BAITARANI RIVER – FINAL DETAILED PROJECT REPORT (DPR) OF NATIONAL WATERWAY NO-14 FROM RIVER MOUTH, DHAMARA (ODISHA) TO DUTTAPUR (ODISHA) LENGTH 48 KM

Volume I: Main Report

DATE OF SUBMISSION: 01 October 2019

CLIENT

	INLAND WATERWAYS AUTHORITY OF INDIA **A-13, Sector-1,** **NOIDA** **DIST-Gautam Budha Nagar** **UTTAR PRADESH** **PIN- 201 301(UP)** **Email:** hc.iwai@nic.in **Web:** www.iwai.nic.in

CONSULTANT:

	Feedback Infra Private Limited **15th Floor, Tower 9B, DLF Cyber City Phase-III** **Gurgaon-122002, Haryana, India** **Tel: + 91 124 431 6100, Fax: + 91 124 431 6655** **Email: transportation@feedbackinfra.com**

Detailed Project Report (DPR) of National Waterway 14: Baitarani River

Stretch: From River Mouth, Dhamra (Odisha) To Duttapur (Odisha) Length 27.24 Km

Volume – I Detail Project Report

Prepared for	Inland Waterways Authority of India
Represented by	Hydrographic Chief

STRUCTURE OF DETAILED PROJECT REPORT

The report contains the following details/Volumes

Volume I – Main Report/Detailed Project Report

- Annexure I – Cost Estimate
- Annexure II – Construction Schedule
- Annexure III –Terms of Reference

Volume II – Drawings

Volume III – Hydrographic Survey

- Volume IIIA - Hydrographic Survey Report
- Volume IIIB - Hydrographic Survey Charts

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LIST OF ABBREVATIONS

AD	:	After Death
AMHS	:	Admiralty Manual of Hydrographic Surveying
BM	:	Benchmark
BOCW	:	Building and Other Construction Workers
BOD	:	Build Own Operate
BOT	:	Build Operate Transfer
BOOT	:	Build Own Operate and Transfer
°C	:	Degree Celsius
CAPEX	:	Capital Expenditure
CD	:	Conservation Dependent
CH	:	Chainage
CP	:	Control Point
CPCB	:	Central Pollution Control Board
CPWD	:	Central Public Works Department
Cr.	:	Crore
CR	:	Critically Endangered
CRZ	:	Coastal Regulation Zone
CSD	:	Cutter Section Dredgers
CUM	:	Cubic Meter
dB	:	Decibels
DM	:	District Magistrate
DPR	:	Detailed Project Report
DG	:	Diesel Generator
DGLL	:	Directorate General of Lighthouses and Lightships
DGPS	:	Differential Global Positioning System
DPCL	:	Dharma Port Company Limited
DWT	:	Deadweight Tonnage
E	:	Easting
EIA	:	Environment Impact Assessment

EIRR	:	Economic Internal Rate of Return
EMP	:	Environment Management/Monitoring Plan
EN	:	Endangered
EPC	:	Engineering, Procurement and Construction
FACOR	:	Ferro Alloys Corporation
FIRR	:	Financial Internal Rate of Return
Fy	:	Yield Stress
G&D	:	Gauge & Discharge
GI	:	Galvanized Iron
GIS	:	Geographic Information System
GL	:	Ground Level
Govt.	:	Government
GPS	:	Global Positioning System
HC	:	Horizontal Crossing
HF	:	High Frequency
HFL	:	High Flood Level
HW	:	High Water
INR	:	Indian Rupees
IBAT	:	Integrated Biodiversity Assessment Tool
IS	:	Indian Standards
IWT	:	Inland Water Transport
IWAI	:	Inland Waterways Authority of India
IHO	:	International Hydrographic Organization
IMD	:	Indian Meteorological Department
IUCN	:	International Union for Conservation of Nature
Km	:	Kilo Meter
Kmph	:	Kilometre per Hour
KN	:	Kilo Newton
LAD	:	Least Available Depth
LAT	:	Latitude
LC	:	Least Concern

LOA	:	Length Over All
LONG	:	Longitude
LW	:	Low Water
LWL	:	Load Waterline Length
MDR	:	Major District Roads
M	:	Meter
MAX	:	Maximum
MARPOL	:	Marine Pollution
MHWS	:	Mean High Water Springs
MHWN	:	Mean High Water Neaps
MIN	:	Minimum
MLWS	:	Mean Low Water Springs
MoEF &CC	:	Ministry of Environment, Forests and Climatic Change
MoWR	:	Ministry of Water Resources
Mpa	:	Mega Pascal
MT	:	Metric Tonne
MSL	:	Mean Sea Level
MTPA	:	Metric Tonnes Per Annum
N	:	Northing
NAAQ	:	National Ambient Air Quality
NBWL	:	National Board for Wildlife
NH	:	National Highway
NIC	:	National Informatics Centre
NOC	:	No Objection Certificate
NPV	:	Net Present Value
NT	:	Near Threatened
NW	:	National Waterway
O&M	:	Operation & Maintenance
OPEX	:	Operational Expenditure
OPSCB	:	Odisha State Pollution Control Board
OSDMA	:	Odisha Disaster Mitigation Authority

OSWC	:	Odisha State Warehouses Corporation
OTDC	:	Odisha Tourism Development Corporation
p.a.	:	Per Annum
PM	:	Particulate Matter
PUC	:	Pollution Under Control
RCC	:	Reinforced Cement Concrete
RFP	:	Request for Proposal
RIS	:	River Information Services
RRC	:	Rice Receiving Centres
SBWL	:	State Board for Wildlife
SD/CD	:	Sounding Datum/ Chart Datum
SDM	:	Sub-Divisional Magistrate
SEIAA	:	State Level Environment Impact Assessment Authority
SH	:	State Highway
SONAR	:	Sound Navigation and Ranging
SPCB	:	State Pollution Control Board
STP	:	Sewage Treatment Plan
SPV	:	Special Purpose Vehicle
Sqm	:	Square Meter
SWOT	:	Strength Weak Opportunity Threat
TOR	:	Terms of Reference
TP	:	Transfer Point
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
VC	:	Vertical Crossing
VHF	:	Very High Frequency
VU	:	Vulnerable
WACC	:	Weighted Average Cost of Capital
WGS	:	World Geodetic System
WL	:	Wildlife

SALIENT FEATURES AT A GLANCE

<table>
<tr><th>Sl. No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>FEEDBACK INFRA PVT. LTD</td></tr>
<tr><td>2.</td><td>Region number & State(s)</td><td>Odisha</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW #
(from…. to; total length)</td><td>NW-14, From Baitarni River Mouth to Duttapur, 48Km
<table>
<tr><th>Stretch</th><th>CH from</th><th>CH to</th><th>Kms</th><th>Location</th></tr>
<tr><td>1</td><td>0.00</td><td>10.00</td><td>10</td><td>Nuagan to Baradia</td></tr>
<tr><td>2</td><td>10.00</td><td>20.00</td><td>10</td><td>Baradia to Matia</td></tr>
<tr><td>3</td><td>20.00</td><td>30.00</td><td>10</td><td>Matia to Kanpur</td></tr>
<tr><td>4</td><td>30.00</td><td>40.00</td><td>10</td><td>Kanpur to Gunthni Pada</td></tr>
<tr><td>5</td><td>40.00</td><td>48.00</td><td>8.0</td><td>Gunthni Pada to Duttapur</td></tr>
</table></td></tr>
<tr><td>4.</td><td>Navigability status</td><td>Ferry services are available in Baitarni River, Partly Navigable.</td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions
(from… to, length, average tidal variation)</td><td>Full stretch of survey river is tidal.
<table>
<tr><th></th><th>STRETCH 1 (0-10) KM</th><th>STRETCH 2 (10-20)</th><th>STRETCH 3 (20-30)</th><th>STRETCH 4 (30-40)</th><th>STRETCH 5 (40-48.00)</th></tr>
<tr><td>Tidal variation</td><td>2.42</td><td>1.85</td><td>1.75</td><td>1.67</td><td>1.09</td></tr>
</table></td></tr>
<tr><td>b)</td><td>LAD (Least Available Depth) w r t CD</td><td>i) Survey period (28 Mar 2017 to 08 Apr 2017)
<table>
<tr><th>LAD</th><th>STRETCH 1</th><th>STRETCH 2</th><th>STRETCH 3</th><th>STRETCH 4</th><th>STRETCH 5</th><th>TOTAL</th></tr>
<tr><td>ii) <1.2</td><td>5.1</td><td>3.4</td><td>5.5</td><td>6.9</td><td>6.1</td><td>27</td></tr>
<tr><td>iii) 1.2-1.4</td><td>0.8</td><td>1.8</td><td>1.8</td><td>0.6</td><td>0.2</td><td>5.2</td></tr>
<tr><td>iv) 1.5-1.7</td><td>1</td><td>1.8</td><td>0.6</td><td>0.5</td><td>0.3</td><td>4.2</td></tr>
<tr><td>v) 1.8-2.0</td><td>1.6</td><td>1.3</td><td>0.3</td><td>0.2</td><td>0.2</td><td>3.6</td></tr>
<tr><td>vi) >2.0</td><td>1.5</td><td>1.7</td><td>1.8</td><td>1.8</td><td>1.2</td><td>8</td></tr>
<tr><td>TOTAL</td><td>10</td><td>10</td><td>10</td><td>10</td><td>8</td><td>48.0</td></tr>
</table></td></tr>
</table>

Sl. No.	Particulars	Details
c)	Cross structures i) Dams, weirs, barrages etc (total number; with navigation locks or not) ii) Bridges, Power cables etc [total number; range of horizontal and vertical clearances]	i) **No Dams, weirs or Barrages** are found in this zone of river. ii) Total number of Cross over Bridges – Five (05) a) Total number of Rail Bridge- Nil b) Total number of RCC Road bridges – Two (02) c) Temporary Bamboo Bridges – Three (03) iii) Total number of HTL Crossing – Nil The details of the vertical and Horizontal Clearance for above structures is provided in Para 2.16, 2.17 and 2.18 of this report
d)	Slope (1 in ….)	Slope in 1m in 16 km The details of slope calculation are provided in Para 2.13 of this report.
5.	Traffic potential	Traffic is available from Chandbali (old port area). The ferry and tourism service is being provided by Govt. Of India (IWT) for nearby villages and Bhitarkanika National Park.
a)	Present IWT operations, ferry services, tourism, cargo, if any	Ferry services- By local dingy or boats and IWT passenger boats. Cargo - Nil

Sl. No.	Particulars	Details
b)	Important industries within 50 km	Nil
c)	Distance of Rail & Road from Industry	State Highway is within 01 Km along the River
6.	Consultant's recommendation for going ahead with TEF / DPR preparation	Recommended
7.	Any other information/ comment	Nil

0. EXECUTIVE SUMMARY

As a part of feasibility study, a total of 48 km of Baitarani river was studied during February 2016 using single line bathymetry / topography survey, preliminary market analysis, passenger traffic potential, etc. Then it was concluded that owing to the tourism potential of the region, and the tidal influence in the river stretch, the project can be considered for further development.

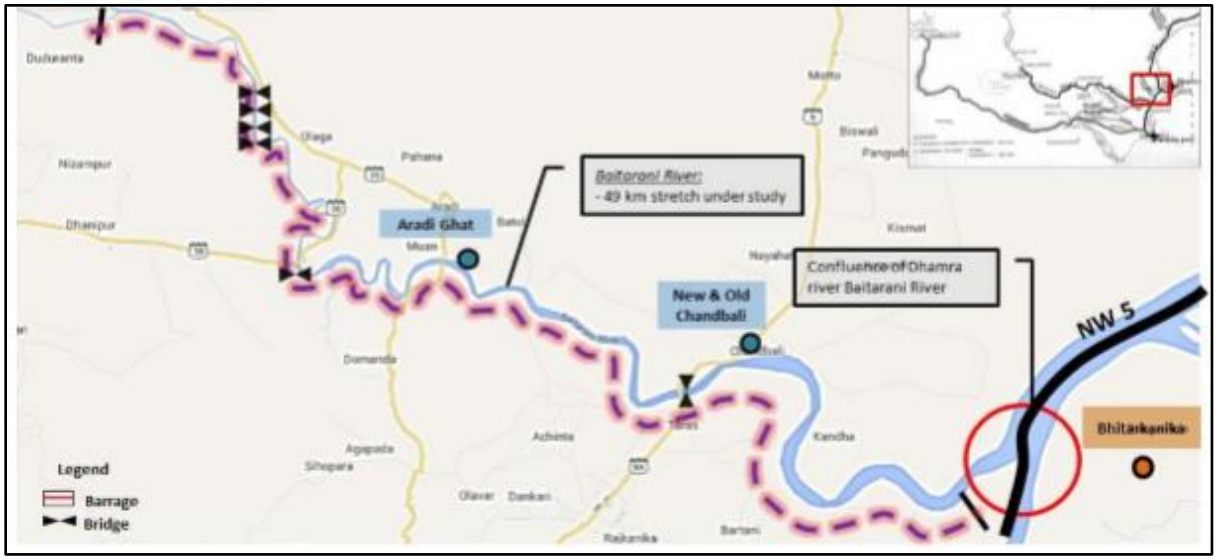
As a result, a total length of 48 km of Baitarani river from Duttapur village to confluence with Dhamra river was studied in detail during March to April 2017 for bathymetry, topography, available secondary data, hydrographic features of the stretch, etc.

0.1. Introduction

0.1.1. Project Location

Baitarani rises from the Gonasika in the Geotagging hills of Keonjhar district. The river traverses a total distance of 360 km before meeting Dhamra River.

Figure 0.1: River stretch under study



The Baitarani basin forms part of Brahmani/Baitarani river basin which is the 17th largest basin having total catchment area of 53,487 Sq.km which is nearly 1.7% of the total geographical area of the country.

0.1.2. Brief scope of work and compliance statement

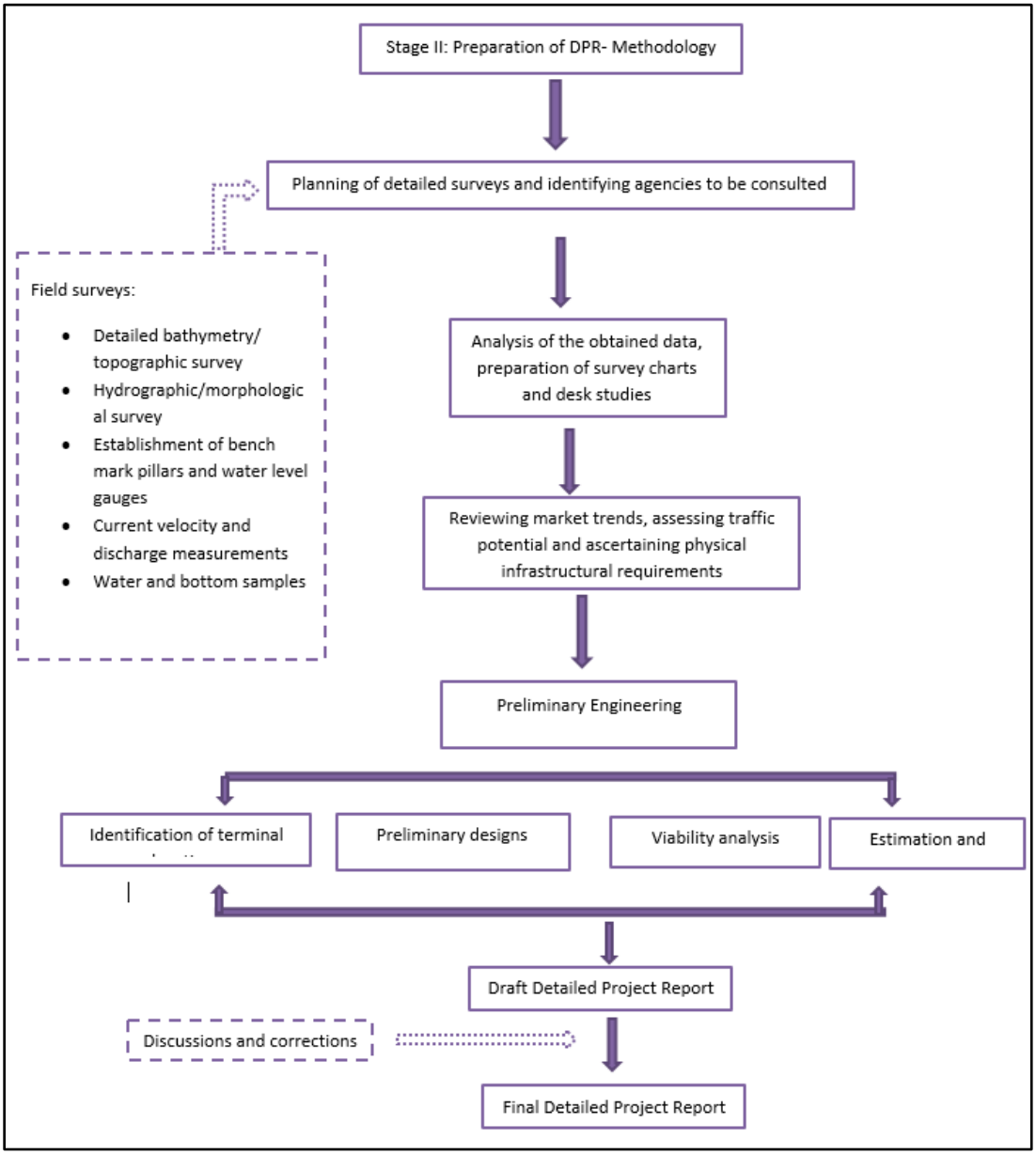
The scope of work in DPR preparation is as follows:

- Assessment of morphological, hydrological, hydrographical conditions and operation and maintenance requirements of the proposed waterways.
- Geo-tech investigation as per guidelines of Geological Survey of India.
- Preliminary engineering designs, drawings, estimates, for the waterway system in an EPC mode.
- River training and bank protection works anticipated.
- Preparation of construction schedule with phasing of expenditure.
- Cost estimate for different alternatives shall be considered and FIRR, EIRR, NPV and SWOT analysis are to be carried out.
- EIA study and suggesting EMP.
- Suggestions for VC and HC to be provided for crossing structures.

0.1.3. Brief methodology and approach

To successfully deliver the project requirements, a stepwise delivery model was followed. The approach and methodology used for Stage -II studies are as shown using the flow chart.

Figure 0.2: Stage II methodology flow chart



0.2. Waterway – Detailed Hydrographic Survey

Hydrological / Topographical Reference levels - Bench Mark Pillars of dimension 0.3m x 0.3m x 1.5m (0.6m above GL) RCC pillar with 6mm thick 50mm diameter GI pipe inserted were constructed, at every 10km interval. Detail description of Benchmark along with its position and value are in report.

Tide poles have been erected at every 10 km and water level was observed from 06:00 hrs to 18:00 hrs throughout the survey.

Chart Datum / Sounding Datum - Sounding datum has been established by transfer of sounding datum methodology specified in AMHS. The four low and three high water were used for transfer of sounding datum. The transfer of sounding datum was carried out from the Dhamara port as, it is the primary port close to the survey area.

Existing Bridges - The existing crossing structures include road and temporary bridges, which are listed below with chainages and their clearances.

Table 0.1: Existing cross structures

Sl no	Structure	chainage (Km)	location	latitude	Longitude	Easting(m0	Northing(m0	Hz cl (m)	V cl w.r.t MHWS(m)	Present Condition
1	Road bridge	16.800	Ostia (Aradi-Chandbali)	20^0 45’45.72"N	086^0 43' 19.2788 "E	471064.57 E	2299510.41N	30	4.2	Completed, in use
2	Road Bridge	34.400	Kayan Gola	20^0 47' 51.000” N	086^0 36' 46.9688 "E	459730.20 E	2299784.71N	30	3.5	Completed, in use
3	Bamboo Bridge	46.275	Betaligaon	20^0 51' 28.092" N	086^0 34' 56.6916 "E	456559.56 E	2306466.84N	3.0	0.5	In use
4	Bamboo Bridge	47.140	Naranpur	20^0 51' N44.105"	086^0 34' 30.6882 "E	455809.44 E	2306961.11 N	3.0	0.7	In use
5	Bamboo Bridge	48.460	Duttapur	20°51' 50.74" N	086°33' 43.61"E	454449.81 E	2307168.90N	2.5	1.2	In use

Note: The temporary Bamboo bridges (Sl No: 3, 4 & 5) are submerged during Monsoon

Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts - There are no Dams, Barrages, weirs, Anicut found in this zone of River.

Radius of Curvatures - average bend radius of river Baitarani has been observed as 800m, excepting in some stretches where it is as low as 160m

0.2.1. Stretch-wise waterway description

Summary of observed depth in each stretch of river (10 km stretches) is provided below.

Table 0.2: Summary of depth

Sl.No.	Chainage	Avg min observed depth (m)	Max observed depth (m)
1	0 - 10 km	0	9.8
2	10 - 20 km	1.4	16.3
3	20 – 30 km	0	12.8
4	30 – 40 km	0	8.8
5	40 – 48 km	0	5.9

0.2.1.1. Stretch 1 (0-10km)

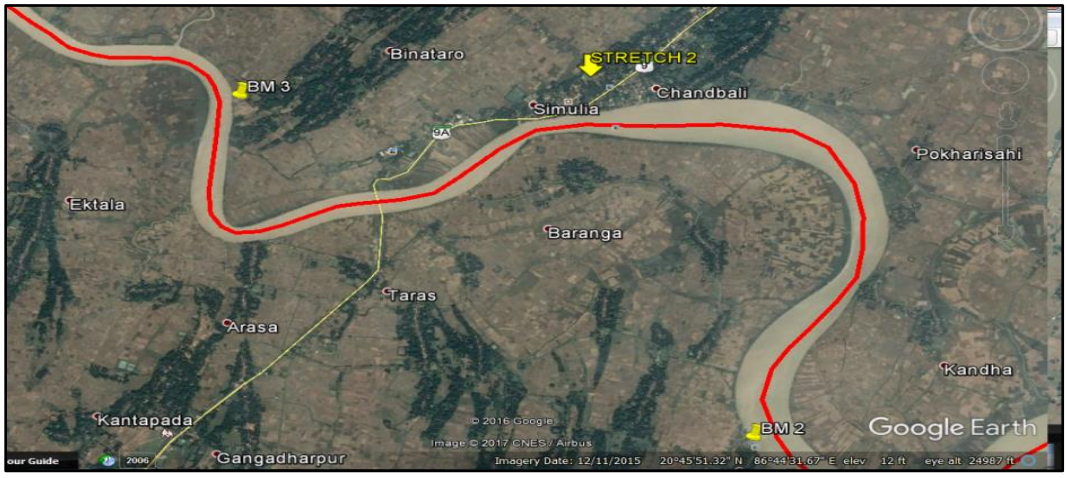
The stretch starts from Nalitpatia village where it separates from Brahmani river. The mouth area is full of crocodiles and the area has been declared as crocodile conservation zone by the Govt of India which is named as Bhitarakanika National Park. Average width of the river is 400 meters. Both sides of the river are mainly used by localities for rice cultivation. One side of the riverbank is partially stone protected and at some places stone protection work is in progress. The small village with sparse pollution is there.

Figure 0.3: Google image of stretch 0-10km

0.2.1.2. Stretch II (10 – 20Km)

Stretch starts from Baradia to Goladia. Stretch width is average 400 mtr sup to ch 15.00 and it becomes narrow afterwards and width becomes average 200 mtrs. Shastri ghat is at ch 14.50 on right bank. State Highway 9 is close to right bank and Chandbali bus stop is at ch 14.50. OTDC guesthouse is near ch 15.00 at Simulia village. At ch 16.50 Ostia bridge is crossing the river. Both sides of riverbank are cultivated land. IWT ferry service is available for Bhitarkanika National Park and small local ferry service is also available from Chandbali to other local villages. Chandbali is also famous for its old Port services. Navigation channel can be developed at Chandbali.

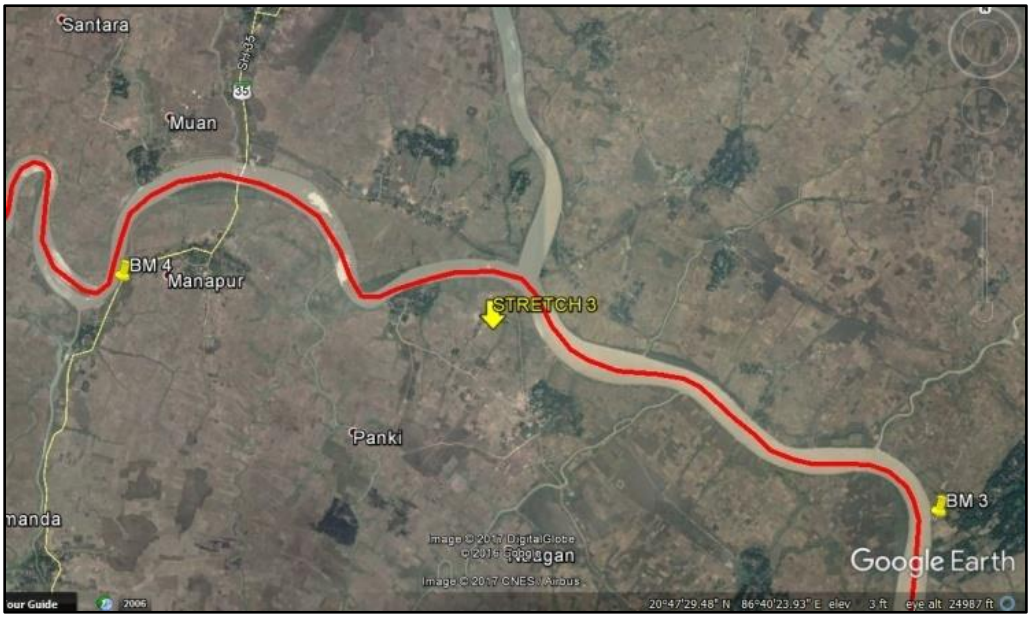
Figure 0.4: Google image of stretch 10-20km



0.2.1.3. Stretch III (20 – 30Km)

Stretch 3 starts from Matia village to Gunthala. Width of the river varies from 150 to 180 mtrs in this stretch. River both sides are cultivated area. The villages near Baitarni bank are mainly dependent on rice cultivation and fishing. The riverbank in this stretch is gradually vanishing due to change of hydraulic direction. River protection wall / bank protection is essential in this stretch.

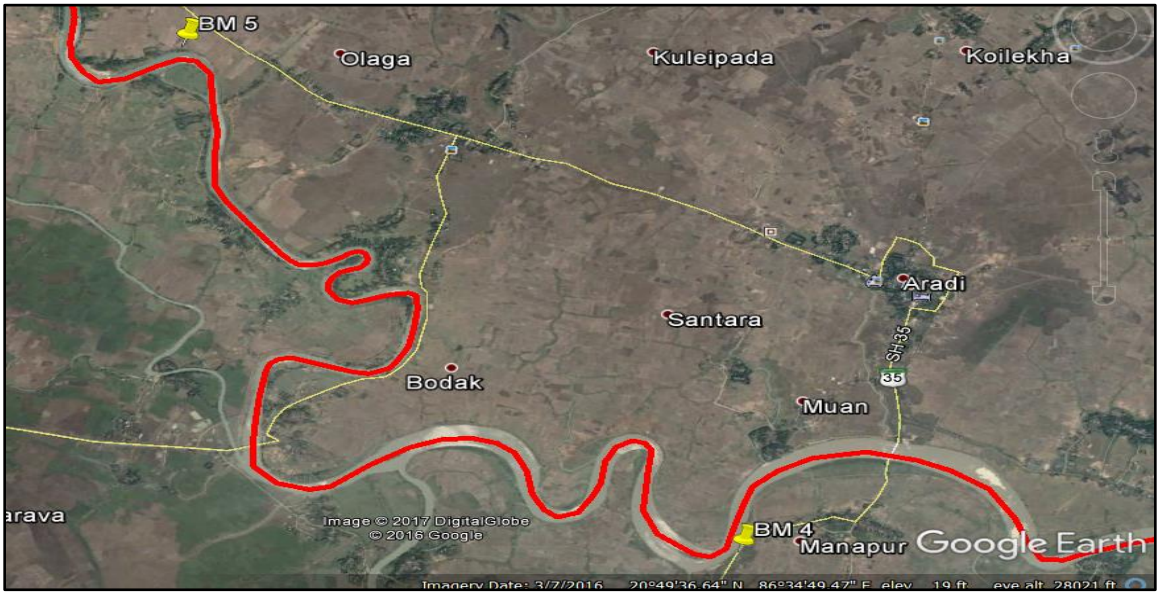
Figure 0.5:Google image of stretch 20-30km



0.2.1.4. Stretch IV (30 –40Km)

Stretch is from Kanpur to Olaga.at ch 34.00 Kayan Gola bridge is there. Average with is 75 mtrs in this stretch. Both sides are cultivated land. To protect the nearby villages, Govt is developing riverbank protection in this stretch. The villagers are using temporary bamboo-bridge for crossing the river also, people of these local villages are using small dinghy for crossing the river.

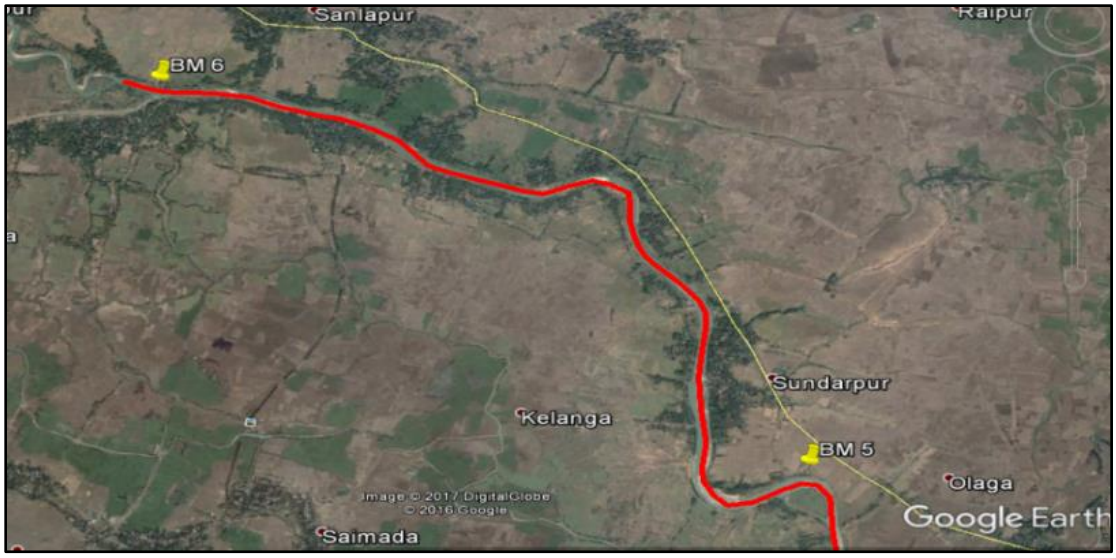
Figure 0.6: Google image of stretch 30-40km



0.2.1.5. Stretch V (40 –48 0 Km)

Stretch starts from Gunthuni Pada to Duttapur. Both sides are cultivated lands. Villages are situated on banks close to river. The local villagers are using bamboo-bridge and small dinghy for crossing the river. The bank of river is partially protected and in some areas construction of river wall is in progress.

Figure 0.7: Google image of stretch 40-48 0 Km



Key Features along the individual stretches are summarized below:

- No dams or barrages
- Full waterway falls under tidal stretch
- No navigation obstructions / encroachments
- No railway lines in vicinity
- No cargo movement / existing industries in vicinity
- Rice cultivation practiced all along the waterway stretch
- State Highways – Bhadrak Highway (SH-9) close to Stretch 1,2,3; SH-35 & 56 closes to Stretch 4,5
- Prominent Cities / Places of Worship
    - Chandbali: Stretch 2
    - Aradi: Stretch 4, 5
    - Bhitarkanika National Park: Stretch 1
- Partially protected banks: Stretch 5

0.2.2. Water and soil sample analysis and results

Water and bottom soil sample are collected from the deepest route at every 10km interval and are tested.

Table 0.3: Water Sample characteristics

BAITARNI RIVER			
Sl No.	Chainage		Water Characteristics
1	0	10	Salt and Muddy Water
2	10	20	Salt and Muddy Water
3	20	30	Salt and Muddy Water
4	30	40	Salt and Muddy Water
5	40	48	Mild Saltwater

0.3. Fairway Development

Classification of inland waterways for rivers (for reference):

Table 0.4: Inland waterway classification

Sl. No.	Class of waterway	Minimum depth (m)	Bottom width (m)	Bend radius (m)	Vertical clearance (m)	Horizontal clearance (m)
1	Class I	1.2	30	300	4	30
2	Class II	1.4	40	500	5	40
3	Class III	1.7	50	700	6	50
4	Class IV	2.0	50	800	8	50
5	Class V	2.0	80	800	8	80
6	Class VI	2.75	80	900	8	80
7	Class VII	2.75	100	900	8	100

0.3.1. Dredging

In the present project, the amount of dredging quantity for developing to different classes in cubic meters are shown below:

Table 0.5: Dredging quantities

S. No	Chainage	Cumulative Dredging for class I (cum)
1	0 - 10 km	8984.8
2	10- 20 km	8984.8
3	20 – 30 km	11789.8
4	30 – 40 km	646114.2
5	40 – 48 km	754706.5

It is proposed to develop the Baitarani river from CH 0km to CH Aradi (27.24km) as Class I waterway, which has minimal intervention in the river hydrography and hence minimal dredging quantity of 8984.8 cubic meters.

0.3.2. River Training

In the present case, river training is required specially to reduce the probability of meandering, to have cut-offs in regions of severe meandering, to maintain sufficient bend radius, etc.

The proposed stretches of cut-offs are at regions where, the river meanders such that the loop length exceeds 1.5 to 2.5 times the chord length, hence it is proposed to have artificial cut-offs there, rest of the places, the curvatures may be smoothened with pitched banks. For the proposed Class I waterway, according to table 3.1 of this report, the permissible minimum bend radius is 300m. Between chainage CH25km and CH 26km at around CH 25.461km, the bend seems to have a radius of around 160m only, hence this requires smoothening of the curvature to attain a specified value of 300m.

0.3.3. Bank protection / embankment strengthening

In the present project, it is recommended to have stone paved protection along with vegetative cover at regions near the terminal i.e., 50m up and downstream of the terminal locations. At Chandbali on northern and southern banks 100m each side and at Aradi, along one bank (along the terminal location) protection is proposed immediately after construction of the terminals. Since Chandbali northern bank already has full-fledged facilities, no new embankment protection is proposed now.

0.3.4. Navigation Markings / Navigation Aids

Channel markings for day navigation need to be erected and maintained in entire waterway. Night navigation is not proposed now, which may be considered in subsequent phases. A DGPS station is planned to be setup at Chandbali, at a subsequent phase. In the first phase, it is proposed to have buoys to demarcate the channel boundaries, range to guide the ships through the centreline of the channels, weather signals at critical locations of sharp bends. Radar beacons are proposed to be provided at intervals in future once the traffic is well developed and the navigation and communication systems are established. Apart from this, it is proposed to have thalweg surveys and issue of river notices.

0.3.5. Land acquisition

A ferry jetty already exists in the Chandbali region. Hence no new proposal is made at Chandbali northern (left) bank. The terminal amenities will require around 1.08 acres of land per terminal. Hence at Chandbali right bank region, 1.08 acres of land is required. At Aradi region, the terminal is proposed at the northern bank alone, requiring 1.08 acres of land there. Hence the total land requirement for developing terminal is around 2.16 acres.

0.3.6. Fairway costing

0.3.6.1. Capital Cost

Table 0.6: Capital cost for fairway development

Sl. No.	Description	Amount (Cr.)
1	River training (creating cut offs)	Rs. 2.90
2	Dredging (Class I)	Rs. 0.18
3	Embankment protection using stones of around 3kg to 10kg weight	Rs. 1.34
4	Aids to navigation (per piece 20,000)	Rs. 0.13
5	Land acquisition for fairway development	Rs. 1.62
	Total (Cr.)	**Rs. 6.17**

0.3.6.2. O&M Cost

The annual operation and maintenance cost work out to be about 5% of initial cost for dredging, 2% for aids to navigation, 1% for bank maintenance and 5% for river training.

Table 0.7: OPEX cost for fairway

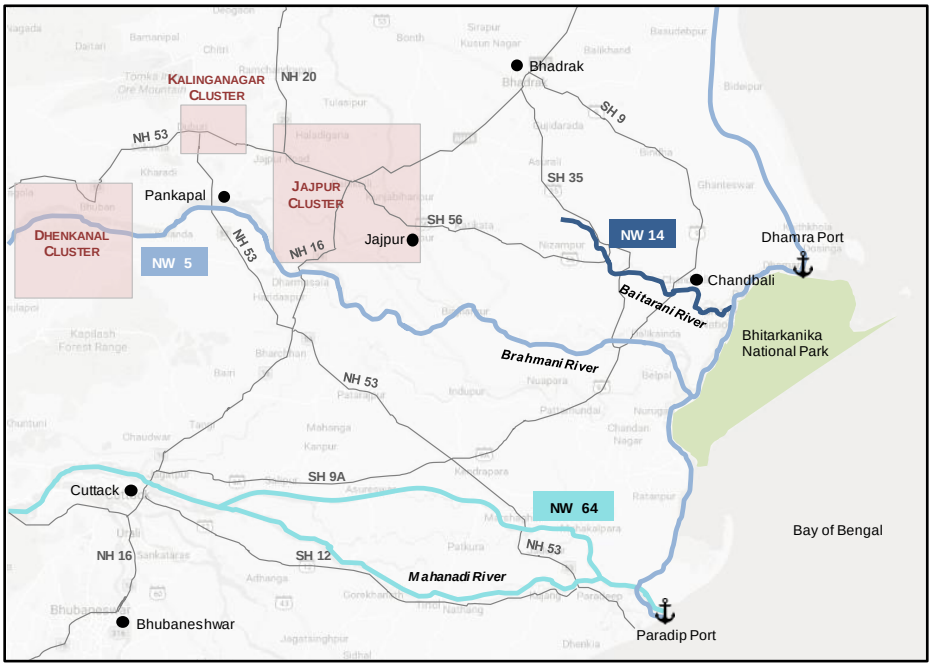
Sl. No.	Description	Amount (Lakhs)
1	Dredging	Rs. 0.89
2	Embankment protection repair	Rs. 1.34
3	Aids to navigation repair	Rs. 0.26
4	River training	Rs. 14.50
	Total (Lakhs)	**Rs. 16.99**

0.4. Traffic study

0.4.1. Influence Area / Hinterland

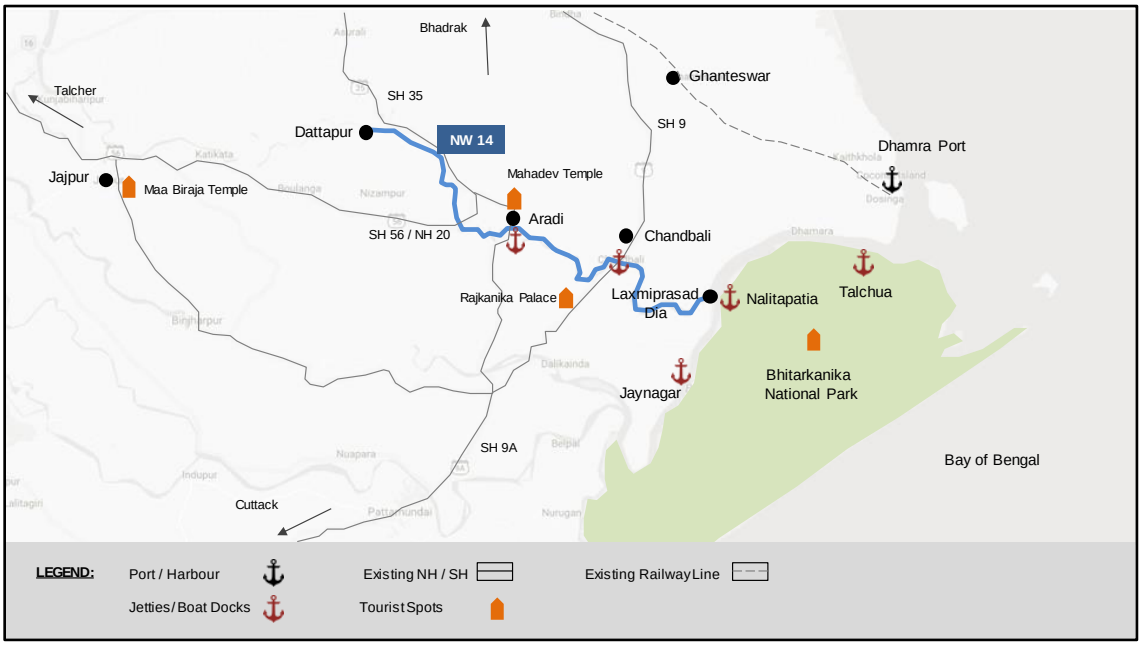
Hinterland of the waterway is defined by geographical stretch of the waterway and by presence of large-scale industrial activity in areas of Jajpur, Kalinganagar and Dhenkanal which might be relevant from industrial cargo perspective. The hinterland is shown below:

Figure 0.8: Catchment Area



The immediate catchment of waterway lacks urban development with Chandbali being the only major town. Nearest major city is Bhadrak (~30 km). The immediate catchment is shown below:

Figure 0.9: National Waterway 14



0.4.2. Existing and proposed industries

Jajpur, Kalinganagar and Dhenkanal industrial clusters have a concentration of large-scale **iron & steel** (steel, ferro alloys and sponge iron) industrial units such as Tata Steel, Visa Steel, Mesco Steel, Jindal Stainless, Bhushan Steel, Viraja Steel etc. The region is highly rich in mineral and ore deposits including **Chromite, Iron Ore, Pyroxenite, Quartzite** etc. Sukinda (Iron ore, Chromite), Daitari Mines (Iron ore) and Kaliapani Mines (Chromite) are the major mines in the region. Besides large coal deposits located nearby are mined by Mahanadi Coal Fields Limited.

Dhamra Port, a major port, situated in the immediate vicinity of the waterway handled 18 MTPA of cargo (mainly coal import, iron ore export) for serving the above industrial clusters and mines. In addition, a major industrial unit of Ferro Alloys Corporation (FACOR) is also located in Bhadrak.

All the industries in the region and Dhamra Port have dedicated rail lines and private terminals due to large volumes of cargo movement. Majority of the finished products of

the industries are distributed domestically through rail / road transport with negligible movement towards nearby areas to the river. Raw materials requirement for these industries is met through nearby mines or imports from Paradip / Dhamra Ports. While industrial traffic between Dhamra and these industries can be considered as addressable traffic, its movement is not viable on subject waterway due to:

- **Development of NW-5**: NW-5 passes in close proximity to these industries and connects to Dhamra port. The waterway is already being developed with an initial capacity of 25 MTPA.
- **Significant first / last mile**: Movement from industrial clusters would involve significant first / last mile movements (Jajpur ~40 km, Dhenkanal ~120 km)
- **Small waterway length**: The subject waterway stretches for ~48 km. Fuel savings from 48 km are not sufficient to cover up additional cost multiple handlings (and associated costs), storage costs (and time) and inventory / working capital costs incurred in the waterway. As a thumb rule, minimum waterway travel distance should be ~250 km.

0.4.3. Other Commodities

The catchment area is primarily agrarian with dominance of rice cultivation. Most of the region's rice production is sold at Bharak / Chandbali with small fraction being used for local consumption. While minor movement of farm products and food grains currently occurs on the waterway, organized waterway transport is not viable due to highly distributed production. Due to small distances, the cost of waterway transport is similar to road transport. Moreover, a consolidation mechanism would be required for collection of food grains along the waterway which is not recommended considering the expected volumes (<100,000 tons per annum) and highly seasonal nature (harvesting lasts for only 3 months and boats would be without fall-back traffic for rest of year).

The catchment also witnesses sand mining activity along its upstream stretches (near Aradi). While majority of the sand is transported through sand, some quantity, especially on the southern riverbank (without road connectivity), is transported through the river. The sand is transported to various villages along the waterway stretch. Small boats (4-5 tons) are used for transporting sand on the waterway. The total annual waterway movement is

estimated to be ~30,000 tons. Due to highly distributed demand and low volumes (maximum 1-2 boats per village per day), it is not recommended to provide permanent facilities for sand handling along the waterway. An administrative facility can be developed for regularization of movement of such boats. Aradi can serve as a suitable location for such an arrangement.

The region has some fishing activity near Dhamra region. The fishing activity, however, doesn't contribute to waterway movement as most of the fish is handled from Dhamra itself (either export or local hinterland transport).

The government / authority should, however, properly regulate the boats and ensure certain safety standards for safe operations through licensing and periodic inspection.

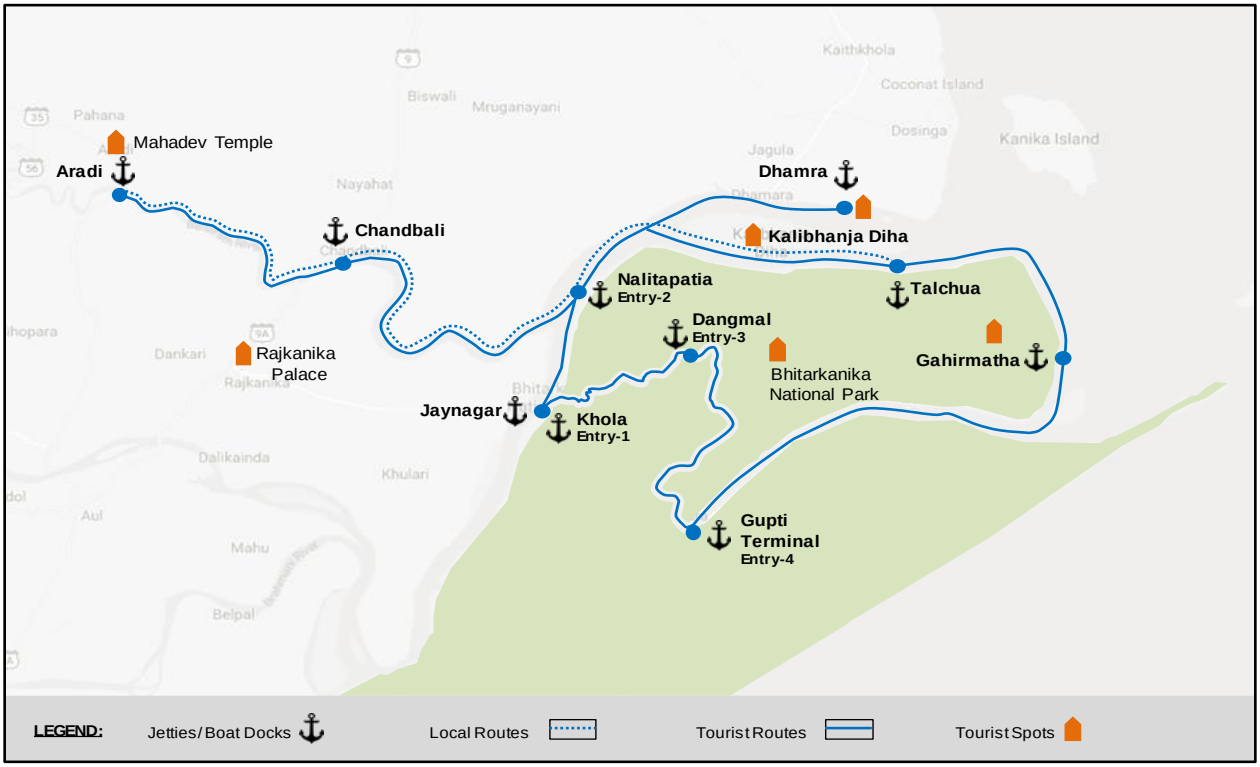
0.4.4. Passenger and tourism traffic

The region attracts ~12 lakh tourists every year, ~9 lakh of which come to visit the Shiva Temple in Aradi. Most of them are day visitors from nearby villages and towns. The other main tourist attraction is Bhitarkanika National Park. As per the data collected by the Department of Commerce and Transport, the waterway traffic on the waterway has increased form ~66,000 in 2011 to 113,000 in 2015. The above waterway movement comprises of both tourist and local passenger traffic. It should be noted that majority of the above traffic is tourist traffic for Bhitarkanika itself. Tourism in Bhitarkanika National Park is limited exclusively to boats only. Passenger boats in the region are operated both by the Odisha Tourism Development Corporation (OTDC) (handful boats) and private boat operators.

The main waterway routes in the area are:

- Chandbali to Aradi – 18 km
- Chandbali to Dhamra / Talachua – 33 / 40 km (16 km in subject stretch)
- Chandbali to Nalitapatia – 16 km
- Chandbali to Jaynagar – 18 km
- Bhitarkanika (interal) – from Khola / Gupti Jetty to Dangamal and back; minor tourists also take the longer circuit through Gahirmatha.

Figure 0.10: Passenger routes



All the above locations have small ferry docks / jetties. All the jetties are managed by State Directorate of Ports and Inland Water Transportation (IWT). IWAI also has a Crew Training Centre owned by Govt. of Odisha, close-by to the existing terminal.

0.4.4.1. Tourism Traffic

The major tourism spots in the region are

- **Akhandalamani (Mahadev) Shiva Temple, Aradi -** The 19th century Shiva temple is the most famous temple in the region. It attracts large number of religious devotees, especially during the festival of Maha Shiva Ratri (Jaagara). This place can be reached from Chandbali via boat in approximately 2 hrs or through road with intermediary river crossing at Tintara Ghat.
- **Bhitarkanika National Park -** The national park, spread over 672 sq. km, is most famous for its Giant Saltwater Crocodiles and also houses wide range of other animals and migratory birds. The park has the second largest mangrove ecosystem in India. It has multiple tourist spots within and around it - Gahirmatha

Sanctuary, Bird Sanctuary, Crocodile Breeding Centre and several nearby islands and beaches.

The National Park is closed between May and July and attracts steady tourist inflow during rest of the months, with **traffic peaking during winter months of November to February**. The National Park handled **80,000 tourists** in 2016[1]. Ferry services are the only mode of transport for touring the park and nearby attractions. Tourists coming from Northern side reach Chandbali and take ferry services from Chandbali or Jaynagar. Tourists coming from Southern side (from Cuttack, Bhubaneswar, Paradip) enter the National Park directly through Khola, Gupti or Jaynagar Jetty. Several tourists from Chandbali get down at Nalitapatia, especially during warmer months.

- **Dhamra -** Dharma is the main economic centre in the catchment on account of presence of **Dhamra Port**. While the area primarily caters to business visitors, several tourists also pay a visit to the large port. The tourists also visit Kalibhanja Diha island just opposite to the port for leisure treks and sightseeing.

0.4.4.2. Local Traffic

The area is characterized by presence of several small villages along the waterway. Chandbali is the major town in the region and it frequented by people from nearby areas for commercial purposes. Due to poor road connectivity in the region, both government and private ferries ply on the waterway carrying local passengers and minor goods (2-wheelers, farm goods, construction materials, daily needs purchases etc.).

Such services ply all around the year (except rainy season as the river is not navigable) as the river is perennial in the subject stretch. The ferry frequency is limited to ~2 round trips per day. The major routes on waterway are

- Chandbali to Dhamra / Talchua – 33 / 40 km (16 km in subject stretch)
- Chandbali to Aradi – 18 km

In addition, the river also has cross-river movements. The main cross-river traffic movement happens at Aradi due to lack of cross-river bridges for pilgrims coming from

[1]Statistical Bulletin-2016 published by Department of Tourism & Culture, Government of Odisha

Chandbali. The pilgrims use ferry services at either Tintara Ghat or Muan Ghat for visiting Aradi. The proposal for bridges at Aradi has been announced long back, however no such contract has been awarded as of now. There are some minor makeshift cross-ferry services on the upstream stretch of the river as there are no bridges for long stretch of river. As per Feedback's estimates, the local traffic movement is limited to 35,000 passengers per annum[2].

0.4.5. Ro-Ro traffic

Due to lack any major industrial / urban activity, Ro-Ro traffic on the waterway is limited to 2-wheeler cross-river movement. Low draft country boat ply on the waterway, especially near Aradi to cater visiting pilgrims. With the construction of bridges in the area, Ro-Ro traffic is expected to cease.

0.4.6. Growth Trend

The waterway has potential to be developed as a tourism circuit with the presence of multiple tourist attractions in its vicinity.

- The festivities at the **Akhandalamani Shiva Temple** can be promoted to attract overnight visitors. Another famous temple - Maa Biraja (13th century Durga temple) at Jajpur, can be promoted for pilgrim tourists
- **Bhitarkanika National Park** has great potential for increasing tourist footfalls by proper marketing to its unique offerings. The park can be promoted as a retreat destination with its quiet and tranquil surroundings.
- **Rajkanika Palace** – The palace, spread over 35 acres, contains a museum with rich historical antiques, artefacts and royal memorabilia. The palace has been proposed to be converted to a heritage hotel.

0.4.7. Proposed Circuits

- **Chandbali – Aradi**: The tourists can take either a single side trip (returning by road) or return trip from Chandbali to Aradi

[2] The waterway handles ~1.1 lakh tourist per annum (as per Department of Commerce and Transport, Govt. of Odisha) statistics for 2015-16. Moreover, the National Park handled 0.7-0.8 lakh tourists annually. Rest of the waterway movement comprises of the local passengers only.

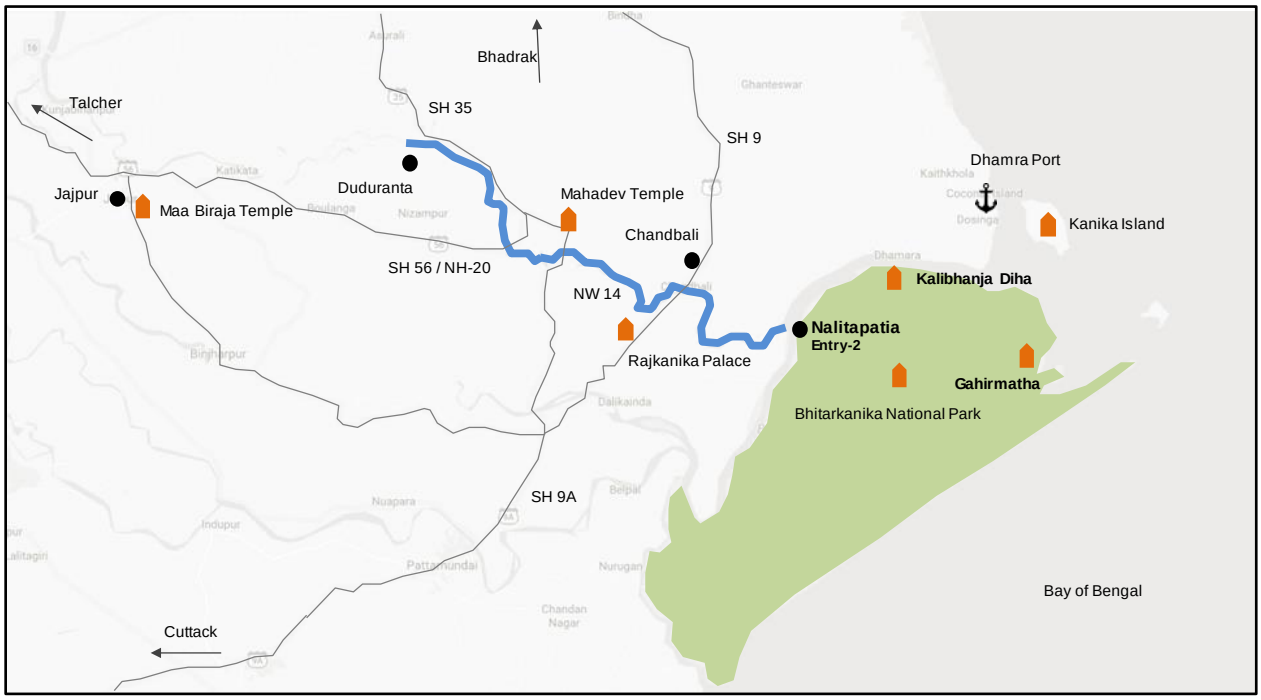
- **Chandbali – Dangmal**: The tourists can take return boat trip from Chandbali to Dangmal

In addition, development of following circuits can be undertaken by the State IWT, as the Nalitapatia terminal falls outside the scope of subject waterway.

- **Chandbali – Nalitapatia**: The tourists can start from Chandbali and get down at Nalitapatia. There they can tour the National Park and go either to Dangmal or return to Nalitapatia for return trip.
- **Aradi – Nalitapatia**: The tourists can take boat from Aradi and reach Nalitapatia with stop-over at Chandbali.

The following map represents the tourism infrastructure in the region.

Figure 0.11: Tourism infrastructure in the region



0.4.8. Projected Waterway Tourist Traffic

The waterway traffic has been segregated into tourist and passenger traffic as follows:

Table 0.8: Present traffic

Passenger	Annual Passenger Movement (est. 2015-16)
• Bhitarkanika (internal) – Tourist	55,000
• Chandbali – Nalitapatia / Bhitarkanika – Tourist	25,000
• Chandbali – Aradi – Tourist	10,000
• Chandbali – Talchua / Dhamra	25,000
Total	**~115,000**

Tourist traffic growth (Bhitarkanika, Aradi) has been considered at 9% p.a. (for next 15 years, subsequently 6% p.a. steady state growth). Local passenger growth has been considered at 5% p.a.

Table 0.9: Projected traffic

Route	2020	2030	2040	2050
1. Bhitarkanika (internal)	0.8	1.6	3.1	5.6
2. Chandbali – Nalitapatia / Bhitarkanika	0.4	1.1	2.1	3.7
3. Chandbali – Aradi	0.1	0.3	0.7	1.2
4. Chandbali - Talchua / Dhamra	0.3	0.5	0.8	1.3

Hence, based on the projected tourist traffic, terminal facilities are recommended at:

- **Chandbali**: For capturing tourist traffic to Bhitarkanika (including Nalitapatia), Aradi and local passenger traffic to Talchua / Dhamra. Chandbali to Bhitarkanika traffic has been considered at 40% of total National Park's traffic in the future.

- **Aradi**: For capturing tourist traffic (pilgrims visiting Mahadev Shiv Temple) from Chandbali.

Table 0.10: Traffic for Recommended Waterway Terminals

Route	2020	2030	2040	2050
Chandbali	0.82	1.90	3.54	6.21
Aradi	0.14	0.33	0.65	1.17

The other traffic terminals (Talchua, Dhamra, Bhitarkanika Terminals) have not been considered as they are located outside the scope of waterway. The Bhitarkanika terminals (Khola, Gupti, Jaynagar, Nalitapatia) handle significant tourist footfalls. Hence, the State IWT should actively develop and upgrade the terminal and their facilities as these are old and degraded.

Hence, following traffic related recommendations are made:

- **Chandbali** – A new terminal would be required with increasing tourist traffic. While the existing terminal can be used initially, a separate terminal (either on village side or far side) would be required with increasing traffic.
- **Aradi** – Either existing boating dock should be upgraded to a proper terminal or a fresh terminal should be developed by IWAI.
- **Arrangement with State IWT** – If existing IWT jetties are upgraded, IWAI should enter in partnership with IWT. IWAI should undertake capital investment (and maintenance works) in lieu for additional terminal charges at these locations. IWAI should also undertake operations of these terminals.
- **Boat operations** – IWAI should not investment in procurement of boats. Government should try to market the waterway to large private boat / cruise operators through state support / subsidies.
- **Night-navigation** facilities should not be provided due to significant capital investment and lack of major night tourist attraction in the region

0.5. Terminals

0.5.1. Terminal layout / master planning including phases of development

It is proposed to use existing terminal facilities in the region. A total of 2 terminals are proposed, for exclusively serving the local passenger and tourist traffic.2 new terminals proposed are:

- Chandbali: One terminal at right bank
- New terminal at Chainage 27.24 km (at Aradi)

From the traffic study, it is observed that, Chandbali is a major town along the route of the river with population over one lakh. People from the other bank needs to cross the river to reach the town region of Chandbali. Also, it is observed that, there exist passenger ferries to Aradi, Dhamra and Raj-Nagar. Hence its proposed to use the existing facilities in Chandbali northern bank and have a terminal at the southern bank of the river. There are difficulties in developing beyond CH 40km as explained in section 3.1 of this report, and based on the proposals of the traffic study, it is proposed to have a terminal at the northern banks at Aradi, where road access is available which will act as an extreme terminal of the waterway for along river movement as is a developed town.

It is recommended to place the terminal such that its lateral distance from the sea-shore line is more than 10km and hence environmental clearance issues can be avoided. The terminal will have necessary amenities as below:

- Parking area: An open parking area may be considered in the initial phase with a size of around 20m X20m.
- Terminal building: Consisting of waiting lounges, shops, refreshing areas, cafeteria, offices, etc.
- Water supply: In the absence of freshwater supply lines near the terminal location, water storage tanks may be planned. Hydrants should be installed at approximately 100-200m intervals.
- Electricity/ Lighting: As far as possible, underground cables may be used. Proper lighting shall be ensured in and around the terminal area even though late night

navigation is not considered, the terminal building and premise is suggested to be well lit.

- Connectivity: The existing road networks may be modified or maintained to ensure proper movement of people between different modes of transport. The proximity of the site to SH-9 is to be made use of and arterial roads is to be planned to connect the terminal with SH via, existing District roads.

0.5.2. Land details

Factors like, availability of government owned land or low cost or less populated areas near the water area have been considered. The total land requirement for the three terminals is 0.889 acres. Based on site inspection, it is observed that the terminals have 0.445 acres' land available for new construction / expansion.

0.5.3. Geotechnical investigation

The team which investigated the site of the terminals and along the river channel, observed that the soil is good with hard strata of sand being available at minimum 2m depth and yielding a minimum of 10 tons per sq.m. safe bearing capacity. Considering the nearby buildings in the locality, it is safe to confirm that no geotechnical investigation is necessary for designing the terminal building which would be used for passenger movements only.

0.5.4. Terminal Infrastructure including equipment

The terminal is intended to handle passengers alone. The terminal may have facilities waiting lounges, kiosks, cafeteria, ticket counters, toilets, etc. Terminal facilities will include docking and mooring structures, various utility facilities and amenities, firefighting equipment and connectivity with major roads in the area.

0.5.5. Berthing structure

Considering the waterway characteristics and traffic, the vessel used for design is of 32m LOA, 5m beam and loaded draft of 1.2m. In the present situation, floating pontoon quay is proposed with an articulated steel trestle. The floating structure is supported such that the movement to accommodate water level fluctuations is possible. These structures can accommodate the seasonal variations in water levels.

Two options are considered:

Option 1: Light structure with a floating structure for passengers and limited two-wheeler traffic

Option 2: Floating structure with anchorage provided to enable up and down movement

Since the traffic is only passenger and majority of local movement and tourism oriented and considering the class of water way being I, option 1 is the preferred alternative. This option has the advantage of being light and well suiting a Class I infrastructure. Since no huge abutments are required, major structures are replaced with light structures.

0.5.6. Terminal costing

0.5.6.1. CAPEX

Table 0.11: Capital expenditure for Terminal

Description	Cost (lakhs)
Berthing structure	Rs. 29.58
Terminal building 100sq.m. housing office, security and passenger amenities.	Rs. 45.26
Landscaping (paving's, lawn, etc.)	Rs. 5.00
Auxiliary items (firefighting, water supply, safety gadgets, lightings, road networks, etc.)	Rs. 20.00

0.5.6.2. OPEX

Table 0.12: OPEX cost for Terminal

Description	Cost (Rs.)
Berthing structure	Rs. 147900.00
Terminal building 100sq.m. housing office, security and passenger amenities.	Rs. 45260.00
Landscaping (paving's, lawn, etc.)	Rs. 5000.00
Auxiliary items (firefighting, water supply, safety gadgets, lightings, road networks, etc.)	Rs. 20000.00

0.6. Preliminary engineering designs

0.6.1. River Training

As explained in section 3.3.3 of this report, for the proposed Class I waterway, according to table 3.1 of this report, the permissible minimum bend radius is 300m. Between chainage CH25km and CH 26km at around CH 25.461km, the bend seems to have a radius of around 160m only, hence this requires smoothening of the curvature to attain a specified value of 300m. The drawing attached as Vol. II can be read for further clarification in the region proposed for training with cut offs.

0.6.2. Bank Protection

From the survey report, it is observed that few stretches of the embankment are protected but rest are left unprotected. The erosion prone areas demand some precaution measures against the action of water especially during flood. Thus, it is suggested to have bank protection adjacent to the terminal locations. At critical locations, like the ones have very close proximity to terminal or the one with very severe velocities are suggested to have stone protections along with vegetative cover (riprap) immediately.

0.6.3. Terminals

0.6.3.1. Berthing Structure

The vessel size adopted for designing the berthing structure is of LOA 32m, 5m beam and 1m draft. Based on the vessel size and requirement, it is proposed to have a quay of length 8m and width 2m. The up and down movement is facilitated by two hollow pipes of around 10cm diameter of Fy 250 Mpa structural steel and bolted to the pontoon and hinged to the pedestal on land. The pedestals are founded on open footings.

0.6.3.2. Trestle

The trestle is proposed to be of steel box or tube sections. The live load considered for design is 5kN/sq.m. The trestle is intended to carry passenger and limited two-wheeler traffic alone. The trestle is supported to the quay and hinged to a pedestal on the land.

0.6.3.3. Mooring piles

At least 6 mooring points, equally spaced along the quay shall be provided to safely keep the varying size of vessels during boarding and alight of passengers. Apart from this it is proposed to have mooring piles of locally available wooden logs placed behind the berthing quay for use in emergency conditions like cyclones or severe winds, where tying to the pontoon alone may not help due to severe turbulence in air and water.

0.6.3.4. Terminal building

A building to accommodate ticket counters, public services like police and passenger amenities is planned. A live load of 5kN/ sqm. is considered for the design. It is proposed to be a trussed structure with open footing.

0.6.4. Construction schedule

The sequence of construction activities shall be as mentioned below:

a). Dredging and site clearance for embankment protection works, terminal building, cut-offs at regions of severe meandering.
b). Temporary works for piling for construction of abutment for supporting the trestle and sub structure of the terminal buildings.
c). In-situ casting and installation of piles and open footing for terminal buildings.
d). Construction of floating pontoon in land or protected water (parallel activity).

e). Land based fabrication of steel trestle and truss for terminal building (parallel activity).

f). In-situ casting and installation of pile muff for the support of the trestle.

g). Construction of terminal buildings superstructure.

h). Installation of truss for terminal building and the steel trestle access.

i). Demarcating the channel and fixing aids to navigation (parallel activity).

j). Laying the road networks and installing other infrastructure amenities (water, light, etc.).

k). Installation of floating pontoon with anchors tied to precast and placed dead weights for guiding the movement.

0.7. Vessel design

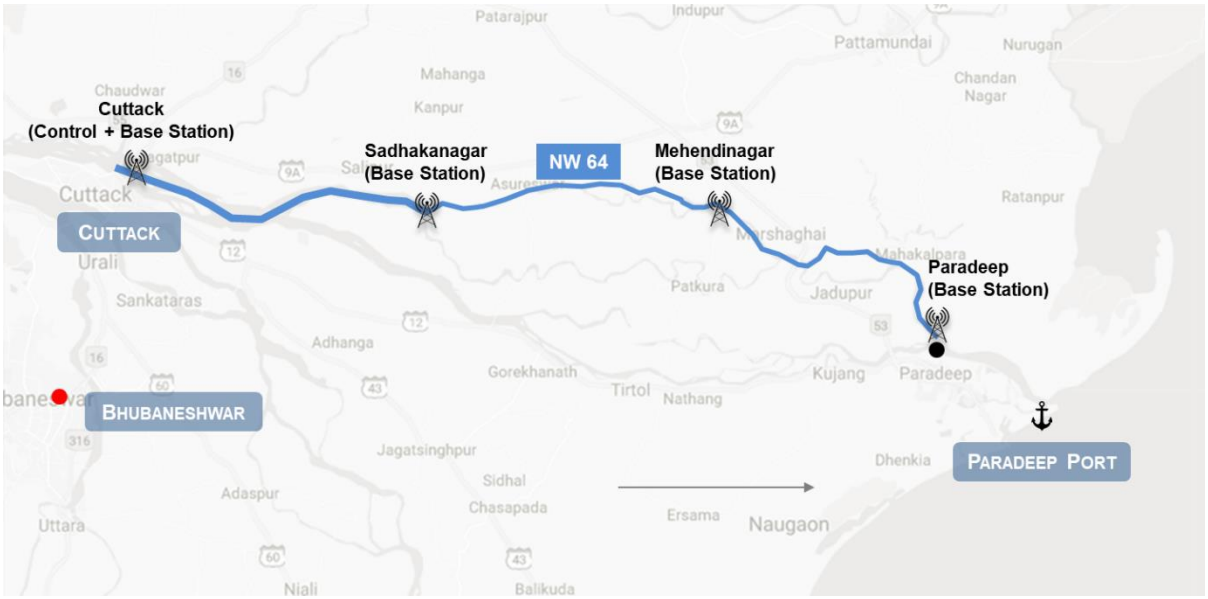
0.7.1. Proposed vessel size and specifications

The size of vessel is related to channel width and depth of waterway available for navigation. The maximum beam of design vessel is limited to1/5th of the width of navigable water and its length is assumed between 4 to 8 times the vessel's beam. Being a protected water, no natural severe wave action is expected, also due to low speed of the vessel owing to soft bed and bank materials, the under-keel clearance can be limited to some10% of max draft. It is, however, important to note one limitation on vessel length viz. that the length of vessel on water-line (LWL) should be less than the width of the channel. With the option of Class being I, the bottom width requirement is 30m and 1.2m minimum depth, a vessel size of 5m moulded breadth 32m LOA and a loaded draft of 1m is proposed based on 'IWAI Act 1985'. The carrying capacity is around 100DWT and is of self-propelled type.

0.8. Navigation and communication system

0.8.1. General Requirements

No night navigation is proposed. Communication stations (base stations for RIS) are proposed to be established at locations shows in the map below. Each communication station is effective within a radius of 25 km. Hence, **4 such stations** have been proposed for the length of the waterway (98 km).



In addition, it is proposed that all boat operators are required to carry emergency communication equipment. If the region is found to be under full signal coverage for uninterrupted mobile phone communication, that should be sufficient in other cases, it is proposed to have portable VHF radios.

The following equipment is proposed for navigation and communication equipment –

a) **DGPS (Differential Global Positioning System)** – Enhancement over convention GPS System, it provides much accurate location (precise within 10 cm). The system proposed to be installed for NW-64 would cover this waterway also.

b) **River Information Service (RIS) System)** – This latest technology consists of VHF, Automatic Identification System (AIS), Meteorological System installed at combination of Control and Base stations. The control station would be established at Cuttack, complemented by 3 base stations along the waterway. The control system hosts RIS software and hardware and acts as the command centre which collects data, processes it and passes on instructions to other base stations.

c) **Survey Equipment** – Total Station, Auto-level, Echo-sounder, Current Meter, Hypack Software, ATG, DGPS receiver, PC & Workstation.

0.8.2. Existing System

No system exists.

0.8.3. Additional requirement

The above said systems are very essential for a properly established terminal and waterway system. No additional navigation and communication system is proposed.

0.8.4. Costing

0.1.1.1. Capital Cost

Total expenditure of ~INR 2.4 Crore is proposed as follows –

Table 0-13: CAPEX on Navigation and Communication Equipment

Sr. No.	Equipment	Qty	Unit Price	Total
Base Station, Control Station				
1	AIS Base Station	2	30,00,000	60,00,000
2	Meteorological Sensor	1	8,00,000	8,00,000
3	ATG	1	11,00,000	11,00,000
4	VHF	1	5,00,000	5,00,000
5	DG Set 10 KVA	1	7,00,000	7,00,000
6	UPS	2	5,00,000	10,00,000
7	DGPS Station	-	-	-
8	RIS Software[3]	1	60,00,000	60,00,000
9	RIS Hardware	1	20,00,000	20,00,000
10	Installation Testing & Commissioning	2	12,00,000	24,00,000
11	Porta cabin	1	7,50,000	7,50,000
12	Monopole Tower	2	30,00,000	60,00,000
13	Survey Equipment			31,80,000
			Total	**2,44,30,000**

0.1.1.2. O&M Cost

Operation and maintenance cost are ~**5% of the installation cost**. As **Chandbali would double as Base cum Control station**, it would require 1 Engineer, 2 operators and 2 security staff. The security personnel requirement can be accommodated with staffing proposed in Institutional Requirements. The operated should be IALA trained and can be effectively utilized for ensuring proper running of RIS system and other equipment. If required, operations of base and control stations can be outsourced through comprehensive AMAC contracts.

[3] Not considered, as the software procured by IWAI would be common across waterways

Table 0.3: Manpower Requirement for Operations of Communication and Navigation Equipment

Sr. No.	Description	CTC (INR lakh)	Staffing Requirement	Total Cost (INR lakh)
1	Engineer	4.8	1	4.8
2	Operator	3.0	2	6.0

0.9. Environmental and social aspects

Environmental settings in project area

Baitarni River is in the North-East part of Odisha. The scope of present study is limited for 48 km of Baitarani River stretch. Bathymetry / topography survey was carried out for this stretch for assessment of topographical features of the River.

Based on analysis of Forest Map available at GIS Website of Odisha (http://gis.ori.nic.in/) developed and run by NIC, no forest land is located alongside the project river stretch.

Bhitarkanika Wildlife sanctuary is located adjacent to end of river stretches under study. Baitarani River was found to have a total 6 nos. cross structures. During survey, a lot of island formations were observed along the river stretches, mainly of sand. Baitarni river is flowing from North to South and crosses various settlements along the proposed waterways.

Estuary and coastal zone

Area along some part of Baitarni River is notified as CRZ III area. Map of CRZ area along project river stretch is presented in the report. CRZ clearance is needed to be taken before starting any construction activities on river stretch.

Potential Environmental and Social Impacts of the Project

Proposed project is likely to change the prevailing environment condition of the project region. Considering some of the adverse impacts associated with project, these impacts have to be mitigated and mitigation measures need to be incorporated in the engineering design. Environmental mitigation measures represent the project's endeavour to reduce its environmental footprint to the minimum possible. These are conscious efforts from the

project to reduce undesirable environmental impacts of the proposed activities and offset these to the degree practicable. Enhancement measures are project's efforts to gain acceptability in its area of influence. They reflect the pro-active approach of the project towards environmental management.

Need for Environmental Clearance

Considered Not Applicable as EIA Notification 2006 does not classify terminals on river or dredging in the river requiring environmental clearance. The applicability of this legislation should be reconfirmed during commencement stage. In addition, following clearances are required:

- CRZ Clearance is required,
- Wildlife clearance subjected to any construction activity within the eco-sensitive zone.
- Forest clearance if revenue forest is required to be acquired during commencement
- Tree felling permission. if tree cutting is involved.

0.10. Institutional requirement

Due to the smaller size of project, Feedback has refrained from an extensive organization setup. However, we have endeavoured to account for adequate support staff for the smooth operations of the project. It has been found that Govt. of India promulgated direction under section 111 of the Major Port Trusts Act 1963 to the selected Major Port Trusts for allocations of National Waterways (NWs) for undertaking the development of the National Waterways through release of grants by the IWAI. The Major Port Trusts are to be the implementing agency for development of the National Waterways. As per the above directions of Govt. of India, the River Baitarani (NW-14) has been allocated to the Paradeep Port Trusts for development.

a) Since, the River Baitarani (NW-14) has been allocated to Paradeep Port Trust for development, the manpower requirement for maintenance under the present scenario shall be an Officer at the level of Assistant Director (T.) and Junior Account Officer may be posted at Head Quarter, Noida and Bhubaneswar to monitor the various

development works undertaken by the different Port Trusts for development of various National Waterways allocated and also monitoring the utilisation of fund.

b) Since the manpower will be deployed by the Paradeep Port Trust for maintenance and development of the River Baitarani (NW-14), the training of personnel shall not be required at the terminals.

0.11. Project costing

Inland Waterway Transportation system cost is built upon the cost of development, operation and maintenance of (a) Fairway and (b) Terminal Infrastructure

0.11.1. Capital expenditure

While estimating the capital cost of the project, the development activities mentioned below are considered and expected that the works can be completed within period of nine months.

- **Fairway development** – includes dredging, river training and bank protection works
- **Terminal infrastructure development** – includes construction of a floating terminal and terminal buildings at 2 locations.

Table 0-14: Capital cost of project

Sl. No.	Description	Total (in Rs.)
1	Berthing structure (one at Chandbali and one at Aradi)	Rs. 29,57,840.00
2	Terminal building (2nos.) (including land cost)	Rs.54,16,044.00
3	Fairway development (including dredging)	Rs 6,03,46,800.00.
4	Utility shifting	Rs. 10,00,000.00
5	Auxiliary items	Rs. 20,00,000.00
6	Landscaping	Rs. 5,00,000.00
7	Navigation and Communication	Rs. 2,44,30,000.00
8	Aids to Navigation	Rs. 13,00,000.00
	Total	**Rs. 9,79,50,684.00**

0.11.2. Operational and maintenance expenditure

Table 0-15: Operational cost of project

Sl. No.	Description	Percentage of capex	Amount (Rs.)
I	**Fairway**		
1	Dredging	5.00	Rs. 89,840
2	Bank maintenance	1.00	Rs. 1,34,000.00
3	Aids to navigation	2.00	Rs. 26,000.00
4	River training	5.00	Rs. 14,50,000.00
II	**Terminal Infrastructure**		
1	Terminal operations (salary of staffs)	Chapter 10	Rs.45,60,000.00
2	Terminal maintenance	1.00	Rs. 45,260.44
3	Navigation and communication	5.00	Rs. 12,21,500.00
4	Berthing structure	5.00	Rs. 1,47,892.00
5	Landscaping	1.00	Rs. 5,000.00
6	Auxiliary items	1.00	Rs. 20,000.00

0.12. Implementation Schedule

The development can be divided into pre-construction and construction activities. Various activities identified under pre-construction are:

1. Clearance from various authorities
2. Preparation of tender document
3. Tender process

Construction Activities would include the following:

- Dredging
- Bank protection works

- Construction of terminal structures
- Procurement of navigational aids
- Commissioning

It is planned that the development of waterway system will take place in a single phase extending over 9 months. It includes all development works including fairway development and terminal infrastructure development. The detailed implementation schedule is provided in the chapter of the report and annexures.

To develop the project and to manage the common infrastructure facilities, it is necessary to establish an independent institutional framework under the IWAI, the implementing agency. This shall be in the form of Special Purpose Vehicle (SPV). SPV shall be the agency for service delivery, operation and maintenance of the Project. The option of SPV owned by the Government entities is best suited for the Baitarani inland waterway development and operation. However, private entities may hold some equity in the SPV, but less controlling stake. Thus, for all practical purpose, the SPV would be a Government entity. In the construction phase of the proposed project IWAI shall be the main implementing agency. IWAI shall create a focused SPV manned by the qualified & experienced professional & multi-disciplinary technical team dedicated to the planning and management of the project. The process of awarding the contract shall be on tender or deposit basis. SPV shall invite, process and award the tenders. As and when necessary the SPV shall invite the offer from government construction agencies on limited tender or deposit basis. An apex coordination committee shall be formed to co-ordinate between the departments related to the project and issue guidelines to the SPV for execution of the works. A policy framework and operating manual containing detailed system and structure of execution shall be prepared for effective control and delivery of the services.

The entire construction (including capital dredging) would be through EPC contracts. The maintenance of Inland Waterways system is to be handled by the SPV through the construction agency for a period specified in the tender document. Afterward O&M shall be handled through the combination of in-house capacity building & outsourcing. The revenue connected with these activities will also be collected by the SPV in the shape of

tariff & user charges. SPV will also have to be provided with the necessary power for building byelaws for efficient functioning of Inland Waterways System.

0.13. Economic and Financial Analysis

The following revenues have been considered:

- **Passenger Charges**: Charges for terminal facilities, waterway development & maintenance. The charges would be payable at the Chandbali jetty by the boat operator[4].
    - Chandbali – Nalitapatia / Bhitarkanika (~60 km for return trip): INR 50
    - Chandbali – Aradi (~50 km for single side trip): INR 25
    - Chandbali – Talchua (~40 km for single side trip): INR 25
- **Commercial Leasing**: INR 500 psf per annum at Chandbali, Aradi and Nalitapatia terminals (Total 1,000 sq. ft)

Based on the above revenue assumptions, following revenues are projected:

Table 0-16: Revenue projections

(INR Crore)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger Charge	0.3	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.9
Commercial Leasing	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Revenues	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.1**	**1.3**	**1.5**	**1.7**	**2.0**

0.13.1. Net Cash Flows

Following general assumptions have been considered

- Passenger Charge/ Lease Escalation : 8% p.a.
- OPEX Escalation : 5% p.a.
- Manpower Escalation : 7% p.a.
- Discount Rate (WACC) : 10%

[4] The tourists currently pay INR 3,000 - 4,000 for ferry services taken from Chandbali to Bhitarkanika and ~INR 2,000 for Chandbali to Aradi (for ~15 seat boat with average utilization of 10 passengers). This translates to INR 300 – 400 per passenger (from Chandbali to Bhitarkanika) and INR 150 (from Chandbali to Aradi)

Projected pre-tax cash flows (for first 10 years) are shown below.

Table 0-17: Projected Pre-tax net cash flows

(INR Crores)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPEX	9.8												
OPEX	-	0.9	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.8
Revenue	-	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.3	1.5	1.7	2.0
Net Cash Flows	**-9.8**	**-0.6**	**-0.6**	**-0.6**	**-0.6**	**-0.5**	**-0.5**	**-0.4**	**-0.3**	**-0.2**	**-0.1**	**-0.0**	**0.2**

The financial returns (FIRR) are (i) NPV: INR (0.6) Cr (ii) IRR: 9.8% p.a. The project returns have been calculated for variations in passenger charges, as they contribute the majority of revenues.

The following table captures the sensitivity:

Table 0-18: Sensitivity analysis

% Changes in Passenger Charges	NPV (INR Cr.)	IRR (%)
-45%	-11.6	4.0%
-30%	-8.0	6.5%
-15%	-4.3	8.3%
0%	-0.6	9.8%
15%	3.1	11.1%
30%	6.8	12.2%
45%	10.5	13.2%

The EIRR analysis of the project establishes significant returns:

Table 0-19: Socio – Economics Returns (Moderate Scenario)

Parameter	Impact	Total Economic Impact (2030) INR crore	Total Economic Impact (2050) INR crore
Operation Efficiency (cost savings)[5]	1.44 per ton km	1.9	3.2
Job Creation[6] (monetary benefits)	INR 10 Crore per 1 lakh tourists	31.5	106.2
Total Economic Impact		**33.4**	**109.4**

0.14. Conclusion

From study of Baitarani river for the development of navigation channel, it can be concluded that:

- The whole 48 km of river studied is observed to be under tidal influence with no major hindrances to navigation in the stretch like barrages, dams, etc. The vertical and horizontal clearances of permanent crossing structures are satisfactory, and the clearance issues are paused only by temporary bamboo bridges which are beyond the considered stretch of Ch 27.24km.
- There is good tourism potential in the region. This can be explored.
- It is proposed to develop the river from Dhamra river confluence to Aradi as Class I waterway with minimum depth of 1.2m, bottom width30m and bend radius of 300m, with the berthing structure yielding comparatively lesser cost.
- The river requires training at few stretches owing to severe loops and meandering of the channel limiting desired bend radius, the channel needs minimum dredging of around 109377 cubic meter to maintain the depth of 1.2m corresponding to Class I characteristics, embankments near the terminal requires immediate protection owing to vessel wakes.
- The expected traffic potential is the one generated due to tourism and local passenger movement. This development can also improve the connectivity of local

[5] Calculated based on number of trips, 100 km distance for each trip and 10-ton average boat size
[6]Based on 300 new jobs for every 1 lakh tourists, average economic benefit of INR 3 lakhs per job

areas by providing a quick and cheap crossing service between the two banks of the river for both passengers and two-wheelers.

- The region is flood prone hence the terminal structure is proposed to be of that type which can accommodate the water level fluctuations, hence floating pontoon jetty with articulated access trestle is suggested.
- Vessels capable of serving the passenger traffic, local country boats and water sport vessels seem sufficient.
- It is proposed to have DGPS station and RIS network (including VHF and AIS) for the safe managing of the vessels along with facilities for receiving weather forecasts from IMD or other similar organizations. Significant cost savings can be achieved by merging RIS software and DGPS system being deployed for NW-64, for this waterway as well.
- The river is already having ferry service and the proposed terminal is beyond 10km lateral distance from the sea mouth, hence environmental clearance is not required. However, CRZ clearance is required.
- The cost for developing the river up to 27.24 km as Class I with one new terminal at Chandbali on south bank and one terminal at the Aradi location is around Rs. 9.80 Crores.
- It is proposed to complete the work within a period of 9 months including a 6-month time for statutory clearances.
- It is observed that EPC mode of implementation is suitable for this kind of works.
- It is not recommended to develop the waterway for cargo transport and instead focus on upgrading the current tourism facilities. Hence, the economic and financial analysis of the waterway has been left out citing lack of cargo traffic and continuation of existing tourist services only.

0.14.1. Recommendation:

It is recommended to develop the river stretch up to Aradi as Class I, so that dredging quantity is relatively less, with one new terminal at Chandbali and using existing terminal at Chandbali to enable crossing between banks and another terminal at Aradi. The total cost works out to be Rs. 9.80 crores. In the future, once the traffic has developed, the waterway can be upgraded to Class III waterways.

1. INTRODUCTION

1.1. Project Background and Summary of previous study

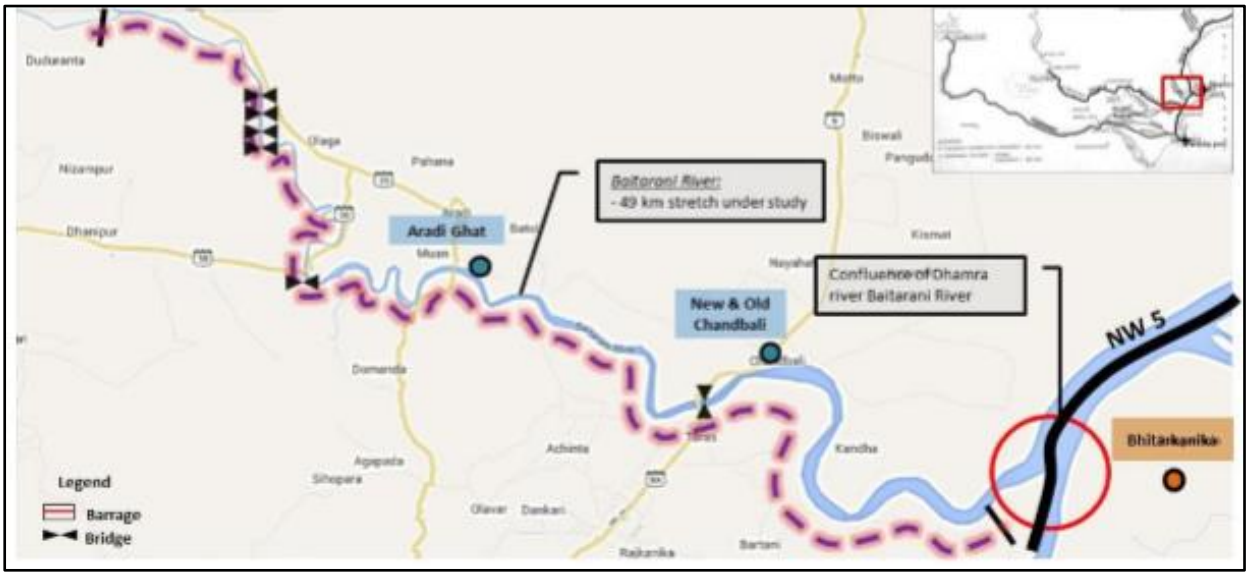
India with about 14,500 km of navigable waterways which comprise rivers, canals, backwaters, creeks, etc., have huge potential in water transport. There is a need to promote these environment-friendly and cost-effective modes of transport as these remain largely underutilized accounting for less than 0.5% of total traffic within India. With National Waterways Act 2016, the Govt Of India designates new rivers and canals as national waterways which are to be developed for year-round commercial navigation. Inland Water Authority of India is the nodal agency responsible for development and operation of IWT infrastructure in India. The consultant is engaged for the preparation of DPR for the 48 km stretch of Baitarani river in Orissa under Cluster 4. The entire scope of the work can be broadly divided into two stages, stage 1 aims at the preparation of a feasibility report and stage 2 requires the preparation of a detailed project report.

During February 2016, around 48 km of the river length from Duttapur village at Latitude 20°51'53.38"N Longitude 86°33'42.42"E to confluence with Dhamra river near Laxmiprasad Dia at Latitude 20°45'13.32"N, Longitude 86°49'15.36"E, was surveyed to ascertain the feasibility of the project. The focus of the study was on the traffic potential of the area and need for a waterway amidst existing infrastructure facilities. As a part of the reconnaissance survey, bathymetry study was carried out using Bathy 500 portable shallow water echo sounder; topographical features were studied to know the details of crossing structures and general land use details; analysis of market and traffic generating clusters in the vicinity were performed, existing rail/road connectivity details were checked, etc. The entire stretch of the study area is found to be tidal and a ferry service presently exist. It was concluded in the feasibility study that, around 7km of river stretch was found to have water depth under 1.5m with slight issues of turning radius at few places, except this there is vast potential for the river to be developed to a waterway. The tourism potential of the region owing to its proximity to Bhitarkanika sanctuary among others may be explored by introducing a cost-effective means of entertainment. The local connectivity can also be improved.

1.2. Project Location / Details of Study Area

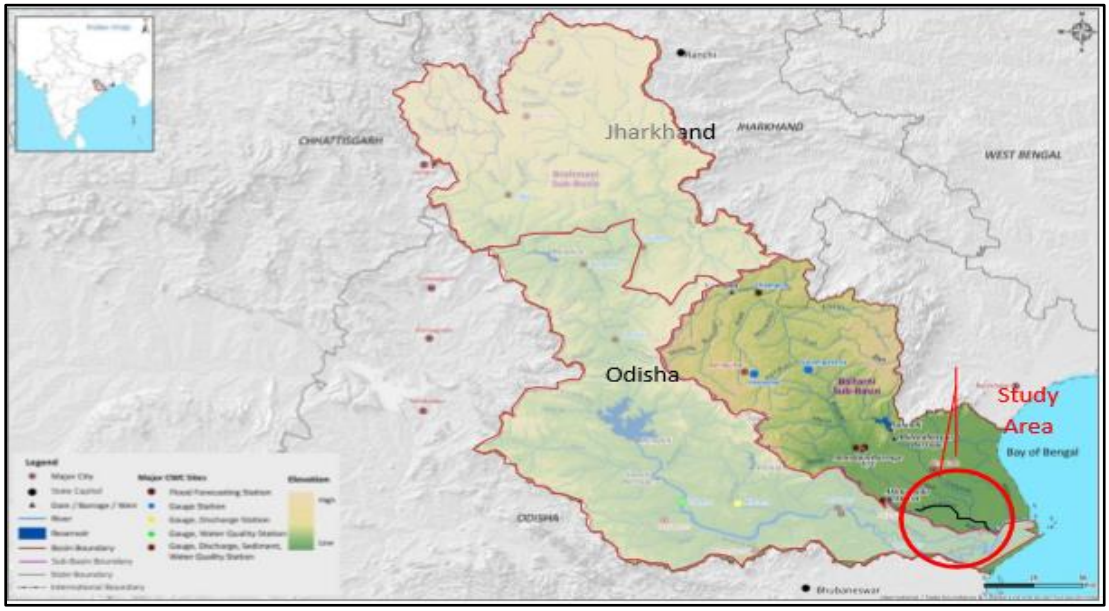
Baitarani rises from the Gonasika in the Guptaganga hills of Keonjhar district. The river traverses a total distance of 360 km before meeting Dhamra River.

Figure 1.1: River stretch under study



Present study consists of 48 km length of the river. The Baitarani basin forms part of Brahmani/Baitarani river basin which is the 17th largest basin having total catchment area of 53,487 Sq.km which is nearly 1.7% of the total geographical area of the country. Baitarani basin lies to the North of Brahmani basin. The upper parts of the basin virtually consist of series of plateaus standing at different levels of elevation. This is followed by middle lower basin with several ranges rising above the coastal plains. The part of the basin covering Odisha state is a complex of denuded hills, plateaus, sharp ridges and mature valleys. The elevation decreases to 10 m towards coastal edge of the basin. The study stretches of Baitarani River falls in coastal basin area. Fifty-nine percent of the land along the river stretch under study is being used for agricultural purpose followed by 15 percent of forest area. Fallow land constitutes 2 percent of the total land available. The chart below shows the land-use pattern along the river.

Figure 1.2: Map of the state highlighting the area under study.



1.3. Brief Scope of Work and Compliance statement

In Stage-2, it is required to carry out detailed hydrographic survey, topographic survey, traffic survey and selection of terminal locations. The activities can be summarized as below:

- Detailed Hydrographic Survey & hydro-morphological survey
- Traffic Survey & Techno economic feasibility
- Preparation of Detailed Project Report

As per the TOR, the detailed hydrographic survey is to be carried out in WGS'84 datum and the horizontal control is to be made using DGPS with minimum 24 hours' observations. The vertical control is to be established w.r.t. the chart datum/ sounding datum. The Benchmark pillars to be constructed at every 10km intervals and the water level gauges are to be erected and connected to the nearest BM by levelling. Bathymetric and topographic survey of 100m wide corridor and c/s sounding lines/ levelling to be run from bank to bank at spacing of 200m. The soundings are to be reduced to SD/CD and current velocity and discharge at an interval of 10km is required. Water and bottom samples are to be collected and analysed. In traffic survey and techno economic feasibility, it is expected to make a forecast of the traffic prospects to facilitate the

projection of the most promising route. Modality of conducting traffic survey shall be based on industrial surveys and a traffic projection for a horizon period (say 5, 10, 15 and 20 years) must be forecasted along with the divertible traffic to waterway.

The scope of work in DPR preparation is as follows:

- Assessment of morphological, hydrological, hydrographical conditions and operation and maintenance requirements of the proposed waterways.
- Geo-tech investigation as per guidelines of Geological Survey of India.
- Preliminary engineering designs, drawings, estimates, for the waterway system in an EPC mode.
- River training and bank protection works anticipated.
- Preparation of construction schedule with phasing of expenditure.
- Cost estimate for different alternatives shall be considered and FIRR, EIRR, NPV and SWOT analysis are to be carried out.
- EIA study and suggesting EMP.
- Suggestions for VC and HC to be provided for crossing structures.

1.4. Brief Methodology & Approach

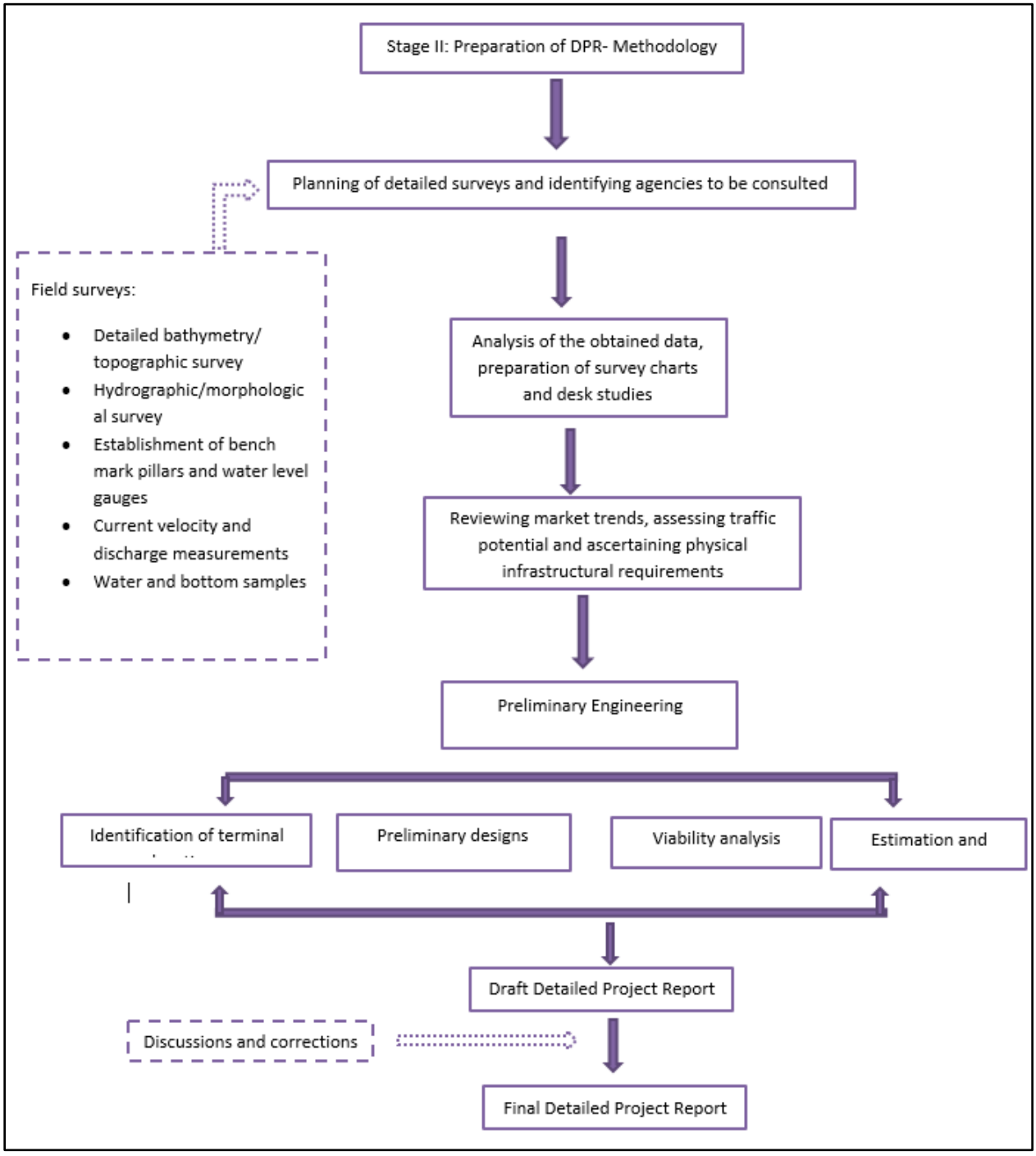
To successfully deliver the project requirements, a stepwise delivery model was followed. The approach and methodology used for Stage -II studies are as shown using the flow chart. The important targets during the study were as follows:

- Survey: With the award of the work, the tentative temporal targets were fixed. All the available secondary data was collected, and sophisticated survey agencies were identified and consulted. The requirements and expected outputs were made clear to the agency. The local authorities and public and private agencies in and around the locality were consulted to gather information relating to various aspects of the study area. The hydrographic survey was carried out in WGS-84 datum and tide data was observed at 10km interval. The projection used was Transverse Mercator and the grid used was Universe Transverse Mercator Grid (Zone 45). Differential signal corrections for the DGPS system were automatically obtained from the nearest DGLL Beacon at Paradip Port. HYPACK Ver.2012 was used for

sounding data processing. The benchmark and sounding datum was established as per the TOR specifications. The traffic study was conducted considering the Paradip and Cuttack industrial clusters and the market potential in the area was studied. After thorough desk studies and discussions, required tables and charts of the survey outputs were finalized.

- Data/ Market Analysis: From the output of the studies conducted, a picture of the requirement of facilities, the amount of developmental activities to be provided, locations of the infrastructures, etc., were obtained. The traffic survey gave an idea about the traffic movements and their potential route. This led to finalizing the number and extend of terminals required. The hydrographic survey helped in arriving at the Class of waterway to which the proposed stretch is to be developed and the type of terminals needed. Each element of the proposed project was thus arrived at based on one of the or a combination of the data obtained.
- Identifying Traffic Potential: The cargo/ passenger in the area was accessed to confirm that the developmental work is justified. The long-term opportunities of the area and divertible traffic to waterways were considered.
- Preliminary Engineering: Based on the requirements, the preliminary dimensions and structural arrangements were arrived at.
- Costing: Estimate of structural components, waterway development, environmental management plans, etc., were considered for costing.
- Viability Analysis: The weakness and opportunities of each option was considered and compared.
- DPR: A draft copy is now being submitted. Upon receiving comments from IWAI, the final report shall be submitted.

Figure 1.3: Stage II methodology flow chart



2. WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1. Hydrographic Survey

2.1.1. Waterway in General and Hydro-morphological Characteristics

The Baitarni River or River Baitarni is one of six major rivers of Odisha, India. Venerated in popular epics and legends, the Baitarni River is a source of water for agricultural irrigation. Most of the potentially arable land in the area is not under cultivation. The coastal plain of Odisha has the name of "Hex deltaic region" or the "Gift of Six Rivers". These deltas divide the coastal plain into three regions from north to south. The Baitarni, the Mahanadi and the Brahmani rivers form the Middle Coastal Plain, with evidence of past "back bays" and present lakes.

The Baitarni originates from the Gonasika/Guptaganga (Cow Nose Shaped) hills and starts flowing a stone looking like the nostril of a cow. Afterwards for about half a kilometre the river flows underground and is not visible from outside. The Baitarni is known here by the name Guptaganga or the Gupta Baitarni, in Gonasika of Keonjhar district in Odisha state of India at an elevation of 900 metres (3,000 ft) above sea level. The uppermost part of the river, about 80 kilometres (50 mi) in length, flows in a northerly direction; then it changes its path suddenly by 90 degrees and flows eastward. The beginning portion of Baitarni acts as the boundary between Odisha and Jharkhand.

Flooding is a regular phenomenon in the Baitarni basin. The inhabitants, near the river, live in a fear of loss to life and property. Even a two-day rain in July 2005 caused the river to overflow its banks, affecting 140,000 people in 220 villages of Jajpur and Bhadrak districts. In at least two places the embankments were breached, and marooning occurred, inflicting massive losses of life and property. Apart from the long pending construction of a dam at Bhimkund and proposed other measures like river bed excavation and construction of embankments etc. in the deltaic region, there remain the unaddressed land use issues in the upstream, to which, till date, no serious thoughts or efforts have been directed.

Due to drainage into the Bay of Bengal, its water become salty as it heads towards the end of the River.

Baitarni basin, with its rich mineral and agricultural resources and with availability of cheap labour, offered an ideal ground for establishment and operation of various industries. However, the principal development activities in the industrial, agricultural and mining sectors have contributed significantly towards deterioration in the water quality.

The river enters a plain at Anandapur and creates a deltaic zone at Akhuapada. The river travels a distance of 360 kilometres (220 mi) to drain into the Bay of Bengal after joining of the Brahmani at Dhamra mouth near Chandbali. The river has 65 tributaries, of which 35 joins from the left side and 30 joins from the right side. The river basin in Odisha is spread among 42 blocks of eight districts. Budhi, Kanjori, Ambajhara, Mushal, Kusei, Salandi are some of the tributaries of Baitarni. The survey was carried out from 28th Mar 2017 to 08th Apr 2017.

Figure 2.1: Considered stretch of river

2.1.2. Existing Hydrological / Topographical Reference levels

Benchmark Pillars of dimension 0.3m x 0.3m x 1.5m (0.6m above GL) RCC pillar with 6mm thick 50mm diameter GI pipe inserted were constructed, at every 10km interval. Detail description of Benchmark along with its position and value to be submitted in report.

Table 2.1: Benchmark details

BM no	Location	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	BM Height above MSL (m)	BM Height above SD(m)
BM 1	Ashoka dia	2.32	20°44'16.15"N	86°48'20.88"E	479781.96 m E	2293143.98 m N	4.025	5.5
BM 2	Baradia	9.9	20°44'48.26"N	86°45'1.00"E	474003.22 m E	2294139.46m N	4.177	5.35
BM 3	Goladia	19.64	20°46'19.51"N	86°42'37.99"E	469872.6 m E	2296951.11m N	3.958	4.68
BM 4	Gunthal	28.7	20°47'20.31"N	86°38'40.41"E	463007.58 m E	2298833.94m N	3.806	4.5
BM 5	Olaga	40.54	20°49'46.29"N	86°36'36.95"E	459449.14 m E	2303330.49m N	4.465	5.13
BM 6	Duttapur	48.58	20°51'53.38"N	86°33'42.42"E	454415.48 m E	2307249.96m N	7.098	7.75

Table 2.2: Details of erected tide gauges

Tide Gauge No.	Location	Chainage (km)	Easting (m)	Northing (m)	Zero of Tide Gauge w.r.t. MSL (m)	Period of observation (Hrs)
TP 1	Ashoka Dia	2.32	480995.54	2292438.25	4.909	06:00 TO 18:00
TP 2	Baradia	9.88	474050.72	2294139.42	4.157	06:00 TO 18:00
TP 3	Goladia	19.64	469839.95	2296960.68	4.935	06:00 TO 18:00
TP 4	Gunthal	28.7	462990.91	2298837.9	3.767	06:00 TO 18:00
TP 5	Olaga	40.55	459425.26	2303316.4	4.323	06:00 TO 18:00
TP 6	Duttapur	48.7	454414.09	2307225.66	8.002	06:00 TO 18:00

Tide poles have been erected at every 10 km and water level was observed from 06:00 hrs to 18:00 hrs throughout the survey. Chart Datum / Sounding Datum

Chart Datum / Sounding Datum

The MHWS and MHWN for Dhamra port were available from Indian tide table. As river is tidal there is no dam weir so the MHWS and MHWN were used for all the calculation.

Table 2.3: Chart datum/ Sounding datum and reductions details

BM	LOCATION	Chainage (km)	CD Below MSL(m)	Reduction(m)	CD Below BM(m)	Correction in WL data for Bathymetric survey (m)
1	Ashoka Dia	2.32	-1.475	-0.590	5.500	All the observed Water Levels were referenced with MSL.
2	Baradia	9.88	-1.17	-1.19	5.35	
3	Goladia	19.64	-0.72	0.26	4.68	
4	Gunthal	28.7	-0.698	-0.74	4.50	
5	Olaga	40.55	-0.669	-0.81	5.13	
6	Duttapur	48.7	-0.65	0.25	7.75	

Note: a) Datum values in tidal regions are w.r.t. to Chart Datum transferred from IWAI BM at Baitarni & Brahmani River mouth.

b) As the total stretch is tidal effected area the datum value for in-between benchmarks are derived by interpolation method.

Transfer of Sounding Datum table for Tidal Rivers: -

The transfer of sounding datum was carried out at 02placesand the same is as follows from Dhamra harbour.

Transfer of Sounding datum BM 2- TP 2									
Established Gauge					New Gauge				
Heights above chart datum					Heights above zero of tide pole				
High Water	Low water	Factor	HW	LW	High Water	Low water	Factor	HW	LW
	0.14	1		0.14		0.76	1		0.76
2.71		1	2.71		3.18		1	3.18	
	0.35	3		1.05		0.69	3		2.07
2.8		2	5.6		3.04		2	6.08	
	0.32	3		0.96		0.8	3		2.4
2.8		1	2.8		3.21		1	3.21	
	0.45	1		0.45		0.61	1		0.61
Sum			11.11	2.6				12.47	5.84
MEAN			2.8	0.3				3.1	0.7
Range		R	2.45				r	2.39	
Observed Mean Tide		M'	1.55				m'	1.92	
Formula 1	Where MHWS and MLWS at established gauge are known								
	MHWS	0		M	0		1.92		
	MLWS	0		d	0	0.4	1.551255		
							0		
Value of Sounding datum				0.000		Above zero of tide pole			
Formula 2	Where "True mean tide level at springs" at established pole is not known								
				d	0.413661				
Value of Sounding datum				0.414		Above zero of tide pole			

Transfer of Sounding datum BM 3- TP 3									
Established Gauge					**New Gauge**				
Heights above chart datum					**Heights above zero of tide pole**				
High Water	**Low water**	**Factor**	**HW**	**LW**	**High Water**	**Low water**	**Factor**	**HW**	**LW**
	0.14	1		0.14		0.07	1		0.07
2.71		1	2.71		1.35		1	1.35	
	0.35	3		1.05		0.17	3		0.51
2.8		2	5.6		1.4		2	2.8	
	0.32	3		0.96		0.16	3		0.48
2.8		1	2.8		1.4		1	1.4	
	0.45	1		0.45		0.23	1		0.23
Sum			11.11	2.6				5.55	1.29
MEAN			2.8	0.3				1.4	0.2
Range		R	2.45				r	1.23	
Observed Mean Tide		M'	1.55				m'	0.77	
Formula 1	Where MHWS and MLWS at established gauge are known								
	MHWS	0		M	0		0.77		
	MLWS	0		d	0	-0.8	1.55125		
							0		
Value of Sounding datum				0.000		Above zero of tide pole			
Formula 2	Where "True mean tide level at springs" at established pole is not known								
		d	-0.0013						
Value of Sounding datum				**-0.001**	Below zero of tide pole				

Transfer of Sounding datum BM-4, TP-4									
Established Gauge					**New Gauge**				
Heights above chart datum					**Heights above zero of tide pole**				
High Water	**Low water**	**Factor**	**HW**	**LW**	**High Water**	**Low water**	**Factor**	**HW**	**LW**
	0.14	1		0.14		1	1		1
2.71		1	2.71		2.77		1	2.77	
	0.35	3		1.05		0.98	3		2.94
2.8		2	5.6		2.64		2	5.28	
	0.32	3		0.96		1.07	3		3.21
2.8		1	2.8		2.18		1	2.18	
	0.45	1		0.45		1	1		1
Sum			11.11	2.6				10.23	8.15
MEAN			2.8	0.3				2.6	1.0
Range		**R**	2.45				**r**	1.54	
Observed Mean Tide		**M'**	1.55				**m'**	1.79	
Formula 1	Where MHWS and MLWS at established gauge are known								
	MHWS	**0**		**M**	0		1.79		
	MLWS	**0**		**d**	0	0.2	1.55125		
							0		
Value of Sounding datum				**0.00**		**Above zero of tide pole**			
Formula 2	Where "True mean tide level at springs" at established pole is not known								
		d	0.8148						
Value of Sounding datum				**0.815**		**Above zero of tide pole**			

Transfer of Sounding datum BM 5, TP 5									
Established Gauge					**New Gauge**				
Heights above chart datum					**Heights above zero of tide pole**				
High Water	**Low water**	**Factor**	**HW**	**LW**	**High Water**	**Low water**	**Factor**	**HW**	**LW**
	0.14	1		0.14		0.65	1		0.65
2.71		1	2.71		2.32		1	2.32	
	0.35	3		1.05		0.73	3		2.19
2.8		2	5.6		2.19		2	4.38	
	0.32	3		0.96		0.61	3		1.83
2.8		1	2.8		2.51		1	2.51	
	0.45	1		0.45		0.79	1		0.79
Sum			11.11	2.6				9.21	5.46
MEAN			2.8	0.3				2.3	0.7
Range		**R**	2.45				**r**	1.62	
Observed Mean Tide		**M'**	1.55				**m'**	1.49	
Formula 1	Where MHWS and MLWS at established gauge are known								
	MHWS	**0**		**M**	0		1.49		
	MLWS	**0**		**d**	0	-0.1	1.55125		
							0		
Value of Sounding datum				**0.000**		**Above zero of tide pole**			
Formula 2	Where "True mean tide level at springs" at established pole is not known								
		d	0.467821						
Value of Sounding datum				**0.468**		**Above zero of tide pole**			

Transfer of Sounding datum BM 6 -TP 6									
Established Gauge					**New Gauge**				
Heights above chart datum					**Heights above zero of tide pole**				
High Water	**Low water**	**Factor**	**HW**	**LW**	**High Water**	**Low water**	**Factor**	**HW**	**LW**
	0.14	1		0.14		0.48	1		0.48
2.71		1	2.71		2.16		1	2.16	
	0.35	3		1.05		0.52	3		1.56
2.8		2	5.6		2.26		2	4.52	
	0.32	3		0.96		0.47	3		1.41
2.8		1	2.8		2.58		1	2.58	
	0.45	1		0.45		0.56	1		0.56
Sum			11.11	2.6				9.26	4.01
MEAN			2.8	0.3				2.3	0.5
Range		R	2.45				r	1.81	
Observed Mean Tide		M'	1.55				m'	1.41	
Formula 1	Where MHWS and MLWS at established gauge are known								
	MHWS	0		M	0		1.41		
	MLWS	0		d	0	-0.1	1.55125		
							0		
Value of Sounding datum				0.000		Above zero of tide pole			
Formula 2	Where "True mean tide level at springs" at established pole is not known								
		d	0.2609						
Value of Sounding datum				**0.261**	Above zero of tide pole				

Note-Establishment of Chart Datum (CD) / Sounding datum

Datum values in tidal regions are w.r.t. to Chart Datum, transferred from IWAI BM-2 at Baitarni& Brahmani River mouth.

Table 2.: Tidal variation with chainage

Tide pole #	Chainage (km)	Tidal variation (m)
1	2.32	2.11
2	9.2	2.42
3	19.64	1.85
4	28.7	1.75
5	40.78	1.67
6	48.6	1.09

2.2. Existing Cross Structures

2.2.1. Bridges

The crossing structures include road and temporary bridges, which are listed below with chainages and their clearances.

Table 2.4: Existing bridges crossing the waterway

Sl no	Structure	chainage (Km)	location	latitude	Longitude	Easting(m0	Northing(m0	Hz cl (m)	V cl w.r.t MHWS(m)	Present Condition
1	Road bridge	16.800	Ostia (Aradi-Chandbali)	20^0 45’45.72"N	086^0 43' 19.2788 "E	471064.57E	2299510.41N	30	4.2	Completed, in use
2	Road Bridge	34.400	Kayan Gola	20^0 47' 51.000 ”N	086^0 36' 46.9688 "E	459730.20E	2299784.71N	30	3.5	Completed, in use
3	Bamboo Bridge	46.275	Betaligaon	20^0 51' 28.092 "N	086^0 34' 56.6916 "E	456559.56E	2306466.84N	3.0	0.5	In use
4	Bamboo Bridge	47.140	Naranpur	20^0 51' N44.105"	086^0 34' 30.6882 "E	455809.44E	2306961.11 N	3.0	0.7	In use
5	Bamboo Bridge	48.460	Duttapur	20°51' 50.74" N	086°33' 43.61"E	454449.81E	2307168.90N	2.5	1.2	In use

Note: The temporary Bamboo bridges (Sl No: 3, 4 & 5) are submerged during Monsoon

2.2.2. Electric Lines / Communication Lines

Not applicable.

2.2.3. Pipelines / Cables

Not applicable.

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

There are no Dams, Barrages, weirs, Anicut found in this zone of River.

2.3. Bends

2.3.1. Radius of Curvatures

In the hydrographic survey, it is stated that average bend radius of river Baitarani has been observed 800m.

2.4. Velocity and Discharge Details

Table 2.5: Current meter observations

Current Meter Observation in Baitarani River											
Sl No.	Date	Chainage(Km)	Location	Easting(m)	Northing(m)	Lat	Long	Depth(m)	Velocity (m/s)		
									0.5 d	0.3 d	d
1	06.04.2017	0.00	LaxmiprasadDia	481614.01	2294652.72	20° 45’ 5.2965” N	086° 49’ 24.1733” E	5.2	1.99	1.93	1.92
2	07.04.2017	10.00	Sikudi	474294.99	2294194.65	20° 44’ 50.0841” N	086° 45’ 11.0916” E	4.2	1.89	1.83	1.81
3	02.04.2017	20.00	Matia	469588.32	2297265.09	20° 46’ 29.7068” N	086° 42’ 28.1392” E	8.9	1.03	0.98	0.92
4	30.03.2017	30.00	Kanapur	462343.31	2299597.41	20° 47’ 45.0966” N	086° 38’ 17.3758” E	2.4	0.92	0.83	0.78
5	29.03.2017	40.00	Gunthinipada	459488.91	2302805.86	20° 49’ 29.2459” N	086° 36’ 38.3698” E	2.7	0.81	0.79	0.68
6	28.03.2017	47.00	Naranapur	454364.19	2307206.48	20° 49’ 29.2459” N	086° 33’ 40.6501” E	2.5	0.68	0.59	0.56

The Discharge of the tidal river is depended on the high and low tide. So same in not calculated.

2.5. Waterway description (stretch-wise of 10 km)

2.5.1. Stretch I (0-10km)

The stretch starts from Nalitapatia village where it separates from Brahmani river. The mouth area is full of crocodiles and the area has been declared as crocodile conservation zone by the Govt of India which is named as Bhitarkanika National Park. Average width of the river is 400 meters. Both sides of the river are mainly used by localities for rice cultivation. One side of the riverbank is partially stone protected and at some places stone protection work is in progress. The small village with sparse pollution is there.

Figure 2.2: Google image of stretch 0-10km

Table 2.6: Features along the stretch I

a)	Prominent Dams / Barrage: No Dam and Barrage in this stretch
b)	Tidal stretch: full stretch is tidal stretch
c)	Conditions of banks (protected, un-protected): full stretch is unprotected
d)	Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes: Nil

e) Encroachment to the waterway: Nil
f) NH/SH/MDR along and/or within 5 km from the waterways: Bhadrak highway is under construction.
g) Railway Line and Stations in the vicinity: Nil
h) Land Use Pattern along Waterway on visual assessment: Nil
i) Crops / Agriculture in the region on visual assessment: Rice cultivation
j) Availability of Bulk / Construction Material: Nil
k) Existing Industries along Waterway with their types and details: Nil
l) Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any): Nil
m) Existing Cargo Movement: Nil
n) Prominent City / Town / Places of Worship / Historical places for Tourism: Nil

CLASS	CH. FROM(KM)	CH.TO(KM)	MIN REDUCED DEPTH(M)	MAX REDUCED DEPTH(M)	LENGTH OFSHOAL(M)	DREDGE QTY(M^3)
I	0	10	0	9.8	270	8984.8
II	0	10	0	9.8	270	20855.4
III	0	10	0	9.8	1100	72100.58
IV	0	10	0	9.8	1200	87183.62
V	0	10	0	9.8	2400	145911.46
VI	0	10	0	9.8	2850	108905.9
VII	0	10	0	9.8	2950	169839.7

2.5.2. Stretch II (10 – 20Km)

Stretch starts from Baradia to Goladia. Stretch width is average 400 mtr sup to ch 15.00 and it becomes narrow afterwards and width becomes average 200 mtr. Shastri ghat is at ch 14.50 on right bank. State Highway 9 is close to right bank and Chandbali bus stop is at ch 14.50. OTDC guesthouse is near ch 15.00 at Simulia village. At ch 16.50 Ostia bridge is crossing the river. Both sides of riverbank are cultivated land. IWT ferry service is available for Bhitarkanika National Park and small local ferry service is also available from Chandbali to other local villages. Chandbali is also famous for its old Port services. Navigation channel can be developed at Chandbali

Figure 2.3: Google image of stretch 10-20km

Table 2.7: Features along the stretch II

a)	Prominent Dams / Barrage: No Dam and Barrage in this stretch
b)	Tidal stretch: full stretch is tidal stretch
c)	Conditions of banks (protected, un-protected): full stretch is unprotected
d)	Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes: Nil
e)	Encroachment to the waterway: Nil
f)	NH/SH/MDR along and/or within 5 km from the waterways: Bhadrak highway is under construction.
g)	Railway Line and Stations in the vicinity: Nil
h)	Land Use Pattern along Waterway on visual assessment: Nil
i)	Crops / Agriculture in the region on visual assessment: Rice cultivation
j)	Availability of Bulk / Construction Material: Nil
k)	Existing Industries along Waterway with their types and details: Nil
l)	Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any): Nil
m)	Existing Cargo Movement: Nil
n)	Prominent City / Town / Places of Worship / Historical places for Tourism: Chandbali Town

CLASS	CH.FROM(KM)	CH.TO(KM)	MIN REDUCED DEPTH(M)	MAX REDUCED DEPTH(M)	LENGTH OFSHOAL(M)	DREDGE QTY(M^3)
I	10	20	1.4	16.3	0	0
II	10	20	1.4	16.3	0	0
III	10	20	1.4	16.3	400	1358.51
IV	10	20	1.4	16.3	1000	6289.32
V	10	20	1.4	16.3	100	12638.28
VI	10	20	1.4	16.3	600	28298.1
VII	10	20	1.4	16.3	800	45360.3

2.5.3. Stretch III (20 – 30Km)

Stretch 3 starts from Matia village to Gunthal. Width of the river varies from 150 to 180 mtr in this stretch. River both sides are cultivated area. The villages near Baitarni bank are mainly dependent on rice cultivation and fishing. The riverbank in this stretch is gradually vanishing due to change of hydraulic direction. River protection wall / bank protection is essential in this stretch.

Figure 2.4: Google image of stretch 20-30km

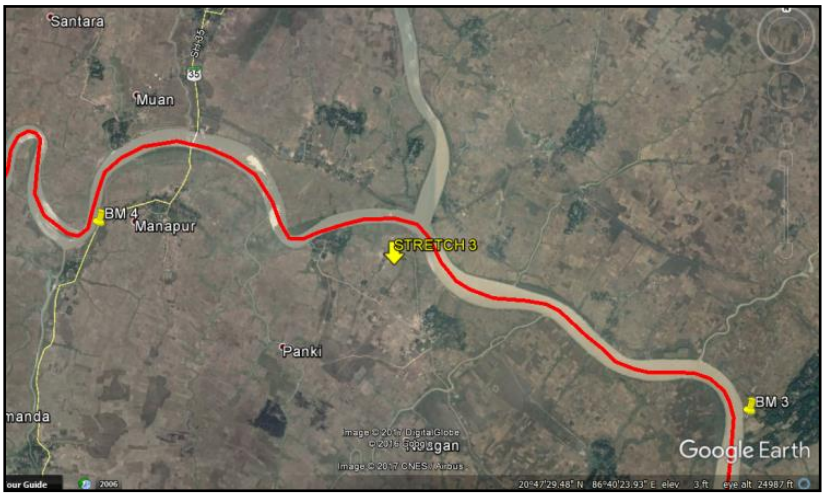


Table 2.8: Features along the stretch III

a) Prominent Dams / Barrage:	No Dam and Barrage in this stretch
b) Tidal stretch:	-full stretch is tidal stretch
a) Conditions of banks (protected, un-protected):	full stretch is unprotected
b) Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes:	Nil
c) Encroachment to the waterway:	Nil
d) NH/SH/MDR along and/or within 5 km from the waterways:	Bhadrak highway is under construction.
e) Railway Line and Stations in the vicinity:	Nil
f) Land Use Pattern along Waterway on visual assessment:	Nil
g) Crops / Agriculture in the region on visual assessment:	Rice cultivation
h) Availability of Bulk / Construction Material:	Nil
i) Existing Industries along Waterway with their types and details:	Nil
j) Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any):	Nil
k) Existing Cargo Movement:	Nil
l) Prominent City / Town / Places of Worship / Historical places for Tourism:	Nil

CLASS	CH.FROM(KM)	CH.TO(KM)	MIN REDUCED DEPTH(M)	MAX REDUCED DEPTH(M)	LENGTH OFSHOAL(M)	DREDGE QTY(M^3)
I	20	30	0	14.9	100	2805
II	20	30	0	14.9	100	4852.3
III	20	30	0	14.9	3800	85848.9
IV	20	30	0	14.9	4100	122347.28
V	20	30	0	14.9	5000	190493.15
VI	20	30	0	14.9	6100	61391.9
VII	20	30	0	14.9	7000	111844.8

2.5.4. Stretch IV (30 –40Km)

Stretch is from Kanpur to Olaga. at ch 34.00 Kayan Gola bridge is there. Average with is 75 mtrs in this stretch. Both sides are cultivated land. To protect the nearby villages, Govt is developing riverbank protection in this stretch. The villagers are using temporary bamboo-bridge for crossing the river also, people of these local villages are using small dinghy for crossing the river.

Figure 2.5: Google image of stretch 30-40km

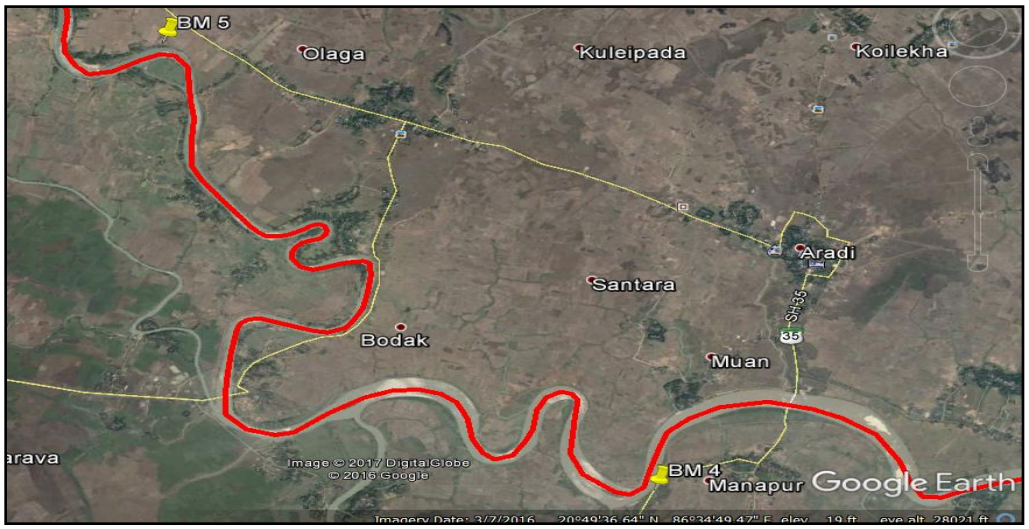


Table 2.9: Features along the stretch IV

a)	Prominent Dams / Barrage: No Dam and Barrage in this stretch
b)	Tidal stretch: full stretch is tidal stretch
c)	Conditions of banks (protected, un-protected): full stretch is unprotected
d)	Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes: Nil
e)	Encroachment to the waterway: Nil
f)	NH/SH/MDR along and/or within 5 km from the waterways: Bhadrak highway is under construction.
g)	Railway Line and Stations in the vicinity: Nil
h)	Land Use Pattern along Waterway on visual assessment: Nil
i)	Crops / Agriculture in the region on visual assessment: Rice cultivation

j) Availability of Bulk / Construction Material: Nil
k) Existing Industries along Waterway with their types and details: Nil
l) Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any): Nil
m) Existing Cargo Movement: Nil
n) Prominent City / Town / Places of Worship / Historical places for Tourism: Nil

CLASS	CH.FROM(KM)	CH.TO(KM)	MIN REDUCED DEPTH(M)	MAX REDUCED DEPTH(M)	LENGTH OFSHOAL(M)	DREDGE QTY(M^3)
I	30	40	0	8.8	2275	634324.4
II	30	40	0	8.8	2325	1087809.8
III	30	40	0	8.8	5250	577198.64
IV	30	40	0	8.8	6150	704735.29
V	30	40	0	8.8	7250	1268114.02
VI	30	40	0	8.8	7900	4497088
VII	30	40	0	8.8	8250	6515822.3

2.5.5. Stretch V (40 –48 Km)

Stretch starts from Gunthuni Pada to Duttapur. Both sides are cultivated lands. Villages are situated on banks close to river. The local villagers are using bamboo-bridge and small dinghy for crossing the river. The bank of river is partially protected and in some areas construction of river wall is in progress.

Figure 2.6: Google image of stretch 40-48 km

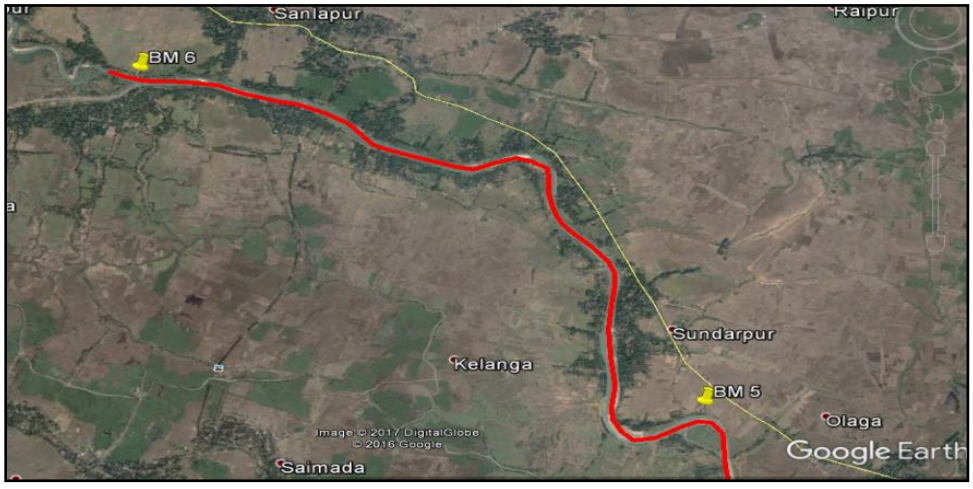


Table 2.10: Features along the stretch V

a)	Prominent Dams / Barrage: No Dam and Barrage in this stretch
b)	Tidal stretch: full stretch is tidal stretch
c)	Conditions of banks (protected, un-protected): stretch is partially protected
d)	Hindrances - Hyacinth, rocks, rapid waterfalls, steep gradient, forest, wild-life sanctuary, security issues. Obstruction (if any) for navigation, e.g. fishing stakes: Nil
e)	Encroachment to the waterway: Nil
f)	NH/SH/MDR along and/or within 5 km from the waterways: Nil
g)	Railway Line and Stations in the vicinity: Nil
h)	Land Use Pattern along Waterway on visual assessment: Nil
i)	Crops / Agriculture in the region on visual assessment: Rice cultivation
j)	Availability of Bulk / Construction Material: Nil
k)	Existing Industries along Waterway with their types and details: Nil
l)	Existing Ghats, Jetties and Terminals (with conditions and facilities). Existing navigation facilities (if any): Nil
m)	Existing Cargo Movement: Nil
n)	Prominent City / Town / Places of Worship / Historical places for Tourism: Nil

CLASS	CH.FROM(KM)	CH.TO(KM)	MIN REDUCED DEPTH(M)	MAX REDUCED DEPTH(M)	LENGTH OFSHOAL(M)	DREDGE QTY(M^3)
I	40	48	0	5.9	3600	108592.3
II	40	48	0	5.9	3800	208443
III	40	48	0	5.9	4050	987852.26
IV	40	48	0	5.9	4290	1146384.12
V	40	48	0	5.9	5500	1873068.34
VI	40	48	0	5.9	5600	740903.5
VII	40	48	0	5.9	5900	1164040.9

Table 2.11: Average bed slope

Reach		River / Canal Bed Level Change (cm)	Distance (km)	Slope(A/B) cm/km
From	To			
0	10	0.152	10	0.015
10	20	0.219	10	0.022
20	30	0.152	10	0.015
30	40	0.659	10	0.066
40	48	2.633	8.0	0.329

2.6. Water and Soil Samples analysis and Results

Water and bottom soil sample are collected from the deepest route at every 10km interval and are tested.

Table 2.12: Analysis results of bottom samples taken at 10km interval

BAITARANI RIVER						
SL.NO.	EASTING (m)	NORTHING (m)	LATITUDE	LONGITUDE	SAMPLES	RAW DEPTH (m)
01	481614.01	2294652.72	20^0 45’ 5.2965 N	086^0 49’ 24.1733 E	COARSE SAND	5.2
02	474294.99	2294194.65	20^0 44’ 50.0841 N	086^0 45’ 11.0916 E	COARSE SAND	4.2
03	469588.32	2297265.09	20^0 46’ 29.7068 N	086^0 42’ 28.1392 E	MUD SAND	8.9
04	462343.31	2299597.41	20^0 47’ 45.0966” N	086^0 38’ 17.3758” E	SILT & FINE SAND	2.4
05	459488.91	2302805.86	20^0 49’ 29.2459” N	086^0 36’ 38.3698” E	SOFT MUD SAND	2.7
06	454364.19	2307206.48	20^0 49’ 29.2459” N	086^0 33’ 40.6501” E	SAND & SILT	2.5

Table 2.13: Water characteristics

BAITARNI RIVER					
Sl No.	**Chainage**		**LATITUDE**	**LONGITUDE**	**Water Characteristics**
1	0	10	20° 45'05.2965" N	086° 49' 24.1733" E	Salt and Muddy Water
2	10	20	20° 44' 50.0841" N	086° 45' 11.0916" E	Salt and Muddy Water
3	20	30	20° 46 '29.7068" N	086° 42' 28.1392" E	Salt and Muddy Water
4	30	40	20° 47' 45.0966" N	086° 38' 17.3758" E	Salt and Muddy Water
5	40	48	20° 49' 29.2459" N	086° 36' 38.3698" E	Mild Saltwater

2.7. Comments for Hydrographic Survey

River Baitarni having length 48 km starting from Dhamra and ends at Duttapur. There are six numbers of benchmarks and six numbers of tide gauges along the waterway. There is tidal effect in the waterway with 2.11m at the Ch 2.32km and 1.09m at the Ch 48.0 km.

The geometry of the waterway generally satisfies as a Class I waterway except for the bend radius at river places. The vertical clearances at the road bridges at two locations are 4.2 m and 3.5m above MHWS. The water characteristics analysis was assessed, and observation is that the water is salty and muddy up to Ch40 kms and the mild saltwater upstream of 40kms. The average bed slope of the riverbed varies from 1:0.000152 to 1:0.002633 from Dhamra to Duttapur.

The riverbed samples for the Last 20 kms from Dhamra are found to be coarse sand at depth varying from 5.2 to 4.2 meters. Upstream of 20 kms in the river, the bed is having sand mixed with mud and fine sand at varying depths. It can be generally concluded that for a depth of Class I waterway the riverbed is of sandy material.

3. FAIRWAY DEVELOPMENT

3.1. Proposed Class / Type of Waterway

The inland waterways in India are classified into seven categories for rivers as well as canals as per the 'The Inland Waterways Authority of India Act, 1985' for safe plying of self-propelled vessels up to 2000 dead weight tonnage(DWT) and tug-barge formation in push-tow units of carrying capacity up to 8000tonnes. The classification of waterways for rivers is discussed below:

Table 3.1: Classification of inland waterways for rivers

S.No.	Class of Waterways	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
1	Class I	1.2	30	300	4	30
2	Class II	1.4	40	500	5	40
3	Class III	1.7	50	700	7	50
4	Class IV	2.0	50	800	10	50
5	Class V	2.0	80	800	10	80
6	Class VI	2.75	80	900	10	80
7	Class VII	2.75	100	900	10	100

From the traffic survey report, it is observed that the tourism destinations concentrated along the Baitarani river is in the areas of Chandbali, Aradi and Dhamra. Among this Chandbali is a major population centre. The river being under tidal influence, it can be proposed to be developed to a Class I waterway without much dredging. It is concluded from the hydrographic survey report and traffic study data that, the river can be developed up to Aradi (CH 27.24km) from Dhamra confluence as Class I waterway, since developing upstream portion of CH 40km seems to require huge investment owing to the reasons mentioned below and traffic beyond Aradi is negligible.

- The quantity to be dredged for developing the river as Class I waterway from CH0km to CH 30km is around 11 Thousand cubic meter and the dredging quantity between CH30km and CH 48 km is around 7.4lakhs cubic meter.
- Three bamboo bridges used for local passenger crossing the river exists at between chainages 46km and 48 km and have limitation of horizontal and

vertical control. Dismantling them and reconstructing permanent structures in their places for developing the waterway proves to be cost intensive.

- The additional land acquisition required between CH 40km and CH 48 km is approximately 2.78 lakh sq. m. based on hydrographic survey charts, for cut-off, as there are few stretches which have the river looping.

Hence the present stretch may be developed to Class I waterways with the requirement for minimum depth as1.2m, bottom width 30m and a bend radius of 300m. The vertical clearance requirement is 4m and the horizontal clearance shall be minimum 30m.

3.2. Details of Shoals

Shoal is a natural submerged ridge, bank, or bar that consists of sand or other unconsolidated material and rises from the bed of a body of water to near the surface. Often, they are submerged ridges, banks or bars that rise near enough to the surface of a water body as to constitute a danger to navigation. Shoals include relatively shallow place in a water body, rocky area on the waterbed within area mapped for navigation, etc. The type of material is seen to be sandy with fine and silt contents, maintenance dredging at intervals may be required to maintain the depth for navigation. In Baitarani, the shoal noticed while surveying is identified and presented in the table 3.2 below. The length of the shoals is arrived for few classes so that a fair comparison of the effort required for developing the waterway to various classes can be felt.

Table 3.2: Shoal length with chainage for different classes

Chainage from (km)	Chainage to (km)	Shoal length (m) (Class I)
0	1	0
1	2	0
2	3	0
3	4	0
4	5	20
5	6	0
6	7	0

Chainage from (km)	Chainage to (km)	Shoal length (m) (Class I)
7	8	0
8	9	100
9	10	150
10	11	0
11	12	0
12	13	0
13	14	0
14	15	0
15	16	0
16	17	0
17	18	0
18	19	0
19	20	0
20	21	0
21	22	0
22	23	0
23	24	0
24	25	0
25	26	0
26	27	0
27	28	0
28	29	0
29	30	100
30	31	200
31	32	50
32	33	100
33	34	675
34	35	50

Chainage from (km)	Chainage to (km)	Shoal length (m) (Class I)
35	36	0
36	37	50
37	38	150
38	39	800
39	40	200
40	41	100
41	42	200
42	43	1000
43	44	100
44	45	200
45	46	200
46	47	800
47	48	1000

3.3. Proposed Conservancy Activities

3.3.1. Low Cost structures

The conservancy works aim at preserving the course of the channel, making it navigable year long. The dredged channel may be conserved using low cost structures as bamboo bundling, sub-merged vanes, etc. But owing to the severe flood expected in the region, bamboo bundling may not help as this will get washed out during rainy season.

To develop the proposed stretch of the river as Class I water way with limited depth of 1.2m, no conservancy works are proposed.

3.3.2. Dredging

Dredging is the removal of sediments and debris from the bottom of lakes, rivers, harbours, and other water bodies. It is a routine necessity in waterways around the world because of sedimentation, the natural process of sand and silt washing downstream gradually fills channels and harbours. It is often focused on maintaining the depth of the

waterway to ensure the safe passage of vessels by preventing the vessels from grounding. In the present project, the amount of dredging quantity for developing to different classes in cubic meters are as for Class II 13.21 Lakhs for Class III, around 17.2 lakhs, for Class IV, around 20.66 lakhs, Class V, around 34.90 lakhs, for Class VI, around 54.36 Lakhs , Class VII, around 80.06 Lakhs for Class I around 7.54 lakhs up to CH 48 km. It is proposed to develop the Baitarani river from CH 0km to CH 27.24km as Class I waterway, which has minimal intervention in the river hydrography and hence minimal dredging quantity for developing up to CH 27.24km is around 9000.00 cubic meters.

As seen from the hydrographic survey report, the bed material is mainly sand and silt. Mechanical dredgers are preferred in small areas of sandy or silty sediment. They produce much smaller fine sediment plumes as compared to hydraulic dredgers. The closed grab dredger can further reduce the turbidity caused when the grab or bucket is hauled through water. The grab can store the dredged material in the barge and being and sand and silt can be used for embankment strengthening.

The dredged materials can be dumped on the riverbanks itself. The maximum depth of deposition is limited to 0.75 m. The calculation for finding the height of the dumping can be formulated as follows:

Height = Dredging quantity (in Volumetric dredging quantity for each km)/ (Proposed length of deposition * Width)

Eg: - For Ch 4-5: (5502.10/ (2000*5)) = 0.5502 m (2 km upstream from 9 km chainage).

For Ch 8-9: (9734.36/ (3000*5)) = 0.65 m (3km upstream from 9km chainage).

For Ch 9-10: (17876.92/ (5000*5)) = 0.72 (5km upstream from 9km chainage)

For Ch 25-26: (10212.14/ (3000*5)) = 0.68 (3km upstream from 26km chainage)

For Ch 26-27: (94.49/ (500*5)) = 0.04 (500m between from 26-27km chainage)

Figure 3.1: A typical grab dredger in operation

Table 3.3: Dredging quantity for various relevant classes

Chainage from	Chainage to	Quantity in each chainage (in cub. M)	Cumulative dredging quantity for Class I (cub. M.)
0	1	0	0
1	2	0	0
2	3	0	0
3	4	0	0
4	5	4.5	4.5
5	6	0	4.5
6	7	0	4.5
7	8	0	4.5
8	9	3361.5	3366
9	10	5618.8	8984.8
10	11	0	8984.8
11	12	0	8984.8
12	13	0	8984.8
13	14	0	8984.8

Chainage from	Chainage to	Quantity in each chainage (in cub. M)	Cumulative dredging quantity for Class I (cub. M.)
14	15	0	8984.8
15	16	0	8984.8
16	17	0	8984.8
17	18	0	8984.8
18	19	0	8984.8
19	20	0	8984.8
20	21	0	8984.8
21	22	0	8984.8
22	23	0	8984.8
23	24	0	8984.8
24	25	0	8984.8
25	26	0	8984.8
26	27	0	8984.8
27	**28**	0	8984.8
28	29	0	8984.8
29	30	2805	11789.8
30	31	3489.1	15278.9
31	32	13.6	15292.5
32	33	782.3	16074.8
33	34	8588.9	24663.7
34	35	69.3	24733
35	36	0	24733
36	37	3.8	24736.8
37	38	749.6	25486.4
38	39	618652.6	644139
39	40	1975.2	646114.2

Chainage from	Chainage to	Quantity in each chainage (in cub. M)	Cumulative dredging quantity for Class I (cub. M.)
40	41	1929.8	648044
41	42	2285.4	650329.4
42	43	41181.9	691511.3
43	44	1697.8	693209.1
44	45	4763.9	697973
45	46	3686.1	701659.1
46	47	12161.7	713820.8
47	48	40885.7	754706.5

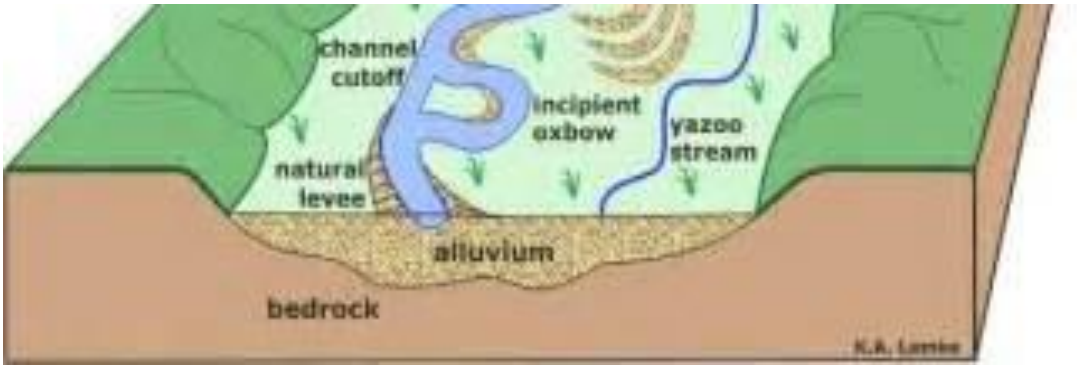
3.3.3. River Training

River training is the stabilization of the channel to maintain the desired cross section and alignment. Training structures are then necessary to protect the channel against the changes that occur due to this disturbance. In general, the objectives of river training may be summarized as:

- To increase the safety against flooding by accommodating the flood flow.
- To improve the efficiency of the sediment transport.
- To minimize bank erosion by stabilizing the course of flow.
- To direct the flow to a desired river, stretch.
- To reduce the probability of meandering.
- And in most of the cases the primary objective of river training is to improve navigation by maintaining channel depth.

In the present case, river training is required specially to reduce the probability of meandering, to have cut-offs in regions of severe meandering, to maintain sufficient bend radius, etc.

Figure 3.2: Channel cut-off



The proposed stretches of cut-offs are at regions where, the river meanders such that the loop length exceeds 1.5 to 2.5 times the chord length, hence it is proposed to have artificial cut-offs there, rest of the places, the curvatures may be smoothened with pitched banks. For the proposed Class I waterway, according to table 3.1 of this report, the permissible minimum bend radius is 300m. Between chainage CH25km and CH 26km at around CH 25.461km, the bend seems to have a radius of around 160m only, hence this requires smoothening of the curvature to attain a specified value of 300m. The drawing attached as Vol. II can be read for further clarification in the region proposed for training with cut offs.

3.4. Bank Protection / Embankment Strengthening

During the monsoon season the floods in the region are very common, so for this reason some short and as well as long temporary embankments are needed in the both banks of the river. Bank protection works are to be taken up to protect land and property on canal sides from flooding. Bank erosion problem due to turbulence would be more severe in the narrow stretches than in wider stretches. Good bank protection is the best mitigation measure, which is suggested in the narrow stretches.

In addition to the traditional canal bank protection measures, many alternative methods of bank protection, which are acceptable visually and functionally, are in use, which includes:

- Rip - Rap (large boulders)
- Concrete blocks or large pre-cast units

- Metal sheet piling
- Gabions (wire mesh cage with tightly packed stones)
- Concrete pile – slab method
- Geotextiles combined with vegetative cover

Figure 3.3: Embankment protection using stone riprap combined with vegetative cover

In the present project, it is recommended to have stone paved protection along with vegetative cover at regions near the terminal i.e., 50m up and downstream of the terminal locations. At Chandbali on northern and southern banks 100m each side and at Aradi, along one bank (along the terminal location) protection is proposed immediately after construction of the terminals. Since Chandbali northern bank already has full-fledged facilities, no new embankment protection is proposed now. The details of the location are shown in the table below. The locations are marked in the drawings of fairway enclosed as Vol. II. In general, riprap is an Armor facing of rock or rock layers, which are dumped or hand-placed to prevent erosion, scour or sloughing. They are highly durable and flexible. They do not fail under minor shifting and can be easily constructed and repaired. Live plants can be used in conjunction with these structural measures, with the benefit of having a diverse and productive riparian habitat shade to help maintain water temperature for fish, source of nutrients for aquatic life, improved water quality, etc.

Table 3.4: Summary of proposed bank protection measures

Type of protection work	Location	Stretch/ length
Stone riprap with vegetative cover	Chandbali northern bank	Already exists
Stone riprap with vegetative cover	Chandbali southern bank	100m
Stone riprap with vegetative cover	Aradi, northern bank	100m

3.5. Navigation Markings / Navigation Aids

Navigation markings are mandatory for safe movement of vessels. Proper markings may be provided demarcating the dredged and maintained channel of the waterway.

The aids commonly applicable to an inland waterway includes fortnightly river notices, pilotage for vessels operating on the waterways, country boats fitted with lights for night navigation, year-round marks for day navigation. Proper maintenance of the markings may be ensured.

Channel markings for day navigation need to be erected and maintained in entire waterway. As of now, night navigation is not proposed, which may be considered in subsequent phases if found feasible at that time. A DGPS station is planned to be setup at Chandbali, at a subsequent phase. In the first phase, it is proposed to have buoys to demarcate the channel boundaries, range to guide the ships through the centreline of the channels, weather signals at critical locations of sharp bends. Radar beacons are proposed to be provided at intervals in future once the traffic is well developed and the navigation and communication systems are established. Apart from this, it is proposed to have thalweg surveys and issue of river notices. In the later phase, providing pilotage is suggested.

Lateral buoys are used to define the borders of channels and to indicate direction. As a general guide, as per IALA recommendation, red buoys mark the terminal side of the channel. Cardinal buoys are provided to indicate the safe side of a danger with approximate bearing.

Table 3.5: List of aids to navigation proposed

Aids to navigation	Proposed	Future plan
Buoy markings	Yes	
Thalweg surveys	yes	
DGPS station at Chandbali		yes
Ranges to mark centreline	yes	
Weather signals		yes
Radar		yes
Night navigation beacons and other aids		yes

Table 3.6: List of buoys proposed in the chainages

Chainage (in km)	Number of Buoys
0 - 10	23
10 - 20	23
20 – 27.24	23

3.6. Modification Requirement in existing Bridges / Cables / Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts

The vertical clearance as required by the IWAI Act 1985 for Class I, it is as, the vertical clearance is 4m and horizontal clearance is 30m minimum. As seen from the hydrographic study report, the cross over structures especially temporary bamboo constructions at Naranpur, Duttapur and at CH 46.235, deviate from the prescribed criteria for both horizontal and vertical clearances. The vertical clearance is in the order of 0.7m, 1.2m and 0.5m respectively w.r.t. CD and the horizontal clearances are 3m, 2.5m and 3m respectively. The permanent structures except the bridge at Kayan Gola seem to be fairly on the safe side w.r.t the hydrographic survey report. The bridge at Kayan Gola need to be modified so that the centre span gets 4m vertical clearance, since the development proposed is up to CH 27.24km only, the bridge does not obstruct the

waterway in the proposed stretch. Dismantling bamboo bridge is not considered here, as development of the channel is proposed till Aradi only and no terminal is proposed beyond CH40km. Hence dismantling the existing facilities without providing alternate better infrastructure is not proposed as it is not as per the requirement of Class I waterways.

Table 3.7: Modifications proposed for various cross structures

Structure	Chainage	Location	HC (m)	VC wrt HFL(m)	Present condition	Proposed modification
Road bridge	16.800	Ostia (Aradi, Chandbali)	30	4.2	Complete, in use	No modification required in view of this project.
Road bridge	34.400	Kayan Gola	30	3.5	Complete, in use	No modification required in view of this project.
Bamboo bridge	46.235		3	0.5	In use	No modification required in view of this project.
Bamboo bridge	47.140	Naranpur	3	0.7	In use	No modification required in view of this project.
Bamboo bridge	48.460	Duttapur	2.5	1.2	In use	No modification required in view of this project.

3.7. Proposed Dams / Barrages / Locks / Weirs to improve depth

As per the hydrographic survey report, it is observed that the river is under the influence of tides. Also, the present Class of waterway needs only 1.2m minimum depth, which is available fairly all the time. Hence no barrages or locks are proposed in lieu of improving the water availability.

3.8. Land Acquisition

A ferry jetty already exists in the Chandbali region. Hence no new proposal is made at Chandbali northern (left) bank. The terminal amenities will require around 1.08 acres of land per terminal. Hence at Chandbali right bank region, 1.08 acres of land is required. At Aradi region, the terminal is proposed at the northern bank alone, requiring 1.08 acres of land there. Hence the total land requirement for developing terminal is around 2.16 acres (3600 sq. mtr)

The Circle rates of Chandbali & Aradi Villages of Bhadrak District of Orissa where the Terminals has been proposed is Rs. 20 Lakh / Acre and we required 2.12 acres for terminal development. So, the cost of Land shall be Rs.43.20 Lakhs.

Land acquisition required for river training is as shown in the table 3.8 below.

Table 3.8: Area of land to be acquired for modifying the alignment

Chainage between (km)	Area of land acquisition (acres)
25.25– 26.25	16.138 acres
Total area (in acres)	**16.138 acres**

Thus, the total land required for fairway development is around 16.138 acres (65307 sq. mtr), Land rates has been taken at the rate of Rs. 10 Lakhs / Acre based on enquiries from local people.

3.9. Fairway Costing

3.9.1. Capital Cost

Table 3.9: Fair way costing for proposed Class I and developing the whole 40km (Capital)

Sl. No.	Description	Amount (Cr.)
1	River training (creating cut offs)	Rs. 2.90
2	Dredging (Class I)	Rs. 0.18
3	Embankment protection using stones of around 3kg to 10kg weight	Rs. 1.34
4	Aids to navigation (per piece 20,000)	Rs. 0.13
5	Land acquisition for fairway development	Rs. 1.62
	Total (Cr.)	**Rs. 6.17**

3.9.2. O&M Cost

The annual operation and maintenance cost work out to be about 5% of initial cost for dredging, 2% for aids to navigation, 1% for bank maintenance and 5% for river training.

Table 3.10: Fair way costing for proposed Class I and developing the whole 40km (Operational)

Sl. No.	Description	Amount (Lakhs)
1	Dredging	Rs. 4.34
2	Embankment protection repair	Rs. 1.34
3	Aids to navigation repair	Rs. 0.26
4	River training	Rs. 14.50
	Total (Lakhs)	**Rs.20.44**

4. TRAFFIC STUDY

This chapters analyses the subject 48 km stretch of Baitarani River (from Duttapur to Laxmiprasad Dia) form the traffic perspective. The traffic analysis has been conducted using the following approach:

- **Identification of Hinterland / Influence Area** – Identification of area likely to contribute to traffic onto the waterway based upon the location of waterways, competition from nearby waterway (NW-5) and characteristics of the hinterland (population, industries, tourism avenues, infrastructure etc.)
- **Commodity Composition**: Identification and analysis of various commodity categories in the influence area including agricultural products, industrial cargo and construction materials.
- **Originating / Terminating Commodities**: Directional analysis of cargo movement, shortlisting of cargo movement in the hinterland as **potential traffic** for waterway movement, identification of traffic movement along the general direction of waterway (with origin and / or destination points along the waterway) as **addressable traffic** which can be targeted for modal shift from road / railways
- **Passenger Traffic**: Analysis of current / potential waterway passenger movement arising from tourist activities, leisure, local transport or cross-river movements
- **Ro-Ro Traffic**: Analysis of Ro-Ro (roll on – roll off) traffic movement on the waterway either for cargo transport or passenger movement or both
- **Growth Trend**: Analysis of historical trends, traffic influencers in the region, competition from other transport modes, infrastructure undertakings, upcoming / expected future development to understand viability for waterway transport and basis for traffic forecasting
- **Forecasting and Potential IWT Assumptions**: Definition of forecasting assumptions, formulation of scenarios and traffic projections based upon the assumptions
- **Terminal wise IWT Analysis**: Analysis of terminal-wise traffic for identification of terminal locations, terminal design and planning and vessel design

4.1. Influence Area / Hinterland

The immediate catchment area of subject waterway is limited due to **small length of waterway** (48 km). The region is primarily characterized by agricultural activity**. Bhitarkanika National Park** is a popular tourist destination famous for its mangroves and saltwater crocodiles.

The waterway's hinterland also comprises of **mineral rich large industrial clusters of Jajpur & Kalinganagar, Dhenkanal** etc. **Dhamra port**, situated in close proximity of the waterway also serves the raw materials requirement of the industrial clusters. However, it should be noted that the above industrial clusters are also located in close proximity of NW 5 as shown in the figure below. The subject waterway connects with NW 5 (Brahmani River, Dhamra River systems from the west, East Coast Canal in North/South). These river systems support the agricultural activity in the region.

Figure 4.1: Catchment Area

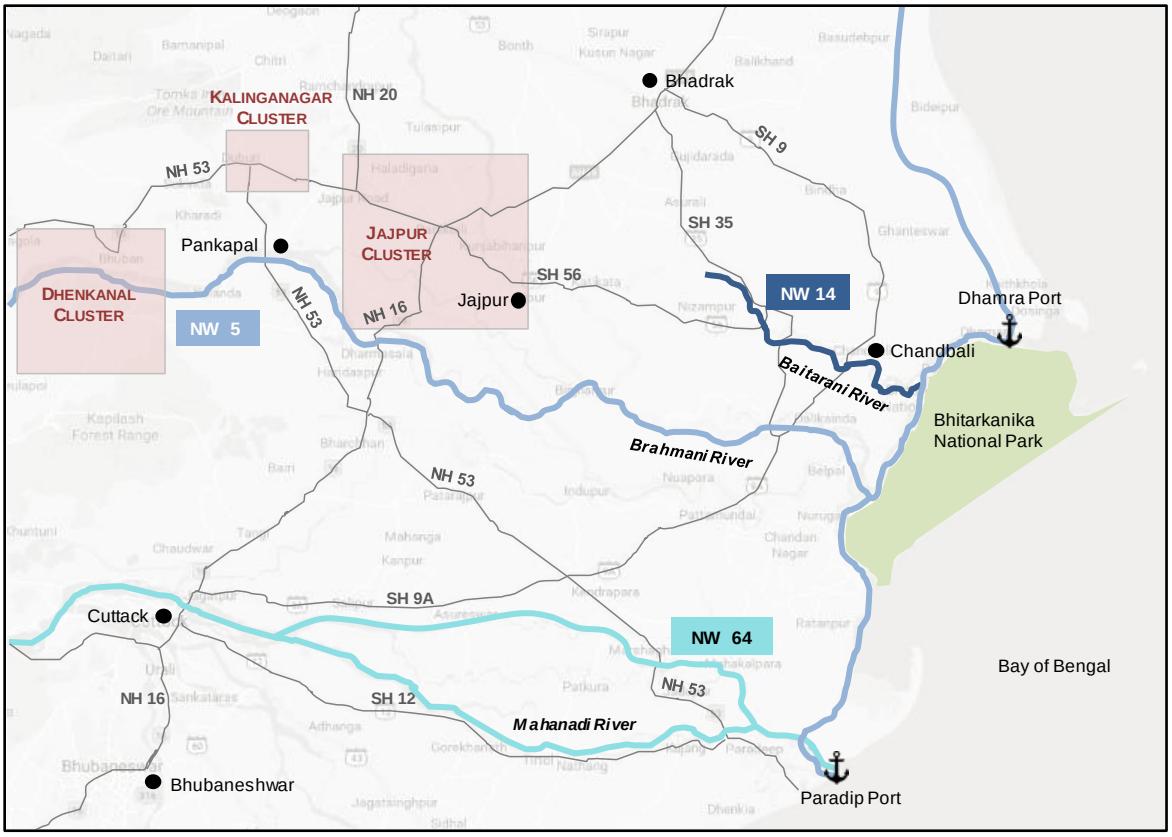
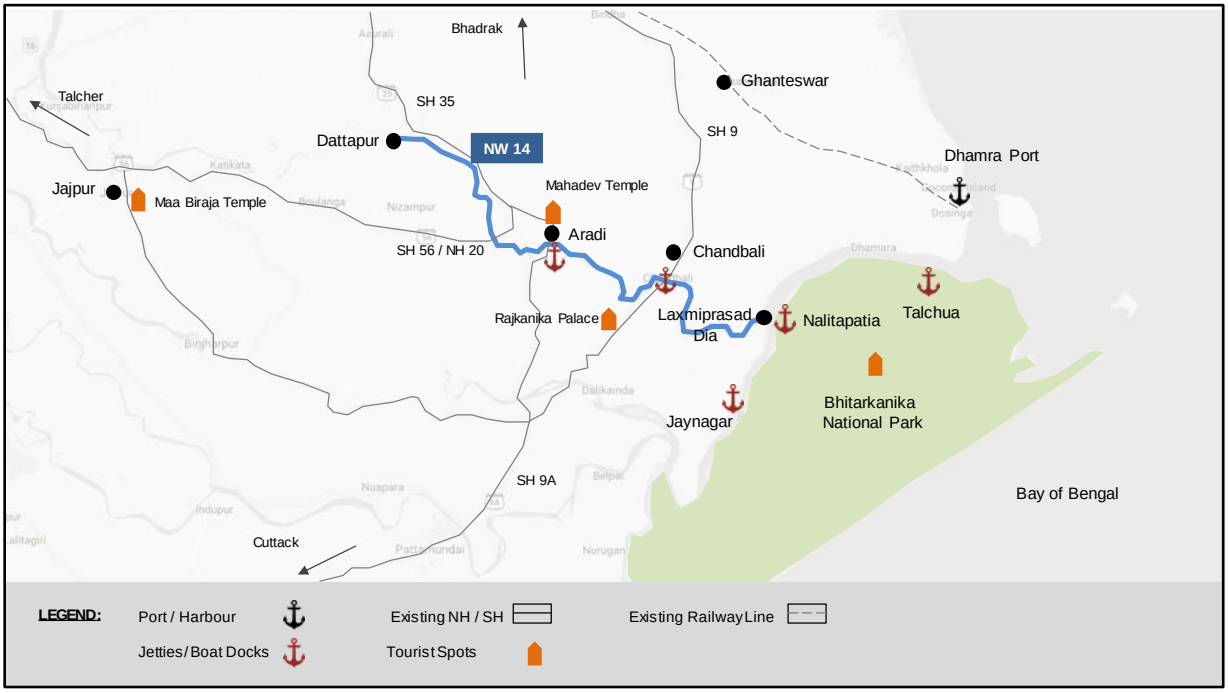


Figure 4.2: National Waterway 14



4.1.1. Population of Hinterland area

The subject stretch of waterway passes through Bhadrak and Kendrapara Districts.

Table 4.1: Hinterland Population

Head	Population (2001 Census)	Population (2011 Census)
Kendrapada	1,302,005	1,440,361
Bhadrak	1,333,749	1,506,337
Total	**26,35,754**	**29,46,698**

The catchment lacks any significant urban development in its vicinity with presence of few towns and villages only. The catchment remains largely under-developed with majority of area still under farms or green cover.

- **Major Towns**: **Chandbali** is the only major town along the waterway **Major Villages**: Aradi, Goladia, Rajabati, Kusunpur and Talchua (<3,000 population)

- **Nearest Cities**: Bhadrak (population - 1.2 lakh, ~30 km), Cuttack (population – 6 lakh, ~140 km)

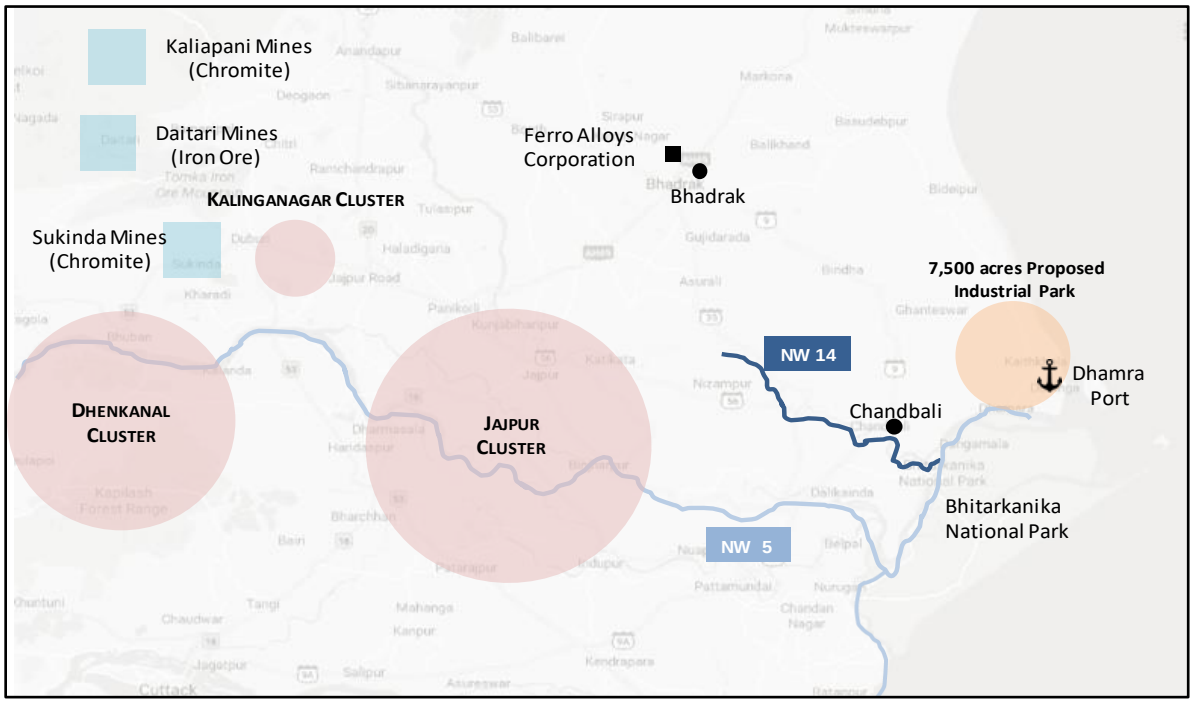
A rough count sets the number of settlements in the catchment (i.e. ~10 km on either side of the river) at ~300. An axis of settlement can be seen along SH 9/9A. Majority of these settlements (~200) lie on/between this axis and the coast.

An average population of 1,000 may be considered (based on average settlement size in Chandbali Block). Thus, the catchment population can be set at ~3,00,000, with greater concentration near and downstream of Chandbali.

4.1.2. Existing and proposed Industries

Ferro Alloys Corporation (FACOR group), Bhadrak is the only industrial unit in the catchment of the waterway. The hinterland comprises of Jajpur (~40 km) and Dhenkanal (~120 km) Industrial Clusters to the west of waterway. The location of industrial areas is shown in the figure below:

Figure 4.3: Nearby Industrial Development



The major industrial units are as below:

Table 4.2: Major Nearby Industries

Cluster	Major players
Jajpur + Kalinganagar Cluster	• **Steel -** Tata Steel, Visa Steel, Mesco Steel, Jindal Stainless, Maithan Ispat, Dinabandhu Steel • **Ferro alloy -** IDCOL Ferro chrome and alloys, Visa Steel, Rohit Ferro Tech
Dhenkanal Cluster	• **Carbon ferro Chrome -** Navbharat Ferro Alloys • **Steel -** Bhushan Steel, Viraja Steel • **Sponge iron -** BRG Steel, Rana Sponge, Rungta Mines, Scaw Industries

The region is highly rich in mineral and ore deposits including Chromite, Iron Ore, Pyroxenite, Quartzite etc. Sukinda Chromite mines hold 97% of the Chromite deposits in India, a critical material in the Steel industry. Other major mines in the region include Odisha Mining Corporation owned Daitari Mines (Iron ore) and Kaliapani Mines (Chromite).

The industrial cargo export / import in the region is handled through **Dhamra and Paradip Ports**. Rail is the dominant mode of transport from the ports with well-developed railway corridors providing connectivity from both the ports. Major **imports include coal, dolomite and major exports are iron ore cargo and steel**.

Dhamra Port is owned and operated by Dhamra Port Company Limited (DPCL), a 100% Dhamra Port Company Limited (DPCL). The port has one of the highest drafts on the eastern coast of India (18 m) and can handle 25 MTPA (2 berths) of cargo with plans to expand capacity to 100 MTPA (14 berths). Further DPCL has proposed development of 2,000 acres industrial park in proximity of the port. The development would be part of the 7,500-acre Special Investment Region (SIR) planned by Odisha Government comprising of industrial parks and a fishing harbour. The proposal was forth by the government in 2015, however no further progress has been made on it. Target industries for the industrial park includes edible oil, fisheries, food processing, steel and others. The port handled 18 MTPA of traffic in 2016-17. Coking coal (for industries), steam coal (for

thermal plants) and limestone were the major imports. Exports mainly comprised of iron ore cargo only.

No industrial development is expected in the catchment of NW-14. Recently, Dhamra Port has requested 2,000 acres from Odisha government for development of an industrial park in its vicinity. However, the waterway has neither sources of raw materials nor consumption centres for industrial outputs to have any relevance for such an industrial development.

4.2. Commodity Composition / Categorization

4.2.1. Agricultural Commodities

Agricultural production Bhadrak and Kendrapara district is as below:

Table 4.3: Agricultural Production ('000 MT (Metric tonnes)

District	2011	2012	2013	2014	2015
Bhadrak	294	357	257	243	416
Kendrapara	251	293	190	210	242

Source - Open Government Data (OGD) Platform, India (data.gov.in)

The catchment area is characterized by rich fertile soil being part of river basin. As a result, large part of catchment is covered by agricultural fields. Rice is the main cultivated crop in the region and contributes over 80% of the total agricultural output. Most of the rice production of the region is sold in Bhadrak, with minor amount used for local consumption in the nearby towns and villages. Odisha State Civil Supplies Corporation Limited has created an RRC (Rice Receiving Centre) in Chandbali. RRCs are also present in Tihidi, Bhadrak, Raj Nagar, Rajkanika and Aul for procuring regional produce. Of these, only Chandbali RCC is in proximity of NW-14. The remainder of agricultural produce, i.e. minor production of other grains and vegetables, is sold directly in local markets.

Food grain demand in the region is managed by Odisha State Warehouse Corporation (OSWC) through Food Corporation supplied rakes. OSWC also manages a godown in

Chandbali[7] for storage of food grains. Local demand for fruits, vegetables is met through farm markets in Bhadrak only.

Transport of agricultural produce via waterway is not viable on account of the following reasons:

- **Distributed Production**: The area is characterized by presence of large number of small farmers (small farmlands). Hence the production is spread across the entire area nearby the waterway.
- **Need for Consolidation mechanism**: Distributed production would require creation (and maintenance) of small godown / collection centres stretched along the waterway length. Moreover, as the produce is ultimately sold at the market in Chandbali, the farmer would not only have to store the produce at such godowns but also travel to Chandbali for selling of the produce which is an additional inconvenience.
- **Seasonal Nature**: Harvesting season lasts for only 2-3 months in a year. Hence the waterway transport activity would be limited to these months only. Without any fallback cargo potential, acquiring boats for agricultural transport is not financially viable. Moreover, as the harvesting season coincides with peak tourism season (November - February), a separate terminal shall be required for cargo which would further increase the CAPEX investment.
- **Cost Savings:** Considering low cargo volume (<100,000 tonnes per year[8]), small vessels (<50 DWT) would be required for operations. While the waterways are cost effective as compared to road transport, the savings reduce significantly and even become negative for such small vessels. Moreover, as the transport distance in consideration is very small (<25 km), the farmer would prefer to directly take the produce to the market in Chandbali as opposed to doing multiple handlings and associated costs on waterway transport (i.e. costs of transportation to waterway storage godown, storage at godown, loading and unloading charges, barge transportation and last-mile transportation to RRC).

  Hence, there is no potential of organized transportation of food produce

[7] At a distance of ~1 km from riverfront
[8] Annual agricultural production of Bhadrak and Kendrapara districts is ~650,000 tonnes (2015) over combined land area of ~5,150 sq km. The river catchment is estimated to be 750 sq km (30 km length between Aradi and Nalitapatia, 25km wide catchment). This translates to ~15% of district land area, which on a proportionate basis translates to ~100,000 Metric tonnes of agricultural production.

through the subject waterway. While minor quantity of local produce of vegetables and grains is currently transported through small country boats, no waterway intervention is recommended towards provision / upgradation of any such facilities and infrastructure. It is however recommended that IWAI / State government should regulate the boats with focus on improving navigability and safety of such boats.

4.2.2. Industrial Commodities

As mentioned earlier, the Jajpur and Dhenkanal Industrial Clusters are dominated by iron & steel industries. Hence the major cargo flow comprises of raw materials (coal, iron ore etc.) and finished products (steel, sponge iron etc.). In addition, the industries also have captive power plants. Thermal coal demand for these plants is split between nearby coal field (Mahanadi Coal Fields) and coal imports (from Paradip and Dhamra Ports). In addition, the region also exports significant quantities of iron and chromite ores, either domestically or internationally. Quantities of important cargo is shown in the following table.

Table 4.4: Industrial Clusters

Cluster	Incoming commodities (MTPA/ Million tonnes per annum)	Outgoing commodities (MTPA/ Million tonnes per annum)
Jajpur + Kalinganagar Cluster	• Chrome Ore - 4.19 • Iron ore - 3.46 • Coal (Iron & Steel) - 3.75 • Coal (Captive Power Plants) - 2.40 • Dolomite/ Quartzite - 1.04 • Limestone - 0.50 • Coke - 0.12	• Iron & Steel- 5.05 • Ferro Alloys- 2.35 • Steel- 1.55 • Sponge Iron- 0.3
Dhenkanal Cluster	• Iron ore - 4.77 • Coal (Iron & Steel) - 3.52 • Coal (Captive Power Plants) - 3.00 • Limestone - 0.68 • Dolomite/ Quartzite - 0.53 • Chrome Ore - 0.10 • Coke - 0.12	• Iron & Steel- 5.45 • Steel- 3.40 • Sponge Iron- 1.98 • Ferro Alloys- 0.08

Source - Final Project Report – Stage 1 for "Project Development Consultancy for Development of National Waterway-5 in PPP mode" prepared by Feedback Infra in March 2016. The information was aggregated through Primary Research and Feedback's analysis.

In addition to the above, the only significant industrial unit in the exclusive catchment of NW-14 is the Ferro Alloy Corporation (FACOR) unit at Bhadrak. FACOR produces minor quantity of Ferro Chrome (~0.07 MTPA) and is not viable for dedicated waterway transport. The region also has some container movement. Major imported commodity is containerized Steel scrap and major outgoing commodity is aluminum ingots to Paradip and Dhamra port.

4.2.3. Sand Mining & Construction materials

The immediate catchment of subject waterway also witnesses minor sand mining activity along its stretch. The sand mining areas are located upstream (nearby Aradi). While majority of the sand is transported through road, some quantity, especially on the southern riverbank (without road connectivity), is transported through the river. The boats used for transportation are small country boats with capacity of ~4-5 tons. At the quarry, the sand mined by cranes is dumped into trucks, whereby it is transferred to boats by manual labour. At the destination, boats are typically docked at temporary structures and emptied by manual labour onto trucks for transport to Neary local construction sites. The Government has awarded a handful of sand mining contracts in the region. These contracts are typically awarded for 5 years. The sand mining business, though, remains controversial, with significant government efforts to curb illegal sand mining in the area.

The mined sand is transported to various villages downstream on the waterway stretch. While the mined sand is not suitable for construction purpose, it is used for filling in building / house foundation. Some of the sand is also transported to Nalitapatia for construction activities. As Nalitapatia and nearby sanctuary area is inaccessible by road (except for significantly longer route through Rajnagar), waterway is the only means of transportation in the area. However, the area is government controlled, being a sanctuary, the sand demand in the area is minimal and sporadic.

The volume of sand mining varies year on year is based on awarded contracts. Hence, the steady-state annual sand transport volume has been estimated using the following assumptions. The assumptions considered are reasonably optimistic[9].

- Number of boats: 30
- Per Boat sand capacity: 5 tons
- Number of trips per boat per day: 1 (3 hours upstream, 3 hours downstream for 20-25 km + loading / unloading time)
- Operational Days per year: 200
- **Total Sand Traffic: 30,000 tons per annum**

Alternatively, sand consumption in the area can be estimated based on per capita demand, as follows.

- Catchment Population (Chandbali and surrounding villages) – ~200,000
- Per Capita sand consumption – 0.6 tons[10] per annum
- Annual Sand consumption in Catchment – 120,000 tons per annum
- As stated earlier, the locally mined sand is not suitable for concrete mixing and its only use is in foundation filling. Assuming only 25%-30% sand is used for filling, 30,000 – 35,000 tons of sand can be estimated to be transported for catchment consumption through both road and waterway. The waterway share is not expected to be more than **10,000-15,000 tons per annum**.

Provision of Infrastructure facilities for sand transportation is not recommended due to following reasons:

- **Distributed Production and Demand**: The sand transportation is distributed to the villages along the waterway stretch. The sand mining activity is also distributed, with private contractors making their own arrangement for loading sand boats.

[9] Primary interactions at Chandbali indicated that maximum 10-15 sand boats operate on the river, with stated carrying capacity of 4-5 tons. Feedback has estimated an aggressive volume to evaluate whether the traffic would still be negligible and too disaggregated for viable waterway transport.
[10] As per Sand Mining Framework, Ministry of Mines, India's sand demand (2017) was 700 million ton, translating to a per capita demand of ~0.6 ton.

- **Low Volume**: The total sand volume as estimated above (~30,000 tons) is very low. The maximum traffic for any location is 1-2 boats per day.

The sand boats are currently handled using temporary structures at river creeks or calm river shores. Hence, construction of permanent jetties (at multiple villages along the waterway) is not recommended. However, it is recommended that an administrative facility can be developed for regularization of movement of such boats. Aradi can serve as a suitable location for such an arrangement.

4.2.4. Fishing

Fishing activities are conducted in the region nearby Dhamra port. The port already has a fishing harbour. There are other docking jetties also present in the region, including Talchua for docking of fishing vessels. The fishing activity is seasonal as government imposes 7-month long bans on fishing to protect Olive Ridley sea turtles. The ban affects significant numbers of fishermen living the area. Majority of the fish produced in the region (at Dhamra Fishing Harbour) is either consumed locally or sent to West Bengal for consumption. Some share goes to fish processing units near Bhadrak. A minority share, comprising mainly of prawns and frozen fish, is exported through Dhamra Port to Japan, South-East Asia, EU and USA. Annual fishing catch in the region is ~3,800 tons[11]. Dhamra port recently acquired EIA certification for exports to EU in 2015[12].

Fishing cargo is not relevant for the waterway as the fishing harbour is located right at the Dhamra Port. Consequently, fishermen do not traverse the waterway for fishing. The fishing produce is either sent via road to Bhadrak (or beyond) or exported via the port. Only a minor share reaches the waterway catchment by road, which can be estimated as follows.

- Catchment Population (as per section 4.1.1) – ~3,00,000
- Nearly half this population overlaps with the hinterland of Dhamra Fishing Harbour or Mahanadi river and cannot be counted.
- Relevant catchment population for fish consumption – 1,50,000

[11] Data on harbours/ jetty/ fish landing centres of Orissa - http://www.odishafisheries.com/File/DATA%20ON%20HARBOURS-FLC-ORISSA.pdf
[12] Dhamara fishing harbour now EIA certified - https://www.dailypioneer.com/2015/state-editions/dhamara-fishing-harbour-now-eia-certified.html

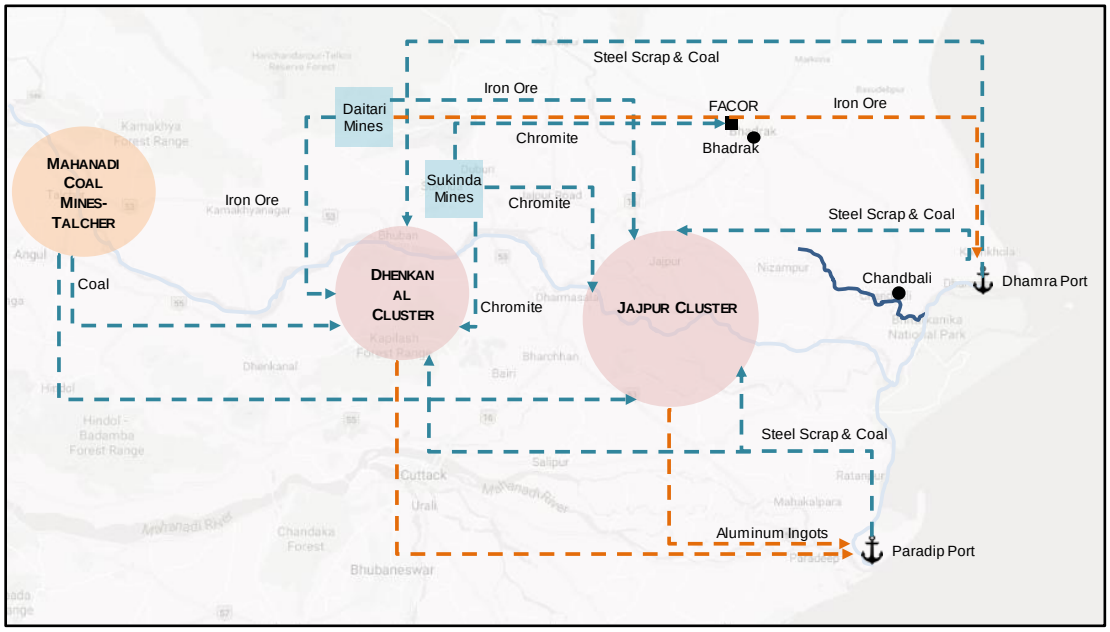
- Per capita consumption – 12.2 kg[13]
- Total Annual Consumption – 1,840 tons
- Total consumption during fishing months (5 months per year) – ~750 tons

Assuming this volume can be transported from Dhamra Port to Chandbali via waterway, it is still low and intermittent (only 5 out of 12 months) and cannot justify dedicated waterway transport infrastructure.

4.3. Origination / Terminating Commodities

The following map shows the major industrial cargo movements in the region.

Figure 4.4: Originating/Terminating Commodities



Around 85% requirement of non-coking coal is supplied by the Mahanadi Coal Limited mines in Talcher district and the remaining 15% is imported via Paradip and Dhamra Port. Around 70%[14] demand of coking coal is fulfilled from imports and the remaining 30% is fulfilled through domestic supply. Limestone, Quartzite and Dolomite are supplied mainly

[13] As per Odisha Fisheries Dept. statistics - http://www.odishafisheries.com/File/tender/2014/Fisheries%20Statistics-24-06-2017.pdf
[14] Source - Final Project Report – Stage 1 for "Project Development Consultancy for Development of National Waterway -5 in PPP mode" prepared by Feedback Infra in March 2016. The information was aggregated through Primary Research and Feedback's analysis.

from Sundargarh, Barraged, Koraput, Napata districts. Majority of iron & steel production from the clusters is transported domestically for consumption through rail / road transport.

As stated earlier, majority of cargo flow is handled through **dedicated rake transport** only. All the major industries and industrial areas have constructed **captive rail terminals** for handling large quantities of cargo movement throughout the year. Also, as observed from cargo flow map above, **NW-5 (Brahmani River) is better suited** for handling cargo movement within the clusters and well as movement to Dhamra Port. NW-5[15] is being developed to handle more than 25 MTPA of cargo (mostly coal, fertilizers, iron ore, industrial and agricultural products) with **terminals at Talcher, Nasirabad, Balasore and Rajnagar**.

Hence transport of industrial cargo on subject waterway is unviable due to following reasons:

- **Development of NW-5**: All the industrial activity in the region (Jajpur, Dhenkanal clusters and nearby mines and power plants) is located in close proximity of NW-5. The waterway not only passes through these regions, but also connects all the way to Dhamra port.
- **Lack of proximal industrial development**: The subject stretch of waterway has no industries in close proximity. The nearest industrial unit is FACOR in Bhadrak, which is ~25 km from the waterway. Thus, any industrial movement will incur significant first / last mile transport cost for accessing the waterway.
- **Small waterway length**: The subject waterway stretches for ~48 km. As a thumb-rule, the waterways are viable for cargo transport only for distances greater than 250 km[16]. Since waterway transport involves multiple handlings (and associated costs), storage costs (and time) and inventory / working capital costs (due to higher transport time), hence larger travel distances help to accrue fuel savings to offset the additional waterway costs.

[15] Source – Same as above
[16] Additional costs on Waterway – Handling charges at origin & destination (~INR 240 / Metric tonne) + First mile & Last mile transport costs (~INR 120 / Metric tonne). To offset additional cost of INR 360 / Metric tonne, waterway cost savings (~INR 1.50 / Metric tonne / km w.r.t. road) need to accrue over a minimum break-even distance of 240 km (360 / 1.5).

Hence, there is no potential of industrial cargo movement on the subject waterway and no waterway intervention is recommended towards provision / upgradation of any such facilities and infrastructure.

4.4. Passenger & Tourism Traffic

The subject waterway is characterized by strong tourism character. Bhitarkanika National Park and Mahadev Temple (at Aradi) attract significant tourist footfalls every year.

Table 4.5: Tourist Footfalls[6] in Nearby Tourist Centres (in lakh)

Nearby Tourist Centres	2013	2014	2015	2016
Aradi	8.2	8.6	8.8	8.9
Chandbali	1.8	1.9	1.9	2.0
Dhamra	1.0	1.1	1.2	1.2
Bhitarkanika	0.6	0.6	0.6	0.8
Total visitors (lakh)	**11.6**	**12.2**	**12.5**	**12.9**

It should be noted that majority of above footfalls are local people only. Aradi and Chandbali hosts large number of local religious tourists which visit the Mahadev Temple. Dhamra is focused primarily on business tourist visits. The hospitality infrastructure in the area is relatively underdeveloped in comparison to its tourist potential. Following table provides number of hotels in the region[17]:

[17] Statistical Bulletin-2016 published by Department of Tourism & Culture, Government of Odisha

Table 4.6: Tourist Visits – Catchment Area

Nearby Tourist Centres	No. of Hotels | No. of Keys
Aradi	7 | 43
Dhamra	4 | 104
Chandbali	6 | 72
Bhitarkanika	8 | 30
Total	**25 | 249**

Source - Statistical Bulletin-2016, Dept. of Tourism & Culture, Govt. of Odisha

The waterway forms an integral part of the tourism activities due to limited accessibility of tourist destinations by roads. As per the data collected by the Department of Commerce and Transport, the waterway traffic for 2011- 2015[18] is shown below:

Table 4.7: Waterway Passenger Traffic

Travel Route	No. of Trips	Annual Passenger Movement
2011-12	699	66,810
2012-13	738	73,790
2013-14	836	84,912
2014-15	1162	101,718
2015-16	1468	113,085

Source – Dept. of Commerce & Transport, Govt. of Odisha

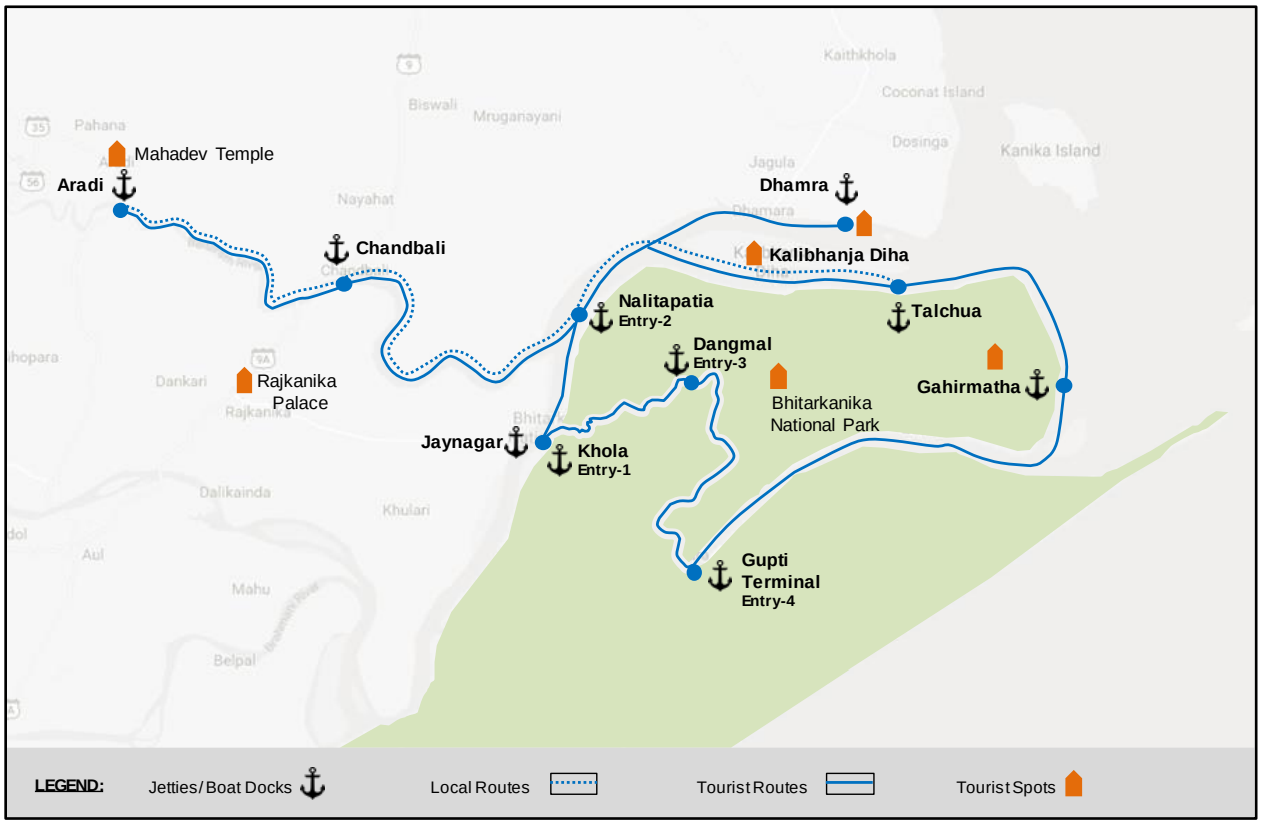
The above waterway movement comprises of both tourist and local passenger traffic. It should be noted that majority of the above traffic is tourist traffic for Bhitarkanika itself. Tourism in Bhitarkanika National Park is limited exclusively to boats only. Passenger boats in the region are operated both by the Odisha Tourism Development Corporation (OTDC) and private boat operators. The ferries are required to obtain permission from forest department for conducting boat operations. The boats are low draft small boats

[18]As per statistics of Department of Commerce and Transport, Government of Odisha *"http://ct.odisha.gov.in/content/1/14"*

with a capacity of ~15 passengers. A couple of larger boats (30 - 50 passenger capacity) are also operated by IWT.

The local passenger movement is from Chandbali to Aradi / Talchua / Dhamra. Tourist Passenger movement is from Chandbali to Aradi / Nalitapatia / Bhitarkanika or within Bhitarkanika itself. Following map shows the waterway circuits.

Figure 4.5: Passenger Routes



Major ferry services on the waterway are as below:

- Chandbali to Aradi – 18 km
- Chandbali to Dhamra / Talachua – 33 / 40 km (16 km in subject stretch)
- Chandbali to Nalitapatia – 16 km
- Chandbali to Jaynagar – 18 km
- Bhitarkanika (interal) – from Khola / Gupti Jetty to Dangamal and back; minor tourists also take the longer circuit through Gahirmatha.

All the above locations have small ferry docks / jetties. The jetties are managed by State Directorate of Ports and Inland Water Transportation (IWT) including the jetties in Bhitarkanika National Park (Khola, Gupti, Jaynagar, Nalitapatia). Chandbali jetty is a moderately sized facility with arrangement for ticketing, waiting area, parking space etc. Rest of jetties simply consist of small civil structure only.

IWAI also has a Crew Training Center at Chandbali, close-by to the existing terminal.

4.4.1. Tourism Traffic

The catchment area has a strong tourism character. The major tourism spots are Bhitarkanika National Park, Akhandalamani (Mahadev) Shiva Temple:

4.4.1.1. Akhandalamani (Mahadev) Shiva Temple, Aradi

The 19th century Shiva temple is the most famous temple in the region. It is located in Aradi on the banks of the river Baitarani. The temple attracts large number of religious devotees, especially during the festival of Maha Shiva Ratri (Jaagara). Other festivals like Panaa Sankranti, Chandan yatra, Siva Vibah and, Jhulana Yatra, Kalipuja & Deepavali also attract significant footfalls.

This place can be reached from Chandbali via boat in approximately 2 hrs. Both government and private boat operators ply this route. Alternatively, local auto rickshaws also provide connectivity through Chandbali-Aradi route, followed by cross-river ferry services to reach Aradi.

4.4.1.2. Bhitarkanika National Park

Bhitarkanika National park is located in the estuary of Brahmani, Baitarani, Dhamra & Mahanadi river systems. The national park, spread over 672 sq km, is most famous for its Giant Saltwater Crocodiles (include rate White Crocodile – Shankha species). The park is also home to a wide range of other animals like rhesus monkey, leopard cat, fishing cat, hyena, boars, dolphin, python, king cobra, spotted deer etc. The park hosts the second largest mangrove ecosystem in India. The park offers multiple tourist spots within and around it:

- **Gahirmatha Marine Wildlife Sanctuary**, one of the world's largest rookeries for the endangered Olive Ridley Sea Turtles

- **Bird Sanctuary** with migratory birds like open billed storks, kingfishers, whistling teals, sand pipers, sea gulls and others
- **Crocodile Breeding Centre** in Dangamal
- The Park is famous for its natural beauty and serene surroundings. It has several serene islands, trekking destinations and sigh-seeing places such as Kalibanja Diha Island, Udabali Sea Beach, Habalikathi Sea Beach, Ekakula Sea Beach, Mangrove Island etc.

The National Park is closed between May and July during the crocodile breeding season. The park is occasionally closed for census and during influx of migratory birds. The park attracts steady tourist inflow during rest of the months, with **traffic peaking during winter months of November to February**. The tourists prefer visiting Dangmal during winter months due to chances of crocodile spotting along the route. During warmer months, the tourists prefer accessing the national park through Nalitapatia instead. The Dangamal routes, however remains popular through the year due to its scenic surroundings and boating experience. The National Park handled **80,000 tourists** in 2016[19]. The tourist footfalls have been on the rise in the National Park (80,000 tourists in 2016 compared to 60,000 in 2015).

Ferry services are the only mode of transport for touring the park and nearby attractions. Tourists coming from Northern side (including large inflow from West Bengal) take the State Highway (SH-9) from Bhadrak to reach Chandbali, followed by ferry services from Chandbali or from Jaynagar. Ferry services from Chandbali go to either Nalitapatia or Dangamal or both for visiting the National Park. Tourists coming from Southern side (from Cuttack, Bhubaneswar, Paradip) take the SH-9A and reach either Jaynagar Jetty or enter the National Park through Khola Jetty or Gupti Jetty. Khola, Gupti and Nalitapatia are the entry points in the National Park.

[19]Statistical Bulletin-2016 published by Department of Tourism & Culture, Government of Odisha

4.4.1.3. Dhamra

Dharma is the main economic centre in the catchment on account of presence of **Dhamra Port**. The port handled ~18 million tonnes of cargo in 2016-17. The area has a well-developed hospitality eco-system. While the area primarily caters to business visitors, several tourists also pay a visit to the large port. The tourists also visit Kalibhanja Diha island just opposite to the port for leisure treks and sightseeing.

4.4.2. Local Traffic

The area is characterized by presence of several small villages along the waterway. Chandbali is the major town in the region and it frequented by people from nearby areas for commercial purposes. Due to poor road connectivity in the region, both government and private ferries ply on the waterway carrying local passengers and minor goods (2-wheelers, farm goods, daily needs purchases etc.).

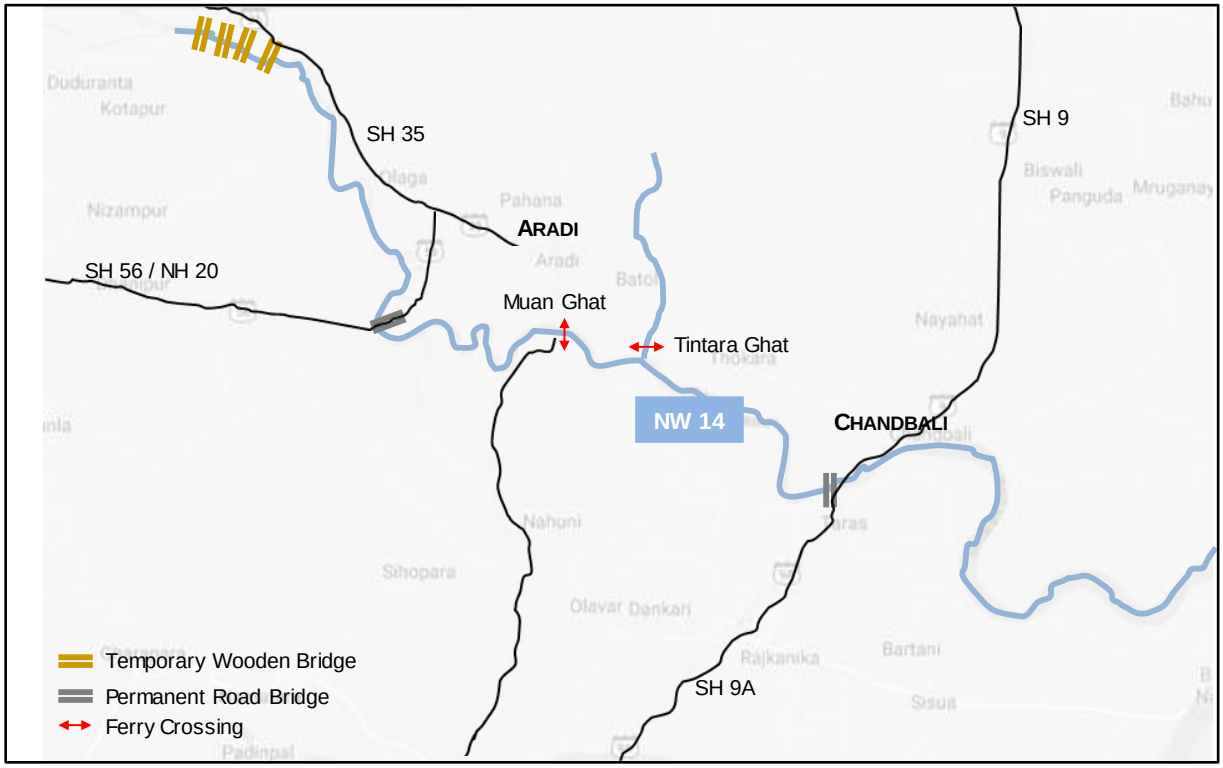
Such services ply all around the year (except rainy season as the river is not navigable) as the river is perennial in the subject stretch. The ferry frequency is limited to 1-2 round trips per day. The major routes on waterway are

- Chandbali to Dhamra / Talchua –33 / 40 km (16 km in subject stretch) – includes stoppage at Nalitapatia
- Chandbali to Aradi – 18 km

In addition, the river also has cross-river movements. The main cross-river traffic movement happens at Aradi due to lack of cross-river bridges for pilgrims coming from Chandbali. The pilgrims use ferry services at either Tintara Ghat or Muan Ghat for visiting Aradi. The location of these cross-ferry movement is shown in the figure below. The proposal for bridges at Aradi has been announced long back, however no such contract has been awarded as of now. There are some minor makeshift cross-ferry services on the upstream stretch of the river as there are no bridges for long river stretch (as shown in the figure below). As per Feedback's estimates, the local traffic movement is limited to ~35,000 passengers per annum[20].

[20]The waterway handles ~1.1 lakh passengers per annum (as per Department of Commerce and Transport, Govt. of Odisha) statistics for 2015-16. Moreover, Bhitarkarnika Park handles 0.7-0.8 lakh tourists annually. Remainder of the waterway traffic can be inferred to comprise of local passengers only.

Figure 4.6: Cross – River Movement



The cross-river passenger movement is, however, expected to reduce significantly with development of road infrastructure and river bridges in the region.

4.5. Ro-Ro Traffic

Due to lack any major industrial / urban activity, Ro-Ro traffic on the waterway is limited to 2-wheeler cross-river movement. Low draft country boat ply on the waterway, especially near Aradi to cater visiting pilgrims.

Hence, due to lack of any meaningful Ro-Ro traffic, no waterway intervention is recommended towards provision / upgradation of any such facilities and infrastructure. It is however recommended that IWAI / State government should regulate cross-river ferry movement with focus on improving navigability and safety of such boats.

4.6. Growth Trend

As analysed above, addressable waterway traffic consists of passenger traffic only (tourist and local). The passenger traffic has been rising steadily in the past with

increasing number of tourists and local passenger movements (refer to **Error! Reference s ource not found.**). The traffic potential of passenger is governed by the following factors:

- **Infrastructure** – Waterway use in the region is dictated (and will be affected by) its geographic features and network of road infrastructure
- **Tourism Potential** – Presence of additional tourist destinations and underdeveloped hospitality infrastructure lends potential to increasing the tourism potential in the area

4.6.1. Infrastructure Analysis

Road Network: Chandbali serves the major nodal point for connectivity in the region. Major Roads connecting the region are as follows:

- **State Highway-9A** – Connectivity from Cuttack/Bhubaneswar
- **State Highway-9:** Connectivity from Bhadrak. Bhadrak serves as the transit point for Jharkhand and West Bengal. Both SH-9 and SH-9A merge onto AH-45 / NH-16, which forms part of the Golden Quadrilateral project and primarily connects Kolkata to Chennai, passing through east coast states of West Bengal, Orrisa, Andhra Pradesh and Tamil Nadu
- **NH-53** – passes from / around Jajpur and provides connectivity to Hazira (Gujarat) to Paradip Port (Odisha)

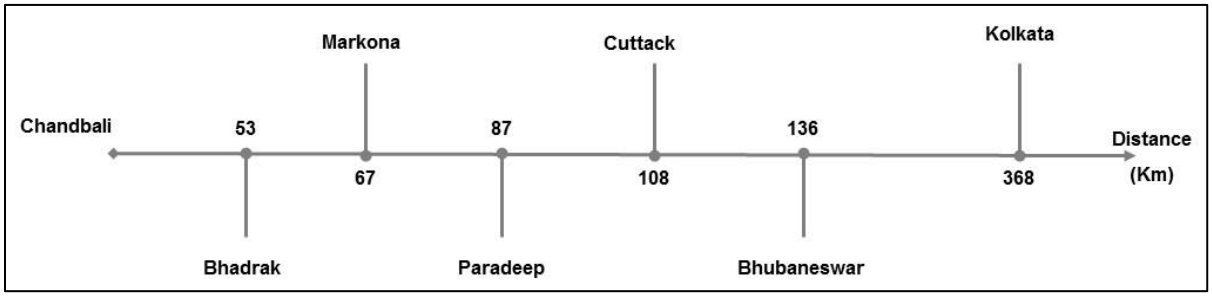
Note: The SH-56 connecting Japur and Aradi has been declared as a National Highway (**NH-20**) in view of improving connectivity for people vising the Shiv Temple in Aradi.

Besides taxi services, regular buses are also available from nearby cities/towns to Chandbali. However, it should be noted that the road condition, especially for SH-9, is not good. It takes about 3 hours to cover the distance between Bhadrak and Chandbali (~53 km)

Railways: The nearest railway stations for the Catchment Area are **Bhadrak (53 km) and Markona (67 km)**. As mentioned, Sh-9 connects these locations to Chandbali and both taxi and buses are available for the distance. In addition, Dhamra Port also has a dedicated railway track and is exclusively used for cargo services.

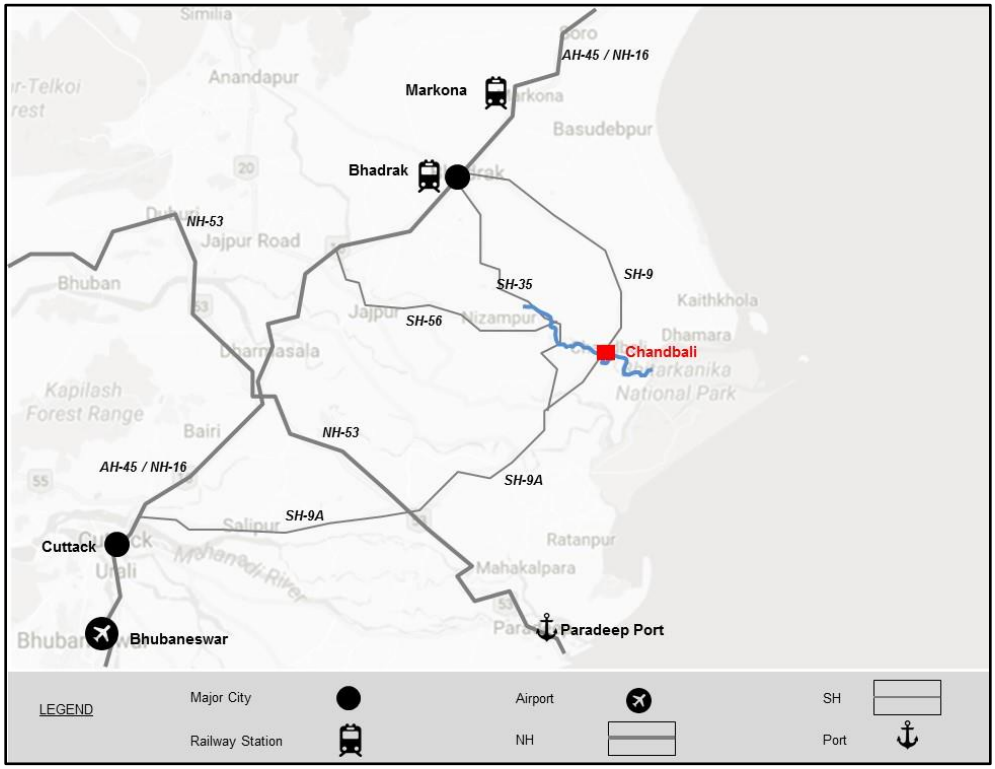
Airport: The nearest airport is Biju Patnaik International Airport at Bhubaneswar (136 km via Salipur on SH-9A and 154 km via Patarjpur on NH-53). Chandbali can also be reached via Netaji Subhas Chandra Bose International Airport in Kolkata (368 km).

Figure 4.7: Major Distances from Chandbali



It can be observed that the region lacks in good connectivity features. With exception of state highways serving the waterway (SH-9, 9A, 35), the village roads are in poor condition. Hence the local people and pilgrims have to rely on waterways for local transport.

Figure 4.8: Transport Infrastructure - Hinterland



4.6.2. Passenger & Tourist Traffic Potential

The waterway has potential to be developed as a tourism circuit with the presence of multiple tourist attractions in its vicinity. The waterway serves as the primary transport medium in Bhitarkanika National Park and with the presence of several serene locations nearby, is the ideal mode for touring the area. Tourism potential of the region is explained below:

- **Aradi –** As already detailed in previous section, Aradi has a famous Shiva Temple which attracts large number of tourists every year. Most of visitors are however local only which come for day visits. The festivals celebrated at the temple can be promoted to create tourism opportunities and attract overnight tourists from outside Odisha. Pilgrims can also visit Maa Biraja (13th century Durga temple) at Jajpur - 40 km from Chandbali.
- **Bhitarkanika National Park** – As already detailed in the previous section, Bhitarkanika National Park attracted over 80,000 tourists in 2016. The sanctuary is one of the relatively lesser known sanctuaries in India. Rather, it should be

marketed as of the most unique sanctuaries in India housing some of the rarest and largest crocodile species. The park also hosts of the largest mangrove ecosystems in India. It is a breeding centre for Oliver Ridley turtles (Gahiramatha Marine Sanctuary) and hosts several migratory birds over the year. The park can be a popular location for nature enthusiasts. The park offers lush green and calm surrounding, picturesque beaches and is a great retreat location. With promotion from state government and further developed of hospitality infrastructure, the park can increase its tourist footfalls significantly.

- **Rajkanika Palace -** The palace, is built on 4 acres with an overall sprawl of 35 acres covered with lush gardens. The palace contains a museum on ground floor housing historical antiques, artefacts and royal memorabilia. The first floor has been proposed to be converted to a heritage hotel. It a popular site for archaeological enthusiasts from around the world. The palace was nominated for status of World Heritage Site of UNESCO. With proper development and marketing, the palace can attract significant footfalls. The palace is situated on SH-9A and can be via road from Chandbali (~7 km). A tiny village of Sialia situated nearby is famous for having door-less houses.
- The region has several islands which can be developed as great retreat destination on the lines of backwaters in Kerala. Water sports activities are however not recommended due to eco-sensitivity of the area and presence of crocodiles.

4.6.2.1. Proposed Circuits

- **Chandbali – Aradi**: The passengers can take either a single side trip (returning by road) or return trip from Chandbali to Aradi
- **Chandbali – Dangmal**: The tourists can take return boat trip from Chandbali to Dangmal

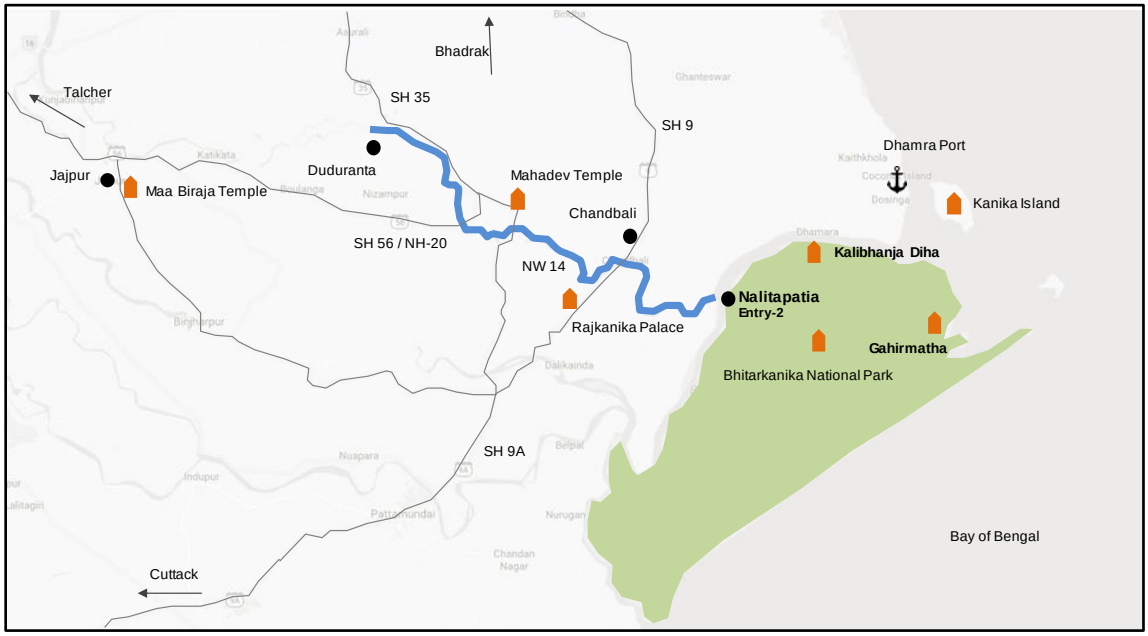
In addition, following circuits can be taken up for development, in conjunction with the State IWT as the Nalitapatia jetty falls outside the scope of waterway.

- **Chandbali – Nalitapatia**: The tourists can start from Chandbali and get down at Nalitapatia. There they can tour the National Park and go either to Dangmal or return back to Nalitapatia.
- **Aradi – Nalitapatia**: The tourists can take boat from Aradi and reach Nalitapatia with stop-over at Chandbali.

Figure 4.9: Tourism Spots near Baitarani River

The following map represents the tourism infrastructure in the region.

Figure 4.10: Tourism Infrastructure



4.7. Forecasting and Potential IWT Assumptions

The current waterway traffic on the river is comprised of (a) tourist and (b) local transport traffic. As already mentioned above, the cross-river traffic is expected to dwindle with infrastructure development in the area, especially the bridges at Aradi. Hence it has not been considered for future waterway traffic. There is a potential to increase the tourist traffic through concerted efforts of the government by promoting the region as an integrated tourism destination. While currently, majority of the tourist traffic on waterway is going to Bhitarkanika National Park, other tourists visiting Aradi, Rajkanika Palace can be targeted through development of waterway as an integral experience of the local tourism circuit. Thus, waterway development can be instrumental in enhancing the tourism experience of the area and help to establish it as a popular tourist destination. This would also help to stimulate the local economy around tourism including restaurants, hotels / lodges, boat operators, terminal facilities, road network, railway station etc. The waterway traffic has been segregated into tourist and passenger traffic as follows:

Table 4.8: Waterway Traffic Breakup by Route

Passenger	Annual Passenger Movement (est. 2015-16)
• Bhitarkanika (internal) – Tourist	55,000
• Chandbali – Nalitapatia / Bhitarkanika – Tourist	25,000
• Chandbali – Aradi – Tourist	10,000
• Chandbali –Talchua / Dhamra	25,000
Total	**~115,000**

Source – Based on primary interactions with local people

Following points should be noted regarding the traffic breakup:

- **National Park Traffic**: As mentioned earlier, **~80,000 tourists visited Bhitarkanika National Park in 2016**. Majority of the tourists visiting the park are from Jharkhand and West Bengal. The tourists come via Bhadrak and Chandbali. These tourists prefer accessing the National Park from Jaynagar Jetty and reach there by road. A lot of tourists, still, take the boat ride from Chandbali itself, inspite of higher charges and get down at Nalitapatia or Dangmal or both. Majority of the tourists visiting the park from Southern side reach the park directly at either Khola or Gupti Jetty and catch boat rides from there itself. Hence based on primary interaction at the region and traffic analysis, **break-up of 55,000 and 25,000** has been considered for tourist taking the ferry services at Bhitarkanika and Chandbali respectively.
- **Local Traffic**: As the waterway handles 115,000 tourists (Table 4-7) and 80,000 tourists visit Bhitarkanika, the remaining **~35,000** passengers can be inferred to be local passengers. Majority of these passengers are fishermen and villagers from Nalitapatia / Talchua region. Rest of traffic is Chandbali-Aradi tourist traffic. The tourists visiting Aradi take the road from Chandbali to Aradi with cross-river ferry in between. Some tourists do however prefer the waterway route. Hence the local traffic has been taken to have a **break-up of 10,000 and 25,000 for Aradi and Talchua / Dhamra** respectively.

The tourist traffic growth for Bhitarkanika National Park and Aradi has been considered as 9% p.a. (for 15 years, till 2033) based on tourist growth rate in Odisha[21]. Steady state growth rate has been considered at 6% p.a. The local passenger traffic growth has however been considered at 5% p.a., buoyed by the following components:

- Population growth - ~2% (~1.6% growth observed between 2001-2011) Upon promotion and development of the region as a tourist destination, the region would expectedly see a surge in local population. In the absence of well-developed road infrastructure, the waterway stands to benefit from this growth in local population.
- Number of trips growth – additional 3% - With increase in tourist footfalls in the region, and spurt in economic activity, the number of trips per capita would also increase.
- Considering these, a conservative estimate of 5% local passenger traffic growth has been taken.

The projected tourist traffic on the waterway is shown in the table below:

Table 4.9: Projected Waterway Traffic

Passenger Traffic (in lakh)	2020	2030	2040	2050
Tourist Traffic (Bhitarkanika, Chandbali – Aradi / Nalitapatia)	1.3 lakh	3.0 lakh	5.9 lakh	10.5 lakh
Local Traffic (Chandbali – Talchua / Dhamra)	0.3 lakh	0.5 lakh	0.8 lakh	1.3 lakh
Total Traffic	**1.6 lakh**	**3.5 lakh**	**6.7 lakh**	**11.8 lakh**

Note – Cross-river traffic has not been considered in above projections, as bridges are proposed at crossing points

[21]Department of Tourism and Culture, Statistical Bulleting 2016, "*http://odishatourism.gov.in/sites/default/files/Statistical%20Bulletin%202016.pdf*"

The required number of boats to service these traffic segments *have been* derived as follows.

- Tourist Traffic (Bhitarkanika, Chandbali – Aradi / Nalitapatia)
  - Typical boat load – ~15 persons
  - Average no. of passengers / Boat / trip – ~10 persons
  - Number of boat trips – Annual Passenger Traffic / ~10 person per boat trip
  - Daily trips per boat – 2
  - Number of operational days per annum – 210 days (9 months tourist season from August to April, i.e. average 210 operational days per boat)
  - Number of annual trips per boat – 420 (2 x 210 days)
  - Number of Boats – Number of boat trips / No. of annual trips per boat
- Local Traffic (Chandbali – Talchua / Dhamra)
  - Typical boat size – ~25-30 persons
  - Number of Passengers / Boat / trip (average) – ~20 persons
  - Number of boat trips – Annual Passenger Traffic / ~20 person per boat trip
  - Daily trips per boat – 2
  - Number of operational days per annum – 270 days (9 months, daily operations)
  - Number of annual trips per boat – 540 (2 x 270 days)
  - Number of Boats – Number of boat trips / No. of annual trips per boat

Table 4.10: Projected Waterway Traffic (Number of Boat Trips)

Number of Boat Trips	2020	2030	2040	2050
Tourist Traffic (Bhitarkanika, Chandbali – Aradi / Nalitapatia)	12,704	30,076	58,564	1,04,880
Local Traffic (Chandbali – Talchua / Dhamra)	1,519	2,475	4,031	6,567
Total Traffic	**14,224**	**32,550**	**62,596**	**1,11,447**

Table 4.11: Estimated Number of Boats in Operation

Number of Boats	2020	2030	2040	2050
Tourist Traffic (Bhitarkanika, Chandbali – Aradi / Nalitapatia)	30	72	139	250
Local Traffic (Chandbali – Talchua / Dhamra)	3	5	7	12
Total Traffic	**33**	**76**	**147**	**262**

4.8. Terminal-wise IWT Traffic Analysis

The traffic projected above, has been segregated into various routes as shown in the table below. The share of Bhitarkanika traffic arriving from Chandbali has been increased from current (31% - 25,000 out of 80,000) to 40% in the future.

Table 4.12: Relevant Waterway Traffic (in Lakh Passengers)[10]

Route	2020	2030	2040	2050
1. Bhitarkanika (internal)	0.8	1.6	3.1	5.6
2. Chandbali – Nalitapatia / Bhitarkanika	0.4	1.1	2.1	3.7
3. Chandbali – Aradi	0.1	0.3	0.7	1.2
4. Chandbali –Talchua / Dhamra	0.3	0.5	0.8	1.3

Hence, based on the projected tourist traffic, terminal facilities are recommended at:

- **Chandbali**: For capturing tourist traffic to Bhitarkanika (including Nalitapatia), Aradi and local passenger traffic to Talchua / Dhamra. The Chandbali terminal would compete with small private jetties in Chandbali. However, with better facilities, it is expected to capture majority of traffic at Chandbali.
- **Aradi**: For capturing tourist traffic (pilgrims visiting Mahadev Shiv Temple) from Chandbali. The waterway boat services would compete with road connectivity. Further the connectivity of Chandbali and Aradi would improve with construction of bridges at Aradi. However, it is expected that some tourists would prefer the

waterway experience with reasonable charges (INR 100 – 150 per person for one side) and travel time (2 hours for one side).

Further, it is recommended that the jetty facilities at Bhitarkanika (Nalitapatia, Gupti, Kohla, Dangmal) should be upgraded by the State IWT. All the locations receive significant tourist footfalls from the national park visitors. Tourists prefer taking the Nalitapatia route during warmer months and the Dangamal route during the cooler months. Majority of tourist taking ferries from Bhitarkanika jetties prefer going to Dangamal itself. Based on site visits, the Chandbali to Bhitarkanika traffic has been considered to increase to 40% of the total National Park's traffic.

Table 4.13: Traffic for Recommended Waterway Terminals

Route	2020	2030	2040	2050
Chandbali	0.82	1.90	3.54	6.21
Aradi	0.14	0.33	0.65	1.17

The other traffic terminals (Talchua, Dhamra, Bhitarkanika Terminals) have not been considered as they are located outside the scope of waterway. However, it is recommended that State Authorities / Forest Department should upgrade the jetty facilities as these are old and degraded. The proposal for their upgradation had been taken cleared by the state government.

4.9. Project Recommendations

Based on the traffic study, **it is recommended to set up terminals at Chandbali and Aradi**. State IWT already operates a jetty at Chandbali. However, due to limited scope of expansion, a terminal facility would be required in view of increasing traffic. The new terminal can be constructed either immediately or once the traffic increases.

Aradi currently has a small civil structure for handling passengers. **The currently IWT docking facilities can be expanded to develop a proper terminal or a new location can be selected for fresh development at these locations**. A terminal can include facilities like ticketing counter, waiting area, parking space, retail shops, eatery stalls, restaurant, tourist information desk, booking counters (taxi, hotel etc.) etc.

In case, the current jetties are being upgraded, IWAI would be required to enter into partnership with IWT. It is recommended that IWAI should undertake capital investment (and maintenance works) in lieu for additional terminal charges at these terminals. IWAI should also undertake operations of these terminals.

The government plies only handful of boats on the waterway. Rest of the boats are privately operated. It is not recommended for IWAI to own and operate boats on the waterway. **The boats should continue to be privately owned and operated**. It would reduce the IWAI's investment. The state government, tourism department can market the waterway to large private boat / cruise operators to set up their operations with guarantees of state support and subsidies if required.

No night navigation facilities are recommended for the waterway. The waterway lacks any night attraction for promoting night tourism. The tourist activities happen during the day only, as the surroundings and forest activity is visible during daytime. Further, night navigation would require significant infrastructure investment in ensuring safe operations (lighting, patrolling, navigation aids, terminal facilities) and hence is not recommended for the waterway.

4.10. End Note

The study includes 48 km stretch of Baitarani river from Dattapur village to confluence with Dhamra River. The river is characterized by a major town (Chandbali), few small

villages and mostly agricultural / forest land. While the region has significant tourism character, agriculture is the main economic activity in the region. Jajpur, Kalinganagar and Dhenkanal Industrial clusters are located in hinterland of the waterway and host several large-scale iron and steel industries on account of presence of several iron ore, chromite and coal mines in proximity. Dhamra Port located in close proximity of the waterway handles ~18 MTPA of traffic (mainly coal, iron ore) serving the nearby Industrial clusters. However, the industrial clusters are better serviced through NW-5, which is being already developed. The agricultural produce of the region is sold in markets in Chandbali and Bhadrak and it not viable for waterway transport. The waterway also has transport of ~25,000 – 30,000 tons of sand per annum from mining operations on its banks. However, a separate jetty for handling sand is not recommended, due to low and disaggregated volumes.

The current traffic on waterway comprises of only passenger traffic – both local population and tourists. The waterway is used by 80,000 visiting Bhitarkanika National Park. Another ~35,000 people use the river for transport between Chandbali to Aradi, Talchua and Dhamra. In addition, there are cross-river boat operations at Aradi and Chandbali. The river has host of tourism points nearby including Akhandalamani Shiva Temple, Maa Biraja Temple, Bhitarkanika National Park and Rajkanika Palace.

This presents an opportunity for development of the area as a major tourism destination. The waterway would serve as the main connecting link between the destinations as well as add a unique flavour to the overall tourist experience. The tourism development would help uplift the local economy and infrastructure. The waterway traffic is expected to grow to ~12 lakh passengers by 2050 (mainly tourist traffic of Bhitarkanika and Aradi - ~10.5 lakh). The tourist traffic in 2050 is projected to comprise of ~5.6 lakh tourists visiting Bhitarkanika directly, ~3.7 lakh tourists visiting the park from Chandbali and ~1.2 lakh tourists going to Aradi from Chandbali. Further 1.3 lakh local passenger traffic is projected between Chandbali and Talchua / Dhamra (2050). For the purpose of this report, only Chandbali and Aradi terminal traffic has been considered.

5. TERMINALS

5.1. General Review

Port is an important element in the economic and social advancement of a region. Through the port, access to the expanded markets may be obtained through cheaper means of transport. Ports also can enhance the job opportunities available in a region. Terminals are components of a port or one or more terminal constitute a port. Ports/ terminals serve as an interchange between the land and sea transport. They contribute to the stable development of industries and improved lives of the local community especially in remote areas. In rural areas, they can offer a reliable means of transport. Terminals for cruise or ferry services can help explore the tourism potential of the area.

Figure 5.1: Typical ferry terminal

5.2. Identification of Site Location

The various aspects considered in general during the identification of the site location includes

5.2.1. Site Condition

The following are the conditions followed:

- ✓ The site having enough area available for the terminal and associated infrastructures with margin for future expansion.
- ✓ The site with proximity to origin or destination of the tourists.

- ✓ Reasonable foundation condition to permit economic design.
- ✓ Availability of appropriate turning circle and vessel mooring yards.
- ✓ Presence of amenities for tourists like hotels, restaurants, local shopping zone, proximity to other modes of transport, etc.

5.2.2. Water area characteristics

The capacity of the water area was evaluated in terms of numbers, types and sizes of vessels which are required to be simultaneously anchored in the quay area. The general water area requirements for the ferry terminal includes:

- ✓ Berthing area: The area in front of the berthing structure required to accommodate the vessels. It is based on the dimensions of the largest design ship and number and type of ships attended. The minimum length of berthing area considered such as to accommodate the passenger vessels carrying passengers/ two-wheelers.
- ✓ Manoeuvring area: The width required for manoeuvring is approximately 0.6 times the length of the vessel for berthing parallel to the fairway.
- ✓ Turning circle: The minimum diameter of the turning circle where vessels may be warped round turning dolphins is 1.2 times the length of the design vessel. Where vessels turn by free interplay of the propeller and rudder assisted by tugs, the minimum diameter of the turning circle should be 1.7 to 2 times the length of the design vessel. Where no tug assistance is available, the diameter is taken as 4 times length of the design vessel.
- ✓ Sheltering from wind, currents: The berthing area is planned in such a way that, tidal currents or wind disturbances are limited.

5.2.2.1. Berthing Aids

The berths are facilitated with the following aids:

- ✓ Fenders: To protect the berthing structure and vessel hull from the berthing force.

- ✓ Mooring piles: Arrangement to properly moor the vessel, so that safe loading/ unloading of cargo is possible. In the present case, it is suggested to have mooring piles, since the quay is of floating type.

5.2.2.2. Type of structure

The berthing structure was opted based on the site condition. The structure must accommodate the existing hydraulic variations in the site and aiming the safe handling of passengers.

5.2.3. **Land area provisions**

The minimum land area behind the berth is related to the basic amenities expected passengers will require. There are provisions like water supply for firefighting, fire alarm, etc.

5.2.3.1. Connectivity to the terminal area

There must be good network of roads and rails in the region of terminal. The road traffic is served by SH-9.

5.2.3.2. Tourist vehicle park location

Demarcated areas are provided behind for parking the vehicles within the terminal premise.

5.2.3.3. Place for arrival/departure

The arrival and departure locations are provided based on the expected passenger traffic. A terminal building is planned with basic amenities for passengers and waiting lounges

5.2.3.4. Proximity to the tourist spots

The site selected is having good proximity to the tourist spots with assured tourism potential.

5.2.3.5. Electricity

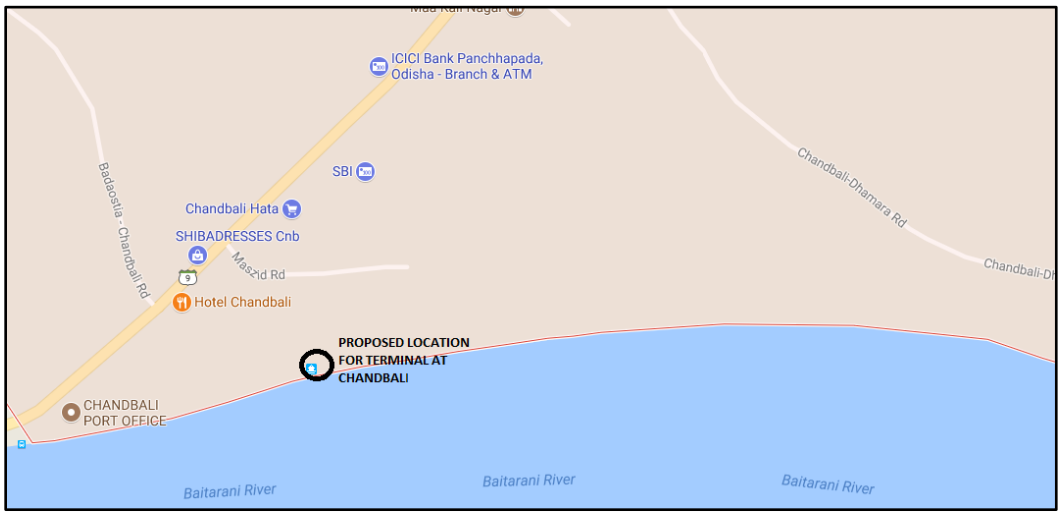
As far as possible underground cables are to be laid for power supply. An uninterrupted electric supply is to be ensured.

5.2.3.6. Water supply

Water supply to vessels and passengers need to be ensured. It is proposed to have a water supply tank.

From the traffic study, it is observed that, Chandbali is a major town along the route of the river with population over one lakh. People from the other bank needs to cross the river to reach the town region of Chandbali. Also, it is observed that, there exist passenger ferries to Aradi, Dhamra and Raj-Nagar. Hence its proposed to use the existing facilities in Chandbali northern bank and have a terminal at the southern bank of the river. There are difficulties in developing beyond CH 40km as explained in section 3.1 of this report, and based on the proposals of the traffic study, it is proposed to have a terminal at the northern banks at Aradi, where road access is available which will act as an extreme terminal of the waterway for along river movement as is a developed town.

Figure 5.2: Chandbali region northern bank



The Chandbali is a developed town with almost all amenities. The Cuttack-Chandbali road passes through the region and has proximity to Chandbali-Dhamra road. There seems to have a need for providing ferries for crossing. It is observed from the site investigation by experts that the existing facilities at Chandbali can be made use of.

Figure 5.3: Chandbali region southern bank

Figure 5.4: Aradi region northern bank

This region has proximity to SH 35, the region is fairly developed with hotels and shopping centres. Being a moderately developed area, it is recommended to have a terminal here based on the traffic data.

5.3. Terminal Layout / Master Planning including phases of development

It is proposed to use the terminal facility in the region where a ferry service presently exists. The layout for terminal at Chandbali (right bank) and the terminal at Aradi is shown in the drawing attached as Vol. II. It is recommended to place the terminal such that its lateral distance from the sea-shore line is more than 10km and hence environmental clearance issues can be avoided. The design vessel based on which the master plan is prepared can be read from Chapter 7.

The terminal will have necessary amenities as listed below:

- Parking area: An open parking area may be considered in the initial phase with a size of around 20m X20m.
- Terminal building: Consisting of waiting lounges, shops, refreshing areas, cafeteria, offices, etc.

Figure 5.5: Typical parking area and building for a passenger terminal

- Water supply: In the absence of freshwater supply lines near the terminal location, water storage tanks may be planned. Hydrants should be installed at approximately 100-200m intervals.
- Electricity/ Lighting: As far as possible, underground cables may be used. Proper lighting shall be ensured in and around the terminal area even though late night navigation is not considered, the terminal building and premise is suggested to be well lit.

- Connectivity: The existing road networks may be modified or maintained to ensure proper movement of people between different modes of transport. The proximity of the site to SH-9 is to be made use of and arterial roads is to be planned to connect the terminal with SH via, existing District roads.

5.4. Land Details

The location is finalized based on factors like, availability of government owned land or low cost or less populated areas near the water area. Also, considering the traffic potential, Chandbali area already has a ghat, the same facilities can be made use of. Also, the region is a major population centre and has hospitality options hence serve as a base for travelling customers. The region has proximity to various tourist destinations like Bhitarkanika National Park, Rajkanika Palace, etc. There is good connectivity in the region and have enough features to attract international tourists. The Aradi region at Ch 27.24km is also a fairly developed region with good connectivity to tourist destinations.

Even though the cadastral map of the region is not available, from the site investigation it can be concluded that there is land availability for developing the terminals in the locations proposed in section 5.2 of this report. The estimated land requirement in each location is around 1800 sqm. The master plan enclosed in the Vol. II may be viewed for the allocation of land in each terminal premise.

5.5. Geotechnical Investigations

The team which investigated the site of the terminals and along the river channel, observed that the soil is fairly good with hard strata of sand being available at minimum 2m depth and yielding a minimum of 10tonnes per sqm. safe bearing capacity. Considering the nearby buildings in the locality, it is safe to confirm the observation to be true. This can be proved by detailed soil investigation before construction.

5.6. Terminal Infrastructure including equipment

The terminal is intended to handle passengers alone. Hence heavy cargo handling gears are not required. The terminal may have facilities to accommodate the passengers like waiting lounges, kiosks, cafeteria, ticket counters, toilets, etc. Considering the general trend, the most common inland port facilities are as below:

5.6.1. Docking and mooring structures

The structures to which the vessels can be tied while berthing. The mooring structures can be simply of a cluster of wooden piles with or without capping. In the present case, it is proposed to have mooring piles, such that one vessel is served in the terminal area at a time.

Figure 5.6: Mooring arrangement

5.6.2. Amenities

The terminal premise may have all necessary amenities for passengers like rest rooms, toilets, cafeteria, fresh water supply, tele-communication access, etc. The minimum facilities required includes:

- ✓ Lighting: The quay structure, walkway, aces to connecting roads, etc. may be well lit.
- ✓ Power supply
- ✓ Potable water
- ✓ Safety equipment: The terminal area, shall be well equipped with lifesaving facilities. The water facing sides of the access shall be provided with ladders and handrails. Lifebuoys with approximately 30m buoyant line may be installed along the berth structure.

- ✓ Security guards: Some agency to ensure the safety of the passengers. Either public services like police officials or private security staffs are suggested.

5.6.3. Proximity to other modes of transport:

The terminal shall be well connected with other modes of transport to enable easy movement of passengers from and to the location.

5.6.4. Firefighting equipment:

Proper arrangements to fight fire in case of an emergency may be ensured. The components like fire mains, pumps, hydrants, fire detection and extinguishing alarm system, ventilation systems including smoke dampers, etc., may be provided.

Figure 5.7: Firefighting system

5.7. Berthing Structure

Berthing structures are used for mooring or tying of vessels while they are serving. The minimum length of berthing structure should be sufficient for mooring the longest vessel expected to arrive. The common type of berthing structures includes gravity based heavy structures, open type piled structures, floating structures, etc.

Figure 5.8: A passenger ship docked to a floating pontoon jetty

Here considering the waterway characteristics and traffic, the vessel used for design is of 32m LOA, 5m beam and loaded draft of 1.2m. In the present situation, floating pontoon quay is proposed with an articulated steel trestle. The floating structure is supported such that the movement to accommodate water level fluctuations is possible. These structures can accommodate the seasonal variations in water levels. The berthing structure shall be protected by fenders in the waterfront sides so as to absorb the berthing energy of the vessels.

Two options are considered:

Option 1: Light structure with a floating structure for passengers and limited two-wheeler traffic

The quay is a floating concrete pontoon structure of size 8m X 2m. Being floating, it can adjust the elevation based on the water level in the river. For pontoon, a total depth of 1.5 m is proposed considering a minimum free board of 0.5 m at all levels of water. These can be supported using steel pipes fixed to the pontoon and hinge supported to a pedestal on land to enable up and down movement. The structure is protected using fenders to absorb the berthing energy. A 3m span steel trestle of around 2m width is provided to connect the land side terminal building with the water side quay structure. Since passenger and limited two-wheeler movement alone is considered, 2m width should suffice. The channel is protected near the terminal location, hence minimum 3m span is

required for the trestle. It is having the advantage of being light and at the same time meeting the requirements.

Figure 5.9: Floating pontoon quay with steel access supported on pedestals resting on open footing (Option 1)

Option 2: Floating structure with anchorage provided to enable up and down movement

The quay is a floating concrete structure of size 10m X 5m. Being floating, it can adjust the elevation based on the water level in the river. These are supported by anchor chains attached to the bottom of the pontoon and tied to dead weight laid on seabed to enable up and down movement. The structure is protected using fenders to absorb the berthing energy. An 8m span steel trestle of around 3.5m width is provided to connect the land side terminal building with the water side quay structure. The trestle is proposed to be of steel box sections and the trestle is supported on piled abutment. Here the advantage is that large amount of passenger and two-wheeler traffic can be accommodated but has the disadvantage of requiring huge investments as it needs abutments supported on piles to support the trestle.

Figure 5.10: Floating pontoon quay with steel access supported on piled abutment (Option 2)

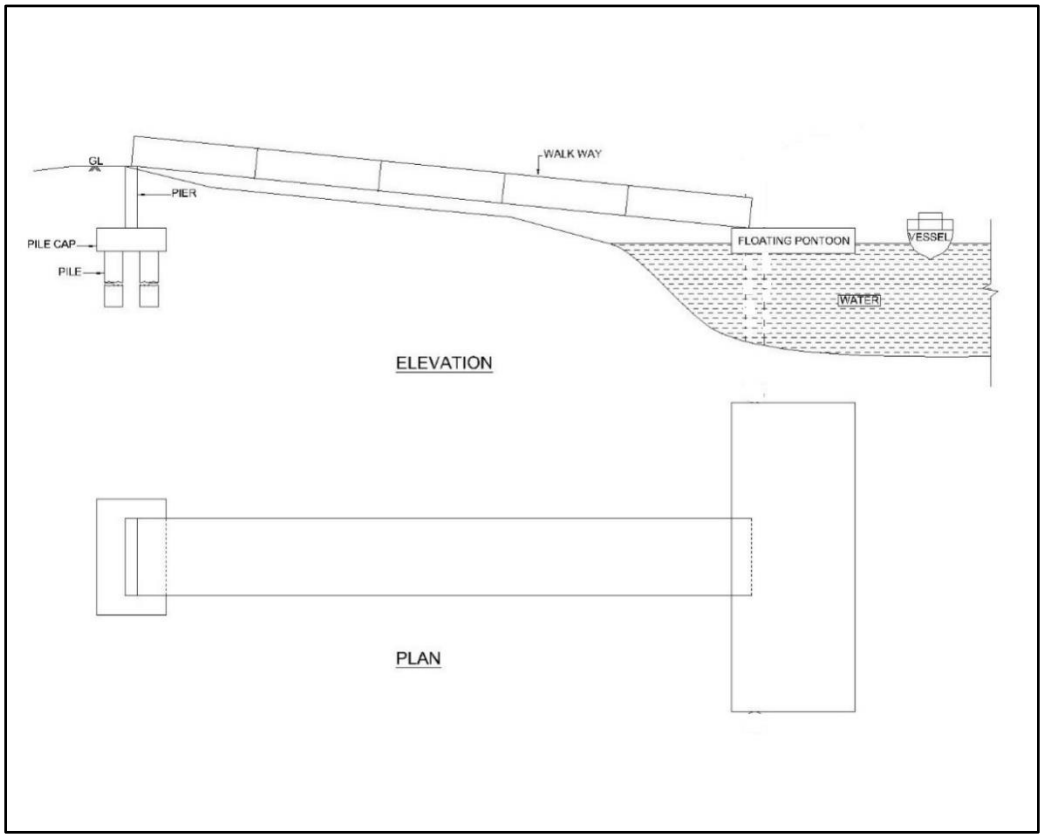
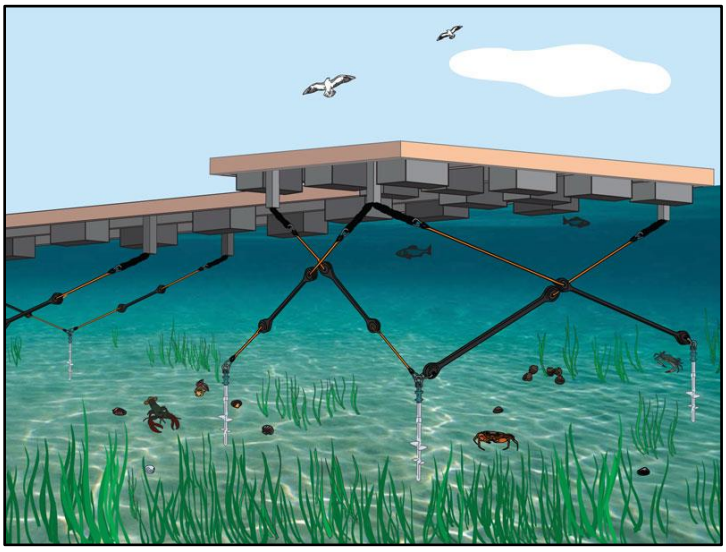


Figure 5.11: A typical floating pontoon jetty supported by anchors



Since the traffic is only passenger and majority of local movement and tourism oriented and considering the class of water way being I, option 1 is the proposed. This option has

the advantage of being light and well suiting a Class I infrastructure. Since no huge abutments are required, major structures are replaced with light structures.

5.8. Terminal Costing

The costing is worked out based on the preliminary engineering is as shown in the table below.

5.8.1. Capital Cost

Table 5.1: Terminal Costing (Capital)

Description	Cost (lakhs)
Berthing structure	Rs. 29.58
Terminal building 100sq.m. housing office, security and passenger amenities.	Rs. 45.26
Landscaping (pavings, lawn, etc.)	Rs. 5.00
Auxiliary items (firefighting, water supply, safety gadgets, lightings, road networks, etc.)	Rs. 20.00

5.8.2. O&M Cost

For operation and maintenance, 1% of initial cost is considered in case of structures on land and 5% for structures in water.

Table 5.2: Terminal Operation and Maintenance Cost

Description	Cost (Rs.)
Berthing structure	Rs. 147900.00
Terminal building 100sq.m. housing office, security and passenger amenities.	Rs. 45260.00
Landscaping (pavings, lawn, etc.)	Rs. 5000.00
Auxiliary items (firefighting, water supply, safety gadgets, lightings, road networks, etc.)	Rs. 20000.00

6. PRELIMINARY ENGINEERING DESIGNS

6.1. River Training

It implies the measures adopted on the river to direct and guide the river flow, to train and regulate the riverbed or to increase the low water depth. In the present case, training is done for depth, i.e., the river is trained to provide sufficient depth for navigation during low stage of water.

As explained in section 3.3.3 of this report, river training works are required at around 4743m length. The lands are to be acquired and cut to have a channel with sufficient depth for navigation. The soil obtained can be used for embankment strengthening.

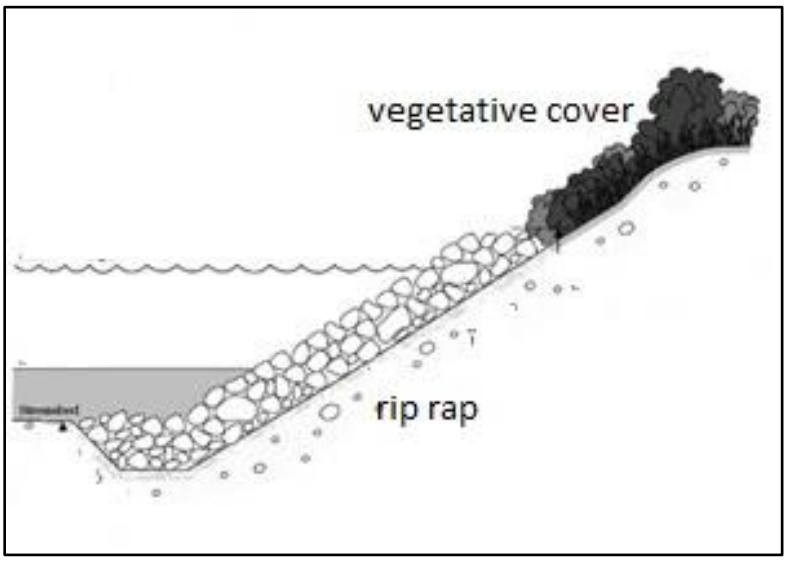
6.2. Bank Protection

The main aim of bank protection includes:

- Checking erosion of bank by currents or vessel wakes.
- Checking sliding of slope due to gradual steepening because of erosion.
- Checking sliding due to drawdown of floods, etc.

From the survey report, it is observed that few stretches of the embankment are protected but rest are left unprotected. The erosion prone areas demand some precaution measures against the action of water especially during flood. Thus, it is suggested to have bank protection adjacent to the terminal locations. At critical locations, like the ones have very close proximity to terminal or the one with very sever velocities are suggested to have stone protections along with vegetative cover immediately.

Figure 6.1:Typical embankment protection using riprap and vegetation cover.



The design of the riprap is based on IS 14262 (Planning and design of revetments guidelines) and IS 8237 (Protection of slopes for reservoir embankments).The major features considered for design includes, rock shape, size and gradation; bank slope and extend of protection; toe treatment; filter layer. It is proposed use a rock density of around 2500 kg/ cub. M. Assuming a side slope angle for the channel as 1 vertical to 2 horizontal and an angle of repose for the rip rap material as 30 degrees. As per IS 14262, the weight of the stone is given as,

$$W = \frac{0{\cdot}023\ 23}{K} \times \frac{S_s}{(S_s - 1)^3} V^6$$

Where, W- weight of stone in kg

S_g-specific gravity of stone

V-mean velocity of water in m/sec over the vertical under reference

K-correction factor for sloping face of the channel, can be obtained from Fig:1 of IS 14262.

Size of the stone is given as,

$$D_s = 0{\cdot}124 \sqrt[3]{\frac{W}{S_s}}$$

And thickness of protection layer is given as,

$$T = \frac{V^2}{2g\,(S_s - 1)}$$

Where, g: acceleration due to gravity.

A filter layer of 300mm thick confirming to IS 8237 is required to be provided below the revetment to prevent failure by sucking action of high velocity flow. From the site investigation, it is observed that the soil there is granular with less than 50 percent or less fens by weight. Hence the following is to be satisfied,

$$\frac{\text{85\% passing size of bed material (mm)}}{\text{Equivalent opening size of bed of fabric (mm)}} \geq 1{\cdot}0$$

Also, the provisions of IS 14262, shall be satisfied. It is recommended to provide a 150mm thick sand layer over the filter fabric to prevent the mechanical rupture of the fabric while placing the stones. To prevent the sliding and failure of the revetment on slope, toe protection is recommended. Assuming that unerodable strata is available at the river bed at a reasonable depth, it is recommended to provide a toe key.

Thus, the proposed weight of stones to be used for embankment protection is minimum 3kg, with minimum diameter around 0.15m, minimum thickness of the protection layer around 0.15m. The drawing showing the typical cross section of the riprap is enclosed at the end of the report as Vol. II.

The construction practices include, clearing and grubbing the slopes and dressed to a smooth surface. Loose, soft materials and large rock projections through the slope are removed and potholes filled with non-cohesive materials and compacted. Toe trench for scour protection is prepared. The filter layer materials are spread evenly on the prepared

bank without any compaction. Over that rocks are placed using a crane. Live plants can be used in conjunction with structural measures. Vegetation recommended is local species.

6.3. Aids to navigation

The aids to navigation are arrangements made to enable a safe movement of vessels. They can be of use during day movements. In the present stretch considering the tourism potential of the area, emphasis is given for both day and night navigation. Again, these aids may be of fixed type or floating type. The important ones include beacons, buoys, radar reflectors, weather beacons, sector light, etc. The recommended types for this project include:

- Buoys: They are used to mark channel boundaries, turns, hazard areas. They are held in position by chain and anchor mooring.
- Ranges: They are fixed structures aligned with a straight section of channel and are used by pilots to determine the position of a vessel in the channel.
- Weather beacon: A sound producing aid that warns of danger when usual aids are obstructed by weather conditions. It could be of fixed or floating type. They may be considered as a future plan.
- Thalweg surveys: Periodically done surveys (monthly basis or so) to check navigability of the channel.

Figure 6.2: A typical buoy

It is required to have beacons to demarcate the channels and to specify locations of danger. Weather signals are recommended as future plan especially at curves considering the climatic conditions of the area. At locations of long straight stretches, it is suggested to have ranges to mark the centreline of the channels. Also, periodic surveys and year-round maintenance of marks for day navigation is proposed. For the time being no night navigation is proposed. The location and arrangement of navigation markings such as buoys supported on wooden poles and ranges to mark the centreline are shown in the drawing enclosed as Vol. II.

6.4. Cargo Terminals and River Ports

A river port is an intermodal transportation centre in which transportation by waterway may be the mode which produces the greatest community economic impact. Those facilities within an inland rivers port which are located on the waterfront for loading and unloading barges are terminals. Terminals come in three types as:

- General purpose terminal: Meant to handle a wide variety of commodities often in bundles.
- Special purpose terminal: They are meant to handle only one type of commodity and they may have a capacity to move large tonnages rapidly.
- Industrial terminals: They are designed to serve a specific industrial plant or processing facility.

Here the Baitarani river stretch from confluence with Dhamra river to Aradi (CH 27.24km) is developed with an aim to promote tourism facilities and to ensure local connectivity. Hence all the terminals are intended to be of primarily passenger terminal type. The ferry terminals typically link rapid road or railway traffic by a floating bridge system. The 2 terminals at Chandbali enables local passenger and two-wheeler crossing and along shore movement of tourists. The terminal at Aradi aims at long shore movement from and to Chandbali. Since only minimum facilities are planned, the amenities provided at all the terminals proposed are typically same, as no further deletion of any component can be done, nor addition of any new facility is justifiable based on the traffic forecasts.

Considering the conclusions of the traffic study, there is no cargo potential along the river. But once the river is developed, popping up of an industrial cluster along the river can be expected. Hence in future the cargo terminals may be planned. The codes referred for arriving at the preliminary design of the structure includes IS 456, 875/3, 4651(I to IV), BS 6349-6-1989, etc.

6.4.1. Berthing structure

The floating pontoon structure is suggested based on the provisions of BS 6349-6-1989, section 4. A detailed drawing with dimension and section is attached with drawings in Vol. II. The vessel size adopted for designing the berthing structure is of LOA 32m, 5m beam and 1m draft. Based on the vessel size and requirement, it is proposed to have a quay of length 8m and width 2m. The up and down movement is facilitated by two hollow pipes of around 10cm diameter of Fy 250 Mpa structural steel and bolted to the pontoon and hinged to the pedestal on land. The pedestals are founded on open footings.

6.4.2. Trestle

The trestle is proposed to be of steel box or tube sections. The live load considered for design is 5kN/sq. m. The trestle is intended to carry passenger and limited two-wheeler traffic alone. The trestle is supported to the quay and hinged to a pedestal on the land.

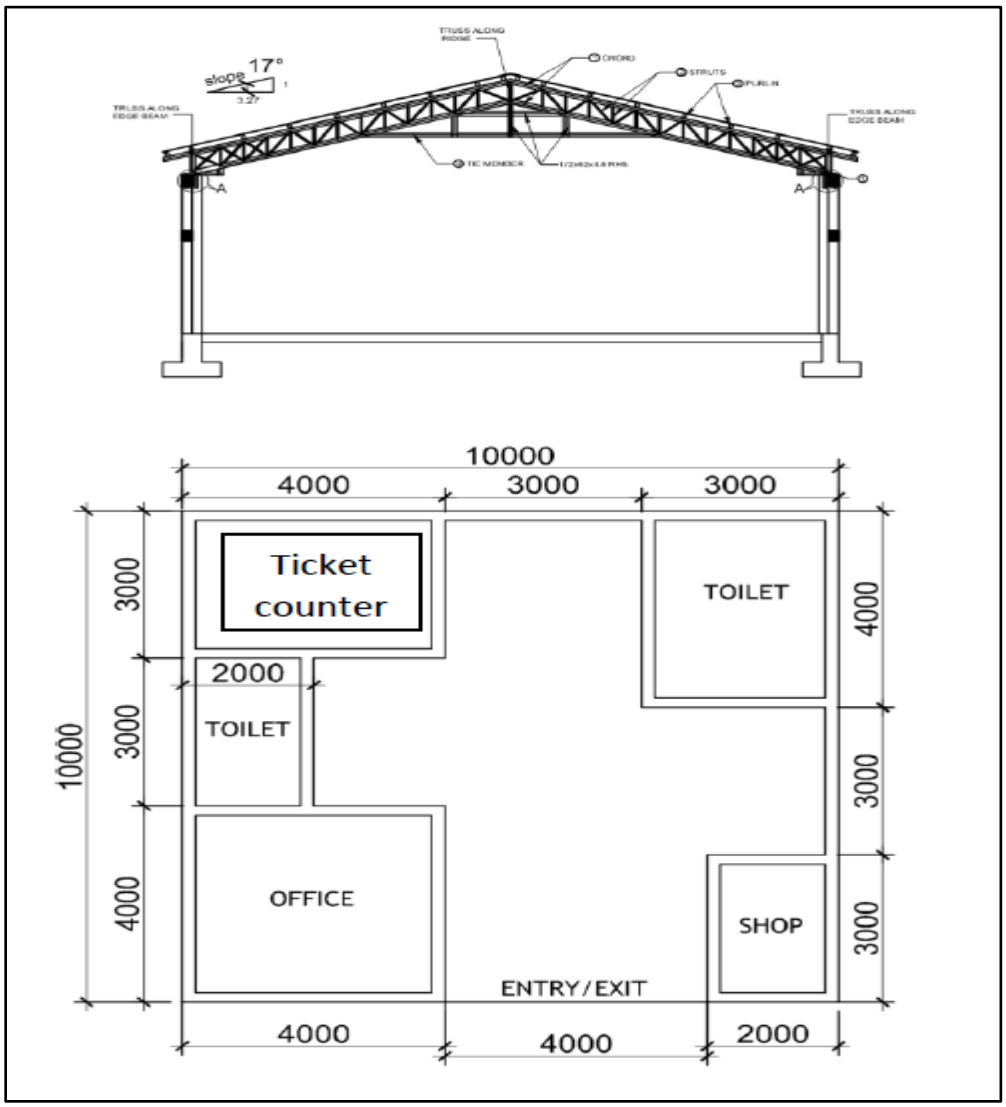
6.4.3. Mooring points and piles

At least 6 mooring points, equally spaced along the quay shall be provided to safely keep the varying size of vessels during boarding and alight of passengers. Apart from this it is proposed to have mooring piles of locally available wooden logs placed behind the berthing quay for use in emergency conditions like cyclones or severe winds, where tying to the pontoon alone may not help due to severe turbulence in air and water.

6.4.4. Terminal building:

A building to accommodate ticket counters, public services like police and passenger amenities is planned as shown in the below figure. A live load of 5kN/ sq.m. is considered for the design. It is proposed to be a trussed structure with open footing for the time being which may be converted to framed multi story building in future as and how required. The detailed drawing is enclosed as Vol. II.

Figure 6.3: Proposed terminal building elevation and plan



6.5. Construction Schedule

In the present project, it is proposed to have a floating jetty terminal for passenger movement. In case of concrete pontoon construction, maximum utilization is to be made of prefabrication using precast slabs and shells. Typically, joints are cast in place, to ensure full continuity of reinforcing steel and to permit splicing of ducts. Segmental construction methods can be utilized. A base slab is laid or cast on a carefully screened crushed rock under base to permit later flooding to penetrate entirely under the rock. This also permits attachment of any fittings that must protrude below the hull proper. Drainpipe is placed in the rock under base. Interior wall segments if any are usually precast concrete

slabs, tilted up using tilt-up building technology, and joined, usually at the juncture of four wall slabs. The steel trestle access bridge proposed is articulated to accommodate the movement of the quay structure.

The sequence of construction activities for shall be as mentioned below:

l). Dredging and site clearance for embankment protection works, terminal building, cut-offs at regions of severe meandering.
m). Temporary works for piling for construction of abutment for supporting the trestle and sub structure of the terminal buildings.
n). In-situ casting and installation of piles and open footing for terminal buildings.
o). Construction of floating pontoon in land or protected water (parallel activity).
p). Land based fabrication of steel trestle and truss for terminal building (parallel activity).
q). In-situ casting and installation of pile muff for the support of the trestle.
r). Construction of terminal buildings superstructure.
s). Installation of truss for terminal building and the steel trestle access.
t). Demarcating the channel and fixing aids to navigation (parallel activity).
u). Laying the road networks and installing other infrastructure amenities (water, light, etc.).
v). Installation of floating pontoon with anchors tied to precast and placed dead weights for guiding the movement.

A detailed construction scheduled is appended as Annexure II, at the end of this report

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7. VESSEL DESIGN

7.1. General Review

A logical decision must be made about the vessels to be permitted in the water way so that the expected performance of the water way can be ensured. The proposed characteristics of the vessel is arrived at considering the cargo to be handled, forecasted traffic data, river regime, etc. From the traffic study, around 1.9 lakh tourist visited Chandbali in the year 2015 and Chandbali being a developed town invites local people also. Thus, it seems like the major traffic is passenger and no cargo traffic reported for the near future. Hence the type vessels required is passenger vessels and water sport vessels. The Waterway is working only for 5-6 Months in a year as well as the use of waterway shall be only for a few Vessels. Therefore, extensive arrangements including the facility of collection for Pollutants generated onboard vessels are not recommended. However, Syntax tank provision for collecting the pollutants is shown in the Typical masterplan of the proposed terminal End of this chapter

Internal toilet is proposed in the terminal buildings. The provision for soak pit, septic tank and the RWH shall provide. Refer DWG No. FIPL/IWAI/10.

7.2. Design Basis

The vessel dimensions are arrived at primarily based on the horizontal and vertical dimensions of the water way under consideration. The design also considers the safety aspects while manoeuvring in the shallow waters and the availability of local resources. The vessel dimensions applicable to the considered channel specifications can be arrived based on the 'The Inland Waterways Authority of India Act 1985'. The basis of the design is limited depth of the waterway of 1.2m, bottom width 30m, top width 42m and turning radius limit of 300m. A suitable vessel size is arrived considering the provisions of the IWAI Act 1985, existing vessels used in similar situations, limitation of the channel dimensions, available traffic, etc.

7.3. Type of proposed Vessels

The purpose here is mainly to cater passengers and explore the potential for tourism in the region. It is proposed to have low draft, self-propelled vessels country boat type for movement of passengers and water sport vessel.

7.4. Proposed Vessel Size and Specifications

The size of vessel is related to channel width and depth of waterway available for navigation. The maximum beam of design vessel is limited to1/5th of the width of navigable water and its length is assumed between 4 to 8 times the vessel's beam. Being a protected water, no natural severe wave action is expected, also due to low speed of the vessel owing to soft bed and bank materials, the under-keel clearance can be limited to some10% of max draft. It is, however, important to note one limitation on vessel length viz. that the length of vessel on water-line (LWL) should be less than the width of the channel. With the option of Class being I, the bottom width requirement is 30m and 1.2m minimum depth, a vessel size of 5m moulded breadth 32m LOA and a loaded draft of 1m is proposed based on 'IWAI Act 1985'. The carrying capacity is around 100DWT and is of self-propelled type. In this manner, the following dimensions of the various types of vessels are permissible under the present project:

Table 7.1: Proposed vessel dimensions

Type	LOA (m)	Beam (m)	Draft (m)
Country boat	5-10	1.25-2.5	0.8 – 1.0
Water Sport	10-15	3 - 5	1

7.5. Turnaround Time

It is the length of the time between arriving at a terminal, unloading and loading the passenger and cargo, refuelling, etc. and being set to depart from that point. Apart from the actual time for loading/ unloading cargo, additional time is required for other activities such as berthing and de-berthing, waiting for clearance for navigation etc. Since the top width of the channel is only 42m, it has to be assumed that the design vessel of 32mLOA

is likely to require dolphin support to turn around. Smaller vessels can turn self-propelled. Hence, it has to be assumed that the largest vessel will take around 10 minutes for tuning and aligning in position parallel to the berth. A berthing and de-berthing time each of 10 minutes is proposed. With a 5minutes margin time for halt, a total of average 30 minutes/ vessel is proposed.

7.6. Number of Vessel Required

The number vessels are based on the expected tourist potential to be handled. It is proposed to have Chandbali northern bank as a major location using the existing facilities and to have the vessels there participating private operators. It is proposed to have a minimum of 2 vessels of country boat category for crossing at Chandbali, 3 boats for along the shore movement from terminals to terminals and up to Dhamra river confluence. Two vessels are proposed for water sport. Apart from this it is proposed to have boat operators engaged such that they can have vessels at any terminal location as and when the traffic booms up. The existing boats plying in the region can be made use of.

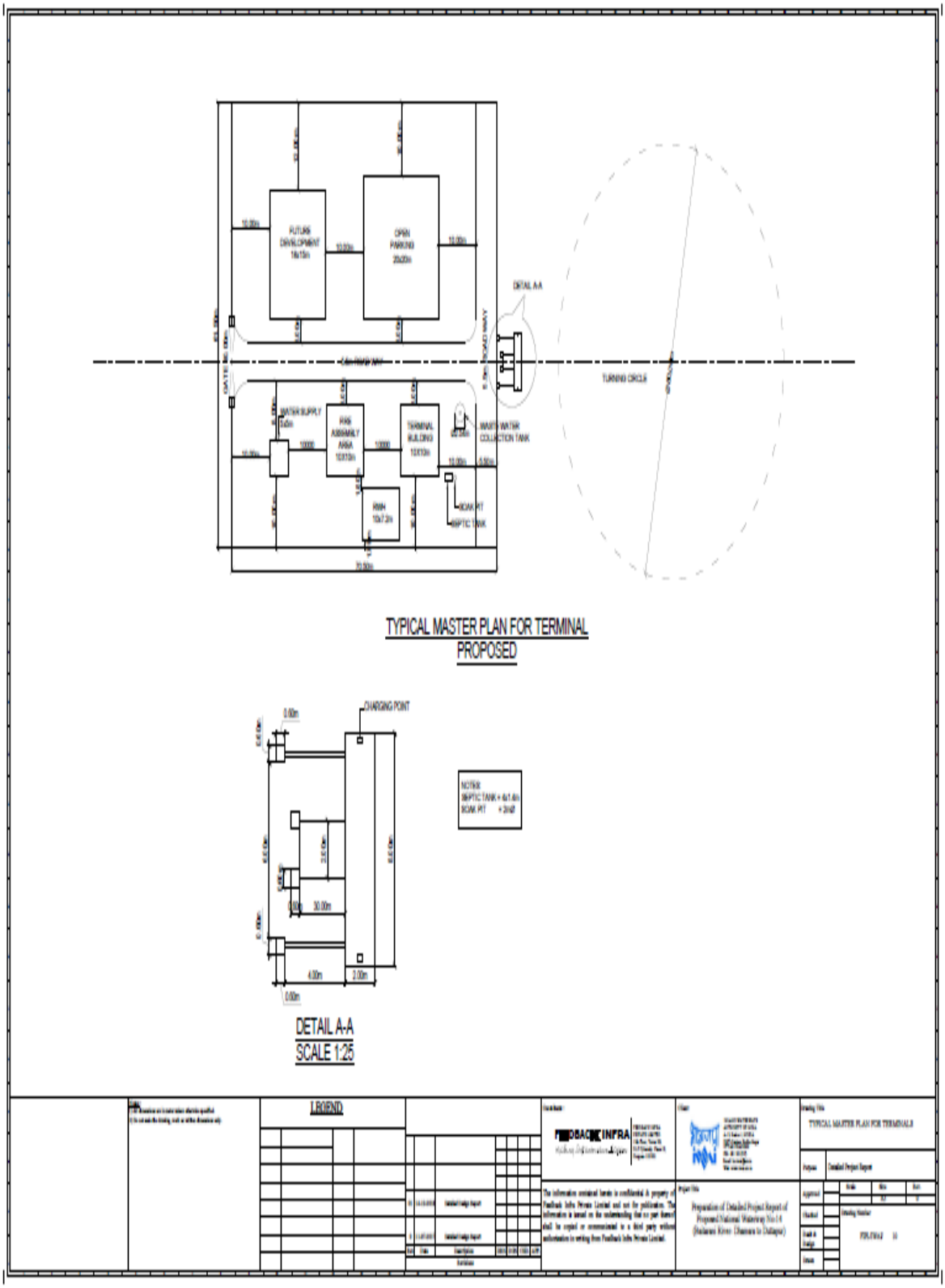
7.7. Vessel Costing

7.7.1. Capital Cost

It is proposed to have private parties engaged for operating the boats. The costing worked out for inland waterway boats of country boat type based on a rule of thumb is around 6 lakhs per boat.

7.7.2. O&M Cost

Operation and maintenance cost are to taken care of by the private operators. 10 % of initial cost is considered as the annual operational and maintenance cost per vessel.


FUTURE DEVELOPMENT 16x15m
OPEN PARKING 25x20m
DETAIL A-A
TURNING CIRCLE
WATER SUPPLY
RMU ASSEMBLY AREA
TERMINAL BUILDING
WASTE WATER COLLECTION TANK
RMH
SOAK PIT
SEPTIC TANK
TYPICAL MASTER PLAN FOR TERMINAL
PROPOSED
CHARGING POINT
NOTE:
SEPTIC TANK = 4x1.4m
SOAK PIT = 2nos
30.00m
4.00m
2.00m
DETAIL A-A
SCALE 1:25
LEGEND
TYPICAL MASTER PLAN FOR TERMINALS
Preparation of Detailed Project Report of Proposed National Waterway No-14 (Baitarani River: Dhamara to Jadhapur)

8. NAVIGATION AND COMMUNICATION SYSTEM

8.1. General Requirements

To ensure the safety of vessels and cargo and to have an uninterrupted telecommunication between the different agencies involved in the terminal operation, in both land and waterside, the communication facilities play a major role. This chapter also includes the requirement of dedicated trained staff for operating the communication facilities.

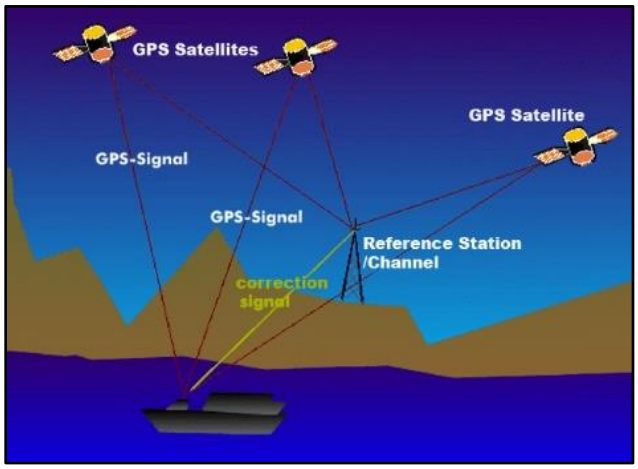
Communication station (Base Station + Control Station) are proposed to be established at Chandbali as shown in the map below. As the communication station is effective within a radius of 25 km, it would be sufficient to cover the entire stretch of recommended waterway development (27.2 km). Moreover, the **navigation and communication network of NW-14, can also be integrated with the NW-64 (Mahanadi-Luna).** This would not only help in information collection and analysis, but also realize potential savings in RIS software and equipment. However, for the purpose of this DPR, we have considered cost of NW-14 Communication Infrastructure on stand-alone basis.

8.1.1. DGPS

DGPS (Differential Global Positioning System) – It is an enhancement over convention GPS system and provides much accurate location (within 10 cm) as compared to conventional GPS (10-15 meters). All the vessels operating in this water way is proposed to be DGPS based.

The DGPS system can be installed at the Chandbali station, along with system components - beacon station with 100W radio modem, transmission antennae, back up battery, etc. DGPS receivers would also be installed on the waterway vessels. However, as the DGPS system has a range of ~150 km, the same facility installed in NW-64 can be used for NW-14 as well, thus optimizing on cost through common infrastructure. The system has and would easily cover the entire subject waterway stretch.

Figure 8.1: Line diagram showing the principle of DGPS



8.1.2. River Information Service (RIS)

River Information Service (RIS) system is one among the latest technology introduced in Inland Water Transport. In the RIS system, a group of internet base stations are located at 50-60Kms intervals. These base stations will have 30 kms (approx.) radial coverage and two-way communication between vessels and base stations. RIS helps in avoiding navigational risks (ship to ship collision, ship to bridge collisions and vessel groundings). It also provides fairway information, traffic information, calamity abatement support etc.

RIS System includes the following major components –

- **VHF (Very High Frequency)** – VHF, also known as Maritime Mobile Band, refers to the radio frequency range between 156.0 and 174 MHz It enables the vessel crew to communicate with other vessels and shore station (e.g. ports, locks, bridges and marinas) on operational, navigation and safety matters, as well as calling for help in an emergency.
- **Automatic Identification Systems (AIS)** – AIS systems provide automated vessel tracking, with help of AIS transponders installed on the barges / vessels. It also helps in identification of navigational marks.
- **Meteorological station** / Weather Monitoring and Forecast System – Meteorological sensors would be required for weather data collection, weather forecasting and providing early warnings to take timely precautions. Thus, it is suggested to also include a weather forecast receiving system and warning systems within the RIS framework to take timely precautions.
- **Radar** – While the radar system further supplements tracking of waterway vessels, installation of such radar is cost intensive. Hence it is suggested that radars may be **considered at a later stage,** with sufficient build-up of waterway traffic. Further, Terma radar would be suitable given their superlative accuracy, range and overall performance.

The installation of RIS system would involve setting up of Base Station cum Control Station at Chandbali, as per the framework suggested below –

- **Control Station** - The control station carries out all standing orders and collect the data of cargo/vessel movement and keep back up for analysis and further improvement of efficiency. Setting up control station includes Central Servers (for AIS data record), WEB Servers (for Web interface), RIS software, and Operator Workstations. Operators have comprehensive tabular information about traffic, wide variety of navigational alarms, traffic management tools like zones, reporting lines, routes, traffic prediction tools, control of AIS base stations. The entire system is completely IP based. Periskal software is suggested for RIS, given their wide

experience in European Waterways. Note that the software cost can be merged with development of NW-64.

- **Base Station** – A series of sensors are deployed at base stations for exchange of information (such as navigable depth, channel limits with virtual buoys, terminal facilities, port clearance etc.) between the control station and the vessels. Two porta cabins would be provided at the station. Following equipment, as explained above, would be installed at base station –
    - **Automatic Identification Systems (AIS) Transponders x 2**
    - **Meteorological Station**
    - **VHF**
    - **Power back-up –** Gen-Set 10 KVA, UPS 5 KVA
    - **Monopole Tower** of 30 m height is recommended for providing coverage for 20-25 km radius. This would be coupled with 6 m pole on vessels and AIS Transponders (Inland Class -A).

Coverage Chart for various height of Mast and Vessel Antenna

Vessel Antenna Ht (in m)	Coverage $=(12.746 \times \text{height})^{1/2}$ (in Kms)	Base station Mast Ht (in m)	Coverage $=(12.746 \times \text{height})^{1/2}$ (in Kms)	AIS/VHF Range for various height of vessel antenna height (M)										
				0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1	3.57	10	11.29	11.3	14.9	16.3	17.5	18.4	19.3	20.0	20.7	21.4	22.0	22.6
2	5.05	20	15.97	16.0	19.5	21.0	22.1	23.1	23.9	24.7	25.4	26.1	26.7	27.3
3	6.18	30	19.55	19.6	23.1	24.6	25.7	26.7	27.5	28.3	29.0	29.7	30.3	30.8
4	7.14	40	22.58	22.6	26.1	27.6	28.8	29.7	30.6	31.3	32.0	32.7	33.3	33.9
5	7.98	50	25.24	25.2	28.8	30.3	31.4	32.4	33.2	34.0	34.7	35.3	36.0	36.5
6	8.75	60	27.65	27.7	31.2	32.7	33.8	34.8	35.6	36.4	37.1	37.8	38.4	38.9
7	9.45	70	29.87	29.9	33.4	34.9	36.1	37.0	37.9	38.6	39.3	40.0	40.6	41.2
8	10.10	80	31.93	31.9	35.5	37.0	38.1	39.1	39.9	40.7	41.4	42.0	42.6	43.2
9	10.71	90	33.87	33.9	37.4	38.9	40.1	41.0	41.9	42.6	43.3	44.0	44.6	45.2
10	11.29	100	35.70	35.7	39.3	40.8	41.9	42.8	43.7	44.4	45.1	45.8	46.4	47.0

The installation of required equipment can be undertaken at the Chandbali terminal itself. Hence, there is no requirement of a separate land area for installation of communication equipment.

8.1.3. Survey equipment

The following survey equipment is recommended to aid the RIS network and DGPS System. The survey equipment would aid in periodic surveys to ensure the safe navigability of the channels.

- **1 Total Station** - Total station is a combination of electromagnetic distance measuring instrument and electronic theodolite. It is used to measure horizontal and vertical angles as well as sloping distance of object to the instrument.
- **1 Auto-Level** – Used in conjunction with levelling staff, the instrument is used for height and levelling measurements
- **1 Echo-sounder** – They are used to measure depth. They may be either single-beam (SBES) or multi-beam type. A side scan sonar system used in conjunction with the eco-sounder enable to have a complete seabed in sonification for small target detection.
- **1 Current Meter** – Required for flow measurement
- **1 Hypack software** – Hydrographic survey software for data collection, terrain imaging
- **1 Automatic Tide Gauge (ATG)** – Required for measuring change in sea level relative to vertical datum
- **1 DGPS Receiver** – Required for on-site / survey team
- **1 PC and 1 Workstation** - Required for on-site / survey team

Figure 8.2: Total station survey

Figure 8.3: Dumpy level and Telescopic Staff

Figure 8.2: Typical figure showing conduct of eco sounding

8.2. Existing System

No system exists.

8.3. Additional requirement

The above said systems are very essential for a properly established terminal and waterway system. No additional navigation and communication system is proposed.

8.4. Costing

8.4.1.1. Capital Cost

The cost for the navigation and communication systems proposed are given in the table below.

Table 8.1: Summary of capital cost required for navigation and communication system

Sr. No.	Equipment	Qty	Unit Price	Total
Base Station, Control Station				
1	AIS Base Station	2	30,00,000	60,00,000
2	Meteorological Sensor	1	8,00,000	8,00,000
3	ATG	1	11,00,000	11,00,000
4	VHF	1	5,00,000	5,00,000
5	DG Set 10 KVA	1	7,00,000	7,00,000
6	UPS	2	5,00,000	10,00,000

7	RIS Software	-	-	-
8	RIS Hardware	1	60,00,000	60,00,000
9	Installation Testing & Commissioning	1	20,00,000	20,00,000
10	Porta cabin	2	12,00,000	24,00,000
11	Monopole Tower	1	7,50,000	7,50,000
Survey Equipment & Software				
12	Total Station	1	8,50,000	8,50,000
13	Auto-Level	1	30,000	30,000
14	Echo-Sounder	1	11,20,000	11,20,000
15	DGPS Receiver	1	2,50,000	2,50,000
16	Hypack Software	1	8,00,000	8,00,000
17	Current Gauge	1	50,000	50,000
18	1 PC and Workstation	1	80,000	80,000
			Total	**2,44,30,000**

8.4.2. O&M Cost

Operation and maintenance cost are ~**5% of the installation cost**. As **Chandbali would double as Base cum Control station**, it would require 1 Engineer, 2 operators and 2 security staff. The security personnel requirement can be accommodated with staffing proposed in Institutional Requirements. The operated should be IALA trained and can be effectively utilized for ensuring proper running of RIS system and other equipment. If required, operations of base and control stations can be outsourced through comprehensive AMAC contracts.

Table 8.3: Manpower Requirement for Operations of Communication and Navigation Equipment

Sr. No.	Description	CTC (INR lakh)	Staffing Requirement	Total Cost (INR lakh)
1	Engineer	4.8	1	4.8
2	Operator	3.0	2	6.0

9. ENVIRONMENTAL AND SOCIAL ASPECTS

9.1. Objective of Environmental and Social Studies

The development of any infrastructure project causes various environmental and social impacts during different stages of its implementation. The objective of this study focuses on assessment of associated environmental and social impacts (for all its offshore as well as onshore components), during designing, construction as well as operational stages of proposed waterways project.

Main objective of the project is given below

- Baselines assessment
- Assessment of impacts
- Development of mitigation plan
- Development of monitoring plans
- To have a check on successful implementation of mitigations measures.
- Institutional mechanism is also designed to ensure an effective implementation of proposed EMP.

This chapter also covers some important points as mentioned in Environment Impact Assessment Guidance Manual of MoEF & CC guidelines for carrying out such Environment and Social studies.

9.1.1. Project Stretch

Baitarni River originates from the Gonasika / Guptaganga (Cow Nose Shaped) hills of Keonjhar district. The river traverses a total distance of 360 kms before meeting Dhamri River. Total length of Baitarni River under project scope is 48 km. The project stretch starts near to Duttapur Village at Latitude 20°51′44.16″N & Longitude 86°33'30.45"E and ends at confluence point of Baitarni and Dhamra River near Laxmiprasad Dia at Latitude 20°45'13.32"N, Longitude 86°49'15.36"E. Figure 9.1 below presents the extend of project stretch under study, whereas, basin map of Baitarni River is shown as Figure 9.2. Project stretch of Baitarni River under study is forming natural common boundary of Bhadrak, Kendrapara and Jaipur Districts.

Figure 9-1: Baitarani River Stretch Under Study

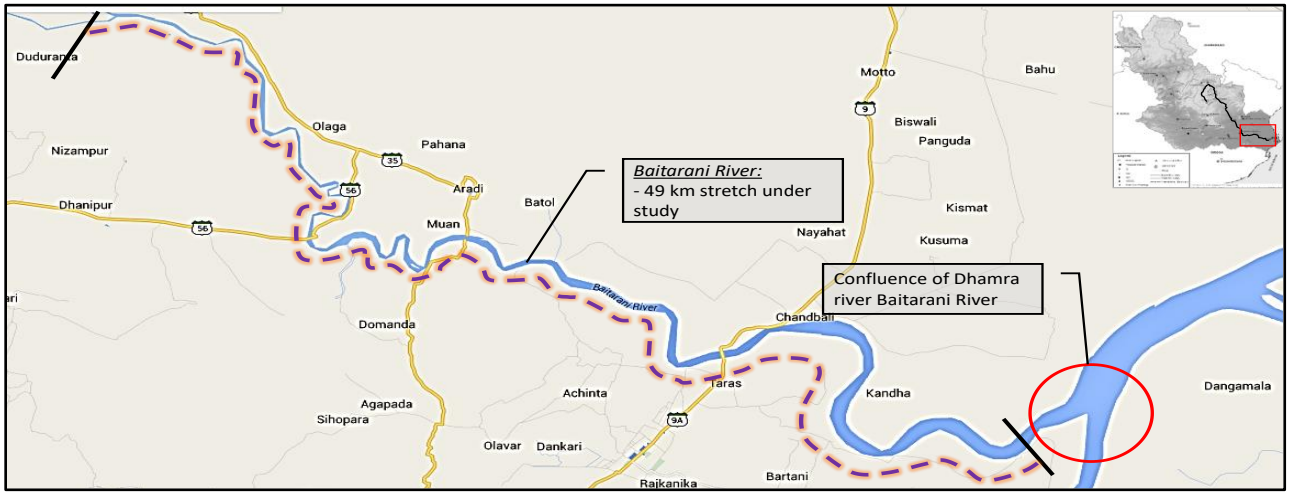
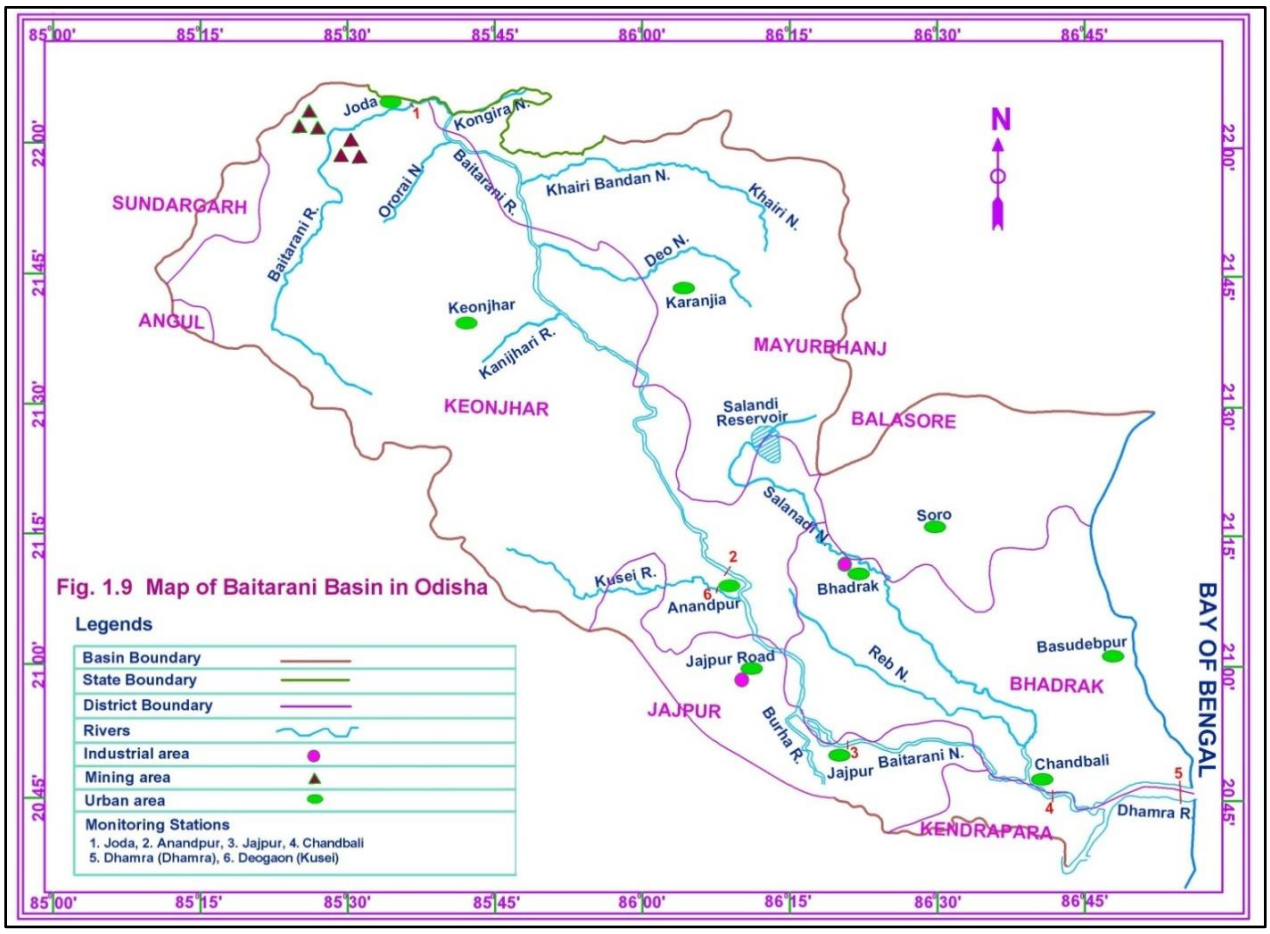


Figure 9-2: Map of Baitarani Basin of Odisha



Source: Odisha State Pollution Control Board

9.2. Environmental Setting in the Project Area

Baitarni River is in the North-East part of Odisha. The scope of present study is limited for 48 km of Baitarani River stretch. Single line bathymetry / topography survey was carried out from 10th February 2016 to 13th February 2016 for assessment of topographical features of the River.

Based on analysis of Forest Map available at GIS Website of Odisha (http://gis.ori.nic.in/) developed and run by NIC, no forest land is located alongside the project river stretch.

Bhitarkanika Wildlife sanctuary is located adjacent to end of river stretches under study. Baitarani River was found to have a total 6 nos. cross structures. During survey, a lot of island formations were observed along the river stretches, mainly of sand. Baitarni river is flowing from North to South and crosses various settlements along the proposed waterways.

9.3. Physiography

Based on homogeneity, continuity and physiographical characteristics, Odisha has been divided into five major morphological regions:

- The Odisha Coastal Plain in the east,
- The Middle Mountainous and Highlands Region,
- The Central plateaus,
- The western rolling uplands and
- The major flood plains

1. **The Odisha Coastal Plains** are the depositional landforms of recent origin and geologically belong to the post-tertiary period.
   This region is the combination of several deltas of varied sizes and shapes formed by the major rivers of Odisha, such as the Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, the Mahanadi, and the Rushikulya. Therefore, the coastal plain of Odisha is called the "Hex deltaic region". Project river stretch is the part of the Odisha Coastal Plains morphology.

2. **Middle Mountainous and Highlands Region** covers about three-fourth of the entire State. Geologically it is a part of the Indian Peninsula which as a part of the ancient landmass of the Gondwanaland. The major rivers of Odisha with their tributaries have cut deep and narrow valleys. This region mostly comprises the hills and mountains of the Eastern Ghats which rise abruptly and steeply in the east and slope gently to a dissected plateau in the west running from north-east (Mayurbhanj) to north-west (Malkangirig).
3. **The Central plateaus** are mostly eroded plateaus forming the western slopes of the Eastern Ghats. The Panposh - Keonjhar -Pallahara plateau comprises the Upper Baitarani catchment basin.
4. **The western rolling Uplands** are lower in elevation than the plateaus having heights varying from 153 metres to 305 metres.
5. **Major Flood Plains** are in the southern part of the Odisha state.

9.4. Geology and Seismicity

9.4.1. Geology

The State of Odisha exposes rocks ranging in age from Meso Archaean to Recent. The geographic distributions of the major Precambrian litho-tectonic domains are:

Eastern Indian Craton (North Odisha Craton) and Singhbhum - Gangapur Odisha Mobile Belt, Mobile Belt	Northern and North-western
Part of Bastar Craton	Western Odisha
Part Eastern Ghats Mobile Belt (EGMB)	Central and Southern Odisha

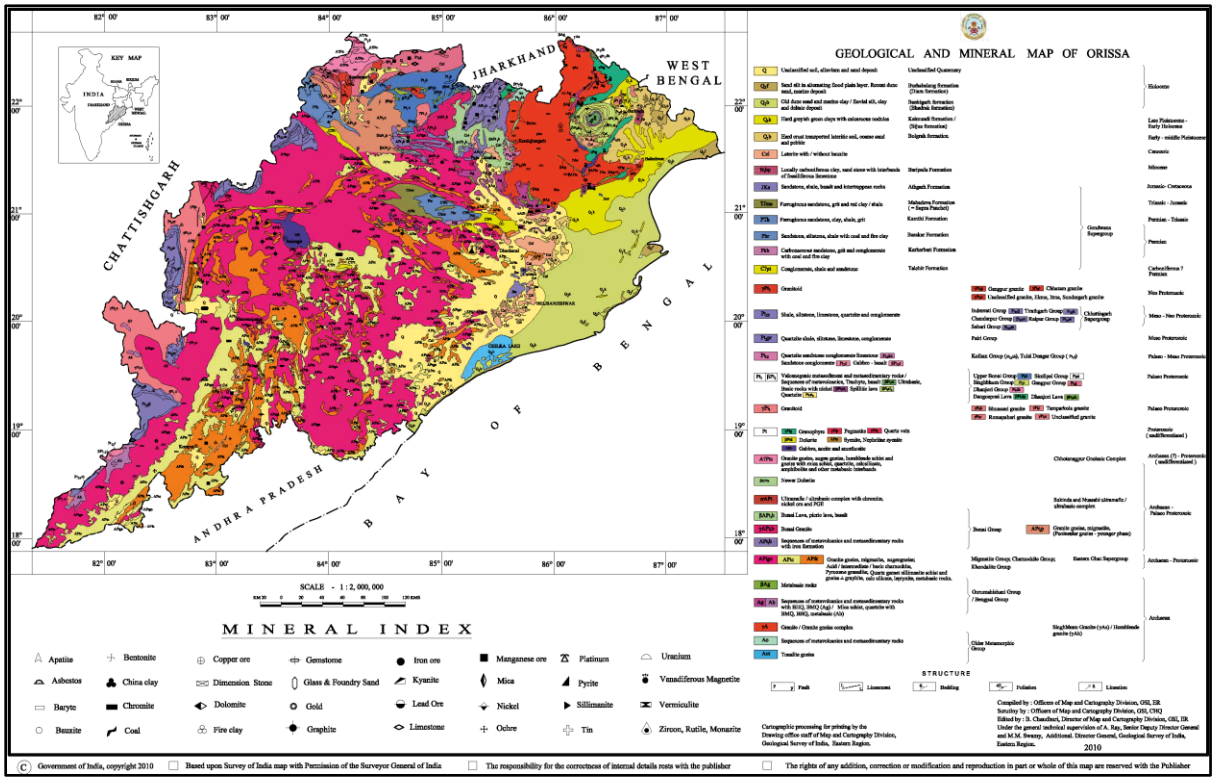
Odisha, situated on the eastern seaboard of India is one of the gifted parts of the world, where a gamut of mineral resources exists in bounty. The state is endowed with large reserves of bauxite, china clay, chromite, coal, dolomite, fireclay, graphite, gemstones, iron ore, limestone, manganese ore, mineral sand, nickel ore, pyrophyllite and quartz. Recent discovery of diamond in the Dharambandha area of Nuapada district by the State

Directorate of Geology has added a coloured feather in the cap of the state. Other minerals of the state include copper ore, lead ore, titanium bearing veneniferous magnetite, talc/soap stone and high magnesia igneous rocks. Recent boom of the mineral industry has turned the state into a hotspot, with entrepreneurs from all over the world crowding for their share of fortune.

The rich mineral wealth of the state is attributed to its favourable geological set-up. Situated on the eastern fringe of the peninsular India, Odisha has about 72.5% of the area occupied by Precambrian metamorphic rocks (of Archaean and Proterozoic age) which host most of the minerals. The Gondwanan hosting the coal resources occur over about 8% of the land mass. The Tertiary and Quaternary formations, occupying rest of the area, provide avenues for aluminous / nickel ferrous laterite and heavy minerals (in beach sand).

Geological and Mineral map of Odisha is given below.

Figure 9-3: Geological Map of Odisha



Source: Geological Survey of India

The project districts can broadly be divided into four distinct geomorphic units

(1) Tidal flat
(2) Coastal plain
(3) Alluvial plain
(4) Flood plain.

The fine sediments carried by the rivers get deposited along the coast because of tidal action, as tidal flat / mud flat. The width of this tidal flat varies from 2 to 5 km.

The coastal plain is a gently sloping plain occurring parallel to the coast and mainly formed by Flavio–marine action and is intersected by network of creeks, which are mainly saline due to tidal action. The area is marshy with shrubby vegetation. The width of this coastal plain varies from 5 to 25 km. The coastal plain encompasses a series of beach ridges characterized by sand dunes of varied relief and extends for kilometres, almost parallel to the coast.

The gently sloping alluvial plain occurs to the west of the coastal plain and forms the most fertile part of the district. The alluvial plain can be further divided into two i.e. (i) Older alluvial plain (ii) Younger alluvial plain

9.4.2. Seismicity

Odisha has witnessed earthquakes in the past. Though seismic zone II and III are under moderate and low risk, the Mahanadi basin can be vulnerable as it is not a passive plate and can cause earthquakes.

9.5. Climate

Odisha State is divided in 10 Agro-climatic zones and average annual rainfall ranges from 1421 mm to 1648 mm. Details of Agro-climatic Zone along with average rainfall is given in Table below and shown in Figure. As per agro-climatic classification, project region is under North-Eastern and South-Eastern Coastal plain.

Table 9-1: Agro-climatic Zone of Odisha

S. No.	Agro-Climatic Zone	Climate	Mean Annual Rainfall (mm)	Soil group
1	North Western Plateau	Hot & Moist	1648	Red & Yellow
2	North Central Plateau	Hot & Moist	1535	Red loamy
3	North Eastern coastal plateau	Hot & moist sub-humid	1568	Alluvial
4	East & South-Eastern Plateau	Hot & humid	1449	Coastal alluvial saline
5	North Eastern Ghat	Hot & moist Sub-humid	1597	Laterite and brown forest
6	Eastern Ghat high land	Warm & humid	1522	Red
7	South Eastern Ghat	Warm & humid	1522	Red, mixed red and yellow
8	Western undulating	Warm & moist	1527	Black, mixed red & black
9	West Central table land	Hot & moist	1527	Red, heavy textured colour
10	Mid Central table land	Hot & dry sub-humid	1421	Red loamy, laterite mixed red & black

Source: NDIM Odisha

Figure 9-4: Agro-Climatic Zone of Odisha

Source: NDIM Odisha

Project districts are characterized by tropical monsoon climate having three distinct seasons in the year, viz. winter, summer and rainy seasons. The Bay of Bengal, which forms the eastern boundary of the districts, plays a prominent role in controlling the climate of the districts.

The winter commences from late November and continues till end of February. The winter is followed by the summer season, which extends up to mid-June. During the period between April and May 3 to 4 cyclonic storms accompanied with rains generally occur in the district. The rainy season sets-in at the advent of the southwest monsoon, generally from the middle of June and continues till end of September.

Chandbali is the nearest Indian Meteorological Dept. (IMD) observatory located adjacent to Baitarni River. Thirty (30) years IMD data since year 1981 to year 2010 was collected to assess the baseline meteorological status of the project region. The summary of meteorology is presented in Table below.

Table 9-2: Summary of Micro – meteorology (1981 – 2010)

S. No.	Month	Temperature (°C) Avg. Monthly		Avg. Humidity (%)		Avg. Monthly Rainfall (mm)	Pre-dominant Wind Direction	Avg. Wind Speed (kmph)
		Minimum	Maximum	Morning	Evening			
1	January	10.2	32.0	77	65	11.1	N & NE	1.7
2	February	13.3	35.3	78	65	30.5	SE & S	2.0
3	March	17.6	39.0	77	63	36.1	S & SE	3.7
4	April	20.1	40.9	74	65	43.9	S & SE	5.1
5	May	20.7	41.3	75	70	101.4	S	5.4
6	June	21.7	39.9	80	77	242.6	S & SW	4.2
7	July	22.8	36.5	84	80	258.6	S & SW	3.7
8	August	22.8	35.1	85	82	358.6	S & SE	3.5
9	September	22.8	35.4	84	82	262.5	S	2.8
10	October	19.8	34.8	81	79	206.0	N & S	1.9
11	November	13.9	33.2	77	72	54.4	N	1.7
12	December	11.1	31.1	76	67	6.1	N & NE	1.7
Annual Average				**79**	**72**	**1611.9**		**3.1**

Source: Climatological Normal (1981-2000)

The average monthly lowest and the highest temperatures (1980-2010) are 10.2°C and 41.3°C respectively. The normal average annual rainfall is 1611.9 mm (1980 – 2010) and out of which 1328.3 mm is monsoon rainfall.

The mean annual wind velocity at Chandbali (IMD observatory) is 3.1 kmph. The wind speed during cyclonic storms becomes very high and ranges from 70 to 100 kmph or even more. Major direction of wind is from south and south-west. The relative humidity,

on an average, varies from 72 to 79% during the year and during monsoon it is much more. The detailed monthly average long-term climatological table is attached as **Enclosure I**.

9.6. Soils

Three types of soils, viz. Alfisols, Aridisols and Entisols occur in the project districts.

9.6.1. Alfisols

These include deltaic and older alluvial soils. The deltaic soils are found along the course of Baitarani River while the older alluvial soils occur in the extreme north-western part. The deltaic alluvial soils are generally deficient in phosphate (P2O5) and nitrogen (N). Both the total and available potassium (K2O) are adequate and pH varies between 6.5 and 7.3.

9.6.2. Aridisols

These are saline and saline alkali soils, occurring along the coastal area and are rich in calcium, magnesium and consist of half decomposed organic matter.

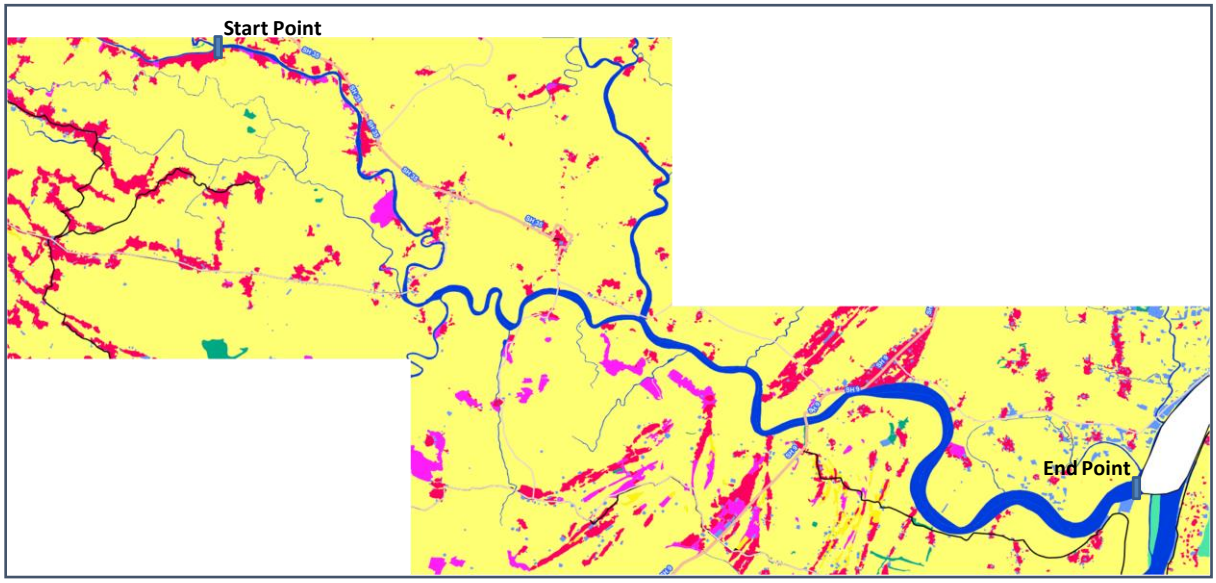
9.6.3. Entisols

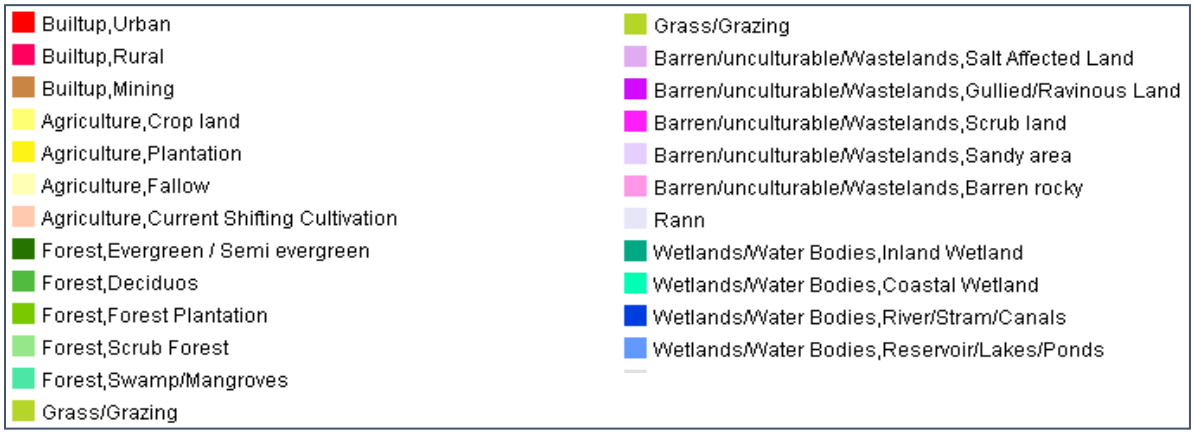
These soils include coastal alluvial soils, which are deficient in nitrogen, phosphoric acid and humus, but not in potash and lime. The soil texture varies from loam to clayey loam. It is alkaline in nature and the most fertile soil in the area.

9.7. Land Use Pattern

Most of the land along the proposed project is Agriculture, then settlement and Barren. Land use pattern of the project area is given below.

Figure 9-5: Land Use Map of Project Region





9.8. Ambient Air Quality

State Pollution Control Board (SPCB) is continuously monitoring the ambient air quality three locations in Cuttack City. The distance of Cuttack City is about 85km from the project river stretch. The details of ambient air quality as monitored by SPCB are given in Table below.

Table 9-3: Ambient Air Quality Status in Cuttack Area

Location	PM10 (µg/m^3)	PM2.5 (µg/m^3)
Traffic Tower Badambadi	98	60
R.O. Building, Surya Vihar	69	60
PHD Office, Barabati	73	53
NAAQ Standards (24 hourly Annual Average)	**100**	**60**

Source: Odisha State Pollution Control Board (OSPCB)

SI. No.	Locations		RSPM	TSPM	SO_2	NO_2	NH3
1	Administrative Building		109.23	211.61	1.729	8.667	1.083
2	Madhuban Pump House		114.93	188.62	1.791	14.099	1.545
3	Brundaban Pump House		136.84	336.27	2.245	35.283	1.838
4	IOHB		202.08	737.85	5.973	57.120	7.716
5	Tippler House		1520.84	5295.13	5.133	21.280	5.351
6	ADB Coal handling Plant		438.74	1788.63	7.000	1.150	7.237
7	Electric Substation-1		972.22	2266.26	4.951	17.016	3.870
8	Marine Site		61.49	136.33	3.652	8.198	2.680
9	Naya Bazaar Pump House		152.03	217.88	0.487	5.841	0.988
10	Atharabanki Gate	Night	512.33	1242.91	3.165	39.930	3.672
		Day	556.18	1736.1	2.138	22.590	2.998

Source: Environmental Pollution Monitoring at Paradip port (PPT/CSIR)

Ambient air quality in Cuttack City is found in compliance to the National Ambient Air Quality Standards. The ambient air quality along the project river stretch shall also be well below the prescribed standards in absence of any major pollution generating source.

No major source of air pollution was observed along the project stretches. Only the transportation system and day to day fuel burning activities in habitats are the source of air pollution in the area. Wind-blown dust from agricultural fields is the pollution source of particulate matter in ambient air.

9.9. Noise Levels

Traffic and small-scale industries alongside the river stretch are the sources of noise pollution in the area. Noise level alongside the river stretch found within acceptable level during site visit.

9.9.1. Kalinganagar

- Latitude & Longitude :20^0 94’ 60” N, 86^0 13’01” E
- Climate/Meteorology: Dry
- Population: 56,946(as per 2011 census)
- Major Land use: Residential & Commercial

Description of monitoring area:

1. Location-A (Residential Zone)-Umapada
2. Location-B (Commercial Zone)-Dhabalagiri Chhak
3. Location-C (Silence Zone)-Inside the premises of CHC, Jajpur road
4. Location-D (Industrial Zone)-Near Tata gate No.3, KNIC, Kalinganagar

NOISE LEVEL, 2015:

Table 9-4: Noise Level in Kalinganagar

NOISE LEVEL DURING DEEPAWALI FESTIVAL, 2015:

Location : A Umapada	Area/ Zone	Normal Day(.5.11.2015)			Deepawali Day(11.11.2015)		
Time duration	Residential	L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr		49.0	94.5	73.2	50.5	93.6	80.0
19:00 to 20:00 Hr		53.8	82.8	67.6	55.2	89.2	62.4
20:00 to 21:00 Hr		52.2	94.5	72.5	58.9	94.8	83.3
21:00 to 22:00 Hr		41.0	73.8	59.1	53.2	91.9	74.1
22:00 to 23:00 Hr		44.0	90.0	77.9	41.0	88.8	61.0
23:00 to 24:00 Hr		39.1	89.5	63.8	42.2	90.2	67.6

Location : B DhabalagiriChhak	Area/ Zone	Normal Day(.5.11.2015)			Deepawali Day(11.11.2015)		
Time duration	Commercial	L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr		49.5	100.6	72.6	57.6	99.5	75.1
19:00 to 20:00 Hr		48.0	102.5	73.7	59.4	93.0	72.1
20:00 to 21:00 Hr		58.6	101.2	76.3	59.7	118.0	87.2
21:00 to 22:00 Hr		47.3	100.9	75.7	56.9	96.7	73.3
22:00 to 23:00 Hr		39.8	81.9	62.2	47.6	100.1	71.1
23:00 to 24:00 Hr		41.6	99.8	72.2	58.4	96.3	74.3

Location : C Inside the premises of CHC, Jajpur road	Area/ Zone	Normal Day(.5.11.2015)			Deepawali Day(11.11.2015)		
Time duration	Silence	L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr		38.6	73.7	53.4	48.6	85.2	61.5
19:00 to 20:00 Hr		37.0	78.1	55.3	50.3	87.3	55.0
20:00 to 21:00 Hr		39.8	85.4	60.9	49.8	85.0	68.0
21:00 to 22:00 Hr		40.6	84.3	58.4	46.8	79.5	57.2
22:00 to 23:00 Hr		36.7	72.3	55.4	40.8	83.2	42.1
23:00 to 24:00 Hr		38.5	77.1	54.3	37.4	84.1	59.3

Location : D Near Tata gate No.3 KNIC, Kalinganagar	Area/ Zone	Normal Day(.5.11.2015)			Deepawali Day(11.11.2015)		
Time duration	Industrial	L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr		44.2	80.2	57.2	47.1	83.6	61.9
19:00 to 20:00 Hr		45.2	78.5	61.2	45.3	79.4	56.4
20:00 to 21:00 Hr		51.2	84.2	59.8	55.9	95.8	79.1
21:00 to 22:00 Hr		52.9	83.5	64.1	54.3	91.2	70.0
22:00 to 23:00 Hr		55.4	82.4	58.4	47.2	75.4	57.3
23:00 to 24:00 Hr		36.2	67.2	47.1	48.8	78.6	54.3

Source: OSPCB

9.9.2. Keonjhar

- Latitude & Longitude :21^0 39.270 N /85^0 36.577 E
- Climate/Meteorology: Dry
- Population: 60,590(as per 2011 census)
- Major land use: Residential& Commercial

Description of monitoring area:

1. Location-A (Residential Zone)-Baniapatchowk
2. Location-B (Commercial Zone) -Punjabi Chowk
3. Location-C (Silence Zone)-Govt. Hospital

Table 9-5: Noise Levels in Keonjhar

Noise Level during Deepawali festival, 2015:

Location : A Baniapatchowk	Area/ Zone	Normal Day (05.11.2015)			Deepawali day (11.11.2015)		
Time duration		L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr	Residential	60.1	88.9	72.9	63.6	89.3	78.3
19:00 to 20:00 Hr		61.4	90.1	77.2	67.1	102.3	83.9
20:00 to 21:00 Hr		59.7	79.6	65.1	68.5	98.7	83.0
21:00 to 22:00 Hr		58.6	82.6	64.8	69.8	103.9	84.2
22:00 to 23:00 Hr		48.3	81.3	53.0	54.5	81.4	59.8
23:00 to 24:00 Hr		49.8	78.3	52.4	57.8	80.6	58.3

Location :B Punjabi Chowk	Area/ Zone	Normal Day (05.11.2015)			Deepawali day (11.11.2015)		
Time duration		L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr	Commercial	61.5	94.2	82.9	65.6	88.3	76.9
19:00 to 20:00 Hr		60.7	86.4	79.7	72.8	101.3	89.3
20:00 to 21:00 Hr		61.2	84.6	72.1	54.6	74.8	60.5
21:00 to 22:00 Hr		62.8	82.4	73.6	68.9	99.6	84.3
22:00 to 23:00 Hr		54.3	78.5	62.8	50.3	69.5	54.0
23:00 to 24:00 Hr		51.3	76.2	59.5	51.8	75.1	59.6

Location : C Govt. Hospital	Area/ Zone	Normal Day (05.11.2015)			Deepawali day (11.11.2015)		
Time duration		L_{min}	L_{max}	Leq dB(A)	L_{min}	L_{max}	Leq dB(A)
18:00 to 19:00 Hr	Silence	57.2	72.5	64.5	61.4	80.6	76.3
19:00 to 20:00 Hr		59.1	76.7	66.9	59.4	78.5	72.6
20:00 to 21:00 Hr		52.8	75.8	56.8	58.5	76.8	71.2
21:00 to 22:00 Hr		48.3	73.2	54.8	51.6	79.5	68.6
22:00 to 23:00 Hr		43.2	70.5	49.4	48.2	63.5	55.5
23:00 to 24:00 Hr		45.1	69.4	48.4	47.1	58.7	52.3

Source: OSPCB

Water Quality

Odisha State Pollution Control Board is continuously monitoring the water quality of Baitarni River in upstream and downstream of Chandbali. The result of water quality analysis as monitored by OSPCB during January to December 2015 is presented in Table below.

Table 9-6: Water Quality of Baitarani River

S. No.	Parameters	Unit	Chandbali U/s Avg Conc. (Min-Max)	Chandbali D/s Avg Conc. (Min-Max)
1	pH		7.8 (7.1-8.2)	7.7 (6.5-8.3)
2	Electrical Conductivity (EC)	µS/cm	6385 (180-16900)	6316 (207-17340)
3	Total Suspended Solids	mg/l	150 (38-759)	167 (45-679)
4	Total Dissolve Solids	mg/l	4729 (106-13010)	4722 (118-13390)
5	Total Hardness	mg/l	878 (48-2350)	926 (52-2400)
6	Total Alkalinity	mg/l	88 (44-192)	91 (54-198)
7	Ammoniacal Nitrogen (NH_4^-N)	mg/l	0.103 (0.056-0.224)	0.149 (0.056-0.728)
8	Free Nitrogen as Ammonia (NH_3^-N)	mg/l	0.004 (0.001-0.007)	0.004 (0-0.011)
9	Total Kjeldahl Nitrogen (TKN)	mg/l	1.38 (0.84-1.96)	1.47 (0.84-2.24)
10	Sodium Absorption Ratio (SAR)		19.16 (0.68-48.68)	18.07 (0.62-46.63)
11	Chloride (Cl-)	mg/l	2414.2 (8.0-7145.2)	2369.5 (15.65-7047.4)
12	Nitrate as NO_3^-	mg/l	3.444 (0.580-7.859)	5.640 (0.753-12.011)
13	Phosphate ($PO_4^{3-}P$)	mg/l	0.144 (0.023-0.734)	0.187 (0.017-0.922)
14	Sulphate (SO_4^-)	mg/l	388.3 (10.3-883.1)	329 (12.0-907.9)

S. No.	Parameters	Unit	Chandbali U/s Avg Conc. (Min-Max)	Chandbali D/s Avg Conc. (Min-Max)
15	Fluoride	mg/l	0.391 (0.230-0.617)	0.392 (0.248-0.566)
16	Boron (B)	mg/l	0.536 (0.010-1.958)	0.620 (0.042-2.185)
17	Iron (Fe)	mg/l	5.373 (1.340-9.100)	4.102 (0.209-9.840)
18	Hexavalent Chromium	mg/l	0.019 (<0.002-0.037)	0.021 (<0.002-0.040)
19	Total Chromium	mg/l	0.054 (0.013-0.094)	0.054 (0.015-0.097)
20	Nickle (Ni)	mg/l	0.026 (0.005-0.082)	0.026 (0.006-0.088)
21	Copper (Cu)	mg/l	0.010 (0.002-0.0-28)	0.010 (0.002-0.028)
22	Zinc (Zn)	mg/l	0.033 (0.003-0.195)	0.033 (0.003-0.201)
23	Cadmium (Cd)	mg/l	0.0034 (0.0007-0.0116)	0.0044 (0.0008-0.0154)
24	Mercury (Hg)	mg/l	0.00025 (<0.00006-0.00083)	0.00024 (0.00006-0.00076)
25	Lead (Pb)	mg/l	0.015 (0.002-0.040)	0.016 (0.004-0.029)
26	Dissolve Oxygen (DO)	mg/l	6.6 (5.4-8.5)	6.7 (5.3-8.7)
27	Biological Oxygen Demand (BOD)	mg/l	1.5 (0.8-2.5)	1.7 (0.9-2.4)
28	Chemical Oxygen Demand (COD)	mg/l	23.7 (5.2-78.8)	25.4 (12.2-59.1)
29	Faecal Coliform (FC)	MPN/100ml	16500 (1700-54000)	38075 (2200-160000)
30	Total Coliform (TC)	MPN/100ml	49142 (4900-160000)	51853 (7900-160000)

Source: Odisha State Pollution Control Board, Odisha

Water Quality doesn't confirm the designated Class C as per IS 2296. The reason as stated by the OSPCB is biological contamination due to human activities.

9.10. Susceptibility to Natural Hazards

Odisha has a history of recurring natural disasters. While the coastal districts of Odisha are exposed to floods and cyclones, western Odisha is prone to acute droughts; a large section of the State is also prone to earthquakes. In addition, the State is also affected by disasters like heat waves, epidemics, forest fire, road accidents etc. The history of disasters substantiates the fact that about 80% of the State is prone to one or more forms of natural disasters. The two successive cyclones in October 1999, the severe cyclone which hit Ganjam coast and the Super Cyclone damaged the infrastructure in 14 districts of the State and disrupted public life. With millions of trees uprooted during the super cyclone, the State, especially the coastal belt has become extremely vulnerable.

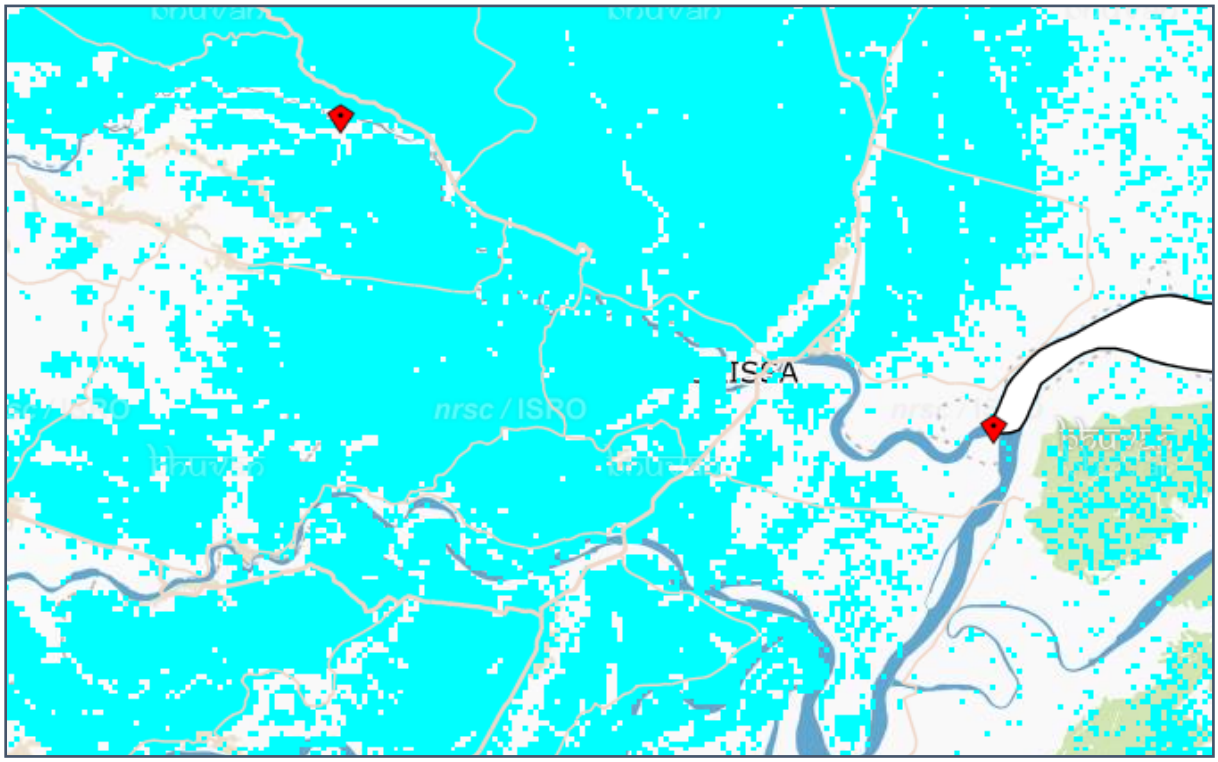
With 80% of annual rainfall concentrated over 3 months, the State is highly vulnerable to floods. High population density, encroachment on the flood plains, poor socio-economic condition, weak infrastructure and mud houses increases the vulnerability of an area. Out of total geographical area of 15.751 lakh hectares, 1.40 lakh hectares are flood prone. There are 516 nos. of vulnerable points in Odisha. Floods are the most recurrent disasters in the State. In the last 25 years, floods have occurred 12 times with varying severity. Report says floods occurred in 27 districts in July-August 2006 with a loss of 90 human beings, 1656 livestock. 3.104 lakh hectares of crop and 120446 nos. of houses damaged.

Cyclones

Odisha is always vulnerable to cyclones in April-May and September-November. Once every few decades a super cyclone strikes Odisha. Recent Super Cyclone that hit Odisha in the last Century were in 1942, 1971 and 1999. The Super Cyclone of 1999 killed about 10,000 and traumatized millions who survived its wrath. Over 15 million people were affected. Throughout India's massive coastline, there are 250 cyclone-warning sets, of which 34 are in Odisha, covering 480 Km of coastline. Odisha Disaster Mitigation Authority (OSDMA) promotes Community Based Disaster Preparedness activities so that people can face emergencies in an organized manner. OSDMA was formed to coordinate and implement the reconstruction work after the super cyclone, keeping in mind the need for disaster preparedness to face any future eventuality. During Super Cyclone of 1999, 97 nos. of blocks and 28 ULBs and about 12569000 populations were affected. The total

agricultural land affected was 1733000 hectares with 9885 nos. of human casualties. The cyclone hazard map of the project area is presented in Figure 9.6 below.

Figure 9-6: Cyclone Map of Project Region



Source: Bhuvan

Aggregated Inundation Flood

The 482 km long of coastline of Orissa exposes the State to flood, cyclones and storm surges. Heavy rainfall during monsoon causes floods in the rivers. In Orissa, rivers such as the Mahanadi, Subarnarekha, Brahmani, Baitarani, Rushikulya, Vansadhara and their many tributaries and branches flowing through the State expose vast areas to floods. Damages are caused due to floods mainly in the Mahanadi, the Brahmani, and the Baitarani. These rivers have a common delta where flood waters intermingle, and when in spate simultaneously, wreak considerable havoc. This problem becomes even more acute when floods coincide with high tide. The entire coastal belt is prone to storm surges. The storms that produce tidal surges are usually accompanied by heavy rain fall making the coastal belt vulnerable to both floods and storm surges. People die; livestock perish; houses are washed away; paddy and other crops are lost, and roads and bridges are

damaged. The floods of 1980, 1982, 2001 and 2003 in the State were particularly severe; property worth crores of rupees were destroyed in the floods.

Due to flood/heavy rain in 2006, 245 Blocks, 3574 GPs, 18912 Villages, 67.39 lakh Population and 4.90 lakh hectare crop areas of the State was affected. 105 persons lost their lives due to flood/heavy rain. 28,327 hectares of crop area were under sand cast due to the floods.

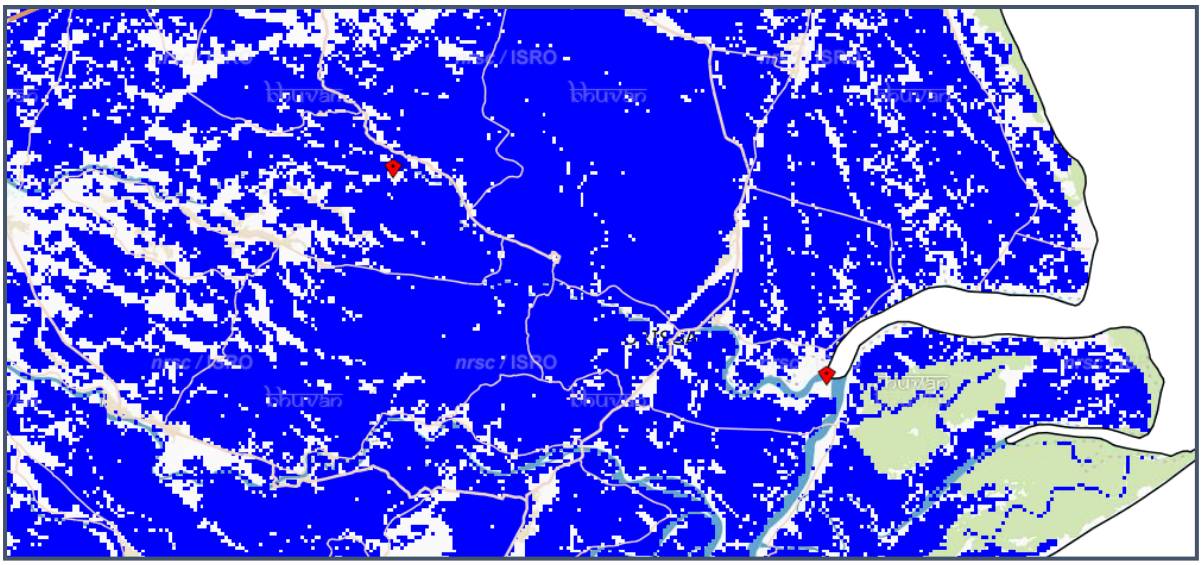
Due to continuous heavy downpour over upper & lower catchments of river Subarnarekha, Jalaka, Baitarani, Budhabalanga and their tributaries from 4th to 6th July,2007 flood brought havoc in five districts namely Balasore, Bhadrak, Jajpur, Keonjhar and Mayurbhanj in the first week of July. Storm surge and saline inundation affected parts of Kendrapara district during the said period.

The State of Orissa was ravaged by floods in June and September during the year 2008. The floods that occurred in June 2008 and in September 2008 are unprecedented. The floods of June and September 2008 were calamities of rare severity. The floods in June'08 brought havoc in districts namely Balasore, Bhadrak, Jajpur, Mayurbhanj and Keonjhar. The flood in September 2008 was due to heavy rainfall in the upper as well as in lower catchments of the Mahanadi River System resulting out of the effect of a deep depression in the Bay of Bengal from 16th to 21st September 2008. During September, 19 districts namely, Angul, Bargarh, Bhadrak, Bolangir, Boudh, Cuttack, Gajapati, Jagatsinghpur, Jajpur, Kalahandi, Kendrapara, Keonjhar, Khurda, Nayagarh, Puri, Rayagada, Sambalpur, Nuapara and Subarnapur had been seriously affected.

Flood 2009 affected 15 districts namely Balasore, Bhadrak, Cuttack, Ganjam, Jajpur, Kalahandi, Kandhamal, Kendrapada, Keonjhar, Khurda, Koraput, Nayagarh, Puri, Subarnapur & Sundergarh. About 56 people lost their lives in the flood.

Area adjacent to project river stretch is prone to inundation. Inundation Hazard Map of the project region is presented in Figure 9.7 below.

Figure 9-7: Inundation Hazard Map of Project Region



Source: Bhuvan

Earthquake

The first recorded earthquake of the State was1676 AD in Balasore area and the first earthquake in which 11 fatalities informed was Berhampur Earthquake of 1897.

Heat Waves

In the year 1998 the State of Orissa faced an unprecedented heat wave situation, because of which 2042 persons lost their lives.

Tsunami

The destructive tsunami of Dec 26th, 2004 on the Indian Coast, in terms of its impact, seems to have occurred for the first time in the known history. As per the assessment made, 266 villages of different districts are vulnerable to Tsunami.

Lightning

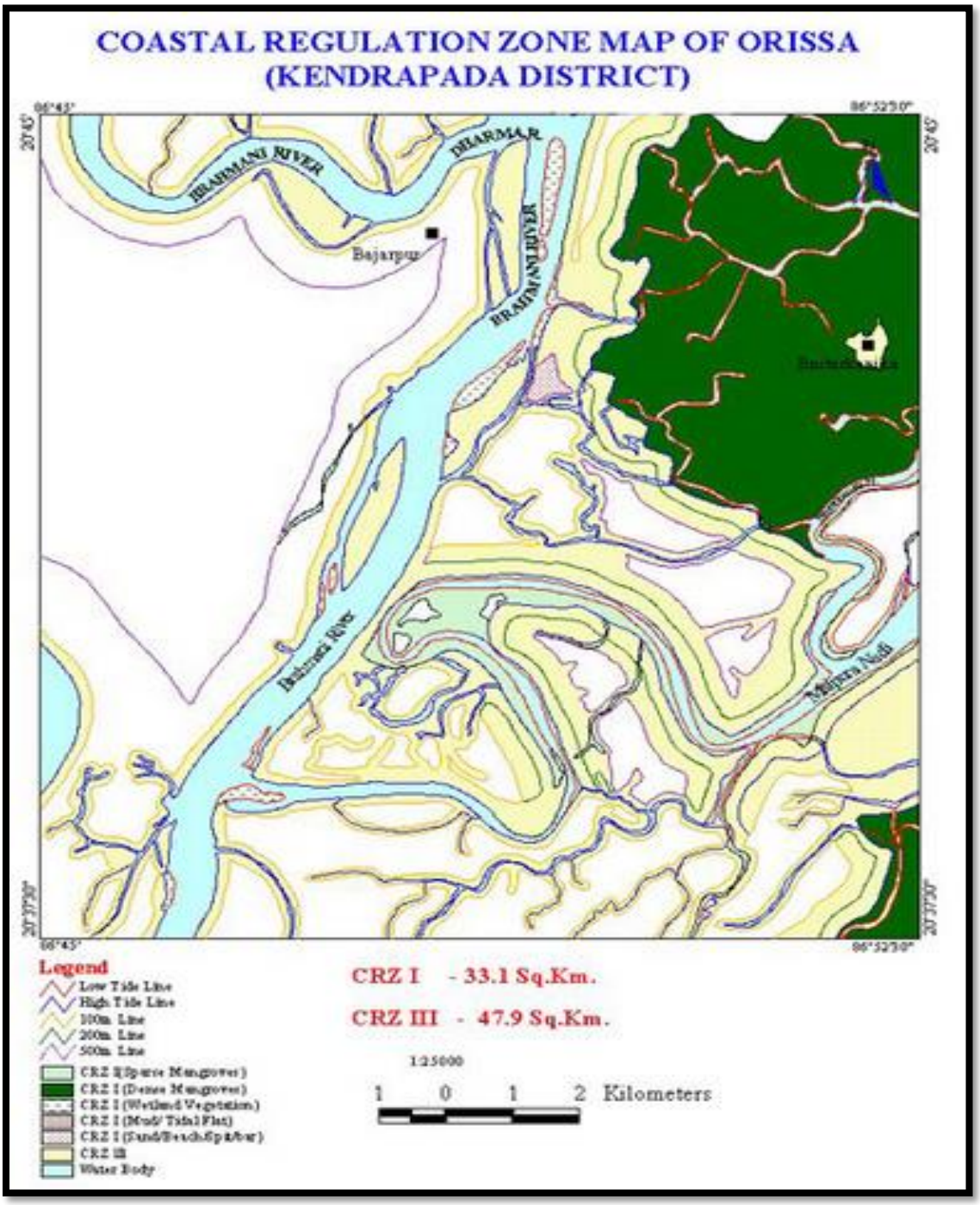
A good number of people, nearly 300 persons succumb to death due to lightning in the State every year.

9.11. Estuary and Coastal Zone

Dhamra estuary is a joint stream formed by the confluence of the Brahmani and Baitarani rivers south of the town of Chandbali. It lies in the Bhadrak district and empties into the Bay of Bengal. The Bhitarkanika wildlife sanctuary, famous for its estuarine crocodiles lie approx. 2.5km from Dhamra estuary.

Area along some part of Baitarni River is notified as CRZ III area. Map of CRZ area along project river stretch is presented as Figure below. CRZ clearance is needed to be taken before starting any construction activities on river stretch.

Figure 9-8: CRZ Map of the Project River Stretch



Source: https://www.annauniv.edu/iom/iomour/results%20CRZ%20orissa.htm

9.12. Archaeological and Heritage Locations

No archaeological monuments found along the project stretch. Baladev jew temple (Temple built during Maratha occupation of Orissa) found approx. 3km in the west side of the Baitarni River, however, this location of Baitarni River is not the part of project under study.

9.13. Flora and Fauna

Odisha has a rich biodiversity as well as the project region. The bio-diversity assessment of the area has been undertaken with the help of IBAT tool. IBAT tool is widely accepted method for decision making. According to the outcome of the study project study area is rich in biodiversity and is the habitat of 20 nos. Amphibians, 369 nos. fauna, 60 nos. Fishes, 63 nos. Mammals, 99 nos. Invertebrates and 34 nos. Reptiles. Detailed list of Fauna as available in project area based on IBAT Tool is presented in table below.

Table 9-7: Faunal Biodiversity in Project Area

S. No.	Species	Common name	IUCN Red List Category
Amphibians			
1	*Duttaphrynus melanostictus*	Black-spectacled Toad	LC
2	*Euphlyctis hexadactylus*	Indian Green Frog	LC
3	*Fejervarya limnocharis*	Asian Grass Frog	LC
4	*Fejervarya orissaensis*	Orissa Frog	LC
5	*Fejervarya syhadrensis*	Bombay Wart Frog	LC
6	*Hoplobatrachus crassus*	Jerdon's Bullfrog	LC
7	*Hoplobatrachus tigerinus*	Indian Bullfrog	LC
8	*Kaloula pulchra*	Malaysian Narrow mouth Toad	LC
9	*Microhyla ornate*	Ant Frog	LC
10	*Polypedates maculatus*	Himalayan Tree Frog	LC
11	*Uperodon systoma*	Marbled Balloon Frog	LC
12	*Uperodon taprobanicus*	Sri Lankan Bullfrog	LC
13	*Uperodon variegatus*	Eluru Dot Frog	LC
Birds			
1	*Accipiter badius*	Shikra	LC

S. No.	Species	Common name	IUCN Red List Category
2	*Accipiter nisus*	Eurasian Sparrow hawk	LC
3	*Accipiter trivirgatus*	Crested Goshawk	LC
4	*Accipiter virgatus*	Besra	LC
5	*Acridotheres fuscus*	Jungle Myna	LC
6	*Acridotheres tristis*	Common Myna	LC
7	*Acrocephalus Agricola*	Paddyfield Warbler	LC
8	*Acrocephalus dumetorum*	Blyth's Reed-warbler	LC
9	*Acrocephalus stentoreus*	Clamorous Reed-warbler	LC
10	*Actitis hypoleucos*	Common Sandpiper	LC
11	*Aegithina tiphia*	Common Iora	LC
12	*Aethopyga siparaja*	Crimson Sunbird	LC
13	*Alauda gulgula*	Oriental Skylark	LC
14	*Alcedo atthis*	Common Kingfisher	LC
15	*Alcedo meninting*	Blue-eared Kingfisher	LC
16	*Alcippe poioicephala*	Brown-cheeked Fulvetta	LC
17	*Amandava amandava*	Red Avadavat	LC
18	*Amaurornis phoenicurus*	White-breasted Waterhen	LC
19	*Ammomanes phoenicura*	Rufous-tailed Lark	LC
20	*Anas crecca*	Common Teal	LC
21	*Anas platyrhynchos*	Mallard	LC
22	*Anas poecilorhyncha*	Indian Spot-billed Duck	LC
23	*Anastomus oscitans*	Asian Openbill	LC
24	*Anhinga melanogaster*	Oriental Darter	NT
25	*Anser indicus*	Bar-headed Goose	LC
26	*Anthracoceros albirostris*	Oriental Pied Hornbill	LC
27	*Anthus godlewskii*	Blyth's Pipit	LC
28	*Anthus hodgsoni*	Olive-backed Pipit	LC
29	*Anthus richardi*	Richard's Pipit	LC
30	*Anthus rufulus*	Paddyfield Pipit	LC
31	*Apus affinis*	Little Swift	LC
32	*Apus pacificus*	Pacific Swift	LC

S. No.	Species	Common name	IUCN Red List Category
33	*Aquila nipalensis*	Steppe Eagle	EN
34	*Ardea alba*	Great White Egret	LC
35	*Ardea cinereal*	Grey Heron	LC
36	*Ardea goliath*	Goliath Heron	LC
37	*Ardea intermedia*	Intermediate Egret	LC
38	*Ardea purpurea*	Purple Heron	LC
39	*Ardeola grayii*	Indian Pond-heron	LC
40	*Arenaria interpres*	Ruddy Turnstone	LC
41	*Argya caudata*	Common Babbler	LC
42	*Artamus fuscus*	Ashy Wood swallow	LC
43	*Arundinax aedon*	Thick-billed Warbler	LC
44	*Asio flammeus*	Short-eared Owl	LC
45	*Athene brama*	Spotted Owlet	LC
46	*Aythya baeri*	Baer's Pochard	CR
47	*Aythya farina*	Common Pochard	VU
48	*Aythya fuligula*	Tufted Duck	LC
49	*Bubo bengalensis*	Rock Eagle-owl	LC
50	*Bubo coromandus*	Dusky Eagle-owl	LC
51	*Bubulcus ibis*	Cattle Egret	LC
52	*Burhinus indicus*	Indian Thick-knee	LC
53	*Butastur teesa*	White-eyed Buzzard	LC
54	*Butorides striata*	Green-backed Heron	LC
55	*Cacomantis passerines*	Grey-bellied Cuckoo	LC
56	*Cacomantis sonneratii*	Banded Bay Cuckoo	LC
57	*Calandrella dukhunensis*	Eastern Short-toed Lark	LC
58	*Calidris alba*	Sanderling	LC
59	*Calidris pugnax*	Ruff	LC
60	*Calidris subminuta*	Long-toed Stint	LC
61	*Calidris temminckii*	Temminck's Stint	LC
62	*Calliope calliope*	Siberian Ruby throat	LC
63	*Caprimulgus affinis*	Savanna Nightjar	LC

S. No.	Species	Common name	IUCN Red List Category
64	*Caprimulgus asiaticus*	Indian Nightjar	LC
65	*Caprimulgus atripennis*	Jerdon's Nightjar	LC
66	*Caprimulgus indicus*	Jungle Nightjar	LC
67	*Caprimulgus macrurus*	Large-tailed Nightjar	LC
68	*Carpodacus erythrinus*	Common Rose finch	LC
69	*Cecropis daurica*	Red-romped Swallow	LC
70	*Centropus sinensis*	Greater Coucal	LC
71	*Ceryle rudis*	Pied Kingfisher	LC
72	*Chalcophaps indica*	Grey-capped Emerald Dove	LC
73	*Charadrius alexandrines*	Kentish Plover	LC
74	*Charadrius dubius*	Little Ringed Plover	LC
75	*Charadrius leschenaultia*	Greater Sand plover	LC
76	*Charadrius mongolus*	Lesser Sand plover	LC
77	*Chlidonias hybrid*	Whiskered Tern	LC
78	*Chloropsis aurifrons*	Golden-fronted Leafbird	LC
79	*Chloropsis jerdoni*	Jerdon's Leafbird	LC
80	*Chrysocolaptes festivus*	White-naped Woodpecker	LC
81	*Chrysocolaptes guttacristatus*	Greater Flame back	LC
82	*Chrysomma sinense*	Yellow-eyed Babbler	LC
83	*Chrysophlegma flavinucha*	Greater Yellow nape	LC
84	*Cinnyris asiaticus*	Purple Sunbird	LC
85	*Circaetus gallicus*	Short-toed Snake-eagle	LC
86	*Circus aeruginosus*	Western Marsh-harrier	LC
87	*Circus cyaneus*	Hen Harrier	LC
88	*Circus macrourus*	Pallid Harrier	NT
89	*Circus melanoleucos*	Pied Harrier	LC
90	*Cisticola juncidis*	Zitting Cisticola	LC
91	*Clamator coromandus*	Chestnut-winged Cuckoo	LC
92	*Clamator jacobinus*	Jacobin Cuckoo	LC
93	*Clanga clanga*	Greater Spotted Eagle	VU

S. No.	Species	Common name	IUCN Red List Category
94	*Clanga hastate*	Indian Spotted Eagle	VU
95	*Columba livia*	Rock Dove	LC
96	*Columba punicea*	Pale-capped Pigeon	VU
97	*Copsychus saularis*	Oriental Magpie-robin	LC
98	*Coracias benghalensis*	Indian Roller	LC
99	*Coracina macei*	Indian Cuckoo-shrike	LC
100	*Corvus macrorhynchos*	Large-billed Crow	LC
101	*Corvus splendens*	House Crow	LC
102	*Coturnix coromandelica*	Rain Quail	LC
103	*Coturnix coturnix*	Common Quail	LC
104	*Cuculus micropterus*	Indian Cuckoo	LC
105	*Cuculus poliocephalus*	Lesser Cuckoo	LC
106	*Culicicapa ceylonensis*	Grey-headed Canary-flycatcher	LC
107	*Cursorius coromandelicus*	Indian Courser	LC
108	*Cyanecula svecica*	Bluethroat	LC
109	*Cyanoderma rufifrons*	Rufous-fronted Babbler	LC
110	*Cyornis poliogenys*	Pale-chinned Flycatcher	LC
111	*Cyornis rubeculoides*	Blue-throated Blue-flycatcher	LC
112	*Cyornis tickelliae*	Tickell's Blue-flycatcher	LC
113	*Cypsiurus balasiensis*	Asian Palm-swift	LC
114	*Delichon dasypus*	Asian House Martin	LC
115	*Dendrocitta vagabunda*	Rufous Treepie	LC
116	*Dendrocopos macei*	Fulvous-breasted Woodpecker	LC
117	*Dendrocygna bicolor*	Fulvous Whistling-duck	LC
118	*Dendrocygna javanica*	Lesser Whistling-duck	LC
119	*Dicaeum agile*	Thick-billed Flowerpecker	LC
120	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	LC
121	*Dicrurus aeneus*	Bronzed Drongo	LC
122	*Dicrurus caerulescens*	White-bellied Drongo	LC
123	*Dicrurus hottentottus*	Hair-crested Drongo	LC

S. No.	Species	Common name	IUCN Red List Category
124	*Dicrurus leucophaeus*	Ashy Drongo	LC
125	*Dicrurus macrocercus*	Black Drongo	LC
126	*Dicrurus paradiseus*	Greater Racquet-tailed Drongo	LC
127	*Dinopium benghalense*	Black-rumped Flame back	LC
128	*Ducula aenea*	Green Imperial-pigeon	LC
129	*Dumetia hyperythra*	Tawny-bellied Babbler	LC
130	*Egretta garzetta*	Little Egret	LC
131	*Elanus caeruleus*	Black-winged Kite	LC
132	*Emberiza lathami*	Crested Bunting	LC
133	*Ephippiorhynchus asiaticus*	Black-necked Stork	NT
134	*Eremopterix griseus*	Ashy-crowned Sparrow-lark	LC
135	*Esacus recurvirostris*	Great Thick-knee	NT
136	*Eudynamys scolopaceus*	Western Koel	LC
137	*Eumyias thalassinus*	Verditer Flycatcher	LC
138	*Euodice malabarica*	Indian Silver bill	LC
139	*Falco amurensis*	Amur Falcon	LC
140	*Falco chicquera*	Red-headed Falcon	NT
141	*Falco naumanni*	Lesser Kestrel	LC
142	*Falco peregrinus*	Peregrine Falcon	LC
143	*Falco tinnunculus*	Common Kestrel	LC
144	*Ficedula albicilla*	Red-throated Flycatcher	LC
145	*Ficedula westermanni*	Little Pied Flycatcher	LC
146	*Francolinus pondicerianus*	Grey Francolin	LC
147	*Fulica atra*	Common Coot	LC
148	*Gallicrex cinereal*	Watercock	LC
149	*Gallinago gallinago*	Common Snipe	LC
150	*Gallinago stenura*	Pintail Snipe	LC
151	*Gallinula chloropus*	Common Moorhen	LC
152	*Galloperdix lunulata*	Painted Spurfowl	LC
153	*Galloperdix spadicea*	Red Spurfowl	LC
154	*Gallus gallus*	Red Junglefowl	LC

S. No.	Species	Common name	IUCN Red List Category
155	*Geokichla citrina*	Orange-headed Thrush	LC
156	*Glareola lacteal*	Little Pratincole	LC
157	*Glareola maldivarum*	Oriental Pratincole	LC
158	*Glaucidium radiatum*	Jungle Owlet	LC
159	*Gracula indica*	Southern Hill Myna	LC
160	*Gracula religiosa*	Common Hill Myna	LC
161	*Gracula robusta*	Nias Hill Myna	CR
162	*Gracula venerate*	Tenggara Hill Myna	EN
163	*Gracupica contra*	Asian Pied Starling	LC
164	*Gymnoris xanthocollis*	Chestnut-shouldered Bush-sparrow	LC
165	*Gyps bengalensis*	White-rumped Vulture	CR
166	*Gyps fulvus*	Griffon Vulture	LC
167	*Gyps indicus*	Indian Vulture	CR
168	*Haematopus ostralegus*	Eurasian Oystercatcher	NT
169	*Halcyon smyrnensis*	White-breasted Kingfisher	LC
170	*Haliaeetus leucoryphus*	Pallas's Fish-eagle	VU
171	*Haliastur indus*	Brahminy Kite	LC
172	*Harpactes fasciatus*	Malabar Trogon	LC
173	*Hemiprocne coronate*	Crested Treeswift	LC
174	*Hemipus picatus*	Bar-winged Flycatcher-shrike	LC
175	*Hieraaetus pennatus*	Booted Eagle	LC
176	*Hierococcyx varius*	Common Hawk-cuckoo	LC
177	*Himantopus himantopus*	Black-winged Stilt	LC
178	*Hirundo rustica*	Barn Swallow	LC
179	*Hirundo smithii*	Wire-tailed Swallow	LC
180	*Hydrophasianus chirurgus*	Pheasant-tailed Jacana	LC
181	*Hydroprogne caspia*	Caspian Tern	LC
182	*Hypothymis azurea*	Black-napped Monarch	LC
183	*Ictinaetus malaiensis*	Black Eagle	LC
184	*Iduna caligata*	Booted Warbler	LC

S. No.	Species	Common name	IUCN Red List Category
185	*Irena puella*	Asian Fairy-bluebird	LC
186	*Ixobrychus cinnamomeus*	Cinnamon Bittern	LC
187	*Jynx torquilla*	Eurasian Wryneck	LC
188	*Ketupa zeylonensis*	Brown Fish-owl	LC
189	*Kittacincla malabarica*	White-rumped Shama	LC
190	*Lalage melanoptera*	Black-headed Cuckoo-shrike	LC
191	*Lalage melaschistos*	Black-winged Cuckoo-shrike	LC
192	*Lanius cristatus*	Brown Shrike	LC
193	*Lanius schach*	Long-tailed Shrike	LC
194	*Lanius vittatus*	Bay-backed Shrike	LC
195	*Larus brunnicephalus*	Brown-headed Gull	LC
196	*Larus ichthyaetus*	Pallas's Gull	LC
197	*Larvivora brunnea*	Indian Blue Robin	LC
198	*Leiopicus mahrattensis*	Yellow-crowned Woodpecker	LC
199	*Leptocoma zeylonica*	Purple-rumped Sunbird	LC
200	*Leptoptilos javanicus*	Lesser Adjutant	VU
201	*Lewinia striata*	Slaty-breasted Rail	LC
202	*Limnodromus semipalmatus*	Asian Dowitcher	NT
203	*Limosa limosa*	Black-tailed Godwit	NT
204	*Lonchura atricapilla*	Chestnut Munia	LC
205	*Lonchura malacca*	Tricoloured Munia	LC
206	*Lonchura punctulata*	Scaly-breasted Munia	LC
207	*Lonchura striata*	White-rumped Munia	LC
208	*Lymnocryptes minimus*	Jack Snipe	LC
209	*Machlolophus xanthogenys*	Black-lored Tit	LC
210	*Mareca Strepera*	Gadwall	LC
211	*Megalurus palustris*	Striated Grassbird	LC
212	*Merops orientalis*	Asian Green Bee-eater	LC
213	*Merops philippinus*	Blue-tailed Bee-eater	LC
214	*Metopidius indicus*	Bronze-winged Jacana	LC
215	*Microcarbo niger*	Little Cormorant	LC

S. No.	Species	Common name	IUCN Red List Category
216	*Microhierax caerulescens*	Collared Falconet	LC
217	*Micropternus brachyurus*	Rufous Woodpecker	LC
218	*Milvus migrans*	Black Kite	LC
219	*Mirafra affinis*	Jerdon's Bushlark	LC
220	*Mirafra erythroptera*	Indian Bushlark	LC
221	*Mirafra javanica*	Horsfield's Bushlark	LC
222	*Mixornis gularis*	Pin-striped Tit-babbler	LC
223	*Monticola cinclorhyncha*	Blue-capped Rock-thrush	LC
224	*Monticola solitaries*	Blue Rock-thrush	LC
225	*Motacilla alba*	White Wagtail	LC
226	*Motacilla cinereal*	Grey Wagtail	LC
227	*Motacilla citreola*	Citrine Wagtail	LC
228	*Motacilla flava*	Western Yellow Wagtail	LC
229	*Motacilla maderaspatensis*	White-browed Wagtail	LC
230	*Muscicapa dauurica*	Asian Brown Flycatcher	LC
231	*Mycteria leucocephala*	Painted Stork	NT
232	*Neophron percnopterus*	Egyptian Vulture	EN
233	*Netta rufina*	Red-crested Pochard	LC
234	*Nettapus coromandelianus*	Cotton Pygmy-goose	LC
235	*Ninox scutulata*	Brown Boobook	LC
236	*Nisaetus cirrhatus*	Changeable Hawk-eagle	LC
237	*Numenius arquata*	Eurasian Curlew	NT
238	*Numenius phaeopus*	Whimbrel	LC
239	*Nycticorax nycticorax*	Black-Crowned Night Heron	LC
240	*Nyctyornis athertoni*	Blue-bearded Bee-eater	LC
241	*Ocyceros birostris*	Indian Grey Hornbill	LC
242	*Oriolus chinensis*	Black-naped Oriole	LC
243	*Oriolus xanthornus*	Black-hooded Oriole	LC
244	*Orthotomus sutorius*	Common Tailorbird	LC
245	*Otus bakkamoena*	Indian Scops-owl	LC
246	*Otus sunia*	Oriental Scops-owl	LC

S. No.	Species	Common name	IUCN Red List Category
247	*Pandion haliaetus*	Osprey	LC
248	*Parus major*	Great Tit	LC
249	*Passer domesticus*	House Sparrow	LC
250	*Pavo cristatus*	Indian Peafowl	LC
251	*Pelargopsis capensis*	Stork-billed Kingfisher	LC
252	*Pelecanus onocrotalus*	Great White Pelican	LC
253	*Pelecanus philippensis*	Spot-billed Pelican	NT
254	*Pellorneum ruficeps*	Puff-throated Babbler	LC
255	*Perdicula asiatica*	Jungle Bush-quail	LC
256	*Perdicula erythrorhyncha*	Painted Bush-quail	LC
257	*Pericrocotus cinnamomeus*	Small Minivet	LC
258	*Pericrocotus erythropygius*	White-bellied Minivet	LC
259	*Pericrocotus ethologus*	Long-tailed Minivet	LC
260	*Pericrocotus flammeus*	Scarlet Minivet	LC
261	*Pericrocotus roseus*	Rosy Minivet	LC
262	*Pernis ptilorhynchus*	Oriental Honey-buzzard	LC
263	*Petrochelidon fluvicola*	Streak-throated Swallow	LC
264	*Phaenicophaeus tristis*	Green-billed Malkoha	LC
265	*Phalacrocorax carbo*	Great Cormorant	LC
266	*Phoenicurus ochruros*	Black Redstart	LC
267	*Phylloscopus affinis*	Tickell's Leaf-warbler	LC
268	*Phylloscopus burkii*	Green-crowned Warbler	LC
269	*Phylloscopus fuscatus*	Dusky Warbler	LC
270	*Phylloscopus griseolus*	Sulphur-bellied Warbler	LC
271	*Phylloscopus humei*	Hume's Leaf-warbler	LC
272	*Phylloscopus inornatus*	Yellow-browed Warbler	LC
273	*Phylloscopus magnirostris*	Large-billed Leaf-warbler	LC
274	*Phylloscopus occipitalis*	Western Crowned Leaf-warbler	LC
275	*Phylloscopus reguloides*	Blyth's Leaf-warbler	LC
276	*Phylloscopus tristis*	Siberian Chiffchaff	LC

S. No.	Species	Common name	IUCN Red List Category
277	*Phylloscopus trochiloides*	Greenish Warbler	LC
278	*Picoides nanus*	Indian Pygmy Woodpecker	LC
279	*Picumnus innominatus*	Speckled Piculet	LC
280	*Picus chlorolophus*	Lesser Yellownape	LC
281	*Picus guerini*	Black-naped Woodpecker	LC
282	*Picus xanthopygaeus*	Streak-throated Woodpecker	LC
283	*Pitta brachyura*	Indian Pitta	LC
284	*Platalea leucorodia*	Eurasian Spoonbill	LC
285	*Plegadis falcinellus*	Glossy Ibis	LC
286	*Ploceus manyar*	Streaked Weaver	LC
287	*Ploceus philippinus*	Baya Weaver	LC
288	*Pluvialis squatarola*	Grey Plover	LC
289	*Podiceps cristatus*	Great Crested Grebe	LC
290	*Pomatorhinus horsfieldii*	Indian Scimitar-babbler	LC
291	*Porphyrio porphyrio*	Purple Swamphen	LC
292	*Prinia buchanani*	Rufous-fronted Prinia	LC
293	*Prinia hodgsonii*	Grey-breasted Prinia	LC
294	*Prinia inornata*	Plain Prinia	LC
295	*Prinia rufescens*	Rufescent Prinia	LC
296	*Prinia socialis*	Ashy Prinia	LC
297	*Prinia sylvatica*	Jungle Prinia	LC
298	*Psilopogon haemacephalus*	Coppersmith Barbet	LC
299	*Psilopogon lineatus*	Lineated Barbet	LC
300	*Psilopogon zeylanicus*	Brown-headed Barbet	LC
301	*Psittacula cyanocephala*	Plum-headed Parakeet	LC
302	*Psittacula eupatria*	Alexandrine Parakeet	NT
303	*Psittacula krameria*	Rose-ringed Parakeet	LC
304	*Pterocles indicus*	Painted Sandgrouse	LC
305	*Ptyonoprogne concolor*	Dusky Crag Martin	LC
306	*Pycnonotus cafer*	Red-vented Bulbul	LC
307	*Pycnonotus flaviventris*	Black-crested Bulbul	LC

S. No.	Species	Common name	IUCN Red List Category
308	*Pycnonotus jocosus*	Red-whiskered Bulbul	LC
309	*Pycnonotus luteolus*	White-browed Bulbul	LC
310	*Rallina eurizonoides*	Slaty-legged Crake	LC
311	*Recurvirostra avosetta*	Pied Avocet	LC
312	*Rhipidura albicollis*	White-throated Fantail	LC
313	*Rhipidura albogularis*	White-spotted Fantail	LC
314	*Rhipidura aureola*	White-browed Fantail	LC
315	*Rostratula benghalensis*	Greater Painted snipe	LC
316	*Sarcogyps calvus*	Red-headed Vulture	CR
317	*Saxicola caprata*	Pied Bushchat	LC
318	*Saxicola torquatus*	Common Stonechat	LC
319	*Saxicoloides fulicatus*	Indian Robin	LC
320	*Sitta castanea*	Indian Nuthatch	LC
321	*Sitta frontalis*	Velvet-fronted Nuthatch	LC
322	*Spatula clypeata*	Northern Shoveler	LC
323	*Spatula querquedula*	Garganey	LC
324	*Spilopelia senegalensis*	Laughing Dove	LC
325	*Spilopelia suratensis*	Western Spotted Dove	LC
326	*Spilornis cheela*	Crested Serpent-eagle	LC
327	*Sterna acuticauda*	Black-bellied Tern	EN
328	*Sterna aurantia*	River Tern	NT
329	*Streptopelia decaocto*	Eurasian Collared dove	LC
330	*Streptopelia orientalis*	Oriental Turtledove	LC
331	*Streptopelia tranquebarica*	Red Turtledove	LC
332	*Strix ocellate*	Mottled Wood-owl	LC
333	*Sturnia malabarica*	Chestnut-tailed Starling	LC
334	*Sturnia pagodarum*	Brahminy Starling	LC
335	*Surniculus dicruroides*	Fork-tailed Drongo-cuckoo	LC
336	*Sylvia crassirostris*	Eastern Orphean Warbler	LC
337	*Synoicus chinensis*	Asian Blue Quail	LC
338	*Sypheotides indicus*	Lesser Florican	EN

S. No.	Species	Common name	IUCN Red List Category
339	*Taccocua leschenaultia*	Sirkeer Malkoha	LC
340	*Tachybaptus ruficollis*	Little Grebe	LC
341	*Tadorna ferruginea*	Ruddy Shelduck	LC
342	*Tephrodornis pondicerianus*	Common Wood-shrike	LC
343	*Tephrodornis virgatus*	Large Wood-shrike	LC
344	*Terpsiphone paradise*	Indian Paradise-flycatcher	LC
345	*Threskiornis melanocephalus*	Black-headed Ibis	NT
346	*Timalia pileate*	Chestnut-capped Babbler	LC
347	*Treron bicinctus*	Orange-breasted Green-pigeon	LC
348	*Treron curvirostra*	Thick-billed Green-pigeon	LC
349	*Treron phoenicopterus*	Yellow-footed Green-pigeon	LC
350	*Tringa glareola*	Wood Sandpiper	LC
351	*Tringa nebularia*	Common Greenshank	LC
352	*Tringa ochropus*	Green Sandpiper	LC
353	*Tringa tetanus*	Common Redshank	LC
354	*Turdoides striata*	Jungle Babbler	LC
355	*Turdus unicolor*	Tickell's Thrush	LC
356	*Turnix suscitator*	Barred Buttonquail	LC
357	*Turnix sylvaticus*	Common Buttonquail	LC
358	*Turnix tanki*	Yellow-legged Buttonquail	LC
359	*Tyto alba*	Common Barn-owl	LC
360	*Tyto longimembris*	Eastern Grass-owl	LC
361	*Upupa epops*	Common Hoopoe	LC
362	*Vanellus cinereus*	Grey-headed Lapwing	LC
363	*Vanellus indicus*	Red-wattled Lapwing	LC
364	*Vanellus malabaricus*	Yellow-wattled Lapwing	LC
365	*Zapornia akool*	Brown Crake	LC
366	*Zoonavena sylvatica*	White-rumped Spinetail	LC
367	*Zoothera dauma*	Scaly Thrush	LC

S. No.	Species	Common name	IUCN Red List Category
368	*Zoothera major*	Amami Thrush	NT
369	*Zosterops palpebrosus*	Oriental White-eye	LC
Fishes			
1	*Amblypharyngodon microlepis*	Indian Carplet	LC
2	*Anguilla bengalensis*	Indian Mottled Eel	NT
3	*Arius arius*	Threadfin Sea Catfish	LC
4	*Awaous grammepomus*	Scribbled Goby	LC
5	*Bangana ariza*	Ariza Labeo	LC
6	*Batasio batasio*		LC
7	*Brachirus pan*	Pan Sole	LC
8	*Channa gachua*	Dwarf Snakehead	LC
9	*Cirrhinus mrigala*	Mrigal	LC
10	*Cirrhinus reba*	Reba Carp	LC
11	*Eleotris fusca*	Brown Spinecheek Gudgeon	LC
12	*Esomus danrica*	Flying barb	LC
13	*Eubleekeria splendens*	Splendid Ponyfish	LC
14	*Exyrias puntang*	Puntang Goby	LC
15	*Gazza minuta*	Toothed Ponyfish	LC
16	*Glossogobius giuris*	Bareye Goby	LC
17	*Hippichthys heptagonus*	Reticulated Freshwater Pipefish	LC
18	*Johnius coitor*	Big-eyed Jewfish	LC
19	*Labeo angra*	Angra Labeo	LC
20	*Labeo bata*	Minor Carp	LC
21	*Labeo boggut*	Boggut labeo	LC
22	*Leiognathus equulus*	Common Ponyfish	LC
23	*Lepidocephalus guntea*	Peppered Loach	LC
24	*Mastacembelus armatus*	Spiny eel	LC
25	*Monopterus albus*	Rice swampeel	LC
26	*Neopomacentrus taeniurus*	Freshwater Damsel	DD

S. No.	Species	Common name	IUCN Red List Category
27	*Omobranchus ferox*	Gossamer Blenny	LC
28	*Ompok bimaculatus*		NT
29	*Ophiocara porocephala*	Spangled Gudgeon	LC
30	*Ophisternon bengalense*	Bengal mudeel	LC
31	*Oryzias dancena*	Indian ricefish	LC
32	*Parachiloglanis hodgarti*	Torrent Catfish	LC
33	*Parambassis ranga*	Indian Glassy Fish	LC
34	*Pastinachus sephen*	Cowtail Stingray	DD
35	*Platycephalus indicus*	Bartail Flathead	DD
36	*Plectorhinchus gibbosus*	Brown Sweetlips	LC
37	*Plicofollis dussumieri*	Blacktip Sea Catfish	LC
38	*Pomadasys argenteus*	Silver Javelin	LC
39	*Psammogobius biocellatus*	Sleepy Goby	LC
40	*Rasbora daniconius*	Slender Barb	LC
41	*Rita chrysea*	Mahanadi rita	LC
42	*Scatophagus argus*	Spotted Scat	LC
43	*Sperata aor*	Long-whiskered Catfish	LC
44	*Taenioides cirratus*	Whiskered Eel Goby	DD
45	*Tenualosa ilisha*	Hilsa	LC
Invertebrates			
1	*Acisoma panorpoides*	Grizzled Pintail	LC
2	*Agriocnemis pygmaea*	Wandering Midget	LC
3	*Anax ephippiger*	Vagrant Emperor	LC
4	*Anax guttatus*	Lesser Green Emperor	LC
5	*Cerithium coralium*	Coral Cerith	LC
6	*Ischnura senegalensis*	Tropical Bluetail	LC
7	*Lestes concinnus*	Dusky Spreadwing	LC
8	*Lestes elatus*	Emerald Spreadwing	LC
9	*Neritina violacea*	Red-mouth Nerite Snail	LC
10	*Pantala flavescens*	Wandering Glider	LC
11	*Polymesoda bengalensis*	Bengali Geloina	LC

S. No.	Species	Common name	IUCN Red List Category
12	*Polymesoda expansa*	Marsh Clam	LC
13	*Tholymis tillarga*	Old World Twister	LC
14	*Tramea basilaris*	Keyhole Glider	LC
15	*Tramea limbate*	Ferruginous Glider	LC
16	*Trithemis aurora*		LC
17	*Trithemis kirbyi*	Orange-winged Dropwing	LC
18	*Trithemis pallidinervis*	Dancing Dropwing	LC
19	*Zygonyx torridus*	Ringed Cascader	LC
Mammals			
1	*Anathana ellioti*	Madras Treeshrew	LC
2	*Antilope cervicapra*	Blackbuck	NT
3	*Axis axis*	Chital	LC
4	*Bandicota bengalensis*	Lesser Bandicoot Rat	LC
5	*Bandicota indica*	Greater Bandicoot Rat	LC
6	*Boselaphus tragocamelus*	Nilgai	LC
7	*Canis aureus*	Golden Jackal	LC
8	*Canis lupus*	Gray Wolf	LC
9	*Cuon alpinus*	Dhole	EN
10	*Cynopterus sphinx*	Greater Shortnosed Fruit Bat	LC
11	*Elephas maximus*	Asian Elephant	EN
12	*Felis chaus*	Jungle Cat	LC
13	*Funambulus pennantii*	Five-striped Palm Squirrel	LC
14	*Golunda ellioti*	Indian Bush-rat	LC
15	*Herpestes auropunctatus*	Small Indian Mongoose	LC
16	*Herpestes edwardsii*	Indian Grey Mongoose	LC
17	*Herpestes smithii*	Ruddy Mongoose	LC
18	*Herpestes vitticollis*	Stripe-necked Mongoose	LC
19	*Hesperoptenus tickelli*	Tickell's Bat	LC
20	*Hipposideros fulvus*	Fulvus Leaf-nosed Bat	LC
21	*Lepus nigricollis*	Indian Hare	LC
22	*Lutrogale perspicillata*	Smooth-coated Otter	VU

S. No.	Species	Common name	IUCN Red List Category
23	*Macaca mulatta*	Rhesus Monkey	LC
24	*Madromys blanfordi*	White-tailed Wood Rat	LC
25	*Manis crassicaudata*	Indian Pangolin	EN
26	*Megaderma lyra*	Greater False Vampire	LC
27	*Mellivora capensis*	Honey Badger	LC
28	*Melursus ursinus*	Sloth Bear	VU
29	*Moschiola indica*	Indian Chevrotain	LC
30	*Muntiacus vaginalis*	Northern Red Muntjac	LC
31	*Mus booduga*	Little Indian Field Mouse	LC
32	*Mus musculus*	House Mouse	LC
33	*Mus terricolor*	Earth-colored Mouse	LC
34	*Panthera pardus*	Leopard	VU
35	*Panthera tigris*	Tiger	EN
36	*Paradoxurus hermaphroditus*	Common Palm Civet	LC
37	*Pipistrellus ceylonicus*	Kelaart's Pipistrelle	LC
38	*Pipistrellus coromandra*	Coromandel Pipistrelle	LC
39	*Pipistrellus tenuis*	Least Pipistrelle	LC
40	*Prionailurus bengalensis*	Leopard Cat	LC
41	*Prionailurus rubiginosus*	Rusty-spotted Cat	NT
42	*Pteropus giganteus*	Indian Flying Fox	LC
43	*Rattus rattus*	House Rat	LC
44	*Ratufa indica*	Indian Giant Squirrel	LC
45	*Rhinolophus Lepidus*	Blyth's Horseshoe Bat	LC
46	*Rhinolophus rouxii*	Rufous Horseshoe Bat	LC
47	*Rhinopoma hardwickii*	Lesser Mouse-tailed Bat	LC
48	*Rousettus leschenaultia*	Leschenault’s Rousette	LC
49	*Rusa unicolor*	Sambar	VU
50	*Saccolaimus saccolaimus*	Bare-rumped Sheathtail-bat	LC
51	*Scotophilus heathii*	Greater Asiatic Yellow House Bat	LC

S. No.	Species	Common name	IUCN Red List Category
52	*Scotophilus kuhlii*	Lesser Asiatic Yellow House Bat	LC
53	*Scotozous dormer*	Dormer's Pipistrelle	LC
54	*Semnopithecus entellus*	Northern Plains Gray Langur	LC
55	*Suncus murinus*	House Shrew	LC
56	*Sus scrofa*	Wild Boar	LC
57	*Taphozous longimanus*	Long-winged Tomb Bat	LC
58	*Tatera indica*	Indian Gerbil	LC
59	*Tetracerus quadricornis*	Four-horned Antelope	VU
60	*Vandeleuria oleracea*	Asiatic Long-tailed Climbing Mouse	LC
61	*Viverricula indica*	Small Indian Civet	LC
62	*Vulpes bengalensis*	Bengal Fox	LC
63	*Vulpes Vulpes*	Red Fox	LC
Reptiles			
1	*Ahaetulla prasina*	Gunther's Whip Snake	LC
2	*Atretium schistosum*	Olive Keelback Water Snake	LC
3	*Batagur baska*	Northern River Terrapin	CR
4	*Boiga forsteni*	Reddish Peninsular Cat Snake	LC
5	*Bungarus fasciatus*	Banded Krait	LC
6	*Calotes minor*	Hardwicke's Bloodsucker	DD
7	*Chamaeleo zeylanicus*	Asian Chameleon	LC
8	*Chitra indica*	Indian Narrow-headed Softshell Turtle	EN
9	*Crocodylus palustris*	Mugger	VU
10	*Crocodylus porosus*	Salt-water Crocodile	LR/lc
11	*Cyrtodactylus nebulosus*	Clouded Indian Gecko	LC
12	*Elachistodon westermanni*	Indian Egg-eater	LC
13	*Eublepharis hardwickii*	Eastern Indian Leopard Gecko	LC
14	*Eutropis allapallensis*	Schmidt's Mabuya	LC
15	*Eutropis carinata*	Keeled Indian Mabuya	LC

S. No.	Species	Common name	IUCN Red List Category
16	*Eutropis trivittata*	Three-banded Mabuya	LC
17	*Gavialis gangeticus*	Gharial	CR
18	*Hemidactylus frenatus*	Common House Gecko	LC
19	*Lissemys punctate*	Indian Flapshell Turtle	LR/lc
20	*Lycodon jara*	Yellow-speckled Wolfsnake	LC
21	*Lycodon travancoricus*	Travancore Wolf Snake	LC
22	*Melanochelys trijuga*	Indian Black Turtle	LR/nt
23	*Nilssonia gangetica*	Indian Softshell Turtle	VU
24	*Nilssonia hurum*	Indian Peacock Softshell Turtle	VU
25	*Oligodon taeniolatus*	Streaked Kukri Snake	LC
26	*Ophiophagus Hannah*	King Cobra	VU
27	*Pelochelys cantorii*	Asian Giant Softshell Turtle	EN
28	*Psammophilus blanfordanus*	Blanford's Rock Agama	LC
29	*Psammophis condanarus*	Indo-chinese Sand Snake	LC
30	*Pseudocerastes persicus*	Perisan Horned Viper	LC
31	*Sitana ponticeriana*	Fan Throated Lizard	LC
32	*Trimeresurus gramineus*	Common Bamboo Viper	LC
33	*Varanus bengalensis*	Common Indian Monitor	LC
34	*Varanus salvator*	Common Water Monitor	LC

Source: i-bat alliance

Table 9-8: List of Floras

Sl. No.	Local Name	Botanical Name
TREES		
1	Achhu	*Morinda tinctoria*
2	Ambada	*Spondias mangifera*
3	Bandhan	*Ougeinia oojeinensis*
4	Char	*Buchanania lanjan*
5	Chhuin patuli	*Stereospermum angustifolium*
6	Dhauranja	*Holoptelia integrifolia*
7	Gambhari	*Gmelina arboria*
8	Genduli	*Sterculia urens*
9	Hinjal	*Barringtonia acutangula*
10	Handiphuta	*Butea parviflora*
11	Jarasanda	*Litsaea sebifere*
12	Karada	*Cleistanthus collinus*
13	Harida	*Terminalia chebula*
14	Kendu	*Diospyros melanoxylon*
15	Kusum	*Schleichera oleosa*
16	Kasi	*Bridellia retusa*
17	Kumbhi	*Careya arboria*
18	Kangada	*Xylia xylocarpa*
19	Khirkoli	*Monilkra hexandra*
20	Khaira	*Acacia catechu*
21	Lodha	*Symplocos recemosa*
22	Mahula	*Madhuca indica*
23	Mai	*Lannea coromondelica*
23	Mahala	*Ailanthus excels*
24	Mankada Kendu	*Diospyros embryopteris*
25	Nimba	*Azadirachta indica*
26	Piasal	*Pterocarpus marsupium*
27	Phasi	*Anogeissus acuminate*

Sl. No.	Local Name	Botanical Name
28	Phanphana	*Oroxylon indicum*
29	Sal	*Shorea robusta*
30	Simili	*Bombax ceiba*
31	Pahadi Sisoo	*Dalbergia latifolia*
32	Salai	*Boswellia serrate*
33	Sahada	*Streblus asper*
34	Samarsinga	*Cordia macleodii*
35	Rakta Chandan	*Pterocarpus santalinus*
36	Tentuli	*Tamarindus indica*
37	Nageswar	*Messua ferrea*
38	Kamini	*Murraya paniculata*
39	Piasal/ Bijasal	*Pterocarpus marsupium*
40	Ashoka	*Saraca indica*
41	Chandan	*Santalum album*
42	Ritha	*Sapindus emarginatus*
43	Nirmala	*Strychnos patatorum*
44	Arjuna	*Terminalia arjuna*
45	Asana / Sahaja	*Terminalia tomentosa*
46	Teak / Saguan	*Tectona grandis*
47	Bela	*Aegle marmelos*
SHRUBS		
1	Bana Tulasi	*Perilla ocmoides*
2	Bisalya Karani	*Tridex procumbens*
3	Patalgaruda	*Raowolfia serpentine*
4	Pengu- Lai Lata	*Celastrus paniculata*
5	Satabari	*Asparagus recemosus*
6	Sabai grass	*Eulaliopsis binata*
7	Kia Ketaki	*Pandanus tectorius*
HERBS		
1	Apamaranga	*Achyranthus aspera*

Sl. No.	Local Name	Botanical Name
2	Bhuinnimba	*Andrographis paniculata*
3	Gheekuanri	*Aloe vera*
4	Palua	*Curcuma aromatica*
5	Kashatandi	*Saccharum spontaneum*
6	Salaparni	*Desmodium gangeticum*
7	Saptapheni	*Opuntia dillenii*
CLIMBERS		
1	Atundi	*Combretum decandrum*
2	Akanabindhi	*Cissamplelos perira*
3	Dantari	*Acacia torta*
4	Siali	*Bauhinia vahlii*
5	Takua Lai	*Vitis repanda*
6	Guluchi	*Tinospora cordifolia*
7	Kankada	*Memordica dioica*
BAMBOOS AND CANES		
1	Beta	*Calamus tenuis*
2	Salia Baunsa	*Dendrocalamus strictus*
3	Kanta Baunsa	*Bambusa bambos*
4	Daba Baunsa	*Bambusa bambos Var–gigantea*
5	Dangi Baunsa	*Schizostachyum pergracile*
6	Pani Baunsa	*Gigantochloa robusta*
MANGROVES		
1	Hental	*Phoenix paludosa*
2	Bani	*Avicinia officinalis*
3	Sundari	*Heritiera littoralis*

Source: Forest work plan Odisha

9.14. National Parks, Forests, Wildlife Sanctuaries and Reserves

The project river stretch under study is not crossing any national park wildlife sanctuaries and conservation reserves according to secondary sources. Bhitarkanika Wildlife Sanctuary / National Park is adjacent to End Point of the project at Dharma Estuary.

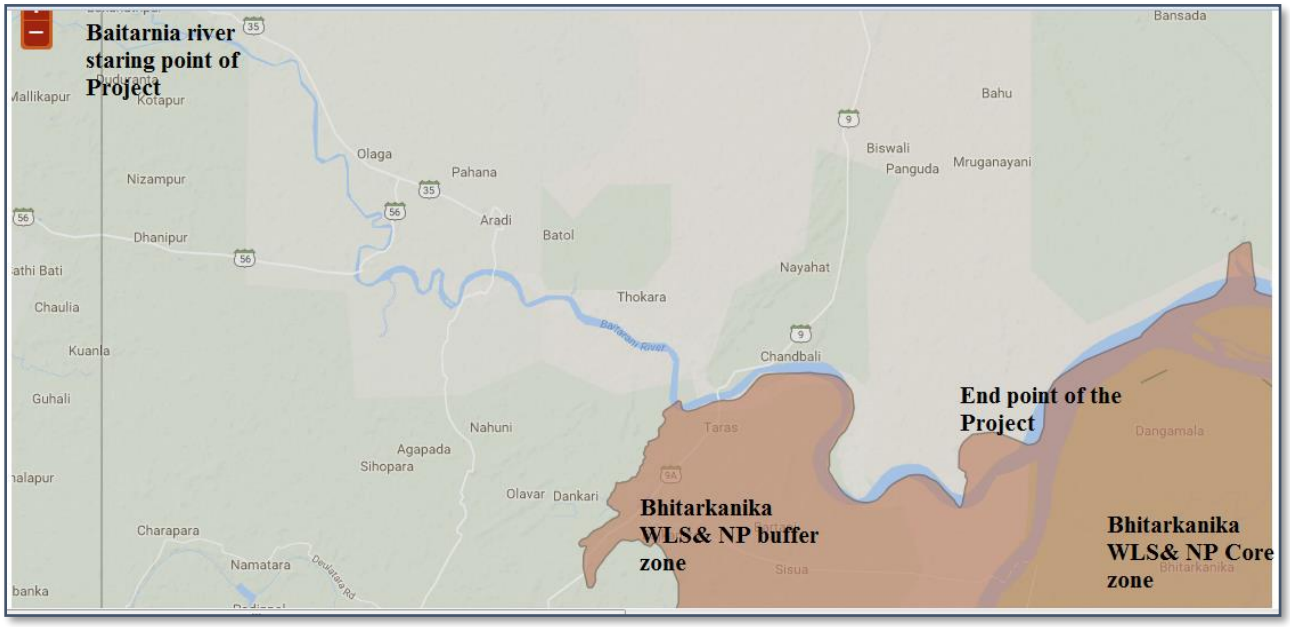
Geographically Bhitarkanika is located between 20º4'-20º8'N Latitudes and 86º45'-87º50' Longitudes. It is the second largest mangrove ecosystem of India, which has much significance with regard to ecological, geomorphologic and biological background that includes mangrove forests, rivers, creeks, estuaries, backwater, accreted land and mud flats. Bhitarkanika mangrove ecosystem flourishes in the deltaic region, formed by the rich alluvial deposits of Brahmani, Baitarani & the Dhamra River.

About 145 km have been notified as Bhitarkanika National Park vide Notification No.19686/F & E dated 16.9.1998 of Forests & Environment Department, Govt. of Orissa. Bhitarkanika National Park is the core area of Bhitarkanika Sanctuary, which was declared vide notification No.6958/FF AH Dated. 22.04.1975 over an area of 650 km^2.

Figure 9-9: Bhitarkanika Wildlife Sanctuary

Source: i-bat alliance

Figure 9-10: Core and Buffer Zone of Bhitarkanika Wildlife Sanctuary and National Park



Source: i-bat alliance

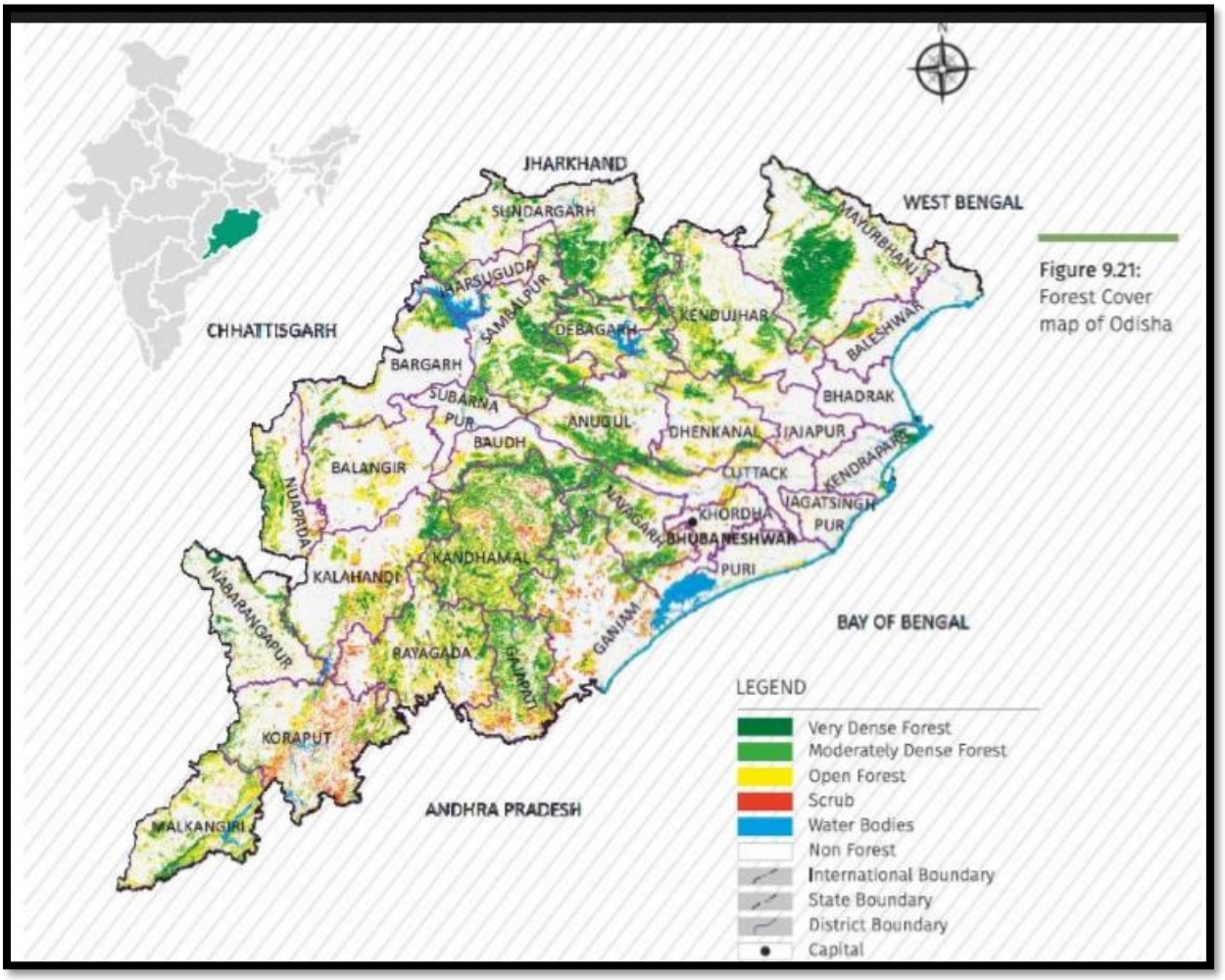
The Sanctuary comprising mangrove forests, meandering rivers, innumerable crisscrossed tidal inundated creeks provide shelter to the endangered estuarine Crocodile (Crocodile porous). Besides estuarine Crocodile, the Sanctuary is rich in other reptiles, birds and mammalian population. Theses mangrove forests are good habitat for King Cobra, Indian Python and Water Monitor Lizard.

About 62 species of mangrove & its associates are found in Bhitarkanika Sanctuary. The dominant genera of mangroves and its associates include *Acanthus, Achrostichum, Aegialitis, Aglaia, Avicennia, Excoecaria, Brownlowia, Bruguiera, Ceriops, Rhizophora, Heritiera, Hibiscus, Kandelia,Lumnizera, Phoenix, Sonneratia, Suaeda* etc.

9.14.1. Forest:

Based on analysis of Forest Map available at GIS Website of Odisha (http://gis.ori.nic.in/) developed and run by NIC, no forest land is located alongside the project river stretch. Presence of revenue forest land shall be established in project execution stage. Forest maps of all three district are attached as **Enclosure II**. Forest map of the project state is given in figure below.

Figure 9-11:Forest map of Odisha



District wise forest details are given below:

S.No.	Name of the district	Total Geographical Area	Very Densy Forest	Moderate Dense Foest	Open Forest	Total
1	Badarak	2505	0	9	66	75
2	Kendrapara	2644	84	88	133	305
3	Jajpur	2899	6	72	225	303

Source: Forest and tree resource in states and Union territory

9.15. Socio-economic Profile

Orissa is the tenth largest state in area and eleventh in population in the country, accounting for 5% of the geographical area and 4% of the population of the country. Cultivators and Agricultural labourer constitute 65% of the total workforce. Agriculture provides direct or indirect employment to 65% of the total work force and contributes 26% of the net state domestic product.

9.15.1. Agriculture

The state has a cultivated area of 62 lakh hectares out of which 27 lakh hectares is high land, 19 lakh hectares medium and 16 lakh hectares low land. The paddy area during kharif is about 42 lakh & during Rabi 2.5 lakh hectares.

Kharif is the main cropping season and rice is the principal crop during kharif season. Cropping during Rabi season is mainly confined to irrigated areas and areas with residual moisture. Other important crops produced in the state are given in table below

Table 9-9: Important crops of the project state

S.No.	Common Name	*Scientific Name*
Pulses		
1.	Arhar	*Cajanus cajan*
2	Mung	*Vigna radiata*
3	Biri	*Vigna radiata*
4	Kulthi	*Macrotyloma uniflorum*
Oil Seeds		
5	Ground Nut	*Apios americana*
6	Til	*Sesamum indicum*
7	Mustard	*Brassica juncea*
8	Niger	*Guizotice abyssinica*
Fibers		
9	Jute	*Corchorus olitorius.*
10	Mesta	*Hibiscus cannabinus*
11	Cotton	*Gossypium*

S.No.	Common Name	*Scientific Name*
12	Sugarcane	*Saccharum*
Fruit		
13	Mango	*Mangifera indica*
14	Banana	*Musa acuminata*
15	Coconut	*Cocos nucifera*
16	Cashew Nut	*Anacardium occidentale*

Due to frequent occurrence of these natural calamities there is always reduction in kharif rice production. Similarly, in drought years there is considerable loss in production of pulses and oilseed crops during Rabi season and kharif season. Another problem in the state is operational household along with poverty line. The average size of the holding is only 1-3 hectares out of cultivable area of 65-99 lakh hectares, about 41% is under irrigated conditions. The total irrigation potential created so far from all sources is about 39.31 lakh hectares (kharif 26.65 lakh and rabbi 12.66 lakh hectares). The gross irrigated cropped area is 27 lakh hectares.

Total geographical area of the state is 155.71 lakh hectares out of which 58.13 lakh hectares is forest area, 4.82 lakh hectares of miscellaneous tree & groves, 4.43 lakh hectares of permanent pasture, 3.92 lakh hectares culturable waste land and 8.43 lakh hectares barren & unculturable land. The State has a cultivated area of 62 lakh hectares out of which 27 lakh hectares is high land, 19 lakh hectares medium and 16 lakh hectares low land.

9.15.2. Settlements along the Project River basin

There are about 22 settlements varying in size and populations project along the project river stretch. The details of settlements are given in the following table.

Table 9-10: Settlements Along the Project River Stretch

S. No.	Village Name	Tehsil	District
1	Duduranata	Chandbali	Bhadrak
2	Navnapur	Chandbali	Bhadrak
3	Ardaulik	Chandbali	Bhadrak
4	Sunderpur	Chandbali	Bhadrak
5	Ekchapur	Rajkanika	Kendrapara
6	Sathivkuda	Chandbali	Bhadrak
7	Vodak	Chandbali	Bhadrak
8	Manpur	Rajkanika	Kendrapara
9	Sanapanki	Chandbali	Bhadrak
10	Vahvida	Chandbali	Bhadrak
11	Kuldi	Chandbali	Bhadrak
12	Barda	Rajkanika	Kendrapara
13	Ostiya	Rajkanika	Kendrapara
14	Buradiya	Rajkanika	Kendrapara
15	Simuliya	Chandbali	Bhadrak
16	Gualigan	Chandbali	Bhadrak
17	Chandvali	Chandbali	Bhadrak
18	Banjaraku	Rajkanika	Kendrapara
19	Pokharishadi	Chandbali	Bhadrak
20	Baradia	Rajnagar	Kendrapara
21	Upulei	Rajkanika	Kendrapara
22	Lakimprasad Diya	Chandbali	Bhadrak

Source: Google earth

9.15.3. Demographic Profile

Project river stretch under study is form the boundary of three districts namely; Kendrapara, Bhadrak and Jajpur. Social profile of the project districts in respect to State statics are presented in Table below.

Table 9-11: Social Profile of the Project Area

Parameter	Kendrapara District	Bhadrak District	Jajpur District	Odisha State
Total Population as per 2011 Census	1440361	1506337	1827192	41974218
Total Male	717814	760260	926034	21212136
Total Female	722547	746077	901158	20762082
Sex Ratio (Females per 1000 Males)	1007	981	973	979
Population SC	309780 (21.5%)	334896 (22.2%)	433387 (23.7%)	7188463 (17.1%)
Population ST	9484 (0.7)	30428 (2.0%)	151432 (8.3%)	9590756 (22.8%)
Literacy Rate (%)	1089265 (85.2%)	1094140 (82.8%)	1290455 (80.1%)	26742595 (72.9%)
Male Literacy Rate (%)	579970 (91.5%)	596269 (89.6%)	706396 (86.8%)	15089681 (81.6)
Female Literacy Rate (%)	509295 (79.0%)	497871 (75.8%)	584059 (73.3%)	11652914 (64.0%)
Total Workers	466890 (32.4%)	468599 (31.1%)	552234 (30.2%)	17541589 (41.8%)

Source: Census of India 2011

Livelihood of the project region is mostly dependent on agricultural activities. The work participation rate of the project districts ranges from 30.2% to 32.4% in respect to the State Work Participation Rate of 41.8%. Therefore, proposed development of waterways

in the region is likely to increase the economy of the region by generation of employment in associated business facilities.

The project region presents good statistics in terms of literacy with rate varies from 86.8% to 91.5% against the state literacy rate of 81.6%.

9.16. Potential Environmental and Social Impacts of the Project

Proposed project is likely to change the prevailing environment condition of the project region. Considering some of the adverse impacts associated with project, these impacts have to be mitigated and mitigation measures need to be incorporated in the engineering design. Environmental mitigation measures represent the project's endeavour to reduce its environmental footprint to the minimum possible. These are conscious efforts from the project to reduce undesirable environmental impacts of the proposed activities and offset these to the degree practicable. Enhancement measures are project's efforts to gain acceptability in its area of influence. They reflect the pro-active approach of the project towards environmental management.

9.16.1. Impacts on Climate

Waterway is more environment friendly compared to other conventional source transport namely road or rail transport modes. However, slight change in the micro-climate of the area is expected due to Heat Island Effect near paved areas as likely to develop for loading and unloading point. However, Impact on the climate conditions from the proposed project will not be significant in long run as deforestation and / or removal of vegetation will be compensated by compensatory plantation to the tune of double the area denuded.

9.16.2. Impact on Air Quality

There will be rise in PM levels during the construction activities of loading-unloading point and strengthening of approach road, which shall again be within prescribed limit once the construction activities are over.

Dredging does not significantly affect the air quality, but operation of dredgers involves generation of emissions which may have effect on the air quality. However, the impact

anticipated are localized and short term as it will be confined for the duration for which dredger will be operated and to the area where the dredger will be operated.

Barges also generate emissions, but this is far less as compared to road and rail for transportation of same quantity of cargo for the same distance. Thus, impacts on air quality are anticipated to be positive. As per analysis there is reduction in emission generation of all the pollutants.

9.16.3. Impact on Noise Levels

Impact on noise quality due to barge movement will be negligible and will be lesser when compared to road and railways generated noise for transportation of similar quantity of material. Intermittent noise of high level may be generated only when hooters are used as warning during navigation. No hooters sign shall be deployed near sensitive areas.

Dredging will be carried out within the navigation channel only, therefore, impacts of the dredging noise on the nearby settlements are likely to be insignificant. Noise generating activities should be carried out in daytime only.

9.16.4. Impact on Water Resources and Quality

Impact of river water quality is expected due to dredging and barging activities. Impacts of dredging on water quality are increase in turbidity; reduced light transmittance; reduced DO; changes in salinity, temperature, pH & concentration of nutrients and release of heavy metals/chemicals. Turbidity of water also increases substantially close to dredging point but it reduces with distance and almost gets normal at a short distance from dredging point. Coarser sediments settle much faster and at shorter distance.

Dredging quantity may be reduced by effective study of river profiles. Sediment loss can be minimized by wise selection of dredger depending on strata and depth and use of Cutter Section Dredgers (CSDs).

Vessels generate garbage, oily waste, sewage, bilge water & ballast water which can affect the water quality of the river. Usage of anti-fouling paints may also impact the water quality as the paints may contain toxins. Settling of the dust of the material transported on river surface again can impact the river water quality. Ship accidents/collision may lead

to spillage of the commodities transported including oil which may impact the water quality of the river.

Management of wastewater, oily waste, bilge water, noxious waste (if any), air emissions and garbage from vessels as per Marine Pollution (MARPOL) can prevent the water quality pollution. All maintenance & repair works should be carried out at designated locations only. Only toxin-free paints should be used for anti-fouling purpose. Experienced crew should be hired to minimize the possibility of accidents.

9.16.5. Impact on Ecological Resources

Bhitarkanika Wildlife Sanctuary / National Park is adjacent to End Point of the project at Dharma Estuary. Bhitarkanika mangrove ecosystem flourishes in the deltaic region, formed by the rich alluvial deposits of Brahmani, Baitarani & Dhamra River.

The Sanctuary comprising mangrove forests, meandering rivers, innumerable crisscrossed tidal inundated creeks provide shelter to the endangered estuarine Crocodile (Crocodile porous). Besides estuarine Crocodile, the Sanctuary is rich in other reptiles, birds and mammalian population. Theses mangrove forests are good habitat for King Cobra, Indian Python and Water Monitor Lizard.

9.16.5.1. Aquatic Ecology

The aquatic floral and faunal diversity comprises of Amphibians, Fish, phytoplankton, zooplankton, zoo-benthos including macro-invertebrates and higher vertebrates. Near vicinity of Bhitarkanika Wildlife Sanctuary / National Park increase the biodiversity and presence of endangered aquatic biodiversity in the project stretch.

Impacts due to maintenance dredging are impact on behavioural response & tissue injury of aquatic organism due to increased noise levels, blocking of fish gills due to increased sediments, intake of toxic pollutants by aquatic fauna as released during dredging.

Fishes and other aquatic mammals are subjected to threat of collision by vessel speeds causing injury and death. Smooth Coated Otter and Crocodile are rarely sighted species and prefers to rest on wetlands of riverbanks, noise impacts are anticipated negligible due to its fast attenuation.

Materials like coal, oil, building construction material, textiles, fertilizers etc. are proposed to be transported through the waterway. In case of accidents these materials can spill in the River and may pollute the water quality and may have significant impact on aquatic ecology.

9.16.5.2. Terrestrial Ecology

No major forest area is observed along the proposed waterways stretch. The riparian flora consists of commonly found trees, shrub and herb species. In absence of any dense forest alongside proposed waterway, no significant terrestrial fauna has been observed during field study. However, forest dept. record and I Bat Tool reflect the presence of Asian Elephant, Black Buck, Sloth Bear and Tiger in nearby forest areas. Study area has good biodiversity in terms of fauna. Some of those species are near threatened or endangered like Eagle, Vulture, etc.

Dredging activities shall have very limited impact on fauna and terrestrial ecology as dredging shall be confined within the impact zone (may be of 500 m or less) and duration of dredging only.

Development of the civil interventions may require clearing of the vegetation from the proposed site. However, most of civil intervention impact shall be limited in proposed terminal areas.

Positive impact on ecology is also anticipated due to development of peripheral green belt and avenue plantation. Green belt will provide excellent habitat to avifauna, insects, small animals like squirrels, lizards, chameleons etc. Tree survival rate will be monitored and will be maintained to minimum 75%. Proper after care will be done for the planned green belt and this has separate budgetary provision under the EMP.

9.16.6. Impact on Land

Land use along the proposed waterway is majorly agriculture land followed by settlement and some vegetation areas.

Impact due to maintenance dredging on land environment is anticipated only due to dredge disposal. Impact in terms of land and soil contamination is expected if the dredged material was found contaminated by pollution load of nearby areas.

Waste generated from barges if disposed off at the terminal facilities or nearby areas may also impact the soil quality. Thus, control measures should be taken to prevent any unauthorized waste/sewage dumping so as impact can be avoided.

Solid waste to be generated during the operation phase includes waste generated at terminal sites and waste generated in vessels which is to be received at terminal sites till the time vessel maintenance and repair facility is developed. The waste may include food waste, plastic, metal tins, papers, dredged sediments, Sewage Treatment Plant (STP) sludge, e-waste and used oil from Diesel Generator (DG) sets at terminal site and. These impacts could be significant and may persist for long periods if left unaddressed and unless mitigated. Hence, appropriate mitigation measures are warranted to minimize the impacts.

9.16.7. Impact on Socio-Economy

Due to project activity, socio-economic condition of the area is benefited such as local employment generation and better transportation system.

Some of the negative impacts will be dismantling of bamboo bridges, which will be proper, mitigated.

9.17. EMP and Mitigation of Environmental Effects

The Environmental Management Action Plan is required to ensure sustainable implementation and operation of proposed waterway. Management plan has been drawn based on-site visit findings and assessment of project impact based on past experience. However, a detailed Environment Management shall be formulated during EIA Stage of the project.

9.17.1. Environment & Social Management Plan

Mitigation measures have been planned for identified adverse impacts. The project impacts and management plan suggested thereof are summarized in table below.

Table 9-12: Probable Impact and Mitigation Measures

Particulars	Stages	Potential Impacts	Mitigation Measures
Physiographic Environment			
Topography	Pre-construction & Construction	• Slight changes are expected due to proposed project • Impacts are marginal, but permanent	• Proper planning to keep the land reformation up to bare minimum
Land & Soil			
Contamination	Construction & Operation	• Disposal of dredged material • Disposal of barges waste	• Scientifically demarcated areas for disposal of contaminated waste and dredged material.
Induced Development	Preconstruction & Construction	• Insignificant change in the land use pattern	• Civil authorities to plan and guide any induced development using the prevailing regulatory framework
Water			
Impact on Water Resource	Design, Preconstruction, Construction & Operation	• Increase in turbidity; reduced light transmittance; reduced DO during dredging • Dumping or leakage of vessels generate garbage, oily waste, sewage, bilge water & ballast water	• Effective study of river profiles to reduce dredging quantity. • Wise selection of dredger depending on strata and depth and use of Cutter Section Dredgers (CSDs) • Management of wastewater, oily waste,

Particulars	Stages	Potential Impacts	Mitigation Measures
		• Usage of anti-fouling paints as the paints may contain toxins. • Ship accidents/collision may lead to spillage of the commodities transported including oil which may impact the water quality of the river.	bilge water, noxious waste (if any), air emissions and garbage from vessels as per MARPOL • All maintenance & repair works should be carried out at designated locations only. • Only toxin-free paints should be used for anti-fouling purpose. • Experienced crew should be hired to minimize the possibility of accidents.
Climate			
Temperature / Rainfall / Humidity	Preconstruction & Construction	• Heat Island Effect near paved areas • Slightly heat increases due to movement of ship and Cargo • Tree felling will have an impact of micro-climate of the area	• Compensatory afforestation of the trees to be cut as per Forest Dept. guidelines • With the proposed avenue plantation scheme, the microclimate of the project corridor will be smoothening
Air			

Particulars	Stages	Potential Impacts	Mitigation Measures
Dust generation	Preconstruction& Construction	• Removal of trees & vegetation, • Transportation of construction material	• Regular Sprinkling of Water • Fine materials to be completely covered, during transport and stocking. • Regular monitoring of particulate matter in Ambient Air
Gaseous pollutants	Preconstruction, Construction & Operation	• Vehicle operation for material transportation • Emission from dredgers • Barges emission	• Air pollution Norms will be enforced. • Only Pollution Under Control (PUC) certified vehicles and machineries shall be deployed • Labourers will be provided with mask. • Regular gaseous pollution monitoring in ambient air
Noise			
Dredging Activity	Construction	• Noise generation due to dredging activities	• Dredging activities should be limited for daytime near to settlement areas • Dredging should be limited for navigation channel only

Particulars	Stages	Potential Impacts	Mitigation Measures
Barges Operation	Operation	• Noise due movement of barges	• No hooters sign near sensitive and residential areas
Ecology			
Flora	Preconstruction, Construction	• Loss of vegetation cover • Felling of trees	• Felling of only unavoidable trees • Compensatory Afforestation as per Forest Dept. guidelines
Fauna	Preconstruction, Construction & Operation	• Impact on behavioural response & tissue injury of aquatic organism due to increased noise levels, • Blocking of fish gills due to increased sediments, • Fishes and other aquatic mammals' collision by vessel speeds causing injury and death. • Accidental spillage of materials like coal, oil, building construction material, textiles, fertilizers etc.	• Use of CSDs and proper planning of dredging activities should be carried out • Maintenance of speed to avoid any collision • Regular maintenance of barges
Social			

Particulars	Stages	Potential Impacts	Mitigation Measures
Socio Environment	Design, Preconstruction & Construction	• Disturbance due to noise generating activities	• Noise generating activities near to settlement areas shall be limited during day time only • No hooter sign during operation phase

9.17.2. Implementation of EMP

The Environmental Officer of the Contractor should be available for the entire construction period of the project. The Environmental Officer shall be primarily responsible for compliance of EMP. The Environmental Specialist of the Monitoring Consultant who should ideally be deployed for the entire duration shall monitor the compliance of the EMP. However, prime responsibility of implementation lies with IWAI.

9.18. Applicable Legal and Regulatory Framework

The Government of India has formulated various policy guidelines; acts and regulations aimed at protection and enhancement of environmental resources. The following table surmises the existing legislations pertaining to the project, the various clearances required for the project and the status as on date. The summary of environment laws and their applicability is given in Table below

Table 9-13: List of Legal & Regulatory Framework

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
1	The Environmental (Protection) Act. 1986, and the Environmental (Protection) Rules, 1987-2002 (various amendments)	Umbrella Act. Protection and improvement of the environment. Establishes the standards for emission of noise in the atmosphere.	Yes (By Project Proponent)	All environmental notifications, rules and schedules are issued under the act	MoEF & CC, State Dept. of Environment & Forest, CPCB and SPCB
2	The EIA Notification, 14th September 2006 & subsequent amendments	Considered Not Applicable (EIA Notification 2006 does not classify terminals on river or dredging in the river as a project requiring environmental clearance. The applicability of	No	Considered Not Applicable as EIA Notification 2006 does not classify terminals on river or routine dredging in the river as a project requiring environmental clearance. The applicability of this legislation should be reconfirmed during Commencement stage.	MoEF & CC & SEIAA

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
		this legislation should be reconfirmed from the concerned authority).			
3	The Water (Prevention and Control of Pollution) Act, 1974	Central and State Pollution Control Board to establish / enforce water quality and effluent standards, monitor water quality, prosecute offenders, and issue licenses for construction / operation of certain facilities.	Yes (By Contractor)	Consent required for not polluting ground and surface water during construction and operation	State Pollution Control Board
4	The Air (Prevention	Empowers OSPCB to set	Yes (By Contractor)	Consent required for not polluting	State Pollution Control Board

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	and Control of Pollution) Act. 1981	and monitor air quality standards and to prosecute offenders, excluding vehicular air and noise emission.		ambient air quality during construction and operation phase	
5	Noise Pollution (Regulation and Control) Act, 1990, 2010 and its subsequent amendments.	Standards for noise emission for various land uses	Yes (By Contractor)	Construction including dredging and barge movement to conform to the prescribed standards	State Pollution Control Board
6	Forest (Conservation) Act, 1980 its subsequent amendments.	Conservation and definition of forest areas. Diversion of forest land follows the process as laid by the Forest Conservation Act.	No	Based on analysis of Forest Map available at GIS Website of Odisha (http://gis.ori.nic.in/) developed and run by NIC, no forest land is located alongside the project river stretch. Presence of revenue forest land	State Forest Department, MoEF & CC

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
				shall be established in project execution stage.	
7	Coastal Regulatory Zone Notification, 2011 its subsequent amendments.	Protect and manage coastal areas	Yes (By Project Proponent)	CRZ Clearance would be required.	MoEF, State Department of Environment
8	Wildlife Protection Act, 1972 its subsequent amendments.	Protection of wildlife in sanctuaries and National Park	No If yes (By Project Proponent)	Bhitarkanika Wildlife Sanctuary found adjacent to project vicinity. Hence, WL clearance / NOC will be required before commencing any developmental activities in this region.	NBWL, SBWL & Chief Wild Life Warden
9	Ancient Monuments and Archaeological sites & Remain Act 1958 its	To protect and conserve cultural and historical remains found.	No	No archaeological monuments found within the project vicinity	Archaeological Survey of India, State Dept. of Archaeology

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	subsequent amendments.				
10	The Motor Vehicle Act. 1988 its subsequent amendments.	Empowers State Transport Authority to enforce standards for vehicular pollution. From August 1997, the "Pollution Under Control Certificate is issued to reduce vehicular emissions	Yes (By Contractor)	All vehicles used for construction will need to comply with the provisions of this act.	State Motor Vehicles Department
11	Public Liability and Insurance Act,1991	Protection to the general public from accidents due to hazardous materials	Yes (By Contractor)	Hazardous materials like Bitumen shall be used for road construction	Ministry of Law and Justice
12	Hazardous and Other Wastes (Management,	Protection to the general public against	Yes (By Contractor)	Hazardous wastes shall be generated due to activities like	State Pollution Control Board

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	& Transboundary Movement) Rules, 2016 and its subsequent amendments'	improper handling and disposal of hazardous wastes		of maintenance and repair work on vehicles	
13	Construction and Demolition Waste Management Rules, 2016 and Solid Waste Management Rules 2016	Safe disposal of construction waste and municipal solid waste	Yes (By Contractor)	Construction waste shall be generated due to the demolition of existing structures and municipal waste shall be generated from the construction worker camp	State pollution Control Board
14	Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996	Protection against chemical accident while handling any hazardous chemicals resulting	Yes (By Contractor)	Handling of hazardous (flammable, toxic and explosive) chemicals during road construction	District & Local Crisis Group headed by the DM and SDM
15	The Building & Other Construction	Employing Labour / workers	Yes (By Contractor)	Employment of labours	District labour Commissioner

S. No.	Law / Regulation / Guidelines	Relevance	Applicability (Yes / No)	Reason for Application	Implementing / Responsible Agency
	Workers (Regulation of Employment & Conditions of Service) BOCW Act, 1996				

9.19. Need for Environmental Clearance

Considered Not Applicable as EIA Notification 2006 does not classify terminals on river or dredging in the river as a project requiring environmental clearance. The applicability of this legislation should be reconfirmed from MoEFCC during commencement stage.

No construction activities shall be carried out within 10 Kms radius from the Wildlife Sanctuary, hence Wildlife Clearance is not required. However at the time execution any Wildlife study required will be carried out asper instructions received from the Statutory Authority.

9.20. Other Major Clearances / Approvals / Permits Applicable to the Project

- CRZ Clearance is required,
- Wildlife clearance not required refer Section 9.20
- Forest diversion not required for approach roads as well as terminal.
- However, at the time execution any tree felling if required, permission from the statutory authority shall be taken

9.21. Cost Implication

As per the scope of services for further environmental and social impact assessment (EIA & SIA) studies and requirement of obtaining all mandatory statutory clearances for the project approximately 1 to 1.5 year is adequate period for consultancy services (1 year

for non-CRZ and 1.5 year for CRZ waterways) related to EIA & SIA studies. In this regard, the project authority may engage to QCI/NABET accredited EIA consultant for Category – A projects, who shall conduct rapid EIA & SIA studies and shall prepare a stand-alone EMMP (EMP & EMoP) for inclusion in the contractor bid documents. The generation of environmental baseline data at pre-construction stage along with environmental monitoring during construction and operation stages shall be carried out by the NABL/MoEF&CC approved laboratory to assess the project performance during entire project cycle.

9.21.1. Estimated Cost at Pre-Construction Stage

As, the statutory fee shall be paid by the project authority for obtaining all mandatory statutory clearances. The estimated environmental and social budget for EIA-EMP & SIA studies have been summarized below:

Table 9-14: Cost for Environmental Study and Monitoring

Item No.	Component	Description	Unit	Quantity	Unit cost (INR)	Total cost (INR)	
						Detail Cost	Cost in Crores
1	**Environment Study Cost**						
1.1	*Detailed EIA	Detailed Environment Impact assessment study for Multilateral funding or MoEF & CC as the case may be	Nos.	1	20,00,000.00	20,00,000.00	0.200
1.2	*Wildlife Clearance / NOC Consultancy	Requirement of Wildlife NOC / Clearance	Nos.	1	15,00,000.00	15,00,000.00	0.150
1.3	*Tree Felling Permission and Forest Clearance for revenue forest (If any)	Advisory services	Nos.	1	10,00,000.00	10,00,000.00	0.100
2	**MONITORING COST**						

Item No.	Component	Description	Unit	Quantity	Unit cost (INR)	Total cost (INR)	
						Detail Cost	Cost in Crores
2.1	Air	Sampling and monitoring ambient Air Quality and gaseous pollutants as per CPCB Standard Procedures at 2 locations on once in a month basis for 2 years	No. of Samples	48	10,000.00	4,80,000.00	0.048
2.2	Water Quality	Collection of grab samples of water quality at 2 locations 5 years (twice a year) in pre-& post monsoon seasons	No. of Samples	20	10,000.00	2,00,000.00	0.020
2.3	Noise	Monitoring Noise level near jetties at 2 locations on six monthly basis for 2 years	Nos.	8	5,000.00	40,000.00	0.004
2.4	Soil	Collection of grab samples of water quality at 2 locations 5 years (twice a year) in pre-& post monsoon seasons	No. of Samples	20	5,000.00	1,00,00.00	0.010
TOTAL COST						**53,20,000.00**	**0.532**
Contingency @ 5% on Total Environmental Cost						**2,66,000.10**	**0.026**
GRAND TOTAL						**55,86,000.00**	**0.558**

*- based on past experience and may vary at the time of commencement based on Consulting Scope and Quality

10. INSTITUTIONAL REQUIREMENTS

10.1. Organizational Set up / Establishment

The organizational set is aimed at enabling effective implementation of decisions and proper monitoring of progress with correction of shortfalls and clearing bottlenecks. Facilitating co-ordination and co-operation between the various stake holders for easy interfacing of the institution is ensured by the organizational set up. Due to the smaller size of project, Feedback has refrained from an extensive organization setup. However, we have endeavoured to account for adequate support staff for the smooth operations of the project.

It has been found that Govt. of India promulgated direction under section 111 of the Major Port Trusts Act 1963 to the selected Major Port Trusts for allocations of National Waterways (NWs) for undertaking the development of the National Waterways through release of grants by the IWAI. The Major Port Trusts are to be the implementing agency for development of the National Waterways. As per the above directions of Govt. of India, the River Baitarani (NW-14) has been allocated to the Paradeep Port Trusts for development.

a) Since, the River Baitarani (NW-14) has been allocated to Paradeep Port Trust for development, the manpower requirement for maintenance under the present scenario shall be an Officer at the level of Assistant Director (T.) and Junior Account Officer may be posted at Head Quarter, Noida and Bhubaneswar to monitor the various development works undertaken by the different Port Trusts for development of various National Waterways allocated and also monitoring the utilisation of fund.

b) Since the manpower will be deployed by the Paradeep Port Trust for maintenance and development of the River Baitarani (NW-14), the training of personnel shall not be required at the terminals.

Figure 10.1: Organizational chart

10.2. Man-Power Requirement

Major assumptions made in the calculation of the of the manpower are:

- The terminal operates only in the daytime and ~365 days per annum with 8hrs working time per day.
- Two terminalis proposed along the waterway – at Chandbali and Aradi.
- Vessels are operated by private parties.

Table 10.1: Manpower Requirement for Administration/Finance Department

Employee	Responsibilities	Nos.
Accountant	Prepare asset, liability and capital account entries by compiling and analysing account information - Summarize current financial status by collecting information, preparing balance sheet, profit and loss statement, and other reports	1

10.3. Training Requirement / Capacity Building

Since the manpower will be deployed by the Paradeep Port Trust for maintenance and development of the River Baitarani (NW-16), the training of personnel shall not be required at the terminals. The employees of each department must be capable doing the work assigned to them. Also, each department are required to provide necessary trainings for the employees if needed like terminal operation, ticketing operation, repair &maintenance, operation of communication systems, etc.

10.4. Cost Implications

As per the assumptions and criteria mentioned in the previous sections, an overview of the operating staff structure and costing is highlighted in the Table 10.4 below. Annual costs are projected at approximately Rs. 45,60,000 per annum.

Table 10-2: Costing of Staff Structure

Labour	**Nos.**	**Wage per annum per position (Rs.)**
Assistant Director (IWAI)	1	10,00,000
Junior Accountant	1	3,60,000
Total		**13,60,000.00**

11. PROJECT COSTING

11.1. General

The cost estimates for the project are extremely important as its entire viability and implementation depends on the project cost. In this section, cost estimate based on the preliminary engineering and analysis for the proposed inland waterway project is provided to meet the traffic requirement at various points in time.

Inland Waterway Transportation system cost is built upon the cost of development, operation and maintenance of following subsystems:

i. Fairway
ii. Terminal infrastructure

Note that cost of mechanical equipment (as no cargo traffic is projected) and vessels (as private vessels would operate on the waterway) has not been considered. The costing of each subsystem development is worked out and presented in the following sections. The detailed rate analysis for individual components, quantity, etc., is to be read from the cost estimate enclosed as Annexure I at the end of this report.

11.2. Basis of Costing

The estimate of capital costs has been worked out based on the project components as detailed in the previous sections and the schematic drawings presented as Vol. II at the end of the report. Detailed bill of quantities is worked out and the total project cost is derived from the following schedule of rates:

- Delhi schedule of Rates 2014 by CPWD
- Standard Data Book 2014 by Ministry of Road Transportation and Highways

Other aspects considered in the project costing are:

i. Rates for works that are not available in above standards were taken from the, budgetary quotes or discussion with suppliers.
ii. Resources in terms of experienced skilled labour, material and equipment is available locally
iii. The whole project takes one year for construction. Inflation of the rates during the construction period is not considered.

Actual costs may vary slightly from the provided cost estimates, depending on the construction timeline, changed market conditions, availability of materials, change of policy and other unlisted factors.

The details of costing with rate analysis, quantity estimate, and abstract are enclosed as Annexure 1.

The different options considered for costing are:

a.) Option 1: Using the option 1 for berthing structure considered in section 5.7.
b.) Option 2: Using the option 2 for berthing structure considered in section 5.7.

11.3. Development Cost

Development cost includes the cost of consultancy services like supervision, quality assurance and project management. Pre-project expenses have been taken at 2% of the capital cost of the project. Provision for engineering consultancy and project management has been made at 5% of the capital cost.

11.4. Capital Expenditure

While estimating the capital cost of the project, the development activities mentioned below are considered and expected that the works can be completed within period of wo years.

- **Fairway development** – includes dredging, river training and bank protection works
- **Terminal infrastructure development** – includes construction of a floating terminal and terminal buildings at 2 locations.
- **Utility shifting**- Modifying and adjusting the location of utilities like existing road through the terminal premises, water supply line, electricity cables, etc.
- **Auxiliary items-** Including firefighting, safety gadgets, public security services, fuel pump, water supply, workshop facilities, communication facility, lighting, internal road network establishment, etc.
- **Land scaping-** Pathway, horticulture development, lawn, etc.
- **Aids to navigation-** Ranges and marker buoys to enable safe navigation.
- **Navigation and communication systems -** Communication equipment like DGPS, VHF radio, etc. Details of Navigation and communication systems has been provided in Chapter 8.

The abstract of the capital cost for the proposed option, Option 1, yielding comparatively lower rate is given in Table 11.2 below and calculation can be read from Annexure I enclosed:

Table 11.1: Summary of Capital Expenditure

Sl. No.	Description	Total (in Rs.)
1	Berthing structure (one at Chandbali and one at Aradi)	Rs. 29,57,840.00
2	Terminal building (2nos.) (including land cost)	Rs.54,16,044.00
3	Fairway development (including dredging)	Rs 6,03,46,800.00.
4	Utility shifting	Rs. 10,00,000.00
5	Auxiliary items	Rs. 20,00,000.00
6	Landscaping	Rs. 5,00,000.00
7	Navigation and Communication	Rs. 2,44,30,000.00
8	Aids to Navigation	Rs. 13,00,000.00
	Total	**Rs. 9,79,50,684**

Table 11.2: Capital investment required for different options described in section 11.2

OPTION	COST (Cr.)
1	Rs. 9.79
2	Rs. 11.65

11.5. Operational and Maintenance Expenditure

The annual operational and maintenance expenditure on the different components of the project should be asserted taking in to account the life of component, repair and maintenance requirements and wages of personnel and cost of consumables. For a correct assessment of this expenditure, the maintenance schedule for each structure and equipment should be determined, personnel strength fixed, and requirement of consumables quantified. Even then, the estimation cannot be precise because of the unpredictable breakdown necessitating considerable expenditure on repairs and replacement. The only practical approach in the situation is to fix the annual expenditure

as a percentage of the capital cost of the project. This percentage is to be judged based on the past performance of similar structures and equipment functioning.

11.5.1. Operation Cost

The operational cost of the waterway includes the following:

Labour	Nos.	Wage per annum per position (Rs.)
Assistant Director (IWAI)	1	10,00,000
Junior Accountant	1	3,60,000
Total		**13,60,000.00**

11.5.2. Maintenance Cost

The maintenance of Inland Waterways System is proposed to be handled by the SPV through the construction agency for a period specified in the tender document. Afterward operations and maintenance shall be handled through the combination of in-house capacity building & outsourcing.

It has been observed that there will be requirement of dredging and channel marking which are to be executed annually to maintain the navigable depth throughout the year. It is presently assumed that some 5% of the capital dredging will be required to be undertaken as maintenance of dredging in each year. The need for maintenance of terminal infrastructure is less noticeable than in the case of mechanical equipment or electrical supply breakdowns where the need for maintenance is obvious.

The percentage for the various items of the project normally adopted is as follows:

i. Dredging and river training -5%
ii. Bank maintenance – 1%
iii. Auxiliary Items – 1%
iv. Civil works – 1% (on land); 2% (in water-front)
v. Aids to navigation – 2%
vi. Navigation and communication - 5%

The annual operational and maintenance cost of the project is estimated at Rs. 80 Lakh. The abstract of the same is shown in the following Table 11.3

Table 11.3: Summary of Operation and Maintenance Expenditure

Sl. No.	Description	Percentage of capex	Amount (Rs.)
I	**Fairway**		
1	Dredging	5.00	Rs. 89,840.00
2	Bank maintenance	1.00	Rs. 1,34,000.00
3	Aids to navigation	2.00	Rs. 26,000.00
4	River training	5.00	Rs. 14,50,000.00
II	**Terminal Infrastructure**		
1	Terminal operations (salary of staffs)	Chapter 10	Rs.45,60,000.00
2	Terminal maintenance	1.00	Rs. 45,260.44
3	Navigation and communication	5.00	Rs. 12,21,500.00
4	Berthing structure	5.00	Rs. 1,47,892.00
5	Landscaping	1.00	Rs. 5,000.00
6	Auxiliary items	1.00	Rs. 20,000.00

11.6. Phasing of Expenditure

As described in the previous sections, the water way development is **proposed to construct in a single phase** and the project costing for the same is also presented.

12. IMPLEMENTATION SCHEDULE

12.1. Time Frame

For timely completion of projects planning and implementation of various modules is important. It should be noted that the timeframes have been estimated based on an assumed construction methodology. The EPC contractor may choose a different construction methodology depending on their capability and understanding and this may change the calculations presented below. It should also be noted that delays in project implementation due to environmental or other statutory approvals, financial closure, construction delays etc., have not been factored in the implementation schedule.

The development can be divided into pre-construction and construction activities. Various activities identified under pre-construction are:

i. Clearance from various authorities
ii. Preparation of tender document
iii. Tender process

Given the requirement of procuring appropriate environment clearances and conducting the entire tender process (preparation of documents, pre-bid queries, contract awarding, work order signing etc.), it is assumed that above mentioned activities would require about **one year** after Government's approval Various activities identified under construction are:

i. Dredging:
   Dredging is the major activity in the development of the channel, which is critical. In this implementation schedule it is assumed that the whole of the drudging will be carried out in as a single contract and can be completed within 6 months after commencing work.
ii. Bank protection works:
   As part of river training works, bank protection works is found mandatory at identified locations. The construction of the same can be started in the initial stage and assumed that can be completed within five months.
iii. Construction of terminal structures:

Construction of terminals is an important stage in the development of waterway projects.

iv. Procurement of vessels and navigation aids:

The procurement of navigation aids and other equipment can be so planned that the same and construction of floating terminals are completed simultaneously.

v. Commissioning:

After completion of whole work within nine months, the waterway will be ready for commissioning by concerned authorities. The bar chart for implementation schedule is prepared and presented in following Figure 12.1.

12.2. Phasing

It is planned that the development of waterway system will take place in a single phase. It includes all development works including fairway development and terminal infrastructure development.

Figure 12.1: Implementation Schedule proposed for the Project

		Months													
Sl No	Item	6 Months		7	8	9	10	11	12	13	14	15	16	17	18
1	Clearances from local, State or Central govt./agencies														
2	Dredging														
3	Embankment Protection														
3a	Arranging stones for construction														
3b	Placing rip rap and vegetal cover														
4	River training by creating cut-offs														
5	Fabrication of steel structure for trestle and roof truss														
6	Construction of sub structures for trestle support and for terminal building														
7	Construction of the pontoons														
8	Construction of terminal building superstructure														
9	Procurement of aids to navigation and other equipment for firefighting, communication, etc														
10	Providing water supply, electrification, lighting, etc														
11	Landscaping and opening the facility for public														

12.3. Suggested Implementation Mechanism

To develop the project and to manage the common infrastructure facilities, it is necessary to establish an independent institutional framework under the IWAI, the implementing agency. This shall be in the form of Special Purpose Vehicle (SPV). SPV shall be the agency for service delivery, operation and maintenance of the Project. The option of SPV owned by the Government entities is best suited for the Baitarani inland waterway development and operation. However, private entities may hold some equity in the SPV, but less controlling stake. Thus, for all practical purpose, the SPV would be a Government entity. In the construction phase of the proposed project IWAI shall be the main implementing agency. IWAI shall create a focused SPV manned by the qualified & experienced professional & multi-disciplinary technical team dedicated to the planning and management of the project. The process of awarding the contract shall be on tender or deposit basis. SPV shall invite, process and award the tenders. As and when necessary the SPV shall invite the offer from government construction agencies on limited tender or deposit basis. An apex coordination committee shall be formed to co-ordinate between the departments related to the project and issue guidelines to the SPV for execution of the works. A policy framework and operating manual containing detailed system and structure of execution shall be prepared for effective control and delivery of the services.

The entire construction (including capital dredging) would be through EPC contracts. The maintenance of Inland Waterways system is to be handled by the SPV through the construction agency for a period specified in the tender document. Afterward O&M shall be handled through the combination of in-house capacity building & outsourcing. The revenue connected with these activities will also be collected by the SPV in the shape of tariff & user charges. SPV will also have to be provided with the necessary power for building byelaws for efficient functioning of Inland Waterways System.

It is recommended that the SPV have full right to fix its own tariff, based on the market realities. SPV should involve the private sector participation in as many as possible with a view to achieve higher efficiency with participation in the construction, operation and maintenance (after a suitable time lag).

12.3.1. Options for Private Sector Participation

The options for private sector participation can be ranged along a spectrum. At one end are those in which the government retains full responsibility for ownership, operations, maintenance, capital investment, financing, and commercial risk – at the other, those on which the private sector takes on much of these responsibilities.

The private participation can take one of the following forms:

- Service contract
- Management contract
- Lease
- Concession

Service contracts secure private sector assistance for performing specific tasks – operations and maintenance of channel, vessels etc. their main benefit is that they take advantage of private sector expertise for technical tasks or open these tasks to competition. Service contracts are the best a cost-effective way to meet technical needs for a project that is already well managed.

Management contracts transfer responsibility for the operations and maintenance of government owned business to the private sector. It ranges from paying a private firm a fixed fee for performing managerial tasks to sophisticated management contracts with incentives for efficiency, by defining performance targets and basing remuneration at least in part of their fulfilment. Management contracts leave all responsibility for investment with the government. Management contracts are likely to be useful where main objective is to rapidly enhance a private sector player's technical capacity and its efficiency in performing specific tasks, or to prepare for greater private involvement.

Under a lease agreement a private firm leases the assets from the government and takes on the responsibility for operating and maintaining them. Leases leave the responsibility for financing and planning investments with the government. So, if major new investments are needed, the government must raise the finance and coordinate its investment program with the operator's operational and commercial program. Leases are most

appropriate where there is scope for big gains in operating efficiency but only limited need or scope for new investments.

A concession gives the partner responsibility not only for the operational and maintenance of a project's asset but also for investments. Asset ownership remains with the government, however, and full use rights to all the assets, including those create by the private partner, revert to the government when the contract/concession ends-usually after 25 to 30 years there are several variants of concession viz. Build Own Operate(BOD), Build Operate Transfer (BOT), Build Own Operate and Transfer(BOOT), etc.

The proposed project implementation structure for the proposed Baitarani Inland Waterway project is outlined below

- IWAI owns the project with no involvement of private sector participant. All capital and maintenance works shall be implemented through contracting system prevalent in the IWAI.

13. ECONOMIC AND FINANCIAL ANALYSIS

This chapter analysis the viability of the project from financial and economic perspectives. Only the ~40 km stretch of waterway has been considered for analysis (as already recommended in earlier chapters). While financial analysis focuses on the project specific expenditures and revenues accounting for time value of money, economic analysis focuses more on larger socio-economic impact of the project in quantifiable terms.

As highlighted in the traffic analysis chapter, the projected waterway traffic comprises of tourist and local passenger traffic. The industrial cargo, mined sand, agriculture, Ro-Ro traffic has either not been found for the waterway or has not been recommended for the purpose of infrastructure and facilities development. Further, it has been suggested that the waterway should be developed with focus on tourism potential of the region.

13.1. Revenue

Three revenue sources have been considered as described below:

- **Passenger Charges**: Charges for terminal facilities, waterway development & maintenance. The usual fairway (waterway) charges have been included in this composite charge only. The charges would be payable at the Chandbali terminal by the boat operator. Note that, it is not advisable for IWAI to invest in boats, as it would increase CAPEX requirements. Further several operators have already invested in boats, and IWAI's parallel investment, would impact their employment severely, thus potentially creating controversy. Hence, it is advised that the existing boats should be brought under proper license regime to ensure compliance with safety and environment standards. The operator shall recover these charges from the tourists. Following charges are proposed[22]:

[22]The tourists currently pay INR 3,000 - 4,000 for ferry services taken from Chandbali to Bhitarkanika and ~INR 2,000 for Chandbali to Aradi (for ~15 seat boat with average utilization of 10 passengers). This translates to INR 300 – 400 per passenger (from Chandbali to Bhitarkanika) and INR 150 (from Chandbali to Aradi)

The charges considered in EIRR/ FIRR are IWA charges only for proviosion of better infrastructure facilities. The actual paasenger charges by the private boat operators are much higher – INR 300 – 400 per passenger (from Chandbali to Bhitarkanika) and INR 150 (from Chandbali to Aradi). Investment in boats has not been recommended to reduce CAPEX burden on IWAI Rate analysis based on the DSR and market rates provided.

  - Chandbali – Nalitapatia / Bhitarkanika (~60 km for return trip): INR 50 per passenger
  - Chandbali – Aradi (~50 km for single side trip): INR 25 per passenger
  - Chandbali – Talchua (~40 km for single side trip): INR 25 per passenger
- **Commercial Leasing**: INR 500 psf per annum at Chandbali and Aradi terminals (Total 1,000 sqft)

Based on the above revenue assumptions, following revenues are projected:

Table 13.1: Projected Revenues

(INR Crore)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Passenger Charge	0.3	0.3	0.4	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.6	1.9
Commercial Leasing	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Revenues	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.1**	**1.3**	**1.5**	**1.7**	**2.0**

13.2. Financial Analysis / FIRR

- Passenger Charge Escalation : 8% p.a.
- Lease Rate Escalation : 8% p.a.
- OPEX Escalation : 5% p.a.
- Manpower Escalation : 7% p.a.
- Discount Rate (WACC) : 10%

13.2.1. CAPEX

As detailed in previous chapter, the expected CAPEX in summarized below for reference. The CAPEX has been considered for option 1 for berthing structure (detailed in section 5.7)

Table 13.2: Expected CAPEX (Class I / Option 1)

Head	CAPEX (INR Cr)
Berthing structure (one on each bank at Chandbali and one at Aradi)	0.30
Terminal building (2nos.)	0.54
Fairway development (including dredging, river training, land acquisition)	6.03
Communication (RIS, VHF, Weather forecasting)	2.44
Aids to Navigation	0.13
Utility shifting	0.10
Auxiliary items	0.20
Landscaping	0.05
Total CAPEX	**9.80**

13.2.2. OPEX

As detailed in previous chapter, the expected OPEX in summarized below for reference:

Table 13.3: Projected Opex (Class I / Option 1)

Head	OPEX (INR Cr)
Dredging	0.01
Bank maintenance	0.01
Aids to navigation	0.00
River training	0.15
Terminal operations (salary of staffs)	0.46
Terminal maintenance	0.00
Navigation and communication	0.12

Head	OPEX (INR Cr)
Berthing structure	0.01
Landscaping	0.00
Auxiliary items	0.00
Total	**0.77**

The OPEX shown above are escalated at OPEX inflation rate for subsequent years.

13.2.3. Net Cash Flows

Pre-tax cash flows (for first 12 years) is shown below. Detailed Cash flows are provided in the annexure.

Table 13.4: Projected Pre-tax Net Cash Flows

(INR Crores)	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
CAPEX	9.8												
OPEX	-	0.9	1.0	1.1	1.2	1.2	1.3	1.3	1.4	1.5	1.6	1.7	1.8
Revenue	-	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.1	1.3	1.5	1.7	2.0
Net Cash Flows	**-9.8**	**-0.6**	**-0.6**	**-0.6**	**-0.6**	**-0.5**	**-0.5**	**-0.4**	**-0.3**	**-0.2**	**-0.1**	**-0.0**	**0.2**

The financial returns (FIRR) are (i) NPV: **INR (- 0.6) Cr** (ii) IRR: 9.8% p.a.

13.2.4. Sensitivity

The project returns have been calculated for variations in passenger charges, as they contribute the majority of revenues. The following table captures the sensitivity:

Table 13.5: Sensitivity Analysis

% Changes in Passenger Charges	NPV (INR Cr.)	IRR (%)
-45%	-11.6	4.0%
-30%	-8.0	6.5%
-15%	-4.3	8.3%
15%	-0.6	9.8%
30%	3.1	11.1%
45%	6.8	12.2%

13.2.5. Conclusion

It can be concluded that the project remains marginally viable with IRR of ~10% p.a.. The project should be developed with focus on tourism promotion and marketing of waterway as a tourist experience. However, the scale of project remains significantly small with CAPEX of only INR ~10 Crore.

13.3. Economic Analysis / EIRR

Inland waterways as a means of transportation has been harnessed worldwide in the face of expanding economies as it is considered as a preferred alternative due to its various direct and indirect benefits as mentioned in this section.

13.3.1. Direct Benefits

13.3.1.1. Employment Generation

Employment occurs both during the construction and operation phases of the transport infrastructure. Inland waterways perform several non-transport related functions that can be easily considered as benefits of economic assessment. In this case, boost to tourism activity in the region is bound to generate significant economic opportunities for the region in terms of hospitality, retail, boat operators etc. These are multiple occasion where the economy of a region revolves around tourism industry, and this catchment area also possesses the potential to replicate it here.

13.3.1.2. Creation of Business Opportunity

Due to the proposed project, the local economy can be promoted through income from barge / boat hires, mooring and licensing fee, water sports, luxury cruise boats, canoeing, and other recreational activities for further tourism development.

13.3.1.3. Environmental and Social Benefits

13.3.1.3.1. Carbon Saving

It is well established that waterway transport incurs significantly lower carbon emissions (due to better fuel efficiency) as compared to other modes of transport – rail and road. In case of this waterway, barge / boat transport is the preferred means of transport due to rive estuaries leading. The national park is an island at the end of river. Moreover, the road / rail transport network is relatively lacking in the area and people have been using waterway for even local transport. While barge / boat transport is already the preferred mode for tourist, steps need to be taken to ensure the vessels plying on the waterway are properly licensed taking into account manning requirements, emissions / discharge regulation, regular maintenance and safety & security provisions.

The shadow price of carbon is used to estimate the value of carbon saving in many government projects. The methodology is based on a damage cost approach and provides values for a tonne of carbon in any given year and requires the costs to be inflated annual to account for increased damages over time. The benefits of carbon savings arising from renewable energy production should be valued at the market price of carbon. The carbon shadow price value of damages on society at large due to emissions is 20$ / tonne. Reduction in carbon emission is a direct factor for damages on society which can be calculated based on this price.

13.3.1.3.2. Air / Noise pollution

Some of the most pervasive and intrusive sources of noise and air pollution are transportation systems. Air pollution comes from a wide variety of man-made and natural sources, with fossil fuel combustion as the largest contributor. Air pollution caused by transportation includes pollutants directly emitted by engines as well as secondary pollutants formed by chemical reactions. Road traffic is, by far, the greatest source of air emissions.

Water transport, conversely, causes far less air pollution than trucking, and less or comparable amounts, than rail. Cumulatively, it has a relatively minor effect on air quality, consumes much less energy (and thus, produces less air pollution) per tonne-km of freight carried than either rail or truck. For the most part, waterway operations are conducted away from population centres, which reduces the impact of its exhaust emissions. Little data exists on noise levels of barge operations, mainly because they are not considered a problem. Towboats operate well away from shore, with the sound of their engines muffled below the water line, and any noise levels are hardly audible beyond the immediate area of the town.

13.3.2. Indirect Benefits

13.3.2.1. Economic Boost

Inland waterways can generate an economic benefit in the form of property premiums beyond the average rent or sale of residential and commercial property. The available studies show that proximity to waterway has effect of price of property. There is an average 8-20% increase in value of land and properties around waterways. There has been significant increase of property prices around NW1 and NW2[23]. The actual economic benefit is location specific and depends on the existing property prices and rental rates in the area.

13.3.2.2. Operational Safety

Transporting cargo safely is an important measure of environmental responsibility, and water transport has the fewest number of accidents, fatalities, and injuries as compared to road or rail. Shallow-draft water transportation has definite advantages over competitive modes. It generally involves less urban exposure than either road or rail, operates on a system that has few crossing junctures, and is relatively remote from population centres – all factors that reduce both the number and impact of waterway incidents. Truck and rail tank car spills occur more often than barge spills. Barges, because of their much larger capacity, require far fewer units than either road or rail to move an equivalent amount of cargo, and so the chance of a spill is less likely.

23http://www.indianchamber.org/wp-content/uploads/2015/06/Sector-Update-Logistics.pdf

13.3.2.3. Land Usage and Social Impact

Since most of the right-of-way for water transport is provided by nature, navigation is less likely than other transport forms to compete with non-transportation uses for land area, an important consideration in urban locations. Extensive land area can be taken up by new highways and railroad corridors, but apart from a few connections and waterside terminals, waterways pre-empt very little land.

13.4. Socio Economic Returns

The following socio-economic impact is envisaged by the development of the waterways.

Table 13.6: Socio – Economics Returns (Moderate Scenario)

Parameter	Impact	Total Economic Impact (2030) INR crore	Total Economic Impact (2050) INR crore
Operation Efficiency (cost savings)[24]	1.44 per ton km	1.9	3.2
Job Creation[25] (monetary benefits)	INR 10 Crore per 1 lakh tourists	31.5	106.2
Total Economic Impact		**33.4**	**109.4**

Thus, the project provides significant economic and social benefits and further improves upon the viability of the project

It should also be noted that promotion of tourism traffic would require significant efforts on part of the governmental as well and may be critical in providing in initial impetus for boosting the tourism economy of the region.

[24] Calculated based on number of trips, 100 km distance for each trip and 10 ton average boat size
[25]Based on 300 new jobs for every 1 lakh tourists, average economic benefit of INR 3 lakhs per job

14. CONCLUSIONS AND RECOMMENDATIONS

From study of Baitarani river for the development of navigation channel, it can be concluded that:

- The whole 48 km of river studied is observed to be under tidal influence with no major hindrances to navigation in the stretch like barrages, dams, etc. The vertical and horizontal clearances of permanent crossing structures are satisfactory, and the clearance issues are paused only by temporary bamboo bridges which are beyond the considered stretch of Ch 27.24km.
- There is good tourism potential in the region. This can be explored.
- It is proposed to develop the river from Dhamra river confluence to Aradi as Class I waterway with minimum depth of 1.2m, bottom width30m and bend radius of 300m, with the berthing structure yielding comparatively lesser cost.
- The river requires training at few stretches owing to severe loops and meandering of the channel limiting desired bend radius, the channel needs minimum dredging of around 109377 cubic meters to maintain the depth of 1.2m corresponding to Class I characteristics, embankments near the terminal requires immediate protection owing to vessel wakes.
- The expected traffic potential is the one generated due to tourism and local passenger movement. This development can also improve the connectivity of local areas by providing a quick and cheap crossing service between the two banks of the river for both passengers and two-wheelers.
- The region is flood prone hence the terminal structure is proposed to be of that type which can accommodate the water level fluctuations, hence floating pontoon jetty with articulated access trestle is suggested.
- Vessels capable of serving the passenger traffic, local country boats and water sport vessels seem sufficient.

- It is proposed to have DGPS station and RIS network (including VHF and AIS) for the safe managing of the vessels along with facilities for receiving weather forecasts from IMD or other similar organizations. Significant cost savings can be achieved by merging RIS software and DGPS system being deployed for NW-64, for this waterway as well.
- The river is already having ferry service and the proposed terminal is beyond 10km lateral distance from the sea mouth, hence environmental clearance is not required. However, CRZ clearance is required.
- The cost for developing the river up to 27.24 km as Class I with one new terminal at Chandbali on south bank and one terminal at the Aradi location is around Rs. 9.80 Crores.
- It is proposed to complete the work within a period of 18 months including a One year for statutory clearances.
- It is observed that EPC mode of implementation is suitable for this kind of works.
- It is not recommended to develop the waterway for cargo transport and instead focus on upgrading the current tourism facilities. Hence, the economic and financial analysis of the waterway has been left out citing lack of cargo traffic and continuation of existing tourist services only

14.1. Recommendation

It is recommended to develop the river stretch up to Aradi as Class I, so that dredging quantity is relatively less, with one new terminal at Chandbali and using existing terminal at Chandbali to enable crossing between banks and another terminal at Aradi. The total cost works out to be Rs. 9.80 crores. In the future, once the traffic has developed, the waterway can be upgraded to Class III waterways.

15. TEMPLATES

15.1. Environmental & Social Screening

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	Yes		Bhitarkanika Wildlife Sanctuary / National Park is very adjacent to Start Point of the project at Dharma Estuary
b) Wildlife/ Bird Sanctuary		No	According to preliminary investigation and secondary sources
c)Tiger or Elephant Reserve		No	According to preliminary investigation and secondary sources
d)Biosphere Reserve		No	According to preliminary investigation and secondary sources
e) Reserved / Protected Forest		No	According to preliminary investigation and secondary sources
f) Wetland		No	According to preliminary investigation and secondary sources
g) Important Bird Areas		No	According to preliminary investigation and secondary sources
h) Mangroves Areas	Yes		In estuary
i)Estuary with Mangroves	Yes		Bhitarkanika is the second largest mangrove ecosystem of India
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting,		No	According to preliminary investigation and secondary sources

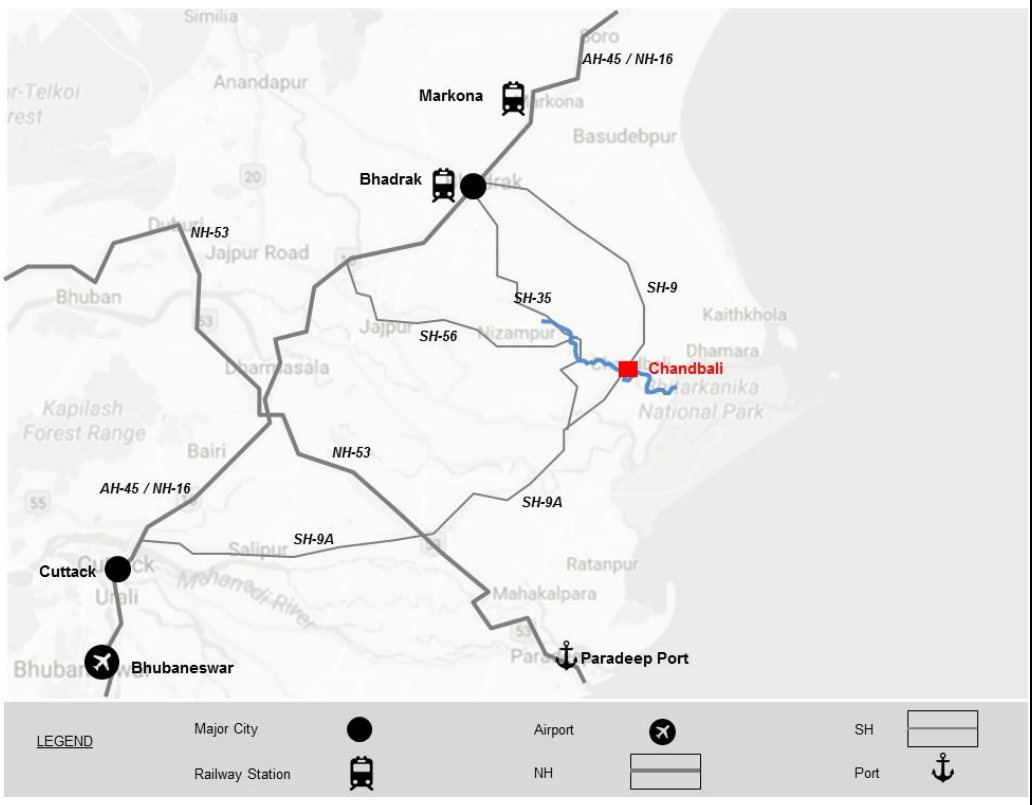
Screening Question	Yes	No	Details / Remarks
foraging, resting, over wintering, migration			
k) World Heritage Sites		No	According to preliminary investigation and secondary sources
l) Archaeological monuments/ sites (under ASI's Central / State list)		No	According to preliminary investigation and secondary sources
2. Is the project located in whole or part in / near any Critically Polluted Areas identified by CPCB?		No	According to preliminary investigation and secondary sources
3. Is, there any defines installations near the project site?		No	According to preliminary investigation and secondary sources
4. Whether there is any Government Order/ Policy relevant / relating to the site?		No	According to preliminary investigation and secondary sources
5. Is the project involved clearance of existing land, vegetation and buildings?		No	According to preliminary investigation and secondary sources
6. Is the project involved dredging?	Yes		To maintain depth of 2m
7. Is the project area susceptible to natural hazard (*earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions*)	Yes		Cyclone, inundation flood, lightning, etc.
8. Is the project located in whole or part within the Coastal Regulation Zone?	Yes		Area along some part of Baitarni River is notified and CRZ III area
9. Is the project involving any demolition of existing structure?		No	According to preliminary investigation and secondary sources
10. Is the project activity require acquisition of private land?		No	According to preliminary assumption

Screening Question	Yes	No	Details / Remarks
11. Is the proposed project activity result in loss of direct livelihood / employment?		No	No only eases the connectivity of the area, also tourism related employment opportunities can be improved
12. Is the proposed project activity affect schedule tribe/ caste communities?		No	No intervention

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

- (*) If any of the clearance like Hazardous waste, solid waste etc., shall be taken by the contractor (Executing Agency)

15.2. Traffic Template

Item	Guidance
The Catchment baseline	• Subject stretch is ~48 km; stretches from Duttapur Village to its confluence with Dhamra River. • Industrial development at Jajpur, Kalinganagar and significant port traffic at Dhamra Port • Chandbali is the only major town along waterway (population – 1 lakh). Bhadrak (~30km away) has a population of 1.2 lakh; handful of small villages along waterway with < 3,000 population each • Almost the entire area is agricultural land, forest area, pastures • Road connectivity: SH-9A (connects Cuttack), SH-9 (connects Bhadrak), NH-53 (Paradip to Jajpur) • Rail connectivity: Nearest stations at Bhadrak (53 km) and Markona (67 km); connected by SH-9 

The Navigation baseline	• Majorly passenger movement on following routes (i) Bhitarkanika (internal) (ii) Chandbali to Aradi (iii) Chandbali to Talchua / Dhamra (iv) Chandbali to Bhitarkanika • Total waterway passenger movement of 1.1 lakh in 2015-16 • Bhitarkanika national park received 80,000 tourists in 2016. Majority of tourist take ferry services from jetties of the park itself – Dangamal, Khola, Gupti, Nalitapatia • Some tourists also take ferry services for Bhitarkanika from Chandbali itself (30%-40% of National Park traffic) • Chandbali also handles tourist traffic to Aradi (~10,000 p.a.) and local passenger traffic to Dhamra / Talchua (~25,000 p.a.). Aradi has a small boating dock. • Industrial Traffic: No movement of industrial traffic along waterway; no industries in immediate catchment • Ro-Ro Traffic: minor Ro-Ro traffic limited to cross river light two-wheeler transport • Sand mining: minor movement of sand from upstream stretches to downstream; distributed consumption along the waterway stretch • Entire stretch is under tidal influence • Vertical and horizontal clearances are satisfied; some bamboo bridges present along the river but are temporary in nature
The Market baseline	• Only tourism and local passenger related traffic exists • 1.1 lakh waterway passengers in 2015 • Overall, more than 10 lakh tourists in the region in 2015. Includes lot of repeat tourist coming to Shiv temple and celebrate festivities in Aradi (mostly day visitors)

Forecasting years	• Total waterway traffic has been projects.
	• Tourist Traffic
	  ○ 2020: 1.3 lakh
	  ○ 2030: 3.0lakh
	  ○ 2050: 10.5 lakh
	• Local Passenger Traffic
	  ○ 2020:0.3 lakh
	  ○ 2030: 0.5 lakh
	  ○ 2050: 1.3 lakh
	• Only passenger traffic from Chandbali to Aradi, Talchua/Dhamra and Bhitarkanika has been considered for subject stretch
	• Tourist directly visiting the Bhitarkanika National Park and using its jetties have not been considered as it falls outside the scope of subject stretch

Presentation of forecasts	• Only passenger and tourist considered
	• **Proposed Circuits**
	  ○ **Chandbali – Aradi**: The passengers can take either a single side trip (returning by road) or return trip from Chandbali to Aradi
	  ○ **Chandbali – Dangmal**: The tourists can take return boat trip from Chandbali to Dangmal
	• Terminals proposed at Chandbali and Aradi. While both locations have existing jetties, new terminals would be required in view of increasing traffic and improving facilities.
	• Chandbali Terminal Traffic: 0.8 lakh (2020), 1.9 lakh (2030), 6.2 lakh (2050)
	• Aradi Terminal Traffic: 0.1 lakh (2020), 0.7 lakh (2030), 1.2 lakh (2050)

Market success factors	• Fleet – There are both government (2-3 vessels) and private vessel operating on the subject waterway stretch currently. • The region needs to be promoted as a tourist destination to attract significantly a greater number of tourists which can then be influenced to experience waterway tourism • Main loading / unloading points are Bhitarkanika, Chandbali and Aradi • Vessel type – Class I waterway provides sufficient headroom for tourist and water sport vessels
Forecasting Methodology	• Tourist traffic: 9% p.a. (based on increase in tourist footfalls in Odisha). 6% in steady state • Local Passenger traffic: 5% p.a. (based on population growth and increase in economic activity)
Alternative forecasts	• -

15.3. Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	• Land, compensation and resettlement: Rs. 1,61,50,000.00 • Dredging: Rs. 17,96,800.00 • River training: Rs.2,90,00,000.00 • Bank protection: Rs. 1,34,00,000.00 • Locks: Rs.0.00 • Barrages: Rs.0.00 • Channel marking: Rs. 13,00,000.00 • Night navigation: Rs.0.00 • Other (including utility shifting, auxiliary items, landscaping): Rs.35,00,000.00
	Terminal Infrastructure	• Fixed infrastructure: ✓ Terminal building: Rs. 45,26,044.00 ✓ Berthing structure: Rs. 29,57,840.00 ✓ Land Cost: Rs. 8,90,000.00 • Loading/uploading and other equipment: Rs.0.00 • Navigation and communication equipment: Rs.2,44,30,000.00 • Other: NIL
Operation and maintenance (O & M) costs	Waterways	• Dredging: 5%: Rs. 89,840.00 • Markings and nav.-aids: 2%: Rs. 26,000.00 • River training: 5% : Rs. 14,50,000.00 • Embankment protection:1% : Rs. 1,34,000.00 • Other (including utility shifting, auxiliary items, landscaping) 1%: Rs. 25,000.000
	Terminals	• Terminal operations: Rs. 13,60,000.00 PA • Terminal maintenance: 1% : Rs. 45,260.44 • Navigation and communication: 5% : Rs.12,21,000.00 • Berthing structure:5%: Rs. 1,47,892.00 • Other: NIL
	Vessel: (NB vessel operating costs/tons-km fall sharply with larger capacity	To be taken care by the private operator.

	vessel, when there is sufficient traffic to utilize them)	
Recurrent costs	Periodic major capital costs that may occur over life of assets	Except maintenance cost, no recurrent cost is noted for the period till 2050, unless any development plan to upgrade the Class of waterway is considered.
Price levels	-	
Value engineering	-	
Cost verification	-	

15.4. Economic Evaluation Template

Consultants shall adhere to the following standard approaches in estimating economic internal rate of return (EIRR)	
Item	**Requirements**
Objective	To assess economic internal rates of return (EIRR) on a consistent basis between different river projects.
Economic evaluation approach	Economic evaluation of each river upgrading project may include: • Capital and O & M costs of (a) navigation infrastructure and (b) terminals • Savings in transport resource costs between IWT and rail and/or road transport • Reduced barge operating costs (where the project facilitates more efficient sizes or operations of an existing barging operation) • Savings in road/rail accident costs • Saving in carbon emissions

Standard values	To ensure consistency between evaluations of different waterways the following should be used: • Road haulage costs: INR 2/tons-km • Rail haulage costa: INR 1/tons-km • IWT haulage costs: to be estimated by the studies depending on optimal barge size and configuration assumed for the specific waterway project • Road accident cost savings: INR 0.2/net tons - km/transferred to IWT • Rail accident costs savings INR 0.1/net tons-km/transferred to IWT • Carbon savings INR 0.1/tons-km transferred from road (nil for transfer from rail)
Other benefits	Other significant regional economic benefits such as stimulation of specific production may be described, and value of increased production included in EIRR if it can be properly substantiated.
Cash flows in real terms	All economic variables to be estimated in constant mid-2014 price levels (i.e. net of inflation)
Resource cost adjustments	Market prices may be taken as equivalent to resource costs for the purposes of the economic evaluation except for nominated items (to be confirmed)
Evaluation period	Initial construction period plus 25 years of operation with ramp-up consistent with financial evaluation.
EIRR	Estimate Overall EIRR. Give commentary explaining results, main costs and benefits, main drivers of the results and sensitivity to assumptions.
Checking and Replicability	Apply systematic checks of spreadsheets and logic trail from assumptions to outputs. Include in report and annexes such data, assumptions and spreadsheet calculations as are necessary for a reader to comprehend and if necessary, replicate the results presented.

15.5. Financial Evaluation Template

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
Objective	To assess financial internal rates of return and financial payback periods on a consistent basis between different river projects.
Financial evaluation approach	Financial evaluation of each river upgrading project should estimate and present actual cash flows (cost and revenues) at market prices within the inland waterway sector consisting of the three sub-sectors: (a) navigation infrastructure; (b) terminal operations; (C) barging operators.
Disaggregation	Cash flow streams and FIRR's to be provided for the inland waterway sector as a whole and also functionally disaggregated by the three sub-sectors. (The separation should be made even if in practice IWAI or another stakeholder might be involved in multiple sub-sectors). Pay –back should be estimated on a total sector basis.
Transfers between Subsectors	Cash flows between the three sectors (such as navigation charges, or terminal charges) should be shown as a negative cash flow to the paying sub-sector and a positive cash flow to receiving sub-sector so that the net cash flows to each subsector are best estimates of actual out-turn.
Incremental barging operations	Where the waterway is an extension of a bigger network, with through working of barges, it is the incremental costs and incremental revenue to barge operators of using the project waterway that should be included.
Cash flows in real terms	All financial variables and projections to be made in constant mid-2014 price levels (i.e. net of inflation)
Evaluation period	Initial construction period, plus 25 years of operation
FIRR and payback period	Estimate both FIRR (sector and sub-sectors) and overall sector payback period, the latter being the year in which the cumulative sector each flow becomes positive.
Ramp-up period	Unless good reasons otherwise, assume 4 years' ramp-up period from first operational year to long-term 'trend' levels of traffic
Commentary on FIRR	Explain overall sector FIRR results and distribution between sub-sectors. Identify main drivers of the results and sensitivity to assumptions

Risks to financial outturn	Identify main risks to the estimated project out-turn or viability and their underlying causes e.g. market risks (traffic, tariffs, and competition), hydrology risks, engineering risks, operational risks etc.
Checking and Replicability	Apply systematic check of spreadsheets and logic trail from assumptions to outputs. Include in report and annexes such data, assumptions and spreadsheet calculations as are necessary for a reader to comprehend and if necessary, replicate the results presented.