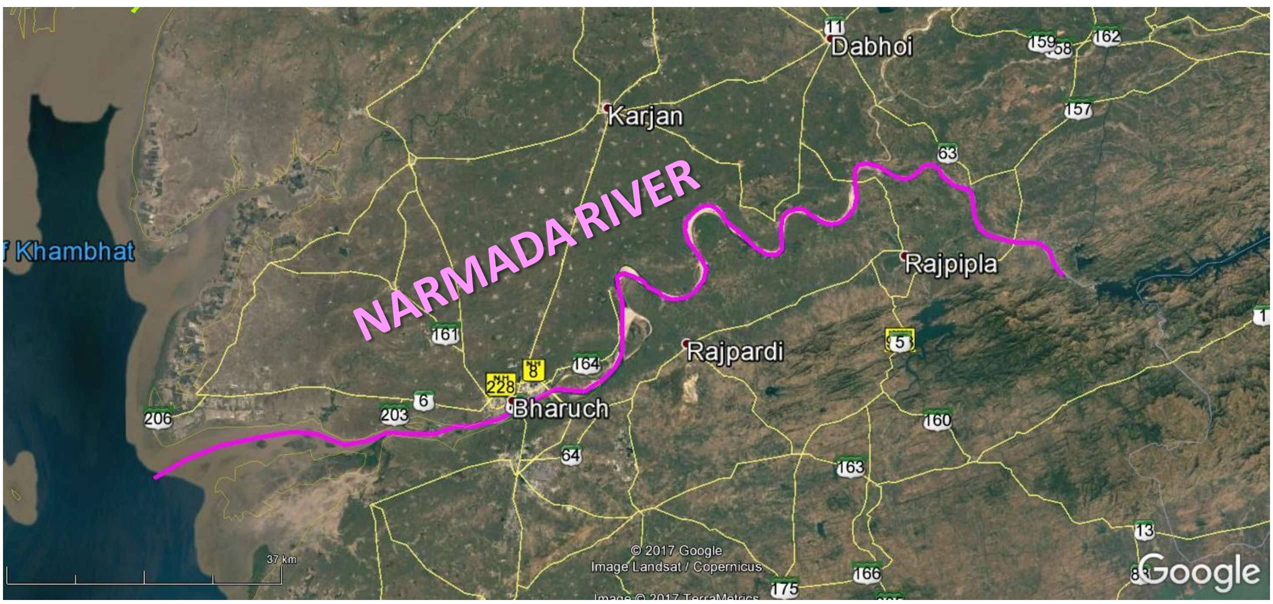
INLAND WATERWAYS AUTHORITY OF INDIA (IWAI)

CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 8 OF NATIONAL WATERWAYS



FINAL DETAILED PROJECT REPORT OF NARMADA RIVER
NATIONAL WATERWAY – 73
STRETCH - 0 Km TO 227 Km

VOLUME-I MAIN REPORT

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Acknowledgement

This Final Detailed Project Report is the outcome of detailed study of existing Hydrography, topography and traffic assessment along Narmada River. This vision is shared jointly by IWAI and WAPCOS Limited.

This report gives the present status of water-ways assets, topographic features, climatic variability, land use / land cover pattern, details of all cross structures along with socio-economic information of the waterway. Report also gives information Traffic and market assessment along the river for development of waterway. Report includes Preliminary Design, cost estimates and financial analysis of the project.

WAPCOS LTD. expresses their gratitude to **Mrs. Nutan Guha Biswas, IAS, Ex Chairperson** for sparing their valuable time and guidance for completing this Project. We would also like to thanks **Shri Pravir Pandey, Chairman (IA&AS); Shri Alok Ranjan, Member (Finance), Shri S.K.Gangwar, Member (Technical) and Shri Shashi Bhusan Shukla Member (Traffic)**

We also wish to express our gratitude to **Capt. Ashish Arya, Hydrographic Chief** for their guidance and inspiration for this project. We would also like to thank **Shri Rajiv Singhal, A.H.S.** for invaluable support and suggestions provided throughout the survey period. WAPCOS is pleased to place on record their sincere thanks to other staff and officers of IWAI for their excellent support and co-operation throughout the project period.

WAPCOS Team

Sector -18, Gurugram
Haryana- 122015

VOLUME-I: MAIN REPORT

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Sr. No.	Particulars	Details		
A.	**GENERAL**			
1.	***Location***	***Narmada River***		
a)	Cluster	8		
b)	State(s)	Gujarat		
c)	Co-ordinates& Name of Place	**Start**		**End**
	Place	Gulf of Khambhat		Pandharia Dam.
	Latitude	21°38'26.81"N		21°57'10.37"N
	Longitude	72°33'28.24"E		74°8'27.46"E
B.	**TECHNICAL**			
1.	***Waterway***			
a)	National Waterway Number	73		
b)	Class	Phase-1 - Class IV Phase 2- Class III Phase 3- Class IV		
c)	Type (Tidal/Non-Tidal)	Tidal & Non-Tidal		
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**
		226.343	89.5	136.843
d)	Average Tidal Variation, if applicable	Average 3.31 meter (0.7 to 7.68 meter)		
e)	Chart Datum	Reliance Dahej terminal (2.3 km chainage), CWC tide gauge, Bharuch (50.8 km chainage) for full tidal stretches **Downstream of Sardar Sarovar Dam** CWC water level gauge at Gaurdeshwar site (169.6km chainage) for non- tidal stretches **Upstream of Sardar Sarovar Dam** the Minimum Drawn Down Level (MDDL) value of 110.64 m from MSL is considered as the Chart Datum		
	Description/Basis	The established chart datum value of 5.09 m below MSL at Reliance Dahej terminal (2.3 km chainage) and CWC tide gauge, Bharuch (50.8 km chainage) was considered for the tidal reaches and for remaining tidal stretches, sounding datum was transferred by adopting standard admiralty method by observing 04 low water and 03 High water on corresponding tide gauges. For fixing chart datum/sounding datum; the non- tidal stretches are sub-divided as downstream and upstream stretches of Sardar Sarovar Dam.		

		Downstream of Sardar Sarovar Dam The difference between water level and Chart datum at CWC water level gauge at Gaurdeshwar site is correlated to the tide gauges established between 89.5 to 182.5 km chainage for computing sounding datum at respective stretches. **Upstream of Sardar Sarovar Dam** The record for average minimum water level for last 10 years could not be obtained from the Sardar Sarovar Dam authority, hence, to fix the chart datum on the upstream of Sardar Sarovar dam, the Minimum Drawn Down Level (MDDL) value of 110.64 m from MSL is considered as the Chart Datum and all sounding values are reduced to this level for chainages between 182.5 to 227 km.				
	Value	Dahej -5.09 CWC Bharuch +1.338 D/s of Sardar Sarovar Dam (CWC Gaurdeshwar) +13.433 U/s of Sardar Sarovar Dam +110.64				
f)	LAD Status (w.r.t. CD)					
		Stretch-1	**Stretch-2**	**Stretch-3**	**Stretch-4**	**Stretch-5**
	Stretch (From……To……)	**0-30 km**	**30-60 km**	**60-89.5km**	**89.5-120 km**	**120-150 km**
	Length with LAD < 1.7 m	20.3	8.1	19.2	13.9	13.1
	With LAD from 1.8-2.0 m	3.2	15.7	5.0	10.7	10.2
	With LAD > 2.0 m	6.5	6.2	5.3	5.9	6.7
		Stretch-6	**Stretch-7**	**Stretch-8**	**Total(Stretch 1-8)**	
	Stretch (From……To……)	**150-182.5 km**	**182.5-210 km**	**210-227 km**	**0–227km**	
	Length with LAD < 1.7 m	21.8	0	0	96.4	
	With LAD from 1.8-2.0 m	5.2	0	0	50	
	With LAD > 2.0 m	5.5	27.5	17	80.6	
		Grand Total			227	
g)	Target Depth of Proposed Fairway (m)	Phase-1 – 2.0m Phase 2- 1.7m Phase 3- 2.0m				
h)	Conservancy Works Required	-				
	Type of Work	**Phase-1**	**Phase -2**	**Phase-3**	**Total**	
	Dredging Required (M. Cum.)	0.95	3.43	1.04	5.42	
	Bandalling	No	No	No	No	
	Barrages & Locks	No	No	No	No	
	River Training/Bank Protection (Km.)	-				
i)	Existing Cross Structures					

	Name of Structure	Type	Nos.	Range of Horizontal Clearance	Range of Vertical Clearance w.r.t. HFL/MHWS
	Dams/Barrages/Weirs/Aqueducts etc.	Under Construction Weir	1	NA	NA
	Bridges	1 Rail & 8 Road Bridges	9	10.27 m to 144 m	No VC to 20.15 m
	HT/Tele-communication lines	23 HT Lines& 1 Crane Cable	24	300 m to 1513 m	10 m to 52 m
	Pipelines, underwater cables, etc.	Sub-bedded high pressure gas line	1	NA	NA
	Bhadbhut Barrage	Near Bhadbhut Village			

2.	***Traffic***	
a)	Present IWT Operations (type of services)	The starting chainage of Narmada river is used for navigation upto 20 km chainage (Shoft Shipyard, Kaladhara). They are building small and medium vessels upto 100 m length and use this waterway to launch and deliver vessels during high-water time.
b)	Major industries in the hinterland (i.e. within 25 km. on either side)	Narmada District: - The major industrial zones near the area of interest are Rajpipla, Rajpipla Phase-2, Sagbara, Dediyapada and Tilakwada. Rajpipla is the district headquarters and prominent industrial area that includes Food processing & Agro based industries, Plastics, Pharmaceuticals, electronic & electrical, engineering items, Chemical & Allied products, Mechanical based items, livestocks, mineral based industries and forest based industries Bharuch District: - The major industrial zones near the area of interest are Dahej, Bharuch, Ankleshwar and Jagadia. The industries include chemicals & petrochemicals, textiles, drugs & Pharmaceuticals, ports and Shipbuilding.
c)	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	Bharuch is the nearest railway station located near to the Area of interest. The other railway's stations near to the survey stretch are Ankleshwar, Jhagadia, Chandod and Rajpipla The area is well connected with road network to other cities like Bharuch, Dahej, Ankleshwar, Rajpipla, Vadodara and Surat
d)	Commodities	Naptha and Containerized Cargo
e)	Future Potential (MMT)	

	Name of Commodity (mnTonnes)	5 years	10 years	15 years	20 years	25 years
	Cargo (Terminal 1)	1.0	1.0	1.0	1.0	1.0
	Containerized Cargo (Terminal 4)	-	-	0.2	0.5	1.1

3.	***Terminals/Jetties***	
a)	Terminal/Jetty - 1	Cargo Terminal at CH 11 Km
	Location (Bank/city/district)	Ambetha, Dahej
	Type/Services	Cargo/Liquid
	Facilities	Jetty, Buildings, Mechanical equipments, Storage Area, Water Supply, Toilets, Parking Area

	Approach	-		
	Land Ownership	Govt. of Gujarat		
	Area (ha.)	**Govt.**	**Private**	
		2 Ha	NA	
b)	Terminal/Jetty – 2 and 3	Tourism Terminal at CH 60 Km & Ch. 168 Km		
	Location (Bank/city/district)	Borbhatha Bet, Bharuch & D/s of Garudeshwar		
	Type/Services	Tourism		
	Facilities	Jetty, Buildings, Material handling equipments, Storage Area, Water Supply, Toilets, Parking Area and Tourism activity		
	Approach	-		
	Land Ownership	Govt.		
	Area (ha.)	**Govt.**	**Private**	
		2 Ha	NA	
c)	Terminal/Jetty – 4	Cargo Terminal at CH 50 Km		
	Location (Bank/city/district)	Bharuch		
	Type/Services	Cargo		
	Facilities	Jetty, Buildings, Water Supply, Toilets, Parking Area		
4.	***Design Vessel***			
	Phase-1 & Phase-3			
a)	Type	Self-propelled vessel		
b)	No. & Size	70m X 12m		
c)	Loaded Draft	1.8 m		
d)	Capacity	1000 DWT		
	Phase-2			
	Type	Self-propelled vessel		
	No. & Size	58m X 9m		
	Loaded Draft	1.5 m		
	Capacity	500 DWT		
5.	***Navigation Aids***			
a)	Type	-		
b)	Nos.	Marine Lantern/Buoys (6 nos.) Phase-1		
		Marine Lantern/Buoys (54 nos.) Phase-2		
		Marine Lantern/Buoys (20 nos.) Phase-3		
b)	Communication Facilities	DGPS, VTMS, Marine Lantern/Buoys, RIS Station		
C.	**FINANCIAL**			
1.	***Project Cost***			
a)	Capital Cost	Phase-1	Phase-2	Phase-3
	Cost (Rs in Crores)	36.43	153.69	83.50
b)	O & M Cost	Phase-1	Phase-2	Phase-3
	Cost (Rs in Crores)	9.50	21.07	10.41
2.	***User Charges***			
a)	For IWAI	@ Rs. 1 per Tonne per Km for using channel		
3.	***Financial Internal Rate of Return***			

	(%)	
a)	For IWAI	**Phase-1** **FIRR: Channel usage @Rs 1 per tonne per Km- (-) value**
4.	***Economic Internal Rate of Return (%)***	**Phase-1** **EIRR: 3.10%**
5.	***Any other Important Feature***	**-**

EXECUTIVE SUMMARY

1.0 Project Background and Introduction

The Govt. of India desires to explore the commercial navigation potential on year round basis in inland waterways. Ministry of Shipping (MoS), Govt. of India had directed Inland Waterways Authority of India (IWAI) to identify the viable waterways in India for their phased development.

Accordingly, to make provisions for existing national waterways and to provide for the declaration of certain inland waterways to be national waterways and also to provide for the regulation and development of the said waterways for the purposes of shipping and navigation, National waterway act, 2016 has received the assent of the President on the 25th March, 2016 declaring a total of 111 National Waterways. All the River stretches/Canals have been divided in different clusters for carrying out the study. Four Rivers in Gujarat & Maharashtra viz. Mahi, Narmada, Tapi and Sabarmati has been identified in Cluster-8 for development of waterways

M/s Inland Waterways Authority of India (IWAI) has entrusted WAPCOS with the responsibility for preparation of two stages DPR for 4 inland waterways (Sabarmati, Mahi, Narmada and Tapi) in the states of Gujarat & Maharashtra.

Accordingly, WAPCOS Ltd. has under taken the feasibility studies for 4 national waterways (Mahi, Narmada, Sabarmati and Tapi River) in Gujarat & Maharashtra during stage-1. During the stage -1 following activities were carried out

A. Reconnaissance Survey

B. Collection and Review of available data

C. Feasibility studies

After the Stage-1 (feasibility studies) following stretch of the rivers were found feasible for further detailed studies.

Sl. No.	Waterway Details	Stretch Details
1.	River Mahi (NW-66)	246.989 km from Lat 22°10'34.71"N, Long 72°30'36.31"E
2.	**River Narmada (NW-73)**	**226.343 km from Lat21°38'26.81"N, Long 72°33'28.24"E**
3.	River Tapi (NW-100)	172.946 from Lat21°2'15.51"N, Long 72°39'29.63"E

2.0 Hydrographic Survey & Data Collection

The purpose of detailed hydrographic survey was to determine the hydraulic features and existing conditions of the Narmada River from confluence with the Arabian Sea at Gulf of Khambhat at Lat 21°38'26.81"N, Lon 72°33'28.24"E to Pandhariya of 227 km length.

Tidal Stretch is 0 to 89.5 Km and Non Tidal Stretch is 89.5 km to 226.343 km. Average tidal variation is 3.31 meter (0.7 to 7.68 meter)

0 to 22 km chainges of Narmada River is used for occasional navigation (during High-tide only) by vessels transiting to Shift Ship building center, Kaladhara.

The Narmada River is partially used for navigation by small boats for fishing and tourism activities.

Water availability

The Waterway of Narmada River for 227 Km river stretch is divided into different stretches for LAD status. The details of the stretches are as follows:-

Table 1 – LAD status

LAD (m) Reduced to Chart Datum	0-30 km	30-60 km	60-89.5km	89.5-120 km	120-150 km	150-182.5 km	182.5-210 km	210 - 227 km	Total
< 1.7m	20.3	8.1	19.2	13.9	13.1	21.8	0	0	**96.4**
1.7m – 2.0m	3.2	15.7	5.0	10.7	10.2	5.2	0	0	**50**
>2.0m	6.5	6.2	5.3	5.9	6.7	5.5	27.5	17	**80.6**
Total	**30.0**	**30.0**	**29.5**	**30.5**	**30.0**	**32.5**	**27.5**	**17**	**227**

Soil and Water samples were collected at different locations. Soil is mainly composed of silt and sand.

Dredging

Phase wise dredging quantities of Narmada River are given in Table-2.

Table 2 - Dredging Summary of Narmada River

Phase	Length of waterway	Dredging Quantity	Proposed Class
Phase-1	0 – 11 km	0.95 Mm^3	Class-IV
Phase-2	60 – 168.5 km	3.43 Mm^3	Class-III
Phase-3	11 – 50 km	1.04 Mm^3	Class-IV

Existing Cross Structures

i) **Weir** - 01 nos (Under construction near Garudeshwar)

ii) **Bridges –**

There is 01 Railway bridge, 06 road bridge and 02 under construction bridges are present in the proposed waterway.

Clearance w.r.t HFL	Min (m)	Max (m)
Horizontal Clearance	10.27	144.0
Vertical Clearance	No vertical clearance	20.15

iii) **HTL –**

There are 23 HTL and 01 Crane cable (Sardar Sarover Dam) is present in the entire survey stretch of Narmada River.

Clearance w.r.t HFL	Min (m)	Max (m)
Horizontal Clearance	300	1513
Vertical Clearance	10	52

HTL are having requisite clearances

iv) **Sub-bedded high pressure gas line -** Sub-bedded high-pressure gas line is present across the Narmada River at 32.6 km chainage (Near Bhadbhut Village) and anchoring and dredging are prohibited at this area however, this area will submerged after construction of proposed Bhadbhut barrage.

3.0 Fairway Development

Proposed class of waterway: WAPCOS has studied the possibility of developing waterway as Class III, Class IV, and Class V. WAPCOS recommend development of waterway in phases as per follow:

Table 3: Proposed class of waterway

Sr. No	Phase	Stretch	Proposed Class of Waterway
1	Phase-1	Anchorage point to Terminal 1 (OPAL)	Class-IV
3	Phase-2	Terminal 2 (Bharuch) to Terminal 3(d/s of Garudeshwar Weir)	Class-III
2	Phase-3	Terminal 4 (Bharuch)	Class-IV

4.0 Traffic Studies

The districts located in the catchment area, i.e. within 25 km. of River Narmada are Bharuch, Vadodara and Narmada. These districts were studied in detail for finding opportunity on the proposed waterway.

The major industries along River Narmada are power plants, steel, chemicals, fertilizer, petroleum, and glass. Commodities like coal, rock phosphate, naphtha, chemicals& fertilizers, steel coils, and sandstone are handled in the region at ports and industries.

Table 3: Potential Commodities for River Narmada

Commodities	Source	Volume (mn T)	Reasoning
Naphtha	OPaL	0.5	The company is interested in shifting its current import arrangement with GCPTCL, and would like to handle the commodity via a captive jetty on River Narmada. Opal is also exploring alternate location for development of Jetty at the mouth of river jointly with other industries.
Ankleshwar ICD Traffic	Industries across the Bharuch and Ankleshwar GIDCs	0.2	Largely, this ICD is represented by high and consistently growing industries like Chemicals & Petrochemicals, and Fertilizers. Spurt in future growth could be targeted by NW 73.

The table given below depicts the current origin-destination particulars for all the cargo that can be moved using River Narmada post required infrastructure development:

Table 4: O-D particulars for potential cargo on River Narmada

Name of companies / Source	Commodity	Volume (mn T)	Origin	Destination
OPaL	Naphtha	0.5	Hazira&Dahej	Dahej (VagraTaluka)
Ankleshwar ICD	Wide range of industries (Import)	0.2	Maharashtra & Gujarat Ports	Ankleshwar GIDC / Bharuch GIDC
	Wide range of industries (export)	0.03	Ankleshwar GIDC / Bharuch GIDC	Maharashtra & Gujarat Ports

The tables given below depicts the traffic estimate and projections for all the terminals:

Table 5: Traffic projections for the proposed OPaL Terminal (Terminal-1)

In Million tonnes

Cargo	Source - Destination	FY20	FY25	FY30	FY35	FY40	FY45
Naphtha	Hazira/Dahej (import)	0.5	1	1	1	1	1
Total		**0.5**	**1**	**1**	**1**	**1**	**1**

Table 6: Traffic Projections for the proposed Ankleshwar terminal (Terminal-4)

In Million tonnes

Cargo	Source - Destination	FY34	FY35	FY40	FY45
Containerized Cargo	Mumbai & Maharashtra Ports - Ankleshwar ICD (Import)	0.2	0.2	0.4	0.9
	Ankleshwar ICD - Mumbai & Maharashtra Ports (Export)	0.03	0.04	0.1	0.2
	Total	0.2	0.2	0.5	1.1

Table 7: Tourist traffic projections for Bharuch – Garudeshwar boat ride

Number in '000

Tourism potential	FY28	FY30	FY35	FY40	FY45
Bharuch - Garudeshwar Boat Ride	108	154	376	500	500

Table 8: Visitors traffic projections at the Amusement park ('000 visitors)

Tourism potential	FY28	FY30	FY35	FY40	FY45
Amusement park	94	125	262	554	700

5.0 Terminals

Following are the proposed terminals in the stretch of river Narmada on the basis of water availability, traffic requirements, land availability and environmental considerations:

Phase	Type of Jetty	Chainage	Location
Phase-1	Terminal 1- Piled Jetty	11 km	ONGC Petro additions Ltd (Dahej)
Phase-2	Terminal 2- Passenger jetty	60 km	Bharuch
Phase-2	Terminal 3- Passenger jetty	168 km	Garudeshwar
Phase-3	Terminal 4- Piled Jetty	50 km	Bharuch

6.0 Preliminary Engineering Design

For Phase-1 and Phase-3, the proposed jetty is required to handle Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m (Class-IV).

For Phase-2, the proposed jetty is required to handle Self-propelled, carrying capacity 500 DWT, Size (58m X 9m), Loaded draft 1.5m (Class-III).

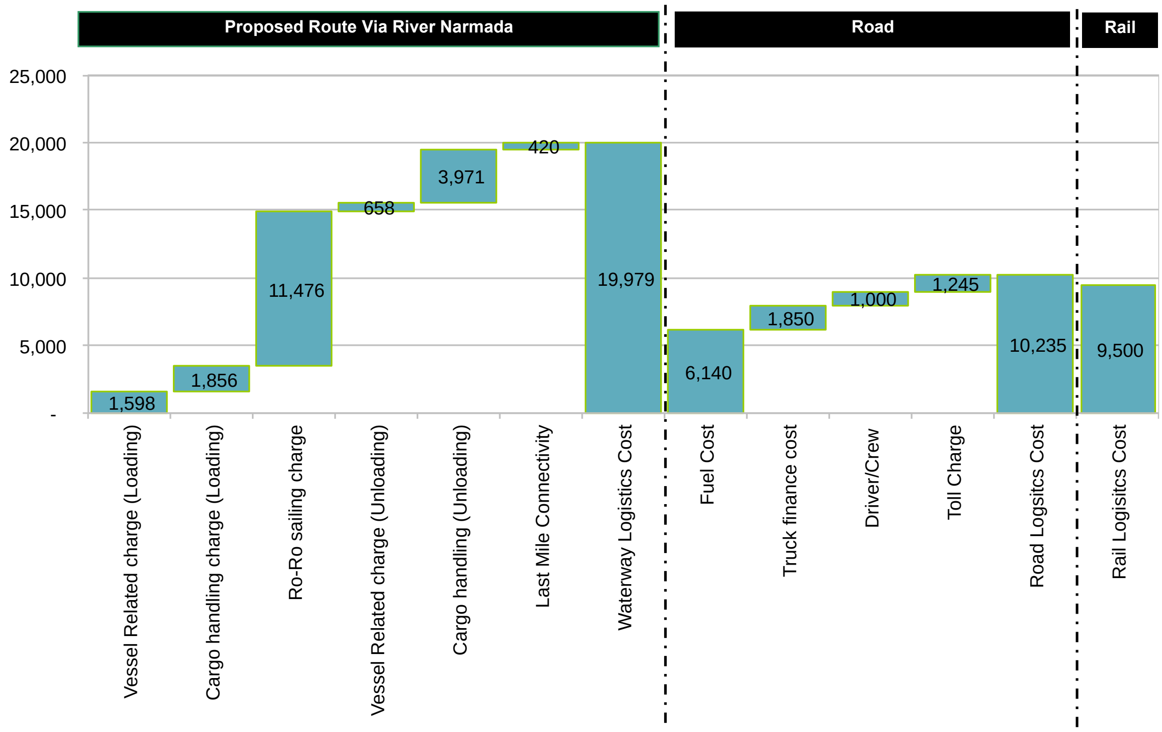
On the basis of topographic and hydrographic survey of Narmada River, no bank protection is required in such a big river.

7.0 Vessel Design

Vessels required for terminal 1 would be procured and deployed by Opal. They would acquire self-propelled tank barges of 1,000 DWT.

Terminal 2 and Terminal 3 would require passenger vessels. These vessels are having low draft of 1.5 m and would be able to ply in class III.

Terminal 4 proposed in phase-3 would be carrying local containers. The logistics cost analysis undertaken has found the cost of transportation using waterways to be higher compared to road and rail. This could be revalidated before implanting phase-3 of the project.



8.0 Navigation & Communication System

Navigational system is considered as an important aid for any vessel movement in coastal and river channel. Navigational Safety in Port's Committee was formed in India known as NSPC to ensure navigational safety in waterways. DGPS, VTMS and Marine Lantern/Buyos (6 nos. in Phase-1, 54 nos. in Phase-2 and 20 nos. in Phase-3) and RIS Station have been proposed to be installed for safe navigation of vessels and to have complete control on traffic handled at terminal.

9.0 Environmental and Social Aspects

The impact of project on potential environment is not much as it will not produce any harmful wastes.

The project will provide the employment to the local villagers nearby to the terminal area and barrages during construction as well as in operational phase this will improve the social and economic conditions of the nearby commuters. Also by shifting of traffic from distant ports or terminals, mode of operation like from road to waterway to these terminals will reduce the overall carbon emission. Hence ultimately will bring a positive impact to the environment.

Presently for phase wise development the Environmental Clearance will not be required. As per Notification issued By GoI dated 21 Dec 2017 “Non-requirement of Environmental clearance for maintenance dredging for the purpose of navigation”.

Other Major Clearances / Approvals / Permits Applicable to the Project

- Coastal Regulation Zone (CRZ) Govt. of Gujarat
- Consent to Establish and operate from state pollution control board, Gujarat
- Narmada Controlling Authority
- Gujarat Maritime Board

Summary of Estimated Environmental & Social Costs for various Stages

Sl. No.	Project Stages	Cost (Rs.Lakhs)
1.	Pre-Construction Stage	67.13
2.	Construction Stage	38.39
3.	Operational Stage	8.63
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		**114.15**

Hence Total Cost say 114 Lakhs.
***** The basis of cost is on our previous experiences of the project but the actual cost will be based on the Approved TOR by MoEF & CC.

10.0 Institutional Requirements

The Authority envisaged is Navigational waterway maintenance, transportation enterprise dealing with passenger and cargo handling, transit and transfer as well as being an administrative unit and an organ of Government which implements Government policies.

This envisages setting up of Inland Waterway Authority construction and maintenance division for Narmada River with its headquarters at Surat. It is proposed to terminals for Tapi and Narmada River are run under this set up. The Inland waterway authority will specifically control and will be responsible for functioning of setup in Narmada River (NW-73).

11.0 Project Costing

The cost arrived at are based on the budgetary quotes and the in house database available on cost estimates. The rates for various items of work have been prepared on the basis of current rates for various items of work prevailing in the region.
Gujarat Maritime Board Schedule of Rate, 2013-14 has been followed and escalated by 5% per annum to arrive at for year 2018 to arrive at the cost of the project.
The estimate of capital cost is made for the various items of civil, mechanical, electrical and utilities works for the development of terminals in the waterway stretch.
The annual operation and maintenance cost on different components of the project will be dependent on a number of variables such as the life of the component, repair and maintenance requirements, wages of crew of consumables etc.

Preliminary design of the terminals and other components has been revised after incorporating the results of geo-technical investigations; accordingly project cost has been revised.

Phase	Capital Cost (in INR Crores)	O & M Cost (in INR Crores)
Phase-1	36.43	9.50
Phase-2	153.69	21.07
Phase-3	83.50	10.41

12.0 Implementation Schedule

Phasing of activities has been done keeping importance of the event in project completion. However, ultimate aim was stick to early completion of project.

13.0 Economic & Financial Analysis

FIRR is coming negative even with 1 Rs./tonne for channel usage charges whereas currently operational NW-1, it is 0.5 Rs./tonne. EIRR is also coming out only 3.10%.

14.0 Conclusions & Recommendations

Out of all terminals, Terminal-1 at Ch.11 is technically viable. It is to be noted that terminal cost and storage facilities will be created by OPaL but this proposal is not consolidated as internal decision are still pending from OPaL side. After final decision from OPaL, Proposed development can be executed.

Following studies should be carried out prior to any development for broad view of implications:

i. Conduct a comprehensive geomorphic study and review and analyse sedimentation processes. The sedimentation study shall be aimed at developing an improved understanding of the significant sedimentation processes within the entire river basin. The major emphasis of this work shall be on analysing major channel morphology and the sedimentation phenomenon during the last 10 year period. As a minimum the sedimentation study shall:
   a. Document the variations in sediment transport (size and quantity);
   b. Identify and quantify all major sources of sediments (bed and banks, tributaries, etc.); and
   c. Locate degrading, aggrading, and stable reaches, and
   d. Establish the range of flows transporting the majority of sediments.
ii. Correlate the results of the sedimentation study with historical changes in the basin (channel improvements, land use, barrage and reservoir construction, etc.) enabling the development of a firm understanding of past and present sedimentation processes. This information shall be used to qualitatively analyse the effects of anticipated project features. This information shall be used to determine what may or may not work when designing navigation improvements. It shall include a determination of those reaches that are stable in depth and width and thus provide the basis for all subsequent preliminary design works. Included in the analysis shall be a study of the bend-ways to determine the siltation and erosion process in the same and the minimum radius required for navigation of the reference vessels.
iii. Undertake various types of model studies to verify and / or enhance all design parameters. As a minimum this shall include a numerical model to produce detailed pictures of flow in the river system under current and future flow conditions and also the required flow/ discharge to maintain 2.5 m LAD throughout the year with or without interventions like (barrages) in River.
iv. Non-destructive testing for bridges can be carried out.

LIST OF ABBREVIATIONS

CD	Chart Datum
BM	Benchmark/Local Reference Level
CH	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning Systems
ETS	Electronic Total Station
GPS	Global Positioning Systems
HC	Horizontal Control
HFL	Highest Flood Level
INT	International Hydrographic Organization
km	Kilometer
LAD	Least Available Depth
LBM	Local Bench Mark
m	Meter
MSL	Mean Sea Level
NTPC	National Thermal Power Corporation
RL	Reference Level
SBAS	Satellite-Based Augmentation System
SBES	Single Beam Echosounder
SD	Sounding Datum
TBC	Trimble Business Center
UTM	Universal Transverse Mercator
VC	Vertical Control
WGS	World Geodetic System

List of all Team Members (In-House & Empanelled Key Experts)

Sl. No.	Name of the Key Expert	Proposed Position
1.	Sh. D. N. Deshmukh	Team Leader
2.	Sh. Prakash Krishnaji Khare	Port Planning and Infrastructure Specialist
3.	Dr. Santosh K. Sati	GIS/Remote Sensing Expert
4.	Sh. R. N. Bansal	Floodplain Specialist
5.	Sh. Bidyadhyar Thakur	Hydrographic Expert
6.	Sh. Prasanta Kumar Kundu	Soil Engineer/Foundation Engineer
7.	Capt. Gary Vaz	Traffic Surveyor
8.	Sh. M Ganesan	Transport Economist

Contact Authority:

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CHAPTER – 1

INTRODUCTION

1.0 Introduction

1.1 Project Background and Summary of previous study

The Govt. of India desires to explore the commercial navigation potential on year round basis in inland waterways. Ministry of Shipping (MoS), Govt. of India had directed Inland Waterways Authority of India (IWAI) to identify the viable waterways in India for their phased development.

Accordingly, to make provisions for existing national waterways and to provide for the declaration of certain inland waterways to be national waterways and also to provide for the regulation and development of the said waterways for the purposes of shipping and navigation, National waterway act, 2016 has received the assent of the President on the25th March, 2016 declaring a total of 111 National Waterways. All the River stretches/Canals have been divided in different clusters for carrying out the study. Four Rivers in Gujarat & Maharashtra viz. Mahi, Narmada, Tapi and Sabarmati has been identified in Cluster-8 for development of waterways

M/s Inland Waterways Authority of India (IWAI) has entrusted WAPCOS with the responsibility for preparation of two stages DPR for 4 inland waterways (Sabarmati, Mahi, Narmada and Tapi) in the states of Gujarat & Maharashtra. The lengths of all four river stretches under the feasibility studies were as given below:

Sl. No.	Name of the River	Description of National Waterway	From:	Up to:
1.	Mahi River, Gujarat	246.9 km length of the river from Kadana Dam to confluence with Gulf of Khambhat near Kavi railway station **(National Waterway 66)**	23°18'22.35"N 73°49'37.45"E	22°10'34.71"N 72°30'36.31"E
2.	Narmada River, Gujarat & Maharashtra	227 km length of the river from Pandhariya to confluence of Narmada with Arabian Sea at Gulf of Khambhat **(National Waterway 73)**	21°57'10.37"N 74° 8'27.46"E	21°38'26.81"N, 72°33'28.24"E
3.	Sabarmati River, Gujarat	212 km length of the river from Barrage near Sadoliya to confluence with Gulf of Khambhat near Khambhat **(National Waterway 87)**	23°26'49.66"N 72°48'34.85"E	22°9'17.99"N 72°27'27.81"E

Sl. No.	Name of the River	Description of National Waterway	From:	Up to:
4.	Tapi River, Gujarat & Maharashtra	436 km length of the river from Hatnur Dam near Mangalwadi Long to confluence with Gulf of Khambhat (Arabian Sea) **(National Waterway 100)**	21°4'21.99"N 75°56'44.88"E	21°2'15.51"N, 72°39'29.63"E

Table 1.1: National Waterways in Gujarat & Maharashtra

The Google Map showing all river stretches is enclosed as **Figure 1.1**

Figure 1.1: Google Map showing four rivers in Gujarat & Maharashtra

Accordingly, WAPCOS Ltd. has undertaken the feasibility studies for 4 national waterways (Mahi, Narmada, Sabarmati and Tapi River) in Gujarat & Maharashtra during stage-1. During the stage -1 following activities were carried out

A. Reconnaissance Survey

B. Collection and Review of available data

C. Feasibility studies

After the Stage-1 (feasibility studies) following stretch of the rivers were found feasible for further detailed studies.

Sl. No.	Waterway Details	Stretch Details
1.	River Mahi (NW-66)	246.989 km from Lat 22°10'34.71"N,Long 72°30'36.31"E
2.	**River Narmada (NW-73)**	**226.343 km from Lat 21°38'26.81"N, Long 72°33'28.24"E**
3.	River Tapi (NW-100)	172.946 km from Lat 21°2'15.51"N, Long72°39'29.63"E

1.2 Project Location / Details of Study Area

The total length of Narmada River from origin to its outfall in the Gulf of Khambhat is 1333 km. The length under consideration for present studies is detailed below:

226.343 km length of the river from Gulf of Khambhat (Arabian Sea) to Pandharia. (National Waterway 73)	**From: 21°38'26.81"N, 72°33'28.24"E**	**Up to: 226.343 km**

Present study stretch of Narmada River passes through Bharuch, Narmada, Vadodara and Chhota Udaipur district administrative of Gujarat and also shares with Nandubar district of Maharashtra State.

Figure 1.2: Project location/Study area

1.3 Brief Scope of Work and Compliance statement

The brief scope of work is depicted as under:

A. Detailed Hydrographic Survey
B. Traffic Survey & Techno economic feasibility
C. Geotechnical Investigations
D. Preparation of Detailed Project Report

The Compliance statement is mentioned below:

A. Completed and given in Volume-III
B. Completed and mentioned in Volume-I Main Report
C. Geotechnical Investigations has been carried out at site and included in Volume-IV
D. DPR has been prepared after incorporating all studies mentioned in scope of work.

1.4 Brief Methodology & Approach

The detailed studies shall be carried out for all the feasible stretches.

The present studies consist of three inland waterways in rivers of Gujarat and Maharashtra having a total length of 646.278 kms:

1. Mahi River – 246.989 km
2. **Narmada River – 226.343 km**
3. Tapi River – 172.946 km

Stage -2 involves detailed surveys and studies; therefore it has been done in two tasks; First Field Surveys & Investigations and then Project Studies.

1. ***FIELD SURVEYS & INVESTIGATIONS:*** It comprises of the Data collection from site, Bathymetry, Topographic and Traffic Surveys, Measurements (Water level, gauge and current measurements), collection and analysis of water and soil samples, Benchmark construction.

2. ***PROJECT STUDIES:*** Project studies are carried out from the collected data, surveyed data and observed data to attain navigation and water transport facility in the potentially feasible stretches.

STAGE -2 : Field Surveys & Investigations

- Benchmark Establishment
- Hydrographic survey & Topographical details
- Water level (Gauge Measurements)
- Current measurements
- Water & soil samples
- Traffic surveys
- Geotechnical Surveys

STAGE-2 : Project Studies

- Analysis of Hydrographic survey data & Existing infrasturucture
- Traffic Studies
- Vessel analysis & dredging
- Proposed location for terminals /Ports Loading and unloading terminals
- Environmental Impact studies
- Waterway crossings, Navigational Aids, Locks, communication facilities
- River training, Shore /Bank protection measures
- Locations requiring detailed geotech Investigations
- Preliminary designs of proposed facilities & infrastructure , alternatives
- Economic analysis & Financial Evaluation (EIRR, SWOT, CASH FLOWS, NPV)
- Detailed Project Report , BOQ &Cost Estimates

CHAPTER – 2

WATERWAY/DETAILED HYDROGRAPHIC SURVEY

2.1 Hydrographic Survey

The purpose of detailed hydrographic survey was to determine the hydraulic features and existing conditions of the Narmada River from confluence with the Arabian Sea at Gulf of Khambhat at Lat 21°38'26.81"N, Lon 72°33'28.24"E to Pandhariya of 227 km length. To assess the navigability in Narmada River, WAPCOS conducted a detailed hydrographic survey during December 2016 – February 2017.

2.1.1 Waterway in General and Hydro-morphological Characteristics

The Narmada, the largest west flowing river of the Peninsula, rises near Amarkantak range of mountains in Madhya Pradesh. It is the fifth largest river in the country and the largest one in Gujarat. It traverses Madhya Pradesh, Maharashtra, and Gujarat and meets the Gulf of Khambhat. The total length of the river from source to sea is 1312 kilometres.

The length under consideration for present studies is detailed below:

226.343 km length of the river from confluence of Narmada with Arabian Sea at Gulf of Khambhat to Pandhariya (National Waterway 73)	**From: 21°38'26.81"N, 72°33'28.24"E**	**Up to: 21°57'10.37"N, 74°8'27.46"E.**

2.1.2 Existing Hydrological / Topographical Reference levels

The Reference Level values of the recovered benchmarks are accepted as the Initial reference point for the transfer of horizontal and vertical control point to the newly established control points through baseline processing method. All values of spot levelling during the topographic survey are referred to Mean Sea Level. The final accepted WGS 84 coordinates and details of all newly established control points used for baseline processing during the conduct of survey are as follows:-

Sl.	Station	Latitude	Longitude	Chainage (km)	Ht. (above MSL)	Source/ Type
1	GTS Bharuch	21°42'35.41405"N	72°59'47.08752"E	51.3	17.898	25 HrsObs/Online Processed
2	NMD 1	21°41'22.02865"N	73°00'24.17622"E	50.8	7.573	25 HrsObs/Baseline Processed
3	CWC TBM	21°53'16.77295"N	73°39'06.01534"E	169.4	39.300	25 HrsObs/Online Processed

Sl.	Station	Latitude	Longitude	Chainage (km)	Ht. (above MSL)	Source/ Type
4	IWAI_BM_NMD_01	21°40'13.63034"N	72°34'27.68630"E	3	5.761	6 HrsObs/Baseline Processed
5	IWAI_BM_NMD_02	21°40'54.42813"N	72°39'35.21930"E	11.7	6.607	6 HrsObs/Baseline Processed
6	IWAI_BM_NMD_03	21°41'27.93944"N	72°44'30.05747"E	21	7.223	6 HrsObs/Baseline Processed
7	IWAI_BM_NMD_04	21°40'03.04818"N	72°48'45.41270"E	29.7	9.938	6 HrsObs/Baseline Processed
8	IWAI_BM_NMD_05	21°40'51.81513"N	72°54'51.21072"E	40.8	14.382	6 HrsObs/Baseline Processed
9	IWAI_BM_NMD_06	21°42'02.00416"N	73°00'02.92842"E	51.1	12.973	6 HrsObs/Baseline Processed
10	IWAI_BM_NMD_07	21°44'11.39617"N	73°05'24.62836"E	61.4	8.157	6 HrsObs/Baseline Processed
11	IWAI_BM_NMD_08	21°47'46.10826"N	73°08'11.89066"E	72.1	20.883	6 HrsObs/Baseline Processed
12	IWAI_BM_NMD_09	21°51'55.06498"N	73°09'52.70223"E	82.5	16.068	6 HrsObs/Baseline Processed
13	IWAI_BM_NMD_10	21°51'38.07421"N	73°14'20.43767"E	96	18.530	6 HrsObs/Baseline Processed
14	IWAI_BM_NMD_11	21°56'14.68354"N	73°14'58.33265"E	106.1	34.535	6 HrsObs/Baseline Processed
15	IWAI_BM_NMD_12	21°53'19.83578"N	73°18'38.06744"E	114.4	19.765	6 HrsObs/Baseline Processed
16	IWAI_BM_NMD_13	21°54'55.95560"N	73°20'33.13687"E	122.7	32.737	6 HrsObs/Baseline Processed
17	IWAI_BM_NMD_14	21°55'18.52205"N	73°25'27.81156"E	133	26.449	6 HrsObs/Baseline Processed
18	IWAI_BM_NMD_015	21°59'10.72399"N	73°27'38.92701"E	142.6	44.823	6 HrsObs/Baseline Processed
19	IWAI_BM_NMD-016	21°59'03.86884"N	73°32'34.17200"E	152.3	40.401	6 HrsObs/Baseline Processed
20	IWAI_BM_NMD_017	21°53'46.93789"N	73°37'11.59116"E	165.9	36.660	6 HrsObs/Baseline Processed
21	IWAI_BM_NMD_018	21°51'50.55649"N	73°41'53.04290"E	175	34.802	6 HrsObs/Baseline Processed
22	IWAI_BM_NMD_019	21°49'04.23238"N	73°44'39.33655"E	182	126.690	6 HrsObs/Baseline Processed
23	IWAI_BM_NMD_020	21°51'05.05575"N	73°52'41.08882"E	197.2	132.938	6 HrsObs/Baseline Processed
24	IWAI_BM_NMD_021	21°53'04.11286"N	73°57'31.27963"E	206.4	130.001	6 HrsObs/Baseline Processed
25	IWAI_BM_NMD_022	21°55'28.24601"N	74°02'15.21008"E	215.7	131.856	6 HrsObs/Baseline Processed
26	IWAI_BM_NMD_023	21°56'53.79298"N	74°06'30.61527"E	223.4	133.504	6 HrsObs/Baseline Processed

Table 2.1: Accepted Station coordinates (WGS-84)

Benchmark near Bharuch Railway station:-

The benchmark near Bharuch Railway station was recovered and accepted as the origin for horizontal and vertical control by online processing of 25 Hrs GPS observation. The details of benchmark near Bharuch Railway station is as follows:-

Benchmark, Bharuch	**Near Bharuch Railway Station** **MSL Value:**- 17.898 mtr

Table 2.2 - Benchmark near Bharuch Railway station

The TBM, CWC Garudeshwar.

The TBM at Right Bankside of Narmada River near CWC Garudeshwar site was recovered and the inscribed value of the TBM as 39.300 m from MSL was recovered on confirmation from Assistant Engineer, CWC Garudeshwar site office, and the details are as below:-

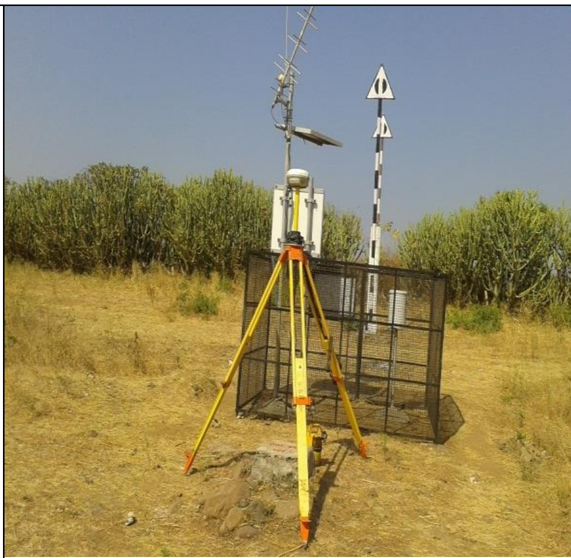
<table>
<tr><td colspan="2">TBM, CWC Garudeshwar</td><td>Lat:- 21°53'16.77295"N
Long:- 73°39'06.01534"E
MSL Value:- 39.300 mtr</td></tr>
<tr><td><u>Source:-</u></td><td colspan="2">Assistant Engineer, CWC Garudeshwar site office
The CWC TBM on the Right Banks Side of Narmada river near the CWC Garudeshwar site. The Benchmark is 01 X 01 feet concrete structure and is 10 cm above the ground level inscribed as TBM -39.300. The MSL Value of the benchmark is 39.300 mtr from MSL.</td></tr>
<tr><td colspan="2">
</td><td></td></tr>
</table>

Table 2.3 - TBM, CWC Garudeshwar

Benchmark at Jageshwar

The benchmark near Jageshwar was recovered and the MSL value and Chart Datum value was obtained from the Gujarat Maritime Board office at Jageshwar. The vertical control details were used for cross verification of the established IWAI BM pillar. The value of Chart datum at of the Benchmark is obtained as 5.09 mtr below Mean Sea level and this vale was transferred to the established Tide Pole of Dahej Reliance terminal. The value of 5.09 mtr below MSL is found to be agreeing with the established tide pole and the general tide behavior in the area. The details of the benchmark are as follows:-

Benchmark, Jageshwar (The Vertical Reference Value is only used for cross verification of the Chart Datum of established Tide Pole.)	**MSL Value:**- 7.2402mtr **CD Value:**- -5.09 mtr

Table 2.4 - Benchmark at Jageshwar

TBM-19 at CWC Garudeshwar office:-

The TBM-19at the CWC Garudeshwar office premises (Transferred from GTS Station at Rajpipla by CWC survey team by Auto leveling method) was obtained as 47.935 mt above MSL from Assistant Engineer, CWC Garudeshwar site office. The details of TBM-19 are as follows:-

TBM-19, CWC Garudeshwar (The Vertical reference Level of the station is used only for cross verification.)		**Lat:-** 21°53'23"N **Long:-**73°39'13"E **MSL Value:**- 47.935mtr
Source:-	Assistant Engineer, CWC Garudeshwar site office *The CWC TBM-19 is at the CWC Garudeshwar office premises and is situated on the North West corner of the CWC office. The station is inscribed as MTBM – 47.935.*	
		

Table 2.5 - TBM-19 at CWC Garudeshwar

2.1.3 Chart Datum / Sounding Datum

The water level observation was carried out at the erected gauges during the conduct of a bathymetric survey of Narmada River. The least MSL value of per kilometre stretch is considered for the computation of sounding datum at very shallow/ dry stretches of Narmada River. The established values like erected tide gauge, CWC gauge level are also considered for fixing the Sounding Datum for the entire stretch of Narmada River. The details of Topographic spot levelling values converted as Depth for volume calculation are forwarded as soft copy along with the report. The details of the chart Datum/Sounding Datum and reduction details are as tabulated below:-

Sl. No.	Location of CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Ch. (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation wrt SD (m)
	A	B	C	D	E	F = (E- WL data in MSL)	G = (E- topo levels in MSL)
			(50% stretch is to be selected on both side of tide gauge)	+ve indicates above MSL -ve indicates below MSL			
1	TP-NMD-01	2.3	0 - 7.2	-5.09	-5.09	Details at Annexure-3	Narmada_Reduced_Elevations_Dredging.xyz
2	TP-NMD-02	11.8	7.2 - 16.2	-	-4.31		
3	TP-NMD-03	21	16.2 - 25.4	-	-2.665		
4	TP-NMD-04	33.7	25.4 - 36.7	-	0.220		
5	TP-NMD-05	40.6	36.7 - 45.9	-	1.042		
6	TP-NMD-06 (CWC Bharuch)	50.8	45.9 - 56	1.338	1.338		
7	TP-NMD-07	64.5	56 - 66.5	-	1.653		
8	TP-NMD-08	72.1	66.5 - 77.3	-	2.111		
9	TP-NMD-09	82.3	77.3 - 89.5	-	2.503		
10	TP-NMD-10	95.7	89.5 - 102.2	-	2.677		
11	-	102.6	102.2 - 103	-	2.75		
12	-	103.5	103 - 104	-	2.806		
13	-	104.5	104 - 105	-	3.262		
14	-	105.5	105 - 106	-	3.495		
15	TP-NMD-11	106.5	106 - 107	-	3.575		
16	-	107.5	107 - 108	-	4.012		
17	-	108.5	108 - 109	-	4.038		
18	-	109.5	109 - 110	-	4.126		
19	-	110.5	110 - 111	-	5.104		
20	-	111.5	111 - 112	-	5.197		
21	-	112.5	112 - 113.3	-	5.378		

Sl. No.	Location of CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Ch. (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation wrt SD (m)
			C	D			
	A	B	(50% stretch is to be selected on both side of tide gauge)	+ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = (E- topo levels in MSL)
22	TP-NMD-12	114.2	113.3 - 118.5	-	5.547		
23	TP-NMD-13	122.6	118.5 - 127.5	-	5.985		
24	TP-NMD-14	132.5	127.5 - 138.6	-	6.594		
25	TP-NMD-15	142.2	138.6 - 147.6	-	6.978		
26	TP-NMD-16	152.4	147.6 - 159.4	-	9.168		
27	TP-NMD-17	166.2	159.4 - 166.2	-	11.016		
28	-	166.6	166.2 - 167	-	11.026		
29	-	167.5	167 - 168	-	11.088		
30	-	168.5	168 - 169	-	11.649		
31	TP_CWC (Garudeshwar)	169.3	169 - 170	13.433	13.433		
32	-	170.5	170 - 171	-	13.433		
33	-	171.5	171 - 172	-	13.433		
34	-	172.5	172 - 173	-	14.241		
35	-	173.5	173 - 174	-	15.451		
36	-	174.5	174 - 175	-	16.158		
37	TP-NMD-18	175.1	175 - 176	-	17.471		
38	-	176.5	176 - 177	-	17.471		
39	-	177.5	177 - 178	-	17.471		
40	-	178.5	178 - 179	-	17.471		
41	-	179.5	179 - 180	-	17.482		
42	-	180.5	180 - 181	-	18.129		
43	-	181.8	181 - 182.6	-	19.295		

Sl. No.	Location of CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Ch. (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation wrt SD (m)
	A	B	C (50% stretch is to be selected on both side of tide gauge)	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = (E- topo levels in MSL)
44	TP-NMD-19	183	182.6 - 190	110.64	110.64		
45	TP-NMD-20	197.2	190 - 201.8	-	110.64		
46	TP-NMD-21	206.4	201.8 - 211.2	-	110.64		
47	TP-NMD-22	215.8	211.2 - 219.5	-	110.64		
48	TP-NMD-23	223.5	219.5 - 227.3	-	110.64		

Table 2.6- Chart Datum/Sounding Datum reduction Details

Transfer of Sounding Datum for Tidal stretch

The tidal stretch of Narmada River is from 0 to 89.5 km chainage and sounding datum was transferred by adopting standard admiralty method by observing 04 low water and 03 High water on corresponding tide gauges. The MHWS/MLWS of established tide poles (TP_01 and TP_06) were not available, hence relevant method as per admiralty is adopted for calculation of sounding datum at new gauge .The details of the transfer of sounding datum are as follows:-

Sl. No.	Tide Pole	Chainage (km)	Stretch	Zero of Tide Pole w.r.t MSL	SD above Zero of TP	SD w.r.t MSL
1	TP-NMD-01	2.3	0 - 7.2	-5.09	Established TP	-5.09
2	TP-NMD-02	11.8	7.2 - 16.2	-4.813	0.503	-4.31
3	TP-NMD-03	21.0	16.2 - 25.4	-3.146	0.481	-2.665
4	TP-NMD-04	33.7	25.4 - 36.7	-0.16	0.380	0.220
5	TP-NMD-05	40.6	36.7 - 45.9	0.374	0.668	1.042
6	TP-NMD-06	50.8	45.9 - 56	0	Established TP	1.338
7	TP-NMD-07	64.5	56 - 66.5	0.017	1.636	1.653
8	TP-NMD-08	72.1	66.5 - 77.3	0.601	1.510	2.111
9	TP-NMD-09	82.3	77.3 - 89.5	2.176	0.326	2.503

Table 2.7- Transfer of Sounding Datum Details from 0 to 89.5 km Chainage

H.533

TRANSFER OF SOUNDING DATUM

(FOR SEMI-DIURNAL TIDES)

Date and Time of 1st LW Observation at Established Gauge 15 Dec 2016, 12:30 HRS

Position of Established Gauge	Lat:	**21°39'35.53"N**	Position of New Gauge	Lat:	**21°40'46.40"N**
	Long:	**72°34'9.23"E**		Long:	**72°39'39.20"E**
	Name:	**NMD_TP01**		Name:	**NMD_TP02**

Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.32	1	-	0.32	-	0.76	1	-	0.76
b	7.20	-	1	7.20	-	5.37	-	1	5.37	-
c	-	0.38	3	-	1.14	-	0.56	3	-	1.68
d	8.90	-	2	17.80	-	6.98	-	2	13.96	-
e	-	0.31	3	-	0.93	-	0.87	3	-	2.61
f	7.20	-	1	7.20	-	5.36	-	1	5.36	-
g	-	0.61	1	-	0.61	-	1.09	1	-	1.09
	Sum of Contribution			32.20	3.00	Sum of Contribution			24.69	6.14
	Observed MHW			8.05	-	Observed MHW			6.17	-
	Observed MLW			-	0.38	Observed MLW			-	0.77

Note:

Observed MHW = Sum of Contributions of HW/4

Observed MLW = Sum of Contributions of LW/8

Observed Mean Range (R)	=	7.68	Observed Mean Range (r)	=	5.41
Observed Mean Level (M')	=	4.21	Observed Mean Level (m')	=	3.47

Note:

Observed Mean Range = Observed MHW - Observed MLW

Observed Mean Level = (Observed MHW + Observed MLW)/2

CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE

(A) Where 'True Spring M.L (M)'at Established gauge is known				(B) Where 'True Spring M.L (M)'at Established gauge is not known		
From A.T.T (Table V of Part II)						
MHWS	=					
MLWS	=					
True Spring M.L (M)	=	0.00				
Note:						
True Spring M.L (M) = (MHWS + MLWS)/2						
SD	=	m'-(M'-M)-M*(r/R)		SD	=	m'-((M'*r)/R)
SD	=	0.00	Mtrs above Zero of Gauge	SD	=	0.503 Mtrs above Zero of Gauge

Table 2.8- Transfer of Sounding Datum - NMD_TP-01 to NMD_TP-02

										H.533
TRANSFER OF SOUNDING DATUM										
(FOR SEMI-DIURNAL TIDES)										
	Date and Time of 1st LW Observation at Established Gauge					15 Dec 2016, 12:30 HRS				
	Position of Established Gauge		Lat:	**21°39'35.53"N**		Position of New Gauge		Lat:	**21°41 '21.80"N**	
			Long:	**72°34'9.23"E**				Long:	**72°44'28.70"E**	
			Name:	**NMD_TP01**				Name:	**NMD_TP03**	
Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.32	1	-	0.32	-	0.70	1	-	0.70
b	7.20	-	1	7.20	-	4.22	-	1	4.22	-
c	-	0.38	3	-	1.14	-	0.39	3	-	1.17
d	8.90	-	2	17.80	-	5.78	-	2	11.56	-
e	-	0.31	3	-	0.93	-	0.88	3	-	2.64
f	7.20	-	1	7.20	-	4.28	-	1	4.28	-
g	-	0.61	1	-	0.61	-	1.03	1	-	1.03
	Sum of Contribution			32.20	3.00	Sum of Contribution			20.06	5.54
	Observed MHW			8.05	-	Observed MHW			5.02	-
	Observed MLW			-	0.38	Observed MLW			-	0.69
	Note:									
	Observed MHW = Sum of Contributions of HW/4									
	Observed MLW = Sum of Contributions of LW/8									
	Observed Mean Range (R)			=	7.68	Observed Mean Range (r)			=	4.32
	Observed Mean Level (M')			=	4.21	Observed Mean Level (m')			=	2.85
	Note:									
	Observed Mean Range = Observed MHW - Observed MLW									
	Observed Mean Level = (Observed MHW + Observed MLW)/2									
	CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE									
	(A) Where 'True Spring M.L (M)'at					(B) Where 'True Spring M.L (M)'at				
	Established gauge is known					Established gauge is not known				
	From A.T.T (Table V of Part II)									
	MHWS		=							
	MLWS		=							
	True Spring M.L (M)		=	0.00						
	Note:									
	True Spring M.L (M) = (MHWS + MLWS)/2									
	SD =	m'-(M'-M)-M*(r/R)				SD =	m'-((M'*r)/R)			
	SD =	0.00	Mtrs above Zero of Gauge			SD =	0.481	Mtrs above Zero of Gauge		

Table 2.9- Transfer of Sounding Datum - NMD_TP-01 to NMD_TP-03

										H.533
TRANSFER OF SOUNDING DATUM										
(FOR SEMI-DIURNAL TIDES)										
	Date and Time of 1st LW Observation at Established Gauge 15 Dec 2016, 12:30 HRS									
	Position of Established Gauge		Lat:	**21°41'24.63"N**		Position of New Gauge		Lat:	**21 °40'52.85"N**	
			Long:	**73°00'23.14"E**				Long:	**72°50'43.51"E**	
			Name:	**NMD_TP06**				Name:	**NMD_TP04**	
Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.35	1	-	0.35	-	0.71	1	-	0.71
b	1.86	-	1	1.86	-	3.61	-	1	3.61	-
c	-	0.24	3	-	0.72	-	0.51	3	-	1.53
d	3.56	-	2	7.12	-	5.12	-	2	10.24	-
e	-	0.06	3	-	0.18	-	0.80	3	-	2.40
f	1.96	-	1	1.96	-	3.69	-	1	3.69	-
g	-	0.26	1	-	0.26	-	0.61	1	-	0.61
	Sum of Contribution			10.94	1.51	Sum of Contribution			17.54	5.25
	Observed MHW			2.74	-	Observed MHW			4.39	-
	Observed MLW			-	0.19	Observed MLW			-	0.66
	Note:									
	Observed MHW = Sum of Contributions of HW/4									
	Observed MLW = Sum of Contributions of LW/8									
	Observed Mean Range (R)			=	2.54	Observed Mean Range (r)			=	3.73
	Observed Mean Level (M')			=	1.46	Observed Mean Level (m')			=	2.52
	Note:									
	Observed Mean Range = Observed MHW - Observed MLW									
	Observed Mean Level = (Observed MHW + Observed MLW)/2									
	CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE									
	(A) Where 'True Spring M.L (M)'at					(B) Where 'True Spring M.L (M)'at				
	Established gauge is known					Established gauge is not known				
	From A.T.T (Table V of Part II)									
	MHWS		=							
	MLWS		=							
	True Spring M.L (M)		=	0.00						
	Note:									
	True Spring M.L (M) = (MHWS + MLWS)/2									
	SD =	m'-(M'-M)-M*(r/R)				SD =	m'-((M'*r)/R)			
	SD =	0.00	Mtrs above Zero of Gauge			SD =	0.380	Mtrs above Zero of Gauge		

Table 2.10- Transfer of Sounding Datum - NMD_TP-06 to NMD_TP-04

										H.533
TRANSFER OF SOUNDING DATUM										
(FOR SEMI-DIURNAL TIDES)										
	Date and Time of 1st LW Observation at Established Gauge 15 Dec 2016, 12:30 HRS									
	Position of Established Gauge		Lat:	**21°41'24.63"N**		Position of New Gauge		Lat:	**21°40'50.54"N**	
			Long:	**73°00'23.14"E**				Long:	**72°54'45.00"E**	
			Name:	**NMD_TP06**				Name:	**NMD_TP05**	
Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.35	1	-	0.35	-	1.01	1	-	1.01
b	1.86	-	1	1.86	-	3.03	-	1	3.03	-
c	-	0.24	3	-	0.72	-	0.79	3	-	2.37
d	3.56	-	2	7.12	-	4.54	-	2	9.08	-
e	-	0.06	3	-	0.18	-	0.94	3	-	2.82
f	1.96	-	1	1.96	-	3.04	-	1	3.04	-
g	-	0.26	1	-	0.26	-	0.87	1	-	0.87
	Sum of Contribution			10.94	1.51	Sum of Contribution			15.15	7.07
	Observed MHW			2.74	-	Observed MHW			3.79	-
	Observed MLW			-	0.19	Observed MLW			-	0.88
	Note:									
	Observed MHW = Sum of Contributions of HW/4									
	Observed MLW = Sum of Contributions of LW/8									
	Observed Mean Range (R)			=	2.55	Observed Mean Range (r)			=	2.90
	Observed Mean Level (M')			=	1.46	Observed Mean Level (m')			=	2.34
	Note:									
	Observed Mean Range = Observed MHW - Observed MLW									
	Observed Mean Level = (Observed MHW + Observed MLW)/2									
	CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE									
	(A) Where 'True Spring M.L (M)'at					(B) Where 'True Spring M.L (M)'at				
	Established gauge is known					Established gauge is not known				
	From A.T.T (Table V of Part II)									
	MHWS		=							
	MLWS		=							
	True Spring M.L (M)		=	0.00						
	Note:									
	True Spring M.L (M) = (MHWS + MLWS)/2									
	SD =	m'-(M'-M)-M*(r/R)				SD =	m'-((M'*r)/R)			
	SD =	0.00	Mtrs above Zero of Gauge			SD =	0.668	Mtrs above Zero of Gauge		

Table 2.11- Transfer of Sounding Datum - NMD_TP-06 to NMD_TP-05

										H.533
TRANSFER OF SOUNDING DATUM										
(FOR SEMI-DIURNAL TIDES)										
	Date and Time of 1st LW Observation at Established Gauge 13 Jan 2017, 16:15 Hrs									
	Position of Established Gauge		Lat:	**21°41'24.63"N**		Position of New Gauge	Lat:		**21°44'11.60"N**	
			Long:	**73°00'23.14"E**			Long:		**73°07'03.30"E**	
			Name:	**NMD_TP06**			Name:		**NMD_TP07**	
Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.40	1	-	0.40	-	1.75	1	-	1.75
b	1.16	-	1	1.16	-	2.46	-	1	2.46	-
c	-	0.06	3	-	0.18	-	1.71	3	-	5.13
d	3.26	-	2	6.52	-	3.84	-	2	7.68	-
e	-	0.35	3	-	1.05	-	1.90	3	-	5.70
f	1.16	-	1	1.16	-	2.47	-	1	2.47	-
g	-	0.06	1	-	0.06	-	1.67	1	-	1.67
	Sum of Contribution			8.84	1.69	Sum of Contribution			12.61	14.25
	Observed MHW			2.21	-	Observed MHW			3.15	-
	Observed MLW			-	0.21	Observed MLW			-	1.78
	Note:									
	Observed MHW = Sum of Contributions of HW/4									
	Observed MLW = Sum of Contributions of LW/8									
	Observed Mean Range (R)			=	2.00	Observed Mean Range (r)			=	1.37
	Observed Mean Level (M')			=	1.21	Observed Mean Level (m')			=	2.47
	Note:									
	Observed Mean Range = Observed MHW - Observed MLW									
	Observed Mean Level = (Observed MHW + Observed MLW)/2									
	CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE									
	(A) Where 'True Spring M.L (M)'at Established gauge is known					(B) Where 'True Spring M.L (M)'at Established gauge is not known				
	From A.T.T (Table V of Part II)									
	MHWS =									
	MLWS =									
	True Spring M.L (M) =			0.00						
	Note:									
	True Spring M.L (M) = (MHWS + MLWS)/2									
	SD =	m'-(M'-M)-M*(r/R)				SD =	m'-((M'*r)/R)			
	SD =	0.00	Mtrs above Zero of Gauge			SD =	1.636	Mtrs above Zero of Gauge		

Table 2.12- Transfer of Sounding Datum - NMD_TP-06 to NMD_TP-07

										H.533
TRANSFER OF SOUNDING DATUM										
(FOR SEMI-DIURNAL TIDES)										
	Date and Time of 1st LW Observation at Established Gauge 13 Jan 2017, 16:15 HRS									
	Position of Established Gauge		Lat:	**21°41'24.63"N**		Position of New Gauge		Lat:	**21°47'44.50"N**	
			Long:	**73°00'23.14"E**				Long:	**73°08'14.50"E**	
			Name:	**NMD_TP06**				Name:	**NMD_TP08**	
Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.40	1	-	0.40	-	1.55	1	-	1.55
b	1.16	-	1	1.16	-	2.25	-	1	2.25	-
c	-	0.06	3	-	0.18	-	1.53	3	-	4.59
d	3.26	-	2	6.52	-	3.34	-	2	6.68	-
e	-	0.35	3	-	1.05	-	1.78	3	-	5.34
f	1.16	-	1	1.16	-	2.25	-	1	2.25	-
g	-	0.06	1	-	0.06	-	1.58	1	-	1.58
	Sum of Contribution			8.84	1.69	Sum of Contribution			11.18	13.06
	Observed MHW			2.21	-	Observed MHW			2.80	-
	Observed MLW			-	0.21	Observed MLW			-	1.63
	Note:									
	Observed MHW = Sum of Contributions of HW/4									
	Observed MLW = Sum of Contributions of LW/8									
	Observed Mean Range (R)			=	2.00	Observed Mean Range (r)			=	1.16
	Observed Mean Level (M')			=	1.21	Observed Mean Level (m')			=	2.21
	Note:									
	Observed Mean Range = Observed MHW - Observed MLW									
	Observed Mean Level = (Observed MHW + Observed MLW)/2									
	CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE									
	(A) Where 'True Spring M.L (M)'at					(B) Where 'True Spring M.L (M)'at				
	Established gauge is known					Established gauge is not known				
	From A.T.T (Table V of Part II)									
	MHWS =									
	MLWS =									
	True Spring M.L (M) =			0.00						
	Note:									
	True Spring M.L (M) = (MHWS + MLWS)/2									
	SD =	m'-(M'-M)-M*(r/R)				SD =	m'-((M'*r)/R)			
	SD =	0.00	Mtrs above Zero of Gauge			SD =	1.510	Mtrs above Zero of Gauge		

Table 2.13- Transfer of Sounding Datum - NMD_TP-06 to NMD_TP-08

H.533

TRANSFER OF SOUNDING DATUM

(FOR SEMI-DIURNAL TIDES)

Date and Time of 1st LW Observation at Established Gauge 13 Jan 2017, 16:15 Hrs

Position of Established Gauge	Lat:	**21°41'24.63"N**	Position of New Gauge	Lat:	**21°51'28.00"N**
	Long:	**73°00'23.14"E**		Long:	**73°09'23.20"E**
	Name:	**NMD_TP06**		Name:	**NMD_TP09**

Sl. No.	AT ESTABLISHED GAUGE					AT NEW GAUGE				
	HEIGHT ABOVE CD			CONTRIBUTION FOR		HEIGHT ABOVE ZERO OF GAUGE			CONTRIBUTION FOR	
	H.W	L.W	FACTOR	H.Ws	L.Ws	H.W	L.W	FACTOR	H.Ws	L.Ws
a	-	0.40	1	-	0.40	-	0.40	1	-	0.40
b	1.16	-	1	1.16	-	1.10	-	1	1.10	-
c	-	0.06	3	-	0.18	-	0.40	3	-	1.20
d	3.26	-	2	6.52	-	1.10	-	2	2.20	-
e	-	0.35	3	-	1.05	-	0.40	3	-	1.20
f	1.16	-	1	1.16	-	1.10	-	1	1.10	-
g	-	0.06	1	-	0.06	-	0.40	1	-	0.40
	Sum of Contribution			8.84	1.69	Sum of Contribution			4.40	3.20
	Observed MHW			2.21	-	Observed MHW			1.10	-
	Observed MLW			-	0.21	Observed MLW			-	0.40

Note:

Observed MHW = Sum of Contributions of HW/4

Observed MLW = Sum of Contributions of LW/8

Observed Mean Range (R)	=	2.00	Observed Mean Range (r)	=	0.70
Observed Mean Level (M')	=	1.21	Observed Mean Level (m')	=	0.75

Note:

Observed Mean Range = Observed MHW - Observed MLW

Observed Mean Level = (Observed MHW + Observed MLW)/2

CALCULATION OF SOUNDING DATUM (d) AT NEW GAUGE

(A) Where 'True Spring M.L (M)'at Established gauge is known	(B) Where 'True Spring M.L (M)'at Established gauge is not known
From A.T.T (Table V of Part II)	
MHWS =	
MLWS =	
True Spring M.L (M) = 0.00	
Note:	
True Spring M.L (M) = (MHWS + MLWS)/2	
SD = m'-(M'-M)-M*(r/R)	SD = m'-((M'*r)/R)
SD = 0.00 Mtrs above Zero of Gauge	SD = 0.326 Mtrs above Zero of Gauge

Table 2.14- Transfer of Sounding Datum - NMD_TP-06 to NMD_TP-09

2.2 Existing Cross Structures

2.2.1 Bridges

There are total 9 no bridges across the River Narmada (studies length 226.343 km) including on one Railway Bridge and one Road Bridge under construction.

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m	Remarks (complete / under - construction), in use or not, condition
1	Railway Bridge	50.6	RCC	Bharuch	**Right Bank:** 21°42'02.16"N 73°00'02.05"E **Left Bank:** 21°6'16.76"N 73°00'14.33"E	**Right Bank:** 293160.18 2401011.30 **Left Bank:** 293491.50 2399652.55	1460	11.5	15	85.5	3.127	Completed
2	Golden Bridge	50.8	RCC	Bharuch	**Right Bank:** 21°42 02.5"N 73°00'03.32"E **Left Bank:** 21°41'21.35"N 73°00'25.55"E	**Right Bank:** 297553.95 2402807.92 **Left Bank:** 298575.43 2401848.21	1420	7.5	23	54.137	5.532	Completed
3	Under construction Bridge	50.8	RCC	Bharuch	**Right Bank:** NA **Left Bank:** 21°41'22.97"N 73°00'25.70"E	**Right Bank:** NA **Left Bank:** 293820.33 2399809	NA	NA	3	54	NA	Under Construction
4	Sardar Bridge	55.8	RCC	Jadeswar (Bharuch)	**Right Bank:** 21°42'58.87"N 73°02'33.35"E **Left Bank:** 21°42'29.24"N 73°03'7.91"E	**Right Bank:** 297527.17 2402711.90 **Left Bank:** 298508.99 2401788.13	1340	20	9	144	3.5	Under Construction
5	Jadeshwar Bridge1	55.9	RCC	Jadeswar (Bharuch)	**Right Bank:** 21°43'2.00"N 73°02'34.24"E **Left Bank:** 21°42'31.22"N 73°03'10.19"E	**Right Bank:** 297553.95 2402807.92 **Left Bank:** 298575.43 2401848.21	1340	10.85	14	92.496	4.6	Completed
6	Jadeshwar Bridge-2	55.9	RCC	Jadeswar (Bharuch)	**Right Bank:** 21°43'2.49"N 73°02'35.81"E **Left Bank:** 21°42'32.15"N 73°03'10.59"E	**Right Bank:** 297599.32 2402822.49 **Left Bank:** 298587.18 2401876.44	1340	8.1	14	92.127	4.5	Completed
7	Poicha Bridge	138.4	RCC	Poicha	**Right Bank:** 21°57'33.55"N 73°26'42.64"E **Left Bank:** 21°57'38.42"N 73°26'8.73"E	**Right Bank:** 339450.08 2429139.25 **Left Bank:** 338478.66 2429298.75	1000	12	10	93.2	20.15	Completed

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m	Remarks (complete / under - construction), in use or not, condition
					Left Bank Right Bank	Left Bank Right Bank						
8	Akteshvar Bridge	168.8	RCC	Garudeswar	**Right Bank:** 21°53'19.63"N 73°38'44.31"E	**Right Bank:** 360083.81 2421133.94	600	7.5	14	34.3	0.45	Completed
					Left Bank: 21°53'0.12"N 73°38'40.72"E	**Left Bank:** 359975.67 2420534.85						
9	Gora Bridge	175.3	RCC	Vasantpura	**Right Bank:** 21°51'50.08"N 73°41'52.47"E	**Right Bank:** 365460.84 2418333.39	721	7	57	10.247	No vertical clearance w.r.t to HFL	Completed
					Left Bank: 21°51'41.44"N 73°41'28.94"E	**Left Bank:** 364783.23 2418073.66						

Table 2.15: Bridges

2.2.2 Electric Lines / Communication Lines

A total of 23 High Tension electrical lines and01 crane cable made of steel wire rope were present across the Narmada River and the details are as follows:-

Sl. No.	Type of Line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal Clearance (Clear Distance between Piers) (m)	Vertical Clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
1	HTL	32	Near Bhadbhut (Village)	**Left Bank:** 21°39'59.39"N 72°50'11.44"E **Right Bank:** 21°40'29.88"N 72°50'3.32"E	**Left Bank:** 276107.87 2397521.11 **Right Bank:** 275895.58 2398410.95	1	930	45	Complete
2	HTL	41.4	Verwada (Village)	**Left Bank:** 21°40'2.24"N 72°55'12.18"E **Right Bank:** 21°40'52.72"N 72°55'3.37"E	**Left Bank:** 284775.31 2397446.17 **Right Bank:** 284540.36 2399004.81	4	370	15	Complete
3	HTL	51.4	Bharuch (Near Railway Bridge)	**Left Bank:** 21°41'22.28"N 73°0'34.11"E **Right Bank:** 21°42'3.73"N 73°0'28.48"E	**Left Bank:** 294060.71 2399784.33 **Right Bank:** 293915.58 2401052.98	1	855	52	Complete
4	HTL	55.8	Bharuch Sardar Bridge	**Left Bank:** 21°42'44.03"N	**Left Bank:** 298087.17	1	300	10	Complete

Sl. No.	Type of Line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal Clearance (Clear Distance between Piers) (m)	Vertical Clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				73°2'52.95"E	2402246.93				
				Right Bank: 21°42'59.72"N 73°2'34.53"E	**Right Bank:** 297550.59 2402742.57				
5	HTL	56.8	Near Bharuch Sardar Bridge (Island)	**Left Bank:** 21°42'49.19"N 73°3'21.3"E	**Left Bank:** 298890.52 2402420.82	3	400	18	Complete
				Right Bank: 21°43'24.91"N 73°3'1.26"E	**Right Bank:** 298349.87 2403509.18				
6	HTL	57.5	Near Bharuch Sardar Bridge (Island)	**Left Bank:** 21°42'44.93"N 73°3'36.05"E	**Left Bank:** 299322.77 2402264.38	2	550	20	Complete
				Right Bank: 21°43'37.92"N 73°3'9.45"E	**Right Bank:** 298584.2 2403898.38				
7	HTL	58	Near Bharuch Sardar Bridge (Island)	**Left Bank:** 21°42'48.89"N 73°3'44.01"E	**Left Bank:** 299552.93 2402385.9	2	500	20	Complete
				Right Bank: 21°43'44.35"N 73°3'13.21"E	**Right Bank:** 298692.5 2404089.03				
8	HTL	63	Ranipura Village To Uchedia (Island)	**Left Bank:** 21°43'12.7"N 73°6'48.07"E	**Left Bank:** 304809.36 2403030.14	2	550	19	Complete
				Right Bank: 21°44'5.16"N	**Right Bank:** 304440.99				

Sl. No.	Type of Line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal Clearance (Clear Distance between Piers) (m)	Vertical Clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				73°6'33.21"E	2404681.94				
9	HTL	68	Kabir Wada Island	**Left Bank:** 21°45'18.62"N 73°8'55.14"E	**Left Bank:** 308534.25 2406811.21	1	800	25	Complete
				Right Bank: 21°45'34.6"N 72°8'30.47"E	**Right Bank:** 307862.42 2407379.28				
10	HTL	75.9	Near Janor Village	**Left Bank:** 21°49'45.94"N 73°8'28.96"E	**Left Bank:** 307892.47 2415107.6	0	700	32	Complete
				Right Bank: 21°49'38.64"N 73°8'5.84"E	**Right Bank:** 307237.15 2414886.42				
11	HTL	85.8	Near Pura Village	**Left Bank:** 21°49'55.96"N 73°10'37.43"E	**Left Bank:** 311593.92 2415375.16	0	780	20	Complete
				Right Bank: 21°50'19.67"N 73°10'45.87"E	**Right Bank:** 311831.36 2416097.5				
12	HTL	86.3	Near Rundh Village	**Left Bank:** 21°49'47.2"N 73°10'52.25"E	**Left Bank:** 312009.01 2415096.44	0	750	35	Complete
				Right Bank: 21°50'9.77"N 73°11'1.59"E	**Right Bank:** 312294.99 2415785.35				
13	HTL	86.5	Near Rundh Village	**Left Bank:** 21°49'45.19"N	**Left Bank:** 312150.78	0	780	19.12	Complete

Sl. No.	Type of Line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal Clearance (Clear Distance between Piers) (m)	Vertical Clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				73°10'57.1"E	2415031.31				
				Right Bank: 21°50'8.53"N 73°11'7.71"E	**Right Bank:** 312465.65 2415747.54				
14	HTL	90.8	Near Rundh Village	**Left Bank:** 21°49'43.92"N 73°11'1.13"E	**Left Bank:** 312265.11 2414990.93	0	780	19.2	Complete
				Right Bank: 21°50'7.03"N 73°11'11.67"E	**Right Bank:** 312576.65 2415698.86				
15	HTL	112.8	Nanikoral Village	**Left Bank:** 21°49'27.37"N 73°13'33.5"E	**Left Bank:** 316640.24 2414432.3	0	800	42	Complete
				Right Bank: 21°49'48.9"N 73°13'18.38"E	**Right Bank:** 316207.82 2415097.72				
16	HTL	113.9	Asha Village	**Left Bank:** 21°53'33.36"N 73°17'36"E	**Left Bank:** 323683.01 2421914.61	0	900	28	Complete
				Right Bank: 21°53'57.41"N 73°17'55.88"E	**Right Bank:** 324269.77 2422650.67				
17	HTL	114	Malsar Village	**Left Bank:** 21°53'5.79"N 73°18'6.91"E	**Left Bank:** 324567.09 2421068.04	0	940	20	Complete
				Right Bank: 21°53'32.37"N	**Right Bank:** 325071.57				

Sl. No.	Type of Line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal Clearance (Clear Distance between Piers) (m)	Vertical Clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				73°18'24.41"E	2421870.19				
18	HTL	115.5	Malsar Village	**Left Bank:** 21°52'40.31"N 73°18'55.34"E	**Left Bank:** 325942.28 2420260.54	0	764	28	Complete
				Right Bank: 21°53'4.79"N 73°19'5.7"E	**Right Bank:** 326255.23 2421019.16				
19	HTL	120	Near Sinor Village	**Left Bank:** 21°53'23.63"N 73°21'0.01"E	**Left Bank:** 329532.72 2421554.83	0	740	35	Complete
				Right Bank: 21°53'26.58"N 73°20'34.63"E	**Right Bank:** 328812.82 2421658.19				
20	HTL	134	Near Barkal Village	**Left Bank:** 21°55'18.53"N 73°26'10.83"E	**Left Bank:** 338495.26 2424996.29	0	500	18	Complete
				Right Bank: 21°55'26.68"N 73°25'56.81"E	**Right Bank:** 338106.38 2425242.83				
21	HTL	144.4	Poicha Mandir Narmada	**Left Bank:** 21°58'16.12"N 73°28'27.14"E	**Left Bank:** 342473.21 2430419.97	0	850	20	Complete
				Right Bank: 21°58'38.98"N 73°28'36.42"E	**Right Bank:** 342736.31 2431113.47				
22	HTL	175.6	Vagadiya Viilage Near Bridge	**Left Bank:** 21°51'27.59"N	**Left Bank:** 364906.01	0	885	10	Complete

Sl. No.	Type of Line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal Clearance (Clear Distance between Piers) (m)	Vertical Clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				73°41'33.14"E	2417648.78				
				Right Bank: 21°51'36.58"N 73°42'2.57"E	**Right Bank:** 365749.36 2417917.61				
23	HTL	181.3	Near Sardar Sarovar Dam	**Left Bank:** 21°49'43"N 73°44'16.01"E	**Left Bank:** 369567.94 2414387.89	0	600	15	Complete
				Right Bank: 21°49'58.28"N 73°44'13.22"E	**Right Bank:** 369530.74 2414820.09				
24	Crane Cable	182.5	Near Sardar Sarovar Dam	**Left Bank:** 21°49'19.42"N73°44'53.77"E	**Left Bank:** 370627.25 2413657.21	0	1513	24.3	Crane Cable across the Dam
				Right Bank: 21°50'7.03"N 73°45'4.81"E	**Right Bank:** 370956.11 2415118.68				

Table 2.16 - High Tension Lines Details

2.2.3 Pipe Lines / Cables

The indication of the presence of underwater/sub-bedded high-pressure pipeline was observed near to the Bhadbhut village and as per local information, at least 07 pipelines are passing across the Narmada River within the 200 mtr corridor across the Narmada River. The pipelines usually have minimum burial depth of 01 mtr all along the route and the at major water crossings pipeline are laid below predicted scour profile of river bed. The gas pipelines are laid as per right to use basis and the physical presence of the buried pipeline cannot be identified by using the existing survey methodology. The collected details of buried pipelines are as follows:-

Sl No	Structure Name	Chainage (km)	Type of Structure	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	Length (m)	Width (m)	Remarks
1	High-Pressure Pipeline	32.0	Under Ground	Bhadbhut	**Right Bank:** 21°40'31.66"N 72°50'9.63"E	**Right Bank:** 276087.740 E 2398463.20N	NA	NA	Minimum of 400 mtr corridor across the Narmada river is not recommended for dredging activities.
					Left Bank: 21°39'48.07"N 72°50'32.53"E	**Left Bank:** 2767480.2 E 2397117.15N			

Table 2.17- Details of other cross structures

Figure 2.1- Underground High-pressure Pipeline warning sign

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

The Sardar Sarovar Dam is the only dam present in the entire survey stretch of Narmada River. The construction of new weir is in progress at Garudeshwar. The details of existing Dam and under construction weirare as follows:-

No	Structure Name	Ch. (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	Crest Level w.r.t MSL(m)	Present condition
1	Sardar Sarovar Dam	182.5	Kevadia	**Right Bank:**21°50'5.39"N73°45'2.93"E	**Right Bank:** 370901.73 E 2415068.69N	1210	40.0	121.92	Operational/ Under Construction
				Left Bank:21°49'29.47"N 73°44'53.21"E	**Left Bank:**370613.68E 2413966.38N				
2	Garudeshwar Weir	170.0	Garudeshwar	**Right Bank:**21°53'10.53"N 73°39'32.35"E	**Right Bank:**361460.37E 2420842.94N	NA	NA	NA	Under Construction
				Left Bank:21°52'56.20"N 73°39'32.58"E	**Left Bank:**361463.31 E2420401.28 N				

Table 2.18 - Details of Check Dams

Figure 2.2 – Downstream and Up-stream view of SardarSarovar Dam

Details of Locks

There are no Locks present in the entire survey stretch of Narmada River.

Details of Aqueducts

There are no Aqueducts present in the survey stretch of Narmada River.

2.3 Bends

There are 39nosof bends noticed in river Narmada in a length of 226.343 km.

2.3.1 Radius of Curvatures

The bends along with radius of curvature are tabulated below:

Sr. No.	Chainage (in Km)	Radius of Curvature(in m)
1	1.4	900
2	3.5	1000
3	12	1300
4	15.5	1150
5	16.5	1160
6	19.9	800
7	25	1470
8	36.2	4200
9	56.2	700
10	60	550
11	60.9	750
12	61.6	700
13	67	1180
14	77.9	1200
15	80.6	550
16	88.4	865
17	95.3	900
18	102	1800
19	106	1420
20	119	1160
21	124.2	900
22	126.9	1000
23	131.8	650
24	142.8	700
25	148.1	600
26	151.1	675
27	152.8	700
28	156	850

Sr. No.	Chainage (in Km)	Radius of Curvature(in m)
29	164.6	560
30	166.7	490
31	167.8	550
32	168.6	700
33	171.8	850
34	180.9	480
35	181.9	560
36	186.8	900
37	189	1110
38	196	1280
39	198.6	850

Table 2.19 Radius of curvatures

2.4 Velocity and Discharge Details

The Valeport801 Velocity meter was used to log the flow rates of the river. The observations were undertaken on the cross section near the BM/ Tide Gauge established during the Hydrographic survey. The current meter observation at stretch no 18 could not be obtained due to unavailability for sufficient water level. The locations of current meter deployment are as follows:

Stretch No.	Chainage (km)	Position		Observed Depth(m) (D)	Velocity (m/sec.)	Average Velocity (m/sec.)	X-Sectional Area (sq. m.)	Discharge (Cu.m)
		Lat/Long	East/North		0.5 D			
1	3.41	21°39'12.2621"N 72°35'1.1925"E	249927.987 2396411.223	6.6	0.649	0.649	15101.12	9815.728
2	11.75	21°40'36.2997"N 72°39'38.3296"E	257937.37 2398874.4	4.5	0.662	0.662	2556.360	1692.310
3	20.5	21°41'12.5533"N 72°44'3.0504"E	265565.45 2399876.6	3.2	0.232	0.232	5857.801	1359.010
4	30.03	21°39'48.1000"N 72°49'4.5877"E	274198.34 2397154.3	3.8	0.276	0.276	3674.954	1014.287
5	41.26	21°40'35.1311"N 72°55'3.0386"E	284524.74 2398459.3	3.2	0.363	0.363	1739.256	631.350
6	50.42	21°41’21.0496”N 73°00’7.8020”E	293305.01 2399756.4	6.7	0.142	0.142	3053.094	433.539
7	60.82	21°42’57.5556”N 73°05’34.6574”E	302737.58 2402606.3	2.5	0.119	0.119	689.348	82.032
8	72.2	21°47’47.6992”N 73°08’19.4833”E	307582.26 2411472.6	5.8	0.129	0.129	1053.728	135.931
9	82.15	21°51’33.5783”N 73°09’22.6127”E	309478.75 2418398.2	2.6	0.041	0.041	339.054	13.901

Stretch No.	Chainage (km)	Position		Observed Depth(m) (D)	Velocity (m/sec.)	Average Velocity (m/sec.)	X-Sectional Area (sq. m.)	Discharge (Cu.m)
		Lat/Long	East/North		0.5 D			
10	96.47	21°52’4.5484”N 73°14’36.3929”E	318498.56 2419245.3	2.5	0.040	0.040	2230.339	89.214
11	105.25	21°56’2.8420”N 73°14’29.7481”E	318391.72 2426576.5	0.8	0.034	0.034	128.592	4.372
12	114.31	21°53’8.2156”N 73°18’23.7327”E	325046.69 2421130.2	3.5	0.009	0.009	623.967	5.616
13	122.31	21°54’40.6002”N 73°20’37.6474”E	328921.26 2423929.6	13.1	0.006	0.006	1460.379	8.762
14	130.24	21°54’40.5704”N 73°24’13.0000”E	335101.58 2423863.2	2.8	0.006	0.006	309.645	1.858
15	142.55	21°59’0.1468”N 73°27’38.3887”E	341076.02 2431786	5.0	0.004	0.004	51.744	0.207
16	152.36	21°58’44.5084”N 73°32’32.7121”E	349513.49 2431222.4	10.5	0.063	0.063	1447.815	91.212
17	165.91	21°53’34.3294”N 73°37’8.1709”E	357328.58 2421610.4	1.1	0.038	0.038	53.616	2.037
19	183.73	21°49’49.2896”N 73°45’38.3567”E	371914.86 2414565.37	58.6	0.002	0.002	56254.170	112.508
20	193.39	21°50’36.3731”N 73°50’44.9849”E	380729.31 2415944.8	65.8	0.001	0.001	57664.090	74.963
21	206.32	21°52’48.8222”N 73°57’37.2017”E	392590.61 2419933.21	56.4	0.002	0.002	43541.140	66.037
22	215.76	21°55’13.9016”N 74°02’25.7952”E	400901.01 2424340.38	58.8	0.013	0.013	39040.610	493.864
23	223.62	21°56’42.3578”N 74°06’42.5677”E	408283.85 2427015.93	54.7	0.011	0.011	33002.550	357.676

Table 2.20- Current meter and discharge Details

2.5 Waterway description

The Waterway of Narmada River for 227 Km river Chainage is divided into different stretches of 30 km each for the easy interpretation. The details of the stretches are as follows:-

2.5.1 Sub-Stretch-01 Confluence of the Narmada at Gulf of Khambhat to Kosva Village (0 km to 30 km)

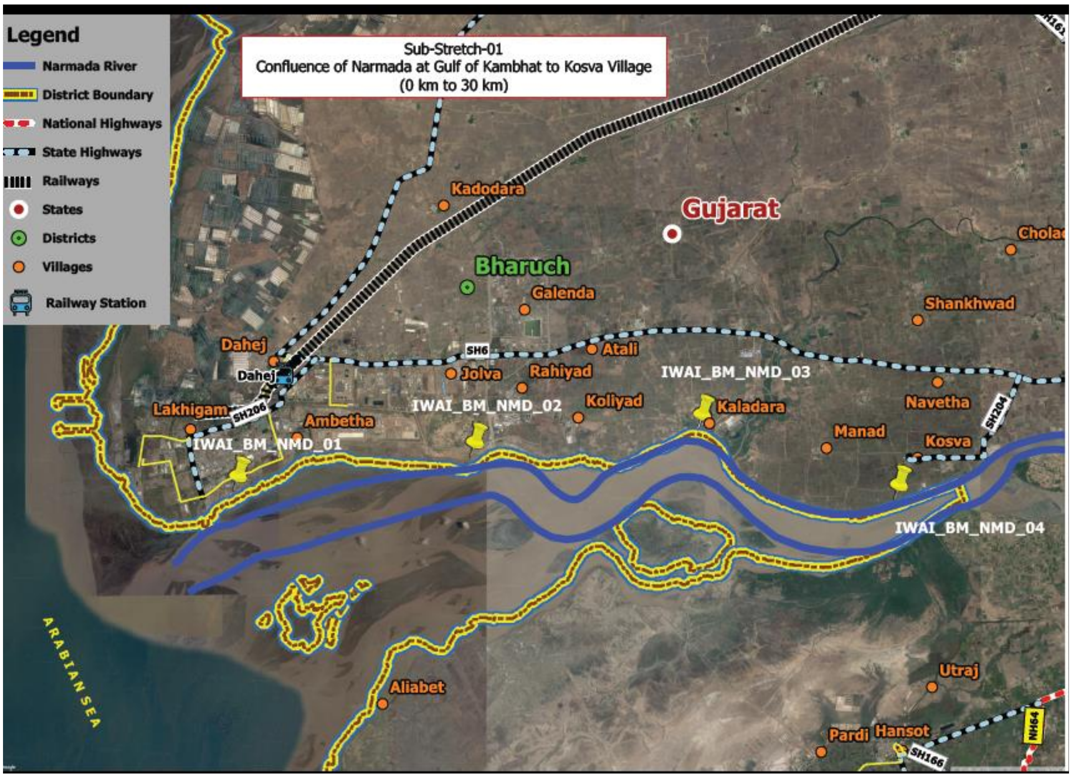


Figure 2.3: Sub-Stretch-01 Confluence of the Narmada at Gulf of Khambhat to Kosva Village (0 km to 30km)

Sub-Stretch-1 (0 to 30 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	0 to 30 km	The full stretch is covered by bathymetric survey
Topographic Survey	0 to 30 km	River banks, drying heights and sand patches

This stretch is from the confluence of Narmada River at Gulf of Khambhat to Kosava Village (0 to 30 km chainage of Narmada River). This full stretch is tidal in nature with a variation of 7.68 mtrs. The river bed is flat and sandy in nature, several sand patches are present in the mouth area and the southern side of the channel are drying heights. There are no Dam, barrages, weirs or any other cross structures in this stretch. The width of the river in this stretch varies from 2.5 to 1.4 km. The river banks are high rise and unprotected in nature and are lined very prominently with marshy and loose clay muds present on the intertidal portion throughout the river banks. The gradient of the river is very gentle and there are no rapids or obstructions in this stretch and there is no encroachment of the river banks in this stretch.

The important places near this stretch are Jageshwar, Ambetha, Jolva, Kaladara, Mahgam and kosva on the right bank side. The Aliabet and Hansot are present on the left side bank of this stretch of Narmada River. The water in this stretch is saline in nature hence the salt water during the ebbing are used for manufacturing of sea salt and are not used for any drinking or agricultural purpose. This stretch is a muddy area on both river bank sides and the land is utilized mainly by several industries. All type of chemical, cotton, oil & gas, plastic manufacturing companies situated here in this stretch

The important terminals like Reliance Dahej Terminal, Ro-Ro Jetty, and ABG shipyard are present near to Dahej area and shoft shipyard, Kaladhara is also present in this stretch. The river bed is sandy in nature and the river banks consist of very loose clay mud. Several workboats and fishing boats are operating in this stretch.

Figure 2.4–Very loose mud in the Inter-tidal area of Sub-Stretch-01

As per discussion with ABG shipping authority, high volume of siltation is observed near the ABG Shipping terminal and the siltation of approximately 06 mtrs was formed near the ABG terminal and the terminals are not being used. The construction of terminal and dredging work near Ro-Ro Jetty is in progress for Gujarat Maritime Board. There are no cross structures present in this area and the tidal variation in this stretch is suitably used for navigation by medium type of vessels. The construction of a terminal for Godrej Company is also in progress at the downstream portion of Reliance Jetty. The right bank of this stretch is Dehag SEZ and small cluster settlements are also present in the upstream portion of this stretch. The left bank side of this stretch is mostly uninhabited in nature with major settlement present on Hansot village.

Figure 2.5 – Vessel berthed alongside Reliance Dahej Terminal

Figure 2.6– View of under- construction Godrej Jetty

The SH-06 between Bharuch to Dahej runs parallel to this survey stretch on Right banks side with the good interconnectivity of roads. The Dahej Railway station is the important railway station near to this stretch, the station is however used only for cargo services. The cargo movement through the waterway is not available in present condition. Dense fishing activities by using small motor boats are observed in this stretch.

Class	Chainage (km)		Observed in Meters			Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	0	30	-	-	-	-3.64	9.68	12643.95	1621452.39
IV	0	30	-	-	-	-3.80	9.68	13659.45	1919546.83
V	0	30	-	-	-	-3.80	9.68	13659.45	2879333.57

Table 2.21–Stretch-1 Dredging Quantity

Stretch -1 River Bed Profile

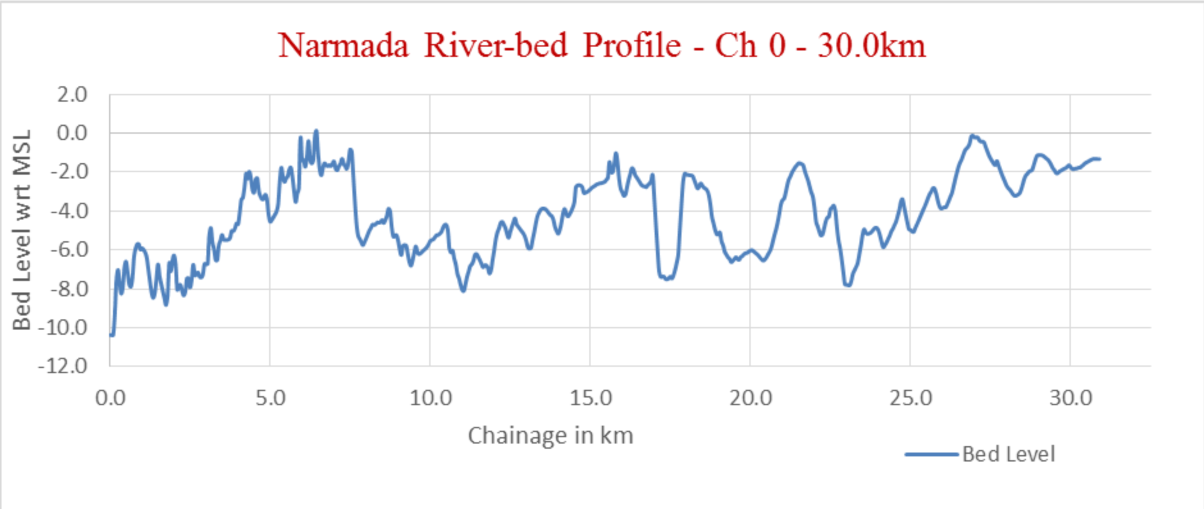


Figure 2.7: Stretch-1 River-bed Profile

2.5.2 Sub-Stretch-2 Kosva Village to Govali Village (30 km to 60 km)

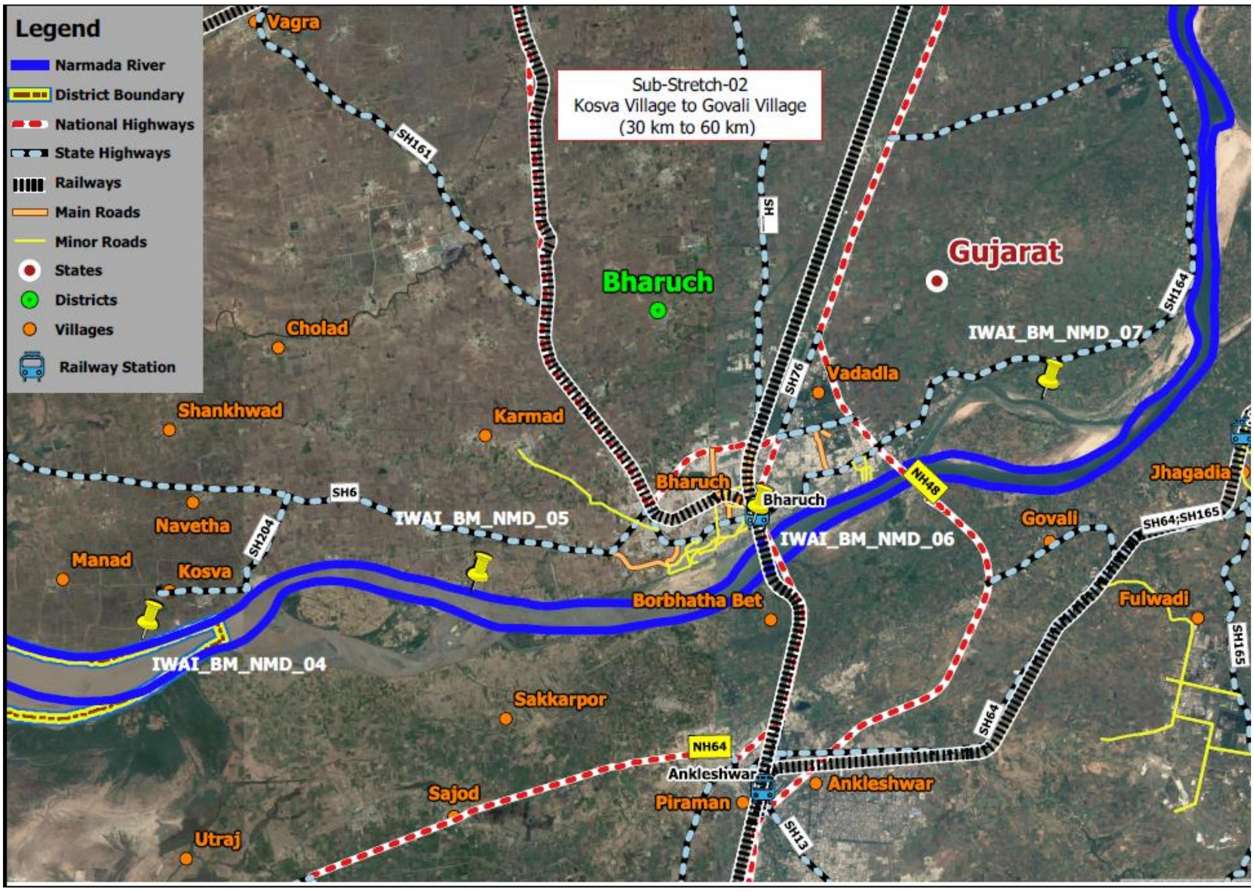


Figure 2.8: Sub-Stretch-02 Confluence of the Narmada at Gulf of Khambhat to Kosva Village (30km to 60km)

Sub-Stretch-2 (30 to 60 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	30 to 60 km	The full stretch is covered by bathymetric survey
Topographic Survey	30 to 60 km	Riverbank, drying height, islands and sand patches

This stretch is from Kosava to Govali Village (30 to 60 km chainage of Narmada River). This full stretch is tidal in nature with a variation of 3.73 mtr. The river bed is flat and sandy in nature with several sand patches present in the River area. There are no Dam, barrages, weirs or any other cross structures in this stretch. The width of the river in this stretch varies from 1400 to 383 m.

Figure 2.9– River bed showing sandy and loose clay mud

The river bed is flat and sandy in nature. The loose clay mud is observed on the intertidal areas near the river bank. The sand mining at various places is observed in this stretch of the Narmada River. Dense fishing activity is observed in this stretch and several fishing boats are present in this region. A small jetty is present in the Bhadbhut and is used by the fishing boats and other small boats in the area. The jetty is accessible only during high tide as the area up to 20 mtr will dry up during low tide. A Large number of sea-going fishing boats are present in this area.

Figure 2.10 – Mining of Sand using Suction Pump

The river banks are high rise and unprotected in nature and are lined very prominently with marshy and loose clay muds present on the intertidal portion throughout the river banks. The gradient of the river is very gentle and there are no rapids or obstructions in this stretch and there is no encroachment of the river banks in this stretch. The important places near this stretch are Bharuch, Ankleshwar, and Zadeshwar. The water in this stretch is saline in nature hence the water in this stretch are not used for drinking or agricultural purpose.

The SH-06 between Bharuch to Dahej runs parallel to this survey stretch on Right banks side with the good interconnectivity of roads. The Bharuch and Ankleshwar railway station are the important railway station near to this stretch. The cargo movement through the waterway is not available in present condition. The Bharuch railway bridge, Golden Bridge, Sardar Bridge and Jadeshawar Bridge are the cross structure present in this stretch. The warning for the high-pressure gas line was observed near to Bhadbhut village in this stretch and it is recommended that anchoring and dredging be avoided in this area.

Figure 2.11 – Railway and Road Bridge at Bharuch

Figure 2.12 – Bridges at Jadeshwar

Class	Chainage (km)		Observed in Meters			Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	30	60	-	-	-	-0.47	11.50	4908.63	226432.73
IV	30	60	-	-	-	-0.47	11.50	6297.21	327612.43
V	30	60	-	-	-	-0.78	11.50	6297.21	522655.07

Table 2.22–Stretch-2 Dredging Quantity

Stretch-2 River-bed Profile

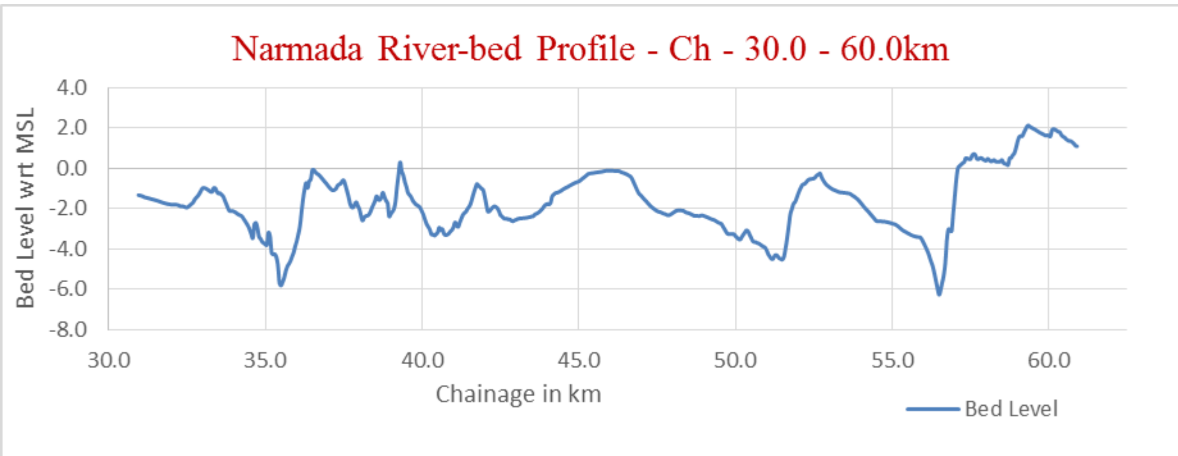


Figure 2.13– Stretch-2 River-bed Profile

2.5.3 Sub-Stretch-3GovaliVillage to MotiKoral Village (60 km to 89.5km)

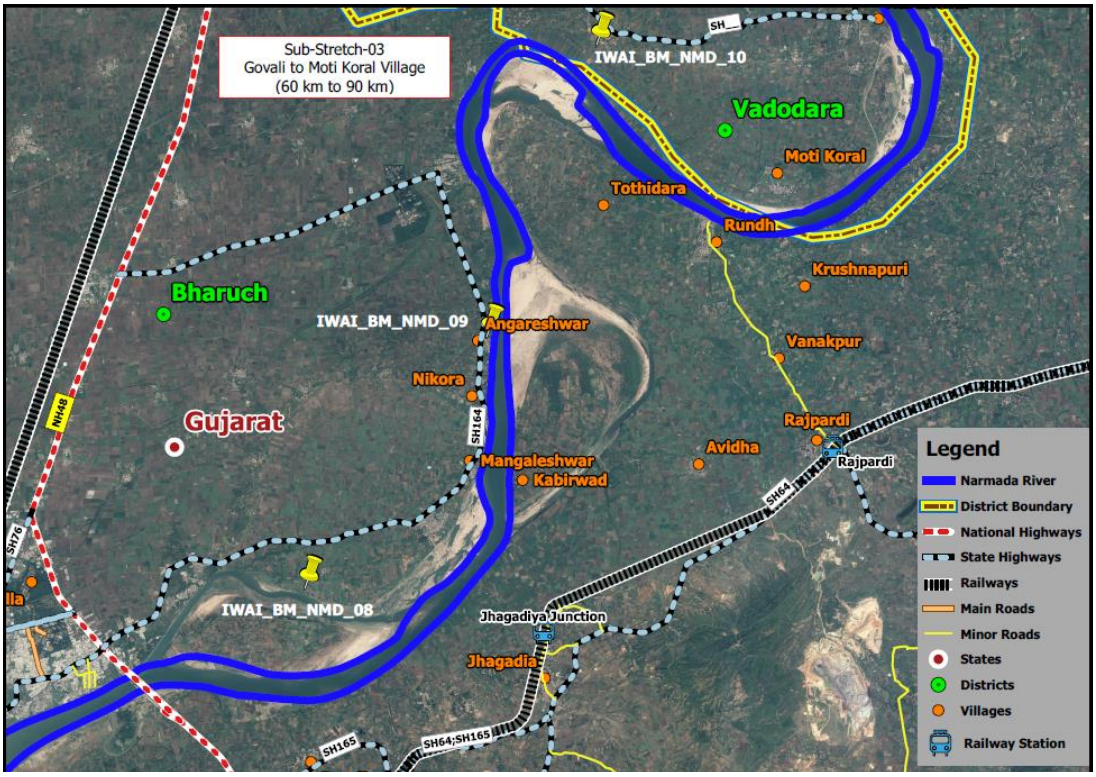


Figure 2.14: Sub-Stretch-03 Govali Village to MotiKoral Village (60 km to 89.5 km)

Sub-Stretch-3 (60 to 89.5 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	60 to 89.5 km	The full stretch is covered by bathymetric survey
Topographic Survey	60 to 89.5 km	Riverbank, drying height, islands and sand patches

This stretch is from Govali to MotiKoral Village (60 to 90 km chainage) of Narmada River. This stretch up to 89.2 km chainage is tidal in nature with a variation of 1.37 km and the chainage 89.2 to 120 km is non-tidal in nature. The river bed is flat and sandy in nature with several sand patches and islands are present in the River area. There are no Dam, barrages, bridges and weirs in this stretch. The width of the river in this stretch varies from 80 to 400 m.

The loose clay mud is observed on the intertidal areas near the river bank. The river bed is sandy in nature and islands/sand patches are present in this stretch. From Kaladara to Jagadia don’t have much change in soil characteristic having no changes of soil, same as muddy, the possibility of cultivation on river bank side is less due to muddy soil and saline water. Paddy cultivation and milk products are also observed in this area. In this stretch from Kadod to Nareswar soil may changing slightly from Muddy to sandy soil on both sides of river bank the vegetables, cotton cultivation, sugarcane, and banana are generally cultivated in this region.

The sand mining at various places is observed in this stretch of the Narmada River. Extensive sand mining is observed between 81 to 84 km chainage. The temporary bridge structure is constructed by sand mining contractor across the river from Right bank side at 82.5 km chainage for transportation of excavated sand. Several bunds were also constructed by various mining contractors between 80 to 84 km chainage from the Left bank side to the sand patches of Narmada River. As per the local information, the gradual erosion of around 130 m on Right bank side has occurred over a long period from 80 to 83 km chainage of Narmada River.

Figure 2.15 – Sand Mining in Progress & Temporary Bridge across the River

Dense fishing activity is observed in this stretch and several fishing boats are present in this region. A small jetty is situated near Nilkandheshwar Temple and Narmada Park, which are used for tourism purpose. Small fishing boats and other small boats are available in this area.

The river banks are high rise and unprotected in nature and are lined very prominently with marshy and Firm muddy river banks on the both river bank. The gradient of the river is very gentle and there are no rapids or obstructions in this stretch and there is no encroachment of the river banks in this stretch. The important places near this stretch are Jhagadia, Rajpardi, Nikola, Angareshwar, Rundh and MotiKoral. Several pumping stations of NTPC and ONGC are present near 73 km chainage of Narmada River for the supply of water to the industrial usage.

Figure 2.16 – Water Intake pump house of NTPC

This stretch is interconnected with various small roads leading from the state highway between Ankleshwar and Rajpipla. The Jhagadia and Rajpardi are the railway station nearest to this stretch. The cargo movement through the waterway is not available in present condition, however, the passenger ferry service by small boats are observed at MotiKoral and Rundh.

Class	Chainage (km)		Observed in Meters			Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	60	89.5	-	-	-	-1.12	17.24	16781.22	1083165.49
IV	60	89.5	-	-	-	-1.12	17.24	18314.81	1421078.12
V	60	89.5	-	-	-	-1.12	17.24	18314.81	2201875.06

Table 2.23 –Stretch-3 Dredging Quantity

Stretch-3 River-bed Profile

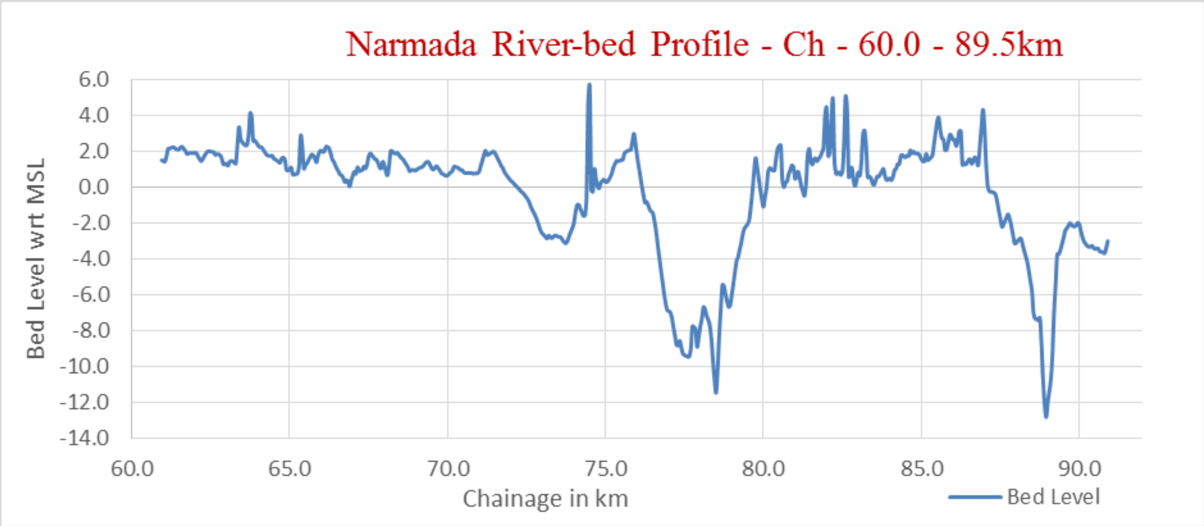


Figure 2.17 – Stretch-3 River-bed Profile

2.5.4 Sub-Stretch-4 Moti Koral to Sinor Village (89.5 km to 120 km)

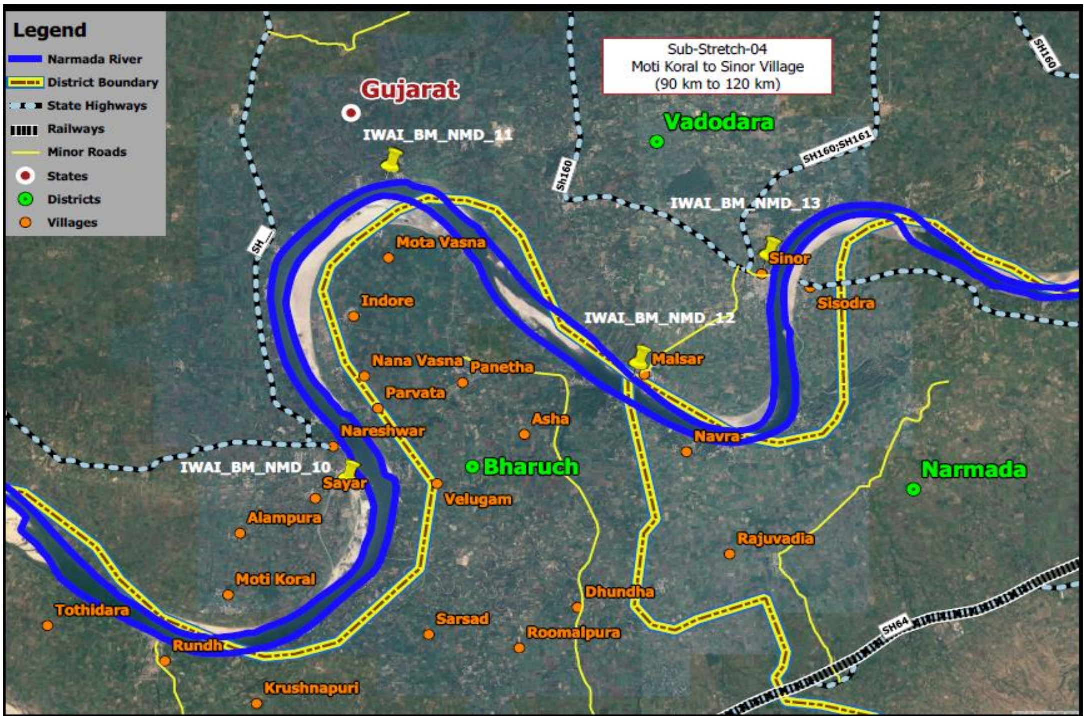


Figure 2.18 -Sub-Stretch-04 MotiKoral to Sinor Village (89.5 km to 120 km)

Sub-Stretch-4 (89.5 to 120 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	89.5 to 102.2km	Covered by bathymetric survey
	113.3 to 120 km	Covered by bathymetric survey
Topographic Survey	102.2 to 113.3 km	Being Dry/very shallow area, covered by topographic method
	89.5 to 120km	Riverbank, drying height, islands and sand patches

This stretch is from MotiKoral to Sinor Village (89.5 to 120 km chainage) of Narmada River. The full stretch is non-tidal in nature. The river chainage from 102.2 to 113.3 km chainage is dry/very shallow in nature and the area was covered by using topographic survey method. The river bed is flat and sandy in nature with several sand patches and islands are present in the River area. There are no Dam, barrages, bridges and weirs in this stretch. The water covered area of the river in this stretch varies from 10 to 450 m.

The Sandy river banks with large sand deposition are observed on the river banks of Narmada River. The river bed is sandy in nature and islands/sand patches are present in this stretch. The sand mining at various places is observed between 102 to 105 km chainage of the Narmada River. The temporary bridge structure is constructed by sand mining contractor across the river from right bank side at 102 km chainage for transportation of excavated sand. Moderate fishing activity is observed in this stretch and several fishing boats are present in this region. Small fishing boats and other small boats are available in this area.

The river banks are high rise and unprotected in nature and are lined very prominently on both river bank. The gradient of the river is very gentle and there are no rapids or obstructions in this stretch and there is no encroachment of the river banks in this stretch. The important places near this stretch are Lilod, Deroil, RanpurMalsar, and Sinor. The stretches from Angareswar to Malsar area is totally sandy area and sand mining activity is observed in the area.

This stretch is interconnected with various small roads and the road network in this stretch is poorly developed. The Nareshwar Road, Motikoral and Rajoardi are the railway station nearest to this stretch. The cargo movement through the waterway is not available in present condition, however, the passenger ferry service by small boats are observed at Lilod, Malsar, and Sinor.

Class	Chainage (km)		Observed in Meters				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	89.5	120	0.00	13.22	13718.44	1174136.69	-0.30	12.99	14558.53	1401280.37
IV	89.5	120	0.00	13.22	13718.44	1445370.96	-0.30	12.99	14855.25	1689085.66
V	89.5	120	0.00	13.22	13718.44	2178989.56	-0.30	12.99	14855.25	2538534.10

Table 2.24– Stretch-4 Dredging Quantity

Stretch-4 River-bed Profile

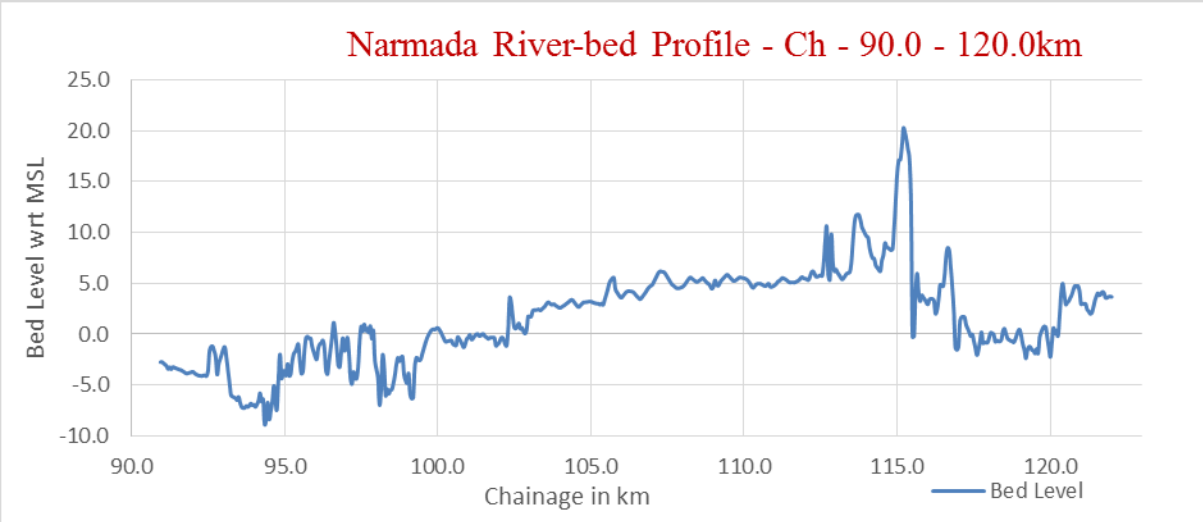


Figure 2.19 – Stretch-4 River-bed Profile

2.5.5 Sub-Stretch-5 Sinor to Varvada Village (120km to 150 km)

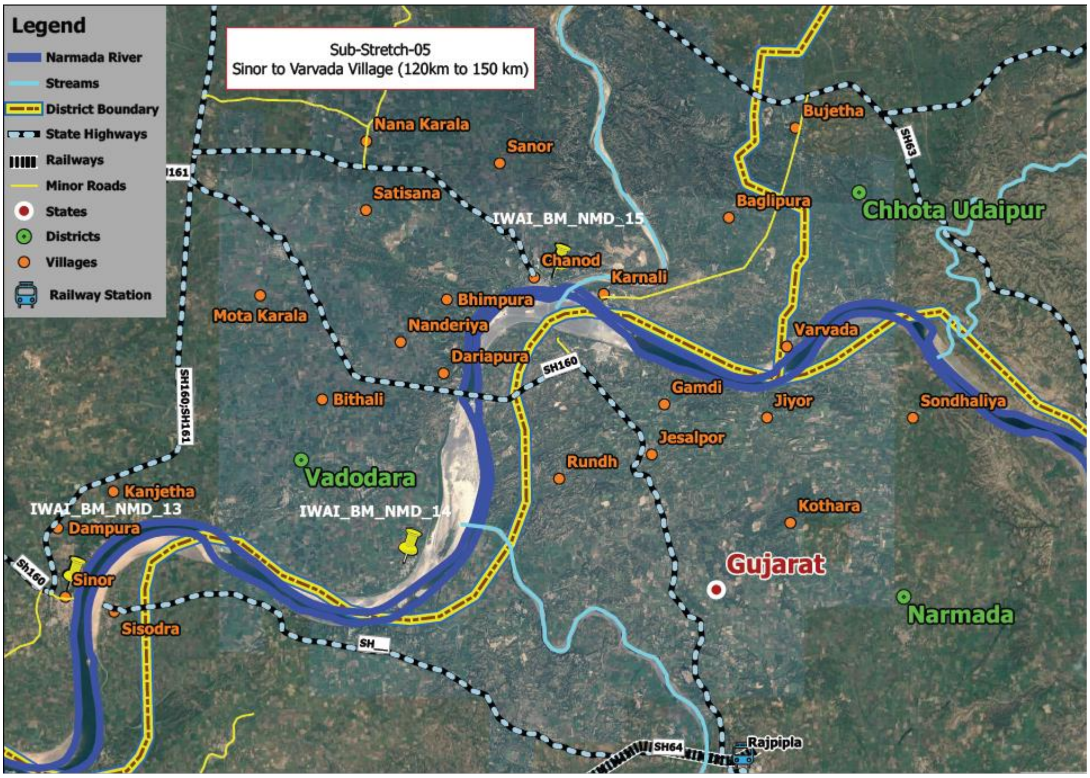


Figure 2.20: Sub-Stretch-05 Sinor to Varvada Village (120 km to 150 km)

Sub-Stretch-5 (120 to 150 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	120 to 150 km	Covered by bathymetric survey
Topographic Survey	120 to 150 km	Riverbank, drying height, islands and sand patches

This stretch is from Sinor to Varvada Village (120 to 150 km chainage) of Narmada River. The full stretch is non-tidal in nature and the river chainage from 126.5 to 138 km is dry/very shallow. The river bed is flat and sandy in nature with several sand patches and shallow areas are present in the River area. The Poicha Bridge is present across the Narmada River at 138 km chainage and there are no Dam, barrages, and weirs in this stretch. The water covered area of the river in this stretch varies from 40 to 250 mtr.

Figure 2.21 – Poicha Bridge near Chandod

The Sandy river banks with large sand deposition are observed on the river banks of Narmada River. The river bed is sandy in nature and sand patches are present in this stretch. The sand mining at various places is observed in this stretch of the Narmada River. Sand mining is observed between 134 to 138 km chainage near Dariapura and at 140 km chainage near Chandod. Very small-scale fishing activity is observed in this stretch and small fishing boats and other small boats are available in this area. This stretch is a sandy area in nature, changing slightly to the rocky structure from Malsar to Chandod. Sugar cane and Banana cultivation are practiced here with cotton cultivation.

The river banks are high rise and unprotected in nature and are lined very prominently on both river banks. The gradient of the river is gentle and there are no rapids or obstructions in this stretch and there is no encroachment of the river banks in this stretch. The important places near this stretch are Sinor, Barkal, Dariapura, Chandod, Karnali, and Varvada. The main tributaries are Karjan and Orsang river confluence with Narmada River on 134 and 142 km chainage in this stretch.

This stretch is interconnected with various small roads and the Pochia Bridge is present across the Narmada River at 138 km chainage, however, the road network in this stretch is poorly developed. The Chandod is the nearest railway station present in this stretch. The cargo movement through the waterway is not available in present condition, however, the passenger ferry services by small boats are observed at Chandod and Karnali area.

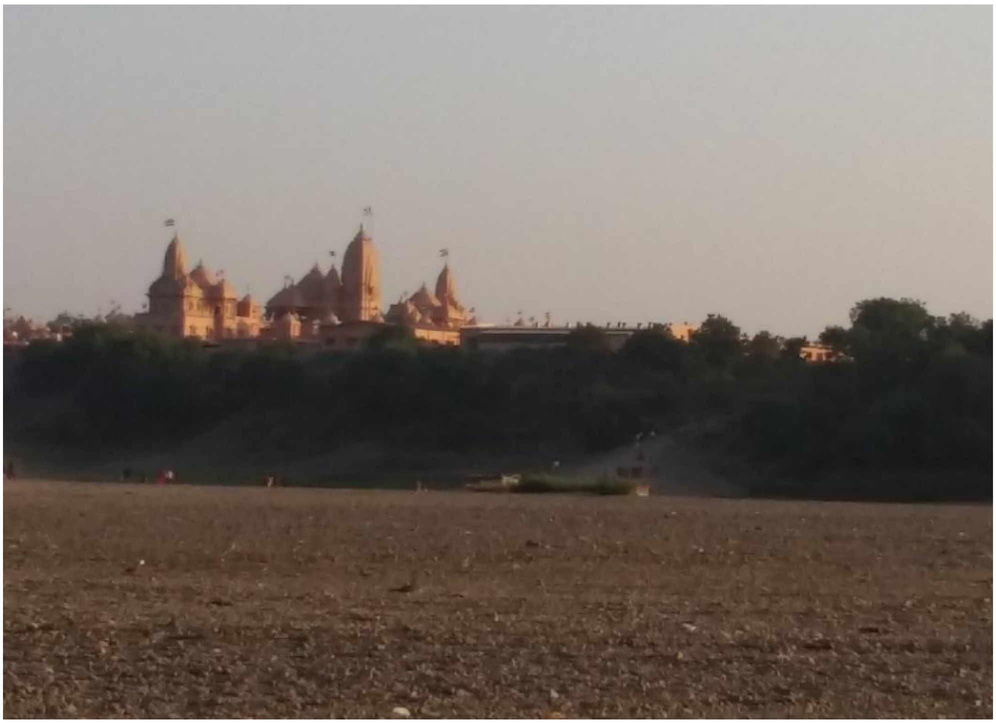


Figure 2.22 – View of Poicha Temple

Class	Chainage (km)		Observed in Meters				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	120	150	0.00	16.87	11230.71	565034.48	-0.30	16.65	12296.45	584666.25
IV	120	150	0.00	16.87	12364.65	759550.73	-0.30	16.65	12755.00	796011.39
V	120	150	0.00	16.87	12364.65	1242997.22	-0.30	16.65	12755.00	1332416.25

Table 2.25 – Stretch-5 Dredging Quantity

Stretch-5 River-bed Profile

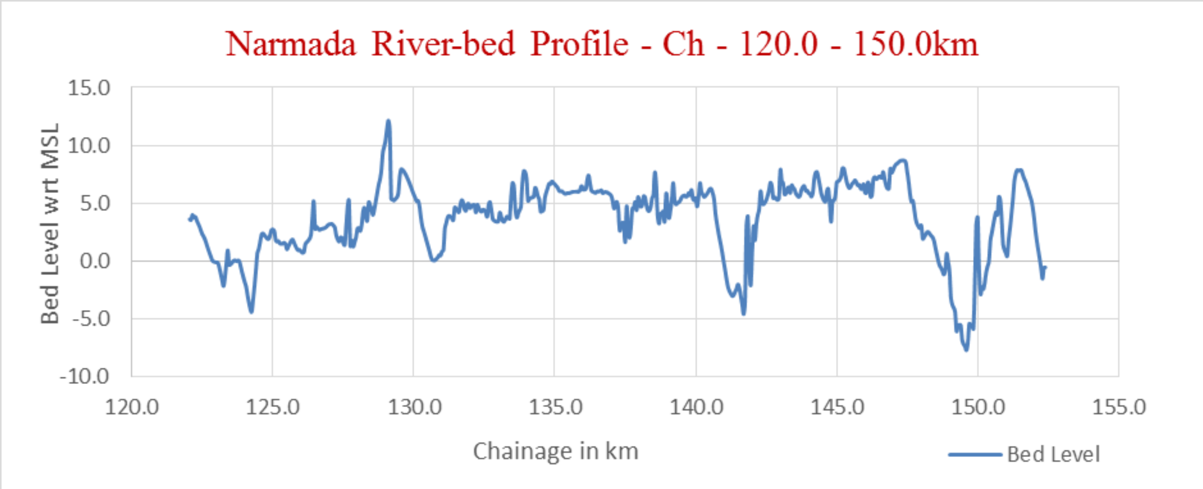


Figure 2.23 – Stretch-5 River-bed Profile

2.5.6 Sub-Stretch-6 Varvada Village to Downstream of Sardar Sarovar Dam (150 km to 182.5 km)

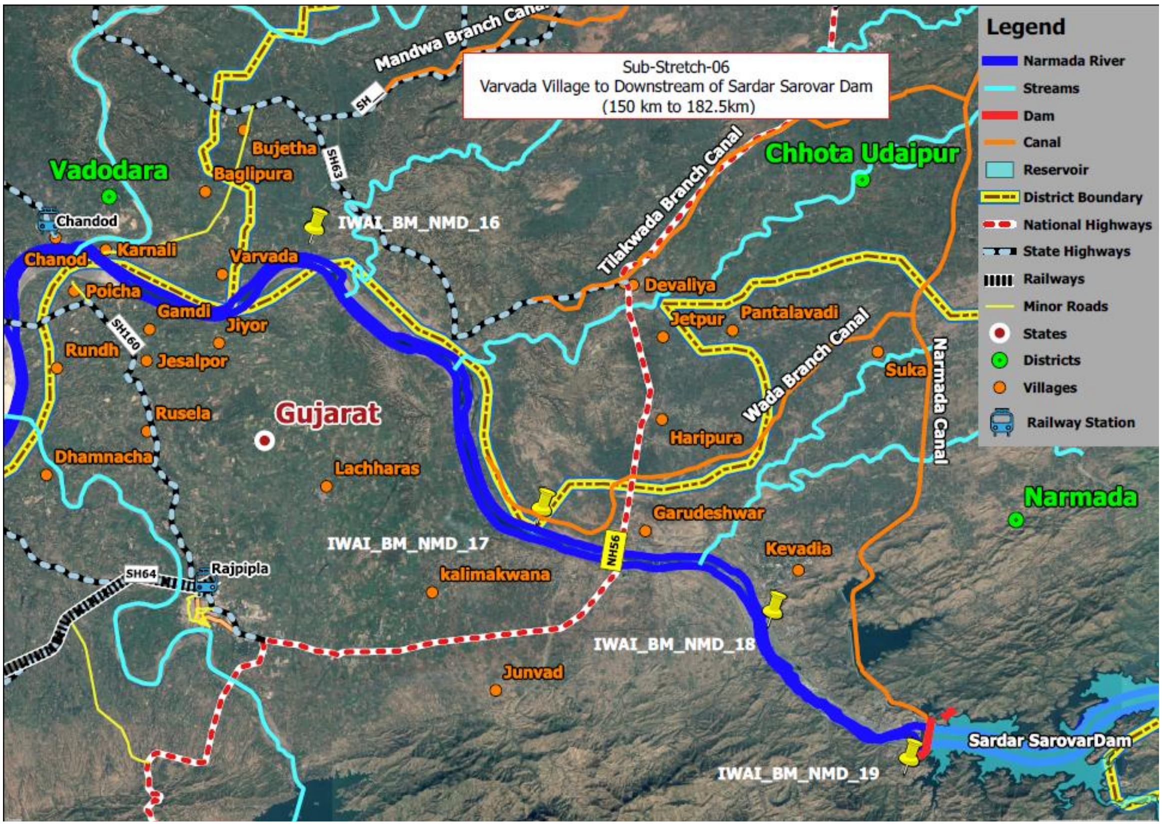


Figure 2.24: Sub-Stretch-06 Varvada Village to Downstream of Sardar Sarovar Dam (150 km to 182.5 km)

Sub-Stretch-5 (150 to 182.5Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	150 to 166.2km	Covered by bathymetric survey
Topographic Survey	166.2 to 182.5 km	Being Dry/very shallow area, covered by topographic method
	150 to 182.5km	Riverbank, drying height, islands and sand patches

This stretch is from Varvada Village to downstream of Sardar Sarovar Dam (150 to 182.5 km chainage) of Narmada River. The full stretch is non-tidal in nature and the river chainage from 167.8 to 182.5 km is dry/very shallow in nature and the area was covered by using topographic survey method. The Sardar Sarovar Dam (182.5 km chainage) and under-construction weir at Garudeshwar (170.1 km chainage) are present in this stretch. The Akteshwar Bridge (168.7 km chainage) and Gora Bridge (175.3 km chainage) are also present in this stretch.

Statue of Unity Site   Weir at Garudeshwar

Figure 2.25 – Construction of Statue of Unity and Weir in Progress

Figure 2.26 – View of Akteshwar and Gora Bridge

The river banks are high rise and unprotected in nature and are lined very prominently on both river bank. The sudden increase in the gradient of the river is observed on the chainage between 169 to 182.5 km chainage. The Sandy river bed with large sand deposition is observed from 150 km to 169 km chainage. The river bed is found to be rocky in nature from 169 to 182.5 km chainage of Narmada River. The water availability from 169 to 182.5 km is very less and are rocky in nature, visual assessment of some stretches was carried out and spot sounding and topographic spot leveling of the area were carried out for obtaining required MSL heights for volume computation.

Figure 2.27 – Very Shallow stretch of Narmada River

Figure 2.28 – Rocky portion at downstream of Sardar Sarovar Dam

The important places near this stretch are Thilakvada, Garudeshwar, Akteshwar, Kevadia and Navigam. Chandod to Garudeswar area are mostly rock boulders occurred in this place, vegetables, banana and Sugar cane cultivation available here.

This stretch is well connected by road network and Akteshwar and Gora Bridges are present across the Narmada River. The Rajpipla is the nearest railway station present in this stretch. The cargo movement/ferry service through the waterway is not available in present condition. The Statue of Unity, the monument statue of Vallabhbhai Patel facing the Narmada Dam is under construction at 179 km chainage on the river island called Sadhu Bet. The 182 meters height statue which would be the world's tallest statue when completed and is planned to be spread over 20,000 square meters of the project area and to be surrounded by an artificial lake spread across 12 km of area. The Construction of weir at Garudeshwar is in progress for retaining of water surrounding the statue.

Class	Chainage (km)		Observed in Meters				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	150	182.5	0.00	14.94	21556.84	1853939.23	-0.30	14.72	22090.20	1961264.71
IV	150	182.5	0.00	14.94	21556.84	2264831.44	-0.30	14.72	22247.06	2376820.75
V	150	182.5	0.00	14.94	21556.84	3421133.06	-0.30	14.72	22247.06	3593653.61

Table 2.26 – Stretch-6 Dredging Quantity

Stretch-6 River-bed Profile

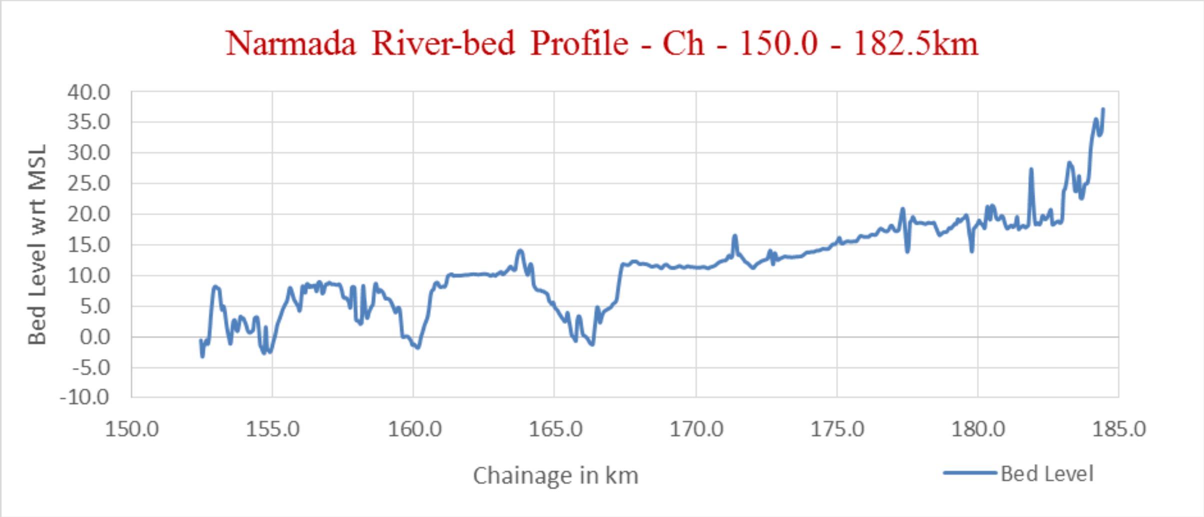


Figure 2.29 – Stretch-6 River-bed Profile

2.5.7 Sub-Stretch-7 Upstream of Sardar Sarovar Dam to Kadada (182.5 km to 210 km)

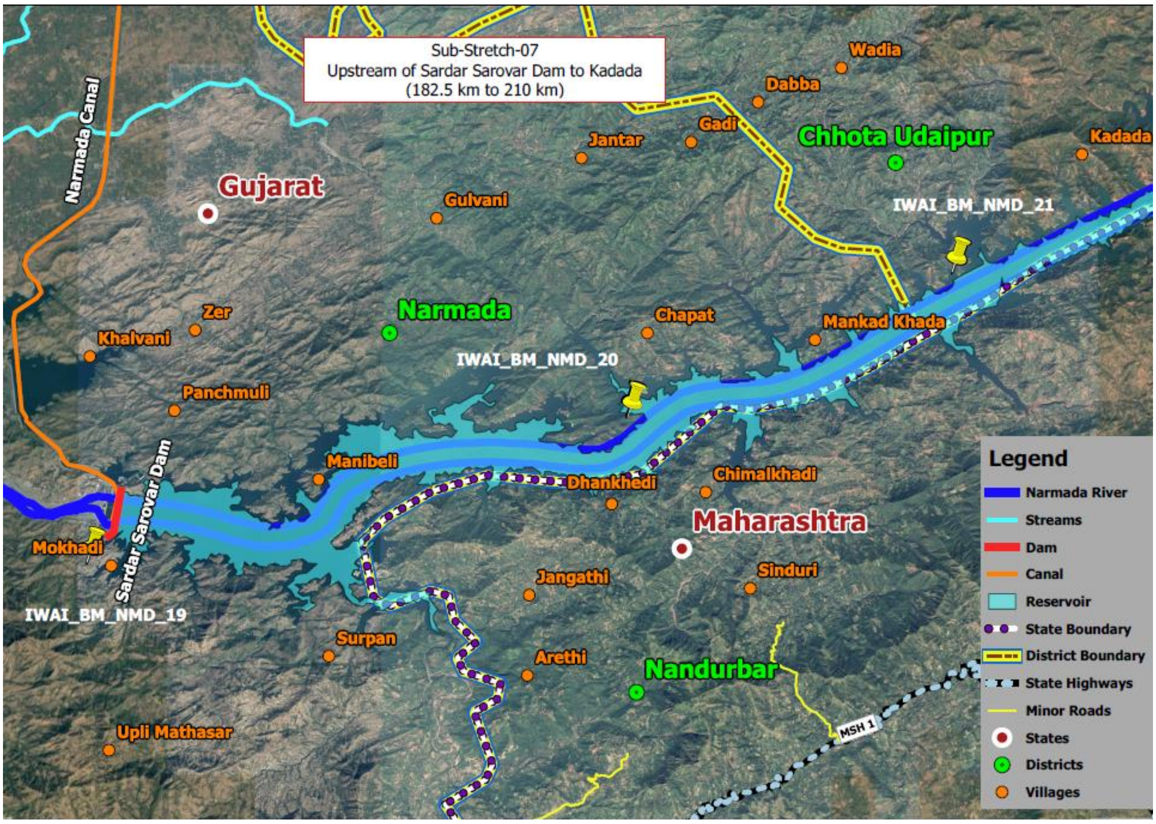


Figure 2.30: Sub-Stretch-07 Upstream of Sardar Sarovar Dam to Kadada (182.5 km to 210 km)

Sub-Stretch-7 (182.5 to 210 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	182.5 to 210 km	The full stretch is covered by bathymetric survey
Topographic Survey	182.5 to 210 km	Transfer of horizontal and vertical control

This stretch is from upstream of Sardar Sarovar Dam to Kadada village (182.5 to 210 km chainage) of Narmada River. The full stretch is on the upstream of the Sardar Sarovar Dam and is non-tidal in nature. The river banks in this stretch can only be accessible by boat. There is no Road or Rail network near to this stretch. The nearest town to this stretch is Kevadia/Rajpipla. The river banks are very high rise hills and are unprotected in nature and the water level in the entire stretch is observed to be at the same level due to ponding effect of Sardar Sarovar Dam.

The local settlements are present in the area at Mokhadai, Manibeli and Dhankhedi are some of the areas where settlements are available. A Gujarat state-run lower primary school and the small dispensary is situated at Manibeli. The Maharashtra state also shares the boundary with Narmada River from 188 to 227 km chainage. This stretch from Garudeswar to the upstream limit is covered entirely with dense forest up to end of upstream.

Class	Chainage (km)		Observed in Meters				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	182.5	210	49.20	82.00	0.00	0.00	38.87	71.54	0.00	0.00
IV	182.5	210	49.20	82.00	0.00	0.00	38.87	71.54	0.00	0.00
V	182.5	210	48.50	82.00	0.00	0.00	38.04	71.54	0.00	0.00

Table 2.27 – Stretch-7 Dredging Quantity

Stretch-7 River-bed Profile

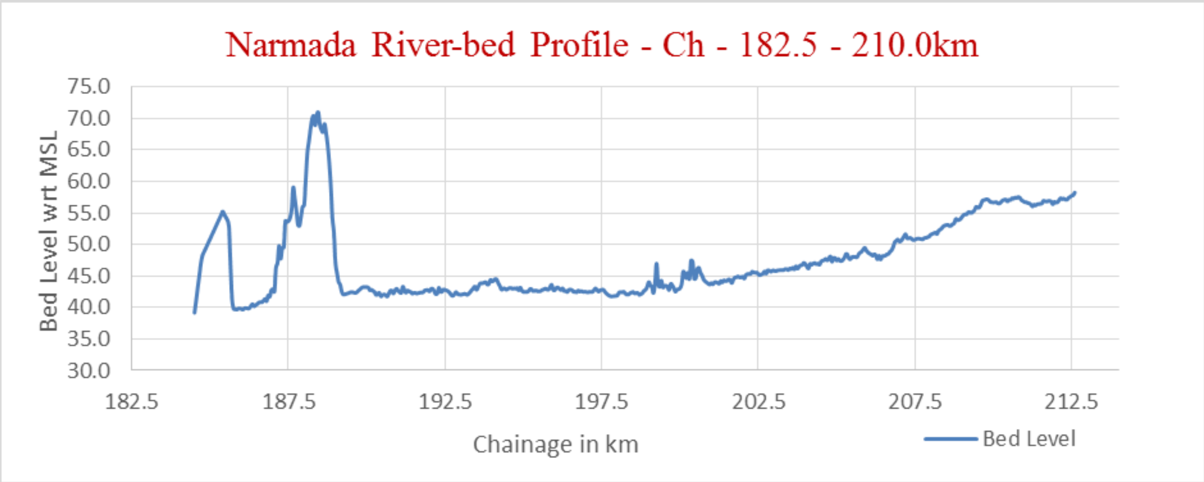


Figure 2.31 – Stretch-7 River-bed Profile

2.5.8 Sub-Stretch-8 Kadada to Pandhariya (210 km to 230)

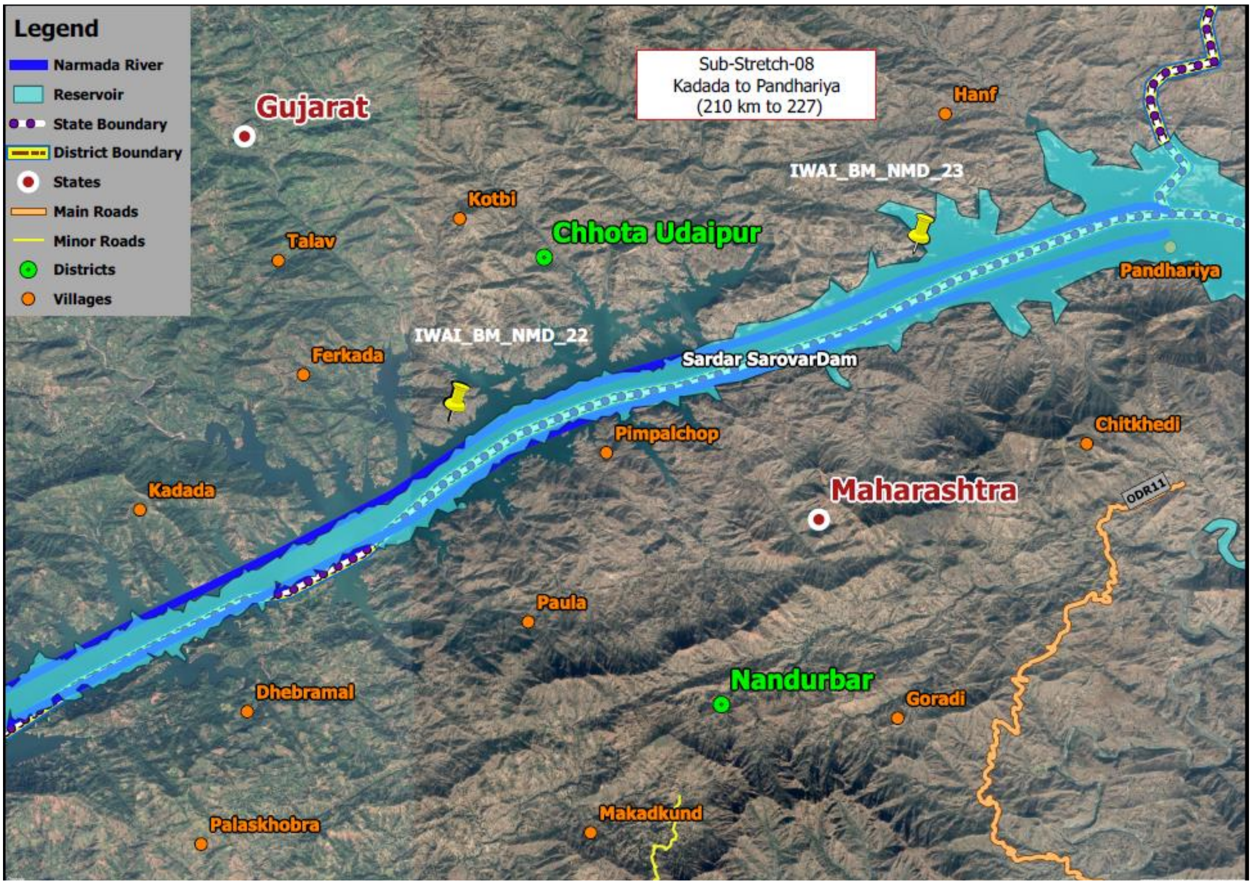


Figure 2.32: Sub-Stretch-8 Kadada to Pandhariya (210 km to 230)

Sub-Stretch-8 (210 to 230 Km)		
Type of Survey	**Chainage**	**Remarks**
Bathymetry Survey	210 to 230 km	The full stretch is covered by bathymetric survey
Topographic Survey	210 to 230 km	Transfer of horizontal and vertical control

This stretch is from upstream of Sardar Sarovar Dam from Kadada to Pandhariya village (210 to 230 km chainage) of Narmada River. The full stretch is on the upstream of the Sardar Sarovar Dam and is non-tidal in nature. The river banks in this stretch can only be accessible by boat or through hilly terrain. There is no Road or Rail network near to this stretch. The nearest town to this stretch is Kevadia/Rajpipla. The river banks are very high rise hills and are unprotected in nature and the water level in the entire stretch is observed to be at the same level due to ponding effect of Sardar Sarovar Dam.

Some isolated local settlements are present in the area at Hanf, Turkheda, Keli, and Pimpalchop are some of the areas where settlements are available. The right bank side areas come under the Gujarat state administration and the left bank side areas are administrated by Maharashtra state.

Class	Chainage (km)		Observed in Meters				Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	210	230	28.50	63.90	0.00	0.00	18.04	53.44	0.00	0.00
IV	210	230	28.50	63.90	0.00	0.00	18.04	53.44	0.00	0.00
V	210	230	28.50	63.90	0.00	0.00	18.04	53.44	0.00	0.00

Table 2.28 – Stretch-8 Dredging Quantity

Stretch-8 River-bed Profile

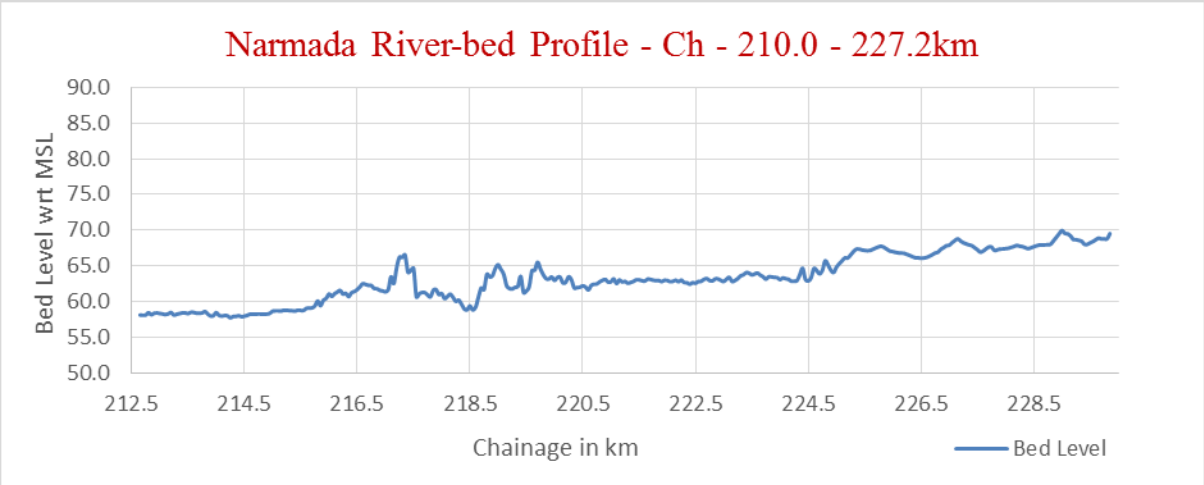


Figure 2.33: Stretch-8 River-bed Profile

2.6 Water and Soil Samples analysis and Results

The soil and water samples were collected near the BM/ Tide Gauge established during the Hydrographic survey. The Soil and water samples at sampling location number 18 could not be obtained due to unavailability if sufficient water level.

2.6.1 Water Sample Analysis and Results

Water sampling was undertaken using Niskin Water Samplers at respective locations and the details are as below:-

Sample No.	Ch. (km)	Position				Total Depth – d (m)	Mid Depth (0.5d) (m)
		Lat	Long	Easting	Northing		
NMD_01	3.41	21°39'12.2621"N	72°35'1.1925"E	249928.0	2396411.2	6.6	3.3
NMD_02	11.75	21°40'36.2997"N	72°39'38.3296"E	257937.4	2398874.4	4.5	2.3
NMD_03	20.5	21°41'12.5533"N	72°44'3.0504"E	265565.5	2399876.6	3.2	1.6
NMD_04	30.03	21°39'48.1000"N	72°49'4.5877"E	274198.3	2397154.3	3.8	1.9
NMD_05	41.26	21°40'35.1311"N	72°55'3.0386"E	284524.7	2398459.3	3.2	1.6
NMD_06	50.42	21°41'21.0496"N	73°00'7.8020"E	293305.0	2399756.4	6.7	3.4
NMD_07	60.82	21°42'57.5556"N	73°05'34.6574"E	302737.6	2402606.3	2.5	1.3
NMD_08	72.2	21°47'47.6992"N	73°08'19.4833"E	307582.3	2411472.6	5.8	2.9
NMD_09	82.15	21°51'33.5783"N	73°09'22.6127"E	309478.8	2418398.2	2.6	1.3
NMD_10	96.47	21°52'4.5484"N	73°14'36.3929"E	318498.6	2419245.3	2.5	1.3
NMD_11	105.25	21°56'2.8420"N	73°14'29.7481"E	318391.7	2426576.5	0.8	0.4
NMD_12	114.31	21°53'8.2156"N	73°18'23.7327"E	325046.7	2421130.2	3.5	1.8
NMD_13	122.31	21°54'40.6002"N	73°20'37.6474"E	328921.3	2423929.6	13.1	6.6
NMD_14	130.24	21°54'40.5704"N	73°24'13.0000"E	335101.6	2423863.2	2.8	1.4
NMD_15	142.55	21°59'0.1468"N	73°27'38.3887"E	341076.0	2431786.0	5.0	2.5

Sample No.	Ch. (km)	Position				Total Depth – d (m)	Mid Depth (0.5d) (m)
		Lat	Long	Easting	Northing		
NMD_16	152.36	21°58’44.5084”N	73°32’32.7121”E	349513.5	2431222.4	10.5	5.3
NMD_17	165.91	21°53’34.3294”N	73°37’8.1709”E	357328.6	2421610.4	1.1	0.6
NMD_19	183.73	21°49’49.2896”N	73°45’38.3567”E	371914.9	2414565.4	58.6	30.0
NMD_20	193.39	21°50’36.3731”N	73°50’44.9849”E	380729.3	2415944.8	65.8	30.0
NMD_21	206.32	21°52’48.8222”N	73°57’37.2017”E	392590.6	2419933.2	56.4	30.0
NMD_22	215.76	21°55’13.9016”N	74°02’25.7952”E	400901.0	2424340.4	58.8	30.0
NMD_23	223.62	21°56’42.3578”N	74°06’42.5677”E	408283.9	2427015.9	54.7	30.0

Table 2.29- Water sampling locations

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Certificate No.	:	**ARC/2910/04.02.2017/2915**	Sheet 1 of 1
Client name and address	:	**IIC Technologies Limited.** 8 - 2 - 350/5/8/22 Road No. 3 Banjara Hills Hyderabad - 500034, Telangana State, INDIA	
Project / Site	:	Narmada River water Samples	
Client's reference	:	IICT/ARC/093-16	
Description	:	Water	
Quantity	:	17 Nos.	
Date of receipt	:	25.01.2017	
Specification followed	:	--	
Period of Testing		28/01/2017 To 04/02/2017	

TEST RESULT

Name Of River	Sample No.	Location	Depth(m)	Sediment Concentration (%)
Narmada River	NMD_01	Jogeswar	6.6	0.01
	NMD_02	Suva	4.5	0.01
	NMD_03	Kaladara	3.2	0.08
	NMD_04	Bhadbhut	3.8	0.06
	NMD_05	Veemwada	3.2	0.03
	NMD_06	Bharuch	6.7	0.02
	NMD_07	Kadod	2.5	0.06
	NMD_08	Angareswar	5.8	0.07
	NMD_09	Ooze	2.6	0.08
	NMD_10	Nareswar	2.5	0.03
	NMD_11	Ramapur	5.8	0.02
	NMD_12	Malsar	3.5	0.02
	NMD_13	Shinor	13.1	0.02
	NMD_14	Barkal	2.8	0.02
	NMD_15	Chandod	5.0	0.02
	NMD_16	Nalgam	10.5	0.01
	NMD_17	Sanjroli	1.1	0.02

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Certificate No. : **ARC/3033/16.02.2017/3014** Sheet 1 of 1

Client name and address : **IIC Technologies Limited.**
B - 2 - 350/5/B/22 Road No. 3 Banjara Hills
Hyderabad - 500034. Telangana State, INDIA

Project / Site : Narmada River water Samples
Client's reference : —
Description : Water
Quantity : 05 Nos.
Date of receipt : 09/02/2017
Specification followed : —
Period of Testing : 10/02/2017 To 16/02/2017

TEST RESULT

Name Of River	Sample No.	Location	Depth(m)	Sediment Concentration (%)
Narmada River	NMD_19	Mokhadi	58.6	0.02
	NMD_20	Manibeli	65.8	0.01
	NMD_21	Chharbara	56.4	0.01
	NMD_22	Periada	58.8	0.02
	NMD_23	Hanf	54.7	0.01

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2.6.2 Soil Sample Analysis and Results

River bed soil sampling was undertaken using Vanveen Grab at respective locations and the details of sample locations are as below:-

Sample No.	Ch. (km)	Position				Depth (m)
		Lat	Long	Easting	Northing	
NMD_01	3.41	21°39'12.2621"N	72°35'1.1925"E	249928.0	2396411.2	6.6
NMD_02	11.75	21°40'36.2997"N	72°39'38.3296"E	257937.4	2398874.4	4.5
NMD_03	20.5	21°41'12.5533"N	72°44'3.0504"E	265565.5	2399876.6	3.2
NMD_04	30.03	21°39'48.1000"N	72°49'4.5877"E	274198.3	2397154.3	3.8
NMD_05	41.26	21°40'35.1311"N	72°55'3.0386"E	284524.7	2398459.3	3.2
NMD_06	50.42	21°41'21.0496"N	73°00'7.8020"E	293305.0	2399756.4	6.7
NMD_07	60.82	21°42'57.5556"N	73°05'34.6574"E	302737.6	2402606.3	2.5
NMD_08	72.2	21°47'47.6992"N	73°08'19.4833"E	307582.3	2411472.6	5.8
NMD_09	82.15	21°51'33.5783"N	73°09'22.6127"E	309478.8	2418398.2	2.6
NMD_10	96.47	21°52'4.5484"N	73°14'36.3929"E	318498.6	2419245.3	2.5
NMD_11	105.25	21°56'2.8420"N	73°14'29.7481"E	318391.7	2426576.5	0.8
NMD_12	114.31	21°53'8.2156"N	73°18'23.7327"E	325046.7	2421130.2	3.5
NMD_13	122.31	21°54'40.6002"N	73°20'37.6474"E	328921.3	2423929.6	13.1
NMD_14	130.24	21°54'40.5704"N	73°24'13.0000"E	335101.6	2423863.2	2.8
NMD_15	142.55	21°59'0.1468"N	73°27'38.3887"E	341076.0	2431786.0	5.0
NMD_16	152.36	21°58'44.5084"N	73°32'32.7121"E	349513.5	2431222.4	10.5
NMD_17	165.91	21°53'34.3294"N	73°37'8.1709"E	357328.6	2421610.4	1.1
NMD_19	183.73	21°49'49.2896"N	73°45'38.3567"E	371914.9	2414565.4	58.6
NMD_20	193.39	21°50'36.3731"N	73°50'44.9849"E	380729.3	2415944.8	65.8
NMD_21	206.32	21°52'48.8222"N	73°57'37.2017"E	392590.6	2419933.2	56.4
NMD_22	215.76	21°55'13.9016"N	74°02'25.7952"E	400901.0	2424340.4	58.8
NMD_23	223.62	21°56'42.3578"N	74°06'42.5677"E	408283.9	2427015.9	54.7

Table 2.30- Soil sampling locations

RESULTS: Soil sample test results show that river bed material is mainly composed of silt and sand Test Report is given below:

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Certificate No. : **ARC/2910/10.02.2017/2959**

Client name and address : **IIC TECHNOLOGIES LTD.**
8-2-350/5/B-22 Road No.3, Banjara Hills,Hyderabad-500034,Telangana State, India.
Project / Site : Narmada River
Client's reference : PO Number IICT/ARC/093-16; Dated 23-Jan- 2017
Description : River Soil
Quantity : 08 Nos.
Date of receipt (Sample) : 25.02.2017
Specification followed : IS 2720
Period of Testing : 27.02.2017-10.02.2017

TEST RESULT

Location	Depth	Sample No.	Grain Size Analysis				Specific Gravity	pH	Uniformity Coeff. Cu	Coeff. Of Curvature Cc
			Gravel	Sand	Silt	Clay				
			%	%	%	%				
Jageswar	6.6	1	0	6	76	18	2.65	8.0	2235.2	619.1
Kaladara	3.20	3	7	16	65	12	2.63	7.8	37.5	10.66
Veerwada	3.20	5	14	21	52	13	2.62	7.2	6.66	9.76
Bharuch	6.70	6	0	11	77	12	2.68	7.4	40	15.62
Kadod	2.50	7	0	16	74	10	2.62	7.6	20	6.61
Angareswar	5.80	8	0	9	68	23	2.67	7.2	650	83.76
Ooze	2.60	9	0	16	70	14	2.63	6.8	23.52	4.25
Nalgam	10.50	16	12	20	57	11	2.62	6.9	25	5.76

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Project / Site	:	Narmada River
Client's reference	:	PO Number IICT/ARC/093-16; Dated 23-Jan- 2017
Description	:	River Soil
Quantity	:	09 Nos.
Date of receipt(sample)	:	25.01.2017
Specification followed	:	IS 2720
Period of Testing	:	27.02.2017-10.02.2017

TEST RESULT

Location	Depth	Sample No.	Grain Size Analysis				Specific Gravity	pH	Uniformity Coeff. Cu	Coeff. Of Curvature Cc
			Gravel	Sand	Silt	Clay				
			%	%	%	%				
Suva	4.5 m	2	0	73	19	8	2.68	7.9	30.00	100.83
Bhadbhut	3.8 m	4	0	62	29	9	2.63	7.6	70.00	8.928
Nareswar	2.5 m	10	0	75	18	8	2.61	6.8	15.71	0.0811
Ranapur	0.8 m	11	16	59	18	8	2.61	7.2	204.54	12.22
Malsar	3.5 m	12	0	90	4	6	2.68	7.4	110.00	22.72
Shinor	13.1 m	13	0	89	5	6	2.63	7.0	242.42	41.25
Barkal	2.8 m	14	0	95	1	4	2.63	7.0	5.71	1.42
Chandod	5.0 m	15	0	75	16	9	2.68	7.0	1500.00	37500.00
Sanjroli	1.1 m	17	0	89	5	6	2.64	7.0	200.00	2.22

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Certificate No. : ARC/3033/20.02.2017/3059

Client name and address	:	**IIC TECHNOLOGIES LTD.** 8-2-350/5/B-22 Road No.3, Banjara Hills,Hyderabad-500034,Telangana State,
Project / Site	:	Narmada River
Client's reference	:	--
Description	:	River Soil
Quantity	:	05 Nos.
Date of receipt(sample)	:	23.01.2017
Specification followed	:	IS 2720
Period of Testing	:	10.02.2017-20.02.2017

TEST RESULT

Location	Depth	Sample No.	Grain Size Analysis				Specific Gravity	pH	Uniformity Coeff. Cu	Coeff. Of Curvature Cc
			Gravel %	Sand %	Silt %	Clay				
Mokhadi	58.6	19	25	38	29	8	2.70	7.5	11500.00	0.019
Manibeli	65.8	20	2	44	45	9	2.75	7.7	265.00	0.37
Chharbara	56.4	21	2	35	56	8	2.77	7.6	2.30	0.33
Ferkada	58.8	22	50	17	26	8	2.74	7.6	29090.90	0.17
Harif	54.7	23	4	53	37	6	2.78	7.5	266.60	0.42

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CHAPTER – 3

FAIRWAY DEVELOPMENT

3.1 Proposed Class / Type of Waterway

In India, the inland waterways are classified into seven categories for rivers as well as canals by the Inland Waterways Authority of India (IWAI) vide GOI Gazette Notification dated 26 January 2007 & 07 November 2016 including amendments for safe passage of self-propelled vessels up to 2000 dead weight tonnage (DWT) and tug barge formation in push tow units of carrying capacity up to 8000 tonnes

The classification of waterways is discussed below.

A. Classification of Inland waterways for Rivers

Table 3.1: Inland Waterway classification for Rivers

Class of Waterway	Rivers				
	Minimum Depth	Bottom Width	Bend Radius	Vertical Clearance	Horizontal Clearance
I.	1.2 m	30 m	300 m	4 m	30 m
II.	1.4 m	40 m	500 m	5 m	40 m
III.	1.7 m	50 m	700 m	6 m	50 m
IV.	2.0 m	50 m	800 m	8 m	50 m
V.	2.0 m	80 m	800 m	8 m	80 m
VI.	2.75 m	80 m	900 m	10 m	80 m
VII.	2.75 m	100 m	900 m	10 m	100 m

B. Classification of Inland waterways for Canals

Table 3.2: Inland Waterway classification for Canals

Class of Waterway	Canals				
	Minimum Depth	**Bottom Width**	**Bend Radius**	**Vertical Clearance**	**Horizontal Clearance**
I.	1.5 m	20 m	300 m	4 m	20 m
II.	1.8 m	30 m	500 m	5 m	30 m
III.	2.2 m	40 m	700 m	6 m	40 m
IV.	2.5 m	50 m	800 m	8 m	50 m
V.	-	-	-	-	-
VI.	3.50 m	60 m	900 m	10 m	60 m
VII.	-	-	-	-	-

The above classification for Rivers and Canals shall be effective if:

- Minimum depth of channel should be available for about 330 days in a year (about 90% days in a year).
- Vertical clearance at cross structures over the waterway should be available at least in central 75% portion of each of the spans in entire width of the waterway.

C. Vertical Clearance for Power Cables / Telephone Lines for all Classes

- Telephone lines and Low Voltage lines 16.5 m
- High Voltage Transmission lines not exceeding 110 KV – 19 m
- High Voltage Transmission lines exceeding 110 KV – 19 m + 1 cm per each KV. In case of underground pipe / power lines and other cables norms to be decided as per conditions and navigational requirement

D. Reference level for vertical clearance for different types of channels

- For rivers – over navigational HFL which is highest flood level at frequency of 5% in any year over a period of last 20 years
- HTL for tidal channels
- For channels design FSL

E. *Type of vessels to be used in different class waterways*

Table 3.3: Type of vessels to be used in different class of waterways

Class	Self-propelled vessel	Tug with barges
I.	Self-propelled, carrying capacity 100 DWT, Size (32m X 5m), Loaded draft 1m	1 Tug + 2 barges – 200 DWT, length 80m X breadth 5m , loaded draft 1m
II.	Self-propelled, carrying capacity 300 DWT, Size (45m X 8m), Loaded draft 1.2m	1 Tug + 2 barges – 600 DWT, length 110m X breadth 8m , loaded draft 1.2m
III.	**Self-propelled, carrying capacity 500 DWT, Size (58m X 9m), Loaded draft 1.5m**	**1 Tug + 2 barges – 1000 DWT, length 141m X breadth 9m , loaded draft 1.5m**
IV.	**Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m**	**1 Tug + 2 barges – 2000 DWT, length 170m X breadth 12m , loaded draft 1.8m**
V.	Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m	1 Tug + 2 barges – 2000 DWT, length 170m X breadth 24m , loaded draft 1.8m (moulded with 24 m)
VI.	Self-propelled, carrying capacity 2000 DWT, Size (86m X 14m), Loaded draft 2.5m	1 Tug + 2 barges – 4000 DWT, length 210m X breadth 14m , loaded draft 2.5m
VII.	Self-propelled, carrying capacity 4000 DWT, Size (86m X 14m), Loaded draft 2.9m	1 Tug + 4 barges – 8000 DWT, length 210m X breadth 28m , loaded draft 2.5m

All structures to be constructed across waterway classified should conform to respective requirement of vertical clearance and horizontal clearance. Before construction of any structure across the national waterway

As per office memorandum IWAI/NW-5/64/Nav. Clearance/2017 dtd.08/12/17, River Narmada is classified as under:-

1) Class -VII from sea (Ch. 0.0) to Village Safruddin, District Bharuch (Ch-43.7 km)
2) Class -IV from Village Safruddin, District Bharuch (Ch-43.7 km) to Motikoral, Taluk Karjan, Dist. Vadodara (Ch. 89.5 Km)

3) Class-III from Motikoral, Taluk Karjan, Dist. Vadodara (Ch. 89.5 Km) to Village Pandhariya, Taluka Kawant, District Vadodara (Ch. 227 Km)

Proposed class of waterway: WAPCOS recommend development of waterway in phased manner as mentioned below:

Table 3.4: Proposed class of waterway

Sr.No	phase	Stretch	Proposed Class of Waterway
1	Phase-1	Anchorage point to Terminal 1 (OPAL)	Class-IV
3	Phase-2	Terminal 2 (Bharuch) to Terminal 3 (D/s of Garudeshwar Weir)	Class-III
2	Phase-3	Terminal 4 (Bharuch)	Class-IV

However, above mentioned phases are based on current traffic studies. Waterways sector are in developing state, keeping that in view, NW-73 can be matured further as mentioned in the notification IWAI/NW-5/64/Nav. Clearance/2017 dtd.08/12/17.

3.2 Details of Shoals (Length, Width and proposed development works)

During hydrographic survey of the river stretch it was found that there are number of shoals in Narmada River. Details of the shoals are as follows:

Table 3.5: Details of Shoals

Chainage		Length(km) of Shoals as per Class-III	Length(km) of Shoals as per Class-IV	Proposed Development Works
From	To			Dredging is required as per proposed class of waterway
0	30	12.64	13.66	
30	60	4.9	6.3	
60	89.5	16.78	18.3	
89.5	120	14.55	14.86	
120	150	12.29	12.76	
150	182.5	22.09	22.25	
182.5	210	0.00	0.00	
210	230	0.00	0.00	

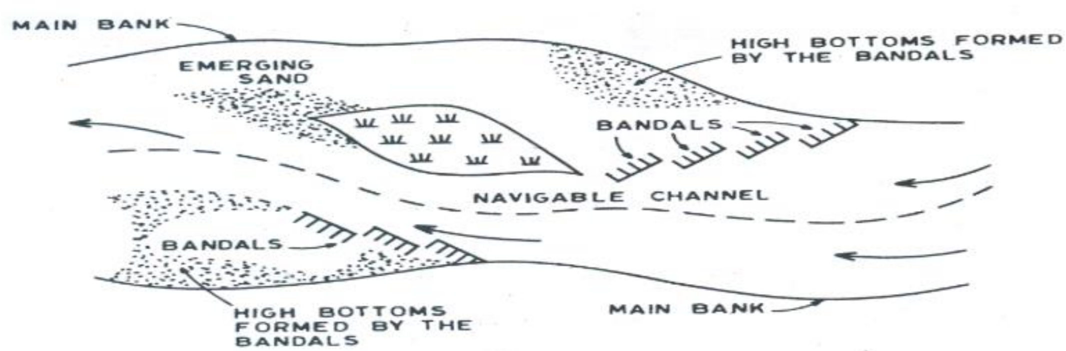
3.3 Proposed Conservancy Activities

3.3.1 Low Cost structures

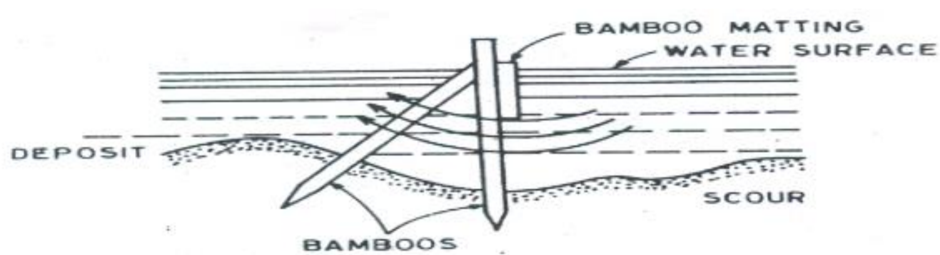
a) Bandalling

Bandals are commonly used low cost structures for improvement of navigation depth in rivers. Bandals are designed to confine the low water flow in a single channel for maintaining required navigation depth. A bandal consist of framework of bamboos driven in to the river bed, set 6m apart by means of horizontal ties and supported by struts at every 1.2 m. Bamboo matting are tied with coir ropes at water levels to the bamboo framework. The bamboo used on the framework are generally 3 to 6m in length and the matting is 0.9m wide strengthened at the edges bye strips of split bamboo as shown in fig 3.1

Bandals are placed at an angle of 30^{o} to 40^{o} inclined downstream. They check the flow and cause sand to be deposited parallel to and behind the bandals. Thus a channel confined between bandals is formed with sand banks on either side and the whole discharge of the river is directed through this channel.



LAYOUT PLAN OF BANDALS



SIDE VIEW OF A BANDAL

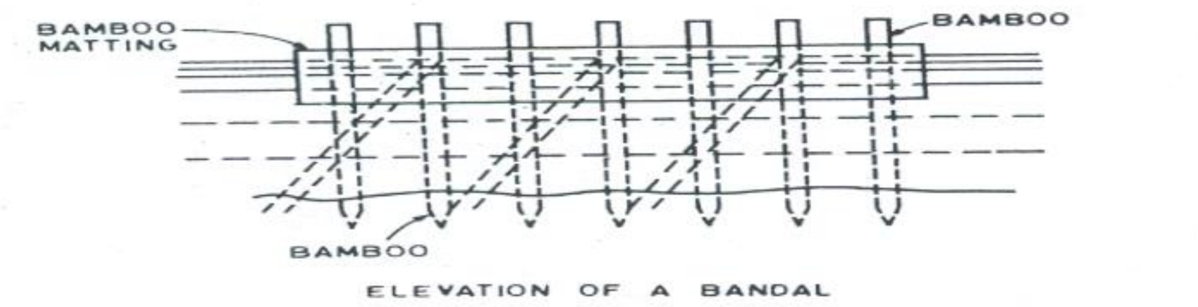


Fig 3.1 Bandalling

b) Sub-merged vanes

Submerged vanes are frequently used as vortex generating for maintaining depth in navigation channel. The vanes are small flow-training structures designed and installed on the riverbed to modify the near-bed flow pattern and redistribute flow and sediment transport within the channel cross section. The structures are laid out so they create and maintain a flow and bed topography that is consistent with that of a stable channel creating optimum conditions for managing the river.

Significant changes in depth can be achieved without causing significant changes in cross-sectional area, energy slope, roughness and downstream sediment transport. As per literature, number, size and layout of the vanes depend on the channel morphology, velocity and depth at a meander bend. Vanes stabilize a channel reach without inducing changes upstream or downstream of that reach. Vanes may not be visible in time as they become buried by depositing sediment and aid the stream in doing the work by redistributing the flow energy to produce a more uniform cross-section without an appreciable increase in the energy loss through the reach.

The structures are installed at an angle of attack of typically 10^{0} to 20^{0} with the flow and their initial height is 0.1 to 0.4 times the local water depth at design stage. Typically, vanes are installed in arrays along one side or both sides of a river channel long enough to create a desired flow and bed redistribution. The advantage over traditional training structures, such as dikes and groins is that they can produce a given redistribution of flow at less resistance to the flow and less cost.

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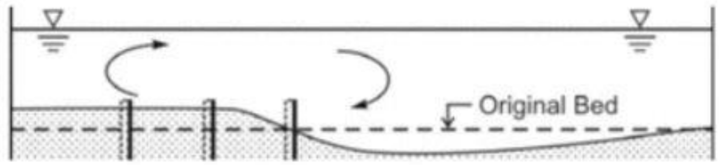


Figure 3.2 Schematic showing changes in bed profile induced by an array of three vanes

3.3.2 Dredging

Among the methods of regulation of rivers for navigation and removal of natural obstructions, dredging is a common remedy. With all training measures it becomes necessary, sometimes to keep the channel open for navigation by resorting to dredging. Natural scour is useful in its own way, but it may not be able maintain depths throughout the year, mainly because the condition in rivers change from season to season. Dredging is a useful auxiliary method, and there are few ports and navigational channels which are maintained without the aid of systematic dredging.

Dredging will be carried out into three phases i.e from Anchorage point to Terminal 1 (OPAL) in Phase 1; in Phase 2Bharuch - d/s of Garudeshwar Weir& Terminal 1(OPAL) to Terminal 4 (Bharuch) in Phase 3;

Sr. No.	Phase	Stretch	Chainage	Length (KM)
1.	Phase-1	Anchorage point- OPAL	Ch. 0 to Ch. 11	11
2.	Phase-2	Bharuch - d/s of Garudeshwar Weir	Ch. 60 to Ch. 168	108
3.	Phase-3	Anchorage point to Terminal 4 (Bharuch)	Ch. 11 to Ch. 50	39

Based on hydrographic survey report dredging quantities are mentioned below:

Sr. No.	Phase	Stretch	Design Vessel	Quantity (Mm^3)
1	Phase-1	Anchorage point to Terminal 1 (OPAL)	Class-IV	0.95
2	Phase-2	Terminal 2 (Bharuch) to Terminal 3 (d/s of Garudeshwar Weir)	Class-III	3.43
3	Phase-3	Anchorage point to Terminal 4 (Bharuch)	Class-IV	1.04
			Total (Mm^3)	**5.42**

For Dredging, Self-propelled Cutter Section Dredger (CSD) is hereby recommended to maintain above mentioned stretches for Phase-1, Phase-2 and Phase-3.

Below milestone is subjected to the condition that contractor should mobilize all the dredgers, allied vessels, equipments and manpower within 45 days from award.

Dredging Work Milestone for Phase-1 **(Anchorage point to Terminal 1 (OPAL)**

Milestones	Milestone Quantity (m^3)	Cumulative Quantity (m^3)	Milestone Month	Cumulative Month
Oct-Dec 19 (1st Quarterly)	200000	200000	3	3
Jan-mar 19 (2ndQuarterly)	200000	400000	3	6
Apr-jun 19 (3rdQuarterly)	200000	600000	3	9
Jul-Sep 19 (4thQuarterly)	-	-	3	12
Oct-Dec 19 (5th Quarterly)	200000	800000	3	15
Jan-mar20 (6th Quarterly)	150000	950000	3	18

Dredging Work Milestone for Phase-2 **(Terminal 2 (Bharuch) to Terminal 3 (d/s of Garudeshwar Weir)**

Milestones	Milestone Quantity (m^3)	Cumulative Quantity (m^3)	Milestone Month	Cumulative Month
Oct-Dec 32 (1st Quarterly)	600000	600000	3	3
Jan-mar33 (2nd Quarterly)	600000	1200000	3	6
Apr-jun33 (3rd Quarterly)	600000	1800000	3	9
Jul-Sep 33 (4thQuarterly)	-	-	3	12
Oct-Dec 33 (5th Quarterly)	600000	2400000	3	15
Jan-mar 34 (6th Quarterly)	600000	3000000	3	18
Apr-jun34 (7thQuarterly)	430000	3430000	3	21

Dredging Work Milestone for Phase-4 **(Terminal 1 (OPAL) to Terminal 2 (Bharuch))**

Milestones	Milestone Quantity (m^3)	Cumulative Quantity (m^3)	Milestone Month	Cumulative Month
Oct-Dec 25 (1st Quarterly)	200000	200000	3	3
Jan-mar26 (2nd Quarterly)	200000	400000	3	6
Apr-jun 26 (3rd Quarterly)	200000	600000	3	9

Milestones	Milestone Quantity (m^3)	Cumulative Quantity (m^3)	Milestone Month	Cumulative Month
Jul-Sep 26 (4th Quarterly)	-	-	3	12
Oct-Dec 26 (5th Quarterly)	200000	800000	3	15
Jan-mar 27 (6th Quarterly)	200000	1000000	3	18

Parameters for Dredger, Allied Vessels & Equipment

Sr. No.	Equipment type and characteristics			Minimum number Period
	Equipment	Minimum Capacity	Max. Age (Years)	
1	Cutter Suction Dredger	250 m^3/hr of solids	15 years	2.0
2	Work Boats/Tugs	For towing dredging unit/anchor shifting etc.	15 years	2.0
3	Accommodation Boats (if required)	To accommodate crew and supervisory staff separately (if required)	15 years	2.0
4	Any other vessel	As required	15 years	As required
5	Vessel and equipment for survey works	As required	15 years	As required

Approximate Principal dimension and other particulars

The principal dimensions & other particulars as mentioned below are purely indicative

Length overall : 27 m

Breadth : 12 m

Depth : 2.5 m

Maximum draught : 1.5 m loaded draft with full Bunkers

Trial speed (deep water) : 8.5 knots (calm water)

Dredge Pump capacity : Mixture capacity of 1250 cub. mt/hr at 20% concentration of solid by volume and mixture density of 1.3 t/cub mt and capable of discharging at 500 m distance using floating pipelines and throw of about 80m with side cast facility on either side (5% variation allowed).

		Discharge coupling at the aft for pumping to be provided.
Fuel Oil Bunker Capacity	:	15 days of operation of the dredger of which 10 days of dredging for 12 hours and 5 days of steaming for 10 hours
Endurance	:	15days
Accommodation	:	For eight persons in 3 cabins, galley, mess cum recreation room, two bio bathrooms cum toilet to be provided Deviation allowed from specified dimensions (length, breadth and depth) in principal particulars shall be +5% &-5%. No deviations allowed for maximum draught and minimum trial speed.

Material to be dredged

As per geotechnical investigation, silty clay of intermediate plasticity in Phase-1, clayey soil of intermediate plasticity in Phase-2 and clayey sand (rocky around Garudeshwar Weir) in Phase-4 have been observed.

Disposal of dredged material:

A total of 0.95 Mm^3 of material in phase-1, 3.43 Mm^3 of material in phase-2 &1 Mm^3 of material in phase-3 have been calculated as described above. In principle, dredged material is being dumped in 3 ways:

(i) Into the river
(ii) Outside the river
(iii) On the bank of the river

From economical consideration the dredged material is proposed to be dumped in the bank with the provision of dowel/ Parapet wall so that dredged material may not slipped back into the river. Clearance would be taken from the competent authorities before dumping the dredged material.

3.3.3 River Training

River training works are used for bank protection and river regulation for improvement of channel. Training structures generally used for river regulation are as:

a) **Spur and Longitudinal training walls**

Spurs are structures constructed transverse to the river flow and extend from the bank in to the river. These structures are known by several names, the most popular being spurs, spur dikes, groynes and transverse dikes and constitute probably the most widely used training works.

The spurs may be either of piles, stones, rock-fill or sand and may be either submersible or non-submersible. Spurs are very helpful in constricting a wide river channel for the improvement of depth for navigation

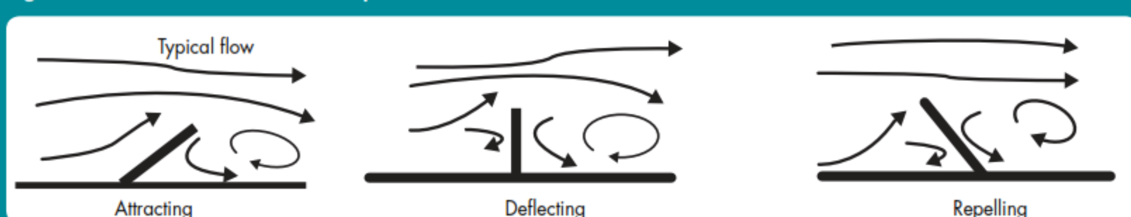
Type of spurs

Attracting spur: These are the spurs which attract flow towards the bank and are aligned in a direction pointing downstream. In a river where there is a heavy attack on one bank, it may be desirable to construct the attracting spurs on the opposite bank in conjunction with a repelling spur on the affected bank

Repelling spur: A spur pointing upstream has the property of repelling the river flow away from it and hence it is termed as repelling spur.

Deflecting spur: Where the spur, usually of short length changes only the direction of flow without repelling it, is known as a deflecting spur and gives only local protection.

Figure 47: Different orientation of spurs



Experience of rivers in many countries shows similarly that groynes facing downstream cause trouble. These groynes endanger adjacent banks, since silting between successive groynes is absent and hence are not recommended. Repelling groynes are usually successful in achieving desired results if they are properly located with due regard to their position in relation to meander length. It is recommended to test them in hydraulic models before adopting them in practice.

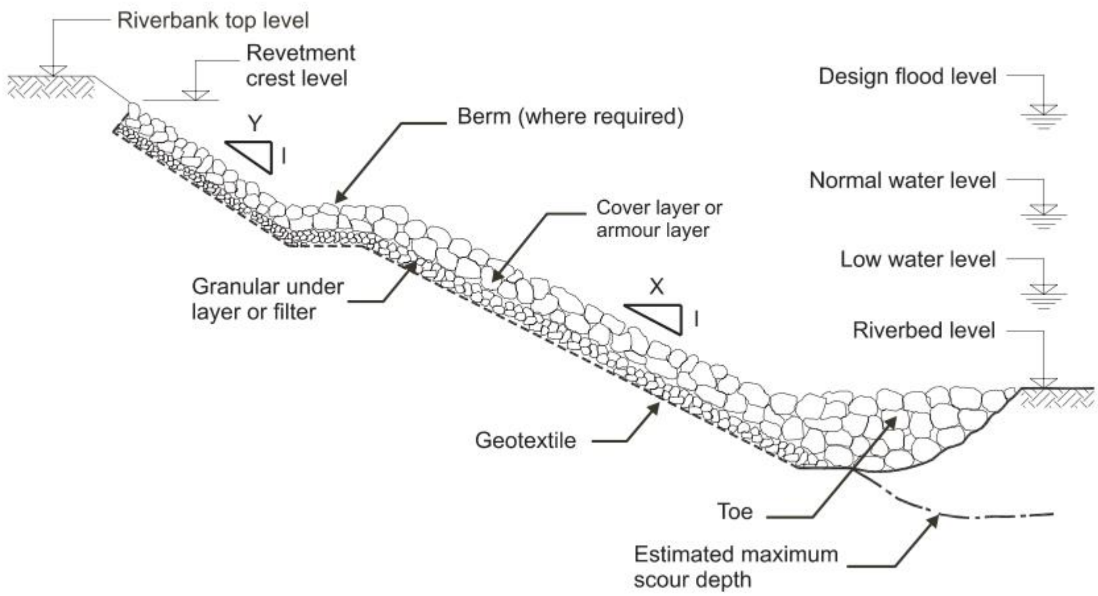
b) Bottom Panels

A new technique improving river channel has been investigated by the Chatou Research and Test Centre of France. Bottom panels are vertical screens wholly immersed and set on the river bed at falling stage when the depth in the channel is about three times the height of panels. They form angle of 100 to 45 with the current diverting the bottom currents out of the navigational channel. The panel are about 25m long and spaced by about two and half times their own length these are left in the river even during floods.

c) Revetment

The most common form of river training structure is the revetment or bank protection. It is composed of a layer of erosion-resistant material that covers the erodible material of the river banks, and sometimes also the bed of the river. Various materials may be used for this purpose, including grouts and geotextiles. The choice of the most suitable material should be made at an early stage in the project. Armour stone can be directly placed onto the bank or bed to be protected.

However, it is generally good practice to place it on an under layer that provides a transition between the coarse armour stone of the cover layer and the fine erodible material of the foundation. The underlayer may be made of crushed rock or gravel that prevents subsoil from being eroded through the voids of the protection. Geo-textiles may be used as a part of the filtering system, either with or instead of the granular filter. The under layer reduces both the risk of the foundation material being washed through the armour layer and of the cover layer punching into the subsoil.



d) Retards

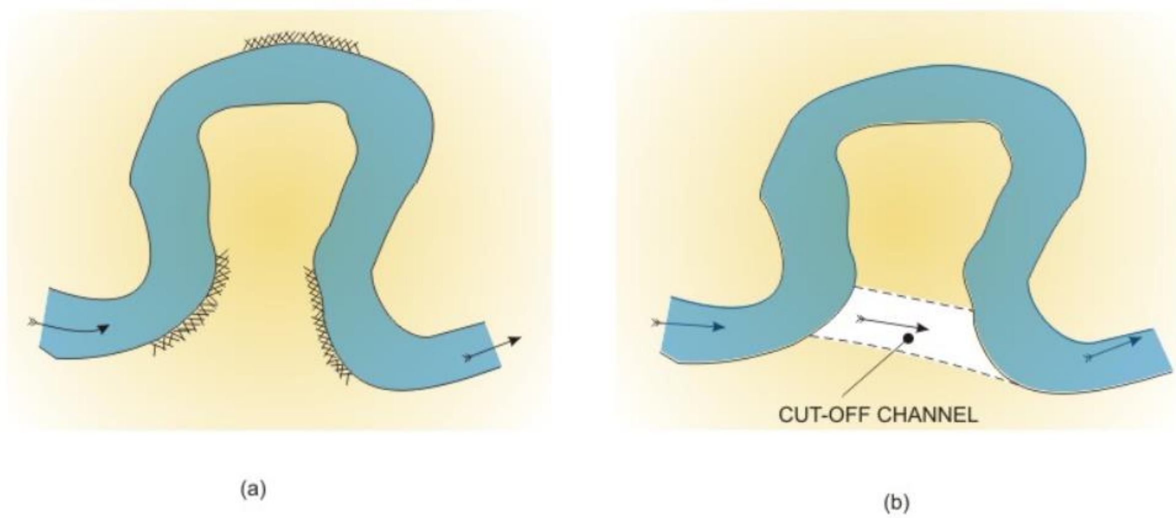
These are the structures constructed spanning a river section. They are used principally to protect eroding concave banks and are constructed by sinking old barges weighted with stones by putting woven wire fence supported on wooden parts or by putting bundles of poles across the river cross section. The structures may be maintained by wires tied to anchors placed upstream. Retarders are lower in cost than spurs and revetment, but are not equally definite in operation. Care in placement and understanding of river behaviour is required for their use.

e) Cut-offs

Cut offs have also been extensively used for improvement of navigation. A cut off is developed by river meandering to acute condition in the form of hair-pin bends. Under favourable condition these bends becomes large loops with narrow necks. The narrowing of the neck reaches a limit when, a break trough occurs and chute channel known as cut-off forms across the neck.

Cut off results in violent changes in river regime. As the river totuosity is decreased the river slope upstream of the cut off steepens and flood levels are lowered. The cut-offs are not enough by themselves. While they correct the instability and in efficiency at sharp bends and loops, where much head is lost by excessive river length, they do little to correct conditions in the reaches between these bend. It becomes necessary therefore to do extensive work between cut offs to improve the alignment width and depth of the channel by supplementary training works. Such works involves two procedures viz., directing the flow and closing of pockets found at unduly wide points of the channel by training groynes of dredged sand fill. Revetment at places, where erosion is likely to take place, should also be provided. The objective is the creation of a uniform river width and establishment where feasible of a central river channel, deep enough to maintain itself by normal scour action.

A typical instance of cut off is shown in fig. below



(a) Meandering river with possible threat of bank erosion(marked as xxxxx)
(b) An engineered cut-off channel

Proposed river training works (stretch wise): River banks are already established in Narmada River hence no river training works are required for river banks.

3.4 Bank Protection / Embankment Strengthening

3.4.1 General consideration:

Current measurements during the survey period reveal that the velocities in the non-tidal reach of channel are considerably less with an average current of the order of 0.001 m/sec to 0.063 m/sec. In tidal reach current varies from 0.041 m/sec to 0.662 m/sec. Geotechnical characteristics of the river bed shows that the soil is composed of mostly silt. The average grain size of the material is about 0.07mm to 0.1mm.Therefore, it appears that the banks are not much susceptible to erosion by natural surface current it may also be mentioned here that while carrying out the hydrographic survey along river stretch under consideration, the banks seen to be fairly stable free of erosion or cut gullies. However once navigation by mechanised vessel is introduced, bank erosion is likely to occur due to fast movement of mechanised vessels in the narrow stretches/navigation channel flows near the bank. Moving vessels generate waves and turbulence of different magnitude depending upon the speed of vessel, its hull form, type and spacing of propellers, draft and river bed form. The effect of these waves and turbulence on the channel cross section including the stability of the sides depends upon the width of the channel and the relative cross-section of the vessel and channel. Further when a vessel moves in a confined channel, the return flow of water is caused by the water displaced water displaced along the vessel side. The extent of return flow depends upon the velocity of the craft and can cause intensive suction effect on the banks eroding the side slopes of the soil. The channel bed gets disturbed by the impact of propeller jet.

3.4.2 Identification of stretches for bank protection works

During Hydrographic survey no embankment was found damaged. Hence no strengthening of embankment is required on Narmada River Wherever the waterway is wide and movement of vessels will not affect the bank, no protection is proposed. Wherever the waterway is very narrow and width is just enough for two-way navigation, and flowing near the river bank stone pitching is proposed. The exact requirement however should be established at the time of construction. The banks in vulnerable region should be inspected after introduction of mechanised vessels and any damaged section should immediately be protected as part of regular maintenance.

3.4.3 Existing Protection works

Stretch No.	Latitude Longitude	Start Chainage	River Bank	Condition	Dist. in Meters	Remarks
1	21°39'33.1547"N 72°32'50.3686"E	0	Right	Un Protected	1200	Near By Light House
2	21°39'31.8178"N 72°33'16.7504"E	1.2	Right	Protected	174	Factory Boundary Line
3	21°39'32.3632"N 72°33'22.8057"E	1.2	Right	Un Protected	1226	
4	21°39'40.5397"N 72°33'38.5815"E	1.374	Right	Protected	1800	Reliance Factory Boundary Line
5	21°40'11.8343"N 72°34'28.7116"E	2.6	Right	Un Protected	7800	
6	21°40'52.9188"N 72°39'36.2764"E	4.4	Right	Protected	350	
7	21°40'58.2792"N 72°39'46.9525"E	12.2	Right	Un Protected	21130	

Stretch No.	Latitude Longitude	Start Chainage	River Bank	Condition	Dist. in Meters	Remarks
8	21°40'47.7881"N 72°50'33.3581"E	12.55	Right	Protected	45	
9	21°40'48.4549"N 72°50'34.6649"E	33.68	Right	Un Protected	315	
10	21°40'54.4219"N 72°50'42.2276"E	33.73	Right	Protected	80	Bathing Steps Near Temple
11	21°40'56.1849"N 72°50'44.5611"E	34.04	Right	Un Protected	3180	
12	21°41'20.7698"N 72°52'41.1945"E	34.12	Right	Protected	240	Boundary Line Near Temple
13	21°41'19.9493"N 72°52'49.5711"E	37.3	Right	Un Protected	40700	Near Water Tank
14	21°50'42.7430"N 73°07'38.9821"E	37.54	Right	Protected	700	Near Water Tank
15	21°51'5.5157"N 73°07'42.4382"E	78.24	Right	Un Protected	62280	
16	21°58'49.9981"N 73°26'36.1969"E	78.94	Right	Protected	80	
17	21°58'51.1374"N 73°26'38.0580"E	141.2	Right	Un Protected	1240	
18	21°59'2.0772"N 73°27'20.8867"E	141.3	Right	Protected	100	Bathing Steps
19	21°59'2.1358"N 73°27'24.6808"E	142.5	Right	Un Protected	27800	
20	21°53'12.9636"N 73°39'17.5497"E	142.6	Right	Protected	120	Garudeswar (Near Under Construction Weir)
21	21°53'12.2420"N 73°39'21.6294"E	170.4	Right	Un Protected	12240	Near SardarSarovar Dam
22	21°38'2.7679"N 72°32'59.0007"E	0	Left	Un Protected	46080	
23	21°40'17.2095"N 72°57'40.1707"E	46.08	Left	Protected	1180	Near By Temple
24	21°40'21.8644"N 72°58'21.2231"E	47.26	Left	Un Protected	1980	
25	21°40'43.4008"N 72°59'28.8041"E	49.24	Left	Protected	520	House Boundary Line Near By Railway Line Bharuch
26	21°40'51.3594"N 72°59'44.7742"E	49.76	Left	Un Protected	62740	
27	21°53'50.1826"N 73°17'12.6882"E	112.5	Left	Protected	60	
28	21°53'48.9041"N 73°17'14.2049"E	112.6	Left	Un Protected	70440	

3.4.4 Proposed bank protection

On the basis of topographic and hydrographic survey of Narmada River no bank protection is required in such a wide river.

3.5 Navigation Marking/ Navigation Aids

The terms Aids to Navigation, Nav-aids and Navigational aids used interchangeably, are all meant to convey marks, including floating marks, such as buoys and beacons, transit and clearing marks as well as signalling systems, radio aids and communications, electronic systems, radar etc. which are installed on land or in water for guidance to all ships for safe and regulated navigation in the channels, anchorages, berths, docks etc. It is envisaged that navigation will be carried out throughout the year, by day and night except during times of high wind speeds and low visibility. For day navigation, channel is demarcated by conventional bamboo marks but when frequency of IWT mode increases it becomes essential to provide night navigation facilities.

Marine Lantern @ 2km C/C is provided along the river Narmada in has been provided. Designed aid is on the basis of light intensity, soil condition and wind direction and velocity

General assembly of proposed buoy is shown in Fig. 6.1 (A) & 6.1(B)

RIS (River Information System):

LIST OF EQUIPMENTS:

Base Station

1) AIS Base Station with Hot stand
2) Mono pole tower
3) Porta Cabin 20'X 8'X8'
4) VHF sets with Antenna
5) Leased Line – Wide Area Network
6) Metrological Equipment
7) Gen Set 10 KVA
8) UPS (UPS APC- SRC6KUXI-6KVA
9) BSNL Leased line

Control Station Servers

1) Central RIS Operating Processor
2) Central Monitoring and Storage Processor
3) Web Server & Time Server
4) Workstation
5) Operator Display 52" LED Wide Screen + With operator display
6) RIS Software
7) Installation, testing, Training and commissioning

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

There are total 9 bridges across the Narmada River under present study stretch. However, there is no need of demolition & reconstruction of bridges in all phases.

As there is sufficient vertical clearance available, there is no need of modification in HT line structures.

Phase-1

No bridges has to be demolished & reconstructed for phase-1 development. As proposed OPAL jetty is at ch. 11 & all bridges are present beyond chainage 50 km.

Phase- 2

No bridges has to be demolished & reconstructed for phase-2 development. Proposed jetty is at chainage 60 km & ch. 168 km. between these two chainages, only Poicha Bridge at ch. 138.4 km will be there which have horizontal as well as vertical clearances.

Phase- 3

No bridges has to be demolished & reconstructed for phase-3 development.

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

No Dams, weir, barrage and navigational locks are proposed in this report; however state government has proposed a barrage near Badhbhut village. This barrage will improve depth on the upstream side and dredging quantity will be reduced.

3.7.1 Implications of Bhadbhut Barrage

Brief about Bhadbhut Barrage

A barrage is proposed across Narmada River near Bhadbhut village by GoG. The catchment area at the barrage site is 97410 Sq. Km. The maximum flood discharge considered is 105000 cumecs. The computed HFL at the barrage site is 10.876 m without tidal effect. The length of the barrage proposed is 2028 m.

Two lanes bridge is proposed with facility for movement of gantry cranes. Similarly a bridge is proposed on downstream side also. Single lane of Class AA or two lanes of Class A loading is considered in the design. Elastomeric bearing pads are also proposed to allow movement due to temperature and shrinkage effect. For vehicular traffic six lanes bridge is proposed.

Navigational lock (70m X 15.5m) is proposed for the movement of boats from one side to the other side i.e. from reservoir to river side and vice- versa. Gates are proposed on the downstream side also to build up the water level to the desired extent. Time taken to fill up are deplete the water is about 10 sec. However the time of fill may be enhanced by partial opening of the gates. The sequence of operation is given along with the design sheets. The lock works till reservoir level = tidal level. If the reservoir level goes below it the operation has to be ceased as otherwise salt water gets mixed up with sweet water. Therefore the lock can be operated till the two levels are one and the same. If the lock has to work when reservoir level goes below + 5.50 m then separate arrangement has to be made.

Implications on NW-73

FRL = + 7.5

Lowest BL = - 3.0

Head = 10.5 m

Bed Slope in the stretch is 1 in 12422 m

For this slope backwater effect will be effective up to 65 km upstream of the barrage. Terminal 2 and 4 are falling in this stretch.

With this backwater effect increased water level at CH 50(Terminal 4) will be +10.25 and at CH 60(Terminal 2) will be +11.86 respectively.

Water availability will improve due to ponding of water in upstream of reservoir subsequently dredging quantity will be reduced.

3.8 Land Acquisition

Land acquisition is not required for fairway development in River Narmada.

3.9 Fairway Costing

3.9.1 Capital Cost

Cost estimates for fairway development components viz. Dredging, Bank Protection, River training works, Aids to Navigation etc. has been worked out based on prevailing rates in the adjoining area and placed in table.

Table 3.6 Capital Cost (Phase-1)

Fairway Development Cost	In Crores
Navigation Locks	-
Demolition & Reconstruction of bridges	-
Total	-
3% Contingencies and 7% Supervision charges on Base cost	-
Total Fairway Development Cost	**-**
Dredging	
Dredging (**0.95 Mm3)**	**28.68**
Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buoys (6 nos.)	0.12
RIS Station	4.93
Total Cost(III)	7.05
3% Contingencies and 7% Supervision charges on Base cost	0.70
Total Navigation & Communication Cost	7.75
Total Capital Cost	**36.43**

Table 3.7 Capital Cost (Phase-2)

Fairway Development Cost	In Crores
Dredging	
Dredging **(3.43 Mm3)**	**102.99**
Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00

Marine Lantern/Buyos (54 nos.)	1.08
RIS Station	9.85
Total Cost(III)	12.93
3% Contingencies and 7% Supervision charges on Base cost	1.29
Total Navigation & Communication Cost	14.22
Total Capital Cost	**117.21**

Table 3.8 Capital Cost (Phase-3)

Fairway Development Cost	In Crores
Dredging	
Dredging **(1.04 Mm3)**	**31.36**
Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (20 nos.)	0.40
RIS Station	0.00
Total Cost(III)	2.40
3% Contingencies and 7% Supervision charges on Base cost	0.24
Total Navigation & Communication Cost	2.64
Total Capital Cost	**34.00**

3.9.2 O&M Cost

The total operating cost for development of waterway has been worked out based on prevailing rates in the state/country. The total operating cost includes maintenance of dredging, bank protection, aids to navigation, manning operation and management of waterway.

Table 3.9 Operation & Maintenance Cost (Phase-1)

S.No.	**O & M Cost**	**In Crores**
(i)	Dredging @ 10%	2.87
(ii)	Ports Crafts/Nav. Aids @ 5%	0.39
(iii)	Fuel Cost	1.00
(iv)	Power Cost	2.00
(v)	Manpower Cost	2.74
(vi)	Miscellaneous	0.50
	Total	**9.50**

Table 3.10 Operation & Maintenance Cost (Phase-2)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	10.30
(ii)	Civil works @ 1%	0.28
(iii)	Mechanical & Electrical Cost @ 5%	0.27
(iv)	Ports Crafts/Nav. Aids @ 5%	0.71
(v)	Fuel Cost	2.00
(vi)	Power Cost	4.00
(vii)	Manpower Cost	3.00
(viii)	Miscellaneous	0.50
	Total II	**21.07**

Table 3.11 Operation & Maintenance Cost (Phase-3)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	3.14
(ii)	Civil works @ 1%	0.35
(iii)	Mechanical & Electrical Cost @ 5%	0.5555
(iv)	Ports Crafts/Nav. Aids @ 5%	0.13
(v)	Fuel Cost	1.00
(vi)	Power Cost	2.00
(vii)	Manpower Cost	3.00
(viii)	Miscellaneous	0.5
	Total II	**10.41**

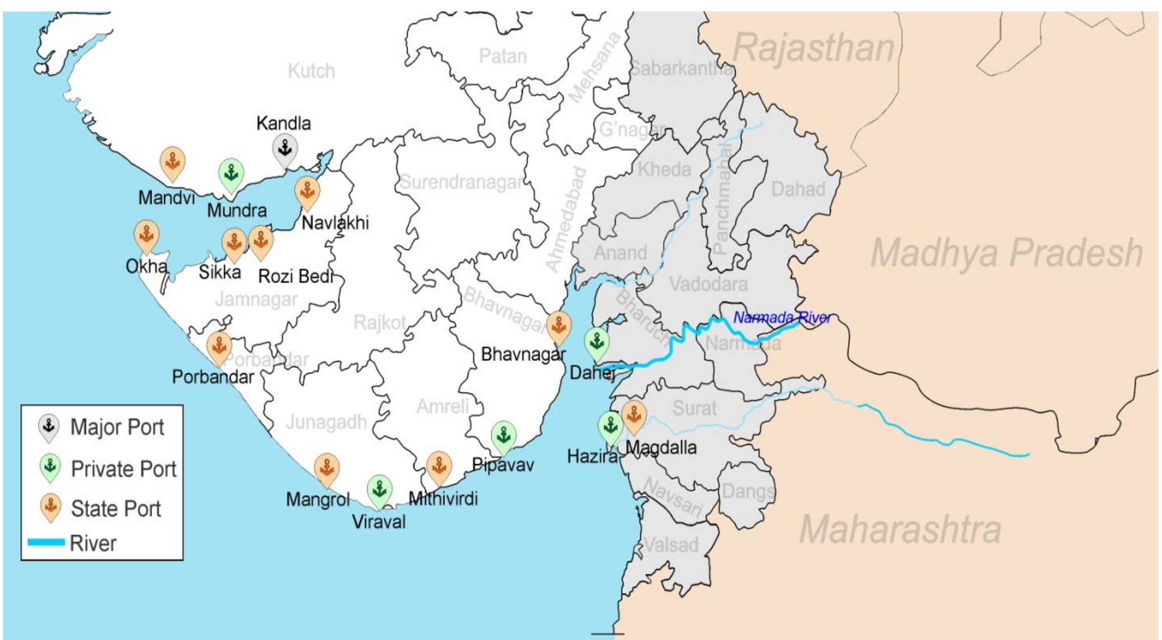
CHAPTER – 4
TRAFFIC STUDY

4.1 General

River Narmada, declared as National Waterway 73 (NW 73), is the largest river of Gujarat and one of the longest rivers in the country. The river originates from Narmada Kund in Amarkantak plateau in Chhattisgarh and flows southwest across the state of Madhya Pradesh, along the northern border of Maharashtra, and then winds through the Gujarat districts Narmada, Vadodara and Bharuch, before merging into the Arabian Sea in Bharuch, through the Gulf of Khambat.

River Narmada is the lifeline of Madhya Pradesh and Gujarat. The total length of the river is 1,312 km. However, for the study 227 km stretch from the Arabian Sea is considered. The primary catchment area is considered within 25 km on both the sides of the river. Bharuch, Vadodara and Narmada are the districts that cover in the primary catchment area. The Eastern strip of the Bharuch district is a hilly and forest area. River Narmada is continuously flowing in Narmada district, which serves as vital source of irrigation. Vadodara district is famous as a "Gateway to the Golden Corridor" because of rail and road corridor that link Delhi, Mumbai and Ahmedabad thorough Vadodara including Delhi-Mumbai Industrial Corridor (DMIC). It is also popular for its Palaces, Parks, Temples and Museums. Following Map represents overall River Narmada overview along with the hinterland.

Figure 4-1 Narmada Overview Map



4.2 Influence area / Hinterland (within 25 km on either side of the waterway)

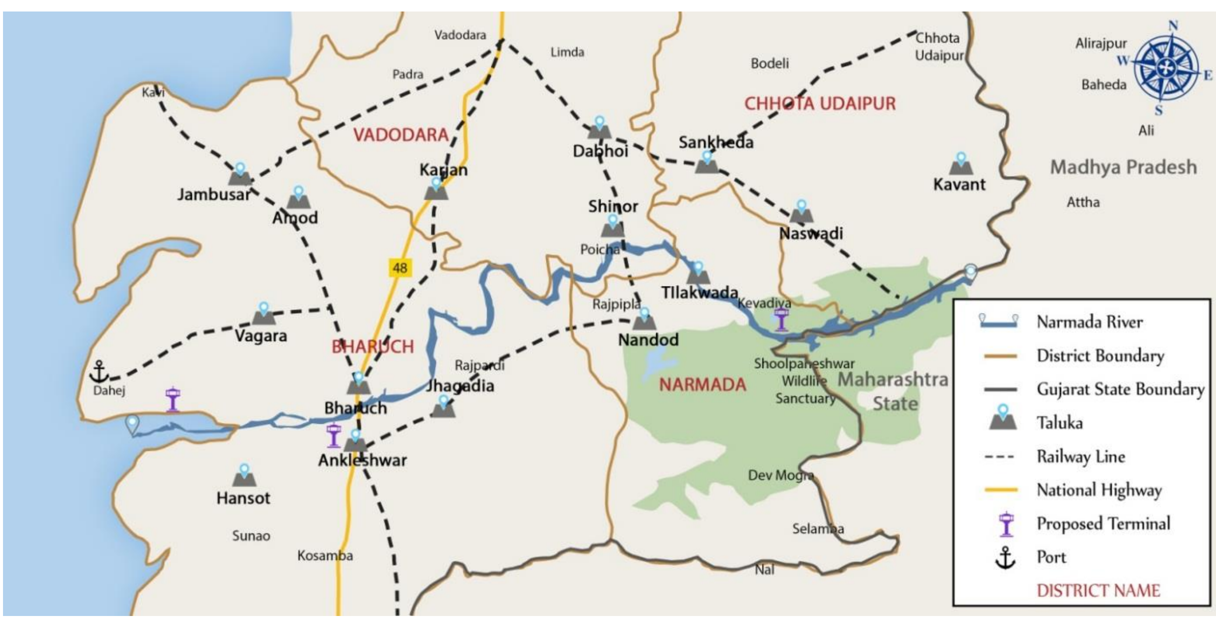
The districts that are located in the catchment area, i.e. within 25 km. of River Narmada are Bharuch, Vadodara and Narmada. These districts are studied in detail in following sections for finding opportunity for the proposed waterway. Vadodara is the largest district with an area of 7.52 lakh hectares and Bharuch is the second largest district with an area of 5.24 lakhs hectare. Vadodara District occupies most of the portion on the upper front of the river in the identified stretch. It is followed by Bharuch and Narmada. Vadodara is also the most industrialized district in Gujarat. Narmada has the largest forest cover and is considered a backward area. Bharuch has the largest unutilized agricultural patch closely followed by Narmada. Profile of each district is shown in below section.

Table 4-1 Land Utilisation Pattern of selected Districts (Ha.)

District	Total Geographical area	Non-Agricultural Land	Pasture-Grazing/forest cover	Cultivable land but not cultivated
Bharuch	5,24,683	72,455	24,506	19,825
Vadodara	7,52,776	74,908	77,788	7,729
Narmada	2,91,023	17,336	1,34,123	19,071
Chota Udaipur	3,43,616	24,046	75,304	4,642

Source: Planning Commission, Dec 2014

Figure 4-2 River Narmada and the Districts in the Catchment Area



Bharuch

Bharuch city is the administrative head quarter. It is considered the Chemical Capital of India as major chemical companies operate here. As River Narmada flows through the centre of the district, there is no lack of water. Regular water supply has flourished the agriculture and industries sector here. Cotton and Groundnuts of Bharuch are famous.

Vadodara

Vadodara is the third largest city in the state of Gujarat after Ahmedabad and Surat. Vadodara city is the administrative headquarter. Three major rivers flow through Vadodara district i.e. Mahi, Vishwamitri and Narmada. This has made Vadodara both culturally and economically rich. Vadodara is a major centre for pharmaceutical, chemical electrical and engineering industries.

Narmada

Narmada District was carved out of Vadodara and Bharuch districts in the year 1997. It has been named after River Narmada. Rajpipla is the administrative headquarters of Narmada District. It is one of the most backward regions in Gujarat. The district is rich in forest resources. Major part of the Shoolpaneshwar Wild Life Sanctuary falls in Narmada District.

Chota Udaipur

Chota Udaipur is the third largest district in this stretch. This district was formed in 2013 by carving it out of Vadodara District. The district consists of six talukas, Chota Udaipur, PaviJetpur, Kawant, Naswadi, Sankheda and the newly created Bodeli taluka. The district headquarter is located at Chota Udaipur. It is a tribal dominated area and is backward in terms of infrastructure and financial strength. The district is rich in terms of mineral reserves.

4.2.1 Population of Hinterland

According to census 2011, the total population of Gujarat is 6,04,39,692. The population of Gujarat forms 4.99 percent of India in 2011. Out of the total population, the male population is 31,491,260 and the female population is 28,948,432. The sex ratio of Gujarat is 919, which is quite less than the national average of 940.

Bharuch forms 2.56% of the state population. The population of males is 8,05,707 and that of females is 7,45,312. Vadodara is the most populated district in the stretch with a total population of 41,65,626. It contributes 6.89% of the state population. Narmada is a tribal backward district. It is mostly covered in forest area; hence the population is very low here. Narmada forms only 0.97% of the total Gujarat population. The male population is 3,01,086 and the female population is 2,63,986. The sex ratio is 961 here.

Chota Udaipur was a part of Vadodara district. As it is a recently formed district, limited data is available about it.

Table 4-2: Population of nearby Talukas as per Census 2011

District	Taluka	Population
Bharuch	Bharuch	4,51,771
	Vagara	1,00,044
	Ankleshwar	3,15,596
	Hansot	61,268
	Jhagadia	1,85,337
Vadodara	Dhabhoi	1,80,518
	Sinor	65,440
	Karjan	1,67,579
Narmada	Nandod	2,41,053
	Tilakwada	2,06,208
Chota Udaipur	Kavant	2,10,002
	Naswadi	1,55,443
	Sankheda	2,03,584

Source: Census 2011

Amongst the above talukas, Bharuch is the most developed in terms of infrastructure. It is the most populated taluka in the identified stretch of the river. Ankleshwar is an industrial hub and is the second most populated area. The above talukas of Vadodara district are less developed, compared to Vadodara taluka. These talukas have moderate population. Hansot in Bharuch district and Sin or in Vadodara are the least populated talukas as these areas are less developed and there is lack of opportunity for people. Narmada district is agricultural district. Majority of the population is engaged in the farming activities. Chota Udaipur is a tribal and backward district like Narmada; hence the population is less here.

4.2.2 Existing and proposed Industries

Gujarat contributes nearly 16% to country's industrial production. Its industrial growth has averaged to about 15% in the last couple of years. The state has the highest industrial production share in Soda Ash, Salt, Castor Seeds, POL, and Drugs & Pharmaceuticals. Gujarat has a manufacturing share of over 50% in POL, 31% in chemical and 45% in pharmaceuticals. On the back of such large-scale production in a wide range of industrial segment, Gujarat has been able to contribute almost 19% to India's total exports of merchandised goods and services.

Existing Industries – South Gujarat

There exist several medium and large scale industries in the districts located in the catchment area of River Narmada. Majority of industries are located in Vadodara district. Gujarat boasts of the longest coastline of 1,600 km in Western part of the country, accounting for 1/3rd of the country's coastline. This makes the state an ideal location for maritime trade. This large stretch of coastline is utilized to its fullest by 42 ports.

Most of the industries in Bharuch district are in Pharmaceutical and Oil & Gas sector. Few companies of the district are in Iron & Steel sector. Vadodara's industry scene is primarily dominated by Engineering and Automobiles sector. South Gujarat is an industrial hub, which caters to a wide range of consumers. The region is also well known for its influence over the clean cargo segment in the state and the country.

Dahej has two important manufacturing units namely Birla Copper and Welspan Gujarat. These two units are discussed in detail in the Industry Section. There are several small and medium enterprises, coming up on the bank of River Narmada. Shoft shipyard has setup its facilities on 30 acres of land on the banks of River Narmada.

Ankleshwar is one of the leading industrial centres in Gujarat. It has several Pharmaceutical Industries, Paint Industries, Dye Industries, and Fabric Industries. Most of these industries are export-oriented unit. They require lot of containerized cargo for import and export. It is close to 320 km. away from JNPT port and close to 900 km. away from Pipavav port. Due to its proximity to JNPT it uses JNPT as its getaway port for export.

All the cargo is moved to the port via road and sometime by rail. The city has one of the ICDs owned and operated by CONCOR located in Ankleshwar. This ICD mostly has domestic cargo and very less amount of export cargo. The reason for this is majority of the cargo export from this region has 7- 9 ton of full container load. Therefore, sometimes it becomes commercially unviable as the transportation cost goes up for exporting factory stuff cargo in container to other destination.

Most of the industries, which transport light cargo, are located at Ankleshwar. Generally, a container holds around 15 tons- 20 tons of cargo. There is underutilization of trucks which are used for transportation. This leads to an increase in per ton transportation cost. In order to avoid these circumstances, these commodities are containerized in Mumbai and then they are exported from JNPT port. Hence, the transportation cost/ton of cargo reduces to 50% vis-à-vis had it been factory stuff into containers. In addition to these, the pharmaceutical industry has high value cargo. So the volume is less and most of them are exported via airways in bulk form. Some of the Companies export packed tablets but they have very less volume roughly around 8 to 10 tons a month, which is equivalent to half a container. So they sent their cargo to freight forwarders who collectively stuffed all these cargo and exported. This containerized cargo would not provide any opportunity for IWT waterway.

There exist several medium and large scale industries in the districts located in the catchment area of River Narmada. Majority of industries are located in Vadodara district. Bharuch caters mostly to the Pharmaceutical and Oil & Gas industries, with few companies operating in the Iron & Steel segment. Industries in Vadodara are primarily focused on Engineering and Automobiles. These items are high value commodities and their volume is low. They are not suitable to be moved using waterways due to the nature of their trade. River movement of cargo on Narmada would be suitable for high volume cargo, preferably lower value commodities. Therefore, any scope for moving cargo generated by industries such as Pharmaceutical, Automobiles, etc does not exist on River Narmada.

Existing Industries – Narmada Catchment

There exists several medium and large scale industries in the districts located in the catchment area of River Narmada. The table below presents a list of industries in these districts.

Figure 4-3 Existing Industries Centre at Narmada Catchment

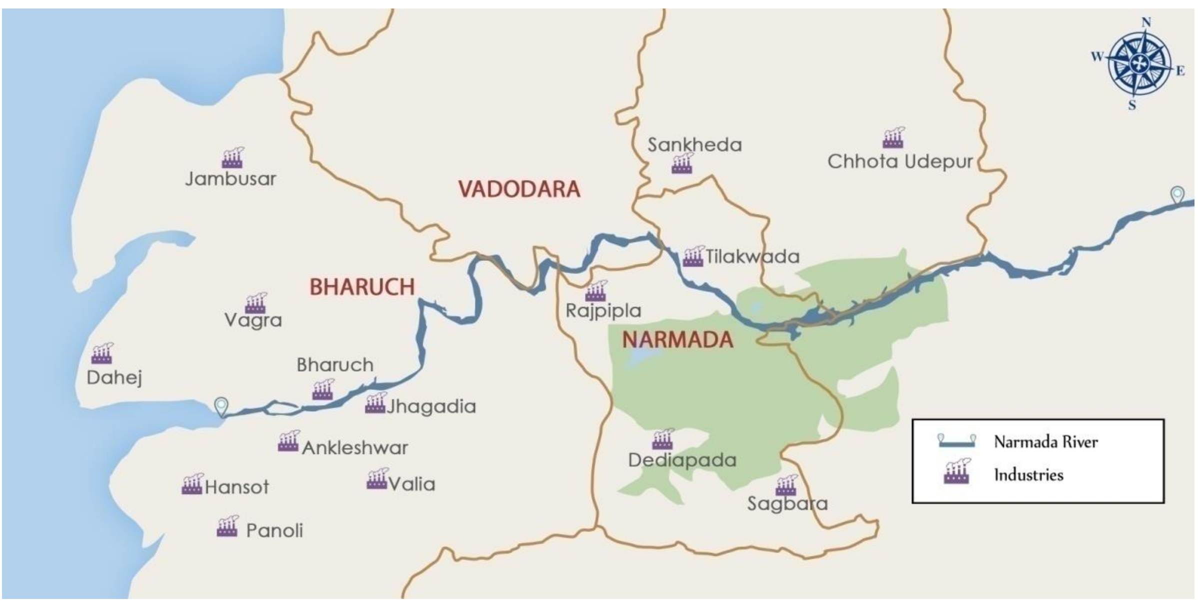
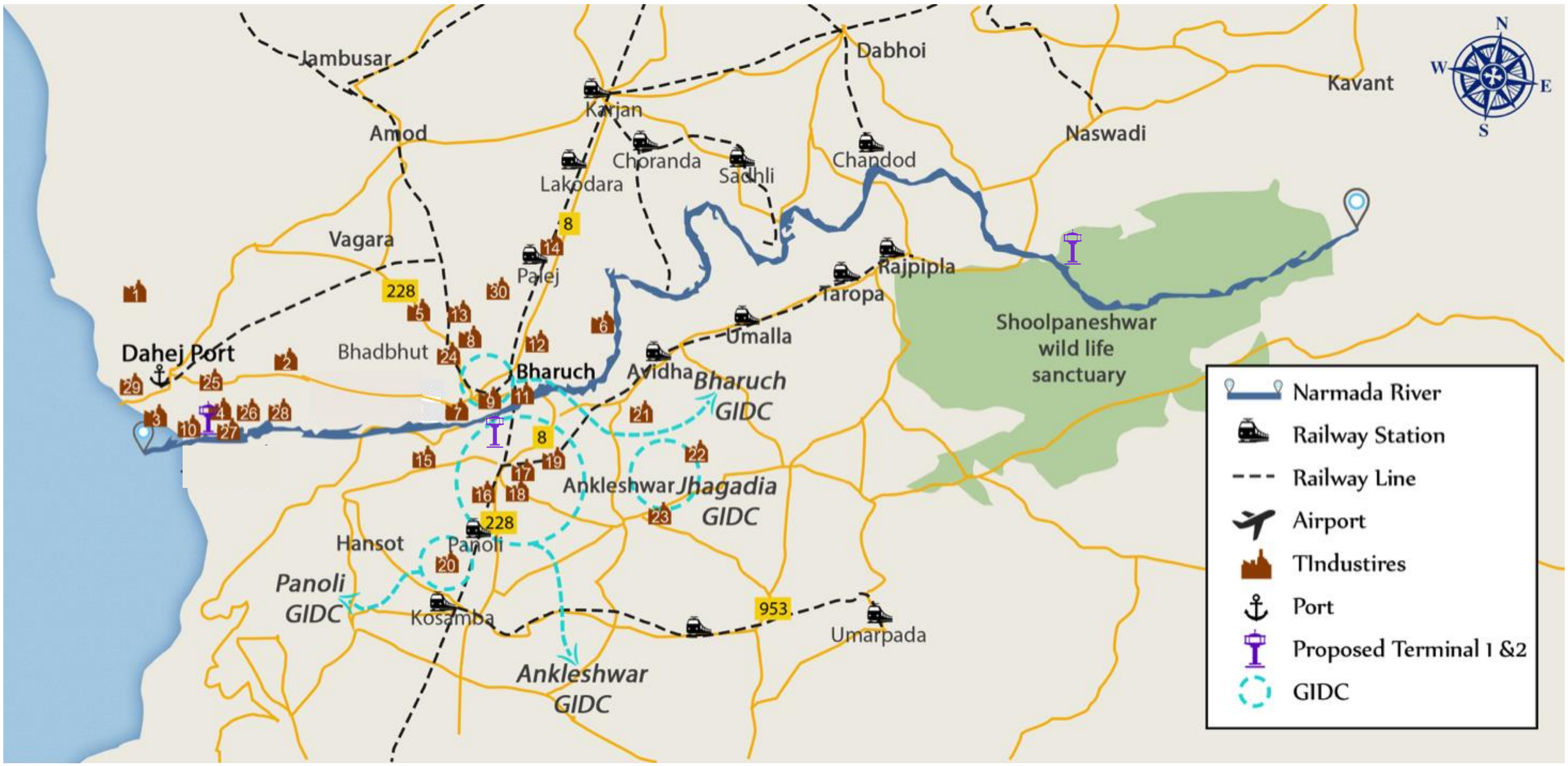


Figure 4-4 Connectivity around Industries via River Narmada



S.No	Industries	S.No	Industries	S.No	Industries
1	Birla Copper	11	Shree Raghuveer Industries	21	Sikka India Pvt. Ltd.
2	Torrent Energy	12	SBS Polychem Pvt. Ltd.	22	Laxness India Pvt. Ltd.
3	Petronet LNG	13	Steel Craft Industries	23	BEC Fertiliser
4	Reliance Industries	14	Steelco Gujarat	24	Alco Industries
5	Everest Industries	15	Maruti Metal Industries	25	GNFC
6	NTPC	16	Kanoria Chemicals & Industries	26	Welspun Corp Ltd
7	National Fertilisers	17	Jackson Chemical Industries	27	Opal
8	Nilkanth Group of Industries	18	Sun Pharmaceuticals	28	Gujarat Flurochemicals
9	Alco Industries	19	Ramdev Chemical Industries	29	Rallis India Ltd
10	Godrej & Boyle MFG. Co. Ltd.	20	World Chem Industries	30	Aditya Birla Grasim

The table below presents a list of industries in these districts.

Table 4-3 Major Industries in the Catchment Area of River Narmada

Industries	Location	Dahej Port			Kandla Port		
		Roadways	Railways	River	Roadways	Railways	River
OPaL Dahej	Dahej	7	0	5	528	517	699
LNG Petronet	Dahej	1	0	0	534	517	689
SRF	Dahej	7	0	0	534	517	689
Welspun	Dahej	10	0	0	534	517	689
Reliance Industries	Dahej	4	0	4	534	517	689
United Phosphorous (UPL)	Ankleshwar	64	63	50	505	479	689
Gujarat Alkalies and Chemicals	Dahej	7	0	0	534	517	689
GNFC	Dahej	21	0	0	534	517	689
GFL	Dahej	16	0	0	534	517	689

Industries	Location	Dahej Port			Kandla Port		
Birla Copper (Hindalco)	Dahej	8	0	0	534	517	689
Sika India	Jhagadia	66	88	66	508	486	689
Aditya Birla Grasim	Vilayat	42	39	44	496	478	689
NTPC Jhanor	Bharuch	51	63	50	487	467	689
Hindustan Chemical	Ankleshwar	63	63	50	507	479	689
Steelco Gujarat	Palej	72	84	80	462	451	689
Gharda Chemicals	Ankleshwar	70	63	50	505	479	689
Sun Pharma	Ankleshwar	68	63	50	505	479	689
Torrent Energy	Samatpor	13	0	3	527	467	689
National Fertilisers	Bharuch	45	63	50	491	467	689
Nilkanth Group of Industries	Ankleshwar	48	63	50	505	467	689
Premier Chemical Industries	Ankleshwar	47	63	50	505	467	689
Godrej & Boyle MFG. Co. Ltd.	Dahej	7	0	4	534	517	689
Shree Raguvir Industries	Bharuch	48	63	50	495	467	689
SBS Polychem Pvt. Ltd	Bharuch	48	63	50	495	467	689
Maruti Metal Industries	Ankleshwar	53	63	50	494	467	689
Jackson Chemical Industies	Ankleshwar	60	63	50	506	467	689
Ramdev Chemicals	Ankleshwar	65	63	50	507	467	689
Laxness India Pvt. Ltd.	Jhagadia	67	63	65	503	467	689
BEC Fertiliser	Ankleshwar	70	63	50	509	467	689
Rallis India Ltd.	Dahej	7	0	4	534	517	689

OPaL (ONGC Petro additions Ltd.)

OPaL has set up a mega petrochemical plant PCPIR region in Dahej. OPaL is a joint venture company promoted by ONGC, GAIL and GSPC, implementing a grass root integrated petrochemical complex located in Special Economic Zone at Petroleum, Chemical and Petrochemical Investment Region (PCPIR), Dahej, Gujarat. The distance of OPaL from mouth of river is around 15 Km. The unit was commissioned in February 2017. The complex has a 1.1 million tonnes Dual Feed cracker with an investment of USD 4.5 billion and is spread out in area of 507 hectares. Dual Feed cracker unit uses the world-class new technologies from M/s LindeAG, Germany. This Unit produces Ethylene, Propylene, HDPE (Swing and Dedicated lines), LLDPE, PP, Benzene, Butadiene, Pygas and CBFS. The Associated Units consists of Pyrolysis Gasoline Hydrogenation Unit, Butadiene Extraction Unit and Benzene Extraction Unit. The Polymer plant of OPaL has7.2 lakh MTPA of LLDPE/HDPE Swing unit, 3.4 lakh MTPA of Dedicated HDPE and 3.4 lakh MTPA of Polypropylene. Total feed required for plant is 2.5 Million Tonnes. Out of which, 1.5 Million Tonnes of Naphtha (Liquid) & 1 Million Tonnes of Ethane, Propane, Butane (Gaseous) are required.
OPaL was constructing a pipeline from ONGC C2 - C3 plant at Surat to OPaL, Dahej. The proposed stretch of pipeline was 100 km. After constructing 65 km of pipeline, the development stopped on 2012 due to some technical problem. This pipeline could not be developed as planned before; hence OPaL has a need to develop its own captive jetty at Dahej to handle Naphtha.

LNG Petronet

It has an LNG receiving and regasification terminal at Dahej. The terminal has a capacity for 10 MMTPA. It is being expanded for another 10MMTPA in a phased manner. This expansion is done through installation of 2nd jetty. The LNG is imported from RasLaffan Liquefied Natural Gas Co. Ltd. (RasGas), Qatar. The RLNG is supplied to the states of Gujarat, Maharashtra, Madhya Pradesh, Rajasthan, Uttar Pradesh, Delhi, Haryana & Punjab. The transportation of RLNG is done with the help of GAIL. The terminal is meeting around 20% of the total gas demand of the country.

SRF Ltd

It has a manufacturing plant in Dahej. It is into manufacturing Technical textiles, fluorochemicals, speciality chemicals, engineering plastics and packaging films. It produces Fluorochemicals and Speciality Chemicals such as HFC-134a, Trichloroethylene and Perchloroethylene, Anhydrous Chlorofluoric Acid, Sulphuric acid etc. The total capacity of this plant is 8,40,000 TPA. It has a captive power plant of 25 MW. It uses 2,16,000 MTPA. of coal for power generation.

Welspun Ltd.

Welspun is a global leader in the field of pipes, coils and home textiles. The manufacturing plant is located at Dahej. The Dahej plant is into the production of pipes and the production capacity is 4 Lakh TPA. The pipe coating capacity is 5 Million sq. mts.
Welspun Gujarat has an integrated manufacturing unit for welded pipes. It has its manufacturing unit located in Gujarat on Bharuch Dahej Road.
The Dahej manufacturing unit is about 420 km from JNPT and about 15 km from its nearest port at Dahej. Company exports close to 10 to 15 TEU of containers monthly to JNPT via road. It exports pipes mostly as General Cargo and over dimension cargo. Due to large dimension of pipes, they cannot be containerized and hence would not provide any opportunity for the proposed waterway in River Narmada.

Reliance

The manufacturing unit is located at Dahej. It consists of a 170,000 TPA vinyl chloride monomer (VCM) plant, polyvinyl chloride (PVC) plant of 180,000 TPA chlor-alkali plant with 115,000 TPA of chlorine and 130,000 TPA of caustic soda. The total capacity of the complex is 9.62 MMTPA
The Dahej unit has a captive power plant with a capacity of 270 MW. It has a dedicated coal jetty for this with a capacity of 2.5 MMTPA.

United Phosphorus Ltd. (UPL)

The plant is located at Jhagadia and Ankleshwar. It has total three units. It manufactures agro-chemicals like pesticide, insecticide, fungicides and herbicides and also seeds. The plant has an agrochemicals capacity of 1,25,000 MT/annum and specialty chemicals capacity of 1,15,000 MT/annum. It exports to almost 120 countries around the world through their own distribution network.

Gujarat Alkalies and Chemicals Ltd.

The plant is situated in Dahej. It is mainly engaged in the production of caustic soda. The other products are Phosphoric Acid, Anhydrous Hydrogen Chloride, Benzyl Chloride, Benzyl Alcohol, Sodium Cyanide, Methylene Chloride, and Chloroform. The capacity of producing caustic soda is 3,58,760 TPA. It exports to countries like USA, Europe, Australia, Africa, Far & Middle East countries, China & South Asian Markets. It has a captive natural gas based power plant with a capacity of 90 MW.

Gujarat Narmada Valley Fertilizer and Chemicals Ltd. (GNFC)

The company is located in Bharuch. It is engaged in manufacturing and selling fertilizers such as Urea, Ammonium Nitro phosphate and Calcium Ammonium Nitrate, methanol acetic acid etc. The total capacity of the plant is 2.79 MMTPA. It also has 2 coal based captive power plant with a capacity of 3,96,000 MWH per annum (180 MW) and CPSU 284515 MWH per annum (130MW).

Gujarat Flourochemicals Limited (GFL)

It is situated at Dahej, Bharuch district. The operations were commenced in 2007.It comprises of a 1,10,000 TPA Caustic Soda/ Chlorine Plant 87,500 TPA chloromethane plant. It is India's largest PTFE resins producer with a capacity of 16,200 TPA. It has a captive coal and gas combined power plant of 90MW. It has distribution network in around 75 countries around the world.

Birla Copper

Birla Copper has a Copper Smelting and Refining complex at Dahej in Gujarat. The copper unit at Dahej comprises copper smelters, backed by a captive power plant, oxygen plants, by-products plants, utilities and a captive jetty. There is also a precious metals recovery plant at Dahej, which produces gold, silver and selenium. The Dahej Harbour Infrastructure Ltd. is used to for logistics and transportation needs. The production capacity is 5 Lakh TPA.

The plant produces copper cathodes, coils and is exported. The company exports close to 20 TEU of coils every day using JNPT as a gateway port. Distance between Birla Copper plant and JNPT is close to 430 km.

Birla Copper also has a captive jetty at Dahej, but due to high tidal variation and fender arrangement of Jetty, the company does not allow berthing of vessels less than 10,000 DWT. Company was considering using coastal movement for moving containers from Dahej to JNPT; however infrastructure constraints and lack of volume are major hindrances in the implementation.

Transportation cost of containers from Birla Copper in Dahej to JNPT is approximately Rs 21,000. Full Container Load of export containers is above 20 tonnes.

Birla copper fears using coastal route from Hazira as this mode would be expensive due to multiple handling of cargo. Moreover, distance between Dahej and Hazira is one third the total distance to JNPT, which does not provide much advantage to the customers.

Sika India Pvt Ltd.

It is located at Jhagadia. It manufactures construction solutions like roofing, flooring, concrete, waterproofing etc. It produces concrete admixtures, mortars, resin floors and adhesives for construction. The hardener reactor plant here has a capacity of 6000 TPA. The PCE plant has a capacity of 10000 TPA.

Grasim Industries

It is located at Vilayat, Vagara. It is a Brownfield expansion project. The plant was commissioned in the financial year 2014-15. The chemical plant is working with a capacity of 1,44,000 TPA. The pulp and fibre plant has a capacity of 1,20,000 TPA. The Vilayat facility has a cellulosic division, chemical division and epoxy resin divison.

NTPC, Jhanor

NTPC is a large energy conglomerate located at Urja Nagar, Bharuch. It is a gas based power plant. It has total 4 units. The plant capacity is 648 MW. It source of the raw material gas is the Gandhar gas fields.It supplies the generated electricity to Madhya Pradesh, Gujarat, Maharashtra, Goa, Daman, Diu, Dadra and Chhattisgarh.

Gujarat Steelco

It is located in Palej, Vadodara. It manufactures Cold Rolled Steel product with a capacity of 184,000 MTPA and Continuous Hot Dip Galvanizing Line with a capacity of 60,000 MTPA. It mainly imports from China and exports to almost 45 countries across the globe.

Hindustan Chemical Industries Ltd.

The registered office is located at Ankleshwar. There are two plants located at Ankleshwar and Bharuch. The company is engaged in manufacturing speciality performance based Oil-field chemicals. It mainly produces powder based products out of Humic Acids and Lubricants. The company is to set up a cellulose Ethers plant at Dahej SEZ II.

Gharda Chemicals

The manufacturing unit is located in Ankleshwar and Panoli. It manufactures plant growth products, public health products, veterinary products, high performance polymers etc. It also manufactures resins like polyetherketone, polyetheretherketone and polybenzimidazole. It has presence all around the world- North and Central America, Europe, Africa, Middle East, Asia and Australia.

Proposed Industries

PCPIR

There are a number of industries and units developing in the PCPIR (Petroleum Chemicals and Petrochemicals Investment Region) in Dahej, Bharuch. It is a special investment region especially for petroleum and chemical products.

Birla Copper Expansion

Birla Copper is expanding its production capacity of the continuous cast copper rod from 2,44,000 TPA 4,84,000 TPA by setting up a new unit.

Coastal Economic Zones (CEZ) is a part of the Sagarmala Project. For this, Bharuch and Vadodara have been identified as industrial clusters. These regions will be focused for petroleum, automobiles, cement, fisheries and tourism. Dahej will be the nodal point for this zone.

The Govt. of Gujarat has projected Kheda, Vadodara and Bharuch as a hub for defence manufacturing in the Vibrant Gujarat 2017 global summit.

4.3 Traffic from Major & Non Major Ports

The state of Gujarat has 1 major port and more than 40 non-major ports. All ports that are owned by state government, private parties, captive jetties, private jetties, etc are categorized under non-major ports.

Figure 4-5 shows listing of all prominent ports of Gujarat along with declared national waterways to arrive at interlinked perspective.

Figure 4-5 Overview of Ports in Gujarat

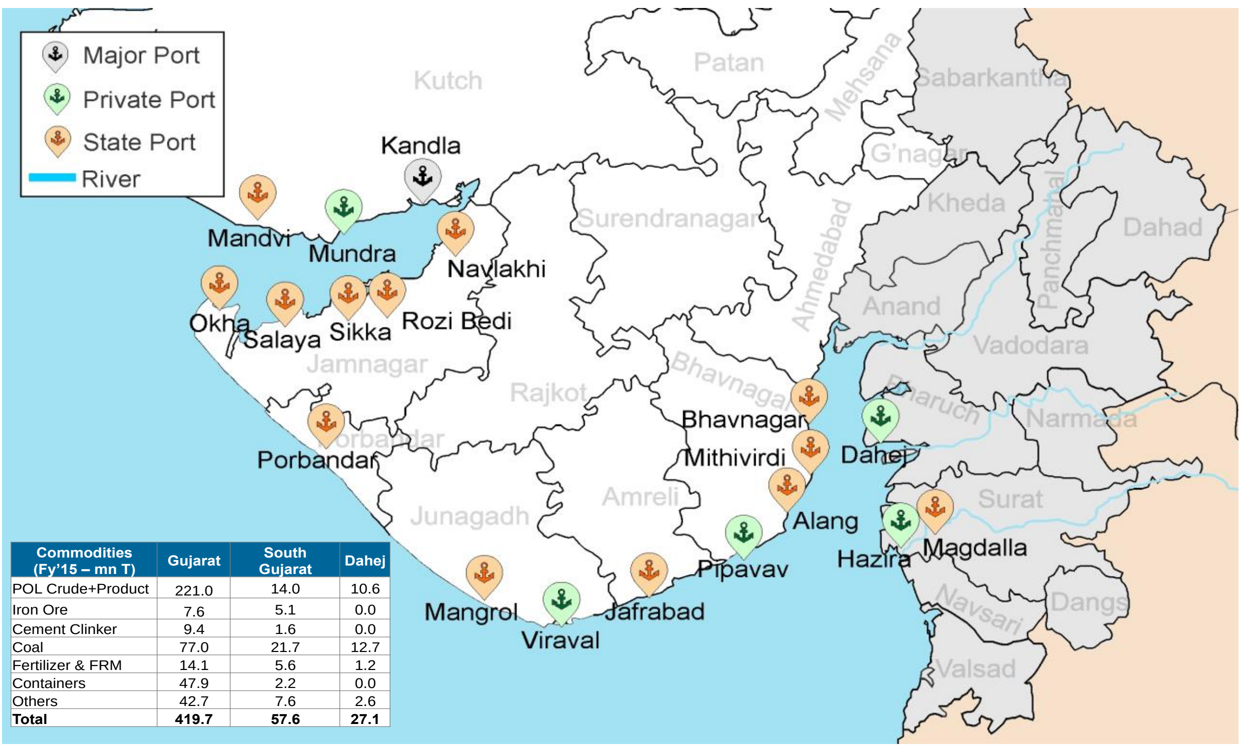


Table 4-4 Traffic Generated in Gujarat for Fy -15

Commodities (Fy'15 – M T)	Gujarat	South Gujarat	Dahej
POL Crude+Product	221	14	10.6

Iron Ore	7.6	5.1	0
Cement Clinker	9.4	1.6	0
Coal	77	21.7	12.7
Fertilizer & FRM	14.1	5.6	1.2
Containers	47.9	2.2	0
Others	42.7	7.6	2.6
Total	**419.7**	**57.6**	**27.1**

4.3.1 Major Ports

There is no major port in the catchment area of River Narmada. Kandla Port is the only major port of Gujarat, which is situated in Kutch, Northern Gujarat. Kandla port is situated in the Kandla Creek and is 90 kms. from the mouth of the Gulf of Kutchh. This port is far from the navigable stretch of River Narmada; hence this port would not be considered for the study of the proposed waterway.

Bulk of the exim cargo generated in South Gujarat gets routed to ports like Kandla, Mundra, JNPT and Mumbai, especially for clean cargo. This is mostly due to lack of infrastructure and suitable handling facilities for these cargos at the ports in South Gujarat.

4.3.2 Non Major Ports

Dahej Port is a non-major port in the catchment area of River Narmada. Dahej port is deep water, multi-cargo port, which is also the only solid cargo handling commercial port, strategically located in the Gulf of Khambhat.

The graph below shows the total trade handled at non major ports in the catchment area of River Narmada. The major trade is of Imported cargo. The volume of exported traffic is very less. Imported cargo has witnessed growth in Fy 15; however in Fy 16, the imported trade has slightly decreased.

Figure 4-6 Total Trade in Narmada Catchment

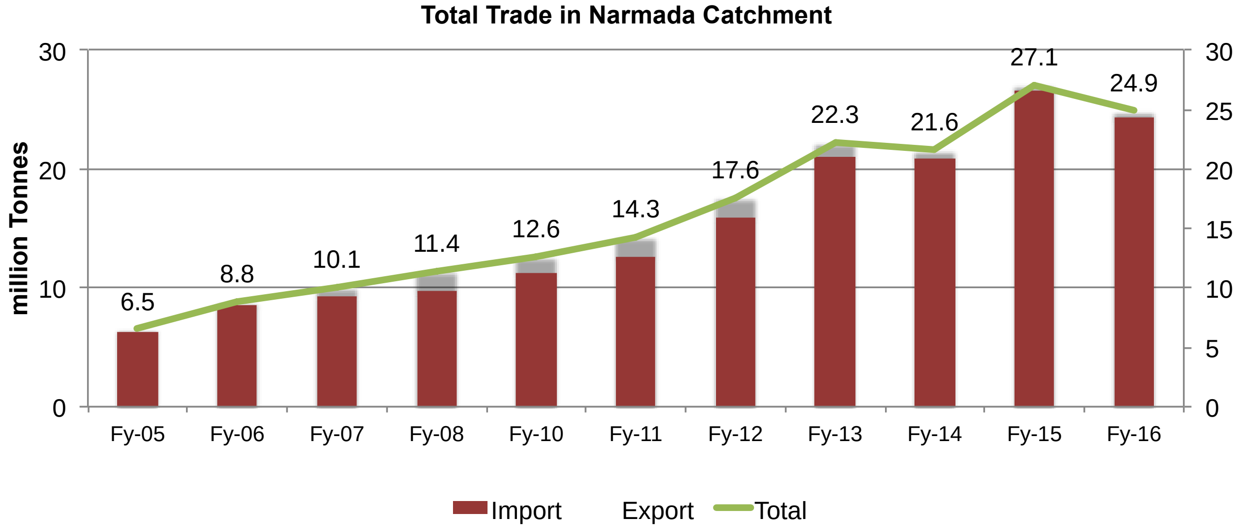
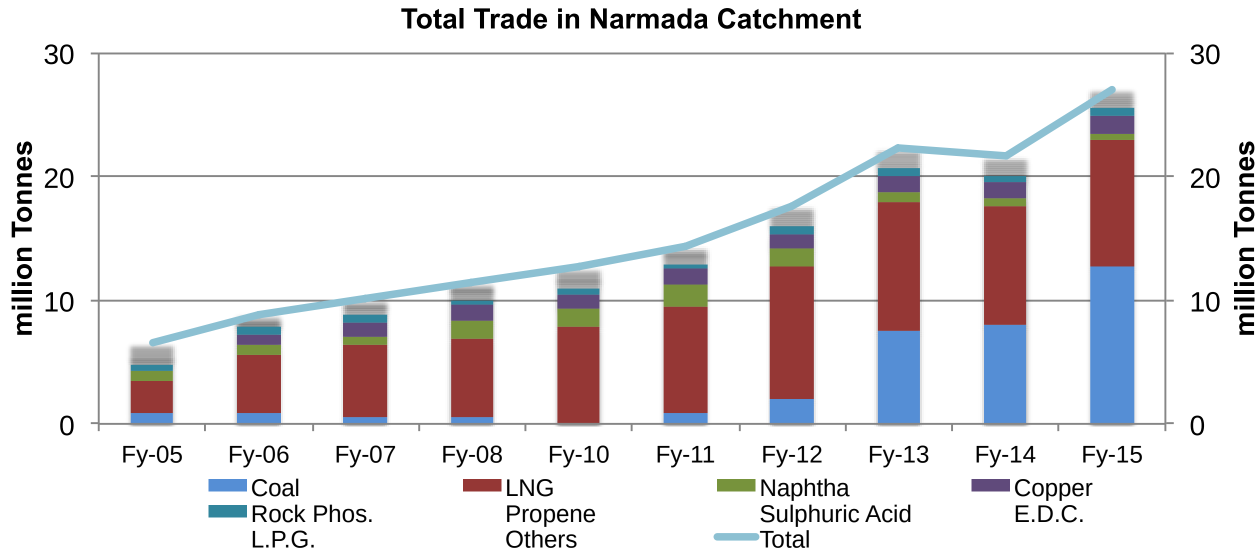


Table 4-5 Historic exim trade in Narmada catchment (Million T)

	Fy-05	Fy-06	Fy-07	Fy-08	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Import	6.3	8.5	9.4	9.7	11.2	12.5	15.9	21.1	20.9	26.6	24.3
Export	0.2	0.3	0.7	1.7	1.4	1.8	1.7	1.1	0.7	0.5	0.6
Total	6.5	8.8	10.1	11.4	12.6	14.3	17.6	22.3	21.6	27.1	24.9

Commodities handled at Dahej Port are LNG, Coal, Bulk (dry), Break bulk and project cargo. The port imports Fertilizer, Rock Phosphate, Coal & Coke, Salt etc. The below table shows the commodities handled in the non-major port of catchment area of River Narmada.

Figure 4-7 Commodity wise total trade in Narmada catchment



As shown in the graph, LNG and Coal are the two major commodities handled in Dahej Port. The table below shows the historic traffic of commodities handled in the port. Since Fy 05, LNG was handled consistently. LNG traffic has witnessed growth in Fy 12, Fy 13 and Fy 15. Coal was not handled in a large volume till Fy 13; however since Fy 13 coal traffic has also increased. There are many coal-based power plants in Gujarat which need imported coal for power generation. Adani and Reliance are some of the major industries that import coal on a large scale. Copper is also handled in the port, but the volume is less. The major importer of Copper is Hindalco (Birla Copper), which has a huge capacity plant at Dahej for producing Copper Cathodes. Rock phosphate has a huge demand with fertilizer producing companies like United Phosphorus Ltd and GNFC. Other commodities are handled in small volume too.

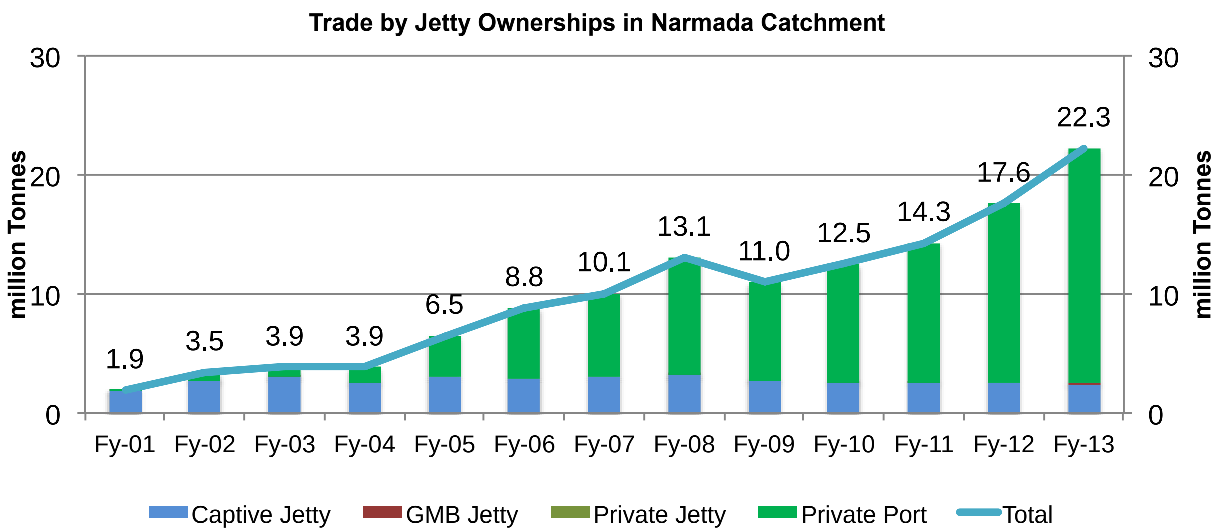
Table 4-6 Commodity wise historic trade in Narmada catchment (Million T)

Commodity	Fy-05	Fy-06	Fy-07	Fy-08	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15
Coal	0.9	0.8	0.6	0.6	0.1	0.9	2.0	7.6	8.0	12.7
LNG	2.6	4.8	5.8	6.3	7.8	8.6	10.7	10.3	9.6	10.3
Naphtha	0.8	0.7	0.7	1.4	1.5	1.7	1.4	0.9	0.7	0.6
Copper		0.9	1.1	1.3	1.2	1.3	1.2	1.2	1.2	1.4
Rock Phos.	0.6	0.6	0.6	0.5	0.5	0.4	0.6	0.7	0.6	0.6
Propene	0.4	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.4
Sulphuric Acid		0.0	0.3	0.5	0.3	0.5	0.5	0.3	0.2	0.2
E.D.C.	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.3	0.1
L.P.G.	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3
Others	1.2	0.6	0.5	0.5	0.9	0.6	0.5	0.6	0.4	0.5
Total	**6.5**	**8.8**	**10.1**	**11.4**	**12.6**	**14.3**	**17.6**	**22.3**	**21.6**	**27.1**

4.3.3 Trade by jetty ownership

The following graph shows historic trade of jetty ownership. There are captive jetties, Jetty owned by GMB, private jetties and private ports in the catchment of River Narmada. Private ports handle the major traffic in the catchment area. After private ports, captive jetties handle cargo traffic in a large scale. Private jetties didn't handle any cargo. GMB jetty has handled some cargo in Fy 13, which is very less in volume.

Figure 4-8 Historic trade by jetty ownership in Narmada catchment



As shown in the Table 4.7, Captive jetties and private ports handle large volume of cargo in the catchment area of River Narmada. Private Ports' traffic has increased in last few years. In FY13, traffic increased to 19.8 Million tonnes. The traffic of Captive jetties has remained, virtually, stagnant since FY10.

Table 4-7 Historic trade by jetty ownership in Narmada catchment (Million T)

	Fy-01	Fy-02	Fy-03	Fy-04	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13
Captive Jetty	1.9	2.7	3.0	2.6	3.0	2.9	3.0	3.2	2.7	2.6	2.6	2.5	2.5
Private Port	0.1	0.8	0.8	1.3	3.5	6.0	7.1	9.9	8.2	9.9	11.7	15.1	19.8
Total	**1.9**	**3.5**	**3.9**	**3.9**	**6.5**	**8.8**	**10.1**	**13.1**	**11.0**	**12.5**	**14.3**	**17.6**	**22.3**

Captive Jetties

There are two captive jetties in the catchment area of River Narmada, IPCL and DHIL. IPCL is a captive jetty of Reliance Industries Limited. DHIL Jetty is a part of Hindalco (Birla Copper Jetty). The jetty generally handles general cargo, raw bulk cargo.

As shown in the graph below DHIL Jetty handles majority of the cargo traffic. Since Fy 10, the volume of cargo handled at DHIL has almost flat-lined. However in Fy 07 and Fy 08, traffic at the jetty had increased.

IPCL jetty has been a consistent performer up till FY06.However, since then the cargo traffic has declined, reaching zero by FY13.

Figure 4-9 Historic trade by captive jetties in Narmada catchment

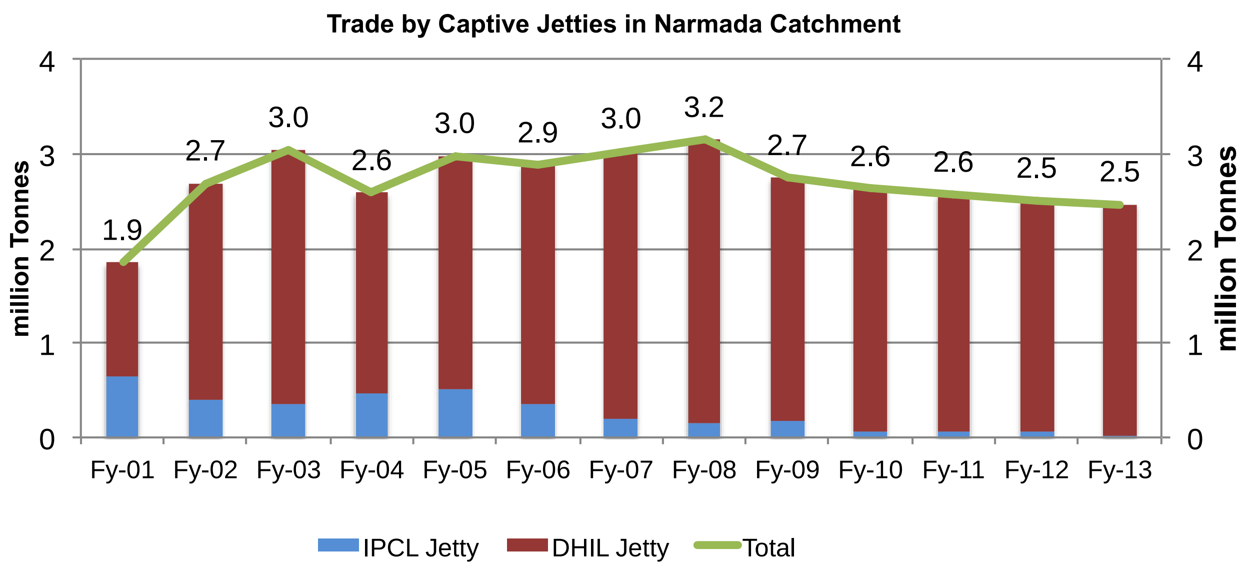


Table 4-8 Historic trade by captive jetty in Narmada catchment (Million T)

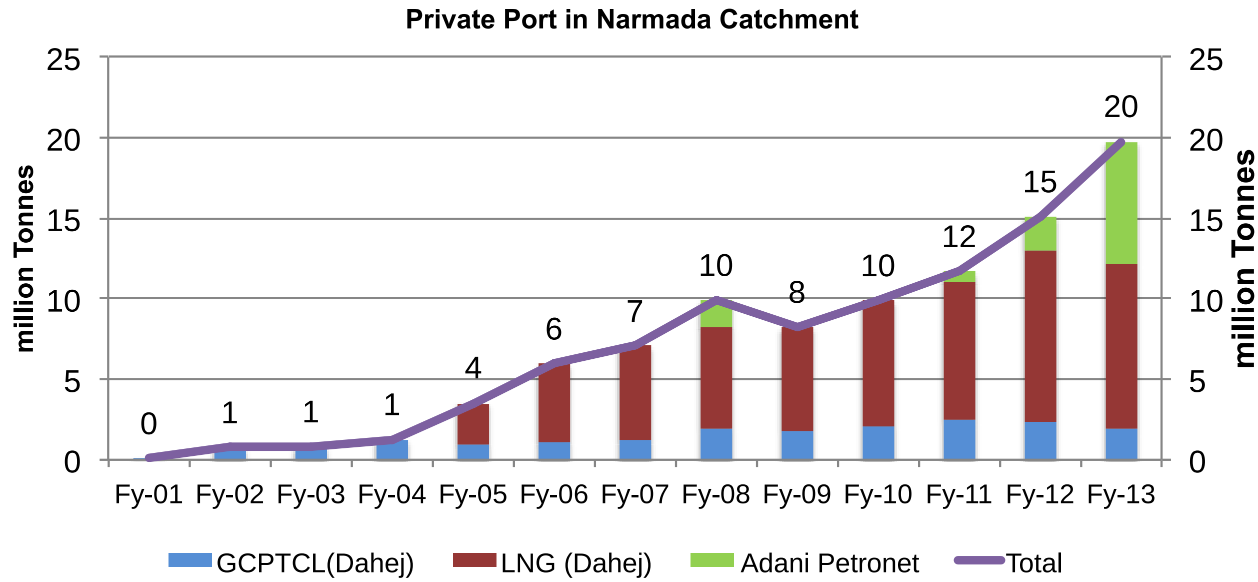
Captive Port	Fy-01	Fy-02	Fy-03	Fy-04	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13
IPCL Jetty	0.6	0.4	0.4	0.5	0.5	0.4	0.2	0.1	0.2	0.1	0.1	0.1	0.0
DHIL Jetty	1.2	2.3	2.7	2.1	2.5	2.5	2.8	3.0	2.6	2.6	2.5	2.5	2.4
Total	**1.9**	**2.7**	**3.0**	**2.6**	**3.0**	**2.9**	**3.0**	**3.2**	**2.7**	**2.6**	**2.6**	**2.5**	**2.5**

Private Port

The private ports are GCPTCL (Dahej), LNG (Dahej) and Adani Petronet. The table below shows historic traffic of private ports in the region.

LNG Dahej has a consistent trade since Fy 05. GCPTCL has also maintained consistency in trade since it became operational. Since Fy 08, GCPTCL's trade has grown; however in Fy 13, the traffic has slightly declined.

Figure 4-10 Historic trade by private port in the Narmada catchment



The Table shows historic trade of private ports in Narmada catchment area. GCPTCL and LNG's trade has witnessed decline in Fy 13. It is less than the previous year. However, Adani Petronet's trade has increased. In Fy 12, the trade was 2.1 Million T, which increased to 7.6 Million T in Fy 13.

Table 4-9 Historic private port trade in Narmada catchment (Million T)

Private Ports	Fy-01	Fy-02	Fy-03	Fy-04	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13
GCPTCL(Dahej)	0.1	0.8	0.8	1.3	1.0	1.1	1.3	2.0	1.8	2.1	2.4	2.3	1.9
LNG (Dahej)	0.0	0.0	0.0	0.0	2.6	4.8	5.8	6.3	6.5	7.8	8.6	10.7	10.3
AdaniPetronet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.6	2.1	7.6
Total	**0.1**	**0.8**	**0.8**	**1.3**	**3.5**	**6.0**	**7.1**	**9.9**	**8.2**	**9.9**	**11.7**	**15.1**	**19.8**

LNG (Dahej)

Dahej Port is located in South Gujarat. It is located North of Magdalla Port and KRIBHCO Jetty. It is located in Bharuch. The Port primarily handles liquid cargo. In 2010-11, liquid and gas constituted close to 85% of the total traffic handled at the port. Shifting of liquid and gas cargo is generally difficult from an existing port to a new port. This is because the liquid and gas cargo have large-scale support infrastructure with them.

Dahej Port handles prominently following four types of commodities. Coal, which is required by Birla Copper, has its copper smelter in Dahej. Copper is also imported by Birla Copper.

The major commodities exported through Dahej port are Caustic Soda, Copper Cathode, Copper Slag, Ethylene, Machinery, Naphtha & Sulphuric Acid.

The major imports of the port are Acetic Acid, Ammonia, Butadiene, Coal, Copper, E.D.C., L.P.G., LNG, Methanol, Naphtha, Normal Paraffin, PFAD, Para-xylene, Propene, Propylene, Rock Phosphate, and Styrene mono.

Liquid cargo at Dahej port is handled by Petronet LNG at its LNG Terminal set up in Dahej. Birla Copper, a unit of DHIL, undertakes dry bulk and liquid imports at its captive DHIL Jetty at Dahej Port. HIL has set up a Copper Refining and Smelting complex at Dahej. The complex produces goods like Copper cathodes, copper rods & precious metals. Even FRM, Fertilizers and Intermediates like Sulphuric Acid, Phosphoric Acid, DAP and other Phosphatic Fertilizers are produced by the company. For its smelter, the company imports about 1.2 Million T – 1.5 Million T of Copper concentrates annually. It also imports close to 5 Lakh Tonnes – 6 Lakh Tonnes of Coal for power generation that operates the complex. On an average, close to 5 Lakh Tonnes of Rock Phosphate is imported annually at the company's captive facility at Dahej. Rock Phosphate is utilised as feedstock in production of Phosphoric Acid. In terms of liquid cargo, the company imports under 9 Lakh Tonnes of Liquid Ammonia per year. In summation, the company handles dirty and liquid cargo, has a captive facility with dedicated infrastructure and connectivity between the jetty and the plant.

Other liquid cargo like Naphtha and POL are handled by a mix of companies, having their captive facility at the Port. Indian Petrochemicals Corporation Ltd. (IPCL), which was merged with RIL in 2007, owns and operates a naphtha-based complex at Vadodara and petrochemical complex at Dahej. The company imports Naphtha and exports POL from its captive facility at the Port. IPCL owns 32% equity and is a promoter of Gujarat Chemical Port Terminal Company Ltd. (GCPTCL), another company owning a captive facility at the Port. GCPTCL is involved in importing chemicals and exporting Naphtha from the Port. Furthermore, all the companies involved in liquid cargo exim already have captive facilities at other ports in the region.

In addition to these there are additional liquid cargo, which gets handled at Dahej port. Most of these cargo has dedicated infrastructure in place.

Welspun's Machinery has a manufacturing unit in Dahej. It imports and exports Machinery at Dahej Port. This is a non-captive cargo and the volume of cargo is very small. Cargo can be shifted to IWT waterway, depending on the services, infrastructure and handling charges provided. Transition may not be ensured as company's location of consumption and generation is in Dahej. Since this cargo is speculative in nature, it has not been considered in projections.

4.4 Commodity Composition / Categorization

The major industries along River Narmada are power plants, steel, chemicals, fertilizer, petroleum, and glass. Commodities like coal, rock phosphate, naphtha, chemicals& fertilizers, steel coils, and sandstone, which are relevant to the industries mentioned above, are discussed below. The following Table 4-10 lists the commodities and their potential to be handled that can provide cargo handling opportunities along River Narmada, along with the reasoning for the same:

Table 4-10 Potential Commodities for River Narmada

Commodities	Source	Volume (M T)	Reasoning
Naphtha	OPaL	1.0	The company is interested in shifting its current import arrangement with GCPTCL, and would like to handle the commodity via a captive jetty on River Narmada. Opal is also exploring alternate location for development of Jetty at the mouth of river jointly with other industries.
Ankleshwar ICD Traffic	Industries across the Bharuch and Ankleshwar GIDCs	0.4	Largely, this ICD is represented by high and consistently growing industries like Chemicals & Petrochemicals, and Fertilizers. Spurt in future growth could be targeted by NW 73.

4.4.1 Naphtha, Polymers, and Chemicals

Naphtha is a highly inflammable liquid mixture of hydrocarbon. It is a petroleum product. There is a shortage of natural gas presently in the country. Therefore power plants have started using naphtha a substitute fuel for power generation. Naphtha is also used in chemicals industries and paint industries. Companies like GCPTCL, Paguthan CCPP, IOCL, RIL and United Phosphorus Limited use naphtha on a huge scale.

Opportunity along River Narmada exists for OPaL, which wants to handle Naphtha for its plant in Dahej via a captive jetty on the River. At present, OPaL procures the raw material from ONGC's plants in Hazira, Uran, and Dahej. This volume is routed via Hazira Port. Earlier, OPaL had plans to lay a 100 km pipeline to transport the raw material from Hazira to its plant directly. About 65 km pipeline was already laid back in 2012, but the arrear was never taken up due to some technical issues. In view of this, OPaL entered into an agreement with GCPTCL, which has its jetty at Dahej Port. ONGC's naphtha from Hazira comes at the GCPTCL jetty, from where it is transported to OPaL's facility via a pipeline. Under this arrangement, OPaL has been importing around 0.5 MillionT of Naphtha every year. As of 2016, ONGC had been supplying one to two shipments of 34,500 MT of the raw material on a monthly basis using barges.

Reliance Industries Ltd. (RIL) is one of the stakeholders in the GCPTCL consortium. Being a competitor, there is a conflict of interest vis-à-vis the existing Naphtha transportation modality for OPaL. To address this concern, the company would like to, instead, develop its own facility to import Naphtha. Also, GCPTCL has hit capacity saturation, and won't be able to import any more Naphtha for OPaL than it does at the moment. This becomes a problem, especially, when OPaL has ramped up its production at the plant, thereby requiring larger volume of Naphtha. In view of these mitigating factors, a captive facility for the company becomes an imperative requirement.

OPaL has a double-feed cracker at the plant, capable of using both Naphtha (liquid) and other gaseous raw materials to undertake production of HDPE, LLDPE, benzene, butadiene, etc. Based on reliable inputs, the company will need 1 Million T against the current 0.5 Million T, by FY20. The increase is likely to be driven by the company's plans to ramp up its production at the plant. This potential volume of Naphtha can be moved using River Narmada.

In case of exports, OPaL has a production capacity of 1.4 Million T of polymers (LLDPE, HDPE, etc.) and 0.5 Million T of chemical products (benzene, butadiene, etc.). The company has begun exporting butadiene to Singapore, and has plans to float a global tender to expand its international presence by exporting other products as well. OPaL's export operation is a non-negotiable obligation for operating in the PCPIR. The obligation states that the company ought to export 50% of its annual production, which can translate into a total volume of nearly 1 Million T. Owing to the proximity of the plant to River Narmada, the waterway can become a viable contender for OPaL's export needs.

4.4.2 Ankleshwar Traffic Potential

The district of Ankleshwar is a base for a large number of industries, operating at different scales. However, the district is largely known for medium and small scale chemicals and fertilizer industries. Chemicals are used by almost every manufacturing company some way or the other for producing their finished goods. These chemicals are used by rubber, plastics, paints, textiles, petroleum refinery, pulp and paper industries. Therefore, chemicals are always in high demand and have a good export value. Also, Dahej has a Special Investment Region called Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR). There are scores of chemical and petrochemical industries in this region. Similarly, there are several companies engaged in trade of fertilizer raw materials, or finished fertilizers, or both throughout the PCPIR. For most of these companies, the annual trade volume is low and inconsistent. For import of raw materials, these companies prefer Hazira, Mundra, Mumbai, and JNPT. For export, the fragmented volume is dispatched to the Ankleshwar ICD for consolidation, which is eventually exported from ports like Hazira, Mundra, Pipavav, Mumbai, and JNPT in containerized forms.

Besides the aforementioned industries, Ankleshwar also has companies. Similar to the ground situation discussed above, trade across these industries is also very low and scattered. Imports of raw materials are carried out from ports mentioned above, and the low volume exports are shipped to the one of the preferred ports via Ankleshwar ICD in containers. A similar inference could be drawn for export volume from Bharuch GIDC, also shipped via Ankleshwar ICD.

4.5 Originating / Terminating Commodities

The following Table 4-11 depicts the current origin-destination particulars for all the cargo that can be moved using River Narmada post required infrastructure development:

Table 4-11 O-D particulars for potential cargo on River Narmada

Name of companies / Source	Commodity	Volume (M T)	Origin	Destination
OPaL	Naphtha	1.00	Hazira&Dahej	Dahej (VagraTaluka)
Ankleshwar ICD	Wide range of industries (Import)	0.30	Maharashtra & Gujarat Ports	Ankleshwar GIDC / Bharuch GIDC
	Wide range of industries (export)	0.06	Ankleshwar GIDC / Bharuch GIDC	Maharashtra & Gujarat Ports

OPaL currently follows complicated logistics to procure its raw material of naphtha. Furthermore, the current delivery mode and method carries high risk of disclosing, typically confidential, operational details to its competitor RIL. In contrast to routing the raw material from Hazira to GCPTCL jetty at Dahej, and then via pipeline for the last mile connectivity to OPaL's plant in Dahej, opting for River Narmada would meet multiple goals. Firstly, the company will be able to import the raw material at a facility that will be private or captive in nature. Secondly, in the event of future expansion, handling capacity can be increased, which is not a luxury OPaL enjoys at the GCPTCL jetty right now. Most critical would be preventing unintended disclosure of its operational performance to its competitors. Export-wise, OPaL prefers Kandla and Pipavav ports. In the absence of a dedicated pipeline, cargo is transported to these ports using roadways, entailing heavy road freight cost. Its recent 34 MT butadiene export to Singapore was transported on road a tanker to the Kandla port for final dispatch. Potentially, shifting to the proposed waterway of River Narmada may reduce this logistics cost.

Companies in Ankleshwar and Bharuch GIDCs import raw materials in low volume, primarily, from ports major ports in Maharashtra and some from Mundra. Companies with large plants are located closer to either of these port facilities, for ease of exim. However, both the GIDCs are populated by, mostly, medium to small scale companies, producing and trading in low volumes. These companies prefer moving transporting their cargo to Ankleshwar ICD, where it gets consolidated and containerized to be, eventually, exported. Ankleshwar ICD provides the shortest route for the companies in GIDC to evacuate their cargo. The shortest distance to River Narmada from Ankleshwar ICD is around 7 km. Containerized cargo from the ICD could be moved on the waterway and then to the desired port of evacuation using coastal waters.

4.6 Passenger Traffic

Passenger traffic consists of Ro-Ro traffic and people visiting famous locations. Visitors to Gujarat travel by road, railway, waterway, or by using multimodal mode. From the standpoint of passengers in and around the River Narmada catchment, only Rundh and Chandod are likely to provide opportunities to handle passengers in the immediate context, and that, too, in . The stretch between these two points is the only region devoid of adequate bridge connectivity across the river. The current rudimentary boat service could be replaced and improved upon by starting a ferry service between these two points.

4.7 Tourism Traffic

Table 4-12 below shows the tourism traffic of Gujarat between FY09 and FY14. The traffic is distributed across tourism contribution from domestic, NRI, and foreign tourists.

Table 4-12 Tourism Traffic in Gujarat ('000 units)

Origin	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Within Gujarat	12,285	13,077	15,062	17,176	19,536	22,161
Other Indian states	3,227	3,624	4,355	4,728	5,356	6,061
NRI	181	203	257	285	316	338
Foreign	114	107	139	175	201	228
Total	15,808	17,011	19,812	22,364	25,409	28,788

Source: Ministry of Tourism, Gujarat

Major source of tourism traffic in the catchment area of River Narmada has always been the people from within the state. Since FY2008, local tourism traffic has increased in the state, followed by traffic from other states. This growing trend is apparent in the tourist figures represented by the NRIs and foreigners as well.

The table below gives a yearly distribution of tourist inflow in districts relevant to River Narmada:

Table 4-13 Tourism Traffic in Catchment Area (units)

District	2008-2009	2009-10	2010-11	2011-12	2012-13	2013-14
Bharuch	2,24,376	1,94,068	2,07,355	1,98,278	3,12,467	3,24,602

Vadodara	6,21,640	6,41,053	8,38,849	10,08,320	11,44,479	13,59,437
Ankleshwar	1,25,245	1,05,840	1,11,621	1,12,713	1,54,078	2,05,284
Surat (including Tapi)	6,80,763	7,65,473	13,33,123	14,10,563	17,05,117	18,42,109

Source: Ministry of Tourism, Gujarat

The table above shows that tourism in all the districts has been rising consistently for the depicted time period. Vadodara and Surat districts have handled significantly large number of visitors in comparison to other districts. Surat has witnessed an abruptly high growth rate in the last 3 years, unmatched by even the consistent growth of Vadodara district. For River Narmada, Surat is unlikely to contribute majorly in tourism, as the waterway will be in direct competition with River Tapi. As for Vadodara, the district is located in the secondary catchment area of River Narmada. Also, the river stretch that extends into this district has not been earmarked for conversion into an inland waterway. So, tourism-centric development on River Narmada will be an attractive prospect for the Vadodara population only under certain conditions. Bharuch is assumed to play a pivotal role, followed by Ankleshwar and Surat, in justifying tourism infrastructure development along the River Narmada stretch. Tourist inflow from these districts should provide bright prospects for brighter returns on project investment. This holds true, especially, when the central government has expressed an interest in starting a boat-ride between Bharuch and Sardar Sarovar Dam.

River Narmada offers access to a variety of tourism activities like religious tourism, eco tourism, wildlife sanctuary, etc. spread across the districts flanking the river. District-wise famous tourist places in the catchment area of River Narmada are depicted in the table below:

Table 4-14 Tourist places on the bank of Narmada

District	Tourist Spots	Distance (KM)
Narmada	KuberBhandari Temple	on the banks of the river
	SardarSarovar Dam/ Reservoir	
	Kayavarohan Shiva Temple	20
	HarsiddhiMataji Temple	15
	GarudeshwarMahadev Temple	
	TriveniSangam	on the banks of the river
	Shoolpaneshwar Temple	
	Shoolpaneshwar Wildlife Sanctuary	
	Statue of Unity (Proposed)	
	Zarwani Waterfall	
Vadodara	NilkanthDhamSwaminarayan Temple	

District	Tourist Spots	Distance (KM)
	KuberBhandari Temple	
	Kayavarohan Shiva Temple	
	NareshwarDham	
Bharuch	Kabirvad	
	Narmada Park	
	Golden Bridge	
	Surpaneshwar Shiva Temple	
	NeelkanthMahadevmandir	
	Baps SwaminarayanMandir	

The number of temples reflects the religious spirit of the state. In Narmada, Vadodara, and Bharuch districts, there exist many temples which are located on the banks of River Narmada. Sardar Sarovar Dam is another famous place, which attract many tourists every year.

Narmada District

Sardar Sarovar Dam/ Reservoir

Sardar Sarovar Dam is located near Rajpipla. It is the largest dam on River Narmada and largest water reservoir in Gujarat. It is a famous tourist attraction the Narmada district. The picturesque dam has ambient viewpoints, garden and boating amenities, which provide memorable experience to the tourists. Godbole Gates, Narmada Main Canal Head regulator, and beautiful dykes breeding thousands of crocodiles are great attraction for tourists.

Godbole Gates offer a beautiful view of water released back to River Narmada for downstream ecology. The viewpoints provide view of some spectacular scenes. There exists some food courts set up at the site, for tourists' gastronomical pleasure. The surrounding area, rich in vegetation, is ideal for trekking.

Tourism flow at the Dam has been increasing regularly at a consistent rate, especially on the weekends. On a typical day, the Dam hosts more than 45,000 visitors, which can increase on the weekends.

Rajpipla

Rajpipla is a nature-centric heritage getaway at 40 kms from Bharuch and about 100 kms from Vadodara. Rajpipla is known for its palaces, and several forests. It is just 36 km from

Sardar Sarovar dam. Rajpipla is home of Rajvant Palace Resort, a heritage hotel. It was once the center of a princely state. The palace is used for film shoots throughout the year.

Harsiddhi Mataji Temple

Harisiddhi Mataji Temple is another famous spot in Rajpipla. It is located only 1.2 km from River Narmada. The temple has strong mythological importance, as it is one of the Shaktipeeths. The temple is managed by the Hindu Devasthan Committee and Mamlatdar of Nandod. More than 200,000 tourists and devotees visit this temple every year.

Garudeshwar Temple

This ancient temple of Lord Shiva (Garudeshwar Mahadev) is situated on the northern bank of River Narmada, and attracts thousands of pilgrims from all over the world. This temple of Garudeshwar Mahadev is around 2,000 years old, and has mythological significance. It is a pilgrimage site with a holy place for bathing called Ghat on the river bank. Major attractions are the temple of Lord Dattatreya and a holy memorial ashram of His Holiness Vasudevananda Sarasvati, who is the author of 'Dattpuraan'. The statue of Lord Dattatreya is made of black granite stone and carved with beautiful wooden designs.

Triveni Sangam

The merger of three holy rivers, viz. Narmada, Orsang and Gupt Saraswati at Poicha near Rajpipla is popularly known as the sacred Triveni Sangam. People sail across the river by boat to Chanod-Karnali, which is the most important place of pilgrimage on the bank of the River Narmada. Hindus perform last rites and other rituals at this site.

Shoolpaneshwar Temple

Shoolpaneshwar Temple is located on the bank of River Narmada. It is just 22 km away from Rajpipla. The temple is dedicated to Lord Shiva. The temple was rebuilt by the Government to replace original ancient temple that was submerged by the dam.

A lot of tourists are attracted during the5 days tribal fair on 'Chaitri Amaas'. Devotees come from faraway places to the beautiful 'Ghaat' for Narmada Snan and the Maha Aarti of Narmada Maiya on every full moon. Panchvati Garden, with its beautiful landscapes, provides an interesting attraction for tourists.

Shoolpaneshwar Wildlife Sanctuary

The Shoolpaneshwar Wild life Sanctuary is located on the bank of River Narmada and is rich in biodiversity. The Sanctuary encompasses an area of 607.71 sq. km in Narmada district. The sanctuary offers a great view of the hills of Satpuda range, and the scenic beauty of moist deciduous forest. Dhaman Mal, the highest peak in this region with an altitude of 882 meter is located in the Rajpipla hills here.

The forests in the region are some of the best and the densest in the state. Moist teak forest, moist mixed deciduous forest, dry deciduous scrub, dry bamboo brakes, and dry tropical riverine forest, constitute varied habitats in the Sanctuary. Teak is the principal species. Patches of pure bamboo dominate the western and north-western parts. A study documented 575 species of flowering plants in the Sanctuary.

The sanctuary is an ideal place to see various types of birds, raptors, python, flying squirrel, pangolin or wild cats. The sanctuary is also home to animals like the sloth bear, leopard, hyena and the near extinct barking deer and rhesus monkey. More than 200 species of birds are found in the Shoolpaneshwar Wildlife Sanctuary. Many migratory birds also visit the place in winters.

Statue of Unity (Proposed Site)

The monument statue of Sardar Vallabhbhai Patel will be constructed facing the Sardar Sarovar Dam, 3.2 km away on the river island called Sadhu Bet or Sadhu Tekri, The total height of the statue from its base will be 240 meter consisting base height of 58 meter, and the actual statue height of 182 meter. After completion of the project, it will be the tallest statue in the world. It will be constructed with steel framing, reinforced cement concrete and bronze coating. The government has plans to develop the area around the statue to further bolster tourism potential of the region.

Zarwani Waterfall

Zarwani Waterfalls is located in a dense forest, inside Shoolpaneshwar Wildlife Sanctuary. The waterfall is 28 kms from Rajpipla towards Kevadia Colony. The nearest village is Thawadia. The waterfall is approachable by road from Rajpipla towards Kevadia Colony. However, visitors need to trek from the nearest available parking spot to reach the waterfall. Also, to visit the falls, permission has to be availed from the Forest Office, which is close to Vadodara. The water is perennial here and can be visited any time of the year. The best season to visit the falls is from November to February, owing to the prevalent moderate climate.

Vadodara District

There are many tourist attractions in Vadodara district, like Ajwa Nimeta Dam and Garden, Maharaja Fatehsingh Museum, Makarpura Palace etc. but these places are far from Narmada river, hence would not provide any opportunity for tourist traffic. The faraway places are not considered for detailed study.

Nilkanth Dham Swaminarayan Temple

Nilkanth Dham Swaminarayan temple is a beautiful temple built in the year 2013 and it is situated on the bank of River Narmada in Poicha in Vadodara district. The main attraction of the temple is the elephants that pull the giant bell with their trunk during the evening aarti. The Sahajanand Universe is also a major attraction; spread over 24 acres where it houses the 151 ft Lord Swaminarayan Idol. There is also a Lord Vishnu idol with Sheshnag in the main temple.

Kuber Bhandari Temple

Kuber Bhandari temple is situated on the bank of River Narmada and is said to be nearly 2500 years old. The lord here is a form of Lord Shiva. The temple is situated 800 ft above the coast of River Narmada and the devotees need to take 680 steps from the bank of River Narmada to the temple. The ritual observed here is to first take a bath in the River Narmada and then visit the temple. One must be careful while taking bath as the river has crocodiles. The temple area has pristine calmness ion its surroundings with the quiet flow of River Narmada. The temple becomes full with pilgrims on the no moon day of the Gujarathi month.

Kayavarohan Shiva Temple

Kayavarohan Temple is situated on the banks of the River Narmada and said to be built by sage Vishwamitra during the Ramayana era. The temple is mentioned in the Puranas and is one of the sixty-eight theertas of Lord Shiva. The temple has been listed as a Heritage site by the Archaeological Survey of India.

Nareshwar Dham

Nareshwar Dham is located on the bank of holy River Narmada and is 45-50 km far from Vadodara city. The dham provides a beautiful and calm ambience with River Narmada flowing by the side. Boat ride is available on this part of the river.

Bharuch District

Kabirvad

Kabirvad is an island in the middle of River Narmada. The main attraction of the place is the Banyan tree, which has grown and spread over an area of 3 kms. The place is serene and the visitors come here to relax in the vicinity of the Banyan tree.

Narmada Park Bharuch

Narmada Park is situated on the banks of the river. The park was started in 2014. The Park has a gazebo, riverside sitting arrangements, jogging track, garden, and playground for children.

Golden Bridge

The Golden Bridge is on the River Narmada that connects Ankaleshwar to Bharuch. It is also called the Narmada Bridge. The bridge structure is nearly 145 years old, which was built by the British.

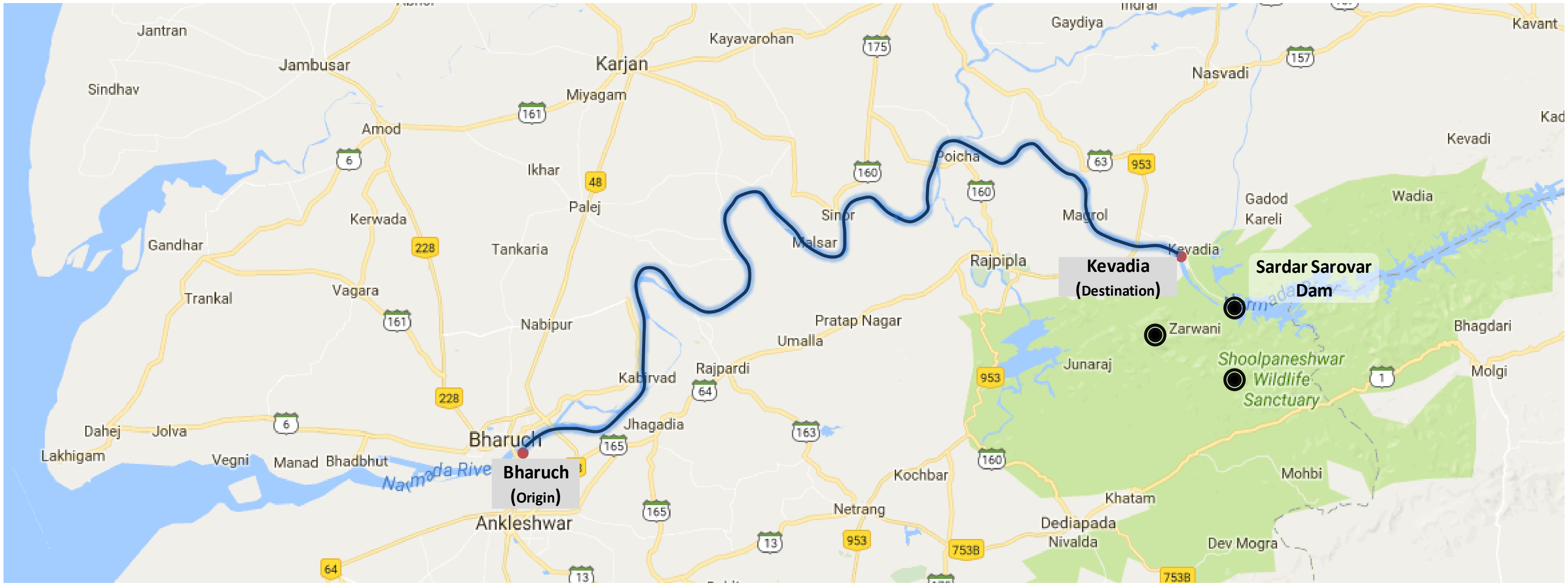
Neelkantheshwar Mahadev Temple

Neelkantheshwar Mahadev Temple is situated on the banks of River Narmada in Bharuch, Gujarat. The temple houses a large idol of Lord Hanuman. Special religious programmes are held in the auspicious Hindu month of Shravan here.

Potential tourist traffic – Bharuch to Sardar Sarovar Dam

Back in March 2017, Central government expressed an interest to carry out a feasibility study for a boat service between Bharuch and Garudeshwar near Sardar Sarovar Dam, also known as Narmada Dam. The proposal stems from the growing popularity of the Dam and the surrounding tourist attractions. The Figure 4-11 below depicts the tentative locations for the jetty that should be set up to cater to the tourist flow across the said River stretch:

Figure 4-11 Proposed boat service between Borbhatha Bet, Bharuch and Garudeshwar



The Dam attracts around 45,000 visitors on cultural or religious occasions. Visit to the Dam also provides the visitors the option to visit one of the numerous religious and tourist spots that populate the district and the adjoining areas. Holy spots like Neelkanteshwar, Shukaltirth, Kabirvad, Nareshwar, Poicha, Madhi, Garudeshwar, and recreational spots like Shoolpaneshwar Wildlife Sanctuary and Zarwani Waterfall are some of the popular attractions in this region. The soon-to-be-finished Statue of Unity will further add to the tourism appeal of the region. The statue will be the tallest in the world, and will be accompanies by a range of other tourism-centric developments at the same spot. Potentially, this one infrastructure carries significant weight in attracting more tourists in the coming times.

The aforesaid boat service is looking to target visitors from Bharuch and Surat districts. This is also likely to include visitors who are stopping over at these locations, or those who access the Wildlife Sanctuary, the Dam, or the Waterfall via these districts. At the moment, there’s no waterway transportation for such visitors, who instead have to use road from Zadeshwar to Kevadia. The envisioned boat service can facilitate this tourist movement, thereby laying groundwork for the anticipated rise in tourism traffic in the region.

Potential tourism attraction –Amusement park

There is anticipation of brisk growth in tourism around Sardar Sarovar Dam. This is primarily due to the Statue of Unity. Along with the statue, there will be a string of complementing developments at the site, some of which are listed as follows:

- The 3-level base of the statue will house a Memorial Garden, and a large exhibit hall showcasing the eponymous Sardar Patel’s contributions to India’s freedom movement

- An observation deck at 500 feet can hold 200 visitors at a time. From this deck, visitors can enjoy breathtaking views of the beautiful Satpuda and Vindhyachal mountain ranges, the 256-km Sardar Sarovar Reservoir, and the 12-km long Garudeshwar Reservoir.

- A state-of-the-art underwater aquarium right next to the statue is also in the offing.

- Miscellaneous facilities like food courts, gift shops, retail outlets, and other amenities will also be developed around the statue to serve the visitors.

In order to take advantage of this all-round development around the statue, and to tap into the anticipated astronomical growth in tourism in the region, a water amusement park has been recommended. This facility can be set up right next to the Terminal that will cater to the tourist traffic from the boat-ride between Bharuch and Sardar Sarovar

Dam. This amusement park will attract a share of this boat-ride traffic, as well as visitors from adjoining areas, particularly Vadodara.

The proposed amusement park will also include water-sports facilities and amusement rides for kids. A similar facility is being operated in Singanapore, near Weir-cum-Causeway on the bank of River Tapi. This facility has a water sports park and a floating restaurant, run by a company called Blue Adventure. A similar facility, minus the floating restaurant, could be developed in the vicinity of the Statue and the Dam.

At present, this region is popular mainly for Sardar Sarovar Dam. The Dam attracts visitors in large numbers on special occasions like religious and cultural holidays. On other days, the place hardly attracts tourists in the hundreds. This, however, is expected to change once the Statue is ready. The tourism industry is on a climb in the adjoining districts of Bharuch, Surat & Tapi, Ankleshwar, and Vadodara. This growth will bode well both for the boat-ride and for the amusement park. A strip of land alongside the Statue of Unity has been reserved for future developments, potentially tourism related. Taken together, the stream of current, proposed, and anticipated developments are likely to transform the region into a tourism hub.

The proposed amusement park could provide, but not be limited to, the following facilities and activities on its premise. Amusement rides will help increase its popularity among kids, too.

- Jet-skiing
- Kayaking
- Speed-boating, Leisure boat rides, Pedal-boat rides, Banana boat rides, etc.
- Various water rides
- Various joy rides

As per a 2015 report, India's amusement-park industry was slated to grow at a 5-year CAGR of 20%, with annual traffic to increase at a 10% - 15% CAGR for the next couple of years. India's urban population was expected to climb from 31% in 2010 to 35% of the total population by 2020. As of 2015, India had about 150 parks serving its total population of 1.2 billion. In comparison, USA had 400 parks for its population of 319 million. The demand-supply gap for India suggests that there's tremendous scope for growth in this segment.

Most parks in India are small scale, with an annual capacity of 0.3 million visitors or less. Such parks are primarily located in and around small towns, and on the outskirts of metro cities. Taking into account the tourism industry of prosperous districts like Bharuch, Surat & Tapi, and Vadodara, a small-scale amusement park will be inadequate. Therefore, a medium-scale amusement park should be built to cater to a large influx of visitors from these multiple districts. Traditionally, a medium-scale amusement park is built on the outskirts of metros and tier-1 cities, and can accommodate about 0.5 million visitors every year. Total capital expenditure (capex) for such parks can fall anywhere between INR 300 million and INR 400 million, occupying a total area of 10 acres to 40 acres. Such a vast expanse of land is available around the upcoming Statue. Preferably, the area between Gora Bridge and the Statue of Unity will be suitable for this construction, right next to the proposed Terminal 4.

4.8 Ro-Ro Traffic

There is also some passenger movement on River Narmada. Due to lack of bridges across the river, people use small boats for transportation. Also there are pilgrimage and devotional places on River Narmada where tourists are seen travelling on small boats over short stretches.

The following image depicts the two most used locations along River Narmada for passenger ferrying across the river:

Figure 4- 12 Existing boats used by passengers on river

Rundh to Poicha

This stretch has lack of river-crossing bridges. It was evident that the villages along the riverside need to travel across the river. Hence some rudimentary ferry services are being provided on this stretch between these two endpoints. Also, Poicha is just across the river from Chandod. So, any passenger service that plies people between Rundh and Poicha can also make a stopover at Chandod. Similarly, passenger traffic between Rundh and Poicha/Chandod can be accommodated by the boat service between Bharuch and Garudeshwar.

Chandod Ghat to Shoolpaneshwar

The identified stretch is known for its pilgrim places, every year lakhs of pilgrims visit this part of stretch of river. There is an ancient Lord Shiva (a.k.a. Garudeshwar Mahadev) temple called Garudeshwar temple situated on the northern bank of River Narmada. The temple attracts thousands of pilgrims from all over the world. Passenger traffic potential between these two spots can also be served by the envisaged boat service between Bharuch and Sardar Sarovar Dam.

Dahej to Ghogha

The Dahej-Ghogha Ro-Ro is a much-awaited service in Gujarat. It was estimated to be operational by April, 2017. This service will drastically shorten the travelling time between South Gujarat and Saurashtra. By road, Dahej and Ghoghaare 296km apart, which takes around 4-5 hours to cover. By waterway, the distance between Dahej and Ghogha reduces to less than 25km.

4.9 Growth Trend

River Narmada has high potential for catering to cargo traffic, especially for OPaL. Some share of exim cargo from Ankleshwar ICD can also be targeted for moving via River Narmada. However, tourist traffic has far greater potential to ply along this waterway. There are existing tourist attractions throughout the stretch that can be of interest for both domestic and foreign visitors.

Cargo Growth

OPaL has recently ramped up its production at the plant, operating at full capacity. As opposed to its earlier annual requirement of 0.5 Million T naphtha, the company anticipates this requirement to be 1 Million T by FY20. They recently exported 34 MT of butadiene to Singapore, and intend to cater to more international market in future by offering other type polymer and chemical products they product at the Dahej plant. Both the import and export volume will increase when the company carries out its expansion plans, which is very likely. The petrochemical sector has seen a steady growth rate between 10% and 12% in the past decade. Experts claim that the sector will witness a growth rate of 12% to 15% in the next decade. Export potential is further bolstered by the fact that India's per capita polymer consumption stands at about 10 kg., as opposed to the global average of 32 kg.

Chemicals, petrochemicals, and fertilizer industries are the major industries in Ankleshwar GIDC. Bharuch GIDC is also known for these industries, along with textiles. Despite low traffic prospect from individual manufacturers from these industries, cumulative traffic potential from the two GIDCs would follow the growth trend of the overall industry. For instance, the chemical and petrochemical industry has been growing at about 12% rate since past decade. Next, the fertilizer industry, both national and international, has been registering a low yet stable annual growth rate of around 2%. Together, exim volume from the GIDCs will also receive a fillip in the coming years, allowing for more cargo handling prospects on River Narmada waterway.

Tourism Growth

The numerous holy sites flanking River Narmada have adequate land connectivity for unhindered access. Promoting waterway movement via River Narmada exclusively dedicated to reach these locations may not be commercially viable. Furthermore, tourist inflow at these locations is seasonal, and may not supply consistent prospects for carrying tourists using the river. Instead, focus should be shifted to tourist attractions where there's perennial supply of tourists round the year. Doing so will help a waterway transportation initiative recover its costs and become a profitable venture in a shorter time span. Sardar Sarovar Dam is one such tourist attraction that carries the potential to transform a ferry service into a profitable venture.

Tourist influx at the Sardar Sarovar Dam and due to the upcoming Statute of Unity is likely to be the driving factors in enhancing tourism in the catchment areas of River Narmada. At present, the Sardar Sarovar Dam is the most famous tourist spot on the earmarked River Narmada stretch. Additionally, the Wildlife Sanctuary and Zarwani Waterfall alongside the Dam also attract visitors from different states. Establishing waterway tourist movement between Bharuch and Kevadia will provide further impetus to the already flourishing tourism industry in the region, especially Bharuch and Surat. This boat service will facilitate tourism growth in the region, and also negate the current alternative of road transport between Zadeshwar and Kevadia. By road, this distance could be anywhere between 110 km to 130 km. Using the waterway instead, the chainage between Bharuch and Kevadia is around 123 km. The boat ride provides a cheaper alternative to road transport, and quick access to other tourist sites that fall along the way on the river banks.

Comparison between FSR and DPR Traffic

The following Table 4-15 gives a brief comparison between the potential cargo for River Narmada waterway, as judged by the FSR and DPR:

Table 4-15 Comparative Analysis of FSR with DPR

Commodity	Source	Considered in FSR	Potential as per DPR	Reasoning
Coal	Imported Coal from Dahej	✓	✗	Barring major companies, coal demand from individual medium-to-small scale companies is low and irregular
Rock Phosphate	Dahej Port	✓	✗	Consumers are too scattered to be able to cater to a consolidated demand without resorting to multiple handling
Fertilizers	Bharuch and Ankleshwar GIDCs	✓	✓	Considered collectively as exim cargo from the GIDCs
Black Trap	Mines in the catchment area	✓	✗	Consumption centers are scattered throughout the district, and waterway transport will induce multiple handlings, likely to increase logistics cost
Sandstone		✓	✗	
Tourism Potential				
Tourism	RundhandChandod	✓	✓	Passenger traffic at Rundh and Chandod can be accommodated into the boat service that's been envisioned between Bharuch and Kevadia at Sardar Sarovar Dam. All round tourism development in the region can be tapped into by an amusement park
	Bharuch – SardarSarovar Dam	✗		
	Amusement Park	✗		

Source: Mantrana Maritime Advisory Pvt. Ltd. & WAPCOS FSR

Coal requirements from major companies like RIL (IPCL), Gujarat Fluorochemicals Ltd., etc. are directly procured from the ports. Proximity to the ports negates the possibility of influencing these companies to switch over to waterway to transport their coal requirements. Medium and small scale industries that require coal are spread across the Ankleshwar and Bharuch GIDCs. Also, most of these companies also acquire imported coal from Dahej and Hazira ports, but at irregular intervals and in low volume. Ideally, waterway transport is effective and viable for long-distance and large-volume transport. Hence, coal cannot be a potential cargo to be moved on River Narmada.

Rock phosphate is used in fertilizer production. It's the raw material to produce phosphoric acid, which is reacted with ammonia to produce Mono-ammonium

Phosphate (MAP) and Di-ammonium Phosphate (DAP). Such fertilizer production is carried out in both Bharuch and Ankleshwar GIDCs, mostly in the former. However, demand for rock phosphate is just as scattered and irregular as coal. Furthermore, multiple handling to enable last-mile connectivity dilutes the overall prospect for waterway movement for this cargo.

Fertilizer products, along with all the major commodities produced in the Ankleshwar and Bharuch GIDCs are dispatched using Ankleshwar ICD. These are stuffed in container and moved to, most preferred, JNPT via rail mode using CONCOR (Container Corporation of India) rakes. Targeting a single commodity from these industrial regions may not a feasible approach, on account of low volume and highly dispersed customers. Instead, whatever export volume is containerized and exported from the ICD, regardless of the type of cargo, can become potential traffic for waterway movement.

Despite proximity to mines along the River Narmada stretch, the end customers are spread throughout multiple districts. Mined black trap and sandstone are currently distributed for local consumption using road transportation. In the event the proposed waterway is factored in to move these cargos, the last leg of connectivity would still require road movement. This multiple handling will only inflate the logistics cost, further to be transferred to the end customer. For a low-value commodity like black trap or sandstone, this is unnecessary cost padding, and compromises the commercial viability of the entire logistics.

Both passenger traffic and tourism traffic have been combined under a single recommendation of the boat service between Bharuch and Garudeshwar. This proposal is based solely on the interest expressed by the Central government. Setting up tourist-handling terminals for moving regular passengers from Rundh and Chandod across the river can be better addressed by the boat service, too. Instead of fully-fledged terminals at Rundh and Chandod, a wooden or concrete ramp for embarking and disembarking of passengers can be constructed at these sites. Hence, the passenger traffic can also be handled in the dedicated Bharuch-Garudeshwar boat service.

The estimated increase in traffic because of the proposed boat ride will also contribute towards the popularity of the suggested amusement park. Amusement park visitors will mostly be constituted by visitors arriving using the boat ride, and visitors from Vadodara taking roadways. A small share could be contributed by visitors who utilize neither the Bharuch – Sardar Sarovar Dam boat ride nor the roadway from Vadodara.

4.10 Forecasting & Potential IWT Assumption

The River will be developed in 3 phases. Phase 1 will see the development of the stretch from the mouth of the River up to OPaL Terminal. The stretch between Bharuch &

Garudeshwar Weir will be developed in Phase 2. Finally, Phase 3 will involve development of the stretch between OPaL and Bharuch. A tentative plan for the construction period and the subsequent operational period is presented in the table below:

Table 4-16 Tentative plan

Phases	Terminal/Stretch	Fy 19	Fy 20	Fy 21	Fy 25	Fy 26	Fy 27	Fy 28	Fy 31	Fy 32	Fy 33	Fy 34	Fy 44	Fy 45
1	Terminal 1	Development		Operation										
2	Terminal 2 & 3				Development			Operation						
3	Terminal 4									Development		Operation		

The following flowchart in the figure-4-13 depicts the rationale behind the traffic study, and the driving factors for the projections undertaken herein:

- Business opportunities in primary hinterland (distance under 25 kms from River Narmada) and secondary Hinterland (distance beyond 25 kms from River Narmada) were researched and analyzed.

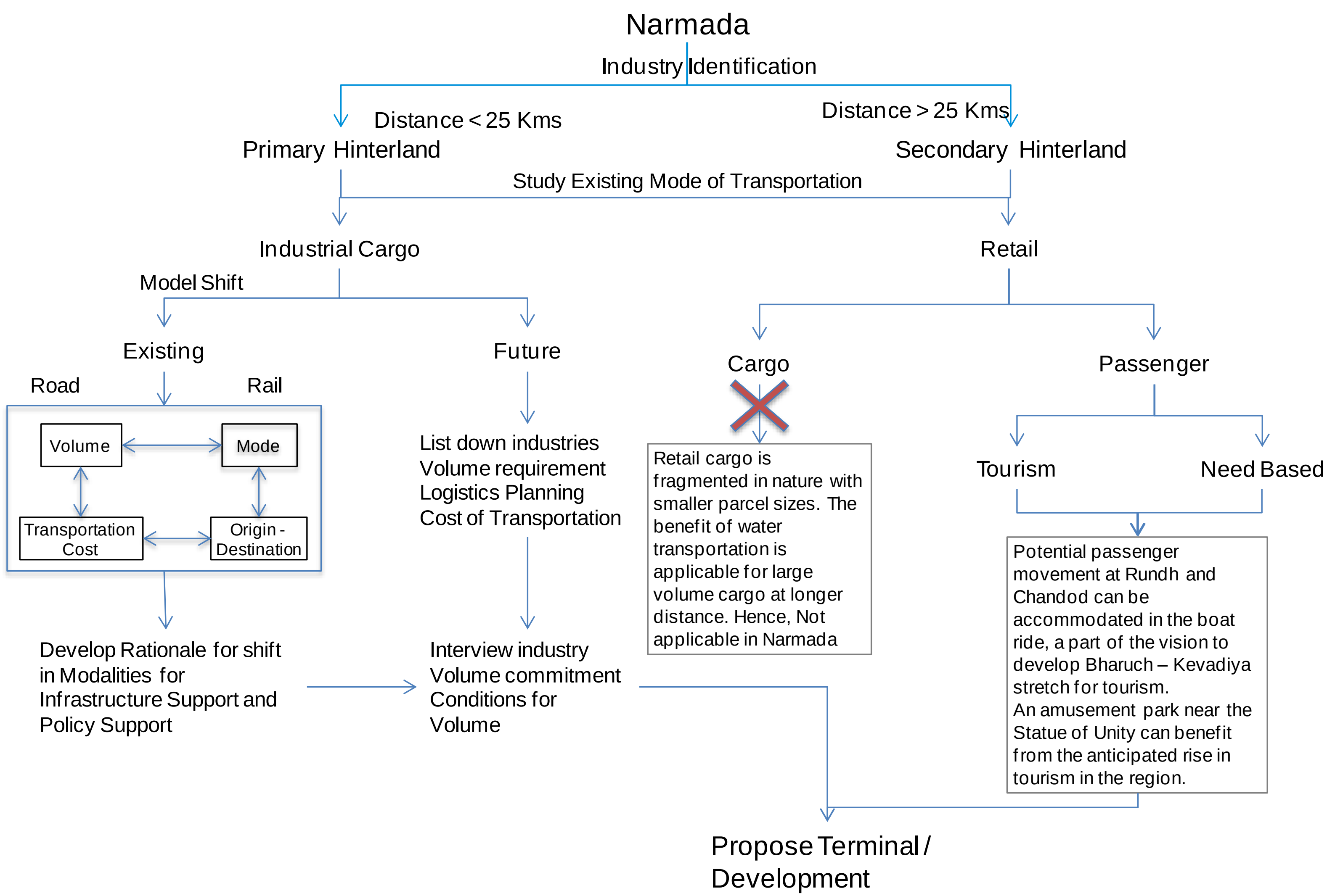
- With respect to tourist and passenger traffic potential, preliminary analysis suggested huge potential in the former. There are low prospects for passenger movement, considering the existing scenario.

- To overcome lack of bridges at Rundh and Chandod, a rudimentary ferry service is operated between these two points for regular passenger traffic across the river.

- Recently, the central government expressed interest in developing the stretch between Bharuch and Garudeshwar (near Sardar Sarovar Dam) for boat services. The intention is to leverage the rise in tourist traffic at the Dam, and serve the tourists visiting religious spots that flank the entire stretch of River Narmada. The envisioned boat service between Bharuch and Garudeshwar can accommodate even the passenger traffic at Rundh and Chandod.

- An additional facility like an amusement park near Terminal 3 can take immense advantage of the surrounding developments, while adding to the overall tourism appeal of this region.

Figure 4-13 Rationale for the traffic study and the projections



- Cargo potential for River Narmada was distinguished between requirements for industries spread in the region (industrial cargo) and retail businesses (retail cargo).

- Retail cargo is distributed in smaller parcel sizes, and to end merchants that are widely dispersed across the districts. Contrastingly, waterway transportation is suitable for large volume cargo, and typically for long-distance shipment.

- Opportunities for industrial cargo can be for export cargo from Ankleshwar ICD that currently using road or rail. Second source of opportunities could come from companies that can benefit from switching to waterway. Both these possibilities were evaluated.

- On the premise that overall logistics would favour the waterway, traffic estimations were calculated for the cargo volume that currently uses other modes.

- Similar assessment was undertaken for future potential based on companies that could benefit from shift. Driven by the rationale of net savings in logistics, the likelihood of using River Narmada for their exim operations was determined.

- The cumulative rationale that drive the traffic potentials, as discussed above, is used to propose terminals along River Narmada.

River Narmada holds potential for both cargo and tourist movement. The proposed terminal for starting a boat service between Bharuch and Garudeshwar will facilitate tourism development in the region. Furthermore, the Statue of Unity near the same Dam will also contribute in increasing tourist traffic. This rise can be tapped into by an amusement park. For reference, this facility can be developed on the scale of the S-Cube Water Park & Gujarat Fun World near Ajwal Lake, 23 km from Vadodara. There are two bridges in Bharuch, viz. Narmada Bridge and Sardar Bridge, connecting the two ends of the River. However, the next immediate bridge, Shreerang Setu, is at a distance of about 80 km upstream. The boat service between Bharuch and Garudeshwar will provide a link across the river, especially for population between the Sardar Bridge and Shreerang Setu. Therefore, two terminals/tourist facilities should be developed, of which one will be in Bharuch and the other near the Sardar Sarovar Dam.

Besides OPaL, none of the major industries near Dahej Port have a high likelihood of using the proposed waterway for exim activities. These industries have well-developed jetty infrastructure for handling their cargo using waterways. Therefore, only one cargo handling facility should be developed, preferably near OPaL's plant in Dahej. The company will be extremely inclined to use this alternative, especially considering the compromising logistics they resort to at the moment. This prospect will utilize the stretch between the mouth of the River and the tentative terminal location marked for OPaL's Terminal 1.

Another terminal may be required for handling cargo generated by medium and small-scale industries from Ankleshwar and Bharuch GIDCs. Since most of them use Ankleshwar, it's essential to set up the terminal on the waterfront near the said ICD. However, potential for this terminal will depend on the overall logistics cost saving, making the switch to the waterway a viable alternative to these industries. For waterway utilization from this terminal, the stretch between OPaL terminal and the terminal near Ankleshwar ICD will have to be developed. In view of the speculative and conditional nature of the associated opportunities, this development will be part of Phase 3.

4.10.1 Potential tourist traffic

The districts of Bharuch, Ankleshwar, and Surat, including Tapi, will contribute to tourist traffic for the proposed boat service. Both Bharuch and Ankleshwar will have larger representation in the overall traffic, and inflow from Surat will be the lowest. The tourist traffic of almost 45,000 at Sardar Sarovar Dam may be likely because of visitors from Maharashtra and even Madhya Pradesh, besides Gujarat. Also, these are rare occurrences, to happen once or couple of times in a year. Therefore, existing tourist traffic at the Dam is assumed to be inconsequential in projecting traffic for the proposed boat service.

Contribution towards tourism traffic at Sardar Sarovar Dam from the boat ride between Bharuch and Kevadia is highly speculative, considering the long stretch these tourists are expected to travel via waterway. In comparison to the current preference for road movement, the waterway journey will be far more time consuming. Also, this development will be taken up between 2025 and 2027, and the overall projections for Narmada River are up to FY45. Hence, FY27-FY45 tourism traffic at Sardar Sarovar Dam and the amusement park beside it will also include tourism traffic from this boat ride.

Tourist traffic in Bharuch has grown at a 5-year CAGR of 8% between FY09 and FY14. Similarly, tourism in Ankleshwar has grown by 10%, while Surat has witnessed an abnormally high 22% growth rate. Before arriving at the tourist traffic for the boat service, tourist traffic for each of these districts has been estimated. For Bharuch, the existing growth rate of 8% has been applied for projections up till FY45. Instead of the existing 10% growth rate for Ankleshwar, 8% y-o-y rate has been assumed to forecast tourist traffic for this district. The entire state's tourist traffic has been growing at 8%, and this trend is realistic enough to be applied to project future tourist traffic for most of the districts in general. Projection for Surat is an exception in this case, however. The 5-year CAGR of 22% is too high to assess the district's tourism potential by FY45. The spike in the district's tourist traffic was witnessed in FY11 and then in FY13, when the traffic grew by 74% and 21% over the preceding year, respectively. In order to propose a balanced view of projections for realistic estimations, 4% y-o-y growth rate for Surat has been assumed.

Tourist traffic projections for the boat service will be constituted by some share from the total traffic at all of the mentioned districts. It's assumed that the service will commence from FY27 onwards, operating 300 days a year. There'd be 4 ferries on weekdays and 6 on weekends to transport passengers and tourists to Sardar Sarovar Dam. Each ferry will have a maximum capacity of 400 passengers. Hence, capacity-wise, total passengers that can be moved using this boat ride will not exceed 500,000 in a year. For the first year, the boat ride will attract 5% of the total tourist traffic from both Bharuch and Ankleshwar districts. From Surat, however, this share will be a meagre 1%. The lower share is to negate the possibility of exaggerated projection figures. Also, River Tapi, another declared waterway, is likely to grab larger share from Surat's total tourist traffic potential. By FY45, it's assumed that boat service will attract 30% each from Bharuch and Ankleshwar districts, while only 10% from Surat. With these final share assumptions, total y-o-y traffic will grow at a CAGR of almost 9.5%. Hence, state-level growth rate of 8% was considered here, too.

Visitor traffic at amusement park will comprise a large share of visitors arriving by boat from Bharuch. The remaining share will be from the district of Vadodara. The park is assumed to commence operations in FY27, along with the boat ride. In its first year, the Park will attract 50% of the total visitors that arrive using the boat ride, and 1% of the total tourist traffic of Vadodara. Vadodara's tourism traffic has grown at a 5-year CAGR of 17% between FY09 and FY14. This growth trend is too high to apply for y-o-y projections. Hence, state-level growth rate of 8% was considered here, too. Next, amusement park is likely to attract only a fraction of this tourist projection. This is due to multiple reasons. First, the park is at a distance of 85 km from Vadodara, with road being the only connecting mode. There are multiple water amusement parks in and around Vadodara, which are likely to grab a major share of the total tourist traffic from the district. Beyond amusement parks, the district has plenty of other tourist attractions, where certain share of its total tourist traffic will get diverted to. Due to these mitigating conditions, only a fraction of the district's total tourist traffic is likely to contribute to the traffic at the amusement park. By FY45, this share is assumed to grow to 5% of the total tourist traffic in Vadodara. Being a medium-scale amusement park, it can accommodate only 0.7 million visitors at the most. This figure serves as the limiting criterion, beyond which the amusement park will not witness any inflow traffic.

4.10.2 Potential cargo traffic

Naptha for OPaL is one of the certain cargoes that can be imported using River Narmada. The waterway movement will enable the company to import the raw material without being prone to unfair competition. Based on company's inputs, their import volume is likely to increase to 1 Million T by FY33 from the current of 0.5 Million T. For projection purposes, it's been assumed that the terminal on River Narmada will start handling naphtha from FY21, and reach 1 Million T by FY25, at the most. This growth will be at a 4-year CAGR of 18.9%. In the absence of definite future expansion plans, it's been assumed that the company will cap its total import at 1 Million T. Hence, import figures for naphtha has not been increase beyond 1 Million T for the projection years that follow.

The chemical & petrochemical industries have grown by 12% in the past decade, the steel industry at 11% in last 5 years, and the fertilizer industry at 2%. Hence, an average y-o-y growth rate of 10% was applied to calculate traffic forecast from Ankleshwar ICD. Between January 2016 and October 2016, Ankleshwar ICD handled a traffic of 7,722 TEU, of which 6,485 was for import and 1,237 for export. On the back of these facts and assumptions, the fourth terminal on River Narmada is estimated to begin operations in FY 33, and handle 25% of the total Ankleshwar ICD exim volume. Gradually, the terminal is expected to attract more of this exim share from the current railway mode. By FY45, this share is estimated to grow to an optimistic 50% of the total exim volume. Between FY33 and FY45, traffic growth is projected to grow at a 12-year CAGR of 15%. For conversion between TEU and MT, an average of 15 MT per TEU was assumed.

4.11 Terminal wise IWT Traffic Analysis

Figure 4-14 shows the proposed location of cargo and tourist terminals on River Narmada. Majority of cargo handling opportunities will result from OPaL's exim requirements, and tourism potential from the purported Bharuch-Garudeshwar boat service.

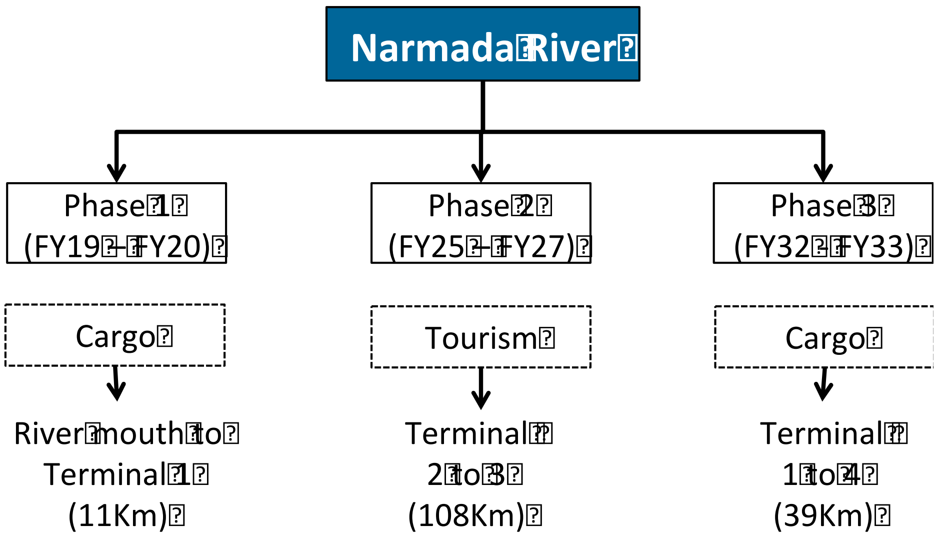
Based on the traffic study, the consultant has proposed four terminals on the bank of River Narmada in 3 different phases. In Phase 1, Terminal 1 could be developed at Ambetha in Dahej. This terminal would be used for handling cargo. In Phase 2, terminals 2 & 3 could be developed at Bharuch and downstream of Garudeshwar weir for tourism purpose. In Phase 3, Terminal 4 could be developed at Borbhatha, Bharuch for handling cargo. The location, longitude/latitude and chainage stretch of both the terminals are mentioned in the table below:

Table 4-17 Description of Proposed Terminal at River Narmada

Phases	Proposed Terminal	Location	Latitude/Longitude	Type of Movement	Chainage (Km)
1	Terminal 1	Ambetha, Dahej	21°40'55.65"N / 72°36'46.81"E	Cargo	11
2	Terminal 2	Bharuch(Ch.60)	21°42'49.96"N / 73° 2'58.72"E	Tourism	60
	Terminal 3	Garudeshwar	21°53'6.87"N / 73°39'30.62"E	Tourism	168
3	Terminal 4	Bharuch(Ch.50)	21°41'12.32"N / 73° 0'10.22"E	Cargo	50

Terminal 1 could be developed at Ambetha in Dahej, this would be used for handling cargo for Opal. Terminal 2 & 3 would cater tourism prospects arising from Sardar Sarovar Dam, the Statue of Unity. Terminal 4 would be used for handling cargo from Ankleshwar/ Bharuch.

Figure 4-14 Phase wise Development of Terminal



All 4 terminals would be developed in 3 different phases. Further developments are always based on the performance of the planned previous phases

Figure 4-15 Proposed Terminal locations at the bank of Narmada River

Phases	Proposed Terminal	Location	Latitude/Longitude	Type of Movement	Chainage (Km)
1	Terminal 1	Ambetha, Dahej	21°40'55.65"N / 72°36'46.81"E	Cargo	11
2	Terminal 2	Bharuch	21°42'49.96"N / 73° 2'58.72"E	Tourism	60
	Terminal 3	Garudeshwar	21°53'6.87"N / 73°39'30.62"E	Tourism	168
3	Terminal 4	Bharuch	21°41'12.32"N / 73° 0'10.22"E	Cargo	50

Cargo traffic at Terminal 1 (Phase 1)

Figure 4-16 shows location of Terminal 1 to be developed as the cargo-handling facility, exclusively, for OPAL.

Figure 4-16 Proposed Terminal 1

The following Table 4-18 lists the cargo and preliminary traffic estimates for OPaL's cargo Terminal at Ambetha in Dahej:

Table 4-18 Commodity-wise traffic estimate for the proposed Terminal 1

Industries	Commodities	Traffic Estimates (M T)	Reasoning
OPaL	Naphtha	0.5	Since the company is interested in changing its current logistics, this entire import and export volume can be targeted for movement on the River Narmada

Lack of capacity expansion plans at OPaL, at the moment, limits the overall exim projection for the proposed Terminal. Besides import, even export volume is tied to the plant's total capacity of 1.9 Million T. In the event the company adds to this capacity, both import and export volumes are certain to rise.

The following table depicts projections for OPaL's Terminal 1on River Narmada:

Table 4-19 Traffic projections for the proposed OPaL Terminal

Cargo	Source - Destination	FY21	FY25	FY30	FY35	FY40	FY45
Naphtha	Hazira/Dahej (import)	0.5	1	1	1	1	1
Total		**0.5**	**1**	**1**	**1**	**1**	**1**

Source: Mantrana Maritime Advisory Pvt. Ltd.

Influenced by the mitigating conditions of the plant's uncertain future expansion plans, the proposed terminal is expected to handle a maximum traffic of about 1MillionT by FY25. Beyond this financial year, the terminal is unlikely to witness any increase in the exim traffic.

Cargo traffic at Terminal 4 (Phase 3)

The following Figure 4-17 shows location of Terminal 4 that will handle exim volume to and from Ankleshwar ICD:

Figure 4-17 Location of Terminal 4 at Borbhatha Bet, Bharuch

The following table shows the traffic volume that the proposed Terminal 4 can target. A consolidated traffic estimate is preferred, as requirement for individual commodities vary y-o-y.

Table 4-20 Consolidated traffic estimate for the proposed Terminal 4

Industries	Commodities	Traffic Estimates (M T, Fy 34)	Reasoning
Ankleshwar& Bharuch GIDCs	Exim	0.2	This is the current exim estimate that can be moved via River Narmada

Source: Khambadkone Statistics

Ankleshwar ICD handles more imports than exports from the industries in the two GIDCs. Commodities like automobile parts, chemicals and petrochemicals, plastic and polymers, machinery spares and parts, textile, rubber goods, foodstuffs, etc. are imported by Ankleshwar ICD. Similarly, the ICD handles a far lower volume of export commodities from the industries spread across the two GIDCs. Maruti Metal Industries exports ferrous and non-ferrous products. Godrej Chemical Industries manufactures and exports fatty acids, glycerine, alpha olefins, etc. to Americas, Asia, Europe, Australia, and Africa. Steelco Gujarat Ltd. is a major exporter of cold-rolled sheets and coils. Targeting these individual companies will not be a viable approach to attract cargo at Terminal 4. Therefore, consolidated into containerized cargo makes it easier for the proposed Terminal 4 to target and cater to these exim demands. Also, Terminal's overall attractiveness over railway will also depend on the logistics savings the former can help realize.

The following table depicts exim projections for Terminal 4 on River Narmada:

Table 4-21 Traffic Projections for the proposed Terminal 4

In Million tonnes

Cargo	Source - Destination	FY34	FY35	FY40	FY45
Containerized Cargo	Mumbai & Maharashtra Ports - Ankleshwar ICD (Import)	0.2	0.2	0.4	0.9
	Ankleshwar ICD - Mumbai & Maharashtra Ports (Export)	0.03	0.04	0.1	0.2
	Total	0.2	0.2	0.5	1.1

Source: Mantrana Maritime Advisory Pvt. Ltd.

Based on the current trend and the applied assumption of 10% y-o-y growth, Terminal 4 is estimated to handle more than 1.1Million T by FY45. Of the total traffic, import is estimated to represent more than 82% of the total traffic volume, leaving the rest for export traffic. This suggests that bulk of the production from the industries in the GIDCs is for domestic consumers. These are likely to be distributed inland using either road or railways, which will not be feasible for Terminal 4 to target.

Tourism traffic at Terminal 2 (Bharuch) to Terminal 3 (Garudeshwar)

Figure 4-18 Location of Tourism Terminal 3 at Garudeshwar

The following table depicts potential tourist traffic the Bharuch-Garudeshwar boat service is likely to handle on River Narmada:

Table 4-22 Tourist traffic projections for Bharuch – Garudeshwar boat ride

Number in '000

Tourism potential	FY28	FY30	FY35	FY40	FY45
Bharuch - Garudeshwar Boat Ride	108	154	376	500	500

Source: Mantrana Maritime Advisory Pvt. Ltd.

By following the estimated y-o-y growth trend of 9.5%, the boat service is likely to hit its maximum handling capacity of 0.5 Million passengers by FY35. These figures do not account for the passenger movement to and from Rundh and Chandod. This passenger traffic is likely to be too low to have a marked impact on the overall tourist traffic on this stretch.

Visitors traffic at the Amusement Park

The following table depicts potential tourist traffic at the proposed Amusement Park near the tourist Terminal 3:

Table 4-23 Visitors traffic projections at the Amusement park ('000 visitors)

Tourism potential	FY28	FY30	FY35	FY40	FY45
Amusement park	94	125	262	554	700

Source: Mantrana Maritime Advisory Pvt. Ltd.

Assuming the facility's maximum capacity of 0.7 Million, visitors' traffic at the Park will increase by a 17-year CAGR of 13%. The Park is likely to operate at its full capacity by FY42. Hence, between FY42 and FY45, total footfall at the facility will not grow beyond 0.7 Million visitors.

Need for new Port/Jetty

The following table shows the traffic at the ports in River Narmada catchment area, along with the current capacity, and their expansion plans:

Table 4-24 Traffic, existing capacities, and expansion plans for ports around River Narmada

Jetties Near Dahej	Traffic (M T)	Existing Capacity (MMTPA)	Future Expansion Capacity	Total Capacity (MMTPA)
Traffic Handled by Captive Jetties				
IPCL Jetty	0.05	1	N.A	1
DHIL Jetty	2.48	5	N.A	5
Total	**2.53**	**6**	**N.A**	**6**
Traffic Handled by Private Ports				
GCPTCL (Dahej)	3.4	4.9	7	12
LNG (Dahej)	14.4	15	5	20
AdaniPetronetPvt Ltd.	6.3	20	N.A	20
Total (Private)	**24**	**39.9**	**N.A**	**52**
Total Traffic in Narmada catchment	**26.6**	**45.9**	**N.A**	**58**

Source: GMB, Company reports, Web Sources

All the private ports in the catchment area, viz. Adani Petronet, Petronet LNG, GCPTCL, and captive jetties from RIL and DHIL (Birla Copper) handled a cumulative traffic of nearly 26.6 Million T in FY16. These ports have a total handling capacity of nearly 46 MMTPA. This indicates that the current cargo handling capacity at these ports is nearly 2 times the traffic that is being handled. Moreover, all the private ports have expansion plans in the pipeline. GCPTCL plans to add 7 MMTPA to its current capacity, while Petronet LNG will increase its capacity from 15 MMTPA to 20 MMTPA. Post capacity expansions, the total cargo handling capacity will be more than double the existing capacity at these ports. At the same time, traffic handling at these ports is unlikely to match these capacities, let alone outstrip it. This surplus handling capacity ensures that there will be no requirement for an additional port in this region. Owing to existing and continuing capacity glut, and financial crisis faced by M/s Sterlite, the proposed Sterlite Port is unlikely to materialize in the near future.

CHAPTER – 5

TERMINALS

5.1 General Review

Terminal is a place where a particular type of cargo is handled. Terminals can be classified as general cargo terminal, bulk cargo terminal and passenger terminals. Inland water terminals are different from sea terminals in the sense that water levels during flood and dry season varies considerably.

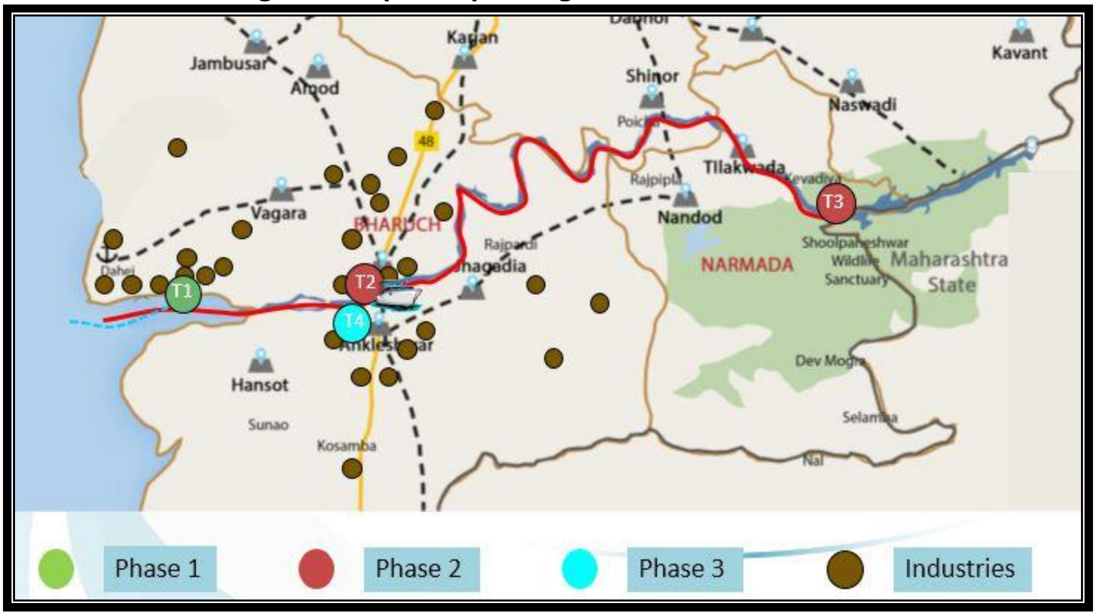
5.2 Identification and site location

Site selection is the most important factor as it dictates investments for establishing the terminal facilities. Therefore, utmost care is taken to select most reliable locations to minimize the capital and the recurring cost for the terminals.

In the stretch of Narmada, four terminals have been proposed on the basis of traffic potential. However, it is to be noted that cargo potential in this stretch is quite less. But, there is an ample scope of tourism. Proposed terminal locations are shown in **Drawing MT-01 to MT-03**. Following are the proposed terminals in the stretch of River Narmada:

Terminal 1: Exclusively for OPAL at Ch. 11 in Phase 1
Terminal 2: Passenger Jetty at Ch. 60 (Bharuch) in Phase 2
Terminal 3: d/s of Garudeshwar Weir at Ch. 168 in Phase 2
Terminal 4: Ankleswar at Ch. 50 in Phase 3

Fig 5.1: Proposed phasing and terminal locations



5.2.1 Criteria for Selection of site

I. River morphology and behaviour
II. Stable river channel with natural depths so as to avoid problems of scouring or siltation at the terminal locations. This also reduces the capital cost as well as annual recurring cost on maintence dredging and training works.
III. Hydraulic conditions to be favourable for berthing of barges and cargo handling operations during most part of the year.
IV. Adequate backup space to be available for cargo handling operations and for providing ancillary facilities.
V. Better connectivity to rail and road transport.
VI. Location should be close to traffic centres.
VII. Site so selected should be favourable for the projected traffic as well as for future development.

5.2.2 Description of selected sites

5.2.2.1 Terminal – 1 (OPaL Cargo Jetty)

Lack of capacity expansion plans at OPaL at the moment, limits the overall projection for Exim traffic that can be handled at the proposed Terminal. Besides import, even the export volume is tied to the plant's total capacity of 1.9 Million Tonne. In the event, the company adds to this capacity, both import and export volumes are certain to rise.

5.2.2.2 Terminal – 2 (Bharuch Passenger Jetty)

Jetty will be exclusively for tourists. On the basis of estimated y-o-y growth trend of 14.5%, the boat service is likely to hit its maximum handling capacity of 0.5 mn passengers by FY35. Traffic can be increased further after construction of under construction Statue of Unity at d/s of Sardar Sarovar dam which is scheduled to be completed on 31 Oct 2018.

5.2.2.3 Terminal – 3 (d/s of Garudeswar Weir)

This jetty will act as landing site for the tourist coming from Ankleshwar.

5.2.2.4 Terminal – 4 (Bharuch Cargo Jetty)

Ankleshwar ICD handles more imports than exports from the industries in the two GIDCs. Commodities like automobile parts, chemicals and petrochemicals, plastic and polymers, machinery spares and parts, textile, rubber goods, foodstuffs, etc. are imported by Ankleshwar ICD. Similarly, the ICD handles a far lower volume of export commodities from the industries spread across the two GIDCs. Maruti Metal Industries exports ferrous and non-ferrous products. Godrej Chemical Industries manufactures and exports fatty acids, glycerine, alpha olefins, etc. to Americas, Asia, Europe, Australia and Africa. Steelco Gujarat Ltd. is a major exporter of cold-rolled sheets and coils. Targeting these individual companies will not be a viable approach to attract Exim cargo at Terminal 2. Therefore, consolidated into containerized cargo makes it easier for the proposed Terminal 2 to target and cater to these exim demands. Total traffic of 0.14 MT will be handle at proposed.

5.2.2.5 Phasing of Development

Total 4 nos. of terminal have been identified. However, terminals will be developed phase wise.

Sr. No	Phase	Terminal
1	Phase-1	Terminal 1 at OPAL (Ch. 11)
2	Phase-2	Terminal 2 at Bharuch (Ch. 60)
3	Phase-2	Terminal 3 at at d/s of Garudeswar Weir (Ch. 168)
4	Phase-3	Terminal 4 at at Bharuch (Ch. 50)

5.3 Terminal Layout / Master Planning including phases of development

5.3.1 General Considerations

The main requirement of a terminal is that it should offer adequate shelter and protection against adverse impact action. Vessels must be able to load / unload during severe weather conditions. No terminal can be designed to exclude all weather conditions. Navigability of vessel needs a fair access, with sufficient wide entrance followed by adequate space to slow down and turn. As vessels can be affected by wind and currents, their requirements impose pronounced criteria for the design.

5.3.2 Water Depth

It goes without saying that the water depth on the channel and around the terminal should be enough for safe vessel movements. Possible shoaling of entrance and terminal basin should be checked. Removal of shoaling is often a recurrent and costly affair. Also, salinity of the water and sediment properties can have a very great influence upon the residual sediment transport, a thorough investigation of the above phenomena is required.

5.3.3 Water Level

Most terminal experience water level variations due to tide, seismic activities and wind action. Movement restricted to high water level may be a nuisance, but the only possibility for an economic design. Terminals with a soft and muddy beds situated in areas with large tidal ranges allow vessels to go around low water with lesser risks.

5.3.4 Water Side Requirements:

a) Easy accessibility of ships to terminal area with safe entrance channel

b) Protection against currents while they are anchored or moored alongside a berth for safe and efficient cargo discharge or loading

c) Sufficient draft below the lowest tidal level to cater to the maximum vessels frequenting the terminal

d) Minimum capital (or initial) dredging and maintenance dredging

e) Low tidal range

f) Port geometry should ensure that it is free from range of schedule phenomena

g) Ship within the harbour should have adequate area for maneuvering to berthing place and also have a turning basin of desired diameter

5.3.5 Requirement at interface between water and land

a) Zoning of harbour area and movements for small craft vessels requiring low drafts as distinct from the areas of deep drafts for larger vessels

b) Zoning in terms of segregation of different types of cargo or allocation berths for different cargos

c) Optimum number of berths to reduce waiting time

d) Quay or wharf dimensions like length and width to accommodate different sizes of ships and space for loading and unloading operations, space for crane tracks, rail tracks, roads for truck movement etc.

e) Soil profile should be such that it is strong enough to take the loads and at the same time does not pose dredging problems

5.3.6 Landside requirements

a) Modern cargo handling equipments for quickest evacuation / loading of cargo.

b) Storage facilities

c) Area for open storage

d) Road and rail connections from quay to storage area

e) Space for railway yards

5.3.7 Planning of water front and navigation facilities

5.3.7.1 The planning of water front and navigation facilities is discussed in this section. This planning is based on the all national standards, codes of practice and PIANC regulations applicable for the planning of berthing and operational areas of the ships.

5.3.7.2 Design Vessel Size

The planning of water front and navigation facilities should be carried out to accommodate all vessels, for which, the first requirement is to determine the dimensions of the Design Vessel Size. In present case, we have planned channel for class IV, while in case of jetty class-VII has been considered as design vessel based on futurist approach. Following are details of various classes:

Table 5.1 Vessel Size details

Class	Self-propelled vessel	Tug with barges
I.	Self-propelled, carrying capacity 100 DWT, Size (32m X 5m), Loaded draft 1m	1 Tug + 2 barges – 200 DWT, length 80m X breadth 5m , loaded draft 1m
II.	Self-propelled, carrying capacity 300 DWT, Size (45m X 8m), Loaded draft 1.2m	1 Tug + 2 barges – 600 DWT, length 110m X breadth 8m , loaded draft 1.2m
III.	**Self-propelled, carrying capacity 500 DWT, Size (58m X 9m), Loaded draft 1.5m**	**1 Tug + 2 barges – 1000 DWT, length 141m X breadth 9m , loaded draft 1.5m**
IV.	**Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m**	**1 Tug + 2 barges – 2000 DWT, length 170m X breadth 12m , loaded draft 1.8m**
V.	Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m	1 Tug + 2 barges – 2000 DWT, length 170m X breadth 24m , loaded draft 1.8m (moulded with 24 m)
VI.	Self-propelled, carrying capacity 2000 DWT, Size (86m X 14m), Loaded draft 2.5m	1 Tug + 2 barges – 4000 DWT, length 210m X breadth 14m , loaded draft 2.5m
VII.	Self-propelled, carrying capacity 4000 DWT, Size (86m X 14m), Loaded draft 2.9m	1 Tug + 4 barges – 8000 DWT, length 210m X breadth 28m , loaded draft 2.5m

5.3.8 Berth Planning

5.3.8.1 Length of Berth

As per BIS: 4651 (Part V) – 1980, for preliminary assessment, the length of the berth is recommended to be 10% more than the overall length of the largest vessel expected, subject to a minimum of 15 m. This may however be increased upto 20% in basin exposed to strong winds and tidal conditions. Consolidating the results of functional planning exercise the information such as the average ship size chosen for ship handling capacity provided, Length of the berth provided at following terminal are as follows:

Sr. No.	Terminal name	Length of berth(m)
1	Terminal 1: Exclusively for OPAL	100
2	Terminal 2: Bharuch for passengers	70
3	Terminal 3: d/s of Garudeshwar Weir	70
4	Terminal 4: Bharuch for cargo	100

Proposed lengths of jetty are more than specification laid in BIS: 4651 (Part V) – 1980, Hence, berths can easily accommodate class-IV vessels.

Width of Berth:

Width of the berth is based on the functional requirement of cranes and adequate manoeuvring space for other equipments. For cargo berth 15.0 m and for floating jetty 10.0 m has been provided.

Required Depth:

Class of Channel	Depth (m)	Bottom width (m)	Bend radius (m)	Vertical clearance (m)	Horizontal clearance (m)
Class- III	1.7	50	700	6	50
Class- IV	2.0	50	800	8	50
Class- V	2.0	80	800	8	80

5.3.8.2 Land Related

For terminal planning land related considerations are as follows:

- **Availability of water front land**
- **Soil conditions and elevation**
- **Utilities connections**

- **Environmental and social Impacts**

Availability of water front land

Generally, lands adjacent to river banks are under cultivation due to availability of sweet water for crops. Acquisition of land for the inland terminal has to be done, if Government land is not available. In order to locate the terminal, a conceptual plan of terminal requiring minimum linear water frontage area along with storage area and area required for future expansion is to be planned.

Soil conditions and elevation

For designing and planning of inland terminals soil strata and its elevation from water levels are very essential. Geotechnical investigations are required to be carried out at terminal location as it can substantially affect construction costs.Land areas for loading / unloading and stacking of materials in the terminal are subjected to high dynamic and static loads due to movement ofheavy lifting equipment along with stacking of heavy cargoes. In case of weak soil strata at the site then it will have to be properly strengthened by proper treatment.

Land elevation is a very important consideration as low lying land is exposed to periodical flooding and may need adequate protection. Another important factor is distance between navigation channel and high flood line as this will decide size offshore structure and cargo handling machinery.

Utilities connections

Utilities such as fresh water connection, sewerage facilities, effluent treatment plant, electricity and telephone connections etc. shall be provided at terminal for efficiently coordinating all activities.

Environmental and Social Impacts

The environmental impacts arising during the dredging and construction activities will be mitigated using required mitigation measures. Both direct and indirect employment potential is anticipated during construction and operations of inland terminal.

5.3.8.3 Transportation

In case of Opal Jetty, there is no need of construction of roads & approaches as it is already available at the site.

In case of terminal 2 & 3, roads are fully developed

In case of terminal 4, approach roads of 1km needs to be developed at the site.

5.3.8.4 Traffic related

To undertake planning of terminal it is necessary to know the volume and type of cargo that is required to be handled. The expected cargo data from various industrial areas have been collected. The traffic data have been compiled in Chapter 4.

5.3.8.5 Cargo Related

In the present case the main cargo is such as

- Containerized cargo
- Naptha
- Polymers & Chemicals

5.4 Land Details

Approximately 2 hectare of land will be required for development of terminal. The land records were collected for the proposed terminal locations.

Table. 5.2 Land Details

Terminal	Location	Land details
Terminal 1	Dahej	Govt. land
Terminal 2	Bharuch ch. 60	Govt. land
Terminal 3	d/s of Garudeshwar	Govt. land
Terminal 4	Bharuch ch. 50	Govt. land

Locations of proposed terminal are shown in **Fig. no. MT-01 to MT-03**

5.5 Geotechnical Investigations

Geotechnical investigations is enclosed in Volume 4 of this report

5.6 Terminal Infrastructure including equipment

Terminal facilities can be grouped into 3 main categories.

- Mooring
- Storage Yard
- Gate and land Transport Access

5.6.1 Mooring Structures

11-nos 20 T @ 10 c/c bollards for mooring will be required in case of cargo jetty & 8-nos 5 T @ 10 c/c bollards for mooring will be required in case of passenger jetty

5.6.2 Storage Yard

The main function of terminal yard includes.

a) Storage of cargo before and after loading or unloading.
b) Parking of trucks.
c) Provision of general services such as equipment maintenance, administrative offices, amenities for labour etc.

5.6.3 Gate and transport access

The main function of the gate and related facilities can be divided into.

a) Cargo and equipment exchange
b) Traffic control
c) Parking
d) General Security.

The gate activities are security check, cargo check, equipment check etc. The gate and the terminal entrance should include a two lane road (in/out) with traffic bumps to slow down the terminal traffic. There must be parking lot for trucks and passenger cars.

5.6.4 Water Supply Requirement

It is assumed that 125 liter per capita per day (LPCD) will be required. A total of 400 nos. of personnel consisting of barge operators, crane operators, truck operators and maintenance operators are assumed to be working on the terminal every day. Hence the total water requirement works to be 50,000 liters per day. Ground storage reservoir (GSR) and over head tank of suitable size needs to be provided for taking care of this requirement.

5.6.5 Power requirement

There will be two cranes on the terminal at terminal 1 & terminal 2, each crane will require power of 125 kW, and hence two cranes will require 250 kW of power. The general lighting on jetties, offices and stacking yard will require 60 kW of power. The sewage treatment plant, water treatment plant and water supply will require65 kW of power. Thus a total of approx. 300 kW of power will be required at this terminal. Singapore and Dumas terminal are passenger terminals. Approx 100 kW of power will be required at these terminals.

5.6.7 Cargo Handling Equipments

Cargo handling equipments are characterized by

- Capacity – Size and type of cargo.

- Distance or reach – the distance
- Speed – the travelling, swinging and hoisting speeds of the various moving components and the resulting overall rate or productivity.

Cargo can be moved in following three principle ways –

- Trucking – rolling of cargoes on wheels
- Lifting – picking up and moving
- Conveying – carrying cargoes continuously

Each cargo handling machine includes combination of the above mentioned principle methods. The configuration of portal cranes is based on pedestal support structure and elevated turn table. In some designs, the support structures comes with four sets of steel wheels which move on rail tracks mounted on the quay. The driver cab in most of the cranes is elevated to enable an unobstructed view of the entire vessel. The pedestal configuration allows the crane to stand closer to the vessel and use shorter boom and smaller swinging radius.

Various types of handling process and equipment are shown below:

5.6.8 General Cargo Handling Process

General cargo will involve different sizes and weights, so it is difficult to handle the cargoes efficiently and quickly they must be unitized and palletized. The dispersive units of cargo will be unitized in larger units say 5-10 tons depending on the capacity of the crane. For the forklift to pick it up, the cargo should be mounted on pallets or skids. When General cargo is unitized, cranes or forklifts can be used and transportation by trucks or wagons can be used.

5.6.9 Bulk Cargo Handling Process

The bulk cargo handling process at bulk terminals involves two systems, one island-to water, and another is water-to-land. The land-to-water system is for the unloading of the trucks to storage or direct shipment, and this system is in the use at most inland terminals. The water-to-land system is unloading the vessel to storage and then loading the trucks or railcars.

5.6.10 Cargo Handling Equipment

Cargo handling equipment is the most basic handling equipment at the inland waterway terminals. The equipment will load or unload barges / vessels directly from the truck, or another vessel. The cargo is first transferred between the vessel and dock, held or stored for short period and taken by trucks to the final destination. For cargo handling rubber tyre gantry crane, level luffing crane, fixed crane and forklift etc. are used. Details of cargo handling equipment are given below:

5.6.10.1 Rubber Tyre Gantry Crane

A rubber tyre gantry crane (Fig. No. 5.2) is a multipurpose machine and is widely used in inland ports. The crane is not limited to vessel handling but can be used for handling trucks as well. The carriage system is on rubber tyres. The tyre cranes are equipped with outriggers. The capacity of these cranes is 5 to 25 tons in most cases. The crane can move to any place easily and fast which is a merit but operation is slow and lift capacity is lower than level luffing crane. However, during hoisting the tyres cannot bear the load of the crane and has to be jacked for sustaining the load hence these are inferior to RMG for speedy loading and unloading.

Fig No. 5.2 Rubber Tyre Gantry Crane

5.6.10.2 Level Luffing Crane

These level luffing cranes (Fig No. 5.3) are used on small inland ports whose throughput is small. It has got four sets of wheels at each corner of structures which enables the crane to move on tracks along the dock. The pedestal configuration allows the cranes to stand closer to the vessel and use smaller boom. Improved boom design called level luffing is based on an articulated boom, which allows through counter movement of the two boom segments for leveled traverse traveling which is more energy efficient and has better maneuverability. These cranes have higher productivity and better reach than tyre cranes. These cranes are operated by electricity thus reducing operational cost.

Fig No.5.3 Level Luffing Crane

5.6.10.3 Grab Type Level Luffing Crane

All general cargo cranes, almost all these cranes can be fitted for handling bulk cargoes. The conversion to bulk cargo handling is quite simple: replacing the hook by a clam-shell or grab attachment and installing additional power (mechanical or electrical). The grab can be attached to any crane system but most commonly it is used with crawler and portal or gantry cranes. Usually, crawler cranes fitted with grabs are very versatile machines; they can both load and unload vessels, and can also load and unload trucks and trains. However, portal and Grab Type Level Luffing Crane (Fig No. 5.4) are usually limited to vessel operation.

The productivity of a grab crane in handling bulk cargo is determined by the capacity (tonnage) of the shell, the path it has to cover and the speed of hoisting, swinging and opening / closing the grabs.

The size of the grab itself is a function of the density of the material it carries; smaller grabs are used with denser and heavier materials on common inland ports. Many ports have been equipped with portal or gantry cranes fitted with grabs to unload the vessels. At present, it is the main method to unload the bulk cargo from vessels.

Fig No. 5.4 Grab Type Level Luffing Crane

5.6.10.4 Fixed Crane

The fixed cranes (Fig No. 5.5) as name suggests can't move on the dock because it has no traveling gear and as such is cheaper and lighter than traveling crane. These cranes are cheaper and are used on small inland ports and can be located on pontoon or on the dock. In the throughput is small fixed cranes are preferable.

Fig No.5.5 Fixed Crane

5.6.10.5 Crawler Crane

The crawler cranes (**Fig No.5.6**) are very versatile and can move on tracks and can both load and unload barges. They can also load and unload trucks. They can crawl on the jetty and take a position wherever loading and unloading is required to be done. This movement of the crane prevents moving of barges/vessels thus reducing the time of loading / unloading.

Fig No.5.6 Crawler cranes

5.6.10.6 Forklift

The forklift (**Fig No.5.7**) combines trucking and lifting of cargo units. The inland ports use 3- 5 ton capacity forklift and for larger terminals it may use 10tons. All terminals forklifts are use for loading / unloading or storage in yard or warehouse. These are not used for transport the cargo over large distance. For large capacity transport trailers can be used over a large distance. Forklifts are probably the most common cargo handling and moving machine. Their versatility is achieved through various attachments which either go over the forks or simple replace them.

These are generally used for handling general cargo such as steel plates, paper bales, coils etc.

Fig No.5.7 Forklift cranes

5.6.10.7 Belt Conveyor

The belt conveyor is probably the most common piece of equipment in material handling. The main advantage of the conveyor is that it usually offers the lowest costal tentative for horizontal movement of cargo. This is an important property in inland areas. The main disadvantage of conveyor stems from the fact that it provides only a point-to point connection and requires fixed support structures, unlike dump trucks and loader, which can move anywhere.

The belt conveyor consists of a belt and idlers, or rollers, which support the belt. The idlers and the belt are usually arranged either “flat” or “troughed”, depending on the properties of the material to be conveyed. Flat belts fit materials which have a steep repose angle (e.g. damp sand) while troughed belts fit lumpy materials (e.g. coal and ore). In addition to the belt and idlers, each conveyor has a support structure, a feeder and discharge device (for loading and unloading) and a tension-maintaining arrangement.

The capacity of the conveyor is the function of the belt width, speed and of course, the specific weight of the conveyed material. The speed is mainly determined by the size of the particles. The speed is adjusted to avoid dust in powdery material and spillage in bulky material. Energy consumption, is a function of both density and speed, and is another consideration. It is important to note that the conveyer is only a means to move materials between machines. Therefore, the conveyer capacity is not only a function of its speed but also a function of the endpoint capacities where the material is fed onto/ from the belt.

5.6.10.8 Gantry Stacker and Reclaimer

The gantry stacker and reclaimer (**Fig No.5.8)** and boom stacker and reclaimer are handling and transfer machines in the inland ports, their characteristics and operations are the same, but the configuration is different. The gantry type is more efficient and economical than the boom type. The gantry stacker and reclaimer is composed of the main gantry and conveyer beam, two legs mounted at the two ends of the top beam, under which the truck can move, and two gears of the bucket wheel mounted on the conveyer beam, it is powered by electricity. The two bucket wheels can move along the conveyer beam to discharge the bulk cargo from the stockpile.

Fig No.5.8 Gantry stacker and Reclaimer

5.6.10.9 Handling Attachments

In handling the cargo, cranes or forklifts, from the hatch of the vessel or truck, special tools – Handing attachments such as,

- Crane attachments
- Forklift attachment is required.

The crane attachments are very simple. They hook on to the hook of the crane, and can pick up the cargo. They are of different sizes and types for different cargoes.

The most popular of them include a side shifter for better positioning; clamps handle baled cargo, paper reels or large carton, grip and backrest devices to handle drums; hanging beam for handling cargoes with hooks; centrally mounted ram for handling reels.

- Bucket Type Grab

- Pal finger type grab
- Tong
- Spreader

Fig No.5.9 Bucket Type Grab

Fig No.5.10 Pal finger type grab

Fig No.5.11 Tong

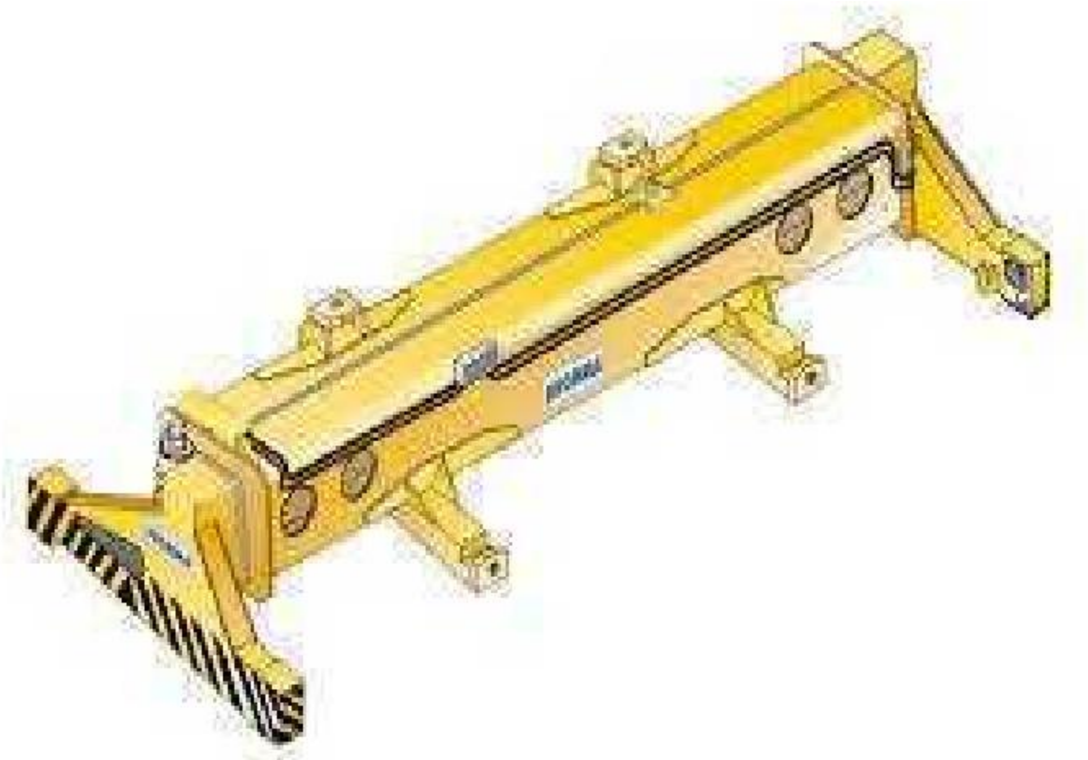


Fig No.5.12 Spreader

5.6.10.10 Equipment at Terminals

Terminal	Location	Equipment
Terminal 1	OPAL	-
Terminal 2	Bharuch	-
Terminal 3	d/s of garudeshwar	-
Terminal 4	Ankleshwar	1-100 TPH MHC

5.7 Berthing Structure

Berthing structures are to be designed such that they provide safe berthing of barges/ vessels without damaging the barges/ vessels as well as the structure. These structures should also cater to the requirements of the various equipments to be used for loading/ unloading of vessels. The requirements of the berth differ depending on the nature of cargo being handled at the berth. The size of the structure depends on the largest vessel likely to use the berth and the type of handling equipment to be used on the deck. The berth should be designed for all possible loads that are likely to act on the structure. The total number of berths required for the proposed terminal and their arrangement was fixed based on the nature of cargo, traffic, alignment of contours and predominant wind, water levels. The berth is planned for handling 4000 DWT Vessels.

Fixed Pile Jetty in Phase 1 & Phase 3

The proposed jetty is required to handle Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m (Class-IV). The jetty is planned as a berthing structure proposed to be on piles, which provide least resistance to natural equilibrium and ease of extension/addition of facilities at a later date. The berthing structure is of length 100 m and width 15m.

Plan, elevation & cross-section of MSL. The thickness of the deck slab of jetty is 0.45 m. The slab at deck level is supported on Cross beams of 0.6m x 0.6 m in the lateral direction, secondary beams of 0.6 m x 0.6m in the longitudinal direction. The Cross beams rest on the pile caps/ pile muffs which in turn support the longitudinal beams. The 600 mm diameter bored cast in situ piles with 6mm thick liner are fixed to the pile caps at the top and fixed into the ground at the bottom. The plan and cross section of jetty is shown as Fig AD-1.

Floating Jetty in Phase 2

Floating Jetty will be in terms of unit. 1 unit will be of 12m, total approximately 6 units will be required. Also, 3 unit along the width will be required to maintain 10m width. Hence, total 18 units will be required to form 70m x5m jetty.

5.8 Terminal Costing

5.8.1 Capital Cost

Phase 1 – NIL
Phase 2- Rs. 28.16 Cr
Phase 3- Rs. 34.90 Cr

5.8.2 O&M Cost

Phase 1 – NIL
Phase 2- Rs. 0.28 Cr
Phase 3- Rs. 0.35 Cr

Chapter – 6

PRELIMINARY ENGINEERING DESIGNS

6.1 River Training

In order to make river navigable certain interventions along and across the river is required. The effect of the structure on the hydraulics of the river and the best ways to train the river such that the structure performs satisfactorily and also there is no significant damage to the riverine environment should be kept in mind while proposing any structure.

Detailed Methodology:

Step 1: Detailed study of river bathymetry especially dry patches/ Dry Stretches in the river.

Step 2: Detailed study of all hindrances (Dams/Barrage/weir/Bridges) & Interventions needed along the river.

Step 3: Preliminary Designs of Proposed Structure

Step 1:

This is already covered in chapter 2; however, brief summary of dry patches/ Dry stretch along River Narmada is mentioned in Table shown below:

Table 6.1: Summary of dry patches/Dry stretch

Sr.No.	Stretch Details	Length
D-1	Ch-2.0 to Ch 16	14 Km
D-2	Ch-20.0 to Ch25	5 Km
D-3	Ch-58.0 to Ch74	16 Km
D-4	Ch-102.0 to Ch113	11 Km
D-5	Ch-126.0 to Ch 150	24 Km
D-6	Ch-166.0 to Ch 170	4 Km

Details are shown in **Dwg. DP-01 to DP-03**

Step 2:

This is also covered in chapter 2 of this report; however, brief summary of hindrances details are shown below:

1) Details of Dams/ *Barrages, Weirs, Anicut*
2) *Details of Bridges*

Table 6.2 – Details of Dam/Weir

No	Structure Name	Ch. (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	Crest Level w.r.t MSL(m)	Present condition
1	Sardar Sarovar Dam	182.5	Kevadia	**Right Bank:**21°50'5.39 "N73°45'2.93"E **Left Bank:**21°49'29.47"N 73°44'53.21"E	**Right Bank:** 370901.73 E 2415068.69N **Left Bank:**370613.68E 2413966.38N	1210	40.0	121.92	No intervention required
2	Garudeshwar Weir	170.0	Garudeshwar	**Right Bank:**21°53'10.53"N 73°39'32.35"E **Left Bank:**21°52'56.20"N 73°39'32.58"E	**Right Bank:**361460.37E 2420842.94N **Left Bank:**361463.31 E2420401.28 N	NA	NA	NA	No intervention required

Table 6.3 – Details of Bridges

Sr. No.	Phase	Bridges to be demolished
1	Phase-1	No bridge
2	Phase-2	No bridge
3	Phase-3	No bridge

Details are shown in **Dwg. EC-1 to EC-3**

Navigation Lock

As such navigation lock is not required. Also, Proposed barrage near Bhadbut Village has provision of navigation lock.

6.2 Bank Protection

No bank protection is required in such a wide river.

6.3 Navigation Aids

6.3.1 General Principles of the System

Within the IALA Buovage System there are 5 types of marks which may be used in combination. The mariner can easily distinguish between these marks by readily identifiable characteristics.

Lateral marks differ between Buoyage Regions A and B as described below, whereas the other 4 types of mark are common to both regions.

6.3.2 Lateral Marks

Following the sense of a conventional direction of buoyage, Lateral marks in Region A utilize red and green colours by day and night to denote the port and starboard sides of channels respectively. However Region B these colours are reversed with red to starboard and green to port.

A modified lateral mark may be used at the point where as channel divided to distinguish the preferred channel, that is to say the primary route or channel which is so designated by an authority.

6.3.3 Cardinal Marks

Cardinal marks indicate that the deepest water in the area lies to the named side of the marks. This convention is necessary even though for example, a North mark may have navigable water not only to the North but also East and West of it. The mariner will know he is safe to the North, but must consult his chart for further guidance.

Cardinal marks do not have a distinctive shape but are normally pillar or spar. They are always painted in yellow and black horizontal bands and their distinctive double cone top-marks are always black.

Cardinal marks also have a special system of flashing white lights. The rhythms are basically all “very quick” (VQ) or “quick” (Q) flashing but broken into varying lengths of the flashing phase. “Very quick flashing” is defined as a light flashing at a rate of either 120 or 100 flashes per minutes, “quick flashing” is a light flashing at either 60 or 50 flashes per minutes.
The characters used for Cardinal marks will be seen to be as follows.

North: Continuous very quick flashing or quick flashing
East: Three “very quick” or “quick” flashes followed by darkness

South; Six "very quick" or "quick" flashes followed immediately by a long flash, then darkness
West: Nine "very quick" or "quick" flashes followed by darkness.

The concept of three, six, nine is easily remembered when one associates it with a clock face. The long flash, defined as a light appearance of not less than 2 seconds, is merely a device to ensure that three or nine "very quick" or "quick" flashes cannot be mistaken for six,

It will be observed that two other marks use white lights. Each has a distinctive light rhythm which cannot be confused with the very quick or quick flashing light of the Cardinal marks.

Isolated Danger Mark

The Isolated Danger mark is placed on a danger of small area which has navigable water all around it. Distinctive double black spherical top marks and Group flashing (2) white lights, serve to associate Isolated Danger marks with Cardinal marks.

Safe Water Marks

The Safe Water mark has navigable water all around it but does rot mark a danger. Safe Water marks can be used, for example, as mid-channel or landfall marks.

Safe water marks have an appearance quite different from danger marking buoys. They are spherical, or alternatively pillar or spar with a single red spherical top marks. They are the only type of mark to have vertical stripes (red and white). Their lights, if any, are white using its phase, occulting, one long flash or morse “A” rhythms.

Special Marks

Special marks are not primarily intended to assist navigation but are used to indicate a special are or feature whose nature may be apparent from reference to a chart or other nautical document.

Special marks are yellow. They may carry a yellow “X” top mark, and any light used is also yellow. To avoid the possibility of confusion between yellow and white in poor visibility, the yellow lights of special marks do not have any of the rhythms used for while lights.

Their shape will not conflict with that of navigational marks, this means, for example, that a special buoy located on the port hand side of a channel may be cylindrical, but will not be conical. Special marks may also be lettered or numbered to indicate their purpose.

New Dangers

It should be specially noted that a “new danger” which is one not yet shown in nautical documents, may be indicated be exactly duplicating the normal mark until the information is sufficiently promulgated. A “new danger” mark may carry a Racon coded Morse “D”.

Body	:	ABS Plastic sealed to IP68 Standard.
Lens	:	185 diamoulded UV stabilized Poly- carbonate lens
Color	:	Red, Green, Yellow, White
Range	:	2 to 3 NM at 0.74 ATF (Specify while ordering)
Light Control	:	Automatic on/off by Photo diode
Light Source	:	High Intensity light emitting diodes LEDS with 100, 000 hours of life
Divergence	:	360^0Horiz. X 15^0 Vertical (at 50%) of Peak Intensity
Character	:	Any one character from 256 IALA recommended character can achieved
Input Voltage	:	Nominal 12 VDC
Battery	:	Maintenance free lead-acid fitted with inside Base
Autonomy	:	200 to 300 Hours period
Solar Panel:	Fitted on the Lantern Dome	
Fixing	:	Four – 10 mm dia Hole on 200 PCD

Weight : 3 Kg approx.

Marine Lantern @ 2km C/C is provided along the river Narmada in has been provided. Designed aid is on the basis of light intensity, soil condition and wind direction and velocity

General assembly of proposed buoy is shown in Fig. 6.1 (A) & 6.1(B)

Fig. 6.1 (A) General assembly-partial

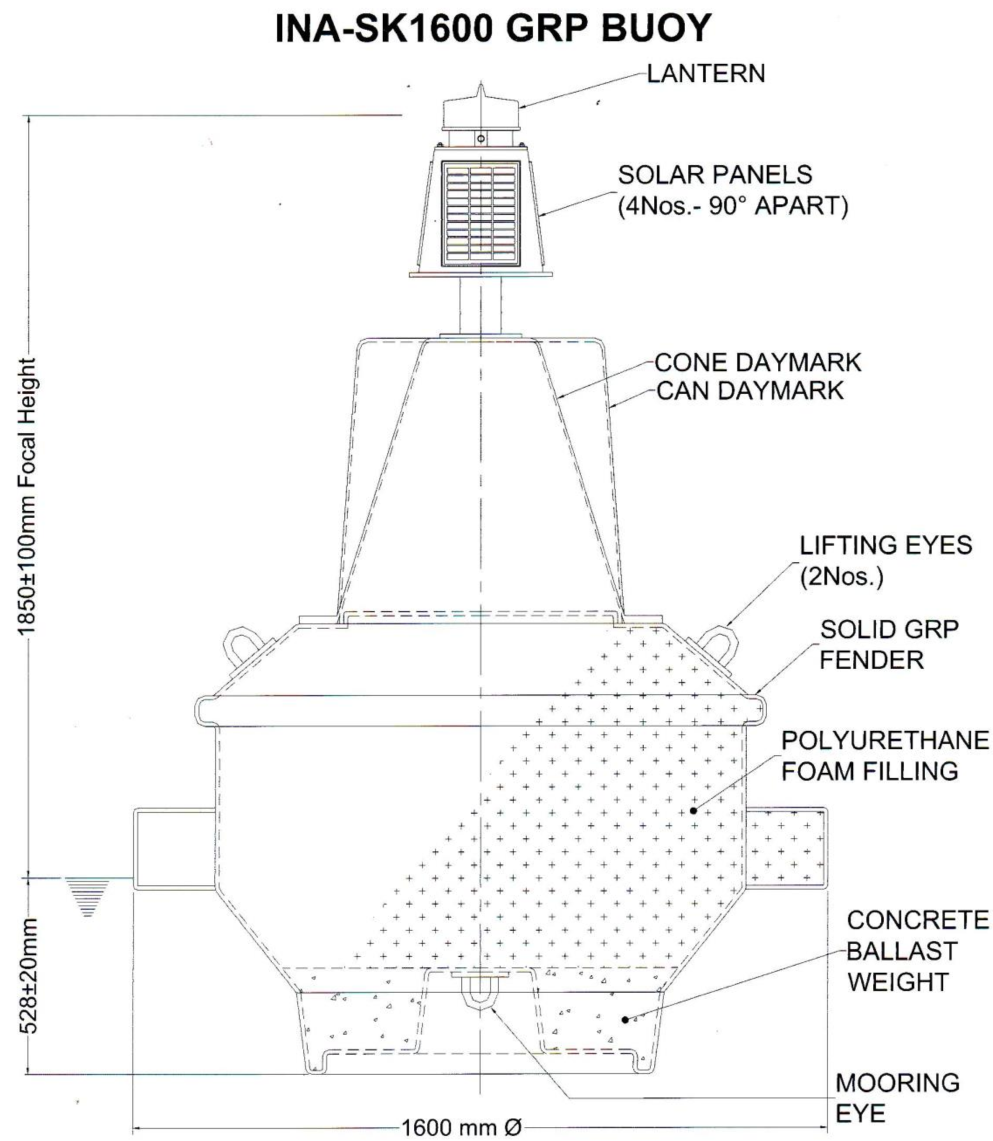
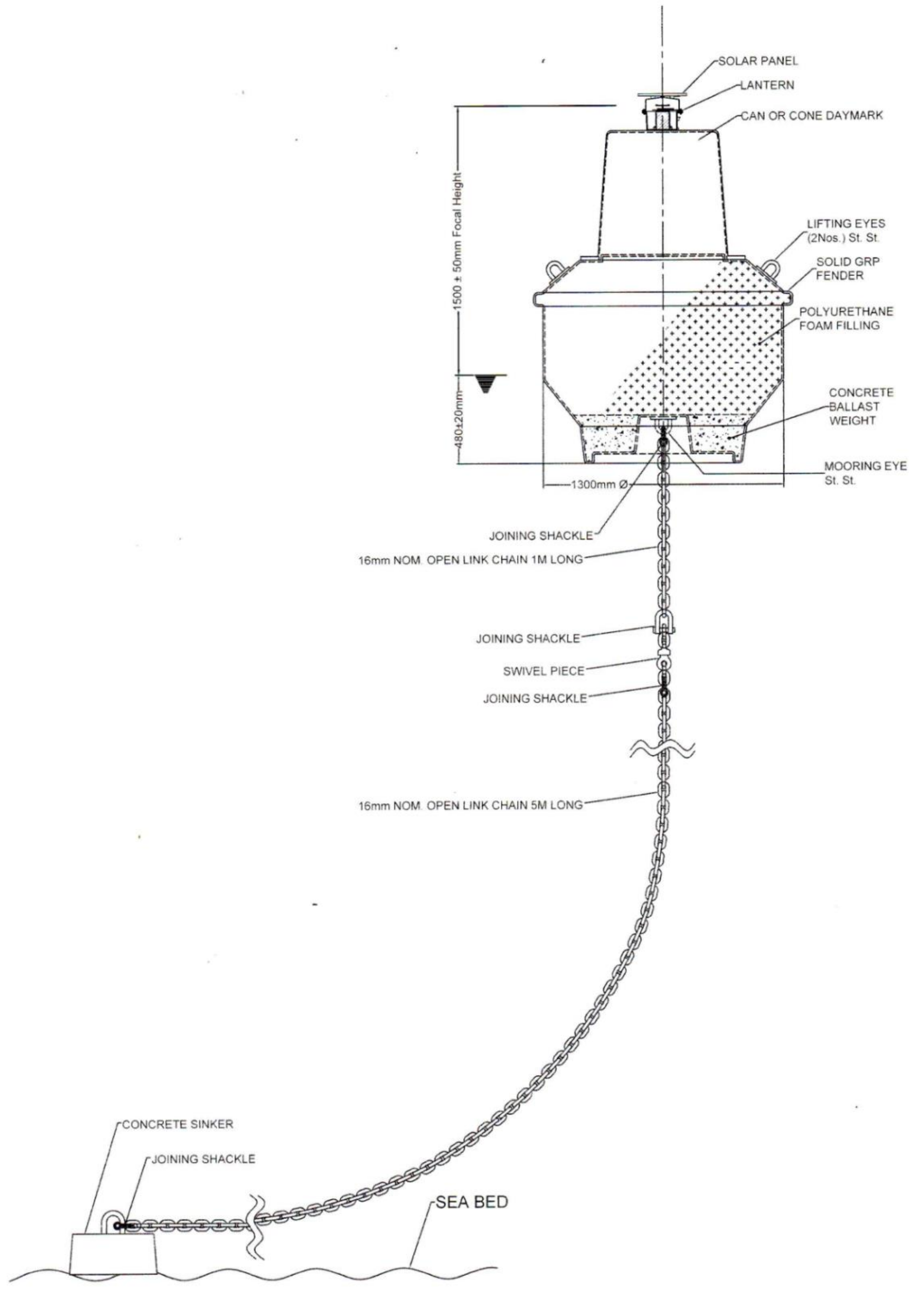


Fig. 6.1 (B) General assembly-Full



6.4 Cargo Terminals and River Ports

Design Codes and Standards

All works shall satisfy the requirement of the latest relevant codes and standards. Generally Indian Standards shall be followed. Wherever, the details for part of works are not defined adequately in Indian standards, the relevant acceptable International Standards shall be adopted. The List of codes and standards covering the major part of the works to be followed is listed below:

Table 6.4 List of Codes and Standards

IS: 456	Code of practice for Plain and Reinforced Concrete
IS: 875	Code of practice for Design Loads for Buildings & Structures
IS: 1893	Criteria for Earthquake Resistant Design of Structures
IS: 4326	Earthquake resistant design and construction of Buildings – Code of practice
IS: 4651	Code of practice for Planning and Design of Ports and Harbours
IS: 9527	Code of practice for Design and Construction of Port and Harbour Structures
UFC4-152-01	US navy corps of engineer unified criteria Piers and Wharves
BS 6349-part 2	Code of practice for Marine structure quay, Wharves, jetties & Dolphins
IS: 800	Code of practice for General Construction in Steel
IS: 1786	Specification for High Strength Deformed Steel bars and wires for Concrete Reinforcement
IS: 13920	Ductile detailing of Reinforced Concrete Structures subjected to Seismic Forces - Code of Practice
IS: 2911	Code of practice for Design and Construction of Pile Foundations
IS: 1904	Code of practice for Design and Construction of Foundations in

	Soils : General Requirements
SP: 7	National Building Code of India
SP: 16	Design aids for Reinforced Concrete to IS: 456
SP: 34	Hand book on Concrete Reinforcement and Detailing
IRC : 21	Standard Specifications and Code of Practice for Road Bridges Section III
IRC : 6	Standard Specifications and Code of Practice for Road Bridges Section II

6.4.1 Design of Terminals

Total 4 nos. of terminal have been identified. However, terminals will be developed phase wise.

Sr. No	Phase	Terminal
1	Phase-1	Terminal 1 at OPAL (Ch. 11)
2	Phase-2	Terminal 2 at at Bharuch (Ch. 60)
		Terminal 3 at at d/s of Garudeshwer Weir (Ch. 168)
3	Phase-3	Terminal 4 at Bharuch (Ch. 50)

Details of Type of jetty

Sr. No	**Phase**	**Type of Jetty**
1	Phase-1	Terminal 1- Piled Jetty
2	Phase-2	Terminal 2- Floating
		Terminal 3- Floating
3	Phase-3	Terminal 4- Piled jetty

Salient Features of Jetty:

Terminal 1 (OPAL)

The proposed jetty is required to handle Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), Loaded draft 1.8m (Class-IV). The jetty is planned as a berthing structure proposed to be on piles, which provide least resistance to natural equilibrium and ease of extension/addition of facilities at a later date. The berthing structure is of length 100 m and width 15m.

Plan, elevation & cross-section of proposed jetty is shown in Fig. **AD-1**

The deck level of jetty is w.r.t MSL. The thickness of the deck slab of jetty is 0.45 m. The slab at deck level is supported on Cross beams of 0.75m x 0.75 m in the lateral direction, secondary beams of 0.75 m x 0.75m in the longitudinal direction. The Cross beams rest on the pile caps/ pile muffs which in turn support the longitudinal beams. The 750 mm diameter bored cast in situ piles with 6mm thick liner are fixed to the pile caps at the top and fixed into the ground at the bottom. The plan and cross section of jetty is shown as Fig. **AD-1**. The important design levels taken into consideration are discussed as follows:

Table 6.5 Design Parameters for Terminal 1 (OPAL)

Top Level of Jetty (Deck slab)	+11.50 m
Top level of Piles	+9.85m
Diameter of piles (D)	0.75m
Unit wt. of RCC	25.0 KN/m^3
Unit wt. of sea water	10.025 KN/m^3
Unit wt. of Steel	78.50 KN/m^3
Founding Level of Piles	-25.00 m below bed Level

Terminal 4 (BHARUCH CH.50)

The proposed jetty is required to handle Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), loaded draft 1.8m (Class-IV). The jetty is planned as a berthing structure proposed to be on piles, which provide least resistance to natural equilibrium and ease of extension/addition of facilities at a later date. The berthing structure is of length 100 m and width 15m.

Plan, elevation & cross-section of proposed jetty is shown in Fig. **AD-1**

The deck level of jetty is w.r.t MSL. The thickness of the deck slab of jetty is 0.45 m. The slab at deck level is supported on Cross beams of 0.6m x 0.6 m in the lateral direction, secondary beams of 0.60 m x 0.60m in the longitudinal direction. The Cross beams rest on the pile caps / pile muffs which in turn support the longitudinal beams. The 600 mm diameter bored cast in situ piles with 6mm thick liner are fixed to the pile caps at the top and fixed into the ground at the bottom. The plan and cross section of jetty is shown as Fig. **AD-1**. The important design levels taken into consideration are discussed as follows:

Table 6.6 Design Parameters for Terminal 4 (BHARUCH)

Top Level of Jetty (Deck slab)	+11.50 m
Top level of Piles	+10.1m
Diameter of piles (D)	0.6m
Unit wt. of RCC	25.0 KN/m^3
Unit wt. of sea water	10.025 KN/m^3
Unit wt. of Steel	78.50 KN/m^3
Founding Level of Piles	-30.00 m below bed Level

Terminal 2 (Bharuch Ch. 60):

Since permanent construction is not viable at Bharuch, floating Jetty is proposed under the project, for embarking & dis-embarking of passengers. To cater to the berthing requirements for easy embarkation/disembarkation to the taxi, a floating jetty of 70 m x 10 m is considered suitable. The floating jetty shall be used to facilitate embarking/disembarking of passengers between the terminal and water taxi. It will have sufficient space for accommodating passengers along with their luggage. The floating jetty will have appropriate arrangement to cater to the mooring requirements of the water taxi. The appearance of the jetty will be good and shall have superior finish as per international standards.

Floating jetties to be supplied shall meet the following broad technical specifications:

Sr. No.	Particulars	Details
A.	**JETTY**	
1.	Size	70m. x 10m.
2.	Max. loaded Draft	1.7 m.
3.	Minimum Free Board	0.5 m. for loading of 2 KM/m2on total deck area of 120 sq. m.
4.	Load Capacity	Deck designed for UDL of 3 KN/m2 or concentrated load of 4.5 KN over an area of 0.3m x 0.3m.
5.	Material for construction of module/block	Concrete
8.	Deck/Top Cover	Concrete
9.	Minimum Reserve Buoyancy	25% under design loading conditions
10.	Frames	Aluminum Alloy Grade – 6082 T5/T6 marine grade or equivalent
12.	Working Life	50 years or more
15.	Handrails	Fabricated out of Stainless Steel, 750 mm high. Reflective stickers to be provided on all the four sides.

Terminal 3 (d/s of Garudeshwer Weir):

Permanent construction is not viable near d/s of Garudeshwer Weir, floating Jetty is best possible option & proposed under the project, for embarking & dis-embarking of passengers. To cater to the berthing requirements for easy embarkation/ disembarkation to the taxi, a floating jetty of 70 m x 10 m is considered suitable.

Floating jetties to be supplied shall meet the following broad technical specifications:

Sr.No.	Particulars	Details
A.	**JETTY**	
1.	Size	70m. x 10m.
2.	Max. loaded Draft	1.7 m.
3.	Minimum Free Board	0.5 m. for loading of 2 KM/m2on total deck area of 120 sq. m.
4.	Load Capacity	Deck designed for UDL of 3 KN/m2 or concentrated load of 4.5 KN over an area of 0.3m x 0.3m.
5.	Material for construction of module/block	Concrete
8.	Deck/Top Cover	Concrete
9.	Minimum Reserve Buoyancy	25% under design loading conditions
10.	Frames	Aluminum Alloy Grade – 6082 T5/T6 marine grade or equivalent
12.	Working Life	50 years or more
15.	Handrails	Fabricated out of Stainless Steel, 750 mm high. Reflective stickers to be provided on all the four sides.

Mooring arrangements

Eight bollards, on the berthing side for water taxi will be fixed for the safe mooring of the water taxi.

Fenders

Protective fenders shall be provided on berthing side to prevent damage at the interface area.

Approach trestle/ gangway

The gangway proposed is floating type with all the specifications, including material of construction, similar to Para - 2.1.

The broad dimensions are tabulated below: -

Length Over All	50.00 m
Breadth Over All	3.00 m
Draft not more than	1.2 m
Free board minimum	0.50 m for loading of 2kN/m2

6.4.1 Design of Terminals

Structural System of Berthing Jetty

The proposed jetty is required to handle Self-propelled, carrying capacity 1000 DWT, Size (70m X 12m), loaded draft 1.8m (Class-IV). The jetty is planned as a berthing structure proposed to be on piles, which provide least resistance to natural equilibrium and ease of extension/addition of facilities at a later date. The berthing structure is of length 100 m and width 15m.

Plan, elevation & cross-section of proposed jetty is shown in Fig **AD-1**

The deck level of jetty is w.r.t CD. The thickness of the deck slab of jetty is 0.45 m. The slab at deck level is supported on Cross beams of 0.75m x 0.75 m in the lateral direction, secondary beams of 0.75 m x 0.75m in the longitudinal direction. The Cross beams rest on the pile caps / pile muffs which in turn support the longitudinal beams. The 750 mm diameter bored cast in situ piles with 6mm thick liner are fixed to the pile caps at the top and fixed into the ground at the bottom. The plan and cross section of jetty is shown as Fig **AD-1**. The important design levels taken into consideration are discussed as follows:

6.4.2 Analysis of Jetty

STAAD Pro Modeling

The dimension of the jetty is 100m x 15m. The analysis of the structure has been performed in STAAD Pro 2007 as shown in **Fig. 6.2**. In the model the piles are assumed to be fixed at base. The pile length used in analysis is based on fixity length i.e 15m. The cut off level of piles is +1.0 m for inner pile.

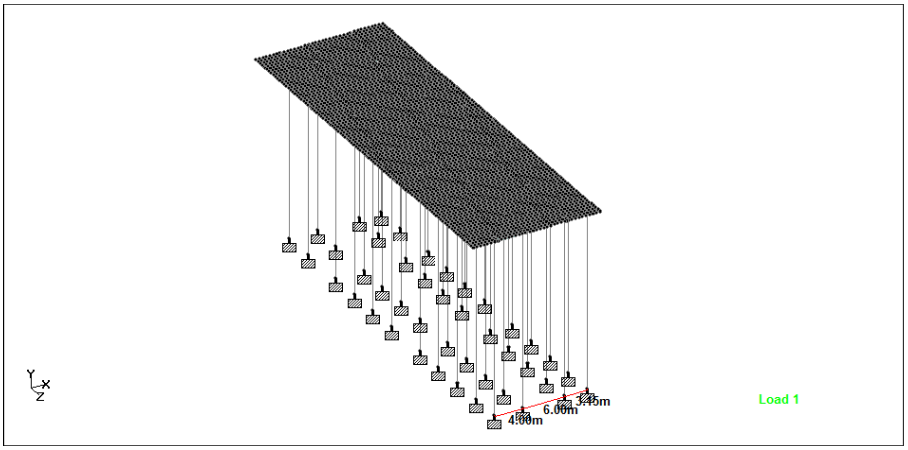


Fig. 6.2: STAAD Panel of the Jetty

6.4.3 Design Loads and Load Combinations

The jetty, approach and bay have been designed considering the following loads:

A. Vertical Loads

a) Dead Load
b) Live Loads
   i) Uniform loading
   ii) Truck loading (IRC Class)

B. Horizontal Loads

c) Berthing load
d) Mooring load
e) Wind load
f) Current load
g) Seismic load

C. Combination of above

The loading has been considered taking into account the guidelines of IS 4651 (Part III): 1974, IRC 6:2000, IS 1893: 2002 (Part 1), IS 875 : 1987 (Part 1 and Part 3). UFC 4-152-01 2005.

(a) Dead Load

The dead load consists of the weight of the entire structure, including all the permanent attachments such as mooring hardware, light poles, utility booms, brows, platforms, vaults, sheds, and service utility lines. A realistic assessment of all present and future attachments has been made and included. Overestimation of dead loads generally will not adversely affect the cost of the structure. However, overestimation of dead loads would not be conservative for tension or uplift controlled design. Standard unit weights have been used to calculate dead loads. Dead load of the structure can be applied on STAAD MODEL.

Table 6.7 Dead Weight of Slab

Component	Depth of Slab (mm)	Unit Weight (KN/m^3)	Load (KN/m^2)
Jetty	450	25	11.25

Dead weight of Rails

(b) Live Loads

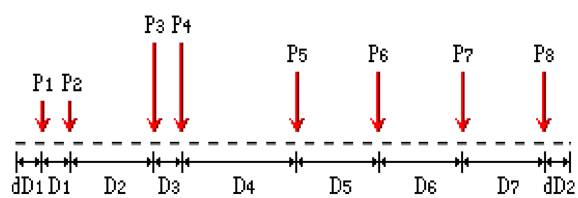
Uniform Live Loads

(i) 30 KN/m^2 (As per IS 4561: part-3,Page-5, Cl. 5.1.2)
(ii) 38KN/m^2 (As per UFC 4-152-01 2005, Page-54,Cl. 3-3.2, Table-3-2)

Critical Load is 38KN/m^2

Truck Loading

IRC Class A truck load has been applied as moving load. The load specification of IRC Class A train of vehicles (with impact factor) is given as under:



P_1 =27 KN	dD_1 = 0.5 m
P_2=27 KN	D_1 = 1.1 m
P_3= 114 KN	D_2 = 3.2 m

P_4= 114 KN	D_3 = 1.2 m
P_5=68 KN	D_4 = 4.3 m
P_6=68 KN	D_5 = 3.0 m
P_7 =68 KN	D_6 = 3.0 m
P_8 =68 KN	D_7 = 3.0 m

(c) Berthing Force

Berthing force is calculated for Self-propelled, carrying capacity 4000 DWT, Size (86m X 14m), Loaded draft 2.9m. According to UFC 4 15202, there are several factors that modify the actual energy to be absorbed by the fender system. The actual kinetic energy E absorbed by the fender system is calculated as per the following

E_{fender} = Energy to be absorbed by the fender system

$E_{fender} = M_D\, Vb^2 \,(C_m\, C_e\, C_s\, C_c)\,/2$

Where:

W_D	Displacement Tonnage (DT) of the vessel, (t)
V_b	Velocity of vessel in m/s, normal to the berth
C_m	Mass coefficient
C_e	Eccentricity coefficient
C_s	Softness coefficient
C_c	Configuratinal Coefficient

Type of Fender			=	**G2 Grade MCS 400 Cell Fender**	
Energy Absorption			=	**21.60**	kN*m
Reaction Force			=	**129**	kN

Details of above calculation is shown in **Annexure 6.1**

(d) Mooring Force

This force is taken according to IS-4561- 1974-Part-III,

(i) Mooring force due to wind

Mooring Force due to wind: $F_w = C_w A_w P$

C_w= Shape Factor

A_w= Windage Area in sqm = 1.175*Lp (D_m-D_L)

P = Wind Speed pressure in N/sqm = 0.6 V_z^2

Vz =V_b *k_1 * k_2* k_3 , where the k_1, k_2 and k_3 are probability factor and terrain height and structure size factor and Topography factor respectively. Values of coefficients are taken from IS-875-Part-III,

k_1 = 1

k_2 = 1

k_3 = 1

- The wind speed is considered as 50m/s for coastal Gujarat (IS - 875-III Part 3 1987, cl-5.4 & pg-9)
- Shape Factor C_w=1.5 is taken for calculation of Mooring force due to wind.

Calculation summery of mooring force is given below

A_w = 1.175*L_p (D_m-D_L)

= 167.49 m^2

P = 0.6 V_z^2 =0.6*(50*1*1*1)^2

= 1500 N/m^2

F_w = 37.7T

As per IS : 4651(Part III) – 1974 When the ships are berthed on both sides of a pier, the total wind force acting on the pier, should be increased by 50 percent to allow for wind against the second ship.

Accordingly, F_w= 1.5*38 = 60 t

(ii) Mooring force due to current

Mooring force due to current: $F_c = L_{pp}\ D_r\ P_c$

F_c = Mooring Force due to current in kg

L_{pp}= Length between the perpendiculars in m

D_r = Loaded draft of vessel in m

P_c = Pressure due to current in kg/sq.m

The current velocity is assumed as 0.6 m/s

$F_c \quad = \quad L_{pp} * D_r*P_c$

$\quad = \quad 4.7$ T

Assuming that the mooring force due to current and wind act simultaneously in the same direction.

Total Mooring Force (F_T) = $F_w + F_c$

= 64.7 t

Considering at least 4 nos. of bollards per vessel, mooring force at each pile,

F_T= 64.7/4 = 16.17 t Say 17 t

Details of above calculation is shown in **Annexure 6.2**

(e) Wind Load

The wind loads on the structure has been considered as per IS 875:Part3. The basic wind speed for Surat is 39 m /sec. Design Wind Speed can be obtained by the following formula:
Design Wind Speed $V_z = K_1*K_2*K_3*V_b$

Where,

K_1, Risk Coefficient as 1.00

K_2, Terrain (Category 2), Height (10m) and structure size factor (class C) as 1.00

K_3, Topography Factor as 1.0

Accordingly, the design wind pressure, $p_z = 0.6\ V_z^2$

$p_z = 0.6\ V_z^2 = 0.6*(50*1.00*1.00*1)^2$

$= 1500\ N/m^2$

(f) Current Force

The current force is given by $\gamma V^2/2g$

Where γ	=	Unit weight at water = 1.025 t/m^3
V	=	Current velocity = 0.6 m/sec.
F_C	=	$\gamma V^2/2g$
	=	1.025*0.6^2/ (2*9.81)
	=	0.018t

(g) Seismic Force

The seismic force has been calculated as per IS-1893-2002. The design horizontal seismic coefficient A_h for a structure shall be determined by the following expression:

$$A_h = (Z/2)*(I/R)*(S_a/g)$$

Where,

Z = Zone factor given in Table 2, IS-1893-2002. Z at the site has been adopted as 0.16 corresponding to Zone III. Map showing the seismic zone from IS 1893-part – I, Gujarat falls in Zone – III.

I = Importance factor = 1.5 has been used.

R = Response reduction factor has been taken as 3.0 for RCC Structures as per Table 7 of IS-1893-2002.

S_a/g = Average response acceleration coefficient has been taken as 1.4 as per Figure 2 of IS-1893 (Part 1):2002 corresponding to T=0.91 seconds. The earthquake force has been applied in X as well main as Z directions.

(h) Load Combinations as per IS 4651 Part IV 2007

Method of Design: The Berth and its structural components have been designed as per Limit State Method. The partial safety factors for loads in limit state design method has been used. Accordingly, following load combinations have been considered as per IS: 4651-2007 (Draft copy)

Limit state of serviceability

1.0(DL+LL)

1.0(DL+LL+BF-S)

1.0(DL+LL+BF-(L)

1.0(DL+LL+MF-S)

1.0(DL+LL+MF-L)

1.0(DL+LL+SFX)

1.0(DL+LL+SF-X)

Limit state of collapsibility

1.2(DL+LL)+(CLX)

1.2(DL+LL)+(CL-X)

1.5(DL+LL+BF-S)+1.0CLX

1.5(DL+LL+BF-L)+1.0CLX

1.5(DL+LL+BF-S)+1.0CL-X

1.5(DL+LL+BF-L)+1.0CL-X

1.5(DL+LL+MF-S)+1.0CLX

1.5(DL+LL+MF-L)+1.0CLX

1.5(DL+LL+MF-S)+1.0CL-X

1.5(DL+LL+MF-L)+1.0CL-X

1.2(DL+LL)+1.0CLX

1.2(DL+LL)+1.0CL-X

1.2(DL+LL)+1.0CLX+1.5SFX

1.2(DL+LL)+1.0CL-X+1.5SFX

1.2(DL+LL)+1.0CLX+1.5SF-X

1.2(DL+LL)+1.0CL-X+1.5SF-X

1.2(DL+LL)+1.0CLX+1.5SFZ

1.2(DL+LL)+1.0CL-X+1.5SFZ

1.2(DL+LL)+1.0CLX+1.5SF-Z

1.2(DL+LL)+1.0CL-X+1.5SF-Z

1.2(DL+LL)+1.5SWLX+1.0CLX

1.2(DL+LL)+1.5SWLX+1.0CL-X

1.2(DL+LL)+1.5SWL-X+1.0CLX

1.2(DL+LL)+1.5SWL-X+1.0CL-X

1.2(DL+LL)+1.5SWLZ+1.0CLX

1.2(DL+LL)+1.5SWLZ+1.0CL-X

1.2(DL+LL)+1.5SWL-Z+1.0CLX

1.2(DL+LL)+1.5SWL-Z+1.0CL-X

DL – Dead Load

LL – Live Load

MF-S – Mooring Force Sea Side

MF-L – Mooring Force Lee Side

BF-S – Berthing Force Sea Side

BF-L – Berthing Force Lee Side

SF – Earthquake load
CL-Current Load
WL-Wind Load

6.4.4 Design of jetty

The governing STAAD Results for Longitudinal Beams, Cross Beams, and columns have been summarized as below:

6.4.5 Detailed Engineering

Table 6.8 Critical Forces in structural members of jetty

Beams	Design Moment (KNm)	Shear (KN)
	1224	1900

Piles	P (KN)	M_{ux}(KNm)	M_{uy} (KNm)
	920	1100	19

Slab	Design Moment (KNm)
	320

Details are shown in **Fig. no. AD-01**

6.5 Construction schedule

Construction of various structures mentioned above will be constructed in order to develop the waterway for navigation as well as for handling of cargo through following sequence of activities.

Activity 1: Construction of terminals & ancillary structures.

Activity 2: Dredging

Construction schedule

PHASE-1

For (OPaL)

Sr.No.	Activity	Time in weeks from LoA
1	Submission of Detailed Construction Drawing & Methodology	04 Weeks
2	Proof Checking of construction drawing	08 Weeks
3	Construction of dyke/Filling/Approach Trestle	20 Weeks
4	Construction of piles	20 Weeks
5	Installation of Precast Beam	30 Weeks
6	Installation of Precast Slab	35 Weeks
7	Laying of cast in-situ slab	43 Weeks
8	Installation of accessories	47 Weeks
9	Testing, commissioning & handing Over of site	55 Weeks

PHASE-2 (Bharuch Ch. 60)

For Floating jetties (Terminal 5)

Sr.No.	Activity	Time in weeks from LoA
1	Submission of Detailed Engineering Drawing & Methodology for Installation	03 Weeks
2	Pre-dispatch third party inspection	04 Weeks
3	Supply of Primary units(Float)	09 Weeks
4	Onsite Inspection of supplied unit	15 Weeks
5	Installation of Gangway	17 Weeks
6	Installation of Jetty along with Accessories	19 Weeks
7	Testing, commissioning & trial	26 Weeks

PHASE-2 (D/s of Garudeshwar)

For Floating jetties (Terminal 4)

Sr.No.	Activity	Time in weeks from LoA
1	Submission of Detailed Engineering Drawing & Methodology for Installation	03 Weeks
2	Pre-dispatch third party inspection	04 Weeks
3	Supply of Primary units(Float)	09 Weeks
4	Onsite Inspection of supplied unit	15 Weeks
5	Installation of Gangway	17 Weeks
6	Installation of Jetty along with Accessories	19 Weeks
7	Testing, commissioning & trial	26 Weeks

PHASE-3

For (Bharuch Ch. 50)

Sr.No.	Activity	Time in weeks from LoA
1	Submission of Detailed Construction Drawing & Methodology	04 Weeks
2	Proof Checking of construction drawing	08 Weeks
3	Construction of dyke/Filling/Approach Trestle	20 Weeks
4	Construction of piles	20 Weeks
5	Installation of Precast Beam	30 Weeks
6	Installation of Precast Slab	35 Weeks
7	Laying of cast in-situ slab	43 Weeks
8	Installation of accessories	47 Weeks
9	Testing, commissioning & handing Over of site	55 Weeks

CHAPTER – 7

VESSEL DESIGN

7.1 General Review

River Narmada could be developed under Class III, Class IV, or Class VI waterways. There are both certain and speculative prospects for cargo movement on the River. OPaL's exim requirements, coupled with their aggressive operation plans, should provide plenty of opportunities for the waterway utilization. Second, exim cargo from Ankleshwar and Bharuch GIDCs could be targeted for diverting them on the River Narmada waterway. The aim should be to cater to consolidated cargo volume arising from and destined to these GIDCs. These are likely to be speculative cargo, as waterway movement would have to compete with the already established logistics of road movement. In total, measured from the mouth of River Narmada, a stretch of roughly 50 km would be utilized for cargo movement. The terminal for OPaL cargo would be located 12 km from the mouth of river, on the outskirt of the company's plant. The next terminal would be situated at Borbhatha Bet in Bharuch to handle cargo from the GIDCs.

A major opportunity lies in moving tourists and passengers between Bharuch and Sardar Sarovar Dam. There is an in-principle backing from the central government to develop this stretch for tourists interested in visiting the Dam and the upcoming Statue of Unity. The initiative has a high probability of materializing on account of all-round focus on developing the region and the state for tourism.

An optimum sized and type of vessel has to be selected for moving naphtha for OPaL. The proposed modality involving River Narmada is likely to be a welcome change for the company, considering the operational compromises they have to resort to import naphtha currently. The likelihood will increase if the cost of operating vessel in Narmada is lower. The cost of transportation of any commodities using waterways is dependent upon the length of travel and volume of cargo. Large volume cargo reduces per-tonne cost of transportation if moved using waterways. Availability of return cargo further adds to the viability of the waterway operation. Return cargoes will be available only for the terminal at Bhorbhatha Bet. In case of OPaL Terminal, the nature of import cargo (naphtha) restricts using the same barge for exporting products like butadiene. So, the company would need to employ a separate barge for exporting purposes only, if it plans to use the waterway over the current road movement. In case of cargoes from the GIDCs, import volumes are likely to be higher than export traffic. Also, the terminal at Bhorbhatha Bet would need Ro-Ro vessels to directly transport truck-carrying containers. This will bring down the capital cost of the terminal as there would be no requirement for setting up cargo-handling equipments and storage facilities.

7.1.1 Terminal 2 and 3

Both Terminal 2 and Terminal 3 have been proposed to handle a common stream of tourist traffic. These terminals have been envisioned to cater to the potential tourist and passenger traffic on account of the boat service between Bharuch-Sardar Sarovar Dam (Nandod). Broadly, these rides could be used for the following two primary purposes:

- Tourist movement between Bharuch and Sardar-Sarovar (Nandod) Dam
- Passenger movement across the boat-service stretch, especially at Rundh and Chandod

The jetties at both these terminals would require small draft and provisions for berthing of passenger crafts. These vessels could be boats made of aluminum, steel, or fiber. Tourist vessels ferrying passengers between Terminal 2 and 3 would not have a draft of more than 1.8 m. These vessels can be found in the range of 25 m – 40 m in length, and a width of between 5 m and 9 m. judging by the long chainage between Bharuch and the Dam, a fast-ferry with a total speed of 20 knots, or more, would be ideal for moving passengers. However, the lowest possible applicable speed should not be less than 10 knots. The ferry boats would have a sitting arrangement, along with a sun deck for passengers to walk around and enjoy the surrounding view. The total passenger capacity should not be less than 200, as that would increase vessel requirements needed to move the daily projected tourist traffic. At 200, the terminal operator would need 6 plus vessels. However, these could be acquired in phases based on the response to the proposed boat service. For instance, based on the projected tourist traffic, the operator would need only 2 vessels in the first 5 years and 2 more in the next 5.

The aforesaid type and size of vessels would qualify in all classes of waterways ratified by IWAI. Also, the chosen vessel characteristics are necessary for the purported boat service’s viability, and to be in line with the region’s push towards tourism development.

7.1.2 Terminal 1

OPaL’s petrochemical plant in PCPIR, Dahej, holds enormous opportunity for waterway cargo movement. This opportunity is certain because of the company’s inherent interest in moving their cargo using an alternative route. The company is focused on bringing this change for naphtha imports, primarily. Terminal 1 would be accepting vessels of 1,000 DWT to 2,000 DWT, with a draft of not more than 1.8 m. However, these would be liquid cargo barges. Assuming 1 barrel equivalent to 0.125 MT of liquid cargo, the total vessel capacity would fall between 8,000 barrels of oil equivalent (boe) to 16,000 boe.

The proposition of Terminal 1 is exclusively for handling OPaL import cargo. IWAI has clarified that they would not be interested in developing a captive terminal. Similarly, OPaL has made its stance clear that they would be building a cargo-handling on River Narmada facility even if IWAI doesn't. In this situation, they would like IWAI to, at least, develop the river for cargo movement. Either way, OPaL and IWAI may have to enter in an agreement in this regard, and find a common ground where interests of both the parties are secured and honored. It is presumed that OPaL would be comfortable with any arrangement that helps prevent them from disclosing their operational details to its competitor. Preliminary analysis suggests that the proposed Terminal is the most suitable alternative for the company at present, both operationally and commercially. Absence of return cargo may increase the overall logistics, albeit marginally. OPaL is unlikely to be dissuaded by this increase, as the company's decision to move to waterway is driven by strategy rather than commerce. Therefore, even if current logistics costs for importing naphtha prove to be lower than proposed shift to waterway, OPaL is unlikely to be deterred from making the shift. At present, naphtha is first moved from one of ONGC's plants to Dahej. So far, these have been carried in barges with a parcel size of 34,500 MT or 35,000 MT from Hazira and Mumbai, respectively. After berthing at the GCPTCL jetty in Dahej, naphtha is pumped to OPaL plant via a pipeline. The cost of transporting liquid cargo via pipeline could be as low as 20% the cost using railway. Still, the additional transportation modality of barging would be diluting the overall cost benefit gained from pipeline movement. More importantly, having one's cargo traversed under the eyes of its major competitor is a strictly undesired and non-negotiable situation. On these two fronts, moving naphtha using River Narmada is a far more appealing prospect.

7.1.3 Terminal 4

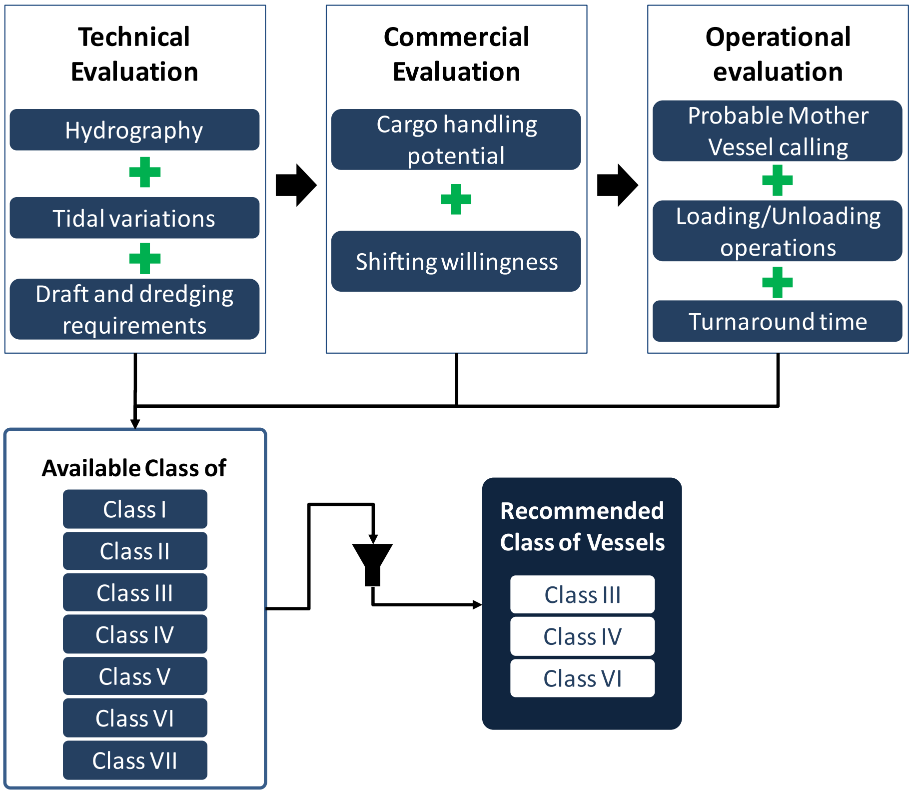
Terminal 4 will be handling cargo from both Ankleshwar and Bharuch GIDCs. Bharuch GIDC is considered because cargo from these industries is also routed via Ankleshwar ICD. Both the GIDCs are home to many small-scale companies operating in fertilizer and chemical industries. Based on the 2016 Ankleshwar ICD data, import volumes exceed export traffic by 5 times. This indicates that final products are distributed for local consumption. Consequently, this will create trade imbalance as barges would be making empty return trips with only ballast. This could impact the overall logistics of the waterway movement for these cargoes.

Targeting containerized cargo, ro-ro vessels would be employed at Terminal 4. Similar to Terminal 1, these vessels will have a maximum draft of 1.8 m, and capacity of 1,000 DWT to 2,000 DWT. A maximum gross weight of 28 MT has been assumed for each truck, where 20 MT is assigned for the container payload, and the rest is the vehicle net weight. These vessels should be able to accommodate 30 trucks to 65 trucks. At present, these containerized cargoes take road or rail route for using ports like Mundra, Hazira, JNPT, MbPT, and Pipavav. So, Terminal 4 will have to compete with the road/rail logistics involved with respect to these ports. Absence of return cargo will hamper the logistics benefit waterway movement typically helps accrue.

7.2 Design Basis

The classification of vessels described by IWAI requires certain length and certain draft of vessel to be maintained for optimum use. Under this condition, there are other factors that will also influence the specific class of vessels that should be deployed on River Narmada to handle traffic to and from the cargo terminals. The following flowchart illustrates the decision-making involved in making the recommendation for the specific classes of vessels IWAI should invest for this Terminal.

Figure 7-1 Decision process for vessel design



The technical evaluation acts as the ultimate framework, within which the vessel design selection has to be made. Primarily, hydrographic study, tidal study, dredging requirement, together helps evaluate technical conditions that the vessel needs to meet for plying on River Narmada. Next, commercial evaluation involving projected traffic volume and type of cargo for Terminal 1 & 2 supplies commercial reasoning. This is further supported by the willingness of the potential clients (OPaL & Ankleshwar ICD) to shift to waterways. Operational evaluation makes way for the probable operational conditions under which barges will be operating. In case of OPaL, this relates to the coastal vessels ONGC uses to bring in naphtha. For Terminal 4 at Bhorbhatha Bet, mother vessels don't feature in the overall logistics. This is because it's been assumed there will be no mid-sea (or at Anchorage) transfer of cargo. Ro-Ro barges would be loading trucks directly from the loading terminal (JNPT or any other). In both the cases, loading and unloading duration will further dictate the turnaround time for barges.

Multiple parameters, as highlighted above, have been applied to choose a preferred class of vessel. These parameters are the prevailing maritime conditions on River Narmada, probable demands that could be met via the waterway, cargo movement frequency, and total operation duration. Determined by the minimum draft of 1.8 m, cargo capacity of 1,000 DWT, and dimensions of 70 m x 12 m, Class IV is the ideal vessel to choose. However, a higher and a lower class of vessel are also suggested for comparison purpose, and for making an informed choice. Hence, Class III, IV, and VI vessels have been recommended to cater to the potential traffic at Terminal 1 & 2. Higher the class of vessels, larger thecapacity, and lower the logistics cost will be.

7.3 Type of proposed Vessels

The following images depict Class VI liquid cargo barge for OPaL traffic (Terminal 1), followed by a Class IV Ro-Ro barge for Ankleshwar ICD traffic (Terminal 4). These vessels are for illustrative purposes only.

Figure 7-2: Class VI Liquid barge

Figure 7-3: Class IV Ro-Ro Barge

Figure 7.4: Proposed Ferry - Passenger / Tourism

Table 7-1 Calculation of ferries and trips for passenger jetties

Financial Year	2028	2030	2035	2040	2045
Class I					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	20	20	20	20	20
No. of Ferries	2	2	3	3	3
No. of Trips	7	11	17	23	23
Class II					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	150	150	150	150	150
No. of Ferries	1	1	1	1	2
No. of Trips	2	3	7	9	5
Class III					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	130	130	130	130	130
No. of Ferries	1	1	1	1	2
No. of Trips	2	2	8	11	5
Class IV					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	200	200	200	200	200
No. of Ferries	1	1	1	1	1
No. of Trips	1	2	5	7	7

Financial Year	2028	2030	2035	2040	2045
Class V					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	130	130	130	130	130
No. of Ferries	1	1	1	1	2
No. of Trips	2	2	8	11	5
Class VI					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	116	116	116	116	116
No. of Ferries	1	1	1	1	2
No. of Trips	3	2	9	12	6
Class VII					
Traffic Per Day	296	422	1030	1370	1370
Passenger Ferry Capacity Per Trip	500	500	500	500	500
No. of Ferries	1	1	1	1	1
No. of Trips	1	2	2	3	3

7.4 Proposed vessel size and specifications

Vessels listed in Table 7-2 are the class of river-sea vessels that IWAI has classified and recommended. Among these, the highlighted ones are recommended to be deployed on River Narmada.

Table 7-2 Characteristics of different class of vessels

Class	Size (m)		Loaded Draft (m)	Capacity (DWT)	Charter Rates - Barge (Rs./Day)	Power (KW)	Consumption			Speed (Knots)
	L	B					Fuel		Ltr/Hr	
I	32	5	1.0	100	18,000	-	DO	1.0	42	6-7
II	45	8	1.2	300	30,000	337	DO	1.6	67	6-7
III	58	9	1.5	500	60,000	-	DO	2.0	83	6-7
IV	70	12	1.8	1,000	80,000	432	DO	2.4	100	6-7
V	70	12	1.8	1,000	80,000	432	DO	2.4	100	6-7
VI	86	14	2.5	2,000	110,000	597	DO	4.4	220	6-7
VII	86	14	2.9	4,000	130,000	-	DO	8.4	350	6-7

Source: IWAI

Class III, IV, and VI are all pliable on the river because the river has enough draft to accommodate these vessels. Even Class V vessel is a good contender, as their specifications are identical to Class IV vessels. Also, these are self-propelled type of vessels.

7.5 Logistics Analysis –Terminal 1 (OPaL)

Barge logistics in case of OPaL naphtha imports have been computed based on river transportation between Dahej Anchorage and Terminal 1. The time it takes for the ONGC coastal vessel to travel between Hazira/Mumbai to Dahej Anchorage hasn't been factored in. Same goes for the costs involved during the said transportation.

7.5.1 Turnaround Time

The following Table 7-3 shows the turnaround time required per barge for every class of vessels classified by IWAI. The entire waterway logistic analysis computed herein is based on the assumption that only day-time navigation (10 hours) will be allowed.

Table 7-3 Turnaround time (One-way Ballast)

Description	Class of Vessels						
	I	II	III	IV	V	VI	VII
Alongside time at Anchorage (Hrs.)	2	2	2	2	2	2	2
Loading time (Hrs)	1	2	3	5	5	9	17
Tide Margin (Hrs)	8	8	8	8	8	8	8
Sailing Time - Loaded (Dahej Anchorage to OPaL Plant) (Hrs)	2	2	2	2	2	2	2
Discharge time @ OPaL Jetty (Hrs)	1	3	2	4	4	8	16
Sailing Time - Ballast (OPaL Plant to Dahej Anchorage) (Hrs)	1	1	1	1	1	1	1
Total Time (Hrs)	**15**	**17**	**18**	**22**	**22**	**30**	**46**

The status quo of OPaL receiving naphtha shipments from ONGC's plant in Hazira or Mumbai has been retained as the major assumption. As per this operation, naphtha would be arriving at Dahej Anchorage in 42,000 DWT – 45,000 DWT coastal vessels, with a parcel size of around 35,000 DWT. These will be oil/chemical tankers with cargo pumps, to be utilized for discharging cargo mid-sea/anchorage. A typical tanker (M.S. Elka Glory) has been used for reference purposes, especially to compute the discharge rate. The said tanker has 19 cargo pumps with varying discharge rates. Cumulatively, the discharge rate is 9,670 m3/hr. For naphtha, it's assumed that 1 m3 is equivalent to 0.74 MT. So, hourly discharge rate for the tanker comes to 7,156 MT/hr, or 71,558 MT/day.

Loading or unloading time is dictated by the lowest loading/unloading rate assumed by one of the two ships during transfer. In case of OPaL, this will be the liquid barge. A general loading/unloading rate of 300 m3/hr or 222 MT/hr has been assumed for the barge. At this rate, the ONGC coastal vessel will need 15 days to completely unload naphtha onto the liquid barge. Tide margin of 8 hours has been assumed. Sailing time of barges will be limited by their loaded speed, which is assumed here as 6 nautical-miles per hour (nmh). This speed has been kept constant for all class of vessels. Discharge rate at OPaL jetty at Terminal 1 is assumed to be the same as the loading rate of the barge, i.e. 222 MT/hr. After discharging naphtha, the barge will have to return to Dahej anchorage for the next iteration of naphtha transport. Since return cargo is not being considered here, these barges will sail back to the Dahej Anchorage with Ballast at 9 nmh speed.

7.5.2 Number of Vessel Required

The following Table 7-4 gives an estimate of the total barges the operator (OPaL or IWAI) may have to invest in. These requirements will differ based on the class of vessels that is ultimately chosen to move cargo on River Narmada.

Table 7-4 Number of barges/vessels required (One-way Ballast)

Description	Class - I	Class - II	Class - III	Class - IV	Class - V	Class - VI	Class - VII
DWT	**100**	**300**	**500**	**1000**	**1000**	**2000**	**4000**
Coastal Vessel - Parcel Size	35,000	35,000	35,000	35,000	35,000	35,000	35,000
Barge - Parcel Size	90	270	450	900	900	1,800	3,600
Number of Days - Unloading	15	15	15	15	15	15	15
Turnaround of Barges - Day & One-way Ballast	15	17	18	22	22	30	46
Cargo unloaded by Each Barge	2,223	5,601	9,164	14,948	14,948	21,839	28,381
Number of Barges	**16**	**7**	**4**	**3**	**3**	**2**	**2**

It is evident from the table above that higher the class of vessels, lesser the number of barges OPaL will have to invest in. These barges are likely to be customized by them, suiting their day-to-day operational requirements. As approximation, it's estimated that OPaL will need 2 to 4 barges to unload each coastal shipment of naphtha from ONGC.

The following table shows the probable number of coastal shipments of naphtha that will call on Dahej based on the projected traffic volume for OPaL:

Table 7-5 No. of naphtha coastal shipments at Dahej per year

Cargo	FY20	FY25	FY30	FY35	FY40	FY45
Naphtha	0.6	1.0	1.0	1.0	1.0	1.0
No. of coastal shipments per year	18	29	29	29	29	29

At the least, barges on River Narmada for OPaL will be utilized for 270 days in the early years of operation, when the total import volume remains under 1.0 mn T. For volumes equal to or greater than 1.0 mn T, it's estimated that a total of 429 days would be required to completely offload the projected naphtha volume from FY22 to FY45. This can be tackled by importing in a larger-size coastal vessel, or by having multiple naphtha shipments catered by a larger fleet of liquid barges.

7.6 Logistics Analysis – Terminal 4 (Bhorbhatha Bet)

Barge logistics in case of Ro-Ro barging have been computed based on O-D choice of JNPT-Terminal 4. Pre-loading and post-unloading operations like stuffing, de-stuffing, custom inspection, etc. have not been considered in the entire logistics analysis. Similarly, costs involved in the aforesaid activities, typically at a CFS/ICD, have not been considered.

7.6.1 Turnaround Time

The following Table 7-6 and Table 7-7 show the turnaround time required per barge for every class of vessels classified by IWAI. The entire waterway logistic analysis computed herein is based on the assumption that only day-time navigation (10 hours) will be allowed.

Table 7-6 Turnaround time (One-way Ballast)

Description	Class of Vessels						
	I	II	III	IV	V	VI	VII
Loading time (Hrs)	0.06	0.13	0.19	0.31	0.31	0.44	0.44
Tide Margin (Hrs)	8	8	8	8	8	8	8
Waiting time (Hrs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sailing Time - Loaded (JNPT to Terminal 4) (Hrs)	36	36	36	36	36	36	36
Unloading time @ Terminal 4 Jetty –(Hrs)	0.06	0.13	0.19	0.31	0.31	0.44	0.44
Sailing Time - Ballast (Terminal 4 to JNPT) (Hrs)	24	24	24	24	24	24	24
Total Time (Hrs)	**68**	**68**	**68**	**69**	**69**	**69**	**69**

Table 7-7 Turnaround time (No Ballast)

Description	Class of Vessels						
	I	II	III	IV	V	VI	VII
Loading time (Hrs)	0.06	0.13	0.19	0.31	0.31	0.44	0.44
Tide Margin (Hrs)	8	8	8	8	8	8	8
Waiting time (Hrs)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Sailing Time - Loaded (JNPT to Terminal 4) (Hrs)	36	36	36	36	36	36	36
Unloading time @ Terminal 4 Jetty –(Hrs)	0.06	0.13	0.19	0.31	0.31	0.44	0.44
Loading time - (Return Cargo) Hrs	0.06	0.13	0.19	0.31	0.31	0.44	0.44
Sailing Time - (Terminal 4 Jetty to JNPT) (Hrs)	36	36	36	36	36	36	36
Unloading time @ JNPT (Hrs.)	0.06	0.13	0.19	0.31	0.31	0.44	0.44
Total Time (Hrs)	**80**	**80**	**81**	**81**	**81**	**82**	**82**

Naturally, more Ro-Ro barges would be required in case return cargo is available at Terminal 4 on the return trip. Judging by the import-export skewed ratio at Ankleshwar ICD, the return cargo is very unlikely. As there is no involvement of a mother vessel at JNPT, the loading and unloading operation would not be conducted mid-sea or at the Anchorage. Instead 20-ft-container-laden trucks will be driven on to the barges. It's assumed that in an hour, 50 trucks can be rolled on to a barge. So, depending on the class of ro-ro barge used, loading time could range from 10 minutes to under an hour. A constant waiting time of half an hour has been considered throughout the logistic analysis. For unloading at Terminal 4, trucks would roll off the barges at a rate same as roll-on operation. Same as OPaL case, ro-ro barge will travel at 6 nmh loaded, and 9 nmh with ballast water.

7.6.2 Number of vessels required

The following

Table 7-8 and

Table 7-9 gives an estimate of the total number of Ro-Ro barges needed to move the projected number of traffic, as shown in Table 7-10. Total vessel requirements will differ based on the class of vessels that is ultimately chosen to container-laden trucks on River Narmada.

Table 7-8 Projected Traffic for Terminal 4 (Bhorbhatha Bet)

Cargo	Source - Destination	FY34	FY35	FY40	FY45
Containerized Cargo	Mumbai & Maharashtra Ports - Ankleshwar ICD (Import)	0.2	0.2	0.4	0.9
	Ankleshwar ICD - Mumbai & Maharashtra Ports (Export)	0.03	0.04	0.1	0.2
	Total	0.2	0.2	0.5	1.1

Table 7-9 Number of Ro-Ro barges required (One-way Ballast)

One-way Ballast	I	II	III	IV	V	VI	VII
Barge Parcel size	3	7	9	15	15	22	22
Turnaround of Barges - Day Navigation & Oneway Ballast	68	68	68	69	69	69	69
FY34 (0.2 mn T)	30	13	9	6	6	4	4
FY35 (0.2 mn T)	35	16	11	7	7	5	5
FY40 (0.4 mn T)	71	31	22	14	14	9	9
FY45 (0.9 mn T)	165	73	51	32	32	22	22

Table 7-10 Number of Ro-Ro barges required (No Ballast)

No Ballast	I	II	III	IV	V	VI	VII
Barge Parcel size	3	7	9	15	15	22	22
Turnaround of Barges - Day Navigation & No Ballast	80	80	81	81	81	82	82
FY34 (0.2 mn T)	21	9	7	4	4	3	3
FY35 (0.2 mn T)	24	11	8	5	5	3	3
FY40 (0.4 mn T)	49	22	15	10	10	7	7
FY45 (0.9 mn T)	115	51	36	22	22	16	16

Assuming an ideal Ro-Ro barge choice of Class IV, the total vessel requirement could be anywhere between 3 and 21. Operating such a large fleet of Ro-Ro barges is uneconomical and a gross waste of resources. The optimistic traffic projections aside, the sheer vessel requirement to accommodate the increase in traffic by FY45 is unrealistic. Looking at the entire operation from this single point of view, barging of cargo from and to Ankleshwar ICD seems unviable. Unless, the operator of Terminal 4 is willing to cap total exim up to a point that's commercially and technically feasible. This could limit overall cargo prospects for Terminal 4. Another alternative will be to start a feeder service instead of using barges. Feeder vessels would occupy larger fleet of trucks, slashing the total vessel requirement by a significant degree. However, a separate study would be needed to arrive at the technical parameters necessary to have such a vessel ply on River Narmada. This suggestion doesn't factor in the logistics cost involved in realizing the feeder vessel operation.

7.7 Summary & Recommendations

Logistics cost comparison is not a requirement to build a case for OPaL. The company intends to develop a cargo-handling facility for itself on River Narmada. They are not even inclined to rely on a third party to develop the infrastructure, or install the necessary equipments. All the company expects is for IWAI to develop the fairway for smoother cargo movement. This would also include maintaining navigable depth on the River round the year.

In case of logistics for Terminal 4, the competition will be against the currently practiced road and rail movement. The following Table 7-11 lists the typical cost heads that will be involved in overall logistics of the waterway movement between JNPT and Terminal 4.

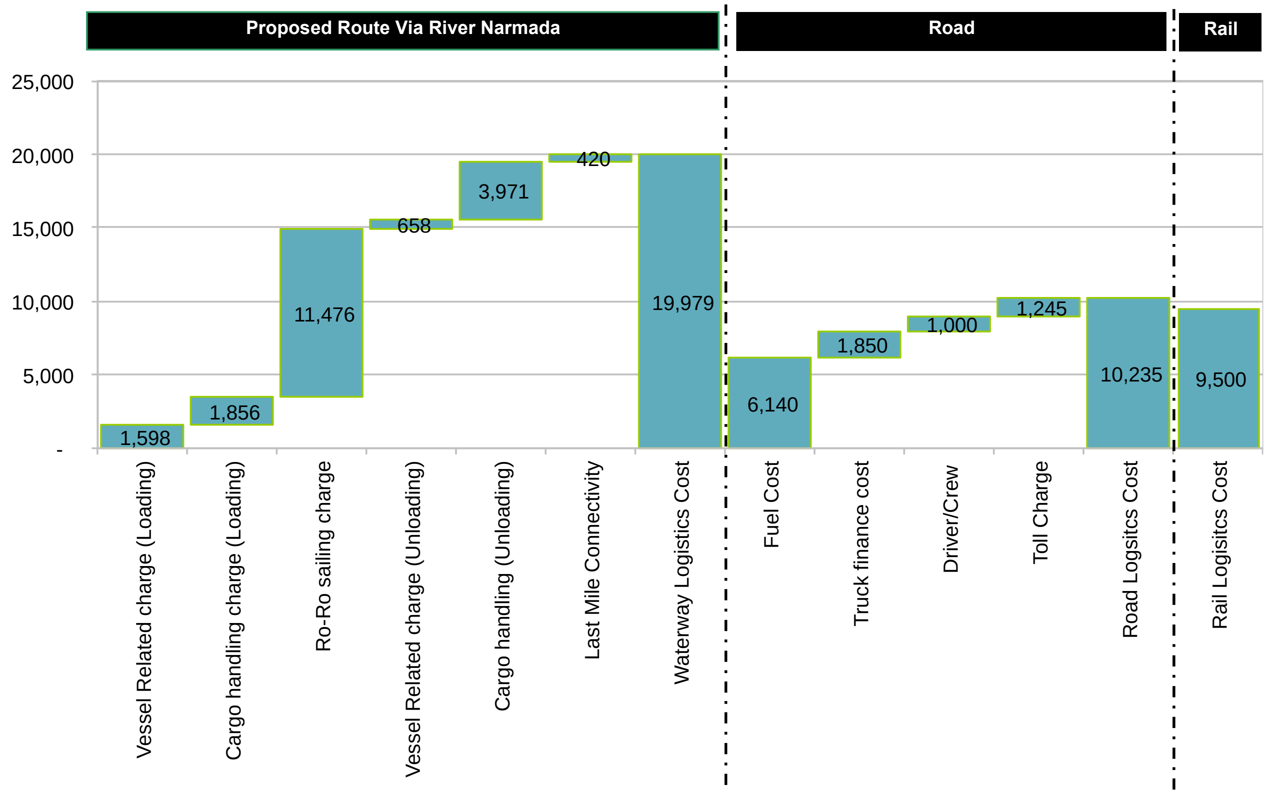
Table 7-11 Ro-Ro logistics cost analysis

Cost Head	Class III	Class IV	Class VI
Ro-Ro			

Cost Head	Class III	Class IV	Class VI
Ro-Ro			
Loading Charges			
Truck Loading rate (per hour) (Assumed)	50	50	50
Truck carrying capacity	9	15	22
Loading time (Hr)	0.2	0.3	0.4
GRT of Barge	375	750	1350
Berth Hire charge (INR) (per GRT/Hr)	38	76	136
Port Dues (for each entry)	761	1523	2741
Total vessel related charges (per entry)	**799**	**1,598**	**2,877**
Container handling charge	1,856	1,856	1,856
Total loading charges (INR/per Truck)	**2,655**	**3,455**	**4,733**
Ro-Ro sailing Charges			
Road Distance (JNPT – Ankleshwar) (km)	358	358	358
River Chainage (km)	385	385	385
Sailing time (JNPT-Terminal 4)	36	36	36
Fuel consumption (l/hr)	83	100	220
Fuel consumption per trip	2,971	3,565	7,843
Fuel Price	65	65	65
Fuel Cost	1,93,094	2,31,713	5,06,769
Charter rate (INR/Day)	60,000	80,000	1,00,000
Charter rate (INR/Trip)	60,000	80,000	1,00,000
Total Cost / Truck Revenue	2,53,094	3,11,713	6,09,769
Ro-Ro Sailing Charge	**26,667**	**20,410**	**27,855**
Unloading Charges			
Vessel Related Charges	2,115	4,230	7,614
Wharfage Charges - Private Jetty	2,468	3,971	5,692
Licence fee for Vessel GMB	1,50,000	3,00,000	5,40,000
Total Vessel Related charges (INR /Per day)	5,024	10,047	18,085
Unloading time (Hr)	0.2	0.3	0.4
Total Unloading charges (INR/TEU)	2,997	4,629	6,518
Last mile connectivity			
Terminal 4 to ICD Ankleshwar (INR/truck)	**420**	**420**	**420**
Total RO-RO cost	**20,940**	**19,979**	**21,414**
Road			
Fuel Cost (At 17.15/km)			6,140
Truck finance cost (per day)			1,850
Driver/Crew (per day)			1,000

Cost Head	Class III	Class IV	Class VI
Ro-Ro			
Toll Charges			1,245
Total Road Cost			**10,235**
Rail			
CONCOR Rail freight (INR/TEU)			9,500

Figure 7-6 Logistics cost comparison between existing & proposed route (INR/Truck)



It's clear that logistics cost incurred in waterway movement of containers will be 2 times the road and rail logistics cost. Intending to promote inland waterway, it's highly unlikely that even subsidies from the government would sway the industries or the transporters to forsake the cheaper road and rail for waterway.

Estimates suggest that River-sea vessels of Class III to Class VI will cost anywhere between INR 4 crore to INR 7 crore. In case of buying these vessels, then total investment will vary based on class type and annual fleet requirement as dictated by traffic projections.

7.8 Vessel Costing

As per directives received from IWAI 11.10.2017 in IWAI office, now the vessel will not be procured by IWAI. Hence, Vessel cost has been excluded from capital cost

7.8.1 Capital Cost

As above.

7.8.2 O&M Cost

As above.

CHAPTER – 8

NAVIGATION & COMMUNICATION SYSTEM

8.1 General Requirement

Navigational system is considered as an important aid for any vessel movement in coastal and river channel. Navigational Safety in Port's Committee was formed in India known as NSPC to ensure navigational safety in waterways.

8.1.1 VHF/HF

VHF communication system is a part of VTS/VTMS system i.e. Vessel Traffic system or Vessel Traffic Management System. This navigational system is required when there is heavy traffic at port or terminals. Though there are international standards published by IMO, each Country and each state or province also follows its own standard. It helps to locate exact position for berthing of vessels and decide traffic lane for vessels accordingly. VHF also comes under Marine Communication Systems. VHF Radio also known as very high frequency radio used for communicating between shore & vessels or between two vessels. Depending upon area of operations of various ships activity of VHF system differs. As per nautical miles from shore of vessels, various types of VHF radio frequency system are used for communication. For Narmada river vessels could contact terminal Manager via VHF system and would be provided guidance for berthing or for anchorage etc. This system would also help in planning vessels arrival & departure schedule for terminal or port.

8.1.2 Differential Global Positioning System (DGPS)

DGPS is satellite-based system. Generally DGPS system has two reference stations, two integrity monitors, control computer, communication system, marine radio beacons and continuous power supply. All these equipment's are necessary for DGPS system to function. Vessel monitoring & controlling could be done from various DGPS stations or remotely from other control stations. Using DGPS corrections could be made in GPS receiver to increase the accuracy of navigation. It is the advance version of GPS system. AT present there are 23 DGPS stations installed on entire coastline of India. In Gujarat, DGPS stations are installed at Okha, Hazira, Porbandar and Gopnath.

8.1.3 RIS/AIS/Radar/VTMS

- River Information System (RIS)

First RIS system has been introduced in India on NW 1 in Fy-16. RIS is a combination of software & hardware equipment used for optimization of traffic & vessels movement in Inland waterways for navigation purposes. RIS is used for electronic data transfer between vessels & shore. Using RIS system many waterway transportation risks like vessels collisions, Vessel – bridge collisions could be avoided. Narmada River also has many bridges on it. Vessels/barges that would use river could be benefitted by using RIS system and safely navigate in complete stretch of the river.

- Automatic Identification System (AIS)

AIS & RIS system together provide safe navigation for vessels. Both these systems are used simultaneously. Under AIS, vessels that would ply on whole river stretch are monitored. Remote stations/base stations site would be installed/developed for monitoring vessels and identify it. This would further strengthen safe navigation for vessels.

- Radar

Radar is basically used to locate other ships and nearby land area. In radar system there are X frequency & S frequency. X stands for secret & S for small range. Radar screen on ship display each and every object that are in the coverage of particular radar on ship. There is antenna on the top of radar, which continuously rotates, & flashes in order to find out any objects on the navigable path of the ships. It not only identifies objects but also shows its distance from ship. This also helps in avoiding accidents in the waterways. Radar system is also considered as user friendly and economical to install due to less consumption of power & electricity.

- Vessel Traffic Management System (VTMS)

Radar, VHF all is part of VTMS. Together it helps to plan ships arrival & departure, monitor anchorage activities, provide traffic guidance to ships and control traffic in the waterways. In case of emergency or rescue operations would be carried out successfully using VTMS system. Some of the vessels arriving at terminals on Narmada River would not be complying necessary norms for berthing purposes. In this case anchorage/pilotage or barges need to be used in order to access terminals on Narmada River. This could be done successfully using VTMS. Overall it helps to have complete control over management of vessels & terminal.

LIST OF EQUIPMENTS:

Sensor System

a. AIS Base Station

b. RADAR

c. VHF System

d. Meteo Sensor

e. Automatic Tank Gauge

Tracking

a. RIS Hardware (Servers & Computers)

b. RIS Software

Power Supply

a. UPS

b. DG Set

Civil Deliverables

a. Trestle Tower for installation RADAR

b. Building for installing RIS equipment / Porta cabin

RIS SYSTEM NARMADA RIVER (NW-73)				
Sr. No.	**Equipment**	**Qty**	**Unit Price**	**Total**
1	AIS Base Station	1	3000000	3000000
2	RADAR	1	5000000	5000000
3	Meteo Sensor	1	700000	700000
4	ATG	1	900000	900000
5	VHF	1	500000	500000
6	DG Set 10 KVA	1	700000	700000
7	UPS	1	500000	500000
8	RIS Software	1	3500000	3500000
9	RIS Hardware	1	10000000	10000000
10	Installation Testing & Commissioning	1	2000000	2000000
11	Porta cabin	3	1200000	3600000
12	Trestle Tower	1	1000000	1000000
			Total	**31400000**
	Operation			-
1	Engineer 1 * Site 1 * Months 12 per year	12	35,000.00	420000
	Operator 3 * Site 1 * Months 12 per year	36	20,000.00	720000
	Security 3 * Site 1 * Months 12 per year	36	15,000.00	540000
2	Second Year			1797600
3	Third Year			1923432
4	Fourth Year			2058072.24
			Total	**7459104.24**

RIS SYSTEM NARMADA RIVER (NW-73)				
Sr. No.	Equipment	Qty	Unit Price	Total
	CAMC for 4 Years			-
1	1st Year	1	3140000	3140000
2	2nd Year	1	3454000	3454000
3	3rd Year	1	3799400	3799400
				-
			Total	**10393400**
			Overall Cost	**49252504.24**

8.2 Existing System

At present there is no navigable or communication system developed on Narmada River.

8.3 Additional requirement

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

8.4 Costing

8.4.1 Capital Cost

Navigation & Communication Cost	In Crores
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (6 nos.)	0.12
RIS Station	4.93
Total Cost(III)	7.05
3% Contingencies and 7% Supervision charges on Base cost	0.70
Total Navigation & Communication Cost	7.75

Table 8.1 Capital Cost for Navigation Aids (Phase-1)

Navigation & Communication Cost	In Crores
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (54 nos.)	1.08
RIS Station	9.85

Navigation & Communication Cost	In Crores
Total Cost(III)	12.93
3% Contingencies and 7% Supervision charges on Base cost	1.29
Total Navigation & Communication Cost	14.22

Table 8.2 Capital Cost for Navigation Aids (Phase-2)

Navigation & Communication Cost	In Crores
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (20 nos.)	0.40
RIS Station	0.00
Total Cost(III)	2.40
3% Contingencies and 7% Supervision charges on Base cost	0.24
Total Navigation & Communication Cost	2.64

Table 8.3 Capital Cost for Navigation Aids (Phase-3)

8.4.2 O&M Cost

Table 8.4 Operation & Maintenance Cost (Phase-1)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	2.87
(ii)	Ports Crafts/Nav. Aids @ 5%	0.39
(iii)	Fuel Cost	1.00
(iv)	Power Cost	2.00
(v)	Manpower Cost	2.74
(vi)	Miscellaneous	0.50
	Total	**9.50**

Table 8.5 Operation & Maintenance Cost (Phase-2)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	10.30
(ii)	Civil works @ 1%	0.28
(iii)	Mechanical & Electrical Cost @ 5%	0.27
(iv)	Ports Crafts/Nav. Aids @ 5%	0.71
(v)	Fuel Cost	2.00

S.No.	O & M Cost	In Crores
(vi)	Power Cost	4.00
(vii)	Manpower Cost	5.50
(viii)	Miscellaneous	0.50
	Total II	**23.57**

Table 8.6 Operation & Maintenance Cost (Phase-3)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	3.14
(ii)	Civil works @ 1%	0.35
(iii)	Mechanical & Electrical Cost @ 5%	0.55
(iv)	Ports Crafts/Nav. Aids @ 5%	0.13
(v)	Fuel Cost	1.00
(vi)	Power Cost	2.00
(vii)	Manpower Cost	2.74
(viii)	Miscellaneous	0.50
	Total II	**10.41**

CHAPTER 9

ENVIRONMENTAL AND SOCIAL ASPECTS

9.1 Objective of Environmental and Social Studies

Objective of Environmental and Social Studies is to acquire an awareness of the environment as a whole and its related problems. Participate in improvement and protection of environment and develop the ability to evaluate measures for the improvement and protection of environment.

Need of the Project

IWAI, Govt. of India intends to find the viability of Narmada River (NW-73) as an Inland navigational waterway. The development of national waterway will help in transportation of cargo and passengers which will help in decongestion of traffic on roads and railways. The transportation through waterway is cheaper and requires less fuel which ultimately reduces the carbon emission and is environment friendly, the development of waterway will contribute to the economy of the country.

This section discusses the global concept of the environmental problem arising as a result of the development of Inland waterway navigation project in Narmada River, construction of terminals and effects on environment due to movement of cargo. The section will cover the land usage pattern along the study area, Physiography of the area, Presence of any National Park, Wild life protected sanctuaries, Wetlands, flora and fauna, Protected sites, Archaeological survey of India declared sites present within 10 km radius will be shown. It will also cover the Geology pattern, air quality and susceptibility to natural hazards of the study area.

Some of the environmental problems are air, land and water pollution, environmental health degradation, rehabilitation, wildlife migration etc. The continuous increase in concentration of air pollutants in the atmosphere has threatened the Green House and atmospheric ozone layer at global level. The carbon dioxide is mainly responsible for Green House effect. Navigation development projects are also of great concern for the environmental degradation. These ecological environmental changes may be reversible or irreversible, due to many interacting parameters. In general the combined effect of two parameters is greater than that of individual one. Consequently these impacts could have repercussions on others. The internationally accepted practice of studying environment impact involves its identification, prediction and evaluation.

Environmental Management Plan (EMP) based on the environmental baseline conditions, planned project activities and impacts assessed earlier, this section enumerates the set of measures to be adopted to minimize the adverse impacts.

To sum up, the objectives of environmental and social studies are to develop a world in which persons are aware of and concerned about environment and the problems associated with it, and committed to work individually as well as collectively towards solutions of current problems and prevention of future problems.
For collection of data related to environment setting in the project area the correspondence Letter *to Additional Principal Conservator of Forests, Gandhinagar dated 6th April,2017 by WAPCOS has been attached in page no:- 264-265*

9.2 Environmental Setting in the Project Area

Narmada River is largest west flowing River of India. It flows through the states of Madhya Pradesh (1,085 km), and thereafter forms the common boundary between Madhya Pradesh and Maharashtra for 39 km, and Maharashtra and Gujarat for 43 km and though Gujarat (166 km).

Narmada basin is bounded on the north by the Vindhyas, on the east by the Maikala range, on the south by the Satpuras and on the west by the Arabian Sea. Lying in the northern extremity of the Deccan plateau, the basin covers large areas in the States of Madhya Pradesh, Gujarat and a comparatively smaller area in Maharashtra and Chhattisgarh. The basin is divided into 3 sub-basins. The Narmada Upper, middle and lower sub-basin with a total of 150 watersheds. Narmada River drains an area of 92,672.42 Sq.km (3% of total geographical area of the country).

The total length of Narmada River from origin to its outfall in the Gulf of Khambhat is 1333 km. The length under consideration for present studies is detailed below:

227 Km length of the river from Pandhariya to confluence of Narmada with Arabian Sea at Gulf of Khambhat (National Waterway 73)	From: 21^{0}57’10.37”N 74^{0}08’27.46”E	Up to: 21^{0}38’26.81”N 72^{0}33’28.24”E

The map showing entire Narmada basin (Source: INDIA WRIS wiki) and Present study stretch is attached as Figure 9.1 (A3 size map of basin attached after last page-269 of this chapter) & Figure 9.2 respectively.

Fig:-9.1 Narmada Basin

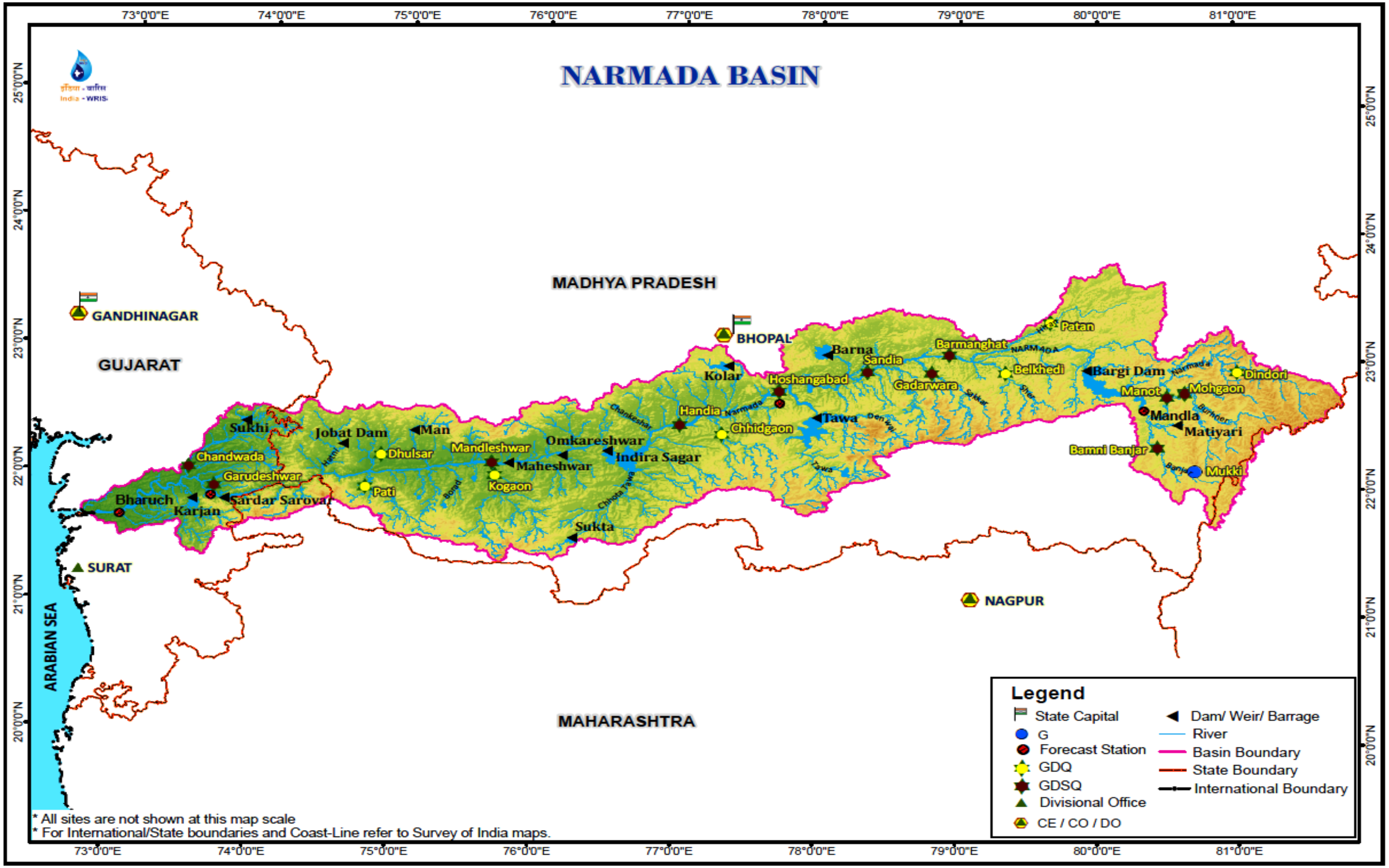
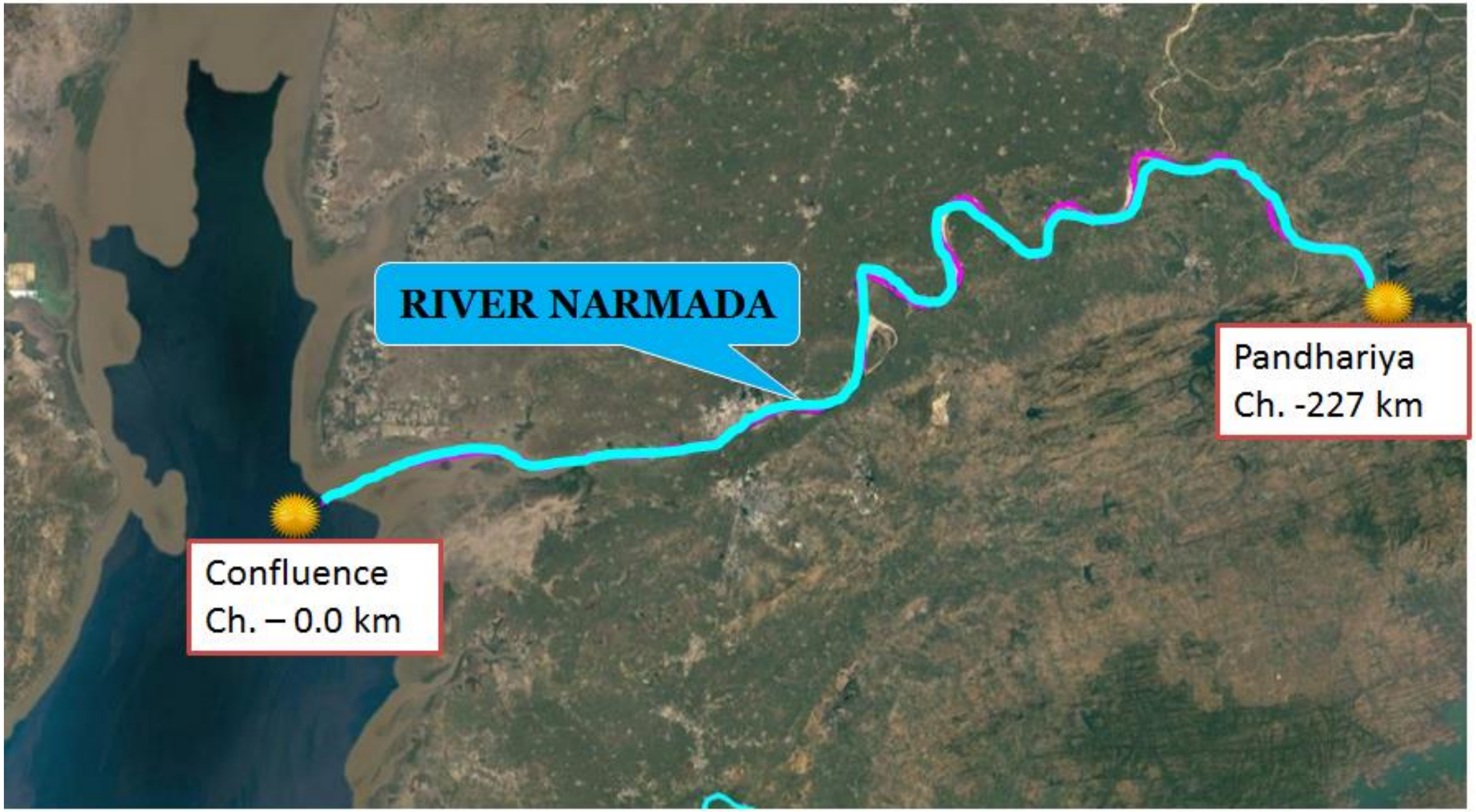


Fig:-9.2 Map showing present stretch of study of River Narmada



Source:-Google Earth

9.3 Physiographic

Physiography of India shown in Fig: 9.3 India Physical map.

The Tropic of Cancer passes through eight states in India – Gujarat, Rajasthan, Madhya Pradesh, Chhattisgarh, Jharkhand, West Bengal, Tripura and Mizoram.

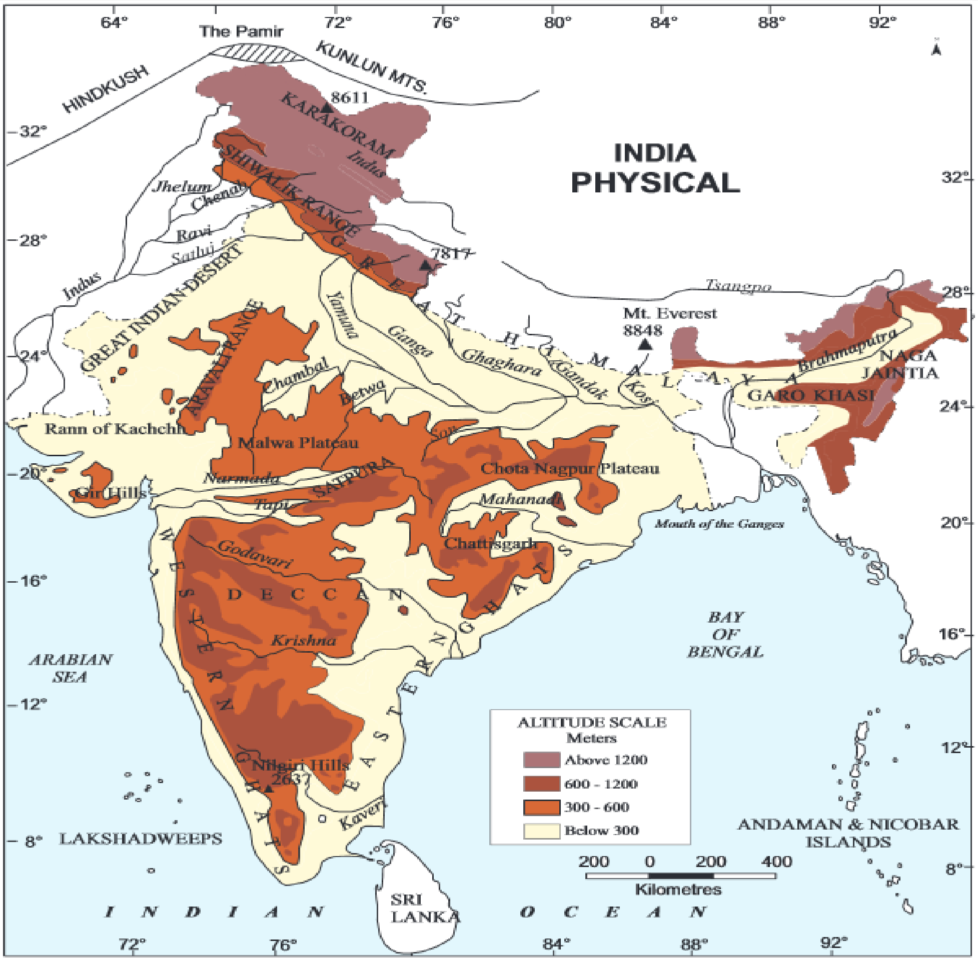
Between the Western and Eastern longitudes there is a difference of 30 degrees which causes a difference of about two hours between the western-most and eastern most areas of the country. The Standard Meridian lies on 82°30′ East longitude, which falls in the middle of the country. It sets the Indian Standard Time (5 and half hour ahead of GMT). The Standard Meridian passes through Mirzapur near Allahabad in Uttar Pradesh.

The coastal plains in India are situated parallel to the Arabian Sea and Bay of Bengal. On the basis of location and active geomorphic processes, it is divided into Western and eastern Coastal Plains. The Western Coastal Plain – Extends from Rann of Kachchh to Kanyakumari. It has four divisions:

Kachchh & Kathiawar coast in Gujarat, Konkan coast in Maharashtra, Goan coast in Karnataka and Malabar Coast in Kerala (has backwaters aka 'kayal'). The western coast is narrow in middle and gets broader in north and south. The rivers in Western Coast do not form Delta.

Physiographically, the basin can be divided into hilly and plain regions. The hilly regions are in the upper part of the basin as well as in the lower middle reaches and are forested. The plain regions in between the hilly tracts and in the lower reaches are broad and fertile areas well suited for cultivation. The available information on soil survey conducted in the basin indicates that black soils are predominant in the basin. The coastal plains are composed of alluvial clays with a layer of black soil on top. The culturable area of the basin is about 5.9 Mha which is 3% of the total culturable area of the basin.

Fig: 9.3- India Physical map



The basin has five well defined physiographic zones. They are –

(i) The Upper hilly areas,
(ii) The Upper Plains,
(iii) The middle plains,
(iv) The lower hilly areas and
(v) The lower plains.

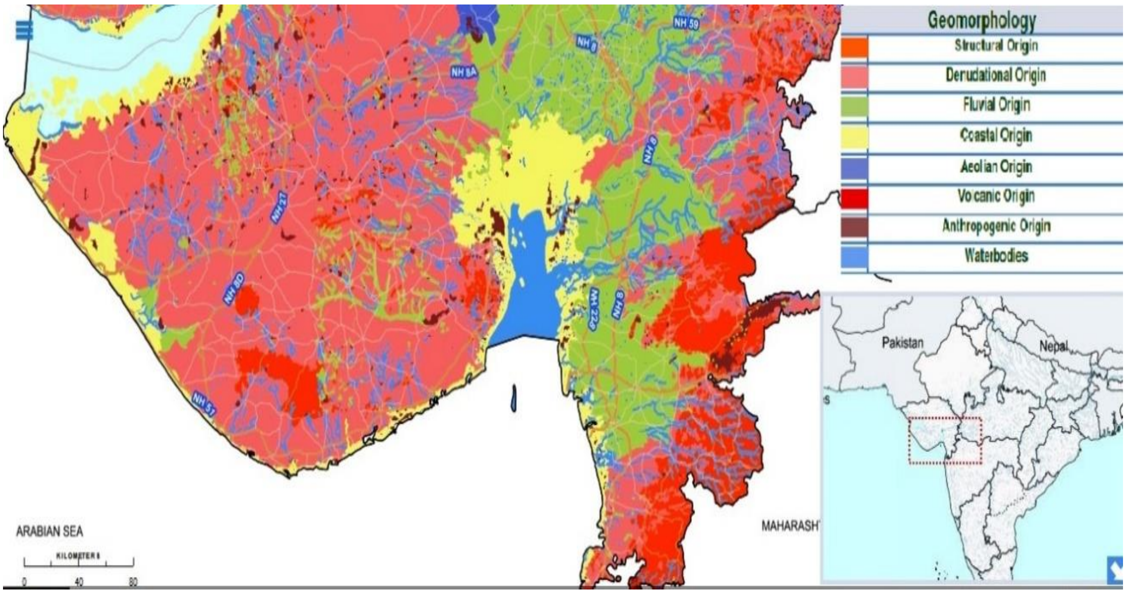
The maximum area of the basin falls in the 300-500 m elevation range. Maximum elevation is observed in the upper most region of the basin. The highest elevation in the basin is 1,317 m.

9.4 Geology and Seismicity (From Primary / Secondary Sources)

9.4.1 Geology

The Geology and seismicity pattern of the region is discussed **Fig 9.4 & 9.5 respectively**

Fig: - 9.4 Geology pattern of Gujarat

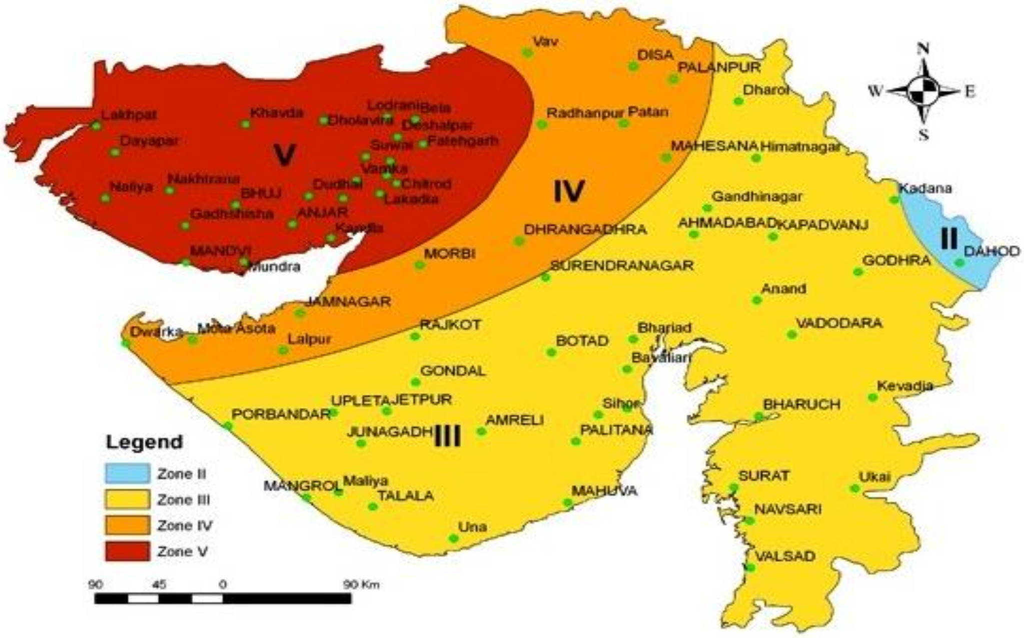


As per figure shown above, our project area is in Gujarat which comprises of fluvial and structural origin.

The Narmada Valley is a graben, a layered block of the Earth's crust that dropped down relative to the blocks on either side due to ancient spreading of the Earth's crust. Two normal faults, known as the Narmada North fault and Narmada South fault, parallel to the river's course, and mark the boundary between the Narmada block and the Vindhya and Satpura blocks or Horsts which rose relative to the Narmada Graben. The Narmada's watershed includes the northern slopes of the Satpuras, and the steep southern slope of the Vindhyas, but not the Vindhyan tableland, the streams from which flow into the Ganges and Yamuna. The Narmada valley is considered extremely important for palaeontological studies in India. Several dinosaur fossils have been found in the area including Titanosaurus indicus found in 1877 by Richard Lydekker and the recently discovered Rajasaurus narmadensis.

9.4.2 Seismicity

Fig: - 9.5 Seismic Map of Gujarat



As per Map shown above it is clear that our project area lies in the Zone III of seismic zone.

9.5 Climate

The climate of the basin is humid and tropical, although at places extremes of heat and cold are often encountered. In the year, four distinct seasons occur in the basin: Cold weather, hot weather, south-west monsoon and post-monsoon. The cold weather season commences in November and continues till the end of February. The hot weather starts in March and continues up to the middle of June. May is usually the hottest month. This season is generally dry. The south-west monsoon sets in by the middle of June and withdraws by the first week of October. June to September is the rainiest months. In the post-monsoon season, a few thunder-storms occur, especially in October. Thereafter, the weather clears up and dry pleasant weather prevails throughout the valley.

The temperature is maximum in the month of May and minimum in the month of January. In general, the upper Narmada Basin records lower temperature as compared to middle basin. In lower section of the basin, the influence of the sea is prominent, and temperature though lowers than the middle basin, is higher than the upper reaches of Narmada River. In the cold weather, January month records the lowest temperature (Minimum Temperature -10.87°C) and May records the highest temperature (MaximumTemperature -40.58 °C) in the hot weather for the period of 36 years.

9.6 Soils

Black soils are predominant in the basin. The majority of the soil is characterized by shallow black soils in the upper basin. In the lower part of the basin, the major soils of the valley and southern plateau are medium deep black soils. On the other hand mixed red and black soils occur in the northern plateau. The sample were collected at 23 locations of the river whose sample wise soil strata is mentioned in the table 9.1.

Table 9.1 Soil sample at different stretch

Sample No.	Ch.(km)	Soil Strata	Depth(m)
NMD_01	3.41	Silt ,Clay	6.6
NMD_02	11.75	Sand, Silt	4.5
NMD_03	20.5	Silt,Sand	3.2
NMD_04	30.03	Sand,Silt	3.8
NMD_05	41.26	Silt,Sand & Gravel	3.2
NMD_06	50.42	Silt,Clay	6.7
NMD_07	60.82	Silt,Sand	2.5
NMD_08	72.2	Silt,Clay	5.8
NMD_09	82.15	Silt,Sand	2.6
NMD_10	96.47	Sand,Silt	2.5
NMD_11	105.25	Sand,Silt & Gravel	0.8
NMD_12	114.31	Sandy	3.5
NMD_13	122.31	Sandy	13.1
NMD_14	130.24	Sandy	2.8
NMD_15	142.55	Sandy Silt	5.0
NMD_16	152.36	Silty Sand & Gravel	10.5
NMD_17	165.91	Sandy	1.1
NMD_19	183.73	Sandy silt & Gravel	58.6
NMD_20	193.39	Sandy Silt	65.8
NMD_21	206.32	Silty Sand	56.4
NMD_22	215.76	Gravel,Silt	58.8
NMD_23	223.62	Sandy Silt	54.7

Grain size analysis of the particle was also done and the same has been mentioned in the *Annexure 10* of the hydrographic survey Report.

9.7. Land Use Pattern

The major land use/ cover classes of Narmada Basin are- Agriculture, Forest, Wasteland, Water bodies and Built-up land. Agriculture is the dominant land use category (56.90 %) in the basin. Also, a large part is covered by forest accounting to

32.88 % of the total area of the basin.

The major land uses observed near to the area of interest are Industrial (up to 50 km chainage), Agricultural (predominantly from 50 to 150 Km), Wasteland (Predominately 150 to 182.5 Km) and forest area (Predominately 182.5 to 227 Km).

Table: - 9.2 Land use pattern of the districts along the Narmada river stretch

Area in Thousand Hectares

District	Forest	Non-Agriculture	Net Sown Area	Uncultivable Barren Land	Fallow lands	Cultivable Waste	Others	Total Area
Bharuch	26	73	327.2	0	50.8	31	16	524
Narmada	121.2	3.2	111.1	0	13	16.5	11	275.5
Vadodara	80	126	520	0	20	7	0	753

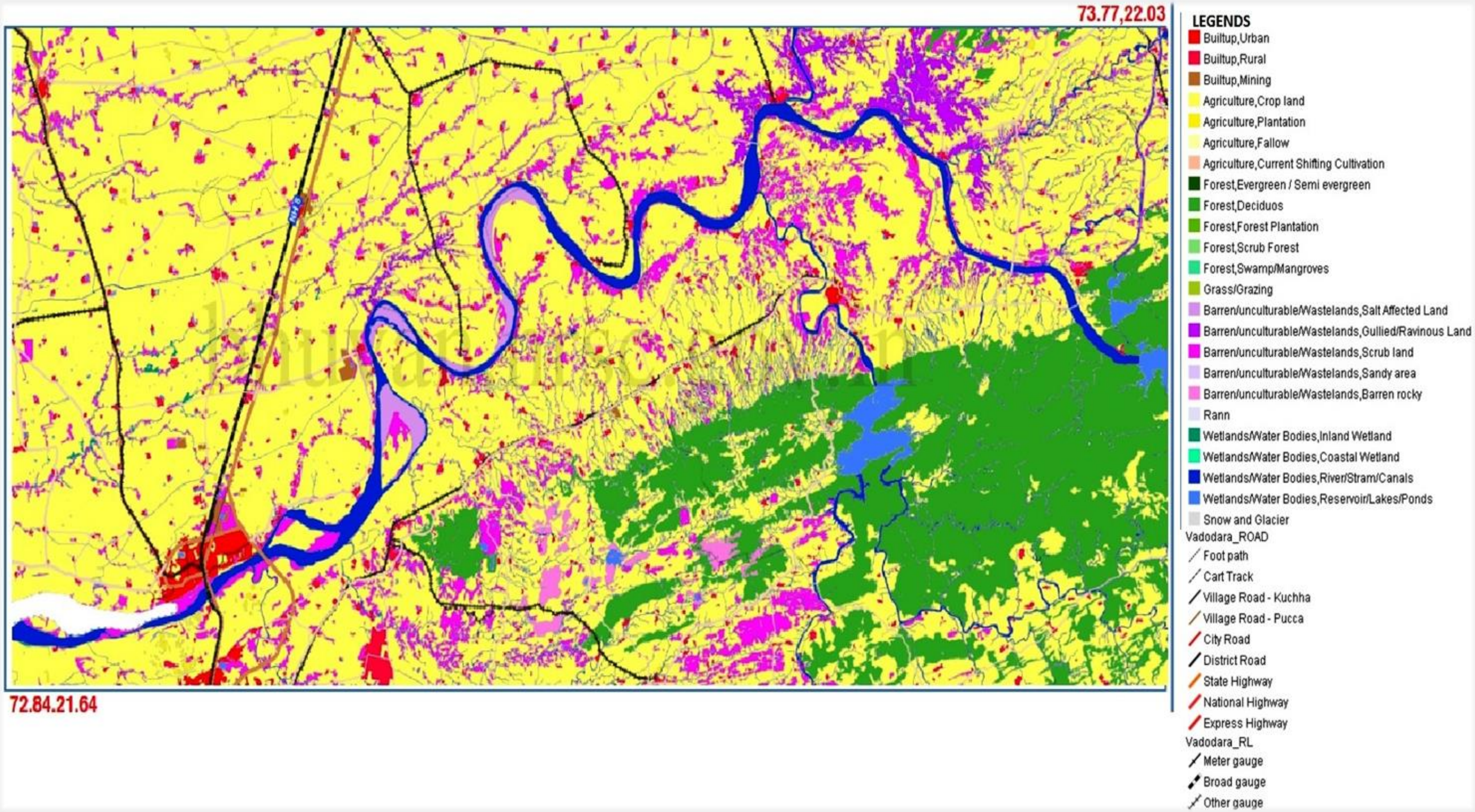
Of the total land area in Bharuch district, a vast portion of about 62 % comes under the net sown category. This is followed by Non-agricultural area and fallow lands each at 14 % and 10 % of the net sown area in district. The district has about 1,27,000 farmers. Out of these 36 % of farmers have less than 1 hectare farming area, about 27 % have area between 1-2 hectares, 27 % have land holdings between 2-5 hectares and only 10 % of farmers have land holdings above 5 hectares. About 5% of total district area is covered by forest. Baruch is an important industrial area along the Narmada River.

Majority of the area in Narmada district comes under forest area. About 44 % of total district area comes under forests. Shoolpaneshwar Wildlife Sanctuary is located in the Narmada district of Gujarat. This sanctuary has 607.70 sq km areas. Over 40% of the total area in district is net sown area. Apart from this the waste cultivable and fallow lands form about 11 % of total district area together. The district has about 17,923 farmers. Out of these 32 % of farmers have less than 1 hectare farming area, about 32 % have area between 1-2 hectares, 28 % have land holdings between 2-5 hectares and only 6 % of farmers have land holdings above 5 hectares.

In Vadodara district, more than 69 % of area is net sown. This is followed by non agriculture land (17 %) and forest area (11 %).The district also has 3 % off allow land less than 15 % area is occupied by cultivable wasteland. Out of these, only 39 % have less than1 hectare land. Medium and large scale farmers (31 % of total land holdings) take up to 68 % of total land in the district. The combined land occupied by small and medium scale farmers (i.e. less than a hectare and between 1-2 hectare lands) is only 32 %. Vadodara is an important industrial area along the Narmada River.

The satellite image of the present scope of the study is shown in figure 9.6

Figure 9.6 Satellite image of land use pattern



Source: *ISRO, Bhuvan*

Crops and Agriculture in the Region:

Agriculture:

Bharuch

Banana and cereals dominate about half of the production of district. More than half of the total sown land area is occupied by cotton & pulses. Wheat, Rice, cereals, pulses is major food crops cultivated in the area while major cash crops are cotton and banana. Major crops shown in Table 9.3

Table 9.3 Major crops for Bharuch District

Major Crops	Area in(00 Hectares)	Production in('00 tonnes)	% to total area sown
Wheat *(Triticum aestivum)*	168	337	5%
Sugarcane (*Saccharum officinarum)*	208	1514	6%
Paddy *(Oryza sativa)*	132	247	4%
Banana *(Musa paradisiaca)*	45	2860	1%
Other Cereals	508	858	16%
Pulses	804	715	25%
Cotton *(Gossypium arboreum)*	1184	2231	36%

Bharuch has a tropical savanna climate, moderated strongly by the Arabian Sea. The summer begins in early March and lasts until June. April and May are the hottest months, the average maximum temperature being 40 °C (104 °F). Monsoon begins in late June and the Village receives about 800 millimetres (31 in) of rain by the end of September, with the average maximum being 32 °C (90 °F) during those months. October and November see the retreat of the monsoon and a return of high temperatures until late November. Winter starts in December and ends in end of February, with average temperatures of around 23 °C (73 °F).

Majorly, three types of soil are present in the district – Heavy black soil (Plain), Heavy black soil (Coastal) and sandy loam soil. Soil Profile shown in Table 9.4

Table 9.4 Soil profile of Bharuch District

Major Soils In Bharuch	Area ('000 ha)	% of total
Heavy black Soil (plain)	327.61	62.52
Heavy black Soil (coastal)	75.25	14.36
Sandy loam	121.15	23.12

Narmada

Wheat, paddy, Makka, Sugar cane and bajra are the major food crops, while Cotton, Ground nut, castor, and soya bean are the major commercial crops grown in the district .Banana is major crop in plantation. Hence, there exists huge potential for establishing new fruit processing industry in the district. Narmada houses Herbal Botanical Garden, consisting of almost 70 species of herbal plants, which are used for the ayurvedic and natural therapy treatment. Table 9.5 shows Major crops of Narmada District.

Table 9.5 Major crops of Narmada District

Major Crops	Area (00 Ha)	Production in ('00 tonnes)	% to total are sown
Cereals	364	573	33%
Banana*(Musa paradisiaca)*	52	3586	5%
Paddy*(Oryza sativa)*	120	105	11%

The district has semi-arid climate. Extreme temperatures, erratic rainfall and high evaporation are the characteristic features. The average annual normal rainfall is 924.8mm for the 30 years. Generally, four types of soil are present in the district:

Black cotton soil: These soils have their origin in trap. They are varies from 60 cm to as high as a few meters.

Gorat soil: It is a sandy alluvial type of soil with contain 40% clay and grater sand particle that's why it do not retain moisture.

Bhatha soil: It is lateritic type of soil; containing lot of pebbles with water observation Capacity is low.

Stony soil: The stony soil covers only forest areas and no cultivation is done on these soils.

Vadodara

The district areas have varied agriculture crops, both food crops &nonfood crops. Main food crops consist of food grains such as paddy, wheat, jowar, bajra, maize etc., and pulses. Other food crops are sugarcane, fruits & vegetables. Non food crops consist of cotton, oil ground nut, castor, tobacco, fodder etc. The majority of the production is dominated by Cotton, maize and cereals. Major crops shown in Table 9.6

Table 9.6 Major crops for Vadodara District

Major Crops	Area in (00 Hectares)	Production in (00 tonnes)
Paddy*(Oryza sativa)*	551	681
Cotton *(Gossypium arboreum)*	1663	6616
Maize*(Zea mays)*	1243	2513
Wheat *(Triticum aestivum)*	475	1326
Cereals	2485	4895

Vadodara lies in transition zone of heavy rainfall areas of South Gujarat and arid areas of North Gujarat plains have sub-tropical climate with moderate humidity. The various season of the year are (a) monsoon - middle of June to October, (b) winter – November to February, and (c) summer – March to June. From March onward the temperature starts rising till it reaches maximum, as high as 41° C in some parts of the district. January is the coldest month of the year. The average annual rainfall ranges in between 900 mm to 1200mm.The soils of Vadodara district can be broadly classified into three groups: black soils, alluvial soils and hilly soils.

9.8 Ambient Air Quality (From Primary / Secondary Sources)

Ambient air quality was collected from the Gujarat Pollution Control Board under the following programme for the Year 2014-15 average is presented below.

1. NATIONAL AIR QUALITY MONITORING PROGRAMME (NAMP)

Under this project Ambient Air Quality monitoring is carried out at 38 stations in the state with the financial help of the Central Pollution Control Board, Delhi. The ambient air quality samples were collected as per the standard norms for ambient air quality monitoring prescribed by CPCB. Status of Ambient Air Quality monitoring NAMP Project. Narmada River is presented in **Table 9.7** for Year 2014-15 average is presented below

Table 9.7 Air quality data [Yearly average 2014-15]

S. No	City	LOCATION	PM 10	PM 2.5	SO2	Nox	O3	NH3	CO	Pb	As	Ni	Benzene	Benzo- a-pyrene
		NATIONAL AMBIENT AIR STANDARDS	60	40	50	40	100	100	2	0.5	6	20	5	1
1	ANKLESHWAR	RALLIS (INDIA) LTD.	92	31	15.3	22.4	10.7	10	1.4	0.15	<1.0	2	2.1	<0.5
2		DURGA TRADERS	87	32	13.6	21.4	11.4	9.3	1.41	0.1	<1.0	2	2	<0.5
3		GIDC JHAGADIA	84	31	13	20.5	11.5	9.1	1.44	0.08	<1.0	2	2.1	<0.5
4		PANOLI	82	30	13.3	20.4	11.3	9.3	1.41	0.09	<1.0	1.9	2.1	<0.5
5	BHARUCH	DAHEJ SEZ	85	30	13.3	20.8	12.1	9.4	1.42	0.09	<1.0	1.7	1.9	<0.5
6		SARASVATI T/S	82	30	13	20.7	11.8	9.2	1.46	0.08	<1.0	1.7	1.9	<0.5
7	BARODA	NANDESARI CETP	96	37	15.2	22.3	10.1	11.5	1.97	0.3	<1.0	1.6	2.5	<0.5
8		GPCB OFFICE	80	30	12.6	19.4	11.3	9.6	1.41	0.06	<1.0	1.3	1.4	<0.5
9		DANDIYA BAZAR	91	34	14	21.7	11.2	9.9	1.6	0.27	<1.0	2.2	2.7	<0.5
10		STERLING GELATIN	90	35	13.6	21.4	11.1	9.3	1.48	0.1	<1.0	1.9	2	<0.5

All parameter are express in µg/m3

Source:-Gujarat pollution control board

Form the table it is clear that the level of PM10 is higher from the permissible ambient air quality standards for the above mentioned cities Ankleshwar, Bharuch and Baroda rest other parameters are within the NAAS limits.

2. State Air Quality Monitoring Programme (SAMP):

Under this project Ambient Air Quality monitoring is carried out at 24 stations in the state. The ambient air quality samples were collected as per the standard norms for ambient air quality monitoring prescribed by CPCB.

Status of Ambient Air Quality monitoring SAMP Project the air quality data of city near to Narmada River is presented in Table **9.8** for Year 2014-15 average is presented below.

Table 9.8 Air quality data *[Yearly average 2014-15]*

S. No	City	LOCATION	PM 10	PM 2.5	SO2	Nox	O3	NH3	CO	Pb	As	Ni	Benzene	Benzo- a-pyrene
		NATIONAL AMBIENT AIR STANDARDS	60	40	50	40	100	100	2	0.5	6	20	5	1
1	ANKLESHWAR	PIRAMAL VILLAGE	83	30	13	20.7	11.9	9.1	1.47	0.07	< 1	1.3	1.7	< 0.5
2		VALIA ROAD	85	30	13.2	20.6	12.3	10.4	1.43	0.09	< 1	1.3	1.5	< 0.5
3	BARODA	BAPOD	84	31	13	20.3	10.7	10.5	1.41	0.08	< 1	1.3	1.3	< 0.5
4		CHHANI	93	34	14.5	21.5	11.5	10.4	1.45	0.14	< 1	1.6	1.9	< 0.5
5		GOTRI	87	32	13.8	21.1	10.1	9.9	1.3	0.08	< 1	1.3	1.4	< 0.5
										All parameter are express in µg/m3				

Source:-Gujarat pollution control board

Form the table it is clear that the level of PM_{10} is higher from the permissible ambient air quality standards for the above mentioned cities Ankleshwar and Baroda rest other parameters are within the NAAS limits.

9.9 Noise Levels (From Primary / Secondary Sources)

Noise levels of the Bharuch, Vadodara and Ankleshwar were collected from pollution control board of Gujarat shown in **Table 9.9**

Table 9.9 Noise Levels Report

Location	Place	Day	Date	Avg. Equivalent dB(A)
Bharuch	Narayan Kunj Society, Bholav	Pre Diwali	15.10.2014	54.19
		Diwali	23.10.2014	90.77
Bharuch	Tulsidham, Zadeshwar road, Bharuch	Pre Diwali	15.10.2014	54.8
		Diwali	23.10.2014	92.83
Bharuch	Jalaram Mandir, Kasak Circle, Bharuch	Pre Diwali	15.10.2014	55.05
		Diwali	23.10.2014	95.19
Bharuch	Shaktinath Mandir, Bharuch	Pre Diwali	15.10.2014	55.92
		Diwali	23.10.2014	95.14
Vadodara	Bapod Area, Vadodara	Pre Diwali	15/10/2014	55.83
		Diwali	23/10/2014	72.77
Vadodara	Gotri, Vadodara	Pre Diwali	15/10/2014	56.58

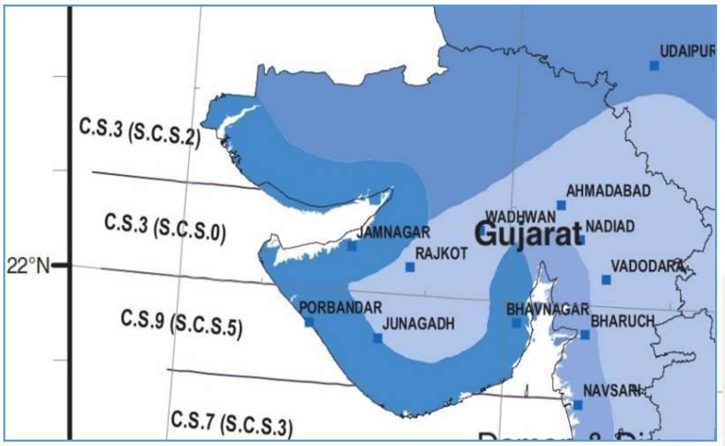
Location	Place	Day	Date	Avg. Equivalent dB(A)
		Diwali	23/10/2014	78.02
Vadodara	Dandia bazar, Vadodara	Pre Diwali	15/10/2014	55.41
		Diwali	23/10/2014	80.45
Ankleshwer	O.N.G.C. colony, Ankleshwar, Dist. Bharuch	Pre Diwali	Normal day	55.85
		Diwali	23/10/2014	90.17
Ankleshwer	Manav Mandir, GIDC,	Pre Diwali	Normal day	56.86
		Diwali	23/10/2014	88.23
Ankleshwer	Dolat Bazar, Rajpipla, Dist. Narmada	Pre Diwali	Normal day	55.85
		Diwali	23/10/2014	85.26
Ankleshwer	Station road, Safed Tower, Rajpipla, Dist.	Pre Diwali	Normal day	55.98
		Diwali	23/10/2014	82.40

Source:-Gujarat pollution control board

9.10 Susceptibility to Natural Hazards

Susceptibility to Natural hazards like cyclone, flood and earthquake is shown **Fig 9.7, Fig 9.8** in the map.

Fig. 9.7 Wind and Cyclone hazard Map



It can be seen from the map of wind and cyclone hazard that our project area is falling in low to moderate range of risk.

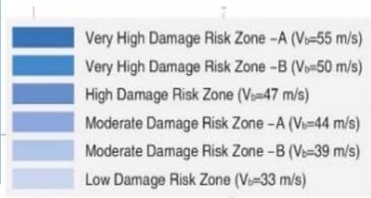
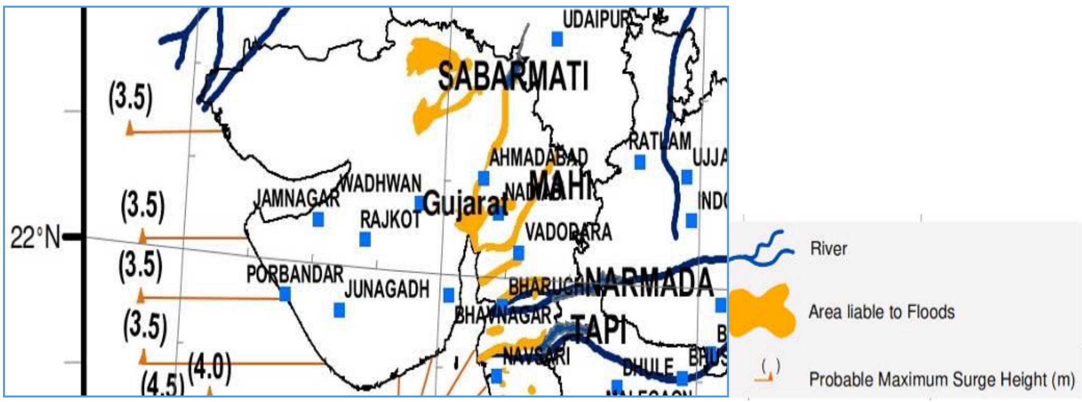


Fig. 9.8 Flood Hazard Map



The above figure shows the areas liable to flood and probable maximum surge height.Earthquake prone areas has been already discussed in point 9.4 which shows our project area falls in seismic zone III.Hence the project area is not prone to natural hazards.

9.11 Estuary and Coastal Zone

An estuary is a partially enclosed body of water along the coast where freshwater from rivers and streams meets and mixes with salt water from the ocean. Estuaries and the lands surrounding them are places of transition from land to sea and freshwater to salt water. Although influenced by the tides, they are protected from the full force of ocean waves, winds, and storms by such land forms as barrier islands or peninsulas.

The reconnaissance revealed that the land around the coastal zone area is covered with natural vegetation including little amount of mangroves. Jangali Babul (*Prosopis juliflora*) is observed to be dominant along the roadside and near the seashore. The areas near the seashore are mostly affected by tides and remain submerged for considerable time. Thus the seashore is inhabited by small salt tolerant plants (mangroves ecosystem) such as *Avicenia, Rhizophora* and *Prosopis juliflora* only on high lands. Aliabet, an island near the mouth of Narmada, is also affected by the tidal fluctuations.

Important coastal area

<u>Important Coastal and Marine Biodiversity Areas(ICMBAs)</u>

India has taken several steps to achieve the National Biodiversity Target no 6 and Aichi Biodiversity Target no 11 which aim to conserve a substantial portion of the coastal and marine areas in the country and world respectively. Towards achieving these two targets, 106 coastal and marine sites have been identified and prioritized as Important Coastal and Marine Areas (ICMBAs) by the Wildlife Institute of India. Sixty-two ICMBAs have been identified along the west coast of India, and 44 have been identified along the east coast. Of these, 22 ICMBAs have been prioritized for immediate conservation actions and proposed to be upgraded as Protected Areas under categories such as Conservation or Communities Reserve to increase participation of the local communities in governance.

Important Coastal and Biodiversity Areas (ICMBA) in Anand and Surat district shown in table 9.10 and fig 9.9 to fig. 9.11 below

Table 9.10 Important Coastal and Biodiversity Areas(ICMBA) in Anand and Surat district

Figure	District	Identified Site	North	East	Area (Km^2)	Suggested category
9.9	Anand	Wadgham	22°16.414	72° 27.661	927	Cons. / Comm.
9.10	Surat	Aliabet	21°38.294	72° 42.909	647	Cons. / Comm.
9.11	Surat	Purna	20°56.254	72° 48.201	147	Cons. / Comm.

Fig:- 9.9 Protected site Wadgham

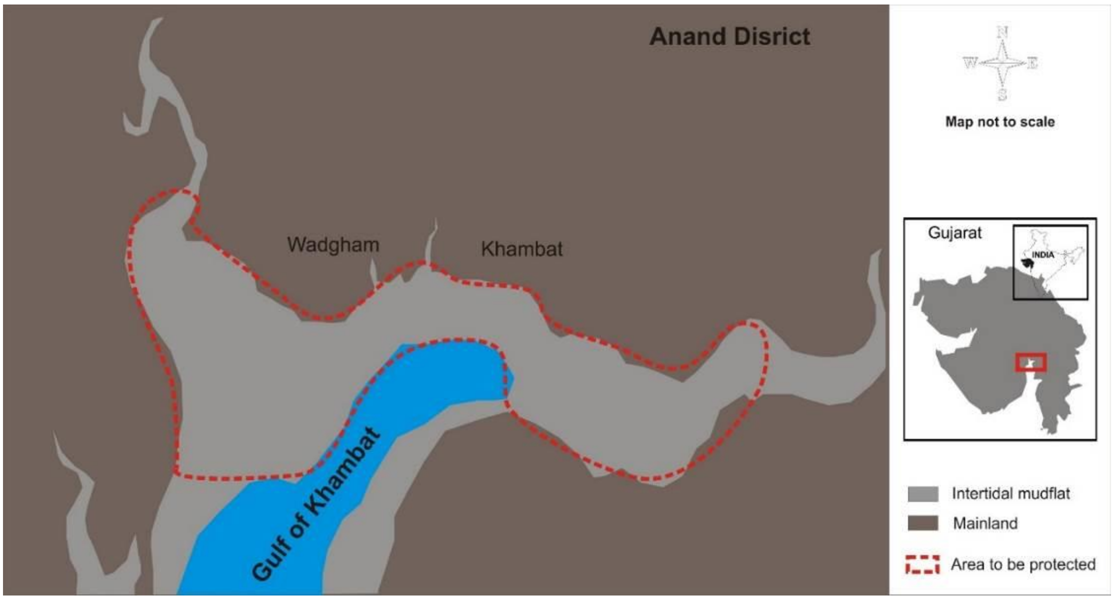


Fig :- 9.10 Protected site Aliabet

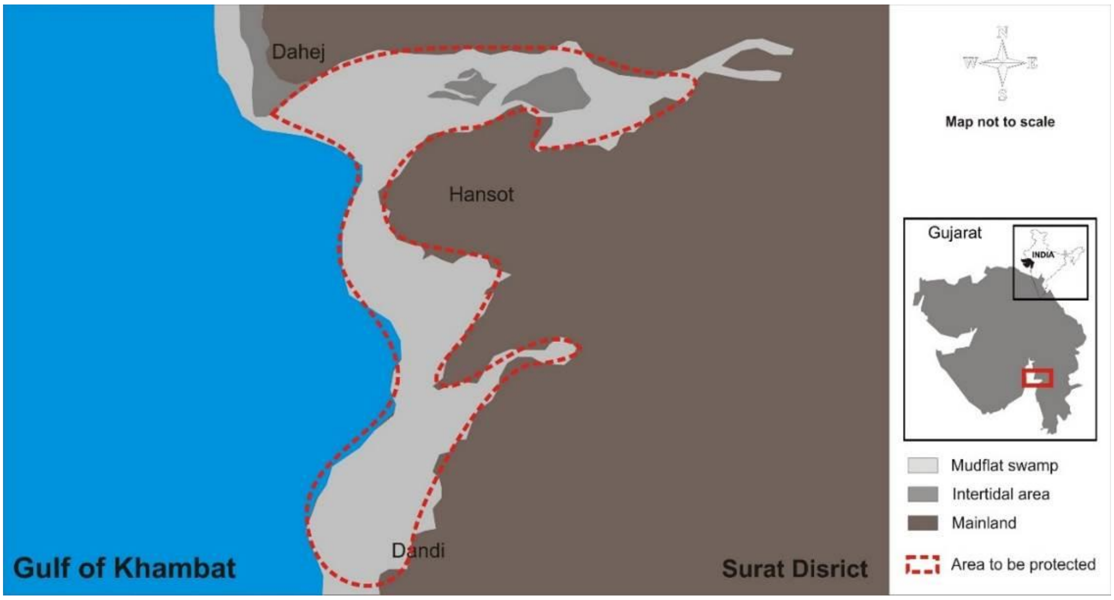
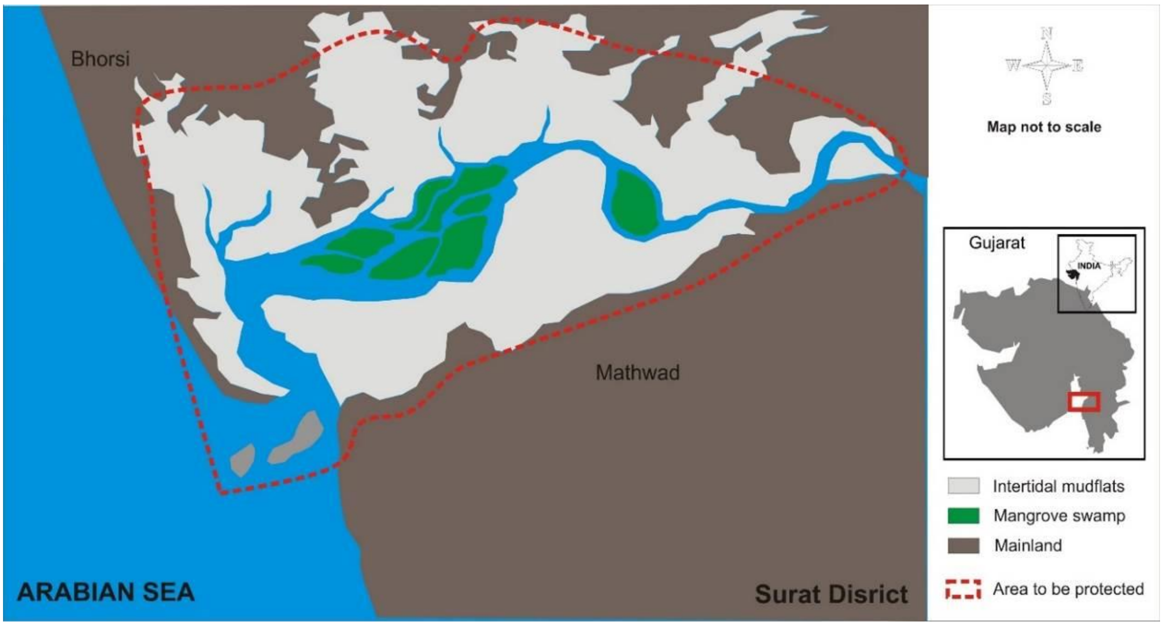
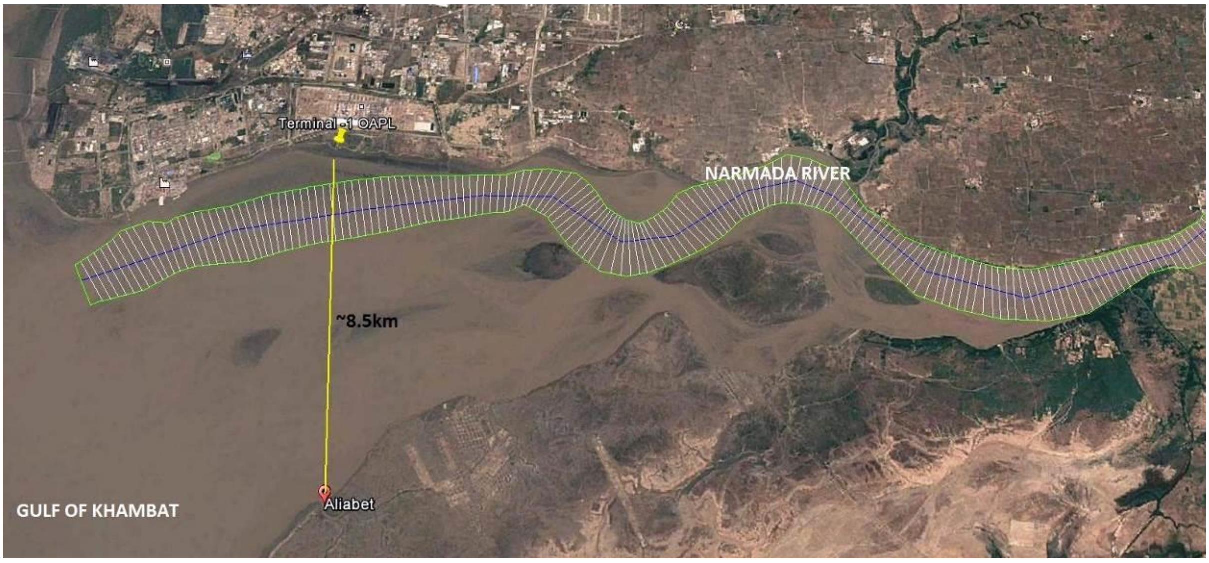


Fig :- 9.11 Protected site Purna



The protected site Aliabet shown in fig 9.11 is falling within 10 km radius of the present stretch of study.The proposed terminal-1 Opal and dredging at the estuary are within 10 km radius shown in fig 9.12 A

Fig :- 9.12A Aliabet protected site and Terminal 1



Wetland Ecosystem of Aliabet

Wetlands are the "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres. The wetlands of Aliabet incorporate riparian and coastal zones adjacent to marine and fresh water bodies deeper than six metres at low tide lying within the wetlands. The freshwater resources of Mahi, Kim and Dadhar rivers are also present at coastal and shallow marine ecosystems.

Aliabet is a complex habitat which is submerged or intermittently inundated by seasonal flooding or daily tides.Characteristic flora and fauna are largely defined by the water depth, current and intensity, underlying soil structure, sediment composition and water temperature in coastal regions. The Prosophis juliflora were found to be the most dominant species on the Aliabet.

Wetland ecosystem of Aliabet depends on water to maintain their ecological functions. The complex ecosystem of this place may easily affected by external factors viz. nutrient and sediment loads. Coastal wetlands (mangroves, estuaries, salt marshes, sea grass beds and mudflats) are vital spawning and nursery areas for large numbers of fishes and shrimps. They are the natural storehouses of considerable levels of biological diversity and provide the life support systems for much of human. The dense forest of Prosopis spp. and sparse mangroves vegetation play a vital role in sediment erosion control, flood control, maintenance of water quality, abatement of pollution and support for fisheries.

Wetland on the Aliabet Island is the border between terrestrial and aquatic environments habitat for a diverse range of animals including waterbirds, frogs, invertebrates and fish species, as well as water-loving plants such as mangroves, bushes and scrub species of Prosopis. Macroinvertebrates like memoers, crustaceans are useful indicators of wetland of Aliabet Island which shows greater tolerance of low dissolved oxygen concentrations, but they are still sensitive to a variety of physical and chemical factors.

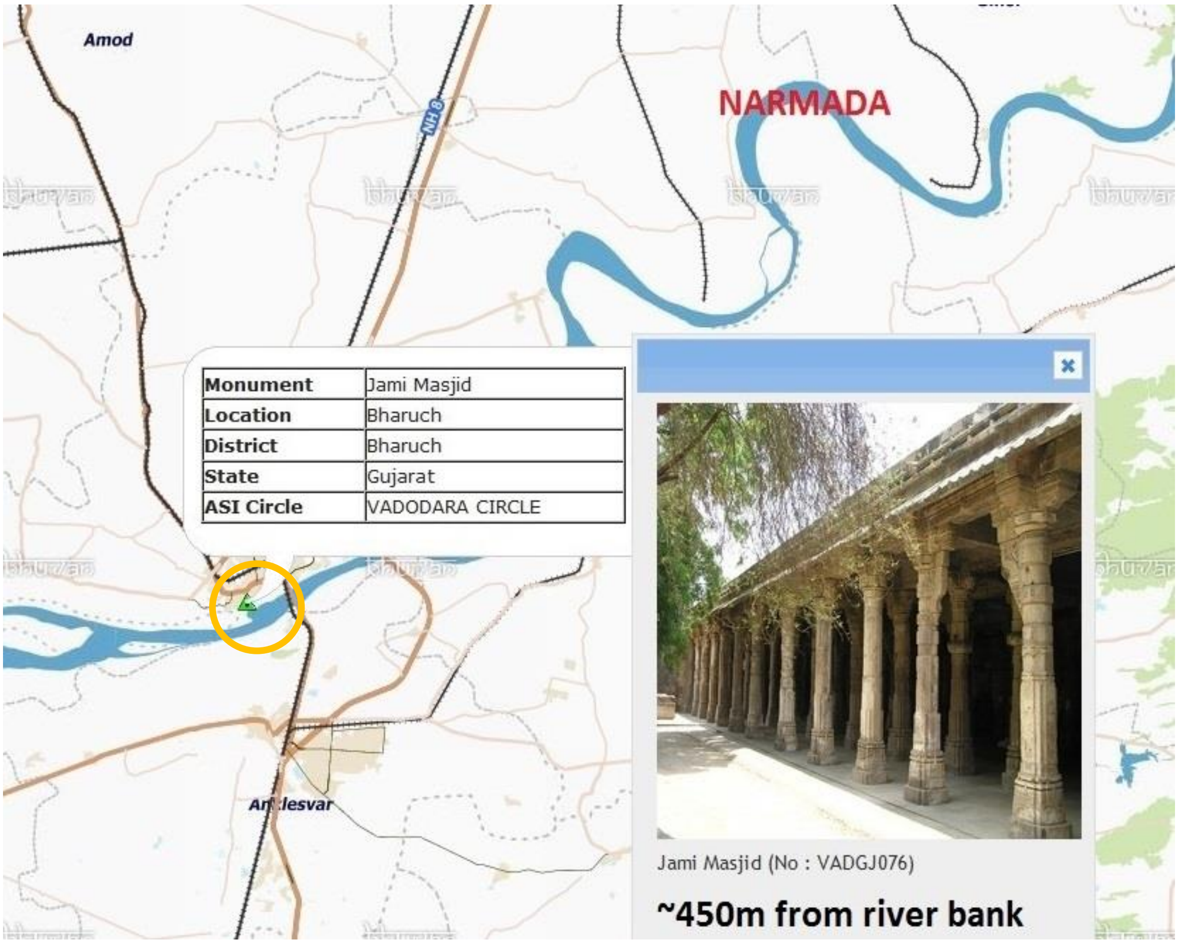
Wetlands provide important breeding and nursery areas for a large range of animals including birds, fish and invertebrates. Estuarine wetlands, which support vegetation such as mangroves and salt marsh, have a well-recognised link with the productivity of estuarine and offshore fisheries.

Aliabet Island ecosystems are cradles of biological diversity, providing the water and primary productivity upon which countless species of plants and animals depend for survival, they support high concentrations of birds (especially waterfowl), mammals, reptiles, amphibians, fish and invertebrate species. Levels of species diversity vary considerably between different wetland ecosystems.

9.12 Archaeological and Heritage Locations

Archeological and Heritage Location was found along and nearby the present scope of study of Narmada river within 10km radius from river bank which is detailed below.Only one site named Jami masjid was found at chainage 51km near Bharuch which is an ASI declared protected by Archeological Survey of India at a distance of ~ 450m from river bank shown below in fig 9.12B.

Fig :- 9.12B ASI site Jami Masjid



Source: Archaeological survey of India

9.13 Flora and Fauna

9.13.1 Flora

Terrestrial flora are important features of the environment. They are organized into natural communities with mutual dependencies among their members and show various responses and sensitivities to anthropogenic influences. The changes in biotic community are studied in terms of their distribution, density and diversity. These changes through time can be utilized to assess the impacts of project on flora of the region, which are important components of biological environment. For this purpose, the baseline condition of the area needs to be studied.

The reconnaissance revealed that the land around the study area is covered with natural vegetation including very less amount of mangroves. Agricultural activities are also undertaken in the nearby villages. Prosopis juliflora (Jangali Babul) are observed to be dominant along the roadside and near the seashore.

Climate of the area is tropical and semi arid. In the coastal area it is slightly humid. The minimum temperature observed during the last ten years was 6.5°C while the maximum temperature recorded during this period was 43°C.

Soil in this tract varies in colour, texture, depth and stoniness depending upon the rock and topography. Soils in the estuaries are very hard, clayey and saline. In the Dahej and adjoining areas it is sandy. The areas near the seashore are mostly affected by tides and remain submerged for considerable time. Thus the seashore is inhabited by small salt tolerant plants (mangroves ecosystem) such as Avicenia, Rhizophora and Prosopis juliflora only on high lands. Aliabet, an island near the mouth of Narmada, is also affected by the tidal fluctuations.Data of flora collected from various forest Government Departments is mentioned below.

Table 9.11 : List of Existing Flora Found in the study area

Sl. No.	Botanical Name	Local Name	Family
1.	*Acacia auriculiformis*	Bengali Baval	*Mimosaceae*
2.	*Acacia catechu*	Khair	*Mimosaceae*
3.	*Acacia leucophioea*	Harmo Baval, Aniyar	*Mimosaceae*
4.	*Acacia nilotica*	Desi Baval	*Mimosaceae*
5.	*Adina cordifia*	Haldu	*Rubiaceae*
6.	*Aegle marmelos*	Bili	*Rutaceae*
7.	*Ailanthas excelsa*	Ardusa	*Simarubaceae*
8.	*Alangium salvifolium*	Ankol	*Alangiaceae*
9.	*Albizzia lebbeck*	Siris	*Mimosaceae*
10.	*Albizzia procera*	Killai (kelvo)	*Mimosaceae*
11.	*Annona squamosa*	Sitaphal	*Annonaceae*
12.	*Anacardium occidentale*	Kaju	*Anacardiaceae*
13.	*Anogeissus latifolia*	Dhavda, Dhamada	*Combretaceae*
14.	*Artocarpus heterophyllus*	Fanas	*Moraceae*
15.	*Azadirachta indica*	Limdo	*Meliaceae*
16.	*Bauhinia purpurea*	Kachnar	*Caesalpiniaceae*
17.	*Bauhinia racemosa*	Ashitro	*Caesalpiniaceae*
18.	*Bombax ceiba*	Shimdo	*Bombacaceae*

Sl. No.	Botanical Name	Local Name	Family
19.	*Borassus flabellifer*	Tad (Todipalm)	*Arecaceae*
20.	*Boswellia serrata*	Gugal	*Burseraceae*
21.	*Bridelia refusa*	Asan, Ahsal	*Euphorbiaceae*
22.	*Buchanania lanzan*	Charoli.	*Anacardiaceae*
23.	*Butea monosperma*	Khakhro	*Papilionaceae*
24.	*Careya arborea*	Kumbh (Kumbhi)	*Lecythidaceae*
25.	*Carica papaya*	Papaya	*Caricaeae*
26.	*Cassia fistula*	Garmalo	*Caesalpiniaceae*
27.	*Cassia siamea*	Kashid	*Caesalpiniaceae*
28.	*Casuarina equisetifolia*	Sharu	*Casuarinaceae*
29.	*Cocos nucifera*	Nariel	*Arecaceae*
30.	*Cordia dichotoma.*	Gunda	*Ehretiaceae*
31.	*Cordia gharaf*	Gundi	*Ehretiaceae*
32.	*Dalbergia latifolia*	Sisam (Mota)	*Papilionaceae*
33.	*Dalbergia paniculata*	Patrali	*Papilionaceae*
34.	*Dalbergia sissoo*	Sissoo	*Papilionaceae*
35.	*Delonix elata*	Sandeshdo	*Caesalpiniaceae*
36.	*Delonix regia*	Gulmohar	*Caesalpiniaceae*
37.	*Diospyros melanoxylon*	Timru	*Ebenaceae*
38.	*Emblica officinalis*	Amla	*Euphorbiaceae*
39.	*Erythrina indica*	Pongaro	*Papilionaceae*
40.	*Eucalyptus species*	Nilgiri	*Myrtaceae*
41.	*Ficus bengalensis*	Vad	*Moraceae*
42.	*Ficus glomerata*	Umero	*Moraceae*
43.	*Ficus hispida.*	Dedh Umardo	*Moraceae*
44.	*Ficus religiosa*	Pipdo	*Moraceae*
45.	*Flacourtia indica.*	Parabor	*Flacourtiaceae*
46.	*Garuga pinnata*	Kakad	*Barseraceae*
47.	*Gmelina arborea*	Sevan	*Verbenaceae*
48.	*Grevillia robusta*	Silver oak	*Proteaceae.*
49.	*Grewia flavescens*	Guthu	*Tiliaceae*
50.	*Grewia tiliaefolia*	Dhaman	*Tiliaceae*
51.	*Hardwickia binata*	Anjan	*Caesalpiniaceae*
52.	*Heterophragma quadriculare*	Padal	*Bignoniaceae*
53.	*Holoptelia integrifolia*	Kanjo	*Ulmaceae*
54.	*Kydia calycina*	Bhindi (warang)	*Malvaceae*
55.	*Lagerstroemia lanceolata*	Hino	*Lythraceae*
56.	*Lagerstroemia parviflora*	Bondarao	*Lythraceae*

Sl. No.	Botanical Name	Local Name	Family
57.	*Lannea coromandelica*	Modad	*Anacardiaceae*
58.	*Limonea acidissima*	Kothi	*Rutaceae*
59.	*Madhuca indica*	Mahudo	*Sapotaceae*
60.	*Mallotus phillippensis*	Kalu jhado	*Euphorbiaceae*
61.	*Mangifera indica*	Amba	*Anacardiaceae*
62.	*Melia azaderach*	Bakam Limdo	*Meliaceae*
63.	*Mitragyna parvifolia*	Kalam	*Rubiceae*
64.	*Morus alba*	Shetur	*Moraceae*
65.	*Morinda tomentosa*	Al	*Rubiaceae*
66.	*Moringa concanensis*	Saragvo (Jangli)	*Rubiaceae*
67.	*Moringa oleifera*	Saragvo	*Moringaceae*
68.	*Oroxylurn indicum*	Timru	*Bignoniaceae*
69.	*Ougenia oojenesis*	Tanachh	*Fabaceae*
70.	*Peltophorum pterocarpum*	Peltophorum	*Caesalpiniaceae*
71.	*Phoenix sylvestris*	Khajuri	*Palmae (Arecaceae)*
72.	*Pithecellobium dulce*	Mithi Amli (Goras Amli)	*Mimosaceae*
73.	*Pongomia pinnata*	Karanj	*Papilionaceae*
74.	*Pterocarpus marsupium*	Biyo	*Papilionaceae*
75.	*Putranjiva roxburghii*	Jetun	*Euphorbiaceae*
76.	*Prosopis cineraria*	Khijdo, Samdo	*Mimosaceae*
77.	*Prosopis juliflora*	Gando Baval	*Mimosaceae*
78.	*Randia brandisii*	Gol	*Rubiaceae*
79.	*Samanea saman*	Rato Sarasdo	*Mimosaceae*
80.	*Sapindus laurifolius*	Arithi	*Sapindaceae*
81.	*Schrebera swietenodies*	Mokho	*Oleaceae*
82.	*Sapindus emarginatus*	Aritha	*Sapindaceae*
83.	*Schleichera oleosa*	Katho umbh.	*Sapindaceae*
84.	*Soymida fabrifuga*	Rayan, Rohan	*Meliaceae*
85.	*Spondias pinnata*	Ambado	*Anacardiaceae*
86.	*Sterculia urens*	Kadaya (kadai)	*Sterculiaceae*
87.	*Stereospermum personatum*	Pad ad	*Bignoniaceae*
88.	*Syzygium cumunii*	Jambudo	*Myrtaceae*
89.	*Syzygium rubecundum*	Tamun	*Myrtaceae*
90.	*Tamarindus indica*	Amli	*Caesalpiniaceae*
91.	*Tecomella undulate*	Ragat Rohido	*Bignoniaceae*
92.	*Tectona grandis*	Sag	*Verbenaceae*
93.	*Terminalia arjuna*	Arju Sad ad	*Combretaceae*
94.	*Terminalia bellerica*	Behdo	*Combretaceae*
95.	*Terminalia chebula*	Herde	*Combretaceae*

Sl. No.	Botanical Name	Local Name	Family
96.	*Terminalia catappa*	Badam	*Combretaceae*
97.	*Wrightia tinctoria*	Dhudio	*Apocynaceae*
98.	*Wrightia tomentosa*	Dudhi	*Apocynaceae*
99.	*Xeromorphis spirosa*	Mindhal	*Rubiaceae*
100.	*Zizyphus mauritiana*	Bor	*Rhamnaceae*
101.	*Zizyphus xylopyrus*	Ghat Bor	*Rhamnaceae*
Shrubs			
1.	*Abelmoschus esculentus*	Bhindi	*Malvaceae*
2.	*Abubutilon indicum*	Khapat	*Malvaceae*
3.	*Anisomeles indica*	Gondaliyo	*Labiatae*
4.	*Barleria Cristata*	Kapas	*Acanthaceae*
5.	*Barleria prionitis*	Kapas	*Acanthaceae*
6.	*Cadaba fruticosa*	Batkani	*Nyctigenat-eae*
7.	*Caesalpinia crista*	Kachka	*Caesalpiniaceae*
8.	*Caesalpinia occidentals*	Suntro	*Caesalpiniaceae*
9.	*Caesalpinia pulcherrima*	Shankhasur	*Caesalpiniaceae*
10.	*Cajanus cajan*	Tuver	*Fabaceae*
11.	*Calotropis gigantean*	Akdo	*Asclepiadaceae*
12.	*Calotropis procera*	Akdo	*Asclepiadaceae*
13.	*Capparis grandis*	Thikari	*Capparaceae*
14.	*Carissa conjesta*	Karmada	*Aprocyanaceae*
15.	*Cassia auriculata*	Aval.	*Caesalpiniaceae*
16.	*Cirtus limon*	Limbu	*Rataceae*
17.	*Clerodendron incerne*	Vilayati Mendi	*Verbenaceae*
18.	*Clitoria notonii*	Gughro	*Fabaceae*
19.	*Commiphora wightii*	Gugal	*Burseraceae*
20.	*Crotalaria leptostachya*	Jangli San	*Fabaceae*
21.	*Crotolaria juncea*	Shun	*Fabaceae*
22.	*Datura innoxia*	Kalo Dhanturo	*Solanaceae*
23.	*Datura metel*	Dhanturo	*Solanaceae*
24.	*Dendrophthoe falcate*	Vando	*Loranthaceae*
25.	*Desmodium gangeticum*	Salvan (chitakiya)	*Fabaceae*
26.	*Dichrostachys cinerea*	Maduled Dhumdhiyu	*Mimosaceae*
27.	*Eranthemum roseum*	Sashmuli	*Acanthaceae*
28.	*Ervatamia divaricata*	Chandni	*Apocynaceae*
29.	*Euphorbia milli*	Thor	*Euphorbiaceae*
30.	*Euphorbia nerifolia*	Thor	*Euphorbiaceae*
31.	*Euphorbia nivulia*	Thor	*Euphorbiaceae*
32.	*Euphorbia tirucalli*	Kharsani	*Euphorbiaceae*
33.	*Fagonia cretica*	Bhango	*Zygophylaceae*

Sl. No.	Botanical Name	Local Name	Family
34.	*Grewia hirsute*	Khabohamni	*Tiliaceae*
35.	*Helectris isora*	Marda Singi	*Sterculiaceae*
36.	*Holarrhena antidysenterica*	Inderjav	*Apocyanaceae*
37.	*Homonoia riparia*	Chandri	*Euphorbiaceae*
38.	*Hygrophila auriculata*	Ako ro.	*Acanthaceae*
39.	*Indigofera caerulea*	Gado	*Fabaceae*
40.	*Indigofera estragallina*	Vikario	*Fabaceae*
41.	*Jatropha curcas*	Ratanjot	*Euphorbiaceae*
42.	*Kirganelia reticulate*	Kamboi	*Euphorbiaceae*
43.	*Lantana carnara*	Lantana	*Verbenaceae*
44.	*Lawsonia inermis*	Mendi	*Lythraceae*
45.	*Leea edgeworthii*	Dussorudi	*Leeacea*
46.	*Maerua oblongifolia*	Hemkand	*Capparaceae*
47.	*Maytenus emarginata*	Vico	*Celastraceae*
48.	*Melochia corchorifolia*	Chungha Khapat	*Sterculiaceae*
49.	*Mimosa hamata*	Kasi baval	*Mimosaceae*
50.	*Mogania macrophylla*	Almuido (Popatiu)	*Fabaceae*
51.	*Nerium indicum*	Karen	*Apocynaceae*
52.	*Nyctanthus arbortristis*	Parijatak	*Oleaceae*
53.	*Opuntia elatior*	Phafdo thor	*Cactaceae*
54.	*Prosopis chilensis*	Molina	*Mimosaceae*
55.	*Psidiurn guajava*	Jamphal	*Myrtaceae*
56.	*Randidi brandisii*	Mindhol	*Rabiaceae*
57.	*Riccinus communis*	Divelo (Erandi)	*Lythraceae*
58.	*Securinega retusa*	Pichrun	*Euphorbiaceae*
59.	*Securinega virosa*	Pichrun	*Euphorbiaceae*
60.	*Sida cordifolia*	Bala	*Malvaceae*
61.	*Sida retusa*	Bala	*Malvaceae*
62.	*Solanum melongena*	Rigana	*Solanpceae*
63.	*Solarium indicum*	Ubhi Ringdi	*Solanaceae*
64.	*Tamarix ericoides*	Chhini (luti)	*Tamaricaceae*
65.	*Tamarix rhomboidea*	—	*Tiliaceae*
66.	*Tephrosia purpurea*	Sartankho	*Fabaceae*
67.	*Thespesia lampas*	Paras Piplo	*Malvaceae*
68.	*Thespesia populnea*	Paras Piplo	*Malvaceae*
69.	*Trichoderma indicum*	Undhaphalli	*Boraginaceae*
70.	*Triumfetta pentandra*	Zipti	*Tiliaceae*
71.	*Urena lobata*	Vagadau Bhindo	*Malvaceae*
72.	*Vitex negundo*	Nagod	*Verbenaceae*
73.	*Waltheria indica*	—	*Sterculiaceae*

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74.	*Woodfordia.fruticosa*	Dhaori	*Lythraceae*
75.	*Xeromorphis ulginosa*	Ghenyda	*Rubiaceae*
76.	*Zizyphus nummularia*	Chanibor	*Rhamnaceae*
77.	*Zizyphus oenoplia*	Boydino velo	*Rhamnaceae*
78.	*Zizyphus rugosa*	To ran	*Rhamnaceae*
79.	*Zizyphus xyloprus*	Ghatbor	*Rhamnaceae*
Herbs			
1.	*Argemone mexicana*	Darudi	*Papaveraceae*
2.	*Acalypha indica*	Dadarjo	*Euphorbiaceae*
3.	*Ammannia multiflora*	Zino Agio	*Lythraceae*
4.	*Aerva sanguinolenta*	Karadia	*Amaranthaceae*
5.	*Aeschynomene scariosis*	Ruchalosamervo	*Fabaceae*
6.	*Acanthospermum hispidum*	—	*Asteraceae*
7.	*Achyranthes aspera*	Anghedi	*Amaranthaceae*
8.	*Aerva lanata*	Gorakh Ganjo	*Amaranthaceae*
9.	*Aeschynomene indica*	—	*Fabaceae*
10.	*Agave Americana*	Ketki	*Agavaceae*
11.	*Alternanthera pungens*	—	*Amaranthaceae*
12.	*Alysicarpus monilifer*	—	*Fabaceae*
13.	*Amaranthus spinosus*	—	*Amaranthaceae*
14.	*Ammannia baccifera*	Jal Agio	*Lythraceae*
15.	*Amorphophallus commutatus*	3angli Suran	*Araceae*
16.	*Apluda mutica*	—	*Poaceae*
17.	*Arachis hypogea*	Mungfali	*Fabaceae*
18.	*Aristida adscensionis*	Dabholu	*Poaceae*
19.	*Arthraxon lancifolius*	—	*Poaceae*
20.	*Asystasia gangetica*	—	*Acanthaceae*
21.	*Bidens laciniata*	—	*Asteraceae*
22.	*Brassica juncea*	Rai	*Brassicaceae (Cruciferae)*
23.	*Brassica nigra*	Jangliraj	*Brassicaceae (Cruciferae)*
24.	*Brassica oleracea*	Cobbij	*Brassicaceae (Cruciferae)*
25.	*Bidens repens*	Zinku Utingan	*Acanthaceae*
26.	*Bergia suffruticosa*	Ropatri	*Elatinaceae*
27.	*Bacopa monnieri*	Bam	*Scrophulariaceae*
28.	*Bidens biternata*	Ajagandha	*Asteraceae*
29.	*Biophytum sensitivum*	Risamnu	*Oxalidaceae*
30.	*Blainvillea acmella*	Dholufuldu	*Asteraceae*

Sl. No.	Botanical Name	Local Name	Family
31.	*Blepharis maderaspatensis*	Utingan	*Acanthaceae*
32.	*Boerhavia diffusa*	Satodi	*Nyctaginaceae*
33.	*Borreria articularis*	Ganthiyu	*Rubiaceae*
34.	*Bothriochloa pertusa*	Zenzvo	*Poaceae*
35.	*Cicer medicaginea*	Adbau Methi	*Rhamnaceae*
36.	*Cyperus pangorei*	—	*Cyperaceae*
37.	*Cassia pumilla*	Nanichimed	*Caesalpiniaceae*
38.	*Catharanthus roseus*	Barmasi	*Apocynaceae*
39.	*Cyperus rotundus*	Chido	*Cyperaceae*
40.	*Cassia tora*	Kunvandio	*Caesalpiniaceae*
41.	*Canna indica*	—	*Cannaceae*
42.	*Causcora diffusa*	Zinkukariatu	*Gentianaceae*
43.	*Capsicum annum*	Marchi	*Solanaceae*
44.	*Cardiospermum species*	—	*Sapindaceae*
45.	*Cassia absus*	Chimed	*Caesaipiniaceae*
46.	*Catharanthus pusillus*	—	*Apocynaceae*
47.	*Celosia argentea*	—	*Amaranthaceae*
48.	*Centella asiatica*	Bhrami	*Apiaceae*
49.	*Citrullus colocynthis*	Indravarna	*Cucurbitaceae*
50.	*Clitoria biflora*	—	*Rhamnaceae*
51.	*Cocumis melo*	Sakkarteti	*Cucurbitaceae*
52.	*Colocasia esculenta*	—	*Araceae*
53.	*Commelina species*	—	*Commelinaceae*
54.	*Convolvulus microphyllus*	Shankhavli	*Convolvulaceae*
55.	*Corchorus aestuans*	Chunch	*Tiliaceae*
56.	*Costus speciosus*	Pavuta	*Zingiberaceae*
57.	*Cressa cretica*	Kali Shankhavli	*Convolvulaceae*
58.	*Crtnum pretense*	—	*Amaryllidaceae*
59.	*Curculigo orchioides*	Kali Musli	*Hypoxidaceae*
60.	*Cyperus alulatus*	—	*Cyperaceae*
61.	*D.triflorum*	—	*Rhamnaceae*
62.	*Datura metel*	Ganthovalo Dhanturo	*Solanaceae*
63.	*Dentella repens*	—	*Rubiaceae*
64.	*Digera muricata*	Kanjro	*Amaranthaceae*
65.	*Euphorbia postrata*	—	*Euphorbiaceae*
66.	*Euphorbia geniculata*	—	*Euphorbiaceae*
67.	*Euphorbia heterophylla*	—	*Euphorbiaceae*
68.	*Euphorbia hirta*	—	*Euphorbiaceae*
69.	*Euphorbia thymifolia*	—	*Euphorbiaceae*
70.	*Echinops echinatus*	—	*Asteraceae*

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71.	*Eclipta prostrate*	Bhangro	*Asteraceae*
72.	*Eleocharis geniculata*	—	*Cyperaceae*
73.	*Elytraria acaulis*	—	*Acanthaceae*
74.	*Emilia sonchifoila*	Hiran Khun	*Asteraceae*
75.	*Enicostema hyssopifolium*	Kadvinai	*Gentianaceae*
76.	*Ensete superbum*	Jangli Kela	*Musaceae*
77.	*Eriocaulon species*	—	*Eriocaulaceae*
78.	*Eriophorum comosum*	—	*Cyperaceae*
79.	*Euphorbia acaulis*	—	*Euphorbiaceae*
80.	*Gomphrena globosa*	—	*Amaranthaceae*
81.	*Gnaphalium luteo-album*	Munderi	*Asteraceae*
82.	*Glinus lotoides*	Mithookharad	*Molluginaceae*
83.	*Gloriosa superba*	Vadvadio	*Liliaceae*
84.	*Glossocardia bosvallea*	Adbausuva	*Asteraceae*
85.	*Gnaphalium indicum*	Phulvo	*Asteraceae*
86.	*Grangea maderaspatana*	Zinkimundi	*Asteraceae*
87.	*Guizotia abyssinica*	Kursan	*Asteraceae*
88.	*Hibiscus sabdariffa*	Khati Bhindi	*Malvaceae*
89.	*Hibiscus lobatus*	Tali	*Malvaceae*
90.	*Habenaria gibsonii*	—	*Orchidaceae*
91.	*Haplanthus verticillatus*	Kalukariyatu	*Acanthaceae*
92.	*Heliotropium marifolium*	Zinkuokharad	*Boraginaceae*
93.	*Indigofera cordifolia*	—	*Rhamnaceae*
94.	*Indigofera glandulosa*	—	*Rhamnaceae*
95.	*Impatiens Kleinii*	—	*Balsaminaceae*
96.	*Indigofera linifolia*	Jinkigali	*Rhamnaceae*
97.	*Indigofera linnaei*	Fatakiya	*Rhamnaceae*
98.	*Impatiens balsamina*	Takmaria	*Balsaminaceae*
99.	*Indoneesidla echioides*	Sarpat	*Acanthaceae*
100.	*Justicia procumbens*	—	*Acanthaceae*
101.	*Justicia diffusa*	—	*Acanthaceae*
102.	*Kichxia ramossisima*	Bhini Ghailodi	*Scrophulariaceae*
103.	*Lamiaceae cairica*	—	*Convolvulaceae*
104.	*Lamiaceae Crustacea*	—	*Scrophulariaceae*
105.	*Ipomoea fistuiosa Mart*	—	*Convolvulaceae*
106.	*Ipomoea hederifolia*	—	*Convolvulaceae*
107.	*Leeaceae macrophylla*	—	*Leeaceae*
108.	*Ipomoea nil*	Kaladana	*Convolvulaceae*
109.	*Lindenbergia parviflora*	—	*Scrophulariaceae*
110.	*Lavandula stricta*	—	*Lamiaceae*

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111.	*Lagascea mollis*	—	*Asteraceae*
112.	*Laportea intrrupta*	—	*Urticaceae*
113.	*Launaea procumbens*	Bhonyadandi	*Asteraceae*
114.	*Lavandula bipinnata*	Roth	*Lamiaceae*
115.	*Lepidagathis trinervis*	Harancharo	*Acanthaceae*
116.	*Leucas aspera*	Kubi	*Lamiaceae*
117.	*Lindenbergia muraria*	Pirsadedi	*Scrophulariaceae*
118.	*Ipomoea aquatica Forsk*	Mali Ni Bhaji	*Convolvulaceae*
119.	*Lycopersicon lycopersicum*	Tamata	*Solanaceae*
120.	*Merremia tridentate*	Bhainigario	*Convotvulaceae*
121.	*Melilotus*	Jangli Methi	*Rhamnaceae*
122.	*Merrernia gangetica*	Undari	*Convolvulaceae*
123.	*Musa paradisiacal*	Kela	*Musaceae*
124.	*Nicotiana tobacum*	Tamaku	*Solanaceae*
125.	*Nicotiana plumbaginifolia*	Pardeshi Tamaku	*Solanaceae*
126.	*Nothosaerva brachiata*	—	*Amaranthaceae*
127.	*Ocimum sanctum*	Tulsi	*Lamiaceae*
128.	*Ocimum basilicum*	Damro	*Lamiaceae*
129.	*Oldenlandia corymbosa*	Parpat	*Rubiaceae*
130.	*Oxalis corniculata*	Changer	*Oxalidaceae*
131.	*Polygala erioptera*	Bhonysan	*Polygalaceae*
132.	*Phyllanthus fraternus*	Bhonya Amli	*Euphorbiaceae*
133.	*Polygala irregularis*	—	*Polygalaceae*
134.	*Physalis minima*	—	*Solanaceae*
135.	*Portulaca oleracea*	Motiluni	*Portulacaceae*
136.	*Peristylus plantagineus*	—	*Orchidaceae*
137.	*Polygonum plebeium*	—	*Polygonaceae*
138.	*Portulaca quadrifida*	Ziniluni	*Portulacaceae*
139.	*Phyllanthus virgatus*	Moti Bhonyamli	*Euphorbiaceae*
140.	*Peristrophe bicalyculata*	Adhedi	*Acanthaceae*
141.	*Peristylus lawii*	—	*Orchidaceae*
142.	*Phyla nodiflora*	Ratvelio	*Verbenaceae*
143.	*Phyllanthus debilis Klein*	—	*Euphorbiaceae*
144.	*Physalis longofolia*	—	*Solanaceae*
145.	*Pimpinella adscendens*	—	*Apiaceae*
146.	*Pistia stratiotes*	—	*Araceae*
147.	*Polycarpaea corymbosa*	—	*Caryophyllaceae*
148.	*Polycarppn prostratum*	—	*Caryophyllaceae*
149.	*Polygala chinensis*	Pilibhonysan	*Polygalaceae*
150.	*Polygonum glabrum*	—	*Polygonaceae*
151.	*Portulaca grandiflora*	Chini-gulab	*Portulacaceae*

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152.	*Rueliia tuberose*	—	*Acanthaceae*
153.	*Rungia pectinata*	Khadsello	*Acanthaceae*
154.	*Solanum nigrum*	—	*Solanaceae*
155.	*Saccharum officinarum*	Sherdi	*Poaceae*
156.	*Salvia plebeian*	—	*Lamiaceae*
157.	*Sauromatum venosum*	—	*Araceae*
158.	*Scirpus tuberosus*	—	*Cyperaceae*
159.	*Sesamum indicum*	Fal	*Pedaliaceae*
160.	*Setaria italica*	Chano	*Poaceae*
161.	*Sida cordata*	Bhoya bala	*Malvaceae*
162.	*Sogittaria*	—	*Alismataceae*
163.	*Sonchus oleraceus*	Sonchus oleraceus	*Asteraceae*
164.	*Sphaeranthus indicus*	Gorakh Mundi	*Asteraceae*
165.	*Spilanthes calva*	Akkalgaro	*Asteraceae*
166.	*Synedrella nodiflora*	—	*Asteraceae*
167.	*Trichodesma indicum*	Agiyakharsan	*Boraginaceae*
168.	*Tacca rotundifolia*	Gol Zipti	*Tiliaceae*
169.	*Tacca leontopetaloides*	—	*Taccaceae*
170.	*Tagetes patula*	—	*Asteraceae*
171.	*Tribulus terrestris*	Bethu Gokhru	*Zygophyllaceae*
172.	*Trichodesma amplexicaule*	Undhafuli	*Boraginaceae*
173.	*Tridax procumbens*	—	*Asteraceae*
174.	*Typha angustata*	Ghabajariu	*Typhaceae*
175.	*Vemonia indica*	—	*Asteraceae*
176.	*Vahlia digyna*	Pilo Agio	*Vahliaceae*
177.	*Vanda tessellate*	—	*Orchidaceae*
178.	*Vemonia cinerea*	—	*Asteraceae*
179.	*Verbascum chinense*	—	*Scrophulariaceae*
180.	*Veronica anagallis*	—	*Scrophutariacea*
181.	*Vigna radiate*	Jangli Mug	*Fabaceae*
182.	*Viscum articulatum*	—	*Loranthaceae*
183.	*Wedelia urticaefolia*	—	*Asteraceae*
184.	*Xanthium strumarium*	—	*Asteraceae*
185.	*Zea mays*	Makai	*Poaceae*
186.	*Zornia gibbosa*	Samara pani	*FabaceaeTiliacea*
Climbers			
1.	*Ampelocissus latfolia*	Jungli Draksh	*Vitaceae*
2.	*Asparagus racemosus*	Satavai	*Liliaceae*
3.	*Bongainvillea spectabilis*	Boganvel	*Nyctaginaceae*
4.	*Butea superba*	Khakharvel	*Papilionaceae*
5.	*Butea parivflora*	Khakharvel	*Papilionaceae*
6.	*Cayratia auricalata*	—	*Vitaceae*

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7.	*Cayratia carnosa*	Khat-Khatumbo	*Vitaceae*
8.	*Celastrus paniculatus*	Malkagani	*Celestraceae*
9.	*Cissampelos pareira*	Venivel	*Menispermaceae*
10.	*Coccinia grandis*	Ghiloda	*Cacurbitaceae*
11.	*Cocculus hirsutus*	Vevdi	*Menispermaceae*
12.	*Crypotostegia grandiflora*	Rubber Vel	*Periplocaceae*
13.	*Cucumis sativus*	Kakadi	*Cucurbitaceae*
14.	*Cucurbita maxima*	Kolu	*Cucurbitaceae*
15.	*Delbergia volubilis*	Nilsoti	*Fabaceae*
16.	*Lagenaria leucantha*	Duthie	*Cacurbitaceae*
17.	*Luffa acutangula*	Turiya	*Cucurbitaceae*
18.	*Luffa acutangula var.amara*	Jungli Turiya	*Cucurbitaceae*
19.	*Mimordica charantia*	Karela	*Cucurbitaceae*
20.	*Mimordica dioca*	Kankoda	*Cucurbitaceae*
21.	*Mukia maderaspatana*	Chanak-Chibadi	*Cacurbitaceae*
22.	*Mucuna pruriens*	Kuvech	*Papilionaceae*
23.	*Mucuna purita*	Kuvech	*Papilionaceae*
24.	*Passiflora foetida*	—	*Passiflora ceae*
25.	*Passiflora edulis*	Krishna Kamal	*Passiflora ceae*
26.	*Quisqualis indica*	Madhu Malti	*Combretaceae*
27.	*Tinospora cordifolia*	Gulvel	*Menispermaceae*
28.	*Trichosanthes cucumis*	—	*Cucurbitaceae*
29.	*Vitis diformis*	Khat Khatumba	*Vitaceae*
Twinners			
1.	*Abrus precatorius*	Chanothi	*Fabaceae*
2.	*Argyreia sericea*	Samudrasos	*Convolvulaceae*
3.	*Correa reflexa*	Amarvel	*Cuscutaceae*
4.	*Clitoria ternatea*	Gharni	*Fabaceae*
5.	*Combretum Ovalifoliam*	Dhummas (Madvel)	*Combretaceae*
6.	*Cryptolepia buchanani*	Mendvel	*Periplicaceae*
7.	*Cuscuta Chinensis.*	Amarvel.	*Cuscutaceae*
8.	*Cylista scariosa*	—	*Fabaceae*
9.	*Dioscorea bulbifera*	Vana Vel (Dhuvasi Kand)	*Dioscoreaceae*
10.	*Dioscorea hispida*	Bhoi-kand	*Dioscoreaccae*
11.	*Dioscorea pentaphylla*	Kuvel	*Dioscoreaceae*
12.	*Dolichos trilobus*	Jangli Papadi	*Fabaceae*
13.	*Hemidesmus indicas*	Dudhvel	*Periploeaceae*
14.	*Ipomoca per-tigridis*	Photial	*Convolvulaceae*
15.	*Ipomoea quamoctit*	Kamlata	*Convolvuiaceae*
16.	*Mucuna prurita*	Kavach	*Fabaceae*
17.	*Pergularia daemia*	Chamar Ducheli	*Asclepiadaccae*
18.	*Pueraria tuberose*	Vidhuari	*Fabaceae*
19.	*Rhynchosia minima*	Nahni Kamal Vel	*Fabaceae*
20.	*Telosma pollida*	Varsha Dodi	*Asclepiadaceae*

Sl. No.	Botanical Name	Local Name	Family
21.	*Teramnus labialis*	Vaiio Velo	*Fabaceae*
22.	*Vigna unguiculate*	Choli	*Fabaceae*
Grasses			
1.	*Acrachne racemosa*	—	*Poaceae*
2.	*Apluda mutica*	—	*Poaceae*
3.	*Aristida adscensionis*	Dabholu	*Poaceae*
4.	*Arthraxon lancifolius*	_—	*Poaceae*
5.	*Bothriochloa pertusa*	Zenzvo	*Poaceae*
6.	*Cymbopo'gon. Martini*	Roicha Ghas	*Poaceae*
7.	*Chloris barbata*	—	*Poaceae*
8.	*Chrysopogon fulvus*	—	*Poaceae*
9.	*Coix lachryma-jobi*	Kahudo	*Poaceae*
10.	*Coix lachryma-jobi*	Kahudo	*Poaceae*
11.	*Cymbopogon citrates*	—	*Poaceae*
12.	*Cynodon dactylon*	Darb	*Poaceae*
13.	*Dendrocalarnus strictus*	Narvans	*Poaceae*
14.	*Dichanthium annulatum*	—	*Poaceae*
15.	*Digitaria adscendens*	—	*Poaceae*
16.	*Echinochloa crusgalli*	Adbau.Samo	*Poaceae*
17.	*Eragrostis tenella*	—	*Poaceae*
18.	*Echinochloa viscose*	—	*Poaceae*
19.	*Echinochloa colonum*	Samo	*Poaceae*
20.	*Eleusine indica*	Adhen Nasli	*Poaceae*
21.	*Eragrostis japonica*	—	*Poaceae*
22.	*Hackelochloa granularis*	—	*Poaceae*
23.	*Hemarthria compressa*	—	*Poaceae*
24.	*Heteropogon contortus*	Dabhsuliu	*Poaceae*
25.	*Melanocenchris*	—	*Poaceae*
26.	*Paspalidium flavidum*	Goriu	*Poaceae*
27.	*Saccharum officinarum*	Sherdi	*Poaceae*
28.	*Setaria italica*	Chano	*Poaceae*
29.	*Themeda quadrivalvis*	—	*Poaceae*
30.	*Zea mays*	Makai	*Poaceae*

Source: - *Forest Division Bharuch district, Gujarat*

9.13.2 Fauna

Fauna are important features of the environment. The changes in biotic community are studied in terms of their distribution, density and diversity. These changes through time can be utilized to assess the impacts of project on fauna of the region, which are important components of biological environment. For this purpose, the baseline condition of the area needs to be studied. Data of fauna collected from various forest Government Departments is mentioned below.

Table 9.12 : Existing Common Fauna in the Study Area.

Sr.No	Common Name	Scientific Name	Vernacular Name	Schedule as per WPA 1972
A. Mammals				
1.	Rhesus macaque	*Macaca mulatta*	Vandra	II
2.	Common langur	*Semnopithecus entellus*	Vandra	II
3.	Common mongoose	*Herpestes edwardsi*	Nurulia, Noria	II
4.	Jackal	*Canis aureus*	Makadi	II
5.	Indian fox	*Vulpes bengalensis*	Siyar	II
6.	Grey musk shrew	*Suncus murinus*	Chhuchhundar	-
7.	Striped hyaena	*Hyaena hyaena*	Jarakh	II
8.	Fivestriped palm squirrel	*Funambulus penanti*	Khiskoli	IV
B. Birds				
1.	Indian Pond Heron	*Ardeola grayii*	-	-
2.	Cattle Egret	*Bubulcus ibis*	-	-
3.	Little Egret	*Egretta garzetta*	-	-
4.	Indian Reef Heron	*Egretta gularis*	-	-
5.	Black Ibis	*Pseudibis papillosa*	-	-
6.	Blackwinged Kite	*Elanus caeruleus*	-	-
7.	Common Pariah Kite	*Milvus migrans govinda*	Samadi	-
8.	Shikra	*Accipiter badius*	-	-
9.	White Eyed Buzzard Eagle	*Butastur teesa*	-	-
10.	Crested hawk- eagle	*Spizaetus cirrhatus cirrhatus*	Morbaaz	-
11.	Bonelli's Eagle	*Hieraaetus fasciatus*	-	-
12.	Indian Longbilled Vulture	*Gyps indicus*	Giddha	-
13.	Indian whitebacked vulture1	*Gyps bengalensis*	Giddha	-
14.	Scavenger vulture	*Neophron percnopterus*	-	-
15.	Crested serpent eagle	*Spilornis cheela*	Chotaliyo sapmar	-
16.	Kestrel	*Falco tinnunculus*	-	-
17.	Grey partridge	*Francolinus pondicerianus*	Teetar	-
18.	Jungle Bush Quail	*Perdicula asiatica*	Vana lavari	-
19.	Common Peafowl	*Pavo cristatus*	Mor	-
20.	White Breasted Waterhen	*Amaurornis phoenicurus*	Davak	-
21.	Red Wattled Lapwing	*Vanellus indicus*	Titodi	-
22.	Yellow Wattled Lapwing	*Vanellus malabaricus*	Titodi	-
23.	Little Ringed Plover	*Charadrius dubius*	-	-

Sr.No	Common Name	Scientific Name	Vernacular Name	Schedule as per WPA 1972
24.	Green Sandpiper	*Tringa ochropus*	Leeli tutvari	-
25.	Blackwinged Stilt	*Himantopus himantopus*	-	-
26.	Small Indian Pratincole	*Glareola lactea*	-	-
27.	Whiskered Tern	*Chlidonias hybrida*	-	-
28.	Indian River Tern	*Sterna aurantia*	-	-
29.	Blue Rock Pigeon	*Columba livia*	Parevun	-
30.	Indian Ring Dove	*Streptopelia decaocto*	Dhol	-
31.	Spotted Dove	*Streptopelia chinensis*	Vana holi	-
32.	Little Brown Dove	*Streptopelia senegalensis*	-	-
33.	Rose Ringed Parakeet	*Psittacula krameri*	Sudo, Popat	-
34.	Blossom Headed Parakeet	*Psittacula cyanocephala*	Tui, Popat	-
35.	Indian Cuckoo	*Cuculus micropterus*	-	-
36.	Koel	*Eudynamys scolopacea*	Koyal	-
37.	Coucal	*Centropus sinensis*	Hokko	-
38.	Jungle Owlet	*Glaucidium radiatum*	Ghubad	-
39.	Spotted Owlet	*Athene brama*	Chibri	-
40.	Indian Jungle Nightjar	*Caprimulgus indicus*	-	-
41.	Common Indian Nightjar	*Caprimulgus asiaticus*	Deshi chhapo	-
42.	House Swift	*Apus affinis*	Ababeelo	-
43.	Lesser Pied Kingfisher	*Ceryle rudis*	Kabaro kalkaliyo	-
44.	Common Kingfisher	*Alcedo atthis*	Lagothi	-
45.	White Breasted Kingfisher	*Halcyon smyrnensis*	Kalkaliyo	-
46.	Green Bee-Eater	*Merops orientalis*	Nano patrangiyo	-
47.	Indian Roller	*Coracias benghalensis*	Nilkant	-
48.	Large Green Barbet	*Megalaima zeylanica*	-	-
49.	Coppersmith	*Megalaima haemacephala*	Tuktukiyo	-
50.	Wryneck	*Jynx torquilla*	-	-
51.	Lesser Golden Backed Woodpecker	*Dinopium benghalense*	Lakkadkhod	-
52.	Yellow Fronted Pied Woodpecker	*Picoides mahrattensis*	Lakkadkhod	-
53.	Larger Golden Backed Woodpecker	*Chrysocolaptes lucidus*	Lakkadkhod	-
54.	Ashycrowned Finch-Lark	*Eremopterix grisea*	Bhon chakli	-

Sr.No	Common Name	Scientific Name	Vernacular Name	Schedule as per WPA 1972
55.	Rufous Tailed Finch-Lark	*Ammomanes phoenicurus*	Khetariyo	-
56.	Malabar Crested Lark	*Galerida malabarica*	-	-
57.	Dusky Crag Martin	*Hirundo concolor*	-	-
58.	Common Swallow	*Hirundo rustica*	-	-
59.	Redrumped Swallow	*Hirundo daurica*	Kenchi ababil	-
60.	Baybacked Shrike	*Lanius vittatus*	Pachnak latoro	-
61.	Rufousbacked Shrike	*Lanius schach*	-	-
62.	Golden Oriole	*Oriolus oriolus*	Peelak	-
63.	Blackheaded Oriole	*Oriolus xanthornus*	-	-
64.	Black Drongo	*Dicrurus adsimilis*	Kalo koshi	-
65.	Greater Racked-Tailed Drongo	*Dicrurus paradiseus*	-	-
66.	Brahminy Myna	*Sturnus pagodarum*	-	-
67.	Rosy Pastor	*Sturnus roseus*	-	-
68.	Indian Myna	*Acridotheres tristis*	Kabar	-
69.	Bank Myna	*Acridotheres ginginianus*	Kabar	-
70.	Jungle Myna	*Acridotheres fuscus*	Vana kabar	-
71.	Indian Tree Pie	*Dendrocitta vagabunda*	Khakhedo	-
72.	House Crow	*Corvus splendens*	Kagdo	-
73.	Jungle Crow	*Corvus macrorhynchos*	Girnari kagdo	-
74.	Small Minivet	*Pericrocotus cinnamomeus*	-	-
75.	Common Iora	*Aegithina tiphia*	Shobinga	-
76.	Goldmantled Chloropsis	*Chloropsis cochinchinensis*	-	-
77.	Redvented Bulbul	*Pycnonotus cafer*	Bulbul	-
78.	Spotted Babbler	*Pellorneum ruficeps*	-	-
79.	Common Babbler	*Turdoides caudatus*	Sheradi	-
80.	Large Grey Babbler	*Turdoides malcolmi*	Laledo	-
81.	Jungle Babbler	*Turdoides striatus*	Vana laledo	-
82.	Redbreasted Flycatcher	*Muscicapa parva*	-	-
83.	Tickell’s Blue Flycatcher	*Muscicapa tickelliae*	Adharanga	-
84.	White Throated	*Rhipidura albicollis*	-	-

Sr.No	Common Name	Scientific Name	Vernacular Name	Schedule as per WPA 1972
	Fantail Flycatcher			
85.	Paradise Flycatcher	*Terpsiphone paradisi*	Tarwariyo	-
86.	Plain Wren-Warbler	*Prinia subflava*	-	-
87.	Ashy Wren-Warbler	*Prinia socialis*	-	-
88.	Jungle Wren-Warbler	*Prinia sylvatica*	-	-
89.	Tailor Bird	*Orthotomus sutorius*	Darjido	-
90.	Striated Marsh Warbler	*Megalurus palustris*	-	-
91.	Magpie Robin	*Copsychus saularis*	Daiyad	-
92.	Black Redstart	*Phoenicurus ochruros*	Thartaro	-
93.	Stone Chat	*Saxicola torquata*	Mendio piddo	-
94.	Indian Robin	*Saxicoloides fulicata*	Deoli	-
95.	Orange Headed Ground Thrush	*Zoothera citrina*	Malagir kasturo	-
96.	Grey Tit	*Parus major*	Ramchakli	-
97.	Yellow Cheeked Tit	*Parus xanthogenys*	-	-
98.	Spotted Grey Creeper	*Salpornis spilonotos*	Rakhodi thad-chad	-
99.	Yellow Wagtail	*Motacilla flava melanogrisea*	Matano pilakya	-
100.	Grey Wagtail	*Motacilla cinerea*	-	-
101.	White Wagtail	*Motacilla alba*	Khatriani	-
102.	Large Pied Wagtail	*Motacilla maderaspatensis*	-	-
103.	Tickell's Flower Pecker	*Dicaeum erythrorhynchos*	-	-
104.	Purple Sunbird	*Nectarinia asiatica*	Phul chakli	-
105.	Yellow Backed Sunbird	*Aethopyga siparaja*	-	-
106.	White-Eye	*Zosterops palpebrosa*	-	-
107.	House Sparrow	*Passer domesticus*	Chakli	-
108.	Yellow Throated Sparrow	*Petronia xanthocollis*	-	-
109.	Baya	*Ploceus philippinus*	Sughari	-
110.	White Throated Munia	*Lonchura malabarica*	Pavai munia	-
C. Reptiles				
1.	Indian Pond Terrapin	*Melanochelys trijuga trijuga*	Kasaba	-
2.	Northern House Gecko	*Hemidactylus flaviviridis*	Garoli	-
3.	Common Garden Lizard	*Calotes versicolor*	Kachindo	-

Sr.No	Common Name	Scientific Name	Vernacular Name	Schedule as per WPA 1972
4.	Forest Calotes	*Calotes rouxi*	Kachindo	-
5.	Southern Green Calotes	*Calotes calotes*	Kachindo	-
6.	Fan-Throated Lizard	*Sitana ponticeriana*	-	-
7.	Indian Chameleon	*Chameleon zeylanicus*	Sarado	-
8.	Common Skink	*Mabuya carinata*	Sani mashi	-
9.	Little Skink	*Mabuya macularia*	-	-
10.	Common Worm Snake	*Ramphotyphlops braminus*	An-sap	-
11.	Ocellate Shield tail	*Uropeltis ocellata*	-	-
12.	Common Rat Snake	*Ptyas mucosus*	Dhaman	-
13.	Checkered Keel Back	*Xenochrophis piscator*	Dendu	-
14.	Indian Cobra	*Naja naja*	Nag	-
15.	Sawscaled Viper	*Echis carinata*	Tarachha	-

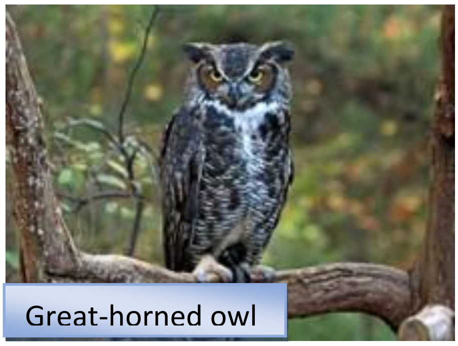
Source: - *Forest Division Bharuch district, Gujarat*

9.14 National Parks, Forests, Wildlife Sanctuaries and Reserves

River in the present stretch of study which is in the region of Gujarat crosses Shoolpaneshwar Wildlife Sanctuary from chainage 175 to 178 km (considering the last location of terminal near sardar sarovar dam) and Jambughoda wild life sanctuary is at a distance of 40-50 km from the nearest river boundary.Fig 9.13 Map showing Jambughoda and Shoolpaneshwar Wild life sanctuary.

The Map of Wildlife Protected Areas of Gujarat is shown in Fig. 9.14 and enclosed in page no.266

Shoolpaneshwar Wildlife Sanctuary


Great-horned owl

This sanctuary has vast, undulating terrain, ever-pervading greenery, tall inspiring canopy, deep awesome valleys, somberly silent rocks, gentle youthful streams, majestic waterfalls, breathtaking landscapes, culminating at the congregation of Vindhyan-Satpura hill ranges. The sanctuary was first created in 1982 over an area of 150.87 sq. km. As "Dumkhal Sanctuary"- an important home for sloth bears. Subsequently, in 1987 and 1989, the area of the sanctuary was enlarged to 607.70sq. Km and Shoolpaneshwar Sanctuary".

Shoolpaneshwar Wild Life Sanctuary The forest area rated as one of the best and thickest in the state, is spread over an area, which includes a major watershed feeding two major reservoirs with the Rajpipla hills as backdrop. The thick vegetative ground cover not only provides endless greenery and habitat and home to a variety of life forms, but also conserves the soil and water.

The sanctuary derives its name "Shoolpaneshwar" from a historic temple of Lord Shiva, which once existed in this region on the banks of river Narmada. The temple is now submerged due to the Sardar Sarovar Reservoir. However, a new Shoolpaneshwar temple has since been built near Rajpipla. The word "Shoolpaneshwar" refers to Lord Shiva portrayed as having "Shool" or "Trishul" in his hand i.e. `Pani'.

Barking Deer

The area is predominantly tribal with 'Vasavas' as the main tribal community. The local population heavily depends on the forest produce for socio-economic sustenance. A mere glance at the tribal houses and habitations reflects their dependence on bamboos in every sphere of life. Bamboo is indeed `poor man's timber'. Large flying squirrel is a nocturnal forest animal. It roosts in tree holes or prepares large leaf nests. Squirrels call during night, which betrays their presence. Although known as flying squirrel, it cannot fly and can only glide through the air, covering wide gaps. The membrane connecting its limbs forms a parachute that helps it glide.

The flora of the ecosystem represents semi-evergreen to moist deciduous forest. There are more than 575 species of flowering plants. There are vast patches of bamboo crops often referred to as bamboo-brakes. Common flora shown in Table 9.11

The sanctuary is a home for 32 species of mammals, several species of reptiles, 198 species of birds and countless insects. Common fauna shown in Table 9.12

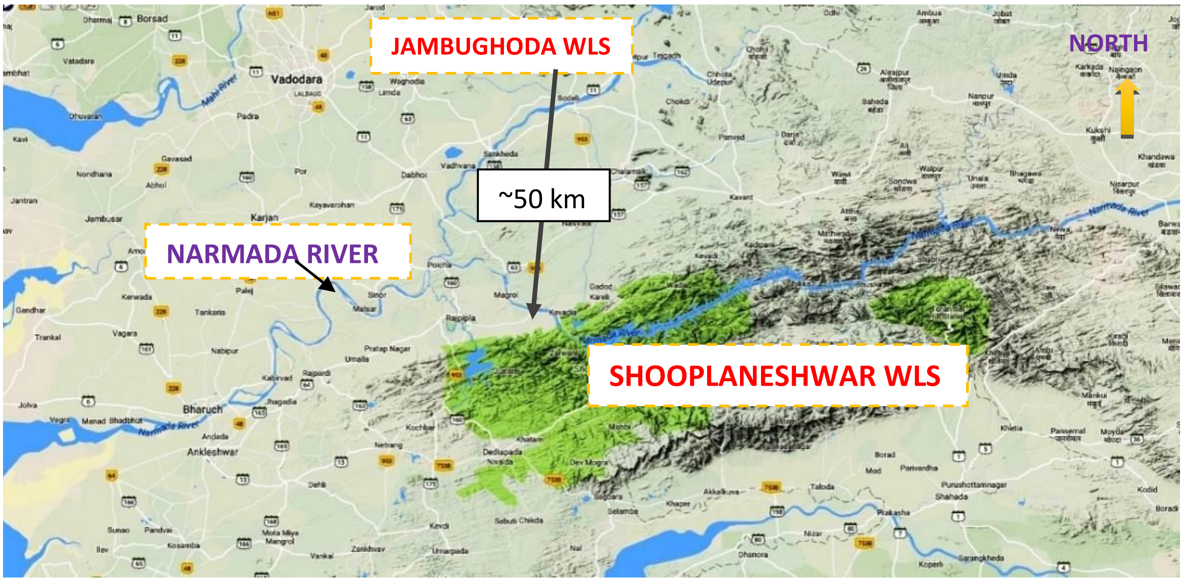
Important Animals

Sloth bear, leopard, rhesus macaque, common mongoose, Indian civet cat, Indian porcupine, four-horned antelope, barking deer, chital, pangolin, flying squirrel, python, snakes, lizards, tortoise etc. The sanctuary has the rare distinction of having flying squirrels. It is reported to have tigers, leopard cat and wild dogs in the past. However, tigers have not been sighted here for more than two decades.

Important Birds

Crested serpent eagle, shikra, sparrow hawk, great-horned owl , gray hornbill, red and gray jungle fowls etc

Fig 9.13 Map showing Jambughoda and Shoolpaneshwar Wild life sanctuary



The above figure shows the Wild life sanctuary Jambhughoda is at a distance of ~45-50 km from Present stretch of study of Narmada river and proposed terminal location.It also showing Shoolpnaeshwar WLS the river is flowing through Shooplaneshwar WLS.

Jambughoda Wildlife Sanctuary

Located in the Panchmahal district of Central Gujarat and 130.38 sq. km. area declared as a sanctuary in May 1990, Jambughoda Wildlife Sanctuary is home for a variety of animals and plants. A small part of the sanctuary (Targol Round) falls in the adjoining Vadodara district. It’s a magnificent forest of teak, bamboos and other miscellaneous species. The area has two water reservoirs- one at Kada and the other at Targol. These water bodies add to the aesthetic settings and habitat diversity. It is falling in Jambughoda taluka, Panchmahal district, Central Gujarat and Sanctuary Area : 130.38 Square Kilometers

Leopard is the top predator here whose population has been increasing. The habitat is shared by other animals such as sloth bear, jackal, blue bull, wild boar and four horned antelopes.The area has also many varieties of reptiles as well, which include many venomous and non-venomous snakes.

The area was a part of the princely state of Jambughoda prior to independence. The most striking feature of the area is the undulating hills having good forest cover with the valleys having small human settlements. The interesting places are Kada, Targol and Jhand Hanuman temple. The most picturesque location is Kada where a beautiful forest rest house stands on the banks of an irrigation reservoir. Kada happens to be a wonderful camping site as well. Due to its location close to a cosmopolitan city of Vadodara, the sanctuary is an ideal resort for city people and very good camping site for nature campers.

Wildlife is considerably rich. Leopard is the big cat existing here, whereas jungle cat is the lesser cat. Among the other carnivores hyena, wolf and jackal should be considered. Barking deer, four horned antelope, blue bull arid wild boar are the ungulates occurring in the Sanctuary. Besides civets, mongoose, porcupine and several species of rodent are also found in the area. Sloth bear is occasionally reported from the area. Python, crocodile and other herpeto fauna also exist here. Birdlife is plentiful. In the past, jungle fowl was abundant here, but the species is now exterminated from the area or has become rare. The wildlife depends on two water reservoirs constructed in the Sanctuary for satisfying the need of water.
Wildlife of this area is considerably rich.

Important Animals: Sloth bear, leopard, hyena, jackal, blue bull, wild boar, four-horned antelopes, barking deer, porcupine, python, crocodiles, etc.
People of the area are mainly tribal. There are 25 villages (including 5 villages inside the Sanctuary) which are distributed among five forest blocks and two ranges. Local tribals collect minor forest produce from the area for their livelihood. People also allow grazing of their livestock and cut wood in the forest.

Status of management of the Protected Area (PA) is good, but needs to be improved by taking up habitat steps, so that animals can be provisioned with adequate food, water and shelter. Population of herbivores is scanty, which in turn compels the leopard to enter the villages in search of alternative domestic prey. Grazing and wood removed by local people and fire in the forest cause damage to the habitat. Local people encroach upon the land of the PA and hence the area needs to be re-demarcated.

9.15 Socio-economic Profile

Demography

The Narmada basin broadly covers 25 districts of Madhya Pradesh, 6 districts of Gujarat, 3 districts of Chhattisgarh and 2 districts of Maharashtra. According to Census-2011, Jabalpur district falling in the basin has the highest population (more than two lakhs).West Nimar, East Nimar, Hoshangabad, Mandla and Narsimhapur districts of Madhya Pradesh falling in the basin are also the most populous districts having population morethan one lakh. Jabalpur is the most important urban centre of this basin. The second largest urban pocket in the Narmada Basin is Bharuch of Gujarat. Other urbanized centres are Khandawa and Dewas of Madhya Pradesh.

Our area of present study is for the Gujarat region only which consists mostly Narmada, Bharuch and Vadodara districts.

Industrial Profile of Narmada District

Industry sectors include textiles, foods & agriculture and chemicals. Rajpipla of Nadod taluka is the main Industrial Centre with GIDC estates in Narmada district. Moreover, in Sagbara, Dediyapada and Tilakwada taluka the GIDC acquired land for setting up industrial estates. Small Scale Industries (SSIs) are mainly engaged in repairing & services, ceramics, wood products, paper and rubber products

Population Demographics:

The district occupies an area of 2,755 km² and has a population of 5, 90,379 (as of 2011).The urban population is 10.44% of total population 2011. The population density of Narmada district is 214 persons per square km. The literacy ratio is 73.25%. A major stratum of population in Narmada district is dependent on Agriculture for livelihood. Industries such as textiles, sugar, and chemicals observed major investments and substantial growth during the past two decades.

Industrial Profile of Bharuch District

Industry sectors include textiles, Engineering, chemicals and Ports & Ship building. Dahej Port operated by Gujarat Maritime Board (GMB), has made significant contribution to facilitate industrial growth in the district. Several private business conglomerates havetheir presence in Bharuch. Some of them include Guardian Corporation, Videocon,Badische Anilin - und Soda- Fabrik (BASF), Reliance, Tatas, Aditya Birla Group, Welspun StahlRohrren,Aventis, Wockhardt,Rallis,Pfizer, Larson & Toubro (L&T), Bayer,Glenmark,Lupin and Gujarat Fluoro-chemicalsLtd. With over70 medium and large scale industries, Ankleshwar is the major industrial center in Bharuch witnessing a large number of business activities. Chemicals, engineering and textiles are the three major Small Scale Industry sectors present in Bharuch district.

Population Demographics:

The district occupies an area of 6,509 km² and has a population of 1.5 million (as of 2011). The urban population is 50% of total population 2011. The population density of district is 238 persons per square km. The literacy ratio is 83.25%. Traditionally, the dependency on agriculture has been high, as indicated by nearly 70 percent share of the primary sector. But recent years have witnessed significant progress toward reducing the dependency on agrarian activities.

Industrial Profile of Vadodara District

The industrial clusters include Chemicals & fertilizers, Pharmaceuticals, Biotechnology, Cotton Textiles, Machine Tools, Glass, Engineering, Tobacco, Fisheries and Dairy. Other key small scale industries include textiles, metal works, chemicals, equipment, rubber products and food products etc. There are thirteen Industrial estates namely Sankheda, Jetpur Pavi, Dabhoi, Ranoli (Autonagar), Limda, Por Ramangamdi, Nadesari, Waghodia,Makarpura, PCC, Savli, Savli Biotech Park and Sehra are at present operating in the district. Moreover, there are also three Special Economic Zones (SEZs) namely Savli SEZ, Suzlon SEZ and Nipam Infrastructure Ltd.

Population Demographics:

The Vadodara population is 4.166 million. The population density of Vadodara district is 552 persons per square km.The male literacy ratio is 85% and female literacy ratio is 72%.Over 45% of population stay in urban area. The majority of population is working.

9.16 Potential Environmental and Social Impacts of the Project

The impact of project on potential environment is not much as it will not produce any harmful wastes. The project will provide the employment to the local villagers nearby to the terminal area during construction as well as in operational phase this will improve the social and economic conditions of the nearby commuters. Also by shifting of traffic from distant ports or terminals, mode of operation like from road to waterway to this terminals will reduce the overall carbon emission.Decongestion of road and railway traffic. Hence ultimately will bring a positive impact to the environment.

9.16.1 Impacts due to construction activities

Pre-construction activities generally do not cause significant damage to environment. Preparatory activities like the use of existing access road, construction of storage sheds, etc. being spread over a large area, would have no further significant impact once the land is acquired and its existing use changes. Clearing, stripping and leveling of sites, construction of bunds for protection from flooding, earth filling and excavation for foundations, will lead to some disturbance to the habitat. The level of construction activities in the proposed project is not of such level and nature, to cause any significant adverse impact on this account.

a) **Operation phase**

Generation of garbage at Terminal area

The problem envisaged during operation phase could be the disposal of garbage. This could comprise floating materials, packaging, polythene or plastic materials, etc. accumulated from the fishing trawlers and boats. Garbage accumulated on the deck also needs to be suitably disposed. Therefore, a system needs to be developed, whereby undue quantity of garbage is not permitted to accumulate in the fishing harbour area and the same could be disposed off on the low lying areas in a scientific manner.

Handling of material like coal at terminals should follow standard guidelines of operation and the heap of material stacked should not be greater than 5m.The clear distance of 5m should be maintained between two heaps.

9.16.2 WATER ENVIRONMENT

a) **Construction phase**

Impacts due to effluents from labour camps

The average and peak labour strength likely to be deployed at the Terminal will be about 100 and 200 respectively.Most of the labour force will come from this village or from nearby village. The labour force engaged by the contractor could come from outside areas. A part of the labour population would stay in area. The balance labour population is likely to stay in labour camps close to the project site during construction phase. It is assumed that about 50% i.e. 100 labourers will stay at the site. Based on the above assumptions, total water requirement for the labour congregating in the area for constructing fishing harbour who will stay during the construction phase are estimated as below:

- Peak labour strength : 200
- Labours likely to stay at construction site (50%) : 100
- Married families (80% of 100) : 80
- Single : 20
- Husband and wife both working (80% of 80) : 64
- Families (64/2) : 32
- Families where only husband is working (50% of 32) : 16
- Family size (assumed) : 5
- Total number : 32x5+16x5+20=260 --(A)
- Add 5% for the persons who will be service provider like shops, repairing facilities, etc. : 13
- 50% of service providers will have families : 7
- Total number : 7x6+6=48 --- (B)

Total population (A+B)	= (A + B) = 260+48=308	
Say 310 Water requirement	:	70 lpcd
Total water requirement	:	21.7 m^3/day

About 100 labour would stay at the construction site, only during working hours. The water requirement for such labour shall be 4.5 m^3/day @ 45 lpcd. Thus, total water requirement works out to (21.7 + 4.5) about 26 m^3/day. Water requirement for construction purpose has been estimated to be of the order of 50,000 lpd, apart from domestic water requirements. The source of water will be near by water supply authority and bore wells.

The sewage generated is normally taken as 80% of the total water requirement i.e. (0.8 x 26) 21 m^3/day. The domestic water normally contains high BOD, which needs proper treatment and disposal, otherwise, it can have an adverse impact on the DO levels of the receiving body. The disposal of sewage without treatment can cause problems of odour and water pollution. The typical composition of untreated sewage is given in Table-9.13

Table-9.13 Typical composition of untreated sewage

Parameters	Value
Total Solids, mg/l	720
Total Dissolved Solids, mg/l	500
Total Suspended Solids, mg/l	220
BOD mg/l	220
Oil and grease, mg/l	100
Alkalinity (as $CaCO_3$), mg/l	100
Total Phosphorus, mg/l	80
Total Nitrates, mg/l	40
Bicarbonates, mg/l	100
Carbonates, mg/l	10
Nitrates, mg/l	40
Phosphates, mg/l	40
Chlorides, mg/l	50
Sulphates, mg/l	30
Calcium, mg/l	40
Magnesium, mg/l	40
Potassium, mg/l	15
Sodium, mg/l	70

It is clear from Table-9.10 that BOD is the major pollutant, as far as sewage is concerned. Normally untreated sewage would find its way to natural drainage system which ultimately confluences into the sea. However, these natural drains are seasonal in nature and are likely to remain dry in the non-monsoon months. During this period, the flow of untreated sewage from the labour colonies in these drains can lead to development of anaerobic conditions, with associated water quality problems. However, in the present case it must be mentioned that the total quantity of sewage (21 m^3/day) generated as a result of congregation during construction phase is quite small and is not expected to cause any adverse impact on the marine water quality. However, it is proposed to treat the sewage from labour camps before disposal.

9.16.3 Impacts due to dredging

The dredging and other construction activities normally increase the turbidity levels in the water column. The total quantity of material to be dredged is to be disposed at nearby low lying areas or areas in the bank of rivers for strengthening or as suggested by the authorities. The dredged material would be dumped at designated disposal sites.The identified site is shown in drawing folder Volume-2 , *Dwg. No.-DL01*

The change in water-column turbidity during dredging is a short-term impact. The increase in turbidity lasts as long as the material is being dredged. The turbidity level returns to the pre-project level sometime after the stoppage of the disposal of the dredged material. The time required for the turbidity level to return to its original turbidity level increases with the increase in clay content. The turbidity increase also depends on the type of dredging method adopted. Normally dredging in similar type of projects is done by a `Cutter Suction Dredger' (CSD). The method is preferred as it has minimal environmental impacts as far as increase in water turbidity is concerned.

This is because of the fact that the dredged material is sucked before it gets an opportunity to spread. The sediments near the construction sites have high amount of fine portion. Due to the operation by CSD, the majority of clayey sediments would be sucked by the suction pipe. However, a small quantity of clay particles is likely to escape the cutter-suction head which may enter the water environment in the immediate vicinity of the dredging site. Since, the clay particles are in the range of 2 to 10μ, it would take about a week for these particles to settle down. The increase in turbidity level is likely to last for a period of 10 to 15 days, once the dredging activities are over.

The other impact of dredging on water quality is chemical in nature. Sediments take up various cations from water through the process of sorption. The cations and anions sorbed by sediments are weakly bonded and are generally released back to the water whenever there are slight changes in the physico-chemical characteristics of the environment. In the marine environment, due to prolonged residence time between water and sediments, cations and anions sorbed by the sediments are in equilibrium with the elemental concentration in water. When the sediments are removed, the concentration gradient between the liquid and the solid phase changes and there could be elemental transfer between the two phases. In the proposed project, it is suggested that dredging be done by a `Cutter Suction' dredger as it does not provide adequate time for the elemental transfer between the sediments and the water phase. Thus, no major change in marine water quality due to transfer of ions from sediments to water is anticipated. It can be concluded that apart from short-term increase in turbidity levels, no other significant effect on marine quality due to dredging is anticipated

9.16.4 IMPACTS ON NOISE ENVIRONMENT

a) Construction phase

The major sources of noise during construction phase are due to operation of various construction equipment. The noise levels generated by various construction equipments are given in Table-9.14

Table-9.14 Average noise levels generated by the operation of various construction equipment

Equipment	Noise level [dB(A)]
Floating pontoon with mixer machine and crane	70
Winch machine	80
Transit mixer	75
Dumpers	75
Generators	85
Batching plant	90
Air compressors	90
Pile drivers	115

Under the worst case scenario, considered for prediction of noise levels during construction phase, it has been assumed that all the equipments are operating at a common point. Likewise, to predict the worst case scenario, attenuation due to various factors too have not been considered for noise modeling.

Modeling studies were conducted to assess the increase in noise level due to operation of various construction equipment, and the results are given in Table-9.15

Table-9.15 Predicted noise levels due to the operation of construction equipment

Distance (m)	Ambient noise level (dB(A))	Increase in noise level due to construction activities (dB(A))	Noise level due to construction activities (dB(A))	Increase in ambient noise level due to construction activities
30	45	70	70	25
50	45	66	66	21
100	45	60	60	15
200	45	54	55	10
500	45	46	49	4
1000	45	36	46	1
1500	45	36	45.5	0.5
2000	45	34	45	-

It is clear from Table 9.15, that at a distance of 100 m and 200 m from the construction site, the increase in noise levels will be about 10 dB(A) and 15 dB(A) respectively. The nearest residential areas are at a distance of about 500 m from the proposed project site. Hence, there could be adverse impacts anticipated on noise levels in the proposed project area.

The other source of noise during construction phase will be due to movement of trucks, which will transport the construction material.

Shooplaneshwar wild life sanctuary is crossing the river from the chainage 175-220km and Jambughoda Wild life sanctuary is at a distance of 40-50 km from the nearest river boundary.

Since the river is passing through wild life sanctuary suitable measures should be taken so that it doesn't disturb or harm the flora and fauna situated inside the sanctuary also the environmental clearance is required for the same.

9.17 EMP and Mitigation of Environmental Effects

Based on the environmental baseline conditions, planned project activities and impacts assessed earlier, this section enumerates the set of measures to be adopted to minimize the adverse impacts.

Environmental Measures during Construction Phase

Provision of Community Kitchen, Sanitation and Drinking Water Facilities in Labour Camps

A community kitchen could be provided where workers have their meals. The fuel used in these community kitchens is LPG or diesel. The labour camps will be provided with adequate arrangement for disposal of solid waste, liquid waste, and ventilation, ample and clean supply of drinking water.

Provision for Free Fuel Distribution in Labour Camps

As a part of the contract, it is proposed to make it mandatory for the contractor to provide community kitchen facilities to its labour and supply of free fuel to avoid falling/cutting of trees in the project area for fuel wood purpose.

Sewage Treatment

One community toilet should be provided per 200 persons. The sewage from community toilets shall be treated in septic tanks. For each 500 persons, one septic tank would be provided. Using the above norms, adequate number of community toilets and septic tanks shall be constructed.

Solid Waste Management

About 200 labour and 20 technical staff is likely to congregate in the area during construction phase. The increase in population is expected to be of the order of 800. The average per capita solid waste generated is of the order of 210 gm/day/person. The solid waste likely to be generated from labour camps shall be of the order of 46.20 kg/day. Adequate facilities for collection, conveyance and disposal of solid waste shall be developed.

For solid waste collection, number of masonry storage vats should be constructed at appropriate locations in various labour camps. These vats should be emptied at regular intervals and the collected waste can then be transported to landfill site.
About 1 tonne per day of spoil shall be generated. The spoils shall be suitably disposed at low lying areas as a landfill site. The site shall be selected in consultation with the district administration. During construction phase, labour colonies are proposed to be located close to the project site.

For solid waste collection, number of masonry storage vats should be constructed at appropriate locations in various labour camps. These vats should be emptied at regular intervals and the collected waste can then be transported to landfill site.

One covered truck to collect the solid waste from common collection point and transfer it to the disposal site should be put to service. A suitable landfill site shall be selected in consultation with the local administration to store municipal waste.

Control of Air Pollution

During construction and operation phases, use of various construction equipment is the major source of noise. However, based on the modeling studies, the noise due to operation of various construction equipment is not likely to have any adverse impact on the habitations in nearby villages. However, efforts need to be made to reduce the noise generated by the various construction equipment. The various measures that could be implemented are as follows:

- Noise from air compressors could be reduced by fitting exhaust mufflers and intake mufflers.
- Chassis and engine structural vibration noise can be dealt by isolating the engine from the chassis and by covering various sections of the engines.
- Noise levels from the drillers can be reduced by fitting of exhaust mufflers and the provision of damping on the steel tool.
- Exposure of workers near the high noise levels areas can be minimized. This can be achieved by job rotation/automation, use of ear plugs, etc.

The effect of exposure of high noise levels on the workers operating the various construction equipment is likely to be harmful. It is known that continuous exposure to high noise levels above 90 dB (A) affects the hearing acuity of the workers/operators and hence, has to be avoided. To prevent the adverse impacts, the exposure to high noise levels should be restricted as per the exposure period suggested by Occupational Safety and Health Association (OSHA).

Greenbelt Development

It is proposed to develop greenbelt around the perimeter of Terminal/port area, colony etc. Sufficient budgetary provisions for its implementation shall be made.

Environmental Monitoring Programme

The Environmental Impact Assessment is basically an evaluation of future events. It is necessary to continue monitoring certain parameters identified as critical by relevant authorities under an Environmental Monitoring Programme. This would anticipate any environmental problem so as to take effective mitigation measures. An Environmental Monitoring Programme will be formulated for implementation during project construction and operation phases shown in table 9.16

Table 9.16 Environmental Monitoring Programme

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	Agency Responsible for Action
1.	Ambient Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO_2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per Sample with various parameters	

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	Agency Responsible for Action
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO_3, PO_4, Cl, SO_4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Surface and ground water to be monitored separately	Per Sample with various parameters	Govt. of Gujarat or Designated Agency
3.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per Sample with various parameters	
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per Sample with various parameters	
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.	-	

9.18 Applicable Legal and Regulatory Framework

9.18.1 Legislations formulated by the Govt. of India for 'Environmental Safeguards'

- *The National Waterway Act, 2016.*
- *The Environment (Protection) Act, 1986 with applicable Rules/Legislation.*
- *The EIA Notification, 14th Sep., 2006 and its latest amendments up to 2017.*
- *The Water (Prevention and Control of Pollution) Act and Rules, 1974 & 1975.*
- *The Air (Prevention and Control of Pollution) Act, Rules and Amendments, 1981, 1982, 1983 & 1987;*
- *The Municipal Solid Waste (Management and Handling) Rules, 2000.*
- *The Hazardous Waste (Management and Handling) Rules, 2008.*
- *The Forest (Conservation) Act, 1980 Forest Conservation Rules, 1981.*
- *The Wildlife (Protection) Act, 1972.*

- *The Wildlife (Protection) Amendment Act, 2006 and Bill, 2013.*
- *The Biodiversity Act, 2002.*
- *The Wildlife Conservation Strategy, 2002.*
- *The Disaster Management Act, 2005.*
- *The Wetlands Rules, 2010.*
- *The Ancient Monuments, Archaeological Sites and Remains Act, 2010*
- *CRZ Notification 2011*

9.19 Need for Environmental Clearance

Presently for phase wise development the Environmental Clearance will not be required.Also for maintenance dredging Environmental clearance is not required as per Notification issued By GoI dated 21 Dec 2017 "Non-requirement of Environmental clearance for maintenance dredging for the purpose of navigation".(office order attached in page No. 267-269)

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

- Coastal Regulation Zone (CRZ) Govt. of Gujarat
- Consent to Establish and operate from state pollution control board, Gujarat
- Narmada Controlling Authority
- Gujarat Maritime Board

9.21 Cost Implications

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, which 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.

The estimated cost for conducting EIA-EMP & SIA studies along with obtaining all mandatory statutory clearances at pre-construction stage and timely and effective implementation of EMMP (EMP & EMoP) during construction and operation stages have been described in the following sections:

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 & SIA studies have been summarized below:

Table – 9.17: Summarized estimated cost for Consultancy Services

Sl. No.	Particulars of Estimated Budget	Amount	Remark (if any)
1.	Salary of 12 Professionals/Domain Experts on intermittent based input (as per QCI/NABET scheme)	50 Lakhs	Lump-sum cost on intermittent basis ranging 2-5 months
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	4.13 Lakhs	To be done for one season (**Table – 9.18**).
3.	Public / Stakeholders Consultation Meeting	5 Lakhs	Lump-sum cost
4.	Reports / Document Printing	1 Lakhs	Lump-sum cost
5.	Travelling Cost for Site Visits (Bus, Taxi, Boat etc.)	3 Lakhs	Lump-sum cost
6.	Lodging & Boarding Cost	3 Lakhs	Lump-sum cost
7.	Cost for collection of metrological data and other information like Maps stationery etc.	1 lakhs	Lump-sum cost
	Grand Total (Rs)	**67.13 Lakhs**	

In words: (i) *Rs. Sixty seven lakhs thirteen thousand only*

Note: No. of Key Experts: 12 as per QCI/NABET Scheme on intermittent basis. Which may increase or decrease by the project proponent as per actual scope of work.
(i) Above consultancy Fee is without GST
(ii) The breakup of Sl. No. 2 is given in Table 9.18.

Table – 9.18: Estimated Sub-Cost for One Time Baseline Data Generation at Pre-Construction Stage

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (Rs)	Amount (Rs)
1.	Ambient Air Quality	$PM_{2.5}$, PM_{10}, CO, SO_2, NO_2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per Sample with various parameters	7	15,000	1,05,000
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO_3, PO_4, Cl, SO_4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Surface and ground water to be monitored separately	Per Sample with various parameters	7	10,000	70,000
3.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per Sample with various parameters	7	6,000	42,000
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per Sample with various parameters	7	8000	56,000
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.	-	7	20,000	1,40,000
	Sub-Total (Baseline Environmental Data Generation Cost)						**4,13,000**
	In Words: *Rs.Four Lakhs thirteen thousand only.*						

Note: Proposed length of NW-73 (River Narmada) is 173 Km / @ 25 Km/station = tentatively 7 Locations will be monitored

9.21.2 Estimated Cost for Construction Stage

The civil work contractor during construction stage shall depute a well experience environmental & safety Officer (ESO), who shall conduct Environmental Monitoring at Construction Stage as per stipulated conditions in the contractor documents. He/she shall also prepare environmental monitoring report to be submitted timely to the project proponent and statutory authorities as per project requirement.

Table-9.19: Estimated Environmental Management Cost during Construction Stage

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Construction Stage.	12.39	To be done one season for three years (**Table –9.20**)
2.	Solid Waste Management	5	Lump-sum cost
3.	Sanitary facilities at labour camps	5	Lump-sum cost
4.	Greenbelt Development nearby terminal Premises by Contractor	5	Lump-sum cost
5.	Purchase of noise meter	1	Lump-sum cost
6.	Water tanker with sprinkler	6	Lump-sum cost
7.	Disaster Management Plan	4	Lump-sum cost
	Total (Lakhs)	**38.39**	

Table – 9.20: Environmental Monitoring Cost for Construction Stage

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations x Years	Unit Rate (Rs)	Amount (Rs)
1.	Ambient Air Quality	PM 2.5, PM10, CO, SO2, NO2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per Sample with various parameters	7x3=21	15,000	315000
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.	Surface and ground water to be monitored separately	Per Sample with various parameters	7x3=21	10,000	210000
3.	Noise Quality monitoring	Day & Time time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per Sample with various parameters	7x3=21	6,000	126000
4.	Soil	Bulk Density, Colour, Texture, Soil Type, pH, Electrical Conductivity, N, P, K *etc.*	Composite sample shall be prepared based on at least 3 replicates from each location.	Per Sample with various parameters	7x3=21	8000	168000
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.	-	7x3=21	20,000	420000
	Sub-Total (Baseline Environmental Data Generation Cost)						**12,39,000**
	In Words: *Rs. Twelve lakhs thirty nine thousand only*						

9.21.3 Estimated Cost at Operation Stage

Like preconstruction stage, the environmental monitoring and supervision to be done by the project proponent.

Table-9.21: Estimated Environmental Management Cost during Operation Stage

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Operational Stage once in a year.	4.13	To be done for one season as per Table-9.18 given above.
2.	Solid Waste Management	2.5	Lump-sum cost
3.	Maintenance of Greenbelt Development nearby terminal Premises by Contractor supervision	2.0	Lump-sum cost
	Total (Lakhs)	**8.63**	Per year

9.21.4 Summary of Estimated Environmental & Social Environmental Budget

This covers the consultancy fee at pre-construction stage along with implementation of EMMP (EMP & EMoP) during construction and operational stages of the project. The statutory fee along with the cost of private and government land acquisition shall be borne by the project proponent. This has been summarized in Table given below:

Table-9.22: Summary of Estimated Environmental & Social Costs for various Stages

Sl. No.	Project Stages	Cost (Rs.Lakhs)
1.	Pre-Construction Stage	67.13
2.	Construction Stage	38.39
3.	Operational Stage	8.63
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		**114.15**

Hence Total Cost says 114 Lakhs.

* The basis of cost is on our previous experiences of the project but the actual cost will be based on the Approved TOR by MoEF & CC.

Note:-

- The EMP should be available at each project location along with availability of all safety PPEs to each worker and First-Aid facility should be easily approachable for all staff.The contractor should also provide separate toilet facility for male and female workers at site.
- Contractor will take prior all the necessary clearances for setting of labour colony near project sites.

Letter to Additional Principal Conservator of Forests, Gandhinagar

वाप्कोस लिमिटेड
WAPCOS LIMITED

(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

ISO 9001 : 2008
- Consultancy Services
- Engineering, Procurement & Construction (EPC)

NO: WAP/P&H/GUJ/ENVR/APR/2017

Date: 06.04.2017

To,
The Additional Principal Chief Conservator of Forests,
D&M
Aranya Bhawan,Block B,3rd Floor,Sector-10/A,
Gandhinagar
Phone:-079 23254135
E-mail:gj050@ifs.nic.in

Sub: Requirement of Environment baseline data for Two Stage DPR of Proposed 04 Inland Waterways in the State of Gujarat & Maharashtra for official use.

Sir,

Ministry of Shipping (MoS), Govt. of India had directed IWAI to identify the viable waterways In India for their phased development; accordingly, 106 new waterways were identified and intimated to MoS. These rivers are in the process of being declared as National Waterway and a bill to this effect has already been passed in the lok Sabha during this winter season. Inland Waterways Authority of India (IWAI) a statutory body under the Ministry of Shipping, Govt. of India has been entrusted with the responsibility for conducting preparation of Detailed Project Report of the proposed waterway.

In order to assess the latest hydro-morphological condition of the rivers, IWAI has awarded the work of preparation of DPR s to M/s WAPCOS LIMITED is a "MINI RATNA-Category I" Public Sector Enterprise under the aegis of the Union Ministry of Water Resources, River Development & Ganga Rejuvenation for below mentioned river

Sl. No.	Name of the River / Canal	Name of the River / Canal Description of Inland Waterway
1.	MAHI RIVER	248 kms length of the river from Kadana Dam at Lat 23°18'22.35"N, Long 73°49'37.45"E to confluence with Gulf of Khambhat near Kavi railway station at Lat 22°10'34.71"N, Long 72°30'36.31"E Baseline Data of 25km from both side of river bank.

76-C, Institutional Area, Sector - 18, Gurgaon - 122 015 (Haryana), INDIA
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E-mail : ho@wapcos.co.in ; mail@wapcos.co.in • Website : http://www.wapcos.co.in
CIN : U74899DL1969GOI005070

2.	NARMADA RIVER	227 km length of the river from Pandhariya at Lat 21°57'10.37"N, Lon 74° 8'27.46"E to confluence of Narmada with Arabian Sea at Gulf of Khambhat Lat 21°38'26.81"N, Lon 72°33'28.24"E Baseline Data of 25km from both side of river bank.
3.	TAPI RIVER	436 kms length of the river from Hatnur Dam near Mangalwadi at Lat 21° 4'21.99"N,Long 75°56'44.88"E to confluence with Gulf of Khambhat (Arabian Sea) at Lat 21°2'15.51"N, Long 72°39'29.63"E Baseline Data of 25km from both side of river bank.

The following data is required for the Project

Terrestrial Ecology

- Description on forest type
- Checklist of floral species
- Forest map covering the study area
- Name and location of Reserve/Protected Forest, Mangrove etc

Wildlife

- Checklist of wild life including Mammals, Reptiles, butterfly, Avifauna etc Major threat to wild life.if any
- Map of migratory path of wild animals if any
- Name and location of National Park/Wildlife Sanctuary etc

It is therefore requested to kindly provide the below required

Thanking you and with best regards,

Yours truly,

Jatinder Kumar
Chief Engineer(Ports&Harbour)
WAPCOS Limited
Email:-Ports@wapcos.co.in

जतिन्द्र कुमार / JATINDER KUMAR
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(भारत सरकार का उपक्रम / A Govt. of India Undertaking)
76-सी, सैक्टर -18, गुड़गाँव-122015 (हरियाणा)
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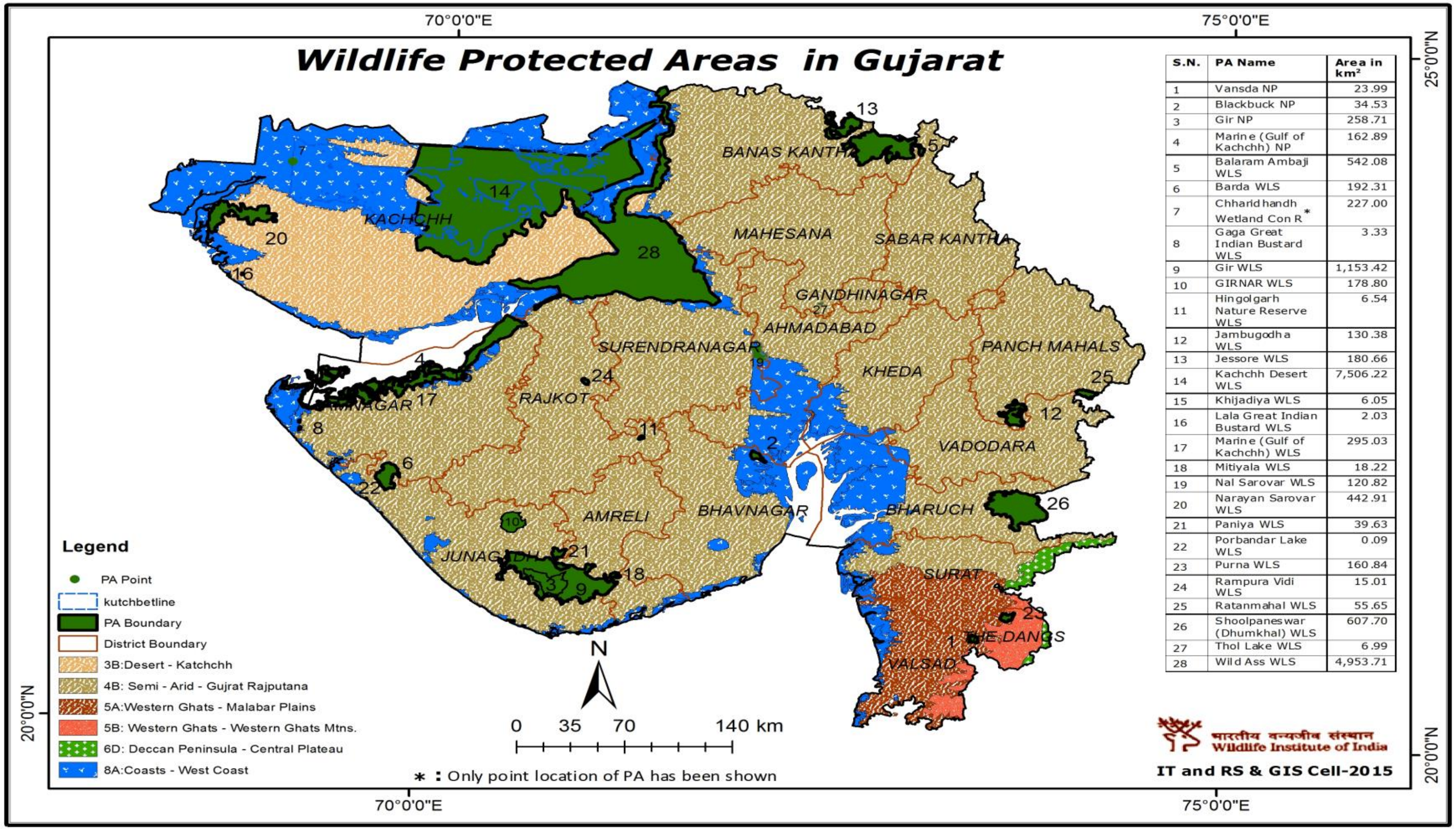
As per above letter regular follow ups were done with the department and our Team has collected the data from the concerned forest divisons.

Fig 9.14 Wildlife Protected Areas in Gujarat



OFFICE ORDER FOR NON REQUIREMENT OF ENVIRONMENT CLEARACE FOR DREDGIG IN RIVER

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

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

Dated: 21st December, 2017.

OFFICE MEMORANDUM

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

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

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

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

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

21/12/17
Sharath Kumar Pallerla
Director

To

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

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ANNEXURE

Environmental safety measures to be implemented

i. 'Consent to Establish' and 'Consent to Operate' shall be obtained from State Pollution Control Board under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974.
ii. The project authority shall ensure that no rivers or tributaries are blocked due to any activities at the project site and free flow of water is maintained.
iii. Shoreline shall not be disturbed due to dumping. Periodical study on shore line changes shall be conducted and mitigation carried out, if necessary.
iv. Dredging shall not be carried out during the fish/turtle breeding seasons.
v. All vessels used in the river will be fitted with noise control and animal exclusion devices so that aquatic life is not unduly disturbed.
vi. Spillage of fuel / engine oil and lubricants from the construction site are a source of organic pollution which impacts aquatic life, particularly benthos. This shall be prevented by suitable precautions and also by providing necessary mechanisms to trap the spillage.
vii. Construction waste including debris shall be disposed safely in the designated areas and in no case shall be disposed in the aquatic environment.
viii. Vessels shall not discharge oil or oily water such as oily bilge water containing more than 15 ppm of oil.
ix. The project authority shall ensure that water traffic does not impact the aquatic wildlife sanctuaries that fall along the stretch of the river.
x. All vessels will also have to comply with 'zero discharge' standards to prevent solid or liquid waste from flowing into the river and affecting its biodiversity.
xi. The dredging shall be carried by integrated and systematic planning by selective grid method by allowing migratory movement of Benthic fauna.
xii. All required Noise and vibration control measures are to be adopted in Dredgers. Cutter section Dredgers should be avoided as much as possible which produces more noise and vibration. No Drilling and Blasting is to be carried out.
xiii. Pre geo-tectonic studies has to be completed and the strata to be dredged is predetermined with complete data pertaining to hardness, compressive and tensile strengths.
xiv. Dredger type and other strata loosening methods shall be preconceived.
xv. Staggered dredging shall be carried based on turbidity monitoring to minimise the impact of turbidity.
xvi. Threshold level of turbidity, which has a minimal effect on fauna, has to be predetermined and Dredging planned accordingly.
xvii. Further silt screens needs to be used for minimising the spread of Turbidity.

xviii. Disposal places of Dredged sediments needs to be predetermined, along the shore by assessment of suitability, which will not affect the shoreline (erosion) and also causing impacts during monsoon and flooding.

xix. As much as possible, it shall not be disposed off in the river itself, and the site should be such that the dispersion is quicker by undertaking modelling studies.

xx. Ballast water control and management measures shall be implemented.

xxi. Waste and waste water reception facilities in Jetty shall be implemented.

xxii. The Risk and Disaster management plan has been prepared in consonance with the manual of terminals and harbours issued by the Ministry of Environment and Forests dated 5th May 2010.

xxiii. Standard Operating Procedures (SOP) and Emergency Response Plan (ERP) for onsite and offsite emergencies shall be prepared and implemented based on Hazard Identification and Risk Assessment to handle, process, store and transport of hazardous substances.

xxiv. Oil spill contingency plan shall be prepared and part of DMP to tackle emergencies. The equipment and recovery of oil from a spill shall be assessed. Guidelines given in MARPOL and Shipping Acts for oil spill management shall be followed.

xxv. No diversion of the natural course of the river shall be made without prior permission from the Ministry of Water resources.

xxvi. All the erosion control measures shall be taken at water front facilities.

xxvii. Necessary Air Pollution Control measures shall be taken during loading, unloading, handling, transport of the material at the berthing and water front facilities.

xxviii. The Vessels shall comply the emission norms prescribed from time to time.

xxix. All safety measures are to be implemented in coordination with the respective state government departments such as State Forest Department, Public Works Department, State Pollution Control Board etc.

21/12/17

Sharath Kumar Pallerla
Director

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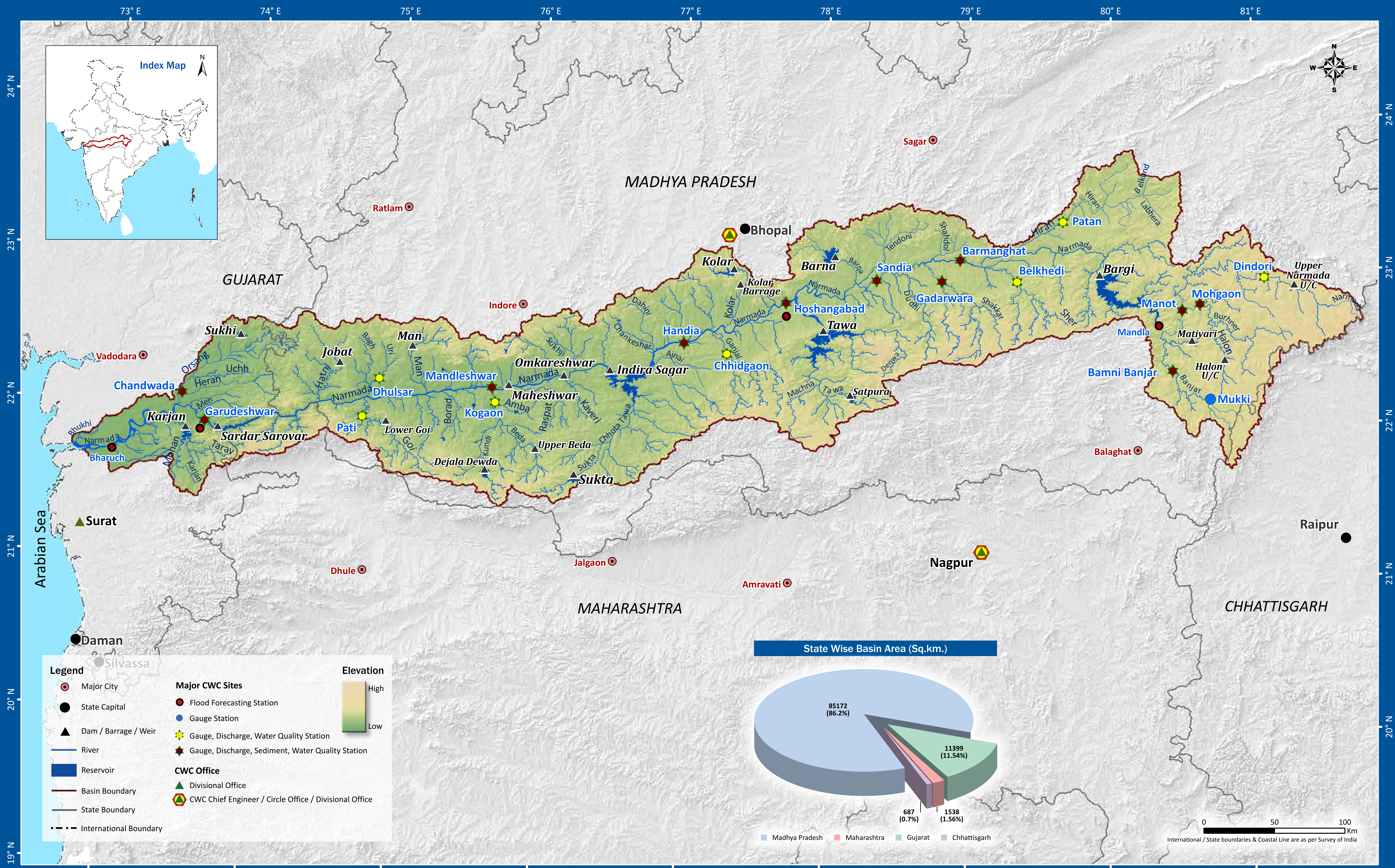
NARMADA BASIN



CHAPTER –10

INSTITUTIONAL REQUIREMENTS

10.1 Organizational Set up / Establishment

The Authority envisaged is Navigational waterway maintenance, transportation enterprise dealing with passenger and cargo handling, transit and transfer as well as being an administrative unit and an organ of Government which implements Government policies. This organization should integrate administrative functions with operation, maintenance and development function and run this enterprise on sound Business Management Principals. The set up should also have jurisdiction and control over all other Government, Public and Private Vessel Operators on the Narmada River (NW-73)

Other Government, Public and Private Parties can be allowed to carry on their present business as usual but under the administrative control on IWAI which frames rules and regulations for such operation.

The conceptual set up of such organization is given in chart 10.1. This envisages setting up of Inland Waterway Authority construction and maintenance division for Narmada River with its headquarters at Surat.

The Inland waterway authority will specifically control and will be responsible for following in Narmada River (NW-73).

- Developing and maintaining navigable waterway.
- Enforcement of rules and regulations of IWT Act.
- Channel Patrol.
- River route survey
- Issue of river notices, river, chart, river warnings
- Rescue and salvage operations on route.
- River training and maintenance works such as bandalling, bottom – paneling, dredging, bank protection etc. required to the extent of maintaining navigable waterway.
- Registration of vessels and issue of certificate of survey (compulsory for any sailing vessel)
- Issuing certificate of competency to masters, seamen, watch-keeping officers, engineers and to all the crew members of the sailing vessel.

- Policing the waterway through patrol and police boats. Checking, catching and prosecuting offenders, cancellation of registration certificates and taking other appropriate legal action.
- Providing pilotage to vessels wherever required.
- Levy and collection of vessel registration fee which will be related to capacity of vessels and river route it travels. (Normally this levy will be related to river route development and maintenance expenditure).
- Operation and maintenance of terminals run by IWAI and collection of berthing, handling and storage charges.
- Operation and levy of pilotage charges on river route.
- Operation and maintenance of various vessels, equipments and other facilities owned by IWAI.
- Maintaining liaison with Gujarat Maritime Board, Deendayal Port Trust and Inland Waterway Authorities to ensure smooth passage of vessels and loading / unloading of cargo.
- Purchasing new equipment/ floating craft as and when required.
- Planning and developing new terminals in Gujarat depending on traffic and additions to existing terminals, fleet and other facilities.
- Liaison with various concerned organization to ensure efficient functioning.
- Business development and expansion of facilities.
- Financial/ administrative/ technical control of operations with a view to raise efficiency, reduce cost and accomplish better handling.

To implement above responsibilities, staff requirement is suggested in chart 10.1

The administrative function and jurisdiction of various departments are briefly described below:

Director: The organization setup of Inland Water Transport division of Tapi, Narmada and Mahi River in Gujarat is headed by a Director who will have his headquarters at Surat. He will be in charge of all constructions, operation and maintenance works assisting the Director is carrying out the tasks are given in chart 10.2 and the specific tasks of some key personnel are detailed below:

1) Repairs Division

Dy. Director (Repairs) heads this division. The main function of this division is to maintain the floating crafts owned by IWAI in working order. Minor repairs are carried out by the Departmental personnel and vessels will be sent to different repair yards if in need of major repair or overhauling. Adequate stocks of spares are kept in ready stock by timely ordering and procurement of same. Fuel and lubricants required for operation will be arranged by the division. Replacement or additional vessels if required will be arranged by division.

2) Waterway Maintenance Division

For effective maintenance waterway the river stretch will be under the joint administrative control of Deputy Director and Senior Hydrographic Surveyor. The major task of this group is to maintain the waterway navigable. The following tasks are entrusted to Deputy Director and Senior Hydrographic Surveyor.

Dy. Director: Deputy Director will be incharge of dredging works, patrol tasks, security of waterway, pilotage and salvage duty.

This department will perform specifically following tasks:

- Patrolling the navigational waterway and gathering information on status of waterway and transmitting this information to barge operators on the route.
- Finding and marking best channel for navigation and clearing these channels of obstructions.
- Checking on observation of rules and regulations of waterways and bring to book the offenders.
- Go to rescue of boats in distress.
- Maintenance of river training work such as bank protective works, bandalling works, bottom paneling works etc. (normally major works are contracted out).
- Maintain required minimum depth in the waterway by dredging the shallow patches wherever required.
- Pilot the cargo boats in difficult reaches.
- Legal enforcement of rules and regulations by catching offenders and legally prosecuting them.
- Operating and maintain communication equipments.

Senior hydrographic surveyor: The task will include checking the water levels, changes in channels, checking position of marking systems and buoys, collection of morphological data, regular cross section soundings and bank levels, discharge measurements etc. This department would make available to barge operators on daily basis following information in the form of river notice and over radio contact.

- Water level at fixed gauge stations.
- Available depth for particular river section in their command and the location of shallowest place/ stretch.
- General information on changes in channels and marking system.
- Execution of river works, dredger location etc. Route mapping shall be carried out on regular basis once in two to three weeks and charts issued to barge operators immediately. Their tasks include maintaining the system of channel marking, buoys and beacons.

3) Terminals

Each terminal will be under the control of Terminal Manager. Terminal Manager will be responsible for operation and maintenance of the terminal. Their tasks include:

- Operations and maintenance of all mechanical handling equipment.
- Berthing and deberthing of cargo and passenger vessels.
- Loading and unloading of cargo vessels.
- Storage and dispatch of cargo
- Collection of berthing, handling, handling and storage charges.
- Operation and maintenance of all utilities in the terminal area.
- Terminal security and communication.

10.2 Man Power Requirement

Man power requirement for Development of waterway in Narmada River includes for terminal operations and departmental requirement. Departmental regional office will be set up at Surat. Every terminal will require institutional setup for proper functioning of terminal operations. Terminal manager will be the head at terminal responsible for overall terminal operations.

S.No.	Staff detail	No. of Personnel Required **Phase-1**	No. of Personnel Required **Phase-2**	No. of Personnel Required **Phase-3**
1	**TERMINAL MANAGER**	1	2	1
2	**ADM OFFICER**	1	2	1
3	**OPERATION MANAGER**	1	2	1
4	**MAINTENANCE MANAGER**	1	2	1
5	**SURVEYOR**	1	2	1
	Mechanical	2	4	2
	Civil	2	4	2
	Electrical	2	4	2
3	**Office Staff**			
	Clerical Staff	2	4	2
4	**Security Staff**	3	6	3
	Total	**16**	**32**	**16**

However, it is to be noted that River Narmada (NW-73) has been allocated to Deendayal Port trust (DPT) for development. In present case scenario, officer at level of assistant director and junior account officer at Head Office may be required to monitor various developments & monitoring of fund utilization.

10.3 Training Requirement / Capacity Building

Capacity Building is the process by which the Organization assesses and assists in sustainable development and improvement of the performance. Capacity Building involves more than training. It should be a strategy that involves a long time vision towards the enhanced production, modernization, and development of human resources leading to overall organizational objectives. In order to improve the efficiency of the navigation education & training in the field of inland navigation should be provided to the man power required.

Training Module

Dredging Technical Training
Safety training courses
Dredging management
Terminal Management & Operation Courses

10.4 Infrastructure

10.4.1 Immovable

Immovable infrastructure established includes Administrative building, Security office, Electrical substation, parking area etc.

10.4.2 Movable

Movable cranes, vehicles and survey boats will be required at terminals.

10.5 Cost Implications

Cost implication for establishing institutional requirement will include salaries of employees deployed at terminals, navigational lock and regional offices. Institutional setup required for operation and maintenance of waterway, locks and terminals. Capacity building through education and training to the staff and employees will also have cost implications. Average annual salary of top management is taken as Rs1600000 (PB-4+ Rs. 8700). Average annual salary of officers and staff at Dy. Director, Terminal Mangers offices is taken as 70000 (PB-3+ Rs. 5400).

Phase-1

Item	Quantity	Rate	Amount
Salaries(Top Management)	4	1600000	6400000
Middle Management	7	700000	4900000
Clerical Staff	2	400000	800000
Unskilled	3	120000	360000
Misc	Lump sum		14952000
Total(Annual)			27412000

Phase-1 & Phase-2 are not viable. Therefore, cost has not been computed.

CHAPTER – 11

PROJECT COSTING

11.1 General and Financial Assumptions

The technical aspects of development of National Waterways for handling of the projected traffic are dealt with in the previous chapters. In the present chapter project cost estimates has been done. In order to arrive at capital cost for the proposal it is necessary to ascertain, for budgetary purposes, unit rates of materials used for construction, dredging etc. Accordingly, efforts were made to obtain the above information from the relevant sources.

11.2 Basis of Costing

An estimate of the capital cost of various facilities is made. The cost arrived at are based on the budgetary quotes and the in house data base available on cost estimates. The rates for various items of work have been prepared on the basis of current rates for various items of work prevailing in the region.

The items and costs have been arrived at broadly on the following:

- Rates taken from current works of similar nature
- Updated rates of work of similar nature completed in the recent past.
- Consultant's in house data bank of cost estimates and budgetary quotations.

Gujarat Maritime Board Schedule of Rate, 2013-14 has been followed and escalated by 5% per annum to arrive at for year 2018 to arrive at the cost of the project. However, for dredging (2015-16) rates has been considered as substantial change has not been observed.

11.3 Development Cost

Development cost of waterway in Narmada River is given as below:

Waterway development cost includes;

- Land Acquisition
- Dredging
- Bank Protection

- Aids to Navigation
- Modifications of Bridges and locks
- Civil Works including Land Acquisition for terminals
- Mechanical Handling Facilities
- Miscellaneous

Phase-1

Fairway Development Cost	In Crores
Navigation Locks	-
Demolition & Reconstruction of bridges	-
Dredging (0.95 Mm3)	28.68
Navigation & Communication Cost	7.75
Total Fairway Development Cost	**36.43**

*****Terminal cost including storage area development, roads, mechanical equipment & bank protection cost will be bear by OPaL*

Phase-2

Fairway Development Cost	In Crores
Navigation Locks	-
Demolition & Reconstruction of bridges	-
Dredging (3.43 Mm3)	102.99
Navigation & Communication Cost	14.22
Total Fairway Development Cost	**117.21**

Phase-3

Fairway Development Cost	In Crores
Navigation Locks	-
Demolition & Reconstruction of bridges	-
Dredging (1.04 Mm3)	31.36
Navigation & Communication Cost	2.64
Total Fairway Development Cost	**34.00**

11.4 Capital Expenditure

The estimate of capital cost is made for the various items of civil, mechanical, electrical and utilities works for the development of terminals in the waterway stretch, cost estimate is presented in Table 11.1 to Table 11.3.

The capital cost worked out is excluding land cost for construction of terminals.

Table 11.1: Capital Cost Estimate (Phase-1)

Capital Cost (Phase-1)	In Crores
(I) Civil Cost	
Fairway Development Cost	
Navigation Locks ***(110m X 44m)***	0.00
Bank Protection	0.00
Demolition & Reconstruction of bridges	0.00
Total	0.00
3% Contingencies and 7% Supervision charges on Base cost	0.00
Total Fairway Development Cost	**0.00**
Terminal Cost	
Exclusively for OPAL ***(100m x 20m)***	0.00
Storage Area(Including roads, warehouse, parking area etc)	0.00
Total Cost(I)	0.00
3% Contingencies and 7% Supervision charges on Base cost	0.00
Total Civil Cost	**0.00**
(II) Vessel Cost	
Procurement of Barges **(10 nos)**	0.00
3% Contingencies	0.00
Total Vessel Cost	0.00
(III) Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (6 nos.)	0.12
RIS Station	4.93
Total Cost(III)	7.05
3% Contingencies and 7% Supervision charges on Base cost	0.70
Total Navigation & Communication Cost	7.75
(IV) Handling Equipment & Utilities	
Mechanical & electrical	0.0
3% Contingencies and 7% Supervision charges on Base cost	0.00
Total Handling Equipment & Utilities Cost	**0.00**
Other cost including financing cost and interest during construction (10% of (I)	0.00
Total Cost ((I)+(II)+(III)+(IV)	**7.75**
(V) Dredging	
Dredging **(0.95 Mm3)**	**28.68**
Total Capital Cost	**36.43**

Detailed BOQ for the capital cost estimate is given in Annexure-11.

Table 11.2 Capital Cost Estimate (Phase-2)

Capital Cost (Phase-II)	In Crores
(I) Civil Cost	
Terminal Cost	
Ankleshwar-Nandod ***(70m x 5m)***	6.60
Storage Area(Including roads, STP, Bio-Toilets,parking area etc)	19.00
Total Cost(I)	25.60
3% Contingencies and 7% Supervision charges on Base cost	2.56
Total Civil Cost	**28.16**
(II) Vessel Cost	
Procurement of Barges **(10 nos)**	0.00
3% Contingencies	0.00
Total Vessel Cost	0.00
(III) Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (54 nos.)	1.08
RIS Station	9.85
Total Cost(III)	12.93
3% Contingencies and 7% Supervision charges on Base cost	1.29
Total Navigation & Communication Cost	14.22
(IV) Handling Equipment & Utilities	
Mechanical & electrical	5.0
3% Contingencies and 7% Supervision charges on Base cost	0.50
Total Handling Equipment & Utilities Cost	**5.50**
Other cost including financing cost and interest during construction (10% of (I)	2.82
Total Cost ((I)+(II)+(III)+(IV)	**50.70**
(V) Dredging	
Dredging **(3.43 Mm3)**	**102.99**
Total Cost	
Total Capital Cost	**153.69**

Detailed BOQ for the capital cost estimate is given in Annexure-11.

Table 11.3 Capital Cost Estimate (Phase-3)

Capital Cost (Phase-III)	In Crores
(I) Civil Cost	
Terminal Cost	
Ankleshwar	22.23
Storage Area(Including roads, warehouse, parking area etc)	9.50
Total Cost(I)	31.73
3% Contingencies and 7% Supervision charges on Base cost	3.17
Total Civil Cost	**34.90**
(II) Vessel Cost	
Procurement of Barges	0.00
3% Contingencies	0.00
Total Vessel Cost	0.00
(III) Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (20 nos.)	0.40
RIS Station	0.00
Total Cost(III)	2.40
3% Contingencies and 7% Supervision charges on Base cost	0.24
Total Navigation & Communication Cost	2.64
(IV) Handling Equipment & Utilities	
Mechanical & electrical	10.1
3% Contingencies and 7% Supervision charges on Base cost	1.01
Total Handling Equipment & Utilities Cost	**11.11**
Other cost including financing cost and interest during construction (10% of (I))	3.49
Total Cost ((I)+(II)+(III)+(IV)	**52.14**
(V) Dredging	
Dredging **(1.04 Mm3)**	**31.36**
Total Cost	
Total Capital Cost	**83.50**

Detailed BOQ for the capital cost estimate is given in Annexure-11.

11.5 Operation and Maintenance Expenditure

The annual operation and maintenance cost on different components of the project will be dependent on a number of variables such as the life of the component, repair and maintenance requirements, wages of crew of consumables, etc. Hence, accurate assessment of cost is not possible. Further even if all the variables are fixed such as the maintenance schedules for each structure and equipment is determined, crew strength is fixed, requirement of consumables quantified, etc., the estimation of O&M costs cannot be precise because of unpredictable breakdowns incurring considerable expenditure on repairs and replacement. The only practicable approach in this scenario is to fix the annual repair expenditure as a percentage of capital cost of project. This percentage is to be fixed on the basis of the past performance of similar structures and equipment functioning in the project or elsewhere under similar marine conditions.

Based on above criteria, the annual maintenance cost is estimated as a percentage and is presented in Table 11.4 and Table 11.6.

Table 11.4 Operation & Maintenance Cost (Phase-1)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	2.87
(ii)	Ports Crafts/Nav. Aids @ 5%	0.39
(iii)	Fuel Cost	1.00
(iv)	Power Cost	2.00
(v)	Manpower Cost	2.74
(vi)	Miscellaneous	0.50
	Total	**9.50**

Table 11.5 Operation & Maintenance Cost (Phase-2)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	10.30
(ii)	Civil works @ 1%	0.28
(iii)	Mechanical & Electrical Cost @ 5%	0.27
(iv)	Ports Crafts/Nav. Aids @ 5%	0.71
(v)	Fuel Cost	2.00
(vi)	Power Cost	4.00

S.No.	O & M Cost	In Crores
(vii)	Manpower Cost	5.5
(viii)	Miscellaneous	0.5
	Total II	**23.57**

Table 11.6 Operation & Maintenance Cost (Phase-3)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	3.14
(ii)	Civil works @ 1%	0.35
(iii)	Mechanical & Electrical Cost @ 5%	0.55
(iv)	Ports Crafts/Nav. Aids @ 5%	0.13
(v)	Fuel Cost	1.00
(vi)	Power Cost	2.00
(vii)	Manpower Cost	2.74
(viii)	Miscellaneous	0.50
	Total II	**10.41**

CHAPTER – 12

IMPLEMENTATION SCHEDULE

12.1 Time Frame

Time scheduling is the assigning of start dates and completion dates to the various activities that take place in project implementation. The important points to be noted to schedule the time are:

- The earliest time that an activity can start
- The latest time that an activity may be completed without delaying the project completion
- The leeway or float or degree of freedom available in scheduling an activity
- The resultant critical path

Before scheduling time of a project with different activities of work, following facts have been considered.

- Determination the parts or implementation phases of the project and the sequence in which the associated activities shall be carried out
- Then estimate the amount of time required for each activity
- List the activities that can be carried out at the same time and identify those to be carried out sequentially

Detailed time schedule is shown in **Annexure-12.1**. Total time of the project completion is as follows:

Phase-1: 2 Years after getting final approval from OPaL
Phase-2: 3 Years
Phase-3: 2 Years

12.2 Phasing:

Phasing of activities has been done keeping importance of the event in project completion. However, ultimate aim was stick to early completion of project.
Construction of terminals & ancillary structures at following locations.

Phase	Terminal No.	Chainage	Purpose
Phase-1	**Terminal 1: Exclusively for OPAL**	11	Cargo
Phase-2	**Terminal 2: Bharuch**	60	Tourism
Phase-2	**Terminal 3: D/s of garudeshwar**	168	Tourism
Phase-3	**Terminal 4: Bharuch**	50	Cargo

Phase 3: Fairaway Development (Dredging, Port Crafts &Navigational Aids)

Activity 1: Dredging-Phase wise

Activity 2: Purchase & instalment of navigational aids

Sequence of all activities is shown in time schedule i.e **Annexure 12.1.**

Progress Flow Chart

A progress flow chart of all the above activities have been presented in Annexure**. 12.2**. The PERT chart was prepared after calculating total time of each activity including setting-up time/curing time and other related activities. The setting / curing time for concrete has been taken as 6 days. Monsoon time of 60 days & other delay of 120 days has already considered for total time calculation. The slow rate of work during monsoon has also been considered in the PERT chart.

12.3 Suggested Implementation Mechanism

If availability of funds with IWAI to implement e-governance initiatives is limited, IWAI can go for PPP models to implement these projects. PPP initiatives not only save the costs but also inject the much needed private sector efficiency in the government sector domain. While there is a need to create PPP deals, these need to be structured to ensure a win – win for all the stakeholders.

In the new regime, standard norms are prescribed for determining the investment and operational efficiency of the project. Target revenue is then calculated as the sum of operating cost, depreciation and an allowable return on capital employed. Target revenue is then categorized into revenue from various services based on estimated demand for each service. These ceiling tariffs are indexed to WPI and escalated year on year, there by removing the effects of varying demand on tariffs (as used to happen in the previous regime during tariff revisions).

Contractual Framework of PPP projects

- All intentions need to be set out in a contract
- Concession Agreement - bundle of rights & obligations and consequences in case of non-fulfilment
- Usually the only tangible security available
- Contracting parties : Government Agency – Concessioning Authority and Private Party – Concessionaire
- Other parties – state government, Lenders, Suppliers of services
- A concession is a license – rights enjoyed for obligations performed

Issues

- Striking a balance between differing concerns & objectives of parties
- Legislative Back up
- Rights and obligations of parties
- Identification and allocation of risks
- Penalties and rewards which would ensure performance

In present case**, DBFOT model** is the best model for implementation of the project as a whole. Hence, in chapter-13, viability of the DBFOT model from operator's point of view has been calculated.

Design Phase

The Independent Engineer shall review the Designs and Drawings submitted by the Concessionaire and provide its comments/observations and suggestions on the same within 21 (twenty one) Days from the date of the receipt of such Designs and Drawings.

In the event that the Independent Engineer has observed that the Designs and Drawings are not in conformity with the Project Requirements, the Concessionaire shall promptly and without any undue delay revise and resubmit the Designs and Drawings or satisfy the Independent Engineer with regards its compliance.

If the Independent Engineer does not make any observation/comments with respect to the Designs and Drawings submitted to it by the Concessionaire within 21 (twenty one) Days of the submission, it shall be deemed that the Independent Engineer has no suggestions to make with respect to the Designs and Drawings and the Concessionaire shall be entitled to proceed with the Project accordingly.

The Concessionaire shall not be entitled to any extension of time for completing construction or any other relief on account of delay caused due to providing any clarification or in resubmitting the Designs and Drawings. Provided however the Concessioning Authority at its sole discretion may suitably extend the Construction Phase or provide other relief to compensate for any such delay not attributable to the Concessionaire.

Notwithstanding the review by the Independent Engineer, the Concessionaire shall be solely responsible for any defect and/or deficiency in the Designs and Drawings relating to the Project or any part thereof and accordingly the Concessionaire shall at all times remain responsible for its obligations under this Agreement.

Any review of the Designs and Drawings conducted by the Concessioning Authority is solely for the Concessioning Authority's own information and that by conducting such review, the Concessioning Authority does not accept any responsibility for the same.

The Concessionaire shall in no way represent to any Person that, as a result of any review by the Independent Engineer, the Concessioning Authority has accepted responsibility for the engineering or soundness of any work relating to the Project/ the Project Facilities and Services or part thereof carried out by the Concessionaire and the Concessionaire shall, in accordance with the provisions of this Agreement, be solely responsible for the technical feasibility, operational capability and reliability of the Project/ the Project Facilities and Services or any part thereof.

12.3.1 Construction Phase

The Concessionaire shall promptly commence and complete the works, including installation of equipment in accordance with the Project Schedule and shall also obtain from the Independent Engineer a certificate as to completion of construction of Project Facilities and Services

During the Construction Phase, the Concessionaire shall:

- Arrange for, in a timely manner all necessary financial and other resources required for construction and installation of the Project Facilities and Services.
- Engage professionally competent Persons for project management and construction and ensure that all works are carried out in compliance with the Construction Standards;
- Give written notice to the Concessioning Authority within 7 (seven) Days of any material modification or change to any of the Financing Documents and/or any Equity Documents and shall simultaneously therewith also furnish copies of such modified/

amended documents to the Concessioning Authority. Provided no such modification/amendment will be made if it in any manner whatsoever has the effect of imposing an additional financial obligation or increasing the financial obligation of the Concessioning Authority in addition to that contemplated under the Financing Documents provided on Financial Close, without the prior written consent of the Concessioning Authority. For avoidance of doubt any such modifications/amendments made without the prior written consent of the Concessioning Authority will not be enforceable against the Concessioning Authority;

- Obtain Applicable Permits, comply with Applicable Laws and Applicable Permits and give priority to safety in its construction and planning activities in order to protect life, health, property and environment;
- Provide to the representative(s) of the Concessioning Authority, at reasonable times and upon prior intimation, access to the Project Site to review progress in construction and to ascertain compliance with any of the requirements of this Agreement. Provided that non-inspection by the Concessioning Authority of any works shall not, in relation to such works,
- Amount to any consent or approval by the Concessioning Authority nor shall the same be deemed to be waiver of any of the rights of the Concessioning Authority under this Agreement; and (ii) release or discharge the Concessionaire from its obligations or liabilities under this Agreement in respect of such work;
- Provide monthly reports on the progress of Construction Works or such other relevant information as may be required by the Independent Engineer;
- Promptly carry out at its cost such further works as may be necessary to remove any defects or deficiencies observed by the Independent Engineer and ensure timely completion of construction of the Project / the Project Facilities and Services in all respects in accordance with the provisions of this Agreement; and
- To ensure safe and timely construction and completion of the Project/Project Facilities and Services, the Concessionaire may, at its cost, interrupt and divert/create barriers on the flow of water or on the road or port traffic, adjacent to the Project Site if such interruption and diversion is imperative for the efficient progress of Construction Works and conforms to Good Industry Practice; provided that such interruption and diversion shall be undertaken by the Concessionaire only with the prior written approval of the Independent Engineer which approval shall not be unreasonably withheld. For the avoidance of doubt, it is agreed that the Concessionaire shall at all times be responsible for ensuring safe operation of Construction Works and shall remove the interruption or diversion within the period specified by the Independent Engineer.

12.3.2 Operations & Maintenance

The Concessionaire shall manage, operate, maintain and repair the Project Facilities and Services, entirely at its cost, charges, expenses and risk in accordance with the provisions of this Agreement. The Concessionaire's obligations shall include but shall not be limited to the following:

(i) Berth and Terminal Operations:

The Concessionaire shall:

- Promptly commence operations upon the Project Facilities and Services being declared by the Concessioning Authority as ready for operations;
- Make efforts to maximise cargo handled so as to achieve optimal utilization of the Project Facilities and Services;
- Ensure compliance of the Project Facilities and Services at least with the Project Requirements;
- Ensure compliance of the Project Facilities and Services at least with the Performance Standards;
- Ensure that the Project Facilities and Services shall adhere to the Operations and Maintenance Standards and Safety Standards and there is safe, smooth and uninterrupted flow of traffic normal operating conditions;
- Minimise disruption to traffic in the event of accidents or other incidents affecting the safety and use of the Project Facilities and Services by providing a rapid and effective response and maintaining liaison with emergency services of the Concessioning Authority or other agencies;
- Make available all necessary financial, technical, technological, managerial and other resources for operation, maintenance, repair and replacement of the Project Facilities and Services in a timely manner;
- Except for the priority and preferential berthing that may be authorized in terms of guidelines issued by the Government from time to time, manage and operate the Project Facilities and Services on a first come - first serve, common-user basis, open to any and all shipping lines, importers, exporters, shippers, consignees and receivers, and refrain from indulging in any unfair or discriminatory practice against any user or potential user thereof;
- Ensure maintenance of proper and accurate record/data/accounts relating to operations of the Project Facilities and Services and the revenue earned therefrom;
- Obtain, maintain and comply with Applicable Permits and comply with the Applicable Laws including those relating but not limited to dock side safety, health, environment and labour;
- Subject to the provisions of this Agreement, perform, undertake or provide, in connection with the Project, all services which the Concessioning Authority is

authorized to perform, undertake or provide under the provisions of the MPT Act; and

- Prevent, with the assistance of concerned law enforcement agencies, any encroachment or unauthorized use of the Project Facilities and Services.

12.3.4 Repairs, Maintenance and Replacement

The Concessionaire at its own cost promptly and diligently maintain, replace or restore any of the project facilities or part thereof which may be lost, damaged, destroyed or worn out.

While carrying out the repairing, maintaining and replacing the project facilities, the Concessionaire acknowledges and accepts that it is holding and maintaining the concession or assets, project facilities in trust for eventual transfer to the Concessioning Authority on termination of the agreement and therefore, will not do any act as a result of which the value of Port Assets and Project Facilities and Services is diminished.

The Concessionaire shall, at all times during the Concession Period, at its own risk, cost, charges and expenses, performance and pay for maintenance repairs, renewals and replacement of various type of assets and equipment in the concessionaire premises and /or the project or any parts thereof, whether due to use and operations or due to deterioration of materials and /or parts, so that on the expiry or termination of Concession, the same shall except normal wear and tear be in good working condition as it were at the time of commencement of the Concession.

While carrying out the repair, maintenance and replacement of the project facilities, the Concessionaire shall carry out the work in accordance with the manufacturer's recommendations and the relevant latest Indian Standards or in its absence ISO/OISD Standards. In the event that the concessionaire, by necessity or otherwise need to follow any other country standard and it shall be equal or superior to the standard specified above.

The repairs and maintenance shall generally conform to the following specifications.

E.1 Maintenance Standards

ISO 4308-1-2003	Maintenance of lifting appliances
ISO 4309-2004	Cranes wire rope care, maintenance and discard
IS 13367: Part 1 : 1992	Safe use of cranes – Code of Practice Part 1 General

BS 7121-2-2003	Code of Practice for safe use of cranes, inspection, testing & examination
BS 7121-4-1997	Code of Practice for safe use of cranes (Lorry Loaders)
BS 7121-5-2006	Code of Practice for safe use of cranes (Tower Cranes)

12.3.5 Safety Standards

The Concessionaire shall ensure compliance with the safety standards set out under Applicable Law/international conventions, as relevant, from time to time including those required under the following:

- Dock Workers (Safety, Health and Welfare) Act, 1986 & Regulations framed thereunder of 1990.
- The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989.
- The Petroleum Act, 1934 along with the Petroleum Rules, 2002.
- OISD – Guidelines – 156 (Oil Industry Safety Directorate): Fire Protection Facilities for Port Oil Terminals.
- The Explosives Act, 1884 along with The Explosive Substance Act, 1983 & The Explosive Rules, 1983
- Guidelines by Fire Advisor, CCE & DG FASLI, Government of India
- National Fire Codes (National Fire Protection Association – USA)
- Drill Manual for the Fire Services of India.
- International Safety Guide for Oil Tankers & Terminals.
- ISPS (International Ship & Port Facility Security) Code (2003 Edition)
- MARPOL CONVENTION
- International Maritime Dangerous Goods Code

Chapter – 13

ECONOMIC AND FINANCIAL ANALYSIS

Cost-benefit analysis

Cost-benefit analysis (CBA), sometimes called benefit-cost analysis (BCA), is an economic decision-making approach, used particularly in government and business. CBA is used in the assessment of whether a proposed project, programme or policy is worth doing, or to choose between several alternative ones. It involves comparing the total expected costs of each option against the total expected benefits, to see whether the benefits outweigh the costs, and by how much.

In CBA, benefits and costs are expressed in money terms, and are adjusted for the time value of money, so that all flows of benefits and flows of project costs over time (which tend to occur at different points in time) are expressed on a common basis in terms of their "present value." This is often done by converting the future expected streams of costs and benefits into a present value amount using a suitable discount rate.

13.1 Revenue

A major source of revenue should arise from the containerized cargo, naptha, polymers and chemicals. Their traffic projection is given in the table below.

Narmada Phase-1 (Fig in Lakhs)						
Cargo - Naphtha	**FY 20**	**FY 25**	**FY 30**	**FY 35**	**FY 40**	**FY 45**
Wharfage Charges	300	600	600	600	600	600
Berth Hire Charges	9.4	18.8	18.8	18.8	18.8	18.8
Mooring Charges	1.4	2.8	2.8	2.8	2.8	2.8
Grand Total	**310.8**	**621.6**	**621.6**	**621.6**	**621.6**	**621.6**

**Tariff taken from GMB*

Table 13.1 Traffic Projections for various terminals

13.2 Possible ancillary revenue

As far as now, there is no possible ancillary revenue.

13.3 Economic Analysis / EIRR

Economic analysis attempts to measure the overall impact of the project on improving the economic welfare of the citizens of the country. It would assess the project in context of national economy rather than project entity. Economic analysis of an investment proposed differs from the financial analysis in terms of identification of identification and evaluation of inputs and outputs and in measurements of cost benefits. Economic and Financial analysis shall be carried out for the feasible stretches.

The economic analysis would be carried out by determining the economic cost involved in the project and economic benefits being accrued with the development of project. The economic cost and benefits associated with a project ultimately leads to EIRR computation.

Economic cost

For EIRR computation, economic cost shall be calculated as a percentage of total cost of project. The total cost for a project consists of capital cost during construction period and operation and maintenance cost over project life.

Capital costs generally involve:

- Land acquisition,
- Dredging,
- Bridges,
- Civil works,
- E & M works
- Navigational aids

Economic benefits

The economic benefits that will accrue with the development of waterways shall be classified as:

- Employment benefits

- Fuel savings
- Carbon credits earned
- Other benefits such as accidents, noise, Traffic Jam & Pollution etc.

Shadow Pricing

The value of Project cost and benefits have been expressed in terms of market prices. These prices do not reflect the real resource cost and value of benefits derived from the project to the economy. The market prices are distorted due to variety of factors. These factors could be controlled/administered prices of inputs, monopolistic market of inputs, Tax structure etc. The factors used for converting project inputs and outputs to economic costs are given in following Table:

S. No	ITEM	FACTOR
1	Capital Cost	0.67
2	Operations & Maintenance Cost	0.67

Table 13.2 Shadow Pricing

Considering life of project to be 30 years, the ***EIRR analysis*** is shown in table 13.3:

Cases considered	EIRR
Phase 1	3.10%

Table 13.3 EIRR Analysis

EIRR is 3.10% as traffic after year 2025 becomes stagnant & O&M cost keeps on increasing. Also, navigation length is only 11 km.

- **Fuel Saving** from 2021-2024 is Rs. 118 lakhs & after year 2024 is Rs. 235 lakhs.
- **Carbon credit** earned 2021-2024 is Rs. 4 lakhs & after year 2024 is Rs. 8 lakhs.
- **Other benefits** from 2021-2024 is Rs. 78 lakhs & after year 2024 is Rs. 157 lakhs.
- **Employment benefits** from 2021-2024 is Rs. 362 lakhs & after year 2024 is Rs. 725 lakhs.

Total Economic benefits are shown below;

	Fuel savings	***Caron Credit***	***Other Benefits***	***Emp benefits***	
Year	***Rs lakhs***	***Rs lakhs***	***Rs lakhs***	***Rs lakhs***	***Rs lakhs***
2019					0
2020					0
2021	118	4	78	362	563
2022	118	4	78	362	563

Year	Fuel savings Rs lakhs	Caron Credit Rs lakhs	Other Benefits Rs lakhs	Emp benefits Rs lakhs	Rs lakhs
2023	118	4	78	362	563
2024	118	4	78	362	563
2025	235	8	157	725	1125
2026	235	8	157	725	1125
2027	235	8	157	725	1125
2028	235	8	157	725	1125
2029	235	8	157	725	1125
2030	235	8	157	725	1125
2031	235	8	157	725	1125
2032	235	8	157	725	1125
2033	235	8	157	725	1125
2034	235	8	157	725	1125
2035	235	8	157	725	1125
2036	235	8	157	725	1125
2037	235	8	157	725	1125
2038	235	8	157	725	1125
2039	235	8	157	725	1125
2040	235	8	157	725	1125
2041	235	8	157	725	1125
2042	235	8	157	725	1125
2043	235	8	157	725	1125
2044	235	8	157	725	1125
2045	235	8	157	725	1125
2046	235	8	157	725	1125
2047	235	8	157	725	1125
2048	235	8	157	725	1125

Detailed calculation is shown in **Annexure 13**

13.4 Financial Analysis / FIRR

For projects involving heavy investment, it becomes very important to analyze the benefits of owner i.e. IWAI/ Govt. & users, i.e. Barge/ ship operators who would use the IWT facility as compared to other modes of transport. FIRR shall be evaluated for IWAI/ Government and Users (barge / Ship operators).

FIRR for IWAI / Govt.

The financial analysis shall be carried out to drive possible levy charges per tonne kilometer of cargo transported through IWT that IWAI / Govt may levy to recover the costs of project from users. For calculations, economic cost along with cargo projection shall be considered for various scenarios.

FIRR for Barge/Ship operators

The development of waterway that include heavy investments is completely defined and meaningful if the user or Barge operator is getting minimum financial benefits as compared to other modes and is therefore attracted to invest money and time. The total cost to be invested by the barge operator may be classified as Capital cost and Operation and maintenance cost (O & M cost)

Capital/Initial cost depends upon the infrastructure proposed and depicts the future planning. A high initial cost may act as burden on the operator and therefore phase-wise development of all infrastructure and allied facilities shall be proposed.

The running profits are usually governs by less operating cost and operational viability. Operating viability depends upon various factors as:

- Vehicle costs,
- Fuel costs
- Crew costs / Administrative expenses
- Repair and Maintenance costs
- Loading Unloading costs
- Cost of insurance
- Manpower cost

Phase: 1

Considering life of project to be 30 years, the ***FIRR analysis*** is shown in table 13.4:

Charges of using the channel	FIRR
Rs 1 per tonne	-ve Return

Table 13.4 FIRR Analysis

Phase: 2 & Phase-3 are non viable.

13.5 Risk Factors

Pre-operative task risks	
External linkages	Refers to the risk that adequate and timely connectivity to the project site is not available, which may impact the commencement of construction and overall pace of development of the project.
Financing risks	Refers to the risk that sufficient finance will not be available for the project at reasonable cost (eg, because of changes in market conditions or credit availability) resulting in delays in the financial closure for a project.
Planning risks	Refers to the risk that the pre-development studies (technical, legal, financial and others) conducted are inadequate or not robust enough resulting in possible deviations from the outcomes that were planned or expected in the PPP project development.
Construction phase risks	
Design risk	Refers to the risk that the proposed design will be unable to meet the performance and service requirements in the output specification. It can result in additional costs for modification and redesign.
Construction risk	Refers to the risk that the construction of the assets required for the project will not be completed on time, on budget or to specification. It may lead to additional raw materials and labour costs, additional financing costs, increase in the cost of maintaining existing infrastructure or providing a temporary alternative solution due to a delay in the provision of the service.
Approvals risk	Refers to the risk that delays in approvals to be obtained during the construction phase will result in a delay in the

	construction of the assets as per the construction schedule. Such delays in obtaining approvals may lead to cost overruns
Operation phase risks	
Operations and maintenance risk	Refers to the risks associated with the need for increased maintenance of assets or machinery over the term of the project in order to meet performance requirements. In a brownfield PPP, where the private partner takes over operation of existing assets, O&M risk is very sensitive to the starting condition of the assets. In this case the private operator's O&M risk is related to the risk of poor or incomplete information about the quality of the assets that it will take over.
Volume risk	Refers to the risk that demand for water or sanitation services will vary from the initial forecast, such that the total revenue derived from the project over the project life will vary from initial expectations.
Payment risk	Refers to the risk that charges for services are not collected in full or are not set at a level that allows recovery of costs. Who bears the payment risk depends on whether the charges for services are paid directly by users, or are paid by the municipality. If charges are paid by the municipality (via taxes) the public sector bears this risk.
Financial risk	Refers to the risk that the concessionaire introduces too much financial stress on a project by using an inappropriate financial structure for the privately financed components of the project. It can result in additional funding costs for increased margins or unexpected refinancing costs.
Performance risk	This is a risk that the quality of services delivered will not meet the performance standards agreed in the Concession Agreement. The Concession Agreement should stipulate penalties or compensation terms in this case.
Environmental risk	Refers to the risk of environmental damage in excess of what is planned for in the environmental impact mitigation

	plan. For example, ground water pollution from sewerage release.
Handover risks	
Handover risk / Terminal value risk	Refers to the risk that the concessionaire will default in the Handover of the asset at the end of the project life, or that it will fail to meet the minimum quality standard or value of the asset that needs to be handed back to the public entity. This risk (and terminal value risk) generally relates to concession and BOT type PPPs. However, it may also be relevant to performance based management contracts in which the private partner is responsible for investing in meters.
Other risks	
Change in law	Refers to the risk that the current legal / regulatory regime will change, having a material adverse impact on the project.
Force Majeure	Refers to the risk that events beyond the control of either entity may occur, resulting in a material adverse impact on either party's ability to perform its obligations under the PPP contract. These events are sometimes also called "Acts of God", to indicate that they are beyond the control of either contracted party.
Concessionaire risk	Refers to the risk that the concessionaire will prove to be inappropriate or unsuitable for delivery of the project, for example due to failure of their company.
Sponsor risk	Refers to the risk that the Sponsor will prove to be an unsuitable partner for the project, for example due to poor project management or a failure to fully recognise the agreed terms of the Concession Agreement.
Concessionaire event of default	Refers to the risk that the concessionaire will not fulfil its contractual obligations and that the public Sponsor will be unable to either enforce those obligations against the concessionaire, or recover some form of compensation or remedy from the concessionaire for any loss sustained by it as a result of the breach.

Government event of default	Refers to the risk that the public Sponsor will not fulfil its contractual obligations and that the concessionaire will be Unable to either enforce those obligations against the Sponsor, or recover some form of compensation or remedy from the Sponsor for any loss sustained by it as a result of the breach.

13.6 Necessity of Govt. support (VGF/PPP)

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

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

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

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

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

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

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

Once cleared by Empowered Institution, the project is eligible for financial support.

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

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

13.7 SWOT Analysis

Strength	**Weakness**
• Dahej port at River mouth • Industrial towns of Bharuch, Jogadia, Ankhleshwar and Rajpipla exist near the bank. • Statue of unity (Under Construction) will attract tourism after completion. • Well-developed approach road. • More environment friendly mode of transport, reduces carbon footprint and decongestion of existing road and rail traffic.	• No navigational locks on existing Weir / Dam • Bridges without sufficient horizontal & vertical clearance • Rocky strata • Lack of awareness among people regarding IWT.
Opportunities	**Threats**
• Possibility of Tourism, recreational and local ferry services as number of tourist places and villages exist along river bank. • Ample opportunities for chemical handling. • Lack of tourist facilities in and around River Narmada. • Socio-Economic development of nearby project areas.	• Shoolpaneshwar Bird Sanctuary and forest area encompasses an area of 607.71 sq. km near Sardar Sarovar dam. Construction of tourism ferry terminals in Sardar sarovar reservoir area may require environmental clearance. • Social problem have been faced during reconnaissance survey. • Maintenance of navigational channel

Chapter – 14
Conclusions & Recommendations

14.1 Conclusions & Recommendations:

WAPCOS has studied four terminal locations in three phases at various places on the basis of traffic potential, water availability and land availability. The details of these terminals are given in table 14.1 below:

Table 14.1: Phase-wise details of terminals

Phase	Terminal	Location	Type	Land details	Chainage
Phase-1	**Terminal 1**	Exclusively for OPaL	Cargo	Govt. land	11
Phase-2	**Terminal 2**	Bharuch Tourist Jetty	Tourist	Govt. land	60
	Terminal 3	Tourist Jetty at d/s of Garudeswar Weir	Tourist	Govt. land	168
Phase-3	**Terminal 4**	Ankleshwar Cargo Jetty	Cargo	Govt. land	52

Phase wise details of waterway in terms of length of each phase, dredging quantity, proposed class and bridges to be demolished is given below in Table 14.2.

Table 14.2: Phase-wise details of length, dredging quantity, proposed class and bridges

Phase	Length of waterway	Dredging Quantity	Proposed Class	Bridges to be demolished
Phase-1	0 – 11km	0.95 Mm^3	Class-IV	No Bridge
Phase-2	60 – 168.5 km	3.43 Mm^3	Class-III	
Phase-3	11 – 50 km	1.04 Mm^3	Class-IV	

Out of all terminals, Terminal-1 at Ch.11 km is technically viable. The terminal cost and storage facilities will be created by OPaL but this proposal is not consolidated as internal decisions are still pending from OPaL side. After clearance from OPaL, Proposed development can be executed.

Outcomes of study:

1) Based on recent survey carried out by WAPCOS, out of total 227 km study stretch of river only, 97 km is having depth below 1.7m which is 43% of the total length.

2) Dredging and maintenance of the river is a very challenging task. Cost of the dredging coming out to be approx. Rs. 29 Crores for Phase-1, Rs. 103 Crores for Phase-2 and Rs. 31 Crores for Phase-3 which is highly uneconomical. Total revenue (revenue from channel usage and dredging levy) is less than O & M cost per year.

3) It is to be noted that cost of dredging for Phase-1, Phase-2 and Phase-3 is 86%, 53% and 30% of the total cost respectively.

4) There is rocky strata present throughout most of the River stretch which is very difficult to dredge and not economical.

5) Negative FIRR is coming out even with 1 Rs./tonne for channel usage charges whereas currently operational NW-1, it is 0.5 Rs./tonne.

6) There is very well developed and well-connected road network around the River Narmada throughout its whole stretch. Hence, usage of River Narmada as waterway will not be economically feasible.

7) In Phase 3, IWT charges are more as compared to road transport. Hence, modal shift cannot be possible without subsidy from Govt.

8) Phase-2 and Phase-3 are not viable from the point of view of financial viability.

This report can be updated at a later stage when required, by considering the fresh cargo analysis, change in requirement of the Government or change in policy either of the state or government of India

Following studies should be carried out prior to any development for broad view of implications:

i. Conduct a comprehensive geomorphic study and review and analyse sedimentation processes. The sedimentation study shall be aimed at developing an improved understanding of the significant sedimentation processes within the entire river basin. The major emphasis of this work shall be on analysing major channel morphology and the sedimentation phenomenon during the last 10 year period. As a minimum the sedimentation study shall:
   a. Document the variations in sediment transport (size and quantity);
   b. Identify and quantify all major sources of sediments (bed and banks, tributaries, etc.); and
   c. Locate degrading, aggrading, and stable reaches, and
   d. Establish the range of flows transporting the majority of sediments.

ii. Correlate the results of the sedimentation study with historical changes in the basin (channel improvements, land use, barrage and reservoir construction, etc.) enabling the development of a firm understanding of past and present sedimentation processes. This information shall be used to qualitatively analyse the effects of anticipated project features. This information shall be used to determine what may or may not work when designing navigation improvements. It shall include a determination of those reaches that are stable in depth and width and thus provide the basis for all subsequent preliminary design works. Included in the analysis shall be a study of the bend-ways to determine the siltation and erosion process in the same and the minimum radius required for navigation of the reference vessels.

iii. Undertake various types of model studies to verify and / or enhance all design parameters. As a minimum this shall include a numerical model to produce detailed pictures of flow in the river system under current and future flow conditions and also the required flow/ discharge to maintain 2.5 m LAD throughout the year with or without interventions like (barrages) in River.

iv. Non-destructive testing for bridges can be carried out.

15.1 Environmental and Social Screening Template
NARMADA RIVER

Screening Question	Yes	No	Details/Remarks
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		No	
b) Wildlife/ Bird Sanctuary		No	River is crossing Shoolpaneshwar Wildlife Sanctuary chainage 175-178km & Aliabet Island at Estuary. At present phases of development is till Chainage 168km only no WLS is present
c) Tiger or Elephant Reserve	-	No	
d) Biosphere Reserve	-	No	
e) Reserved/Protected Forest	Yes	-	Shoolpaneshwar Forest range, Near Navgam
f) Wetland	Yes		Estuary Aliabet island, ICMBA
g) Important Bird Areas	Yes		Estuary Aliabet island, ICMBA
h) Mangroves Areas	Yes		Estuary Aliabet island, ICMBA
i) Estuary with Mangroves	Yes		Estuary Aliabet island, ICMBA
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, overwintering, migration	-	No	
k) World heritage sites	-	No	
l. Archeological monuments/ sites (under ASI's Central / State list)	Yes		Within 10km ~450m from river bank (Jami Masjid)
2. Is the project located in whole or part in/near any Critically Polluted Areas identified by CPCB?	-	No	
3. Is, there any defense installations near the project site?	-	No	
4. Whether there is any Government Order/ Policy relevant / relating to the site?	-	No	
5. Is the project involved clearance of existing land, vegetation, and buildings?	-	No	

6. Is the project involved dredging?	Yes	-	
7. Is the project area susceptible to natural hazard (*earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions*)	-	No	
8. Is the project located in whole or part within the Coastal Regulation Zone?	Yes	-	Part area comes under CRZ, The Tidal variation upto Ch-89.5 km in Narmada River come under CRZ area and three proposed terminals fall in the CRZ area.
9. Is the project involved any demolition of the existing structure?	Yes		Bridges which are not meeting vertical as well as horizontal Clearance falling in the stretch.
10. Is the project activity require the acquisition of private land?	-	No	
11. Is the proposed project activity result in loss of direct livelihood/employment?	-	No	
12. Is the proposed project activity affect schedule tribe/ caste communities?	-	No	

Sl.No.	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	Yes
5.	Wildlife Clearance is required	No
6.	NOC from SPCB is required	Yes
7.	Social Impact Assessment is Required	yes
8.	Abbreviated RAP is required	yes
9.	Full RAP is required	
10.	Any other clearance is required	Clearance from Narmada control Authority and Gujarat maritime Board is required at respective areas.

15.2 Traffic Template

15.2.1 Catchment Baseline

- Local economic geography – River Narmada origin – Narmada Kund (Amarkantak plateau), Chhattisgarh
- Catchment area – Bharuch, Vadodara, Narmada district of Gujarat
- Population – As per census 2011, total population residing in Bharuch district is 15,51,019; 41,65,626 in Vadodara and 5,65,072 in Narmada district
- Economic activities – Rice, cotton, wheat, and sugarcane cultivation under Agriculture activities; sand, lignite, silica, gravel, black trap, etc. in mining; Marine Fishing; textiles, power, construction, chemicals & fertilizers, biotechnology, pharmaceuticals, and engineering in industrial activities
- Major industries - Gujarat State Fertilizers and Chemicals (GSFC), Indian Petrochemicals Corporation Limited (IPCL), Gujarat Alkalis and Chemicals Limited (GACL), ONGC Petro Additions Pvt. Ltd. (OPaL)

- Connectivity
  - ✓ Major roads – Dahej-Bharuch Road, Delhi-Mumbai Industrial Corridor (DMIC) passes through the Narmada district.
  - ✓ Major railway – Narmada has poor rail connectivity with only 4 railway stations; Vadodara is well connected major locations like Delhi and Mumbai, and to other districts in the state via a Broad-gauge rail line; broad-gauge of 50 km in Bharuch district across 33 railway lines makes it a well-connected district

- Specific Developments
  - ✓ Number of industrial units coming up at Petroleum Chemicals and Petrochemicals Investment Region (PCPIR)
  - ✓ Birla Copper expanding its production capacity from 0.24 MTPA to 0.48 MTPA
  - ✓ Dahej's Solid cargo terminal capacity to increase from 3 MTPA to 12 MTPA in the near future
  - ✓ Plans to increase LNG Petronet Jetty (Dahej) from 15 MTPA to 20 MTPA by FY20.

Figure 15.1Catchment area Map

Phases	Proposed Terminal	Location	Latitude/Longitude	Type of Movement	Chainage (Km)
1	Terminal 1	Ambetha, Dahej	21°40'55.65"N / 72°36'46.81"E	Cargo	11
2	Terminal 2	Bharuch	21°42'49.96"N / 73° 2'58.72"E	Tourism	60
	Terminal 3	Garudeshwar	21°53'6.87"N / 73°39'30.62"E	Tourism	168
3	Terminal 4	Bharuch	21°41'12.32"N / 73° 0'10.22"E	Cargo	50

15.2.2 Navigation Baseline

- Existing Waterway Usage
  - ✓ The earmarked stretch is currently not utilized for cargo movement.
  - ✓ No tourism activity found on the river. However, occasional passenger movement is seen across the river stretch at Rundh and Chandod.

15.2.3 Market Baseline

- Potential Market
  - ✓ Liquid Bulk – Naphtha
  - ✓ Container Cargo (Ro-Ro cargo)

Commodity	Source	Reasoning
Naphtha	ONGC (Hazira, Mumbai)	OPaL intends to change its current transport logistics to prevent from disclosing its operational details to its competitor. The company is intent on using River Narmada to handle naphtha.
Container	Ankleshwar ICD	Overall viability hinges on logistics appeal of River Narmada against the current road and rail movement from Ankleshwar ICD.

15.2.4 Forecasting Years

- IWT Share
  - ✓ In case of naphtha, IWT will be utilized for 100% share, rather than deriving some partial share from existing cargo movement. OPaL has confirmed about shifting naptha cargo. However presently they are evaluating other options too.
  - ✓ Ro-Ro traffic share for IWT has been assumed to be 50% of the total estimated exim traffic at Ankleshwar ICD.

Phases	Name of Cargo	Type of Cargo	Origin	Original Terminal on NW	Co-ordinates	Final Destination	Destination Terminal on NW	Co-ordinates	Unit p.a	Fy-16	Fy-21	Fy-25	Fy-28	Fy-30	Fy-34	Fy-35	Fy-40	Fy-45
Proposed Terminal 1 Opportunity for IWAI																		
1	Naphtha	Liquid bulk	Anchorage Dahej Port	n/a	Anchorage	OPaL plant, Vagarataluka (Dahej)	IWT 1	21°40'55.65"N/ 72°36'46.81"E	mn T	-	0.5	1	1	1	1	1	1	1
								Total	mn T	**-**	**0.5**	**1**	**1**	**1**	1	**1**	**1**	**1**
Proposed Terminal 2 to 3 Opportunity for IWAI																		
2	Tourism	N.A	IWT 2	IWT 2	21°42'49.96"N / 73° 2'58.72"E	IWT 3	IWT 3	21°53'6.87"N / 73°39'30.62"E	000'	-	-	-	202	279	458	638	1054	1200
								Total		-	-	-	202	279	458	638	1054	1200
Proposed Terminal 4 Opportunity for IWAI																		
3	Container	Ro-Ro	Ankleshwar ICD	IWT 4	21°41'12.32"N / 73° 0'10.22"E	JNPT	n/a	n/a	('000 Trucks)	-	-	-	-	-	13	13	27	60
	Container	Ro-Ro	JNPT	n/a	n/a	Ankleshwar ICD	IWT 4	21°41'12.32"N / 73° 0'10.22"E		-	-	-	-	-	2	3	7	13
								Total		-	-	-	-	-	**15**	**16**	**33**	**73**

15.2.5 Presentation of Forecast

Phases	Name of Cargo	Type of Cargo	Origin	Final Destination	Unit p.a	Distance O - D (Km)	Fy-16	Fy-21	Fy-25	Fy-28	Fy-30	Fy-34	Fy-35	Fy-40	FY45
Proposed Terminal 1 Opportunity for IWAI															
1	Naphtha	Liquid Bulk	Dahej Anchorage	OPaL plant, Dahej	mn T-km	18	-	9	18	18	18	18	18	18	18
				Total	**mn T-km**		-	9	18	18	18	18	18	18	18
Proposed Terminal 4 Opportunity for IWAI															
4	Container	Ro-Ro	JNPT	Ankleshwar ICD	mn T-km	385	-	-	-	-	-	77	77	154	347
	Container	Ro-Ro	Ankleshwar ICD	JNPT			-	-	-	-	-	12	15	39	77
				Total	**mn T-km**		-	-	-	-	-	89	92	193	424

15.2.6 Market Success Factors

15.2.6.1 Fairway availability

- OPaL expects IWAI to develop fairway, allowing the company to move naphtha between Dahej anchorage and the Terminal 1 location at Ambetha in Dahej.
- Between Dahej Anchorage and Terminal 1, the total chainagerequired to be developed for maintaining navigable conditions is 18 km.
    - The navigable length needs to be maintained round the year because the company, at present, is importing 2 shipments of the raw material every month. In future, this is likely to increase.
- In case of Terminal 4 at Bharuch near Golden bridge, IWAI needs to develop and maintain 50-km stretch for enabling Ro-Ro movement from and to the Terminal
    - Based on the Ro-Ro projections and vessel design logistics, Terminal 4 would also require round-the-year maintenance of navigable stretch. Assuming a Class IV vessel, at least 2 trucks / day has been estimated. This traffic flow will increase by the year, even after deploying multiple barges.

In totality, IWAI would need to develop 50-km stretch of River Narmada, measured between Dahej anchorage and Terminal 4 at Bharuch near golden bridge, for cargo movement. Both OPaL and Ankleshwar ICD are engaged in regular exim operations. OPaL in particular, needs reliable navigation conditions on River Narmada, as the company may also further utilize the river formoving its export cargo.

- For Tourism purpose, IWAI would have to develop navigation for movement of tourism ferry from river stretch of 60 Km in Bharuch to 168 Km Garudeshwar i.e near Statue of Unity. Statue of unity is expected to be built by October, 2018 and it is going to be centre of Gujarat tourism in future.

15.2.6.2 Vessel types

The following table lists the range of RSVs recommended to move cargo on River Narmada:

Terminals	Type - Capacity	Fleet capacity (No. of Barges)							Loading Point	Discharge Point
		FY21	FY25	FY30	FY34	FY35	FY40	FY45		
Terminal 1 (One-way Ballast)	Class IV - 1,000 DWT	40	67	67	67	67	67	67	Dahej Anchorage	Terminal 1 (Ambetha)
	Class V - 1,000 DWT	40	67	67	67	67	67	67		
	Class VI - 2,000 DWT	27	46	46	46	46	46	46		
Terminal 4 (One-way Ballast)	Class IV - 1,000 DWT	-	-	-	6	7	15	35	JNPT / Bharuch(Terminal 4)	Terminal 4 (Bharuch) / JNPT

The total number of vessels required per vessel type varies based on traffic projections estimated for each of the above terminals.

15.2.6.3 Complementary Investment

IWAI is required to invest in fairway development and construction of the proposed terminals only. In case of OPaL terminal at Ambetha, terminal construction is optional. The company has indicated strong intentions of developing the necessary infrastructure themselves.

Connectivity from the terminals to the final consumption point (OPaL plant for Terminal 1, and Ankleshwar ICD for Terminal 4) is available. In case of OPaL, last-mile connectivity would be by pipeline, which will be installed by the company. Last mile cargo movement for Terminal 4 would be by road. Here, widening of road connecting to Gujarat State Highway 76 may be required.

15.2.7 Forecasting Methodology

- Naphtha for OPaL is a certain cargo that can be imported using River Narmada. The waterway movement will allow the company to carry out imports while preventing disclosure of its operational details to its competition. Based on company's inputs, their import volume is likely to increase to 1 mn T by FY25 from the current of 0.5 mn T. For projection purposes, it's been assumed that the terminal on River Narmada will start handling naphtha from FY21, and reach 1 mn T by FY25, at the most. In the absence of definite future expansion plans, it's been assumed that the company will cap its total import at 1 mn T. Hence, import figures for naphtha will not increase beyond 1 mn T for the projection years that follow.

- The chemical & petrochemical industries have grown by 12% in the past decade, the steel industry at 11% in last 5 years, and the fertilizer industry at 2%. Hence, an average y-o-y growth rate of 10% was applied to calculate traffic forecast from Ankleshwar ICD. Between January 2016 and October 2016, Ankleshwar ICD handled a traffic of 7,722 TEU, of which 6,485 was for import and 1,237 for export. On the back of these facts and assumptions, the fourth terminal on River Narmada is estimated to begin operations in FY33, and handle 50% of the total Ankleshwar ICD exim volume. Gradually, the terminal is expected to attract more of this exim share from the current railway mode. By FY45, this share is estimated to grow to an optimistic 100% of the total exim volume. Between FY19 and FY45, traffic growth is projected to grow at a 13-year CAGR of 15%. For conversion between TEU and MT, an average of 15 MT per TEU was assumed.

15.3 Project Costing Template

15.3.1 Capital Cost Estimate (Phase-1)

Capital Cost (Phase-1)	In Crores
(I) Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (6 nos.)	0.12
RIS Station	4.93
Total Cost(III)	7.05
3% Contingencies and 7% Supervision charges on Base cost	0.70
Total Navigation & Communication Cost	7.75
(II) Handling Equipment & Utilities	
Mechanical & electrical	0.0
3% Contingencies and 7% Supervision charges on Base cost	0.00
Total Handling Equipment & Utilities Cost	**0.00**
Other cost including financing cost and interest during construction (10% of (I)	0.00
Total Cost ((I)+(II)+(III)+(IV)	**7.75**
(III) Dredging	
Dredging **(0.95 Mm3)**	**28.68**
Total Capital Cost	**36.43**

Capital Cost Estimate (Phase-2)

Capital Cost (Phase-II)	In Crores
(I) Civil Cost	
Terminal Cost	
Ankleshwar-Nandod ***(70m x 5m)***	6.60
Storage Area(Including roads, STP, Bio-Toilets,parking area etc)	19.00
Total Cost(I)	25.60
3% Contingencies and 7% Supervision charges on Base cost	2.56
Total Civil Cost	**28.16**
(II) Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (54 nos.)	1.08
RIS Station	9.85
Total Cost(III)	12.93
3% Contingencies and 7% Supervision charges on Base cost	1.29

Total Navigation & Communication Cost	14.22
(III) Handling Equipment & Utilities	
Mechanical & electrical	5.0
3% Contingencies and 7% Supervision charges on Base cost	0.50
Total Handling Equipment & Utilities Cost	**5.50**
Other cost including financing cost and interest during construction (10% of (I)	2.82
Total Cost ((I)+(II)+(III)+(IV)	**50.70**
(IV) Dredging	
Dredging **(3.43 Mm3)**	**102.99**
Total Cost	
Total Capital Cost	**153.69**

Capital Cost Estimate (Phase-3)

Capital Cost (Phase-III)	In Crores
(I) Civil Cost	
Terminal Cost	
Ankleshwar	22.23
Storage Area(Including roads, warehouse, parking area etc)	9.50
Total Cost(I)	31.73
3% Contingencies and 7% Supervision charges on Base cost	3.17
Total Civil Cost	**34.90**
(II) Vessel Cost	
Procurement of Barges	0.00
3% Contingencies	0.00
Total Vessel Cost	0.00
(III) Navigation & Communication Cost	
DGPS	1.00
VTMS	1.00
Marine Lantern/Buyos (20 nos.)	0.40
RIS Station	0.00
Total Cost(III)	2.40
3% Contingencies and 7% Supervision charges on Base cost	0.24
Total Navigation & Communication Cost	2.64
(IV) Handling Equipment & Utilities	
Mechanical & electrical	10.1
3% Contingencies and 7% Supervision charges on Base cost	1.01
Total Handling Equipment & Utilities Cost	**11.11**
Other cost including financing cost and interest during construction (10% of (I))	3.49
Total Cost ((I)+(II)+(III)+(IV)	**52.14**
(V) Dredging	
Dredging **(1.04 Mm3)**	**31.36**
Total Cost	
Total Capital Cost	**83.50**

15.3.2 Operation & Maintenance Cost

Table 11.4 Operation & Maintenance Cost (Phase-1)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	2.87
(ii)	Ports Crafts/Nav. Aids @ 5%	0.39
(iii)	Fuel Cost	1.00
(iv)	Power Cost	2.00
(v)	Manpower Cost	2.74
(vi)	Miscellaneous	0.50
	Total	**9.50**

Table 11.5 Operation & Maintenance Cost (Phase-2)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	10.30
(ii)	Civil works @ 1%	0.28
(iii)	Mechanical & Electrical Cost @ 5%	0.27
(iv)	Ports Crafts/Nav. Aids @ 5%	0.71
(v)	Fuel Cost	2.00
(vi)	Power Cost	4.00
(vii)	Manpower Cost	5.5
(viii)	Miscellaneous	0.5
	Total II	**23.57**

Table 11.6 Operation & Maintenance Cost (Phase-3)

S.No.	O & M Cost	In Crores
(i)	Dredging @ 10%	3.14
(ii)	Civil works @ 1%	0.35
(iii)	Mechanical & Electrical Cost @ 5%	0.55
(iv)	Ports Crafts/Nav. Aids @ 5%	0.13
(v)	Fuel Cost	1.00
(vi)	Power Cost	2.00
(vii)	Manpower Cost	2.74
(viii)	Miscellaneous	0.50
	Total II	**10.41**

15.3.3 Recurrent Cost

Mechanical & Electrical cost will be recurrent cost. Same will be added after every 10 years from completion of project.

Phase -1

Nil

Phase -2

Handling Equipment & Utilities	In Crores
Mechanical & electrical	5.0
3% Contingencies and 7% Supervision charges on Base cost	0.50
Total Handling Equipment & Utilities Cost	**5.50**

Phase -3

Handling Equipment & Utilities	In Crores
Mechanical & electrical	10.1
3% Contingencies and 7% Supervision charges on Base cost	1.01
Total Handling Equipment & Utilities Cost	**11.11**

15.3.4 Cost Verification

Gujarat Maritime Board Schedule of Rate, 2013-14 has been followed and escalated by 5% per annum to arrive at for year 2018 to arrive at the cost of the project. However, for dredging (2015-16) rates has been considered as substantial change has not been observed.

In annexures of chapter 11, reference of rates has been provided in to reach realistic overall cost.

15.4 ECONOMIC EVALUATION TEMPLATE

Template 15.4.1: EIRR Analysis (Phase-1)

S.No	Year	Capital Cost	Annual O&M Cost	Total Cost	Economic costs Rs lakhs	Economic Benefits Rs lakhs	Net cash flow Rs lakhs
1	2019	12	0	12	804		-804
2	2020	12	0	12	804		-804
3	2021		10	10	639	563	-77
4	2022		10	10	659	563	-96
5	2023		10	10	678	563	-116
6	2024		10	10	699	563	-136
7	2025		11	11	720	1125	406
8	2026		11	11	741	1125	384
9	2027		11	11	763	1125	362
10	2028		12	12	786	1125	339
11	2029		12	12	810	1125	315
12	2030		13	13	834	1125	291
13	2031		13	13	859	1125	266
14	2032		13	13	885	1125	240
15	2033		14	14	912	1125	214
16	2034		14	14	939	1125	186
17	2035		15	15	967	1125	158
18	2036		15	15	996	1125	129
19	2037		15	15	1026	1125	99
20	2038		16	16	1057	1125	68
21	2039		16	16	1088	1125	37
22	2040		17	17	1121	1125	4
23	2041		17	17	1155	1125	-30
24	2042		18	18	1189	1125	-64
25	2043		18	18	1225	1125	-100
26	2044		19	19	1262	1125	-137
27	2045		19	19	1300	1125	-174
28	2046		20	20	1339	1125	-213
29	2047		21	21	1379	1125	-254
30	2048		21	21	1420	1125	-295
						EIRR	**3.10%**
						NPV (in Rs lakhs)	-680

Template 15.4.2: Economic Benefits (Phase-1)

		Economic Benefits				Total
		Fuel savings	*Carbon Credit*	*Other Benefits*	*Emp benefits*	
S.No	***Year***	***Rs lakhs***	***Rs lakhs***	***Rs lakhs***	***Rs lakhs***	***Rs lakhs***
1	2019					0
2	2020					0
3	2021	118	4	78	362	563
4	2022	118	4	78	362	563
5	2023	118	4	78	362	563
6	2024	118	4	78	362	563
7	2025	235	8	157	725	1125
8	2026	235	8	157	725	1125
9	2027	235	8	157	725	1125
10	2028	235	8	157	725	1125
11	2029	235	8	157	725	1125
12	2030	235	8	157	725	1125
13	2031	235	8	157	725	1125
14	2032	235	8	157	725	1125
15	2033	235	8	157	725	1125
16	2034	235	8	157	725	1125
17	2035	235	8	157	725	1125
18	2036	235	8	157	725	1125
19	2037	235	8	157	725	1125
20	2038	235	8	157	725	1125
21	2039	235	8	157	725	1125
22	2040	235	8	157	725	1125
23	2041	235	8	157	725	1125
24	2042	235	8	157	725	1125
25	2043	235	8	157	725	1125
26	2044	235	8	157	725	1125
27	2045	235	8	157	725	1125
28	2046	235	8	157	725	1125
29	2047	235	8	157	725	1125
30	2048	235	8	157	725	1125

Template 15.4.3: Fuel Saving (Phase-1)

Year	**Total traffic potential by IWT**	**Total traffic potential by IWT**	**Fuel Saving**	**Fuel Saving**	
	mn tonnes	***million TKM***	***in million litre***	***in Rs million***	***in Rs lakhs***
2021	0.50	6	0.16	12	118
2022	0.50	6	0.16	12	118
2023	0.50	6	0.16	12	118
2024	0.50	6	0.16	12	118
2025	1.00	11	0.31	24	235
2026	1.00	11	0.31	24	235
2027	1.00	11	0.31	24	235
2028	1.00	11	0.31	24	235
2029	1.00	11	0.31	24	235
2030	1.00	11	0.31	24	235
2031	1.00	11	0.31	24	235
2032	1.00	11	0.31	24	235
2033	1.00	11	0.31	24	235
2034	1.00	11	0.31	24	235
2035	1.00	11	0.31	24	235
2036	1.00	11	0.31	24	235
2037	1.00	11	0.31	24	235
2038	1.00	11	0.31	24	235
2039	1.00	11	0.31	24	235
2040	1.00	11	0.31	24	235
2041	1.00	11	0.31	24	235
2042	1.00	11	0.31	24	235
2043	1.00	11	0.31	24	235
2044	1.00	11	0.31	24	235
2045	1.00	11	0.31	24	235
2046	1.00	11	0.31	24	235
2047	1.00	11	0.31	24	235
2048	1.00	11	0.31	24	235

Template 15.4.4: Carbon Credits Earned (Phase-1)

Year	Total traffic potential by IWT	Total traffic potential by IWT	Fuel Saving	Carbon Credit Earned	
	mn tonnes	*million TKM*	*in million litre*	*in Rs million*	*in Rs lakhs*
2021	0.50	6	0.16	0.40	4
2023	0.50	6	0.16	0.40	4
2024	0.50	6	0.16	0.40	4
2025	0.50	6	0.16	0.40	4
2026	1.00	11	0.31	0.80	8
2027	1.00	11	0.31	0.80	8
2028	1.00	11	0.31	0.80	8
2029	1.00	11	0.31	0.80	8
2030	1.00	11	0.31	0.80	8
2031	1.00	11	0.31	0.80	8
2032	1.00	11	0.31	0.80	8
2033	1.00	11	0.31	0.80	8
2034	1.00	11	0.31	0.80	8
2035	1.00	11	0.31	0.80	8
2036	1.00	11	0.31	0.80	8
2037	1.00	11	0.31	0.80	8
2038	1.00	11	0.31	0.80	8
2039	1.00	11	0.31	0.80	8
2040	1.00	11	0.31	0.80	8
2041	1.00	11	0.31	0.80	8
2042	1.00	11	0.31	0.80	8
2043	1.00	11	0.31	0.80	8
2044	1.00	11	0.31	0.80	8
2045	1.00	11	0.31	0.80	8
2046	1.00	11	0.31	0.80	8
2047	1.00	11	0.31	0.80	8
2048	1.00	11	0.31	0.80	8
2049	1.00	11	0.31	0.80	8

Template 15.4.5: Emp. Benefits (Phase-1)

Year	**Total traffic potential by IWT**	**Output**	**Output**	**Output Stimulus**	**Emp generation**	**Emp benefits**	
	mn tonnes	*lakh tonne*	*Rs lakh*	**Rs lakh**	*Man years*	*Rs million*	*Rs lakhs*
2021	0.50	5	5127	7639	3295	36	362
2022	0.50	5	5127	7639	3295	36	362
2023	0.50	5	5127	7639	3295	36	362
2024	0.50	5	5127	7639	3295	36	362
2025	1.00	10	10253	15277	6590	72	725
2026	1.00	10	10253	15277	6590	72	725
2027	1.00	10	10253	15277	6590	72	725
2028	1.00	10	10253	15277	6590	72	725
2029	1.00	10	10253	15277	6590	72	725
2030	1.00	10	10253	15277	6590	72	725
2031	1.00	10	10253	15277	6590	72	725
2032	1.00	10	10253	15277	6590	72	725
2033	1.00	10	10253	15277	6590	72	725
2034	1.00	10	10253	15277	6590	72	725
2035	1.00	10	10253	15277	6590	72	725
2036	1.00	10	10253	15277	6590	72	725
2037	1.00	10	10253	15277	6590	72	725
2038	1.00	10	10253	15277	6590	72	725
2039	1.00	10	10253	15277	6590	72	725
2040	1.00	10	10253	15277	6590	72	725
2041	1.00	10	10253	15277	6590	72	725
2042	1.00	10	10253	15277	6590	72	725
2043	1.00	10	10253	15277	6590	72	725
2044	1.00	10	10253	15277	6590	72	725
2045	1.00	10	10253	15277	6590	72	725
2046	1.00	10	10253	15277	6590	72	725
2047	1.00	10	10253	15277	6590	72	725
2048	1.00	10	10253	15277	6590	72	725

Template 15.4.6: Other benefits (Phase-1)

Year	**Total traffic potential by IWT**	**Total traffic potential by IWT**	**Other Benefits**
	mn tonnes	***million TKM***	***Rs lakhs***
2021	0.50	6	78
2022	0.50	6	78
2023	0.50	6	78
2024	0.50	6	78
2025	1.00	11	157
2026	1.00	11	157
2027	1.00	11	157
2028	1.00	11	157
2029	1.00	11	157
2030	1.00	11	157
2031	1.00	11	157
2032	1.00	11	157
2033	1.00	11	157
2034	1.00	11	157
2035	1.00	11	157
2036	1.00	11	157
2037	1.00	11	157
2038	1.00	11	157
2039	1.00	11	157
2040	1.00	11	157
2041	1.00	11	157
2042	1.00	11	157
2043	1.00	11	157
2044	1.00	11	157
2045	1.00	11	157
2046	1.00	11	157
2047	1.00	11	157
2048	1.00	11	157

15.5 Financial Evaluation Template

Template 15.5.1: FIRR, Revenue and Sensitivity Analysis assuming charge for using the channel is Rs. 1/tonne (Phase-1)

S.No.	Year	Capital cost	Annual O & M Cost	Total Cost	Revenue Channel	Subsidy from Govt	Dredging Levy from Operator	Total Revenue	Net Cash Flow	SENSITIVITY ANALYSIS					
										Cap. Cost (+) 10%	Cap. Cost (-) 10%	ANNUAL O &M COST (+) 10%	ANNUAL O &M COST (-) 10%	REVENUE (+) 10%	REVENUE (-) 10%
	1	2	3	4 = (2+3)				5	6= (5-2)	10	11	12	13	14	15
1	2019	18	0	18					-18.22	-20	-16	-18	-18	-18	-18
2	2020	18	0	18					-18.22	-20	-16	-18	-18	-18	-18
4	2021		9.8	9.8	0.55	0.00	0.93	1.48	-8.27	-8	-8	-9	-7	-8	-8
5	2022		10.0	10.0	0.55	0.00	0.93	1.48	-8.57	-9	-9	-10	-8	-8	-9
6	2023		10.3	10.3	0.55	0.00	0.93	1.48	-8.87	-9	-9	-10	-8	-9	-9
7	2024		10.7	10.7	0.55	0.00	0.93	1.48	-9.18	-9	-9	-10	-8	-9	-9
8	2025		11.0	11.0	1.10	0.00	0.93	2.03	-8.95	-9	-9	-10	-8	-9	-9
9	2026		11.3	11.3	1.10	0.00	1.86	2.96	-8.34	-8	-8	-9	-7	-8	-9
10	2027		11.6	11.6	1.10	0.00	1.86	2.96	-8.68	-9	-9	-10	-8	-8	-9
11	2028		12.0	12.0	1.10	0.00	1.86	2.96	-9.03	-9	-9	-10	-8	-9	-9
12	2029		12.4	12.4	1.10	0.00	1.86	2.96	-9.39	-9	-9	-11	-8	-9	-10
13	2030		12.7	12.7	1.10	0.00	1.86	2.96	-9.76	-10	-10	-11	-8	-9	-10
14	2031		13.1	13.1	1.10	0.00	1.86	2.96	-10.15	-10	-10	-11	-9	-10	-10
15	2032		13.5	13.5	1.10	0.00	1.86	2.96	-10.54	-11	-11	-12	-9	-10	-11

S.No.	Year	Capital cost	Annual O & M Cost	Total Cost	Revenue Channel	Subsidy from Govt	Dredging Levy from Operator	Total Revenue	Net Cash Flow	SENSITIVITY ANALYSIS					
										Cap. Cost (+) 10%	Cap. Cost (-) 10%	ANNUAL O &M COST (+) 10%	ANNUAL O &M COST (-) 10%	REVENUE (+) 10%	REVENUE (-) 10%
	1	2	3	4 = (2+3)				5	6= (5-2)	10	11	12	13	14	15
16	2033		13.9	13.9	1.10	0.00	1.86	2.96	-10.94	-11	-11	-12	-10	-11	-11
17	2034		14.3	14.3	1.10	0.00	1.86	2.96	-11.36	-11	-11	-13	-10	-11	-12
18	2035		14.8	14.8	1.10	0.00	1.86	2.96	-11.79	-12	-12	-13	-10	-11	-12
19	2036		15.2	15.2	1.10	0.00	1.86	2.96	-12.23	-12	-12	-14	-11	-12	-13
20	2037		15.7	15.7	1.10	0.00	1.86	2.96	-12.69	-13	-13	-14	-11	-12	-13
21	2038		16.1	16.1	1.10	0.00	1.86	2.96	-13.16	-13	-13	-15	-12	-13	-13
22	2039		16.6	16.6	1.10	0.00	1.86	2.96	-13.64	-14	-14	-15	-12	-13	-14
23	2040		17.1	17.1	1.10	0.00	1.86	2.96	-14.14	-14	-14	-16	-12	-14	-14
24	2041		17.6	17.6	1.10	0.00	1.86	2.96	-14.65	-15	-15	-16	-13	-14	-15
25	2042		18.1	18.1	1.10	0.00	1.86	2.96	-15.18	-15	-15	-17	-13	-15	-15
26	2043		18.7	18.7	1.10	0.00	1.86	2.96	-15.73	-16	-16	-18	-14	-15	-16
27	2044		19.3	19.3	1.10	0.00	1.86	2.96	-16.29	-16	-16	-18	-14	-16	-17
28	2045		19.8	19.8	1.10	0.00	1.86	2.96	-16.87	-17	-17	-19	-15	-17	-17
29	2046		20.4	20.4	1.10	0.00	1.86	2.96	-17.46	-17	-17	-20	-15	-17	-18
30	2047		21.0	21.0	1.10	0.00	1.86	2.96	-18.07	-18	-18	-20	-16	-18	-18
	Total	**36**	**397**	**434**											
FIRR(%)									**Negative Value**						
NPV@ discount factor 9% in Cr.									**Rs. - 118.75**	**Rs. - 121.96**	**Rs. - 115.55**	**Rs. - 129.47**	**Rs. - 108.04**	**Rs. - 116.71**	**Rs. - 120.80**

ANNEXURE 6.1 Berthing Force

Design Vessel	Displacement Tonnage	L_{OA} (m)	L_{PP} (m)	Beam (m)	Draft (m)
Class-VII	**4000**	**86**	**86**	**14**	**2.9**

1) Kinetic Energy, E imparted to Fendering System

$E = M_D V_b^2 (C_m C_e C_s C_c) / 2$

W_D	Displacement Tonnage (DT) of the vessel, (t)
V_b	Velocity of vessel in m/s, normal to the berth
C_m	Mass coefficient
C_e	Eccentricity coefficient
C_s	Softness coefficient
C_c	Configuratinal Coefficient

a) Displacement Tonnage, W_D (Tonnes) 4000 t

b) Approach Velocity (m/s) 0.20 m/s

Choose Site Condition - Berthing Condition from the following menu:

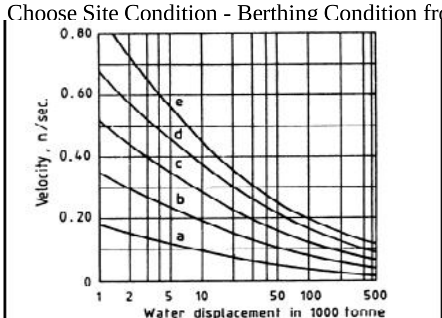


Figure 1 — Design berthing velocity as function of navigation conditions and size of vessel (Brolsma et al, 1977)

a) Good berthing, sheltered.
b) Difficult berthing, sheltered.
c) Easy berthing, exposed.
d) Good berthing, exposed.
e) Navigation conditions difficult, exposed.

c) Mass Coefficient Cm = 1.41

=

Unit Weight of sea water (g_w) = 1.0026 t/m^3

Cm = 1+ 2D/B =

d) Eccentricity Coefficient Ce = **0.60**

e) Softness Coefficient Cs = **1.00**

Kinetic energy, E = = (4000*(0.2^2)*1.41428571428571*0.6*1/(2*9.81)

= 6.92 **t-m**

Factor of safety = 1.4

Kinetic Energy, E imparted to a fendering system = **9.688** **t-m**

= **96.88** **kN*m**

According to this Kinetic energy following fender has been assumed

G2 grade of MCS 2000

Type of Fender	=	**MCS 400 Cell Fender**	
Energy Absorption	=	**21.60**	kN*m
Reaction Force	=	**129**	kN

Annexure 6.2 Analysis Of Mooring Force Due To Wind And Current

Class-VII Vessel

Design Vessel	Displacement Tonnage	L_{OA} (m)	L_{PP} (m)	Beam (m)	Draft (m) D_R
Vikrant	4,000	86.0	86.0	14.0	2.9

1) Mooring Force due to Wind:

Mooring Force due to wind: $F_w = C_w A_w P$

C_w	=	Shape Factor
	=	1.5
L_{pp}	=	Length between the perpendiculars in m
	=	86.0
D_R	=	Loaded draft in m
	=	2.9
D_M	=	Moulded depth in m
	=	3.9
	=	3.9 m
D_L/D_M	=	58%
	=	3.9 * 0.575
	=	2.2425
A_w	=	Windage area in sq. m
	=	$1.175\ L_p\ (D_M - D_L)$
	=	1.175 * 86 * (3.9 - 2.2425)
	=	167.49 m^2
V z	=	Design normal wind speed in m/s
	=	50.0
P_w	=	$0.06\ V^2$
	=	0.06 * (50 ^ 2)
	=	150

Mooring Force due to wind:	**F_w (kg)**	**=**	37,685.33
	F_w (T)	=	**37.7**
	F_w (kN)	=	**376.85**

2) Mooring Force due to Current:

Pressure due to current: $P_c = g_w V^2 / 2g$

where,

P_c =	Pressure due to current in kg/sq.m	=	18.8
g_w =	Unit weight of water in kg/cu.m	=	1025
V =	Current velocity in m/s	=	0.60
g =	Acceleration due to gravity in m/s^2	=	9.81

Mooring force due to current: $F_c = L_{pp} D_r P_c$

where,

F_c =	Mooring Force due to current in kg		
L_{pp} =	Length between the perpendiculars in m	=	86.0
D_R =	Loaded draft of vessel in m	=	2.9
Pc =	Pressure due to current in kg/sq.m (as explained abo	=	18.8

Mooring Force due to current: **F_c (kg)** 4690.55

F_c (T) **4.7**

Assuming that the mooring force due to current and wind act simultaneously in the same direction, Total Mooring Force (T) **42.4**

The total force can be assumed to be equally distributed to three bollards if the ship is moored to eight bollards

Force on each Bollard (T) **14.13**

Highest of the two above calculated mooring forces for coal and container vessel is 135.5 T per bollard. Hence 150 T Bollard Pull is adopted.

To,
Reshu Verma
WABCOS
Gurgaon

03 November 2017

Dear Ms Verma,

Our ref: Floating Tourist Jetty

Further to our recent discussion we take pleasure in submitting this proposal for a state-of-the-art floating tourist jetty at an undisclosed location as per your request. To facilitate our calculations we have assumed the site to be in a tidal creek with a silt riverbed located within 200 kms of Bombay. We have also assumed the site to have an existing concrete quay wall or other form of bankseat to secure the shore end of the gangway.

1. Introduction to Marinetek

The Marinetek Group is one of the world's largest designers, manufacturers, and installers of floating jetty systems. We have undertaken more than 2,000 top reference projects in 40 countries. Please see details on the Group website www.marinetekgroup.com

We enclose our Marinetek India brochure.

For your project the pontoons will be manufactured in at our production facility near Bombay and transported to your location by road.

2. Description of the Floating Jetty

We propose to supply our Premier all-concrete pontoons for your project; please see enclosed data sheet.

We propose a Type 1 jetty comprising 3No. pontoons, as shown on the enclosed drawings at Fig. 1.

The freeboard of the pontoon will be approx 0.5m. This freeboard is the international standard, and it has proved ideal for the embarkation and disembarkation of passengers. This is well illustrated in Fig. 2.

The jetty will be positioned approximately as shown on the Google Earth image enclosed as Fig. 3. However, we can adjust the location as you may require.

We will fit 150mm D-rubber fender along the berthing face of the pontoon. This fender will be secured to stainless steel cast-in sockets.

We will fit 6No. 5t capacity stainless steel twin-post mooring bollards along the 24m long berthing face, and 3No. to the rear berthing face, and 2No. on the gangway landing pontoon.

We have not at this stage quoted for guardrails or any MEP (mechanical, electrical and plumbing) on the jetty but this can be arranged, if you wish.

We have allowed for a solar-powered, double fixed-red navigation light on the jetty. This would be in accordance with IALA Regulations.

3. Advantages of Marinetek Floating Jetties

Marinetek floating jetties offer many very positive features, including:

a) They are genuinely unsinkable by virtue of their core of closed-cell foam. Unlike with steel or plastic pontoons, there are no compartments that may leak and cause them to sink.

b) The concrete deck of the pontoon is highly anti-slip, even in the pouring rain.

c) The pontoon has a design life of 50 years in normal use, with essentially zero maintenance. Unlike with a steel pontoon there is no need to regularly chip and paint, or to have a dry-docking every couple of years (as often required by insurers). And unlike with plastic pontoons, the sun's UV rays have no effect.

d) The heavy mass of the Type 1 floating jetty (about 47 tons) means that it will barely move under the weight of passengers or from waves in the river. This lack of movement ensures that passengers and tourists are safe and feel happy.

4. Gangway

The floating jetty will be accessed by a gangway fabricated of marine-grade aluminium. This aluminium is corrosion-free which means it is maintenance free. It will be designed for a live-loading of 4KPa, in accordance with international standards. The deck will be of fibre-reinforced plastic (FRP) panels with an anti-slip gritted surface.

Subject to a further site inspection and confirmation of the precise location for the jetty, we have allowed for a gangway of 10m length and 1.5m width.

Certain accessories and enhancements are available for a small additional cost. For example:

- Handrails with integral LED down-lighting.
- Painting of the gangway in your corporate colours.
- Display panels along both sides of the gangway.

5. Moorings

For your project, we propose to secure the floating jetty in position with mooring chains. This means that there will be no "construction" in the river or on the riverbed and therefore (to the best of our knowledge and understanding) there will be no conflict with the CRZ Law and no need to seek clearance from the environmental authorities.

Please note that the moorings should be checked once every two years by an engineering diver. We also recommend that sacrificial anodes on the chain be renewed as and when required.

6. Client Supply Items

Our price is based on you being responsible for the following:

- A bathymetric survey adequate for the mooring design.
- All permissions needed to install and operate the pontoon system.
- Providing free and clear access to the site for our trucks and mobile crane.

7. Price & Terms of Payment

Our lump-sum contract price will be **INR 98,00,000/-** (Rupees Ninety Eight Lacs), plus relevant taxes.

For the avoidance of doubt this price includes:

- Manufacturing and transporting the pontoons.
- Fabricating and transporting the gangway.
- Procuring and transporting the moorings.
- Laying the moorings, launching the pontoons, and connecting-up.
- Installing the gangway.

This jetty will be manufactured exclusively for your project, and therefore our terms of payment shall be:

a) An advance payment of 40% of the above lump-sum price.

b) An interim payment of 30% when the 3No. pontoons have been completed but before they are dispatched from our yard.

c) An interim payment of 20% when the gangway has been completed but before it is dispatched from our yard.

d) The balance within 14 days of the jetty and gangway installation having been completed.

For each, (a) to (d) above, the amounts shall have relevant taxes added.

8. Terms & Conditions

This offer is subject to the following.

a) Ownership of the floating jetty shall remain vested in Marinetek until all payments have been made to us. Until such time as we have received the final payment, the jetty may not be used unless with our prior permission given in writing.

b) All Intellectual Property Rights relating to the pontoon shall remain the exclusive property of Marinetek. You acknowledge the distinctiveness, validity, originality, value, goodwill and sole ownership by Marinetek of these Intellectual Property Rights.

c) Any dispute arising out of or relating to the performance, validity, or termination of the contract that arises from this offer and the commercial consequences thereof, shall be finally settled by arbitration in accordance with the Arbitration Rules of the Mumbai Chamber of Commerce then in effect, and the provisions of the Arbitration and Conciliation Act 1996 shall apply. The arbitration shall take place in Mumbai and the proceedings shall be conducted, and the award shall be rendered in the English language. There shall be one arbitrator. The arbitration award shall be final and binding on both Parties and not subject to any appeal.

d) The price in this offer is valid for 60 days unless previously withdrawn.

I trust that this offer will meet with your approval. Please do not hesitate to contact me for any further information, or to let me know if I have misunderstood any of your requirements.

Yours faithfully,

By email - no signature

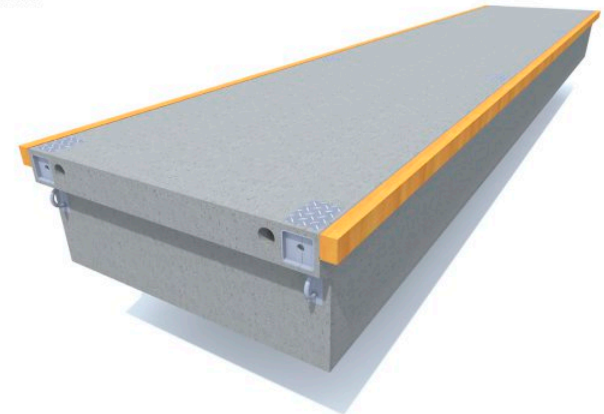
Gautama Dutta
Managing Director

Enc. Marinetek India brochure

PREMIER | M2712PE M2716PE M2720PE M3312PE M3316PE M3320PE

Premier Pontoons 2700, 3300

Based on the world famous Marinetek breakwaters, the completely new **Premier Pontoon** range represents the latest technology in concrete pontoon construction. All units can be provided with integral top entry service channels. As with all Marinetek concrete systems these are of exceptionally strong construction with continuous floatation providing a high loading capacity with higher freeboard for large boat marinas. Premier pontoons can be moored by piles, chain or Seaflex.



TECHNICAL DATA

Concrete strength: 45 N/mm^2 steel reinforced plastic fibre concrete. Exposure class according to European EN 206-1 standard

Core: Expanded polystyrene, density 15 kg/m^3

Reinforcement: Partly or fully hot dip galvanised or stainless steel

Optional accessories: Wooden deck, fixing rails, cable ducts, service channels (240x120 mm) and fenders (timber or wood plastic composite)

FLOATS	M2712PE	M2716PE	M2720PE	M3312PE	M3316PE	M3320PE
Length (m)	12,20	16,05	19,90	12,20	16,05	19,90
Width with fenders (m)	2,7	2,7	2,7	3,3	3,3	3,3
Concrete width (m)	2,4	2,4	2,4	3,0	3,0	3,0
Weight (t)	12,5	16,5	20,6	15,6	20,7	25,7
Height (m)	1,0	1,0	1,0	1,0	1,0	1,0
Net capacity (kN/m^2)	5,6	5,6	5,6	5,6	5,6	5,6
Freeboard (m)	0,56	0,56	0,56	0,56	0,56	0,56
Strenght of joint (kN)	2x322	2x322	2x322	2x322	2x322	2x322
Joint gap (mm)	35	35	35	35	35	35

Exact unit weight and freeboard are subjects to detailed specification of the unit, equipment and mooring methods. Shown numbers are for standard and unloaded units.

Marinetek operates a policy of continuous development and reserves the right to change specifications without notice.

Modification date: 14.11.2014

MARINETEK GROUP OY

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MARINETEK

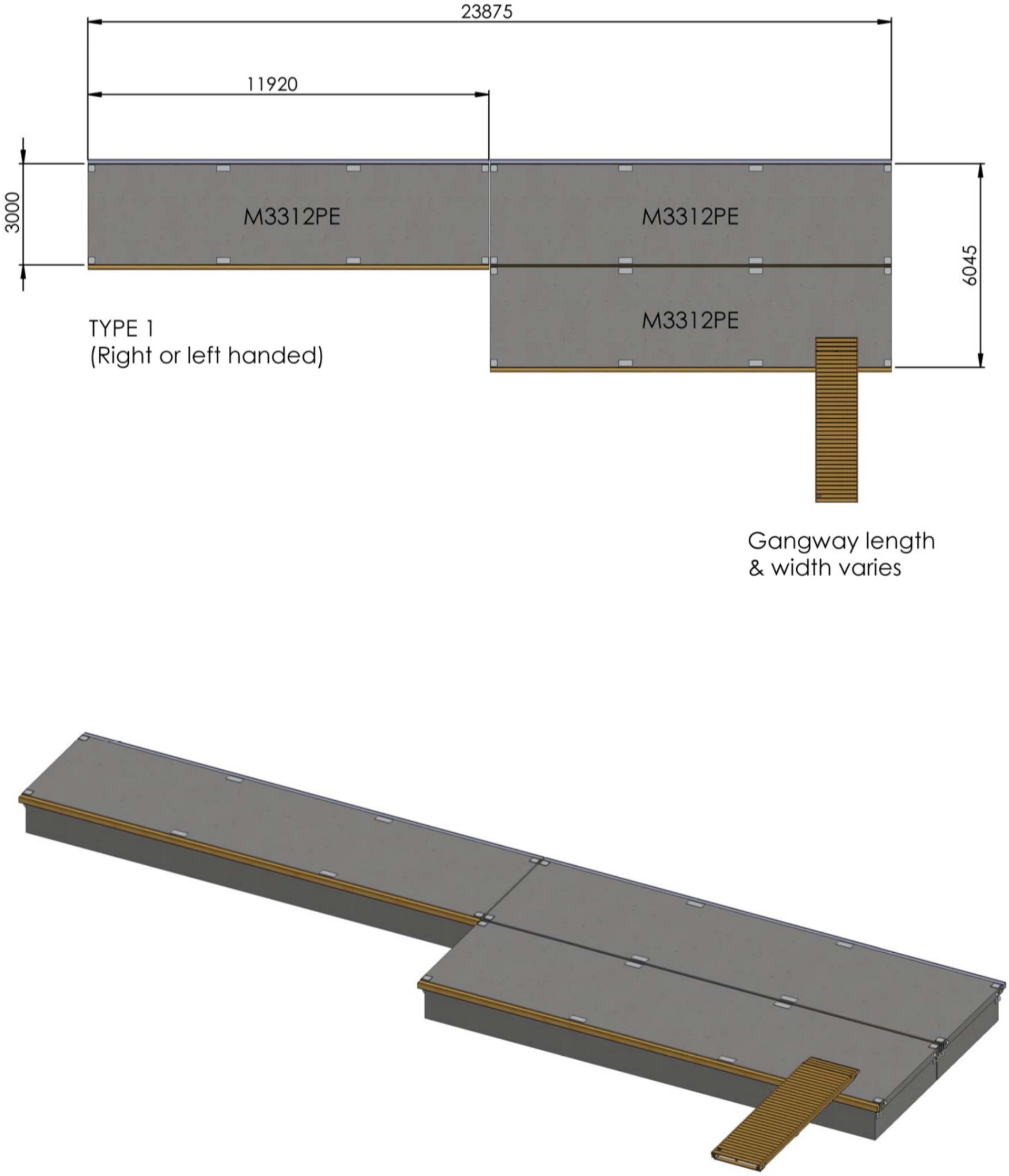

23875
11920
3000
6045
M3312PE
M3312PE
M3312PE
TYPE 1
(Right or left handed)
Gangway length
& width varies

Fig. 1

Fig. 2

Fig. 2

Schematic Layout of Type 1 Floating Jetty

MARINETEK INDIA

Fig. 3

PROJECT COSTING

Annexure 11.1 Cost estimate for dredging

Dredging					(In Rs.)
Sr No	**Description**	**Quantity**	**Unit**	**Rate**	**Amount**
Phase-1	Dredging by dredger in creek / channel / infront of wharf / Jetty etc. in rocky strata including disposal of materials on shore for a lead up to 1000 m and all lift (Including tidal condition).	956037	M^3	300.00	28,68,11,100
Phase-2	Dredging by dredger in creek / channel / infront of wharf / Jetty etc. in rocky strata including disposal of materials on shore for a lead up to 1000 m and all lift (Including tidal condition).	3432936	M^3	300.00	102,98,80,800
Phase-3	Dredging by dredger in creek / channel / infront of wharf / Jetty etc. in rocky strata including disposal of materials on shore for a lead up to 1000 m and all lift (Including tidal condition).	1045346	M^3	300.00	31,36,03,800

Annexure 11.2 Cost estimate for Jetty

Sr No	Reference	Description	Qty	Unit	Rate	Amount
1	Ch. 1 Para 1.2 - 6	Mobilisation of plants and equipment to site for installation of bored cast-in-situ pile(600mm dia) Dembolisation of plant and equipment after piling	1.00	Job	0.05	10613230.47
2	GMB SOR Sr. No. 27014 Page No. 196	Providing , fabricating and delivering to the site 6 mm thick M .S. plate liners of specified diameter for bore piles , including cost of material , welding, labour and transportation etc. complete	619.92	Tonne	103493.79	64157737.80
3	GMB SOR Sr. No. 27015 Page No. 196	Driving of steel liners for cast in situ bore piles upto specified depth including pitching of liners using GPS, welding, jointing etc. using pile driving rig and other mechanical equipments , cutting down extra length not required etc .complete	3508.80	m	976.05	3424769.57
4	GMB SOR Sr. No. 27018 Page No. 197	Boring in all sorts of soil including boulders but other than rock using hydraulic piling rig with supporting equipment and removal of excavated earth with all lifts and lead upto 1000m including shifting of piling rig from one bore location to another etc . Complete - 600 mm dia piles.	3508.80	RM	2454.11	8610971.06

Sr No	Reference	Description	Qty	Unit	Rate	Amount
5	GMB SOR Sr. No. 5018 Page No. 37	Supplying, bending, hooking and binding thermomechanically treated (TMT) corrosion resistant Fe-415 grade bar reinforcement including placing in position etc. complete upto floor two level.	962208.00	Kg	98.57	94840031.52
6	GMB SOR Sr. No. 8010 Page No. 64	Conducting standard penetration test at requiredintervals	33.00	No.	243.10	8022.34
7	DSR Code No.. 7247 Page No. 201	Pile load test on single vertical pile (initial load test on test pile or routine load test on working pile) in accordance with IS:2911 (part-IV) or load testing on wells as directed.	2.00	per test	48984.90	97969.80
8	GMB SOR Sr. No. 27027 Page No.198	Providing and laying design mix cement concrete M40 grade using minimum cement 478 kg/cum and graded crushed stone aggregates 20 mm nominal maximum size , for RCC bored cast -in- situ piles excluding the cost of reinforcement but including lowering of reinforcement while concreting and using tremie pipe all as perdrawing and technical specifications.	3969.00	Cum	8371.19	33225259.24

Sr No	Reference	Description	Qty	Unit	Rate	Amount
9	GMB SOR Sr. No. 27034 Page No.200	Providing and laying cast -in-situ design mix cement concrete M -40 grade using minimum cement 435 kg/cum and graded crushed stone aggregates 20 mm nominal maximum size for RCC slab, wearing coat etc . of RCC jetty or such other structure using vibrator , including nominal side formwork but excluding the cost of bottom formwork and reinforcement as per drawing and technical specifications. - Pile Caps	23.80	Cum	9289.51	221090.26
10	GMB SOR Sr. No. 27040 Page No.201	Providing and laying cast -in-situ design mix cement concrete M -40 grade using minimum cement 435 kg/cum and graded crushed stone aggregates 20 mm nominal maximum size for RCC slab, wearing coat etc . of RCC jetty or such other structure using vibrator , including nominal side formwork but excluding the cost of bottom formwork and reinforcement as per drawing and technical specifications.- Deck Slab	525.00	Cum	7880.13	4137066.68

Sr No	Reference	Description	Qty	Unit	Rate	Amount
11	GMB SOR Sr. No. 27040 Page No.201	Providing and laying cast -in-situ design mixcement concrete M -40 grade using minimumcement 435 kg/cum and graded crushed stoneaggregates 20 mm nominal maximum size forRCC slab, wearing coat etc . of RCC jetty or suchother structure using vibrator , including nominalside formwork but excluding the cost of bottomformwork and reinforcement as per drawing andtechnical specifications.-Beams	236.00	Cum	7880.13	1859709.98
12	GMB SOR Sr. No. 27040 Page No.201	Providing and laying cast -in-situ design mix cement concrete M -40 grade using minimum cement 435 kg/cum and graded crushed stone aggregates 20 mm nominal maximum size for RCC slab, wearing coat etc . of RCC jetty or such other structure using vibrator , including nominal side formwork but excluding the cost of bottom formwork and reinforcement as per drawing and technical specifications. - Wearing Coat	150.00	Cum	7880.13	1182019.05
13	GMB SOR Sr. No. 27055 Page No.204	Supplying and Fixing CI Bollards all as per design/type as shown in the drawing excluding the cost of bolts, nuts, washers etc. complete including two coats of paint over one coat of red lead paint.	14.00	q	12954.26	181359.61

Sr No	Reference	Description	Qty	Unit	Rate	Amount
14	GMB SOR Sr. No. 27079 Page No.209	Manufacture and Supply of "CELL" type fenders of size 400 H, weighing approximately 75 kgs at site and installing the same on dock wall at all levels upto low water as shown in the drawing oras directed including cost of all materials , SS (non magnetic) anchor bolts of size 22 mm, transportation, testing of materials , drilling of hole , anchoring fixtures using mechanical /chemical anchors as per design etc.complete.	7.00	nos	45514.63	318602.42
		Total (Ex. Mob Demob)				212264609.33
					Total Cost	**222877839.80**

Annexure 11.3 Cost estimate for Navigational Lock

NAVIGATIONAL LOCKS						
Sr No	**Reference**	**Description**	**Qty**	**Unit**	**Rate (Rs.)**	**Amount (in Rs)**
1	GMB SOR Sr. No.250140 Page No.174	Clearing the land by uprooting rank vegetation, grass, bushes, shrubs, saplings and trees girth upto 300mm, and disposal upto 1 km. including all labour,tools & plants etc complete.	20000	Sqm	5.56	111132
2 i	GMB SOR Sr. No. 40040 Page No. 27	Excavation for foundation upto 1.5m depth including sorting out and stacking of useful materials and disposing of the excavated stuff upto 50 metre lead. (D) Soft rock not requiring blasting (up to 1.5 M depth)	31500	Cum	217.87	6862748.29
ii	GMB SOR Sr. No. 40090 Page No.27	(1.5 to 3.0 M depth)	31500	Cum	236.39	7446191.29
iii	GMB SOR Sr. No. 40140 Page No. 28	(3.0 to 5 M depth)	42000	Cum	301.21	12650989.05
3	Consolidation grouting					
a)		Consolidation grouting of foundation area by drilling holes at the rate of 1 hole per 3 sq.m area, minimum depth 5 m area and	8000	m	700	5600000

NAVIGATIONAL LOCKS						
Sr No	**Reference**	**Description**	**Qty**	**Unit**	**Rate (Rs.)**	**Amount (in Rs)**
		grouting with cement slurry				
b)		Grouting	12000	Bags	500	6000000
4		M-30 concrete in Pier and Side walls	28900	Cum	6880	198832000
5	GMB SOR Sr. No. 26058 Page No. 187	Cement Concrete M20 grade of specified thickness in pavement using OPC grade 43 minimum @ 325 kg/cum and graded stone aggregates 25 mm nominal maximum size laid to required slope and camber in panels as required using mechanical mixer including admixture (super plasticizer) @ 0.4 % by weight of cement,formwork, vibrating, finishing, curing etc complete.	8370	Cum	5337.58	44675522.42
6	GMB SOR Sr. No. 5001 5.3.2 Page No. 35	Providing and Laying CC 1:3:6 (1 cement :3 coarse sand : 6 hand broken stone aggregate 40mm nominal size) and curing complete excluding cost of form work in. (A) Foundation and plinth	1800	Cum	3950.40	7110711.56

NAVIGATIONAL LOCKS						
Sr No	**Reference**	**Description**	**Qty**	**Unit**	**Rate (Rs.)**	**Amount (in Rs)**
7		Providing water stop @ 25m c/c	420	m	500	210000
8	GMB SOR Sr. No. 27054 Page No. 204	Bitumastic filler for joints	420	m	520.93	218791.13
9	GMB SOR Sr. No. Sr. No 5017 5.4.11 page 37	Reinforcement steel in R.C.C	1985.1	tonne	66794.96	132594680.1
10	GMB SOR Sr. No. 27054 Page No. 204	Providing and Laying filter media of specified thickness with granular material /stone crushed aggregates satisfying the requirements laid downin clause 2504.2.2 of MORT&H specifications with smaller size towards the soil and bigger size towards the wall and provided over the entire surface behind whaft wall , abutment, wing wall or return wall , including watering and compacting complete as per drawing and technical specifications	5625	Cum	1841.09	10356113.25
11		Providing swing bridge (2 Nos. x 15m clear span)	36	m	L.S	50
12		Fender	15	Nos	2000	30000

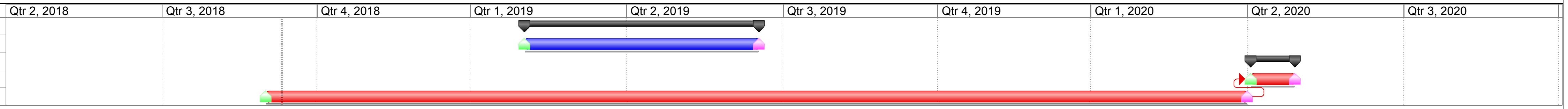
NAVIGATIONAL LOCKS						
Sr No	Reference	Description	Qty	Unit	Rate (Rs.)	Amount (in Rs)
13		Security Room (4 Nos) 3m x 3m each	20	Sqm	4000	80000
14		Lock operating room (2 nos) with operating panel 3m x 7m each	42	Sqm	4000	168000
15		Power Room (2 Nos) for battery with acid resistance tiles 3m x 4m each	24	Sqm	5000	120000
16		Stand by Generator Room (2 Nos) 5m x 3m each	30	Sqm	4000	120000
17		Store Room (2 Nos) 8m x 5m each	80	Sqm	4000	320000
19		Bollard	5	Nos	20000	100000
20		Mast	4	Nos	20000	80000
21		Fencing	250	m	200	50000
22		Lock Lighting Arrangement	L.S			1000000
23		Instrumentation	L.S			1500000
		Sub-total (1 to 23)				**446694910.7**
24		Dewatering at 2% of above cost				8933898.21
Total (Lakhs)						**4456.29**

Annexure 11.4 Cost estimate for RIS

RIS SYSTEM RIVER NARMADA (NW-73)				
Sr. No.	**Equipment**	**Qty**	**Unit Price**	**Total**
1	AIS Base Station	1	3000000	3000000
2	RADAR	1	5000000	5000000
3	Meteo Sensor	1	700000	700000
4	ATG	1	900000	900000
5	VHF	1	500000	500000
6	DG Set 10 KVA	1	700000	700000
7	UPS	1	500000	500000
8	RIS Software	1	3500000	3500000
9	RIS Hardware	1	10000000	10000000
10	Installation Testing & Commissioning	1	2000000	2000000
11	Porta cabin	3	1200000	3600000
12	Trestle Tower	1	1000000	1000000
			Total	**31400000**
	Operation			-
1	Engineer 1 * Site 1 * Months 12 per year	12	35,000.00	420000
	Operator 3 * Site 1 * Months 12 per year	36	20,000.00	720000
	Security 3 * Site 1 * Months 12 per year	36	15,000.00	540000
2	Second Year			1797600
3	Third Year			1923432
4	Fourth Year			2058072.24
			Total	**7459104.24**
	CAMC for 4 Years			-
1	1st Year	1	3140000	3140000
2	2nd Year	1	3454000	3454000
3	3rd Year	1	3799400	3799400
				-
			Total	**10393400**
			Overall Cost	**49252504.24**

Time Frame-Narmada River (Phase-1)

ID		Task Name	Duration	Predecessors
1		**6.2 Bank Protection**	**100 days**	
2		Near terminal 1	100 days	
3		**6.3 Navigation Aids**	**20 days**	
4		Marine Lantern	20 days	5
5		Dredging	413 days	



Project: NW 100 Construction Schedu
Date: Fri 11/10/17

Task	Progress	Summary	External Tasks	Deadline
Split	Milestone	Project Summary	External Milestone	

Chapter – 13
ECONOMIC AND FINANCIAL ANALYSIS
ANNEXURES

Annexure 13.1 EIRR Analysis (Phase-1)

S.No	Year	Capital Cost	Annual O&M Cost	Total Cost	Economic costs Rs lakhs	Economic Benefits Rs lakhs	Net cash flow Rs lakhs
1	2019	12	0	12	804		-804
2	2020	12	0	12	804		-804
3	2021		10	10	639	563	-77
4	2022		10	10	659	563	-96
5	2023		10	10	678	563	-116
6	2024		10	10	699	563	-136
7	2025		11	11	720	1125	406
8	2026		11	11	741	1125	384
9	2027		11	11	763	1125	362
10	2028		12	12	786	1125	339
11	2029		12	12	810	1125	315
12	2030		13	13	834	1125	291
13	2031		13	13	859	1125	266
14	2032		13	13	885	1125	240
15	2033		14	14	912	1125	214
16	2034		14	14	939	1125	186
17	2035		15	15	967	1125	158
18	2036		15	15	996	1125	129
19	2037		15	15	1026	1125	99
20	2038		16	16	1057	1125	68

S.No	Year	Capital Cost	Annual O&M Cost	Total Cost	Economic costs Rs lakhs	Economic Benefits Rs lakhs	Net cash flow Rs lakhs
21	2039		16	16	1088	1125	37
22	2040		17	17	1121	1125	4
23	2041		17	17	1155	1125	-30
24	2042		18	18	1189	1125	-64
25	2043		18	18	1225	1125	-100
26	2044		19	19	1262	1125	-137
27	2045		19	19	1300	1125	-174
28	2046		20	20	1339	1125	-213
29	2047		21	21	1379	1125	-254
30	2048		21	21	1420	1125	-295
						EIRR	**3.10%**
						NPV (in Rs lakhs)	-680

Annexure 13.2 FIRR, Revenue and Sensitivity Analysis assuming charge for using the channel is Rs. 1/tonne (Phase-1)

S.No.	Year	Capital cost	Annual O & M Cost	Total Cost	Revenue Channel	Subsidy from Govt	Dredging Levy from Operator	Total Revenue	Net Cash Flow	SENSITIVITY ANALYSIS					
										Cap. Cost (+) 10%	Cap. Cost (-) 10%	ANNUAL O &M COST (+) 10%	ANNUAL O &M COST (-) 10%	REVENUE (+) 10%	REVENUE (-) 10%
	1	2	3	4 = (2+3)				5	6= (5-2)	10	11	12	13	14	15
1	2019	18	0	18					-18.22	-20	-16	-18	-18	-18	-18
2	2020	18	0	18					-18.22	-20	-16	-18	-18	-18	-18
4	2021		9.8	9.8	0.55	0.00	0.93	1.48	-8.27	-8	-8	-9	-7	-8	-8
5	2022		10.0	10.0	0.55	0.00	0.93	1.48	-8.57	-9	-9	-10	-8	-8	-9
6	2023		10.3	10.3	0.55	0.00	0.93	1.48	-8.87	-9	-9	-10	-8	-9	-9
7	2024		10.7	10.7	0.55	0.00	0.93	1.48	-9.18	-9	-9	-10	-8	-9	-9
8	2025		11.0	11.0	1.10	0.00	0.93	2.03	-8.95	-9	-9	-10	-8	-9	-9
9	2026		11.3	11.3	1.10	0.00	1.86	2.96	-8.34	-8	-8	-9	-7	-8	-9
10	2027		11.6	11.6	1.10	0.00	1.86	2.96	-8.68	-9	-9	-10	-8	-8	-9
11	2028		12.0	12.0	1.10	0.00	1.86	2.96	-9.03	-9	-9	-10	-8	-9	-9
12	2029		12.4	12.4	1.10	0.00	1.86	2.96	-9.39	-9	-9	-11	-8	-9	-10
13	2030		12.7	12.7	1.10	0.00	1.86	2.96	-9.76	-10	-10	-11	-8	-9	-10
14	2031		13.1	13.1	1.10	0.00	1.86	2.96	-10.15	-10	-10	-11	-9	-10	-10
15	2032		13.5	13.5	1.10	0.00	1.86	2.96	-10.54	-11	-11	-12	-9	-10	-11
16	2033		13.9	13.9	1.10	0.00	1.86	2.96	-10.94	-11	-11	-12	-10	-11	-11
17	2034		14.3	14.3	1.10	0.00	1.86	2.96	-11.36	-11	-11	-13	-10	-11	-12
18	2035		14.8	14.8	1.10	0.00	1.86	2.96	-11.79	-12	-12	-13	-10	-11	-12
19	2036		15.2	15.2	1.10	0.00	1.86	2.96	-12.23	-12	-12	-14	-11	-12	-13

S.No.	Year	Capital cost	Annual O & M Cost	Total Cost	Revenue Channel	Subsidy from Govt	Dredging Levy from Operator	Total Revenue	Net Cash Flow	SENSITIVITY ANALYSIS					
										Cap. Cost (+) 10%	Cap. Cost (-) 10%	ANNUAL O &M COST (+) 10%	ANNUAL O &M COST (-) 10%	REVENUE (+) 10%	REVENUE (-) 10%
	1	2	3	4 = (2+3)				5	6= (5-2)	10	11	12	13	14	15
20	2037		15.7	15.7	1.10	0.00	1.86	2.96	-12.69	-13	-13	-14	-11	-12	-13
21	2038		16.1	16.1	1.10	0.00	1.86	2.96	-13.16	-13	-13	-15	-12	-13	-13
22	2039		16.6	16.6	1.10	0.00	1.86	2.96	-13.64	-14	-14	-15	-12	-13	-14
23	2040		17.1	17.1	1.10	0.00	1.86	2.96	-14.14	-14	-14	-16	-12	-14	-14
24	2041		17.6	17.6	1.10	0.00	1.86	2.96	-14.65	-15	-15	-16	-13	-14	-15
25	2042		18.1	18.1	1.10	0.00	1.86	2.96	-15.18	-15	-15	-17	-13	-15	-15
26	2043		18.7	18.7	1.10	0.00	1.86	2.96	-15.73	-16	-16	-18	-14	-15	-16
27	2044		19.3	19.3	1.10	0.00	1.86	2.96	-16.29	-16	-16	-18	-14	-16	-17
28	2045		19.8	19.8	1.10	0.00	1.86	2.96	-16.87	-17	-17	-19	-15	-17	-17
29	2046		20.4	20.4	1.10	0.00	1.86	2.96	-17.46	-17	-17	-20	-15	-17	-18
30	2047		21.0	21.0	1.10	0.00	1.86	2.96	-18.07	-18	-18	-20	-16	-18	-18
	Total	**36**	**397**	**434**											
FIRR(%)									**Negative Value**						
NPV@ discount factor 9% in Cr.									**Rs. -118.75**	**Rs. -121.96**	**Rs. -115.55**	**Rs. -129.47**	**Rs. -108.04**	**Rs. -116.71**	**Rs. -120.80**

Dear Ms Verma,

Further to our discussion and trailing mails, please find below our **Budgetary quote of Terex Gottwald Mobile Harbour Crane (4 rope)**

Proj no. 16713
CIF East Coast, India
Budgetary Price for: 1 x Model: GHMK 2305 B

FOB North Sea Port: EURO 944779.91
**including freight costs*

Included Options (per crane):

- ✓ Tropical package – Temperature Zone 3
- ✓ Second Stairway
- ✓ Emergency Descending Device

Excluded Options (not offered):

- ✓ Grabs
- ✓ Assembly equipment
- ✓ Test weights

Attached alongwith is the brochure and technical details for your reference. Please note that G HMK 2305 B is fitted with an additional axle.
The updated files for the same will be submitted to you within due course.

We request you to go through the details and reconfirm your technical suitability.

Kind Regards,
Nikhil Misal

Terex Port Solutions
T: 91 2135 61 4578
M: 91 96733 31806

G HMK 2304 Mobile Harbour Crane

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1.0 Main Dimensions

Length of chassis without stabiliser pads	approx.	14.7 m
Width of chassis without stabiliser pads *	approx.	8.1 m
Size of stabiliser pads *		1.2 m x 1.8 m
Propping base (length, width)		11.5 m x 11.0 m
Tail radius		6.1 m
Height of boom pivot point	approx.	9.8 m
Crane operator viewing height	approx.	16.1 m
Boom length		40.0 m
Maximum radius		40.0 m
Minimum radius		11.0 m
Hoisting height on hook above quay *	11 m to 15 m radius	40.0 m
	40 m radius	14.0 m
Hoisting height on hook below quay		12.0 m

2.0 Weights

Counterweight		63.0 t
Total weight of operational crane***	approx.	240.0 t

3.0 Main Drive

Type of drive system	Diesel – electric

3.1 Diesel Engine *

Manufacturer	MAN
Model	D 2868 LE122
Engine type	Diesel
Cooling	Water
Nominal output	570 kW at 1800 rpm
Number of cylinders	8
Fuel consumption (at full load)	max. 213 g/kWh

3.2 Fuel Tank

Volume of main fuel tank in chassis	approx.	5400 l
Possible operating time without refueling (depending on operating mode and intensity)		up to 200 h

3.3 Fuel Saving Potential

Savings possible using optional hybrid drive and ultracaps	to 23 %[1]

[1]Achieved under specific deployment conditions and based on experience gained from operating a Terex® Gottwald Generation 5 crane over a period of more than one year.

4.0 Hoist

Number of rope drums		1
Number of ropes		2
Hoisting speeds:		
	without load	85.0 m/min
	10.0 t	67.0 m/min
	45.0 t	38.0 m/min
	63.0 t	30.0 m/min
	80.0 t	25.0 m/min

5.0 Slewing Gear

Number of slewing gear drive units		1
Slewing speeds:		
	to 47.0 t	to 1.4 rpm
	to 80.0 t	to 0.6 rpm
Maximum peripheral speeds at boom head:		
	to 47.0 t	to 180 m/min
	to 80.0 t	to 80 m/min

6.0 Luffing Gear

Average luffing speeds:	to 47.0 t	60 m/min
	to 80.0 t	27 m/min

7.0 Travel Gear

Travel speed	up to	80.0 m/min
Total number of axles		4
Number of steered axles		4
Number of driven axles		2
Number of wheels		16
Tyre size		14.00-24
Climbing ability		6.0 %
Vertical axle compensation		+250 mm / -250 mm
Minimum inner curve radius	approx.	5.5 m
Minimum outer curve radius	approx.	13.5 m
Maximum crab steering angle	approx.	25°

8.0 Ambient Conditions

Permissible wind speeds:

Crane in operation	to	20 m/s
Crane in travel operation	to	20 m/s
Crane out of service	to	46 m/s

At wind speeds above 46 m/s, the boom head should be lowered and secured.

Permissible ambient temperatures: **	minimum	-20° C
	maximum	+45°C

9.0 Stability Requirement (Percentage of Tipping Load)

Normal-load operation / heavy-load operation	≤ 75 %
Motor grab operation	≤ 50 %

10.0 Classification of Crane and Mechanisms

Classification in accordance with: FEM 1.001, 3rd edition, 1998

10.1 Crane Classification

Container operation (single lift)		A6
Motor grab operation	32.0 t	A7
Normal-load operation	47.0 t	A6
Heavy-load operation	63.0 t	A5
	80.0 t	A4

10.2 Classification of Mechanisms

Hoist:		
Container operation (single lift)		M6
Motor grab operation	32.0 t	M7
Normal-load operation	47.0 t	M6
Heavy-load operation	63.0 t	M3
	80.0 t	M3
Slewing gear:		
Container operation (single lift)		M7
Motor grab operation	32.0 t	M7
Normal-load operation	47.0 t	M7
Heavy-load operation	80.0 t	M7
Luffing gear:		
Container operation (single lift)		M7
Motor grab operation	32.0 t	M7
Normal-load operation	47.0 t	M7
Heavy-load operation	80.0 t	M7
Travel gear:		M4

11.0 Lighting

Boom head *	Metal vapour lamp	1 x 2000 W
Bottom of boom *	Metal vapour lamp	1 x 2000 W
Front of tower *	Metal vapour lamp	2 x 400 W
Rear of tower *	Metal vapour lamp	1 x 400 W
Boom head obstacle beacon **		1
Tower head obstacle beacon **		1

12.0 Surface Treatment

Surface treatment of the steel structure:		EN ISO 12944
Surface preparation:		Sa 2.5 (ISO 8501-1)
Edge protection:	Two-component epoxy resin with micaceous iron ore	
Primer coat:	Two-component epoxy resin	≥ 60 µm
Intermediate coat:	Two-component epoxy resin	≥ 60 µm
Top coat:	Two-component acrylic-polyurethane	≥ 50 µm
Total coating thickness:		≥ 170 µm

Key:

- * Data for basic equipment. Alternative special equipment available
- ** Data for special equipment
- ***Depending on the configuration selected

Subject to technical modification without prior notice.

9.6 - DREDGING

✓

Sr. No.	Item Code	Name of Item	Unit	2015-16
1	DRED0001	Labour for drilling holes in Nilgiri Vertical /Horizonal piles and fitting of MS assorted size bolts and nuts with labour and material in all respect	Per Hole	191
2	DRED0002	Labour for shifting of HDPE or Steel pipe up to 500 mm dia. (Min. 10 mtrs distance). It includes shifting, lowering and shifting 500 mm dia steel OR HDPE pipes with all materials etc. within harbour area. **0- 6 mtrs length**	per mtr distance	58
3	DRED0003	Labour for shifting of HDPE or Steel pipe up to 500 mm dia. (Min. 10 mtrs distance). It includes shifting, lowering and shifting 500 mm dia steel OR HDPE pipes with all materials etc. within harbour area. **0- 12mtrs length**	Mtr	81
4	DRED0004	Labour for shifting of HDPE or Steel pipe up to 500 mm dia. (Min. 10 mtrs distance). It includes shifting, lowering and shifting 500 mm dia steel OR HDPE pipes with all materials etc. within harbour area. **0- 18 mtrs length**	Mtr	115
5	DRED0005	Marinating floating steel or HDPE pipe as well under water pipelines, ball and socket pontoons etc. including anchoring, positioning as per needs complete in all respect without any breakage leakage.	Mtr	23
6	DRED0006	Labour charges for handling, pitching and driving Nilgiri piles includeing cutting down extra un-driven length if not required in soft strata.	Mtr	69
7	DRED0007	Labour charges for handling, pitching and driving Nilgiri piles including cutting down extra un-driven length if not required in soft strata. **3.00 to 6.00 m**	Mtr	92
8	DRED0008	Labour charges for handling, pitching and driving timber including cutting down extra un-driven length if not required in hard strata. **0.00 to 3.00 m**	Mtr	92
9	DRED0009	Labour charges for handling, pitching and driving timber including cutting down extra un-driven length if not required but in hard strata **3.00 to 6.00 m**	Mtr	115

Sr. No.	Item Code	Name of Item	Unit	2015-16
10	DRED0010	Labour charges for handling pitching and driving timber piles in foundation of the structure including cutting down extra un-driven length if not required in tidal zone viz. in jetties, dolphins, wharves etc. **0.00 to 3.00 m**	Mtr	104
11	DRED0011	Labour charges for handling pitching and driving timber piles in foundation of the structure including cutting down extra un-driven length if not required in tidal zone viz. in jetties, dolphins, wharves etc. **3.00 to 6.00 m**	Mtr	138
12	DRED0012	Opening, cleaning, servicing, rousing of anchor spud guide pulley and fitting back with necessary trials. Labour charges only.	No	863
13	DRED0013	Opening, cleaning, servicing, overhauling of main derrick of Dredger and also replacing worn out parts excluding cost of materials but including satisfactory trials and consumables.	No	17538
14	DRED0014	Opening, cleaning, servicing, overhauling of hydraulic operated suction valve of dredge pump of Dredger by replacing worn-out parts with satisfactory trials and consumables. Labour job only.	No	19435
15	DRED0015	Removal and replacement of sunk fit CS coupling of output shaft for reduction gearbox of dredge pump of Dredger (a) Removal of sunk fit CS coupling. (b) Replacement of bearing and oil seal. (c) Checking trueness of shaft. (d) Checking trueness of CS coupling and machining the same as per requirement. (e) Refitting of the coupling on the shaft assembly of gearbox. (f) Alignment of gearbox. (g) Complete test and trials to be given to the satisfaction of EIC	No	37398
16	DRED0016	Checking and doing alignment of dredge pump shaft with gearbox output shaft in Dredger with standard permissible limits. Chokes and foundation bolts will be provided by department while other materials and equipments will be arranged by the contractor.	Job	36455

Sr. No.	Item Code	Name of Item	Unit	2015-16
17	DRED0017	Hopper door water tightness checking/rectification labour charges only	No	22793
18	DRED0018	Hopper door damaged sealing renewal labour charges.	Each	10833
19	DRED0019	straightening of eyes of hopper door.	Each	5635
20	DRED0020	Labour for opening, cleaning, servicing, overhauling of main derrick of dredger and also replacing workout parts excluding cost of materials but including satisfactory trials.	Each	14490
21	DRED0021	Dismantling & erecting of grab bucket after MS plate its pin and pulley bushes complete in all respect with satisfactory trials. **up to 1 cu.m. capacity**	each	6555
22	DRED0022	Dismantling & erecting of grab bucket after MS plate its pin and pulley bushes complete in all respect with satisfactory trials. **between 1.1-2.0 cu.m. capacity**	each	9085
23	DRED0023	Dismantling & erecting of grab bucket after MS plate its pin and pulley bushes complete in all respect with satisfactory trials. **Between 2.1-3.0 cu.m.**	each	10810

10.7 - DREDGING COMPONENTS

Sr. No	Component Code	Name of Components	Group Code	Unit	Unit Rate in Rs
1	DREDG00001	Dredging with Cutter Suction incl. mob-demob	DR1	Cu.M.	228
2	DREDG00002	Dredging with Trailer-suction incl. mob-demob	DR1	Cu.M.	248
3	DREDG00003	Dredging with Grab incl. mob-demob	DR1	Cu.M.	155
4	DREDG00004	Dredged material delivery by pump- pipe upto 100 m. distance	DR2	Cu.M.	10
5	DREDG00005	Dredged material delivery by pump- pipe upto 300 m. distance	DR2	Cu.M.	17
6	DREDG00006	Dredged material delivery by pump- pipe upto 1000 m. distance	DR2	Cu.M.	29
7	DREDG00007	Dredged material delivery by pipe upto 2000 m. distance	DR2	Cu.M.	41
8	DREDG00008	Dredged material delivery by barge upto 500 m. distance	DR2	Cu.M.	92
9	DREDG00009	Dredged material delivery by barge upto 2000 m. distance	DR2	Cu.M.	115
10	DREDG00010	Dredged material delivery by barge upto 5 nautical mile distance	DR2	Cu.M.	132
11	DREDG00011	Dredged material delivery by barge above 5 n. m. distance	DR2	Cu.M.	155
12	DREDG00012	Dredged material delivery by barge above 10 n. m. distance	DR2	Cu.M.	-
13	DREDG00013	Dredged material dumping by trucks upto 1000 m. distance	DR2	Cu.M.	46
14	DREDG00014	Dredged material dumping by trucks between 1000m. to 5000 m. distance	DR2	Cu.M.	69
15	DREDG00015	Dredged material dumping by trucks beyond 5000 m. distance	DR2	Cu.M.	92

Sr. No.	Component Code	Name of Component	Group Code	Unit	Unit Rate in Rs
16	DREDG00016	Dredger Toyo Pump Mob- Demob to site upto 10 Km. distance	DR3	per unit	57500
17	DREDG00017	Dredger backhoe Mob- Demob to site upto 10 Km. distance	DR3	per unit	57500
18	DREDG00018	Dredger cutter-suction Mob- Demob to site upto 10 Km. distance incl. assembly	DR3	per unit	1,72,500
19	DREDG00019	Dredger cutter-suction Mob- Demob to site upto 100 Km. distance excl.assembly	DR3	per Km	403
20	DREDG00020	Dredger cutter-suction Mob- Demob to site above 100 Km. distance excl. assembly	DR3	per Km	345
21	DREDG00021	Dredger cutter/trailing-suction Mob-Demob by sea to site upto 100 n.m. distance	DR3	per unit	2,87,500
22	DREDG00022	Dredger cutter/trailing-suction Mob-Demob by sea to site above 100 n.m. distance	DR3	per n.m.	863
23	DREDG00023	Mob-Demob of Dredger- Grab/Toyo pump/Backhoe for jobs upto 100,000 cu.m.	DR3	per cu.m.	21
24	DREDG00024	Mob-Demob of Dredger- Grab/Toyo pump/Backhoe above 100,000 cu.m.	DR3	per cu.m.	12
25	DREDG00025	Mob-Demob of Dredger-Cutter/Trailing Suction for jobs upto 500,000 cu.m.	DR3	per cu.m.	41
26	DREDG00026	Mob-Demob of Dredger-Cutter/Trailing Suction for jobs above 5 upto 1,000,000 cu.m.	DR3	per cu.m.	21
27	DREDG00027	Mob-Demob of Dredger-Cutter/Trailing Suction for jobs above 1,000,000 cu.m.	DR3	per cu.m.	12

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Sr. No.	Component Code	Name of Components	Group Code	Unit of Measurement	Unit Rate in Rs.
		DREDGING			
1	DREDG00001	Dredging with Cutter Suction incl. mob-demob	DR1	Cu.M.	198
2	DREDG00002	Dredging with Trailer-suction incl. mob-demob	DR1	Cu.M.	216
3	DREDG00003	Dredging with Grab incl. mob-demob	DR1	Cu.M.	135
4	DREDG00004	Dredged material delivery by pump- pipe upto 100 m. distance	DR2	Cu.M.	9
5	DREDG00005	Dredged material delivery by pump- pipe upto 300 m. distance	DR2	Cu.M.	15
6	DREDG00006	Dredged material delivery by pump- pipe upto 1000 m. distance	DR2	Cu.M.	25
7	DREDG00007	Dredged material delivery by pipe upto 2000 m. distance	DR2	Cu.M.	36
8	DREDG00008	Dredged material delivery by barge upto 500 m. distance	DR2	Cu.M.	80
9	DREDG00009	Dredged material delivery by barge upto 2000 m. distance	DR2	Cu.M.	100
10	DREDG00010	Dredged material delivery by barge upto 5 nautical mile distance	DR2	Cu.M.	115
11	DREDG00011	Dredged material delivery by barge above 5 n. m. distance	DR2	Cu.M.	135
12	DREDG00012	Dredged material delivery by barge above 10 n. m. distance	DR2	Cu.M.	
13	DREDG00013	Dredged material delivery by trucks upto 1000 m. distance	DR2	Cu.M.	40
14	DREDG00014	Dredged material delivery by trucks upto 5000 m. distance	DR2	Cu.M.	60
15	DREDG00015	Dredged material delivery by trucks upto 10000 m. distanc	DR2	Cu.M.	80

GMB 13-14

Sr. No.	Component Code	Name of Components	Group Code	Unit of Measurement	Unit Rate in Rs.
		DREDGING			
16	DREDG00016	Dredger Toyo Pump mob-bemob to site upto 10 Km. distance	DR3	per unit	50000
17	DREDG00017	Dredger backhoe mob-bemob to site upto 10 Km. distance	DR3	per unit	50000
18	DREDG00018	Dredger cutter-suction mob- bemob to site upto 10 Km. distance incl. assembly	DR3	per unit	1,50,000
19	DREDG00019	Dredger cutter-suction mob- bemob to site upto 100 Km. distance excl.assembly	DR3	per Km	350
20	DREDG00020	Dredger cutter-suction mob- bemob to site above 100 Km. distance excl. assembly	DR3	per Km	300
21	DREDG00021	Dredger cutter/trailing-suction mob- bemob by sea to site upto 100 n.m. distance	DR3	per unit	2,50,000
22	DREDG00022	Dredger cutter/trailing-suction mob- bemob by sea to site above 100 n.m. distance	DR3	per n.m.	750
23	DREDG00023	Mob-demob of Dredger-Grab/Toyo pump/Backhoe for jobs upto 100,000 cu.m.	DR3	per cu.m.	18
24	DREDG00024	Mob-demob of Dredger-Grab/Toyo pump/Backhoe above 100,000 cu.m.	DR3	per cu.m.	10
25	DREDG00025	Mob-demob of Dredger-Cutter/Trailing Suction for jobs upto 500,000 cu.m.	DR3	per cu.m.	36
26	DREDG00026	Mob-demob of Dredger-Cutter/Trailing Suction for jobs above 5 upto 1,000,000 cu.m.	DR3	per cu.m.	18
27	DREDG00027	Mob-demob of Dredger-Cutter/Trailing Suction for jobs above 1,000,000 cu.m.	DR3	per cu.m.	10

List of all Team Members (In-House & Empanelled Key Experts)

Sl. No.	Name of the Key Expert	Proposed Position
1.	Sh. D. N. Deshmukh	Team Leader
2.	Sh. Prakash Krishnaji Khare	Port Planning and Infrastructure Specialist
3.	Dr. Santosh K. Sati	GIS/Remote Sensing Expert
4.	Sh. R. N. Bansal	Floodplain Specialist
5.	Sh. Bidyadhyar Thakur	Hydrographic Expert
6.	Sh. Prasanta Kumar Kundu	Soil Engineer/Foundation Engineer
7.	Capt. Gary Vaz	Traffic Surveyor
8.	Sh. M Ganesan	Transport Economist

Contact Authority:

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SECTION-6 TERMS OF REFERENCE

1.0 OBJECTIVE OF THE STUDY:

Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of proposed waterways to achieve navigation and to develop water transport facilities across India. After carrying out the feasibility study if there is scope for navigation and potential to develop waterway transport facility, a Detailed Project Report needs to be prepared for those waterways which would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

The study would consist of 2 stages:

1. **Stage-1**
2. **Stage-2**

1.1 STAGE-1

Stage-I is only for feasibility of the waterway for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-1 would consist of the following activities:

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

1.1.1 Reconnaissance Survey

The detailed field reconnaissance survey may be taken up immediately after the analysis of available data. The primary tasks to be accomplished during the reconnaissance surveys include:

i- Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System. Bathymetric surveys in the proposed waterways are to be carried out in the deepest route. Deepest route can be accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, if required, is to be taken up at lowest ground levels, which can be decided on visual assessment.

ii- Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location. Details about Barrages, Dams, Locks enroute are also to ~~be~~ collected. horizontal and vertical clearance is to be given as approximate on visual assessment. Photographs are required to be submitted in the report.

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iii- Topographical features of the proposed Inland Waterways.

iv- Typical physical features along the alignment i.e. land use pattern:

v- Preliminary identification of stretches having year round flow and critical depth for navigational purpose.

vi- Preliminary Traffic identification on the proposed Inland Waterways.

vii- Inventory of major aspects including proposed Inland Waterway width, Terrain, Bridges and structures across the proposed Inland Waterways (Type, size and location), urban areas (location extent). Geologically sensitive areas environmental features. Hydrological features

viii- Critical areas requiring detailed investigations and

ix- Requirements for carrying out supplementary investigations

x- Soil (textural classifications) (only visual inspection at every 10km) and drainage conditions.

xi- Type and extent of existing utility services along the alignment.

xii- Identification of various agencies of the govt. from whom the concerned project clearances for implementation are to be sought.

The data derived from the reconnaissance surveys may be utilized for planning and programming the detailed surveys and investigations. All field studies including the traffic surveys should be taken up on the basis of information derived from the reconnaissance surveys. For the critical locations, River cross sections survey needs to be carried out..

1.1.2 Collection and Review of Available Data

A review has to be done based on the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps. Consultant has to collect available data for the proposed Inland Waterways from the State Agencies and Central Water Commission. An introductory letter will be issued by IWAI for collecting information from State / Central Government.

<u>An inception report has to be prepared which would consist of the findings based on the analysis of the existing data and reconnaissance surveys.</u>

1.1.3 Feasibility Report

The Consultant has to prepare Feasibility Report for the proposed waterways based on the available data and reconnaissance survey. It must include the following prospects:

1. **Introductory considerations:**
   The Consultant shall provide an introduction, describing the scope of the assignment, its methodology in fulfilling the assignment and the expected outcome of the assignment.

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2. **Analysis of present state of affairs:**
The Consultant shall provide a quantitative and qualitative description of the current utilization of proposed inland waterways. In addition, the Consultant shall describe the status of goods transport, including utilization of road and transport, as well as river facilities.

3. **Market Analysis:**
The consultant shall analyze the market and potential usage of proposed Inland Waterways. This analysis shall examine both the existing market and the potential future market. Contractor has to collect the details of available Industries along the waterway, type of production in these industries, ferry services, type of crop along the waterway, previous history of movement of cargo in the waterway etc. Above is to be collected after discussion with local village people while conducting reconnaissance survey etc. and also after interaction with State Govt. Officials, Irrigation / Water Resources departments.

4. **Reconnaissance Survey:**
Analysis of the data collected in the reconnaissance survey should reflect the possibility of year round flow in the proposed Inland Waterways to achieve the commercial navigation. It should also consist the map of proposed Inland Waterways indicating existing cross structures viz. bridges, dams etc. Navigability of the waterway (for the periods) is to correlate with CWC/Irrigation water level data.

The Consultant has to submit the Feasibility Report for proposed Inland Waterways. Consultant also has to emphasize that which stretches of proposed inland waterways has potential of possible navigation. Only for those stretches of proposed inland waterways, which have potential of possible navigation, Stage 2 has to be carried out.

After obtaining approval from IWAI for identified stretches, Consultant may proceed for Stage - 2. Based on the feasibility report, IWAI will accord the approval for Stage-II, and stretch for DPR will be based on feasibility study.

1.2 STAGE-2

For Stage-2, Consultant has to carry out detailed hydrographic survey, topographic survey, traffic survey and selection of terminal locations.

Stage-2 would consist of the following activities:

1A. Hydrographic Survey &hydro-morphological survey

1B. Traffic Survey & Techno economic feasibility

1C. Preparation of Detailed Project Report

1.2.1 HYDROGRAPHIC SURVEY & HYDROMORPHOLOGICAL SURVEY

Based on the recommendation after reconnaissance survey of proposed Inland Waterways

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Hydrographic survey may b as per the International Standards including the following for finding the poter l Inland Waterways for inland navigation:-

(i) The detailed hydrog s to be carried out in WGS'84 datum.

(ii) The horizontal co made using DGPS with minimum 24 hours observations at some platform/base.

The vertical control is to be established with respect to the chart datum / sounding datum from the following methods:-

i. Chart datum/ sounding datum already established by Port Authorities (Chart Datum), Central Water Commission (Average of last six years minimum Water Level) / State Irrigation Department (Full Supply Level (FSL)) and at their gauge stations along the river/canal. Secrecy undertaking forms etc. will be provided by IWAI for collection of CWC data. Introductory letter will be issued to the successful Consultant for collection of other required information from State Departments.

ii. Standard method shall be adopted for transfer of datum in rivers/canals. For tidal reaches standard transfer of datum as per Admiralty Manual shall be adopted.

iii. **By erection of tide gauges – at every 10km interval and also at upstream and downstream of Locks, Sluice gates, Barrages, Dams etc.**

Other Terms of Reference for the survey work shall be as given below: -

1.2.1.1 BENCH MARK PILLARS

a. Construct Bench Mark Pillars of dimension 0.3m x 0.3m x 1.5m (0.6m above GL) RCC pillar with 6mm thick 50mm dia GI pipe inserted (as per construction drawing of Survey Pillar in the tender document), at every 10km interval. Detailed description of the bench mark along with its position and value to be given in the report for future recovery.

1.2.1.2 WATER LEVEL GAUGES

i. Water level gauges are to be erected at every 10 km interval along the canal/river **and also at upstream and downstream of Locks, Sluice gates, Barrages, Dams etc. simultaneously.** Readings are to be taken at 1 hr interval for 12 hours (6 AM to 6 PM) or for the entire period of survey. The gauges are to be connected to a nearest Bench Mark by leveling and its datum value shall be established w.r.to MSL & CD. Water level gauges are to be installed temporarily during the survey period.

ii. At least 2 gauges (one U/s and one D/s at 10 Km apart) shall be read simultaneously and soundings to be carried out within the gauge stations. Soundings are to be reduced for datum of a gauge for 5km length of the canal/river on both side of a gauge.

1.2.1.3 BATHYMETRIC AND TOPOGRAPHICAL SURVEY

Sl. No.	Name of the River / Canal	Description of Inland Waterway
		CLUSTER-8
1	MAHI RIVER:	248 kms length of the river from Kadana Dam at Lat 23°18'22.35"N, Long 73°49'37.45"E to confluence with Gulf of Khambhat near Kavi railway station at Lat 22°10'34.71"N, Long 72°30'36.31"E

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2	NARMADA RIVER	227 km length of the river from Pandhariya at Lat 21°57'10.37"N, Lon 74° 8'27.46"E to confluence of Narmada with Arabian Sea at Gulf of Khambhat Lat 21°38'26.81"N, Lon 72°33'28.24"E
3	SABARMATI RIVER:	212 kms length of the river from Barrage near Sadoliya at Lat 23°26'49.66"N, Long 72°48'34.85"E to confluence with Gulf of Khambhat near Khambhat at Lat 22° 9'17.99"N, Long 72°27'27.81"E
4	TAPI RIVER:	436 kms length of the river from Hatnur Dam near Mangalwadi at Lat 21° 4'21.99"N, Long 75°56'44.88"E to confluence with Gulf of Khambhat (Arabian Sea) at Lat 21° 2'15.51"N, Long 72°39'29.63"E

#	River/Canal	State	Length (km)	Spacing (m)	Ave. width (m)
		CLUSTER-8			
1	MAHI RIVER	Gujarat	248	200	400
2	NARMADA RIVER	Maharashtra & Gujarat	227	200	500
3	SABARMATI RIVER	Gujarat	212	200	150
4	TAPI RIVER	Maharashtra & Gujarat	436	200	350
			1123		

Note:- Bathymetric and Topographical survey of specified Waterways is to be conducted for average width specified in above table. Average width of the Waterways is the average of narrow and wider portions of the river. For reservoir / ponding areas, only bathymetric survey of maximum 500m width in the deepest channel is to be carried out. Minimum 100m wide corridor is to be surveyed (only for rivers / canals having less than 60m water width). 100m wide corridor includes width of proposed Waterways. Bathymetric and topographic survey is to be carried out for 50m width on both side from the centre line of the channel.

a. Bathymetric and Topographical survey of proposed Inland Waterways is to be conducted for width specified in above table. Minimum 100m wide corridor is to be surveyed to assess the extent of land acquisition required for 100m wide corridor (100m wide corridor includes width of proposed Inland Waterways).
b. Cross-section sounding lines / leveling are to be run from bank to bank at spacing specified in above table, to identify the navigable channel.
c. Continuous soundings are to be taken by running the sounding boat at constant speed on the cross-section so as to get smooth contours. Intermediate line is to be run at bends, if the line spacing is more than the specified above.
d. For cross-sectional bathymetric survey more than 60m in proposed Inland Waterways, spot levels at line spacing x 20m length grid, on both banks should be taken. If Island or sandchur exist in the middle of the waterway, spot levels on the same spacing should also be taken and indicated in the charts along the same cross-section line.
e. If bathymetry cross-section is limited up to 60 mts width in waterway, then Consultant has to cover 100m corridor including spot levels in line spacing x 20m length grid on both banks.
f. If bathymetry cross-sectional is limited up to 20 mts width in waterway, then Consultant has to run three (03) nos. longitudinal lines. One in centre and one each at equal interval (near the edges of water).
g. If bathymetry cross-sectional is limited up to 10 mts width in waterway, then Consultant has to run one (01) no. longitudinal line at centre only.

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h. If Island or sandchur exist in the middle of the river, spot levels on the same spacing should also be taken and indicated in the charts along the same cross-section line.
i. Surveys in non-approachable areas are to be informed by the Consultant and joint inspection (Consultant's representative & Engineer-In-Charge or his representative) will be held to confirm the non-approachable areas.
j. The survey area may consist of canal sections, rivers, sea openings of different dimensions. Hence, Consultant has to inspect the area to be surveyed and satisfy themselves with respect to site conditions before submission of bid. However, variation in quantity will be considered only for length of the river/canal (longitudinal length).
k. The soundings are to be reduced to the chart datum/ sounding datum established at every gauge stations.

1.2.1.4 <u>CURRENT VELOCITY AND DISCHARGE MEASUREMENT</u>

a. The current velocity and discharge at every 10 km interval shall be observed once in a day during the survey period. Current velocity and discharge at every 10 km interval are to be measured only once at different depths while carrying out survey in that region.
b. Current meter measurement should be taken at 1m below water surface or 0.5d (if depth is less than 1m), where d is measured depth of water & values indicated in the report along with position.
c. Measurements at different depths may be taken by single equipment over three different time spans.
d. Measurement of current velocity at different depth is to be measured for at least 15 minutes or as per listed calibration period of the equipment, under use for this project.
e. Current velocity and discharge can also be measured with the help of ADCP during survey, at every 10km interval. Discharge can be measured either by ADCP or standard formulas.

1.2.1.5 <u>WATER AND BOTTOM SAMPLES</u>

a. Water and bottom samples are to be collected from the deepest route at every 10 km interval and are to be tested and the results/characteristics of the soil and the water are to be incorporated in the report. Soil sample can be collected by a grab and water sample at 0.5d (d-measured depth of water) by any approved systems. The following tests are to be carried out for Bottom samples:-

i) Grain size distribution
ii) Specific gravity,
iii) PH value
iv) Cu, Cc
v) Clay silt%
and Sediment concentration for Water Samples.

1.2.1.5 <u>COLLECTION OF TOPOGRAPHICAL FEATURES</u>

a. Photographs of the prominent features are to be taken and included in the report along with its position.

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rmanent structures located within this corridor are also required to be indicated on e report & charts.

l prominent shore features (locks, bridges, aqueducts, survey pillars if available etc) ..d other conspicuous objects are to be fixed and indicated on the chart and included in the report.

d. Identify cross structures which are obstructing navigation.
e. Details (horizontal and vertical clearances above High Flood Level in non-tidal area and High Tide Level in tidal area) of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location.
f. Details of water intake/ structures are to be collected and shown on the charts and include in the report.
g. Availability of berthing place, existing jetty, ferry ghats, approach roads etc. are to be indicated on the charts and include in the report.
h. During the survey, conditions of the banks are also required to be collected. It is to be noted that banks are pitched (protected) or not protected. Estimate the length of bank protection, where banks erosion is taking place.
i. Positions and levels of corners of permanent structures within the corridor are to be physically surveyed and marked on survey charts.
j. Approachable roads / rails / places outside the corridor may be incorporated from Toposheets/Google Map/Google Earth.

1.2.1.6 SURVEY CHART PREPARATION

a. The survey chart is to be prepared on a scale of 1:1,000 for Waterways width less than 100m. On a scale of 1:2,000 for Waterways width between 100m to 300m. On a scale of 1:5,000 for Waterways width between 300m to 500m and On a scale of 1:10,000 for Waterways width more than 500m.
b. Contours of 0m, 1m, 2m, 3 m, 5m and 10 m are to be indicated on the charts with respect to Chart Datum / Sounding Datum.
c. Reduced spot levels w.r.to MSL to be indicted on the charts. Spot level values are to be given w.r.t. Mean Sea Level (MSL) & Soundings w.r.t. Chart Datum / Sounding Datum. A separate file (xyz) (soft copy only) is also to be created for spot levels w.r.t. Chart Datum / Sounding Datum for dredging calculation purpose.
d. On completion of the cross-sections, dredge channel is to be identified/ established by linking deepest soundings on the cross-sections. Dredging quantity is to be estimated for developing a navigational channel of
   i. dimension of 32m x 1.8m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is less than or equal to 100m).
   ii. dimension of 45m x 2.0m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is more than 100m).
e. Dredging quantity is to be indicated in the report for per km length of the waterway.
f. Minimum & maximum reduced depth and length of shoal for per km length of the waterway is also to be indicated in the report.
g. Current meter measurement values shall be indicated in the report along with position.
h. The results/characteristics of the soil and the water are to be incorporated in the report.
i. Shallow patches /shoal and submerged sand-chur having less than 1.0 m depth, rocky outcrops, rapids and other navigational impediments are to be indicated on the charts.
j. A brief write up on condition of the locks, Sluice gates, Barrages, Dams etc. (

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vailable) are also to be included in the report. Brief write up based on visual observation, photographs and information from State Irrigation Deptt. and local urces.

e chart shall also be suitably updated with prominent land features from the Topo-ets/site. Available Survey of India (SOI) Topographic sheet will be shared with cessful Consultant on receipt of Undertaking. Satellite imageries are not available IWAI for the designated area. Route map and survey plan will be provided by I to the successful Consultant.

aw data and processed data of Automatic Hydrographic Survey System are required to be submitted. Standard procedure is to be adopted for data processing. All RAW, EDIT, SORT and field data are required to be submitted by the Contractor.

m. All surveyed field data including leveling data (csv file) are required to be submitted.
n. All position data of ground features, waterway structures are to be submitted in both hard copies and soft copies.

1.2.2 TRAFFIC SURVEY & TECHNO ECONOMIC FEASIBILITY

This is a detailed study to make a forecast of the traffic prospects to facilitate the projection of the most promising route for waterway transport and to assess the quantum of traffic of vessels/cargo on that route. This survey is to be under-taken in conjunction with Reconnaissance and Hydrographic surveys so that the Techno Economic feasibility and costs of the alternative proposals can be taken into account while formulating the recommendations.

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) has to be forecasted based on standard methods. Divertible traffic to IWT is also to be assessed.

1.2.3 DETAILED PROJECT REPORT

The scope of works is as follows:

a. Assessment of the morphological, hydrological, hydrographical conditions, and operation and maintenance requirements of the proposed waterways to identify works in sufficient details that are required in respect of:
   - River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation.
   - Navigational aids and communication facilities.
   - Improvements with reference to horizontal and vertical clearances required on the existing or proposed cross structures such as bridges, power cables, locks etc.

b. Geo-tech investigation will be carried out by the consultant as per standard guidelines of Geological Survey of India, Government of India.

c. To conduct necessary investigations for the preliminary design, to ensure a coordinated development to cover waterways engineering works and structures, waterway crossing, navigational structures, riverine ports and terminals, land and rail access.

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d. Prepare preliminary engineering designs, drawings and estimates for the optimum structure of river training and bank protection measures and navigational aids to develop and maintain a navigable channel for the waterway system in an EPC mode.

e. For preliminary engineering designs, the data about soil characteristics shall be collected from the local sources based on the structures constructed nearby. In case of critical structures, consultant can suggest that detailed soil investigation including borehole tests etc.

f. River training/bank protection works particularly for those stretches where either the channel is narrow and needs to be widened by dredging or where it is anticipated that the bank can erode due to continuous movement of barges.

g. Identify the location and carry out preliminary designs of cargo terminals and river ports to handle the anticipated cargo as duly updated.

h. Prepare a realistic construction schedule for the whole project indicating the priority of different components of the project. The phasing of expenditure is also to be worked. Also suggest phased programs of construction including riverine terminals and ports which shall be fully integrated with the existing and planned irrigation and hydropower facilities.

i. Prepare cost estimate for various possible alternatives for the entire proposed infrastructure, handling, and other allied facilities. While comparing the different alternatives, the cost and economy factors shall also be evaluated. The most suitable alternative recommended shall have detailed costing for all the components of the project. The Consultant is to propose the River conservancy including river training, bank protection, dredging etc. needed for shipping and navigation. Alternate possible methods for water augmentation are also to be suggested in detail. FIRR, EIRR, NPV and SWOT analysis are also to be carried out by the Consultant.

j. Assess the environmental impacts due to these development works and suggest suitable environmental management plan (EMP) to mitigate the adverse impacts, if any, including its cost. Flood Plain specialist will be responsible to assess the Environmental Impact and preparation of EMP. Consultant has to identify the Authorities who will give the clearances for EIA/EMP. Consultant will not be required to take clearances from these identified Authorities.

k. Suggest horizontal and vertical clearances to be provided on cross structure such as bridges, power cables, locks etc. for commercial viable navigation in present as well as in future. For this, IWAI guidelines Section-IV, may also be referred to.

2.0 PERIOD OF SERVICES

Consultant may associate with sub Consultant(s) to enhance their expertise. The applicant shall submit a Memorandum of Understanding (MOU) with the Sub Consultant regarding the role and responsibilities of the Associate Company along with the proposal.

2.1 TIME SCHEDULE/SUBMISSION OF REPORTS:

(a) The time of completion of various sub-stages of the assignment will be as given below:

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	Sl. No	Activity	Cluster-8 Time in weeks**
Stage-I	a)	Mobilization of the Team and submission of Inception Report (2 copies)	15
	b)	Submission of Draft Feasibility Report (3 copies)	18
	c)	Comments from IWAI	20
	d)	Presentation and Submission of Final Pre-feasibility Report (3 copies)	22
Stage-II	a)	Acceptance of Stage-I report and go ahead for Stage-II by IWAI	24
	b)	Submission of Hydrographic Survey Charts and report (3 copies)	38
	c)	Submission of Draft Detailed Project Report (3 copies)	46
	d)	Receipt of comments of IWAI on Draft DPR.	48
	e)	Submission of Final Detailed Project Report (10 copies) after incorporating final comments of IWAI.	54
reckoned from the date of signing of Contract or 15 days from the date of issuance of work order, whichever is earlier.			

NOTE: -The consultants are required to submit the following outputs in Stage-II in the enclosed standard templates:-

vi) Traffic Template: at Annex-IV
vii) Project Costing Template: at Annex-V
viii) Financial Evaluation Template: at Annex-VI
ix) Economic Evaluation Template: at Annex-VII
x) Environmental & Social Screening Template: at Annex-VIII

3.0 Minimum Qualification of Key Professionals

Sl. No	Key Professionals	Qualification Criteria
1.	**Waterway Expert (Team Leader)**	**Educational Qualification:** • Should be Graduate in Civil Engineering. Higher professional qualification in Port and Harbor Engineering/Structural Engineering/Geo-technical Engineering will be preferred. **Professional Qualification:** • Minimum 15 years' experience in planning, design, construction, preparing Feasibility Report/Detailed Project Report for various waterway/port/river front development/river training works, terminals, trade facilitations and other infrastructures in different natural and operational conditions with at least 5 years in a reputed firm of consultants.
2.	**Port planning & Infrastructure Specialist**	**Educational Qualification:** • Should be Graduate in Civil Engineering. Postgraduate training/ studies in Port & Harbor Engineering will be preferred. **Professional Qualification:**

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Sl. No	Key Professionals	Qualification Criteria
		• Minimum 10 years' experience in Port planning, Port infrastructure Planning and development of physical facilities for port operations. Should be well conversant with different types of port structures and other physical facilities required for the provision of various port services efficiently. Should preferably have experience/ exposure of constructing several modern ports.
3.	**Remote Sensing/GIS Expert**	**Educational Qualification:** • Should be Graduate in Engineering/Geology. Higher professional qualification in Remote Sensing/ Geoinformatics will be preferred. **Professional Qualification:** • Minimum 10 years' experience in waterway/port/river mapping and a demonstrated proficiency in using the GIS software. Working knowledge of spatial data formats and related metadata issues. Working knowledge of web mapping applications, such as Google Earth/Bhuvan.
4.	**Floodplain Specialist**	**Educational Qualification:** • Should be Graduate in Civil/Environmental Engineering. Higher professional qualification in Floodplain Management/Hydrology/Water Resource Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in Floodplain Management. Working knowledge of water and/or wastewater modeling is desirable.
5.	**Hydrographic Expert**	**Educational Qualification:** • Should be ITI in Survey/Diploma in Civil Engineering. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 8 years' experience in conducting hydrographic surveys, investigations and measurements, bathymetric surveys/Topographic Survey in a variety of geographical locations and natural.
6.	**Soil Engineer/ Foundation Engineer**	**Educational Qualification:** • Should be Graduate in Civil/Environmental Engineering. Higher qualification in Marine Structure/Geotechnical Engineering will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of the soil investigation, reclamation work, soil improvement and will be associated in foundation design. He will also be responsible for preparation of cost estimates/BOQ.
7.	**Traffic Surveyor**	**Educational Qualification:** • Should be Graduate in Engineering. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of traffic survey of waterways/river/canal or similar facilities.

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Sl. No	Key Professionals	Qualification Criteria
8.	**Transport Economist**	**Educational Qualification:** • Should be Graduate in transport planning management, transport economics, transport/road/rail/Civil engineering/MBA or equivalent qualifications. Higher qualification in relevant field will be preferred. **Professional Qualification:** • Minimum 10 years' experience in related field. He should have experience of estimating transport investments and implementing transport programs.

NOTE1:-If the Key Personnel proposed in the CV does not fulfill the minimum academic qualification, the overall score of his CV will be evaluated as zero. All such Key Personnel (whose CV scores less than 75% or who does not fulfill the minimum qualification) will have to be replaced by the firm. H-1 firm will be intimated for replacement of such personnel and work will be awarded after receipt of CV's fulfilling the tender criteria.

Note 2:- IWAI may call each key personnel of the preferred Consultant at the time of award of work, at the cost of Consultant.

Note 3: - In case during interaction with the key personnel, it is found that the key personnel proposed is un-suitable for the assignment position, his replacement by equivalent or better shall be provided by the consultant. The key personnel with such un-suitable CV shall not be considered in any future bids for that position for two years. No deduction for such replacement, who are not found suitable during interaction shall be made.

Note 4:- Role and responsibilities of the Key Professional shall be as per the requirement of the project and Terms of Reference of the tender document and the same has to be accessed by prospective bidder.

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