TRACTEBEL ENGINEERING pvt. ltd..
Intec House
37, Institutional Area, Sector 44
Gurgaon 122 002 (Haryana) – INDIA
tel. +91 124 469 85 00 - fax +91 124 469 85 86
engineering-in@tractebel.engie.com
tractebel-engie.com

DPR – DABHOL CREEK / VASHISHTI RIVER (45.228KM) NW-28

Our ref.: **P.010257-W-10305-004**

Imputation: P.010257

RESTRICTED

Client: **INLAND WATERWAYS AUTHORITY OF INDIA**

Project: **CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER – 7 OF NATIONAL WATERWAYS**

Subject: **DETAILED PROJECT REPORT – DABHOL CREEK/VASHISHTI RIVER (45.228KM) NW-28**

Comments:

Revision No.	Date	Prepared / Revision By	Description
01	2019 05 08	Bidhan Chandra JHA	Final Submission

01	19/05/08	Active	SARIKA KUMARI	ARUN KUMAR	N. SIVARAMAN	B.C.JHA
REV.	**YY/MM/DD**	**STAT.**	**WRITTEN**	**VERIFIED**	**APPROVED**	**VALIDATED**

ACKNOWLEDGEMENTS

Inland Waterways Authority of India (IWAI) assigned the Consultancy Services for "Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 7 of National Waterways". The study has been carried out for this assignment and the result has been compiled in the present study.

The consultant would like to put on record their deep appreciation of cooperation and ready access to information and advice rendered by IWAI.

The consultants are grateful to Mr. S. K. Gangwar, Member (Technical), Mr. R. P. Khare (Ex. Member, Technical & Sr Consultant); Vice Admiral (Retd.) S. K. Jha (Sr. Advisor); Capt. Ashish Arya, (Hydrographic Chief) and Mr Rajeev Singhal (SHS) who provided their valuable guidance from time to time to make this report success.

(B. C. JHA)
Tractebel Engineering Pvt Ltd

DISCLAIMER / PROPREITORY RIGHTS

M/s Tractebel Engineering Pvt., Ltd., (M/s TEPL), Gurgaon has been assigned with the Consultancy Services for the "Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 7 of National Waterways" by Inland Waterways Authority of India (IWAI). Accordingly, the study on NW – 28 – Dabhol Creek / Vashishti River has been carried out for this assignment / analyzed / compiled based on the findings of the following field studies / investigations.

Detailed Hydrographic Survey along with the Topographical Survey was carried out from 17/12/2016 to 04/01/2017.

Traffic Survey was carried out, as detailed and summarized in Annexure 4.2.

Terminal Land Survey was carried out on 28/04/2017.

Geotechnical Borehole was carried out from 18/06/2017 to 22/06/2017 and subsequently Laboratory Tests have been carried out on the collected samples.

Stake Holder's meet was considered on 04/12/2017 at "Mumbai" and the viewpoints have been summarized and placed appropriately.

Proprietary rights of the information contained herein belong to "Inland Waterways Authority of India (IWAI)", Ministry of Shipping, Government of India. The information contained in this DPR is intended to be used for the mentioned purpose/project only, as permitted by IWAI. In case of misuse of information and any claim arising thereof, cost and consequence will be on the party misusing the information.

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 State Government or Government of India.

(B. C. JHA)

Tractebel Engineering Pvt Ltd

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Abbreviations	Acronyms
BFL	Bombay Floating Light
CD	Chart Datum
Ch	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning System
DMIC	Delhi Mumbai Industrial Corridor
DPR	Detailed Project Report
FSL	Full Supply Level
GAIL	Gas Authority of India Ltd.
HC	Horizontal Clearance
IO	Iron Ores
IOCL	Indian Oil Corporation Ltd.
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
JnPT	Jawaharlal Nehru Port Trust
KP	Km Points
LAD	Least Available Depth
MHWS	Mean High Water Spring
MMTPA	Million Metric Tonne Per Annum
MnT	Million Tonnes
MOEFCC	Ministry of Environment, Forest & Climate Change
MOS	Ministry of Shipping
MbPT	Mombai Port Trust
MRPL	Mangalore Refineries and Petrochemicals Ltd.
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
NH	National Highway
NMPT	New Mangalore Port Trust
NW	National Waterway
OMPT	Old Mangalore Port Trust
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
SEB	State Electricity Board
SH	State Highway
UPCL	Udupi Power Corporation Ltd
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

SALIENT FEATURES

#	Particulars	Details			
		DABHOL CREEK/ VASHISHTI RIVER (NW-28)			
A	**GENERAL**				
1	***Location***				
a	Cluster	Cluster-7			
b	State(s)	Maharashtra			
c	Co-ordinates& Name of Place	**Start**		**End**	
	Place	Dabhol		Pedhe	
	Latitude	17°34'31.1762"N		17°32'39.43"N	
	Longitude	73°09'09.5984"E		73°30'33.95"E	
B	**TECHNICAL**				
1	***Waterway***				
a	National Waterway Number	NW-28			
b	Class	IV			
c	Type (Tidal/Non-Tidal)	Fully Tidal			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		45.228km	45.228km	Nil	
d	Average Tidal Variation, if applicable	2.896m Chainage / Tidal Variation 02.800 / 2.730 09.100 / 2.835 20.900 / 2.815 32.700 / 3.050 43.100 / 3.050			
e	Chart Datum				
	Description/Basis	Sakhri trishul 17°34'25.477"N 73°13'45.870"E	Parchuri 17°34'40.117"N 73°18'17.352"E	Maldoli 17°34'56.302"N 73°24'19.185"E	Gawalkot 17°32'59.62"N 73°29'04.64"E
	Value (from Zero of Gauge)	-0.085m*	-0.283m*	-0.476m*	-0.584m*
		* zero of gauge below Chart datum			
f	LAD Status (w.r.t. CD)				
		Stretch-1	**Stretch-2**	**Stretch-3**	**Total**
	Stretch (From…...To……)	0 – 15.00	15.00 – 30.00 km	30.00 – 45.228 km	
	Length with LAD < 1.2 m	0.0	0.0	6.228	6.228
	With LAD from 1.2-1.4 m	0.0	0.0	0.0	0.000

#	Particulars	Details				
	With LAD from 1.5-1.7 m	0.0	0.0	3.0	3.000	
	With LAD from 1.8-2.0 m	0.0	0.0	1.0	1.000	
	With LAD > 2.0 m	15.0	15.0	5.0	35.000	
	Total	15.0	15.0	15.228	45.228	
g	Target Depth of Proposed Fairway (m)	2.00m				
h	Conservancy Works Required					
	Type of Work	**Stretch-1**	**Stretch-2**	**Stretch-3**	**Total**	
	Dredging Required (Cum.)	0.00	0.00	445585.26	445585.26	
	Bandalling	Nil	Nil	Nil	Nil	
	Barrages & Locks	Nil	Nil	Nil	Nil	
	River Training/Bank Protection (Km.)	7 nos – 4000 m i.e., 500 m at Ch 11.50; Ch 12.50; Ch 17.20; Ch 21.50 & Ch 42.40 + 750 m between Ch 9.5 & Ch 10.5 and 750 m between Ch 43.0 & Ch 44.5				
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.	Nil	Nil	Nil	Nil	
	Bridges	Road	Nil	Nil	Nil	
	HT/Tele-communication lines	HT Lines	3	240m to 740m	8.35m to 12.55m	
	Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil	
2	***Traffic***					
a	Present IWT Operations (type of services)	At the mouth of the river Dabhol port (non major) is operational. Dabhol port handles liquid, break bulk & project cargo. No cargo operation found in the rest of the river stretch.				
b	Major industries in the hinterland (i.e. within 25 km. on either side)	Chemical Industries located in Lote Parshuram MIDC.				
c	Connectivity of major industries with Rail/Road network (Distances/Nearest Railway Stations etc.)	Major roads - NH 66 crosses over the river from tail side. SH 96 & SH 4 crosses near the mouth of the river. Apart from these two State Highways, there do not exist any bridge or roadway on the river. Both highways are more than 30 km away from each other. Industries use NH66 to transport cargo to JNPT for export purpose. Major railway – Konkan railway line is the only railway line running. Chiplun & Khed are passenger railway stations in the catchment of the river. This railway line is nearby to end of the river. No rail connectivity at mouth of the river.				
d	Commodities	**In-bound**		**Out-bound**		

#	Particulars	Details				
1	Chemical / Container	Lote Parshuram		JNPT - Export		
e	Future Potential					
	Name of Commodity	**5 years**	**10 years**	**15 years**	**20 years**	**25 years**
	Proposed IWAI Terminal					
1	Liquid, Bulk, Break bulk (Ro-Ro) ('000 Trucks)	125	152	185	225	273
3	***Terminals/Jetties***					
a	Terminal/Jetty – 1	RO-RO				
	Location (Bank/city/district)	17°32'44.26"N & 73°30'32"E (right bank) near Pedhe, in Ratnagiri district				
	Type/Services	Ro-Ro Service				
	Facilities	--				
	Approach	Road is available				
	Land Ownership	Both private and Govt land				
	Area (ha.)	3 ha				
4	***Design Vessel***					
a	Type	Ro-Ro Vessel				
b	No. & Size	2 Nos in FY 20. After observation, if need be 6 Nos in every 2 yrs from FY 30 Size is 52.8 m - 55 m x 14 m				
c	Loaded Draft	1.8 m / 2.5 m				
d	Capacity	21 TEU				
5	***Navigation Aids***					
a	Type	Beacon and Lights				
b	Nos.	10				
b	Communication Facilities	-				
C	**FINANCIAL**					
1	***Project Cost***					

#	Particulars	Fairway		Ro-Ro
a	Capital Cost	**Fairway**		**Ro-Ro**
		With development	Without development	With development
	Cost (INR)	7.5 cr (FY18-FY27) + 88.3 cr (FY26-FY40)	7.5 cr	38.6 cr
b	O & M Cost	0.28 cr (FY18-FY27) + 14.14 cr (FY26-FY40)	0.57 cr	0.7 cr
2	***User Charges***			
a	For IWAI	-		
b	For Operator	-		
3	***Financial Internal Rate of Return (%)***	**Fairway**	**Ro-Ro**	**Whole Project**

#	Particulars	Details			
		With development	Without development	With development	With development
a	For IWAI	79% (Promotional Period) 7% (Official Period)	80%	Non-existent	- 5 %
b	Operator	--			
4	***Economic Internal Rate of Return (%)***	**Fairway**		**Ro-Ro**	**Whole Project**
		With development	Without development	With development	With development
		318% (Promotional Period) 37% (Official Period)	318%	103%	21 %
5	***Any other Important Feature***	Phase 1 with nominal investment is recommended as a promotional venture. Phase 2 is not recommended.			

EXECUTIVE SUMMARY

Vashishti River (Dabhol Creek) is one of the waterways declared as National Waterway in March, 2016 as NW 28. The River Vashishti originates in the Western Ghats and snakes its way westwards towards the Arabian Sea. The study stretch is fully tidal. Out of the total length, the stretch from Arabian Sea at Dabhol Lat 17°34'51"N Long 73°09'18"E to Bridge at Pedhe Lat 17°32'39" Long. 73°30'36" has been declared as new national waterway and proposed to undertake the two stage DPR. M/s Tractebel has been assigned with the work of Preparation of a two stage DPR. Subsequent to the Stage 1 preliminary findings, the Waterway stretch of 45.228 kms from starting point Lat 17°34'31.1762" N, Long 73°09'09.5984" E has been taken up for the Stage 2 Detailed Project Report (DPR) so as to assess the required developments and the IWT Traffic potential along with inter alia activities including the working out of Cost / Return factors for taking a decision on developments / investments.

The major components in the DPR can be considered as Fairway Development; Traffic Confirmations; Terminal Development; Vessel Requirement and Financial Analysis. Bathymetric Survey of the study stretch has been carried out along with the Topographical Survey so as to arrive at the conservancy requirements including Dredging; Channel demarcation and other Waterway requirements for safe navigation. The next one is Traffic Confirmations. The present Traffic scenario, possible divertible traffic to IWT is to be estimated. In sequence, Terminal Development, Vessel Requirement and Financial Analysis have been considered.

River Morphological analysis of the study stretch has been considered by analyzing the river regime of the past 15 to 20 years with 5 years span and the findings have been recorded. As such there is no major Regime disturbance in the study stretch. Based on the Hydrographic Survey inputs and other site data collected, it has been noticed that there is no Bridge structure in the entire study stretch. 3 Nos of HT Lines are crossing the study area, of which 1 is to be stringed to have safe clearance. No pipe line is crossing the study area. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 23 Nos. Of Bend locations have been identified in the study stretch, with 240 m as lowest at Ch. 43.50 km and at Ch 44.25 km.

Existing waterway is being used for local ferry mobility and also some Tourism potential has been observed. The fairway without any development can have safe navigation to Class IV standard of National Waterway for a length of about 35 kms. Yet there is no utilization of this waterway. Keeping in view the proximity of Industrial Belt in the end stretch of the River, being planned and designated by Maharashtra State Government, the possibility of Ro-Ro mobility could be established with an estimated Ro-Ro vehicles mobility to the extent of 125,000 vehicles P. A in FY 20 and expected growth to an extent of 273,000 vehicles P. A in FY 40. There is a possibility of this mobility directly from JNPT through IWT vessel traversing the costal route and the full stretch of the Vashishti River.

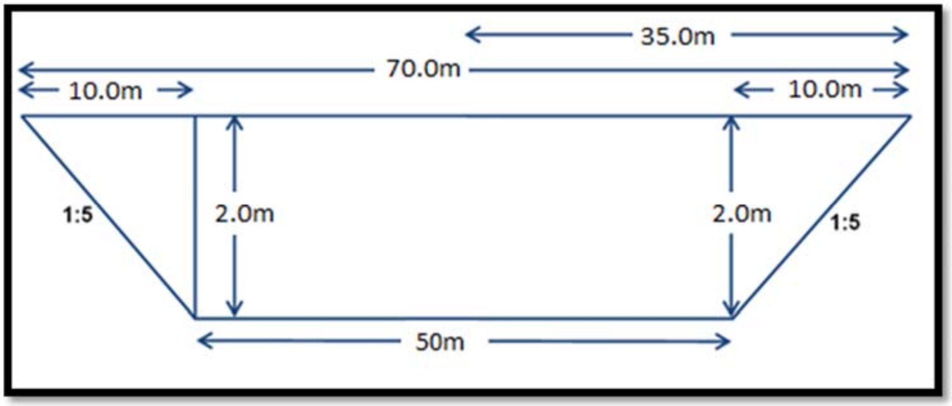
The fairway requirements are being considered for analysis for its maximum / optimum utilization. The most advantageous part of this waterway is that the initial 35 kms out of the 45.228 km has water depth > 2.0 m (w. r. to CD). This will facilitate the mobility of class IV vessel and accordingly, it is proposed for the development as Class IV for Ro-Ro mobility with 21 TEUs. The vessel requirement is 52.8 m to 55 m (Length) x 14 m (Breadth) x 1.8 m / 2.5 m (Draft / Depth). Accordingly, the fairway requirement of Class IV with 50 m (Bottom Width) x 2.0 m (Depth) and with Bend Radius of 800 is proposed. Clearance corridor of 50 m Horizontal Clearance (HC) and 10 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel.

Keeping in view the most advantageous aspect of the Fairway availability, no investment has been proposed at the initial stage. In the proximity of Ch 34 km, there is an approach road existing both in North side (Bank near “Bhairavali” village) and South side (Bank near “Karambave” village), which are connected to NH 66 with a lead of 10 kms – 12 kms. Accordingly, phase 1 has been considered (up to 34 km) without any investment / rather very nominal investment to facilitate Ro-Ro operation to achieve the initial estimated volumes (to decide upon the investment in phase 2) and if the same is able to achieve full estimated volumes, no investment is suggested. The promotional aspect with observation is proposed up to FY 25.

This promotional aspect is proposed as Phase 1, where there is no investment (rather nominal investment) for development. 10 Nos of Lattice Bridge with Lighting; Institutional build up and L. S provisions have been worked out for INR 7.52 Cr in Phase 1.

If Phase 2 is to be considered, after having meticulous observation of the growth mobility, the fairway stretch between Ch 35 and to the end is proposed to be developed along with the development of IWAI Ro-Ro Terminal at the end of the stretch near Ch 45 km, just D/s of the Bridge.

The Dredging quantities have been worked out for the Class IV NW system.



Observed						Reduced w. r. t. Sounding Datum			
Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)
From	To	Max.	Min.		Per km drg	Max.	Min.		Per km drg
0.0	15.00					17.8	8.8	0.0	0.00
15.00	30.00	TIDAL ZONE				17.9	4.4	0.00	0.00
30.00	35.00					13.1	6.4	0.00	0.00
35.00	45.228					12.4	-1.5	6300	445585.26
							Total	6300	445585.26

The stretch between Ch 35 km and Ch 45.228 km, may have to be dredged for the shoal length of about 6,300 m with an estimated quantity of 4.46 Lakhs Cu. M. As a part of Phase 2 development, in order to provide a class IV safe navigable fairway, Dredging of 4.4 Lakhs Cu. M in Soils and 0.50 Lakhs in Hard Soils; 4000 m of Bank Protection; 110 Nos of Day / Night Navigation Buoy / Light etc., have been suggested.

The Terminal requirement has been considered with 1 Roll-On Roll-Off (Ro-Ro) IWT Terminal. Taking into the consideration of the origin and destination and fairway, the most probable location identified is near Ch 45 km, on the right side of the river with approx Lat 17°32'44.26"N and Long 73°30'32"E. This location is having good accessibility to the road.

A tentative Land requirement has been worked out and arrived at with 30,008 Sq. M and the Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Pedhe Village; Chiplun Taluka; Ratnagiri District of Maharashtra state. Terminal Infrastructure has been considered to suit to the Ro-Ro operation.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
RO RO	63	16.60

Preliminary Designs have been worked out for Spurs; Bank Protection with Gabions; Navigational Aids through Beacons & Buoys (Polyethylene) along with Lights (4 NM) and Ro-Ro Jetty.

The Vessel Design has been discussed with international standards, as in vogue. To meet the mobility of the existing cargo, though, it was proposed / recommended for the convoy, the following standards have been considered.

Ro-Ro Vessel:	**(21 TEU)**	**INR 900 Lakhs each**
LOA	52.8 m to 55 m	
Breadth	14.0 m	
Loaded Draft / Depth:	1.8 m / 2.5 m +	
Propulsion:	Marine Diesel Engines of 3 x 375 Bhp	
Speed (with Load):	20 Kmph (Av)	

Note: Depth + is an indication for provision of increased depth for the vessel mobility as a coaster.

2 Ro-Ro vessels may be required at the initial stages in FY 20 to consider the promotional Phase 1 mobility. If Phase 2 implementation is established with due analysis, suggested the deployment carefully i.e., one additional vessel in the following sequence of FY 30; FY 32; FY 34; FY 36; FY 38 and FY 40.

Regarding the Navigation & Communication System, it has been worked out the provision of RIS / AIS / Locating the Vessels / Buoys. An attempt has been made to ascertain the details on the Vessels Traffic Management System (VTMS). It was observed that the same is more costly than the RIS system and has not been discussed. It was understood that the Ministry of Shipping, Govt. Of India has already initiated the working about feasibility and implementation of “National Coastal Grid of

VTMS”. This proposal is from the strategic safety point of view and is expected to take some more time. It is suggested to have a dialogue at later date by IWAI for a fool proof communication / navigation system in the National Waterways joining the sea in both west / east coast. Hence, a feasible system could not be recommended at this point of time. However, the cost implications have been worked out and placed, which are indicative and may be useful for implementation, at later stage.

With regard to the Environmental aspects, considering the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices. Since limited dredging is involved, impact on aquatic ecology is also anticipated to be negligible. No structures are present over the land identified for construction of terminals or related project components. Therefore, the project does not involve any dislocation of population. The entire project area falls under the tidal zone. As such the project shall require obtaining clearance under the CRZ Notification 2011. Consent to Establish and Consent to Operate from the SPCB shall be required under the Air and Water Acts. No other major clearances / approvals / permits relating to environmental and social aspects are applicable to the project. No wildlife clearance is envisaged for the proposed waterway. Since no structures of cultural, historical or archaeological are anticipated to be impacted due to the project, no clearance from the Archaeological Survey of India (ASI) or the State Department of Culture is envisaged for the project.

Regarding the Institutional requirements, it has been proposed to establish a Regional office to look after the Waterways under Cluster 7 covering Maharashtra and Goa. The office will be supported with appropriate Manpower and other office infra requirements. Further, it is proposed to have 2 Nos. Survey Vessels (2 engines of 175 Bhp each) fitted with Survey Instruments; Related Software; Laptop; 2 Nos. Tug – cum – Buoy Maintenance vessels and 2 Nos. Speed Boats etc.

As explained above, the development is suggested in TWO Phases. Phase 1 is with minimal investment for considering the promotional mobility. Phase 2 may have to be considered only after establishing the growth possibility for the increased Ro-Ro mobility.

Investment in Phase 1 is working out to INR 7.5 Cr.

Investment in Fairway in Phase 2 is working out to INR 88.36 Cr.

Investment in Ro-Ro Terminal in Phase 2 is working out to INR 38.56 Cr.

The FIRR and EIRR have been worked out and the details are placed.

Project Modules	FIRR	EIRR
Phase 1	80 %	318 %
Phase 2 (Fairway)	7 %	37 %
Phase 2 (Ro-Ro Terminal)	Non-Existent	103 %
Phase 2 (Whole Project)	-5 %	21 %

It is recommended to consider Phase 1 Promotional mobility till 2025 / 2026, with a nominal investment, with the operation up to 34 km / 35 km. No investment is suggested for further development, without any meticulous assessment in order to develop the entire study stretch of Vashishti River (Dabhol Creek) of about 45 kms with Class IV system of the NW standards to facilitate the Ro-Ro vessel mobility.

CHAPTER 1: INTRODUCTION

1.1 Project Background and Summary of Previous Study

Globally, the renewal of Inland Water Transport (IWT) is under serious consideration predominantly due to its energy efficient aspect and cheaper mode on comparison. Further overburdening of the Rail and Road network are also the dominant factors. Transport planners are now leaning towards the development of IWT system for transportation of bulk / IWT sensitive cargo.

India has about 14,500km of navigable waterways which comprise Rivers, Canals, Backwaters, Creeks, etc., out of which about 5200km of the river and 4000 km of canals can be used by mechanized crafts. Yet, IWT mode remains underdeveloped / underutilized in India and its share in overall internal cargo transport remains abysmally low. IWT sector presently has a meagre modal share of 0.1% in India compared to other large countries and geographic areas like the United States, China and the European Union.

Inland Waterways Authority of India (IWAI), a statutory authority under the Ministry of Shipping, came into existence on 27th October 1986 with the prime responsibility of development and regulation of inland waterways for shipping and navigation including the development and maintenance of IWT infrastructure on national waterways. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration. The head office of the Authority is at Noida (Uttar Pradesh). The regional offices of IWAI are at Patna (Bihar), Kolkata (West Bengal), Guwahati (Assam) and Kochi (Kerala) whereas sub-offices are at Allahabad & Varanasi (Uttar Pradesh), Bhagalpur (Bihar), Farakka & Hemnagar (West Bengal), Dibrugarh (Assam), Kollam (Kerala), Vijayawada (Andhra Pradesh), Chennai (Tamil Nadu) and Bhubaneshwar (Orissa).

There are now one hundred and eleven national waterways (NW) across the country which includes five existing national waterways besides 106 waterways which have recently been declared as national waterways through a central legislation i.e., through a bill passed in the Parliament in March 2016.

NW 1, the Ganga – Bhagirathi – Hooghly river system between Haldia (Sagar) & Allahabad was declared in October 1986 for a Length of 1620 km.

NW 2, the Dhubri – Sadiya stretch of Brahmaputra River was declared in September 1988 for a Length of 891 km.

NW 3, the Kottapuram – Kollam stretch of the West Coast Canal along with the Udyogmandal Canal and Champakkara Canal was declared in February 1993 for a Length of 205 km.

NW 4, the Kakinada – Puducherry stretch consisting of canals and the Kaluvelly Tank along with Bhadrachalam – Rajahmundry stretch of River Godavari and Wazirabad – Vijayawada stretch of River Krishna was declared in November 2008 for a Length of 1095 km.

NW 5, the Talcher – Dhamra stretch of the Brahmani River, the Geonkhali – Charbatia stretch of the East Coast Canal, the Charbatia – Dhamra stretch of Matai river and the Mangalgadi – Paradip stretch of the Mahanadi River Delta was declared in November 2008 for a Length of 623 km.

Regarding the **106 Newly Declared National Waterways,** IWAI is carrying out feasibility studies / Detailed Project Report (DPR) preparation through a number of consultants. Two stage preparation of DPR for 53 Waterways have been initiated through 8 Clusters, whereas M/s Tractebel Engineering had been awarded with 2 Clusters i.e., Custer-VI (consisting of 11 waterways – 7 waterways in Karnataka & 4 waterways in Kerala) & Cluster-VII (consisting of 10 waterways – 7 waterways in Maharashtra & 3 waterways in Goa).

The Waterways considered for the study of DPR under Cluster VII are detailed herewith.

TABLE 1-1: List of Rivers/Creeks of under Cluster VII in the States of Maharashtra and Goa (Length-460.043km)

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
1.	Amba River	NW-10	44.971	Maharashtra
2.	Dabhol Creek/ Vashishti River	NW-28	45.228	Maharashtra
3.	Kalyan-Thane-Mumbai waterway, Vasai creek and Ulhas River	NW-53	145	Maharashtra
4.	Rajpuri Creek	NW-83	31	Maharashtra
5.	Revadanda creek / Kundalika River	NW-85	30.736	Maharashtra
6.	Savitri River (Bankot creek)	NW-89	45.47	Maharashtra
7.	Shastri River/ Jaigad creek	NW-91	52	Maharashtra

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
8.	Chapora River	NW-25	25	Goa
9.	Mapusa / Moide River	NW-71	26.638	Goa
10.	Sal River	NW-88	14	Goa
	Total		460.043	
	Waterways restricted to Stage I study.			

Accordingly, the Stage II study for the River Vashishti (NW 28) is under consideration in the present DPR.

1.2 Brief Scope of Work and Compliance statement

The Scope of the Work for the present study is well defined in the Work allocation along with the Terms of Reference (ToR). The same is annexed herewith at Annexure 1.1. Compliance of the ToR is placed at Annexure 1.2.

The ultimate requirement from the study is to get a conclusion on the aspect of implementation. Whether the study stretch under consideration is amenable for implementation or not is the final derivative from the study. In order to get this conclusion, the study is subjected to the Infrastructure Requirement for development, the cost for the development with the Expenditure schedules and the viability of the project with the possible revenues and by meeting the social commitment and responsibilities.

The IWT project for development of a waterway stretch can be broadly segregated into the following aspects viz., Fairway Development; Traffic Confirmations; Terminal Development; Vessel Requirement; Financial Analysis.

1.2.1 Fairway Development

In order to ascertain the existing condition of any waterway, the Bathymetric Survey data along the full stretch at the specified intervals and specified width and the Topographical Survey at important / appropriate locations are required. Based on these site surveys, Conservancy requirements including dredging; Channel demarcation requirements can be arrived at.

1.2.2 Traffic Confirmations

The present Traffic scenarios in the hinterland and along the waterway are to be ascertained and possible volumes of divertible traffic to IWT including the type of cargo are to be assessed for planning and development. The possibility of Passenger and Tourism potential are also to be ascertained.

1.2.3 Terminal Development

Terminal development may have to be initiated with the Site confirmation linking up with various intricacies including the origin and destination of the Traffic. According to the type of cargo and quantum of cargo, the Terminal Infrastructure requirements are to be firmed up. The possibility of moulding the Terminal operation and maintenance as a separate business unit also can be looked into.

1.2.4 Vessel Requirement

Based on the type of cargo, quantum of cargo, distance to be moved etc., also keeping in view the travel time, the type of vessel and No. of vessels requirement are to be worked out. As per the existing / present industry standards, the vessel deployment and its operation and maintenance will not form part of the development except the projection of the requirements for the project, as a whole. Hence this aspect is only indicative.

1.2.5 Financial Analysis

Any project, without the mention of the Cost and economic viability will end up as incomplete. Hence, the detailed Cost analysis; Firming up of the cost for all the items indicated for development; implementation schedule and phasing of the project; operation and maintenance cost etc., are the key factors to be looked into. Working out the possible revenues will be the other key factor. Subjecting the above for a critical Financial and Economic analysis will provide clarity on the implementation of the project, as a whole.

1.3 Brief Methodology & Approach

The Terms of Reference of the subject study, the scope of work defined for the study itself are indicative about the Methodology to be adopted for the study. Further, the Approach and Methodology had already been explained in the Stage I report and at this juncture, it is prudent to mention the sequential and systematic approach to the project. Accordingly, a flow diagram has been placed at Annexure 1.3, which is self-explanatory and by following the activities as specified, the project report will be in complete shape.

1.4 Project Location / Details of Study Area

Stage 1 study was completed for all the 10 National Waterways under Cluster VII and the Feasibility Study Reports of individual National Waterways have been presented to IWAI. Based on the inputs of the FSR, IWAI asked M/s Tractebel to go ahead with the Stage II study on 6 out of 10 National Waterways i.e., 4 in the state of Maharashtra and 2 in the state of Goa, as detailed.

TABLE 1-2: Waterways for Stage II study

Sl. No.	NW-No. / Name of the Waterway	Defined Limits
Cluster 7	(Maharashtra)	
1.	NW-10 / AMBA RIVER	44.971 kms from starting point Lat 18°50' 26.7055" N, Long 72° 56' 44.2695" E.
2.	NW-28 / DABHOL CREEK / VASHISHTI RIVER	45.228 kms from starting point Lat 17°34'31.1762" N, Long 73°09'09.5984" E.
3.	NW-85 / REVADANDA CREEK / KUNDALIKA RIVER	30.736 kms from starting point Lat 18°32'16.7857" N, Long 72°55'33.4735" E.
4.	NW-89 / SAVITRI RIVER (BANKOT CREEK)	45.47 kms from starting point Lat 17°58'47.2472" N, Long 73°02'15.0195" E.
Cluster 7	(Goa)	
1.	NW-25 / CHAPORA RIVER	25 kms from starting point Lat 15°36'31.2547" N, Long 73°44'06.5695" E.
2.	NW-71 / MAPUSA / MOIDE RIVER	26.638 kms from starting point Lat 15°30'22.0887" N, Long 73°50'36.2908" E.

The present study is about the Dabhol Creek/Vashishti River – NW 28 for a distance of 45.228kms from the Arabian Sea mouth to Upstream, in the state of Maharashtra.

TABLE 1-3: Description of Dabhol Creek/Vashisti River (NW-28)

Sl. No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Dabhol Creek/Vashishti River (NW-28)
2	State/ District through which river passes	The Dabhol Creek/Vashishti River passes through the Ratnagiri district of Maharashtra State.
3	Length of the river / canal	Out of the total length, the stretch from Arabian Sea at Dabhol Lat 17°34'51"N Long 73°09'18"E to Bridge at Pedhe Lat.

Sl. No.	Introductory Consideration	Description of the River
		17°32'39" Long. 73°30'36" has been declared as new national waterway.
4	Map	The index map of Dabhol Creek/Vashishti River showing proposed waterway stretch, topographic features and road networks are shown in Figure1.1. The study stretch of the Dabhol Creek/Vashishti River for the Detailed Project Report (DPR) is presented in **Volume-II Drawing No. P. 010257-W-20301-A04 (Sheet – 1 to 7).**
Characteristic of River		
5	River Course	The Vashishti River begins in the Western Ghats and snakes its way westwards towards the Arabian Sea. The River becomes tidal near Chiplun. At the downstream of Pedhe, the river widens and shows meandering and after a course of 40 km through low mud banks and mangroves it joins the Arabian Sea at Dabhol. The drainage pattern of Vashishti river is predominantly dendritic. The river flows straight courses and turn right angled bends at various places viz. at Govalkot and Parare. A variety of landforms have developed along Vashishti river/Dabhol Creek, which are due to erosional and depositional processes of both fluvial and marine origin. The erosional features viz. mesa, hog backs and river terraces of depositional features are observed along the Vashishti River. However, the common shoreline features i.e., Rias, Estuaries and Beach are also available in Dabhol Creek near its confluence with Arabian Sea. Development of Mud flats has been observed at the mouths of Vashishti River towards Arabian Sea. These flats consist of unconsolidated to consolidated sediments and are found to be covered by thin layers of mud. The mud is brown or brownish black in colour and is plastic in character.
6	Tributaries / Network of Rivers / Basin	Shiv Nadi, Jagbudi and Kodjai are the main tributaries of Vashishti River.
7	Catchment Area	The total catchment area of Dabhol Creek/Vashishti River is 2238 sq. km.

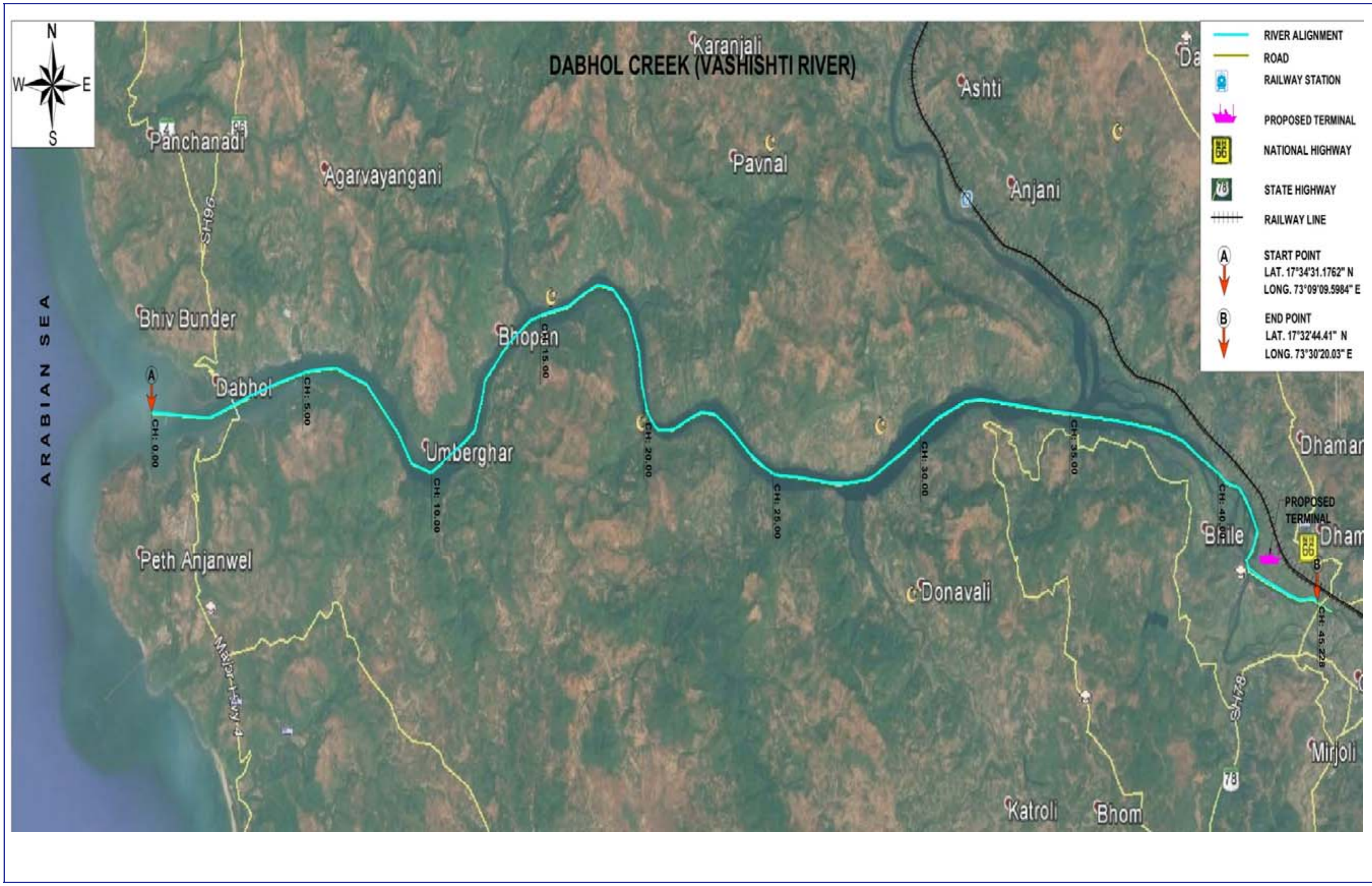


FIGURE 1.1 : INDEX MAP

CHAPTER 2: WATERWAY / DETAILED HYDROGRAPHIC SURVEY

2.1. Hydrographic Survey

Hydrographic survey is the science of measurement of Water depths and description of features which affect maritime navigation, marine construction, dredging, offshore oil exploration / offshore oil drilling and related activities. Hydrographic survey are being carried out for one or more of the following activities like measurement of tides for sea coast works (e.g. construction of sea defence works, harbours etc.), determination of bed depth of water bodies, by soundings (for navigation, location of rocks, sand bars, navigation light).

2.1.1. Waterway in General and Hydro-morphological Characteristics

Waterway in General

River Vashishti is one of the larger rivers in the Konkan coast of Maharashtra, India. The river originates in the Western Ghats and traverses its way westwards towards the Arabian Sea and joins the sea at Dabhol in Ratnagiri district. The river has many riverine islands. The length of the Vashishti main stream in the catchment from the origin to the outfall in the Arabian Sea is about 72km. The present study is for 45.228 kms from the confluence with the sea as 0.00 km.

The Vashishti River is bounded by Chiplun, Pedhe, Bhile, Matwadi, Maldoli and Hodarpad in the upper stretch, Donavali, Waghivare, Panhalaje, Wavghar, Pangari Tarf Haveli, Bhopan and Umberghar in the middle stretch and Koliwadi Chalkewadi Tr. Dhopale, Gudaghe, Urgaon, Veldur and Dabhol in the lower stretch.

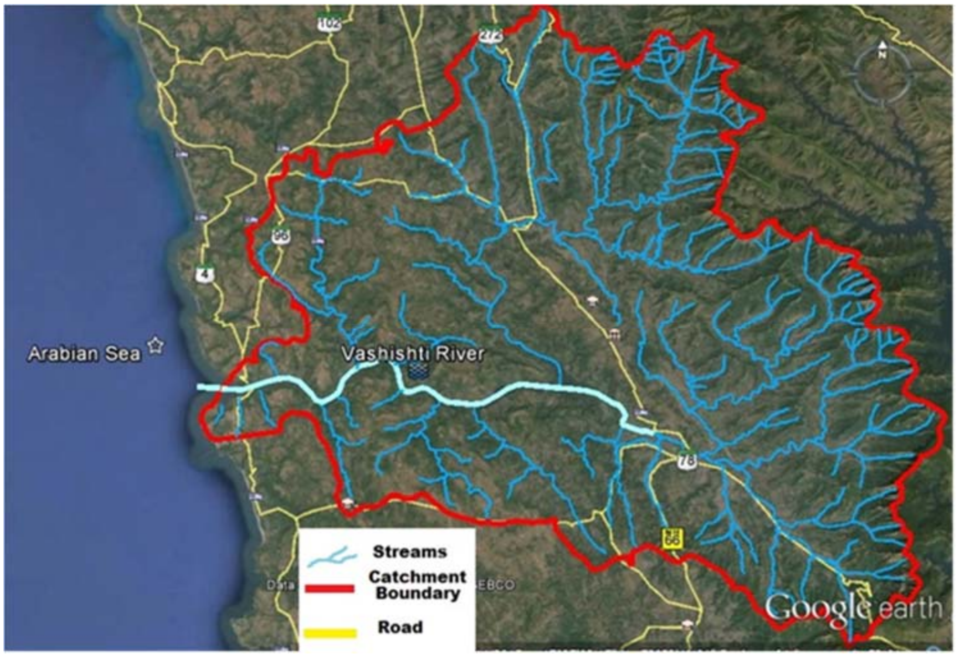


FIGURE 2.1: Catchment Area Map of Vashishti River (Source: Google Earth)

The total catchment area of Vashishti River basin is 2238 sq-km. The catchment receives an average annual rainfall of about 3391mm. Apart from Jagbudi, a major right bank tributary, several other tributaries such as Shiv Nadi (left bank), Kodjai (right bank) join Vashishti River. Kolkewadi Dam, near Alore has a vast reservoir which feeds a tributary of the river and is within the catchment. The town of Chiplun lies on its banks.

A map showing Vashishti catchment basin is shown in above figure. The figure indicates that the river flows close to the coastal region; thus the lower stretch of river is expected to be tidal affected zone and the tidal reaches may have navigation potential.

Hydro-morphological Characteristics

The combined study of hydrology and morphology gives a clear picture of hydro morphological characteristics of any water body.

Hydro morphology of the study area

Due to maritime influence, the diurnal range of temperature during the day is not large. March, April and May are the hottest months. The months of March, April and May, experience very high temperatures which are often accompanied by thunderstorms. Temperature varies between 22°C-39°C during summer season. Cool dry spell, with clear skies gentle breeze and pleasant weather prevails from November to February.

Temperature varies between 12°C-34°C during winter season. During post monsoon time, the temperature varies between 23.1°C - 32.9°C. It is hot during the day time and cold during the night with humidity being very low.

The most important factor which influences the climate is the towering presence of the Western Ghats which block the monsoon bearing winds coming from the Arabian Sea and cause rainfall. The annual rainfall of the state can vary from 400 - 6000 mm and occurs for 3 - 4 months in a year. The months of March, April and May, experience very high temperatures which are often accompanied by thunderstorms. Rainfall starts normally in the first week of June. July is the wettest month in Maharashtra, while August too gets substantial rain. Monsoon starts its retreat with the coming of September from the state.

The soil status of Maharashtra is residual, derived from the underlying basalts. In the semidry plateau, the regur (black-cotton soil) is clayey, rich in iron and moisture-retentive, though poor in nitrogen and organic matter. When re-deposited along the river valleys, the kali soils are deeper and heavier. The higher plateau areas have pather soils, which contain more gravel.

The soil texture for Vashishti River has been observed during the reconnaissance survey. It is observed that soft clay is present in lower stretch up to about 20.00km in the river under study stretch. Further, sandy soil is observed in the upstream stretch whereas rocky patches in the upper most stretch under study area is observed beyond Ch 46.00km.

Formation of braiding pattern is popularly attributed to heavy sediment load in a river having a wide and shallow cross section. Rise in river bed levels, rise in flood levels, accumulation of silt rendering channels shallow, bank erosion as a result of development of multiple channels and sudden change in flow direction are some of the conditions associated with braided rivers. However from the survey it was seen that there is no braiding in this river course.

Any part of river falls under rapid zone if the river bed has a relatively steep gradient which causes increase in velocity and turbulence. Thus rapid zone characterization is important as it indicates whether navigation will be safe or not. The slopes of this river indicate that the study stretch does not fall under rapid zone.

Due to the topography of Western Ghats, rivers flowing in this region do not have the capacity to flood the banks or nearby areas. During reconnaissance survey this fact was checked and found that the discharge of River Vashishti is influenced by tide.

Geomorphology

According to the classification of the waterway from class I to class VII, the minimum width required and minimum depth required has been given as 100 m and 2.75 m for two way navigation. Keeping aside the FSR stage recommendation and keeping in view the recent Administrative circulation etc., the present analysis has been relooked with the possibilities for 100 m width and 2.75 m depth for Class VII and also being considered with the stake holder's requirement, if any.

Vashishti River (Ch 0.00 km - Ch 10.00 km)

The satellite image for the stretch of first 10 km for four time periods have been placed (February, 2004, March, 2010, May, 2013 and December, 2015).

FIGURE 2.2 : River stretch from Ch 0.00km to 5.00km in February, 2004(Source: Google Earth)

FIGURE 2.3 : River stretch from Ch 0.00km to 5.00km in March, 2010(Source: Google Earth)

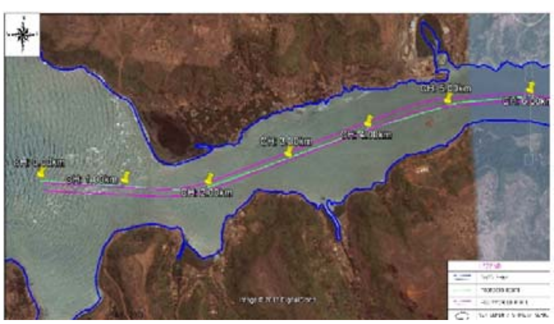


FIGURE 2.4 : River stretch from Ch 0.00km to 5.00km in May, 2013(Source: Google Earth)

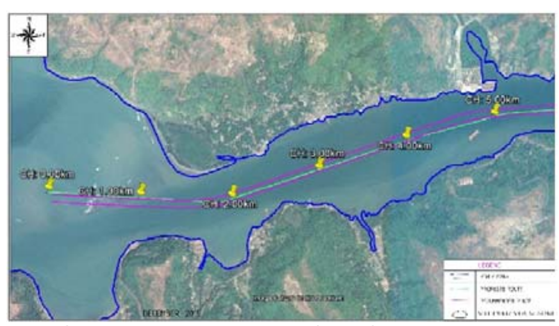


FIGURE 2.5 : River stretch from Ch 0.00km to 5.00km in December, 2015(Source: Google Earth)

FIGURE 2.6 : River stretch from Ch 6.00km to 10.00km in February, 2004 (Source: Google Earth)

FIGURE 2.7 : River stretch from Ch 6.00km to 10.00km in March, 2010 (Source: Google Earth)

FIGURE 2.8 : River stretch from Ch 6.00km to 10.00km in May, 2013 (Source: Google Earth)

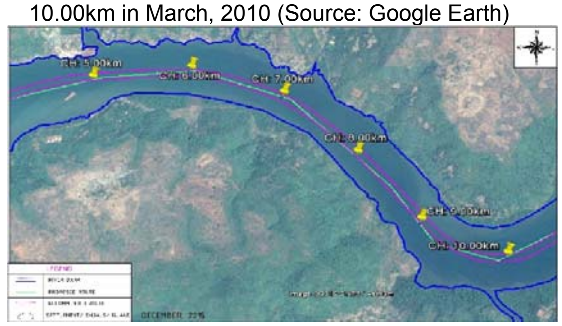


FIGURE 2.9 : River stretch from Ch 6.00km to 10.00km in December, 2015 (Source: Google Earth)

From the figures shown above, it is seen that the right river bank facing the mouth near Ch 1.00 km has been eroded from February, 2004 to December, 2015. The left and right banks at Ch 10.00 km is observed to have been slightly submerged from 2004 to 2015.

One tributary joins the river at the left bank near Ch 10.00 km.

The river flows through a wide bend at Ch 10.00 km.

There is no significant change in the river course over the time period.

Vashishti River (Ch 11.00 km - Ch 20.00 km)

The satellite image for the stretch of next 10 km for four time periods have been placed (February, 2004, March, 2010, May, 2013 and December, 2015).

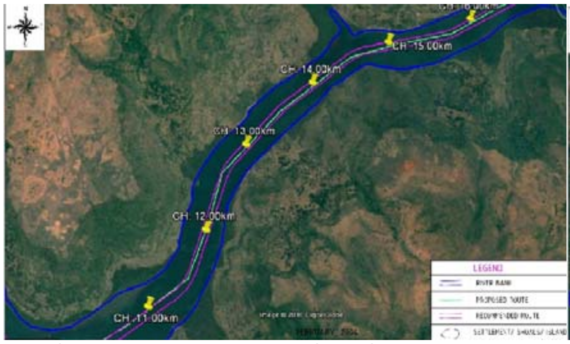


FIGURE 2.10: River stretch from Ch11.00km to 15.00km in February, 2004 (Source: Google Earth)

FIGURE 2.11: River stretch from Ch11.00km to 15.00km in March, 2010 (Source: Google Earth)

FIGURE 2.12: River stretch from Ch11.00km to 15.00km in May, 2013 (Source: Google Earth)

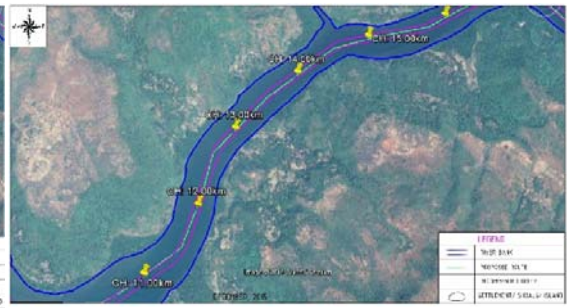


FIGURE 2.13: River stretch from Ch11.00km to 15.00km in December, 2015 (Source: Google Earth)

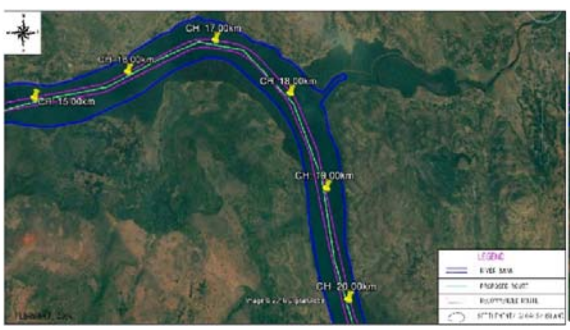


FIGURE 2.14: River stretch from Ch15.00km to 20.00km in February, 2004 (Source: Google Earth)

FIGURE 2.15: River stretch from Ch15.00km to 20.00km in March, 2010 (Source: Google Earth)

FIGURE 2.16: River stretch from Ch15.00km to 20.00km in May, 2013 (Source: Google Earth)

FIGURE 2.17: River stretch from Ch15.00km to 20.00km in December, 2015 (Source: Google Earth)

From the images of February 2004, March 2010, May 2013 and December, 2015, it is seen that two tributaries join the river from the right bank near Ch 15.00 km and Ch 18.00 km.

The river flows through a wide bend at Ch 17.00 km.

There is no significant change in the river course over the time period.

Vashishti River (Ch 21.00 km - Ch 30.00 km)

The satellite image for the stretch of next 10 km for four time periods have been placed (February, 2004, March, 2010, May, 2013 and December, 2015).

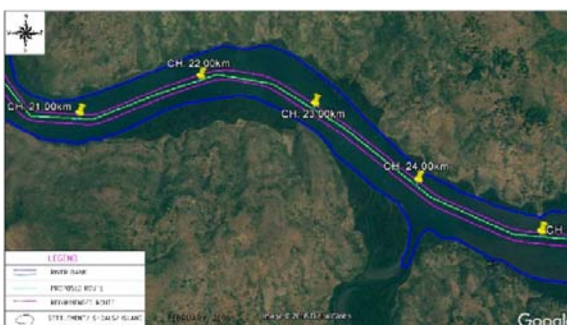


FIGURE 2.18: River stretch from Ch21.00km to 25.00km in February, 2004 (Source: Google Earth)

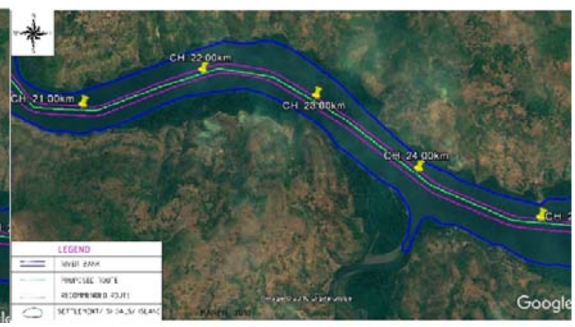


FIGURE 2.19: River stretch from Ch21.00km to 25.00km in March, 2010 (Source: Google Earth)

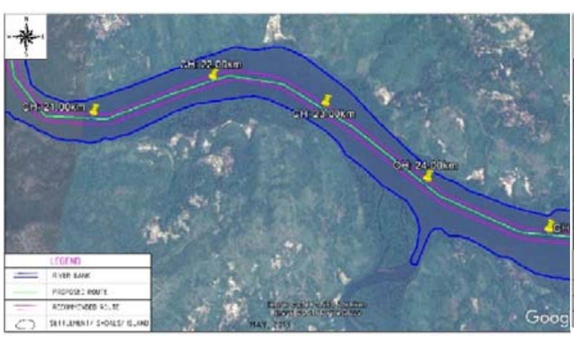


FIGURE 2.20: River stretch from Ch21.00km to 25.00km in May, 2013 (Source: Google Earth)

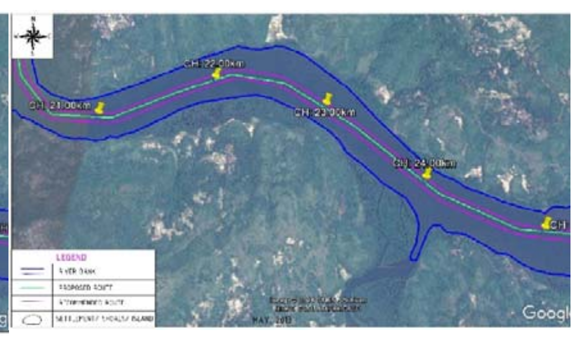
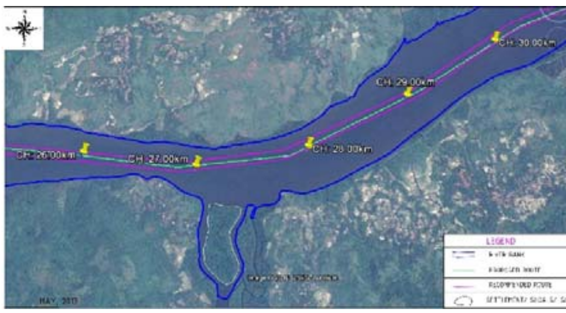


FIGURE 2.21: River stretch from Ch21.00km to 25.00km in December, 2015 (Source: Google Earth)

FIGURE 2.22: River stretch from Ch26.00km to 30.00km in February, 2004 (Source: Google Earth

FIGURE 2.23: River stretch from Ch26.00km to 30.00km in March, 2010 (Source: Google Earth)



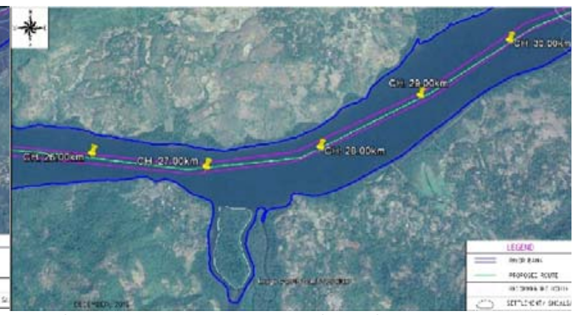


FIGURE 2.24: River stretch from Ch26.00km to 30.00km in in May, 2013 (Source: Google Earth)

FIGURE 2.25: River stretch from Ch26.00km to 30.00km in December, 2015 (Source: Google Earth)

From the images of February 2004, March 2010, May 2013 and December, 2015, it is seen that one tributary joins the river from the left bank near Ch 24.00 km.

There is a shoal near the left bank near Ch 27.00 km. It is covered with mangroves. The relative position of the settlement of soil remain same from 2004 to 2015. Since it does not show any migration with time and does not come in the waterway route, it can be concluded that the route remains undisturbed.

Vashishti River (Ch 31.00 km - Ch 40.00 km)

The satellite image for the stretch of next 10 km for four time periods have been placed (February, 2004, March, 2010, May, 2013 and December, 2015).

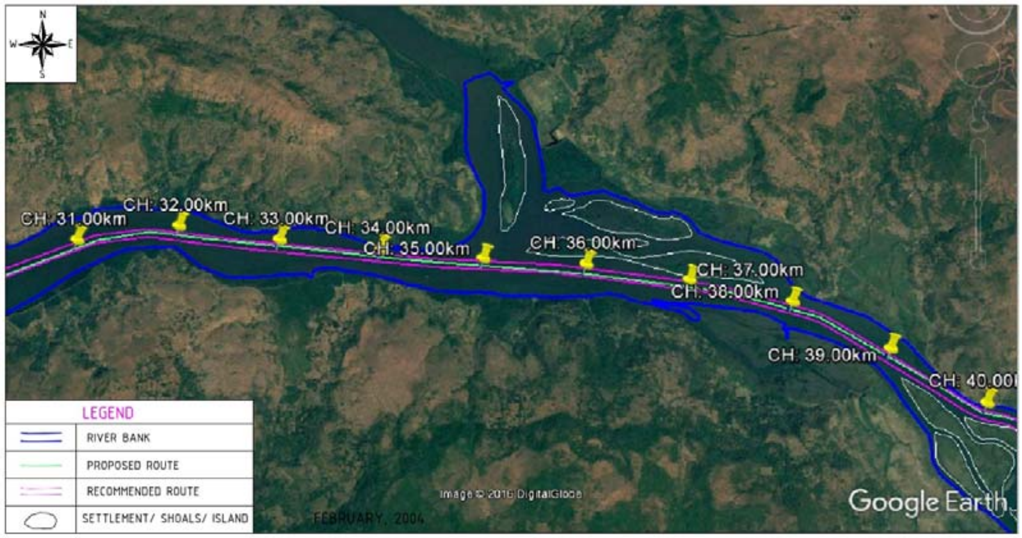


FIGURE 2.26: River stretch from Ch 31.00km to 40.00km in February, 2004 (Source: Google Earth)

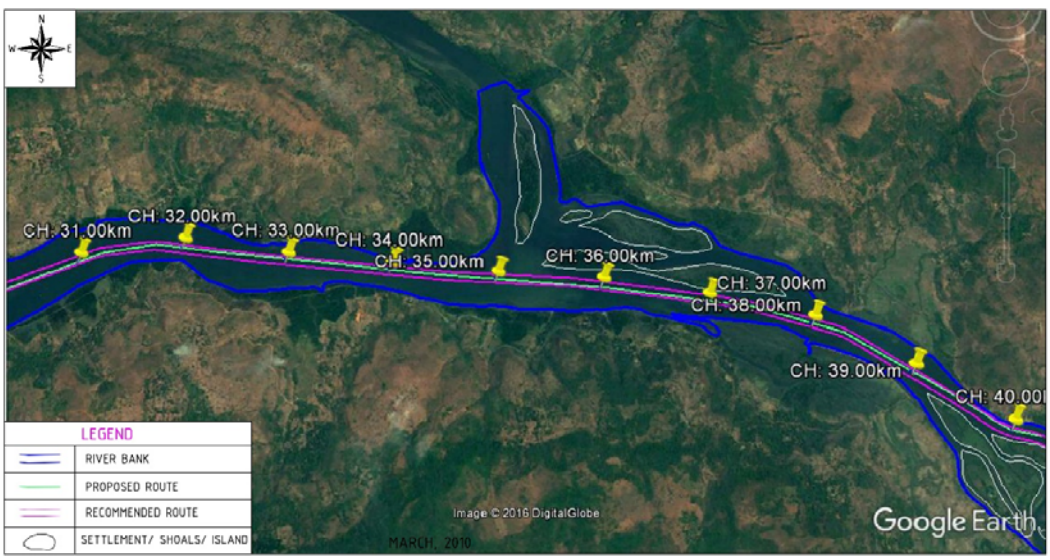


FIGURE 2.27: River stretch from Ch 31.00km to 40.00km in March, 2010 (Source: Google Earth)

FIGURE 2.28: River stretch from Ch 31.00km to 40.00km in May, 2013 (Source: Google Earth)

FIGURE 2.29: River stretch from Ch 31.00km to 40.00km in December, 2015 (Source: Google Earth)

There are three big shoals present near the right bank of the river between Ch 35.00 km and Ch 37.00 km. They are covered with mangroves for major portions. From the figures below, it is seen that some parts of the land was submerged in 2004 when compared to 2015. There is no migration of these settlements. However, it can be concluded that dredging of 5534 cu.m (from Ch 35.00 km to Ch 40.00 km) will be suitable for the waterway route.

Vashishti River (Ch 41.00 km - Ch 45.22 km)

The satellite image for the stretch of next 10 km for four time periods have been placed (February, 2004, March, 2010, May, 2013 and December, 2015).

FIGURE 2.30: River stretch from Ch 41.00km to 45.22km in February, 2005 (Source: Google Earth)

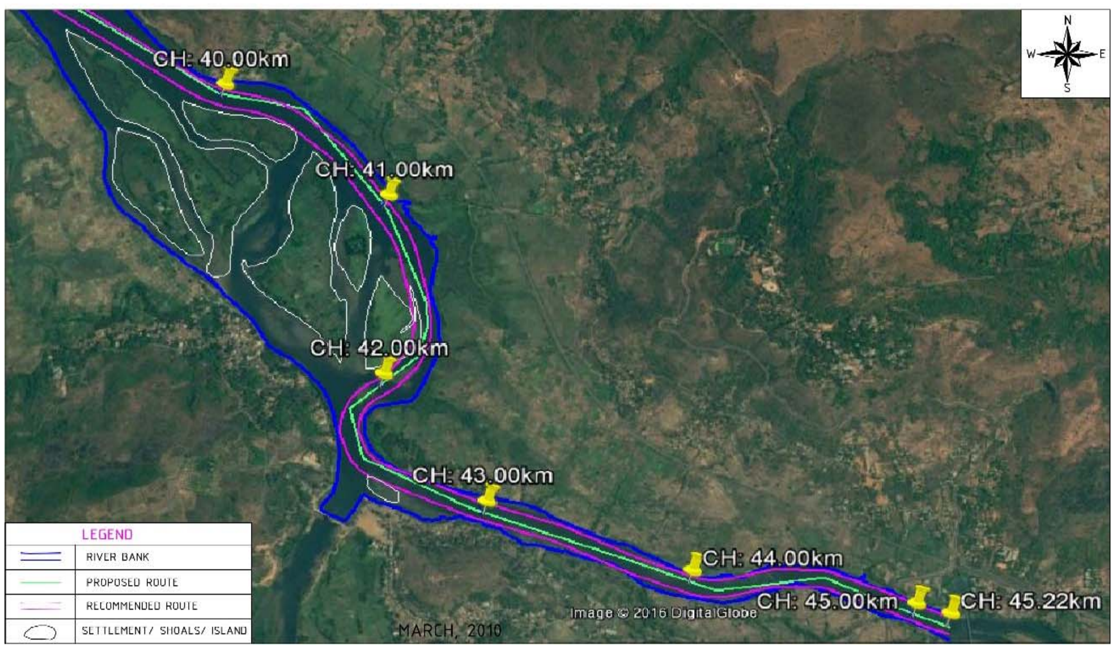


FIGURE 2.31: River stretch from Ch 41.00km to 45.22km in March, 2010 (Source: Google Earth)

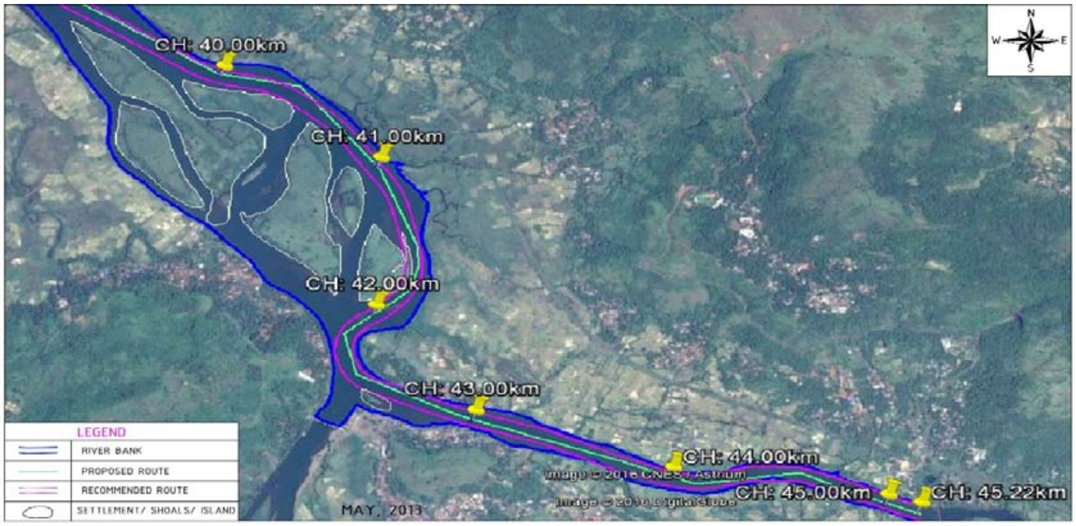


FIGURE 2.32: River stretch from Ch 41.00km to 45.22km in May, 2013 (Source: Google Earth)

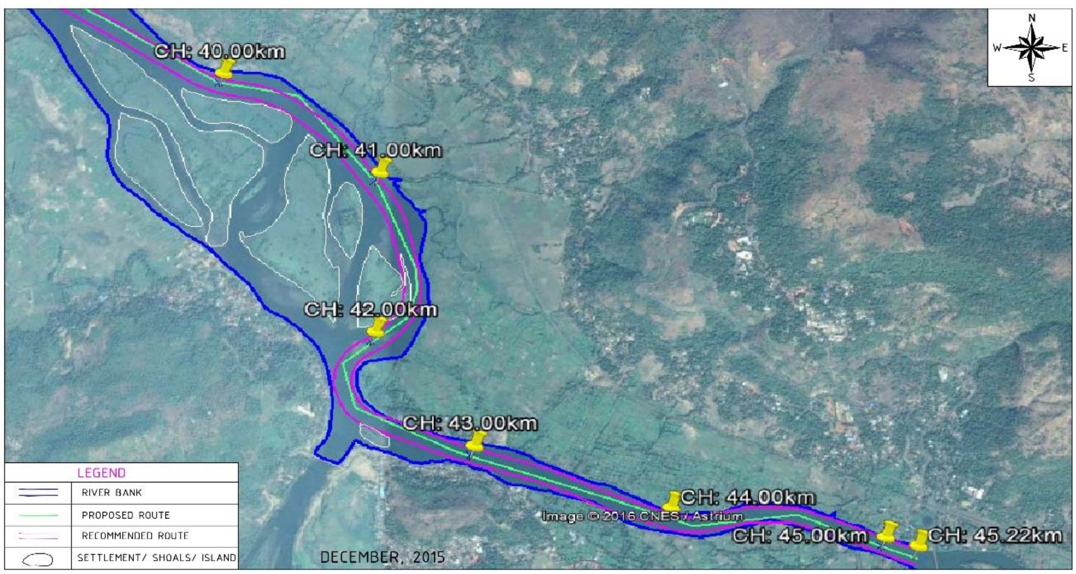


FIGURE 2.33: River stretch from Ch 41.00km to 45.22km in December, 2015 (Source: Google Earth)

Six big shoals are present between Ch 40.00 km and Ch 42.00 km. The relative position of the shoal remains the same. However dredging of approximately 4.4 lakhs cu.m in this stretch could result in better navigation route.

The river flows through a narrow strip of bend between Ch 42.00 km and Ch 43.00 km. No significant variation is observed.

The river width decreases after Ch 42.00 km.

Conclusion

From Ch 0.00 km to Ch 45.22 km, a total of five shoals were present which were found to be immobile in duration of recent five years, i.e., December, 2011 to December, 2016. Therefore no dredging is required except for one shoal at Ch 42.00 km, some part of which comes in the way of the waterway route. Three tributaries are found in the stretch. Six big shoals are located near Ch 40.00 km.

2.1.2. Existing Hydrological / Topographical Reference levels

TABLE 2-1: Accepted Station coordinates (WGS-84)

Station	Chainage (KM)	Latitude (N) Longitude (E)	Easting Northing	Height above MSL (m)	Height above CD (m)
VAS-1	2.800	17°35'04.6827"N 073°10'35.8208"E	306498.135 E 1945162.482 N	2.459	4.135
VAS-2	9.100	17°34'25.4771"N 073°13'45.8701"E	312090.73 E 1943904.07 N	4.297	5.658
VAS-3	20.900	17°34'39.6028"N 073°18'17.6758"E	320109.408 E 1944265.111 N	2.792	3.821
VAS-4	32.700	17°34'56.2527"N 073°24'19.3913"E	330779.072 E 1944684.448 N	2.615	3.200
VAS-5	43.100	17°33'00.0077"N 073°29'05.2314"E	339178.162E 1941042.000N	3.216	3.588

Source: Data collected

TABLE 2-2: Details of Chart Datum used for Data Reduction

Sl. No.	Location	Latitude	Longitude	Z_0*(m)
1	Dabhol	17°35'05"	73°10'36"	-1.676

**- Below Mean Sea Level*

Note: The benchmark value of Dabhol jetty was provided by MMB, Mumbai. The BM is monographed on one side of an iron pipe firmly driven in SE corner of compound of custom office, Dabhol. Reference level was provided by MMB SOI BM value 4.398m above CD.

Source: Data collected

2.1.3. Chart Datum / Sounding Datum

The water depths have been determined as a result of short period observations at both an established gauge (where the chart datum is known) and new gauge (where the chart 2 datum has been established) in the area. The four consecutive low waters and the three intervening high waters have been recorded during spring tide, when the range of differences between high and low waters was the greatest. The locations with coordinates of established gauge and new gauge that have been used to reduce the soundings along the surveyed stretch are tabulated below.

TABLE 2-3: Details of Chart Datum Used for Data Reduction

Transfer Sounding Datum	**H- 533**
For Semi - Diurnal Tides	

Date and Time of 1st LW Observation at Established Gauge = 28.12.2016, 16:30 hrs

Position of Established Gauge			Position of Established Gauge		
	Lat	17°35'04.864"N		Lat	17°34'25.477"N
	Long	73°10'36.018"E		Long	73°13'45.870"E
	Name	**Dabhol**		Name	**Sakhri trishul**

	At Established Gauge @ 2.800km						At New Gauge @ 9.100km					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.752	x	1		0.75	-	0.693	x	1		0.69
b	3.257	-	x	1	3.26		3.378	-	x	1	3.378	
c	-	1.697	x	3		5.09	-	1.653	x	3		4.96
d	3.037	-	x	2	6.07		3.078	-	x	2	6.156	
e	-	0.577	x	3		1.73	-	0.588	x	3		1.76
f	3.307	-	x	1	3.31		3.423	-	x	1	3.423	
g	-	1.637	x	1		1.64	-	1.593	x	1		1.59
	Sum of Contribution				12.64	9.21	Sum of Contribution				12.957	9.01
	Observed M. H.W.				3.16		Observed M.H.W.				3.2393	
	Observed M.L.W.					1.15	Observed M.L.W.					1.13
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.01	Observed Mean Range = r				=	2.11313
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.16	Observed Mean Level = m'				=	2.18269
	M' = (M.H.W +M.L.W.)/2						M' = (M.H.W. +M.L.W.)/2					
	Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.											
	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**	m above of Zero of Gauge	SD =	**-0.085**	m below of Zero of Gauge

Source: Data collected

TABLE 2-4: Details of Chart Datum Used for Data Reduction

Transfer Sounding Datum — **H- 533**

For Semi - Diurnal Tides

Date and Time of 1st LW Observation at Established Gauge = 28.12.2016, 16:30 hrs

	Position of Established Gauge		Lat	17°35’04.864”N			Position of Established Gauge		Lat		17°34’40.117”N	
			Long	73°10’36.018”E					Long		73°18’17.352”E	
			Name	**Dabhol**					Name		**Parchuri**	
	At Established Gauge @ 2.800km						At New Gauge @ 20.900km					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.752	x	1		0.75	-	0.485	x	1		0.49
b	3.257	-	x	1	3.26		3.180	-	x	1	3.18	
c	-	1.697	x	3		5.09	-	1.445	x	3		4.34
d	3.037	-	x	2	6.07		2.870	-	x	2	5.74	
e	-	0.577	x	3		1.73	-	0.400	x	3		1.20
f	3.307	-	x	1	3.31		3.215	-	x	1	3.215	
g	-	1.637	x	1		1.64	-	1.385	x	1		1.39
	Sum of Contribution				12.64	9.21	Sum of Contribution				12.135	7.41
	Observed M. H.W.				3.16		Observed M.H.W.				3.0338	
	Observed M.L.W.					1.15	Observed M.L.W.					0.93

Note : Observed MHW = Sum of Contribution of HW / 4

Observed MLW = Sum of Contribution of LW / 8

Observed Mean Range = R	=	2.01	Observed Mean Range = r	=	2.1081
R = M.H.W. - M.L.W.			r = M.H.W. - M.L.W.		
Observed Mean Level = M'	=	2.16	Observed Mean Level = m'	=	1.9797
M' = (M.H.W +M.L.W.)/2			M' = (M.H.W. +M.L.W.)/2		

Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.

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**	m above / below of Zero of Gauge	SD =	**-0.283**	m below of Zero of Gauge

TABLE 2-5: Details of Chart Datum Used for Data Reduction

Transfer Sounding Datum												**H- 533**
For Semi - Diurnal Tides												
Date and Time of 1st LW Observation at Established Gauge = 28.12.2016, 16:30 hrs												
	Position of Established Gauge		Lat		17°35’04.864”N		Position of Established Gauge		Lat		17°34’56.302”N	
			Long		73°10’36.018”E				Long		73°24’19.185”E	
			Name		**Dabhol**				Name		**Maldoli**	
	At Established Gauge @ 2.800km						At New Gauge @ 32.700km					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a	-	0.752	x	1		0.75	-	0.440	x	1		0.44
b	3.257	-	x	1	3.26		3.360	-	x	1	3.36	
c	-	1.697	x	3		5.09	-	1.360	x	3		4.08
d	3.037	-	x	2	6.07		3.010	-	x	2	6.02	
e	-	0.577	x	3		1.73	-	0.370	x	3		1.11
f	3.307	-	x	1	3.31		3.420	-	x	1	3.42	
g	-	1.637	x	1		1.64	-	1.280	x	1		1.28
	Sum of Contribution				12.64	9.21	Sum of Contribution				12.8	6.91
	Observed M. H.W.				3.16		Observed M.H.W.				3.2	
	Observed M.L.W.					1.15	Observed M.L.W.					0.86
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.01	Observed Mean Range = r				=	2.3363
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.16	Observed Mean Level = m'				=	2.0319
	M' = (M.H.W +M.L.W.)/2						M' = (M.H.W. +M.L.W.)/2					
	Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.											
	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**	m above / below of Zero of Gauge				SD =	**-0.476**	m below of Zero of Gauge			

TABLE 2-6: Details of Chart Datum Used for Data Reduction

Transfer Sounding Datum													**H- 533**
For Semi - Diurnal Tides													
Date and Time of 1st LW Observation at Established Gauge = 28.12.2016, 16:30 hrs													
	Position of Established Gauge		Lat	17°35'04.864"N			Position of Established Gauge			Lat	17°32'59.62"N		
			Long	73°10'36.018"E						Long	**73°29'04.64"E**		
			Name	**Dabhol**						Name	**Gawalkot**		
	At Established Gauge @ 2.800km						At New Gauge @ 43.100km						
	Height Above CD				Contribution for		Height Above CD				Contribution for		
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW	
a	-	0.752	x	1		0.75	-	0.330	x	1		0.33	
b	3.257	-	x	1	3.26		3.250	-	x	1	3.25		
c	-	1.697	x	3		5.09	-	1.250	x	3		3.75	
d	3.037	-	x	2	6.07		2.900	-	x	2	5.8		
e	-	0.577	x	3		1.73	-	0.260	x	3		0.78	
f	3.307	-	x	1	3.31		3.310	-	x	1	3.31		
g	-	1.637	x	1		1.64	-	1.180	x	1		1.18	
	Sum of Contribution				12.64	9.21	Sum of Contribution				12.36	6.04	
	Observed M. H.W.				3.16		Observed M.H.W.				3.09		
	Observed M.L.W.					1.15	Observed M.L.W.					0.76	
	Note : Observed MHW = Sum of Contribution of HW / 4												
	Observed MLW = Sum of Contribution of LW / 8												
	Observed Mean Range = R				=	2.01	Observed Mean Range = r				=	2.335	
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.						
	Observed Mean Level = M'				=	2.16	Observed Mean Level = m'				=	1.9225	
	M' = (M.H.W +M.L.W.)/2						M' = (M.H.W. +M.L.W.)/2						
	Note : Observed Mean Range = Observed M. H.W. -Observed M.L.W.												
	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**	m above / below of Zero of Gauge				SD =	**-0.584**	m below of Zero of Gauge				

2.2. Existing Waterway Structures

2.2.1. Bridges

There are no Bridges in the entire stretch.

2.2.2. Electric Lines / Communication Lines

The details of Electric lines/ Communication lines crossing the Vashishti River are given in the Table below. The vertical clearance required for power cables or telephone lines is 19 m. From the below table it is seen that the HT lines may need modification. The support base of these HT lines will have to be raised by 6.5m to 10.5m get the required clearance.

TABLE 2-7: Details of High Tension Lines

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
1	HTL	23.33	Parchuri	Left Bank: 17°34'59.94"N 73°19'46.70"E Right Bank: 17°34'34.00"N 73°19'38.33"E	Left Bank: 322740.02E 1944867.92N Right Bank: 322486.20E 1944071.87N	2	735m	10.35	Complete
2	HTL	24.35	Parchuri	Left Bank: 17°34'36.69"N 73°19'59.30"E Right Bank: 17°34'24.60"N 73°19'40.29"E	Left Bank: 323105.11E 1944149.01N Right Bank: 322541.24E 1943782.37N	2	740m	8.35	Complete
3	HTL	41.37	Gawalkot	Left Bank: 17°34'11.43"N 73°28'37.48"E Right Bank: 17°34'0.17"N 73°28'29.08"E	Left Bank: 338377.51E 1943244.16 Right Bank: 338127.41E 1942900.79N	2	240m	12.55	Complete

Source: Data collected

2.2.3. Pipe Lines / Cables

There are no pipe lines, under water cables present in the entire survey stretch of Vashishti River.

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

There are no Dam, Barrages, Weirs, Anicut and Locks etc. in Vashishti River in the entire survey stretch.

2.3. Bends

On the proposed waterway route, there are many bends in Vashishti River, which are given in the Table below. River bend radius as given below is sufficient for Class –IV vessel.

TABLE 2-8: River Bend Radius in Vashishti River

Sr. No.	Chainage (Km)	Radius
1	2.00	2240
2	6.03	1600
3	7.0450	1020
4	8.25	2740
5	9.90	580
6	10.10	520
7	11.50	540
8	12.50	860
9	14.75	1440
10	17.20	660
11	18.05	2130
12	21.50	690
13	23.00	1010
14	25.50	2290
15	28.50	2760
16	32.40	2030
17	39.50	4050
18	41.75	1490
19	42.40	700
20	43.50	240
21	44.25	240
22	46.25	650
23	46.50	600

Source: Data collected

2.4. Velocity and Discharge Details

The details of Velocity and Discharge in the Vashishti River are given below in Table.

TABLE 2-9: Current meter deployment locations and discharge details

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (M/sec.) 0.5 D	Avg. Vel. (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m/sec)
1	2.800	17°34'55.3683"N 073°10'39.5048"E	306604.01E 1944875.08N	4	2.0	0.57	5831.500	3323.955
2	9.100	17°34'30.4518"N 073°13'52.6839"E	312293.08E 1944055.13N	7	3.5	1.15	6223.910	7157.497
3	20.930	17°34'42.7567"N 073°18'21.2285"E	320215.03E 1944361.13N	8	4.0	1.36	3246.375	4415.07
4	32.710	17°35'01.3951"N 073°24'20.2348"E	330805.27E 1944842.32N	3.5	1.75	0.51	2300.320	1173.163
5	43.120	17°33'02.6310"N 073°29'06.9367"E	339229.09E 1941122.24N	1	0.5	0.23	455.835	104.842

Source: Data collected

The period of survey is December - January, which is a normal flow condition. As per the statistics collected, the maximum velocity is 4.0 m/s and discharge is 7157.497 m^3/s at the gauging station at Ch 9.10 km near the confluence of the river and the Arabian Sea.

2.5. Waterway description

Vashishti River (Ch 0.00km – Ch 15.00km)

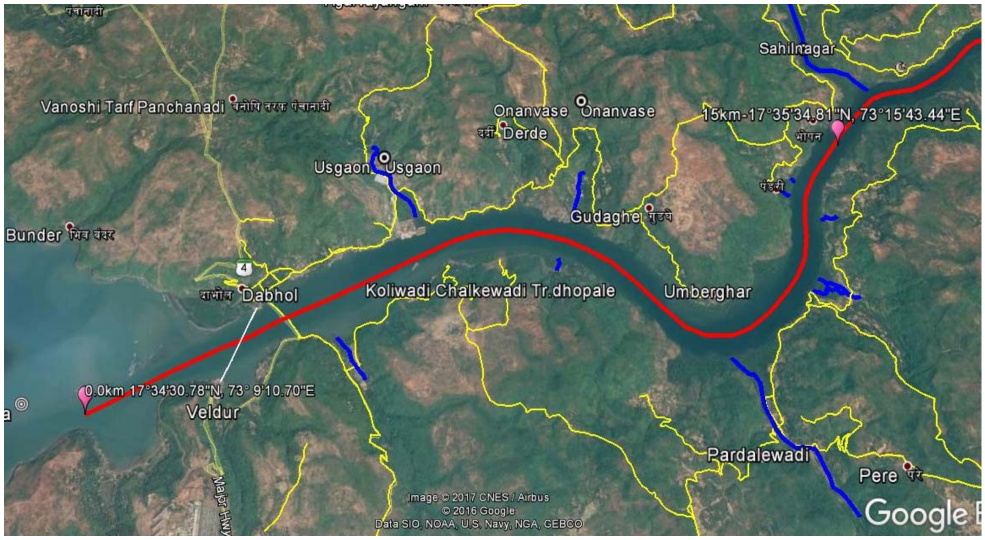


FIGURE 2.34: Vashishti River from Ch 0.00km to Ch 15.00km

TABLE 2-10: Reduced depth from Ch 0.00km to Ch 15.00km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Dredging Qty (cu.m)
From	To	Max	Min			
0	1	15.9	9.9	0	0	0
1	2	17.4	9.2	0	0	0
2	3	11	9.8	0	0	0
3	4	11.3	8.8	0	0	0
4	5	14	9.2	0	0	0
5	6	17.8	11.6	0	0	0
6	7	15.3	13	0	0	0
7	8	15.2	11.1	0	0	0
8	9	17.6	9.5	0	0	0
9	10	17.8	10	0	0	0
10	11	17.1	10.1	0	0	0
11	12	16.9	10.3	0	0	0
12	13	14.7	9.5	0	0	0
13	14	14.4	10.3	0	0	0
14	15	14.3	10	0	0	0

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). The Dabhol Creek/Vashishti River starts from the Arabian Sea at Dabhol. There are mangroves observed on either side of the river. The Dabhol Jetty is on the north-bank of the Dabhol Creek/Vashishti River (Ch 2.90km. The Veldur Jetty and Dhopave Jetty are on the south-bank (Ch 1.90km and Ch 3.20km, respectively) around which a few settlements are observed. The south-bank in this section is mostly covered with mangroves with a small settlement seen near Ch 5.60km. A small stream is seen branching near Ch 10.40km on the south bank. There are mangroves seen along both banks of the river with a few scattered settlements. It was observed that the whole stretch is having influence of tidal effect. No Dam, Barrages, Weirs, Anicut, Locks, No Encroachment, no gauge and discharge site as established by Central Water Commission were found in the entire survey stretch.

Vashishti River (Ch 15.00km – Ch 30.00km)

FIGURE 2.35: Vashishti River from Ch 15.00km to Ch 30.00km

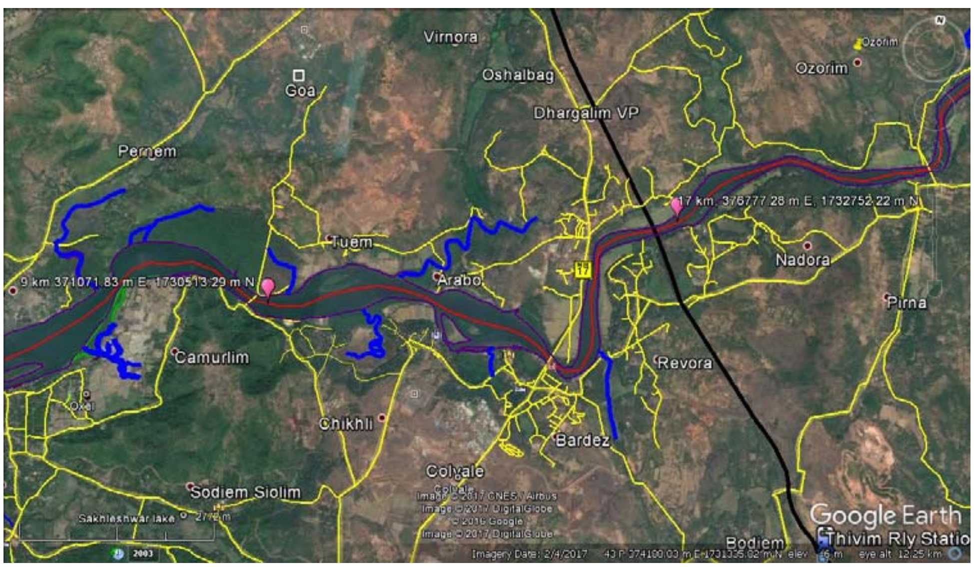


TABLE 2-11: Reduced depth from Ch 15.00km to Ch 30.00km

Chainage (km)		Reduced depth with respect to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Dredging Qty (cu.m)
From	To	Max	Min			
15	16	12.1	9.9	0	0	0
16	17	17.9	11.7	0	0	0
17	18	16.9	9.9	0	0	0
18	19	17.2	8.6	0	0	0
19	20	13.4	10.3	0	0	0
20	21	17.4	15	0	0	0
21	22	17.9	11.1	0	0	0
22	23	14.5	8.2	0	0	0
23	24	10.9	8.6	0	0	0
24	25	14.7	9.2	0	0	0
25	26	12.3	5.7	0	0	0
26	27	6	4.4	0	0	0
27	28	6.6	5.2	0	0	0
28	29	8.7	6.3	0	0	0
29	30	8.6	5.8	0	0	0

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). A small stream is seen branching near Ch 15.90km on the north bank towards Sahil Nagar. Both banks of the river are covered with mangroves in this section. A small stream is seen branching near Ch.18.70km from Unhavare from the east. The northern bank is outlined with mangroves while there are a few streams branching on the south-bank near Ch 25.00km and between Ch 28.00km to Ch 28.60km. The south-bank is mostly covered with mangroves with a few scattered settlements. It was observed that the whole survey stretch is having influence of tidal effect. No Dam, Barrages, Weirs, Anicut, Locks, No Encroachment, no gauge and discharge site as established by Central Water Commission were found in the entire survey stretch.

Vashishti River (Ch 30.00km – Ch 45.228km)

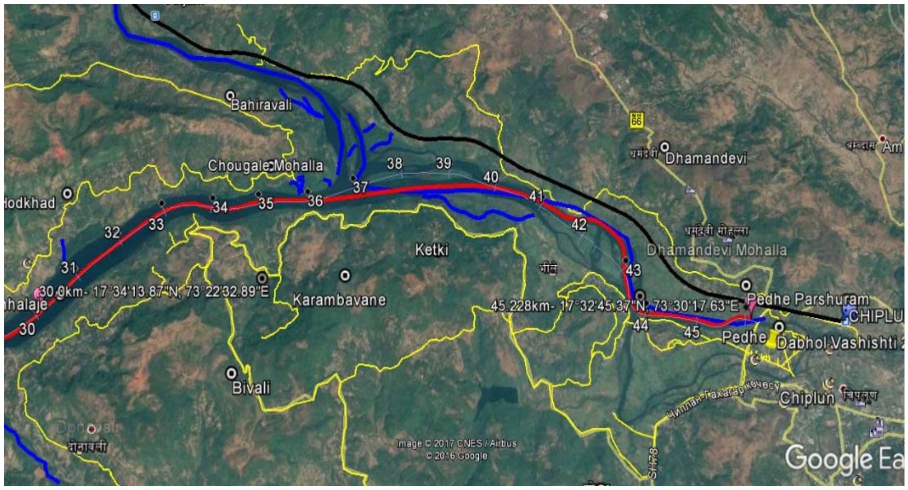


FIGURE 2.36: Vashishti River from Ch 30.00km – Ch 45.228km

TABLE 2-12: Reduced depth from Ch 30.00km – Ch 45.228km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cu.m)	Cumulative Dredging Qty (cu.m)
From	To	Max	Min			
30	31	8.1	6.4	0	0	0
31	32	9.6	6.6	0	0	0
32	33	10.3	6.4	0	0	0
33	34	12.3	7.7	0	0	0
34	35	13.1	9.8	0	0	0
35	36	12.4	1.7	300	268.52	268.52
36	37	3	1.6	900	1641.18	1909.7
37	38	3.1	1.7	450	668.41	2578.11
38	39	5.5	1.2	300	386.84	2964.95
39	40	3.7	1.1	900	2569.33	5534.28
40	41	5.1	1.9	0	0	5534.28
41	42	5.8	-0.2	750	29742.52	35276.8
42	43	3.3	-1.5	900	94489.2	129766
43	44	0.2	-1.4	900	168793.61	298559.61
44	45.228	1.2	-1.3	900	147025.65	445585.26

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class IV). There are mangroves seen along both banks of the river. The north bank is mostly covered with mangroves with the confluence of River Jagbudi near Ch36.40km. The southern bank is outlined with mangroves while there is a stream branching near Ch 38.20km. There are some fields and settlements seen on the far side of the south bank, north of which there are few islands covered with mangroves seen from Ch 43.70km to Ch 45.00km. The north bank is mostly covered with mangroves and a few fields at some places. There are some shallow patches and islands seen near Ch 43.70km and Ch 44.40km. The river branches on the south bank from Kalsute Bridge near Ch 44.30km. Major settlements and fields are seen on either side of the river up until Pedhe. It was observed that the whole survey stretch is having influence of tidal effect. No Dam, Barrages, Weirs, Anicut, Locks, No Encroachment, no gauge and discharge site as established by Central Water Commission were found in the entire survey stretch.

2.6. Water and Soil Samples analysis and Results

TABLE 2-13: Water sample results

SAMPLE NO.	LOCATION	Easting	Northing	WATER SAMPLES	
				Sediment concentration (ppm)	pH
VAS-1	Dabhol	306604.00	1944875.00	418	7.71
VAS-2	Sakhari	312293.00	1944055.00	217	7.64
VAS-3	Parchuri	320215.00	1944361.00	205	6.87
VAS-4	Maldoli	330805.27	1944842.32	165	6.15
VAS-5	Gowalkot	339229.09	1941122.24	197	6.49

Source: Data collected

The river water is slightly acidic in nature with average pH being 6.97.

TABLE 2-14: Soil sample results

SAMPLE NO.	LOCATION	Easting	Northing	Specific Gravity	Grain Size Analysis (%)				Cu	Cc
					Gravel	Sand	Silt	Clay		
VAS-1	Dabhol	306604.00	1944875.00	2.60	0	16	66	18	-	-
VAS-2	Sakhari	312293.00	1944055.00	2.58	0	74	20	6	17.667	2.318
VAS-3	Parchuri	320215.00	1944361.00	2.65	25	15	52	8	32.609	0.557
VAS-4	Maldoli	330805.27	1944842.32	2.66	0	1	86	13	6.897	1.589
VAS-5	Gowalkot	339229.09	1941122.24	2.60	0	37	52	11	40.000	2.500

Source: Data collected

The river bed is silty clay with sand at Dabhol, sandy silt with clay at Sakhari, silty clay with gravel at Parchuri, silty clay at Maldoli and silty sand with clay at Gowalkot. Thus the river bed can be concluded to be silty at most parts with sand and clay in the remaining stretch.

CHAPTER 3: FAIRWAY DEVELOPMENT

3.1. Proposed Class / Type of Waterway

The Fairway availability and its utilization along with the developments required etc., are to be concluded based on the detailed Hydrographic survey, Traffic mobilization including the hinterland requirement, future planning of the hinterland amenability and the stake holder's view point etc.,

The detailed Hydrographic survey and charts have been referred. As per the data available, the study stretch of the waterway is amenable for maintenance of a good fairway channel for a majority of a distance i.e., initial 35 kms (out of 45.228 km) is having a reduced depth more than 2 m, which is most advantageous from the Fairway point of view.

As per the IWT traffic data, the river Vashishti is not having any cargo Traffic. However, the end point of the river is having good connectivity with Chemical plants, which are depending on JnPT for all the Raw materials etc., with EXIM operations. This either can be directly operated from / to JnPT or from the mouth of the river (Dabhol Port). Hence, the fairway improvements will facilitate the Ro-Ro mobility. The Day / Night navigation may be a boost for such operations with quick turn around time etc.

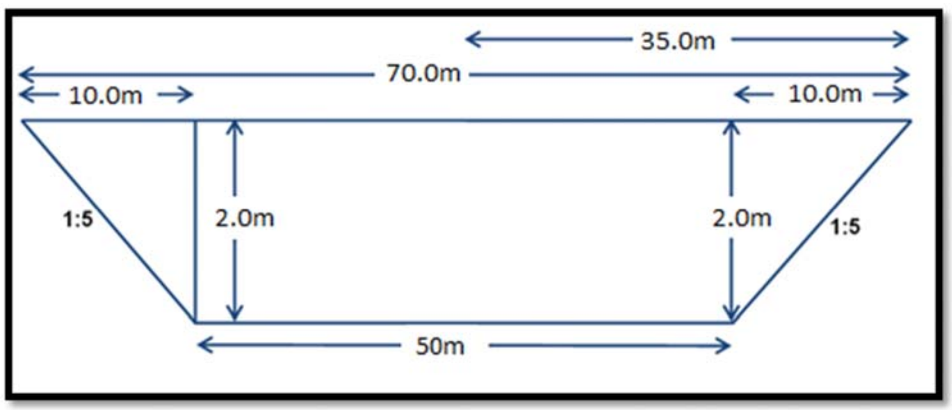
Accordingly, to meet the estimated traffic volumes of about 125,000 Trucks in FY 20 to 273,000 Trucks in FY 40 and keeping in view the favorable fairway condition, 21 TEU vessel mobility with 2 m depth and with Day / Night navigation facilities, uninterrupted mobility can be established. Hence, the class of waterway can be concluded as ***Class IV*** for mobility of up to the Ch. 45.228 km. The vessel requirement is 70 m (Length) x 12 m (Breadth) x 2.0 m (Draft). Accordingly, the fairway requirement is 50 m (Bottom Width) x 2.0 m (Depth) with Bend Radius of 800. Clearance corridor of 50 m Horizontal Clearance (HC) and 10 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel. Modified vessel deployment is suggested to meet the 21 TEU criteria.

With regard to the cross structures in the stretch, No Bridges are there in the entire study stretch and 3 Nos HTL are observed, however not suggested with any modification.

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

In order to meet the Ro-Ro mobility Class IV NW standards is under consideration. Accordingly, the Dredging quantities have been worked out for the system as per Indian class of Class IV for the subject study.

CLASS IV:



Observed						Reduced w. r. t. Sounding Datum			
Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)
From	To	Max.	Min.		Per km drg	Max.	Min.		Per km drg
0.0	15.00	TIDAL ZONE				17.8	8.8	0.0	0.00
15.00	30.00					17.9	4.4	0.00	0.00
30.00	35.00					13.1	6.4	0.00	0.00
35.00	45.228					12.4	-1.5	6300	445585.26
							Total	6300	445585.26

In the stretch, up to Ch 35 km, there is no need of Dredging, which is the best sign of water availability. However, the rest of the stretch between Ch 35 km and Ch 45.228 km, may have to be dredged for the shoal length of about 6,300 m with an estimated quantity of 4.46 Lakhs Cu. M.

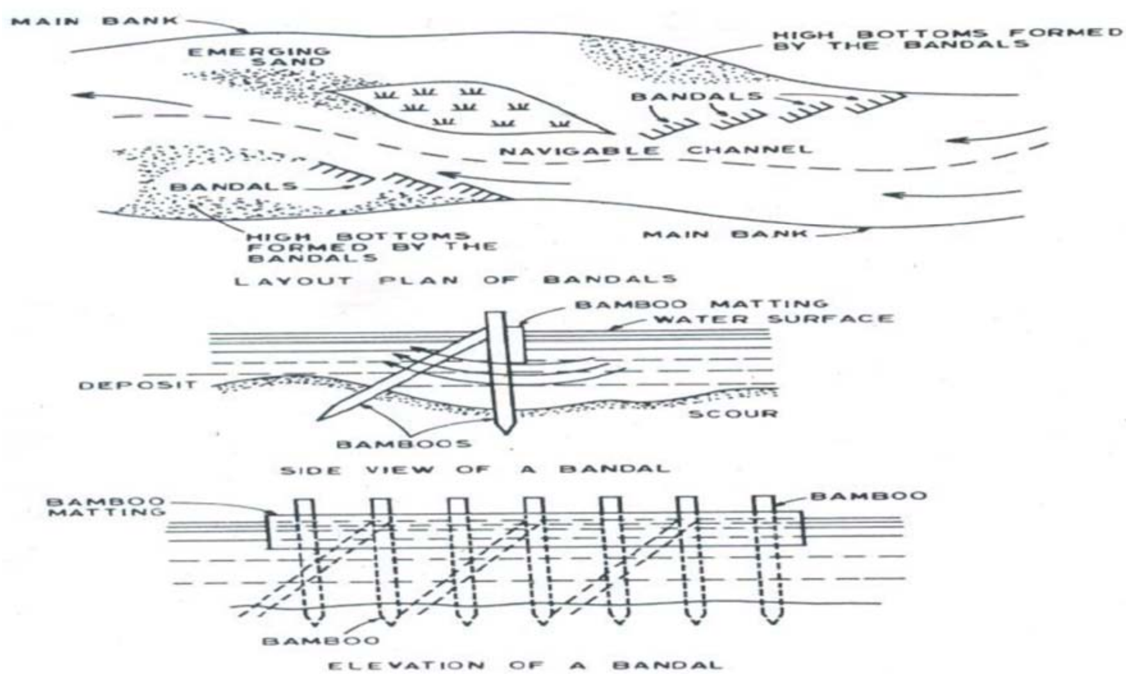
3.3. Proposed Conservancy Activities

Rivers are the natural channels of drainage carrying water along with sediments from the catchment to the sea. The main river course will be joined with various tributaries depending on its catchment configuration carrying the water from run-off and also carrying the sediments enroute. The dynamic equilibrium of such river flow tends to change the course of the river on the Geometric cross section and on the Gradient. The braiding channel of the river will create meandering streams leading to multiple channel flow. This type of distribution of the cross section discharge into multiple channels is a major threat for safe navigation in the particular stretch of the river / waterway. The meandering tendency of a particular stretch / river always leads to the formation of loops / bends. Hence, the perspective appreciation over the behaviour of the river / study stretch for navigation is most essential to arrive at a dependable River Training measures for achieving the safe navigational fairway of the study stretch.

The taming of the river / study stretch for provision of a safe fairway for navigation is ultimately depending on the cost criteria and also the economics. Certain low cost solutions are already in practice in the national waterways on NW 1 and NW 2 systems viz., Bandalling; Bottom Panelling; Submerged Vanes etc., Considering the seasonal aspects in the river like Lean season and Flood season and in order to meet the quick time lines for providing the safe channel, the Dredging of the river is also under consideration. However, to have a sustainable channel with long term requirement, the permanent solution of taming the river through the training measures viz., Spurs; Groins etc.,. Bank protection measures also can be adopted at certain critical locations as Training measures.

3.3.1. Low Cost structures

Bandalling" is a low cost and ancient technique adopted in NW 1 & NW 2 in order to improve the navigation conditions. Bandalling is the temporary structure made up of "Bamboos" and "Bamboo Mats". The ideology of this structure is to divert the flow of secondary channel to main channel, where split discharge observed. Bamboos will be driven in line for 25m to 30m (1 Chute) and arranged with the screen made up of Bamboo Mats placed / immersed from the surface of water by a third of the depth. This structure will be placed at 35 degrees to 45 degrees to the secondary channel flow. No. Of Chutes will vary on the width of the secondary channel. These Chutes will be supported by cross Bamboos to withstand the flow. This can improve the channel depths from 1.8 m to 3.0 m. The process ultimately silts up the secondary channel and improves the velocity / discharge in the main channel. The below mentioned Figure will give an idea about the structure. The Bandalling locations may have to be identified, during the receding stage of the Flood and are to be placed while considerable flow is observed both in main and secondary channels.



In the study stretch, no major divided discharge locations have been observed and hence there is no need of implementation of Bandalling in this stretch.

3.3.2. Dredging

“Dredging” is the removal of sediments and debris from the bottom of lakes, rivers, harbours, and other water bodies. It is a routine necessity in waterways around the world because of the sedimentation process (the natural process of sand and silt washing downstream and gradually fills channels and harbours). Dredging often is focused on maintaining or increasing the depth of navigation channels, anchorages, or berthing areas to ensure the safe passage of boats and ships. Vessels require a certain amount of water in order to float and not touch bottom. This water depth continues to increase over time as larger and larger ships are deployed and with the increased volumes of bulk cargo operation, dredging plays a vital role in the nation's economy.

Dredging is also performed to reduce the exposure of fish, wildlife, and people to contaminants and to prevent the spread of contaminants to other areas of the water body. Environmental dredging is often necessary because sediments in and around cities and industrial areas are frequently contaminated with a variety of pollutants. The sediment management and disposal of dredged material are also important issues to be managed and carried out effectively.

Dredging used to be carried out in the river by various types of Dredgers viz., Bucket and grab dredgers; Suction and cutter-suction dredgers; Trailing hopper dredgers etc.,. However, the most acceptable form of the dredger is “Cutter Suction Dredger” (CSD) being deployed on National Waterways by IWAI. The type of soil, if hard, may have to be tackled with the appropriate dredger. In the morphological rivers, the shoals will be formed with divided discharge and accordingly, the dumping of dredged soil is preferred in closing the secondary channel and within the flood plains. In the West Flowing Rivers, in general, the velocities are comparatively higher. Once the dredged cross section is achieved, the maintenance will be automatic in the natural way for longer period. The catered provisions in the O & M will take care of such minimal nominal requirements.

In order to maintain the Class IV standard of fairway, the total quantity with 10 % addition will be to an extent of 4.90 Lakhs Cu. M. Accordingly, 4.4 Lakhs Cu.m as General soils and 0.5 Lakhs Cu. M can be considered. The General soil dredging may have to be taken up through CSD. The Hard soil Dredging of 50,000 Cu. M, will be taken up according to the site requirement at the point of dredging.

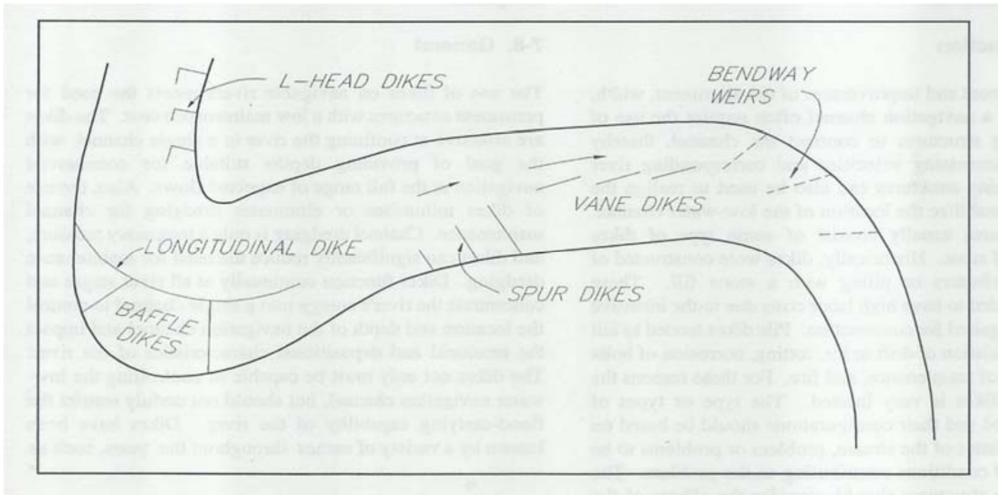
Regarding the disposal of dredged material, a portion of the same can be considered, as explained above for closing the secondary channel. Further, as observed, the sand from the river is being considered as a valuable construction material in the entire Arabian sea coast. Hence, the disposal is not a problem. In addition, the dredged spoil can be dumped in the low lying areas on the nearest amenable locations, wherever feasible. The dumping can also be prudently / effectively utilized to protect the banks in vulnerable stretches and near the terminal area by constructing a layer of “Gabion Walls”, which will also prevent the fall back into the Dredged fairway. The type of “Gabion Walls” for such arrangement is shown below.

3.3.3. River Training

River Training is nothing but taming of a river section to achieve the objective / purpose with the encroachment over the natural flow condition. Navigation and Flood Control are generally the common purposes for taming the river with various training measures.

In general, there are two types of waterway training structures: Re-directive and Resistive. Re-directive, as the name implies, is the use of the River's energy and Managing the energy in a way that benefits the system i.e., enhance the navigation channel. A resistive structure acts to maintain the system as status quo i.e., reducing bank erosion.

Re-directive structures are usually a series of dikes placed along the inside of a river bend where sediment usually deposits. Dikes have been known by a variety of names, such as groins (or groynes), contracting dikes, transverse dikes, cross dikes, spur dikes, spur dams, cross dams, wing dams, and spurs. The most common dikes in use today are shown in the Figure, as under.



sFIGURE 3.1: Types of dike structures

Resistive structures are primarily used to prevent bank erosion and channel migration to establish or maintain a desired channel alignment. Revetments and Bank Protection works are examples for such structures.

In the rivers of Maharashtra, especially the west flowing rivers, in general have the tendency of rapid draining off due to the comparative limitation in traverse length between the lower mountain range and the Arabian Sea.

Keeping in view the above, the suggested River Training works are Spurs; R. C. C. Porcupines; Bamboo Porcupines. Further the Bank Protection / Revetments also can be considered as a part of the River Training at certain amenable locations. The structures are detailed with the figures and the preliminary designs have been placed in appropriate chapter (Chapter 6).

The “Gabions with Boulders” type of structure can be considered as Spurs and also as Bank Protection on these rivers, as detailed in the Figure.

In wider reaches, it is suggested the provision of spurs with “Gabions with Boulders” as detailed in the Figure, given below. The preliminary Design details have been placed in Chapter 6.

River Training works may be essential, in general, at the sharp bend locations and at other locations where there is a need of taming the river with morphological variations / disturbances creating hurdle for smooth navigation.

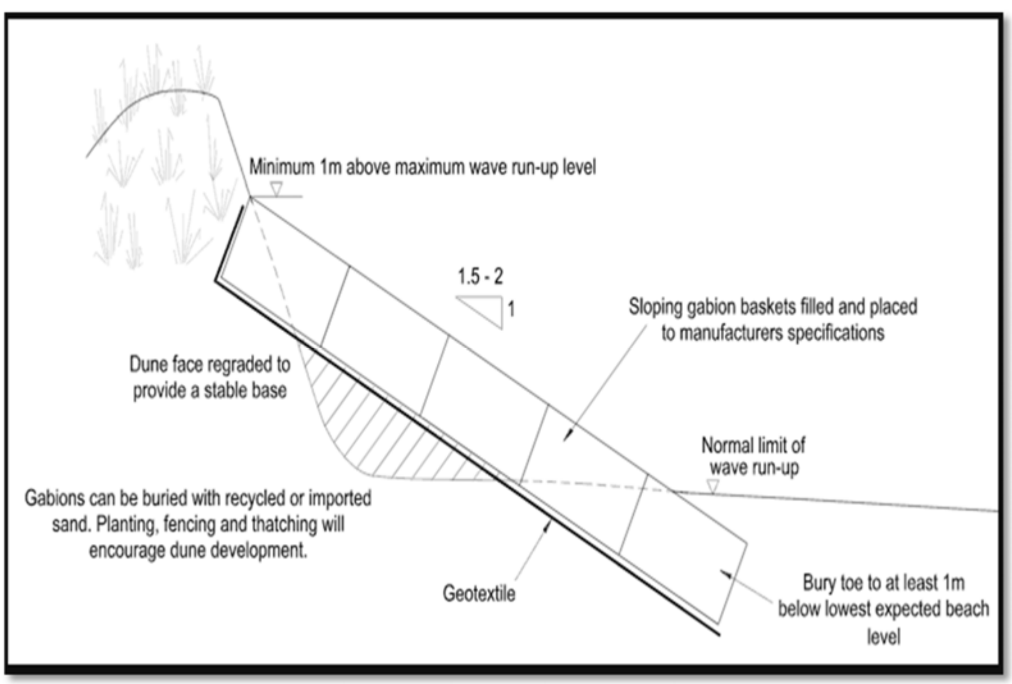
In the study stretch, there is no such location with any River Training requirements.

3.4. Bank Protection / Embankment Strengthening

In the rivers, wherever bends or curves exist, the concave side of the river will always be subjected to the erosion. The pace of erosion will depend on the soil condition and terrain and also the velocity of the flow at the location.

As early as the seventeenth century, the Germans were protecting the banks of rivers with masses of brush formed into fascines (bundles). This method of bank protection, called blesswerk, was also used for bank and shore protection in Holland.

As explained earlier, the characteristics of the rivers originating from Western Ghats are unique. In such a condition, Gabions filled with rocks will be the most advantageous type of the Bank Protection. Further, the basic raw material, rock, is abundantly available within a reasonable leads. Gabions are wire mesh baskets filled with crushed rock. They are filled in situ, with locally available material (rocks) and thus have a low capital cost. Because they are flexible and porous, they can absorb some wave and wind energy, thereby reducing the scour problems.



It has been proposed to consider the Bank Protection in the vulnerable locations. In the study stretch, there is no such location with any Bank Protection requirement. However, the Bend location may be essential to be taken care, which in turn may lead to the vulnerability of Bank erosion.

Keeping in view the above phenomenon, a nominal provision of 4000 m (8 locations @ 500 m at each location) Bank Protection is suggested. The protection work is proposed with the Gabions filled with rocks. The proposed Bank Protection works are to meet the vulnerable Bend locations 7 nos – 4000 m i.e., 500 m at Ch 11.50; Ch 12.50; Ch 17.20; Ch 21.50 & Ch 42.40 + 750 m between Ch 9.5 & Ch 10.5 and 750 m between Ch 43.0 & Ch 44.5. However, this Bank Protection work is suggested for execution only in Phase 2 after observing the river morphological condition, Bank condition at these locations and preferably after the completion of Dredging.

3.5. Navigation Markings / Navigation Aids

Keeping in view the River width / Channel width etc., the Navigational Markings can be considered, either in the Shore or in the River with floating condition. The Shore Markings can be considered with a reasonable Beacon type structure fitted with Light at the top, whereas, the marking in the river can be considered with the floating Buoys as per the IALA standards fitted with Light at the top.

In the Terrain of west flowing rivers, it is amenable to keep the light on a 15 m Trestle Tower with a reasonable illumination of Light for a considerable distance. IWAI is having 2 NM / 4 NM Light systems on NW 1, NW 2 and NW 3 (already operational) and hence it is preferred to consider 15 m Trestle Tower fitted with 4 NM light on the top. The 4 NM illuminations will have a visibility for about 9.0 km and with a rational approach, the same can be considered at every 5 Kms all along the stretch with alternative side of the River. The preliminary Design of Beacon & Light systems along with the specification are placed at Chapter 6, appropriately.

The preliminary Design of Beacon & Light systems along with the specification are placed at Chapter 6, appropriately.

Regarding the Buoy & Light system, it is proposed to consider the same type of Buoy and Light deployed in NW 1, NW 2 & NW 3 with the details as sketched in the figure below. Further the Technical specifications of Buoy & Light, as available in the Market as a proprietary item are also detailed in Chapter 6.

In the study stretch of Kundalika River, it is only suggested to consider the Beacon Light system. However, in due course of time, if need be, the Buoy / Light system also can be considered, for close marking system.

Keeping in view the 4 nm light and considering the clear visibility range as 8000 m, the interval can be considered as 5000 m. Hence, it is proposed to work out the requirement with 5000 m interval and in Zigzag position (i.e., 1 Left Shore Mark then 1 Right Shore Mark and 1 Left Shore Mark). Accordingly, it is estimated to provide 10 Nos in the initial phase 1 stretch upto Ch. 45.228 kms {45000 / 5000 + 10 % approx.) of Shore Marks with Beacon Light unit.

Regarding the Buoy & Light system, considering the clear visibility range as 500 m and in Zigzag position (i.e., 1 Left Mark then 1 Right Mark and 1 Left Mark), it is estimated to provide 110 Nos {45000 / 500 + 8 Bends + 10 % apprpox) of Buoy and Light unit (with chain attachments etc.). A provision of Tug – cum – Buoy laying vessel has been considered, which will act as a multi-purpose vessel. Hence the provision has been catered as a part of overall cluster 7 requirement for all the waterways.

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

In the study stretch, there is no Bridge.

In the study stretch, 3 HT lines are observed of which, one may require stringing. This can be attended in consultation with the concerned Department by utilizing the catered provisions made in contingencies. No modification is suggested.

No cross structures viz., Dams / Barrages & Locks / Weirs / Anicuts / Aqueducts are observed in the present study stretch. Hence, modification doesn’t arise.

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

In order to improve the fairway, including the depth, there is no requirement of Dams / Barrages & Locks / Weirs in the present study stretch.

3.8. Land Acquisition

No Land Acquisition requirement was observed for Fairway Development in the present study stretch. Land Acquisition requirement for Terminal purpose is being considered, as a part of Terminal development, wherever required.

3.9. Fairway Costing

3.9.1. Capital Cost

As ascertained, the Vashishti River is not being used for regular inland Navigation, except at the mouth of the river. Keeping in view the concentrated Industrial clusters at the end of the Waterway stretch and observing the mobility of vehicles dominantly from / to JNPT, It is proposed to consider the Ro-Ro operation through Sea / Waterway.

The most advantageous aspect of the Vashishti River is the availability of Fairway for about 35 Kms from the mouth (Ch. 0 km) and there is no need to consider any investment. In the proximity of Ch 34 km, there is an approach road existing both in North side (Bank near “Bhairavali” village) and South side (Bank near “Karambave” village), which are connected to NH 66 with a lead of 10 kms – 12 kms.

Accordingly, phase 1 has been considered (up to 34 km) without any investment / rather very nominal investment to facilitate Ro-Ro operation to achieve the initial estimated volumes (to decide upon the investment in phase 2) and if the same is able to achieve full estimated volumes, no investment is suggested. The promotional aspect with observation is up to FY 25 will be continued.

Accordingly, Phase 1 is with a nimonal investment for considering the promotional mobility with a tie up through an enterprenuer and if the nominal growth is achieved, then the investment decision of phase 2 from FY 26 till FY 29 along with the IWAI Terminal development is proposed.

Accordingly, the Capital Cost for the Fairway Phase 1 has been considered with 10 Nos. of Beacon Lights (INR 1.97 Cr). Fairway Phase 2 has been considered with 4.4 Lakhs Cu. M of Dredging in soils + 0.5 Lakhs Cu. M of Dredging in hard strata (INR 13.2 Cr + 4.5 Cr); 110 Nos. of Buoy with Light (INR 3.7 Cr) and 4000 m of Bank Protection (INR 49.29 Cr). Cost estimates are placed with details in Chapter 11 and its Annexures.

Phase 1 Fairway development is INR 7.52 Cr.

Phase 2 Fairway development is INR 88.35 Cr.

Cost estimates are placed with details in Chapter 11 and its Annexures.

3.9.2. O&M Cost

The item wise Operation and Maintenance cost have been considered as per the circulated parameters, as defined by IWAI, which have been analyzed and considered. Some more assumptions have been considered appropriately, wherever required.

CHAPTER 4: TRAFFIC STUDY

4.1. General

Market analysis for Vashishti river catchment area comprises of the analysis for existing and potential waterway traffic (cargo and passenger traffic), their existing trends of flow between origin and destination and the feasibility of diversion from existing transport/shipping modes to waterways.

Vashishti River is one of the larger rivers in Konkan area. The River originates in Western Ghat and meets in Arabian sea. Navigable length of the river is 45 Km. Vashishti river flows through Ratnagiri district and touches Dapoli, Khed, Guhagar & Chiplun taluka. There exists one non-major port at the mouth of the river namely Dabhol port. All the rivers in Ratnagiri district originates in the Sahyadri ranges and flow from east to west directions and merges into Arabian Sea. The below map shows Vashishti river and its catchment area.

Figure 4-1 Vashishti River Overview

Source: Site Visit

Figure 4-2 Vashishti river & surroundings

4.2. Hinterland Analysis

Ratnagiri district includes western slope of Sahyadri range. Ratnagiri district is covered by forest area. Forest area includes Hills, Forts, Wildlife etc. about 85% of land area of the district is covered by hilly region. Though there are industries in the region the output from such industries is comparatively low. Transport connectivity to other state is very poor.

Vashishti river end point of stretch is near Pedhe village in Chiplun taluka. Primary catchment area of the river from all directions is - towards south direction is up to Muslondi village in Guhagar taluka from mouth of the river and up to Aravali railway station in Sangmeshwara taluka from tail of the river. Towards north direction up to Palande village in Dapoli taluka from mouth of the river and from tail of the river up to Rasalwadi village in Khed taluka. On the east direction up to Nandivase village in Chiplun taluka. In the secondary catchment area on East side of the river has steep hilly region compare to primary catchment area. Hills located in secondary catchment area have elevation more than 800 meter. There does not exist any industry on the east side. Hilly region increases time required for transportation due to curvy road.

4.2.1. Demography Profile of Hinterland

Local people of the hinterland mostly depend on agriculture for their livelihood, apart from working in industries located in MIDC. People have their own private lands where they grow coconut, mango trees etc. The table below shows taluka wise population in Ratnagiri district.

Table 4-1 Taluka wise population around the river

Taluka	Population
Dapoli	1,44,084
Khed	1,64,723
Chiplun	2,11,586
Gahagar	1,21,588
Total	6,41,981

Source: Census, 2011

The highest population is in Chiplun taluka, followed by Khed.

4.2.2. Economic profile of Maharashtra

Vashishti River flows through Ratnagiri district. Agriculture, Horticulture, fisheries and tourism are major growth driving sectors to the economy of Ratnagiri. Ratnagiri district is considered as socio-economically underdeveloped, hence it would not provide much opportunity for the proposed waterway in Vashishti River.

Following table shows Gross State Domestic Product prices of Maharashtra.

Table 4-2 Historic GSDP of Maharashtra

(INR in Crore)

Year	Primary	Secondary	Tertiary	GSDP
2005	48,418	1,19,531	2,47,531	4,15,480
2009	81,001	2,30,921	4,42,048	7,53,970
2010	93,988	2,49,698	5,12,065	8,55,751
2011	1,34,356	3,06,571	6,08,223	10,49,150
2012	1,40,314	3,25,096	7,04,711	11,70,121
2013	1,48,710	3,67,979	8,05,534	13,22,222
2014	1,76,016	4,05,002	9,29,115	15,10,132

Source: GOG, Directorate of planning, statistics, evaluation

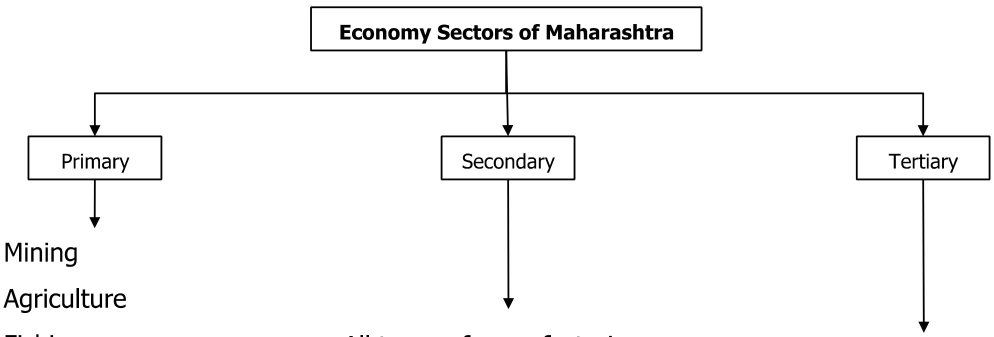
Table 4-3 shows sector wise annual growth rates of GSDP. Whereas growth rate has declined in secondary sector, the tertiary sector's growth remains stagnant.

Table 4-3 Sectoral annual growth rates of GSDP

Sector	**2013**(%)	**2014**(%)	**2015**(%)
Primary	0.5	7.7	-8.5
Secondary	9.2	4.5	4
Tertiary	8.1	8.6	8.1

Source: DES, GoM

The below chart shows Primary, Sceondary and Tertiary sectors of Maharashtra state. As depicted in the chart, Primary sector consists of Mining, Agriculture, Fishing and Forestry. Whereas Secondary sector includes different types of manufacturing industries. Service based industries come under Tertiary sector.



- Mining
- Agriculture
- Fishing
- Forestry

Agriculture production in Maharashtra contributes more than 55% to GSDP but there is lack of organized sector for farming in Raigad.

Marine fish production has shown growth over the years compare to inalnd fishing

Minerals like limestone, bauxite etc. found in Raigad, Ratnagiri areas

All types of manufacturing industries comes under secondary sector.

In raigad district there are iron & steel, chemical factories and traders dealing with minerals are present.

All other service providing industries like banking & insurance, Hotels and restaurants, Communications etc. comes under this sector.

About 40% of India's internet users are in Maharashtra

Figure 4-3 Sectors of Maharashtra

4.2.2.1. PRIMARY SECTOR

Primary sector consists of Agriculture, Forestry, Fishing and Mining. Ratnagiri region lacks infrastructure facility like cold storages and connectivity.

Table 4-4 Primary sector historic growth in Maharashtra

(INR in Crore)

Primary Sector	2009	2010	2011	2012	2013	2014
Agriculture	41,549	43,286	54,016	51,633	51,282	55,441
Forestry	10,775	9,610	10,227	10,862	11,508	12,258
Fishing	1,484	1,461	1,504	1,570	1,594	1,613
Mining	3,571	3,760	3,897	4,135	4,161	3,799

Source: Directorate of economics & statistics, MH

a. Agriculture

Coconut trees, Areca Palm, Mango, Cashew Nuts, Jackfruit, Ratambi etc. are found in Ratnagiri district.

Rice is the main crop in the district. Local people lack crop management and because of this saturation or oversupply situation arises. Alphonso Mango is major exported horticulture produce. It is also processed in the local market for storage purpose. Vegetable cultivation in the district is not on an advanced scale; therefore vegetables are supplied from other nearby districts to Ratnagiri.

Rose, Marigold, Jarbera, Gladiolus, Aster, Gerbera are produced on open floriculture land and in Greenhouses. 80 Ha. area is under floriculture. Greenhouses are found in Chiplun, Ratnagiri, Guhagar and Dapoli taluka. This sector offers employment and entrepreneurship opportunity for masses.

Following table describes other agriculture productions in the catchment area of river.

Table 4-5 Agriculture Productions in the catchment area of river

Taluka	**Rice**		**Nachni**		**Total Production (MT)**
	Area (Ha)	Production (MT)	Area (Ha)	Production (MT)	
Dapoli	8,400	27,200	2,300	3,220	30,420
Khed	11,000	32,450	1,500	1,950	34,400
Chiplun	11,400	34,770	1,700	2,295	37,065
Guhaghar	4,600	15,040	3,700	5,365	20,405
Total	35,400	1,09,460	9,200	12,830	1,22,290

Source: Agriculture Records

Even though agriculture is the most significant sector providing employment opportunity to people about 56% it's contribution to Maharashtra state economy is declining over time because of unfavorable climatic condition and growth of other sectors specially service.

Most of the young population of the district has migrated to other states and cities for better employment opportunities. This results in acute shortage of farm labour, so adequate measures are taken for Agriculture Mechanization. At present, migrants from Uttar Pradesh and Nepal work in Agriculture sector. They are engaged in cashew seed collection and Alphonso Mango Orchards and fisheries.

b. Horticulture

Table 4-6 Horticulture productions in the catchment area

Taluka	Mango	Cashew	Coconut	Chiku	Beetlenut	Others	Total	Total Excluding Coconut
	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)
Dapoli	12,744	19,087	70,55,112	26	124	19	70,87,112	32,000
Khed	11,490	22,029	38,25,739	14	3	7	38,59,281	33,543
Chiplun	12,206	19,378	83,37,860	28	6	23	83,69,501	31,641
Guhaghar	9,918	12,331	76,73,981	7	757	59	76,97,054	23,072
Total	46,358	72,826	2,68,92,692	75	890	108	2,70,12,948	1,20,257

Source: Horticulture records

Ratnagiri district is Agri Export Zone. Mango, Cashew Nut, Coconut, Arecanut are major exporting items of the district. To boost the district economy, State Government has declared it as Horticulture District.

c. Fishing

There are more than 90% traditional fishermen operating in whole Maharashtra. Coastal region of Ratnagiri is famous for fishing activity. 80% of the coastal region is covered by hilly terrain. Shell fisheries could be found in the creek area and backwaters of Ratnagiri. Fishing activity in the district is from September up to the end of May. In rainy season fishing activity only takes place in creeks and not in coastal areas. Tuna, Surmai, Promfret, Karel, dagol, catfish, sharks etc. are some of the varieties of fish, found in Ratnagiri district.

Fishing sector provides employment for more than five million fish farmers. There are about 118 fishing villages along the coastal line of the district and about 16,000 fishermen are engaged in this activity. Anjanwel is the famous fishing village located at the mouth of the river in Guhagar taluka.

Following graph represents fish production in whole Maharashtra. It is clearly visible that marine fish production is more than inland fish production.

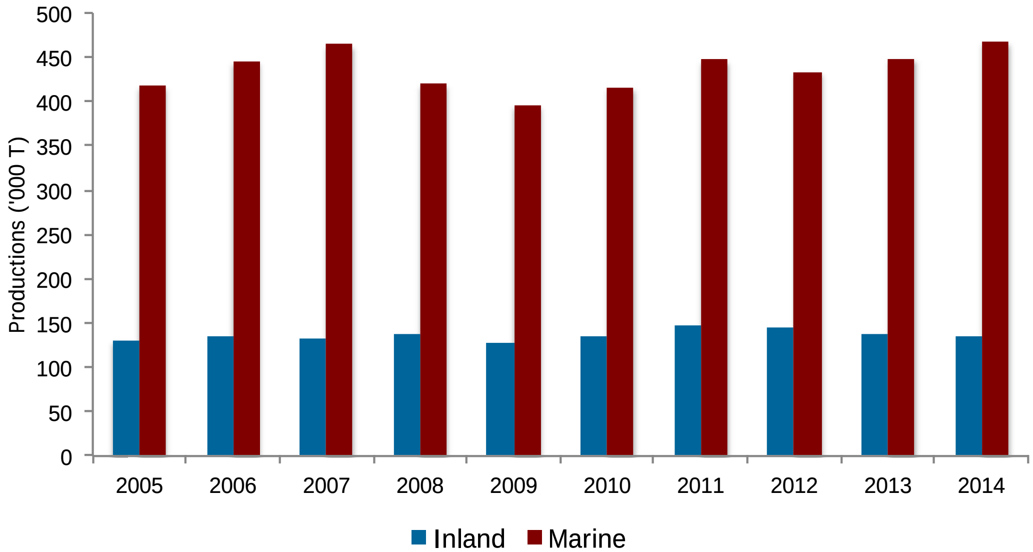


Figure 4-4 Fish Production in MH

Source: Consultant Analysis

Table 4-7: Fish Type & Fishing Season in Ratnagiri District

Type	Season	Nets
Sharks, skates and rays	September - May	Long-lines and bottom-set gill-nets
Mackerel and sardine	November - February	Rampan-nets
Tuna and Surmai	September - December	Surface drift-nets
Pomfrets	September - December & April – May	Bottom set gill nets
Silver bar or karli	January - May	Bottom-set gill-nets
Dagol and catfishes	September - May	-

Source: Profile of study area, Ratnagiri district

Table 4-8: Inland & Marine Fish Productions in MH (000 T)

Year	Inland	Marine
2004-05	130	418
2005-06	135	445
2006-07	132	464
2007-08	137	420
2008-09	127	396
2009-10	135	416
2010-11	149	447
2011-12	145	434
2012-13	137	449
2013-14	135	467

Source: Consultant's Analysis

Figure 4-5 Fishing at Dabhol

Source: Site Visit

Table 4-9 Historic fish production in the catchment area

(MT)

Taluka	Villages	2005	2006	2007	2008	2009
Dapoli	Veshwi-Bankot	2,473	1,495	1,203	854	701
	Kelshi	927	591	432	302	264
	Aade/Uttambar	2,006	1,509	994	765	715
	Burondi	1,788	2,503	1,390	1,575	1,389
	Kolthere	855	566	394	468	420
	Oni/Bhati	1,267	868	291	288	275
	Veldur/Navanagar/Dhopave	3,589	2,654	1,766	1,064	1,012
	Asgoli	1,727	1,148	1,051	611	560
	Palshet	481	450	344	309	322
	Budhal	75	139	121	103	135
	Kondkaru	1,117	516	694	528	379
	Velneshwar	837	779	520	395	468
	Sakharhedvi	280	412	173	132	63
	Dabhol	4371	4232	1764	3311	1822
	Total	21,793	17,862	11,137	10,705	8,525

Source: Department of fisheries, MH

There are 21 fish curing yards on the coastal line. Chiplun, Sangmeshwara and Lanje are considered as developed fish market. Fish traders sell fish catch of about 1,731 tons to Mahad, Miraj, Kolhapur, Satara, Karad and Belgum apart from selling it in local market. Some of the fish exporters have their collection center and cold storages in Ratnagiri and they export to European countries.

Part of the wet salted fish catch is also sent to Chennai for domestic consumption as well as for subsequent export to Sri Lanka and other places. Dapoli taluka is where coastal & Inland fishing take place. In Dabhol village of Dapoli, fishing activity is carried out. Rest all the villages are located nearby coastal region. In Dabhol, fish are dried and canned on large scale for exporting.

d. Forestry

85% of land area in Ratnagiri district is a hilly region. Ratnagiri classified forest area is 5,860 Ha. There are lot of private lands & unclassified forest area in the district. Rajapur, Dapoli, Lanja, Khed are forest areas in the district. Firewood, Timber, Gum and Shikakai are major forest products. There is no classified forest at talukas, but there are many private lands and unclassified forests on land area.

Timber of teak and one third of firewood are sold in the local market of Chiplun, Khed and Ratnagiri taluka. Two third of firewood is transported to Mumbai by road due to direct connectivity with destination. Transportation of forest product via waterway is not feasible because of the turbulence in the river.

Table 4-10 Forest distribution in Ratnagiri District (Taluka wise)

Taluka	Geographical Area (Ha.)	Forest Area (Ha)
Dapoli	86,339	-
Guhagar	63,603	-
Chiplun	1,11,613	240
Sangmeshwar	1,25,117	-
Total	3,86,672	240

Source: Mahaagri.gov.in

4.2.2.2. SECONDARY SECTOR

Manufacturing industries, Electricity, Gas, Water supply providing and construction companies come under secondary sector. Ratnagiri district has largest variety of food processing industries from pulp etc. Some of the mango pulp canning industries could be found in Chiplun, Ratnagiri, Rajapur taluka. Many of the local people are engaged in making bamboo baskets and other wooden products required to pack mangoes. There are small units of pickles and papad and making Amsuls from Kokam as well.

Dapoli taluka does not have any MIDC estate. The below table shows GSDP by industry of origin.

Table 4-11: GSDP by industry of origin

(INR in Crore)

Secondary Sector	2009	2010	2011	2012	2013	2014
Industry	2,36,089	2,55,108	3,11,591	3,31,343	3,74,219	4,10,789
Registered Manufacturing	1,20,748	1,28,812	1,61,529	1,67,853	1,95,185	1,98,919
Unregistered Manufacturing	46,437	51,147	59,312	60,414	63,174	74,312
Construction	52,512	55,658	68,368	79,277	85,553	94,878
Other	11,224	14,081	17,363	17,552	24,067	36,893
Total	4,67,010	5,04,806	6,18,163	6,56,439	7,42,198	8,15,791

Source: Directorate of economics & statistics, MH

4.2.2.3. TERTIARY SECTOR

Hotels, Restaurants, Transport, storage and other communication industries, Banking & insurance, Public administration etc. come under tertiary sector. Tertiary sector has grown steadily over the years. Growth in service sector boosts the economy. Dapoli, Chiplun, Khed, Guhagar, Sangmeshwara are some of the potential areas of service sector. There are some areas, which are developed for agro tourism sector.

4.2.2.4. INFRASTRUCTURE ANALYSIS

Infrastructure plays major role in the development. It is essential to understand various types of infrastructure around the river and new development that would become support-connecting waterway with other modes of transportation. It becomes backbone for any new development.

4.2.2.5. CONNECTIVITY ANALYSIS

Railway, roadway and airports around the waterway help to understand various ways through which evacuation of cargo and passengers could take place. It helps to determine best multimodal route for evacuation.

- **Roadway**

NH 66 crosses over the river from tail side. SH 96 & SH 4 crosses near the mouth of the river. Apart from these two State Highways, there do not exist any bridge or roadway on the river. Both highways are more than 30 km away from each other. In between there are villages along the river where road connectivity is very poor; curvy road increases the journey time. During site visit, it was found that a bridge on the river is planned to be constructed between SH 4 and NH 66. Upcoming and existing bridge on the river restrict any potential traffic that could be diverted to Vashishti.

- **Railway**

Konkan railway line is the only line running beside Vashishti River. Chiplun & Khed are passenger railway stations on this line. There does not exist any freight station within 25 km area from the river. There is no captive rail siding of any industry

- **Airport**

There is no airport in the primary or secondary catchment area of Vashishti River.

4.2.2.6. EXISTING INFRASTRUCTURE

Following table summarizes existing landing points for passenger and fish and cargo as well as ports infrastructure in the catchment area of river. Both Dabhol and Palshet are coastal facing areas in the catchment area of the river. These places are not inside the river.

Table 4-12 Type of jetties in the catchment area of Vashishti River

Name	Passenger	Fishing	Natural landing point	Break Water	Cargo	Other	Total
Dabhol	94	2			3		99
Palshet	1		3				4
Total	95	2	3	0	3	0	103

Source: MMB

There exist more jetties in Dabhol in the catchment area of Vashishti River.

Table 4-13 Existing storage area in Ratnagiri

District	Number of godowns	Capacity (MT)
Ratnagiri	26	11,550

Source: Economic survey of MH, 2015

Figure 4-6 Bharati Shipyard at Usgaon

Source: Google Earth

Bharati Shipyard at Usgaon area is spread over 250 acres of land. The shipbuilding Capacity of this shipyard is 1,00,000 DWT. This facility is designed to build dredgers, tankers, chemical tankers and all types of advanced vessels. The Facility is surrounded by hills on three sides. This shipyard started operation in 2007 but since Fy 2013, the shipyard didn't get any business from the region; hence shipbuilding activity is at halt.

4.2.2.7. UPCOMING INFRASTRUCTURE

- **Upcoming railway line**

A 103 km long railway line is proposed to be developed from Chiplun to Karad in next 5- 6 years. Karad is located in Satara district of western Maharashtra.

- **Khed smart city**

There is a plan to develop Khed as a smart Industrial city. Special Economic Zone and other industrial area would be developed along with residential complex. Khed city SEZ would be a sector specific SEZ on 100 Ha. of land for engineering & electronic stores. On non residential area, there is proposal to develop entertainment, healthcare

& other utility services. Khed is located at about 24 km distance from the tail of Vashishti River. NH 66 is the nearest highway that connects Khed with the river.

- **HPCL & BPCL Opportunity for Konkan region**

Existing refineries of HPCL & BPCL are located in landlocked area and having capacity of 8 MTPA & 12 MTPA respectively. Some of the previous refinery projects in Ratnagiri got deferred due to complex land acquisition process. In past, HPCL wanted to acquire a land in Ratnagiri district for setting up refinery with capacity of 9 MTPA but at that time entire Western Ghat range was declared as ecologically sensitive land area. All the three major giants in refineries sector are looking for a suitable land on the West Coast.

IOCL, BPCL & HPCL have formed alliance to build 60 mnT p.a refinery by investing about INR 1.5 trillion. To develop such huge infrastructure, 15,000 acres of land is required. Finding such a huge land in Konkan region is a difficult task due to hilly terrain; therefore GOI has put proposal to reduce the land area to 6,000 to 8,000 acres or refineries would be put on different land parcel sizes. The location of land area is yet to be finalized.

4.2.3. Existing & Proposed Industries

Ratnagiri is considered as chemical hub. There exist Koyana Wildlife Sanctuary between Satara MIDC and Vashishti River. The distance between the tail of the river and Satara MIDC is 125 km and Dabhol is located at 205 km from Satara MIDC. The Sanctuary has elevation of 600 meter to 1,000 meter. JNPT port provides direct connectivity to the industries of this region. Therefore the proposed waterway would not be commercially viable for Satara MIDC.

4.2.3.1. EXISTING INDUSTRIES

Lote Parshuram MIDC is the closest industrial estate to Vashishti River. Table 4-14 summarizes some of the major industries in the MIDC area. At present, all the industries use JNPT port for transportation. Lote Parshuram is home for around 200 industries and about 95% of industries are of medium and small scale. Other industrial areas in Chiplun like Kherdi, Gane Khodpoli are not as developed as Lote Parshuram. Lote Parshuram MIDC is considered as largest chemical hub in Asia. This shows its significance over other industrial estates.

Table 4-14 Industries in the catchment area of Vashishti river

MIDC	Company	JNPT (Km)	Dabhol (Km)	Proposed Terminal near Pedhe village (Km)	Opportunity
Lote Parshuram, Chiplun	GHARDA Chemicals	204	65	12	✗
	Dow-Agro Sciences				
	Rallis India				
	Indian Oxalate				
	S I Group India				
	Pentoky Organy				
	Excel Industries				
	Omkar Speciality Chemicals				
	Urdhwa Chemicals				
	Arvind Industries				
	Litmus Organics				
	Ratnagiri Chemicals				
	Ratnagiri Gas & Power				
	CETP				
	Sahastra Chemicals				
	Shree Pushkar Chemicals				
	Hindustan Unilever				
Kherdi	Three M Paper Manufacturing	255	92	8	✗
	Associated Cables				
Gane - Khodpoli	Prathamesh Fiber Glass	251	84	2	✗
	J K Files	227	66	13	

Source: Mantrana Maritime Advisory Pvt Ltd, Site visit

These industries are reluctant to use Vashishti River for various reasons like depth of water, multiple handling, cost incurred due to multiple handling, etc. Under current scenario, these industries will not shift their cargo to the waterway. However, with technical, operational, and commercial support from IWAI, these industries could be influenced to shift. The following map shows Industrial area, existing in the catchment area of Vashishti River.

Figure 4-7 Industrial areas in the catchment area of river

- **Gharda Chemical**

The Company is a research based organization having four manufacturing units and it started operation in 1967. This Export oriented company uses JNPT for export purpose. Apart from the plant located at Lote, the company has another plant at Dombivali. The Company has its own Godown, located at Akola in Vidarbha region of Maharashtra.

Gharda Chemical has a Co-Generation power plant with 4 MW capacity at Lote area. Co-Generation power projects are encouraged by GOI for Sugar factories. JNPT has direct connectivity with plant, which proves beneficial for industry and saves time.

- **Dow – Agro Sciences**

Dow Agro is an US based company. Its plant at Lote manufactures fungicide, herbicide and plant growth stimulators. The table below presents a list of products, manufactured by Dow Agro Sciences.

Table 4-15 Product Portfolio of Dow Agro Sciences

Fungicides	Herbicides	Plant growth stimulator
Beam	Clincher	Humicil
Bengard	Gardenclean	Humicil G
Dithane M 45	Goal	Miraculan
Karathane	Granite	
Piccor	Weedall	
Systhane		

Source: Company Website

- **Rallis India**

Rallis have four manufacturing plants in India. The Company produces more than 10,000 MT of technical grade pesticides & 30,000 T/litre of formulation p.a. The Company has a strong distribution network, spread all over India. The company's network covers about 80% of the districts of India. However, production capacity of this plant is too low to recommend diversion to IWT.

- **Indian Oxalate**

Indian Oxalate is manufacturing Oxalic acid, Diethyl Oxalate at its Lote plant. The Plant was commissioned in 1992. The production capacity of the plant is 7,200 TPA. The Company imports 300 T sugar per month as a raw material from Yashwantrao Mohite Krishna Sahakari Sakhar Karkhana located in Satara and sometimes from JNPT. However the volume of sugar is not consistent and production capacity of the plant is too low, and hence, limits the opportunity for the proposed waterway.

- **Pentokey Organy**

The Plant started operation in 1986. This plant manufactures Acetic Acid, Ethyl Acetate & Acetaldehyde. The Plant is based on 12,658 Sq. Mtr. area. NH 17 is well connected with this plant. The nearest Railway station is about 17 km away from the plant. The company has closed down its business since last 8 months.

- **Excel Industries**

The Plant produces Organophosphonates at its Lote plant and uses JNPT port for export purpose.

- **Omkar Speciality Chemical**

Omkar Group has seven manufacturing units and one of them is located at Lote. The Plant manufactures chemicals & Pharma Intermediaries. The Company uses JNPT for exporting its products to Europe, Canada, South Asia and Australia. Company did not show any interest in using waterways.

o **Litmus Organics**

The company has recently started its plant in 2005. It is a very small company in terms of production, thereby limiting scope for the proposed waterway in Vashishti River.

o **Ratnagiri Chemicals**

Ratnagiri Chemicals manufactures antioxidant additives for food & petrochemical based industries. The Company uses JNPT port for exporting its products to USA, Europe and Middle East.

o **Ratnagiri Gas & Power**

Ratnagiri Gas & Power established its business in the year 2005 and is promoted by NTPC & GAIL. This company was established to revive Dabhol Power project. The Plant is located near coastal region, and therefore, do not provide any opportunity for Vashishti river.

o **Shree Pushkar Chemical**

The Company has three to four plants in Lote. The Company has installed capacity of 10,000 MT of Dyes Intermediates. This company operates on a very limited scale, which limits the opportunity of shifting cargo to IWT.

o **Rawmin Mining**

The State Government has given mega project status to Rawmin's upcoming project to set up Alumina Refinery along with captive power plant and warehousing facilities. The proposed capacity of the refinery would be 0.75 to 1 mnT p.a. MOU has been signed between State Government and Rawmin Mining for this project. The proposed Refinery would come up in 700 Ha. of land. Ratnagiri and Kolhapur are the two locations finalized for the proposed plant, however plant would come up in either of the two locations. Up till now this project is still in planning stage.

4.2.4. Traffic from Major & Non Major Ports

There does not exist any Major port in the primary catchment area of the river. Industries use JNPT port for export, import purpose. The distance from industries to JNPT is more than 200 km. Industries give preference to JNPT due to direct connectivity. Cargo is received by industries within 6 to 7 hrs excluding custom clearance.

4.2.4.1. NON MAJOR PORTS

There is only one non major port at the mouth of the river i.e. Dabhol. The below table shows historic traffic of Dabhol Port.

Table 4-16 Commodity wise historic traffic of Dabhol Port

('000 T)

Commodity	2012	2013	2014	2015	2016
Chemical	-	-	-	54	-
LNG	-	-	1,123	1,323	3,215
Project Cargo	39	399	12	-	-
Steel & Product	2	-	-	-	-
Total	41	399	1,136	1,377	3,215

Source: MMB

It can be seen from the above table that Dabhol port mostly handles LNG. It is the third LNG terminal in India after Dahej & Hazira. Ratnagiri Gas and Power Limited took over Dabhol Power Company and developed its own captive terminal at Dabhol.

Total traffic of Dabhol port consist of traffic handled at RGPPL (Captive Jetty) and Bharati Shipayrd' (MMB Jetty). Chemical cargo consists of only Naphtha. However, since Fy-13 Bharati shipyard business is at halt.

Figure 4-8 Dabhol Port

Source: Site Visit

4.2.4.2. MAJOR PORTS

There does not exist any major port in the primary catchment area of Vashishti River. All the major ports are located more than 100 km away. There is direct connectivity between JNPT and Industrial plants of the region.

4.3. Commodity Composition

4.3.1. Mineral

There is no captive or any other jetty in Vashishti River which handles minerals. Dabhol port on the mouth of Vashishti River did not handle minerals in last five years.

Table 4-17 Minerals composition in Ratnagiri district

Mineral	Lease	Non Forest Area (Ha.)
Silica Sand	8	454
Bauxite	6	778
Total	14	1,232

Source:Mahadgm.gov.in

Table 4-18 Taluka wise number of mines in Ratnagiri district

Tahsil	Bauxite
Dapoli	4

Source:Mahadgm.gov.in

Apart from Dapoli Tahsil, there are other tahsils also in Ratanagiri district; however as only Dapoli tahsil falls in the catchment of Vashishti River, so only this tahsil is studied for the report. Other tahsils are not included in the study.

4.4. Originating & Terminating commodities

The cargo volume handled at non-major ports in the primary catchment area of the river is very inconsistent. These ports lack supportive infrastructure. All the roads in the catchment area of the river are curvy. The River is surrounded by hills. Industries located at Lote are not willing to use any terminal on the river. Therefore, there would not be any commodity that hold potential for river transportation. Dabhol port, which is a non-major port, does not handle any other bulk or break bulk commodity on a large scale. Also, Dabhol port's traffic does not get consumed in the regions bifurcated by the entire stretch of Vashishti river. These mitigating factors limit the scope of diverting the port's traffic to the river. Beyond these two sources, there does not exist any other major industry dealing in Cement, Coal, Iron & Steel, etc. in the catchment area of the river.

The below table shows commodities that could be potential traffic for the proposed waterway in Vashishti river. The table describes reasons for those commodities that would provide opportunity for the river and the commodities, which would not provide any opportunity.

Table 4-19 Commodities and potential for Vashishti river

Commodity	Potential	Reasoning
Thermal Coal	X	Gharda Chemical has its own power plant of 4 MW at Lote Parshuram. It is a co - generation power project for sugar factories. Apart from this plant, there is no existing or upcoming power plant in the region. Local people's strong opposition for industrial development is a major hurdle. Many projects have deferred before because of this problem and also due to unavailability of adequate land. Unavailability of coal traders and coal based thermal power plants in the catchment area, do not create any opportunity of river.
Iron & Steel	X	Iron Ore/ Iron & Steel plant development at Satara, which is proposed by Government in future would not help to attract cargo to Vashishti river. Satara comes in the secondary catchment area There exists Koyana Sanctuary between Satara and Vashishti river. Distance from Satara to the tail of the river is more than 120 km. Dabhol port which is located on the mouth of the river is more than 200 km away from Satara. No existing or upcoming iron & steel based industrial development plan was found in the catchment area of the river.
Cement	X	There exists no cement plant in the catchment area of the river. Based on interaction with ACC cement and site visit, it is concluded that no further expansion unit or upcoming cement is coming in the region.
POL	X	HPCL, BPCL and IOCL together have formed alliance for developing 60 mn T p.a refinery on 15,000 acres of land along the west coast in Konkan region. However land parcel size and acquisition are the major problems. It is difficult to get huge parcel size land in the region due to hilly terrain. The hills in the catchment area of Vashishti river have elevation of 100 - 200 meters. There is also a sanctuary nearby. Even if in future on a smaller scale they set up plants they would have their own captive jetty in place to handle cargo.
Chemical	X	Existing chemical hub at Lote Parshuram use JNPT due to direct connectivity and time factor. Existing industrial cargo are transported by means of chemical. All these industries are not willing to use Vashishti river. Main reason sited by industries is seasonal river, narrow road, multiple handling, additional logistic cost etc.

Commodity	Potential	Reasoning
Food Grain / Horticulture	X	Local consumption of food grains in the region does not provide any scope for IWT transportation.
Fertilizer	X	Major fertilizer Plant i.e RCF has its own rail siding and logistics & distribution of fertilizer takes place by third party distributor. Deepak fertilizer plant located in Khopoli region, distributes fertilizer by roadways. Deepak fertilizer also exports its product using JNPT.

Source: Consultant's Analysis

4.5. Passenger Traffic

Passenger traffic consists of Ro-Ro traffic and also people visiting famous locations and doing adventure activities in the catchment area of Vashishti River.

4.6. Tourism Traffic

There does not exist any major tourist spot around Vashishti River. The river also lacks proper road connectivity. The River is accessible by narrow, curvy and elevated roads. Only one State and National highway cross the river, but these roads are at a far distance and about 30 km far from each other. The table below presents a list of famous tourist places near Vashishti River.

Table 4-20 Famous Tourist Spots around Vashishti River

Location	River	Distance (km)
Gowalkot Fort	Vashishti	0.4
Sawatsada Waterfall	Vashishti	1
Mahipatgad Fort	Vashishti	29
Guhagar Beach	Vashishti	10

Source: Internet, Site visit

4.6.1. Gowalkot Fort

This fort is located on the bank of Vashishti River in Chiplun. The fort is surrounded by river on three sides and a trench on fourth side of the fort. This fort was built to protect Chiplun port in ancient times. At the bottom of the fort, there exists a temple of goddess Karanjai. This temple is 2 km away from Chiplun. There are steps behind the temple to reach the Fort. It takes around 15 minutes to reach the top of the fort.

4.6.2. Sawatsada Waterfall

This Waterfall is accessible in rainy season only. Parshuram temple is very close to this waterfall. The distance from waterfall to Chiplun is 5 km.

4.6.3. Mahipatgad Fort

This Fort is spread on 200 acres of land and is located at a height is 960 meter on top of a hill in Khed taluka. There exist Pareshwar Mahadev temple on the fort. There is a small lake in front of the temple

4.6.4. Guhagar Beach

Guhagar is a gem of Ratnagiri district. Beaches of Guhagar has shady Suru trees and famous for temples of Vyadeshvar and Durga Devi. Following image shows some of the activities and infrastructure build to attract tourists. Similar structure could be followed to attract tourists for riverine sports & activities.

Figure 4-9 Guhagar Beach

Source: Site visit

4.6.5. Maldoli Crocodile Safari

Maldoli village is located at the end of the river near Chiplun. This place is famous for crocodile safari. In the ancient times, Maldoli harbor was used to transport goods to Chiplun market.

4.6.6. Ambet

The State government has received Indu mill land for development of Ambedakar memorial. Total 12 acres of land has been acquired for this project. CRZ clearances are brought and MMRDA has already started cleaning the place for development.

4.7. Ro-Ro Traffic

All the passenger ferry terminals in Maharashtra are located on the coastal areas/on the mouth of the river as per data provided by Maharashtra Maritime Board. There exists two ferry services at the mouth of the river. Passenger ferry service runs between Dabhol to Veldur and Dabhol to Dhopave. Dabhol to Dhopave can accommodate vehicles along with passengers. Dabhol to Veldur ferry cannot accommodate vehicles. Dabhol to Dhopave can accommodate 50 people and 8 to 10 vehicles at a time. Dabhol to Veldur can accommodate 15 people at a time.

Table 4-21 Passenger ferry terminal with traffic in the catchment area of Vashishti River

Numbers in (‘000)

Ferry Terminal	2012	2013	2014	2015	2016
Dabhol	384	362	393	441	433
Palshet	-	-	1	1	-
Total	384	362	394	442	433

Source: MMB

It can be seen from the above table that Dabhol is the only point on the mouth of the river, which handles majority of passenger traffic. The figure below shows existing passenger ferry points at different parts of the river. Dabhol to Dhopave ferry boat has reduced the road distance of 90 km from Dapoli to Guhagar.

Figure 4-10 Passenger Ferry service on Vashishti river

Source: Site Visit

4.8. Growth Trend

4.8.1. Cargo Growth

Konkan region is famous for Mango & Cashew Nut production and export. Local people are concerned about these two crops and fear that industrialization would affect these two major exporting commodities. Hence, there has been lot of opposition from local community for developing power plant and other major industries in the region. So many projects have been deferred in the past. This situation is likely to remain same in near future.

Existing industries in MIDC area are chemical based and they export liquid cargo via JNPT. Existing industries are not willing to shift their mode of transportation to Multimodal because Vashishti River is a seasonal river JNPT has direct connectivity and it is a convenient mode of transportation. Also, multimodal transportation in small stretches increases cost of transportation. Existing Dabhol port at the mouth of the river is a non-major port and traffic volume at this port is very inconsistent. There are no wider roads for evacuation of cargo. The region is surrounded by hills, so roads are curvy and it would be difficult to widen roads for smooth operation of cargo on road. There is no major freight station in the primary catchment area. Dabhol port does not have rail siding or any rail connectivity with existing Konkan Railway line. This creates problem for evacuation of cargo. In summer season, the draft of the river reduces, which is not ideal for cargo carrying vessels. This reduces the potential for cargo movement on Vashishti River in future. Furthermore, there is no supportive infrastructure and other developments along the river stretch in the pipeline that may change this status quo. These causes restrict cargo growth in favour of the IWT. If transportation via waterway is commercially attractive and time of transportation is less or same as via roadway, industries may consider shifting to the waterway.

4.8.2. Passenger Growth

At present there are two operational ferry routes at the mouth of the river, Dabhol to Dhopave and Dabhol to Veldur. It was found during interactions with ferry operators that in future passenger traffic is likely to reduce. A new bridge is proposed to be developed on Vashishti River that would reduce the passenger traffic from ferry terminal which would become nil once the bridge becomes operational. Passenger traffic via roadway would likely to increase due to additional road apart from NH 66 & SH 4, SH 78.

4.8.3. Tourism Growth

Konkan area is famous for its serene beaches and tourist attraction. River tourism is not much developed in the region like Kerala. Beach & coastal tourism is the major attraction at the mouth of Vashishti River. There also exists a crocodile safari in Maldoli village. There is lack of awareness among tourists about this crocodile safari. This crocodile safari needs to be promoted to attract more tourists. There is also a need to develop infrastructure with tourism potential near the river. Watersport activity, Riverfront resorts etc. could be developed to attract more tourists. Vashishti river is a seasonal river thereby its draft reduces in summer season. However for tourism purpose and other watersport activities, there is no constraint of draft. Awareness should be created among people about tourism activities on the river to increase tourist growth in the region.

4.8.4. Comparison of FSR & DPR study

The below table shows an analysis of the commodities, which are considered as potential traffic for the proposed waterway in FSR and also considered in DPR. There is suitable reasoning for those commodities, which are not considered in DPR. The table also shows potential of tourist and passenger traffic along with suitable reasoning.

Table 4-22 Analysis of FSR study

Commodity	Source	DPR Consideration	Potential	Reasoning
LNG	RGPPL	✓	✗	RGPPL have captive jetty to handle LNG cargo required for their plant. RGPPL plant is located on the mouth of the river
Chemical	Lote Parshuram ,	✓	✗	These Chemical industries use JNPT and they are not ready to use river due to multiple handling and time factor.
Coal	MSPGC	-	-	Local people & farmers opposition to set up any big industrial development in konkan region still exists. MSPGC's coal terminal plan has been deferred due to this opposition and least likely to come up in future.
Iron Ore	Satara MIDC	✓	✗	Satara MIDC do not come in the primary catchment area. There is wildlife sanctuary in between river and MIDC area. No direct connectivity with river. Roads are curvy and have Ghats. Time, Distance and multiple handling system for less km of river stretch restrict cargo movement
Other Ore		✓	✗	
Coaking Coal		✓	✗	
Steel	Satara MIDC	✓	✗	
Cement	ACC	✓	✗	
POL	BPCL & HPCL	✓	✗	Obtaining a land on the western coast side is a difficult task. Strong opposition of local people.
Fertilizer	RCF, DFPCL	✓	✗	Considered but no potential because RCF do not look after logistics & distribution also company has it's own

Commodity	Source	DPR Consideration	Potential	Reasoning
				rail siding. Deepak Fertilizer plants do not come in the primary catchment area.
Food Grain	-	✓	X	Local consumption.
Container	-	✓	X	Seasonal river, unavailability of enough draft to handle container, Existing containerized base companies not willing to shift to river.
Passenger	-	✓	X	Upcoming bridge on the river would make existing passenger ferry traffic nil
Tourism	-	✓	May be	Maldoli crocodile safari need to be developed to attract more tourist traffic on river

Source: Mantrana Maritime Advisory Pvt Ltd

The below table shows potential for the river from Industrial and other cargoes, fish products, passenger and tourism.

Table 4-23 Overall attractiveness of Vashishti river

Traffic	Attractiveness	Reasoning
Cargo (Industrial & Commodities)	X	Only Chemical industries are found in Lote Parshuram MIDC. These industries use JNPT port for EXIM purpose. Industries are not willing to use Vashishti river for cargo movement. There are few industries in Kherdi & Gane MIDC areas and they would not hold any potential for river transportation. Vashishti river is seasonal river. In summer season at some places there is no water at all. There does not exist any major Cement, Coal based power plant, fertilizer industry, Iron & Steel industries in the catchment area of the river. There is no plan for any upcoming industry. Evacuation of cargo becomes difficult due to narrow & curvy road along the river
Fishing	X	Inland fishing volume is very low and now becoming extinct. Sudden water level

Traffic	Attractiveness	Reasoning
		fluctuation brought by hydropower dams has reduced fish catch in the river.
Passenger	X	Dabhol to Veldur, Dabhol to Dhopave are two ferry line on the mouth of the river. During site visit it was found that new bridge on the river would be constructed and it is going to have adverse effect on existing passenger traffic of the ferry.
Tourism	Maybe	Maldoli Crocodile Safari is the only tourist spot on the river. Dapoli & Guhagar beaches are other famous tourist attractions. To attract tourist traffic, tourism related infrastructure need to be developed and this would take time and require high capital cost.

Source: Mantrana Maritime Advisory Pvt Ltd

4.9. Forecasting & Potential IWT Assumption

The inference drawn from above analyses and after interacting with port's authority, industries, and local people is that Vashishti River does not hold potential for transportation of cargo. However, it is assumed that there may exist potential for Ro-Ro operation on the river only under certain ideal conditions. Existing industries that use JNPT port for dispatching their container by using NH 66 could use Ro-Ro service, provided the shift induces cost and time savings. Broadly, the logistics should favor the switch to IWT, both operationally and commercially.

It is also assumed that apart from chemical containers, other liquid cargo like LPG etc., which at present use the same NH-66 to transport in Konkan region, could also use Ro-Ro service. Based on site visit and inputs from industries, approximately 292 trucks ply on n a daily basis on NH 66. If the aforementioned conditions are met, then even this traffic could be targeted by IWT.

4.10. Terminal wise IWT Traffic analysis (Exception Case)

Extensive analysis of the hinterland around Vashishti River did not find industries (Lote Parshuram) that could use river for transportation of cargo. Dabhol port on the mouth of river primarily handles LNG. There is no scope for developing alternate port facility for cargo handling. Some of the factories in the hinterland use MbPT/JNPT ports for their EXIM trade. Cargo from these industries uses roadways to reach these major ports. In the event these cargo volumes are targeted for shifting to IWT, the modal shift would be a function of logistics cost savings in comparison to the existing modes of transportation. At present, these industries will provide no traffic potential for the proposed IWT. **Figure 4-11** shows proposed terminal location and connectivity.

Figure 4-11 Proposed Terminal Location

Source: Google Earth

4.10.1. Logistic cost Comparison for Ro-Ro (Exception Case)

The ideal condition that could drive the business in IWT's favour will rest primarily on the integrated logistics costs involved. The current transportation logistics adopted by the industries in Lote Parshuram is indicative of their preference for moving their exim cargo. Proposing traffic shift to a different mode requires a very strong and a practical driving factor. Lower integrated logistics cost, as compared to road logistics cost, can act as the most ideal distinguishing criterion in this regard.

The Following Figure 4-11 illustrates time and distance difference between the current roadway movement and potential ro –ro operation using the Vashishti River:

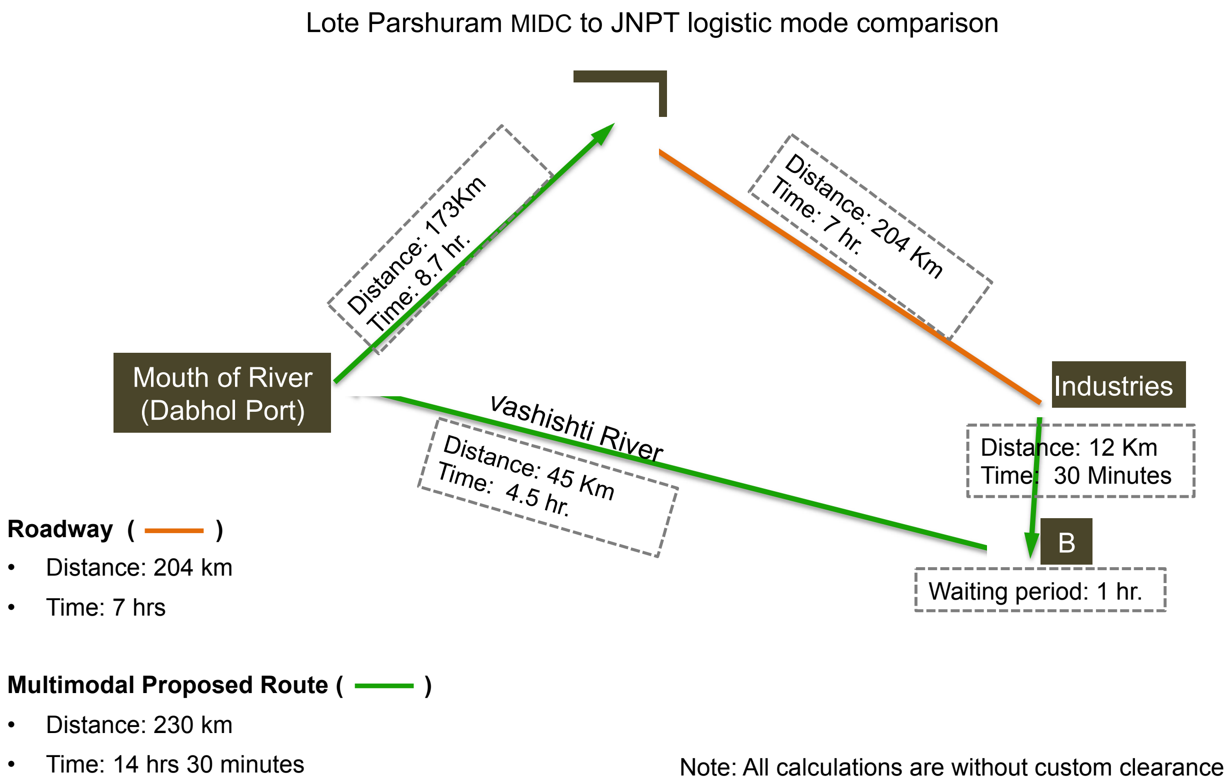


Figure 4-12 Time & Distance Comparison

It is evident from the graphical representation above that time required to cover the distance to reach JNPT is more in case of multimodal route involving the waterway and road. Therefore, time and cost involved in multimodal transportation is also more compared to roadway. Proposed IWT route would also involve multiple handling of trucks. This adds to the total logistic cost in transportation. An elaboration of the impact on overall logistics cost difference is depicted in the logistics cost comparison chart between roadway and waterway in the following

Figure **4-13.** The chart shows logistics comparison in two different cases under Ro-Ro cost dynamics. In Case I, vessel with a cumulative engine power of 839 kW and 20 kmph speed has been considered. In Case II, vessel with only one engine of 350 kW power and loaded speed of 10 kmph has been taken for cost comparison.

Ro-Ro/Trade Cost Dynamics

Origin	Destination
JNPT	Lote Parshuram

Ro-Ro Cost Dynamics (235 km)

Steps involved	Unit	Case I	Case II
Engine	kW	839	350
Engine fuel requirement	l/hr	222	102
Per Truck Ro-Ro Tariff	INR/Truck	12,039	11,434
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**12,181**	**11,576**

Truck Cost Dynamics (204 km)

Components	Cost (Rs.)	Cost
Fuel	INR	3,499
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**4,744**

Figure 4-13 Logistic Cost Comparison

Two scenarios have been considered to arrive at logistic cost for a possible Ro-Ro service on the proposed IWT route. In case of Ro-Ro logistics cost analysis, Ro-Ro Tariff assumes costs related to the multi-modal logistics.

The cost associated with transporting trucks using Ro-Ro on waterways is independent of the loading (Occupancy) of trucks. Logistics cost comparison for Ro-Ro service detailed out two multimodal case scenarios and compared with present mode of transportation. This includes nominal fairway charges, charges associated with vessel chartering and the associated fuel cost, and port-related charges (berth hire and port dues). Traffic diversion from road to waterway entails cost saving in relation to truck transportation cost. Primarily, this saving is on fuel cost and toll charges. While calculating Ro-Ro cost dynamics, these haven't been considered, as these cost heads will never feature in Ro-Ro transportation logistics. In case of truck cost dynamics, there are other parameters that influence the total roadway logistics cost. These include Repair & Maintenance cost, driver/crew wages, truck finance cost, profit & other costs. Including these for truck logistics analysis will necessitate inclusion of the same cost heads in case of Ro-Ro cost dynamics. However, these costs will be nullified, as their impact on both the logistics cost dynamics will produce a similar cost escalation, leading to a similar logistics cost difference. It is assumed that IWAI will develop the entire infrastructure (Terminal & Navigation), and hand it over to the operator without looking to recover the development cost. IWAI will also be required not to take Terminal charges, Fairway usage charges, etc. in order to increase the appeal of any Ro-Ro service on Vashishti River.

Costs involved in both the Ro-Ro cases are on the higher side when compared to roadways. This cost difference favours the roadway, as the difference between the two discussed transportation modes is at least over INR 7,000. In case of just Ro-Ro cost comparison, Case II is marginally cheaper than Case I.

4.10.1.1. RO-RO TERMINAL WITH SUBSIDY

It is evident from the logistics cost comparison that both the cases of waterway movement will be costlier than existing mode of transportation using roadways by a significant margin. As per Case I (higher engine power 839 KW), the logistics cost difference for roadway and waterway is INR 7,437/truck. Cost of transporting per truck on the waterway with the said engine configuration would be nearly twice as expensive as roadway. In Case II (Lower engine power 350 KW), this cost difference is narrower with INR 6,832/truck. For development of a Ro-Ro Terminal and for it to attract the projected traffic, government needs to subsidize the shift by offering this cost difference to the transporters? The subsidy amount will compensate for high logistics cost, but additional incentives also need to be offered to make up for the increase in time and distance. In such a scenario, IWAI should bear costs associated with maintenance of the Terminal (repairs and maintenance) and the navigation infrastructure (dredging, night navigation, buoys, etc.). A combination of subsidy and incentives would be essential to induce shift of traffic from existing roadways to waterway to cater to the EXIM requirements of the industries in Lote Parshuram.

The higher cost difference could be reduced or have a relatively negligible impact on the appeal of waterway logistics over the competing modalities. It's assumed that exim requirements of the industries in Lote Parshuram will continue to rise, leading to increase in cargo volume on road. Shift of higher cargo volumes over to the waterway could make up for the higher per-truck logistics cost. This could also lead to a lower subsidy amount required for disbursal to the transporters to influence them to shift to waterways. In order to approach deployment of Ro-Ro under suitable market conditions, IWAI should observe the market for the next 3 years. In the event exim requirements for Lote Parshuram industries continue their upward trend, as projected in traffic volumes up to 2040, decision for setting up Ro-Ro Terminal on Vashishti River could be taken by 2020. Taking into account construction period of 2 years, the Ro-Ro terminal should become operational by 2022. This is an ideal scenario, suggested to explore and exploit possible opportunities leading to development of the said Ro-Ro Terminal.

Ro-Ro vessels have ramps that facilitate self loading and unloading without help of external crane.The trucks loaded on to Ro-Ro would drive down to their final location. The last mile distance from proposed terminal on river to industries is 12 km. The last mile cost to reach industries is considered under the heading of Ro-Ro cost dynamics that includes fuel, truck cost and driver wages. The cost of running Ro-Ro vessels mentioned in table would be applied for return journey as well.

Table 4-24 Terminal & commodity wise projections (Exception Case)

Name of the waterway: NW-28 (Dabhol Creek/Vashisti River, 45.228 km)														
Sr. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Origin Terminal on NW**	**Destination Terminal on NW**	**Final Destination**	**Co-ordinates**	**Unit p.a**	**Fy-16**	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Existing Terminals on River (No Terminal Present on River)														
Proposed Terminal Opportunity for IWAI														
1	Liquid, Bulk, break bulk	Ro-Ro	JNPT	n/a	Point B - Pedhe	Lote Parshuram	17°32'44.26"N, 73°30'32.00"E	('000 Trucks)	0	75	91	111	135	164
			Lote Parshuram	Point B - Pedhe	n/a	JNPT			0	50	61	74	90	109
Total									0	125	152	185	225	273
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..														

Source: Consultant's Analysis

Only Chemical industries are found in the Lote Parshuram MIDC. Other Industries in Kherdi & Gane MIDC areas are very few and do not hold any potential for river transportation. Industries use JNPT port for all EXIM purpose. There do not exist any major Cement, Coal based power plant, fertilizer industry, Iron & Steel industries in the catchment area of the river. During site visit and telephonic interview, the consultant didn't find any development or expansion plan of the above mentioned industries. There is no plan for any upcoming industry in the region.

The projections for Ro-Ro traffic on River Vashishti is influenced by following factors

- No cargo traffic potential due to absence of Thermal Power Plants, Iron & steel industries, Fertilizers units etc. No upcoming plans of these sectors within the hinterland of Vashishti in coming years.
- Existing chemical industries predominantly use roadways and they are unwilling to shift to waterways.
- Logistic cost comparison between roadway & multimodal route
- Secondary sector performance in Maharashtra
- Direct road connectivity from industrial units of the hinterland to JNPT

All the assumptions are based on inputs provided by industrial units and site visit.

Lote Parshuram MIDC is one of the major industrial areas in the hinterland. Majority of industrial units inside this MIDC are chemical based. Some of the chemical units have large-scale operation and rest are small and medium scale units. There is no major port in the hinterland. Dabhol Port, which is a riverine and non- major port located on the mouth of the river, lacks container-handling facility. Due to these factors, all the industries in the hinterland use JNPT for EXIM purpose. NH 66 (Mumbai-Goa) is used for transporting cargo from industries in the hinterland to JNPT.

Industries did not show willingness to use Vashishti River, stating cost and time as major factor. A detail logistic cost analysis of present mode (roadway) v/s multimodal route justifies the same. There is huge difference in logistic cost of the two modes. One-way cost for per truck on roadway is INR 4,744. Whereas, in multimodal route of Case I and Case II, cost is INR 12,181/truck and INR 11,576/truck respectively. Hence, it is concluded that due to huge cost difference, industries would not prefer waterway for transporting their cargo. However, provided subsidy & additional incentives, industries might opt for waterways as an alternate mode of transportation.

Another major reason is time involved in transportation. Multimodal route would take 14 hrs. 30 mnts. to reach JNPT without custom clearance; whereas through roadway, it takes around 7 hrs. (Excluding custom clearance) to reach JNPT. Considering all these factors, it is not feasible to develop Ro-Ro on a stand-alone basis. Thus, hypothetically, assuming the Government provides Operational subsidy & additional incentives, traffic was projected.

- It was observed during road survey undertaken on NH 66 that on an average 450 trucks/day move which are destined to chemical hub, located in the hinterland of Vashishti (Lote Parshuram MIDC) and Savitri (Mahad MIDC). It is assumed that 65% of trucks would be shifted to river Vashishti because scale of operation of Lote Parshuram MIDC is comparatively larger than Mahad MIDC, which is in the hinterland of river Savitri. Due to larger scale of operation in Lote Parshuram MIDC, 65% share is assumed for river Vashishti.
- The base traffic considered for river Vashishti, i.e. 65% of 450 trucks/day, is increased at a moderate growth rate of 4% Y-O-Y. This has been linked to industrial growth rate. Annual growth rate of Secondary sector decreased by 4.7 from Fy 13 to Fy 14 and thereafter it remained constant, i.e. 4%.
- Further, total traffic projected on Vashishti is divided into two-way truck traffic, i.e. from industrial units to JNPT & vice versa. As per interaction with industries, it was found that number of trucks moving from JNPT to industries is higher compared to movement of trucks from industries to JNPT. Hence, it is assumed that 60% of total traffic projected for Vashishti would move from JNPT to industries and 40% of total projected traffic would move from industries to JNPT.

4.10.1.2. RO-RO TERMINAL WITHOUT SUBSIDY

Without the offer of aforementioned subsidy amount, industries would not deviate from their current logistics practice. In such a case, any Ro-Ro Terminal on Vashishti River will not be a viable enterprise to pursue. Therefore, in such a scenario, it will be counterproductive and a loss making venture to develop a Ro-Ro Terminal on the River.

Also, in the event the market doesn’t show marked increase in traffic volume for the Lote Parshuram industries, the decision to set up a Ro-Ro terminal on Vashishti river becomes irrelevant. The cost difference between roadways and waterways will remain the same or widen even further.

The Total logistics cost using IWAI is higher than present cost incurred using Roadways. Hence, a direct subsidy would have to be given equivalent to the difference in logitstics cost between waterway and road to attract cargo. Without this subsidey, shift to Ro-Ro on waterways is not possible.

Even in the ideal situation where the government will be willing to compensate the cost difference, the Ro-Ro terminal is unlikely to generate profits in the long run. A combination of increased costs, time, and distance will weigh on the overall appeal and benefits of waterway movement, deterring potential customers.

4.10.1.3. RO-RO TERMINAL CONCLUSION

Driven by the current market conditions and probable future developments, it is not recommended to develop a Ro-Ro Terminal on Vashishti River. The logistics cost difference is too high for such an operation to even commence and sustain over the projected timeline of 2040. However, under ideal market conditions discussed above, coupled with fiscal incentives from the government, the decision for a Ro-Ro Terminal could be revisited after 3 years. In such a scenario, it's suggested that a Ro-Ro terminal could handle enough traffic to negate the logistics cost difference or make it seem negligible.

Abbreviation	Full Form
DES	Directorate Of Economics & Statistic
GOM	Government of Maharashtra
GSDP	Gross State Domestic Product
MT	Metric Ton
Ha.	Hectare
SH	State Highway
SEZ	Special Ecomic Zone
MIDC	Maharashtra Industrial Development Corporation
MMB	Maharashtra Maritime Board
DWT	Deadweight Tonnage
TPA	Tons Per Annum
MMTPA	Million Metric Tonnes per Annum
TPP	Thermal Power Plant
MMB	Maharashtra Maritime Board
JNPT	Jawaharlal Nehru Port Container Terminal
HPCL	Hindustan Petroleum Corporation Ltd
BPCL	Bharat Petroleum Corporation Ltd
IOCL	International Container Transshipment Terminal
GAIL	Gas Authority of India Limited
GOI	Government of India
RCF	Rashtriya Chemicals Fertilizers Limited
RGPPL	Ratnagiri Gas and Power Private limited
POL	Petroleum
EXIM	Export, Import
ICTT	International Container Transshipment Terminal

CHAPTER 5: TERMINALS

5.1. General Review

Terminals act as a connecting centre for shift of cargo and passengers from one mode to other mode. Inland Waterway Terminal (IWT) is a hub centre with a facility of connecting transport mode from / to the vessels on the water body to land provisioned with all the related infrastructure facilities like structure for berthing of vessels; facilities for loading / unloading of cargo; embarkation / disembarkation of passengers; storing / resting of cargo / passengers; connectivity to other modes of transport etc.,.

5.2. Identification and Site Location

Planning of the Inland Water Terminal location predominantly depends on the Traffic Origination and Traffic Destination criteria, which gives impetus to movement of traffic in inland waterways. Subsequent to the above, the site location in the vicinity can be considered duly taking into consideration of various influencing parameters, as below. In most of the cases the site location may not fulfil the idealistic scenario. However, the possibility of zeroing to a most suitable site may be possible based on certain basic parameters, as detailed.

Backup Land availability / Stability of Bank / Water Depth availability in Lean season / Velocity & Discharge both in Lean season and Flood season / Approach Road / Possibility of Rail connectivity / Nearness to City or Town / Availability of essential services / Impact of Social, Ecological & Environmental aspects etc.,.

In the morphological rivers, due to seasonal precipitation there are fluctuations in river flow and the rapid changes in water flow causes shift in the location of the deep channel and also results in erosion of banks and siltation. Accordingly, the basic requirement of an inland terminal is to ensure a permanent access to the navigational channel throughout the year. Keeping in view the above all, the terminal site location has been considered on Vashishti River.

The Dabhol Creek/ Vashishti River passes through the Ratnagiri district of Maharashtra State. Navigational traffic is present in survey stretch of Vashishti River. The Vashishti River / Dabhol Creek waterway has one port, one ship yard facility, one floating deck and 15 jetties for ship building, fishing & transportation purpose. Dabhol Port is a captive Terminal for Ratnagiri Gas and Power Private Limited (RGPPL) and has handled 3.21 MMTPA of cargo in year 2015-16. The stretch considered for development of the river is being navigated by local for fishing and transportation.

Important industries within 50 km are: MIDC-Chiplun, MIDC- Lote Parshuram, MIDC-Dapoli, MIDC- Satara, Ratnagiri Gas & Power Pvt. Ltd., Rawmin Mining and Industries Pvt. Ltd., Akash Universal Ltd, Ashapura Minechem Ltd., Core Minerals ltd., Indorama synthetics (I) Ltd etc.

Both Rail & Road network is available within 2.0 km of distance from the nearest industrial area (MIDC-Chiplun)

At present, it is being utilised by ferry service for local transport facilities used locally at Nvase village, Kernel village and Govalkot village and between Dabhol jetty to Veldur jetty and Dhopave. About 4.2 lakh passengers use ferry services per year in this waterway.

Taking into the consideration of the origin and destination and fairway on Dabhol River, NW 28, the most probable location has been considered from Arabian Sea at Dabhol to Gawalkot to Bridge at Pedhe. The location has approx Lat 17°32'44.26"N and Long 73°30'32.00"E.

The traffic volumes, as identified at Dabhol are Liquid, Bulk and Breakbulk. No cargo opportunity is found in Vashishti River. However, keeping in view the Traffic, 1 Roll-on Roll-off (Ro-Ro) Berthing facility has been planned. Thus, these expected traffic arrivals are to be taken into consideration for IWAI Terminal development on Vashishti River.

A tentative Land requirement has been worked out before undertaking the Land Survey etc., duly considering the following requirements for the proposed Ro-Ro operation.

Terminal Land Area Requirement for the Waterway Dabhol in Cluster 7

S.No.	Facility	Nos.	Size	Area (in m2)
1	Open Mobility Area	1	200 m x 100 m	20000
2	Covered Storage Godown (Nominal)	1	50m x 30m	1500
3	Ro-Ro Truck Parking	20	16m x 3m	960
4	40' Container Stack Yard	20	40 Sq. m	800
5	Main Parking Area	1	30m x 30m	900
6	Public Utility	1	6m x 4m	24
7	Weigh bridge	1	8m x 3m	24
8	Utility Room (Near Weigh Bridge)	1	3m X3m	9
9	Area under internal Roads	1	7.5m x 250m	1875

S.No.	Facility	Nos.	Size	Area (in m2)
10	Administration building	1	12 m x 15 m	180
11	Business Area	1	10m x 3m	30
12	Staff Parking Area-4 wheelers	1	13.5m x 6m	81
13	Staff Parking Area-2 wheelers	1	8m x 2m	16
14	Security shed for watch and ward	2	4m x 4m	32
15	Electrical facility	1	5m x 5m	25
16	Fuel Bunkers	1	10m x 5m	50
17	Water Supply Room	1	3m x 4m	12
18	Fire and Safety Room	1	3m x 4m	12
19	DGPS receiver & transmitter shed	1	8m x 4m	32
20	DG shed	1	5m x 5m	25
21	Canteen with Store	1	12m x 8m	96
22	Sewerage Treatment Plant (STP)	1	15m x 15m	225
23	Overhead Tank	1	10m dia	100
24	Green Area	1		1000
25	Future Requirement	1		2000
				30008

5.3. Terminal Layout / Master Planning including phases of development

The Terminal layout of the identified site based on the site land survey data available has been prepared .Refer Volume-II Drawing No. **P.010257-W-20351-X04**. With regard to the Land, there is no need of consideration of any phased development, since the ground development shall be taken up at initial phase itself. Further, the Terminal location is connected to the NH 66 near “Pedhe” village and the distance is about 475 m (Estimated cost of 0.72 Cr), which may have to be taken up by the concerned agency.

Accordingly, a layout plan demarcating the infrastructure requirement is developed. Refer Volume-II Drawing No. **P.010257-W-20311-A04** for details.

5.4. Land Details

The Land area identified is at Location as below

TABLE 5-1: Terminal Land Details

Coordinates (UTM) N/E	**1940686.46**	**341303.92**
Coordinates (DMS) N/E	**17°32'44.26" N**	**73°30'32.00" E**
Village	Pedhe	
Taluka	Chiplun	
District	Ratnagiri	
State	Maharashtra	
Nearest Town	Chiplun	
Distance of town (km)	2.5	
Land use	Mostly barren land	
Ownership	Mixed (both private and Govt land)	
Water Distance	on edge of land 5m	
Nearest Road	NH-66	
Road Distance (m)	475	
Nearest Railhead	Chiplun Rly Stn	
Railhead Distance	2km	
Nearby major Structure	Bridge on river	
Terrain	River bank land	
Soil/Subsurface strata	Reddish coloured Gravely soil	
Surveyed Area (Approx.)	91890 (m2)	

5.5. Geotechnical Investigations

Geotechnical investigation has been carried out at the proposed terminal location to find out the subsoil stratification in the project area and to collect data for deciding type of foundation and the design foundation. The scope of geotechnical investigation work consists of one bore hole at terminal of 20 m depth or 3 m into the bed rock whichever is earlier.

5.5.1. Regional Geology

The selected area/site is very near to Chiplun, a Taluka of Ratnagiri District in Maharashtra and is located on the right bank of Vashishti River, a major river draining the area. The site is located 20km downstream of Kolkewadi Dam (Konkani region). The most distinctive feature of Maharashtra's geology, as shown below in Figure 1, is that the state is widely covered with the Deccan Traps of Cretaceous age (flood basalts-green). A flood basalt consists of vast amount of lava flows formed by fissure eruptions, and is the largest kind of volcanic activities on the Earth.

Outside of the Deccan Traps, very old geological formations from Archeozoic to Carboniferous are distributed. These old geological formations, consist mainly of metamorphic rocks, are limited to the eastern and southern part of the state, and are characteristically rich in minerals such as iron, copper, manganese, and coal. On the contrary, the Deccan Traps are poor in minerals other than bauxite. Geological formations younger than the Deccan Traps are rarely distributed in abundance. Considerable distribution of unconsolidated sedimentary layers of Quaternary (shown in yellow) are seen in the northern part of the state in a narrow basin along a river.

The project area is covered under Geological Quadrangle map sheet No 47G (not available) of Geological Survey of India (GSI). However, GSI has prepared another map of Maharashtra titled Geological & Mineral map of Maharashtra. The project area on this map is shown in **Figure 5.1**. This map reveals that the project area is occupied by Deccan traps with intertarppen beds of Cretaceous to Eocene age which majorly consist of Basalt flows.

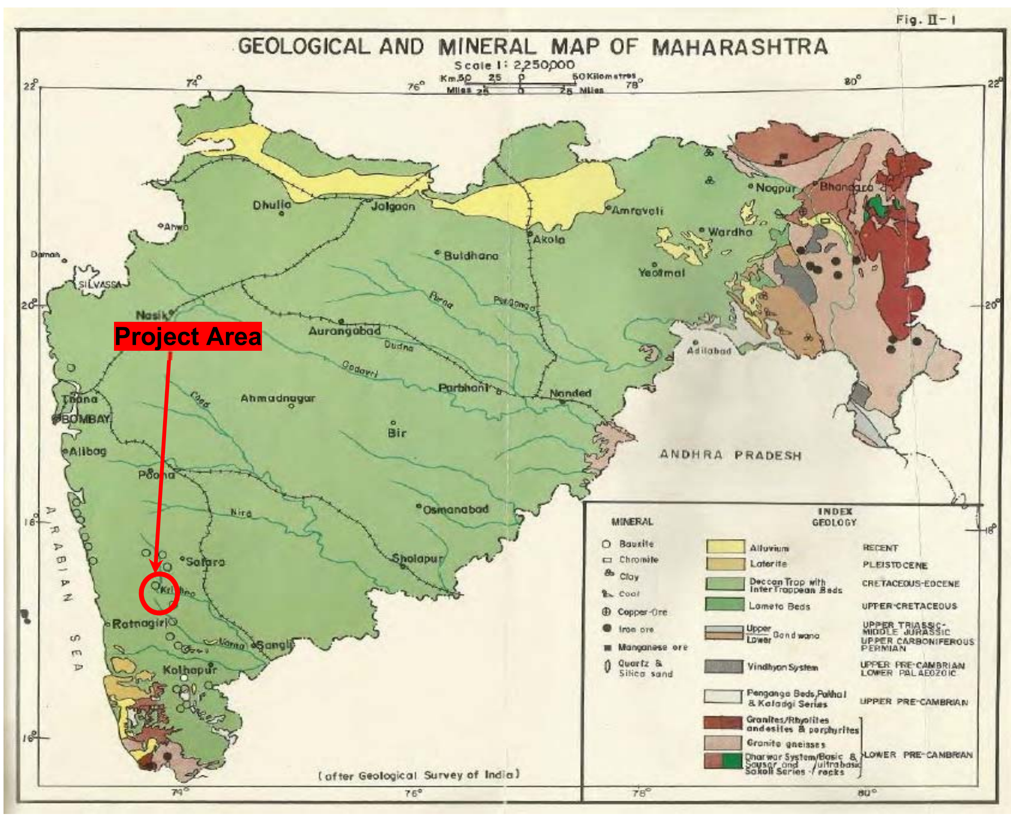


Figure 5.1: Geological & Mineral map of Maharashtra sowing Project area (Source: Geological Survey of India)

Central Ground Water Board, Government of India has also carried out the detailed study of the ground water status in the entire Ratnagiri district form 1980's onwards. The report published by CGWB also shows that the entire Ratnagiri district is occupied by basaltic flows which are overlain by laterites. The project area on the map prepared by CGWB is shown in **Figure 5.2**.

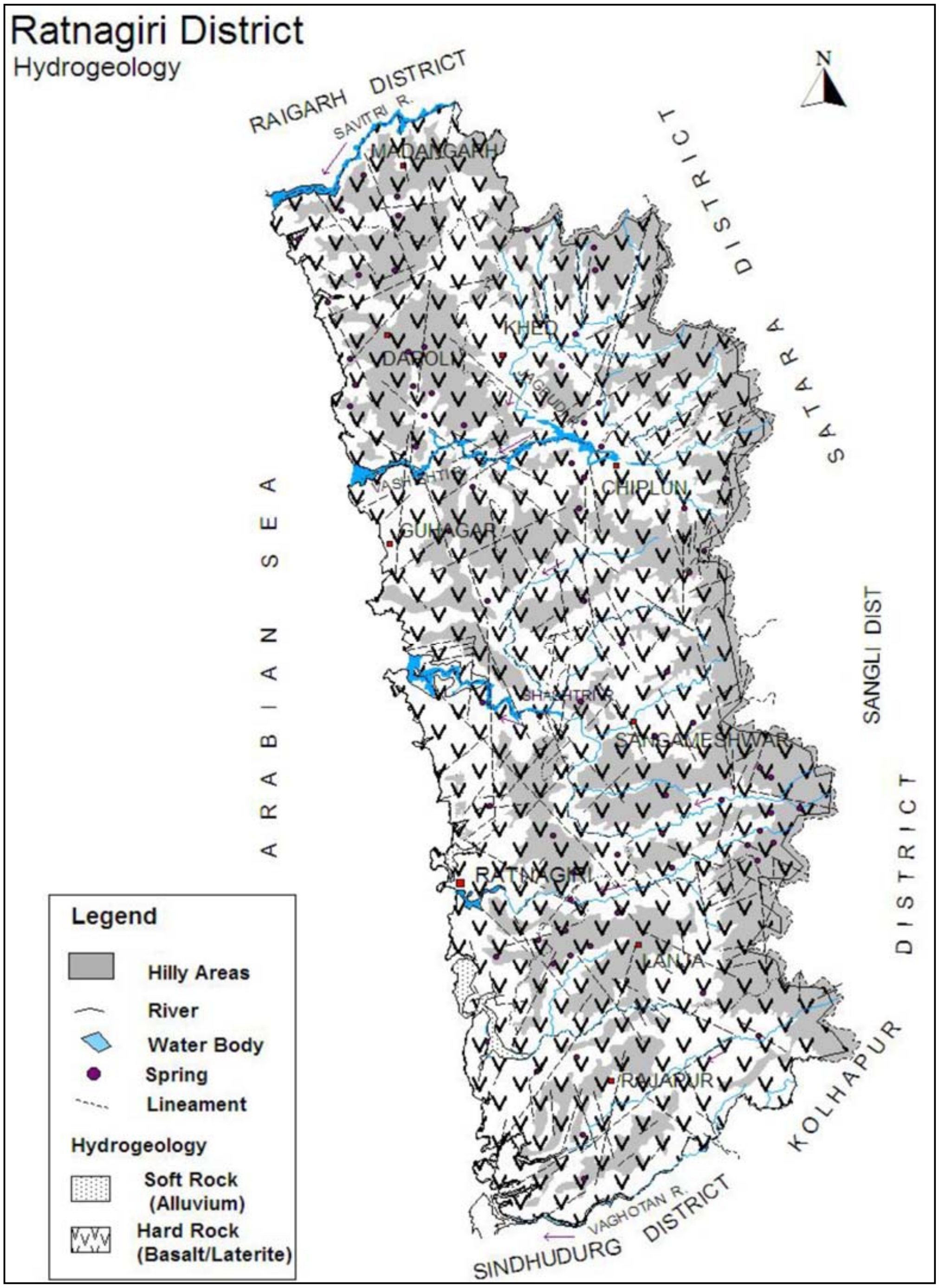


Figure 5.2: Geological map of Ratnagiri District sowing Project area (Source: Government of India, Ministry of Water Resources, Central Ground Water Board, Ground Water Information, Ratnagiri District, Maharashtra)

5.5.2. Physical Condition and Drainage

Chiplun the important tehsil township which lies in the southwestern corner of the area (47G/I0) is situated on Bombay-Goa Highway. The NNW-SSE running Sahyadri ranges forming a scarp, face acts as main water divide in the area. The drainage flows towards the west in the west of it and towards ear in the east of the 'Divide'. The terrain is hilly highly dissected and character rugged topography with high peaks ranging in altitude for 6 m to 8m along the course of Vashishti river to the hi peak of Δ 1116 m to the northwest of Dhangarwadi.

Most the hill ranges in the area have arcuate physiographic expressions. The individual hills are either elliptical or sub-circular in expression with more or less flat tops and steep slopes along the valleys. The Vashishti River running nearly east-west with its tributaries forms the main drainage and drains the water to the Arabian Sea. Above the ghats the drained water flows into the Koyna River.

The area receives heavy precipitation during for season, as much as 4500 mm to 5000 mm. from June to Oct. The area above the ghats experiences relatively less and enjoys temperate climate While areas around. Chiplun, Raigarh (below 'Divide') are temperate to hot in the parts and hot and sultry along, the coastal parts. The maximum temperature is reported to be around 45°C during the summer.

The project area/selected site forms a part of Vashishti river basin which constitutes the major drainage of the area. The location of the selected site on Google earth is shown as **Figure 5.3** while the enlarged view of the same is shown as **Figure 5.4** while the figures showing the actual condition of the site is shown as **Figure 5.5**, **5.6** and **5.7** respectively.

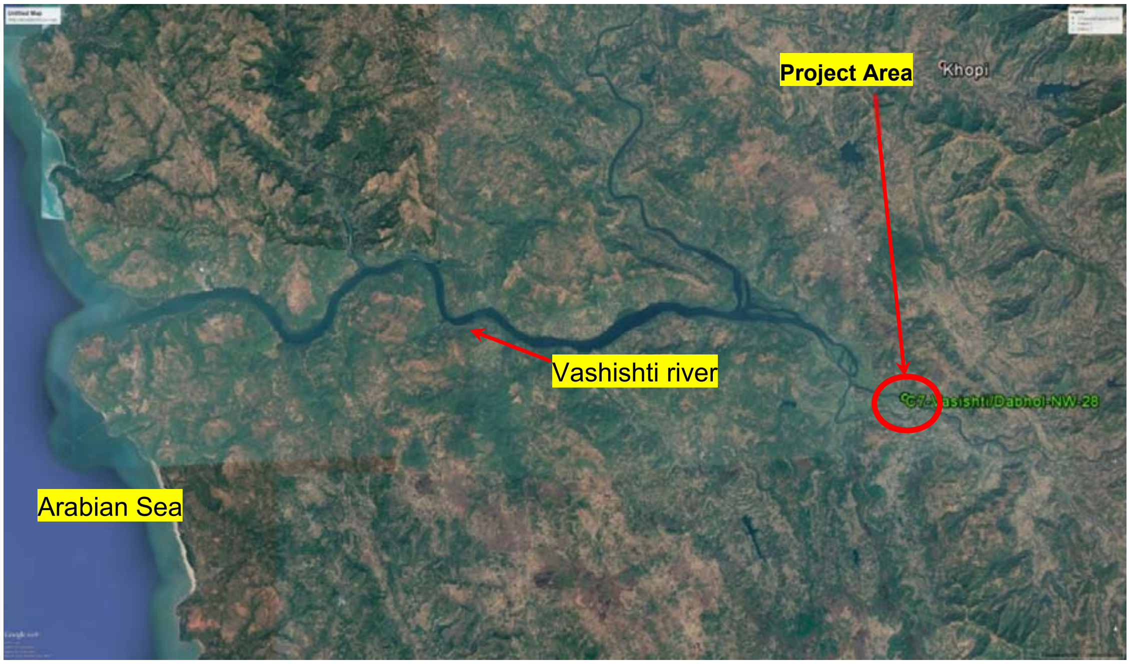


Figure 5.3: Google earth image showing Project area (in Circle)

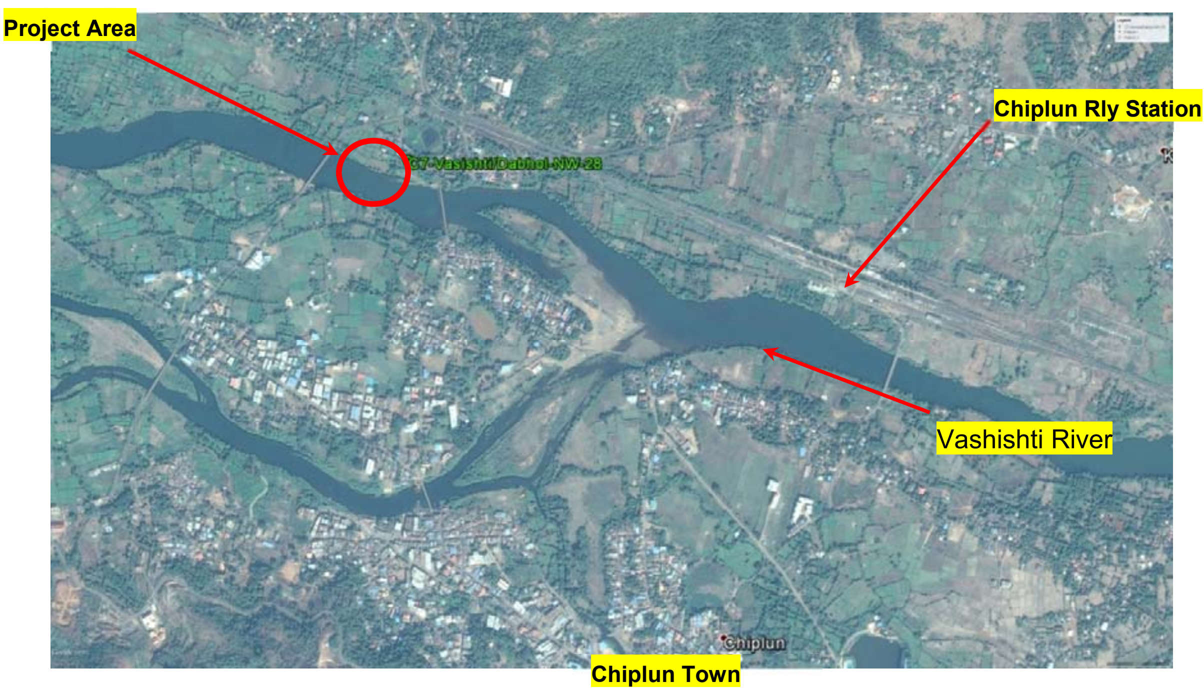


Figure 5.4: Enlarged view of Google earth image showing Project area (in Circle)

Figure 5.5: Image showing River Vashishti and part of selected site (right bank)

Figure 5.6: Image showing River Vashishti and part of selected site (right bank)

Figure 5.7: Image showing River Vashishti and part of selected site (right bank)

5.5.3. General Geology and Stratigraphy

The rock types of the area consist, of Deccan basalt, 1ateriscd at places and associated with thin mantle of soil. The occurrence of alluvia is limited to area in flood plain; along the course of Vashishti River, its tributaries and other perennial streams. The basalts are covered with lateritic deposits which are formed by the decomposition of the basalt with time.

Stratigraphic Sequence

The stratigraphic succession of these rock formations as observed, in the area is as below-

Formation	Age	Thickness
Soil and river alluvia	Recent	--
Laterite	Pleistocene	--
Basalt flows	Cretaceous-Eocene	--

The order of super position of different flows along with thickness of distinct unit had to be built up from study of different hill sections as configuration of all the flows exposed in the area has not been represented in any single section.

Al though maximum altitude in the area is about < 1116 m from. M. S. L., the thick lateritic capping occurring above 960 m. elevation is obscures the study of the basalt flows beyond that level. Thus the pile of lava flows from about 9m msl to about 960 m. had been studied to arrive at the stratigraphic sequence demarcating different flows in chronological order.

The contacts between the flows have been demarcated using usual criteria such as presence of red bole bed or fragmentary top, highly vesicular zones with reddened-tops etc. in case of debris or soil covered areas indirect criteria like break in slope, concentration of boulders overlain immediately by dense basalt along a particular line has been used for fixing the approximate location of flow contacts.

In the area covered, 12 groups of 28 basaltic flows have been delineated. Of these, one is of compound pahoehoe type while the rest are of aa category. Laterite capping the basalt flows is of ferruginous type with cavities at places filled with yellowish, greenish or white clayey material. The concretionary laterite is very rare in the area.

Laterite

The basaltic flow above the level of 15 to 23 m is covered by laterite. It is difficult to determine the actual thickness of the laterite as it is not uniform everywhere. However it has got a 15 m. apparent thickness east of Sandkol. The laterite cover caps about 90% of the area here, while exposures of basalts are only fringing the coastline. As no time lithomargic profile could be seen. The laterite here is therefore probably of secondary nature with very little insitu laterite where it is admixture of primary and secondary. The laterite is having wide range variety in textural characteristic, colour of mineral association. The brick red iron rich patches, aluminous lighter shade varieties and bauxitised patches of light cream colour.

5.5.4. Sub-surface Investigations

The selected site has been investigated by one drill hole (BD-1) which has been drilled for depth of 13.50 m. The detail of the drill hole is tabulated below in **Table 5-2**.

Table 5-2: Summary of Drill hole

Sl. No	Hole No.	Location	Total Drilled Depth (m)	Depth		Thickness (m)	Description of Strata	N-Value	Core Recovery	RQD	Remarks
				From (m)	To (m)				%	%	
1.	BD-1	Centre of Terminal Area, right bank of Vasisthi river	13.50	0	3.5	3.5	Reddish /Brownish Medium Dense Sandy Silty Clay with Gravel	26-R			0.95 m below GL
				3.5	7.6	4.1	Very Dense Silty / Clayey Sand with Gravel	70-R			R stands for Refusal
				7.6	13.5	5.9	Greyish / Brownish Moderately Weathered Basalt.	R	52-88	Nil-78	

The description of the drill hole is as given below.

BD-1: Drill hole BD-1 has been drilled over the terminal location area on the right bank of Vashishti River near Chiplun. The drill hole has been drilled vertically down to the depth of 13.50m from EL.9.25m to EL. -4.25m. The drill hole has encountered 3.50m thick Reddish / Brownish Very Stiff Silty Gravelly Clay after which 4.1 m thick completely decomposed rock stratum was encountered. After this 5.9 m thick Greyish / Brownish Moderately Weathered Basalt was encountered in the drill hole i.e. up to the termination depth. The core recovery in the bed rock varies from 52.00%-88.00% and RQD ranges from 0.00%-78.00%.

The drill hole log and photographs of execution of drill hole and core box are appended in Volume IV- Geotechnical Investigation Report.

5.5.5. Geotechnical Results and Analysis

In-situ Test Results

Six Standard penetration test (SPT) has been carried out in accordance of IS 2131 in the drill hole to ascertain the consistency of the different soil strata. The depth wise N-values from the SPT for soil strata are as tabulated in **Table 5-3**.

Table 5-3: Summary of In-Situ Test Results

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
1	Reddish /Brownish Medium Dense Sandy Silty Clay with Gravel	1.5	2.1	26
		3	3.32	R
2	Very Dense Silty / Clayey Sand with Gravel	3	3.32	R
		4.5	5.1	70
		6	6.28	R
		7.5	7.62	R

Laboratory Test Results

Testing on soil samples from SPT & Undisturbed Samples (UDS)

4 SPT soil samples has been collected from the drill hole from different depths and has been tested in laboratory to know the engineering properties of sub-surface strata like Mechanical analysis, Consistency Limits (atterberg limits), Shear strength parameters, consolidation test, Natural Moisture content, Density, soil classification, specific gravity etc. The details of the soil sample collected and summary of results of the various tests are tabulated in T**able 5-4**.

Table 5-4: Summary of Laboratory Test Results on Soil Samples

Bore Hole	Strata Description	Depth		Sample Type	Density		Natural Moisture Content, w	Mechanical Analysis				Consistency Limits				IS Soil Classification	Shear Strength			Consolidation		Specific Gravity
					Wet	Dry		Gravel	Sand	Silt	Clay	Liquid Limit	Plastic Limit	Plasticity Index, I_p	Shrinkage, S_L		Type	Cohesion	Friction	Compression Index	Initial Void Ratio	
		From	To		Kg/cm³		%	%	%	%	%	%	%	%	%			Kg/cm²	degree	C_C	e_0	G
BD-1	Reddish /Brownish Medium Dense Sandy Silty Clay with Gravel	3.00	3.32	SPT	1.875	1.584	18.35	28	12	19	41	54	27	27		CH	UU	0.104	31			2.63
		4.5	5.10	SPT	1.882	1.549	21.51	22	51	27		32				SM-SC	UU	0.044	31			2.64
		6.00	6.28	SPT	1.893	1.586	19.35	25	51	24		30				SM-SC	UU	0.032	32			2.65

Bore Hole	Strata Description	Depth		Sample Type	Density		Natural Moisture Content, w	Mechanical Analysis				Consistency Limits				IS Soil Classification	Shear Strength			Consolidation		Specific Gravity
	Very Dense Silty / Clayey Sand with Gravel (Completely Decomposed Rock)	7.5	7.62	SPT	1.915	1.64	16.78	22	59	19						SM	UU	0.039	33			2.65

Testing on Rock Core Samples

Three core samples of bed rock recovered from the drilling has been tested in laboratory to know the engineering parameters of the bed rock like crushing load, Point load index, UCS, Water absorption, porosity, Dry density & rock type. The details of the rock sample collected and results of the various tests are tabulated in Table 5-5.

Table 5-5: Summary of Laboratory Test Results on Rock Samples

Bore Hole	Strata Description	Depth		Crushing Load	Point load Index	Uniaxial Compressive Strength	Modulus of Elasticity	Poisson's Ratio	Water Absorption	Porosity	Dry Density
		From	To	Kg	Kg/cm²	Kg/cm²	Kg/cm²		%	%	gm/cm³
BD-1	Greyish / Brownish Moderately Weathered Basalt.	9.0	10.5	1850		95.38	3.0E+04	0.2	1.24	2.54	2.23
		10.5	12.0	6500		277.48	1.0E+05	0.23	1.57	4.21	2.58

Geotechnical Analysis

Bearing Capacity Calculations

The bearing capacity and pile load capacity is worked out based on the following adopted soil parameters.

SOIL PARAMETERS ADOPTED FOR THE ANALYSIS

Depth From (m)	Depth To (m)	Strata Type	Average N Value	Thickness (m)	Unit Weight (kN/m^3)	Cohesion (kN/m^2)	Angle of Internal Friction (Degrees)	Compression Index (Cc)	Initial void Ratio (e_0)
0	3.5	Clay	26	3.5	18.7	10.4	21	0.3	0.8
3.5	4.5	Sand	70	1.0	18.8	4.4	31	-	-
4.5	7.6	Sand	70	3.1	18.8	3.2	32	-	-
7.6	13.5	Weathered Rock							

The bearing capacity is calculated for different size of isolated footing at different proposed depth. The details are given below. The sample calculations are given in **Annexure-5.1**.

SUMMARY OF BEARING CAPACITY CALCULATIONS (KN/M^2)

S. No	Size of Isolated Footing	Depth of Footing (m)			
		1.5	2.0	2.5	3.0
1.	1.5 m x 1.5 m	38	56	87	106
2.	2.0 m x 2.0 m	32	47	75	100
3.	2.5 m x 2.5 m	28	41	67	96
4.	3.0 m x 3.0 m	26	38	61	95

Pile Capacity Calculations

The pile capacity is calculated for different diameters of piles resting over rock. The details are given below. The sample calculations are given in Annexure**-5.2**.

SUMMARY OF PILE CAPACITY CALCULATIONS

S. No	Diameter of Pile (m)	Depth of Pile below NSL (m)	Capacity of Pile in compression (kN)	Uplift Capacity of Pile (kN)
1.	1.0	7.6	774	313
2.	1.3	7.6	1235	465
3.	1.4	7.6	1415	522

5.6. Terminal Infrastructure including equipment

The land area identified is measuring to about 33350 Sq. m and proposed to be taken through Land acquisition. The land requirement with the requirement of facilities for the terminal has been worked out to 30008 Sq. m, which can be accommodated within the Land proposed to be taken on Acquisition.

Considering the Class IV waterway classification, RO- RO facility shall be planned for the terminal location.

Note: The suggested Terminal details are only to the extent of Preliminary Engineering / Design. At this juncture, it is pertinent to mention that the Appropriate provisions and infrastructure are to be catered for “Disposal of Operational waste including the waste oil from vessels berthing at the terminal locations” and the related aspects are to be addressed to / attended to in accordance with the Gazette Notification vide No. 480 dt. 13/07/2016 of Ministry of Shipping {GSR No. 687 (E)} at the stage of Detailed Engineering / Design. In the similar way, the collection and disposal of Pollutants generated, on board vessel, also to be addressed during the Detailed Engineering/ Design.

5.7. Berthing Structure

The berthing structures shall be designed such that they provide safe berthing of barges/vessels without damaging the barges/vessels as well as the structure. The requirements of the berth differ depending on the nature of traffic being handled at the berth. The size of the structure shall depend on the largest vessel likely to use the berth. The berth shall be designed for all possible loads that are likely to act on the structure as per BS 6349 & IS 4651. The total number of berths required for the proposed terminal shall be fixed based on the nature of cargo (if any), traffic, and water level variation. The RO RO berth has been designed for 40ft container loading as per IRC classification.

Deck Level

As per IS 4651 _IV, the deck level of the berthing structure shall be fixed based on the variations in water levels during the monsoon and non monsoon season. Keeping this in view, the deck of RO RO is maintained in a slope of 1:12, maintaining the deck level at the shore side at 1m above the highest water level. On the river side, the deck level is fixed maintaining under keel clearance of 0.5 m below the vessel. The position of vessel approaching the berth shall vary corresponding to the water depth available at site. The fixed ramp shall be submerged in water corresponding to the variations in water level available at site.

Deck Dimensions

The dimensions of the berthing structure are decided on the basis of the dimensions of the largest vessel that are likely to use the terminal facilities as well as the function of the terminal.

TABLE 5-6: Salient Features of berth structure

Description	Length(m)	Width (m)
RORO	63	16.60

The structural arrangement of the berth including the preliminary design has been explained in the chapter 6. (Refer Volume-II Drawing No. **P.010257-W-20341-E04**)

Note: The above Berthing structure has been considered based on the Preliminary Designs, as advised. Before taking up the work in the site, Detailed Engineering/ Design are to be considered.

5.8. Terminal Costing

5.8.1. Capital Cost

Development of 1 Lo-Lo is proposed after attaining the saturation of the existing infrastructure and also after observing the growth trend in cargo. As such, the Ro-Ro terminal operation is viable, only on extension of the subsidy etc. The Capital Cost for the Ro-Ro Terminal is of 38.56 Cr. The detailed cost estimates have been placed in Chapter 11 and its Annexures.

5.8.2. O&M Cost

The item wise Operation and Maintenance cost have been considered as per the circulated parameters, as defined by IWAI, which have been analyzed and considered. Some more assumptions have been considered appropriately, wherever required.

CHAPTER 6: PRELIMINARY ENGINEERING DESIGNS

6.1. River Training (including Barrages and Locks, if proposed)

River training covers those engineering works which are constructed on a river, so as to guide and confine the flow to the river channel. The river training works may serve the objectives as below:

To prevent the river from changing its course and to avoid outflanking of structures like, weirs, aqueducts, etc.

To protect the river banks by diverting the river away from the attacked banks.

To ensure effective disposal of sediment load.

To provide minimum water depth required for navigation.

Barrages are the structures to be constructed to channelize the flow condition duly building up the water depths and controlling the flow according to the requirements in the downstream. For safe navigation with controlled discharges in the waterways, this ideology is applicable. However, the problem of difference in the depth due to the pondage etc. shall be considered by constructing a lock structure for safe passage of the vessels in this zone. This type of "Barrages & Locks" combination is a comparatively costly proposal and such proposals may not be found viable in normal conditions. If such construction has other concurrent advantages, may be economical. Further in the inevitable situation of crossing the deep depth variation, such crossings may be recommended.

6.1.1. River Training through Spurs

Spurs or Groynes are constructed transverse to the river flow extending from the bank into the river. This form of river training works perform one or more functions which includes training the river along the desired course to reduce the concentration of flow at the point of attack by deflecting high velocity flow away from the vulnerable bank. Effectively designed spur-dikes encourage sediment deposition between the spurs and consequently the re-establishment of an eroded bank line. Spurs structures restrict the width of a river channel in low flows, thereby improving its navigability. Different types of spurs are shown in the Figure.

Impermeable spurs do not permit appreciable flow through them whereas permeable ones permit restricted flow through them. Impermeable spurs are constructed of a core of sand or sand and gravel or soil as available in the river bed and protected on the sides and top by strong armour of stone pitching or concrete blocks. Spur-dikes can be constructed from gabions mattresses which may be economical form of construction when the required stone sizes are available from the river bed.

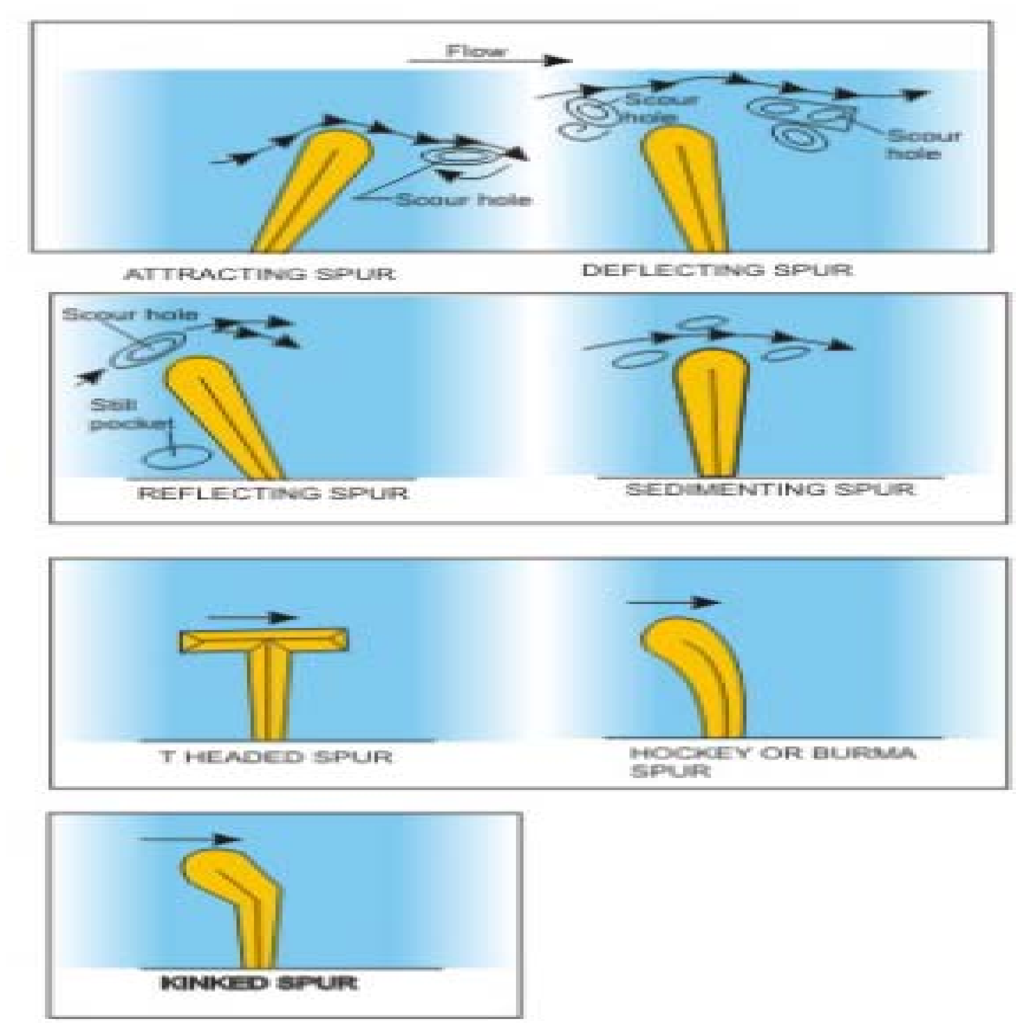


FIGURE 6.1: Different types of Spur

General Design Considerations

Layout of Spurs

Spurs are much more effective when constructed in series as they create a pool of nearly still water between them which resists the current and gradually accumulates silt forming a permanent bank line in course of time. In general, in the T-shaped spurs, greater length of the cross spurs projects upstream and a smaller portion downstream of the main spurs. Typical plan view of system of spur-dikes is shown in below Figure.

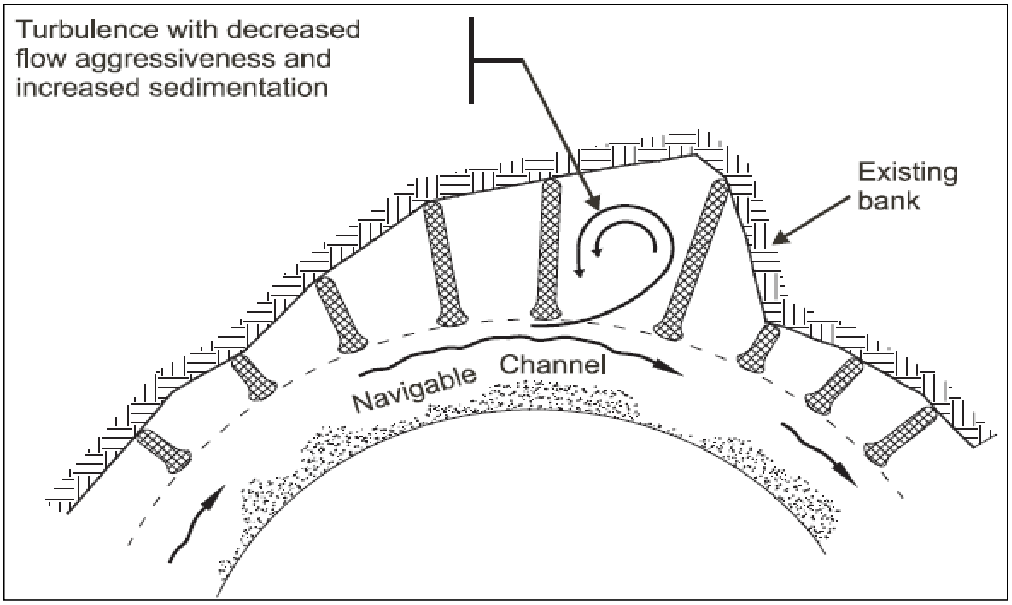


FIGURE 6.2: Plan view of system of spur-dikes constructed to control and stabilize the erosion of the outer band

Spacing

Each spurs protects only a certain length. The stability of eddies is govern by the non-dimensional spur ratio, $e_{sp.}$, which is ratio of the head loss in the river between two spurs, $U^2 S_{SP} / (C^2 h)$ (m), to the velocity head $U^2 / (2g)$ (m) of the river.

Where,

U = depth-averaged velocity (m/s)

S_{SP} = spacing between spur-dikes (m)

C = Chezy coefficient of the river ($m^{0.5}/s$)

h = cross-sectional average water depth of the river (m)

$e_{SP} = (2g S_{SP}) / (C^2 h)$,

e_{SP} should never exceed 1.

For the navigational requirement

$S_{SP} / B = 0.5$ to 2

Where B= width of the constricted river (m) as shown in Figure below.

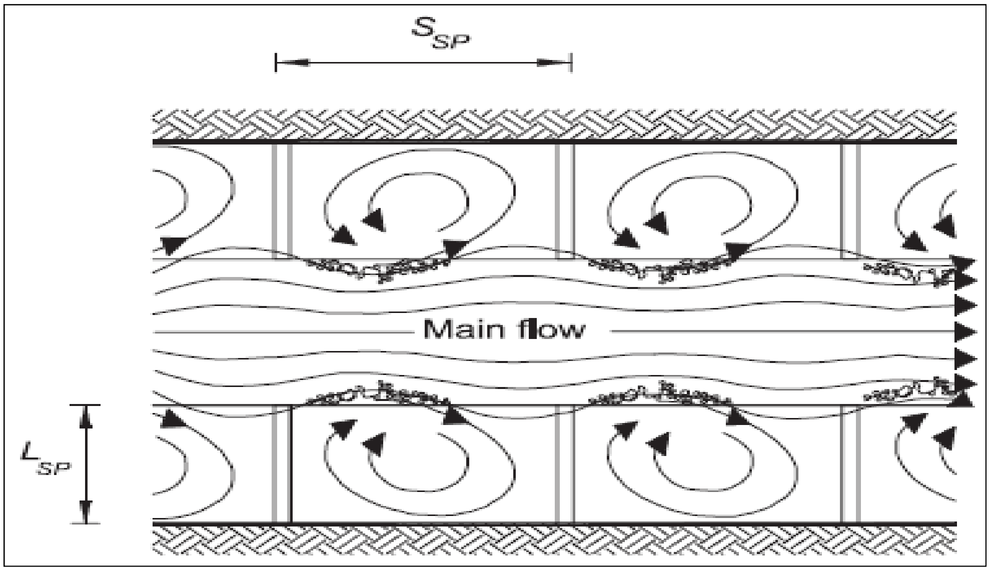


FIGURE 6.3: Diagram showing the length and spacing of the individual dikes with respect to the river width

In general, the prime factor for spur spacing between adjacent spurs is their lengths. Generally, spur spacing adopted = 2 to 2.5 time the length of spur at convex banks and Spur spacing = Length of spur at concave banks

Length

The ratio of spacing of spur to its length (SSP / LSP) varies from 1 to 6.

Length of spurs depends upon the position of the original bank line and the designed normal line of the trained river channel. In erodible rivers, too long spurs may get damaged and cause failure. Hence, it is suggested / recommended to construct shorter ones in the beginning and extend them gradually, after due site observations.

Top width of spur

The top width of spur is kept as 3 to 6 m at formation level.

Free board

The top level of spur is kept with a free board of 1 to 1.5 m above the highest flood level for 1 in 500 years flood or anticipated highest flood level, whichever is more.

Side slope

Slope of upstream shank and nose is generally kept not steeper than 2:1. Downstream slope is kept which varies from 1.5:1 to 2:1.

Size of stone of pitching

Stones are placed over filters so that fines do not escape through the interstices of the pitching. For average velocity up to 2 m/s, burnt clay brick on edge are used as pitching material. For average velocity of 3.5m/s, pitching of stone weighing from 40 to 70 km (0.3 to 0.4 m in diameter) and for higher velocities, cement concrete blocks of depth equal to the thickness of pitching can be used.

Thickness of pitching

Thickness of pitching is determined from the formula,

T = 0.06 Q 1/3,

Where, Q = design discharge in Cumecs.

Thickness of stone need not be provided the same through-out the entire length of spur. It can be progressively reduced from the nose.

Provision of filters

In general, Filters are provided below the pitching at nose and on the upstream face for a length of 30m to 45m from the nose. The thickness of the same may be 20 cm to 30cm. The thickness for the next 30m to 45 m on the upstream face may be reduced to about 15cm and beyond that, it can be omitted. However, may also refer the codal provisions, if available.

A typical layout of a spur is shown in Figure.

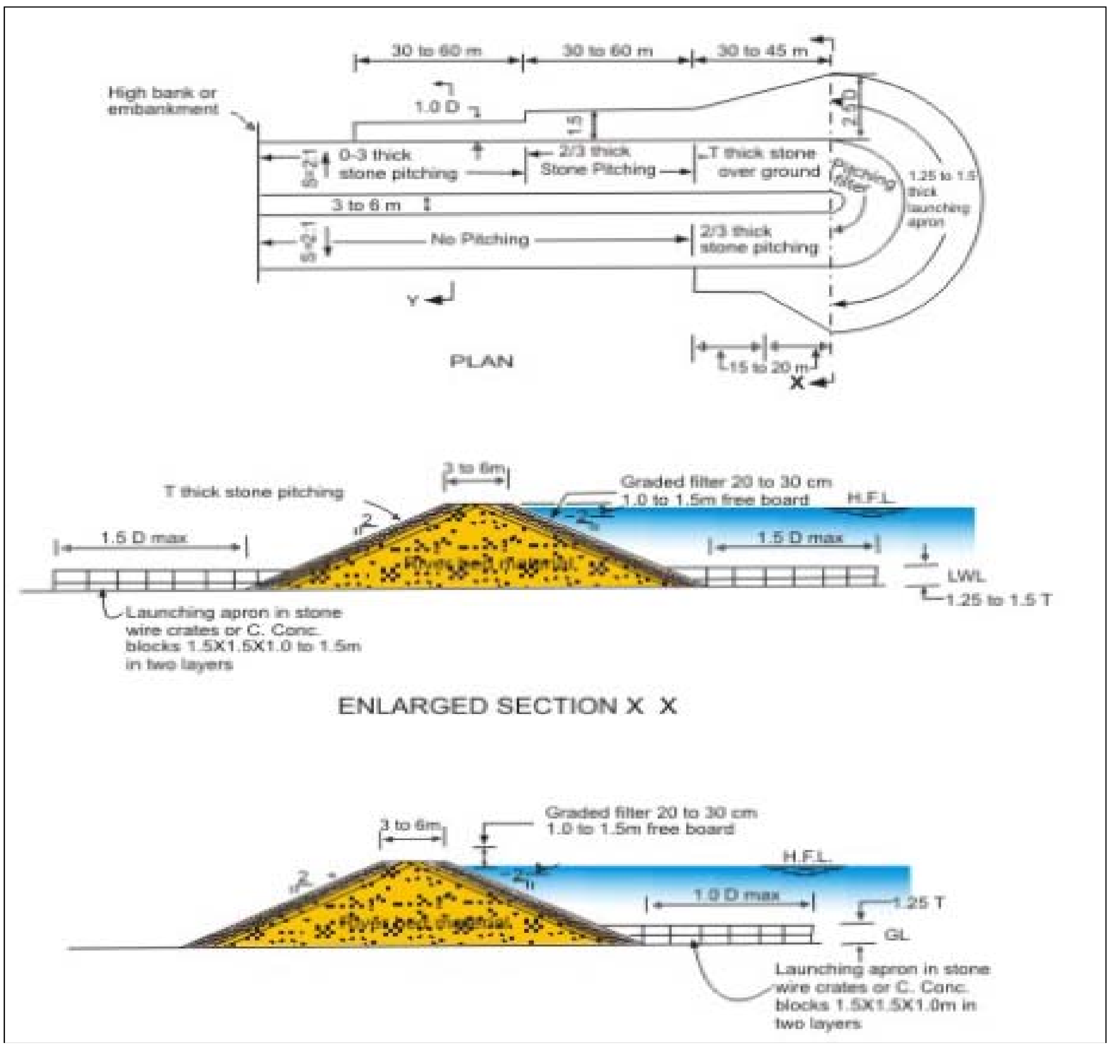
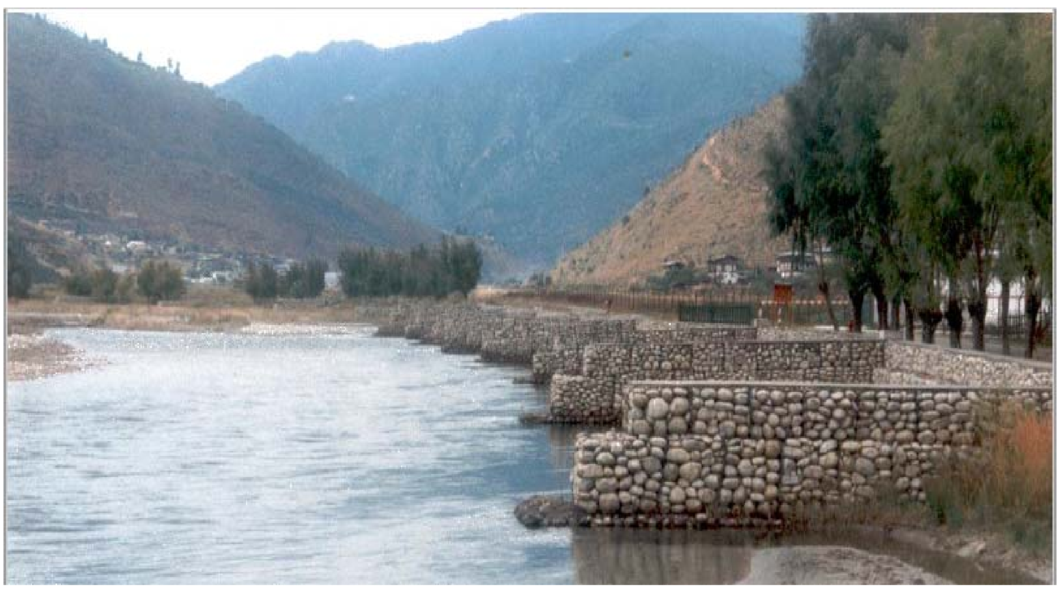


FIGURE 6.4: Typical layout and section of spur

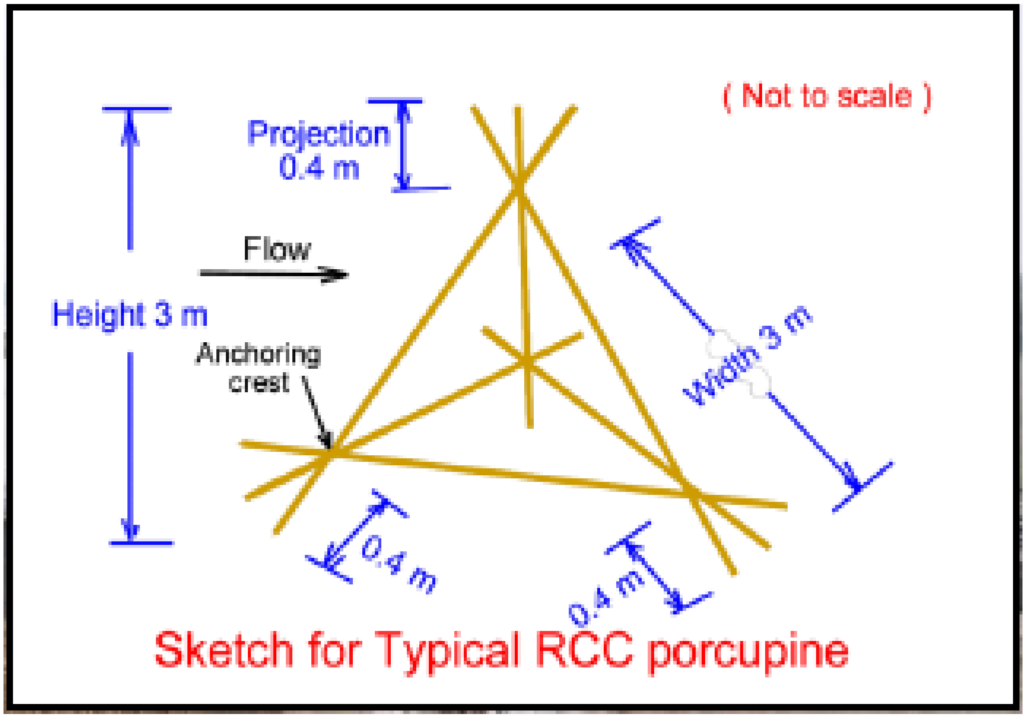
Impermeable spurs



Series of spurs

6.1.2. River Training through Porcupines

River Training through RCC Porcupines are coming up nowadays and the same is under consideration on NW 1 for various activities including the Flood mitigation and taming of the river. Accordingly, the same also is under consideration for the study stretch, wherein the Design and Photos are placed herewith.



6.2. Bank Protection

6.2.1. Basis of Design

The following specifies design principles, criteria and requirements to be taken into account for the design of the Bank Protection / Revetments.

All the banks are within a floodplain and made up by sand, silt and clay. This soil type may present different failure modes, such as scour, loss of fines, erosion, piping, etc. A special attention is to be paid to overall and local geotechnical failures. It is suggested to consider the required investigations at site and Detailed Engineering Designs etc., based on the soil parameters at the site.

There are many materials available in the market to be used for revetments, i.e., box gabions, block stone, cabled concrete blocks, dense stone asphalt, gabion mattresses, grouted stone, hand-pitched stone, in-situ poured concrete, loose concrete blocks, precast concrete slabs, open stone asphalt, soil reinforcement systems, etc.… The selection of the type of material is based on a trade-off between hydraulic/geotechnical performances, construction related aspects (availability and supply, equipment and labor, access and infrastructure, etc…) and costs

Gabion revetments at the site shall be considered in the present study stretch. As the gabions do not need special equipment nor high-skilled labour for execution, their maintenance is not cumbersome and further they are more durable and economical than geotubes or geobags.

A. Design Principles

Applicable Codes, Standards and Guidelines

The following national design guidelines shall be used while carrying out the design of the revetment and the embankment:

- IS1893 (Part1): 2002. Criteria for earthquakes resistant design of structures
- IS7894: 1975. Code of practice for stability analysis of earth dams
- IS8408:1992. Planning and design of groins in alluvial rivers
- IS10751:1994. Planning and design of guide banks for alluvial rivers
- IS12094:2000. Guidelines for planning and design of river embankments
- IS14262:1995. Planning and design of revetment guidelines
- IS11532:1995. Construction and maintenance of river embankments.
- Escarameia M. (1998). River and Channel revetments: a design manual. Thomas Telford Publications, London.
- Bezuijen A. and Vastenburg E.W. (2013). Geosystems: Design Rules and Applications. CRC Balkema.
- PIANC (2015). Guidelines for Protecting Berthing Structures from Scour Caused by Ships. Report no. 180.
- PIANC (2014). Harbour approach channels design guidelines. Report no. 121.
- CIRIA, CUR, CETMEF (2007). The Rock Manual. The use of rock in hydraulic engineering (2nd edition). C683, CIRIA, London.

- Pilarczyk, K.W. (2000). Geosynthetics and Geosystems in Hydraulic and Coastal Engineering. Taylor & Francis Group, London & New York.
- Lafleur, J. (1999). Selection of geotextiles to filter broadly graded cohesionless soils. Geotextiles and Geomembranes, 17(5), p. 299-312.
- BAW (1993). Code of practice - Use of geotextile filters on waterways. BAW, Karlsruhe.
- Craig, R.F. (1987). Soil mechanics. Chapman and hall, 4th edition.
- Maccaferri (2014). *Stone fill for gabions.*
- PIANC (1987) Guidelines for the design and construction of flexible revetments incorporating geotextiles for inland waterways.
- Gary E.F and J. Craig. (2000). Gabions for Streambank Erosion Control.
- EN 1997 Eurocode 7 – Geotechnical Design.
- BAW (2010). Principles for the Design of Bank and Bottom Protection for Inland Waterways (GBB).
- Blaauw H.G. & van de Kaa E.J. (1978). Erosion of bottom and sloping banks caused by the screw race of manoeuvring ships. Publication no. 202, July 1978. Delft Hydraulics Laboratory.
- Dash S.K., Dutta S., Sreedeep S. and Rao G.V. (2013). Design of a Bank Protection System on River Brahmaputra at Jamuguri. . The Masterbuilder, October 2013.

B. Design Vessel

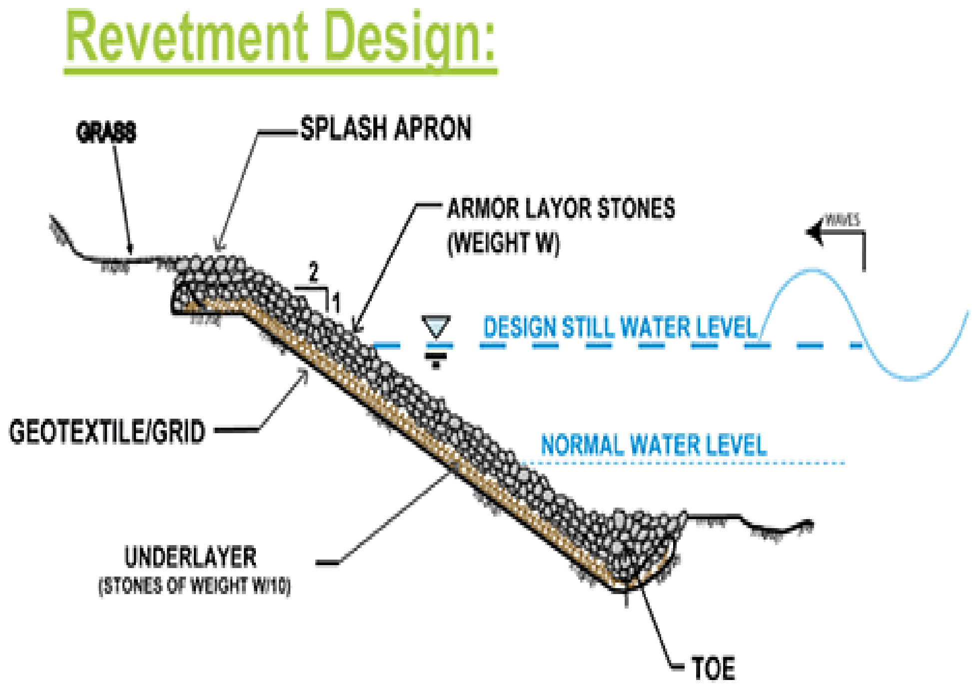
Vessel features are important in the design because moving vessels induce waves and currents in the river, which are a hydraulic load on the bank and river bed. These parameters will influence the design of the free board, the hydraulic stability of the structure and the size of the scour protection respectively for the revetments and the embankments.

C. Design requirements for Revetments

Gabions are wire mesh baskets filled with crushed rock. They are filled in situ, with locally available material and thus have a low capital cost. Because they are flexible and porous, they can absorb some wave and wind energy, thereby reducing the scour problems.

Gabions should be placed as sloping revetments with a preferable slope of 1:2 (Refer Volume-II **Drawing No.P.010257-W-20303-X04** for details).

Subdivided into equal sized cells, standard gabion baskets are of thickness 1, 1.5 and 3 feet and are available in lengths of 6, 9 and 12 feet.



D. Filter

A geotextile filter is required to prevent the underline sand being washed out through the gabions.

E. Toe protection

To prevent the sliding and failure of the revetment on the slope, a toe protection is required.

F. Anchoring

Proper anchoring is required for keeping the revetment in place. For this purpose the revetment will be extended both upstream and downstream.

Anchorage is required at the top of the submerged bank. It needs to be extended and anchored in the upper bank with a top key.

G. Hydraulic and Geotechnical Design

1) Revetment

a. Stone size

The minimum size of the stones should not be less than the ones specified in Figure. The figure is based on following assumptions:

- δ = friction angle between the geotextile bag surface and the subsoil, 20 degrees is recommended to be a conservative value;

- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made;
- The specific gravity of the stones is 2.65.

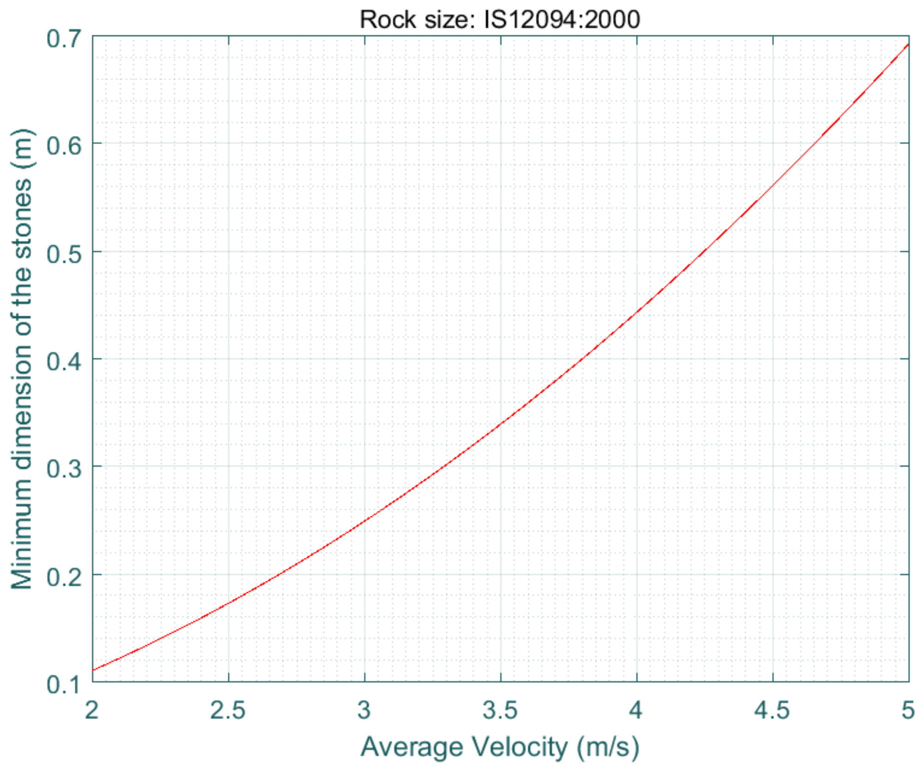


FIGURE 6.5: Minimum rock size according to the IS12094

From the above figure, it can be inferred that for average velocities higher than 3-4 m/s the rock size becomes very high. Under such circumstances small stones in crates or gabions are generally used. Therefore the use of gabions is proposed as alternative for the revetment.

b. Gabion size

The formulation of Pilarczyk allows accounting for additional phenomena compared to the national codes (IS12094). This formulation is referred to standard guidelines such as PIANC. Therefore it is proposed to use that formula to perform a sensitivity analysis and to include more local effects (like the turbulence expected in the bends, difference between continuous layer and edges/transitions and influence of the propeller jet). It should be kept in mind that near the terminal the river current and the propeller can act together, for that case the formulation can be expressed as:

$$\Delta D = \phi_{sc} \frac{0.035}{\psi_{cr}} k_s^{-1} \frac{(k_{h1} k_{t,r}^2 V_h^2 + k_{h2} k_{t,p}^2 V_r^2)}{2g}$$

Where:

- D = characteristic dimension/ thickness [m];
- Δ = relative density of the system (=1.17). According to the IS12094 the porosity for gabions can be computed as follows:

$$\Delta_t = (1-e)\cdot\frac{\rho_s-\rho_w}{\rho_w}$$

$$e = 0.245 + \frac{0.086}{D_{50}^{0.21}}$$

- D_{50}= mean diameter of the stones (= 0.30)
- *Sb* = Specific gravity of the stones, 2.65
- V_h = Maximum velocity of the propeller jet at the bottom [m/s];
- V_r = Maximum velocity of the currents at the bottom [m/s]
- ϕ = stability parameter, depending on the application (1, for gabions placed in edges or transitions and 0.75 for continuous top layer)
- Ψ = Shields parameter (0.07, gabions)
- $k_{t,r}^2$= turbulence factor of the river current (1.5 higher turbulence at river bends)
- $k_{t,p}^2$= turbulence factor of the propeller yet (3-4, load to the water jet)
- K_s = factor related to the slope angle

$$K_s = \sqrt{1-\left(\frac{\sin\alpha}{\sin\delta}\right)^2}$$

- δ = friction angle between the gabion surface and the subsoil, 20 degrees is recommended to be a conservative value (for rip-rap is equal to 40 degrees)
- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made
- K_{h1} = factor related to the depth (1 for a very rough current). This factor translates the depth-averaged flow velocity into the flow velocity just above the bottom protection. The roughness of the gabion depends on the stone size and the height of the gabion, among other things. Therefore a value of 1 is chosen as a very conservative value to account for uncertainties in the vertical velocity field distribution and the roughness of the gabion.
- K_{h2} = factor related to the depth. For propeller jet PIANC (2016) recommends to use 1

In **Figure**, the minimum rock size for the gabions is shown. Assumptions have been taken for the calculation of the velocity and turbulence factors applied for the river currents.

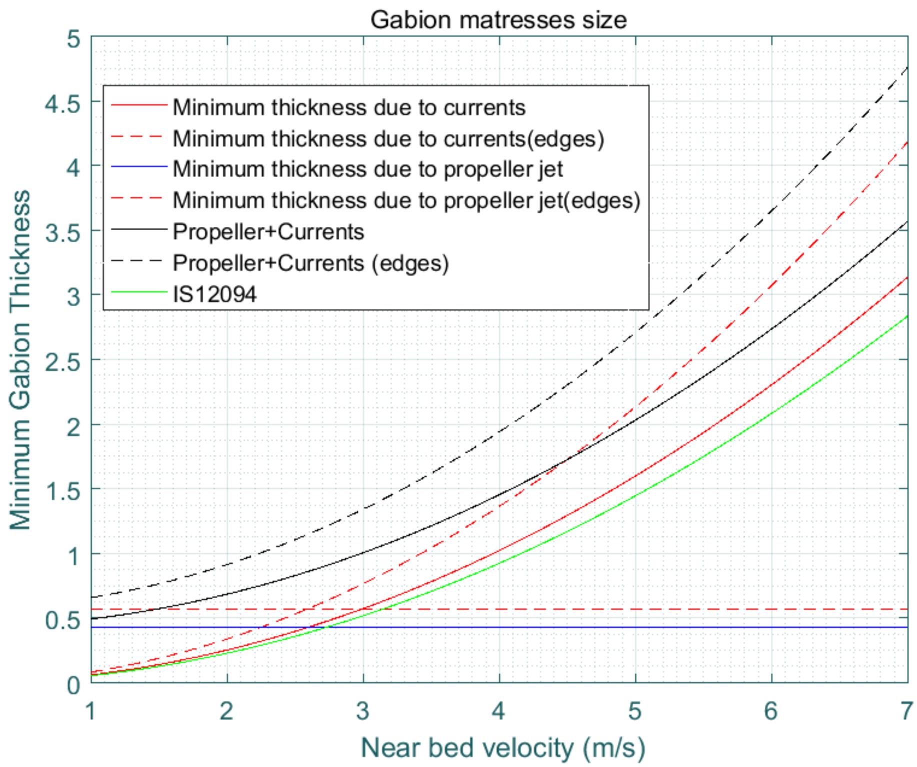


FIGURE 6.6: Minimum required thickness for revetment

The values given by Pilarczyk are chosen for the design since they allow for certain optimization. It should be noticed that, when changing slopes, the thickness of the gabion mattresses should be increased to account for the effects of the turbulence present on the transitions. The scour protection is considered as an edge of the revetment because high turbulence is also expected.

It is expected that the waves / currents calculated in section will not have any impact in the design. For revetments the required thickness to withstand wave / current loads can be worked out with next conservative formula (Klein & Pylarczyk, 1998):

$$\frac{\mathrm{H_s}}{\Delta \mathrm{D}} = \frac{9\cos(\alpha)}{\varepsilon_{op}^{2/3}}$$

- D = characteristic dimension/ thickness [m];
- Δ = relative density of the gabion
- α = slope angle of the structure, because the slope angle is unknown, an assumption of 1V:2H is made
- ε_{op}= Breaking parameter

$$\varepsilon_{op} = \frac{\tan(\alpha)}{\sqrt{\frac{\mathrm{H_s}}{1.56Tp^2}}}$$

c. Rock specifications

It is proposed to use a light grading which is appropriate for amour layers produced in bulk, usually by crusher opening. The size of the stone should be such that its length, width and thickness should be more or less the same. Round stones or very flat stones having small thickness should be avoided.

Standard grading should be used whenever possible. Determination of the gradation of the granular material is important for a number of reasons: 1) the packing and the volumetric layer porosity depend on the overall slope of the grading curve, 2) phenomena such as filtering and piping are governed by the gradation.

In Table 6.1 Some assumption for the rock grading are shown according to EN13383. Different rock layers are required to fill a determined gabion. In this sense the same table provides guidance on the amount of layers needed to fill a gabion.

TABLE 6-1: Typical Values for a grading of 10 to 60 Kg [1](following EN13383)

Grading (kg)	ELL	NLL	NUL	EUL	D_{n50}	D_{50}	Kt	nlayer	Ltmin
10-60	2	10	60	120	0.25	0.30	0.96	1	0.24
10-60	2	10	60	120	0.25	0.30	0.96	2	0.48
10-60	2	10	60	120	0.25	0.30	0.96	3	0.73
10-60	2	10	60	120	0.25	0.30	0.96	4	0.97
10-60	2	10	60	120	0.25	0.30	0.96	5	1.21
10-60	2	10	60	120	0.25	0.30	0.96	6	1.45

The major consideration in the design of gabion structures is the expected velocity at the gabion face. The gabion must be designed to withstand the force of the water in the stream. However the median stone size for gabion mattresses has to be in such a way that movement of the filler stone in the mattresses is prevented. This eliminates deformation that can occur when stone sizes are not large enough to withstand the forces of the water. The result of mattress deformation is stress on the basket wire and increases the resistance to flow and the likelihood of basket failure. A recommended value of a d_{50} in function of the water depth depends on manufacturer experiences; however some formulas are available in the literature (Gary E.F, J. Craig, 2000):

[1] *G=Grading Denomination, ELL= the mass below which no more than 5 per cent passing by mass is permitted, NLL= the mass below which no more than 10 per cent passing by mass is permitted, NUL= the mass below which no more than 70 per cent passing by mass is permitted, EUL= the mass below which no more than 97 per cent passing by mass is permitted, Dn50=Maximum Foreseen medium nominal diameter, D50= mean stone diameter (D50=Dn50/0.84), Kt= Layer thickness coefficient, Lt= layer thickness*

$$d_m = S_f C_s C_v d\left[\left(\frac{\gamma_w}{\gamma_s - \gamma_w}\right)^{0.5} \frac{V}{\sqrt{gdK_1}}\right]^{2.5}$$

Where:

- C_s = Stability coefficient (= 0.1), C_v = Velocity coefficient (= 1.25), S_f = safety factor (= 1.1)
- d_m = average rock diameter in gabions
- d = local flow depth at V
- V = depth average velocity (= 4 m/s)
- γ_s = unit weight of stone (2650 kg/m^3)
- γ_w = unit weight of the water (1000 kg/m^3)
- K_1 = side slope factor (= 0.98 for a slope of 1:3)

Figure below shows that for a medium stone diameter of 0.3 m and for the design velocity of 2.5 m / sec, the grading 10-60 kg is suitable.

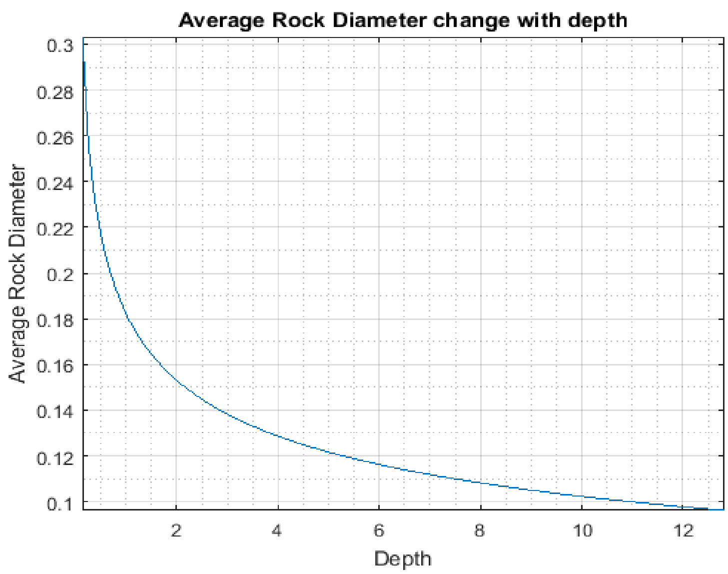


FIGURE 6.7: Minimum average rock diameter

The table below shows the properties from a well-known supplier (Maccaferri, 2014) for a durable stone fill for gabions:

TABLE 6-2: Technical specs for stone fill for gabions

Property	European standard references	Suggested requirements
Mechanical strength	Los Angeles, LA (EN 1097-2:1998) Fragmentability, FR (EN 1097-2:1998)	LA < 45 or LA > 45 and FR < 7
Resistance to attrition	Micro-Deval (EN 1097-1:1996) Fragmentability FR (EN 1097-2:1998)	MDE < 45 or MDE >45 and FR < 7

Property	European standard references	Suggested requirements
Resistance to freeze and thawing	EN 13383-1:2002	Category for FT_A (as assessed by loss of mass during testing): Loss of mass < 0.5%
Density of rock	EN 13383-2:2002	Apparent density > 2.2 t/m3
Amour stone grading	EN 13383-1:2002	CP90/180 or equivalent
Type of rock	Petrography	Calcareous, siliceous, metamorphic or igneous rock

d. Gabion specifications

The gabion basket is a double twisted wire mesh of variable sizes, uniformly partitioned in cells. A typical gabion has dimensions of 2 m length x 1 m width x 1 m height and comprises of a mesh type 80 mm x 100 mm. At the terminals, a mesh of 80 mm x 100 mm and a height of 1.4 m is proposed. A gabion mattress consists of gabions with relatively small height dimensions compared to length and width and would usually be of a smaller mesh type. A typical gabion mattress would have dimensions of 6 m length x 2 m width x 0.6 m in height and comprise mesh type 60 mm x 80 mm. At the terminals, a mesh of 60 mm x 80 mm and a height of 1-1.4 m is proposed.

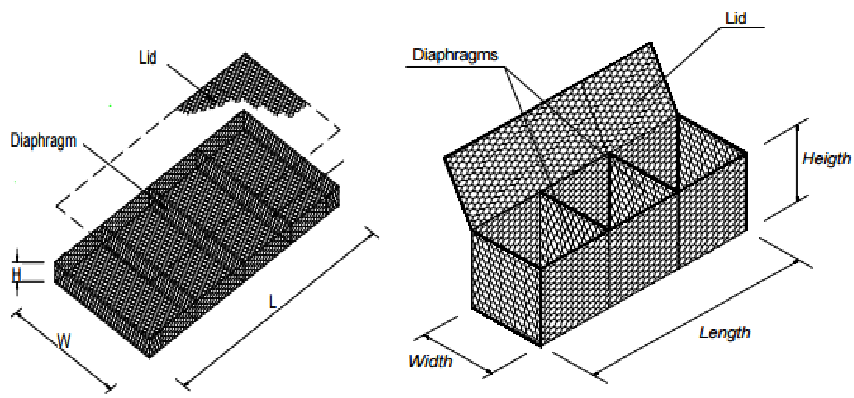


FIGURE 6.8: Example of a gabion mattress and gabion basket

According to IS14262:1995 gabions should be laid with the longer dimension along the slope of the bank. The size of the mesh of the crate should be smaller than the smallest stone in the crate. The mesh should be double knotted. Wire of minimum diameter of 4 mm should be used for crates. Crate units may be tied to each other by 5 mm wire.

A summary of the relevant European standards for gabions are given in table below, some suggestions are cited following the recommendations of the Rock Manual (CIRIA et al., 2007). Notice IS rules are more strict than EN for wire minimum diameter and those should be respected.

TABLE 6-3: European standards for the wire mesh

Wire Properties	European testing	Content
Steel wire composition	EN 10218-2:1997	Steel composition, strength
Steel mesh composition	EN 10223-3:1998	Mesh 60 mm x 80 mm wire: d = 2.2 or 2.4 mm Selvedge wire= 2.7 mm Mesh 80 mm x 100 mm wire: d = 2.7 mm Selvedge wire = 3.40 mm
Corrosion protection (galvanising)	EN 10244-1:2001 EN 1024402:2001	Thickness of the coating conforms to class A, mass of coating mc, depends on wire diameter: d = 2.2or 2.4 mm, mc = 23- g/m^2 d = 2.7 mm, mc = 245 g/m^2
Corrosion protection (polymer coating)	EN 10245-1:2001 EN 10245-2:2001 EN 10245-3:2001	Requirements for organic coating, PVC or PE, thickness, composition, strength, durability, flexibility
Tensile strength	EN 10223-3	60 mm x 80 mm: Tensile = 35 kN/m 80 mm x 100 mm: Tensile = 51 kN/m
Elongation	EN 10233-3	Elongation shall not be less than 10%

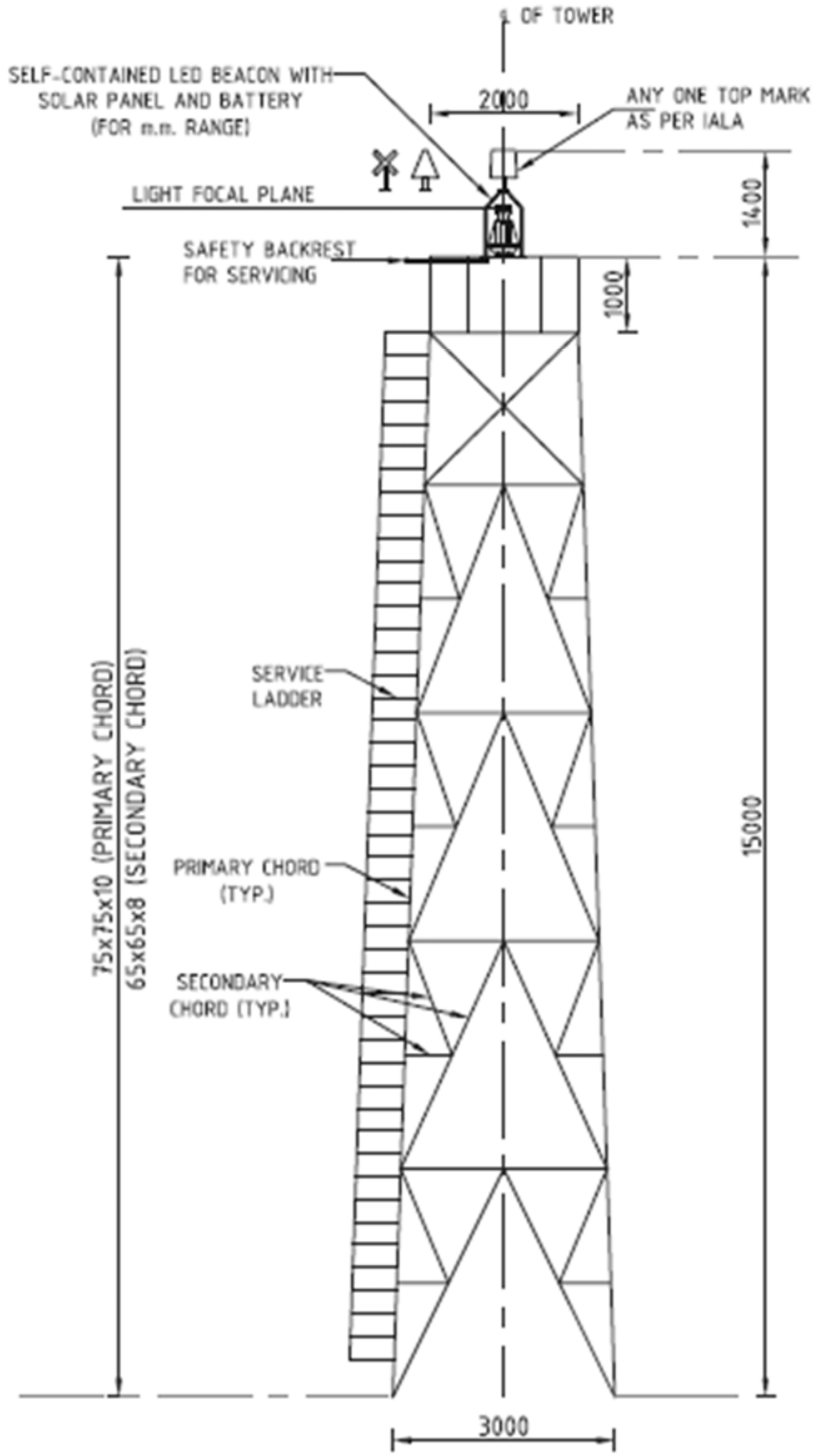
6.3. Navigation Aids

The Navigation system is of Two Types i.e., one is shore based and the other is water body based. The provision of Light is common in both the cases showing the Day / Night Marking system. The left / right marking during the day / night can be controlled through colour coding system. These aspects are being elaborated with guidelines by IALA at international level and are being followed in India also.

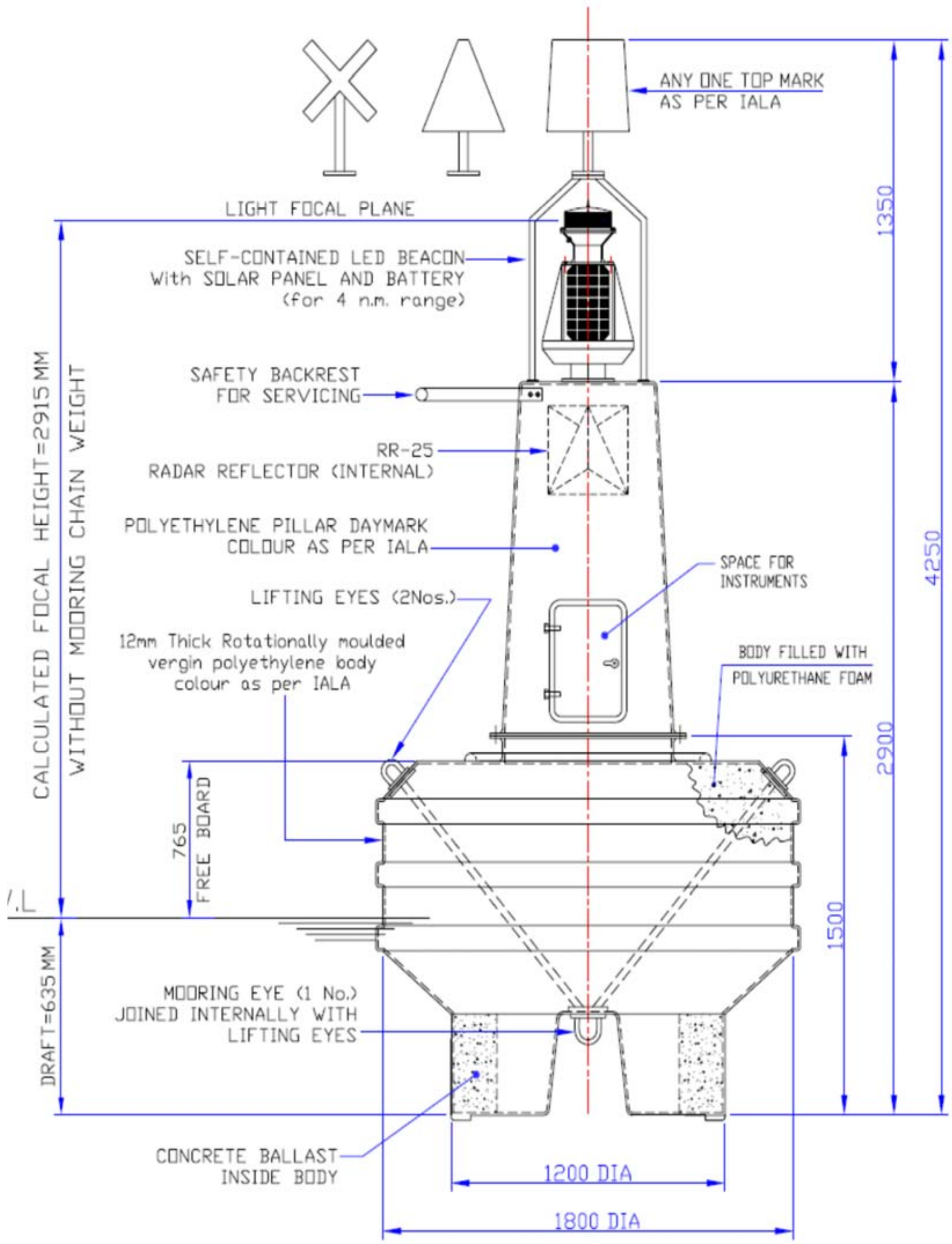
In the Shore based system, for the west flowing National Waterways of Cluster 7 and Cluster 6, it has been preferred to have a Beacon / Light system, wherein the Buoy / Light system has been preferred.

The standard preliminary Design with drawing / along with specifications is placed hereunder.

BEACON WITH LIGHT SYSTEM:



BUOY WITH LIGHT SYSTEM:



POLYETHYLELENE CHANNEL MARKING BUOYS: (PORT HAND) 1 No. - PEB/1 800 Polyethylene Buoys, each complete with Day mark, Top Mark and Radar Reflector. Main features are as given below:

Body Diameter: 1800 mm / Wall Thickness : 12 mm thick body / Body Material : Rotationally moulded in low density UV-Stabilized virgin polyethylene / Foam : Body filled with Closed Cell Polyurethane Foam / Weight without Mooring : 645kg (approx.) / Focal Height : 29 15 mm / Draft : 635 mm / Free Board : 765 mm / Reserve buoyancy : 1893 kgs / Displacement : 26.0 kg./cm of immersion / Mooring Eyes : 1 No. of Steel / Lifting Eyes : 2Nos / Body Colour : As per IALA system, UV- stabilised colour pigments mixed thoroughly with polyethylene powder before moulding operation / Daymark : P E Module (as per IALA system) / Radar Reflector : RR - 25 as specified (25M2).
1 Set - Mooring gear – Each set comprised of the following:

1 No. - 3M x 26 mm dia open link chain with enlarged end links.
1 No. - 15M x 26 mm dia open link pendant chain with enlarged end links.
4 Nos. - 26 mm nom. dia forelock end shackles.
1 No. - 26 mm nom. dia swivel piece with end links.
1 No. - 250 kg. M.S. stockless Anchor.

Note: The chains shall be made as per 1S4692, shackles and swivel as per IS 4484 and stockless steel Anchor. The chain shackles and swivel shall carry proof load test certificate witnessed by the IRS. All the above shall be given one coat of coal tar paint.

Solar Operated LED lighting 1 No. MLB-200-4 Self contained LED beacon fitted with PLC-12 programmable LED controller. Specification of Each Light is as detailed below:

Luminous range: 4 n. miles. (T 0.74) / Light Colour: as per IALA System. (Red) / Light Source : High intensity Light Emitting diodes (LEDs) with UEP to 60,000 hrs of burning life / Optical system : 200 mm dia clear polycarbonate UV stabilized diffuser lens / Lantern Body : High impact polystyrene / Cable entry : M I6 Cable glands fitted / Fixing : 4 fixings for Ml 0 bolts at 200 mm PCD / Lantern weight : 3.0 kg (approx.).

1 No. - PLC 12 programmable microprocessor based LED controller (fitted in the base of the Lantern). Main description is given as below:

Input Voltage: 12 V to 18 V d. c / Output Voltage: Switch-mode stabilized to suit LED operating current / LED load (max): upto 12 Amp. at 12 V d.c / Light Character: Any of the 256 IALA character can be selected / Solar charge regulator: Provided in the PLC-12 circuit / Light control: Automatic ON/ OFF by Photo diode / Protection: Against reverse polarity and excessive input voltage / Temperature range : -20°C to + 60°C.

SOLAR SUPPLY SYSTEM FOR MLB-200-4 LED Light: 1 Set — Solar supply system as detailed below:

4 Nos. - 12V 5 watt solar panel / 1 No. – 12 V 42 AH sealed, maintenance free battery / Autonomy period = 21 days Light Assembly : Lantern, Solar panel and battery are mounted on the GRP box, all assembled and wired as one self contained unit, ready for fitting on top of buoy structure.

6.4. Cargo Terminals and River Ports

Design Criteria

All structures shall be designed using limit state design approach. 3-D structural analysis of the structure shall be carried out under all specified loads and load combinations as per Indian Standards as explained in this report using STAAD Pro software. The design shall be done manually using the results of the analysis obtained from STAAD.

Design Life

All permanent structures shall be designed for a design life of 50 years.

Material Properties

Density of reinforced concrete 25.0 kN/m3

Density of Steel 78.5 kN/m3

Density of plain concrete 24.0 kN/m3

Density of Backfill soil 18.0 kN/m3 (May vary based on soil fill proposed during detail design)

Structural Steel

Minimum yield stress: 250 N/mm²

However, higher grade of steel (310/355 Mpa) shall be used based on the availability during the detailed design stage and subject to owner's approval.

Reinforcing Steel (Corrosion Resistant)

The grade of steel to be used as reinforcement in the structural concrete members shall comply with IS 1786 and will have minimum strength and elongation as mentioned below.

Yield Strength 500 Mpa

Elongation 14.5%

However, use of higher grade steel in the detail design is subject to availability of higher grade steel meeting the ductility requirements (as per revised latest code).

Cover to Reinforcement

The clear cover to main reinforcement shall be as follows:

Piles	100 mm
Deck Slab	75 mm
Longitudinal beams:	75 mm
Columns:	75 mm
Cross Beams	75 mm

Concrete Grades

Grade of RCC members	M40 for Piles
	M40 for Beams and Slab
	M40 for all precast elements
Grade of reinforcement	Fe500 confirming to IS 1786

Overall Deflection Criteria

The criteria for deflection shall be so limited that it shall not produce difficulties in serviceability conditions nor shall it cause damage to the structures and its components.

Deflection limits

Pile deflection at the deck level is normally considered as H/350 under extreme condition, where H is the distance from the point of fixity of piles to the top elevation of deck.

Crack Control

The crack width criteria shall comply with the provisions of IS: 4651(Part 4).

However the assessed surface width of cracks (for service load combinations only) at points nearest to the main reinforcement will be restricted to 0.004 times the cover to the main reinforcement.

Corrosion Protection Painting

All steel surfaces in the splash zone and atmospheric zone shall be painted in accordance with the painting specifications. Areas and joints that are inaccessible for maintenance and thereby susceptible to corrosion shall be suitably sealed by methods such as boxing with plates.

All appurtenances such as walkway bridges shall be painted as per technical specifications of corrosion resistance suitable for the environment.

Classification of Loads

A. General Loading

The Self weight of the structure shall be calculated using the following

Density of reinforced concrete 25.0 kN/m3

Density of Steel 78.5 kN/m3

Density of plain concrete 24.0 kN/m3

Density of Backfill soil 18.0 kN/m³ (May vary based on soil fill proposed during detail design)

In addition superimposed dead load and live load shall be considered

The various loads acting on the berthing structure are classified as:

1. Loads from the River Side:

The loads from the river side include the horizontal forces caused by the river currents and the forces caused by berthing and vessel's pull from bollard. The forces caused by the berthing of the vessels are determined from the velocity and angle of approach of the vessels.

2. Loads from Deck

The important loads from the deck are the vertical loads caused by self weight of the deck and the superimposed loads from handling equipments. Also horizontal loads due to wind and seismic forces are considered.

3. Loads from Shore

Seismic loading

Earthquake loads shall be adopted as applicable for the site as per IS 1893 – 2002. The river fall under Zone IV, as per the seismic map of India shown in IS 1893-2002. Design horizontal seismic coefficient shall be evaluated as per procedure detailed in IS 1893-2002.

The horizontal seismic coefficients are as follows:

TABLE 6-4: Seismic Loading

Seismic zone	IV
Design horizontal seismic coefficient, Ah	Z I (Sa/g)/ (2R)
Zone Factor Z	0.24
Importance factor, I	1.5
Response Reduction Factor, R	3 (for ordinary RC moment resisting frame)
Average response acceleration coefficient Sa/g	Depending on time period of structure

Time period of specified structures shall be evaluated by STAAD analysis considering Dead Load + 50% Live load.

Scour

Scour depth is considered in calculating the total length of the pile.

$R = 0.473 (Q/f)^{1/3}$

Where R = depth of scour below HFL

Q = discharge m^3/s

f = silt factor (=1)

Max scour around piers = 2 R.

Hence, scour length of around 20 m has been considered from the HFL.

However, based on the geotechnical investigations carried out at site, pile length has been considered as 5.5 m (Including socket length).

Loads & Load Combinations

All the structural members shall be designed to sustain safely the effect of the combination of various loads/forces and stresses that can possibly co-exist. The load combinations shall comply with the requirements of Indian reference standards both for limit state of collapse & serviceability.

Structural Design of Berthing Structure

Structural Arrangement

The RO-RO berthing structure shall consist of a concrete deck supported on piles. i.e. the sub structure shall comprise of piles at 7.5 m c/c in transverse direction, whereas the super structure shall comprise of the pile caps and concrete deck & precast planks supported on longitudinal beams and cross beams. The pile caps span in the transverse direction with the longitudinal beams resting on the pile caps.

The structure shall be designed for its self-weight and also for forces arising due to wind / seismic loads, current forces, vehicular loads etc. as explained below.

For RO-RO berthing structure, an overall width of approx. 16.6 m is provided

The deck of RO-RO shall be submerged in water with varying water levels, depending on the season. Expansion loops shall be provided along the stretch at almost every 35-40 m.

Towards the terminal facility i.e. the shore end the deck has been considered above MHWS.

A staged construction approach is assumed in the design viz:

- Piles,
- Precast pile caps and placement of cross head beams,
- Placement of precast longitudinal beams with precast planks for slab
- Placement of concrete for cast-in-situ ties between beams and deck slab.

The RO-RO berthing structures considered in design has salient features as below:

TABLE 6-5: Salient Features of Ro-Ro

Description	Total Length(m)	Total Width (m)
RORO	63	16.60

Design Loads on Berthing Structures

a) Dead Load

The dead load comprise of the weight of all components of the structure as well as the weight of all permanent connections.

For RO RO berthing structures, the member load has been defined directly by STAAD Pro using the self-weight command. The weight of concrete slab & precast panels has been applied in STAAD Pro software using floor load command.

b) Live Load

In general, the vertical live loads comprise of loads from vehicular traffic of all kinds including trucks and trailers. The vertical live loads as defined in IS 4651 (III) shall be considered in the analysis and design of the berthing structure.

TABLE 1 TRUCK LOADING AND UNIFORM LOADING

Function of Berth	Truck Loading (IRC Class)	Uniform Vertical Live Loading T/m²
(1)	(2)	(3)
Passenger berth	B	1·0
Bulk unloading and loading berth	A	1 to 1·5
Container berth	A or AA or 70 R	3 to 5
Cargo berth	A or AA or 70 R	2·5 to 3·5
Heavy cargo berth	A or AA or 70 R	5 or more
Small boat berth	B	0·5
Fishing berth	B	1·0

Note — The relevant Indian Road Congress (IRC) codes may be referred for axle load. The spacing of the loads may be changed to suit individual design requirements.

For RO – RO berthing structure, vehicular loading as per IRC 6 Class 70R as defined below shall be considered

A Tracked vehicle of 70 ton load or

Wheel load of 100 ton or

Bogie axle load of 40 ton, whichever is critical.

Moving loads has been applied in STAAD Pro software for all the three load cases defined above to obtain the maximum value of bending moment and shear force.

c) Seismic Forces

The river is in zone IV as per IS 1893:2002(part I). Dynamic analysis has been done to calculate the time period of the structure. The spectral acceleration is calculated based on the time period of the structure obtained for its mode as per IS 1893:2002 for rocky soils types.

The maximum mass participation is observed for mode 1 in X direction and for mode 2 in Z direction.

The time period obtained is of the order of 3 sec in X direction and 3 sec in Z direction Hence based on the acceleration value the horizontal seismic coefficient is worked out as

Ah = (Z/2) x (I/R) x (Sa/g).

Z = zone factor =0.24

I= importance factor =1.5

R = reduction factor =3

Sa/g= spectral acceleration based on time period

50 % Live load is considered for the dynamic analysis of the structure.

Thus Ah = 0.05 (in X direction) and Ah = 0.05 (in Z direction)

d) Wind Forces

Wind loads on the structure shall be applied according to IS: 875 (Part 3) -1987

Wind Pressure Pz = 0.6 Vz^2

Where

Pz = Design Wind Pressure in N/m2 at height Z

Vz = Design wind speed at any height in m/s

Vb = Basic wind speed at any height in m/s

K1 = Probability factor (risk coeff)

K2= Terrain height and structure size factor

K3 = Topographic factor

Pz is calculated as 1.5 KN/m2 taking Vb as 44 m/s

The wind force is applied on piers and deck slab in both X and Z direction in STAAD Pro software.

e) Mooring Load

The Mooring loads are the lateral loads caused by the mooring lines when the vessel is pulled into or along the deck or hold it against the forces of wind or current. The maximum mooring forces are due to wind force, on exposed area, on the board side of the vessel.

IS 4651_III, gives Bollard Pulls of vessel as below

For 2000 Tonnes displacement Line pull = 100 KN (total)

TABLE 4 BOLLARD PULLS

(*Clauses* 5.3.4 *and* 6.1)

DISPLACEMENT (TONS)	LINE PULL (TONNES)
(1)	(2)
2 000	10
10 000	30
20 000	60
50 000	80
100 000	100
200 000	150
Greater than 200 000	200

NOTE 1 — For ships of displacement tonnage 50 000 and over the value of line pulls given above should be increased by 25 percent at quays and berths where there is a strong current.

NOTE 2 — Main bollards at the ends of individual large vessel berths at river structures should be designed for a line pull of 250 tons for ships up to 100 000 tons displacement and for double the values given above for larger ships.

f) Current Forces

As per IS 4651 III, pressure due to current is applied to the area of vessel below the water line when fully loaded.

Current force F = w $v^2/2g$ per m^2

Where v = velocity =2.5 m/s

W= 10 kN/m^2

F = 3. 5 kN/m^2

Load Combinations

The load combinations as per IS 4651(IV): General Design Considerations are considered in design of structure. Suitable partial safety factors as per IS: 4651 - 1989 applied to the loads for limit state design are considered.

All operational load combinations will be checked to satisfy the serviceability criteria.

TABLE 6-6: Partial Safety Factors for Loads in Limit State Design

Loading	Partial Safety Factor					
	Limit State Serviceability		Limit State of Collapse			
Dead load [4.1(a)]	1.0	1.0	1.5	1.2 (or 0.9)	1.2 (or 0.9)	1.2 (or 0.9)
Vertical live load [4.1(b)]	1.0	1.0	1.5	1.2 (or 0.9)	1.2 (or 0.9)	1.2 (or 0.9)
Earth Pressure [4.1(f)]	1.0	1.0	1.0	1.0	1.0	1.0
Hydrostatic and hydrodynamic forces [4.1(g)]	1.0	1.0	1.0	1.2	1.0	1.0
Berthing and mooring forces [4.1(h) and 4.1(j)]	-	1.0	1.5	-	-	-
Secondary stresses [4.1(m)	1.0	-	-	-	-	-
Wind forces [4.1(k)	-	-	-	-	1.5	-
Seismic forces [4.1(p)	-	-	-	-	-	1.5

NOTE: For the limit states of serviceability, the values given in the table are applicable for short terms effects. While assessing the long term effects due to creep, the dead load and the part of the live load, likely to be permanent, may only be considered.

Structural Analysis and Design of Berthing Structures

Based on the structural arrangement and loadings described above, a 3-D model was developed in Staad Pro software for RO-RO Berthing structures. The structure is modelled with its deck (long & cross beams) along with piles at every 7.5 m in transverse direction.

Linear elastic analysis has been carried out using the Staad model for estimating the actual forces in structural length of the pile for all loads considered. The design is carried out the most critical load combination.

RCC members are designed manually considering limit state design approach as per latest available Indian standards.

A one-third increase in permissible stresses shall be allowed in seismic case as per clause 6.3.5.1 of IS 1893 part-1 2002.

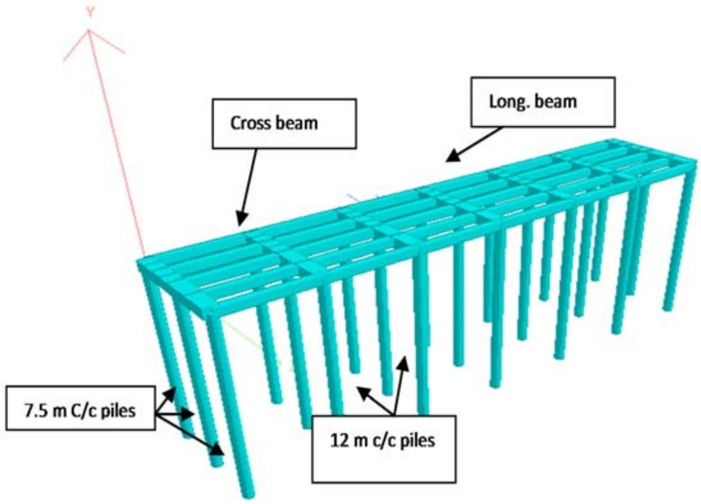


FIGURE 6.9: Perspective view of 3 dimensional model prepared in STAAD for RO-RO

SIZING OF RO-RO

Member Description	Length(m)	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	7.5	1.8	1.5		Concrete
Longitudinal Beams	12	1.0	1.25		Concrete
CastIn situ Slab				0.15	Concrete
Pile Diameter, OD		1.3	5.5*		Concrete

* Including socket length of 0.6 m

It is evident that the soil above the rock bed shall be scoured during HFL condition as Scour level is more than Rock level. In order to carry the specified load the pile has be socketed into the competent rock. Considering competent rock at EL. -1.25m, socket length of the pile has been calculated as follows:

TABLE 6-7: CALCULATION OF SOCKETED PILE CAPACITY- DABHOL RO-RO

	Rock Socketed Pile : VASITHI RO-RO				
1.	METHOD 1 : UCS directly established using standard method of testing, IRC 78-2014				
1.1.	Input				
	Rock Quality Designation,RQD		=	34	%
	Core recovery, CR		=	74	%
	Uniaxial Compressive Strength (UCS), qc		=	27.75	MPa
	Dia of Pile		=	1.3	m
	Length of Socket		=	0.6	m
	Load on Pile		=	5500	KN
	Grade of Concrete		=	M40	
	Scour Depth		=	20	m
1.2.	Pile Capacity				
	Ultimate end bearing capacity of socketed pile, Re	Ksp*qc*df*Ab	=	26553.91	KN
	Coefficient base on CR & RQD, Ksp		=	0.61	
	Depth Factor		=	1.2	
			=	1.2	
	Area of base, Ab	pi* d^2/4	=	1.33	m^2
	Ultimate side socket shear, Raf	As* Cus	=	2904	KN
	Ultimate shear strength of rock along socket length, Cus		=	1.185	MPa
	Using Shear Capacity of rock	0.225*qc^0.5	=	1.185	MPa
	Using Shear Capacity of concrete	3*(fck/35)^0.5	=	3.207	MPa
	Area of socket, As	pi*d*L	=	2.45	m^2
	Ultimate capacity of socketed pile, Qu	Re + Raf	=	22814.26	KN
	Allowable capacity of socketed pile, Qallow	Re/3 + Raf/6	=	7120.68	KN

6.5. Construction Schedule

Construction schedules of different structures will be discussed and elaborated as a part of the implementation schedule in the appropriate chapter.

CHAPTER 7: VESSEL DESIGN

7.1. General Review

The design of a vessel is dependent on various factors viz., Waterway / Fairway structure; Flow pattern in the Fairway for different seasons; Waterway morphological behaviour in different seasons; Cross structures across the fairway; Navigational constraints (Presence of Locks); Cargo volumes to be handled; Type of cargo to be handled; Cargo handling facilities available at Origin and destination; Turnaround time; Capacity of the fairway.

In the above, the predominant factors are Fairway and Cargo i.e., the Fairway availability and Cargo Volumes to be transported. The Fairway details have been discussed in Chapter 03 and the IWT Cargo scenario has been discussed in Chapter 04. Further the present status on the vessels plying in the study stretch also have been collected and placed in subsequent chapters, which will also have bearing in the vessel deployment.

There are not many countries internationally in which IWT is a significant industry, so skills and techniques in IWT vessel research and development are globally scarce. The countries that have significant IWT industries can therefore gain by learning from each other. Vessel design, including vessel loading/unloading methods, is expected to be a fruitful area for USA, EU and China to utilize international experience, particularly in newer, more specialized vessel types.

7.2. Design Basis

The design waterway channel width / depth is usually determined according to the following information: Design Width / depth = f {vessel size, vessel steering characteristics, traffic density, vessel speed, water depth, channel type, flow currents, waves and winds}

Further, the determination of the vessels will be based on traffic / freight projection. The higher the amount of traffic / volumes and lesser the freight cost, the more transport capacity can be foreseen, either in the form of larger vessels or by using more vessels.

7.2.1. Vessel Classification adopted in Indian Inland Waterway

Ministry of Shipping, Road Transport and Highways (Inland Waterways Authority of India) has classified the Inland waterways into seven categories for rivers and canals for safe plying of self-propelled vessels up to 2000 tonne Dead Weight Tonnage (DWT) and tug-barge formation in Push Tug + 4 barges units of carrying capacity up to 8000 tonne (Ref: IWAI, Gazette Notification 2006).

The classification criteria of waterways are mentioned in **Table 7.1** for Rivers and in **Table 7.2** for canals.

TABLE 7-1: Classification of Inland Waterways for Rivers

Class of Waterways	Rivers				
	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
I	1.2	30	300	4	30
II	1.4	40	500	5	40
III	1.7	50	700	7	50
IV	2.0	50	800	10	50
V	2.0	80	800	10	80
VI	2.75	80	900	10	80
VII	2.75	100	900	10	100

TABLE 7-2: Classification of Inland Waterways for Rivers

Class of Waterways	Canals				
	Minimum Depth (m)	Bottom Width (m)	Bend Radius (m)	Vertical Clearance (m)	Horizontal Clearance (m)
I	**1.5**	**20**	**300**	**4**	**20**
II	**1.8**	**30**	**500**	**5**	**30**
III	**2.2**	**40**	**700**	**7**	**40**
IV	**2.5**	**50**	**800**	**10**	**50**
V	-	-	-	-	-
VI	**3.5**	**60**	**900**	**10**	**60**
VII	-	-	-	-	-

Vertical clearance for power cables or telephone lines or cables for any transmission purpose for all the classes of waterways mentioned shall be as follows:

i) Low voltage transmission lines including telephone lines -16.5 metres

ii) High voltage transmission lines, not exceeding 110 kilo volt-19.0 metres

iii) High voltage transmission line, exceeding 110 kilovolt- 19.0 metres+1centimetres extra for each additional kilovolt

The vessel sizes for self-propelled or tug and barge combination for different classes of waterways are described in **Table 7.3**.

TABLE 7-3: Classification of Vessel Size

Class of waterways	Self-Propelled Vessel Tonnage (Size, L x B x Draft in m)	Tug and Barges Combination Tonnage (Size, L x B x Draft in m)
I	100 (32 x 5 x 1)	200 (80 x 5 x 10)
II	300 (45 x 8 x 1.2)	600 (110 x 8 x 1.2)
III	500 (58 x 9 x 1.5)	1000 (141 x 9 x 1.5)
IV	1000 (70 x 12 x 1.8)	2000 (170 x 12 x 1.8)
V	1000 (70 x 12 x 1.8)	4000 (170 x 24 x 1.8)
VI	2000 (86 x 14 x 2.5)	4000 (210 x 14 x 2.5)
VII	2000 (86 x 14 x 2.5)	8000 (210 x 28 x 2.5)

In general, total weight of the vessel considered to be 1.4 X DWT. Refer Figure 7.1 below for proposed dimensions of one way navigation channel.

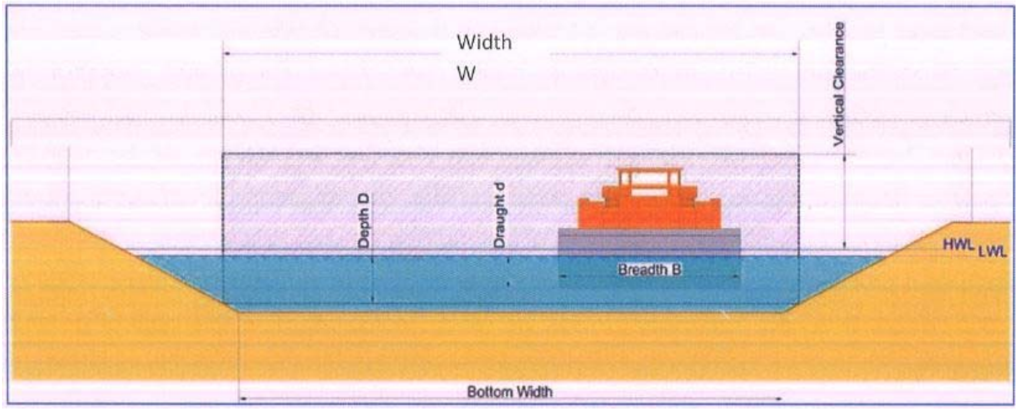


FIGURE 7.1: Dimensions – one way navigation Channel

Proposed dimensions of two ways navigation channel has been shown in **Figure 7.2** below.

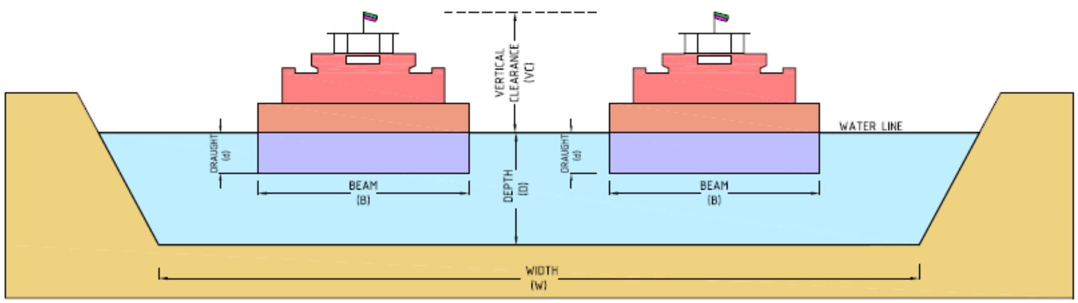


FIGURE 7.2: Dimensions – Two way navigation Channel

7.2.2. Vessel Classification of USA Inland Waterway

As per American Association of State Highway and Transportation Officials (AASTHO) standards, vessels with following dimensions referred in **Figure 7.3** below is under consideration with the characteristics as given in **Table 7-4** and **Table 7-5**.

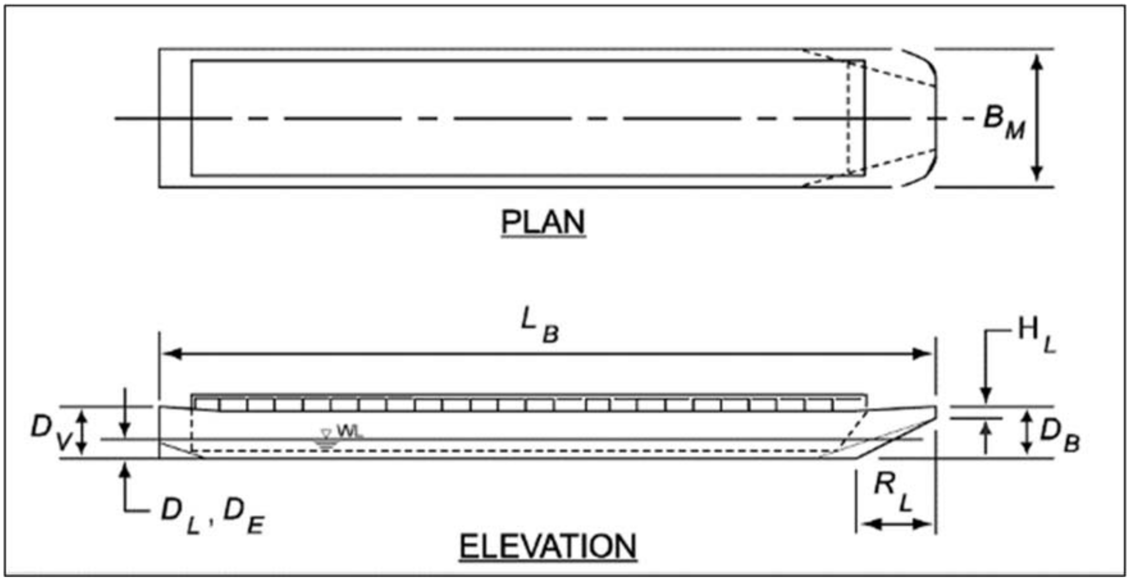


FIGURE 7.3: Plan and Elevation of vessel

TABLE 7-4: Typical Barge Tow Characteristics

Particulars	Symbol	Unit	Jumbo Hopper	Oversize Tank	Special Deck
Width	BM	ft/m	35 / 10.67	53 / 16.15	72 / 21.95
Length	LB	ft/m	195 / 59.44	290 / 88.39	250 / 76.20
Head log Height	HL	ft/m	2-3 / 0.61-0.91	2-3 / 0.61-0.91	3-5 / 0.91-1.52
Depth of Vessel	DV	ft/m	12 / 3.66	12 / 3.66	17 / 5.18
Depth of Bow	DB	ft/m	13 / 3.96	13 / 3.96	18 / 5.49
Bow rake length	RL	ft/m	20 / 6.10	25 / 6.10	30 / 9.14
Loaded Draft	DL	ft/m	8.7 / 2.65	8.7 / 2.65	12.5 / 3.81
Empty (light) draft	DE	ft/m	1.7 / 0.52	1.7 / 0.52	2.5 / 0.76
Cargo Capacity	CC	tons	1700	3700	5000
Empty Displacement	WE	tons	200	600	1300
Loaded Displacement	WL	tons	1900	4300	6300

TABLE 7-5: Typical Characteristics of Barges on the Inland Waterways System

Barge Type	Size	Length (ft/m)	Width (ft/m)	Draft (ft/m)	Capacity (tons)
Open Hopper	Small	120 / 36.58	30 / 9.14	7 / 2.13	630
Open Hopper	Standard	175 / 53.34	26 / 7.92	9 / 2.74	1060
Open Hopper	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Open Hopper	Oversize	245 / 74.68	35 / 10.67	10 / 3.05	2400
Covered Hopper	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Deck Barge	Small	100/150 ------- 30.48/45.72	26/32 ------- 7.92/9.75	6 / 1.83	350/600
Deck Barge	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Deck Barge	Oversize	200 / 60.96	50 / 15.24	9 / 2.74	2050
Tank Barge	Small	135 / 41.15	40 / 12.19	9 / 2.74	1300
Tank Barge	Jumbo	195 / 59.44	35 / 10.67	9 / 2.74	1700
Tank Barge	Oversize	185/290 ------- 56.39/88.39	53 / 16.15	9 / 2.74	2530/3740

7.2.3. Vessel Classification of European Inland Waterway

As per European, CEMT standards vessel dimensions are under consideration as given in below **Table 7-6** (Ref: SMART Rivers 2015-PIANC).

TABLE 7-6: Classification of European Inland Waterways-1992

Type of Inland Waterways		Classes of Navigable waterways	Motor Vessels and barges					Pushed Convoys					Minimum Height under Bridges
			Type of Vessels Characteristics					Type of convoys: General Characteristics					
			Designation	Maximum Length	Maximum Beam	Draught	Tonnage		Length	Beam	Draught	Tonnage	
				L (m)	B (m)	d (m)	T (t)		L (m)	B (m)	d (m)	T (t)	H (m)
1		2	3	4	5	6	7	8	9	10	11	12	13
Of Regional Importance	To West of Elbe	I	Barge	38.5	5.05	1.80-2.2	250-400						4.0
		II	Campine barge	50-55	6.6	2.50	400-650						4.0-5.0
		III	Gustav Koeings	67-80	8.2	2.50	650-1000						4.0-5.0
	To East of Elbe	I	Gross Finow	41	4.7	1.40	180						3.0
		II	BM-500	57	7.5-9.0	1.60	500-600						3.0
		III		67-70	8.2-9.0	1.60-2.00	470-700		118-132	8.2-9.0	1.6-2.0	1000-1200	4.0
Of International Importance		IV	Johann Welker	80-85	9.5	2.50	1000-1500		85	9.5	2.5-2.8	1250-1450	5.25 or 7.0
		Va	large Rhine Vessels	95-110	11.4	2.50-2.80	1500-3000		95-110	11.4	2.5-4.5	1600-3000	5.25 or 7.0 or 9.1
		Vb							172-185	11.4	2.5-4.5	3200-6000	
		VIa							95-110	22.8	2.5-4.5	3200-6000	7.0 or 9.1
		VIb		140	15.0	3.90			185-195	22.8	2.5-4.5	6400-12000	7.0 or 9.1

7.2.4. Vessel Classification of China Inland Waterway

As per European, CEMT standards vessel dimensions are under consideration as given in below **Table 7-7** (Ref: SMART Rivers 2015-PIANC)

TABLE 7-7: Characteristics of Reference Motor cargo Vessels- Chinese Classification

Class	Type of vessel: General Characteristics					Type of convoy : General Characteristics				
		Length	Beam	Draught	Tonnage		Length	Beam	Draught	Tonnage
		m	m	m	T	Push tows	m	m	m	T
II	Barge	75	14	2.6	2000	1) 2P. barge -2 rows *1 columns	180	14	2.6	4000
		65	15.8	2.6-2.9		2) 2P. barge -2 rows *1 columns	160	15.8	2.6-2.9	
	Motor Vessel	90	15.4	2.6		3)1 motor vessel	90	15.4	2.6	2000
		65	13	2.6-2.9		3)1 motor vessel	65	13	2.6-2.9	
III	Barge	65	10.8	1.9-2.2	1000	1) 2 P. barge -2 rows *1 columns	160	10.8	1.9-2.2	2000
		55	10.8	2.5		2) 6 T. barges	357	10.8	2.5	6000
	Motor Vessel	68	10.8	2.6		3) 1 motor vessel	68	10.8	2.6	1000
IV	Barge	42	9.2	1.9	500	1) 2 P. barge -2 rows *1 columns	108	9.2	1.9	1000
		42	8.2	1.9-2.1		2) 7 T. barges	320	8.2	1.9-2.1	3500
	Motor Vessel	52	9.6	2.2		3) 1 motor vessel	52	9.8	2.2	500
V	Barge	30	8	1.8-1.9	300	1) 2 P. barge -2 rows *1 columns	82	8	1.9	600
		35	6.8	1.7-2.0		2) 8 T. barges	303	6.8	1.7-2.0	2400
	Motor Vessel	42	8.2	1.8-2.2		3) 1 motor vessel	42	8.2	1.8-2.2	300

After having elaborate analysis over the important ratios, the following comparison has been found as an apt requirement to arrive at the Channel vessel relationship and the same has been compared with the present Classification of IWT vessels considered by IWAI.

TABLE 7-8: Waterway Ratios of different Countries

Relative Waterway Dimensions from Guidelines for different Countries

Location	Ship	Two-lane			One-lane		Driving Quality
	(B x L x D)	F/B	D/d	n	F/B	D/d	category
China Canel	**Average (Class III-VII)**	**4.4**	**1.3**	**7**	**-**	**-**	**A-B**
China Cannel	**Average (Class II-VII)**	**4.4**	**1.4**	**6-7**	**-**	**-**	**A-B**
China River	**Average (Class I-VII)**	**4.4**	**1.2**	**-**	**2.3**	**1.2**	**A-B**
Dutch normal	11.45 x 185 x 3.5	4.0	1.4	8.7	2	1.3	A-B
Dutch narrow	11.45 x 185 x 2.8	3.0	1.3	6.7	-	-	B-C
France	11.45 x 105 x 2.5	3.1	1.4	5.8	-	-	B-C
Germany	11.45 x 185 x 2.8	3.3	1.4	5.6	1.8	1.4	B-C
Russia	16.5 x 135 x 3.5	2.6	1.3	-	1.5	1.3	C
US River	10.7 x 59.5 x 2.7	3.3	1.3	4.9	2.2	1.3	B-C

TABLE 7-9: Waterway Ratios of Indian IWT (Rivers)

Relative Waterway Dimensions (in Rivers) from Guidelines in vogue in India

Class	SPV			Tug and Barge		SPV L x B x d / Convoy L x B x d
	F/B	D/d	n	F/B	D/d	Waterway F x D
Class I	**6.00**	**1.20**	**7.20**	**6.00**	**1.20**	**32 x 5 x 1.0 / 80 x 5 x 1.0 30 x 1.2**
Class II	**5.00**	**1.17**	**5.83**	**5.00**	**1.17**	**45 x 8 x 1.2 / 110 x 8 x 1.2 40 x 1.4**
Class III	**5.56**	**1.13**	**6.30**	**5.56**	**1.13**	**58 x 9 x 1.5 / 141 x 9 x 1.5 50 x 1.7**
Class IV	**4.17**	**1.11**	**4.63**	**4.17**	**1.11**	**70 x 12 x 1.8 / 170 x 12 x 1.8 50 x 2.0**
Class V	**6.67**	**1.11**	**7.41**	**3.33**	**1.11**	**70 x 12 x 1.8 / 170 x 24 x 1.8 80 x 2.0**
Class VI	**5.71**	**1.10**	**6.29**	**5.71**	**1.10**	**86 x 14 x 2.5 / 210 x 14 x 2.5 80 x 2.75**
Class VII	**7.14**	**1.10**	**7.86**	**3.57**	**1.10**	**86 x 14 x 2.5 / 210 x 28 x 2.5 100 x 2.75**

TABLE 7-10: Waterway Ratios of Indian IWT (Canals)

Relative Waterway Dimensions (in Canals) from Guidelines in vogue in India

Class	SPV			Tug and Barge		SPV L x B x d / Convoy L x B x d Waterway F x D
	F/B	D/d	n	F/B	D/d	
Class I	4.00	1.50	6.00	4.00	1.50	32 x 5 x 1.0 / 80 x 5 x 1.0 20 x 1.5
Class II	3.75	1.50	5.63	3.75	1.50	45 x 8 x 1.2 / 110 x 8 x 1.2 30 x 1.8
Class III	4.44	1.47	6.52	4.44	1.47	58 x 9 x 1.5 / 141 x 9 x 1.5 40 x 2.2
Class IV	4.17	1.39	5.79	4.17	1.39	70 x 12 x 1.8 / 170 x 12 x 1.8 50 x 2.5
Class V	--	--	--	--	--	70 x 12 x 1.8 / 170 x 24 x 1.8 --
Class VI	4.29	1.40	6.00	4.29	1.40	86 x 14 x 2.5 / 210 x 14 x 2.5 60 x 3.5
Class VII	--	--	--	--	--	86 x 14 x 2.5 / 210 x 28 x 2.5 --

The parameters of Horizontal clearance and Vertical clearance considered in the Indian Waterway classification guidelines are related to the Cross Structures in the particular waterway. These aspects can be modified for the requirement of Vessel / Waterway size, on need basis.

Further, the Bend Radius criterion is related to the terrain, which can be taken care by Cutting / Protection in the curves.

Hence, the basic Vessel design criteria is related to the Cross Section of the Waterway and accordingly, the factors on Breadth (F / B); Depth (D / d) and Cross Section Area (n), which is now being considered for comparison i.e., the Indian IWT classification with the Waterway classifications of other countries, with reference to the Tables above.

The Range variation on the Factors – Width F / B; Depth D / d and N have been tabulated herewith for an overview.

TABLE 7-11: Range Variation of the Factors

Factor on Width "F / B"

Indian classification – Rivers – SPV / Single Channel	4.17 to 7.14
Indian classification – Canals – SPV / Single Channel	3.75 to 4.44
Others – Waterways – SPV / Single Channel	1.50 to 2.30

Indian classification – Rivers – Convoy	3.33 to 6.00
Indian classification – Canals – Convoy	3.75 to 4.44
Others – Waterways – Convoy	2.60 to 4.44
Factor on Depth “D / d”	
Indian classification – Rivers – SPV / Single Channel	1.10 to 1.20
Indian classification – Canals – SPV / Single Channel	1.39 to 1.50
Others – Waterways – SPV / Single Channel	1.20 to 1.40
Indian classification – Rivers – Convoy	1.10 to 1.20
Indian classification – Canals – Convoy	1.39 to 1.50
Others – Waterways – Convoy	1.20 to 1.40
Factor on Cross Section Area “n”	
Indian classification – Waterways – SPV / Single Channel	4.63 to 7.86
Indian classification – Canals – SPV / Single Channel	5.63 to 6.00
Others – Waterways – Convoy	4.90 to 8.70

Note: Other Waterways, only Chinese waterways are having the segregation available between Rivers and canals. However, the same has not been taken into consideration.

Indian IWT classification has not been provided with “n” value for convoy system, which is essential.

Other Waterways has not been provided with “n” value for SPV / Single Channel.

In the above, the range of Indian IWT Classification on Width factor “F/B” and Cross Section area factor “n” are well within the safer range. Whereas, the Depth factor “D/d” may have to be relooked into and this will have larger implication on the West flowing rivers i.e., the present study stretch areas.

7.3. Type of proposed Vessels

The most suitable river vessel is to be considered based on the following aspects viz., Fairway availability; Availability of Day / Night navigation system; Obstructions enroute like Locks; Navigational clearances free cross structures; Haulage distance; Type and Nature of Cargo; Terminal facilities etc.,.

In brief, the study stretch of river Vashishti has been limited to Class IV in the entire study stretch up to Ch 45.228 km, keeping in view the stretch utility etc.

Vessel Requirement for a waterway can be segregated mainly into two parts i.e., Waterway maintenance vessels and Cargo vessels. There are many vessels required for maintenance of waterway viz., Dredgers; Tugs; Survey vessels; Navigational Equipment maintenance vessels; Patrol Boats; Pilot Boats; Inspection Vessels etc.,. The said abundant types of vessels may not be required for the proposed stretch and neither suggested nor recommended. However, 2 Nos of Survey Vessels / 2 Nos. of Buoy Layiong Vessels / 2 Nos. of Inspection Boats have been provisioned for the entire Cluster of 6 waterways and projected as a part of the Institutional requirement in Chapter 10. The apportioned cost for river "Vashishti (Dabhol Creek)" has been considered, as a part of development of this waterway. Hence, the present discussions are being concentrated only on Cargo Vessels. Keeping in view the Trucks mobility in the study stretch, Ro-Ro vessel deployment is under consideration.

With regard to the Ro-Ro operation, mobility of 125000 vehicles (preferably of 40 TEU container trucks) P A by FY 20 is estimated and expected to be increased to 273,000 vehicles P A by FY 40. The vessel size proposed for such mobility will be considered with 52.8 m to 55 m LOA x 14 m Breadth x 1.8 m Loaded Draft / 2.50 m + Depth, which can carry 21 Nos. TEU. The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each. Initially the operation will be taken up with two vessels deployment and can be increased to total five nos. by FY 40. The requirement will be worked out based on the Turn Around Time etc.

7.4. Proposed Vessel Size and Specifications

In line with the above derivations, the vessel size and specifications are placed herewith.

Ro-Ro Vessel:	**(21 TEU)**	**{Recommended} INR 900 Lakhs each**
Length:	52.8 m to 55 m	
Breadth:	14 m	
Loaded Draft / Depth:	1.8 m / 2.5 m +	
Cargo Capacity:	16 TEUs – 21 TEUs	
Propulsion:	Marine Diesel Engines of 3 x 375 Bhp	

Note: ***Depth + is an indication for provision of increased depth for the vessel mobility as a coaster.***

Keeping in view the Ro-Ro operation, the Ro-Ro vessel will be considered for deployment. The structural designs of vessels are to be considered as per the Inland Vessels Act and as per the rules of Indian Register of Shipping. Further, the vessels now proposed are to maneour in the west flowing rivers like Vashishti and also through Arabian Sea. Accordingly, the concerned applicable rules and acts are also to be consulted while constructing such vessels. The Tugs / Work Boats are to be capable of maintaining a good speed of about 16 kmph to 20 kmph with load in down stream mobility and 12 kmph to 16 kmph with load in upstream mobility. The relative trial tests are also essential to be conducted, as per the guidelines.

7.5. Turn around Time

Turn Around Time (TAT) for the Inland Navigation is a most critical analysis, involving many practical issues, linked with the Fairway constraints; Terminal Operational Constraints; Availability of Day / Night Navigation system; Vessel speed etc.,.

Ro-Ro Operation:
The Ro-Ro Terminal is provisioned to meet the mobility of 125,000 vehicles per annum (preferably the containers) in FY 20 which may increase to 273,000 Vehicles per annum in FY 40. Considering 300 to 330 days operation, the daily volumes will be of about 380 to 420 vehicles per day.

The origin of Ro-Ro vessels mobility is being planned from JNPT / MbPT, which is about 190 Kms and accordingly, the total distance can be considered as 235 Kms. Taking the average speed of 20 Kmph, it will take about 12 Hrs for one mobility.

The TAT will be as detailed:

Entry / Exit of Vehicles at JNPT / MbPT 1 Hr + Onward Journey 12 Hrs + Entry / Exit of Vehicles at Terminal 1 Hr + Return Journey 12 Hrs = Total 26 Hrs. say the turnaround time 1 day.

7.6. Number of Vessels Required

In order to handle the initial traffic of 75,000 Vehicles (One sided), (230 Vehicles per day), it is essential to deploy 11 Nos. of Ro-Ro Vessels. However, the Ro-Ro operation is suggested only on promotional basis and hence it is suggested with cautious approach and may need to be suspended at any point of time.

2 Ro-Ro vessels may be required at the initial stages in FY 20.

Additional 6 from FY 28 / 30 onwards, one additional vessel will have to be acquired in the year FY 30; FY 32; FY 34; FY 36; FY 38 and FY 40. A total of 8 vessels would be needed to handle the projected traffic of FY 40.

7.7. Vessel Repair facilities

Vessel Repair facility in close proximity always will have added advantage for ease and timely operation of IWT Vessels. On board Minor repairs can be considered, while the vessel under mobility, wherein the Major repairs and Dry Dock repairs may have to be attended only in the Ship Yards. There is a repair yard in the study stretch of Dabhol Creek / Vashishti to attend the repairs of IWT Vessels plying in this region viz., Bharati Shipyard, Usgaon, on the Northern bank / Right Bank near the Ch. 5 km.

In addition, the Agardanda Shipyard in Rajpuri Creek (North) and Lavgan Dockyard and Katale Shipyard in Jaigad River (Shastri River) (South) are also approachable from Dabhol Creek.

7.8. Vessel Costing

7.8.1. Capital Cost

At the outset, it is to place that the Capital Cost of the vessel may not form part of the Financial / Cost analysis, since the deployment of vessels will be considered by the Vessel Owners, who will deploy the required type of vessel. It has been noted that the Capital Vessel Building Subsidy is under consideration by IWAI / Administrative Ministry of Shipping, which is being recommended herewith to give boost to this sector.

Hence, the indicative cost, as ascertained from the Market, is being furnished herewith.

Ro-Ro Vessel: with Length – 52.8 m to 55 m; Breadth – 14 m; Loaded Draft / Depth – 1.8 m / 2.5 m +; Cargo Capacity – 16 Nos. to 21 Nos. TEUs and Propulsion by Marine Diesel Engines of 3 x 375 Bhp is costing about **INR 900 Lakhs each.**

7.8.2. O&M Cost

The Operation & Maintenance cost (O & M Cost) for the Vessels being considered in the IWT project, in general, consists of Running Cost of the vessels; Crew Cost; Repair Cost; Depreciation Cost; Insurance factor and Interest Factor. The vessel mobility is under consideration of 1 Ro-Ro Vessel, for which the indicative O & M Costs have been worked out.

1 Ro-Ro Vessel (For 1 Year)

- 1 Ro-Ro vessel Running cost for 330 days operation with 1 day turnaround (330 Cycles) of which 22 Hrs mobility in a cycle, cost per annum will be as detailed.
- 330 cycles x 22 Hrs x {0.1 Liter per hour x 3 Engines x 375 Bhp} x INR 70 per Liter = **INR 572 Lakhs Per Annum**.
- 8 Nos. Crew on 1 Ro-Ro vessel @ INR 0.50 Lakhs per month.
- Crew cost for 12 months will be 12 x 8 x 0.5 = **INR 48 Lakhs Per Annum** per Unit.
- Repair Cost is @ 2 % P. A of CAPEX i.e., 0.02 {1 x 900} = **INR 18 Lakhs Per Annum.**
- Depreciation is proposed by considering the life of vessels as 20 Yrs.
- Interest factor is proposed as per the industry norms.
- Insurance factor is proposed as per the industry norms.

CHAPTER 8: NAVIGATION AND COMMUNICATION SYSTEM

8.1. General Requirements

A full proof communication system in the River Navigation is a most important requirement in order to maintain the safety of the entire system. Safety is one of the important parameters that have to be considered for the development of the inland navigation along with the protection of the environment and efficiency. In order to have undisturbed and uninterrupted development and maintenance of Inland navigation System, safe communication is most important.

Safety implies that navigation risks on the waterway stretch need to be at an acceptable level. In particular, the risks of:

- Ship-to-ship collisions;
- Ship-bridge collisions;
- Groundings;

Need to be minimised, rather to be nullified. Accordingly, to accomplish, an adequate visual marking of the fairway have to be done. Even if more advanced and potentially more accurate systems are deployed, visual fairway markings are used to verify proper navigation and are also a necessary backup in case of system failures.

8.1.1. VHF / HF

Communication is essential for navigation in Inland Waterways. Due to the VHF the captains of the vessel can communicate with each other. The VHF communication can be recorded if the system will be equipped with VHF-transceiver. The recordings of the VHF can be used to investigate incidents or near-incidents to prevent future incidents.

8.1.2. GPS

The DGPS system provides the RIS-system with a correction value. This correction value increases the accuracy of the AIS transponders on-board of the vessels. The AIS base station transmits the correction signal through the designated AIS message or DGPS correction.

8.1.3. RIS / AIS / Radar / VTMS

RIS is a concept for harmonised information services which supports traffic and transport management in inland navigation, including interfaces to other transport modes.

The general technical solution is depicted in Figure below.

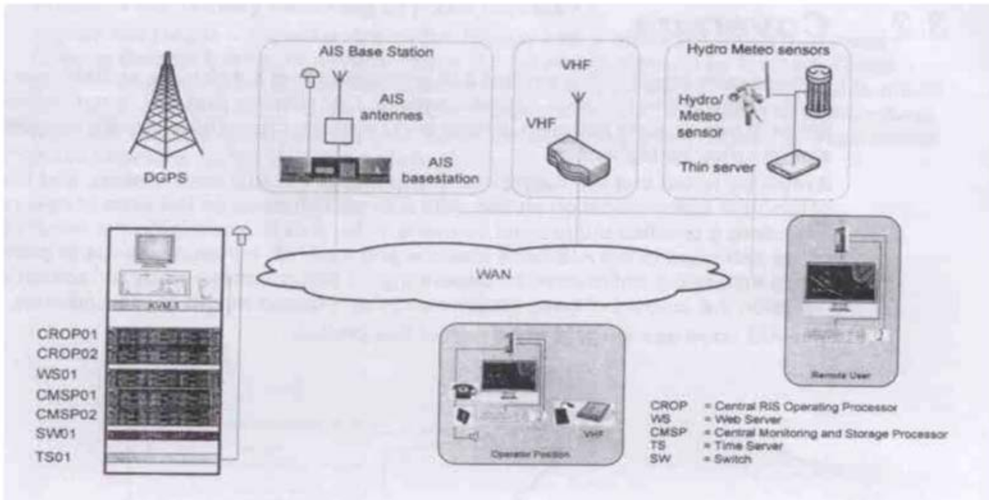
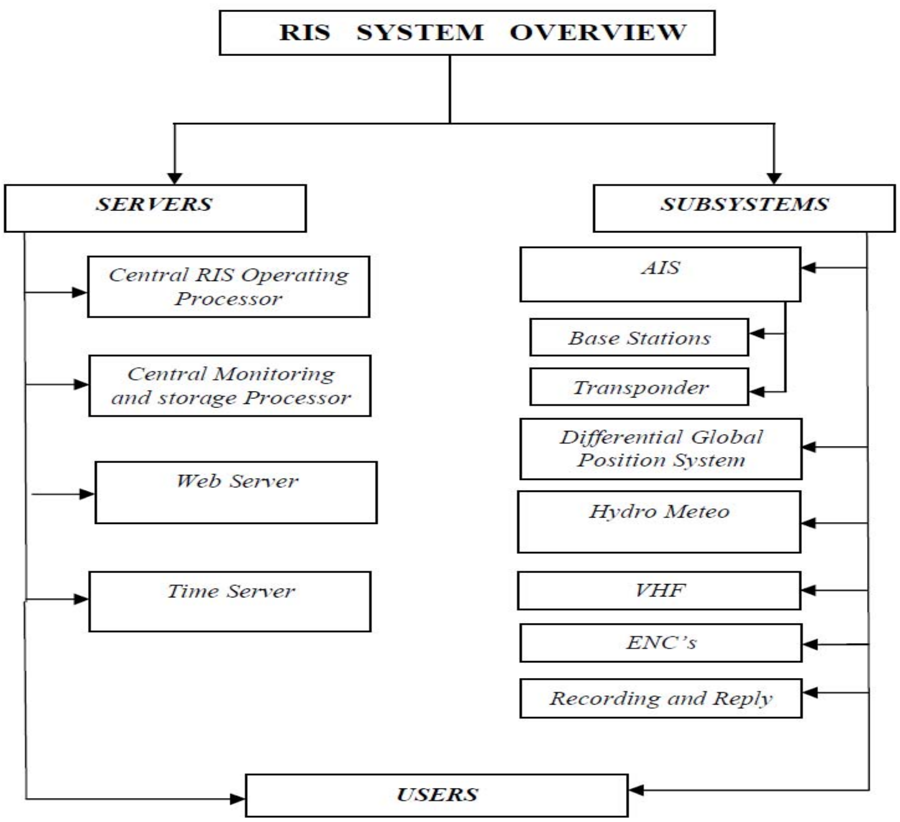


Fig 8.1 Main components of the RIS system are given below in flowchart:



River Information Service (RIS) system is one among the latest technology introduced in Inland Water Transport sector, which is in nascent stage in India. It has been ascertained that the system is suitably designed keeping in view the PIANC and IALA guidelines for setting up of RIS.

In the RIS system, a group of base stations is connected by LAN through lease line. Each of the stations is located at 50-60Kms intervals. These base stations will have 30 Kms (approx) radial coverage and two way communication between vessels plying in their region and management authority. The goal of safe and efficient transportation can be achieved by avoiding navigational risks like ship to ship collision, ship to bridge collisions and vessel groundings. In addition, RIS system provides fairway information, traffic information, calamity abatement support etc. Efficiency of this system gets greatly increased when there are multiple users of the waterway with different type of vessels and different types of cargo.

Components of RIS systems: The River Information Services (RIS) System consists of (a) base stations, (b) control stations and (c) Mobile /user stations.

a. Base station: Deploy series of sensors for exchange of electronic data between the control station and the vessels. Two porta cabin at each stations are equipped with latest version of the sophisticated electronic equipment's transmit the waterway information namely navigable depth in their jurisdiction, channel limits with virtual buoys, terminal facilities, port clearance etc. The AIS and VHF antennae and meteorological sensors are installed on the mono pole tower of 30 meter height at each station to provide update weather information. The basis of height calculation will be considered based on the geographical position including the Antenna height and the vessel Antenna elevation.

The list of equipment's include

- Automatic Identification Systems (AIS) equipment
- Meteorological equipment.
- VHF equipment's with Tx/Rx installed on 30 mtr mono pole.
- Gen Set 10 KVA with UPS 5 KVA for 2 hours backup.

b. Control station: The control station is responsible for situational awareness of waterway for undertaking coordinated actions to ensure safe passage of vessels through the waterway. The control station has been set up along with any one of the base station suitability near to the Regional Office. As the name indicates, control station carry out all standing orders and collect the data of cargo/vessel movement and keep back up for analysis and further improvement of efficiency. The control centers include 2x control Centers Servers for AIS data record and display, WEB Servers which provide traffic situation presentation via Web interface. This also includes Operator Workstations. Operator have comprehensive tabular information about traffic, wide variety of navigational alarms, traffic management tools like zones, reporting lines, routes, traffic prediction tools, control of AIS base stations. Tools such as Playback are available for each Operator. All above mentioned system components interact between each other via TCP/IP protocol i.e. proposed system is completely IP based. The control station consists of the following computer hardware:-

- Central RIS Operating Processor
- Central Monitoring and Storage Processor
- Web Server & Time Server
- Workstation
- Operator Display 52” LED wide Screen+ with operator display
- RIS software

c. Mobile/user station;- The state of art equipment installed on board each vessel for her safe navigation and smooth sailing for 24x7 in clock.

- AIS Transponder Inland Class – A
- VHF Sets with Antenna
- Echo Sounder
- DGPS Receiver
- Short Range Radar
- Laptop (Tough Book) - 14” with 5 KVA UPS
- MFD Multi-Function Display 19” size

d. Manpower: Each of the base stations and control station are manned 24x7 round the clock by 3 operators and 3 security personnel. Accommodation facilities have been provided in the porta cabins. The manpower deployments are covered under Operation and Maintenance of RIS system.

As ascertained, IWAI has already initiated the implementation of RIS system in phased manner.

Observations:

1. AIS receiver is must on board the vessels utilizing the Waterway.
2. Preferred to provide the RADARs installed at selected locations, for easy tracking of vessels.
3. Trained Operators can effectively be utilized for ensuring proper running of RIS system.

8.1.4. Vessel / Hydrographic Survey equipment

The RIS-system also requires that certain systems are available and working on the used vessels. The system should be connected and integrated with each other. The required systems are:

- AIS transponder
- VHF

- Radar
- Hydro and meteo sensors
- Echo sounder
- Electronic chart display capable of displaying virtual buoys

8.2. Existing System

IWAI is already having the communication system on NW 1 / NW 2 along with Day / Night Navigation system which have been developed considering the AIS and DGPS stations. Further, the adaptable Digitized charts are already being used linked with Survey Equipments viz., Echo-sounders and GPS with a provision for updating the charts. Provision also is under consideration to link up with the Day / Night Navigation Buoys.

8.3. Additional requirement

The communication system technology is rapidly changing with Technology change. Accordingly, within a short gap of time, the existing system is leading to an obsolete scenario. Hence, development of a sustainable system is very difficult. However, an attempt has been made and a workable rather reliable system has been worked out and placed as Annexure 8.1. This is only indicative. A map indicating the Radar station is also placed for reference at Annexure 8.2.

Further to the above, an attempt has been made to ascertain the details on the alternative real time ship tracking system viz., Vessels Traffic Management System (VTMS). It was observed that the same is more costly than the RIS system and has not been discussed.

Subsequent to the discussions with the stakeholders' viz., Maharashtra Maritime Board and Mumbai Port Trust, it was noticed that the Ministry of Shipping, Govt. Of India has already initiated the working about feasibility and implementation of "National Coastal Grid of VTMS", in which a considerable distance of the Rivers joining the sea also is under consideration. This proposal is from the strategic safety point of view and is expected to take some more time. It is suggested to have a dialogue at later date by IWAI for a full proof communication / navigation system in the National Waterways joining the sea in both West / East coast.

Regarding the RIS on "Dabhol Creek / Vashishti River", there is no considerable cargo mobility to substantiate the provision of RIS. However, the cost details are provisioned for taking up the same, at later date, if the need is judicious.

8.4. Specifications of certain equipment's of the system

The following indicative specifications on various equipment's proposed for developing the RIS unit are placed. A system context Diagram is placed at the end.

VHF sets with Antenna

- Channel Capacity minimum - 100
- Frequencies 156.00 - 161.50 Mhz (Marine Universal frequency band)
- Rx @ Rated Audio 2 A max
- Tx @ Rated Audio 14.5 A max
- Power Supply 12 VDC to 24 VDC
- Channel Spacing :- 12.5 kHz/ 25 kHz
- Audio Response:- + 1, -3 dB
- Adjacent Channel Selectivity:- 60 dB @ 12.5 kHz 70 dB @ 25 kHz

Metrological Equipment's (Anemometer, Barometer, Relative Humidity)

Wind Speed

- Range: 0 to 60 m/s
- response time 250 ms
- accuracy : 0 to 35 m/s: ±0.3 m/s or ±3%, whichever is greater
- Output resolution and unit: 0.01m/s
- Protection IP66
- Serial Output:RS232/485

Wind Direction

- Azimuth: 0 to 360°
- Response time: 250 ms
- Accuracy: ±3°
- Output resolution and unit: 1°
- Protection IP66
- Serial Output:RS232/485

Air temperature

- Range: - 50 3 to +60 °C
- Accuracy for sensor at +20 °C: ±0.3 °C
- Output resolution and unit: 0.1 °C

Barometric pressure

- Range: 600 to 1100 hPa
- Temp: -50 to +60 °C
- Accuracy: ±0.5% of analog pressure range, digital accuracy 0.2 hPa (25°C)
- Output resolution: 0.2hPa

Relative humidity

- Range: 0 to 100 %RH
- Accuracy: ±3 %RH within 0 to 90 %RH ±5 %RH within 90 to 100 %RH

Output resolution and unit: 0.1 % RH

Control Station Servers (CROP / CMSP / WS / TS)

Central RIS Operating Processor (Application cum Data base Server)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 2TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition
- 52" LED Display. The Operator console should be minimum 21" size.

Central Monitoring and Storage Processor (Web Server / GIS Software)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 10TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition

Web Server & Time Server (Application cum Data base Server)

- Processor Intel Xeon – 4 core
- RAM 64 GB
- HDD 4TB
- DVD RW (Re Writable)
- Operating System :- Windows Server latest edition
- Concurrent 50 web users

Operator Console

• Processor :-	Intel® Core™ Xeon Processor or
• Operating	Latest Windows operating system 64
• Display :-	24. 0" (min)
• Memory :-	16 GB RAM (min)
• Hard Drive :-	2.0 TB SATA Hard Drive (min)
• Optical Drive	DVD +/- RW
• USB Ports	4 Ports minimum
• Memory card	Standard Memory Card Reader slots
• Warranty :-	3 Year Complete Cover Accidental

Operator Display

- 52" LED Display wide Screen

General Features for RIS Software/ Application

1. Provide the situational awareness and Traffic overview of channel to the Traffic Operators in the Control centre.

2. Facilitate planning of the river Channel activities on a ‘Time-line’ view of the Traffic Display.

- The GUI (Graphical User Interface) should be capable of displaying the arrival and departure information of vessels entering and exiting the Channel with date and time indicators.
- List all important activities being undertaken in the Channel
- Should Display various important activities being undertaken in the Channel, which includes activities of the ‘previous Operator Watch’, ‘current Watch’ and the activities being planned for the ‘next Watch’.
- It must be possible to define start and end-point of the time line
- It must be possible to choose the waterway for the time line.

3. Facilitate the Operator to ‘Define’ the conditions for generating Alerts / Warnings by the system and automatic generation of Alerts / Warnings in the event of any abnormality
4. Facilitate escalation of the alerts / warnings to all important stakeholders using SMS / email.
5. Undertake Incident management during emergencies
6. Receive AIS messages from Base stations and store important AIS messages. Data storage facilities should be able to store data for a period of one year. AIS messages received by multiple stations shall be stored only once.
7. Send out AIS messages broadcast and individual to Vessels in the river channel
8. Disseminate met data on case to case basis to vessels in the system.
9. Facilitate communications between the Traffic operator and captains of the vessels using VHF.
10. Provide the situational awareness and Traffic overview of the river channel to important stakeholders over the web using web access. Web Access shall be planned for minimum 50 stakeholders which shall be scalable at later date.
11. Application should be web based and available on PC, tablet and smartphone (Android and IoS). Application must be available as App for Android Users.
12. BITE facility to provide system status to the Operators to detect any abnormality in the functioning of the sensors integrated with the system.
13. Support integration with other Command and Control systems of security agencies of Police, Navy / Coastguard etc. for building up a collaborative contingency plan in case of emergencies.
14. Should facilitate Storing of important information being received from the sensors such as:-

- Storing of display scenarios
- AIS messages

- VHF data
- Warning / Alerts

Minimum one year data shall be stored.

15. Facilitate automatic detection of the abnormal behaviors of Vessels such as over speeding, vessel entering or leaving demarcated non-entry area, Anchor watch etc. This automatic detection shall be done based on AIS data in the system.
16. Should be able to Zoom, and navigate to any geographical area in the Channel.
17. Should be possible to switch between ENC and Google Maps presentation.
18. Should have the facility for inserting temporary charts (such as plotting point, lines, circle etc.) on the map.
19. Should be able to search any vessel on the geographical location at the given instant.
20. Should have tools to calculate "Closest Point of Approach, TCPA, Range & Bearing Line, ETA, Distance between 2 Vessels or points" etc. in the Channel.
21. Facilitate geo fencing.
22. Capability to provide Virtual Buoys / Aids to Navigation inputs. This according international standard for ATON via AIS.

Based on the market survey, the cost implications are placed herewith,

8.5. Capital Cost / O & M Cost

Provision of RIS is not suggested, at this point of time. However, cost implications are placed.

COST FOR RIS SYSTEM ON "DABHOL CREEK / VASHISHTI RIVER (NW-28)"

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
A.	**CAPITAL COST**			
1	AIS Base Station (Hot standby for 2 locations)	2	30,00,000	60,00,000
2	RADAR	2	50,00,000	100,00,000
3	Meteo Sensor	2	8,00,000	16,00,000
4	ATG	2	11,90,000	23,80,000
5	VHF	2	5,00,000	10,00,000
6	DG Set 10 KVA	2	7,00,000	14,00,000
7	UPS	2	5,00,000	10,00,000

COST FOR RIS SYSTEM ON "DABHOL CREEK / VASHISHTI RIVER (NW-28)"

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
8	RIS Software	2	65,00,000	130,00,000
9	RIS Hardware	1	120,00,000	120,00,000
10	Installation Testing & Commissioning	2	20,00,000	40,00,000
11	Porta cabin	4	12,00,000	48,00,000
12	Trestle Tower	2	10,00,000	20,00,000
13	Land Cost	-	Lump Sum	34,20,000
14	Buildings etc.,	-	Lump Sum	74,00,000
			Total	**7,00,00,000**
B.	**MANPOWER COST**			
	1ST YEAR			
	1 Engineer * 1 NW * 12 months p. a	12	35,000	4,20,000
	3 Operators * 2 Sites * 12 months p. a	72	20,000	14,40,000
	3 Security * 2 Sites * 12 months p. a	72	15,000	10,80,000
	Total for 1st year			**29,40,000**
	Total for 2nd year (7 % on the previous year)			**3,145,800**
	Total for 3rd year (7 % on the previous year)			**3,366,006**
	Total for 4th year (7 % on the previous year)			**3,601,626**
C.	**CAMC for 4 years**			
	1st year			**-Nil-**
	2nd year (10 % on the Capital Cost)			**70,00,000**
	3rd year (+ 10 % on the previous year Cost)			**77,00,000**
	4th year (+ 10 % on the previous year Cost)			**84,70,000**
D.	**LICENSE COST (per annum)**			
	Wireless etc.,			33,00,000
	VHF	3	5,000	15,000
	Other Miscellaneous		Lump Sum	85,000
			Total	**34,00,000**

A. Equipment Cost has been ascertained from the Market, in consultation with IWAI.

B. Man Power Cost has been worked out as per the reuirement and only indicative.

C. Cumulative Annual Maintenance Cost is indicative.

D. The Annual License Cost may vary acoording to the policy of the Licensing Authority.

E. The above cost is not being considered for any cost analysis, since it is only optional.

F. If RIS is planned for implementation, additional cost of INR 0.5 Lakhs / Buoy may have to be added.

An Indicative Module of River Vessel Tracking Information System has been placed at Annexure 8.1.

Further, the following indicative Figures / Diagrams are placed herewith.

1. Typical Automatic Identification System (AIS) on Dabhol Creek / Vashishti River and its connectivity to Control Centre

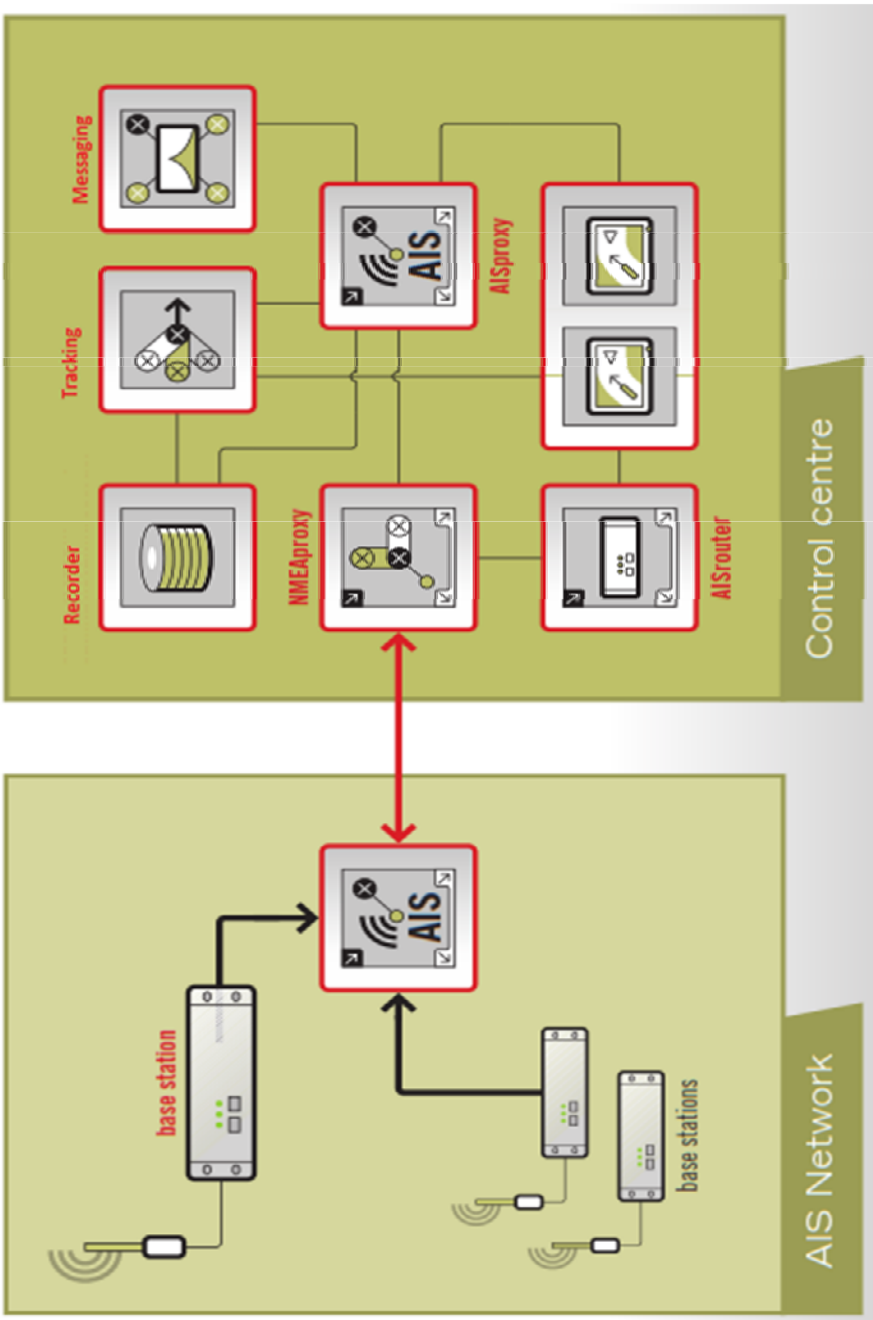
2. Diagram indicating the existing Centres (MR) along the coast and Proposed Centres (RR) along the National Waterway

3. Typical line diagram showing the interface of other systems with the Radar system are placed herewith.

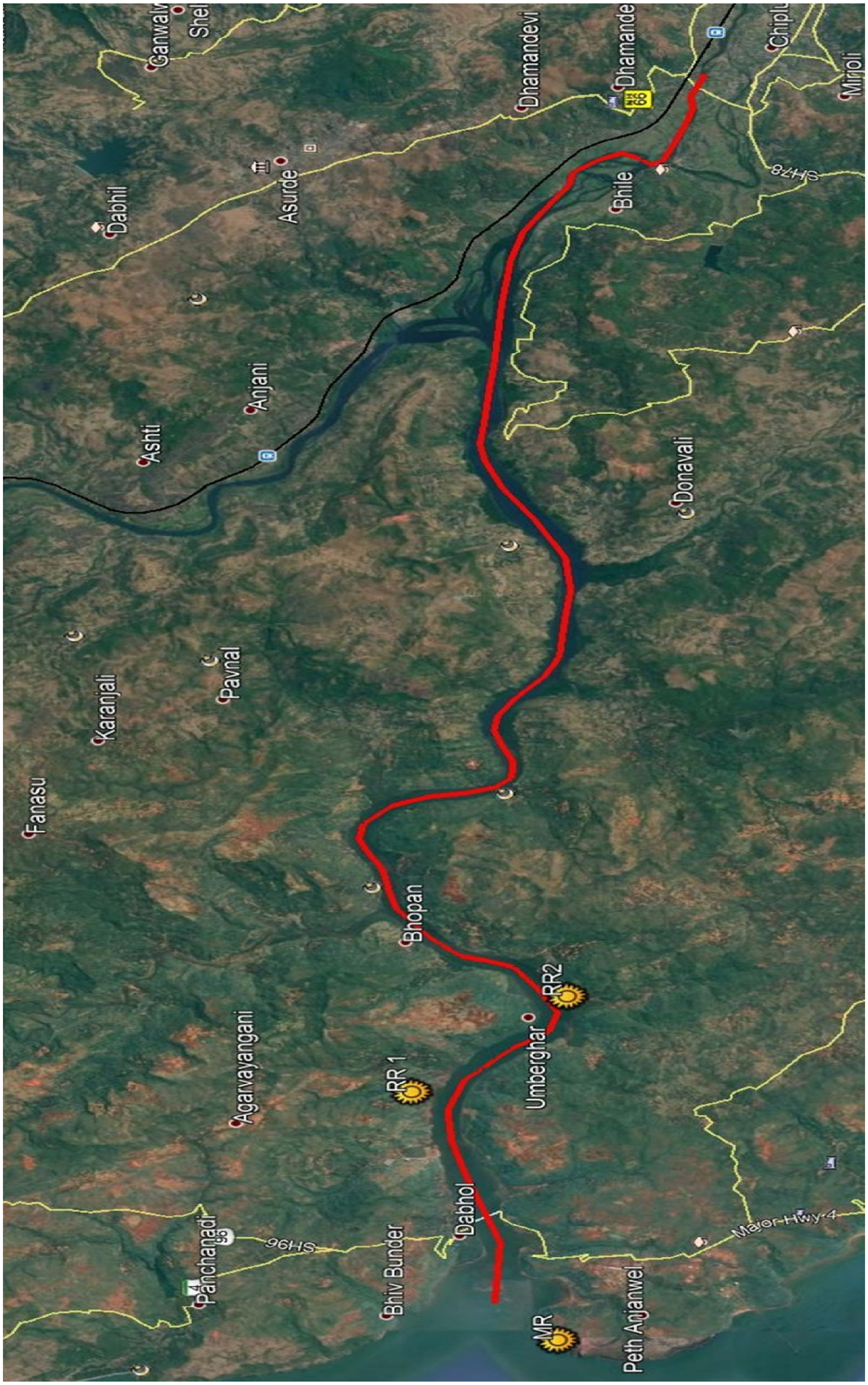
AIS (Automatic Identification System)

Vessels equipped with an AIS transponder broadcast their position, velocity, ships name, call sign and several other data in regular intervals on a VHF channel.

The AIS Base Stations installed in VTS will receives ships information and send to data processing for process and display on Display Terminals.



AIS (Automatic Identification System)


Dhamandevi
Dhamande
Mirjoli
Dabhil
Asurde
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SH78
Anjani
Ashti
Donavali
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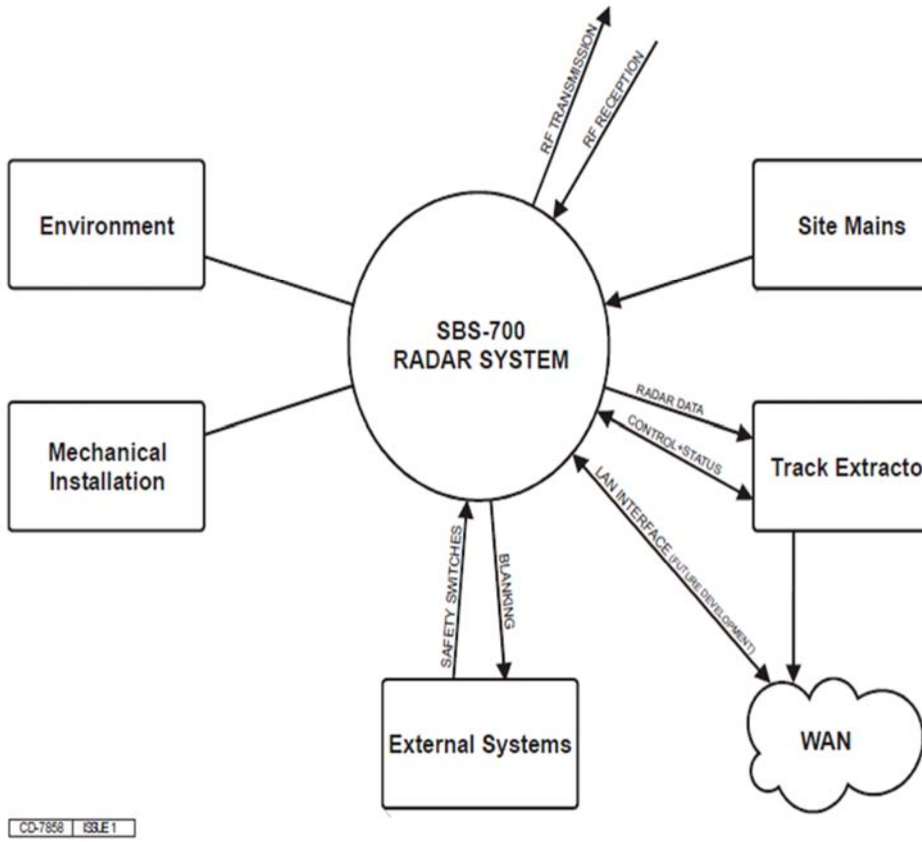
Fanasu
Bhopan
RR2
Umberghar
RR 1
Agarvayangani
Dabhol
Bhiv Bunder
Panchanadi
SH96
Major Hwy-4
MR
Peth Anjanwel


RF TRANSMISSION
RF RECEPTION
Environment
Site Mains
SBS-700
RADAR SYSTEM
RADAR DATA
CONTROL+STATUS
Mechanical
Installation
Track Extractor
LAN INTERFACE (FUTURE DEVELOPMENT)
SAFETY SWITCHES
BLANKING
External Systems
WAN
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CHAPTER 9: ENVIRONMENTAL & SOCIAL ASPECTS

9.1. Objective of Environmental and Social Studies

The objective of the environmental and social studies is to assess the environmental and social impacts due to the proposed development works and suggest a suitable environmental management plan (EMP) to mitigate adverse impacts, if any, including its cost. In addition, Consultant has to identify the authorities who will give the clearance for EIA / EMP.

9.2. Environmental Setting in the Project Area

The proposed project is designated as national waterway no. 28 under the National Waterways Act 2016 and is located on Dabhol Creek/ Vashishti River in the Ratnagiri district of Maharashtra State. It is about 45 km stretch of the Dabhol Creek/ Vashishti River from Arabian Sea at Dabhol Lat 17°34'51.33"N, Long 73° 9'17.83"E to Bridge at Pedhe Lat 17°32'39.45"N, Long 73°30'35.56"E.

Ratnagiri is one of the coastal district of Maharashtra and forms part of Konkan region. It is situated in between the Western Ghats and the Arabian sea and lies between north latitudes 16^0 30' and 18^0 04' and east longitudes 73^0 20' and 73^0 52' and falls in parts of Survey of India degree sheets 47F,47P,and 47H. The District has geographical area of 8208 sq km, out of which about 60 sq km is covered by forest, whereas cultivable area is 4010 sq km and net sown area is 2630 sq km. The district forms part of coastal basin and it is drained by Savitri, Vasisthi, Shastri, Ratnagiri, jaitapur and Wagothan rivers.

The environmental setting in the project area is described in the sections that follow.

9.2.1. Physiography

Physiographically, Maharashtra state may be divided into three natural divisions - the Maharashtra Plateau, the Sahyadri or the Western Ghats and the Coastal Strip (the Konkan).

Maharashtra Plateau: The major physical characteristics of the state include many small plateau and river valleys. In the north the plateau is flanked by Satpuda ranges, which run in the East-West direction in Maharashtra. The river Narmada flows along the north boundary of Maharashtra, and other major rivers like Krishna, Godavari, Bhima, Penganga-Wardha, and Tapi-Purna have carved the plateau in alternating broad river valleys and intervening highlands.

The Sahyadri Range: The Western Ghats of Maharashtra known as the ‘Sahyadri’ mountain ranges have an average elevation of 1000-1200 m above the MSL. The Sahyadri hills run parallel to the seacoast, with many offshoots branching eastwards from the main ranges (Satmala, Ajanta, Harishchandra, Balaghat and Mahadeo). The special features are the hills of Trimbakeshwar, Matheran and the Mahableshwar plateau. Its highest peak is Kalsubai at an altitude of 1650 m. Most of the rivers in Maharashtra originate in the Sahyadri and then divide to join the eastward and westward flowing rivers. These ranges are also characterized by a number of ghats, the important ones being Thal, Bor, Kumbharli, Amba, Phonda and Amboli.

The Konkan Coastal Strip: The narrow strip of coastal land between the Sahyadri and the Arabian Sea is called the Konkan coastal strip. It is barely 50 km in width; it is wider in the north and narrows down in the south. River creeks and branches of the Sahyadri, which reach right up to the coast, dissect this coastline. The important creeks in Konkan are Terekhol, Vijaydurg, Rajapuri, Raigad, Dabhol, Daramthar, Thane and Vasai. The rivers of Konkan rise from the cliffs of Sahyadri and have a short swift flow into the Arabian Sea. Some important rivers are Ulhas, Savitri, Vashishti and Shastri.

(Source: State of Environment Report:Maharashtra, Prepared by Indira Gandhi Institute of Development Research, Mumbai, Sponsored by Maharashtra State Pollution Control Board, Ministry of Environment and Forests, Government of India)

Ratnagiri district, where the proposed waterway is located, is one of the 36 districts of Maharashtra state in Western India. Ratnagiri (city) is the district headquarters of the district. The district is 11.33% urban. The district is bounded by the Arabian Sea to the west, Sindhudurg district to the south, Raigad district to the north and Satara, Sangli and Kolhapur districts to the east. This district is part of Konkan division.

The Sahyadri Mountains border Ratnagiri to the east. Over 85% of the land surface in Ratnagiri district is hilly. All rivers in the district originate in the Sahyadri ranges and flow from east to west and merge in Arabian Sea. Ratnagiri has a long indented coastline. The length of the coastline is about 167 kms, with a number of creeks and inlets. It has 167 km long sea coast which contains many beaches, pats, and forts. 180 km long Sahyadri hill range contains hills, hill forts, wild life and many places of scenic beauty. Number of creeks-ideal and safe for water sports, boating, fishing, swimming, camping etc. Though the district forms an important part of the traditional Konkan Plain, it is characterized by ruggedness and uneven topography.

On the basis of variation in local relief, the district can be classified into six group’s viz. Sahyadri Hills, Konkan Forested Hills, Sudhagad Plateau, Ulhas Basin, Kal-Savitri Valley and Ratnagiri Coast.

The topography is mainly hilly regions of the Sahyadri Ranges and sandy beaches near the Arabian Sea. The Sahyadri stretches like a huge wall from North to South of the District having valleys & peaks. Many rivers originate from these ranges. The villages & towns are located in between They flow westwards and meet the Arabian Sea. The following Rivers are the important Rivers of the region:

- Jagbudi River
- Savitri River
- Muchkundi River
- Kajali River
- Shuk River

River Vashishti is one of the larger rivers in the Konkan coast of Maharashtra, India. The river originates in the Western Ghats and traverses its way westwards towards the Arabian Sea and joins the sea at Dabhol. The river has many riverine islands. The total catchment area of Vashishti River basin is 2238 sq-km.

The Vashishti River has a course of about 72 km and the river becomes tidal near Chiplun, below the island of Govalkot, the river widens in sweeping meanders and after a course of 40 km through low mud banks and mangroves it joins the Arabian Sea at Dabhol. The estuarine mouth is shallow due to sand bar.

Apart from Jagbudi a major tributary, several smaller tributaries join Vashishti on either banks such as Shivnadi (Left Bank) and Kodjai (Right Bank) join Vashishti River. Kolkewadi Dam, near Alore has a vast reservoir which feeds a tributary of the river and is within the catchment area. The Chiplun town lies on its bank.

The southwest monsoon influences the river considerably during June to September and an average rainfall is about 350 cm (Chiplun). The fresh water influx during monsoon results in excellent flushing of the estuarine system.

The total length of the river is about 72 km; major portion of the river is affected by tide (backwater effect) of the Arabian Sea. The Vashishti River meets the tidal wave at Dabhol. The total identified stretch of Inland Waterway of Vashishti River is under tidal zone.

9.2.2. Geology and Seismicity

The entire area of the State forms a part of the “Peninsular Shield”, which is composed of rocks commencing from the most ancient rocks of diverse origin, which have undergone considerable metamorphism. Over these ancient rocks of Precambrian era lie a few basins of Proterozoic era and of permo carboniferous periods which are covered by extensive sheets of horizontally bedded lava flows comprising the Deccan trap. More than 80% area of the State is covered by these Deccan trap, which have concealed geologically older formations. The most important economic minerals such as coal, iron ore, manganese ore, limestone, etc. are found in the geologically older formations.

Structurally, the entire area of the state forms a part of the “Peninsular Shield” of India which represents a fairly stable block of earth crust that has remained unaffected by, mountain building movements, since the advent of the Palaeozoic era. Some of the subsequent movements in the crust have been of the nature of normal and block faulting which have laid down certain portions bounded by tensional cracks of faults giving rise to basins in which sedimentary beds of the Gondwana age have been deposited, particularly in the Vidarbha region giving rise to the important limestone as Penganga beds and coalfields of the Pench-Kanhan valley, the Umred – Bander field, the Wardha valley and Vidarbha valley.

It is generally accepted that the Western coast has been formed as a result of the faulting. Along this coast from Ratnagiri to Mumbai, and further north in Thane district there exists a series of hot springs arranged almost in linear fashion which suggests that they are situated on a line of fracture. Further evidence regarding the formation of west coast by faulting is offered by the Western Ghats comprising Deccan trap lava flows, which are several hundred meters thick near the coast and which gradually thins out east wards.

In the Ratnagiri District, Deccan trap basalt of upper Cretaceous to lower Eocene is the major rock formation and intruded by a number of dykes. The western part of the district consisting of basalt flows are altered to laterite. Recent deposits comprising beach sand and alluvium occur along the coast and in the river mouth.

A massive earthquake struck Maharashtra on September 30, 1993 at Killari in Latur district. Extensive damage was caused to life and property in the districts of Latur and Dharashiv with 7,928 people killed, 16,000 injured and 15,847 livestock killed. In Latur and Dharashiv, 52 villages were razed to ground wherein 27,000 houses, amenities and related infrastructure facilities were totally damaged. Nearly 2,20,000 houses in the adjoining villages of Latur and Dharashiv and 11 other districts of Solapur, Satara, Sangli, Beed, Parbhani, Ahmednagar, Nanded, Kolhapur, Aurangabad, Pune and Nashik suffered varying degrees of damage. A moderately strong earthquake of magnitude 5.1 Richter occurred on 14 March 2005, with its epicenter around Koyna. This area has been witnessing a large number of tremors of low magnitude consistently over a quarter of a century since the first earthquake appeared in 1968.

As per the seismic zoning map of India, the project area falls under seismic zone III.

(Source: Maharashtra: Natioal Disaster Risk Reduction Portal, National Institute of Disaster Management)

9.2.3. Climate

The climate of the State is tropical. The Western Ghats hill ranges run north to south separating the coastal districts of Thane, Mumbai, Raigad, Ratnagiri and Sindhudurg from rest of the State.

The State experiences four seasons during a year. March to May is the summer season followed by rainy season from June to September. The post monsoon season is October and November. December to February is the winter season.

The weather is mostly humid throughout the year. The maximum summer temperature varies between 36°C and 41°C and during winter the temperature oscillates between 10°C and 16°C.

Maharashtra receives its rainfall mainly from south-west monsoon. Rainfall starts in the first week of June and July is the wettest month. The rainfall in state varies considerably. There is heavy rainfall in the coastal region, scanty rains in rain shadow areas in the central part and moderate rains in eastern parts of the state.

The Konkan sub-division comprising of coastal districts and Western Ghats receive the heaviest rains, the Ghats receive more than 6000 mm and the plains 2500 mm. Rainfall decreases rapidly towards eastern slopes and plateau areas where it is minimum (less than 500 mm).

(Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

9.2.4. Soils

The National Bureau of Soil Survey and Land Use Planning (NBSS &LUP) has divided the State of Maharashtra into 356 soil-mapping units, which are broadly categorized as follows:

- Soils of Konkan coast
- Soils of Western Ghats

- Soils of Upper Maharashtra
- Soils of Lower Maharashtra

About 96.4 per cent of the states geographic area is subjected to various degrees of erosion. The soil profile reveals that the incidence of severe erosion is the highest in the Western Ghats 53.1 percent), followed by lower Maharashtra (11.5 percent).

The soil status of Maharashtra is residual, derived from the underlying basalts. In the semidry plateau, the regur (black-cotton soil) is clayey, rich in iron and moisture-retentive, though poor in nitrogen and organic matter. When re-deposited along the river valleys, the kali soils are deeper and heavier, better suited for Rabi crops.

In the rainy Konkan, and the Sahyadri Range, the same basalts give rise to the brick-red laterites, which are productive under a forest-cover, but readily stripped into a sterile varkas when devoid of vegetative cover.

(Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

The soil of the District is generally classified into three types i.e. (1) Laterite soil (2) Salty soil and (3) Coastal alluviums.

9.2.5. Laterite soil

The predominant soils in the District are laterite soils and extensive spreads of laterites are noticed throughout the District. They vary in colour from red to brownish red, owing to the preponderance of hydrated iron oxides. They are fairly well supplied with nitrogen and organic matter. Their texture is loamy. They are porous and not retentive of moisture. These soils are found in several grades, the main being rice soil and varkas soil. Both of these soils are available on the slopes of the hill and are partly eroded yellowish red and poor in fertility. Further they are shallow in depth and coarse in texture.

Salty soil

Due to the inundation of the sea a part of the coastal soils has become salty. They are locally known as Khar or Khajan.

Coastal alluviums

The coastal strips have deep sandy loams and in these soils coconut and arecanut gardens thrive well.

Mineral Assets

Limenite, silica and bauxite are the most vital minerals found in this district.

Manganese and Iron Ores are found in the southern part of Ratnagiri District. Limenite is found along the coast from Purangad to Malgund in Ratnagiri Tahsil.

Silica is found in Rajapur Tahsil, Bauxite is found in Mandagad and Dapoli Tahsils. Rajapur Tahsil is also blessed with deposits of silica sand and annually thousands of tons of silica sand is being dispatched to places like Mumbai, Pune, Kolhapur, Belgaum, Ichalkaranji etc. The feldspar, a minor mineral found in this District can be used in the manufacture of potteries.

Other minor minerals found in the District are mica, mineral pigments such as clay, asbestos, building stones, glass, sand, copper, salt, limestone etc.

(Source: District Census Handbook: Ratnagiri, Census of India -Series-28, Part XII-A, Directorate Of Census Operations, Maharashtra, 2011)

9.2.6. Land Use Pattern

Land use is the surface utilization of all developed and vacant lands on a specific space at a given time. Lands are used for forest, pastures, transportation, settlement, industrial and commercial purposes. Whereas, uncultivable waste land, barren and fallow land are unused lands.

Ratnagiri District forms a part of the Maharashtra littoral, the micro level division of Coastal Plains. District as a whole is a hilly tract. Over 85 per cent of the land surface is hilly. On the basis of local variation in relief and other characteristics, the District can be grouped into the following three parts:

(i) The Sahyadri Hills, which is main system of hills and spreads along the eastern boundary of the District,

(ii) Ratnagiri Plateau- the transverse chains of small hills which projecting towards west from the Sahyadri hills and run parallel to each other and

(iii) The Ratnagiri coast.

Sahyadri Hills in the District spread elongated over the parts of Mandangad, Khed, Chiplun, Sangameshwar, Lanja and Rajapur Tahsils in the north-south direction in the extreme east of the District. The hills have an elevation of over 200 metres which is more than 600 metres at the upper reaches and is characterized by having very steep slopes. The highest spot height is 1,239 metres in Khed Tahsil. It slopes towards west. In fact it is western scarp of Sahyadri. It is densely covered by forests.

The Ratnagiri plateau has an elongated north-south extent varying considerably in width through the centre of the District. It covers parts of all the Tahsils of the District. In this portion hill ranges run parallel to each other and as a result the numerous streams, which flow through the valleys, have formed a parallel drainage pattern. The height of plateau varies between 100 metres and 200 metres from mean sea level. The slopes of hills have partly eroded, yellowish red soils, which are shallow in depth, coarse in texture and poor in fertility. However in kharif season, rice, ragi, small millets, kodra, kulthi, udid etc. are grown in this area. In the valleys arecanut and coconut gardens thrive well in deep sandy loams. Cashewnut, jackfruits, kokam and world renowned Alphonso mangoes are also grown on the slope of hills, mainly in Ratnagiri and Rajapur Tahsils.

The Ratnagiri Coast is extending in a narrow strip of land running the entire length of the District covering parts of Rajapur, Ratnagiri, Guhagar, Dapoli and Mandangad Tahsils. It attains the height below 100 metres. This coast is cliffy and erosion seems to be predominant as can be seen from the number of wave cut platform and cliffs. Beaches, in general, are not well developed and are very narrow and occur only in small patches. Some patches of salty land are also found in the low lying areas. This coastal strip in Dapoli, Guhagar, Ratnagiri and Rajapur Tahsils has a deep sandy loam soils in which coconut and arecanut gardens thrive well. Rice, ragi, kulthi and other crops are grown in the kharif season.

For the District as a whole, 30.18 percent of the total area is cultivable. Among all the Community Development (C.D.) Blocks, Dapoli has the highest percentage of cultivable area (40.95 percent) and Khed has the lowest percentage (20.70 percent). Only 2.21 percent of the cultivable area of the District is irrigated. Guhagar C.D. Block has the highest percentage of irrigated area to cultivable area (3.94 percent) and Rajapur C.D. Blocks has the lowest (0.98 percent).

(Source: District Census Handbook: Ratnagiri, Census of India -Series-28, Part XII-A, Directorate Of Census Operations, Maharashtra, 2011)

The project area is characterized by mixed land use comprising largely mangrove forests and agricultural land interspersed with minor settlements, fishing jetties and roads.

9.2.7. Ambient Air and Noise Quality

The Air (Prevention & Control of Pollution) Act, 1981 of India describes air pollutants as *'Any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may or tend to be injurious to human beings or other living creatures or plants or property or environment'*. The condition of air quality in the surroundings is the ambient air quality.

In India the Central Pollution Control Board (CPCB) coordinates the air quality monitoring regime through its nationwide programme known as National Air Quality

Monitoring Programme (NAMP). CPCB has been monitoring ambient air quality through 363 stations in 139 cities across the country as of November, 2009.

Limited relevant secondary data on ambient air and noise quality is available for the project area. As per the Annual Report (2010-11) of Maharashtra Pollution Control Board (MPCB), ambient air quality has been assessed through fifty-five locations under National Air Quality monitoring Programme (NAMP), eight locations under State Air Quality Monitoring Programme (SAMP) and eight locations under Continuous Ambient Air Quality Monitoring (CAAQM).

The Annual Report (2010-11) of MPCB observes that there is rise in level of SO_2 in few commercial and residential areas as compared to the preceding two year's ambient air quality monitored at different locations under NAMP, SAMP Project & CAAQM Stations. However, compared to the preceding year the level of NOx is reduced in industrial areas while a rise is seen in its level in residential and commercial locations.

The project area has a few minor settlements and some industries with emission norms regulated by the SPCB. Accordingly, the overall ambient air / noise quality in the project area is anticipated to be within permissible limits. No secondary data on ambient air and noise quality is available specific to the project area. The impact on the existing ambient air and noise quality is expected to be largely limited to the emissions due to vehicular movement and movement of men and material during project construction phase.

Primary data on ambient air quality monitoring in the project area may be collected at a later stage as required.

9.2.8. Ambient Water Quality

Some industries are established on the banks of this river. However, discharge of effluents by these industries is regulated by the Maharashtra State Pollution Control Board and the Vashishti river water quality in the proposed stretch, as observed at site, does not appear to be impacted by industrial effluents.

Surface water quality analysis has been done at five sample locations in the project stretch as part of the hydrographic survey carried out for the present DPR study. The sample locations for water quality analysis include Dabhol, Sakhari, Parchuri, Maldoli and Gowalkot. The pH value for the five locations is 7.71, 7.64, 6.87, 6.15 and 6.49 respectively. The river water is slightly acidic in nature with average pH being 6.97.

The Central Pollution Control Board (CPCB) has established a network of monitoring locations on aquatic resources across the country. The present network operated under Global Environmental Monitoring System (GEMS) and Monitoring of Indian

National Aquatic Resources System (MINARS) covers 445 rivers in 29 States and 6 Union territories having 1275 locations.

Based on an analysis of the water quality data for the years 2009-2012, CPCB published a report in February 2015 titled ‘River Stretches for Restoration of Water Quality’ (Monitoring of Indian National Aquatic Resources Series: MINARS/37 /2014-15).

In the said report, the rivers have been prioritized based on the concentration of BOD in five classes from Priority I to V. The criteria of each priority are elaborated indicating the concentration range of BOD in mg/l. The degree of violation is with respect to water quality criteria for drinking water source with conventional treatment with respect to BOD. The polluted locations in a continuous sequence are defined as polluted river stretches.

Criteria for Priority I
Monitoring locations exceeding BOD concentration 30 mg/l.

Criteria for Priority II
Monitoring locations having BOD between 20-30 mg/l.

Criteria for Priority III
Monitoring locations having BOD between 10-20 mg/l.

Criteria for Priority IV
Monitoring locations having BOD between 6-10 mg/l.

Criteria for Priority V
Monitoring locations having BOD between 3-6 mg/l.

According to this report, water quality of rivers in Maharashtra is measured at 156 locations on 49 rivers and among them 153 locations are non-complying to the Water Quality Criteria with respect to BOD. These 153 locations are on 49 rivers. The names of 49 polluted rivers are; Wena, Wainganga, Godavari, Bhima, Krishna, Ulhas, Kundalika, Tapi, Girna, Panchganga, Nira, Bhatsa, Rangavali, Indrayani, Chandrabhaga, **Vashishti**, Mithi, Kanhan, Koyna, Amba, Amravati, Bindusara, Darna, Ghod, Gomai, Hiwara, Kan, Manjra, Mor, Morna, Mula, Mula- Mutha, Mutha, Panzara, Patalganga, Pawna, Pedhi, Pehlar, Penganga, Purna, Savitri, Sina, Surya, Urmodi, Vel, Vaitrana, Venna, Waghur and Wardha. However, **the identified polluted stretch of 3 km of Vashishti River, which runs from Kherdi to Dalvante, has been categorized as Priority Class V which means it falls in the least polluted category.**

As per another report published by the Maharashtra State Pollution Control Board in April 2014 titled 'Water Quality Status of Water Bodies of Maharashtra with Recourse to Analytical / Statistical Tools (2007-2011)', water quality was measured at four locations on Vashishti River and for all four locations of Vashishti River, it was observed that parameters such as DO, BOD, Ammonia and Nitrate complied with the prescribed standards. PH and TC values were within the prescribed standards for other three locations.

Central Ground Water Board (CGWB) has been monitoring the ground water quality of the Ratnagiri district over the last four decades through its established monitoring wells. The objective is to develop an overall picture of the ground water quality of the district. During the year 2011, the Board had carried out the ground water quality monitoring of 39 monitoring wells. The parameters analyzed included pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO_3) and Fluoride (F). As per this study, the concentration of most of the parameters was found to be within desirable limits of the BIS standards for drinking water (IS-10500-91, Revised 2003). (Source: Ground Water Information, Ratnagiri District, Maharashtra, Central Ground Water Board, Ministry of Water Resources, Government of India, 2014)

Primary data on water quality monitoring in the project area may be collected at a later stage as required.

9.2.9. Susceptibility to Natural Hazards

Maharashtra is prone to various disasters such as drought, floods, cyclones, earthquake and accidents. As per the State of Environment Report for Maharashtra published by the Ministry of Environment and Forests, Ratnagiri District, where the proposed project is located, is vulnerable to river floods in the monsoon.

The Koynagar earthquake of 1967 affected Chiplun and Sangameshwar talukas killing three people, but chances of future earthquakes in Ratnagiri District are rare.

The 167 km coastline of Ratnagiri district could attract cyclones, but no major cyclones have been reported in the past. In the Arabian Sea, during the period 1890-1995, around 207 depressions, mild cyclonic storms or severe cyclonic storms have been recorded. However, most of them have moved away from Maharashtra as out of 207 disturbances, only 19 have affected Maharashtra-Goa coast. Out of these 19, six were major ones causing 70 deaths, with 150 boats and 160 crew missing and extensive damage to trees and ships. Thus, in spite of having a long coastal region, Maharashtra has experienced only 6 cyclones in last 50 years, though there have been numerous threats. Thus, climatologically, the state is having low risk of cyclone.

The district is not vulnerable to droughts.

(Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

9.2.10. Estuary and Coastal Zone

The Maharashtra coast is characterized by pocket beaches flanked by rocky cliffs of Deccan basalt on one side and estuaries with patches of mangroves on the other. Maharashtra state has about 720 km long indented coastline, which is marked by the presence of major estuaries and narrow creeks. It comprises of the coastal districts of Thane, Raigad, Greater Bombay, Ratnagiri and Sindhudurg. The shoreline is generally straight.

(Source: State of Environment Report:Maharashtra, Prepared by Indira Gandhi Institute of Development Research, Mumbai, Sponsored by Maharashtra State Pollution Control Board, Ministry of Environment and Forests, Government of India)

Ratnagiri district, where the proposed waterway is located, has a coastline of 167 km.

Being a coastal district, Ratnagiri enjoys a unique combination of nature's endowment, a significant component of which is the diversity of its coastal habitats characterized by a variety of landforms like beaches, estuaries, island's etc.

The river Vashishti joins the Arabian Sea at Dabhol, forming the Dabhol Creek system. A long sandy beach is present near Guhagar about 7 km south of the Vashishti River confluence with Arabian Sea. Tidal flat s also present at a few places. The near shore is relatively shallow and close to the river mouth. Dabhol Power Company has set up a Natural Gas based power generation project at Dabhol and a service jetty has been constructed at the river mouth.

Ratnagiri coast has been blessed with luxuriant, thick mangrove vegetation with patches of other associated flora and fauna. Bhatye estuary is situated at $73^{0}15'$ East and $16^{0}51'$ North near Ratnagiri and known for the mangroves on the mud flats. The zooplanktons are the secondary producers and the first level converters of plant matter into animal substances and thus they occupy an important place in the food web of aquatic environments like mangroves. The zooplankton assume a great ecological significance in mangrove ecosystems as this ecosystem if the feeding, breeding and nursery grounds for many fin and shell fishes; and the young fin and shell fishes spend most of their live times in the brackish waters, and after becoming adult they move over to sea. Hence, zooplankton determines the quantum of fish stock. The zooplankton species like Acrocalanus flavicornis, Mesocyclops species and Pontellina plumata dominated the estuarine region.

In Ratnagiri district the two estuaries, namely Terekhol and Vashishti, provide excellent area where mangroves widely available. Terekhol estuary has an undisturbed estuarine ecosystem, while the construction of Koyna dam and the emptying of its tail waters in the estuary of Vashishti have a significant effect on the ecosystem. The mangroves from Chiplun onwards have been exposed to fresh water conditions.

According to the National Institute of Oceanography studies, Vashishti estuary shows marked reduction in Dissolved Oxygen (DO) with high nutrients, indicating that the estuary is under stress due to ongoing discharges. The contents of heavy metals like Cr, Mn, Co, Ni, Cu and Zn is higher at the upper segment and the source of these metals is suspected to be anthropogenic. Bacterial counts are high both in the coastal and estuarine segments. High standing stock of phytoplankton and zooplankton in the estuary suggests organic pollution induced biological productivity in the estuary.

The Ministry of Environment and Forests, Govt. of India, under the provision of Environment (Protection) Act, 1986, had issued a notification in February, 1991, declaring an area of 500 m. from the high tide line along the sea coast, bays and estuaries and up to 100 m from the rivers and creeks as a Coastal Regulation Zone. The developments within this zone are required to be regulated in accordance with the provisions of the notification and the Coastal Zone Management Plan which the State Govt. is required to prepare for the area.

The CRZ Notification 1991 was later amended and a new Notification was issued in 2011 namely CRZ Notification, 2011. The notification imposes certain restrictions on the setting up and expansion of industries, operations or processes and the like in the CRZ.

The entire project area falls under the tidal zone. Accordingly, the proposed project will require clearance under the CRZ Notification 2011.

9.2.11. Archaeological and Heritage Locations

A study of the project alignment on the Google Map clearly indicates that no structures of archaeological, cultural or historical importance are located close to the project area in a manner that these will be impacted by the project. Therefore, no such structures are anticipated to be impacted due to the proposed project.

Prohibited and Regulated Areas with respect to protected monuments are defined in the **Ancient Monuments and Archeological Sites and Remains (Amendment and Validation) Act, 2010**, and the definition of the two terms is as follows:

Prohibited Area: Every area, beginning at the limit of the protected area or the protected monument, as the case may be, and extending to a distance of one hundred metres in all directions shall be the prohibited area in respect of such protected area or protected monument.

Regulated Area: Every area, beginning at the limit of prohibited area in respect of every ancient monument and archaeological sites and remains, declared as of national importance and extending to a distance of two hundred metres in all directions shall be regulated area in respect of every ancient monument and archeological site and remains.

As per the information available on the website of Archaeological Survey of India, none of the structures under the category of National / State protected monuments are located close to the project site for the suggested stretch for development. Therefore, no clearance requirement is envisaged with respect to these structures.

A list of the protected monuments located in Raigad District is provided in Table 9-1 below.

TABLE 9-1: Protected Monuments in Ratnagiri District, Maharashtra

S.No.	Name of Monument / Site	Location	District
1.	Mosque	Dabhol	Ratnagiri
2.	Rock cut Caves (Ganesh Lena group)	Panhala Kaji	Ratnagiri
3.	Suvarnadurg Fort	Harnai	Ratnagiri
4.	Jaygad Fort	Jaygad	Ratnagiri
5.	Vijaydurg Fort	Vijaydurg	Ratnagiri

Source: http://www.asimumbaicircle.com/images/list-of-protected-monuments-n-forts.pdf

9.2.12. Flora and Fauna

9.2.12.1 FLORA

Mangroves are found to be located on both banks of the Vashishti River along the proposed waterway stretch. The Coastal Regulation Zone Notification (2011) under the Environmental Protection Act (1986) recognizes the mangrove areas as ecologically sensitive and categorizes them as CRZ-I which implies that these areas are afforded protection of the highest order.

There are dense forests in the foothills of the Sahyadri ranges in this district. The Sahyadri Hills and Valleys are full of rainforest. The teak, ain, kinjal, khair, undin and other trees are found in abundance in these forests. Many medicinal plants are also found in the district. The forest department has recorded more than 300 bushes / plants in the district which have medicinal properties.

(Source:http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

There are dense forests in Khed, Sangameshwar, Lanje and Dapoli taluka. There are forests in some parts of Chiplun and Mandangad talukas.

TABLE 9-2: Floral Species in Ratnagiri District

S.No.	Scientific Name	Common Name
1.	*Terminalia tomentosa*	Ain
2.	*Terminalia paniculata,*	Kinjal
3.	*Garuga pinnata*	Kakad
4.	*Terminalia belerica*	Behada
5.	*Adina cordifolia*	Hed
6.	*Salmalia malbarica*	Savar
7.	*Mangifera indica*	Amba
8.	*Albizzia procera*	Kinai
9.	*Xylia xylocarpa*	Jamba
10.	*Albizzia lebbek*	Shiras
11.	*Anogeissus latifolia*	Dhavada
12.	*Alstonia scholaris*	Satvin
13.	*Tectona grandis*	Teak
14.	*Lagerstroemia lanceolata*	Nana
15.	*Syzygium cumini*	Jambhul
16.	*Ixora Coccinia*	Pendkul
17.	*Dalbergia latifolia*	Sisum
18.	*Emblica officianalis*	Awala
19.	*Cassia fistula*	Bahawa
20.	*Memecylon edule*	Anjani
21.	*Terminalia chebula*	Hirda
22.	*Mallotus philippinensis*	Shendri
23.	*Bridelia retusa*	Asana
24.	*Lagerstroemia parviflora*	Lendi

S.No.	Scientific Name	Common Name
25.	*Holigarna amottiana*	Bibi
26.	*Glochidion lanceolaria*	Bhoma
27.	*Olea dioica*	Parjambhul
28.	*Lea macrophylla*	Dinda
29.	*Cinnamomum tamala*	Tamalpatra
30.	*Murraya paniculata*	Pandhari
31.	*Atalantia monophylla*	Makad limbu
32.	*Connarus wightii*	Kutkuta
33.	*Mappia foetida*	Narkya
34.	*Clerodendron infortunatum*	Bhandira
35.	*Canthium umbellatum*	Tupa
36.	*Gardenia lucida*	Dikmali
37.	*Streblus asper*	Karavti
38.	*Zanthoxylum rheisa*	Triphal
39.	*Hydnocarpus laurifolia*	Kalhoni
40.	*Ligustrum nelgherrense*	Kapshi
41.	*Pouteria tomentosa*	Kumbhal
42.	*Grewia microcosm*	Hasoli
43.	*Vagatea spicata*	Wakeri
44.	*Strobilanthes callosus*	Karvi
45.	*Rauvolfia serpentina*	Harki
46.	*Vitex negundo*	Nirgudi
47.	*Vitex thwaitesii*	Nirgunda

9.2.12.2 FAUNA

Animals such as leopards, wild boars, jackals, wolves, monkeys are found in the forests of the districts. Birds such as egrets, peacocks, cuckoos (koels), pigeons and parakeets are also found here.

The species of reptiles found in Ratnagiri forests include Python, Monitor Blizzard, Snakes, Rat snakes, Kraits, Vipers, Crocodile, and Cobra.

The following varieties of birds are found in Ratnagiri/Vashishti area:

TABLE 9-3: Avifaunal Species in Ratnagiri / Vashishti Area

S. No.	Scientific Name	Common Name
1.	*Rhynchaca engalensis*	Snipe
2.	*Dendrocyngana fulva*	Whistling teal
3.	*Ortigornis pondicariann*	Painted partidge
4.	*Prancolinus pondicrianus*	Grey partridge
5.	*Coturnix coturnis*	Grey quail
6.	*Coturnix coromandelicus*	Rainquail
7.	*Turnix aigoor*	Bustard quail
8.	*Perdicula asiatica*	Jungle bush quail
9.	*Pavo eristalus*	Pea fowl
10.	*Gallus sonnerattii*	Grey jungle fowl
11.	*Columbera livia*	Blue rock pigeon
12.	*Butex furox*	Bazzards
13.	*Coicus marrurus*	Pale harrior

The following species of mammals are found in Ratnagiri forests.

TABLE 9-4: Mammalian Species in Ratnagiri Forests

S. No.	Scientific Name	Common Name
1.	*Panthera pardus*	Panther
2.	*Rusa unicolor*	Sambar
3.	*Canis lupus*	Wolf
4.	*Hynaena hyaena*	Hyaena
5.	*Ursus arctos*	Aswal
6.	*Muntjak vaginalis*	Bhekar
7.	*Boselaphus tragocamelus*	Nilgai

S. No.	Scientific Name	Common Name
8.	*Sus cristatus*	Ran dukkar
9.	*Vulpes vulpes*	Kolha
10.	*Canis aurenus*	Khokad
11.	*Herpestes edwardsic*	Mongoose
12.	*Hystrix leucura*	Sayal
13.	*Lepus ruficaudatus*	Hare
14.	*Felis cheus*	Baul
15.	*Viverra Malaccansis*	Kalindri
16.	*Macaca radiata*	Makad
17.	*Semmopithecus entethus*	Wanar
18.	*Bos gaurus*	Gaur
19.	*Ratufa indica*	Indian Giant Squirral
20.	*Muntiacus muntjack*	Indian Muntjac

Large number of species of fishes are found in Arabian Sea and creeks such as Silver Pomfret (*Stromateus argenteus*), Sea Bass (*Lates calcarifer*), Gold Spotted Anchovy (*Coilia dussumieri*), Mackrel (*Rastrelliger Kanagurta*), Bombay Duck (*Harpadon nehereus*), Little Tuna (*Euthynnus affinis*), Ribbon Fish (*Lepturacanthus savala*), Dhoma (*Sciaena dussumieri*), Seer Fish (*Scomberomorus guttatus*), Silver bar (*Chirocentrus dorab*), Sepia (*Sepia officinalis*), Mud Crab (*Scylla serrata*), Prawns (*Penaeus monodon*) etc and bulk of the catch is sent to local market and Mumbai market.

(Source:http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

The sea bordering the district is a source of lavish marine wealth. In the lagoons and creeks along the coast are found many kinds of fish. A variety of shell-fish called mussels is found in Ratnagiri, Jaitaur, Harnei, etc. Crabs too are caught along the coast.

There is a demand for prawns from foreign countries. The Konkan Krishi Vidyapeeth runs centers for breeding these marine animals. Hence, fisherman gets new information about research, breeding and catching of fish.

9.2.13. National Parks, Forests, Wildlife Sanctuaries and Reserves

Forest is the second largest land use after agriculture in the State. The share of Forestry in GSDP (at current prices) during 2013-14 was 2.2 per cent. At the end of year 2013-14, the total forest area of the State was 61,733.91 sq km (provisional) constituting about 20.1 per cent of geographical area of the State as against the target of 33 per cent set under National Forest Policy, 1988.

The jurisdiction of the total forest area in the State is divided amongst Forest Department (55,368.6 sq km, provisional), Forest Development Corporation of Maharashtra (FDCM) (3,590.2 sq km provisional), Private forest brought under possession of Forest Department (1,162.4 sq km provisional) and Revenue Department (1,612.8 sq km, provisional).

Out of the total forest area 50,882.8 sq km was reserved, 6,733.2 sq km was protected and 4,117.9 sq km was unclassed forest.

Forest provides major products like timber, firewood and minor products like bamboo, tendu leaves, gum, grass, etc. All these forest produce are of great value in terms of generating revenue and providing livelihood to local people.

(Source: Economic Survey of Maharashtra, 2014-15, Directorate of Economics and Statistics, Planning Department, Government of Maharashtra, Mumbai)

Ratnagiri District, where the project is located, is fairly rich in Forest Areas. The district has a forest cover of 6706.50 ha out of which 4885.00 ha forest is reserved forest, 2.75 ha is protected forest and 1640.68 ha is unclassified forest. Remaining forest is under the forest department and the revenue department.

There are six National parks, 47 Sanctuaries and four Conservation Reserves in the State. According to ‘Status of Tigers in India, 2014’ report, the number of estimated tigers in the State is 190 as against 169 in 2010.

A study of the project alignment and its surrounding area upto a radius of 10 km on the Google Map reveals that no components of the proposed waterway fall under any of the Protected Areas such as the national parks or wildlife sanctuaries or their eco-sensitive zones.

9.2.14. Socio-economic Profile

Maharashtra is the second largest state in India in terms of population and has geographical area about 3.08 lakh sq. km. It has a population of 11.24 crore (Census 2011) which is 9.3 per cent of the total population of India and is highly urbanised with 45.2 per cent people residing in urban areas.

The State has 36 districts which are divided into six revenue divisions viz. Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur for administrative purposes, with effective machinery for planning at the district level. For local self-governance in rural areas, there are 34 Zilla Parishads, 351 Panchayat Samitis and 27,873 Gram Panchayats. The urban areas are governed through 26 Municipal Corporations, 226 Municipal Councils, 13 Nagar Panchayats and seven Cantonment Boards.

Ratnagiri district, where the proposed waterway is located, is included in the Konkan division. Ratnagiri district is one of the four coastal districts situated along the western coast of the State.

Ratnagiri District lies along the west coast forming a part of traditional „Konkan Land" between 16 º 13' to 18 º 04' North Latitudes and 73 º 02' to 73 º 52' East Longitudes. The District is bounded by Raigarh District in the north, Arabian Sea towards the west, Sindhudurg District on the south and Satara, Sangli and Kolhapur Districts to the east.

The District has an area of 8,208 sq km, and a population of 16,15,069 persons as per Census 2011. While the area of the District accounts for 2.67 percent of the total area of the State, the District population constitutes 1.44 percent of the total population of the State. The density of population is 197 persons per sq km. The District ranks 18th in terms of area, 28th in terms of population and 32nd in terms of density.

The headquarters of the District is at Ratnagiri, a Town having population of 76,229 persons, which is located at 370 km, from the State capital of Maharashtra, Mumbai. It is well connected from Mumbai and Kanyakumari by Konkan Railway. District also has a good network of roads which connects it from the other parts of the country.

For administrative purposes, the district is divided into 3 sub-divisions viz., Ratnagiri, Dapoli and Chiplun and 9 Tahsils.

Ratnagiri sub-division includes Ratnagiri, Lanja and Rajapur Tahsils, Dapoli sub-division includes Dapoli, Mandangad and Khed Tahsils and Chiplun sub-division includes Chiplun, Sangameshwar and Guhagar Tahsils.

The district collector along with the District Judge, Superintendent of Police, Chief Executive Officer of Zilla Parishad and other senior officers of the State Government look after the development and regulatory functions in the district.

At the Tahsil level the Tahsildar, Block Development Officer, Judicial Magistrate, Deputy Engineers and other officers look after their respective departments for development and regulatory functions.

District Highlights – 2011 Census

- Ratnagiri district is famous for alphanso mango crop and processing industries.
- Marine fishery is the most important non agricultural economic activity of the district.
- The economy of the district is mainly dependent on cultivation.
- Ratnagiri is one of the least urbanized districts in the state, having about 16.3 percent population in urban areas whereas about 45.2 percent of the state's population lives in urban area.
- The "White Beach" and "Ganpati Pule" are very famous tourist centres in Ratnagiri district.
- Ratnagiri district has the highest sex ratio (1122) in the state (929).
- There are only 6 uninhabited villages in the district.
- Rajapur tahsil is having the highest number of villages (238) in the district.
- Power supply facility is available for all inhabited villages (100 percent).
- Harnai Village in Dapoli C.D. Block is the most populated (7,274 persons) and Ambetvillage in Sangmeshwar C.D. Block is the least populated (2 persons).
- Khorninko village in Lanja C.D. Block has the largest area (3,239.0 hectares) and villages AlsureKh.(Khed C.D. Block), Nava Someshwar, ThikanChakradev, ThikanSoman and Muslimwadi (Ratnagiri C.D. Block) have the smallest area (2.0 hectares each) among all villages of the district.
- Literacy rate of Ratnagiri district (82.2 percent) and males and females literacy rate is reported (90.9 percent) and (74.5 percent) respectively.

Source: District Census Handbook: Ratnagiri, Census of India -Series-28, Part XII-B, Directorate Of Census Operations, Maharashtra, 2011.

Important Statistics

			State		District	
Number of Villages		Total	43,665		1,537	
		Inhabited	40,959		1,531	
		Uninhabited	2,706		6	
Number of Towns		Statutory	256		5	
		Census	278		11	
		Total	534		16	
Number of Households		Normal	24,296,607		395,395	
		Institutional	67,432		560	
		Houseless	57,480		1,160	
Population	Total	Persons	112,374,333		1,615,069	
		Males	58,243,056		761,121	
		Females	54,131,277		853,948	
	Rural	Persons	61,556,074		1,351,346	
		Males	31,539,034		630,213	
		Females	30,017,040		721,133	
	Urban	Persons	50,818,259		263,723	
		Males	26,704,022		130,908	
		Females	24,114,237		132,815	
Percentage Urban Population			45.22		16.33	
Decadal Population Growth 2001-2011			Number	Percentage	Number	Percentage
		Persons	15,495,706	15.99	(81,708)	-4.82
		Males	7,842,460	15.56	(33,377)	-4.20
		Females	7,653,246	16.47	(48,331)	-5.36
Area (in sq Km.)			307713		8208.00	
Density of Population (Persons per sq Km.)			365		197	
Sex Ratio		Total	929		1,122	
(Number of females per 1000 males)		Rural	952		1,144	
		Urban	903		1,015	

Important Statistics						
		State		District		
		Number	Percentage	Number	Percentage	
Literates	Persons	81,554,290	82.34	1,199,392	82.18
	Males	45,257,584	88.38	619,012	90.93
	Females	36,296,706	75.87	580,380	74.53
Scheduled Castes	Persons	13,275,898	11.81	66,948	4.15
	Males	6,767,759	11.62	31,967	4.20
	Females	6,508,139	12.02	34,981	4.10
Scheduled Tribes	Persons	10,510,213	9.35	20,374	1.26
	Males	5,315,025	9.13	10,402	1.37
	Females	5,195,188	9.6	9,972	1.17
Workers and Non-Workers					
Total Workers (Main and Marginal)	Persons	49,427,878	43.99	714,076	44.21
	Males	32,616,875	56	407,008	53.47
	Females	16,811,003	31.06	307,068	35.96
(i) Main Workers	Persons	43,762,890	38.94	554,973	34.36
	Males	29,989,314	51.49	344,089	45.21
	Females	13,773,576	25.44	210,884	24.70
(ii) Marginal Workers	Persons	5,664,988	5.04	159,103	9.85
	Males	2,627,561	4.51	62,919	8.27
	Females	3,037,427	5.61	96,184	11.26
Non-Workers	Persons	62,946,455	56.01	900,993	55.79
	Males	25,626,181	44	354,113	46.53
	Females	37,320,274	68.94	546,880	64.04
Category of Workers (Main & Marginal)					
(i) Cultivators	Persons	12,569,373	25.43	296,913	41.58
	Males	7,592,313	23.28	137,823	33.86
	Females	4,977,060	29.61	159,090	51.81
(ii)Agricultural Labourers	Persons	13,486,140	27.28	153,117	21.44
	Males	6,774,538	20.77	68,085	16.73
	Females	6,711,602	39.92	85,032	27.69
(iii)Workers in household industry	Persons	1,225,426	2.48	17,230	2.41
	Males	690,755	2.12	9,571	2.35
	Females	534,671	3.18	7,659	2.49
(iv) Other Workers	Persons	22,146,939	44.81	246,816	34.56
	Males	17,559,269	53.83	191,529	47.06
	Females	4,587,670	27.29	55,287	18.00

Source: District Census Handbook: Ratnagiri, Census of India -Series-28, Part XII-B, Directorate Of Census Operations, Maharashtra, 2011.

Most of the people of this District are engaged in agricultural activities and as per 2011 Census, 41.58 percent of the total workers are engaged as cultivators and 21.44 percent of the total workers are engaged as agricultural labourers in the District. They together constitute 63.02 percent of the total workers of the District.

The District is famous for its mango crop specially the world renowned Alphonso. Plenty of Cashew nut is grown in this area. On the mountain tops are the perennial forests, where varkas soils are rich in humus because of their being protected from erosion. They are reddish-brown in colour. Most of these soil being brought under plantations. Entire land-scape is also dotted with Coconut, Kokum, Arecanut and Jackfruit trees which thrive well in these soils and climate. Spices like pepper and other pulses are also cultivated especially in the coastal area.

Ratnagiri is one of the most important maritime Districts in Maharashtra. Therefore, marine fishery is naturally an important economic activity in the District. Fishing is done all along the coast, in the sea, generally up to 65 km from the coast. The important fishery centres in the District are Harnai, Dabhol, Jaigad, Ratnagiri and Jaitapur. Fishing activities are carried out during nine months from September to May.

The commercially important varieties of fish available in quantities are Bangada, Tarli, Pedva, Mushi, Shingada, Paplet, Halwa, Tuna, Surmai, Zinga, Dhoma, Ghol, Karli and Ravas etc. Besides these clam, oysters are also available along the entire coastal line, mainly in the creeks and backwaters.

Industrially, Maharashtra is one of the advanced states in the country but Ratnagiri is one of the most industrially under-developed Districts in the state. There are very few industries in the District. They are located in Ratnagiri, Chiplun and Khed Tahsils. The employment in non-agricultural sector depends mainly upon the village and cottage industries.

The most important small scale industries in the District are cashew nut processing, having a great demand in the national market, fruit preservation and Silica processing. Other registered units are oil mills, saw mills, cement products, sodium silicate, laundry soap, printing, book binding, bidi making etc., which are located in Ratnagiri and Chiplun Tahsils. By the size of employment generated, fishing is the largest occupation in the District. Powdered dry fish produced is used as a fertilizer.

The district is well connected with the state capital and surrounding districts, tehsils and villages through road, rail and waterways. The road network consists of express way, national highways, state highways, major district roads and village roads. The rail network consists of broad gauge and narrow gauge. The districts headquarter and other 9 tahasils of district are well connected to each other by roadway, railway and waterways for transport and trade to major cities within the state.

9.3. Potential Environmental and Social Impacts of the Project

Based on the traffic demand analysis, the DPR provides for two Alternatives for development of the proposed project – one without any new development of fairway or of terminal (the stretch being limited to 35 km of the National Waterway 28), and another with development of fairway and terminal (covering the entire stretch of 45.228 km under NW 28).

Potential Environmental and Social Impacts in Alternative I

No construction activities as proposed for Phase 1 development. Alternative I does not require any dredging or land for terminal construction as the existing depth is sufficient for the required navigability.

Alternative I, thus, does not require any terminal construction, dredging, approach road development or bank protection works. It involves dredging for creation of a navigable channel and installation of beacon lights only. Therefore, no land use change is anticipated to occur due to the development of the project as proposed in Alternative I.

For Alternative I, existing Dabhol Port located at the mouth of the river shall be used. Approach road for Dabhol Port already exists. Accordingly, no additional road construction is envisaged in Alternative I. Consequently, no land use change is anticipated on account of construction of approach / access roads in Alternative I.

Impacts on aquatic ecology during operation of the project need to be established as part of the EIA study to be commissioned for the project separately by IWAI.

The project does not involve any dislocation of population.

The positive impacts of the project will include improved waterway facilities and other allied infrastructure facilities for the local population. It will also generate some employment and small business opportunities for the local population.

Potential Environmental and Social Impacts in Alternative II

The construction activities as proposed for Alternative II are as follows:

i. Construction of terminal buildings – Yes, one terminal.
ii. Construction of access roads – Yes, 7.5 wide road for a length of 265 m
iii. Bank protection works – Yes, at 4 locations comprising a total length of approximately 2 km
iv. Dredging of the river in the proposed waterway stretch – Yes

v. Installation of navigational lights - Yes

Alternative II, thus, envisages construction of a terminal facility, approach road development, bank protection works, dredging for creation of a navigable channel and installation of beacon lights.

The estimated land area for the proposed terminal is 3.34 ha. The land identified for the terminal location is completely barren land which is partly privately owned and part of which is Government land. No structures are present over the land identified for construction of terminal or related project components. Therefore, the project does not involve any dislocation of population. As the identified terminal location is barren land, no adverse land use change will occur due to the construction of terminals for the operation of the proposed waterway.

For Alternative II, construction of 7.0 m wide road for 475 m length shall be required for connectivity to the proposed terminal.

Bank protection works envisaged for the project are also to be carried out in Alternative II of the project. The cumulative length for which the bank protection works shall be required is 4.0 km covering seven locations.

The project involves limited dredging for creation of a navigable channel. Alternative II requires dredging to the tune of 4.4 lakh cu m between Ch 35 km to Ch 45.228 km and one terminal located at Ch 45 km. All the dredged material is proposed to be disposed of within the flood banks of the river or alternatively proposed for sale disposal / Sea disposal. As such there is no impact on the land environment due to dumping of dredged material. Since limited dredging is involved, impact on aquatic ecology is also anticipated to be negligible.

Impacts on aquatic ecology due to dredging and disposal of the dredged material within the river banks need to be established as part of the EIA study to be commissioned for the project separately by IWAI.

In general, the construction phase will involve mobilization of manpower and equipment at site, movement of vehicles, use of existing water resources and use of DG sets for construction power.

Impacts on air and noise, arising out of vehicular movement and fugitive dust emission, will be largely limited to the construction period.

Potential impacts on water quality of the river can be suitably mitigated by constructing the labour camps away from the river banks and by not allowing any debris to be thrown into the river during the construction and operation phases.

No structures are present over the land identified for construction of terminal or related project components. Therefore, the project does not involve any dislocation of population.

Taking into consideration the scale of construction and operation relating to the project, limited significant adverse impacts are anticipated on account of the project. Most of the impacts will be limited to the construction phase and can be suitably mitigated by following good industry practices.

The positive impacts on the project will include improved waterway facilities and other allied infrastructure facilities the local population. It will also generate some employment and small business opportunities for the local population.

9.4. EMP and Mitigation of Environmental Effects

As already stated most of the potential impacts will be limited to the construction period.

The management measures required to mitigate the potential impacts of the project on the ambient air quality during construction period include suppression of fugitive dust by water sprinkling, transportation of construction debris in covered vehicles, maintaining the specified stack height of DG sets under use and ensuring that the vehicles and equipment used during the construction period are in well maintained condition. To ensure that the ambient air quality remains within the prescribed standards by the Central Pollution Control Board (CPCB), periodic monitoring of ambient air quality should be undertaken through an accredited laboratory. Suitable corrective measures should be implemented if the ambient air quality is found to exceed the prescribed limits.

The measures to ensure that there is no adverse impact on the water quality on account of the project during the construction period would include setting up of labour camps at a safe distance from the river banks. In addition, no construction debris should be allowed to flow or be thrown into the river. The batching pants and concrete mixing plants should be located away from the river banks and these should be set up and operated strictly in accordance with the conditions stipulated by the SPCB.

To mitigate land, air and water contamination by the construction workers, adequate fuel, water and sanitation facilities should be provided to the construction workers. Hunting or poaching of wildlife should be strictly prohibited by any of the construction workers or employees. Also, it should be ensured that no unauthorized tree / forest cutting is undertaken by anyone engaged on the project.

Minimum required land should be acquired for the project. The private land owners, if any, whose land is to be acquired for the project, should be compensated adequately in accordance with law.

The project should take care that the traditional fishing rights of the local population are not impacted adversely in any manner. Adequate consultation with the local population should be undertaken as required.

The project authorities should ensure that the Contractors engaged on the project have an approved environment management plan in place and that this management plan forms a part of the Contract document so as to ensure its effective implementation by the Contractors.

9.5. Applicable Legal and Regulatory Framework

The Maharashtra Pollution Control Board (MPCB) acts as the nodal agency for environmental management, prevention & control of pollution and for the enforcement of following important acts & rules:

- Water (Prevention & Control of Pollution) Act, 1974
- Water (Prevention & Control of Pollution) Cess Act, 1977
- Air (Prevention & Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Notifications issued under Environment (Protection) Act, 1986
- Noise Pollution (Regulation & Control) Rules, 2000

Key legal and regulatory provisions as applicable to the project are described below.

Consent to Establish and Consent to Operate

The project will require obtaining the Consent to Establish from the SPCB under the Air and Water Acts prior to commencement of construction. Prior to commencement of operation, it shall require obtaining the Consent to Operate from the SPCB under the same Acts.

CRZ Clearance

The entire project area falls under the tidal zone. **Based on the categorization provided in CRZ Notification, 2011, the NW-28 project shall fall under CRZ – I. Accordingly, the project shall require obtaining clearance under the CRZ Notification 2011.**

The Ministry of Environment, Forest and Climate Change, (MoEFCC) Govt. of India, under the provision of Environment (Protection) Act, 1986, had issued a notification in February, 1991, declaring an area of 500 m. from the high tide line along the sea coast, bays and estuaries and up to 100 m from the rivers and creeks as a Coastal Regulation Zone. The developments within this zone are required to be regulated in accordance with the provisions of the notification and the Coastal Zone Management Plan which the State Govt. is required to prepare for the area.

The CRZ Notification 1991 was later amended and a new Notification was issued in 2011 namely CRZ Notification 2011.

The CRZ Notification, 2011 declares the following areas as CRZ:

i. the land area from High Tide Line (HTL) to 500 mts on the landward side along the sea front.

ii. the land area between HTL to 100 mts or width of the creek whichever is less on the landward side along the tidal influenced water bodies that are connected to the sea and the distance up to which development along such tidal influenced water bodies is to be regulated shall be governed by the distance up to which the tidal effects are experienced which shall be determined based on salinity concentration of 5 parts per thousand (ppt) measured during the driest period of the year and distance up to which tidal effects are experienced shall be clearly identified and demarcated accordingly in the Coastal Zone Management Plans (hereinafter referred to as the CZMPs).

    Explanation - For the purposes of this sub-paragraph the expression tidal influenced water bodies means the water bodies influenced by tidal effects from sea, in the bays, estuaries, rivers, creeks, backwaters, lagoons, ponds connected to the sea or creeks and the like.

iii. the land area falling between the hazard line and 500mts from HTL on the landward side, in case of seafront and between the hazard line and 100mts line in case of tidal influenced water body the word 'hazard line' denotes the line demarcated by Ministry of Environment, Forest and Climate Change (MoEFCC) through the Survey of India (SoI) taking into account tides, waves, sea level rise and shoreline changes.

iv. the land area between HTL and Low Tide Line (LTL) which will be termed as the intertidal zone.

v. the water and the bed area between the LTL to the territorial water limit (12 Nm) in case of sea and the water and the bed area between LTL at the bank to the LTL on the opposite side of the bank, of tidal influenced water bodies.

The coastal zone is categorized for the purposes of regulation in the following categories:

(i) CRZ-I,–

A. The areas that are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast,-

(a) Mangroves, in case mangrove area is more than 1000 sq mts, a buffer of 50meters along the mangroves shall be provided;

(b) Corals and coral reefs and associated biodiversity;

(c) Sand Dunes;

(d) Mudflats which are biologically active;

(e) National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves;

(f) Salt Marshes;

(g) Turtle nesting grounds;

(h) Horse shoe crabs habitats;

(i) Sea grass beds;

(j) Nesting grounds of birds;

(k) Areas or structures of archaeological importance and heritage sites.

B. The area between Low Tide Line and High Tide Line;

(ii) CRZ-II,-

The areas that have been developed up to or close to the shoreline.

Explanation.- For the purposes of the expression “developed area” is referred to as that area within the existing municipal limits or in other existing legally designated urban areas which are substantially built-up and has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains;

(iii) CRZ-III,-

Areas that are relatively undisturbed and those do not belong to either CRZ-I or II which include coastal zone in the rural areas (developed and undeveloped) and also areas *within municipal limits or in other legally designated urban areas, which are not substantially built up.*

(iv.) CRZ-IV,-

A. the water area from the Low Tide Line to twelve nautical miles on the seaward side;

B. shall include the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide which is measured as five parts per thousand during the driest season of the year.

(v) Areas requiring special consideration for the purpose of protecting the critical coastal environment and difficulties faced by local communities,-
A. (i) CRZ area falling within municipal limits of Greater Mumbai;
(ii) the CRZ areas of Kerala including the backwaters and backwater islands;
(iii) CRZ areas of Goa.
B. Critically Vulnerable Coastal Areas (CVCA) such as Sunderbans region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 and managed with the involvement of coastal communities including fisherfolk.

The development or construction activities in different categories of CRZ are regulated by the concerned Coastal Zone Management Authority (CZMA) in accordance with the norms as defined under the CRZ Notification 2011.

Forest Clearance

Even though mangroves are present on both banks of the Kundalika River along the NW-28 stretch, no Forest Clearance on this account is required to be obtained for the project.

9.5.1. Need for Environmental Clearance

Inland waterways are not listed as an activity that requires prior environmental clearance under the EIA Notification 2006. However, the Notification, as amended in 2009, includes 'Dredging' as an activity for which prior environmental clearance is required.

However, **as per the MoEFCC letter dated 21 December 2017, National Waterway projects are exempt from the requirement of prior Environmental Clearance on account of maintenance dredging for creation of navigational channel.** The project, therefore, does not need to obtain Environmental Clearance from the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. The MoEFCC letter to this effect is enclosed as Annexure 9.1 of the DPR.

The project shall, however, have to comply with the conditions stipulated in the said letter.

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

Other clearances required for the project shall include those that need to be obtained by the Contractors such as the Certificate of Registration from the Labour Department under various applicable labour laws, permission from SPCB for setting up of batching plants, license for storing petroleum / diesel etc.

No wildlife clearance is envisaged for the proposed waterway.

Since no structures of cultural, historical or archaeological are anticipated to be impacted due to the project, no clearance from the Archaeological Survey of India (ASI) or the State Department of Culture is envisaged for the project.

A summary of major clearances / approvals / permits and their applicability to the project is provided in Table 9-5 below.

TABLE 9-5**:** Major Clearances / Approvals / Permits and their Applicability to the Project

S. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
1.	Environmental Clearance	No	EIA Notification 2006	Exempted by MoEFCC vide its letter dated 21 December 2017.
2.	Forest Clearance	No	Forest Conservation Act, 1980	No clearance of mangrove vegetation or diversion of any forest land for any other purposes is involved in the development of NW-28 for the recommended stretch.
3.	Wildlife Clearance	NO	Wildlife Protection Act, 1972	No part of the project falls within the boundary of any of the protected areas of their eco-sensitive zones.

S. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
4.	CRZ Clearance	Yes	CRZ Notification 2011	The entire project falls in CRZ I.

9.6. 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.

9.6.1. Estimated Cost at Pre-Construction Stage

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

TABLE 9-6: Summarized Estimated Cost for Consultancy Services

Sl. No.	Particulars of Estimated Budget	Amount (in Rs. Lakh)	Remark (if any)
1.	Salary of 12 Professionals/Domain Experts on intermittent based input (as per QCI/NABET scheme)	40	Lump-sum cost on intermittent basis

Sl. No.	Particulars of Estimated Budget	Amount (in Rs. Lakh)	Remark (if any)
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	3.20	To be done for one season **(Table – 9-7).**
3.	Public Consultation Meeting (PCM)	4	Lump-sum cost
4.	Reports / Document Printing	1	Lump-sum cost without break-up
5.	Travelling Cost for Site Visits (Bus, Taxi, Boat *etc.*)	5	Lump-sum cost
6.	Lodging & Boarding Cost	5	Lump-sum cost
7.	Cost for collection of metrological data and other information like Maps *etc.*	5	Lump-sum cost
	Grand Total (Rs)	**63.20**	

In words: (i) *Rs. Sixty Three Lakhs Twenty 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 Service Tax.

(ii) The breakup of Sl. No. 2 is given in Tables 9-7.

TABLE 9-7: 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, PM10, CO, SO2, NO2 etc.	24 Hourly sampling (Day & Night time) to be done at each location.	Per Sample with various parameters	4	20,000	80,000
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	4	15,000	60,000
3.	Noise Quality monitoring	Day & Time monitoring to be done at each location	24 Hourly sampling (Day & Night time) to be done	Per Sample with various parameters	4	10,000	40,000
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	4	10,000	40,000

Sl. No.	Environmental Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations	Unit Rate (Rs)	Amount (Rs)
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.	-	4	25,000	100,000
	Sub-Total (Baseline Environmental Data Generation Cost)						**320,000**
	In Words: *Rs. Three Lakh twenty Thousand only…………………………..*						

Note: 1 monitoring station @ 15 Km/station = tentatively 4 locations shall be monitored.

9.6.2. Estimated Cost at 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 shall also prepare environmental monitoring report that to be submitted timely to the project proponent and statutory authorities as per project requirement.

TABLE 9-8: Estimated Cost for Environment Management during Construction

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Construction Stage once in a year	9.60	Shall be carried on half yearly basis for entire construction period (**Table 9-7)**
2.	Greenbelt Development nearby terminal Premises by Contractor	6	Lump-sum cost
3.	Solid Waste Management	6	Lump-sum cost
4.	Sanitary facilities at labour camps	6	Lump-sum cost
5.	Disaster Management Plan	5	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**34.60**	

TABLE 9-9: Environmental Monitoring Cost for Construction Stage

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 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	4X3 = 12	20,000	240,000
2.	Water Quality monitoring	***Physical Properties:*** pH, Temp., DO, Conductivity, ***Chemical Properties:***	Surface and ground water to be monitored separately	Per sample with various parameters	4X3 = 12	15,000	180,000

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
		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.					
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 location with various parameters	4X3 = 12	10,000	120,000
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	4X3 = 12	10,000	120,000
5.	Aquatic Ecology	Trophic Status, Primary Productivity, Species diversity & densities of Phytoplankton, Zooplankton, Benthic Organism	One time study at this stage.		4X3 = 12	25,000	300,000

Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
		(Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.					
Total (Rs)							**960,000**

9.6.3. Estimated Cost at Operation Stage

Like preconstruction stage, the environmental monitoring and supervision to be done by the project proponent.

TABLE 9-10: Estimated Environment Management Cost during Operation

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
1.	Environmental Monitoring Cost at Operational Stage once in a year.	3.20	Shall be carried for one season as per Table 9-7 given above for pre-construction stage.
2.	Maintenance & Supervision of Greenbelt Developed during construction stage	2	Lump-sum cost
3.	Solid Waste Management	2	Lump-sum cost
4.	Sanitary facilities nearby terminals	2	Lump-sum cost
5.	Disaster Management Plan (if applicable)	2	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**13.20**	Per Year

9.6.4. Summary of Estimated Environmental & Social 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 9-11 given below:

TABLE 9-11: Summary of Estimated Environmental & Social Costs for various Stages

Sl. No.	Project Stages	Cost (INR)	Remark
1.	Pre-Construction Stage	63.20	Lump-sum
2.	Construction Stage	34.60	
3.	Operational Stage	13.20	
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		111.00	

In Words: Tentative estimated cost is INR 111.00 Lakhs.

The above proposed expenditure may have to be considered against the allocated provisions under the head of Fairway Development & Terminal development.

CHAPTER 10: INSTITUTIONAL REQUIREMENTS

10.1. Organizational Set up / Establishment

The Inland Waterways Authority of India (IWAI) has been carved out duly taking over the responsibilities etc., of the erstwhile Inland Water Transport (IWT) directorate under Ministry of Surface Transport / Ministry of Shipping with a vision of more thrust on the IWT sector along with more Autonomy, by an Act of Parliament (IWAI Act 82 of 1985). Accordingly, IWAI is vested with the functions / duties and responsibilities connected to the safe navigation in the National Waterways and in the interconnected waterways, where IWT is considered for development. The Para 14 of IWAI ACT 82 of 1985 is provisioned with the Functions and Powers of authority, as detailed, which is self-explanatory.

Functions and Powers of the authority:

14. (1) The Authority may-

(a) carry out surveys and investigations for the development, maintenance and better utilization of the national waterways and the appurtenant land for shipping and navigation and prepare schemes in this behalf; (b) provide or permit setting up of infrastructural facilities for national waterways;

(c) carry out conservancy measures and training works and do all other acts necessary for the safety and convenience of shipping and navigation and improvement of the national waterways;

(d) control activities such as throwing rubbish, dumping or removal of material, in or from the bed of the national waterways and appurtenant land, in so far as they may affect safe and efficient, shipping and navigation, maintenance of navigable channels, river training and conservancy measures;

(e) remove or alter any obstruction or impediment in the national waterways and the appurtenant land which may impede the safe navigation or endanger safety of infrastructural facilities or conservancy measures where such obstruction or impediment has been lawfully made or has become lawful by reason of long continuance of such obstruction or impediment or otherwise, after making compensation to person suffering damage by such removal or alteration;

(f) provide for the regulation of navigation and traffic (including the rule of the road) on national waterways; (g) regulate the construction or alteration of structures on across or under the national waterways;

(h) disseminate navigational meteorological information about national waterways;

(i) ensure co-ordination of inland water transport on national waterways with other modes of transport; and (j) establish and maintain pilotage on national waterways;

(k) enter into joint ventures concerning inland shipping by way of equity participation.

14. (2) The Authority may also-

(a) advise the Central Government on matters relating to inland water transport;

(b) study the transport requirement with a view to co-coordinating inland water transport with other modes of transport;

(c) carry out hydrographic surveys and publish river charts;

(d) assist, on such terms and conditions as may be mutually agreed upon, any State Government in formulation and implementation of scheme for inland water transport development;

(e) develop consultancy services and provide such services, on such terms and conditions as may be mutually agreed upon, in India and abroad in relation to planning and development of waterways for shipping and navigation or any facility thereat;

(f) conduct research in matters relating to inland water transport including development of craft design mechanization of country crafts, technique of towage, landing and terminal facilities, port installations and survey techniques;

(g) lay down standards for classification of inland waterways;

(h) arrange programme of technical training for inland water transport personnel within and outside the country; and

(i) perform such other functions as may be necessary to carry out the provisions of this Act.

14. (3) Any dispute arising out of or concerning the compensation referred to in clause(e) of subsection(1) shall be determined according to the law relating to like disputes in the case of land required for public purposes.

14. (4) Every scheme, prepared by the Authority to carry out functions under sub-sections(1) and (2), involving capital expenditure exceeding the amount as may be prescribed, shall be submitted to the Central Government for approval.

14. (5) The Central Government may either approve the scheme submitted to it under sub-section (4) without modification or with such modifications as it may consider necessary or reject the scheme with directions to the Authority to prepare a fresh scheme according to such directions.

In order to consider a planned and systematic implementation with the assigned functions of the authority, a strong Institutional mechanism is required.

If we keenly observe the Institutional systems of similar administrations / establishment globally and the parallel administrations / establishments nationally, the key factor emerging out of the same is only the Policy and procedure of implementation of the assigned responsibilities. It is yet a debatable aspect i.e., whether to have a full pledged organization so as to undertake the works through contractual agencies or to have a mechanism of Out Sourcing the work along with supervision to different contractual agencies (Out Sourcing the work to an agency and the Project Management to other agency).

10.2. Man Power Requirement

It is suggested that the Outsourcing the work to a contractual agency is the best alternative for the subject study and accordingly, the Manpower requirement is under consideration

As ascertained, IWAI is having an Institution Mechanism consisting of a Board along with Functional Manpower having the inverted conical organization pattern. The major functional aspects have already been segregated as Project; Planning; Survey; Marine; Traffic; Finance and Administration. Hence, dislocation of the existing system is not suggested. The present requirement within the study stretch should be unique, which should be amenable to the existing system in the office of Policy making with Control.

Accordingly, the Controlling office (at NOIDA) has been depicted in the pictorial form and will have 1 Chief Engineer to look after the Central part of the country (Hyderabad) to deal with the Waterways / National Waterways in the states of Maharashtra; Goa; Karnataka; Orissa; Telangana; Andhra Pradesh; Tamilnadu & Kerala (including NW 3). Refer the Annexure 10.1.

The present study stretch of Cluster 7 having 6 National Waterways will be looked after by a Directorate (suggested / recommended) with an office within the Geographical zone, preferably accessible to all the Waterways / National Waterways. The Organizational requirement has been depicted in Annexure 10.2. A skeleton staff requirement of 3 Nos. also has been projected as a support requirement in the Chief Engineer's office.

10.3. Training Requirement / Capacity Building

IWAI is having various disciplines within the organization viz., Civil Engineering; Mech. Marine Engineering; Hydrographic Survey; Traffic; Administration / Establishment; Finance etc.,.

It is suggested and recommended to have an intra discipline and inter discipline training for all the employees of the IWAI at entry level i.e., at Technical Assistant / Assistant Director; Junior Hydrographic Surveyor / Assistant Hydrographic Surveyor; Junior Accounts Officer / Accounts Officer; Section Officer / Assistant Secretary etc.,. The National Inland Navigation Institute (NINI) of IWAI at Patna premises can be used for such training. It is preferred to have such Trainings as onsite training, while the works are under progress.

10.4. Infrastructure

The Infrastructure for the Institution will not have much implication, except the Land for the Office premises, if at all to have the own building of IWAI. However, the infrastructure for functional aspects may be essential within the accessibility of the site controlling office viz., the office of the Director.

The functional requirement can be identified as Survey Vessels; Survey Instruments in order to carry out the mandatory periodical Survey works on the National Waterways. Likewise, to maintain the Night Navigation system, there should be a powerful Tug – cum – Buoy maintenance vessel should be available within the bounds of the office. Further, to have quick inspections and also to have periodical visits, Speed Boats are to be available as an Infrastructure within the controlling office.

Accordingly, 2 Nos. of Survey Vessels; 2 units of Survey Instruments with Software; 2 Nos. of Tug – cum – Buoy maintenance vessel; 2 Nos. of Speed Boats are suggested / Recommended for each Directorate office to look after approximately 6 Nos. of the National Waterways within its jurisdiction.

10.4.1. Immovable

The immovable asset, Land is not suggested at this point of time. In the Long run, even if identified the need of having own office, this will be considered at one of the Terminal Locations, amenable with ease approach. Hence there is no suggestion / recommendation of Land / immovable asset under Institution.

10.4.2. Movable

As discussed above, the asset requirement for attending the functions and responsibilities catered will be considered for procurement. The details have been tabulated directly as a financial Implication with segregation of Capital Cost Implication and Monthly Cost Implication, including the Manpower monthly implication in the forth coming Paras. Keeping in view the Organization requirement, as derived, the implication has been worked out duly taking into consideration of the 7Th Pay commission Pay system, so as to have an implementable approach.

10.5. Cost Implications

The cost implication for the apportioned project has been worked out and placed herewith.

TABLE 10-1: MANPOWER FINANCIAL IMPLICATION PER MONTH

Sl. No.	Name of the Post	Nos. of the Post	Basic Pay (INR)	Implication per month @ 95 % extra (INR)	Remarks
1.	Director	1	78800	153,660	Annexure 10.2 may be referred.
2.	Asst. Director Civil / Mechanical	3	56100	328,185	
3.	Asst. Hy. Surveyor	1	56100	109,395	
4.	Junior Hy. Surveyor	1	47600	92,820	
5.	Junior Accounts Officer	1	47600	92,820	
6.	Supervisor	3	35400	207,090	
7.	Steno / P. A	1	35400	69,030	
8.	Upper Divisional Clerk	1	25500	49,725	
9.	Data Entry Operator	6	21700	253,890	
10.	Driver	1	21700	42, 315	25 % extra for statutory allowances and 20 % extra for perks have been taken into consideration.
11.	Attendant	6	21700	253,890	
	Total	25		1,652,820	
	Chief Engineer’s Office Component				
1.	Deputy Director	1	67600	131,820	
2.	Technical Assistant	1	47600	92,820	
3.	Data Entry Operator	1	21700	42,315	
	Total	3		266,955	
	Grand Total	28		1,919,775	

TABLE 10-2: FINANCIAL IMPLICATION – CAPITAL AND MAINTENANCE

Sl. No.	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
1.	Office premises	*	75,000	* In the initial stages, office will function on rented premises only
2.	Furniture etc.,	1,000,000	--	L. S.
3.	Pay and Allowances for 28 Nos.	--	1,919,775	As per the Table 10.1
4.	Vehicle 1 No.	500,000	--	
5.	Running & Maintenance of the Vehicle	--	50,000	
6.	Computer Systems including UPS etc., 6 Nos. @ 1 lakh each	600,000	60,000	
7.	Printers 4 Nos. @ 0.5 lakhs each	200,000	*	* Taken into General Office maintenance
8.	Laptops 6 Nos. @ 1 lakh each	600,000	*	* Taken into General Office maintenance
9.	Drawing Printer 1 No. @ 5 lakhs each	500,000	*	* Taken into General Office maintenance
10.	High Speed Printer 1 No. @ 3 lakhs each	300,000	*	* Taken into General Office maintenance
11.	Alternate Uninterrupted Power Supply with D. G set 1 No @ 10 Lakhs per no.	1,000,000	50,000	
12.	2 Nos. Survey Vessels (2 engines of 175 Bhp each) @ 350 lakhs each	70,000,000	1,000,000	Inclusive of Staff charges, on board.
13.	2 Units of Survey Instruments (9.5 lakhs each) + Software (6.5 lakhs each) + Laptop (1 lakh each) etc.,	3,400,000	200,000	Maintenance is inclusive of Survey Stationery and Consumables.
14.	2 Nos. Tug – cum – Buoy Maintenance vessel (2 engines of 375 Bhp) @ 750 lakhs each	150,000,000	1,200,000	Inclusive of Staff charges, on board.
15.	2 Nos. Speed Boats (2 engines of 75 Bhp) @ 75 Lakhs each	15,000,000	150,000	Inclusive of Staff charges, on board.
16.	Other General Office maintenance including stationery, consumables etc.,	--	500,000	
	Total	**243,100,000**	**5,204,775**	

+ The Cost implications for segregated functions like Fairway Development Cost; Terminal Development Cost; Vessel maintenance Cost; Navigation and Communication system implementation cost etc., have been taken into consideration at the appropriate heads, whereas the item Nos. 12 to 15 above are being provisioned for undertaking the requisite functions under the Institution requirements.

+ The above expenditure may have to be considered for 6 National Waterways and accordingly the apportioned cost for River Vashishti i.e., Capital cost will be INR 405.00 Lakhs {2431 Lakhs / 6} and maintenance cost per month will be INR 8.70 Lakhs. {52.05 Lakhs / 6} say 9 Lakhs per month.

+ It is also suggested to have the Limited Manpower of 1 Asst. Director (AD) + 1 Supervisor + 1 Junior Accounts Officer (JAO) + 1 Data Entry Operator (DEO) + 1 Attendnat as a skeleton staff and the deployment is recommended at initial stages duly meeting the cost from the suggested provisions. It can be reviwed from time to time based on the volume of work requirement.

CHAPTER 11: PROJECT COSTING

11.1. General and Financial assumptions

Project Costing is an important aspect, which is to be worked out rationally to assess the apt requirement of the project with a reasonable costing structure so as to ascertain the end result of returns and also will play a vital role in decision making on the implementation of various project components.

It is also essential to define certain financial requirements, in terms of assumptions for the project, which are to be rational i.e., not to be irrational.

In this context, certain parameters, as defined, by IWAI have been analyzed and considered in the cost working and Return working. The circulated data has been placed at Annexure 11.1. However, the same may not suffice the requirements in working out the cost / returns and hence some more assumptions have been considered appropriately, wherever required.

11.2. Basis of Costing

In general, the costing used to be worked out based on the quantity requirements along with rate per unit quantity. The quantities for the subject project have been arrived at based on the actual item wise requirements. The estimated costs have been worked out based on the DSR / relevant Schedule of Rates (SoR) of the concerned region / state. Rates for the non-available items have been proposed based on the Market Rates or based on the realistic budgetary quotations, to the extent possible.

11.3. Development Cost

Based on the utility, the Vashishti River is not being used with good IWT mobility, however in the mouth considerable cargo mobility is going on, through the Dabhol (Non Major Port). Stake holders are interested to come forward for utilizing this waterway, if considered with appropriate infra-structure. Accordingly, the Ro-Ro operation is suggested. This traffic may have to be handled at a newly identified terminal location at Pedhe on the right side.

This Ro-Ro Terminal can be planned for operation from FY 20, as a promotional activity. Accordingly, the costing has been segregated into 2 Phases i.e., Phase 1 with a nominal investment and after careful observation, the Phase 2 may have to be taken up with investment in Fairway and Ro-Ro Terminal.

11.4. Capital Expenditure

As explained above, the Fairway related development cost has been worked out and placed herewith.

TABLE 11-1: Abstract of Cost for Vashishti Fairway Development (Phase1)

Sl. No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
A	**Fairway**		
1	Dredging		
(i)	General Soil	0.00	
(ii)	Hard Soil	0.00	
2	Low Cost River Structures		
(i)	Bandaling	0.00	
(ii)	Bottom Paneling	0.00	
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	0.00	
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	0.00	
(ii)	Shore Marking with Latiice Bridge & Lighting Equipments	196.54	11.4
5	Land Acquisition	0.00	
	Sub-total (A)	**196.54**	
B	**Modification of Structures**		
(i)	Bridges	0.00	
(ii)	Cables	0.00	*
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**0.00**	
C	**Communication System**		

Sl. No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	
	Sub-total (C)	**0.00**	
D	**Institutional Requirement**		
(i)	Office Development Cost	405.00	
	Sub-total (D)	**405.00**	
	Sub-total (A)+(B)+(C)+(D)	**601.54**	
E	Environmental Management Plan Cost@5% of Prime cost	30.08	
F	Project Management & consultancy Charges @10% of Prime cost	60.15	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	60.15	
	Project total Hard Cost	**751.93**	
		7.52 Crores	

TABLE 11-2: Abstract of Cost for Vashishti Fairway Development (Phase 2)

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
A	**Fairway**		
1	Dredging		
(i)	General Soil	1320.00	11.2
(ii)	Hard Soil	450.00	11.2
2	Low Cost River Structures		
(i)	Bandaling	0.00	
(ii)	Bottom Paneling	0.00	
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	4928.65	11.3
(iii)	Porcupine		

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	369.88	11.4
5	Land Acquisition	0.00	
	Sub-total (A)	**7068.53**	
B	**Modification of Structures**		
(i)	Bridges	0.00	
(ii)	Cables	0.00	*
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	**0.00**	
C	**Communication System**		
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	
	Sub-total (C)	**0.00**	**Indicative Costs are placed at Para 8.4**
D	**Institutional Requirement**		
(i)	Office Development Cost	0.00	
	Sub-total (D)	**0.00**	
	Sub-total (A)+(B)+(C)+(D)	**7068.53**	
E	Environmental Management Plan Cost@5% of Prime cost	353.43	
F	Project Management & consultancy Charges @10% of Prime cost	706.85	
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	706.85	

S.No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
	Project total Hard Cost	**8835.66**	
		88.35 Crores	

* The stringing of HT cable is required at one location and can be considered in consultation with concerned authorities with a nominal charge from the allocated contingency provisions.

The Ro-Ro facility requirement has been worked out and placed herewith.

TABLE 11-3: Abstract of Cost for Vashishti RORO Facility (Phase 2)

Sl. No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
A	**Terminal** (only 1 RO RO so total cost)		
(i)	Land	557.66	11.5
(ii)	Riverine Components	362.11	11.6
(iii)	Infrastructure Components including internal roads	1813.22	11.7
(iv)	Approach Road (External) Cost	43.25	11.8
(v)	Bank Protection Works for terminal	308.70	11.9
	Sub-total (A)	3084.94	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	0.00	
C	**Cargo Handling Equipments**		
(i)	Ambulance	0	
(ii)	Dumper Trucks 16 T Capacity	0	
(iii)	Cranes with 50 T Capacity	0	
(iv)	Fork lift trucks 20 T Capacity	0	
	Sub-total (C)	0.00	
	Sub-total (A)+(B)+(C)	3084.94	
D	Environmental Management Plan Cost@5% of Prime cost	154.25	
E	Project Management & consultancy Charges @10% of Prime cost	308.49	

Sl. No.	Item Description	Amount (in Lakh Rs.)	Reference in Annexure
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	308.49	
	Project total Hard Cost	3856.18	
		38.56 crores	

11.5. Operational and Maintenance Expenditure

The operation & Maintenance expenditure has been considered as at Annexure 11.1 and as per the industrial standards.

11.6. Phasing of Expenditure

Fairway: As explained above, the project is being considered in 2 Phases. Careful observation will be considered till FY 25. Investment decision or otherwise will be considered then. As such, the Phase 2 is not recommended at this point of time.

CHAPTER 12: IMPLEMENTATION SCHEDULE

12.1. Time Frame

The development of river Vashishti is proposed to be considered in TWO Phases. Keeping in view the availability of fairway depth up to Ch 35 Km, the Phase 1 development is suggested with a nominal investment for considering the promotional mobility of Ro-Ro operation between JnPT and to the end reach of the National Waterway (the industrial cluster).

This Phase 1 operation will be considered till 2025 and after having meticulous analysis, based on the observed growth of mobility, the Phase 2 investment decision may have to be taken. The Phase 2 investment is not suggested, if the growth is not observed.

In order to facilitate the estimated Ro-Ro traffic, in Phase 2, Fairway development, the activities of Dredging; Bank protection; Day / Night Navigation facilities; along with Environmental Management Plan (EMP) have been proposed. With the development of fairway, the revenue collection can be considered for the traffic with possible expandable traffic. The Implementation Schedule in Pictorial form is placed at Annexure 12.1 for Phase 1 and Annexure 12.2 for Phase 2.

12.2. Phasing

The Phase 1 development is with immediate effect (from FY 2020) for considering the Promotional mobility.

The Phase 2 development, if to be considered, will be in 36 months from FY 26 to FY 28.

The Vessel deployment, however, will be taken care by Entrepreneurs.

12.3. Suggested Implementation Mechanism

The implementation will be considered through the Project Management Consultancy, as provisioned. However, it is suggested that the overall supervision will be under the control of the IWAI supervision mechanism.

CHAPTER 13: ECONOMIC AND FINANCIAL ANALYSIS

13.1. Introduction

Dabhol-Vashishti River development has been distinguished across two development modules. This is depicted in the following Table 13 1:

TABLE 13-1: Dabhol-Vashishti River Development

<table>
<tr><th></th><th>Sub-sector</th><th>FY18</th><th>FY26</th><th>FY27</th><th>FY28</th><th>FY40</th></tr>
<tr><td rowspan="5">With Development</td><td rowspan="3">Fairway*</td><td colspan="3">Operational (Promotional)</td><td></td><td></td></tr>
<tr><td></td><td colspan="3">Development (Official)</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Operational (Official)</td></tr>
<tr><td rowspan="2">Ro-Ro</td><td></td><td colspan="3">Construction</td><td></td></tr>
<tr><td></td><td></td><td></td><td colspan="2">Operational</td></tr>
<tr><td>Without Development</td><td>Fairway**</td><td colspan="5">Operational</td></tr>
</table>

** "Observation" period only up till FY25. Remaining 2 years (FY26 & FY27) is operational extension until the fairway is developed up to chainage of 43 km.*

*** "Observation" period up till FY25 is applicable, except the operation shall continue on 35-km stretch on the back of positive industry response.*

In an attempt to persuade the industries into switching over to IWT, a "promotional" campaign will be instituted between FY18 and FY27. Technically, the evaluation of this promotional campaign will be only till FY25. By the end of FY25, IWAI will decide whether to maintain the status quo of operating on the 35 km stretch (requiring no infrastructure development or dredging), or to extend the fairway farther by 8 km (a total chainage of 43 km) and also construct a Ro-Ro Terminal on that stretch. If the market responds as enthusiastically as expected, then the need to develop the waterway and to set up the terminal will be negated. In that case, the second model of "Without Development" will be put into effect. Here, the fairway of up to 35 km chainage will continue to be utilized for Ro-Ro operation, with nominal investment for night navigation. Concurrently, no Ro-Ro terminal will be set up, as the temporary arrangement at a 35-km chainage location will suffice to cater to the estimated truck traffic. So post promotional period, the project could go in one of the two directions. The project would either proceed without requiring any development, or the project would subsume fairway development (extending till 43 km) and Ro-Ro terminal construction. Both these developments would become operational from FY28 onwards, i.e. the last year of development/construction period.

13.2. Input Sheet

The following table lists all the assumptions and input values used in the financial modeling of Dabhol-Vashishti River. This includes financial analysis for the navigation infrastructure (fairways), and terminal operations (Ro-Ro):

TABLE 13-2: Input Sheet for Dabhol-Vashishti River project

Description	Unit	Fairway	Ro-Ro
Loan Tenure	Years	10	10
Moratorium Period (Years Construction)	Years	3	3
Rate of Interest	Annual	11%	11%
Corporate Tax	Annual	30%	30%
Royalty to MMB	INR/Tonne		20
Revenue Share	Annual	4%	4%
Area for Terminal	Ha		3.7
Annual Lease Rental Increase	Annual	2%	2%
Cargo Revenue Escalation	Annual	6%	6%
Other Revenue Escalation	Annual		6%
Administrative Cost	of Revenue	3%	2%
Manpower Cost Escalation	Annual	5%	5%
Cargo Costs Escalation	Annual	5%	
Other Costs Escalation	Annual		6%
Fairway Chainage	km	35*; 43	
Chainage (mouth of the river to Ro-Ro Terminal)	Km		43
** Fairway chainage during promotional period from FY18 to FY25/FY27*			
Tariff for Revenue Calculation			
Various Revenue Sources	**Unit**	**Fairway**	**Ro-Ro**
Fairway Cost			
Movement of vessel	GRT/km	0.1	
Charges of Handling Ro-Ro Trucks			
Vessel Berthing Charges	Per GRT		1000
Vehicle Unloading Charges	Per Truck		50
Revenue prospects from Ancillary Activity			
Truck Parking Charges	Per Day		50
Weigh Bridge Charges	Per Truck		100
Leasing Space Coffee Shops	Per Day		500
Lease space for Rest/Retiring	Rs/Day/Truck		30
Operation & Maintenance			
Description	**Unit**	**Fairway**	**Ro-Ro**
Civil Infrastructure	Cost		1%
Dredging	Cost	10%	
Ship Operating Cost	Cost		
Utilities	Cost	5%	5%
Machinery Infrastructure	Cost		5%
IT & Other Soft Factors	Cost	5%	5%
Insurance Cost	Capex	2%	2%

Description	Unit	Fairway	Ro-Ro
Assumptions for EIRR			
Parameters	**Unit**	**Value**	**Reference**
Economic loss due to Road Accidents	of GDP	3%	Tractebel
GDP of India@ Current Prices	Rs Lakhs Crores	125.41	
Value of economic loss due to road accidents	Rs Lakhs Crores	3.7623	
Total Road network in India	Lakh KM	0.4865	
Safety Index (IWT as base)	times safer than road	50	
	times safer than rail	5	
Accidental Loss			
Road	Rs Lakhs/KM	7.73	Tractebel
Rail	Rs Lakhs/KM	0.77	
IWT	Rs Lakhs/KM	0.15	
Fuel Cost (1 liter of fuel moves)			
Road	t-km	24.00	Tractebel
Rail	t-km	85.00	
IWT	t-km	105.00	
Total Cargo	Million Ton	16.48	
Total Distance	KM	Fairway – 2x35 or 2x43; Ro-Ro - 2x43	
Fuel price	Rs/Litre	60.00	
Vehicular Operating Cost (VOC)			
Road	Rs/t-km	2.58	Tractebel
Rail	Rs/t-km	1.41	
IWT	Rs/t-km	1.06	
Direct Employment Creation			
Road	Per Million t-km	20	Tractebel
Rail	Per Million t-km	2	
IWT	Per Million t-km	0.5	
Employment cost	Rs Lakhs per Annum	2.5	
Emission Reduction			
Road	g CO2/t-km	60	Tractebel
Rail	g CO2/t-km	13.3	
IWT	g CO2/t-km	6	
Shadow Factor			
CAPEX/O&M Cost- To convert financial cost to economic cost		0.85	Tractebel
O&M Cost escalation	p.a.	5%	
Carbon Credits Factors			
Carbon Shadow price	$/Tonne	20	Tractebel
Exchange rate	Rs/USD	67	

Source: Consultant, Market standards

All the necessary assumptions for financial modeling are either market driven or provided by IWAI. Fairway and terminal tariff have been taken from IWAI. The vessel parcel size is estimated at 90% of the rated DWT, and GRT is estimated at 70% of the rated DWT. The chainage of 35 km is from the mouth of the River to a temporary location where the Ro-Ro operation will terminate/commence from during the “promotional” period. The chainage of 43 km will come into the picture when IWAI decides to carry out further development on the fairway, and set up a fully-fledged Ro-Ro Terminal to attract the industries. This will be on the back of a lackluster response to the promotional campaign. In case of fairway and Ro-Ro revenue calculations, only one-way trip across the chainage of 26 km is considered. In EIRR, round-trip distance is considered in each of the sub-sector's economic viability evaluation.

Keeping in line with the "with development" and "without development" model, all the subsequent sections will include financial analysis accordingly.

13.3. Revenue

Revenue for the cumulative stretch of Dabhol-Vashishti River will be generated from the core operations, which include utilization of the fairways by the potential users from the Lote Parshuram industry, and operation at the Ro-Ro terminal. Secondary revenues sources, labeled "Ancillary Revenue", will be generated from sources like truck parking, weighbridge, land leasing for commercial operations (tea-stall, coffee shops, inn, etc.), and leased resting area for truck operators. The revenue break-up and total revenue for IWAI on Dabhol-Vashishti River are presented in the table below:

TABLE 13-3: Revenue for Dabhol-Vashishti River (INR Lakhs)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*	-	981	1,597	-	-	-
Fairway**	-	-	-	2,004	3,263	5,313
Ro-Ro Terminal	-	-	-	286	464	753
Without Development						
Fairway	-	981	1,597	2,600	4,233	6,893

*Note: *Promotional Period, **Official Period post development*

As mentioned earlier, the promotional period will extend up to FY27, but the observation period will end in FY25. This is why revenue generated from FY18 to FY27 for both "with development" and "without development" fairway model will be the same, on account of the same chainage of 35 km. The lack of any considerable investment bodes well for returns in case of fairway utilization. Even in case of development post promotional period, the high traffic volume and increased chainage will continue to favourably impact the revenue prospects. FY18 has been reserved for laying the necessary groundwork to initiate the promotional campaign. So, FY19 is the year when the estimated traffic will start moving the fairway.

13.4. Costs

This section presents the total project cost, and equity-debt distribution in phased manner. The following table shows these cost-heads for both the core business operations:

TABLE 13-4: Project Cost

Description	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
With Development				
Fairway*				
Fairway	196.5	196.5	-	-
Institutional Requirement	405.0	405.0	-	-
Environmental Management Plan Cost@5% of Prime cost	30.1	30.1	-	-
Project Management & consultancy Charges @10% of Prime cost	60.2	60.2	-	-
Contingencies and Unforeseen Items of Works@10% of Prime cost	60.2	60.2	-	-
Total Project Cost	**751.9**	**751.9**	-	-
Fairway**				
Fairway	7,068.5	2,827.4	2,120.6	2,120.6
Environmental Management Plan Cost@5% of Prime cost	353.4	106.0	106.0	141.4
Project Management & consultancy Charges @10% of Prime cost	706.9	212.1	212.1	282.7
Contingencies and Unforeseen Items of Works@10% of Prime cost	706.9	212.1	212.1	282.7
Total Project Cost	**8,835.6**	**3,357.6**	**2,650.7**	**2,827.4**
Ro-Ro Terminal				
Terminal	3,084.9	1,234.0	925.5	925.5
Environmental Management Plan Cost@5% of Prime cost	154.2	46.3	46.3	61.7
Project Management & consultancy Charges @10% of Prime cost	308.5	92.5	92.5	123.4
Contingencies and Unforeseen Items of Works@10% of Prime cost	308.5	92.5	92.5	123.4
Total Project Cost	**3,856.2**	**1,465.3**	**1,156.9**	**1,234.0**

Description	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
Without Development				
Fairway				
Fairway	196.5	196.5	-	-
Institutional Requirement	405.0	405.0	-	-
Environmental Management Plan Cost@5% of Prime cost	30.1	30.1	-	-
Project Management & consultancy Charges @10% of Prime cost	60.2	60.2	-	-
Contingencies and Unforeseen Items of Works@10% of Prime cost	60.2	60.2	-	-
Total Project Cost	**751.9**	**751.9**	-	-

*Note: *Promotional Period, **Official Period post development*

The only cost fairway utilization (promotional period and without development) will entail is for shore marking with lattice bridge and for lighting equipment. Cost for dredging activity and bank protection works will be incurred only during the "with development" period.

For Ro-Ro operations, 2 Ro-Ro vessels may be required during the promotional period. An additional 6 vessels will be needed, whose acquisition will be spread across FY30, FY32, FY34, FY36, FY38, and FY40. So, a total of 8 vessels are needed to cater to the estimated Ro-Ro traffic on the River. The onus of these vessel acquisitions lie with the private operator and not IWAI. Hence, these costs will not be factored in to develop model for the Ro-Ro Terminal. Capital and O&M costs associated with these vessel acquisitions and operations are indicated in the table below:

TABLE 13-5: Cost associated with vessel acquisition and operation

Parameters	Unit	1 Ro-Ro
Vessel Cost	Lakhs	900
Running Cost	Lakh/annum	490
Crew	No.	8
Crew Wages	Lakh/annum	0.5
Crew Cost	Lakh/annum	48
Repair Cost (@2% Capex)	Lakh/annum	16

13.5. Financial Analysis / FIRR

The financial indicators dictating FIRR for individual ventures, viz. fairways development and terminal operations have been presented in Table 13-8. These indicators help measure the financial return on investment, which will enable IWAI in taking an informed decision in regard to implementing the project. However, before presenting FIRR for the project, some major components such as Salary, Depreciation, Project Cashflow, and P&L statement are provided in the following four tables, respectively:

TABLE 13-6: Employment schedule and salary expenditure (INR Lakh)

Parameter	No.	CTC p.a. / person (INR Lakh)	FY18	FY20	FY25	FY30	FY35	FY40
With Development								
Fairway*								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	4	6	-	-	-
Hydrographer	1	8	-	26	34	-	-	-
Executives	2	3	-	20	25	-	-	-
Engineer	1	4	-	13	17	-	-	-
Total Salary (INR Lakh)	**-**	**-**	**-**	**64**	**82**	**-**	**-**	**-**
Fairway**								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	-	-	5	6	8
Hydrographer	1	8	-	-	-	29	37	48
Executives	2	3	-	-	-	22	28	36
Engineer	1	4	-	-	-	15	19	24
Total Salary (INR Lakh)			**-**	**-**	**-**	**70**	**90**	**115**
Ro-Ro Terminal								
Manpower Expenditure								
Manager Cargo Handling	1	6	-	-	-	22	28	36
Security Guards (Jetty x 2)	2	2	-	-	-	13	17	21
Executives for billing and commercial	1	3	-	-	-	11	14	18
Total Salary (INR Lakh)	**1**	**6**	**-**	**-**	**-**	**46**	**59**	**75**
Without Development (Fairway)								
Manpower Expenditure								
Fibre Boat for Inspection	2	2	-	4	6	7	9	12
Hydrographer	1	8	-	26	34	43	55	70
Executives	2	3	-	20	25	32	41	53
Engineer	1	4	-	13	17	22	28	35
Total Salary (INR Lakh)	-	-	-	64	82	104	133	170

*Note: *Promotional Period, **Official Period*

Manpower cost has been considered in Total Project Cost under "Institutional Requirement". However, this investment component toward manpower will accommodate expenses only for the initial years, covering construction period. Manpower expenses in case of the Ro-Ro terminal isn't necessarily directed towards IWAI. It will be borne by whosoever operates the terminal. IWAI can either own and operate the infrastructure, or lease it to a private third party on a suitable PPP model.

TABLE 13-7: Depreciation (Using SLM Method) (INR Lakh)

Depreciation & Amortization	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Gross Block	751.9	751.9	751.9	-	-	-
Depreciation & Amortization	0.0	61.8	31.7	-	-	-
Cumulative Depreciation & Amortization	0.0	123.5	372.1	-	-	-
Net Block	751.9	628.4	379.8	-	-	-
Fairway**						
Gross Block	-	-	-	8,835.7	8,835.7	8,835.7
Depreciation & Amortization	-	-	-	800.9	447.4	447.4
Cumulative Depreciation & Amortization	-	-	-	2,927.9	5,659.8	7,897.0
Net Block	-	-	-	5,907.8	3,175.8	938.6
Ro-Ro Terminal						
Gross Block	-	-	-	3,856.2	3,856.2	3,856.2
Depreciation & Amortization	-	-	-	349.5	195.3	195.3
Cumulative Depreciation & Amortization	-	-	-	1,277.8	2,470.1	3,446.5
Net Block	-	-	-	2,578.4	1,386.0	409.7
Without Development						
Fairway						
Gross Block	751.9	751.9	751.9	751.9	751.9	751.9
Depreciation & Amortization	0.0	61.8	31.7	31.7	19.2	1.0
Cumulative Depreciation & Amortization	0.0	123.5	372.1	530.5	674.0	751.9
Net Block	751.9	628.4	379.8	221.4	78.0	0.0

Note: *Promotional Period, **Official Period

Depreciation has been calculated using the Straight Line Method (SLM). Under this method, cost of asset is evenly distributed across its useful life. Gross Block in each case is sum of total hard cost and pre-operative expenses, which includes environmental management plan @ 5% of the Capex.

TABLE 13-8: O & M Cost (INR Lakh)

Parameter	Fy18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	20	22	28	-	-	-
Total Cost	**20**	**22**	**28**	-	-	-
Fairway**						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	-	-	-	863	1,106	1,414
Total Cost	-	-	-	**863**	**1,106**	**1,414**
Ro-Ro Terminal						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	-	-	-	39	52	70
Total Cost	-	-	-	**39**	**52**	**70**
With Development						
Fairway						
Direct Operating Costs	-	-	-	-	-	-
Maintenance and Other Cost	20	22	28	35	45	57
Total Cost	**20**	**22**	**28**	**35**	**45**	**57**

Note: *Promotional Period, **Official Period

TABLE 13-9: P&L Statement (INR Lakh)

Parameter	Fy18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
PBDIT	**-30.9**	**815.3**	**1,364.6**	-	-	-
Depreciation	-	61.8	31.7	-	-	-
Interest	53.8	41.8	11.9	-	-	-
PBT	**-84.7**	**711.7**	**1,321.0**	-	-	-
Tax	-	213.5	396.3	-	-	-
PAT	**-84.7**	**498.2**	**924.7**	-	-	-
Fairway**						
PBDIT	-	-	-	**797.6**	**1,706.8**	**3,280.1**
Depreciation	-	-	-	800.9	447.4	447.4
Interest	-	-	-	470.9	68.6	0.0
PBT	-	-	-	**-474.1**	**1,190.7**	**2,832.7**
Tax	-	-	-	0.0	357.2	849.8
PAT	-	-	-	**-474.1**	**833.5**	**1,982.9**
Ro-Ro Terminal						
PBDIT	-	-	-	**-259.4**	**-213.9**	**-92.4**
Depreciation	-	-	-	349.5	195.3	195.3
Interest	-	-	-	205.5	29.9	0.0

Parameter	Fy18	FY20	FY25	FY30	FY35	FY40
PBT	-	-	-	**-814.5**	**-439.1**	**-287.7**
Tax	-	-	-	0.0	0.0	0.0
PAT	-	-	-	**-814.5**	**-439.1**	**-287.7**
With Development						
Fairway						
PBDIT	**-30.9**	**815.3**	**1,364.6**	**2,267.3**	**3,747.9**	**6,171.6**
Depreciation	-	61.8	31.7	31.7	19.2	1.0
Interest	53.8	41.8	11.9	-	-	-
PBT	**-84.7**	**711.7**	**1,321.0**	**2,235.6**	**3,728.6**	**6,170.6**
Tax	-	213.5	396.3	670.7	1,118.6	1,851.2
PAT	**-84.7**	**498.2**	**924.7**	**1,564.9**	**2,610.0**	**4,319.4**

Note: *Promotional Period, **Official Period

Only fairway sub-sector project is expected to turn out to be a profitable venture. Virtually non-existent development cost and O&M cost during the promotional period and in the "without development" model allows this sub-sector project to derive profit as high as 16 times the total cost. This is an exceptional case, and possible only in an absolutely ideal market condition wherein the industry is willing to shift all its cargo operation to the IWT. The relatively high construction cost and subdued revenue generating potential for the Ro-Ro Terminal is evident in the losses this sub-sector project will accrue. The Terminal may generate profit, but that is likely to be beyond the projection period of FY40.

The following table is the ultimate assessment of the viability of the individual projects planned under the development of the Dabhol-Vashishti River:

TABLE 13-10: FIRR for Dabhol-Vashishti River (INR Lakh)

Parameter	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Project Cashflow (Pre-tax)	-783	815	1,365	-	-	-
Project IRR(Pre-tax)	**104%**					
Project cash flow(Post-tax)	-783	602	968	-	-	-
Project IRR(Post-tax)	**80%**					
Fairway**						
Project Cashflow(Pre-tax)	-	-	-	797.6	1,706.8	3,280.1
Project IRR(Pre-tax)	**10%**					
Project Cashflow(Post-tax)	-	-	-	797.6	1,350	2,430
Project IRR(Post-tax)	**7%**					
Ro-Ro Terminal						

Parameter	FY18	FY20	FY25	FY30	FY35	FY40
Project Cashflow(Pre-tax)	-	-	-	-259.4	-213.9	-92.4
Project IRR(Pre-tax)	**Non-existent**					
Project Cashflow(Post-tax)	-	-	-	-259.4	-213.9	-92.4
Project IRR(Post-tax)	**Non-existent**					
Without Development						
Fairway						
Project Cashflow(Pre-tax)	-783	815	1,365	2,267	3,748	6,172
Project IRR(Pre-tax)	**104%**					
Project Cashflow(Post-tax)	-783	602	968	1,597	2,629	4,320
Project IRR(Post-tax)	**80%**					

Note: *Promotional Period, **Official Period

As highlighted earlier, the extraordinary revenue prospect for fairway will enable this sub-sector project to generate higher rate of returns. This is clearly apparent from the unnaturally high IRRs in both the development cases. It's the imbalance between negligible cost and extremely high revenues that has made this possible. Ro-Ro Terminal, on the other hand, is likely to be a loss-making venture. Based on the EIRR for the Ro-Ro sub-sector, Viability Gap Funding (VGF) can be sought.

In contrast to the above project component-wise FIRR, the following table provides FIRR for the project as a whole.

TABLE 13-11: FIRR for Dabhol-Vashishti River – Whole Project (INR Lakh)

Parameter	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Whole Project						
Project Cashflow (Pre-tax)	-5,575	-4,837	-254	-47	743	2,222
Project IRR (Pre-tax)	**-3%**					
Project Cashflow(Post-tax)	-5,575	-4,837	-254	-47	526	1,558
Project IRR (Post-tax)	**-5%**					

The impact of an unviable Ro-Ro Terminal sub-segment project is reflected in the whole project's return potential. Negative returns are indicative of the unviability of the entire project. However, a cumulative assessment of the project may not be an accurate indicator to evaluate a project's ultimate viability. Individual components of the project may have the potential to provide good returns, but a loss-making project component may overshadow such a project when the entire project is assessed together for its profitability.

13.6. Economic Analysis / EIRR

Economic Internal Rate of Return (EIRR) includes all the financial benefits of a project as well as the non-financial benefits of that project. Non-financial benefits would include reduction in CO2 emission, decreased health care interventions, reduced traffic, and other quantified benefits that a project can have on a region considered for a project. The EIRR looks at any investment decision from the perspective of improving the welfare of the society in general.

Only the Ro-Ro sub-sector under Dabhol-Vashishti River development would require financial intervention from the government. A strong EIRR could warrant capital inflow from state and/or central government in the form of Viability Gap Funding (VGF). Estimated EIRR for each of these sub-sectors is presented in the table below:

TABLE 13-12: Project EIRR (INR Crores)

Parameters	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Economic Cash Outflow	0.0	25.2	30.0	-	-	-
Net Cash Flow to Project	-7.7	25.0	29.8	-	-	-
Project EIRR	**318%**					
Fairway**						
Economic Cash Outflow	-	-	-	43.4	52.0	63.3
Net Cash Flow to Project	-	-	-	36.0	42.7	51.4
Project EIRR	**37%**					
Ro-Ro Terminal						
Economic Cash Outflow	-	-	-	43.81	52.50	63.06
Net Cash Flow to Project	-	-	-	43.81	52.50	63.06
Project EIRR	**103%**					
Without Development						
Fairway						
Economic Cash Outflow	0.0	25.2	30.0	35.9	43.1	51.8
Net Cash Flow to Project	-7.7	25.0	29.8	35.6	42.7	51.3
Project EIRR	**318%**					

*Note: *Promotional Period, **Official Period*

All the sub-sector projects exhibit positive impact on the local economy, and invariably, the economy of the state and the nation. Of these, only Ro-Ro terminal is relevant here, as this sub-sector project is an eligible contender for VGF.

Similar to calculating FIRR of the whole project, the following table shows the EIRR of the whole project:

TABLE 13-13: Project EIRR – Whole Project (INR Crores)

Parameters	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Whole Project						
Economic Cash Outflow	-4	21	25	28	46	56
Net Cash Flow to Project	-53.80	-22.16	24.53	28.35	46.26	56.40
Project EIRR	**21%**					

The project as a whole produces a positive EIRR, but the quantum of impact it may have on the overall region's development is lowest compared to EIRR of individual project component. This further could be indicative of low-to-negligible return potential of the project as a whole.

13.7. Sensitivity Analysis

Variations in tariff rates and project cost (+/- 10%) have been applied to measure the overall impact these could have on the project's earnings and profitability. Sensitivity Analysis for each of the sub-sectors is shown in the table below:

TABLE 13-14: Sensitivity Analysis (+10% Revenue, +10% Project Cost)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Revenue	0	1,079	1,757	-	-	-
PAT	-154	550	1,020	-	-	-
Project IRR (Pre tax)	**105%**					
Project IRR (Post tax)	**80%**					
Fairway**						
Revenue	-	-	-	2,205	3,590	5,844
PAT	-	-	-	-514	924	2,190
Project IRR (Pre tax)	**10%**					
Project IRR (Post tax)	**7%**					
Ro-Ro Terminal						
Revenue	-	-	-	314	510	828
PAT	-	-	-	-847.0	-423.3	-243.4
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	0	1,079	1,757	2,860	4,657	7,582

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
PAT	-154	550	1,020	1,725	2,876	4,882
Project IRR (Pre tax)	**105%**					
Project IRR (Post tax)	**80%**					

*Note: *Promotional Period, **Official Period*

TABLE 13-15: Sensitivity Analysis (+10% Revenue, -10% Project Cost)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Revenue	0	1,079	1,757	-	-	-
PAT	-76	572	1,034	-	-	-
Project IRR (Pre tax)	**127%**					
Project IRR (Post tax)	**95%**					
Fairway**						
Revenue	-	-	-	2,205	3,590	5,844
PAT	-	-	-	-61	1,168	2,467
Project IRR (Pre tax)	**15%**					
Project IRR (Post tax)	**12%**					
Ro-Ro Terminal						
Revenue	-	-	-	314	510	828
PAT	-	-	-	-728	-368	-190
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	0	1,079	1,757	2,860	4,657	7,582
PAT	-76	572	1,034	1,740	2,891	4,773
Project IRR (Pre tax)	**127%**					
Project IRR (Post tax)	**96%**					

*Note: *Promotional Period, **Official Period*

TABLE 13-16: Sensitivity Analysis (-10% Revenue, +10% Project Cost)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Revenue	0	883	1,437	-	-	-
PAT	-93	425	815	-	-	-
Project IRR (Pre tax)	**86%**					
Project IRR (Post tax)	**65%**					
Fairway**						

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
Revenue	-	-	-	1,804	2,937	4,782
PAT	-	-	-	-887	499	1,498
Project IRR (Pre tax)	**5%**					
Project IRR (Post tax)	**3%**					
Ro-Ro Terminal						
Revenue	-	-	-	257	417	678
PAT	-	-	-	-901	-510	-385
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	0	883	1,437	2,340	3,810	6,203
PAT	-93	425	815	1,390	2,329	3,866
Project IRR (Pre tax)	**86%**					
Project IRR (Post tax)	**67%**					

*Note: *Promotional Period, **Official Period*

TABLE 13-17: Sensitivity Analysis (-10% Revenue, -10% Project Cost)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
With Development						
Fairway*						
Revenue	0	883	1,437	-	-	-
PAT	-76	444	827	-	-	-
Project IRR (Pre tax)	**104%**					
Project IRR (Post tax)	**78%**					
Fairway**						
Revenue	-	-	-	1,804	2,937	4,782
PAT	-	-	-	-434	743	1,776
Project IRR (Pre tax)	**10%**					
Project IRR (Post tax)	**7%**					
Ro-Ro Terminal						
Revenue	-	-	-	257	417	678
PAT	-	-	-	-782	-455	-332
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
Without Development						
Fairway						
Revenue	0	883	1,437	2,340	3,810	6,203
PAT	-76	444	827	1,401	2,340	3,876

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
Project IRR (Pre tax)	**104%**					
Project IRR (Post tax)	**79%**					

*Note: *Promotional Period, **Official Period*

Under no scenario does the Ro-Ro sub-sector project produce positive FIRR. This means that even in imaginable optimistic conditions of higher revenue and lower cost, Ro-Ro terminal is highly unlikely to generate positive returns in the projected period up to FY40. Prima facie, this indicates that Ro-Ro Terminal is not a sound investment to make.

13.8. Risk Factors & Mitigation

Risk is a function of the probability of an event's occurrence and the impact it can have on the project. The major risk associated with the Project is the industry's willingness to shift to IWT, even with possible subsidy. The promotional campaign will provide a strong indicator for the market's willingness in this regard. Other risks typically impressing upon such a project are political, technical, environmental, and financial in nature. A broad assessment of such risks for the Dabhol-Vashishti River waterway development project is depicted in below table:

The following table enumerates risks identified in executing the Project, the rationale behind it, and the potential mitigation or management measures:

TABLE 13-18: Risk Factors & Mitigation measures

Risk	Description	Likelihood*	Impact**	Risk #	Mitigation / Management
Industry's unwillingness	Industries operate on the commercial template, which minimizes their expenses while maximizing the return. IWT will involve multi-modal operation, which raises logistics cost and transportation time. This could be a major deterrence	4	5	20	• Exploring other cargo, especially where IWT will result in cost and time savings • Shelving the idea for Ro-Ro Terminal
Low or Uncertain Future traffic	In the exceptional case where industries agree to transition to IWT, the estimated traffic may not be materialize, leading to low revenue prospects while development cost and O&M cost don't change.	3	4	12	• Lowered cost of handling to widen the margin. • Targeting different commodities to supplement the terminal's income
Project delay	The cause could either be due to delay in acquiring necessary permissions and clearances, meeting environmental regulations and guidelines, delay in procurement of necessary equipment, local resistance, natural disaster, etc. Or, the delay could be the result of any combination of above determinants.	2	3	6	• Project Insurance • Increased lending to bridge gap due to cost overruns

*, ** - Severity increases with the scale; # - Likelihood x Impact

13.9. Necessity of Govt. Support (VGF / PPP)

Difficulty in securing funds aside, some projects are not even considered to be financially viable, although they might be economically justified and indispensable. To take care of such projects and to carry them towards their successful completion, the government has designed Viability Gap Funding (VGF). Viability Gap Funding is the grant provided by the government towards financing projects that are termed financially unviable but are economically justified. The scheme and the projects are monitored by the Ministry of Finance and amount is allocated through annual budget. The usual grant given by the government is 20% of the total capital cost of the project, which can be supplemented by the state government through an additional 20% grant.

Ro-Ro Terminal project is commercially unviable, but economically viable. So, this particular sub-sector project is eligible for VGF. A broad analysis is undertaken in the following table to test if use of VGF will have any bearing on the return of the Ro-Ro Terminal:

TABLE 13-19: Probable impact of VGF on project returns

Reduction in Project Cost	Ro-Ro Terminal - With Development	
	-20%	-40%
Project IRR (Pre Tax)	Non-existent	Non-existent
Project IRR (Post Tax)	Non-existent	Non-existent
Project EIRR	120%	147%

Even with significant financial support from the government, Ro-Ro Terminal may fail to produce the desired positive returns.

13.10. Conclusion

The following table gives a snapshot of the project cost and viability indicators for all the sub-sector developments under Dabhol-Vashishti River:

TABLE 13-20: Critical indicators for the Dabhol-Vashishti River Project

Parameter	Unit	With Development			Without Development	With Development
		Fairway*	Fairway**	Ro-Ro Terminal	Fairway	Whole Project
Project Cost	INR Cr.	7.5	88.36	38.6	7.5	134.4
Revenue (FY40)	INR Cr.	19.4	53.1	7.5	68.9	60.66
FIRR	%	80%	7%	Non-existent	80%	-5%
EIRR	%	318%	37%	103%	318%	21%

*Note: *Promotional Period, **Official Period*

The extremely high positive returns in case of fairway are unrealistic. Even if the FIRRs were within normal limits, the likelihood of this or all the sub-sector projects actually coming online would be dependent on the logistics cost differential and the government's intervention to address that. The logistics cost comparison in Chapter 4 highlights the subsidy amount required per truck in order to influence the industries into opting for IWT. In addition to subsidy, other measures would be needed to package and promote IWT as a better option over other modes, despite the increased transportation time and distance in the former's case. The following chart depicts the annual subsidy cost government will have to incur if it were to go ahead with cargo movement on Dabhol-Vashishti:

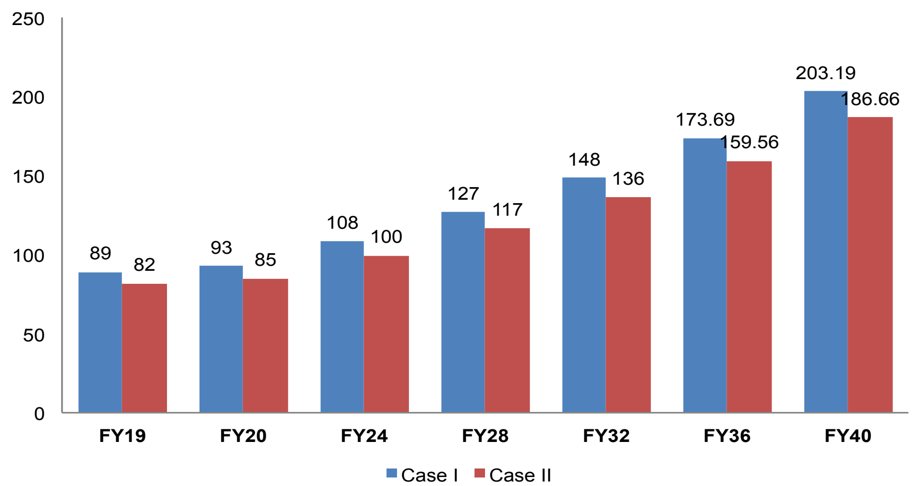


FIGURE 13.1: Dimensions – one way navigation Channel

Even the lowest subsidy expense of INR 82 cr. is more than the combined cost of fairway investment (with development) and the Ro-Ro Terminal. At no stage does the combined revenue generated from fairway and Ro-Ro Terminal comes even half as close to breaking even with just the subsidy cost. This sole reason of steep subsidy requirement, on account of the wide logistics cost difference, renders this entire project unviable. So, unless the government is willing to bear the cost of subsidy, development of Dabhol-Vashishti River is not a commercially sound investment prospect.

CHAPTER 14: CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Vashishti River (Dabhol Creek) (NW 28) in the stretch of 45.228 Kms from Lat 17° 34' 31.1762" N, Long 73° 09' 09.5984" E has been carried out as per the Terms of Reference (ToR) and the details of the study are given in the preceding chapters.

A summary of the recommendations and conclusions as a result of the study is placed herewith:

- Detailed Hydrographic Survey has been carried out and based on the Survey carried out / Site data collected / subsequent to the Morphological analysis etc., the required developments in the Fairway along with interrelated activities have been identified. As such there is no major Regime disturbance in the study stretch.
- The National Waterway (NW 28) “Vashishti River” is having a 2.0 m depth (w. r. to CD) up to 35 kms out of 45.228 kms. Inspite of such fairway availability, there is no cargo mobility in the river.
- Keeping in view the proximity of Industrial Belt in the end stretch of the River, {being planned and designated by Maharashtra State Government}, the possibility of Ro-Ro mobility could be established with an estimated Ro-Ro vehicles mobility to the extent of 125,000 vehicles P. A in FY 20 and expected grow to an extent of 273,000 vehicles P. A in FY 40. There is a possibility of this mobility directly from JnPT through IWT vessel traversing the costal route and the full stretch of the Vashishti River.
- Accordingly, the possibility of Ro-Ro mobility has been considered with Class IV standard of Waterway with 50 m Bottom Width of fairway and 2.0 m Depth of fairway with a vessel / convoy requirement for Class IV as 170 m (Length) x 12 m (Breadth) x 1.8 m (Draft).
- A promotional operation has been suggested for initial operation with 2 Ro-Ro vessels (Deployment by Enterprenuer) between JnPT and Ch 34 km, just downstream of the tributary “Jagbudi”, where approach road is existing both in North side (Bank near “Bhairavali” village) and South side (Bank near “Karambave” village), which are connected to NH 66 with a lead of 10 kms – 12 kms.
- This promotional aspect is proposed as Phase 1, where there is no need of any investment (rather nominal investment) for development. 10 Nos of Lattice Bridge with Lighting and L. S provisions have been worked out for INR 7.52 Cr in Phase 1.
- No development is suggested till a critical and micro level analysis with observation of increase in volumes of Ro-Ro operation. If there is any need for investment, then Phase 2 can be considered.

- As a part of Phase 2 development, in order to provide a class IV safe navigable fairway, Dredging of 4.4 Lakhs Cu. M in Soils and 0.50 Lakhs in Hard Soils; 4000 m of Bank Protection; 110 Nos of Day / Night Navigation Buoy / Light etc., have been suggested.
- Roll-On Roll-Off (Ro-Ro) IWT Terminal has been considered taking into the consideration of the mobility up to the end of the NW. The most probable location identified is on the right side of the river with approx Lat 17° 32' 44.26"N and Long 73° 30' 32"E. This location is having good accessibility to the NH 66 and the tentative Land requirement has been arrived at with 30,758 Sq. M in the Pedhe Village; Chiplun Taluka; Ratnagiri District of Maharashtra state.
- Terminal Infrastructure has been considered to suit to the Ro-Ro operation with the length of the Berthing structure as 63 m and width as 16.60 m.
- In order to facilitate the Ro-Ro operation, The following Vessel type and size have been considered i.e., the type as Ro-Ro Vessel with 21 TEU capacity LOA 52.8 m to 55 m; Breadth 14.0 m; Loaded Draft / Depth 1.8 m / 2.5 m +; Propulsion with Marine Diesel Engines of 3 x 375 Bhp and with Average Speed (with Load) of 20 Kmph. The indicative cost is about INR 900 Lakhs.
- Cost estimates have been worked out for Fairway (in Phase 1) as INR 7.52 Cr; Fairway (in Phase 2) as INR 88.36 Cr and Ro-Ro Terminal development as INR 38.56 Cr. All the capital assets will be provisioned in 36 months from FY 26, in Phase 2.
- The FIRR and EIRR have been worked out and the details are placed.

Project Modules	FIRR	EIRR
Phase 1	80 %	318 %
Phase 2 (Fairway)	7 %	37 %
Phase 2 (Ro-Ro Terminal)	Non-Existent	103 %
Phase 2 (Whole Project)	-5 %	21 %

- It is recommended to consider Phase 1 Promotional mobility till 2025 / 2026 with the operation up to 34 km / 35 km. No investment is suggested for further development, without any meticulous assessment so as to develop the entire study stretch of Dabhol Creek / Vashishti River of about 45 kms with Class IV system of the NW standards to facilitate the Ro-Ro vessel mobility.

CHAPTER 15: TEMPLATES

15.1. Environmental & Social Screening Template

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site			
a) National Park		✓	
b) Wildlife/ Bird Sanctuary		✓	
c) Tiger or Elephant Reserve		✓	
d) Biosphere Reserve		✓	
e) Reserved / Protected Forest		✓	
f) Wetland		✓	
g) Important Bird Areas		✓	
h) Mangroves Areas	✓		Mangroves are present on both the banks of Vashishti river in the NW-28 stretch, but the development of NW project does not involve clearing of any mangrove vegetation.
i) Estuary with Mangroves	✓		
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration		✓	
k) World Heritage Sites		✓	
l) Archeological monuments/ sites (under ASI"s Central / State list)		✓	
2. Is the project located in whole or part in / near any Critically Polluted Areas identified by CPCB?		✓	

Screening Question	Yes	No	Details / Remarks
3. Is, there any defense installations near the project site?		✓	
4. Whether there is any Government Order/ Policy relevant / relating to the site?	✓		Discussed in Section 9.5 of the DPR
5. Is the project involved clearance of existing land, vegetation and buildings?		✓	
6. Is the project involved dredging?	✓	✓	No dredging for development of Alternative I. Limited dredging is involved in Alternative II.
7. Is the project area susceptible to natural hazard (*earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions*)		✓	
8. Is the project located in whole or part within the Coastal Regulation Zone?	✓		The entire project falls in CRZ I.
9. Is the project involved any demolition of existing structure?		✓	
10. Is the project activity requires acquisition of private land?	✓		Only in case Alternative 2 as recommended in the DPR is taken up for development. Alternative 2 requires a terminal to be constructed, the land identified for which is partly privately owned.
11. Is the proposed project activity result in loss of direct livelihood / employment?		✓	
12. Is the proposed project activity affect schedule tribe/ caste communities?		✓	

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	No
5.	Wildlife Clearance is required	No
6.	NOC from SPCB is required	Yes
7.	Social Impact Assessment is Required	Only as part of EIA study
8.	Abbreviated RAP is required	No
9.	Full RAP is required	No
10.	Any other clearance is required	Other clearances required include those that are to be obtained by the Contractors during the construction period such as the Certificate of Registration under Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act 1996, licenses / permits under other applicable labour laws, permission from SPCB for setting up of batching plants and for use of DG sets etc.

15.2. Traffic Template

15.2.1. Catchment Baseline

- Local economic geography - Vashishti River is one of the larger rivers in Konkan area. Ratnagiri district includes western slope of Sahyadri range. Ratnagiri district is covered by forest area. Forest area includes Hills, Forts, and Wildlife etc. about 85% of land area of the district is covered by hilly region.
- Catchment area – Khed, Chiplun, Guhagar, Dapoli taluka of Ratnagiri district.

- Population – As per census 2011, total population residing in above mentioned taluka of Ratnagiri districts is 6,41,981. Highest population resides in Chiplun followed by Khed.
- Economic activities - Agriculture, Horticulture, fisheries and tourism are major growth driving sectors to the economy of Ratnagiri. Ratnagiri district is considered as socio-economically underdeveloped.
- Major industries - Chemical industries in Lote Parshuram MIDC
- Connectivity

✓ Major roads - NH 66 crosses over the river from tail side. SH 96 & SH 4 crosses near the mouth of the river. Apart from these two State Highways, there do not exist any bridge or roadway on the river. Both highways are more than 30 km away from each other.

✓ Major railway – Konkan railway line is the only railway line running. Chiplun & Khed are passenger railway stations in the catchment of the river.

- Specific Developments

  A bridge on the river is planned to be constructed between SH 4 and NH 66. A 103 km long railway line is proposed to be developed from Chiplun to Karad in next 5- 6 years. Karad is located in Satara district of western Maharashtra.
- Catchment area Map

15.2.2. Navigation Baseline

- Existing Waterway Usage

✓ Dabhol to Veldur passenger ferry and Dabhol to Dhopave ro-ro ferry service runs on the river.

- ✓ Bharati Shipyard which is closed down due to less business potential, exist at Usgaon village on 250 acres of land.

15.2.3. Market Baseline

- Potential Market

  No cargo potential exist for Vashishti River. However a possibility of Ro-Ro traffic under certain conditions has been discussed in detail in Chapter 4 section no. 4.10

Commodity	Source	Reasoning
Chemical	Lote Parshuram	These Chemical industries use JNPT to export chemicals in the form of container by roadway and they are not ready to use river due to multiple handling and time factor.

15.2.4. Forecasting Years

- IWT Share
  - ✓ Ro-Ro traffic share of IWT is 60%. It is assumed that even after developing ro-ro service under certain conditions, there would be some trucks that would still prefer roadway.
  - ✓ Out of total share of IWT in Ro-Ro service, for Vashishti river IWT share is considered as 65%. Due to large scale chemical industries located in Lote Parshuram as compare to Mahad MIDC.

Following table depicts possible ro –ro traffic only if Government provides subsidy.

Name of the waterway: NW-28 (Dabhol Creek/Vashisti River, 45.228 km)

Sr. No	Name of Cargo	Type of Cargo	Origin	Origin Terminal on NW	Final Destination	Destination Terminal on NW	Co-ordinates	Unit p.a	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Terminals on River (No Terminal Present on River)														
Proposed Terminal Opportunity for IWAI (Condition Applies)														
1	Liquid, Bulk, break bulk	Ro-Ro	JNPT	n/a	Lote Parshuram	Point B - Pedhe	17°32'44.26"N, 73°30'32.00"E	('000 Trucks)	0	125	152	185	225	273

* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc.

15.2.5. Presentation of Forecast

Sr. No	Name of Cargo	Type of Cargo	Origin	Final Destination	Unit p.a	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Terminals on River (No Terminal Present on River)											
Proposed Terminal Opportunity for IWAI (Condition Applies)											
1	Liquid, Bulk, break bulk	Ro-Ro	JNPT	Lote Parshuram	(mn T- Km)	0	491	596	726	883	1,071

Source: Consultant's Analysis

15.2.6. Market Success Factors

The market success factor regarding the development of the Vashishti River is the present fairway availability with abundant required navigational channel and on the other side the present road mobility is facing the hilly terrain of its mobility.

The disadvantage in the Road mobility and the advantage of IWT mobility will be the Market success factor.

Further, the MIDC proposals in the hinterland will have lot of game change on IWT.

15.2.7. Forecasting Methodology

Following are assumptions and methodology taken into consideration to determine possible ro-ro traffic under certain conditions.

- ✓ Total number of trucks per day traveling on NH 66 from JNPT/MbPT is 750. Out of this total traffic, 60% could use ro-ro service on both Savitri & Vashishti river. Industries located nearby both rivers use JNPT port for export purpose therefore it is assumed that Ro-Ro traffic share for Vashishti river is assumed to be 65% of 450 per day.
- ✓ IWT share in Vashishti River is assumed to be on a higher note because of the scale of industries located in Lote Parshuram MIDC compare to Mahad MIDC.
- ✓ Projections are made considering Government would provide subsidy to make Ro-Ro service commercially viable.

15.3. Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	☐ Land, compensation and resettlement : No ☐ Capital dredging: Phase 1 : No Phase 2 : 4.4 lakhs cu.m Ordinary soil – 13.20cr 0.5 lakhs cu.m Hard soil – 4.5cr ☐ Bank protection: Phase 2: 7 Nos-4000m ☐ Channel market ☐ Night navigation Phase 1: (Beacon & Lights) 10 Nos – 1.96cr Phase 2: (Buoy & Lights) 110 Nos – 3.69cr

Cost type	Cost categories	Components to be itemized
		☐ Other: Communication system – No ☐ Locks: No ☐ Barrages: No
Terminal Infrastructure		Ro-Ro facility ☐ Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) ☐ Loading/uploading and other equipment (itemized) Considered ☐ Buildings : Considered in infrastructure ☐ Other : --
Operation and maintenance (O & M) costs	Waterways	☐ Maintenance dredging ☐ Markings and nav.-aids ☐ Bank maintenance Considered as per standard ☐ Other
	Terminals	☐ Terminal operations ☐ Terminal maintenance Considered as per standard ☐ Other
	Vessel: (NB vessel operating costs/tons-km fall sharply with larger capacity vessel, when there is sufficient traffic to utilize them)	☐ Crew ☐ Fuel ☐ Maintenance ☐ Registration & insurance ☐ Fees and charges ☐ Vessel capital amortization (or leasing cost equivalent) Considered as per standard ☐ Total costs ☐ (Cost/tons-km for use in evaluation)
Recurrent costs		Periodic major capital costs that may occur over life of assets : Considered as per standard
Price levels		All costs to be expressed in mid-2014 price levels. Costs derived from other years to be indexed to 2014 price levels : Considered accordingly

Cost type	Cost categories	Components to be itemized
Value engineering		Not all investments will be necessary in all projects. Value engineering should be applied to project scoping and specification to avoid „gold-plating" of costs and undermining viability of project: --
Cost verification		Costs that are estimated on a „bottom-up" basis should be verified or tested for reasonableness against actual costs for such activities evidenced in the market place: Considered as per standard

15.4. Economic Evaluation Template

Item	Requirements
Objective	To assess economic internal rates of return (EIRR) on a consistent basis between different river projects.
Economic evaluation approach	Economic evaluation of each river upgrading project may include: **Capital Cost:** *i) With Development* (a) Navigation infrastructure (FY18-FY27) – INR 7.5 crore (b) Navigation infrastructure (FY26-FY40) – INR 88.36 crore (c) Terminal Ro-Ro Cost - INR 38.56 crore *ii) Without Development* (a) Navigation infrastructure (FY18-FY40) – INR 7.5 crore **O & M costs:** *i) With Development* (a) Navigation infrastructure (FY18-FY27) – INR 0.28 crore (b) Navigation infrastructure (FY26-FY40) – INR 14.14 crore (c) Terminal Ro-Ro Cost - INR 0.7 crore *ii) Without Development* (a) Navigation infrastructure (FY18-FY40) – INR 0.57 crore

Item	Requirements
	Savings in transport resource costs between IWT and rail and/or road transport **Saving on Fuel:** *i) With Development* (a) Navigation infrastructure (FY18-FY27) – INR 14.2 crore (b) Navigation infrastructure (FY26-FY40) – INR 29.1 crore (c) Terminal Ro-Ro Cost - INR 29.1 crore *ii) Without Development* (a) Navigation infrastructure (FY18-FY40) – INR 23.7 crore **Saving on Vehicle Operating Cost:** *i) With Development* (a) Navigation infrastructure (FY18-FY27) – INR 12.9 crore (b) Navigation infrastructure (FY26-FY40) – INR 26.4 crore (c) Terminal Ro-Ro Cost - INR 26.4 crore *ii) Without Development* (a) Navigation infrastructure (FY18-FY40) – INR 21.5 crore **Savings in road/rail accident costs:** *i) With Development* (a) Navigation infrastructure (FY18-FY27) – INR 2.9 crore (b) Navigation infrastructure (FY26-FY40) – INR 3.5 crore (c) Terminal Ro-Ro Cost - INR 3.5 crore *ii) Without Development* (a) Navigation infrastructure (FY18-FY40) – INR 2.9 cr.

Item	Requirements
	Saving in carbon emissions: *i) With Development* (a) Navigation infrastructure (FY18-FY27) – INR 0.6 crore (b) Navigation infrastructure (FY26-FY40) – INR 0.8 crore (c) Terminal Ro-Ro Cost - INR 1.2 crore *ii) Without Development* (a) Navigation infrastructure (FY18-FY40) – INR 0.9 crore
Standard values	To ensure consistency between evaluations of different waterways the following has been used: Vehicle operating Cost Road : INR 2.58/tons-km Rail : INR 1.41/tons-km IWT: INR.1.06/tons-km Road accident Loss: INR 7.73 Lakhs/km Rail accident Loss: INR 0.77 Lakhs/km Carbon shadow price : 20 dollars/tons
Other benefits	Other significant economic benefits such as direct employment creation has also been considered in the evaluation. Employment cost has been taken as INR 2.5 Lakhs per annum.
Cash flows in real terms	Economic cost has been considered as 85% of actual values without any escalation.
Resource cost adjustments	Market prices has been taken on 2017 price level as equivalent to resource costs for the purposes of the economic evaluation.
Evaluation period	The “promotional period” for waterway utilization is assumed to start from FY18, whereby no development is required (for chainage of 35 km from the river mouth). On the back of market response at the end of observation period in FY25, future development decisions will be made. Under optimistic conditions, no development will be required, and the entire fairway operation will be relegated to the first 35 km chainage. A

Item	Requirements
	development period of 3 years (FY26 – FY28) has been allotted in case the market doesn't respond well, and further fairway development is necessary to further increase the waterway transport's leverage. Traffic across the extended fairway (chainage of 43 km) will commence from FY28, the last year of development. Between the development period of FY26 and FY28, traffic will continue to be handled up till 35-km chainage, supported by a ramp at an existing terminal location, which would require negligible investment, having immaterial impact on the overall investment dynamics and quantum. Ro-Ro Terminal construction will also coincide with the decision to extend the fairway beyond 35 km. The construction period for the terminal will also be from FY26 to FY28.
EIRR	The EIRRs for all the individual projects under development of the Dabhol-Vashishti River are positive. However, of all the sub-segment projects, Ro-Ro Terminal is not commercially viable, because of the non-existent FIRR. There are immediate prospects for fairway utilization, and cargo volume is expected to grow in the coming future driven by the growth in secondary sector. It is essential to develop the fairway along with night navigation. However, the high logistics cost for the waterway will act as a major deterrent, and possibly dissuade any interested party from making the switch. This is despite the extremely low tariff rates applied by the IWAI. Development of Dabhol-Vashishti as an alternate mode for transportation of cargo for industries is likely to generate employment. Economic IRR of Navigational Structure during the observation period is 318%, 37% during official deployment period between FY26 and FY40, and 318% when there's no development to be carried out for the fairway. For the Ro-Ro Terminal, the EIRR comes at 103%.
Checking and Replicability	Systematic checks of spreadsheets and logic trail have been done keeping in mind the input data, assumptions and calculations.

15.5. Financial Evaluation Template

Item	Requirements
Objective	To assess financial internal rates of return and financial payback periods of Dabhol-Vashishti River
Financial evaluation approach	Financial evaluation of each river upgrading project should estimate and present actual cash flows (cost and revenues) at market prices within the inland waterway sector consisting of the two sub-segments: (a) navigation infrastructure; (b) terminal operation. **Returns for Navigation infrastructure (With Development) are:** *i) Promotional Period (FY18 – FY27)* Total Revenue: INR 19.4 cr. in FY27 O&M Cost: INR 0.28 cr. in FY27 Tax: INR 4.9 cr. In FY27 (@ 30% on EBITDA) EBIDA: INR 16.7 cr. In FY27 Project Capital Cost (with escalation): INR 7.5 cr. Net Cash Flow: INR 11.3 cr. In FY27 *ii) Official Deployment Period (FY26 – FY40)* Total Revenue: INR 53.1 cr. in FY40 O&M Cost: INR 14.14 cr. in FY40 Tax: INR 8.5 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 32.8 cr. In FY40 Project Capital Cost (with escalation): INR 88.3 cr. Net Cash Flow: INR 24.3 cr. In FY40 **Returns for Navigation infrastructure (Without Development) are:**

Item	Requirements
	Total Revenue: INR 68.9 cr. in FY40 O&M Cost: INR 0.57 cr. in FY40 Tax: INR 19.02 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 63.4 cr. In FY40 Project Capital Cost (with escalation): INR 75.2 cr. Net Cash Flow: INR 44.4 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** Total Revenue: INR 7.5 cr. in FY40 O&M Cost: INR 0.7 cr. in FY40 Tax: INR 0.0. In FY40 (@ 30% on EBITDA) EBIDA: INR -0.9 cr. In FY40 Project Capital Cost (with escalation): INR 38.6 cr. Net Cash Flow: INR -0.9 cr. In FY40
Disaggregation	Cash flow streams and FIRRs have been attached as annexures in Financial Evaluation chapter-13 for Navigation Structure and terminals separately. It is not considered as a whole. Payback is also considered separately for all 2 facilities. **Returns for Navigation infrastructure (With Development) are:** *i) Promotional Period (FY18 – FY27)* Total Revenue: INR 19.4 cr. in FY27 O&M Cost: INR 0.28 cr. in FY27 Tax: INR 4.9 cr. In FY27 (@ 30% on EBITDA) EBIDA: INR 16.7 cr. In FY27 Project Capital Cost (with escalation): INR 7.5 cr. Net Cash Flow: INR 11.3 cr. In FY27 *ii) Official Deployment Period (FY28 – FY40)*

Item	Requirements
	Total Revenue: INR 53.1 cr. in FY40 O&M Cost: INR 14.14 cr. in FY40 Tax: INR 8.5 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 32.8 cr. In FY40 Project Capital Cost (with escalation): INR 88.3 cr. Net Cash Flow: INR 24.3 cr. In FY40 **Returns for Navigation infrastructure (Without Development) are:** Total Revenue: INR 68.9 cr. in FY40 O&M Cost: INR 0.57 cr. in FY40 Tax: INR 19.02 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 63.4 cr. In FY40 Project Capital Cost (with escalation): INR 7.5 cr. Net Cash Flow: INR 43.2 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** Total Revenue: INR 7.5 cr. in FY40 O&M Cost: INR 0.7 cr. in FY40 Tax: INR 0.0. In FY40 (@ 30% on EBITDA) EBIDA: INR -0.9 cr. In FY40 Project Capital Cost (with escalation): INR 38.6 cr. Net Cash Flow: INR -0.9 cr. In FY40

Item	Requirements
Evaluation period	The “promotional period” for waterway utilization is assumed to start from FY18, whereby no development is required (for chainage of 35 km from the river mouth). On the back of market response at the end of observation period in FY25, future development decisions will be made. Under optimistic conditions, no development will be required, and the entire fairway operation will be relegated to the first 35 km chainage. A development period of 3 years (FY26 – FY28) has been allotted in case the market doesn’t respond well, and further fairway development is necessary to further increase the waterway transport’s leverage. Traffic across the extended fairway (chainage of 43 km) will commence from FY28, the last year of development. Between the development period of FY26 and FY28, traffic will continue to be handled up till 35-km chainage, supported by a ramp at an existing terminal location, which would require negligible investment, having immaterial impact on the overall investment dynamics and quantum. Ro-Ro Terminal construction will also coincide with the decision to extend the fairway beyond 35 km. The construction period for the terminal will also be from FY26 to FY28.
FIRR and payback period	Estimate both FIRR (sector and sub-sectors) and overall sector payback period, the latter being the year in which the cumulative sector each flows becomes positive. : Described in financial evaluation
Ramp-up period	Unless good reasons otherwise, assume 4 years ramp-up period from first operational year to long-term trend“ levels of traffic: 5 years ramp up period considered
Commentary on FIRR	Explain overall sector FIRR results and distribution between sub-sectors. Identify main drivers of the results and sensitivity to assumptions: Barring for the Ro-Ro Terminal, the project for development of Dabhol-Vashishti River exhibits potential for positive rate of return on investment (FIRR).

Item	Requirements
	Factors influencing healthy financial returns of the project are: • The optimistic scenario where no development will be undertaken on the fairway, up to a chainage of 35 km from the mouth of the river. This is made possible due to availability of adequate depth across this stretch, negating any further need for dredging. • Absence of development requirement on fairway up to 35-km chainage means no cost, while revenue continues to be generated. This has an unnaturally and intensely positive impact over the returns for the fairway. • Even in the case of developing the waterway beyond 35-km chainage, the quantum of revenue over project costs is far higher, leading to profitability throughout the projection period of up to FY40, and positively impacting the rate of returns. • Ro-Ro Terminal is highly unlikely to provide good returns, on account of high development cost, coupled with too low tariff rates assigned by the IWAI. This also severely impacts the viability of the entire Ro-Ro terminal sub-segment project.
Risks to financial out-turn	Identify main risks to the estimated project out-turn or viability and their underlying causes e.g. market risks (traffic, tariffs, and competition), hydrology risks, engineering risks, operational risks etc.: • The market doesn't respond at all, or the expected appeal of the waterway is far dilute than expected. This will make the promotional period irrelevant, and may even cast a serious doubt on the need to develop the fairway beyond the 35-km chainage to coax the industries to consider making the shift. • The extremely high logistic cost difference between roadway and waterway will make it nearly impossible for, one, industries to consider waterway movement for cargo, and two, for any transporter to even consider deploying their barge(s) on the waterway. • Future traffic may not be as high as the projected estimate.
Checking and Replicability	Systematic checks of spreadsheets and logic trail have been done keeping in mind the input data, assumptions and calculations.

ANNEXURES

ANNEXURE 1.1 – TOR OF THE AGREEMENT

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.

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.

An inception report has to be prepared which would consist of the findings based on the analysis of the existing data and reconnaissance surveys.

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.

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, Hydrographic survey may be carried out as per the International Standards including the following for finding the potential of proposed Inland Waterways for inland navigation:-

(i) The detailed hydrographic survey is to be carried out in WGS'84 datum.

(ii) The horizontal control is to be 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-2		
1	DHANSIRI / CHATHE	110 km length of the river from Bridge near Morongi T.E. village Lat 26°24'40.65"N, Lon 93°53'46.75"E to Numaligarh Lat 26°42'1.20"N, Lon 93°35'15.42"E
2	LOHIT RIVER	100 km length of the river from Parasuram Kund Lat 27°52'40.06"N, Lon 96°21'39.70"E to Saikhowa Ghat, Sadiya Lat 27°47'49.14"N, Lon 95°38'13.84"E

3	SUBANSIRI RIVER	111 km length of the river from Gerukamukh Lat 27°27'3.14"N, Lon 94°15'16.12"E to Brahmaputra confluence at Lat 26°52'24.93"N, Lon 93°54'31.26"E
4	TIZU and ZUNGKI RIVERS	42 km length of the river from Longmatra at Lat 25°46'11.98"N, Lon 94°44'35.04"E to Avanghku at Myanmar border Lat 25°35'2.94"N, Lon 94°53'6.12"E and in Zungki river from bridge at Lat 25°48'26.10"N, Lon 94°46'35.96"E to confluence of Zungki and Tizu rivers at Lat 25°46'58.03"N, Lon 94°45'20.51"E
	CLUSTER-3	
1	BIDYA RIVER	55 km length of the river from Lot No. 124 at Lat 21°54'42.88"N, Lon 88°41'8.48"E to near Uttar Danga at Lat 22°11'47.93"N, Lon 88°51'54.93"E
2	CHHOTA KALAGACHI (CHHOTO KALERGACHI) RIVER	15 km length of the river from near Rajani ferry ghat Lat 22°19'57.49"N, Lon 88°54'21.40"E to near Nazat at Lat 22°26'5.40"N, Lon 88°50'11.69"E
3	DVC CANAL	130 km length of the canal from Durgapur Barrage Lat 23°28'47.36"N, Lon 87°18'19.04"E to Confluence point of DVC canal with Hooghly river near Tribeni Lat 23° 0'30.95"N, Lon 88°24'54.72"E
4	GOMAR RIVER	7 km length of the river from near Ramkrishnapur Lat 22°11'53.35"N, Lon 88°44'41.97"E to near Gosaba Kheya ghat at Lat 22°10'5.44"N, Lon 88°47'37.17"E
5	HARIBHANGA RIVER	16 km length of the river from Bangladesh Border Lat 21°53'18.81"N, Lon 89° 1'23.61"E to confluence with Jhila river at Lat 21°58'17.66"N, Lon 88°55'8.38"E
6	HOGLA (HOGAL)-PATHANKHALI RIVER	37 km length of the river from near Parandar Lat 22°12'22.05"N, Lon 88°40'42.77"E to near Sandeshkhai Ferry Ghat at Lat 22°21'12.26"N, Lon 88°52'47.99"E
7	KALINDI (KALANDI) RIVER	8 km length of the river from Bangladesh Border at Hingalganj Lat 22°28'8.48"N, Lon 88°59'46.19"E to Bangladesh Border near Khosbash at Lat 22°24'41.40"N, Lon 88°58'20.68"E
8	KATAKHALI RIVER	23 km length of the river from Bangladesh Border near Barunhat Lat 22°30'31.44"N, Lon 88°58'24.53"E to Lebukhali ferry at Lat 22°21'45.36"N, Lon 88°57'30.27"E
9	MATLA RIVER	98 km length of the river from Bay of Bengal at Lat 21°33'4.13"N, Lon 88°38'25.65"E to Canning ferry ghat at Lat 22°18'38.87"N, Lon 88°40'42.65"E
10	MURI GANGA (BARATALA) RIVER	27 km length of the river from Bay of Bengal near Bisalakshmipur Lat 21°37'51.94"N, Lon 88°10'0.24"E to near Kakdwip at Lat 21°52'17.39"N, Lon 88° 9'7.52"E
11	RAIMANGAL RIVER	52 km length of the river from Hemnagar at Lat 22°11'40.58"N, Lon 88°58'1.08"E to Rajnagar at Lat 22°33'56.95"N, Lon 88°56'16.64"E
12	SAHIBKHALI (SAHEBKHALI) RIVER	14 km length of the river from near Ramapur Lat 22°17'52.04"N, Lon 88°56'34.78"E to Bangladesh Border near Khosbash at Lat 22°24'41.40"N, Lon 88°58'20.68"E
13	SAPTAMUKHI RIVER	37 km length of the river from Bay of Bengal at Henry Island Lat 21°34'57.35"N, Lon 88°19'8.47"E to near Chintamanipur at Lat 21°51'14.01"N, Lon 88°18'40.50"E
14	THAKURRAN RIVER	64 km length of the river from Bay of Bengal at Lat 21°33'31.95"N, Lon 88°27'45.40"E to Madhabpur at Lat 22° 2'52.19"N, Lon 88°33'27.96"E
	CLUSTER-4	
1	BAITARNI RIVER:	49 kms length of the river from Dattapur village at Lat 20°51'44.61"N, Long 86°33'30.45"E to confluence with Dhamra river near Laxmiprasad Dia at Lat 20°45'13.32"N, Long 86°49'15.36"E

2	BIRUPA / BADI GENGUTI / BRAHMANI RIVER SYSTEM:	102 kms length of the river from Birupa Barrage at Choudwar at Lat 20°30'49.00"N, Long 85°55'20.17"E to confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat 20°37'36.25"N, Long 86°24'19.13"E including alternative route of 25 kms from Samaspur village at Lat 20°35'40.59"N, Long 86° 6'31.50"E to near Kharagpur village at Lat 20°38'27.77"N, Long 86°17'31.81"E and additional 54 kms length of Brahmani river from confluence of Birupa & Brahmani rivers near Upperkai Pada village at Lat 20°37'36.25"N, Long 86°24'19.13"E to Brahmani river at Katana Lat 20°39'26.28"N, Long 86°44'52.86"E
3	BUDHA BALANGA:	56 kms length of the river from Barrage (approx 300m from Patalipura village) at Lat 21°38'12.96"N, Long 86°50'53.17"E to confluence of Budha Balanga river with Bay of Bengal at Chandipur Fishing Port Lat 21°28'12.14"N, Long 87° 4'11.60"E
4	MAHANADI RIVER:	425 kms length of the river from Sambalpur Barrage at Lat 21°27'34.33"N, Long 83°57'49.80"E to Paradip at Lat 20°19'38.12"N, Long 86°40'16.96"E
CLUSTER-5		
1	PENNAR RIVER:	29 kms length of the river from Penna Barrage, Pothireddypalem at Lat 14°28'8.38"N, Long 79°59'9.31"E to confluence with Bay of Bengal near Kudithipalem at Lat 14°35'36.75"N, Long 80°11'30.61"E
2	KAVERI / KOLLIDAM RIVER:	364 kms length of the river from Uratchikottai Barrage at Lat 11°29'3.09"N, Long 77°42'13.68"E to confluence with Bay of Bengal at Pazhaiyar Lat 11°21'37.97"N, Long 79°49'53.23"E
3	PALAR RIVER:	141 kms length of the river from rail bridge at Virudampattu, Vellore Lat 12°56'14.07"N, Long 79° 7'29.70"E to confluence with Bay of Bengal at Sadurangapattinam Lat 12°27'52.16"N, Long 80° 9'13.47"E
4	PAZHYAR RIVER:	20 kms length of the river from Bridge near Veeranarayana Mangalam village at Lat 8°13'48.97"N, Long 77°26'27.34"E to confluence with Arabian Sea at Manakudi at Lat 8° 5'15.01"N, Long 77°29'7.61"E
5	PONNIYAR RIVER	125 km length of the river from Sathanur Dam at Lat 12°11'0.06"N, Lon 78°51'1.25"E to Cuddalore at confluence of Bay of Bengal at Lat 11°46'21.76"N, Lon 79°47'41.70"E
6	TAMARAPARANI RIVER:	64 kms length of the river from Sulochana Mudalir bridge, Tirunelveli at Lat 8°43'43.17"N, Long 77°42'53.94"E to confluence with Bay of Bengal near Punnaikayal at Lat 8°38'24.90"N, Long 78° 7'37.85"E
CLUSTER-6		
1	West Coast Canal	160 kms length of the canal as extension of NW-3 towards north of Kottapuram - from Kottapuram at Lat 10°11'38.32"N, Long 76°12'4.39"E to Kozhikode at Lat 11°13'38.83"N, Long 75°46'43.90"E
2	ALAPPUZHA-CHANGANASSERY CANAL	28 km from Boat jetty, Alappuzha at Lat 9°30'2.85"N, Lon 76°20'37.05"E to Changanassery Jetty at Lat 9°26'41.61"N, Lon 76°31'41.76"E
3	ALAPPUZHA- KOTTAYAM – ATHIRAMPUZHA CANAL	38 km from Boat jetty, Alappuzha at Lat 9°30'2.85"N, Lon 76°20'37.05"E to Athirampuzha market Lat 9°40'04"N, Lon 76°31'54"E
4	KOTTAYAM-VAIKOM CANAL	28 km from Kottayam, near Kodimatha at Lat 9°34'38.67"N, Lon 76°31'7.67"E to Vechoor joining National Waterway no. 3 at Lat 9°40'0.19"N, Lon 76°24'10.65"E
5	GURUPUR RIVER	10 km length of the river from confluence of Netravathi river at Lat 12°50'44.04"N, Lon 74°49'44.51"E to confluence of Mangalore Port Bridge at Lat 12°55'34.81"N, Lon 74°49'37.34"E

6	KABINI RIVER	23 km length of the river from Kabini Dam Lat 11°58'24.52"N, Lon 76°21'9.69"E to Beeramballi at Lat 11°56'9.55"N, Lon 76°14'17.58"E
7	KALI RIVER	54 km length of the river from Kodasalli Dam Lat 14°55'8.24"N, Lon 74°32'6.90"E to confluence of Kali river with Arabian Sea near Sadashivgad bridge at Lat 14°50'30.95"N, Lon 74° 7'21.32"E
8	NETRAVATHI RIVER	78 km length of the river from Netravathi Dam, Dharmsthala Lat 12°57'55.23"N, Lon 75°22'10.19"E to confluence with Arabian sea at Bengre Lat 12°50'42.73"N, Lon 74°49'28.86"E
9	PANCHAGANGAVALI (PANCHAGANGOLI) RIVER	23 km length of the river from Gangoli Port at Lat 13°38'1.30"N, Lon 74°40'8.43"E to Bridge at Badakere at Lat 13°44'50.01"N, Lon 74°39'15.13"E
10	SHARAVATI RIVER	29 km length of the river from Honnavar Port Sea Mouth at Lat 14°17'56.23"N, Lon 74°25'27.04"E to link at highway at Gersoppa Lat 14°14'14.73"N, Lon 74°39'6.15"E
11	UDAYAVARA RIVER	16 km length of the river from Arabian Sea Mouth at Malpe Lat 13°20'57.24"N, Lon 74°41'28.22"E to Bridge near Manipura Lat 13°17'32.70"N, Lon 74°46'25.56"E
	CLUSTER-7	
1	CHAPORA RIVER	33 kms length of the river from Bridge at State highway # 124 (1Km from Maneri village) Lat 15°42'47.31"N, Long 73°57'23.38"E to Confluence of Chapora river with Arabian Sea at Morjim Lat 15°36'33.27"N, Long 73°44'0.93"E
2	MAPUSA / MOIDE RIVER	27 kms length of the river (including Moide river) from bridge on NH17 at Mapusa Lat 15°35'20.79"N, Long 73°49'17.20"E to confluence point of Mapuca & Mandovi rivers at Porvorim Lat 15°30'20.01"N, Long 73°50'42.09"E
3	SAL RIVER	14 kms length of the river from Orlim Deusa Bridge at Lat 15°13'11.41"N, Long 73°57'29.77"E to confluence with Arabian Sea at Mobor Lat 15° 8'31.93"N, Long 73°56'59.89"E
4	AMBA RIVER	45 kms length of the river from Arabian Sea, Dharamtaar creek near village Revas at Lat 18°50'15.14"N, Long 72°56'31.22"E to a Bridge near Nagothane ST Stand at Lat 18°32'19.82"N, Long 73° 8'0.29"E
5	DABHOL CREEK/VASHISHTI RIVER	45 km length of the river from Arabian Sea at Dabhol Lat 17°34'51.33"N, Lon 73° 9'17.83"E to bridge at Pedhe Lat 17°32'39.45"N, Lon 73°30'35.56"E
6	KALYAN-THANE-MUMBAI WATERWAY, VASAI CREEK AND ULHAS RIVER	145 km length of the waterway from Arabian Sea at Navi Mumbai Lat 18°55'49.78"N, Lon 72°53'21.67"E via Ulhas river to bridge on State Highway No.76 near Malegaon T. Waredi Lat 19° 2'38.20"N, Lon 73°19'53.79"E Bridge on Kalyan-Badlapur road near Kalyan railway yard at Kalyan Lat 19°14'6.39"N, Lon 73° 8'49.13"E to Kalyan Lat 19°15'35.03"N, Lon 73° 9'27.77"E Vasai Creek from Lat 19°18'53.50"N to Lon 72°47'30.18"E to Kasheli at Lat 19°13'22.84"N, Lon 73° 0'21.44"E
7	RAJPURI CREEK	31 km length of the river from Arabian Sea at Rajpuri Lat 18°18'3.15"N, Lon 72°56'42.94"E to Mhasala at Lat 18° 8'15.37"N, Lon 73° 6'45.35"E
8	REVADANDA CREEK / KUNDALIKA RIVER	31 km length of the river from Arabian Sea at Revadanda Lat 18°32'19.85"N, Lon 72°55'32.80"E to bridge on Roha-Astami Road near Roha Nagar Lat 18°26'31.50"N, Lon 73° 7'10.74"E
9	SAVITRI RIVER (BANKOT CREEK)	44 kms length of the river from Bridge near Sape at Lat 18° 5'54.11"N, Long 73°20'8.81"E to Arabian Sea at Harihareswar Lat 17°58'47.10"N, Long 73° 2'15.01"E
10	SHASTRI RIVER / JAIGAD CREEK	52 kms length of the river from Sangmeshwar at Lat 17°11'15.83"N, Long 73°33'2.57"E to confluence with Arabian Sea at Jaigad Lat 17°19'11.92"N, Long 73°12'39.30"E

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
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-2			
1	Dhansiri / Chathe	Assam	110	150	150
2	Lohit	Assam & Arunachal Pradesh	100	200	1000
3	Subansiri	Assam	111	200	1000
4	Tizu and Zungki	Nagaland	42	50	100
			363		
		CLUSTER-3			
1	BIDYA RIVER	West Bengal	55	200	1500
2	CHHOTA KALAGACHI (CHHOTO KALERGACHI) RIVER	West Bengal	15	200	500
3	DVC CANAL	West Bengal	130	100	100
4	GOMAR RIVER	West Bengal	7	200	400
5	HARIBHANGA RIVER	West Bengal	16	200	2000
6	HOGLA (HOGAL)-PATHANKHALI RIVER	West Bengal	37	200	300
7	KALINDI (KALANDI) RIVER	West Bengal	8	200	500
8	KATAKHALI RIVER	West Bengal	23	200	200
9	MATLA RIVER	West Bengal	98	200	2000
10	MURI GANGA (BARATALA) RIVER	West Bengal	27	200	3000
11	RAIMANGAL RIVER	West Bengal	52	200	800
12	SAHIBKHALI (SAHEBKHALI) RIVER	West Bengal	14	200	300
13	SAPTAMUKHI RIVER	West Bengal	37	200	700
14	THAKURRAN RIVER	West Bengal	64	200	1000
			583		
		CLUSTER-4			
1	Baitarni	Odisha	49	100	100
2	Birupa / Badi Genguti / Brahmani	Odisha	156	100	200
3	Budha Balanga	Odisha	56	100	100
4	Mahanadi	Odisha	425	200	500
			686		

CLUSTER-5					
1	Pennar	Andhra Pradesh	29	100	400
2	Kaveri / Kollidam	Tamil Nadu	364	200	400
3	Palar	Tamil Nadu	141	200	500
4	Pazhyar	Tamil Nadu	20	50	100
5	PONNIYAR	Tamil Nadu	125	200	300
6	Tamaraparani	Tamil Nadu	64	150	300
			743		
CLUSTER-6					
1	West Coast Canal	Kerala	160	50	100
2	ALAPPUZHA- CHANGANASSERY CANAL	Kerala	28	50	100
3	ALAPPUZHA- KOTTAYAM – ATHIRAMPUZHA CANAL	Kerala	38	50	100
4	KOTTAYAM-VAIKOM CANAL	Kerala	28	50	100
5	GURUPUR RIVER	Karnataka	10	100	400
6	KABINI RIVER	Karnataka	23	200	500
7	Kali	Karnataka	54	150	450
8	Netravathi	Karnataka	78	100	300
9	PANCHAGANGAVALI (PANCHAGANGOLI) RIVER	Karnataka	23	150	600
10	SHARAVATI RIVER	Karnataka	29	150	400
11	UDAYAVARA RIVER	Karnataka	16	100	250
			487		
CLUSTER-7					
1	CHAPORA RIVER	Goa	33	100	250
2	MAPUSA / MOIDE RIVER	Goa	27	50	100
3	SAL RIVER	Goa	14	50	100
4	AMBA RIVER	Maharashtra	45	150	300
5	DABHOL CREEK/VASHISHTI RIVER	Maharashtra	45	150	400
6	KALYAN-THANE-MUMBAI WATERWAY, VASAI CREEK AND ULHAS RIVER	Maharashtra	145	150	350
7	RAJPURI CREEK	Maharashtra	31	150	1000
8	REVADANDA CREEK / KUNDALIKA RIVER	Maharashtra	31	150	400
9	SAVITRI RIVER (BANKOT CREEK)	Maharashtra	46	150	400
10	SHASTRI RIVER / JAIGAD CREEK	Maharashtra	52	150	300
			469		
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.
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.
b. Permanent structures located within this corridor are also required to be indicated on the report & charts.
c. All prominent shore features (locks, bridges, aqueducts, survey pillars if available etc) and 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 <u>SURVEY CHART PREPARATION</u>

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. (if available) are also to be included in the report. Brief write up based on visual observation, photographs and information from State Irrigation Deptt. and local sources.
k. The chart shall also be suitably updated with prominent land features from the Topo-sheets/site. Available Survey of India (SOI) Topographic sheet will be shared with successful Consultant on receipt of Undertaking. Satellite imageries are not available with IWAI for the designated area. Route map and survey plan will be provided by IWAI to the successful Consultant.
l. All raw 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.

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:

			Cluster -2	Cluster -3	Cluster -4	Cluster -5	Cluster -6	Cluster -7	Cluster -8
	Sl. No	**Activity**	**Time in weeks****						
Stage-I	a)	Mobilization of the Team and submission of Inception Report (2 copies)	6	9	10	11	8	8	15
	b)	Submission of Draft Feasibility Report (3 copies)	9	12	13	14	11	11	18
	c)	Comments from IWAI	11	14	15	16	13	13	20
	d)	Presentation and Submission of Final Pre-feasibility Report (3 copies)	13	16	17	18	15	15	22
Stage-II	a)	Acceptance of Stage-I report and go ahead for Stage-II by IWAI	15	18	19	20	17	17	24
	b)	Submission of Hydrographic Survey Charts and report (3 copies)	23	30	29	31	24	26	38
	c)	Submission of Draft Detailed Project Report (3 copies)	31	38	37	39	32	34	46
	d)	Receipt of comments of IWAI on Draft DPR.	33	40	39	41	34	36	48
	e)	Submission of Final Detailed Project Report (10 copies) after incorporating final comments of IWAI.	39	46	45	47	40	42	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 for all the clusters 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:** • 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

Sl. No	Key Professionals	Qualification Criteria
		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.
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.

NOTE 1:- 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:- Since two clusters only will be awarded to one bidder, the same CVs cannot be proposed for at least two clusters. The same CV's can be proposed if the bidder is bidding for more than two Clusters.

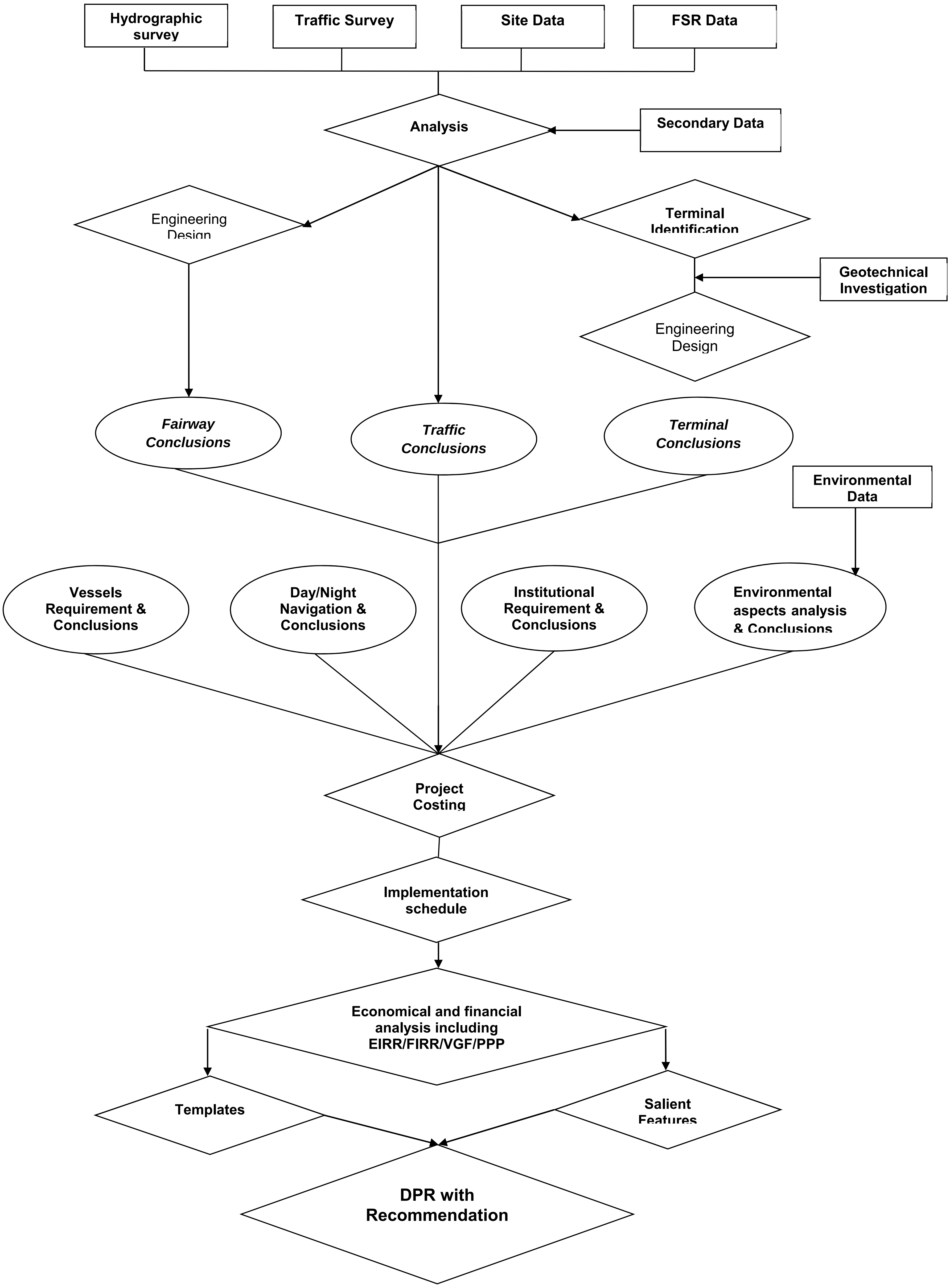
Note 5:- Role and responsibilities of the Key Professional shall be as per the requirement of the project and Terms of Reference of the tender document and the same has to be access by prospective bidder.

ANNEXURE 1.2 – COMPLIANCE ON TOR OF THE AGREEMENT

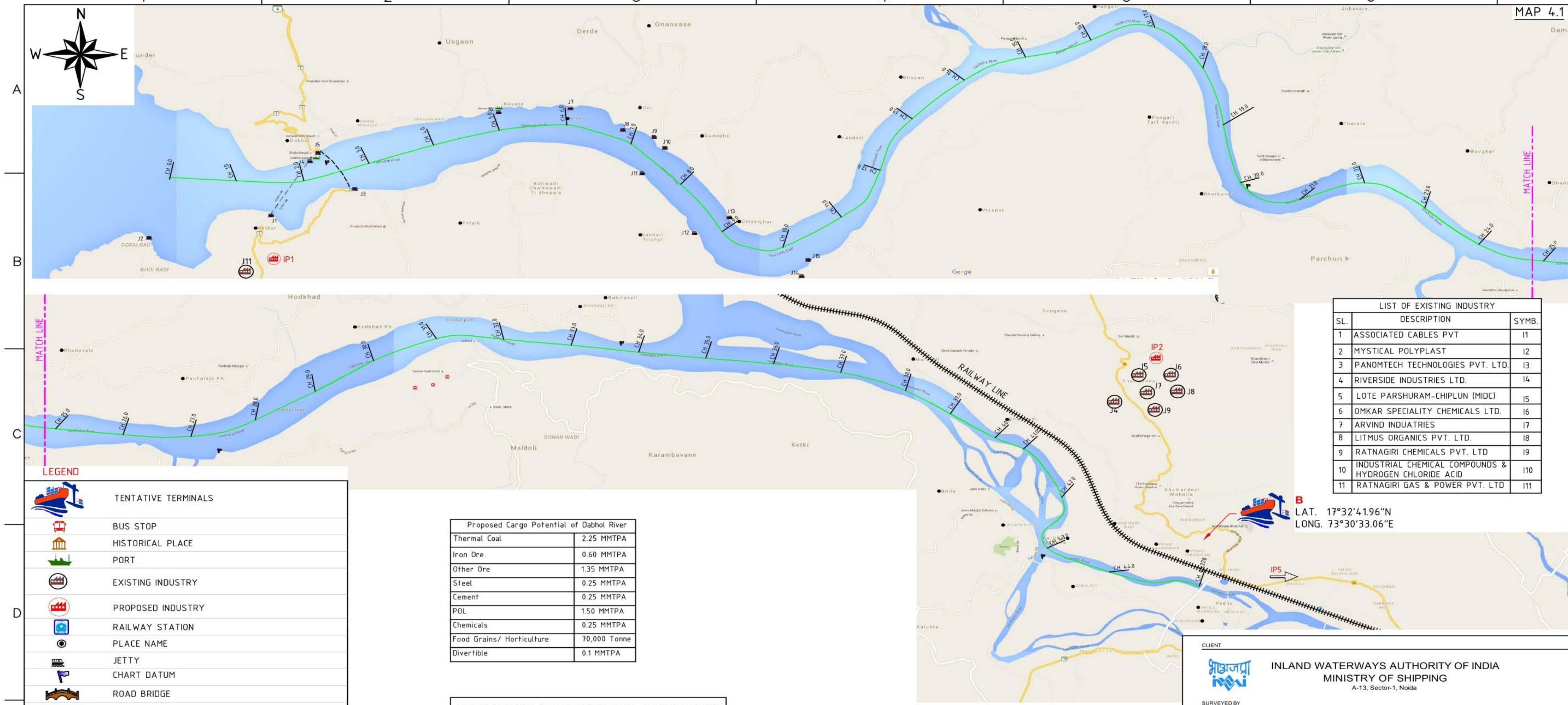
COMPLIANCE ON THE TERMS OF REFERENCE
DABHOL CREEK / VASHISHTI RIVER (NW 28)

Brief of ToR	Compliance
1.0 OBJECTIVE OF THE STUDY: The study would consist of 2 stages: Stage-1 & Stage-2	
1.1 STAGE-1 1.1.1 Reconnaissance Survey – i) to xii) 1.1.2 Collection and Review of Available Data 1.1.3 Feasibility Report 1. Introductory considerations: 2. Analysis of present state of affairs: 3. Market Analysis: 4. Reconnaissance Survey:	Stage I has been completed and based on the same, Stage II Work Order was provided by IWAI.
1.2 STAGE-2 1.2.1 HYDROGRAPHIC SURVEY & HYDROMORPHOLOGICAL SURVEY (i) The detailed hydrographic survey is to be carried out in WGS‟84 datum. (ii) The horizontal control is to be 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	Detailed Hydrographic Survey was completed and the data compiled / analysed (including the Charts) have been submitted under Volume III of the report. Further, the analysed data have been taken into Volume I and Volume II of the Report appropriately.
1.2.1.1 <u>BENCH MARK PILLARS – a)</u>	-do-
1.2.1.2 <u>WATER LEVEL GAUGES i) & ii)</u>	-do-
1.2.1.3 <u>BATHYMETRIC AND TOPOGRAPHICAL SURVEY – a) to k)</u>	-do-
1.2.1.4 <u>CURRENT VELOCITY AND DISCHARGE MEASUREMENT – a) to e)</u>	-do-
1.2.1.5 <u>WATER AND BOTTOM SAMPLES – a) – i) to vi)</u>	-do-
<u>COLLECTION OF TOPOGRAPHICAL FEATURES – a) to j)</u>	-do-
1.2.1.6 <u>SURVEY CHART PREPARATION – a) to n)</u>	-do-
1.2.2 TRAFFIC SURVEY & TECHNO ECONOMIC FEASIBILITY	Submitted in Chapter 4 and in the inter related chapters
1.2.3 DETAILED PROJECT REPORT The scope of works is as follows: in paras a) to k)	Submitted the Volume I of the DPR.
2.0 PERIOD OF SERVICES	
2.1 TIME SCHEDULE/SUBMISSION OF REPORTS:	Delay observed, as narrated from time to time.
NOTE: - The consultants are required to submit the following outputs in Stage-II i) Traffic Template: at Annex-IV ii) Project Costing Template: at Annex-V iii) Financial Evaluation Template: at Annex-VI iv) Economic Evaluation Template: at Annex-VII v) Environmental & Social Screening Template: at Annex-VIII	Submitted at Chapter 15 – Templates in the DPR Volume I.

ANNEXURE 1.3 – SEQUENTIAL APPROACH TO THE PROJECT IN SCHEMATIC FORM



ANNEXURE 4.1 – LAYOUT MAP SHOWING EXISTING JETTIES AND INDUSTRIES IN THE VICINITY OF DABHOL CREEK/VASHISHTI RIVER



LEGEND

- TENTATIVE TERMINALS
- BUS STOP
- HISTORICAL PLACE
- PORT
- EXISTING INDUSTRY
- PROPOSED INDUSTRY
- RAILWAY STATION
- PLACE NAME
- JETTY
- CHART DATUM
- ROAD BRIDGE
- NATIONAL HIGHWAY (Hwy)
- ROAD
- NALA/SUB CREEK/SMALL RIVER
- FERRY LINE
- ROUTE PROVIDED BY IWAI
- SURVEY (VESSEL TRACK)
- DEEPEST SURVEYED WATER DEPTH (THALWEG)
- RAILWAY LINE

B
LAT. 17°32'41.96"N
LONG. 73°30'33.06"E

Existing Cargo Potential of Dabhol River							
	Overseas (in MTPA)			Coastal (in MTPA)			
COMMODITY	Unloaded	Loaded	Total	Unloaded	Loaded	Total	Grand Total
LNG	3,215,292		3,215,292	---	---	---	3,215,292

Proposed Cargo Potential of Dabhol River	
Thermal Coal	2.25 MMTPA
Iron Ore	0.60 MMTPA
Other Ore	1.35 MMTPA
Steel	0.25 MMTPA
Cement	0.25 MMTPA
POL	1.50 MMTPA
Chemicals	0.25 MMTPA
Food Grains/ Horticulture	70,000 Tonne
Divertible	0.1 MMTPA

LIST OF PROPOSED INDUSTRIES/INDUSTRIAL AREAS EXPANSIONS

SL.	DESCRIPTION	SYMB.
1	DABHOL-CHIPLUN (MIDC)	IP1
2	LOTE PARSHURAM-CHIPLUN (MIDC)	IP2
3	GANE KHADPOLI-CHIPLUN (MIDC) (5KM FROM CHIPLUN, VIA UMBRAJ CHIPLUN)	IP3
4	POPHALI-CHIPLUN (MIDC) (20KM FROM CHIPLUN, VIA KHARAD-CHIPLUN ROAD)	IP4
5	SATARA (127KM FROM CHIPLUN, VIA UMBRAJ CHIPLUN ROAD)	IP5

LIST OF EXISTING INDUSTRY

SL.	DESCRIPTION	SYMB.
1	ASSOCIATED CABLES PVT	I1
2	MYSTICAL POLYPLAST	I2
3	PANOMTECH TECHNOLOGIES PVT. LTD.	I3
4	RIVERSIDE INDUSTRIES LTD.	I4
5	LOTE PARSHURAM-CHIPLUN (MIDC)	I5
6	OMKAR SPECIALITY CHEMICALS LTD.	I6
7	ARVIND INDUATRIES	I7
8	LITMUS ORGANICS PVT. LTD.	I8
9	RATNAGIRI CHEMICALS PVT. LTD	I9
10	INDUSTRIAL CHEMICAL COMPOUNDS & HYDROGEN CHLORIDE ACID	I10
11	RATNAGIRI GAS & POWER PVT. LTD	I11

LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
1	DABHOL CREEK/VELDUR JETTY	J1
2	DABHOL CREEK/ANJANVEL JETTY	J2
3	DABHOL CREEK/DHOPAVE JETTY	J3
4	DABHOL CREEK/DABHOL T TYPE JETTY	J4
5	DABHOL CREEK/DABHOL JETTY	J5
6	DABHOL CREEK/FADBUNDER	J6
7	DABHOL CREEK/BHATTI PACHIMVADI	J7
8	DABHOL CREEK/DARDE JETTY	J8
9	DABHOL CREEK/GUDGE JETTY	J9
10	DABHOL CREEK/GUDGENEW JETTY	J10
11	DABHOL CREEK/SHAKHRI TRISHUL TELIVADI	J11
12	DABHOL CREEK/UMBARGHAR	J12
13	DABHOL CREEK/UMBARGHAR OLD	J13
14	DABHOL CREEK/PEVE JETTY	J14
15	DABHOL CREEK/PEVE RABH BHOIVADI JETTY	J15

PROPOSED WATERWAY LENGTH 45.228Km

SCALE 0 1.20 3KM

CLIENT

INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING
A-13, Sector-1, Noida

SURVEYED BY

Project

CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER -7 OF NATIONAL WATERWAYS

Subject

LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES IN VICINITY OF DABHOL CREEK/VASHISHTI RIVER (MAP 4.1)

CONSULTANT

TRACTEBEL ENGIE

TRACTEBEL ENGINEERING PVT. LTD.
Intec House, 37
Institutional Area, Sector 44
122002 Gurgaon-INDIA

Status Of Drawing: ISSUED FOR DPR
Scale: 1:1000 Size: A1
DRG N°: P.010257 Rev.: A Sheet: 1 Of 1

ANNEXURE 4.2 – SUMMARY OF INTERVIEWS

Company	Name of the Person	Designation
GHARDA Chemicals	SK Gandhi	General Manager
Dow-Agro Sciences	Chandrakant Dhuri	Company Manager
Rallis India	Vivek Thakre	Import Export
Indian Oxalate	MD Yadav	Manager
S I Group India	Vishal Anand Dange	Director
Pentoky Organy	-	-
Excel Industries	S Balaji	Logistics
	Abhay Dandekar	Raw Materials
Omkar Specialty Chemicals / Urdhwa Chemicals	-	Export Manager
Arvind Industries	Vishwas Joshi	Director
Litmus Organics	Shubhang Shah	Director
Ratnagiri Chemicals	-	Company Manager
Ratnagiri Gas & Power	-	Fuel Manager
CETP / Sahastra Chemicals	Jadhav D A	Managing Director

Name of Company: Gharda Chemicals

Contact Person: Mr. S.K. Gandhi

Designation: General Manager

Gharda Chemicals deal with dyestuffs, pesticides, veterinary drugs and polymers. It includes agro chemical products as well as polymers.

Mode of Transport: It transports via roadways between JNPT & Lote. It is around 230 Km away and will take cargo to reach destination in 6-7 hrs (excluding custom clearance). 2000 Tonnes of raw materials are transported every month from JNPT I.E 24000 Tonnes annually.

Gharda Chemicals have 4 MW captive cogeneration plant at Lote. They use very little coal for generation purpose.

Name of Company: Dow Agro Sciences

Contact Person: Mr. Chadrakant Dhuri

Designation: Company Manager

Dow Agro Sciences deal with fungicides, insecticides, seeds & traits to prevent plants from damage. For example Beam for protection of rice from blast disease. It is situated at 230 Km from Mumbai.

Mode of Transport: Finished Products are transported to JNPT via roadways. It is exported to different countries from JNPT. Raw materials are mainly obtained from local dealers.

Volume of finished product is around 5 Containers per month i.e. 1200 tonnes annually. It takes around 6-7 hrs to transport finished goods from Lote to JNPT.

They are not ready to use waterway as their volume is very less.

Name of Company: Rallis India Ltd.

Contact Person: Mr. Vivek Thakre

Designation: Import Export Manager

Rallis India Ltd. is one of leading Agrochemical Industry in India. They are into manufacturing domestic crop protection chemicals. It is situated at Lote, Maharashtra.

Mode of Transport: Cargo is transported between JNPT & Lote via roadways. It is 220 Km far from Mumbai. It takes around 7 hrs to reach JNPT to Lote.

Raw materials are imported from China. Finished Products are exported via JNPT to different countries like USA, Japan Bangladesh & Mexico.

Name of Company: Indian Oxalate Ltd

Contact Person: M D Yadav

Designation: Company Manager

Indian Oxalate Ltd. manufactures Diethyl Oxalate and Oxalic Acid. Diethyl Oxalate is manufactured by esterification of Oxalic Acid and Alcohol. Oxalic Acid is manufactured by oxidation of sugar with help of Nitric Acid in presence of sulphuric Acid using Vanadium Pentoxide as catalyst. Therefore sugar is used as main raw material for the plant.

Mode of Transport: Raw material is transported via roadways from Krishna Sugar Mills as well as JNPT. It is 220Km away from Mumbai. 300 Tonnes per month of Sugar as a raw material is transported from Krishna Sugar Factory to Plant via JNPT to Mahad. It will take maximum 24 hrs to reach the plant including Custom clearance. Finished Product is exported to Iraq and some other countries.

Name of Company: S I Group of Industries

Contact Person: Mr. Vishal Anand Dange

Designation: Director

S I Group of Industries manufactures rubber resins, antioxidants, fuels and lubricants, plastic additives, industrial resins, health & wellness, adhesive resins, surfactants, engineering plastics and pharma & specialty.

Mode of Transport: It uses roadways transport for cargo movement. It is 220 Km away from Mumbai. The production capacity of the plant is around 4245 Tonnes. Volume of cargo is very small in quantity. They are having some expansion plan for manufacturing of resins at Lote plants.

Name of Company: Pentoky Organi

It has been closed 8 months back due to some financial issues.

Name of Company: Excel Industries

Contact Person: Mr. Abhay Dandekar

Designation: Raw Materials Manager

Excel Industries at Lote manufactures a wide range of specialty and performance chemicals. It is leading producer of Organo phosphonates, which are used as chelating agents in water treatment, soaps and detergents, textile auxiliaries.

Mode of Transport: Raw materials are transported via Roadways from JNPT to Lote. Volume of Raw Materials used as 2 Containers per month i.e. 24 containers annually. Therefore, total volume transported as 420 Tonnes annually. The cost of transport is around Re 1/kg. At Present, there has been direct delivery from JNPT Port within 24 hrs including Custom Clearance. They are demanding Single Point Clearance.

Name of Company: Omkar Specialty Chemicals / Urdhwa Chemicals

Designation: Export Manager

Omkar Specialty Chemicals / Urdhwa Chemicals both are situated at Lote, Maharashtra. This is unit no 5 with the name of Omkar Specialty Chemicals, MIDC, Lote Parshuram. There is unit no 6 with the name of Urdhwa Chemicals Co. Pvt. Ltd. MIDC, Lote, Maharashtra. Cargo is exported to various other places from JNPT. The volume of cargo is very less.

Mode of Transportation: Roadways from Plant to JNPT.

Name of Company: Arvind Industries

Contact Person: Mr. Vishwas Joshi

Designation: Director

Arvind Industries mainly deals with metal works. This is very small industry with 12 tonne of raw material annually. There is no scope of waterways transportation as volume is very less.

Name of Company: Litmus Organics

Contact Person: Mr. Shubhang Shah

Designation: Director

Litmus is multipurpose chemical manufacturing facility, capable of handling various solid & liquid operations. It is 225 km from Mumbai city at MIDC Lote Parshuram, INDIA.

Mode of Transport: Monthly 160 Tonnes of raw material is transported through JNPT via road route to Lote. The cost of transportation is around 2 INR per Kg. Terminal near Dabhol / Chiplun along with one time clearance from Custom will be very beneficial for Industries.

There is no scope of waterways transportation as annual volume is very less.

Name of Company: Ratnagiri Chemicals

Designation: Company Manager

Ratnagiri Chemical deals with manufacture of Anti-oxidant additives for Food, and Petrochemical industries.

Mode of Transport: Ratnagiri Chemicals require very small amount of raw materials. Therefore cargo movement is very less.

Hence, there is no scope of waterways as volume of cargo is very less.

Name of Company: Ratnagiri Gas & Power Plant

Designation: Fuel Manager

RGPPL doesn't use Dabhol creek as raw materials come via open sea only. It is 300 Km away from Mumbai. Associated gas pipeline is Dahej- Panvel-Dabhol pipeline. There is very less requirement of coal too for Power Generation.

Name of Company: CETP / Sahastra Chemicals

Contact Person: Mr. Jadhav D.A

Designation: Director

Sahastra Chemicals has 2 Production Units of manufacturing streams in each unit, with a Research & Development (R&D) Laboratory, Quality Control (QC) Laboratory, Raw Material Stores, Finished Goods Stores, Utility Section, Liquid Material Storage and Effluent Treatment Plant (ETP).

Mode of Transport: Raw materials (Liquid) are transported from Taloja / Khopoli to Lote via roadways.

ANNEXURE 5.1– CALCULATION OF SAFE BEARING CAPACITY

Calculation of Safe Bearing capacity as per IS 6403 - 1981

Width of Footing/Raft (B)	=	1.50	m	
Length of Footing/Raft (L)	=	1.50	m	
Cohesion (C)	=	10.4	KN/m^3	For BD-1
Angle of Internal Friction (ϕ)	=	21.0	degree	For BD-1
Bulk Unit weight (γ)	=	18.7	KN/m^3	For BD-1
Unit weight of water (γ_w)	=	10	KN/m^3	
Submerged Unit Weight	=	8.7	KN/m^3	
Type of Failure	=	**Local Shear Failure**		
Depth of foundation (Df)	=	3.0	m	
Factor of Safety	=	2.5		
Shape of Footing / Raft	=	Rectangle		
L/B	=	1		
Shape factor (sc)	=	1.2	(Table 2 of IS 6403)	
Shape factor (sq)	=	1.2	(Table 2 of IS 6403)	
Shape factor (sγ)	=	0.6	(Table 2 of IS 6403)	
Nϕ	=	2.117	(cl. 3 of IS 6403)	
Depth factor (dc)	=	1.582	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dq)	=	1.291	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dγ)	=	1.291	(cl. 5.1.2.2 of IS 6403)	
Inclination of load to vertical (α)	=	0	degree	
Inclination factors (ic)	=	1	(cl. 5.1.2.3 of IS 6403)	
Inclination factors (iq)	=	1	(cl. 5.1.2.3 of IS 6403)	
Inclination factors (iγ)	=	1	(cl. 5.1.2.3 of IS 6403)	

From Table 1 of IS 6403

ϕ' for local shear failure ($\Phi'=\Phi*2/3$)	=	14.354	degree
Bearing capacity factor (Nc')	=	10.65	For Punching Shear Failure
Bearing capacity factor (Nq')	=	3.74	For Punching Shear Failure
Bearing capacity factor (Nγ')	=	2.48	For Punching Shear Failure

q = Effective surcharge at the base level of foundation = γ*Df

qa = Net pressure for a specified settlement of 50 mm

R = Relative density of soil

W' = Correction factor for Water Table = 0.50 (cl. 5.1.2.4 of IS 6403)

Qu' (Local shear failure) = 1/F(2/3*c* Nc' *sc*dc*ic + γ*Df*(Nq' -1) *sq*dq*iq + 0.5*γ*B*Nγ' *sγ*dγ*iγ*W')

106.00 KN/m^2

Load at 50 mm Settlement = 149.00 kN/m^2 (As per Calcula

Safe Bearing Capacity = 106.00 kN/m^2

Calculation of Settlement as per IS 8009 (Part I) - 1976

Proposed Depth of foundation =	3.0	m
Total depth of Borehole =	13.5	m
Depth of bed rock =	8.8	m
Proposed Length of Footing (L) =	1.5	m
Proposed Width of Footing (B) =	1.5	m
Depth of effective zone = 1.5B =	2.25	m
Bottom level of Influence zone =	5.25	m
Effective thickness of Layer-1 for Settlement =	0.50	m
Effective thickness of Layer-2 for Settlement =	1.75	m
Effective thickness of Layer-3 for Settlement =	0.75	m

Available Soil properties at different depths are given below;

	Layer-1	Layer-2		Layer-3	
Start Level (EL) of Layer =	**0**	**3.5**	m	**4.5**	m
End Level (EL) of Layer =	**3.5**	**4.5**	m	**7.6**	m
Average Unit Weight =	8.70	8.80	kN/m^3	8.80	kN/m^3
Cohesion (C) =	10.4	4.4	kN/m^2	3.2	kN/m^2
Angle of Internal Friction (ϕ) =	21	31	degree	32	degree
Compression Index (Cc) =	0.3	0		0	
Initial void Ratio (e_0) =	0.8	0		0	

Three Layers

Initial pressure at the center of Layer-1 Below Foundation Level (σ_0) =	28.28	kN/m^2
Initial pressure at the center of Layer-2 below Foundation Level (σ_0) =	38.15	kN/m^2
Initial pressure at the center of Layer-3 below Foundation Level (σ_0) =	42.55	kN/m^2
Assumed Pressure increment at the base of footing =	**106**	kN/m^2
Pattern of pressure distribution below based of footing =	2	V:1H
=	0.5	H:1V
Total Load at the base of the footing=	238.5	kN

Calculation of settlement for Layer-1

Length of load dispersion at top of Layer-1 (L) =	1.5	m
Width of load dispersion at top of Layer-1 (W) =	1.5	m
Pressure increment at top of Layer-1 =	**106.00**	**kN/m^2**
Length of load dispersion at middle of Layer-1 (L) =	1.750	m
Width of load dispersion at middle of Layer-1 (W) =	1.750	m
Pressure increment at middle of Layer-1 =	**77.88**	**kN/m^2**
Length of load dispersion at top of Layer-1 (L) =	2.00	m
Width of load dispersion at top of Layer-1 (W) =	2.00	m
Pressure increment at top of Layer-1 =	**59.63**	**kN/m^2**
Average pressure increment for Layer-1 (as per Simpson's rule) =	**79.52**	**kN/m^2**
Total Settlemt of Layer-1 (Sf) =	0.0484	m
	48.43	**mm**

Calculation of settlement for Layer-2

Length of load dispersion at top of Layer-2 (L) =	2.00	m
Width of load dispersion at top of Layer-2 (W) =	2.00	m

Pressure increment at top of Layer-2 =	**59.63**	**kN/m^2**
Length of load dispersion at middle of Layer-2 (L) =	2.875	m
Width of load dispersion at middle of Layer-2 (W) =	2.875	m
Pressure increment at middle of Layer-2 =	**28.85**	**kN/m^2**
Length of load dispersion at top of Layer-2 (L) =	3.75	m
Width of load dispersion at top of Layer-2 (W) =	3.75	m
Pressure increment at top of Layer-2 =	**16.96**	**kN/m^2**
Average pressure increment for Layer-2 (as per Simpson's rule) =	**32.00**	**kN/m^2**
Total Settlemt of Layer-2 (Sf) =	0.0000	m
	0.00	**mm**

Calculation of settlement for Layer-3

Length of load dispersion at top of Layer-3 (L) =	3.75	m
Width of load dispersion at top of Layer-3 (W) =	3.75	m
Pressure increment at top of Layer-3 =	**3.44**	**kN/m^2**
Length of load dispersion at middle of Layer-3 (L) =	4.13	m
Width of load dispersion at middle of Layer-3 (W) =	4.13	m
Pressure increment at middle of Layer-3 =	**2.85**	**kN/m^2**
Length of load dispersion at top of Layer-3 (L) =	4.50	m
Width of load dispersion at top of Layer-3 (W) =	4.50	m
Pressure increment at top of Layer-3 =	**2.39**	**kN/m^2**
Average pressure increment for Layer-3 (as per Simpson's rule) =	**2.87**	**kN/m^2**
Total Settlemt of Layer-3 (Sf) =	0.0000	m
	0.00	**mm**

Calculation of Immediate Settlement

(Clause 9.2.3.2 of IS 8009 Part 1 - 1976)

The immediate settlement beneath the center or corner of the flexible loaded area is given by

Si = p*B*(1-μ^2)/E*I

p = Effective Pressure at foundation level =			26.05	kN/m^2
μ = Poisson's Ratio =			0.5	For Saturated clay
I = Influence Factor (L/B) =	1	=	1.12	For Flexible Loaded Area
(Table 2 of IS 8009 Part 1)			0.896	For rigid loaded area (0.82 for rigic
Young's Modulus of Elasticity (E) =			300	kg/cm^2 (Assumed)
			30000	kN/m^2
Width of footing (B) =			1.50	m
Immediate Settlement (Si) =			0.001094	m
			1.0941	mm
Total Settlement including immediate settlement =			**49.53**	**mm**
Value of D/sqrt(L*B) =			2.00	
Value of sqrt(L*B)/D =			0.50	
Correction Factor for Depth of foundation =			0.72	(Fig 12 of IS 8009_Part 1)
Correction Factor for Rigidity of Foundation =			1.00	(Clause 9.5.2 of IS 8009_Part 1) (Cc
Settlement after Corrections =			35.66	mm
Allowable Settlement for Isolated footing =			50	mm (Table -1 of IS 1904-1986)
Load at 50 mm Settlement =			**149.00**	**kN/m^2**

ANNEXURE 5.2– CALCULATION OF PILE CAPACITY

TRACTEBEL engie

Working Pile - Vertical Capacity in Soil (Both Friction and End Bearing as per IS 2911-1-2 : 2010) i.e. Bored Cast in situ Pile of BD-1

Dia of Pile (D) =	1.00	m		0 to 3.5 m	3.5 to 4.5 m	4.5 to 7.6 m
Assumed Ground Level =	0.0	m	Submerged Unit Weight (kN/m^3) =	8.70	8.8	8.8
Pile Cutoff Level (Assumed) =	0.0	m				
Maximum Scour Level	0	m	Overburden Pressure Correction Factor CN = 0.77*log10(2000/σ0)			
FoS (Bearing and Friction)	2.5		Ultimate Shaft Resistance = S ((Ks*Pdi*tanδ)*Asi + a*C(As))			
Effective Length of Pile = 15D =	15	m	Ki = Earth Pressure Coefficient	**Value**	**ϕ (Degree)**	**Factor**
Length of Pile below Scour level =	7.6	m		1	30	
Unit Weight of Reinforced Concrete	25	kN/m^3		1.5	40	0.05

Depth below NSL (m)	EL (m)	Friction angle (ϕ) as per Fig-1 (IS 6403)	Cohesion (C) kN/m^2	Wall Friction Angle δ (Degree)	Earth Pressure Coefficient (Ki)	Adhesion Factor (α)	Overburden Pressure at bottom of the	al Area of Pile Shaft (Asi) (m^2)	Ultimate Shaft Friction (kN)
0	0	0	0	0	0	0	0	0	0
1.5	-1.5	11	10.4	11	1.00	1.00	13.05	4.71	55.0
3	-3	11	10.4	11	1.00	1.00	26.1	4.71	66.9
3.5	-3.5	11	10.4	11	1.00	1.00	30.45	1.57	25.0
4.5	-4.5	31	4.4	31	1.05	1.00	39.25	3.14	82.9
5	-5	32	3.2	32	1.10	1.00	43.6	1.57	49.8
6	-6	32	3.2	32	1.10	1.00	52.3	3.14	113.6
7	-7	32	3.2	32	1.10	1.00	61	3.14	132.4
7.6	-7.6	32	3.2	32	1.10	1.00	66.22	1.88	88.4

Total Ultimate Skin Friction Resistance, Qst (kN) = 613.97
Total Allowable Skin Friction Resistance, Qst (kN) = 245.59

Note : Effective Length of Pile = 15D. Effective Overburden pressure will not increase after effective length of Pile.

End Bearing (T) = Ap*(Nc*Cp+0.5*D*γ*Nγ+Pd*Nq)

Cohesion (C) =	3.2	kN/m^2
Depth of Pile Tip (Pile Bottom) from Ground Level =	7.6	m
Effective Overburden Pressure at Pile Tip =	66.22	kN/m^2
Angle of Internal Friction at Pile Tip (ϕ) =	32	degree
Bearing Capacity Factor (Nc)	9	
Bearing Capacity Factor (Nq)	30.000	(As per IS 2911Part-1 Sec-2 -2010)
Bearing Capacity Factor (Nγ)	32.660	(As per IS 6403 -1981)

End Bearing (T) =	1694.47	kN
Allowable End Bearing Capacity of Pile =	**677.79**	**kN**
Self Weight of Pile =	149.23	kN
Net Bearing Capacity of Pile =	**774.0**	**kN**

Uplift Capacity of Pile

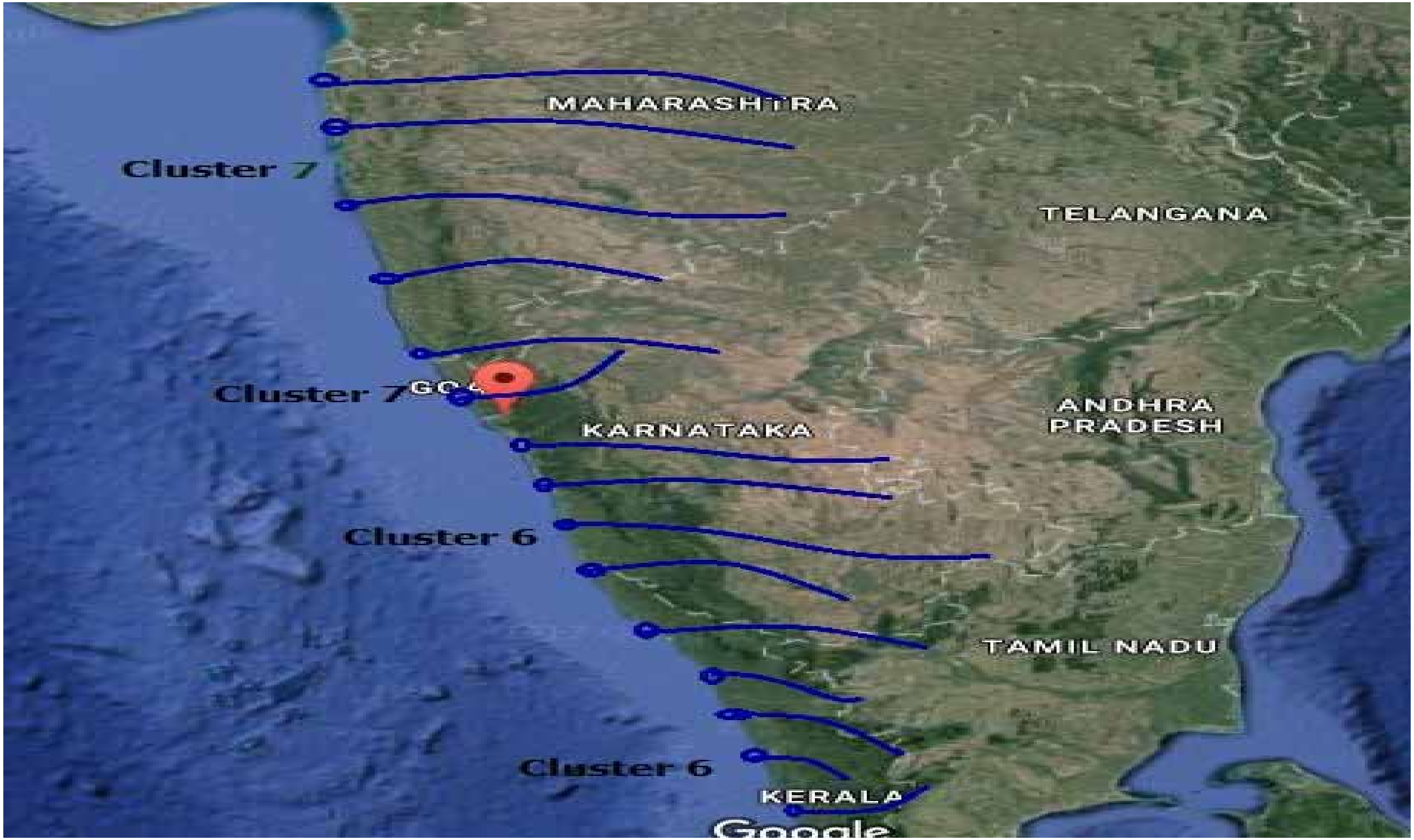
Safe Uplift Capacity of Pile = 2/3*Frictional Resistance = 163.73

Safe Uplift Capacity (Including Weight of Pile)= 313.0 kN

ANNEXURE 8.1– RIS / AIS

RIVER VESSEL TRACKING INFORMATION SYSTEM

- RIS Objective
- Proposed AIS Base Station
- RIS Key Technologies
  - (a) Vessel Tracking & Tracking
  - (b) Onshore Facilities
- AIS Base Station Set up
- AIS Station Tower Design
- AIS Station VHF Range
- AIS Onboard Device
- Onboard ECDIS Interface
- RIS Centre
- Communication Segments
- Bill of Material



MAHARASHTRA
Cluster 7
TELANGANA
Cluster 7
GOA
KARNATAKA
ANDHRA PRADESH
Cluster 6
TAMIL NADU
Cluster 6
KERALA
Google

Services for skippers

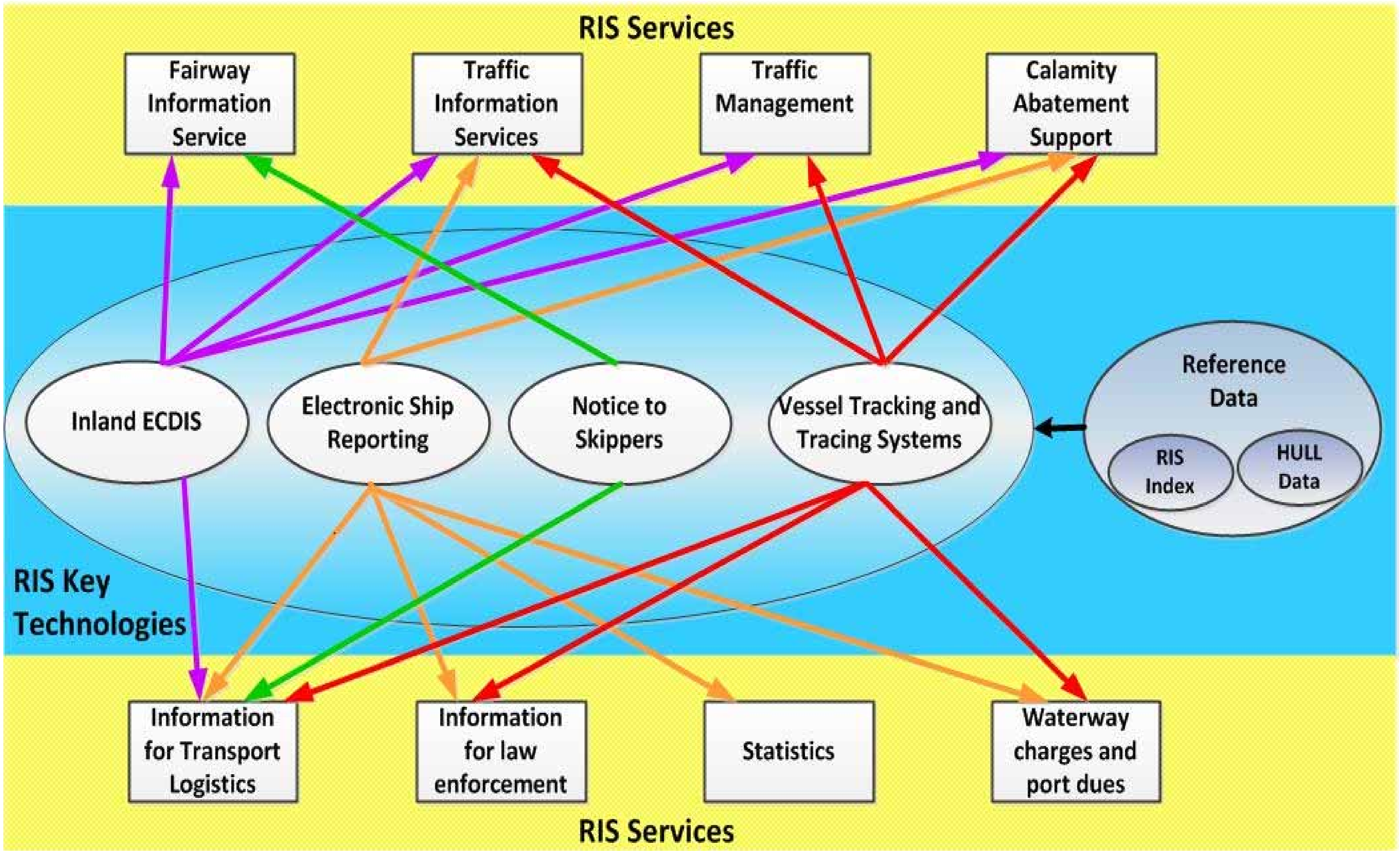
- Electronic Navigational Charts / Inland ECDIS
- Information on nautical conditions (fairway, obstructions, water level, etc.)
- Real time traffic information
- Electronic reporting of cargo and voyage
- Electronic pre-announcement at locks and harbours

Services for authorities

- Real time traffic monitoring (tracking and tracing)
- Analysis of accidents
- Exchange of safety related messages
- Electronic vessel register
- Electronic lock management
- Reception of electronic cargo reports
- Border surveillance

Services for logistic users

- Electronic cargo documents
- Data for fleet management
- Data for voyage planning
- Fairway conditions
- Water level forecast
- Availability of locks
- Calculations of arrival times

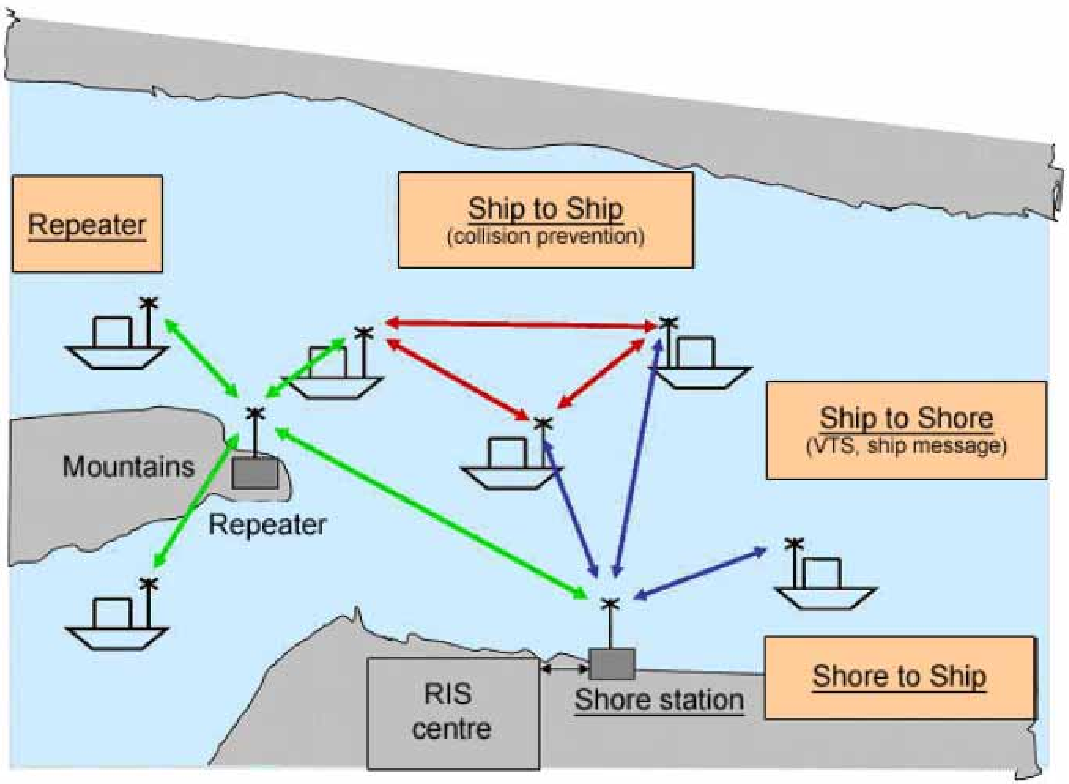

RIS Services
Fairway Information Service
Traffic Information Services
Traffic Management
Calamity Abatement Support
Inland ECDIS
Electronic Ship Reporting
Notice to Skippers
Vessel Tracking and Tracing Systems
Reference Data
RIS Index
HULL Data
RIS Key Technologies
Information for Transport Logistics
Information for law enforcement
Statistics
Waterway charges and port dues
RIS Services

The key technologies of RIS are

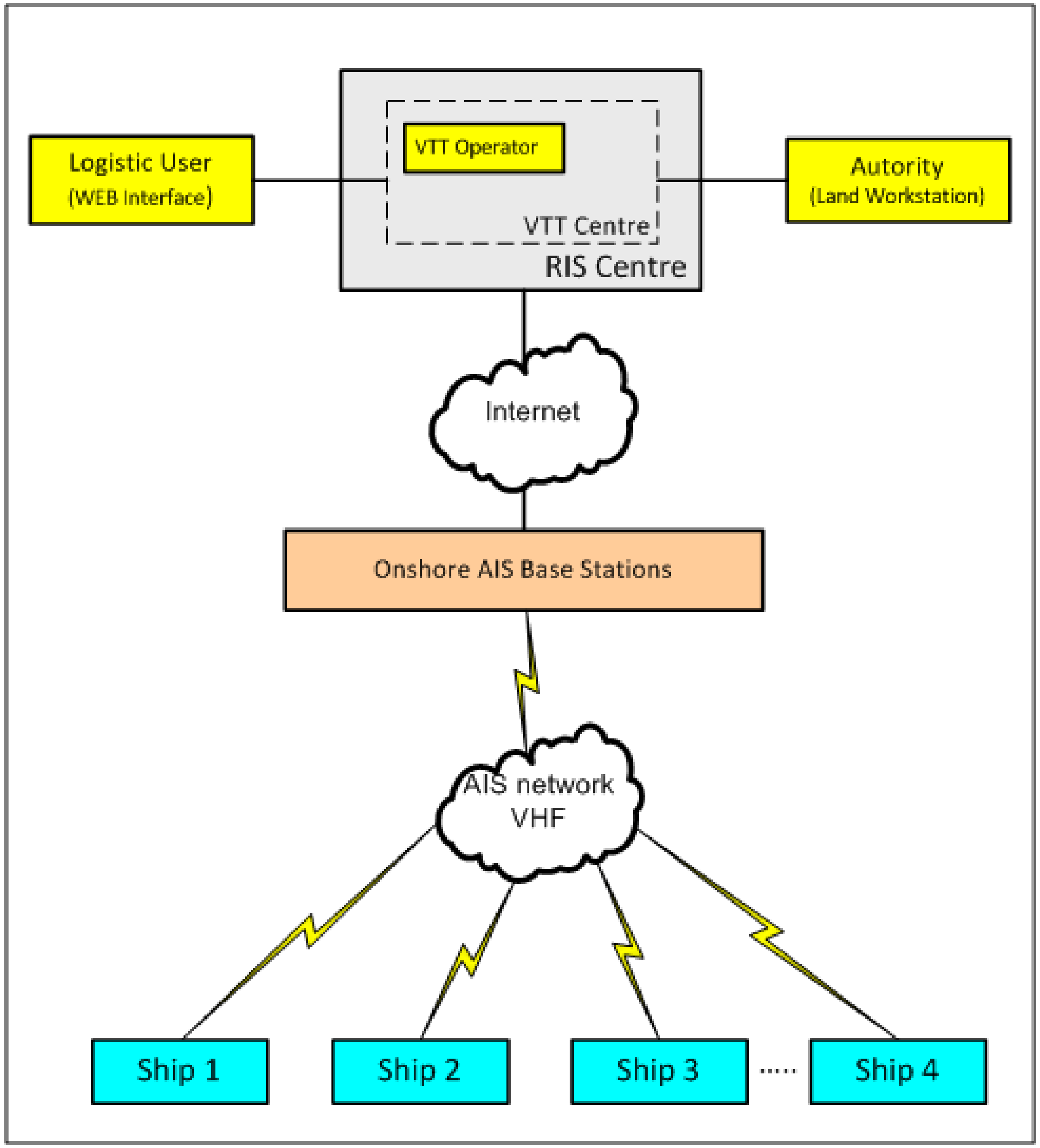
- VTT (Vessels Tracking and Tracing)
- ECDIS (Electronic Charts)
- NtS (Notice To Skippers)
- ERI (Electronic Reporting International)
- HULL Database
- LMS (Lock Management System)

Some technologies needs to be adapted to the local laws and operating procedures.

System to get a Strategic and Tactical Traffic Image using AIS technology with INLAND extension

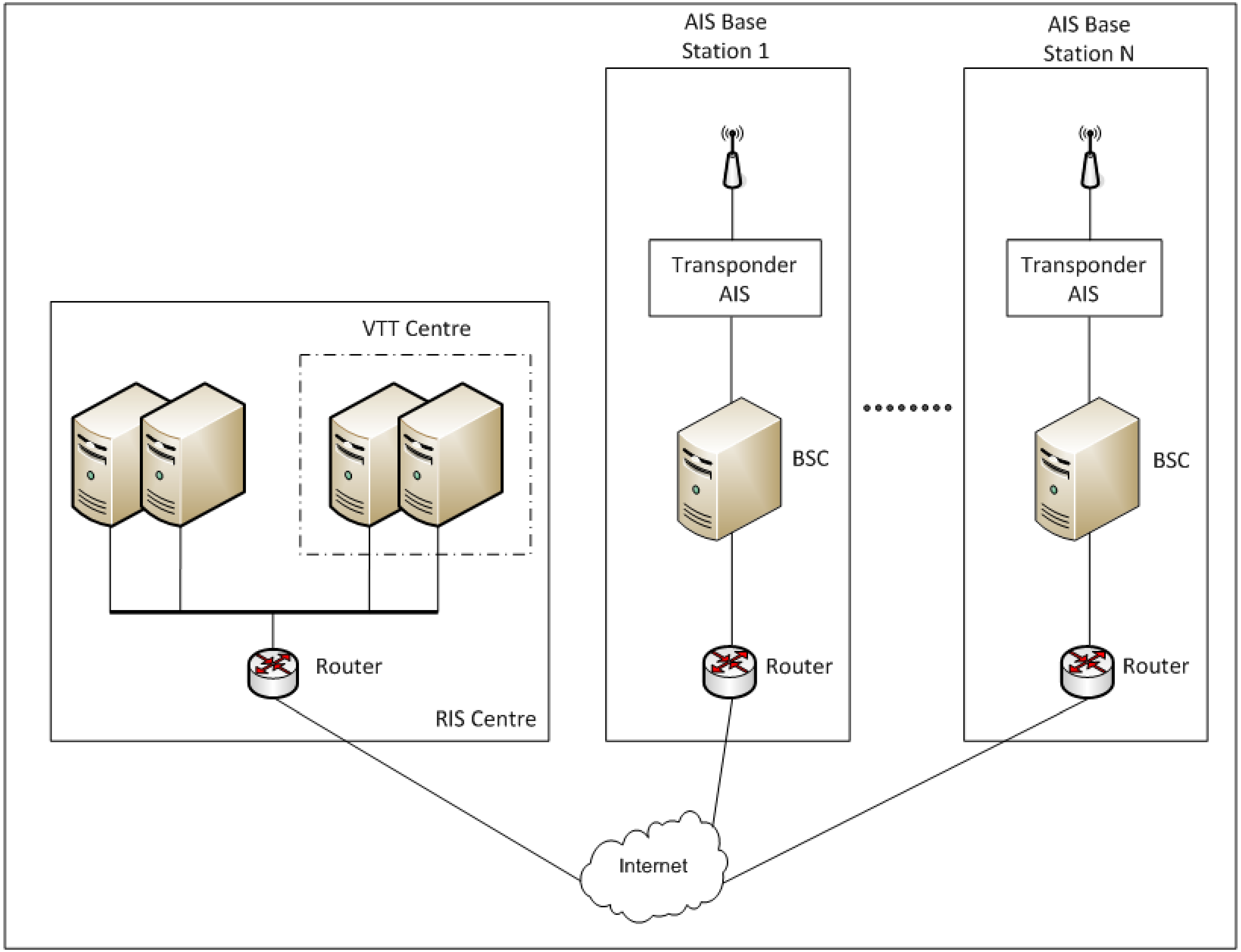


Onboard AIS devices transmit the identity of the vessel, its position and other data at regular intervals. By receiving these transmissions, AIS shore stations or ships fitted with AIS can automatically recognize, identify and track vessels equipped with AIS on a suitable screen, such as an inland ECDIS display. AIS systems are meant to boost the safety of navigation by use from vessel-to-vessel alongside onshore Vessel Traffic Services (VTS) to trace and track vessels and to assist in calamity abatement.

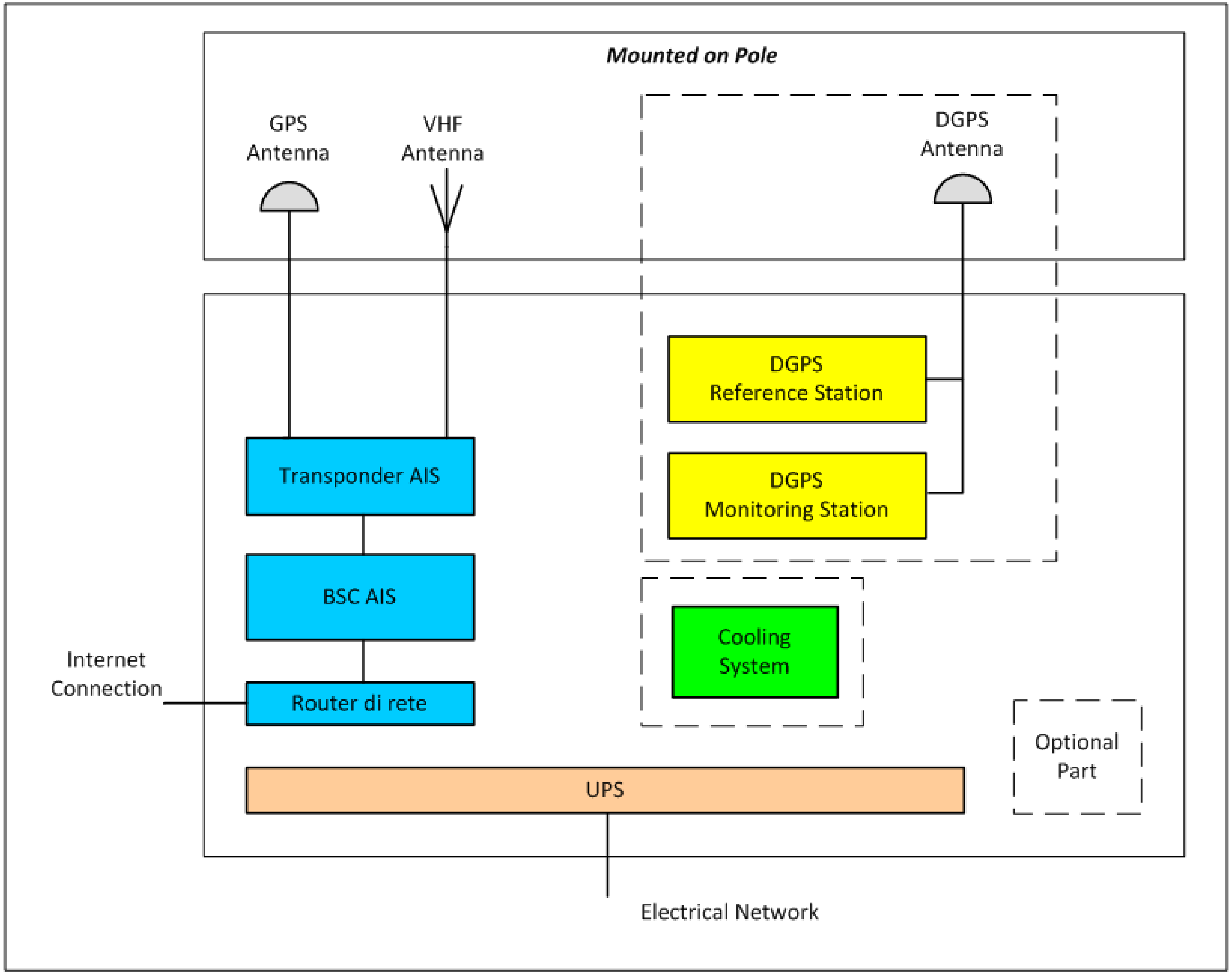


VTT Operator
Logistic User
(WEB Interface)
VTT Centre
Autority
(Land Workstation)
RIS Centre
Internet
Onshore AIS Base Stations
AIS network
VHF
Ship 1
Ship 2
Ship 3
Ship 4

AIS BASE STATION & RIS CENTRE
ONSHORE FACILITIES



AIS BASE STATION



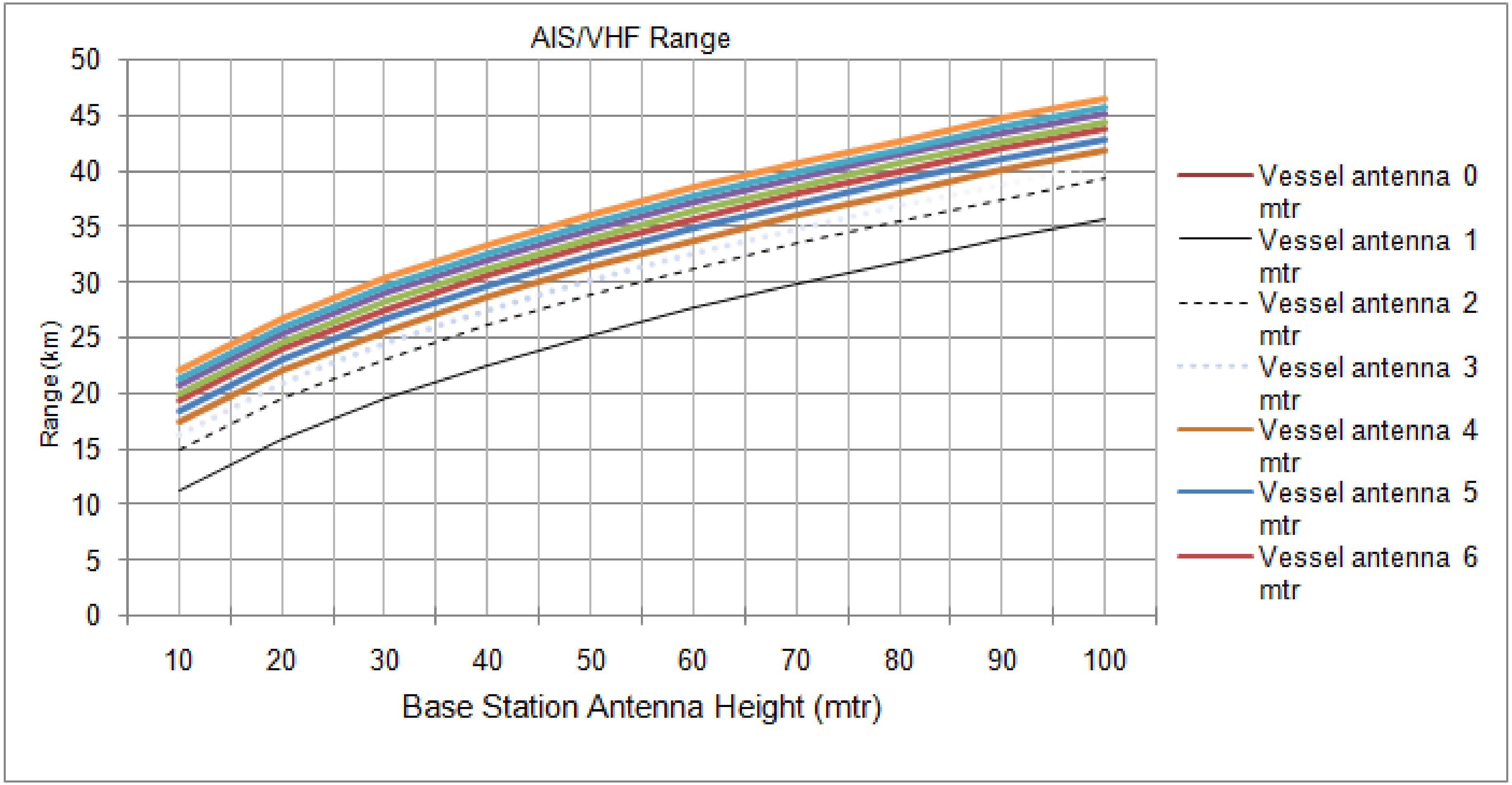
AIS STATION TOWER DESIGN

The type of tower depends upon the environment & also capable to carry Radar. Some of the examples are shown in the pictures

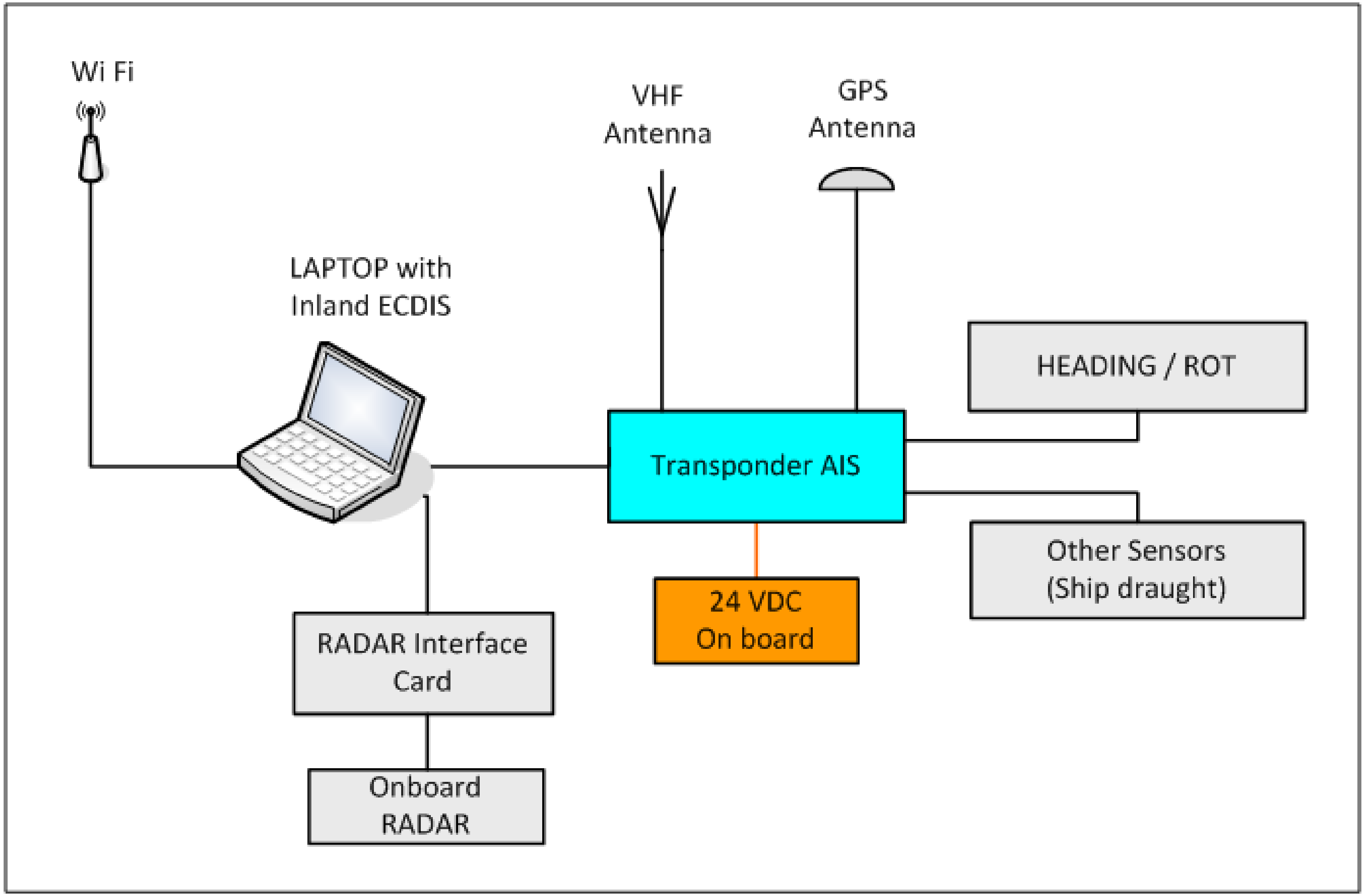
AIS STATION VHF RANGE

AIS/VHF Range												
Base Station antenna Height (mtr.)	Vessel Antenna Height	0	1	2	3	4	5	6	7	8	9	10
10		11.3	14.9	16.3	17.5	18.4	19.3	20	20.7	21.4	22	22.6
20		16	19.5	21	22.1	23.1	23.9	24.7	25.4	26.1	26.7	27.3
30		19.6	23.1	24.6	25.7	26.7	27.5	28.3	29	29.7	30.3	30.8
40		22.6	26.1	27.6	28.8	29.7	30.6	31.3	32	32.7	33.3	33.9
50	Range (km)	25.2	28.8	30.3	31.4	32.4	33.2	34	34.7	35.3	36	36.5
60		27.7	31.2	32.7	33.8	34.8	35.6	36.4	37.1	37.8	38.4	38.9
70		29.9	33.4	34.9	36.1	37	37.9	38.6	39.3	40	40.6	41.2
80		31.9	35.5	37	38.1	39.1	39.9	40.7	41.4	42	42.6	43.2
90		33.9	37.4	38.9	40.1	41	41.9	42.6	43.3	44	44.6	45.2
100		35.7	39.3	40.8	41.9	42.8	43.7	44.4	45.1	45.8	46.4	47

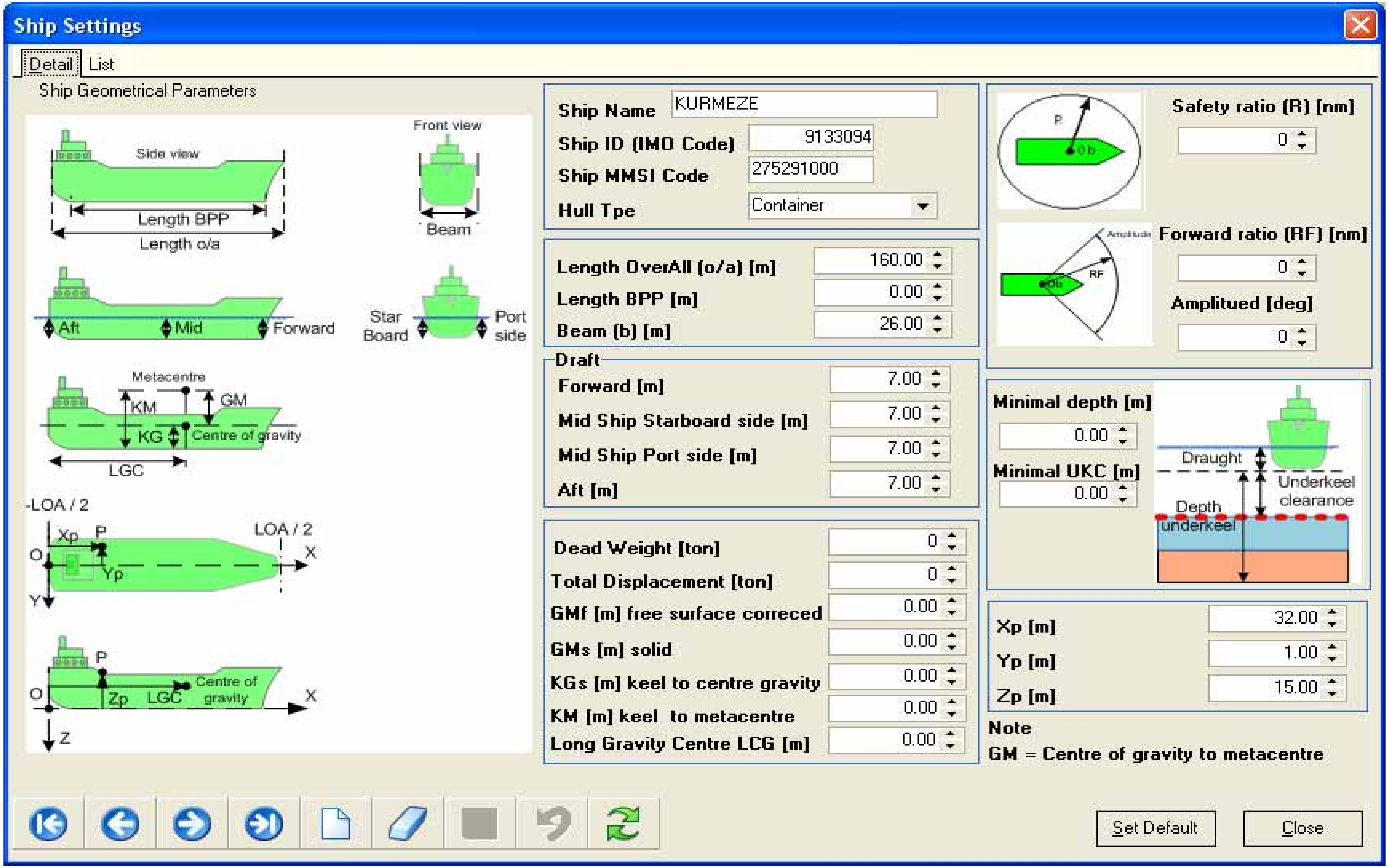
AIS STATION VHF RANGE



AIS ON BOARD DEVICE

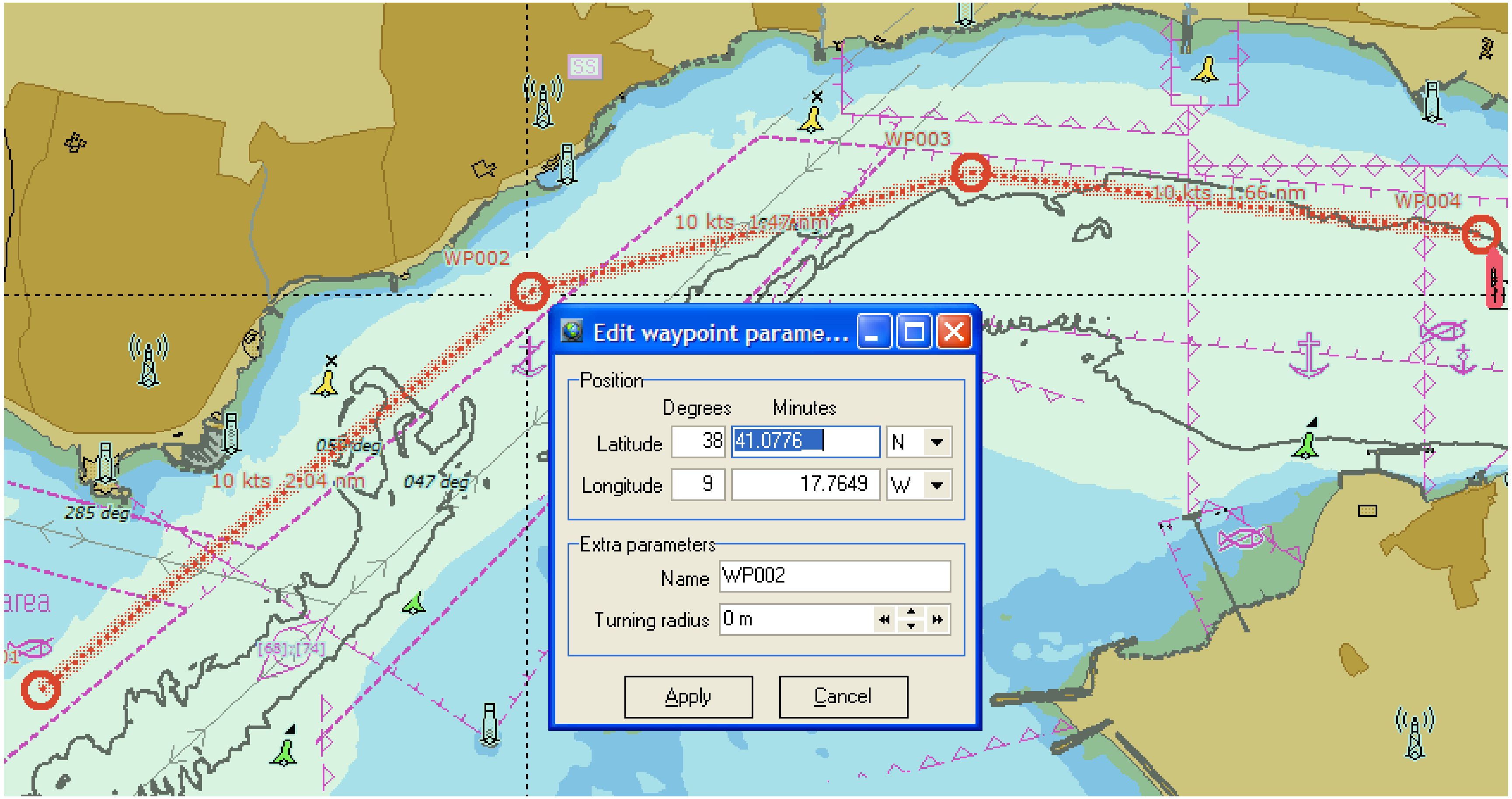


Interface to insert ship data

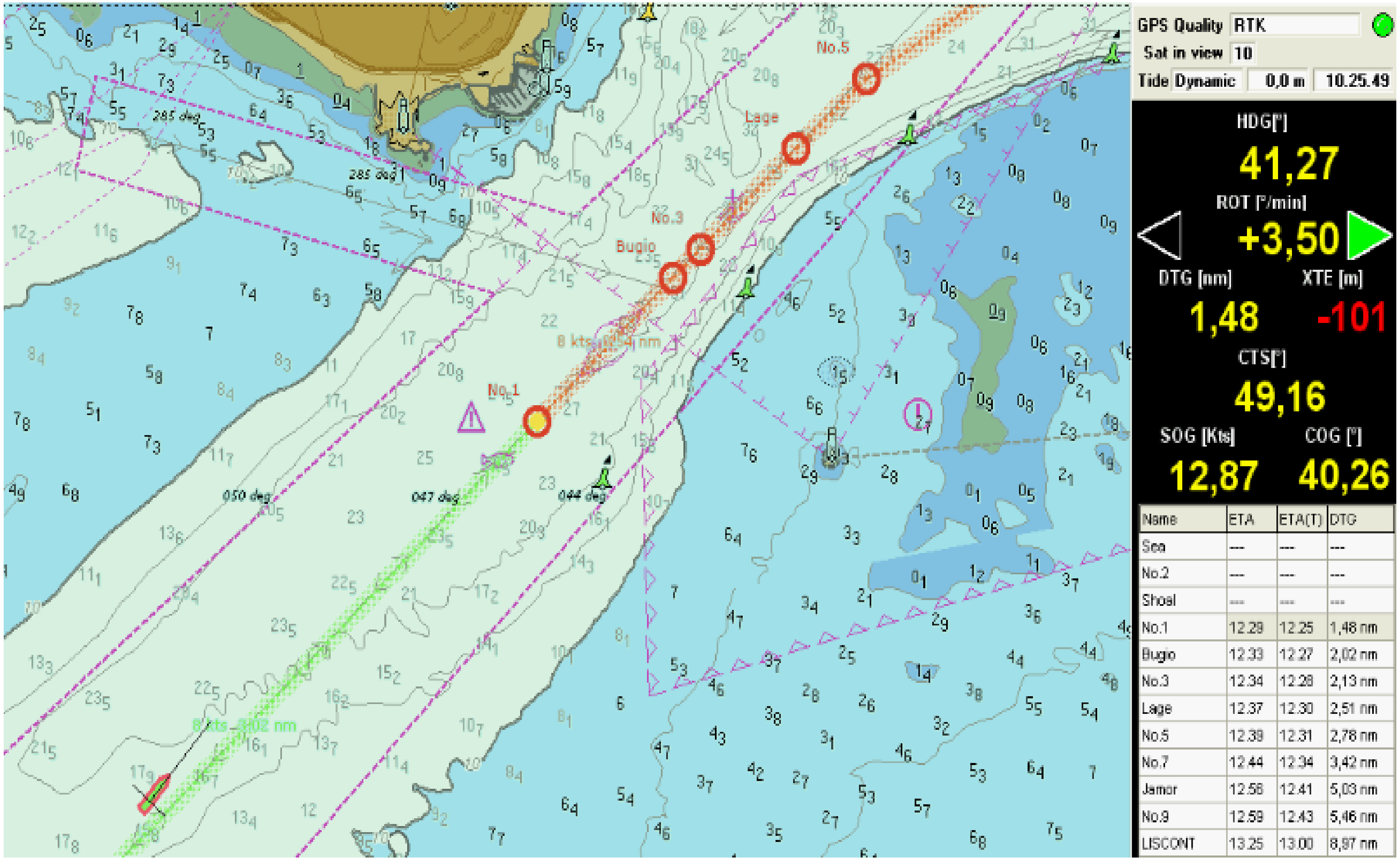


ONBOARD INTERFACE

Interface to for voyage planning

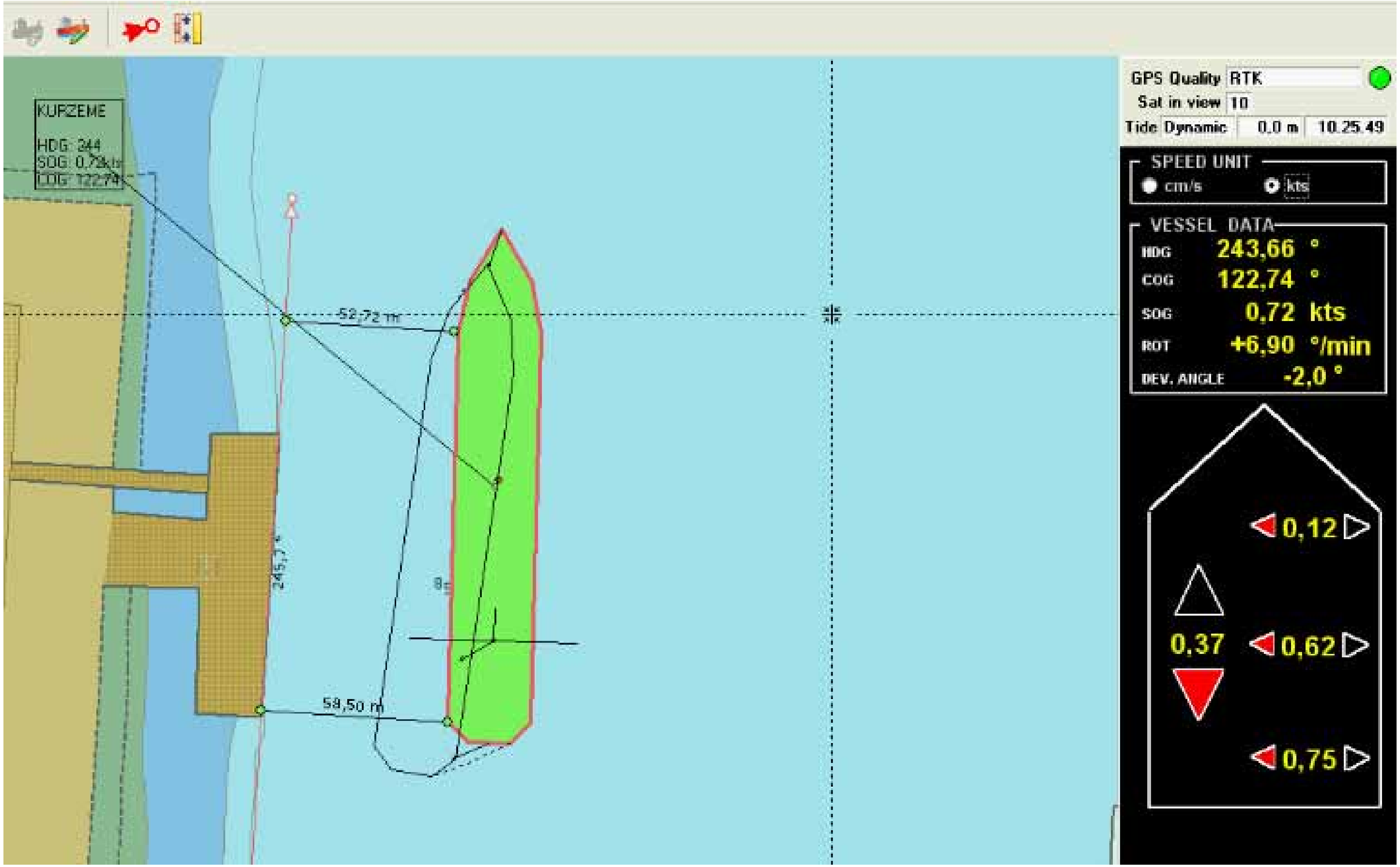


Interface in navigation mode



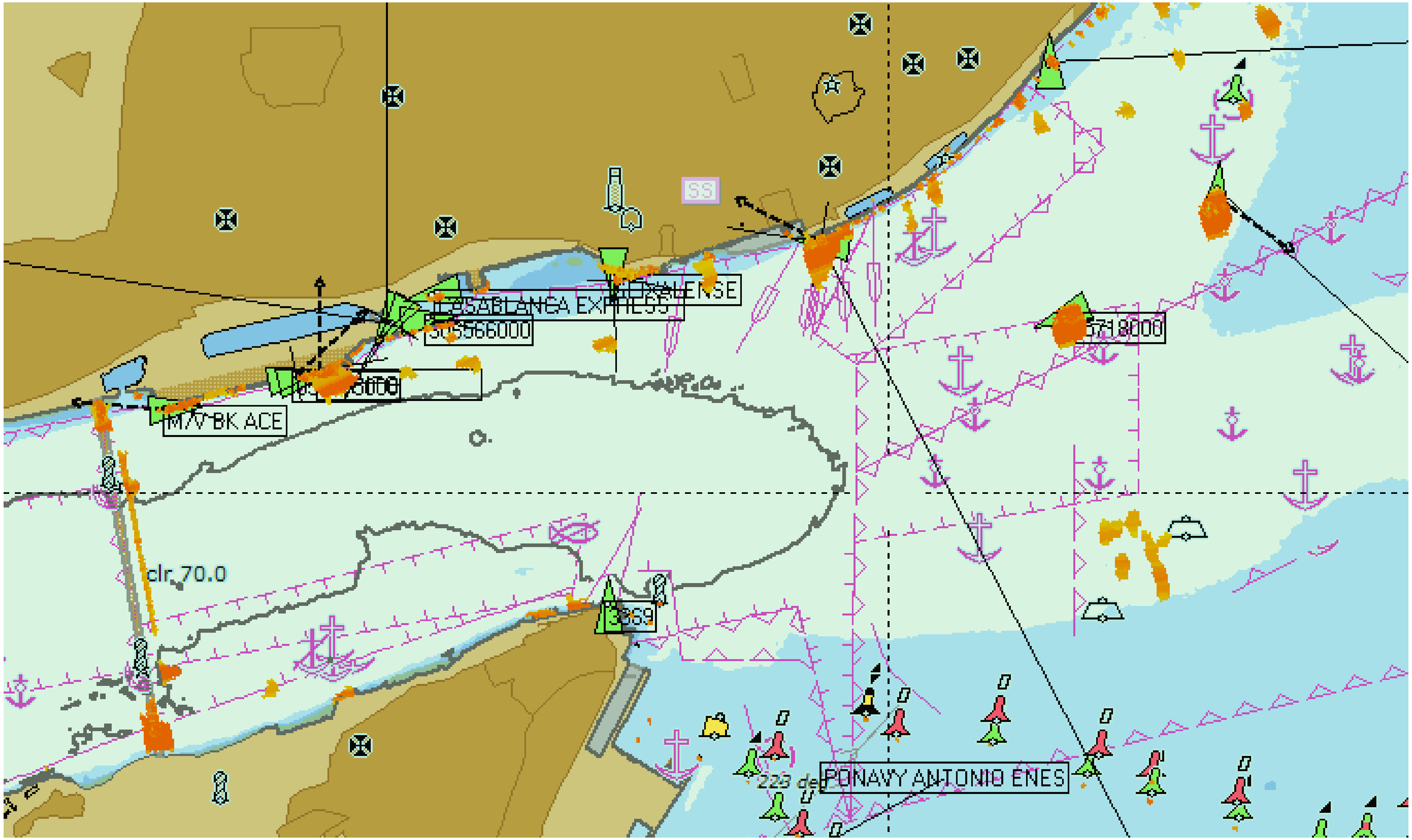
ONBOARD INTERFACE

Interface for docking

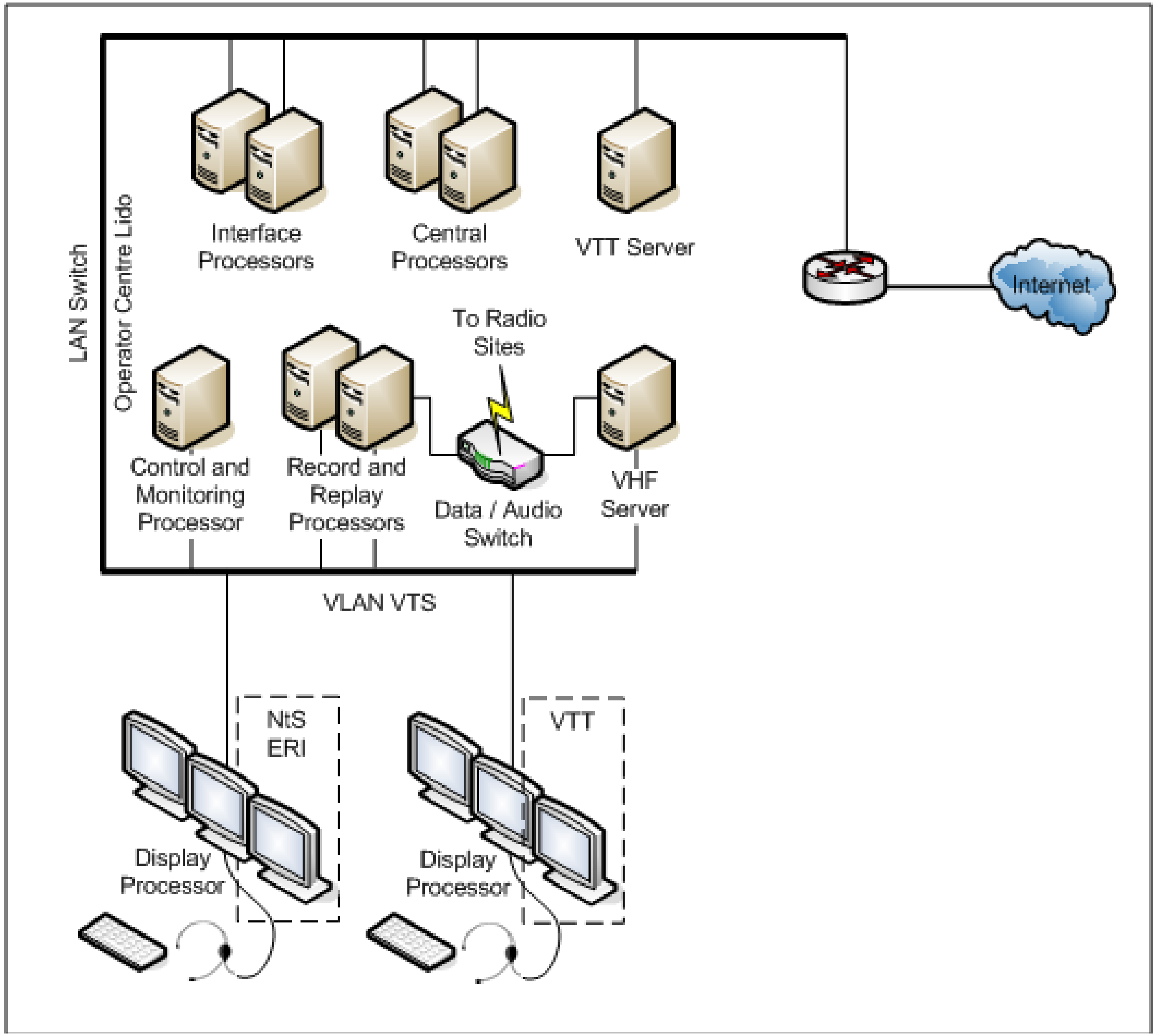


ONBOARD INTERFACE

Tactical Traffic Image + RADAR

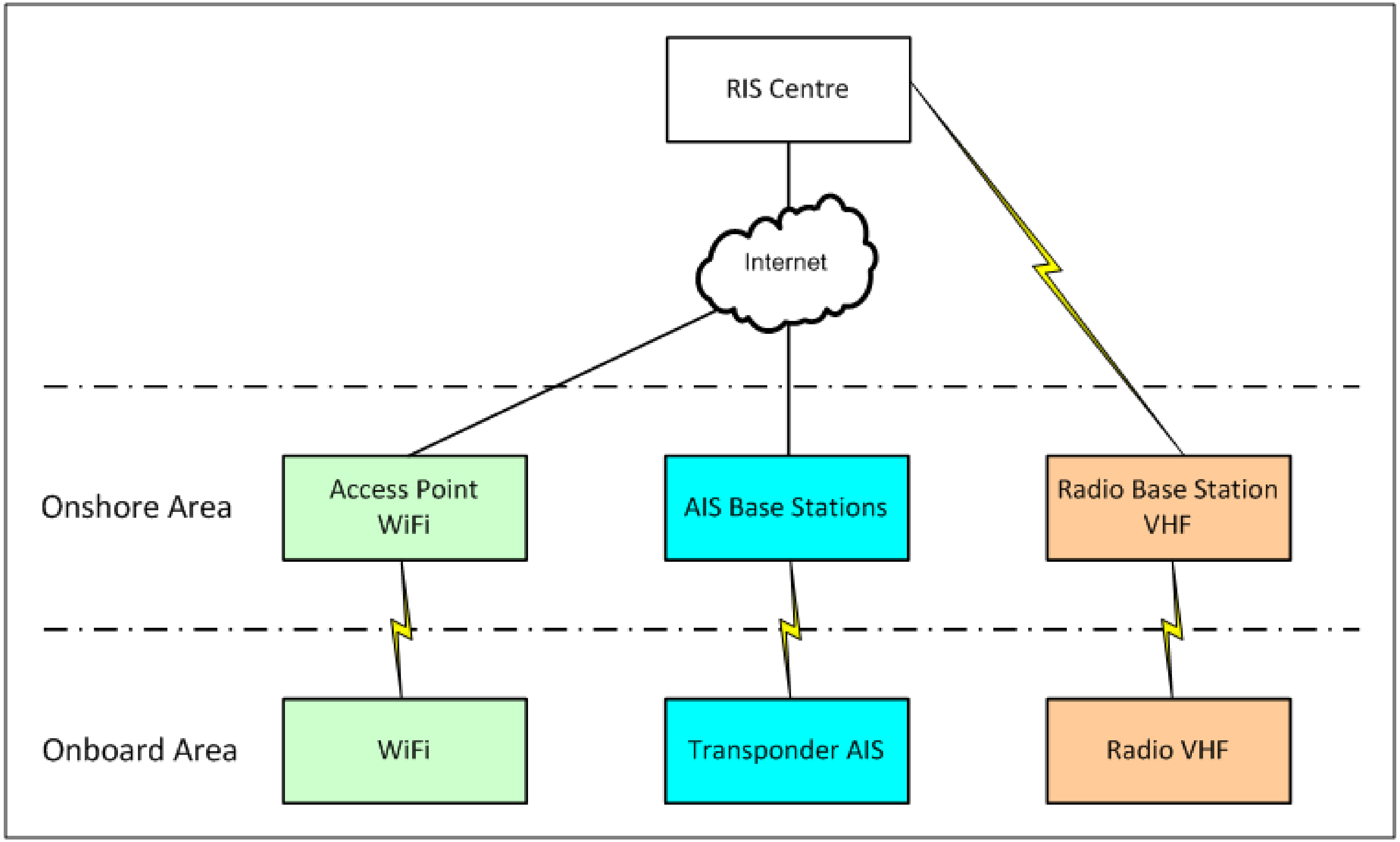


RIS CENTRE


LAN Switch
Operator Centre Lido
Interface Processors
Central Processors
VTT Server
Internet
To Radio Sites
Control and Monitoring Processor
Record and Replay Processors
Data / Audio Switch
VHF Server
VLAN VTS
NtS ERI
VTT
Display Processor
Display Processor

COMMUNICATION SEGMENTS

- **Voice**
- **AIS**
- **WiFi for Charts Update and WEB Interface**



MAIN ACTIVITIES

- VHF/WiFi Coverage Study of the Inland Area
- Identification of Location for WiFi Access Point
- Identification of Location of VHF voice base stations
- Detailed definition of Main VTT Functionalities
- Notice To Skipper for River Levels
- Instrumentation with Inland AIS class A of each ship
- Creation of Inland ECDIS-S57 Chart
- DGPG integration in AIS Base Stations for 10cm precision in ships location (RTCM via AIS Msg. 17)
- Integration with Local Level and Meteo Monitoring Systems ?
- Lock/Bridge/Terminal Management ?

BILL OF MATERIAL

Onboard Vessel composed of

- AIS Transponder+ VHF

Onshore Area composed of

- AIS Base Stations + Controller + radio base VHF (voice)

1 RIS Centre Composed of

- Workstations with Data management software

ANNEXURE 9.1– LETTER OF MoEFCC

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

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.

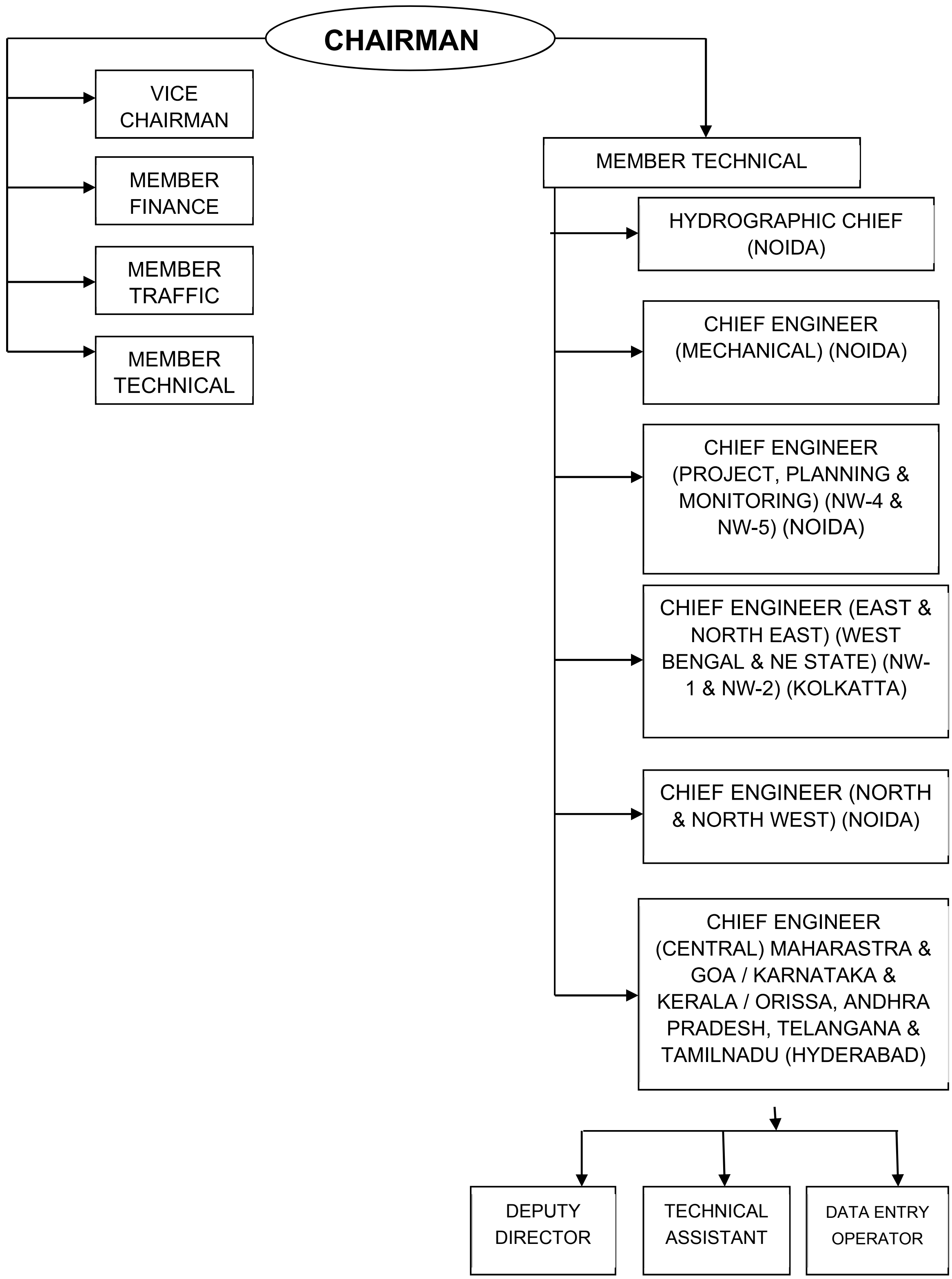
xxviii. The Vessels shall comply the emission norms prescribed from time to time.

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.

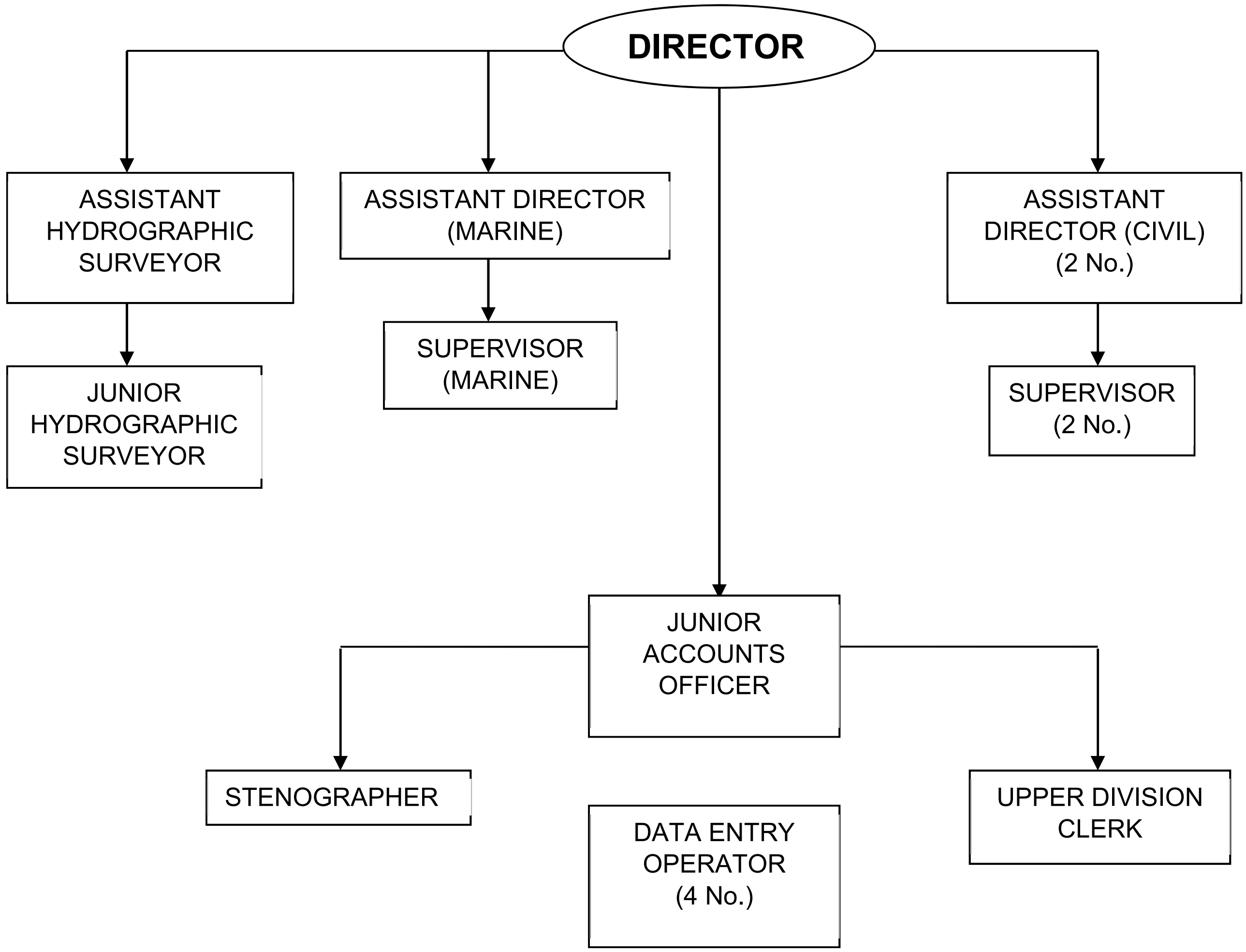
21/12/17

Sharath Kumar Pallerla
Director

ANNEXURE 10.1– INSTITUTIONAL REQUIREMENT HEAD OFFICE COMPONENTS



ANNEXURE 10.2– INSTITUTIONAL REQUIREMENT IN MAHARASTRA AND GOA



ANNEXURE 11.1 – COSTING/FINANCIAL ASSUMPTIONS

FINANCIAL ANALYSIS

Broad Assumptions

Based on Financial Analysis as per DPR of NW5

Abstract

Broadly identified assumptions in order to facilitate financial analysis of Category II shortlisted waterways development

Inland Waterways Authority of India

FINANCIAL ANALYSIS BROAD ASSUMPTIONS[1]:

Capital Expenditure:

Elements to be covered (based on planned infrastructure requirement for respective rivers)

Suitable assumptions with relevant justification shall be made for any missing items.

CAPEX HEAD	TOTAL COST (INR CRORE)
Land Acquisition	Cost initially to be considered for acquisition of land for land side development of floating jetty
Dredging	**Normal Condition** Standard dredging rate of Rs. 200/cum to be considered. Suitable adjustments shall be made (with proper justification) for change in quality of dredge material/any special requirement for disposal of dredge material
Barrages with Navigational Locks	Based on requirement standard charges as per Planned Infrastructure of respective rivers.
Raising Banks	
Protection Measures	
Environmental Monitoring	
Navigational Aids	
Bridges	
Cross Drainage Works	
Facilities to Local People	
Terminals	Initially while calculating CAPEX terminal cost shall include cost for development of required numbers of floating jetty along respective waterways, cost of equipment, manpower required for terminal operation
Total Capital Expenditure	**Sum of all parameters mentioned above**
DC, PMC, IE Services, Loan Fees	10% of Total CAPEX
Overall Contingency	3% of Total CAPEX
Escalation	1.5% of Total CAPEX
Total Hard Capex	
Interest During Construction	
Total Project Cost	

Operations & Maintenance Expenditure:

(Pick up the cost items relevant to your study and planned infrastructure components)

Suitable assumptions with relevant justification shall be made for any missing items.

Annual Escalation shall be assumed @ 5.0%.

---

1 These assumptions are to facilitate consultants in giving a sense of direction in which they shall move to make the reporting of final outcome consistent. Any missing information shall be assumed suitably (with valid justification) by the consultants in order to provide desired end result.

Cost Items	% of CAPEX
Dredging	5%
Cross Drainage	2%
Locks	2%
Bridges	1%
Terminals	2%
Navigation Aids	2%
Protection Measures	2%
Raising Banks	2%
Facility to Local People for Ferry Services	2%
Environmental Monitoring	2%
Cost of Barrages with Navigation Locks	2%
Total Waterway O&M Costs	

Revenue Estimation:

For estimating the revenue, the tariff structure proposed by IWAI (Levy & Collection of fees and charges) Regulations, 2011 shall be used as a reference.

Existing Tariff Structure & Charges by IWAI (Shall be verified from the latest published Tariffs)

Suitable assumptions with relevant justification shall be made for any missing items.

Tariff Heads	Charge unit	Charges (INR)
(A) Usage Charges		
Movement of Vessels	GRT/km	0.02
(B) Vessel related charges		
Berthing charges	Vessel	1000.00
Towage	Vessel/hour	600.00
Pilotage	Day	750.00
(C) Cargo related charges		
(i) Terminal Charges		
Dry Cargo	Ton (or part thereof)	1.00
Liquid Cargo	Ton (or part thereof)	1.00
Containerised Cargo	TEU	50.00
(ii) Transit shed charges		
First 3 days	MT per day	
First 7 days	MT per day	
7-21 days	MT per day	5.00
22-35 days	MT per day	10.00
After 35 days	MT per day	40.00
(iii) Open storage charges		
Hard Stand		
First 3 days	MT per day	
First 7 days	MT per day	0.00
7-21 days	MT per day	2.00
22-35 days	MT per day	4.00
After 35 days	MT per day	16.00
On Open Area		
First 3 days	MT per day	

Tariff Heads	Charge unit	Charges (INR)
First 7 days	MT per day	0.00
7-21 days	MT per day	1.00
22-35 days	MT per day	2.00
After 35 days	MT per day	8.00
(D) Composite Charges		
Movement of Over Dimensional Cargo	Per MT per km	1.50
Customs clearance convenience charges	Per MT	40.00
(E) Miscellaneous charges		
Crane, fork lift, bunkering of fuel, water supply, etc.	Of total revenue	
Crane (including Pontoon crane)		
5 MT capacity Crane	Per shift of 8 hrs	800.00
20 MT capacity Crane	Per shift of 8 hrs	2000.00
>20 MT capacity Crane	Per shift of 8 hrs	2500.00
Container Crane	Per hr	1100.00
Fork Lift (3MT capacity)	Per shift of 8 hrs	600.00
Electricity supply to Vessels		As per Electricity Board
Bunkering of fuel/ Petroleum Oil Lubricants		As per Market Rates
Water Supply	Per km	300.00
Sewage Disposal	Per km	100.00
Weighing scale	Per MT	5.00

In order to estimate the effective charge that the end users are expected to face, it is assumed that the margin charged by barge operators is Rs. 1.20 per MT per km.

FINANCING

The financing parameters considered for the study are as follows:

Suitable assumptions with relevant justification shall be made for any missing items.

Item	Unit	Value
Leverage Ratio	% Debt	70%
Moratorium	Quarters	2
Door-to-door Tenor	Years	15
Interest Rate	%	8%
Debt Drawal Start Quarter	No.	1
Debt Repayment Start Quarter	No.	22
Debt Repayment End Quarter	No.	60
Discount Rate (For NPV calculations)	%	16%

OTHER ASSUMPTIONS

Suitable assumptions with relevant justification shall be made for any missing items.

Tax Rate Assumptions

Type of Tax	Rate
Corporate Income Tax Rate	34.61%
Minimum Alternate Tax Rate	21.34%

Final IRR Reporting:

The consultant shall report the Project FIRR & EIRR considering different scenarios. Broadly the sensitivity shall include (but not limited to) following parameters as variable:

- Traffic (15-20% ± of projected divertible cargo, as at this stage the divertible cargo potential)
- Development Cost (15-20% ± of planned cost)
- Leverage Ratio (70:30 in base case, 10-15% ± in optimistic & pessimistic scenarios)

ANNEXURE 11.2 –COST OF DREDGING

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Dredging in General Soil	Cum	440,000	300	1320.00
2	Dredging in Hard Soil	Cum	50,000	900	450.00
	Total Cost of Dredging				**1770.00**

INR 200/ per Cu. M + 20 % for escalation + 30 % for Managing the disposal
Considered 3 times over the General Soil, keeping in view the hardness observed in the site.

ANNEXURE 11.3 –COST OF BANK PROTECTION WORKS AT RIVER

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	17400	3231.30	562.25	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	11380	354.45	40.34	DSR 2016, Cl.no. 22.20 15% reduction in rate due to market rate status
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	500	2700.00	13.50	Market Rate
	Cost of Bank Protection Works for 500 m				616.082	
	Cost of Bank Protection Works for 1 m				1.23	
	Cost of Bank Protection Works for 4000 m for 8 locations				**4928.65**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.4 –COST OF NIGHT NAVIGATION WORKS

(Phase 1: Beacon & Lights)

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Land Area Cost	Sq.m	25	1,120	0.28
2	Lattice bridge structure	No.	1	865,000	8.65
3	Lattice bridge structure Foundation)				
3-a	RCC (Cement) 3.5 m x 3.5 m x 2.5 m	Cu. M	31	7,949	2.43
3-b	RCC (Steel) @ 3.3 Kg / Cu. M	Kg	101	7,850	7.93
4	Lighting equipment	No.	1	35,500	0.36
					19.65
	Cost of Night Navigation Works		10		**196.54**

(Phase 2: Buoy & Lights)

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Providing and laying 1.8 m dia. Polythene Buoy, Mooring Gear & fixing Lighting Equipments	No.	110	336,250	369.88
	Cost of Night Navigation Works				**369.88**

Rates based on Quotation / Market Rates

ANNEXURE 11.5 –COST OF LAND FOR RO-RO

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
(i)	Land inside the terminal area	m^2	33350.00	1120.00	373.52
(ii)	Land required for Road Extension or construction of external approach road	m^2	1855.00	1120.00	20.78
(iii)	Area under Mangrooves clearance	m^2	0.00	1120.00	0.00
(iv)	Boundary wall 250 mm thk brick masonary (1:6) surrounding the entire terminal on 3 sides except RORO and LOLO side	m^2	2080.00	1120.00	23.30
2	Filling & compaction Cost (2.5 m)	m^3	83375.00	168.00	140.07
	Total Cost of Land				**557.66**

Rate As Rs.39 lakh per Acre.

1 Acre = 4047 m2

1120.00 Rs. Amount for 1 m2 land

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1.0	**RCC Concrete Works (M40 grade concrete)**					
	CONCRETE - Reinforced Cement Concrete of specified Grade M40 in different structural members above pile cut-off level.					
1.1	Providing and laying Vertical M40 Grade Concrete Piles of 1.3 m diameter					
	Vertical Piles					
	Grid A	No	6			
	Grid B	No	6			
	Grid C	No	6			
	Total Piles	cu.m	346			
1.2	Pile Caps (1800x1800x1000)	cu.m	58.32			
1.3	Longitudinal Beams (1000x1250)					
	Grid A	cu.m	75.00			
	Grid A1	cu.m	75.00			
	Grid B	cu.m	75.00			
	Grid B1	cu.m	75.00			
	Grid C	cu.m	75.00			
1.4	Cross Beams (18000x1500)					
	grid 1 to 8	cu.m	201.42			
1.5	Deck Slab	Cu.m	348.60			
	Total Concrete	Cu.m	1329.77	7985.88	106.19	DSR 2016, Cl.no. 5.33.1 & 5.34.3
2.0	**Steel Reinforcement**					
	REINFORCEMENT - High yield strength deformed bars Reinforcement Grade Fe500 in reinforcing cage including ring bars as detailed on the drawings					
2.1	Vertical Piles 1.3 m dia	MT	51.96			
2.2	Pile Caps (1800x1800x1000)	MT	4.67			
2.3	Longitudinal Beams (1000x1150)					
	Grid A	MT	13.50			
	Grid A1	MT	13.50			
	Grid B	MT	13.50			
	Grid B1	MT	13.50			
	Grid C	MT	13.50			

2.4	Cross Beams (18000x1500)					
	grid 1 to 8	MT	36.26			
2.5	Deck Slab	MT	41.83			
	Total Reinforcement	MT	202	61133.66	123.62	DSR 2016, Cl.no.5.22.4
3.0	**Structural Steel works**					
3.1	Structural Steel hand rail with steel grade Fy=240 Mpa	MT	120	81120	97.34	DSR 2016, Cl.no.10.2
4.0	**Bollards**					
	Supply and fix in position cast steel bollards of working loads capacity of 40 ton, twin horn type of approved make, including galvanized holding down bolts, nuts, washers (80microns zinc coating) and painting as per specification and drawings complete.	MT	6	82,500	4.95	As per Market rate
5.0	**Fenders**					
	Supply and fix in position fender system in the rear side of jetty structure from an approved manufacturer meeting the berthing energy absorption and reaction forces requirements given in technical specification and drawings for the following type of fenders. The rate include design, supply, installation, testing and commissioning of fenders and necessary fixtures such as chains, U bolts, fasteners etc., complete.	LS			30.00	
	Total cost of Riverrine Structures at RORO Terminal				**362.11**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.7 –COST OF STRUCTURES AT TERMINAL

S.No.	Facility	Nos.	Size	Area (in m2)	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Open Mobility Area	1	200 m x 100 m	20000	5,934	1,186.75
2	Covered Storage Godown **	1	50m x 30m	1500	17,801	267.02
3	Ro-Ro Truck Parking	20	16m x 3m	960	1,333	12.79
4	40' Container Stack Yard	20	40 Sq. m	800	8,901	71.21
5	Main Parking Area	1	30m x 30m	900	1,010	9.09
6	Public Utility	1	6m x 4m	24	29441.54	7.07
7	Weigh bridge	1	8m x 3m	24	250000	60.00
8	Utility Room (Near Weigh Bridge)	1	3m X3m	9	29441.54	2.65
9	Area under internal Roads	1	7.5m x 250m	1875	15000	37.50
10	Administration building	1	12 m x 15 m	180	37860.29	68.15
11	Business Area	1	10m x 3m	30	37860.29	11.36
12	Staff Parking Area-4 wheelers	1	13.5m x 6m	81	1332.65	1.08
13	Staff Parking Area-2 wheelers	1	8m x 2m	16	1446.50	0.23
14	Security shed for watch and ward	2	4m x 4m	32	4029	1.29
15	Electrical facility	1	5m x 5m	25	14087	3.52
16	Fuel Bunkers	1	10m x 5m	50	5555.56	2.78
17	Water Supply Room	1	3m x 4m	12	14,170	1.70
18	Fire and Safety Room	1	3m x 4m	12	18337	2.20
19	DGPS receiver & transmitter shed	1	8m x 4m	32	6824.75	2.18
20	DG shed	1	5m x 5m	25	6643.5	1.66
21	Canteen with Store	1	12m x 8m	96	13629.69	13.08
22	Sewerage Treatment Plant (STP)	1	15m x 15m	225	12437	27.98
23	Overhead Tank	1	10m dia	100	1923.08	1.92
24	Green Area	1		1000	800	8.00
25	Future Requirement	1		2000	600	12.00
	Total cost of Other Components					**1,813.22**

* Rates worked out based on the DSR rates duly considering related items.

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

** The requirement is to be critically examined, in detail at implementation stage and provisioned accordingly.

ANNEXURE 11.8 –COST OF APPROACH (EXTERNAL) ROADS

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	External Roads				
(i)	Pacca Road (7.5 m wide road)	m	265.00	15000	39.75
2	Pipe Culvert on External Road			LS	3.50
	Total Cost of Approach Roads				**43.25**

* Rates worked out based on the DSR rates duly considering related items.

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.9 –COST OF BANK PROTECTION WORKS AT TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Reference
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	8700	3231.30	281.12	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	5365	368.11	19.75	DSR 2016, Cl.no. 22.20 15% reduction in rate due to market rate status
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	290	2700.00	7.83	Market Rate
	Cost of Bank Protection Works for 500 m				**308.70**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE

DABHOL CREEK / VASHISHTI RIVER

Sl.No.	Items	Phase 1 (12 Months on immediate Pilot Basis)																																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils																																				
	Ordinary Soils																																				
	1.b) Dredging																																				
	Hard Soils																																				
	Hard Soils																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (NIL)																																				
	4. Night Navigation																																				
	Beacon/ Lights (Approval & Tendering)																																				
	Beacon / Lights (10 Nos)																																				
	5. Land Acquisition (No land acquisition for fairway)																																				
B	**Modification of Structures (NIL)**																																				
C	**Communication System (NIL)**																																				
D	**Institutional Requirement**																																				
	Office / Manpower (Establishment & Recruittment)																																				
	Office / Manpower (Deployment)																																				
	Vessels (Approvals & Tendering)																																				
	Vessels (Procurement & Deployment of 2 SLs; 2 Tugs; 2 IBs)																																				
E	**Environmental Management Plan**																																				
		Phase 2 (36 Months ending 2029)																																			
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils (Approvals & Tendering)																																				
	Ordinary Soils (Execution of 4,40,000 Cu. M)																																				
	1.b) Dredging																																				
	Hard Soils (Approvals & Tendering)																																				
	Hard Soils (Execution of 50,000 Cu. M)																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (Approval & Tendering)																																				
	River Training Works/ Bank Protection (4000 m @ 7 Locations)																																				
	4. Night Navigation																																				
	Buoy/ Lights (Approval & Tendering)																																				
	Buoy / Lights (110 Nos)																																				

*Phase 2 implementation will be from 2026 / 2027 to 2029 (36 month) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended for immediate implementation.

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE RO-RO

DABHOL CREEK / VASHISHTI RIVER

Sl.No.	Items	Phase 2 (36 Months ending 2029)																																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A	**Lo - Lo Terminal (Phase 2)***																																				
	Land Acuisition																																				
	Riverine Components																																				
	Infrastructure Components internal roads (Approvals & Tendering)																																				
	Infrastructure Components internal roads (Execution)																																				
	Approach Road Cost																																				
	Bank Protection Works for terminal (Approvals & Tendering)																																				
	Bank Protection Works for terminal (Execution)																																				
	Cargo Handling Equipments																																				
	Ambulance																																				
	Cranes with 125 T Capacity																																				
	Fork lift trucks 20 T Capacity																																				
	Environmental Management Plan																																				
	Vessels																																				
B	**Ro - Ro Terminal (Phase 2)***																																				
	Land Acuisition																																				
	Riverine Components																																				
	Infrastructure Components internal roads (Approvals & Tendering)																																				
	Infrastructure Components internal roads (Execution)																																				
	Approach Road Cost																																				
	Bank Protection Works for terminal (Approvals & Tendering)																																				
	Bank Protection Works for terminal (Execution)																																				
	Cargo Handling Equipments																																				
	Ambulance - 1 no.																																				
	Cranes with 125 T Capacity - 4 no.																																				
	Fork lift trucks 20 T Capacity - 2 no.																																				
	Environmental Management Plan																																				
	Vessels																																				

***Phase 2 implementation will be from 2026 / 2027 to 2029 (36 month) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended for immediate implementation.**

LIST OF DRAWINGS

Sl.No	DRAWING NAME	DRAWING NUMBER
1.	LAYOUT PLAN OF DABHOL CREEK/VASHISHTI RIVER (7 SHEETS)	P.010257-W-20301-A04
2.	TERMINAL LOCATION MAP OF DABHOL CREEK/VASHISHTI RIVER (1 SHEET)	P.010257-W-20351-X04
3.	TERMINAL LAYOUT PLAN (WITH PROPOSED INFRASTRUCTURE FACILITY (1 SHEET)	P.010257-W-20311-A04
4.	RO-RO TERMINAL PLAN (2 SHEETS)	P.010257-W-20341-E04
5.	BANK PROTECTION TYPICAL SECTION (1 SHEET)	P.010257-W-20303-X04

LIST OF VOLUMES

VOLUME-I MAIN REPORT

VOLUME-II DRAWINGS

VOLUME-IIIA HYDROGRAPHIC SURVEY REPORT

VOLUME-IIIB HYDROGRAPHIC SURVEY CHARTS

VOLUME-IV GEO-TECHNICAL INVESTIGATION REPORT