL ASPECTS

9.1 OBJECTIVE OF ENVIRONMENTAL AND SOCIAL STUDIES

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

Among many rivers, the section of Subarnrekha River from 0.000 Km to 30.000 Km falling in Baleswar District of Odisha State is also considered for waterway and declared as National Waterway No. 96 (NW-96).

Subarnrekha River flows through the Indian states of Jharkhand, West Bengal and Odisha. After originating near Piska/ Nagri, near Ranchi, the capital of Jharkhand, the Subarnrekha traverses a long distance through Ranchi, Seraikela Kharsawan and East Singhbhum districts in the state. Thereafter, it flows for shorter distances through Paschim Medinipur district in West Bengal for 83 kilometres and Baleswar district of Odisha. There, it flows for 79 kilometres and joins the Bay of Bengal near Talsari. The total length of the river is 395 kilometres. The basin of the Subarnrekha is smaller than most multi-state river basins in India. The rain-fed river covers a drainage area of 18,951 square kilometres. The river drains a total area of 19,671 sq. km. The important tributaries on the right bank of this river are Kanchi and Kharkai which meet Subarnrekha above Chandil dam and another right bank main tributary named as Kharkai meets this river near Jamshedpur at upstream of Galudi barrage. Dulung is the main tributary which joins Subarnrekha from its left in the Paschim Medinipur district of West Bengal.

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

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

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

9.2 ENVIRONMENTAL SETTING IN THE PROJECT AREA

9.2.1 Physiographic

The study stretch passes through Baleswar District in the state of Odisha.

The district Baleswar lies between 21° 03' and 21°59' North latitude and 86° 20' to 87°29' East longitude. The district is bounded by Midnapore district of West Bengal on the North, Bay of Bengal on the East, Bhadrak district on the South and Kendujhar and Mayurbhanj districts on the West. Extending over an area of about 3806 sq. km which covers 2.44% of total area of the state, it ranks 20th among the districts of Odisha in size.

Baleswar district belongs to the Mahanadi Delta. It is a crescent shaped plain having gentle slope towards the coast. Baleswar District is situated on Mahanadi Deltaic region which is divided into 3 sub micro divisions i.e., Baleswar Coastal Plain, Lower Subarnrekha Basin and Nilagiri Upland.

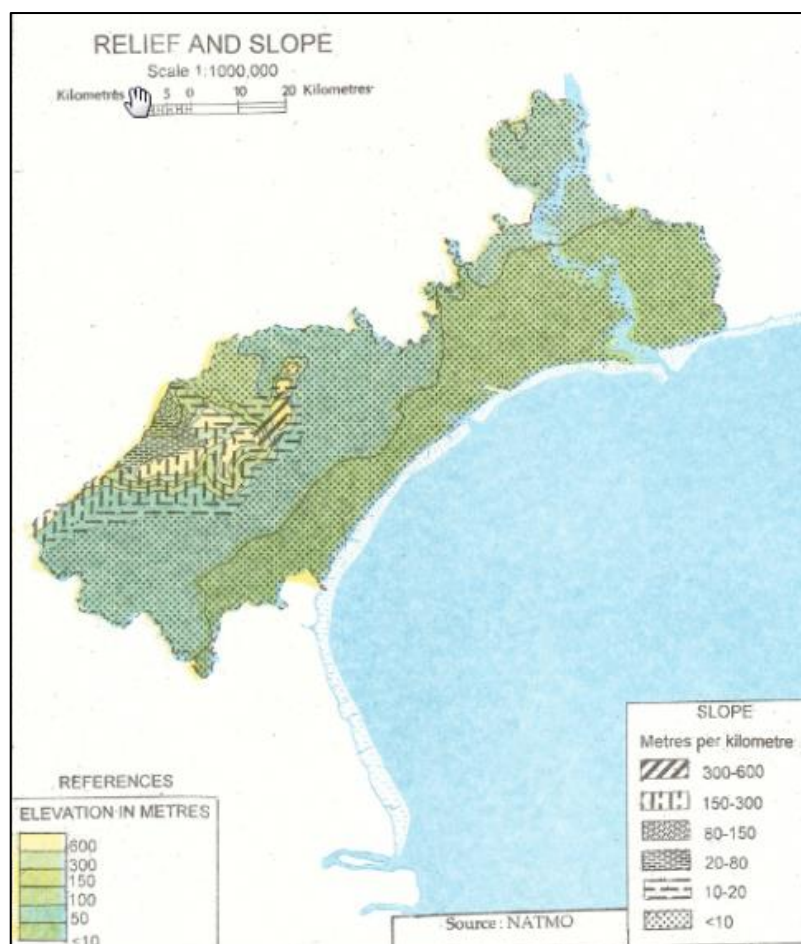
a) Baleswar coastal plain: This region covers 8 police stations such as Bhograi, Jaleswar, Singla, Basta, Baleswar, Soro, Chandipur and Baliapal. It is a flat crescent shaped alluvial plain along the coast of the Bay of Bengal covering entire eastern position of the district.

b) Lower Subarnrekha Basin: This region covers 8 police stations namely, Jaleswar, Bhograi, Basta, Baleswar, Remuna, Baripada, Singla and Raibania. This region consists of a thin strip of land stretching from North-East to South West direction.

c) Nilagiri Upland: This region covers Nilagiri Sub division with 6 police stations i.e. Nilagiri, Berhampur, Oupada, Soro, Similia and Khaira. It is a small upland gradually sloping down in all directions encircled by plain land. There are mountains which belong to Eastern Ghat range of Mountains of all the peaks the highest are Debagiri pahad (682.45m) and Bamanhulipahad (682.45m) and the lowest is Hatidhara pahad (215m), the others are Jhanuadi pahad (626.97m) and Swarnachuda pahad (544.37m).

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Relief and Slope Map of Baleswar District is furnished in **Figure 23**.



Source : NATMO

Figure 23: Relief and Slope Map of Baleswar District

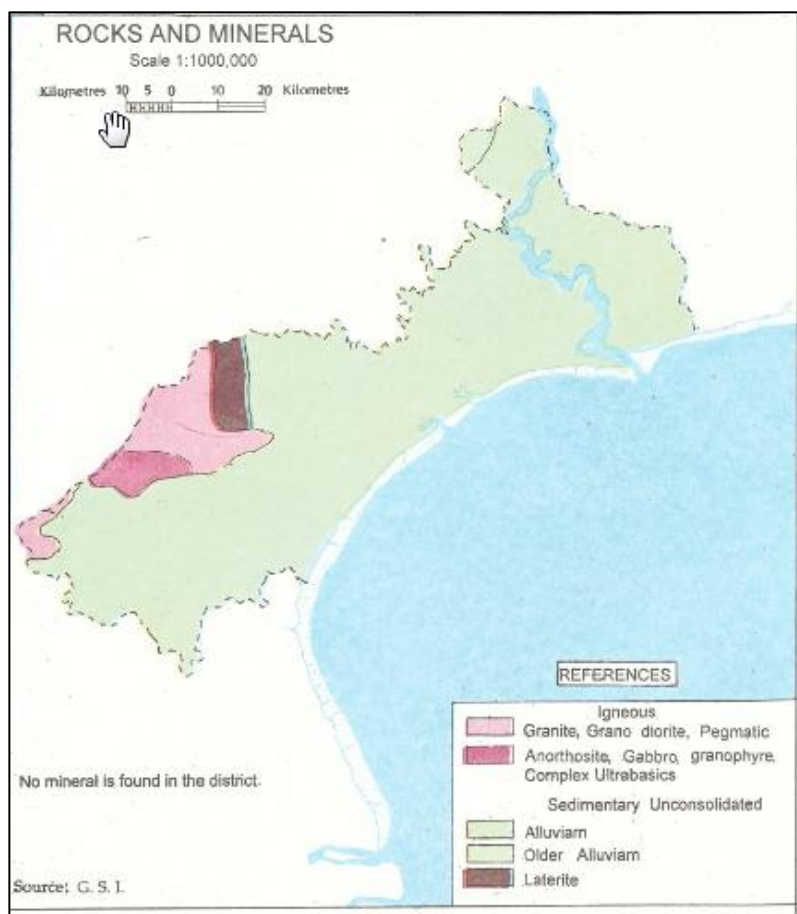
9.2.2 Geology and Seismicity

Geology:

The geological formations of the district are ranging from Pleistocene laterite to the recent alluvium with a few areas bordering Mayurbhanj district covering Archean Unclassified Gneisses including Singhbhum Granite in Nilagiri upland. Only a limited number of rock types are met within the North Western hilly tract of the district, while the vast coastal tract in south east portion is devoid of any rock type. Thus the various formations exposed in the

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district of Baleswar belong to Archean, middle Proterozoic, Pleistocene and recent groups. The Rock and Mineral Map of Baleswar District is presented in **Figure 24**.



Source : NATMO

Figure 24: Rock and Mineral Map of Baleswar District

Seismicity:

The project falls under the seismic **zone II** as defined by the Indian Standard (IS) 2002 seismic zoning classification system, i.e. a zone of relative stability. The seismicity is measured on a scale from II to V where zone II is most stable and Zone V is considered to be least stable. The seismic zone map of India is shown in **Figure 25**.

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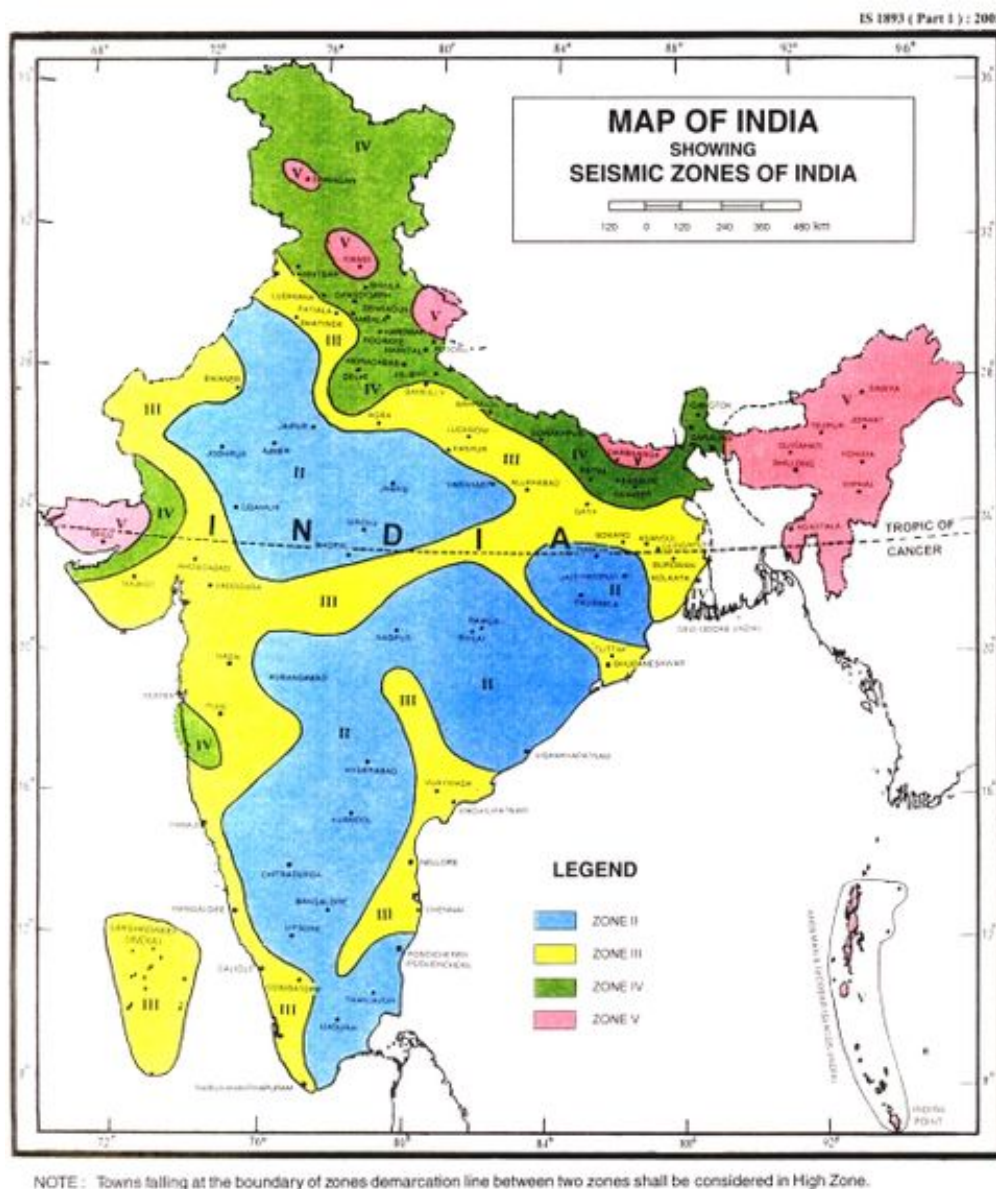


Figure 25: Seismic Zoning map of India

9.2.3 Climate

In the district the summer starts from March with steady rise of temperature and June is gradually the hottest month of the year. When the temperature increases just before onset of monsoon, the weather becomes oppressive. The South West monsoon season starts from mid-June and continues up to September. After monsoon the temperature starts decreasing from the month of October and January becomes the coolest month.

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The Relative Humidities are high i.e. more than 75% in the South West monsoon season i.e. from July to October. Later humidity decreases during winter season and lies between 60% - 70% till the month of April when the air become dry.

The annual normal rainfall recorded in the district is 1592 mm. More than 80% of annual rainfall is received during the monsoon season i.e. from June to September. Since 2008, the Weather Department of Odisha warned on irregular monsoon over all the districts of the state.

It is recorded that maximum rainfall occurred in the month of July and August during 2012 to 2016. However the heaviest rainfall was 746 mm in October of the year 2013. On the whole, 5 months of the year i.e. from Nov to March, the district received very scanty rainfall; whereas maximum rainfall occurred in the monsoon season.

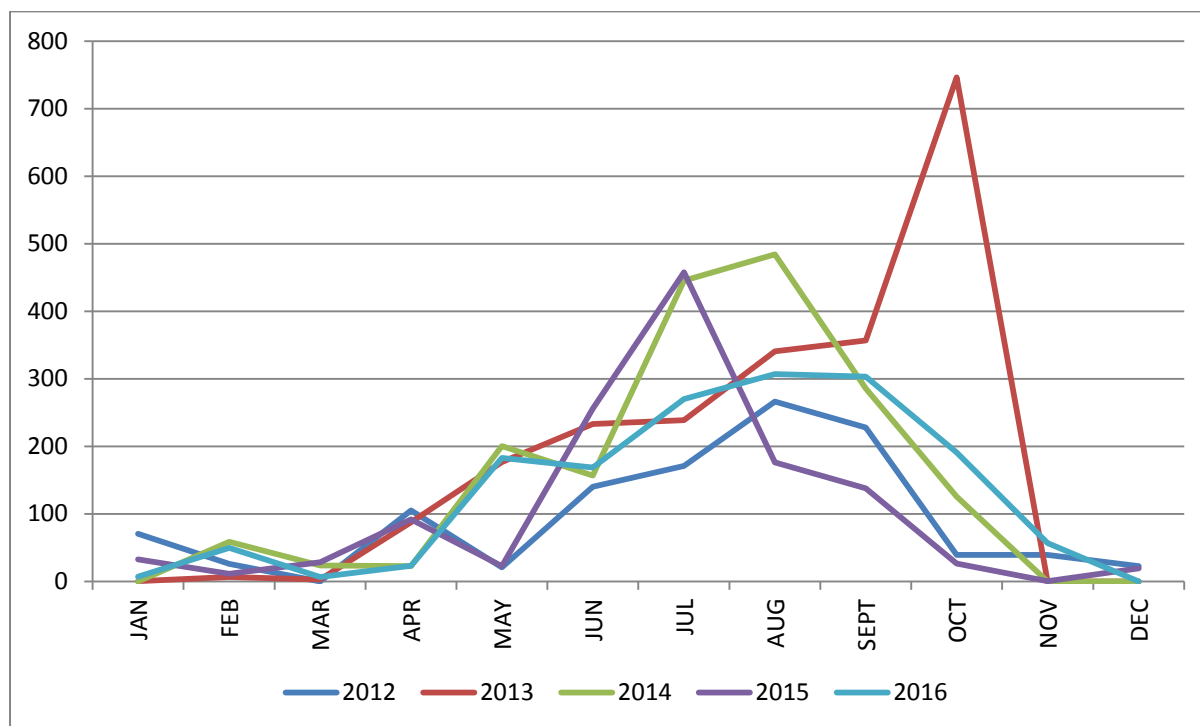
The pattern of Rainfall in Baleswar District is furnished in below table and figure.

Table 31: Rainfall Pattern of Baleswar District

Year	Month wise Rainfall Pattern (mm)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
2012	70.7	26.1	0	105.2	20.8	140.1	171	266.1	228	39.4	39.3	22.9
2013	0.3	6.6	2.9	87.6	176.9	233.3	238.9	340.8	356.6	746	0	0
2014	0	58.7	23.4	22.5	200.4	156.8	445.3	484.4	285.7	125.7	0	0.1
2015	32.8	11.3	28.2	91.7	22.9	255.6	457.9	176.3	137.9	26.4	0.2	19.4
2016	6.9	49.5	6.7	23.2	182.7	168.7	270	307.1	303.2	190.7	56.9	0

Source: India Meteorological Department

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Source: India Meteorological Department

Figure 26: Rainfall Pattern of Baleswar District

The observatory of Indian Meteorology Department is located in Baleswar District. Based on observations between 1973 -2000 the temperature profile of the project area is furnished in below table. April is the warmest month of the year. The temperature in April averages 35.9 °C. The lowest average temperatures in the year occur in January, when it is around 14.4 °C.

Table 32: Daily (Mean) Maximum and Minimum temperature by month in the Project Area (1973-2000)

Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
January	27.1	14.4
February	29.5	17.5
March	33.4	21.4
April	35.9	24.4
May	35.7	25.7
June	33.9	26.0

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Month	Temperature in ° C (Mean)	
	Daily Maximum	Daily Minimum
July	32.2	25.7
August	31.7	25.6
September	32.1	25.2
October	31.9	23.1
November	30.1	18.7
December	27.4	14.5

Source: India Meteorological Department

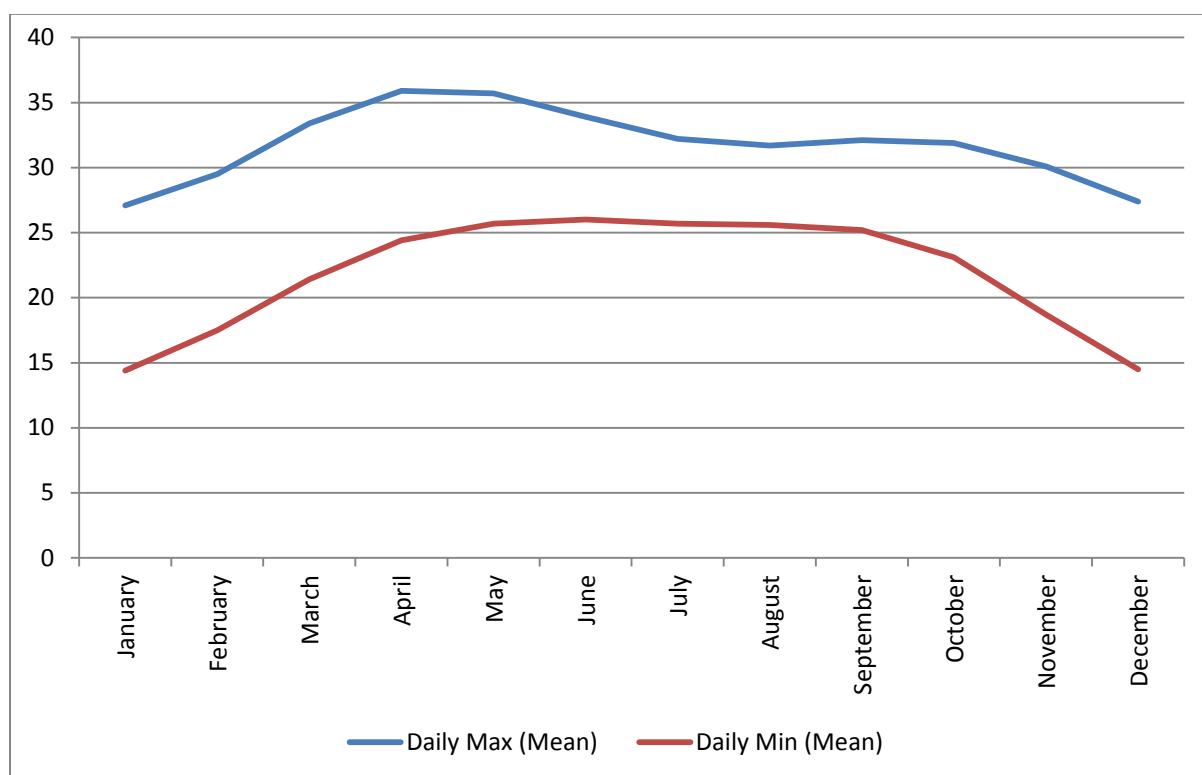
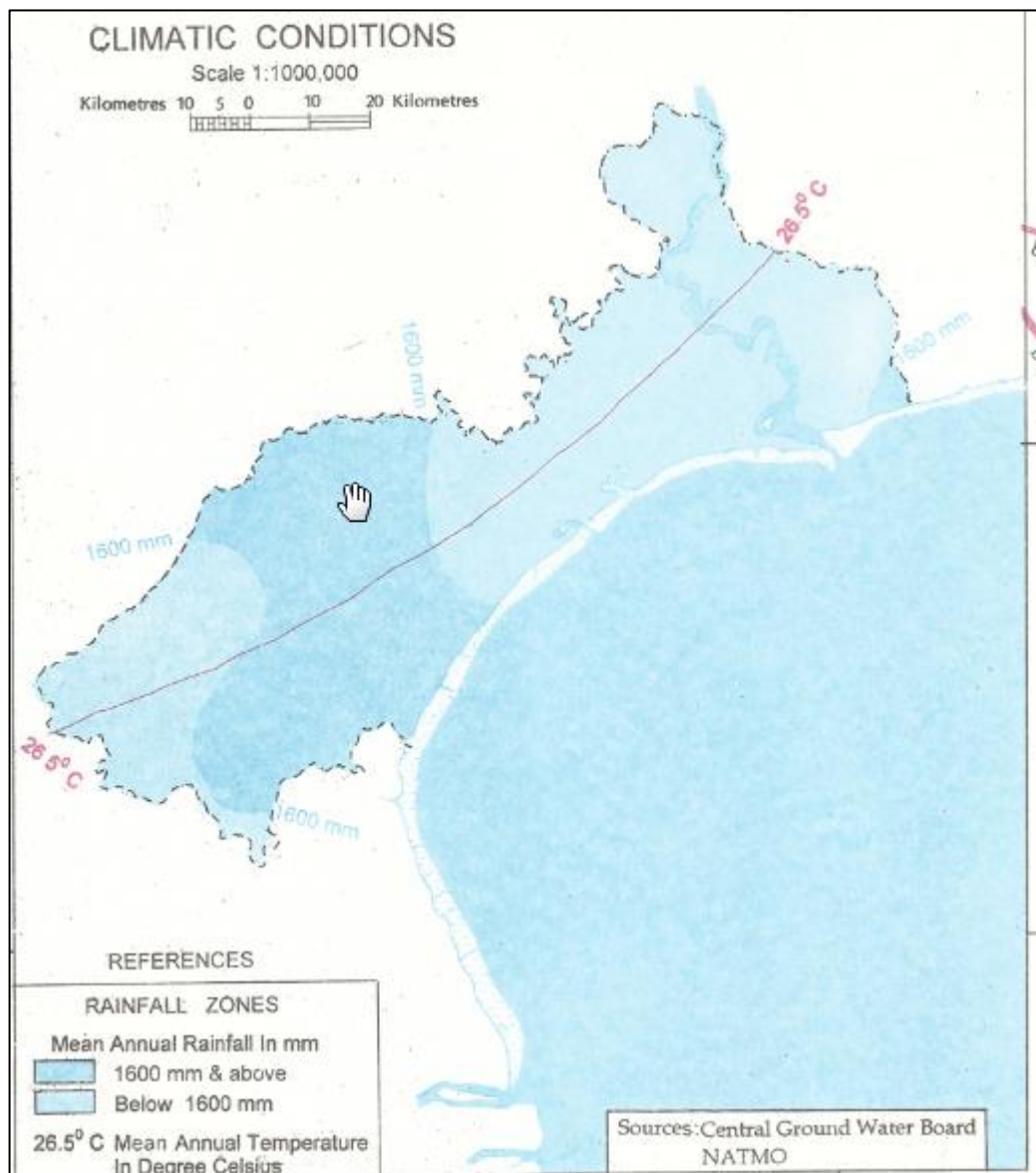


Figure 27: Temperature Graph

The **Figure 28** showing climatic condition of Baleswar district is furnished below.

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Source : NATMO

Figure 28: Climatic condition of Baleswar District

9.2.4 Soils

The soil of Balasore district is mostly alluvial laterite. The soil of Central region is mostly clay, clay loam and sandy loam which is very fertile for paddy and other farm produces. Nilgiri Sub-division is mostly gravelly and lateritic soil, which is less fertile. A small strip of saline soil is also seen along the extreme coastal part of the district.

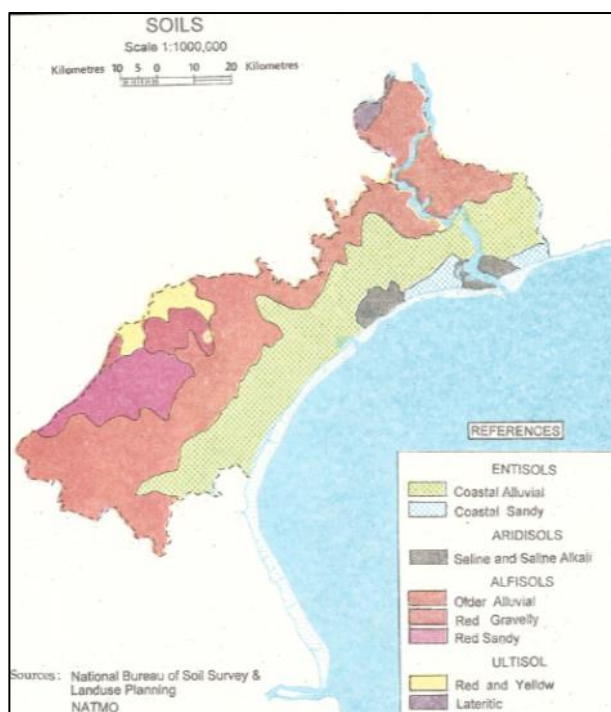
The type of soils of Baleswar district is discussed in the following sections.

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- **Baleswar Coastal Plain:** The entire region is formed of brown hydromorphic and coastal alluvial. The Sub-order association of the soil is known as Aquepts –Aquepts.
- **Lower Subarnrekha Basin:** In this region soils are recently formed Sandy and recent alluvium. The Sub-order association of the soil is known as Fluvenys-Psamments- Orhents
- **Nilagiri Upland:** High based status red loamy, red sandy, alluvial, shallow black, brown and alluvial soils of northern region. The Sub-order association is named as Ustaffs- Ochrepts and Ochrepts- Orthents.

The soil quality along the river is sandy alluvium in nature which has deficit in potassium and slightly acidic in nature.

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



Source : NATMO

Figure 29: Soil Map of Baleswar District

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9.2.5 Land Use Pattern

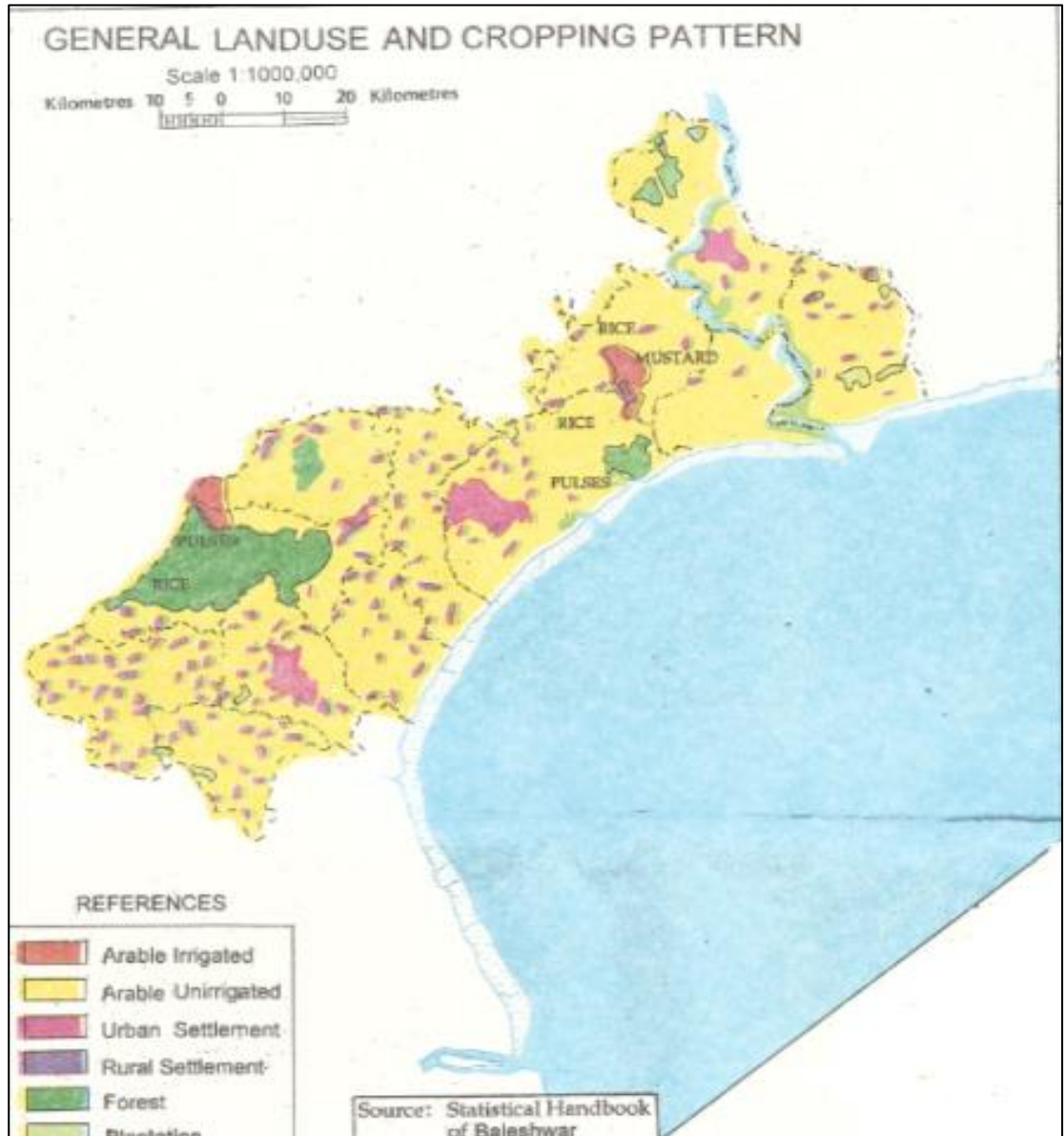
The land use along the project waterway is predominantly agricultural land followed by built-up & barren land. There is no industrial development along the waterway. Land use pattern of the project influenced district is presented in below table.

Table 33: Land use Pattern of the project affected districts (Area in '000 ha.)

S. No.	Land Use	Balasore
1	Forest area	33
2	Misc. Tree & Groves	25
3	Permanent pastures	16
4	Culturable waste	9
5	Land put to non-agricultural use	33
6	Barren and unculturable land	10
7	Current fallow	59
8	Other fallow	5
9	Net sown area	191
10	Total Geographical area	381

Source: Odisha Agriculture Statistics 2013-14, Gov. of Odisha

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Source : NATMO

Figure 30: Land Use Map of Baleswar

9.2.6 Ambient Air Quality

During the reconnaissance survey, it was found that the Air quality along the study area of Subarnrekha River was free from dust. However, it was also confirmed from the local people that there is no problem caused due to Air pollution. Also there is no major industrial development along the waterway stretch. The Air quality in Balasore district is given in below:

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Table 34: Air Quality of Balasore District, 2017

District	Parameters			
	PM ₁₀	PM _{2.5}	SO ₂	NO _x
Balasore	83.0	73.0	5.0	14.0

Source: Odisha State Pollution Control Board

9.2.7 Noise

During the reconnaissance survey, it was found Noise is not a big issue in the surrounding areas of Subarnrekha River. There are not any noise-generating sources in the nearby areas.

9.2.8 Water Quality

The water quality of the Subarnrekha river in Rajghat location of Balasore district is given below

Table 35: Water Quality of Subarnrekha River (Jan-Dec 2016)

Sl. No	Sampling Location	No. of Obs.	Annual average values (Range of values)				Frequency of violation (Percent of violation) from designated criteria value		Designated Class	Existing Class	Parameters responsible for downgrading the water quality	Possible Reason
			Parameters				BOD	TC				
			pH	DO (mg/l)	BOD (mg/l)	TC (MPN/100 ml)						
1.	Rajghat	12	8.1 (7.8-8.5)	7.5 (5.6-8.8)	1.3 (0.6-1.9)	3733 (490-7900)	0	2 (17)	C	C		
Class 'C' water quality Criteria (IS-2296-1982)			6.5-8.5	4 and above	3 or less	5000 or less			Drinking water source with conventional treatment followed by disinfection			

Source: Odisha State Pollution Control Board

9.2.9 Susceptibility to Natural Hazards

Orissa is vulnerable to multiple disasters. Due to its sub-tropical littoral location, the state is prone to tropical cyclones, storm surges and tsunamis. Its densely populated coastal plains are the alluvial deposits of its riverine systems. The rivers in these areas with heavy load of silt have very little carrying capacity, resulting in frequent floods, only to be compounded by breached embankments. Though a large part of the state comes under Earthquake Risk Zone-II (Low Damage Risk Zone), the Brahmani Mahanadi graben and their deltaic areas come under Earthquake Risk Zone-III (Moderate Damage Risk Zone) covering 43 out of the 103 urban local bodies of the state.

Susceptibility to various kinds of Natural Hazards are elaborated in the following sections-

- **Susceptibility to Floods**

Amongst all the natural disasters afflicting the State, floods are the most frequent and devastating. Almost 80% of the annual rainfall is concentrated over a short monsoon period of 3 months. While the coastal plains are very flat, the slopes in the inlands are precipitous. This leads to heavy siltation, flash floods and poor discharge of flood waters into the sea and thus the embankments are breached with alarming frequency. The entire coastal belt is prone to storm surges, which is usually accompanied with heavy rainfall thus making the estuary region vulnerable to both storm surges and river flooding.

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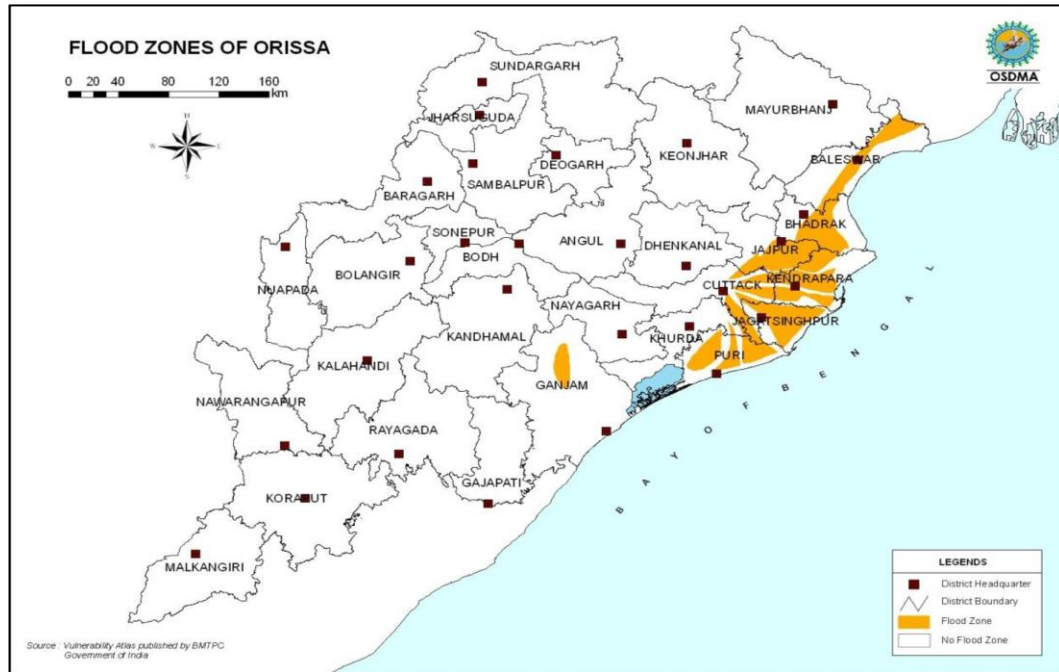


Figure 31: Flood Prone Zones of Odisha

- **Susceptibility to Cyclones**

The East Coast of India is one of the six most cyclone-prone areas in the world. Of all severe cyclones that make landfall on the eastern coast, 20% hit Odisha, particularly during April–May and September–November. Once every 2 - 3 decades, a severe cyclone strikes Odisha. All the coastal districts are vulnerable to cyclones.

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Figure 32: Wind and Cyclone Zones of Odisha

- **Susceptibility to Drought**

The pattern of drought in the State is of a varied one, sometime affecting the entire State, sometimes a few regions, and sometimes a few districts. However, the contiguous patch consisting of the subdivisions of Padampur, Bolangir, Titilagarh, Patnagarh, Nuapada, Khariar, Bhawanipatna and Phulbani comprising of 47 blocks have been identified as chronic drought-prone zones. The construction of Upper Indravati Project has considerably improved the position in Bhawanipatna Sub division.

- **Susceptibility to Heat Wave**

Climatic changes, decrease in tree cover, depletion of ground water resources and increase in day temperature especially during the months of May and June, have made majority of the districts of the State vulnerable to heat wave. In 1998, the State witnessed a severe heat wave, which claimed over 2,000 lives. Several districts also suffered from extreme scarcity of drinking water.

- **Susceptibility to Earthquakes**

The project falls under the seismic zone II as defined by the Indian Standard (IS) 2002 seismic zoning classification system, i.e. a zone of relative stability.

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- **Susceptibility to Tornadoes**

The State has had past histories of tornados and is also vulnerable to hail storms, thunder and lightning deaths or injury nearly every year.

- **Vulnerability to Tsunami**

Odisha coast is vulnerable to tsunami. 328 villages covering 6 coastal districts located within 1.5 km of the coastline are identified as tsunami prone villages. Since there is no specific tsunami event in the recent past, the disaster cannot be ruled out.

Besides these natural hazards, human-induced disasters such as accidents, stampede, fire, etc, vector borne disasters such as epidemics, animal diseases and pest attacks and industrial / chemical disasters add to human suffering

9.2.10 Estuary and Coastal Zone

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

The section of waterway starts from the confluence point of Subarnrekha River and Bay of Bengal. Hence section of waterway is part of estuarine stretch where tidal influence is quite prominent. The section of waterway falls in Coastal Regulatory Zone (CRZ). Thus CRZ clearance under purview of CRZ Notification 2011 should be taken for this developmental proposal.

At the mouth of Bay of Bengal on the left bank of Subarnrekha River there is a Mangrove forest patch present namely Bichitrapur Bani PRF.

9.2.11 Archaeological and Heritage Locations

Kumbhiringari or Bhusandeswar, a village situated between the Bay of Bengal and the Subarnrekha river in Bhograi area is noted for the worship of Bhusandeswar Siva Linga. In summer season people usually visit the place in large numbers for worship. The Siva Linga is made of well polished black chlorite stone and is designed in three separate sections.

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The mud fort complex at Raibania is located about 17Km away from project stretch on the right bank of the river Subarnrekha in the district of Balasore in Orissa. This fort complex is considered as the biggest medieval fort of eastern India. This monument is protected by Archaeological Survey of India.

There are several ancient temples like Khirachora Gopinatha Temple in Remuna, Chandaneswar, Panchalingeshwar, Bhudhara Chandi temple, Sajanagarh, Marichi temple, Ayodha, Brahmani Temple in Abhana, Jagannath temple at Nilagiri, Maninageswar Temple at Bardhanpur in the district.

Balasore District is very much famous for its glorious history, art, culture and tradition. The copper coins collected from Bhogra and the collection of statues of Lord Buddha from places like Avana, Kupari, Basta and Ayodhya magnifies the existence of Buddhism here. Buddhism is also popular during "Bhoumakar". The statue of Lord Jaina at Jaleswar, Balasore and Avana hints about Jainism that is practiced in this District, which was also popular during 10th and 11th centuries.

9.2.12 Flora and Fauna

According to Forest Survey of India Report, 2015 the total forest cover of Baleswar District is 351Km² which is about 9.22 % of the district's total geographical area (3806 Km²). Out of 351 Km², 23 Km² falls under very dense forest area category; whereas Moderately Dense Forest and Open Forest area covers 126 Km² and 202 Km² area respectively. The comparative statement showing forest cover of Baleswar District and Odisha state is presented in below table. It is observed from the table that state's Forest Cover percentage in respect to total geographical area is quite higher than districts overall coverage.

Table 36: Forest Cover of Baleswar District and Odisha State

District / State	Forest Cover in Sq. Km					Percentage of GA
	Geographical Area (GA)	Very Dense Forest	Moderately Dense Forest	Open Forest	Total	
Baleswar	3806	23	126	202	351	9.22
Odisha	155707	7023	21470	21861	50354	32.34

Source : Forest Survey of India, 2015

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At the mouth of Bay of Bengal on the left bank of Subarnrekha River there is a Mangrove forest patch present namely, Bichitrapur Bani PRF. Total area of Bichitrapur Bani PRF is 563 ha. As communicated by Forest Dept. among flora about 16 Mangrove Species and 10 Mangrove Associated species have been recorded from the area.

Species like *Shorea robusta* (Sal), *Pterocarpus marsupium* (Piasal), *Dalbergia sissoo* (Sisoo), *Anogeissus latifolia* (Dhaura), *Terminalia arjuna* (Arjuna) and *Gmelina arborea* (Gambhari) are mainly found in this area. Casuarina sp. plantations enrich the vegetation of forest areas on the coastal sands. Mangrove species like *Avicennia officinalis* (Baen), *Avicennia marina* (Chota bani), *Avicennia alba* (Kala baen), *Bruguiera cylindrica* (Bokul), *Bruguiera sexangula* (Kankra), *Rhizophora sp* (Garjan), *Aegiceras corniculatum* (Khalsi), *Aegialitis rotundifolia* (Safari), *Ceriops decandra* (Goran), *Sonneratia apetala* (Keora), *Xylocarpus granatum* (Dhundul), *Xylocarpus mekongensis* (Pitamari), *Acanthus illicifollus* (Hargoza), *Excoecaria agallocha* (Goan) are recorded from Bichitrapur PRF. According to IUCN *Aegialitis rotundifolia* (Safari) and *Ceriops decandra* (Goran) falls under Nearly Threatened category. Among Mangrove associated species *Suaeda maritime* (herbaceous seepweed), *Sesuvium portulacastrum* (sea purslane), *Clerodendrum inerme* (Indian Privet), *Myriostachya wightiana* (Myriostachya), *Porteresia coarctata* (Wild Rice), *Ipomea sp* (Ipomea), *Cynodon dactylon* (grass), *Dalbergia spinosa* (Chillingi), *Caesalpinia crista* (natakaranja) etc have also been recorded from the area.

No flag ship species like Elephant, Tiger, Giant squirrels are seen in the project area. As stated by concerned forest and wildlife officials South Asian River Dolphins (***Platanista gangetica*; Schedule I**) the freshwater species are spotted in Subarnrekha River. Migratory Olive Ridely Turtles (***Lepidochelys olivacea*; Schedule I**), Red Crabs, Horse shoe Crabs are seen in the coast of Bay of Bengal as well as in the confluence area of Subarnrekha River. Olive Ridley turtles generally congregate at the coastal area during November to March for nesting. **As per IUCN conservation status South Asian River Dolphin and Olive Ridely Turtle respectively falls under Endangered and Vulnerable Category.**

Among avian species *Chroicocephalus ridibundus* (Black Headed Gull), *Chroicocephalus brunnicapillus* (Brown headed Gull), *Alcedo atthis* (Common Kingfisher), *Halcyon smyrnensis* (White Breasted Kingfisher), *Anastomus oscitans* (Asian Openbilled Stork), *Microcarbo niger* (Little Cormorant), *Egretta garzetta* (Little Egret), *Ardeola grayii* (Pond

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Heron), *Calidris minuta* (Little Stint), *Gallinago gallinago* (Common Snipe), *Podiceps cristatus* (Great crested grebe) have been recorded from the study area.

9.2.13 National Parks, Forests, Wildlife Sanctuaries and Reserves

National Parks, Wildlife sanctuaries, Biosphere Reserve play a vital role in protecting the wildlife of a particular area and providing them their natural habitat. There are no national parks, wildlife sanctuaries and Biosphere Reserves adjacent to the project section of Subarn Rekha River. The nearest protected area (under purview of Wildlife Act, 1972) from project area is Kuldiha Wild Life Sanctuary which is located about 60 Km away from the proposed project area. The details of various protected areas in Odisha covered under purview of Wildlife Act, 1972 is given in **Figure 33**.

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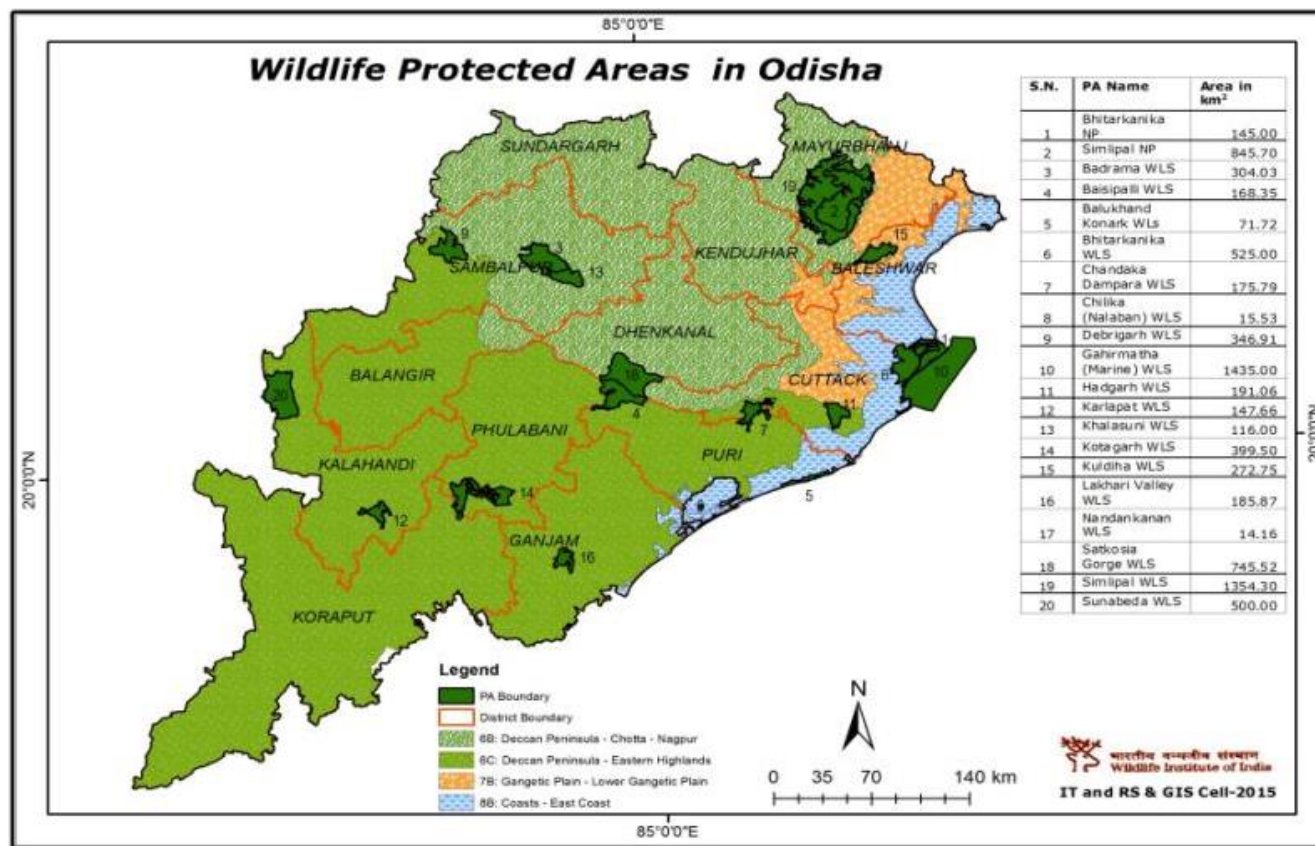


Figure 33: Wildlife Protected Area of Odisha

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9.2.14 Socio Economic Profile

Demography

The distribution of population in rural and urban area in the district as per 2011 census shows that majority of the population i.e. 89.08% live in rural areas. The total population of the district is 2320529 (Males- 11,85,787. Female – 11,34,742). The literary rate and sex ratio being 79.8% and 957 respectively, the percentage of SC and ST was 20.6 and 11.9 in the district. There is 2953 no. of Villages in the district. The demographic profile of the project district is presented in below table.

Table 37: Demographic Profile of Balasore District

Total Population	Male Population	Female Population	Literary Rate (%)	Sex Ratio	SC (%)	ST (%)
2320529	1185787	1134742	79.8	957	20.6	11.9

Major settlements/village located along the section of Subarnrekha section has been listed in the following table along with population details as per Census of India Data, 2011.

Table 38: Major settlements/village along the project stretch of Subarnrekha River

S. No.	Village/ Town name	Population (nos.)
1	Jaleswar	204090
2	Bhograi	283586
3	Baliapal	197259
4	Narayan Mohanty Padia	2879
5	Chaumukha	8306
6	Chandrabali	620
7	Kumbhirdi	1497
8	Dagara	180
9	Gosanibindha	255
10	Kathasagara	1473
11	Maniksimulia	676
12	Jagei	478
13	Pratappur	1303
14	Tahalia No-2	1051
15	Jamkunda	8452

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S. No.	Village/ Town name	Population (nos.)
16	Bishnupur	703
17	Bartana	907
18	Kachuapada	1505
19	Parulia	700
20	Jharpimpal	3579

Economic Profile

Agriculture: Agriculture starts just before monsoon. The cultivators plough their fields in the month of May and sowing of grain starts from Akshaya Trutiya i.e. last part of May. Harvesting of Kharif crops is done in the month of December and January, where as that of Rabi crops is done within March .Growing & Harvesting in autumn and winter season is known as Kharif crop and in summer season is known as Rabi crops throughout the districts of Odisha.

Paddy being the main crop is cultivated under 3 main categories i) Biali or Autumn Paddy ii) Sarada or Winter Paddy iii) Dalus or Summer Paddy. The district Baleshwar being situated on the coastal belt is suitable for cultivation of different fruits like banana, coconut, guava, sapeta, lichi and mango etc.

Besides another cash crops pan (betal leaf) is cultivated in and around Bhograi area i.e. North Baleshwar. Among the other cereals wheat, maize, jawar, bazar etc. are also produced in the district. Besides pulses (mung, biri, kulthy), oilseeds (groundnut, til, mustard and castor etc.) and sugar cane are also produced during Rabi season.

Irrigation: Almost 82% of net sown area were utilised for irrigation purposes. The total irrigation potential created up to 2010-11 from all sources was 252.27 thousand hectares (153.25 thousand ha during Kharif and 99.02 thousand ha during rabi). The Gross irrigated area during 2010-11 was 176.89 thousand ha (102.19 thousand ha during kharif and 74.70 thousand ha during Rabi) which covered 70.12% of the irrigation potential created. Only paddy was grown in 68.3% of total irrigation area. All other crops covered 31.7% of total irrigated area.

All the crops with irrigation cover an average 42% of total covered area, though pulses & oilseeds are grown with 14% & 15% area only during Kharif season. But during Rabi 100% covered area gets irrigated for all crops except for crops pulses and oilseeds. On the whole during 2010-11, 55.11% crop covered area was available by irrigation for all the crops in the district.

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Animal Husbandry: Livestock resources play a vital role in the development of its socio economic condition. The activities of the animal Husbandry sector have been oriented towards the health of livestock and increased production of milk, meat and eggs. Different Animal Husbandry and Dairy Development to programmes are being implemented through Animal Resources development sector to improve the socio-economic stand of general public. Also this sector contributes significantly in supplementing the increase of small marginal and landless labourers.

As per 17th Quinquennial Livestock Census-2003 there were 863511 indigenous, 31924 crossbreed and 1486 exotic cattle, 4385 buffaloes, 9558 sheep, 344604 goats and 18235 pigs, Fowl i.e. Poultry numbers 409880 in Baleshwar district. Thus the cattle population accounts for 70.42% of Livestock population. Out of total Livestock population the Buffalo population accounts 0.34%, Sheep population 0.75%, the Goat population 27.06% and the pig population accounts for 1.43%. During 2003-2007 as per ARD- 2010-11, the poultry population numbered 909566, which recorded very high increase of 121.91% in the district.

Fishery: Fishery is divided into 3 sectors i.e. i) Inland fishery ii) Brackish water Fishery iii) Marine fishery. The Inland water sources which may be treated as fresh water resources include rivers, tanks, lakes, ponds and canals etc. Recently scientific technology, thorough training and financial assistance are being adapted for enhancing productivity and utilisation of brackish and inland water resources for pisciculture. There are fish farms in the district. Being a coastal district the fish production from sea has been significantly increased with respect to freshwater fish. The total production of fish from fresh water, brackish water and marine during 2010-11 was 13826.61 MT, 3288.22 MT and 35,183 MT respectively.

Industry: Though Baleshwar is one of the richest districts in the field of agriculture; there are a few no. of micro and small-scale industries functioning in the district. The micro small and medium enterprises play a major role in broad basing the industrial growth and creating employment opportunities, revenue exports and economic growth. According to MSME Act, 2006, the MSM Enterprises are classified in 2 classes i.e., manufacturing and service enterprises. The manufacturing enterprises are defined in terms of investment in plant and machinery, whereas service enterprises engaged in providing or rendering of services are defined in terms of investment in equipment.

Trade & Commerce: Baleshwar is well approached by a network of roads and railway lines. National Highway no. 5 running between Kolkata and Chennai passes through this district touching its district headquarter. Railway line of E-Railway runs through it. Due to its proximity to Kolkata the traders of Baleshwar frequently visit that place for their need. After independence the trade and commerce in

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the district are mainly agro-based, forest based and marine based at different trade centres. In rural areas the greater part of the local trade is carried out in weekly markets (hats) scattered throughout the district at convenient places. There are also large number of scheduled tribe and scheduled caste people in the district who live mostly in far off interior places and village weekly markets (hats) are of great importance to them since they sell their local produce in exchange of their daily necessities. Merchants also come to these village markets to purchase goods at low rate. To regulate the sale and purchase of agricultural commodities there are some regulated markets in the district.

For the benefit of farmers and traders 143 agricultural credit co-operative societies, 25 nonagricultural credit co-operative societies, 45 primary employ and students, consumer cooperative stores and 2 specialized commodity marketing cooperative societies are operating in the district during the year 2008-09.

Transport: Due to increasing demand for more and better roads and for breaking the age old isolation of many in accessible areas, construction of roads and development of road transport were considered. At present, the district Baleshwar is served by National Highways, State Highways, major and other district roads and village roads etc.

During 2008-09, the district has the network of roads with nh-119 kms, major district roads 189 kms, other district roads 327 kms forest roads 82 kms, g. P roads 1682 kms and village roads 1271 (p) kms. Also there are bus services to different tourist spots in the district as regards railway routes, there are 18 railway stations connected by broad-gauge with double line measuring 114.98 kms in length. Eastern railway i.e. Chennai to Kolkata passes through the district. During the year 2008-09, total 13,594 nos, of motor vehicles were registered in the district. Among all motor cycles, scooters and moped were numbered the highest i.e. 11,610.

9.3 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS OF THE PROJECT

Environmental and Social 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 as follows:

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9.3.1 Impacts during Construction Phase

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

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

Dredging of about 640 m is proposed. Dredging may changes the water quality, river bed topography and benthos. These activities must not occur at sites used for drinking water and fish spawning.

The total quantity of muck generated due to dredging will be 21,000 cum. The muck will disposed at low lying area around the proposed cargo terminal for flood protection measures and land filling.

B. IMPACTS ON LAND

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

- Loss of land / land acquisition: The total land required to be acquired for the project is 2,390 m². The land shall be acquired for development/construction of Passenger Ferry Terminal at the following locations
 - Pantei Ghat (Chandeneswar Side)
 - Pantei Ghat (Baliapal Side)
- Change in topography
- Cange in land use
- Detorioration 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.

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- ✓ 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 properly utilized and may be 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 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 the 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 carried out in a confined area contamination of soil can be avoided to a great extent. 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 is anticipated 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.

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- ✓ 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.
- ✓ Waste containing contaminated water to dispose off site at an approved disposal site in consultation with State Pollution Control Board.
- ✓ Dispose of waste from the oil interceptors only through suitable waste-handling contractor and request for safe disposal certificates.
- ✓ The movement of construction vehicles and equipments will be restricted to only designated route.
- ✓ Mix cement, concrete and chemicals on a concrete plinth and contain spillages or overflows into the soil.
- ✓ Vehicle maintenance are not allowed on site.
- ✓ If oil spills occur, disposing contaminated soil at a disposal site in consultation with State Pollution Control Board.
- ✓ Stockpiling of subsoil and overburden in all construction and lay down areas.

D. IMPACTS ON AIR

The air quality parameter is the most common environmental feature, which is being affected by any infrastructure projects at different stages i.e. during constructional as well as operational phase. The major indicators of Ambient Air Quality relevant to the project are the concentration of Particulate matters of size less than 10 μ (PM10), Particulate matters of size less than 2.5 μ (PM2.5), Sulphur dioxide (SO₂), 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 of labour camp, 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.

Shrub Vegetation existing at proposed terminal site will be removed. Bare & loose soil after removal will be exposed to wind and will add on to the concentration of ambient dust levels.

Mitigation Measures:

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- ✓ 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 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.
- ✓ Plantation of trees having adequate canopy should be implemented.

E. IMPACTS ON AMBIENT NOISE AND VIBRATION

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

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

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

Mitigation Measures:

- ✓ All noise generating equipments 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 along the Subarnarekha River. At the mouth of Bay of Bengal on the left bank of Subarnrekha River there is a Mangrove forest patch present namely, Bichitrapur Bani PRF. As communicated by Forest Dept. among flora about 16 Mangrove Species and 10 Mangrove Associated species have been recorded from the area. However, no such construction activity is proposed in the vicinity of the said area and jetty terminals will be constructed about 13 Km upstream near Pantei. Hence no major impact on ecology is anticipated. However, dredging is proposed near terminal cum jetty locations at Pantei. About 640 m length of dredging will take place between two terminals on River Subarnarekha. Some shrubs may also affected due to construction of terminal. Likely impact on population of phytoplankton, zooplankton, benthic communities and fishes are envisaged due to 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 if tree felling is absolutely unavoidable.

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- ✓ Ensure any landscaping to be undertaken will be done with locally indigenous species and low maintenance requirements.
- ✓ Dredging should be avoided during breeding season of aquatic fauna.
- ✓ Construction workers should be strictly instructed not to harm any unknown/rarely seen fauna if encountered
- ✓ The generated muck due to dredging should not be disposed off in the waterway
- ✓ Construction vehicles should run along specified access to avoid accidents to cattle

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
- Siltation due to surface runoff
- Improper handling and stacking of construction material

Mitigation Measures:

- ✓ The site surface should be 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.
- ✓ Use of tarpaulin sheets during transportation of construction material. Proper stacking of material
- ✓ Use of Silt fencing during construction
- ✓ Stockpiling of subsoil and overburden in all construction and lay down areas

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.

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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 likely to be generated. These wastes are refuse 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.
- ✓ Camp 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**

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Land may be acquired due to Construction of cargo Terminal and jetties. The total amount of land will be affected is 0.437 Ha. The affected land owners should be compensated by proper compensation as per the norms of Government of Odisha/Government of India.

- **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 generation 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. 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.

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- ✓ 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.

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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:

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

9.3.2 Impacts during Operation Phase

A. IMPACTS ON AIR

Sensitive receptors and nearby habitation area may be affected temporarily by increased traffic and other related impacts. Air pollution may generate at jetty/terminal area during transportation and storage activities of material, loading and unloading of material.

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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 embarking and disembarking of passengers at site and vessel/barges, movement of vessel, operation of backup power generators, pumps and other equipment. However, the main effect on the environmental noise level will be from increased vehicular movement entering and leaving the terminal site. Sensitive receptors and nearby habitation areas may also be affected by increased traffic and related impacts. 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

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There may be possibility of oil spillage from barges/vessels during transportation. This will affect 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.
- ✓ 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.

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

Mitigation Measures:

- ✓ Provision of septic tanks in the toilets.
- ✓ 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 arise during the movement of vessel/barges.

Mitigation Measures:

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- ✓ Dredging should be avoided during breeding season of aquatic fauna.
- ✓ Vessel Operators should be strictly instructed not to harm any unknown/rarely seen fauna if encountered
- ✓ The generated muck due dredging should not be disposed off in the waterway

F. IMPACTS ON HEALTH AND SAFETY

Danger of operations and maintenance-related injuries and accidental drowning may occur during operation stage. Safety of workers and general public must be ensured.

Poor waste management practices and unhygienic conditions at the improved facilities can breed diseases.

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.
- ✓ Provision of life tubes at jetty locations as well as in vessels
- ✓ Ensuring all workers are provided with Personal Protective Equipment.
- ✓ Provision of medical insurance coverage for workers.

G. IMPACTS ON REGIONAL ECONOMY

The project is expected to bring the economic benefits of the region directly through expansion of regional trade, increase new business opportunity, development of new industries.

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.

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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 39** 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 39: Environmental Management Plan (EMP)

S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
A. DESIGN AND DEVELOPMENT/ PRE-CONSTRUCTION PHASE				
1.	Loss of Land	<ul style="list-style-type: none"> Land acquisition will be marginal. The acquisition of land will be carried out in accordance with the entitlement 	IWAI	IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>framework for the project.</p> <ul style="list-style-type: none"> • Early identification of entitlement for Compensation of the Losses. • All the affected people will be compensated as norms of Government of Odisha/Govt. of India 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. 		
2.	Tree cutting	<ul style="list-style-type: none"> • No major felling of trees has been envisaged for the project. Few trees standing at proposed terminal sites can be saved. • However, if felling of trees becomes unavoidable, the statutory permission for tree felling will be obtained prior to cutting of trees from Forest Department. • 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 atleast 1:3 	IWAI/Contractor	IWAI
3.	Arrangements for temporary land for Establishing Camps/Plants/ Temporary diversions	<ul style="list-style-type: none"> • The Contractor as per prevalent rules will carry out negotiations with the landowners for obtaining their consent for temporary use of lands for workers camp, construction sites traffic detours etc. • The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner. • The Contractor will ensure that the site is properly restored to the satisfaction of the land owner prior to handling over to the owner and shall submit satisfactory certificate from the Land Owner. 	Contractor	Supervision Consultants, IWAI
4.	Establishment of Construction Camp	<ul style="list-style-type: none"> • The locations of construction camp to be identified by the Contractor. Construction camps will not be proposed within 500 m from the nearest settlements to avoid 	Contractor	Supervision Consultants, IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>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.</p> <ul style="list-style-type: none"> The Contractor will submit the legal agreement/ written Consent letter from the owner of the land for using fir specific purpose along with its rehabilitation plan as agreed by the owner. The Camp site will be provided with all the necessary facilities as per norms. 		
5	Material Sources	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> The topsoil from all areas of cutting and all areas to be permanently covered will be stripped to a specified depth of 150 mm and stored in stockpiles of height not exceeding 2m. The stored topsoil will be spread back to maintain the soil physico-chemical and biological activity. The preserved top soil will be used for restoration of sites, in landscaping and avenue plantation 	Contractor	Supervision Consultants, IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Impervious platform and oil and grease trap for collection of spillage from construction equipment vehicle maintenance platform will be appropriately provided at construction camp, servicing area and liquid fuel and lubes at storage areas. 	Contractor	Supervision Consultants, IWAI
(v)	Contamination of land from construction wastes and spoils	<ul style="list-style-type: none"> All spoils will be disposed off as desired and the site will be fully cleaned before handing over. 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. Waste containing contaminated water to 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 	Contractor	Supervision Consultants, IWAI
2.	Impact on Air			
(i)	Emission from	<ul style="list-style-type: none"> All vehicles, equipment and machinery 	Contractor	Supervision

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
	construction vehicles and machinery	<p>used for construction will be regularly maintained to ensure that the pollution emission levels conform to the SPCB norms.</p> <ul style="list-style-type: none"> 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'. Workers at mixing sites will be provided with good quality personal protective equipments (PPE) reduce the chances of ill effect of dust DG sets will conform to the emission standards as stipulated under Environment (Protection) Rules, 1986 Vehicles transporting earth and other materials will be covered properly to prevent fugitive emissions Mixing equipment will be well sealed and equipped as per PCB norms. Sprinkling of water in construction area and other excavation areas for suppressing fugitive dust Periodical monitoring of fine Particulate Matters (PM10 and PM2.5) will be carried out as per Environmental Monitoring Plan. 		Consultants, IWAI
(ii)	Dust Pollution	<ul style="list-style-type: none"> 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. 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 (PM₁₀ and PM_{2.5}) will be carried out as per Environmental Monitoring 	Contractor	Supervision Consultants, IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>Plan.</p> <ul style="list-style-type: none"> 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	<p>The Contractor will confirm the following:</p> <ul style="list-style-type: none"> All plants and equipments used in construction shall strictly conform to the MoEFCC/CPCB/SPCB noise standards. All vehicles and equipment used in construction will be fitted with exhaust silencers. Servicing of all construction vehicles and machinery will be done for exhaust silences and will be checked and if found defective will be replaced. All the construction sites within 150m of the nearest habitation, noisy construction work such as crushing, concrete mixing will be stopped during the night time between 10.00 pm to 6.00 am. No noisy construction activities will be permitted around educational institutions/health centers (silence zones) up to a distance of 100 m from the sensitive receptors. Monitoring shall be carried out at the construction sites 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. 	Contractor	Supervision Consultants, IWAI
4	River Water contamination	<ul style="list-style-type: none"> The site surface should be 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 Use of tarpaulin shees during transportation of construction material. 	Contractor	Supervision Consultants, IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>Proper stacking of material</p> <ul style="list-style-type: none"> • Use of Silt fencing during construction • Stockpiling of subsoil and overburden in all construction and lay down areas 		
5.	Impact on Flora and Fauna	<ul style="list-style-type: none"> • 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. • Dredging should be avoided during breeding/spawning season of aquatic fauna. • The generated muck due to dredging should not be disposed off in the waterway • Construction vehicles should run along specified access to avoid accidents to cattle 	Contractor	Supervision Consultants, IWAI
6.	Safety			
(i)	Accidents due to construction activities	<ul style="list-style-type: none"> • To ensure safe construction in the temporary accesses during construction, lighting devices and safety sign boards will be installed. • Traffic rules and regulations will be strictly adhered to. • Safety of workers undertaking various operations during construction will be ensured by providing helmets, masks, safety goggles, etc • The electrical equipment will be checked regularly • At every camp site, a readily available first aid unit including an adequate supply of dressing materials, a mode of transport (ambulance), para medical staff and an attending doctor will be provided. • Road safety education will be imparted to drivers running construction vehicles. In case of negligent driving, suitable action will be taken. • Adequate signage, barriers and persons with flags during construction to control 	Contractor	Supervision Consultants, IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		the traffic will be provided.		
(ii)	Occupation Health and Safety	<ul style="list-style-type: none"> The Contractor will provide adequate good quality Personal Protective Equipments (PPE) to all the workers working at construction zones and Plant sites and will ensure that these PPEs are used by workers at all time during works. Adequate drainage, sanitation and waste disposal will be provided at workplaces. Proper drainage will be maintained around sites to avoid water logging leading to various diseases Adequate sanitation and waste disposal facilities will be provided at construction camps by means of septic tanks, soakage pits etc. A health care system will be maintained at construction camp for routine check up of workers and avoidance of spread of any communicable disease Readily available First Aid kit bearing all necessary first aid items will be proved at all the work sites and should be regularly maintained. 	Contractor	Supervision Consultants, IWAI
7.	Wastes	<ul style="list-style-type: none"> 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
8.	Camp management Site	<ul style="list-style-type: none"> 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 	Contractor	Supervision Consultants, IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
		<p>construction and maintenance of labour camp.</p> <ul style="list-style-type: none"> The location, layout and basic facility provision of each labour camp will be submitted to the Engineer and IWAI prior to their construction. The construction will commence only upon the written approval of the Engineer. The contractor will maintain necessary living accommodation and ancillary facilities in functional and hygienic manner and as approved by the Engineer. Periodical medical check up will be ensured for all the workers The Contractor will provide potable water facilities within the precincts of every workplace in an accessible place. The sewage system for the camp will be designed, built and operated in such a fashion that it should not pollute the ground water or nearby surface water. Separate toilets/bathrooms, will be arranged for men and women Adequate water supply is to be provided in all toilets and urinals The Contractor will provide segregated garbage bins in the camps and ensure that these are regularly emptied and disposed off in a hygienic manner as per the Comprehensive Solid Waste Management Plan approved by the Environmental Expert of SC. 		
9.	Monitoring of Air, Water & Noise Quality Pollution Monitoring	<ul style="list-style-type: none"> 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 by SC will be the responsibility of Contractor 	Contractor	Supervision Consultants, IWAI
C. OPERATION PHASE				
1.	Monitoring of Operation Performance	<ul style="list-style-type: none"> The IWAI will monitor the operational performance of the various mitigation/enhancement measures carried out as a part of the project. 	Contractor	IWAI

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S. No.	Environmental issue/ Activity	Mitigation Measures	Institutional Responsibility	
			Implementation	Supervision
2.	Air	<ul style="list-style-type: none"> • Ensure compliance with the Air Act. • Ensure compliance with emission standards • Uses of cleaner fuel • Water sprinkling should be carried out at terminal sites to bring down the dust level 	IWAI	IWAI
3.	Noise	<ul style="list-style-type: none"> • 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 	IWAI	IWAI
4.	Water and Waste water	<ul style="list-style-type: none"> • 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 	IWAI	IWAI
5.	Oil Spillage from Vessel/barges	<ul style="list-style-type: none"> • All waste water and solid waste or maintenance waste should be disposed at the designated barge maintenance facility only. • Provision of oil water interceptors • Vessels should not be washed or cleaned at terminal/jetty facility and washings should not be discharged at the terminal/jetty location. Washing should be undertaken only at the maintenance facility only. 	IWAI	IWAI

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9.5 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 programme:

- 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 40**.

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Table 40: Key Environmental Laws and Regulation

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, Odisha State Pollution Control Board	√	..	This act is applicable to all environmental notifications, rules and schedules are issued under this act.
Environment Impact Assessment Notification	2006	To provide environmental clearance to new development activities following environmental impact assessment	MOEFCC	--	√	Environment Impact Assessment Notification has been issued for requirement of EIA and activities requiring clearance from Central Government in the Ministry of Environment and Forests (MoEFCC). The proposed project does not require environmental clearance as per MoEFCC letter No. F. No. 14-9/2016- IA-III dated 21st December 2017.
Municipal Solid	2000	To manage	MOEFCC, GoI,	√	..	Applicable for the

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Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
Waste (Management and Handling) Rules		collection transportation, segregation, treatment and disposal of municipal solid waste	Odisha State Pollution Control Board			project for the management of Solid waste
Indian Forest Act The Forest (Conservation) Act The Forest (Conservation) Rules	1927 1980 1981	To check deforestation by restricting conversion of forested areas into non forested areas.	Forest Department, Govt. of Odisha, MOEFCC- Regional Office and MOEFCC.	..	√	No diversion of Forest land required for this project
Wildlife (Protection) Act	1972	To protect wildlife through creation of National Parks and Sanctuaries.	Chief Conservator. Wildlife, Wildlife Wing, Forest Department, Gov. of Odisha 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.	Odisha State Pollution Control Board	√	..	Applicable during construction and operation stage
Air (Prevention	1981	To control air	Odisha State	√	..	Applicable during

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Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
and Control of Pollution) Act		pollution by controlling emission of air pollutants as per the prescribed standards.	Pollution Control Board			construction stage
Noise Pollution (Regulation and Control) Rules The Noise Pollution (Regulation and Control) Amendment Rules	2000 2006	To regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise	CPCB; SPCB & Transport Department; Govt. of Odisha	√	..	This act will be applicable during construction phase of the project.
Central Motor Vehicle Act Central Motor Vehicle Rules	1988 1989	To check vehicular air and noise pollution.	Transport Department and Odisha 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	Archaeological Dept. GOI, Indian Heritage Society and Indian National Trust for Art and Culture Heritage (INTACH).	--	√	This act will not be applicable

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Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		the construction stage. The Act requires prior authorization of the Archaeological Survey of India (ASI) for development within 300 m of a Protected Property				
Wetland Conservation and Management Rules	2010	The rule specifies the activities which are harmful and prohibited in the wetlands such as industrialization, construction, dumping of untreated waste and effluents and reclamation.	Central Wetland Regulatory Authority; MOEFCC	...	√	Not applicable
CRZ Notification	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	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.

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Acts/Rule/ Policy	Year	Objective/ criteria	Authority	Applicability		Remarks
				Yes	No	
		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.				

9.5.2 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, which is enclosed as **Annexure 4**.

9.5.3 Other Major Clearances / Approvals / Permits Applicable to the Project

The CRZ Clearances may be applicable as per the CRZ Notification 2011.

The other clearances and permits required for project at different stages is given in **Table 41**.

Table 41: Other Statutory Clearances required for the Project

S. No.	Type of Clearances / Permits	Regulatory Authority	Applicability	Project Stage	Responsibility
1	NOC and consents under Air & Water Act	Odisha Pollution Control Board	For development of Waterway	Pre-construction Stage	IWAI
2	NOC (Consent to Establish and	Odisha Pollution Control Board	For siting, erection and operation of	Construction Stage	Contractor

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S. No.	Type of Clearances / Permits	Regulatory Authority	Applicability	Project Stage	Responsibility
	Consent to Operate) under Air and Water Act		stone crusher, Hot Mix Plant, batching plant, WMM Plant etc.		
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	State Department of Mines and Geology	Quarry operation	Construction stage (Prior to initiation of Quarrying)	Contractor
5	Environmental Clearance for stone quarry	District Level environmental Impact Assessment Authority,	Opening of new Quarry and Borrow area for earth material	Construction stage (Prior to initiation of Quarrying)	Contractor
6	Permission for extraction of ground water for use in construction activities	Central Ground Water board	Extraction of ground water	Construction stage (Prior to initiation of installation of Bore wells and abstraction of water from such source)	Contractor
7	Permission for use of water for construction purpose	Irrigation department	Use of surface water for construction	Construction stage (Prior to initiation of abstraction of water from such source)	Contractor
8	Labour license	Labour Commissioner Office	Engagement of Labour	Construction stage (Prior to initiation of any work)	Contractor

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9.6 ENVIRONMENT COST

The estimated environment cost is as follows:

(A) Estimated cost at Pre-construction Stage:

The estimated cost for EIA-EMP & SIA studies have been summarized in **Table 42**:

Table 42: Summary of Estimated Cost of EIA_EMP and SIA Studies

Sl. No.	Particulars	Unit	Amount (Lakh INR)
1.	Man Power Cost (13 nos. of Experts: 1 no EC and 12 nos. FAE)	Lump sum	30.00
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	One season cost (Table 43)	8.975
3.	Public Consultation Meeting (PCM)	Lump sum	2.00
4.	Surveys/ Reports / Document Printing	Lump sum	5.00
5.	Travelling Cost for Site Visits	Lump sum	3.00
6.	Lodging & Boarding Cost	Lump sum	5.00
7.	Cost for collection of metrological data and other information like Maps etc.	Lump sum	2.00
Total			55.975

Table 43: Estimated cost for Baseline data generation

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	No. of Tentative Locations	Unit Rate (Rs)	Amount (Lakh INR)
1.	Ambient Air Quality	PM 2.5, PM10, CO, SO2, NO2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	3 (Twice a week for twelve week): 72 Nos.	10000	7.2
2.	Surface Water Quality monitoring	Physical Properties: pH, Temp., DO, Conductivity, Chemical Properties: TSS, Alkalinity, Hardness, BOD,	Grab Sampling	1	8000	0.08
3.	Ground Water Quality Monitoring		Grab Sampling	1	8000	0.08

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Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	No. of Tentative Locations	Unit Rate (Rs)	Amount (Lakh INR)
		COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. Bacteriological Properties: Total Coliform.				
4.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	1	4000	0.04
5.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K etc.	Composite sample shall be prepared based on at least 3 replicates from each location.	1	7500	0.075
6.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study	1	150000	1.5
		Sub-Total				8.975

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(B) Estimated cost at construction Stage:

Table 44: Estimated Cost during Construction Stage

Sl. No.	Particulars of Estimated Budget	Unit	Amount (Lakh INR)
1.	Environmental Monitoring Cost at Construction Stage for one year	Table 45	5.15
2.	Greenbelt Development nearby terminal Premises by Contractor	Lump sum	6.00
3.	Solid Waste Management	Lump sum	3.00
4.	Sanitary facilities at labour camps	Lump sum	3.00
5.	Disaster Management Plan	Lump sum	2.00
6.	Environmental Training	Lump sum	1.00
Total			20.15

Table 45: Environmental Monitoring Cost during Construction Phase

S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
1.	Ambient Air Quality monitoring of PM10, PM2.5, CO, SO ₂ &NO ₂ (2 locations in the interval of 3 months for 1 years except monsoon) Break up: 2 Locations X 3 Seasons X 1 Years = 6	No.	6	10,000	0.6
2.	Ambient Noise level monitoring Leq dB(A) Day & Nighttime (2 locations in the interval of 3 months for 1 year except monsoon) Break up: 2 Locations X 3 Seasons X 1 Years = 6	No.	6	4,000	0.24
3.	Monitoring of River water Quality (1 locations in the interval of 3 months for 1 years during HFL and LFL except monsoon)	No.	6	8000	0.48

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S. No.	Item	Unit	Quantity	Rate (INR.)	Amount (Lakh INR.)
	Break up: 1 Locations X 3 Seasons X 1 Years X 2 (HFL&LFL) = 6				
4.	Monitoring of ground water (1 locations in the interval of 3 months for 1 year except monsoon) Break up: 1 Location X 3 Seasons X 1 Year = 3	No.	3	8000	0.24
5.	Soil Quality monitoring (1 location along the Bank of River and 1 location at Construction site for three season for on year except monsoon) Break up: 2 Locations X 3 Seasons X 1 Year = 6	No.	6	7,500	0.45
6.	Monitoring of drinking water quality at construction camp (1 location in the interval of 3 months for 1 year except monsoon) Break up: 1 Locations X 3 Seasons X 1 Years = 3	No.	3	8,000	0.24
7.	Study of Acquatic and terrestrial fauna (2 location twice a year for two year) Break up: 1 Locations X 2 Seasons X 1 Years = 2	No	2	150000	3.00
Sub-Total					5.15

(C) Estimated cost during operation Stage

Table 46: 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 47	3.275
2.	Maintenance & Supervision of Greenbelt Developed	Lump sum	3.00
3.	Solid Waste Management	Lump sum	5.00
4.	Sanitary facilities nearby terminals	Lump sum	5.00

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5.	Miscellaneous	Lump sum	5.00
Total			21.275

Table 47: 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 once in a year for 1 years during HFL and LFL except monsoon) Break up: 1 Location X 1 Season X 1 Years X 2 (HFL&LFL) = 2	No.	2	10000	0.10
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
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					3.275

The total estimated Environmental cost for the project is given in

Table 48.

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Table 48: Estimated Environmental and Social Cost for the Project

Sl. No.	Project Stages	Cost (INR Lacs)
1.	Pre-Construction Stage	55.975
2.	Construction Stage	20.15
3.	Operational Stage	21.275
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		97.4

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10.0 INSTITUTIONAL REQUIREMENTS

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

10.1 ORGANIZATIONAL SET UP / ESTABLISHMENT

The proposed PMU organisation structure is presented in **Figure 34**

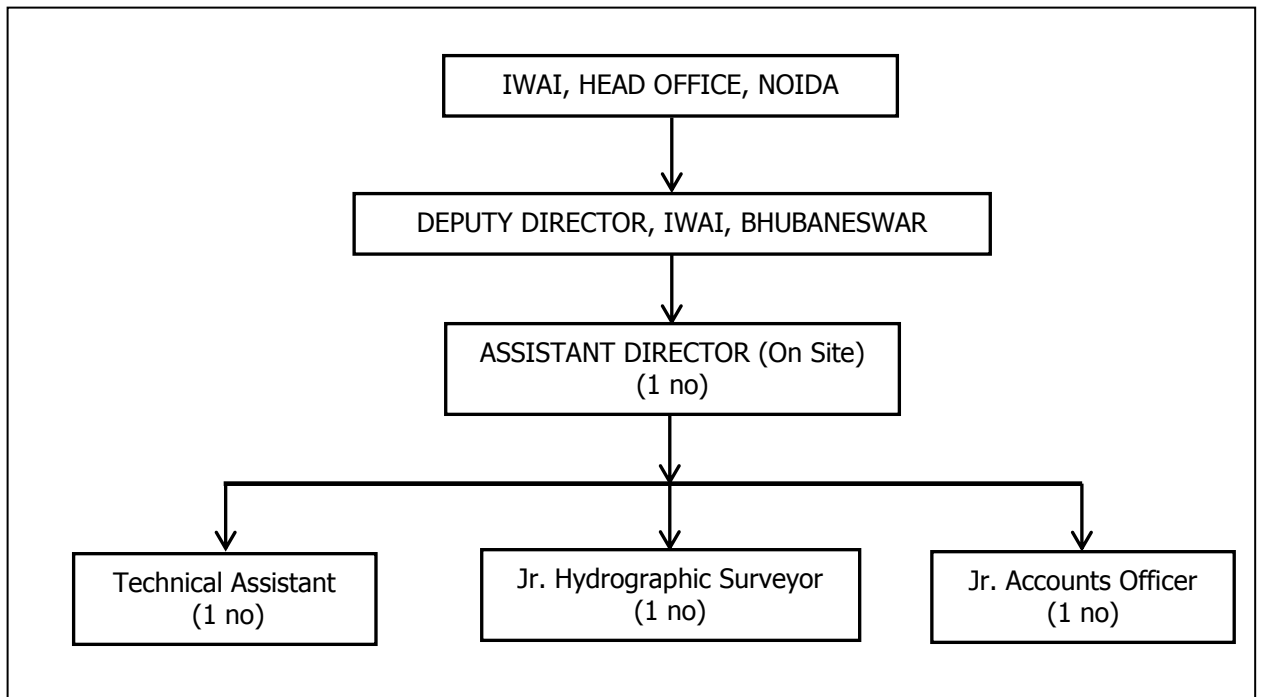


Figure 34: Organisation Structure of Project Monitoring Unit (PMU)

10.2 MAN POWER REQUIREMENT

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

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

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

10.3 TRAINING REQUIREMENT / CAPACITY BUILDING

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

10.4 INFRASTRUCTURE

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

10.4.1 Immovable

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

10.4.2 Movable

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

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

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10.5 COST IMPLICATIONS

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

Capital Cost

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

Table 49: Capital Cost for developing infrastructural works for Institutional Setup

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

Annual Expenses

Man power: The tentative manpower cost on the basis of 7th CPC is provided in **Table 50** as below:

Table 50: 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	1	4.25
3	Jr. Hydrographic Surveyor	L-6	35,400	1	4.25
4	Jr. Accounts Officer	L-6	35,400	1	4.25
6	Project/support staff		20,000	4	9.60
	Total				29.08

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The total manpower cost for Rupnarayan waterway project works out to **INR 29.08 Lacs** annually.

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

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

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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 Odisha
- b) The consultants experience on various projects sites proximity to the project area.
- c) Local enquiries at the time of conducting surveys.
- d) Market surveys and enquires
- e) Judgement based on Consultant's Experience
- f) "Estimates of State Domestic Product, Odisha", report published by Directorate of Economics & Statistics, Odisha, Bhubaneswar, dated February 2019.
- g) Land Rate for Baliapal, Balasore District of Odisha state as obtained from Odisha Industrial Infrastructure Development Corporation website <http://www.idco.in/2009/landrate.aspx>.

11.2 DEVELOPMENT COST

Subarnrekha waterway is proposed to be developed for passenger ferry services at Pantei ghat. The development cost for waterway comprises of:

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

11.3 CAPITAL EXPENDITURE

The expenses expected to be incurred in construction and development of the waterway, terminal structures including jetties and procurement of vessels are considered as capital expenditure. The detail capital cost estimated to be incurred on the basis of proposed infrastructure and preliminary design at this stage of studies is provided in **Table 51**.

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Table 51: Summary of Capital Cost of Project

Sl. No.	Item	Reference Table	Amount in Lacs (INR)
1.0	Capital cost for Fairway Development of 640m stretch		42.00
2.0	Capital cost for two (2) Terminals	Table 16	1166.20
3.0	Capital Cost for two (2) Passenger ferry Vessels	Table 28	183.996
4.0	Capital Cost for Aids to Navigation and Communication	Table 30	95.90
5.0	Cost for EMP	Table 48	76.125
6.0	Capital cost for Institutional requirements	Table 49	39.00
	Total Capital Cost (excluding Land Cost)		1603.22
7.0	Land cost for two terminals	Table 16	5.32
	Total Capital Cost (including Land Cost)		1608.54

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 52** as below:

Table 52: Summary of annual O & M Cost of Project

Sl. No.	Item	Reference Table	Amount in Lacs (INR)
1.0	O&M cost for Fairway Development		4.20
2.0	O&M cost for Terminals	Table 19	174.65
3.0	O&M Cost for Vessels	Table 29	86.16
4.0	O&M Cost for Aids to Navigation and Communication		4.80
5.0	EMP Cost during operation stage	Table 48	21.275
6.0	Operational cost under Institutional requirements		34.08
	Total O&M Cost		325.165

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11.5 PHASING OF EXPENDITURE

Based on the analysis of the Construction Schedule for a period of 2 years, the phasing of expenditures has been established during construction period. The detail of cost repartition during construction period is provided in **Table 53** and also shown in **Figure 35** below.

Table 53: Phasing of Expenditure

Months >	M1 – M6	M7 – M12	M13 – M18	M19 – M24
% of Cash Flow	15%	30%	30%	25%
Total Cash Flow INR Lacs (excluding land cost)	240.48	480.97	480.97	400.81
Total Cash Flow INR Lacs (including land cost)	241.28	482.56	482.56	402.14

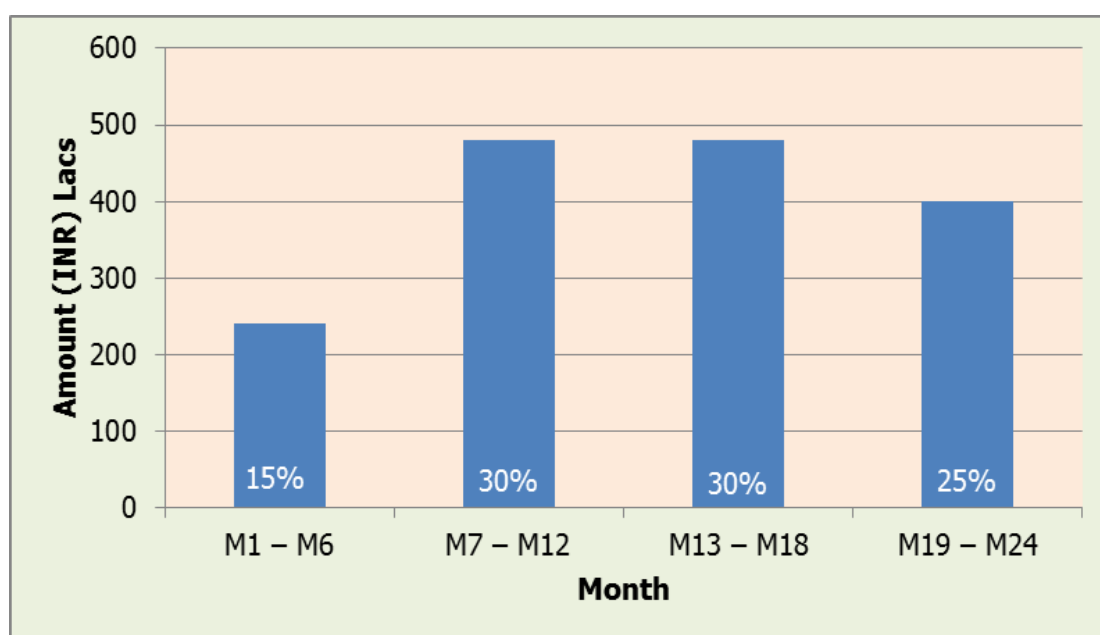


Figure 35: Phasing of Expenditure (excluding land cost)

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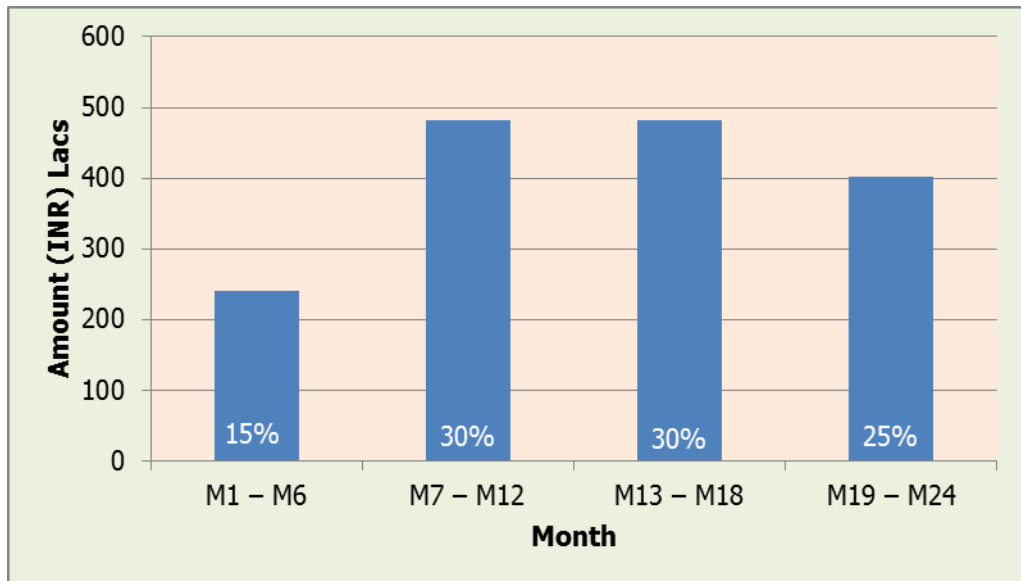


Figure 36: Phasing of Expenditure (including land cost)

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12.0 IMPLEMENTATION SCHEDULE

The implementation schedule for the development of 640 m stretch of Subarnrekha fairway and its associated facilities are presented in this chapter. The probable time schedule for various activities from onset to completion of the project and commencement of operation are also discussed in this chapter.

12.1 TIME FRAME

The total project is scheduled to be completed in 24 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 Subarnrekha waterway include both the construction of offshore and onshore facilities, apart from installation of mechanical and electrical equipment's.

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

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

12.3 SUGGESTED IMPLEMENTATION MECHANISM

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

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

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The following are the major activities involved for effective completion of Subarnrekha 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 ferry terminal;
- Construction of offshore facilities for ferry terminal;
- Procurement of vessels;
- Up gradation/construction of access roads;
- Supply, installation and commission of electrical and mechanical equipment's.

12.4 PROJECT CONSTRUCTION SCHEDULE

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Sl. No.	Activities	1 st Year												2 nd Year												
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	
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)	Dredging				■		■		■		■		■													
4	Procurement and installation of Aids to Navigation							■																		
5	Setting up of IWT terminals																									
a)	Land acquisition	■																								
b)	Construction of terminal building, landside facilities													■												
6	Upgrading existing road to terminals																								■	

Figure 37: Construction Schedule

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13.0 ECONOMIC AND FINANCIAL ANALYSIS

Financial feasibility is a key determinant in a business oriented investment decision. In case of the projects of public/national interest like development of Inland Water Terminals, the viability of the project depends on the economic feasibility which act as the deciding factor. In this chapter, the financial and economic viability for development of Subarnrekha 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 following assumption as stated below:

- a) 2 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 has been worked out by considering the tariff of commodity movement by IWT as INR 6/- per person per trip for passenger ferry services, with an increment of 10% per year. On the basis of above assumptions, the revenue that could be generated from passenger ferry operations at Pantei ghat on Subarnrekha waterway is provided in **Table 54**.

Table 54: Annual Revenue Generation with 5% passenger growth trend

Sl. No	Year	No. of Passengers	Annual Revenue (INR Lacs)
0	2020	2205	79.38
1	2021	2315	91.68
2	2022	2431	105.89
3	2023	2553	122.31
4	2024	2680	141.27
5	2025	2814	163.16

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Sl. No	Year	No. of Passengers	Annual Revenue (INR Lacs)
6	2026	2955	188.45
7	2027	3103	217.66
8	2028	3258	251.40
9	2029	3421	290.37
10	2030	3592	335.38
11	2031	3771	387.36
12	2032	3960	447.40
13	2033	4158	516.75
14	2034	4366	596.84
15	2035	4584	689.35
16	2036	4813	796.20
17	2037	5054	919.61
18	2038	5307	1,062.15
19	2039	5572	1,226.79
20	2040	5851	1,416.94

13.2 FINANCIAL ANALYSIS/ FIRR

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

The direct and indirect benefits of the project are following:

- 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.

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The financial analysis of the project is done on the basis of estimated cost proposed to be incurred for construction/development of fairway, terminal and procurement of vessels including other miscellaneous expenses, O& M cost proposed to be incurred during proposed project life cycle of 20 years and revenue that could be generated.

The implementation of this project has been conceptualized as Government funded project and in view of small capital cost, no loan has been considered. However, the FIRR for Subarnrekha waterway is done with following options:

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

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

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

The Financial analysis for all the above options are worked out and provided in **Table 55** to **Table 59**.

Table 55: FIRR (Option 1: Total Capital Cost + Total O&M cost) excluding Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-2	2018-2019	721.45		721.45		-721.45
-1	2019-2020	881.77		881.77		-881.77
0	2020-2021		325.17	325.17	79.38	-245.79
1	2021-2022		341.42	341.42	91.68	-249.74
2	2022-2023		358.49	358.49	105.89	-252.60
3	2023-2024		376.42	376.42	122.31	-254.11
4	2024-2025		395.24	395.24	141.27	-253.97
5	2025-2026		415.00	415.00	163.16	-251.84
6	2026-2027		435.75	435.75	188.45	-247.30
7	2027-2028		457.54	457.54	217.66	-239.88
8	2028-2029		480.42	480.42	251.40	-229.02
9	2029-2030		504.44	504.44	290.37	-214.07
10	2030-2031		529.66	529.66	335.38	-194.28
11	2031-2032		556.14	556.14	387.36	-168.78
12	2032-2033		583.95	583.95	447.40	-136.55

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Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
13	2033-2034		613.15	613.15	516.75	-96.40
14	2034-2035		643.80	643.80	596.84	-46.96
15	2035-2036		675.99	675.99	689.35	13.36
16	2036-2037		709.79	709.79	796.20	86.41
17	2037-2038		745.28	745.28	919.61	174.33
18	2038-2039		782.55	782.55	1,062.15	279.60
19	2039-2040		821.68	821.68	1,226.79	405.11
20	2040-2041		862.76	862.76	1,416.94	554.18
					IRR	-7.47%

Table 56: FIRR (Option 1: Total Capital Cost + Total O&M cost) including Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-2	2018-2019	723.84		723.84		-723.84
-1	2019-2020	884.70		884.70		-884.70
0	2020-2021		325.17	325.17	79.38	-245.79
1	2021-2022		341.42	341.42	91.68	-249.74
2	2022-2023		358.49	358.49	105.89	-252.60
3	2023-2024		376.42	376.42	122.31	-254.11
4	2024-2025		395.24	395.24	141.27	-253.97
5	2025-2026		415.00	415.00	163.16	-251.84
6	2026-2027		435.75	435.75	188.45	-247.30
7	2027-2028		457.54	457.54	217.66	-239.88
8	2028-2029		480.42	480.42	251.40	-229.02
9	2029-2030		504.44	504.44	290.37	-214.07
10	2030-2031		529.66	529.66	335.38	-194.28
11	2031-2032		556.14	556.14	387.36	-168.78
12	2032-2033		583.95	583.95	447.40	-136.55
13	2033-2034		613.15	613.15	516.75	-96.40
14	2034-2035		643.80	643.80	596.84	-46.96

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Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
15	2035-2036		675.99	675.99	689.35	13.36
16	2036-2037		709.79	709.79	796.20	86.41
17	2037-2038		745.28	745.28	919.61	174.33
18	2038-2039		782.55	782.55	1,062.15	279.60
19	2039-2040		821.68	821.68	1,226.79	405.11
20	2040-2041		862.76	862.76	1,416.94	554.18
					IRR	-7.48%

Table 57: FIRR (Option 2: Option 1 - Vessel Capital & O&M cost) excluding Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-2	2018-2019	638.65		638.65		-638.65
-1	2019-2020	780.57		780.57		-780.57
0	2021-2022		239.01	239.01	79.38	-159.63
1	2022-2023		250.96	250.96	91.68	-159.27
2	2023-2024		263.50	263.50	105.89	-157.61
3	2024-2025		276.68	276.68	122.31	-154.37
4	2025-2026		290.51	290.51	141.27	-149.25
5	2026-2027		305.04	305.04	163.16	-141.87
6	2027-2028		320.29	320.29	188.45	-131.84
7	2028-2029		336.30	336.30	217.66	-118.64
8	2029-2030		353.12	353.12	251.40	-101.72
9	2030-2031		370.78	370.78	290.37	-80.41
10	2031-2032		389.31	389.31	335.38	-53.94
11	2032-2033		408.78	408.78	387.36	-21.42
12	2033-2034		429.22	429.22	447.40	18.18
13	2034-2035		450.68	450.68	516.75	66.07
14	2035-2036		473.21	473.21	596.84	123.63
15	2036-2037		496.87	496.87	689.35	192.48
16	2037-2038		521.72	521.72	796.20	274.48

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Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
17	2038-2039		547.80	547.80	919.61	371.81
18	2039-2040		575.19	575.19	1,062.15	486.96
19	2040-2041		603.95	603.95	1,226.79	622.83
20	2041-2042		634.15	634.15	1,416.94	782.79
					IRR	0.19%

Table 58: FIRR (Option 2: Option 1 - Vessel Capital & O&M cost) including Land Cost

Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-2	2018-2019	641.05		641.05		-641.05
-1	2019-2020	783.50		783.50		-783.50
0	2021-2022		239.01	239.01	79.38	-159.63
1	2022-2023		250.96	250.96	91.68	-159.27
2	2023-2024		263.50	263.50	105.89	-157.61
3	2024-2025		276.68	276.68	122.31	-154.37
4	2025-2026		290.51	290.51	141.27	-149.25
5	2026-2027		305.04	305.04	163.16	-141.87
6	2027-2028		320.29	320.29	188.45	-131.84
7	2028-2029		336.30	336.30	217.66	-118.64
8	2029-2030		353.12	353.12	251.40	-101.72
9	2030-2031		370.78	370.78	290.37	-80.41
10	2031-2032		389.31	389.31	335.38	-53.94
11	2032-2033		408.78	408.78	387.36	-21.42
12	2033-2034		429.22	429.22	447.40	18.18
13	2034-2035		450.68	450.68	516.75	66.07
14	2035-2036		473.21	473.21	596.84	123.63
15	2036-2037		496.87	496.87	689.35	192.48
16	2037-2038		521.72	521.72	796.20	274.48
17	2038-2039		547.80	547.80	919.61	371.81
18	2039-2040		575.19	575.19	1,062.15	486.96

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SUBARNREKHA RIVER (30 KM)**

Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
19	2040-2041		603.95	603.95	1,226.79	622.83
20	2041-2042		634.15	634.15	1,416.94	782.79
					IRR	0.18%

Table 59: FIRR (Option 3: Vessel Capital Cost + Vessel O&M Cost)

Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
-2	2018-2019	0.00		0.00		-
-1	2019-2020	184.00		184.00		-184.00
0	2021-2022		86.16	86.16	79.38	-6.78
1	2022-2023		90.47	90.47	91.68	1.22
2	2023-2024		94.99	94.99	105.89	10.90
3	2024-2025		99.74	99.74	122.31	22.57
4	2025-2026		104.73	104.73	141.27	36.54
5	2026-2027		109.96	109.96	163.16	53.20
6	2027-2028		115.46	115.46	188.45	72.99
7	2028-2029		121.24	121.24	217.66	96.43
8	2029-2030		127.30	127.30	251.40	124.10
9	2030-2031		133.66	133.66	290.37	156.71
10	2031-2032		140.35	140.35	335.38	195.03
11	2032-2033		147.36	147.36	387.36	240.00
12	2033-2034		154.73	154.73	447.40	292.67
13	2034-2035		162.47	162.47	516.75	354.28
14	2035-2036		170.59	170.59	596.84	426.25
15	2036-2037		179.12	179.12	689.35	510.23
16	2037-2038		188.08	188.08	796.20	608.12
17	2038-2039		197.48	197.48	919.61	722.13
18	2039-2040		207.35	207.35	1,062.15	854.80
19	2040-2041		217.72	217.72	1,226.79	1,009.06
20	2041-2042		228.61	228.61	1,416.94	1,188.33

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Sl. No	Year	Capital Cost (INR Lacs)	O&M Cost (INR Lacs)	Total Outflow (INR Lacs)	Revenue (INR Lacs)	Net Cash Flow (INR Lacs)
					IRR	28.51%

From the above analysis with various options it is concluded that the passenger ferry services in Subarnrekha waterway is financially viable with Option 2 and Option 3, separately, which shows that the implementation of the whole project may be taken up as two packages:

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

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

13.3 ECONOMIC ANALYSIS / EIRR

Jetties proposed at Pantei ghat on Subarnrekha waterway to cater passenger traffic only. Hence economic benefit due to road and rail haulage cost saving, road accident cost savings and carbon savings is not considered for economic evaluation. Also, as the ferry operations are currently active along the proposed fairway route, saving in fuel cost due to IWT operation is also not foreseen.

Economic benefit only due to job creation is considered for economic evaluation. The economic benefit analysis, done for the proposed fairway is provided in **Table 60**.

Table 60: Economic benefit from IWT as compared to Road Transport

Job creation per year =	54	numbers
Average annual salary =	400000	INR
Average existing annual salary =	144000	INR
Annual additional earning by Job creation =	13824000	INR per year
	138.24	INR Lacs per year
Total savings by using IWT from road transport =	138.24	INR Lacs per year
Incremental saving per year =	1%	

Similar to FIRR, EIRR for Subarnrekha waterway is also done with following options:

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

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

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

EIRR is calculated for all the above four options and summary of all FIRRs and EIRRs is provided in **Table 61 & Table 62.**

Table 61: FIRR & EIRR for various options excluding Land Cost

Sl. No	Year	Economic Benefit (INR lacs)	Option-1		Option-2		Option-3	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
-2	2018-2019		-721.45	-721.45	-638.65	-638.65	-	0.00
-1	2019-2020		-881.77	-881.77	-780.57	-780.57	-184.00	-184.00
0	2020-2021	138.24	-245.79	-107.55	-159.63	-21.39	-6.78	131.46
1	2021-2022	139.62	-249.74	-110.12	-159.27	-19.65	1.22	140.84
2	2022-2023	141.02	-252.60	-111.58	-157.61	-16.59	10.90	151.92
3	2023-2024	142.43	-254.11	-111.68	-154.37	-11.94	22.57	165.00
4	2024-2025	143.85	-253.97	-110.12	-149.25	-5.39	36.54	180.39
5	2025-2026	145.29	-251.84	-106.55	-141.87	3.42	53.20	198.49
6	2026-2027	146.74	-247.30	-100.55	-131.84	14.91	72.99	219.73
7	2027-2028	148.21	-239.88	-91.66	-118.64	29.57	96.43	244.64
8	2028-2029	149.69	-229.02	-79.32	-101.72	47.98	124.10	273.80
9	2029-2030	151.19	-214.07	-62.88	-80.41	70.78	156.71	307.90
10	2030-2031	152.70	-194.28	-41.58	-53.94	98.76	195.03	347.73
11	2031-2032	154.23	-168.78	-14.55	-21.42	132.81	240.00	394.23
12	2032-2033	155.77	-136.55	19.22	18.18	173.95	292.67	448.44
13	2033-2034	157.33	-96.40	60.93	66.07	223.40	354.28	511.61
14	2034-2035	158.90	-46.96	111.94	123.63	282.53	426.25	585.15
15	2035-2036	160.49	13.36	173.85	192.48	352.97	510.23	670.72
16	2036-2037	162.10	86.41	248.50	274.48	436.58	608.12	770.22
17	2037-2038	163.72	174.33	338.05	371.81	535.53	722.13	885.85
18	2038-2039	165.36	279.60	444.96	486.96	652.31	854.80	1020.15
19	2039-2040	167.01	405.11	572.12	622.83	789.84	1,009.06	1176.07
20	2040-2041	168.68	554.18	722.86	782.79	951.47	1,188.33	1357.01

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Sl. No	Year	Economic Benefit (INR lacs)	Option-1		Option-2		Option-3	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
	Internal Rate of Return (IRR)		-7.47%	0.09%	0.19%	6.84%	28.51%	79.68%

Table 62: FIRR & EIRR for various options including Land Cost

Sl. No	Year	Economic Benefit (INR lacs)	Option-1		Option-2		Option-3	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
-2	2018-2019		-723.84	-723.84	-641.05	-641.05	-	0.00
-1	2019-2020		-884.70	-884.70	-783.50	-783.50	-184.00	-184.00
0	2020-2021	138.24	-245.79	-107.55	-159.63	-21.39	-6.78	131.46
1	2021-2022	139.62	-249.74	-110.12	-159.27	-19.65	1.22	140.84
2	2022-2023	141.02	-252.60	-111.58	-157.61	-16.59	10.90	151.92
3	2023-2024	142.43	-254.11	-111.68	-154.37	-11.94	22.57	165.00
4	2024-2025	143.85	-253.97	-110.12	-149.25	-5.39	36.54	180.39
5	2025-2026	145.29	-251.84	-106.55	-141.87	3.42	53.20	198.49
6	2026-2027	146.74	-247.30	-100.55	-131.84	14.91	72.99	219.73
7	2027-2028	148.21	-239.88	-91.66	-118.64	29.57	96.43	244.64
8	2028-2029	149.69	-229.02	-79.32	-101.72	47.98	124.10	273.80
9	2029-2030	151.19	-214.07	-62.88	-80.41	70.78	156.71	307.90
10	2030-2031	152.70	-194.28	-41.58	-53.94	98.76	195.03	347.73
11	2031-2032	154.23	-168.78	-14.55	-21.42	132.81	240.00	394.23
12	2032-2033	155.77	-136.55	19.22	18.18	173.95	292.67	448.44
13	2033-2034	157.33	-96.40	60.93	66.07	223.40	354.28	511.61
14	2034-2035	158.90	-46.96	111.94	123.63	282.53	426.25	585.15
15	2035-2036	160.49	13.36	173.85	192.48	352.97	510.23	670.72
16	2036-2037	162.10	86.41	248.50	274.48	436.58	608.12	770.22
17	2037-2038	163.72	174.33	338.05	371.81	535.53	722.13	885.85
18	2038-2039	165.36	279.60	444.96	486.96	652.31	854.80	1020.15
19	2039-2040	167.01	405.11	572.12	622.83	789.84	1,009.06	1176.07
20	2040-2041	168.68	554.18	722.86	782.79	951.47	1,188.33	1357.01

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Sl. No	Year	Economic Benefit (INR lacs)	Option-1		Option-2		Option-3	
			Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)	Financial Income (INR Lacs)	Total Income (INR Lacs)
	Internal Rate of Return (IRR)		-7.48%	0.08%	0.18%	6.82%	28.51%	79.68%

13.4 SENSITIVITY ANALYSIS

Sensitivity analysis shows the uncertainty in the output values for different sources of uncertainty in its inputs. The financial and economic evaluation of proposed IWT operations in Subarnrekha 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 Subarnrekha waterway is carried out for varying fare considering the basic operational and serviceability conditions as same. For varying fare, the change in FIRR and EIRR is shown in **Table 63** & **Table 64**.

Table 63: Sensitivity Analysis w.r.t to varying IWT fare excluding land cost

Sr. No.	Fare (INR) (per trip one way)	FIRR (%)			EIRR (%)		
		Option-1	Option-2	Option-3	Option-1	Option-2	Option-3
1	3.00	Not Calculable	Not Calculable	10.55	Not Calculable	-7.6	54.99
2	5.00	Not Calculable	-4.05	23.05	-4.48	3.93	71.71
3	6.00	-7.47	0.19	28.51	0.09	6.84	79.68
4	8.00	0.30	5.61	39.45	5.66	11.12	95.21
5	10.00	4.82	9.37	51.02	9.42	14.4	110.42
6	12.00	8.14	12.36	63.33	12.38	17.14	125.42
	Not Calculable	All/majorly negative cash-flows					

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Table 64: Sensitivity Analysis w.r.t to varying IWT fare including land cost

Sr. No.	Fare (INR)	FIRR (%)			EIRR (%)		
	(per trip one way)	Option-1	Option-2	Option-3	Option-1	Option-2	Option-3
1	3.00	Not Calculable	Not Calculable	10.55	Not Calculable	-7.61	54.99
2	5.00	Not Calculable	4.06	23.05	-4.49	3.91	71.71
3	6.00	-7.48	0.18	28.51	0.08	6.82	79.68
4	8.00	0.29	5.59	39.45	5.64	11.1	95.21
5	10.00	4.81	9.35	51.02	9.4	14.37	110.42
6	12.00	8.13	12.34	63.33	12.36	17.1	125.42
	Not Calculable	All/majorly negative cash-flows					

From the above table, it can be concluded that with the existing tariff of INR 3/- per person per trip as detailed in Traffic study chapter, the proposed IWT operation along Subarnrekha waterway is not financially viable and economically viable for Option 1 and 2.

However, in case the project is implemented in two packages, as defined above, both the packages become financially and economically viable with a tariff of INR 6.00 per person one way.

13.5 RISK FACTORS AND MITIGATION

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

- a) Dependency on inter-modality –

Integrated road transport connectivity is required for passenger ferry services.

13.6 NECESSITY OF GOVT. SUPPORT (VGF/PPP)

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

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

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

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

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

The project should provide a service against payment of a predetermined tariff or user charge.

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

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

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

FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96 SUBARNREKHA RIVER (30 KM)

14.0 CONCLUSIONS AND RECOMMENDATIONS

The viability of Island Water Transport project for introduction of navigation on any waterway can be judged by both technically and commercially. The technical viability of the project can be assessed based on availability of discharges to maintain navigable depth in a design channel suitable to ply design vessel. The commercial viability of the project can be gauged 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 and so on. The recommendation for implementation of the project is 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 design waterway and construction of IWT terminals has been worked out as INR 1603.22/- Lacs excluding land cost and INR 1608.54 Lacs including land cost and the estimated operating and maintenance cost per annum is INR 325.165/- Lacs.

The cost benefit analysis, calculations done for financial internal rate of return (FIRR) and Economic internal rate of return (EIRR) concludes that the project is financially and economically viable with a tariff of INR 6.00 per trip one way, in case the project is implemented in two packages as below:

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

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

ANNEXURES

ANNEXURE – 1
ToR OF THE AGREEMENT

ANNEXURES – 2

MINIMUM AND MAXIMUM DEPTH W.R.T SD

(For total stretch of 30 Km)

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

Chainage (km)		Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
0	1	2.5	5.2	0	0	0
1	2	2.3	3.6	0	0	0
2	3	3	6.9	0	0	0
3	4	4.7	8.3	0	0	0
4	5	4	9	0	0	0
5	6	2.4	5.2	0	0	0
6	7	1.4	3.4	41	242.77	242.77
7	8	2	5.1	0	0	242.77
8	9	1.8	6.3	0	0	242.77
9	10	1.4	6.5	0	0	242.77
10	11	1.2	3.2	56	1105.32	1348.09
11	12	2.3	4.7	367	2742.75	4090.84
12	13	0.6	3.4	22	82.8	4173.64
13	14	0.1	3.3	415	15574.89	19748.53
14	15	1	4.8	836	28691.31	48439.84
15	16	0.5	4.8	432	20161.14	68600.98
16	17	1.1	3	403	18570	87170.98
17	18	2.2	9.2	185	713.59	87884.57
18	19	1.5	8	295	273.47	88158.04
19	20	0.1	6.3	9	6.35	88164.39
20	21	0.9	7.6	96	524.88	88689.27
21	22	-0.3	7.1	736	23268.37	111957.6
22	23	-0.7	0.8	230	10948.26	122905.9
23	24	-0.3	7.3	1000	62412.84	185318.7
24	25	1.2	7.3	1000	95418.76	280737.5
25	26	0.5	10.6	599	9330.21	290067.7
26	27	1.6	10.7	653	3330.03	293397.7

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

Chainage (km)		Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulative Dredging Qty.
27	28	1.1	7.4	726	9120.55	302518.25
28	29	0.1	6.6	1000	50011.14	352529.39
29	30	-0.5	3.7	1000	71387.37	423916.76

ANNEXURES – 3

ENVIRONMENTAL & SOCIAL SCREENING TEMPLATE

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

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	√		At the mouth of Bay of Bengal on the left bank of Subarnarekha River there is a Mangrove forest patch present namely, Bichitrapur Bani PRF
f) Wetland		√	
g) Important Bird Areas		√	
h) Mangroves Areas	√		At the mouth of Bay of Bengal on the left bank of Subarnarekha River there is a Mangrove forest patch present namely, Bichitrapur Bani PRF
i) Estuary with Mangroves	√		-do-
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration	√		<ul style="list-style-type: none"> • Migratory Olive Ridely Turtles (<i>Lepidochelys olivacea</i>; Schedule I), are seen in the coast of Bay of Bengal as well as in the confluence area of Subarnarekha River for nesting purpose (during November to March) • South Asian river Dolphins (<i>Platanista gangetica</i>; Schedule I) the freshwater species are spotted in Subarnarekha River
k) World Heritage Sites		√	
l) Archeological monuments/ sites (under ASI's Central / State list)		√	<ul style="list-style-type: none"> • An ASI site, the mud fort complex at Raibania is located far away (about 17Km away from project stretch) on the right bank of the river Subarnarekha
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?	√		Jetty / Terminal is proposed
6. Is the project involved dredging?	√		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding,	√		Prone to Flood, Cyclones and heavy winds

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

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

S. N.	Result of Screening Exercise	(Yes / No)
1	Environment Impact Assessment is Required	Yes
2	CRZ Clearance is Required	Yes. 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

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**

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

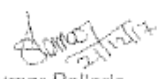
Subject: Non-requirement of environment clearance for maintenance dredging in rivers for the purpose of navigation - regarding.

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 Pallarla
Director

To

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

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FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96 SUBARNREKHA RIVER (30 KM)

ANNEXURE

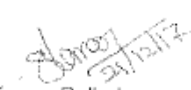
Environmental safety measures to be implemented

- 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.

Page 2 of 3

FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96 SUBARNREKHA RIVER (30 KM)

- 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

ANNEXURES – 5

PHOTOGRAPHS

FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96 SUBARNREKHA RIVER (30 KM)



Topographic Survey



Bathymetric Survey

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Data Logging system in Boat



BM SR- 1

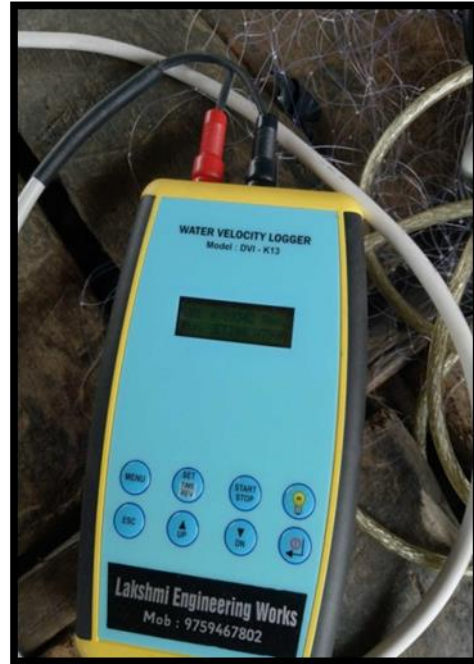


Tide Reading

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Tide Pole near SR-1



Current meter Observation



Boat Mobilisation

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Sand Dunes at Chainage 0.0



Bank Protection at Chainage 1.0



Chandrabali Jetty Area at Chainage 1.5

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Chandrabali Jetty Area at Chainage 1.5



Bank Protection at Chainage 1.4

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Project Bank Protection at Chainage 1.4 near Chandrabali



Fishing Pond at Chainage 2.5

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Opo survey & Bank Protection at Chainage 4.0



Fishing Pond at Chainage 5.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Vusudeswar Creek at chainge 4.6



Fishing Boats near Chainge 4.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Soil Erosion at chainge 5.5



Unprotected Bank at chainge 6.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Soil Erosion at chainge 7.5



Soil Erosion at chainge 8.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Mangrooves at Chainge 8.5 to 9.0



Sand dunes at Chainge 9.5

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Soil Erosion at Chainge 11.0



Soil Erosion at Chainge 12.3

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Bank Erosion at Chainage 13.0



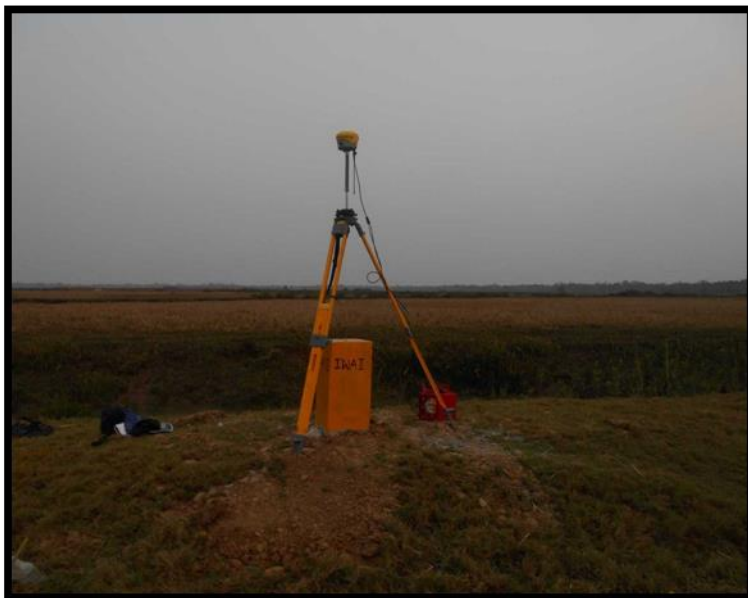
Dense Bushes at Chainage 15.5



Bathymetric Survey



**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Base Station At BM SR 2



Creek at Chainage 15.5



Unprotected Bank at Chainage 13.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Island at chainage 15.0



**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Current meter observation

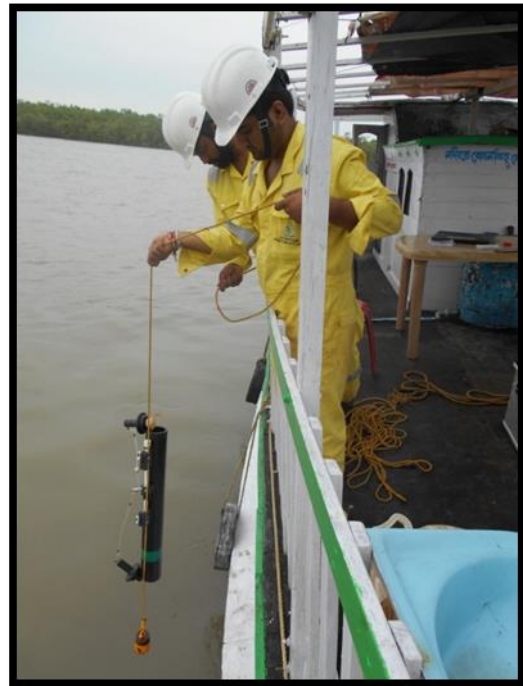


Gathering Topo Points at Low Water Level

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Shallow Patch during Low Water



Water Sampler



BM SR 3



BM SR 4

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Current Meter Observation



Island at Chainage 20.5

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Bank Protection at Chainage 24.0



Bunds at Chainage 28.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Bridge at Balipal Chainage 29.0



Bridge at Balipal Chainage 29.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Bank Protection at Chainage 28.3



Bund at Chainage 29.0

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



River Bank at Chainage 29.5



Temple at Chainage 29.5

**FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO. 96
SUBARNREKHA RIVER (30 KM)**



Boat Grounded at Chainage 30.0

VOLUME – II

DRAWINGS