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DPR – AMBA RIVER (44.971KM) NW-10

Our ref.: **P.010257-W-10305-03**

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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 – AMBA RIVER (44.971km) NW-10**

Comments:

Revision No.	Date	Prepared / Revision By	Description
REV.01	2019 04 30	Bidhan Chandra JHA	Final Submission

REV.	YY/MM/DD	STAT.	WRITTEN	VERIFIED	APPROVED	VALIDATED
01	19/04/30	Active	SARIKA KUMARI	ARUN KUMAR	N. SIVARAMAN	B.C.JHA

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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 – 10 – Amba River has been carried out for this assignment / analysed / compiled based on the findings of the following field studies / investigations.

Detailed Hydrographic Survey along with the Topographical Survey was carried out from 25/11/2016 to 04/12/2016.

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

Terminal Land Survey was carried out on 26/04/2017.

Geotechnical Borehole was carried out from 26/06/2017 to 28/06/2017 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)

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LIST OF ABBREVIATIONS

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.
IPCL	Indian Petrochemicals Corporation Ltd.,
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
KIOCL	Kudremukh Iron Ore Company Limited
km	Kilo Metres
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
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
NH	National Highway
NW	National Waterway
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
SEB	State Electricity Board
SH	State Highway
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

SALIENT FEATURES

#	Particulars	Details			
		AMBA (NW-10)			
	GENERAL				
	Location				
	Cluster	Cluster-7			
	State(s)	Maharashtra			
	Co-ordinates& Name of Place	**Start**		**End**	
	Place	Rewas Jetty		Nagothane Bridge	
	Latitude	18°50'26.7055"N		18°32'19.82"N	
	Longitude	72°56'44.2695"E		73°08'00.29"E	
	TECHNICAL				
	Waterway				
	National Waterway Number	NW-10			
	Class	8000 T SPV / Class VII (up to 19.64km) and Class III (from 19.64km to 44.971km)			
	Type (Tidal/Non-Tidal)	Fully Tidal			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		44.971km	44.971km	Nil	
	Average Tidal Variation, if applicable	Avg. Tidal variation - 3.73 m			
		Chainage (m)	LW (in m)	HW (in m)	Tidal variation (m)
		1.914	0.88	4.73	3.85
		11.288	0.98	4.83	3.85
		19.720	0.57	4.82	4.25
		33.802	0.38	3.83	3.45
		44.014	0.22	3.45	3.23
		Mumbai Apollo bandar*	0.76	4.42	3.660
	Chart Datum				
	Description/Basis	Mankule 72°59'05.9727"N 18°45'34.5305"E	Dharamtar Jetty 73°01'33.1105" N 18°41'39.5822" E	Gandhe 73°05'07.1485"N 18°36'11.4397"E	Nagothane 73°08'00.3153"N 18°32'22.8049"E
	Value (from Zero of Gauge)	+ 0.153 m	- 0.402m *	- 0.592m *	- 0.963m *
		*below of Zero of Gauge			

LAD Status (w.r.t. CD)					
	Stretch-1	**Stretch-2**	**Stretch-3**	**Stretch-4**	**Total**
Stretch (From…. To……)	0.00 – 11.55	11.55 -23.10	23.10 -34.65	34.65 – 44.971	
Length with LAD < 1.2 m	0.0	0.0	6.4	9.57	15.97
With LAD from 1.2-1.4 m	0.0	0.0	1.0	0.0	1.0
With LAD from 1.5-1.7 m	0.0	0.0	2.0	1.0	3.0
With LAD from 1.8-2.0 m	0.0	0.0	0.0	0.0	0.0
With LAD > 2.0 m	11.55	11.55	1.901	0.0	25.001
Total	11.55	11.55	11.301	10.57	44.971
Target Depth of Proposed Fairway (m)	2.75m for Class VII or 5.3m for SPV of 8000 T upto Ch 19.64km and 1.70m for Class III from Ch 19.64km to Ch 44.971km.				

Conservancy Works Required						
Type of Work	**Stretch-1**	**Stretch-2**	**Stretch-3**			**Total**
	0 - 10	10 - 20				
Shoal Length (in m) / Dredging Required (in M. Cum.) Class VII / SPV	3142.39 / 1594204.67	8460.99 / 1496172.04				11603.38 / 3090376.71
Bandalling	Nil	Nil	Nil			Nil
Barrages & Locks	Nil	Nil	Nil			Nil
River Training/Bank Protection (Km.)	Considered under Phase 2 at 4 locations @ Ch. 6.5 km; Ch. 9.5 km; Ch. 13.0 km and @ Ch. 19.3 km.					

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	Rail and Road	5	15m to 40m	2.50m to 10.50m
HT/Tele-communication lines	HT Lines	7	342m to 1157m	10.50m to 20.50m
Pipelines, underwater cables, etc.	Nil	Nil	Nil	Nil

Traffic	
Present IWT Operations (type of services)	At present Amba river is operational. Dharamtar & PNP terminal are handling bulk cargo.
Major industries in the hinterland (i.e. within 25 km. on either side)	JSW Steel, Cement, Sanghi Cement, Reliance, Supreme Petrochem, RCF
Connectivity of major industries with Rail/Road network (Distances/Nearest	ü Major roads - NH 66, NH 166 A, SH 89. ü Industries are closer to national & state highways. ü Major railway – Konkan railway line going parallel with Amba River.

Railway Stations etc.)	One railway line crosses Amba River which go towards Thal. RCF has its own rail sidings. Nearest railway station is Pen & Nagothane				
Commodities	**In-bound**		**Out-bound**		
Coal, Coaking Coal, Iron Ore	Anchorage, Jaigad Port		n/a		
Clinker, Cement	Gujarat		n/a		
Finished Product	n/a		Export- Foreign Country		
Limestone, Dolomite	Import, Anchorage, Mumbai		n/a		
Future Potential (MMT)					
Name of Commodity	**5 yr. (Fy-20)**	**10 yr. (Fy-25)**	**15 yr. (Fy-30)**	**20 yr. (Fy-35)**	**25 yr. (Fy-40)**
JSW/Dharamtar					
Iron Ore	4.6	16.0	20.4	20.4	20.4
Cooking Coal & Coal	6.2	7.0	9.0	9.0	9.0
Limestone & Dolomite	0.8	7.0	8.9	8.9	8.9
Finished Product	0.8	2.0	2.6	2.6	2.6
Cement	0.03	1.5	1.9	1.9	1.9
Clinker	0.1	2.0	2.6	2.6	2.6
PNP					
Coal	4.0	4.0	4.0	4.0	4.0
Proposed IWAI Terminal on Amba River					
Liquid/Breakbulk/Container ('000 Trucks + MT)	13 + 0.2	16 + 0.3	19 + 0.3	23 + 0.3	28 + 0.4
Iron & Steel	1.0	1.0	1.0	1.0	1.0
Coal	1.9	2.6	3.1	3.1	3.1
Terminals/Jetties					
Terminal/Jetty - 1	LO-LO & RO-RO				
Location (Bank/city/district)	18°42'34.36"N & 73°01'20.63"E near PNP Captive Jetty				
Type/Services	Handling of Bulk/Break Bulk Cargo and RO-RO vehicles mobility				
Facilities	Cranes and Forklifts are provisioned				
Approach	Road is available				
Land Ownership					
Area (ha.)	**Govt.**		**Private**		
	3.3		NIL		
Design Vessel	(Vessel of the Stake holder is of SPV with 4.8 m Draft)				
Type	Pusher Tug & Dumb Barges/ RO-RO vessels				
No. & Size	SPVs / 4 PTs+16 DBs / 5 RO-RO vessels				
Loaded Draft	4.8 m / 2.5 m / 1.94 m				
Capacity	SPV of 8000 T / Each DB of 2000 Tonne/ Each RO-RO vessel with 21 TEU				
Navigation Aids					
Type	Beacon and Light / Buoy and Light				

Nos.	5 / 50 in Phase 1 & 6 / 60 in Phase 2		
Communication Facilities	Suggested the provision of RIS		
FINANCIAL			
Project Cost			
Capital Cost	Fairway	Lo-Lo	Ro-Ro
Cost (INR)	213.57 cr	66.17 cr	15.07cr
O & M Cost	28.29 cr by FY 25 56.06 cr by FY 40	23.4 cr by FY 25 71.86 cr by FY 40	4.89 cr by FY 25 142.6 cr by FY 40
User Charges			
For IWAI	-		
For Operator	-		
Financial Internal Rate of Return (%)	Fairway	Lo-Lo	Ro-Ro
For IWAI	10.7 %	- 4.5 %	- 21.0 %
Operator	-		
Economic Internal Rate of Return (%)	Fairway	Lo-Lo	Ro-Ro
	82.4 %	91.8 %	64.4 %
Any other Important Feature			

EXECUTIVE SUMMARY

Amba River is one of the waterways declared as National Waterway in March, 2016 as NW 10. The Amba River originates in the Borghat hill of the Sahyadri ranges and joins the Arabian Sea in Dharamtar creek near village Revas duly traversing about 76 Kms. The declared stretch of the river is of about 45 km length from Arabian Sea, Dharamtar 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° 08' 00.29" E. 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 44.971 Kms from Lat 18° 50' 26.7055" N, Long 72° 56' 44.2695" 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 5 Nos. of Bridges are located with the least vertical clearance of 2.50 m w. r. to MHWS at Ch. 44.02 Km. 7 Nos. of HT Lines are crossing the study area. No pipe line is crossing the study area. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 11 Nos. of Bend locations have been identified in the study stretch.

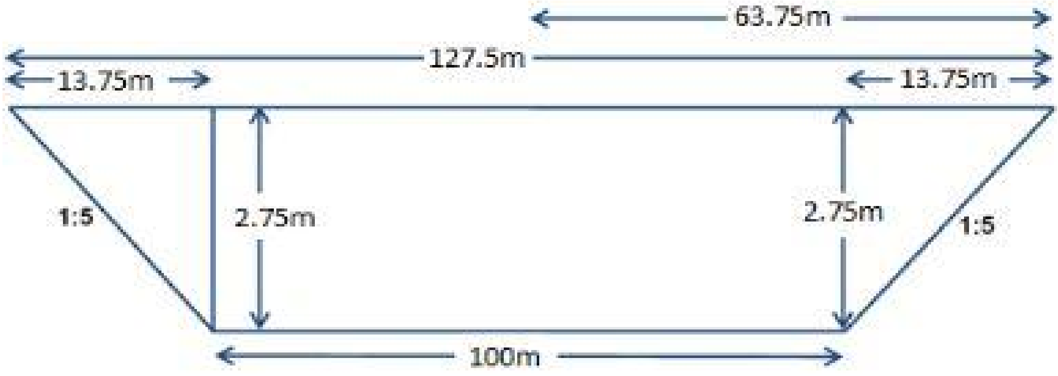
Existing waterway of the study stretch is being used for mobility of the cargo of M/s JSW and M/s PNP through their captive jetties located just downstream of the Bridge at 19.64 km. The cargo for the captive jetty at M/s JSW Jetty is about 9.27 MMTPA in FY 16 and expected to increase to 45.31 MMTPA in FY 40 consisting of Iron Ore; Coking Coal; Coal; Lime Stone; Finished Products; Cement; Clinkers and Dolomite. The increase is due to the plant capacity expansion of M/s JSW with their increased planned activities. The Coal cargo in captive jetty of M/s PNP is at 3.2 MMTPA in FY 16, which is expected to increase to 4.0 MMTPA in FY 40. In order to meet the estimated cargo apart from the above volumes consisting of Bulk / Break Bulk of Iron & Steel and Coal of 4.1 MMTPA in FY 40, a Lo-Lo Terminal is proposed and to meet the Vehicles mobility of 13,000 in FY 20 and 28,000 in FY 40 a Ro-Ro Terminal is proposed, which are to be developed by IWAI, at later date.

The fairway requirements are being considered for analysis for its maximum / optimum utilization. Based on the existing fairway and the hindrances etc., it has been proposed to consider the development of the Initial stretch from Ch. 0.00 km to Ch. 19.64 km as Class VII for mobility of 8000 T as a convoy of 4 x 2000 T, up to the JSW Dharamtar Port area i.e., up to Ch. 19.00 km. The vessel / convoy requirement is 210 m (Length) x 28 m (Breadth) x 2.5 m (Draft). Accordingly, the fairway requirement is 100 m (Bottom Width) x 2.75 m (Depth) with Bend Radius of 900. Clearance corridor of 100 m Horizontal Clearance (HC) and 10 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel / Convoy.

However, M/s JSW is planning to deploy SPV with 115 m LOA x 22 m Beam x 4.8 m draft to achieve the economic scale of operation and in order to cater to the stake holder’s requirement, the fairway is considered with 110 m (Bottom width) x 5.3 m (Depth).

Balance Stretch from Ch. 19.64 km to Ch. 44.971 km has been limited to Class III waterway. The usage of the waterway in this stretch has been observed as minimal, rather nil. Considering the traffic study analysis and keeping in view the clearances in view, the stretch from 19.64 km to 44.971 km can be limited. Hence, it is not suggested for any development in this stretch.
The Fairway with the Dredging quantity details are provided herewith.

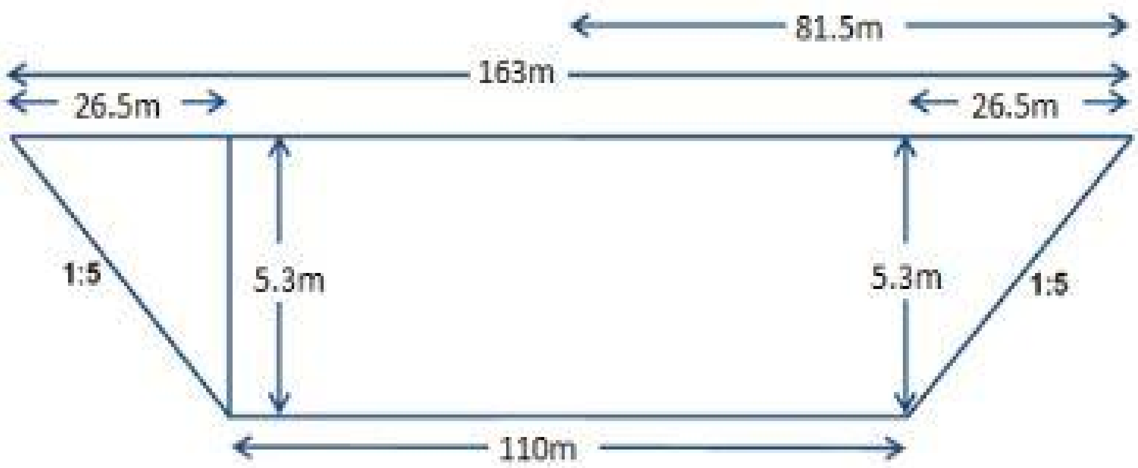
Class VII Waterway for Lower Reaches



Class	Chainage (km)		Observed				Reduced w. r. to. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Accumulated Qty. (Cu. M)
VII	0	10	TIDAL ZONE				1.6	7.9	450	3142.39	3142.39
VII	10	20					1.8	8.8	1500	8460.99	11603.38

The total shoal length is of 1950 m and dredging quantity is of 0.12 Lakhs Cu. M.

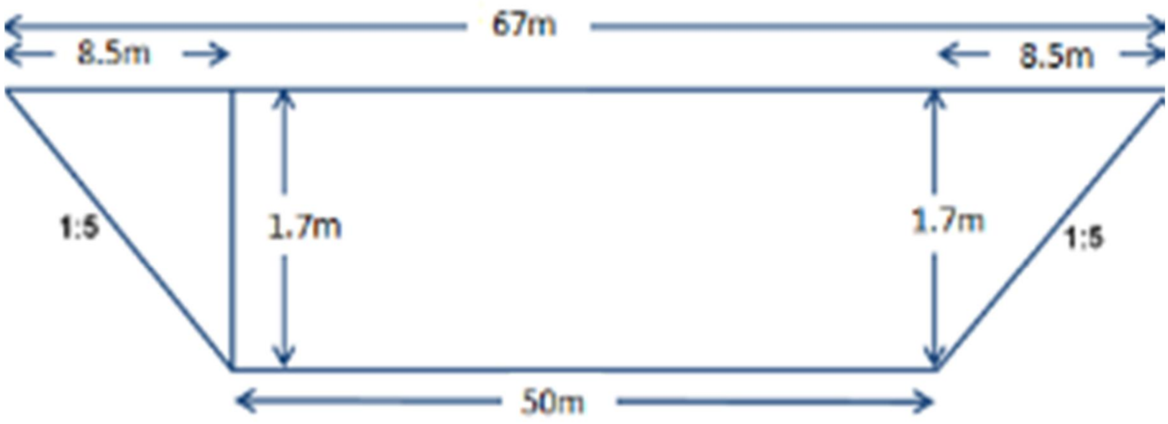
SPV for JSW mobility



Class	Chainage (km)		Observed				Reduced w. r. to. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Accumulated Qty. (Cu. M)
SPV	0	10	TIDAL ZONE				0.7	7.9	8500	1594204.67	1594204.67
SPV	10	20					1.5	8.9	9300	1496172.04	3090376.71

The total shoal length is of 17800 m and dredging quantity is of 30.9 Lakhs Cu. M.

Class III in upper reaches



Class	Chainage (km)		Observed				Reduced w. r. to. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Accumulated Qty. (Cu. M)
III	20	30	TIDAL ZONE				-0.8	6.7	3300	50595.17	50595.17
III	30	40					-0.5	7.0	8230	356856.92	407452.09
III	40	44.971					-0.2	4.9	4440	260299.86	667751.95

The total shoal length is of 15970 m and dredging quantity is of 6.68 Lakhs Cu. M.

The Development and Investment etc., are being proposed in TWO Phases i.e., in Phase 1, it is suggested to develop the Fairway stretch only up to Ch. 19.64 Kms to provide safe mobility of IWT Traffic of M/s JSW Energy and M/s PNP. Accordingly, the development is proposed for initial 3 years / up to 2020. A period of 5 years is suggested for critical and Micro Level observation on the Growth Trend of Traffic. It is suggested to consider the Phase 2 only after the increase in Traffic volumes and keeping in view the possible growth. In Phase 2, the development period is suggested of 3 years (2025 – 2028) and the proposed developments are Lo-Lo jetty; Ro-Ro jetty and the Fairway development beyond Ch. 19.64 km and up to 44.971 Km with Class III standards.

It was understood that 2 Pipelines are passing across the Karanja Creek i.e., 26” dia Pipeline of GAIL and 10” dia Pipeline of IPCL and the same are beyond the purview of the study area. However, while considering the 5.3 m depth of fairway for SPV mobility, depending on its present location (according to depth), the same may have to be deep trenched or rerouted. This aspect may have to be looked into in consultation with the concerned authorities by IWAI at the appropriate time at the implementation stage. A provision of INR 125 Crores has been catered with market enquiry for deepening to the level of IWT mobility, which however has not been considered as a part of capital cost, since the same has to be borne by the concerned stake holders.

In order to provide a safe navigable fairway, in Phase 1, dredging of about 34 Lakhs Cu. M; Beacon / Lights of 5 Nos; Buoy / Lights of 50 Nos; Rerouting of the Pipe Lines and Provision of River Information system are suggested along with the Institutional Requirements etc., are suggested and recommended.

Terminal requirement has been considered in Phase 2 with 1 Lift-on Lift-off (Lo-Lo) IWT Terminal along with handling facilities and 1 Roll-on Roll-off (Ro-Ro) IWT Terminal for vehicle transhipment. Taking into the consideration of the origin and destination and fairway, the most probable location can be just Downstream of the existing PNP jetty area on the left side of the river. The location near the Ch. 18.45 Km (within the Ch. 19.41 km, wherein the fairway development is under consideration for Class VII) with approx Lat 18°42'34.36"N and Long 73° 1'20.63"E. This location is comparatively having lesser mangroves concentration and just adjacent to the PNP industry area.

A tentative Land requirement has been worked out and arrived at with 35,000 Sq. M and the Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Vadkhal Village; Pen Taluka; Raigarh District of Maharashtra state. Geotechnical Investigations have been taken up and the Preliminary structural Designs etc., have been considered accordingly.

As per the Class VII waterway classification, the maximum of 8000 T is to be mobilized in 4 x 2000 T barges with 12 m - 14 m width and 2.5 m Loaded Draft / 2.75 m Depth in front of the Berthing Structure. Considering the vessel size of berthing of 2 SPVs / 2 DBs of 86 m (say 90 m) each, the optimum length of Berth requirement has been taken as 120 m. In this length of 120 m, 4 cranes shall be made operational at any point of time. It is suggested to initially deploy 2 Rubber mounted cranes capable of handling 125 TPH with 80 % efficiency, which will be increased to 4 Cranes. In the ultimate requirement, it will be considered as 2 Berths + 8 Cranes to meet the 4.5 MMTPA.

The Ro-Ro vessel size has been proposed with 52.80 m – 55.0 m of LOA; 12 m – 14.0 m Breadth x 1.94 m Loaded Draft / 2.50 m Depth, which can carry up yo 21 Nos. TEU. Initially the operation will be taken up with one vessel deployment and can be increased to meet the required handling of 28,000 vehicles P. A i.e., approx 95 to 100 vehicles per day, which can be completed in 5 cycles.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
RO RO	84	16.60
LO LO	120	32

Regarding the Ro-Ro Operations an academic type of exercise has been considered and, as such this operation is not found viable and may have to be considered with subsidy, hence not recommended. In this analysis, other hidden positive indirect factors viz., Carbon Credit / Road movement through hilly tracks / Road jams etc., could not be quantified. In such a scenario with Micro Level critical analysis, the Ro-Ro operation may become viable. An attempt has been made in this report with provision of data and working for usage, after some time at later date.

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

The Vessel Design has been discussed with international standards, as in vogue. To meet the mobility of the cargo in excess after attaining the saturation level by the infrastructure at captive Terminal locations, the following Vessel sizes are suggested and proposed for deployment in line with the Terminal Development. The convoy system only has been suggested. Costs are indicative. Deployment will be by Entrepreneurs.

Self-Propelled Vessel: (2000 T) {Not Recommended} with Length – 86 m to 90 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 2.5 m / 3.0 m +; Cargo Capacity – 2000 T and Propulsion by Marine Diesel Engines of 3 x 625 Bhp is costing about **INR 1000 Lakhs each.**

Pusher Tug: with Length – 30 to 40 m; Breadth – 12 to 14 m; Draft / Depth – 1.7 m / 2.0 m + and Propulsion by Marine Diesel Engines of 3 x 800 Bhp is costing about **INR 900 Lakhs each.**

Dumb Barge: with Length – 86 m to 90 m; Breadth – 12 to 14 m; Loaded Draft / Depth – 2.5 m / 2.75 m +; Cargo Capacity – 2000 T is costing about **INR 650 Lakhs each.**

Ro-Ro Vessel: with Length – 52.80 m to 55 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 1.94 m / 2.5 m +; Cargo Capacity – 21 Nos. TEUs and Propulsion by Marine Diesel Engines of 3 x 375 Bhp is costing about **INR 800 Lakhs each.**

2 PTs + 8 DBs may be required by 2028.	**{Construction from 2025 to 2028}**
Other 2 PTs + 8 DBs may be required by 2035.	**{Construction from 2032 to 2035}**
2 Ro-Ro vessels may be required by 2028.	**{Construction from 2025 to 2028)**
Other 3 Ro-Ro vessels may be required by 2035.	**{Construction from 2032 to 2035}**

Vessel of M/s JSW: with Length – 115 m; Breadth – 22 m; Loaded Draft / Depth – 4.8 m / 5.3 +; Cargo Capacity – 8000 T to 10000 T.

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

Regarding the Navigation & Communication System, the provision of RIS / AIS / Locating the Vessels / Buoys have been worked out. 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 synchronised fool proof communication / navigation system in the National Waterways joining the sea in both west / east coast. Since the present Traffic is heavy, the need of implementation of River Information System is suggested and recommended along with the provisions.

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 fitted with Survey Instruments; Related Software; Laptop; 2 Nos. Tugs and 2 Nos. Inspection Boats (Speed Boats) etc,

As explained above, the development is suggested in TWO Phases. The cost estimates have been worked out for the above suggested 2 Phases.
Fairway in Phase 1 is working out to INR 213.57 Cr.
Fairway in Phase 2 is working out to INR 76.80 Cr.
Lo-Lo Terminal in Phase 2 is working out to INR 66.2 Cr.
Ro-Ro Terminal in Phase 2 is working out to INR 15.1 Cr.

All the capital assets will be provisioned in 36 months. Phase 2 is not recommended at this stage. Investment decision for Phase 2 may have to be considered in 2025 after observing the growth trend between 2020 and 2025. The FIRR and EIRR have been worked out and the details are placed.

Project Modules	FIRR	EIRR
Fairway	10.7 %	82.4 %
Lo-Lo Terminal	- 4.5 %	91.8 %
Ro-Ro Terminal	- 21.0 %	64.4 %

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 4000km 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 (Tamilnadu) 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

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
7.	Shastri River/ Jaigad creek	NW-91	52	Maharashtra
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 Amba (NW 10) 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 Amba River – NW 10 for a distance of 44.971 kms from the Arabian Sea mouth to Upstream, in the state of Maharashtra.

TABLE 1-3: Description of Amba River (NW-10)

Sl. No.	Introductory Consideration	Description of the River
1.	Name of the river / canal	Amba River (NW-10)
2.	State/ District through which river passes	The Amba River passes through the Raigad district of Maharashtra State.
3	Length of the river / canal	Amba River is 76 km long and originates in the Borghat hill of the Sahyadri ranges and joins the Arabian Sea in Dharamtar creek near village Revas. Out of the total 76 km, 45 km length of the Amba 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 at Lat 18°32'19.82"N, Long 73° 8'0.29"E have been declared as new national waterway and proposed to undertake the two stage DPR.
4	Map	The index map of Amba River showing proposed waterway stretch, topographic features and road networks are shown in Figure1.1. The study stretch of the Amba River for the Detailed Project Report (DPR) is presented in Volume-II Drawing No. P. 010257-W-20301-A03 (Sheet – 1 to 7).
Characteristic of River		
5	River Course	The river Amba originates in the Borghat hill of the Sahyadri ranges and joins the Arabian Sea in Dharamtar creek near village Revas. The total length of the river is about 76 km; major portion of the river is affected by tide (backwater effect) of the Arabian Sea. The Amba River meets the tidal wave at Nagothane. The total identified stretch of Inland Waterway of Amba River is under tidal zone. Just downstream of Nagothane, the river channel at low tide being blocked by rocky ledges. Near Dharamtar, the rocks disappear leaving a deep muddy channel, about 1.5km wide, with low swampy banks green with mangrove and other sea bushes.
6	Tributaries / Network of Rivers / Basin	The River Amba receives two streams from the right bank and two from the left. Of the right bank streams the Nigde river, joins the Amba about 10km below Nagothane. The next, about 19km further, is the Vasi, a salt creek. The tributaries from the left are the Shahapur River, falls into the Amba, about 8km below Dharamtar. The other is the Revas creek, joins the Amba at Revas, about 02km from its entrance into Bombay harbor.
7	Catchment Area	The total catchment area of Amba River is 740 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, harbors 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

Amba River originates in the Borghat hill of the Sahyadri ranges near Khopoli-Khandala road at an altitude of about EL 554.0m and joins the Arabian Sea in Dharamtar creek near village Revas; district Raigad in the state of Maharashtra. Amba River initially flows in the South up to Wazaroli and then turns further in to North West direction and finally merge in to the Arabian Sea.

The Amba River is bounded by Nagothane, Welshet, Bense, Zotirpada, Palas and Takhar in the upper stretch, Gandhe, Durgadarya, Samberi, Chikhli, Kalai, Pandapur and Fanasapur in the middle stretch and Waghwira, Pitakiri, Kachali, Walawade, Dhakte Shahapur, Mankule, Ranjankhar Davali, Khar Davali, Beneghat, Narvel and Karanja in the lower stretch.

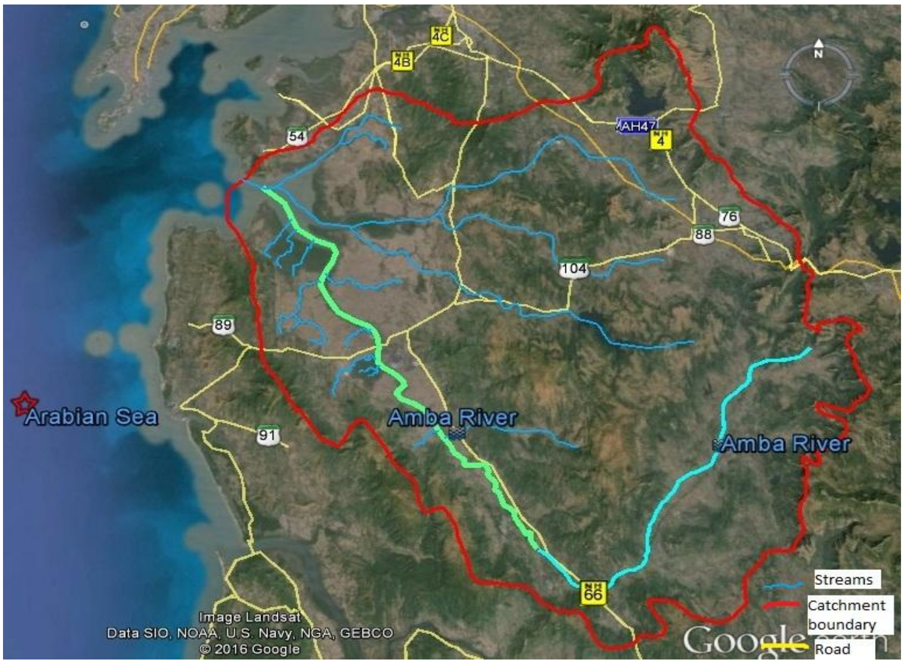


FIGURE 2.1: Catchment Area Map of Amba River (Source: Google Earth)

The total catchment area of Amba River basin is 740 sq-km. The total length of the river from origin to its outfall in the Arabian Sea is 76.0km. The present study is for 44.971 kms from the confluence with the sea as 0.00 km. Amba River has a relatively small catchment area. Its tributaries are small feeder streams and canals such as Patalganga stream, Nigade stream, Bori-Khadi, Kolave Khadi from right bank, Mankule Khadi and Mhasoba Mandir Lake from left bank.

A map showing Amba 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.

For Amba River, the soil texture has been observed during the reconnaissance survey. It is observed that soft clay soil is found in most part of the river under study stretch. Sand and scattered rocky patches are found in the upper study stretch beyond Ch 30.00 km.

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 the detailed survey this fact was checked and found that the discharge of River Amba is influenced by tide at the end reaches.

Geomorphology

According to the classification of the waterway (from class I to class VII), the maximum width and maximum depth requirement have been considered 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.

Amba River (Ch 0.00 km - Ch 10.00 km)

The satellite images for the stretch of first 10 km for four time periods have been placed (November, 2003; December, 2005; April, 2011 and October, 2016).

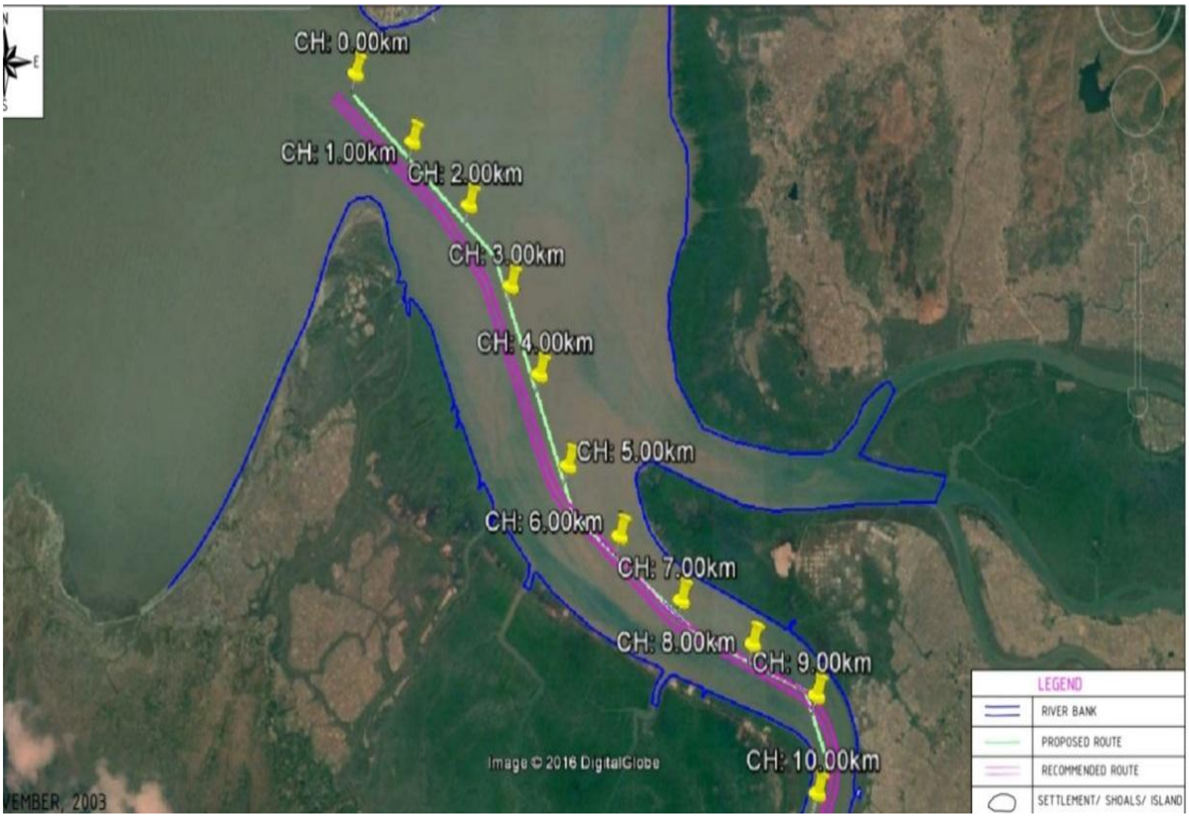


FIGURE 2.2 : River stretch from Ch 0.00km to 10.00km in November, 2003 (Source: Google Earth)

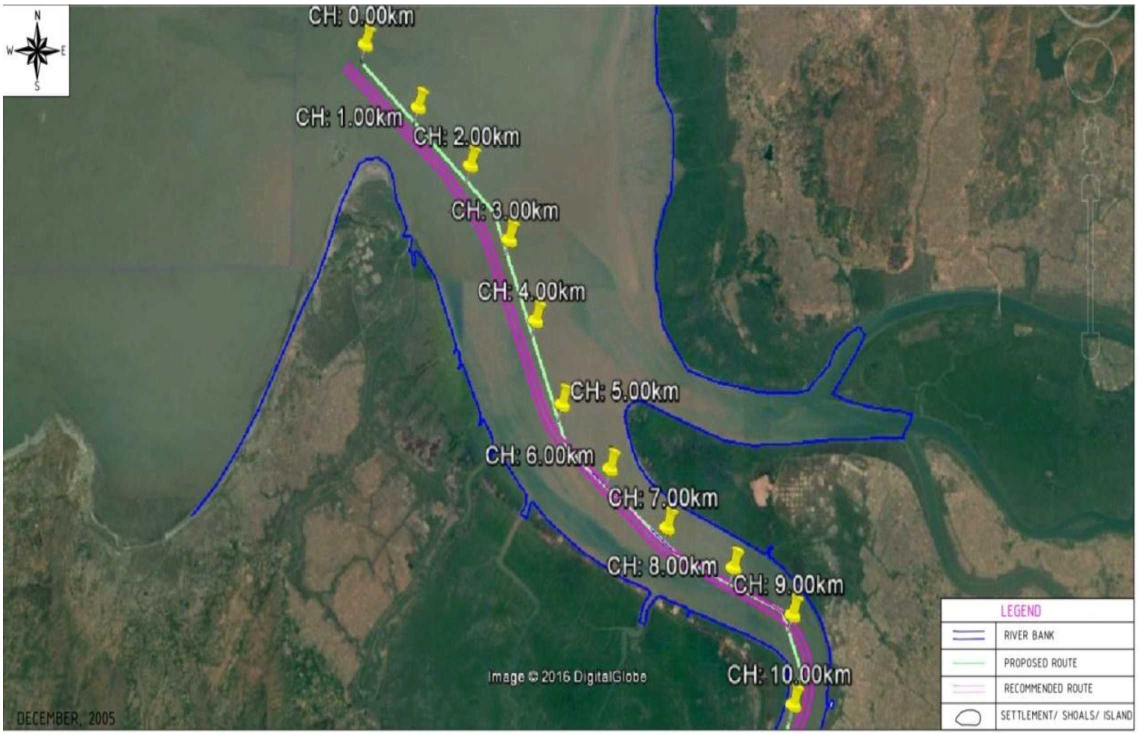


FIGURE 2.3 : River stretch from Ch 0.00km to 10.00km in December, 2005 (Source: Google Earth)

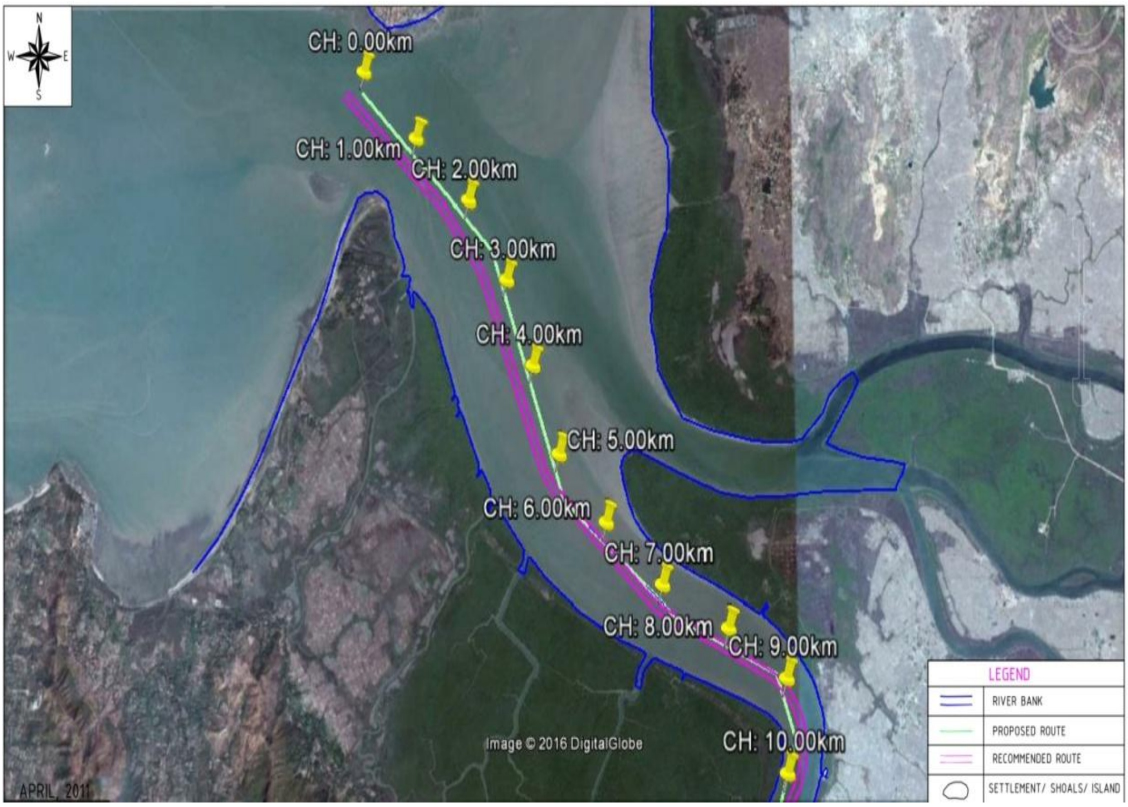


FIGURE 2.4 : River stretch from Ch 0.00km to 10.00km in April, 2011 (Source: Google Earth)

FIGURE 2.5 : River stretch from Ch 0.00km to 10.00km in October, 2016 (Source: Google Earth)

The depth of water is observed to be shallow in years 2003 and 2005. Minor effect of accretion is seen in these time periods which are predominant up to Ch 7.00 km. However, depth is seen to be sufficient from the images of 2011 and 2016.

One very small shoal is present on the right bank near Ch 10.00 km which shows inconsiderable migration during the time. Slight change in the river bank is observed from November, 2003 to October, 2016.

Five tributaries join on the left bank near Ch 3.00 km, Ch 5.00 km, Ch 6.00 km, and Ch 7.00 km and between Ch 10.00 km and Ch 11.00 km. Two tributaries join the right bank of the river between Ch 8.00 km and Ch 9.00 km.

In all the above four figures, it has been noted that the river flow passes through a narrow strip with bend near Ch 10.00 km. No significant variation observed.

Amba River (Ch 11.00 km - Ch 20.00 km)

The satellite image for the stretch of next 10 km for four time periods has been placed (November, 2003, December, 2005, April, 2011 and October, 2016).

FIGURE 2.6 : River stretch from Ch 11.00km to 15.00km in November, 2003 (Source: Google Earth)

FIGURE 2.7 : River stretch from Ch 11.00km to 15.00km in December, 2005 (Source: Google Earth)

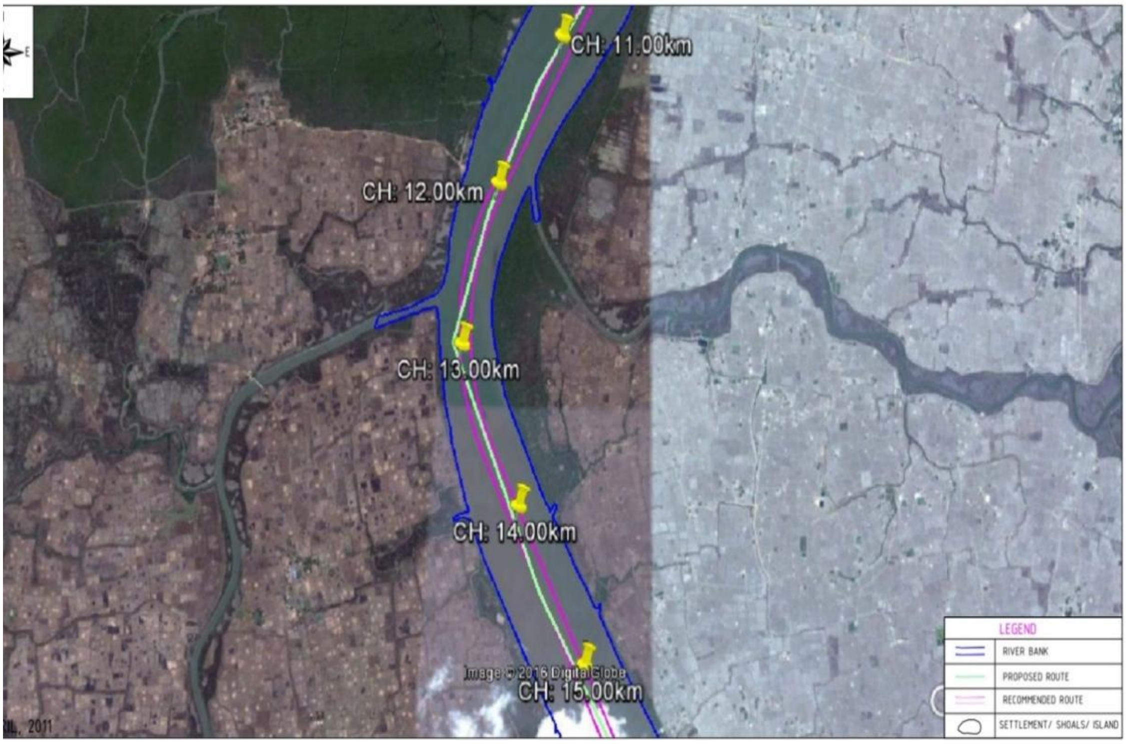


FIGURE 2.8 : River stretch from Ch 11.00km to 15.00km in April, 2011 (Source: Google Earth)

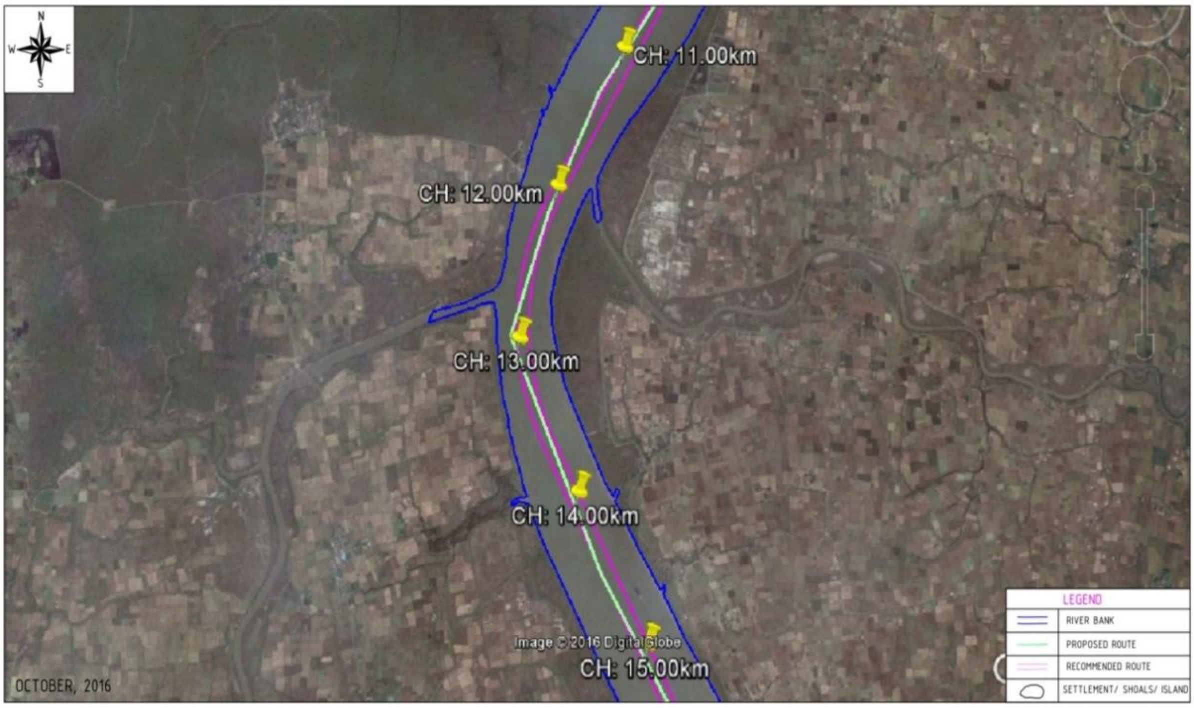


FIGURE 2.9 : River stretch from Ch 11.00km to 15.00km in October, 2016 (Source: Google Earth)

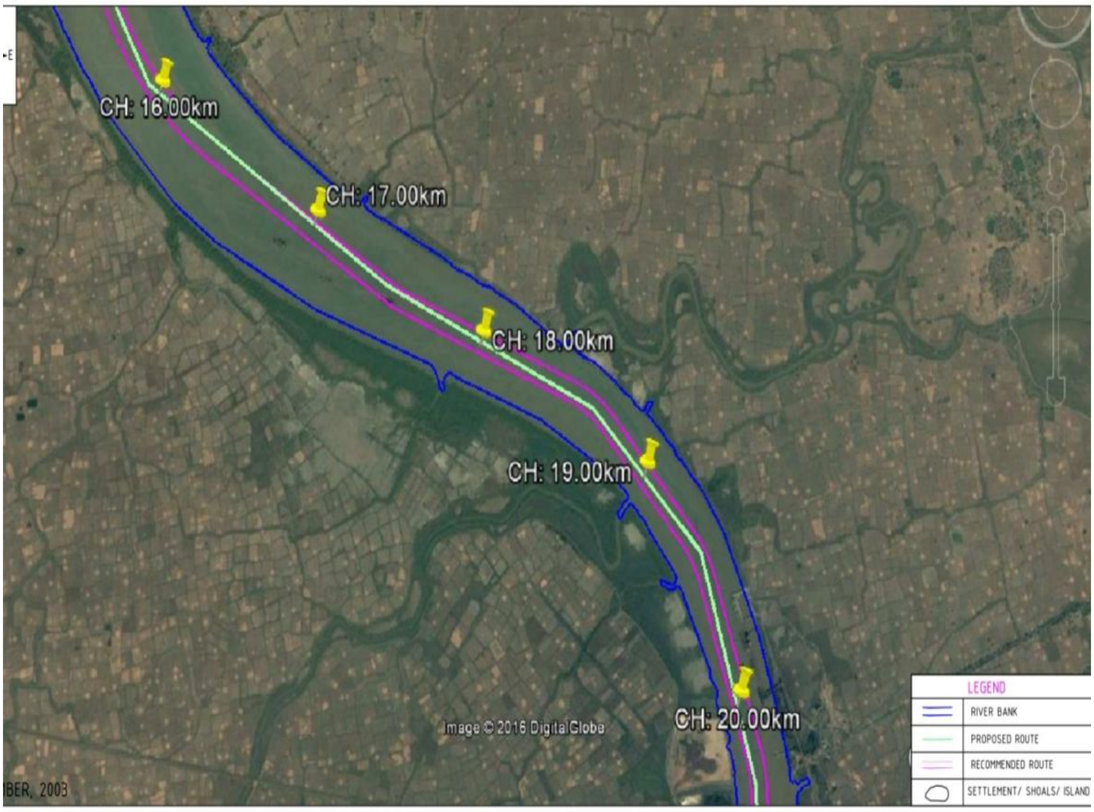


FIGURE 2.10 : River stretch from Ch 16.00km to 20.00km in November, 2003 (Source: Google Earth)

FIGURE 2.11 : River stretch from Ch 16.00km to 20.00km in December, 2005 (Source: Google Earth)

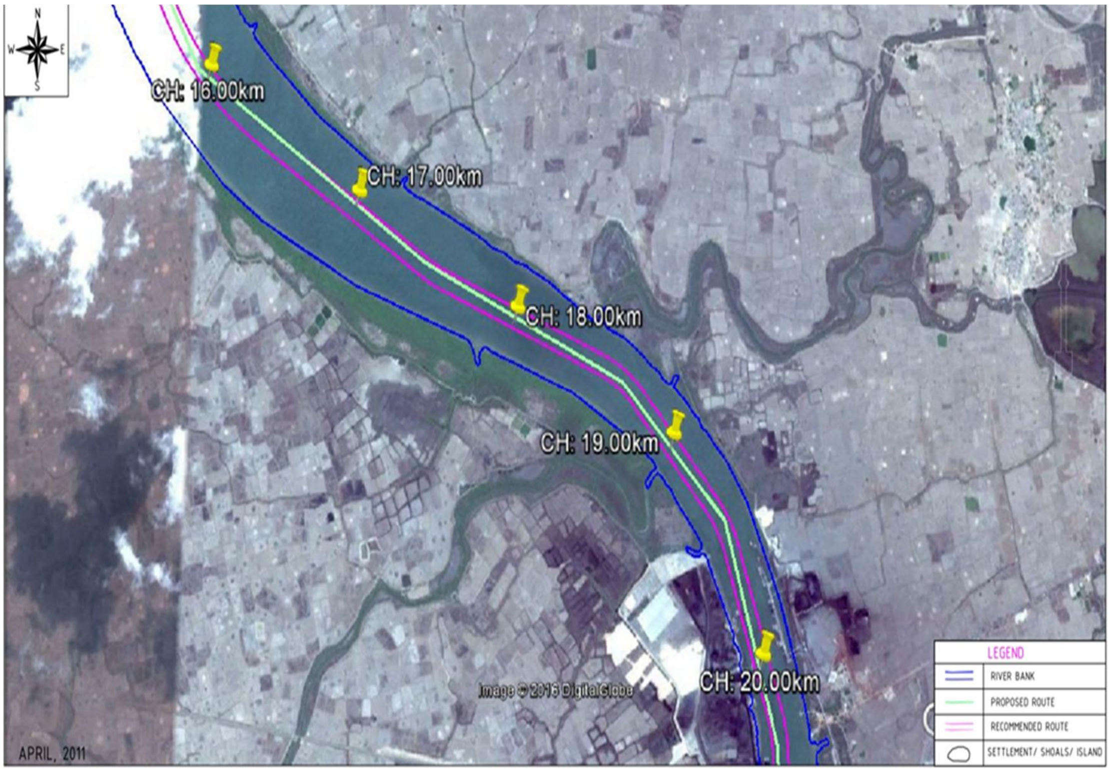


FIGURE 2.12 : River stretch from Ch 16.00km to 20.00km in April, 2011 (Source: Google Earth)

FIGURE 2.13 : River stretch from Ch 16.00km to 20.00km in October, 2016 (Source: Google Earth)

Comparing all the figures, minor change in both the banks are seen in November, 2003. However this shift is noticeable mainly in the left bank in December, 2005.

River depth is sufficient throughout the time period within this stretch.

Two tributaries join the river on the right side, one between Ch 11.00 km and Ch 12.00 km and the other near Ch 18.00 km. Two tributaries join the river on the left side, one between Ch 12.00 km and Ch 13.00 km and the other near Ch 19.00 km.

There are no shoals in this stretch.

Amba River (Ch 21.00 km - Ch 30.00 km)

The satellite images for the stretch of next 10 km for four time periods have been placed (November, 2003, December, 2005, April, 2011 and October, 2016).

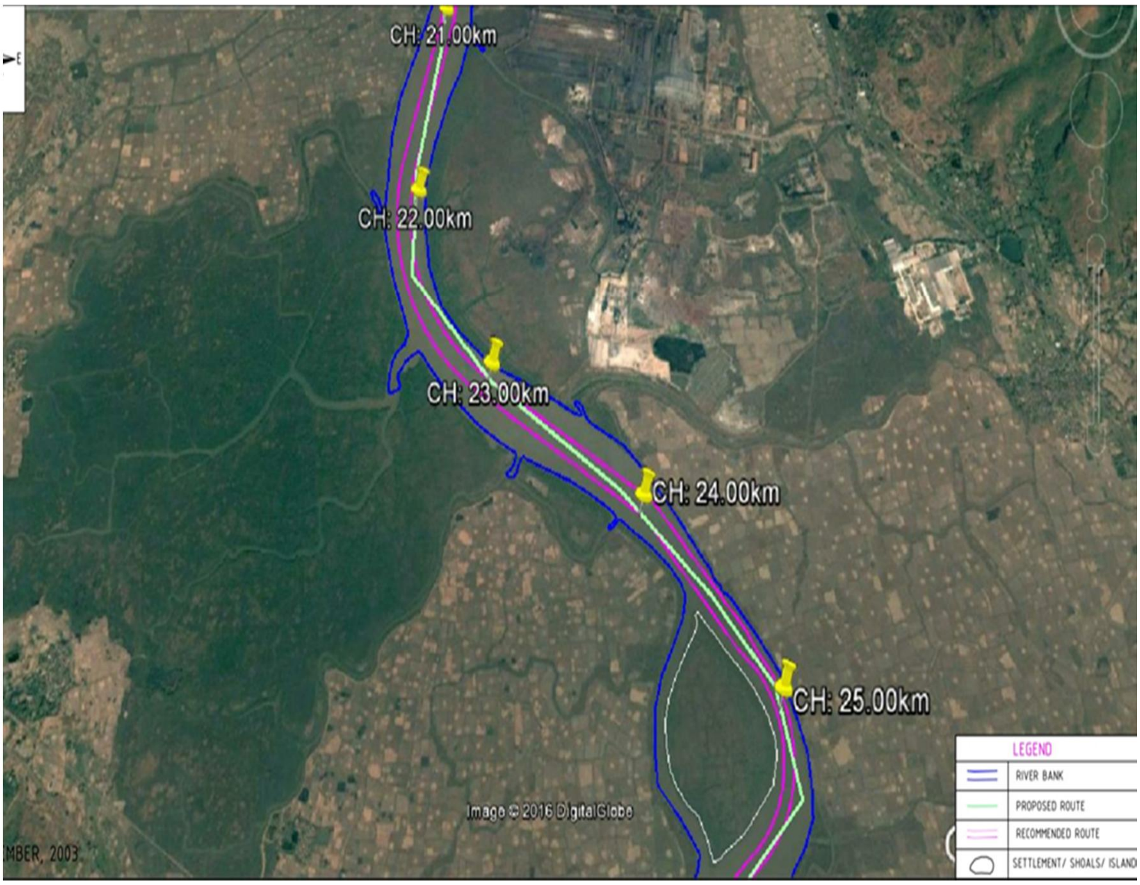


FIGURE 2.14 : River stretch from Ch 21.00km to 25.00km in November, 2003 (Source: Google Earth)

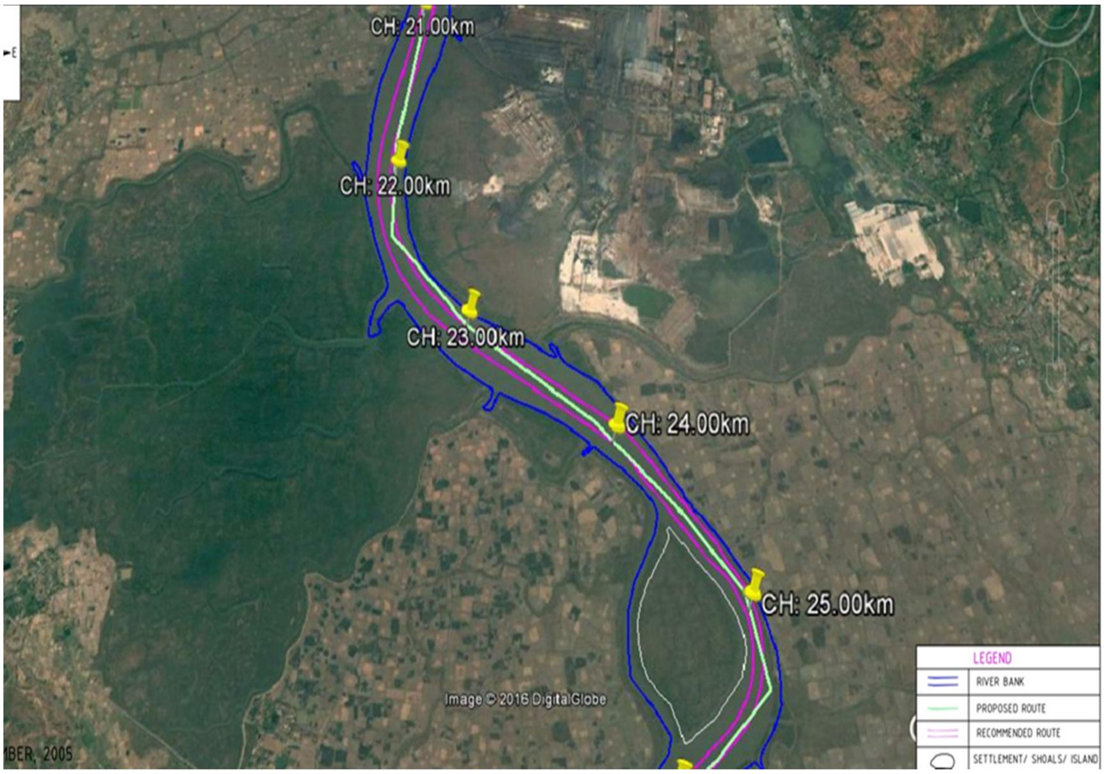


FIGURE 2.15 : River stretch from Ch 21.00km to 25.00km in December, 2005 (Source: Google Earth)

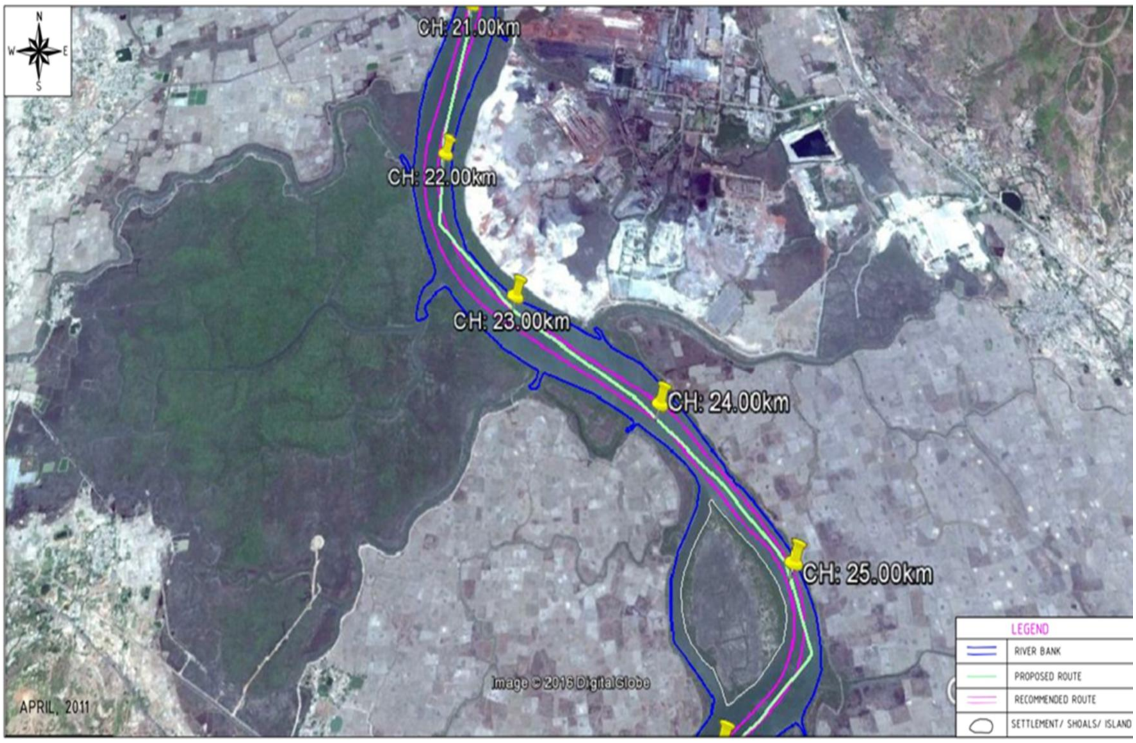


FIGURE 2.16 : River stretch from Ch 21.00km to 25.00km in April, 2011 (Source: Google Earth)

FIGURE 2.17 : River stretch from Ch 21.00km to 25.00km in October, 2016 (Source: Google Earth)

FIGURE 2.18 : River stretch from Ch 26.00km to 30.00km in November, 2003 (Source: Google Earth)

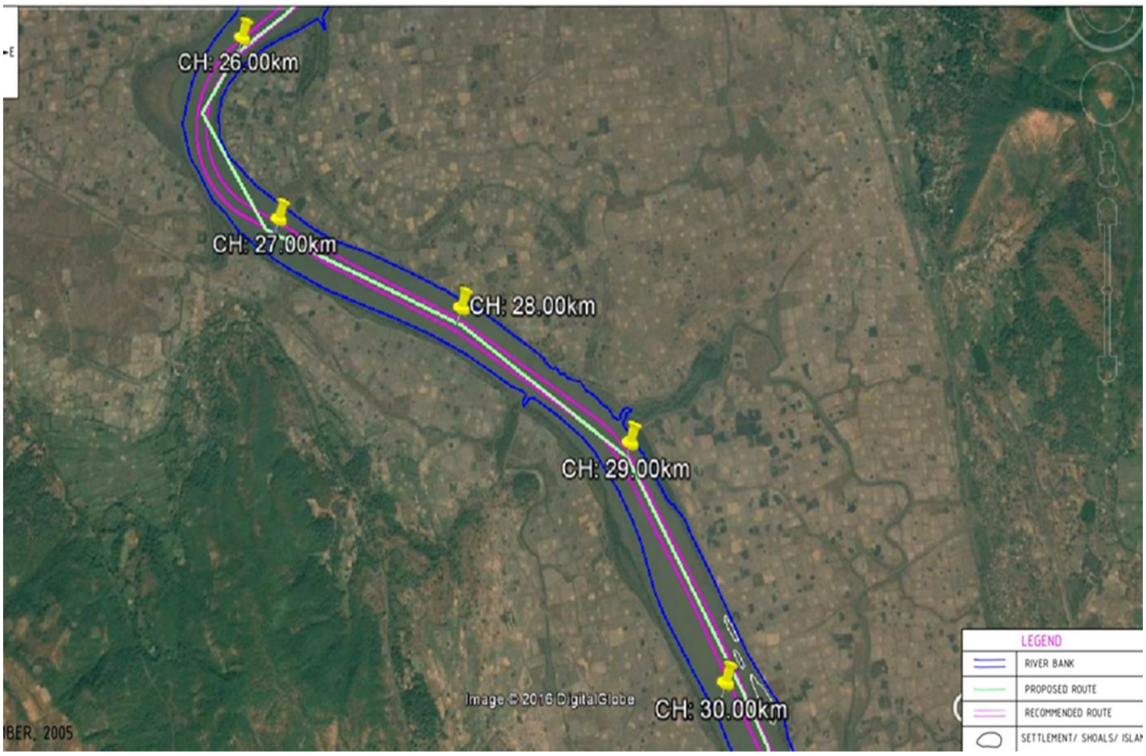


FIGURE 2.19 : River stretch from Ch 26.00km to 30.00km in December, 2005 (Source: Google Earth)

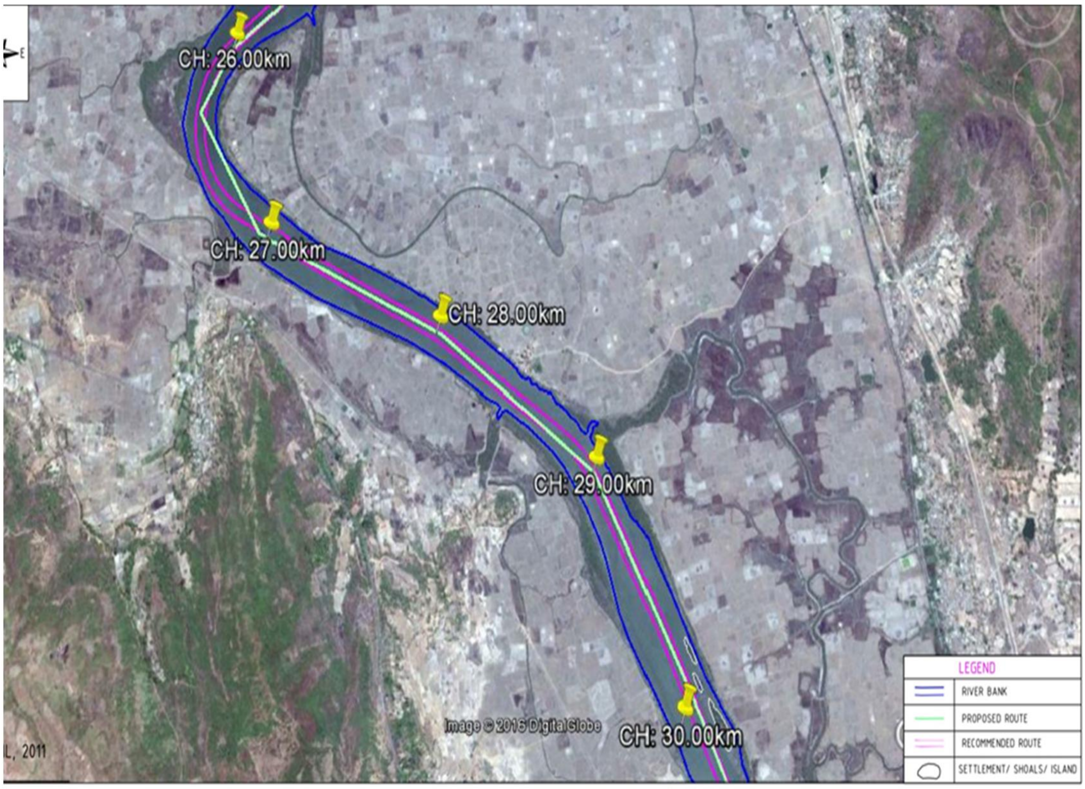


FIGURE 2.20 : River stretch from Ch 26.00km to 30.00km in April, 2011 (Source: Google Earth)

FIGURE 2.21 : River stretch from Ch 26.00km to 30.00km in October, 2016 (Source: Google Earth)

One big shoal is present near Ch 25.00 km. Slight migration of the shoal is observed in November, 2003 and December, 2005 towards the left bank. It splits the river which joins again. Three small shoals are present at Ch 30.00 km. In November, 2003 these shoals were smaller in size and a little left from the present position. However in April, 2011 the size of these land masses increased, which infer that it might have submerged, with time, as seen in October, 2016.

The left river bank has shifted, near Ch. 30.00km, which can be seen while comparing the four figures. The change is seen throughout when left bank line of November, 2003 is compared to that of October, 2016. However from figure of December, 2005 major change can be seen near Ch 26.00 km and between Ch 28.00 km and Ch 30.00 km.

From the above figures, it has been noted that the river flow passes through a narrow strip with bend between Ch 26.00 km and Ch 27.00 km.

No significant variation observed.

Amba River (Ch 31.00 km - Ch 40.00 km)

The satellite image for the stretch of next 10 km for three time periods have been placed (December, 2005; April, 2011 and October, 2016).

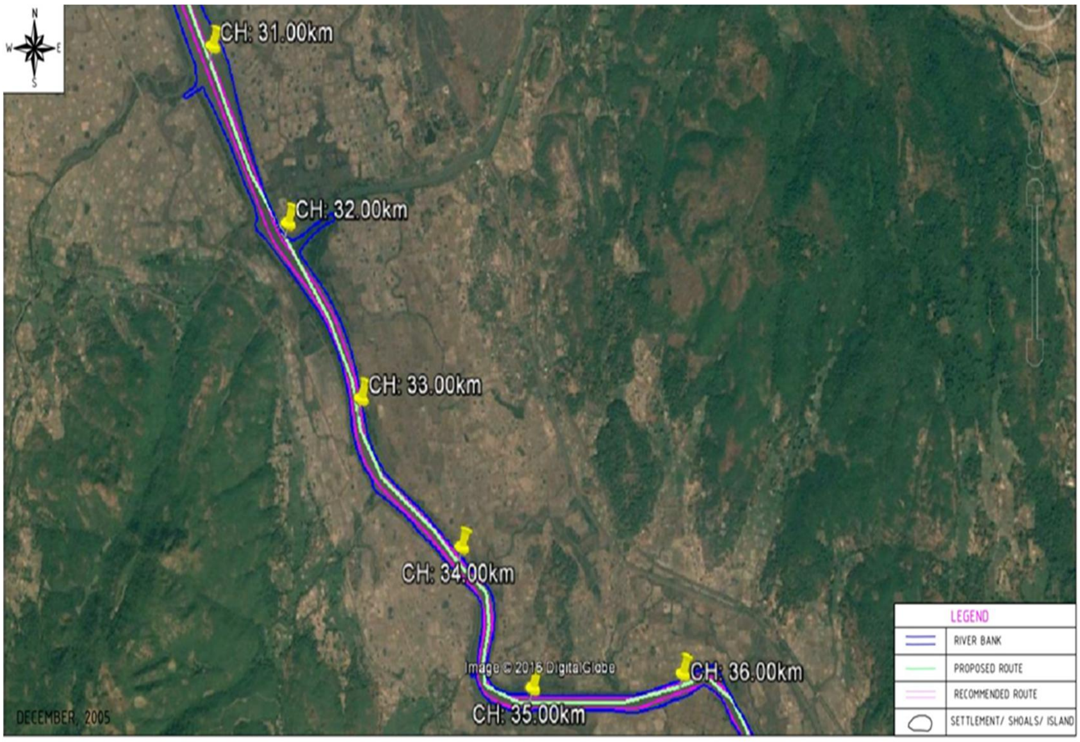


FIGURE 2.22 : River stretch from Ch 31.00km to 36.00km in December, 2005 (Source: Google Earth)

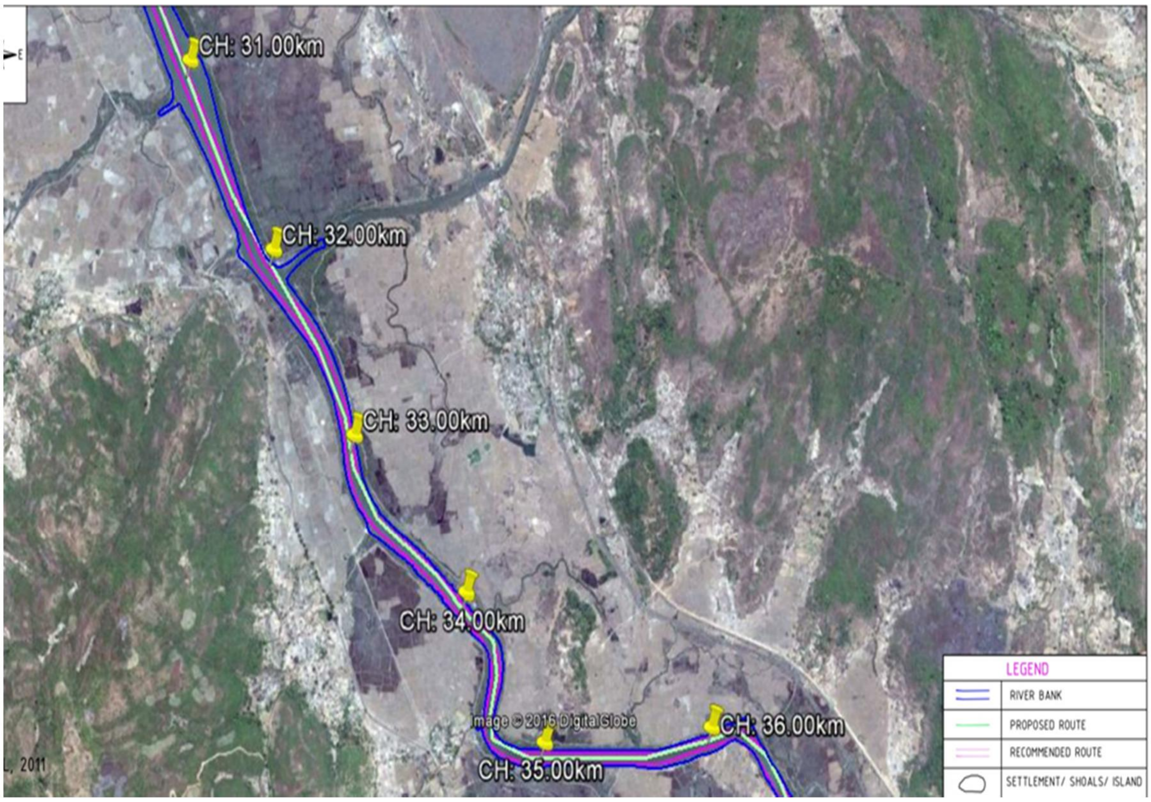


FIGURE 2.23 : River stretch from Ch 31.00km to 36.00km in April, 2011 (Source: Google Earth)

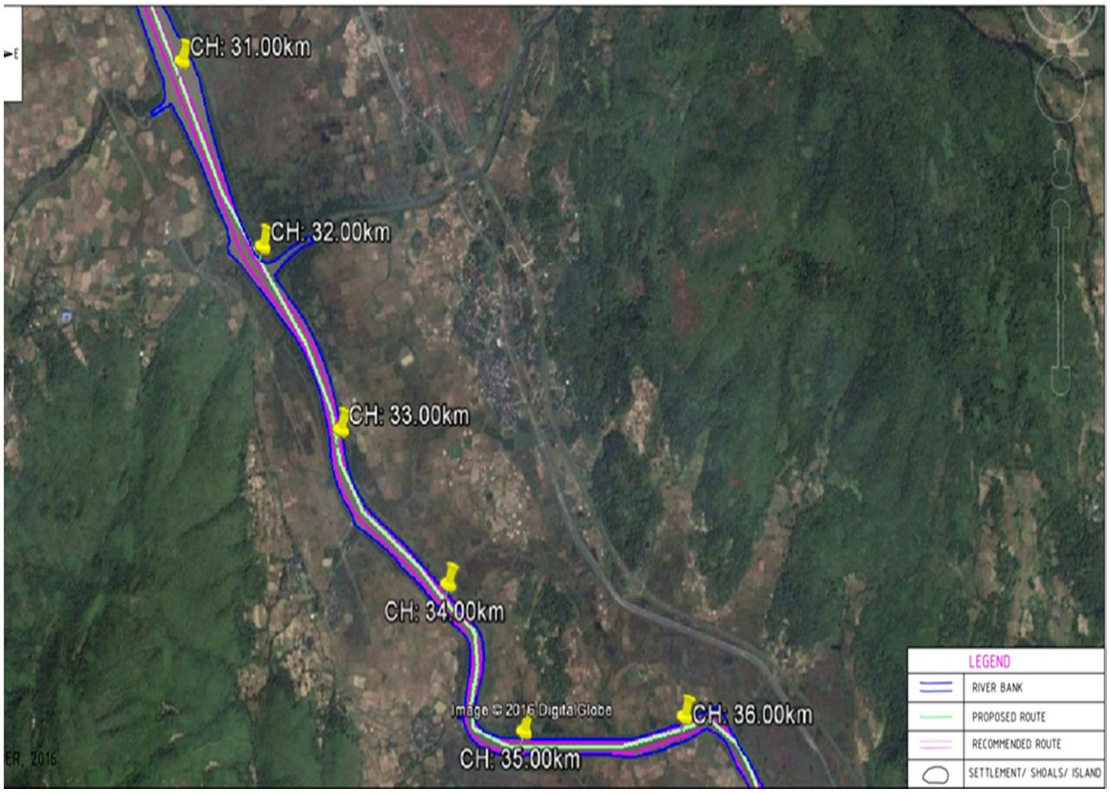


FIGURE 2.24 : River stretch from Ch 31.00km to 36.00km in October, 2016 (Source: Google Earth)

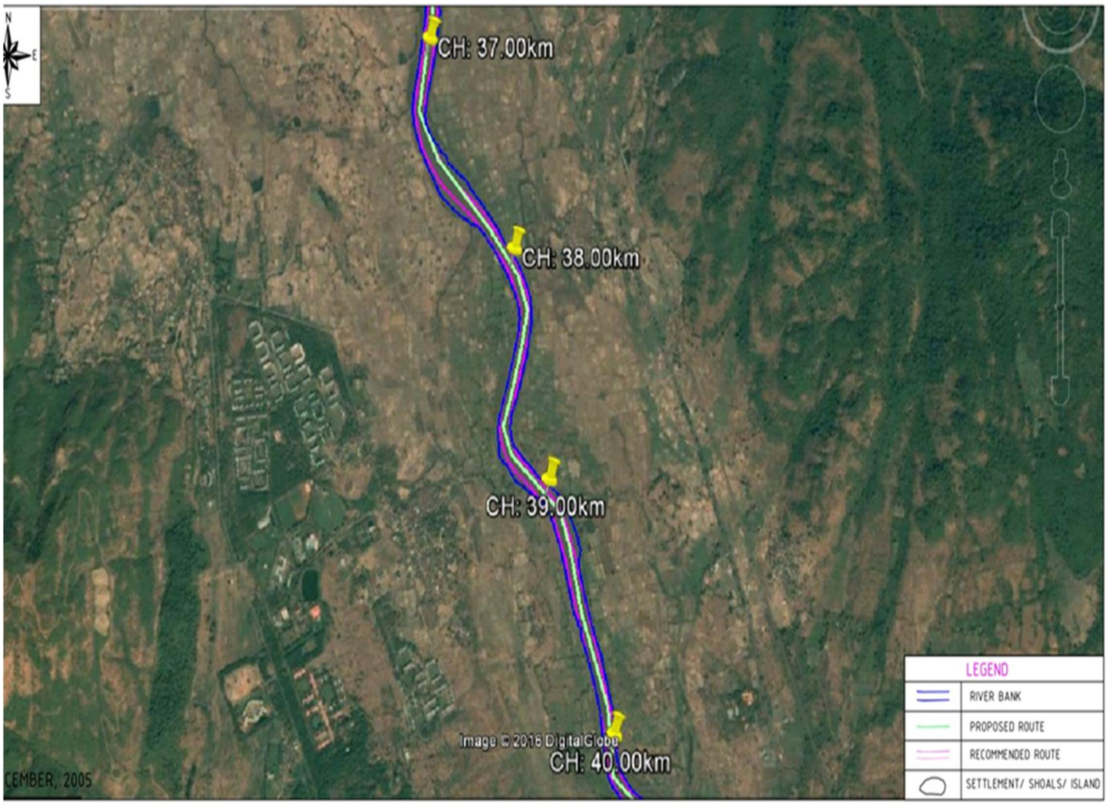


FIGURE 2.25 : River stretch from Ch 37.00km to 40.00km in December, 2005 (Source: Google Earth)

FIGURE 2.26 : River stretch from Ch 37.00km to 40.00km in April, 2011 (Source: Google Earth)

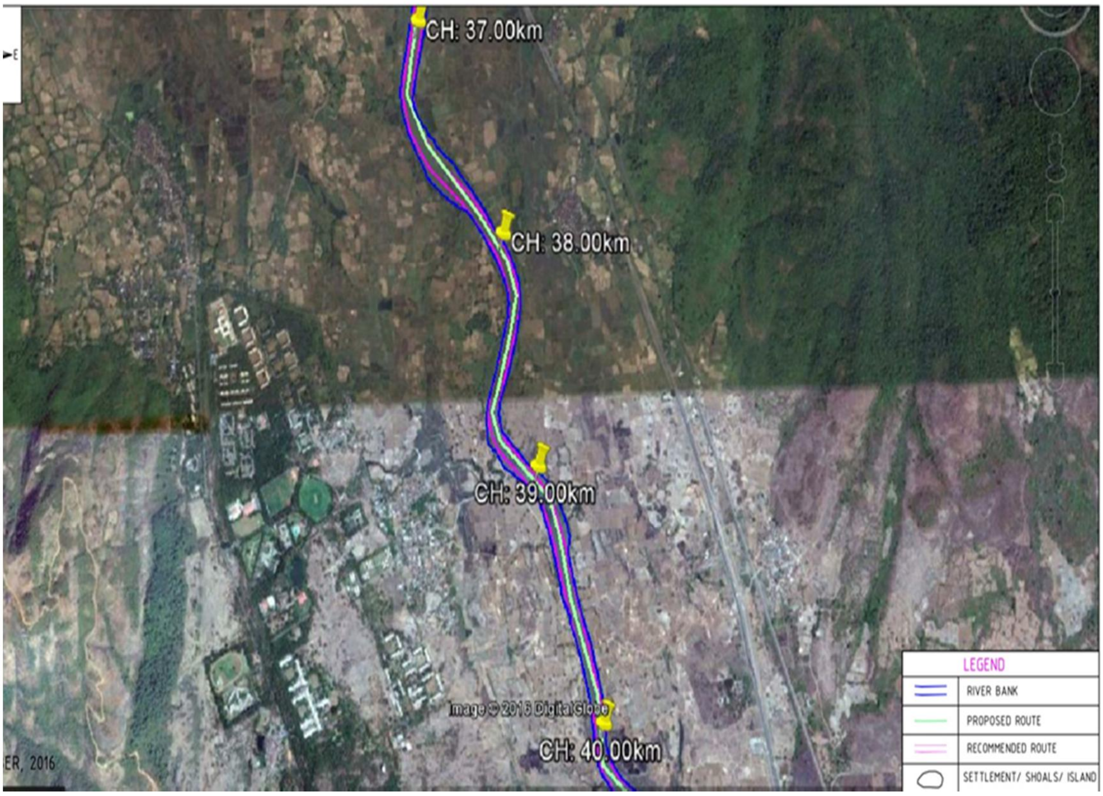


FIGURE 2.27 : River stretch from Ch 37.00km to 40.00km in October, 2016 (Source: Google Earth)

The width of the river decreases after Ch 31.00 km. From figure of December, 2005 major change can be seen near up to Ch 32.00 km. There are no shoals present in this stretch.

In the above figures it has been noted that the river flow passes through a narrow strip with two bends between Ch 34.00 km and Ch 37.00 km. No significant variation observed.

Amba River (Ch 41.00 km - Ch 44.971 km)

The satellite image for the stretch of next 4.971 km for four time periods has been placed (December, 2005, April, 2011 and October, 2016).

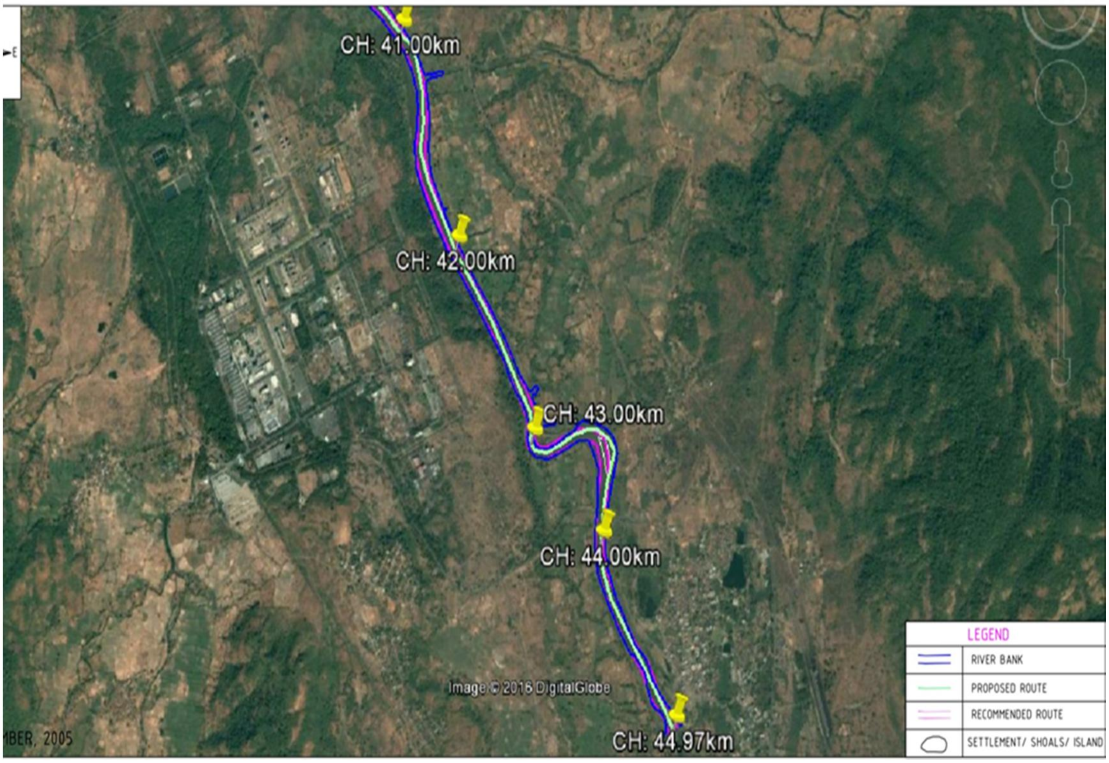


FIGURE 2.28 : River stretch from Ch 41.00km to 44.97 km in December, 2005 (Source: Google Earth)

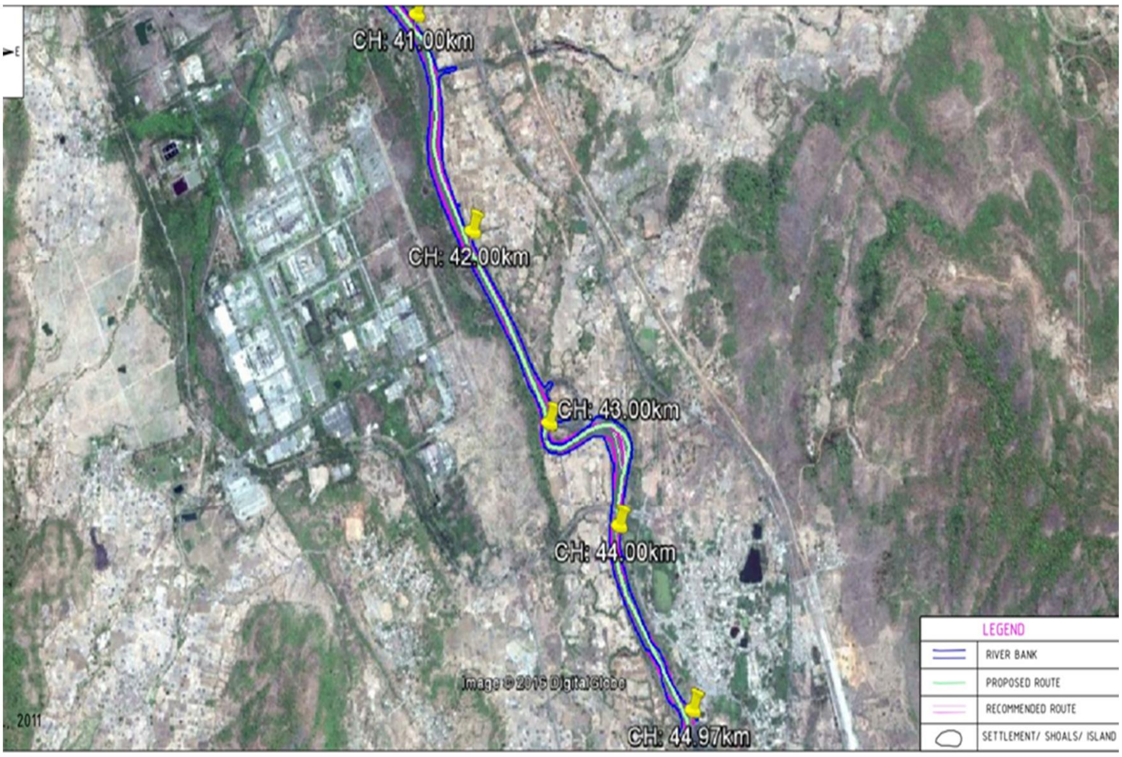


FIGURE 2.29 : River stretch from Ch 41.00km to 44.97 km in April, 2011 (Source: Google Earth)

FIGURE 2.30 : River stretch from Ch 41.00km to 44.97 km in October, 2016 (Source: Google Earth)

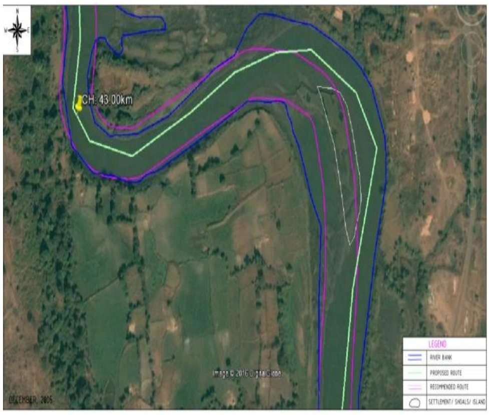


FIGURE 2.31: River stretch near Ch 43.00 km in December, 2005 (Source: Google Earth)

FIGURE 2.32: River stretch near Ch 43.00 km in April, 2011 (Source: Google Earth)

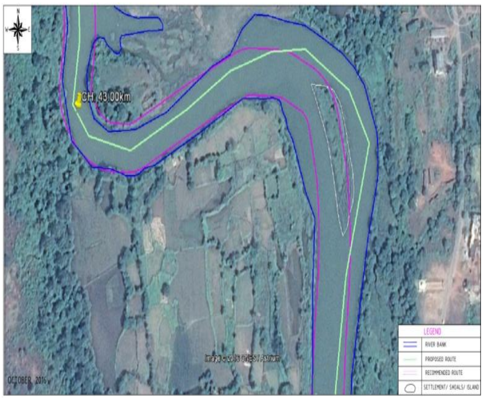


FIGURE 2.33: River stretch near Ch 43.00 km in October, 2016 (Source: Google Earth)

One shoal is present between Ch 43.00 km and Ch 44.00 km. Comparing all the figures, it is seen that the shape of the shoal changes and there is no migration. The settlement of the soil decreases in size over the time from 2005 to 2016.

In the above figures it has been noted that the river flow passes through a narrow strip with bend between Ch 43.00 km and Ch 44.00 km. No significant variation observed.

Conclusion

From Ch 0.00 km to Ch 44.97 km, a total of six shoals were present out of which some were found to be immobile and some showed migration. However none of the shoals affect the waterway route. Therefore no significant dredging is required except for maintenance of Class fairway. Eleven tributaries are found throughout the stretch. The river passes through almost five bends.

From the satellite images of the above mentioned time periods, it is seen that river bank line experiences some shift during December, 2005 as compared to that in December, 2016 as mentioned above. This shift is predominant in the lower stretch of the river i.e. up to Ch 32.00 km.

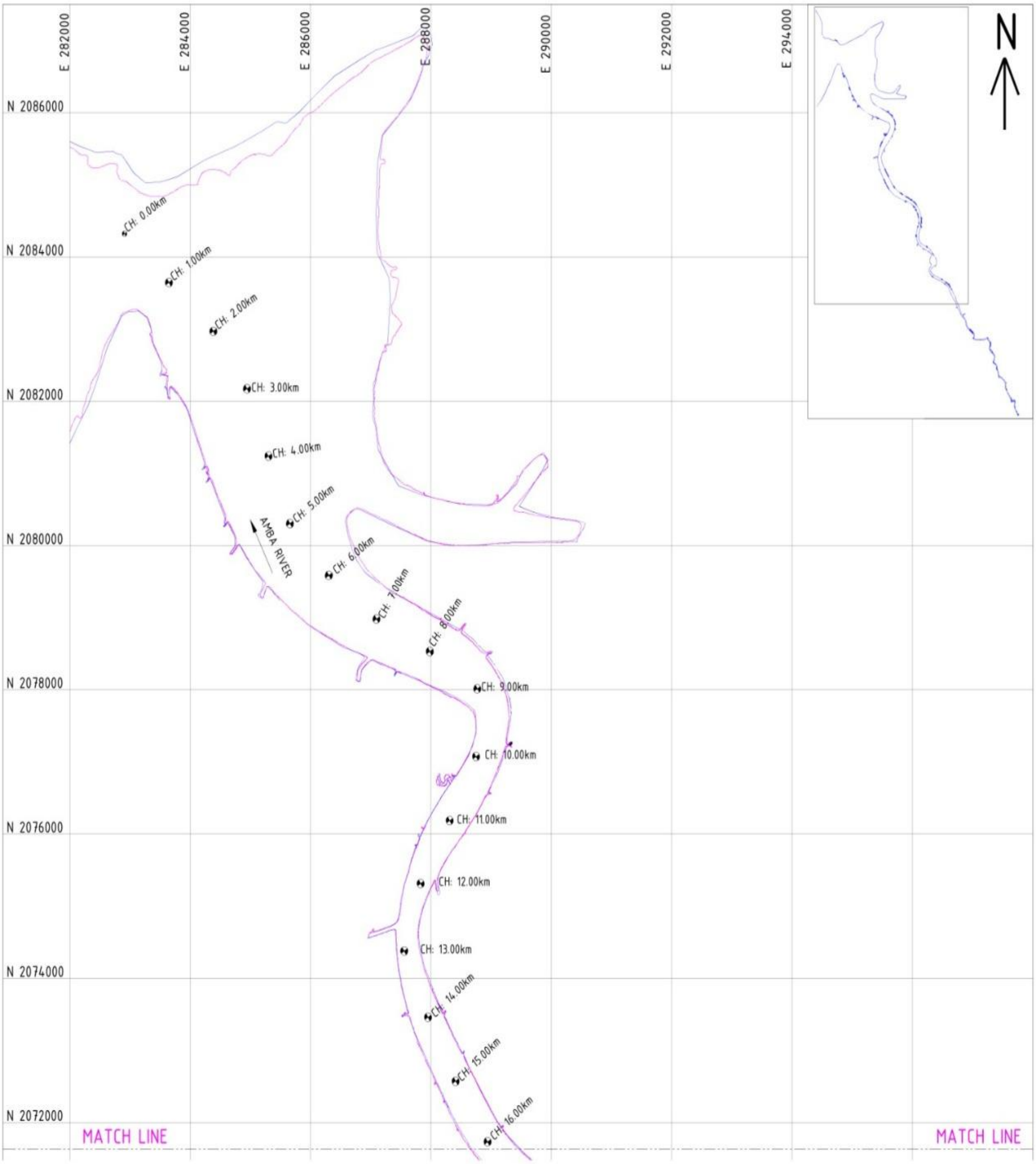


FIGURE 2.34: River bank in 2005 and 2016 in the lower stretch of the river

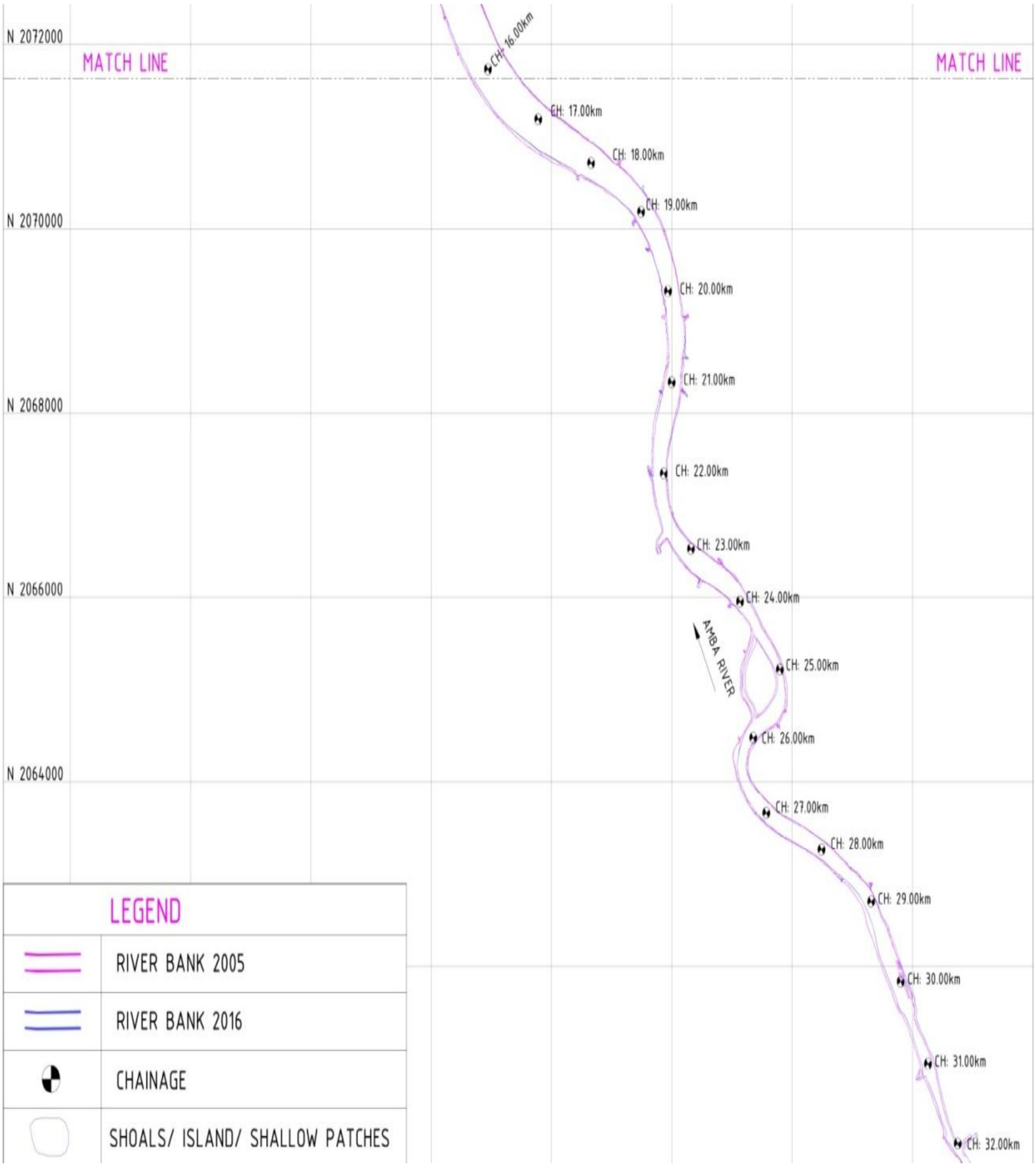


FIGURE 2.35: River bank in 2005 and 2016 in the lower stretch of the river

2.1.2. Existing Hydrological / Topographical Reference levels

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

Station	Chainage (KM)	Latitude (N) Longitude (E)	Easting (m) Northing (m)	Height above MSL (m)	Height above CD (m)
AMB-1	1.914	72°56’48.1123” N 18°49’18.1478” E	283624.121E 2082351.226N	4.920	7.556
AMB-2	11.288	72°59’06.6849” N 18°45’35.9353” E	287604.342E 2075471.702N	2.912	5.261
AMB-3	19.72	73°01’32.3908” N 18°41’41.0133” E	291792.395E 2068200.240N	2.979	4.727
AMB-4	33.802	73°05’07.4451” N 18°36’10.4044” E	297985.357E 2057966.074N	2.552	3.730
AMB-5	44.014	73°08’00.6529” N 18°32’22.2357” E	302990.569E 2050897.058N	4.181	4.319

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

Sl. No.	Location	Latitude	Longitude	Z_0*(m)
1.	Revas Bandar	18°49’11” N	72°56’51” E	-2.636

*** - Below Sea Level (m)**

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

Transfer of Sounding Datum	**H- 533**
For Semi - Diuranal Tides	
Date and Time of 1st LW Observation at Established Gauge = 1.12.2016, 18.45hrs	

Sl. No.	Position of Established Gauge						Position of Established Gauge					
			Long	72º56'46.7102" E					Long	72º59'05.9727" E		
			Lat	18º49'13.1063" N					Lat	18º45'34.5305" N		
			Name	**REWAS JETTY, TP-1**					Name	**Mankule, TP-2**		
	At Established Gauge						At New Gauge					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a		0.88	x	1		0.88		0.983	x	1		0.98
b	4.730		x	1	4.73		4.833		x	1	4.823	
c		1.880	x	3		5.64		1.983	x	3		5.95
d	4.060		x	2	8.12		4.163		x	2	8.326	
e		0.930	x	3		2.79		1.053	x	3		3.31
f	4.590		x	1	4.59		4.683		x	1	4.683	
g		1.820	x	1		1.82		1.973	x	1		1.97
	Sum of Contribution				17.44	11.13	Sum of Contribution				17.832	12.21
	Observed M. H.W.				4.36		Observed M.H.W.				4.458	
	Observed M.L.W.					1.39	Observed M.L.W.					1.53
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.97	Observed Mean Range = r				=	2.93125
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.88	Observed Mean Level = m'				=	2.992375
	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 is known						Established 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 = **0.153** m above Zero of Gauge					

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

Transfer of Sounding Datum	**H- 533**

For Semi - Diuranal Tides

Date and Time of 1st LW Observation at Established = 1.12.2016, 18.45hrs

Sl. No.	Position of Established		Long	72°56'46.7102" E			Position of Established Gauge		Long	73°01'33.1105" E		
			Lat	18°49'13.1063" N					Lat	18°41'39.5822" N		
			Name	**REWAS JETTY, TP-1**					Name	**Dharamtar Jetty, TP-3**		
	At Established						At New					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a		0.88	x	1		0.88		0.570	x	1		0.57
b	4.730		x	1	4.73		4.820		x	1	4.82	
c		1.880	x	3		5.64		1.620	x	3		4.86
d	4.060		x	2	8.12		4.180		x	2	8.36	
e		0.930	x	3		2.79		0.740	x	3		2.22
f	4.590		x	1	4.59		4.710		x	1	4.71	
g		1.820	x	1		1.82		1.580	x	1		1.58
	Sum of Contribution				17.44	11.13	Sum of Contribution				17.89	9.23
	Observed M. H.W.				4.36		Observed M.H.W.				4.4725	
	Observed M.L.W.					1.39	Observed M.L.W.					1.15
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.97	Observed Mean Range = r				=	3.31875
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.88	Observed Mean Level = m'				=	2.813125
	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 is known						Established 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 below of Zero of Gauge				SD = **- 0.402**m below Zero of Gauge					

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

	Transfer of Sounding Datum	H- 533

For Semi - Diurnal Tides

Date and Time of 1st LW Observation at Established Gauge = 1.12.2016, 18.45hrs

Sl. No.	Position of Established Gauge			Position of Established Gauge		
		Long	72º56'46.7102" E		Long	73º05'07.1485"E
		Lat	18º49'13.1063" N		Lat	18º36'11.4397" N
		Name	REWAS JETTY, TP-1		Name	Gandhe, TP-4

Sl. No.	At Established Gauge						At New Gauge					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a		0.88	x	1		0.88		0.380	x	1		0.38
b	4.730		x	1	4.73		3.828		x	1	3.828	
c		1.880	x	3		5.64		0.858	x	3		2.570
d	4.060		x	2	8.12		3.790		x	2	7.580	
e		0.930	x	3		2.79		0.715	x	3		2.150
f	4.590		x	1	4.59		3.815		x	1	3.815	
g		1.820	x	1		1.82		1.390	x	1		1.390
	Sum of Contribution				17.44	11.13	Sum of Contribution				15.223	6.490
	Observed M. H.W.				4.36		Observed M.H.W.				3.81	
	Observed M.L.W.					1.39	Observed M.L.W.					0.81

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

Observed MLW = Sum of Contribution of LW / 8

Observed Mean Range = R	=	2.97	Observed Mean Range = r	=	2.99
R = M.H.W. - M.L.W.			r = M.H.W. - M.L.W.		
Observed Mean Level = M'	=	2.88	Observed Mean Level = m'	=	2.31
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 is known			(B) Where 'True Spring M.L (M)' at Established 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 below of Zero of Gauge	SD = **- 0.592**m below Zero of Gauge

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

Transfer of Sounding Datum	H- 533

For Semi - Diuranal Tides

Date and Time of 1st LW Observation at Established Gauge = 1.12.2016, 18.45hrs

Position of Established Gauge			Position of Established Gauge		
	Long	72º56'46.7102" E		Long	73º08'00.3153" E
	Lat	18º49'13.1063" N		Lat	18º32'22.8049"N
	Name	**REWAS JETTY, TP-1**		Name	**Nagothane, TP-5**

	At Established Gauge						At New Gauge					
	Height Above CD				Contribution for		Height Above CD				Contribution for	
Sl. No.	HW	LW	Factor		HW	LW	HW	LW	Factor		HW	LW
a		0.88	x	1		0.88		0.250	x	1		0.25
b	4.730		x	1	4.73		3.450		x	1	3.45	
c		1.880	x	3		5.64		0.450	x	3		1.35
d	4.060		x	2	8.12		2.800		x	2	5.6	
e		0.930	x	3		2.79		0.220	x	3		0.66
f	4.590		x	1	4.59		3.400		x	1	3.4	
g		1.820	x	1		1.82		0.440	x	1		0.44
	Sum of Contribution				17.44	11.13	Sum of Contribution				12.45	2.70
	Observed M. H.W.				4.36		Observed M.H.W.				3.1125	
	Observed M.L.W.					1.39	Observed M.L.W.					0.34
	Note : Observed MHW = Sum of Contribution of HW / 4											
	Observed MLW = Sum of Contribution of LW / 8											
	Observed Mean Range = R				=	2.97	Observed Mean Range = r				=	2.775
	R = M.H.W. - M.L.W.						r = M.H.W. - M.L.W.					
	Observed Mean Level = M'				=	2.88	Observed Mean Level = m'				=	1.725
	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**	0.00m below Zero of Gauge	SD =	**-0.963**m	below Zero of Gauge

2.2. Existing Waterway Structures

2.2.1. Bridges

The details of Bridges crossing the Amba River are given in the Table below. The vertical clearance at Dharamtar Rail Bridge at Ch 19.845km is sufficient for all Class. The vertical clearance at other bridges fulfils the criteria for Class- III. Nagothane Old Road Bridge at Ch 45.02km has a vertical clearance of 2.5m and located at the upstream of the end location of proposed waterway hence its vertical clearance has not been considered for analysis. However horizontal clearances of about 35m is available from Dharamtar rail bridge (Ch 19.845km) to Nagothane new road bridge (Ch 42.945km) which is falling in class I.

TABLE 2-6: Details of cross structures

Sl no	Structure Name and for road / rail	Chain age (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long) Left Bank Right Bank	Position (UTM) Left Bank Right Bank	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
1	Dharamtar Rail Bridge	19.84	RCC	Dharamtar	Left Bank: 18°41'56.0555"N 73°01'48.1665"E Right Bank 18°41'57.5761"N 73°01'36.6600E	Left Bank: 2068657.67N 292259.770E Right Bank: 2068708.15 N 291923.120E	340	6	6	40.0	10.50	Operatio nal
2	Dharamtar Old Road Bridge	20.00	RCC	Dharamtar	Left Bank: 18°41'51.1831N 73°01'47.0527E Right Bank: 18°41'52.8263N 73°01'36.3110E	Left Bank: 2068508.21 N 292225.480E Right Bank: 2068562.51N 291911.280E	320	6	8	30.0	8.50	Operatio nal
3	Dharamtar New Road Bridge	20.02	RCC	Dharamtar	Left Bank: 18°41'50.4648"N 73°01'47.1201"E Right Bank: 18°41'51.9954"N 73°01'36.3414"E	Left Bank: 2068486.10N 292227.210E Right Bank: 2068536.65N 291911.890E	320	8	8	25.0	8.50	Operatio nal
4	Nagothane New Road Bridge	42.94	RCC	Nagothane	Left Bank: 18°32'50.9147"N 73°07'47.8841"E	Left Bank: 2051782.74N 302625.24E	130	9	7	16.00	8.50	Operatio nal

Sl no	Structure Name and for road / rail	Chain age (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
					Left Bank Right Bank	Left Bank Right Bank						
					Right Bank: 18°32'50.8717"N 73°07'43.5445"E	Right Bank: 2051803.69N 302497.96E						
5	Nagothane Old Road Bridge	45.023	RCC	Nagothane	Left Bank: 18°32'20.7901"N 73°08'02.0056"E	Left Bank: 2050852.20N 303029.780E	140	3.5	8	15.00	2.50	Operational
					Right Bank: 18°32'18.6363"N 73°07'57.7839"E	Right Bank: 2050787.26N 302905.280E						

* MHWS (4.42m as per Mumbai port) is Considered for Vertical Clearances.

2.2.2. Electric Lines / Communication Lines

The details of Electric lines/ Communication lines crossing the Amba 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 line at Ch 13.65km near Dherand needs no modification. However all the other HT lines will need modification. The support base of these HT line will have to be raised in range of 6.0m to 9.0m to get the required clearance.

TABLE 2-7: Details of High Tension Lines

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w. r. to HFL / MHWS (m)	Remarks (complete / under - construction)
				Left Bank Right Bank	Left Bank Right Bank				
1	HTL	13.65	Dherand	Left Bank: 18°44'19.06"N 72°59'41.96"E	Left Bank: 288611.025E 2073096.148N	2	1157.64	20.50	Complete
				Right Bank: 18°44'9.13"N 72°59'16.00"E	Right Bank: 287487.059E 2072799.371N				
2	HTL	22.74	JSW Kharkarawi	Left Bank: 18°40'43.98"N 73°2'5.58"E	Left Bank: 292745.655E 2066435.806N	2	421.37	15.50	Complete
				Right Bank: 18°40'35.33"N 73°01'54.40"E	Right Bank: 292415.092E 2066173.43N				

Sl No	Type of	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	No of Piers	Horizontal clearance	Vertical clearance	Remarks (complete /
3	HTL	34.41	Kalai	Left Bank: 18°36'9.2363"N 73°5'24.3753"E Right Bank: 18°35'57.9685"N 73°5'29.6012"E	Left Bank: 298481.33E 2057924.87N Right Bank: 298630.86E 2057576.78N	2	378	10.50	Complete
4	HTL	39.56	Bense	Left Bank: 18°35'07.2851"N 73°06'28.7646"E Right Bank: 18°35'06.0316"N 73°06'10.4826"E	Left Bank: 300349.015E 2056000.031N Right Bank: 299812.57E 2055967.14N	2	535	10.50	Complete
5	HTL	39.822	Pigonde	Left Bank: 18°33'51.3968"N 73°7'12.7161"E Right Bank: 18°33'59.5436"N 73°7'04.7670"E	Left Bank: 301613.30E 2053653.14N Right Bank: 301382.82E 2053906.07N	2	342	13.50	Complete
6	HTL	42.332	Welshet	Left Bank: 18°33'06.2972"N 73°7'38.9503"E Right Bank: 18°32'59.3646"N 73°7'41.0930"E	Left Bank: 302368.16E 2052258.43N Right Bank: 302428.78E 2052044.62N	2	223.4	13.50	Complete
7	HTL	42.428	Welshet	Left Bank: 18°33'7.5977"N 73°07'36.5133"E Right Bank: 18°32'54.5308"N 73°7'38.1211"E	Left Bank: 302297.11E 2052299.16N Right Bank: 302340.08E 2051896.90N	2	405.6	10.50	Complete

2.2.3. Pipe Lines / Cables

There is no Pipe lines, under water cable present in the entire survey stretch of Amba River.

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

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

2.3. Bends

On the proposed waterway route, there are many bends in Amba River, which are given in the Table below. River bend radius before Ch 35.75km is sufficient for Class – V vessel. There are some sharp bends in the course of river, such as, at Ch 35.75km with radius 150m, Ch 37.30km with radius 100m, Ch 39.86km with radius 200m and Ch 44.17km with 75m. These bends might need some smoothening for plying of vessels with class zone.

TABLE 2-8: River Bend Radius in Amba River

Sr. No.	Chainage (Km)	Radius
1	10.00	(R-850m)
2	13.50	(R-1800m)
3	20.80	(R-2000m)
4	23.00	(R-1200m)
5	26.25	(R-425m)
6	27.30	(R-475m)
7	35.75	(R-150m)
8	37.30	(R-100m)
9	38.35	(R-375m)
10	39.86	(R-200m)
11	44.17	(R-75m)

2.4. Velocity and Discharge Details

The details of Velocity and Discharge in the Amba 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/s) 0.5 D	Avg. Vel. (m/s)	X-Sectional area (m2)	Discharge (m3/s)
1	2.350	18°49'55.1887"N 72°57'20.769"E	2083479.45N 284573.23E	1.5	0.583	0.533	16250	8661.25
2	11.288	18°45'32.3024"N 72°59'14.1736"E	2075357.51N 287822.44E	2	0.56	0.458	2247.5	1029.36
3	20.436	18°41'38.2530"N 73°01'38.2428"E	2068113.47N 291962.94E	3.2	0.55	0.425	1173	498.53
4	33.802	18°36'11.0498"N 73°05'09.1319"E	2057985.39N 298035.02E	3	0.54	0.412	468.9	193.19

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (m/s) 0.5 D	Avg. Vel. (m/s)	X-Sectional area (m2)	Discharge (m3/s)
5	44.014	18°32'20.6631"N 73°07'59.9400"E	2050848.92N 302969.16E	1	0.13	0.076	57.09	4.34

The period of survey is November-December, which is a normal flow condition. As per the statistics collected, the maximum velocity is 0.583 m/s and discharge is 8661.25 m3/s at the gauging station at Ch 2.350km near the confluence of the river and the Arabian Sea.

2.5. Waterway description

Amba River (Ch 0.00km – Ch 10.00km)

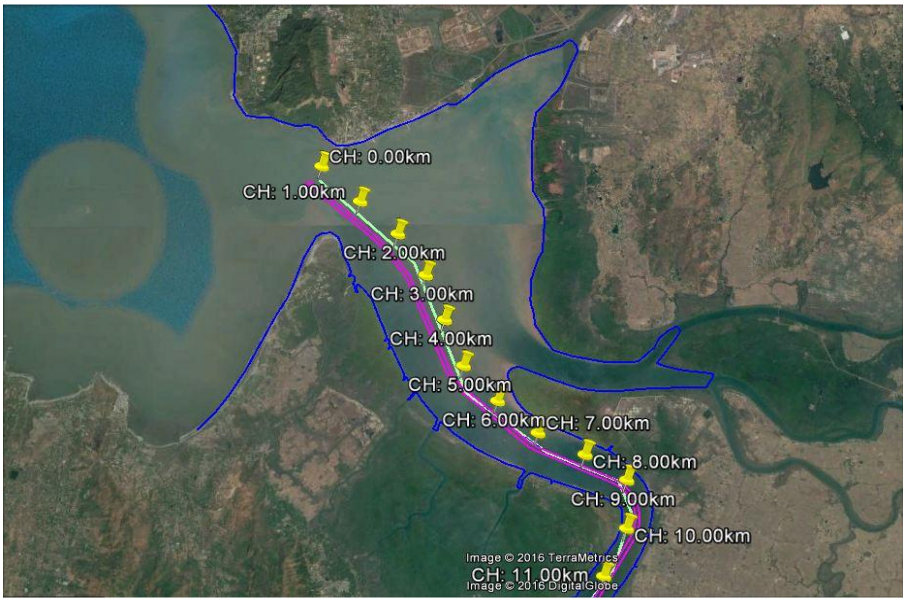


FIGURE 2.36: Amba River from Ch 0.00km to Ch 10.00km

TABLE 2-10: Reduced depth from Ch 0.00km to Ch 10.00km (class VII)

Chainage (km)		Reduced w.r.t Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
0	1	3.1	7.4	0	0	0
1	2	3.2	7.1	0	0	0
2	3	2.7	3.8	0	0	0
3	4	2.8	3.8	0	0	0

Chainage (km)		Reduced w.r.t Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
4	5	2.8	4.9	0	0	0
5	6	3	4.4	0	0	0
6	7	2.1	5.5	150	94.69	94.69
7	8	1.6	4.7	300	3047.7	3142.39
8	9	3.1	7.8	0	0	3142.39
9	10	2.6	6.2	0	0	3142.39

TABLE 2-11: Reduced depth from Ch 0.00km to Ch 10.00km (SPV)

Chainage (km)		Reduced w.r.t Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
0	1	3.7	7.4	750	17846.97	17846.97
1	2	3.6	7.4	450	15865.46	33712.43
2	3	2.7	4.5	1000	162614.17	196326.6
3	4	2.2	3.6	1000	278014.59	474341.19
4	5	2.2	4.4	1000	302643.59	776984.78
5	6	0.7	5.9	1000	160336.91	937321.69
6	7	2.2	4.5	1000	148133.63	1085455.32
7	8	2.1	5.5	1000	198106.19	1283561.51
8	9	1.7	4.7	1000	297792.6	1581354.11
9	10	5	7.9	300	12850.56	1594204.67

The maximum and minimum LAD for the above mentioned stretch are given in the above table (as per class VII/SPV). There are no cross structures. There are no shoals in the first 10km. Mangroves are observed on either side of the river. As observed from the charts, the bed slope is 1 in 13333 in this stretch. The stretch is bounded by places like Nagaon, Karanja, Revas, Ranjhankhar, Davali, Khopate, Koproli, Dadar and Vitthal Vali. From the obtained information, it can be concluded that the stretch has potential for navigation.

Amba River (Ch 10.00km – Ch 20.00km)

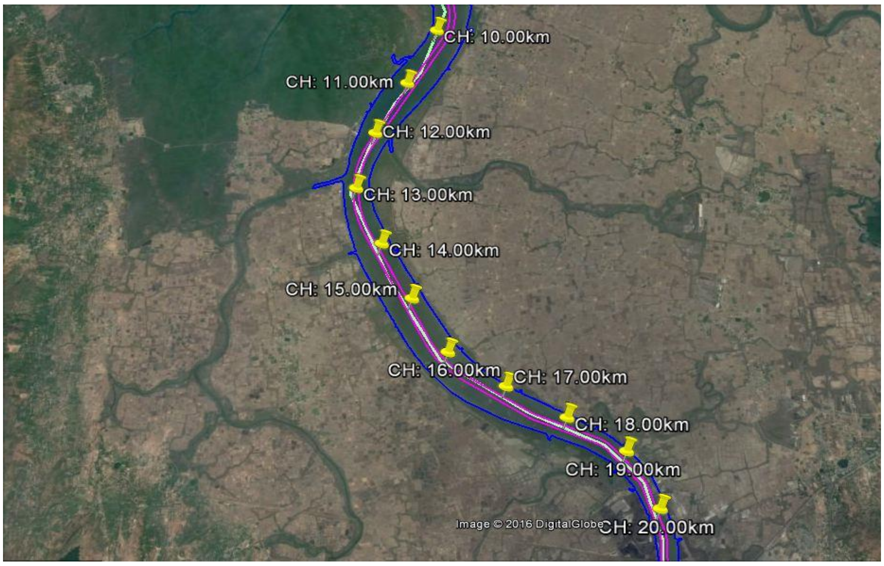


FIGURE 2.37: Amba River from Ch 10.00km to Ch 20.00km

TABLE 2-12: Reduced depth from Ch 10.00km to Ch 20.00km (class VII)

Chainage (km)		Reduced w.r.t Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
10	11	2.8	5.4	0	0	0
11	12	3.8	8.8	0	0	0
12	13	3	5.5	0	0	0
13	14	2.2	3.9	150	273.31	273.31
14	15	1.8	3.8	750	6152.98	6426.29
15	16	2.4	4.2	300	1663.87	8090.16
16	17	2.1	4.8	0	0	8090.16
17	18	3.1	5.4	0	0	8090.16
18	19	2.3	6.4	150	363.18	8453.34
19	20	2.4	6.1	150	7.65	8460.99

TABLE 2-13: Reduced depth from Ch 10.00km to Ch 20.00km (SPV)

Chainage (km)		Reduced w.r.t Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
10	11	2.6	6.3	850	115282.79	115282.79
11	12	2.7	7.2	1000	152609.43	267892.22
12	13	3.3	8.9	450	1332.01	269224.23
13	14	2.9	6.3	1000	111007.06	380231.29
14	15	1.9	4	1000	279674.53	659905.82
15	16	1.7	3.9	1000	263193.93	923099.75
16	17	1.5	4.3	1000	247723.57	1170823.32
17	18	2.1	4.8	1000	197490.11	1368313.43
18	19	2.8	5.5	1000	63698.03	1432011.46
19	20	2.4	5.5	1000	64160.58	1496172.04

The maximum and minimum LAD for the above mentioned stretch are given in the above table (as per class VII/SPV upto Ch 19.84km). There are no cross structures. There are no shoals between Ch 10.00km to Ch 20.00km. One HT line passes at Ch 13.65km. There are three bridges present in this stretch. Dharamtar Rail Bridge is at Ch 19.84km, Dharamtar old road bridge is present at Ch 20.00km and Dharamtar new road bridge is present at Ch 20.02km. Mangroves are observed on either side of the river. As observed from the charts, the bed slope is 1 in 12500 in this stretch. The stretch is bounded by places like Narvel, Mankule, Benavale, Dherand, Sarebhag and Beneghat. From the obtained information it can be concluded that the stretch has potential for navigation.

Amba River (Ch 20.00km – Ch 30.00km)

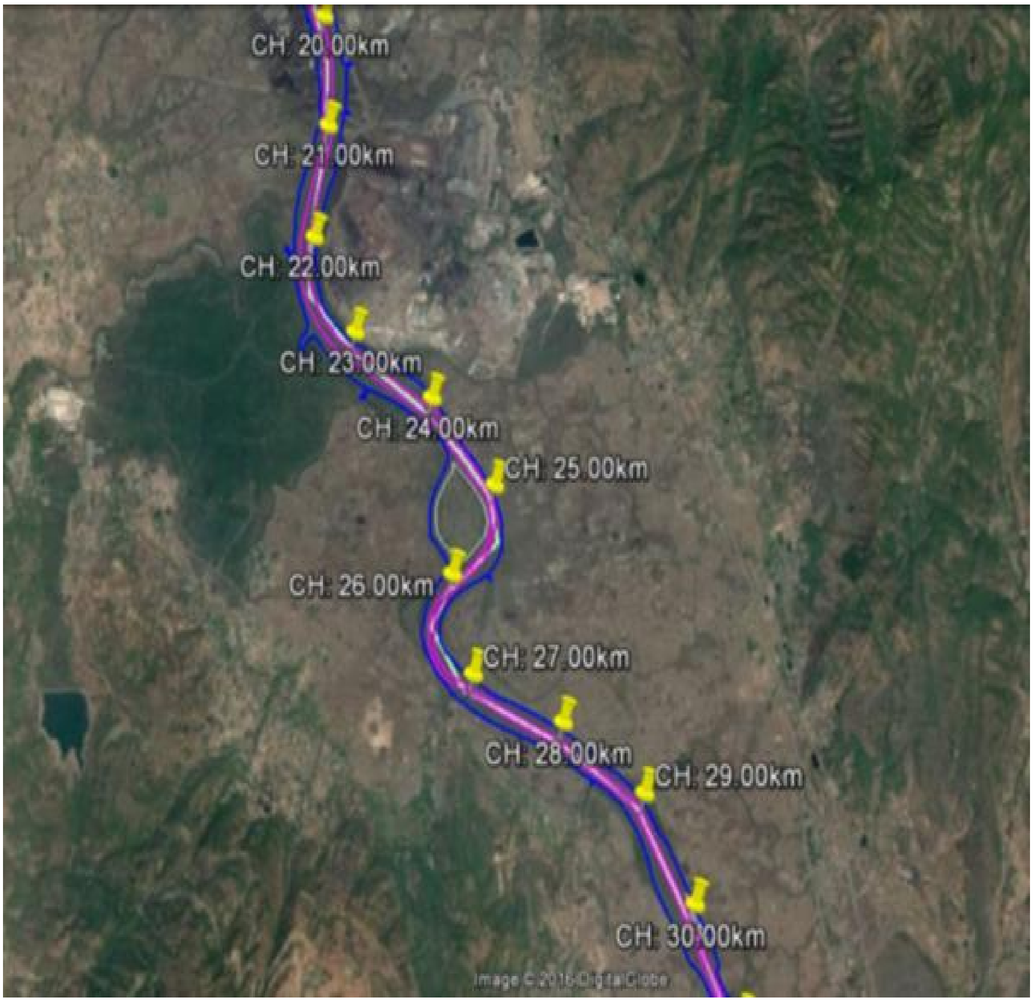


FIGURE 2.38: Amba River from Ch 20.00km to Ch 30.00km

TABLE 2-14: Reduced depth from Ch 20.00km to Ch 30.00km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
20	21	3.1	4.5	0	0	0
21	22	3	5.1	0	0	0
22	23	2	3.7	0	0	0
23	24	1.3	5.8	100	12.85	12.85
24	25	1.7	5.4	0	0	12.85
25	26	1	6.7	850	9,403.91	9416.76
26	27	1	3.4	400	1,986.89	11403.65

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
27	28	0.8	3.9	500	4,619.54	16023.19
28	29	-0.8	3.7	450	3,551.22	19574.41
29	30	0	1.8	1000	31,020.76	50595.17

The maximum and minimum LAD for the above mentioned stretch are given in the above table (as per class III). There are no cross structures. The total length of shoal present in this stretch is 3300 m. There are no cross structures. One HT lines passes at Ch 22.74km. Mangroves are observed on either side of the river. As observed from the charts, the bed slope is 1 in 3389 in this stretch. The stretch is bounded by places like Dolvi, Juibapuji, Kharghat, Pitakiri, Waghwira, Kopari, Fanasapur, Chikhli and Kurdus. From the obtained information it can be concluded that the stretch has potential for navigation with some dredging requirement.

Amba River (Ch 30.00km – Ch 40.00km)

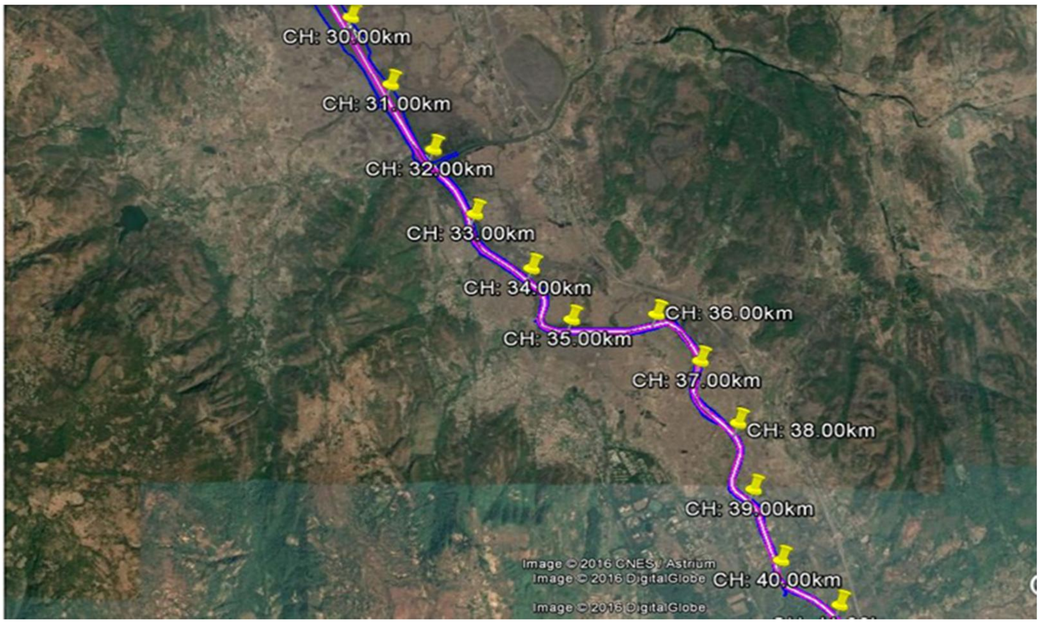


FIGURE 2.39: Amba River from Ch 30.00km to Ch 40.00km

TABLE 2-15: Reduced depth from Ch 30.00km to Ch 40.00km

Chainage (km)		Reduced w. r. to Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty. (cum)	Accumulated Dredging Qty. (cum)
From	To	Min	Max			
30	31	-0.1	3.3	1000	47,267.90	47,267.90
31	32	1.1	4.6	1000	37,084.68	84,352.58
32	33	1.1	7	800	8,771.08	93,123.66
33	34	1.5	6.6	300	1,255.86	94,379.52
34	35	0	4.5	450	3,353.84	97,733.36
35	36	0	3.8	680	6,096.05	103,829.41
36	37	0	3.6	1000	44,267.75	148,097.16
37	38	-0.5	2.9	1000	69,346.99	217,444.15
38	39	-0.5	4.1	1000	73,983.34	291,427.49
39	40	-0.7	3.6	1000	65,429.43	356,856.92

The maximum and minimum LAD for the above mentioned stretch are given in the above table (as per class III). There are no cross structures. The total length of shoal present in this stretch is 8230 m. There are no cross structures. Three HT lines pass at Ch 34.41km, Ch 39.56km and Ch 39.822km. Rocky patches are scattered throughout the river after Ch 36.00km. As observed from the charts, the bed slope is 1 in 40000 in this stretch. The stretch is bounded by places like Pandapur, Navkhar Tarf Shrigaon, Sambari, Chole, Kalai, Gandhe, Talekhar, Tarshet, Shetpalas amd Bense. From the obtained information it can be concluded that the stretch has potential for navigation with moderate dredging requirement.

Amba River (Ch 40.00km – Ch 44.971km)

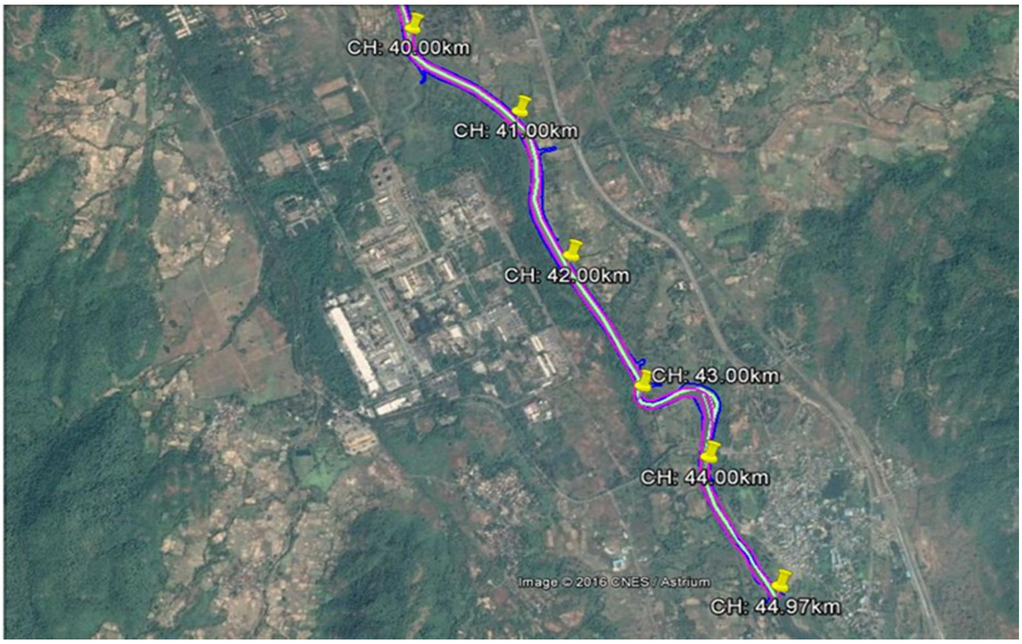


FIGURE 2.40: Amba River from Ch 40.00 km to Ch 44.97 km

TABLE 2-16: Reduced depth from Ch 40.00 km to Ch 44.971 km

Chainage (km)		Reduced w.r.t Sounding Datum				
		Reduced Depth (m)		Length of Shoals (m)	Dredging Qty (cum)	Cumulative Qty. (cum)
from	to	Min	Max			
40	41	-0.7	3.6	1000	48,615.99	48,615.99
41	42	-0.4	4.6	1000	62,890.84	111,506.83
42	43	-0.4	6.6	1000	57,779.59	169,286.42
43	44	-1.2	2.9	1000	42,134.78	211,421.20
44	44.971	-0.8	1.8	440	48,878.66	260,299.86

The maximum and minimum LAD for the above mentioned stretch are given in the above table (as per class III). There are no cross structures. The total length of shoal present in this stretch is 4440 m. Nagothane new road bridge crosses the river at Ch 42.945km and Nagothane old road bridge crosses at Ch 44.023km. Two HT line passes at Ch 42.332km and Ch 42.428km. As observed from the charts, the bed slope is 1 in 3012 in this stretch. The stretch is bounded by places like Palas, Pigonde, Welshet and Nagothane. From the obtained information it can be concluded that the stretch has potential for navigation with moderate dredging required.

2.6. Water and Soil Samples analysis and Results

TABLE 2-17: Water sample results

SAMPLE NO.	LOCATION	Easting (m)	Northing (m)	WATER SAMPLES	
				Sediment concentration (ppm)	pH
AB-1	Rewas Jetty	285075.29	2082616.91	326	7.48
AB-2	Mankule	287822.44	2075357.51	188	7.39
AB-3	Poynad	291962.94	2068113.47	349	7.46
AB-4	Gandhel	298035.02	2057985.39	187	7.67
AB-5	Nagothane	302969.00	2050849.00	197	7.82

The river water is slightly basic in nature with average pH being 7.56.

TABLE 2-18: Soil sample results

SAMPLE NO.	LOCATION	Easting (m)	Northing (m)	Specific Gravity	Grain Size Analysis (%)				Cu	Cc
					Gravel	Sand	Silt	Clay		
AB-1	Rewas Jetty	285075.29	2082616.91	2.63	0	1	68	31	-	-
AB-2	Mankule	287822.44	2075357.51	2.58	3	38	50	9	43.590	1.357
AB-3	Poynad	291962.94	2068113.47	2.51	2	13	56	29	-	-
AB-4	Gandhel	298035.02	2057985.39	2.62	13	76	5	6	20.500	1.062
AB-5	Nagothane	302969.00	2050849.00	2.58	60	22	11	7	472.220	35.179

The river bed is silty clay at Rewas Jetty (Ch 2.350km), silty sand at Mankule (Ch 11.288km), silty clay at Poynad (Ch 20.436km), sandy at Gandhel (Ch 33.802km) and sandy silt (Ch 44.014km). Thus the river bed can be concluded to be silty at most parts with clay and sand 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; Vessel sizes 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 up to class VII of the waterway from the Fairway point of view, in the initial stretch of about 20 kms.

As per the IWT traffic analysis, the river Amba is being extensively used by JSW Steel plant for mobilization of the raw materials for its nearby plant situated at Dolvi. JSW are having their own captive jetty located at Ch. 19.0 km on the right side of the river (Dharamtar Port). The Captive jetty of another plant of M/s Pallonji and Pallonji (PNP), situated on the left side of the river at Ch. 17.0 km, are also using this waterway. However, the volumes are less on comparison. Hence, the fairway requirements are being considered for analysis for its maximum / optimum utilization.

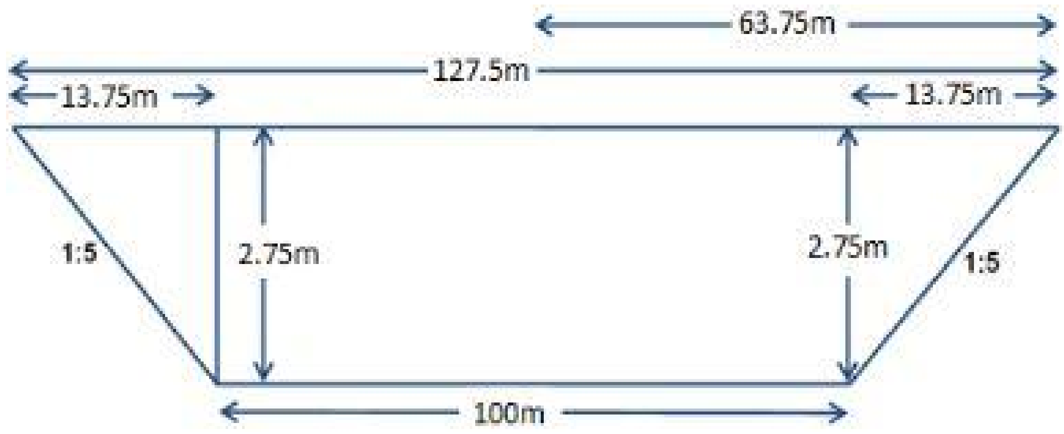
Initial stretch from Ch 0.00km to Ch 19.64km: According to the requirement of the bigger stake holder, M/s JSW, the mobility of vessel / convoy of 8000 T capacity has been identified for its immediate future requirement. Hence, the class of waterway can be concluded as ***Class VII*** for mobility of 8000 T as a ***convoy*** of 4 x 2000 T, up to the JSW Dharamtar Port area i.e., upto Ch. 19.00 km. The vessel / convoy requirement is 210 m (Length) x 28 m (Breadth) x 2.5 m (Draft). Accordingly, the fairway requirement is 100 m (Bottom Width) x 2.75 m (Depth) with Bend Radius of 900. Clearance corridor of 100 m Horizontal Clearance (HC) and 10 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel / Convoy.

With regard to the cross structures in the stretch up to JSW, Dharamtar Port, no Bridges are observed. However, a High Tension (HT) line has been observed with the HC of 1158 m and VC of 20.50 m. According to the suggested / recommended class VII vessel size, the clearances are found amenable and within the allowed standards.

Stretch from Ch 19.64km to Ch 44.971km: There are 3 (Three) Bridges on the waterway u/s of the JSW port at Dharamtar i.e., Dharamtar Rail Bridge at Ch. 19.84km with HC as 35 m and VC as 10.5 m; Dharamtar old Road Bridge at Ch. 20.00 km with HC as 35 m and VC as 8.5 m; Dharamtar New Road Bridge at Ch. 20.02 km with HC as 35 m and VC as 8.5 m. The usage of the waterway up stream of the Three Bridges is observed as minimal, rather nil. Considering the traffic study analysis and keeping the clearances in view, the stretch from ch. 19.64 km to 44.971 km can be limited to ***Class III*** waterway. However, it is ***not suggested*** for any development in this stretch, since there is no cargo confirmation for this stretch.

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

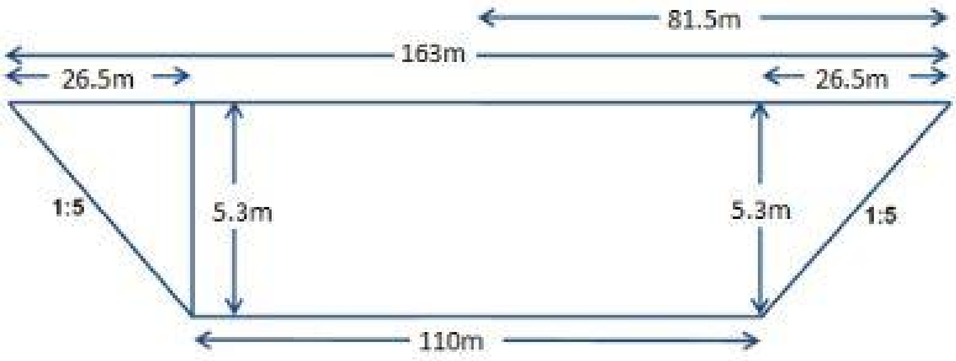
In order to meet the mobility of 8000 T, if we consider the convoy system of Class VII, the cross section and Dredging calculations are placed hereunder.



Class	Chainage (km)		Observed				Reduced w. r. to. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Accumulated Qty. (Cu. M)
VII	0	10	TIDAL ZONE				1.6	7.9	450	3142.39	3142.39
VII	10	20					1.8	8.8	1500	8460.99	11603.38

The total shoal length is of 1950 m and dredging quantity is of 0.12 Lakhs Cu. M.

As per the JSW Energy's (Major stakeholder's) requirement, the vessel sizes under consideration are for 8000 DWT / 10,000 DWT with 115 m of LOA; 22 m of Beam and 4.8 m of Draft. The vessel size Vs Fairway has been discussed in vessel chapter, wherein the Bottom width of the fairway can be considered as 5 times the Beam and the Depth of the fairway can be considered as 1.1 times the Draft. The fairway requirement is of 110 m of bottom width; 5.3 m of depth with 1:5 side slope on both the sides. The Fairway Channel and Dredging calculations are as detailed.



Class	Chainage (km)		Observed				Reduced w. r. to. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Accumulated Qty. (Cu. M)
SPV	0	10	TIDAL ZONE				0.7	7.9	8500	1594204.67	1594204.67
SPV	10	20					1.5	8.9	9300	1496172.04	3090376.71

The total shoal length is of 17800 m and dredging quantity is of 30.9 Lakhs Cu. M.

The Upstream stretch beyond the Dharamtar Port is amenable for Class III waterway and accordingly the shoal length and Dredging quantities have been worked out, as detailed.

Class	Chainage (km)		Observed				Reduced w. r. to. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (Cu. M)	Accumulated Qty. (Cu. M)
III	20	30	TIDAL ZONE				-0.8	6.7	3.300	50595.17	50595.17
III	30	40					-0.5	7.0	8.230	356856.92	407452.09
III	40	44.971					-0.2	4.9	4.440	260299.86	667751.95

The total shoal length is of 15970 m and dredging quantity is of 6.68 Lakhs Cu. M.

In order to facilitate the movement of the Bulk cargo of the major stake holder M/s JSW, the stretch upto 19.64 Km is recommended for development with a bottom width of 110 m (5 times of the beam of the SPV) and depth of 5.3 m (1.1 times the draft of the SPV), which will facilitate the Bulk cargo movement of about 8000 T / 10000 T with economic scale of operation. Accordingly, the shoal length of 17800 m and dredging quantity of 30.9 Lakhs Cu. M is to be considered for development. Dredging quantity has been worked out to 34 Lakhs Cu. M by taking + 10 % variation. A small patch of hard soil has been observed, which is under consideration for removal by M/s JSW. However, JSW is presently restricting their depth of cut to have the operation by taking the tidal advantage. Hence a provision of 10 % of the quantity has been taken for Hard Soil / Rock excavation.

The suggested Class III development is possible by dredging the shoal length of 15970 m with 6.68 Lakhs Cu. M for fairway development in the upper reach in between Ch. 20 km and Ch. 44.971 km. Dredging quantity has been worked out to 7.35 Lakhs Cu. M by taking + 10 % variation. In the upper reaches hard soil was observed and accordingly, considered with 6.60 Lakhs Cu. M in all soils and 0.75 Lakhs Cu. M in hard soils.

3.3. Proposed Conservancy Activities

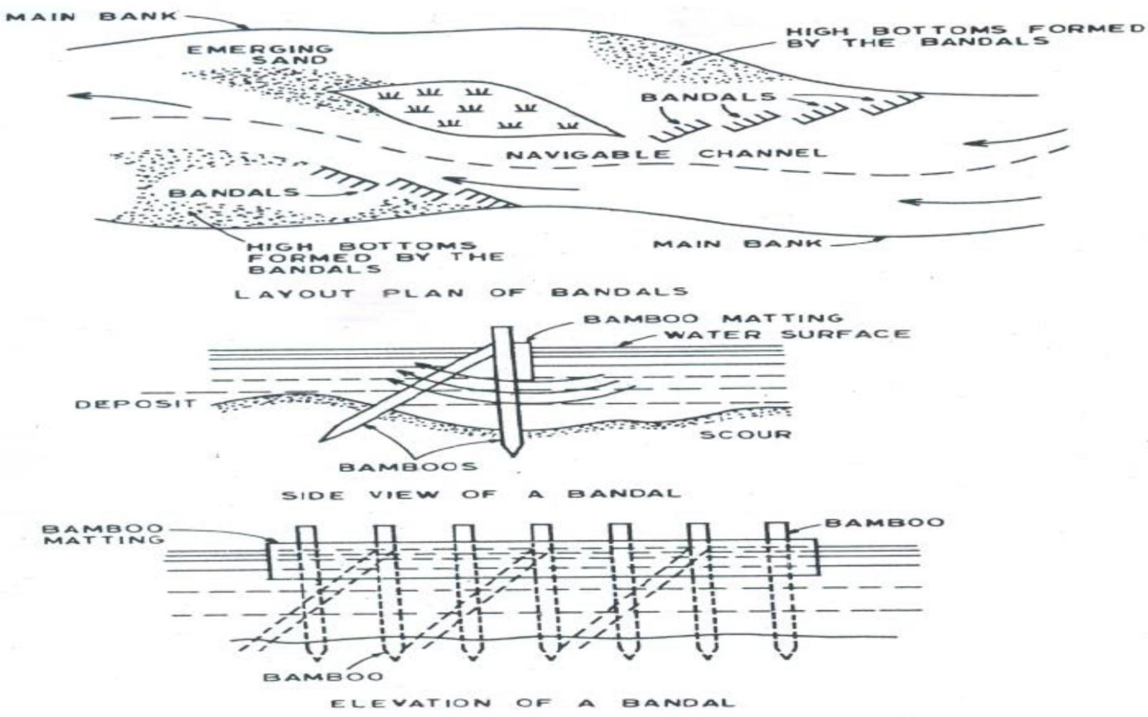
Rivers are the natural channels of drainage carrying water along with sediments from the catchment to the sea. The main river course will be joined with various tributaries depending on its catchment configuration carrying the water from run-off and also carrying the sediments enroute. The dynamic equilibrium 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 divided discharge locations have been observed and hence there is no need of implementation of Bandalling in this stretch. However, at the seasonal maintenance, such structures can be considered at later date, as amenable.

3.3.2. Dredging

“Dredging” is the removal of sediments and debris from the bottom of lakes, rivers, harbors, 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 harbors). 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 the stretch, up to ch 19.64 km, there is a need of dredging the shoal length of about 14,750 m with an estimated quantity of 34 Lakhs Cu. M and may have to be taken up through CSD.

In the phase 2, stretch beyond Ch. 19.64 (Between Ch 19.64 km and Ch 44.971 km) though suggested for development of Class III, the development in this stretch is not recommended, since there is no cargo established.

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.

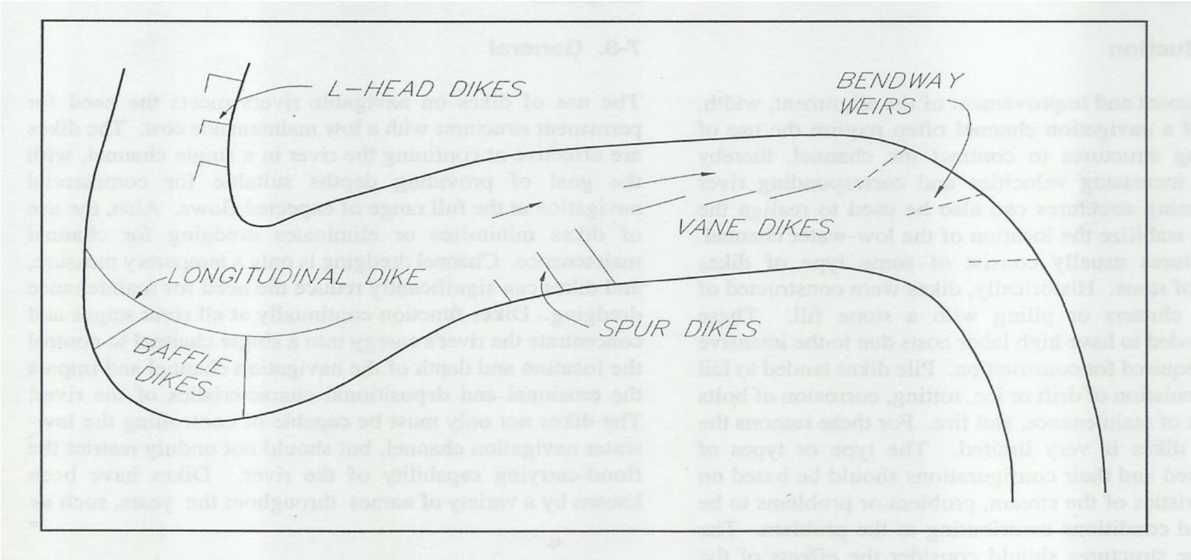


FIGURE 3.1: Types of dike structures

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.

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.

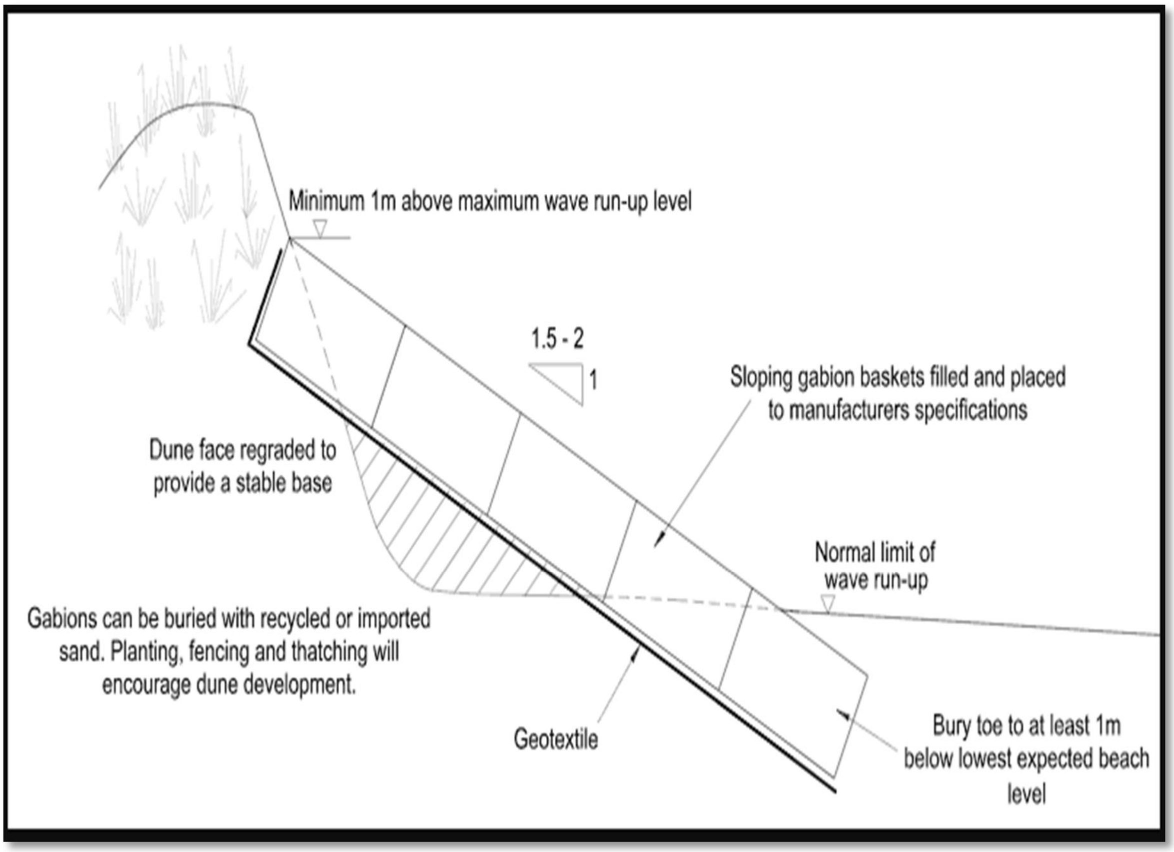
In the study stretch, there is no such location with any River Training work requirement.

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 stretch, up to ch 19.64 km, there is no such location with any Bank Protection requirement. However, the proposed Dredging activity may have nominal morphological disturbance, which in turn may lead to the vulnerability of Bank erosion.

Keeping in view the above phenomenon, a provision of 2000 m (4 locations of 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 at Ch. 6.5 km; Ch. 9.5 km; Ch. 13.0 km and @ Ch. 19.3 km. 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.

Keeping in view the 4 nm light and considering the clear visibility range as 9000 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 5 Nos in the initial phase 1 stretch upto Ch. 19.64 ~ 20 kms {20000 / 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 50 Nos {20000 / 500 + 4 Bends + 10 % approx.) 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.

The preliminary Design of Beacon & Light system along with the specification are placed at Chapter 6, appropriately. The Technical specifications of Buoy & Light, as available in the Market as a proprietary item are also detailed in Chapter 6. Both the above systems are recommended for implementation on Amba River in Phase 1 upto 20 Kms and in Phase 2 in the rest of the stretch.

In the phase 2 stretch beyond Ch. 19.64 (Between Ch 19.64 km and Ch 44.971 km) the requirement is estimated of 6 Nos Beacon & Light system and 60 Nos. of Buoy & Light system, which have been recommended. However, since there is no cargo established, the development in the upper stretch (Phase 2) is not recommended.

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

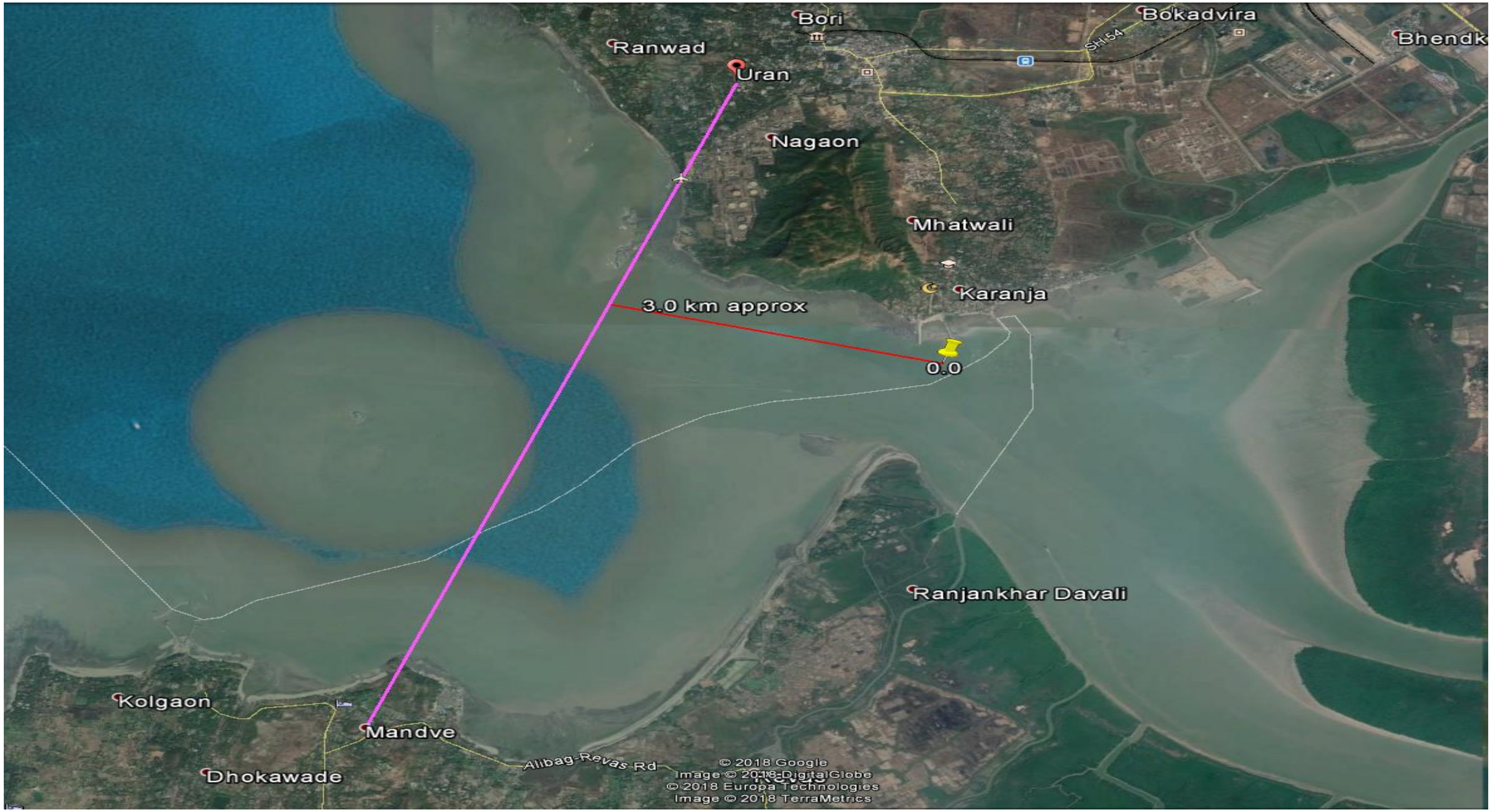
In the stretch, up to ch 19.64 km, there is no Bridge present and hence Bridge modification doesn't arise. Further, the only HTL available at Ch. 13.65 is having the safe Vertical clearance of 20.5 m and hence Power Cable modification doesn't arise.

The upper phase 2 stretch beyond ch. 19.64 km, 4 Bridges are present (Ch. 19.84 km / Ch. 20.00 km / Ch. 20.02 km/ Ch. 42.94 km), which are having Horizontal and Vertical clearances as per the required standard for Class III. The Bridge at the end of the stretch i.e., at ch. 45.02 km is beyond the study stretch. 6 Nos. of Power cables (Ch. 22.74 km / Ch. 34.41 km / Ch. 39.56 km / Ch. 39.822 km / Ch. 42.332 km / Ch. 42.428 km), are present in this upper stretch, which are also having amenable clearances. If need be, at later date, the same can be considered from the contingency provision catered in the stretch. As above, this stretch is not proposed for any development due to the non-availability of cargo.

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

It was understood that 2 Pipelines are passing across the Karanja Creek i.e., 26" dia Pipeline of GAIL and 10" dia Pipeline of IPCL and the same are beyond the purview of the study area. However, while considering the 5.3 m depth of fairway for SPV mobility, depending on its present location (according to depth), the same may have to be deep trenched according to the requirement. During the stake holder's meet, it was emphasized that the deep trenching may not be amenable to cater to the deep draft vessels mobility to Karanja Port. However, the depth for deepening cannot be concluded at this DPR forum, since such proposals are to be dealt with by keeping in view the interlinked stake holders holistic requirements and also with due consideration of the mobility of the deep draft vessels. This can also be attended by Re-Routing of the Pipelines at Upstream, where crossing width can be reduced. These aspects may have to be looked into in consultation with the concerned authorities by IWAI at the appropriate time at the implementation stage. A provision of INR 125 Crores has been catered with market enquiry for deepening to the level of IWT mobility. The cost considerations may have to be considered appropriately.

The location Drawing and the possible diversion plan are placed as guidance / reference.


Bori
Bokadvira
Bhendk
Ranwad
Uran
SH-54
Nagaon
Mhatwali
Karanja
3.0 km approx
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Ranjankhar Davali
Kolgaon
Mandve
Dhokawade
Alibag-Revas Rd
© 2018 Google
Image © 2018 DigitalGlobe
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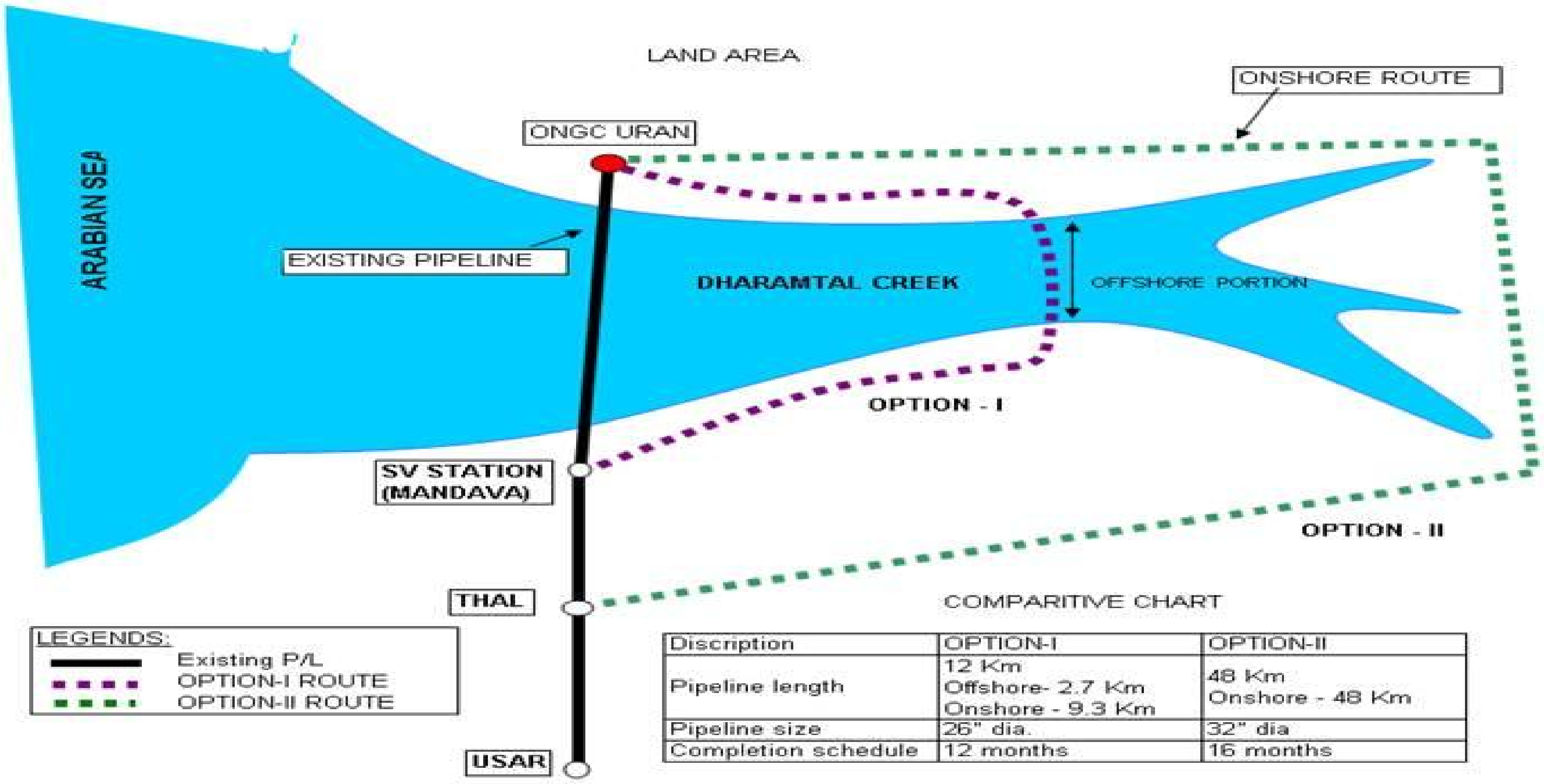
Image © 2018 TerraMetrics

<u>**TYPICAL DIAGRAM- REROUTING OF URAN THAL PIPELINE**</u>



Discription	OPTION-I	OPTION-II
Pipeline length	12 Km Offshore- 2.7 Km Onshore - 9.3 Km	48 Km Onshore - 48 Km
Pipeline size	26" dia.	32" dia
Completion schedule	12 months	16 months

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 narrated, the Amba River is extensively being used by M/s JSW; M/s PNP etc. The IWT operation by the major stake holder i.e., M/s JSW is having the captive terminal with handling system at Daramtar Port (Ch. 19.64 km). Further, M/s JSW is having an expansion plan for increased cargo mobility. Hence, the development has been segregated into 2 Phases i.e., Phase 1 from Ch. 0.0 to Ch. 19.64, to facilitate the SPV mobility with 4.8 m draft, whereas the upper reaches between Ch. 19.64 km and Ch. 44.971 has been limited to Class III waterway with development in Phase 2. Phase 1 will be developed in 3 yrs (up to 2020-2021) and the growth trend will be observed for taking the investment decision in Phase 2. Further, the IWAI Terminal development is proposed for the increase in cargo volumes after the saturation of cargo with the existing infrastructure and suggested in Phase 2. The Phase 2 implementation or otherwise will be decided in due course of time. Accordingly, the Capital Cost for the fairway has been considered for 34 Lakhs Cu. M of Dredging (INR 15300 Lakhs) and 5 Nos. of Beacons with Light (INR 98.27 Lakhs) and 50 Nos. of Buoys with Light (INR 193.13 Lakhs). 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 Amba river catchment area constitutes analysis of existing and potential waterway traffic for cargo and passenger, existing trends of cargo flow between origin and destination and the feasibility of diversion from existing land based transport modes to waterways.

Figure 4-1 Amba River Overview

Amba River originates in the Borghat hills of Sahyadri ranges, near Khopoli- Khandala road at an altitude of about 554 m. Initially, the river flows in south direction and then turns further into the north-west direction, where it merges in Dharamtar creek near village Revas before joining the Arabian Sea. A part of Amba River is also known as Dharamtar Creek. Dharamtar port is on the right bank of Amba River and is 16 km upstream from the mouth of the river. The total length of the river is about 76 km before joining the sea. The navigable length of the river is 45 km. The river is affected by tidal effect of the Arabian Sea (backwater effect) up to Chikan village located at about 31 km from Arabian Sea. During high tide, the river is accessible further ahead of Nagothane for about 38 km. Amba River has water throughout the year, in every season. At present, barges of 3,000 DWT size move in Amba River.

Amba River flows through Pen, Alibaug and Sudhagad districts of Maharashtra. All these places are about 90 to 100 km away from Mumbai Metropolitan region. Mumbai is the financial capital of India. There is good rail/ road connectivity in the catchment area of Amba River. Development of IWT route in Amba River, NW- 10 could help in decongestion of overly loaded roadways like Mumbai Goa-highway and railways. It would also help in efficient utilisation of the waterways bestowed by the nature. Amba River is also a source of water supply to industries located in nearby region and Alibaug. The surrounding hilly region of the river is clearly visible from the map Figure 4-1.

4.2. Hinterland Analysis

Primary catchment area of Amba River stretches from Nagothane. This is the originating point (upstream) of the navigable length of river till Murud on south west and Nigudshet village in south. The primary catchment area is spread from Karanja (mouth of river) till Apta on the east side. The talukas that come in the primary catchment area are Alibaug, Pen, Sudhagarh and Khalapur. Primary catchment area consists of regions, within 25 km from Amba River. Faraway regions of Sudhagarh and Khalapur talukas are considered as secondary catchment area of Amba River.

Industries, like JSW Steel & Cement plant, Nagothane MIDC are located on the banks of the river. Other industries located in Pali, Pen, Thal, etc. are also considered in primary catchment area. There are two functional non-major ports namely Dharamtar Port (captive Port of JSW) and PNP port (private port) on Amba River. Prominent cargo handled on Amba River consists of coal, cement, iron & steel.

Secondary catchment area consists of talukas, located within 25 km to 40 km radius from the river. Secondary catchment is spread from Nagothane end till Mangaon in south, Aambay Valley in east & Lonavala in north. Lonavala is a hub of food processing industries like maple etc. High hills exists in the secondary catchment area, with more than 500 m elevation on the east & north side of Nagothane. Kundalika river with two operational jetties, Sanegaon & Salav and one non-major port namely Dighi Port (Private Port) exists in secondary catchment area. Availability of multiple ports and jetties (terminals) in the secondary catchment area of Amba restrict large scale cargo diversion to the river. The industries located in the secondary catchment area, i.e. south of Amba River would prefer utilizing facilities of existing ports and jetties for water transport. Hence, secondary catchment area would not offer much potential for the proposed waterway.

Mumbai and part of Navi Mumbai, both important and large cities, are located farther than 25 km from Karanja point i.e. mouth of the river; hence these regions are considered as secondary catchment area for Amba river. Navi Mumbai's Panvel comes under primary catchment area as it is within 25 km from Amba. Two major ports Mumbai Port Trust (MbPT) & JNPT with annual cargo handling traffic of more than 125 million tones within secondary catchment area limiting scope for Amba River to cater to industries of Mumbai. Some of the industries located in Khopoli or Khalapur area could be considered in the secondary catchment area. These industries are closer to JNPT port compared to Dharamtar or Nagothane port; thereby limiting scope for the proposed waterway from these regions.

Raigad district has close proximity with Mumbai region. Natural resources like soil, water favorable for agriculture and horticulture is present in the district. Road connectivity is good in talukas. However, villages & rural areas need improved connectivity via good road or state highway. Area also has issues such as irregular power supply, lack of water management and labor unavailability. Raigad has focus on food processing industries. However, the district does not have enough cold storage facility for storing perishable items.

4.2.1. Demography Profile of Hinterland

Alibaug and Khalapur are densely populated areas, compared to Pen and Sudhagarh. Alibaug is a tourist place and tourism is a major revenue source for the local population. Government is planning to develop part of Khalapur as a SMART city project. This development would further result in growth of population in Khalapur area. The table below shows number of villages, area and population in the talukas of the catchment area of Amba River.

Table 4-1 Village wise population around Amba river

Taluka	No. of villages	Area (Sq. km.)	Population
Alibaug	218	500	2,36,137
Pen	171	499	1,95,454
Khalapur	141	179	2,07,464
Sudhagarh	99	463	62,380
Total	629	1,641	7,01,435

Source: Census, 2011

The table shows that Alibaug has the largest land area among other talukas and highest number of villages and population. The reason is abundance of famous tourism spots & beaches in and around Alibaug. Sudhagarh has the least number of villages and population residing in it. Sudhagad Fort is located here, which is 2,000 feet above the sea level. There exists medium to low opportunity for people living in these talukas due to availability of various types of industries & MIDC.

4.2.2. Economic profile of Maharashtra

Khargar and Panvel nodes of Navi Mumbai come under Raigad district. In past few years, Navi Mumbai has witnessed major developments, which has helped to boost the economy of Raigad district. Petrochemical, iron & steel industries of Raigad have helped in urbanization of the district. GSDP of Maharashtra in FY 16 was the highest among all other states of India. Maharashtra's contribution to GSDP of India is 13%; GSDP in FY16 was US $300.51 billion. Mumbai & Pune are the two major cities and the contribution of these cities to GSDP is comparatively higher than other cities in the state. Maharashtra is considered as an industrialized state due to the dominating existence of many small-scale industries. Following table shows Gross state domestic product prices of Maharashtra. The table shows historic GSDP of the three sectors.

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 image presents three sectors- Primary, Secondary and Tertiary and the respective industries.

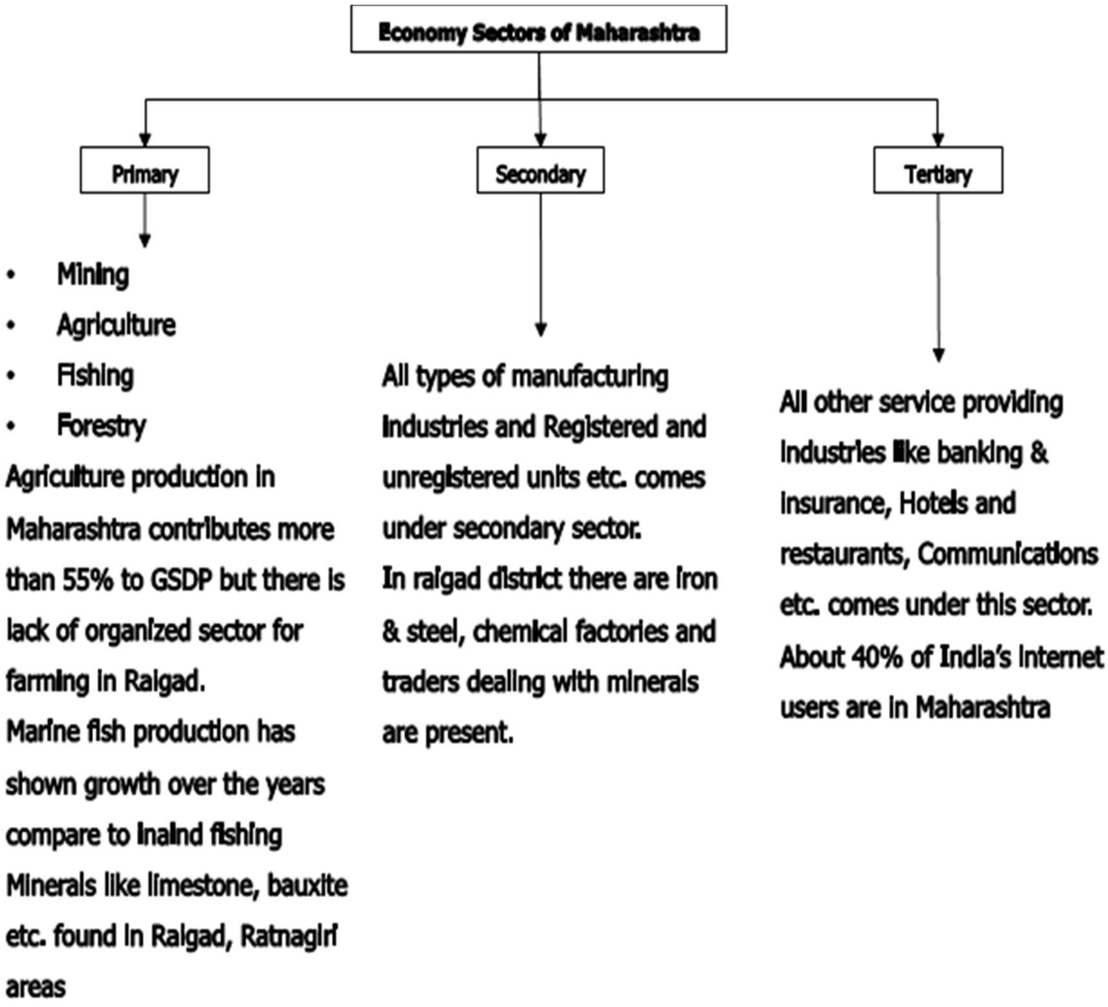


Figure 4-2 Sectors of Maharashtra

4.2.3.1. PRIMARY SECTOR

Primary sector consists of agriculture, forestry, fishing and mining. The below table shows historic growth in last 5-6 years in different sectors, i.e. agriculture, forestry, fishing & mining, which come under primary sector in Maharashtra. In FY 2014, agriculture witnessed major growth in primary sector, followed by forestry sector. Contribution of fishing is less than other sectors.

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

Agriculture sector contributes as a prominent sector to the economy of Raigad district. Mango and cashew are two major commercial crops of Raigad district. The regions in agriculture sector can be divided into 3 regions.

- Sea Shore region – Alibaug
- Hill Top region – Khalapur, Sudhagad
- Kharland region – Panvel, Pen, part of Alibaug

Following table describes major agriculture productions in the catchment area of Amba River. Major crop produced in the catchment area is rice, followed by nachni. Rice is grown in an area of 41,463 Ha, including all the talukas that fall in the catchment area of Amba.

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

Taluka	Rice		Nachni		Total	
	Area (Ha)	Production (MT)	Area (Ha)	Production (MT)	Area (Ha)	Production (MT)
Alibaug	14,891	46,162	14	14	14,905	46,176
Pen	12,355	38,301	363	363	12,718	38,664
Khalapur	3,672	11,383	10	10	3,682	11,393
Panvel	10,545	32,690	5	5	10,550	32,695
Total	41,463	1,28,536	392	392	41,855	1,28,928

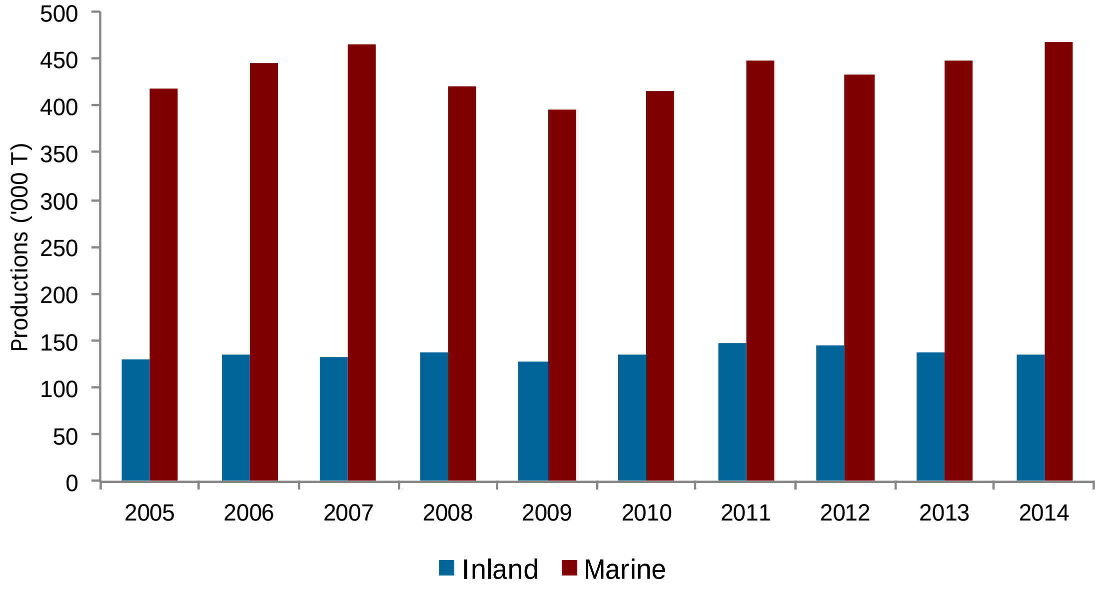
Source: FSR Study

Agriculture is the most significant sector in the catchment area, providing employment opportunity to about 56% people. However, its contribution to economy of Maharashtra is declining over years because of unfavorable climatic condition and growth of other sectors, especially service sector. In recent times due to brackish water in areas like Alibaug, Pen, Panvel taluka, land has become unproductive for agriculture. Among all the talukas in the catchment area, Alibaug has the largest area under agriculture and the total production is more than other talukas.

b. Fishing

There are more than 90% traditional fishermen operating in whole of Maharashtra. It is observed that inland fishing activity does not take place in Amba River. As Amba River is used for cargo handling purpose, encouraging fishing activity here may not prove fruitful.

The below graph shows Inland and Marine fish production in Maharashtra. It is evident that Marine fishing is more popular than inland fishing. The historic fish traffic shows that since 2005, there is clear growth in marine fishing, whereas inland fish production remains stagnant.



Source: Consultant's Analysis

Figure 4-3 Fish productions in Maharashtra

Table 4-6 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

At present no fishing activity has been seen in Amba River. However, in the catchment area of the river, there are few fish landing points where fishing is carried out. Following table describes total fish production in Raigad district since 2005. Only Mora Karanja and Alibaugare located in the catchment area of river; hence the table shows fish production of these talukas.

Table 4-7 Historic fish production in the hinterland of Amba river

Zone Name	2005	2006	2007	2008	2009
Mora Karanja	771	995	1,087	704	817
Alibaug	20,287	18,349	13,025	13,765	16,672
Total	21,058	19,344	14,112	14,469	17,489

(Production in MT)

Source: Department of Fisheries, MH

It can be seen from the above table; Alibaug is the major fish production center and contributes about 50% to whole of Raigad district. Mora Karanja which is located near the mouth of Amba River contributes only 2- 3% of total fish catch. Nearly half of the river stretch is used for cargo operations, which has adverse effect in fishing in the river. There is very limited scope for development of fish related activity in the river; hence fishing sector would not provide any opportunity for Amba River.

c. Forestry

This district is fairly rich in forest areas. The Sahyadri hills and valleys are full of rainforest. Total forest area of Raigad district is 1,725 sq. km., out of which 1,465 sq. km forest is reserved, 135 sq. km is protected and 125 sq. km. of forest is unorganized. Dense forest is of 566 sq. km. Phansad wildlife and Karnala bird sanctuaries are located in Raigad district. Teakwood, bamboo and medicinal plants are the main produces of the forest. Forest based industries in the district constitutes of wooden furniture, ayurvedic and herbal products, saw mill, wooden packing boxes, Electrical switch boards and glass articles manufacturing industries.

d. Mining

In Raigad district inside creeks and rivers, illegal sand mining takes place. Government is now taking action against such illegal mining. Majority of mining activities take place in deeper Raigad district and other districts of Maharashtra like Nagpur, Yavatmal, Chandrapur district and these places do not come in the catchment area of Amba River. Apart from mining, minerals get handled at Dharamtar Port. As per statistics of Maharashtra Maritime Board, in Fy 16, Dharamtar Port handled 0.7 mn T of minerals. 0.7 mn T consists of Dolomite (0.24 mn T) Bentonite (0.01 mn T), Limestone (0.41 mn T) and Bauxite (0.03 mn T). Out of these minerals, only Bauxite got handled at PNP jetty and rest of the minerals is handled at JSW's jetty. The minerals that get handled at Dharamtar would only provide opportunity for proposed waterway as there does not exist any major mines in the catchment area of Amba River.

4.2.3.2. SECONDARY SECTOR

Manufacturing industries, electricity, gas, water supply providing and construction companies come under secondary sector. There exist iron & steel, chemical manufacturing industries in Raigad region. The table below shows different types of industries and their contribution in GSDP since 2009. There is growth in GSDP in last 6-7 years in the catchment area.

Table 4-8 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

4.2.3.3. 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 results in growth in overall economy. Tertiary sector constitutes services industry and hence does not directly offer cargo opportunities in Amba.

4.2.3.4. INFRASTRUCTURE ANALYSIS

Infrastructure is crucial in the development of a region. It is also essential to understand various types of existing and upcoming infrastructure around Amba River, as they would provide support and connectivity for waterway with other modes of transportation. It becomes backbone for any new development.

4.2.3.5. CONNECTIVITY ANALYSIS

Railway, roadway and airports around the waterway help in evacuation of cargo and passengers. It helps to determine best multimodal route for evacuation. Following image depicts connectivity around Amba River.

Figure 4-4 Connectivity around Amba River

Above image shows accessibility of Amba River by roadway and railway. The strong local & regional connectivity of rail &road network can be a competition to inland water transport, unless effectively utilized for IWT mobility. Nagothane, Khopoli & Pen are the main railway stations in the catchment area. The major freight loading points are located in Nagothane, Pen, PNP, Thal and JSW. Maharashtra state has four international & seven domestic airports.

PNP has developed 2 rail sidings inside port area for evacuation of coal. The major hinterland of PNP is Mumbai, Nasik, Amravati and Bhusaval. There is a direct rail connectivity from the port to the hinterland. All the cargo handled at rail siding pass through Pen railway station, which is 10 km away from PNP Port.

PNP port connects to Mumbai and central part of the state via Pen village. NH 66, NH 4 and SH 88 (Pen Khopoli road) are well connected with the port. There is good roadway network around Amba River.

All the ferry terminals are located on the shore side & not on the bank of the river. At present, there is no ferry service plying on the river. There is no airport in the catchment area of Amba River.

4.2.3.6. EXISTING INFRASTRUCTURE

Following image shows existing cargo handling infrastructure available around Amba River. Dharamtar Port is located on the river. There is facility for bulk cargo storage at Dharamtar. The region has good road/ rail connectivity. Konkan Railway passes through the region.

Source: Source: Consultant's Site Visit

Figure 4-5 Infrastructure in the catchment area of Amba River

Following table summarizes existing landing points for passenger, fishing and cargo on the catchment area of Amba River. Karanja has the maximum number of jetties in the catchment area of Amba River. There are total 44 jetties in Karanja, followed by Dharamtar where 26 jetties are located. Mora and Rewas have few existing jetties.

Table 4-9 Type & Number of jetties in the catchment area of Amba River

Name	Passenger	Fishing	Natural landing point	Cargo	Other	Total
Mora	1	3	-	-	3	7
Karanja	23	10	7	-	4	44
Dharamtar	20	2	-	5	-	26
Rewas	1	1	-	-	1	3

Source: MMB

There are several non-major ports developed in Maharashtra. This could be further categorized into state port, private ports and captive ports. Apart from non-major ports, Maharashtra has 2 major ports controlled by Government of India. Some of these ports are expanding their infrastructure and cargo handling capacity by putting in large investment on the infrastructural development and have evolved as an option to industries located far off from the major ports, such as Mumbai Port Trust and JNPT. The table below shows existing port, its type and available infrastructure in the primary and secondary catchment area of Amba River.

Table 4-10 Infrastructure of Existing Ports

Port	Volume (mnT)	Draft (m)	Berth	DWT	Type
MbPT	61	11	31	-	Natural Harbour with Impounded wet docks
JNPT	64	14	14	1,00,000 +	All weather tidal port
Dharamtar	10	5	5	3,600	Captive Port
PNP	4	4	4	2,700	Anchorage Port

Source: IPA

a. Mumbai Port Trust

Mumbai Port is one of the major ports of Maharashtra. Following table shows storage facility provided for dry cargo at MbPT.

Table 4-11 Storage facility at MbPT

Cargo	Storage	Number	(000')Sq. meter
Dry Cargo	Transit Shed	30	139
	Warehouse	23	132
	Open	64	501

Source: MbPT Admin report, 2015

Following are infrastructure expansion plan of the port in coming future

ü Deepening of anchorage to handle bigger vessels for transporting mid-stream cargo to other ports.

- ü Floating storage & re-gasification unit.
- ü Bunkering terminal to meet fueling needs.
- ü Development of marina on a stretch of 31,000 sq. meter of land & 84,000 sq. meter of water.

b. JNPT

It is one of the biggest container handling ports in India and also a major port in Maharashtra. The table below shows the existing facilities at JNPT. The port is equipped with various equipment for handling cargo.

Table 4-12 Infrastructure at JNPT

Container Terminal	Units	JNPCT+SWB	NSICT	GTICT	NSIGT
Quay Length	Meter	680+445	600	712	330
Capacity	(mn TEU)	1.5	1.2	1.8	1
Reefer Plugs	Number	576	778	840	336
RMQCs	Number	12	8	10	4
RTGCs	Number	18	29	40	12
RMGCs	Number	5	3	3	n/a
Tractor Trailers	Number	148	110	130	30
Backup Area	Ha.	62	25	52	27
Reach Stackers	Number	8	3	2	1
Railway Siding Tracks for ICD	-	4	2	3	n/a

Source: JNPT website

c. Dharamtar Port

Dharamtar port is a lighterage captive port on the banks of Amba River. Existing capacity of the port is 15MM TPA. The company plans to increase capacity of port up to 38 MMTPA by 2020 to match the additional cargo requirement of JSW plant after expansion. Achieving capacity addition to increase capacity to 38 MMTPA by 2020 appears to be aggressive. Achieving a capacity of 34MMTPA at Dharamtar Port by 2025/2030 looks more likely. Dharamtar port plans to handle other commercial cargoes upto 25% of its capacity. Presently about 3,000 DWT capacity barges are allowed in river and at port with the help of tide. However, Dharamtar Port plans to increase the capacity of infrastructure suitable for handling 8,000 DWT mini bulk carrier.

Following are the broad facilities available at Dharamtar port:

- 3 barge iron ore un-loaders, with the capacity of 2,500 tons per hour
- 3 conveyer and storage facility
- 2 mobile harbour cranes
- 10 acres of transshipment stacking area

This port currently serves JSW Group's Dolvi steel plant export-import requirements. JSW Ispat steel plant's all dry bulk cargo is handled at this jetty. The cargoes handled are limestone pellets and lumps, dolomite, hot briquette iron, DRI (sponge iron), PCI coal, coke, scrap, and iron ore pellets, lumps and fines. The jetty's handling capacity is around 45,000 tonnes per day for Iron Bearing Raw Materials.

The port has infrastructure expansion plan. Jetty length would be expanded to 1,740 meter to provide more berthing facility so that 17 barges could be handled at any time.

d. PNP Port

Barges are handled at PNP port only in case of high tide. The table below shows specifications of barges that are operated in Amba River.

Table 4-13 Specification of barges handled in Amba river

DWT	2,000 – 2,700 tons
LOA	70-78 meter
Beam	12- 14 meter
Draught	3.2- 3.8 meter

Source: PNP Maritime Services Pvt. Ltd.

Table 4-14 Berthing facility available in Amba river

Berth Number	Cargo Handled	Length (m)	Width (m)
1	Bulk, Cement	32	10
2	Bulk	32	10
3	Bulk	32	10
4	Steel Coil	30	n/a

Source: PNP Maritime Services pvt. Ltd.

The above table shows berthing facility at PNP Port in Amba River. Four berths are available at present, which are used to handle bulk cargo, cement and steel coil. Berth 4 has mooring dolphin facility. Fixed ship, shore crane are used to handle steel coil.

4.2.3.7. UPCOMING INFRASTRUCTURE

There are several ports and other logistics infrastructure planned in the catchment area of Amba River. There are two prominent port infrastructures conceptualized by private sector at the mouth of the creek, namely Rewas and Karanja. Rewas and Karanja are located opposite to each other.

Reliance industry is planning to develop Rewas port. It has plans of developing 70 berths with handling capacity of 457 MMTPA of cargo. At present, forest land of 86 ha is allocated to Rewas port and another 1,065 ha of land is yet to be allocated to the port for development. The proposed port by Reliance at Rewas has been put on hold for various reasons. The port is unlikely to commission in coming few years.

Karanja port is located at the mouth of Amba River. SKIL Ports & Logistics Ltd. is developing Karanja Port. The project is in the advanced development and construction stage. Once developed, it would be a multipurpose terminal with primary focus on containers. The terminal would have a depth of 4 m.

It is expected that by the end of March 2017 port will start its operation as per SKIL Ports & Logistics. However it is still under planning & construction phase. Port has plans to set up its own CFS in near future to attract more traffic. Future traffic at Amba River would not get affected by the development of Karanja Port.

Dharamtar Port is planning to expand its jetty length from 332 meter to 1,750 meter that would help in expansion of capacity from 15 to 40MMTPA. Total project cost for this development is INR 1,550 Cr.

Mumbai Port Trust is developing a new terminal for inland passengers near Ferry Wharf. The budget of this project is INR 140 crore. This new proposed terminal will provide facilities like safe navigation for Raigad district and to the Elephanta caves. Such development would help to increase passenger traffic in near future.

Roha is going to be developed as a megacity project. Nagothane which is the end point of Amba River is 17 km away from Roha. MIDC area in Dhatav about 7 km from Roha, is declared as chemical industrial zone by MIDC.

New Ro-Ro ferry service is proposed from New Ferry Wharf to Dharamtar Port to decongest traffic of Vadkhal Naka, which is an important node in Mumbai Goa highway. Other supportive infrastructure like waiting room, restaurant and recreational facility would also be developed in the land area of Dharamtar. Dharamtar port is also in the expansion phase and it is expected to handle 34 MMTPA of cargo by the end of 2030.

All upcoming cargo-handling infrastructures in the catchment area of Amba River are captive infrastructure. Other industries would not be benefitted from this. Thus exist need to develop IWAI terminal for common use.

4.2.3. Existing & Proposed Industries

4.2.3.1. EXISTING INDUSTRIES

Many industries are setting up plant in Raigad district, away from Mumbai's city life and road congestion problem. More people are attracted to industrial sector for employment opportunities. Panvel & Kamothe Industrial areas are closer to JNPT than

Amba River. The following table shows the type of industries in the catchment of Amba River and their distance from the existing ports and Amba River.

Table 4-15 Industrial areas in the catchment area of river

Industrial Location	Area (Ha.)	Type of Industries	Distance (km)				Opportunity	Reasoning
			To river	River to port	Direct MbPT (Rail/Road)	Direct JNPT (Rail/Road)		
Kamothe	24	Chemical, Iron & Steel, Paper	40	19	42	30	Nil	Kamothe & Panvel region would not provide much opportunity for Amba river due to their close proximity to JNPT. Some of the industries in Khopoli region like steel industries and coal traders would use Amba river
Panvel	12		36	19	46	28	Nil	
Khopoli	11		39	19	79	63	Possible	

Source: Consultant's Analysis

The below table shows large, medium and small types of industries located in Raigad district. Most of the below mentioned industries are in MSME category (micro, small and medium enterprises).

Table 4-16 Type of industries in Raigad district

Large	Medium	Small
Food Processing	Horticulture	Rice mill
Repairs of Agri Implements	Bamboo, Bricks	Packing material
Idol making for festival	Auto parts	Rubber, Plastic product
Fish and products	Electrical equipment	Stone blasting

Source: Industrial State Profile of MH

Figure 4-6 Industries around Amba river

The above image shows various industries located on the catchment area of Amba River and the connectivity around them. There is good road/ rail connectivity; however there is no airport in the catchment area. The only major airport, Chatrapati Shivaji Airport is located in Mumbai.

a. RCF

Thal urea plant has production capacity of 2 MMTPA. Following table describes historic production at Thal RCF plant.

Table 4-17 Thal Plant historic production & utilization

Thal	2013	2014	2015	2016
Urea Production (mn T)	2.0	2.0	2.2	2.1
Capacity utilization (%)	98	100	109	105

Source: RCF corporate presentation

In FY 16 Thal plant of RCF produced about 21 lac MT of urea. RCF Thal plant is planning to expand its urea production capacity by adding another single stream ammonia & urea plant. The capacity expansion plan is given in the table below. This proposal is waiting for approval from the Government.

Table 4-18 RCF Thal plant Expansion

Plant	Capacity (MTPD)
Ammonia Plant	2,200
Urea Plant	3850
Total	**6,050**

Source: Annual report FY16

RCF Thal plant also provides paddy, fruit sapling & free fertilizers to nearby villages as a livelihood enhancement project and has spent Rs 9.7 lacs for carrying out this social activity. RCF does not handle logistics or supply chain directly. The company selects dealer through tender process for distribution. Thal Plant would not provide any opportunity for the proposed waterway because there is direct railway connectivity from Thal plant, which is used for transporting fertilizer cargo.

b. Steel Industries

There are three Iron & Steel companies located on the catchment area of Amba River, namely JSW Steel, Uttam Galva and Bhushan Steel. The following table describes the additional capacity of iron and steel cargo from these companies.

Table 4-19 Iron & Steel Companies expansion plan

Company	Plans	Additional Capacity (mnT)
JSW	Set up of Coke Oven Plant at Dolvi through DCPL	1.5
	Tinplate Mill at Tarapur	0.2
Uttam Galva	Present pig iron facility expansion into hot rolled coil product	1.5

Source: Company expansion plan, Annual reports

§ **JSW Steel**

About 0.5 mn TPA of steel coils and HSR plates are moved through coastal vessels and unloaded at Dharamtar port for JSW steel plant.

§ **Uttam Galva**

Uttam Galva is a secondary steel producer, which makes cold rolled as well as galvanised steel. The cold rolled sheets are used by the automotive sector, while galvanised steel mainly goes into construction. The company has an installed capacity of 1 million tonne of cold rolled and galvanised steel at Khopoli, Maharashtra. The galvanizing capacity of Uttam Galva is around 750,000 MTPA. Uttam Galva imports roughly 0.6 MMTPA of iron and steel coils using the Mumbai Port Trust. The import volume has remained stagnant.

§ **Bhushan Steel**

Bhushan Steel has three plants at Ghaziabad (UP), Khopoli (Maharashtra) and Orissa. Imported coils are mostly used at the Khopoli plant. The below table shows the capacity of the various units of Bhushan Steel Plant.

Table 4-20 Bhushan Steel plant details

Description	Average (mn T)
HR/CR Steel Strips/Sheets	1.0
Ghaziabad Plant (50%)*	0.5
Khopoli Plant (50%)*	0.5

Source: Consultant's Analysis

In the domestic market, UGSL supplies to high quality conscious auto-major players like M&M, Bajaj Auto, Bajaj Tempo, Piaggio, and Tata Motors. In the white goods appliance segment, its clientele includes Godrej, Daewoo, Anchor, etc. Skin Panels of white goods like refrigerators, washing machines are supplied in DD, EDD and GP skin passed steel. In the engineering and electrical segment, the company supplies to BHEL, L&T, Crompton Greaves, Kirloskar etc.

A majority of iron & steel importers are traders; some of them are based in Khopoli, Pune, Kalamboli, etc. Khopoli is located more than 35km away from river. Kalamboli is very near to JNPT; thereby there exists no scope from Kalamboli region for the proposed waterway of Amba river. Due to Mumbai Pune Express Highway connectivity, it would be difficult to attract traders from Pune. Automobile companies import coils for their productions, using Mumbai port. There are also several industrial units such as Bajaj, Force motors, Honda, and GM, which import these coils in small quantities ranging from 2,000 tonnes to 10,000 tonnes.

c. Reliance Petrochemical

Reliance industry has its manufacturing plant in Nagothane. It is a petrochemical complex operating since 1989. The plant has total capacity of 600 KTA PA. Production units in this complex produce Polyethylene, Polypropylene, EO and MEG. Nagothane MIDC area has been allotted to Reliance, which was previously with IPCL. Total land area is 750 Ha Reliance petrochemical unit at Nagothane takes raw material from its own Jamnagar plant. Reliance is planning to develop 486 km long pipeline on BOT (Build-Operate-Transfer) basis that would connect Dahej plant with Nagothane plant. It is expected that 1.4 MMTPA of liquid cargo would be transported using this pipeline. This development would further limit the opportunity for liquid cargo movement through Amba River.

d. Venus Wire

Venus Wire located in Khopoli has steel wire, bars manufacturing plant, which exports to Europe, North America, parts of Asia. Size of steel coarse wire ranges from 0.70 mm to 22 mm & steel fine wire size ranges from 0.10 mm to 0.90 mm. JNPT is about 40 km away from Venus Wire plant, which is used for exporting purpose. For domestic distribution of finished product, the company use sits own vehicle to transport to Bangalore, Gujarat & Andhra Pradesh etc. Domestic cargo volume is very low about 6,000 MTPA, thereby limiting scope of domestic cargo distribution through Amba River. Distance to Dharamtar/PNP, Karanja & Nagothane is higher from Khopoli as compared to JNPT.

e. Supreme Petrochem

The company has its plant located in Wangani village in Nagothane. The company is developing a new captive terminal for handling liquid cargo in Dherand village. Dherand is located between Karanja and Dharamtar. As the company has its own captive terminal; hence there is no scope from this company to the proposed waterway. The company has already acquired land for the development and got the environment related clearances. There is poor road connectivity from Dherand village, which are being sorted out. The below table shows the installed capacity details of the plant.

Table 4-21 Installed capacity of Supreme Petrochem

Product	Unit	Installed Capacity
Polystyrene	TPA	2,72,000
Expandable Polystyrene	TPA	32,000
Specialty Polymers and Compounds	TPA	33,500
Extruded Polystyrene Foam Boards	Cubic Meter p.a	1,20,000

Source: Company Website

f. Tata Power

Tata power is also developing its own terminal in Dherand village. The company has taken all the environment clearances and waiting for the land acquisition. Tata would not use any other jetty, once its own jetty is developed. This would limit scope for coal traffic movement through Amba River.

g. Sanghi Cement

Sanghi Cement has silos located in Amba River's primary catchment area. About 2,100 MT cement in one time is transported from Kandla port to MbPT and then to its Dharamtar unit, using barges at PNP port. These cargoes are stored in silos to serve the demand for bulk cement in the region.

h. JSW Cement

JSW is operating a small clinker-grinding unit, with clinkers imported from Persian Gulf. About 0.15 MMTPA of clinker is unloaded at JSW jetty.

4.2.4. Traffic from Major & Non Major Ports

The decline in the traffic of major ports has been a boon to the non-major ports of the state. These ports recorded a cumulative growth of 17% per annum in the last five years. This has been due to large investment in the port sector by the government and the private companies. Raw material requirement for major industries have boosted the growth of the non-major ports of Maharashtra. Coal and iron ore have recorded the substantial share.

a. Non Major Ports

The state has developed several private ports and captive ports. These ports have put a large investment on the infrastructural development and have evolved as an option to industries located far off from the major ports, such as Mumbai Port Trust and JNPT. Non-Major ports have experienced boost in traffic only in the last 5 years. They have grown at a rate of 29% to more than 15 MMTPA of import from overseas in the last five years, which is more than double the growth rate in the last 10 years. Dharamtar port has attracted traffic with a growth rate of 9% in the last five years.

Table 4-22 show the historic import & export trade from overseas in non-major ports of Maharashtra. Import trade in Dharamtar port is more than other non-major ports. Export trade at Dharamtar port is less compared to import trade.

Table 4-22 Overseas Historic Import Trade of Non Major Ports of MH

('000 T)

Ports	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Dharamtar	4,191	3,062	3,512	2,921	2,146	3,803	2,569	3,639	3,887	5,244	5,898	6,723
Other Ports	443	844	589	564	266	726	2,161	5,554	7,743	8,744	9,972	11,966
Total	4,634	3,906	4,101	3,485	2,412	4,529	4,730	9,193	11,630	13,988	15,870	18,689

Source: IPA

Table 4-23 Overseas Historic Export Trade of Non Major Ports of MH

(000' T)

Ports	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Dharamtar	311	118	36	366	87	104	652	191	172	38	74	47
Other Ports	1,214	1,022	572	1,117	1,925	1,303	1,758	3,230	2,952	2,626	2,548	2,219
Total	1,525	1,140	608	1,483	2,012	1,407	2,410	3,421	3,124	2,664	2,622	2,266

Source: IPA

Import has surged at a cumulative rate (CAGR) of 29% in the last five years but the export grew only with a rate of 13%. This trade deficit is because the major import of raw material for the industries is in bulk form and is done through ports. A major share of the finished cargo is taken away by the road transport. In FY16, the total trade at MMB ports grew close to 19 MMTPA, out of which the share of import accounts for more than 85%.

Overseas traffic at non-major ports in Maharashtra has stimulated by the development of infrastructure at these ports. They have been able to successfully acquire a big chunk of share of major ports. Coal has been a prime commodity of import at these ports. However, it has not seen significant growth in the coastal trade. Road traffic has still managed to retain its share. The reason is non-major ports do not have a customized infrastructure, which could compete with cost effectiveness by road movement.

Table 4-24Historic Coastal Export traffic of Non Major Ports of MH

('000 T)

Ports	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Dharamtar	135	91	68	18	2,856	40	3	0	0	2	59	17
Other Ports	990	103	499	498	653	303	190	228	678	206	1,664	2,039
Total	1,125	194	567	516	3,509	343	193	228	678	208	1,723	2,056

Source: IPA

Table 4-25 Historic Coastal Import traffic of Non Major Ports of MH

('000 T)

Ports	Fy-05	Fy-06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Dharamtar	3083	3003	3185	3017	-	2893	3857	3692	5664	4895	4136	3100
Other Ports	1610	2567	3099	3112	2483	3339	3681	3411	3095	3016	2,914	2,625
Total	4,693	5570	6284	6129	2,483	6232	7538	7103	8759	7911	7,050	5,725

Source: IPA

The table below shows the historic traffic of Dharamtar Port. Among major commodities, coal is handled majorly. There is growth in volume of coal. The other commodity after coal, which is majorly handled at the Port is iron ore & products. However, the volume of iron ore & products reduced in FY 16.After FY 2013, Coastal trade has diminished; whereas overseas trade has grown over years.

Table 4-26 Commodity wise historic traffic of Dharamtar Port

('000 T)

Dharamtar Port	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Cement & Clinker	330	295	192	223	146
Coal	2,196	2,638	2,599	3,350	4,801
Coke	599	955	1,155	172	-
Iron Ore & Products	3,538	5,619	4,874	5,031	3,644
Mineral other than coal & Coke	720	942	927	1,022	709
Steel & Product	165	197	376	321	581
Others	91	35	55	28	6
Total	7,638	10,681	10,179	10,148	9,887

Source: MMB

Table 4-27 PNP commodity wise traffic handled in FY 16

(Volume in MMT)

Port	Coal	Steel coil	Other cargo (Cement, Bauxite, Slag)	Total
PNP	3.20	0.56	0.03	3.79

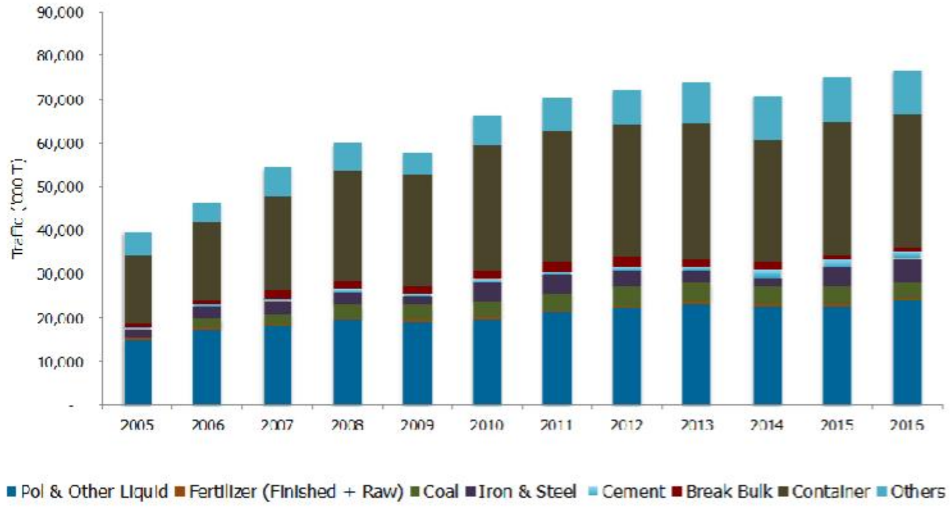
Source: PNP Maritime services

The table above shows cargo traffic handled at PNP in FY 16.In FY 16, 1.71 MMT of coal cargo was evacuated by rail and 1.25 MMTT of coal, cement & steel coil was evacuated by road.

b. Major Ports

There exist two major ports in the catchment area, MbPT and JNPT. The historic traffic of both the ports is presented in below tables, Figure 4-7 and Figure 4-8.

All the industries located in deeper Maharashtra region have only two option for export and import purpose. Though there are non- major ports operating in Maharashtra, industries are using MbPT& JNPT for their EXIM purpose even though it is located more than 100 km away. Industries which are in close proximity of Major ports are in benefits and such industries are least likely to use Amba River for any purpose.



Source: Consultant's Analysis

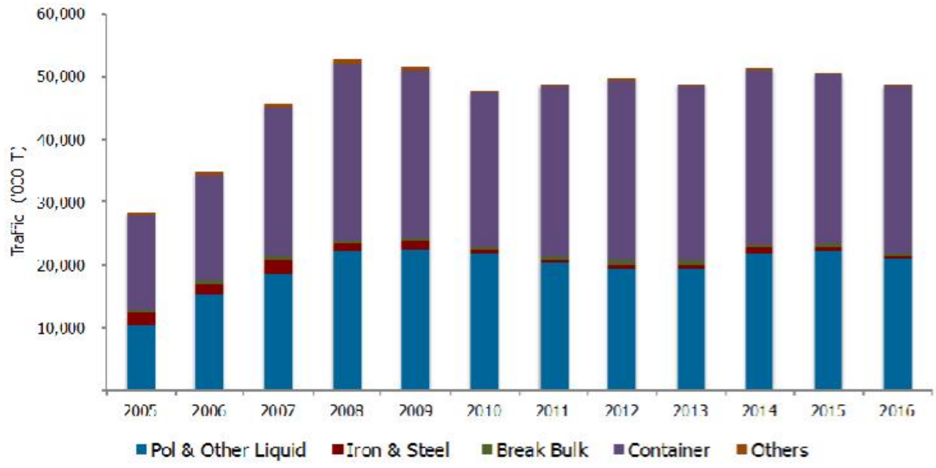
Figure 4-7 Commodity wise imported historic traffic of Major Ports (MbPT + JNPT)

The above graph shows imported historic traffic of MbPT and JNPT. POL & other liquid and containerized products are unloaded at major ports on a larger scale compare to other commodities. It is clearly visible that coal import traffic at major ports is gradually decreasing. Fertilizer is the least imported commodities at major ports. Iron & Steel imported at major ports is getting consumed in Khopoli region. Imported container cargo is getting consumed in Konkan region of Maharashtra. All these container cargo and liquid cargo in the form of trucks moves towards their final destination via NH66.

Table 4-28 Historic Import Traffic at Major Ports (000 T)

Commodity	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pol & Other Liquid	15,009	17,214	17,980	19,614	19,261	19,658	21,179	22,346	23,183	22,617	22,510	24,121
Fertilizer (Finished + Raw)	611	628	503	310	346	481	553	481	586	302	447	439
Coal	-	1,844	2,533	2,951	3,266	3,745	3,869	4,321	4,018	4,221	4,304	3,451
Iron & Steel	1,814	2,876	2,862	2,807	1,927	3,949	4,105	3,505	2,941	1,886	4,102	5,643
Cement	473	597	618	741	813	1,020	862	855	842	2,120	2,102	1,649
Break Bulk	1,028	1,081	1,729	1,719	1,729	1,917	2,361	2,460	2,202	1,769	836	634
Container	15,352	17,992	21,467	25,423	25,242	29,036	30,024	30,238	30,914	27,831	30,671	30,927
Others	5,407	4,157	6,673	6,448	5,102	6,725	7,254	7,980	9,067	10,227	10,199	9,912
Total	39,694	46,389	54,365	60,013	57,686	66,531	70,207	72,186	73,753	70,973	75,171	76,776

Source: IPA



Source: Consultant's Analysis

Figure 4-8 Commodity wise exported historic traffic of Major Ports (MbPT + JNPT)

Containerized cargo and POL& Other liquid are the major loaded commodities at major ports. Iron & Steel products in finished forms also gets exported from Major ports however it's share in whole exporting category is very minimal. All the containers for export purpose are coming from deeper Maharashtra region to Major Ports due to lack or no container handling facility at other non-major ports of Maharashtra. Direct road connectivity from Major ports towards industrial plant area is also major factor due to which Major ports are used for all EXIM purpose compare to other non-major ports of Maharashtra.

Table 4-29 Historic Export Traffic of Major Ports (000 T)

Commodity	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Pol & Other Liquid	10,184	15,279	18,595	22,116	22,454	21,786	20,443	19,401	19,403	21,675	22,196	21,064
Iron & Steel	2,091	1,515	2,020	1,275	1,266	623	505	721	741	1,040	610	342
Break Bulk	586	617	764	590	562	300	429	570	451	436	508	492
Container	15,043	16,943	23,807	28,132	26,651	24,666	27,055	28,546	27,826	27,853	26,806	26,400
Others	397	301	483	750	548	189	256	489	354	260	170	63
Total	28,301	34,655	45,669	52,863	51,481	47,564	48,688	49,727	48,775	51,264	50,290	48,361

Source: IPA

§ **Mumbai Port Trust (MbPT)**

Mumbai Port Trust is a major port in India. It is located in the main city of Mumbai. The port faces problem in evacuating its cargo to the hinterland due to city traffic. Mumbai is one of the most populous city of India. Hence, there exists a possibility to divert some of the cargo from Mumbai Port destined towards Southern Maharashtra to waterways. At present, roadway is used for cargo movement. Mumbai Port handles about 60 MMTPA of cargo annually. About 60% of the total cargo handled in Mumbai Port constitutes petroleum products including Crude and refined petroleum products.

The cargo is for the local refinery owned by BPCL and HPCL. Crude imported to Mumbai Port is consumed by these refineries. The products generated from these refineries are evacuated to hinterland using pipelines, railways and roadways.

Apart from petroleum products in the form of liquid, other prominent cargo includes coal, iron & steel, pulses, automobiles, etc. Coal from Mumbai Port has to be shifted to keep the city clean. Amba River and the non-major ports in Amba, predominantly PNP are likely to be the largest recipient of this shifted cargo. High court has also given its ruling to shift coal by the year 2020. Iron & Steel, which is transported using roadways, also possess potential to get evacuated using waterways from Mumbai Port.

Mumbai Port Trust (MbPT) handles iron and steel cargo, both for export and import. Mumbai Port handles more than 50% of the total Iron & Steel trade undertaken in India. Iron and steel constitutes close to 8% of its total cargo. Mumbai has steel plants at Khopoli, Kalamboli and Thane, which are major consumption centres for rolled steel coils, which are imported using Mumbai Port Trust. A large share of the finished product generated from these centres is also exported using Mumbai Port Trust. It is estimated that more than 40% of the total Iron and Steel cargo handled at Mumbai Port gets consumed in a radius of about 150 km from Mumbai which could be diverted to Amba River.

§ **Jawaharlal Nehru Port (JNPT)**

JNPT is the largest container port in India. JNPT handles containers, petroleum products and cement. It handles about 4.25 million TEU containers annually. The port has large terminals, suitable for handling large ships carrying large parcels. A small share of containers handled at JNPT is for the hinterland in the catchment area of Amba. The volume of containers is very small and it would not be commercially attractive to shift those using waterways. A few years back container barges had begun to ply between JNPT and PNP port. The containers were transported using small barges of united shippers. However, the project stopped due to low volume of containers, refusal of JNPT to provide priority berthing to small barges, increasing focus of PNP on dirty cargo such as coal, etc. It is commercially not attractive for JNPT to handle small barge carrying about 80 containers or 100 containers.

There are also 3 terminals, which are operated by private operators at JNPT. The 4th terminal which is under development stage, would be owned and operated by private operator. Hence, it becomes challenging to convince them to handle small barges. JNPT and Ulwe-Belapur acts as a gateway for cement consumed in Navi Mumbai.

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4.3. Commodity Composition

Indian railway is one of the prominent mode of transporting freight in India. The following table analyses cargo moved by railways from the catchment area of Amba River

Table 4-30 Commodities transported by railway (Jan-June, 2015)

Commodities	Origin	Destination	Consigner	Consignee	Rakes Demand (no.)	Opportunity	Reasoning
Containers	JSWT	JNPT	CONCOR	CONCOR	9	✗	Container cargo is not potential commodity for Amba river. CONCOR has well established infra to handle such cargo. Kalamboli & JNPT both have close proximity with each other. Container also gets destined to Delhi from Kalamboli. These both places do not come in the primary catchment area.
	TISCO, Kalamboli	Delhi, JNPT	GRPL	GRPL	10		
	Innovative B2B logistic		CWC	DLI	3		
Coal (Imported)	PNP Maritime	Bhusawal & Bhopal	GORL, RATT	BORL, RATT	4	✓	PNP terminal is on the bank of Amba river. Imported coal handled at this terminal is destined to Bhusawal, Jalgaon & Bhopal, M.P.
Iron & Steel	JSWD	KSWR, BOR, JSWV, MGN, BPTV, KLMG, MSTB, CMCT	JSW	JSWK, AAAC, JTIL, MULT, NSAI, PEBS	188	✗	JSW's iron & steel is getting consumed in Nagpur (MH), Rajasthan, Hyderabad areas. Destination places are landlocked region
	Nagothane	NTSK	MSLD	MSLD	1	✗	
POL	MBPP	LPBG, LPBP, IOBP, HPCS, BPCL, BPAG, LPGK, HPCA	BPC	BPC, HPC, IOC	77	✗	POL Product is getting handled among major oil refineries like BPCL, HPCL own siding. These refineries do not have plant or storage areas in the catchment area of river
TAR	Pen	CCIL	PUB	CCIL	1	✗	This commodity is transported from Pen to Delhi region. Pen & Delhi are landlocked place.

Source: FOIS

The containers which move from catchment area of Amba is destined for JNPT. This cargo is unlikely to shift due to competitive price offered by Indian railways. This is industrial cargo of JSW originating in plant for export. There exists regular movement of rakes from JNPT to Kalamboli.

A large volume of coal gets transported using railways from PNP port to power plants located in Madhya Pradesh. This volume of cargo is likely to increase further with closing down of coal handling at Mumbai Port Trust completely.

Imported Coal volume is considered based on the plants which are dependent on thermal coal for producing finished product. For projection of coal traffic at proposed IWT terminal, current capacity of all the existing power plants, steel and other plants are considered. Their expansion plans are also taken into consideration. Deferred TPP plans are not considered in projecting future coal volume. Unless, these power plants expand their capacity further, it is unlikely that imported coal volume would increase.

4.3.1. Thermal Coal

Coal is being unloaded at PNP & Dharamtar port in Amba River. However there does not exist any power plant in the catchment area of river. Coal handled in the river is for JSW's upcoming cement plant & also for thermal power plants of Mahagenco. Due to clean cargo policy of MbPT, coal traffic is likely to get diverted to Amba River. Coal is imported from Indonesia at PNP through 800-2,000 DWT vessels and is transported to power plants in Nashik in Maharashtra and Bina in Madhya Pradesh by railway. 2 - 3 rakes of about 10,000 MT per day through rail are transported to Rasayni, Khopoli, Kalyan, Bhivandi, Vada and Taloja etc. Good railway connectivity from Dharamtar port & PNP port creates additional advantage in further transportation of coal.

4.3.2. Iron Ore

At Mumbai anchorage, iron ore is unloaded from mother vessels of 50,000 DWT into 2,500 DWT vessels and then iron ore is transported through conveyer belt from Dharamtar port to steel plant of JSW.

4.3.3. Cement & Clinker

For JSW's cement grinding unit, clinker is imported from Persian Gulf, which is handled at Dharamtar port.

4.4. Originating & Terminating commodities

The below table shows commodities handled at major port in the hinterland, which could be potential market for the proposed waterway in Amba river. The table also presents reasoning for targeting these commodities and potential they would provide for the waterway.

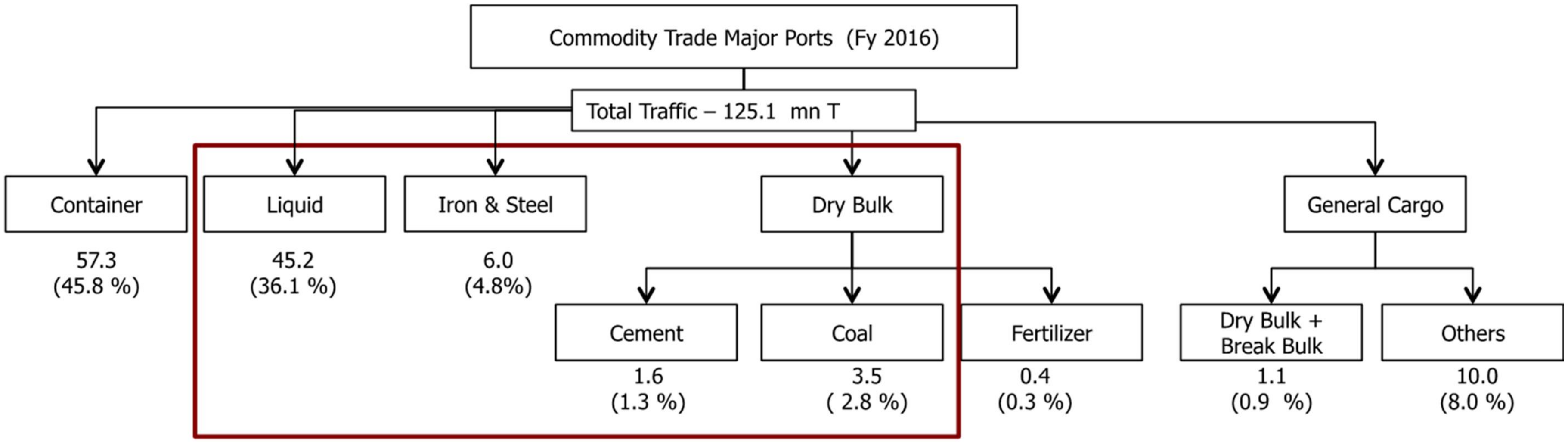
Table 4-31 Opportunities for river movement of commodities handled at Major Ports

Cargo	Volume (mn T)	Potential for Dharamtar	Potential for Proposed terminal	Reasoning
Coal	3.5	✓	✓	MbPT's coal handling operation has seized. Coal would no longer be handled at Haji bunder, i.e. ban is imposed on coal operation on land but not on shore. JNPT does not handle coal cargo. However, there is no ban on coal handling at Tata Power jetty in Trombay, Mumbai. Because coal gets consumed in the plant located near to jetty. Coal does not get transported from TATA power jetty into city area. So, coal would get handled at anchorage, Mumbai and then through barges it could move in IWT route. Dharamtar is already handling coal cargo of MAHAGENCO's power plant. In near future, possibility of other power plants of Maharashtra to use non-major ports for coal import exists. Possibility of this coal to be handled at the proposed terminal exists.
Cement	1.6	✓	✗	Many development projects are coming around the river like Roha Mega City Plan etc. Such projects would increase demand for cement consumption in the region. Connectivity development projects in the region would also likely boost demand. Karanja terminal, which would be developed at the mouth of river, is already in talk with Ultra Tech Cement for dedicated cement berthing facility. JSW cement plant has its own dedicated jetty. No other cement industry is located in the catchment area of river.
Iron & steel	6.0	✓	✓	Khopoli & nearby areas have iron & steel making industries, which are willing to use waterway on Amba River for export or import purpose. JSW steel has its own terminal. Iron & steel traffic from MbPT gets consumed in Khopoli region. Possibility of diverting this traffic to Amba river exists.
Other Bulk/Break Bulk	1.5	✗	✗	Other bulk cargo like fertilizer or minerals do not provide any opportunity for proposed IWT terminal. RCF Thal plant has its own dedicated rail siding and dealer distribution in India, hence limiting fertilizer scope. Deepak Fertilizer plants in Taloja have closer proximity (36 km) to JNPT than Amba river.
Chemical		✗	✗	MIDC has declared Roha as chemical cluster, which is 17 km away from Nagothane and more than 40 km from PNP. All other chemical hubs are located near Savitri and

Cargo	Volume (mn T)	Potential for Dharamtar	Potential for Proposed terminal	Reasoning
				Vashishti river.
Liquid Cargo	45.2	✗	✗	PNP is planning to handle liquid cargo in near future. It has acquired 135 ha of land, adjacent to port area for infrastructure development. This development would likely attract more cargo for PNP terminal, hence and does not hold potential for proposed IWT terminal. No other liquid based plant was found during site visit.
Container	57.3	✗	✗	There is no containerized based industry in the catchment area of Amba river.
Others	10.0	✗	✗	Other cargo are fragmented cargo and do not provide any opportunity on larger scale for Amba river.
Total	125.1			-

Source: Consultant's Analysis

At present there exist two ports on Amba River. There are three upcoming terminal in the pipeline, for which land has been acquired namely Karanja Port, two captive terminals at Dherand. Distance between Karanja to PNP is about 20 km. Dherand and PNP terminal are at a distance of 5 km. Existing industries in the primary catchment area are already using existing terminal i.e. PNP and Dharamtar. Industries in secondary catchment area are using JNPT port due to close proximity and direct connectivity. Nagothane MIDC area is obtained by Reliance industries. Reliance is planning to develop a pipeline connecting Gujarat to their Nagothane plant. Thereby there is no cargo potential from Nagothane MIDC area to proposed IWT terminal.



- Above graph represents total traffic of MbPT & JNPT with major commodities and their contribution to total traffic.
- Red box indicates commodities that could be diverted from Major port to either Dharamtar Port or to the new terminal that would be developed in Amba river.
- However there exists possibility to shift traffic from Major port to upcoming Rewas & Karanja Port located at the mouth of Amba river.
- Khopoli, which is known as steel hub is at a distance 40 km from Dharamtar port and it takes additional 10 km to reach Nagothane. All the major industries are in Khopoli and nearby region. Developing a terminal near Nagothane would not be beneficial for industries.
- Cargo which gets consumed in Khopoli, Lonavala area could get benefitted from Amba river development.
- PNP is planning to handle liquid cargo in future and has acquired land for development of handling liquid cargo.

Figure 4-9 Cargo opportunity for Amba river from Major Ports

4.5. Passenger Traffic

As Amba river is used for cargo operation, there does not exist much opportunity to develop any infrastructure to attract passenger traffic on the river.

4.6. Tourism Traffic

Alibaug is the major famous tourist destination nearby Amba River. From the mouth of Amba River, Dharamtar port is located at a distance of about 20 km. The Port handles cargo traffic. After Dharamtar port till Nagothane, there is no cargo activity in the remaining stretch of the catchment area. Almost half of the river stretch is heavily used by vessels for carrying cargoes, mainly coal i.e. dirty cargo. Movement of dirty cargo in the river restricts tourism related activities in the river stretch.

Table 4-32 Famous Tourist Spots around Amba River

Location	River	Distance (km)
Alibaug	Amba	17
Chaul	Amba	15
Sarasgad Fort	Amba	10
Shri Ballaleshwara Temple	Amba	10
Indian Sculpture Park	Amba	1
Imagica	Amba	28
Karnala Fort& Sanctuary	Amba	18
Kolaba Fort	Amba	19
Ghangad Fort	Amba	24

Source: Source: Consultant's Analysis, Trip advisor, Site visit

4.6.1. Alibaug

Alibaug is situated at the mouth of Amba River. It is the major weekend gateway for Mumbai & other suburban region. Tourism is the only major revenue generating source for Alibaug region. There are many water sports activity on the beaches of Alibaug. Kashid is the famous beach of Alibaug.

4.6.2. Chaul

Chaul is very quiet & beautiful village, located on the west side of Amba River. There exists famous Datta Mandir, which has 1,500 concrete steps. It is located nearby to Revadanda, which is also very popular tourist place.

4.6.3. Sarasgad Fort

Sarasgad Fort is famous trekking spot for young enthusiasts. It is located in a village near Pali and accessible by Mumbai- Pune expressway.

4.6.4. Shri Ballaleshwara Temple

This is famous Ganesh temple located in Pali village.

4.6.5. Karnala Fort

It is located in urban jungle i.e. nearby Navi Mumbai area, near NH 66. Karnala bird Sanctuary is located here. Karnala bird sanctuary is stretch over an area of 4.8 sq. meters. 150 resident bird species and about 37 types of avian migrants can be found in the sanctuary. It is accessible by Mumbai Pune highway to Goa.

4.6.6. Kolaba fort

Kolaba fort is located in the sea and 1-2km away from Alibaug. The Fort is about 25 feet high and has two main gateways.

4.6.7. Ghangad Fort

It is a famous trekking place. This fort is 3,000 ft. high. It takes 45 minutes to 1 hour to reach on the top of the fort. This fort is accessible by Pune Mulshi road via Tamhini Ghat.

All the tourism places around Amba River are located more than 10 km away, thereby it is very unlikely that people would use river to reach these tourist spots. It is more convenient to go by roadways due to direct accessibility; hence there is limited opportunity for tourism.

4.7. Ro-Ro Traffic

Passenger ferry terminals in the catchment area of Amba River exists. These terminals are located at Karanja, Mandwa, Rewas, Alibaug and Thal. The table below shows historic traffic of these terminals. Among the existing passenger terminals, Mandwa handles most passengers in last 5 years. Alibaug and Thal terminals handle fewer passengers compared to other terminals in the catchment area.

Table 4-33 Passenger Ferry Terminals& Historic Passenger Traffic

(Unit- in '000)

Terminal	2012	2013	2014	2015	2016
Karanja	220	214	185	229	332
Mandwa	988	1,139	1,198	1,317	1,398
Rewas	347	383	336	329	466
Alibaug	64	77	51	36	12
Thal	2	9	9	5	2
Total	4,662	5,044	5,057	5,269	5,773

Source: MMB

Passenger traffic from Karanja to Rewas is carried through ferry machwas. Alibaug Launch services are available from September to May like Catamaran, normal ferry boat etc. Ferry service operates on Mumbai-Alibaug route between 6 am to 7 pm in the evening. All the above mentioned passenger ferry terminals are located on the coastal side and not inside the Amba river. No criss-cross ferry service operates in Amba River. Thereby passenger traffic generated by above-mentioned terminals does not provide any opportunity for Amba River.

4.8. Growth Trend

4.8.1. Passenger & Tourism Growth for Amba River

Growth potential for passenger and tourism traffic in Amba River is negligible. Due to existing extensive dirty cargo operation on the river, people are reluctant to use river for transportation. In future, possibility of growth in cargo movement on Amba River is high, which would further restrict any development on passenger & tourism front.

4.8.2. Cargo Growth for Amba River

At present about 14 MMTPA of cargo is handled by waterway in Amba River. JSW Dharamtar Port & JSW Plant have expansion plan to increase their cargo handling capacity and production capacity. This development would likely result in increase of future cargo traffic in Amba river. There are two more captive terminals proposed on Amba River in Dherand village. Commissioning of these terminals would also increase further growth in cargo traffic.

It is evident that the proposed waterway would be used extensively for cargo movement. Fishing, Passenger and Tourist movement would not provide any opportunity for Amba, as dirty cargo handling in the river would restrict fishing and ferry movement.

4.8.3. Comparison of FSR & DPR study

The below table shows identified commodities and potential they would provide for Amba river. Few commodities like POL, Fertilizer, Food grains, Container were considered as potential cargo for Amba River in feasibility study; however they would not provide opportunity for the proposed waterway. The below table shows the commodities, which would provide opportunity for the waterway, along with reasoning. The table also shows and commodities, which would not provide opportunity for Amba river.

Table 4-34 Analysis of FSR Study

Commodity	Source	DPR Consideration	Potential for Amba	Reasoning
Thermal Coal	Nashik Power Plants	✓	✓	PNP port is already handling coal cargo & it is about to increase in future. Possibility of diverting coal traffic of MbPT to Amba river due to ports clean cargo policy. Some of the TPP have already started using Dharamtar port for import of coal.
Iron Ore	JSW	✓	✓	JSW steel use iron ore for their production purpose & capacity expansion of plant likely to increase iron ore traffic.
Coaking Coal	JSW	✓	✓	JSW steel plant uses coaking coal for producing steel, so Amba river is already in use.
Other Ore	-	✗	✗	No industries found. Very less volume handled at PNP.
Steel	-	✓	✓	JSW steel plant on the banks of Amba and Dharamtar port are handling their cargo.
Cement	JSW Clinker unit	✓	✓	JSW clinker unit is located on the bank of Amba river. Dharamtar port already handles this cargo.
Other Cargo	-	✓	✗	Other cargoes are not handled on large scale and they are fragmented in nature.
POL	BPCL & HPCL	✗	✗	PNP's plan of development of liquid terminal could attract liquid cargo to river; however PNP has only acquired land at this moment. No construction has been started yet. Even if liquid terminal; gets developed it would be captive in nature.
Fertilizer	RCF & DFPCL	✓	✗	Fertilizer holds no potential because RCF does not look after logistics & distribution. The company has its own rail siding. Deepak Fertilizer is 73km away from Nagothane and 36 km away from JNPT. 5 containers per week are exported from JNPT. Thereby no scope for handling any fertilizer cargo on Amba river.
Chemical	RCF & DFPCL	✓	✓	Supreme Petrochem is planning to develop captive liquid terminal at Dherand village. However this

Commodity	Source	DPR Consideration	Potential for Amba	Reasoning
				terminal would be captive in nature. Other chemical cargo generated by RCF or Deepak Fertilizer do not hold any potential for water transportation
Food Grain	-	✓	✗	Considered but due to local consumption in the primary catchment area no potential exist for river transportation
Container	-	✗	✗	Not considered because handling container cargo require huge storage facility & draft. Previously from Dharamtar to JNPT container service was started but it was deferred due to various reasons and in future it is not likely to start again.
Passenger	-	✓	✗	Considered but extensive use of Amba river for dirty cargo operation would restrict passenger and tourism movement on river thereby no potential for Amba river.
Tourism	-	✓	✗	

Source: Consultant's Analysis

Table 4-35 Overall River Attractiveness

Traffic	Attractiveness	Reasoning
Cargo (Industrial & Commodities)	✓	Two existing non-major ports (PNP & Dharamtar) on the river are operational and two more ports are proposed, namely Rewas & Karanja at the mouth of Amba river. Development of two more captive terminals at Dherand are in planning stage. All these infrastructure would result in extensive use of Amba river for cargo operation in near future.
Fishing	✗	Dirty cargo is being handled at existing non-major ports and half of the river is used for cargo operation. This limits the scope for fishing and tourism activity. Polluted river & good NH, SH connectivity in the region limit the scope for ferry operation for passengers across river.
Passenger	✗	
Tourism	✗	

Source: Consultant's Analysis

4.9. Forecasting & Potential IWT Assumption

4.9.1. Dharamtar Port

Dharamtar Port is planning to expand its jetty length (from 332 meter to 1,750 meter) that would help in expansion of capacity from 15 MMTPA (existing capacity) to 34 MMTPA (in FY 2025). Total project cost for this development is INR 1,550 Cr.

Table 4-36: Dharamtar Port Capacity Expansion Plan

(MMTPA)

	2016	2020	2025
Dharamtar Port	15	17	34

Source: Port's annual report & plans of expansion

JSW plants near Dharamtar port is also in the expansion stage, which would further increase cargo traffic in coming years. Following table summarizes commodity wise future traffic of Dharamtar Port, which would be transported using Amba River.

Table 4-37: Commodity wise projection of Dharamtar

Traffic (MMTPA)

Commodity	Fy-16	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Iron Ore	3.4	4.6	16.0	20.4	20.4	20.4
Coking Coal	1.3	1.8	6.0	7.7	7.7	7.7
Coal	3.2	4.4	1.0	1.3	1.3	1.3
Limestone	0.41	0.5	4.0	5.1	5.1	5.1
Finished Product	0.58	0.8	2.0	2.6	2.6	2.6
Cement	0.03	0.0	1.5	1.9	1.9	1.9
Clinker	0.11	0.1	2.0	2.6	2.6	2.6
Dolomite	0.24	0.3	3.0	3.8	3.8	3.8
Total	9.27	12.48	35.50	45.31	45.31	45.31

Source: Personal interview with JSW

a. Coke

The demand for Coke (Coking coal) at Dolvi plant of JSW is linked to the capacity addition and operational utilization of JSW plant. A steel plant based on coking coal requires about 0.8 MMTPA of coking coal for every 1 MMTPA tonnes of finished steel production. The present capacity of JSW plant has been increased to 5 MMTPA. Hence, there would be an annual requirement of about 4.0 MMTPA of coking coal at Dolvi plant. This requirement of coking coal would further increase with additional capacity augmentation of plant.

b. Coal

Prominent traffic of thermal coal in Dharamtar creek would arise out of shifting of thermal coal traffic from Mumbai Port Trust. Environment consideration has required coal cargo to shift from Mumbai Port Trust. Mumbai Port is envisaged to focus on clean cargo along with petroleum products and tourism activities. Handling of thermal coal on land has been restricted on the orders of High Court and Pollution Control Board. However coal would be handled at shore and then by means of barges it could move to other non-major ports of Maharashtra as per demand.

The court hearing petition filed by local Non-Government Organisation (NGO) had recommended shifting of coal handling at Mumbai to MMB Port at Dharamtar. The extension period given to Mumbai Port Trust for handling of coal has expired in October 2015. However, an extension was granted to handle coal till 2017. The present regulations and judgment may not allow Mumbai Port to handle coal for long. Mahagenco (the state power generator) has shifted its imported coal from Mumbai Port to Dharamtar.

c. Iron Ore

The import or coastal movement of Iron ore at JSW plant would be a function of the steel production at the plant. It takes around 1.5 tonnes of Iron ore to produce 1 tonne of steel. The volume growth of Iron at Dharamtar would depend upon future capacity utilisation of JSW plant at Dolvi and its capacity augmentation.

4.9.2. PNP Port

PNP port has acquired land for developing liquid terminal. Commissioning of this terminal would add another cargo type to be handled on Amba River. At present PNP is handling 3.2 MMTPA of coal. Existing PNP terminal has cargo handling capacity of 4 MMTPA. Once the traffic reaches the capacity, there would be a need for capacity expansion or another terminal on the river. Following table summarizes projected traffic that would be handled at existing PNP terminal in future.

Table 4-38 PNP port traffic projection

Traffic (MMTPA)

Terminal	FY -20	FY -25	FY -30	FY -35	FY -40
PNP	3.2	4.0	4.0	4.0	4.0

Source: Consultant's Analysis

4.9.3. Tata Power Captive Jetty at Dherand village

Tata power has plans to develop coastal thermal power plant of 1,600 MW. For this TATA has acquired all the environment clearances. Land acquisition is at final stage. This terminal would increase coal handling on Amba River. However this terminal would be used as captive terminal and would handle captive cargo. Any possibility that this cargo could be handled at proposed IWT terminal on Amba River does not exists.

4.9.4. Supreme Petrochem Captive Jetty at Dherand Village

Supreme Petrochem is also planning to develop captive terminal for handling its liquid cargo. This would increase Amba river cargo utilization; however this cargo generation would not get handled at the proposed IWT terminal.

4.9.5. Proposed IWT terminal at Nagothane

Nagothane MIDC area has been allotted to Reliance industries. Reliance is going to develop direct pipeline from Gujarat for procuring raw material; however other industries located in Khopoli region, including major steel players are not willing to use proposed Nagothane terminal due to longer distance from their plant to Nagothane. From PNP, a parallel road goes towards Nagothane. Considering all these factors, it could be assumed that traffic generation at Nagothane would be negligible. Hence, it is advised to develop a terminal near PNP and not at Nagothane.

4.9.6. Proposed IWT terminal near PNP

MbPT has a new policy of handling clean cargo. Shipping Ministry and National Green Tribunal (NGT) have ordered that MbPT would only handle clean cargo and no dirty cargo would pass inside the city area. This order would not change in near future. Therefore, it is unlikely that imported coal would get handled at Haji Bunder in near future. In FY 16, MbPT handled about 3.5 MMTPA of coal, which is a dirty cargo. It is assumed that majority of coal cargo that is handled at MbPT would get shifted to the proposed terminal near PNP. It is expected that about 70% of coal of MbPT could be handled at this proposed terminal. Some of the coal based power plants have already started to use Dharamtar port for handling imported coal. For example MAHAGENCO uses Dharamtar Port now. In near future, thermal power plants located in central Maharashtra, which are partially or fully dependent on imported coal could use additional terminal near PNP. Apart from coal based Thermal Power Plants, there are coal traders who operate near Mumbai region like Khopoli. Most likely, these traders would also use proposed terminal near PNP for coal trading purpose.

4.10. Terminal wise IWT Traffic analysis

At present, there exist two terminals namely Dharamtar port & PNP port on the bank of Amba River. Another additional terminal is going to come up in future i.e. Karanja Port at the mouth of the river. Two captive jetties at Dherand village, which are between Karanja & Dharamtar, are also proposed to be developed by Tata Power & Supreme Petrochem. This would further increase competition in the region and also result in cargo growth in the catchment area of Amba River in near future. Industries located in the primary catchment area are already using existing terminals on the river i.e. PNP and Dharamtar. The below image shows two terminals proposed on Amba river and road and railway connectivity around it. As per detailed analysis of each terminal it is advised to develop IWT terminal near PNP and not at Nagothane (B2). Refer to section number 4.9.5 for detailed reasoning about Nagothane (B2) terminal. The below image shows existing terminal at Amba river and the proposed terminal, that could be developed.

Source: Google Earth

Figure 4-10 Proposed Terminal Location

Table 4.39 shows the future projection of identified commodities at existing terminals. The commodities are also categorized in bulk, break bulk etc.

Ban on coal handling in city areas is the major contributing factor to the proposed terminal of IWAI. MbPT & captive Tata Power plant jetty handles coal. However, there is ban on coal handling at MbPT in Haji Bunder. Coal, which would be handled at shore could be moved through barges and get handled at Dharamtar/PNP. Tata power plant cannot expand its current capacity due to lack of land availability. Coal, i.e. getting handled at TATA jetty at Trombay is for captive use, hence it would not get diverted to IWT route. The only potential coal traffic diversion that could take place would be from MbPT's shore/anchorage area.

Table 4-39 Terminal & Commodity wise Projection

Name of the waterway: NW-10 (Amba River,44.971km)														
Sr. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Original 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**
Captive Jetty (JSW/Dharamtar) - The infrastructure will be developed by JSW. IWAI needs to ensure fairway development at higher depth, night navigation, etc														
1	Iron Ore	Bulk	Anchorage, Jaigad Port	Dharamtar Port	n/a	JSW Dolvi Plant	n/a	mn T	3.4	4.6	16.0	20.4	20.4	20.4
2	Coking Coal	Bulk	Anchorage, Jaigad Port			JSW Dolvi Plant			1.3	1.8	6.0	7.7	7.7	7.7
3	Coal	Bulk	Anchorage, Jaigad Port			JSW Dolvi Plant			3.2	4.4	1.0	1.3	1.3	1.3
4	Limestone	Bulk	Import, Anchorage, Mumbai			JSW Dolvi Plant			0.41	0.5	4.0	5.1	5.1	5.1
5	Finished Product	Break Bulk	Dharamtar			Foreign, MbPT anchorage			0.58	0.8	2.0	2.6	2.6	2.6
6	Cement	Bulk	Gujarat			Local consumption			0.03	0.03	1.5	1.9	1.9	1.9
7	Clinker	Bulk	Gujarat			Dharamtar			0.11	0.1	2.0	2.6	2.6	2.6
8	Dolomite	Bulk	Import, Anchorage, Mumbai			JSW Dolvi Plant			0.24	0.3	3.0	3.8	3.8	3.8
	Total								9.27	12.53	35.50	45.40	45.40	45.40

Existing Private Jetty (PNP) - Capacity 4 mn Tonnes														
	Coal	Bulk	Anchorage, Jaigad Port	n/a	PNP	Khopoli	n/a	mn T	3.2	4.0	4.0	4.0	4.0	4.0
Proposed Terminal Opportunity for IWAI														
2	Iron & Steel	Bulk	MbPT	n/a	PNP (IWAI Terminal)	Khopoli	18°42'34.36"N 73° 1'20.63"E	mn T		1.0	1.0	1.0	1.0	1.0
3	Coal	Bulk	Anchorage	n/a		TPP in MH		mn T	0	1.9	2.6	3.1	3.1	3.1
	Total								0	2.9	3.6	4.1	4.1	4.1
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..														

Source: Consultant's Analysis

As per personal interview with JSW's personnel, JSW is acquiring lands and is in the process of expanding their storage and evacuation process. After expansion and further development, JSW's capacity of handling cargo would increase. JSW has plan to handle 45 mn T of cargo by end of Fy 25. However, considering the current scenario, it is assumed that market forces would not allow this fast development of JSW's handling capacity. It would take additional 20-25 years to achieve this target and it could be achieved by end of Fy 40.

Dharamtar and PNP jetty are captive jetties and captive cargo handled at this jetty is consumed in its catchment area only. Thereby, no strategy is required to retain the traffic handled at these terminals.

Among all the existing terminals in Amba River, JSW has its own well developed infrastructure. JSW has plans for further development also. JSW would need support of IWAI only in maintaining higher depth of river. IWAI also needs to provide support in providing night navigation throughout in the river. JSW has plans to handle about 35 MMTPA of cargo by FY 25.

Coal handled at PNP gets consumed in Khopoli region and by other Thermal Power Plants in Maharashtra. It is assumed that PNP has coal-handling capacity of 4 MMTPA. So once the terminal reaches its capacity a need of expansion of capacity or build a new terminal would arise. It is assumed that by FY20, PNP terminal would reach its capacity.

Proposed terminal opportunity for IWAI

At present around 2MMTPA of iron & steel gets distributed in Khopoli region, out of which at least 1MMTPA could get handled at proposed IWAI terminal near PNP. Apart from iron & steel, coal cargo could be handled at the proposed terminal.

Summarized Assumptions for projected traffic in Table **4-39 Terminal & Commodity wise Projection is mentioned below.**

1. Coal

The projections for Coal traffic on Amba river has been influenced by following:

- Shifting of Coal traffic from Mumbai Port Trust due to regulatory and Court ruling
- No plans for development of additional power plants in the region
- Expansion plans for JSW due to expansion of existing industries as well as diversification into additional sector namely Cement, Limestone, and Clinker.
- Connectivity of private port PNP with the larger hinterland due to availability of railway siding. This connects the terminal to the larger hinterland more than 500 Kms from the port

Coal traffic of Dharamtar Port was influenced by the requirements from local industries and it remained stagnant between Fy 12 to Fy 14. This was primarily due to absence of any major expansion in the region. This traffic increased by 45% on Dharamtar, i.e. from 2.5 mnT to 4.8 mn T between Fy 14 & Fy 16, primarily due to expansion of local industries and shift of Coal handled at Mumbai Port to other ports of Maharashtra due to environment concerns. Dharamtar & PNP together handled 8 mnT of coal on river Amba in Fy 16. Imported coal from PNP port also destined to Bhusawal (Maharashtra) & Bhopal (MP), which are located at a distance of more than 500 kms from the port, using railway sidings available with the port. MAHAGENCO imports coal, using river Amba. Gandhar Oil Refinery's coal division, Ratan India Power Limited, Bharat Oman Refinery are some of the other companies that import coal through PNP. Last mile delivery of imported coal is handled by railway. 2 -3 rakes of about 10,000 MT get transported from PNP on a daily basis.

Imported coal traffic of MbPT has gradually increased between Fy 06 to Fy 15. In Fy 06 port handled 1.8 mnT, which increased to 4.3 mn T in Fy 12. Between Fy 12 and Fy 15, coal traffic has increased, but with intermittent fall. Due to clean cargo policy, traffic has started to fall after Fy 15. Clean cargo policy of MbPT is the major reason behind dramatic increase of coal traffic on Amba after Fy 14. Hence, there has been high growth for imported coal observed on Amba. We have assumed that a major share of coal traffic, i.e. 70% of total coal traffic of MbPT, would likely shift to Amba, due to close proximity to MbPT and balance 30% would shift on Kundalika. This is a subjective assumption taken based on observed shift, better infrastructure at PNP terminal compared to coal unloading facility in Kundalika region.

The prominent assumptions for traffic of Coal in Amba River are as follows

- The traffic at JSW terminals on Amba will be linked to the demand for coal due to captive demand. The company has already provisioned for expansion of its terminal to match the Coal demand.
- The demand for additional coal (Non Captive Coal) of the region would be handled at existing PNP terminal or the additional terminal proposed by IWAI at Amba
- Interactions with PNP Terminal it was found that their company has not planned any expansion for the terminal in next 3 years to 5 years. Hence, it has been assumed that any traffic on and above PNP Terminal capacity would need additional terminal. IWAI could develop a terminal to target this traffic.
- It is assumed that PNP would utilize its complete capacity by Fy 19. Hence additional coal traffic (Shift from MbPT) at IWT terminal would commence from Fy 20.
- The traffic growth has been assumed at a moderate growth rate of 4% till Fy-25. 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%.

- A growth rate of 2% has been considered between Fy-25 to Fy-30. The nominal growth has been considered due to higher emphasis on use of clean energy, absence of any expansion, etc.
- It has been assumed that volume of coal imported (combination of imported coal and coastal movement of coal) would remain constant beyond Fy-30. No new plants would get commissioned. All expansion for newer energy source would take place using cleaner fuel. The ministry of power is planning to replace coal fired power plants with alternative energy source by the year 2100. Hence, the existing coal procurement would remain till the duration of projections in this study. The unavailability of land and social issues in Maharashtra, there is no plan for upcoming TPP in the state, which further restricts major growth share of coal to be handled on Amba after Fy 30.
- It has been assumed that PNP Terminal would have an annual coal handling capacity of 4 million tonnes. Hence, all the surplus coal generated from 3rd party demand (Excluding JSW) would have to be handled at IWAI Terminal.

There exists one risk associated with Coal in Amba River. Government of India is taking efforts to ensure optimum utilization of domestic coal rather than imported coal; hence many power plants of India have reduced or stopped importing coal based on government guidelines. Any such restriction could force coal importers in the central part such as Bhushawal, Bhopal, etc to procure coal from central India or ECL using railways. This might witness some fluctuations in coal at PNP terminal and IWAI terminal. However, due to poor quality of domestic coal the existing importers would eventually again shift to the imported coal.

2. Iron & Steel

It is one of the commodities handled on Amba, due to presence of JSW's plant in the vicinity of Dharamtar Port. JSW's iron & steel gets consumed in Nagpur (MH), Rajasthan and Hyderabad. Iron & steel handled at Dharamtar is captive cargo of JSW. This commodity has been considered as target commodity for IWAI terminal in River Amba. Following broad assumptions have been made for projecting Iron & Steel traffic for IWAI terminal in Amba.

- Shifting Iron & steel coils traffic from MbPT going to Khopoli region industrial hub using road to waterways
- There is a cost advantage of about INR 2,300 for every 20 T coil on average between road and waterway

MbPT handles iron & steel with about 50% share in India's Iron & Steel trade. Unloaded traffic of iron & steel of MbPT in Fy 05 was 1.8 mnT, which increased to 5.64 mnT in Fy 16. From last decade, MbPT has witnessed growth in unloaded traffic of iron & steel, with some intermittent cases of fall in few years. Secondary steel producers such as Bhushan Steel and Uttam Galva have their plants in Khopoli. Apart from these, several Steel traders and some of the automobile units such as Bajaj, Force Motors, Honda, General Motors, etc consume a large share of imported Steel Coils. Automobile points, consumer durables such as ACs, Refrigerators, etc are manufactured using imported steel re-rolled. All major industries consuming Iron and Steel coils fall in the hinterland of river Amba procure iron steel using MbPT. Interactions with the aforementioned companies and movement of Steel coil trucks from MbPT to Khopoli on NH 66 confirm the same. A dedicated terminal to handle iron & steel on river Amba would decongest heavy outflow of trucks from MbPT and also create additional non-captive iron & steel traffic for Amba. Uttam Galva’s unit in Khopoli has installed capacity of 1 mnT and it imports 0.6 mnT p.a. of iron & steel through MbPT. Bhushan Steel also uses MbPT for importing (import and Coastal movement from Paradip) about 1.2 mnT per annum of steel coils (primary interview with Bhushan steel say 70,000 tonnes a month inward from Mumbai Port and 30,000 tonnes a month outward processed steel coils for export). Other manufacturing units & traders also use MbPT for importing iron & steel in fragmented volume. Hence, it is estimated that more than 2 mnT per annum of iron & steel traffic, which originates from MbPT is consumed in Khopoli region.

A shift is 50% of this traffic has been assumed from Road to Waterway. Based on company interaction and market scenario, minimum traffic of 1 mnT per annum of Iron and Steel traffic has been on river Amba. A major factor behind considering additional iron & steel traffic on Amba is competitive logistic cost of transporting iron & steel using multimodal route. It takes INR 13,600 to transport per 20 tons of iron & steel from MbPT to Khopoli by roadway, whereas, multimodal logistic cost (Propelled Barge +Road) of transportation is INR 11,300. Hence, multimodal transportation using waterway and roadway is cheaper than roadway.

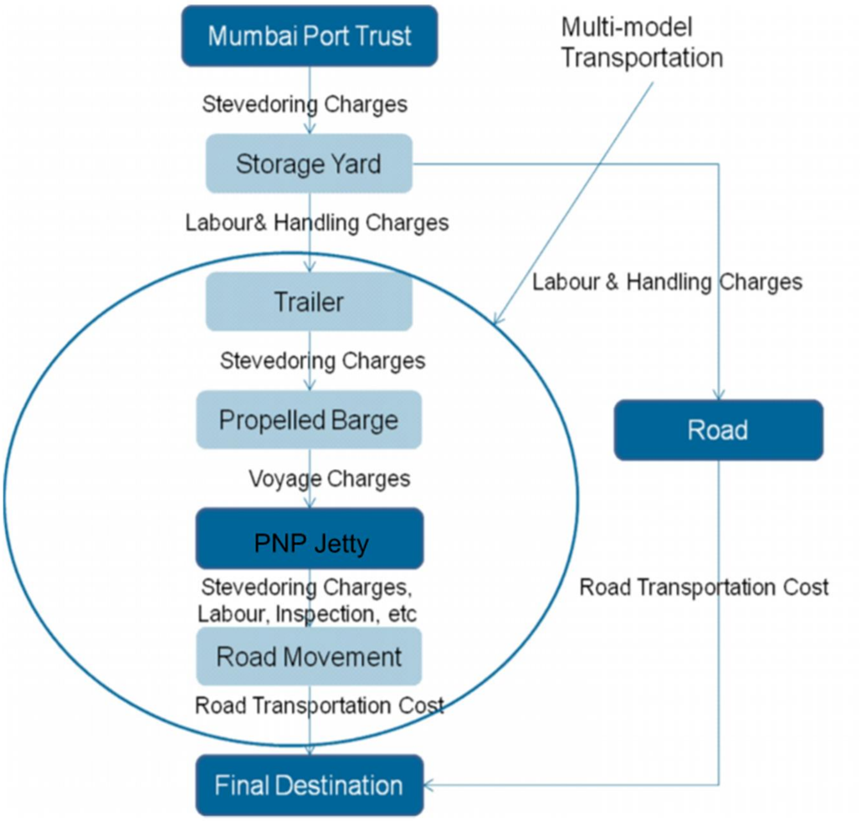
3. Captive Cargo (JSW)

JSW handled 9.2 mnT p.a cargo in Fy 16. Annual Reports and personnel of JSW during interaction stated that JSW would increase its traffic to 45 mn T p.a in Fy 25. The company is understood to have made a presentation as well to IWAI regarding their expansion plan and cargo traffic. However, considering the market scenario (secondary sector performance and policies etc.), it is assumed that market forces would not allow this fast upgradation of JSW. It would take additional 20-25 years to achieve 45 mnT p.a. target and it could be achieved by end of Fy 40. It is assumed that IWAI would maintain proper depth of the river for movement of JSW vessels. This would eventually help JSW to handle more cargo and achieve their target. JSW is in the process of acquiring more land for expanding their storage & cargo evacuation process and expansion of their jetty length. This would enable JSW to handle more traffic. Cargo handled at Dharamtar Port is captive cargo. Cargo, which originates either from MbPT and Jaigad anchorage or from Gujarat, gets consumed in JSW's units. A portion of this cargo gets consumed in local markets. Finished products of JSW are exported using MbPT's anchorage. All the projections of Dharamtar Port are only for JSW as it is captive cargo; hence this would not create additional traffic for river Amba under IWT.

4.10.1. Logistics cost comparison for lo-lo service

At present, most of the industries in the hinterland use both roadways and waterways for transporting their cargo. Dharamtar Port and PNP Port are already operational and used by industries. Development of Amba River as National Waterways would be beneficial for the industries as it would reduce road congestion and make the cargo movement on waterway smoother. With IWAI's promotion and facilities, waterway on Amba River would be a preferred mode of cargo movement for the industries in the catchment area.

The below image shows step-wise factors of Multi Modal transportation on Amba river. The image shows types of costs involved in Multi- Modal transportation of cargo, which gets handled at Mumbai Port Trust and PNP Port.



Source: Consultant's Analysis

Figure 4-11 Factors involved in Multi Modal Transportation

The above graph shows projection of factors/cost involved in multi-modal transportation. It is proposed that cargoes that are handled at Mumbai Port Trust would be stored in Storage yard. From there, they would be moved further, using multi- modal transportation. Cargo would be moved by using trailers and then barges to reach PNP port. From PNP port, they would be evacuated by using roadways and would reach the final destination.

Iron and steel cargo is currently moved using roadways. However, with the introduction of multimodal transportation, which can partly use waterways and partly use roadways, the road movement can be reduced. This would help to decongest roads.

The below table shows comparison of costs, by using roadways vs. multi-modal route, using barges and roadways. Cost of multi- modal transportation is cheaper than transportation using roadways. There are various costs, associated with multi-modal transportation, like cost of handling and storage, which are not applied to roadways transportation.

Table 4-40 illustrates logistics costs involved in shifting cargo to IWT route from present mode of transportation. Cargo handled at Dharamtar and PNP are import/export cargo. As there is no other alternative mode of transportation available, so all the cargo would use waterways only.

Table 4-40 Transport cost comparison using Multimodal route

Particulars	INR/20 Ton	
	Propelled Barge +Road	**Road**
Total Handling cost at MbPT	1,600	1,100
Voyage cost MbPT to Proposed terminal (IWAI)	1,800	-
Cost of handling & storage	2,400	-
Road Transport cost Proposed Terminal(IWAI) to Khopoli	5,500	-
Road Transport cost MbPT to Khopoli	-	12,500
Transportation from MbPT to Khopoli	11,300	13,600
Total	22,600	27,200

Source: Consultant's Analysis

In case of Lo-Lo, logistics cost to transport by roadways is higher compare to waterways. In spite of multiple handling of cargo transportation using waterways is much cheaper. Therefore consultant has proposed to develop a terminal for handling iron & steel. Traffic that would be attained if the lo-lo terminal gets developed is mentioned in table 4:36 sr. number 2 under the heading of proposed terminal opportunity for IWAI.

4.10.2. Possible Ro-Ro operation

Consultant recommends development of the above discussed Lo-Lo Terminal. However, a hypothetical discussion is undertaken to evaluate the possibility of a Ro-Ro service on Amba River in future. . Similar to the Lo-Lo Terminal, the probability of such a terminal on the river will rest on the integrated logistics cost Involved.

4.10.2.1 LOGISTICS COST COMPARISON FOR RO-RO SERVICE

During traffic volume count and site visit, it was observed that from two major ports in Mumbai i.e. MbPT and JNPT cargo in the form of trucks follows the road network mainly Mumbai Goa highway (NH 66) to distribute cargo into deeper Maharashtra like Konkan region. Bulk and break bulk cargo by trucks from Mumbai port and container trailers from JNPT use this highway and go to Khopoli area and in Konkan area. NH 66 is all time congested route and has heavy traffic due to these slow moving trucks and trailers. Distance between PNP and Khopoli by road is 42 km and Nagothane to Khopoli via Pen Khopoli road is 60 km and via SH 92 it is 52 km. Above table describes possible routes that could be developed to handle cargo traffic in the form of trucks at proposed IWT terminal near PNP. It is advised that Ro-Ro service could be started from either MbPT, JNPT or Karanja. 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.

Table 4-41 Possible Ro-Ro ferry route

Origin	Destination	Commodity
MbPT	(IWAI) PNP Terminal	Break bulk, Bulk
JNPT		Container
Karanja		Other

Source: Consultant's Analysis, Site visits

- Loaded trucks traveling from Mumbai region do not get handled at PNP at present.
- Trucks from Mumbai region, which goes towards Khopoli, follow either expressway or NH 4 or goes via Pen Khopoli road or by using NH 66.
- There exist possibility of handling Ro-Ro cargo at PNP for industries located in the Khopoli region.

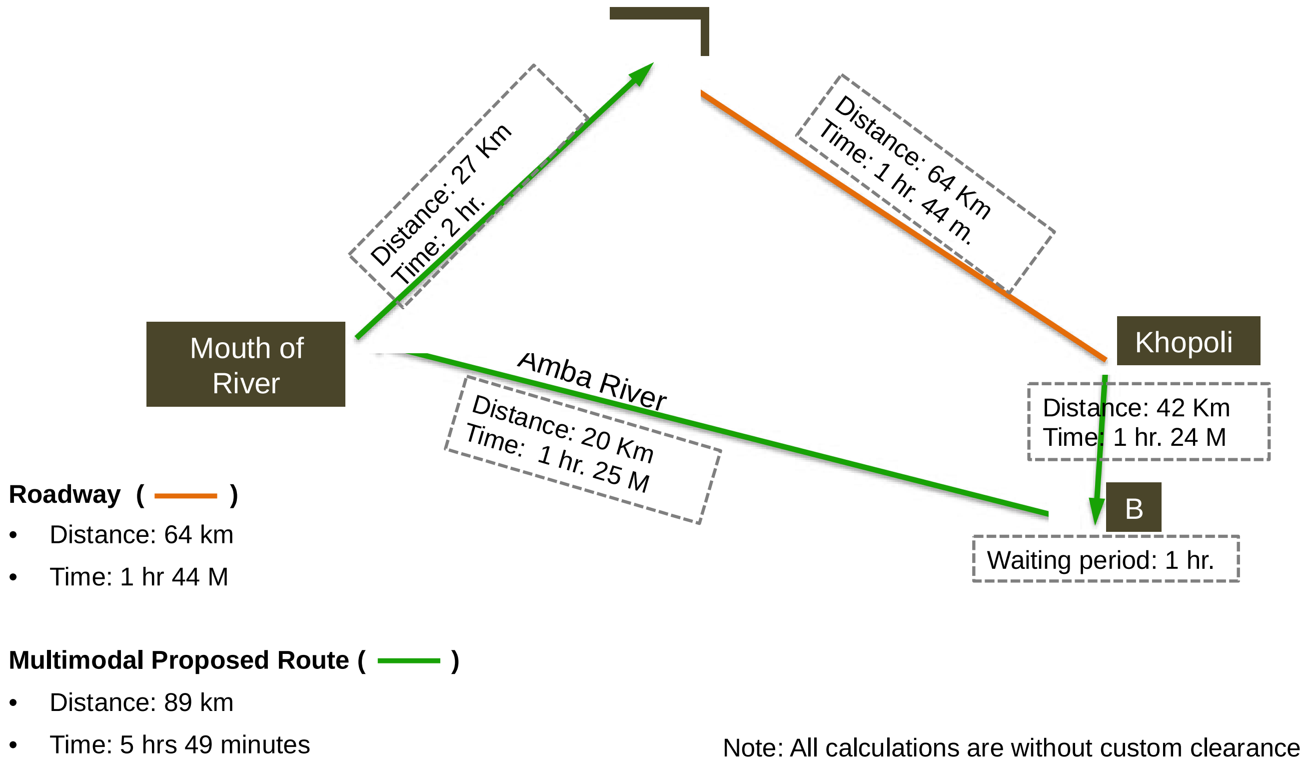


Figure 4-12 Time & Distance Comparison

It is clear from the graphical representation above that time required 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. This proposed waterway route on Amba river will also involve multiple handling, affecting logistics cost adversely. Likely impact on overall logistics cost 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 1790 kW (3 x 800 bhp) 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 on NW	Final Destination
JNPT	IWAI (PNP)	Khopoli

Ro-Ro Cost Dynamics

Steps involved	Unit	Case I	Case II
Engine	kW	1790	350
Engine fuel requirement	l/hr	420	102
Per Truck Ro-Ro Tariff	INR/Truck	18,617	11,366
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**18,759**	**11,508**

Truck Cost Dynamics

Components	Cost (Rs.)	Cost
Fuel	INR	1,303
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**2,548**

Source: Consultant's Analysis

Figure 4-13 Transport cost comparison for Ro-Ro

Two scenarios have been considered to arrive at logistic cost for a possible Ro-Ro service on the proposed IWT route. Ro-Ro Tariff assumes costs like 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. This saving is on fuel cost and toll charges. In Ro-Ro cost dynamics calculation, these cost heads haven't been considered, as these not feature in Ro-Ro transportation logistics. In case of truck cost dynamics, there are parameters that influence total roadway logistics cost. These include Repair & Maintenance cost, driver/crew wages, truck finance cost, profit & other costs. These costs haven't been included in either calculation, as these costs will cancel each other out, ultimately producing the same cost difference. It is assumed that IWAI will develop the entire infrastructure (Terminal & Navigation), and hand it over to the operator without looking for development cost recovery. IWAI will also need to forego Terminal charges, Fairway usage charges, etc., in order to drive the appeal of Ro-Ro service on Amba River.

Ro-Ro will have 2 way movement. There is 2 way movement of Iron & Steel and other commodities on trucks. Logistic cost analysis undertaken in this section is a one way cost. Similar cost would be applied for return journey.

Costs involved in both the cases of Ro-Ro transportation cases are on the higher side, as compared to roadways. The cost difference favours the roadway, as the difference between the two discussed transportation modes is nearly INR 9,000. In case of just Ro-Ro cost comparison, Case II is significantly cheaper than Case I.

- **Ro-Ro traffic with subsidy**

The above logistics cost comparison indicates that both the cases of waterway movement will be costlier than existing roadway mode of transportation by a significant margin. As per Case I (higher engine power 1,790 kW), the logistics cost difference for roadway and waterway is INR 16,211/truck. Cost of transporting per truck on the waterway with the said engine configuration would be nearly eight times as expensive as roadway. In Case II (Lower engine power 350 KW), this cost difference is narrower with INR 8,960/truck. To make Ro-Ro appealing for transporters, government needs to subsidize the shift by offering this cost difference. The subsidy will compensate for high logistics cost, but additional incentives also need to be offered to make up for the increase in time and distance. To further facilitate promoting IWT, 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 traffic diversion from roadways to waterway to cater to iron & steel industries in Khopoli.

In order to approach deployment of Ro-Ro under suitable market conditions, It is suggested that IWAI should observe the market for the next 3 years. 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. Following table depicts future possible traffic for Amba River in case the subsidy is provided.

Table 4-42 Terminal & Commodity wise projection (Exception Case)

Sr. No	Name of Cargo	Type of Cargo	Origin	Original 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
Suggestive Ro-Ro Terminal (Exception Case)														
1	Liquid, Breakbulk, Container	Ro-Ro	JNPT, MbPT	n/a	Khopolli Konkan region	PNP (IWAI Terminal)	18°42'34.36"N	('000 Trucks)	0	13	16	19	23	28
							73° 1'20.63"E	mn T	0	0.2	0.2	0.3	0.3	0.4
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc..														

Summarized Assumptions for projected traffic of Ro- Ro in above table is mentioned below.

NH 66 (Mumbai-Goa) is majorly used for transporting cargo from MbPT/JNPT to internal parts of Maharashtra. Loaded trucks traveling from Mumbai region do not get handled at PNP at present but their consumption area comes within the hinterland of river Amba. In case of modal shift, lower integrated logistic cost and time act as a major driving factor.

During road traffic survey, many trucks carrying bulk/break-bulk/liquid & containers were observed on NH 66. Large number of trucks causes congestion and traffic on highway.

Multimodal route on river means multiple handling, affecting logistics cost adversely. Logistic cost comparison between present & multimodal route shows huge logistic cost difference. Per truck one way on roadway costs INR 2,548. Whereas, in multimodal route of Case I and Case II, cost is INR 18,759 and INR 11,508 respectively. Hence, it is assumed that Ro-Ro service is feasible, only if Government provides logistic cost difference as subsidy with additional incentives. Subsidy & incentives should also be provided due to additional time involved in waterway transportation. By roadway, it takes 1 hr. 44 mnts. to reach the destination, whereas multimodal route takes 5 hr. 49 mnts. Annual growth rate of Maharashtra's secondary sector (manufacturing/industrial units) decreased by 4.7 from Fy 13 to Fy 14 and thereafter it remained constant i.e. 4%. Hence, a moderate growth rate of 4% is assumed with five years interval for projecting Ro- Ro traffic on Amba.

Following are common assumptions considered for development of Ro-Ro

- IWAI would develop Terminal on Amba & Navigation on river with no development cost recovery
- IWAI need to forego Terminal charges, Fairway usage charges etc. to attract traffic
- It is suggested to observe market for next 3 years
- It is assumed that construction of terminal would take 2 years so in Fy 22 terminal would commence its operation
- Without subsidy & incentives, industries would not shift and it could become loss-making venture.

o **Ro-Ro traffic without subsidy**

Without the subsidy amount, industries would not shift from their current mode of transportation. In such a case, any Ro-Ro Terminal on Amba River will not be a viable in such scenario. It will be counterproductive and a loss making venture to develop a Ro-Ro Terminal on the River.

4.10.3. Conclusion

The cargo growth potential is high in Amba River. A substantially large share of additional cargo in future would be handled by JSW for their steel plant, cement plant, etc. The company is already expanding its terminals to accommodate future growth in cargo traffic by them. Some of other industries proposed in future such as Supreme Petrochem and Tata Power would develop their own captive jetties. Hence, the industries only expect development of fairway by IWAI in river Amba (NW-10).

There exists one terminal, PNP, which is handling all 3rd party industrial cargo. This PNP port is estimated to have a capacity of about 4 MMTPA. PNP is handling coal and its capacity would be fully utilised by FY 2020. PNP's full utilization would further result in requirement for additional jetties after FY 2020, for handling cargo. This could be either developed by PNP or could be developed by IWAI.

It is proposed to develop additional cargo handling infrastructure for namely coal, Iron & Steel. Development of Coal and Iron & Steel terminal is commercially viable on a stand-alone basis. However the suggestive ro-ro terminal would only be viable in case the Government provides subsidy.

Ro-Ro vessels have ramps that facilitate self-loading and unloading without help of external crane. MbPT already handles Ro-Ro vessels. The trucks loaded on to Ro-Ro would drive down to their final location. The last mile connectivity cost includes fuel, truck cost and driver wages.

Abbreviation	Full Form
BHEL	Bharat Heavy Electricals Limited
BOT	Build Operate Transfer
BPTV	Victoria Dock BPT Railway
BPAG	Bharat Petroleum Corporation
CCIL	Continental Carbon India Ltd.,
CFS	Container Freight Station
CMCT	Continental Multimodal Container Terminal
CONCOR	Container Corporation of India
CWC	Central Warehousing Corporation
DES	Directorate of Economics and Statistics
DFPCL	Deepak Fertilizer and Petrochemical Corporation
DWI	Direct Reduced Iron
DWT	Dead Weight Tonnage
GAIL	Gas Authority of India
GoM	Government of Maharashtra
GSDP	Gross State Domestic Product
GTICT	Gateway Terminals India (APM Terminals & Container Corporation of India)
Ha	Hectare
HPCS	Hindustan Petroleum Co.
HPCA	Hindustan Petroleum Co.
IPCL	Indian Petrochemicals Corporation
IOBP	Indian oil corporation Bottling Plant
ICTT	International Container Transshipment Terminal
IPA	Indian Ports Association
IWT	Inland Water Transport
JNPT	Jawaharlal Nehru Port Trust
JNPCT	Jawaharlal Nehru Port Container Terminal
JSW	Jindal Steel Works
JSWT	JSW Steel Limited Siding
KLMG	Kalamboli Goods
KSWR	Kalmeshwar
LPBG	LPG siding for BPCL, Bhitoni
LPBP	LPG Bottling Plant, Lalru
LPGK	LPG Bottling Plant siding, Gan
LOA	Length Overall (Vessel)
M&M	Mahindra & Mahindra
MbPT	Mumbai Port Trust
MBPP	Bharat Petroleum Corporation

MGN	Megh Nagar
MH	Maharashtra
MIDC	Maharashtra Industrial Development Corporation
MMB	Maharashtra Maritime Board
MMRDA	Mumbai Metropolitan Region Development Authority
MMTPA	Million Metric Tonnes per Annum
MSTB	Sanjvik Terminals
MT	Metric Tonnes
MTPD	Metric Tonnes Per Day
NH	National Highway
NSICT	Nhava Sheva International Container Terminal
NSIGT	Nhava Sheva India Gate Terminal
NTSK	New Tinsukia
PCI	Pulverised Coal injection
RCF	Rashtriya Chemicals and Fertilizers
SWB	Shallow Water Berth
TPA	Tonnes Per Annum

CHAPTER 5: TERMINALS

5.1. General Review

Terminals act as a connecting center 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 Amba River.

Amba River is being utilized by M/s JSW port and M/s PNP port for the raw material mobility and both these stakeholders are having their own captive terminals. Hence, there is no need of development of any terminal infrastructure for loading / unloading of their traffic volumes. Accordingly, the fairway development suiting to their traffic volume mobility is essential, which has already been considered as a part of Fairway development.

The traffic other than the captive terminal requirements, as identified are of Bulk / Break-Bulk and Truck mobility. The Bulk / Break-Bulk cargo are estimated to the extent of 3.1 MMTPA by the year 2020 and may increase to an extent of 4.5 MMTPA by the year 2040. With regard to the truck mobility, it is expected to be in the range of 13,000 Nos. P. A and expected to increase to 28,000 Nos. P. A. These volumes are to be taken into consideration for IWAI Terminal development on Amba River.

Keeping in view the type of cargo, it has been identified that 1 Lift-on Lift-off (Lo-Lo) IWT Terminal with handling facilities and 1 Roll-on Roll-off (Ro-Ro) IWT Terminal are necessary for transhipment. Taking into the consideration of the origin and destination and fairway, the most probable location can be just downstream of the existing PNP jetty area on the left side of the river. The location near the Ch. 18.45 Km (within the ch. 19.41 km, wherein the fairway development is under consideration for Class VII / SPV) with approx Lat 18°42'34.36"N and Long 73° 1'20.63"E. This location is comparatively having lesser mangroves concentration, just adjacent to the PNP industry area.

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

Sl. No.	Facility	Nos.	Size	Area (m^2)
1	Open Storage Area	1	200 m x 100 m	20000
2	Covered Storage Godown	1	100m x 30m	3000
3	Ro-Ro Truck Parking	20	16m x 3m	960
4	40' Container Stack Yard	20	40 Sq. m	800
5	Parking for Handling equipments	1	30m x 15m	450
6	Main Parking Area	1	30m x 30m	900
7	Public Utility	1	6m x 4m	24
8	Weigh bridge	1	8m x 3m	24
9	Utility Room (Near Weigh Bridge)	1	3m X3m	9
10	Area under internal Roads	1	7.5m x 600m	4500
11	Bank protection with Geotextile Bags			
12	Administration building	1	12 m x 15 m	180
13	Business Area	1	10m x 3m	30
14	Staff Parking Area-4 wheelers	1	13.5m x 6m	81
15	Staff Parking Area-2 wheelers	1	8m x 2m	16
16	Security shed for watch and ward	2	4m x 4m	32
17	Electrical facility	1	5m x 5m	25
18	Fuel Bunkers	1	10m x 5m	50

Sl. No.	Facility	Nos.	Size	Area (m^2)
19	Water Supply Room	1	3m x 4m	12
20	Fire and Safety Room	1	3m x 4m	12
21	DGPS receiver & transmitter shed	1	8m x 4m	32
22	DG shed	1	5m x 5m	25
23	Canteen with Store	1	12m x 8m	96
24	Sewerage Treatment Plant (STP)	1	15m x 15m	225
25	Overhead Tank	1	10m dia	78.5
26	Green Area	1	L. S	1000
27	Future Requirement	1	L. S	2000
	Total			34562 say about 35000

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-X03** for details). IWT Terminal on Amba River is required only after the saturation of cargo handling in PNP Terminal and the same is to be carefully watched before taking any activity. However, with regard to the Land, it is suggested to start the Acquisition in the proposed location and Terminal development can be considered at later phase, on confirmation of cargo etc. Further, the Terminal location is connected to the SH 88 – Alibaug – Pen Road near “Walawade” village and the distance is about 4770 m (Estimated cost of 7.16 Cr), which may have to be taken up by the concerned agency.

Accordingly, a Terminal Layout plan demarcating the infrastructure requirement has been prepared. (Refer Volume-II **Drawing No.P.010257-W-20311-A03** for details).

5.4. Land Details

TABLE 5-1: Terminal Land Details

Coordinates (UTM) N/E	**2069844.4**	**291465.9**
Coordinates (DMS) N/E	**18°42'34.36" N**	**73°01'20.63" E**
Village	Vadkhal	
Taluka	Pen	
District	Raigarh	
State	Maharashtra	
Nearest Town	Pen	
Distance of town (km)	10	
Land use	Barren/Marshy/ backwater land	

Ownership	Govt. Land
Water Distance	on edge of land
Nearest Road	Alibagh - Pen Highway
Road Distance (m)	4770
Nearest Railhead	PNP Port Rail yard
Railhead Distance	1500m
Nearby major Structure	JSW Jetty (Dharmatar Port)
Terrain	Creek Area/Flat land
Soil/Subsurface strata	Thick marshy land with black sticky soil
Surveyed Area (Approx.)	47000 (m2) {A portion is submerged}

5.5. Geotechnical investigation

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 30 m depth or 3m into the bed rock whichever is earlier.

5.5.1. Regional Geology

Regionally, the project area is covered with basaltic lava flows of upper cretaceous to Lower Eocene age. This basaltic pile in turn is intruded by number of basic intrusives. Recent deposits such as beach sand and patches of alluvium are found along the coast and strips of alluvial patches along the banks of Bhogeshwar Balagane River and Amba rivers, besides extensive cappings and spreads of Pleistocene laterite deposits which are conspicuous in Central and the western parts. Within this lava pile, in all 13 flows have been delineated. Out of the 13 flows so identified, 6 flows are of pahoehoe type and 7 of aa type. The pahoehoe flows are generally compound in nature and made up of several flow units having pipe amgdules at the base. At places, a thin redden crust separates individual flows/flow units. The aa flows are generally dense, massive and porphyritic with shows of fragmentary or clinkery top portions or display weathered profile of reddish coloured soil on top surfaces. The basal clinkers are generally concealed and impersistent.

A thick blanket of laterite/bauxite formation lies on the basalt flows on the hills of Mica dongar, Dhangarvadi, Tadgeon, Kilavadi, Kankeshwar etc, generally noticed at an elevation of 350 m. above msl forming a plantation surface. A general regional gradient exhibited by the flow is 1 in 25 to 50 towards SW to W. However, in the coastal tract these flows shows relatively steep westerly gradient of 1 in 25 to 30 in the area west of Chora, Dangi hill, Kankeshwar hill etc.

Geological Survey of India (GSI) has carried out detailed study of the area in 1984-85. The regional geological map prepared by GSI showing the project area is shown as **Figure 5.2** while the blow up from the same map is shown as **Figure 5.1** (with index) which shows that the area is occupied by alluvium deposits which is also reflected by the site conditions also.

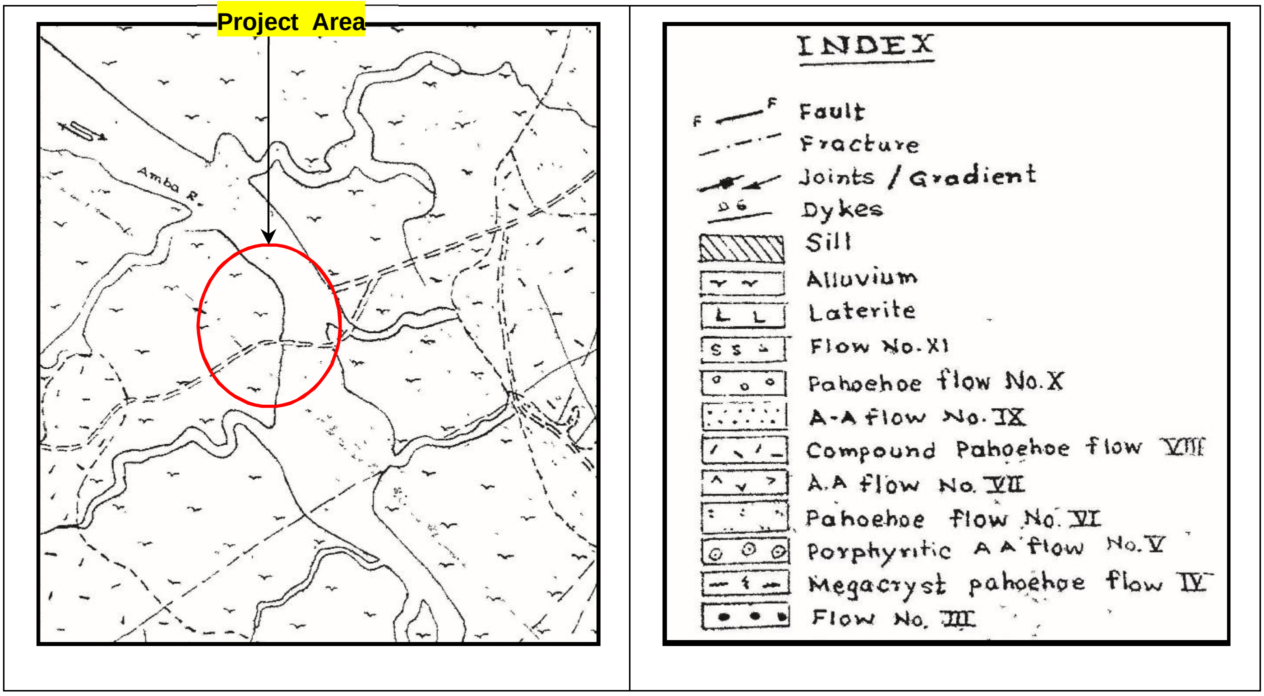


FIGURE 5.1: Blow up of the Project Area from Regional Geological Map (Figure 1.2)

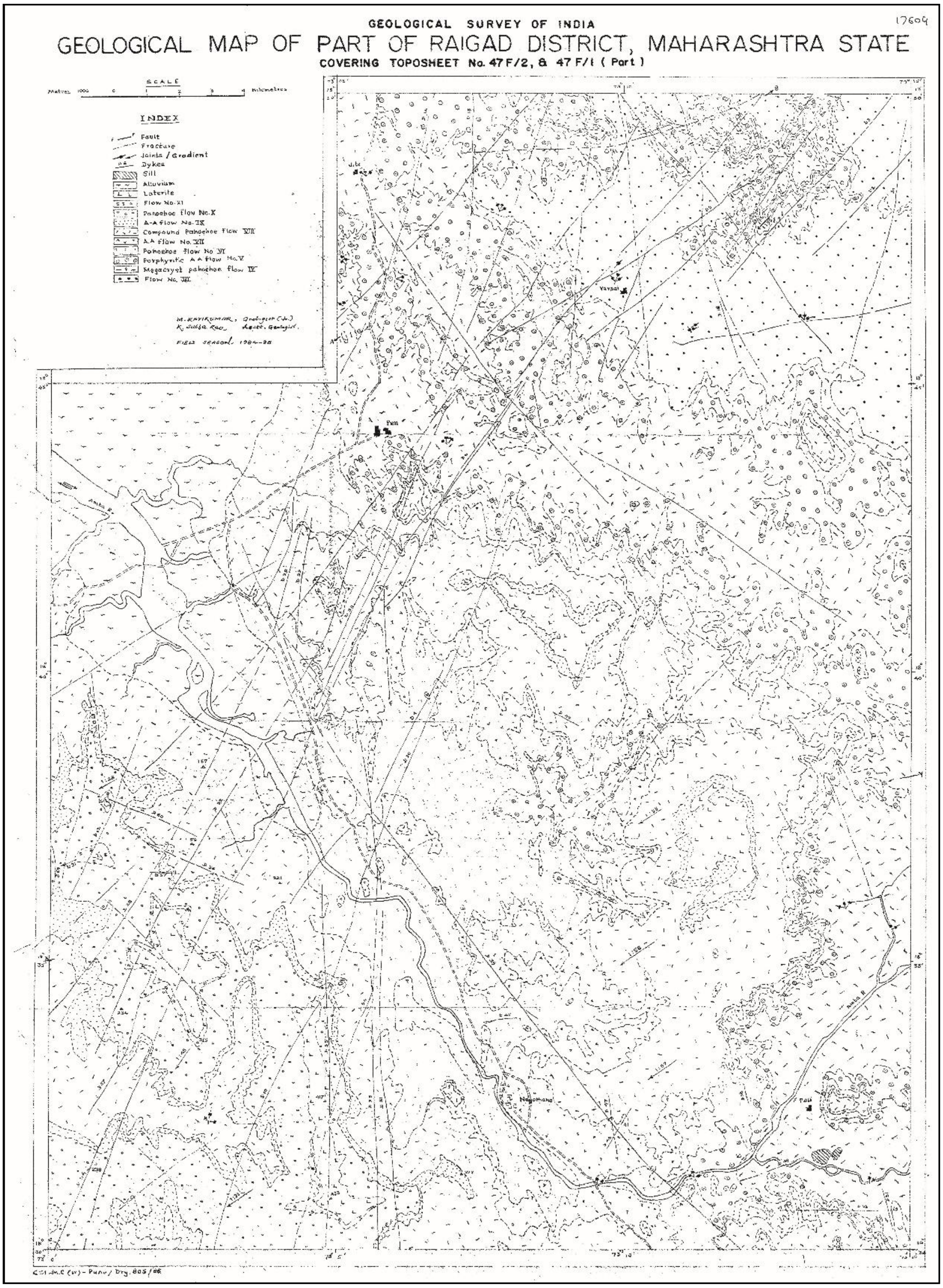


FIGURE 5.2: Regional geological map showing Project area

Source: Geological Survey of India, Maharashtra Circle (West), Geology of parts of Raigad district, Maharashtra. (Progress report for the field season 1984-85) By M. Ravi Kumar, Geologist (Jr) and K. Subba Rao, Asstt. Geologist, Geological Survey of India, September, 1986.

5.5.2. Physical Condition and Drainage

The topographic features of the area in general reveal a rugged and dissected terrain comprising lower foot hills, steep and rising hill spurs and lofty hill ranges of Western Ghats. The hill ranges exhibit are ate disposition trending to N-S to NNW-SSE directions. At places, the arms of hills are projected to NNE-SSW directions in parts of Toposheet 47F/1 and F/2. The lowest elevation in the area is about 20m above msl and the highest 575 m above msl is noticed at the top of Manichgad dongar. The next highest elevation 569 m above msl is located south of 575 at Mira dongar top of which is capped with thick capping of Bauxite/Laterite. Number of streamlets originate along the mountain ranges and flow in to Balaganga and Bhogeshwar rivers in the North, Nigade and Nidi nadi in the middle and in to Amba river in the southern parts of the area. The Nigada nadi and Nidi-nadi flow towards west and opens in to Amba river, whereas the Amba river initially flows towards SSW before abruptly swinging to NW direction with a straight course to the Arabian Sea. Along the banks of these rivers, strips of thick alluvial bands supports rich cultivation and at the confluence point of these rives with the Arabian sea has thick blanket of alluvium and mud flat over an extensive area supporting lush growth of cultivation besides number of salt pans for extracting common sales Radial type or dendritic to sub dendritic drainage system in generally noticed in 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 is **Figure 5.4**.

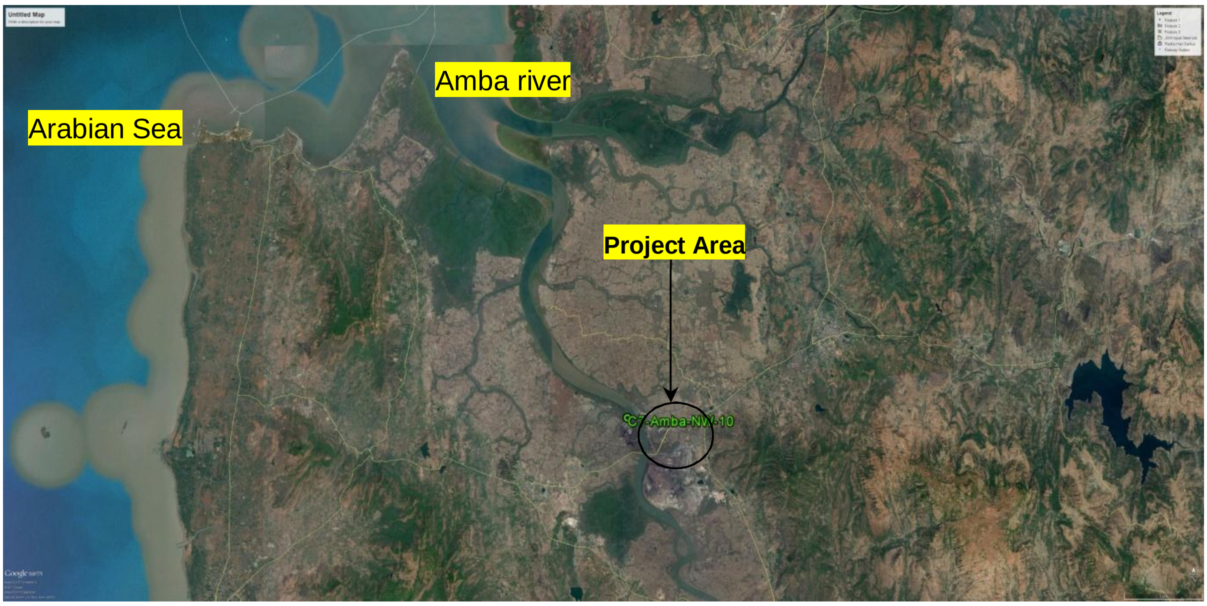


FIGURE 5.3: Google earth image showing Project area (in Circle)

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

5.5.3. General Geology and Stratigraphy

Generally the area is occupied by thick patches of alluvium which are seen deposited along the banks Amba river. These deposits extend ever large areas and are comprised of loose grit, fine silt and marshy and swampy patches of sand bars particularly along the course of river.

Stratigraphically, the Deccan basalt pile exposed in the area which has a cumulative thickness of about 980m as noticed between the elevations of 20 m and 575 m above msl. Within this pile, 13 individual flows had been recognised in the area, and numbered serially as I to XIII, with number I being the lower most flow. There are two groups of aa flows that are identified within the flow No. V and VII and are further numbered as capital Aa, Aa2, Aa3, and small aa1, aa2, aa3, respectively. Megascopically, depending on the abundance of phenocrysts, these flows could be categorised from non-porphyritic to moderately porphyritic to highly porphyritic varieties.

Sequence of basalt flows

Based on the field observations, following sequence of flows comprising the basaltic pile and other formations, encountered in the area is given below:-

Table 5-2: Geological Stratigraphy

		Thickness in mts		Age
	Alluvium, beach sand, Basic dykes and granites Basalt flows	Gravel		Recent Post trappean flows
XIII	Kankeshwar aa	porphyritic flow	40+	Upper cretaceous to lower eocene
XII	Kankeshwar pahoehoe	Non-porphyritic vesicular flows	80	
XI	Kankeshwar aa	porphyritic flow	80	
X	Chora pahoehoe	Porphyritic to sparsely porphyritic, vesicular flow some with olivine	180	
IX	Mira dongar aa	porphyritic flow	40	
VIII	Chandipatt. Compound pahoehoe	Moderately porphyritic to nonporphyritic flows.	220	
VII	Simal aa	Group of thin porphyritic aa flows	45	
VI	Manickghad pahoehoe	Sparsely porphyritic to nonporphyritic vesicular flows.	60	
V	Thakurvadi aa	Group of porphyritic aa flows -------------RB--------	55	
IV	Megacryst pahoehoe	Non-porphyritic to moderately porphyritic flows with megacryst unit	60	
III	Ambivali aa	Porphyritic flow	45	
II	Parkhande pahoehoe	Non porpnyritic to sparsely porphyritic flow	55	
I	Koynanayar aa	Porphyritic flow	20	

5.5.4. Sub-surface Investigations

The selected site has been investigated by one drill hole (BA-1) which has been drilled for depth of 19.50m. The detail of the drill hole is tabulated below in **Table 5-3**.

TABLE 5-3: 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.	BA-1	Centre of Terminal Area, left bank of Amba river	19.50	0	7.1	7.1	Greyish /Brownish Medium Stiff Clayey silt	5-7			Ground Water Table: Getting flooded during high tide, marshy land
				7.1	11.8	3.5	Greyish Medium Dense Sandy Clay	13-R			
				11.8	15.5	3.7	Greyish Brownish highly Weathered disintegrated rock	R	0-32	Nil	R stands for Refusal
				15.5	19.5	4.0	Greyish Basalt	R	58-84	32-62	

The description of the drill hole is as given below.

BA-1: Drill hole BA-1 has been drilled at the terminal location area on the left bank of Amba River. The drill hole has been drilled vertically down to the depth of 19.50m from EL. 2.00m to EL. -17.50m. The drill hole has encountered 7.10m of thick Medium stiff Silty Clay followed by 3.5m thick Medium dense Clayey Sand. After this, completely decomposed rock stratum having 3.7m thickness was observed up to 15.50m depth from NSL. After this Greyish, Highly to moderately weathered Basalt was encountered till termination of hole.

The bed rock encountered is Greyish basalt which is highly to moderately weathered in nature. The core recovery in the bed rock varies from 58.00%-84.00% and RQD ranges from 32.00%-62.00%.

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 are as tabulated in **Table 5-4**.

TABLE 5-4: Summary of In-Situ Test Results

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
1	Greyish /Brownish Medium Stiff Clayey Silt	1.5	2.1	5
		4.5	5.1	7
2	Greyish Medium Dense Sandy clay	7.5	8.1	13
		9	9.6	17
		10.5	10.82	Refusal
		12	12.08	Refusal
		13.5	13.55	Refusal
		15	15.05	Refusal

Laboratory Test Results

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

4 SPT & 2 UDS 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 **Table 5-5**.

TABLE 5-5: 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
BA-1	Greyish /Brownish Medium Stiff Silty Clay	1.5	2.1	SPT				0	5	60	35	62	35	27		MH						
		3.0	3.5	UDS	1.673	1.18	42	0	6	65	29	62	35	27		MH	UU	0.23	10	0.436	1.232	2.63
		3.0	3.5														CU	0.138	28			

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
		6.0	6.5	UDS	1.83	1.39	32	0	7	62	31	59	31	28		MH	UU	0.3	8	0.357	0.9	2.64
	Greyish Medium Dense Clayey Sand	7.5	8.1	SPT				0	45	36	19	37	19	18		CI	DST	.0143	29			
		9.0	9.5	SPT				7	19	45	29	33	18	15		CL	DST	.062	31			2.63
		10.5	10.82	SPT				17	26	38	19	31	18	13		CL	DST	.097	32			2.64

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 5.6**.

TABLE 5-6: 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/cm^2	Kg/cm^2	Kg/cm^2		%	%	gm/cm^3
BA-1	Greyish Brownish highly Weathered disintegrated rock	13.5	15	180	6.15	135.30					2.7
	Greyish Basalt	15	16	2500		118.99	4.0E+04	0.17	0.79	2.06	2.60
		18	19.5	12500		551.37	1.0E+05	0.20	0.36	1.02	2.80

Geotechnical Analysis

Bearing Capacity Calculations

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

TABLE 5-7: SOIL PARAMETERS ADOPTED FOR THE ANALYSIS

Depth		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)
From (m)	To (m)								
0	7.10	Silt	6	7.1	16.7	23	10	0.396	1.0
7.10	11.8	Clay	13	3.5	18.0	100	-	-	-
11.8	15.5		R	3.7	-		-	-	-

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-1**.

TABLE 5-8: 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	30	35	39	44
2.	2.0 m x 2.0 m	20	24	28	32
3.	2.5 m x 2.5 m	16	19	22	26
4.	3.0 m x 3.0 m	14	16	19	21

Pile Capacity Calculations

The pile capacity is calculated for different diameter of piles up to rock level. The details are given below. The sample calculations are given in **Annexure-2**.

TABLE 5-9: 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 m	12	548	563
2.	1.3 m	12	732	822
3.	1.4 m	12	795	918

5.6. Terminal Infrastructure including equipment

The land area identified is measuring to about 47000 Sq. m and proposed to be taken through Land acquisition. The land requirement with the requirement of facilities has been worked out to 35,000 Sq. m, which can be accommodated within the Land proposed to be taken on Acquisition.

As mentioned earlier, the cargo of JSW and PNP are being handled in their own captive jetties. The other cargo of 3.1 MMTPA is estimated in FY 20, which is expected to increase to 4.5 MMTPA in FY 40 comprising of Bulk / Break-Bulk cargo consisting of Iron, Steel and Coal. This cargo shall be expected to be handled in a Terminal structure, preferably by a Lift-On and Lift-Off (LO LO) type of Inland Water Transport (IWT) Terminal along with crane facility.

As per the Class VII waterway classification, the maximum of 8000 T is to be mobilized in 4 x 2000 T barges with 14 m width and 2.5 m Loaded Draft / 2.75 m Depth in front of the Berthing Structure. Even by considering the vessel size of berthing of 2 SPVs of 86 m (say 90 m) each, the optimum length of Berth requirement shall be taken as 120 m. In this length of 120 m, 4 cranes shall be made operational at any point of time. Keeping in view the slow pace of cargo increase, it is proposed to initially deploy 2 Rubber mounted cranes capable of handling 125 TPH.

In order to evacuate the 2000 T vessel, it is proposed to consider the deployment of 2 cranes with a capacity of 125 T per hour. One crane can handle 1000 T in a day (10 Hrs operations) with 80 % efficiency. The same will be 2000 T by Two Cranes.

1 Berth x 2 Cranes x 300 Days in an year x 10 Hrs a day x 125 TPH x 80 % efficiency = 0.6 MTPA

Though the estimated requirement is of about 3.1 MTPA with an increase to 4.5 MTPA, this is to be observed carefully for optimum utilization of Terminal Structure and also for optimum utilization of the handling equipments. However, to attract the IWT cargo, the initial set up is most essential and the above LO-LO IWT Terminal with 2 Cranes are suggested / recommended at the initial phase. The following iterations of improvement are also suggested / recommended with the estimated traffic improvement.

1 Berth x 2 Cranes x 300 Days in an year x 10 Hrs a day x 125 TPH x 80 % efficiency = 0.6 MTPA

1 Berth x 2 Cranes x 300 Days in an year x 20 Hrs a day x 125 TPH x 80 % efficiency = 1.2 MTPA

1 Berth x 4 Cranes x 300 Days in an year x 20 Hrs a day x 125 TPH x 80 % efficiency = 2.4 MTPA

If the cargo increase is going beyond the above capacity, provision of second berthing structure may also be planned which may enhance the handling capacity of the Terminal to 4.8 MMTPA.

Keeping this in view, the Lo-Lo and Ro-Ro berthing structures are being planned 192 m apart at this stage. Thus, in such a scenario, the additional berthing structure shall be planned for development in between the Lo-Lo and Ro-Ro Terminals just D/s of the existing Lo-Lo structure (with abreast).

There are many vendors available in the market for supply of the above specified cranes viz., TATA-HITACHI; Caterpillar; Kobelco etc. As enquired in the market, the crane is available at a cost INR 200 Lakhs each.

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. These structures shall also cater to the requirements of the various equipments to be used for loading /unloading of the vessels. The requirements of the berth differ depending on the nature of cargo being handled at the berth. The size of the structure shall depend on the largest vessel likely to use the berth and the type of the handling equipment to be used on the deck. 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, traffic, and water level variation. The proposed berth under study is planned for handling 2 nos of barges/vessels of 2000 DWT at a time. The RORO berth has been designed for 40ft container loading whereas the LOLO berth is designed taking into account crawler crane loading.

Deck Level

As per IS 4651 _IV, the deck level of the berthing structure shall be fixed considering the optimum position of the cargo transfer to cater for two extreme conditions viz the largest vessel in light displacement condition at highest water level and the smallest vessel fully laden at lowest water.

The deck level of LO LO is calculated taking a freeboard of 1 m above the highest water level.

However, the deck of RO RO is maintained in a slope of 1:12, maintaining the deck level at the shore side at about 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 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.

The RORO and LOLO berthing structures are kept at a minimum distance of 2x vessel length apart for safe and efficient handling and operation.

TABLE 5-10: Salient Features of berth structure

Description	Length(m)	Width (m)
RO RO	84	16.60
LO LO	120	32

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-E03** for details).

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 & 1 Ro-Ro 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 Lo-Lo Terminal is of INR 66.2 Cr and Ro-Ro Terminal is of INR 15.1 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 a strong armor 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.

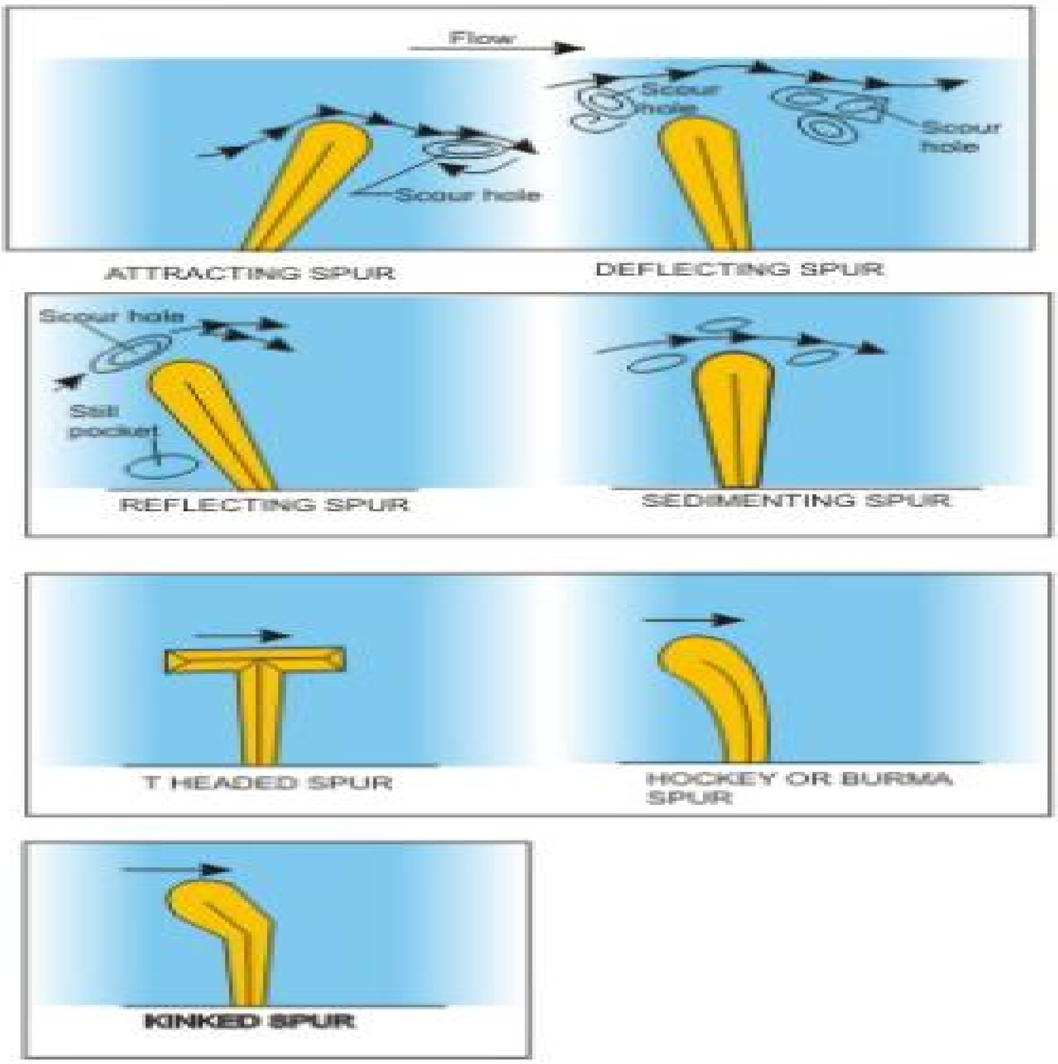


FIGURE 6.1: Different types of Spur

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.

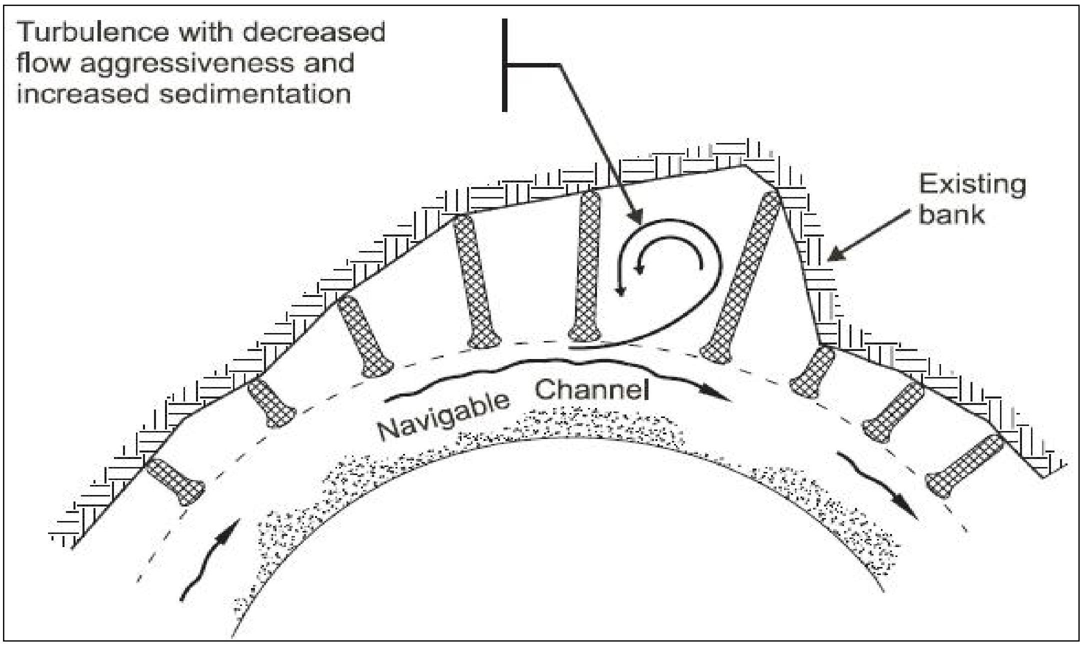


FIGURE 6.2: Plan view of system of spur-dikes constructed to control and stabilize the erosion of the outer band

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.

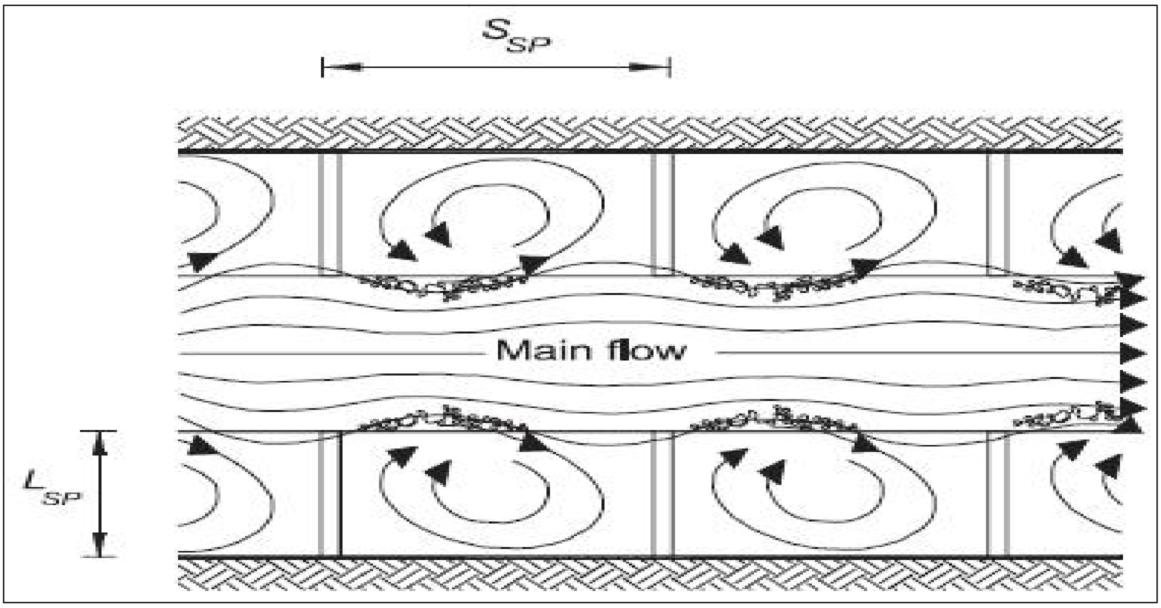


FIGURE 6.3: Diagram showing the length and spacing of the individual dikes with respect to the river width

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.

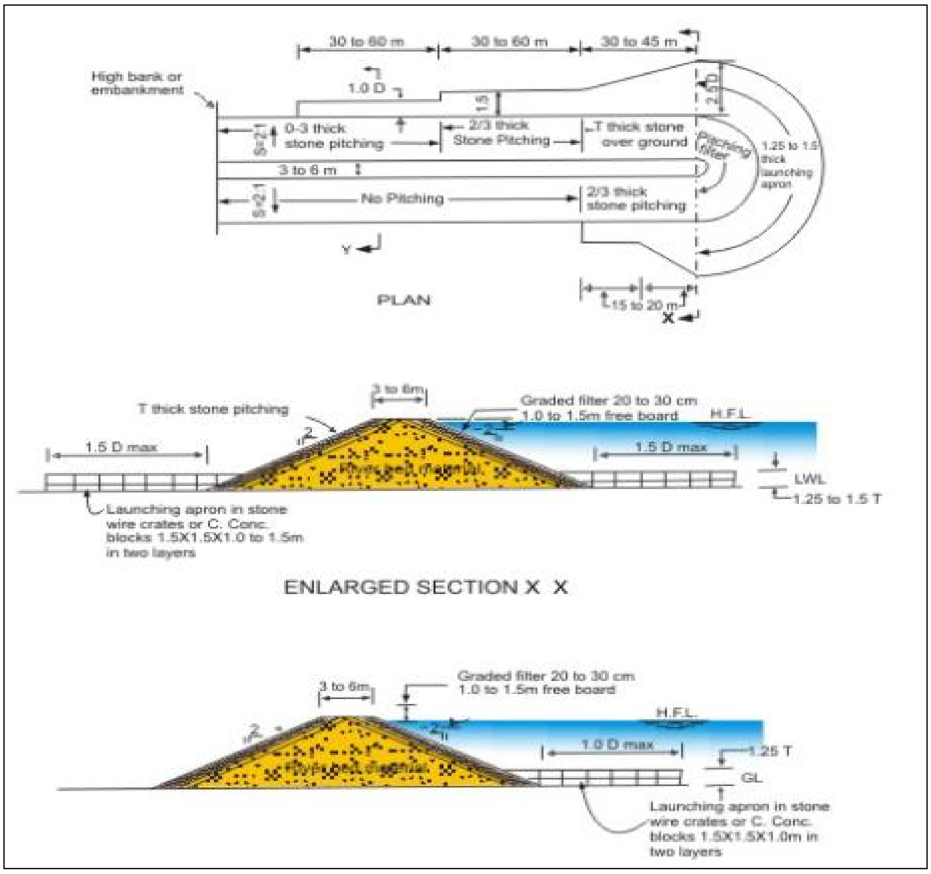
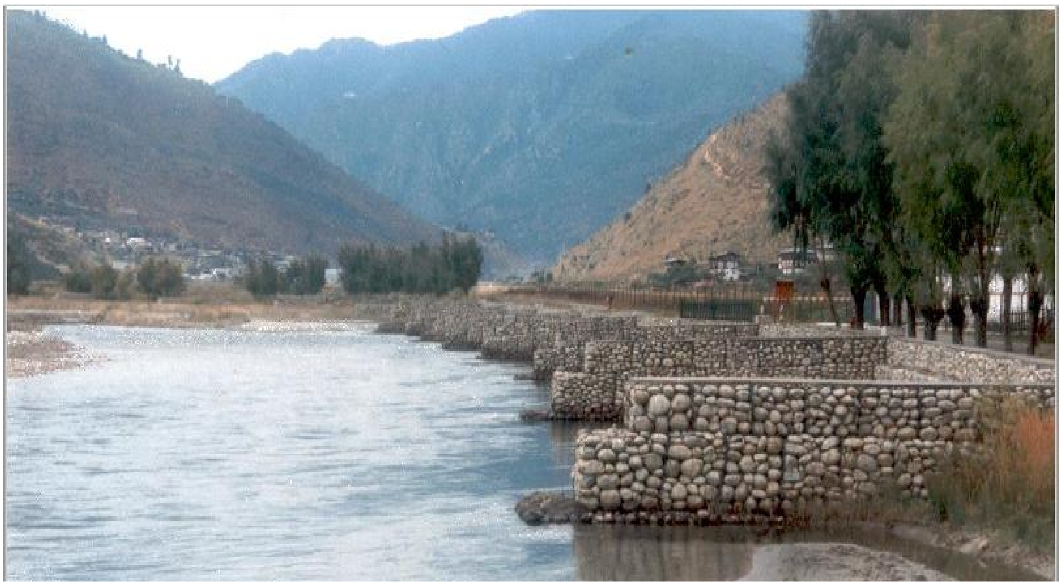


FIGURE 6.4: Typical layout and section of spur

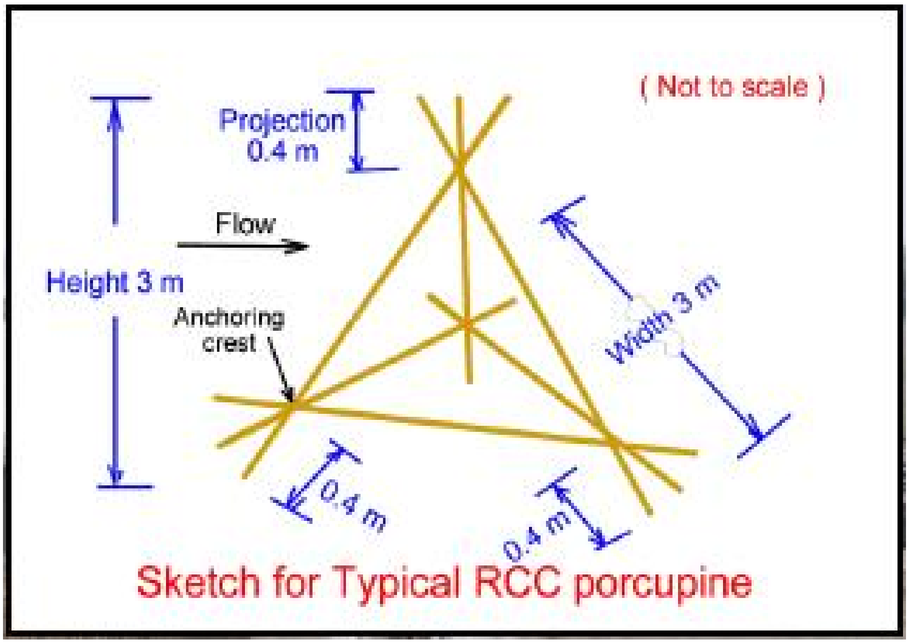
Impermeable spurs



Series of spurs

6.1.2. River Training through Porcupines

River Training through RCC Percupines 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 dtrech, 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

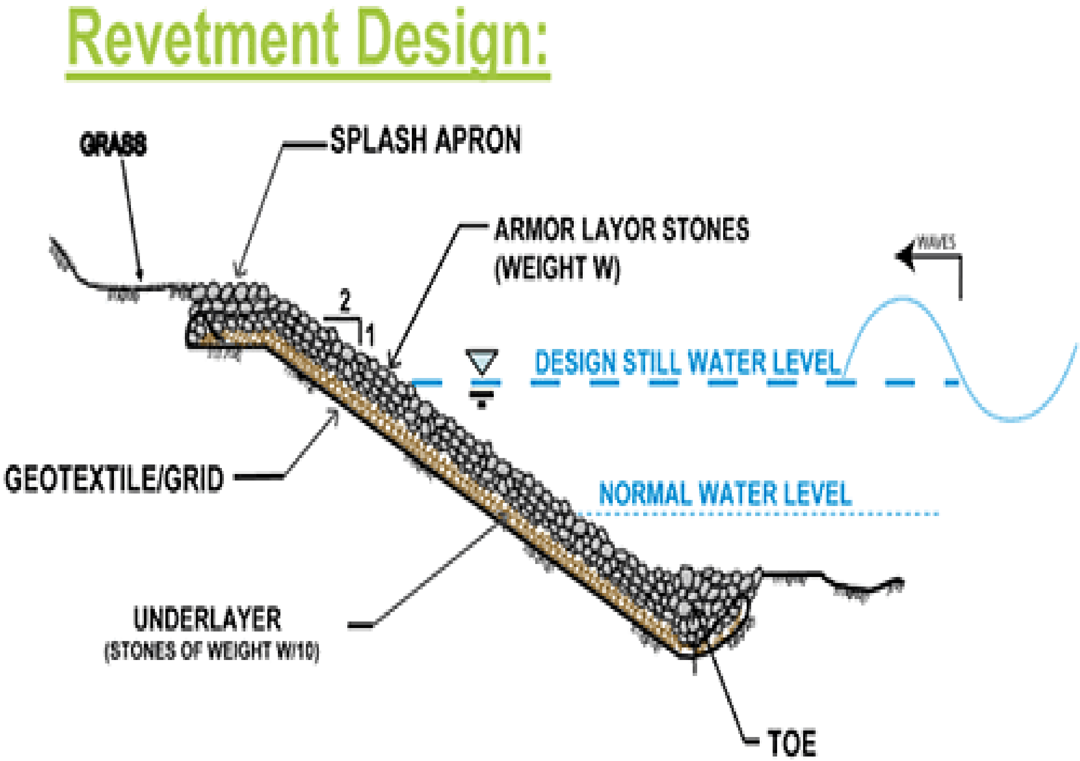
Vessel features are important in the design because moving vessels induce waves and currents in the river, which are a hydraulic load on the bank and river bed. These parameters will influence the design of the free board, the hydraulic stability of the structure and the size of the scour protection 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-X03** 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.

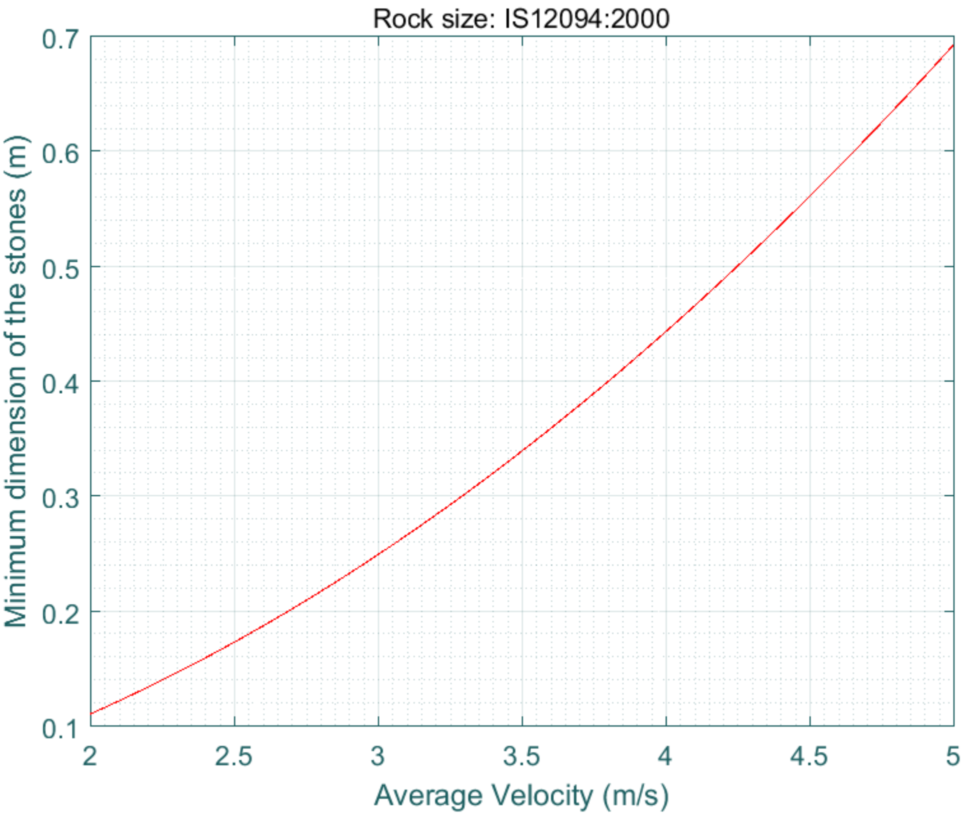


FIGURE 6.5: Minimum rock size according to the IS12094

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 to account for additional phenomena compared to the national codes (IS12094). This formulation is referred to a 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:

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

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

- 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]
- *f* = 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.

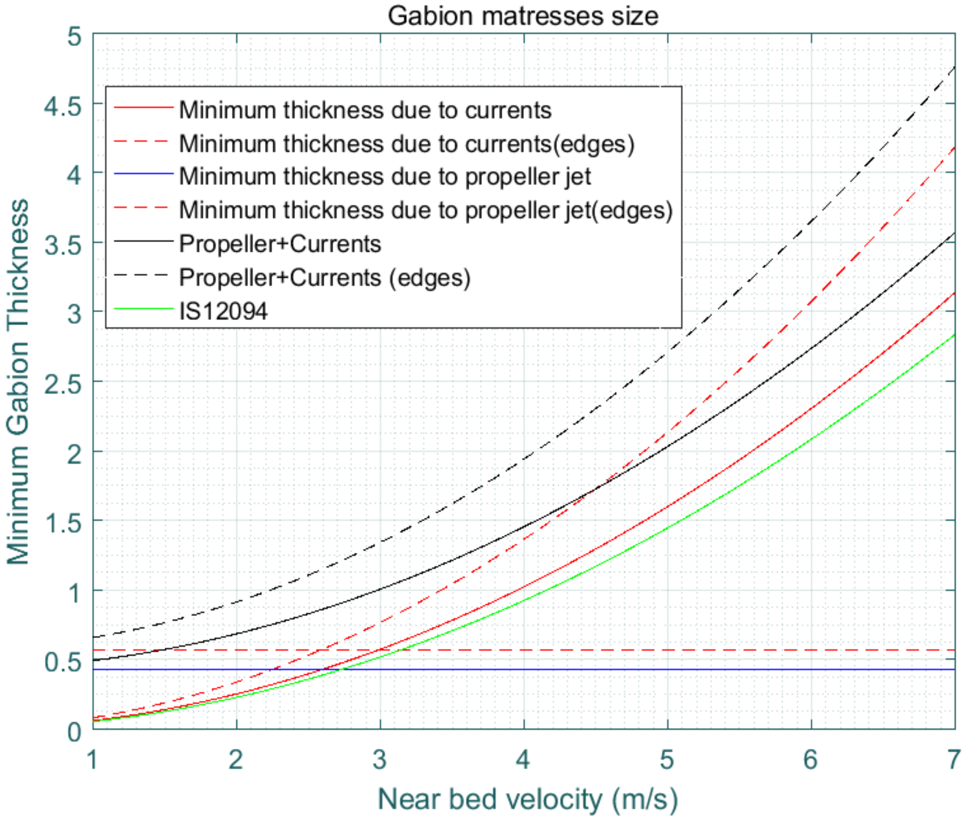


FIGURE 6.6: Minimum required thickness for revetment

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):

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

- 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

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

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 permited, NLL= the mass below which no more than 10 per cent passing by mass is permited, NUL= the mass below which no more than 70 per cent passing by mass is permited, EUL= the mass below which no more than 97 per cent passing by mass is permited, 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.

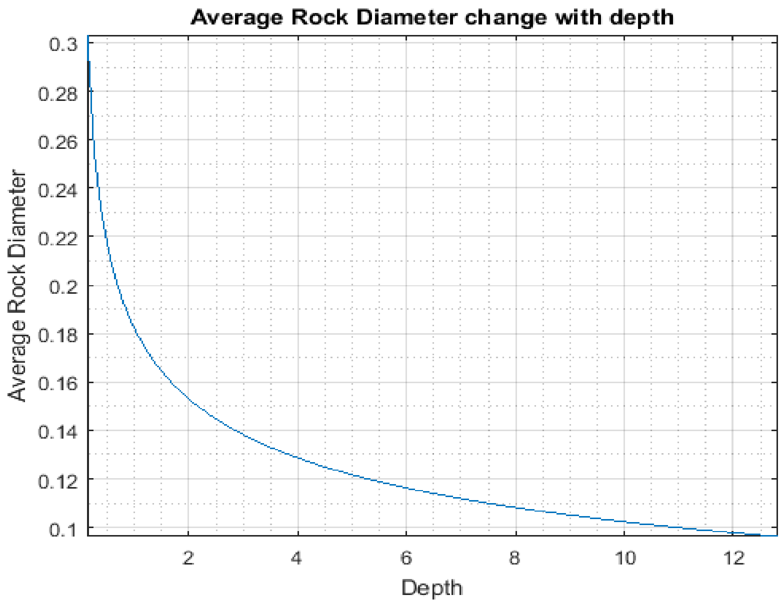


FIGURE 6.7: Minimum average rock diameter

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

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.

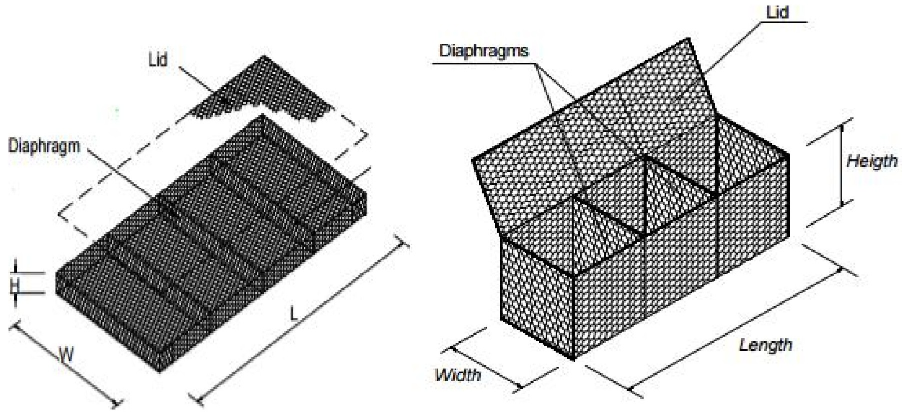


FIGURE 6.8: Example of a gabion mattress and gabion basket

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%

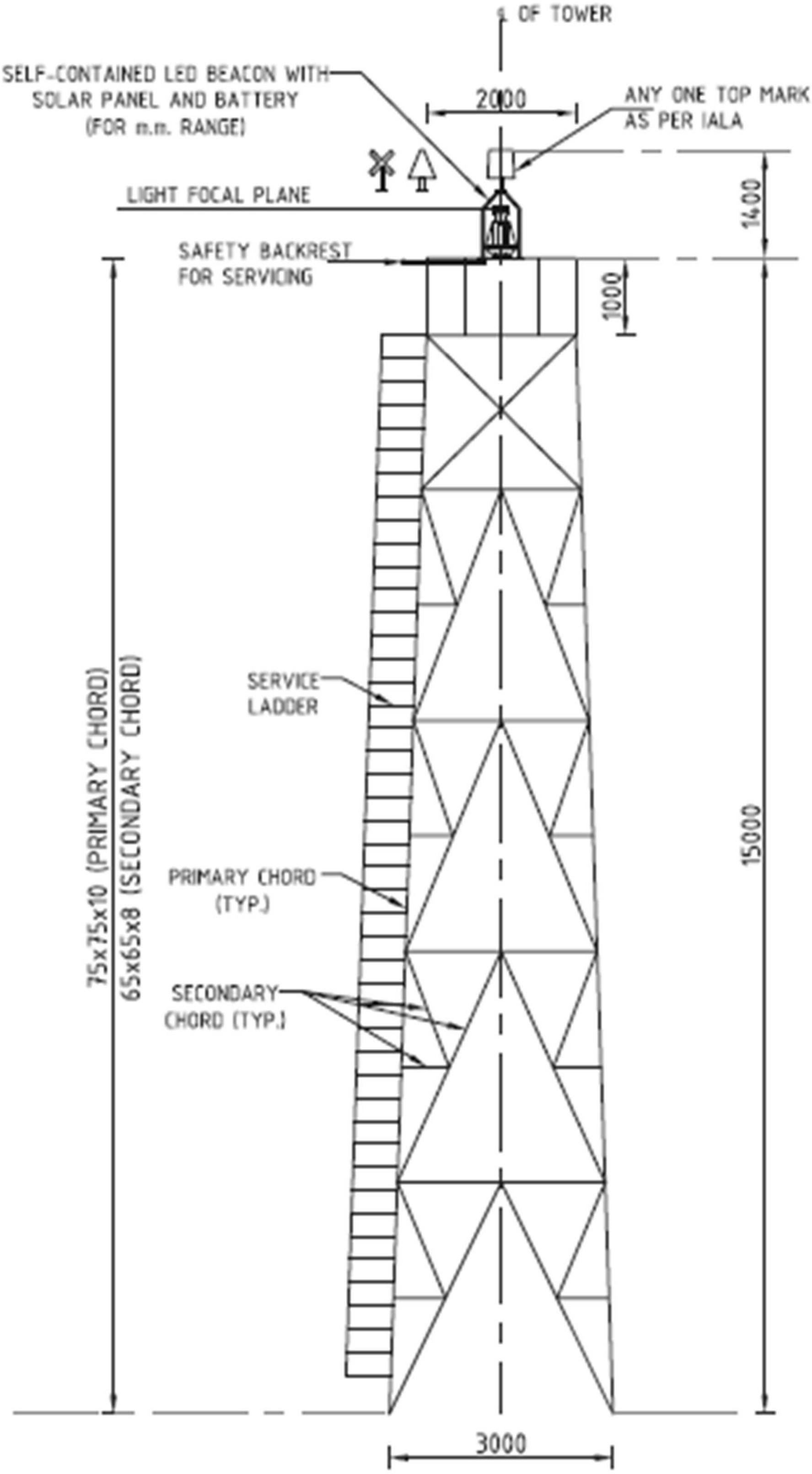
6.3. Navigation Aids

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 is being followed in India also.

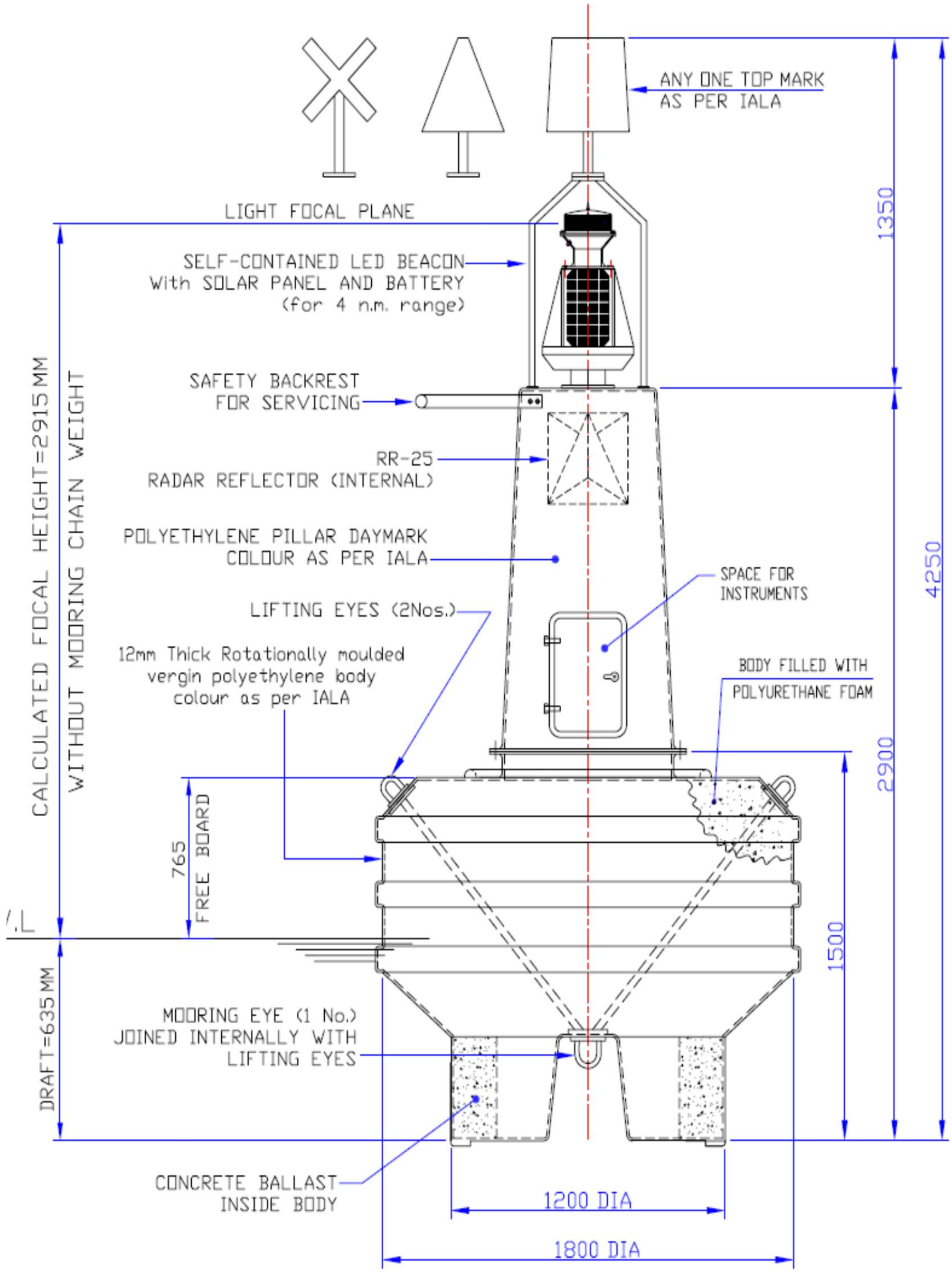
In the Shore based system, for the west flowing National Waterways of Cluster 7 and Cluster 6, it has been preferred to have a Beacon / Light system, wherein the Buoy / Light system has been preferred.

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

BEACON WITH LIGHT SYSTEM:



BUOY WITH LIGHT SYSTEM:



Specifications of BUOY & LIGHT:

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 coaltar 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 l6 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. Amba river fall under Zone III, 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	III
Design horizontal seismic coefficient, Ah	Z I (Sa/g)/ (2R)
Zone Factor Z	0.16
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 16 m has been considered from the HFL.

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 and LO-LO 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. (Refer Volume-II **Drawing No.P.010257-W-20341-E03** for details).

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, an overall width of 16.6 m is provided, whereas for LO-LO the overall width of 32 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 45 m.

For LO-LO the deck has been considered at approx 1 m above HFL.

Expansion loops has been provided along the stretch at almost 30-40 m

A staged construction approach is assumed in the design viz:

- Piles,

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

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

TABLE 6-5: Salient Features of Ro-Ro and Lo-Lo

S.No	Type	Total Length	Total Width
1	RO-RO	84 m	16.6 m
2	LO-LO	120 m	32 m

Design Loads on Berthing Structures

i. Dead Load

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

Both for LO LO and 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.

ii. Live Load

The vertical live loads comprise of loads from vehicular traffic of all kinds including trucks/ trailers/track and cranes, and other mechanical handling equipments and also, surcharges due to stored and stacked materials such bulk .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 LO LO berthing structure, uniform loading corresponding to container berth of 30 KN/m2 has been considered in the analysis. However, no additional surcharges because of stored and stacking of material has been considered.

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

1. A Tracked vehicle of 70 ton load or
2. Wheel load of 100 ton or
3. 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.

iii. Seismic Forces

Amba river is in zone III 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 =0.16

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)

iv. 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 in both X and Z direction in STAAD Pro software.

v. Berthing Load (applicable for LO LO)

Berthing forces on the structure are applied according to IS 4561 (III). When an approaching vessel impacts on the berth, horizontal forces act on the berth. The magnitude of this force depends on the kinetic energy that can be absorbed by the fender system. When the berthing takes place, the fenders absorb the kinetic energy and convert into strain energy and in that process, passes on the reaction force to the structure, for which the berth is designed. The kinetic energy, E, imparted to a fender system by a vessel moving with velocity V is given by E = (Wd x V^2 x Cm x Ce x Cs) / (2x g)

Where,

E = Berthing Energy (Tm)

Wd= Displacement Tonnage of the Vessel (T)

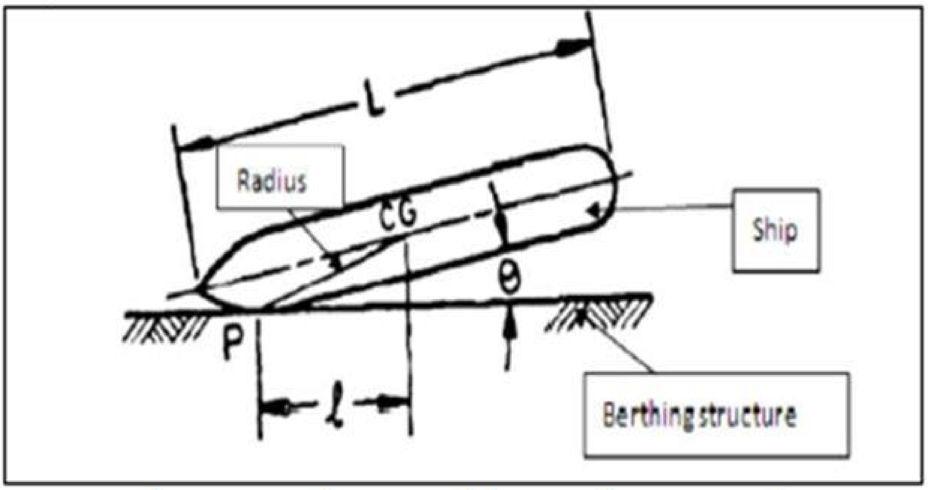
V= Berthing Velocity in m/s

Cm = Mass co –efficient

Ce = Eccentricity co-efficient

Cs = Softness co-efficient

G = Acceleration due to gravity (m/s2)



Mass Co-efficient

Taking Wd = 4000 DWT

Cm = 1+ (pi (). D^2. L.w/Wd)

D= draught of vessel =1.94 m

L = length of vessel =90 m (for LO LO)

W= unit weight of water

Cm =1.0665

Eccentricity Co-efficient

Let the vessel berth at angle O = 15 deg
Ce= 1 + (l/r)^2 sin^{2}O / (1+ (l/r)^2)
Taking l= L/2
r = L/4
Ce =0.26

Softness Co-efficient
Cs = 0.95 (Is 4651 –III)

IS : 4651 (Part III) - 1974

TABLE 2 NORMAL VELOCITIES OF VESSELS

(*Clause* 5.2.1.1)

SL No.	SITE CONDITION	BERTHING CONDITION	BERTHING VELOCITY NORMAL TO BERTH IN m/s			
			Up to 5 000 DT	Up to 10 000 DT	Up to 100 000 DT	More than 100 000 DT
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Strong wind and swells	Difficult	0·75	0·55	0·40	0·20
ii)	Strong wind and swells	Favourable	0·60	0·45	0·30	0·20
iii)	Moderate wind and swells	Moderate	0·45	0·35	0·20	0·15
iv)	Sheltered	Difficult	0·25	0·20	0·15	0·10
v)	Sheltered	Favourable	0·20	0·15	0·10	0·10

Velocity of Vessel normal to berth = 0.45 m/s

E = 108.7kNm /3 = 36.3 kNm. Thus a moment of 36.3 kNm has been applied in the software.

vi. Mooring Load for both RORO & LOLO

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 4000DWT Line pull = 200 kN

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.

vii. 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 = 3.185 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 both RO-RO and LO-LO 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.

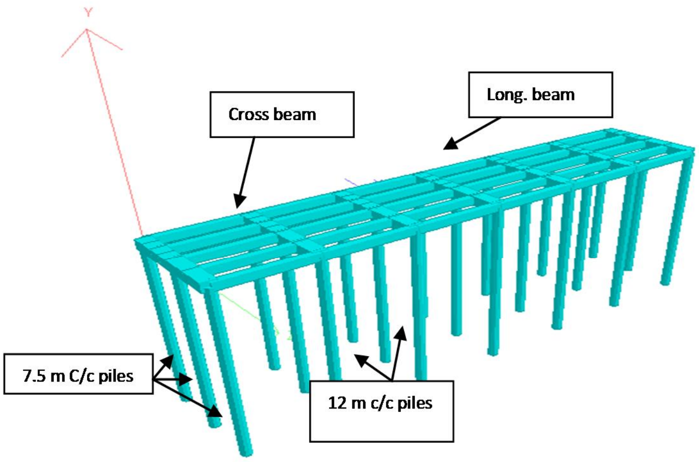


FIGURE 6.9: Perspective view of 3 dimensional model prepared in STAAD for RO-RO

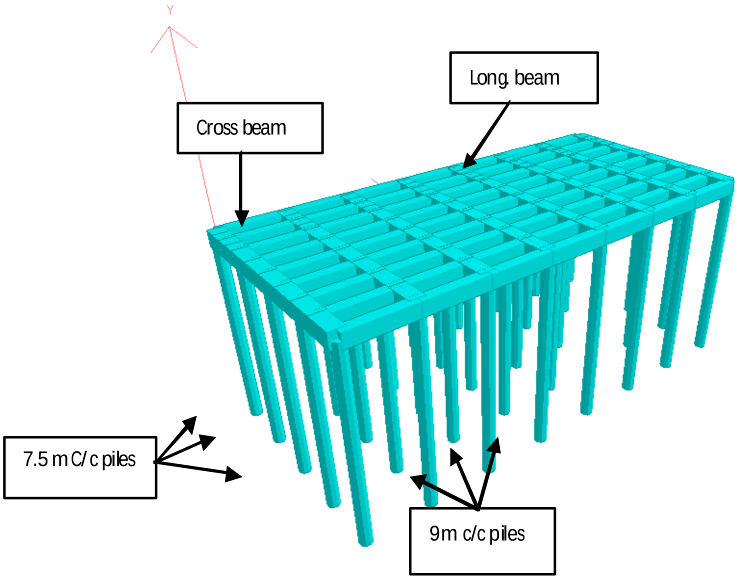


FIGURE 6.10: Perspective view of 3 dimensional model prepared in STAAD for LO-LO

SIZING OF RO-RO

Member Description	Length(m) C/C	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	17.5*		Concrete

* Including socket length of 1.5 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. -10.8m, socket length of the pile has been calculated as follows:

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

	Rock Socketed Pile : AMBA RO-RO				
1.	METHOD 2 : UCS < 10 MPa, IRC 78-2014				
1.1.	Input				
	Rock Quality Designation, RQD		=	0	%
	Core recovery, CR		=	20	%
	Uniaxial Compressive Strength (UCS), qc		=	8.1	MPa
	N-Value below base		=	140	
	Average shear strength below base of pile (based on N-value), Cub		=	1.2	MPa
	N-Value along Socket		=	120	
	Ultimate shear strength along pile socket (based on N-value), Cus		=	0.9	MPa
	Coefficient, Nc		=	9.0	
	Dia of Pile		=	1.3	m
	Area of base, Ab	$P_i * d^2/4$	=	1.33	m2
	Length of Socket		=	1.5	m
	Area of socket, As	$P_i * d * L$	=	6.31	m2

	Load on Pile		=	5500	KN
	Scour Depth		=	16	m
1.2.	Pile Capacity				
	Ultimate end bearing capacity of socketed pile, Re	$C_{ub}*N_c*A_b$	=	14096.17	KN
	Ultimate side socket shear, Raf	A_s*C_{us}	=	5207	KN
	Ultimate capacity of socketed pile, Qu	$R_e + R_{af}$	=	19303.36	KN
	Allowable capacity of socketed pile, Qallow	$R_e/3 + R_{af}/6$	=	5566.59	KN

SIZING OF LO-LO

Member Description	Length(m) C/C	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	7.5	2	1.8		Concrete
Longitudinal Beams	9	1.2	1. 5		Concrete
Cast In situ Slab				0.15	Concrete
Pile Diameter, OD		1.4	17.5*		Concrete

* Including socket length of 1.5 m

TABLE 6-8: CALCULATION OF SOCKETED PILE CAPACITY- AMBA LO-LO

	Rock Socketed Pile : AMBA LO-LO				
1.	METHOD 2 : UCS < 10 MPa, IRC 78-2014				
1.1.	Input				
	Rock Quality Designation, RQD		=	0	%
	Core recovery, CR		=	20	%
	Uniaxial Compressive Strength (UCS), qc		=	8.1	MPa
	N-Value below base		=	140	

	Average shear strength below base of pile (based on N-value), Cub		=	1.2	MPa
	N-Value along Socket		=	120	
	Ultimate shear strength along pile socket (based on N-value), Cus		=	0.9	MPa
	Coefficient, Nc		=	9.0	
	Dia of Pile		=	1.4	m
	Area of base, Ab	$P_i * d^2/4$	=	1.54	m2
	Length of Socket		=	1.5	m
	Area of socket, As	$P_i * d * L$	=	6.60	m2
	Load on Pile		=	5500	KN
	Scour Depth		=	16	m
1.2.	Pile Capacity				
	Ultimate end bearing capacity of socketed pile, Re	$C_{ub} * N_c * A_b$	=	16348.22	KN
	Ultimate side socket shear, Raf	$A_s * C_{us}$	=	5608	KN
	Ultimate capacity of socketed pile, Qu	$R_e + R_{af}$	=	21955.96	KN
	Allowable capacity of socketed pile, Qallow	$R_e/3 + R_{af}/6$	=	6348.03	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.

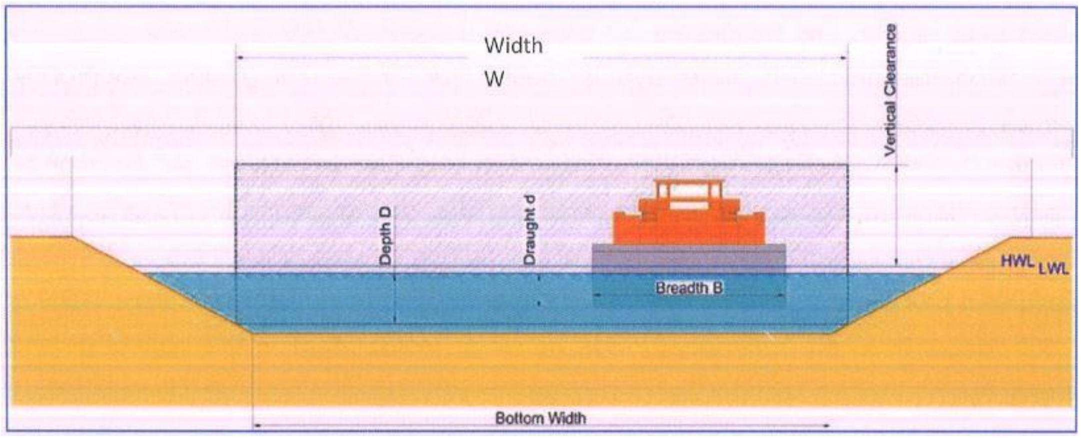


FIGURE 7.1: Dimensions – one way navigation Channel

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

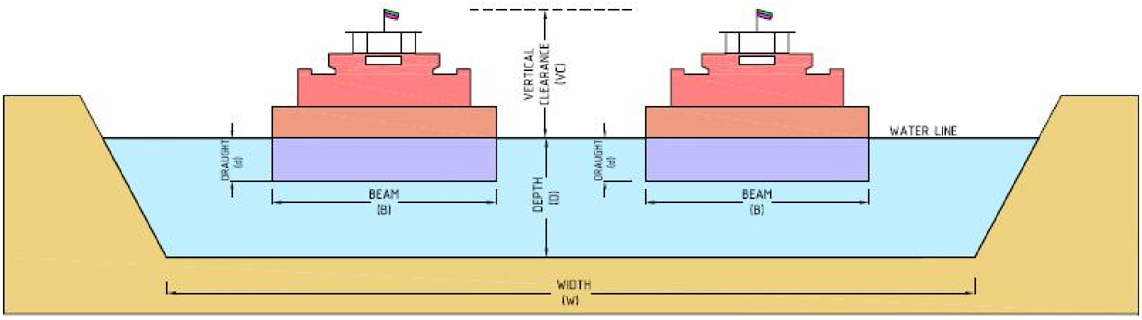


FIGURE 7.2: Dimensions – Two way navigation Channel

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**.

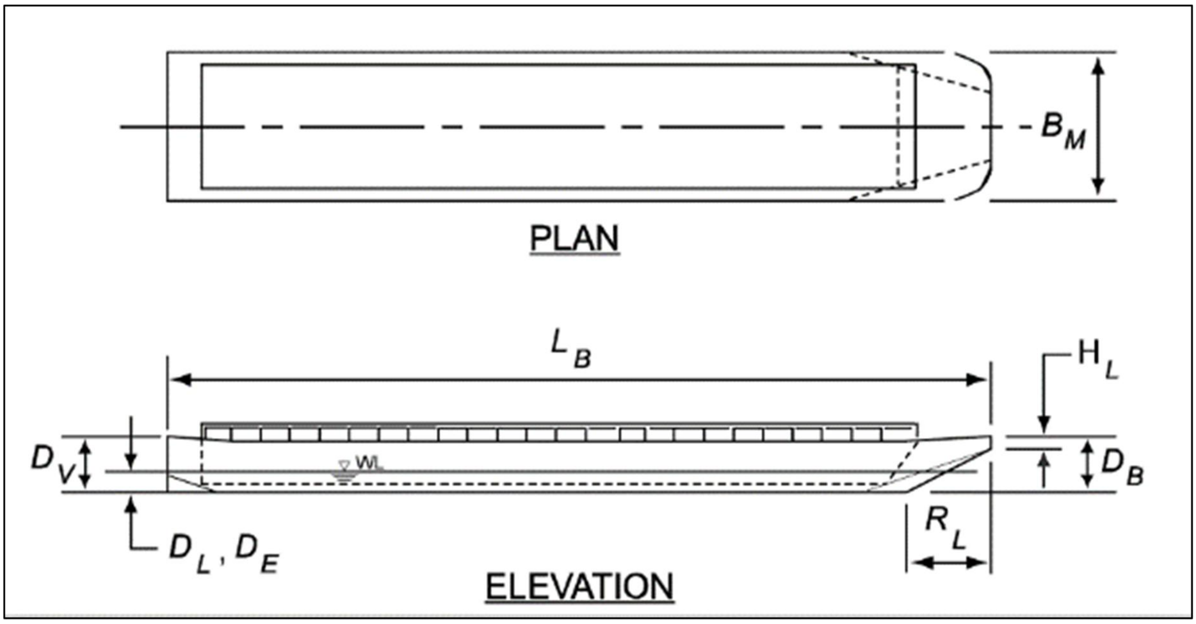


FIGURE 7.3: Plan and Elevation of vessel

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 have 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 Amba has been limited to Class III in the upper reaches i.e., beyond Ch 20 km, keeping in view the Bridge structures between Ch 19 km and 20 km. Probably, JSW Dharamtar Port has considered the location advantage and developed their infrastructure just downstream of the Bridge structures.

View JSW Dharamtar Port

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 Tug – cum – Buoy Laying 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 "Amba" has been considered, as a part of development of this waterway. Hence, the present discussions are being concentrated only on Cargo Vessels.

The river Amba is being used extensively with the mobility of about 2000 - 2700 T vessels upto JSW's Dharamtar Port. Vessels plying in this region are of 70 – 78 m Length x 12 – 14 m Beam x 3.2 to 3.8 m Draft. These vessels are plying with tidal advantage for smooth uninterrupted mobility. The IWT Traffic volumes to an extent of 12 to 13 MMTPA are being moved / handled only by JSW units. Hence, the IWT mobility is comparatively high in river Amba while comparing with the rivers flowing in to the west coast and draining into the Arabian Sea.

Keeping in view the traffic growth and also keeping in view the classification standards in vogue, in India, the maximum standard that can be considered as 8000 T mobility with 4 Barges (Dumb Barges – DB) of 2000 T with 1 Pusher Tug (PT) combination, which is most amenable for the initial stretch up to the JSW Port. The same combination may be sufficient for usage by PNP Port in the opposite side of the river and the proposed IWAI Terminal just downstream of the PNP Port.

For the above scenario, the most suitable vessel size has already been defined in Class VII of the classification. The recommended vessel configuration, as already discussed will be with the max sizes of 86 m x 14 m x 2.5 m for SPV and 210 m x 28 m x 2.5 m for 1 PT + 4 DBs with the channel requirement of 100 m x 2.75 m for Two way Navigation. In general, there will be a saving in the power of about 20 % in "Push Towing" for comparable Loads. Further, keeping in view the operational safety considerations in the river navigation, the "Pull Towing" is avoidable and hence only the "Push Towing" is recommended.

7.4. Proposed Vessel Size and Specifications

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

Self Propelled Vessel: (2000 T) INR 1000 Lakhs each. (Not recommended)

Length:	86 m to 90 m
Breadth:	12 m to 14 m
Loaded Draft / Depth:	2.5 m / 3.0 m +
Cargo Capacity:	2000 T
Propulsion:	Marine Diesel Engines of 3 x 625 Bhp

Tug Barge Combination: (1 P. T + 4 DBs of 2000 T each – 8000 T)

Pusher Tug	**INR 900 Lakhs each**
Length:	30 m to 40 m
Breadth:	12 m to 14 m
Draft / Depth:	1.7 m / 2.0 m +
Cargo Capacity:	- -
Propulsion:	Marine Diesel Engines of 3 x 800 Bhp
Speed (with Load):	16 kmph to 20 kmph in D/s and 12 kmph to 16 kmph in U/s

Dumb Barge	**INR 650 Lakhs each**
Length:	86 m to 90 m
Breadth:	12 m to 14 m
Loaded Draft / Depth:	2.5 m / 2.75 m +
Cargo Capacity:	2000 T

Ro-Ro Vessel: (21 TEU) INR 800 Lakhs each

Length:	52.8 m – 55 m
Breadth:	12 m to 14 m
Loaded Draft / Depth:	1.94 m / 2.50 m +
Cargo Capacity:	16 TEU – 21 TEU
Propulsion:	Marine Diesel Engines of 3 x 375 Bhp
Speed (with Load):	16 kmph to 20 kmph in D/s and 12 kmph to 16 kmph in U/s

JSW Energy (Stake Holder's) Vessel: (8000 T – 10000 T)

Length:	115 m
Breadth:	22 m
Loaded Draft / Depth:	4.8 m / 5.3 m +
Cargo Capacity:	8000 T – 10000 T

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

2 PTs + 8 DBs may be required by 2028. {Construction from 2025 to 2028}

Other 2 PTs + 8 DBs may be required by 2035. {Construction from 2032 to 2035}

Keeping in view the type of cargo as Bulk / Break Bulk, the SPV and the DBs will be considered as a Hold type. 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 Amba 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 downstream 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

With regard to the Ro-Ro operation, mobility of 13000 vehicles (preferably of 40 TEU container trucks) P A by FY 20 is estimated and increase to 28,000 vehicles P A by FY 40. The vessel size proposed for such mobility will be considered with 52.80 m – 55 m LOA x 12 m to 14 m Breadth x 1.94 m Loaded Draft / 2.50 m+ Depth, which can carry 16 Nos. – 21 Nos. TEU and with an average speed of 12 Kmph – 20 Kmph. 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. This Ro-Ro operation is to be considered in phase 2 and may have to be considered after careful observation from 2025.

{+ is the indication for provision of additional Depth, keeping in view the coastal movement of these vessels}.

2 Ro-Ro vessels may be required by 2028. {Construction from 2025 to 2028)

Other 3 Ro-Ro vessels may be required by 2035. {Construction from 2032 to 2035}.

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.,.

JSW projects are having their own captive terminal system with fully equipped equipments and also they are equipped with Vessel asset for the project. The requirement for the project from the IWAI may be only the provision of “Fairway” with proper Navigational channel dimensions and a safe Day / Night Navigation system.

The PNP project requirement is also of the similar. Since, the PNP Terminal is downstream of the JSW Port; the provision of “Fairway” for JSW Port will suffice the requirement of PNP Captive project requirements also.

Hence, the working of TAT may be essential only to cater to the requirement of other traffic proposed / expected to be handled in the IWAI Lo-Lo and Ro-Ro Terminal jetties to handle the Bulk / Break Bulk cargo of 3.1 MMTPA in FY 20 to 4.5 MMTPA in FY 40 and Ro-Ro vessels of 13000 vehicles PA in FY 20 to 28000 vehicles PA in FY 40.

Bulk / Break Bulk Cargo:
In the proposed IWAI Terminal, just downstream of PNP location, maximum designed propositions are catered with 2 Berths of 120 m length each to accommodate 4 Dumb Barges at a point of operation and considering 4 cranes (Each Crane of 125 TPH with 80 % efficiency) in each Berth with 20 Hrs of operation, it can clear about 4.8 MMTPA.

The Bulk / Break Bulk cargo is to be moved from Anchorage to PNP IWAI Berth i.e., for a distance of about 30 Kms. (Anchorage to Amba River Mouth is 10 Kms + Distance in the river upto PNP IWAI Terminal is about 20 Kms). Keeping in view the average speed of the vessel as 15 to 16 Kmph, the journey Time is 2 Hrs.

The TAT will be as detailed:

Loading at Anchorage 20 Hrs + Onward Journey 2 Hrs + Unloading at Terminal 20 Hrs + Return Journey 2 Hrs = Total 44 Hrs say 48 Hrs.

Ro-Ro Operation:

The Ro-Ro Terminal is provisioned to meet the mobility of 13,000 vehicles per annum (preferably the containers) in FY 20 which may increase to 28,000 Vehicles per annum in FY 40. Considering 300 days operation, the daily volumes will be of about 93 say 100 vehicles per day.

The origin of Ro-Ro vessels mobility is being planned from MbPT, which is about 20 Kms from the Anchorage and accordingly, the total distance can be considered as 50 Kms. Taking the average speed of 20 Kmph, it will take about 2 ½ Hrs for one mobility.

The TAT will be as detailed:

Entry / Exit of Vehicles at MbPT 1 Hr + Onward Journey 2 ½ Hrs + Entry / Exit of Vehicles at Terminal 1 Hr + Return Journey 2 ½ Hrs = Total 7 Hrs.

7.6. Number of Vessels Required

In order to handle Bulk / Break Bulk cargo, 1 unit of 1 PT + 4 DBs in 2 days of TAT with 48 Hrs round trip can carry 8000 T. Accordingly, in 300 days, it can handle about 1.2 MMTPA, wherein 4 units with 4 PTs + 16 DBs can handle about 4.8 MMTPA.

In the initial stages, it is proposed to go ahead with 2 units of 1 PT + 4 DBs i.e., 2 PTs + 8 DBs, which may have to be expanded to the ultimate stage of 4 PTs + 16 DBs..

2 PTs + 8 DBs may be required by 2028. {Construction from 2025 to 2028}

Other 2 PTs + 8 DBs may be required by 2035. {Construction from 2032 to 2035}

In order to handle the initial traffic of 13,000 Vehicles, it is essential to deploy 2 Nos. of Ro-Ro Vessels and may require to be augmented with the increase in mobility. However, to meet the ultimate requirement of 28,000 Vehicles, it is essential to deploy a total of 5 Ro-Ro vessels.

2 Ro-Ro vessels may be required by 2028. {Construction from 2025 to 2028)

Other 3 Ro-Ro vessels may be required by 2035. {Construction from 2032 to 2035}.

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 no specific repair yard in the study stretch of Amba River to attend the repairs of IWT Vessels plying in this region.

It was observed that the nearest IWT ship repair facility for the vessels plying on “Amba River” is in “Sewri” area in Mumbai, which is about 20 Kms from the mouth of Amba River. The prominent shipyard is one being promoted by “Brilliant Seagull”, as noted.

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.

Self Propelled Vessel: (2000 T) {Not Recommended} with Length – 86 m to 90 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 2.5 m / 3.0 m +; Cargo Capacity – 2000 T and Propulsion by Marine Diesel Engines of 2 x 625 Bhp is costing about **INR 1000 Lakhs each.**

Pusher Tug: with Length – 30 to 40 m; Breadth – 12 to 14 m; Draft / Depth – 1.7 m / 2.0 m + and Propulsion by Marine Diesel Engines of 3 x 800 Bhp is costing about **INR 900 Lakhs each.**

Dumb Barge: with Length – 86 m to 90 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 2.5 m / 2.75 m +; Cargo Capacity – 2000 T is costing about **INR 650 Lakhs each.**

Ro-Ro Vessel: with Length – 52.80 m to 55 m; Breadth – 12 m to 14 m; Loaded Draft / Depth – 1.94 m / 2.5 m +; Cargo Capacity – 21 Nos. TEUs and Propulsion by Marine Diesel Engines of 3 x 375 Bhp is costing about **INR 800 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 Unit as 1 PT + 4 DBs and 1 Ro-Ro Vessel, for which the indicative O & M Costs have been worked out.

1 PT + 4 DBs (For 1 Year)

· 1 PT Running cost for 300 days operation with 2 days turnaround (150 Cycles) of which 4 Hrs mobility in a cycle, say with 5 Hrs / Cycle, cost per annum will be as detailed.

- 150 cycles x 5 Hrs x {0.1 Liter per hour x 3 Engines x 800 Bhp} x INR 70 per Liter = **INR 126 Lakhs Per Annum** per Unit.
- No Running cost for Barges.
- 8 Nos. Crew on 1 PT + 2 Nos. Crew on each DB, totaling to 16 Nos. @ INR 0.50 Lakhs per month.
- Crew cost for 12 months will be 12 x 16 x 0.5 = **INR 96 Lakhs Per Annum** per Unit.
- Repair Cost is @ 2 % P. A of CAPEX i.e., 0.02 {1 x 900 + 4 x 650} = **INR 70 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.

1 Ro-Ro Vessel (For 1 Year)

- 1 Ro-Ro vessel Running cost for 300 days operation with 1 day turnaround (300 Cycles) of which 5 Hrs mobility in a cycle, say with 6 Hrs / Cycle, cost per annum will be as detailed.
- 300 cycles x 6 Hrs x {0.1 Liter per hour x 3 Engines x 375 Bhp} x INR 70 per Liter = **INR 141.75 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 800} = **INR 16 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 fool 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 has 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 schematic form in the Figure below.

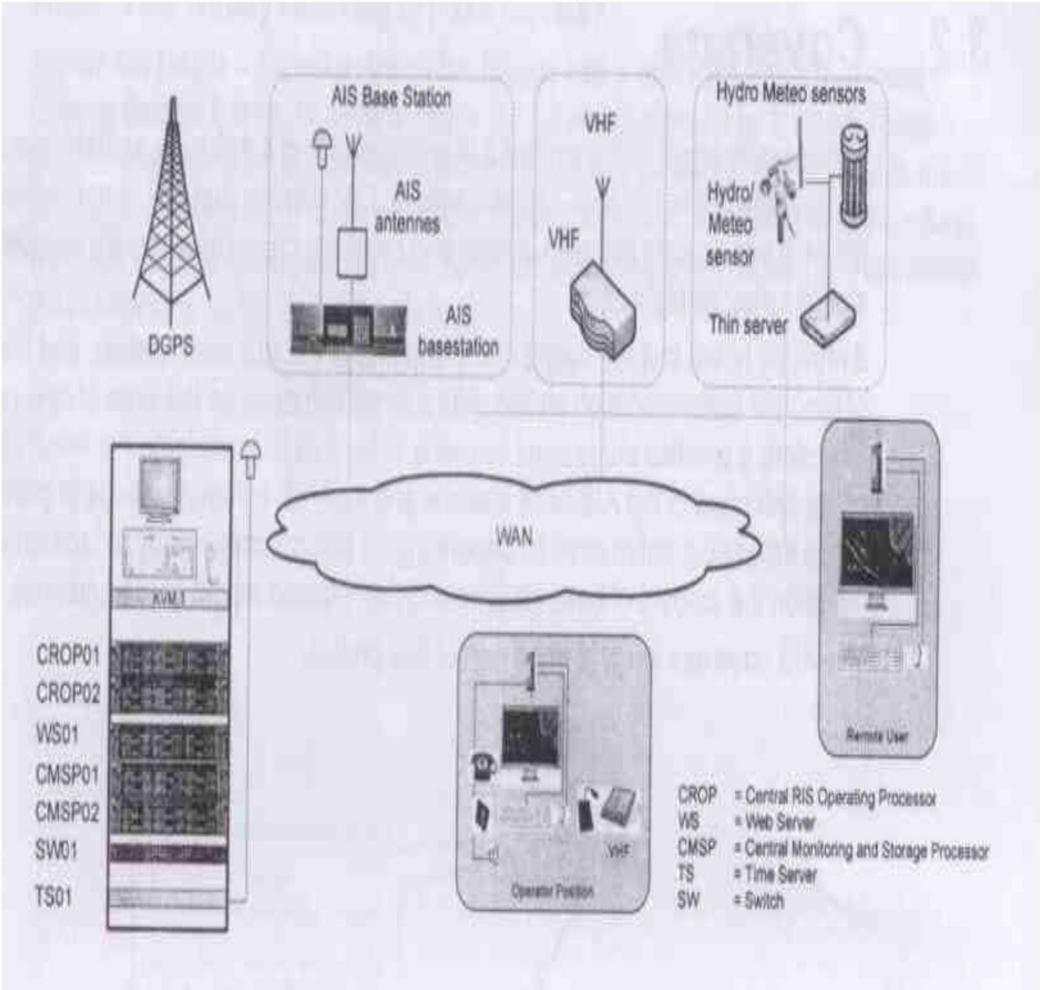
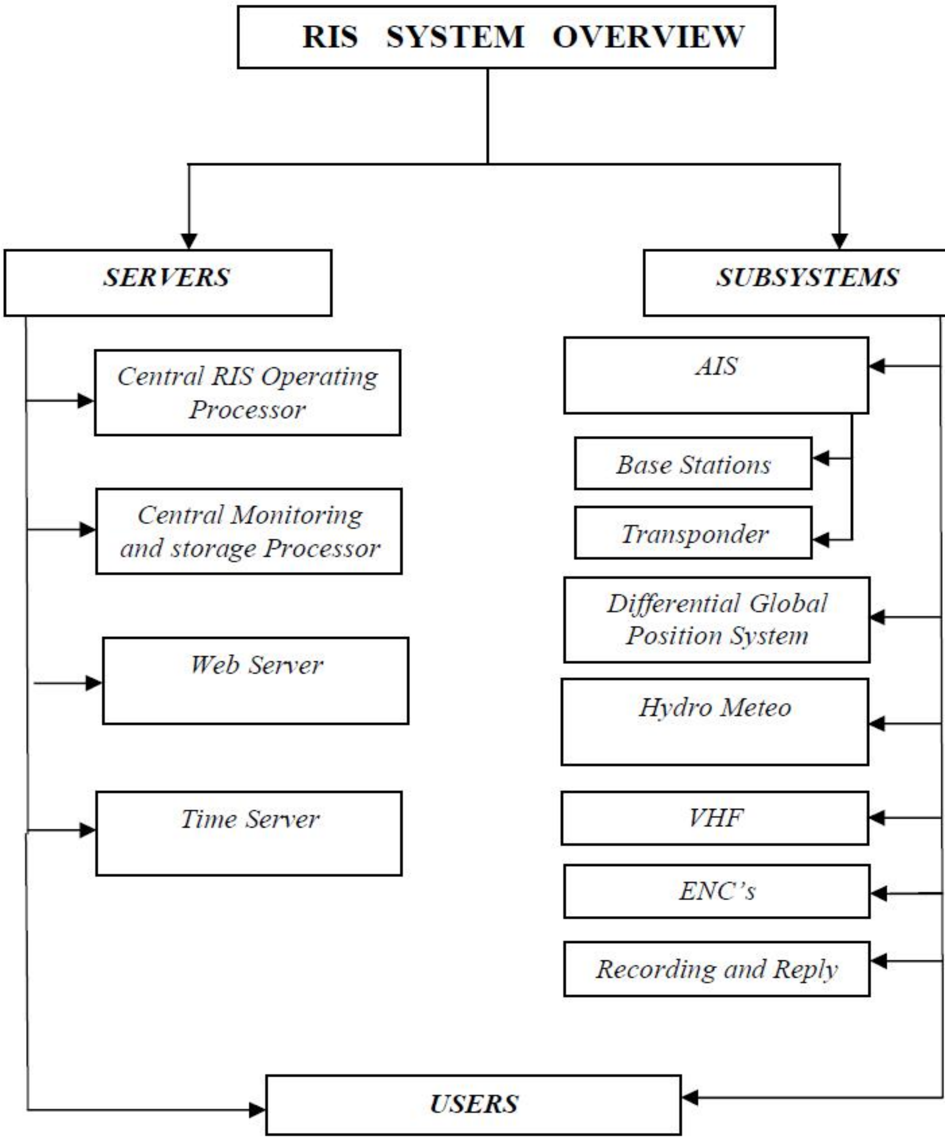


Fig 8.1 Main components of the RIS system are given below in flowchart:



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 require interface with the systems available / working on the 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 Equipment's 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.

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 fool-proof communication / navigation system in the National Waterways joining the sea in both West / East coast.

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.

<u>VHF sets with Antenna</u>

- 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

<u>Metrological Equipment's (Anemometer, Barometer, Relative Humidity)</u>

Wind Speed

- Range: 0 to 60 m/s
- response time 250 ms
- accuracy : 0 to 35 m/s: $\pm$0.3 m/s or $\pm$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: $\pm$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. Costing

8.5.1. Capital Cost & Operation / Maintenance Cost

The cost estimates are placed below:

COST FOR RIS SYSTEM ON RIVER "AMBA (NW-10)"

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	260,00,000	520,00,000
3	Meteo Sensor	2	8,00,000	16,00,000
4	ATG	2	11,00,000	22,00,000
5	VHF	2	5,00,000	10,00,000
6	DG Set 10 KVA	2	10,00,000	20,00,000
7	UPS	2	7,00,000	14,00,000
8	RIS Software	1	125,00,000	125,00,000
9	RIS Hardware	1	140,00,000	140,00,000
10	Installation Testing & Commissioning	2	40,00,000	80,00,000
11	Porta cabin	4	12,00,000	48,00,000
12	Trestle Tower	2	17,00,000	34,00,000
13.	Land Cost	-	Lump Sum	30,00,000
14.	Buildings etc.,	-	Lump Sum	70,00,000
			Total	**1089,00,000**
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**
D.	**CAMC for 4 years**			
	1st year			**-Nil-**
	2nd year (10 % on the Capital Cost)			**1,08,90,000**

COST FOR RIS SYSTEM ON RIVER "AMBA (NW-10)"

Sl. No.	Equipment	Qty	Unit Price (in INR)	Total (in INR)
	3rd year (+ 10 % on the previous year Cost)			**1,19,79,000**
	4th year (+ 10 % on the previous year Cost)			**1,31,76,900**
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 requirement and only indicative.
C. Cumulative Annual Maintenance Cost is indicative.
D. The Annual License Cost may vary according to the policy of the Licensing Authority.
E. The above capital cost is being considered for cost analysis.
F. If RIS is planned for implementation, additional cost of INR 0.5 Lakhs / Buoy may have to be added. The same has been taken appropriately.

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

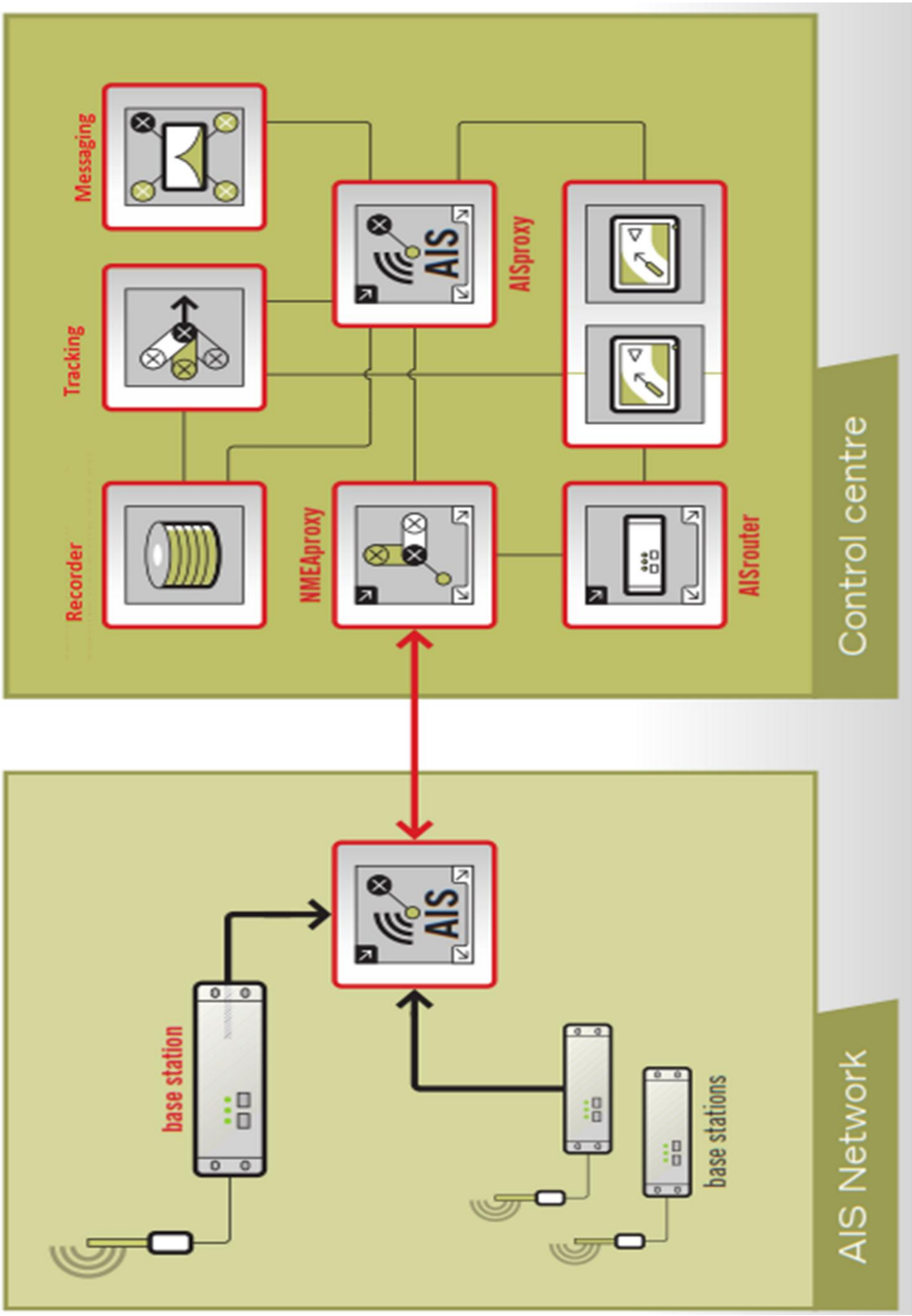
Further, the following indicative Figures / Diagrams are placed herewith.

1. *Typical Automatic Identification System (AIS) on Amba 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)

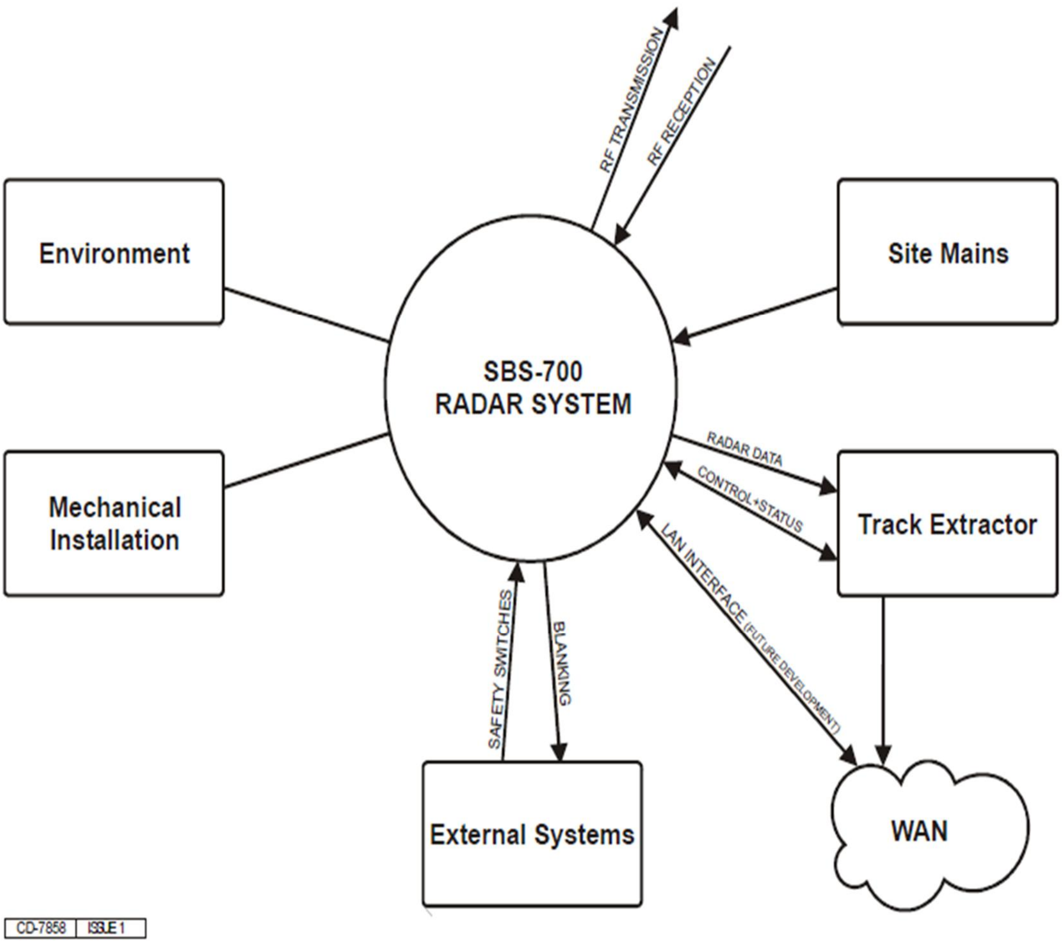
Vessels equipped with an AIS transponder broadcast their position, velocity, ships name, call sign and several other data in regular intervals on a VHF channel.

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)

RR 1
RR 2
M R 1
Mandve
Alibag
Poynad
Pen
Alibag-Pen Rd
Mumbai-Goa Rd
NH 66
AH47
88
89
91
Google Earth


RF TRANSMISSION
RF RECEPTION
Environment
Site Mains
SBS-700
RADAR SYSTEM
Mechanical
Installation
RADAR DATA
CONTROL+STATUS
Track Extractor
LAN INTERFACE (FUTURE DEVELOPMENT)
SAFETY SWITCHES
BLANKING
External Systems
WAN
CD-7858
ISSUE 1

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. 10 under the National Waterways Act 2016 and is located on Amba River in the Raigad district of Maharashtra State. It is about 45 km stretch of the Amba river beginning from Dharamtar creek in the Arabian Sea near village Revas at Lat 18°50'15"N, Lon 72°56'31"E and ending near the Bridge at Nagothane ST Stand (Approx. at Lat 18°32'20"N, Lon 73°08'0"E).

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 sea coast, 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, Vashishthi 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)

Raigad District, where the proposed waterway is located, is mainly composed of Sahyadri Hills at one side and Arabian Sea at the other side. Raigad district forms a part of Maharashtra littoral, the micro level divisions of coastal plain. It is slightly elongated in the north - south direction. Raigad has a long indented coastline. The length of the coastline is about 240 kms, with a number of creeks and inlets. 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 Raigad 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 Sahyadri Hills & Arabian Sea. The following Rivers are the important Rivers of the region:

- Amba River
- Kundalika River
- Bamangar River
- Savitri River

(Source: Brief Industrial Profile of Raigad District, MSME-Development Institute, Ministry of MSME, Government of India)

Amba River is 76 km long and originates in the Borghat hill of the Sahyadri ranges and joins the Arabian Sea in Dharamtar creek near village Revas. The total length of the river is about 76 km; major portion of the river is affected by tide (backwater effect) of the Arabian Sea. The Amba River meets the tidal wave at Nagothane. The total identified stretch of Inland Waterway of Amba River is under tidal zone. Below Nagothane, the river channel at low tide is blocked by rocky ledges. Near Dharamtar, about 14km north of Nagothane, the rocks disappear leaving a deep muddy channel, about 1.5km wide, with low swampy banks green with mangrove and other sea bushes.

The River Amba receives two streams from the right bank and two from the left, in the study stretch. Of the right bank streams, the Nigde River joins the Amba about 10 km below Nagothane, and the Vasi, a salt creek, joins it about 19 km further downstream. The tributaries from the left are the Shahapur River, which falls into the Amba about 8 km below Dharamtar, and the Revas creek, which joins the Amba at Revas, about 2 km from its entrance into Bombay harbor.

The total catchment area of Amba River is 740 sq km.

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 metres thick near the coast and which gradually thins out east wards.

In the Raigad 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: National 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.

The main types of soils found in the Raigad district are forest soils, varkas soils, rice soils, khar or salt soils, coastal alluvium and laterite soils.

(Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

9.2.5 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.

As per the land use data provided in the District Census Handbook for Raigarh district (Census 2011), For the District as a whole, 29.77 percent of the total area is cultivable. Among all the Community Development (C.D.) Blocks, Alibag has the highest percentage of cultivable area (44.83 percent) and Tala has the lowest percentage (16.13 percent). Only 9.15 percent of the cultivable area of the District is irrigated. Roha C.D. Block has the highest percentage of irrigated area to cultivable area (24.52 percent) and Mhasla has the lowest (0.94 percent). (Source: District Census Handbook: Raigarh, Series-28, Part XII-A, Directorate of Census Operations, Maharashtra, Census of India 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.

Detailed analysis of Land Use / Land cover in the project area is to be taken up as part of the EIA study to be carried out for the project by IWAI.

9.2.6 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.

With respect to air quality in Raigad region, the above mentioned Annual Report of MPCB states that Raigad region accommodates highly polluted areas like Panvel, Khopoli and also major industrial areas like Patalganga, Roha and Mahad. The ambient air quality was monitored at five industrial locations, four residential locations and one commercial location.

As per the MPCB report, there is improvement in the quality of air in Roha and Mahad locations as the levels of SPM and RSPM were found well within prescribed limits as compared to the preceding three years. Panvel city and Khopoli were found to be most polluted places in the Region.

The report states that the problem of major Air Pollution arises due to heavy traffic density near Panvel and Kamothe area. Moreover, there is typical problem of non-availability of buffer zone between the residential and the industrial zone, resulting in the said problems.

The overall ambient air quality in the project area is found to be of acceptable standards. The impact on the existing ambient air and noise quality is largely limited to the emissions due to vehicular movement. The project area has a few minor settlements and some industries with emission norms regulated by the SPCB.

Primary data on ambient air and noise quality monitoring in the project area is to be collected as a part of the EIA study to be commissioned by IWAI.

9.2.7 Ambient Water Quality

The river Amba originates from the mountains range of Sahyandri, flows through Sudhagad Taluka and ultimately meets to Dharamtar creek at Nagothane. Some industries are established on the bank of this river. However, discharge of effluents by these industries is regulated by the Maharashtra State Pollution Control Board and the Amba 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 Rewas Jetty, Mankule, Poynad, Gandhel and Nagothane. The pH value for all the five locations has been found to be over 7, which indicates the alkaline nature of water in the identified stretch of NW-10 in the Amba River.

As per the status of river water quality provided in the Annual Report (2010-11) of Maharashtra Pollution Control Board (MPCB), the rivers Patalganga, Kundlika, Amba and Savitri are of great importance for water supply to the industries as well as are the sources of ‘drinking water’.

With respect to Amba River, the report states that though there is no major industrial estate established, there are some industries present on the bank of this river. The river is a source of water supply for these industries, R.C.F. and Alibag city. The water quality of the river Patalganga along with the tributaries Balganga, Bhogeshwari and Amba has been assessed through fourteen locations. From the results it is seen that the water quality of river Patalganga seems to be improved during the year compared to last year as it is noticed that there is a reduction in the BOD levels and coliform at most of the places. However at few places there is a marginal increase in BOD level. At Shilphata and Khalapur there is a rise in Coliform.

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 two locations on Amba River. The Water Quality index (WQI) evaluated for the available data of the Amba River indicated that the water quality was good to excellent at the sample locations.

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 5 km of Amba River, which runs from Bense to Roha, has been categorized as Priority Class V which means it falls in the least polluted category.**

Central Ground Water Board (CGWB) has been monitoring the ground water quality of the Raigad 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 20 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). Accordingly, **the potability of ground water in the wells monitored in the district was found to be good.** (Source: Ground Water Information, Raigarh District, Maharashtra, Central Ground Water Board, Ministry of Water Resources, Government of India, 2013)

Primary data on water quality monitoring in the project area is to be collected as a part of the EIA study to be commissioned by IWAI.

9.2.8 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, Raigad District, where the proposed project is located, is vulnerable to floods, earthquakes, cyclones and droughts.

As per a report of National Institute of Disaster Management (NIDM) prepared for the State of Maharashtra, a number of landslides had occurred in Mumbai and Raigad districts due to heavy rains in July and August 2005 killing several people and causing loss to property. (Source: http://nidm.gov.in/PDF/DP/MAHARASHTRA.PDF)

Further analysis relating to susceptibility of the project area to natural hazards is to be taken up during the course of the EIA study to be commissioned by IWAI.

9.2.9 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)

Raigad district, where the proposed waterway is located, has a coastline of 240 km. Raigad has luxuriant growth of mangroves in Alibagh and Roha division.

In Alibagh near Dharamtar creek, density of *A. marina*, *Acanthus ilicifolius* and *Ceriops tagal* is high near the confluence of the creek and Arabian Sea, but it gradually decreases thereafter. At some places natural regeneration of *Avicennia marina* is seen.

In Roha forest division, mainly Kundalika River, Rajapuria creek, Mhasla creek, Srivardhan, Savitri River are home to luxuriant growth of mangroves. In Kundalika River, species found are *A. marina*, Ipomoea sp., *Acanthus ilicifolius*, *Sonneratia apetala Pongamia pinata* etc. In Rajapuria creek more than 50 % of the area is covered with *R. mucronata*. Other species are *Avicennia officinalis*, *Avicennia marina*, *Acanthus ilicifolius*, *Excoecaria agallocha* and *Ipomoea* sp. Species found in the Mandad river area are *Rhizophora sp.*, *Ceriops tagal*, *Avicennia sp*., *Sonneratia apetala*, *Excoecaria agallocha*, *Aegiceras corniculatum* etc. *Acacia* is also seen in this area. In Mhasla creek mangrove species are scattered and show poor growth. Here, species encountered are *Sonneratia alba* and *Avicennia sp*.

Srivardhan area is dominated mostly by *Sonneratia alba*. Height of these plants varies from 20-25 ft. Other dominating species are *Rhizophora mucronata*, *Rhizophora apiculata*, *Ceriops tagal*, *Avicennia alba* and *Bruguiera gymnorrhiza*. Root suckers are observed around the roots of *Sonnerartia alba*.

Along the banks of Savitri river very narrow strips of mangroves are seen. Density of these mangroves is between 40-70 %. Species found are Sonneratia apetala, which dominates about 70 % of the area, followed by Avicennia marina and Rhizophora sp. Height of the Sonneratia apetala trees is about 20- 30 ft. Density of mangroves in this area is high due to inaccessibility to the place. (Source: Coastal Zones of India, Space Application Centre, ISRO, Ahmedabad, sponsored by the Ministry of Environment and Forests, Government of India, 2012)

Mangroves are also present along the Amba River on both banks.

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 NW-10 project area falls under the tidal zone. Accordingly, the proposed project will require clearance **under the CRZ Notification 2011.**

9.2.10 Archaeological and Heritage Locations

No structures of archaeological, cultural or historical importance will 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 1-4 below.

Table 9-1: Protected Monuments in Raigad District, Maharashtra

S.No.	Name of Monument / Site	Location	District
1.	Songad (Songiri)	Achloli	Raigad
2.	Cathedral	Agarkot	Raigad
3.	Chaukoni-Castle or factory of Cheul	Agarkot	Raigad
4.	Church & Convent of the Augustinians	Agarkot	Raigad
5.	Dominican Church & Convent	Agarkot	Raigad

S.No.	Name of Monument / Site	Location	District
6.	Jesuit Church & Convent	Agarkot	Raigad
7.	Kothi	Agarkot	Raigad
8.	One Buruj	Agarkot	Raigad
9.	St. Francis Xavier's Chapel	Agarkot	Raigad
10.	Satkhani Buruj	Agarkot	Raigad
11.	Two Gates-Potra DA Mar & Potra DA Terra	Agarkot	Raigad
12.	HiraKota old Fort	Agarkot	Raigad
13.	Kolaba Fort Containing i) Manik Chawada, ii) Nanisahibn's palace iii)North Causeway, iv) Padmavati shrine v) Reservoir Apsaras, vi) Sarja Kot vii) Shrine of Bhawani, viii) Shrine of Maruti ix) Shrine of Yashvantadari x) South causeway xi) Talghar xii) Temple of Bopdeo xiii) Temple of anpati-pen-Chyaten xiv) Temple of Gulabai or Mahtshuri xv) Temple of Kanoba xvi) Temple of Mahadev xvii) Thorle wada xviii) Tomb of a Mahammadan saint.	Alibag	Raigad
14.	Cave	Ambivli	Raigad
15.	Birwadi Fort	Birwadi	Raigad
16.	Barber's Mahal	Cheul	Raigad
17.	Dadar (Stair Case)	Cheul	Raigad
18.	Kaman(Arch)	Cheul	Raigad
19.	Mosque	Cheul	Raigad
20.	Rajkot	Cheul	Raigad
21.	Tomb of Angre	Cheul	Raigad
22.	Wada of Dancing Girls	Cheul	Raigad
23.	Chandragad	Dhavala	Raigad
24.	Elephanta Caves	Gharapuri	Raigad
25.	Ghereagad or Surgad Fort	Ghera Surgad	Raigad
26.	Ghosalgad Fort	Ghosale	Raigad

S.No.	Name of Monument / Site	Location	District
27.	Old Fort containing a temple of the God Kangormel & Two tanks	Kadasari Kangori	Raigad
28.	Buddhist Caves	Gomashi	Raigad
29.	A percipitious hill near Raigad Fort Containing one rock-cut cistern of water. It was formerly used as a jail for prisoners.	Kadasari Lingana	Raigad
30.	Kol Caves	Kol	Raigad
31.	Caves in Survey No. 49 & No. 50	Kol	Raigad
32.	Kondane Caves	Kondane	Raigad
33.	Korlai Fort	Korlai	Raigad
34.	Avchitgad	Medhe	Raigad
35.	Kuda Caves	Kuda	Raigad
36.	Kasa (Kamsa) fort	Murud	Raigad
37.	Thanala Caves	Nadsur	Raigad
38.	Nagothane Bridge	Nagothane	Raigad
39.	Khadsambla Caves	Nenavali	Raigad
40.	Jijamata's Samadhi consisting of four Towers	Pachad	Raigad
41.	Jijamata's Wada comprising four dilapated houses & three wells surrounded by a stone wall.	Pachad	Raigad
42.	Caves	Pale	Raigad
43.	Caves near the Kotali Fort	Peth	Raigad
44.	Kotali Fort with two iron guns and one bronze gun	Peth	Raigad
45.	Janjira Fort	Rajapuri	Raigad
46.	Tombs at Kholkar Najik Ghumaj (Khokeri Ghumaj)	Rajapuri	Raigad
47.	Fort of Raigad	Raigad	Raigad
48.	Tala Fort	Tala	Raigad
49.	Ancient bricks stupa at Elephanta Island	Gharapuri	Raigad

S.No.	Name of Monument / Site	Location	District
50.	Kondane Caves	Khapoli	Raigad

Source: http://www.asimumbaicircle.com/images/list-of-protected-monuments-n-forts.pdf

9.2.11 Flora and Fauna

Flora

The Sahyadri Hills and Valleys are full of rainforest. The forest has Ain (*Terminalia crenulata*), Mango (*Mangifera indica*), Apta (*Bahunia racemosa*) , Ashok (*Saraca indica*), Babhul (*Acacia Arabica*), Behda (*Terminalia bellerica*), Nimb (*Azadirachta indica*), Chandan (*Santalum album*), Dhavda (*Anogeissus latifolius*), Palas (*Butea manosperma*), Khair (*Acacia catechu*), Banian tree (*Ficus benghalensis*), Bamboo (*Bambusa bambos*), Teak tree (*Tectona grandis*), Kusum (*Scbleichera oleosa*), Hed (*Haldina cordifolia*) and several other palnt species. 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)

Mangroves are found to be located on both banks of the Amba 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.

Fauna

With a coastline of about 240 kms, Raigad is one of the most important maritime districts of the Maharashtra state. Fishing ranks only next to agriculture as a means of livelihood. The fishing industry is mainly dependent upon the exploitation of marine resources. The fishing seasons commence from September and lasts till the end of May. There is practically no fishing activity in the monsoon season, except in the creeks, lakes and rivers. Mora, Karnaja, Revas, Mandwa, Alibag, Revdanda, Rajpuri, Dighi and Bagmandala are important fishing ports in the district. (Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

Large number of species of fishes are found in Arabian Sea and creeks such as Silver Pomfret (*Stromateus argenteus*), Sea Bass (*Lates calcorifer*), Gold Spotted Anchovy (*Coilia dussumieri*), Mackrel (*Rastrelliger kanagurta*), Bombay Duck (*Harpadon nehereus*), Little Tuna (*Euthynus affinis*), Ribbon Fish (*Lepturacanthus savala*), Dhoma (*Sciaena dussumierii*), Seer Fish (*Scomberomorus guttatus*), Silver bar (*Chirocentrus dorab*), Sepia (*Sepia offcinalis*), Mud Crab (*Scylla serratta*), 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)

9.2.12 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)

Raigad District, where the project is located, is fairly rich in Forest Areas. The district has a forest cover of 1486.94 sq. kms, out of which 79.17 per cent forest is a reserved forest, 10.60 per cent is protected forest and 10.17 per cent is unclassified forest. Out of the total 96.55 per cent forest is under the forest department and remaining under the revenue department. (Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

The Sahyadri Hills and Valleys are full of rainforest. The forest has Ain (*Terminalia crenulata*), Mango (*Mangifera indica*), Apta (*Bahunia racemosa*) , Ashok (*Saraca indica*), Babhul (*Acacia Arabica*), Behda (*Terminalia bellerica*), Nimb (*Azadirachta indica*), Chandan (*Santalum album*), Dhavda (*Anogeissus latifolius*), Palas (*Butea manosperma*), Khair (*Acacia catechu*), Banian tree (*Ficus benghalensis*), Bamboo (*Bambusa bambos*), Teak tree (*Tectona grandis*), Kusum (*Scbleichera oleosa*), Hed (*Haldina cordifolia*) and several other palnt species. The forest department has recorded more than 300 bushes / plants in the district which have medicinal properties.

There are six National Parks, 47 Wildlife 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. (Source: Economic Survey of Maharashtra, 2014-15, Directorate of Economics and Statistics, Planning Department, Government of Maharashtra, Mumbai)

Phansad Wildlife Sanctuary is situated in the Raigad District of Maharashtra between 72^0 54' to 73^0 02' North latitude and between 18^0 20' to 18^0 22' East longitude and is spread over an area of 69.79 sq km. It was declared as a Wildlife sanctuary in 1986.

Karnala Bird Sanctuary (18°53'N and 73°7'E) is situated in Panvel taluka of Raigad district and is about 60 km from Mumbai on the Mumbai-Goa Highway (NH-17), with an elevation range of approximately 20 mts to 450 mts. It was declared as a sanctuary in 1968 with an area of 4.48 sq.km. In 1975 the area was increased to 12.11 sq.km (or 1,211 hectares). Situated in the Biogeographic province of Malabar Plains Region the Sanctuary is part of one of the spurs of the Northern Sahyadri Range in the Western Ghats. The highest point of the sanctuary is the Karnala Fort at 450 mts. (Source: Raju Kasambe and Asif Khan, Checklist of birds of Karnala Bird Sanctuary, District Raigad, Maharashtra, Newsletter for Birdwatchers 55(2) 2015)

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 or their Eco-Sensitive Zones.**

9.2.13 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.

Raigad district, where the proposed waterway is located, is included in the Konkan division. Raigad district is one of the four coastal districts situated along the western coast of the State and is located between north latitude 17°51'00" and 19°08'00" and east longitudes 72°50'00" and 73°40'00". It is bounded by Thane district in the north, Ratnagiri district in the south, Pune district in the east and Arabian Sea forms the western boundary having a length of about 250 km.

Alibag is the District Headquarters of Raigad District. Alibag is situated on western coast of India and on the shores of the Arabian Sea.

Raigad district presently consist of 42 towns and 1909 villages spread over 15 tahsils namely Alibag, Murud, Panvel, Uran, Mangaon, Tala, Mahad, Poladpur, Pen, Karjat, Khalapur, Roha, Sudhagad, Shriwardhan and Mhasala.

The total geographical area of Raigad district is 7152 sq km. For administrative purposes the district is divided into 8 sub divisions viz., Alibag, Panvel, Mangaon, Mahad, Pen, Karjat, Roha and Shriwardhan.

Alibag sub-division includes Alibag and Murud tahsils; Panvel sub-division includes Panvel and Uran; Mangaon sub-division includes Mangaon and Tala; Mahad sub-division includes Mahad and Poladpur; Pen has one Tahsil namely Pen; Khalapur and Karjat tahsils are included in Karjat Sub-division; Roha sub-division has Roha and Sudhagad tahsils; and Shriwardhan sub-division has Shriwardhan and Mhasala tahsils.

Details of Sub-Divisions, Tahasils, Villages, Circles and Sazzas in Raigad district are provided in Table below.

Table 9-2: Details of Sub-Divisions, Tahasils, Villages, Circles and Sazzas in Raigad District

Sr. No	Name of Sub-Division	Name of Tahasil	No. of Villages	No. of Circles	No. of Sazzas
1.	*Alibag*	*Alibag*	218	7	44
		Murud	74	3	14
		2	292	10	58

Sr. No	Name of Sub-Division	Name of Tahasil	No. of Villages	No. of Circles	No. of Sazzas
	Total Talukas in Sub-division				
2.	*Panvel*	*Panvel*	178	6	35
		Uran	62	3	17
	Total Talukas in Sub-division	2	240	9	52
3.	*Mangaon*	*Mangaon*	187	5	31
		Tala	61	2	8
	Total Talukas in Sub-division	2	248	7	39
4.	*Mahad*	*Mahad*	183	6	36
		Poladpur	87	3	14
	Total Talukas in Sub-division	2	270	9	50
5.	*Pen*	*Pen*	171	5	30
	Total Talukas in Sub-division	1	171	5	30
6.	*Karjat*	*Karjat*	185	5	28
		Khalapur	141	3	20
	TotalTalukas in Sub-division	2	326	8	48
7.	*Roha*	*Roha*	162	4	26
		Sudhagad	99	3	15
	Total Talukas in Subdivision	2	261	7	41
8.	*Shriwardhan*	*Shriwardhan*	78	3	18
		Mhasala	84	2	14
	Total Talukas in Sub-division	2	162	5	32
District Total	8	15	1970	60	350

Source: http://raigad.nic.in

The District Collector along with the District Judge, Superintendent of Police, Chief Executive Officers of the State Government looks 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.

In 2011, Raigad had a population of 2,634,200 comprising 1,344,345 males and 1,289,855 females respectively. There was a change of 19.31 percent in the population in 2011 compared to population as per 2001. In the previous census of India 2001, Raigad District recorded increase of 20.99 percent to its population compared to 1991. Scheduled Castes (SCs) and Scheduled Tribes (STs) constitute 5.1% and 11.6% respectively of the total population of the State.

District Highlights – 2011 Census

· Raigad is the coastal district of Maharashtra. There are many small ports on the seashore of the district. Nhava-Sheva is famous international port located at Uran.

· Rasayani is the main industrial centre developed with large scale public and private limited industries.

· That Vayshef is famous for fertilizer plants.

· The 125 years old famous observatory is located in Alibag.

· Pen town is famous for manufacturing of Ganesh idols in Maharashtra. Thousands of Ganesh idols are manufactured every year in this town.

· Raigad fort, the capital of Shivaji Maharaj's Kingdom is located near Mahad, where Samadhi of Shivaji Maharaj is existed.

· 'Harihareshwar' in Shrivardhan tahsil is famous for old Shiv Mandir. It is known as south kashi.

· The famous Ashtavinaya kamandir, Shri Ballaleshwar temple is located at Pali on Nagothane Khopoli Road in Sudhagad tahsil and Shri Varadvinayak temple is at Mahad village in Khalapur tahsil.

· Elephanta caves in Uran tahsil are tourists' main attractions. Hundreds of people visit these caves daily.

· Matheran, the hill station of tourists' attractions is located in this district.

· There are 49 uninhabited villages in the district.

· Alibagtahsil is having the highest number of villages (212) in the district.

· Raigad district has higher sex ratio (959) compared to the state (929).

· Choul Village in Alibag C.D. Block is the most populated (9894 persons) and Palambe village in Alibag C.D. Block is the least populated (2 persons).

Source: District Census Handbook: Raigad, Census of India -Series-28, Part XII-B, Directorate Of Census Operations, Maharashtra, 2011.

Rice (*Orzya sativa*) is an important crop in the Raigad district. Other important crops that are grown in the district include common millet – Vari (*Panicum miliaccum*), finger millet- Nagli (*Eleusine coracana*), carpet legume – Val (*Dolichos lablab*), spiked dolichos- Pavta (*Dolichos lablab L*), pigeon pea – Tur (*Cajanus cajan*), cow pea – Chavali (*Vigna catjang*), horse gram – Kulth (*Marcotyloma uniflorum*). In the coastal soil, crops like coconut (*Cocos nucifera*), areca nut – Supari (*Areca catechu*), mango (*Mangifera indica*), cashew nut (*Anacardium occidentale*), jackfruit (*Artocarpus heterophyllus*), sapota / chickoo (*Achras zapota L*), kokum (*Garcinia indica*) and watermelon (*Citrullus vulgaris)* etc. are grown. (Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/6703/7/07_chapter%202.pdf)

With a coastline of about 240 kms, Raigad is one of the most important maritime districts of the Maharashtra state. Fishing is next to agriculture as a means of livelihood. The fishing industry is mainly dependent upon the exploitation of marine resources. The fishing season commences from September and lasts till the end of May. There is practically no fishing activity in the monsoon season, except in the creeks, lakes and rivers. Mora, Karnaja, Revas, Mandwa, Alibag, Revdanda, Rajpuri, Dighi and Bagmandala are important fishing ports in the district.

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 15 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 present DPR recommends development of NW-10 in two phases – Phase 1 and Phase 2.

Phase 1 envisages development of the initial stretch from Ch. 0.00 km to Ch. 19.64 km with the limited activities out of the total stretch of approximately 45 km designated as NW-10.

Phase 2 comprising the remaining activities in the initial stretch of NW-10 and suggested the development of balance stretch, proposed to be developed in future if and when the traffic demand arises.

Potential Environmental and Social Impacts in Phase 1

The construction activities as proposed for Phase 1 development are as follows:

i. Dredging of the river in the proposed waterway stretch – Yes
ii. Construction of terminal buildings - No
iii. Construction of access roads - No
iv. Bank protection works - No
v. Installation of Navigational Lights - Yes

Phase 1, thus, does not require any terminal construction, 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 Phase 1.

The proposed construction period is of three years. In general, the construction phase will involve mobilization of manpower and equipment at site, movement of vehicles, and use of existing water resources and use of DG sets for construction power.

The estimated quantity of dredged material in Phase 1 is 34 Lakhs Cu. M. All the dredged material is proposed to be disposed of within the flood banks of the river. As such there is no impact on the land environment due to dumping of dredged material.

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.

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.

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 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 Phase 2

The construction activities as proposed for Phase 2 development are as follows:

i. Construction of terminal buildings – Yes, one terminal near PNP Terminal

ii. Construction of access roads – Yes, 7.5 wide road for a length of 4.77 km

iii. Bank protection works – Yes, at 4 locations comprising a total length of approximately 2 km (in Lower Reahes)

iv. Dredging of the river in the proposed waterway stretch – Yes

v. Installation of navigational lights - Yes

Phase 2, 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.

In general, the construction phase will involve mobilization of manpower and equipment at site, movement of vehicles, and use of existing water resources and use of DG sets for construction power.

The estimated quantity of dredged material in Phase 2 is 7.35 Lakhs Cu. M. All the dredged material is proposed to be disposed of within the flood banks of the river. As such there is no impact on the land environment due to dumping of dredged material.

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.

Limited land use change will occur due to the construction of terminal facility for the operation of the proposed waterway. 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. 3.3 ha of land is estimated to be required for terminal construction. The land identified for terminal construction is located near Ch 19 km and is of Govt. Land.

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.

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 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.

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, 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. As such the project shall require obtaining clearance under the CRZ Notification 2011.

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 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.

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).

ii. 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 upto 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.

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 Amba River along the NW-10 stretch, no Forest Clearance on this account is required to be obtained for the project as envisaged for development in Phase 1, which is the recommended stretch for development.

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. 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 for the suggested stretch for development, 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 9-3 below.

Table 9-3: 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-10 for the recommended stretch from Ch 0.00 km to Ch 19.64 km.
3.	Wildlife Clearance	NO	Wildlife Protection Act, 1972	No part of the project falls either within the boundary of any of the

S. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
				protected areas or within their eco-sensitive zones.
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, who shall conduct rapid EIA & SIA studies and shall prepare a stand-alone EMMP (EMP & EMoP) for inclusion in the contractor bid documents. The generation of environmental baseline data at pre-construction stage along with environmental monitoring during construction and operation stages shall be carried out by the NABL/ MoEF&CC approved laboratory to assess the project performance during entire project cycle.

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 9-4: 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 – 9-5).**
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 9-5

Table 9-5: 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
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 9-6: 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 9-7: 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:*** TSS, Alkalinity, Hardness, BOD, COD, NO3, PO4, Cl, SO4, Na, K, Ca, Mg, Silica, Oil & grease, Phenolic compounds, Residual	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)
		Sodium Carbonate. ***Bacteriological Properties:*** Total Coliform.					
3.	Noise Quality monitoring	Day & 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 (Benthos, Macro-benthos), Fish and Macrophytes, Shanon Weiner Diversity Index.	One time study at this stage.		4X3 = 12	25,000	300,000
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 9-8: 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 9-5 given above for pre-construction

Sl. No.	Particulars of Estimated Budget	Cost (Rs. Lakhs)	Remark (if any)
			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 9-9 given below:

Table 9-9: Summary of Estimated Environmental & Social Costs for various Stages

Sl. No.	Project Stages	Cost (Rs.)	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 Rs. 111.00 Lakhs

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;

I 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. 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. There should be a powerful Tug and 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 Tugs ; 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. 25 % extra for statutory allowances and 20 % extra for perks have been taken into consideration.
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	
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. Tugs (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 Amba 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 Amba River is being used extensively with good IWT mobility, which can be considered as the maximum utility in the West Coast Rivers. The same is being used by M/s JSW with the mobility to their captive port in Dharamtar on the right side, whereas M/s PNP with the mobility to their captive port in Dharamtar on the Left side. Based on the traffic studies, there is an estimated cargo in Bulk / Break Bulk and Ro-Ro apart from the captive cargo, which may have to be considered at a newly identified terminal location just downstream of M/s PNP on the left side.

It has been proposed the implementation in 2 Phases i.e., Phase 1 & Phase 2. Accordingly, the costing has been segregated into

1. Development of Fairway up to Ch. 19.64 km to support the captive cargo being moved by M/s JSW and M/s PNP in Phase 1.
2. Development of Lo-Lo facility in the proposed IWAI Terminal with 80 % of the common facilities in Phase 2.
3. Development of Ro-Ro facility in the proposed IWAI Terminal with 20 % of the common facilities in Phase 2.
4. Development of Fairway from Ch. 19.64 km to Ch. 44.971 km in Phase 2. Including a part in Phase 1)

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 Amba Fairway Development for Captive Terminal Operations (Phase 1)

S.No.	Item Description	Amount (INR in Lakhs)	Schedule
A	**Fairway**		
1	Dredging		
(i)	General Soil	9180.00	**3 yrs in Phase 1**
(ii)	Hard Soil	6120.00	**3 yrs in Phase 1**
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		**3 Yrs in Phase 2 from 2025**
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	193.13	**3 yrs in Phase 1**
(ii)	Shore Marking with Lattice Bridge & Lighting Equipments	98.27	**1 yr in Phase 1**
5	Land Acquisition	0.00	
	Sub-total (A)	**15591.40**	
B	**Modification of Structures**		

S.No.	Item Description	Amount (INR in Lakhs)	Schedule
(i)	Bridges	0.00	
(ii)	Cables	0.00	
(iii)	Dams & Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others (Pipe Lines)	0.00	
	Sub-total (B)	**0.00**	
C	**Communication System**		
(i)	RIS Centre	1089.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys (Nominal provision considered)	0.00	
	Sub-total (C)	**1089.00**	
D	**Institutional Requirement**		
(i)	Office Development Cost	405.00	
	Sub-total (D)	**405.00**	**3 yrs in Phase 1**
	Sub-total (A)+(B)+(C)+(D)	**17085.40**	
E	Environmental Management Plan Cost@5% of Prime cost	**854.27**	**3 yrs in Phase 1**
F	Project Management & consultancy Charges @10% of Prime cost	**1708.54**	**3 yrs in Phase 1**
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	**1708.54**	**3 yrs in Phase 1**
	Project total Hard Cost	**21356.75**	
		213.57	**Crores**

TABLE 11-2: Abstract of Cost for Amba Fairway Development (Phase 2)

S.No.	Item Description	Amount (INR in Lakhs)	Schedule
A	**Fairway**		
1	Dredging		
(i)	General Soil (Upper Reaches)	1980.00	**3 Yrs in Phase 2 from 2025**
(ii)	Hard Soil (Upper Reaches)	1350.00	**3 Yrs in Phase 2 from 2025**
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 (Lower Reaches)	2464.37	**3 Yrs in Phase 2 from 2025**
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments (Upper Reaches)	231.75	**3 Yrs in Phase 2 from 2025**
(ii)	Shore Marking with Latiice Bridge & Lighting Equipments (Upper Reaches)	117.93	**1 yr in Phase 2 from 2025**
5	Land Acquisition	0.00	
	Sub-total (A)	6144.05	
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	

S.No.	Item Description	Amount (INR in Lakhs)	Schedule
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys (Nominal provision considered)	0.00	
	Sub-total (C)	0.00	
D	**Institutional Requirement**		
(i)	Office Development Cost		
	Sub-total (D)	0.00	
	Sub-total (A)+(B)+(C)+(D)	6144.05	
E	Environmental Management Plan Cost@5% of Prime cost	307.20	**3 Yrs in Phase 2 from 2025**
F	Project Management & consultancy Charges @10% of Prime cost	614.40	**3 Yrs in Phase 2 from 2025**
G	Contingencies and Unforeseen Items of Works@10% of Prime cost	614.40	**3 Yrs in Phase 2 from 2025**
	Project total Hard Cost	**7680.05**	
		76.80	**Crores**

The Lo-Lo facility requirement has been worked out and placed herewith.

TABLE 11-3: Abstract of Cost for Amba LOLO Facility

(Phase 2)

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
A	**Terminals**		
(i)	Land	657.36	
(ii)	Riverine Components	1512.15	
(iii)	Infrastructure Components including internal roads	1710.66	
(iv)	Approach Road Cost	14.80	
(v)	Bank Protection Works for terminal	492.87	
	Sub-total (A)	**4387.84**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Cargo Handling Equipments**		
(i)	Ambulance - 1 no.	10	

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
(ii)	Dumper Trucks 16 T Capacity - 0 no.	0	
(iii)	Cranes with 125 T Capacity - 4 no.	800	
(iv)	Fork lift trucks 20 T Capacity - 2 no.	96	
	Sub-total (C)	**906.00**	
	Sub-total (A)+(B)+(C)	**5293.84**	
D	Environmental Management Plan Cost@5% of Prime cost	264.69	
E	Project Management & consultancy Charges @10% of Prime cost	529.38	
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	529.38	
	Project total Hard Cost	**6617.30**	**3 Yrs from 2025**
		66.17	Crores

The Ro-Ro facility requirement has been worked out and placed herewith.

TABLE 11-4: Abstract of Cost for Amba RORO Facility

(in Phase 2)

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
A	**Terminal**		
(i)	Land	164.34	
(ii)	Riverine Components	486.28	
(iii)	Infrastructure Components including internal roads	427.66	
(iv)	Approach Road (External) Cost	3.70	
(v)	Bank Protection Works for terminal	123.22	
	Sub-total (A)	**1205.20**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Cargo Handling Equipments**		
(i)	Ambulance - 1 no.	0	
(ii)	Dumper Trucks 16 T Capacity - 1 no.	0	
(iii)	Cranes with 50 T Capacity - 1 no.	0	

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
(iv)	Fork lift trucks 20 T Capacity - 1 no.	0	
	Sub-total (C)	**0.00**	
	Sub-total (A)+(B)+(C)	**1205.20**	
D	Environmental Management Plan Cost@5% of Prime cost	60.26	
E	Project Management & consultancy Charges @10% of Prime cost	120.52	
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	120.52	
	Project total Hard Cost	**1506.50**	**3yrs from 2025**
		15.07	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 i.e., the fairway development up to 19.64 kms to facilitate the existing stake holder for early increase of IWT cargo. The Phase 2 development is to be considered at 2025 after careful analysis and growth trend observation. The development of fairway will be completed in 3 Years (36 months) of Phase 1.

Development of Lo-Lo and Ro-Ro will accordingly be considered and also taking in to possible cargo mobility in the upper reaches. As such, Phase 2 is not recommended at this point of time.

CHAPTER 12: IMPLEMENTATION SCHEDULE

12.1. Time Frame

Developmental activities on Amba River has been segregated into 2 Phases also with the segregation of 2 stretches 0 km to 19.64 km and 19.64 km to 44.971 km. Cargo mobility has not been observed in the upper reaches, hence not recommended. Further, the initial stretch will facilitate the growth trend in cargo.

In view of the above, the phase 1 will be implemented upto 2020 / initial 3 years and the growth trend will be observed upto 2025. Implementation of phase 2 will be decided on confirmations after having meticulous micro level analysis. The Time Frame for the development of river Amba in phase 1 is being considered with the target completion in 36 Months / by 2020.

In order to facilitate the ongoing IWT Traffic of M/s JSW and M/s PNP, in the Fairway development in Phase 1, the activities of Dredging; Shore Beacons with Light / Buoy and Light and River Information System have been considered along with Institutional Requirements and with Environmental Management Plan (EMP). With the development of fairway, the revenue collection can be considered for the traffic with possible expandable traffic by M/s JSW and M/s PNP. The Implementation Schedule in Pictorial form is placed at Annexure 12.1.

The Phase 2 is to be considered in 2025 after carefully observing the growth trend and with assessment of viability. Investment decision, if found feasible, then it is proposed to develop 1 Lo-Lo Jetty Terminal and 1 Ro-Ro Jetty terminal to facilitate the mobility of the identified IWT divertible Traffic, which is proposed for development in 36 months. The Implementation Schedule in Pictorial form is placed at Annexure 12.2.

12.2. Phasing

The fairway development of initial stretch is in 36 months. (Phase 1)

The fairway development of end stretch is in 36 months. (Phase 2)

Lo-Lo Terminal development in 36 months (Phase 2) and Ro-Ro Terminal development in 36 months (Phase 2), which are to be taken up simultaneously. The Vessel requirements 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

The table below depicts the development & operational period of Amba River.

Table 13-1: Amba River Development in Phases

Sub-sector	2018	2020	2025	2027	2040
Fairway - Phase 1	Development				
		Operational			
Fairway - Phase 2			Development		
				Operational	
Lo-Lo			Construction		
				Operational	
Ro-Ro			Construction		
				Operational	

Source: Tractebel; Consultant

The plan is to develop the fairway in 2 phases, while the two terminals, viz. (Lo-Lo and Ro-Ro) will be developed in one phase, but post 2025. An observation period between 2020-2025 will be used to evaluate the market and to arrive at the decision of going ahead with Phase 2 development of the fairway. In the event the market is not conducive for fairway expansion, Phase 1 operational status quo will be maintained. Operations at each of these sub-sector projects are expected to commence in the last year of its construction period. So, fairway should start generating revenue from FY20 in Phase 1 and FY27 in Phase 2. Similarly, Lo-Lo and Ro-Ro Terminal are expected to commence operation by FY27.

Under Phase 2 development plan for fairway, it was envisaged that the river stretch would be extended beyond the stretch limit earmarked for Phase 1 i.e 20kms. However, traffic has not been identified for the additional stretch envisioned under Phase 2 fairway development. This negates the need for making investment towards the development, which further removes the need to conduct standalone financial analysis for Phase 2 fairway operation. In view of this, fairway on Amba will be developed based on the investment allocated in Phase 1, and the fairway will be conducting business as usual well beyond FY25 and up till the projected period of FY40. Therefore, the financial analysis to follow for fairway will be made up of only the investment and other parameters assigned under Phase 1.

Proposed IWT route involves multiple cargohandling, this adds to the total logistic cost involved in transportation. Total time and cost involved in this multimodal transportation is more as compared to roadway. An elaboration on the impact on overall logistics cost difference is depicted in the logistics cost comparison chart between the two modes in the following figure**Error! Reference source not found.**.

Ro-Ro/Trade Cost Dynamics

Origin	Destination on NW	Final Destination
JNPT	IWAI (PNP)	Khopoli

Ro-Ro Cost Dynamics

Steps involved	Unit	Case I	Case II
Engine	kW	1790	350
Engine fuel requirement	l/hr	420	102
Per Truck Ro-Ro Tariff	INR/Truck	18,617	11,366
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**18,759**	**11,508**

Truck Cost Dynamics

Components	Cost (Rs.)	Cost
Fuel	INR	1,303
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**2,548**

FIGURE 13-1 Logistic Cost Comparison

As per Case I (higher engine power 1,790 kW), the logistics cost difference for roadway and waterway is INR 16,211/truck. Cost of transporting per truck on the waterway with the said engine configuration would be nearlyeight times as expensive as roadway. In Case II (Lower engine power 350 KW), this cost difference is narrower with INR 8,960/truck. This logistic assessment clearly indicates the unviability of operating a Ro-Ro Terminal on the River. This terminal has been considered only as a suggestion here, against the final advisory of the Consultant of not going ahead with this development.

While in case of Lo-Lo, logistics cost to transport by roadways is higher compare to waterways. In spite of multiple handling, cargo transportation using waterways is much cheaper. Therefore consultant has proposed to develop a terminal for handling iron & steel. The table below shows the detailed calculation of transportation cost and their comparison between proposed route and roadways.

Table 13-2: Logistic cost comparison for Lo-Lo

Particulars	INR/20 Ton	
	Propelled Barge +Road	Road
Total Handling cost at MbPT	1,600	1,100
Voyage cost MbPT to Proposed terminal (IWAI)	1,800	-
Cost of handling & storage	2,400	-
Road Transport cost Proposed Terminal(IWAI) to Khopoli	5,500	-
Road Transport cost MbPT to Khopoli	-	12,500
Transportation from MbPT to Khopoli	11,300	13,600
Total	22,600	27,200

13.1. Input Sheet

The following table lists all the assumptions and input values used in the financial modeling of Amba River. This includes financial analysis for the navigation infrastructure (both fairways), terminal operations (both the Ro-Ro terminals), and barging (vessel chartering):

Table 13-3: Input Sheet for Amba River project

Description	Unit	Fairway	Ro-Ro	Lo-Lo
Loan Tenure	Years	10	10	10
Moratorium Period (Years Construction)	Years	3	3	3
Rate of Interest	Annual	11%	11%	11%
Corporate Tax	Annual	30%	30%	30%
Royalty to MMB	INR/Tonne		20	20
Revenue Share	Annual	4%	4%	4%
Cargo Revenue Escalation	Annual	6%	6%	6%
Other Revenue Escalation	Annual		6%	6%
Administrative Cost	of Revenue	3%	2%	2%
Manpower Cost Escalation	Annual	5%	5%	5%
Cargo Costs Escalation	Annual	5%		
Other Costs Escalation	Annual		6%	6%
Fairway Chainage	km	20		
Chainage (from JNPT)	Km		47	
Chainage (from MbPT)	Km			36
Tariff for Revenue Calculation				
Various Revenue Sources	**Unit**	**Fairway**	**Ro-Ro**	**Lo-Lo**
Fairway Cost				

Movement of vessel	GRT/km	0.37		
Charges for Handling Ro-Ro Trucks				
Vessel Berthing Charges	Per vessel/Day		1,000	
Vehicle Unloading Charges	Per Truck		37	
Charges of Handling Coal				
Vessel Berthing Charges	Per GRT			1,000
Vehicle Unloading Charges	Per Ton			76
Charges of Handling Iron & Steel				
Vessel Berthing Charges	Per GRT			1,000
Vehicle Unloading Charges	Per Ton			76
Revenue prospects from Ancillary Activity				
Truck Parking Charges	Per Day		100	100
Weigh Bridge Charges	Per Truck		200	200
Leasing Space Coffee Shops	Per Day		500	500
Lease space for Rest/Retiring	Rs/Day/Truck		70.2	70.2

Operation & Maintenance

Description	Unit	Fairway	Ro-Ro	Lo-Lo
Civil Infrastructure	Cost		1%	1%
Dredging	Cost	10%		
Ship Operating Cost	Cost			
Utilities	Cost	5%	5%	5%
Machinery Infrastructure	Cost		5%	5%
IT & Other Soft Factors	Cost	5%	5%	5%
Insurance Cost	Capex Mechanical	1%	1%	1%

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	Tractebel
Value of economic loss due to road accidents	Rs Lakhs Crores	3.7623	Tractebel
Total Road network in India	Lakh KM	0.4865	Tractebel
Safety Index (IWT as base)	times safer than road	50	Tractebel
	times safer than rail	5	Tractebel
Accidental Loss			
Road	Rs Lakhs/KM	7.73	Tractebel
Rail	Rs Lakhs/KM	-	Tractebel
IWT	Rs Lakhs/KM	0.15	Tractebel
Fuel Cost (1 liter of fuel moves)			
Road	t-km	24.00	Tractebel
Rail	t-km	-	Tractebel

IWT	t-km	105.00	
Total Cargo	Million Ton	16.48	
Total Distance	KM	Fairway – 2x20; Ro-Ro 2x36 Lo-Lo & Vessel – 2 x 47	
Fuel price	Rs/Litre	75.00	
Vehicular Operating Cost (Lo-Lo/Ro-Ro/Fairway)			
Road	Rs/t-km	2.58	Tractebel
Rail	Rs/t-km	-	
IWT	Rs/t-km	1.06	
Direct Employment Creation			
Road	Per Million t-km	20	Tractebel
Rail	Per Million t-km	-	
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	-	
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. 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 36km is from the Ro-Ro Terminal near PNP Port to MbPT Anchorage and 47km between Ro-Ro terminal and JNPT. In case of fairway revenue calculations, only one-way trip is considered, i.e.20 km. In EIRR, round-trip distance is considered in each project sub-sector's economic viability evaluation.

The Consultant has made its recommendation in regard to Ro-Ro Terminal in the Traffic Study documented in Chapter 4. Working on the same premise, the financial model for Ro-Ro Terminal is as a mere suggestion only. The conditions needed for the terminal to become viable still stand, and a healthy IRR for the terminal here will be immaterial to the final advisory already disbursed in Chapter 4.

13.2. Revenue

Revenue for the cumulative stretch of Amba River will be generated from the core operations, which include utilization of the fairways by existing and potential users, operations at the Ro-Ro and Lo-Lo terminals, and vessel chartering. 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 Amba River are presented in the table below:

Table 13-4: Revenue for Amba River (INR Lakhs)

Revenue Source	FY18	FY20	FY25	FY30	FY35	FY40
Fairway	-	2,415	5,215	7,898	10,634	13,196
Lo-Lo Terminal	-	-	2	5,218	6,983	9,345
Ro-Ro Terminal	-	-	4	121	194	314

Source: Consultant

Existing traffic plying on Amba River for JSW and PNP, and projected traffic for the two IWAI terminals bode well for overall revenue generation from fairway utilization. Similarly, Lo-Lo Terminal has high probability of attracting a significant cargo volume, leading to higher revenue generation. The Ro-Ro Terminal has lower revenue generating potential as the estimated traffic at the Terminal will barely cross half-a-million-tonne mark by FY40.

13.3. Costs

This section presents the total project cost, and equity-debt distribution in phased manner. The following table shows these cost-heads for all the three core business operations:

Table 13-5: Project Cost

Description	Total Investment (INR Lakhs)	Investment Cost (INR Lakhs)		
		1st Year	2nd Year	3rd Year
Fairway				
Fairway	15,591	5,296	5,148	5,148
Communication System	1,089	327	327	436
Institutional Requirement	405	81	162	162
Environmental Management Plan Cost@5% of Prime cost	854	285	285	285
Project Management & consultancy Charges @10% of Prime cost	1,709	570	570	570

Description	Total Investment (INR Lakhs)	Investment Cost (INR Lakhs)		
		1st Year	2nd Year	3rd Year
Contingencies & Unforeseen Items of Works@10% of Prime cost	1,709	570	570	570
Total Project Cost	**21,357**	**7,128**	**7,060**	**7,169**
Lo-Lo Terminal				
Terminal	4,388	1,755	1,316	1316
Cargo Handling Equipment	906	181	362	362
Environmental Management Plan Cost@5% of Prime cost	265	79	79	106
Project Management & consultancy Charges @10% of Prime cost	529	159	159	212
Contingencies and Unforeseen Items of Works@10% of Prime cost	529	159	159	212
Total Project Cost	**6,617**	**2,333**	**2,075**	**2,208**
Ro-Ro Terminal				
Terminal	1205	482	362	362
Environmental Management Plan Cost@5% of Prime cost	60	18	18	24
Project Management & consultancy Charges @10% of Prime cost	121	36	36	48
Contingencies and Unforeseen Items of Works@10% of Prime cost	121	36	36	48
Total Project Cost	**1507**	**572**	**452**	**482**

Source: Consultant

In case of Lo-Lo Terminal, 2 Push Tugs (PT) and 8 Dumb Barges (DB) would have to be procured between FY25 and FY28 to cater to the projected traffic at the Terminal. Another 2 PT and 8 DB will be needed post FY32 and to be deployed by FY35. Following an identical timeline, 2 Ro-Ro vessels will have to be acquired by FY28 and 3 more vessels by FY35. The onus of these vessel acquisitions will be on the private operator and not IWAI. Hence, these will costs will not be factored in to develop model for either of these terminals. Capital and O&M costs associated with these vessel acquisitions and operations are indicated in the table below:

Table 13-6 Cost associated with vessel acquisition and operation

Parameters	Unit	1 PT + 4DB	Ro-Ro
Vessel Cost	Lakhs	1550	800
Running Cost	Lakh/annum	108	121.5
Crew	No.	16	8
Crew Wages	Lakh/annum	6	6
Crew Cost	Lakh/annum	96	48
Repair Cost (@2% Capex)	Lakh/annum	70	16

Source: Tractebel

13.4. Financial Analysis / FIRR

The financial indicators dictating FIRR for individual ventures, viz. fairways development and terminal operations have been presented in Table 13.11. 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 13-7: Employment schedule and salary expenditure (INR Lakh)

Parameter	No.	CTC p.a. / person (INR Lakh)	FY18	FY20	FY25	FY30	FY35	FY40
Fairway								
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**
Lo-Lo Terminal								
Manager Cargo Handling	2	6	-	-	-	46	59	75
Security Guards (Jetty x 2)	4	1.8	-	-	-	28	35	45
Executives	2	3	-	-	-	23	29	37
Weighbridge	1	2	-	-	-	15	20	25
Total Salary (INR Lakh)			-	-	-	**181**	**231**	**294**
Ro-Ro Terminal								
Manager Cargo Handling	1	6	-	-	-	23	29	37
Security Guards (Jetty x 2)	2	1.8	-	-	-	14	18	22
Executives	1	3	-	-	-	11	15	19
Total Salary (INR Lakh)			-	-	-	**48**	**62**	**79**

Source: Consultant

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. The above manpower schedule and expenditure elaborates upon the expenses from FY20, when operation commences. A similar case will prevail for both the terminals operation, where manpower costs provided above will come into effect from FY27, last year of the construction period. Also, expenses in case of both the terminals aren’t necessarily directed towards IWAI. It will be borne by whosoever operates these terminals. IWAI can either own and operate the infrastructure, or lease it to a private third party on a suitable PPP model.

Table 13-8: Depreciation (Using SLM Method) (INR Lakh)

Depreciation & Amortization	FY18	FY20	FY25	FY30	FY35	FY40
Fairway						
Gross Block	7,128	21,357	21,357	21,357	21,357	21,357
Depreciation & Amortization	-	1,929	1,075	1,075	159	9
Cumulative Depreciation & Amortization	-	3,213	11,436	16,812	21,271	21,357
Net Block	7,128	18,144	9,921	4,545	86	-
Lo-Lo Terminal						
Gross Block	-	-	2,333	6,617	6,617	6,617
Depreciation & Amortization	-	-	-	585	321	321
Cumulative Depreciation & Amortization	-	-	-	2,721	4,431	6,035
Net Block	-	-	2,333	3,896	2,187	583
Ro-Ro Terminal						
Gross Block	-	-	572	1,507	1,507	1,507
Depreciation & Amortization	-	-	-	137	76	76
Cumulative Depreciation & Amortization	-	-	-	636	1,041	1,423
Net Block	-	-	572	871	465	84

Source: Consultant

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 13-9: O&M Cost (INR Lakh)

Parameter	**FY18**	FY20	FY25	FY30	FY35	FY40
Fairway						
Direct Operating Cost	-	-	-	-	-	-
Maintenance & Other Cost	-	845	2,829	3,550	4,471	5,606
Total O&M	**-**	**845**	**2,829**	**3,559**	**4,471**	**5,606**
Lo-Lo Terminal						
Direct Operating Cost	-	-	-	3,675.7	4,691.2	5,987.3
Maintenance & Other Cost	-	-	23.4	403.4	927.2	1,198.8
Total O&M	**-**	**-**	**23.4**	**4,079.1**	**5,618.4**	**7,186.2**
Ro-Ro Terminal						
Direct Operating Cost	-	-	-	10.93	17.71	28.85
Maintenance & Other Cost	-	-	4.89	66.78	87.03	113.75
Total O&M	**-**	**-**	**4.89**	**77.72**	**104.74**	**142.60**

Table 13-10: P&L Statement (INR Lakh)

Parameter	FY18	FY20	FY25	FY30	FY35	FY40
Fairway						
PBIT	-	1,473	2,178	4,023	5,738	7,062
Depreciation	-	1,929	1,075	1,075	159	9
Interest	510	1,527	563	-	-	-
PBT	-510	-1,983	540	2,948	5,579	7,053
Tax	-	-	162	884	1,674	2,116
PAT	**-510**	**-1,983**	**378**	**2,063**	**3,905**	**4,937**
Lo-Lo Terminal						
PBIT	**-**	**-**	-22	111	266	965
Depreciation	-	-	0	585	321	321
Interest	**-**	**-**	167	293	18	0
PBT	-	-	-188	-768	-73	645
Tax	**-**	**-**	0	0	0	193
PAT	**-**	**-**	**-188**	**-768**	**-73**	**451**
Ro-Ro Terminal						
PBIT	**-**	**-**	-1	-38	-11	47
Depreciation	-	-	0	137	76	76
Interest	**-**	**-**	41	67	4	0
PBT	-	-	-42	-241	-91	-29
Tax	**-**	**-**	0	0	0	0
PAT	**-**	**-**	**-42**	**-241**	**-91**	**-29**

Source: Consultant

Fairway will start to turn in profit only post FY31 and both the terminals post FY35. Until then, the high development cost will be adversely impacting the fairway sub-sector's return potential. Low tariffs, low traffic potential, and higher development costs are the major factors impacting these infrastructures' commercial prospects.

As per the rates provided by IWAI, project does not show any IRR. Following calculation is done on the higher tariff rates just to evaluate the scale of rate at which IRR exists.

Table 13-11: FIRR for Amba River (INR Lakh)

Parameter	FY18	FY20	FY25	FY30	FY35	FY40
Fairway						
Project Cashflow(Pre-tax)	-7,128	-5,696	2,178	4,023	5,738	7,062
Project IRR(Pre-tax)	**12.7%**					
Project Cashflow(Post-tax)	-7,128	-5,696	2,016	3,138	4,064	4,946
Project IRR(Post-tax)	**10.7%**					
Lo-Lo Terminal						
Project Cashflow(Pre-tax)	**-**	**-**	-2,355	111	266	965
Project IRR(Pre-tax)	**-3.4%**					
Project Cashflow(Post-tax)	**-**	**-**	-2,355	111	266	772
Project IRR(Post-tax)	**-4.5%**					
Ro-Ro Terminal						
Project Cashflow(Pre-tax)	**-**	**-**	-574	-38	-11	47
Project IRR(Pre-tax)	**-21.0%**					
Project Cashflow(Post-tax)	**-**	**-**	-574	-38	-11	47
Project IRR(Post-tax)	**-21.0%**					

Source: Consultant

Above table clearly depicts that in case of Lo-Lo and Ro-Ro, even after considering the higher rates than the actual IWAI's rate, IRR is still negative. While on new rates, Fairways terminal shows positive returns. Variations in tariff rates have been applied to measure the overall impact of these rates on the project's profitability. Sensitivity Analysis for each of the sub-sector is shown in the table below. It is based on different tariff rates, i.e IWAI Rates, Minimum tariff rates at which IRR exists and tariff rates at which IRR would turn healthy.

Table 13-12: Financial IRR on different tariff rates

Sub-Sector	Contents	Units	Rates as per IWAI	Min. rates for returns	Rates for 14% returns
Tariff Rates					
Fairway	Movement of Vessel	GRT/Km	Rs. 0.02	Rs. 0.37	Rs. 0.44
Lo-Lo Terminal	Vessel Berthing Charges	Day/Vessel	Rs. 1,000	Rs. 1,000	Rs. 11,500
	Cargo Unloading Charges	Per Ton	Rs. 1	Rs. 76	Rs. 91
Ro-Ro Terminal	Vessel Berthing Charges	Day/Vessel	Rs. 1000	Rs. 1,000	Rs. 15,000
	Vehicle Unloading Charges	Per Truck	-	RS. 37	RS. 100
Financial IRR					
Fairway			Non-Existent	10.7%	14.2%
Lo-Lo Terminal			Non-Existent	-4.5%	14.1%
Ro-Ro Terminal			Non-Existent	-21.0%	14.1%

Source: IWAI and Consultant's Analysis

13.5. 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.

All the three sub-sectors under Amba River development would require financial intervention to be implemented. A strong EIRR could warrant capital inflow from state and/or central government in this regard in the form of Viability Gap Funding (VGF).The need for EIRR is evident only in the case of Fairway sub-sector implementation. Estimated economic impact of each of these sub-sectors and their associated EIRR is presented in the table below:

Table 13-13: Project EIRR (INR Crores)

Parameters	**FY18**	FY20	FY25	FY30	FY35	FY40
Fairway						
Economic Cash Outflow		151	238	239	237	235
Net Cash Flow to Project	-71	79	238	239	237	235
Project EIRR	**82.4%**					
Lo-Lo Terminal						
Economic Cash Outflow	**-**	**-**	0	78	90	107
Net Cash Flow to Project	-	-	-23	78	90	107
Project EIRR	**91.8%**					
Ro-Ro Terminal						
Economic Cash Outflow	-	-	0	11	13	16
Net Cash Flow to Project	-	-	-6	11	13	16
Project EIRR	**64.4%**					

Source: Consultant

All the sub-sector projects exhibit positive impact on the local economy, and invariably, the economy of the state and the nation. EIRR for fairway is unnaturally high, and this could be because of the cumulative traffic (from other private terminals) plying on the waterway, generating large volume business and revenue. The same is not true for the two terminals, where traffic is likely to be low to moderate.

13.6. 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 unwillingness of industries to shift from existing mode of transportation i.e. roadways to proposed waterway due to the seasonal behavior of river & Cost factor. Other risks typically impressing upon such a project are political, technical, environmental, and financial in nature. A broad assessment of such risks for the Amba River waterway development project is depicted in Table 13-14:

The following Table enumerates risks identified in executing the Project, the rationale behind it, and the potential mitigation or management measures:

Table 13-14: Risk Factors & Mitigation measures

Risk	Description	Likelihood*	Impact**	Risk Rank#	Mitigation / Management
Unwillingness of industries	Cost/Time Factor & Multiple handling reduces logistics advantage of waterway cargo movement, against the competing existing road and rail movement.	3	3	9	· Incorporate industries' expectations in terms of infrastructure and facilities · Tariff low enough to appeal prospective industries, and to retain profitable operation for IWAI
Low or Uncertain Future traffic	Terminal traffic (especially Ro-Ro) can be a cause for worry, and severely impact the overall project's commercial potential.	3	3	9	· Appealing logistics and subsidies in per-ton cargo handling to attract more share and more industries.
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

Source: Consultant

*, ** - Severity increases with the scale; # - Likelihood x Impact

13.7. 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.

Under the tariff provided by IWAI, all the three sub-sectors are commercially unviable i.e generate no IRR. If fairway tariff is increased to 0.37 from 0.02 GRT/Km, then the FIRR comes positive. However, in the case of Ro-Ro and Lo-Lo terminal, even after increasing the tariff rates, FIRR is negative. However, if project further continues with tariff provided by IWAI, then returns will be low and loss making even after significant financial support from the government at 40% grant.

13.8. Conclusion

The following table gives a snapshot of the project cost and viability indicators for all the sub-sector developments under Amba River:

Table 13-15: Critical indicators for the Amba River Project

Parameter	Unit	Fairways	Lo-Lo Terminal	Ro-Ro
Project Cost	INR Cr.	213.57	66.2	15.1
Revenue (FY40)	INR Cr.	131.9	93.45	3.14
FIRR	%	10.7%	-4.5%	-21.0%
EIRR	%	82.4%	91.8%	64.4%

Source: Consultant

CHAPTER 14: CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Amba River (NW 10) in the stretch of 44.971 Kms from the mouth of the river (Lat 18° 50' 26.7055" N, Long 72° 56' 44.2695" E) has been carried out as per the Terms of Reference (ToR).

A summary of the recommendations and conclusions as a result of the study is placed herewith:

- Based on the Detailed Hydrographic Survey carried out / Site data collected and subsequent to the Morphological analysis etc., the required developments in the Fairway along with interrelated activities have been identified.
- Existing waterway of the study stretch is being used for mobility of the cargo of M/s JSW and M/s PNP through their captive jetties located just downstream of the Bridge at 19.64 km. The cargo for the captive jetty of M/s JSW Jetty is about 7.94 MMTPA in FY 16 and expected to increase to 37 MMTPA in FY 40. The cargo for the captive jetty of M/s PNP Jetty is about 3.2 MMTPA in FY 16 and expected to increase to 4.0 MMTPA in FY 40.
- In order to meet the estimated cargo volumes beyond the above of 3.2 MMTPA in FY 20 and 4.0 MMTPA in FY 40, a Lo-Lo Terminal is proposed and to meet the Vehicles mobility of 13,000 in FY 20 and 28,000 in FY 40, a Ro-Ro Terminal is proposed, which are to be developed by IWAI, at later date.
- It has been proposed to consider the development of the Initial stretch from ch 0.00 km to ch 19.64 km as Class VII for the mobility of 8000 T as a convoy of 4 x 2000 T, up to the JSW Dharamtar Port area. Alternatively, the SPV mobility also has been considered and the same has been projected / suggested for fairway development, so as to meet the requirement of the bigger stake holder, M/s JSW.
- Balance Stretch from ch 19.64 km to ch 44.971 km has been limited to Class III waterway. The usage of the waterway in this stretch has been observed as minimal, rather nil. Considering the traffic study analysis and keeping in view the clearances in view, the stretch from ch. 19.64 km to 44.971 km can be limited. Hence, it is not suggested for any development in this stretch.
- The vessel / convoy requirement for Class VII is 210 m (Length) x 28 m (Breadth) x 2.5 m (Draft). SPV requirement is 115 m LOA x 22 m (Breadth) x 4.8 m (Draft).

- In order to meet the mobility of 8000 T, the convoy system of Class VII has been worked with the fairway requirement of 100 m Bottom width x 2.75 m Depth. Further, an alternative mobility of Self Propelled Vessel also was thought of, which is approximately leading to the requirement of fairway with 110 m Bottom width with 5.3 m depth. Accordingly, the Dredging quantities have been worked out for both the alternatives.
- Suggested the development in 2 Phases i.e., in Phase 1 – Development of Fairway up to 19.64 Kms (for SPV mobility) and in Phase 2 – Development of 1 Lo-Lo Terminal and 1 Ro-Ro Terminal + Development of Fairway between Ch. 19.64 kms and Ch. 44.971 kms (for Class III vessel mobility).
- In order to provide a safe navigable fairway, for two way navigation, 34 Lakhs Cu. M of Dredging quantity may have to be dredged in the Phase 1 and also proposed the provision of 5 Nos Beacon / Light system; 50 Nos Buoy / Light system; River Information system and Rerouting of the Pipe Lines at the entry of the stretch.
- Regarding the Berthing Structures, as worked out, Salient features are tabulated.

SALIENT FEATURES OF BERTH STRUCTURE

Description	Length(m)	Width (m)
RO RO	84	16.60
LO LO	120	32

- The cost estimates have been worked out for the above suggested 2 Phases.
  Fairway in Phase 1 is working out to INR 213.57 Cr.
  Lo-Lo Terminal in Phase 2 is working out to INR 66.17 Cr.
  Ro-Ro Terminal in Phase 2 is working out to INR 15.07 Cr.
  Fairway in Phase 2 is working out to INR 76.80 Cr.
- All the capital assets will be provisioned in 36 months. Phase 2 is not recommended at this stage. Investment decision for Phase 2 may have to be considered in 2025 after observing the growth trend between 2020 and 2025.
- The FIRR and EIRR have been worked out and the details are placed

Project Modules	FIRR	EIRR
Fairway	**10.7 %**	**82.4 %**
Lo-Lo Terminal	**- 4.5 %**	**91.8 %**
Ro-Ro Terminal	**- 21.0 %**	**64.4 %**

- Ø It is recommended to develop the stretch of Amba River for about 19.64 Kms with 110 m Bottom width and 5.3 m depth to facilitate the SPV mobility of 115 m LOA x 22 m width x 4.8 m draft.
- Ø Phase 2 is not recommended at this stage, which may have to be considered in 2025 after careful and meticulous analysis.

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		ü	
b) Wildlife/ Bird Sanctuary		ü	
c) Tiger or Elephant Reserve		ü	
d) Biosphere Reserve		ü	
e) Reserved / Protected Forest		ü	
f) Wetland		ü	
g) Important Bird Areas		ü	
h) Mangroves Areas	ü		Mangroves are present on both banks of Amba river in the NW-10 stretch, but the development of NW-10 project does not involve clearing of any mangrove vegetation.
i) Estuary with Mangroves		ü	
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration		ü	
k) World Heritage Sites		ü	
l) Archeological		ü	

Screening Question	Yes	No	Details / Remarks
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?		ü	
3. Is, there any defense installations near the project site?		ü	
4. Whether there is any Government Order/ Policy relevant / relating to the site?	ü		Discussed in Section 9.5 of the DPR.
5. Is the project involved clearance of existing land, vegetation and buildings?		ü	
6. Is the project involved dredging?	ü		Details have been discussed in Section 9.3 of the DPR.
7. Is the project area susceptible to natural hazard (*earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions*)	ü		
8. Is the project located in whole or part within the Coastal Regulation Zone?	ü		The entire project falls in CRZ I.
9. Is the project involved any demolition of existing structure?		ü	

Screening Question	Yes	No	Details / Remarks
10. Is the project activity require acquisition of private land?		ü	
11. Is the proposed project activity result in loss of direct livelihood / employment?		ü	
12. Is the proposed project activity affect schedule tribe/ caste communities?		ü	

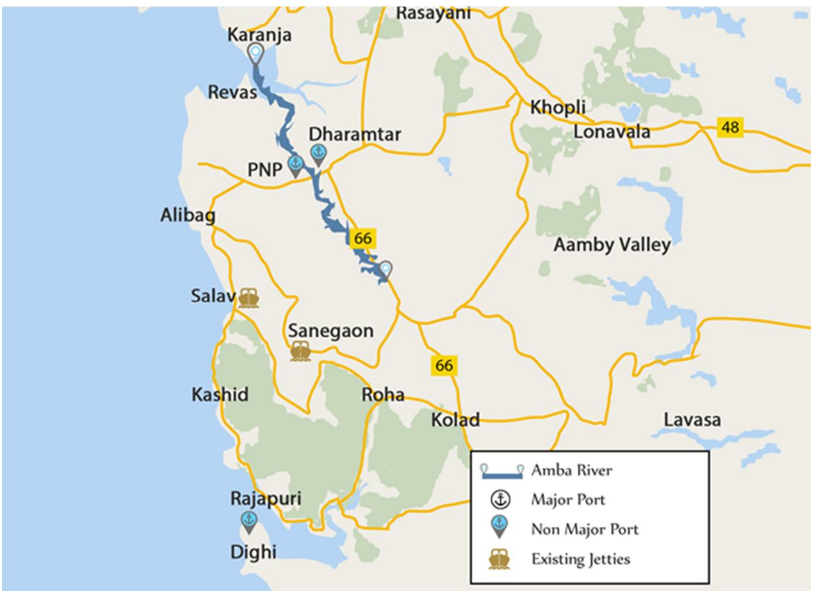
Sl. No.	Result of Screening Exercise	(Yes / No)
1.	Environment Impact Assessment is Required	Yes
2.	CRZ Clearance is Required	Yes
3.	Environmental Clearance is Required	No
4.	Forest Clearance is required	No
5.	Wildlife Clearance is required	No
6.	NOC from SPCB is required	Yes
7.	Social Impact Assessment is Required	Only as part of EIA study
8.	Abbreviated RAP is required	No

Sl. No.	Result of Screening Exercise	(Yes / 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 - Amba river origin – Borghat hill, Sahyadri Range
- Catchment area - Pen, Alibaug, Sudhagad district of Maharashtra
- Population – As per census 2011, total population residing in Alibaug taluka is 2,36,137 in Pen taluka 1,95,454 in Khalapur taluka 2,07,464 and in Sudhagarh taluka 62,380
- Economic activities – Rice and Nachani cultivation under Agriculture activities, Marine Fishing, industrial activities
- Major industries - JSW Steel, Cement, Sanghi Cement, Reliance, Supreme Petrochem, RCF
- Connectivity
  - Major roads - NH 66, NH 166 A, SH 89. NH 66 is parallel to Amba river
  - Major railway – Konkan railway line going parallel with Amba River. One railway line crosses Amba River which go towards Thal.
- Specific Developments
  - Two captive terminal in Dherand village on the bank of Amba River. (TATA & Supreme Petrochem)
  - Dharamtar port capacity expansion upto 34 MMTPA by 2025.
  - Karanja Port is an upcoming port on the mouth of Amba river
- Catchment area Map



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15.2.2. Navigation Baseline

- Existing Waterway Usage
  - Amba River is used for cargo operation at present through the Dharamtar Port of M/s JSW and PNP Port of M/s PNP, located on the bank of river (Right side and Left side respectively) and handling break & break bulk cargo.
  - 2,500 – 3,000 tons of barges are at present moving on Amba River.
  - No country boat or tourism activity found on river.
  - 26 Number of jetties are present along the study stretch of Amba River.
  - Total 5 Numbers of bridges are found in the study stretch with Horizontal Clearances of 20m to 35m and Vertical Clearances of 2.5m to 10.5m respectively.
  - No Dams, Barrages and weirs are found in the study stretch.

15.2.3. Market Baseline

- Potential Market
  - Bulk & Semi bulk commodities – Thermal Coal, Iron Ore, Steel, Cement
  - General/ Other Cargo – Ro-Ro

Commodity	Source	Reasoning
Thermal Coal	Nashik Power Plants	PNP port is already handling coal cargo & it is about to increase in future. Possibility of diverting coal traffic of MbPT to Amba river due to ports clean cargo policy. Some of the TPP have already started using Dharamtar port for import of coal.
Iron Ore	JSW	JSW steel use iron ore for their production purpose & capacity expansion of plant likely to increase iron ore traffic.
Coaking Coal	JSW	JSW steel plant uses coaking coal for producing steel, so Amba river is already in use.
Steel	-	JSW steel plant on the banks of Amba and Dharamtar port are handling their cargo.
Cement	JSW Clinker unit	JSW clinker unit is located on the bank of Amba river. Dharamtar port already handles this cargo.
Other Cargo	-	Other cargoes are not handled on large scale and they are fragmented in nature. Proposed Ro-Ro terminal would suffice requirement for these fragmented cargoes.
Chemical	RCF & DFPCL	Supreme Petrochem is planning to develop captive liquid terminal at Dherand village. However this terminal would be captive in nature. Other chemical cargo generated by RCF or Deepak Fertilizer do not hold any potential for water transportation
Commodity	Source	Reasoning

15.2.4. Forecasting Years

- IWT Share

ü Nearly half of steel cargo handled at MbPT that gets consumed in Khopoli region, would get handled at proposed IWT terminal. Hence IWT share in this case is 100%.

ü Ro-Ro traffic share of IWT is 50%. It is assumed that even though ro-ro service is developed half of trucks could still prefer roadway.

ü In case of coal traffic, IWT share is 70%. It is assumed that coal handled at anchorage/ shore of MbPT would get unloaded in barges and would get handled at proposed terminal of IWT.

Name of the waterway: NW-10 (Amba River, 44.971km)														
Sr. No	Name of Cago	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
Captive Jetty (JSW/Dharamtar) - The infrastructure will be developed by JSW. IWAI needs to ensure fairway development at higher depth, night nevigation, etc														
1	Iron Ore	Bulk	Anchorage, Jaigad Port	Dharamtar Port	n/a	JSW Dolvi Plant	n/a	mn T	3.4	4.6	16.0	20.4	20.4	20.4
2	Coking Coal	Bulk	Anchorage, Jaigad Port			JSW Dolvi Plant			1.3	1.8	6.0	7.7	7.7	7.7
3	Coal	Bulk	Anchorage, Jaigad Port			JSW Dolvi Plant			3.2	4.4	1.0	1.3	1.3	1.3
4	Limestone	Bulk	Import,Anchorage, Mumbai			JSW Dolvi Plant			0.41	0.5	4.0	5.1	5.1	5.1
5	Finished Product	Break Bulk	Dharamtar			Foreign, MbPT anchorage			0.58	0.8	2.0	2.6	2.6	2.6
6	Cement	Bulk	Gujarat			Local consumption			0.03	0.03	1.5	1.9	1.9	1.9
7	Clinker	Bulk	Gujarat			Dharamtar			0.11	0.1	2.0	2.6	2.6	2.6
8	Dolomite	Bulk	Import, Anchorage, Mumbai			JSW Dolvi Plant			0.24	0.3	3.0	3.8	3.8	3.8
	Total								9.27	12.53	35.5	45.4	45.4	45.4
Existing Private Jetty (PNP) - Capacity 4 mn Tonnes														
1	Coal	Bulk	Anchorage, Jaigad Port	n/a	PNP	Khopoli	n/a	mn T	3.2	4.0	4.0	4.0	4.0	4.0
Proposed Terminal Opportunity for IWAI														
1	Iron & Steel	Bulk	MbPT	n/a	PNP (IWAI Terminal)	Khopoli	18°42'34.36" N 73° 1'20.63"E	mn T		1.0	1.0	1.0	1.0	1.0
2	Coal	Bulk	Anchorage	n/a		TPP in MH		mn T	0	1.9	2.6	3.1	3.1	3.1
	Total								0	2.9	3.6	4.1	4.1	4.1
* 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
Captive Jetty (JSW/Dharamtar) - The infrastructure will be developed by JSW. IWAI needs to ensure fairway development at higher depth, night navigation, etc.											
1	Iron Ore	Bulk	Anchorage, Jaigad Port	JSW Dolvi Plant	mn T- Km	738	998	3472	4427	4427	4427
2	Coking Coal	Bulk	Anchorage, Jaigad Port	JSW Dolvi Plant		282	391	1302	1671	1671	1671
3	Coal	Bulk	Anchorage, Jaigad Port	JSW Dolvi Plant		694	955	217	282	282	282
4	Limestone	Bulk	Import,Anchorage, Mumbai	JSW Dolvi Plant		13	16	124	158	158	158
5	Finished Product	Break Bulk	Dharamtar	Foreign, MbPTanchorage		18	25	62	81	81	81
6	Cement	Bulk	Gujarat	Local consumption		24	0	1194	1512	1512	1512
7	Clinker	Bulk	Gujarat	Dharamtar		88	80	1592	2070	2070	2070
8	Dolomite	Bulk	Import, Anchorage, Mumbai	JSW Dolvi Plant		7	9	93	118	118	118
	Total					1864	2473	8056	10318	10318	10318
Existing Private Port (PNP) - Capacity 4 mn Tonnes											
1	Coal	Bulk	Anchorage, Jaigad Port	Khopoli	mn T - Km	704	880	880	880	880	880
Proposed Terminal Opportunity for IWAI											
1	Iron & Steel	Bulk	MbPT	Khopoli	mn T - Km	0	31	31	31	31	31
2	Coal	Bulk	Anchorage	TPP in MH		0	59	81	96	96	96
	Total					0	90	112	127	127	127

15.2.6. Market Success Factors

The market success factor regarding the development of the Amba River is fairway availability with abundant required navigational channel parameters which is being utilized by M/s JSW and M/s PNP in advantageous manner. Accordingly, on both the banks of the river near Ch 19km and Ch 20 km captive terminals are under operation effectively. The traffic volumes at the Captive Terminal locations and also for the additional divertable traffic may grow with the proposed developmental activities.

15.2.7. Forecasting Methodology

- Coal handled at PNP gets consumed in Khopoli region and by other Thermal Power Plants in Maharashtra. It is assumed that PNP has coal-handling capacity of 4 MMTPA. So once the terminal reaches its capacity a need of expansion of capacity or build a new terminal would arise. It is assumed that by FY20, PNP terminal would reach its capacity.
- JSW would need support of IWAI only in maintaining higher depth of river. IWAI would provide support for night navigation throughout in the river.
- Trucks carrying Container cargo, chemical tanker, other break bulk cargo would be loaded at either MbPT, JNPT or at Karanja onto Ro-Ro ferry and would be landed at proposed terminal near PNP and from there it could go to Khopoli region. At present around 2MMTPA of iron & steel gets distributed in Khopoli region, out of which at least 1MMTPA could get handled at proposed IWAI terminal near PNP.
- JSW plants near Dharamtar port is also in the expansion stage, which would further increase cargo traffic in coming years.
- The demand for Coke (Coking coal) at Dolvi plant of JSW is linked to the capacity addition and operational utilisaiton of JSW plant. A steel plant based on coking coal requires about 0.8 MMTPA of coking coal for every 1 MMTPA tonnes of finished steel production. The present capacity of JSW plant has been increased to 5 MMTPA. Hence, there would be an annual requirement of about 4.0 MMTPA of coking coal at Dolvi plant. This requirement of coking coal would further increase with additional capacity augmentation of plant.
- The import or coastal movement of Iron ore at JSW plant would be a function of the steel production at the plant. It takes around 1.5 tonnes of Iron ore to produce 1 tonne of steel. The volume growth of Iron at Dharamtar would depend upon future capacity utilisation of JSW plant at Dolvi and its capacity augmentation.

- At present PNP is handling 3.2 MMTPA of coal. Existing PNP terminal has cargo handling capacity of 4 MMTPA. Once the traffic reaches the capacity, there would be a need for capacity expansion or another terminal on the river.
- Average carrying capacity of trucks is 18 tons.

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) 30.6 lakhs Cu. M Ordinary soil / 3.4 lakhs Cu. M of Hard soil – 153 cr (Phase 2) 6.60 lakhs Cu. M Ordinary soil / 0.75 lakhs Cu. M of Hard soil 33.30 cr · River training/bank protection: 4 Nos-2000m 24.64 cr · Locks: No · Barrages: No · Channel market · Night navigation (Phase 1) 5 Nos Beacon & Light: 0.98 cr 50 Nos Buoy & Light: 1.93 cr (Phase2) 6 Nos Beacon & Light: 1.18 cr 60 Nos Buoy & Light: 2.32 cr · Other: Communication system – River Information System : 10.89 cr Pipe Lines – 125 cr
Terminal Infrastructure		Lo-Lo facility · Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) · Loading/uploading and other equipment (itemized) Considered · Buildings : Considered in infrastructure · Other : -- Ro-Ro facility · Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) · Loading/uploading and other equipment (itemized) Considered · Buildings : Considered in infrastructure · Other : --

Cost type	Cost categories	Components to be itemized	
Operation and maintenance (O & M) costs	Waterways	· Maintenance dredging · Markings and nav.-aids · Bank maintenance · Other	Considered as per standard
	Terminals	· Terminal operations · Terminal maintenance · Other	Considered as per standard
	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) · Total costs · (Cost/tons-km for use in evaluation)	Considered as per standard
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	
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:** (a) Navigation infrastructure – INR 213.57 crore (b) Terminal Ro-Ro Cost - INR 15.07 crore (c) Terminals Lo-Lo Cost -INR 66.17 crore · **O & M costs:** (a) Navigation infrastructure – INR 56.06 crore (b)Terminals Ro-Ro Cost – INR 1.42 crore (c) Terminals Lo-Lo Cost -INR 71.86 crore Savings in transport resource costs between IWT and rail and/or road transport **Saving on Fuel** (a) Navigation infrastructure - INR 176.1 crore (b)Terminals Ro-Ro Cost - INR 5.1 crore (c) Terminals Lo-Lo Cost - INR 28.5 crore **Saving on Vehicle Operating Cost** (a) Navigation infrastructure - INR 42 crore (b)Terminals Ro-Ro Cost - INR 4.0 crore (c) Terminals Lo-Lo Cost - INR 6.8 crore · **Savings in road/rail accident costs** (a) Navigation infrastructure - INR 1.5 crore (b)Terminals Ro-Ro Cost - INR 3.5 crore (c) Terminals Lo-Lo Cost - INR 2.7 crore

Item	Requirements
	· **Saving in carbon emissions** (a) Navigation infrastructure - INR 5.9 crore (b)Terminals Ro-Ro Cost - INR 0.2 crore (c) Terminals Lo-Lo Cost - 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 · · 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	Initial construction period has been adopted as 3 years for Navigation infrastructure, Ro-Ro & Lo-Lo terminal. Fairway will be developed in single phase only, as against the earlier plan of doing it in 2 phases. Construction will be from FY18 to FY20. For the two terminals, construction period will be from FY25 to FY27. A total 20 years for operation period has been taken into for fairway (FY20 – FY40), and operation for the two terminals (FY27 – FY40).
EIRR	The EIRR for all the individual projects under development of the Amba River is positive. However, these projects are not commercially viable, because FIRR for all the sub-segment projects are either negative or non-existent. Immediate prospects for fairway utilization exist, and cargo volume is expected to grow in the coming future as per the growth of secondary sector. This bodes well for fairway, and significant revenue could be generated, provided market driven tariff rates are applied (as against IWAI rates used in the financial model). It is also essential to develop the fairway at Amba along with night navigation.

Item	Requirements
	At present, industries located in catchment area are using roadways to reach MbPT for EXIM trade. Development of Amba as an alternate mode for transportation of raw materials and finished products for industries is likely to generate employment. The waterway would decongest the roads by traffic diversion and likely to save fuel used in road transportation along with reduction in environment pollution. The reduction of vehicular operating cost due to use of Amba is also likely to generate overall benefits to the project. Economic IRR of Navigational Structure, Ro-Ro terminal &Lo-Lo terminal projects are 51.7%, 64.4% and 91.8% respectively.
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

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.

Item	Requirements
Objective	To assess financial internal rates of return and financial payback periods of Amba 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 operations. **Returns for Navigation infrastructure are:** Total Revenue: INR 131.96 cr. in FY40 O&M Cost: INR 56.06 cr. in FY40 Tax: INR 21.16 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 70.62 cr. In FY40 Project Capital Cost (with escalation): INR 213.57 cr. Net Cash Flow: INR – 449.82 cr. In FY40 **Returns for Lo-Lo Terminal operations are:** Total Revenue: INR 93.45 cr. in FY40 O&M Cost: INR 71.86 cr. in FY40 Tax: INR 1.93 In FY40 (@ 30% on EBITDA) EBIDA: INR 9.65 cr. In FY40 Project Capital Cost (with escalation): INR 66.17 cr. Net Cash Flow: INR -29.24 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** Total Revenue: INR 3.14 cr. in FY40 O&M Cost: INR 1.42 in FY40 Tax: INR 0 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 0.47 cr. In FY40 Project Capital Cost (with escalation): INR 15.07 cr. Net Cash Flow: INR -17.60 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 are:** Total Revenue: INR 131.96 cr. in FY40 O&M Cost: INR 56.06 cr. in FY40 Tax: INR 21.16 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 70.62 cr. In FY40 Project Capital Cost (with escalation): INR 213.57 cr. Net Cash Flow: INR – 449.82 cr. In FY40 **Returns for Lo-Lo Terminal operations are:** Total Revenue: INR 94.45 cr. in FY40 O&M Cost: INR 71.86 cr. in FY40

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.

Item	Requirements
	Tax: INR 1.93 In FY40 (@ 30% on EBITDA) EBIDA: INR 9.65 cr. In FY40 Project Capital Cost (with escalation): INR 66.17 cr. Net Cash Flow: INR -29.24 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** Total Revenue: INR 3.14 cr. in FY40 O&M Cost: INR 1.42 in FY40 Tax: INR 0 cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 0.47 cr. In FY40 Project Capital Cost (with escalation): INR 15.07 cr. Net Cash Flow: INR -17.60 cr. In FY40
Evaluation period	Construction period has been adopted as 3 years for all the sub-segment projects. For fairway, a total 20 years for operation period has been taken into account for the entire operation (FY20 – FY40). For both the terminals, the operation period is from FY27 to FY40.
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: The project for development of Amba River does not exhibit any potential for positive rate of return on investment (FIRR). Factors influencing healthy financial returns of the project are: • Potential revenue likely to be generated across the board is not high enough, mainly because of low traffic potential (especially Ro-Ro) and high development cost for fairway. • Indicatively, total logistics cost for Ro-Ro is higher as compared to existing mode of transportation. This will keep the industries from diverting to waterways. While, logistics cost for Lo-Lo in IWT mode is less as compared to roadways. • The tariff rates supplied by IWAI are too low, which further impacts revenue potential, and eventually, viability of the project within the projected period up till FY40. Therefore, rates considered for calculating IRR in this project is taken higher than actual IWAI rates.
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.: • Future traffic is uncertain, especially for the cargo that have been proposed for the IWAI terminals. Traffic for private operators should generate decent revenue to eventually recover costs of fairway development in the long run.

Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.

Item	Requirements
	• Industries are very much concerned about the time & cost factor. There are high chances of rejecting the utilization of waterways if overall logistics cost including tariff charged for usage of terminal & fairway is higher than existing mode of transportation for them.
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.

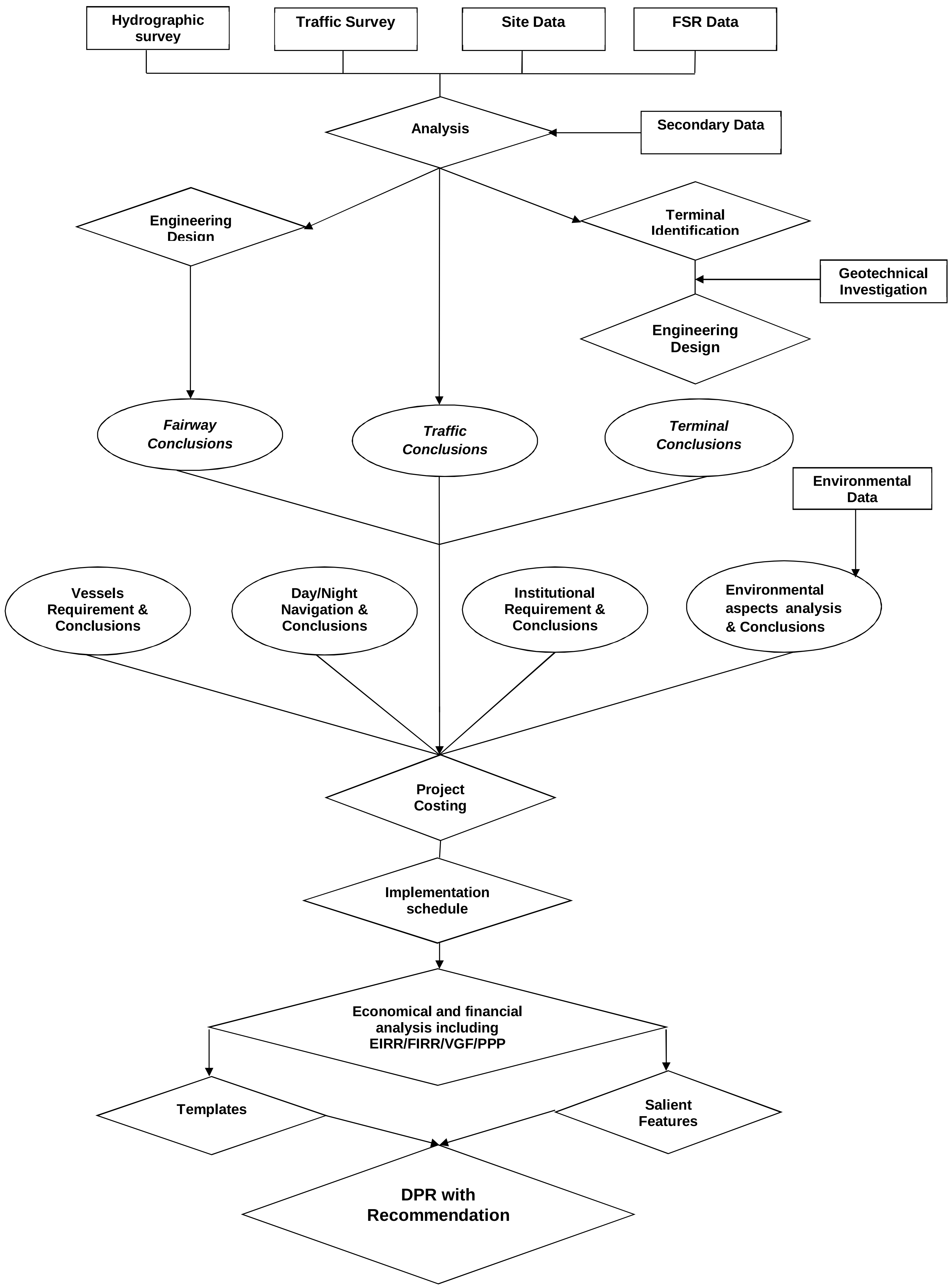
ANNEXURE 1.2 – COMPLIANCE ON TOR OF THE AGREEMENT

COMPLIANCE ON THE TERMS OF REFERENCE

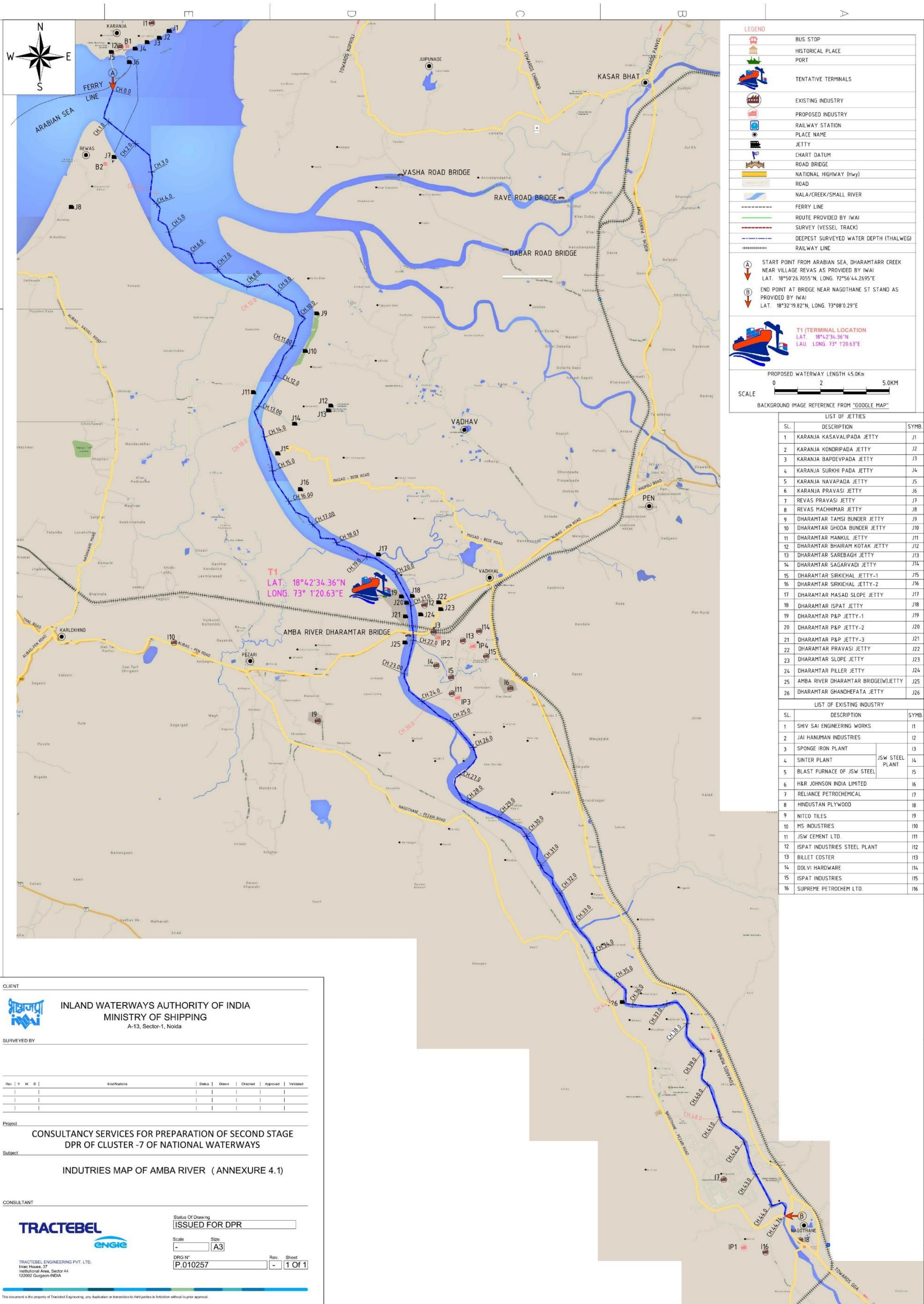
AMBA RIVER (NW 10)

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 BENCH MARK PILLARS – a)	-do-
1.2.1.2 WATER LEVEL GAUGES i) & ii)	-do-
1.2.1.3 BATHYMETRIC AND TOPOGRAPHICAL SURVEY – a) to k)	-do-
1.2.1.4 CURRENT VELOCITY AND DISCHARGE MEASUREMENT – a) to e)	-do-
1.2.1.5 WATER AND BOTTOM SAMPLES – a) – i) to vi)	-do-
COLLECTION OF TOPOGRAPHICAL FEATURES – a) to j)	-do-
1.2.1.6 SURVEY CHART PREPARATION – a) to n)	-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 AMBA RIVER



LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
1	KARANJA KASAVALIPADA JETTY	J1
2	KARANJA KONDRIPADA JETTY	J2
3	KARANJA BAPDEVPADA JETTY	J3
4	KARANJA SURKHI PADA JETTY	J4
5	KARANJA NAVAPADA JETTY	J5
6	KARANJA PRAVASI JETTY	J6
7	REVAS PRAVASI JETTY	J7
8	REVAS MACHHIMAR JETTY	J8
9	DHARAMTAR TAMSI BUNDER JETTY	J9
10	DHARAMTAR GHODA BUNDER JETTY	J10
11	DHARAMTAR MANKUL JETTY	J11
12	DHARAMTAR BHAIRAM KOTAK JETTY	J12
13	DHARAMTAR SAREBAGH JETTY	J13
14	DHARAMTAR SAGARVADI JETTY	J14
15	DHARAMTAR SIRKICHAL JETTY-1	J15
16	DHARAMTAR SIRKICHAL JETTY-2	J16
17	DHARAMTAR MASAD SLOPE JETTY	J17
18	DHARAMTAR ISPAT JETTY	J18
19	DHARAMTAR P&P JETTY-1	J19
20	DHARAMTAR P&P JETTY-2	J20
21	DHARAMTAR P&P JETTY-3	J21
22	DHARAMTAR PRAVASI JETTY	J22
23	DHARAMTAR SLOPE JETTY	J23
24	DHARAMTAR PILLER JETTY	J24
25	AMBA RIVER DHARAMTAR BRIDGE(W)JETTY	J25
26	DHARAMTAR GHANDHEFATA JETTY	J26

LIST OF EXISTING INDUSTRY

SL.	DESCRIPTION		SYMB.
1	SHIV SAI ENGINEERING WORKS		I1
2	JAI HANUMAN INDUSTRIES		I2
3	SPONGE IRON PLANT	JSW STEEL PLANT	I3
4	SINTER PLANT		I4
5	BLAST FURNACE OF JSW STEEL		I5
6	H&R JOHNSON INDIA LIMITED		I6
7	RELIANCE PETROCHEMICAL		I7
8	HINDUSTAN PLYWOOD		I8
9	NITCO TILES		I9
10	MS INDUSTRIES		I10
11	JSW CEMENT LTD.		I11
12	ISPAT INDUSTRIES STEEL PLANT		I12
13	BILLET COSTER		I13
14	DOLVI HARDWARE		I14
15	ISPAT INDUSTRIES		I15
16	SUPREME PETROCHEM LTD.		I16

CLIENT

INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING
A-13, Sector-1, Noida

SURVEYED BY

Rev	Y	M	D	Modifications	Status	Drawn	Checked	Approved	Validated

Project

CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER -7 OF NATIONAL WATERWAYS

Subject

INDUTRIES MAP OF AMBA RIVER (ANNEXURE 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: -
Size: A3
DRG N°: P.010257
Rev.: -
Sheet: 1 Of 1

ANNEXURE 4.2 – SUMMARY OF INTERVIEWS

Industries	Name of the Person	Designation
Deepak Fertilizer	Karan Jadhav	Commercial Head
RCF	Sawant Birje	Marketing Manager
Bhushan Steel	N M Kumbhar	GM Logistics
Uttam Galva	Manoj	Logistics
JSW	Pranab Jha	Head of BD
India Steel Works	Yatin Jain	Logistic Incharge
Venus Wire Industries	Albert	Export
	Satish	Domestic Cargo Operation
Posco Steel	Soumyajit Lahiri	-
Supreme Petrochem	Manoj Khemka	Domestic Logistic Incharge
Karanja Terminal & Logistics	Dilip S Garde	VP (Material handling & port operation)
Nagothane MIDC	R S Mulukh	-
Sanghi Cement	Pavan Sethi	-
JSW Cement	Vijay Sharma	Logistics-Dolvi Plant

JSW Ltd

Name: Pranab Jha

- Big industries on bank of rivers will give a vibrant look to waterways by good connectivity. Currently JSW is taking 20,000 tonnes of steel per month on barges to the customers.
- Possibilities for trade shifting to waterway are as high as 60% of total volume.
- From Supermax to Cape size vessels used for handling steel JSW hires vessels only on spot basis, they don't have any interest in long term contracts. The reason is they already have two long term chartering contracts and chances of defaulting is high than spot.
- JSW exports around 30,000 tonnes finished products to Africa & Far East countries.
- Rates charged are 50$ per consignment; not more than 50,000 tonnes volume is traded.

Rashtriya Chemical & Fertilizers

Name: Sawant Birje

- Approx. 20 lac MTPA fertilizer gets imported at RCF plant.
- RCF has appointed dealers who place their order for fertilizer and dealers only look after the transportation and decides mode of transportation. It is upto dealers to decide which port they want to use and through which mode of transportation.
- RCF has no role in logistics/transportation of fertilizers. Irrespective of big fertilizer Industry, there is scarcity of fertilizers in India.

- RCF only load sits fertilizers into rail wagons apart from that everything is being taken care by dealer. They have their own warehouses located all over India.
- RCF's Coal gasification plant, which is coming up in Talchar, is going to be built up by GAIL and coal will be procured domestically.

Deepak Fertilizers

Name: Kiran jadhav

Designation: Commercial Head

- Most of the times transportation is done by roadways. Total volume traded is around 8,00,000 tons annually. West Maharashtra is the major region of distribution; they also move their goods to Agra, Karnataka, and Jharkhand etc.
- They export fertilizers to many countries, 1 container is exported in 1 day i.e. 5 containers in a week.
- Export is done only from JNPT as it is the nearest port to them. Transportation depends upon the market, commodity.

Bhushan Steel

Name: N M Kumbhar

- Bhushan Steel procures raw material and dispatches finished goods via roadway and waterway. For export of finished products plants use JNPT. Monthly trade of raw material is up to 15,000 MT per/month and production in lump sum is upto 40,000 to 50,000 MT per/month.
- If containerised cargo could also get transported through Amba River, it would benefit so many industries. At present 1,000 container going to JNPT from this plant. Breakbulk, bulk cargo vessels are much larger in size compared to containers.
- Bhushan Steel procures raw material from Paradip to Mumbai about 70,000 MT p.m. that could be diverted to Amba River. Export volume is 25-30,000 MT p.m. This would benefit lot of industries. It would be cheaper from rail road as well.

Karanja Terminal & Logistics pvt. Ltd.

Name: Dilip S Garde

Designation: VP (Material Handling & Port Operations)

- Existing draft at port is 4.5 meter. There is underwater pipeline by IPCL & GAIL nearby to Karanja port which is difficult to move to some other location, as it creates hindrance to availability of draft. Without pipeline draft could have been 11 meter.

- There are very few industries in Konkan area which export Mangoes through container which goes from road to port which could be diverted for coastal movement, Mangoes could be transported in container on geared vessel from Karanja.
- Karanja terminal has given suggestion to MMRDA to keep upcoming bridge clearance of Rewas and Karanja to 9m.
- Future cargo to be handled by Karanja Port are- Steel coil, Grain, Pulses, Cement, Container, Engineering goods, Project Cargo and Vessels of 4,000 DWT could be handled at Karanja Port.
- Karanja port has proposed to MMB for having anchorage facility at port.
- Karanja port is likely to get into an agreement with Ultra Tech Cement for handling cement at dedicated berth at port. Karanja port also plans to set up their own CFS in future to attain more traffic.

Uttam Galva

Name: Manoj Salian

- Uttam Galva could possibly use Dharamtar Port or new upcoming terminal for coastal movement. Everything depends on size of vessel barges, hauling time, double handling cost etc.
- 25,000 T p.m. volume is exported from this plant, which holds potential for using Amba river.

India Steel Works

Name: Yatin Jain

Designation: Logistic Incharge

- India steel work is export based industry. Company uses 500-900T raw materials by truck. Company uses JNPT for export purpose.
- From Khopoli to JNPT, cost of transportation is INR 9,000 for per ton cargo. It is not possible to use Nagothane or JSW/PNP for the company due to multiple handling of cargo.

Posco Steel

Name: Soumyajit Lahiri

- Posco Steel plant located at Mangaon is 40km away from Amba river. This plant uses Dighi port for unloading cargo of about 1 lac ton per month.
- For loading purpose the company uses MbPT & JNPT. From MbPT about 20,000 to 30,000 tons per month is exported.
- For company Dighi port is closer as compared to Nagothane, which is the end point of Amba river in the given scope.

Venus Wire

Name: Satish

Designation: Domestic Transportation In-charge

- 1-2 ton cargo is transported daily from plant by the company's vehicle.
- Domestic market of Venus Wire is Bangalore, Gujarat, and Andhra Pradesh.
- Maximum 500 tons p.m. gets transported by 2-3 vans per month.
- There are more than 10 godown/ warehouses in Khopoli area owned by various transport & logistic companies.
- Production capacity of the plant is 2,000 Ton p.m. for domestic & export. It is very difficult to move domestic cargo through Amba River.

Sanghi Cement

Name: Pavan Sethi

- Sanghi Cement does not have plant in Maharashtra; however they have silos in Dharamtar. Their trade takes place from Kandla Port to MbPT and then to Dharamtar
- Through barges they transport cement and store in silos located at Dharamtar. From there, cement is transported in bulk form to other destinations by road transportation. Approx. 2,100MT Cement is transported on each ship at one time.
- The business areas of Sanghi Cement are basically in New Mumbai, Masjid Bandar etc.
- Only cement plants located nearby coastal area will get benefitted from the upcoming waterway.

JSW Cement

Name: Vijay Sharma

Designation: Logistics – Dolvi Plant

- The Company uses its own PNP port, which is approx. 2km from Dolvi plant.
- JSW transport cement to Pakistan; the volume is about 1,000 MT per month.
- JSW uses its own jetty to transport cargo to foreign countries; JSW doesn't use any other port.

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)	=	23.0	KN/m^3	For BA-1
Angle of Internal Friction (ϕ)	=	10.0	degree	For BA-1
Bulk Unit weight (γ)	=	16.7	KN/m^3	For BA-1
Unit weight of water (γ_w)	=	10	KN/m^3	
Submerged Unit Weight	=	6.7	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	=	1.421	(cl. 3 of IS 6403)	
Depth factor (dc)	=	1.477	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dq)	=	1.238	(cl. 5.1.2.2 of IS 6403)	
Depth factor (dγ)	=	1.238	(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 (Φ'=Φ*2/3)	=	6.704	degree
Bearing capacity factor (Nc')	=	7.12	For Punching Shear Failure
Bearing capacity factor (Nq')	=	1.88	For Punching Shear Failure
Bearing capacity factor (Nγ')	=	0.71	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')

89.00 KN/m^2

Load at 50 mm Settlement = 44.00 kN/m^2 (As per Calcula

Safe Bearing Capacity = 44.00 kN/m^2

Calculation of Settlement as per IS 8009 (Part I) - 1976

Proposed Depth of foundation =	3.0	m
Total depth of Borehole =	19.5	m
Depth of bed rock =	11.8	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 =	2.25	m
Effective thickness of Layer-2 for Settlement =	0.0	m

Available Soil properties at different depths are given below;

	Layer-1	Layer-2	
Start Level (EL) of Layer =	**0**	**7.1**	m
End Level (EL) of Layer =	**7.1**	**10.6**	m
Average Unit Weight =	6.70	6.70	kN/m^3
Cohesion (C) =	23	23	kN/m^2
Angle of Internal Friction (ϕ) =	10	10	degree
Compression Index (Cc) =	0.3965	0.3965	
Initial void Ratio (e_0) =	1	1	

One layer

Initial pressure at the center of Layer-1 Below Foundation Level (σ_0) =	27.64	kN/m^2
Initial pressure at the center of Layer-2 below Foundation Level (σ_0) =	0.00	kN/m^3
Pressure increment at the base of footing =	**89.00**	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=	200.25	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 =	**89.00**	**kN/m^2**
Length of load dispersion at middle of Layer-1 (L) =	2.625	m
Width of load dispersion at middle of Layer-1 (W) =	2.625	m
Pressure increment at middle of Layer-1 =	**29.06**	**kN/m^2**
Length of load dispersion at top of Layer-1 (L) =	3.75	m
Width of load dispersion at top of Layer-1 (W) =	3.75	m
Pressure increment at top of Layer-1 =	**14.24**	**kN/m^2**
Average pressure increment for Layer-1 (as per Simpson's rule) =	**36.58**	**kN/m^2**
Total Settlemt of Layer-1 (Sf) =	0.1633	m
	163.33	**mm**

Calculation of settlement for Layer-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 =	**14.24**	**kN/m^2**

Length of load dispersion at middle of Layer-2 (L) =	3.75	m
Width of load dispersion at middle of Layer-2 (W) =	3.75	m
Pressure increment at middle of Layer-2 =	**14.24**	**kN/m^2**
Length of load dispersion at top of Layer-2 (L) =	3.8	m
Width of load dispersion at top of Layer-2 (W) =	3.8	m
Pressure increment at top of Layer-2 =	**14.24**	**kN/m^2**
Average pressure increment for Layer-2 (as per Simpson's rule) =	**14.24**	**kN/m^2**
Total Settlemt of Layer-2 (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

$Si = p*B*(1-\mu^2)/E*I$

p = Effective Pressure at foundation level =			20.10	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 rigi
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) =			0.000844	m
			0.8442	mm
Total Settlement including immediate settlement =			**164.17**	**mm**
Value of D/sqrt(L*B) =			2.00	
Value of sqrt(L*B)/D =			0.50	
Correction Factor for Depth of foundation =			0.62	(Fig 12 of IS 8009_Part 1)
Correction Factor for Rigidity of Foundation =			1.00	(Clause 9.5.2 of IS 8009_Part 1) (C
Settlement after Corrections =			101.79	mm
Allowable Settlement for Isolated footing =			50	mm (Table -1 of IS 1904-1986)
Load at 50 mm Settlement =			**44.00**	**kN/m^2**

ANNEXURE 5.2– CALCULATION OF PILE CAPACITY

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 BA-1

Dia of Pile (D) =	1.00 m		0 to 7.1 m	7.1 to 11.8 m	
Ground Level =	0.0 m	Saturated Unit Weight (kN/m^3) =	6.70	8.0	
Pile Cutoff Level (Assumed) =	0.0 m	Unit Weight of Water (kN/m^3) =	10.00		
Maximum Scour Level	0 m	Overburden Pressure Correction Factor CN = 0.77*log10(2000/s0)			
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 =	11.8 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	0.00	0.00	0	0.00	0.0
1.5	-1.5	10	23	10	1.00	1.00	10.05	4.71	112.6
3	-3	10	23	10	1.00	1.00	20.10	4.71	120.9
4.5	-4.5	10	23	10	1.00	1.00	30.15	4.71	129.3
6	-6	10	23	10	1.00	1.00	40.20	4.71	137.6
7.1	-7.1	10	23	10	1.00	1.00	47.57	3.46	106.2
9	-9	0	100	0	0.00	0.43	60.30	5.97	256.7
10.5	-10.5	0	100	0	0.00	0.43	70.35	4.71	202.6
11.8	-11.8	0	100	0	0.00	0.43	79.06	4.08	175.6

Total Ultimate Skin Friction Resistance, Qst (kN) = 1241.49

Total Allowable Skin Friction Resistance, Qst (kN) = 496.59

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) =	100 kN/m^2
Depth of Pile Tip (Pile Bottom) from Ground Level =	11.8 m
Effective Overburden Pressure at Pile Tip =	79.06 kN/m^2
Angle of Internal Friction at Pile Tip (ϕ) =	0 degree
Bearing Capacity Factor (Nc)	9
Bearing Capacity Factor (Nq)	0.000 (As per IS 2911Part-1 Sec-2 -2010)
Bearing Capacity Factor (Nγ)	0.000 (As per IS 6403 -1981)

End Bearing (T) =	706.86 kN
Allowable End Bearing Capacity of Pile =	**282.74 kN**
Self Weight of Pile =	231.69 kN
Net Bearing Capacity of Pile =	**548.0 kN**

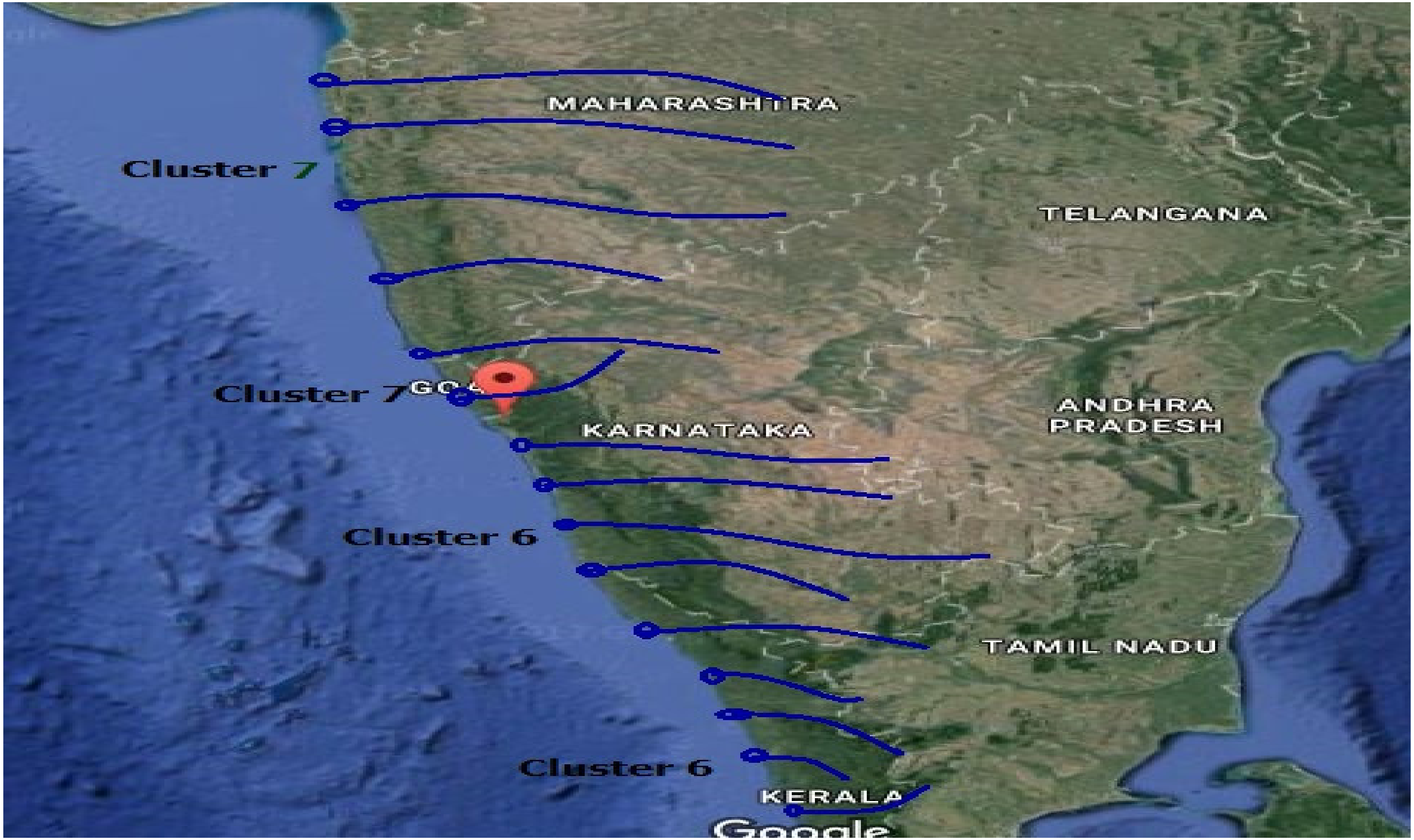
Uplift Capacity of Pile

Safe Uplift Capacity of Pile = 2/3*Frictional Resistance =	331.06
Safe Uplift Capacity (Including Weight of Pile)=	**563.0 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

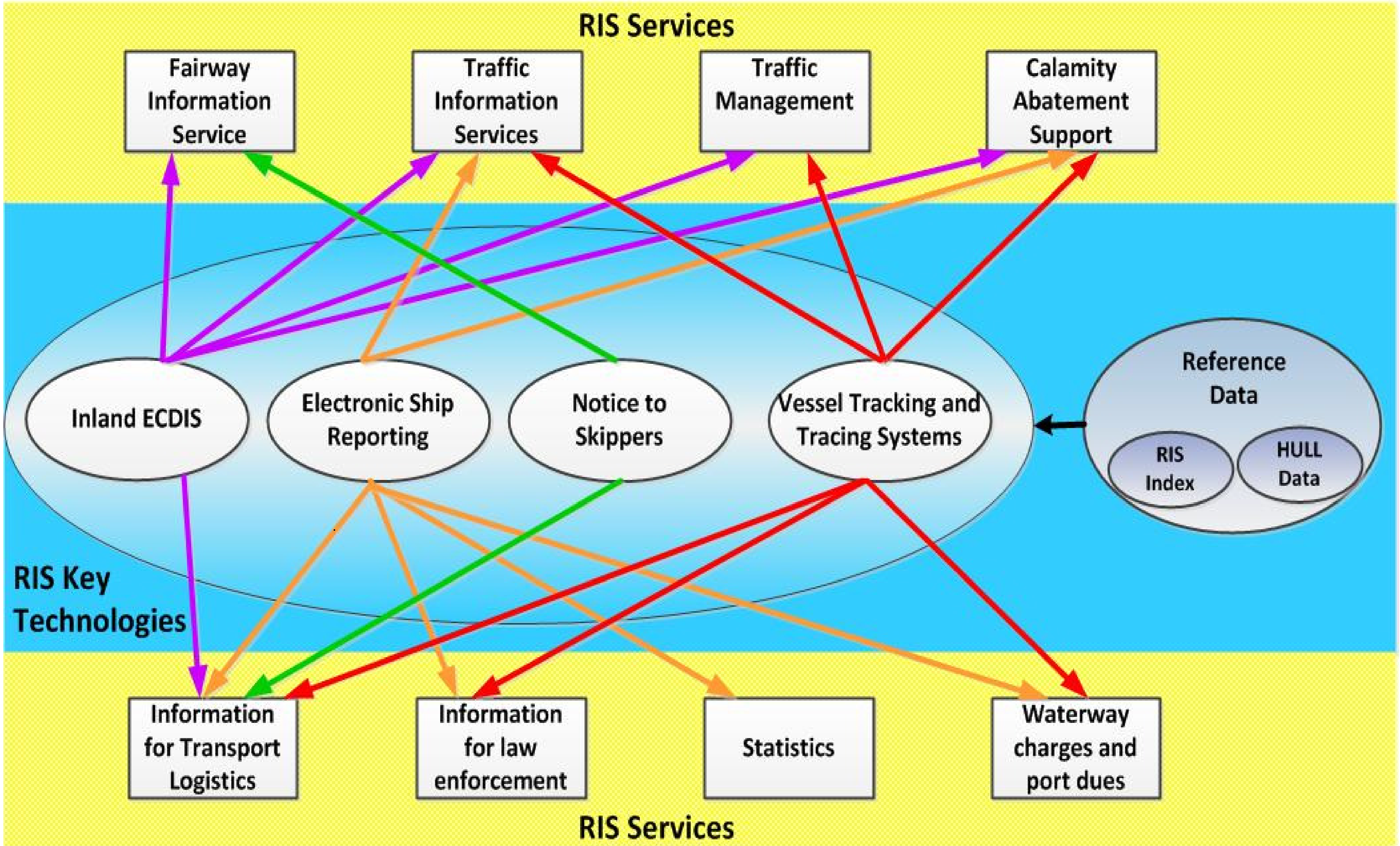
- Electronic Navigational Charts / Inland ECDIS
- Information on nautical conditions (fairway, obstructions, water level, etc.)
- Real time traffic information
- Electronic reporting of cargo and voyage
- Electronic pre-announcement at locks and harbours

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

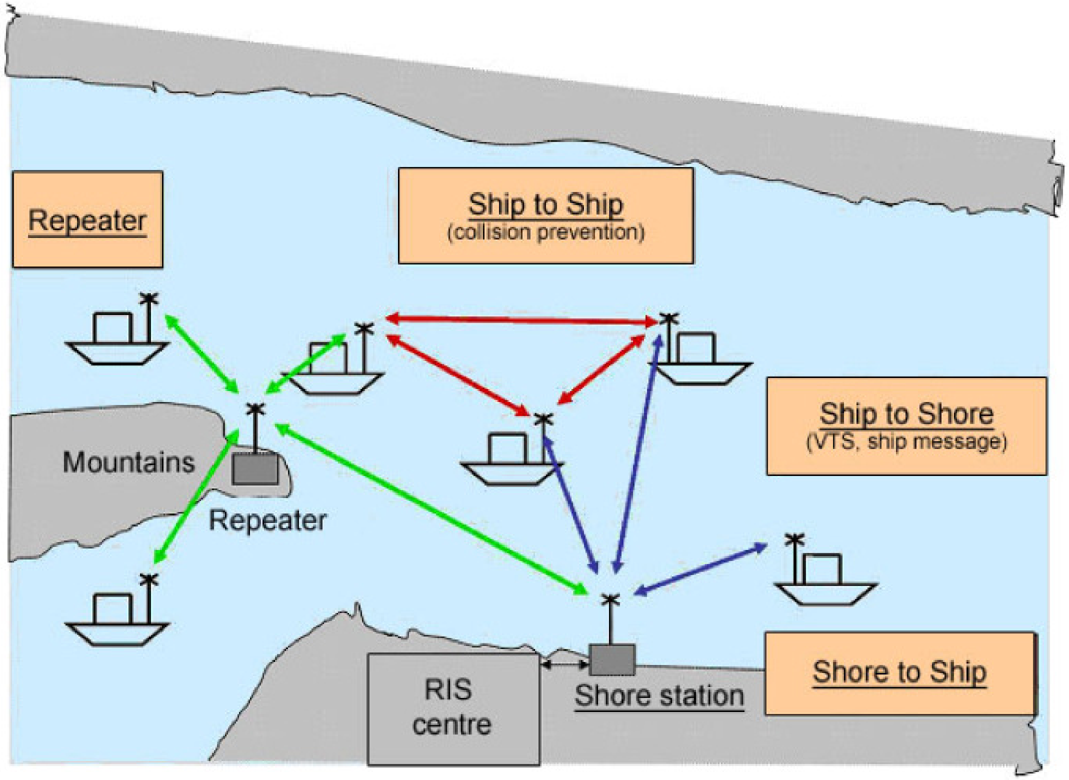

RIS Services
Fairway Information Service
Traffic Information Services
Traffic Management
Calamity Abatement Support
Inland ECDIS
Electronic Ship Reporting
Notice to Skippers
Vessel Tracking and Tracing Systems
Reference Data
RIS Index
HULL Data
RIS Key Technologies
Information for Transport Logistics
Information for law enforcement
Statistics
Waterway charges and port dues
RIS Services

The key technologies of RIS are

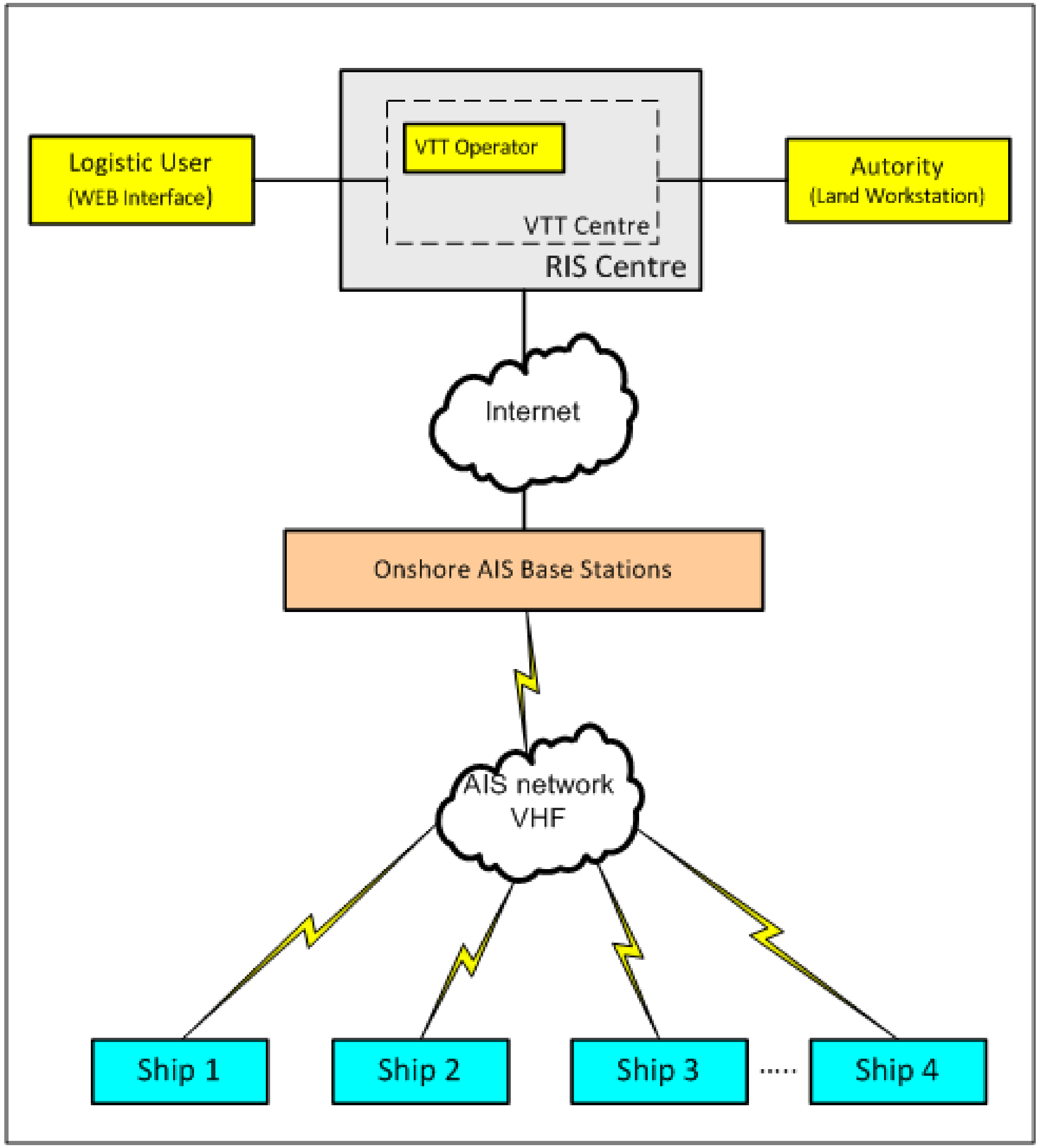
- VTT (Vessels Tracking and Tracing)
- ECDIS (Electronic Charts)
- NtS (Notice To Skippers)
- ERI (Electronic Reporting International)
- HULL Database
- LMS (Lock Management System)

Some technologies needs to be adapted to the local laws and operating procedures.

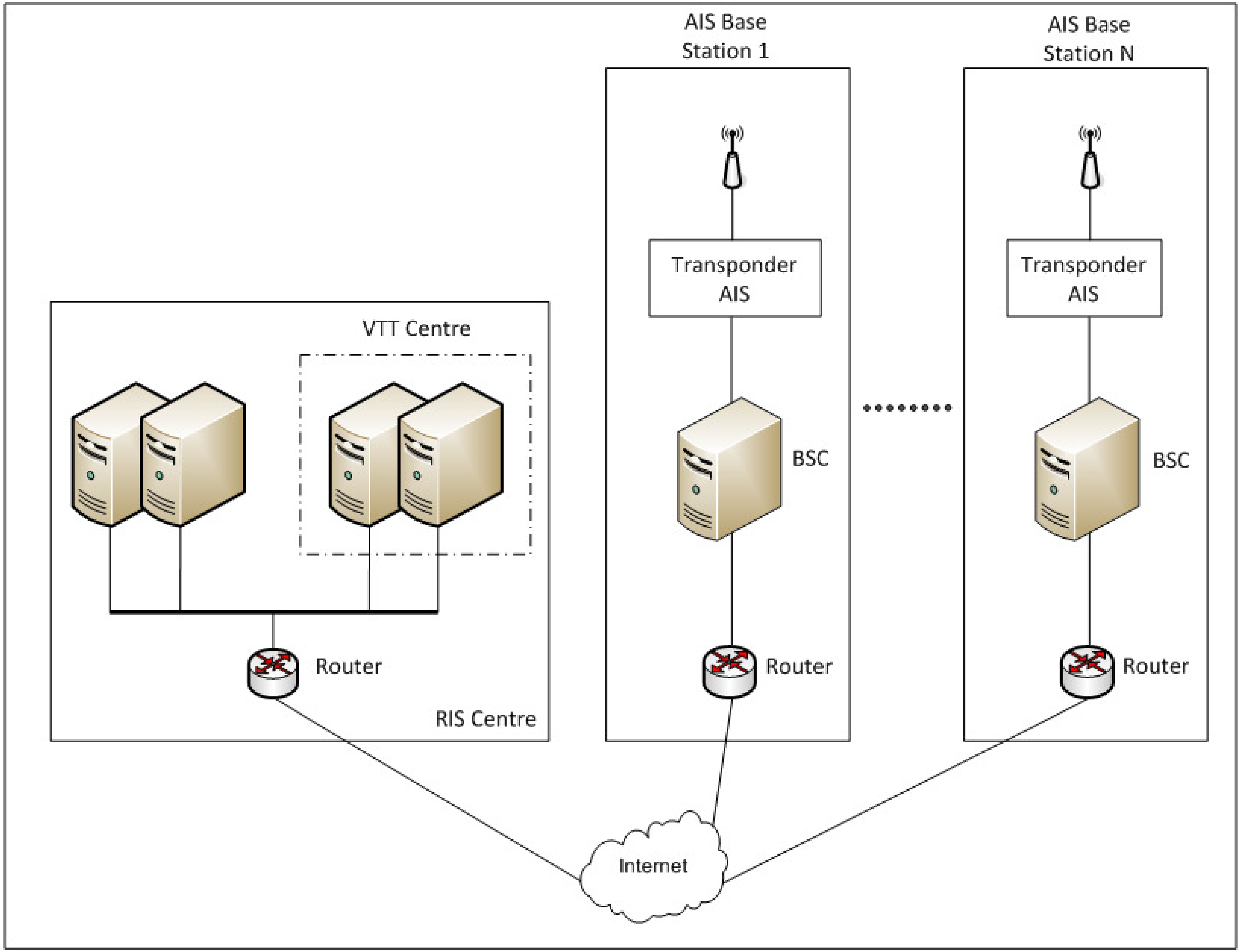
System to get a Strategic and Tactical Traffic Image using AIS technology with INLAND extension



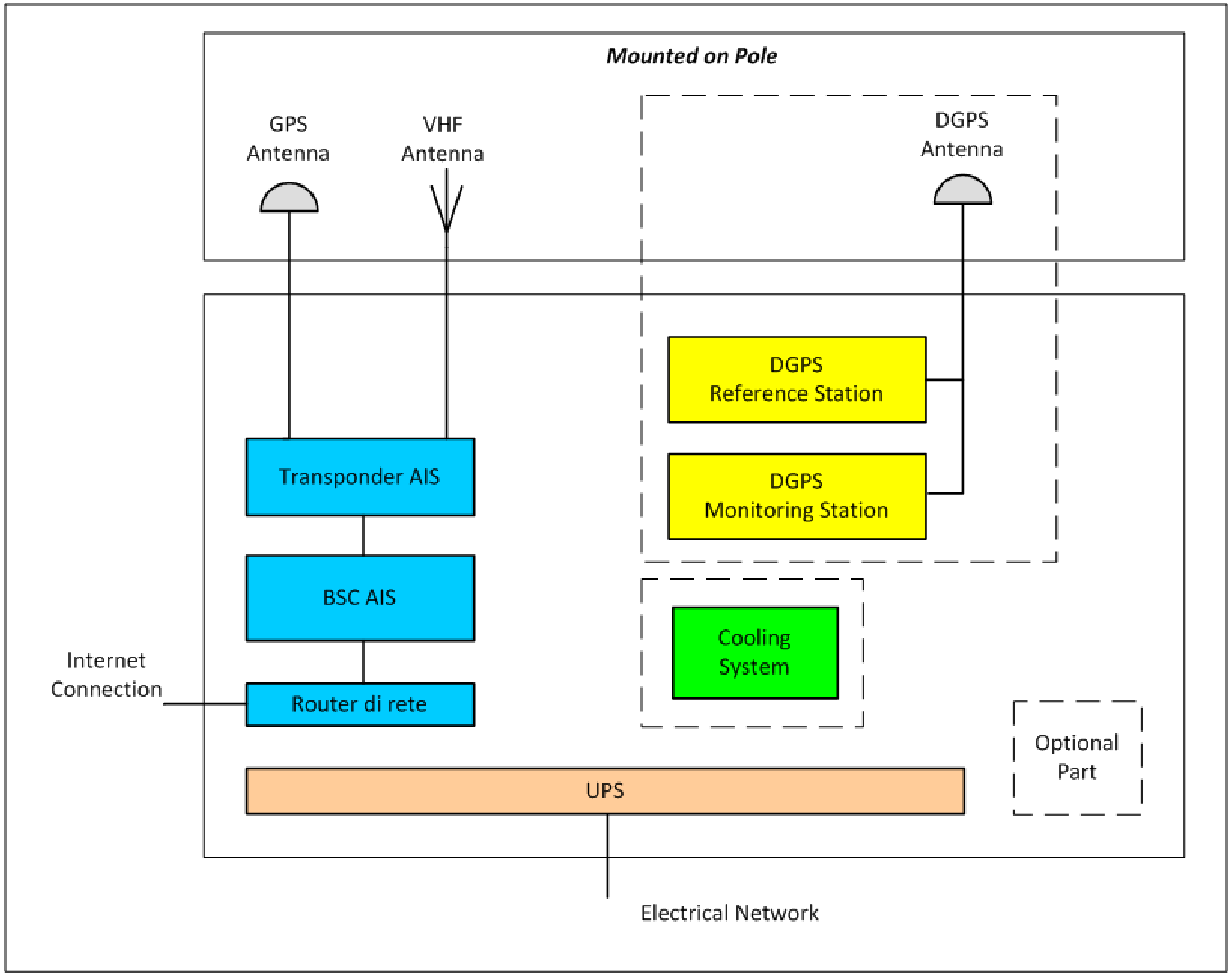
Onboard AIS devices transmit the identity of the vessel, its position and other data at regular intervals. By receiving these transmissions, AIS shore stations or ships fitted with AIS can automatically recognize, identify and track vessels equipped with AIS on a suitable screen, such as an inland ECDIS 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.


Logistic User
(WEB Interface)
VTT Operator
VTT Centre
RIS Centre
Autority
(Land Workstation)
Internet
Onshore AIS Base Stations
AIS network
VHF
Ship 1
Ship 2
Ship 3
Ship 4

AIS BASE STATION & RIS CENTRE ONSHORE FACILITIES

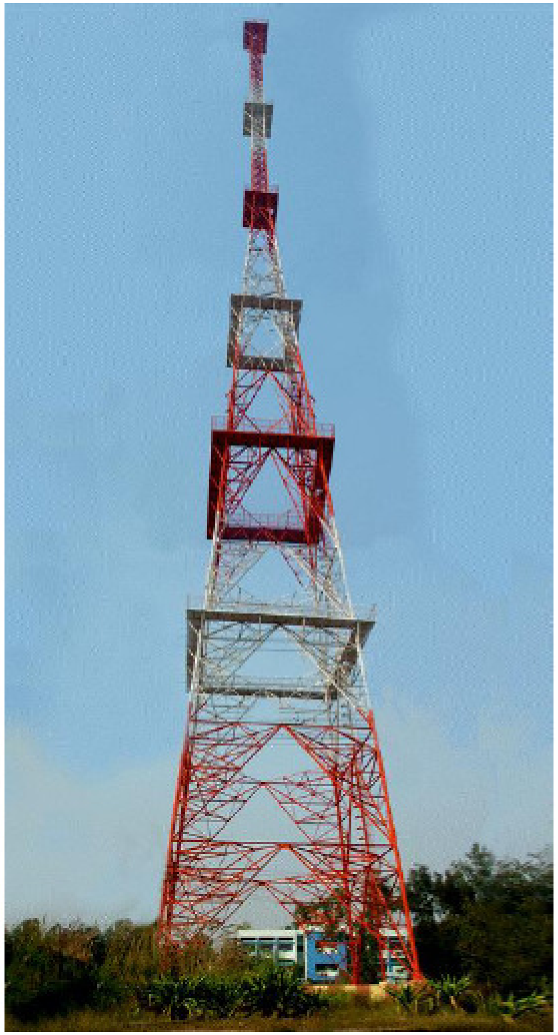


AIS BASE STATION



AIS STATION TOWER DESIGN

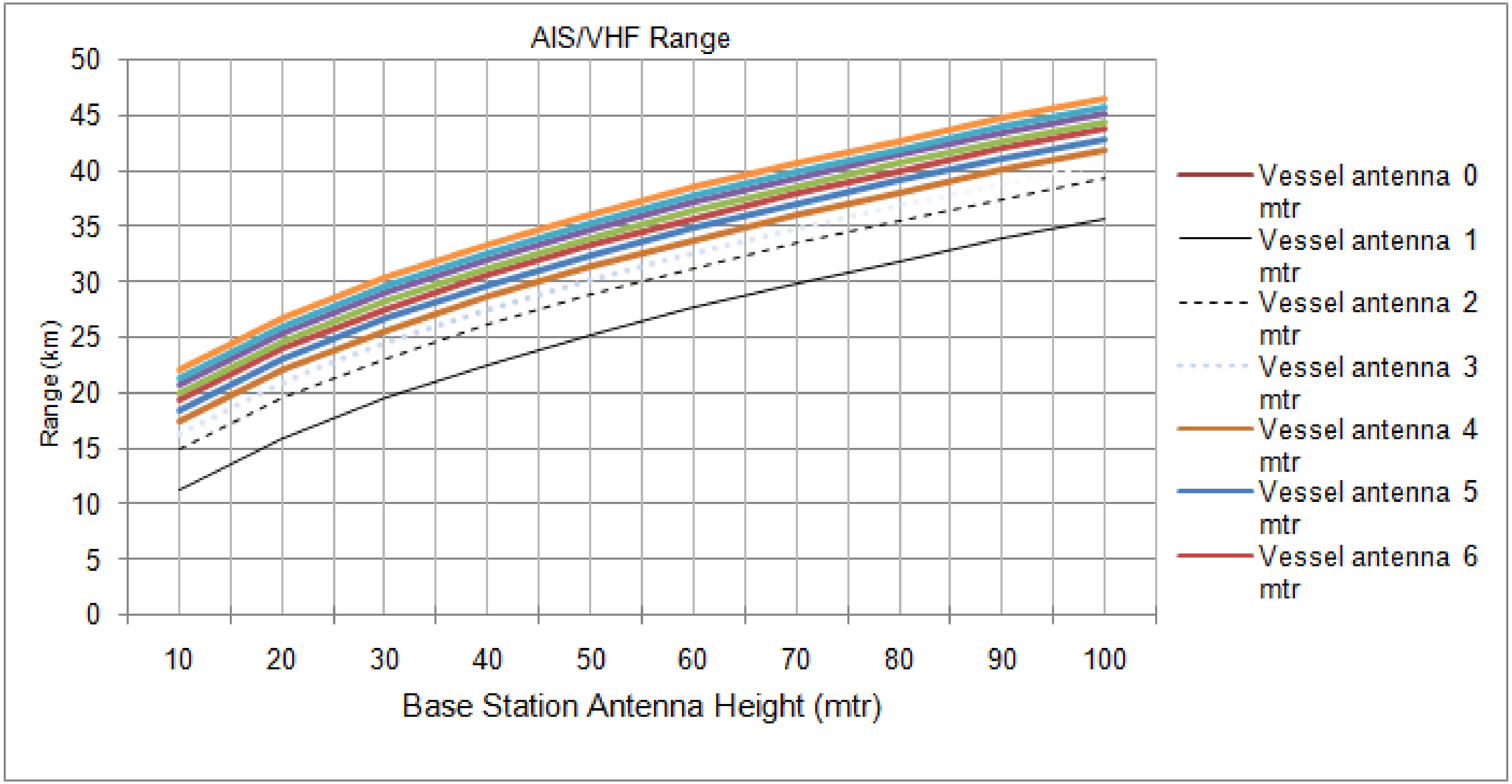
The type of tower depends upon the environment & also capable to carry Radar. Some of the examples are shown in the pictures



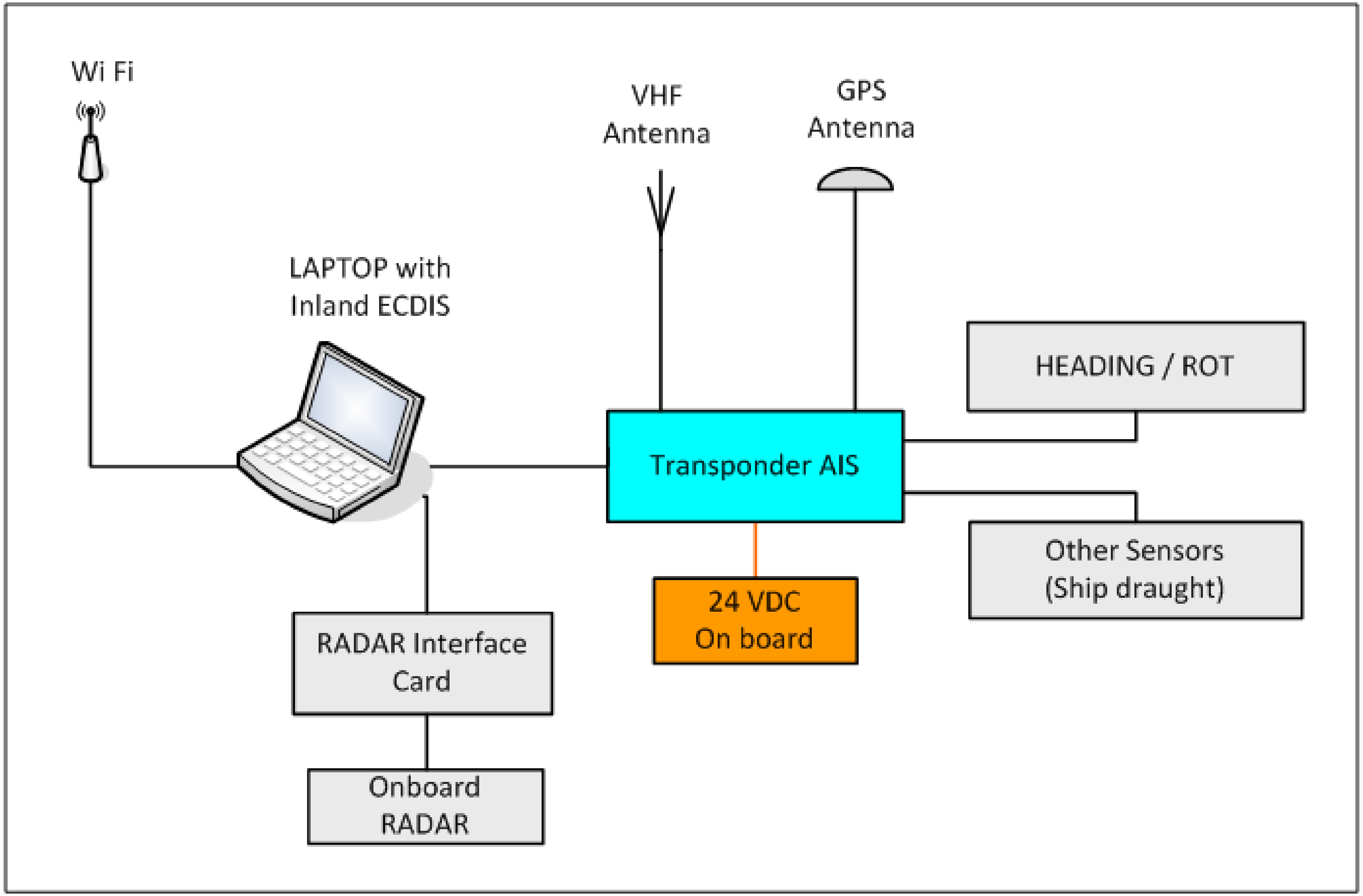
AIS STATION VHF RANGE

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

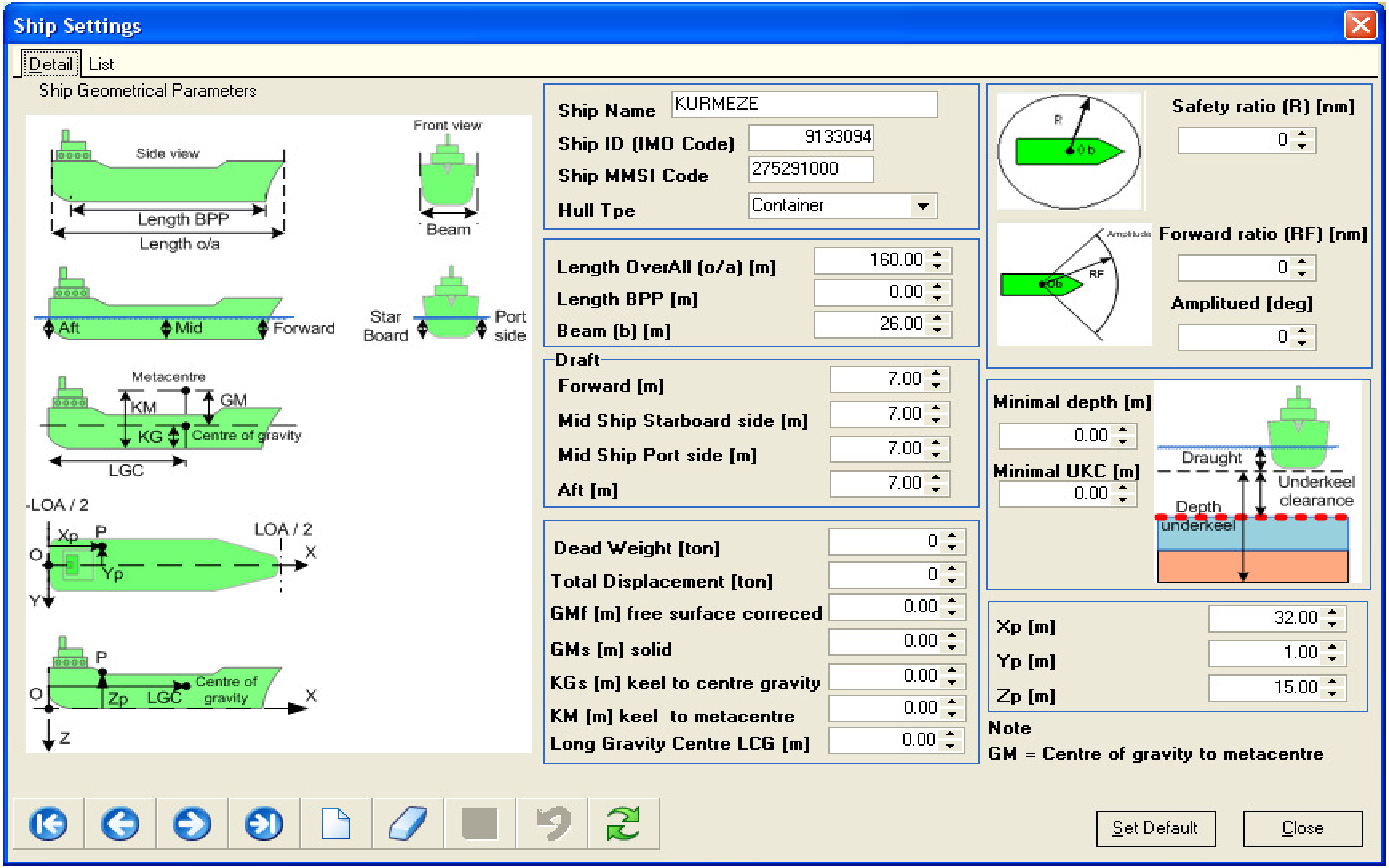
AIS STATION VHF RANGE



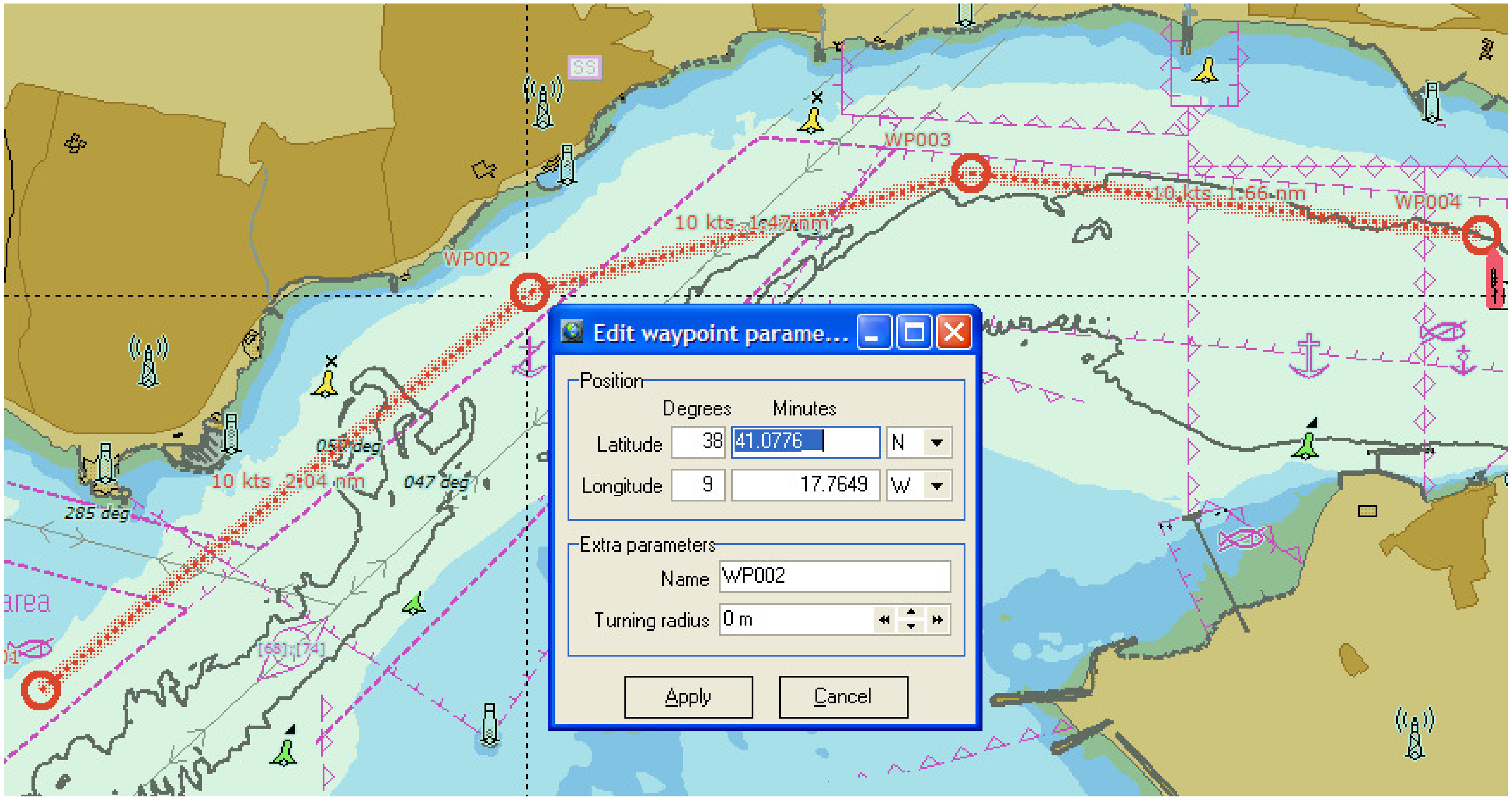
AIS ON BOARD DEVICE



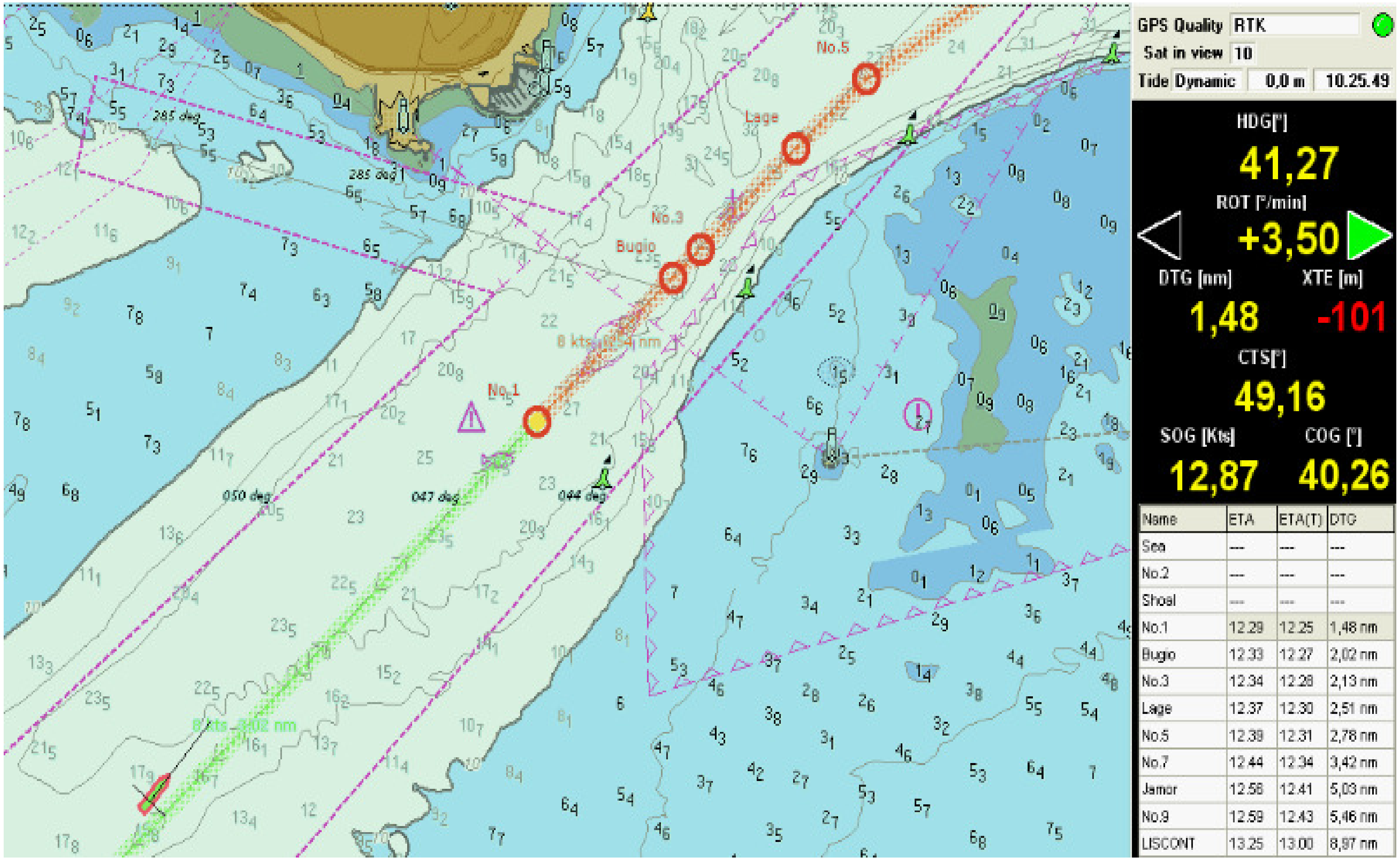
Interface to insert ship data



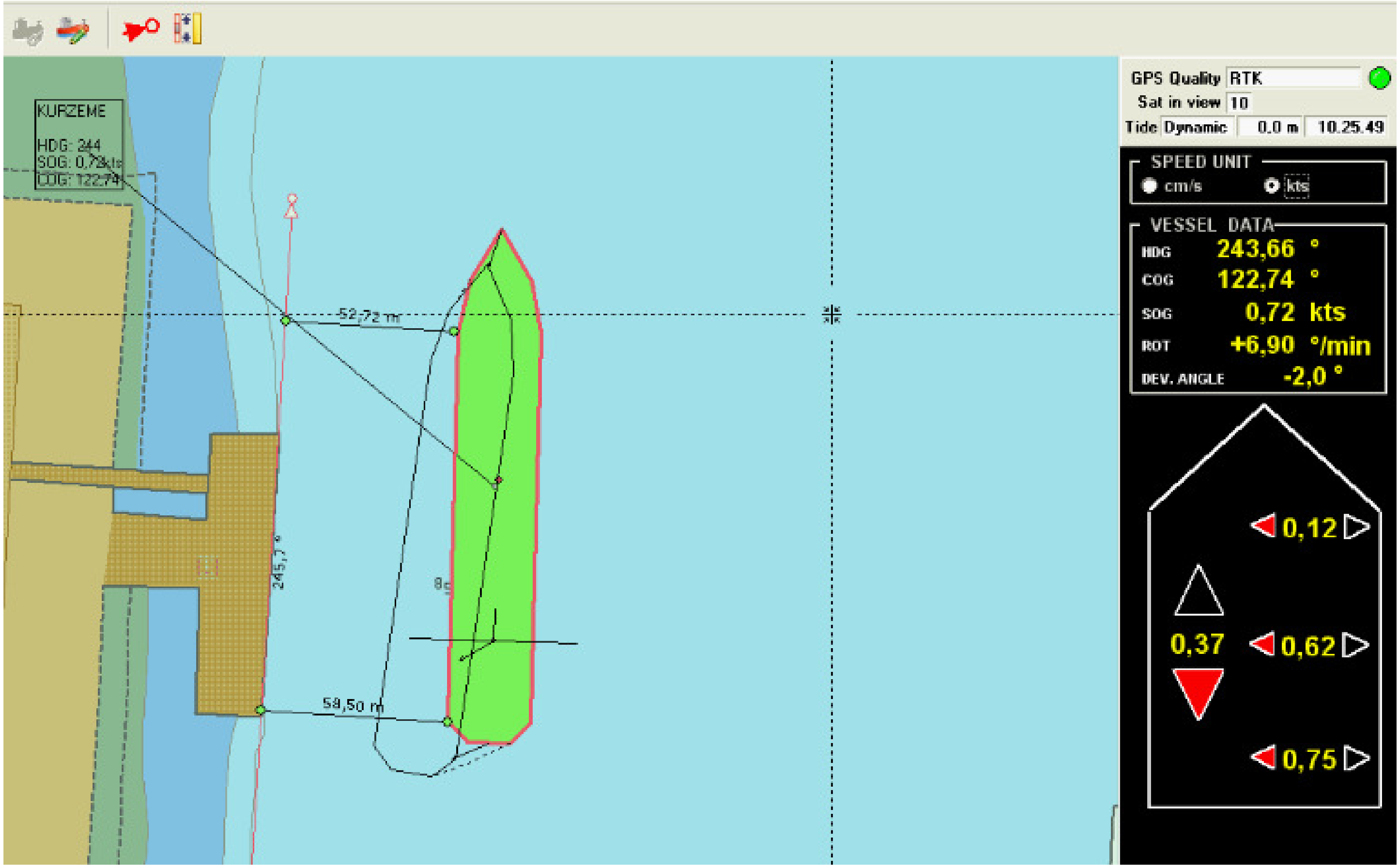
Interface to for voyage planning



Interface in navigation mode

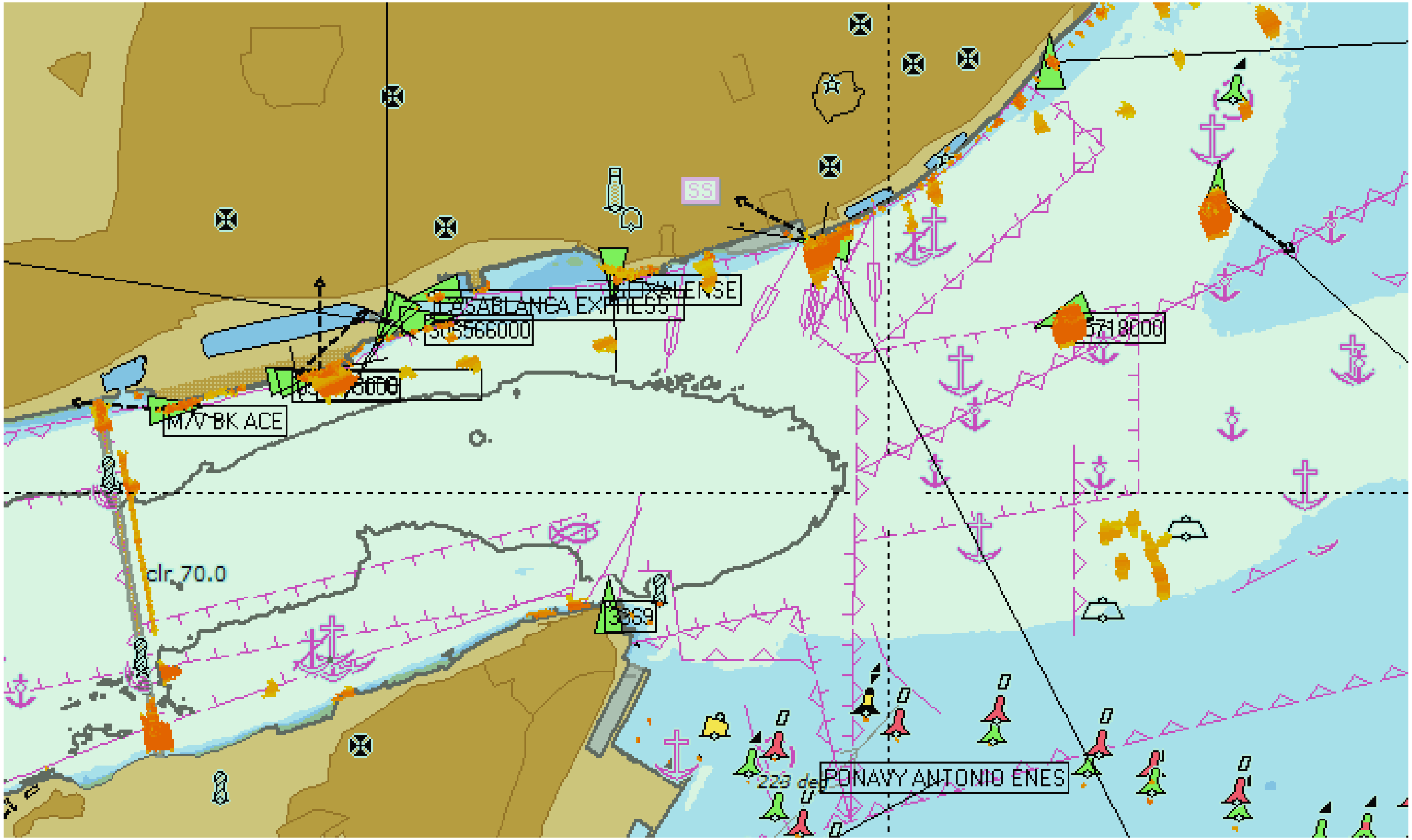


Interface for docking

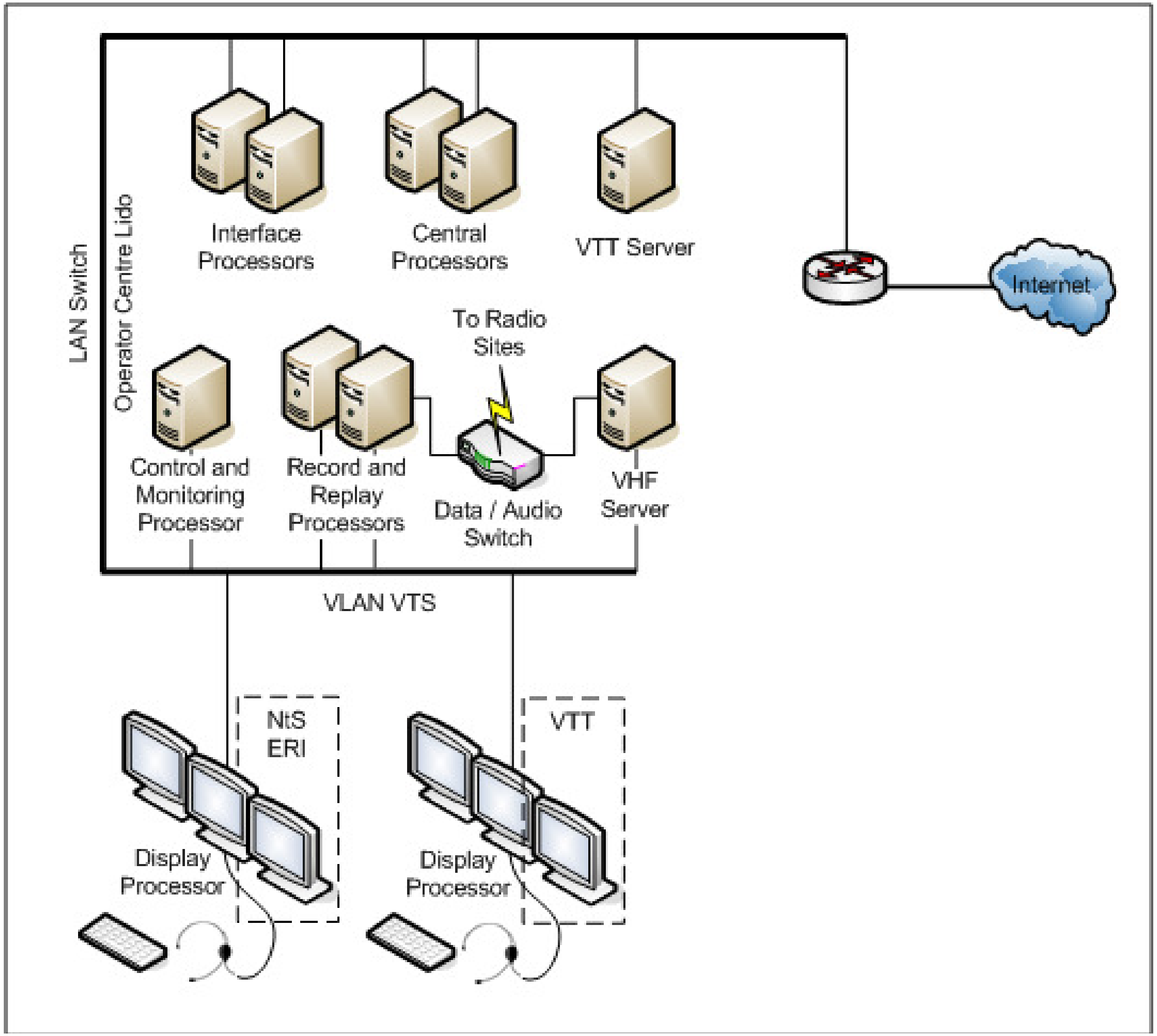


ONBOARD INTERFACE

Tactical Traffic Image + RADAR

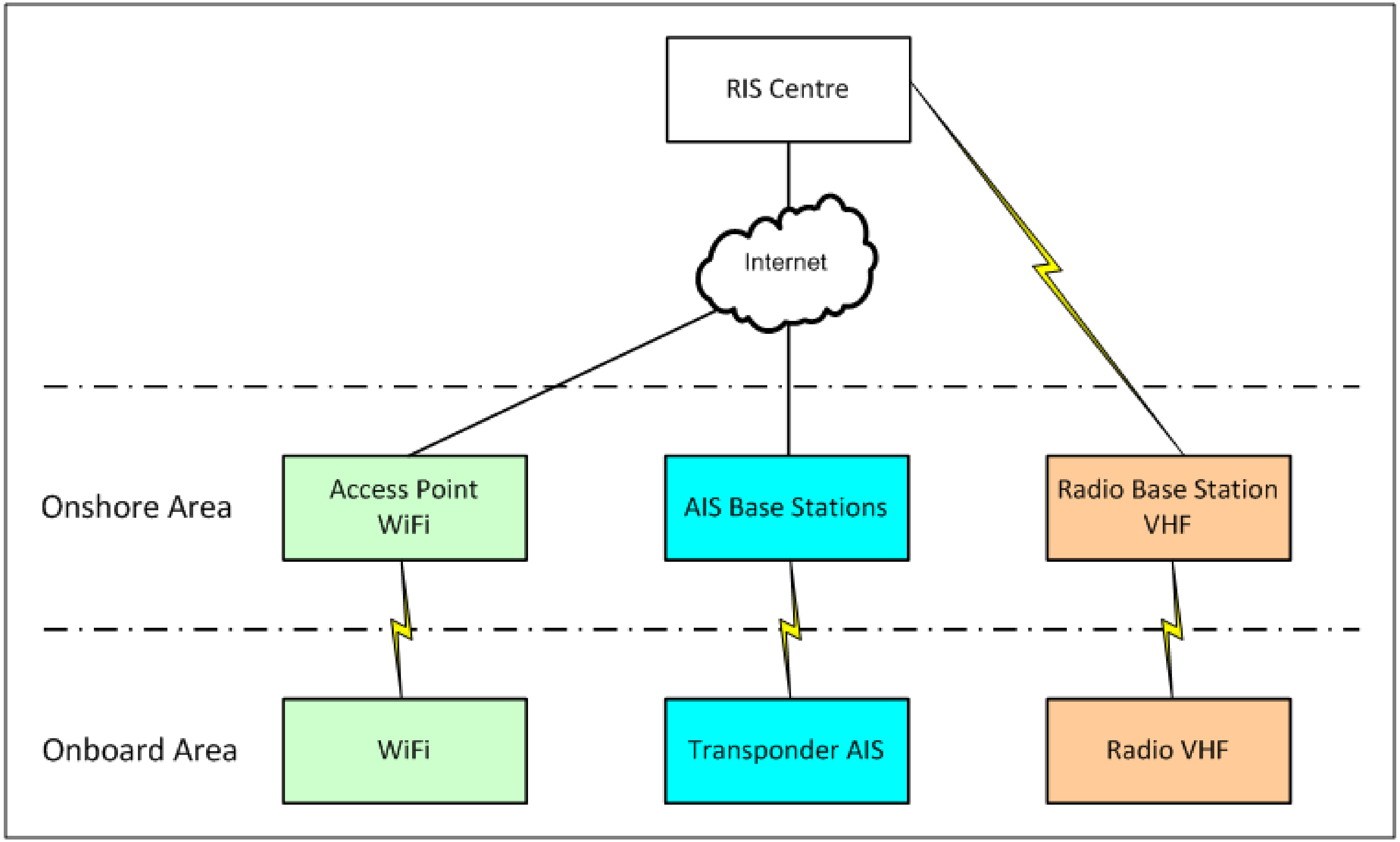


RIS CENTRE


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.

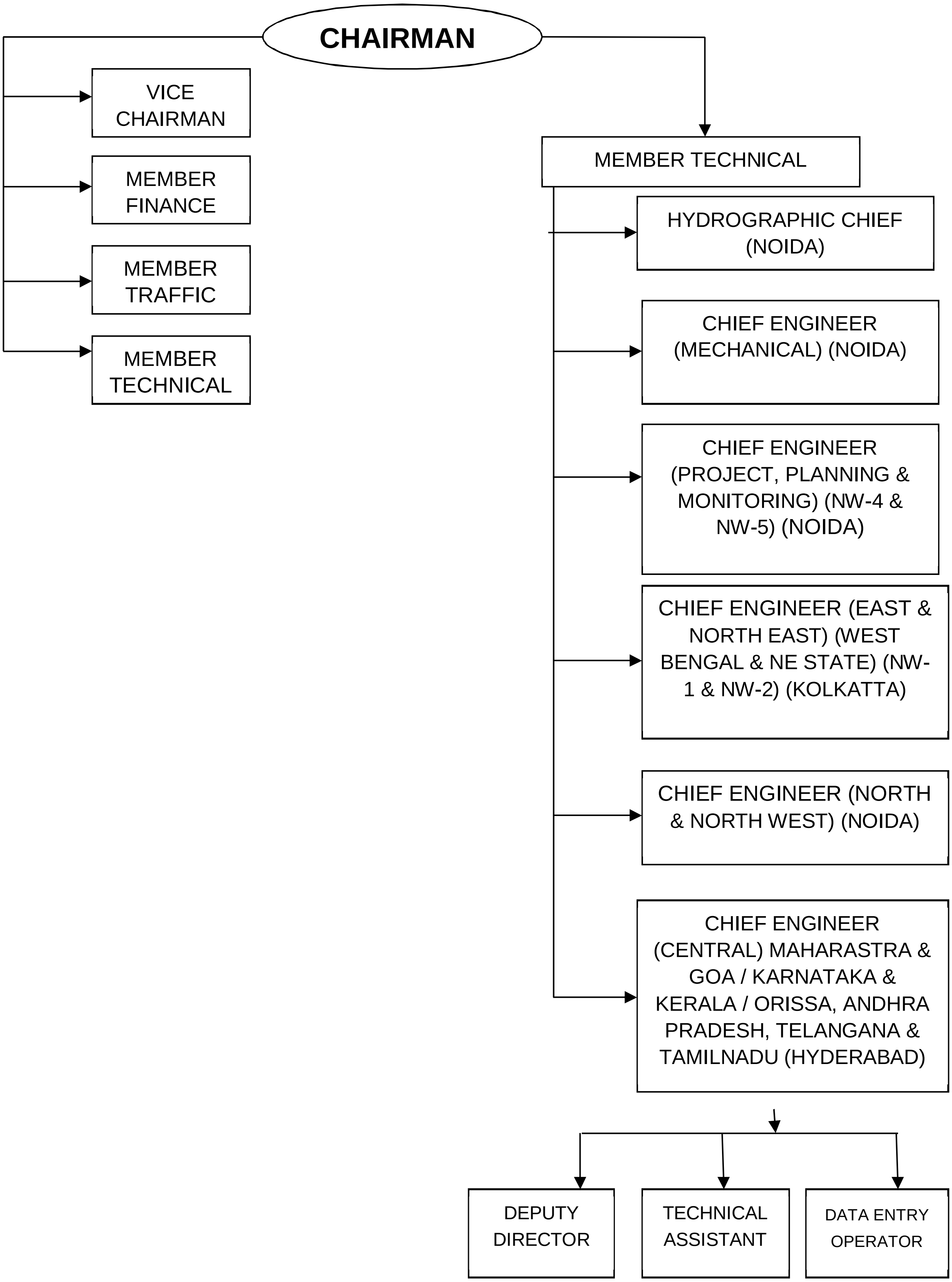
xxviii. The Vessels shall comply the emission norms prescribed from time to time.

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.

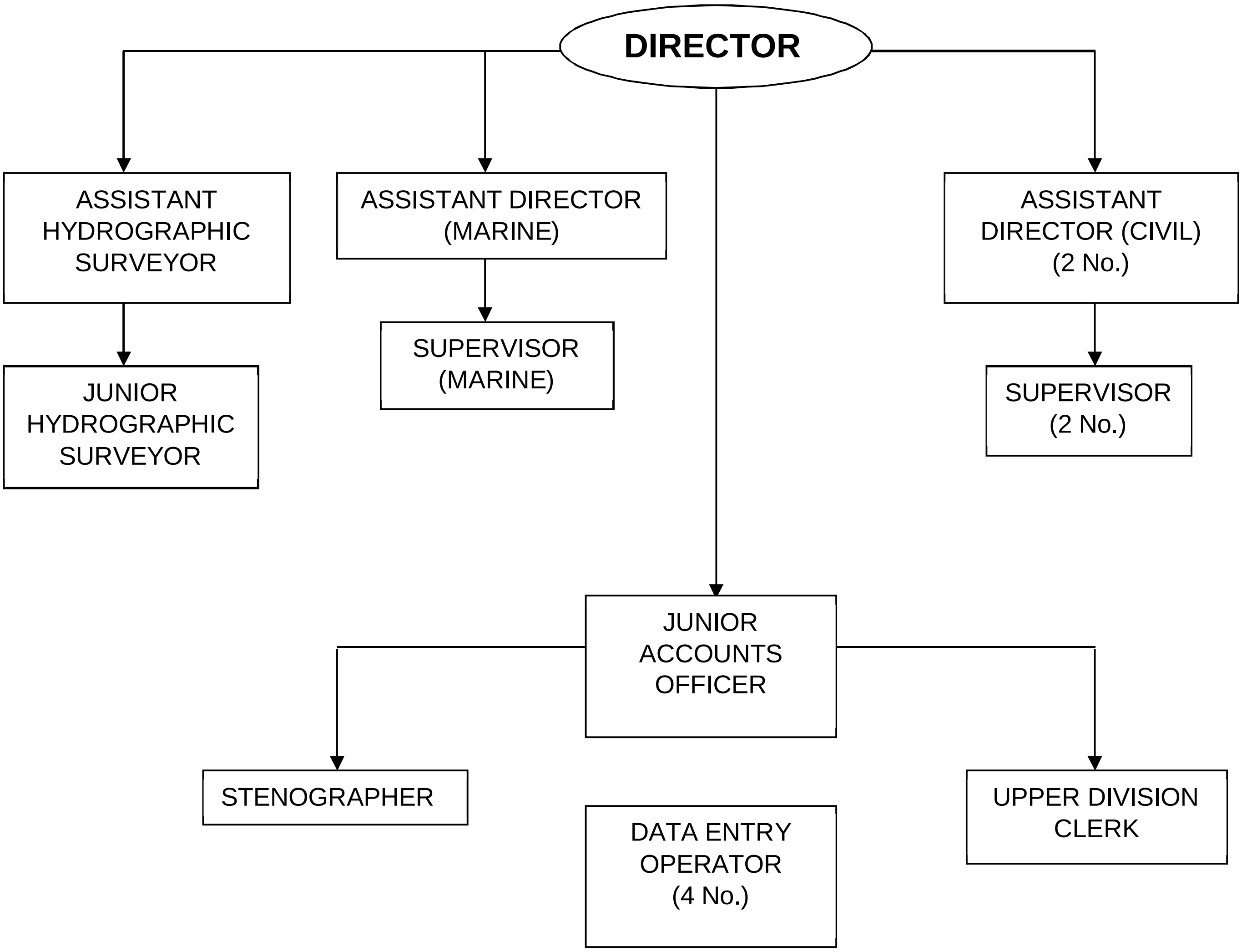
21/12/17

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%.

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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

Phase 1:

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Dredging in General Soil	Cum	30,60,000	300	9180.00
2	Dredging in Hard Soil	Cum	3,40,000	1800	6120.00
	Total Cost of Dredging				**15300.00**

Phase 2:

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Dredging in General Soil	Cum	6,60,000	300	1980.00
2	Dredging in Hard Soil	Cum	75,000	1800	1350.00
	Total Cost of Dredging				**3330.00**

INR 200/ per Cu. M + 20 % for escalation + 30 % for Managing the disposal
Considered 6 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	354.54	40.35	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				616.09	
	Cost of Bank Protection Works for 1 m				1.23	
	Cost of Bank Protection Works for 2000 m for 4 locations				**2464.37**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.4 (a) –COST OF NIGHT NAVIGATION WORKS (Beacon & Lights)

Phase 1:

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		5		**98.27**

Phase 2:

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		6		**117.93**

Rates based on Quotation / Market Rates

ANNEXURE 11.4 (b) –COST OF NIGHT NAVIGATION WORKS (Buoy & Lights)

Phase 1:

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks
1	Providing and laying 1.8 m dia. Polythene Buoy, Mooring Gear & fixing Lighting Equipments	No.	50	3,36,250	168.13	Market rate as per quotation
2	Addition for RIS Chip embedment etc.,.	No.	50	50,000	25.00	Lump sum
	Cost of Night Navigation Works				**193.13**	

Phase 2:

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks
1	Providing and laying 1.8 m dia. Polythene Buoy, Mooring Gear & fixing Lighting Equipments	No.	60	3,36,250	201.75	Market rate as per quotation
2	Addition for RIS Chip embedment etc.,.	No.	60	50,000	30.00	Lump sum
	Cost of Night Navigation Works				**231.75**	

ANNEXURE 11.5 –COST OF LAND FOR RO-RO & LO-LO

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Land Area Cost				
(i)	Land inside the terminal area	m^2	47000.00	1120.00	526.40
(ii)	Land required for Road Extension or construction of external approach road	m^2	2500.00	1120.00	28.00
(iii)	Area under Mangrooves clearance	m^2	4240.00	1120.00	47.49
(iv)	Boundary wall 250 mm thk brick masonary (1:6) surrounding the entire terminal on 3 sides except RORO and LOLO side	m^2	2000.00	1120.00	22.40
2	Filling & compaction Cost	m^3	117500.00	168.00	197.40
	Total Cost of Land				**821.69**

Rate As Rs.39 lakh per Acre.

1 Acre = 4047 m2

1120.00 Rs. Amount for 1 m2 land

ANNEXURE 11.6 (A) – COST OF RIVERINE STRUCTURES AT AMBA RO-RO FACILITY

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	References
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	9			
	Grid B	No	9			
	Grid C	No	9			
	Total Piles	cu.m	538			
1.2	Pile Caps (1800x1800x1000)	cu.m	77.76			
1.3	Longitudinal Beams (1000x1250)					
	Grid A	cu.m	105.00			
	Grid A1	cu.m	105.00			
	Grid B	cu.m	105.00			
	Grid B1	cu.m	105.00			
	Grid C	cu.m	105.00			
1.4	Cross Beams (18000x1500)					
	grid 1 to 8	cu.m	358.56			
1.5	Deck Slab	Cu.m	488.04			
	Total Concrete	**Cu.m**	**1986.93**	7948.89	157.94	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	80.63			
2.2	Pile Caps (1800x1800x1000)	MT	6.22			
2.3	Longitudinal Beams (1000x1250)					
	Grid A	MT	18.90			
	Grid A1	MT	18.90			
	Grid B	MT	18.90			
	Grid B1	MT	18.90			
	Grid C	MT	18.90			
2.4	Cross Beams (18000x1800)					

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	References
	grid 1 to 8	MT	64.54			
2.5	Deck Slab	MT	58.56			
	Total Reinforcement	**MT**	**304**	70350.83	214.19	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	66,000	79.20	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 Amba Riverrine Structures at RORO Terminal				**486.28**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 11.6 (B) –COST OF RIVERRINE STRUCTURES AT AMBA LO-LO FACILITY

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	
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 1.4 m diameter					
	Vertical Piles					
	Grid A	No	16			
	Grid B	No	16			
	Grid C	No	16			
	Grid D	No	16			
	Grid E	No	16			
	Total Piles	cu.m	2,155			
1.2	Pile Caps (1800x1800x1000)	cu.m	178.20			
1.3	Longitudinal Beams (1200x1500)					
	Grid A	cu.m	216.00			
	Grid A1	cu.m	216.00			
	Grid B	cu.m	216.00			
	Grid B1	cu.m	216.00			
	Grid C	cu.m	216.00			
	Grid C1	cu.m	216.00			
	Grid D	cu.m	216.00			
	Grid D1	cu.m	216.00			
	Grid E	cu.m	216.00			
1.4	Cross Beams (2000x1800)					
	grid 1 to 14	cu.m	1612.80			
1.5	Deck Slab	Cu. m	1344.00			
	Total Concrete	**Cu. m**	**7234.13**	7948.89	575.03	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	Piles 1.4 dia	MT	323.27			
2.2	Pile Caps (1800x1800x1000)	MT	14.26			
2.3	Longitudinal Beams (1200x1500)					

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	
	Grid A	MT	38.88			
	Grid A1	MT	38.88			
	Grid B	MT	38.88			
	Grid B1	MT	38.88			
	Grid C	MT	38.88			
	GridC1	MT	38.88			
	Grid D	MT	38.88			
	Grid D1	MT	38.88			
	Grid E	MT	38.88			
2.4	Cross Beams (2000x1800)					
	grid 1 to 14	MT	290.30			
2.5	Deck Slab	MT	161.28			
	Total Reinforcement	**MT**	**1,139**	70350.83	801.32	DSR 2016, Cl.no.5.22.4 and factored
3.0	**Structural Steel works**					
3.1	Structural Steel hand rail with steel grade Fy=240 Mpa	MT	120	66,000	79.20	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	8	82,500	6.60	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			50.00	LS
	Total cost of Amba Riverrine Structures at LOLO Terminal				**1,512**	

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 Storage Area	1	200 m x 100 m	20000	5,934	1,186.75
2	Covered Storage Godown	1	100m x 30m	3000	17,801	534.04
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	Parking for Handling equipments	1	30m x 15m	450	1,333	6.00
6	Main Parking Area	1	30m x 30m	900	1,010	9.09
7	Public Utility	1	6m x 4m	24	29441.54	7.07
8	Weigh bridge	1	8m x 3m	24	250000	60.00
9	Utility Room (Near Weigh Bridge)	1	3m X3m	9	29441.54	2.65
10	Internal Roads	1	600 m X 7.5m	-	15000	90.00
11	Administration building	1	12 m x 15 m	180	37860.29	68.15
12	Business Area	1	10m x 3m	30	37860.29	11.36
13	Staff Parking Area-4 wheelers	1	13.5m x 6m	81	1332.65	1.08
14	Staff Parking Area-2 wheelers	1	8m x 2m	16	1446.50	0.23
15	Security shed for watch and ward	2	4m x 4m	32	4029	1.29
16	Electrical facility	1	5m x 5m	25	14087	3.52
17	Fuel Bunkers	1	10m x 5m	50	5555.56	2.78
18	Water Supply Room	1	3m x 4m	12	14,170	1.70
19	Fire and Safety Room	1	3m x 4m	12	18337	2.20
20	DGPS receiver & transmitter shed	1	8m x 4m	32	6824.75	2.18
21	DG shed	1	5m x 5m	25	6643.5	1.66
22	Canteen with Store	1	12m x 8m	96	13629.69	13.08
23	Sewerage Treatment Plant (STP)	1	15m x 15m	225	12437	27.98
24	Overhead Tank	1	10m dia	78.5	1923.08	1.51
25	Green Area	1		1000	800	8.00
26	Future Requirement	1		2000	600	12.00
	Total cost of Other Components					**2,138.32**

* 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 11.8 –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 (7.5m wide road)	m	100.00	15000	15.00
2	Pipe Culvert on External Road			LS	3.50
	Total Cost of Approach Roads				**18.50**

* 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	17400	3231.30	562.25	DSR 2016, Cl.no. 16.95
2	Providing and laying geotextile as per technical specifications	Sqm	11380	354.54	40.35	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				**616.09**	

Note: The Rates have been marginalised based on the site condition etc., by applying nominal variation factors.

ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE (FAIRWAY)

AMBA RIVER

Sl.No.	Items	Months																																			
		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 (Phase1)																																				
	Ordinary Soils (Approvals & Tendering)																																				
	Ordinary Soils (Execution of 34,00,000 Cu. M)																																				
	1.b) Dredging (Phase2)*																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (Phase2)*																																				
	4. Night Navigation																																				
	Beacon/ Lights & Buoy / Light (Approval & Tendering)																																				
	Beacon / Lights (5 Nos) & Buoy / Light (50 Nos)																																				
	5. Land Acquisition (No land acquisition for fairway)																																				
B	**Modification of Structures**																																				
	Rerouting of Pipe lInes																																				
C	**Communication System**																																				
	River Information System																																				
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 implementation will be from 2025 to 2028 (36 month) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended, since there is no cargo volumes beyond Ch 20.00km (upto Ch 44.971 km).

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE (TERMINALS)

AMBA RIVER

Sl.No.	Items	Months																																			
		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)																																				
	Vessels																																				
	Cargo Handling Equipments																																				
	Ambulance - 1 no.																																				
	Cranes with 125 T Capacity - 4 no.																																				
	Fork lift trucks 20 T Capacity - 2 no.																																				
	Environmental Management Plan																																				
B	**Ro - Ro Terminal (Phase 2)***																																				
	Land Acuisition																																				
	Riverine Components																																				
	Infrastructure Components including internal roads																																				
	Infrastructure Components including internal roads																																				
	Approach Road Cost																																				
	Bank Protection Works for terminal																																				
	Vessels																																				
	Cargo Handling Equipments																																				
	Ambulance - 1 no.																																				
	Cranes with 125 T Capacity - 4 no.																																				
	Fork lift trucks 20 T Capacity - 2 no.																																				
	Environmental Management Plan																																				

*Phase 2 implementation will be from 2025 to 2028 (36 month) after analysing the Growth Trend in cargo etc and may have to be stalled, if not viable. As such not recommended, since there is no cargo volumes beyond Ch 20.00km (upto Ch 44.971 km).

LIST OF DRAWINGS

Sl.No	DRAWING NAME	DRAWING NUMBER
1.	LAYOUT PLAN OF AMBA RIVER (7 SHEETS)	P.010257-W-20301-A03
2.	TERMINAL LOCATION MAP OF AMBA RIVER (1 SHEET)	P.010257-W-20351-X03
3.	TERMINAL LAYOUT PLAN (WITH PROPOSED INFRASTRUCTURE FACILITY (1 SHEET)	P.010257-W-20311-A03
4.	LO-LO/RO-RO TERMINAL PLAN (5 SHEETS)	P.010257-W-20341-E03
5.	BANK PROTECTION TYPICAL SECTION (1 SHEET)	P.010257-W-20303-X03