CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER-6 NATIONAL WATERWAYS: KERALA (NW-8)

DETAILED PPROJECT REPORT : ALAPPUZHA-CHANGANASSERY CANAL (29.30Km)-(NW-8)
VOLUME-I: MAIN REPORT (Final)
Project No.: P.010631
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Inland Waterways Authority of India (IWAI) - Government of India
Noida | India

RESTRICTED

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DPR – ALAPPUZHA – CHANGANASSERY CANAL (29.123KM) NW-8

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Client: **INLAND WATERWAYS AUTHORITY OF INDIA**

Project: **CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER – 6 (KERALA) OF NATIONAL WATERWAYS**

Subject: **DETAILED PROJECT REPORT – ALAPPUZHA – CHANGANASSERY CANAL (29.123 km) NW-8**

Comments:

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01	2019 07 26	B. C. Jha	Submitted for Review and Approval.
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ACKNOWLEDGEMENTS

Inland Waterways Authority of India (IWAI) assigned the Consultancy Services for “Preparation of Second Stage Detailed Project Report (DPR) of Cluster – 6 (Kerala) 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); 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)

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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 – 6 (Kerala) of National Waterways" by Inland Waterways Authority of India (IWAI). Accordingly, the study on ALAPPUZHA - CHANGANASSERY CANAL (29.30 KM) NW – 8 has been carried out for this assignment / analyzed / compiled based on the findings of the following field studies / investigations.

Detailed Hydrographic Survey along with the Topographical Survey was carried out from 26/03/2017 to 09/05/2017.

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

Terminal Land Survey was carried out on 29/04/2017.

Geotechnical Borehole was carried out from 30/07/2017 to 01/08/2017 and subsequently Laboratory Tests have been carried out on the collected samples.

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.

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DETAILED PROJECT REPORT – ALAPPUZHA – CHANGANASSERY CANAL (29.123 KM) NW-8

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LIST OF ABBREVIATIONS

Abbreviations	Acronyms
CD	Chart Datum
Ch	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning System
DMIC	Delhi Mumbai Industrial Corridor
DPR	Detailed Project Report
FSL	Full Supply Level
GAIL	Gas Authority of India Ltd.
HC	Horizontal Clearance
IO	Iron Ores
IOCL	Indian Oil Corporation Ltd.
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
KIOCL	Kudremukh Iron Ore Company Limited
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
MRPL	Mangalore Refineries and Petrochemicals Ltd.
MSME	Micro Small & Medium Enterprises
MTPA	Metric Tonne per Annum
NH	National Highway
NW	National Waterway
OMPT	Old Mangalore Port Trust
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
SEB	State Electricity Board
SH	State Highway
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

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SALIENT FEATURES

#	Particulars	Details			
A	**GENERAL**				
1	***Location***				
a	Cluster	Cluster-6			
b	State(s)	Kerala			
c	Co-ordinates & Name of Place	**Start**	**End**		
	Place	Alappuzha	Changanassery Jetty		
	Latitude	09°30'02.85"N	09°26'41.61"N		
	Longitude	76°20'37.05"E	76°31'41.76"E		
B	**TECHNICAL**				
1	***Waterway***				
a	National Waterway Number	NW-8			
b	Class	III (up to 29.123km)			
c	Type (Tidal/Non-Tidal)	The survey Stretch of Alappuzha - Changanassery Canal is partially tidal. During the survey period the Thannermukkam bund lock is close thus there is no influence of tidal force throughout the survey period. Therefore, during survey period canal is non tidal.			
	Length (Km.)	**Total**	**Tidal**	**Non-Tidal**	
		29.123 km	29.123 km	---	
d	Average Tidal Variation, if applicable	Non tidal during survey period due to gate closure of Thinurmukhum. Therefore no tide variation.			
e	Chart Datum				
	Description/Basis	CHRY-1	CHRY-2	CHRY-3	CHRY-4
	Value (Chart Datum below MSL)	-0.500	-0.466	-0.426	-0.400
f	LAD Status (w.r.t. CD)				
		Stretch-1 (km)	**Stretch-2 (km)**	**Stretch-3 (km)**	**Total (km)**
	Stretch (From 0.0To 29.123)	0.00 – 10.00	10.00-20.00	20.00-29.123	
	Length with LAD < 1.5 m	1.00	1.00	3.003	5.003
	With LAD from 1.5-1.8 m	1.00	1.00	1.00	3.00
	With LAD from 1.8-2.2 m	1.00	0.00	0.17	1.17
	With LAD from 2.2 -2.5 m	2.00	2.50	2.50	7.00
	With LAD > 2.5 m	5.00	5.50	2.45	12.95
	Total	10.0km	10.0km	9.123km	29.123km
g	Target Depth of Proposed Fairway (m)	2.20m upto Ch 29.123 km			
h	Conservancy Works Required	4.46 Lakhs Cu. M of Dredging with 15 km of Bank Protection			
i)	Existing Cross Structures				

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#	Particulars	Details				
	Name of Structure	**Type**	**Nos.**	**Range of Horizontal Clearance**	**Range of Vertical Clearance w.r.t. MHWS/HFL**	
	Dams/Barrages/Weirs/Aqueducts etc.	Nil	Nil	Nil	Nil	
	Bridges	Foot-Over/ Road	5	15-20m	3.5-7.5m	
	HT/Tele-communication lines	Nil	50	19-300	5.2-18m	
	Pipelines, underwater cables, etc.	Water Pipe Line	1	82m	6m	
2	***Traffic***					
A	Present IWT Operations (type of services)	No cargo operation. Only tourism related activities like Houseboat & passenger ferry service in NW 8				
B	Major industries in the hinterland (i.e. within 25 km. on either side)	No major industries. All are small scale industries. Volume are not enough and production is based on demand & customer requirement.				
C	Connectivity of major industries with Rail/Road network (Distances/ Nearest Railway Stations etc.)	✓ Major roads – SH 11 is major highway which runs parallel to NW 8. N.H. 66 connects Alappuzha with Thiruvananthapuram & Cochin, N.H. 183 connects Changanassery with Kottayam & Adoor. ✓ Major railway – Southern railway runs in Alappuzha & Changanassery.				
D	Commodities	**In-bound**	**Out-bound**			
	NA	n/a	n/a			
E	Future Potential ('00)	**Existing Terminals on NW 8 (At present there are 13 jetties on NW 8) are being used for handling passenger traffic. Houseboat also operates on this route. Therefore, no additional demand or need exist for another passenger or tourism terminal. However, for exception case Ro-Ro terminal could be developed, if it is logistically viable. Following is the traffic that could be achieved if Ro-Ro terminal is developed with subsidy. It is assumed that terminal would get developed in FY 23)**				
	Name of Commodity	**5 yr. (Fy-20)**	**10 yr. (Fy-25)**	**15 yr. Fy-30)**	**20 yr. (Fy-35)**	**25 yr. (Fy-40)**
	Changanassery To Kochin Port (Loaded Trucks + Containers) Ro-Ro	222	246	271	299	330
	Kochin Port to Changanassery (Loaded Trucks + Containers) Ro-Ro	246	270	298	327	361
	Proposed IWAI Terminal on NW8					
1	Tourism	--				
3	***Terminals/Jetties***					
A	Terminal/Jetty	Ro-Ro				
	Location (Bank/city/district)	09°26'26.31" N & 76°31'29.83" E near Changanassery in Kottayam District				
	Type/Services	Ro-Ro / Tourism				

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#	Particulars	Details	
	Facilities	Ambulance is provisioned	
	Approach	Road is available	
	Land Ownership		
	Area (ha.)	**Govt.**	**Private**
		1.5 ha	NIL
4	***Design Vessel***		
a	Type	Ro-Rovessels	
b	No. & Size	1 Ro-Ro vessel 50 m – 55 m (LOA) x 9 m – 12 m (Breadth)	
c	Loaded Draft	1.6 m – 1.8 m	
d	Capacity	300 T – 500 T / 15 TEU – 21 TEU (Equivalent Ro-Ro)	
5	***Navigation Aids***		
a	Type	Buoy and Light	
b	Nos.	65	
b	Communication Facilities	Not Suggested.	
C	**FINANCIAL**		
1	***Project Cost***		
a	Capital Cost	Fairway	Ro-Ro
	Cost (INR) - **Option -1**	50.328 cr	24.950 cr
	Cost (INR) - **Option -2**	74.615 cr	24.950 cr

This financial analysis for the navigation infrastructure (fairways), and terminal operations (Ro-Ro) has been shown in the table below while the detail analysis is discussed in chapter 13.

Scenario	**Project Components**	**Cost in Lakhs (Rs.)**	***Financial Internal Rate of Return (FIRR %)***	***Economic Internal Rate of Return (EIRR %)***
Scenario I :- Project Cost Option 1 and IWAI Tariff	Fairway Cost	5032.81	Non-Existent	56.8%
	Ro-Ro Cost	2495.02	-5.1%	56.8%
Scenario II :- Project Cost Option 1 and MbPT Tariff	Fairway Cost	5032.81	-11.0%	62.6%
	Ro-Ro Cost	2495.02	4.9%	59.8%
Scenario III :- Project Cost Option 2 and IWAI Tariff	Fairway Cost	7461.51	Non-Existent	36.5%
	Ro-Ro Cost	2495.02	-5.1%	56.8%
Scenario IV :- Project Cost Option 2 and MbPT Tariff	Fairway Cost	7461.51	Non-Existent	41.2%
	Ro-Ro Cost	2495.02	4.9%	59.8%

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EXECUTIVE SUMMARY

The Canal stretch from Alappuzha to Changanassery is one of the waterways declared as National Waterway in March, 2016 as NW 8. The Alappuzha Changanassery Canal is greatly depended for discharging water from the paddy polders to the Pallathuruthy River with Agricultural plots on either side of the canal; Small markets at Kavalam, Kidangara etc; Large Agricultural Lands; Manorama Church at Kuppappuram; Lake Vembanadu etc. National Waterways NW 8, NW 9 and NW 59 are traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar. The Vembanad Wet Land System covers an area of over 2033 km^2 thereby making it the largest wetland system in India.

The stretch of 28 kms from Boat Jetty, Alappuzha at Lat 09°30'02.85"N, Long 76°20'37.05"E to Changanassery Jetty at Lat 09°26'41.61"N, Long 76°31'41.76"E has been proposed for undertaking the two stage DPR. M/s Tractebel has been assigned with the work of Preparation of the two stage DPR. Subsequent to the Stage 1 preliminary findings, the Waterway stretch of 29.30 kms from Alappuzha Boat Jetty to Changanassery Jetty 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 has been estimated. In sequence, Terminal Development, Vessel Requirement and Financial Analysis have been considered.

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Based on the Hydrographic Survey inputs and other site data collected on NW 8, it has been noticed that 5 Nos. of Bridges; 50 Nos. of Power Cables and 1 No. Pipe Line are present / crossing the study area. No Dams / Barrages / Locks / Weirs / Anicuts / Aqueducts are located. 21 Nos of Bend locations have been identified in the study stretch, with 25 m as lowest at Ch. 28.7 km. 1 No. Bridge at Ch. 24.16 km is suggested for modification. Lump Sum provision has been catered for stringing Power Cables. Day / Night Navigation system is suggested. Land Acquisition of 12 Hectares is essential along with 15 kms of Bank Protection. Most of the Bends will vanish, while widening.

Present study stretch of NW 8 is being used for Passenger Ferry mobility by Kerala State Water Transport Department (HQ: Alappuzha) by deploying the Passenger vessels. No Cargo mobility is observed in the stretch. The Geographical advantage of NW 8 is that the same is inter-connected with the existing NW 3 and inter alia connecting Kottappuram in the North and Kollam in the south and also the Kochi area including the ICTT, Kochi through Waterway. The South Eastern part of the country will be the hinter land for Changanassery.

Keeping in view of the above, the possibility of Ro-Ro operation has been tried out and the estimated traffic volumes will be to the extent of about 46,800 vehicles in FY 20 and may grow to 69,100 vehicles in FY 40. The mode shift will reduce the congestion on the road, especially in the land scarce Kerala. However, as a part of suggestion / recommendation for the development of NW 8, no recommendation is proposed on immediate basis. The development is suggested only with the observed positive growth confirmations through Ro-Ro mobility and such micro level observation is suggested till 2022. Development is estimated there upon in 3 yrs from 2022, if such need is felt.

The fairway requirements are being considered for analysis for its maximum / optimum utilization. Keeping in view the Ro-Ro operation, the mobility of Class III vessel with Canal standard is being considered with 15 TEUs (Equivalent Ro-Ro) capacity. The vessel requirement is 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each. The Fairway requirement has been considered in line with the present NW 3 standards to have a throughput with 32 m Bottom Width of fairway in narrow reaches and 38 m Bottom Width of fairway in wider reaches however with 2.2 m Depth of fairway in both the reaches. Clearance corridor of 40 m Horizontal Clearance (HC) and 6 m Vertical Clearance (VC) is the requirement specified at Cross structures for safe passage of Vessel.

The fairway size and dredging quantities of the study stretch are placed below for Class III waterway for the study stretch of NW 8.

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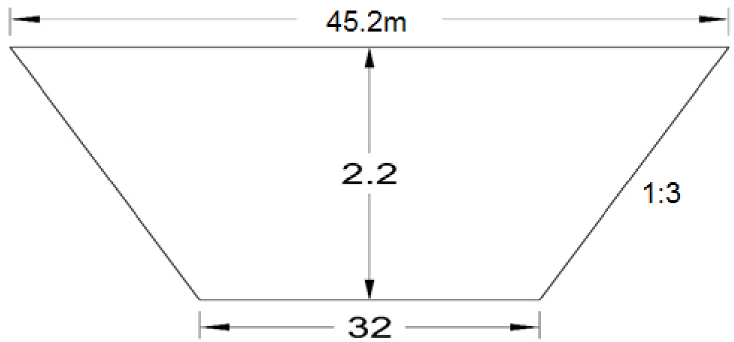
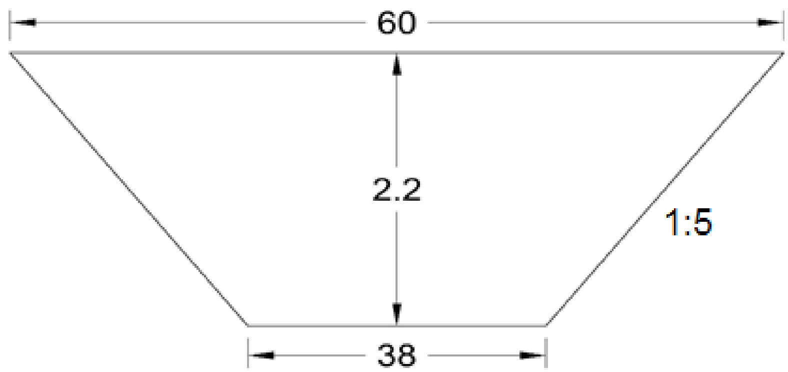


Narrow Reaches with 50 m Land Acquisition.



Wider Reaches with No Land Acquisition.

CLASS-III

CLASS	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	0	10	13.60	0.00	1950.0	44650.31	12.70	-3.15	4650	203964.99
	10	20	9.00	0.89	750.0	6542.73	8.82	0.10	2600	27489.23
	20	29.123	8. 70	0.00	6470.0	193634.08	8.73	-1.9	7120	316486.87
			Grand	Total	9170.0	244827.12			14370	547941.09
The 1st 2 Kms are not to be considered, since a part is beyond the IWAI Cargo Terminal and a part is the existing NW 3 stretch. Accordingly, deduction of quantity has been affected.									2000	141930.41
			Net quantity being considered						12370	406010.68

Accordingly, the shoal length is of 12370 m and the respective estimated dredging quantity has been computed as 4.06 Lakhs Cu. M. Apart from the above Fairway developments, some Institutional Requirement has also been suggested.

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IWAI Terminal requirement has been considered with 1 Roll-on Roll-off (Ro-Ro) IWT Terminal at Changanassery for entry / exit of the vehicles. The most probable location for such Berthing / Ro-Ro IWT Terminal at the other end (one end is Ro-Ro Terminal at Bolghatty, Kochi) is in Chanaganssery with approx. Lat 09° 26' 26.31" N and Long 76° 31' 29.83" E. A tentative Land requirement has been worked out and arrived at with 13083 Sq. M at Changanassery. Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Changanssery Village; Changanassery Taluka; Kottayam District of Kerala state. Terminal Infrastructure has been considered to suit to the Ro-Ro operation with the length of the Berthing structure as 75 m and width as 12 m.

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

The following Vessel standard is suggested for a cautious deployment as per the requirement.

SPV / Ro-Ro Vessel:	**(300 T – 500 T / 15 TEUs – 21 TEUs) INR 700 Lakhs each**
LOA	50m – 55m
Breadth	9m – 12m
Loaded Draft / Depth:	1.6m – 1.8m / 2.2m +
Propulsion:	Marine Diesel Engines of 3 x 375 Bhp
Speed (with Load):	20 Kmph (Av)

1 Ro-Ro vessel may be required at the initial stages i.e., by 2023. Other Ro-Ro vessel may be considered based on the requirement at that point of time.

Regarding the Navigation & Communication System, it has been worked out the provision of RIS / AIS / Locating the Vessels / Buoys. An attempt has been made to ascertain the details on the Vessels Traffic Management System (VTMS). It was observed that the same is more costly than the RIS system and has not been discussed. A feasible system could not be recommended at this point of time.

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 /

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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 that NW 8 will be a part of the present Kochi office and as a supporting system for NW 3. Hence, a nominal provision of INR 40 Lakhs (approx.) is suggested.

The cost estimates have been worked out for development of Fairway with a capital cost of 50.328 Cr and Terminal with a capital cost of 24.950 Cr. This is Option-1 for the project development. Implementation of the above is suggested in 3 years from 2022. It is suggested for the observations and firming up of the Ro-Ro traffic volumes up to 2022 and the investment for development is suggested only after having positive growth trend and confirmation. There is another consideration as suggested by Govt. of Kerala regarding implementation of some new & reconstruction of cross over existing facilities/ structures and an option-2 has been mooted which will further add to the financial implication in light of suggestions received from Kerala Govt. The cost of Option-1 is 75.278 Crores with its breakup as below:

Sl No.	Parameter	INR (In Cr.)
1	Fairway	50.328
2	Ro-Ro Terminal	24.950
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	0.00
	Total	**75.278**

The Cost of option -2 has been considered taking the financial impact of the suggestion of Govt. of Kerala vide their letter Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020. So this will entail the development cost as computed in the option-1 & considering the financial impact of structure suggested & by the Govt. of Kerala.

Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-8) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
1)	Bridge	Cross Structure Under PWD	01	20.00	20.00
2)	Foot Bridge	Cross Structure Under LSGD	03	1.20	3.60

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Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-8) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
3)	LT Lines	Kerala State Electricity Board	50	.01	0.50
4)	Regulator Cum Bridge & Navigation Lock	Irrigation Dept. & Navigation Dept.	---	---	---
5)	Water Pipe -line	Kerala water Authority	01	0.187	0.187
	Total				**24.287**

Therefore, the total cost as per the Option-2 shall be as detailed in the below table.

Sl No.	Parameter	INR (In Cr.)	Remarks
1	Fairway	50.328	Similar to as Per Option-1
2	Ro-Ro Terminal	24.950	Similar to as Per Option-1
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	24.287	As detailed in table above
	Total	**99.565**	

Hence the total cost of project development in case of Option-1 & Option-2 is Rs.75.278 Crores and Rs. 99.565 Crores respectively. The FIRR and EIRR have been worked out for Option-1 & 2 and the critical indicators are placed in the table below.

No	Factors	Section	Unit	Scenarios			
				I	II	III	IV
1	Project Cost	Fairway	Cr.	50.3	50.3	74.6	74.6
		Ro-Ro Terminal	Cr.	24.95	24.95	24.95	24.95
2	Tariff	Vessel Berthing	INR Vessel/Day	1,000.0	1,713.6	1,000.0	1,713.6
		Vehicle Unloading	INR Per Vehicle	50.0	196.9	50.0	196.9
		Fairway Usage	INR GRT-Km	0.02	1.0	0.02	1.0
2	Traffic	Trucks	In Thousands	FY 22 - 48.7 and FY 40 - 69.1			
3	Revenue	Fairway (FY40)	Cr.	0.31	15.6	0.31	15.6
		Ro-Ro (FY40)	Cr.	3.4	6.8	3.4	6.8
4	FIRR	Fairway	-	Non-Existent	-11.0%	Non-Existent	Non-Existent

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No	Factors	Section	Unit	Scenarios			
				I	II	III	IV
		Ro-Ro Terminal	-	-5.1%	4.9%	-5.1%	4.9%
5	EIRR	Fairway	-	56.8%	62.6%	36.5%	41.2%
		Ro-Ro Terminal	-	56.8%	59.8%	56.8%	59.8%

Implementation / Development of NW 8 is not recommended till the confirmations of the Ro-Ro traffic with critical observation till 2022. Investment on Development may be considered only with positive growth confirmations to develop the stretch of NW 8 for about 29 Kms with Class III Canal system of the NW standards.

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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 meager 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 Farakka & Hemnagar (West Bengal); Prayagraj & Varanasi (Uttar Pradesh), Sahebganj (Jharkhand); Dhubri, Dibrugarh & Silchar (Assam), Kollam (Kerala), Vijayawada (Andhra Pradesh) 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.

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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 VI are detailed herewith.

TABLE 1-1: LIST OF RIVERS/CREEKS OF UNDER CLUSTER VI IN THE STATES OF KARNATAKA AND KERALA (LENGTH-453.895KM)

Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
1.	West Coast Canal	NW-3	169.794	Kerala
2.	**Alappuzha - Changanassery Canal**	**NW-8**	**29.300**	**Kerala**
3.	Alappuzha- Kottayam – Athirampuzha Canal	NW-9	51.700	Kerala
4.	Kottayam-Vaikom Canal	NW-59	18.800	Kerala
5.	Gurupur River	NW-43	10.041	Karnataka
6.	Kabini River	NW-51	23.56	Karnataka
7.	Kali River	NW-52	53.415	Karnataka
8.	Netravathi	NW-74	30.000	Karnataka
9.	Panchagangavali (Panchagangoli) River	NW-76	23.000	Karnataka
10.	Sharavati River	NW-90	28.674	Karnataka
11.	Udayavara River	NW-105	16.000	Karnataka

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Sl. No.	Name of Rivers/ Creeks	National Water Way (NW)	Length(km)	State
	Waterways restricted to Stage I study.	**Total**	**453.895**	

Accordingly, the Stage II study for the Alappuzha – Changanassery Canal (NW 8) is under consideration in the present DPR.

A portion of the existing NW 3 from Kollam to Kottappuram; NW 8; NW 9 and NW 59 are traversing through the Vembanad Lake in Kerala. The Vembanad Lake is one of the identified sites of the **Ramsar Convention,** which is an international treaty for the conservation and sustainable use of wetlands. It is also known as the **Convention on Wetlands**.

A Macro Level Route Map of the National waterways in Vembanad Lake along with the major points and the route traversing is presented herewith for more understanding.

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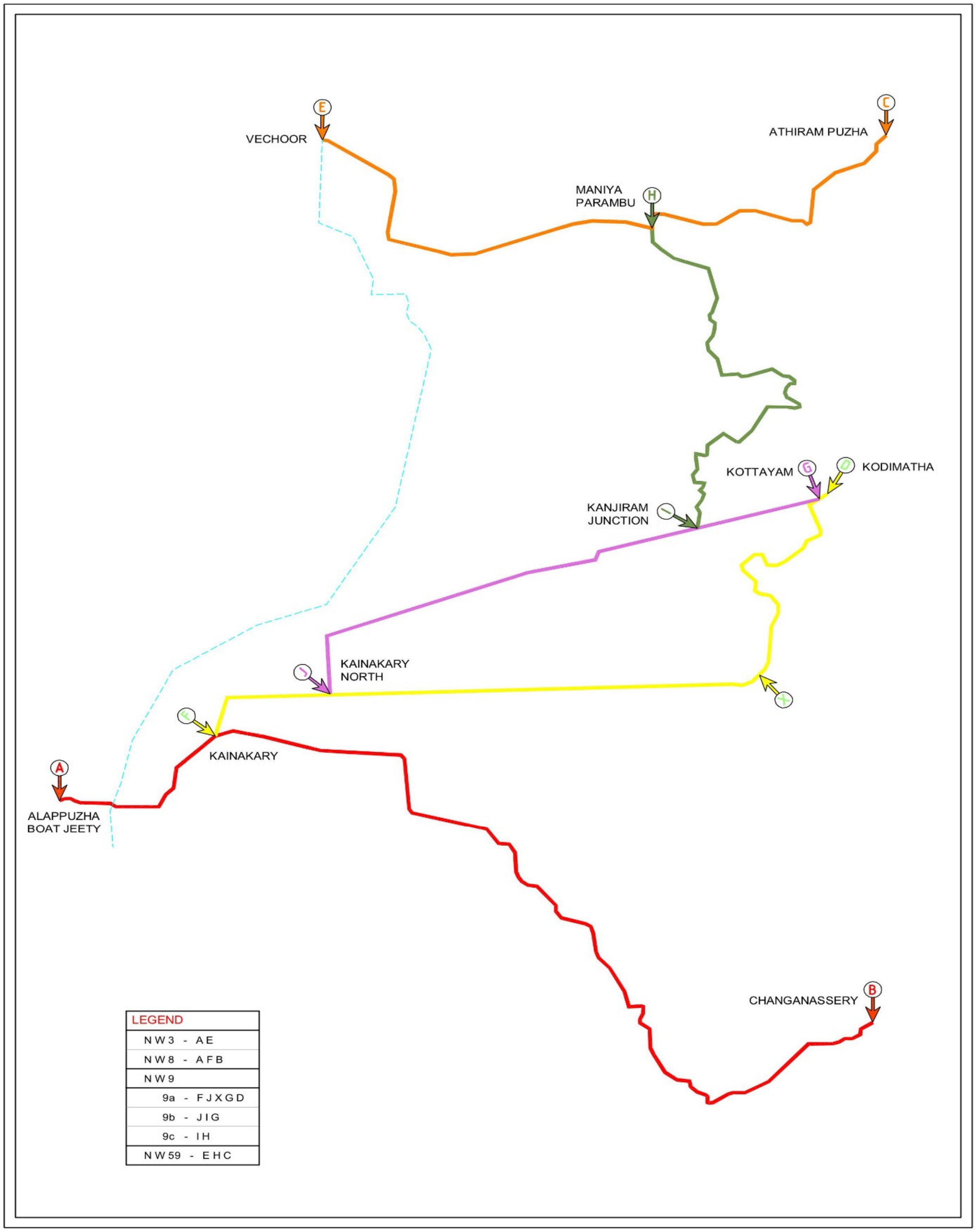

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LENGTH AND POINTS OF NATIONAL WATERWAYS IN VEMBANAD LAKE

ORIGINAL		REVISED	
Name of the Place	Latitude / Longitude	Name of the Place	Latitude / Longitude
NW – 8 **Alappuzha – Changanassery Canal**			
From Boat jetty, Alappuzha (A) To Changanassery Jetty (B)	From 09°30'02.85"N, 76°20'37.05"E. To 09°26'41.61"N, 76°31'41.76"E	From Boat jetty, Alappuzha **(A)** To Changanassery Jetty **(B)**	From 09°30'03"N, 76°20'37"E. To 09°26'42"N, 76°31'42"E
NW – 9 **Alappuzha – Kottayam – Maniyaparambu canal**			
From Boat jetty, Alappuzha (A) To Athirampuzha market (C)	From 09°30'02.85"N, 76°20'37.05"E To 09°40'04"N, 76°31'54"E	From Alappuzha **(F)** To Kottayam near Kodimatha **(D)**	From 09°31'01.31"N, 76°22'44.15"E To 09°34'39"N, 76°31'08"E
		From Kanjiram Junction **(I)** To Maniaparambu **(H)**	From 09°34'09.06"N, 76°29'21.91"E To 09°38'40.18"N, 76°28'42.71"E
		From Kainakary North **(J)** To Kottayam **(G)**	From 09°31'37.75"N, 76°24'19.33"E To 09°34'32.96"N, 76°30'53.39"E
NW – 59 **Kottayam – Vaikom Canal**			
From Kottayam, near Kodimatha (D) To Vechoor joining National Waterway no. 3 (E)	From 09°34'38.67"N, 76°31'07.67"E To 09°40'00.19"N, 76°24'10.65"E	From Vechoor joining National Waterway-3 **(E)** To Athirampuzha Market **(C)**	From 09°40'00"N, 76°24'11"E To 09°40'04"N, 76°31'54"E

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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 investigated.

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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 investigated. 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.

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 11 National Waterways under Cluster VI 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 9 out of 11 National Waterways i.e., 5 in the state of Karnataka and 4 in the state of Kerala, as detailed.

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TABLE 1-2: WATERWAYS FOR STAGE II STUDY

Sl. No.	NW-No. / Name of the Waterway	Defined Limits
	Cluster 6 (Karnataka)	
1.	NW-43 / GURUPUR RIVER	10.041 kms from starting point Lat 12°50' 44.093" N, Long 74° 49' 44.783" E.
2.	NW-51 / KABINI RIVER	23.56 kms from starting point Lat 11°56'0.9311" N, Long 76°14'17.5004" E.
3.	NW-52 / KALI RIVER	53.415 kms from starting point Lat 14°50'33.5786" N, Long 74°07'19.7098" E.
4.	NW-74 / NETRAVATHI RIVER	30.00 kms from starting point Lat 12°50'44.6904" N, Long 74°49'33.3734" E.
5.	NW-90 / SHARAVATI RIVER	28.674 kms from starting point Lat 14°17'56.5621" N, Long 74°25'36.4534" E.
	Cluster 6 (Kerala)	
1.	NW-3 / WEST COAST CANAL	169.794 kms from starting point Lat 10°11'38.9421" N, Long 76°12'04.152" E.
2.	NW-8 / ALAPPUZHA – CHANGANASSERY CANAL	29.3 kms from starting point Lat 09°30'03"N, 76°20'37"E.
3.	NW-9 / ALAPPUZHA-KOTTAYAM-MANIYAPARAMBU CANAL	51.7 kms from starting point Lat 09°31'1.31"N, 76°22'44.15"E.
4.	NW – 59 / VECHOOR – ATHIRAMPUZHA CANAL	18.8 kms from starting point Lat 09°40'0"N, 76°24'11"E.

The present study is about the Alappuzha – Changassery Canal – NW 8 is a canal in the Vembanad Lake, in the state of Kerala.

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TABLE 1-3: DESCRIPTION OF ALAPPUZHA – CHANGANASSERY CANAL (NW-8)

Sl. No.	Introductory Consideration	Description of the Canal
1.	Name of the river / canal	The Alappuzha Changanassery Canal (NW-8)
2.	State / District through which river passes	The present study stretch of the Alappuzha - Changanassery Canal starts from Boat Jetty, Alappuzha of Alappuzha district of Kerala State and ends at Kerala State Water Transport Department Boat Jetty at Changanassery of Kottayam district of Kerala State.
3	Length of the river / canal	Boat Jetty, Alappuzha at Lat 09°30'03" N, Long 76°20'37" E to Changanassery Jetty Lat 09°26'42" N, Long 76°31'42" E has been declared as NW 8 and proposed to undertake the two stage DPR. The Second Stage DPR of 29.30 Kms from Boat Jetty, Alappuzha to Changanassery jetty is under consideration.
4	Map	The index map of Alappuzha Changanassery Canal showing proposed waterway stretch, topographic features and road networks are shown in Figure1.1. The study stretch of NW 8 for the Detailed Project Report (DPR) is presented in **Drawing No. P. 010631-W-20301-A01**.
		Characteristic of River
5	River / Canal Course	The Alappuzha Changanassery Canal is greatly depended for discharging water from the paddy polders to the Pallathuruthy River with Agricultural plots on either side of the canal, small markets at Kavalam, Kidangara etc. Large Agricultural Lands, Manorama Church at Kuppappuram, Lake Vembanadu etc.
6	Tributaries / Network of Rivers / Basin	National Waterways NW 8, NW 9 and NW 59 are traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.
7	Catchment Area	The Vembanad Wet Land System covers an area of over 2033 km² thereby making it the largest wetland system in India.

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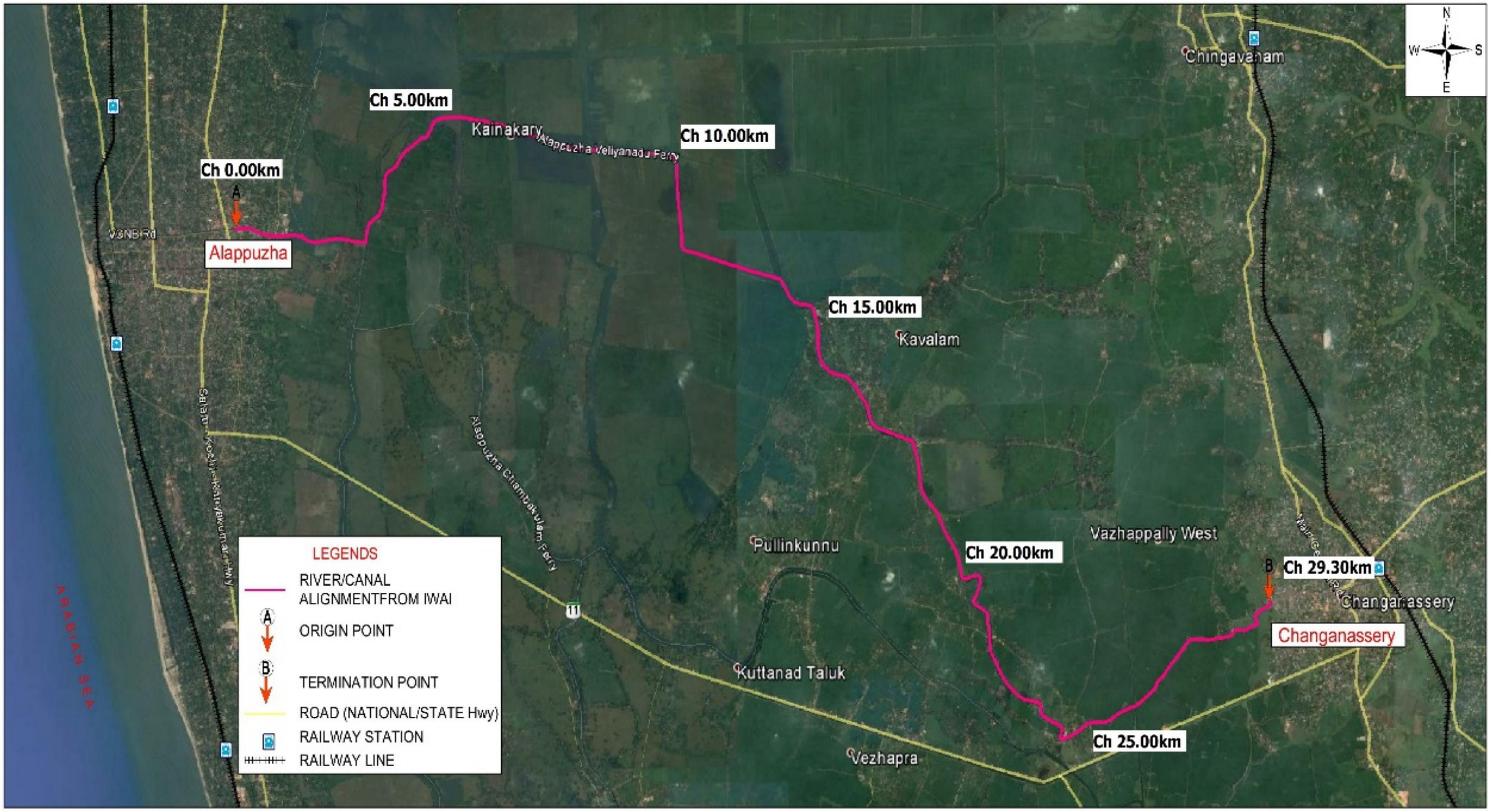

Figure 1-1: Index Map of Alappuzha-Changanassery Canal

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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 defense works, harbours etc.), determination of bed depth of water bodies, by soundings (for navigation, location of rocks, sand bars, navigation light).

2.1.1 Waterway in General and Hydro-morphological Characteristics

Waterway in General

The Alappuzha-Changanassery Canal or National Waterway No. 8 is a 29.3 km stretch of this inland navigational route located in Kerala, India and runs from Alappuzha boat jetty Lat 09°30'02.85"N, Long 76°20'37.05"E to Changanassery jetty Lat 09°26'41.61"N, Long 76°31'41.76"E have been declared as new national waterway and proposed to undertake the two stage DPR.

Alappuzha (or Alleppey) is a city on the Laccadive Sea coast in the southern Indian state of Kerala. It's best known for houseboat cruises along the rustic Kerala backwaters, a network of tranquil canals and lagoons. Alappuzha beach is the site of the 19th-century Alappuzha around the Lighthouse. The city's Mullakkal Temple features a traditional design. Punnamada lake's snake boat races are a well-known annual event. Changanassery is an urban agglomeration in Kottayam district in the state of Kerala, located 18 km south of Kottayam and 8 km north of Thiruvalla on the Main Central road. The Alappuzha Changanassery Canal is greatly depended for discharging water from the paddy polders to the Pallathuruthy River with Agricultural plots on either side of the canal, small markets at Kavalam, Kidangara etc. Large Agricultural Lands, Manorama Church at Kuppappuram, Lake Vembanadu etc.

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Tributaries of Alapuzha Changanassery River

No Major tributaries, its tributaries are small feeder streams and canals. The tributaries in the Alapuzha Changanassery Canal as shown in the map.

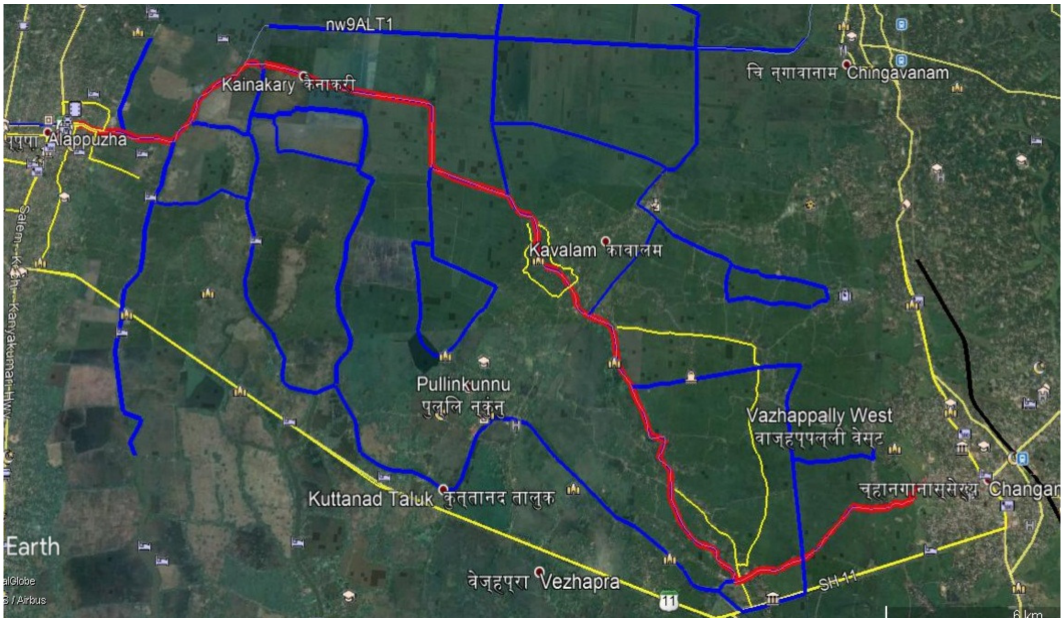

Figure 2-1: Tributaries/ Network of Rivers/Basin

National Waterway NW 8 is traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.

The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summer. The Western Ghats plays a major role in the climatic conditions that prevail all along the state. The period of March to the end of May is the hot season, followed by South West Monsoon season that continued till the beginning of October. From October to December, it is the North East Monsoon season and two months, January and February, are the winter season. The state is extremely humid due to the existence of Arabian Sea in the west of it.

The annual rainfall ranges from 2435.9 to 3755.2 mm and the average annual rainfall of the district is 3169.28 mm. The South West monsoon contributes nearly 59 % of the total rainfall and while the North East monsoon contributes nearly 21% of the total rainfall in this area.

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Ten broad groups of soils are red soil, laterite soil, coastal alluvial soil, riverine alluvial soil, grayish Onattukara soil, brown hydromorphic soil, hydromorphic saline soil, acid saline soil, black soil and forest soil. On the basis of morphological and physico-chemical properties, the Soil in Alappuzha District has classified the soils of Alappuzha district into four types viz. (1) Coastal alluvium (Entisols), (2) Riverine Alluvium (Inceptisols) (3) Brown hypidimorphic soil (Alfisols) and (4) Lateritic soil (Oxisols), whereas in Kottayam Distrct, it has been grouped into (1) Lateritic soil. (2) Riverine alluvium, (3) Brown hydromorphic, and (4) Forest loams.

Vembanad Lake: National Waterways NW 8, NW 9 and NW 59 are traversing within the Vembanad Lake area in Kerala. The diversified ecological system of Vembanad Lake will have its impact on the Development of the above waterways, particularly due to its identification in the Ramsar Wet Land List.

In this context, it is to state that the Ramsar Wet Land Convention was signed way back in 1971 (2nd February, 1971) named after the location of convention where it was signed i.e., Ramsar, Iran consisting of 169 parties. The **Ramsar Convention** is an international treaty for the conservation and sustainable use of wetlands, it is also known as the **Convention on Wetlands**.

In spite of the conventions, treaties and other hard line decisions, study after study demonstrates that wetland area and quality continue to decline in most regions of the world; 64% of the world's wetlands have disappeared in the last century. As a result, the ecosystem services that wetlands provide to people are compromised. Hence, managing wetlands is a global challenge, and the Convention's 169 Contracting Parties recognize the value of having one international treaty dedicated to a single ecosystem. By setting international standards for wetland conservation and providing a forum for discussing global wetland issues, the Convention enables Contracting Parties to share information on wetlands and address issues together.

Many studies have been taken up on the Wet Lands / Estuaries in the World and in India. These studies are in progress on the Hydro Dynamic and Geo Morphological Characteristics on the water body. Regarding the Morphological Characteristics of the estuaries, it may be considered as the long term changes in Sedimentological and Hydrodynamic features which tend to attain a steady state. Several factors including the Topography; Wave activity; Tides; Storms; Inflow Discharge; Hydrodynamics and Human Impacts seem to be the influencing factors on the Estuaries.

The study area of NW 8, NW 9 and NW 59 are within such identified zone of the wet land system viz., The Vembanad wetland system. It covers an area of over 2033.02 km² thereby making it the largest wetland system in India. Of this, an area of 398.12 km² is located below the MSL and a total of 763.23 km² area is located below 1 m MSL.

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The lake is bordered by Alappuzha, Kottayam and Ernakulam districts. It is separated from the Arabian Sea by a narrow barrier island.

The lake surrounds the islands of Pathiramanal, Perumbalam and Pallippuram. The Vembanad Lake is approximately 14 kilometres wide at its widest point. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.

A unique characteristic of the lake is the 1,252 metres (4,108 ft)-long Thanneermukkom salt water barrier (Barrage) constructed as a part of the Kuttanad Development Scheme to prevent tidal action and intrusion of salt water into the Kuttanad low-lands. It is the largest mud regulator in India and essentially divides the lake into two parts, one with perennial brackish water and the other with fresh water from rivers draining into the lake. This barrier has helped farmers in Kuttanad by freeing the area of salinity and allowing them an additional crop in the dry season. The Thanneermukkom barrier is located at one of the narrower parts of the Vembanad Lake. Only two-thirds of the original number of gates is opened in July to release flood flow. These gates remain closed until mid-November. The main drawback of the structure has been the loss of opportunity for fish and prawns to migrate upstream, and also an increase in weed growth in the upstream, severely restricting the natural flushing of pollutants. In order to have the Navigation throughput, Locks have been provisioned in this Barrage.

The Vembanad Wetland system has formed an intricate network of estuaries, lagoons and canals which spans over 196 km in the north-south and 29 km in the east-west directions. Almost all villages in these areas can be accessed via water transport. The major rivers of Muvattupuzha, Meenachil, Pamba and Achencovil rivers, are all navigable up to distances of about 30 km upstream in the tidal reach. The Kottappuram-Kollam segment of the west coast canal system – NW 3, has a major chunk passing through the Vembanad Lake.

The most popular location on the shores of the lake is the Kumarakom Tourist Village situated on the east coast of the lake. The Kumarakom Bird Sanctuary is located on the northern fringes of Kumarakom village. The Lake is at the heart of Kerala Backwaters tourism with hundreds of kettuvallams plied on it and numerous resorts on its banks. The Kumarakom Bird Sanctuary is located on the east coast of the lake. The lake has become a major tourist attraction. The Nehru Trophy Boat Race is conducted in a portion of the lake.

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Waterway Classification: According to the classification of the waterway from class I to class VII, the minimum and maximum width and depth requirements have been circulated and accordingly, maximum width and depth required have been specified as 100 m and 2.75 m for two-way navigation. The analysis in the present study is being relooked with the possibilities for a maximum possible width and depth. The NW 8 is having the connectivity to the existing NW 3, which is under operation and having connectivity to the Kochi Major Port. In view of the above, the class may have to be considered in line with the present movement of Class III standard to have the continuity of the mobility.

2.1.2 Existing Hydrological / Topographical Reference levels

The established benchmark value provided by IWAI office, Cochin at Alappuzha light house. Description of reference benchmark as given:

TABLE 2-1: REFERENCE BENCH MARK

Description	Height above		Benchmark No.
	MSL	CD	
In the middle of first stone step from Top of a flight leading to the entrance of light house at the port of Alappuzha.	11.109ft (3.387m)	13.019ft (3.969m)	6/5

TABLE 2-2 ACCEPTED STATION COORDINATES (WGS-84)

Bench Mark	Chainage (km)	Longitude (E) Latitude (N)	Easting (m) Northing (m)	BM Height above MSL (m)	BM Height above SD (m)
CHRY-1	0.047	076°20'37.9334"E 09°30'03.8083"N	647514.16E 1050534.10N	2.435	2.935
CHRY-2	9.945	076°25'21.4027"E 09°30'44.3530"N	656154.00E 1051814.10N	1.492	1.958
CHRY-3	21.496	076°28'39.4599"E 09°26'23.6795"N	662228.12E 1043831.25N	1.617	2.043
CHRY-4	29.052	076°31'43.25"E 09°26'40.7666"N	667832.10E 1044380.32N	1.946	2.346

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2.1.3 Chart Datum / Sounding Datum

The survey stretch of Alappuzha-Changanassery Canal is tidal water body, during the survey period the Thannermukkam bund lock is close for irrigation purpose. Therefore no influence of tidal force throughout the survey period. However after discussed with IWAI, Cochin/Noida, CD was taken 0.5m below MSL at chainage 0.0km and 0.4m below MSL at Chainage 29.123 km. The locations with coordinates of established gauge have been used to reduce the soundings along the surveyed stretch are tabulated below.

TABLE 2-3 CHART DATUM / SOUNDING DATUM AND REDUCTION TABLE

Sl#	Location of CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data converted as depth for volume calculation wrt SD (m)
	A	B	C	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = (E- topo levels in MSL)
NW8	TP-1	0.047	0.0-5.0	-0.500	-0.500	Details are given in Annexure-4. (Vol-III)	Details are given in Annexure-4. (Vol-III)
	TP-2	9.945	5.0-15.0		-0.466		
	TP-3	21.496	15.0-25.0		-0.426		
	TP-4	29.052	25.0-29.123	-0.400	-0.400		

2.2 Existing Waterway Structures

2.2.1 Bridges

There are 4 bridges and 1 water pipe line in the whole stretch of survey. Details are given in table.

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TABLE 2-4: DETAILS OF CROSS STRUCTURES

Sl. No.	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
1	Foot Over Bridge	0.135	RCC	Near Church Road	Left Bank: 09°30'03.1776"N 076°20'40.8309"E Right Bank 09°30'03.9825"N 076°20'40.7941"E	Left Bank: 1050515.07N 647602.60E Right Bank: 1050539.79N 647601.38E	28	2	2	20	7.5	Complete
2	Foot over Bridge	0.570	RCC	Near Matha Jetty	Left Bank: 09°30'00.0955"N 076°20'54.4496"E Right Bank: 09°30'00.8783"N 076°20'54.5678"E	Left Bank: 1050422.00N 648018.29E Right Bank: 1050446.06N 648021.80E	28	2	2	20	7.3	Complete
3	Kidangara – Kunnamkari Road Bridge	24.16	RCC	Veliyandu Jetty	Left Bank 09°25'28.49"N 076°29'32.73"E Right Bank 09°25'30.45"N 076°29'32.03"E	Left Bank 663861.00E 1042142.83N Right Bank 663838.76E 1042203.06N	80	5	2	20	3.5	Complete
4	Foot Over Bridge	24.50	RCC	Kidangara	Left Bank 09°25'34.31"N 076°29'41.98"E Right Bank: 09°25'34.77"N 076°29'41.68"E	Left Bank 664141.72E 1042322.73N Right Bank: 664132.52E 1042337.04N	18	2	2	15	5.2	Complete
5	Water Pipe Line	23.90	RCC	Near kidangara St Greorious church	Left Bank: 09°25'32.2630"N 076°29'27.4648"E Right Bank: 09°25'32.48"N 076°29'29.89"E	Left Bank: 1042257.91N 663699.18E Right Bank: 1042265.19N 663773.24E	82	1	2	82	6.0	Complete

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2.2.2 Electric Lines / Communication Lines

There are total 50 no. of Electric lines crossed including HT & LT lines along the waterways. The details of Electric lines/ Communication lines are crossing the NW 8 as given in the Table below.

TABLE 2-5: 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.t. HFL/MHWS (m)	Remarks (complete / under - construction)
1	LT	0.590	Near Church Road	Left Bank	Left Bank	2	28	7.3	Complete
				09°29'59.96"N	648034.81E				
				076°20'54.08"E	1050418.10 N				
				Right Bank	Right Bank				
				09°30'00.68"N	648034.29 E				
				076°20'54.97"E	1050444.22 N				
2	LT	0.638	Kovini palam	Left Bank	Left Bank	2	28	5.2	Complete
				09°29'59.7620"N	648084.06 E				
				076°20'56.60"E	1050412.01N				
				Right Bank	Right Bank				
				09°30'00.67"N	648075.77 E				
				076°20'56.33"E	1050440.42N				
3	11KV (HT)	2.22	Near Zero Jetty	Left Bank	Left Bank	2	47	11	Complete
				09°29'56.6809"N	649647.75 E				
				076°21'47.86"E	1050323.47 N				
				Right Bank	Right Bank				
				09°29'58.2013"N	649646.31 E				
				076°21'47.82"E	1050370.17 N				
4	11KV (HT)	2.51	Near Punchiri Jetty	Left Bank	Left Bank	2	90	12	Complete
				09°29'55.0929"N	649918.24 E				
				076°21'56.72"E	1050275.75N				
				Right Bank	Right Bank				
				09°29'57.1433"N	649952.02 E				
				076°21'57.84"E	1050338.87 N				
5	132KV (HT)	3.04	Near Kuppapuram Village	Left Bank	Left Bank	2	180	16	Complete
				09°30'05.15"N	650226.49m E				
				076°22'06.87"E	1050586.21 N				
				Right Bank	Right Bank				
				09°30'10.3687"N	650149.07 E				
				076°22'04.35"E	1050745.93 N				
6	LT	5.05	Mangalassery Jetty	Left Bank	Left Bank	2	103	10.5	Complete
				09°30'58.3969"N	651363.15 E				
				076°22'44.36"E	1052226.17 N				
				Right Bank	Right Bank				

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Sl No	Type of line	Chainage (km)	Location	Position (Lat, Long)	Position (UTM)	No. of piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL/MHWS (m)	Remarks (complete / under - construction)
				09°30'59.6996"N	651265.41 E				
				076°22'41.16"E	1052265.80 N				
7	LT	5.71	Puthan Kayal Jetty	Left Bank	Left Bank	2	46	10.5	Complete
				09°31'02.6821"N	651917.07 E				
				076°23'02.54"E	1052360.02 N				
				Right Bank	Right Bank				
				09°31'04.3678"N	651912.89 E				
				076°23'02.41"E	1052411.79 N				
8	LT	6.15	Near Cheru Kayal Jetty	Left Bank	Left Bank	2	38	10.5	Complete
				09°31'00.6520"N	652342.85 E				
				076°23'16.49"E	1052299.36N				
				Right Bank	Right Bank				
				09°31'01.8633"N	652347.31 E				
				076°23'16.64"E	1052336.59 N				
9	LT	6.578	Near Cheru Kayal Jetty	Left Bank	Left Bank	2	48	10.5	Complete
				09°30'507.74"N	652752.38 E				
				76°23'29.9146"E	1052211.67 N				
				Right Bank	Right Bank				
				09°30'59.2760"N	652764.41 E				
				076°23'30.31"E	1052258.78 N				
10	LT	6.74	Near Cheru Kayal Jetty Kainakary	Left Bank	Left Bank	2	48	11	Complete
				09°30'55.6258"N	652907.54 E				
				076°23'34.993"E	1052147.22 N				
				Right Bank	Right Bank				
				09°30'57.3948"N	652926.51 E				
				076°23'35.62"E	1052201.64 N				
11	LT	8.32	Near C Block Jetty	Left Bank	Left Bank	2	137	9	Complete
				09°30'44.0547"N	654449.68 E				
				076°24'25.51"E	1051797.98 N				
				Right Bank	Right Bank				
				09°30'46.6556"N	654444.50 E				
				076°24'25.35"E	1051877.86 N				
12	LT	9.59	Near Priya darshini Jetty	Left Bank	Left Bank	2	151	10	Complete
				09°30'41.2366"N	655717.03 E				
				076°25'07.06"E	1051716.57 N				
				Right Bank	Right Bank				
				09°30'45.9932"N	655730.05 E				
				076°25'07.50"E	1051862.75 N				
13	LT	10.16	Priya darshini Jetty	Left Bank	Left Bank	2	137	10	Complete
				09°30'39.7623"N	656061.64E				
				076°25'18.35"E	1051672.69 N				
				Right Bank	Right Bank				
				09°30'24.3372"N	656251.74 E				

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				076°25'24.52"E	1051199.60 N				
14	LT	11.06	Near Nalayiram Jetty	Left Bank	Left Bank	2	137	8	Complete
				09°30'06.0762"N	656078.55 E				
				076°25'18.7705"E	1050637.90 N				
				Right Bank	Right Bank				
				09°30'06.14"N	656304.82 E				
				076°25'26.19"E	1050641.06 N				
15	LT	11.30	Near Nalayiram Jetty	Left Bank	Left Bank	2	138	9	Complete
				09°29'58.1288"N	656146.75 E				
				076°25'20.97"E	1050394.03 N				
				Right Bank	Right Bank				
				09°29'58.827"N	656312.30 E				
				076°25'26.40"E	1050416.15 N				
16	LT	11.48	Near Nalayiram Jetty	Left Bank	Left Bank	2	146	10	Complete
				09°29'53.614"N	656321.79 E				
				076°25'26.695"E	1050256.05N				
				Right Bank	Right Bank				
				09°29'54.788"N	656316.68E				
				076°25'26.532"E	1050292.1N				
17	LT	12.08	Near Nalayiram Jetty	Left Bank	Left Bank	2	143	9.5	Complete
				09°29'44.6911"N	656823.11 E				
				076°25'43.09"E	1049983.99 N				
				Right Bank	Right Bank				
				09°29'49.7816"N	656861.17E				
				076°25'44.36"E	1050140.53 N				
18	132 KV (HT)	12.71	Near Nalayiram Jetty	Left Bank	Left Bank	2	195	18	Complete
				09°29'39.3560"N	657412.46E				
				076°26'02.39"E	1049822.52N				
				Right Bank	Right Bank				
				09°29'44.1182"N	657487.92 E				
				076°26'04.89"E	1049969.13 N				
19	LT	13.29	Near Ranganath Jetty	Left Bank	Left Bank	2	57	10	Complete
				09°29'34.0152"N	658075.74 E				
				076°26'24.12"E	1049661.19N				
				Right Bank	Right Bank				
				09°29'40.0332"N	657969.45 E				
				076°26'20.66"E	1049845.63 N				
20	LT	15.00	Kunnumma Village	Left Bank	Left Bank	2	78	9	Complete
				09°28'58.6926"N	658861.16 E				
				076°26'49.728"E	1048579.31N				
				Right Bank	Right Bank				
				09°28'58.7244"N	658957.99 E				
				076°26'52.90"E	1048580.60N				

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21	LT	15.10	Near CSI Church	Left Bank 09°28'58.0506"N 076°26'50.22"E Right Bank 09°28'58.4540"N 076°26'52.89"E	Left Bank 658876.29 E 1048559.65N Right Bank 658957.80 E 1048572.38N	2	66	9	Complete
22	LT	15.23	Thattassery Ferry	Left Bank 09°28'50.605N 076°26'53.09"E Right Bank 09°28'51.8472"N 076°26'55.19"E	Left Bank 658964.84E 1048331.31N Right Bank 659028.91E 1048369.71N	2	68	8	Complete
23	LT	16.88	East Kunnumma Village	Left Bank 09°28'16.7949"N 076°27'29.87"E Right Bank 09°28'16.8025"N 076°27'31.70"E	Left Bank 660091.05 E 1047217.30 N Right Bank 660146.84 E 1047297.77 N	2	84	5.3	Complete
24	220 kV (HT)	17.62	Krishna puram Jetty	Left Bank 09°28'05.6664"N 076°27'49.74"E Right Bank 09°28'11.5691"N 076°28'00.68"E	Left Bank 660698.46 E 1046957.97 N Right Bank 661031.46 E 1047140.71 N	2	300	12	Complete
25	LT	18.88	Near St. Gregorious Church	Left Bank 09°27'29.7015"N 076°28'06.64"E Right Bank 09°27'31.1259"N 076°28'07.80"E	Left Bank 661218.48 E 1045855.27 N Right Bank 661253.71 E 1045899.18 N	2	71	5.3	Complete
26	LT	18.94	Pallikudam Jetty	Left Bank 09°27'27.1652"N 076°28'11.96"E Right Bank 09°27'30.5326"N 076°28'11.98"E	Left Bank 661379.41 E 1045778.04N Right Bank 661381.31E 1045881.49N	2	67	7.5	Complete
27	LT	19.00	Near Pallikudam Jetty	Left Bank 09°27'26.9451"N 076°28'07.55"E Right Bank 09°27'30.5297"N 076°28'11.98"E	Left Bank 661246.67 E 1045770.71 N Right Bank 661381.31 E 1045881.4 N	2	76	8	Complete
28	LT	20.83		Left Bank	Left Bank	2	67	8	Complete

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			Near Madathil aakkan Jetty	09°26'43.0457"N	661954.30E				
				076°28'30.56"E	1044425.05 N				
				Right Bank	Right Bank				
				09°26'43.1889"N	662032.68E				
				076°28'33.13"E	1044429.78 N				
29	LT	21.57	Bathlahen Jetty	Left Bank	Left Bank	2	92	7	Complete
				09°26'23.7007"N	662231.94E				
				076°28'42.86"E	1043832.34 N				
				Right Bank	Right Bank				
				09°26'22.8480"N	662340.18 E				
				076°28'43.13"E	1043806.18 N				
30	LT	22.11	Aattuchira Jetty	Left Bank	Left Bank	2	66	10	Complete
				09°26'06.7455"N	662429.81 E				
				076°28'45.99"E	1043311.87 N				
				Right Bank	Right Bank				
				09°26'06.9586"N	662499.63 E				
				076°28'48.28"E	1043318.71 N				
31	LT	22.12	Near Aattuchira Jetty	Left Bank	Left Bank	2	89	10	Complete
				09°26'06.7274"N	662429.05E				
				076°28'45.97"E	1043311.31 N				
				Right Bank	Right Bank				
				09°26'06.8975"N	662527.06 E				
				076°28'49.18"E	1043316.95 N				
32	LT	23.02	Near K C Jetty	Left Bank	Left Bank	2	68	9.5	Complete
				09°25'47.8064"N	663103.15 E				
				076°29'07.99"E	1042732.89 N				
				Right Bank	Right Bank				
				09°25'50.0268"N	663116.92 E				
				076°29'08.45"E	1042801.16 N				
33	LT	23.51	Near Kidangara Jetty	Left Bank	Left Bank	2	75	10	Complete
				09°25'38.1098"N	663403.22 E				
				076°29'17.78"E	1042436.27 N				
				Right Bank	Right Bank				
				09°25'39.9200"N	663442.67 E				
				076°29'19.08"E	1042492.05 N				
34	LT	24.17	Near Kidangara Bridge	Left Bank	Left Bank	2	20	11	Complete
				09°25'29.2066"N	663867.75 E				
				076°29'32.97"E	1042164.73 N				
				Right Bank	Right Bank				
				09°25'29.7359"N	663860.47 E				
				076°29'32.74"E	1042180.96 N				
35	LT	24.28		Left Bank	Left Bank	2	24	10	Complete
				09°25'30.5984"N	663962.06 E				

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			Near Kidangara Bridge	076°29'36.07"E Right Bank 09°25'31.2560"N 076°29'35.73"E	1042207.89 N Right Bank 663951.57 E 1042228.05 N				
36	LT	24.33	Near Kidangara Bridge	Left Bank 09°25'31.4847"N 076°29'37.69"E Right Bank 09°25'32.1500"N 076°29'37.39"E	Left Bank 664011.23 E 1042235.33 N Right Bank 664002.03E 1042255.73N	2	25	10	Complete
37	LT	24.37	Near Kidangara Bridge	Left Bank 09°25'32.0085"N 076°29'38.67"E Right Bank 09°25'32.7320"N 076°29'38.32"E	Left Bank 664041.05 E 1042251.55 N Right Bank 664030.30 E 1042273.73 N	2	24	9.5	Complete
38	LT	24.45	Near Maradakari Jetty	Left Bank 09°25'33.2860"N 076°29'40.85"E Right Bank 09°25'34.2026"N 076°29'40.47"E	Left Bank 664107.52 E 1042291.08 N Right Bank 664095.79 m E 1042319.19 m N	2	19	8	Complete
39	LT	24.56	Near Puthuval Jetty	Left Bank 09°25'35.6717"N 076°29'43.83"E Right Bank 09°25'36.3487"N 076°29'43.31"E	Left Bank 664198.25 E 1042364.76 N Right Bank 664182.19 E 1042385.49 N	2	24	9	Complete
40	LT	24.70	Near Puthuval Jetty	Left Bank 09°25'36.6531"N 076°29'48.06"E Right Bank 09°25'37.9125"N 076°29'47.14"E	Left Bank 664326.90 E 1042395.46 N Right Bank 664298.91 E 1042434.03 N	2	36	10	Complete
41	LT	25.03	Near Road Mukku Jetty	Left Bank 09°25'37.2148"N 076°29'59.71"E Right Bank 09°25'38.4955"N 076°29'57.86"E	Left Bank 664682.34 E 1042414.24 N Right Bank 664625.59 E 1042453.34 N	2	26	9	Complete
42	LT	25.40	Near Parambissery Jetty	Left Bank 09°25'43.2643"N 076°30'09.19"E	Left Bank 664970.83 E 1042601.33 N	2	24	9	Complete

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				Right Bank	Right Bank				
				09°25'44.6995"N	664949.78 E				
				076°30'08.51"E	1042645.33 N				
43	LT	25.60	Near Parambissery Jetty	Left Bank	Left Bank	2	26	10	Complete
				09°25'46.3642"N	665211.86 E				
				076°30'17.11"E	1042697.60 N				
				Right Bank	Right Bank				
				09°25'47.5805"N	665210.68 E				
				076°30'17.08"E	1042734.96 N				
44	LT 11KV	26.88	Near Velakulam Jetty	Left Bank	Left Bank	2	64	12	Complete
				09°26'13.5442"N	666090.07 E				
				076°30'46.02"E	1043536.41 N				
				Right Bank	Right Bank				
				09°26'15.2097"N	666019.13 E				
				076°30'43.70"E	1043587.27 N				
45	LT	27.00	Near Velakulam Jetty	Left Bank	Left Bank	2	60	5.3	Complete
				09°26'17.4052"N	666150.75 E				
				076°30'48.02"E	1043655.29 N				
				Right Bank	Right Bank				
				09°26'18.7038"N	666108.39 E				
				076°30'46.64"E	1043695.00 N				
46	220KV (HT)	27.43	Near Kavalakari Jetty	Left Bank	Left Bank	2	201	15	Complete
				09°26'13.6540"N	666527.92 E				
				076°31'00.37"E	1043541.68 N				
				Right Bank	Right Bank				
				09°26'26.4935"N	666497.00 E				
				076°30'59.41"E	1043936.00 N				
47	Cable	27.83	Near Vettithuruthu Church	Left Bank	Left Bank	2	38	10	Complete
				09°26'22.2295"N	666910.23 E				
				076°31'12.94"E	1043806.80 N				
				Right Bank	Right Bank				
				09°26'23.5656"N	666908.49 E				
				076°31'12.89"E	1043847.84 N				
48	LT	27.85	Near Vettithuruthu Church	Left Bank	Left Bank	2	39.88	10	Complete
				09°26'22.5381"N	666931.05 E				
				076°31'13.63"E	1043816.37 N				
				Right Bank	Right Bank				
				09°26'23.7813"N	666921.24 E				
				076°31'13.31"E	1043854.52 N				
49	LT	28.88	Near Changanassery Jetty	Left Bank	Left Bank	2	80	10	Complete
				09°26'37.8084"N	667678.94 E				
				076°31'38.21"E	1044288.77 N				
				Right Bank	Right Bank				

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				09°26'38.5928"N	667661.20 E				
				076°31'37.63"E	1044312.79 N				
50	LT	28.92	Near Changanassery Jetty	Left Bank	Left Bank	2	82	9	Complete
				09°26'38.4126"N	667708.56 E				
				076°31'39.18"E	1044307.46 N				
				Right Bank	Right Bank				
				09°26'38.8264"N	667680.20 E				
				076°31'38.26"E	1044320.05 N				

2.2.3 Pipe Lines / Cables

There is one Pipe line and no underwater cable present in the entire survey stretch of waterways.

TABLE 2-6: DETAILS OF PIPE LINES

Sl#	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
1	Water Pipe Line	23.90	RCC	Near kidangara St Greorious church	Left Bank: 09°25'32.2630"N 076°29'27.4648" E	Left Bank: 1042257.91 N 663699.18E	82	1	2	82	6.0	Complete
					Right Bank: 09°25'32.48"N 076°29'29.89"E	Right Bank: 1042265.19 N 663773.24E						

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

There are no Dams, barrages, weirs, anicut, Locks etc. in this entire survey stretch.

2.3 Bends

The Bend Radius observed in the stretch of NW 8 is tabulated here under.

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TABLE 2-7: DETAILS OF BENDS

Sl. No.	CHAINAGE (IN KM)	BEND RADIUS (IN METER)
1.	2.6	70
2.	3.9	200
3.	5.4	325
4.	10.0	90
5.	11.5	120
6.	13.5	165
7.	14.0	200
8.	14.4	350
9.	17.7	140
10.	20.1	100
11.	20.5	80
12.	21.0	90
13.	21.3	165
14.	23.4	60
15.	24.0	75
16.	25.2	35
17.	27.3	80
18.	28.3	110
19.	28.5	60
20.	28.7	25
21.	28.9	40

2.4 Velocity and Discharge Details

The details of velocity and discharge in the NW-8 waterways are given below in Table, as observed.

TABLE 2-8: CURRENT METER DEPLOYMENT LOCATIONS AND DISCHARGE DETAILS

Stretch No.	Chainage (km)	Latitude Longitude	Northing N (m) Easting E (m)	Obs. Depth (m) (D)	Velocity (M/sec.) 0.5 D	Avg. Vel. (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m/sec)
1	0.065	09°30'03.4906"N 088°20'38.438"E	1050524.40N 647529.59E	1.6	0.8	0.08	49.95	3.996
2	9.75	09°30'43.6810"N 088°25'14.964"E	1051792.65N 655957.74E	3.1	1.55	0.18	449.0	80.82
3	21.50	09°26'23.5992"N 088°28'41.362"E	1043829.03N 662286.15E	3.3	1.65	0.28	199.2	55.77
4	29.00	09°26'39.6810"N 088°31'41.226"E	1044346.70N 667770.55E	1.9	0.95	0.06	39.9	2.394

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2.5 Waterway description

2.5.1 Alappuzha-Changanassery Canal Stretch (Ch 0.0km – Ch 10.0km)

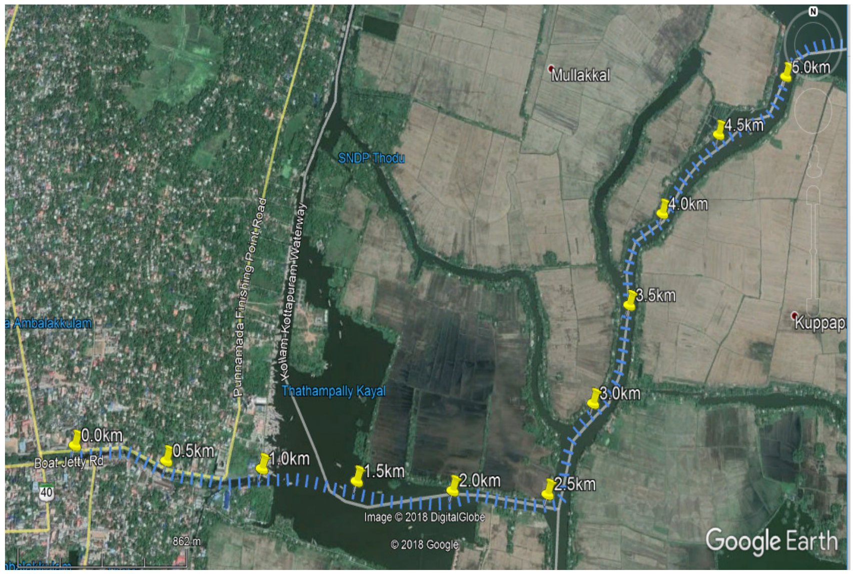

Figure 2-2: Ch 0.00km to Ch 5.00km

Figure 2-3: Ch 5.0km to Ch 10.0km

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TABLE 2-9: REDUCED DEPTH FROM CH 0.00KM TO CH 10.00KM

							Reduced w. r. t. Sounding Datum				
Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)		Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	
From	To	Max.	Min.		Per km drg	Accum. drg.	Max.	Min.		Per km drg	Accum. drg.
0	1	3.0	0.0	1000	39579.63	39579.63	2.5	-3.2	1000	117805.88	117805.88
1	2	3.2	1.4	50	133.69	39713.32	2.2	0.6	1000	36467.56	154273.44
2	3	8.8	0.7	200	641.04	40354.36	7.5	-0.3	550	5581.40	159854.84
3	4	13.1	2.2	0	0.00	40354.36	12.1	0.2	50	0.00	159854.84
4	5	9.8	2.5	0	0.00	40354.36	8.5	1.5	50	33.09	159887.93
5	6	9.1	1.7	200	980.66	41335.02	8.6	1.3	300	7424.01	167311.94
6	7	7.1	2.2	0	0.00	41335.02	6.6	2.2	0	4.01	167315.95
7	8	3.8	1.7	400	3015.17	44350.19	3.3	1.3	700	20485.55	187801.50
8	9	3.1	1.7	50	19.61	44369.80	2.6	1.4	500	8929.64	196731.14
9	10	3.5	1.7	50	280.51	44650.31	2.9	1.3	500	7233.85	203964.99

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class III). The starting point of survey was about 1.0km before Alappuzha IWAI terminal. Around 1.0km stretch fall under town area. In this area canal width varies 18m to 40m, so land acquisitions are required. After chainage 1.0km, width of canal varies 50m to 100m. There are two foot over bridge under this stretch at chainage 0.135km and 0.57km. On both the sides of the canal are Agriculture land/paddy fields has been noted. There are 11 jetties in this stretch (5 jetties left side and 6 jetties right side) of the canal. There are 12 electric lines crossing including LT and HT. There were no prominent dams/barrages, tidal, stretch tidal range, pondage stretch, weirs, anicut, locks, hindrance, encroachment, wildlife, defense, atomic power plants, industries, Ghats, sand mining, nala, polluted water discharge in to the canal and treatment plant found in the whole survey stretch. The whole stretch is protected.

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2.5.2 Alappuzha-Changanassery Canal Stretch (Ch 10.0km – Ch 20.0km)

Figure 2-4: Ch 10.0km to Ch 15.0km

Figure 2-5: Ch 15.0km to Ch 20.0km

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TABLE 2-10: REDUCED DEPTH FROM CH 10.0KM TO CH 20.0KM

Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)		Reduced w. r. t. Sounding Datum: Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	
From	To	Max.	Min.		Per km drg.	Accum. drg.	Max.	Min.		Per km drg.	Accum. drg.
10	11	3.6	2.6	0	0.00	0.00	3.1	1.9	100	502.07	502.07
11	12	3.3	2.2	0	0.00	0.00	2.7	1.7	450	3915.79	4417.86
12	13	2.9	1.7	50	185.32	185.32	2.3	1.4	1000	11043.83	15461.69
13	14	7.4	1.5	350	4038.05	4223.37	7.4	0.1	450	8777.16	24238.85
14	15	6.9	2.2	0	0.00	4223.37	6.4	0.6	100	150.78	24389.63
15	16	6.9	1.0	50	149.11	4372.48	6.4	0.6	100	518.40	24908.03
16	17	6.7	0.9	50	82.95	4455.43	6.3	0.5	100	311.79	25219.82
17	18	8.0	0.9	50	44.44	4499.87	8.2	0.5	100	198.78	25418.60
18	19	6.1	2.2	0	0.00	4499.87	5.9	1.0	50	2.12	25420.72
19	20	9.0	0.9	200	2042.86	6542.73	8.8	0.7	150	2068.51	27489.23

The maximum and minimum LAD for the above mentioned stretch is given in the above table (as per class III). In this section coconut trees and houses are observed on the either side of the canal. Transmission line can be seen at Ch 17.60km. There are 12 LT line and six 11 kV line cross the canal. There are 24 jetties in this stretch (13 jetties left side and 11 jetties right side) of the canal. Width of the canal is varying from 50m to 100m in this stretch. In this section the banks of canal are mostly covered with agriculture field. There are 15 electric line are passing through this stretch including LT & HT lines.

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2.5.3 Alappuzha-Changanassery Canal Stretch (Ch 20.0km – Ch 29.3km)

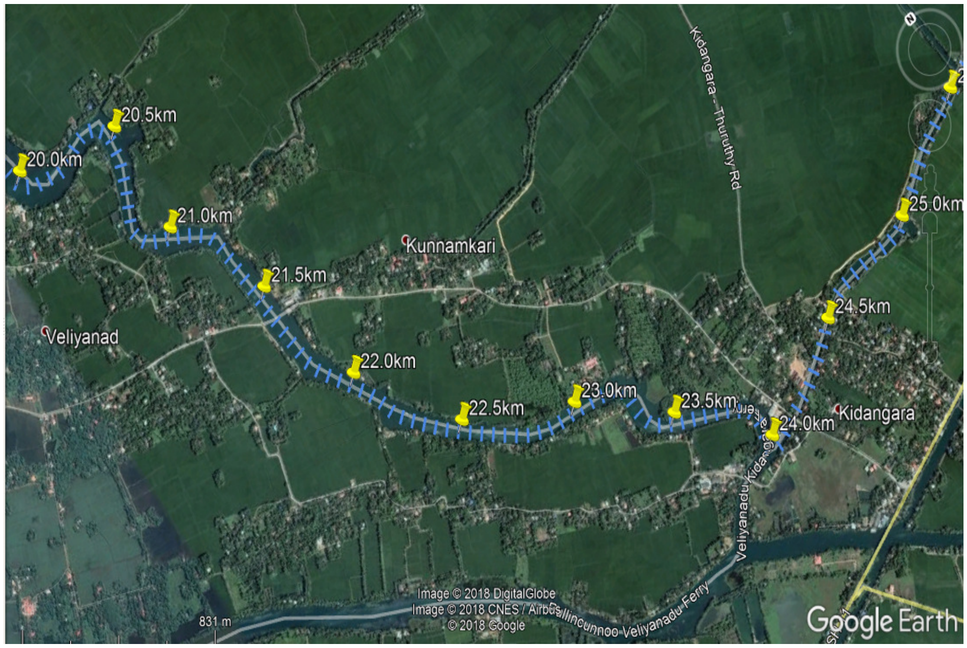

Figure 2-6: Ch 20.0km to Ch 25.0km

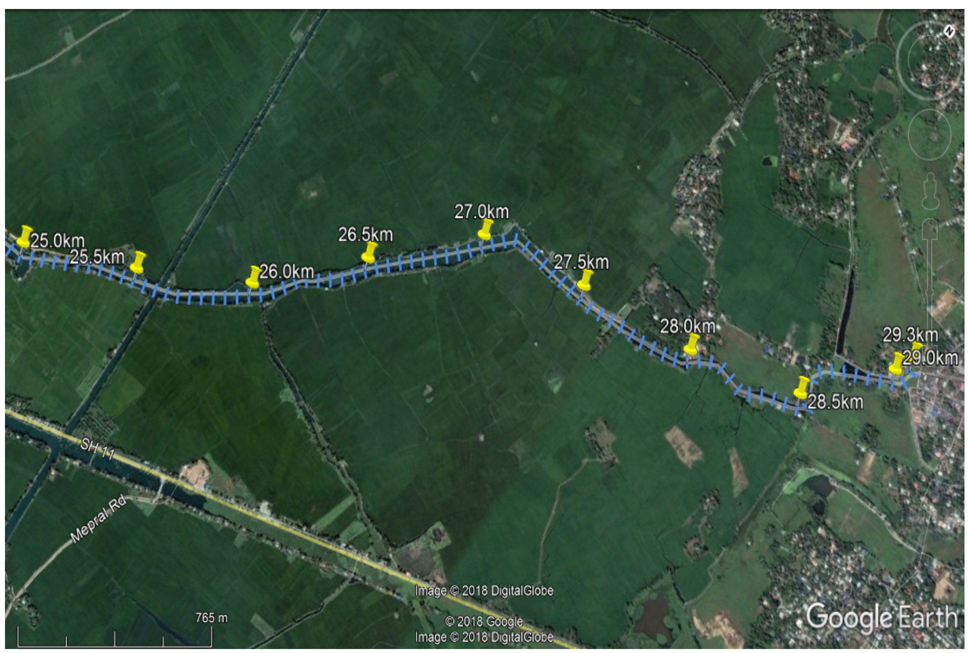

Figure 2-7: Ch 25.0km to Ch 29.3km

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TABLE 2-11: REDUCED DEPTH FROM CH 20.0KM TO CH 29.123KM

							Reduced w. r. t. Sounding Datum				
Chainage (km)		Observed depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)		Reduced depth (m)		Length of Shoal (m)	Dredging quantity (cu.m.)	
From	To	Max.	Min.		Per km drg.	Accum. drg.	Max.	Min.		Per km drg.	Accum. drg.
20	21	8.7	0.3	200	2182.45	2182.45	8.7	-0.1	300	3230.33	3230.33
21	22	5.0	0.8	300	5313.87	7496.32	4.7	0.4	400	7643.19	10873.52
22	23	4.3	0.5	150	2643.27	10139.59	4.5	0.1	500	4747.32	15620.84
23	24	6.9	0.1	700	14179.57	24319.16	6.7	-0.7	800	17388.03	33008.87
24	25	6.8	0.0	1000	29058.97	53378.13	6.7	-1.0	1000	42071.60	75080.47
25	26	3.0	0.0	1000	30753.91	84132.04	2.3	-0.5	1000	53061.55	128142.02
26	27	2.1	0.6	1000	23707.90	107839.94	1.4	-0.3	1000	47557.05	175699.07
27	28	1.7	0.0	1000	39663.63	147503.57	1.0	-1.9	1000	65436.08	241135.15
28	29	2.1	0.0	1000	42335.97	189839.54	1.5	-1.2	1000	67729.74	308864.89
29	29.123	2.3	0.0	120	3794.54	193634.08	1.7	-0.6	120	7621.98	316.486.87

The maximum and minimum LAD for the above-mentioned stretch is given in the above table (as per class III). In this stretch, the banks of canal mostly covered with agriculture field. There are 23 electric lines crossing over the canal including LT & HT. canal is passing through residential area of Kidangara village. There are 1 Jetties on the left and 3 Jetties on the right side of the canal. In this stretch the width of canal is varying from 18.0m to 50.00m. land acquisitions are required for smooth navigation.

There were no prominent dams/barrages, tidal, stretch tidal range, pondage stretch, weirs, anicut, locks, encroachment, wildlife, defence, atomic power plants, industries, Ghats, sand mining, nala, polluted water discharge in to the canal, Water spot recreation facilities and treatment plant found in the whole survey stretch. The whole stretch is protected.

Changanassery railway station is 5km from the end of the stretch. N.H.-183 connects Changanassery with Kottayam & Adoor. Water weeds were obstructing to conduct survey on either side of the bank up to 4km. Fishing actives used to be carried out throughout the year. Passenger ferry services are available throughout of the year. Changanassery terminal is proposed in this stretch at chainage 28.5km.

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2.6 Water and Soil Samples analysis and Results

Bed soil and water sampling was undertaken at average 10 Km. evenly distributed throughout the Alappuzha-Changanassery Canal Stretch. The Vanveen grab and Naskin water bottles were kept standby for the collections of samples. The canal water is slightly basic in nature with average pH being 7.08. The Test Results of soil and water sample locations are as given in table.

TABLE 2-12: WATER TEST RESULT

#	Chainage (km)	Easting (m)	Northing (m)	Sediment concentration (ppm)	ph
1	0.047	647500.25	1050522.13	27	7.08
2	9.945	656150.92	1051742.24	18	7.06
3	21.496	662266.99	1043994.29	32	7.15
4	29.052	667799.09	1044365.67	16	7.02

TABLE 2-13: SOIL TEST RESULT

#	Chainage (km)	Easting (m)	Northing (m)	Specific gravity	Fine Gravel (20mm to 4.75mm)	Coarse Sand (4.75 mm to 2.00mm)	Medium Sand (2.00mm to 0.425mm)	Fine Sand (0.425mm to 0.075mm)	Silt (0.075 mm to 0.002mm)	Clay (<0.002mm)	Cu	Cc
1	0.047	647500.25	1050522.13	2.63	0	3	21	28	41	7	62.220	0.6002
2	9.945	656150.92	1051742.24	2.59	0	8	38	23	25	6	53.191	1.0100
3	21.496	662266.99	1043994.29	2.62	9	10	50	24	1	6	4.385	1.0697
4	29.052	667799.09	1044365.67	2.63	0	0	1	2	61	36	-	-

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CHAPTER 3 FAIRWAY DEVELOPMENT

3.1 Proposed Class / Type of Waterway

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

The detailed Hydrographic survey and charts have been referred. As per the data available, the study stretch of the waterway is amenable for development up to class III of the waterway from the Fairway point of view, so as to have the inter connectivity with the existing / developed NW 3.

The NW 8 is having connectivity to ICTT, Kochi through NW 3 and hence it is most preferred to develop the fairway with Class III waterway and also to facilitate the Ro-Ro type of vessels, wherein the evacuation of ICTT, Kochi container Truck volumes towards south eastern part of the country can be diverted. This mobility will ease the road traffic in Kerala. The Road Traffic in Kerala already facing lot of constraints, in particular on the widening aspects. The traffic density on the road can be eased by this IWT mobility.

NW 8 is the waterway as a canal system not of the river system, which is having a distinct standard made available as per the Classification of Waterways.

The present Study stretch of NW 8 can be considered for development as a ***Class III*** waterway, for carrying out the Ro-Ro trucks mobility after having industry confirmations with meticulous observation. Accordingly, the observation period can be considered up to 2022 and the development of Infrastructure, on confirmations, can be considered as 36 months from 2022.

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

Dredging quantities have been worked out for the suggested Class III Waterway standards for the canal system with 32 m in the Narrow Reaches and 38 m in the Wider Reaches. The canal Cross section for both the reaches are depicted herewith.

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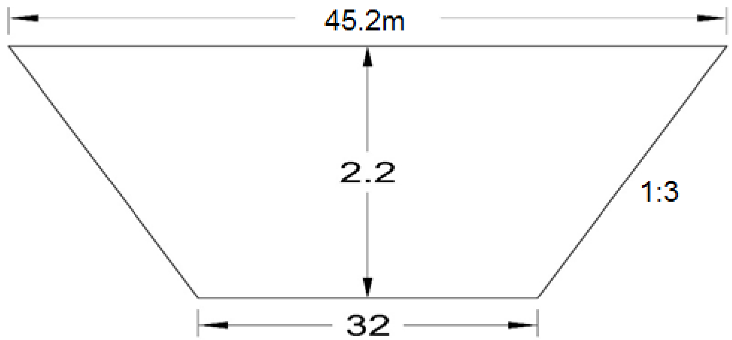
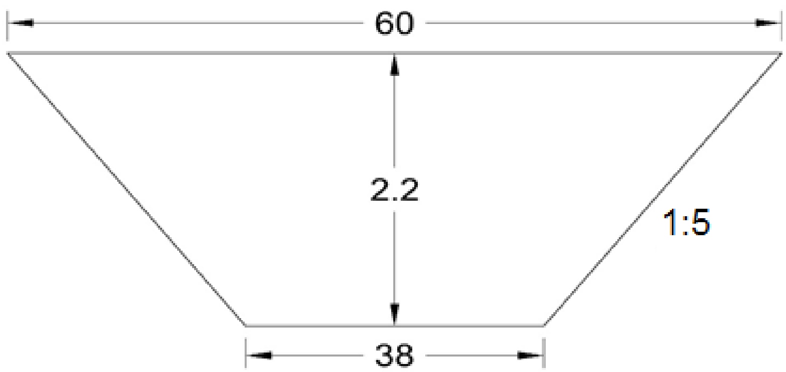


Narrow Reaches with 50 m Land Acquisition.



Wider Reaches with No Land Acquisition.

CLASS-III

CLASS	Chainage (km)		Observed				Reduced w.r.t. Sounding Datum			
	From	To	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Max. Depth (m)	Min. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)
III	0	10	13.6	0.00	1950.0	44650.31	12.7	-3.2	4650	203964.99
	10	20	9.0	0.9	750.0	6542.73	8.8	0.1	2600	27489.23
	20	29.123	8.7	0.00	6470.0	193634.08	8.7	-1.9	7120	316486.87
			Grand	Total	9170.0	244827.12			14370	547941.09
The 1st 2 Kms are not to be considered, since a part is beyond the IWAI Cargo Terminal and a part is the existing NW 3 stretch. Accordingly, deduction of quantity has been affected.									2000	141930.41
			Net quantity being considered (cum)						12370	406010.68

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3.3 Proposed Conservancy Activities

The present study stretch of NW 8 is the Canal system in the Vembanad Lake area and as such no need of taking up of any conservancy activity. However, to maintain the safe fairway, Widening / Dredging and side protection are required.

3.3.1 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 Sheltered Waterways 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. The advantage of “Cutter Suction” type of Dredger is that the spoil can be taken out from the fairway area to an appropriate specified location.

In the study stretch, Dredging has been identified along with Land Acquisition with widening. In order to meet the Ro-Ro operation, possibility with Class III standard has been considered. The shoal length for Class III is 12370m with an estimated quantity of dredging as 4.06 Lakhs Cu. M. However, in the canal system, the Dredging volumes are allowed in the Tender for 0.3 m additional depth variation, which accounts for nearly 10% to 30 % of the volumes, the estimated quantity may reasonably be considered as 10% over & above the estimated dredging quantity of 4.06 cum and hence the total

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estimated dredging quantity shall be 1.1 X 4.06 Lakhs Cu. M = 4.46 Lakhs Cu. M, which has been taken into account. The mode of measurement shall be in cum and as per the actual dredged quantity.

3.3.2 River Training

NW 8 is basically a canal stretch available with a lesser natural width of the channel than the standard criteria. This is probing the Land Acquisition / Widening / Bank Protection etc.

In the present study stretch, there is no need of any Training requirements.

3.4 Bank Protection / Embankment Strengthening

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

NW 8 is a canal system proposed for development of Class III standards. The majority of the stretch is under thick habitation. Since the Land Acquisition is involved in this stretch, a micro level analysis has been considered and a Km wise LA / Bank Protection requirement has been worked out. The below given Table is being provided with the details for the same.

TABLE 3-1: LIST OF LAND ACQUISITION AND BANK PROTECTION REQUIREMENTS

Sl. No.	Chainage From ---- To ---- (in Km)	Existing Width (in m)	Extra Width Requirement (in m)	Length (in m)	Area of Land Acquisition (in Sq. m)	Bank Protection Requirement (in m)	Remarks, if any
1	2	3	4	5	(6) = (4) x (5)	7	8
1	0 to 1	40	--	600			* > 50 m
2	1 to 2	*	--	1000			
3	2 to 3	*		600		1200	= No Bank Protection
4	3 to 4	*		1000		=	
5	4 to 5	*		200		=	
6	5 to 6	*		400		=	
7	6 to 7	40	10	800	8000	1600	
8	7 to 8	*		1000		=	
9	8 to 9	*		1000		=	
10	9 to 10	*		1000		=	
11	10 to 11	*		1000		=	

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Sl. No.	Chainage From ---- To ---- (in Km)	Existing Width (in m)	Extra Width Requirement (in m)	Length (in m)	Area of Land Acquisition (in Sq. m)	Bank Protection Requirement (in m)	Remarks, if any
12	11 to 12	*		1000		=	
13	12 to 13	*		1000		=	
14	13 to 14	*		400		800	
15	14 to 15	*		800		1600	
16	15 to 16	*		1000		=	
17	16 to 17	*		500		1000	
18	17 to 18	*		1000		=	
19	18 to 19	*		1000		=	
20	19 to 20	*		1000		=	
21	20 to 21	*		1000		=	
22	21 to 22	*		1000		=	
23	22 to 23	*		1000		=	
24	23 to 24	*		1000		=	
25	24 to 25	*		1000		=	
26	25 to 26	10	40	1000	40000	2000	
27	26 to 27	20	30	1000	30000	2000	
28	27 to 28	30	20	1000	20000	2000	
29	28 to 29	40	10	1000	10000	2000	
30	29 to 29.13	10	40	300	12000	600	
					120000	14800	
					Say 12 Hectares	Say 15000 m	

As above, the Bank Protection requirement has been worked out to 14,800 m say 15,000 m. In canals, the usual types of Bank Protection in Kerala are Revetment / Rip-Rap or Pile & Slab. Since the NW 8 is traversing through the Lake area and keeping in view the Land Acquisition requirement, the preferred type is Pile & Slab for which a preliminary Drawing with the details are provisioned the Chapter 6. Accordingly, 15,000 m of Pile & Slab Bank Protection is suggested and recommended herewith.

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.

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NW 8, being a canal system, the beacon type structure is not amenable and not suggested. i.e., suggested with Buoy & Light system.

Regarding the Buoy & Light system, it is proposed to consider the same type of Buoy and Light deployed in NW 3. The Technical specifications of Buoy & Light, as available in the Market as a proprietary item are detailed in Chapter 6.

Considering 500m interval and in Zigzag position (i.e., 1 Left then 1 Right Mark and 1 Left Mark), it is estimated to provide 65 Nos. in the stretch for 29.30 kms {29000 / 500 + 10 % approx. for Bends etc.).

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

In the present study stretch of NW 8, 5 Bridges are existing at Ch. 0.135km; Ch 0.570km; Ch 23.9 (Pipe Line Bridge); Ch 24.16 and Ch 24.5km. Bridge at Ch. 24.5km can be managed without any modification, duly considering single lane operation and with operational efficiency. Modification for the Bridge @ Ch 24.16km is suggested with an estimated preliminary costing, as detailed.

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TABLE 3-2: COST OF MODIFICATION OF BRIDGES

Referring Cl 2.18 and 2.19 of P.010631-W-10305-001- Hydrographic Survey Report for ALAPPUZHA - CHANGANASSERY CANAL (29.30 KM) - (NW-8) 5 Cross structures are encountered with following details:

For Class III Vessel, with single lane operation, the critical clearances in horizontal direction is taken as 13.5m to 15m

Horizontal Clearance	=	13.5	m
Vertical Clearance	=	6	m

SL No	Chainage	Center Position		Location	Type of structure	Type of super structure	Width	No of span (Nos) x Length of Span (m)	Hz clearance	Height wrt MSL	Modification Required		Estimated Cost of Modification
		Latitude	Longitude								Hz	Vt	
1	0.135	09°30'03.18"	76°20'40.83"	Near Church Road	Foot Over Bridge	RCC	2	1 x 28	20	7.5	No	No	
2	0.57	09°30'00.10"	76°20'54.57"	Near Matha Jetty	Foot Over Bridge	RCC	2	1 x 28	20	7.3	No	No	
3	24.16	09°25'28.49"	76°29'32.73"	Veliyandu Jetty	Kidangra-Kunnamkari Road Bridge	RCC	5	1 x 20	20	3.5	No	Yes	5,500,000
4	24.5	09°25'34.31"	76°29'41.98"	Kidangara	Foot Over Bridge	RCC	2	1 x 18	15	5.2	No	Yes	Not suggested
5	23.9	09°25'32.48"	76°29'29.89"	Near ST Georges Church	Water Pipe Line	RCC		1 x 80	82	6	No	No	
												Total Cost	**5500000**

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NOTES:

NOTE 1: For Foot Over Bridge at Ch 24.5, vertical clearance of 0.8m is required. Since the variation is less, and taking into account tidal variation, no modification is suggested.

NOTE 2: Modification of Road bridge at Ch 24.16 is proposed by increasing the height. Since, this is single span, the road level is increased by 2.5 and suitable gradient is provided at both ends. The Abutments will increase by 2.5m on both sides. Foundation will also need modification as per the increased height.

NOTE 3: The cost of modification may have to be updated before construction at Detailed Engineering Stage.

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Further, 50 Nos. of Power Cables + 1 No. Pipe Line are in existence. Most of the cables may not require any modification. However, anticipated stringing of Cables for which L. S provision has been catered.

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

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

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

3.8 Land Acquisition

NW 8 stretch is in the Vembanad Lake and majority of the stretch is having very less width and depth and Land Acquisition is required for Fairway Development. The Km wise requirement has already been tabulated and accordingly, the requirement has been worked out to an extent of 12 Hectares and the approx. cost involved is about INR 10.45 Cr. Land Acquisition requirement for Terminal purpose is being considered, as a part of Terminal development with an estimated cost of 1.53 Cr.

3.9 Fairway Costing

3.9.1 Capital Cost

The identified Traffic for IWT for this Waterway is of Ro-Ro operation with specific criteria of achieving the operational volumes of about 46,800 vehicles p.a in 2020, which may rise to 69,100 vehicles p. a in 2040.

Investment is suggested with Positive growth and confirmations.

The Capital Cost for the fairway has been considered for 4.46 Lakhs Cu. M of Dredging in soils {INR 10.92 Cr}; 15,000 m of Bank Protection at the identified chainages {INR 21.75 Cr}; Land Acquisition of about 12 Hectares (INR 10.45 Cr); 65 Nos. of Buoy with Light (INR 2.41 Cr) and Modification of Structure i.e., at 1 Bridge (0.55 Cr) and Stringing of 50 HT + Modification of Pipe Line (INR 0.25 Cr + 0.03 Cr). Cost estimates are placed with details in Chapter 11. An option-2 had also been discussed in light of some suggestions obtained from Govt. of Kerala vide their letter dated 07.03.2020, the detail has been discussed in chapter 13.

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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 analysed and considered. Some more assumptions have been considered appropriately, wherever required.

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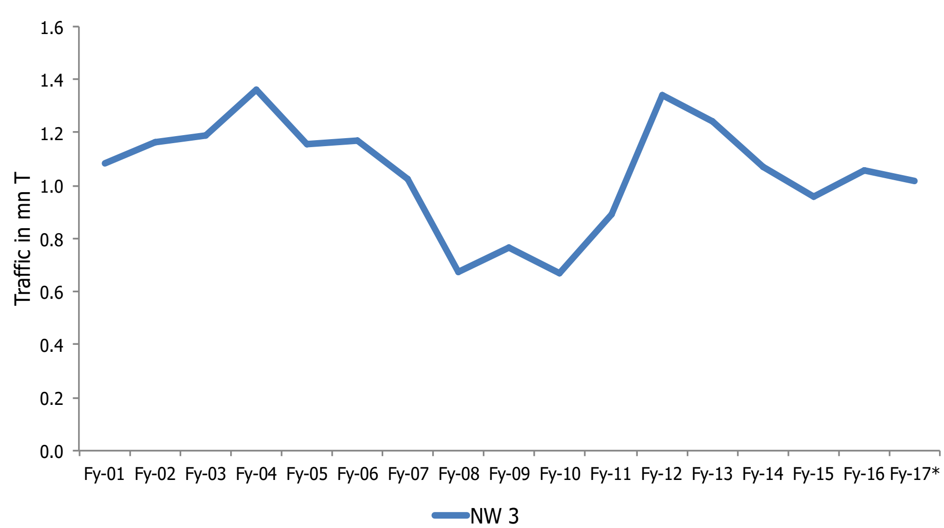
CHAPTER 4 TRAFFIC STUDY

4.1 General

The navigable length of NW 8, Alappuzha-Changanassery canal is 29 km. Alappuzha & Kottayam are the main districts that fall in the catchment area of NW 8; however, some talukas of these identified districts are far from NW 8 and would be studied as the secondary catchment area. Another district that comes in the secondary catchment area is Pathanamthitta. NW 8 is connected with NW 3 at Alappuzha. It is proposed that NW 8 would act as one of the feeder routes to NW 3.

Most of the feeder canals and waterways of Kerala suffer from navigational hazards like shallow water and narrow width of channel during dry weather, siltation, bank erosion, absence of infrastructural facilities like terminals and inadequacy of navigational aids. Kerala Shipping and Inland Navigation Corporation have 12 barges, 11 boats and 2 Jankars. Houseboats do not operate within 1 km from starting point of the canal and in last 5 km stretch of NW 8 from Changanassery.

Following graph shows the historic traffic of NW 3, which is the only operational waterway of Kerala. The existing NW 3 starts from Kottapuram and ends at Kollam.



Source: IWAI

Figure 4-1 Historic Traffic handled at NW 3

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It is clearly visible from the above graph that between Fy 06 and Fy 11 traffic handled by NW 3 has decreased substantially. After Fy 11 though traffic has gradually grown, it is still in down trend. At present Sulphur, Rock Phosphate, Phosphoric Acid and Furnace Oil, which are used as raw materials for fertilizer industries are the only commodities that get transported by barges in NW 3. Fertilizer & Chemical Travancore (FACT) and Binani Zinc are major industries, which are using NW 3. FACT has made major investments into terminals for barge handling on both ends of NW 3. This investment has proved to be a major factor to make NW 3 operational.

The operational cost of barges in NW 3 is INR 55 per ton. As FACT is the major client of NW 3, its plant's production affects cargo volume, handled at NW 3. In Fy 13, FACT closed down its operation for short period, due to some development project. Binani Zinc has permanently closed down its operation; hence NW 3 is solely dependent on FACT's cargo. There are nine terminals developed on NW 3; only some of the terminals are operational, rest are lying idle.

If cargo potential exists for NW 8, it would get transported via NW 3 at Alappuzha. NW 3 is the only waterway as of now, which has navigational facility at all stretches. In this case NW 3 would have additional cargo apart from raw materials for the fertilizer plant. Following image shows all the proposed waterways in the study and their connectivity with the existing NW 3. It is clearly visible from the below map that NW 8 connects with NW 3 at Alappuzha. Therefore, if cargo potential exists for NW 8, it would go to Cochin port/ ICTT by using operational NW 3. If IWAI helps in smooth navigation in NW 3 and removes existing bottlenecks, then nearby industries would show willingness to use this waterway. Few bottlenecks in the existing NW 3 are listed below:

- Lock/bridge clearance issue exists on Kollam to Kottapuram stretch.
- There is inadequate depth and if dredging takes place then there exist issue of disposing dredged material.
- Fishermen put net at many places, causing disturbance in smooth movement of vessels in NW 3.

NW 3 also consists 37 km stretch of two canals, namely Champakara & Udyogamandal. Total length of NW 3 is 205 km. IWAI has installed night navigation facilities in 168 km stretch for reduction in turnaround time & increase the loops of vessel movement. It is the only waterway in India to have navigational facilities for 24 hrs. /day. However only two canals, Champakara & Udyogamandal are operational in whole NW 3 for cargo movement. Backwater navigation department of Kerala has brought down logistic cost of transporting bulk material through waterways. In Fy- 04 transportation cost of bulk material via waterway was INR 1,600/ton, which has reduced to INR 275/ton in Fy-14.

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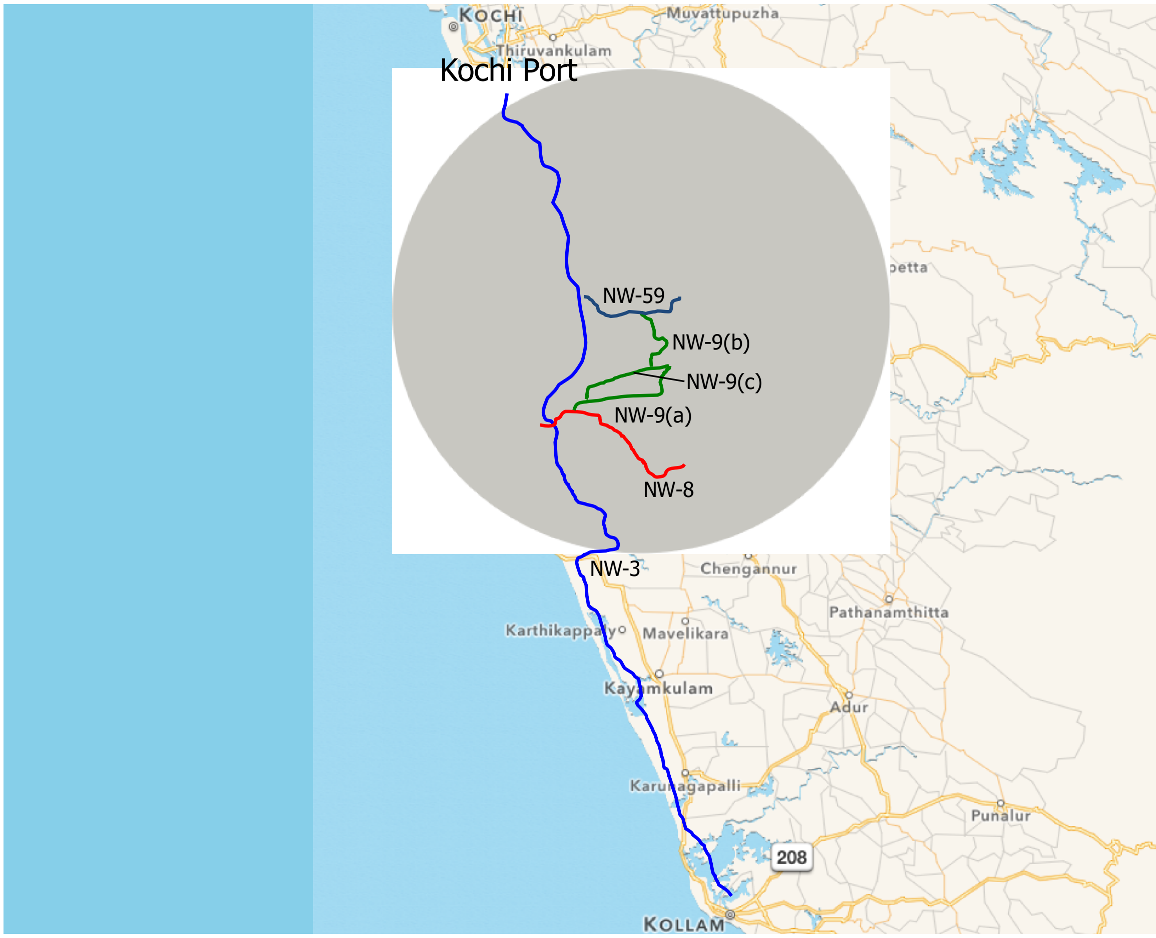

Source: IWAI

Figure 4-2 NW 3 connectivity with other proposed waterways in Kerala

The above figure shows the hinterland of NW 8 and other national waterways and highways. It can be seen in the figure that NW 8 connects NW 9 & NW 3 on different points. Majority of industries are located in the hinterland of NW 9 & NW 59. NW 8 on stand-alone basis cannot be used for cargo movement.

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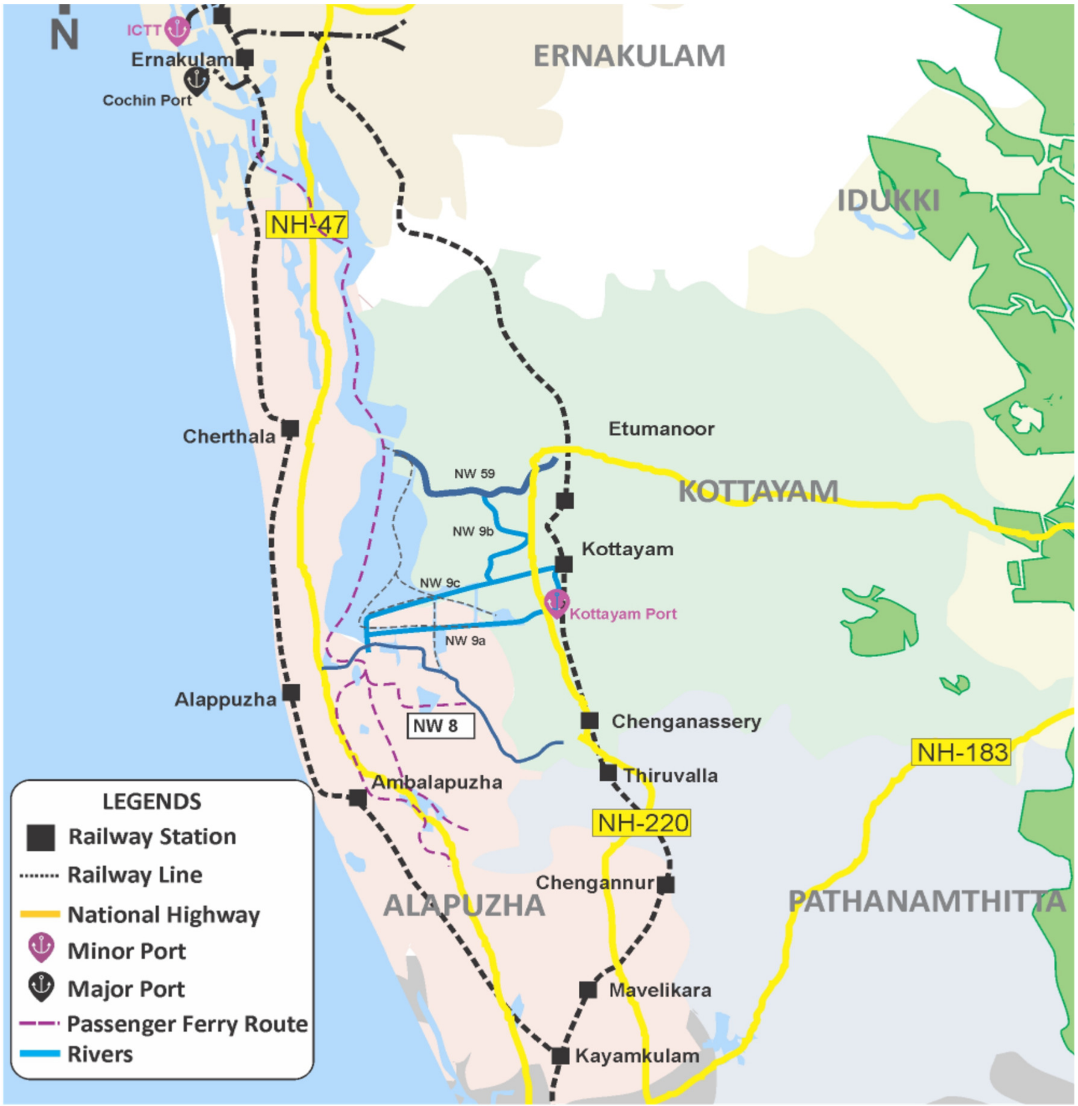

Source: IWAI / Consultant's Analysis

Figure 4-3 NW 8 Overview

Source: Site Visit

Figure 4-4 Waterfront area of NW 8

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4.2 Hinterland Analysis

NW 59 & NW 9 come under the primary catchment area of NW 8. Both NW 59 & NW 9 are on the northern side of NW 8. Kottayam and Alappuzha districts of Kerala comprise the primary catchment area of NW 8 and this catchment area is also shared by other two canals, NW 9 & NW 59. Apart from these two districts, part of Pathanamthitta district comes in secondary catchment area of NW 8.

The districts of Alappuzha & Kottayam are famous for paddy production and fishing. Some medium scale industries are present in the vicinity of the proposed waterway, which include paper, food & rubber-based industries. Alappuzha district is famous for its backwaters and river tourism. There exist many ferry services in Alappuzha and Kottayam district. Pathanamthitta district is one of the most important pilgrim centers in Kerala with many temples and churches. Sabarimala in Pathanamthitta, located at an altitude of 3,790 feet, is one of the most famous pilgrim centers in the country. World famous Aranmula mirrors are manufactured in Pathanamthitta district. Coir, Rubber and textile product making industries are found in Kottayam & Alappuzha. Pallippuram, Cherthala is the major industrial zone of Alappuzha district, which is within 25 km of reach from ICTT. 109,582 ha. of land of Kottayam is dedicated to the rubber plantations and houses the headquarters of the Indian Rubber Board. It is also called land of latex.

4.2.1 Demography Profile of Hinterland

Kottayam taluka has highest population among all other talukas and district wise Alappuzha has recorded highest population as per census 2011. Kottayam has the highest literacy rates in Kerala; it is also called as literacy capital of Kerala. People of Alappuzha are engaged in agriculture, shell collection, coir industries, backwater fishing, handicraft and handloom activities etc. for their income. Alappuzha has a unique culture of its own. People of Kottayam are engaged in rubber industries etc. Kottayam is one of the leading districts of Kerala in the field of mass communication, education and culture.

Pathanamthitta district is famous for its rural lifestyle and is being promoted as rural tourism by state government. 80% of the population of Pathanamthitta district is dependent on agriculture, either directly or indirectly.

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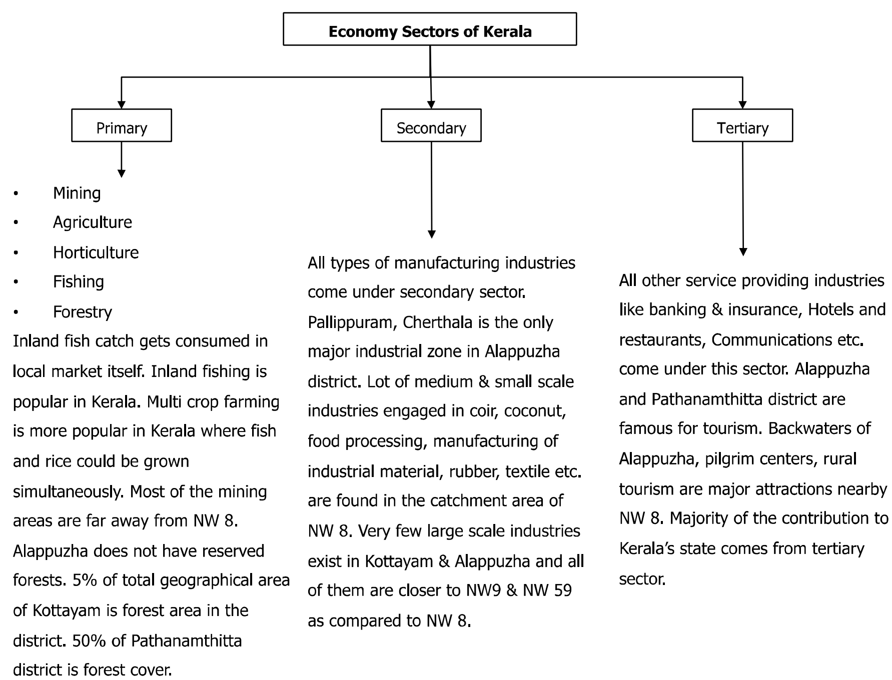
Table 4-1 Village wise population around the river

District	Taluka	Population
Alappuzha	Cherthala	5,42,657
	Ambalappuzha	4,54,864
	Karthikapally	4,06,524
	Mavelikkara	3,33,318
	Chengannur	1,97,419
	Kuttanad	1,93,007
Kottayam	Kottayam	6,31,885
	Changanassery	3,55,736
Pathanamthitta	Kozhenchery	3,38,560
	Thiruvalla	2,23,503
	Mallappally	1,34,219

Source: Census, 2011

4.2.2 Economic profile



Source: India Brand Equity Foundation (IBEF)

Figure 4-5 Economy Sectors of Kerala

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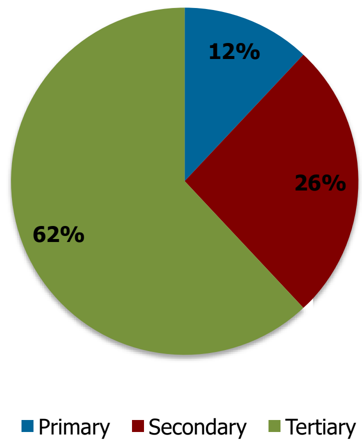

Source: India Brand Equity Foundation (IBEF)

Figure 4-6 Sector wise contribution in Kerala's economy

It is clearly visible from Figure 4.6 that tertiary sector is the major contributing sector of Kerala. Tourism is the main source in tertiary sector share in state economy. Though Kerala has paddy fields and mineral reserves of various types, primary sector's contribution is the least in Kerala's economy. Following graph Figure 4-7 shows historic contribution of each sector in Kerala's economy.

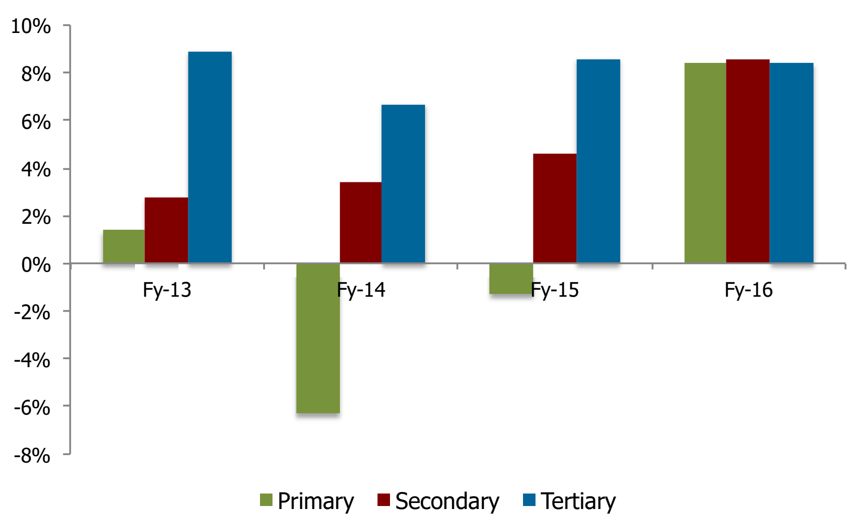

Figure 4-7 Sector wise historic growth of Kerala's economy

Source: Central Statistics Office, PRS

Agriculture sector is the most volatile among other primary sectors, which has affected the growth of the state's economy. Kerala Government is planning to increase the share of manufacturing sector to 10% of the GSDP by 2030. Kerala contributes to total 69%

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to overall India's rubber production. Tertiary sector is booming since past so many years.

4.2.2.1 PRIMARY SECTOR

Primary sector consists of Agriculture, Forestry, Fishing and Mining. The table below shows sector wise GSDP of the districts that fall in the catchment area of NW 8.

TABLE 4-2 SECTOR WISE GSDP (IN LACS)

Sr.no	Industry Of Origin	Pathanamttitha	Alappuzha	Kottayam
1	Agriculture & Allied activities	1,05,337	58,690	1,85,648
2	Forestry & Logging	11,223	14,542	13,785
3	Fishing	464	37,719	1,827
Agriculture and Allied		1,17,024	1,10,951	2,01,260
4	Mining and Quarrying	3,968	2,063	4,368
Total of Primary Sector		1,20,993	1,13,014	2,05,628

Source: Directorate of Economics and Statistics, Thiruvanthapuram

a. Agriculture

Kerala is a leading agricultural state in the country and the largest producer of rubber, pepper, coconut and coir. Rice being the major crop cultivated in the districts, its production forms the major part of agricultural produce. The major spices produced are black pepper, cured ginger and cured turmeric. Other agriculture productions include cash crops such as sugarcane, arecanut, tamarind and nutmeg.

The important crops cultivated in Kottayam district are rubber, pepper and paddy. Area under paddy cultivation in the District during the year 2010-11 contributed to 6.93% of the state total. Rubber is the major plantation crop cultivated in Kottayam; total area under rubber cultivation in the District is 113,730 Hectare, which is about 21% of the total rubber cultivated area of the state. Production statistics of rubber shows Kottayam district's contribution to total production in the state is about 22%.

Paddy, coconut, tapioca, jack, mango and plantain are the major crops cultivated in Alappuzha district. Paddy cultivated in Alappuzha is around 34.16% of the total cropped area in the district and 17.38% of total paddy crop of Kerala. Other than paddy, coconut is produced majorly, which forms 36.26% of the total cropped area of Alappuzha. The major rice production is comprised of Champakulam, Veliyanad and Ambalapuzzha block, which contribute 82.79% rice in the district. Kuttanad Taluka of Alappuzha district is known as the rice bowl of Kerala and the main occupation of people here is agriculture.

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Paddy, tapioca, rubber, pepper, banana and coconut are the important crops cultivated in Pathanamthitta district. Area under paddy cultivation in the district is around 1.4 percentage of total paddy area of Kerala. Rubber is the major plantation crop cultivated in the District.

TABLE 4-3 TALUKA WISE AGRICULTURE PRODUCTION (FY 15)

(Production in Tons)

District	Taluka	Rice	Spices	Others
Alappuzha	Cherthala	1,028	23	248
	Ambalappuzha	10,999	9	255
	Karthikapally	11,440	47	291
	Mavelikkara	9,255	149	190
	Chengannur	3,560	239	227
	Kuttanad	60,762	4	618
	Municipalities	6,047	11	82
Kottayam	Kottayam	1,398	343	637
	Changanassery	6,529	225	313
	Municipalities	2,493	33	239
Pathanamthitta	Kozhenchery	718	521	389
	Thiruvalla	5,670	119	390
	Mallappally	278	146	215
	Municipalities	128	73	155

Source: Department of Economics and Statistics, Kerala

The Kerala Agriculture University (KAU) has introduced the technique of integrated farming in Alappuzha through which fish and rice could be grown simultaneously. Due to this, the cost of production of rice has dropped significantly. The table below shows food grains production in the catchment area of NW 8.

TABLE 4-4 lists out food grain production in Alappuzha & Kottayam districts. In Pathanamthitta district area under production is far less compared to both Alappuzha & Kottayam districts.

TABLE 4-4 FOOD GRAIN PRODUCTION IN FY 15

Sl. No.	District	Cereals		Pulses		Oil Seeds		Total	
		Area (Ha)	Production (T)	Area (Ha)	Production (T)	Area (Ha)	Production (million nuts/T)	Area (Ha)	Production (million nuts/T)
1	Alappuzha	34,415	103,095	56	37	35,338	218/17	69,809	218/1,03,149
2	Kottayam	17,295	49,393	99	69	26,638	140/0	44,032	140/49,462
	Total	51,710	152,488	155	106	61,976	358/17	113,841	358/1,52,611

*- Million nuts for Coconut, rest all in Tons

Source: Economics & Statistics Dept., Govt. of Kerala

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b. Horticulture

Jackfruit is the major fruit produced, followed by Plantain, Pineapple, Banana and Mango. Others section includes Raw Cashew Nuts, Tapioca, Betel leaves and Cocoa.

TABLE 4-5 TALUKA WISE HORTICULTURE PRODUCTION (FY 15)

(Production in Tons)

District	Taluka	Fruits	Coconut (Nuts)	Others
Alappuzha	Cherthala	623	44,000	1
	Ambalappuzha	338	19,000	1
	Karthikapally	712	62,000	10
	Mavelikkara	1,814	27,000	45
	Chengannur	2,090	15,000	29
	Kuttanad	299	27,000	0
	Municipalities	675	24,000	3
Kottayam	Kottayam	2,996	21,000	44
	Changanassery	1,851	14,000	20
	Municipalties	1,147	7,000	3
Pathanamthitta	Kozhenchery	1,574	18,000	42
	Thiruvalla	2,168	22,000	23
	Mallappally	1,141	13,000	16
	Municipalties	968	10,000	10

Source: Department of Economics and Statistics, Kerala

c. Fishing

Kerala's share in the national marine fish production is about 20%. The fisheries sector provides occupation to about 4 lakh people, making it a significant employment-providing sector of the State. Kerala is rich with resources of freshwater and Brackish water. Kerala has a total 3,32,000 ha. estimated freshwater area, consisting of reservoirs, rivers, ponds, tanks, irrigation tanks and paddy fields. 0.7 lac ha. of paddy fields is in Kuttanad. 35,000 hectares of Padasekharams is distributed in Alappuzha, Kottayam and Pathanamthitta districts. More than 77% of brackish water areas are left unused. Most of the inland production is consumed locally and marketed domestically.

TABLE 4-6 DISTRICT WISE FISH PRODUCTION (FY 16)

District	Fish Production (MT)		Total (MT)
	Marine	Inland	
Alappuzha	44,388	34,930	79,318
Kottayam	-	12,308	12,308
Pathanamthitta	-	3,525	3,525

Source: Directorate of Fisheries

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Inland fishing is popular in both Alappuzha & Kottayam districts; however very few fish landing centres are located along the waterway. Kottayam district doesn't have any marine fishing, as the district is not located along the coastline.

A total of 34 minor inland fish landing centres are available in the districts of Alappuzha & Kottayam, but there is no landing point on NW 8. There are two coastal harbours for fishing in Alappuzha's primary catchment area, namely Katrur Pollathai, Punnapra, which are 10 & 8 km away from Alappuzha, which is the starting point of river.

d. Forestry

Alappuzha is the only district in the state, which has no reserved forests. Total forest area of Kottayam District is 101 sq. km., which is around 5% of the total geographical area of the district. Total forest area of Pathanamthitta District is 1,534 sq. km., which forms around 60% of the total geographical area of the District. The forest area falls under Konni Division (253 sq. km), Ranni Division (1,058 sq. km.) and Achancoil Division (222 sq.km.) Evergreen forest, semi-evergreen forest and moist deciduous forest are found in the district. Pathanamthitta has nearly half of its total area under forest cover.

e. Mining

During Fy-11, Kerala has seen a drop by 11% of mineral production. Kerala has its state owned mineral deposits of placers, china clay (kaolin), limestone, lime shell, silica sand, bauxite, graphite, iron ore, granite etc. The major mineral based industries are Indian Rare Earths, Kerala Minerals and Metals, Malabar Cements; Travancore Cements , Kundara Ceramics, English Indian Clays (EICL), Excel Glass Industry, Kerala Clays and Ceramic Products. Only Travancore cements falls in the catchment area, however this industry is on the bank of NW 9 providing no scope for NW 8.

Extensive deposits of silica sand are found in the coastal tract between Alappuzha and Aroor in Alappuzha District. Minerals like Sand, Silica Sand, and Laterite are found in Alappuzha District. and Graphite & Lime-shell are found in Kottayam district. But most of these mineral mining areas are not located in the vicinity of Alappuzha-Changanassery Canal.

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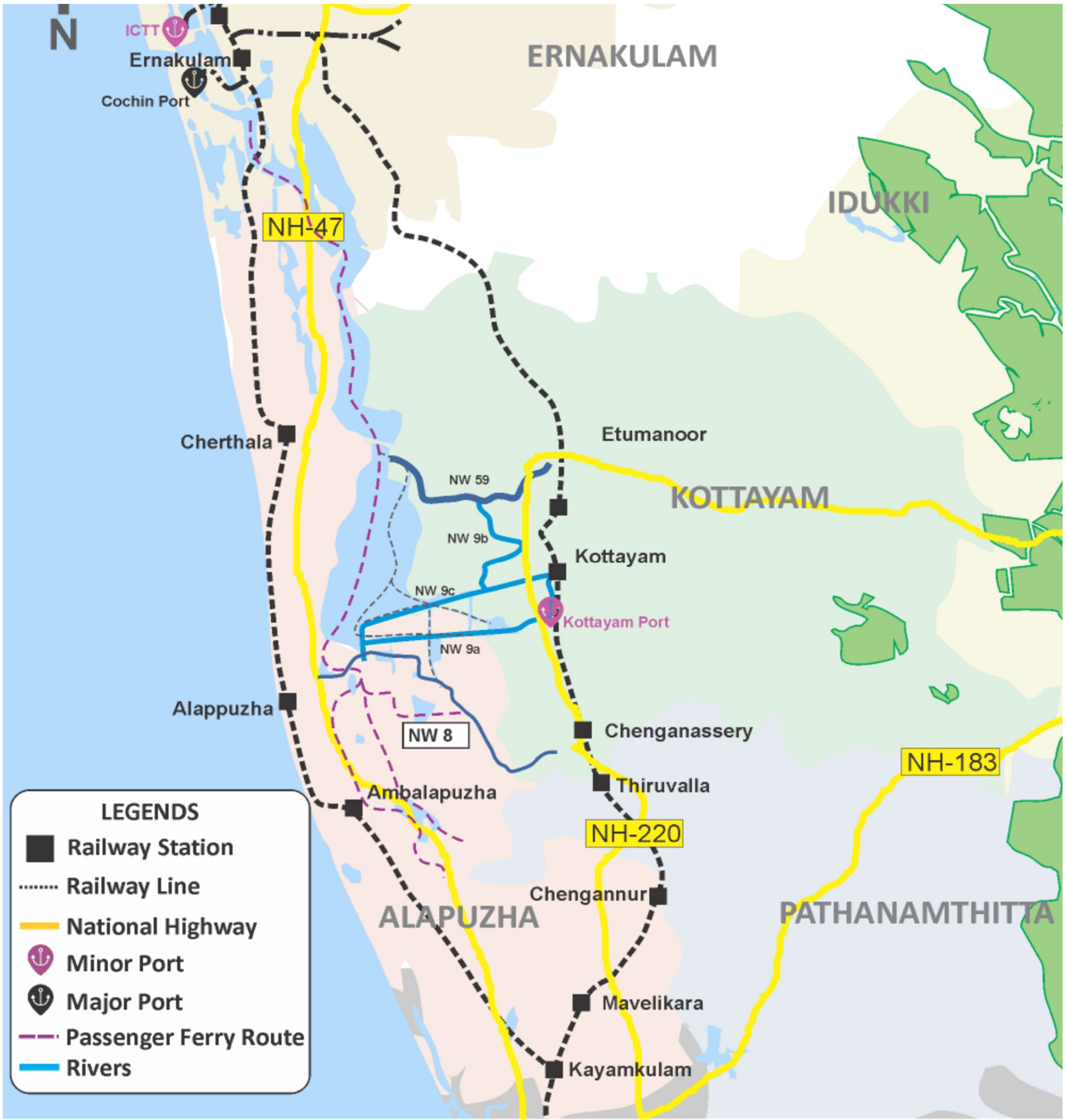

Source: IWAI / Consultant's Analysis

Figure 4-8 Minerals along NW 8

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TABLE 4-7 DISTRICT WISE MINERAL PRODUCTION

District	Types of Mineral	Production (Tons)
Major		
Alappuzha	Granite Building Stone	2,378
Kottayam	Lime Shell	27,745
Pathanamthitta	Granite Building Stone	2,80,084
Total		3,10,207
Minor		
Alappuzha	Laterite	10,991
	Sand	2,65,956
	Silica Sand	66,402
Kottayam	Granite Building Stone	18,21,254
	Sand	4,577
	Ordinary Earth	13,47,363
	Laterite	19,298
	Brick Clay	59,831
Pathanamthitta	Laterite	34,525
	Ordinary Earth	6,37,682
	Brick Clay	2,550
Total		42,70,429

Source: Dept. Of Mining and Geology

TABLE 4-8 SILICA SAND RESERVES IN CHERTHALA, ALAPPUZHA DISTRICT

Village	Area (Ha.)	Reserves (mn T)
Pallipuram	300	18
Thycauttuserry	120	7
Panavally	50	4
Total	470	29

Source: Department of Mines and Geology

Due to the deficiency of high grade limestone, the requirement by the chemical industry is dependent on the lime shell resources available in the backwaters/estuaries, river mouths and lagoons along the coastal tract. The largest lime shell reserve is found in Vembanad Lake and adjoining portions of Alappuzha, Kottayam and Ernakulam Districts. Out of the 2.75 million tonnes reserve of Lime shell, 2.50 million tonnes reserve is in Vembanad lake and 0.25 million tone reserve in Thannirmukkom. Government has put ban on any extraction from Vembanad Lake, therefore this lake is no longer origin point of raw materials for mineral based industries.

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4.2.2.2 SECONDARY SECTOR

Alappuzha is backward in industrialization. The district is famous for coir industry. Easy availability of raw materials, existence of backwaters and canals for the wetting of green husk and accessibility of transportation are the main factors for the development of coir industry. Medium and small-scale industries in coir, coconut, food processing, construction material and software based industries could be found in Alappuzha district.

Kottayam industries form the backbone of the economy of Kottayam and they have developed over the years. There are in total 11 large scale as well as medium scale industries in the city of Kottayam. There exist 12 Mini industrial estates and 12,000 small scale industrial units at Kottayam. The agriculture based Kottayam Industries have attained the maximum amount of boost in the region. Rubber industry has witnessed growth in last few years. Some of the factors that contributed to the growth are increase in rubber production and introduction of modernized techniques for processing. The Rubber Board and Rubber Research Institute of India are based in Kottayam. The establishment of tyre industry in Kottayam has further intensified the growth of the rubber industry.

Wood industry is another important industry of Kottayam. Different types of timber wood are available in the surrounding areas of Kottayam. This has favored the growth of almost 1,300 wood producing and processing units in Kottayam. Kottayam is self-sufficient in products like spices, coconut, meat, milk, and paddy. All these favor the Agro industries in the region.

TABLE 4-9 explains various types of industries in the districts that fall in the catchment area. Construction industry's contribution to GSDP in all the three districts is more.

TABLE 4-9 GSDP BY INDUSTRY ORIGIN

(Lacs.)

Industry Of Origin	Pathanamttitha	Alappuzha	Kottayam
Manufacturing	20,408	1,02,035	75,795
Medium	9,115	45,573	33,853
Small	11,293	56,462	41,942
Construction	1,01,360	1,99,398	1,89,094
Electricity, Gas and Water Supply	12,941	22,512	24,029
Electricity	11,728	19,810	21,445
Gas	261	439	401
Water Supply	952	2,263	2,183
Total of Secondary Sector	1,34,710	3,23,945	2,88,918

Source: Directorate of Economics and Statistics, Kerala

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4.2.2.3 TERTIARY SECTOR

Kerala is one of the few states to have marketed its natural beauty successfully to grow its tourism sector. The state's unique heritage and cultural diversity have attracted tourists from around the world. BBC Travel survey has rated Kerala as the top favorite tourist destination among foreign travelers. Foreign tourist arrivals increased by 6% during Fy 15-16 over Fy 14-15. Tourism is Kerala's booming industry and one of the fastest growing, high income and employment-generating sector.

TABLE 4-10 GSDP IN TERTIARY SECTOR

(Lacs.)

Industry of Origin	Pathanamttitha	Alappuzha	Kottayam
Transport, Storage & Communication	1,81,521	2,03,811	2,54,102
Railways	579	5,279	4,699
Transport by other means	82,434	87,618	99,802
Storage	105	1,158	2,002
Communication	98,402	1,09,755	1,47,599
Trade, Hotel & Restaurants	1,11,206	2,65,910	2,56,454
Banking & Insurance	98,658	1,19,527	1,36,257
Real estate ownership, Business, Legal	1,08,015	1,69,277	1,51,314
Public administration	36,982	56,683	61,525
Other Services	1,25,013	16,966	1,69,473
Total of Tertiary Sector	6,61,393	9,85,173	10,29,125

Source: Directorate of Economics and Statistics, Kerala

Kerala being a consumer state depends on other states for almost all commodities of daily consumption. The demand for construction activities from real estate and other sectors of the economy also results in higher goods transportation.

4.2.2.4 INFRASTRUCTURE ANALYSIS

Transport infrastructure of the State consists of 4 lakh km of roadways, 1,257 km of Railways, 1,687 km of Inland Waterways and 3 Airports and 18 Ports.

4.2.2.5 CONNECTIVITY ANALYSIS

Alappuzha district’s passenger and goods are mainly dependent on roads and railways for mobility.

Kottayam District has good road and railway network. Road and rail connectivity is considerably fair in Pathanamthitta District.

a. Roadway

Alappuzha district has total 171 km length of state highway (SH) and 1,033 km length of major district roads. Kollam Theni National Highway and Main Central Road, which

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connect Thiruvananthapuram and Angamaly pass through Kottayam. Pathanamthitta has 218 km of state highway, 574 km of major district roads, 621 km of other district roads and 43 km of village roads. State highway (SH) 11 runs parallel to NW 8 and connects Alapuzzha and Changanassery. Both the towns of Alappuzha & Changanassery are well connected by a network of State & National Highways. N.H. 66 connects Alappuzha with Thiruvananthapuram & Cochin, N.H. 183 connects Changanassery with Kottayam & Adoor. Roads, which connect many of the Minor and Intermediate Ports with the hinterland are not equipped for heavy vehicles.

b. Railway

Alappuzha & Changanassery are served by Southern Railways. Kottayam district has a major railway station, which is considered as one of the major railway stations in Central Kerala, whereas Alappuzha district is well connected by rail network. Pathanamthitta has access to Thiruvalla railway station, which is 30 km away from the district head quarter of Pathanamthitta.

c. Airport

The nearest airport from the districts in the catchment of NW 8, is Cochin International Airport, which is about 83 km away.

d. Ferry Terminal

There exist Ferry terminals at the start and at the end point of canal at Alappuzha and Changanassery.

TABLE 4-11 EXISTING FERRY TERMINALS

Sl. No.	Station Name	District
1	Alappuzha	Alappuzha
2	Nedumudy	
3	Kavalam	
4	Pulinkunnoo	
5	Edathua	
6	Vaikom	
7	Mohamma	
8	Panuavally	
9	Kottayam	Kottayam
10	Changanassery	

Source: State Water Transport Department, Govt. of Kerala

Though there are bridges to cross over the canal, but they are located far away from each other; therefore irrespective of existing roadways, ferry service is widely used.

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Figure 4-9 Changanassery ferry terminal

Source: Site Visit

First ferry from Changanassery starts in the morning around 9:15 am. Last ferry from Changanassery to Kavalam leaves at 8 pm at night. Ferry that connects Alappuzha & Changanassery has seating capacity of 100 people at one time. Ferry that plies on Kavalam & Changanassery has seating capacity of 75 people. Overall in a day, Changanassery terminal handles 350 passengers.

At present, only passenger ferry service runs for people. There is no Ro- Ro ferry service on NW 8. However in Kerala, Cochin Shipyard has introduced two Ro- Ro passenger ferry services. This ferry has capacity of 50 passengers and 12-18 cars.

4.2.2.6 EXISTING INFRASTRUCTURE

Being a backwater tourism canal, Alappuzha- Changanassery has 3 working ferry service lines and 13 jetties. Kovini Palam, Vada canal footbridges are the existing infrastructure over the river.

NW 8 also has ship repair yard in Alappuzha, opposite to Rajiv Jetty. Following image shows exact location of the site and actual site visit images.

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Figure 4-10 Ship Repair Yard on NW 8

Source: Site Visit

Figure 4-11 Landing Point

Source: Site Visit

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Apart from existing ferry terminals there are small landing points found on NW 8. Figure **4-11** shows one of the landing points near the repair yard.

Figure 4-12 IWAI Terminal in Alappuzha

Source: Google Earth, Site Visit

During site visit, developed IWAI terminal was found for handling cargo at the beginning of NW 8. Due to no cargo opportunity in the catchment area no activity is taking place at the moment. This terminal is not operational, neither for passengers nor tourists.

4.2.2.7 UPCOMING INFRASTRUCTURE

- The Government of Kerala has already decided to develop five minor ports through PPP mode. These Ports are Azheekal, Beypore, Ponnani, Alappuzha and Kollam. A major port, Vizhinjam Deepwater International Container Transshipment Terminal is also coming up.
- Erection of dry dock facility at Alappuzha is going to be completed soon.
- KSINC also intends to construct 2 cargo barges to transport furnace oil and hydrochloric acid through inland waterways and a theme cruise vessel with facilities for night stay in PPP mode.
- Night halt centre at Perumbalam (Near Cochin) for houseboats would be developed.
- Idle parking & maintenance yard would be developed at Pulincunnu. Distance between NW 8 & Pulincunnu is within 5 km.

4.2.3 Existing & Proposed Industries

At present NW 8 is not used for any industrial cargo movement. Majority of the industries in the catchment area use roadways for transportation. Large number of

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industrial units are located in Alappuzha and Kottayam district as compared to Pathananamthitta district. There exists KINFRA industrial park in Kunnamthanam, Pathanamthitta. Total area of the park is 39 acres. There are 21 operational units in this park. Industries of Pathanamthitta are small to medium scale industries. There exist some large and several medium & small industries in Alappuzha & Kottayam districts. The table below presents a list of industries in the catchment area of NW 8 and the potential they would provide to the proposed waterway.

4.2.3.1 EXISTING INDUSTRIES

Majority of industries in Alappuzha are based in Cherthala that is near Vembanad Lake and near to NW 9 & NW 59. NW 8 is in the south of Vembanad Lake. Industries in Kottayam are nearer to the banks of NW 9. Therefore if any potential exists from industries of Alappuzha & Kottayam, it would get diverted to NW 9 & 59 and not to NW 8. There exists no potential from industrial cargo from Alappuzha & Kottayam to NW 8. There exists KINFRA industrial Park in Pathanamthitta district; however these small & medium industries of Pathanamthitta do not generate enough volume for waterway transportation. Most of the industries take order on demand basis or as per their customer requirement. Only coir industry could provide opportunity for waterway transportation as per industries point of view. However, coir based industries are not there in the catchment area of NW 8. Therefore, there does not exist any potential for diverting industrial cargo to NW 8.

There do not exist any Power Plant or Iron & Steel, fertilizer industries in the vicinity of NW 8. Hence, there does not exist any industrial potential for NW 8. Annexure is attached for list of industries in the catchment area of NW 8.

4.2.3.2 PROPOSED INDUSTRIES

At present, the State Government has no plan to put up any industrial unit in the catchment area of NW 8. Also, the existing industries do not have any expansion plan.

4.2.4 Traffic from Major & Non Major Ports

Kerala has a coastal length of 585 km and the State has an average width of about 60 km with one major port at Cochin and 17 minor ports. Out of 17 minor ports in Kerala, four are considered as intermediate ports based on berthing, cargo handling and storage facilities available in them. They are Vizhinjam, Beypore, Azheekal and Kollam ports. The remaining 13 minor ports in the state are Neendakara, Alappuzha, Valiyathura, Kayamkulam, Manakkodam, Munambam, Ponnani, Vadakara, Thalasserry, Manjeswaram, Neeleswaram, Kannur and Kasaragod.

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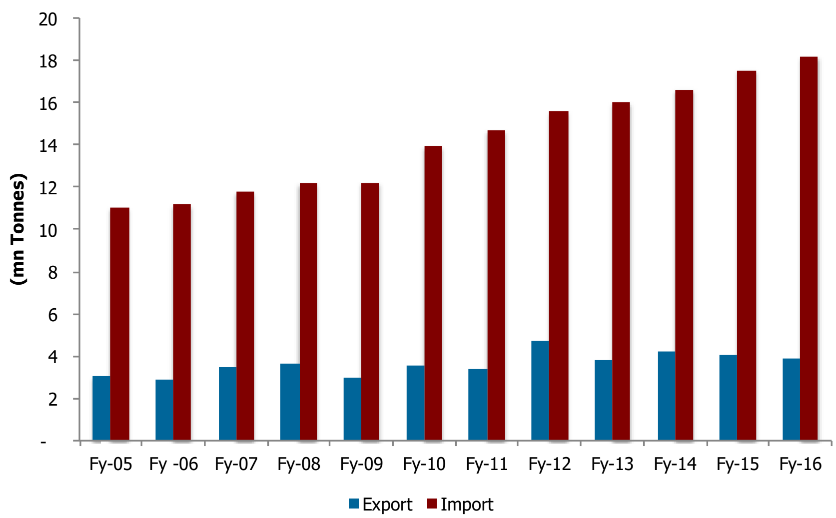
4.2.4.1 COCHIN PORT TRUST

Cochin is the fastest growing logistic centre, emerging in to a major International transshipment terminal. Cochin port is located more than 45 km from NW 8. It is the only major port in Kerala. Following image Figure 4-13 shows historic export & import traffic handled at Cochin port. It is clearly visible from the below image that volume of import is exceeding export volume. Since Fy 09, import traffic handled at the port is constantly growing; however export is not following the same trend. Over the last 10 years, export traffic has shown steady growth.



Source: IPA

Figure 4-13 EXIM trade of Cochin Port

Total area of Cochin Port Trust is 2,133 Acres, which includes Willingdon Island, Vallarpadam, Puthuvypeen, Palluruthy, Fort Cochin, Bolgatty, Thevera Foreshore, Ernakulam and Pachalam. There are 7 berths, which are listed below:

1. Cochin Oil Terminal (COT)
2. North Tanker Berth (NTB)
3. South Tanker Berth (STB)
4. South Coal Berth (SCB)
5. Boat Train Peir Berth (BTP)
6. Single Poing Mooring and
7. LNG Berth for storing/handling petroleum products

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a. Proposed development at Cochin Port

Jindal Steel located at Alibaug has approached the management of Cochin Port Trust for using the port area to handle its finished product, i.e. steel coils. The company intends to utilise the cost-effective coastal shipping route to move these high volume cargo from Maharashtra to cater to the south Indian markets.

TABLE 4-12 HISTORIC COMMODITY WISE COCHIN PORT TRAFFIC (MN T)

Commodity	Fy-05	Fy -06	Fy-07	Fy-08	Fy-09	Fy-10	Fy-11	Fy-12	Fy-13	Fy-14	Fy-15	Fy-16
Loaded												
Container	1.16	1.12	1.46	1.61	1.63	1.96	1.67	1.86	1.69	1.87	1.79	1.87
Iron & Steel	-	-	0.00	0.01	0.00	0.00	0.00	-	0.00	-	-	-
Liquid	1.84	1.78	1.97	2.00	1.32	1.61	1.73	2.83	2.15	2.38	2.27	2.04
Break Bulk	0.01	0.01	0.00	0.00	-	-	-	-	-	0.00	-	-
Dry Bulk	0.03	0.01	0.03	-	-	-	-	-	-	-	-	-
Total	3.04	2.92	3.46	3.62	2.95	3.57	3.40	4.68	3.83	4.25	4.06	3.91
Unloaded												
Container	1.15	1.37	1.49	1.63	1.63	1.97	2.84	2.90	2.92	2.92	3.46	3.92
Liquid	8.56	8.16	8.73	9.48	9.32	10.49	10.57	11.28	11.88	12.20	12.29	12.44
Fertilizer	0.57	0.73	0.64	0.45	0.57	0.62	0.62	0.56	0.53	0.56	0.70	0.48
Cement	0.00	-	-	0.05	0.05	0.13	0.26	0.35	0.32	0.62	0.70	0.82
Food Grain	-	-	0.19	0.01	-	-	-	-	-	-	-	0.10
Iron & Steel	0.15	0.20	0.21	0.10	0.09	0.02	-	0.04	0.01	0.03	0.02	0.04
Coal	0.21	0.20	0.22	0.25	0.25	0.26	0.04	0.03	0.03	-	0.10	0.09
Break Bulk	0.12	0.16	0.21	0.13	0.13	0.11	0.07	0.07	0.10	0.16	0.03	0.02
Dry Bulk	0.07	0.15	0.09	0.10	0.13	0.28	0.11	0.08	0.16	0.12	0.20	0.18
Other	0.21	0.20	-	-	0.08	0.07	0.18	0.27	0.07	0.04	0.04	0.11
Total	11.05	11.17	11.80	12.19	12.24	13.94	14.69	15.58	16.01	16.64	17.54	18.18

Source: IPA

b. Export Traffic

Container & liquid cargo contributes majority of share to export traffic. There is no drastic change in the container volume handled over the last 10 years. Rubber, textile based and food processing industries are found in Alappuzha & Kottayam district. These industries are mostly export based. There is BPCL refinery at Cochin with crude oil refining capacity of 9.5 MMTPA. At Puthuvypeen near Cochin, there is a plan to develop a liquid terminal to handle increasing demand in near future.

c. Import Traffic

It is clearly visible from the above table that import traffic handled at Cochin port is more, compared to export traffic and it has steadily grown over the years. Majority of the commodities get imported in Kerala either from other countries or from neighboring state.

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4.2.4.2 KOTTAYAM PORT AND CONTAINER TERMINAL (KPACT)

Kottayam Port and Container Terminal a minor port and Inland Container Depot in Kerala state, situated in Nattakom, is 15 km away from NW 8.

Being a backwater tourist river, no Major Ports are present in the catchment area. Kottayam port is located 60 km away from Alappuzha Changanassery canal.

TABLE 4-13 HISTORIC CONTAINER TRAFFIC OF KOTTAYAM PORT

Traffic	Fy-13	Fy-14	Fy-15	Fy-16	Fy-17
Import	697	1,523	2,012	2,470	2,139
Export	60	90	113	173	173
Total	757	1,613	2,125	2,643	2,312

Source: Kottayam Port

Kottayam Port also follows same trend as Cochin Port, i.e. import traffic handled at the port is more than export traffic. At present, some of the industries in Kottayam & Alappuzha first send their consignment to Kottayam Port and then it goes to Cochin port for export purpose and vice - versa. The above chart explains in detail component wise handling charges for 20 ft. & 40 ft. container at Kottayam Port.

Table 4-14 Container charges of Kottayam Port

S. No.	Type of charges	20' Container	40' Container
1	Transportation Charges	11,000	15,000
2	Stuffing / De Stuffing Charges	4,500	6,000
3	Reefer Cargo	5,500	7,750
4	EDI Charges	250	250
5	Custom Seal Charges	100	100
6	Weighment Charges	250	300
7	Documentation Charges (For Import)	750	750
8	ICD Charges	2,000	2,500
9	Palatalization Charges	1,500	2,000

Source: Kottayamport.com

4.2.4.3 ICTT, COCHIN

An Inland container transshipment terminal is available at Cochin. The terminal currently handles approximately 4 lakh TEU's of traffic annually. Most of the traffic from Kerala is coming to this terminal using trucks. ICTT is located more than 65 km by roadway from Alappuzha i.e. mouth of NW 8. The Vallarpadam -Idappalli railway line connects ICTT with

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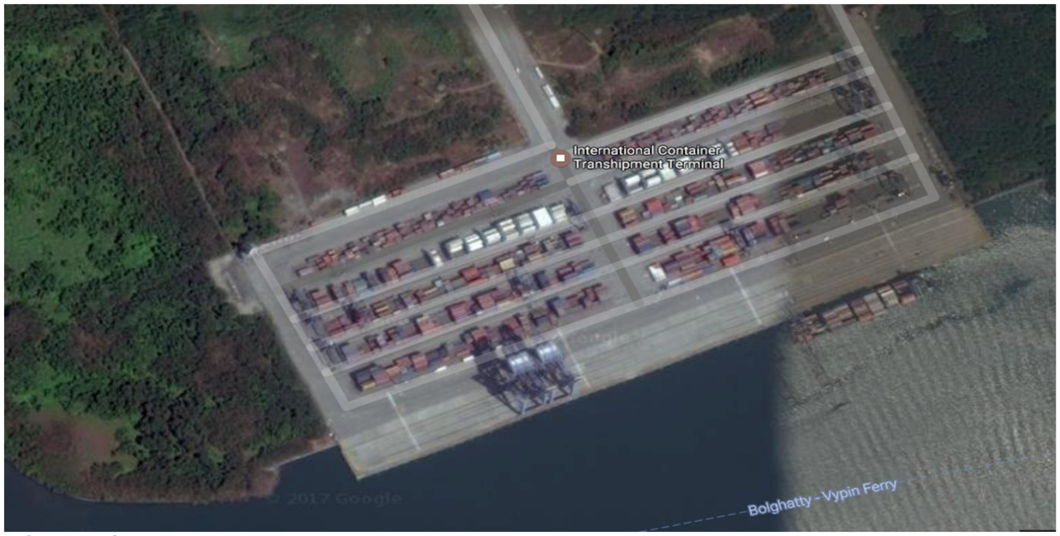
the existing Southern Railway Network and the terminal has excellent road connectivity to NH 17 and NH 47.



Source: Google Map

Figure 4-14 ICTT, Cochin

4.3 Commodity Composition

4.3.1 Fertilizer

There does not exist any fertilizer industry or fertilizer dealer in Alappuzha, Kottayam & Pathanamthitta districts. Below table shows fertilizer consumption in the catchment area. 94,528 metric tonnes of Fertilizers are consumed in Alappuzha & Kottayam district per year. This fertilizer is used for agriculture and horticulture purpose. The land holding size of Alappuzha shows 95 % of the farmers own less than 0.3 ha. Indian Farmers Fertilizer Co-Operatives are formed for farmers where they get fertilizer at a subsidized rate provided by the Government. Hence, there does not exist any potential to transport fertilizer via waterway.

Table 4-15 Fertilizer consumption in the catchment area

(MT)

District	Fertilizer Consumption					
	Urea	SSP	MOP	NPK	DAP	City Compost
Alappuzha	-	-	753	5,060	-	8
Kottayam	38,119	174	22,407	16,422	11,483	102
Total	38,119	174	23,160	21,482	11,483	110

Source: Fertilizer Monitoring System, Govt. of India

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4.3.2 Cement

4.3.2.1 MALABAR CEMENT

The cement grinding unit of Malabar Cements is located at Alappuzha. Malabar cement factory is located near Vembanad Lake. Cochin Port is 34 km away from the factory by roadway. Malabar Cement plant is located between Cochin Port and NW 8. The capacity of the clinker-grinding unit at Cherthala in Alappuzha district is 2 lakh tons per annum. Cherthala is located on the bank of NW 3. The company's major unit is located in Walayar, which is located more than 200 km away from Alappuzha. At present, Malabar cement has been able to meet 10% of total cement consumption in Kerala. It has its own sales depot and stockists located in the entire Kerala market. The Company has appointed dealers for distribution of cement.

4.3.2.2 COCHIN PORT

Cochin Port Trust handles approximately 0.7 MMTPA of cement annually. The same is shipped as Dry bulk and its packaging is done at the Bagging plants located at Cochin Port. The Port has bagging plants for three cement manufacturers namely, Ambuja Cement, Ultratech Cement & Zuari Cement. The bagged cement is then transported to various cities in Kerala & South India via trucks. However, stakeholders are not willing to use waterway for transportation of cement in the catchment area of the river. Thereby there exist no potential of shifting cement handled at the port to waterways.

4.3.3 POL

4.3.3.1 COCHIN REFINERY (BPCL)

BPCL's Cochin refinery is the only major refinery in Kerala. The total quantity of raw material (crude oil) is transported to the refinery from Cochin Port through 30" via pipeline, having total length of 25 km. 59% of the total production of BPCL is transported through pipelines, 24% through tankers, 14% via road and 3% is transported through rail. Total length of pipeline distance is ranging from minimum 1.1 km to maximum 33 km, with varying diameter starting from 8" to 24" feet for transporting products. At present, BPCL's capacity is 9.5 mn T and expansion plan of upto 15.5 mn T. All the transportation of raw materials and finished product of BPCL takes place between Ernakulam and Cochin Refinery. Both these places are out of the catchment area of NW 8. Cochin Refinery does not have any operation in the catchment area of NW 8; hence there would not be any scope of POL transportation through NW 8. Annexure is attached about the refinery's operation in Kerala.

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4.3.3.2 COCHIN PORT

POL products handled at Cochin port is getting consumed in nearby port areas and more than 60% of POL is getting transported by pipeline. Thereby there exists no scope for diverting POL traffic to NW 8.

4.4 Originating & Terminating commodities

Majority of commodities handled at major and non-major ports in the catchment area of NW 8 are not destined to the hinterland of NW 8. Existing small & medium scale industries use KPACT terminal. However volume of industries differs as per demand and requirement of the customers. There is no fixed volume that could be determined from industries to be diverted to the waterway. Hence, industrial cargo would not provide much potential for NW 8.

4.5 Passenger Traffic

Passenger traffic consists of Ro-Ro traffic. Following section brings out detailed analysis of Tourism and passenger traffic in the catchment area of NW 8.

4.6 Tourism Traffic

Alappuzha district being surrounded by backwaters, is the cradle of important boat races like Nehru Trophy Boat Race, Pulinkunnu Rajiv Gandhi Boat Race, Neerettupuram Boat Race, Champakulam Boat Race, Karuvatta and Thaikottan races. These races are mainly conducted at the time of 'Onam' festival.

Kottayam Taluka is famous for Kumarakom, a famous tourist spot, located 10 km away from the district headquarter. It is famous for its lakes, ponds and bird sanctuary. The place attracts both foreign and domestic tourists. Snake boat race held in August-September is also a major tourist attraction of this place. A growing number of Ayurvedic resorts can be seen to meet the increasing demand of foreigners for massage, yoga and Ayurvedic treatments.

Pathanamthitta receives an estimated 3 to 4 million pilgrims during the festival season of Sabrimala. Aranmula is a picturesque village in Pathanamthitta district, which has been declared as an international tourism destination by the Union Government for its famous product "Aranmula Kannady", the indigenously made impeccable metal mirror.

The below table depicts historic tourist arrival in Alappuzha & Kottayam.

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TABLE 4-16 TOURIST ARRIVAL IN THE CATCHMENT OF NW 8

District	International Tourist Arrivals				
	2010	2011	2012	2013	2014
Alappuzha	41,977	46,019	50,760	55,364	60,337
Kottayam	32,561	37,573	40,926	40,932	44,366
Total	74,538	83,592	91,686	96,296	1,04,703
District	**Domestic Tourist Arrivals**				
	2010	**2011**	**2012**	**2013**	**2014**
Alappuzha	1,83,416	1,99,670	2,11,799	2,25,061	2,46,156
Kottayam	3,01,599	3,34,747	3,54,270	3,82,197	4,13,182
Total	4,85,015	5,34,417	5,66,069	6,07,258	6,59,338

Source: Kerala Tourism Statistics, 2014 (Govt. of Kerala)

Famous tourist places in the catchment area, along with the distance from NW 8 is presented in the below table.

TABLE 4-17 FAMOUS TOURISTS SPOTS

Sr. No.	Location	Distance (km)
1	Karumadikuttan	25
2	Vijay Beach Park	4
3	Ambalappuzha Sree Krishna Temple	15
4	Kalloorkad St. Mary's Basilica Church, Champakulam	16
5	Sabarimala Sri Dharmasastha Temple	3
6	Kaviyoor Mahadeva Temple	15
7	Sree Vallabha Temple	9
8	Sri Subrahmanya Swamy Temple	22
9	Charalkunnu / Charal Mount (Hill Station)	25
10	The Great Backwaters	3
11	Alleppey Boathouse	0
12	Mullackal Rajarajeshwari Temple	0

Source: Secondary Research

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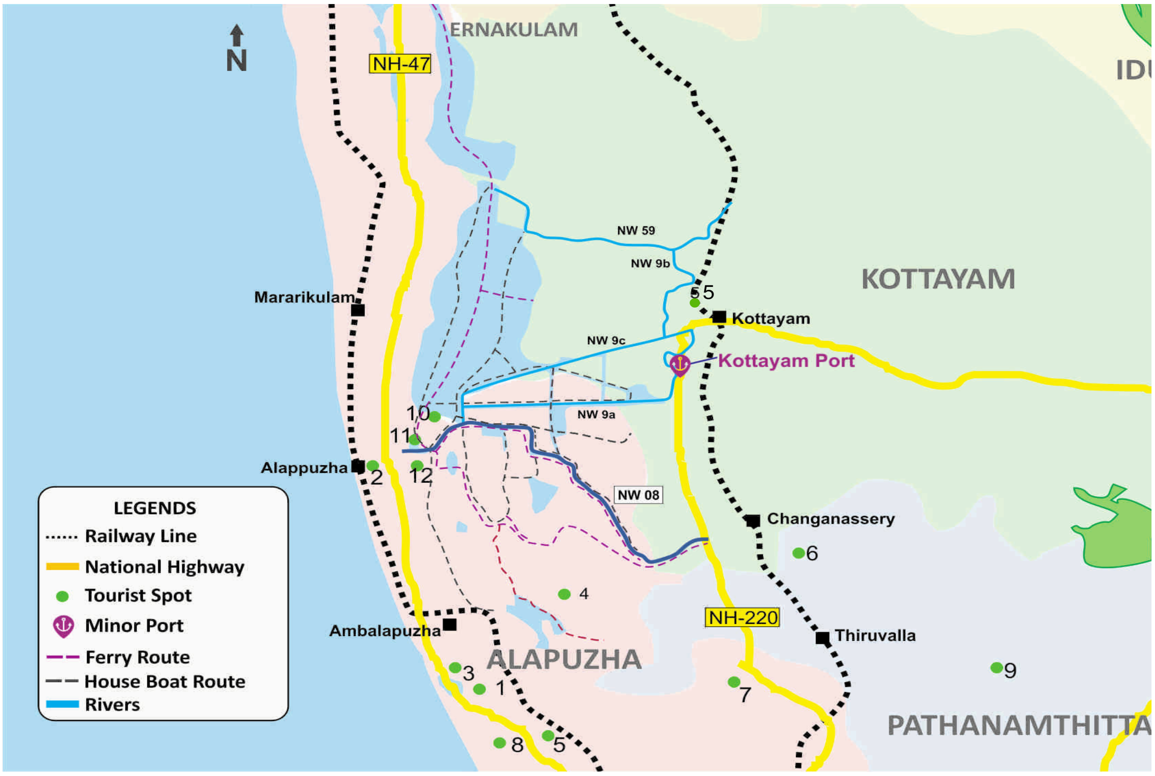

Source: Consultant's Analysis

Figure 4-15 Tourists Spots around NW 8

Apart from the above mentioned tourist places, there are other famous tourist spots in the identified districts, but they are closer to NW 9 & NW 59. Hence, they would not provide potential for NW 8.

Some famous tourist places in the catchment area are described below.

4.6.1 Karumadikuttan

Located at about 5 km east of Ambalappuzha, it is a Buddhist pilgrim centre. Protected by the State Archaeological Department, many legends are associated with the 11th century statute of Lord Buddha. The locals credit Lord Buddha with many healing powers. The nearest state highway is Ambalappuzha – Thiruvalla Road. The nearest airport is Cochin International Airport at a distance of about 101 Km.

4.6.2 Ambalappuzha Shree Krishna Temple

Built in Kerala architectural style, this temple is famous for Palpayasam, an offering made of sweet milk porridge. The inner temple walls of the Chuttambalam display paintings of the ten incarnations of Lord Vishnu. The temple is well connected by roadway and railway. The nearest highway is the Ambalappuzha – Thiruvalla State highway. Ambalappuzha railway station is about 2 km away.

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4.6.3 St. Mary's Basilica Church

This church is among the oldest churches of St. Mary's in Kerala and is believed to be established in 427 AD. There are annual feasts of Champakulam Valia Palli, on the third Sunday of October every year and feast of St. Joseph on March 19th. Near to the church, wooden statues of Christ are made and exported all over the world. Located on the western bank of River Pamba the nearest ferry line is Alappuzha Champakulam ferry line and the nearest road is Champakulam – Padaharam road. Alappuzha railway station is about 16 km away from this church.

4.6.4 Sabarimala Sri Dharmasastha Temple

Dedicated to Lord Ayyappa, it is the most famous and popular pilgrim centre of Kerala. This place is popular among the domestic tourists. It is situated on a hilltop 3,000 feet above the sea level. The only way to reach this temple is through the forest via foot as vehicles go upto Pamba only. It is 4 km away from Pamba. The temple is not open throughout the year and is open for worship only during the days of Mandalapooja and Makara Vilakku, i.e. November-January which is the peak pilgrim season. The pilgrims are required to follow fasting for 41 days to cleanse their minds before going to Sabarimala.

4.6.5 Kaviyoor Mahadeva Temple

This temple is located on the banks of the river Manimala and is preserved as a monument by the Archaeological Department. The temple is also known as Thrikkaviyoor Mahadeva Temple. The architectural style of the temple resembles Pallava Style. Historians date it to as early as the 8th century AD. The main deity of this temple is Lord Shiva and the Shivalinga is about three feet high carved, out of rock. The nearest road is Changanassery Kaviyoor Road, and the nearest railway station is Thiruvalla (which is 5 km from Kaviyoor).

4.6.6 Chakkulathukavu sree Bhagavathy Temple

This temple is located on the border of Pathanamthitta and Alappuzha district at Neerettupuram. The temple is dedicated to Mother Goddess and has a history of more than 3,000 years. Pamba River and Manimala River flow on either sides of the temple. Pongala festival is celebrated in grandeur on the month of Vrischikam (November/December). On Pongal, thousands of women devotees assemble on the temple premises and prepare sweet dish made of rice porridge, molasses and coconut gratings. This sweet dish is believed to be the favorite of the goddess. The nearest highway is the Ambalappuzha- Thiruvalla State highway, and Thiruvalla railway station is about 11 km away.

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4.6.7 Shree Vallabha Temple

Situated on the banks of the River Manimala, it is a 400 years old temple and has a beautiful 8 ft. idol of Shree Vallabha. The attraction of this temple is the unique Garuda Sthamba, a 54 ft. flag mast made from a single block of granite. 20 days long annual festival is held in February-March and 12,000 bunch of variety of bananas are offered on the first day. Kathakali is performed as a ritual offering every night. The temple is open from 4:30 am to 11:30 pm and from 5:00 pm to 8:00 pm in the evening. The nearest state highway is Ambalappuzha- Thiruvalla road, whereas the nearest railway station is Thiruvalla, which is 3 km away.

4.6.8 Charalkunnu

Being a picturesque hill station near Ranni, it offers a panoramic view of the nearby valleys. Camp house facility is available on the hill. The nearest state highway is Kottayam-Kozhencherry. Thiruvalla is the nearest railway station, which is about 17 km away.

4.6.9 The Great Backwaters

The Great Backwaters is a 900 km long water world spread across Kerala. The important stretch of this unique water world is the 168 km expanse from Kollam to Kottapuram, declared as a National Waterway.

4.6.10 Mullackal Rajrajeshwari Temple

Mullakal Rajrajeshwari Temple also known as Mullakal Bhagwathy temple. It is located in the middle of Alappuzha city. The Goddess is revered as ‘Mullakal Amma‘ by the locals. The temple also houses other deities too. The temple is run by the Travancore Devasom Board. The unique feature of the temple is the open roof shrine (Sreekovil).

4.7 Passenger Ferry Terminal

The passenger services are operated by State Water Transport Department (SWTD), Government of Kerala. The water transport department has total of 14 stations under its control, out of which 8 fall under Alappuzha district & 2 fall under Kottayam District. As per STWD’s opinion about 4,130 passengers use ferry services from Alappuzha on a daily basis. Out of this, about 400 passengers travel on Alappuzha- Changanassery route on a daily basis. State Water Transport Department is providing connectivity to Kuttanad with around 50 boat services daily, primarily in Alappuzha-Changanassery canal.

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TABLE 4-18 EXISTING FERRY ROUTE FROM ALAPPUZHA

Route No.	Route Name	Travel Time (hh:mm)	Average Passengers Handled (Daily)
1	Alappuzha to Nedumudy	1:30	550
2	Alappuzha to Pulinkunnoo	2:30	200
3	Alappuzha to Kavalam (Island)	2:15	650
4	Alappuzha to Kayalapuram	2:15	750
5	Alappuzha to Changanassery	3:00	400
6	Alappuzha to Kottayam	2:30	300
7	Alappuzha to Kainakari	1:00	530
8	Alappuzha to Venattukadu	1:30	750

Source: State Water Transport Department, Govt. of Kerala

TABLE 4-19 EXISTING FERRY ROUTES FROM CHANGANASSERY

Route No.	Route Name	Travel Time (hh:mm)	Average Passengers Handled (Daily)
1	Changanassery to Alappuzha	3:00	125
2	Alappuzha to Meghailpally	1:30	110
3	Meghailpally to Lissio	1:00	45
4	Lissio to Changanassery	1:30	40
5	Changanassery to Rajapuram	1:30	2
6	Rajapuram to Kidangara	1:00	2
7	Kidangara to Lissio	1:00	40
8	Changanassery to Lissio	1:30	80

Source: State Water Transport Department, Govt. of Kerala

The existing four ferry service routes are Alappuzha-Changanassery, Kollam Kottapuram Waterway, Alappuzha Veliyanadu Ferry Route and Veliyanadu Kidangra Ferry. The various jetties used as stops by the backwater ferry boats are Kuppapuram boat jetty, Vilakkumaram Jetty, Punchiri Jetty, Mangalasery Boat Jetty, KV houseboat Jetty, Cherukayal Boat Jetty, Janatha Jetty, Bathlahem Jetty, Changanassery Boat Jetty, Zero Jetty, Nehru Trophy Jetty, Rajiv Jetty and Matha Jetty.

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Source: Site Visit

Figure 4-16 Ferry Stations

Source: Site Visit

Figure 4-17 Existing passenger ferry

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4.8 Growth Trend

4.8.1 Cargo Growth

Existing industries in the catchment area of NW 8 also share the catchment area of NW 9 & NW 59. Majority of large scale industries are in the vicinity of NW 9 & 59 and not NW 8. Very few small scale industries are located closer to NW 8. The existing industries have no expansion plan and there is no new upcoming plants of any major contributing commodities in the catchment area of river; hence there is no cargo growth potential for NW 8.

4.8.2 Passenger Growth

On the entire stretch of NW 8, passenger ferries ply from Alappuzha to Changanassery. At present, there is no passenger Ro-Ro plying on this route. As per STWD's analysis, there has been increase in passenger traffic over the years. Though road connectivity is present in the region, people would prefer traveling via ferry service in future also. If IWAI increases current draft of the river, then passenger Ro-Ro could be started in NW 8. However, there is a parallel highway to NW 8, i.e. SH 11, which connects Alappuzha to Changanassery. During site visit no traffic or congestion was found on SH 11. Thereby no potential exists for Ro-Ro service.

4.8.3 Tourism Growth

Kerala is famous for tourism. At present, houseboat is the major tourism activity in NW 8 stretch. Apart from houseboats, there are few places like Pathiramanal Island, Buddhist Pilgrim Centre etc. Majority of tourism places are in the hinterland of other national waterways also, i.e. NW 9 & NW 59. Both Alappuzha & Kottayam districts' tourist arrival has increased over the years and it is about to increase in future. State Government is coming up with new ideas to boost tourism in the state. For example, Hydrofoil ferry system would be introduced in Kerala from Cochin Marine Drive to Beypore. If it gets commenced, then it would be India's first high speed boat hydrofoil ferry. Alappuzha is a popular backwater destination among international tourists. Alappuzha has also received an award for best backwaters destination in India. Tourism sector contributes a major share to Kerala's economy. In future, tourist traffic would increase in the catchment of NW 8, which would further provide opportunity for the proposed waterway. Following are some upcoming tourism projects initiated by the Government.

- Gallery & landscaping would be developed at Punnamada finishing point which is just one km away from NW 8.
- Night boat terminal at Vilakkumaram which is on NW 8

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4.8.4 Comparison of FSR & DPR study

TABLE 4-20: ANALYSIS OF FSR STUDY

Commodity	Source	DPR Consideration	Potential	Reasoning
Cement	Malabar Cement, Cochin Port (Ambuja, Ultra Tech, Zuari)	✓	✗	Malabar Cement factory is located near Vemband lake and closer to Cochin port. Other stakeholders like Ambuja, Ultra Tech, Zuari are not willing to shift to waterway.
POL	BPCL Refinery, Cochin	✓	✗	Majority of POL products are handled by pipeline. Transportation of all the raw material and finished products takes place nearby Cochin Port area and not in the catchment area of NW 8. Thereby no scope for POL transportation via waterways.
Fertilizer	Consumption in Alappuzha & Kottayam district	✓	✗	There does not exist any major fertilizer industry in the catchment area of the river. Existing fertilizer consumption in the catchment area of the river is for agriculture & horticulture purpose. Volume of consumption is low, therefore no opportunity for waterway transportation through NW 8.
Food Grain	Production in Alappuzha & Kottayam district	✓	✗	All the food grain production gets consumed locally. Apart from local consumption, Kerala also imports food grains from neighboring states like Tamil Nadu. Therefore no potential exists for food grain transportation on waterway.
Container	KPACT, ICTT	✓	✗	Coir products is the major commodity that goes into container form. At present, industries send their containers to KPACT & from there containers go to Cochin for export. However, there exists no coir industry in the catchment area of NW 8.

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Commodity	Source	DPR Consideration	Potential	Reasoning
Minerals	Alappuzha & Kottayam	✓	✗	Graphite & Silica sand are found in the catchment area of NW 8. Silica sand is found in the coastal belt of Alappuzha. At present, these minerals are not getting exported from any port of Kerala.
Fisheries	Alappuzha & Kottayam	✓	✗	Kottayam is not located on the coastal side, so no marine fishing takes place in this district. Alappuzha has both marine & inland fish catch. Majority of inland fish catch gets consumed in local market; hence no potential from fisheries in the catchment area.
Passenger	Local people of Alappuzha & Kottayam	✓	✗	At present, the entire river stretch is used by passenger ferries. Though roadways/bridges are developed, there is no upcoming road/railway infrastructure development plan in the catchment area of NW 8. Therefore in coming years, local people would continue using ferry service. However the existing terminals are well developed and functional. They are capable to handle passenger traffic; thereby no potential exists for new IWAI terminal.
Tourism	Domestic & International tourists	✓	✗	House boat tourism is the only tourism activity on the river. There does not exist any other watersport activity like kayaking etc. on the river. Kerala backwaters are famous for houseboats. More watersport activities could be developed in the canal to attract more tourists. Houseboat starts from Alappuzha and there is well-developed terminal to handle houseboat tourists; thereby there is no requirement for a new terminal.

Source: Consultant's Analysis

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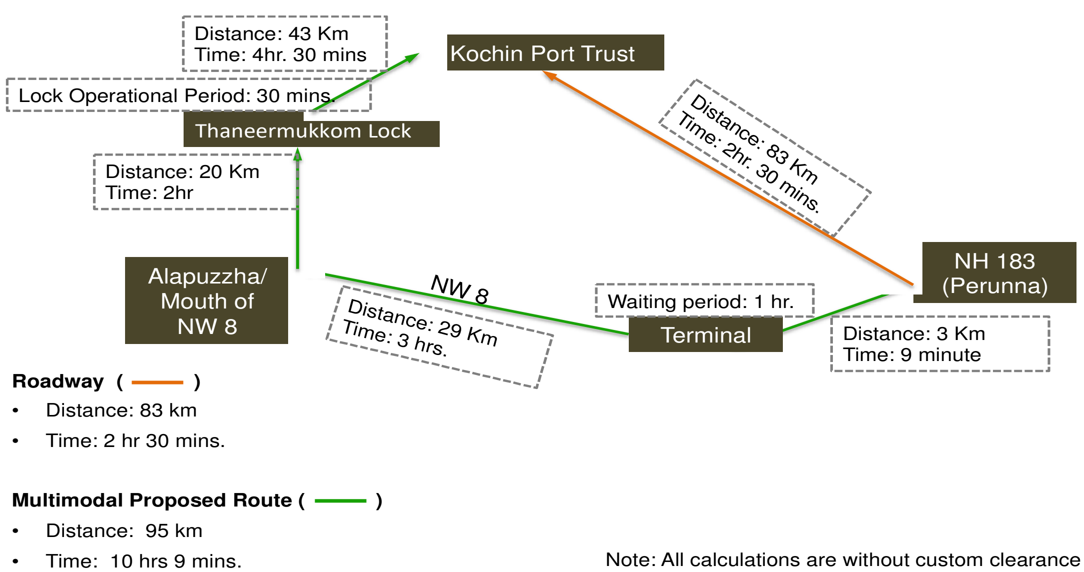
4.9 Forecasting & Potential IWT Assumption

- It is assumed that in coming years there would be growth in passenger & tourism traffic for NW 8; however existing terminal would suffice the requirement.
- Per day total capacity of a ferry that runs four times from Changanassery terminal handles 350 passengers daily.
- There exists SH 11, which runs along the NW 8 canal, connecting both Alappuzha and Changanassery.

4.10 Logistic Cost Comparison for Ro-Ro (Exception Case)

At present nearby industries use roadway to reach Kochin port trust from Changanassery. Roadway distance between Changanassery to Kochin Port Trust is 83 km by NH 66. Time required to reach port is 2 hr. 9 minutes. Unless and until there is very strong and a practical driving factor industries would not shift to waterways. Lower integrated logistics cost, as compared to road logistics cost, can act as the most ideal distinguishing criterion in this regard. Based on this comparison only, viability of the proposed Ro-Ro Terminal can be ascertained.

The Following Figure 4 18 Illustrates time and distance difference between the current roadway movement and the proposed route using NW 8. It is assumed that Ro-Ro vessel speed would be 20 kmph while calculating time & Distance for multimodal and roadway.



Source: Consultant's Analysis

Figure 4-18 Time & Distance Comparison

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It is evident from the graphical representation above that time required to cover the distance to reach Kochin Port is more in case of multimodal route of waterway and road. Therefore, time and cost involved in multimodal transportation is also more compared to roadway. Proposed IWT route also involves multiple handling of trucks. This adds to the total logistic cost involved in transportation. 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 chart. The table shows logistics comparison in two different cases under Ro-Ro cost dynamics. In Case I, vessel with a cumulative engine power of 839 kW and 20 kmph speed has been considered. In Case II, vessel with only one engine of 350 kW power and loaded speed of 10 kmph has been taken for cost comparison.

Ro-Ro/Trade Cost Dynamics

Origin	Destination
Perunna,Changanassery	Kochin Port

Ro-Ro Cost Dynamics (95 km)

Steps involved	Unit	Case I	Case II
Engine	kW	839	350
Engine fuel requirement	l/hr	222	102
Per Truck Ro-Ro Tariff	INR/Truck	7,203	6,967
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**8,406**	**7,561**

Truck Cost Dynamics (83 km)

Components	Cost (Rs.)	Cost
Fuel	INR	1,423
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**2,668**

Source: Consultant's Analysis

Figure 4-19 Logistics Cost Comparison

Two scenarios have been considered to arrive at logistic cost for a possible Ro-Ro service on the proposed IWT route. In case of Ro-Ro logistics cost analysis, Ro-Ro Tariff assumes costs related to the multi-modal logistics. This includes nominal fairway charges, charges associated with vessel chartering and the associated fuel cost, and port-related charges (berth hire and port dues). Traffic diversion from road to waterway entails cost saving in relation to truck transportation cost. Primarily, this saving is on fuel cost and toll charges. While calculating Ro-Ro cost dynamics, these haven't been considered, as these cost heads will never feature in Ro-Ro transportation logistics. In case of truck cost dynamics, there are other parameters that influence the total roadway logistics cost. These include Repair & Maintenance cost, driver/crew wages, truck finance cost, profit & other costs. Including these for truck logistics analysis will necessitate inclusion of the same cost heads in case of Ro-Ro cost dynamics. However, these costs will be nullified, as their impact on both the logistics cost dynamics will produce a similar cost escalation, leading to a similar logistics cost difference. It is assumed that IWAI will develop the entire infrastructure (Terminal &

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Navigation), and hand it over to the operator without looking to recover the development cost. IWAI will also be required not to take Terminal charges, Fairway usage charges, etc. in order to increase the appeal of any Ro-Ro service on NW 8.

Costs involved in both the Ro-Ro cases are on the higher side when compared to roadways. This cost difference favors the roadway, as the difference between the two discussed transportation modes is at least over INR 4,800. In case of just Ro-Ro cost comparison, Case II is marginally cheaper than Case I. The cost involved in both the cases is relatively on higher side as compared to roadways. There are various costs associated with multi-modal transportation, like cost of multiple handling (loading, unloading whenever there is a change in mode of transportation) etc. which are not applied to roadways transportation.

4.10.1 Ro-Ro terminal with Subsidy

It is perfectly visible from the logistics cost comparison that both the cases of waterway movement will be costlier than existing mode of transportation using roadways by a significant margin. As per Case I (higher engine power 839 KW), the logistics cost difference for roadway and waterway is INR 5.738/truck. Cost of transporting per truck on the waterway with the said engine configuration would be more than twice as expensive as roadway. In Case II (Lower engine power 350 KW), this cost difference is narrower with INR 4,893/truck. For development of Ro-Ro Terminal and for it to attract the projected traffic, government needs to subsidize the shift by offering the cost difference to the transporters. The subsidy amount will compensate for high logistics cost, but additional incentives need to be offered to make up for the increase in time and distance. 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 is needed to induce shift of traffic from existing roadways to waterway.

Though there do not exist any cargo potential on NW 8, part of the traffic from (NH 183) road could be diverted to NW 8. To determine the feasibility of NW 8 about Ro-Ro road survey was conducted.

Table 4-21 Traffic Volume Count (O-D)

Period	Outflow (From changanessery)			Inflow to changanessery		
	Loaded Trucks	Empty Trucks	Containers	Loaded Trucks	Empty Trucks	Containers
Per Day (No.)	376	360	67	421	315	59
Annual (No.)	1,37,240	1,31,400	24,333	1,53,787	1,14,853	21,413

Source: Site visit

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For projecting traffic, following factors are assumed. As Alappuzha Changanassery is used for passenger transportation as well as tourism, it is less likely that cargo in the form of trucks could use NW 8. Projected Traffic on NW 8 would be entirely dependent on government subsidy because at present as per the transporters, they are not facing any problem in the existing roadway movement. In case of containers, the share considered is minimum because containers commodities are time bound therefore it is very much unlike that containers could use Ro-Ro service for a short distance. Therefore consultant has taken minimum growth rate for projecting traffic. It is also assumed that Ro-Ro service of NW 8 would further connect to existing NW 3 to reach Kochi Port Trust.

At present, Alappuzha-Changanassery waterway route is only used for passenger and tourist transportation.There is less opportunity to move cargo in this route through IWT. Alappuzha is under developed in industrialization. As observed during Traffic Survey in this route, cargo traffic is very less in the hinterland of NW 8.

There is no plan for future infrastructure development of industries in the region. Due to all these factors, it is assumed that cargo traffic on NW 8 would be less. Despite this, to promote inland waterways on NW 8, the consultant has assumed that 15% of road cargo share (especially on NH 183) could be transported using NW8.Consultant has proposed shifting of road traffic to waterways based on interaction with transporters during OD survey. Though the cargo transporters are not very enthusiastic regarding waterway transportation but a combination of subsidy and incentives would attract the transporters for waterway movement.

In case of containers, the share would be lesser, i.e. 5% because container commodities are time sensitive. Hence, it is very unlikely that containers would be moved using Ro-Ro service for a short distance.

The consultant has taken minimum growth rate, i.e. 2% for projecting future traffic. It is also assumed that Ro-Ro service on NW 8 would further connect to existing NW 3 to reach Kochi Port Trust/ICTT.

Table 4-22 Assumption Methodology for projection

Waterway Share for loaded trucks	15%
Growth rate	2%
Waterway Share for Container	5%
Growth	2%

Source: Consultant's analysis

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TABLE 4-23 TERMINAL & COMMODITY WISE PROJECTIONS (EXCEPTION CASE OF Ro – Ro)

Name of the waterway: NW-08 (Alappuzha Changanassery Canal, 29.00 km)														
Sr. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Origin Terminal on NW**	**Final Destination**	**Destination Terminal on NW**	**Co-ordinates**	**Unit p.a**	**Fy-18**	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Existing Terminals on River (At present there are 13 jetties on NW 8, which are used for handling passenger traffic. Houseboat also operates on this route. Therefore no additional demand or need exist for another passenger or tourism terminal. However for exception case Ro-Ro terminal could be developed if it is logistically viable. Following is the traffic that could be achieved if Ro-Ro terminal is developed with subsidy. It is assumed that terminal would get developed in FY 20. FY-18 traffic is the present traffic movement by roadway)														
1	Loaded Trucks	-	Changanassery	Changanassery	Kochin Port	n/a	9°26'18.9"N 76°31'36.7"E	Numbers in (00')	1,372	210	232	256	283	312
2	Containers	-	Changanassery		Kochin Port				243	12	14	15	17	18
	Total								1,616	222	246	271	299	330
1	Loaded Trucks	-	Kochin Port	n/a	Changanassery	Changanassery	9°26'18.9"N 76°31'36.7"E		1,538	235	260	287	317	350
2	Containers	-	Kochin Port		Changanassery				214	11	11	11	11	11
	Total								1,752	246	270	298	327	361
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc.														

Source: Consultant's Analysis

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4.10.2 Ro-Ro terminal without Subsidy

Without the offer of aforementioned subsidy amount, industries would not deviate from their current logistics practice. In such a case, Ro-Ro Terminal on NW8 will not be a viable enterprise to pursue. Therefore, in such a scenario, it is not recommended to develop Ro-Ro Terminal on the River.

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

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<u>**Annexure**</u>

Abbreviation	Full Form
NW	National Waterway
SWTD	State Water Transport Department
FACT	Fertilisers and Chemicals Travancore
IWAI	Inland Waterway Authority of India
ICTT	International Container Transhipment Terminal
GSDP	Gross State Domestic Product
MT	Metric Tons
T	Tons
Km	Kilometers
Sq. qm	Square Kilometers
Ha.	Hectare
KSINC	Kerala Shipping and Inland Navigation Corporation
KINFRA	Kerala Industrial Infrastructure Development Corporation
Fy	Financial Year
EXIM	Export – Import
mn T	Million Tons
IPA	Indian Ports Association's
MMTPA	Million Metric Tons Per Annum
IOC	Indian Oil Corporation
BPCL	Bharat Petroleum Corporation
LPG	Liquefied petroleum gas
TEU	The twenty-foot equivalent unit
NH	National Highway
POL	Petroleum Oil Lubricants
KPACT	Kottayam Port and Container Terminal
Ro-Ro	Roll-on/roll-off
Ft	Feet
DTPC	District Tourism Promotion Councils

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TABLE 4-24 POL PRODUCTS HANDLED AT COCHIN PORT VIA PIPELINE

Sr. No.	Pipe lines used for transporting raw material	From	To	Year of Installation	Length of pipeline (Km)		Diameter of pipeline (Inches)
					Above GL	Below GL	
Genesh Benzoplast							
1	Furnace Oil	South Coal Berth	South end reclamation area	2001	0.3	1.9	10
2	Chemical						
3	Handled Sulphric acid Now empty				1.6	0.7	8
Ruchi Infrastructure							
1	Di Actyle Phathalate Now empty	South Coal Berth	South end reclamation area	2003	0.3	2.8	14
Konkan Storage System							
1	Furnace Oil	South Coal Berth	South end reclamation area	2003	0	3.2	12
2	White Oil						
					0	3.2	10
B.R. Petrochem							
1	Proposed Pipe line not yet commissioned	South Coal Berth	South end reclamation area	2007	0.3	2.9	14
Indian Oil Corporation							
1	LSFO	Boat train Pier (BTP) Berth	North end of Willingdon	2008	0	0.2	10
2	LVFO						
3	LSHF HSD						8
4	JPS						
5	FO	North end of Willingdon	Timber Pond Jetty	-	0.1	0.1	8
6	HF HSD			-			
7	LVFO			-			6
HHA Tank Terminal							

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Sr. No.	Pipe lines used for transporting raw material	From	To	Year of Installation	Length of pipeline (Km)		Diameter of pipeline (Inches)
					Above GL	Below GL	
1	Aviation fuel	South Coal Berth	Storage tank at MURAF area	1999	0.2	0.1	8
2	Furnace Oil						
3	White Oil						10
4	Chemical						6
Bharat Petroleum Corporation Limited- Cochin Refinary (BPCL-KR)							
1	Crude Oil	SPM at Arabian sea	Farm (STF) at shore at Puthuvypeen	2008	nil	19	48
		Farm (STF) at shore at Puthuvypeen	Refinary at Ambalmugal			8	30
Gas Authority of India							
1	LNG	Puthuvypeen	Cochin, Koottanadu, Bangalore, Mangalore	2010	nil	4.5	30
Cochin Port Trust							
1	Crude Oil	Cochin Oil Terminal	North Tanker Berth	1984	0.2	1	30
2	Black Oil						16
3	White Oil						
Bharat Petroleum Corporation & Indian Oil Corporation							
1	POL	North Tanker Berth Jetty head	North Tanker Berth shore	1970	0.3	0.4	30
							10
							12
2	4nos pipeline of same length and dia			1998	0.5	0.2	24
3	SKO	South Tanker Berth Jetty head	South Tanker Berth shore	1960	0.3	0.4	16
4	4nos pipeline of same length and dia						
5	Crude Oil						6

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TABLE 4-25 INDUSTRIES IN THE CATCHMENT AREA OF NW 8

Sr. No.	Industries	Districts	Commodity
1	Autokast	Alappuzha	Foundry
2	DC Mills	Alappuzha	Floor mats
3	Palm Fibre	Alappuzha	Coir, yarn retailers
4	Travancore Mats and Mattings Company	Alappuzha	Rubber Mats
5	Wilton Weavers	Alappuzha	Floor covering
6	Evershine Chemical	Alappuzha	Chemicals
7	Oxide India	Alappuzha	Industrial chemicals, catalyst
8	Ram Coir Mill	Alappuzha	Carpet Manufacture
9	Petrogas	Alappuzha	
10	Travancore Cements	Kottayam	Cement
11	MRF	Kottayam	Rubber
12	Canara Paper Mills	Kottayam	Paper
13	Diamond Roller Flour mill	Kottayam	Flour
14	Midas Precured tread	Kottayam	Rubber
15	Kotayam Textiles	Kottayam	Textiles
16	Kottayam Integrated Powerloom	Kottayam	Textiles
17	TJP Rubber Industries	Kottayam	Rubber
18	Hi- Tech Cast iron Industries	Kottayam	Iron cast
19	Traco Cables	Pathanamthitta	Cables
20	Modern Rice Mill	Nambiyakulam	Rice
21	Nature Pure Supercritical Extracts	Pathanamthitta	Oil extraction and food colouring
22	Amity Rock Products	Pathanamthitta	Granite Mining and Crushing, Ready-mix Concrete

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Sr. No.	Industries	Districts	Commodity
23	The Travancore Sugers and Chemicals	Pathanamthitta	Sugar and Distillery
24	SN Timbers	Pathanamthitta	Timber
25	Volto Paints	Pathanamthitta	Paints
26	Camex Technologies	Pathanamthitta	Switch gears / Electrical Panel Boards & Control systems

Source: District Industries Centre, Alappuzha & Kottayam

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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.

The Alappuzha Changanassery Canal (NW-8) is greatly depended for discharging water from the paddy polders to the Pallathuruthy River with Agricultural plots on either side of the canal, small markets at Kavalam, Kidangara etc. Large Agricultural Lands, Manorama Church at Kuppappuram, Lake Vembanadu 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 at Alappuzha Changanassery Canal (NW-8).

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SH 11 is major highway which runs parallel to NW 8. N.H. 66 connects Alappuzha with Thiruvananthapuram & Cochin, N.H. 183 connects Changanassery with Kottayam & Adoor. Southern railway runs in Alappuzha & Changanassery. The nearest railway station is Changanachaerry station at about 5.5 km from Terminal.

No major industries are found within 50 km of the hinterland.

Taking into the consideration the origin and destination and fairway, the most probable location has been considered at approx. Lat 09°26' 26.31" N and Long 76° 31' 29.83" E, at approx Ch. 28.5 km.

The traffic volumes, as identified at NW-08 (Alappuzha Changanassery Canal) is nil. However, keeping in view the suggested and anticipated Ro-Ro mobility of 46,800 vehicles p.a in 2020, which may rise to 69,100 vehicles p. a in 2040, 1 Roll-on Roll-off (Ro-Ro) Berthing facility and IWT Terminal has been planned. Thus, these expected traffic volumes are to be taken into consideration for IWAI Terminal development on NW 8.

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

TABLE 5-1: Terminal Land Area Requirement for Changanassery Ro-Ro Terminal

S.No.	Facility	Nos.	Size	Area (in m2)
1	Open Mobility Area	1	-	4000
2	Covered Storage Godown	1	-	-
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	-	2500
6	Main Parking Area	1	-	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	7m x 100m	700
11	Bank Protection with Geotextile Bags			
12	Administration building	1	12m x 15m	180
13	Business Area	1	10m x 3m	30
14	Staff Parking Area-4 wheelers	1	13.5m x 6m	81

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S.No.	Facility	Nos.	Size	Area (in m2)
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
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	100
26	Green Area	1	-	750
27	Future Requirement	1	-	1500
				13083

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.010631-W-20351-X01**. With regard to the Land, there is no need of consideration of any phased development, since the ground development shall be taken up at initial phase itself.

Accordingly, a layout plan demarcating the infrastructure requirement is developed Refer Volume-II Drawing No. **P.010631-W-20301-A01** for details.

5.4 Land Details

The Land area identified is at Location as below:

TABLE 5-2: TERMINAL LAND DETAILS

Coordinates (UTM) N/E	1043934	667424
Coordinates (DMS) N/E	09°26'26.31" **N**	76°31'29.83"**E**
Village	Changanassery	
Taluka	Changanassery	
District	Kottayam	

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State	Kerala
Nearest Town	Kottayam
Distance of town (km)	18
Land use	Kuttanad Area
Ownership	Govt. Land / Patta Land
Water Distance	50m
Nearest Road	SH-11
Road Distance (m)	1000
Nearest Railhead	Changanassery
Railhead Distance	5.5 km
Nearby major Structure	KSWTD Passenger Terminal
Terrain	Water logged land
Soil/Subsurface strata	Black Yellow Medium Dense to Dense Silty Sand
Surveyed Area (Approx.)	15000 (m2)

5.5 Geotechnical Investigations

Geotechnical investigation has been carried out at the proposed terminal location to find out the subsoil stratification in the project area and to collect data for deciding type of foundation and the design foundation. The scope of geotechnical investigation work consists of one bore hole at terminal, terminated at a depth of 25.6 m below EGL.

5.5.1 Regional Geology

The geology of Kerala is a part of the south Indian Precambrian terrain, which is composed of granulites, gneisses, granites and greenstones. The granulites and associated gneisses belong to the Precambrian in Kerala state. The younger Meso-Cenozoic dykes and pegmatites are found to intrude late Precambrian rocks. The tertiary sedimentary formations belong to Neogene period only (Soman, 2002). The geology map of Kerala state is shown as **Figure 5.1**.

The Charnockites and charnockitic gneisses are the oldest rock complex units of Kerala state. Charnockitic gneisses, gneisses and the pyroxene-bearing granulites occupy the major parts of the Western Ghats and the midland regions located within Kerala state. The granulitic gneisses are very well spatially connected with lineaments and faults in Kerala state (Soman, 2002). Khondalites are yet another major rock formation of south Kerala and are associated with garnet-biotite gneiss and garnetiferous quartzofeldspathic gneiss.

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The presence of intrusives especially, the dykes, have hydrogeological role to find good zones of water bearing fractures. Intrusive formation dykes of Lower-Middle Proterozoic age, pegmatites of Middle Proterozoic age, host of younger granites (Late Precambrian-early Palaeozoic age) and later dolerite dykes, contemporaneous with Cretaceous-Paleocene Deccan Basalt magmatism, are the common elements seen in granulitic terrain of this state.

The western parts of the state consist of sedimentary formations of Neogene period and quaternary period having four distinct beds viz. Alleppey, Vaikom, Quilon and Warkali. In midland regions, the Tertiary and crystalline formations are found as lateritized units which act as good aquifer. Along the coastal regions, alluvial deposits of recent origin are found. The stratigraphic succession of the Kerala is given under **Table 5.3**.

TABLE 5-3: GENERAL STARTIGRAPHIC SUCCESSION OF KERALA

(After Poulose and Narayanaswami 1968)

Recent to Sub Recent	Soils and alluvium Beach sand deposits Lime shell deposits of backwaters Old and red Teri sands of sub recent marine and lacustrine formations Peat beds with semi carbonised woods Calcareous clays with shell Laterite
	——————**Unconformity**——————
Warkallai formation (Mio-pliocene)	Current bedded friable variegated sandstone interbedded with plastic & variegated clays Carbonaceous and alum clays with(Mio-Pliocene)Lignite seams Gravel and pebble beds. Base marked by gibbsitic clay
Quilon formation (Middle Miocene)	Fossiliferous shell limestone alternating with thick beds of sandy clays, calcareous clays. Base unknown
	——————**Unconformity**——————
Archaean	Crystallaine Rocks

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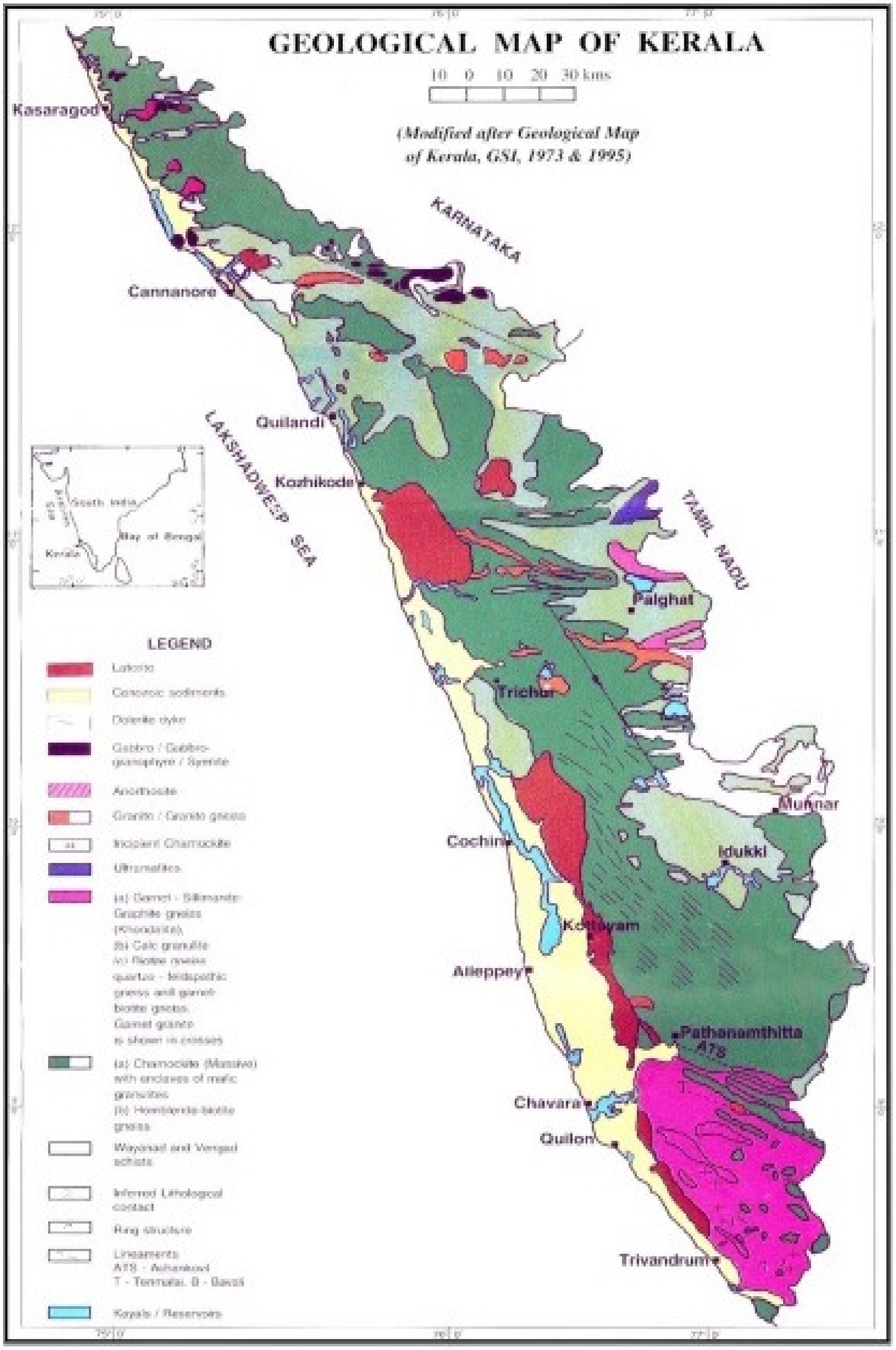

Figure 5-1: Geological Map of Kerala

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5.5.2 Physical Condition and Drainage

Physiographically the state can be divided into four domains from east to west, viz., the Western Ghats, the foothills, the midland and the coastal low- land. The Western Ghats, bordering the eastern boundary of the State, form an almost continuous mountain wall, except near Palakkad where there is a natural mountain pass known as the Palakkad Gap. The average elevation of the Ghats is about 1500 meters above sea level, occasionally soaring to peaks of 2000m to 2500m. From the Ghats, the land slopes to the west on to the plains, into an unbroken coastline.

The foothills of the Western Ghats comprise the rocky area from 200 to 600m.above MSL. It is a transitional zone between the high-ranges and midland. The strip of hills and valleys on the eastern edge, close to the Ghats, comprises of steep mountains and deep valleys, covered with dense forests. Almost all the rivers of the state originate here.

In the Midland Plains of central region, the hills are not very steep and the valleys are wide. This forms an area of gently undulating topography with hillocks and mounds. Laterite capping is commonly noticeable on the top of these hillocks. The low, flat-topped hillocks forming the laterite plateau range in altitude from 30-200m and are observed between coastal low-land and the foothills. The valleys have been developed as paddy fields and the elevated lands and hill slopes are converted into estates of rubber, fruit trees and other cash crops like pepper, arecanut and tapioca. Tea and coffee estates have cropped up in the high ranges during the last two centuries.

Coastal low-land is identified with alluvial plains, sandy stretches, abraded platforms, beach ridges, raised beaches, lagoons and estuaries. The low- land and the plains are generally less than 10m above MSL. The Coastal Belt strip is comparatively plain. Extensive paddy fields, thick groves of coconut trees and picturesque backwaters, interconnected with canals and rivers, are the features of this region. No wonder, Alappuzha an old sea port town of this region is known as the 'Venice of the East'. In the southern and northern parts of the state, the coastal belt also has some small hillocks.

Drainage:

The State is drained by 44 rivers, of which 3 are east flowing **(Figure 5.2)**. Rivers are generally swift flowing having very steep gradient in their higher reaches. Absence of delta formation is characteristics if Kerala rivers. The general drainage pattern of these rivers is dendritic, although at places trellis, sub-parallel and radial occur. The segments of river courses are nearly straight, indicating structural control, coinciding with prominent lineament directions (NW-SE and NE-SW). Many of the rivers do not have a continuous flood plain. As per national norm (Rao, 1979), there are no major

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rivers in Kerala. The four medium rivers, namely Chaliyar, Bharathapuzha, Periyar, and Pamba have a total drainage area of only 8250 km^2 with length 169 km, 244 km and 176 km respectively. The length of rest of the rivers varies from 16 km to 130 km, with an average length of 62 km and total drainage area of 19,485 km^2. The river flow is modulated by about 30 reservoirs, mostly located in highlands (KSLUB, 2002; CWRDM, 1995). Apart from the 44 rivers, there are few streams with separate watersheds draining an area of about 900 km2 with lengths falling short of the 15 km limit set for the categorization as river (Anon, 1974).

Figure 5-2: Drainage Map of Kerala

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A chain of Kayals (backwaters), lying parallel to the coastline is a characteristic feature of Kerala coast. These are mostly interconnected by natural or man-made canals. There are 27 estuaries and 7 lagoons listed in Kerala (Anon, 1974). The project area/selected site form a part of Alappuzha - Changanassery canal. The location of the selected site on Google earth is shown as **Figure 5.3** while the enlarged view of the same is shown as **Figure 5.4.**

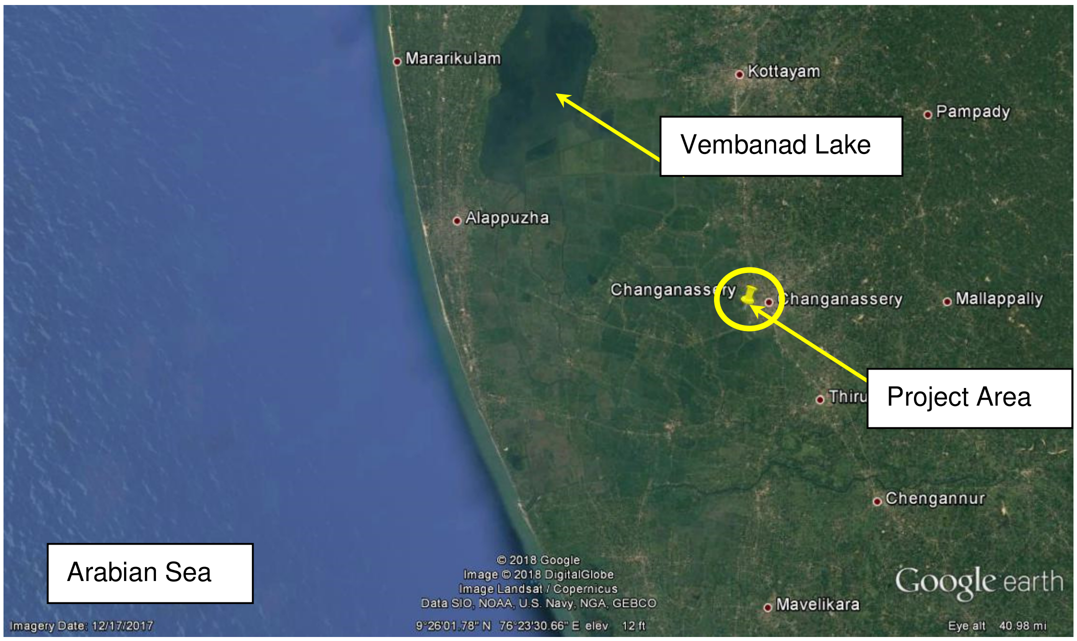

Figure 5-3: Google Earth Image showing Project Area

Figure 5-4: Enlarged View of Google Earth Image showing Project Area

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5.5.3 General Geology and Stratigraphy

Khondalite is the oldest rock of the area and it includes quartzites which occur as lenticular bodies and garnet-biotite-sillimanite gneiss with or without graphite. The charnockite group of rocks including acid and intermediate varieties are found in the north eastern parts. Rocks of the migmatite group represented by biotite gneiss (quartzo-feldspathic gneiss) are noticed as small bodies in along the eastern margin of the district. Near Chengannur, a massive granite body representing the acid intrusive occurs. Hills in the southern and western parts are capped by Tertiary sedimentary rocks (Warkalli Formations). Drilling by CGWB indicated that the Tertiary basin is deepest along the coastal plains of the district and is more than 600m deep south of Alappuzha town. The Kuttanad low land covering an area of approximately 100 sq. km. is reported to have plenty of semi-carbonised and partly decayed wood trunks, roots, branches, leaves etc. buried under a thin veneer of black carbonaceous clay. This region is locally known as Karipadams because of yielding of coal-like (carbonised wood) material from the paddy field. It is believed that this area is submerged forest of Quaternary period. The other Quaternary sediments include strand line/palaeo beach deposit (Guruvayoor Formation), fluvial deposits (Periyar Formation), tidal/mudflat deposit (Viyyam Formation) and beach deposit (Kadappuram Formation).

The drill hole completed within the project area reveals the stratification as below:

Strata I: Filled Up Soil

Strata II: Grey Medium Stiff to Stiff Silty Clay

Strata III: Black Yellow Medium Dense to Dense Silty Sand

5.5.4 Sub-surface Investigations

The selected site has been investigated by one drill hole (8 B1) which has been drilled for depth of 25.6 m. The detail of the drill hole is tabulated below in **Table 5.4**.

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TABLE 5-4: SUMMARY OF DRILL HOLE

Sl. No	Hole No.	Location	Total Drilled Depth (m)	Depth From (m)	Depth To (m)	Thickness (m)	Description of Strata	N-Value	Core Recovery %	RQD %	Remarks
1.	8 B1 (NGL – 0.85 m)	Left bank of Chanaganassery Canal, Changanassery **(09⁰ 26' 26.31'' N, 76⁰ 31' 29.83'' E)**	25.6	0	2.9	2.9	Filled Up Soil	45	-	-	Water Table 0.55 m below GL
				2.9	15.9	13.0	Grey Medium Stiff to Stiff Silty Clay	3 - 21	-	-	
				15.9	25.6	9.7	Black Yellow Medium Dense to Dense Silty Sand	24 - 32	-	-	

The description of the drill hole is as given below.

8 B1: Drill hole 8 B1 has been drilled over the terminal location area on the Left bank of Chanaganassery canal, Changanssery, Kerala. The drill hole has been drilled vertically down to the depth of 25.6m from EL.0.85m to EL. -24.75m. The drill hole encountered 2.9m thick Back Filled Material, 13.0m Blackish Grey Clay underlain by 9.7m thick strata of Yellow Black Clayey Silty Sand.

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

Fifteen Standard penetration test (SPT) has been carried out in accordance of IS 2131 in the drill hole to ascertain the consistency of the different soil strata. The depth wise N-values from the SPT for soil strata are as tabulated in **Table 5.5**.

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TABLE 5-5: SUMMARY OF IN-SITU TEST RESULTS

Sl. No.	Strata Description	Depth		SPT 'N' Value
		From	To	Observed
1	Filled Up Soil	1.5	2.1	45
2	Grey Medium Stiff to Stiff Silty Clay	3.0	3.6	3
		6.0	6.6	5
		7.5	8.1	5
		10.5	11.1	10
		12.0	12.6	11
		13.5	14.1	13
		15.0	15.6	21
3	Black Yellow Medium Dense to Dense Silty Sand	16.5	17.1	24
		18.0	18.6	26
		19.5	20.1	26
		21.0	21.6	27
		22.5	23.1	30
		24.0	24.6	31
		25.0	25.6	32

LABORATORY TEST RESULTS

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

Among fifteen 4 SPT samples, 2 UDS soil samples 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 5.6**.

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TABLE 5-6: 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/cm^3		%	%	%	%	%	%	%	%	%			Kg/cm^2	degree	C_C	e_0	G
8 B1	Grey Medium Stiff to Stiff Silty Clay	4.5	5.0	UDS-1	1.690	1.34	26.57	0	11	48	41	57	32	25	---	CH	UU	0.231	12	---	---	2.63
		9.0	9.5	UDS-2	1.720	1.32	30.24	0	15	42	43	55	30	25	---	CH	UU	0.322	8	---	---	2.61
		4.5	5.0	UDS-1												CH	CU	0.165	23	---	---	
		9.0	9.5	UDS-2												CH	CU	0.050	23	---	---	
		13.5	14.1	SPT	1.750	1.37	27.65	0	11	54	35	54	29	25	---	CH	---	---	---	---	---	2.62
		16.5	17.1	SPT	1.700	1.51	12.68	5	72	23	---	Non - plastic			---	SM	UU	0.009	22	---	---	2.63

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Bore Hole	Strata Description	Depth		Sample Type	Density		Natural Moisture Content, w	Mechanical Analysis				Consistency Limits				IS Soil Classification	Shear Strength			Consolidation		Specific Gravity
		From	To		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	
					Kg/cm³		%	%	%	%	%	%	%	%	%			Kg/cm²	degree	C_C	e_0	G
	Black Yellow Medium	19.5	20.1	SPT	1.832	1.61	13.67	3	70	27	---	Non - plastic			---	SM	UU	0.222	20	---	---	2.64
	Dense to Dense Silty Sand	24.0	24.6	SPT	1.843	1.63	12.98	5	62	33	---	Non - plastic				SM	UU	0.003	26	---	---	2.64

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Bearing Capacity Calculations

TABLE 5-7: SOIL PARAMETERS ADOPTED FOR THE ANALYSIS

Depth		Strata Type	Average N Value (observed)	Thickness (m)	Unit Weight (kN/m³)	Cohesion (kN/m²)	Angle of Internal Friction (Degrees)	Compression Index (Cc)	Initial void Ratio (e_0)
From (m)	To (m)								
0	2.9	Filled up soil	45	2.9	18.3	0.00	33	-	-
2.9	9	Medium stiff Silty Clay	5	6.1	16.9	23.00	12	0.342	0.82
9	15.9	Stiff Silty Clay	13	6.9	17.2	32.00	8	0.301	0.83
15.9	19.5	Medium Dense Sand	24	3.6	17	0.90	22	-	-
19.5	24	Medium Dense Sand	27	4.5	18.3	0.22	26	-	-
24	25.6	Dense Sand	31	1.6	18.4	0.3	26	-	-

Pile Capacity Calculations

The pile capacity is calculated for different diameters of piles resting over dense sand. The details are given below. The sample calculations are given in **Annexure-5.1.**

TABLE 5-8: SUMMARY OF PILE CAPACITY CALCULATIONS

S. No	Diameter of Pile	Penetration Depth of Pile below Ground Level (m)	Capacity of Pile in compression (kN)	Uplift Capacity of Pile (kN)
1.	1.0 m	46.5	1899	2527
2.	1.3 m	46.5	3519	4155
3.	1.4 m	46.5	4124	4829

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5.6 Terminal Infrastructure including equipment

The land area identified is measuring to about 15000 Sq. m and proposed to be taken through Land acquisition. The land requirement with the requirement of facilities for each terminal has been worked out to 13083 Sq. m, which can be accommodated within the Land proposed to be taken on Acquisition.

Considering the Class III waterway classification, Ro - Ro facility shall be planned for this location.

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

5.7 Berthing Structure

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

Deck Level

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

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Deck Dimensions

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

TABLE 5-9: SALIENT FEATURES OF Ro-Ro STRUCTURE

Description	Length(m)	Width (m)
RO-RO	75	12

The structural arrangement of the berth including the preliminary design has been explained in the chapter 6. (Refer Volume-II Drawing No. **P.010631-W-20341-E01**).

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

The Capital Cost for the fairway has been considered in Chapter 11 along with the proposed development for Ro-Ro Terminal facilities at the defined location. The Capital Cost of terminal works out to be about 24.95 Crores i.e., Land Cost (1.53 Cr); Riverine component (7.65 Cr); Infrastructure component + Internal Road (6.89 Cr); External Approach Road (0.04 Cr) and Bank Protection (6.89 Cr) etc., with provision of PMC & Contingencies etc.

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.

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CHAPTER 6 PRELIMINARY ENGINEERING DESIGNS

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

River training in Canal stretches is not required, wherein the Bank Protection may be essential in the widening reaches.

6.2 Bank Protection

6.2.1 Typical Revetment

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. Typical arrangement is shown in **Figure 6.1**.

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

Arabian Sea

construction related aspects (availability and supply, equipment and labor, access and infrastructure, etc…) and costs.

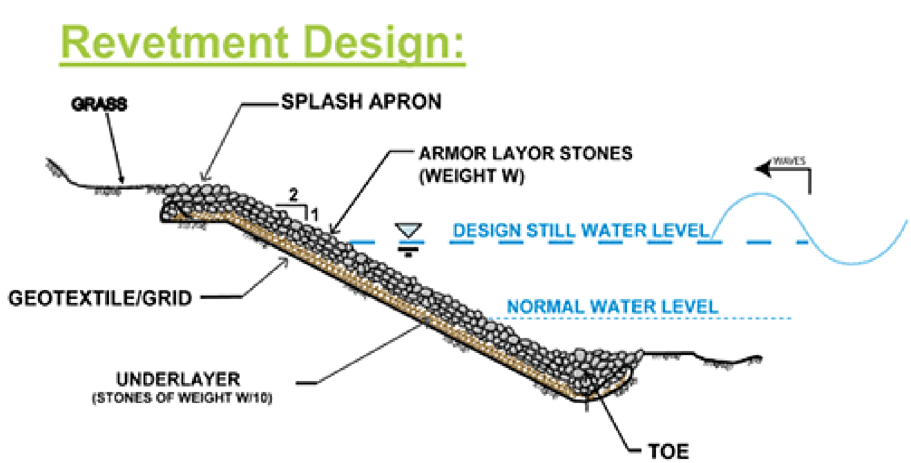

Figure 6-1: Typical Arrangement of Revetment

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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.

6.2.2 Typical Pile and Slab

The present study stretch of NW 8 is a canal amenable for Class III Waterway and similar to that of present NW 3 waterway and having connectivity. Further, the NW 8 is traversing through the Kuttanad area and hence the Pile & Slab type of Bank Protection is most suitable. The typical drawing is placed below in **Figure 6.2.**

The entire material is of M 40 grade concrete with standard steel components and Geo Filter Membrane.

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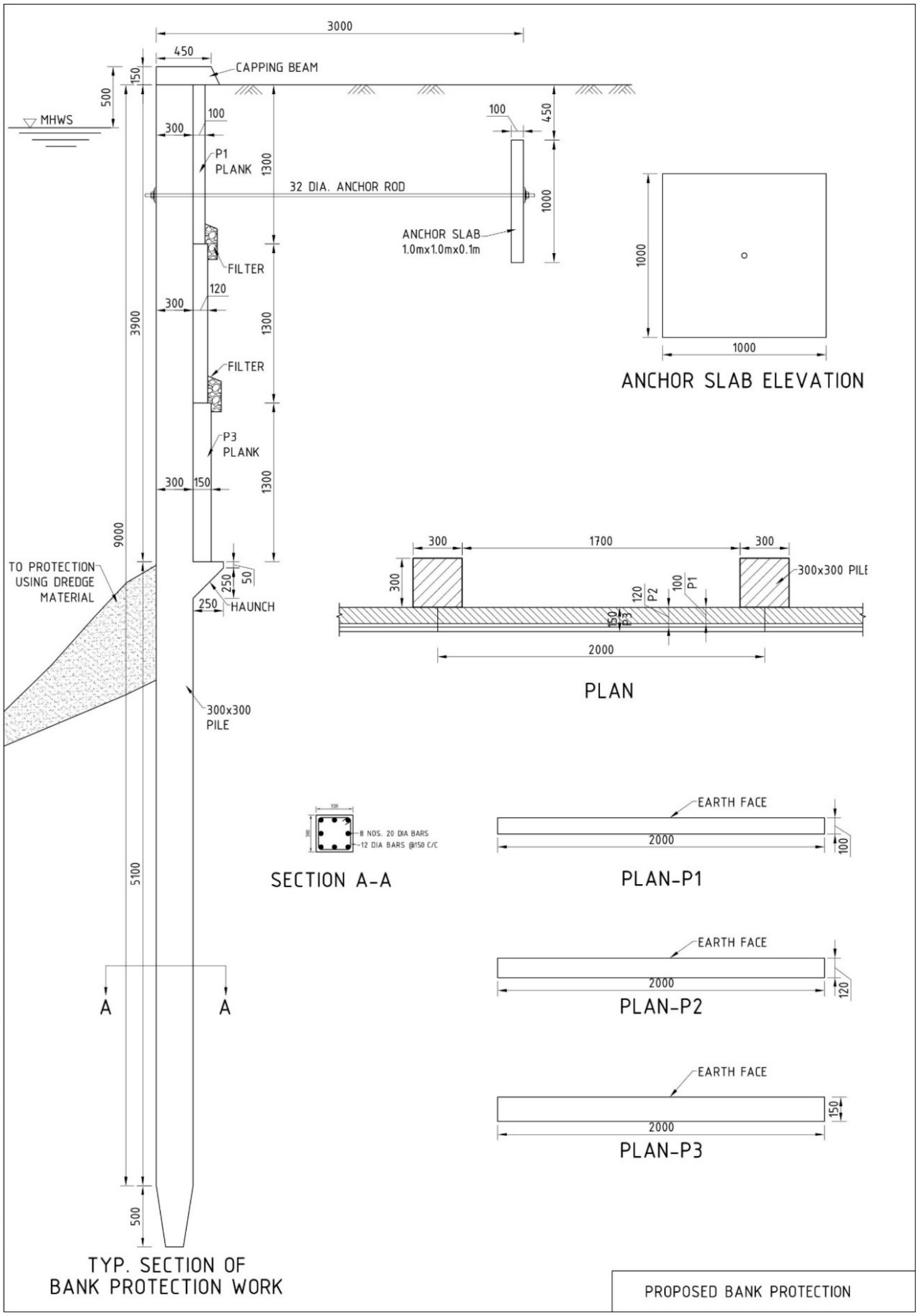

Figure 6-2: Typical section of Pile and Slab type bank protection

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6.3 Navigation Aids

The detailed Drawing and Specifications are reproduced in **Figure 6.3** for consideration.

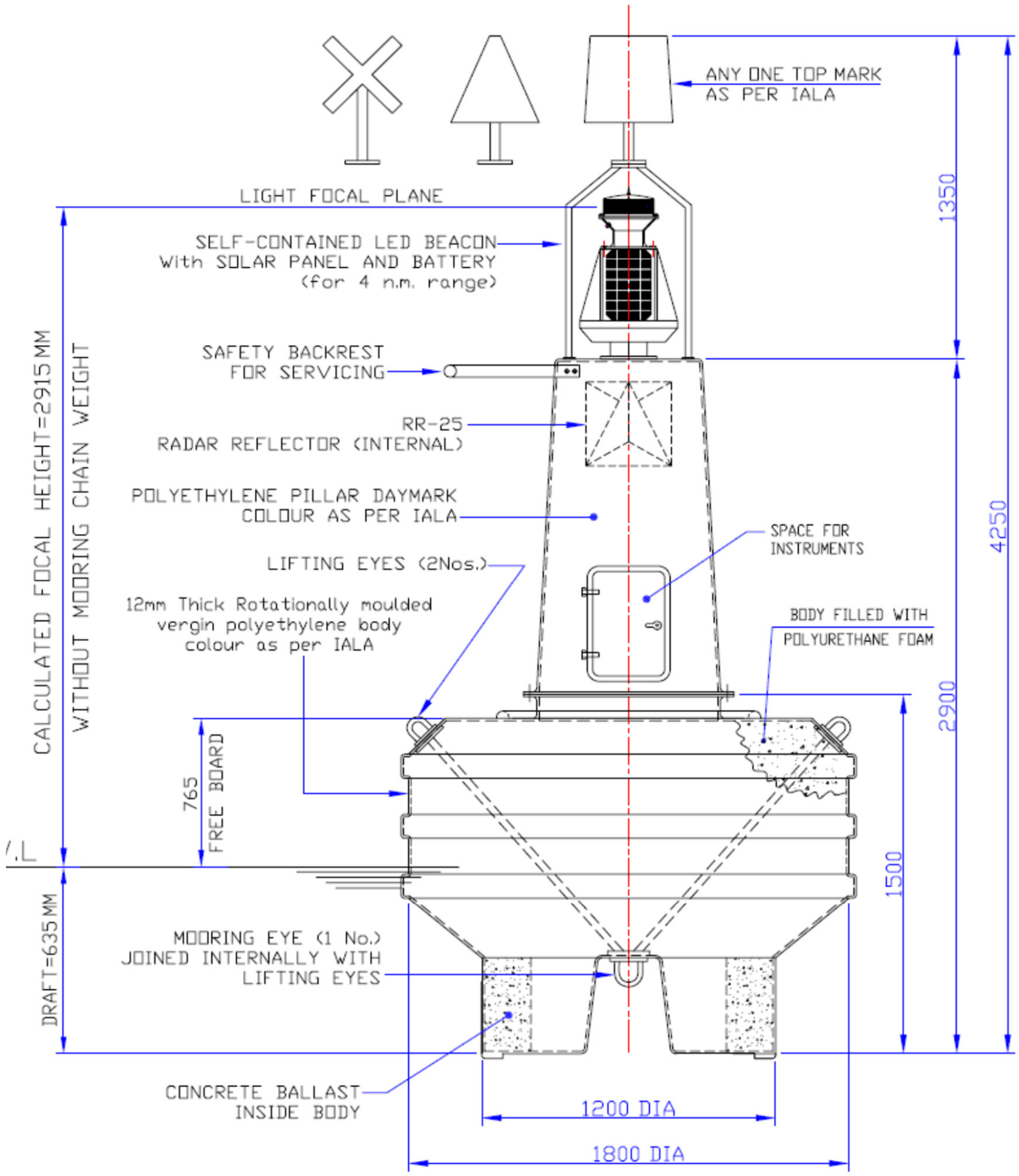

Figure 6-3: Typical section of Navigational Aids

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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 I6 Cable glands fitted / Fixing : 4 fixings for MI 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:

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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℃ to + 60℃.

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%

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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

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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. All districts in the state lie in 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 6-1: SEISMIC LOADING

Seismic zone	III
Design horizontal seismic coefficient, Ah	Z I (Sa/g)/ (2R)
Zone Factor Z	0.10
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.

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

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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 6 m has been considered from the HFL.

The depth of pile is computed from G.L (0.85 m) at exploratory Bore hole (BH) location.

Loads & Load Combinations

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

Structural Design of Berthing Structure

Structural Arrangement

The Ro-Ro berthing structure shall consist of a concrete deck supported on piles i.e., the sub structure shall comprise of piles at 5.1 m c/c in transverse direction, whereas the super structure shall comprise of the pile caps and concrete deck & precast planks supported on longitudinal beams and cross beams. The pile caps span in the transverse direction with the longitudinal beams resting on the pile caps.

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

For Ro-Ro berthing structure, an overall width of approx 12 m is provided

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

Towards the terminal facility i.e. the shore end the deck has been considered at approx 1 m above FRL.

A staged construction approach is assumed in the design viz:

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

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

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TABLE 6-2: SALIENT FEATURES OF Ro– Ro

Description	Total Length(m)	Total Width (m)
RORO	75	12

Design Loads on Berthing Structures

a) Dead Load

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

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

b) Live Load

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

TABLE 1 TRUCK LOADING AND UNIFORM LOADING

FUNCTION OF BERTH	TRUCK LOADING (IRC CLASS)	UNIFORM VERTICAL LIVE LOADING T/m²
(1)	(2)	(3)
Passenger berth	B	1·0
Bulk unloading and loading berth	A	1 to 1·5
Container berth	A or AA or 70 R	3 to 5
Cargo berth	A or AA or 70 R	2·5 to 3·5
Heavy cargo berth	A or AA or 70 R	5 or more
Small boat berth	B	0·5
Fishing berth	B	1·0

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

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

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.

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c) Seismic Forces

All districts in the state lie 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 =0.10

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 = 0.04 (in X direction) and Ah = 0.04 (in Z direction)

d) Wind Forces

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

Wind Pressure Pz = 0.6 Vz^2

Where

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

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

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

K1 = Probability factor (risk coeff)

K2= Terrain height and structure size factor

K3 = Topographic factor

Pz is calculated as 1.59 KN/m2 taking Vb as 39 m/s

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

e) Mooring Load

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

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IS 4651_III, gives Bollard Pulls of vessel as below:

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

TABLE 4 BOLLARD PULLS

(*Clauses* 5.3.4 *and* 6.1)

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

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

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

f) Current Forces

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

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

Where, v = velocity =2.6 m/s

W= 10 kN/m^2

F = 3. 5 kN/m^2

Load Combinations

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

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

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TABLE 6-3: 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 the Ro-Ro Berthing structure. The structure is modelled with its deck (long & cross beams) along with piles at every 5.1 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.

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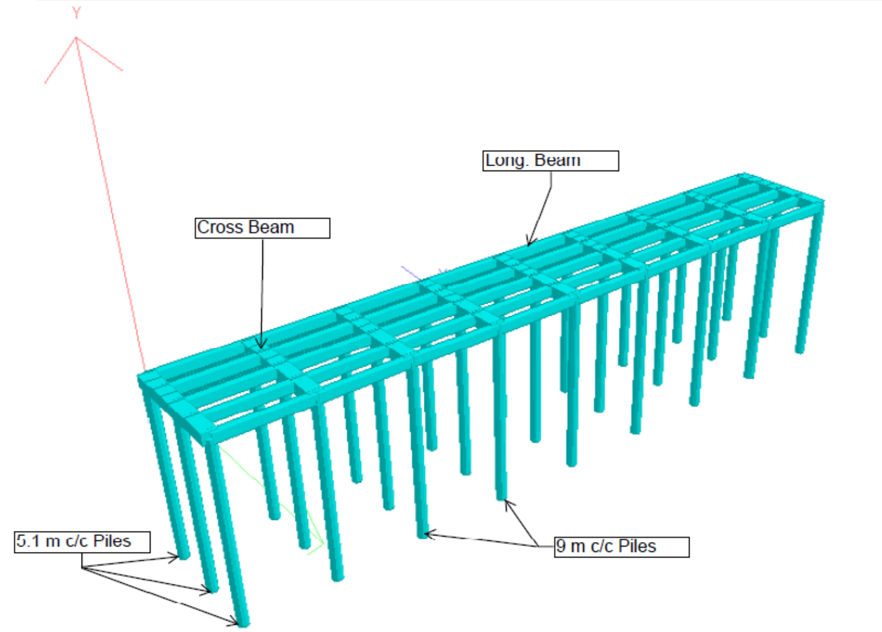

Figure 6-4: Perspective view of 3 dimensional model prepared in STAAD for Ro-Ro

TABLE 6-4:SIZING OF RO-RO

Member Description	Length(m)	Member Sizes(m)			Material
		Width	Depth	Thick	
Cross Beams	5.1	1.8	1.5		Concrete
Longitudinal Beams	9	1.0	1.25		Concrete
CastIn situ Slab				0.15	Concrete
Pile Diameter, OD		1.4	48.15		Concrete

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.

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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.

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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

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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.

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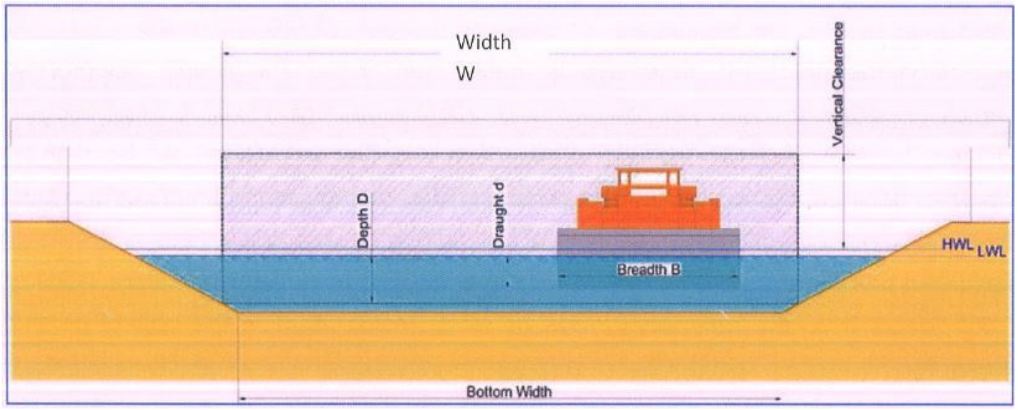

FIGURE 7-1: Dimensions – one way navigation Channel

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

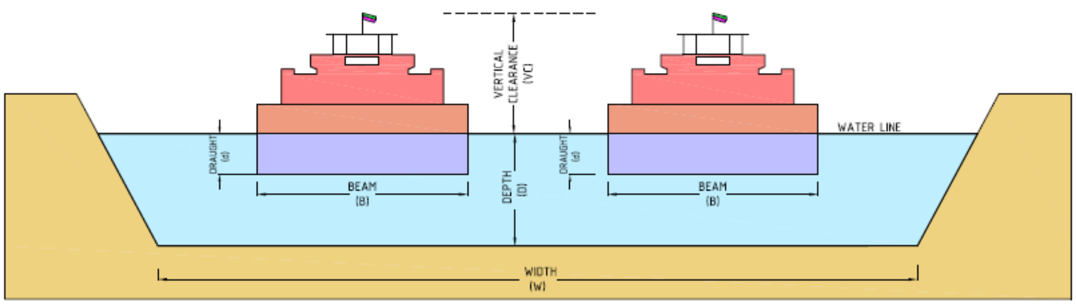

FIGURE 7-2: Dimensions – Two way navigation Channel

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**.

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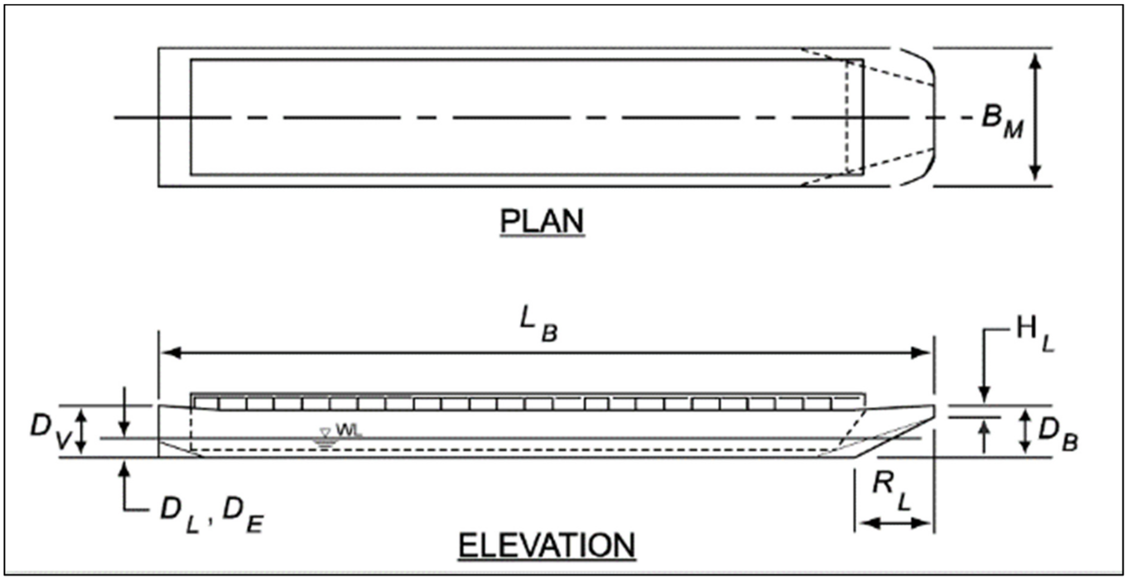

FIGURE 7-3: Plan and Elevation of vessel

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

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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)

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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.

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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

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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
	F/B	D/d	N	F/B	D/d	Waterway F x 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.

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TABLE 7-11: RANGE VARIATION OF THE FACTORS

Factor on Width "F / B"	
Indian classification – Rivers – SPV / Single Channel	4.17 to 7.14
Indian classification – Canals – SPV / Single Channel	3.75 to 4.44
Others – Waterways – SPV / Single Channel	1.50 to 2.30
Indian classification – Rivers – Convoy	3.33 to 6.00
Indian classification – Canals – Convoy	3.75 to 4.44
Others – Waterways – Convoy	2.60 to 4.44
Factor on Depth "D / d"	
Indian classification – Rivers – SPV / Single Channel	1.10 to 1.20
Indian classification – Canals – SPV / Single Channel	1.39 to 1.50
Others – Waterways – SPV / Single Channel	1.20 to 1.40
Indian classification – Rivers – Convoy	1.10 to 1.20
Indian classification – Canals – Convoy	1.39 to 1.50
Others – Waterways – Convoy	1.20 to 1.40
Factor on Cross Section Area "n"	
Indian classification – Waterways – SPV / Single Channel	4.63 to 7.86
Indian classification – Canals – SPV / Single Channel	5.63 to 6.00
Others – Waterways – Convoy	4.90 to 8.70

Note:

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

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

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

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

7.3 Type of proposed Vessels

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

Kerala State Inland Navigation Corporation Ltd., Kochi is the prime utilizer of the existing NW 3. The vessels being deployed in NW 3 by KSINC are placed below. There is a possibility of plying these vessels on NW 3 (Extension) / NW 8 / NW 9 / NW 59 after its development to Class III standards.

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KERALA SHIPPING AND INLAND NAVIGATION CORPORATION LIMITED
KOCHI -20, KERALA

DETAILS OF CARGO FLEET OWNED BY KSINC / PLYING ON NW-3

Sl. No.	Name of the vessel	Year Built	Length (LOA) (in m)	Width (in m)	Draft / Depth (in m)	Cargo Capacity (in T)	Engine Make	Engine X HP (No x HP)	Other details, if any
1.	**Archana**	1982	36.45	7.98	1.80 / 2.60	300	Ashok Leyland 370	ALHM, KFEM, 2 x 98 HP	POL barge
2.	**Bhama**	1994	35.37	7.40	1.80 / 2.20	213	Ashok Leyland	AWHM26392, 26454 2 x 160 HP	POL
3.	**Bharatha**	1994	35.25	7.37	1.80 / 2.19	201	Ashok Leyland	22220610431 426, 2x156HP	POL
4.	**Ocean Breeze**	2013 Dec.	53.00	10.00	1.80 / 3.00	498 Gross 175 Net	Cummins India Ltd.	25365721; 25365722 2 x 325 HP	POL - operates only in port area
5.	**Athulya**	2010 March	52.285	10.00	1.80 / 2.80	425	Ashok Leyland	KXHM – 575397 KXHM – 575398 2 x 156HP	Bulk
6.	**Orion**	2017	49.00	9.00	1.80 / 2.75	349	Ashok Leyland 60T19	HFHM 408150; 408151 2 x 220 HP	bulk
7.	**Amla**	1987	34.09	7.45	1.80 / 2.64	276	Ashok Leyland ALMU 402	LKEM 0423801; 042383 2 x 88 HP	Phosphoric Acid

ALL BARGES OPERATE ONLY IN THE UDYOGAMANDAL AND CHAMPAKKARA CANALS OF NW-3

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In brief, the study stretch of NW 8 is being considered for Ro-Ro operation with Class III canal standard, which can operate Ro-Ro vessel

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.

With regard to the Ro-Ro vessel, it is suggested the deployment of 1 No. vessel at initial stages and may be considered with augmentation, on observing the Growth.

7.4 Proposed Vessel Size and Specifications

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

With regard to the Ro-Ro operation, the vessel size proposed for such mobility will be considered at the initial stage with 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each. Initially the operation will be taken up with ONE vessel deployment and can be augmented with growth observation.

1 Ro-Ro vessel may be required at the initial stages i.e., by 2022.

Other Ro-Ro vessel may be required after 10 years, based on the growth trend.

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.,.

In the existing study stretch of NW 8, the Origin / Destination may be from ICTT, Kochi, which may be of about 90km.

Ro-Ro Operation: The maximum time to be traversed between ICTT, Kochi and Changanassery is of 4 ½ Hrs, taking the average speed of 20 Kmph. Further working at this stage may not have much implication for any suggestion / recommendation. To ascertain the operational requirements etc., 1 cycle operation is possible in a day.

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7.6 Number of Vessels Required

As suggested above,

1 Ro-Ro vessel may be required at the initial stages i.e., by 2022.

Other Ro-Ro vessel may be required may be after 10 yrs.

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.

In the NW 8 reach, i.e. in Vembanad Lake area, No repair yard exists to attend the Dock type of Repairs of IWT Vessels plying in this region.

The “Cochin Ship Yard” in Kochi Kochi is the Public Sector Undertaking under the Ministry of Shipping, Government of India.The Ship Yard is catered for undertaking the Construction and Repair of the Sea going ships. It may attend the construction of IWT Vessels. However, undertaking the repair of IWT Vessels may not be cost effective for such big Ship Yard. CSY,

KSINC is having a Boat Yard in Perumanoor area of Kochi adjacent to Venduruthy (Rail) Bridge connecting Wellingdon Island, Kochi with main Ernakulam city. KSINC has been constructing passenger boats, speed boats, house boats, tourist boats and small seagoing vessels. It constructs the vessels using wood, steel or FRP as per the requirements of customers. KSINC also has experience in repair (both hull and machinery) of large variety vessels. KSINC has a slipway, where vessels of weight up to 200 MTs can be hauled up and repaired. There are facilities to dock six vessels at a time. Facilities for manufacture, repair and servicing of seagoing and inland navigation vessels are available. This location is about 60 Kms. North of NW 8 study area.

Kerala Water Transport Department is having a Boat Repair Yard at Alappuzha, which attends only the repair and docking of Department / Govt. of Kerala Vessels.

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The following are certain repair yards in KOCHI area, attending the repair of IWT Vessels, as ascertained.

Sl.no	Name of company	Address	email id	Phone number
1	J Pee Marine	14/548 Nazreth, Kochi - 682002	jpeemarine@gmail.com	91-9496072700
2	Unotech Marine Engineering and service Pvt Ltd	39/2394 C First floor veejay towers, Salim - Rajan road Gandhinagar, Kochi - 682017	mail@unotechmarine.com	91-484-2206033
3	Cochin Marine Engineering	Door No.7/472 Kochangadi Road, Kochi - 682002	cinmarine@gmail.com	91-9895480901
4	Sea Blue Shipyard Ltd	1/212, VP Road, Azheekal PO, Vypin, Kochi – 682510	josejames@seablueshipyard.com	91-484-4567890
5	Krishna Marine Engineering	40/7818, Anjaly T.D Rd, Ernakulam, Kochi – 682035	appuajay93@gmail.com	91-9388850888
6	Western Marine Engineering	Near St.Lawrence school, P.Box. 915 Edakochi, Kochi - 682010	westernmarine@gmail.com	91-9895186610
7	Walrus Marine And Engineering Co.Pvt.Ltd	Anjikkattu Towers, Near Metro Pillar 363,Koonamthai, Edappally, Kochi - 682024	navneeth@walrusmarine.com	91-9746475712
8	Sea Max Marine Service Pvt Ltd	Thoppil tower, 2nd Floor, Opp.St.Joseph Church, N.F.Gate, Tripunithura, Kochi - 682301	ops@seamax.co.in	91-9947107775
9	4.Square Marine	61/589, Zaabil Building, R. Madhavan Nair Road (Old Thevara Road), Kochi, - 682016	info@4squaremarine.com	91-9496252868

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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.

The SPV / Ro-Ro vessel is suggested with 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion by Marine Diesel Engines of 3 x 375 Bhp is costing about **INR 700 Lakhs each.**

7.8.2 O&M Cost

The Operation & Maintenance cost (O & M Cost) for the Vessels being considered in the IWT project, in general, consists of Running Cost of the vessels; Crew Cost; Repair Cost; Depreciation Cost; Insurance factor and Interest Factor. The vessel mobility is under consideration of 1 Ro-Ro Vessel, for which working the O & M Costs will not have any bearing at this point of time. The following cost factors are only indicative.

1 Ro-Ro Vessel (For 1 Year)

- 1 vessel running cost for 300 days operation for 8 Hrs / day (Optimum running).
- 300 days x 8 Hrs x {0.1 Liter per hour x 3 Engines x 375 Bhp} x INR 70 per Litre = **INR 189 Lakhs Per Annum**.
- 8 Nos. Crew on 1 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 700} = **INR 14 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.

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

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Further, the indicative details considered are leading to the following O & M cost of the vessels. The Entire responsibility of vessel acquisitions is with private operator, not IWAI. Therefore any kind of cost and revenue related to vessel operation is not factored in to financial analysis. However, O&M cost of Vessels to be deployed in NW-8 is calculated below.

(INR Lakhs)

Parameter	Fy-21	Fy-23	Fy-26	Fy-29	Fy-32	Fy-35	Fy-38	Fy-40
Vessel Running Cost	192.8	200.6	212.8	225.9	239.7	254.4	269.9	280.8
Stores & Spares	7.1	7.4	7.9	8.4	17.8	18.8	20.0	20.8
Port & Other Misc Charges	4.1	4.2	4.5	4.8	10.1	10.8	11.4	11.9
Repair Cost	14.3	14.9	15.8	16.7	17.8	18.8	20.0	20.8
Class survey	1.0	1.1	1.1	1.2	2.5	2.7	2.9	3.0
Salary & Other	50.4	55.6	64.3	74.5	86.2	99.8	115.5	127.4
Total O&M Cost	**269.7**	**283.7**	**306.4**	**331.4**	**374.1**	**405.3**	**439.7**	**464.7**

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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 have to be considered for the development of the inland navigation along with the protection of the environment and efficiency. In order to have undisturbed and uninterrupted development and maintenance of Inland navigation System, safe communication is most important.

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

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

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

8.1.1 VHF / HF

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

8.1.2 GPS

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

8.1.3 RIS / AIS / Radar / VTMS

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

The general technical solution is depicted in Figure below.

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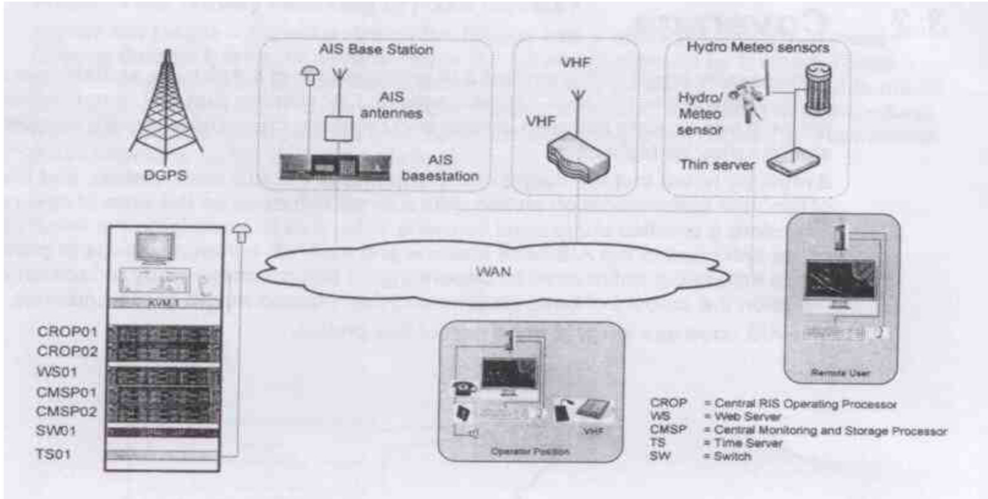
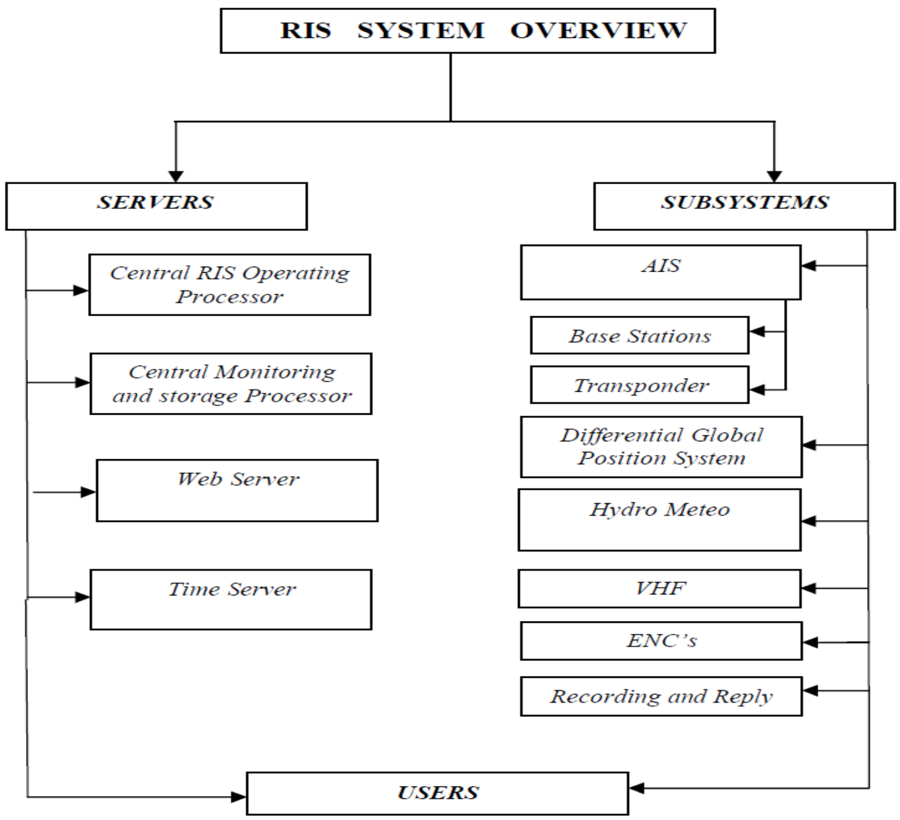


Figure 8-1: Main components of the RIS system are given below in flowchart:



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.

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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 includes

- 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 carries 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

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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.

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8.1.4 Vessel / Hydrographic Survey equipment

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

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

8.2 Existing System

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

8.3 Additional requirement

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

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

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

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Regarding the RIS on "NW 8", this stretch is nothing but a canal system and not amenable for provision of RIS. However, the cost details are provisioned for taking up the same, at later date, if the need is judicious.

At this stage, it is recommended to proceed ahead with the available Mobile Networking system and later on an amenable system can be adopted, subsequent to the considerable progress on "National Coastal Grid of VTMS".

8.4 Specifications of certain equipment's of the system

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

VHF sets with Antenna

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

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

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

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

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

Barometric pressure
- Range: 600 to 1100 hPa
- Temp: -50 to +60 °C

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- Accuracy: ±0.5% of analog pressure range, digital accuracy 0.2 hPa (25℃)
- 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 Better
• Operating System :-	Latest Windows operating system 64 bit (English)
• 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

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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.

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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 / O & M Cost

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

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COST FOR RIS SYSTEM ON "NW 8"

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	1	50,00,000	50,00,000
3	Meteo Sensor	1	8,00,000	8,00,000
4	ATG	2	11,90,000	23,80,000
5	VHF	2	5,00,000	10,00,000
6	DG Set 10 KVA	1	7,00,000	7,00,000
7	UPS	1	5,00,000	5,00,000
8	RIS Software	1	65,00,000	65,00,000
9	RIS Hardware	1	120,00,000	1,20,00,000
10	Installation Testing & Commissioning	1	20,00,000	20,00,000
11	Porta cabin	2	12,00,000	24,00,000
12	Trestle Tower	2	10,00,000	20,00,000
13	Land Cost	-	Lump Sum	34,20,000
14	Buildings etc.,	-	Lump Sum	74,00,000
			Total	**5,21,00,000**
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 (10 % on the previous year)			**32,34,000**
	Total for 3rd year (10 % on the previous year)			**35,57,400**
	Total for 4th year (10 % on the previous year)			**39,31,140**
D.	**CAMC for 4 years**			
	1st year			**-Nil-**
	2nd year (10 % on the Capital Cost)			**52,10,000**
	3rd year (+ 10 % on the previous year Cost)			**57,31,000**
	4th year (+ 10 % on the previous year Cost)			**63,04,100**
D.	**LICENSE COST (per annum)**			
	Wireless etc.,			33,00,000
	VHF	2	5,000	10,000
	Other Miscellaneous		Lump Sum	90,000
			Total	**34,00,000**

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

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

Further, Typical Automatic Identification System (AIS) and its connectivity to Control Centre and a 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

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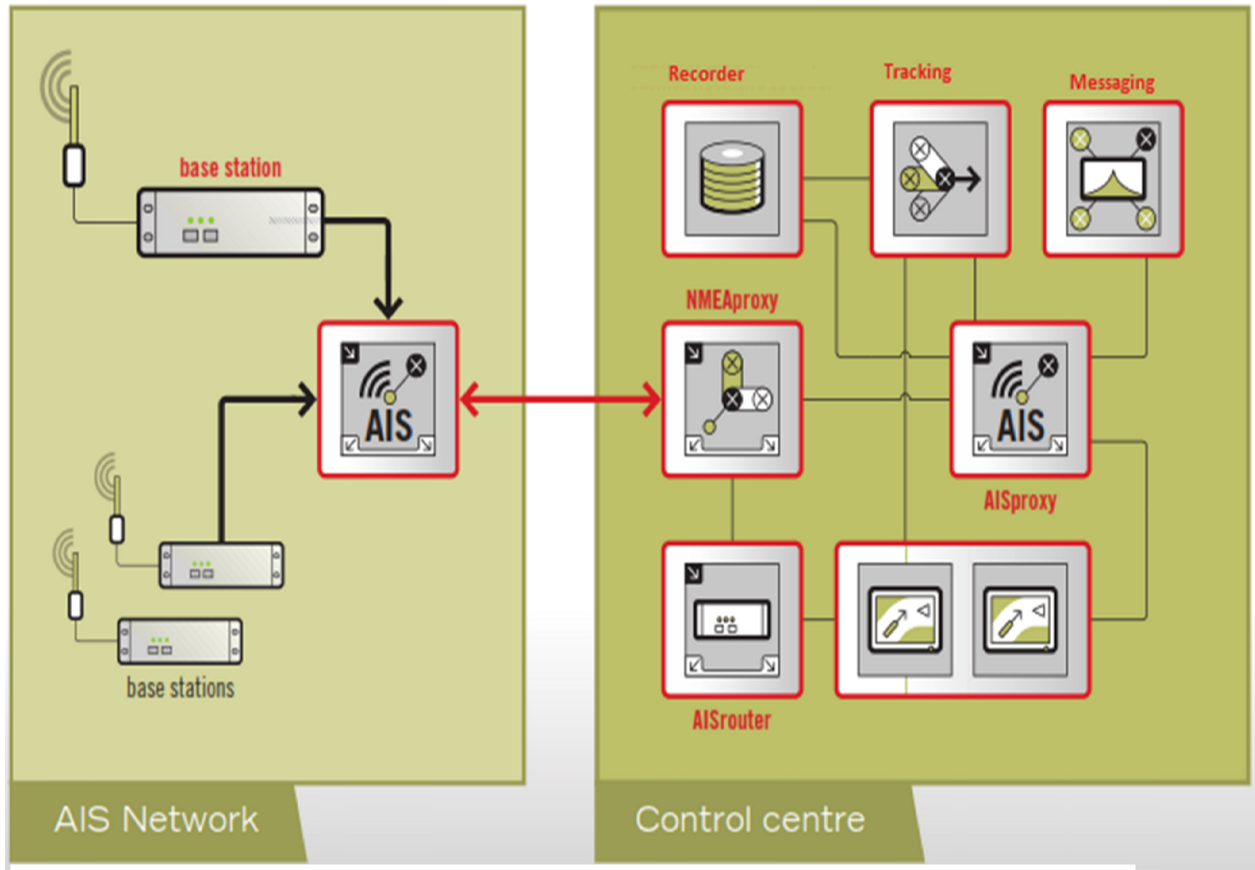

AIS (Automatic Identification System)

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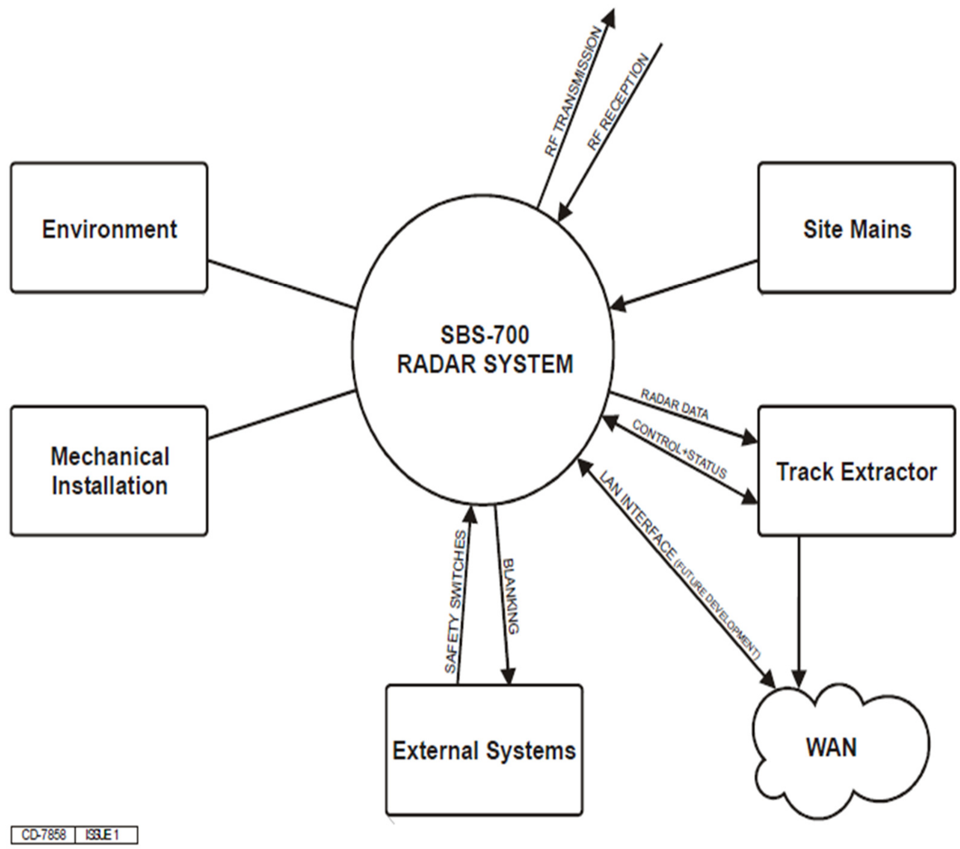

The proposed navigation on “NW 8” is on a canal system. The cost details are worked out only for taking up the same at later date, if the need is required. Inland Waterways Authority of India (IWAI) is planning for installation of RIS in NW-3 West Coast Canal System (Kottapuram- Kollam, Udyogmandal & Champakara): 205 km. The system shall enhance swift electronic data transfer between mobile vessels and shore (Base stations) through advance and real-time exchange of information. As RIS ensures safety of vessels in navigation, as per the Inland Vessel Act, all the vessels is to be equipped with RIS compatible equipment. The range of RIS system shall normally be in the range of 100-125 kms surrounding the base station, hence there is no requirement of separate RIS for NW-8/ NW-9 & NW-59 as these waterways shall be covered by RIS system being planned under NW-3. The cost has not been included in the DPR cost.

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CHAPTER 9 ENVIRONMENTAL & SOCIAL ASPECTS

9.1 Objective of Environmental and Social Studies

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

9.2 Environmental Setting in the Project Area

The proposed project is designated as national waterway no. 8 (NW-8) under the National Waterways Act 2016 and is located on Alappuzha-Changanassery Canal passing through Alappuzha and Kottayam districts of Kerala State. It is a 29.30 km stretch beginning from Alappuzha boat jetty site at Lat 9°30'03.52"N, Lon 76°20'37"E to the Changanassery jetty at Lat 9°26'42"N, Lon 76°31'42"E. The Alappuzha-Changanassery Canal is an ancient navigational waterway and is under use for ferrying passengers, cargo transportation and extensive fishing activities.

NW-8 is located within the Vembanad Lake in Kerala, which is designated as a Ramsar wetland site. The lake is fed by 10 rivers flowing into it including the six major rivers of central Kerala namely Achenkovil, Manimala, Meenachil, Muvattupuzha, Pamba and Periyar.

The Vembanad wetland system covers an area of over 2033.02 km^2 thereby making it the largest wetland system in India. The lake is bordered by Alappuzha, Kottayam and Ernakulam districts. It is separated from the Arabian Sea by a narrow barrier island.

A unique characteristic of the lake is the 1,252 metres (4,108 ft) long Thanneermukkom salt water barrier (Barrage) constructed as a part of the Kuttanad Development Scheme to prevent tidal action and intrusion of salt water into the Kuttanad low-lands. It is the largest mud regulator in India and essentially divides the lake into two parts, one with perennial brackish water and the other with fresh water from rivers draining into the lake.

This barrier has helped farmers in Kuttanad by freeing the area of salinity and by allowing them an additional crop in the dry season. The Thanneermukkom barrier is located at one of the narrower parts of the Vembanad Lake. An Index Map of Alappuzha-Changanassery Canal (NW 8) is shown in Figure 9.1 below.

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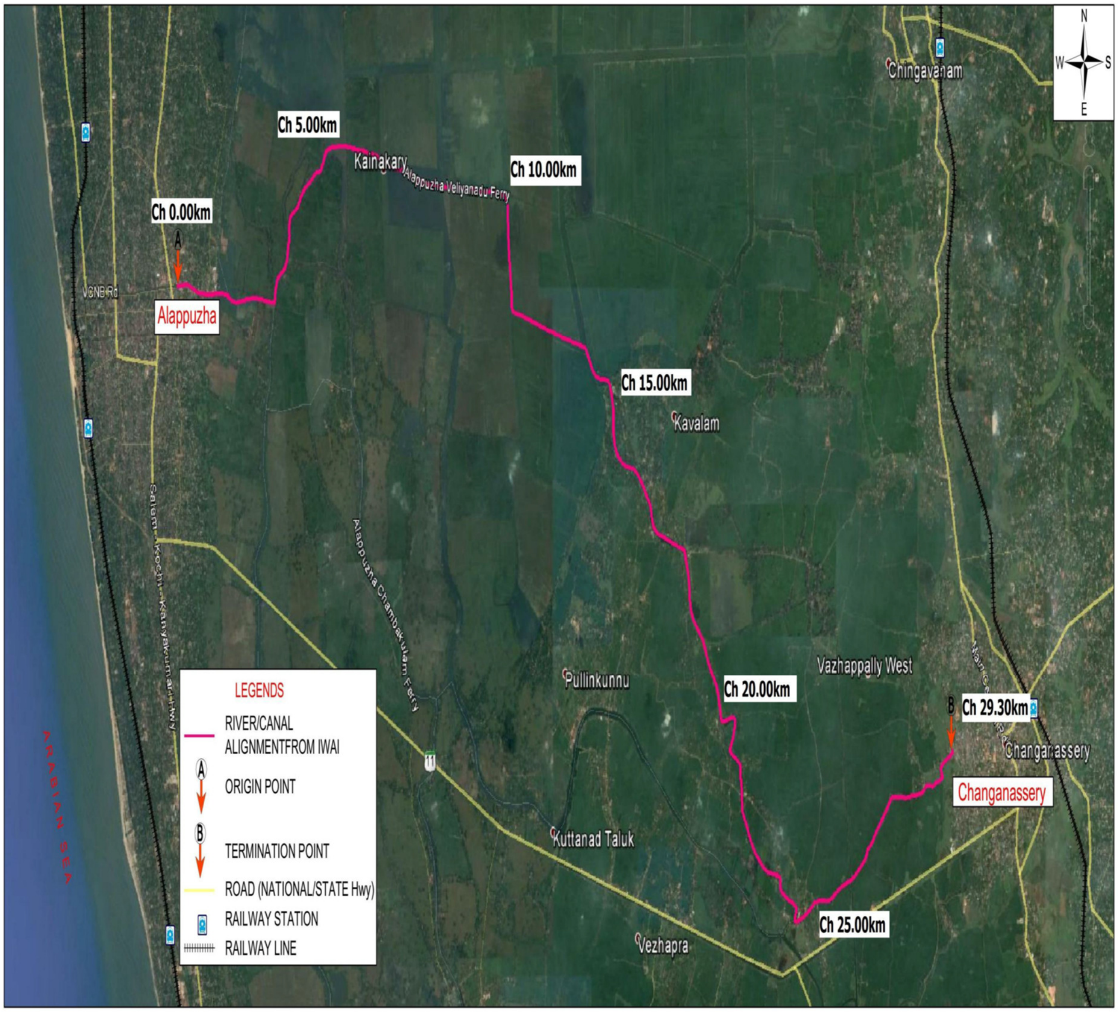

Figure 9-1: Index Map of Alappuzha-Changanassery Canal

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

9.3 Physiography

Kerala State is situated between 8°8' and 18°48' North latitude and 74°4' to 77°50' East longitude, along the windward side of the Western Ghats of Indian Peninsula. The State is located in the tropical region of Indian Peninsula and extends to an area of about 38863 km^2, which accounts for about 1. 2 per cent of the total geographical area of the country. The State has a total coastline of about 560 km and from sea level it rises to about 2694 m above msl.

The State is bordered by the Arabian Sea on the western side and the Western Ghats on the eastern side. Kerala shares it borders with Karnataka State at the extreme north and with Tamil Nadu in the remaining eastern and southern sides.

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Physiographically, the terrain has three natural regions namely: (i) the highlands (600–1800 m high), (ii) the midlands (300–600 m high) and (iii) the lowlands (6–300 m high). These three zones lie parallel to one another in the south-north direction. The broadest part of Kerala is at the middle, which is nearly 130 km wide and towards the north and south, it narrows down to about 30 km.\

(i) The Highlands

The mountain terrains of the Western Ghats constitute the highlands. Around 48% of Kerala's land area is taken up by the Western Ghats. The main hill range covers more than 20,000 sq km of land in Kerala. The average height of the Western Ghats in Kerala is 900 m but there are a number of peaks above 1800 m and the highest peak, Anaimudi, has a height of 2694 m. The highlands have dense forest cover and also have large tracts of plantations of cardamom tea and coffee.

(ii) The Midlands

The midlands lying between the highlands and the lowlands form roughly 40% of the land area. The midlands have a topography of undulating hills and valleys. Here natural forests are sparse and most areas are under cultivation of crops such as cashew, coconut, areca nut, tapioca, banana, rubber and different varieties of vegetables.

(iii) The Lowlands

The lowlands comprise the western coastal plains which are made up of 81 lagoons, river deltas, backwaters and the shores of Arabian Sea. Coconut and rice are widely cultivated in these areas.

Kerala has 44 perennial rivers, of which three are east flowing and the remaining 41 are emptied into the Lakshadweep Sea, along the western side of the State. Rivers are generally swift flowing having very steep gradients in their higher reaches. Absence of delta formation is characteristic of Kerala Rivers. As per national norm (Rao, 1979), there are no major rivers in Kerala. The four medium rivers, namely Chaliyar, Bharathapuzha, Periyar and Pamba have a total drainage area of only 8250 km^2 with length 169 km, 209 km, 244 km and 176 km respectively. The length of rest of the rivers varies from 16 km to 130 km, with an average length of 62 km and total drainage area of 19,485 km^2.

There are two fresh water lakes in the State namely the Pookot and Sasthamkottah. The State is also having a total of 46.13 km^2 of estuaries and backwaters. The important backwaters are Vembanad and Ashtamudi lakes.

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Alappuzha district is drained mainly by Pamba River and its tributaries viz. Achankovil and Manimala Rivers. The Pamba River drains an area of 804 sq.km of the district and forms a deltaic region skirting the south eastern, southern and south western fringes of Vembanad Lake. The Manimala River enters the Kuttanad area at Thondara and confluences with Pamba River at Neerettupuram. Achancovil Ar enters Kuttanad at Pandalam and joins Pamba River at Veeyapuram. Vembanad Lake, the largest back water in the State lies on the north eastern part of the district separating Alappuzha from Kottayam district.

The major rivers in Kottayam district are the Meenachil River, the Muvathupuzha River and the Manimala River. The Meenachil River flows through Meenachil, Vaikom and Kottayam taluks. The total catchment area of Meenachil River is 1272 sq km and is formed by several streams originating from the Western Ghats in Idukki district. The Poonjar river join at Erratupetta, the Chittar River join at Kondur and the Payapparathodu join at Lalam. Finally the river confluences with Vembanad Lake. The Muvattupuzha River originates from Idukki district flowing mostly through Vaikom taluk and joins with Vembanad Lake. The Manimala river flows through Kanjirapally and Chanaganacherry taluks. The Chittar joins it on its course further down the west as it flow towards Alappuzha district.

(Sources: 1. http://www.kerenvis.nic.in/Database/ENVIRONMENT_821.aspx;

2. http://shodhganga.inflibnet.ac.in/bitstream/10603/87093/9/09_chapter%204.pdf

3. http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_ala.pdf

4. http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

9.3.1 Geology and Seismicity

Geologically, Kerala is occupied by four major rock formations namely, crystalline rocks of Precambrian age, sedimentary rocks of Tertiary confined to Neogene period, laterites capping the crystalline and sedimentary rocks and recent and sub recent sediments forming the low-lying areas and river valleys. There are sporadic Paleozoic granites and pegmatite and Meso-Cenozoic dykes intruding these rocks. The oldest rocks so far dated in Kerala are the charnockites, which yielded an age of 2930 ± 50 Ma (Soman, 1997& 2002). The varied rock formations under different geological domains harbour different mineral deposits and the transformed rock strata stockpile copious groundwater resource. (Source: State of Environment Report, Kerala 2007, Volume I, Kerala State Council for Science, Technology and Environment, Government of Kerala)

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Khondalite is the oldest rock in the Alappuzha district and it includes quartzites which occur as lenticular bodies and garnet-biotite-sillimanite gneiss with or without graphite. The charnockite group of rocks including acid and intermediate varieties are found in the north eastern parts. Rocks of the migmatite group represented by biotite gneiss (quartzo-feldspathic gneiss) is noticed as small bodies in along the eastern margin of the district. Near Chengannur, a massive granite body representing the acid intrusive occurs. Hills in the southern and western parts are capped by Tertiary sedimentary rocks (Warkalli Formations). Drilling by CGWB indicated that the Tertiary basin is deepest along the coastal plains of the district and is more than 600m Deep South of Alappuzha town. The Kuttanad low land covering an area of approximately 100 sq. km. is reported to have plenty of semi-carbonised and partly decayed wood trunks, roots, branches, leaves etc. buried under a thin veneer of black carbonaceous clay. This region is locally known as Karipadams because of yielding of coal-like (carbonised wood) material from the paddy field. It is believed that this area is submerged forest of Quaternary period. The other Quaternary sediments include strand line/palaeo beach deposit (Guruvayoor Formation), fluvial deposits (Periyar Formation), tidal/mudflat deposit (Viyyam Formation) and beach deposit (Kadappuram Formation). (Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_ala.pdf)

Geologically, Kottayam district shows a very interesting correspondence between the major rock classes and their physiographic expression. The east comprises Precambrian metamorphic rocks and forms hilly ground. The central part is a low plateau, where Tertiary sediments containing lignite occur. These are followed by further west by a low plain, which is underlain by Quaternary Formations, fluvial or partly marine. The Charnockite Group dominates in areal distribution with charnockite, charnockite gneiss and diopside gneiss occupying the major part. Pyroxenen granulite (with hornblende granulite), magnetitie quartzite and cordierite gneiss occur as concordant bands within charnockite. The linear bands of quartzite (Khondalite Group) are the oldest rock of the area. Biotite geniss (composite gneiss) representing the Migmatite Complex has a limited areal extent, west of Ettumanur and along the eastern boundary. Three major granite bodies are emplaced in the district, two along the southwest and other in the east. Numerous dolerite and gabbro dykes trending NW-SE traverse the older basement rocks in the central and eastern parts. A prominent gabbro dyke extends from north to south with a NNW-SSE trend. Tertiary sediments comprising sandstone, clay with lignite intercalations are confined to the west and they occur as small patches, especially as capping on hillocks. Both the Archaean and Tertiary rocks are lateritised. Quaternary alluvial deposits occur to the west. They have been classified into various morphostratigraphic units, based on their environment of formation, as Guruvayur Formation (palaeo-marine), Periyar Formation (fluvial) and Viyyam Formation (fluvio-marine). (Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)As per the seismic zoning map of

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India, the project area falls under seismic zone III and indicates moderate seismicity. Kerala has experienced occasional mild tremors since historical times. A seismic hazard map with 10% probability of exceedance in 50 years assigns low-level hazard to regions falling in Kerala. However pockets of higher ground acceleration have been identified in central Kerala. In Kerala, several deep seated faults exist, the notable among them are Periyar fault, Idamalayar fault, Muvattupuzha fault, Bhavali fault and Kuthuparamba fault. Besides there are many more minor faults and fractures that can generate minor tremors as a result of crustal readjustment. Minor tremors in Kerala are also explained by hydroseismicity model wherein pressure transients generated due to sudden increase in hydrostatic heads especially after rains results in increased pore pressure and movement along pre-existing faults (Radhakrishnan, 2007). (Source: Kerala State Disaster Management Plan Profile, Kerala State Disaster Management Authority, Government of Kerala as available on http://documents.gov.in/KL/16344.pdf)

9.3.2 Climate

The climate of Kerala is tropical monsoon with seasonally excessive rainfall and hot summer. The Western Ghats plays a major role in the climatic conditions that prevail all along the state.

The year may be divided into four seasons. The period of March to the end of May is the hot season which is the summer month and is uncomfortable due to high temperature and humidity. This is followed by South West Monsoon season that continued till the beginning of October. From October to December is the North East Monsoon season and two months, January and February, are the winter season. The climate is pleasant from September to February. The state is extremely humid due to the existence of Arabian Sea in the west of it.

The annual precipitation varies between 100 cm (around Chinnar) to 500 cm (around Neriyamangalam), with a state average of about 300 cm. March to May is the hottest with maximum temperature reaching more than 32°C and the minimum is attained during December to January. Winds over the state are seasonal; diurnal variation is felt owing to the maritime influence. Annual relative humidity varies between 79 – 80% in the morning and 73 – 77% in the evenings.

(Source: http://www.moef.gov.in/sites/default/files/KERALA%20STATE%20ACTION%20PLAN%20ON%20CLIMATE%20CHANGE.pdf)

Alappuzha district has a tropical humid climate with an oppressive summers and plentiful seasonal rainfall. The period from March to the end of May is the hot season. This is followed by the southwest monsoon season, which continues till the end of September. During October and major part of November southwest monsoon retreats

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giving place to the northeast monsoon, and the rainfall up to December is associated with northeast monsoon season. The district receives an average annual rainfall of 2965.4 mm. The southwest monsoon season from June to September contributes nearly 60.3% of the annual rainfall. This is followed by the northeast monsoon season from October to December, which contributes about 20.9% of the annual rainfall, and the balance 18.8% is received during the period from January to May months. (Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_ala.pdf)

Kottayam district has, in general, wet type of climate and four seasons are seen in this district. The hot summer season from March to May, the South West monsoon season from June to September, the North East monsoon season from October to December and cool climate prevails during January and February.

The major contribution of rainfall in Kottayam district is during South West monsoon followed by the North East monsoon. The analysis of rainfall data reveals that the distribution of rainfall increases from west to east. The highest rainfall recorded at Pala while the lowest recorded at Ettumanur. The annual rainfall ranges from 2435.9 to 3755.2 mm and the average annual rainfall of the district is 3169.28 mm. The South West monsoon contributes nearly 59 % of the total rainfall and while the North East monsoon contributes nearly 21% of the total rainfall in the district. (Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

9.3.3 Soils

Ten broad groups of soils based on morphological features and physico-chemical properties have been identified in Kerala (Anon, 1978). They are red soil, laterite soil, coastal alluvial soil, riverine alluvial soil, grayish Onattukara soil, brown hydromorphic soil, hydromorphic saline soil, acid saline soil, black soil and forest soil. (Source: http://www.kerenvis.nic.in/Database/ENVIRONMENT_821.aspx)

Soils of Alappuzha District

On the basis of morphological and physico-chemical properties, the Soil Survey Division of Department of Agriculture, Govt. of Kerala has classified the soils of Alappuzha district into four types viz. (1) Coastal alluvium (Entisols), (2) Riverine Alluvium (Inceptisols) (3) Brown hypidimorphic soil (Alfisols) and (4) Lateritic soil (Oxisols).

Coastal Alluvium (Entisols)

These soils are seen along the western parts of the district all along the coast and have been developed from recent marine and estuarine deposits. The texture is dominated by sand fraction and is extensively drained with very high permeability. These soils have low content of organic matter and of low fertility level.

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Riverine alluvium (Inceptisols)

These soils occur mostly in the central pediplains and eastern parts of the area along the banks of Pamba River and its tributaries and show wide variation in their physicochemical properties depending on the nature of alluvium that is deposited and characteristics of the catchment area through which the river flows. They are very deep soils with surface textures ranging from sandy loam to clayey loam and moderately supplied with organic matter like nitrogen and potassium.

Brown hydromorphic soil (Alfisols)

These are mostly confined in the western low-lying areas of the district along the coast. These soils have been formed as a result of transportation and sedimentation of material from the adjoining hill slopes and also through deposition by rivers and exhibit wide variation in their physical and chemical properties. They are moderately supplied with organic matter like nitrogen, potassium and deficient in lime and phosphate.

Lateritic soil (Oxisols)

The lateritic soil is the result of weathering process of Tertiary and Crystalline rocks under tropical humid conditions and is seen in the south-eastern part of the district. Heavy rainfall and temperature prevalent in the area are conducive to the process of formation of this soil type and have been formed by leaching of base and silica from the original parent rock with accumulation of oxides of iron and aluminum. They are poor in nitrogen, phosphorous, potassium and low in bases. The organic content is also low and is generally acidic with pH ranging from 5.0 to 6.0.

(Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_ala.pdf)

Soils of Kottayam District

The soil types occurring in Kottayam district can be broadly grouped into four types on the basis of their physico-chemical properties and morphological features. They are (1) Lateritic soil. (2) Riverine alluvium, (3) Brown hydromorphic, and (4) Forest loams.

Lateritic soil

The lateritic soil is the pre-dominant soil type, which covers almost the entire midland areas of the Kottayam district. The surface soil is mostly reddish brown to yellowish red in colour and the texture ranges from gravelly loam to gravelly clay loam. Heavy rainfall and high temperature prevalent in the area are conducive to the process of formation of this soil type. It is well drained and the presence of organic content is low. This soil is poor in nitrogen, phosphorous and potassium. It is acidic in nature with a pH value ranging from 5.0 to 6.2.

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Riverine alluvium

The occurrence of these soils is restricted along the river courses and their tributaries. They show wide variation in their physico-chemical properties depending on the nature of the alluvium that is deposited and the characteristics of the catchments area drained by the river. They are very deep soils with surface textures ranging from sandy loam to clay loam. These soils are characterised by moderate amount of organic matter, nitrogen and potassium. Presence of mica flakes has been observed in the alluvial soils.

Brown hydromorphic soil

These soils are mostly confined to valley bottoms between undulating topography in the midland and in low-lying areas. They have been formed as a result of transportation and sedimentation of material from adjoining hill slopes and also through deposition by local streams. These soils are very deep and brownish in colour and exhibiting wide variation in physico-chemical properties and morphological features. The surface soil texture varies from sandy loam to clay. Their pH value ranges between 5.2 and 6.4 and are acidic in nature.

Forest loam

These soils are the products of weathering of crystalline rocks under forest cover. They are occurring in the eastern hilly areas. These are dark reddish brown to black in colour. The surface texture varies from loam to silt loam. They are characterised by a surface layer very rich in organic matter. Generally they are acidic, rich in nitrogen and their pH ranging from 5.5 to 6.3.

(Source: http://dmg.kerala.gov.in/docs/pdf/dsr/dsr_kot.pdf)

9.3.4 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.

Kerala has a diverse land use and cropping pattern. The data on land use pattern of Kerala for the year 2009-10 reveals that out of a total geographical area of Kerala, net sown area is about 56 per cent. Forest occupies around 28 per cent. Agriculture and forest sectors together account for over 84 per cent of the land area. There was an increase in the area under current fallow (9186 ha) and a decrease in the area under fallow other than current fallow (581 ha) during 2009-10 over 2008- 09. The area under cultivable waste increased by 1821 ha. and barren and uncultivated land declined by 7019 ha.

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(Source:http://www.moef.gov.in/sites/default/files/KERALA%20STATE%20ACTION%20PLAN%20ON%20CLIMATE%20CHANGE.pdf)

Land Use in Alappuzha District

According to Agricultural Statistics for 2010-11, relating to land use pattern of the district, there is no forest area in the district. Land under non-agricultural use which was 16.74 per cent in 1997-98 has decreased to 14.80 per cent (20881 ha) in 2010-11. The net cropped area has marginally declined from 1032.12 sq km to 874.45 Sq.kms. The fallow other than current fallow has increased from 17.70 sq km in 1997–98 to 39.54 sq km in 2010–11. There is increase in the area under culturable waste during the corresponding period.

TABLE 9-1: CLASSIFICATION OF AREA ON THE BASIS OF LAND UTILIZATION IN ALAPPUZHA DISTRICT

S. No.	Type of Land	Area in sq km
1	Total area	1410.11
2	Forest area	0
3	Land put to non-agricultural use	208.81
4	Barren & uncultivable	0.32
5	Permanent pastures and grazing land	0.39
6	Land under miscellaneous tree crops	1.5
7	Cultivable waste	128.29
8	Fallow other than current fallow	39.54
9	Current fallow	31.45
10	Marshy Land	0.33
11	Still water	121.44
12	Waterlogged area	3.26
13	Social forestry	0.33
14	Net sown area	874.45
15	Area sown more than once	210.44
16	Total cropped area	1084.89

(Source: District Census Handbook, Alappuzha District, Series 33, Part XII A, Directorate of Census Operations, Kerala, Census of India, 2011)

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Land Use in Kottayam District

Kottayam District has an area of about 2204.42 sq km. It accounts for 5.68 percentage of the total area of the State (38862.87 sq km). According to agricultural statistics for 2010-11, the data on land use pattern of the district reveals that forest occupies around 3.69 per cent. In view of the high density of population, the pressure for non-agricultural use is increasing. Land under non-agricultural use which was 11.86 per cent in 2000-01 has decreased to 11.74 % during 2010-11. The net cropped area decreased from 1734.94 sq km to 1644.51 sq km during the period. There was an increase in the area under current fallows (58.08 sq km) and increase in area for fallows other than current fallows (30.46 sq km).

TABLE 9-2: CLASSIFICATION OF AREA ON THE BASIS OF LAND UTILIZATION IN KOTTAYAM DISTRICT

S. No.	Type of Land	Area in sq km
1	Total area	2204.42
2	Forest area	81.41
3	Land put to non-agricultural use	258.93
4	Barren & uncultivable	14.69
5	Permanent pastures and grazing land	0
6	Land under miscellaneous tree crops	1.33
7	Cultivable waste	48.9
8	Fallow other than current fallow	30.46
9	Current fallow	58.08
10	Still water	63.62
11	Waterlogged area	1.59
12	Social forestry	0.9
13	Net sown area	1644.51
14	Area sown more than once	423.38
15	Total cropped area	2067.89

(Source: District Census Handbook, Kottayam District, Series 33, Part XII A, Directorate of Census Operations, Kerala, Census of India, 2011)

The project area is characterized by mixed land use on both banks of the designated stretch of NW-8 comprising residential use, agricultural land with paddy and coconut trees, fishing and ferry jetties, temples and churches, schools and transmission lines

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and towers. The chainage wise details of land use and land cover along the entire NW-8 stretch is provided in the hydrographic survey report prepared as part of the present DPR.

9.3.5 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.

Ambient air is monitored by the Kerala State Pollution Control Board for Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur Dioxide (SO_2) and Oxides of Nitrogen (NO_X) from stations located in industrial, residential and sensitive areas. Observations at these stations show that SPM and RSPM regularly exceed allowable limits. SO_2 and NO_X levels are observed to be almost always within the prescribed limits.

Even increasing use of fossil fuel in the transportation and industrial sectors is adversely affecting the air quality in Kerala.

The increasing number of vehicles is also responsible for the increase in ambient noise. The number of vehicles on the roads in Kerala has increased more than 20 times since 1975. Vehicular emission and noise from this vehicles are severe in the three major cities of Kerala namely, Thruvananthapuram, Kochi and Kozhikode.

Kerala's industrial growth has been very low when compared to the rest of India. The number of industries, which can be categorized as Large or Medium, is about 640. Most of these units are in the private sector and a majority of them are located at Kochi. There are about 2.5 lakh SSI units, which are dispersed in the different districts of the state. Kerala state pollution control board brought nearly 600 large/medium scale industries and about 2500 SSI units under the consent regime of Air (Prevention and Control of Pollution) Act. Majority of the smaller units comprise stone crusher units.

(Source: http://www.kerenvis.nic.in/Database/Air_Pollution_835.aspx)

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

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9.3.6 Ambient Water Quality

As per surface water sample tests carried out as part of the present study, the canal water in the NW-8 stretch is slightly basic in nature with pH value being above 7 for all sample locations. Surface water quality analysis has been done at three 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 Changanassery, Kainakary and Alappuzha. The pH values for the three locations are 7.08, 7.15 and 7.02 respectively, which indicates the alkaline nature of water in the identified stretch of NW-8 in the Alappuzha-Changanassery canal.

TABLE 9-3: SURFACE WATER QUALITY IN THE PROJECT AREA OF NW-8

Sample Locations	Easting	Northing	pH
Changanassery	647500.25	1050522.13	7.08
Kainakary	662266.99	1043994.29	7.15
Alappuzha	667799.09	1044365.67	7.02

Source: Report of Detailed Hydrographic Survey in Alappuzha Changnassery Canal – NW-8

Kerala is one of the most thickly populated regions in the world and the population is increasing at a rate of 14% per decade. The rivers of Kerala have been increasingly polluted from the industrial and domestic waste and from the pesticides and fertilizer in agriculture. Industries discharge hazardous pollutants like phosphates, sulphides, ammonia, fluorides, heavy metals and insecticides into the downstream reaches of the river. The river Periyar and Chaliyar are very good examples for the pollution due to industrial effluents. It is estimated that nearly 260 million litres of trade effluents reach the Periyar estuary daily from the Kochi industrial belt.

The major water quality problem associated with rivers of Kerala is bacteriological pollution. The assessment of river such as Chalakudy, Periyar, Muvattupuzha, Meenachil, Pamba and Achenkovil indicates that the major quality problem is due to bacteriological pollution and falls under B or C category of CPCB classification. There are local level quality problems faced by all rivers especially due to dumping of solid waste, bathing and discharge of effluents.

With regard to groundwater, water quality characteristics of wells in Kerala are found to be affected by chemical and biological contaminants. The ground water quality problems in the coastal areas are mainly because of the presence of excess chloride. The chloride concentration >250mb/l was detected in the well water samples of Azhikode, Kakkathuruthy, Edathinjil, Kadalundi, Chellanum, Nallalam, Mankombu and Haripad.

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In Alappuzha district, flouride concentration in the pumping wells was observed to be high. In midland region, with regard to ionic concentration, the concentration of flouride iron and chloride were found to be on the higher side. The flouride content was observed to be beyond the permissible limit of 1 mg/l. Deep wells in Chittur taluk and Kanjikode areas of Palakkad district are found to contain flouride concentration greater than 1mg/l.

Open well of Kerala are under threat of bacteriological contamination. In Kerala about 60% of the population relies on ground water for drinking. At the same time studies have shown that faecal contamination is present in 90% of drinking water wells. The open character of the wells, and conventional maintenance habits, and use of buckets and rope to draw water, kitchen wastes and pit latrines with average family load factor of 5 members at a distance of less than 5 meters from wells are some of the factors, which are contributing to the bacteriological contamination.

Ground water contamination due to industrial pollution has been reported from places of Kochi (eastern part of Aluva), Palakkad and some parts of Kollam, Kozhikode and Kannur.

(Source: http://www.kerenvis.nic.in/Database/Waterpollution_834.aspx)

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.

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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, there are 73 monitoring locations on 55 rivers in Kerala out of which 18 locations are exceeding the Water Quality Criteria limit with respect to BOD. These 18 non-complying locations are situated on 13 rivers. The names of the rivers are; Chitrapuzha, Kadambayar, Kallai, Karamana, Keecheri, Kuppam, Manimala, Neeleswaram, Periyar, Pullur, Puzhckal, Thirur and Uppala. These rivers are classified in three priority classes (Class – I, IV and V).

The details of the polluted river stretches in Kerala are provided in Table 9-4.

TABLE 9-4: DETAILS OF POLLUTED RIVER STRETCHES IN KERALA

S. No.	River Name	Stretch Identified	Towns Identified	Approx. Length of the Stretch (in km)	BOD Range / Max. Value	Priority Class
1.	Chitrapuzha	Irumpanam to Karingachira	Chittethukara	15	8	IV
2.	Kadambyar	Manckakadavu to Brahmapuram	Kakkattikara, Thengumthuruthu	8	4.4-8.0	IV
3.	Kallai	Thekepuram to Arakkinar	Kozhikode, Mananchira	5	6	V
4.	Karamana	Malekkdu to Thiruvallam	Trikkannapuram	4	80	I
5.	Keecheri	Puliyannor to Kechery	Thrissur	6	3.8	V
6.	Kuppam	Thaliparamba to Velichangool	Marathakkad, Kuttiyeri	12	5.4	V
7.	Manimala	Kalloopara to Thondra	Mallappally, Vaipur	10	4.2-4.4	V
8.	Neeleswaram	Nambiarkal Dam to Hosdurg	Puthukai	8	3.3-3.8	V
9.	Periyar	Alwaye-Eloor to Kalamassery	Muttinakam, Edampaadam	5	3.7-6.0	V
10.	Pullur	Ramnagar to Kannoth	Kottapara,	2	3.1	V

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S. No.	River Name	Stretch Identified	Towns Identified	Approx. Length of the Stretch (in km)	BOD Range / Max. Value	Priority Class
11.	Puzhackal	Olarikkara to Puzhackal	Puthurkara, Chettupuzha	3	5.4	V
12.	Thirur	Naduvilangadi to Thalakkadathur	Chembra, Thazhepalam, Mangalam, Thiruthummal	8	4.4	V
13.	Uppala	Poyya to Mulinja	Manjeshwar, Hosabettu	3	3.3	V

(Source: River Stretches for Restoration of Water Quality, CPCB, 2015 (Monitoring of Indian National Aquatic Resources Series: MINARS/37 /2014-15).

The NW-8 stretch from Alappuzha to Changanassery traverses through Vembanad Lake. As per information provided in National Wetland Atlas prepared as part of the project on National Wetland inventory and Assessment (NWIA) by Space Application Centre (ISRO), Ahmedabad and Kerala State Remote Sensing & Environment Centre, Thiruvanathapuram and published in February 2010, turbidity of the lake water is low.

Additional primary data on water quality in the project area may be collected at a later stage as part of the EIA study to be carried out separately by IWAI.

9.3.7 Susceptibility to Natural Hazards

According to the Kerala State Disaster Management Plan Profile prepared by the Kerala State Disaster Management Authority, Government of Kerala, the State of Kerala is prone to a host of natural hazards such as coastal erosion, flood, drought, lightening, landslide and earthquake. All most all districts of Kerala are multi-hazard prone. In Kerala lightning, landslides (debris flows) and floods are the most commonly occurring natural hazards. Droughts and minor earth tremors also occur occasionally.

Kerala is prone to high incidence of lightning, especially during the months of April, May, October and November. It is estimated that about 70 people die every year due to lightning.

In Kerala, riverine flooding is a recurring event consequent to heavy or continuous rainfall exceeding the absorptive capacity of soil and flow capacity of streams and rivers. About 14.8% of the state is prone to flooding. Kerala has been experiencing seasonal drought conditions every year during summer months. Between 1871-2000, the state experienced 12 moderate drought years.

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Apart from floods the mountain regions of the state experience several landslides during the monsoon season. Landslides commonly occur in localised areas of the Western Ghats region where the slope is steep and the soil is over saturated as a result of prolonged rainfall. The landslides in the state include rock falls, rock slips, debris flow and in a few cases rotational types of slides. But the most prevalent recurring and disastrous type of earth or tectonic movement noted in Kerala are the debris flow (urulpottal) characterized by the swift and sudden down slope movement of highly water saturated overburden ranging in size from soil particles to boulders destroying and carrying with it everything that is lying in its path. About 1500 sq km area in the Western Ghats is prone to landslides. A total of 65 fatal landslides occurred between 1961 and 2009 causing the death of 257 individuals.

With a length of 570 km and covering about 15% of state‘s total area, the coastal zone of Kerala is an important physiographic unit. Hazards in the coastal zone are erosion, monsoon, storm surges, sea level rise etc. More than 300 km of sea shore is erosion prone. Extensive sea wall construction along with gabion-box and groins has failed to arrest the erosion in many cases. The tsunami of 2004 which was experienced along most of the coastal regions of the state has added a new dimension to the disaster scenario of the state.

(Source: Kerala State Disaster Management Plan Profile, Kerala State Disaster Management Authority, Government of Kerala; Website: http://documents.gov.in/KL/16344.pdf)

9.3.8 Estuary and Coastal Zone

The Kerala coast extends from Manjeswaram in north to Pozhiyur in the south. Well-developed sandy beaches are in Chittari, Kappad, Ponnani, Calicut, Cochin, Alleppey and Kovalam. The beach consists of sands of different fractions along with broken molluscan shells. In addition to this, crescent shaped pocket beaches are observed at Ezhimals, Dharmadom, Tellicherry, Kadur point and Ealthur.

Spits are seen at the estuarine of Vambanad, Asthamudi, Shiriys, Bypore and Veli. At some places during the lean season opening of small estuaries got blocked by the growth of the spits.

Cliff and rocky coasts are observed at many places on the Kerala coast. The rocky shores are made up of laterites or Precambrian crystalline such as Khondalites or Charnockites. Some of the prominent rocky coasts are near Bekal, Ezhimala, Azhikode and Kadalur point in the north and Vizhinjam, Varkala and Tangasseri in the south.

The mangrove vegetation in the coastal area of Kerala is very sparse and thin. The Kerala coast has a number of islets or islands. Most of them are populated. Locally the

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islands are called thuruths. Man-made thuruths are also common. The Vembanad, the Asthamudi, and Kakavvayi estuaries show more islands. The islands in the Vembanad estuary in central Kerala are large in size compared to the islands in the Kavvayi estuary. The major islands are Wellington, Kumbalam, Nettur, Madavana, Cheppanam and Perumbalam. Dharmadom, a large island with mangroves is situated in the northern Kerala. Mudflat occupies 41.61 sq km and Habitation with vegetation occupies 4903.70 sq km.

(Source: Coastal Zones of India, Space Application Centre, ISRO, Ahmedabad, 2012)

The coastal plain of Kerala also constitutes a special ecological mosaic. The Coastal Zone in Kerala is the low land fringing the sea extending over 560 km with a height of less than 8 m from the MSL, covers about 15 % of the state's total area of 38,863 sq km. A chain of water bodies, locally known as kayals running parallel / oblique to the coastline is a characteristic feature of Kerala coast. These are mostly interconnected by natural or man-made canals, facilitating internal navigation almost for the entire length of the coast. Numerous perennial rivers discharge into these kayals. Southern half of the Kerala coast harbours more of larger backwaters. The kayals of the Kerala coast are mostly separated from the sea by elongated sandbars and based on this they can be treated as "coastal lagoons". (Source: http://kerenvis.nic.in/Database/Coastal_and_Environment_1204.aspx)

The entire National Waterway 8 project area falls in the tidal zone.

9.3.9 Archaeological and Heritage Locations

No structures of archaeological, cultural or historical importance will be impacted due to the proposed project.

As per the information available on the website of the Department of Cultural Affairs, Government of Kerala, there are 13 State Protected Monuments in Alappuzha District and eight (08) State Protected Monuments in Kottayam District. These monuments have been declared as Protected by the State Archaeological Department, Government of Kerala. The list of the State Protected Monuments in the two districts through which NW-8 passes viz. Alappuzha and Kottayam is provided in Table 9-5 below. As can be noted from Table 9-5, none of the State Protected Monuments are located close to the project site. The nearest protected monument from the project site, which is Thrikkodithanam Sri Mahavishnu Temple in Kottayam District, is located at a distance of 3.75 km from the project site. Therefore, no clearance requirement is envisaged with respect to protected monuments.

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TABLE 9-5: STATE PROTECTED MONUMENTS LOCATED IN ALAPPUZHA AND KOTTAYAM DISTRICTS, KERALA

Sl.No	MONUMENTS	LOCATION (District)	Shortest Distance from Project Alignment (in km) as Measured on Google Earth
1.	Buddha Image, Karunagappally	Alappuzha	39.35
2.	Buddha Image, Mavelikkara	Alappuzha	21.22
3.	Sree Kumaramangalam Subramanya Swamy Temple, Muthavazhi	Alappuzha	9.36
4.	Buddha Image, Karumadikuttan	Alappuzha	12.20
5.	Buddha Image Bharanikavu	Alappuzha	1.56
6.	Narasimha Temple, Chathankulangara	Alappuzha	146.00
7.	Krishnapuram Palace, Kayamkulam	Alappuzha	30.55
8.	Excavated yatch and its surroundings, Kadakkarappally	Alappuzha	22.00
9.	Sri Karthiyayini Temple, Kuttemperoor	Alappuzha	16.00
10.	Varanad Naduvilay Kovilakam	Alappuzha	19.55
11.	St. Raphel's Church and Compound	Alappuzha	36.03
12.	Sri Itti Achuthan Vaidyar Kuriala, Oushada Sasyakavu	Alappuzha	Not traceable on Google Earth/Google Map
13.	Trikkuyrutty Mahadeva Temple, Mannar	Alappuzha	12.65
14.	Pundareekapuram Devaswam	Kottayam	32.00
15.	Thrikkodithanam Sri Mahavishnu Temple	Kottayam	3.75
16.	Old Seminary	Kottayam	17.82
17.	House of freedom fighter Chembilarayan	Kottayam	Not traceable on Google Earth/Google Map
18.	St. Mary's Church, St. Augustian's Church & two storied building in which Thoma Kathanar was residing	Kottayam	9.86
19.	Menhir, Kottayam	Kottayam	13.66
20.	Venniamala Sree Rama Lakshmana Swami Temple, its Pond & Cave	Kottayam	16.21
21.	Sree Dharma Sastha Temple, Poonjar	Kottayam	38.64

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Source: http://www.keralaculture.org/keralaasi-protected-mounments/628

Prohibited and Regulated Areas 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 the Department of Cultural Affairs, Government of Kerala, there are a total of 27 Centrally Protected Monuments in the State of Kerala. These are the monuments that have been declared as Protected by the Archaeological Survey of India, Government of India. As per the list available on the above mentioned website (http://keralaculture.org/protected-monuments-asi/627), none of the 27 Centrally Protected Monuments in Kerala are located in the districts of Alappuzha and Kottayam. Therefore, no clearance requirement is envisaged with respect to these structures.

9.3.10 Flora and Fauna

The Western Ghats region, wherein the state is situated, is one of the 25 biodiversity hotspots in the whole world. The state contains more than 4,500 species of flowering plants of which above 1,500 taxa are endemic in nature. There is also equally rich fauna belt in the state. The diversity of lower plants and animal groups, and the marine flora and fauna in particular even though not fully known, is remarkably rich in the state. (Source: http://www.kerenvis.nic.in/Database/Hotspot_1804.aspx)

Flora of Kerala comprises of a total of 11,840 taxa of plants (SoE, 2007). Among them, angiosperms comprises the dominant group, composed of 4968 taxa, of which about 900 are those endemic to Western Ghats. Among the Western Ghats endemics, 252 taxa are those confined to Kerala State.

The flora comprises of 866 species of algae, 4800 species of fungi, 520 species of lichens, 350 species of bryophytes, 332 species of pteridophytes, 4 species of gymnosperms and 4968 species of angiosperms or flowering plants.

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Habitat wise, algal species are mostly confined to aquatic or damp conditions whereas the other plant groups in the State ate mostly terrestrial in habit. Habit or life form-wise, there are herbs, shrubs, trees, lianas, epiphytes, lithophytes, saprophytes, etc. within the plant kingdom. Based on this the habitats are also different for different species.

Table 9-6 below gives the details of the representation of different plant groups in the flora of Kerala.

TABLE 9-6: TOTAL NUMBER OF PLANT TAXA BELONGING TO DIFFERENT GROUPS RECORDED FROM KERALA

S. No.	Plant Groups	No. of Taxa
1	Algae	866
2	Fungi	4800
3	Lichens	520
4	Bryophytes	350
5	Pteridophytes	332
6	Gymnosperms	4
7	Angiosperms	4968
	Total	**11,840**

Apart from this there are hundreds of cultivated species either on plantations or crop levels or as garden plants, ornamentals, etc. There are also 850 species and varieties of cultivars growing the State with their origin in mostly tropical parts of the globe. Due to various reasons, many of them are in various threat categories of IUCN Red List of flora and fauna (2004), prepared at global level.

(Source: http://www.kerenvis.nic.in/Database/Flora-Kerala_1399.aspx)

Medicinal Plants constitute an important component of the plant resource spectrum of Kerala. Recent analysis shows that out of estimated 4600 flowering plants in Kerala, about 900 possess medicinal values. Of these, 540 species are reported to occur in forest ecosystems. Over 150 species of plants that are either indigenous or naturalized in Kerala are used in the Indian system of Medicine like Ayurveda and Sidha. The rural folk and tribal communities make use of about 2,000 species of lesser-known wild plants for various medicinal uses. About 60 to 65% of plants required for Ayurvedic medicine and almost 80% of plants used in Sidha medicine are found in the forests of Kerala. (Source: http://www.forest.kerala.gov.in/index.php/forest/flora)

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Fauna

The Western Ghat's encompassing the forests of Kerala is one of the 34 Biodiversity hot spots in the World and Kerala has close to 90 % of its vertebrate fauna. Very high levels of species diversity and endemism provide importance to the faunal wealth of Kerala.

TABLE 9-7: FAUNAL WEALTH OF KERALA

Sl.No	Group	No.of.Species
1	Mammals	145
2	Birds	486
3	Reptiles	164
4	Amphibians	85
5	Freshwater Fishes	196
6	Insects	4027
	TOTAL	**5103**

(Source: http://www.forest.kerala.gov.in/index.php/forest/fauna)

According to one estimate, 285 species of Vertebrate are reported to be endemic to Western Ghats, which include 12 mammals, 16 birds, 89 reptiles, 87 amphibians, and 84 fresh water fishes. Among large mammals, no species is endemic to Kerala. However, birds such as White breasted laughing thrush, Wayanad laughing thrush, White bellied shortwing, Southern treepie, Rufous babbler are possible endemic birds which may slightly overlap state boundaries in the southern Western Ghats. (Source: http://www.forest.kerala.gov.in/index.php/forest/fauna)

TABLE 9-8: FAUNA ENDEMIC TO WESTERN GHATS-FOUND IN KERALA

Group	Nos.
Amphibians	61
Reptiles	57
Birds	16

National Parks, Forests, Wildlife Sanctuaries and Reserves

The geographical area of the state is 38,863 sq km of which 11309.50 sq km (29.10%) is forest area. By legal status, the entire forest area of Kerala is divided into the following three categories:

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i) Reserved Forests,

ii) Proposed Forests and

iii) Vested Forests and ecologically Fragile Lands

The area falling under the above mentioned three categories of forests in Kerala is provide in Table 9-9 below.

TABLE 9-9: FOREST AREAS IN KERALA

Forest Area	
Total Forest Area	**11309.5032 Sq.Km**
Percentage of forest area to the total area of the state	**29.101 %**
By Legal Status(Area as per records)	
Reserved Forests	**9107.2006 Sq.Km**
Proposed Reserve	**364.5009 Sq.Km**
Vested Forests & Ecologically Fragile Lands	**1837.7957 Sq.Km**
TOTAL	**11309.5032 Sq.Km**

(Source: http://www.forest.kerala.gov.in/index.php/forest/forest-area).

There are two Biosphere Reserve in Kerala namely Nilgiri Biosphere Reserve and Agasthyamalai Biosphere Reserve. Parts of these biospheres reserves fall in other adjoining States too. The parts of the biosphere reserves falling in Kerala are delineated in Table 9-10 below.

TABLE 9-10: BIOSPHERE RESERVES IN KERALA

S.No.	**Name of Biosphere Reserve**	**Extent (sq km)**	**Forest Areas falling in Kerala**
1.	Nilgiri Biosphere Reserve	1455.40	Wayanad Wildlife Sanctuary Silent valley National Park Nilambur South (New Amarambalam, Karimpuzha) Mannarkkad (Attappady) Palakkad (Siruvani Reserved Forests) Nilambur North, (Chakkikuzhy, Kozhipara, Punchakolly, Ex.Karulai Range (Nilambur Kovilakom)

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S.No.	Name of Biosphere Reserve	Extent (sq km)	Forest Areas falling in Kerala
			Kozhikode (Kuttyadi, Thamarassery, Vested Forests) Wayanad South (Kalpetta)
2.	Agasthyamalai Biosphere Reserve	1828	Neyyar Peppara and Shendurney wildlife sanctuaries Achencoi Thenmala Konni Punalur and Thiruvananthapuram territorial divisions and Agasthyavanam Biological Park Range

There are five National Parks, 17 Wildlife Sanctuaries and one Community Reserve in the State spread across an area of 3213.24 sq km, out of which, two WLSs have been declared as Tiger Reserves. The wildlife sanctuaries that have been declared as Tiger Reserves are Parambikulam and Periyar wildlife sanctuaries.

(Source: http://www.forest.kerala.gov.in/index.php/wildlife/2015-03-16-09-50-24/introduction)

The proximity of the project alignment / site to the National Parks and Wildlife Sanctuaries in Kerala has been verified on Google Earth and it is found that the project area is not located close to any of these national Parks or Wildlife Sanctuaries. Mangalavanam Bird Sanctuary and Idukki Wildlife Sanctuary are the nearest protected areas from the project site and even these are located at a disatnce of over 50 km from the project site. Therefore, no Wildlife Clearance is envisaged for the project.

The list of National parks and Wildlife sanctuaries in the State has been provided in Table 9-11 below.

TABLE 9-11: PROTECTED AREAS IN KERALA

Sl. No.	Name of WLS/NPs	G.O. No. & Date	Year of Formation	Total Area (Sq. km)	Approximate Distance from the Project Site (in km) as measured on Google Earth
	National Parks				
1	Eravikulam National Park	G.O.(MS)142/78 dated 19-05-1978	1978	97.0000	91.00

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Sl. No.	Name of WLS/NPs	G.O. No. & Date	Year of Formation	Total Area (Sq. km)	Approximate Distance from the Project Site (in km) as measured on Google Earth
2	Silent Valley National Park	GO-5462/FSA3/82/AD dated 15.11.84	1984	237.5200	172.00
3	Anamudi Shola National Park	G.O.12876/F2/2003/F&WLD dated 14-12-2003	2003	7.5000	109.00
4	Mathikettan Shola National Park	GO(MS)No.50/2003/F&WLD dated 10-10-2003	2003	12.8170	99.21
5	Pambadum Shola National Park	G.O.12875/F2/2003/F&WLD dated 14-12-2003	2003	1.3180	109.60
	Wildlife Sanctuaries				
6	Parambikulam Wildlife Sanctuary **(Tiger Reserve)**	GO(P)39/73/AD dated 12..02..1973 GO(P) No. 443/06/F&WLD dated 31..10..2006	1973	643.6600	104.83
7	Periyar Wildlife Sanctuary **(Tiger Reserve)**	F1-2854/AD dated 11-08-1950 G-11025/34/FRY(PT) dated 29-08-1977	1950	925.0000	77.95
8	Neyyar WLS	GO(MS)871/58 dated 06..08..1958	1958	128.0000	121.83
9	Peechi-Vazhani WLS	GO(MS)871/58 dated 06..08..1958	1958	125.0000	107.62
10	Wayanad WLS	GO(MS)182/73/AD dated 30..05..1973	1973	344.4400	238.39
11	Idukki WLS	GO.7898/FM3/76/AD dated 09.02.76	1976	70.0000	61.61
12	Peppara WLS	GO(P)379/83/AD dated 21..12..1983	1983	53.0000	112.94
13	Thattekkad B.S	GO.35743/FM3/83/AD dated 27..08..83	1983	25.0000	74.55
14	Shendurney WLS	GO(P)258/84/AD dated 25..08..1984	1984	171.0000	100.71
15	Chinnar WLS	GO(P)229/84/AD dated 04..08..1984	1984	90.4400	120.91
16	Chimmony WLS	GO(P)259/84/AD dated 25..08..1984	1984	85.0000	101.99
17	Aralam WLS	GO(P)300/84/AD dated 15..10..1984	1984	55.0000	274.57

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Sl. No.	Name of WLS/NPs	G.O. No. & Date	Year of Formation	Total Area (Sq. km)	Approximate Distance from the Project Site (in km) as measured on Google Earth
18	Mangalavanam Bird Sanctuary	G.O(MS) No.42/04/F&WLD dated 31..08..2004	2004	0.0274	53.40
19	Kurinjimala Sanctuary	G.O.(P)36/2006/F&WLD dated 06-10-2006	2006	32.0000	118.50
20	Choolannur Pea Fowl Sanctuary	G.O.(P) 24/2007/F&WLD dated 15-05-2007	2007	3.4200	134.94
21	Malabar Sanctuary	G.O (P) 26/2009 / F&WLD dated 05-06-2009	2009	74.2150	230.42
22	Kottiyoor Wildlife Sanctuary	G.O (P) 17/2011 / F&WLD dated 01-03-2011	2011	30.3798	266.61
	Community Reserve				
23.	Kadalundi-Vallikunnu Community Reserve	G.O(MS)No.66/2007/F&WL dated 17-10-2007	2007	1.5000	189.09
	TOTAL			3213.2372	

(Source: http://www.forest.kerala.gov.in/index.php/wildlife/2015-03-16-09-50-24/introduction)

9.3.11 Socio-economic Profile

The NW-8 project is located in two districts of Kerala namely Alappuzha and Kottayam.

Alappuzha District

Alappuzha district was carved out of the erstwhile Kottayam and Quilon (Kollam) Districts, on the 17th August 1957, consisting of seven Taluks namely, Sherthalai (Cherthala), Ambalappuzha, Kuttanad, Thiruvalla, Chengannur, Karthikappally and Mavelikkara. The then name of the District i.e., Alleppey, an anglicised form, was changed later on as 'Alappuzha' as per GO (P) No.133/90/RD dated 7.2.90.

As per GO (MS) No.1026/82/RD dated 29.10.1982, another District named Pathanamthitta was constituted taking portions from the then Alleppey, Quilon and

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Idukki Districts. Thiruvalla Taluk as a whole and parts of Chengannur and Mavelikkara Taluks had been transferred to the newly formed Pathanamthitta District.

The present Alappuzha District comprises six Taluks, namely, Cherthala, Ambalappuzha, Kuttanad, Karthikappally, Chengannur and Mavelikkara.

The two administrative systems prevailing in the District are Revenue and Local Self-Government. Under the Revenue System, the District is divided into Revenue Divisions, Taluks and Villages. Under the Local Administration set up, the District is divided into Statutory Towns and Panchayats. For the implementation of development activities, Panchayats are grouped under Community Development Blocks.

The District with two Revenue Divisions, consists of 6 Taluks and 92 Villages. The two Revenue Divisions are Alappuzha Division comprising of Cherthala, Ambalappuzha and Kuttanad Taluks covering 47 Villages and Chengannur Division, comprising of Karthikappally, Chengannur and Mavelikkara Taluks covering 45 Villages.

Under the Local Self-Government System, the District is divided into 5 Statutory Towns, 12 Development Blocks and 73 Panchayats.

District Highlights 2011 Census: Alappuzha District

- Alappuzha District was formed on the 17th August 1957.
- In terms of area, Alappuzha is the smallest district in the State.
- The District has the fourth highest effective literacy rate (95.72 per cent) and with regard to female literacy rate, it also stands at the 4th in the State.
- Alappuzha is the second densest district (1504) in the state in terms of population per sq. km.
- The District has a higher sex ratio (1100) than the State (1084).
- Alappuzha is the only district in the state where there are no reserved forests.
- Kuttanad Taluk, known as the rice bowl of the state, has a predominant position in the production of rice.
- With 2127789 persons, Alappuzha district ranks 9th among the districts of the state in population.
- In work participation rate (37.81 per cent), the district has the 4th position among the districts.
- Alappuzha District ranks the 3rd in female work participation rate (24.02 per cent).
- In child sex ratio, the district has 13th rank with 951 female children per 1000 male children.
- In the percentage of Scheduled Tribe population to total population, the district has the 13th rank (0.31 per cent) among the districts.
- It stands at the 7th position in the percentage of Scheduled Caste population to total population (9.45 per cent).

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- In the district, 74.13 per cent of workers are main workers and 25.87 percent are marginal workers.
- The district stands at the 2nd position in the percentage of workers in household industry (4.46 per cent).

(Source: District Census Handbook: Alappuzha, Series 33, Part XII-B, Directorate of Census Operations, Kerala, Census of India, 2011)

Alappuzha District, known as the Rice Bowl of the State, has a predominant position in the production of rice which is mainly concentrated in Kuttanad Taluk. Since the most of the area of the district does not have highlands, plantation crops are cultivated in a limited area in the Eastern portion of the district.

Paddy is cultivated in three seasons of the year mainly Viruppu associated with Autumn, Mundakan associated with Winter and Punja associated with Summer. Kuttanad Tract in Kuttanad Taluk and Onattukara Tract comprising of Karthikappally Taluk and portion of Mavelikkara Taluk are the two important paddy growing areas of the district.

Coconut is also a predominant crop cultivated on a large scale in all the Taluks. More yields are obtained from the deltaic region of the district. Other important crops grown in the district are tapioca, rubber and Mango.

Though the District is normally favoured with heavy rainfall, there are major and minor irrigation projects which help the agricultural development of this district. Pamba Irrigation Project is the major irrigation project utilising the tailrace water of Sabarigiri Hydro Electric Project, irrigating land in Chengannur, Mavelikkara and Karthikappally Taluks. Kuttanad Development Scheme is the other major scheme under which the Salt Water Barrier at Thanneermukkam and the Spillway at Thottappally to control salinity of water and to bring down the floodwater were constructed.

The District is poor in cattle wealth because of the scarcity of green grass, as most of the area is waterlogged. Straw is the main cattle feed and so production of milk is very low as compared to most of the other districts.

The district with the Arabian Sea in the West has 82 km long coastal area stretched between Pallithode in the North and Valiyazheekal in the South. The District has the benefit of immense wealth of marine and inland fishing. The Vembanad and Kayamkulam Backwaters and the network of rivers and canals enrich the inland fishing. Both brackish water fish farming and fresh water fish farming are done in the district. Oil Sardines, Prawns, Mackerel, Anchoviella, Other Sardines, etc., are the major species of economic importance and Lobsters, Elarmobranches, Scienids, Catfishes, Pomfrets, Leiognathus, etc., are the other kinds of fish landing in the coast.

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Though the district is industrially backward, industries based on coir and coir products, marine products, handloom, different types of handicrafts, toddy tapping, etc. are a part of the local tradition. The district is known as the traditional home of coir industry in Kerala.

There are 15466 Small-Scale Industrial Units in Alappuzha District in 2011. Of these, 500 units are promoted by Scheduled Castes/Scheduled Tribes, 4756 units by women, 14966 units by others and 85984 persons are employed in these factories. There are three Industrial Estates at Aroor, Maithara and Kollakadavu and 6 Mini Estates at Mannanchery, Mararikkulam, Mannar, Nooranad, Pathiyoor and Thamarakkulam functioning in the District. Industrial area is earmarked at Aroor and Kollakadavu. Industrial development plots are marked at Punnapra, Mundankavu and Cherthala. There are 339 Industrial Co-operative Societies and 26 Handloom Societies in the district.

Alappuzha District is most favoured by the natural link of rivers, canals and backwaters. Most of the early trade and traffic of Alappuzha District was by means of waterways as the area is extensively connected by rivers and backwater systems. Now the district is well connected by a good network of roads, waterways and railways.

All the major towns of the district have been connected through rail network. The coastal railway line functions parallel to the already existing railway line through Kottayam.

The Vembanad Lake is the main artery of the Inland Navigation System. It forms the most important part of the West Coast Canal System which starts from Hosdurg in the North and ends in Thiruvananthapuram. A network of rivers and canals connects the places of commercial importance like Kochi, Kottayam, Changanassery and Chengannur. Alappuzha Town is connected with Changanassery by Alappuzha-Changanassery Canal passing through Kuttanad area. The Wadai and Commercial Canals take off from the Vembanad Lake and run parallel through the heart of the Town. Some of the inland canals falling in the District are Alappuzha-Ambalappuzha, Alappuzha-Changanassery, Alappuzha Commercial Canal, Alappuzha-Kottayam, Alappuzha-Wadai, Alappuzha-Thalavady, Alappuzha-West junction, Kakkazham-Kayamkulam Salt Shell, Muhamma-Puchakkal Canal, etc. There are ferry services in almost all the water-logged areas.

In the District, the three predominant religions are Hindus, Muslims and Christians. Other religious communities such as Sikhs, Buddhists and Jains are insignificant as their percentage to the total population is very negligible. Hindus, Muslims and Christians constitute about 99.63 per cent of the total population.68.6 per cent population of the District are Hindus. Muslims (10.55 per cent) and Christians (20.44 per cent) together account for 31 per cent of the total population.

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The population of the Scheduled Tribes in the District in 2011 was 6,574 with 3,175 males and 3,399 females. They accounted for 1.4 per cent of total Scheduled Tribe population in the State. As per 2011 Census, the population of the Scheduled Castes in the district was 201,211 with 97,183 males and 104,028 females. The proportion of Scheduled Caste population in the District is 9.5 per cent with 11.4 per cent in rural and 7.8 per cent in urban.

(Source: District Census Handbook: Alappuzha, Series 33, Part XII-A, Directorate of Census operations, Kerala, Census of India, 2011)

Kottayam District

The present Kottayam District was previously a part of the erstwhile Princely State of Travancore. Then the Travancore State consisted of two Revenue Divisions, viz., the Southern and Northern Divisions under the administrative control of 'Diwan Peshkar' for each Division. Thereafter in 1868, two more Divisions – Quilon and Kottayam were constituted. Though the fifth division – Devicolam came next, in course of time, it was added to Kottayam.

At the time of the integration of the State of Travancore and Cochin in 1949, these Revenue Divisions were renamed as Districts and Diwan Peshkars gave way to District Collectors and that marked the birth of the District of Kottayam.

There are two systems of administrative set up in the District – Revenue and Local Self Government. Under the Revenue System, the District is divided into two Revenue Divisions, five Taluks and 95 Villages. The two Revenue Divisions are Palai, comprising Meenachil and Vaikom Taluks with 42 Villages and Kottayam, comprising Kottayam, Kanjirappally and Changanassery Taluks with 53 Villages.

Under the Local Self Government System, the District is divided into four Statutory Towns and 14 Development Blocks, consisting of 75 Panchayats.

District Highlights -2011 Census: Kottayam District

- Kottayam district was formed on the 1st July 1949 at the time of the integration of the States of Travancore and Cochin.
- Kottayam district was formed on the 1st July 1949 at the time of the integration of the States of Travancore and Cochin.
- Kumarakam is a beautiful tourist spot, 10 Kms away from Kottayam on the beaches of the Vembanad Lake. Kumarakom Bird Sanctuary is noted for its rare species of birds arriving from Siberia in the winter season.
- The district with 2206 sq km of area ranks the 10th among the districts.
- Kottayam district is devoid of Coastal line.
- The district stands first in rubber production in the state.

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- In Literacy rate, Kottayam district has the 1st position in 2011 Census also with the highest female literacy (96.48 per cent) among the districts.
- The important rivers of the district are the Meenachil River, The Muvattupuzha River, and the Manimala River. The Vembanad Lake, the largest backwater in the state forms the Western boundary of Kottayam district.
- With 19,74,551 persons, Kottayam district ranks the 10th in population among the districts.
- The district ranks the 8th in total density (895) and 6th in Urban density (2066).
- In sex ratio, the district ranks the 11th with 1039 females per 1000 males.
- The district has the 8th rank in Child Sex ratio with 964 female children per 1000 male children.
- In the percentage of Scheduled Caste population to total population, the district ranks the 9th with 7.8 per cent.
- It ranks the 6th in the percentage of Scheduled Tribes Population to total population (1.1 per cent).
- The total work participation rate of the district is 37.3 per cent and has the 6th position among the Districts.
- In the District, 82.2 per cent of the workers are main workers and 17.8 per cent are marginal workers.
- Kottayam district ranks the 6th position in Female Work Participation rate with 20.4 per cent.

(Source: District Census Handbook: Kottayam, Series 33, Part XII-B, Directorate of Census operations, Kerala, Census of India, 2011)

Agriculture is a predominant sector of the District economy. Food crops as well as cash crops are cultivated here. Paddy and Tapioca are the main food crops while rubber, coconut and pepper are the main cash crops. Annual crops like plantain and pineapple, seasonal crops like ginger, tubers, vegetables and a wide range of perennial crops like jack, mango, etc. are also grown.

Paddy is the most important food crop. Kayal land cultivation is a peculiarity of the District and the neighbouring District of Alappuzha. Kayal lands are below mean sea level.

Rubber is the major cash crop in the District. The District has the credit of largest content of area under this crop. Meenachil Taluk has maximum area under rubber cultivation. Indian Rubber Board has its Headquarters at Kottayam.

Meenachil Irrigation Project is the major irrigation project. This project was started in 1980. Besides this, lift irrigation projects and other minor irrigation projects help to irrigate the cultivable area in the District.

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The main species of livestock in the District are cows, buffaloes, goats and pigs. The majority of cattle found in the District is Rangayam, Hallikyr and cross breeds of Jersey, Sindhi and Swiss Brown. There are fairly large number of cross breed Jersey and Swiss Brown animals in the District. The two other breeds found here are Murrah and Surabhi.

The District is deprived of sea coast. But it has abundant lakes and rivers which are the base of inland fishing. The main sources of fish in the District are the Vembanad Lake and the Muvattupuzha and Meenachil Rivers.

Industrially, Kottayam District is not highly advanced.

The main modes of transport in the district are by roads and railways. The inland water transport is negligible. In the District, there is only one National Highway, which is NH-220 i.e., Kottayam–Kumily passing through Manarcad, Pampady, Kanjirappally, Mundakayam, etc. SH-1 popularly known as MC Road passes through Changanassery, Kottayam and Meenachil Taluks. It enters the District from the South in Changanassery Taluk. The main roads branching from MC Road are; Changanassery – Alappuzha, Changanassery – Kumily, Ettumanoor – Palai – Erattupetta – Thekkedy (i.e., SH-14) and Ettumanoor – Kuruppumthara – Kaduthuruthy – Thalayolaparambu (i.e., SH – 15).

A part of the traffic and cargo is borne by the Vembanad Lake and the rivers flowing into it. There are also a few navigable canals in Changanassery, Kottayam and Vaikom Taluks. Kottayam Town is connected by a canal to the Vembanad Lake.

The District with 5.7 per cent of the total geographical area of the State accommodates 5.9 per cent of the total population of the State.

In the District, the three predominant religious groups are Hindus, Christians and Muslims. Other religious communities such as Sikhs, Buddhists and Jains etc. are insignificant as their percentage to the total population is very negligible. Hindus, Muslims and Christians constitute about 99.7 per cent of the total population. 49.81 per cent of the populations are Hindus, closely followed by Christians (43.48 per cent). Muslim population accounts for only 6.41 per cent.

According to 2011 Census, the population of the Scheduled Castes in the District is 153,909 with 75,503 males and 78,406 females. They accounted for 5.06 per cent of the total Scheduled Castes in the State.

The population of the Scheduled Tribes in the District in 2011 was 21,972 with a break-up of 10,974 males and 10,998 females. They formed 4.53 per cent of the total Scheduled Tribe population in the State.

(Source: District Census Handbook: Kottayam, Series 33, Part XII-A, Directorate of Census operations, Kerala, Census of India, 2011)

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9.4 Potential Environmental and Social Impacts of the Project

Development of NW-8, which shall be for a stretch of about 29.3 km, shall involve dredging of about 4.46 Lakhs Cu M in General Soils of river material, construction of one terminal at Changanassery in Kottyam District, construction of a 7.5 m wide approach road for a length of 100 m near the Terminal, 15 kms of Bank protection works are envisaged under the project.

Thus, the development of NW-8 envisages the following major construction activities:

- Construction of a terminal building.
- Construction of access roads leading to the terminal.
- Bank protection works
- Dredging of the river for development of fairway.

These activities 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 proposed construction period is of three years.

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.

As has been mentioned above, a terminal is proposed to be constructed at Changanassery for operation of NW-8. The proposed terminal is located near village Changanassery at Ch 28.5 km (Lat 09°26'26.30"N and Long 76°31'29.81"E).

A total of 1.5 ha of land will be required for the terminal building. The land identified for the construction of terminal is Partially Government land and Partially with Ownership. No dislocation of population is envisaged due to the project. The ownership of land is to be identified for construction of terminal at the time of taking up the project.

Since limited land is required for construction of terminal and access roads, no significant adverse impact on account of land use change is anticipated due to the project.

Development of NW-8 also envisages dredging for creation of a navigable channel. The estimated quantity of dredged material for NW-8 is about 4.46 Lakhs Cu. M. All the dredged material is proposed to be disposed of appropriately and since the same is having alternate usage by local dwellers, this can be accordingly, being utilized. As such there is no impact on the land environment due to disposal of dredged material. Impacts on aquatic ecology due to dredging and disposal of the dredged material within

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the river banks need to be established as part of the EIA study to be carried out separately for the project by IWAI.

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.

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 positive impacts on the project will include improved waterway facilities and other allied infrastructure facilities the local population. It will also generate some employment and small business opportunities for the local population.

9.5 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

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workers or employees. Also, it should be ensured that no unauthorized tree / forest cutting is undertaken by anyone engaged on the project.

Minimum required land should be acquired for the project. The private land owners, if any, whose land is to be acquired for the project, should be compensated adequately in accordance with law.

The project should take care that the traditional fishing rights of the local population are not impacted adversely in any manner. Adequate consultation with the local population should be undertaken as required.

The project authorities should ensure that the Contractors engaged on the project have an approved environment management plan in place and that this management plan forms a part of the Contract document so as to ensure its effective implementation by the Contractors.

9.6 Applicable Legal and Regulatory Framework

The Kerala State Pollution Control Board (KSPCB) 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 in tidal zone. As such the project shall require clearance under the CRZ Notification 2011.

Forest Clearance

Forest Clearance from the MoEF is required only if the project involves diversion of any forest land. The ownership of land required for construction of the terminal and for approach roads is yet to be ascertained. Need for Forest Clearance relating to

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construction of these components can be confirmed only after the ownership of land required for these activities is known.

9.6.1 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.

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

Other clerances 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.

The project area is not located close to any Protected Areas. Therefore, the project shall not require Wildlife Clearance from the MoEF, Government of India.

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.

TABLE 9-12: 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.

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S. No.	Clearance / Approval	Applicability to the Project	Applicable Legislation	Remarks
2.	Forest Clearance	May be required for terminal and approach road construction.	Forest Conservation Act, 1980	
3.	Wildlife Clearance	No	Wildlife Protection Act, 1972	
4.	CRZ Clearance	Yes		The entire project falls in tidal zone.

9.7 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.

9.7.1 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:

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TABLE 9-13: 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
2.	Cost of one Time Baseline Data Generation at Pre-Construction Stage	3.20	To be done for one season **(Table – 9-14).**
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: *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 9-14.

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TABLE 9-14: 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 @ 10 Km/station = tentatively 4 locations shall be monitored.

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9.7.2 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 9-15: 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 for three years	9.60	Shall be carried on yearly basis for entire construction period (**Table 9-16)**
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**	
	In Words: *Rs. Thirty Four Lakh Sixty Thousand only*		

TABLE 9-16: 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,	Surface and ground water to be monitored separately	Per sample with various parameters	4X3 = 12	15,000	180,000

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Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
		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.					
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**

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Sl. No.	Env. Attributes	Parameters	Monitoring Frequency	Unit	No. of Tentative Locations (for 3 Years)	Unit Rate (Rs)	Amount (Rs)
		In Words: *Rs. Nine Lakh Sixty Thousand only*					

9.7.3 Estimated Cost at Operation Stage

Like pre-construction stage, the environmental monitoring and supervision to be done by the project proponent.

TABLE 9-17: 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 9-14 given above for pre-construction stage.
2.	Maintenance & Supervision of Greenbelt Developed during construction stage	2	Lump-sum cost
3.	Solid Waste Management	2	Lump-sum cost
4.	Sanitary facilities nearby terminals	2	Lump-sum cost
5.	Disaster Management Plan (if applicable)	2	Lump-sum cost
6.	Any other/miscellaneous	2	Lump-sum cost
	Total (Lakhs)	**13.20**	Per Year
	In Words: *Rs. Thirteen Lakh Twenty Thousand only*		

9.7.4 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 9-18 given below:

TABLE 9-18: SUMMARY OF ESTIMATED ENVIRONMENTAL & SOCIAL COSTS FOR VARIOUS STAGES

Sl. No.	Project Stages	Cost (Rs. Lakh)	Remarks
1.	Pre-Construction Stage	63.20	Lump-sum
2.	Construction Stage	34.60	
3.	Operational Stage	13.20	

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Sl. No.	Project Stages	Cost (Rs. Lakh)	Remarks
Total Estimated Budget (Except Statutory Fee & Land Acquisition & R&R Costs)		111.00	
In Words: *Rs. One Crore Eleven Lakh only*			

The project has two components which consists of fairway development & Ro-Ro terminal construction. The cost shall be distributed in proportion to the capex for each of the components. Provision has already been catered in the proposed estimates appropriately.

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CHAPTER 10 INSTITUTIONAL REQUIREMENTS

10.1 Organizational Set up / Establishment

The Inland Waterways Authority of India (IWAI) has been carved out duly taking over the responsibilities etc., of the erstwhile Inland Water Transport (IWT) directorate under Ministry of Surface Transport / Ministry of Shipping with a vision of more thrust on the IWT sector along with more Autonomy, by an Act of Parliament (IWAI Act 82 of 1985). Accordingly, IWAI is vested with the functions / duties and responsibilities connected to the safe navigation in the National Waterways and in the interconnected waterways, where IWT is considered for development. The Para 14 of IWAI ACT 82 of 1985 is provisioned with the Functions and Powers of authority, as detailed, which is self-explanatory.

Functions and Powers of the authority:

14. (1) The Authority may-

(a) carry out surveys and investigations for the development, maintenance and better utilization of the national waterways and the appurtenant land for shipping and navigation and prepare schemes in this behalf; (b) provide or permit setting up of infrastructural facilities for national waterways;

(c) carry out conservancy measures and training works and do all other acts necessary for the safety and convenience of shipping and navigation and improvement of the national waterways;

(d) control activities such as throwing rubbish, dumping or removal of material, in or from the bed of the national waterways and appurtenant land, in so far as they may affect safe and efficient, shipping and navigation, maintenance of navigable channels, river training and conservancy measures;

(e) remove or alter any obstruction or impediment in the national waterways and the appurtenant land which may impede the safe navigation or endanger safety of infrastructural facilities or conservancy measures where such obstruction or impediment has been lawfully made or has become lawful by reason of long continuance of such obstruction or impediment or otherwise, after making compensation to person suffering damage by such removal or alteration;

(f) provide for the regulation of navigation and traffic (including the rule of the road) on national waterways; (g) regulate the construction or alteration of structures on across or under the national waterways;

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(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.

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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 6 having 03 National Waterways in the state of Kerala will be looked after by the existing Directorate at kochi within its geographical zone, for a better control on the project implementation. No additional organizational requirement has been envisaged.

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10.3 Training Requirement / Capacity Building

IWAI is having various disciplines within the organization viz., Civil Engineering; Mech. Marine Engineering; Hydrographic Survey; Traffic; Administration / Establishment; Finance etc.,.

It is suggested and recommended to have an intra-discipline and inter discipline training for all the employees of the IWAI at entry level i.e., at Technical Assistant / Assistant Director; Junior Hydrographic Surveyor / Assistant Hydrographic Surveyor; Junior Accounts Officer / Accounts Officer; Section Officer / Assistant Secretary etc.,. The National Inland Navigation Institute (NINI) of IWAI at Patna premises can be used for such training. It is preferred to have such Trainings as onsite training, while the works are under progress.

10.4 Infrastructure

The Infrastructure for the Institution will not have much implication, except the Land for the Office premises, if at all to have the own building of IWAI. However, the infrastructure for functional aspects may be essential within the accessibility of the site controlling office viz., the office of the Director.

The functional requirement can be identified as Survey Vessels; Survey Instruments in order to carry out the mandatory periodical Survey works on the National Waterways. Likewise, to maintain the Night Navigation system, there should be a powerful Tug – cum – Buoy maintenance vessel should be available within the bounds of the office. Further, to have quick inspections and also to have periodical visits, Speed Boats are to be available as an Infrastructure within the controlling office.

Accordingly, 2 Nos. of Survey Vessels; 2 units of Survey Instruments with Software; 2 Nos. of Tug – cum – Buoy maintenance vessel; 2 Nos. of Speed Boats are suggested / Recommended for each Directorate office to look after approximately 6 Nos. of the National Waterways within its jurisdiction.

10.4.1 Immovable

The immovable asset, Land is not suggested at this point of time. In the Long run, even if identified the need of having own office, this will be considered at one of the Terminal Locations, amenable with ease approach. Hence there is no suggestion / recommendation of Land / immovable asset under Institution.

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10.4.2 Movable

As discussed above, the asset requirement for attending the functions and responsibilities catered will be considered for procurement. The details have been tabulated directly as a financial Implication with segregation of Capital Cost Implication and Monthly Cost Implication, including the Manpower monthly implication in the forth coming Paras. Keeping in view the Organization requirement, as derived, the implication has been worked out duly taking into consideration of the 7th Pay commission Pay system, so as to have an implementable approach.

10.5 Cost Implications

The cost implication for the apportioned project has been worked out and placed herewith.

TABLE 10-1: MANPOWER FINANCIAL IMPLICATION PER MONTH

Sl. No.	Name of the Post	Nos. of the Post	Basic Pay (INR)	Implication per month @ 95 % extra (INR)	Remarks
1.	Director	1	78800	153,660	Annexure 10.2 may be referred.
2.	Asst. Director Civil / Mechanical	3	56100	328,185	
3.	Asst. Hy. Surveyor	1	56100	109,395	
4.	Junior Hy. Surveyor	1	47600	92,820	
5.	Junior Accounts Officer	1	47600	92,820	
6.	Supervisor	3	35400	207,090	
7.	Steno / P. A	1	35400	69,030	
8.	Upper Divisional Clerk	1	25500	49,725	
9.	Data Entry Operator	6	21700	253,890	
10.	Driver	1	21700	42, 315	25 % extra for statutory allowances and 20 % extra for perks have been taken into consideration.
11.	Attendant	6	21700	253,890	
	Total	25		1,652,820	
	Chief Engineer's Office Component				
1.	Deputy Director	1	67600	131,820	
2.	Technical Assistant	1	47600	92,820	
3.	Data Entry Operator	1	21700	42,315	
	Total	3		266,955	
	Grand Total	28		1,919,775	

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TABLE 10-2: FINANCIAL IMPLICATION – CAPITAL AND MAINTENANCE

Sl. No.	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
1.	Office premises	*	75,000	* In the initial stages, office will function on rented premises only
2.	Furniture etc.,	1,000,000	--	L. S.
3.	Pay and Allowances for 28 Nos.	--	1,919,775	As per the Table 10.1
4.	Vehicle 1 No.	500,000	--	
5.	Running & Maintenance of the Vehicle	--	50,000	
6.	Computer Systems including UPS etc., 6 Nos. @ 1 lakh each	600,000	60,000	
7.	Printers 4 Nos. @ 0.5 lakhs each	200,000	*	* Taken into General Office maintenance
8.	Laptops 6 Nos. @ 1 lakh each	600,000	*	* Taken into General Office maintenance
9.	Drawing Printer 1 No. @ 5 lakhs each	500,000	*	* Taken into General Office maintenance
10.	High Speed Printer 1 No. @ 3 lakhs each	300,000	*	* Taken into General Office maintenance
11.	Alternate Uninterrupted Power Supply with D. G set 1 No @ 10 Lakhs per no.	1,000,000	50,000	
12.	2 Nos. Survey Vessels (2 engines of 175 Bhp each) @ 350 lakhs each	70,000,000	1,000,000	Inclusive of Staff charges, on board.
13.	2 Units of Survey Instruments (9.5 lakhs each) + Software (6.5 lakhs each) + Laptop (1 lakh each) etc.,	3,400,000	200,000	Maintenance is inclusive of Survey Stationery and Consumables.
14.	2 Nos. Tug – cum – Buoy Maintenance vessel (2 engines of 375 Bhp) @ 750 lakhs each	150,000,000	1,200,000	Inclusive of Staff charges, on board.
15.	2 Nos. Speed Boats (2 engines of 75 Bhp) @ 75 Lakhs each	15,000,000	150,000	Inclusive of Staff charges, on board.

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Sl. No.	Name of the Item	Capital Cost (INR)	Financial Implication per month (INR)	Remarks
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.

+ Here, in Cluster 6, the West Coast Canal has been taken as equal to 2 Modules of 6 Waterways, wherein, Kabini Dam area will be segregated as separate one by not bringing into the overall system due to its far proximity of other 6 Waterways of Cluster 6.

+ Since the NW 8 is of 29 Kms, and within the existing NW 3 jurisdiction, it is not suggested / recommended with any expenditure on Infrastructure and suggested a nominal one time provision of INR 40 Lakhs for NW 8. No maintenance is required.

+ However, the limited Manpower requirement of 1 AD + 1 Supr + 1 JAO + 1 DEO + 1 Attendant can be taken as skeleton staff and the same is suggested for the initial stages duly meeting the cost from the suggested provisions. It can be reviewed from time to time based on the volume of the work requirement.

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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 financial analysis. 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 CPWD Schedule of Rates (SoR) published in December 2018 and updated with WPI in March 2020 as new SOR has not been published. 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

The NW 8 canal stretch is having IWT mobility by KSWTD's passenger vessels, as on date, on regular basis. However, there is a possibility of establishing the Ro-Ro mobility for the traffic destined to the hinterland of South East part of the country (originating from ICTT, Kochi and the nearby area). This may ease the Road traffic density. In view of the above, the costing has been considered for fairway development and Development of one Ro-Ro Terminal at Changanassery.

11.4 Capital Expenditure

As explained above, the Fairway related development cost has been worked out and placed herewith in two conditions. There were some observations received from Minstry of Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020The letter described the requirement

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of modification of existing structures as well as requirement of new structures. Modification of structures have already been considered in the DPR however in light of suggestion received from Govt. of Kerala and its financial impact has been incorporated in the DPR. There are two situations and may be referred as Option-1 and Option-2. These are referred as below:

1. **Option-1** -The project cost doesnot include the financial impact as suggested vide Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020.

2. **Option-2** -The project cost includes the financial impact as suggested vide Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020.

11.4.1 Option-1

The cost computation and the abstract of cost under option-1 in as below:

TABLE 11-1: ABSTRACT OF COST FOR NW 8 FAIRWAY DEVELOPMENT FOR CAPTIVE TERMINAL OPERATIONS (OPTION-1)

S. No.	Item Description	Amount (in Lakh Rs.)	Schedule/ References
A	**Fairway**		
1	Dredging		
(i)	General Soil	1092.70	Phase 1/ Annexure 11.3
(ii)	Hard Soil	0.00	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	2175.82	Phase 1/ Annexure 11.4
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	240.97	Phase 1/ Annexure 11.5
(ii)	Shore Marking with Lattice Bridge & Lighting Equipments	0.00	Phase 1
5	Land Acquisition	1045.44	Annexure 11.6
	Sub-total (A)	4554.92	

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S. No.	Item Description	Amount (in Lakh Rs.)	Schedule/ References
B	**Modification of Structures**		
(i)	Bridges	55.00	Annexure 11.15
(ii)	Cables	28.00	
(iii)	Dams	0.00	
(iv)	Barrages	0.00	
(v)	Locks	0.00	
(vi)	Others	0.00	
	Sub-total (B)	83.00	
C	**Communication System**		
(i)	RIS Centre	0.00	
(ii)	AIS Base Station	0.00	
(iii)	Vessels - Survey vessel & Other Vessel	0.00	
(iv)	Buoys	0.00	
	Sub-total (C)	0.00	
D	**Institutional Requirement**		
(i)	Office Development Cost	40.00	
(ii)			
	Sub-total (D)	**40.00**	
	Sub-total (A)+(B)+(C)+(D)	**4677.92**	
E	Environmental Management Plan as per chapter 9 of the DPR	74.21	
F	Project Management & consultancy Charges @3% of Prime cost	140.34	
G	Contingencies and Unforeseen Items of Works@3% of Prime cost	140.34	
	Project total Hard Cost	**5032.81**	
		50.33	**Crores**

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

TABLE 11-2: ABSTRACT OF COST FOR NW 8 Ro-Ro FACILITY

S.No.	Item Description	Amount (in Lakh Rs.)	References
A	**Terminal**		
(i)	Land	153.57	Annexure 11.10

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S.No.	Item Description	Amount (in Lakh Rs.)	References
(ii)	Riverine Components	765.52	Annexure 11.11
(iii)	Infrastructure Components including internal roads	689.46	Annexure 11.12
(iv)	Approach Road (External) Cost	3.50	Annexure 11.13
(v)	Bank Protection Works for terminal	689.02	Annexure 11.14
	Sub-total (A)	**2301.08**	
B	**Vessels**		
(i)	Vessel Size	0.00	
(ii)	Vessel Capacity	0.00	
	Sub-total (B)	**0.00**	
C	**Equipments for Both Terminals**		
(i)	Ambulance - 1 no.	18.00	
(ii)	Dumper Trucks 16 T Capacity - 1 no.	0	
(iii)	Cranes with 50 T Capacity - 1 no.	0	
(iv)	Fork lift trucks 20 T Capacity - 1 no.	0	
	Sub-total (C)	**18.00**	
	Sub-total (A)+(B)+(C)	**2319.08**	
D	Environmental Management Plan Cost@5% of Prime cost	36.79	
E	Project Management & consultancy Charges @10% of Prime cost	69.57	
F	Contingencies and Unforeseen Items of Works@10% of Prime cost	69.57	
	Project total Hard Cost	**2495.02**	
		24.95 Cr	

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TABLE 11-3: TOTAL COST (OPTION-1)

Sl No.	Parameter	INR (In Cr.)
1	Fairway	50.328
2	Ro-Ro Terminal	24.950
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	0.00
	Total	**75.278**

11.4.2 Option-2

The cost computation and the abstract of cost under option-2 in as below. As explained, option -2 has ben considered taking the financial inpact of the suggestion of Govt. of Kerala vide theit letter Coastal Shipping & Inland Navigation (A) Dept., Govt. of Kerala vide their letter no. A2/224/2018/CSIND dated 07.03.2020. So, this will entail the development cost as computed in the option-1 & considering the financial impact of the suggested measures by the govt. of Kerala.

TABLE 11-4: FINANCIAL IMPACT AS SUGGESTED BY GOVT. OF KERALA (OPTION-2)

Sl No.	Name of Structure	Type & Owner of Structure	Waterway (NW-8) Nos. of Structure	Cost Per Structure (In Crores)	Approximate Amount of Reconstruction (In Crores)
6)	Bridge	Cross Structure Under PWD	01	20.00	20.00
7)	Foot Bridge	Cross Structure Under LSGD	03	1.20	3.60
8)	LT Lines	Kerala State Electricity Board	50	.01	0.50
9)	Regulator Cum Bridge & Navigation Lock	Irrigation Dept. & Navigation Dept.	---	---	---
10)	Water Pipe - line	Kerala water Authority	01	0.187	0.187
	Total				**24.287**

Therefore, the total cost as per the Option-2 shall be as detailed in the below table.

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TABLE 11-5: TOTAL COST (OPTION-2)

Sl No.	Parameter	INR (In Cr.)	Remarks
1	Fairway	50.328	Similar to as Per Option-1
2	Ro-Ro Terminal	24.950	Similar to as Per Option-1
3	Financial Impact of Govt. of Kerala Letter dated 07.03.3030	24.287	As Detailed in Table 11.4.
	Total	**99.565**	

Hence the total cost of project development in case of Option-1 & Option-2 is rs.75.278 Crores and Rs. 99.565 Crores respectively.

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

As explained above, the project is proposed to be considered after having the possibility of Ro-Ro vessel / Ro-Ro Trucks mobility from the industry. The confirmations are to be firmed up by 2022 and the implementation is being suggested in 3 years from 2023, however, only on positive confirmations.

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CHAPTER 12 IMPLEMENTATION SCHEDULE

12.1 Time Frame

The present utility of Alappuzha – Changassery canal NW – 8 is limited to the mobility of KSWTD's Passenger vessels. It is suggested in this study to have a considerable utilization of NW 8 with an estimated diversion of road traffic destined to South east part of the country from ICTT, Kochi and from surrounding areas.

The estimated Ro-Ro traffic mobility with the possibility of diversion to IWT is of 0.47 Lakhs to 0.69 Lakhs. This is a considerable volume especially in the state of Kerala, where lot of problems are being faced in the Land availability for Acquisition for Road development. Besides Kerala is facing lot of problems with the Road accidents and this suggested Ro-Ro IWT mobility will become a boon once established, though economically is not viable without support system, as worked out.

12.2 Phasing

The development of Fairway and Ro-Ro Terminal are suggested only after having positive confirmations on the Truck volumes, which is to be observed till 2022 and there upon the development is proposed to be completed in 36 months.

The Vessel requirement will be taken care by Entrepreneurs i.e., 1 Ro-Ro vessel may be required at the initial stages and Other Ro-Ro vessels may be deployed based on the requirement at that point of time.

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.

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CHAPTER 13 ECONOMIC AND FINANCIAL ANALYSIS

Development of Alappuzha Changanassery Canal (NW 8) has been discussed in one development module. This is depicted in the following **Table 13-1**:

Table 13-1 NW 8 Development

<table>
<tr><th></th><th>Sub-sector</th><th>FY23</th><th>FY24</th><th>FY25</th><th>FY30</th><th>FY40</th></tr>
<tr><td rowspan="4">With Development</td><td rowspan="2">Fairway</td><td colspan="3">Development</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Operational</td></tr>
<tr><td rowspan="2">Ro-Ro</td><td colspan="3">Construction</td><td></td><td></td></tr>
<tr><td></td><td></td><td colspan="3">Operational</td></tr>
</table>

Source: Tractebel; Consultant

NW8 development has been planned with prospects for cargo handling along the whole stretch. The infrastructure has been planned considering optimistic conditions. The fairway and ro-ro terminal is envisaged to divert trucks plying on nearby national and state highways that are destined or originating from ICTT, Cochin. The infrastructure for this terminal has been proposed at Changanassery (9°26'18.9"N 76°31'36.7"E).

Trucks moving between Changanassery and ICTT, Kochi using road could be diverted to waterways. Traffic moving from Changanassery to ICTT needs to utilize entire stretch of NW8 and later on NW3 to reach ICTT, Cochin. NW3 is already operational and well developed for waterway movement. Hence, construction and development on NW8 will operationalize integrated water transport. Construction period for NW8 has been assumed to be for 3 years i.e FY23, FY24 and FY25. The waterway could be operationalize in FY-25 and continue till FY40.

The end-to-end logistics cost using multimodal route of NW-8 has to be cheaper compared to existing mode for shift to waterways. IWAI prescribed terminal and fairway tariffs (notified in 2011) has been assumed for the Logistics Cost calculations in below figure. Terminal handling charges at origin and destination of proposed route (NW8 + NW3) Changanassery and Cochin Port Trust have been considered as per the rates provided by IWAI. IWAI tariff is very old and low compared to other ports in the vicinity. IWAI tariff sheet has not prescribed any tariffs for Ro-Ro cargo. Consultants have assumed proportional tariff for IWAI. The fairway and Ro-Ro terminal is unlikely to gain any financial or economic returns on investment. Hence, consultants have made financials assuming Mumbai Port Trust (MbPT) tariff for comparision. MbPT tariff has been chosen as it is one of the leading Ro-Ro operator in India. The table below shows the scale rates of IWAI and MbPT.

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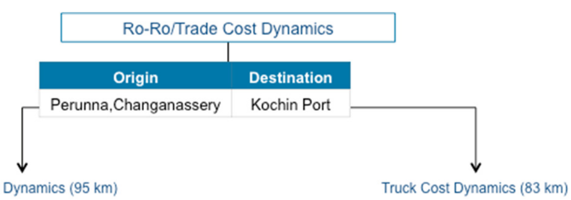
Table 13-2 Tariff Structure of IWAI and MbPT

Sr. No	Contents	As per IWAI	Actual rates @MbPT
1	Vessel Berthing Charges	INR 1,000 per Vessel/Day	INR 0.119 GRT/Hr
2	Vehicle Unloading Charges (Ro-Ro)	INR 50 per Vehicle (Assumed)	INR 196.89 per Vehicle
3	Fairway Usage	INR 0.02 GRT-Km	INR 1.00 GRT-Km (Assumed)

Source: IWAI and Scale rate of MbPT

Proposed IWT route involves multiple handling of trucks. Multiple handling at terminals adds to the total logistic cost involved in transportation. This leads to rise in total time and cost involved in multimodal transportation on NW8 compared to roadway. An elaboration on the impact on overall logistics cost difference is depicted in the logistics cost comparison chart of road and NW-8 is in the following **Figure** 13-1.



Steps involved	Unit	Case I	Case II
Engine	kW	839	350
Engine fuel requirement	l/hr	222	102
Per Truck Ro-Ro Tariff	INR/Truck	7,203	6,967
Port-related charges	INR/Truck	142	142
Total Cost	**INR/Truck**	**8,406**	**7,561**

Components	Cost (Rs.)	Cost
Fuel	INR	1,423
Toll Charges	INR	1,245
Total Cost	**INR/Truck**	**2,668**

Figure 13-1 Logistic cost comparison

It is evident that costs involved in multimodal transportation using Ro-Ro are higher when compared to roadways. This cost difference favours the roadway. Analysis for 2 cases has been carried out for end to end logistics cost comparison. Both the cases involve different types of vessels. Case I has higher power engine. Hence, it takes shorter time to travel. However, logistics cost of case I is higher on account of higher fuel requirement.

Case I logistics cost is INR 5,738/truck higher for waterway compared to road. The Cost of transporting every truck on the waterway would be nearly four times as expensive as roadway. In Case II, the cost using waterway is higher by around INR 4,893/truck compared to road. In case of just Ro-Ro cost comparison, Case II is

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marginally cheaper than Case I. This cost comparison highlights the subsidy amount required per truck i.e cost difference for waterways and roadways, to influence the industries divert trucks to IWT. In addition to subsidy, other measures would be needed to package and promote IWT as a better option over other modes, despite the increased transportation time and distance in the former's case.

13.1 Input Sheet

The following table lists all the assumptions and input values used in the financial modeling of Alappuzha Changanassery Canal. This includes financial analysis for the navigation infrastructure (fairways), and terminal operations (Ro-Ro):

Table 13-3 Input Sheet for NW 8

Description	Unit	Fairway	Ro-Ro
Loan Tenure	Years	10	10
Moratorium P eriod (Years Construction)	Years	3	3
Rate of Interest	Annual	11%	11%
Corporate Tax	Annual	30%	30%
Cargo Revenue Escalation	Annual	6%	6%
Other Revenue Escalation	Annual		6%
Administrative Cost	of Revenue	3%	2%
Manpower Cost Escalation	Annual	5%	5%
Cargo / Dredging Costs Escalation	Annual	5%	
Other Costs Escalation	Annual		6%
Fairway Chainage	km	29.3 + 63	
Chainage (mouth of the river to Ro-Ro Terminal)	Km		29.3
** Fairway chainage during promotional period from FY18 to FY25/FY27*			
Tariff for Revenue Calculation			
Various Revenue Sources	**Unit**	**Fairway**	**Ro-Ro**
Revenue prospects from Ancillary Activity			
Truck Parking Charges	Per Day		50
Weigh Bridge Charges	Per Truck		100

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Various Revenue Sources	Unit	Fairway	Ro-Ro
Leasing Space Coffee Shops	Per Day		500
Lease space for Rest/Retiring	Rs/Day/Truck		30

Operation & Maintenance

Description	Unit	Fairway	Ro-Ro
Civil Infrastructure	Cost		1%
Dredging		10%	
Machinery Infrastructure			5%
Insurance Cost	Capex	2%	2%

Assumptions for EIRR

Parameters	Unit	Value	Reference
Economic loss due to Road Accidents	of GDP	3%	Tractebel
GDP of India@ Current Prices	Rs Lakhs Crores	125.41	
Value of economic loss due to road accidents	Rs Lakhs Crores	3.7623	
Total Road network in India	Lakh KM	0.4865	
Safety Index (IWT as base)	times safer than road	50	
	times safer than rail	5	
Accidental Loss			
Road	Rs Lakhs/KM	7.73	Tractebel
IWT	Rs Lakhs/KM	0.15	
Fuel Cost (1 liter of fuel moves)			
Road	t-km	24.00	Tractebel
IWT	t-km	105.00	
Total Distance	KM	Fairway – (29.3+63)x2; Ro-Ro – 29.3x2	
Fuel price	Rs/Litre	60.00	

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Parameters	Unit	Value	Reference
Vehicular Operating Cost (VOC)			
Road	Rs/t-km	2.57	Tractebel
IWT	Rs/t-km	1.06	
Direct Employment Creation			
Road	Per Million t-km	20	Tractebel
IWT	Per Million t-km	0.5	
Employment cost	Rs Lakhs per Annum	2.5	
Emission Reduction			
Road	INR/Trip	650	Tractebel
IWT	INR/Trip	105.5	
Shadow Factor			
CAPEX/O&M Cost- To convert financial cost to economic cost		0.85	Tractebel
O&M Cost escalation	p.a.	5%	

Source: Consultant, Market standards

All the necessary assumptions for financial modeling are either market driven or provided by IWAI. Fairway and terminal tariff have been taken from IWAI & MbPT. The vessel parcel size is estimated at 90% of the rated DWT. The chainage of 29.3 km is from the mouth of the River to a terminal location where the Ro-Ro operations commence. In EIRR, round-trip distance is considered in each of the sub-sector's economic viability evaluation.

Sensitivity analysis for the development of NW 8 is prepared in 4 scenarios. These scenarios are as follows

- Scenario I :- Project Cost Option 1 and IWAI Tariff
- Scenario II :- Project Cost Option 1 and MbPT Tariff
- Scenario III :- Project Cost Option 2 and IWAI Tariff
- Scenario IV :- Project Cost Option 2 and MbPT Tariff

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Two different project costs are considered i.e Option 1 and Option 2 (Option 1 + Additional Structural modification suggested by Kerala Government i.e 24.28 Cr.). While for Revenue generation two different Tariff structures are taken i.e IWAI (circulated as on 2011) and MbPT, these tariff rates are already mentioned above. As listed above, four different scenarios are derived from the combination of aforementioned project cost and tariff structure. For Scenario I entire financial analysis is represented in this report, while for Scenario II, III and IV only final outcome i.e FIRR and EIRR in conclusion section.

Following sections are based on the Scenario I i.e Project Cost Option 1 and tariff rates by IWAI. Final outcome of other scenarios are represented under Sensitivity Analysis section.

13.2 Revenue

Revenue for the cumulative stretch of Alappuzha Changanassery Canal will be generated from the core operations, which include utilization of the fairways by the potential users located nearby, and operation at the Ro-Ro terminal. Secondary revenues sources, labeled “Ancillary Revenue”, will be generated from sources like truck parking, weighbridge, land leasing for commercial operations (tea-stall, coffee shops, inn, etc.), and leased resting area for truck operators. The revenue break-up and total revenue for IWAI on Alappuzha Changanassery Canal are presented in the table below:

Table 13-4 Revenue for NW 8 (INR Lakhs)

Particulars	FY23	FY24	FY25	FY30	FY35	FY40
Fairway						
Fairway Usage	**-**	**-**	**9.7**	**14.3**	**21.1**	**31.1**
Ro-Ro Terminal						
Vessel Berthing	-	-	27.6	40.7	60.1	88.6
Vehicle Loading	-	-	29.0	42.7	63.1	93.0
Vessel Berthing Revenue	-	-	56.6	83.5	123.1	181.6
Bus Parking Charges	-	-	29.0	42.7	63.1	93.0
Real Estate (2 Shops)	3.7	3.9	4.1	5.5	7.3	9.8
Retiring	-	-	17.4	25.6	37.8	55.8
Ancillary Revenue	3.7	3.9	50.5	73.9	108.2	158.6
Total Revenue	**3.7**	**3.9**	**107.1**	**157.4**	**231.3**	**340.2**

Source: Consultant

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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 both the core business operations:

Table 13-5 Project Cost – Option 1

Description	Total Investment Cost (INR Lakhs)			
	Total	1st Year	2nd Year	3rd Year
Ro-Ro Terminal				
Terminal	2,301.1	920.4	690.3	690.3
Cargo Handling Equipment	18.0	7.2	5.4	5.4
Environmental Management Plan Cost as per chapter-9 of the DPR	36.8	14.7	11.0	11.0
Project Management & consultancy Charges @ 3% of Prime cost	69.6	27.8	20.9	20.9
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	69.6	27.8	20.9	20.9
Total Project Cost	**2,495.0**	**998.0**	**748.5**	**748.5**
Fairway				
Fairway	4,554.9	1,822.0	1,366.5	1,366.5
Structure Modification	83.0	33.2	24.9	24.9
Institutional Requirement	40.0	16.0	12.0	12.0
Environmental Management Plan Cost as per chapter-9 of the DPR	74.2	29.7	22.3	22.3
Project Management & consultancy Charges @ 3% of Prime cost	140.3	56.1	42.1	42.1
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	140.3	56.1	42.1	42.1
Total Project Cost	**5,032.8**	**2,013.1**	**1,509.8**	**1,509.8**

For Ro-Ro operations, 1 Ro-Ro vessels may be required till FY40 to cater to the estimated Ro-Ro traffic on the canal. The onus of these vessel acquisitions lie with the private operator and not IWAI. Hence, these costs will not be factored in to develop model for the Ro-Ro Terminal. Capital and O&M costs associated with these vessel acquisitions and operations are indicated in the table below:

Table 13-6 Cost associated with vessel acquisition and operation

Parameters	Unit	1 Ro-Ro
Vessel Cost	Lakhs	700
Running Cost	Lakh/annum	182
Crew	No.	8
Crew Wages	Lakh/annum	6
Crew Cost	Lakh/annum	48
Repair Cost (@2% Capex)	Lakh/annum	14

Source: Tractebel

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13.4 Financial Analysis / FIRR

The financial indicators dictating FIRR for individual ventures, viz. fairways development and terminal operations have been presented in following table. 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)	FY23	FY24	FY25	FY30	FY35	FY40
Fairway								
Manpower Expenditure								
Fibre Boat for Inspection	2	2		-	4.4	5.6	7.2	9.2
Hydrographer	1	8		-	26.5	33.8	43.1	55.0
Executives	2	3		-	19.8	25.3	32.3	41.3
Engineer	1	4		-	13.2	16.9	21.6	27.5
Total Salary (INR Lakh)				**-**	**63.9**	**81.6**	**104.2**	**132.9**
Ro-Ro Terminal								
Manpower Expenditure								
Manager Cargo Handling	1	6	-	-	19.8	25.3	32.3	41.3
Security Guards (Jetty x 2)	2	2	-	-	11.9	15.2	19.4	24.8
Executives for billing and commercial	1	3	-	-	9.9	12.7	16.2	20.6
Total Salary (INR Lakh)	**1**	**6**	**-**	**-**	**41.7**	**53.2**	**67.9**	**86.6**

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. Manpower expenses in case of the Ro-Ro terminal isn't necessarily directed towards IWAI. It will be borne by whosoever operates the terminal. IWAI can either own and operate the infrastructure, or lease it to a private third party on a suitable PPP model.

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

Depreciation & Amortization	FY23	FY24	FY25	FY30	FY35	FY40
Fairway						
Gross Block	2,013.1	3,523.0	5,032.8	5,032.8	5,032.8	5,032.8
Depreciation & Amortization	-	256.5	366.5	295.5	295.5	30.6
Cumulative Depreciation & Amortization	-	256.5	623.0	2,334.6	3,812.0	5,024.5
Net Block	2,013.1	3,266.4	4,409.8	2,698.2	1,220.8	8.3
Ro-Ro Terminal						
Gross Block	998.0	1,746.5	2,495.0	2,495.0	2,495.0	2,495.0
Depreciation & Amortization	-	127.2	181.7	146.5	146.5	15.1
Cumulative Depreciation & Amortization	-	127.2	308.9	1,157.6	1,890.1	2,491.3
Net Block	998.0	1,619.3	2,186.1	1,337.4	604.9	3.7

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 P&L Statement (INR Lakh)

Parameter	FY23	FY24	FY25	FY30	FY35	FY40
Fairway						
PBDIT	- 185.8	- 338.7	- 561.0	- 713.9	- 908.2	-1,154.9
Depreciation	-	256.5	366.5	295.5	295.5	30.6
Interest	143.9	251.9	359.8	129.6	-	-
PBT	- 329.7	- 847.1	-1,287.3	-1,139.0	-1,203.7	-1,185.5
Tax	-	-	-	-	-	-
PAT	**- 329.7**	**- 847.1**	**-1,287.3**	**-1,139.0**	**-1,203.7**	**-1,185.5**
Ro-Ro Terminal						
PBDIT	- 6.1	- 14.1	36.1	63.1	108.0	178.6
Depreciation	-	127.2	181.7	146.5	146.5	15.1
Interest	71.4	124.9	178.4	64.2	-	-

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Parameter	FY23	FY24	FY25	FY30	FY35	FY40
PBT	- 77.5	- 266.2	- 324.0	- 147.6	- 38.5	163.5
Tax	-	-	-	-	-	49.0
PAT	**- 77.5**	**- 266.2**	**- 324.0**	**- 147.6**	**- 38.5**	**114.4**

Source: Consultant

Ro-RO terminal project is expected to barely meet its day to day expenses in last 5 years of the 20 year implementation period. The relatively high construction cost and subdued revenue generated due to lower traffic potential for the Ro-Ro Terminal is evident in the losses this sub-sector project will accrue at least till FY35. The Terminal generates profit, but beyond the FY36 that too very nominal.

The following table is the ultimate assessment of the viability of the individual projects planned under the development of the NW 8:

Table 13-10 FIRR for NW 8 (INR Lakh)

Parameter	FY23	FY24	FY25	FY30	FY35	FY40
Fairway						
Project Cashflow(Pre-tax)	-2,198.9	-1,848.5	-2,070.8	-713.9	- 908.2	-1,154.9
Project IRR(Pre-tax)	**Non-existent**					
Project Cashflow(Post-tax)	-2,198.9	-1,848.5	-2,070.8	-713.9	- 908.2	-1,154.9
Project IRR(Post-tax)	**Non-existent**					
Ro-Ro Terminal						
Project Cashflow (Pre-tax)	- 1,004.1	- 762.6	- 712.4	63.1	108.0	178.6
Project IRR(Pre-tax)	**-4.7%**					
Project Cashflow(Post-tax)	- 1,004.1	- 762.6	- 712.4	63.1	108.0	129.5
Project IRR(Post-tax)	**-5.1%**					

Source: Consultant

Revenue prospect for both the sectors generates no rate of returns. It's because of very low traffic and high cost of project. Both the phases are likely to be a loss-making. Based on the EIRR for the Ro-Ro sub-sector, Viability Gap Funding (VGF) can be sought.

In contrast to the above project component-wise FIRR, the following table provides FIRR for the project as a whole:

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Table 13-3 FIRR for NW 8 – Whole Project (INR Lakh)

Parameter	FY23	FY24	FY25	FY30	FY35	FY40
With IWAI Tariff						
Project Cashflow (Pre-tax)	- 3,203.0	- 2,611.2	- 2,783.2	- 650.8	- 800.2	- 976.4
Project IRR (Pre-tax)	**Non-existent**					
Project Cashflow(Post-tax)	- 3,203.0	- 2,611.2	- 2,783.2	- 650.8	- 800.2	- 976.4
Project IRR (Post-tax)	**Non-existent**					
With MbPT Tariff						
Project Cashflow (Pre-tax)	- 3,203.0	- 2,611.2	- 2,218.9	181.2	427.1	833.9
Project IRR (Pre-tax)	**-3.1%**					
Project Cashflow(Post-tax)	- 3,203.0	- 2,611.2	- 2,218.9	181.2	427.1	758.6
Project IRR (Post-tax)	**-3.3%**					

Source: Consultant

This project doesn't appear to produce the necessary economic impact to warrant such a conclusion. This could primarily be due the less traffic, leading to low utilization of fairway. Furthermore, the high project cost for development could also be one of the factors.

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. The table below shows the estimated EIRR for each of these sub-sectors is presented in the table below:

13-12 Project EIRR (INR Crores)

Parameters	FY23	FY24	FY25	FY30	FY35	FY40
Fairway						
Economic Cash Outflow	-4.9	-11.3	41.1	46.5	50.0	54.5
Net Cash Flow to Project	-25.0	-26.4	26.0	46.5	50.0	54.5
Project EIRR	**56.8%**					
Ro-Ro Terminal						
Economic Cash Outflow	-0.9	-2.8	17.1	20.6	23.5	27.1
Net Cash Flow to Project	-10.8	-10.3	9.6	20.6	23.5	27.1
Project EIRR	**56.8%**					

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Source: Consultant

Similar to calculating FIRR of the whole project, the following table shows the EIRR of the whole project:

Table 13-4 Project EIRR – Whole Project (INR Crores)

Parameters	FY23	FY24	FY25	FY30	FY35	FY40
With IWAI Tariff						
Economic Cash Outflow	-5.7	-13.8	-1.9	-1.1	-2.2	-2.0
Net Cash Flow to Project	-35.8	-36.3	-24.5	-1.1	-2.2	-2.0
Project EIRR	**Non-existent**					
With MbPT Tariff						
Economic Cash Outflow	-5.7	-13.8	3.6	7.0	9.7	14.9
Net Cash Flow to Project	-35.8	-36.3	-19.0	7.0	9.7	14.9
Project EIRR	**3.5%**					

Source: Consultant

13.6 Sensitivity Analysis

Variations in tariff rates and project cost have been applied to measure the overall impact these could have on the project's earnings and profitability. Sensitivity Analysis for each of the sub-sectors done in four different scenarios is shown in the table below.

Table 13-5 Sensitivity Analysis – Scenario II

Particulars	FY23	FY24	FY25	FY30	FY35	FY40
Financial IRR (in Lakhs)						
Fairway						
Revenue	-	-	485.5	715.8	1,055.9	1,557.5
PAT	- 329.7	- 847.1	- 825.7	- 458.5	- 200.0	206.5
Project IRR (Pre tax)	**-10.4%**					
Project IRR (Post tax)	**-11.0%**					
Ro-Ro Terminal						
Revenue	3.7	3.9	212.0	312.0	459.4	676.7
PAT	- 77.5	- 266.2	- 221.2	2.8	129.5	345.2
Project IRR (Pre tax)	**6.4%**					
Project IRR (Post tax)	**4.9%**					
Economic IRR (in Crore)						
Fairway						

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Economic Cash Outflow	-4.9	-11.3	45.6	53.1	59.8	68.0
Net Cash Flow to Project	-25.0	-26.4	30.5	53.1	59.8	68.0
Project EIRR	**62.6%**					
			Ro-Ro Terminal			
Economic Cash Outflow	-0.9	-2.8	18.1	22.0	25.2	29.3
Net Cash Flow to Project	-10.8	-10.3	10.6	22.0	25.2	29.3
Project EIRR	**59.8%**					

Source: Consultant

Table 13-6 Sensitivity Analysis – Scenario III

Particulars	FY23	FY24	FY25	FY30	FY35	FY40
Financial IRR (in Lakhs)						
			Fairway			
Revenue	-	-	9.7	14.3	21.1	31.1
PAT	- 496.3	- 1,178.3	-1,721.8	-1,492.0	-1,531.9	- 1,423.2
Project IRR (Pre tax)	**Non-existent**					
Project IRR (Post tax)	**Non-existent**					
			Ro-Ro Terminal			
Revenue	3.7	3.9	107.1	157.4	231.3	340.2
PAT	- 77.5	- 266.2	- 324.0	- 147.6	- 38.5	114.4
Project IRR (Pre tax)	**-4.7%**					
Project IRR (Post tax)	**-5.1%**					
Economic IRR (in Crore)						
			Fairway			
Economic Cash Outflow	-7.4	-15.5	35.8	41.8	45.2	50.2
Net Cash Flow to Project	-37.2	-37.9	13.4	41.8	45.2	50.2
Project EIRR	**36.5%**					
			Ro-Ro Terminal			
Economic Cash Outflow	-0.9	-2.8	17.1	20.6	23.5	27.1
Net Cash Flow to Project	-10.8	-10.3	9.6	20.6	23.5	27.1
Project EIRR	**56.8%**					

Source: Consultant

Table 13-7 Sensitivity Analysis – Scenario IV

Particulars	FY23	FY24	FY25	FY30	FY35	FY40
Financial IRR (in Lakhs)						
			Fairway			
Revenue	-	-	485.5	715.8	1,055.9	1,557.5
PAT	- 496.3	- 1,178.3	-1,260.2	- 811.5	- 528.2	40.1
Project IRR (Pre tax)	**-27.6%**					
Project IRR (Post tax)	**Non-existent**					

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Ro-Ro Terminal						
Revenue	3.7	3.9	212.0	312.0	459.4	676.7
PAT	- 77.5	- 266.2	- 221.2	2.8	129.5	345.2
Project IRR (Pre tax)	**6.4%**					
Project IRR (Post tax)	**4.9%**					
Economic IRR (in Crore)						
Fairway						
Economic Cash Outflow	-7.4	-15.5	40.3	48.4	55.0	64.4
Net Cash Flow to Project	-37.2	-37.9	17.9	48.4	55.0	64.4
Project EIRR	**41.2%**					
Ro-Ro Terminal						
Economic Cash Outflow	-0.9	-2.8	18.1	22.0	25.2	29.3
Net Cash Flow to Project	-10.8	-10.3	10.6	22.0	25.2	29.3
Project EIRR	**59.8%**					

Source: Consultant

Scenario I & III and Scenario II & IV are similar in case of Ro-Ro Terminal; this is because of no change in project cost. Difference between Project Cost Option 1 & 2 is just that, Option 2 includes additional INR 24.28 Crore of structural modifications in Fairway as suggested by Kerala Government. While Ro-Ro Terminal project cost remains same in both the options.

13.7 Risk Factors & Mitigation

The project has not been found commercially viable. The projected traffic volumes are very low. The financial analysis undertaken for the project shows non-existent IRR. Hence, there is no need to develop this project.

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13.8 Necessity of Govt. Support (VGF / PPP)1092

Difficulty in securing funds aside, some projects are not even considered to be financially viable, although they might be economically justified and indispensable. To take care of such projects and to carry them towards their successful completion, the government has designed Viability Gap Funding (VGF). Viability Gap Funding is the grant provided by the government towards financing projects that are termed financially unviable but are economically justified. The scheme and the projects are monitored by the Ministry of Finance and amount is allocated through annual budget. The usual grant given by the government is 20% of the total capital cost of the project, which can be supplemented by the state government through an additional 20% grant.

Ro-Ro Terminal and fairway both the projects are commercially unviable while economically viable. The table below shows the outcome of return under 20% and 40% grant.

Table 13-8 Probable impact of VGF on project returns

Reduction in Project Cost	Ro-Ro Terminal		Fairway	
	-20%	-40%	-20%	-40%
Project IRR (Pre Tax)	-2.0%	1.5%	Non-existent	Non-existent
Project IRR (Post Tax)	-2.6%	0.5%	Non-existent	Non-existent

Source: Consultant

With 20% financial support from the government, both the projects i.e Ro-Ro terminal and Fairway does not produce the desired positive returns commercially. However, Ro-Ro Terminal generates nominal positive return on entire 40% of government support.

13.9 Conclusion

The following table gives a snapshot of the project cost and viability indicators for all the sub-sector developments for NW 8 under different scenarios:

Table 13-9 Critical indicators for the NW 8 under different Scenarios

No	Factors	Section	Unit	Scenarios			
				I	II	III	IV
1	Project Cost	Fairway	Cr.	50.3	50.3	74.6	74.6
		Ro-Ro Terminal	Cr.	24.95	24.95	24.95	24.95
2	Tariff	Vessel Berthing	INR Vessel/Day	1,000.0	1,713.6	1,000.0	1,713.6

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No	Factors	Section	Unit	Scenarios			
				I	II	III	IV
		Vehicle Unloading	INR Per Vehicle	50.0	196.9	50.0	196.9
		Fairway Usage	INR GRT-Km	0.02	1.0	0.02	1.0
2	Traffic	Trucks	In Thousands	FY 22 - 48.7 and FY 40 - 69.1			
3	Revenue	Fairway (FY40)	Cr.	0.31	15.6	0.31	15.6
		Ro-Ro (FY40)	Cr.	3.4	6.8	3.4	6.8
4	FIRR	Fairway	-	Non-Existent	-11.0%	Non-Existent	Non-Existent
		Ro-Ro Terminal	-	-5.1%	4.9%	-5.1%	4.9%
5	EIRR	Fairway	-	56.8%	62.6%	36.5%	41.2%
		Ro-Ro Terminal	-	56.8%	59.8%	56.8%	59.8%

Source: Consultant

Above table clearly depicts that developing fairway and Ro-Ro terminal on NW 8 is un-viable under Scenario I & III. This entirely because of high project cost and tariff charged to the users, as IWAI tariff is very low. Under these scenarios where IWAI tariff rates are considered, fairway and terminals are not able to generate sufficient income that could meet the least operating cost. While in Scenario II & IV, only Ro-Ro terminal gives positive IRR, this seems unreal because of MbPT tariff consideration in revenue calculation. No industry would ever shift in any case at this tariff rates.

If in future, industries located nearby the terminal don't show marked increase in traffic volume, then the decision to set up a Ro-Ro terminal on NW8 river becomes irrelevant. The cost difference between roadways and waterways will remain the same or widen even further. Even in the ideal situation where the government will be willing to compensate the cost difference, the Ro-Ro terminal is unlikely to generate profits in the long run. A combination of increased costs, time, and distance will weigh on the overall appeal and benefits of waterway movement, deterring potential customers.

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It is evident from the logistics cost comparison that both the cases of waterway movement will be costlier than existing mode of transportation using roadways by a significant margin. For development of Ro-Ro Terminal and for it to attract the projected traffic, government needs to subsidize the shift by offering the cost difference to the transporters. The subsidy amount will compensate for high logistics cost, but additional incentives need to be offered to make up for the increase in time and distance. 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 is needed to induce shift of traffic from existing roadways to waterway. The following chart depicts the annual subsidy cost government will have to incur if it were to go ahead with cargo movement on NW8:

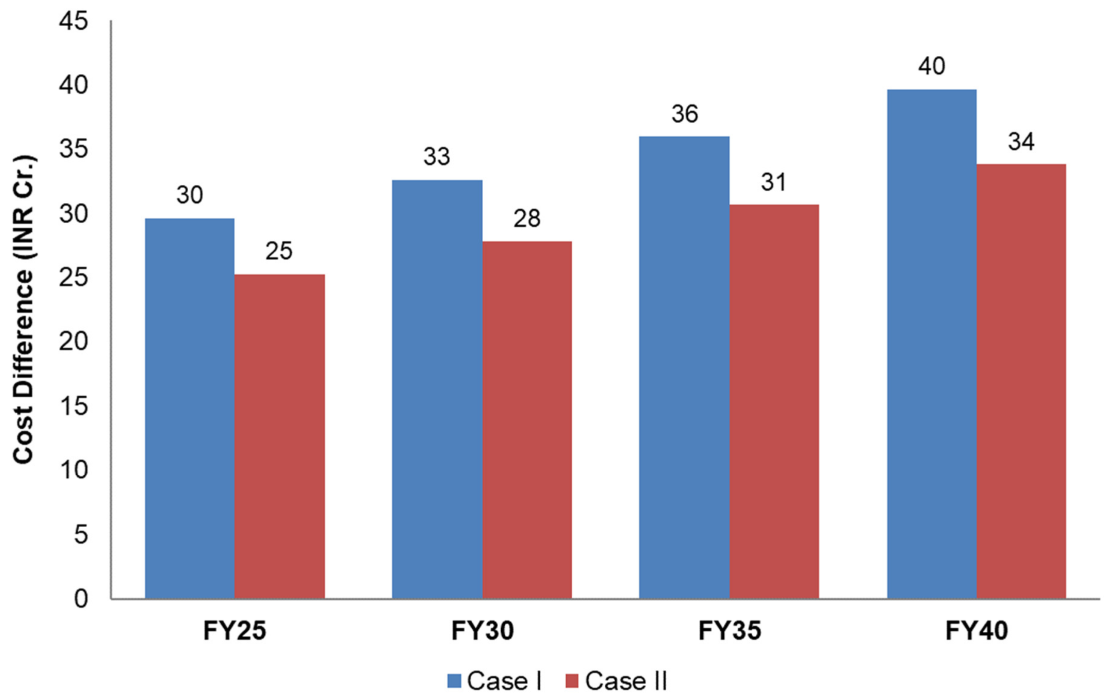

Figure 13-2 Annual Subsidy Expense (INR Cr.)

Source: Consultant

At no stage does the combined revenue generated from fairway and Ro-Ro Terminal comes even half as close to break even with just the subsidy cost. This sole reason of steep subsidy requirement, on account of the wide logistics cost difference, renders this entire project unviable. So, even after bearing the cost of subsidy, development of Alappuzha Changanassery Canal is not a commercially sound investment prospect.

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CHAPTER 14 CONCLUSIONS AND RECOMMENDATIONS

The study of Second Stage Detailed Project Report (DPR) for Development of Alappuzha – Changanassery canal NW – 8 in the stretch of 29.30 Kms from Boat Jetty Alappuzha (Lat 09°30' 02.85" N, Long 76°20' 37.05") to Chanaganssery Jetty (Lat 09°26' 41.61" N, Long 76°31' 41.76" E) has been carried out as per the Terms of Reference (ToR) and the details of the study are given in the preceding chapters.

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

- Detailed Hydrographic Survey has been carried out and based on the Survey carried out / Site data collected / subsequent to the Morphological analysis etc., the required developments in the Fairway along with interrelated activities have been identified. The study stretch is in the "Vembanad Lake" area in Kerala, which is one of the identified sites under Ramsar Convention of wet land. Since it is in the Lake area, as such there is no major Regime disturbance in the study stretch.
- The National Waterway 8 (NW 8) is having a depth lesser than 1.5 m (w. r. to Lowest Water Level) for half of the stretch. More shoal zones have been observed in the end stretch near Changanassery. NW 8 has been considered for Class III waterway in line with the requirement of connectivity for mobility through existing NW 3. There is no cargo mobility in the stretch, however, the Passenger mobility is being carried out by Kerala State Water Transport Department (KSWTD) {HQ: Alappuzha} by deploying Passenger Boats.
- The present waterway of the study stretch of NW 8 is having connectivity with the existing NW 3 i.e., with Kottappuram and Kollam including the Kochi area and ICTT, Kochi. Accordingly, Ro-Ro vessel mobility is suggested connecting ICTT, Kochi and Kochi area for movement of vehicles through Changanassery with the South Eastern part of the hinterland. This aspect is to be carefully observed up to end of 2022 and with the positive confirmations, development of NW 8 can be considered from 2023 with 3 years span of time for development.
- Accordingly, the possibility of vessel mobility has been considered with Class III standard of Waterway with 32 m Bottom Width of fairway in narrow reaches and 38 m Bottom Width of fairway in wider reaches however with 2.2 m Depth of fairway in both the reaches with a vessel requirement for Class III as 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each.

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- No development is suggested till a critical and micro level analysis (till 2022 and with observation of positive growth trend amenable for Ro-Ro operation, development is suggested in 3 years from 2022.
- As a part of development, in order to provide a class III safe navigable fairway, Dredging of 4.46 Lakhs Cu. M in Soils has been suggested along with the development of 1 Ro-Ro Terminal at Changanassery.
- The most probable location for such Berthing / Ro-Ro IWT Terminal at the other end (one end is Ro-Ro Terminal at Bolghatty, Kochi) is in Chanaganssery with approx Lat 09° 26' 26.31" N and Long 76° 31' 29.83" E.
- A tentative Land requirement has been worked out and arrived at with 13083 Sq. M at Changanassery Land Survey was considered accordingly. Land Details of the location has been firmed up and the same is in the Changanssery Village; Changanassery Taluka; Kottayam District of Kerala state.
- Terminal Infrastructure has been considered to suit to the Ro-Ro operation with the length of the Berthing structure as 75 m and width as 12 m.
- In order to facilitate the Ro-Ro operation, the following Vessel type and size have been considered i.e., initially for Tourism development and however to handle as Ro-Ro Vessel with 50 m – 55 m of LOA x 9 m – 12 m Breadth x 1.6 m – 1.8 m Loaded Draft / 2.2 + m, which can carry 300 T – 500 T or 15 Nos. TEU – 21 TEU (Equivalent Ro-Ro). The Propulsion will be 3 Nos of Marine Diesel Engines of 375 Bhp each. The indicative cost is about INR 700 Lakhs. Not suggested for any deployment without Traffic confirmations.
- It is suggested for the observations and firming up of the Ro-Ro traffic volumes up to 2022 and the investment for development is suggested only after having positive growth trend and confirmation.
- The cost estimates have been worked out for development of Fairway with a capital cost of 50.33 Cr and Terminal with a capital cost of 24.95 Cr. Implementation of the above is suggested in 3 years from 2023.
- The FIRR and EIRR have been worked out both for Option-1 & Option-2 and the critical indicators are placed.

Scenario	**Project Components**	**Cost in Lakhs (Rs.)**	***Financial Internal Rate of Return (FIRR %)***	***Economic Internal Rate of Return (EIRR %)***
Scenario I :- Project Cost Option 1 and IWAI Tariff	Fairway Cost	5032.81	Non-Existent	56.8%
	Ro-Ro Cost	2495.02	-5.1%	56.8%
Scenario II :- Project Cost Option 1 and MbPT Tariff	Fairway Cost	5032.81	-11.0%	62.6%
	Ro-Ro Cost	2495.02	4.9%	59.8%
Scenario III :- Project Cost Option 2 and IWAI Tariff	Fairway Cost	7461.51	Non-Existent	36.5%
	Ro-Ro Cost	2495.02	-5.1%	56.8%

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Scenario	Project Components	Cost in Lakhs (Rs.)	*Financial Internal Rate of Return (FIRR %)*	*Economic Internal Rate of Return (EIRR %)*
Scenario IV :- Project Cost Option 2 and MbPT Tariff	Fairway Cost	7461.51	Non-Existent	41.2%
	Ro-Ro Cost	2495.02	4.9%	59.8%

- Not recommended any investment till the confirmations of the Ro-Ro traffic with critical observation till end of 2022. Investment on Development is suggested only with positive growth confirmations to develop the stretch of NW 8 for about 29 Kms with Class III Canal system of the NW standards.

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CHAPTER 15 TEMPLATES

15.1 Environmental & Social Screening Template

Screening Question	Yes	No	Details / Remarks
1. Is the project located in whole or part in / near any of the following Environmentally Sensitive Area? If yes, please provide the name and distance from the project site			
a) National Park		✓	
b) Wildlife/ Bird Sanctuary		✓	
c) Tiger or Elephant Reserve		✓	
d) Biosphere Reserve		✓	
e) Reserved / Protected Forest			No.
f) Wetland	✓		The project traverses through Vembanad Lake which is a Ramsar Wetland Site. Clearance shall be obtained in accordance with CRZ Notification 2011.
g) Important Bird Areas		✓	
h) Mangroves Areas		✓	
i) Estuary with Mangroves		✓	
j) Areas used by protected, important or sensitive species of fauna for breeding, nesting, foraging, resting, over wintering, migration		✓	
k) World Heritage Sites		✓	
l) Archaeological 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?		✓	
3. Is, there any defense installations near the project site?		✓	
4. Whether there is any Government Order/ Policy relevant / relating to the site?	✓		EIA Notification 2006 Wildlife Protection Act, 1972 Water Act, 1974 Air Act 1981

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Screening Question	Yes	No	Details / Remarks
			CRZ Notification 2011 Wetland Rules, 2010
5. Is the project involved clearance of existing land, vegetation and buildings?	✓		For construction of terminal building and access roads.
6. Is the project involved dredging?	✓		
7. Is the project area susceptible to natural hazard (earthquakes, subsidence, erosion, flooding, cyclone or extreme or adverse climatic conditions)		✓	
8. Is the project located in whole or part within the Coastal Regulation Zone?	✓		
9. Is the project involved any demolition of existing structure?		✓	No.
10. Is the project activity require acquisition of private land?	✓		Acquisition is required for Fairway development and nominal Acquisition of land is anticipated for terminal construction.
11. Is the proposed project activity result in loss of direct livelihood / employment?		✓	No dislocation is anticipated on account of the project.
12. Is the proposed project activity affect schedule tribe/ caste communities?		✓	

S. N.	Result of Screening Exercise	(Yes / No)
1.	Environment Impact Assessment is Required	Yes
2.	CRZ Clearance is Required	Yes
3.	Environmental Clearance is Required	No
4.	Forest Clearance is required	No
5.	Wildlife Clearance is required	No
6.	NOC from SPCB is required	Yes
7.	Social Impact Assessment is Required	Only as part of EIA study
8.	Abbreviated RAP is required	No
9.	Full RAP is required	No

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S. N.	Result of Screening Exercise	(Yes / 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 -
- Catchment area – Kottayam, Alappuzha district of Kerala.
- Population – As per census 2011, total population residing in Alappuzha, Kottayam & part of Pathanamthitta is 38,11,692
- Economic activities –Agriculture activities, Horticulture, Marine & Inland Fishing, Fish catch/ productions from inland fishing is more compare to marine fishing.
- Major industries - No major industries found.
- Connectivity
  - ✓ Major roads – SH 11 is major highway which runs parallel to NW 8. N.H. 66 connects Alappuzha with Thiruvananthapuram & Cochin, N.H. 183 connects Changanassery with Kottayam & Adoor.
  - ✓ Major railway – Southern railway runs in Alappuzha & Changanassery.
- Specific Developments

  No specific developments found.
- Catchment area Map

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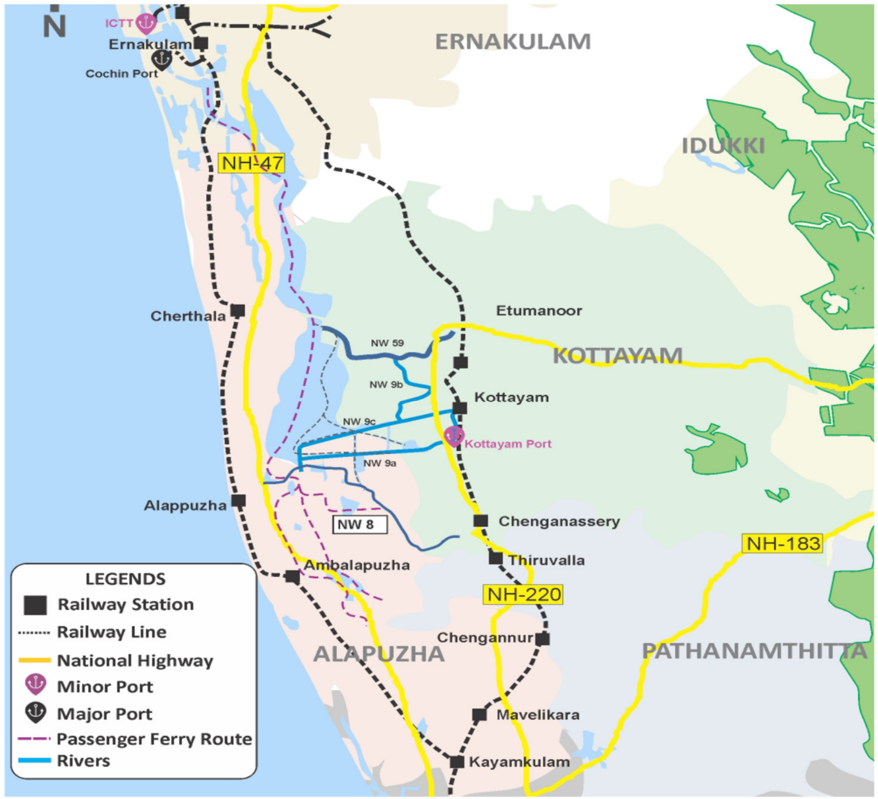

15.2.2 Navigation Baseline

- Existing Waterway Usage

  ✓ The stretch of NW 8 mostly is surrounded by agricultural fields. No major industries or settlements are located along the waterway.

  ✓ At present, passenger ferry services are operational in both Alappuzha & Kottayam districts. Passenger services are operated by State Water Transport Department, Government of Kerala.

  ✓ At present only passenger ferry and houseboat runs on NW 8. No cargo operation found.

15.2.3 Market Baseline

- Potential Market

  Only passenger & tourism potential exist on NW 8. Scale of operation of existing industries in the catchment area is not big enough to generate sufficient volume for waterway transportation.

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15.2.4 Forecasting Years

- IWT Share
  - ✓ Loaded Trucks 15%
  - ✓ Containers 5%

Name of the waterway: NW-08 (Alappuzha Changanassery Canal, 29.00 km)														
Sr. No	**Name of Cargo**	**Type of Cargo**	**Origin**	**Origin Terminal on NW**	**Final Destination**	**Destination Terminal on NW**	**Co-ordinates**	**Unit p.a**	**Fy-18**	**Fy-20**	**Fy-25**	**Fy-30**	**Fy-35**	**Fy-40**
Existing Terminals on River (At present there are 13 jetties on NW 8, which are used for handling passenger traffic. Houseboat also operates on this route. Therefore no additional demand or need exist for another passenger or tourism terminal. However for exception case Ro-Ro terminal could be developed if it is logistically viable. Following is the traffic that could be achieved if Ro-Ro terminal is developed with subsidy. It is assumed that terminal would get developed in FY 20. FY-18 traffic is the present traffic movement by roadway)														
1	Loaded Trucks	-	Changanassery	Changanassery	Kochin Port	n/a	9°26'18.9"N 76°31'36.7"E	Numbers in (00')	1,372	210	232	256	283	312
2	Containers	-	Changanassery		Kochin Port				243	12	14	15	17	18
	Total								1,616	222	246	271	300	330
1	Loaded Trucks	-	Kochin Port	n/a	Changanassery	Changanassery	9°26'18.9"N 76°31'36.7"E		1,538	235	260	287	317	350
2	Containers	-	Kochin Port		Changanassery				214	11	11	11	11	11
	Total								1,752	246	271	298	328	361
* BULK/BREAK BULK/BULK LIQUID/ TRUCKS (in No.), etc.														

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15.2.5 Presentation of Forecast

Sr. No	Name of Cargo	Type of Cargo	Origin	Final Destination	Unit p.a	Fy-18	Fy-20	Fy-25	Fy-30	Fy-35	Fy-40
Existing Terminals on River (At present there are 13 jetties on NW 8, which are used for handling passenger traffic. Houseboat also operates on this route. Therefore no additional demand or need exist for another passenger or tourism terminal. However for exception case Ro-Ro terminal could be developed if it is logistically viable. Following is the traffic that could be achieved if Ro-Ro terminal is developed with subsidy. It is assumed that terminal would get developed in FY 20)											
Proposed Terminal Opportunity for IWAI											
1	Loaded Trucks	Ro-Ro	Changanassery	Kochin Port	(mn T- Km)	-	348	384	424	468	517
2	Containers	Ro-Ro	Changanassery	Kochin Port	(mn T- Km)	-	21	23	25	28	31
3	Loaded Trucks	Ro-Ro	Kochin Port	Changanassery	(mn T- Km)	-	390	430	475	524	579
4	Containers	Ro-Ro	Kochin Port	Changanassery	(mn T- Km)	-	18	18	18	18	18

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15.2.6 Market Success Factors

The Market success factor for development of NW 8 is the Geographical location with its connectivity with the existing NW 3 i.e., to ICTT, Kochi. The Trucks destined to South Eastern part of the country can move through IWT by reducing the road density in Kerala.

15.2.7 Forecasting Methodology

Though there do not exist any cargo potential on NW 8, part of the traffic from (NH 183) road could be diverted to NW 8. To determine the feasibility of NW 8 about Ro-Ro road survey was conducted.

Table 15-1 Traffic Volume Count (O-D)

Period	Outflow (From changanessery)			Inflow to changanessery		
	Loaded Trucks	Empty Trucks	Containers	Loaded Trucks	Empty Trucks	Containers
Per Day (No.)	376	360	67	421	315	59
Annual (No.)	1,37,240	1,31,400	24,333	1,53,787	1,14,853	21,413

Source: Site visit

For projecting traffic, following factors are assumed. As Alappuzha Changanassery is used for passenger transportation as well as tourism, it is less likely that cargo in the form of trucks could use NW 8. Therefore, consultant has assumed 15% of share that could use NW 8. In case of containers, the share considered is minimum because containers commodities are time bound therefore it is very much unlike that containers could use Ro-Ro service for a short distance. In last few years, especially in Kerala, negative growth rate of secondary sectors is noticed. Therefore, consultant has taken minimum growth rate for projecting traffic. It is also assumed that Ro-Ro service of NW 8 would further connect to existing NW 3 to reach Kochin Port Trust.

Table 15-2 Assumption Methodology for projection

Waterway Share for loaded trucks	15%
Growth rate	2%
Waterway Share for Container	5%
Growth	2%

Source: Consultant's analysis

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15.3 Project Costing Template

Cost type	Cost categories	Components to be itemized
Capital costs	Waterway Infrastructure	☐ Land, compensation and resettlement : 10.45 cr ☐ Capital dredging:4.46 lakhs cu.m Ordinary soil – 10.92 cr ☐ River training/bank protection: 21.75 cr ☐ Locks: No ☐ Barrages: No ☐ Channel market : No ☐ Night navigation : 0.25 cr ☐ Other: Communication system – 0.83 cr
Terminal Infrastructure		Ro-Ro facility ☐ Fixed infrastructure: berths, moorings, hard-standing etc. (itemized) ☐ Loading/uploading and other equipment (itemized) ☐ Buildings : Considered in infrastructure ☐ Other : -- Considered
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

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Cost type	Cost categories	Components to be itemized
Price levels		All costs derived as per DSR 2018, December effective from Jan2019 and indexed to March-2020 price levels.
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 (FY20-FY40) – INR 50.33 crore (b) Terminal Ro-Ro Cost - INR 24.95 crore **O & M costs:** (a) Navigation infrastructure (FY19-FY40) – INR 11.68 crore (b) Terminal Ro-Ro Cost - INR 1.62 crore Savings in transport resource costs between IWT and rail and/or road transport **Saving on Fuel:**

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Item	Requirements
	(a) Navigation infrastructure (FY20-FY40) – INR 5.7 crore (b) Terminal Ro-Ro Cost - INR 1.8 crore **Saving on Vehicle Operating Cost:** (a) Navigation infrastructure (FY20-FY40) – INR 5.7 crore (b) Terminal Ro-Ro Cost - INR 1.8 crore **Savings in road/rail accident costs:** (a) Navigation infrastructure (FY20-FY40) – INR 6.9 crore (b) Terminal Ro-Ro Cost - INR 2.2 crore **Saving in carbon emissions:** (a) Navigation infrastructure (FY20-FY40) – INR 4.5 crore (b) Terminal Ro-Ro Cost - INR 4.5 crore
Standard values	To ensure consistency between evaluations of different waterways the following has been used: Vehicle operating Cost Road : INR 2.58/tons-km Rail : INR 1.41/tons-km IWT: INR.1.06/tons-km Road accident Loss: INR 7.73 Lakhs/km Rail accident Loss: INR 0.77 Lakhs/km Carbon shadow price : 20 dollars/tons

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Item	Requirements
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 2019 price level and indexed to march 2020 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 terminal. Both the sector will be developed in single phase only. Construction will be from F23 to FY25. A total 16 years for operation period has been taken into account entire operation
EIRR	The EIRR for all the individual projects under development of the Alappuzha Changanassery Canal is positive. However, these projects are not commercially viable, because EIRR for all the sub-segment projects are either negative or non-existent. At present, industries located in catchment area are using roadways to reach ICTT. Development of Alappuzha Changanassery Canal as an alternate mode for transportation of trucks 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 Alappuzha Changanassery Canal is also likely to generate overall benefits to the project. Economic IRR of Navigational Structure/Ro-Ro terminal is 53.8%.

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Item	Requirements
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 Alappuzha Changanassery Canal
Financial evaluation approach	Financial evaluation of each river upgrading project should estimate and present actual cash flows (cost and revenues) at market prices within the inland waterway sector consisting of the two sub-segments: (a) navigation infrastructure; (b) terminal operation. *Operational Period (FY23 – FY40)* **Returns for Navigation infrastructure (With Development) are:** Total Revenue: INR 0.31 cr. in FY40 O&M Cost: INR 11.96 cr. in FY40 Tax: Nil in FY40 (@ 30% on EBITDA) EBIDA: INR -11.55 cr. In FY40 Project Capital Cost (with escalation): INR 50.33 cr. Net Cash Flow: INR -11.55 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** Total Revenue: INR 3.4 cr. in FY40 O&M Cost: INR 1.62 cr. in FY40 Tax: INR 0.1 Cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 1.79 cr. In FY40 Project Capital Cost (with escalation): INR 24.95 cr.

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Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
	Net Cash Flow: INR 1.295 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. *Operational Period (FY23 – FY40)* **Returns for Navigation infrastructure (With Development) are:** Total Revenue: INR 0.31 cr. in FY40 O&M Cost: INR 11.86 cr. in FY40 Tax: Nil in FY40 (@ 30% on EBITDA) EBIDA: INR -11.55 cr. In FY40 Project Capital Cost (with escalation): INR 50.33 cr. Net Cash Flow: INR -11.55 cr. In FY40 **Returns for Ro-Ro Terminal operations are:** Total Revenue: INR 3.4 cr. in FY40 O&M Cost: INR 1.62 cr. in FY40 Tax: INR 0.1 Cr. In FY40 (@ 30% on EBITDA) EBIDA: INR 1.79 cr. In FY40 Project Capital Cost (with escalation): INR 24.95 cr. Net Cash Flow: INR 1.295 cr. In FY40
Evaluation period	Construction period has been adopted as 3 years for all the sub-segment projects. For fairway & terminal, a total 19 years for operation period has been taken into account for the entire operation (FY25 – 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

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Consultants shall adhere to the following standard approaches in estimating financial internal rate of return (FIRR) and payback period.	
Item	**Requirements**
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 Alappuzha Changanassery Canal 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 (especially for Ro-Ro) is higher as compared to existing mode of transportation. This will keep the industries from diverting to waterways. • 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.
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.

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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.

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ANNEXURES

ANNEXURE 1.1 – TOR OF THE AGREEMENT

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SECTION-6 TERMS OF REFERENCE

1.0 OBJECTIVE OF THE STUDY:

Government of India intends to explore the potential of additional waterways across the country for year round commercial navigation, for this it is planned to conduct a Feasibility Study and recommending thereafter the possibility of Composite and Integrated development of proposed waterways to achieve navigation and to develop water transport facilities across India. After carrying out the feasibility study if there is scope for navigation and potential to develop waterway transport facility, a Detailed Project Report needs to be prepared for those waterways which would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc.

The study would consist of 2 stages:

1. **Stage-1**
2. **Stage-2**

1.1 STAGE-1

Stage-I is only for feasibility of the waterway for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-1 would consist of the following activities:

1A. Reconnaissance Survey

1B. Collection and review of available data

1C. Feasibility Report

1.1.1 Reconnaissance Survey

The detailed field reconnaissance survey may be taken up immediately after the analysis of available data. The primary tasks to be accomplished during the reconnaissance surveys include:

i- Single line longitudinal survey (Bathymetric survey or Topographic survey) in the deepest depths or lowest height lands, with the help of DGPS using Automatic Hydrographic Survey System. Bathymetric surveys in the proposed waterways are to be carried out in the deepest route. Deepest route can be accessed by taking two or three longitudinal line soundings at equal interval. Topographic survey, if required, is to be taken up at lowest ground levels, which can be decided on visual assessment.

ii- Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route are to be collected and indicated on the chart and also included in the report along with their co-ordinates and location. Details about Barrages, Dams, Locks enroute are also to be collected. horizontal and vertical clearance is to be given as approximate on visual assessment. Photographs are required to be submitted in the report.

iii- Topographical features of the proposed Inland Waterways.

iv- Typical physical features along the alignment i.e. land use pattern:

v- Preliminary identification of stretches having year round flow and critical depth for navigational purpose.

vi- Preliminary Traffic identification on the proposed Inland Waterways.

vii- Inventory of major aspects including proposed Inland Waterway width, Terrain, Bridges and structures across the proposed Inland Waterways (Type, size and location), urban areas (location extent). Geologically sensitive areas environmental features. Hydrological features

viii- Critical areas requiring detailed investigations and

ix- Requirements for carrying out supplementary investigations

x- Soil (textural classifications) (only visual inspection at every 10km) and drainage conditions.

xi- Type and extent of existing utility services along the alignment.

xii- Identification of various agencies of the govt. from whom the concerned project clearances for implementation are to be sought.

The data derived from the reconnaissance surveys may be utilized for planning and programming the detailed surveys and investigations. All field studies including the traffic surveys should be taken up on the basis of information derived from the reconnaissance surveys. For the critical locations, River cross sections survey needs to be carried out.

1.1.2 Collection and Review of Available Data

A review has to be done based on the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps. Consultant has to collect available data for the proposed Inland Waterways from the State Agencies and Central Water Commission. An introductory letter will be issued by IWAI for collecting information from State / Central Government.

<u>An inception report has to be prepared which would consist of the findings based on the analysis of the existing data and reconnaissance surveys.</u>

1.1.3 Feasibility Report

The Consultant has to prepare Feasibility Report for the proposed waterways based on the available data and reconnaissance survey. It must include the following prospects:

1. **Introductory considerations:**
   The Consultant shall provide an introduction, describing the scope of the assignment, its methodology in fulfilling the assignment and the expected outcome of the assignment.

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 WATER AND BOTTOM SAMPLES

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 COLLECTION OF TOPOGRAPHICAL FEATURES

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 SURVEY CHART PREPARATION

a. The survey chart is to be prepared on a scale of 1:1,000 for Waterways width less than 100m. On a scale of 1:2,000 for Waterways width between 100m to 300m. On a scale of 1:5,000 for Waterways width between 300m to 500m and On a scale of 1:10,000 for Waterways width more than 500m.

b. Contours of 0m, 1m, 2m, 3 m, 5m and 10 m are to be indicated on the charts with respect to Chart Datum / Sounding Datum.
c. Reduced spot levels w.r.to MSL to be indicted on the charts. Spot level values are to be given w.r.t. Mean Sea Level (MSL) & Soundings w.r.t. Chart Datum / Sounding Datum. A separate file (xyz) (soft copy only) is also to be created for spot levels w.r.t. Chart Datum / Sounding Datum for dredging calculation purpose.
d. On completion of the cross-sections, dredge channel is to be identified/ established by linking deepest soundings on the cross-sections. Dredging quantity is to be estimated for developing a navigational channel of
   i. dimension of 32m x 1.8m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is less than or equal to 100m).
   ii. dimension of 45m x 2.0m, with side slope of 1:5, w.r.t. chart datum/sounding datum (if channel width is more than 100m).
e. Dredging quantity is to be indicated in the report for per km length of the waterway.
f. Minimum & maximum reduced depth and length of shoal for per km length of the waterway is also to be indicated in the report.
g. Current meter measurement values shall be indicated in the report along with position.
h. The results/characteristics of the soil and the water are to be incorporated in the report.
i. Shallow patches /shoal and submerged sand-chur having less than 1.0 m depth, rocky outcrops, rapids and other navigational impediments are to be indicated on the charts.
j. A brief write up on condition of the locks, Sluice gates, Barrages, Dams etc. (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

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COMPLIANCE ON THE TERMS OF REFERENCE

ALAPPUZHA – CHANGANASSERY CANAL (29.30KM) NW-8

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.

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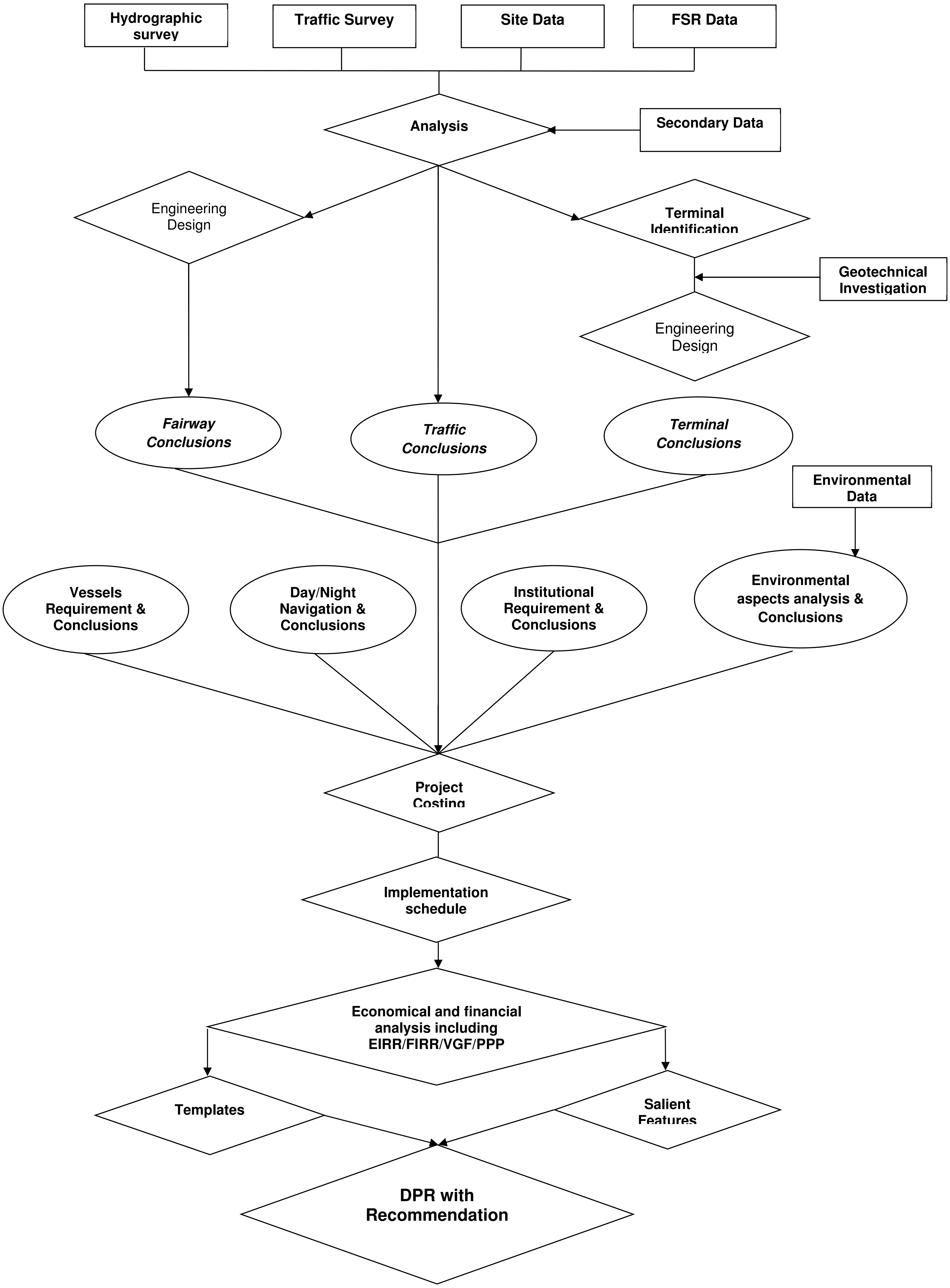
ANNEXURE 1.3 – SEQUENTIAL APPROACH TO THE PROJECT IN SCHEMATIC FORM



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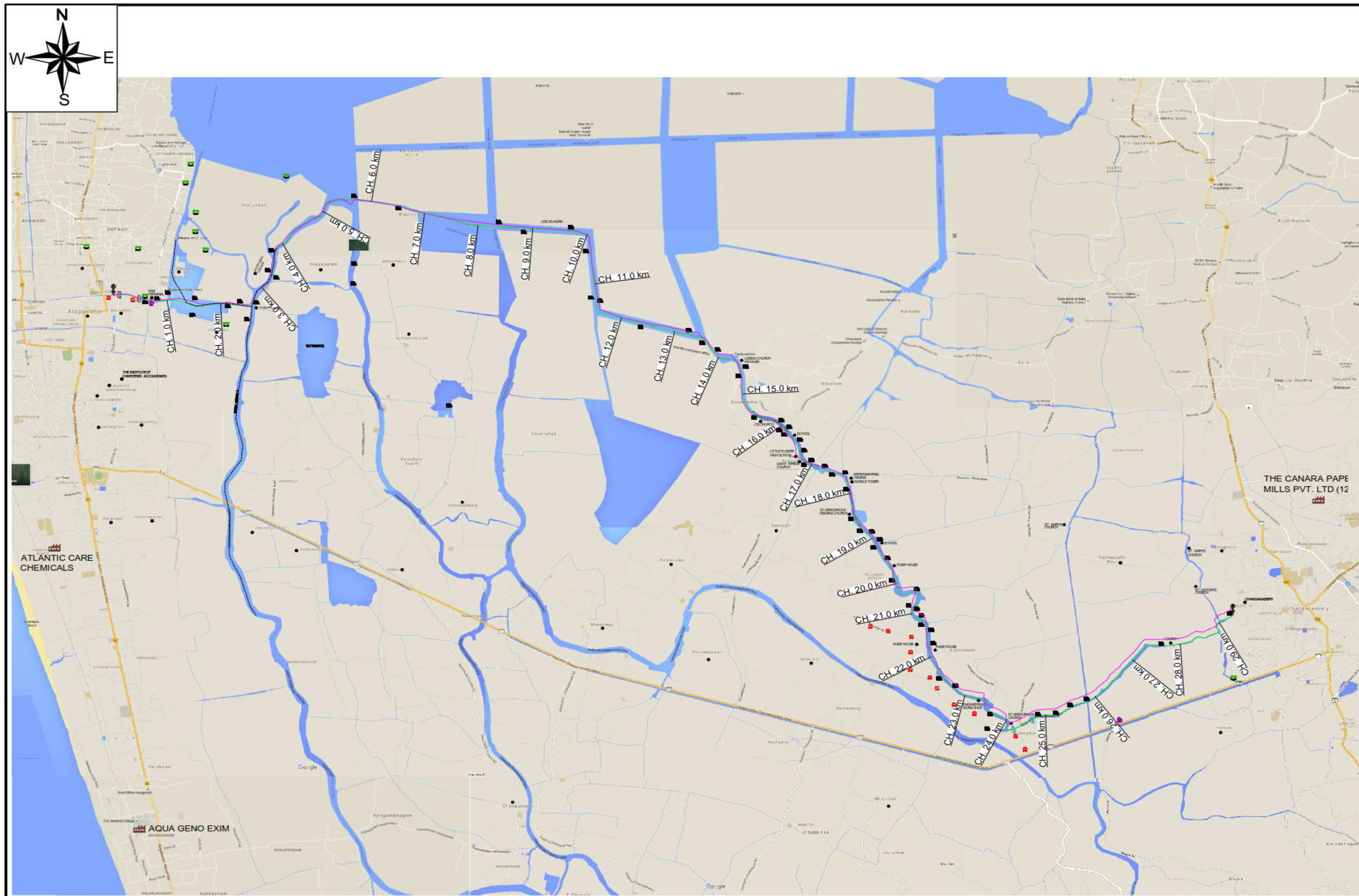
ANNEXURE 4.1 – LAYOUT MAP SHOWING EXISTING INDUSTRIES IN THE VICINITY OF NW-8



Sr. No.	Industries
	Industries Shown in this Map
12	Canara Paper Mills
	Industries beyound the Map
1	Autokast
2	DC Mills
3	Palm Fibre
4	Travancore Mats and Mattings Company
5	Wilton Weavers
6	Evershine Chemical
7	Oxide India
8	Ram Coir Mill
9	Petrogas
10	Travancore Cements
11	MRF
13	Diamond Roller Flour mill
14	Midas Precured tread
15	Kotayam Textiles
16	Kottayam Integrated Powerloom
17	TJP Rubber Industries
18	Hi- Tech Cast iron Industries
19	Traco Cables
20	Modern Rice Mill
21	Nature Pure Supercritical Extracts
22	Amity Rock Products
23	The Travancore Sugers and Chemicals
24	SN Timbers

LEGEND

BUS STOP
PLACE NAME
FUEL STATION/PUMP
BRIDGE
JETTY
INDUSTRY
RESORT
NATIONAL/STATE HIGHWAY (Hwy)
ROAD
FERRY LINE
ROOT PROVIDED BY IWAI
SURVEY (VESSEL TRACK) / THALWEG
(A) START POINT FROM BOAT JETTY, ALAPPUZHA AT LAT. 9°30'03" N LON. 76°20'37" E
(B) END POINT CHANGANASSERY AT LAT. 9°26'42" N LON. 76°31'42" E
CH. 21.0 km — CHAINAGE MARK

TRACTEBEL
ENGIE
TRACTEBEL ENGINEERING PVT. LTD.
Intec House, 37
Institutional Area, Sector 44
122002 Gurgaon-INDIA

CLIENT : INLAND WATERWASYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

CONTRACTOR :

PROJECT NAME : CONSULTANCY SERVICES FOR PREPARATION OF SECOND STAGE DPR OF CLUSTER -6 OF NATIONAL WATERWAYS

TITLE : ALAPPUZHA-CHANGANASSERY CANAL (KERALA) NW 8
LAYOUT MAP SHOWING EXISTING INDUSTRIES

STATUS OF DRAWING:- ISSUED FOR DPR

DRAWING NO:- ANNEXURE 4.1 | REV. | SHEET 1 OF 1

SCALE 1:150 | SIZE A

Rev.	Y M D	Modifications	Status	Drawn	Checked	Approved	Validated
			DPR	HDR	SRI	NSR	BCJ
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

SCALE 0 2.0 4.0KM

NOTES
1.

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

PROPOSED WATERWAY LENGTH 29.30Km (AS PER TENDER)
TOTAL WATERWAY LENGTH FROM POINT 'A' TO POINT 'B' 29.30Km

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ANNEXURE 4.2 – SUMMARY OF INTERVIEWS

Summary of Interviews on NW 8 / NW 9 / NW 59

Sr. No.	Name of Port/Industries	Designation
1	Cochin Port	Deputy Traffic Manager / Sr. Asst. Traffic Manager
2	Kottayam Port & Container Terminal	Chief Executive Officer
3	State Water Transport Department	Director
4	Travancore Cements Ltd.	Deputy Manager
5	MRF	Sr. Manager
6	Petrogas India	Plant Manager
7	Diamond Roller Flour Mill	General Manager

Name of Company: Cochin Port

Contact Person: Mr. Girish Thomas / Mr. D Anil Kumar

Designation: Deputy Traffic Manager / Sr. Asst. Traffic Manager

Coal handling at Cochin Port has reduced to 44,000 T. Coal from Cochin Port is transported to Malabar Cement and Hindustan Newsprint Ltd. in Kottayam. There is some scope to transport cement to Kozhikode but due to some unknown reasons, industries are not using waterways for cement transport. Electronics, Garments, Tiles & Timber are the major goods for container movement. It can also be transported through waterways if industries demand it.

Name of Company: Kottayam Port & Container Terminal

Contact Person: Mr. Cherian K. Varghese

Designation: Chief Executive Officer

As per discussion with the Chief Executive Officer of KPACT, Mr. Cherian K. Varghese, KPACT needs IWAI to develop certain facilities, which includes a jetty, cranes for handling cargo and smooth navigation in the proposed waterway.

Name of Company: State Water Transport Department

Contact Person: Mr. Shaji V Nair

Designation: Director

Mr. Nair shared his inputs regarding the existing ferry services in Alappuzha, Kottayam & Changanassery. SWTD has witnessed increasing growth in the demand of ferries for passengers/tourists. SWTD has a plan to move Catamaran boat for passengers and tourists. When asked about the potential of Ro-Ro in the existing ferry routes, Mr. Nair shows optimism for Ro-Ro;

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however he showed concern about less draft problem in some places in the waterway. He said that if the problem of less draft is solved then there is good potential for Ro-Ro in the waterway.

Name of Company: Travancore Cements Ltd.
Contact Person: Mr. P. Ashok Kumar / Mr. Kanan
Designation: Deputy Manager (Marketing)/ Deputy Manager (Maintenance & Internal Projects)

In 2017: As per Mr. Kanan, at present the company does not use Vembanad Lake for lime shell, which was the major raw material for manufacturing cement. Earlier, TCL used to procure limestone from Tirunelveli, Tamil Nadu through roadways, however at present TCL stopped using lime shell and limestone as raw materials. TCL now uses clinker as substitute because Limestone and lime shell are calcium carbonate and clinker also is made of the same material. TCL imports clinker from Gulf countries through Cochin Port and the company's expansion plans are also depended on clinker as raw material. According to Mr. Kanan, the plant of TCL is shut down now; however it would start operation form June 2017. The plant produces around 2,000-2,500 tonnes of white cement per month.

TCL has shared some concerns about using IWT Waterway, they are listed below.

- According to Mr. Kanan, the draft of the existing NW in some places is less, i.e. 2 mtrs. only, which is very less for even medium size vessels.
- Mr. Kanan also shared his concern about Thanneermukkom Bund, which is a gate type structure in Vembanad lake and used as salt water barrier. This barrier essentially divides the lake into two parts. This barrier opens when any ship or vessel crosses; however the breadth of the barrier is very less and is not enough for bigger vessels. TCL plans to transport 500-1,000 metric tonne clinkers in one go through vessels in waterway. This means the size of their vessel would be bigger and the opening structure would not be sufficient for the vessel to cross. If IWAI solves this problem, then TCL would like to use waterway extensively in future for its plant.
- The proposed waterway would stretch till Kollam in South; however TCL is interested to use waterway further ahead in South, if IWAI develops waterway in South.
- TCL has an expansion plan to increase production of grey cement to 10,00,000 tonnes (1 mn T) and white cement to 60,000 tonnes. The raw material for this plant would be clinker.
- However, in future the company may consider using limestone also. The expansion plan is at DPR stage now.
- TCL has offered IWAI a parcel of land on its premise for the development of a terminal and additional infrastructure. This development would be based on mutual agreement and revenue profit sharing with IWAI.

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In 2018 According to Mr. Kanan, the plant of TCL is operational now. At present, the plant consumes 1000 tonnes clinker per month for manufacturing white cement. It produces 1000 tonnes of white cement per month. It is expected that the production of white cement would increase to 1200 – 1500 tonnes per month.

- The production of grey cement depends on future market demand. Therefore, as of now, it is not certain.

Name of Company: MRF, Kottayam

Contact Person: Eapen George

Designation: Sr. Manager

Mr. George shared that the annual capacity of MRF, Kottayam plant is 56,000 tonnes. The plant produces around 160 tonnes per day and they have 350 working days in a year. The plant uses Cochin Port for EXIM trade. Synthetic rubber is used as raw material and is imported from Russia, Japan & USA. Natural rubber is imported from Malaysia. The company also uses Cochin Port for export to different countries. At present, MRF is using roadways to transport cargo to/from Cochin Port. The company faces road congestion problems on highways on a daily basis.

As per Mr. George if the waterway is developed by IWAI and the transportation cost by waterways is cheaper, then definitely they would prefer waterway for their cargo transportation.

Name of Company: Oil Palm India

Contact Person: V.M. Jaisar

As per the discussion with Mr. Jaisar, the company produces 20 tonnes per hour palm oil. The company's annual production is around 0.17 million tonnes/annum. The finished product, refined oil is distributed in different states of India through roadways, using lorries. The company does not export its products to different countries. Oil Palm India is not willing to use waterways for transportation of its cargo.

Name of Company: Petrogas India

Contact Person: Mr. A.V. Varghese

Designation: Plant Manager

Petrogas India doesn't import anything. However, the company exports its products to different countries. For export, Cochin Port is used. The company also distributes its products in domestic market through roadways. Export quantity varies according to order; on an average the company exports 30 tonnes product per month.

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Name of Company: Diamond Roller Flour Mill

Contact Person: Mr. E.K. Shajahan

Designation: General Manager

As per discussion with Mr. Shajahan, the company is involved in EXIM trade. The annual capacity of the plant is 66,000 MT. The plant procures raw material from Rajasthan, Gujarat, MP, UP and sometimes imports from other countries too through Cochin Port. The plant distributes the finished product to Kerala and Tamil Nadu; it also exports to other countries. Rail & Coastal Shipment is used for raw material movement, whereas road is used for transporting finished products.

As per discussion with the company representative, the major hurdle of present mode of transportation cargo is that Rail transportation in full rake load entails demurrage. The company is willing to use waterway if it is cost effective. Mr. Shajahan was concerned that multiple handling may add to transportation cost.

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ANNEXURE 5.1– CALCULATION OF PILE CAPACITY

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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 NW8

Dia of Pile (D) =	1.40	m		0 to 2.9 m	2.9 to 9.0 m	9.0 to 15.9 m
Ground Level =	0.85	m	Saturated Unit Weight (kN/m^3) =	8.30	6.90	7.2
Pile Cutoff Level =	2.5	m		15.9 to 19.5 m	19.5 to 24.0 m	24.0 to 25.6 m
Maximum Scour Level	-4.8	m		7.0	8.3	8.4
FoS (Bearing and Friction)	2.5		Ultimate Shaft Resistance = S ((Ks*Pdi*tanδ)*Asi + a*C(As))			
Effective Length of Pile = 15D =	21	m	Ki = Earth Pressure Coefficient	**Value**	**ϕ (Degree)**	**Factor**
Length of Pile below Scour level =	40.85	m		1	30	
Unit Weight of Reinforced Concrete	25	kN/m^3		1.5	40	0.05

Depth below NSL (m)	EL (m)	Friction angle (ϕ) as per Fig-1 (IS 6403)	Cohesion (C) kN/m^2	Wall Friction Angle δ (Degree)	Earth Pressure Coefficient (Ki)	Adhesion Factor (α)	Overburden Pressure at bottom of the	al Area of Pile Shaft (Asi) (m^2)	Ultimate Shaft Friction (kN)
0	0	0	0	0	0	0	0	0	0
1.5	-0.65	33	0.00	33	1.15	1.00	12.45	6.60	30.7
3.75	-2.9	33	0.00	33	1.15	1.00	31.125	9.90	161.0
4.5	-3.65	12	23.00	12	1.00	1.00	36.3	3.30	99.5
5.65	-4.8	12	23.00	12	1.00	1.00	44.235	5.06	159.6
7.5	-6.65	12	23.00	12	1.00	1.00	57	8.14	274.7
9	-8.15	12	23.00	12	1.00	1.00	67.8	6.60	239.2
9.85	-9.00	12	23.00	12	1.00	1.00	73.92	3.74	142.3
12	-11.15	8	32.00	8	1.00	1.00	89.4	9.46	411.1
12.9	-12.05	8	32.00	8	1.00	1.00	95.88	3.96	178.2
15	-14.15	8	32.00	8	1.00	1.00	110.58	9.24	429.6
16.75	-15.9	8	32.00	8	1.00	1.00	122.83	7.70	372.5
18	-17.15	22	0.90	22	1.00	1.00	131.58	5.50	287.5
19	-18.15	22	0.90	22	1.00	1.00	138.58	4.40	244.0
20.35	-19.5	22	0.90	22	1.00	1.00	148.03	5.94	349.1
21	-20.15	20	0.22	26	1.00	1.00	152.58	2.86	210.2
23	-22.15	20	0.22	26	1.00	1.00	152.58	8.80	656.6
24.85	-24	20	0.22	26	1.00	1.00	152.58	8.14	607.3
25.6	-24.75	26	0.30	26	1.00	1.00	152.58	3.30	246.5
26.45	-25.6	26	0.30	26	1.00	1.00	152.58	3.74	279.3
28	-27.15	26	0.30	26	1.00	1.00	152.58	6.82	509.4
31	-30.15	26	0.30	26	1.00	1.00	152.58	13.19	985.9
34	-33.15	26	0.30	26	1.00	1.00	152.58	13.19	985.9
37	-36.15	26	0.30	26	1.00	1.00	152.58	13.19	985.9
40	-39.15	26	0.30	26	1.00	1.00	152.58	13.19	985.9
43	-42.15	26	0.30	26	1.00	1.00	152.58	13.19	985.9
45	-44.15	26	0.30	26	1.00	1.00	152.58	8.80	657.3
46.5	-45.65	26	0.30	26	1.00	2.00	152.58	6.60	494.9
						Total Ultimate Skin Friction Resistance, Qst (kN) =			11519.13
						Total Allowable Skin Friction Resistance, Qst (kN) =			**4607.65**

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) =	0.30	kN/m^2
Depth of Pile Tip (Pile Bottom) from Ground Level =	46.5	m
Effective Overburden Pressure at Pile Tip =	152.58	kN/m^2
Angle of Internal Friction at Pile Tip (ϕ) =	26	degree
Bearing Capacity Factor (Nc)	22.6	(As per IS 6403 -1981)
Bearing Capacity Factor (Nq)	13.000	(As per Fig 1 of IS 2911Part-1 Sec-2 -2010)
Bearing Capacity Factor (Nγ)	13.180	(As per IS 6403 -1981)
End Bearing (T) =	3181.74	kN
Allowable End Bearing Capacity of Pile =	**1272.70**	**kN**
Self Weight of Pile =	1756.82	kN
Net Bearing Capacity of Pile =	**4124.0**	**kN**

Uplift Capacity of Pile

Safe Uplift Capacity of Pile = 2/3*Frictional Resistance =	3071.77	
Safe Uplift Capacity (Including Weight of Pile)=	**4829.0**	**kN**

ANNEXURE 8.1– RIS / AIS

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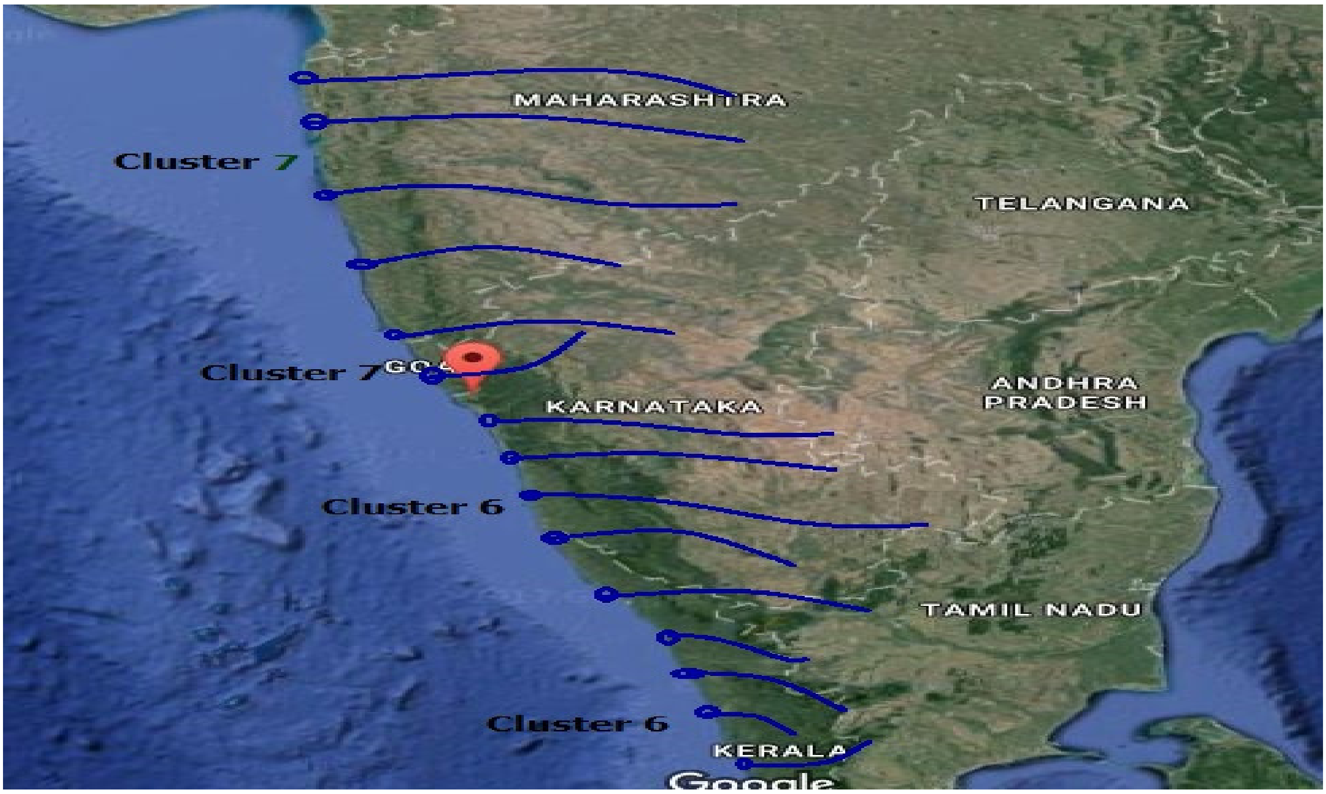
RIVER VESSEL TRACKING INFORMATION SYSTEM

- 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



Services for skippers

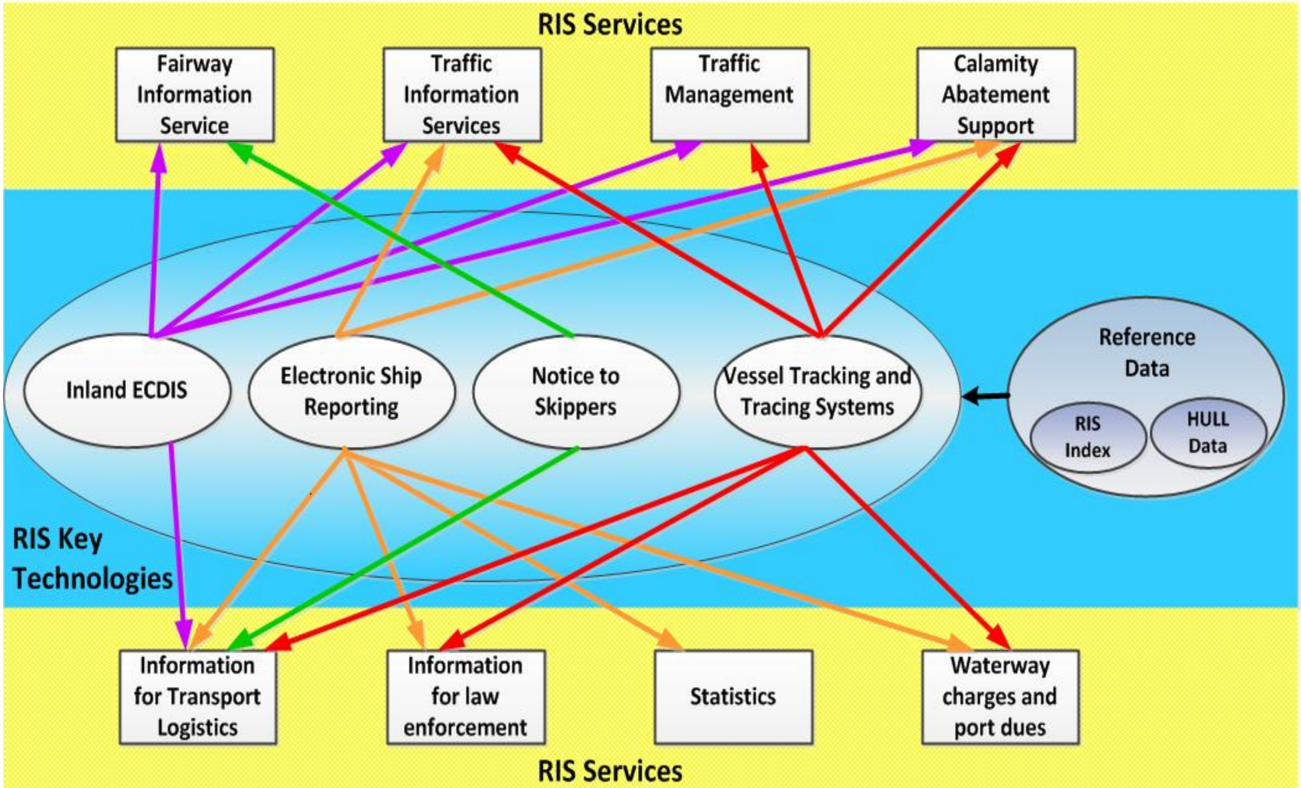
- Electronic Navigational Charts / Inland ECDIS
- Information on nautical conditions (fairway, obstructions, water level, etc.)
- Real time traffic information
- Electronic reporting of cargo and voyage
- Electronic pre-announcement at locks and harbours

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

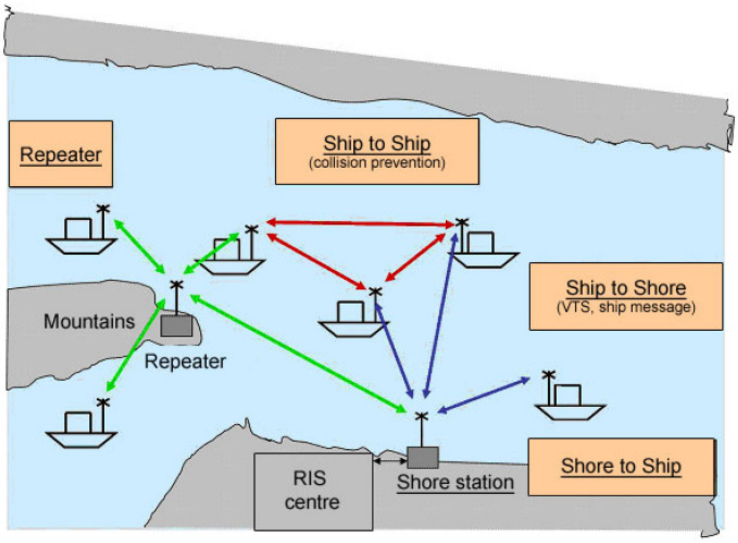


The key technologies of RIS are

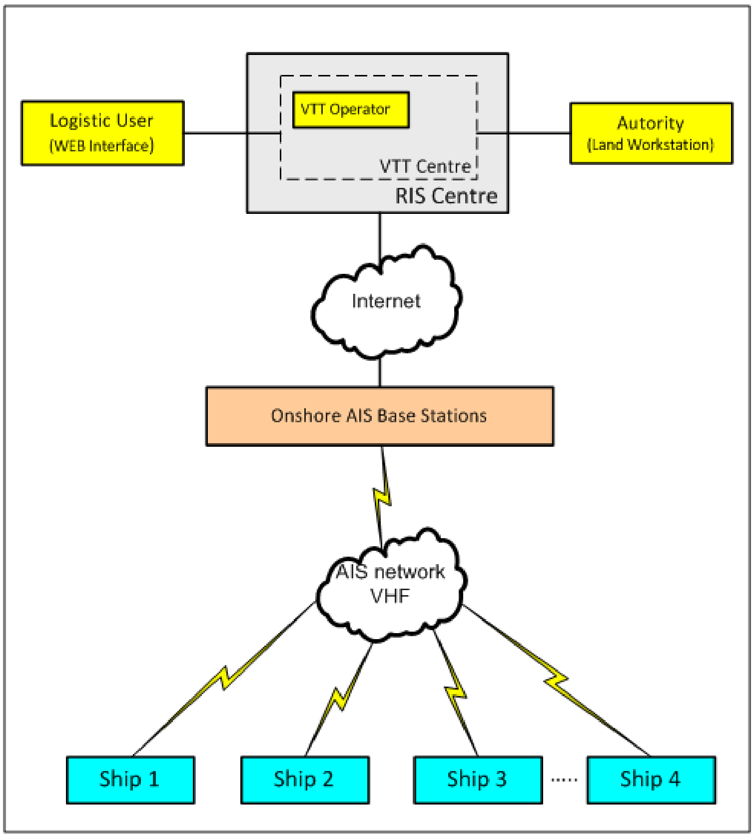
- VTT (Vessels Tracking and Tracing)
- ECDIS (Electronic Charts)
- NtS (Notice To Skippers)
- ERI (Electronic Reporting International)
- HULL Database
- LMS (Lock Management System)

Some technologies needs to be adapted to the local laws and operating procedures.

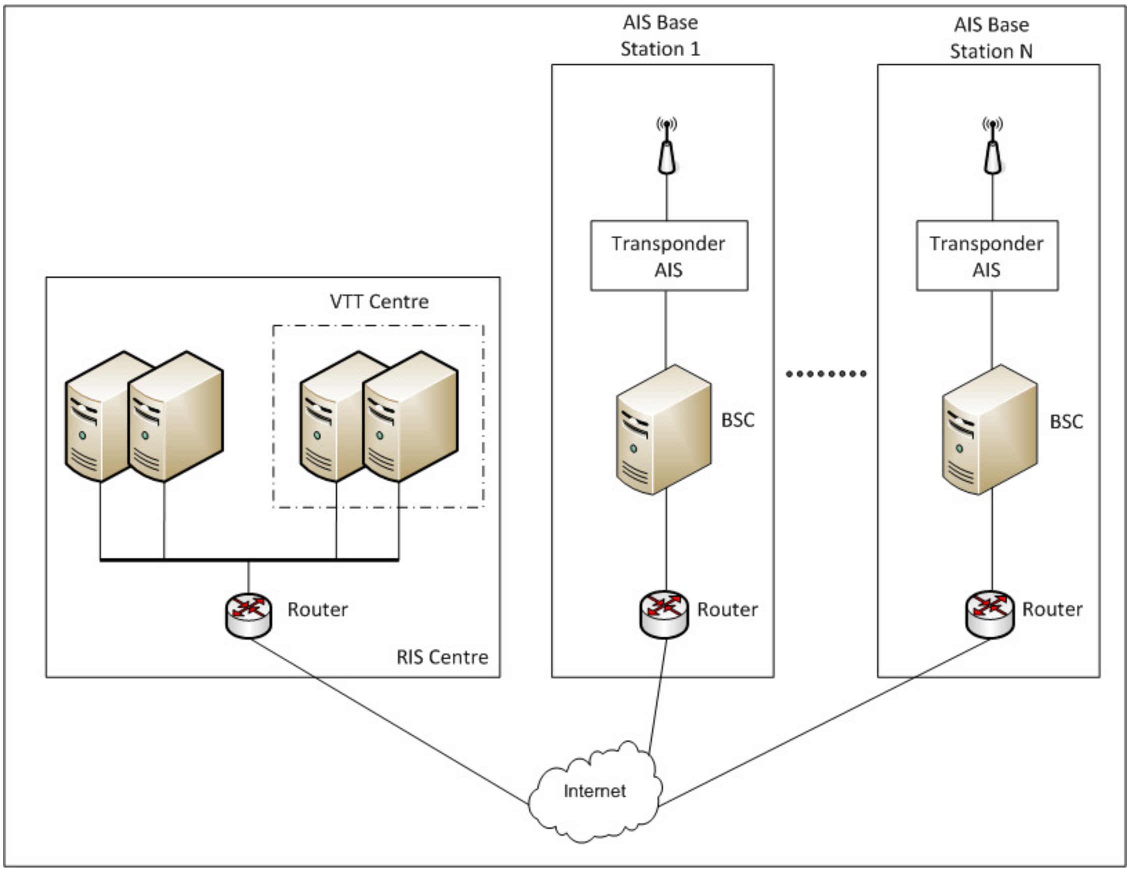
System to get a Strategic and Tactical Traffic Image using AIS technology with INLAND extension



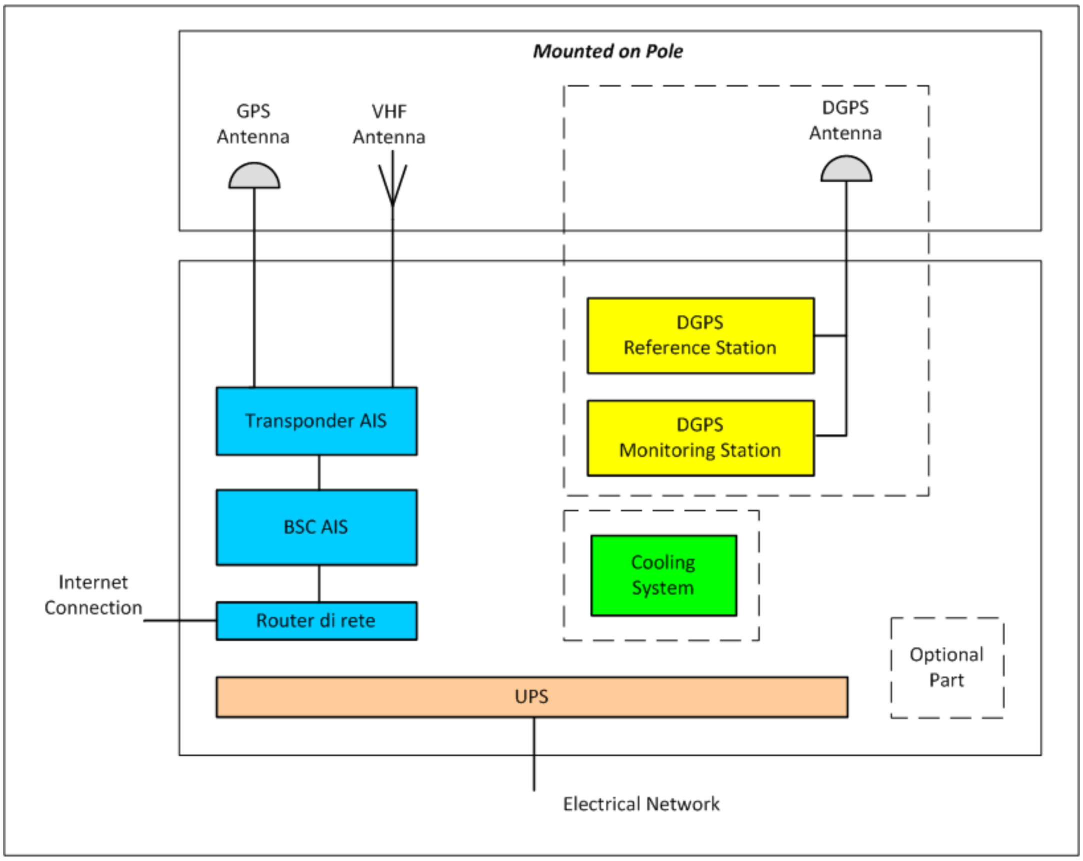
Onboard AIS devices transmit the identity of the vessel, its position and other data at regular intervals. By receiving these transmissions, AIS shore stations or ships fitted with AIS can automatically recognize, identify and track vessels equipped with AIS on a suitable screen, such as an inland ECDIS 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.



AIS BASE STATION & RIS CENTRE ONSHORE FACILITIES

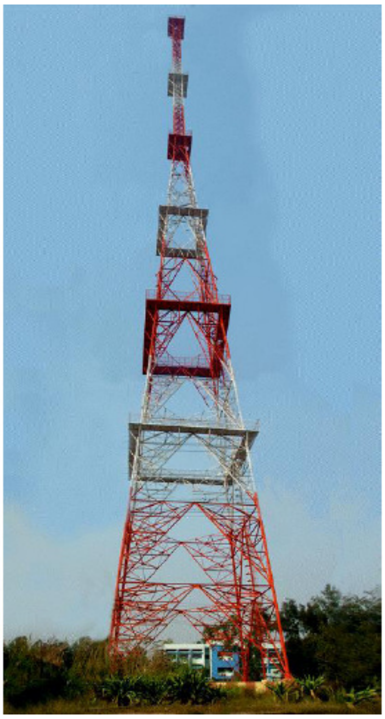


AIS BASE STATION



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

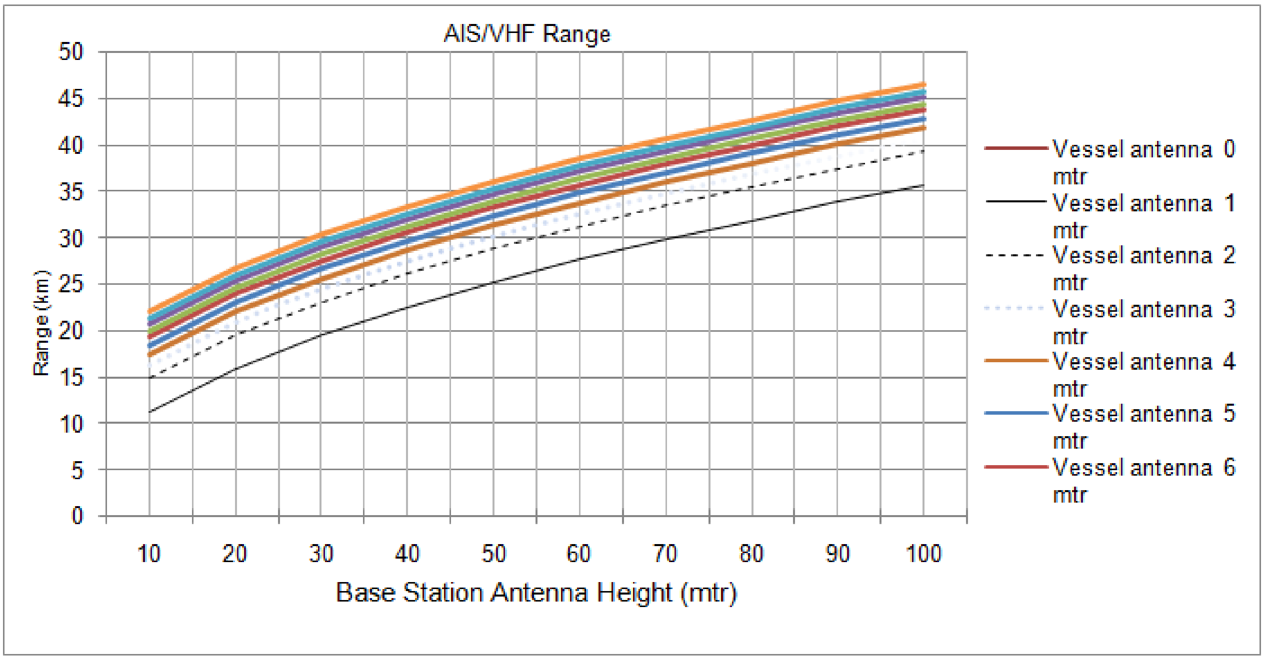


AIS STATION VHF RANGE

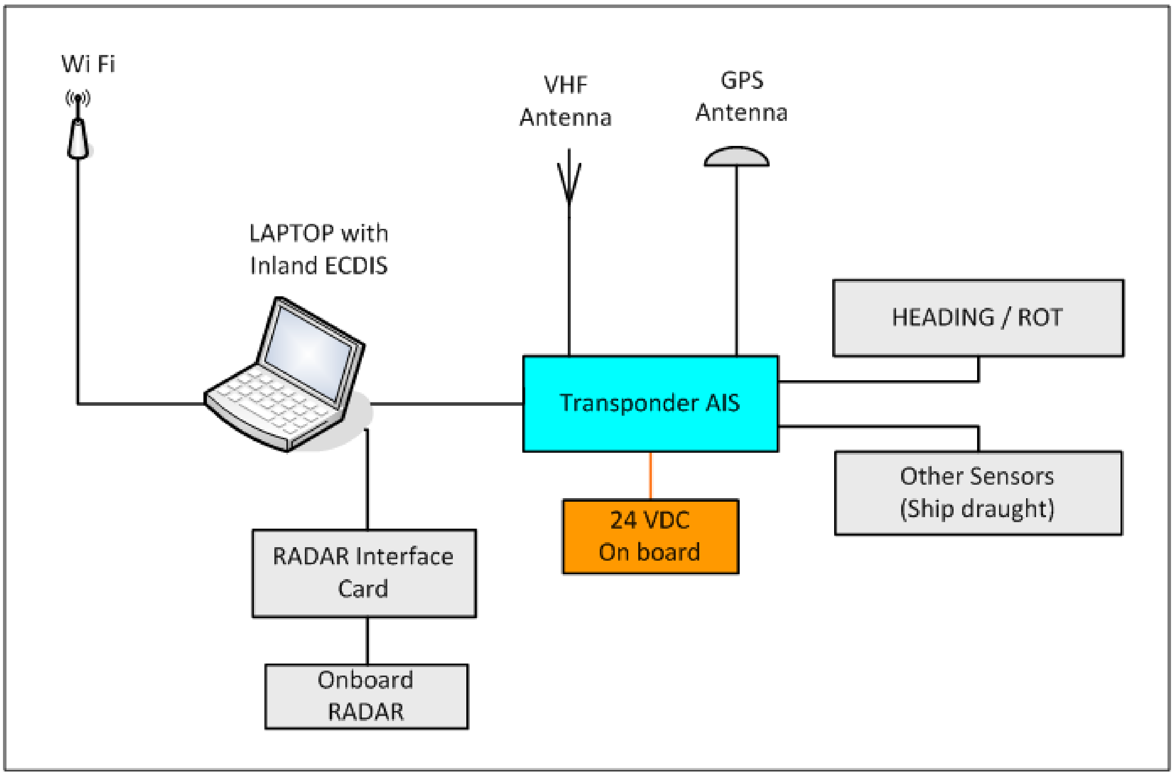
AIS/VHF Range

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

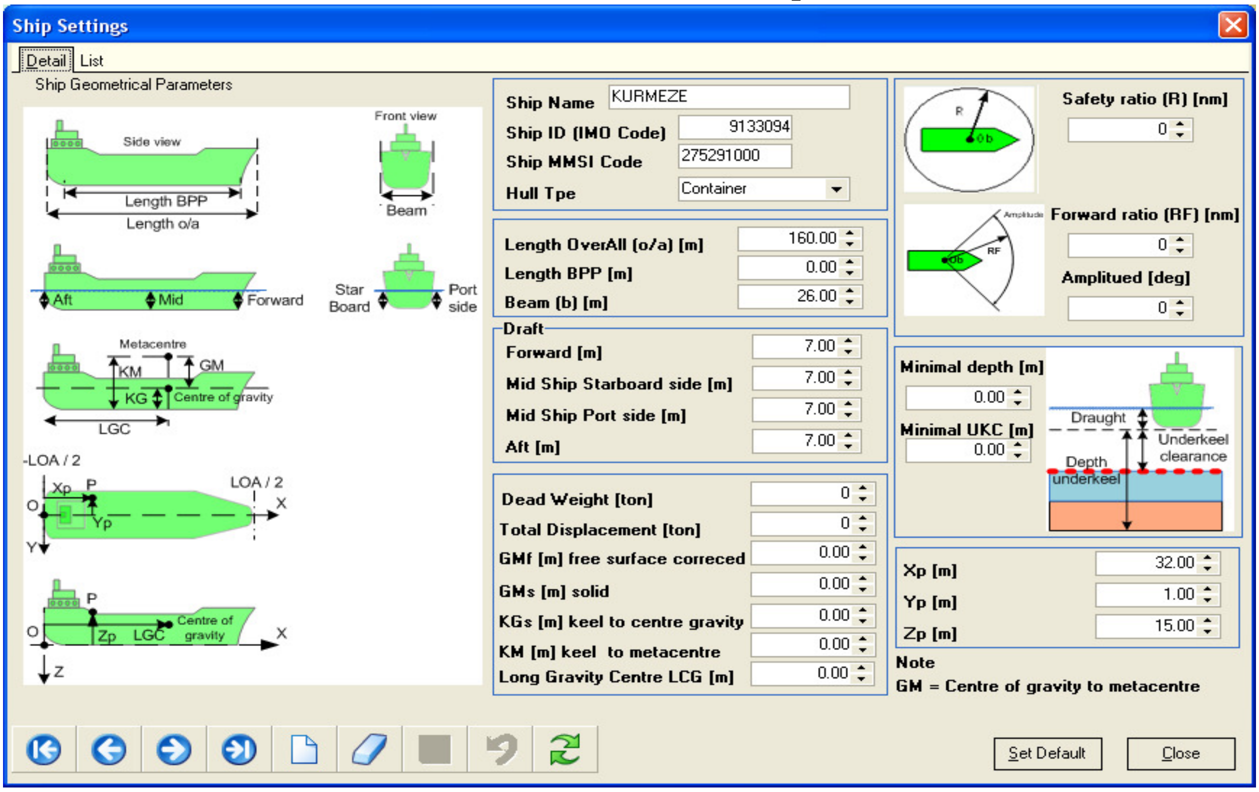


AIS ON BOARD DEVICE



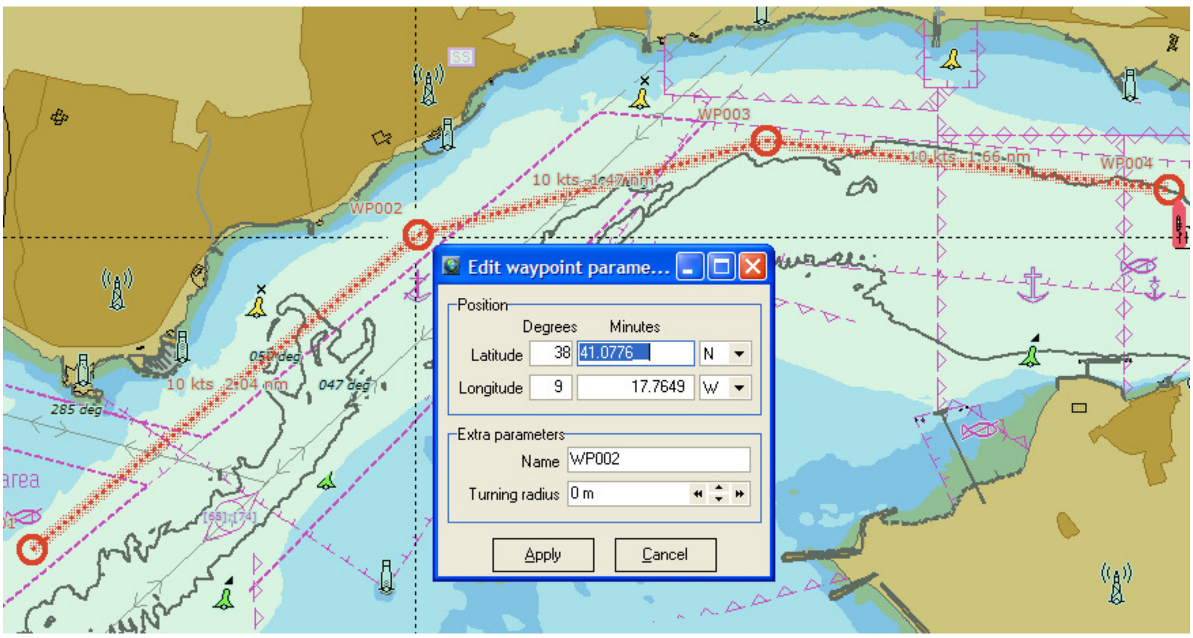
ONBOARD ECDIS INTERFACE

Interface to insert ship data

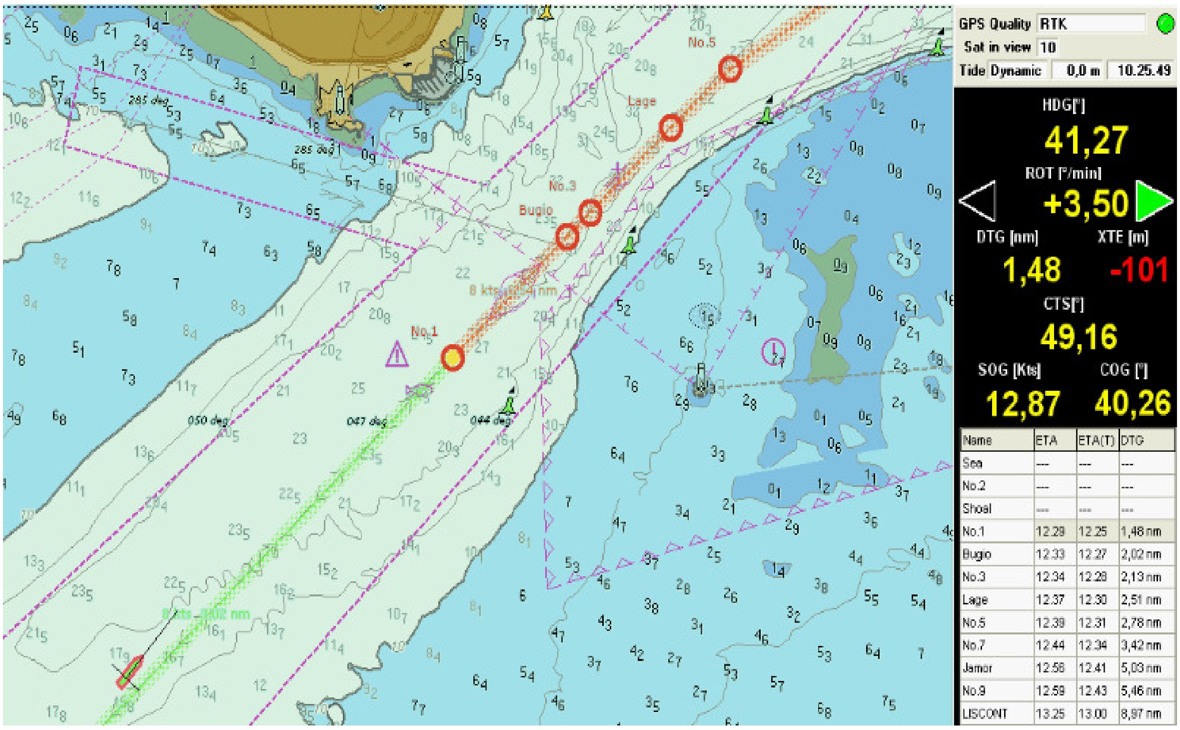


ONBOARD INTERFACE

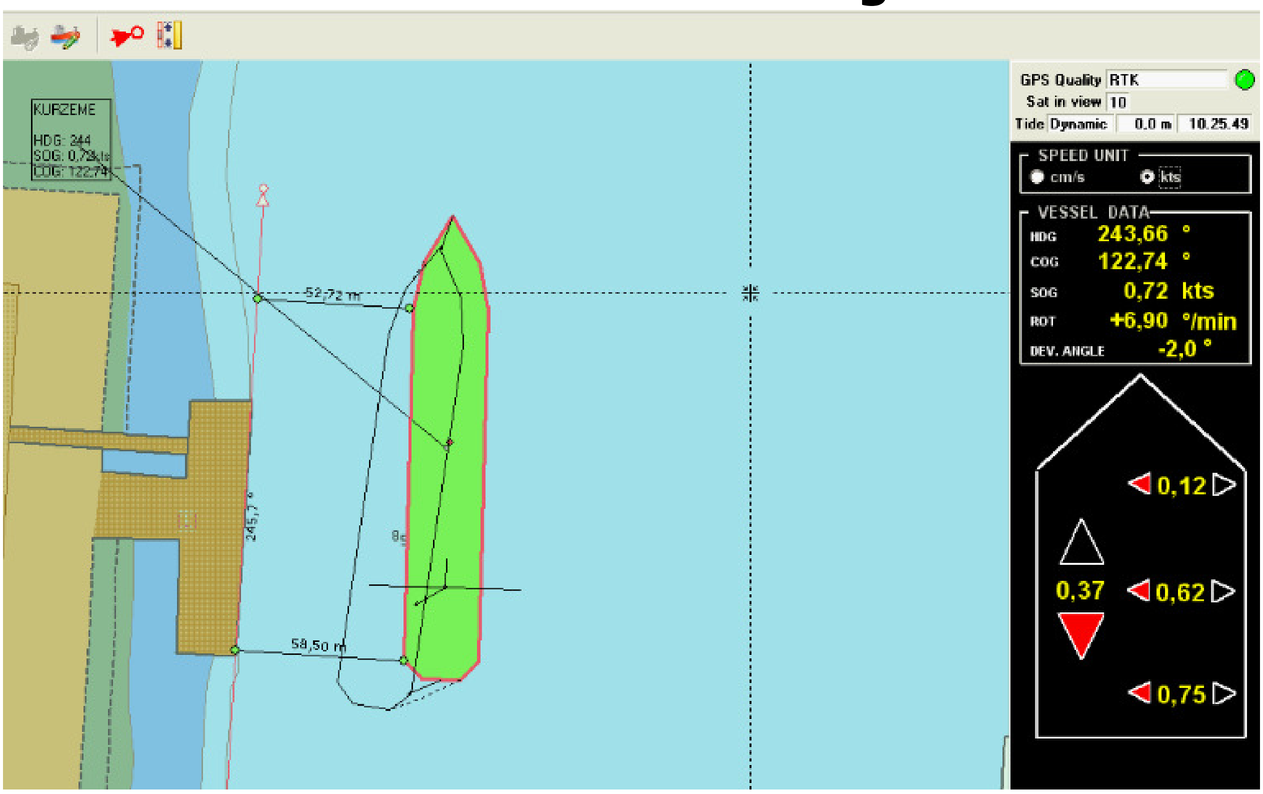
Interface to for voyage planning



Interface in navigation mode

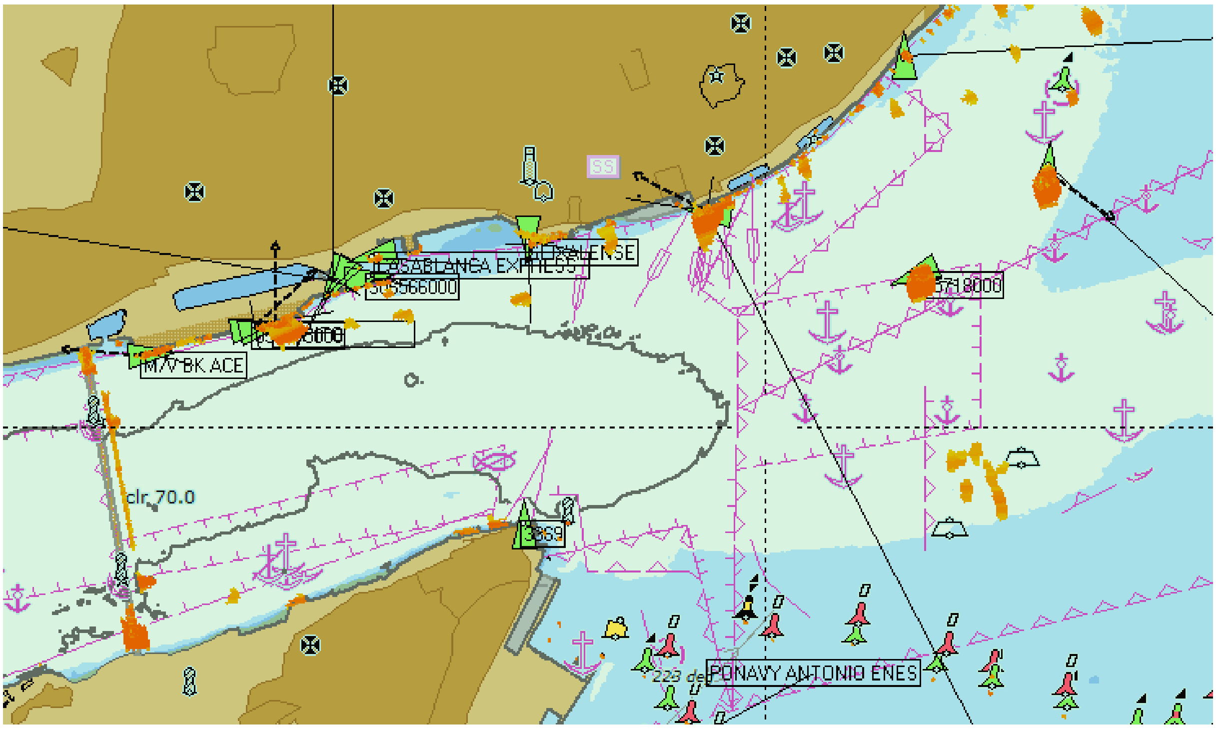


Interface for docking

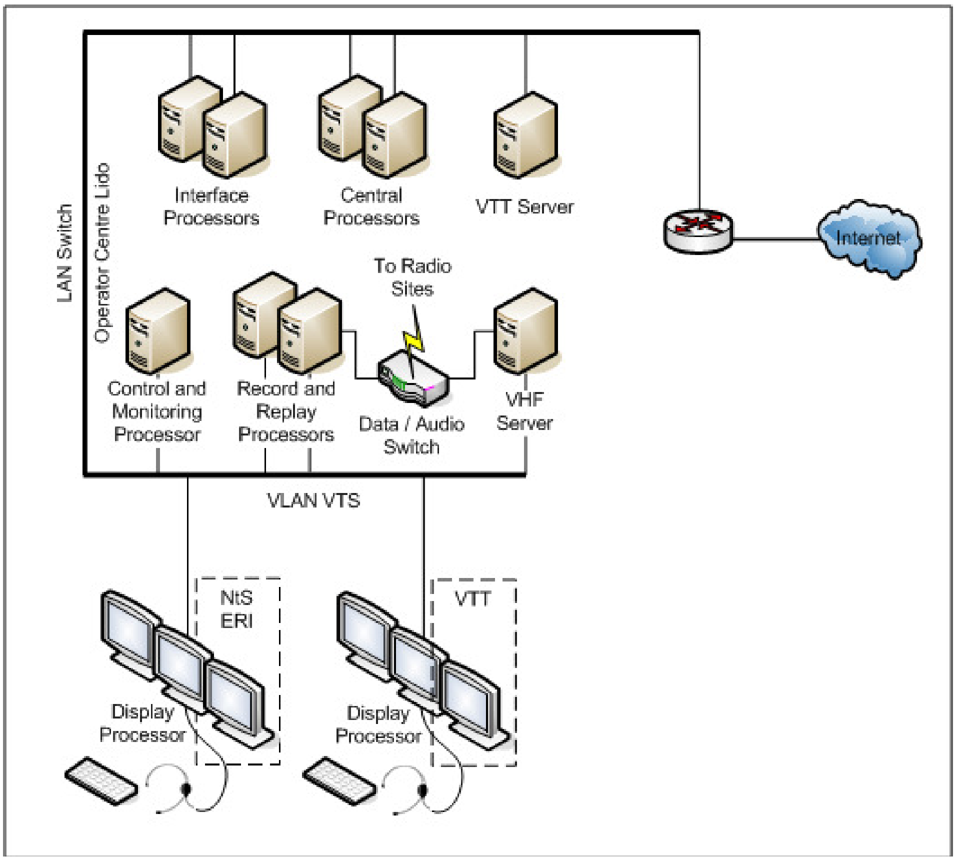


ONBOARD INTERFACE

Tactical Traffic Image + RADAR

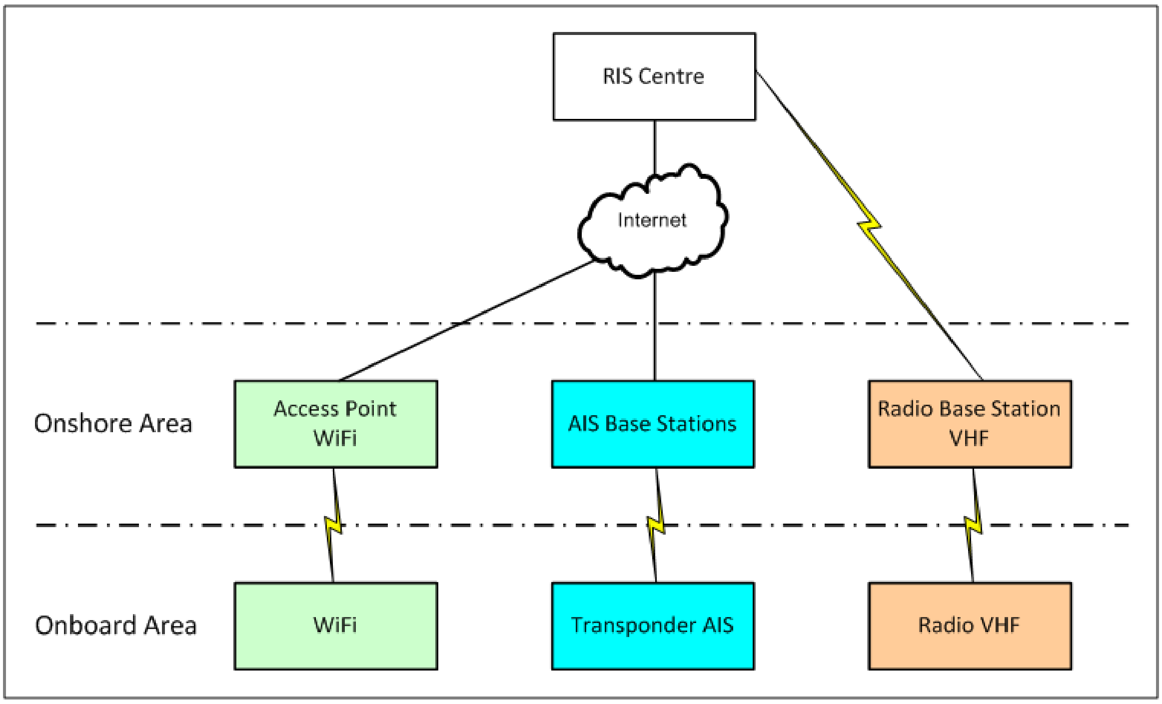


RIS CENTRE



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

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No. F.No.14-9/2016-IA-III
Government of India
Ministry of Environment, Forest and Climate Change
(Impact Assessment Division)

Indira Paryavaran Bhawan
Jor Bagh Road, Aliganj
New Delhi-110003

Dated: 21st December, 2017.

OFFICE MEMORANDUM

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

This has reference to your Office Memorandum IWT-11011/89/2016-IWT-(Vol.II) dated 7th December 2017 on the above mentioned subject.

2. The minutes of the meeting held under chairmanship of Hon'ble Minister, Road Transport & Highways, Shipping and Water Resources, River Development & Ganga Rejuvenation held on 24.10.2017 concluded that as per the extant legal position, no prior EC is required for maintenance dredging for navigational channel for Inland Waterways.

3. In view of the above the Ministry of Shipping may like to go ahead with the decision taken during the meeting held under chairmanship of Hon'ble Minister, Road Transport & Highways, Shipping held on 24.10.2017 subject to the implementation of the environmental safety measures as enclosed as annexure.

4. This issues with the approval of the competent authority.

Sharath Kumar 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.

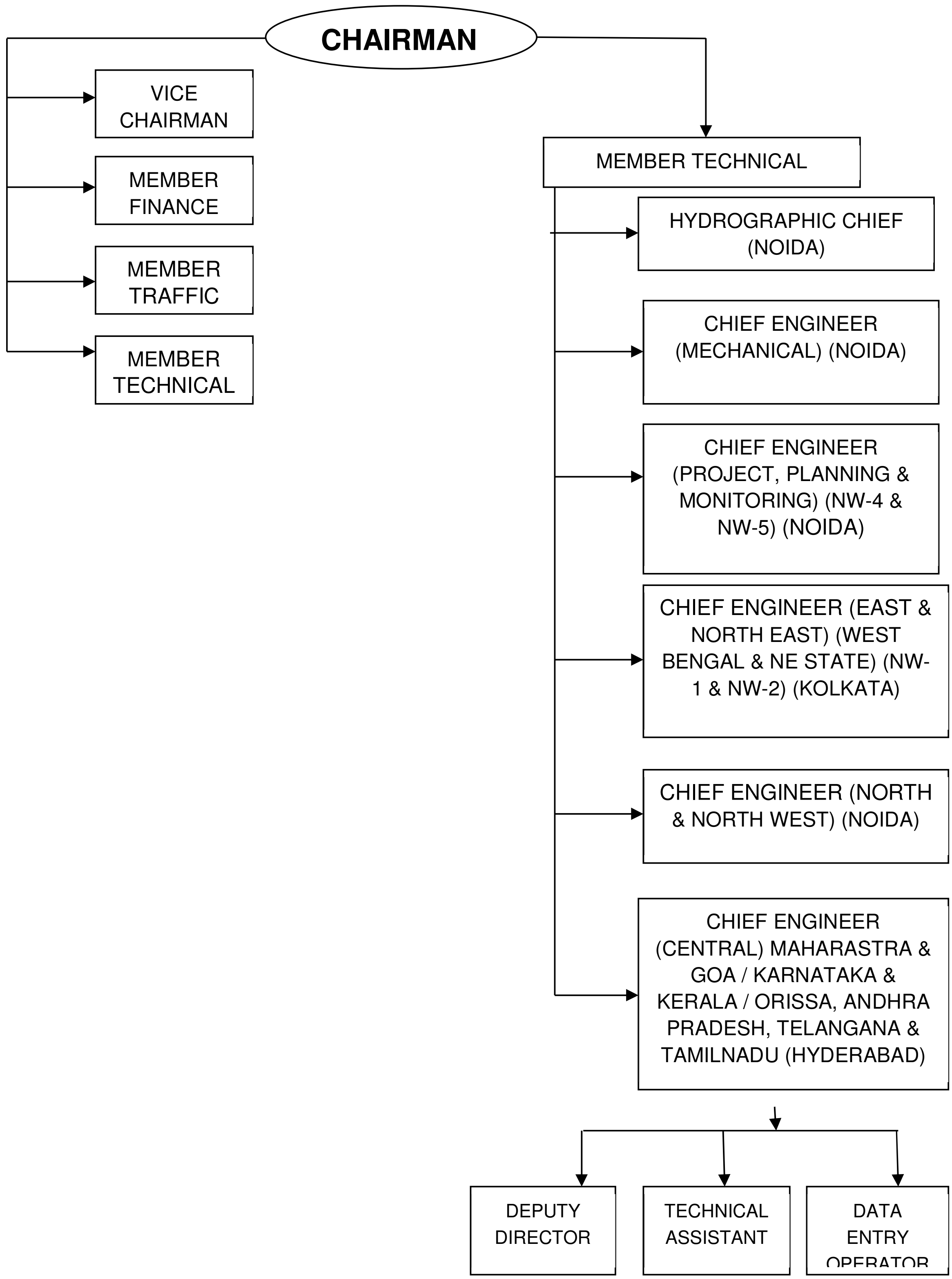
xxviii. The Vessels shall comply the emission norms prescribed from time to time.

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



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ANNEXURE 11.1 – COSTING/FINANCIAL ASSUMPTIONS

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FINANCIAL ANALYSIS

Broad Assumptions

Based on Financial Analysis as per DPR of NW5

Abstract

Broadly identified assumptions in order to facilitate financial analysis of Category II shortlisted waterways development

Inland Waterways Authority of India

FINANCIAL ANALYSIS BROAD ASSUMPTIONS[1]:

Capital Expenditure:

Elements to be covered (based on planned infrastructure requirement for respective rivers)

Suitable assumptions with relevant justification shall be made for any missing items.

CAPEX HEAD	TOTAL COST (INR CRORE)
Land Acquisition	Cost initially to be considered for acquisition of land for land side development of floating jetty
Dredging	**Normal Condition** Standard dredging rate of Rs. 200/cum to be considered. Suitable adjustments shall be made (with proper justification) for change in quality of dredge material/any special requirement for disposal of dredge material
Barrages with Navigational Locks	Based on requirement standard charges as per Planned Infrastructure of respective rivers.
Raising Banks	
Protection Measures	
Environmental Monitoring	
Navigational Aids	
Bridges	
Cross Drainage Works	
Facilities to Local People	
Terminals	Initially while calculating CAPEX terminal cost shall include cost for development of required numbers of floating jetty along respective waterways, cost of equipment, manpower required for terminal operation
Total Capital Expenditure	**Sum of all parameters mentioned above**
DC, PMC, IE Services, Loan Fees	10% of Total CAPEX
Overall Contingency	3% of Total CAPEX
Escalation	1.5% of Total CAPEX
Total Hard Capex	
Interest During Construction	
Total Project Cost	

Operations & Maintenance Expenditure:

(Pick up the cost items relevant to your study and planned infrastructure components)

Suitable assumptions with relevant justification shall be made for any missing items.

Annual Escalation shall be assumed @ 5.0%.

[1] These assumptions are to facilitate consultants in giving a sense of direction in which they shall move to make the reporting of final outcome consistent. Any missing information shall be assumed suitably (with valid justification) by the consultants in order to provide desired end result.

Cost Items	% of CAPEX
Dredging	5%
Cross Drainage	2%
Locks	2%
Bridges	1%
Terminals	2%
Navigation Aids	2%
Protection Measures	2%
Raising Banks	2%
Facility to Local People for Ferry Services	2%
Environmental Monitoring	2%
Cost of Barrages with Navigation Locks	2%
Total Waterway O&M Costs	

Revenue Estimation:

For estimating the revenue, the tariff structure proposed by IWAI (Levy & Collection of fees and charges) Regulations, 2011 shall be used as a reference.

Existing Tariff Structure & Charges by IWAI (Shall be verified from the latest published Tariffs)

Suitable assumptions with relevant justification shall be made for any missing items.

Tariff Heads	Charge unit	Charges (INR)
(A) Usage Charges		
Movement of Vessels	GRT/km	0.02
(B) Vessel related charges		
Berthing charges	Vessel	1000.00
Towage	Vessel/hour	600.00
Pilotage	Day	750.00
(C) Cargo related charges		
(i) Terminal Charges		
Dry Cargo	Ton (or part thereof)	1.00
Liquid Cargo	Ton (or part thereof)	1.00
Containerised Cargo	TEU	50.00
(ii) Transit shed charges		
First 3 days	MT per day	
First 7 days	MT per day	
7-21 days	MT per day	5.00
22-35 days	MT per day	10.00
After 35 days	MT per day	40.00
(iii) Open storage charges		
Hard Stand		
First 3 days	MT per day	
First 7 days	MT per day	0.00
7-21 days	MT per day	2.00
22-35 days	MT per day	4.00
After 35 days	MT per day	16.00
On Open Area		
First 3 days	MT per day	

Tariff Heads	Charge unit	Charges (INR)
First 7 days	MT per day	0.00
7-21 days	MT per day	1.00
22-35 days	MT per day	2.00
After 35 days	MT per day	8.00
(D) Composite Charges		
Movement of Over Dimensional Cargo	Per MT per km	1.50
Customs clearance convenience charges	Per MT	40.00
(E) Miscellaneous charges		
Crane, fork lift, bunkering of fuel, water supply, etc.	Of total revenue	
Crane (including Pontoon crane)		
5 MT capacity Crane	Per shift of 8 hrs	800.00
20 MT capacity Crane	Per shift of 8 hrs	2000.00
>20 MT capacity Crane	Per shift of 8 hrs	2500.00
Container Crane	Per hr	1100.00
Fork Lift (3MT capacity)	Per shift of 8 hrs	600.00
Electricity supply to Vessels		As per Electricity Board
Bunkering of fuel/ Petroleum Oil Lubricants		As per Market Rates
Water Supply	Per km	300.00
Sewage Disposal	Per km	100.00
Weighing scale	Per MT	5.00

In order to estimate the effective charge that the end users are expected to face, it is assumed that the margin charged by barge operators is Rs. 1.20 per MT per km.

FINANCING

The financing parameters considered for the study are as follows:

Suitable assumptions with relevant justification shall be made for any missing items.

Item	Unit	Value
Leverage Ratio	% Debt	70%
Moratorium	Quarters	2
Door-to-door Tenor	Years	15
Interest Rate	%	8%
Debt Drawal Start Quarter	No.	1
Debt Repayment Start Quarter	No.	22
Debt Repayment End Quarter	No.	60
Discount Rate (For NPV calculations)	%	16%

OTHER ASSUMPTIONS

Suitable assumptions with relevant justification shall be made for any missing items.

Tax Rate Assumptions

Type of Tax	Rate
Corporate Income Tax Rate	34.61%
Minimum Alternate Tax Rate	21.34%

Final IRR Reporting:

The consultant shall report the Project FIRR & EIRR considering different scenarios. Broadly the sensitivity shall include (but not limited to) following parameters as variable:

- Traffic (15-20% ± of projected divertible cargo, as at this stage the divertible cargo potential)
- Development Cost (15-20% ± of planned cost)
- Leverage Ratio (70:30 in base case, 10-15% ± in optimistic & pessimistic scenarios)

ANNEXURE 11.2 – ABSTRACT OF COST FOR FAIRWAY DEVELOPMENT

Abstract of Cost for NW 8 Fairway Development

S.No.	Item Description	Amount (in Lakh Rs.)	Schedule
A	**Fairway**		
1	Dredging		
(i)	General Soil	1092.70	Phase 1
(ii)	Hard Soil	0.00	Phase 1
2	Low Cost River Structures		
(i)	Bandaling	0.00	0.00
(ii)	Bottom Paneling	0.00	0.00
3	River Training Works		
(i)	Spurs		
(ii)	Bank Protection Works for river	2175.82	Phase 1
(iii)	Porcupine		
4	Night Navigation		
(i)	Channel Marking Buoy, Mooring Gear & Lighting Equipments	240.97	Phase 1
(ii)	Shore Marking with Lattice Bridge & Lighting Equipments	0.00	Phase 1
5	Land Acquisition	1045.44	0.00
	Sub-total (A)	**4554.92**	**0.00**
B	**Modification of Structures**		
(i)	Bridges	55.00	0.00
(ii)	Cables	28.00	0.00
(iii)	Dams	0.00	0.00
(iv)	Barrages	0.00	0.00
(v)	Locks	0.00	0.00
(vi)	Others	0.00	0.00
	Sub-total (B)	**83.00**	**0.00**
C	**Communication System**		
(i)	RIS Centre	0.00	0.00

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(ii)	AIS Base Station	0.00	0.00
(iii)	Vessels - Survey vessel & Other Vessel	0.00	0.00
(iv)	Buoys	0.00	0.00
	Sub-total (C)	**0.00**	**0.00**
D	**Institutional Requirement**		
(i)	Office Development Cost	40.00	
(ii)			
	Sub-total (D)	**40.00**	**0.00**
	Sub-total (A)+(B)+(C)+(D)	**4677.92**	**0.00**
E	Environmental Management Plan Cost as per chapter-9 of the DPR	74.21	0.00
F	Project Management & consultancy Charges @ 3% of Prime cost	140.34	0.00
G	Contingencies and Unforeseen Items of Works@ 3% of Prime cost	140.34	0.00
	Project total Hard Cost	**5032.81**	**0.00**

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ANNEXURE 11.3 –COST OF DREDGING

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Dredging in General Soil	Cum	4,46,000	245	1092.70
2	Dredging in Hard Soil	Cum	0	900	0.00
	Total Cost of Dredging				**1092.70**

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ANNEXURE 11.4 – COST OF BANK PROTECTION FOR RIVER

Cost of Bank Protection Works at Canal (with Pile & Slab) - NW8						
S.No.	**Item Description**	**Unit**	**Estimated Quantity**	**Rate (in Rs.)**	**Amount (in Lakh Rs.)**	**Remarks/ References**
1.0	**RCC Concrete Works (M40 grade concrete)**					
1.1.	3 Stages of slab of given sizes shall be considered:					
a)	1500x120x3000 =		0.54			
b)	1250x105x3000 =		0.39			
c)	1000x90x3000 =		0.27			
	Total Slab	**cum**	**1.20**			
1.2	Total depth of pile (from founding level)	m	8000.00			
	Pile section	sqm	250x250			
	Total Piles	**cum**	**0.50**			
	Total (1.1+1.2)	cum	1.70			
	Additional 10% for Filter		0.17			
	Additional 10% for Anchor		0.17			
	Total		**2.04**	**8297**	**16923.34**	DSR 2018, Cl.no. 5.33.1 & 5.34.3 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (1.89%) till march 2020. The combined effect is 1.01%
2.0	**Steel Reinforcement**					
	Reinforcement (@0.15/cum)	MT	0.30	**84419**	**25325.55**	DSR 2018, Cl.no.5.22.4 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
	Total				**42248.89**	
	Additional 3% PS & Contingencies				**1267.47**	
	Grand Total				**43516.36**	
	Cost/m				**14505.45**	
				Say	**14505**	
3.0	**Cost of Bank Protection Works for 15000 m**				**2175.82**	

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ANNEXURE 11.5 –COST OF NIGHT NAVIGATION WORKS

Cost of Night Navigation Works (Buoy & Lights) (Phase 1)

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Providing and laying 1.8 m dia. Polythene Buoy, Mooring Gear & fixing Lighting Equipments	No.	65	3,70,716	240.97
	Cost of Night Navigation Works				**240.97**

Rates based on Quotation / Market Rates

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ANNEXURE 11.6 –COST OF LAND FOR FAIRWAY

Sl. No.	Chainage From ---- To ---- (in Km)	Existing Width (in m)	Extra Width Requirement (in m)	Length (in m)	Area of Land Acquisition (in Sq. m)	Bank Protection Requirement (in m)	Remarks, If any
1	2	3	4	5	(6) = (4) x (5)	7	8
1	0 to 1	40	--	600			* > 50 m
2	1 to 2	*	--	1000			
3	2 to 3	*		600		1200	= No Bank Protection
4	3 to 4	*		1000		=	
5	4 to 5	*		200		=	
6	5 to 6	*		400		=	
7	6 to 7	40	10	800	8000	1600	
8	7 to 8	*		1000		=	
9	8 to 9	*		1000		=	
10	9 to 10	*		1000		=	
11	10 to 11	*		1000		=	
12	11 to 12	*		1000		=	
13	12 to 13	*		1000		=	
14	13 to 14	*		400		800	
15	14 to 15	*		800		1600	
16	15 to 16	*		1000		=	
17	16 to 17	*		500		1000	
18	17 to 18	*		1000		=	
19	18 to 19	*		1000		=	
20	19 to 20	*		1000		=	
21	20 to 21	*		1000		=	
22	21 to 22	*		1000		=	
23	22 to 23	*		1000		=	
24	23 to 24	*		1000		=	
25	24 to 25	*		1000		=	
26	25 to 26	10	40	1000	40000	2000	
27	26 to 27	20	30	1000	30000	2000	
28	27 to 28	30	20	1000	20000	2000	
29	28 to 29	40	10	1000	10000	2000	
30	29 to 29.13	10	40	300	12000	600	
					120000	14800	
					Say 12 Hectares	Say 15000 m	

Land Area=	12 ha.	120000	sq-m	Cost @ 871.2 per sq-m	1045.44

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ANNEXURE 11.7 –COST OF ENVIRONMENT AND SOCIAL ASPECTS

ESTIMATED ENVIRONMENTAL (EMP) & SOCIAL COSTS FOR VARIOUS STAGES (NW8)

Sl. No.	Project Stages	Cost (Rs. Lakh)	Remarks
1	Pre-Construction Stage	63.20	As provisioned in Chapter-9 of the DPR
2	Construction Stage	34.60	
3	Operational Stage	13.20	
	Total Estimated Budget	111.00	(Statutory Fee, Land Acquisition cost and R&R Costs are not included)
	Estimated EMP Budget for Ro-Ro terminal & Fairway development (Separately)		The project has two components which consists of fairway development & Ro-Ro terminal construction. The cost of INR.111.0 Lakhs shall be distributed in proportion to the capex for each of the components. Provision has already been catered in the proposed estimates appropriately.

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ANNEXURE 11.8 –WHOLESALE PRICE INDEX

India - Wholesale price index

1. Figure 0 may be treated as Index for particular item not available.
2. Figures for the latest two months are provisional. Latest two months are to be reckoned with reference to the latest monthly press release issued.

Base Year: 2011-12 = 100 (Revision of base year of All-India Wholesale Price Index (WPI) from 2004-05 to 2011-12 vide Press release by GOVERNMENT OF INDIA MINISTRY OF COMMERCE & INDUSTRY DEPARTMENT OF INDUSTRIAL POLICY & PROMOTION OFFICE OF ECONOMIC ADVISOR Udyog Bhawan, New Delhi, Dated 12th May 2017) https://eaindustry.nic.in/choose_item_201112.asp

Yearly Wholesale Price Index
Name of Commodity : ALL COMMODITIES
Type : Group Item
Weight : 100
Base Year : 2011-12 = 100

Calendar Year	Index
2020 - March	122.23
2019	121.2
2018	118.9

Source - Office of the Economic Adviser, Govt. of India, Ministry of Commerce & Industry Department for Promotion of Industry and Internal Trade (DPIIT)

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
2018	116	116.1	116.3	117.3	118.3	119.1	119.9	120.1	120.9	122	121.6	119.7	118.9417

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
2019	119.2	119.5	119.9	121.1	121.6	121.5	121.3	121.5	121.3	122	122.3	122.8	121.1667

% Increase in the Year 2019 = (122.8-119.2)/119.2 = 3.02%

Month/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
2020	123.4	122.2	121.1										122.23

% Increase/Decrease in the Year 2020 (Three Months) = (121.1-123.4)/123.4 = 1.86%

The combined effect of WPI from January 2019 to March 2020 shall be = (1+3.02%) X (1-1.86%) = 1.011%

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Abstract of Cost for Changanassery Ro-Ro Facility (NW8)

S.No.	Item Description	Amount (in Lakh Rs.)
A	**Terminal**	
(i)	Land	153.57
(ii)	Riverine Components	765.62
(iii)	Infrastructure Components including internal roads	689.46
(iv)	Approach Road (External) Cost	3.50
(v)	Bank Protection Works for terminal	689.02
	Sub-total (A)	**2301.18**
B	**Vessels**	
(i)	Vessel Size	0.00
(ii)	Vessel Capacity	0.00
	Sub-total (B)	**0.00**
C	**Equipments for Both Terminals**	
(i)	Ambulance - 1 no.	18
(ii)	Dumper Trucks 16 T Capacity - 1 no.	0
(iii)	Cranes with 50 T Capacity - 1 no.	0
(iv)	Fork lift trucks 20 T Capacity - 1 no.	0
	Sub-total (C)	**18.00**
	Sub-total (A)+(B)+(C)	**2319.18**
D	Environmental Management Plan Cost as per chapter-9 of the DPR	36.79
E	Project Management & consultancy Charges @ 3% of Prime cost	69.57
F	Contingencies and Unforeseen Items of Works @ 3% of Prime cost	69.57
	Project total Hard Cost	**2495.02**

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ANNEXURE 11.10 –COST OF LAND FOR Ro-Ro

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks
A	**Terminal (T)**					
1	Land Area Cost					
(i)	Land inside the terminal area	m^2	15000.00	958.32	143.75	
(ii)	Land required for Road Extension or construction of external approach road	m^2	0.00	0.00	0.00	
(iii)	Area under Mangrooves clearance	m^2	0.00	0.00	0.00	
2	Land Cutting/Excavation for 0.7 m depth (Based on the Contours, considered the average depth as 0.7 m)	m^3	10500.00	93.57	9.82	DSR-2018, 2.1 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
	Sub-total 1				**153.57**	

The fairvalue of land shown in "Department of Registration-Govt. of Kerala" website is the value per Are (i.e. 87120 INR/ Are)

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ANNEXURE 11.11 –COST OF RIVERRINE STRUCTURES AT NW-8

Ro-Ro FACILITY AT TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ 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 1.4 m diameter					
	Vertical Piles					
	Grid A	No	9			
	Grid B	No	9			
	Grid C	No	9			
	Total Piles	cu.m	1,746			
1.2	Pile Caps (2000x1800x600)	cu.m	58.32			
1.3	Longitudinal Beams (1000x1250)					
	Grid A	cu.m	90.00			
	Grid A1	cu.m	90.00			
	Grid B	cu.m	90.00			
	Grid B1	cu.m	90.00			
	Grid C	cu.m	90.00			
1.4	Cross Beams (1800x1500)					
	grid 1 to 9	cu.m	291.60			
1.5	Deck Slab	Cu.m	302.40			
	Total Concrete	Cu.m	2847.98	8296.77	236.29	DSR 2018, Cl.no. 5.33.1 & 5.34.3 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
2.0	**Steel Reinforcement**					
	REINFORCEMENT - High yield strength deformed bars Reinforcement Grade Fe500 in reinforcing cage					

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S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ References
	including ring bars as detailed on the drawings					
2.1	Vertical Piles 1.4 m dia	MT	261.85			
2.2	Pile Caps (2000x1800x600)	MT	4.67			
2.3	Longitudinal Beams (1000x1250)					
	Grid A	MT	16.20			
	Grid A1	MT	16.20			
	Grid B	MT	16.20			
	Grid B1	MT	16.20			
	Grid C	MT	16.20			
2.4	Cross Beams (1800x1500)					
	grid 1 to 9	MT	52.49			
2.5	Deck Slab	MT	36.29			
	Total Reinforcement	MT	436	84418.50	368.31	DSR 2018, Cl.no.5.22.4 - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.011%.
3.0	**Structural Steel works**					
3.1	Structural Steel hand rail with steel grade Fy=240 Mpa	MT	120	1,02,869	123.44	DSR 2018, Cl.no.10.2 - - The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.011%.
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	3	85,868	2.48	As per Market rate. 7% escalation per annum
5.0	**Fenders**					

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S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ References
	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			35.00	
	Total cost of Riverrine Structures at Ro-Ro Terminal				**765.52**	

* Rates worked out based on the DSR rates duly considering related items.

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ANNEXURE 11.12 –COST OF STRUCTURES AT TERMINAL

S.No.	Facility	Nos.	Size	Area (in m2)	Rate (in Rs.)	Amount (in Lakh Rs.)
1	Open Mobility Area	1	-	4000	6,764.46	270.58
2	Covered Storage Godown	1			23,057.11	0.00
3	Ro-Ro Truck Parking	20	16m x 3m	960	1,510.31	14.50
4	40' Container Stack Yard	20	40 Sq. m	800	11,528.56	92.23
5	Parking for Handling equipments	1	-	2500	1,510.31	37.76
6	Main Parking Area	1	-	900	1,222.32	11.00
7	Public Utility	1	6m x 4m	24	37,494.96	9.00
8	Weigh bridge	1	8m x 3m	24	2,52,750.00	60.66
9	Utility Room (Near Weigh Bridge)	1	3m X3m	9	37,494.96	3.37
10	Area under internal Roads	1	7m x 100m	700	15,165.00	15.17
11	Bank Protection with Geotextile Bags					
12	Administration building	1	12 m x 15 m	180	24,734.82	44.52
13	Business Area	1	10m x 3m	30	24,734.82	7.42
14	Staff Parking Area-4 wheelers	1	13.5m x 6m	81	1,510.31	1.22
15	Staff Parking Area-2 wheelers	1	8m x 2m	16	1,563.76	0.25
16	Security shed for watch and ward	2	4m x 4m	32	8,593.50	2.75
17	Electrical facility	1	5m x 5m	25	27,802.50	6.95
18	Fuel Bunkers	1	10m x 5m	50	5,616.67	2.81
19	Water Supply Room	1	3m x 4m	12	27,886.75	3.35
20	Fire and Safety Room	1	3m x 4m	12	32,099.25	3.85
21	DGPS receiver & transmitter shed	1	8m x 4m	32	17,510.52	5.60
22	DG shed	1	5m x 5m	25	13,496.85	3.37
23	Canteen with Store	1	12m x 8m	96	17,901.88	17.19
24	Sewerage Treatment Plant (STP)	1	15m x 15m	225	26,134.35	58.80
25	Overhead Tank	1	10m dia	100	1,944.23	1.94
26	Green Area	1	-	750	808.80	6.07
27	Future Requirement	1	-	1500	606.60	9.10
	Total cost of Other Components					**689.46**

* Rates worked out based on the DSR rates duly considering related items.

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ANNEXURE 11.13 –COST OF APPROACH (EXTERNAL) ROADS

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)
A	**Terminal (T)**				
1	External Roads				
(i)	Pacca Road (7m wide road)	m	0.00	15750	0.00
2	Pipe Culvert on External Road			LS	3.50
	Sub-total 1				**3.50**
	Total Cost of Approach Roads				**3.50**

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ANNEXURE 11.14 –COST OF BANK PROTECTION WORKS AT TERMINAL

S.No.	Item Description	Unit	Estimated Quantity	Rate (in Rs.)	Amount (in Lakh Rs.)	Remarks/ reference
A	**Terminal (T)**					
1	Providing and laying gabion for erosion control, river training works and protection works as per technical specifications	Cum	15535.80	3623.88	584.53	DSR 2018, Cl.no. 16.95 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
2	Providing and laying geotextile as per technical specifications	Sqm	11497.50	641.73	76.61	DSR 2018, Cl.no. 14.91 & 14.92 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
3	Boundary wall 250 mm thk brick masonary (1:6)	Cum	350	7673.94	27.89	DSR 2018, Cl.no. 6.4.2 The rate has been updated with Wpi (3.02%) in 2019 & Wpi (-1.86%) till march 2020. The combined effect is 1.01%.
	Sub-total				**689.02**	
	Cost of Bank Protection Works				**689.02**	

* Rates worked out based on the DSR rates duly considering related items.

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ANNEXURE 11.15 –COST OF RENOVATION OF EXISTING STRUCTURES

Refering Cl 2.18 and 2.19 of P.010631-W-10305-001- Hydrographic Survey Report for ALAPPUZHA - CHANGANASSERY CANAL (29.30 KM) - (NW-8). 5 Cross structures are encountered with following details:

For Class III Vessel, with single lane operation, the critical clearances in horizontal direction is taken as 13.5m to 15m.

Horizontal Clearance = 13.5 m

Vertical Clearance = 6 m

SL No	Chainage	Center Position		Location	Type of structure	Type of super structure	Width	No of span(Nos) x Length of Span(m)	Hz clearance	Height wrt MSL	Modification Required		Estimated Cost of Modification
		Latitude	Longitude								Hz	Vt	
1	0.19	9°30'3.37"	76°20'40.84"	Near Church Road	Foot Over Bridge	RCC	2	1 x 28	20	7.5	No	No	
2	0.44	9°30'0.32"	76°20'54.57"	Near Matha Jetty	Foot Over Bridge	RCC	2	1 x 28	20	7.3	No	No	
3	23.97	9°25'29.38"	76°29'32.72"	Veliyandu Jetty	Kidangra-Kunnamkari Road Bridge	RCC	5	1 x 20	20	3.5	No	Yes	55,00,000
4	24.3	9°25'34.52"	76°29'41.89"	Kidangara	Foot Over Bridge	RCC	2	1 x 18	15	5.2	No	Yes	
5	23.7	9°25'32.41"	76°29'28.2"	Near ST Georges Church	Water Pipe Line	RCC		1 x 80	82	6	No	No	
Total Cost													**5500000**

Notes

Note 1 For Foot Over Bridge at Ch 24.3, vertical clearance of 0.8m is required. Since the variation is less, and taking into account tidal cases, the bridge is considered as safe.

Note 2 Modification of Road bridge at Ch 23.97 is proposed by increasing the height. Since, this is single span, the road level is increased by 2.5 and suitable gradient is provided at both ends. The Abutments will increase by 2.5m on both sides. Foundation will also need modification as per the increased height.

Note 3 The cost of modification may have to be updated before construction at Detailed Engineering Stage.

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ANNEXURE 11.16 – FAIR VALUE OF LAND COST IN KERELA

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Department of Registration
Government of Kerala

FAIRVALUE OF LAND

1.Select District : Kottayam
2.Select RDO : RDOKOTTAYAM
3.Select Taluk : Changanacherry
4.Select Village : Changanacherry
5.Select Desam :
6.Block No :
7.Land Type : Water logged land
8.Survey No :
9.Re Survey No :

View

District	Kottayam	Taluk	Changanacherry
Village	Changanacherry	Land Type	Water logged land

Download Gazette

Survey No	SubDiv.No	Resurvey No.	ReSubDiv.No	Land Type	Fairvalue Per Are(Rs.)

1

Additional Notification by the RDOs

Survey No	SubDiv.No	Resurvey No.	ReSubDiv.No	Land Type	Fairvalue Per Are(Rs.)

1

Fixation of Fairvalue by Collectors

Survey No	SubDiv.No	Resurvey No.	ReSubDiv.No	Fairvalue Per Are(Rs.)
		18	6	87120

1

Page 1 of 1

ss

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ANNEXURE 11.17- LETTER BY KERELA GOVERNMENT FOR ADDITIONAL STRUCTURE

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GOVERNMENT OF KERALA

No. A2 /114 / 2018 / CSIND

Coastal Shipping & Inland
Navigation (A) Department,
Thiruvananthapuram,
Dated : 07 / 03 / 2020.

From

The Additional Chief Secretary to Government.

To

Dr. Amita Prasad IAS
Chairperson , IWAI (Ministry of Shipping)
Government of India .

The Director (Tech.)
Inland Waterways Authority of India ,
Ministry of Shipping ,
Government of India ,
A-13 , Sector – I , Noida – 201301 (U.P.)

Sir,

Sub :- CSIND – Comments on the Draft DPRs of extended portions of NW– 3 (Kottappuram – Kozhikkode), NW - 8 (Alappuzha - Changanassery canal , NW - 9 Alappuzha – Kottayam , NW - 59 (Kottayam – Vaikom Canal) by IWAI - reg.

Ref :-
1. Lr. No. IWAI / Hy / Kerala / 2016 / PMU – 106 / 15 / 412 dtd. 28/01/2019 from the Chief Engineer (Tech.) , IWAI , Ministry of Shipping , Govt. of India .
2. Lr. No. IWAI/NNW / DPR / 2017 – 18/04 dtd. 12/02/2019 from the Director (Tech.), IWAI, Ministry of Shipping, Govt. of India .
3. Lr. No. IWAI/NNW/DPR/ 2017 – 18 dtd. 26/11/2019 from the Chief Engineer (Tech.) , IWAI , Ministry of Shipping , Govt. of India .
4. D.O.Letter No. A2/114/2018/CSIND dtd. 17/12/2019 addressed to Chairperson , IWAI , Government of India .

Kind attention is invited to the references cited. The following comments / views of Kerala with regard to the DPRs NW-3 (Kottappuram – Kozhikkode) NW8 - Alappauzha- Changanassery canal , NW-9 Alappuzha – Kottayam, NW59 Kottayam -Vaikom Canal , is conveyed for your kind consideration

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The Development of four National Waterway portions in Kerala (NW-3,NW-8,NW-9,NW-59) are undertaken by IWAI. The structures constructed by various departments like bridges (Public Works Department), foot bridges (Local Self Government Department), HT&LT lines (Kerala State Electricity Board Limited), regulators , check dams, locks (Irrigation Department) and water supply main lines (Kerala Water Authority) do not have sufficient vertical and horizontal clearances for navigation. Reconstruction of these structures involved huge financial commitments.

The list of cross structures (department wise) and approximate cost for the reconstruction of the structures are detailed below . The cost is worked out based on rough cost estimation arrived in consultation with concerned departments .

1. Cross structures under Public Works Department

Total of 57 bridges and 2 foot bridges come under the control of PWD and PWD already proposed to reconstruct 15 bridges in NW3 with the aid of various agencies. They have to arrange the balance 42 bridges and 2 foot bridges under NW norms. The approximate amount required to reconstruct these structures is 840 Crores for bridges and 2.40 Cr for foot bridges. Approximate amount for one bridge is taken as 20.00 Crores. The amount may vary from site to site. It depends upon the character of soil, depth of pile, land acquisition, approach road etc. Approximate amount for foot bridge is taken as 1.20Crores . Thus the total cost of re-construction of 42 bridges and 2 foot bridges come to Rs. 842.40 Crores.

Sl. No	Name of Structures / obstructions	NW-3 (Kottappuram - Kozhikode)	NW8 Alappauzha-Changanassery canal	NW-9 Alappuzha - Kottayam			NW59 Vechoor Athiram puzha	Structures already proposed to reconstruct by PWD as per NW norms	Bal. to be arranged	Approx. amt. to re-construct in Rs crores
				9A	9 B	9 C				
1	Bridges	41	1	1	8	1	5	15	42	840.00
2	Foot bridges			-	2	-			2	2.40

TOTAL Rs. 842 . 40 Cr.

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2. Cross structures under LSGD

Total Amount required for the reconstruction of foot bridges (41 nos.) is 49.20 Crores. Approximate amount for foot bridge is taken as 1.20Crores

Sl No.	Name of Structures / obstructions	NW-3 (Kottappuram - Kozhikode)	NW-8 Alappauzha – Changanassery canal	NW-9 Alappuzha - Kottayam			NW 59 – Vechoor - Athirampuzha	Structures proposed to reconstruct as per NW norms	Balance to be arranged	Approx amount to reconstruct in crores
				9 A	9 B	9 C				
1	Foot bridges	26	3	-	9	-	3		41	49.20

TOTAL Rs. 49 . 20 Cr .

3. Cross structures under Kerala State Electricity Board

Total Amount comes to Rs. 7.08 Crores (for HT and LT lines (17+198 = 215 nos.). Approximate amount for shifting of one HT Line is taken as 30.00 Lakhs and1.00 Lakhs for LT lines.

Sl. No	Name of Structures / obstructions	NW-3 (Kottappuram - Kozhikode)	NW-8 Alappauzha – Changanassery canal	NW-9 Alappuzha -Kottayam			NW 59 – Vechoor - Athirampuzha	Structures proposed to reconstruct as per NW norms	Balance to be arranged	Approximate amount to reconstruct in crores
				9 A	9 B	9 C				
1	HT Lines	17	-					Nil	17	5.10
2	LT Lines	32	50	25	52	14	25	Nil	198	1.98

TOTAL Rs. 7. 08 Cr .

4. Cross structures under Irrigation / Inland Navigation Department

Total amount comes to Rs. 458.80 Crores for reconstruction of various structures (41 nos.). Approximate amount for one bridge is taken as 20.00 Crores. The amount may vary from site to site. It depends upon the character of soil.

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depth of pile, land acquisition, approach road etc. Approximate amount for foot bridge is taken as 1.20Crores. Approximate amount for one Lock/Regulator/ Barrages is taken as 35.00 Crores.

Sl. No	Name of Structures / obstructions	NW-3 (Kottappuram – Kozhikkode)	NW-8 (Alappuzha – Changanassery Canal)	NW-9 (Alappuzha – Kottayam)			NW-59 – Vechoor – Athirampuzha	Structures proposed to reconstruct as per NW norms	Balance to be arranged	Approximate amount to reconstruct in crores
				9A	9B	9C				
1	Bridges	11							11	220.00
2	Foot Bridges	24							24	28.80
3	Regulator cum bridge without Navigation lock	2							2	70.00
4	Barrages	2							2	70.00
5	Navigation lock	3						1	2	70.00

TOTAL Rs. 458 . 80 Cr.

5. <u>Cross structures under Kerala Water Authority</u>

The proposed estimate is given by KWA is Rs. 0.187 Cr.

Sl. No.	Name of Structures / obstructions	NW-3 (Kottappuram – Kozhikkode)	NW – 8 (Alappuzha -Changanassery Canal)	NW-9 (Alappuzha - Kottayam)			NW-59 – (Vechoor – Athiramnpuzha)	Structures proposed to reconstruct as per NW norms	Balance to be arranged	Approximate amount to reconstruct in crores
				9 A	9B	9C				
1	Water pipeline	-	1						1	0.1870

TOTAL Rs. 0 . 187 Cr .

The total Amount required for the reconstruction of cross structures as per IWAI norms come to **Rs. 1358 Crores**. The development works include land acquisition, reconstruction of these structures and eviction of encroachers. The reconstruction of these structures in NW standards involves huge financial commitments to the State Government. <u>Now 15 bridges</u> are proposed to reconstruct by PWD and <u>1 Navigation lock</u> by Inland Navigation department. If IWAI has to bear the cost , these works can be arranged as deposit work and 12 to 18 months time is required to complete the structures. The structures can be reconstructed in phased manner with in 6 years period if IWAI provide funds for executing these reconstruction work as deposit work by concerned department . The

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land acquisition as per NW standards can be done by the aid of central assistance. The eviction of encroachments and hindrance free land will be provided by state Government.

May I therefore request you to kindly consider the above comments / views of the State Government and to provide funds for executing the above reconstruction works as deposit work by departments concerned within a time limit of 12 to 18 months to complete the major structures of National Waterways .

Yours faithfully,

DR. VISHWAS MEHTA
ADDITIONAL CHIEF SECRETARY

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ANNEXURE 11.17 A- FINANCIAL CONSIDERATION DUE TO KERELA GOVERNMENT LETTER ON NW- 8

FINANCIAL IMPACT AS SUGGESTED BY GOVT. OF KERALA (NW-8 ; OPTION-2)					
Sl No.	**Name of Structure**	**Type & Owner of Structure**	**Waterway (NW-8) Nos. of Structure**	**Cost Per Structure (In Crores)**	**Approximate Amount of Reconstruction (In Crores)**
1)	Bridge	Cross Structure Under PWD	1	20	20
2)	Foot Bridge	Cross Structure Under LSGD	3	1.2	3.6
3)	LT Lines	Kerala State Electricity Board	50	0.01	0.5
4)	Regulator Cum Bridge & Navigation Lock	Irrigation Dept. & Navigation Dept.	---	---	---
5)	Water Pipe -line	Kerala water Authority	1	0.187	0.187
	Total				**24.287**

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ANNEXURE 11.17 B- FINANCIALS OF OPTION -1

Description (Option-1)	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
NW8 - Development - Option -1				
Fairway (Official Period)				
Fairway	4,554.92	1,821.97	1,366.48	1,366.48
Structure Modification	83	33.20	24.90	24.90
Institutional Requirement	40.00	16.00	12.00	12.00
Environmental Management Plan Cost as per chapter-9 of the DPR	74.21	29.68	22.26	22.26
Project Management & consultancy Charges @ 3% of Prime cost	140.34	56.14	42.10	42.10
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	140.34	56.14	42.10	42.10
Total Project Cost	**5,032.81**	**2,013.12**	**1,509.84**	**1,509.84**

Ro-Ro Terminal (NW-8)				
Terminal	2,301.08	920.43	690.32	690.32
Cargo Handling Equipment	18.00	7.20	5.40	5.40
Environmental Management Plan Cost as per chapter-9 of the DPR	36.79	14.72	11.04	11.04
Project Management & consultancy Charges @ 3% of Prime cost	69.57	27.83	20.87	20.87
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	69.57	27.83	20.87	20.87
Total Project Cost	**2,495.02**	**998.01**	**748.51**	**748.51**

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ANNEXURE 11.17 C- FINANCIALS OF OPTION -2

Description (Option-2)	Total Investment Cost (INR Lakhs)			
	(INR Lakhs)	1st Year	2nd Year	3rd Year
NW8 - Development - Option -2				
Fairway (Official Period)				
Fairway	4,554.92	1,821.97	1,366.48	1,366.48
Structure Modification (DPR-Rev.01)	83.00	33.20	24.90	24.90
Structure Modification (Suggested By Kerala Govt.)	2428.7	971.48	728.61	728.61
Institutional Requirement	40.00	16.00	12.00	12.00
Environmental Management Plan Cost as per chapter-9 of the DPR	74.21	29.68	22.26	22.26
Project Management & consultancy Charges @ 3% of Prime cost	140.34	56.14	42.10	42.10
Contingencies and Unforeseen Items of Works@ 3% of Prime cost	140.34	56.14	42.10	42.10
Total Project Cost	**7,461.51**	**2,984.60**	**2,238.45**	**2,238.45**

Ro-Ro Terminal				
Terminal	2,301.08	920.43	690.32	690.32
Cargo Handling Equipment	18.00	7.20	5.40	5.40
Environmental Management Plan Cost as per chapter-9 of the DPR	36.79	14.72	11.04	11.04
Project Management & consultancy Charges @ 3% of Prime cost	69.57	27.83	20.87	20.87
Contingencies and Unforeseen Items of Works @ 3% of Prime cost	69.57	27.83	20.87	20.87
Total Project Cost	**2,495.02**	**998.01**	**748.51**	**748.51**

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ANNEXURE 12.1 –IMPLEMENTATION SCHEDULE

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NW - 8 (Alappuzha - Changanassery Canal)

(36 Months Commencing from 2022)

Sl.No.	Items	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils / Hard Soils (Approval & Tendering)																																				
	Ordinary Soils (4.66 Lakhs Cu. M)																																				
	1.b) Dredging																																				
	Hard Soils																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (15 kms)																																				
	4. Night Navigation																																				
	Buoy / Lights (Approval & Tendering)																																				
	Buoy / Lights (65 Nos)																																				
	5. Land Acquisition (12 Hectares for Fairway)																																				
	LA process may continue, but handing over / taking over is expected shortly.																																				
B	**Modification of Structures (NIL)**																																				
	1 Bridge + Power Lines																																				
C	**Communication System (NIL)**																																				
D	**Institutional Requirement (Along with Cl 6 development)**																																				
	Office / Manpower (Establishment & Recruittment)																																				
	Office / Manpower (Deployment)																																				
	Vessels (Approvals & Tendering)																																				
	Vessels (Procurement & Deployment of 2 SLs; 2 Tugs; 2 IBs) (NIL)																																				
E	**Environmental Management Plan**																																				
A	**Fairway**																																				
	1.a) Dredging																																				
	Ordinary Soils / Hard Soils (Approvals & Tendering)																																				
	Ordinary Soils (10.5 Lakhs Cu. M)																																				
	1.b) Dredging																																				
	Hard Soils (1.5 Lakhs Cu. M)																																				
	2. Low Cost Riverine Structures (NIL)																																				
	3. River Training Works/ Bank Protection (Approval & Tendering)																																				
	River Training Works/ Bank Protection (6 Locations 3000 m)																																				
	4. Night Navigation																																				
	Buoy/ Lights (Approval & Tendering)																																				
	Buoy / Lights (70 Nos)																																				

* Fairway Development (along with 1 No. Ro-Ro Terminal) is to be taken up after having the confirmation of Ro-Ro Volumes. Implementation will be in 36 months commencing 2022. As such recommended for implementation only after observations with positive growth.

ANNEXURE 12.2 –IMPLEMENTATION SCHEDULE Ro-Ro

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NW 8 (Alappuzha - Changanassery Canal)

(36 Months Commencing from 2022)

Sl.No.	Items	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	**Ro - Ro Terminal - 1 No. ***																																				
	Land Acuisition																																				
	Riverine Components																																				
	Infrastructure Components internal roads (Approvals & Tendering)																																				
	Infrastructure Components internal roads (Execution)																																				
	Approach Road Construction																																				
	Bank Protection Works for terminal (Approvals & Tendering)																																				
	Bank Protection Works for terminal (Execution)																																				
	Cargo Handling Equipments																																				
	1 No. Ambulance																																				
	Cranes with 125 T Capacity																																				
	Fork lift trucks 20 T Capacity																																				
	Environmental Management Plan																																				
	Vessels																																				
B	**Lo - Lo Terminal**																																				
	Land Acuisition (Should be completed by 2030)																																				
	Riverine Components																																				
	Infrastructure Components internal roads (Approvals & Tendering)																																				
	Infrastructure Components internal roads (Execution)																																				
	Approach Road																																				
	Bank Protection Works for terminal (Approvals & Tendering)																																				
	Bank Protection Works for terminal (Execution)																																				
	Cargo Handling Equipments																																				
	Ambulance - 0 no.																																				
	Cranes with 125 T Capacity - 0 no.																																				
	Fork lift trucks 20 T Capacity - 0 no.																																				
	Environmental Management Plan																																				
	Vessels																																				

* Ro-Ro Terminal Development (along with Fairway) is to be taken up after having the confirmation of Ro-Ro Volumes. Implementation will be in 36 months commencing 2022. As such recommended for implementation only after observations with positive growth.

LIST OF DRAWINGS

S. No.	DRAWING NAME	DRAWING NUMBER	SHEETS
1	ALAPPUZHA-CHANGANASSERY CANAL (KERALA) NW8 LAYOUT PLAN	P.010631-W-20301-A01	3
2	ALAPPUZHA-CHANGANASSERY CANAL (KERALA) NW8 TERMINAL LOCATION MAP AT CHANGANASSERY	P.010631-W-20351-X01	1
3	ALAPPUZHA-CHANGANASSERY CANAL (KERALA) NW8 TERMINAL LAYOUT PLAN AT CHANGANASSERY (WITH PROPOSED INFRASTRUCTURE FACILITY	P.010631-W-20311-A01	1
4	ALAPPUZHA-CHANGANASSERY CANAL (KERALA) NW8 Ro-Ro TERMINAL AT CHANGANASSERY PLANS & SECTIONS	P.010631-W-20341-E01	2
5	ALAPPUZHA-CHANGANASSERY CANAL (KERALA) NW8 BANK PROTECTION TYPICAL SECTION	P.010631-W-20303-X01	1

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