TRACTEBEL

ENGIE

CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DPR OF CLUSTER VII OF PROPOSED 53 NATIONAL WATERWAYS

FEASIBILITY REPORT-SHASTRI RIVER/JAIGAD CREEK (52KM) - (NW-91)
Project No. P.009051
Document No. P.009051-W-10204-D10
Final Report

Goa and Maharashtra | INDIA

Inland Waterways Authority of India (IWAI) - Government of India Ministry of Shipping - Head Office

23 September 2016

Report

Rev.03

RESTRICTED

CATEGORY-II WATERWAYS: STAGE-I REPORTS

SALIENT FEATURES AT A GLANCE

<table>
<tr><th>Sl.No.</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>Tractebel Engineering Pvt. Ltd.</td></tr>
<tr><td>2.</td><td>Cluster Number & State(s)</td><td>Cluster-VII & Maharashtra</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW#</td><td>Shastri River / Jaigad Creek (52 km), NW-91</td></tr>
<tr><td>4.</td><td><u>Navigability status</u></td><td></td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions (from…….to, length, average tidal variation)</td><td>Fully Tidal (Chainage 0.0 km to Chainage 48.52 km, average tidal variation of 2.37 m)
Tidal Variation is 4.42m/0.32m</td></tr>
<tr><td>b)</td><td>LAD status (w.r.t.CD)
i) Survey period (26 to 28 Feb., 2016)
ii) < 1.0 m (km)
iii) 1.0 m to 1.5 m (km)
iv) 1.5 m to 2.0 (km)
v) >2.0 m (km)</td><td>
<table>
<tr><th rowspan="2">Chainage (Km)</th><th colspan="4">Length of River (Km)</th></tr>
<tr><th><1m</th><th>1-1.5m</th><th>1.5-2.0m</th><th>>2m</th></tr>
<tr><td>0-10</td><td>-</td><td>-</td><td>0.12</td><td>9.88</td></tr>
<tr><td>10-20</td><td>-</td><td>-</td><td>0.23</td><td>9.77</td></tr>
<tr><td>20-29</td><td>-</td><td>-</td><td>-</td><td>9.00</td></tr>
<tr><td>29-37</td><td>-</td><td>0.25</td><td>-</td><td>7.75</td></tr>
<tr><td>37-45</td><td>0.92</td><td>0.92</td><td>1.84</td><td>4.32</td></tr>
<tr><td>45-48.52</td><td>2.24</td><td>0.28</td><td>0.28</td><td>0.72</td></tr>
<tr><td>Total</td><td>3.16</td><td>1.45</td><td>2.47</td><td>41.44</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross Structures
i) Dams, weirs, barrage etc. (total number; with navigation locks or not)
ii) Bridges, Power cables etc. (total number; range of horizontal and vertical clearances)</td><td>Cross Structures
i) Nil
ii) 6 no. of Bridges, HC: 20 m - 60 m, VC: 5 m - 12.0 m
1 no. HT line, VC : 20.0 m
2 no. Electric line, VC: 6.5 m – 13.5 m
(VC are above MHWS / HFL)</td></tr>
<tr><td>d)</td><td>Avg. discharge & no. of days</td><td>Since the entire study stretch is tidal, discharge of river is not relevant.</td></tr>
<tr><td>e)</td><td>Slope (1 in……)</td><td>1 in 5288</td></tr>
<tr><td>5.</td><td><u>Traffic Potential</u></td><td></td></tr>
<tr><td>a)</td><td>Present IWT operations, ferry services, tourism, cargo, if any</td><td>Ferry Services between Tavsal and Jaigad are operational.
25 jetties (apart from the Port jetties) are being utilized for Fishing and Local Transport.</td></tr>
<tr><td>b)</td><td>Important industries within 50 km</td><td>Jindal Power Plant, Lavgan Dockyard pvt Ltd.
(For details refer Annexure 4.1)</td></tr>
<tr><td>c)</td><td>Distance of Rail & Road from Industry</td><td>Both Rail & Road network is available within 2.0 km of distance from the nearest industrial area (MIDC-Sangmeshwar). Jindal Power Plant is at the distance of about 40km from Sangmeshwar Railway Station.</td></tr>
</table>

Sl.No.	Particulars	Details
6.	Consultant's recommendation for going ahead with Stage-II (DPR preparation)	Recommended for development as Class-V waterway for Ch 0.00 km to 48.52km.
7.	Any other information/comment	48.52 km of bathymetric survey is considered and the remaining 5.88 km upto the end stretch is to be updated with land topographical data. MHWS – 4.42m, HTL— 4.42m, LTL— 0.32m, Average Tidal Variation—2.37m & Port Name: Apollo Bandar.

Date: 23/09/2016

Consultant signature

CONSULTANCY SERVICES FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT OF PROPOSED 53 NATIONAL WATERWAYS

SHASTRI RIVER/JAIGAD CREEK

(NW-91)

CLUSTER - VII

GOA AND MAHARASHTRA, INDIA

			N Bawa	Pradyumna Machhkhand	B. C. Jha
03	23.09.2016	For Acceptance	N Bawa	Pradyumna Machhkhand	B. C. Jha
Rev.	Date	Description	Prepared By	Checked By	Approved By

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LIST OF ABBREVIATIONS

Abbreviations	Acronyms
BFL	Bombay Floating Light
CD	Chart Datum
Ch	Chainage
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DGPS	Differential Global Positioning System
DFPCL	Deepak Fertilizers & Petrochemical Corporation
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 Transportation
KP	Km Points
LAD	Least Available Depth
LNG	Liquefied Natural Gas
MHWS	Mean High Water Spring
MIDC	Maharashtra State Industrial Development Corporation
MMB	Maharashtra Maritime Board
MMTPA	Million Metric Tonne Per Annum
MnT	Million Tonnes
MOEFCC	Ministry of Environment, Forest & Climate Change
MOS	Ministry of Shipping
MSEB	Maharashtra State Electricity Board
MSME	Micro, Small & Medium Enterprises
MSPGC	Maharashtra State Power Generation company
MTPA	Metric Tonne Per Annum
NH	National Highway
NTPC	National Thermal Power Corporation
NTPC 1980	National Transport Policy Committee, 1980
NW	National Waterway
PGCIL	Power Grid Corporation of India Limited
PWD	Public Works Department
RGPPL	Ratnagiri Gas and Power Private Limited
SEB	State Electricity Board

SH	State Highway
UP	Uttar Pradesh
VC	Vertical Clearance
WRD	Water Resources Department
WRIS	Water Resources Information System of India

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EXECUTIVE SUMMARY

A. Introduction

The available water resource in the globe can be used and utilized in various ways whereas Inland Water Transport (IWT) is one among them. The water bodies can be utilized for IWT also. India has been bestowed with vast water bodies consisting of rivers, canals, backwaters, creeks and lakes and having the potential for development of efficient waterways transport network. However, when compared to the development of IWT in certain countries, the same is to be geared up in our country. IWT mode remains underdeveloped 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 42% in European Union, 8.7% in China and over 8% in USA. This is a great economic opportunity loss to the country.

Based on various earlier studies on IWT, subsequent to the recommendations of National Transportation Policy Committee (NTPC 1980) and in order to give more thrust to the Inland Water Transport mode, duly keeping in view the major benefits of this mode viz., Cheaper operational cost on comparison / Higher fuel efficiency / Eco friendly nature of the mode, the IWT development system is under consideration in our country. The potential through IWT mode can be used as an alternate and supplementary mode of transportation in certain favourable conditions.

India has about 14,500 km of navigable waterways which comprise Rivers, Canals, Backwaters, Creeks, etc., out of which about 5200 km of the river and 4000 km of canals can be used by mechanized crafts. About 55 million tonnes of cargo is being moved annually by Inland Water Transport (IWT). Its operations are currently restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the River Brahmaputra, the River Barak, the Rivers in Goa, the Backwaters in Kerala, Inland Waters in Mumbai area and the Deltaic regions of the Godavari - Krishna Rivers.

Inland Waterways Authorities of India (IWAI), a statutory body under the Ministry of Shipping, Government of India, intends to explore the navigational potential of newly declared national waterways across the country for year round commercial navigation.

National Waterways Act, 2016 has come into force to make provisions for existing national waterways and to provide for the declaration of certain inland waterways to be national waterways and also to provide for the regulation and development of the said waterways for the purposes of shipping and navigation and for matters connected therewith or incidental thereto. There are now a total of one hundred and eleven national waterways altogether across the country which include five existing national waterway besides 106 newly declared waterways as national waterways through National Waterways Act, 2016. The objective is to

promote integrated development of waterways throughout the country so as to have a considerable and maximum mode shift to IWT, which can reduce the density in rail/road apart from the environmental benefits of IWT mode.

It has been planned to study in two stages comprising feasibility study in stage-I followed by preparation of DPR in stage-II and recommending thereafter the possibility of composite and integrated development of proposed newly declared national waterways to achieve navigation and to develop water transport facilities.

This report presents study detail of stage-I of national waterway of Shastri River / Jaigad Creek in the State of Maharashtra. Shastri River / Jaigad Creek has been designated as national waterway-91 with its description in the gazette notification as, Shastri River / Jaigad Creek from Arabian Sea at Jaigad Lat 17°19'11.92"N, Long 73°12'39.30"E to Sangmeshwar at Lat 17°11'15.83"N, Long 73°33'2.57".

Sl. No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Shastri River/Jaigad Creek (NW-91)
2	State/ District through which river passes	The Shastri River/Jaigad Creek passes through the Ratnagiri district of Maharashtra State.
3	Length of the river / canal	Out of the total 80km length, 52km length of the Shastri River/Jaigad Creek starts from Arabian Sea at Jaigad Lat 17°19'11.92"N, Long 73°12'39.30"E to Sangmeshwar at Lat 17°11'15.83"N, Long 73°33'2.57"E has been declared as new national waterway. The index map of Shastr River / Jaigad Creek showing proposed waterway stretch, topographic features and road networks are shown in **Figure1.1 & Figure 1.2**.
4	Catchment Area	The total catchment area of Shastri River/Jaigad Creek is 2174 sq. km.

B. Methodology Adopted

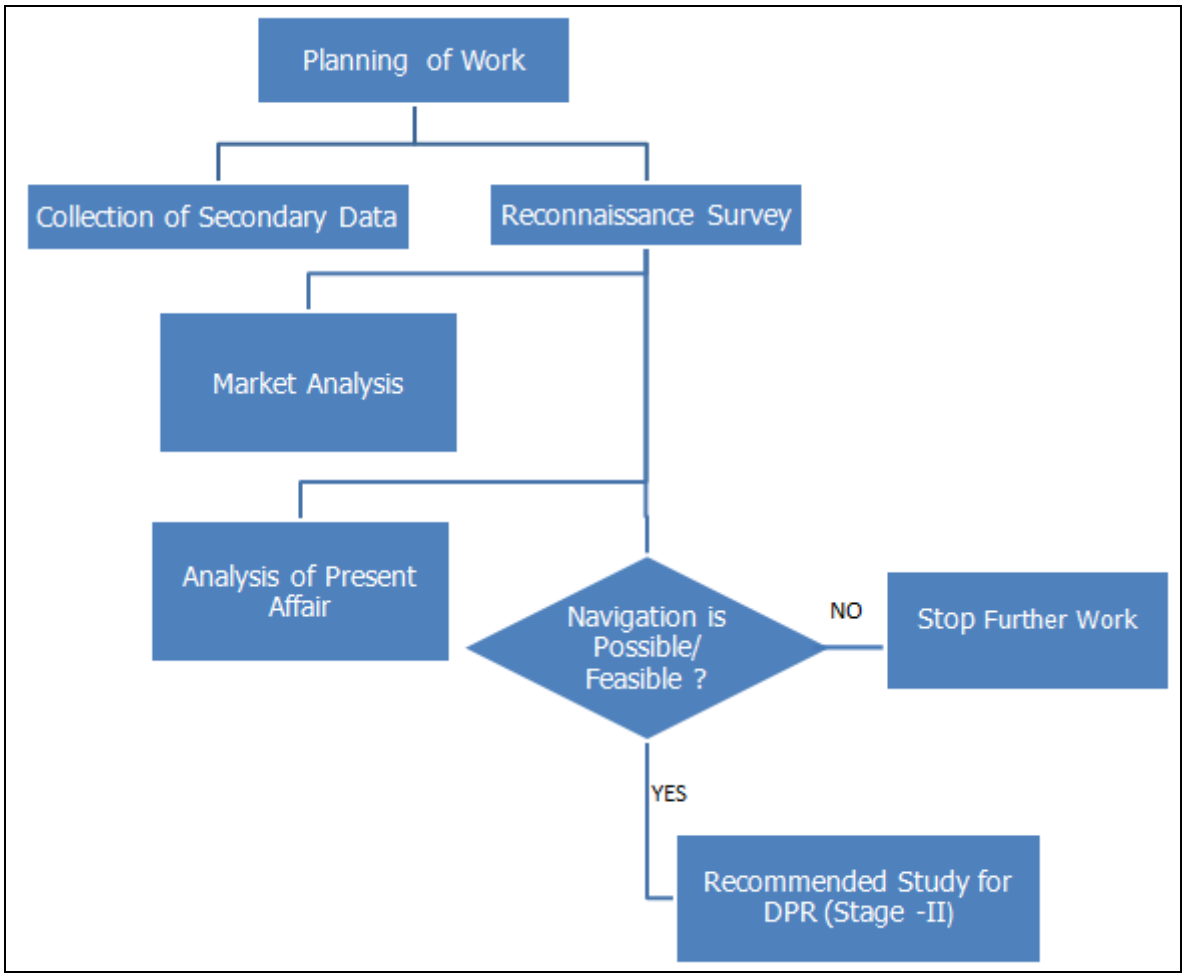
The feasibility of the navigation in the considered waterway has been examined from the following three perspectives:

a) The Physical System: - It includes the study of hydrographic characteristics of the channel/stability of channel/water depth/width of river/ LAD/ terminal/ infrastructure/ cross over structure/ sediment analysis/ physical constraints/ hindrances etc.

b) The Current Functions: - It covers the current utilization of the river – existing navigation/ ferry services/ jetties/ cross over structures/ irrigation facilities/ dam/ barrage/ canals/ fishery/mining etc.

c) The Market Potential: - This aspect covers ferry services, existing cargo movement, existing rail & road network, population served, local produces, industrial establishment, future potential, transfer of cargo movement to inland waterways transport system etc.

Work Execution for stage-I study has been depicted through following diagram.



Execution Diagram of Stage I

C. Collection of Data and Analysis

Reconnaissance survey has been conducted through an expert agency for collection of primary data and various secondary data have also been collected from different sources e.g. benchmark, G & D data & chart datum from IWAI, Govt. of India / MMB, Govt. of Maharashtra / MSME, Govt. of India/ Maharashtra Pollution Control Board, Mumbai/ Cargo Movement Data for the Year 2014 and 2015 provided by IWAI, Govt. of India/ Captain of Ports, Govt. of Goa/ WRD, Govt. of Goa/ WRD, Govt. of Maharashtra/ IOCL, Govt. of India undertaking/ MIDC, Govt. of Maharashtra/ MSEB, Govt. of Maharashtra, respective district authorities of State Govt. of Maharashtra and information available in the public domain through web.

A review of the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways has been done for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps.

D. Observations and Inferences

Following conclusions have been derived for establishing the navigability of the proposed waterway;

1. The river length as given by IWAI is 52km, whereas the total surveyed length along the river to capture the thalweg is 48.52km. The deepest channel route has been reckoned as 48.52km. All inferences derived for identifying the navigable length have been derived with reference to the deepest channel length (48.52km).
2. The river is tidal affected for a majority of length under study and relevant chart datum has been used. 79% of the surveyed length, starting from 0.00km (a confluence of river with sea near Jaigad in the creek), has water depth more than 2.0m, however not continuous. The average tidal variation is 2.37m with maximum high tide of 4.42m and low tide of 0.32m as per the records available for this region. The average tide height of 2.37m would be an added advantage for the safe navigation.
3. It has been observed that the feasibility study suggests that the river is navigable without any significant obstructions up to the Bhatgaon Road Bridge (at Ch. 34.43km) and with modifications to the Bridges at Bhatgaon (at Ch. 34.43km) and Phungus Road Bridge (at Ch. 43.95km), it can traverse up to the Rail Bridge at Ch. 45.84km. Further, by considering the single lane operation at Pirdavane – Khurdunda Rail Bridge (at Ch. 45.84km) the entire stretch can be considered for elevation to Class V so as to meet the industrial cluster at Sanghameshwar.
4. The lengths of the waterway, with a depth more than 2.0m, 1.5m and 1.0m with reference to the Chart Datum have been compiled in the main report. This is given in Table 3.9 of the report and is being reproduced below:

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-10	17.05	1.75	9.88	0.12	-	-
10-20	16.74	1.63	9.77	0.23	-	-
20-29	18.59	3.18	9.00	-	-	-
29-37	12.17	1.32	7.75	-	0.25	-
37-45	5.47	0.79	4.32	1.84	0.92	0.92
45-48.52	4.11	-1.3	0.72	0.28	0.28	2.24
Total			**41.44**	**2.47**	**1.45**	**3.16**

5. Two H. T. Lines and one Electric Line are located within the study stretch with the vertical clearance ranging from 6.5m to 20.0m above MHWS. The minimum vertical clearance required shall be 20.1m corresponding to 220kVA transmission line.
6. As explained above, two Bridges are to be modified to meet the specified clearance criteria and one Bridge may have to be navigated with single lane operation.

The description & classification of the waterway has been presented schematically based on the survey observation and duly keeping in view the river classification criteria in Table 3.18 as reproduced below.

Criteria	Classification																			
Length of waterway from start (km)	3	5	8	11	14	16	19	22	24	27	30	33	35	38	41	44	46	49	52	54
Chainage length in %	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Depth availble	C-V														C-I					
Rail & raod Bridge Vert. clearance	All Class														C-II					
Rail & raod Bridge Hor. clearance	All Class														C-II					
HT Line Vert. clearance	All Class																	Base Raise		
Bend Radius	C-II																			
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

E. Cargo Feasibility

The present mobility in the Shastri River / Jaigad Creek area with the coastal movement is about 8.24 MMTPA. The majority of the cargo is Thermal Coal followed with Iron Ore. (As confirmed from the cargo data of 2015-16).

Subsequent to the preliminary market survey and its analysis, there is a possible growth of cargo mobility to the extent of about 0.7 MMTPA to 1.2 MMTPA through the study stretch, which is a considerable increase.

In order to meet the above increase in the cargo potential, the waterway development is felt essential. Accordingly, the waterway is to be developed to Class V to meet the above increase in volume and keeping in view the future industrial growth in upper hinterland.

F. SWOT Analysis

SWOT analysis has been carried out for deriving meaningful information specifying the objectives of the study for development of the waterway for year round commercial navigation and identifying the internal & external factors that are favourable and unfavourable in the development of the waterway.

Strength

1. 79% of the surveyed length has water depth more than 2 m and is safe for navigation.
2. The above depth is available for about 45kms, however not continuous and certain patches may be required to be attended with a considerable conservancy activity involving dredging.
3. The Creek is tidal effected for about 50 kms. up to Nawadi, under the study stretch of 52 kms. The tidal variation is an additional strength for navigability and the study stretch is having a Maximum tide as 4.42m, Minimum tide as 0.32m and the Mean Sea level as observed is of 2.51m.
4. Approximately 5.6 lacs of population is residing in the region of Guhagar, Sangameshwar and Ratnagiri in the vicinity of Shastri River / Jaigad Creek, which will have direct or indirect benefits from the IWT and related projects coming up in the area.
5. The Existing Cargo movement in the Jaigad Port area will have some influence in IWT, on its development. Further, a considerable cargo is divertible from / to hinterland, as per the preliminary study.
6. Cargo increase has been observed in the analysis to an extent of about 0.7 MMTPA to 1.2 MMTPA.
7. The MSIDC is planning its industrial spread in the river front and hinterland which is more attractive especially at the upstream end of the stretch at Sangameshwar industrial area, which is hopeful for IWT development.

Weakness

1. Presently, there is no IWT movement. However, the traffic estimations present an optimistic picture for IWT.
2. Modifications proposed at two Bridge locations may be a weakness; however it will become strength, if Ro – Ro cargo mobility picks up in this area.

Opportunity

1. 79% of the existing waterway is having a depth more than 2m, which can be used advantageously for the mobility of hinterland cargo.
2. The proposal of MIDC Industrial area in the vicinity / hinterland is an opportunity, if used by IWT.
3. The different types of Cargo viz. Coal, Food grains and Chemicals apart from Aluminium Cargo have been identified as divertible in the hinterland and will be the opportunity for this stretch development.
4. The present Rail and Road connectivity, though may be competing with IWT, may also be an opportunity for creating an efficient intermodal hub for IWT.
5. Policies are to be firmed up for development of IWT in this stretch.
6. Since the industrial areas of the MIDC are in the upstream stretch, the entire waterway can be best utilized.

7. Tourism may flourish in the Shastri River, if developed, connecting the Sangameshwar Temple (in the upstream reach of the river) and other temples nearby. Further, a Tourist Hub also can be framed linking Sangameshwar / Marleshwar / Ganpatipule, Jaigad Fort etc., with beaches i.e., linking the river / creek with the coast.

Threat

1. The NH 17 (NH 66) surrounded by SH-4, SH-105 & SH-106 in the study area may create competing modes of transport especially with respect to cargo traffic for the proposed waterway.
2. The present rail network also may pose some threats as an alternative mode of transport.
3. The Shastri River banks covered by marginal mangrove trees in certain places may involve some socio-environmental issues and may require statutory approvals and clearances to construct the jetties/ terminal/ ports/ intermodal connectivity.

G. Development Cost (Tentative)

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable. Henceforth, the development of the proposed national waterway involves physical interference in the form of dredging, construction of terminals at the identified locations, modification of HT Lines at crossing locations to provide a minimum vertical clearance of 20.1m (with respect to 220 kVA) or the case may be combined with some unforeseen expenses. Moderate dredging effort has been envisaged with an average dredging of 1.0m required in 7.0km of the length of proposed waterway reckoned with reference to ascertained data. The cost of dredging has been considered @ INR 230 per cum. The cost of terminal has been estimated @ INR 20.0 crore each for two terminals. HT line crossing shall need modification which shall require two towers at the bank of requisite height and the stringing over pair of poles crossing the Shastri River. The cost of transmission tower has been estimated to be INR 20.00 lacs each and the stringing cost across towers shall be INR 4.0 lacs per pair of towers. The total estimated cost for modification to the four HT Lines shall be INR 3 x 44.0 lacs = INR 132.0 lacs. Two nos. of Bridges may have to be modified with reconstruction at an estimated cost of INR 2.5 crores each amounting to INR 5.0 crores. The cost of navigational aids for day/night navigation has been considered as INR 430 lacs. 10% of the amount for dredging, terminal construction, tower / bridge modification and night navigational aids has been envisaged as unforeseen. The tentative total cost of development to make the river navigable round the year to achieve safe navigation for the required classification of vessel mobility has been estimated to INR 51.40 crore. (Reproduced below as in Table 5.1).

Sl. No.	Name of Waterway	Length of Water way	Dredging Required (wrt. 2 m draft & 40.0m width)	Dredging Cost @ INR 230/ cum	Terminal Proposed	Terminal Cost @ INR 20 Cr each	Cost of Modification of Transmission line	Night Navigation	Total cost incld. 10% unforeseen
		(km)	(km)	INR in Cr.)	(Nos)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)
1	Shastri River / Jaigad Creek	48.52	7.0	6.44	2.00	40.00	6.32	4.3	62.80

H. Classification of Waterway

The 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 DWT and tug-barge formation in push tug + four barge units of carrying capacity up to 8000 DWT (Ref: IWAI, Gazette Notification dated 26th January 2007).

As per the above Classification of Inland Waterways, the entire waterway of Shastri River / Jaigad Creek (NH 91) waterway of 45.74km length has been classified based on available minimum water depth, bottom width, minimum vertical and horizontal clearances of cross over structures and bend radius in the river. The classification of Shastri River / Jaigad Creek (NH 91) Waterway is described below. (Reproduced below is Table 5.2).

Chainage (km)	Minimum Depth (m)	Bottom Width (m)	Minimum Vertical Clearance (m)	Minimum Horizontal Clearance (m)	Bend Radius (m)	Classification of Waterway (Proposed)
0.0 – 48.52	0.79	200.0	6.5 (Bridge & H. T. Line)	30 (Bridge)	250	**Class – V**

The study stretch of the waterway is amenable for development as Class V waterway as explained above. However, considerable Dredging may be required.

In order to consider the full stretch as **Class V**, two nos. of Bridges are to be modified and one Bridge is to be considered with single lane operation. Further smoothening of bends is essential.

The above stretch of the waterway, hence, can be considered under Class V which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 1000 DWT (approximate size 70m overall length, 12m moulded breadth and 1.8m loaded draft) or one tug and four

barges combination of 4000 DWT (approximate size 170m overall length, 24m breadth and 1.8m loaded draft).

I. Recommendation

The national waterway-91 of Shastri River / Jaigad Creek has been identified having potential for development as waterway of Class-V for a distance of 51.98 km as described above. This stretch of the river is therefore recommended for stage-II study for preparation of Detailed Project Report (DPR) to establish the viability for implementation as a project.

Accordingly, the national waterway NW-91 of Shastri River / Jaigad Creek is proposed for development as **Class V** waterway in the stretch of the waterway as (as at Table 3.19) depicted below:

River Stretch	0.0 km	51.98km
Classification		
	Class- V	
Horizontal clearance (m)	80	
Vertical clearnce (m)	10	
Minimum Depth (m)	2	
Bottom Width (m)	80	
Self Propelled Vessel		
Dead Weight Tonnage	1000	
Vessel size (m)	70 x 12 x 1.8	
Tug + Barge		
Dead Weight Tonnage	4000	
Vessel size (m)	170 x 24 x 1.8	

Note:

1. All vertical clearances of cross over structures have been reckoned with MHWS of 4.42m above MSL and details are described in Para 3.3.5.
2. MHWS – 4.42m, HTL— 4.42m, LTL— 0.32m, Average Tidal Variation—2.37m & Port Name: Apollo Bandar.

CHAPTER 1: INTRODUCTION

1.1 Introduction to Inland Waterways

The Inland Waterways Authority of India (IWAI) came into existence on 27th October 1986 for development and regulation of inland waterways for shipping and navigation. Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. The Authority primarily undertakes projects for development and maintenance of IWT infrastructure on national waterways through grant received from the Ministry of Shipping, Government of India. The head office of the Authority is at Noida, UP. It does the function of building the necessary infrastructure in these waterways, surveying the economic feasibility of new projects and also administration. The Authority also has its regional offices at Patna, Kolkata, Guwahati and Kochi and sub-offices at Allahabad, Varanasi, Bhagalpur, Farakka, Swaroopganj, Hemnagar, Dibrugarh (Assam), Dhubri, Kollam, Vijayawada (Andhra Pradesh) and Bhubaneshwar (Odisha).

India has about 14,500 km 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. About 55 million tonnes of cargo is being moved annually by Inland Water Transport (IWT), a fuel - efficient and environment - friendly mode. Freight transportation by waterways is highly underutilized in India compared to other large countries and geographic areas like the United States, China and the European Union. Its operations are currently restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the River Brahmaputra, the River Barak, the Rivers in Goa, the Backwaters in Kerala, Inland Waters in Mumbai area and the Deltaic regions of the Godavari - Krishna Rivers.

Besides these organized operations by mechanized vessels, country boats of various capacities also operate in various rivers and canals and substantial quantum of cargo and passengers are transported in this unorganized sector as well. The total cargo moved (in tonne kilometres) by the inland waterway was just 0.1% of the total inland traffic in India. There are now one hundred and eleven national waterways across the country which include five existing national waterways besides 106 waterways which have been declared recently as national waterways through a central legislation.

1) National Waterway 1

The Ganga - Bhagirathi - Hooghly river system between Haldia (Sagar) & Allahabad.

Estd. = October 1986.
Length = 1620 km
Fixed terminals = G R Jetty 2, Kolkatta, Pakur, Farakka, Gaighat (Patna) & Allahabad.

Floating terminals = Kolkatta, Diamond Harbour, Katwa, Bahrampur, Jangipur, Bhagalpur, Semaria, Doriganj, Ballia, Ghazipur, Varanasi, Chunar, Allahabad.

Cargo Movement = 3 million tonnes Approx.

2) National Waterway 2

Sadiya — Dhubri stretch of Brahmaputra river.

Estd = September 1988.

Length = 891 km

Fixed terminals = Pandu

Floating terminals = Dhubri, Jogighopa, Tezpur, Silghat, Jamgurhi, Bogibil, Dibrugarh, Saikhowa and Sadiya

Cargo Movement = 2.0 million tonnes Approx.

3) National Waterway 3

Kottapuram-Kollam stretch of the West Coast Canal, Champakara Canal and Udyogmandal Canal.

Estd = February 1993

Length = 205 km

Fixed terminals = Kottapuram, Aluva, Bolgatty, Willingdon Island, Maradu (Kochi), Cherthala (Vaikom), Thannermukkom, Alappuzha, Thrikkunnapuzha, Kayamkulam (Ayiramthengu), Chavara and Kollam.

Cargo Movement = 1.0 million tonnes Approx.

4) National Waterway 4

Kakinada–Pondicherry stretch of canals and the Kaluvelly Tank, Bhadrachalam – Rajahmundry stretch of River Godavari and Wazirabad – Vijayawada stretch of River Krishna.

Estd = November 2008

Length = 1095 km

Tentative Cargo Potential = 2.0 million tonnes Approx which can go up to 4.0 million tonnes in next 15 years or so.

5) National Waterway 5

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.

Established = November 2008

Length = 623 km

Tentative Cargo Potential = Coal from Talcher to Dhamra and Paradip ports is the most important potential cargo for this waterway. Immediately after the development of the waterway, it is estimated in the DPR that

about 11.0 million tonnes of cargo can be transported per year which can go up to 23.0 million tonnes in next 15 years or so.

6) 106 Newly Declared National Waterways

For newly declared national waterways, IWAI is carrying out feasibility studies /DPR preparation through a number of consultants.

1.2 Project Background of the Present Study

IWAI, Ministry of Shipping, 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 study in two stages comprising feasibility study followed by preparation of DPR and recommending thereafter the possibility of composite and integrated development of proposed waterways to achieve navigation and to develop water transport facilities across India.

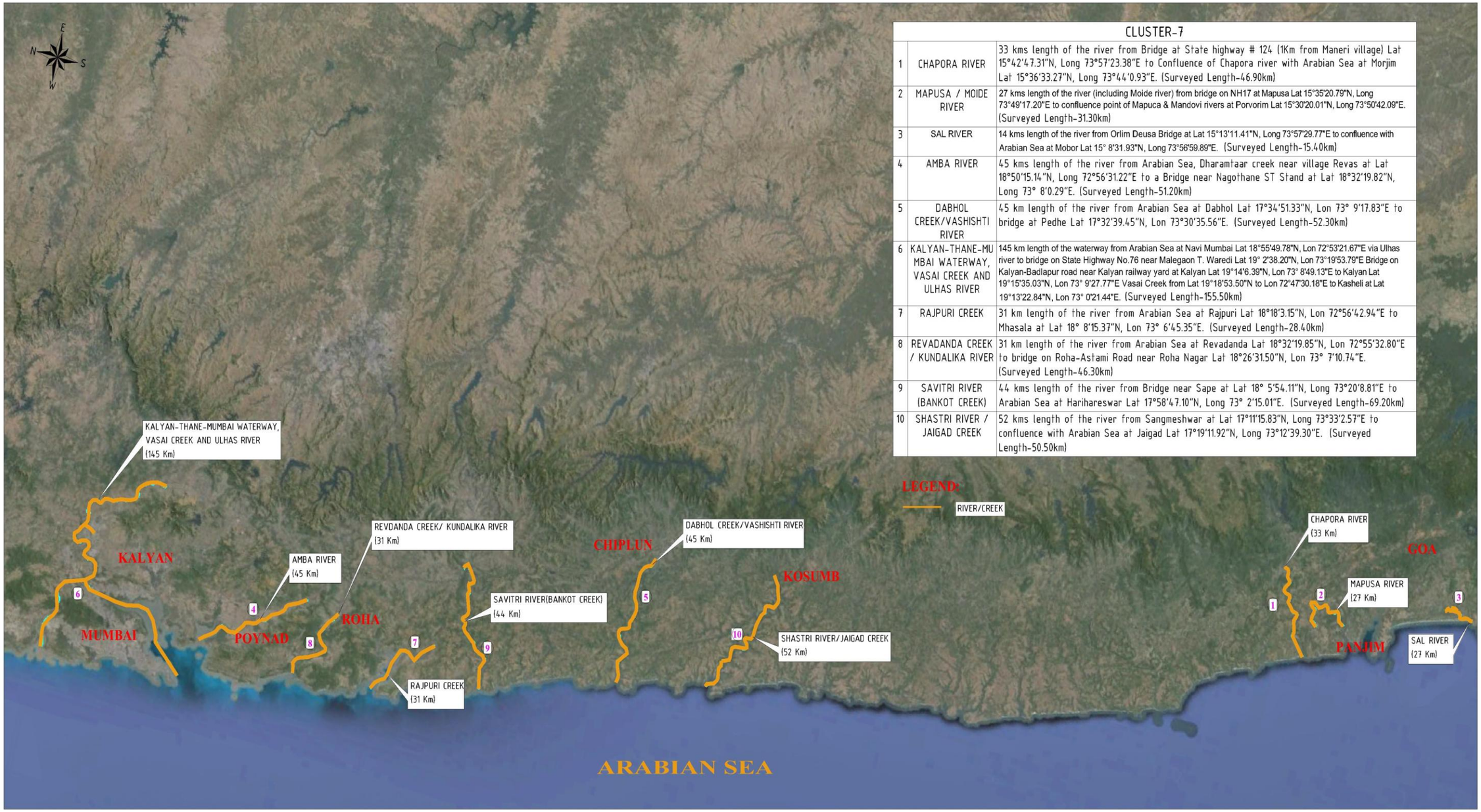
106 more waterways across the country have been declared as new national waterways through a bill passed in the Parliament in March 2016 with contention that the measure is aimed at providing a cheaper mode of transport and reducing traffic burden on the roads. These 106 new national waterways will be in addition to the five existing national waterways. The proposed legislation is aimed at integrated development of inland waterways throughout the country since the water transport is "lagging behind" road and rail sectors. Promotion of waterways is a priority as it is a cheaper mode of transportation, being economical compared to roads and railways, and at the same time it is environment friendly too.

Feasibility study shall examine the viability of navigational routes and therefore potential to develop waterway transport facility is to be established. This shall be followed by preparation of Detailed Project Report (DPR) for those feasible waterways, which would include detailed hydrographic surveys and investigation, traffic survey, proposed location for terminals and cost assessment etc. Tractebel Engineering had been awarded two of the clusters i.e. Cluster-VI & Cluster-VII consisting of the rivers/canals/creeks for two stage studies, screen the rivers with respect to navigational feasibility and subsequently prepare a Detailed Project Report for the development of Inland Waterways. This report deals with the study of Shastri River/Jaigad Creek which is one of the waterways of Cluster-VII which consists of rivers/creeks of Maharashtra and Goa (length-467 km) and described in **Table 1.1** as shown below:-

Table 1.1: List of Rivers/Creeks of Maharashtra and Goa under Cluster-VII (length-467.0 km)

Sl No.	Name of Rivers/ Creeks	National Water Way (NW)	Length (km)	State
1.	Chapora River	NW-25	33	Goa
2.	Mapusa / Moide River	NW-71	27	Goa
3.	Sal River	NW-88	14	Goa
4.	Amba River	NW-10	45	Maharashtra
5.	Dabhol Creek/ Vashishti River	NW-28	45	Maharashtra
6.	Kalyan-Thane-Mumbai waterway, Vasai creek and Ulhas River	NW-53	145	Maharashtra
7.	Rajpuri Creek	NW-83	31	Maharashtra
8.	Revadanda creek / Kundalika River	NW-85	31	Maharashtra
9.	Savitri River (Bankot creek)	NW-89	44	Maharashtra
10.	**Shastri River/ Jaigad creek**	**NW-91**	**52**	**Maharashtra**
	Total		**467**	

The layout plan of all the ten rivers/creeks covered in Cluster-VII, showing the location and Index Map of Shastri River/Jaigad Creek are shown in **Figure 1.1 & Figure 1.2** respectively.



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. (Surveyed Length-46.90km)
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. (Surveyed Length-31.30km)
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. (Surveyed Length-15.40km)
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. (Surveyed Length-51.20km)
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. (Surveyed Length-52.30km)
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. (Surveyed Length-155.50km)
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. (Surveyed Length-28.40km)
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. (Surveyed Length-46.30km)
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. (Surveyed Length-69.20km)
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. (Surveyed Length-50.50km)

Figure 1.1: Location Map of the Proposed Waterway of Cluster-VII in Goa and Maharashtra

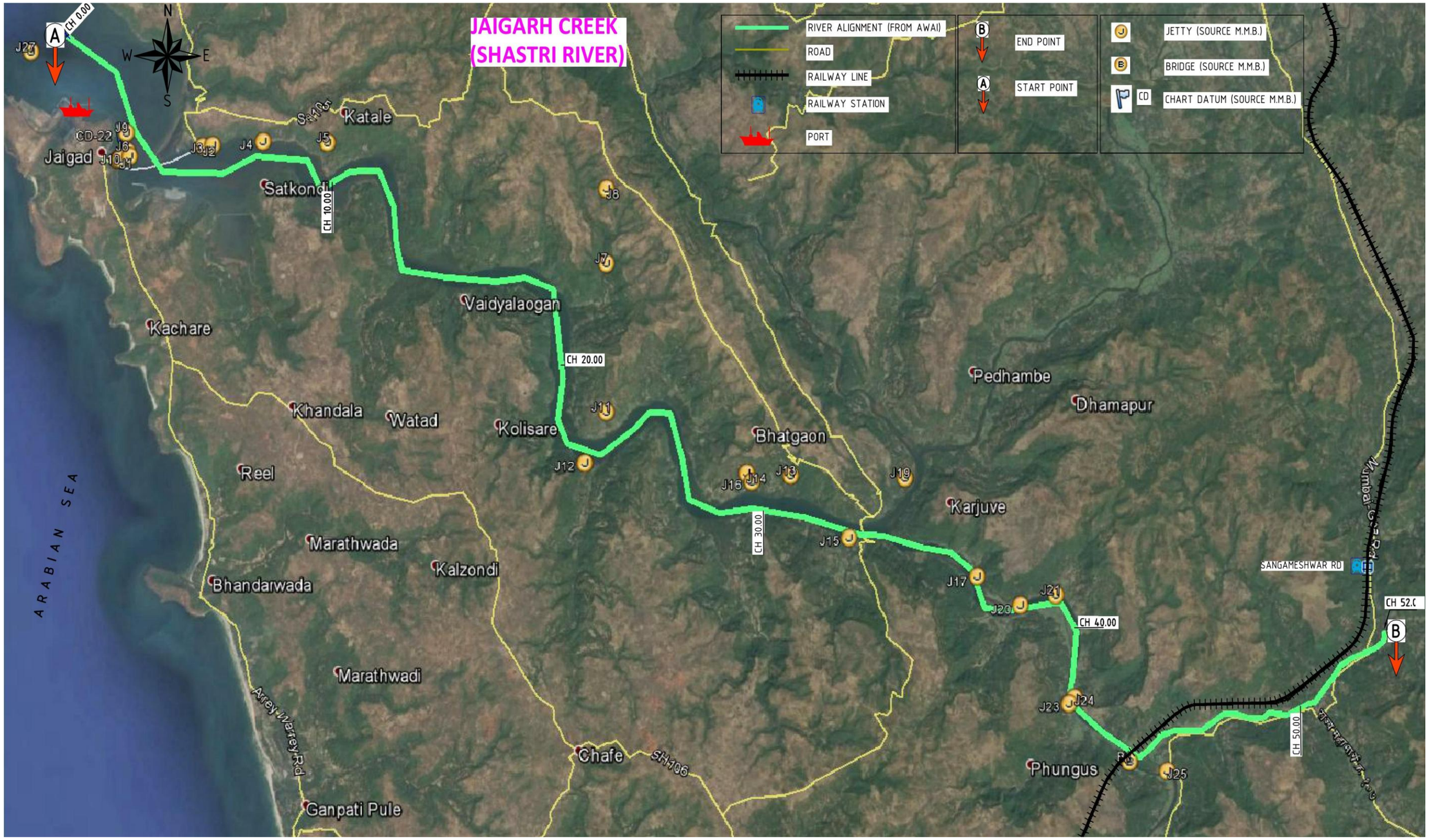


Figure 1.2: Index Map of Shastri River/Jaigad Creek

1.3 Objectives of the Study

IWAI, Ministry of Shipping, Government of India intends to explore the potential of additional waterways across the country for commercial navigation.

The objectives of the study shall necessarily include:

1. To Explore the Potential of Year Round Commercial Navigation on the Proposed National Waterways by conducting Feasibility Studies.
2. Recommending thereafter the possibility of Composite and Integrated development of proposed waterways under cluster – VII consisting of Creeks/ Rivers to achieve navigation and to develop water transport facilities on these waterways.

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, viability etc.

1.4 Scope of the Assignment

The complete scope of the assignment shall include the study in 2 stages:

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.
2. **Stage-II** would consist of the detailed hydrographic survey, topographic survey, detailed traffic survey including the divertible traffic, selection of terminal locations and preparation of detailed project report including the returns /viability analysis for implementation as a project.

This report covers the activities of Stage-I only for feasibility of the **Shastri River/Jaigad Creek** for navigation, which may have the potential for year round navigation or at least for a few months in a year.

Stage-I consists of the following activities:

A. Reconnaissance Survey

B. Collection and review of available data

C. Feasibility Report

1.5 Methodology Adopted

The Stage I Feasibility Study of the Inland Waterway stretches is based on three approaches:

1. The Physical System

2. The Current Functions and
3. The Market Potential

1.5.1 Physical System

The potential for inland navigation strongly depends on the physical environment. Success of navigation will depend on:

- The stability of the channel: frequent variations of channel positions requires river conservancy measures;
- The regime: in most cases good navigation conditions are required most of the time for fluvial navigation to develop as a competitive transport mode, if such conditions are not met, other – more reliable - modes of transportation will be used, making it difficult to get a return on the investments required for navigation (ships, maintenance, port infrastructure):
    - The regime which defines the variability of water depth, draught and water level (position of port infrastructure, vertical clearance at bridges).
    - Sediment supply: certain stretches are characterized by high sediment supply; developing such sections would require high maintenance efforts to keep the channels at depth; it must be economically and technically feasible to maintain a balance between dredging and sediment supply; therefore, the decision to construct barrages to increase the water depth, must be taken with care, as these may act as sediment traps.
- Hydrographic characteristics of the channel: depth and width of the channel. The fairway design shall conform to channel geometry. The discharge should guarantee sufficient water depth alternatively, weirs, canals could be constructed to allow required water depth for safe navigation.

From a quick scan of satellite images it becomes clear that the morphological and hydrological conditions of the different rivers vary strongly, even within the same river. Satellite images provide a complete, accessible and qualitative data source for a first appraisal of potential.

Morphological features can be easily derived from satellite images. The morphological analysis of satellite images, therefore, has been used as a basis for a first, but reliable appraisal of the physical potential of the river (for navigation). Such analysis is, therefore, proposed as one of the methods in stage I.

It should be pointed out, however, that the period in which the satellite images have been taken may strongly affect the appearance: otherwise dry sections may well be flooded in monsoon season. A careful evaluation shall be contemplated. Also, information obtained from water managers such as CWC, and local authorities will be useful complement to evaluate navigability.

1.5.2 Current Functions

Current functions of the river have also been taken into consideration:

- Navigation, present in certain areas – it's relevant to know why, how it's organized:
  - Transportation of people (including the tourism potential) and goods
- Structures aligned to rivers
- Crossing infrastructure
  - Bridges: vertical clearance, may even be absent for navigation.
  - Weirs, barrages: water supply, regulation, hydropower.
  - Ferry terminals: variations in water levels and terminal infrastructure.
- Fishery
- Mining, occurring along certain rivers, and depending on (the often) shallow channels for processing
- Irrigation/ water supply, the available water may be shared between different functions, barrages exist to tap water for supply – as Indian agriculture is important for the GDP and the employment of most of the population, equilibrium must be found between available water resources and additional uses such as use for navigation.

1.5.3 Market Potential

Historically, economic demand is a driving force behind waterway development. In several cases waterways were constructed and developed for specific industries. Also navigation was developed using existing irrigation or water supply canals. Further, the accessibility also was another driving force, when alternative mode development was difficult/ uneconomical.

In an emerging economy, such as India, the presence of waterways probably will also stimulate further economic development. While rail and road networks connect cities and industrial areas independently of the hydrographic network, now it must be analyzed where the hydrographic network can establish alternative and new links between cities. In navigable portions such links would be logical.

Environmental concerns viz. the emissions, consequences on air pollution and climate change, and social and economic pressure of congestion, led to a boost of inland navigation projects in all around the world. Such development can also be expected in India, as the development of waterways may be economically and socially more beneficial than the construction of the road and rail networks, not necessarily as a substitute, but to be developed in parallel, in a multi-modal transportation system.

The current scope for Stage I is executed as per following framework shown in **Figure 1.3**.

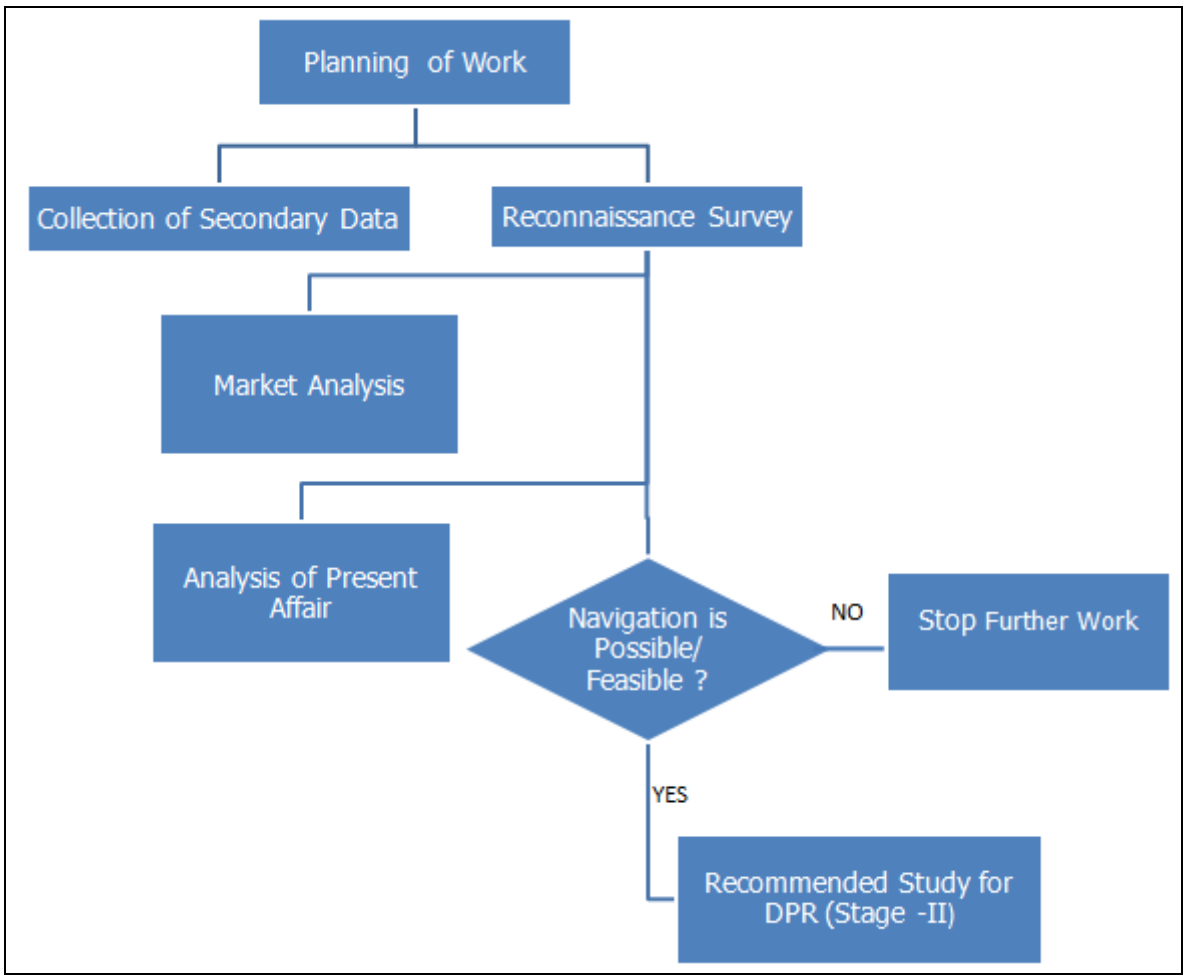


Figure 1.3: Execution Framework for Stage I

1.6 Collection of Data

For evaluating the feasibility of the waterway in Shastri River/Jaigad Creek for year round navigation, the reconnaissance survey for collecting the Primary data has been taken up. Secondary data have also been collected from various sources. IWAI issued a letter in the name of M/s Tractebel, to all the concerned stakeholders for data collection from State/ Central Government.

(A) **Primary Data:** M/s Tractebel Engineering Pvt. Ltd. has appointed a separate survey agency M/s Fugro Survey (India) Pvt. Ltd. (FSINPVT) for carrying out the reconnaissance survey for collection of following primary data:

(i) Single line longitudinal survey (Bathymetric survey or Topographic survey);

(ii) Details (horizontal and vertical clearances above High Flood Level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route etc;)

(iii) Details of locations of permanent structures viz. Bridges, Barrages, Dams, Locks, Jetties, Ports etc;

(iv) Photographs of important structures along the route;
(v) Topographical features of the proposed Inland Waterways;
(vi) Typical physical features along the alignment i.e. land use pattern;
(vii) Preliminary identification of stretches having year round flow;
(viii) Critical depth for navigational purpose;
(ix) Preliminary traffic identification on the proposed Inland Waterways;
(x) Inland Waterway width, Terrain, Bridges and structures across the proposed Inland Waterways;
(xi) Urban areas (location & extent);
(xii) Geologically sensitive areas and environmental features;
(xiii) Critical areas requiring detailed investigations;
(xiv) Soil (textural classifications) (only visual inspection at every 10km);
(xv) Drainage conditions;
(xvi) Existing utility services along the alignment;
(xvii) Present Status of navigation on different sub stretches of the waterway;

All the data derived from the above reconnaissance surveys shall be utilized for planning and programming the detailed surveys and investigations. All reconnaissance field studies including the traffic surveys have been taken up and the classification of proposed waterway has been carried out as per IWAI guidelines on this matter. The list of data collected and sources of data are being enclosed as **Annexure 1.1**.

(B) **Secondary Data:** The following secondary data has been collected from the concerned authorities as well as from sources available in public domain.

(i) Benchmark Data from IWAI, Noida;
(ii) Chart Datum data from MMB, Maharashtra;
(iii) Brief Industrial Profile of Raigad and Ratnagiri Districts, Ministry of Micro, Small & Medium Enterprises (MSME), Government of India;
(iv) Report on Environmental Status of Raigad Region, Maharashtra Pollution Control Board, Mumbai;
(v) Cargo Movement Data for the Year 2014 and 2015 provided by IWAI and recent data collected by the consultant;

All the data derived from the above reconnaissance surveys details shall be utilized for determining the navigability of the proposed national waterway. A review of the existing data available with the State Agencies and Central Water Commission for the proposed Inland Waterways has been done for determining the nature, extent, adequacy, validity of the available data and identifying the data gaps. Feasibility Report is to be

prepared for the proposed national waterway based on the available data, reconnaissance survey and the market analysis. The structure of the report has been elaborated in succeeding section 1.9 of this chapter.

1.7 Expected Outcome of the Assignment

Combining knowledge on the physical constraints, actual and future uses of the river and the valley, economic potential and needs, or absence thereof, allows the characterization of the river for development as a waterway.

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable. The potential of possible navigation in the stretches of proposed inland waterways has been determined using raw water depths reduced to the chart datum in the area of tide affected rivers. To define the navigability of river/creeks, several gradations can be distinguished:

- No or limited effort: navigable (for a specific draught) without measures;
- Limited to moderate effort: e.g. occasional dredging works at a limited number of location;
- Moderate to high: frequent dredging over a considerable length or large number of locations;
- High to very high: the construction of one or more weirs and or locks, or the construction of a canal;

In accordance with the above criteria, the stretch of the proposed waterway of Shastri River/Jaigad Creek under Cluster VII has been defined in the context of availability of navigable depth (more than 2m). Taking into account for further development in the stretches of less than 2m depth, the solutions for the navigation have been proposed.

Combining economic potential and physical characteristics allows categorizing the river or specific stretches for navigation potential on the basis of following criteria:

(i) Water Availability
(ii) Flow Depth
(iii) Vertical & Horizontal Clearance
(iv) Nautical Continuity
(v) Cargo Availability
(vi) Economic & Social Parameters

The analyses of physical and economic parameters have been the basis of a suggestion for classification of Inland waterways for further study. The waterways shall be classified into categories of Class-I to Class VII as per description derived from the compilation of Inland Waterways Authority of India (Classification of Inland

Waterways in India) Regulations, 2006. Referring the data derived from the reconnaissance single beam bathymetry survey, cargo traffic details, market potential, vertical and horizontal clearances with respect to existing cross over structures, the proposed waterway has been classified in to seven categories on the basis of IWAI guidelines for safe plying of self-propelled vessels up to 2000 Dead Weight Tonnage (DWT) and tug-barge formation in push-tow units of carrying capacity up to 8000 DWT. A recommendation of a selection of proposed inland waterway stretch has been done (based on IWAI classification) for further analysis and preparation of DPR in Stage II.

1.8 Description of Shastri River/Jaigad Creek (NW-91)

The Shastri River emerges from Prachitgad, at an elevation of 839 m above sea level and flows down to the west of the Sahyadri Mountain Ranges and eventually meets the Arabian Sea at Jaigad. The river basin falls entirely in the Ratnagiri district of Maharashtra. The detailed description of the river has been compiled in Table 1.2.

Table 1.2: Description of Shastri River/Jaigad Creek (NW-91)

Sl. No.	Introductory Consideration	Description of the River
1	Name of the river / canal	Shastri River/Jaigad Creek (NW-91)
2	State/ District through which river passes	The Shastri River/Jaigad Creek passes through the Ratnagiri district of Maharashtra State.
3	Length of the river / canal	Out of the total 80km length, 52km length of the Shastri River/Jaigad Creek starts from Arabian Sea at Jaigad Lat 17°19'11.92"N, Long 73°12'39.30"E to Sangmeshwar at Lat 17°11'15.83"N, Long 73°33'2.57"E has been declared as new national waterway.
4	Map	The index map of Shastri River/Jaigad Creek showing proposed waterway stretch, topographic features and road networks is shown in **Figure1.2**. The section of the Shastri River/Jaigad Creek under feasibility study for inland waterway showing reconnaissance survey routes is presented in **Drawing No. P. 009051-W-20201-A10 (Sheet – 1 to 8)**.
Characteristic of River		
5	River Course	Shastri River originates in Sahyadri Mountain Ranges and flows down westwards through Ratnagiri district and eventually meets Arabian Sea at Jaigad. It passes through Sangameshwar, Ratnagiri and Guhagar taluks. The River Shastri is tidal affected and forms the major mangrove harbouring estuary in Maharashtra. A variety of landforms has developed along Shastri River/Jaigad Creek, which are due to erosional and depositional processes of both fluvial and marine origin. The erosional features viz. mesa, hog backs and river terraces of depositional features are observed along

Sl. No.	Introductory Consideration	Description of the River
		the Shastri River/Jaigad Creek. Development of Mud flats has been observed at the mouths of Shastri River towards Arabian Sea. These flats consist of unconsolidated to consolidated sediments and are found to be covered by thin layer of mud. The mud is brown or brownish black in color and is plastic in character. The Shastri River is of high cultural significance with sacred groves and Shiva Temples at each hydrological junction. The pilgrim places viz. Marleshwar, Sangmeshwar, Velneshwar and Saptlingeshwar are located along the Shastri River/ Jaigad Creek.
6	Tributaries / Network of Rivers / Basin	Major tributaries are Gadgadi, Bav, Gad, Asavi and Gandagi, which join into the Shastri River at various locations.
7	Catchment Area	The total catchment area of Shastri River/Jaigad Creek is 2174 sq. km.

1.9 Structure of the Feasibility Study Report (FSR)

The Feasibility Study Report for proposed Inland Waterways of **Shastri River/Jaigad Creek** has been prepared and emphasized with stretches of proposed inland waterways having the potential for navigation. Stage-II study for preparation of DPR shall be carried out only for those stretches of proposed inland waterways, which have the potential for navigation.

The Feasibility Study Report starts with a comprehensive report in the form of executive summary giving description of the methods used for the data collection, overview of the collected data followed by a description of the Present State of Affairs, Reconnaissance Survey, findings of Market Potential and observations & inferences thereof.

The executive summary concludes with Waterway Navigation Potential of the proposed waterway on Shastri River/Jaigad Creek followed with recommendations for going ahead with classification of river. The structure of FSR is as below;

I. **Executive Summary:** Executive summary describes the suitability of the proposed waterway in terms of its navigability and market potential. It contains a brief statement of the characteristics of the river, present use of the river, data captured in the reconnaissance survey, hindrances, acceptability of the waterway, enhanced connectivity to the region, capability to decongest the existing mode of transport, important aspects for techno commercial viability etc. The background information, concise analysis and main conclusions form part of the document. It helps to understand the overall scenario and decide the suitability of development of a specific waterway.

II. **Introduction:** This chapter describes the Project background of the present study, objective of the assignment, scope of the assignment, methodology adopted, outcome of the assignment, river characteristics including the structure of the feasibility study report.

III. **Analysis of Present State of Affairs**: It provides the details about the existing town/ city/ taluka/ historical & tourist places, current utilization of proposed waterway, status of goods transport, road and rail transport as well as existing river facilities. The quantitative and qualitative description of the current utilization of proposed inland waterways are provided in the report. In addition, the descriptions about the status of goods transport, including utilization of road and transport services as well as river facilities have been covered.

IV. **Reconnaissance Survey:** The analysis of the data collected in the reconnaissance survey has been carried out to reflect the possibility of year round flow in the proposed Inland Waterways to achieve the commercial navigation. Bathymetry survey details, observed bed profiles and soil texture classification @ 10 km are compiled in this section. Observed waterway bed profile has been plotted with respect to existing Chart Datum in case of tidal affected rivers else the bed profile relates to CWC/ Irrigation water level data or FSL in case of canal. Maps of proposed Inland Waterways have been generated and referred with at the relevant locations indicating existing cross structures viz. bridges, jetties, established chart datum locations, dams, barrages, HT line, LT line, water pipe line, cables etc.

V. **Market Analysis:** The analysis of the market and potential usage of proposed Inland Waterways have been carried out. In the analysis, both the existing market and the potential future market have been examined. The details of available existing industries along the waterway, type of production in these industries, ferry services, cargo movement, type of crop along the waterway, previous history of movement of cargo in the waterway etc. have been collected and included in the report. All the data have been collected after discussion with local people while conducting reconnaissance survey etc. and also after interaction with State Govt. Officials, Irrigation / Water Resources Departments and other stakeholders. The possible divertible cargo to IWT has been assessed.

VI. **Observations and Inferences**: The observations and Inferences of the feasibility study are presented in context of stretches of proposed inland waterways, which have potential for navigation and for which Stage-II studies may be conducted. Technical Feasibility has been discussed which shall establish the navigability and potential usage of proposed Inland Waterway. The stretches of proposed inland waterways which have potential for navigation have been categorized into Class-I to Class VII

as per description derived from classification of rivers/canals by Inland Waterways Authority of India Regulations, 2006. SWOT Analysis of Proposed Waterway has also been described covering the overall aspect of the proposed waterway in terms of its Strength, Weakness, Opportunity and Threat to decide the suitability and the ranking of the waterway.

CHAPTER 2 ANALYSIS OF PRESENT STATE OF AFFAIRS

In order to establish the feasibility of waterway the state of affairs as existing today along proposed inland waterway on **Shastri River/Jaigad Creek (NW-91)** is studied. Out of total 80 km length of the river, 52 km has been proposed by IWAI for feasibility study. This chapter provides details about the current affairs, status of goods transport including utilization of road and rail transport along or near by the waterway.

2.1 Current Utilization

The River Shastri, rising in the Sahyadri hills near Prachitgad a historical fort in the newly-declared Sahyadri Forest Reserve at an elevation of 839 m above sea level and flows down to the west of the Sahyadri mountain ranges, meeting the Arabian Sea in a short journey of 80 km. The river is under tidal effect of the Arabian Sea upto Sangameshwar about 52 km from sea. The river is of high cultural significance with Shiva Temples. Local community of three talukas i.e. Sangameshwar, Guhagar and Ratnagiri of Ratnagiri district depends directly or indirectly on the river for ecosystem benefits, drinking water and water for agriculture. Shastri river/ Jaigad creek waterway has two ports namely JSW Port & Angre Port, one Dockyard i.e., at Lavgan and 29 Jetties (including JSW Jetty).

The JSW port is fully operational with 2 berths having a cargo handling capacity of 15 Million Tonnes Per Annum and Angre port has facility to handle Containers, Bulk and Liquid cargo. Dockyard on left bank of the creek is used for repairing Barges and Ships. Of 28.5 MMTPA of cargo handled at all fifteen MMB ports in the year 2015-16, about 8.24 MMTPA (29%) was handled at Jaigad Port of JSW and Angre Port.

There is a significant passenger movement in this waterway. About 2 lakh passengers use ferry services per year from this creek. Main ferry services along the river are between Tavsaal and Jaigad, which connect right and left banks.

29 Jetties are being used for transport and fishing purposes by locals. Jaigad Creek is one of the important fishing creeks in Western coast, supporting nearly 42 fishing villages. Fish catch for the year 2009-10 was 3953 Tonnes (Fish Production Report, GOM, 2010).

Details of existing structures along and across Shastri River/ Jaigad Creek waterway is presented in following sections.

2.2 Existing Waterway Structures

Existing waterway structures/ facilities in Shastri River/Jaigad Creek include ports, dockyard and jetties. **Table 2.1** below provides the details of existing facilities along Shastri River/Jaigad Creek waterway with current utilization status.

Table 2.1: Existing Facilities on Shastri River/Jaigad Creek (NW 91)

Sl. No.	Existing Facility	Chainage (Km)	Coordinates	Current Utilization
1.	JSW Port	0.00	17°18'42.09"N 73°11'36.09"E	Currently, the JSW port is operational with 2 berths having a cargo handling capacity of 15 Million Tonnes Per Annum. JSW 4 X 300 MW Coal based thermal power plant located along Jaigad Creek is currently producing 300 MW in Phase I.
2.	JSW Jetty	0.08	17°18'18.03"N 73°12'39.07"E	
3.	Jambhari Jetty	3.20	17°17'56.62"N 73°13'26.24"E	Used for fishing/ local transport.
4.	Jambhary tar Jetty	3.50	17°17'51.69"N 73°13'22.71"E	Used for fishing/ local transport.
5.	Katle Jungle Jetty	3.80	17°17'41.08"N 73°13'20.65"E	Used for fishing/ local transport.
6.	T Type Pravasi Jetty	4.00	17°17'32.39"N 73°13'26.52"E	Pravasi Jetty connects the ferry service with State Highway SH-4 leading to Ratnagiri district headquarter.
7.	Jaigad Jetty	4.20	17°17'27.44"N 73°13'26.10"E	Utilized as ferry jetty connecting Tavsal and Jaig ad. The Tavasal ferry jetty is located at Ch. 6.6 km on the North bank.
8.	Angre Port	4.60	17°17'13.19"N 73°13'47.64"E	A fully integrated port facility with towing facilities to bring vessels to berthage, material handling systems to handle containers, bulk and liquid cargo to warehouse space to store all types of clean cargo.
9.	Lavgan Dockyard	5.30	17°17'8.89"N 73°14'19.84"E	Equipped with 6 dry repair berths, 250m wet repair berthage, a ship lift system, ship and module transfer mechanism, workshops and modern material handling equipments. The infrastructure and location enables the yard to lift ships at any state of tide and at any time of the year – thus providing 365 day and 24 hour repair facilities.
10.	Tavsal mohalla L type Jetty	6.10	17°17'44.00"N 73°14'45.00"E	Used for fishing/ local transport
11.	Padwe L type Jetty	6.50	17°17'45.00"N 73°14'54.00"E	Used for fishing/ local transport.
12.	Chich Bunder T type Jetty	7.60	17°17'48.00"N 73°15'41.00"E	Used for fishing/ local transport.
13.	Katle L type Jetty	8.90	17°17'42.05"N 73°16'20.40"E	Used for fishing/ local transport.

Sl. No.	Existing Facility	Chainage (Km)	Coordinates	Current Utilization
14.	Jambhari Dhakti Jetty	17.50	17°16'7.12"N 73°19'45.95"E	Used for fishing/ local transport.
15.	Kundli Jetty	19.60	17°15'3.16"N 73°20'26.03"E	Used for fishing/ local transport.
16.	Kolisare Jettty	22.30	17°13'41.58"N 73°20'23.90"E	Used for fishing/ local transport.
17.	Agarnaral Jetty	22.70	17°13'33.56"N 73°20'40.48"E	Used for fishing/ local transport.
18.	Chave Jetty	30.50	17°13'3.48"N 73°23'46.29"E	Used for fishing/ local transport.
19.	Bhatgaon Durg Bunder Jetty	30.90	17°12'49.12"N 73°23'57.43"E	Used for fishing/ local transport.
20.	Medhe Jetty	32.40	17°12'30.00"N 73°24'45.00"E	Used for fishing/ local transport.
21.	Medhe Jetty	32.40	17°12'30.00"N 73°24'45.00"E	Used for fishing/ local transport.
22.	Bhatgaon Ovli Jetty	33.60	17°12'45.28"N 73°25'32.22"E	Used for fishing/ local transport.
23.	Bhatgaon Tisang Jetty	33.80	17°13'3.32"N 73°25'35.93"E	Used for fishing/ local transport.
24.	Manjre Jetty	34.20	17°12'19.20"N 73°25'37.50"E	Used for fishing/ local transport.
25.	Kajway Tiwri Jetty	36.20	17°11'59.00"N 73°26'44.00"E	Used for fishing/ local transport.
26.	Vesvi Jetty	38.10	17°11'36.78"N 73°27'24.57"E	Used for fishing/ local transport.
27.	Pirdavne Jetty	39.10	17°11'44.00"N 73°27'57.00"Es	Used for fishing/ local transport.
28.	Dingani Jetty	41.00	17°10'22.61"N 73°28'14.98"E	Used for fishing/ local transport.
29.	Dingani old Jetty	41.90	17°10'22.00"N 73°28'14.00"E	Used for fishing/ local transport.
30.	Phungus Jetty	42.00	17°10'16.75"N 73°28'9.29"E	Used for fishing/ local transport.
31.	Kolambe Jetty	45.00	17° 8'18.00"N 73°29'25.00"E	Used for fishing/ local transport.
32.	Kurdhunda Jetty	45.20	17° 9'23.00"N 73°29'40.00"E	Used for fishing/ local transport.

Out of the total 29 jetties mentioned in Table 2.1 above, four jetties namely Kolambe Jetty, Kurdhunda Jetty, Bhatgaon Ovli Jetty and Bhatgaon Tisang Jetty are on the tributaries of the waterway.

As mentioned in the above table, the Shastri River/ Jaigad Creek waterway is being mainly used for cargo movement at JSW & Angre Port, ship building & repair requirements at Lavgan Dockyard, fishing activities and local transport.

Figures 2.1 to 2.4 show some of the above mentioned facilities.

Figure 2.1: JSW Port at Chainage 3.6km

Figure 2.2: Jaigad Jetty at Chainage 3.9km

Figure 2.3 : Lavgan Dockyard at Chainage 5.8km

Figure 2.4: Tavsaal Ferry Jetty at Chainage 8.4km

2.3 Crossing Over Shastri River/Jaigad Creek Water Way

Apart from existing facilities on banks of the waterway as described in section 2.1.1 above, four Road Bridges and one Rail Bridge are existing in the study stretch. Further, one Road bridge is under construction in the study stretch of Shastri River. **Table 2.2** shows details of the existing and under construction bridge structures.

Table 2.2: Details of Rail and Road Bridges across Shastri River/Jaigad Creek

Sl. No.	Name of Structure	Chainage (km)	Location	Horizontal Clearance (m)	Vertical Clearance above MHWS (m)	Center Position	
						Latitude	Longitude
1	Bhatgaon Road Bridge	34.43	Bhatgaon	60	6.5	17°12'35.30"N	73°24'56.20"E
2	Phungus Road Bridge	43.95	Dingani	40	8.5	17°10'14.51"N	73°28'15.21"E
3	Pirdavane – Khurdunda Railway Bridge	45.84	Kurdunda	30	12.0	17°09'36.26"N	73°29'04.69"E
4	Asoda Road Bridge	51.98	Navadi	20	5.0	17°10'28.56"N	73°32'05.51"E
5	New Shastri (Road Bridge Under Construction)	53.53	Kasaba	25	8.0	17°10'57.40"N	73°32'44.60"E
6	Old Shastri Road Bridge	53.53	Kasaba	20	6.5	17°10'57.40"N	73°32'44.60"E

From Table 2.2 above, it can be seen that the vertical clearance above MHWS along various structures vary from 6.0m to 9.0m. The clearance of 9.0m above MHWS is under construction at Fhungus road bridge connecting Phungus-Dingani at Chainage 43.9 km and 6.0m is as Asoda Road bridge connecting Navdai with Dharmpur –Dhamani-Asurde road at chainage 51.9 km. For all other three bridges at Kasaba, Kurdunda and Bhatgaon, the vertical clearance is 8.0m above MHWS. The horizontal clearances at bridge structures vary from 20 to 25m.

2.4 Connectivity of Waterway

Proposed stretch of Shastri River/ Jaigad Creek waterway lies in the coastal area of Ratnagiri district which is well connected with the state capital and surrounding districts, tehsils and villages through road and rail. **Figure 2.5** shows road and rail connectivity of the area adjacent to the Shastri River waterway.

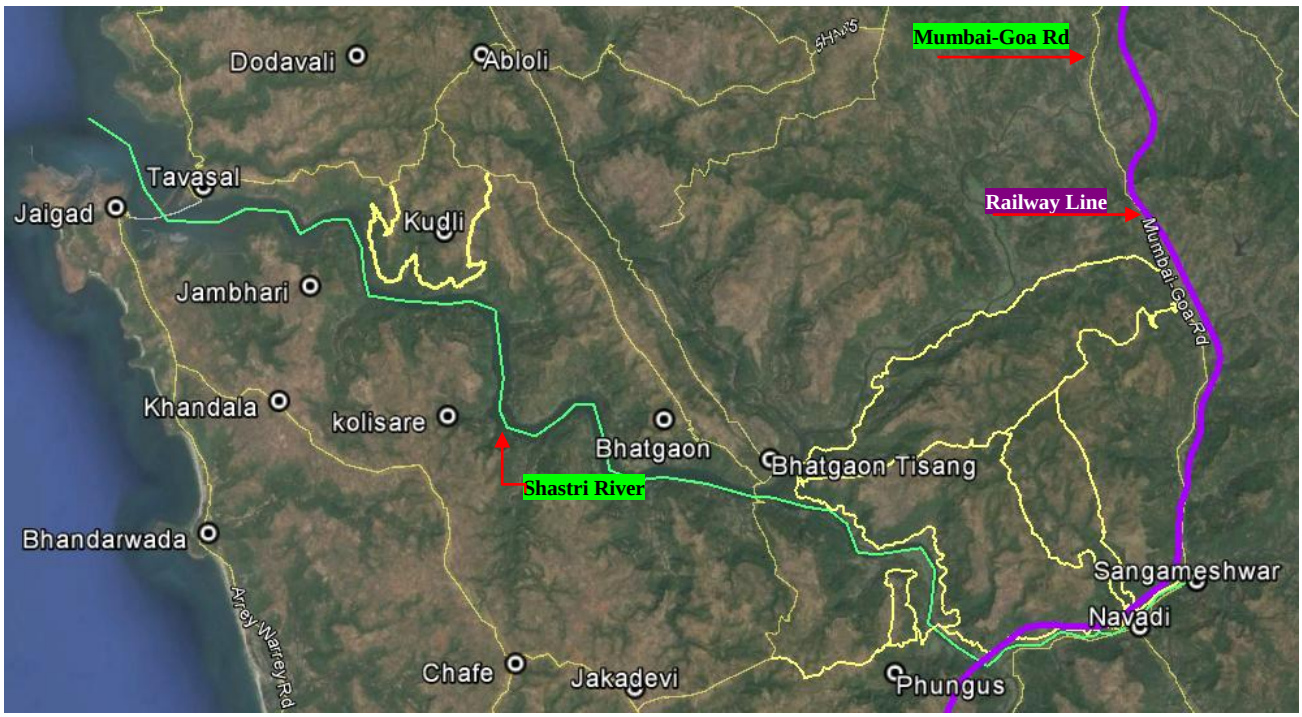


Figure 2.5: View of Rail and Road Network around Shastri River

In **Figure 2.5**, Shastri River waterway is shown in green color whereas yellow and purple colors represent the road and rail network respectively around the waterway. The area under study is well connected with highway and rail network.

2.5 Important Places

Many important places of Ratnagiri district are situated in the vicinity of the waterway. These places are well connected with the waterway by road and rail transport. **Table 2.3** shows the distance of the waterway from nearby important places.

Table 2.3: List of District/Town/Taluka in vicinity of Shastri River/Jaigad Creek Waterway

Sl No.	Important Places	Category	Distance from Creek/River (km)	Bank
1.	Sangameshwar	Taluka	0.1	Left bank
2.	Guhagar	Taluka	18.0	Right Bank
3.	Ratnagiri	District	20.0	Left bank
4.	Kosumb	Village	9.0	Left bank
5.	Ugdi	Village	8.0	Left Bank
6.	Chafe	Village	6.0	Left Bank

Sl No.	Important Places	Category	Distance from Creek/River (km)	Bank
7.	Makhjan	Village	11.0	Right Bank
8.	Abloli	Village	8.0	Right Bank
9.	Khandala	Village	4.0	Left Bank
10.	Katale	Village	1.5	Right Bank
11.	Satkondi	Village	0.5	Left Bank
12.	Muslondi	Village	7.0	Right Bank

2.6 Road Connectivity

The Shastri River passes through Ratnagiri district which is mostly covered by hills. As per data available for 2008-2009, the total length of the roads in Ratnagiri district is 7409.0 Km. Out of the total length, about 275.0 km is National Highway; 849.0 km State Highway, 1398.0 km district roads and other district roads are 1273.0 km. About 3197.0 km roads are in village area. The total road length per unit geographical area in Ratnagiri district is 0.89 km/sq.km.

Road connecting Phungus-Dingani and Navdai with Dharmpur-Dhamani-Asurde road crosses the Shastri River at Chainage 43.9 km and 51.9 km respectively.

2.7 Rail Connectivity

Railways and roads are the main transport facilities in the Shastri River catchment of Ratnagiri District. Railway transport in this region is developed under the Konkan Railway Project. The main trunk route of the railway is aligned almost parallel to the coast line. Ratnagiri district has a total length of about 194 km broad gauge railway line. There are 15 railway stations in the district of Ratnagiri namely Ratnagiri, Chiplun, Khed, Sanghmeshwar, Rajapur Road, Adavali, Aravali Road, Savarda, Vilavade, Diwan Khavati, Anjani, Bhoke, Uksi, Kamathe and Nivasar.

The end point of study stretch of waterway is at Sangameshwar and railway station of Sangameshwar is on the Konkan railway. Panvel, the origin station on Konkan railway line, is located at about 258.0 km by road and 246.0 km by rail from Sangameshwar. Panvel is the main nodal point of NH-17, NH-4, NH-4B & expressway and the main junction of Central railway, Konkan railway & Harbor railway. The railway station at Sangameshwar is 2.0 km from the waterway.

2.8 Status of Goods Transport

Status of goods transport through River waterway is detailed in **Chapter 4 on Market Analysis of this report**.

2.9 Conclusion

a) Total length of Shashtri River is 80 km before joining the sea. The river is under tidal influence of Arabian Sea (backwater effect) upto Sangameshwar (about 52 km), thus the total study stretch of National Waterway (NW-91) is under tidal effect.

b) Out of 52 km length of proposed waterway, about 5km is presently under multi-purpose commercial utilization through existing ports at Jaigad and Angre. In 2015-16, Jaigad Port and Angre Port handled 8.24 MMTPA of cargo which included thermal coal, iron ore, other ores, chemicals, food grains and project cargo.

c) Lavgan Dockyard, equipped with 6 dry repair berths, 250m wet repair berthage, a ship lift system, ship and module transfer mechanism, workshops and modern material handling equipments is located on the creek. The infrastructure and location enables the yard to lift ships at any state of tide and at any time of the year – thus providing 365 day and 24 hour repair facilities.

d) There is a significant passenger movement in this waterway. About 2 lakh passengers use ferry services per year. Many ferry services in the waterway are between Tavsal and Jaigad which connect right and left banks.

e) Jaigad Creek is one of the important fishing creeks in Western coast, supporting nearly 42 fishing villages. Fish catch for the year 2009-10 was 3953 Tonnes (Fish Production Report, GOM, 2010).

f) The area in and around the waterway is well connected through road and rail network. The end point of study stretch of waterway is at Sangameshwar and railway station of Sangameshwar is on the Konkan railway. Panvel, the origin station on Konkan railway line, is located at about 258.0 km by road and 246.0 km by rail from Sangameshwar. Panvel is the main nodal point of NH-17, NH-4, NH-4B & expressway and the main junction of Central railway, Konkan railway & Harbor railway.

g) There is one number railway and four numbers of road bridges existing across the waterway. One new road bridge is under construction across the waterway. The vertical clearances above MHWS at the Bridge structures vary from 6.0m to 9.0m, whereas the horizontal clearances vary from 20m to 25m.

CHAPTER 3 RECONNAISSANCE SURVEY

3.1 River Profile

River Shastri originates near Prachitgad, a historical fort in the newly declared Shayadri Forest reserve on the crest line of the Western Ghats, at an elevation of 839m above Mean Sea Level (MSL) and joins the Arabian Sea at Jaigad Creek. The total catchment area of Shastri River basin is 2174 sqkm. The catchment receives an average annual rainfall of about 3260mm. The length of the Shastri main stream in the catchment from the origin to the outfall in the Arabian Sea is about 80km. The upstream river stretch of about 20km flows in hilly area with steep slope, whereas lower reach has mild and flatter slope. A map showing Shastri catchment basin is shown in **Figure 3.1**. Major tributaries are Gadgadi, Bav, Gad, Asavi and Gandagi, which join into the Shastri River at various locations. Shastri River flows entirely in the Ratnagiri district of Maharashtra, a region famed for its rich horticulture product viz. Alphpnso Mangoes, Cashew Nuts and Jackfruits. River passes through Sangameshwar, Ratnagiri and Guhagar talukas and many villages including Jaigad, Boria, Palshet and Malgund. Pilgrim places viz. Marleshwar, Sangmeshwar, Velneshwar and Saptlingeshwar are located along the Shastri River/ Jaigad Creek.

Figure 3.1 indicates the major part of the river flow close to the coastal region; thus the lower stretch of river is expected to be tidal affected zone. Given the size of the river, some lower reaches may have navigation potential. IWAI expects the lower 52.00km, shown in green colour in Figure 3.1, to have potential for navigation and thus, the subject of study under this assignment.

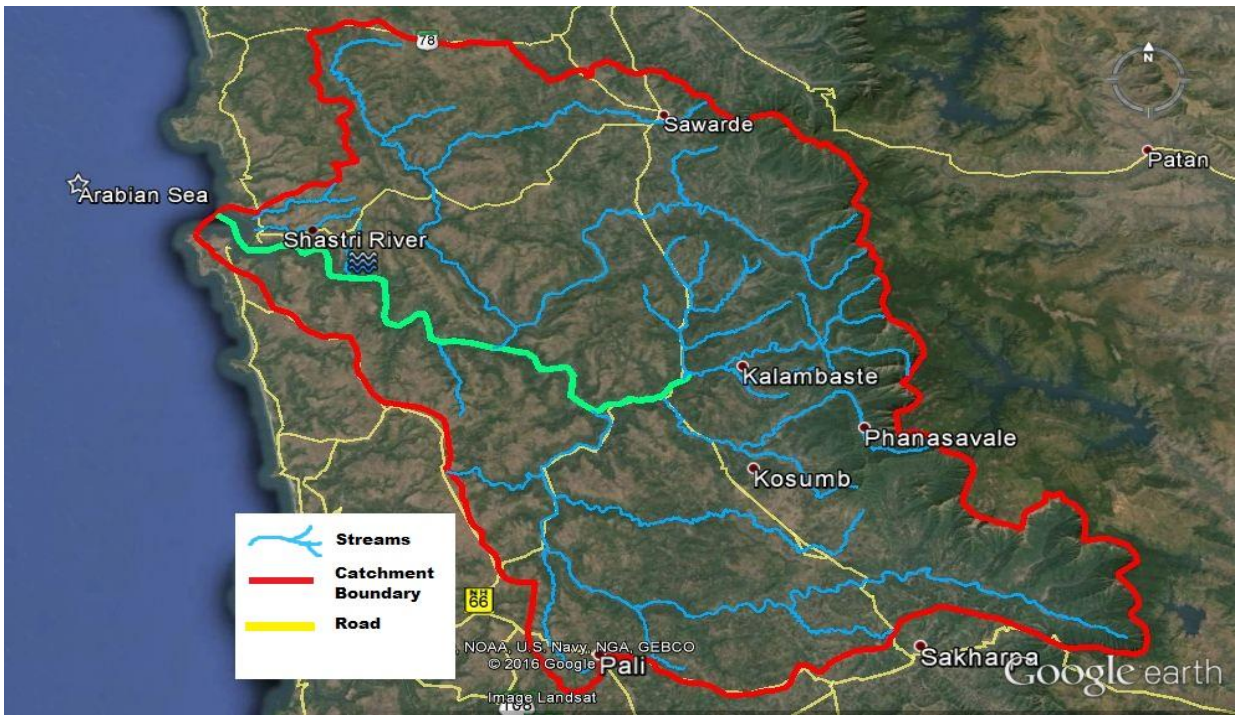


Figure 3.1: Catchment Area of Shastri River/Jaigad Creek

The stretch of the Shastri River/Jaigad Creek considered for assessment of navigation potential is defined as below:

52 kms length of the river from confluence with Arabian Sea at Jaigad to Sangmeshwar	From: 17° 19' 11.92" N, 73° 12' 39.30" E.	Up to: 17° 11' 15.83" N, 73° 33' 2.57" E	National Waterway: 91

3.2 Reconnaissance Survey

This section presents a stretch-wise description of Shastri River/Jaigad Creek. It also covers the Hydrological analysis of collected data viz maximum and minimum water depths. The route map of Shastri River is shown in **Figure 3.2** below.

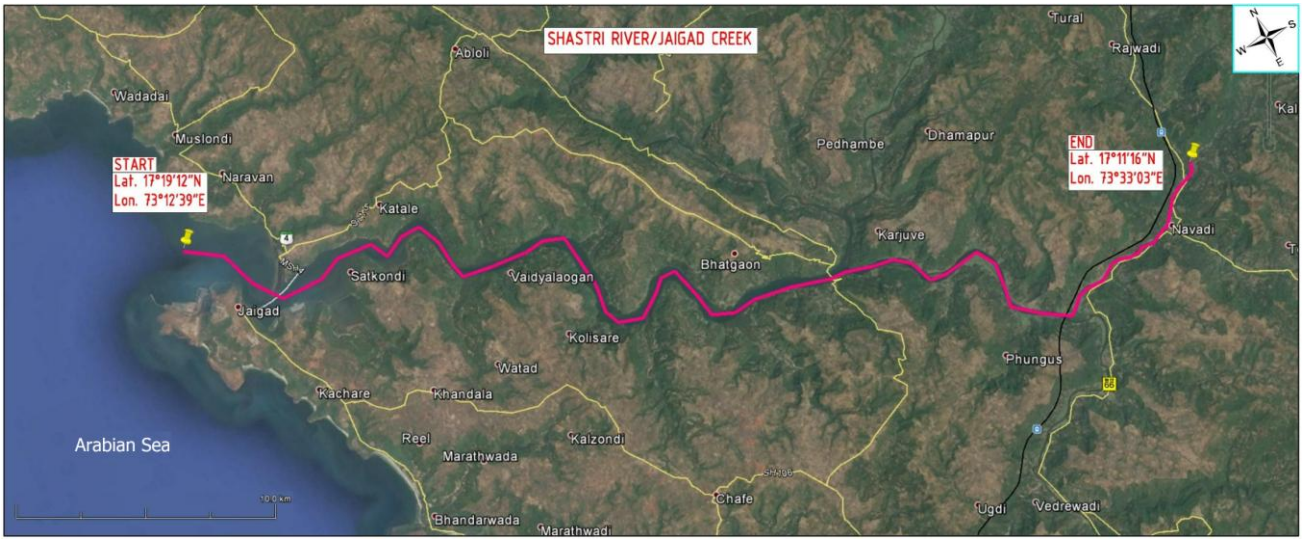


Figure 3.2: Route Map of Shastri River/Jaigad Creek

3.2.1 Methodology of Survey

Single beam bathymetry survey was carried out to determine the river profile along its deepest route (single line survey) along the proposed waterway by deploying DGPS positioning system and single beam echo sounder. Wherever bathymetry survey was not feasible due to shallow water depths, survey was continued using topography survey method.

Along with the river bathymetry, other relevant data/information like horizontal and vertical clearances above high flood level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables en-route were collected along with their coordinates and locations. Soil samples were also collected along the survey area at about 10.0km interval. Texture of the collected soil samples was analyzed visually.

The survey was conducted in WGS84 datum; UTM Projection (Zone 43 N, CM 075° E). The geodetic parameters used during the survey are mentioned in **Table 3.1.**

Table 3.1: Geodetic Datum and Projection Parameters

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984
Spheroid:	World Geodetic System 1984
Semi Major Axis:	a = 6 378 137.000m
Inverse Flattening:	1/f = 298.257 223 563
Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 43 N;
Central Meridian:	075° 00′ 00″ East
Latitude of Origin:	0° 00′ 00″ North
False Easting:	500 000m
False Northing:	0m
Scale Factor on Central Meridian:	0.9996
Units:	Metre

The layout diagram of the equipment used for bathymetric survey has been shown in **Figure 3.3** below.

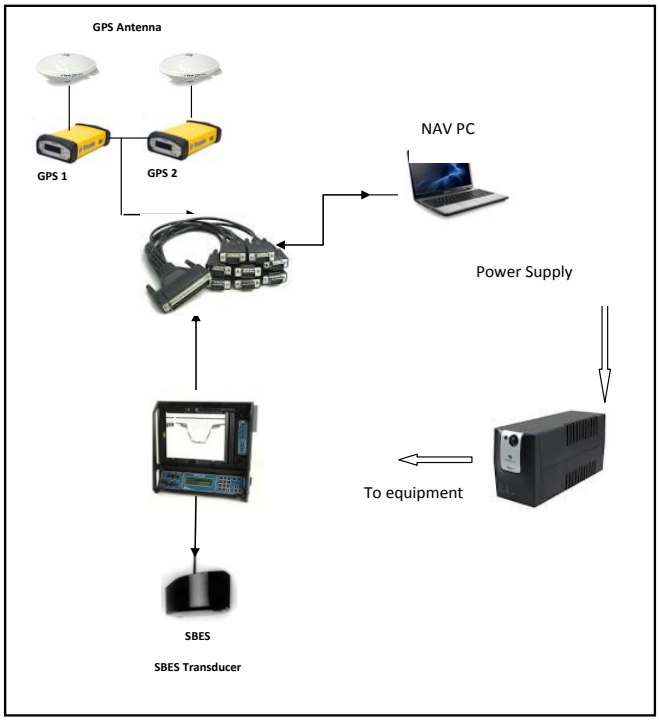


Figure 3.3: Equipment Diagram

Team surveying at site with equipment mounted on the boat is depicted in **Figure 3.4** as shown below:

Figure 3.4: Team Surveying at Site with Equipment Mounted on the Boat

An overview chart for Shastri River/Jaigad Creek bathymetry is enclosed as **Annexure 3.1**

3.2.2 Chart Datum of the Proposed Waterway

The water depths have been determined as a result of all soundings reduced to Chart Datum (the lowest tide level observed for a considerable period at specific location) in the area. The location with coordinates of Chart Datum obtained from MMB (**Annexure 3.2**) is compiled for record purpose and placed in **Table 3.2**.

Table 3.2: Details of Chart Datum Used for Data Reduction

Sl. No.	Location	Latitude	Longitude	Z_0 *(m)
1	Jaigad Jetty	17° 29' 55"	73° 13' 30"	1.768

**- Below Mean Sea Level*

However, the authenticated data of Chart Datum as ascertained from Indian Tide Table of Apollo Bandar has been used for this subject study, as detailed.

Sl. No.	Location	Latitude	Longitude	Z_0* (m)
1	Apollo Bandar	18°55'13.29"	72°49'46.65"	2.51

**- Below Mean Sea Level*

3.2.3 Bathymetry and Site Data Collected

A. Shastri River/Jaigad Creek (Ch 0.00km to Ch 10.00km)

Jindal Power Plant and the Jindal Port Jetty are on the South bank from Ch 1.00km to Ch 3.50km. The Chauqula Port jetty and the Jaigad jetty are on the West bank at Ch 3.60km and Ch 3.90km respectively. Jaigad Jetty is located near the Jaigad village. Lavgan dockyard lies in the South bank at Ch 5.80km. The Tavasal ferry jetty is located at Ch 6.60km on the North bank. Tavasal fishing village and its Jetty are located on the North bank at Ch 8.40km. The minimum depth recorded in this section is 1.8m (Ch 3.18km) and the maximum depth is 17.1m (Ch 3.77km). The above is shown below in **Table 3.3.** The stretch is shown in **Figure 3.5**.

Table 3.3: Maximum - Minimum Depth in Shastri River/Jaigad Creek from Ch 0.00km – Ch 10.00km

Maximum –Minimum Depths			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
0.0	10	17.1	1.8

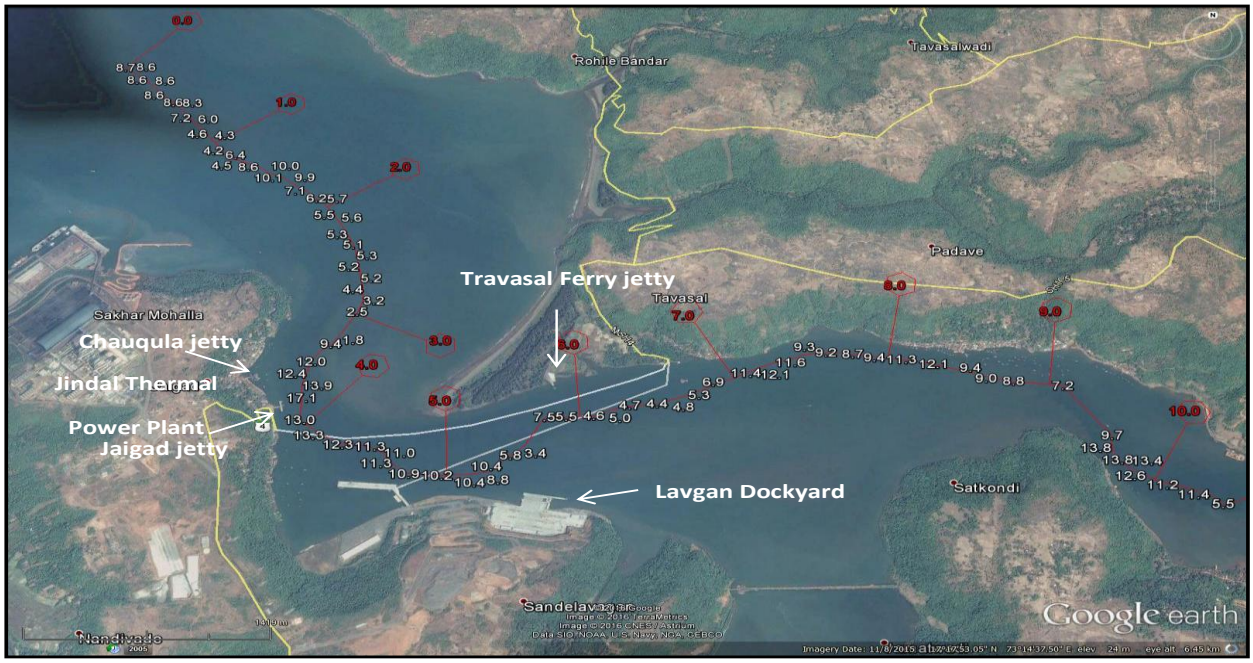


Figure 3.5: Route Chart of the Survey from Ch 0.00km to Ch 6.00km

B. Shastri River/Jaigad Creek (Ch 10.00km to Ch 20.00km)

Mangroves are observed along the Shastri River along the North bank in this stretch. There were a few fields and settlements seen on the South bank in this stretch from Ch 10.20km to Ch 12.50km. Shallow patches covered with mangroves were observed where small streams join the river. Two sets of high tension lines were observed crossing the river at approx. Ch 14.49km and Ch 14.51km.

Another South bank tributary joins the river at Ch 15.00km. A minor Right bank (North bank) tributary merges into the Shastri River near Ch 15.50km. Vaidyagaon village is located near Ch 16.60km. The minimum depth recorded in this section is 1.6m (Ch 14.38km) and the maximum depth is 16.7m (Ch 11.72km) as given below in **Table 3.4.** The stretch is shown in **Figure 3.6**.

Table 3.4: Maximum - Minimum Depth in Shastri River/Jaigad Creek from Ch 10.00km to Ch 20.00km

Maximum –Minimum Depths			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
10.0	**20.0**	16.7	1.6

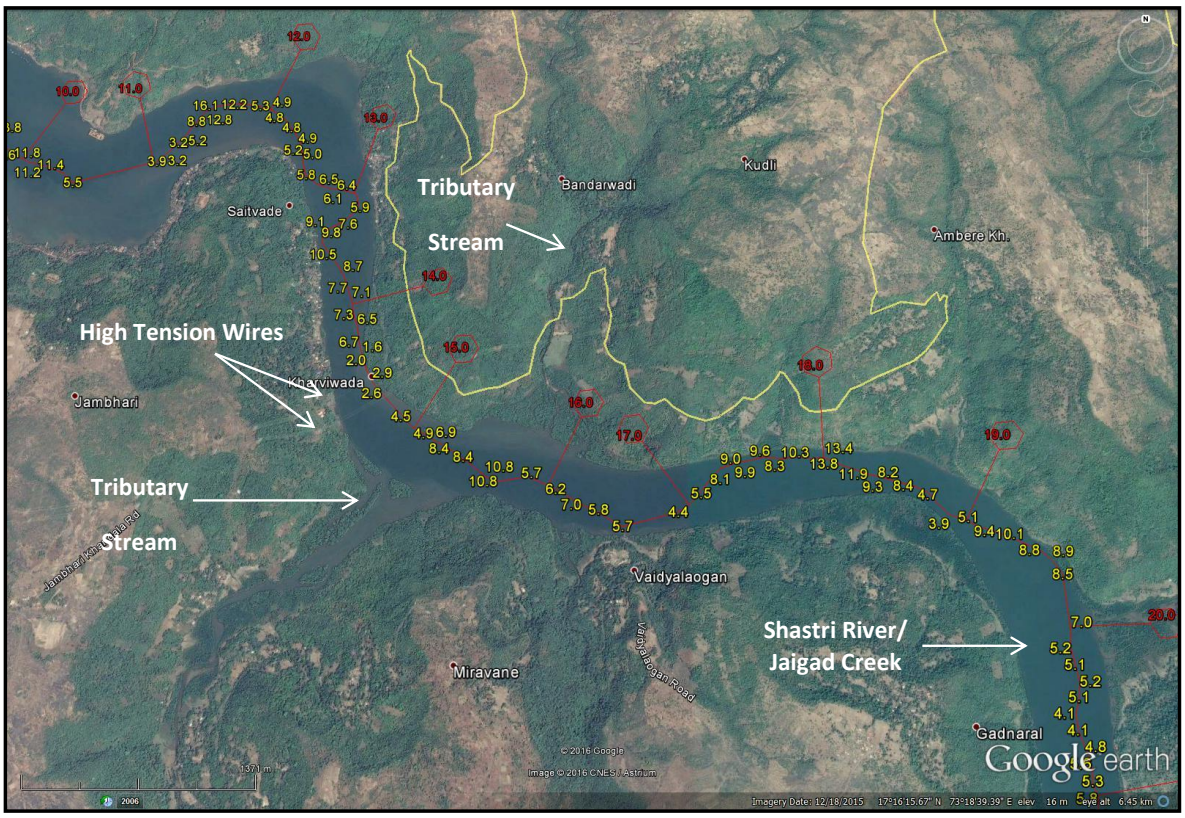


Figure 3.6: Route Chart of the Survey from Ch 10.00km to Ch 20.00km

C. Shastri River/Jaigad Creek (Ch 20.00km to Ch 29.00km)

There are mangroves seen along both the banks of the river with a few scattered settlements. The North bank has a few open/ agricultural fields. Gadnaral and Kolisare, the two villages, are located on the West bank. Chafe Jetty is seen on the Southern bank at Ch 23.50km. A minor left bank tributary joins the river at Ch 24.50km. Chikalwadi village lies near the West bank of the river. The minimum depth recorded in this section is 3.2 m (Ch 27.00km) and the maximum depth is 18.59m (Ch 26.02km) as given below in **Table 3.5.** The stretch is shown in **Figure 3.7**.

Table 3.5: Maximum – Minimum Depth in Shastri River/Jaigad Creek from Ch 20.00km to Ch 29.00km

Maximum –Minimum Depths			
Chainage (km)		Reduced Water Depth (m) w.r.t. Chart Datum	
From	To	Max	Min
20.0	**29.0**	18.59	3.2

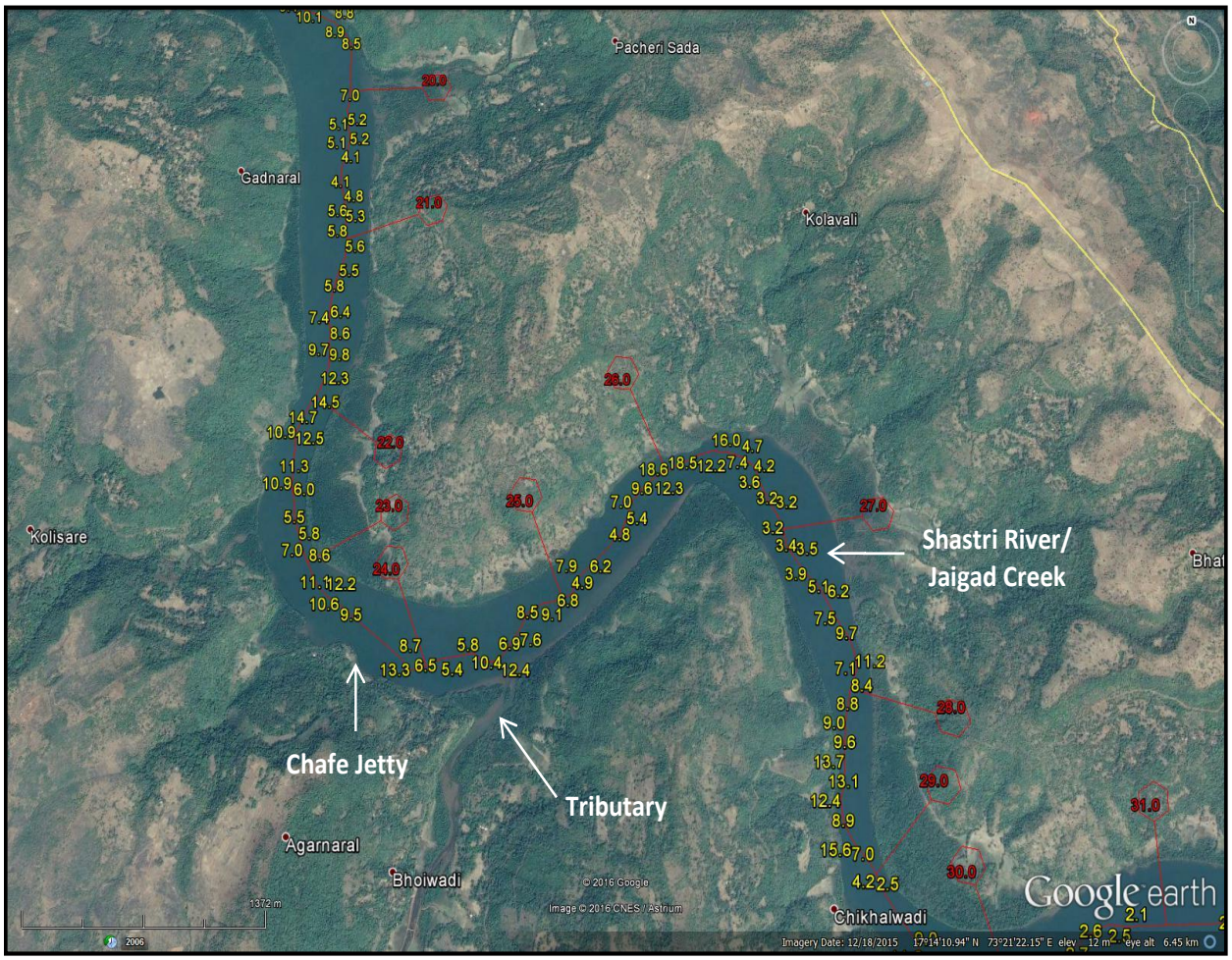


Figure 3.7: Route Chart of the Survey from Ch 20.00km to Ch 29.00km

D. Shastri River/Jaigad Creek (Ch 29.00km to Ch 37.00km)

Left bank of the river is covered with mangrove in this stretch. A small stream (left bank) joins the river at Ch 30.00km. The Rai Village Jetty is located on the South bank of the river at Ch 32.30km. The Bhatgaon Bridge crosses the river at Ch 34.43km with a vertical clearance of 6.5m and horizontal clearance of 25m between piers. Some construction activity was seen on the bank of the river. A major tributary joins the Shastri River on the right side near Ch 35.00km. Shallow patches near the confluence were seen on Shastri River. The minimum depth recorded in this section is 1.3m (Ch 29.88km) and the maximum depth is 12.2m (Ch 31.94km) as given below in **Table 3.6.** The stretch is shown in **Figure 3.8**.

Table 3.6: Maximum – Minimum Depth in Shastri River/Jaigad Creek from Ch 29.00km to Ch 37.00km

Maximum –Minimum Depths			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
29.0	**37.0**	12.2	1.3

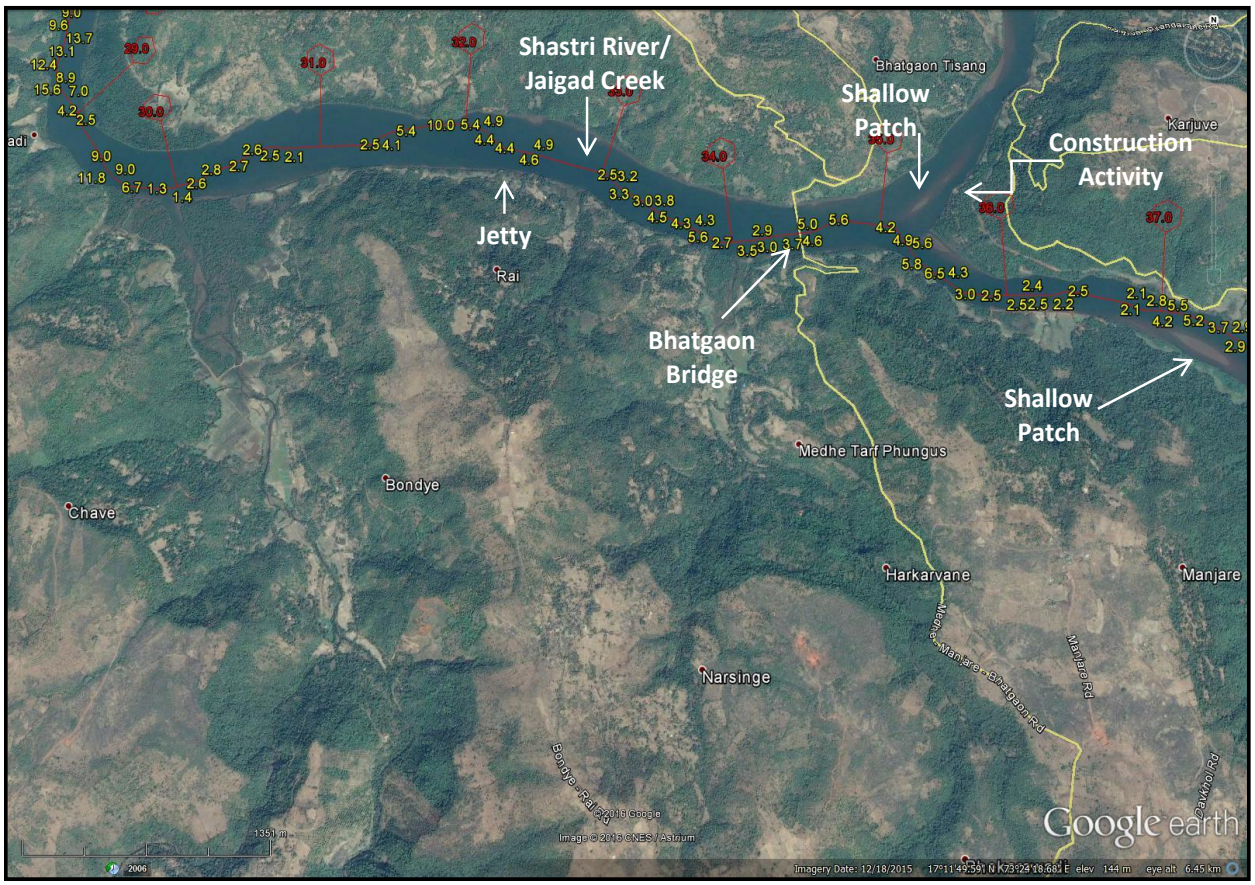


Figure 3.8: Route Chart of the Survey from Ch 29.00km to Ch 37.00km

E. Shastri River/Jaigad Creek (Ch 37.00km to Ch 45.00km)

Field, settlement and a few mangroves were seen along both the banks. A shallow patch is observed close to the south bank of river between Ch 36.70km to Ch 37.60km. There is an island seen between Ch 38.50km and Ch 39.40km. The river banks are covered with vegetation and open fields. Phungus village lies on the West bank where as Dingni Kuran lies on the East bank at Ch 43.80km. The Phungus - Dingani Road Bridge crosses the river at Ch 43.95km. The vertical clearance is 7.5m and the distance between piers is 25m. The minimum depth recorded in this section is 0.8m (Ch 43.98km) and the maximum depth is 5.5m (Ch 37.18km) as shown in **Table 3.7.** The stretch is depicted in **Figure 3.9**.

Table 3.7: Maximum – Minimum Depth in Shastri River/Jaigad Creek from Ch 37.00km to Ch 45.00km

Maximum –Minimum Depths			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
37.0	45.0	5.5	0.8

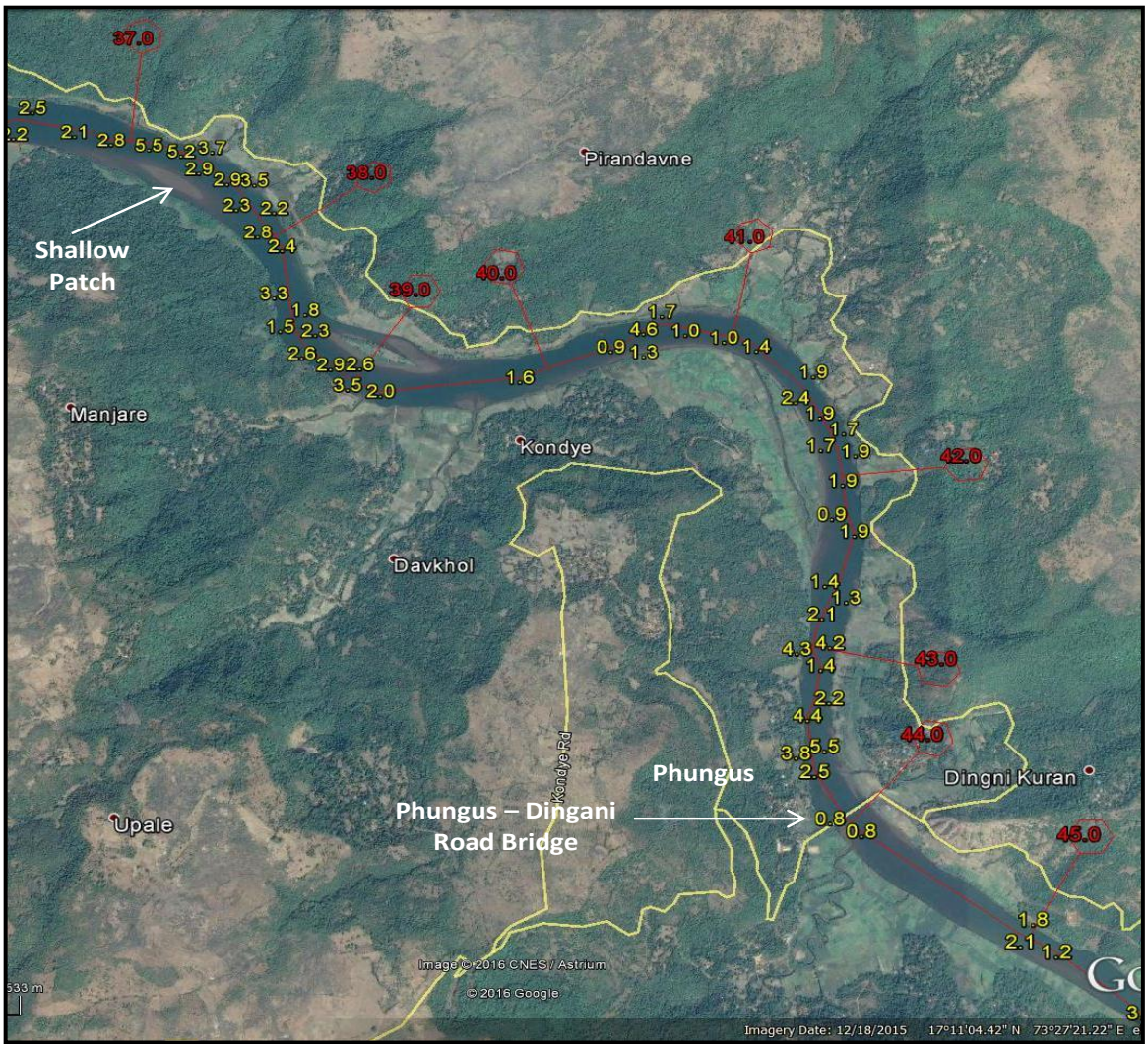


Figure 3.9: Route Chart of the Survey from Ch 37.00km to Ch 45.00km

F. Shastri River/Jaigad Creek (Ch 45.00km to Ch 54.40km)

Fields and mangroves were seen along both the banks. Two electric lines cross the river in this reach i.e. one at Ch 45.73km and other at Ch 48.98km. A Railway Bridge crosses the river at Ch 45.84km. Another road bridge crosses the river at Ch 51.98km. Bav tributary joins the river near Ch 46.00km, where it meanders. Shallow patch was observed in this stretch between Ch 46.30km to Ch 46.80km. The bathymetric survey was completed near Bhirkond (Lat 17° 10′ 06.46″ N, Lon 73° 30′ 29.19 E) up to CH 48.52km. Due to shallow

depth, boat could not move further in the upstream. However, the stretch of proposed National waterway on Shastri River / Jaigad creek ends near Sangameshwar (Lat 17° 11' 15.83"N, Lon 73° 33' 02.57"E) at Ch 54.4km. The bathymetric survey from Ch 48.52km to Ch 54.40km could not be preceded due to shallow water depth. Therefore, topographic survey has been carried out. However, all the features of bridges and other structures have been collected up to Sangameshwar (Ch 54.40km) i.e. up to end of the stretch defined. The minimum depth recorded in this section is -1.3m (Ch 47.63km) and the maximum depth is 4.1m (Ch 45.85km) as shown below in **Table 3.8.** The stretch is depicted in **Figure 3.10**

Table 3.8: Maximum – Minimum Depth in Shastri River/Jaigad Creek from Ch 45.00km to 48.52km

Maximum –Minimum Depths			
Chainage (km)		Reduced Water Depth (m) w. r. t. Chart Datum	
From	To	Max	Min
45.0	48.52	4.1	-1.3

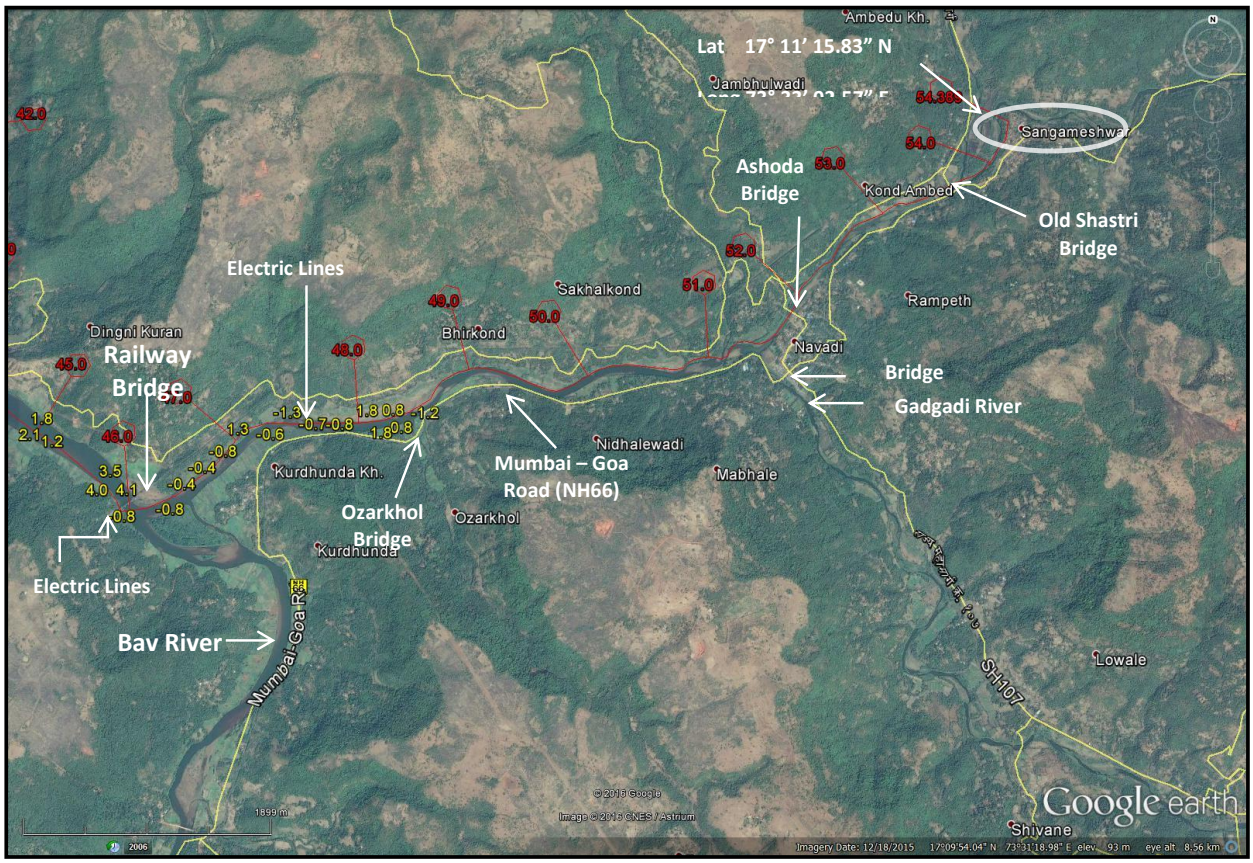


Figure 3.10: Route Chart of the Survey from Ch 45.00km to 54.40km

The maximum and minimum depths with reference to the Chart Datum in the small intervals have been summarized in **Table 3.9** describing the length of stretch showing various ranges of water depth available.

Table 3.9: Maximum – Minimum Depth in Shastri River/Jaigad Creek From Ch 0.00km to Ch 48.52km

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-10	17.05	1.75	9.88	0.12	-	-
10-20	16.74	1.63	9.77	0.23	-	-
20-29	18.59	3.18	9.00	-	-	-
29-37	12.17	1.32	7.75	-	0.25	-
37-45	5.47	0.79	4.32	1.84	0.92	0.92
45-48.52	4.11	-1.3	0.72	0.28	0.28	2.24
Total			**41.44**	**2.47**	**1.45**	**3.16**

The above data indicates that water depth of 2.0m and above is available up to 39.16km of the waterway under study. It may be noted that the above depths have been reckoned with CD. Since the entire study stretch of Shastri River/Jaigad Creek is under tidal influence, the available effective depths would be more than 2.37m (average tide height) which will be advantageous for safe navigation. It confirms the availability of 2.0m and above water in 72% of river in the proposed stretch under study. The detailed hydrographic survey information indicating location, observed water depth at each point of data reading has been given in **Annexure 3.3**

3.2.4 Soil Texture Classification

The soil texture has been observed during the reconnaissance survey. The observed soil texture at 10km interval has been given in **Table 3.10**.

Table 3.10: Soil Texture in Shastri River/Jaigad Creek at 10.0km Interval

Chainage (Km)	Latitude	Longitude	Depth (m)	Soil Texture
0.00	17°19'11.404"	73°12'42.055"	8.69	Clay
10.04	17°17'14.191"	73°16'24.737"	11.81	Clay
20.03	17°15'29.528"	73°20'20.024"	7.05	Clay
30.07	17°12'47.010"	73°22'40.019"	2.65	Clay
40.05	17°11'33.740"	73°27'28.943"	0.14	Clay
48.55	17°10'01.628"	73°30'24.900"	Exposed Soil	Rock

From the above table it is observed that clayey soil is present in most part of the river under study stretch whereas rocky patches in the upper most stretch under study area are observed beyond Ch 48.0km.

3.3 Classification of Waterways

The 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 2000tonne Dead Weight Tonnage (DWT) and tug-barge formation in push-two units of carrying capacity up to 8000tonne (Ref: IWAI, Gazette Notification 2006). The classification criteria of waterways are mentioned in **Table 3.11** for Rivers and in **Table 3.12** for canals.

Table 3.11: 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 3.12: Classification of Inland Waterways for Canals

Class of Waterways	Rivers				
	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	-	-	-	-	-

The vessel sizes for self propelled or tug and barge combination for different classes of waterways are described in **Table 3.13**.

Table 3.13: 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)

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)
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)

Vertical Clearance for power cables or telephone lines or cables for any transmission purpose for all classes:

- Low Voltage Transmission lines and Telephone line 16.5m
- High Voltage Transmission line not exceeding 110 kV 19.0m
- High Voltage Transmission line exceeding 110 kv 19.0m +1 cm per each additional kv

In case of underwater pipelines, power cables and other cables, norms are to be decided as per site condition and navigational requirement.

Reference level for vertical clearance for different types of channels:

- For Rivers:- Over the Navigational High Flood Level (NHFL), which is the highest flood level at frequency of 5 % in any year over a period of last twenty years;
- For Tidal Canals:- Over the highest high water level;
- For Other Canal:- Over designed full supply level (FSL);

The above classification for rivers and channels shall be effective if:

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

The data gathered through the reconnaissance study has been analyzed from the parameters mentioned hereinabove and conclusions have been made with regard to the class of navigation channel that the relevant stretch of Shastri River/Jaigad Creek falls into. Furthermore, it is to be determined whether the entire 54.40km stretch can be classified under one class of channel or there is a possibility and advantage of developing sub-reaches under different classes of navigation channel.

3.3.1 Cross Over Structures

The details of High Tension lines and Bridges crossing the Shastri River/Jaigad Creek are given below in **Table 3.14** and **Table 3.15**.

Table 3.14: Details of High Tension and Electric Lines across Shastri River/Jaigad Creek

Sl. No.	Cross-Structure Name	Chainage (km)	Location	Position (Above vessel track)		Vertical Clearance above MHWS (m)
				Latitude	Longitude	
1	HT Line	14.49	Kharviwada	17°16'24.40"N	73°17'48.70"E	20.00
2	Electric Line	45.73	Pridavane	17°09'39.00"N	73°29'02.30"E	13.50
3	Electric Line	48.98	Bhirkond	17°10'09.10"N	73°30'36.20"E	6.50

Table 3.15: Details of Bridges across Shastri River/Jaigad Creek

Sl. No.	Name of Structure	Chainage (km)	Location	Horizontal Clearance (m)	Vertical Clearance above MHWS (m)	Center Position	
						Latitude	Longitude
7	Bhatgaon Road Bridge	34.43	Bhatgaon	60	6.5	17°12'35.30"N	73°24'56.20"E
8	Phungus Road Bridge	43.95	Dingani	40	8.5	17°10'14.51"N	73°28'15.21"E
9	Pirdavane – Khurdunda Railway Bridge	45.84	Kurdunda	30	12.0	17°09'36.26"N	73°29'04.69"E
10	Asoda Road Bridge	51.98	Navadi	20	5.0	17°10'28.56"N	73°32'05.51"E
11	New Shastri (Road Bridge Under Construction)	53.53	Kasaba	25	8.0	17°10'57.40"N	73°32'44.60"E
12	Old Shastri Road Bridge	53.53	Kasaba	20	6.5	17°10'57.40"N	73°32'44.60"E

From the above information, waterway Ch 0.00km to Ch 45.73km, sufficient vertical clearance is available from HT line. Thereafter, support base of each electric line will have to be raised in the range of 3.0m to 10.0m to get the required clearance.

The vertical clearance at the bridges fulfills the criteria for Class II. Bhatgaon Road Bridge is located at Ch 34.43km. Prior to this bridge, the stretch can be classified for all classes. Thereafter, the vertical clearance at bridges is falling in **Class II**. Shastri Bridge at Ch 53.53km is located at the upstream end of the proposed waterway and hence its vertical clearance has not been considered for analysis.

The horizontal clearance on the classification has been provisioned for two lane navigation. With due caution considering the provision of single lane mobility under the Pirdavane – Khurdunda Railway Bridge, Ch 45.84km and Asoda Road Bridge, Ch 51.98km (without any change in the structure modification), the class of the waterway can be elevated to **Class V**.

Photos of important structures such as port, bridges, jetties, transmission lines and plants as taken during site visit are shown in **Annexure 3.4**.

3.3.2 Dams, Barrages and Reservoirs

No dams, barrages or reservoirs exist along the surveyed route.

3.3.3 Bends along the Route

On the proposed waterway route, there are many bends in Shastri River/Jaigad Creek, which are given below in **Table 3.16.**

Table 3.16: River Bend Radius in Shastri River/Jaigad Creek

Sl. No.	Chainage (Km)	Radius (m)	Sl. No.	Chainage (Km)	Radius (m)
1.	2.50	992.00	2.	7.00	619.00
3.	9.50	262.00	4.	12.25	250.00
5.	13.40	880.00	6.	18.30	1300.00
7.	26.00	380.00	8.	30.10	650.00
9.	31.50	2100.00	10.	34.40	470.00
11.	35.75	545.00	12.	39.50	1000.00
13.	40.75	560.00	14.	47.10	545.00
15.	48.80	425.00	16.	50.50	430.00
17.	51.60	355.00	18.	53.75	795.00
19.	54.20	1400.00			

The river takes mild and sharp bends at various locations and needs smoothening of bends for plying of vessels with class zone. In the study stretch based on the river radius criteria it may be fit for **Class II** vessels with depth improvement at some locations and by smoothening of the bends, however on confirmation of cargo.

The pictorial detailed information showing the proposed waterway indicating various cross-structures (i.e. bridges, transmission lines etc.), major industrial locations and important places along the waterway have

been shown in **Drawing No P009051-W-20201-A10** (Sheet 1 to 8). Drawing also depicts various information such as Jetties, Rail and Road location along the waterway.

3.3.4 Gauge & Discharge data

In the Shastri River/Jaigad Creek catchment, no gauge and discharge site as established by Central Water Commission was observed. For the Stage II study, the gauge data will be analyzed if the same is available within a reasonable reach and if found relevant.

3.3.5 Bed Profile of Waterway

All soundings were reduced to Chart Datum in the area. Tidal heights are predicted using MMB data to reduce the raw water depths to Chart Datum. The observed bed profile of Shastri River/Jaigad Creek waterways is shown below in **Figure 3.11** and presented in **Annexure 3.5**.

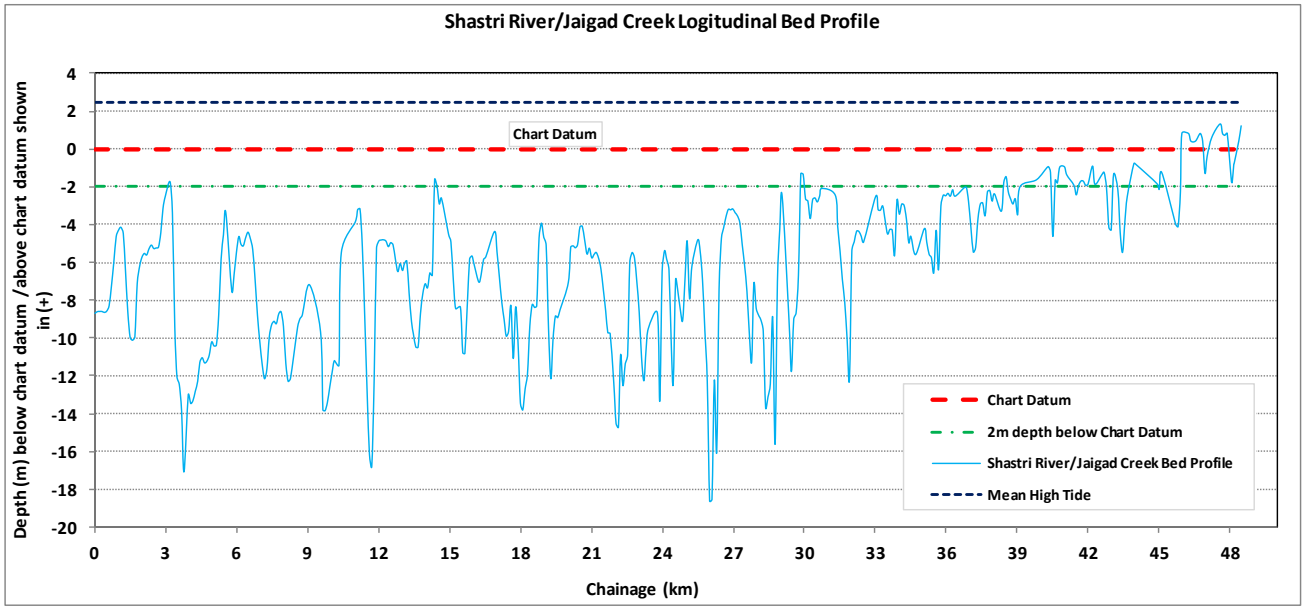


Figure 3.11: Longitudinal River Bed Depth Profile of Shastri River/Jaigad Creek from Ch 0.00km to Ch 48.52km

Figure 3.11 also shows the Chart Datum line, 2m below the Chart Datum line and mean high tide 2.37m above Chart Datum. However, tides in this region were observed in the range of 0.32m to 4.42m (MHWS). The following key observations are made from **Figure 3.11:**

(i) The tidal effect of the Arabian Sea in the Shastri River/ Jaigad Creek is affected up to the Sangameshwar at about 50.0km from the sea.

(ii) As observed at the site, the study stretch generally has the soil texture as clay.

(iii) Mangrove has been observed marginally on both banks of Shastri River/ Jaigad Creek up to Sangameshwar and its upstream. The tide in the region has Semi-Diurnal characteristics.

(iv) The initial half of the river stretch from the mouth is flatter which gradually becomes steeper having an average slope of 1 in 5288 in 52.00km of the river stretch under study.

(v) Water depth of 2m is available naturally for up to 39.00km with minimum dredging required at some places.

(vi) With some moderate dredging between 39.00km and 54.40km (15.4km stretch), a minimum draft of 2.0m may be achieved.

3.4 Tidal Effect on Navigability of Shastri River/Jaigad Creek

The tidal effect on the river navigability may be put to an advantage in order to optimize the cargo movement from import ships and taking bulk cargo to a jetty located upstream of the river bank near the industrial units for planned bulk consumption of the cargo. Industrial units e.g. Steel plants/ Thermal & Gas based plants/ Cement plants/ Oil terminals are either operational or have been planned near the coast line as a preferred location either on the river banks near the mouth of the river or in creeks meeting high sea.

Shallow waterways in these rivers and creeks put a restriction on movement of large ships which calls for unloading of the cargo from ships at high sea into smaller vessels. These vessels transport the cargo to smaller jetties of the plants. Normally, there is a travel restriction of the movement of vessels by variation in the available draft in the river/creek due to tide. If the available draft in the river is adequate to sail a particular type of vessel, the vessel can move into the river/creeks or vice versa; else they wait for the high tide. Thus, movements of the vessels through the river depend upon the draft available which is affected by the tide.

3.4.1 Present Usability of Shastri River/Jaigad Creek

With the information gathered during the reconnaissance survey, presently, no vessels are plying upstream of the Jaigad Port area. Tide dependent water level in the Shastri River / Jaigad Creek can be used advantageously for the smooth movement of the vessels in the study stretch.

3.4.2 Chart Datum & Variation in Navigation Draft

The draft variation in the Shastri River/Jaigad Creek has been established from 0.80m to 17.01m with respect to Chart Datum during the reconnaissance survey. The tide tables are available for the region and water level in the creek can be forecasted at any point of time. It helps in knowing that a particular type of vessel can sail in the creek at a given point of time. The average tidal variation is in the order of 2.37m with its minimum of 0.32m and maximum depth of 4.42m in Shastri River as per the records available for this region. Hence, it is noted that if the high tide is considered for navigation, a higher water depth is actually available for navigation

along the waterway although water depth with respect to Chart Datum shall depict a lower depth corresponding to the least available depth (LAD). So, conceptually, navigation in a tidal river is more effective considering the tidal effect which is observed in such cases elsewhere. Arabian Sea at the confluence location of Shastri River has a semidiurnal tide having two high and two low water levels each tidal day, with relatively small differences in the respective highs and lows effect which provides a tidal cycle of 6.0 hours.

The speed of these vessels is normally 8 knots in a still river and the travel time of these vessels may be about 2.0 hours inclusive of the docking time. Hence, a six hour tidal window shall be advantageously used for optimization of vessel movement from sea to destined location as well as for unloading the material and the low tide shall be made use of to sail from local jetty to the high sea with a lower draft requirement of empty vessel which is again available during the low tide. Similar considerations shall be effective for other industrial units that are either already planned or that may be planned in future on this waterway. This shall also facilitate the classification of the water way either in one category or into various categories with a consideration of river length being actively used currently, and future possibilities for cargo movement beyond the present use.

3.4.3 Benefits of Tidal Effect

The above contention for using tidal window using high tide for facilitating navigation shall help to decide many other logistics which may consist of exact vessel size, loading time, unloading time, facilities available at loading and unloading locations etc. A better insight into tidal information shall help to decide the following:

(i) Classification of the waterway;
(ii) Vessel Size;
(iii) Scheduling of vessel movement;
(iv) Number of vessels for defined quantity of the cargo;
(v) Flotilla Combination;
(vi) Different size of vessels instead of only one size;
(vii) Handling facilities at the terminal location;
(viii) Desirability and quantum of dredging required;
(ix) Vessel allocation decision;

The benefits of tidal effect will be more useful in operation of vessels and in improving the efficiency of vessel operation.

3.5 Agencies to be approached for Clearances, if any

Based on the reconnaissance survey, interaction with local people and consultation with government officials, the information regarding clearances and approvals required from the concerned authorities for operation of National Waterway NW-91 (Shastri River/Jaigad Creek) has been given in **Table 3.17**.

Table 3.17: List of Clearances and Approvals Required

Environment Clearance	Forest Clearance	Wildlife Clearance	Coastal Regulation Zone (CRZ) Clearance	Consent to Establish/ Operate	No Objection Certificate from Directorate of Fisheries	NOC from WRD/PWD/ Railways
√	To be ascertained at DPR Stage-II	To be ascertained at DPR Stage-II	√	√	√	√

3.5.1 Compilation of Data in Feasibility Format

The field information gathered through single line bathymetry survey, data collection from IWAI, data collection from various agencies, site visit and information derived from web has been compiled in the format as provided by IWAI for the Shastri River/Jaigad Creek. The consolidated data shall be useful in deriving basic information about each of the waterway in IWAI format as enclosed as **Annexure 3.6**.

3.6 Conclusion

Based on the survey observation, the classification of proposed waterways based on various criteria has been summarized in below **Table 3.18**.

Table 3.18: Classification of Proposed Waterway

Criteria	Classification																			
Length of waterway from start (km)	3	5	8	11	14	16	19	22	24	27	30	33	35	38	41	44	46	49	52	54
Chainage length in %	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Depth availble	C-V														C-I					
Rail & raod Bridge Vert. clearance	All Class														C-II					
Rail & raod Bridge Hor. clearance	All Class														C-II					
HT Line Vert. clearance	All Class																	Base Raise		
Bend Radius	C-II																			
Index	All Class		Class-V			Class-IV			Class-III			Class-II			Class-I					

The study stretch of the waterway is amenable for development as Class V waterway. However, considerable Dredging may be required. In order to consider the full stretch as **Class V**, two nos. of Bridges are to be modified and one Bridge is to be considered with single lane operation. Further smoothening of bends is essential.

The above stretch of the waterway, hence, can be considered under Class V which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 1000 DWT (approximate size 70m overall length, 12m moulded breadth and 1.8m loaded draft) or one tug and four barges combination of 4000 DWT (approximate size 170m overall length, 24m breadth and 1.8m loaded draft).

Accordingly, the national waterway NW-91 of Shastri River / Jaigad Creek is proposed for development as **Class V** waterway in the stretch of the waterway as depicted below:

Table 3.19: Final Conclusion for Possible Navigation

River Stretch	0.0 km	51.98km
Classification		
	Class- V	
Horizontal clearance (m)	80	
Vertical clearnce (m)	10	
Minimum Depth (m)	2	
Bottom Width (m)	80	
Self Propelled Vessel		
Dead Weight Tonnage	1000	
Vessel size (m)	70 x 12 x 1.8	
Tug + Barge		
Dead Weight Tonnage	4000	
Vessel size (m)	170 x 24 x 1.8	

CHAPTER 4 MARKET ANALYSIS

River Shastri originates in Sahyadri Mountain Ranges and flows westwards towards the Arabian Sea and outfalls into Arabian Sea traversing through Jaigad Creek. The River passes through Ratnagiri District from Karjue in the study reach and touches three Talukas of Gauhaghar, Sanghmeshwar and Ratnagiri. Important towns located near to the banks of Jaigad Creek/Shastri River are Jaigad and Sanghmeshwar.

The navigable length of the River/Creek is 52 km. Based on the deepest Bathymetry single line survey carried out during the study and as per the classification of "Inland water ways" as per Ministry of Shipping, Government of India notification. It can be classified as "Class V" for the first 34 km from start at Chainage 0 and as "Class II" for the remaining length i.e., from Ch 34km to Ch 52km (**Refer Map 4.1**).

There are 32 jetties along the River/Creek in the study stretch including 1 Port of JSW; 1 Jetty of JSW; 1 Port of Angre and 1 Dock Yard Lavgan, which are being used for various activities of Cargo, Fishing and Passenger mobility. Of 28.5 Million Metric Tonne Per Annum (MMTPA) of cargo handled at all fifteen Maharashtra Maritime Board (MMB) Ports in the year 2015-16, about 8.24 MMTPA (29%) (**Figure 4.1 and Table 4.1**) was handled at Jaigad Ports of JSW at Dhamankol, Angre at Lavgaon and Marine Syndicate Ltd at Katale villages in Ratnagiri District.

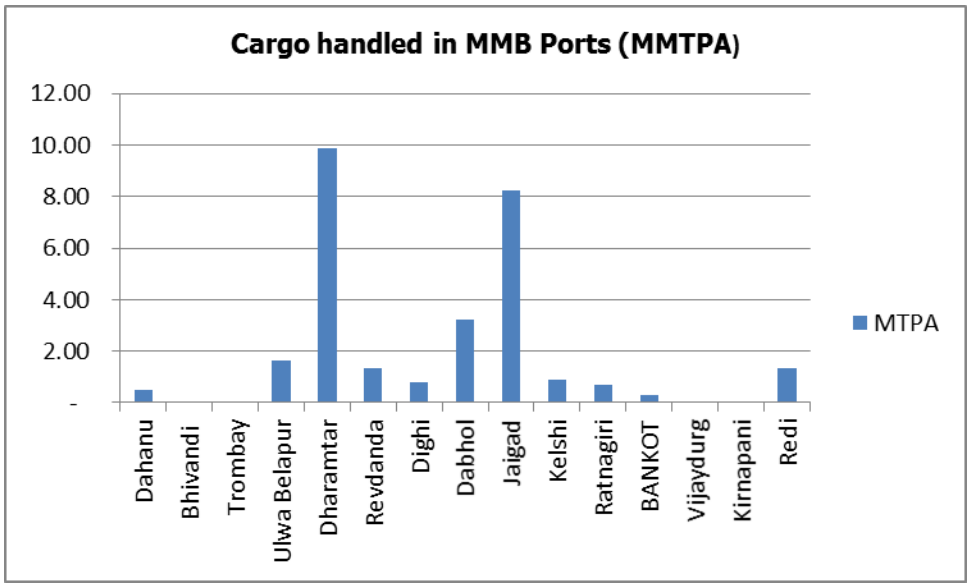


Figure 4.1: Cargo Handled at MMB Ports in 2015-16 (MMTPA)

Table 4.1: Details of Cargo Handled in MMB Ports in 2015-16

Cargo Handled			
Sl No.	Ports	MMTPA	%
1	Dahanu	0.47	1.6%
2	Bhivandi	0.003	0.01%
3	Trombay	0.01	0.0%
4	Ulwa Belapur	1.62	5.6%
5	Dharamtar	9.89	34.3%
6	Revdanda	1.34	4.7%
7	Dighi	0.78	2.7%
8	Dabhol	3.22	11.1%
9	Jaigad	8.24	28.6%
10	Kelshi	0.91	3.1%
11	Ratnagiri	0.71	2.5%
12	BANKOT	0.27	0.9%
13	Vijaydurg	0.05	0.2%
14	Kirnapani	-	0.0%
15	Redi	1.34	4.6%
and Total		**28.85**	**100.0%**

These Ports are located within 5 km from the mouth of the Creek, where the cargo movement is taking place. Currently, minimal cargo mobility is observed beyond the 5 km and upto 52 Kms of the study stretch. Passenger movement is significant i.e. about 2.0 lakh passengers use Ferry services per year from this Creek.

4.1 Existing Cargo Traffic

JSW Ports Ltd., Jaigad at Dhamankhol, is a Green field, multi-cargo deep water (20 m), all weather port having handling capacity of 15 MMTPA. It handles bulk cargo of Bauxite, Coke, Iron Ore, Lime Stone, Project cargo, Molasses, Rock Phosphate, Steam Coal, Sugar, and Sulphur etc. It has a backup area of 33 acres and has covered storage facilities for coal, fertilizers and agro commodities; Reefer facilities, Tanks for Molasses and edible oil. A cape-size vessel can berth at the port.

The port is now expanding this to 80 MTPA by building capability to handle containers, Ro-Ro vessels, LNG, POL and offshore business.

The Port is connected to the NH-17 (NH-66) at Nivali via a 42 KM long, 2 lane State Highway (SH-164), which is planned to be widened to a six lane Highway. Currently, Port has developed a private rail siding at Ratnagiri (55km from Jaigad). It is also developing a 33.7 km new railway line to connect new Digni station on Konkan

Railway network through PPP route, with a capacity to handle 20 trains each way per day. In addition, the proposed Chiplun – Karad Rail connectivity project, sanctioned by the Ministry of Railways, is about 103 km rail line between Central Railway and Konkan Railway (Chiplun Station and Karad Station). This rail line will reduce the distance from Chiplun to Karad from 528 KM to 103 KM. It would also reduce distances to other cargo generating locations like Belgaum, Bijapur, Gulbarga, Latur, Parli and Solapur. Once developed, this rail gateway would provide JSW Jaigad Port access to the entire Central India and expand the hinterland manifold.

Angre Port Ltd (Jaigad) near Lavgan, Dist. Ratnagiri offers year-round handling and storage facilities for clean cargo such as containers, dry bulk and liquid cargo. With a draft of 13m, the Port is well equipped to handle vessels of up to 35,000 DWT including handy-size vessels. It is connected by NH-17 (NH-66) and State Highway (SH) 106. The Konkan Railway route is 45km away from the port with a 4-lane road and a dedicated rail link is under proposal.

At Marine Syndicate Ltd. Jaigad Creek, Village Katale, Dist. Ratnagiri, no cargo has been handled for the past 2 years.

Jaigad Ports handled 8.24 MMTPA of cargo (**Table 4.2 & Figure 4.2**) in the year 2015-16; 77% of it was overseas cargo (Import: Export = 95%:5%), while 25% of it was coastal cargo of which of which nearly 76% was loaded. The cargo handled at these ports in the last 4 years has been stable at about 8 MMTPA.

The cargo handled is at the Ports mentioned above, wherein the activities have been restricted within 5 km from the confluence of the Creek.

Table 4.2: Jaigad Port: Cargo Handled from April 2015-March 2016 (in MTPA)

	Overseas			Coastal			
COMMODITY	**Unloaded**	**Loaded**	**Total**	**Unloaded**	**Loaded**	**Total**	**Grand Total**
Iron Ore	13,51,913	-	13,51,913	-	13,05,879	13,05,879	26,57,792
Max/Project cargo	-	1,507	1,507	942	-	942	2,449
Met Coke	1,20,620	-	1,20,620	-	-	-	1,20,620
Molasses	-	2,68,200	2,68,200	-	-	-	2,68,200
Quartzite	-	-	-	-	5,505	5,505	5,505
Steam coal	45,00,326	-	45,00,326	30,000	5,12,014	5,42,014	50,42,340
Sugar	-	19,660	19,660	-	-	-	19,660
Sulphur	9,502	-	9,502	-	-	-	9,502
Coke	6,980	-	6,980	-	-	-	6,980
Rock Phospate	1,07,820	-	1,07,820	-	-	-	1,07,820
TOTAL	**60,97,161**	**2,89,367**	**63,86,528**	**30,942**	**18,23,398**	**18,54,340**	**82,40,868**

Source: MMB

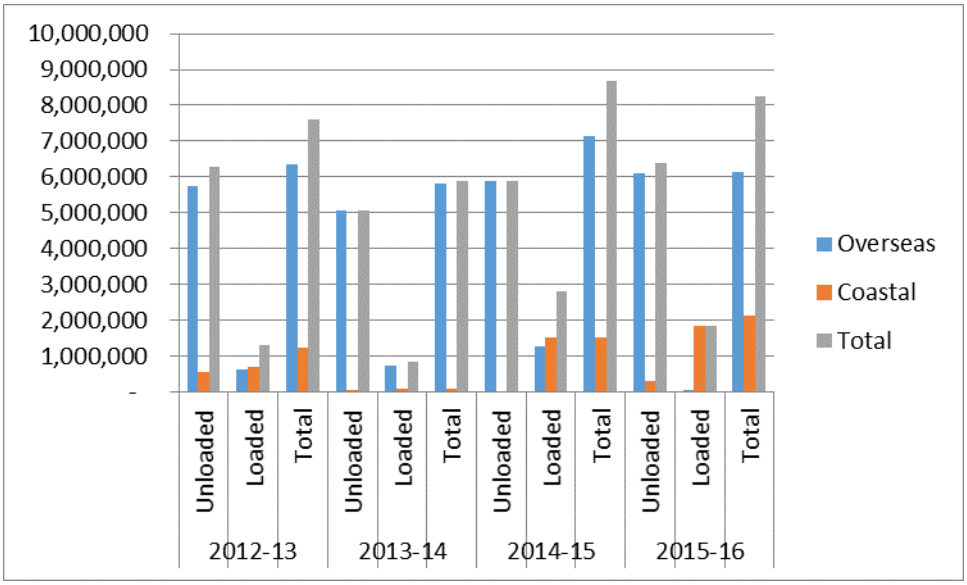


Figure 4.2: Cargo Handled at Jaigad Ports from 2013-16 in MTPA

Source: MMB & Basic Port Statistics of India 2014-15

Major commodity handled at Jaigad port in 2015-16 (**Table 4.2**) was:

- **Thermal Coal:** (**5.0 MMTPA**): Majority of Thermal Coal is imported for the requirements of JSW Energy. There is also a plan to move Thermal Coal from Jaigad to requirements of JSW at Dharamtar through Mini Bulk carrier (MBC) of 8,000 DWT. The Draft at Amba River will accordingly be increased. About 0.5 MMTPA of coal is also loaded as coastal cargo.
- **Iron Ore:** (**2.65 MMTPA**): About 1.35 MMTPA of imported iron ore was moved as costal cargo to requirements of JSW Steel Plants at other locations.
- **Other Ores:** (**0.24 MMTPA**): Other ores such as Rock Phosphate, Coke and Quartizite were also handled at the Port.
- **Chemicals:** (**0.27MMTPA**): A large quantity of Molasses (0.26 MMTPA) was exported and a small quantity of sulphur was imported.
- **Food Grains:** (**19,660 MT**): Sugar was also exported from these Ports.
- **Project Cargo:** (**2449MT**): Project Cargo was also handled at the port.

At present, there is no movement of Cement, POL and Containers in this River/Creek.

4.2 Future Cargo Potential

Ratnagiri District has plans for development of industrial areas such as:

- **MIDC Industrial areas**: A MIDC area at Sanghmeshwar, in the vicinity of Shastri River, is planned. It is in the early stages of development.

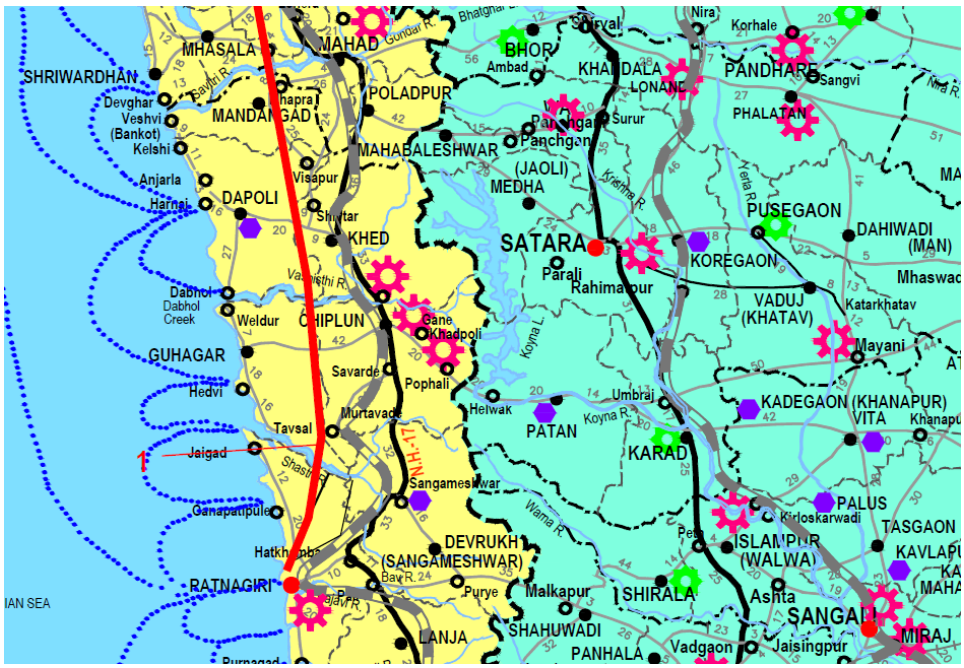


Figure 4.3: MIDC Industrial Areas Planned in Shastri River Region

- **Directorate of Industries:** A large industrial investment of more than Rs 4,000 Cr (**Table 4.3**) is envisaged in the near future, of which an Alumina Refinery with a captive power plant is envisaged in Sanghmeshwar area and a chemical based industry in Jaigad area.

Table 4.3: Industrial Projects Planned in Ratnagiri District

S. No	Industry	Type	Investment	Taulka/District
1	Core Minerals ltd.	Metallurgical grade alumina and captive power plant	Rs 1,350 Cr	Sanghmeshwar, Ratnagiri
2	Indorama synthetics (I) Ltd.	Chemical	Rs 2,726 Cr	Jaigad, Ratnagiri
	Total		**Rs 4,076 Cr**	

Based on above developments and discussions with local industries, preliminary estimation of potential traffic along Shastri River/Jaigad Creek is as follows:

- **Thermal Coal**

  The Captive power plant of proposed Alumina refinery in the region is likely to be handled from Jaigad Port; hence, no additional cargo is likely to move through the Inland Water Way. This will be examined in detail at the DPR stage.
- **Iron Ore, Coking Coal and Other Ores, Steel, Container Reefers, POL**

  As Jaigad Port has sufficient capacity to handle these commodities, no additional cargo is likely to move through the Inland Water Way. This will be examined in detail at the DPR stage.

- **Cement**

  Currently there is no proposal to set up cement plant in this area. Its possibility will be examined in detail at the DPR stage in consultation with cement manufacturing association.

- **Fertilizers and Chemicals**

  The fertilizer allocation in Maharashtra is through Rashtriya Chemicals and Fertilizers Ltd. (RCF) at Thal, Raigarh and Deepak Fertilizers & Petrochemical Corporation (DFPCL) at Taloja. The allocation to Shastri catchment Talukas is 6,668 MT (**Table 4.4**), which is very small.

Table 4.4: Allotment of Fertilizers in Shastri Catchment Area

Taluka	Fertilizers Allotment 2016-17					in MT
	Urea	DAP	MOP	MSP	NPK	Total
Guhaghar	722	33	60	80	657	1,552
Sanghmeshwar	1,220	47	65	30	710	2,072
Ratnagiri	1,723	59	77	125	1,060	3,044
Total in Shastri River area	**3,665**	**139**	**202**	**235**	**2,427**	**6,668**
Total in Ratnagiri District	**10,800**	**300**	**400**	**800**	**6,700**	**19,000**

About 6,679 kilos of insecticides are required in the Shastri catchment region, which is also a small amount. (**Table 4.5**).

Table 4.5: Allotment of Insecticides in Shastri River Catchment Region

Taluka	Insecticides Allotment 2016-17					in Kilo
	Mono crotophas	Carbareel	COC	Cypermethri	Kwalphas	Total
Guhaghar	148	210	513	25	336	1,232
Sanghmeshwar	378	540	1,350	65	864	3,197
Ratnagiri	266	380	950	46	608	2,250
Total in Shastri River area	**792**	**1,130**	**2,813**	**136**	**1,808**	**6,679**
Total in Ratnagiri District	**2,458**	**3,510**	**8,763**	**421**	**5,616**	**20,768**

Considering that Jaigad Port has the required facilities to handle Fertilizers and Chemicals, it is unlikely that this cargo will be moved through Inland water transport.

- **Food grains**

About 260,000 MT of Rice and Nachni is produced in Ratnagiri district (**Table 4.6**), of which about 89,000 MT is produced in catchment area of Shastri River/Jaigad Creek.

Table 4.6: Major Food Grain Production in Shastri River Catchment Area

S. No.	Taluka	Rice		Nachni		Total
		Area (Ha)	Production (MT)	Area (Ha)	Production (MT)	Production (MT)
1	Guhaghar	4,600	15,040	3,700	5,365	20,405
2	Sanghmeshwar	12,600	39,370	1,500	2,175	41,545
3	Ratnagiri	8,000	24,800	1,700	2,380	27,180
	Total in Shastri Area	**25,200**	**79,210**	**6,900**	**9,920**	**89,130**
	Total in Ratnagiri District	**77,000**	**2,39,245**	**16,600**	**23,064**	**2,62,309**

About 2,70,000 MT of Horticulture produce excluding coconut is produced in Ratnagiri district (**Table 4.7**), of which about 94,000 MT is produced in catchment area of Shastri River.

Table 4.7: Major Horticulture Production in Shastri River Catchment Area

Taluka	Mango	Cashew	Coconut	Chiku	Beetlenut	Others	Total	Total Excluding Coconut
	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)	Production (MT)
Guhaghar	9,918	12,331	76,73,981	7	757	59	76,97,054	23,072
Sanghmeshwar	12,530	19,326	53,22,277	12	4	8	53,54,157	31,880
Ratnagiri	32,178	6,607	1,24,33,650	11	13	12	1,24,72,472	38,821
Total in Shastri Area	**54,626**	**38,265**	**2,54,29,909**	**30**	**774**	**79**	**2,55,23,683**	**93,774**
Total in Ratnagiri District	**1,30,692**	**1,37,010**	**5,82,75,000**	**124**	**965**	**161**	**5,85,43,952**	**2,68,952**

Considering that Jaigad Port has required facilities to handle Food Grains and Reefers, it is unlikely that this cargo will be moved through Inland water transport.

- **Passengers**

  About 5.6 lakh people live in the catchment of Shastri River/Jaigad Creek (**Table 4.8**). A possibility of increasing water transportation exists and the same will be explored at DPR stage.

Table 4.8: Population in Shastri River Catchment Area

S. No	Taluka	Area (Sq Km)	Population
1	Guhaghar	647	1,23,309
2	Sanghmeshwar	1,259	1,98,343
3	Ratnagiri	936	2,43,220
	Total in Shastri area	**2,842**	**5,64,872**
	Total in Ratnagiri District	**8,208**	**16,15,069**

- **Tourism**

Maharashtra Tourism Development Corporation is planning to start House Boat services (as in Kerala) and cruise Boat services in the coastal rivers of Maharashtra. Ganpatipule, a popular tourist place is in the vicinity, so tourism potential exists in this Creek/River. This will be examined at the DPR stage.

- **Ro – Ro Cargo system**

In order to bring in the IWT connectivity as a support system to the mega planned port development and in particular to connect the Samgameshwar Industrial area (which is at the upstream end of the study stretch), Ro – Ro Cargo mobility may flourish in this area (similar to that of the support system existing for ICTT, Kochi). This may considerably reduce the congestion in other modes. Accordingly, it is estimated that a cargo of about 0.6 MMTPA can be considered, which may be raised to 1.2 MMTPA. This will be examined in detail at DPR Stage.

4.3 Conclusions

Considering that Ports at Jaigad have facilities for direct berthing, all weather operations, with multi-purpose, multi cargo facility with connectivity to rail and road being improved, potential of additional cargo traffic for Inland Water Transport appears to be less beyond the Jaigad Ports.

The length of navigable river is 52 km and it may be more economical to move major cargo directly to Jaigad Ports rather than through Double handling through New Terminal, if constructed.

However, the economies of moving transportation through inland water ways for different cargo type will be examined at DPR stage.

Accordingly, keeping in view the proposed Ro – Ro cargo operation, substantial cargo is expected to move through this stretch to an extent of 0.7 MMTPA to 1.2 MMTPA. This will be examined in detail at the DPR stage.

CHAPTER 5 OBSERVATIONS AND INFERENCES

5.1 Waterway Feasibility

Based on the details presented in the Chapter-3, following conclusions have been derived for establishing the navigability of the proposed waterway;

1. The river length as given by IWAI is 52km, whereas the total surveyed length along the river to capture the thalweg is 48.52km. The deepest channel route has been reckoned as 48.52km. All inferences derived for identifying the navigable length have been derived with reference to the deepest channel length (48.52km).
2. The river is tidal affected for a majority of length under study and relevant chart datum has been used. 79% of the surveyed length, starting from 0.00km (a confluence of river with sea near Jaigad in the creek), has water depth more than 2.0m, however not continuous. The average tidal variation is 2.37m with maximum high tide of 4.42m and low tide of 0.32m as per the records available for this region. The average tide height of 2.37m would be an added advantage for the safe navigation.
3. It has been observed that the feasibility study suggests that the river is navigable without any significant obstructions up to the Bhatgaon Road Bridge (at Ch. 34.43km) and with modifications to the Bridges at Bhatgaon (at Ch. 34.43km) and Phungus Road Bridge (at Ch. 43.95km), it can traverse up to the Rail Bridge at Ch. 45.84km. Further, by considering the single lane operation at Pirdavane – Khurdunda Rail Bridge (at Ch. 45.84km) the entire stretch can be considered for elevation to Class V so as to meet the industrial cluster at Sanghameshwar.
4. The lengths of the waterway, with a depth more than 2.0m, 1.5m and 1.0m with reference to the Chart Datum have been compiled in the main report. This is given in Table 3.9 of the report and is being reproduced below:

Chainage (Km)	Depth Available		Length of River (Km)			
	Max. (m)	Min. (m)	>2m	1.5-2.0m	1-1.5m	<1m
0-10	17.05	1.75	9.88	0.12	-	-
10-20	16.74	1.63	9.77	0.23	-	-
20-29	18.59	3.18	9.00	-	-	-
29-37	12.17	1.32	7.75	-	0.25	-
37-45	5.47	0.79	4.32	1.84	0.92	0.92
45-48.52	4.11	-1.3	0.72	0.28	0.28	2.24
Total			**41.44**	**2.47**	**1.45**	**3.16**

5. Two H. T. Lines and one Electric Line are crossing the study stretch with the vertical clearance ranging from 6.5m to 20.0m above MHWS. The minimum vertical clearance required shall be 20.1m corresponding to 220kVA transmission line.

6. As explained above, two Bridges are to be modified to meet the specified clearance criteria and one Bridge may have to be navigated with single lane operation.

The description & classification of the waterway has been presented schematically based on the survey observation and duly keeping in view the river classification criteria in Table 3.18 as reproduced below.

Criteria	Classification																		
Length of waterway from start (km)	3	5	8	11	14	16	19	22	24	27	30	33	35	38	41	44	46	49	52	54
Chainage length in %	5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
Depth availble	C-V														C-I					
Rail & raod Bridge Vert. clearance	All Class														C-II					
Rail & raod Bridge Hor. clearance	All Class														C-II					
HT Line Vert. clearance	All Class																	Base Raise		
Bend Radius	C-II																			
Index	All Class		Class-V		Class-IV		Class-III		Class-II		Class-I									

5.2 Cargo Feasibility

The present mobility in the Shastri River / Jaigad Creek area with the coastal movement is about 8.24 MMTPA. The majority of the cargo is Thermal Coal followed with Iron Ore. (As confirmed from the cargo data of 2015-16).

Subsequent to the preliminary market survey and its analysis, there is a possible growth of cargo mobility to the extent of about 0.7 MMTPA to 1.2 MMTPA through the study stretch, which is a considerable increase.

In order to meet the above increase in the cargo potential, the waterway development is felt essential. Accordingly, the waterway is to be developed to Class V to meet the above increase in volume and keeping in view the future industrial growth in upper hinterland.

5.3 SWOT Analysis

SWOT analysis has been carried out for deriving meaningful information specifying the objectives of the study for development of the waterway for year round commercial navigation and identifying the internal & external factors that are favourable and unfavourable in the development of the waterway.

Strength

1. 79% of the surveyed length has water depth more than 2 m and is safe for navigation.
2. The above depth is available for about 45kms, however not continuous and certain patches may be required to be attended with a considerable conservancy activity involving dredging.

3. The Creek is tidal affected for about 50 kms. up to Nawadi, under the study stretch of 52 kms. The tidal variation is an additional strength for navigability and the study stretch is having a Maximum tide as 4.42m, Minimum tide as 0.32m and the Mean Sea level as observed is of 2.51m.
4. Approximately 5.6 lacs of population is residing in the region of Guhagar, Sangameshwar and Ratnagiri in the vicinity of Shastri River / Jaigad Creek, which will have direct or indirect benefits from the IWT and related projects coming up in the area.
5. The Existing Cargo movement in the Jaigad Port area will have some influence in IWT, on its development. Further, a considerable cargo is divertible from / to hinterland, as per the preliminary study.
6. Cargo increase has been observed in the analysis to an extent of about 0.7 MMTPA to 1.2 MMTPA.
7. The MSIDC is planning its industrial spread in the river front and hinterland which is more attractive especially at the upstream end of the stretch at Sangameshwar industrial area, which is hopeful for IWT development.

Weakness

1. Presently, there is no IWT movement. However, the traffic estimations present an optimistic picture for IWT.
2. Modifications proposed at two Bridge locations may be a weakness; however it will become strength, if Ro – Ro cargo mobility picks up in this area.

Opportunity

1. 79 % of the existing waterway is having a depth more than 2m, which can be used advantageously for the mobility of hinterland cargo.
2. The proposal of MIDC Industrial area in the vicinity / hinterland is an opportunity, if used by IWT.
3. The different types of Cargo viz. Coal, Food grains and Chemicals apart from Aluminium Cargo have been identified as divertible in the hinterland and will be the opportunity for this stretch development.
4. The present Rail and Road connectivity though may be competing with IWT may also be an opportunity for creating an efficient intermodal hub for IWT.
5. Policies are to be firmed up for development of IWT in this stretch.
6. Since the industrial areas of the MIDC are in the upstream stretch, the entire waterway can be best utilized.
7. Tourism may flourish in the Shastri River, if developed, connecting the Sangameshwar Temple (in the upstream reach of the river) and other temples nearby. Further, a Tourist Hub also can be framed linking Sangameshwar / Marleshwar / Ganpatipule, Jaigad Fort etc., with beaches i.e., linking the river / creek with the coast.

Threat

1. The National Highway 17 (NH-66) SH-4, SH-105 and SH-106 in the study area may create competing modes of transport especially with respect to cargo traffic for the proposed waterway.
2. The present rail network also may pose some threats as an alternative mode of transport.
3. The Shastrii River banks covered by marginal mangrove trees in certain places may involve some socio-environmental issues and may require statutory approvals and clearances to construct the jetties/ terminal/ ports/ intermodal connectivity.

5.4 Development Cost (Tentative)

The reconnaissance survey data with regard to physical constraints may have cost implications for making the river stretch navigable. Henceforth, the development of the proposed national waterway involves physical interference in the form of dredging, construction of terminals at the identified locations, modification of HT Lines at crossing locations to provide a minimum vertical clearance of 20.1m (with respect to 220 kVA) or the case may be combined with some unforeseen expenses. Moderate dredging effort has been envisaged with an average dredging of 1.0m required in 7.0km of the length of proposed waterway reckoned with reference to ascertained data. The cost of dredging has been considered @ INR 230 per cum. The cost of terminal has been estimated @ INR 20.0 crore each for two terminals. HT line crossing shall need modification which shall require two towers at the bank of requisite height and the stringing over pair of poles crossing the Shastri River / Jaigad Creek River. The cost of transmission tower has been estimated to be INR 20.00 lacs each and the stringing cost across the towers shall be INR 4.0 lacs per pair of towers. The total estimated cost for modification to the four HT Lines shall be INR 3 x 44.0 lacs = INR 132.0 lacs. Two nos. of Bridges may have to be modified with reconstruction at an estimated cost of INR 2.5 crores each amounting to INR 5.0 crores. The cost of navigational aids for day/night navigation has been considered as INR 430 lacs. 10% of the amount for dredging, terminal construction, tower / bridge modification and night navigational aids has been envisaged as unforeseen. The tentative total cost of development to make the river navigable round the year to achieve safe navigation for the required classification of vessel mobility has been estimated to INR 62.80 crore.

Table 5.1: Tentative Development Cost of Shastri River / Jaigad Creek Waterway (NW 91)

Sl No.	Name of Waterway	Length of Water way	Dredging Required (wrt. 2 m draft & 40.0m width)	Dredging Cost @ INR 230/ cum	Terminal Proposed	Terminal Cost @ INR 20 Cr each	Cost of Modification of Transmission line	Night Navigation	Total cost incld. 10% unforeseen
		(km)	(km)	INR in Cr.)	(Nos)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)	(INR in Cr.)
1	Shastri River / Jaigad Creek	48.52	7.0	6.44	2.00	40.00	6.32	4.3	62.80

5.5 Classification of Waterway

The 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 DWT and tug-barge formation in push tug + four barge units of carrying capacity up to 8000 DWT (Ref: IWAI, Gazette Notification dated 26th January 2007).

As per the above Classification of Inland Waterways, the entire waterway of Shastri River / Jaigad Creek (NW 91) of 45.74km length has been classified based on available minimum water depth, bottom width, minimum vertical and horizontal clearances of cross over structures and bend radius in the river. The classification of Shastri River / Jaigad Creek River Waterway is described below.

Table 5.2: Classification of Shastri River / Jaigad Creek (NW 91)

Chainage (km)	Minimum Depth (m)	Bottom Width (m)	Minimum Vertical Clearance (m)	Minimum Horizontal Clearance (m)	Bend Radius (m)	Classification of Waterway (Proposed)
0.0 – 48.52	0.79	200.0	6.5 (Bridge & H. T. Line)	30 (Bridge)	250	**Class – V**

The study stretch of the waterway is amenable for development as Class V waterway as explained above. However, considerable Dredging may be required.

In order to consider the full stretch as **Class V**, two nos. of Bridges are to be modified and one Bridge is to be considered with single lane operation. Further smoothening of bends is essential.

The above stretch of the waterway, hence, can be considered under Class V which is navigable without any hindrance and shall be used for plying self-propelled vessel of carrying capacity upto 1000 DWT (approximate size 70m overall length, 12m moulded breadth and 1.8m loaded draft) or one tug and four barges combination of 4000 DWT (approximate size 170m overall length, 24m breadth and 1.8m loaded draft).

5.6 Recommendation

The national waterway-91 of Shastri River / Jaigad Creek has been identified having potential for development as waterway of Class-V for a distance of 51.98 km as described above. This stretch of the river is, therefore, recommended for stage-II study for preparation of Detailed Project Report (DPR) to establish the viability for implementation as a project.

Accordingly, the national waterway NW-91 of Shastri River / Jaigad Creek is proposed for development as **Class V** waterway in the stretch of the waterway as (as at Table 3.19) depicted below:

River Stretch	0.0 km	51.98km
Classification		
	Class- V	
Horizontal clearance (m)	80	
Vertical clearnce (m)	10	
Minimum Depth (m)	2	
Bottom Width (m)	80	
Self Propelled Vessel		
Dead Weight Tonnage	1000	
Vessel size (m)	70 x 12 x 1.8	
Tug + Barge		
Dead Weight Tonnage	4000	
Vessel size (m)	170 x 24 x 1.8	

ANNEXURE 1.1

DATA COLLECTION & SOURCE OF DATA

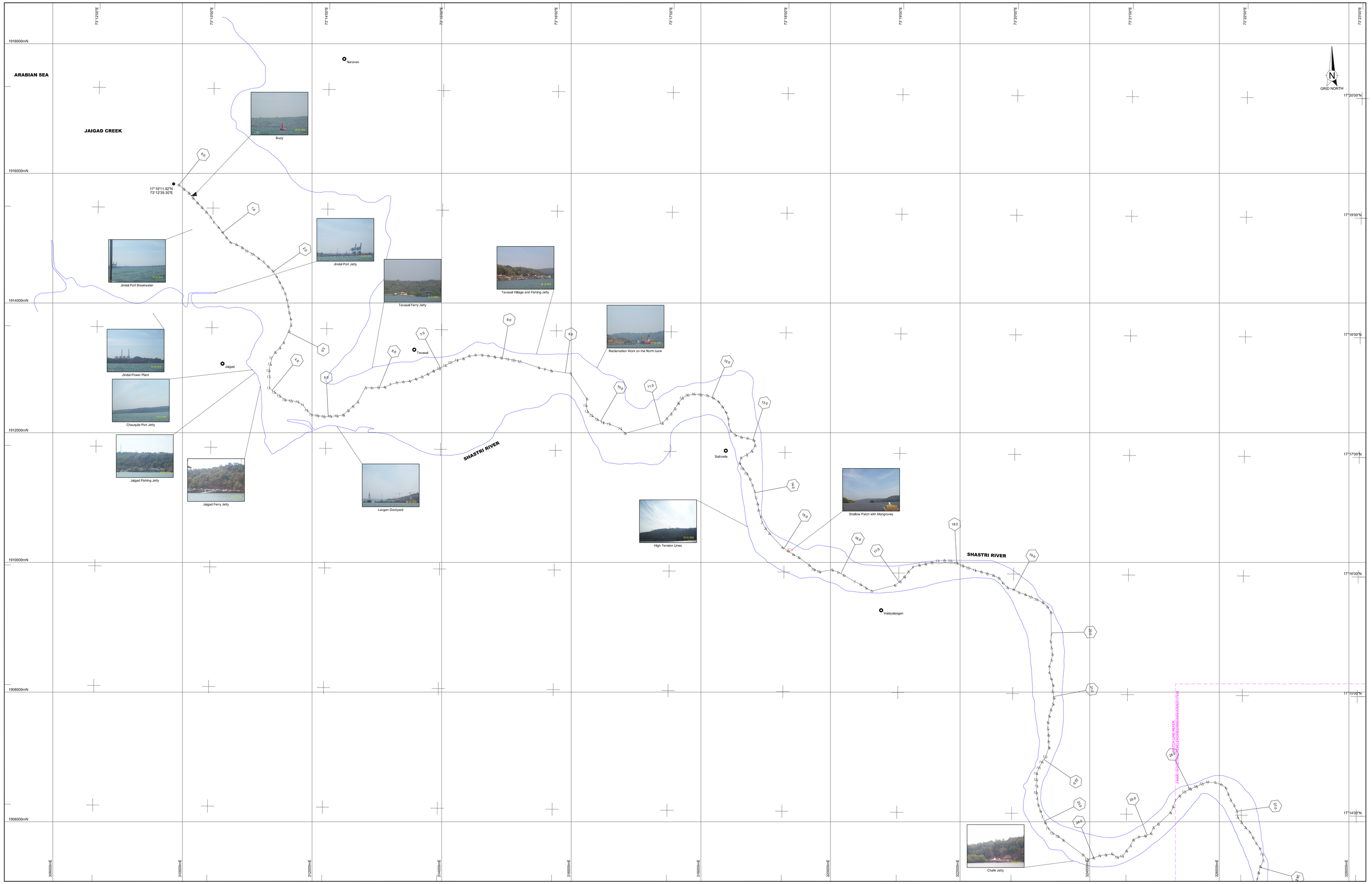
Source of Data Cluster-7

Sl. no	Name of Authority, place	Contacted Person	Designation	Required Data	Collected Data	Date of Receiving Data	Remarks
MAHARASHTRA							
1	Office of Hydrographer, Maharashtra Maritime Board, Khar (West), Mumbai	Mr. Sandip Dhuraji	Hydrographer	Chart Datum & Structure Detail in Water Way	Yes	3/4/2016	Official Letter Submitted to the Department. Data Received
2	Office of Hydrographer, Maharashtra Maritime Board, Khar (West), Mumbai	Mr. Anil Kadam	Assistant Hydrographer	River Gauge & Discharge Data/ Structure Detail	Yes	3/4/2016	Official Letter Submitted to the Department. Data Received
3	Kolkewadi Dam Maintainance Division, Alore, WRD, Maharashtra	Mr.K M Mane	Sectional Engineer (Admin)	River Gauge & Discharge Data/ Structure Detail/ Chart Datum	---	---	Official Letter Submitted to the Department. Data is Awaited
4	Indian Oil Corporation Ltd. (IOCL), Indian Oil Bhawan, G-9, Ali Yavar Jung Marg, Bandra (East), Mumbai	Mr. R. D. Kherdekar	GM (Consumer)	POL Data	Yes	7/6/2016	Discussion
5	Maharashtra Maritime Board, Main Office, Ramji Bhai Kamani Marg Ballard Estate, Mumbai	Mr. Atul Patane	Chief Executive Officer	existing traffic data on Cluster-7 Inland waterways and associated ports in Maharashtra	Yes	8/6/2016	Official Letter Submitted to the Department. Data Received
6	Maharashtra Industrial Development Corporation, Udyog Sarathi, Andheri (E), Mumbai	Mr. Yuvraj Poman	OSD (Markering)	Industries along the Cluster-7 Inland waterways in Maharashtra	Yes	8/6/2016	Official Letter Submitted to the Department. Maharashtra MIDC Industrial Area Map Received
7	Maharashtra Tourism Development Corporation Ltd. Opp. LIC (Yogakshema) Building, Madame Cama Road, Mumbai	Mr. Satish Soni	Director of Tourism & Jt. MD	Existing Tourism Development and Future Plan on Cluster-7 Inland waterways in Maharashtra	Yes	8/6/2016	Discussion
8	Direcorate of Industries, Government of Maharashtra	Mr. S. B. Patil	Jt. Director	Industries along the Cluster-7 Inland waterways in Maharashtra	To be Provided	---	Data is Awaited
9	Collectorate & DM Office, Raigarh, Maharashtra	Mr. Sagar Pathak	District Disaster Management Officer	Population data along the Cluster-7 Inland waterways in Ragarh district	Yes	9/6/2016	Population Data Received

Source of Data Cluster-7

Sl. no	Name of Authority, place	Contacted Person	Designation	Required Data	Collected Data	Date of Receiving Data	Remarks
10	District Industrial Centre, Raigarh, Maharashtra	Mr. Lohnde	GM	Industries along the Cluster-7 Inland waterways in Raigarh district	Yes	9/6/2016	Industrial Data Received
11	Collectorate & DM Office, Raigarh, Maharashtra	Mr. K. Shinde	Superintendent of Agriculture	Crops/Fruits along the Cluster-7 Inland waterways in Raigarh district	Yes	9/6/2016	Agriculture/Horticulture Data Received
12	Collectorate & DM Office, Ratnagiri, Maharashtra	Mr. Suryavanshi	District Disaster Management Officer	Population data along the Cluster-7 Inland waterways in Ratnagiri district	To be Provided	10/6/2016	Data is Awaited
13	Collectorate & DM Office, Ratnagiri, Maharashtra	Mr. Vidyadhar Vaidya	Superintendent of Agriculture	Crops/Fruits along the Cluster-7 Inland waterways in Ratnagiri district	Yes	10/6/2016	Agriculture/Horticulture Data Received
14	District Industrial Centre, Ratnagiri, Maharashtra	Mrs. Ranjana Basantrao Pol	Manager	Industries along the Cluster-7 Inland waterways in Ratnagiri district	Yes	10/6/2016	Industrial Data Received
GOA							
1	Works Division - III, Water Resource Department, Goa	Mr. R. B. Ghanti,	Executive Engineer	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
2	Water Resource Department, Goa	Mr. S T Nandkarni	Chief Engineer	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
3	Water Resource Department, Works Division-III, Goa	Mr. P. B. Badami	Executive Engineer	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
4	Water Resource Department, Works Division-III, Goa	Mr. Rajan	Section Engineer, WRD. Goa	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited
5	Captain of Ports Department, Govt. of Goa.	Mr. Sagar Chandra Rai	Captain	River Gauge & Discharge Data/ Structure Detail	---	---	Official Letter Submitted to the Department. Data is Awaited

BATHYMETRY



LEGEND:

FEATURES IDENTIFIED FROM CURRENT SURVEY

GENERAL

- GEOGRAPHICAL GRATICULE INTERSECTION
- CHAINAGE ALONG CENTER LINE

BATHYMETRY

- DEPTHS IN METRES BELOW CHART DATUM

FEATURES OBTAINED FROM OTHER SOURCES (AS INDICATED)

- RIVER BOUNDARY (DRAWN FROM GOOGLE)
- SHALLOW PATCHES
- BRIDGE
- BUOY
- JETTY

NOTES:

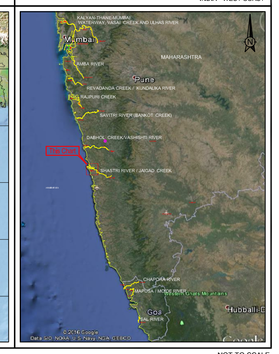
1) SURVEY VESSEL BHAVANI WAS DEPLOYED FOR THIS SURVEY IN FEBRUARY 2016.
2) THE COORDINATES OF THE SURVEY CORRIDOR WERE PROVIDED BY THE CLIENT.
3) FUGRO'S STARFIX SYSTEM WAS USED FOR POSITIONING AND CONTROL OF SURVEY.
4) REFER TO FSNPVT SURVEY REPORT NO. J-MAR-16-012 FOR DETAILS ON THE RESOURCES MOBILISED AND METHODOLOGY ADOPTED FOR THIS SURVEY.
5) SOUNDINGS WERE REDUCED TO CHART DATUM USING CLIENT SUPPLIED PREDICTED TIDES.
6) THE RESULTS OF SURVEY ARE PLOTTED IN WGS84 DATUM, UTM PROJECTION, ZONE 43N, CENTRAL MERIDIAN 075° E.

REFERENCE DRAWINGS

Rev. No:	Date:	Drawing No.	Source	Description:
-	-	-	-	-

OVERVIEW PLAN

LAYOUT PLAN — INDIA - WEST COAST



NOT TO SCALE

CLIENT

TRACTEBEL ENGINEERING PVT. LTD.
2nd FLOOR, BUILDING NO-10C,
DLF CYBER CITY,
GURGAON - 122002
HARYANA (INDIA)

SURVEY CONTRACTOR

FUGRO SURVEY (INDIA) PVT. LTD.
FUGRO HOUSE
D-222/30, TTC INDUSTRIAL AREA, MIDC, NERUL, NAVI
MUMBAI - 400 706, INDIA
TEL : +91 22 2762 9500 FAX : +91 22 2762 9140
(AN ISO 9001:2008 COMPANY)

PROJECT TITLE

RECONNAISSANCE SURVEY AND FEASIBILITY REPORT FOR STAGE-1 IN MAHARASHTRA AND GOA WEST COAST OF INDIA

FEBRUARY 2016

CHART SHOWING

OVERVIEW CHART FOR JAIGAD CREEK (SHASTRI RIVER)

BATHYMETRY

SHEET 01 OF 02

HORIZONTAL SCALE 1 : 20,000

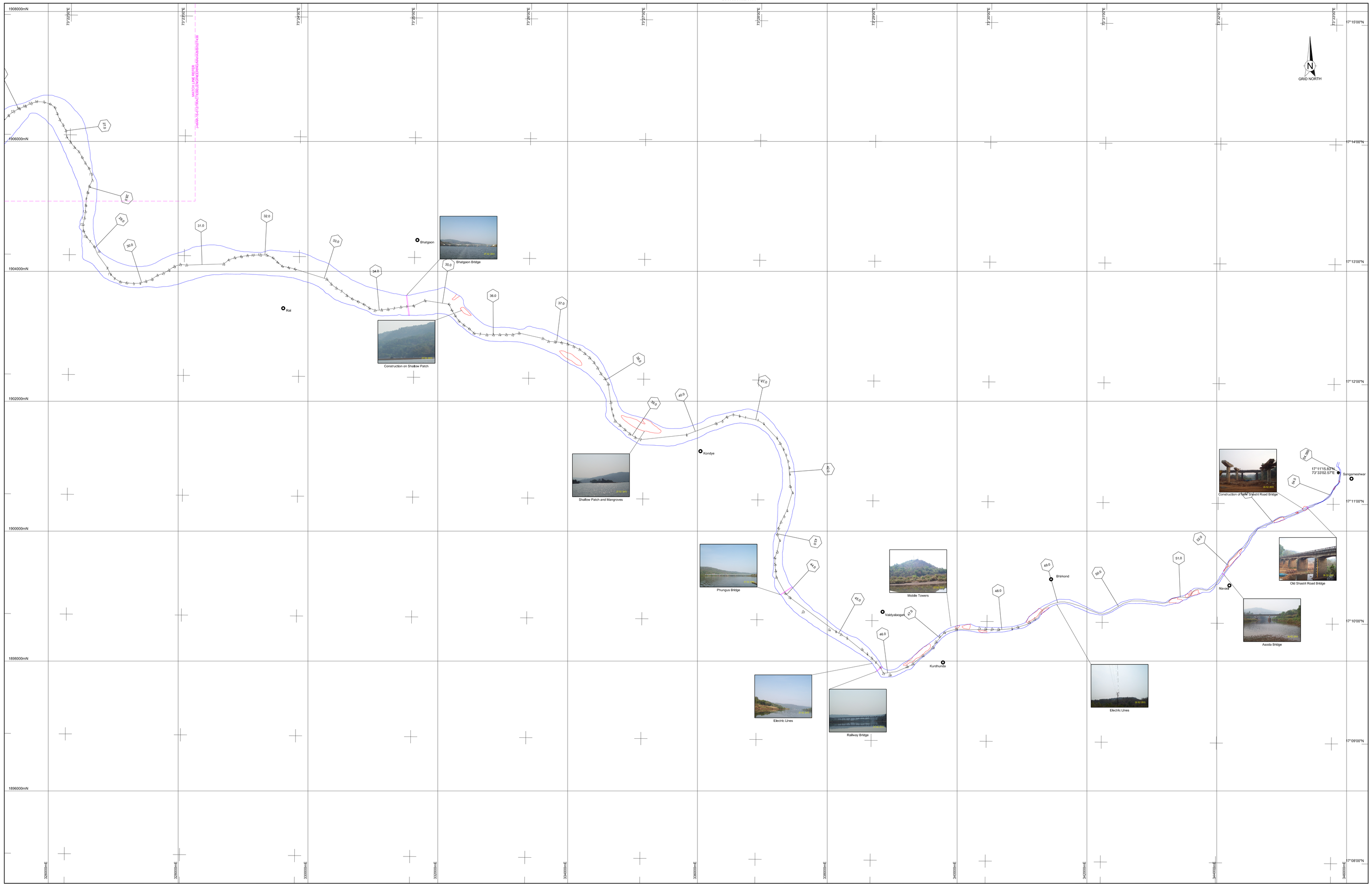
400m 0m 400m 800m 1200m 1600m 2000m

Vessel:- Project Ref: J-MAR-16-012

Rev. No:	Date:	Description:	Surveyed :	Interp:	Drawn:	Chkd:	Appr:
0	13/06/2016	ISSUED FOR APPROVAL	SD	--	RP/SG	KS/PM	MI

Drawing File No:	Drawing No:	Encl:
7439-01R0	J-MAR-16-012/TRACTEBELENGINEERING/MAHA/B/01/7438	01 OF 02

BATHYMETRY



LEGEND:

FEATURES IDENTIFIED FROM CURRENT SURVEY

GENERAL

- GEOGRAPHICAL GRATICULE INTERSECTION
- CHAINAGE ALONG CENTER LINE

BATHYMETRY

- DEPTHS IN METRES BELOW CHART DATUM

FEATURES OBTAINED FROM OTHER SOURCES (AS INDICATED)

- RIVER BOUNDARY (DRAWN FROM GOOGLE)
- SHALLOW PATCHES
- BRIDGE
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NOTES:

1) SURVEY VESSEL BHAVANI WAS DEPLOYED FOR THIS SURVEY IN FEBRUARY 2016.
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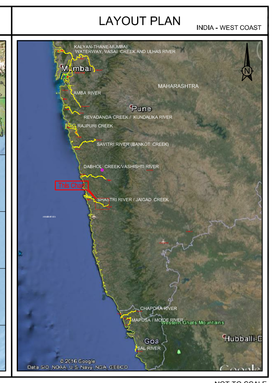
5) SOUNDINGS WERE REDUCED TO CHART DATUM USING CLIENT SUPPLIED PREDICTED TIDES.
6) THE RESULTS OF SURVEY ARE PLOTTED IN WGS84 DATUM, UTM PROJECTION, ZONE 43N, CENTRAL MERIDIAN 075° E.

REFERENCE DRAWINGS

Rev. No:	Date:	Drawing No.	Source	Description:
-	-	-	-	-

OVERVIEW PLAN

LAYOUT PLAN INDIA - WEST COAST



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PROJECT TITLE

RECONNAISSANCE SURVEY AND FEASIBILITY REPORT FOR STAGE-1 IN MAHARASHTRA AND GOA WEST COAST OF INDIA

FEBRUARY 2016

CHART SHOWING

OVERVIEW CHART FOR JAIGAD CREEK (SHASTRI RIVER)

BATHYMETRY

SHEET 02 OF 02

HORIZONTAL SCALE 1 : 20,000

400m 0m 400m 800m 1200m 1600m 2000m

Vessel:-

Project Ref: J-MAR-16-012

Rev. No:	Date:	Description:	Surveyed :	Interpr:	Drawn:	Chkd:	Appr:
0	13/06/2016	ISSUED FOR APPROVAL	SD	--	RP/SG	KS/PM	MI

Drawing File No: 7438-02R0

Drawing No: J-MAR-16-012/TRACTEBELENGINEERING/MAHA/B/027438

Encl: 02 OF 02

ANNEXURE 3.2

CHART DATUM OF SHASTRI RIVER/JAIGAD CREEK JAIGAD JETTY FROM MMB

Taigad Creek
23

Tid. Anal.

SURVEY OF INDIA

List of Harmonic Tidal Constants

Place Taigad Jetty

Latitude	Longitude L	Standard time S	Observational data	
			Length	Central day
° ′ ″	° ′ ″			
17 1 55 N	73 13 30 E	I.S.T	29 days	9-2-'56.

Notes :—

(1) Description of the tide-gauge site : Tide pole erected near the N. end of the jetty.

(2) B.M. of reference : BOM on top of the basement of the lamp-post at the entrance to the wharf.

(3) Height of chart datum { (a) below B.M. of reference 4·865 ft. m. / (b) above Zero of tide-gauge 1401 ft. m.

	H	g		H	g		H	g		H	g
	ft. m.	°		ft. m.	°		ft. m.	°		ft. m.	°
S_o *	3·168	—	$2Q_1$	0·004	52·1	OQ_2			MO_3	0·007	40·6
Z_o †	1·768	—	σ_1	0·001	52·1	MNS_2			M_3	0·009	352·5
			Q_1	0·028	51·5	$2N_2$	0·023	268·1	SO_3		
Sa			ρ_1			μ_2	0·029	275·3	MK_3	0·004	192·3
Ssa			O_1	0·175	51·0	N_2	0·169	272·2	SK_3		
Mm	0·066	330·6	MP_1			ν_2	0·033	272·2			
Msf	0·032	19·1	M_1	0·011	96·2	OP_2			MN_4	0·014	342·4
Mf			χ_1			M_2	0·743	316·3	M_4	0·019	3·3
			π_1	0·007	52·8	MKS_2			SN_4	0·004	344·3
			P_1	0·120	52·8	λ_2			MS_4	0·016	40·2
			S_1			L_2	0·042	34·4	MK_4		
			K_1	0·362	52·8	T_2	0·016	355·3	S_4		
			ψ_1	0·003	52·8	S_2	0·277	355·3	SK_4		
			ϕ_1	0·005	52·8	R_2					
			θ_1			K_2	0·076	355·3	$2MN_6$	0·011	248·7
			J_1	0·027	65·5	MSN_2			M_6	0·014	267·1
			SO_1			KJ_2			MSN_6	0·006	303·3
			OO_1	0·016	79·2	$2SM_2$	0·003	157·7	$2MS_6$	0·015	328
									$2MK_6$		
									$2SM_6$	0·002	85·2
									MSK_6		

* S_o = Height of mean-sea-level above Zero of tide-gauge.

† Z_o = " " " chart datum.

ANNEXURE 3.3

BATHYMETRIC SURVEY AS RECEIVED FROM HYDROGRAPHIC SURVEYOR

Annexure 3.3: Digital Data, Chainage vs Water Depth

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
0.00	17° 19' 11.40429"	73° 12' 42.05521"	11.26	8.69
0.10	17° 19' 09.39498"	73° 12' 44.71172"	11.17	8.60
0.20	17° 19' 07.40988"	73° 12' 47.38391"	11.16	8.59
0.30	17° 19' 04.93582"	73° 12' 49.57687"	11.17	8.59
0.40	17° 19' 02.55143"	73° 12' 51.86750"	11.22	8.64
0.50	17° 19' 00.24652"	73° 12' 54.24505"	11.15	8.57
0.60	17° 18' 57.91244"	73° 12' 56.59883"	10.87	8.29
0.70	17° 18' 55.40727"	73° 12' 58.73479"	9.82	7.24
0.80	17° 18' 52.84533"	73° 13' 00.74396"	8.57	5.98
0.90	17° 18' 50.42054"	73° 13' 02.99629"	7.23	4.64
1.00	17° 18' 47.83766"	73° 13' 05.02933"	6.89	4.30
1.10	17° 18' 45.28589"	73° 13' 07.12268"	6.74	4.15
1.20	17° 18' 42.85266"	73° 13' 09.30697"	7.06	4.47
1.29	17° 18' 41.78197"	73° 13' 12.47169"	8.95	6.36
1.39	17° 18' 40.28567"	73° 13' 15.47525"	11.18	8.59
1.49	17° 18' 38.51119"	73° 13' 18.29081"	12.56	9.96
1.59	17° 18' 37.02670"	73° 13' 21.27289"	12.71	10.11
1.69	17° 18' 35.07902"	73° 13' 23.92789"	12.53	9.93
1.79	17° 18' 33.17007"	73° 13' 26.66038"	9.72	7.12
1.89	17° 18' 30.94415"	73° 13' 29.11957"	8.82	6.22
1.99	17° 18' 28.66797"	73° 13' 31.52607"	8.33	5.73
2.09	17° 18' 26.01963"	73° 13' 33.48777"	8.13	5.53
2.19	17° 18' 23.17477"	73° 13' 35.11339"	8.21	5.61
2.29	17° 18' 20.33245"	73° 13' 36.73389"	7.88	5.28
2.39	17° 18' 17.43104"	73° 13' 38.18224"	7.69	5.09
2.49	17° 18' 14.28836"	73° 13' 39.01693"	7.88	5.27
2.59	17° 18' 11.12663"	73° 13' 39.79389"	7.85	5.24
2.69	17° 18' 07.91654"	73° 13' 40.32581"	7.81	5.20
2.79	17° 18' 04.77912"	73° 13' 41.13130"	7.03	4.42
2.88	17° 18' 01.68368"	73° 13' 41.27540"	5.78	3.17
2.98	17° 17' 58.58860"	73° 13' 40.28174"	5.12	2.51
3.18	17° 17' 52.93329"	73° 13' 37.38657"	4.36	1.75
3.28	17° 17' 50.18947"	73° 13' 35.57927"	5.99	3.38
3.38	17° 17' 47.91906"	73° 13' 33.16066"	12.01	9.40
3.47	17° 17' 45.15709"	73° 13' 31.50898"	14.62	12.01
3.57	17° 17' 41.97928"	73° 13' 30.79959"	15.04	12.43
3.67	17° 17' 38.81713"	73° 13' 30.02098"	16.48	13.87
3.77	17° 17' 35.61839"	73° 13' 30.36453"	19.67	17.05
3.95	17° 17' 29.95081"	73° 13' 30.38535"	15.60	12.99
4.05	17° 17' 27.93726"	73° 13' 32.99190"	16.06	13.44
4.15	17° 17' 26.04304"	73° 13' 35.74188"	15.90	13.29
4.25	17° 17' 24.19424"	73° 13' 38.51512"	15.41	12.79
4.35	17° 17' 23.69444"	73° 13' 41.84799"	14.88	12.27
4.44	17° 17' 23.21260"	73° 13' 45.18984"	13.88	11.28
4.54	17° 17' 21.58367"	73° 13' 47.96567"	13.64	11.03
4.64	17° 17' 18.99102"	73° 13' 49.94382"	13.91	11.30
4.74	17° 17' 16.77351"	73° 13' 52.37413"	13.82	11.21

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
4.84	17° 17' 16.37623"	73° 13' 55.72054"	13.49	10.89
4.94	17° 17' 15.94746"	73° 13' 59.07606"	12.80	10.20
5.04	17° 17' 16.13392"	73° 14' 02.44568"	13.01	10.41
5.14	17° 17' 16.30871"	73° 14' 05.82219"	12.97	10.37
5.24	17° 17' 16.79468"	73° 14' 09.11313"	11.35	8.76
5.34	17° 17' 19.03560"	73° 14' 11.55677"	8.45	5.85
5.44	17° 17' 21.18135"	73° 14' 14.09174"	7.14	4.55
5.54	17° 17' 23.41618"	73° 14' 16.54800"	5.96	3.37
5.79	17° 17' 30.61206"	73° 14' 20.49841"	10.08	7.49
5.89	17° 17' 30.54639"	73° 14' 23.87560"	9.23	6.65
5.99	17° 17' 30.73834"	73° 14' 27.25373"	8.06	5.48
6.09	17° 17' 30.98346"	73° 14' 30.61341"	7.22	4.64
6.18	17° 17' 32.35888"	73° 14' 33.66879"	7.62	5.04
6.28	17° 17' 33.30810"	73° 14' 36.90363"	7.70	5.13
6.38	17° 17' 33.68298"	73° 14' 40.26379"	7.27	4.70
6.48	17° 17' 34.11207"	73° 14' 43.61464"	6.98	4.41
6.58	17° 17' 35.20718"	73° 14' 46.79767"	7.31	4.75
6.68	17° 17' 36.30454"	73° 14' 49.97934"	7.89	5.33
6.78	17° 17' 37.71979"	73° 14' 53.02358"	9.46	6.91
6.88	17° 17' 39.28691"	73° 14' 55.98987"	11.34	8.79
6.98	17° 17' 40.54097"	73° 14' 59.09086"	12.74	10.19
7.08	17° 17' 42.08443"	73° 15' 02.06993"	13.92	11.38
7.18	17° 17' 43.63401"	73° 15' 05.04354"	14.68	12.14
7.28	17° 17' 44.83151"	73° 15' 08.19082"	14.15	11.62
7.38	17° 17' 45.63293"	73° 15' 11.46577"	12.47	9.94
7.48	17° 17' 46.99039"	73° 15' 14.53233"	11.81	9.29
7.58	17° 17' 47.47130"	73° 15' 17.87297"	11.63	9.11
7.68	17° 17' 47.52351"	73° 15' 21.25728"	11.74	9.23
7.78	17° 17' 47.10574"	73° 15' 24.61317"	11.23	8.72
7.88	17° 17' 46.63651"	73° 15' 27.96345"	11.11	8.61
7.98	17° 17' 46.14673"	73° 15' 31.30951"	11.88	9.38
8.08	17° 17' 45.61786"	73° 15' 34.65053"	13.82	11.32
8.18	17° 17' 45.05670"	73° 15' 37.98371"	14.77	12.28
8.28	17° 17' 44.41569"	73° 15' 41.30003"	14.60	12.11
8.58	17° 17' 41.43286"	73° 15' 50.96059"	11.89	9.41
8.68	17° 17' 40.64014"	73° 15' 54.23294"	11.44	8.97
8.78	17° 17' 39.93811"	73° 15' 57.53761"	11.24	8.77
9.08	17° 17' 38.68832"	73° 16' 07.58817"	9.63	7.18
9.55	17° 17' 25.92798"	73° 16' 16.24818"	12.08	9.66
9.65	17° 17' 22.71492"	73° 16' 15.77705"	16.19	13.78
9.74	17° 17' 19.70539"	73° 16' 16.53959"	16.24	13.83
9.84	17° 17' 17.57850"	73° 16' 19.01601"	15.79	13.39
9.94	17° 17' 15.77938"	73° 16' 21.81949"	14.98	12.58
10.04	17° 17' 14.19072"	73° 16' 24.73748"	14.20	11.81
10.14	17° 17' 13.52303"	73° 16' 28.04337"	13.57	11.18
10.33	17° 17' 11.17822"	73° 16' 33.97243"	13.80	11.43
10.43	17° 17' 08.86238"	73° 16' 36.34793"	7.85	5.49
11.02	17° 17' 14.11183"	73° 16' 55.71825"	6.18	3.87

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
11.12	17° 17' 16.46027"	73° 16' 58.05348"	5.52	3.22
11.22	17° 17' 18.88024"	73° 17' 00.30917"	5.47	3.18
11.32	17° 17' 21.47015"	73° 17' 02.35371"	7.46	5.18
11.42	17° 17' 24.24726"	73° 17' 04.11277"	11.13	8.85
11.52	17° 17' 26.86403"	73° 17' 06.10291"	15.03	12.76
11.62	17° 17' 28.34236"	73° 17' 09.09540"	18.37	16.11
11.72	17° 17' 28.82432"	73° 17' 12.43065"	18.99	16.74
11.82	17° 17' 28.65014"	73° 17' 15.80483"	14.41	12.16
11.92	17° 17' 28.25029"	73° 17' 19.15129"	7.49	5.25
12.02	17° 17' 27.02769"	73° 17' 22.26155"	7.10	4.87
12.12	17° 17' 25.19702"	73° 17' 25.05743"	7.04	4.82
12.22	17° 17' 22.63976"	73° 17' 27.14385"	7.02	4.81
12.32	17° 17' 19.91314"	73° 17' 28.97650"	7.08	4.88
12.42	17° 17' 16.88405"	73° 17' 30.16688"	7.37	5.17
12.52	17° 17' 13.66292"	73° 17' 30.61748"	7.15	4.96
12.62	17° 17' 10.50925"	73° 17' 31.42773"	7.26	5.08
12.72	17° 17' 08.52860"	73° 17' 33.99634"	8.01	5.84
12.82	17° 17' 07.45700"	73° 17' 37.16164"	8.65	6.49
12.92	17° 17' 06.90892"	73° 17' 40.49581"	8.21	6.06
13.02	17° 17' 05.97822"	73° 17' 43.70754"	8.58	6.43
13.10	17° 17' 03.29538"	73° 17' 44.45784"	8.21	6.07
13.20	17° 17' 00.55225"	73° 17' 42.66854"	8.07	5.93
13.30	17° 16' 58.61504"	73° 17' 39.97997"	9.76	7.63
13.40	17° 16' 57.06396"	73° 17' 37.06303"	11.24	9.12
13.48	17° 16' 54.42230"	73° 17' 36.34314"	11.88	9.77
13.58	17° 16' 51.75366"	73° 17' 38.11249"	12.55	10.46
13.68	17° 16' 49.21046"	73° 17' 40.21216"	12.56	10.47
13.78	17° 16' 46.41019"	73° 17' 41.92005"	10.80	8.71
13.88	17° 16' 43.37698"	73° 17' 43.12761"	9.73	7.65
13.98	17° 16' 40.32272"	73° 17' 44.27000"	9.20	7.13
14.08	17° 16' 37.13694"	73° 17' 44.93991"	9.40	7.34
14.18	17° 16' 34.07575"	73° 17' 45.99431"	8.60	6.55
14.28	17° 16' 30.88118"	73° 17' 46.51124"	8.73	6.68
14.38	17° 16' 27.75547"	73° 17' 47.39964"	3.67	1.63
14.48	17° 16' 24.69967"	73° 17' 48.51558"	4.01	1.98
14.58	17° 16' 21.84115"	73° 17' 50.10879"	4.95	2.93
14.67	17° 16' 19.34499"	73° 17' 52.23801"	4.63	2.62
14.97	17° 16' 12.28046"	73° 17' 59.17829"	6.51	4.52
15.07	17° 16' 10.57708"	73° 18' 02.04538"	6.91	4.93
15.17	17° 16' 08.85995"	73° 18' 04.86517"	8.88	6.91
15.27	17° 16' 07.30915"	73° 18' 07.81514"	10.40	8.44
15.47	17° 16' 03.53334"	73° 18' 13.23229"	10.30	8.36
15.57	17° 16' 01.41204"	73° 18' 15.76964"	12.70	10.77
15.66	17° 16' 00.28729"	73° 18' 18.67536"	12.72	10.80
15.86	17° 16' 01.30530"	73° 18' 25.21195"	7.74	5.83
15.96	17° 16' 00.07274"	73° 18' 28.33837"	7.56	5.66
16.06	17° 15' 58.66970"	73° 18' 31.38475"	8.05	6.16
16.25	17° 15' 55.39109"	73° 18' 37.07413"	8.91	7.04

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
16.35	17° 15' 54.11564"	73° 18' 40.17449"	8.50	6.64
16.45	17° 15' 52.37036"	73° 18' 42.99269"	7.71	5.85
16.55	17° 15' 50.87186"	73° 18' 45.91426"	7.55	5.70
16.92	17° 15' 53.83523"	73° 18' 58.03574"	6.18	4.37
17.02	17° 15' 55.74456"	73° 19' 00.77095"	7.25	5.45
17.12	17° 15' 58.12881"	73° 19' 02.99978"	8.56	6.77
17.22	17° 16' 00.67362"	73° 19' 05.09681"	9.86	8.08
17.32	17° 16' 03.01443"	73° 19' 07.42391"	10.79	9.01
17.41	17° 16' 04.04112"	73° 19' 10.61682"	11.66	9.89
17.51	17° 16' 04.68399"	73° 19' 13.93103"	11.40	9.64
17.61	17° 16' 05.38851"	73° 19' 17.22913"	10.05	8.29
17.71	17° 16' 06.27057"	73° 19' 20.48161"	12.82	11.07
17.81	17° 16' 06.50988"	73° 19' 23.81880"	10.09	8.35
17.91	17° 16' 06.31605"	73° 19' 27.17582"	11.98	10.25
18.01	17° 16' 05.27323"	73° 19' 30.34481"	15.14	13.42
18.11	17° 16' 03.93726"	73° 19' 33.39321"	15.50	13.79
18.21	17° 16' 02.86297"	73° 19' 36.57567"	14.38	12.68
18.31	17° 16' 01.74558"	73° 19' 39.74226"	13.57	11.88
18.41	17° 16' 01.00128"	73° 19' 43.02297"	11.03	9.35
18.51	17° 16' 00.12462"	73° 19' 46.23240"	9.90	8.23
18.61	17° 15' 59.24604"	73° 19' 49.44659"	10.04	8.38
18.70	17° 15' 57.90708"	73° 19' 52.38051"	9.95	8.30
18.80	17° 15' 55.41357"	73° 19' 54.48550"	6.36	4.72
18.90	17° 15' 53.22845"	73° 19' 56.74919"	5.57	3.93
19.00	17° 15' 52.21741"	73° 19' 59.96249"	6.31	4.68
19.10	17° 15' 50.73057"	73° 20' 02.95592"	6.71	5.09
19.20	17° 15' 49.75703"	73° 20' 06.18411"	11.06	9.45
19.30	17° 15' 48.54460"	73° 20' 09.32132"	13.74	12.14
19.39	17° 15' 47.23006"	73° 20' 12.38562"	11.69	10.09
19.49	17° 15' 45.85001"	73° 20' 15.43629"	10.43	8.84
19.59	17° 15' 43.66582"	73° 20' 17.85967"	10.50	8.92
19.69	17° 15' 40.96487"	73° 20' 19.67352"	10.08	8.50
20.04	17° 15' 29.52820"	73° 20' 20.02444"	8.59	7.05
20.14	17° 15' 26.32232"	73° 20' 19.66686"	6.74	5.20
20.24	17° 15' 23.12886"	73° 20' 20.18128"	6.66	5.13
20.34	17° 15' 19.91485"	73° 20' 20.61123"	6.75	5.23
20.43	17° 15' 16.92487"	73° 20' 20.20195"	6.58	5.07
20.53	17° 15' 13.85143"	73° 20' 19.10243"	5.64	4.14
20.63	17° 15' 10.69223"	73° 20' 19.19774"	5.60	4.10
20.73	17° 15' 07.60954"	73° 20' 20.12655"	6.31	4.82
20.83	17° 15' 04.49576"	73° 20' 21.07256"	7.04	5.56
20.93	17° 15' 01.26638"	73° 20' 20.90239"	6.72	5.25
21.03	17° 14' 58.11345"	73° 20' 21.55995"	7.22	5.76
21.13	17° 14' 54.94081"	73° 20' 21.21019"	7.04	5.58
21.22	17° 14' 52.06121"	73° 20' 20.06529"	6.93	5.48
21.32	17° 14' 48.93796"	73° 20' 19.23572"	7.21	5.78
21.42	17° 14' 45.75155"	73° 20' 18.63591"	7.79	6.36
21.52	17° 14' 42.51851"	73° 20' 18.53519"	8.85	7.43

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
21.62	17° 14' 39.37444"	73° 20' 18.92623"	9.97	8.56
21.71	17° 14' 36.14085"	73° 20' 18.95550"	11.12	9.71
21.81	17° 14' 33.10692"	73° 20' 19.21116"	11.16	9.76
21.96	17° 14' 28.49677"	73° 20' 17.56180"	13.68	12.30
22.06	17° 14' 25.86950"	73° 20' 15.69634"	15.86	14.50
22.16	17° 14' 22.96275"	73° 20' 14.21931"	16.05	14.69
22.25	17° 14' 20.11819"	73° 20' 12.90762"	12.25	10.90
22.35	17° 14' 16.94878"	73° 20' 12.90824"	13.85	12.50
22.45	17° 14' 13.72604"	73° 20' 13.06911"	12.68	11.34
22.55	17° 14' 10.49628"	73° 20' 12.85362"	12.21	10.87
22.64	17° 14' 07.40128"	73° 20' 13.55328"	7.33	6.00
22.74	17° 14' 04.25939"	73° 20' 13.89284"	6.80	5.48
22.84	17° 14' 01.27211"	73° 20' 15.03125"	7.08	5.77
22.94	17° 13' 58.25572"	73° 20' 16.19056"	8.34	7.04
23.04	17° 13' 55.38123"	73° 20' 17.67220"	9.94	8.64
23.14	17° 13' 52.50658"	73° 20' 19.21511"	12.35	11.06
23.24	17° 13' 50.22913"	73° 20' 21.57895"	13.52	12.24
23.33	17° 13' 48.62676"	73° 20' 24.46584"	11.88	10.60
23.43	17° 13' 46.74684"	73° 20' 27.11011"	10.74	9.47
23.81	17° 13' 39.39105"	73° 20' 37.53158"	9.93	8.69
23.91	17° 13' 37.15021"	73° 20' 39.92511"	14.55	13.31
24.01	17° 13' 37.90222"	73° 20' 43.03839"	7.72	6.49
24.11	17° 13' 39.14711"	73° 20' 46.15913"	6.61	5.39
24.20	17° 13' 39.53672"	73° 20' 49.39310"	7.05	5.83
24.30	17° 13' 40.02905"	73° 20' 52.69929"	7.61	6.40
24.40	17° 13' 38.37829"	73° 20' 55.49340"	11.65	10.45
24.48	17° 13' 39.01964"	73° 20' 58.21130"	13.58	12.38
24.58	17° 13' 41.63269"	73° 21' 00.21946"	8.11	6.92
24.68	17° 13' 44.24329"	73° 21' 02.20802"	8.75	7.57
24.78	17° 13' 47.12748"	73° 21' 03.76055"	9.67	8.50
24.88	17° 13' 48.66992"	73° 21' 06.60049"	10.22	9.05
24.98	17° 13' 49.21281"	73° 21' 09.93336"	8.00	6.84
25.07	17° 13' 50.38787"	73° 21' 12.92079"	6.03	4.87
25.17	17° 13' 53.35388"	73° 21' 14.05966"	9.06	7.91
25.27	17° 13' 55.25887"	73° 21' 16.72515"	7.35	6.21
25.52	17° 14' 01.01243"	73° 21' 23.00003"	5.94	4.81
25.62	17° 14' 03.94512"	73° 21' 24.40161"	6.54	5.42
25.72	17° 14' 06.98561"	73° 21' 25.53990"	8.07	6.95
25.82	17° 14' 09.47040"	73° 21' 27.70375"	10.73	9.62
25.92	17° 14' 11.49580"	73° 21' 30.34052"	13.37	12.27
26.02	17° 14' 12.97610"	73° 21' 33.35111"	19.68	18.59
26.12	17° 14' 14.20482"	73° 21' 36.46753"	19.59	18.50
26.22	17° 14' 15.66494"	73° 21' 39.47934"	13.31	12.23
26.32	17° 14' 16.47776"	73° 21' 42.73926"	17.06	15.99
26.42	17° 14' 16.31198"	73° 21' 46.11140"	8.48	7.41
26.52	17° 14' 15.34147"	73° 21' 49.33458"	5.80	4.73
26.61	17° 14' 13.64224"	73° 21' 51.83532"	5.26	4.20
26.71	17° 14' 10.60625"	73° 21' 53.00659"	4.67	3.61

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
26.81	17° 14' 07.62987"	73° 21' 54.34828"	4.26	3.21
26.91	17° 14' 04.90006"	73° 21' 56.16949"	4.28	3.23
27.00	17° 14' 02.16192"	73° 21' 57.60689"	4.22	3.18
27.10	17° 13' 58.97542"	73° 21' 58.07194"	4.42	3.38
27.20	17° 13' 56.40008"	73° 22' 00.08979"	4.58	3.55
27.30	17° 13' 53.83322"	73° 22' 02.15020"	4.95	3.92
27.40	17° 13' 51.58523"	73° 22' 04.58151"	6.08	5.06
27.50	17° 13' 48.80663"	73° 22' 06.28662"	7.18	6.16
27.60	17° 13' 45.95063"	73° 22' 07.83634"	8.54	7.53
27.70	17° 13' 43.34466"	73° 22' 09.85031"	10.74	9.73
27.80	17° 13' 40.42392"	73° 22' 11.19950"	12.24	11.24
27.89	17° 13' 37.28650"	73° 22' 11.66166"	8.14	7.14
27.99	17° 13' 34.36324"	73° 22' 10.21007"	9.40	8.41
28.09	17° 13' 31.24741"	73° 22' 09.32175"	9.77	8.78
28.19	17° 13' 28.05814"	73° 22' 08.68525"	10.03	9.04
28.29	17° 13' 24.82444"	73° 22' 08.34567"	10.60	9.62
28.39	17° 13' 21.58364"	73° 22' 08.17304"	14.64	13.66
28.49	17° 13' 18.35392"	73° 22' 07.80364"	14.08	13.10
28.59	17° 13' 15.20319"	73° 22' 06.98470"	13.38	12.41
28.69	17° 13' 11.98541"	73° 22' 07.28576"	9.88	8.91
28.79	17° 13' 09.15357"	73° 22' 08.72617"	16.57	15.60
28.89	17° 13' 06.64756"	73° 22' 10.87454"	7.99	7.03
28.99	17° 13' 04.12545"	73° 22' 13.00374"	5.20	4.24
29.09	17° 13' 01.89814"	73° 22' 15.46443"	3.47	2.51
29.38	17° 12' 53.39954"	73° 22' 20.01834"	9.99	9.04
29.48	17° 12' 50.46285"	73° 22' 21.45077"	12.70	11.76
29.58	17° 12' 48.19088"	73° 22' 23.86438"	9.95	9.01
29.68	17° 12' 46.55536"	73° 22' 26.74053"	9.61	8.67
29.78	17° 12' 46.09508"	73° 22' 30.08907"	7.61	6.68
29.88	17° 12' 45.83045"	73° 22' 33.45824"	2.25	1.32
29.98	17° 12' 45.99737"	73° 22' 36.81248"	2.28	1.35
30.08	17° 12' 47.00987"	73° 22' 40.01887"	3.57	2.65
30.18	17° 12' 48.05251"	73° 22' 43.21384"	3.69	2.77
30.28	17° 12' 50.00648"	73° 22' 45.90196"	4.61	3.69
30.38	17° 12' 51.00208"	73° 22' 49.11598"	3.61	2.69
30.48	17° 12' 52.68466"	73° 22' 51.99909"	3.52	2.60
30.58	17° 12' 54.53153"	73° 22' 54.76198"	3.72	2.81
30.68	17° 12' 55.56301"	73° 22' 57.95170"	3.40	2.49
30.77	17° 12' 55.27318"	73° 23' 01.27679"	3.01	2.10
31.34	17° 12' 55.98740"	73° 23' 20.54095"	3.36	2.46
31.44	17° 12' 58.02398"	73° 23' 23.16115"	4.99	4.09
31.54	17° 12' 59.17603"	73° 23' 26.31097"	6.29	5.39
31.64	17° 12' 59.78815"	73° 23' 29.63471"	7.81	6.91
31.74	17° 13' 00.28654"	73° 23' 32.97738"	9.02	8.12
31.84	17° 13' 00.47475"	73° 23' 36.34305"	10.94	10.04
31.94	17° 13' 00.72351"	73° 23' 39.71497"	13.06	12.17
32.04	17° 13' 00.58712"	73° 23' 43.09123"	6.30	5.41
32.14	17° 12' 59.29124"	73° 23' 46.17318"	5.81	4.92

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
32.24	17° 12' 57.06790"	73° 23' 48.60374"	5.25	4.36
32.34	17° 12' 55.12561"	73° 23' 51.07384"	5.44	4.37
32.44	17° 12' 54.48672"	73° 23' 54.38975"	5.71	4.63
32.54	17° 12' 53.75071"	73° 23' 57.68381"	6.01	4.92
33.05	17° 12' 48.85237"	73° 24' 14.35132"	3.65	2.52
33.15	17° 12' 46.40971"	73° 24' 16.58292"	4.34	3.21
33.25	17° 12' 44.39653"	73° 24' 19.23324"	4.39	3.25
33.35	17° 12' 42.85534"	73° 24' 22.21122"	4.17	3.03
33.45	17° 12' 40.78904"	73° 24' 24.77126"	4.93	3.79
33.55	17° 12' 39.09116"	73° 24' 27.64156"	5.65	4.50
33.65	17° 12' 37.72372"	73° 24' 30.70940"	5.42	4.26
33.75	17° 12' 36.37441"	73° 24' 33.76861"	5.47	4.30
33.85	17° 12' 34.56311"	73° 24' 36.57553"	6.80	5.63
33.95	17° 12' 33.32795"	73° 24' 39.63306"	3.92	2.74
34.05	17° 12' 33.64207"	73° 24' 42.99993"	4.65	3.46
34.15	17° 12' 34.00105"	73° 24' 46.36270"	4.13	2.93
34.25	17° 12' 34.45587"	73° 24' 49.71247"	4.19	2.99
34.35	17° 12' 35.09390"	73° 24' 53.02989"	4.92	3.71
34.45	17° 12' 35.42417"	73° 24' 56.38886"	6.18	4.96
34.54	17° 12' 35.82649"	73° 24' 59.72792"	5.86	4.63
34.74	17° 12' 38.49323"	73° 25' 05.66725"	6.82	5.59
35.11	17° 12' 36.76504"	73° 25' 18.17698"	5.50	4.22
35.21	17° 12' 33.83421"	73° 25' 19.62142"	6.20	4.92
35.31	17° 12' 31.07921"	73° 25' 21.41875"	6.86	5.57
35.41	17° 12' 28.45322"	73° 25' 23.40722"	7.06	5.76
35.51	17° 12' 26.41291"	73° 25' 26.03417"	7.85	6.54
35.61	17° 12' 24.58176"	73° 25' 28.82687"	5.62	4.31
35.71	17° 12' 22.39012"	73° 25' 31.32441"	7.71	6.39
35.81	17° 12' 21.92648"	73° 25' 34.64741"	4.36	3.03
35.91	17° 12' 21.62910"	73° 25' 38.01673"	3.80	2.46
36.01	17° 12' 21.68804"	73° 25' 41.40030"	3.84	2.49
36.11	17° 12' 21.73948"	73° 25' 44.78428"	3.71	2.36
36.21	17° 12' 21.79318"	73° 25' 48.16824"	3.87	2.51
36.31	17° 12' 21.78886"	73° 25' 51.53847"	3.53	2.17
36.41	17° 12' 22.57825"	73° 25' 54.82010"	3.88	2.51
36.79	17° 12' 19.98640"	73° 26' 07.28224"	3.47	2.07
36.89	17° 12' 18.50542"	73° 26' 10.28138"	3.47	2.06
36.98	17° 12' 18.37759"	73° 26' 13.63809"	4.20	2.79
37.08	17° 12' 18.01389"	73° 26' 16.99576"	5.57	4.15
37.18	17° 12' 17.33832"	73° 26' 20.28463"	6.87	5.45
37.28	17° 12' 16.11795"	73° 26' 23.41999"	6.65	5.22
37.38	17° 12' 14.62618"	73° 26' 26.42222"	5.13	3.69
37.48	17° 12' 12.69762"	73° 26' 29.14412"	4.37	2.92
37.58	17° 12' 10.55523"	73° 26' 31.68841"	4.32	2.87
37.68	17° 12' 08.16657"	73° 26' 33.97919"	5.00	3.54
37.78	17° 12' 05.49532"	73° 26' 35.90779"	3.75	2.28
37.88	17° 12' 02.69457"	73° 26' 37.62287"	3.68	2.21
37.98	17° 12' 00.19518"	73° 26' 39.73345"	4.25	2.77

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
38.08	17° 11' 57.47957"	73° 26' 41.52258"	3.87	2.39
38.37	17° 11' 48.31064"	73° 26' 42.89174"	4.81	3.30
38.47	17° 11' 45.08138"	73° 26' 43.25039"	3.32	1.80
38.57	17° 11' 41.93525"	73° 26' 44.09673"	3.01	1.48
38.66	17° 11' 38.98083"	73° 26' 45.25149"	3.80	2.26
38.76	17° 11' 36.84623"	73° 26' 47.80297"	4.20	2.65
38.86	17° 11' 34.71786"	73° 26' 50.36116"	4.48	2.92
38.96	17° 11' 32.60881"	73° 26' 52.93642"	4.22	2.65
39.06	17° 11' 30.81815"	73° 26' 55.75474"	5.06	3.49
39.16	17° 11' 29.69438"	73° 26' 58.91135"	3.59	2.01
39.86	17° 11' 32.30615"	73° 27' 22.37149"	3.26	1.64
40.35	17° 11' 38.09982"	73° 27' 37.90703"	2.61	0.95
40.45	17° 11' 39.28933"	73° 27' 40.95178"	2.93	1.26
40.55	17° 11' 41.42336"	73° 27' 43.50001"	6.31	4.63
40.65	17° 11' 42.56196"	73° 27' 46.61120"	3.35	1.66
40.74	17° 11' 42.03848"	73° 27' 49.85018"	3.51	1.82
40.84	17° 11' 41.19260"	73° 27' 53.08944"	2.68	0.98
41.04	17° 11' 39.88579"	73° 27' 59.67173"	2.68	0.96
41.14	17° 11' 38.21738"	73° 28' 02.55931"	3.12	1.39
41.44	17° 11' 31.13730"	73° 28' 09.52339"	3.69	1.93
41.54	17° 11' 28.44898"	73° 28' 11.38497"	4.21	2.44
41.64	17° 11' 25.57104"	73° 28' 12.95094"	3.72	1.94
41.74	17° 11' 22.61216"	73° 28' 14.35611"	3.49	1.71
41.84	17° 11' 19.52673"	73° 28' 15.41777"	3.51	1.72
41.94	17° 11' 16.34128"	73° 28' 16.07410"	3.73	1.94
42.04	17° 11' 13.12042"	73° 28' 16.35064"	3.67	1.87
42.23	17° 11' 06.89704"	73° 28' 16.82610"	2.74	0.92
42.33	17° 11' 03.82790"	73° 28' 17.93429"	3.71	1.88
42.62	17° 10' 54.76342"	73° 28' 15.18132"	3.23	1.38
42.72	17° 10' 51.87640"	73° 28' 13.62180"	3.12	1.26
42.82	17° 10' 48.93530"	73° 28' 12.18052"	3.93	2.07
42.92	17° 10' 45.92578"	73° 28' 10.89718"	6.03	4.16
43.02	17° 10' 42.74559"	73° 28' 10.23120"	6.16	4.28
43.12	17° 10' 39.86918"	73° 28' 11.48635"	3.26	1.37
43.30	17° 10' 34.07712"	73° 28' 10.32367"	4.07	2.17
43.40	17° 10' 31.06539"	73° 28' 09.09284"	6.32	4.42
43.50	17° 10' 27.82801"	73° 28' 09.25106"	7.38	5.47
43.60	17° 10' 24.58418"	73° 28' 09.50172"	5.74	3.82
43.70	17° 10' 21.39176"	73° 28' 09.96855"	4.44	2.52
43.98	17° 10' 13.40915"	73° 28' 14.62161"	2.74	0.79
44.08	17° 10' 11.23386"	73° 28' 17.13018"	2.81	0.85
44.95	17° 09' 54.47000"	73° 28' 41.02942"	3.87	1.84
45.05	17° 09' 52.90539"	73° 28' 43.99038"	4.19	2.15
45.15	17° 09' 51.22501"	73° 28' 46.87342"	3.29	1.24
45.65	17° 09' 41.19529"	73° 28' 59.98186"	5.60	3.52
45.75	17° 09' 38.94509"	73° 29' 02.41666"	6.08	4.00
45.85	17° 09' 36.51158"	73° 29' 04.65903"	6.20	4.11
45.95	17° 09' 33.63989"	73° 29' 06.16927"	4.37	2.27

Chainage (km)	Easting(m)	Northing(m)	Raw Depth(m)	Reduced Depth w.r.t CD (m)
46.01	17° 09' 32.38096"	73° 29' 08.91204"	1.40	-0.80
46.29	17° 09' 36.64704"	73° 29' 17.74180"	1.40	-0.80
46.39	17° 09' 37.96902"	73° 29' 20.80918"	1.80	-0.40
46.59	17° 09' 42.12728"	73° 29' 25.98048"	1.80	-0.40
46.79	17° 09' 46.20848"	73° 29' 31.20661"	1.40	-0.80
46.89	17° 09' 49.05905"	73° 29' 32.74058"	1.80	-0.40
46.99	17° 09' 51.85224"	73° 29' 34.60769"	3.50	1.30
47.08	17° 09' 54.36730"	73° 29' 37.83001"	2.60	0.41
47.28	17° 09' 55.55884"	73° 29' 43.31075"	1.60	-0.60
47.63	17° 09' 56.12328"	73° 29' 55.19861"	1.00	-1.30
47.73	17° 09' 55.73631"	73° 29' 58.54657"	1.40	-0.80
47.83	17° 09' 55.64886"	73° 30' 01.92630"	1.50	-0.70
47.93	17° 09' 55.58704"	73° 30' 05.29940"	1.40	-0.80
48.11	17° 09' 56.54462"	73° 30' 12.82000"	3.99	1.75
48.14	17° 09' 55.95529"	73° 30' 12.31407"	4.00	1.80
48.21	17° 09' 57.27787"	73° 30' 16.10789"	3.06	0.81
48.22	17° 09' 56.68648"	73° 30' 15.32379"	3.10	0.80
48.42	17° 09' 59.27301"	73° 30' 21.28078"	1.80	-0.40
48.52	17° 10' 01.03665"	73° 30' 24.10155"	1.10	-1.20

Note: Reduced depth has been reckoned by applying tide variation Min 0.89m & Max 2.62m

ANNEXURE 3.4

PHOTOS CAPTURED BY SURVEY TEAM DURING RECONNAISSANCE SURVEY

ANNEXURE 3.4: PHOTOS CAPTURED BY SURVEY TEAM DURING RECONNAISSANCE SURVEY

Photo 1: Buoy on the mouth of Jaigad Creek at Ch 0.28km (17°19′05.5″N, 73°12′49.4″E)

Photo 2: Jindal Port breakwater at Ch 0.67km (17°18′49.2″N, 73°12′49.4″E)

Photo 3: Jindal Power Plant on South bank at Ch 1.20km (17°18'28.6"N, 73°13'02.3"E)

Photo 4: Jindal Port Jetty on South bank. Reclamation work in progress at Ch 1.2km

(17°18'28.6"N, 73°13'02.3"E)

Photo 5: Chauqula Port Jetty on West bank of river at Ch 3.65km (17°17'39.7"N, 73°13'30.16"E)

Photo 6: Jaigad Fishing Jetty on West bank of river at Ch 3.65km (17°17'39.7"N, 73°13'30.16"E)

Photo 7: Jaigad Ferry Jetty on West bank of river at Ch 3.89km (17°17'31.8"N, 73°13'30.3"E)

Photo 8: Lavgan Dockyard Pvt. Ltd on South bank of river at Ch 5.15km (17°17'16.2"N, 73°14'06.1"E)

Photo 9: Tavasal Ferry Jetty on North bank of river at Ch 5.92km (17°17'29.1"N, 73°14'25.3"E)

Photo 10: Reclamation on the North bank of river at Ch 9.38km (17°17'33.7"N, 73°16'18.3"E)

Photo 11: High Tension Line Crossing River at Ch 14.49km (17°16'24.4"N, 73°17'48.8"E)

Photo 12: Shallow patch covered by Mangroves in the centre of the river at Ch 14.68km (17°16'19.4"N, 73°17'52.4"E)

Photo 13: Chafe Jetty on south bank at Ch 23.77km (17°13'40.4"N, 73°20'36.7"E)

Photo 14: Bhatgaon Road Bridge at Ch 34.43km (17°12'35.3"N, 73°24'56.2"E)

Photo 15: Bhatgaon Road Bridge from east side at Ch 34.92km (17°12'41.0"N, 73°25'12.5"E)

Photo 16: Shallow Patch and Construction activities on North Bank at Ch 35.07km (17°12'42.6"N, 73°25'17.8"E)

Photo 17: Shallow Patch covered with mangroves at Ch 38.41km (17°11'46.6"N, 73°26'43.1"E)

Photo 18: Phungus Road Bridge crossing river at Ch 43.95km (17°10'01.3"N, 73°28'26.7"E)

Photo 19: Railway Bridge crossing river at Ch 45.11km (17°09'51.6"N, 73°28'46.0"E)

Photo 20: Electrical line crossing river at Ch 45.73km (17°09'39.0"N, 73°29'02.3"E)

Photo 21: Mobile towers on the south bank at Ch 47.23km (17°09'56.1"N, 73°29'41.7"E)

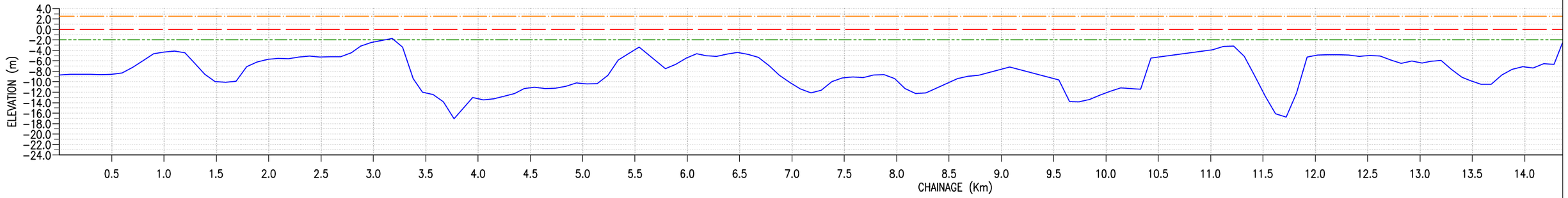
Photo 22: Electric lines crossing the River at Ch 48.98km (17°10'09.1"N, 73°30'36.2"E)

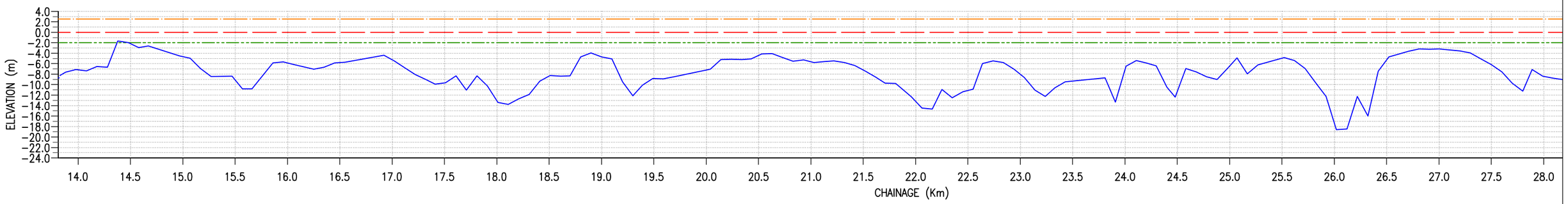
Photo 23: Asoda bridge 180 m downstream at Ch 51.98km (17°10'28.56"N, 73°32'05.51"E)

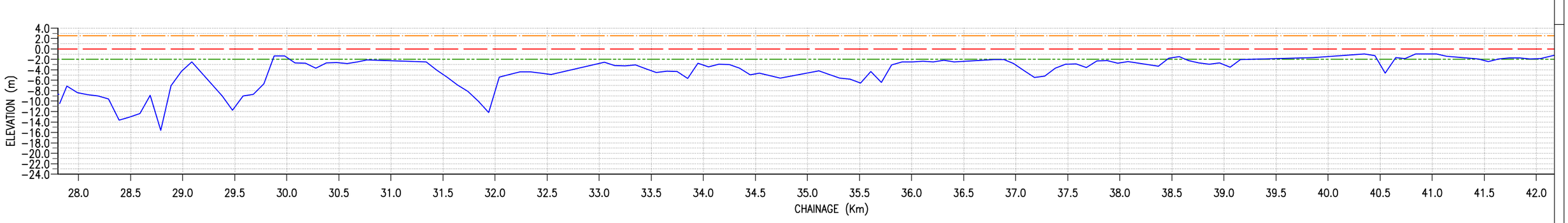
Photo 24: Old Shastri Bridge and Construction of new both way bridge at Ch 53.53km (17°10'01.3"N, 73°32'44.6"E)

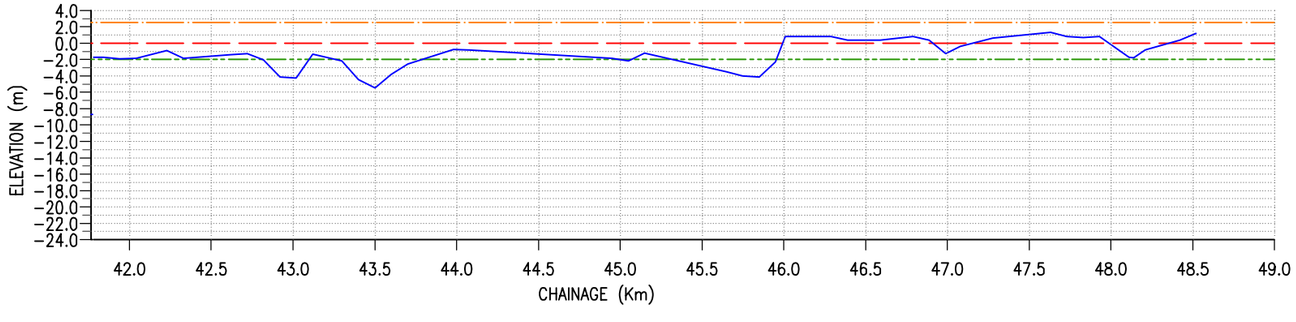
ANNEXURE 3.5

OBSERVED BED PROFILE OF SHASTRI RIVER/JAIGAD CREEK WATERWAY









LEGENDS

- HIGH TIDE
- CHART DATUM
- 2m DEPTH BELOW CHART DATUM
- SHASTRI RIVER/JAIGAD CREEK BED PROFILE

ANNEXURE 3.5

SHASTRI RIVER/JAIGAD CREEK LONGITUDINAL BED PROFILE

ANNEXURE 3.6

COMPILATION OF FIELD INFORMATION OF SHASTRI RIVER/JAIGAD CREEK IN IWAI FORMAT

Annexure 3.6: Format for Submission of Initial Field Information Report

SL#	DESCRIPTION	DETAILS	REMARKS
	NAME OF THE FIRM	**Fugro Survey(India) Pvt Ltd.**	
	REGION / CLUSTER NO.	**Cluster-7/ Stage-1/ Maharashtra**	
1	NAME OF THE WATERWAY	Shastri River /Jaigad Creek	
2	LENGTH OF THE WATERWAY (km)	52	
3	WATERWAY IN THE STATES OF	Maharashtra	
4	FIELD WORK COMPLETED FOR THE LENGTH OF THE WATERWAY (km)	52 (Data captured on 26,27 & 28.02.2016)	Data acquisition based on High Tide timings
TIDAL WATERWAYS			
5	Length of the waterway having tidal effects (km)	50	
6	Start & end location name having tidal effects	JSW Jetty to Sangameshwar	
7	Tidal variation (m)	-	Tide variation measurement scope is not in Stage-1, we have not carried out the same at site
DEPTH INFORMATION			
8	Length of the waterway, where depths more than 2m is observed	41.44 Km	
9	Length of the waterway, where depths more than 1.5m is observed	43.91 Km	
	Length of the waterway, where depths more than 1.0m is observed	45.36 Km	
10	Existing Water level (m)	Exposed soil to 18.59 m	
11	Minimum Water Level (m)	Dry Height	
12	Highest Flood level (m)	-	We have not seen HFL marking in any Bridges
CROSS-STRUCTURE INFORMATION			
13	Existing list of Dam, Barrages, Locks	Nil	
14	Existing Bridges (nos.)	6	
15	Minimum Vertical and Horizontal clearances (m) as per visual estimation	1) Bhatgaon Road Bridge - Ch 34.43 km, VC: 6.5 m, HC: 60 m 2) Phungus Road Bridge - Ch 43.95 km, VC: 8.5 m, HC: 40 m 3) Pirdavane – Khurdunda Railway Bridge- Ch 45.84 km, VC: 12.0 m, HC: 30 m 4) Asoda Road Bridge - Ch 51.98 km, VC: 5.0 m, HC: 20 m 5) New Shastri (Road Bridge Under Construction)- Ch 53.53 km, VC: 8.0 m, HC: 25 m 6) Old Shastri Road Brid.- Ch 53.53 km, VC:6.5 m, HC: 20 m	Vertical clearance above MHWS
16	High Tension lines	1	2 Electric Lines
NAVIGATIONAL OBSTRUCTION			
17	Rocks	Last 2 km River bed is rocky though water is flowing over it	
18	Steep gradients	-	
ENVIRONMENTAL & OTHER ISSUES			
19	Details of wildlife /forest area	Nil	
20	Protected areas	Nil	
21	Security clearances	Nil	
CARGO AND OTHER DETAILS			
22	Availability of passenger ferry services along the waterway	Ferry Service at chainge 6.2 km Ferry Service at Chainage 1.5 km	
23	Estimated cargo movement through proposed waterway, road and rail	0.7 MMTPA to 1.2 MMTPA of Cargo is estimated to move through proposed waterway	
24	Type of crops (in different seasons) and industries along the waterway	Crops: Rice and Nachni Industries: Jindal Power Plant, Lavgan Dockyard pvt Ltd. and Sanghmeshwar MIDC	
25	Availability prominent towns / City along the waterway.	Sangameshwar, Guhagar, Ratnagiri	
26	Historical and tourist places along waterway	Jaigarh Fort, Sangameshwar and Ganpatipule are the popular tourist/pilgrimage places at the vicinity of this proposed waterway.	
27	Existing water sport and recreational activities and future probability	-	Not known to us
28	Existing Jetties and Terminals	29 Jetties, 2 Ports and 1 Dockyard	

ANNEXURE 4.1

LARGE AND MEDIUM SCALE INDUSTRIES IN SHASTRI CATCHMENT REGION

Annexure 4.1: Large and Medium scale Industries in Shastri Catchment Region

Sr. No.	COMPANY NAME	PRODUCTS	INVESTMENT	UNIT	TALUKA
1	RGPPL	Power generation	8444	Cr.	GAUHAGHAR
2	Vanaz Engineers Ltd.	Chemicals	25.84	Cr.	Sanghmeshwar
3	Ratnagiri Power plant	JSW Energy (4 units of 300 MW each)			Jaigarh

Source: District Industries Centre, Ratnagiri District

ANNEXURE 4.2

MEETING AND DISCUSSIONS

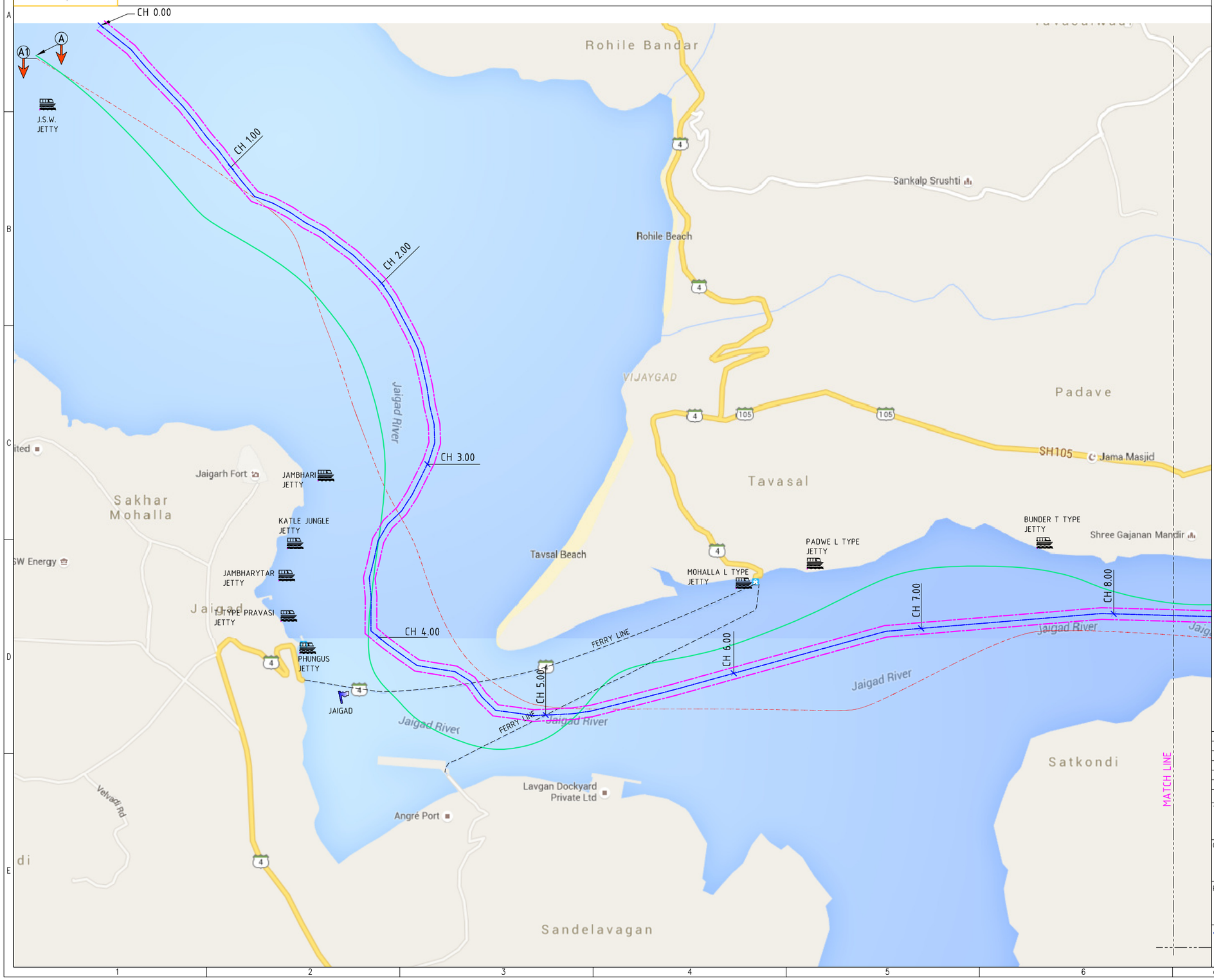
Annexure 4.2: Meeting and Discussions

S.No	Department	Persons met
1.	Maharashtra Maritime Board	CEO, Port Superintendent, Traffic Department, Hydrographer
2.	Maharashtra Industrial Development Corporation	OSD
3.	Maharashtra Tourism Development Corporation Ltd.	Director of Tourism & Jt, MD, Manager Adventure Sports
4.	Indian Oil corporation Ltd.	GM, Consumer Sales
5.	Directorate of Industries, Government of Maharashtra (GOM)	Jt. Director
6.	Planning Department, GOM	Deputy Secretary
7.	Department of Agriculture, GOM	Jt. Secretary
8.	Cement Manufacturing Association	Sr. Deputy Secretary
9.	Collectorate & DM Office, Raigarh	District disaster Management officer
10.	Collectorate & DM Office, Raigarh	Superintendent of Agriculture
11.	District Industries Centre, Raigarh	GM
12.	Collectorate & DM Office, Ratnagiri	District disaster Management officer
13.	Collectorate & DM Office, Ratnagiri	Superintendent of Agriculture (Office)
14.	District Industries Centre, Ratnagiri	Manager
15.	JSW Dharamtar Port Pvt. Ltd.	CEO, Vice President
16.	PNP Port	Head Ports Operations
17	JSW Salav Jetty	Ports Office

DRAWINGS

P.009051-W-20201-A10 R0 (SHEET-1 TO 8): LAYOUT PLAN – SHASTRI RIVER/JAIGAD CREEK

53NW CLUSTER-7
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK



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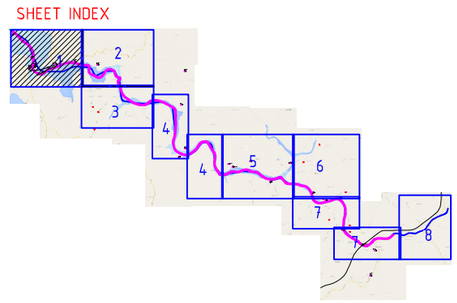

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	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
	FERRY LINE
	SURVEY (VESSEL TRACK)
	ROUTE PROVIDED BY IWAI
	DEEPEST SURVEYED WATER DEPTH (THALWEG)
	DREDGED CHANNEL / RIVER LENGTH
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B1	END POINT OF RECONNAISSANCE SURVEY AT SANGMESHWAR LAT. 17°10'06.62", LONG. 73°30'29.20"

PROPOSED WATERWAY LENGTH 52.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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TITLE
LAYOUT PLAN
SHASTRI RIVER/ JAIGAD CREEK

CLIENT
INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. **P.009051**

TRACTEBEL Engineering GDF SUEZ

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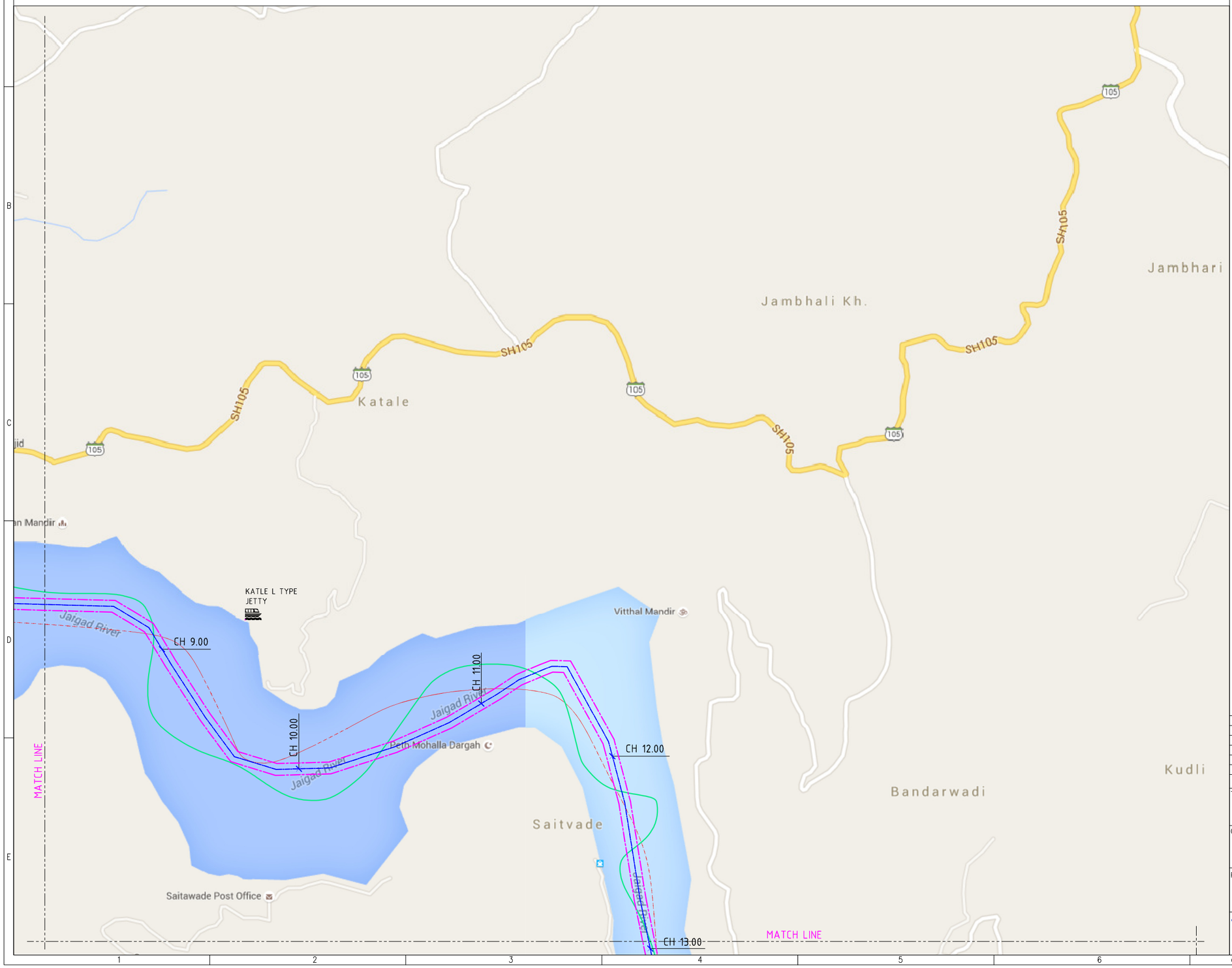
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK



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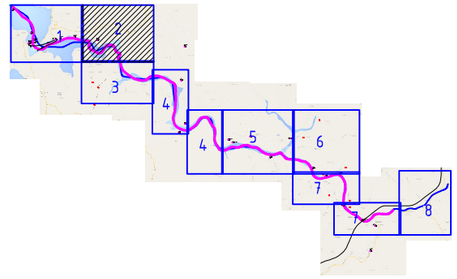

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SCALE 0 0.4 1.0KM

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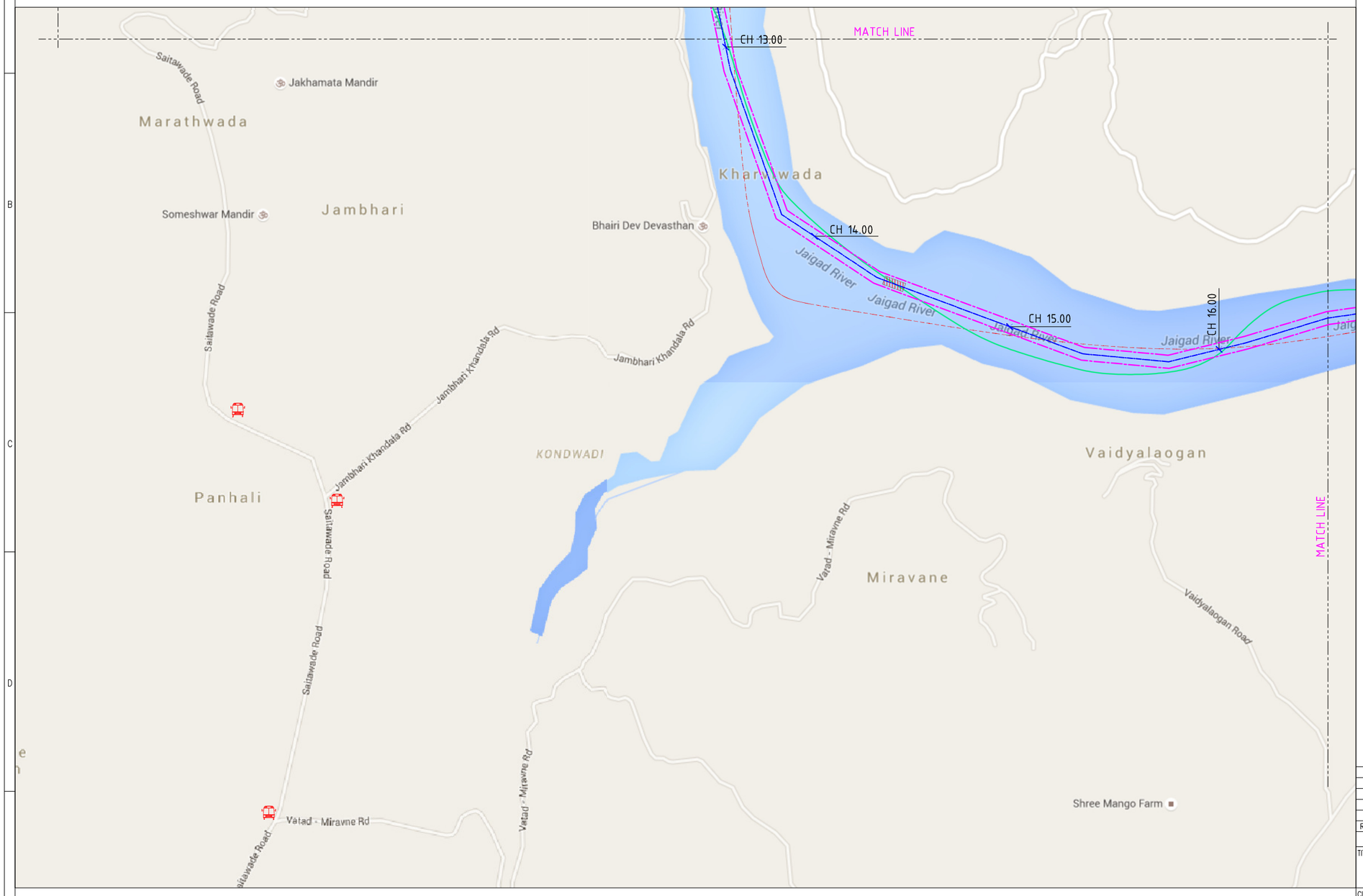
SHASTRI RIVER/ JAIGAD CREEK



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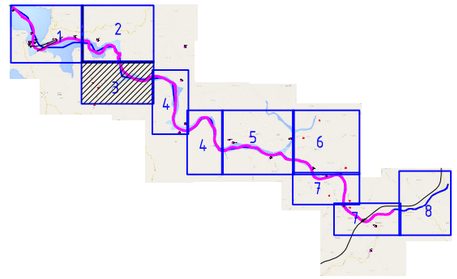

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PROPOSED WATERWAY LENGTH 52.0Km

SCALE 0 0.4 1.0KM

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P.009051

TRACTEBEL Engineering GDF SUEZ

SIZE: A3 | SCALE: 1:20000 | SHEET: 3–8

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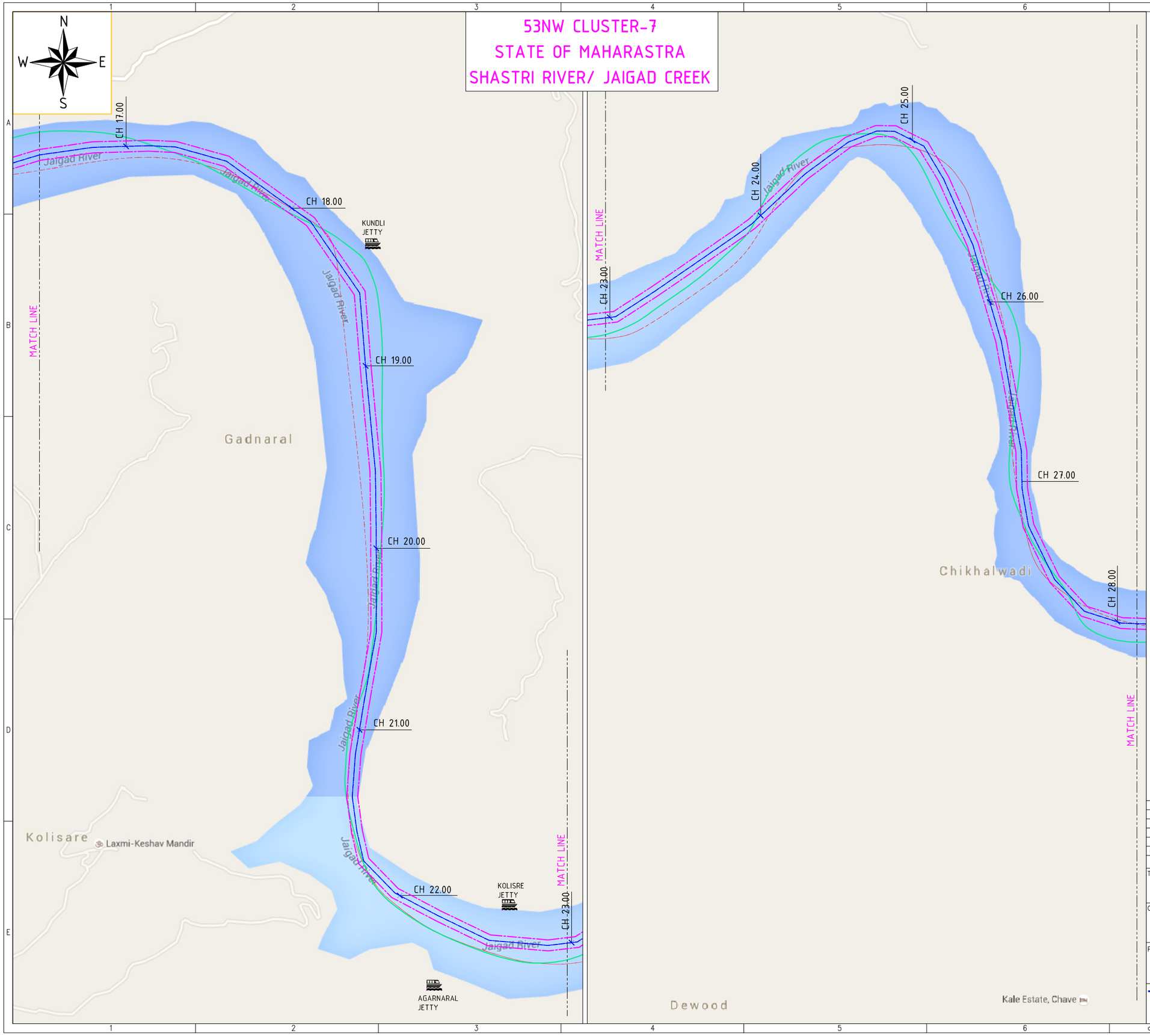
53NW CLUSTER-7
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK



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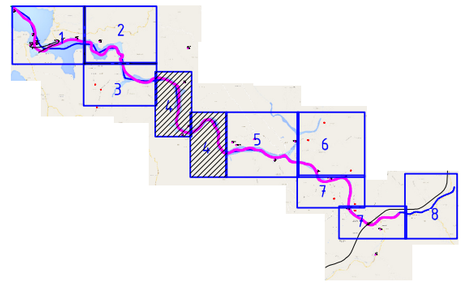

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SCALE	0 0.4 1.0KM

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GDF SUEZ

DRAWING NUMBER
P.009051–W–20201–A10 REV 0

53NW CLUSTER-7
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK

N
W E
S

Bhatgaon

Dhakka
Bhatgaon

Bhatgaon
Tisang

Rai

Medhe Tarf
Phungus

Bondye

MANJRE
JETTY

BHATGAON TISANG
JETTY

DURG BUNDER
JETTY

CHAVE
JETTY

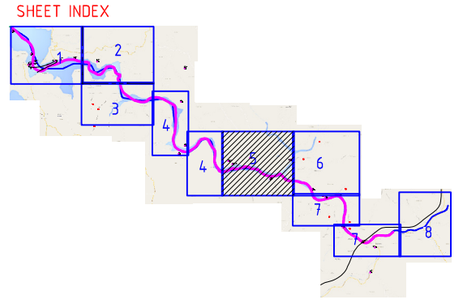
MEDHE
JETTY

CH 28.00
CH 29.00
CH 30.00
CH 31.00
CH 32.00
CH 33.00
CH 34.00

Jaigad River
Jaigad Khadi
Karjuve - Pirandavane Rd
Bondye - Rair Rd
Medhe - Manjare - Bhatgaon Rd

MATCH LINE
MATCH LINE

SHEET INDEX



LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
	FERRY LINE
	SURVEY (VESSEL TRACK)
	ROUTE PROVIDED BY IWAI
	DEEPEST SURVEYED WATER DEPTH (THALWEG)
	DREDGED CHANNEL / RIVER LENGTH
	RAILWAY LINE
A	START POINT NEAR SEA AT JAIGARH AS PROVIDED BY IWAI LAT. 17°19'11.92", LONG. 73°12'39.30"
A1	START POINT OF RECONNAISSANCE SURVEY NEAR SEA AT JAIGARH LAT. 17°19'18.21", LONG. 73°12'28.52"
B	END POINT AT SANGMESHWAR AS PROVIDED BY IWAI LAT. 17°11'15.63", LONG. 73°33'02.57"
B1	END POINT OF RECONNAISSANCE SURVEY AT SANGMESHWAR LAT. 17°10'06.62", LONG. 73°30'29.20"

PROPOSED WATERWAY LENGTH 52.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

REV.	DATE	SIGN	SIGN	SIGN	SIGN	
REVISION		DRAWN	DESIGNED	CHECKED	APPROVED	SUBJECT OF REVISION
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TITLE
LAYOUT PLAN
SHASTRI RIVER/ JAIGAD CREEK

CLIENT
INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

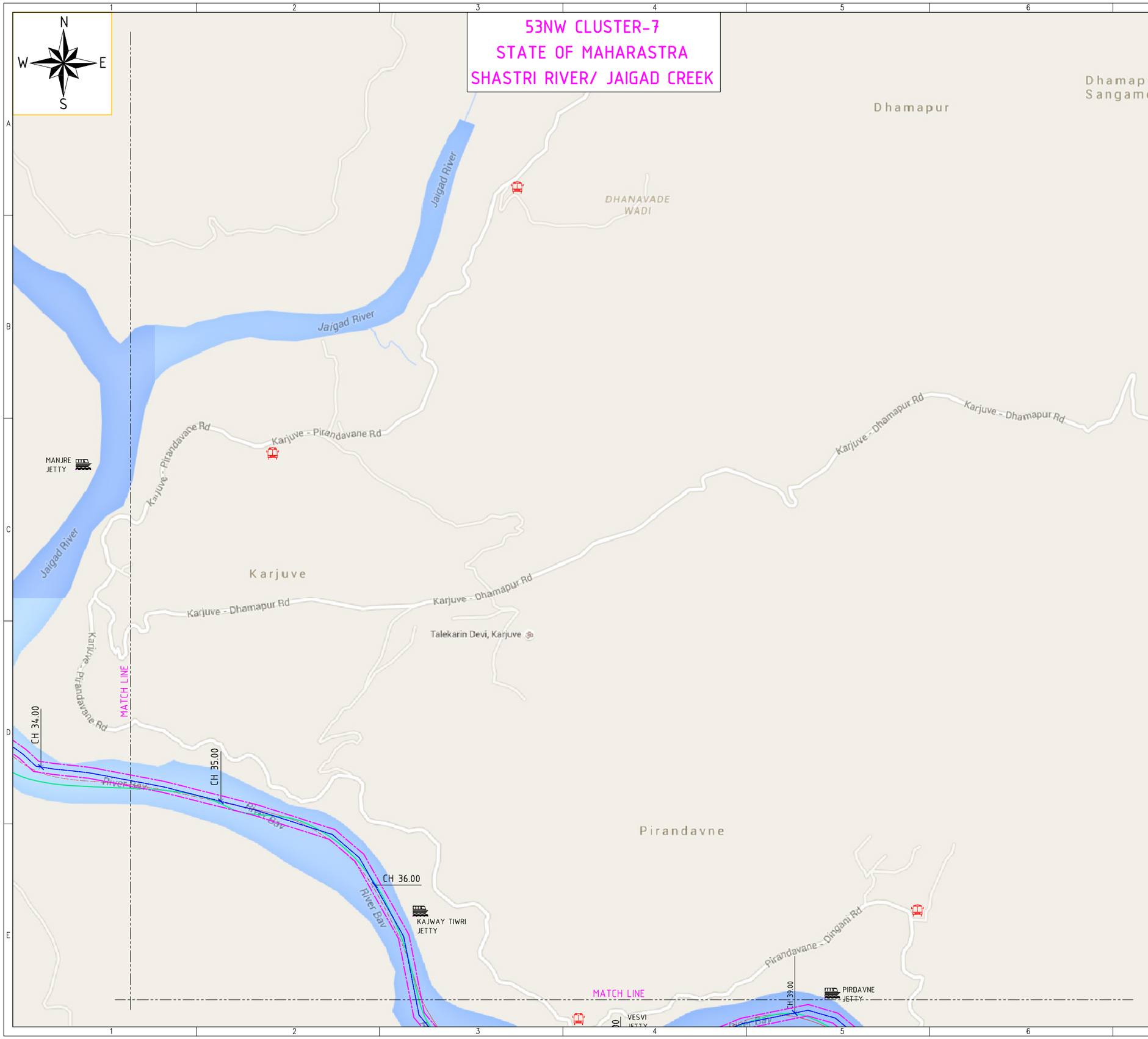
PROJECT NO.
P.009051

TRACTEBEL Engineering
GDF SUEZ

SIZE: A3 | SCALE: 1:20000 | SHEET: 5–8

DRAWING NUMBER
P.009051-W-20201-A10 REV 0

53NW CLUSTER-7
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK



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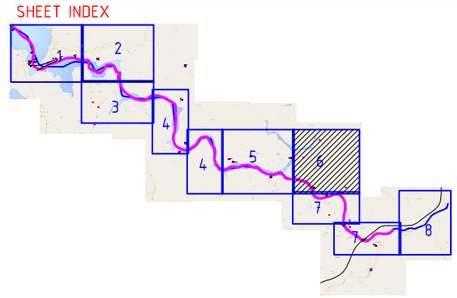

LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
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	NALA/SUB CREEK/SMALL RIVER
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PROPOSED WATERWAY LENGTH 52.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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TITLE
LAYOUT PLAN
SHASTRI RIVER/ JAIGAD CREEK

CLIENT
INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

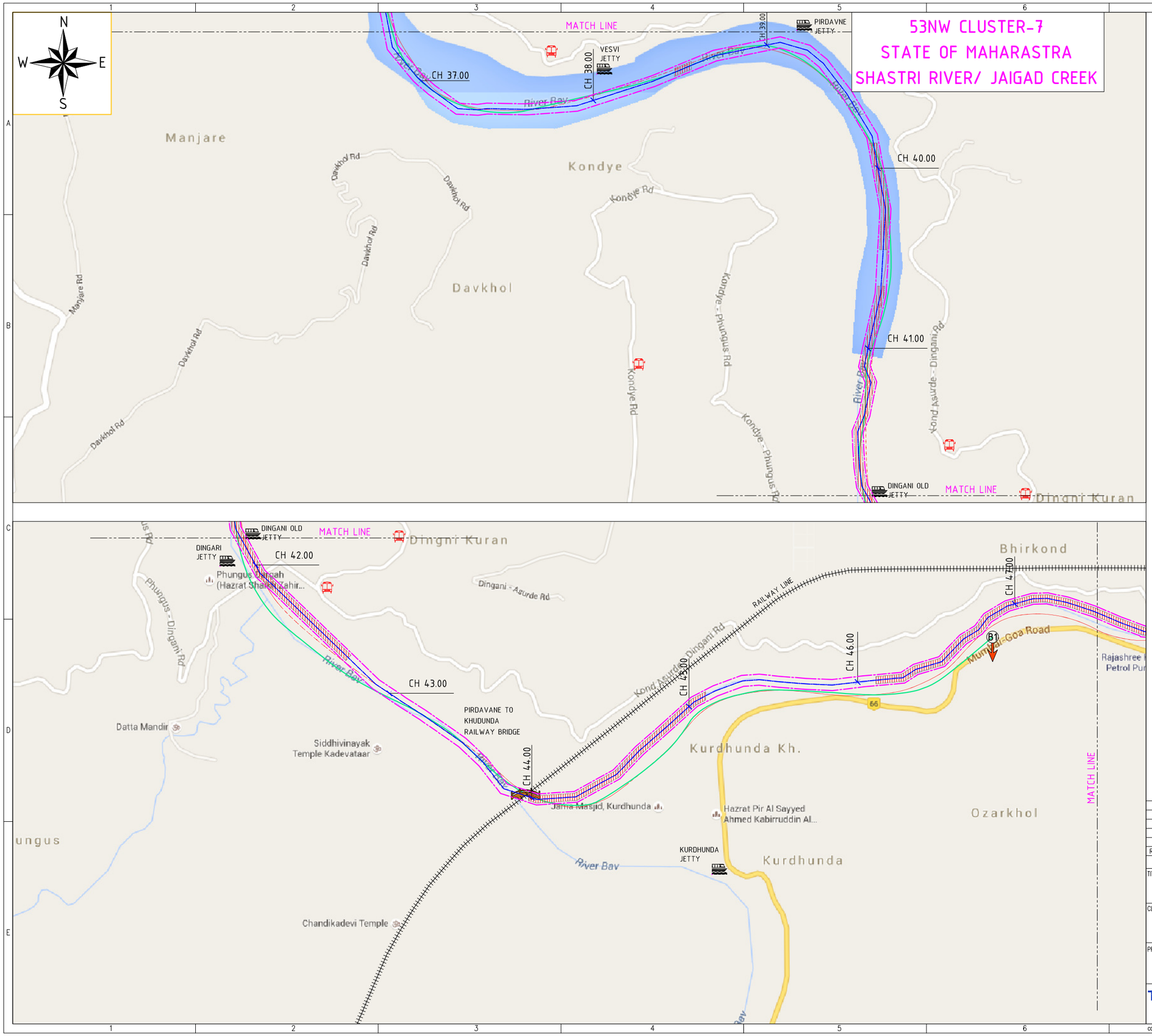
PROJECT NO. **P.009051**

TRACTEBEL Engineering GDF SUEZ

SIZE: A3 | SCALE: 1:20000 | SHEET: 6–8

DRAWING NUMBER
P.009051-W-20201-A10 REV 0

53NW CLUSTER-7
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK



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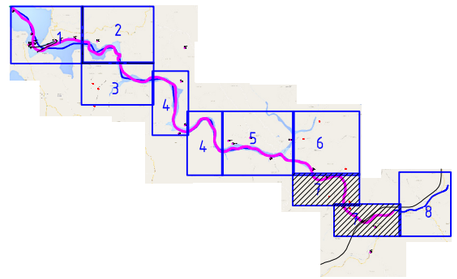

LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
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	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
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PROPOSED WATERWAY LENGTH 52.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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REVISION		DRAWN	DESIGNED	CHECKED	APPROVED	
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TITLE
LAYOUT PLAN
SHASTRI RIVER/ JAIGAD CREEK

CLIENT
INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 – FEASIBILITY REPORT

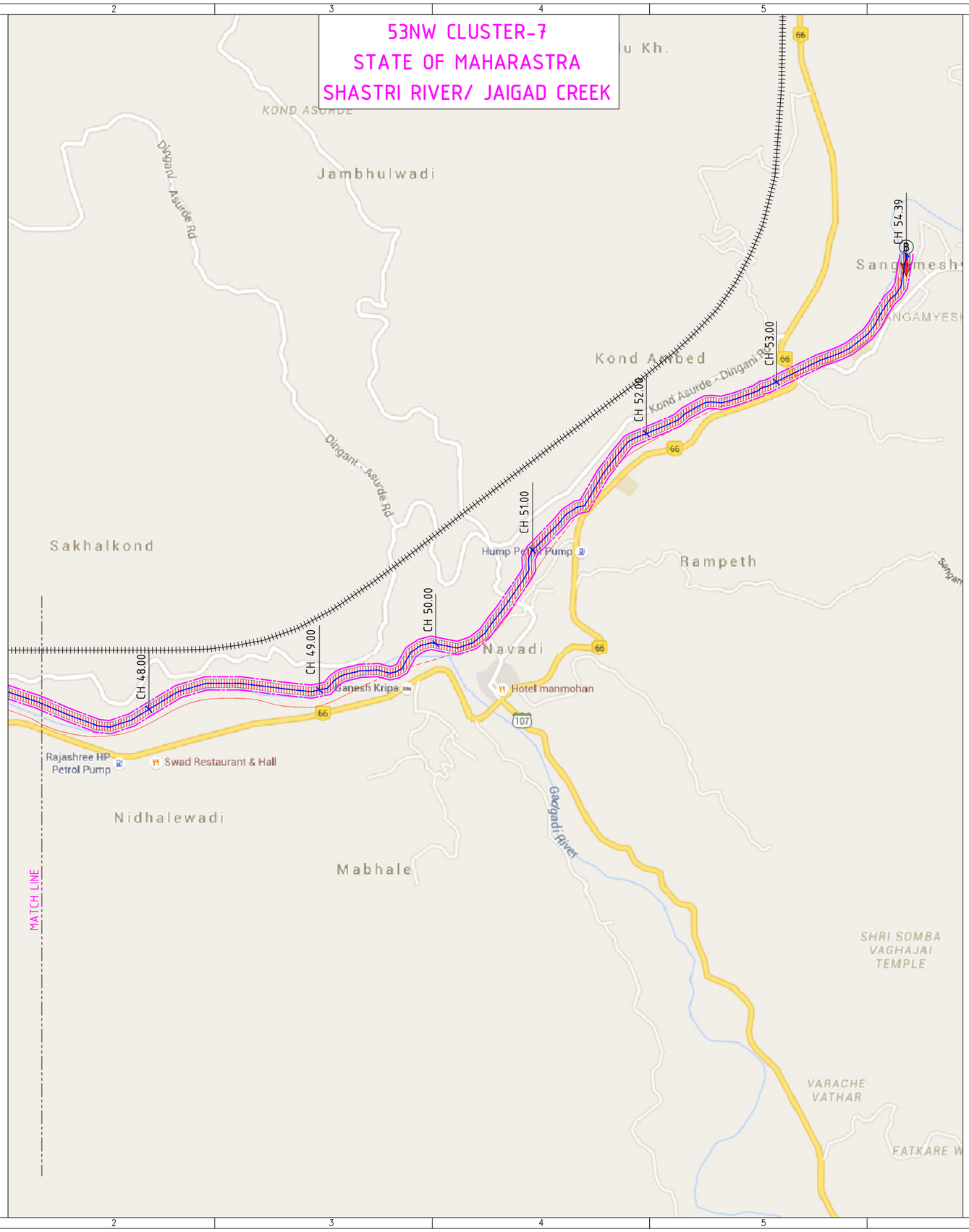
PROJECT NO. **P.009051**

TRACTEBEL Engineering GDF SUEZ

SIZE: A3 | SCALE: 1:20000 | SHEET: 7–8

DRAWING NUMBER P.009051–W–20201–A10 REV 0

53NW CLUSTER-7
STATE OF MAHARASTRA
SHASTRI RIVER/ JAIGAD CREEK



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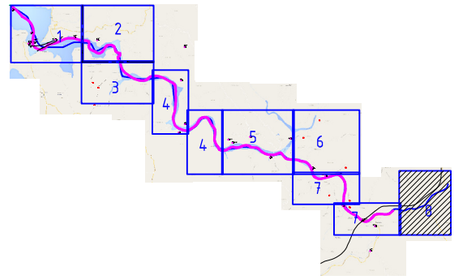

LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
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	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
	FERRY LINE
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PROPOSED WATERWAY LENGTH 52.0Km

SCALE 0 0.4 1.0KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

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TITLE
LAYOUT PLAN
SHASTRI RIVER/ JAIGAD CREEK

CLIENT
INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT
CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. **P.009051**

TRACTEBEL Engineering GDF SUEZ

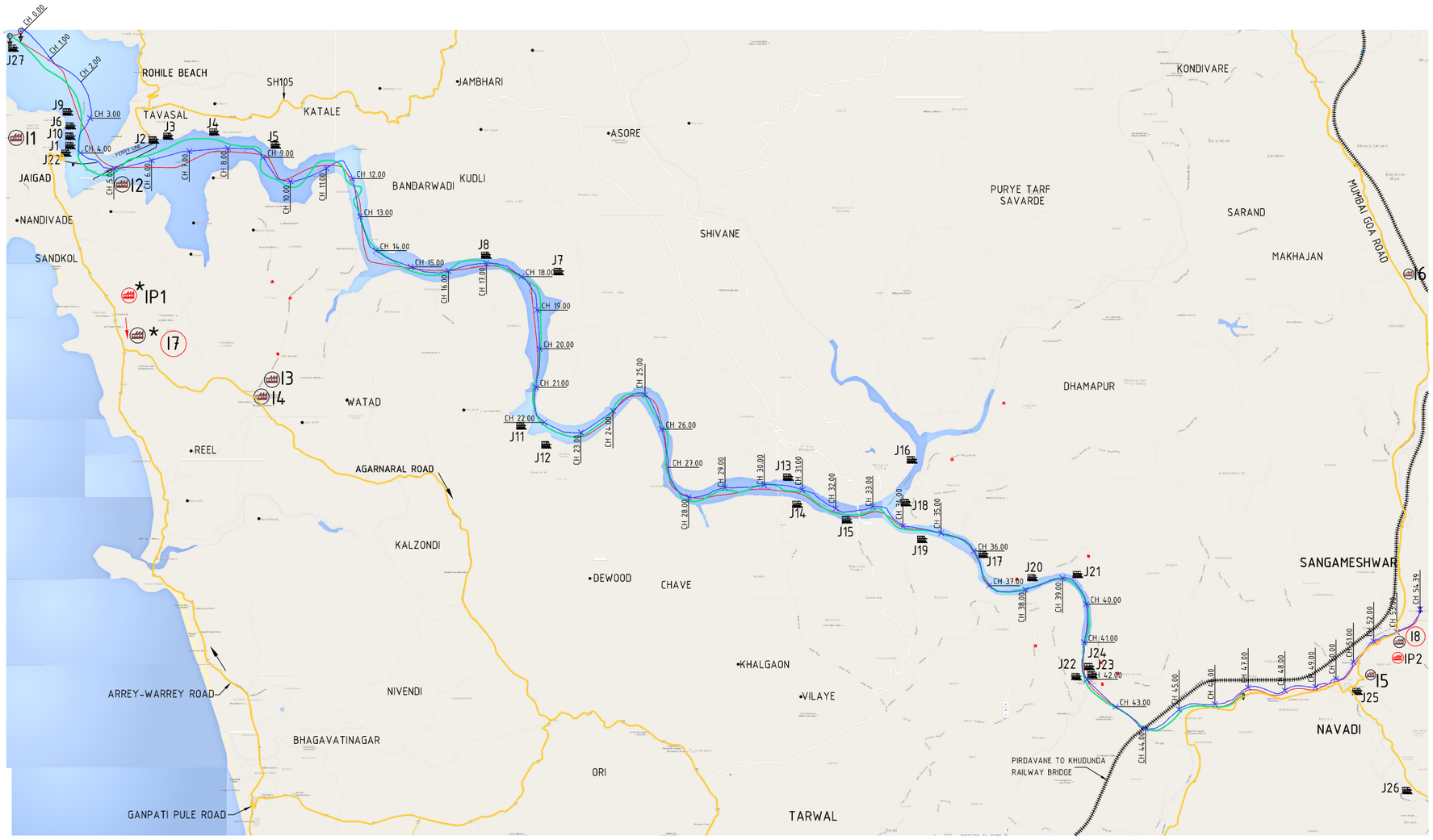
SIZE: A3 | SCALE: 1:20000 | SHEET: 8-8

DRAWING NUMBER
P.0090051-W-20201-A10 REV 0

MAP

MAP 4.1 – LAYOUT MAP SHOWING EXISTING JETTIES AND INDUSTRIES IN VICINITY OF SHASTRI RIVER/JAIGAD CREEK

MAP 4.1



LEGEND

	BUS STOP
	HISTORICAL PLACE
	PORT
	EXISTING INDUSTRY
	PROPOSED INDUSTRY
	RAILWAY STATION
	PLACE NAME
	JETTY
	CHART DATUM
	ROAD BRIDGE
	NATIONAL HIGHWAY (Hwy)
	ROAD
	NALA/SUB CREEK/SMALL RIVER
	FERRY LINE
	ROUTE PROVIDED BY IWAI
	SURVEY (VESSEL TRACK)
	DEEPEST SURVEYED WATER DEPTH (THALWEG)
	RAILWAY LINE
A	START POINT FROM ARABIAN SEA, RAJPURI AS PROVIDED BY IWAI LAT. 18°18'03.15", LONG. 72°56'42.94"
A1	START POINT OF RECONNAISSANCE SURVEY FROM ARABIAN SEA RAJPURI LAT. 18°18'26.37", LONG. 72°57'47.42"
B	END POINT AT MHASALA AS PROVIDED BY IWAI LAT. 18°08'15.37" LON. 73°06'45.35"
B1	END POINT OF RECONNAISSANCE SURVEY AT MHASALA LAT. 18°09'39.19", LONG. 73°05'37.45"
	PROPOSED WATERWAY LENGTH 27.61Km
SCALE	0 2.5 6.25KM

BACKGROUND IMAGE REFERENCE FROM "GOOGLE MAP"

LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
1	JAI GARH CREEK / T TYPE PRAVASI JETTYRAJPURI	J1
2	JAI GARH CREEK / TAVSAL MOHALLA L TYPE JETTY	J2
3	JAI GARH CREEK / PADWE L TYPE JETTY	J3
4	JAI GARH CREEK /CHICH BUNDER T TYPE JETTY	J4
5	JAI GARH CREEK / KATLE JUNGLE JETTY	J5
6	JAI GARH CREEK / KATLE JUNGLE JETTY	J6
7	JAI GARH CREEK / KUNDLI JETTY	J7
8	JAI GARH CREEK / JAMBHARI DHAKTI JETTY	J8
9	JAI GARH CREEK / JAMBHARI JETTY	J9
10	JAI GARH CREEK / JAMBHARY TAR JETTY	J10
11	JAI GARH CREEK / KOLISRE JETTY	J11
12	JAI GARH CREEK / AGARNARAL JETTY	J12
13	JAI GARH CREEK / CHAVE JETTY	J13
14	JAI GARH CREEK /BHATGAON DURG BUNDER JETTY	J14
15	JAI GARH CREEK / MEDHE JETTY	J15
16	JAI GARH CREEK / BHATGAON TISANG JETTY	J16
17	JAI GARH CREEK / KAJWAY TIWRI JETTY	J17
18	JAI GARH CREEK /BHATGAON OVALI JETTY	J18
19	JAI GARH CREEK / MANJRE JETTY	J19

LIST OF JETTIES

SL.	DESCRIPTION	SYMB.
20	JAI GARH CREEK / VESVI JETTY	J20
21	JAI GARH CREEK /PIRDAVNE JETTY	J21
22	JAI GARH CREEK / PHUNGUS JETTY	J22
23	JAI GARH CREEK / DINGANI JETTY	J23
24	JAI GARH CREEK / DINGANI OLD JETTY	J24
25	JAI GARH CREEK /KURDHUNDA JETTY	J25
26	JAI GARH CREEK / KOLAMBE JETTY	J26
27	JAI GARH CREEK / J . S . W. JETTY	J27

LIST OF EXISTING INDUSTRY

SL.	DESCRIPTION	SYMB.
1	JSW ENERGY Ltd.	I1
2	LAVGAN DOCKYARD PRIVATE Ltd.	I2
3	SHREE GANESH HARDWARE	I3
4	SWASTIK HARDWARE	I4
5	SANGAM HARDWARE & ELECTRICALS	I5
6	OMKAR STONE METAL INDUSTRY	I6
7	MIDC RATNAGIRI	*I7
8	MIDC SANGAMESHWAR	I8

LIST OF PROPOSED INDUSTRIES/INDUSTRIAL AREAS EXPANSIONS

SL.	DESCRIPTION	SYMB.
1	MIDC RATNAGIRI	*IP1
2	MIDC SANGAMESHWAR	IP2
	*TENTATIVE LOCATION	

(AROUND 45km FROM JAIGAD, VIA NH-4)

Proposed Cargo Potential of Shastri River	
Expected Cargo	07-1.2 MMTPA

Existing Cargo Potential of Shastri River

	Overseas (in MTPA)			Coastal (in MTPA)			
COMMODITY	Unloaded	Loaded	Total	Unloaded	Loaded	Total	Grand Total
Iron Ore	1,351,913	-	1,351,913	-	1,305,879	1,305,879	2,657,792
Max/Project cargo	-	1,507	1,507	942.000	-	942.000	2,449
Met Coke	120,620	-	120,620	-	-	-	120,620
Molasses	-	268,200	268,200	-	-	-	268,200
Quartzite	-	-	-	-	5,505	5,505	5,505
Steam coal	4,500,326	-	4,500,326	30,000	512,014	542,014	5,042,340
Sugar	-	19,660	19,660	-	-	-	19,660
Sulphur	9,502	-	9,502	-	-	-	9,502
Coke	6,980	-	6,980	-	-	-	6,980
Rock Phospate	107,820	-	107,820	-	-	-	107,820
TOTAL	6,097,161	289,367	6,386,528	30,942	1,823,398	1,854,340	8,240,868

TITLE: LAYOUT MAP SHOWING EXISTING JETTIES & INDUSTRIES IN VICINITY OF SHASTRI RIVER / JAIGAD CREEK (MAP 4.1)

CLIENT: INLAND WATERWAYS AUTHORITY OF INDIA
MINISTRY OF SHIPPING

PROJECT: CONSULTANCY SERVICE FOR PREPARATION OF TWO STAGE DETAILED PROJECT REPORT (DPR) OF CLUSTER 7 OF PROPOSED 53 NATIONAL WATERWAYS.
STAGE 1 - FEASIBILITY REPORT

PROJECT NO. P.009051

TRACTEBEL Engineering GDF SUEZ

At the helm of the Energy Transition, Tractebel provides a full range of engineering and consulting services throughout the life cycle of its clients' projects, including design and project management. As one of the world's largest engineering consultancy companies and with more than 150 years of experience, it's our mission to actively shape the world of tomorrow. With about 4,400 experts and offices in 33 countries, we are able to offer our customers multidisciplinary solutions in energy, water and infrastructure.

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