Preface

India is the largest peninsula in the world with a coastline of about 7517 km with 12 major ports and 185 non major / intermediate ports with a very impressive water network consisting of rivers, lakes, creeks and canals.

An efficient transport sector is vital for development of the economy to stimulate optimum competitive business environment. Indian transport system comprises various modes, viz. Railways, Roadways, Inland Waterways, Coastal Shipping and Airways. Integrated development of waterways can generate waterway grid that may in future help shift cargo traffic from road transport to the cheaper and eco-friendly inland waterways.

The first national waterways were established in India in mid 1980s & 1993 with a combined length of 2,716 km:

NW 1 (1620 km):	Ganga - Bhagirathi- Hooghly river system between Haldia & Allahabad declared as National Waterway in 1986
NW 2 (891 Km):	Brahmaputra River between Bangladesh Border and Sadiya declared as National Waterway in 1988
NW 3 (205 km):	West coast canal (168 km) - Udyogmandal canal (23 km) - Champakara canal (14 km) declared as National Waterway in 1993.

The government also declared the following two inland waterways as national waterways during 2008:

NW 4 (1078 km):	Kakinada-Pondicherry canal - Godavari and Krishna rivers
NW 5 (588 km):	East Coast Canal - Brahmani River and Mahanadi delta

Given the untapped potential of India's inland waterways, the Govt. of India desires to explore the commercial navigation potential on year round basis. Ministry of Shipping (MoS), Govt. of India has directed Inland Waterways Authority of India (IWAI) to identify the viable waterways in India for their phased development.
Accordingly, to make provisions for existing national waterways and to provide for the declaration of certain inland waterways to be national waterways and also to provide for the regulation and development of the said waterways for the purposes of shipping and navigation, National waterway act, 2016 has received the assent of the President on the 25th March, 2016 declaring a total of 111 National Waterways.

IWAI, a statutory body under MoS, Govt. of India, has entrusted WAPCOS with the responsibility for preparation of two stages DPR of four national waterways in the state of Gujarat and Maharashtra: **National waterway No's 66 (Mahi), 73 (Narmada), 87 (Sabarmati), 100 (Tapi)** for a total length of 1123 km.

This Final Feasibility Report (Stage-I) covers the review of data and reconnaissance survey for Sabarmati River in Gujarat. The WAPCOS team has physically visited the river stretches and gathered all requisite information.

Acknowledgement

This Final Feasibility report is the outcome of review of existing infrastructure along the Sabarmati River and present state of affairs. This vision is shared jointly by IWAI and WAPCOS Limited.

This report gives the present status of water-ways assets; topographic features, climatic variability, land use / land cover pattern, deepest bed levels, and details of all cross structures along with socio-economic information of the waterway.

We, WAPCOS project team acknowledge Cdr. P. K. Srivastava, Hydrographic Chief, Inland Waterways Authority of India; Sh Rajiv Singhal, AHS for constant encouragement and guidance, technical discussions and for evincing keen interest in the project and this report.

WAPCOS Team

Sector -18, Gurgaon
Haryana- 122015

List of Abbreviations

BM	Bench Mark / Local Reference Level
CH	Chainage
CM	Central Meridian
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
CVT	Calibration, Verification & Test
DF	Dual Frequency
DGPS	Differential Global Positioning System
DPR	Daily Progress Report
GPS	Global Positioning System
HFL	Highest Flood Level
HC	Horizontal Clearance
HSE	Health, Safety and Environment
kHz	kilohertz
km	kilometer
m	meter
mmpta	million metric tons per annum
MN	million
m/s	meter per second
ms	milliseconds
MSL	Mean Sea Level
PWD	Public Works Department
QA/QC	Quality Assurance / Quality Control
QMS	Quality Management System
Rev	Revision
Rep.	Representative
SBES	Single Beam Echo sounder
SD	Standard Deviation
Sr	Senior
UTM	Universal Transverse Mercator
VC	Vertical Clearance
WGS	World Geodetic System

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SUMMARY: SALIENT FEATURES AT A GLANCE

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<tr><td>3.</td><td>Waterway stretch, NW 87 (from….to; total length)</td><td>212 km length of the river from Barrage near Sadoliya to confluence with Gulf of Khambhat near Khambhat (National Waterway 87)</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>From the analysis of survey of India toposheets for the coastal zone, it was found that the tidal reach of the river is about 30 km but the tidal effect was considered upto 14 km as per discussion with IWAI. The Nearest Port is Dahej Bandar. The tidal variation is about 6 m.
Tide Source: Admiralty Tide Table Vol-3, Dahej Bandar</td></tr>
<tr><td>b)</td><td>LAD status (w.r.t. CD)
i) Survey period (April to May 2016)
ii) < 1.0 m (km)
iii) 1.0 m to 1.2 m (km)
iv) 1.2 m to 1.4 m (km)
v) 1.4 m to 1.7 m (km)
vi) 1.7 m to 2.0 m (km)
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<tr><th>LAD (m)</th><th>-0.583 - 13.76</th><th>13.76-25</th><th>25-50</th><th>50-75</th><th>75-100</th><th>Total (km)</th></tr>
<tr><td><1</td><td>2.06</td><td>1.32</td><td>7.08</td><td>14.44</td><td>14.28</td><td>39.18</td></tr>
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<tr><th>LAD</th><th>100-125</th><th>125-150</th><th>150-175</th><th>175-200</th><th>200-210</th><th>Total (km)</th></tr>
<tr><td><1</td><td>9.72</td><td>9.76</td><td>14.20</td><td>17.01</td><td>4.31</td><td>55</td></tr>
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<tr><td>1.7-2.0</td><td>1.54</td><td>2.39</td><td>0.44</td><td>0.65</td><td>0.96</td><td>5.98</td></tr>
<tr><td>>2</td><td>7.63</td><td>10.78</td><td>9.15</td><td>4.29</td><td>1.33</td><td>33.18</td></tr>
<tr><td>Total (Km)</td><td>25.39</td><td>24.80</td><td>24.95</td><td>25.24</td><td>9.99</td><td>110.37</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross structures
i) Dams, weirs, barrages etc. (total number; with navigation locks or not)</td><td>There are 2 barrages namely Wasna Barrage and Sant Sarovar or Indroda Barrage, 1 weir (Lakroda weir at upstream end of stretch) and 7 broken check dams over Sabarmati river in its present study stretch. None of the barrages, weir and check dams are provided with</td></tr>
</table>

<table>
<tr><td></td><td>ii) Bridges, Power Cables etc. (total number; range of horizontal and vertical clearances)</td><td>navigational lock.

23 road bridges, 1 rail bridge (Sabarmati rail bridge), 1 water pipeline bridge, 27 high tension lines and 2 electric lines exist over Sabarmati in the present study stretch.
VC for bridges varies from 0m to 15m.
HC for bridges varies from 8m to 45m.

VC for Power Cables varies from 1m to 94m.
HC for Power Cables varies from 100m to 350m.</td></tr>
<tr><td>d)</td><td>Avg discharge & no. of days</td><td>Gauge- discharge at 2 gauging sites(Subhash Bridge , Vathua) on river Sabarmati were collected from CWC Out of these 2 gauging stations, at Vathua site water level gauge and discharge data were available and at Subhash bridge site only water level gauge data were available.
Vautha
➢ June to September - From 15 to 250 m^3/s
➢ October to December - From 80 to 25 m^3/s
➢ January to May - From 25 to 15 m^3/s</td></tr>
<tr><td>e)</td><td>Slope (1 in ….)</td><td>Average bed slopes for Sabarmati River for the reach under consideration is about 1/2560
<table>
<tr><th colspan="2">Reach</th><th rowspan="2">River Bed Level Change</th><th rowspan="2">Distance</th><th rowspan="2">Slope</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td>Sadolia dam

RBL 79 m</td><td>Subhash Bridge

RBL 38 m</td><td>41 m</td><td>68 km</td><td>1/1660</td></tr>
<tr><td>Subhash Bridge

RBL 38 m</td><td>Vautha

RBL 11 m</td><td>27 m</td><td>70 km</td><td>1/2592</td></tr>
<tr><td>Vautha

RBL 11 m</td><td>Mouth

RBL -2.0 m</td><td>13 m</td><td>65 km</td><td>1/5000</td></tr>
</table></td></tr>
<tr><td>f)</td><td>Consultant’s inference</td><td>Reach: River Mouth to 30.0 km (Ch 0.0 to 30.0 km)
Tidal reach of Sabarmati River is 30 km. Reduced water depths of around 2 m are easily available upto 14 km from mouth since tidal effect is dominant. From 14 km to 30 km, depths are available in the range of 1-1.5 m expect for a small stretch. Prima facie, this reach is Prima facie feasible for navigation Class I with a little capital dredging. Port Dahej bander also exists at river mouth that creates a lot of</td></tr>
</table>

		opportunity for cargo movement. **Reach: Ch 30.0 to Vautha Gauge (at Ch 75.4 km)** Depths of 0 – 0.5 m (above C.D.) and above are available for around 170 days in a year. Depths of 0.5 – 1.2m and more are available for around 120 days during monsoon. Reduced Depths in the range of 4.40 m to -0.91 m exist in this stretch. Reduced depths of <1 m exist for 18 m length in this stretch of 45.4 km. With capital dredging in this 18 km stretch, this stretch has the potential for navigation for class I. **Reach: Vautha Gauge (at Ch 75.4 m) to Wasna Barrage (Ch 135.7 km)** Depths of 0.5 – 1.0 m (above C.D.) are available for around 170 days. Depths above 1.0 m are available for around 75-90 days during monsoon. Depths above 0.5 m (from 0.5 to above 1 m) are available for a period of 170-200 days. This stretch starts from Downstream of Wasna Barrage. Hence this stretch can be developed for navigation class I with additional measures. **Reach: Wasna Barrage (Ch 135.7 km) to Sardar Patel Ring Road Bridge (Ch 156 km)** Depths of 0.5 – 1.0 m (above C.D.) are available for all round the year-360 days. Depths of 1.0 – 1.5 m are available for around 75-90 days during monsoon (75 days) The C.D. at Subhash Bridge is nearly 2.5 m above River bed level at Subhash Bridge gauging site. A part of this stretch near sadar bazaar up to Wasna Barrage had already developed as Sabarmati waterfront by Govt of Gujarat. At upstream of Indira Bridge, Released water from Narmada canal ensures all round the year availability of water in this stretch and downstream. This stretch is feasible for navigation class II waterway. **Reach: Sardar Patel Ring Road Bridge (Ch 156 km) to Lakroda Bridge (210 km)** This reach is at the upstream of siphon over Narmada Canal where water from Narmada canal is released into Sabarmati river. There is practically no flow in this reach except during monsoon season for 4-5 months or Narmada canal release at upstream. Hence this stretch is not suitable for navigation
5.	<u>Traffic Potential</u>	
a)	Present IWT operations,	There are no passenger ferry services available on the proposed

	ferry services, tourism, cargo, if any	stretch of Sabarmati River. At present there is no cargo movement happening on the river stretch. The majority of goods movement is by roads and some by rail. The Thermal power plant in Gandhinagar is located near to the river stretch are potential sources for movement of cement and fly ash. Black trap has its market in Ahmadabad and Gandhinagar which have proximity to the river stretch. The Ahmadabad district is home to one of the famous World Heritage Site, the Adalaj Vav (Step well). The Calico museum in Ahmadabad is one of the best textile museums in the world, comprising marvelous and well-labeled collection of textile, aircrafts, designs and technology.The lake in Nalsarovar Bird Sanctuary in the district is a freshwater body, having rich biodiversity of wide variety of fishes, various vegetation, algae, and medicinal plants and over 250,000 birds Sarkhej Roza is a mosque, tomb and royal complex that witnesses a blend of Hindu and Islamic designing. Other tourist spots in the district are pairs of Shaking Minarets, Gandhi Ashram, Swaminarayan Temple, and City Museum Polo forests and the ruins of old Hindu and Jain temples in Vijaynagar are known for their natural beauty and historical significance
b)	Important Industries within 50 km	Gandhinagar has seven Special Economic Zones and ten Industrial Estates along with creative IT Park and Gujarat International Finance Tech City (GIFT). A large number of industries related to textiles, chemicals, machinery, metal products, pharmaceutical, engineering, plastics, electrical appliances, electronics, passenger cars etc. are located in the district. There are 12 main Industrial Estates, 12 Special Economic Zones, and 10 Industrial Parks/Developers in Ahmadabad district. Several business conglomerates such as Adani Group, Reliance Industries, Nirma Group of Industries, Arving Mills, Claris Life Sciences, Cadila Pharmaceuticals, Shell, Vadilal Indusries Ltd., Rasna, bosch Rexroth (Germany), Stock and Rollepal (Netherland) are present in the district.
c)	Distance of Rail & Road from industry	Industrial areas in Gandhinagar and Ahemdabad districts are well connected with rail and road. NH-8 and 8C passes through the Gandhinagar district and connects it with other major cities of the States and also woth the whole of India. Western Railways connects the district with major cities in India such as Delhi and Mumbai via Ahmadabad.
6.	Consultant's recommendation for going ahead with Stage-II (DPR preparation)	It was observed that commercial navigation may not be feasible in sabarmati river, However, the river can be developed for recreation and tourism purposes in different stretches as recommended below: On further scrutinising LAD data it was found that in the reach from river mouth to chainage 35 km, only 4.5 km has depth <1 m. In that 4.5 km stretch also, majority of stretch have depths of 0.7-0.9 m. Afterwards depths of about 5 m are available for 10 km upstream of wasna barrage near Sabarmati waterfront developed by Govt of

		Gujarat. This stretch may be extended by construction of another weir/barrage downstream of Wasna barrage. **Hence WAPCOS recommends Stage II studies in two stretches for 0-35 km reach from Sabarmati river mouth and (115-135.7 km Wasna barrage) 20 km downstream of Wasna barrage.**
7.	Any other information/ comment	-

1. Introduction:

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

Table 1: National Waterways in Gujarat & Maharashtra

Sl. No.	Name of the River	Description of National Waterway	From:	Up to:
1.	Mahi River, Gujarat	248 km length of the river from Kadana Dam to confluence with Gulf of Khambhat near Kavi railway station **(National Waterway 66)**	23°18'22.35"N 73°49'37.45"E	22°10'34.71"N 72°30'36.31"E
2.	Narmada River, Gujarat & Maharashtra	227 km length of the river from Pandhariya to confluence of Narmada with Arabian Sea at Gulf of Khambhat **(National Waterway 73)**	21°57'10.37"N 74° 8'27.46"E	21°38'26.81"N, 72°33'28.24"E
3.	**Sabarmati River, Gujarat**	**212 km length of the river from Barrage near Sadoliya to confluence with Gulf of Khambhat near Khambhat (National Waterway 87)**	**23°26'49.66"N 72°48'34.85"E**	**22°9'17.99"N 72°27'27.81"E**
4.	Tapi River, Gujarat & Maharashtra	436 km length of the river from Hatnur Dam near Mangalwadi Long to confluence with Gulf of Khambhat (Arabian Sea) **(National Waterway 100)**	21°4'21.99"N 75°56'44.88"E	21°2'15.51"N, 72°39'29.63"E

The Google Map showing all river stretches is enclosed as **Figure 1**.

Figure 1: Google Map showing four rivers in Gujarat & Maharashtra

Accordingly, WAPCOS Ltd. undertakes the studies for 4 national waterways (Mahi, Narmada, Sabarmati and Tapi River) in Gujarat & Maharashtra. The brief scope of work is depicted as under:

Stage-1

A. Reconnaissance Survey
B. Collection and Review of available data
C. Feasibility Report

Stage-2

A. Hydrographic Survey & Hydro-morphological survey
B. Traffic Survey & Techno economic feasibility
C. Preparation of Detailed Project Report

The present studies are limited to establish the feasibility of national waterways for Inland navigation i.e. up to Stage 1 only**.** The studies are being carried out as detailed below:

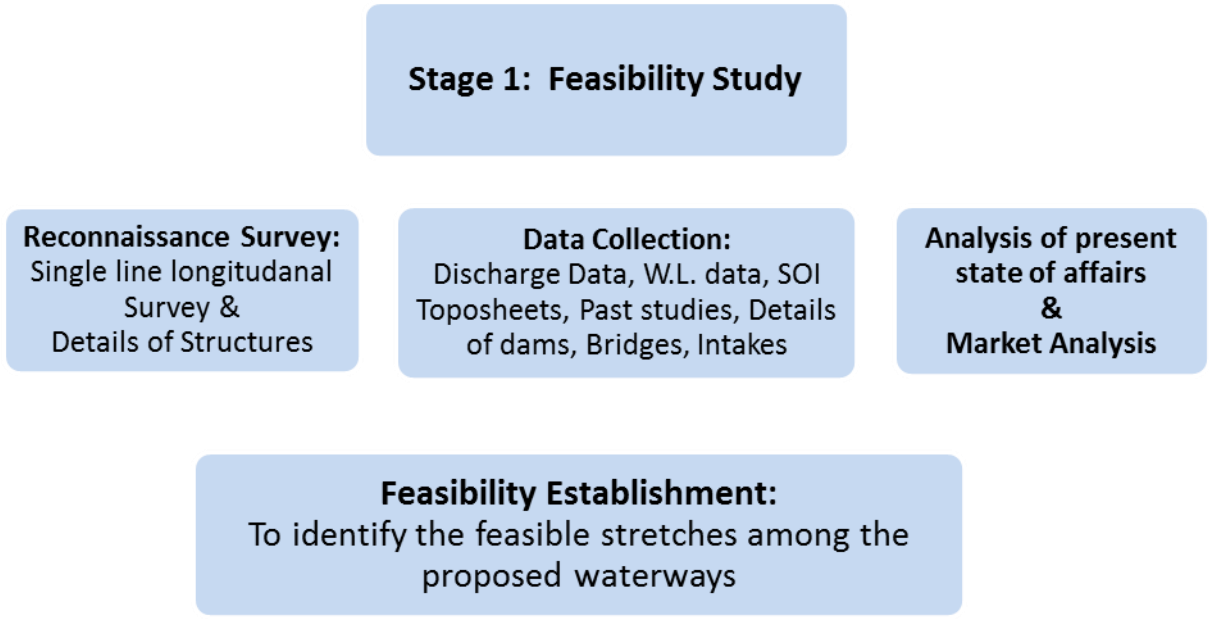


Figure 2: Feasibility Studies (Stage 1)

The present **Final Feasibility report** covers the review of data, reconnaissance survey and present state of affairs for Sabarmati River in Gujarat as detailed below:

- ✓ **Introduction**
- ✓ **Classification of waterways**
- ✓ **River basin and hydrological details**
- ✓ **Details of existing structures**
- ✓ **Single line longitudinal survey**
- ✓ **Bed profile**
- ✓ **Data collection**
- ✓ **Soil texture**
- ✓ **Hydrological data collection and analysis**
- ✓ **Preliminary Traffic Studies and Market analysis**
- ✓ **Results and feasibility of waterway for navigation**

2. Introductory Considerations

As discussed in introduction, present studies consist of four rivers in the states of Gujarat & Maharashtra. This chapter covers origin, hydrological parameters like altitude, length, catchment area, Annual rainfall, major dams and barrages along the river, tributaries, and major cities along their bank, historical and religious places for Sabarmati River.

2.1 Sabarmati River

2.1.1 Length of River

The total length of the Sabarmati River from origin to its outfall in the Gulf of Khambhat is 371 km. The length under consideration for present studies is detailed below:

212 km length of the river from Barrage near Sadoliya to confluence with Gulf of Khambhat near Khambhat (National Waterway)	**From:** **23°26'49.66"N** **72°48'34.85"E**	**Up to:** **22°9'17.99"N** **72°27'27.81"E**

2.1.2 State, District through which river passes

Sabarmati River is one of the major west flowing rivers of India. Sabarmati river passes through Udaipur, Sirohi, Pali and Dungarpur districts of Rajasthan, Sabarkantha, Kheda, Ahmadabad, Anand, Surendranagar, Sabarkantha, Rajkot, Bhavnagar, Kheda, Panchmahal, Mahesana, Gandhinagar and Banaskantha districts of Gujarat.

2.1.3 Maps

The maps showing entire Sabarmati basin (Source: CWC) and Present study stretch are attached as **Figure 3** & **Figure 4** respectively.

2.1.4 River Course

Sabarmati originates from Aravalli hills at an elevation of 762 m near village Tepur in Udaipur district of Rajasthan. The total length of river from origin to outfall into the Arabian Sea is 371 km and its principal tributaries joining from left are Wakal, Hathmati and Watrak whereas Sei joins the river from right.

2.1.5 River Basin (Catchment Area)

Sabarmati basin extends over the states of Rajasthan and Gujarat having an area of 21,674 Sq. km with maximum length and width of 300 km and 150 km respectively. It lies between 70°58’ to 73°51’ east and 22°15’ to 24°47’ north. The basin is bounded by Aravalli hills in the north and north-east, Rann of Kutch in the west and Gulf of Khambhat in the south. The Sabarmati basin extends over parts of Udaipur, Sirohi, Pali and Dungarpur districts of Rajasthan, Sabarkantha, Kheda, Ahmadabad, Mahesana, Gandhinagar and Banaskantha districts of Gujarat.

Table 2 : Sabarmati River Basin Area

State	Drainage area (sq. km.)
Rajasthan	4124
Gujarat	17550
Total	21674

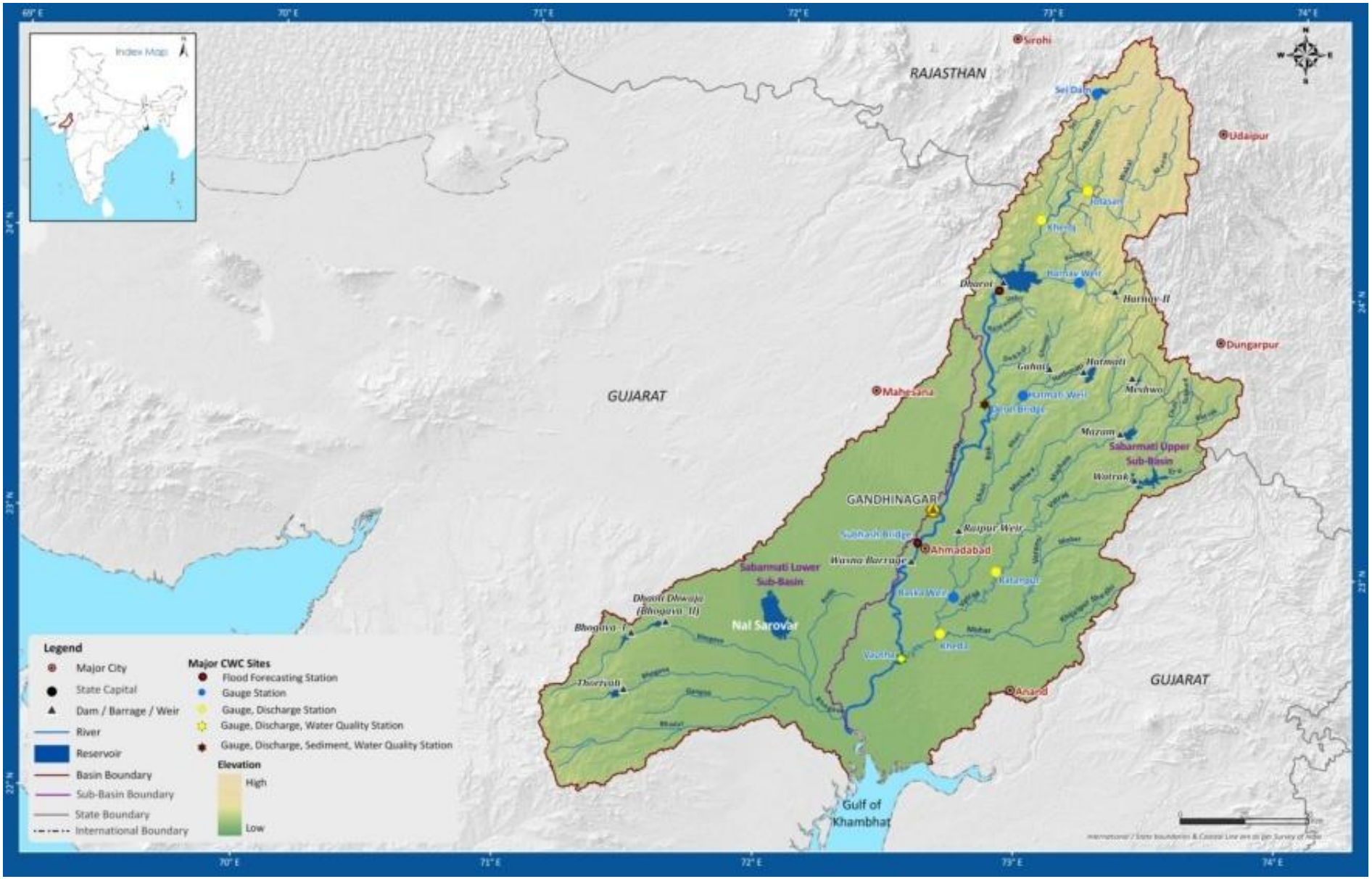


Figure 3: Sabarmati River Basin Area

Figure 4: Google image showing Sabarmati River stretch (212 km) under present studies

2.1.6 Tributaries

This river comprised of major tributaries on both the banks viz. Wakal, Hathmati, Watrak, Harnav and Sei. Its principal tributaries joining from left are Wakal, Hathmati and Watrak whereas Sei joins the river from right. Watrak itself is a big river and merges into Sabarmati river.

Table 3: Major tributaries of Sabarmati River

Sl. No.	Tributaries	Total length (km)
1	Sei	74.89
2	Wakal	88.54
3	Harnav	59.07
4	Hathmati	118.27
5	Watrak	231.69
6	Dhamoi	49.70
7	Majam	96.509
8	Meswo	169.552

2.1.7 Topography

The Sabarmati basin is bounded by Aravalli hills in the north and north-east, Rann of Kutch in the west and Gulf of Khambhat in the south. The basin has maximum length and width of about 300 km and 150 km, respectively. The terrain of Sabarmati basin is hilly in the early reaches up to Dharoi dam after which the river flows mostly in plains. The northern part of the basin is marked by hilly terrain while the southern part has large alluvium plain having gentle slope.

2.1.8 Climate, Temperature & Humidity

Sabarmati basin experiences 3 marked seasons - Summer (March-May), Monsoon (June-September) and Winter (October-February).

The winter season begins in December and continues till the end of February. January is the coldest month of the year. From March onwards, the hot weather sets in and continues till the middle of June. The south-west monsoon normally sets in by the middle of June and continues to be active till September.

95% of the annual rainfall occurs during this period. The south-west monsoon withdraws by about the middle of September and the weather clears up. Pleasant weather prevails till the end of December.

The annual average maximum, minimum and mean temperature for the basin for the years from 1969 to 2004 is found to be 33.01°C, 19.64°C and 26.33°C respectively.

2.1.9 Rainfall

The Average annual rainfall in the Sabarmati basin is 689.90 mm. The southwest monsoon sets in by middle of June and withdraws by the first week of October. The rainfall is mainly influenced by the southwest monsoon. Monsoon contributes nearly 91-94% of annual precipitation.

2.1.10 Land Use

Major part of the basin is covered with agricultural land with an area of 16186.38 Sq. km (74.68% of the total geographical area). Sabarmati River and its tributaries have contributed to the land cover of 4.19 %. The built up land (Includes Urban and Rural class) is 1.95% covering an area of 423.14 Sq. km. Forest cover in the basin is 2595.69 Sq. km which accounts for 11.98% of total area. Wasteland in the basin occupies 7.15%, covers an area of 1549.13 Sq. km. Grassland accounts for 0.05% with an area of 10.72 Sq. km. The other main categories of land use/land cover in the basin are

fallow land, scrub land, scrub forest, river/stream/canal, rural, urban mining, swamp/mangrove, etc.

2.1.11 Soil

The basin consists mainly of black, alluvial and sandy soils. The eastern part of Dungarpur and Udaipur districts has mixed red and black soils while the western part has red and yellow soils. Sirohi is a vast sandy plain with isolated hills and rock outcrops. Sabarkantha district has medium black soils occur in the major part of the district, while 'Goradu' soil (rich foam) is found in the western portion. In the district of Panchamahal, the soils are somewhat different from those in the other districts, in that they are residual soils formed by the decomposition of granites and gneisses. The soils are of light color, shallow and infertile, but those situated in the lower plains are darker, clayey and fertile. In Mehsana, except for the western portion of the district which has sandy soils, the rest of the area is covered by 'Goradu' loam. In Ahmadabad, two types, namely black soil and 'Goradu' soil (rich loam) occur. Soils in the south-west are black and those in the northern and eastern portions are 'Goradu'. Kaira district has four types of soils, namely light reddish brown or Goradu, medium or 'Besar', black or 'Kali' and alluvial or 'Bhata' occur. In Banaskantha district, shallow sandy soils and sandy loams occur.

2.1.12 Demography

As per 2001 census, the total population in the basin is about 13,307,250 which occupy around 14 districts of Gujarat and Rajasthan. The population density varies from region to region. The most densely populated district in the basin is Ahmadabad (Gujarat) while Sirohi (Rajasthan) is the least populated district. The total no. of literates is 90,50,178 whereas the no. of illiterates is 54,51,073. The basin is well connected through railway network and national highways.

The industrial development in the basin has taken place mainly in the lower part of the basin. The basin is served by a network of the Western Railway of Broad-gauge, Meter-gauge and Narrow gauge lines. The middle and the lower parts of the basin are well served with communications; whereas the upper part lacks communication facilities.

2.1.13 Dams, Barrages/ Weirs/ Anicuts

There are a total of 50 Dams in the Sabarmati basin among which 17 dams fall in Sabarmati lower sub basin and 33 dams,10 weirs, 2 barrages fall in the Sabarmati upper sub basin. The details of dams, weir and barrages in the present stretch are presented in chapter 3.

2.1.14 Tourism

There are a total of 11 major water tourism places in the basin. These include National parks, Lake, Step Well, Museums, Pilgrimages and waterfall, etc. The details of major tourism places near the present stretch are presented in chapter 5.

2.2 Methodology and Data collection

2.2.1 Importance of Hydrological and Topographical data

Navigability of a natural river channel or tidal creek will primarily depend upon hydraulic parameters flow depth, water discharge, velocity, sediment load and width of river channel. These parameters are function of topography/bathymetry of river bed and discharge in river during different seasons. Apart from these important parameters, there are other natural factors such as tidal range and length of tidal reach, type/nature of river bed (rocky, sandy, silty, clayey), bends in river course and stability of alignment of deep channel of river over long period. Apart from above natural factors, information on other factors such as various structures across (Dams/weirs/barrages/bridges) and along the river bank (river training and bank protection works) is also required.

2.2.2 Data Requirement

The following data was required for Stage-1 feasibility report:

1. Type of crops (in different seasons) and industries along the waterway
2. Availability of passenger ferry services. Prominent towns / City along the waterway.
3. Historical and tourist places.
4. Existing water sport and recreational activities and future probability.
5. Details of cross-structures (bridges, aqueducts, electric lines, telephone lines, pipe lines, cables) and their clearances. Salient features of Dams / Barrages / Weirs.
6. Availability of water in different seasons. Also to correlate this with CWC / Irrigation datum's.
7. Ponding level and limit of Dams / Barrages / Weirs.
8. Encroachment in the waterway, width of the waterway, sharp bends.
9. Environmental impacts. CRZ or wildlife clearances.
10. Local/pronounced name of the rivers in different stretches.
11. Any Border issue with other country.
12. Incorporation of topographical features (outside survey limits) from Google Earth imageries.
13. Obstructions to the navigation and un-approachable areas.
14. Photographs of all cross-structures, gauges, obstructions - annotated with location & chainage. In report with lat/long, easting/northing, chainage details
15. Permanent structures located within this corridor.
16. All prominent shore features (locks, bridges, aqueducts, survey pillars if available etc) and other conspicuous objects shall be fixed and indicated on the chart and included in the report.
17. Details of water intake/ structures shall be collected and shown on the charts and include in the report.
18. Availability of berthing place, existing jetty, ferry ghats, approach roads etc. in the area shall be indicated on the charts and include in the report.
19. During the survey, condition of the banks shall also be collected, whether that banks are pitched (protected) or not protected. The length of bank protection, where banks erosion is taking place shall also be estimated.
20. Positions and levels of corners of permanent structures within the corridor shall be physically surveyed and marked on survey charts.

2.2.3 Primary Data- Sources

A. Survey of India (SOI) Dehradun, during March & April 2016

Toposheets and satellite imageries are useful to obtain information such as extent of tidal reach, HTL & LTL, width of river and deep channel, important places, nature of river bed and bank along reach, channel bends, slope of river channel, and locations of various structures across and along river course and tendency of shifting of deep channel (general morphology of the deep channel of the river course).

As the coastal zone falls under restricted category, the restricted and non-restricted Toposheets of Survey of India /hydrographic charts and satellite imageries has been collected after taking approval from **Ministry of Water Resources, Govt. of India**.

A total of 9 toposheets of 1: 50000 scale were procured from SOI for Sabarmati river stretch and are being analyzed to study various aspects mentioned above. The satellite imageries of different years from Google are also being analyzed.

The details of toposheets for Sabarmati River as collected from SOI are given as under:

1.	**Sabarmati**	46 A/12, 46 A/16, 46 A/15, 46 B/5, 46 B/6, 46 B/7, 46 B/8, 46 B/9, 46 B/10

B. Data from Reconnaissance survey during April-May 2016

The reconnaissance survey was carried out in April- May 2016.

The details of existing cross-structures, Weirs, Barrages, Anicut, Dams, HT/ LT line, Type of Crops, Soils, shore protection along the waterway, Historical and tourist places, existing ferry services were collected. The collected data and photographs have been detailed in reconnaissance survey (Chapter 3).

2.2.4 Secondary Data- Sources

A. Central Water Commission (CWC), Govt of India and Water Resource Division (WRD), Gandhinagar during April and May 2016

These data give most vital information on water availability in river reach and sediment concentration in river water. The letters for gauge discharge data collection are sent to concerned chief engineers (attached as **Annexure 1**).

It was informed from the department that the data collection will take about 2-3 months and all the data have already been uploaded in WRIS website. Accordingly, the hydrological data viz. gauge, discharge, sediment and cross-section data at all G.D. sites have been downloaded from the website for all the gauge stations in Sabarmati River.

Gauge discharge- sediment data collected

Gauge- discharge, sediment and river cross section data (at gauging sites) was collected from CWC/WRIS website for three gauging stations, Kheda, Vautha and Subhash Bridge on Sabarmati River. However, Since Kheda is located on the tributary of Sabarmati River and not on Sabarmati River; It is not considered for analysis. Hydrological analysis of Vautha and Subhash Bridge is carried out based on this data.

Table 4: Gauge Discharge Sediment data collected from CWC

River	Gauging station	Data type	From	To	Frequency
Sabarmati River					
Kheda, Dist. Kheda, Gujarat	$22^0\ 44'\ 44''$ N $72^0\ 40'\ 48''$ E	Gauge- discharge	1985	2013	Daily
		Sediment	-	-	-
		Cross-section	-	-	-
Subhash Bridge Dist. Ahmadabad, Gujarat	$23^0\ 03'\ 39''$ N $72^0\ 35'\ 08''$ E	Gauge- discharge	1979	2010	Daily
		Sediment	-	-	-
		Cross-section	2007	2010	1 Day/year
Vautha Dist. Ahmadabad, Gujarat	$23^0\ 38'\ 58''$ N $72^0\ 32'\ 02''$ E	Gauge- discharge	1999	2013	Daily
		Sediment	-	-	-
		Cross-section	2001	2012	2 Days/year

The details of collected data and analysis are given in Chapter 4.

2.2.5 Methodology

The studies are being carried out as detailed below:

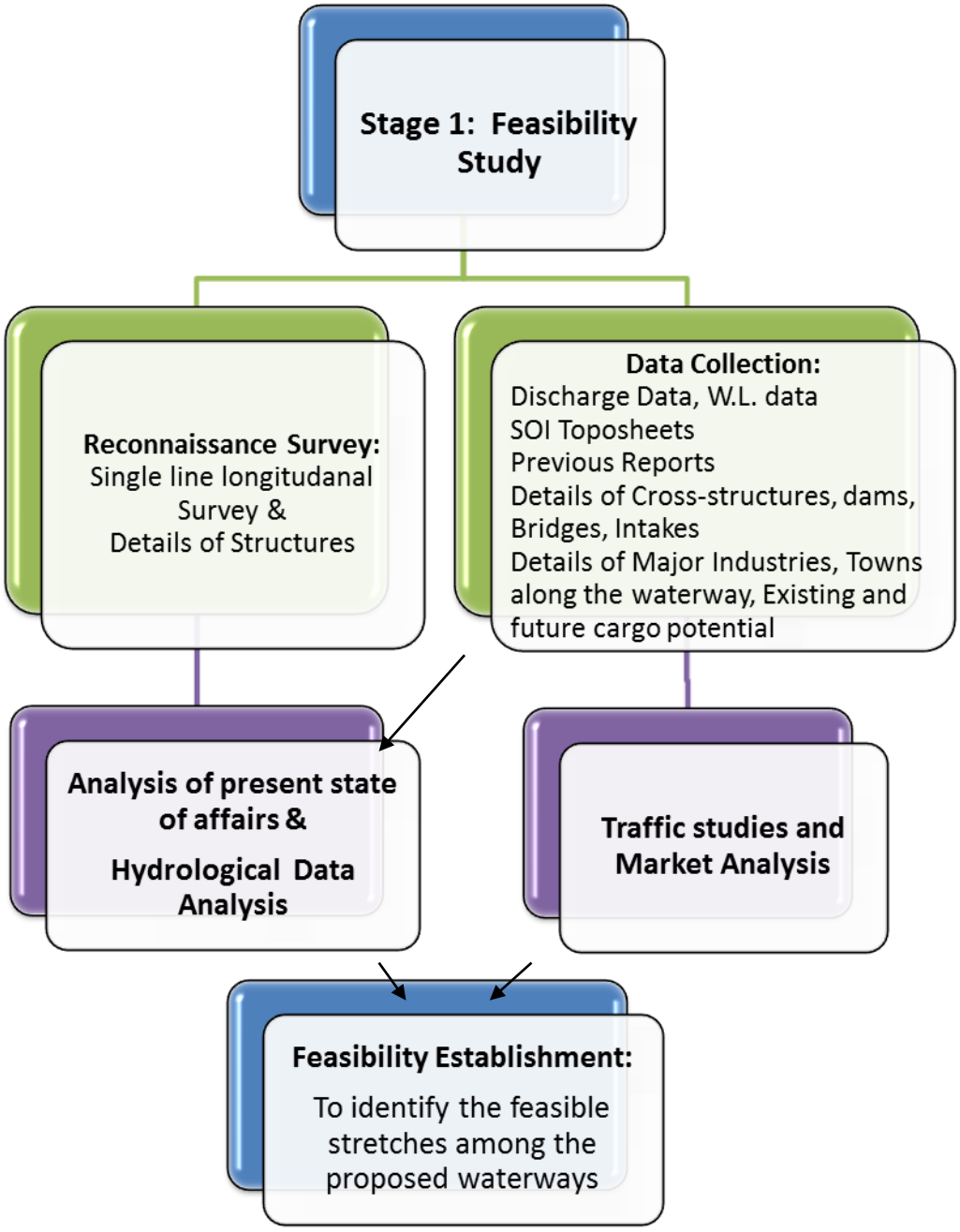


Figure 5: Feasibility Studies (Stage 1)

The detail methodology for reconnaissance survey, Hydrological data analysis and Traffic studies is given in their respective chapters. The feasibility of waterways is established after hydrological and traffic studies and analysis. Based on hydraulic conditions (depth, width, curvatures etc.) of the navigation channel, the class of the waterway are established in accordance with the classification notified by the Inland Waterways Authority of India (IWAI) vides Gazette Notification dated 26 January 2007. The same has been detailed below:

2.2.6 Classification of Waterways

In India, the inland waterways are classified into seven categories for rivers as well as canals by the Inland Waterways Authority of India (IWAI) vides Gazette Notification dated 26 January 2007 for safe passage of self-propelled vessels up to 2000 dead

weight tonnage (DWT) and tug barge formation in push tow units of carrying capacity upto 8000 tonnes.

The classification of waterways is discussed below.

A. *Classification of Inland waterways for Rivers*

Table 5: Inland Waterway classification for Rivers

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

B. *Classification of Inland waterways for Canals*

Table 6: Inland Waterway classification for Canals

Class of Waterway	Canals				
	Minimum Depth	Bottom Width	Bend Radius	Vertical Clearance	Horizontal Clearance
I.	1.5 m	20 m	300 m	4 m	20 m
II.	1.8 m	30 m	500 m	5 m	30 m
III.	2.2 m	40 m	700 m	7 m	40 m
IV.	2.5 m	50 m	800 m	10 m	50 m
V.	-	-	-	-	-
VI.	3.50 m	60 m	900 m	10 m	60 m
VII.	-	-	-	-	-

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

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

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

- Telephone lines and Low Voltage lines 16.5 m
- High Voltage Transmission lines not exceeding 110 KV – 19 m
- High Voltage Transmission lines exceeding 110 KV – 19 m + 1 cm per each KV

In case of underground pipe / power lines and other cables norms to be decided as per conditions and navigational requirement

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

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

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

Table 7: Type of vessels to be used in different class of waterways

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

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

Wapcos has carried out hydrological studies to establish the feasibility of development of National Waterway 87 for Inland Navigation. In cases where minimum depth (of 1.2m as per Govt. of India notification) is not available round the year, the no. of days of availability and available depth is calculated and presented in chapter 4. The project authorities may review the waterway classification for navigation. The feasibility of these stretches may be established for some part of the year after detailed studies in stage 2 after the approval. Measures to improve the depth are also stressed upon.

3. Reconnaissance Survey and Analysis of present state of affairs

This chapter identifies the existing cross-structures viz. Dams, Weirs, Barrages, Locks, Bridges, Crossings, pipelines, cables, HT/LT line, in all the river stretches collected during the reconnaissance survey.

The reconnaissance survey of Sabarmati River was carried out in the months of April-May 2016. The present status on river cross-structures is given below:

3.1 Existing Dams, Weir, Barrage, Anicuts and Locks

The details of existing dams/weir/barrages are given in table below. WAPCOS has tried to collect the data about each barrage from state govt./central govt. offices. The collected data is attached at **Annexure 2**. It may also be noted that none of these existing Check Dams /Anicut /Barrages /Dams have navigational lock due to which through navigation in the river is possible only by constructing new locks/ canals.

Table 8: Existing Dams /Barrages/Weir over Sabarmati River

Sl No	Structure Name	Chainage (km)	Location	Position (Along survey track) WGS84 Datum; UTM Projection: Zone 43N			
				Latitude(N)	Longitude(E)	Easting (m)	Northing (m)
1	Wasna Barrage	135.7	Ahmadabad	22° 59' 17.97"N	72° 33' 27.38"E	249625.1	2544312.3
2	Broken check Dam	165.1	Gandhinagar	23° 10' 12.77"N	72° 39' 46.41"E	260744.8	2564283.3
3	Sant Sarovar Barrage	168.6	Gandhinagar	23° 12' 02.66"N	72° 39' 42.44"E	260686.2	2567666.2
4	Broken check Dam	179.6	Bhundiya	23° 16' 56.43"N	72° 42' 04.43"E	264867.7	2576640.6
5	Broken check Dam	184.9	Rajpur	23° 19' 36.04"N	72° 42' 51.13"N	266272.7	2581530.4
6	Broken check Dam	189.6	Amarapur	23° 21' 47.47"N	72° 43' 20.72"E	267177.2	2585561.0
7	Broken check Dam	193.8	Delvad	23° 23' 23.75"N	72° 43' 23.82"E	267311.9	2588522.0
8	Broken check Dam	199.2	-	23° 24' 32.87"N	72° 45' 50.72"E	271516.8	2590583.3
9	Broken check Dam	205.5	-	23° 24' 55.57"N	72° 47' 52.02"E	274971.9	2591228.8
10	Lakroda Weir	209.9	-	23° 26' 52.61"N	72° 48' 31.41"E	276145.1	2594812.7

3.2 Existing Bridges and Crossing Over River

Table 9: Existing Bridges and Crossing Over Sabarmati River

Sl No	Structure Name	Chainage (km)	Location	Position (Along survey track) WGS84 Datum; UTM Projection: Zone 43 N Latitude [N]	Longitude [E]	Easting (m)	Northing (m)	Vertical clearance above H.F.L.(m)	Horizontal Clearance (m)	Span Nos.
1	Vataman bridge (SH-6)	47.1	Khambat	22° 30' 02.69"	72°26' 00.48"	235957.5	2490518.9	2	25	9
2	Mud road bridge (Cause way)	62.1	Khambat, Dholka	22°35' 46.06"	72°29' 00.64"	241286.5	2500996.4	-	-	-
3	Vautha bridge (SH-149)	76	Kheda, Dholka	22°39' 07.66"	72°32' 1.42"	246554.2	2507113.0	15	30	11
4	Rasikpura bridge	85	Sahij	22°42' 00.74"	72°31' 03.21"	244980.8	2512466.1	0	10	4
5	Saroda bridge	110.9	Saroda	22°49' 29.86"	72°30' 15.37"	243848.1	2526308.3	0	8	14
6	Under Construction Bridge	115.8	-	22°51' 54.55"	72°29' 44.75"	243050.3	2530775.2	Under construction	Under construction	Under construction
7	Sardar Patel Ring Road bridge-1	125.2	Kamod	22°55' 51.93"	72°32' 11.50"	247357.1	2538008.7	4	25	11
8	Sardar Patel Ring Road bridge-2	125.2	Kamod	22°55' 52.50"	72°32' 12.16"	247376.2	2538025.9	4	25	11
9	Vishala Bridge -1 (NH-8A)	134.1	-	22°58' 50.76"	72°32' 37.49"	248189.8	2543498.8	7	25	13
10	Vishala Bridge -2 (NH-8A)	134.1	Ahmadabad	22°58' 51.48"	72°32' 38.17"	248209.6	2543520.7	7	25	13
11	Ambedkar Bridge	136.8	Ahmadabad	22°58' 51.48"	72°32' 38.17"	250309.2	2545182.1	4	30	6
12	Sardar Bridge	139	Ahmadabad	23° 00' 39.65"	72° 34' 29.97"	251448.2	2546703.7	0	20	11

Sl No	Structure Name	Chainage (km)	Location	Position (Along survey track) WGS84 Datum; UTM Projection: Zone 43 N Latitude [N]	Longitude [E]	Easting (m)	Northing (m)	Vertical clearance above H.F.L.(m)	Horizontal Clearance (m)	Span Nos.
13	Ellis Bridge	140.2	Ahmadabad	23° 01' 19.96"	72° 34' 32.97"	251555.7	2548034.9	5	25	8
14	Nehru Bridge	140.7	Ahmadabad	23° 01' 36.16"	72° 34' 26.44"	251378.0	2548536.4	3	30	
15	Gandhi Bridge	142.2	Ahmadabad	23° 02' 23.44"	72° 34' 26.12"	251393.0	2549991.3	3	18	12
16	Dadhichi Bridge	143.8	Ahmadabad	23° 03' 13.12"	72° 34' 38.32"	251765.7	2551514.2	3	35	6
17	Subhash Bridge	145	Ahmadabad	23° 03' 40.47"	72° 35' 08.20"	252630.4	2552341.7	5	45	4
18	Sabarmati Rail Bridge	145.4	Ahmadabad	23° 03' 42.65"	72° 35' 21.43"	253008.2	2552402.5	3	10	18
19	Indira Bridge	151.7	Ahmadabad	23° 05' 28.89"	72° 37' 46.95"	257204.4	2555603.6	6	30	9
20	Sardar Patel Ring Road Bridge	156	Nana Chiloda	23° 06' 55.03"	72° 38' 58.59"	259286.3	2558221.0	5	35	12
21	Valad Bridge	162.5	Valad	23° 09' 04.62"	72° 40' 32.72"	262028.8	2562165.3	3	40	15
22	Gandhinagar Bypass Bridge	166.9	Gandhinagar	23° 11' 07.58"	72° 39' 27.03"	260220.7	2565978.6	8	35	9
23	High way 8C Bridge (NH-8C)	174.5	Gandhinagar	23° 14' 40.13"	72° 41' 00.90"	262995.0	2572475.6	6.5	30	9
24	Lakroda Bridge	209.7	-	23° 26' 46.63"	72° 48' 30.47"	276115.6	2594629.1	5	18	17

Note: Vertical clearance is measured above H.F.L. The HFL is calcuted above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years of Gauge Discharge Data as collected from CWC.

3.3 Pipelines and cables

Table 10: Existing Bridges and Crossing Over Sabarmati River

Sl No	Structure Name	Chainage (km)	Location	Position (Along survey track) WGS84 Datum; UTM Projection: Zone 43 N				Vertical clearance above H.F.L.(m)	Horizontal Clearance (m)	Span Nos.
				Latitude [N]	Longitude [E]	Easting (m)	Northing (m)			
1	Water pipeline bridge	47.1	Khambat	22° 30' 02.27"	72°25' 59.54"	235930.4	2490506.2	2	25	9

Note: Vertical clearance is measured above H.F.L. The HFL is calcuted above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years Gauge Discharge Data as collected from CWC.

3.4 Details of High Tension and Electric Lines

Table 11: HT and Electric Lines over Sabarmati River

Sl No	Structure Name	Chainage (km)	Location	Position (Above survey track) WGS84 Datum; UTM Projection: Zone43 N				Vertical clearance above H.F.L.(m)	Horizontal Clearance (m)
				Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		
1	HT Line	45	Khambat	22° 29' 06.52"	72°25' 14.65"	234617.2	2488812.8	30	250
2	HT Line	47.4	Khambat	22° 30' 10.11"	72°26' 03.95"	236060.7	2490745.2	70	250
3	HT Line	48.1	Khambat	22° 30' 34.82"	72°26' 14.64"	236436.5	2491499.4	70	250
4	HT Line	48.9	Khambat	22° 30' 55.41"	72°26' 20.00"	236543.4	2492131.2	94	250
5	HT Line	49.1	Khambat, Dholka	22° 31' 03.86"	72°26' 22.97"	236632.7	2492389.7	94	300
6	HT Line	49.9	Khambat, Dholka	22° 31' 23.57”	72°26' 27.01"	236758.5	2492994.2	92	300
7	HT Line	74.1	Kheda, Dholka	22° 38' 17.18"	72°31' 51.49"	246244.9	2505564.5	28	250
8	Electric Line	80.8	-	22° 41' 24.98"	72°33' 05.06"	248441.3	2511308.0	4	250
9	Electric Line	85.1	Sahij	22° 42' 02.28"	72°31' 05.61"	245050.1	2512512.4	4	250
10	HT Line	85.9	Rasikpura	22° 42' 29.46"	72°31' 08.10"	245135.2	2513347.5	14.5	250
11	HT Line	99.1	-	22° 46' 43.34"	72°31' 00.02"	245035.5	2521163.1	14	100
12	HT Line	125.7	Kamod	22° 56' 01.65"	72°32' 17.41"	247530.5	2538305.0	6	250
13	HT Line	132.9	Singarva	22° 58' 32.78"	72°31' 59.86"	247108.5	2542963.6	16	250

Sl No	Structure Name	Chainage (km)	Location	Position (Above survey track) WGS84 Datum; UTM Projection: Zone43 N				Vertical clearance above H.F.L.(m)	Horizontal Clearance (m)
				Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		
14	HT Line	134.7	-	22° 59' 01.55"	72°32' 56.71"	248742.9	2543821.7	7	250
15	HT Line	136.2	Ahmadabad	22° 59' 35.58"	72°33' 31.75"	249758.6	2544852.1	18	250
16	HT Line	146.4	Ahmadabad	23° 04' 03.11"	72° 35' 51.96"	253887.8	2553017.7	12.5	250
17	HT Line	147.8	Ahmadabad	23° 04' 43.82"	72° 35' 55.38"	254005.7	2554268.7	15	250
18	HT Line	155.8	Nana Chiloda	23° 06' 46.57"	72° 38' 56.75"	259229.7	2557961.6	17	250
19	HT Line	155.9	Nana Chiloda	23° 06' 51.11"	72° 38' 57.31"	259247.9	2558101.0	17	250
20	HT Line	156.3	-	23° 07' 04.51"	72° 39' 00.48"	259344.8	2558511.8	15	350
21	HT Line	156.9	Near Gujarat Police Academy	23° 07' 23.95"	72° 38' 54.40"	259181.4	2559112.8	15	250
22	HT Line	162.4	Valad	23° 09' 00.48"	72° 40' 29.49"	261934.8	2562039.4	12	250
23	HT Line	174.8	Gandhinagar	23° 14' 48.82"	72° 40' 59.16"	262949.8	2572743.8	17	250
24	HT Line	175.1	Gandhinagar	23° 14' 59.07"	72° 40' 57.55"	262909.1	2573059.9	17	250
25	HT Line	179.3	Bhundiya	23° 16' 47.67"	72° 42' 04.34"	264860.9	2576371.1	17	250
26	HT Line	179.8	Bhundiya	23° 17' 00.58"	72° 42' 04.58"	264874.0	2576768.2	26	250
27	HT Line	186.6	Sadra	23° 20' 23.04"	72° 43' 17.07"	267032.5	2582964.9	22	250
28	HT Line	194.8	Delvad	23° 23' 49.54"	72° 43' 32.96"	267584.0	2589311.4	18	250
29	HT Line	196.2	-	23° 24' 15.43"	72° 44' 13.53"	268748.7	2590089.9	17	250

Note: Vertical clearance is measured above H.F.L. The HFL is calcuted above MHWS for Tidal reach and at gauge site is calculated as maximum water level in last twenty years Gauge Discharge Data as collected from CWC.

3.5 Hindrances during conducting the reconnaissance survey

As per the Reconnaissance survey there has been no rocky strata has been found near the river or at the river bed. The detailed study shall be carried out in Stage-II.

3.6 Encroachment to the waterway

There is no encroachment in the waterway in the reach under consideration in this study.

3.7 Details of Protected Area, Wildlife, Defence

There are no such areas present in the vicinity of river.

3.8 NH/SH/MDR along and/or in Vicinity

Twenty five (25) road and rail bridges cross Sabarmati River in its 212 km long stretch. The national highway NH 8Q, NH 8C, NH 47and NH 147 crosses Sabarmati river in this stretch. The state highways crossing over Sabarmati River in 212 km stretch are SH 6, SH 16 and SH 142.

3.9 Railway Line and stations in the vicinity

The main railway stations present along the river are Sabarmati North, Sabarmati, Ahmadabad Railway station, Ahmadabad central, Aaasrwa, Naroda and Gandhigram Railway station. Ahmadabad Sabarmati railway line crosses Sabarmati River near Sabarmati waterfront.

3.10 Geologically Sensitive Areas

During reconnaissance survey, no rocky strata has been found. However this will be critically identified in stage 2.

3.11 Critical Areas requiring detail investigations

Detailed investigations shall be required at proposed ferry locations nearby temples, existing boating points and ghats.

4. Reconnaissance Survey

This chapter gives the stretch wise description of entire river stretches and presents the observed water level during survey. The reconnaissance survey report of Sabarmati River along with all charts and data is also attached as **Annexure 3**. This chapter also covers the Hydrological analysis of the collected data viz. Minimum and maximum water levels, discharges, average 10 daily discharges, change in cross-section over the years and establishment of sounding datum in river. The route map of Sabarmati River is given below:

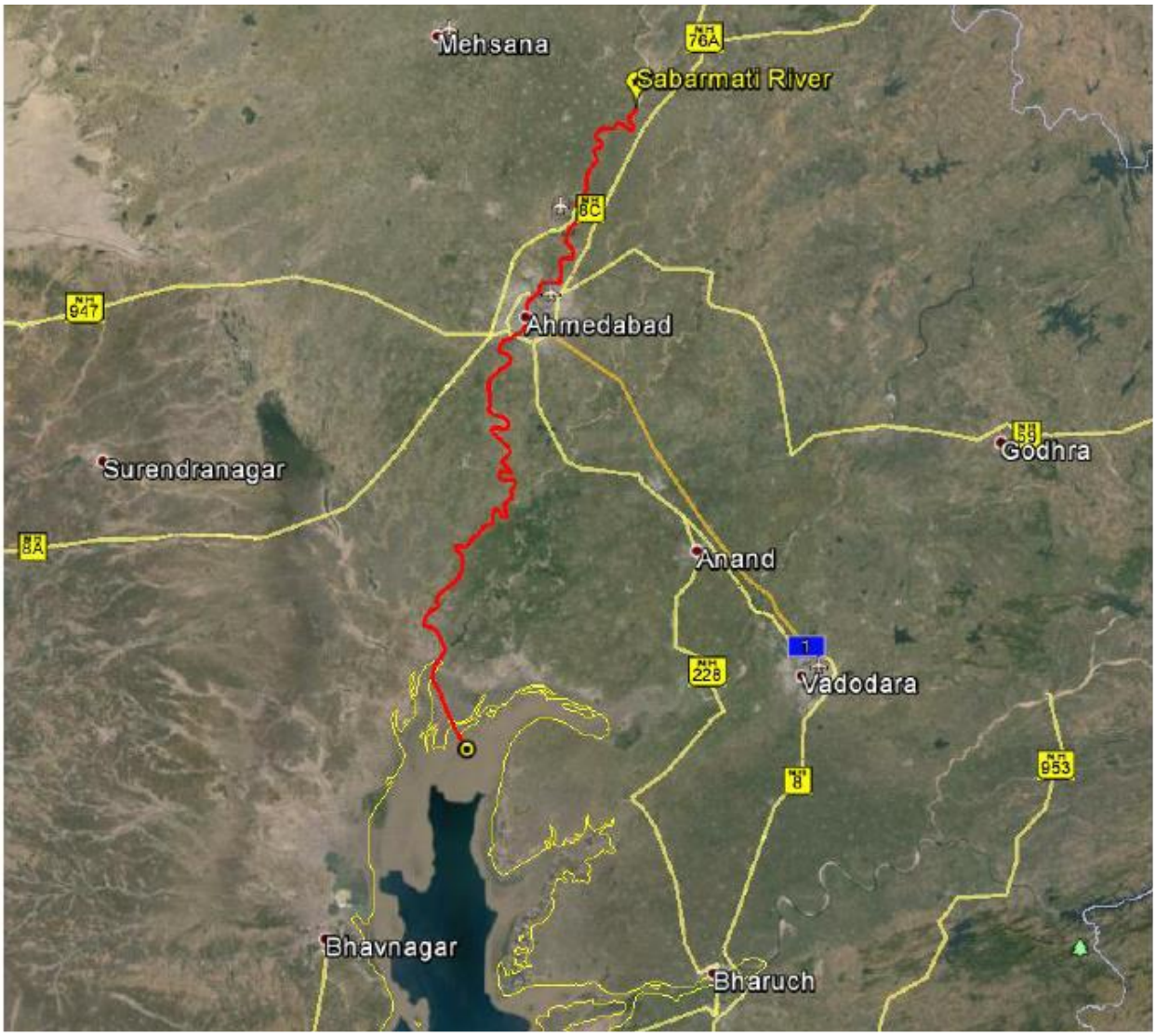


Figure 6: Route map of Sabarmati River

4.1 Resources, Equipment used and Methodology adopted

4.1.1 Resources & Equipment used

Table 12: Survey Personnel

Personnel Name	Function
Deepak Jana	Surveyor , Fugro Limited
Jenil Johnson	Surveyor , Fugro Limited
Raib Maji	Asst. Surveyor , Fugro Limited

Following equipment and systems were mobilised for the data acquisition.

Table 13: Equipments for data acquisition

Equipment / System	Description / Make / Model/Resolution /Accuracy
Software / Navigation	Starfix.Seis V. 10.1 PC based data acquisition and survey vessel navigation package and accessories
Positioning	12 Channel Single frequency (L1 & L2) DGPS System and accessories
Echo Sounder	ODOM Hydrotrac single Frequency Echo sounder, 210KHz Transducer and accessories
Soil sample collection	Grab Sampler with accessories
Laser Distometer	

Survey Vessel

Locally Hired boat 'Blue Pantoon' and 'Patanjali' was used for carrying out the bathymetry survey.

4.1.2 Detailed methodology adopted for survey

a) Specifications for survey: Survey Geodesy

The survey was conducted in WGS84 datum; UTM Projection (Zone 43 N, CM 075°). The geodetic parameters used during the survey are as follows:

Table 14: Global Positioning System Geodetic Parameters

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
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:	500 000 m
False Northing:	0 m
Scale factor on Central Meridian:	0.9996
Units:	Meter

b) ***Field Calibrations & Verifications***

All survey equipments used for the survey were calibrated and bench tested prior to their mobilisation for this task. After installation on the survey vessel, field verification and tests were carried out as per standard survey methods. On completion of successful Mobilization, Calibration, Verification and Testing of all equipment as per the relevant work practices, the survey task was commenced.

c) ***DGPS Calibrations***

In order to ensure the integrity of the horizontal control of survey the DGPS system was bench checked against a known point, prior to mobilisation to site, at workshop and found to be satisfactory.

d) ***Single Beam Echo Sounder (SBES)***

Odom Hydrotrac single frequency (210 kHz) echo sounder was used for measuring water depths. The echo sounder system was bench calibrated at FSINPVT workshop prior to mobilization for the survey. The echo sounder transducer was side mounted on the survey vessel and its draft below the water-line was measured and recorded. Thereafter, the echo-sounder was calibrated by the standard bar-check method at site, prior to deployment on the survey job. The echo sounder system was interfaced with the Starfix.Seis navigation and survey system for navigation and data logging.

e) ***Data Acquisition & Survey Run-Line Logs***

The Navigation and depth data from the Starfix.HP DGPS was logged continuously and monitored using the Starfix.Seis navigation suite. A survey run-line log book was maintained where the quality of data was noted. Details such as horizontal and vertical clearances above high flood level of bridges, aqueducts, electric lines, telephone lines, pipe lines, cables enroute were assessed on the spot and recorded, and their coordinates and location were plotted on the chart and included in the report. Photographs of important structures along the route are included as part of this report.

f) ***Soil Sampling and Visual Analysis***

Soil samples were collected from the river bed along the surveyed route at about 10 km intervals, and the nature and texture of the samples collected were visually analyzed and reported.

g) ***On-line QC of Data Logged***

Real Time Graphs and QC Plots as provided by the Starfix survey software suite were used by experienced surveyors to monitor and control the quality of sensor data on-line, before they are logged. Time stamping on all the data was done by means of Starfix Timing Module through Navigation network synchronized with the GPS (high precision) 1PPS time signal. The data / record obtained from each survey sensor such as Navigation, Heading, SBES and Motion Sensor etc. were quality checked and an extract of the same were made available for verification and confirmation to proceed further.

h) ***Survey of Data Processing and interpretation methods***

The survey data was logged in Binary Format (BF), and processed using the Starfix.Proc software. Heading, motion and position data were processed and checked to ensure good data quality.

The measured offsets for all survey sensors was entered into the navigation system and processed using Starfix.Proc to enable track charts was plotted and 'corrected' navigation files was integrated with other sensor data at a later stage. These included:

- GPS position absolute of the primary & secondary positioning systems.
- Common Reference Point.
- Single beam echo sounder.

i) Bathymetry Data Analysis and Presentation

Starfix Proc and Starfix Workbench were used to import and process the navigation, bathymetry, tides and sound velocity data. The data was filtered, cleaned, and combined to create geographically positioned bathymetric data set that has been corrected for tides and sound speed.

j) Equipment Layout Diagram

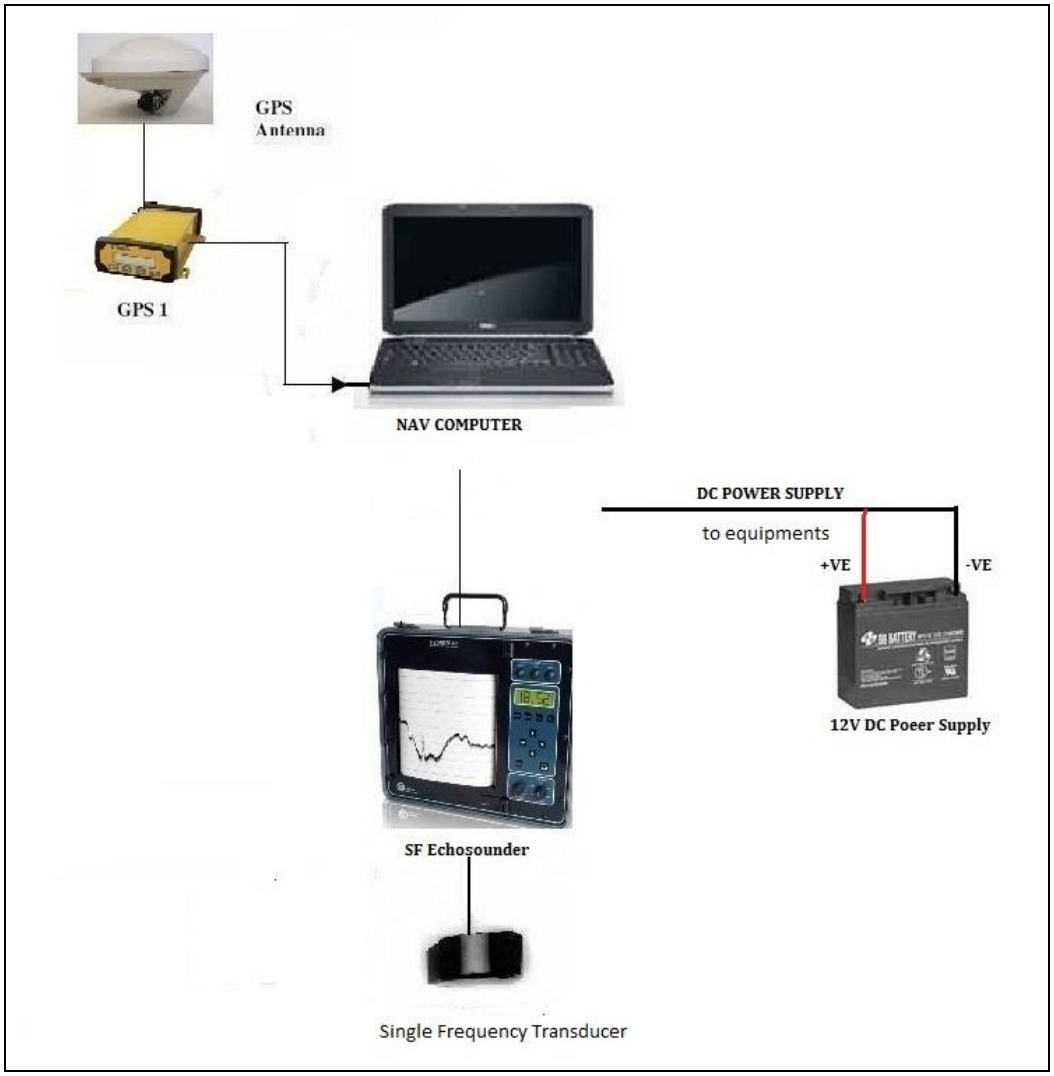


Figure 7: Equipment layout diagram

4.2 Description of bench marks (B.M.)/ authentic reference level used

Two GTS bench marks were successfully recovered on the river stretch at the below mentioned locations. All the Topographic heights of the riverbed in this report are referenced to these recovered BMs for obtaining their height above the MSL.

Table 15: Details of Bench Marks used for obtaining the height of riverbed above the MSL

Sr. No.	Location	Type of BM	Latitude (N)	Longitude (E)	Height above MSL (m)	Used for River stretch Chainage
1	Dholka	GTSBM	22° 44' 06.295'	72°26' 02.73''	23.799	29.5 to 115
2	Ahmadabad	GTSBM	23° 01' 29.55''	72°34' 48.99''	49.338	116 to 209.7

FUGRO

Fugro Survey (India) Pvt. Ltd.
D-222/30, TTC Industrial Area,
MIDC, Nerul, Navi Mumbai
Pin - 400 075 (India)

Reccee report on Geodetic Station/Bench Mark

Job No. :	J_MAR_16_029	Station Name/ID:
Client :	WAPCOS	
Location :	Behind BSNL Office, Apna Bazar, Ahmedabad.	GTS BM AHMEDABAD
Date of Reccee:	3-May-16	

Brief Narrative on the Recovery of the Station

a) What is the Source of Station Description Data;	Provided by Client
b) Was the station recovered successfully?	Yes
c) What were the differences in Coordinates after verification using Starfix.HP?	Initial coordinates were not provided by Client. Observation could not be done on the Bench Mark as it was obstructed by a Pipal tree on top of it. Hence the observation was carried out at a distance of 13.95m West of the BM and the position of BM was calculated using range and bearing from the established Temporary Bench Mark.
d) Give Link to Starfix Mean Posn/Final Fix Report.	Observation was done using Starfix HP 8200 and Data logger.

Final Coordinates in WGS84 Datum after verification using Starfix.HP

GEOGRAPHICAL COORDINATES:			UTM COORDINATES:	Zone No:		CM:		°E
LATITUDE :	23°01'29.55251"	N	EASTING:	252016.931	m		(+/-0.21 m)	
LONGITUDE :	72°34'48.99332"	E	NORTHING:	2548322.46	m		(+/- 0.18 m)	
ELLIPSOIDAL HEIGHT :	-5.147	m	Ht above MSL/CD	49.338	m			

Describe the General Location & Access to the Station :	The station is marked on a concrete structure (0.6m X 0.6m X 0.6m),situated on the North East corner of a triangle shaped Parking area. This concrete structure is enclosed in a railed off space (3.45m X3.45m)The parking area is surrounded by Apna Bazar to the north, BSNL office and Bhadra Qila to the East and Zila panchayat to the South at Ahmedabad.
Describe how the Stn is marked on the Ground	The station is engraved "GTS STANDARD BENCH MARK 1907". The height of the BM is also engraved in the structure which is 161.869 feet above MSL.
Expected durability of the Station (in Years) :	

DETAILED DIAGRAM :

Figure 8: Benchmark details GTS BM at Ahmadabad

Fugro Survey (India) Pvt. Ltd. D-222/30, TTC Industrial Area, MIDC, Nerul, Navi Mumbai Pin - 400 075 (India)	Location : Behind BSNL Office, Apna Bazar, Ahmedabad.	TBM at Apna Bazar, Ahmedabad

Figure 9: Benchmark details: TBM at Ahmadabad

Brief Description of Survey Execution

1. Purpose of Establishing the station :- Observation could not be carried out on the actual Bench Mark as the BM is situated under a Pipal tree Hence a TBM is established where it is possible to take

Fugro Survey (India) Pvt. Ltd. D-222/30, TTC Industrial Area, MIDC, Nerul, Navi Mumbai Pin - 400 075 (India)	Reccee report on Geodetic Station/Bench Mark		
	Job No. :	J_MAR_16_029	Station Name/ID:
	Client :	WAPCOS	
	Location :	Dholka, Gujarat	GTS BM PWD Office, Dholka
	Date of Reccee:	23-Apr-16	

Brief Narrative on the Recovery of the Station	
a) What is the Source of Station Description Data;	Provided by Client
b) Was the station recovered successfully?	Yes
c) What were the differences in Coordinates after verification using Starfix.HP?	Initial coordinates were not provided by Client. Observation could not be done on the Bench Mark as it was obstructed by an Office of PWD. Hence the observation was carried out at a distance of 8m from the BM and the position of BM was calculated using range and bearing from the Temporary Bench Mark.
d) Give Link to Starfix Mean Posn/Final Fix Report.	Observation was done using Starfix HP 8200 and Data logger.

Final Coordinates in WGS84 Datum after verification using Starfix.HP

GEOGRAPHICAL COORDINATES:			UTM COORDINATES:	Zone No:		CM:		°E
LATITUDE :	22°44'06.29541"	N	EASTING:	236469.21	m		(+/-0.21 m)	
LONGITUDE :	72°26'02.72902"	E	NORTHING:	2516475.49	m		(+/- 0.18 m)	
ELLIPSOIDAL HEIGHT :	-33.978	m	Ht above MSL/CD	23.799	m			
Describe the General Location & Access to the Station :	The station is situated beside the stairs to the office, in the premises of PWD store office cum rest house, near Dholka Railway station .							
Describe how the Stn is marked on the Ground	The station is engraved "GTS BM - RL 78.08" with a North arrow in it on a concrete surface (0.6m X 0.6m)							
Expected durability of the Station (in Years) :								

DETAILED DIAGRAM :

Figure 10: Benchmark details for GTS BM at PWD office, Dholka

Fugro Survey (India) Pvt. Ltd. D-222/30, TTC Industrial Area, MIDC, Nerul, Navi Mumbai Pin - 400 075 (India)	**Station Description** Job No. : J_MAR_16_029 Client : WAPCOS Location : Dholka, Gujarat	**Station Name:** **TBM at PWD Office Dholka**

Brief Description of Survey Execution

1. Purpose of Establishing the station :- Observation could not be carried out on the actual Bench Mark. Hence a TBM is established where it is possible to take GPS observations.
2. Equipment / Method used :- DGPS 8200 HP and Data logger. An observation of 30mint was done on the TBM.
3. Date of Survey / Observation :- 23-Apr-16
4. Observed by :- Deepak Jena

Final Coordinates in WGS84 Datum

GEOGRAPHICAL COORDINATES:		UTM COORDINATES:		(Zone ; CM °E)
LATITUDE	: 22° 44' 06.50327" N	EASTING	:	236474.285 m (+/- 0.2 m)
LONGITUDE	: 072° 26' 02.90294" E	NORTHING	:	2516481.801 m (+/- 0.2 m)
ELLIPSOIDAL HEIGHT	: -33.81 m	CONVERGENCE	:	(-) 0°59'31.9436"

LOCATION & ACCESS : The station is marked on the road, which lies between the guest house and the office of PWD at Dholka, in the premises of PWD store office-cum-rest house, near Dholka Railway station. The TBM is established 8m NE of the GTS Bench Mark.

STATION MARKING : The station is marked with a circle and a dot in red paint. TBM is written to the North of the circle in red.

Expected durability of the Station (Years) : 1 year

DETAILED DIAGRAM :

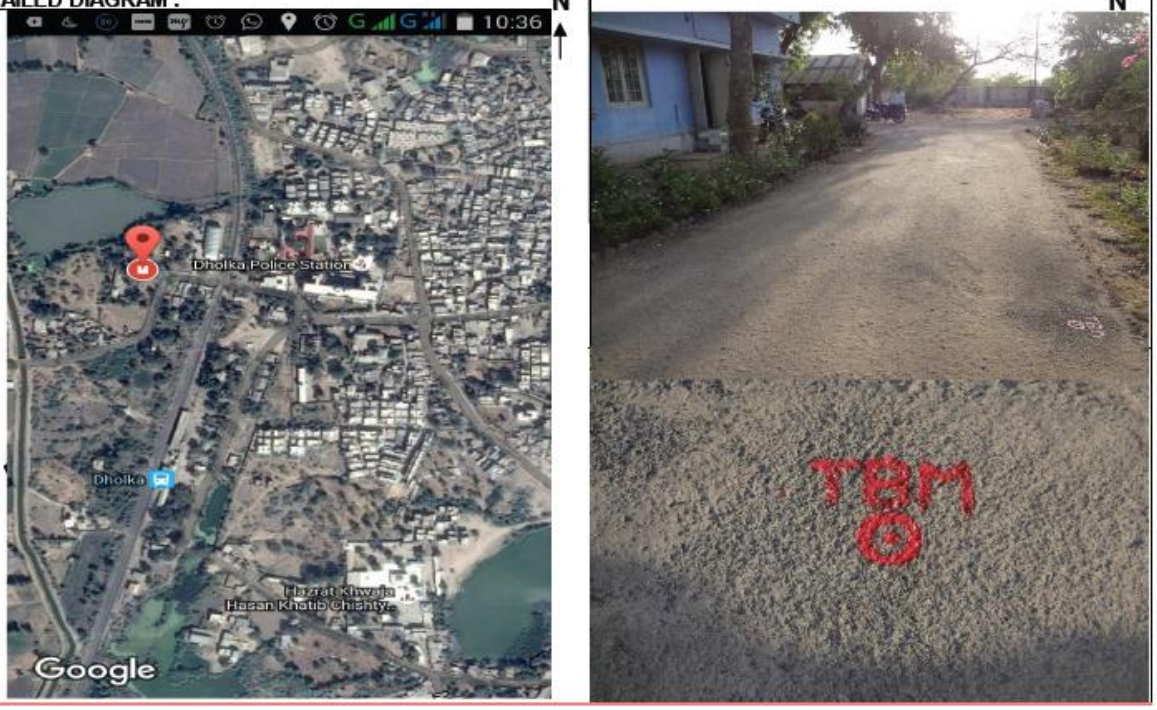


Figure 11: Benchmark details for TBM at PWD office at Dholka

4.3 Tidal Influence Zone and Tidal Variation in different stretches

From the analysis of toposheets for the coastal zone, it was found that the tidal reach of the river is about 30 km but the tidal effect was considered upto 14 km as per discussion with IWAI. The Nearest Port is Dahej Bandar. The tidal variation is about 6 m. ***(Source: Admiralty Tide Table Vol-3, Dahej Bandar)***

4.4 Chart datum / Sounding datum and reduction details

4.4.1 Horizontal control

Worldwide Starfix.HP DGPS was used for positioning the survey vessel during this survey. The accuracy of the x, y, z position data obtained from the Starfix.HP DGPS system is +/- 10 cms at 95% assurance levels. Starfix software suite was used for navigation, data logging, and online quality control of the survey data logged.

4.4.2 Vertical control

a) Chart Datum at the River Estuary

From CH 0.0 to CH 13.7 which have tidal influence, the soundings were reduced to Chart Datum using real time tidal observations and applying MSL~CD value of 4.9 m for the nearest port Dahej Bandar, obtained from ATT Vol-3. The coordinates of the port and the value of Chart Datum (CD) used in this survey are given below:

Table 16: Details of Chart Datum Used for Reduction of Soundings

Sr. No.	Location	Latitude (N)	Longitude (E)	Z0 (m)	Source
1	Dahej Bandar	21° 44' 00''	72°33' 00''	4.9	ATT -3

The Value of Z0 is taken below M.S.L.

b) Chart Datum for the upstream part of the River

The gauge discharge data of two gauge stations Vautha and Subhash Bridge on this river are collected by WAPCOS. As directed by the IWAI, the Chart Datum/ Sounding datum at these gauge locations are taken as average of last six years Minimum Water Levels. This is detailed in Para 4.18.

4.5 Hydrographic Survey

4.5.1 Hydrographic Survey

a) Length of stretch for which bathymetry survey has been carried out

The bathymetry survey has been carried out in the following stretches:

Tidal Reach

The tidal effect was predominant up to chainage 13.7 km from river mouth. Bathymetry Survey has been carried out in this reach.

Source data : Dahej Bandar tide data (8 April 2016- 12 April 2016)

Non-Tidal Reach

From (km)	To (km)
13.835	33.359
36.022	39.815
41.479	42.99
46.854	81.178
135.968	145.474

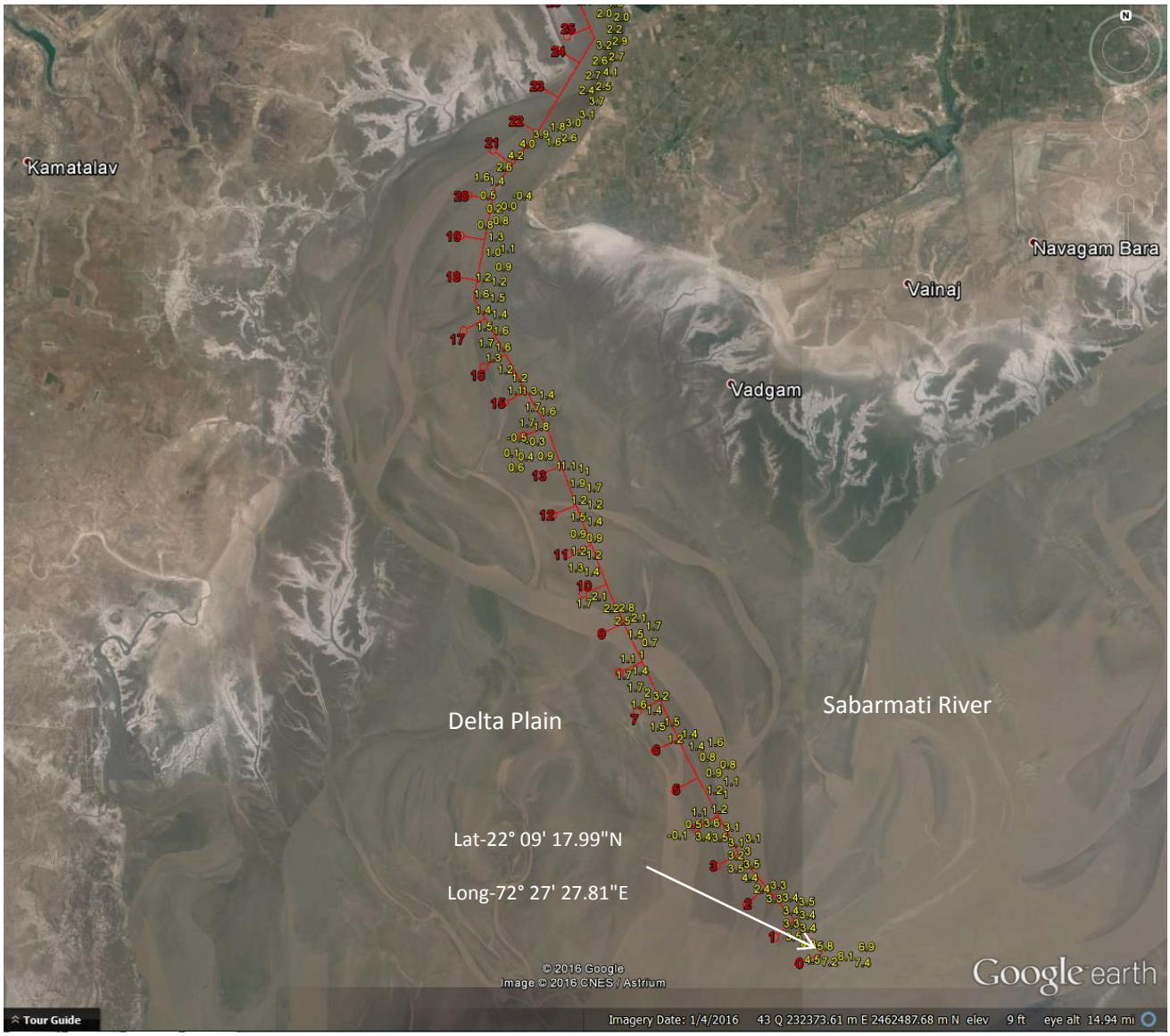
b) Minimum and Maximum Depths

As per IWAI suggestion, following sign convention is adopted
(+): Riverbed below CD
(-): Riverbed above CD
(+): Water Depth below CD
(-): Water Depth above CD.

c) Minimum and Maximum Depths

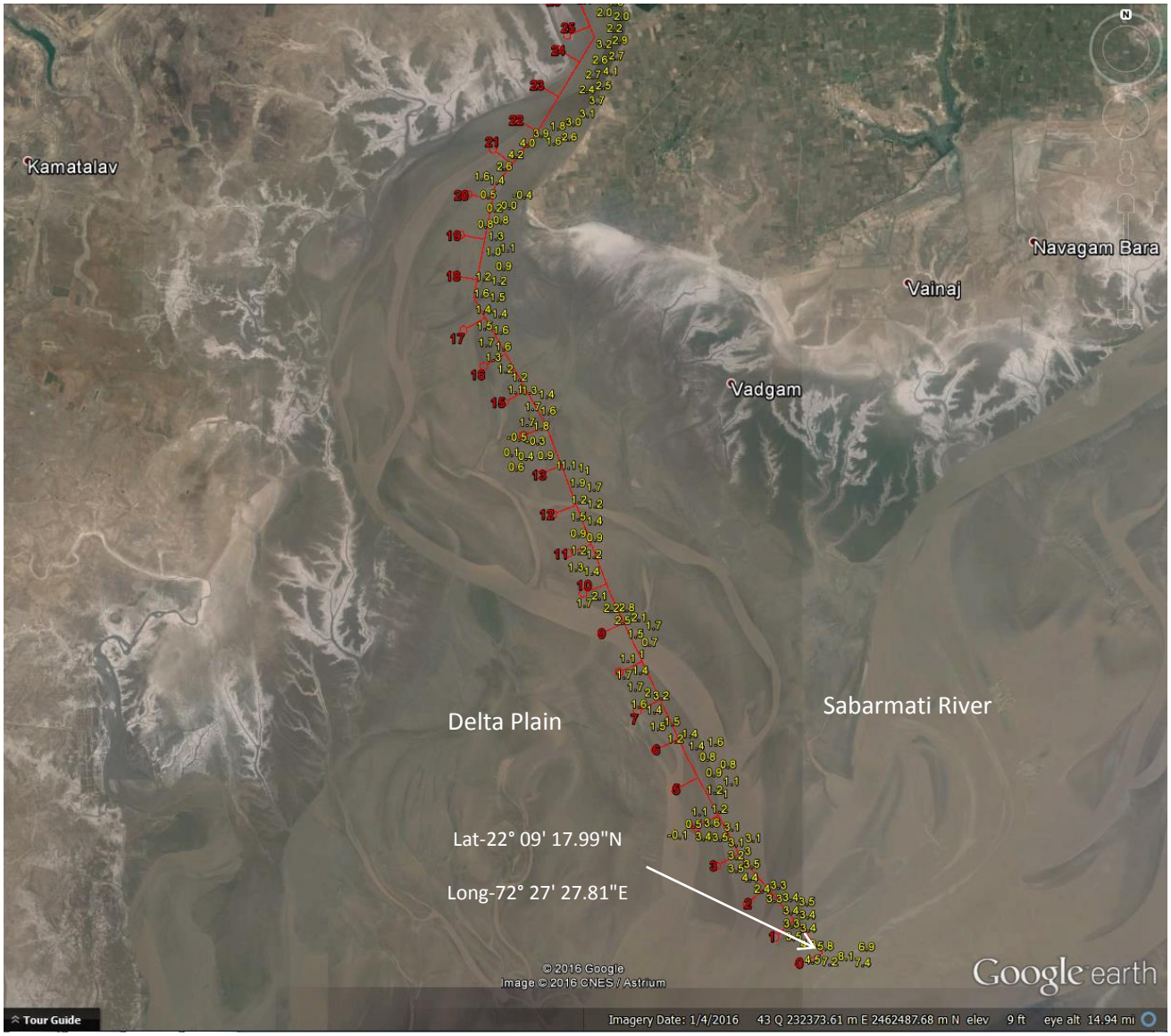
River Stretch (From CH 0.0 to CH 13.7)

Agricultural fields are found on both banks of the river. Patches of vegetation are also seen along the river banks. The reduced water depth in this section is minimum 0 m (CH 13.766) and the maximum is 4.456 m (CH 0.026).



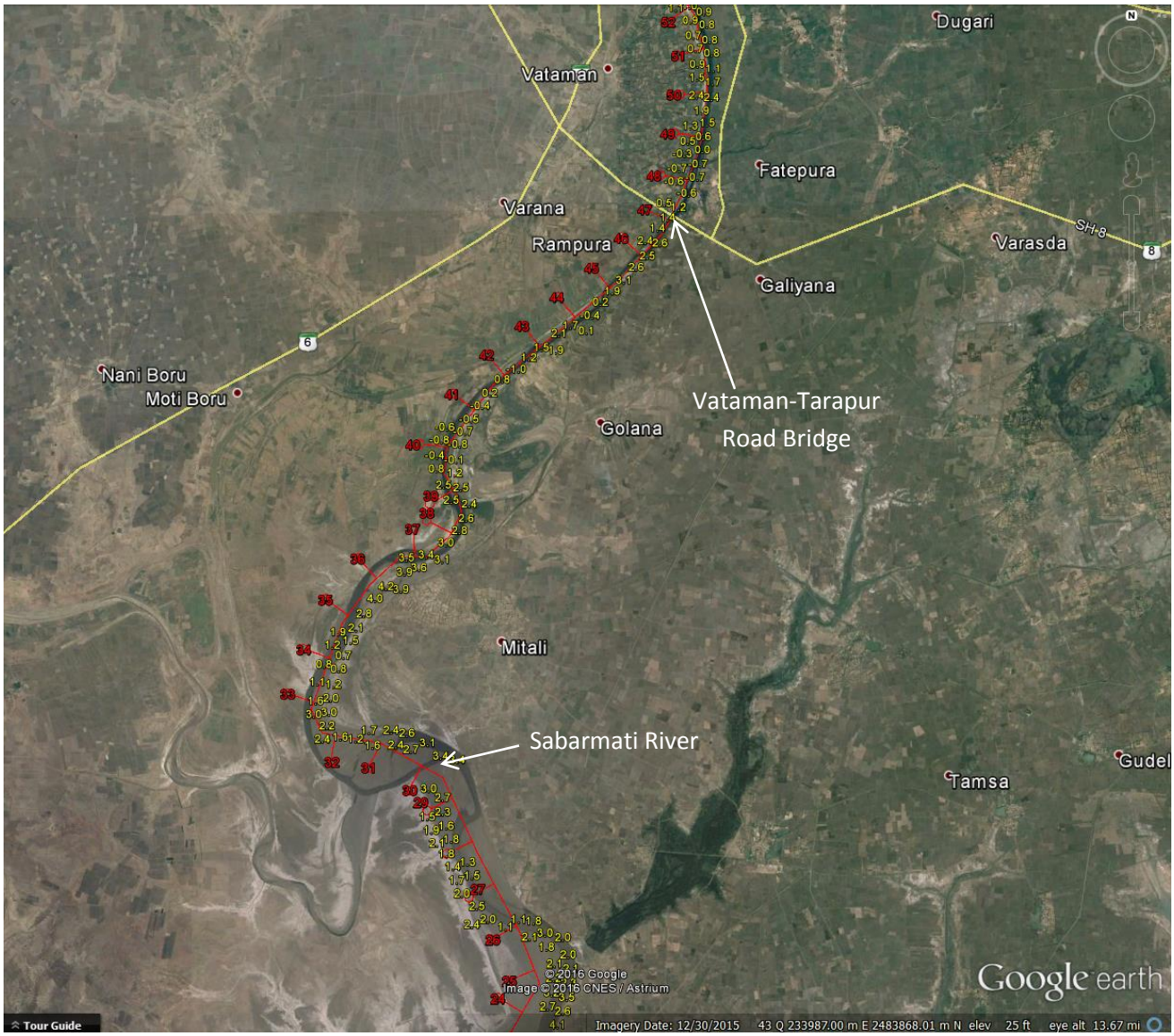
River Stretch (From CH 13.7 to CH 25.0)

Agricultural fields are found on both banks of the river. Patches of vegetation are also seen along the river banks. The reduced water depth in this section minimum 0 m (CH 20.143) & maximum 4.230 m (CH 21.101).



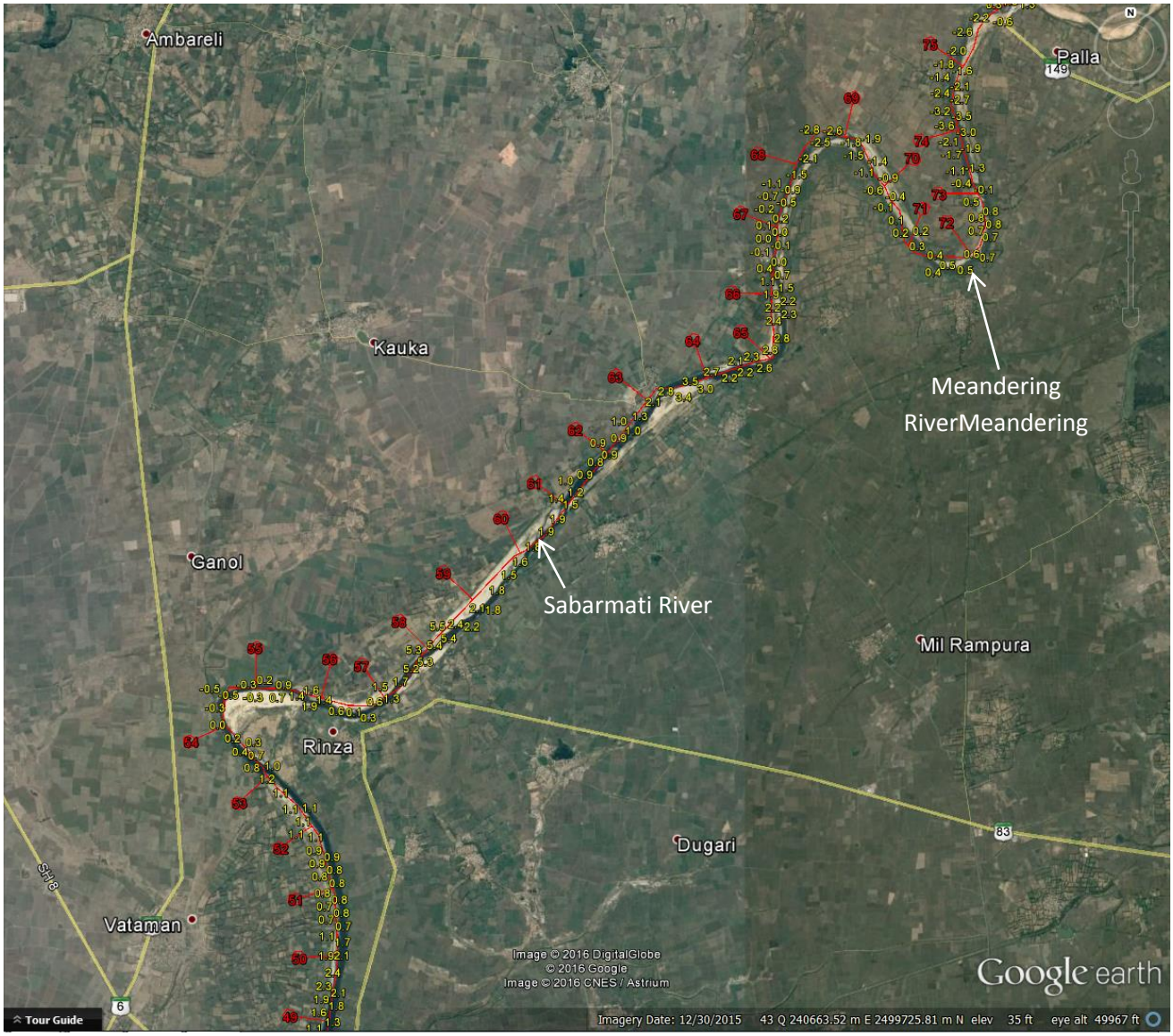
River Stretch (From CH 25.0 to CH 50.0)

Agricultural fields are found on both banks of the river. Patches of vegetation are also seen along the river banks. Vataman Village on the North bank and Tarapur on the South bank are connected by Vataman -Tarapur Road Bridge at CH 47.1. The reduced water depth in this section minimum is 0 m (CH 42.040) and the maximum is 5.144 m (CH 38.417).



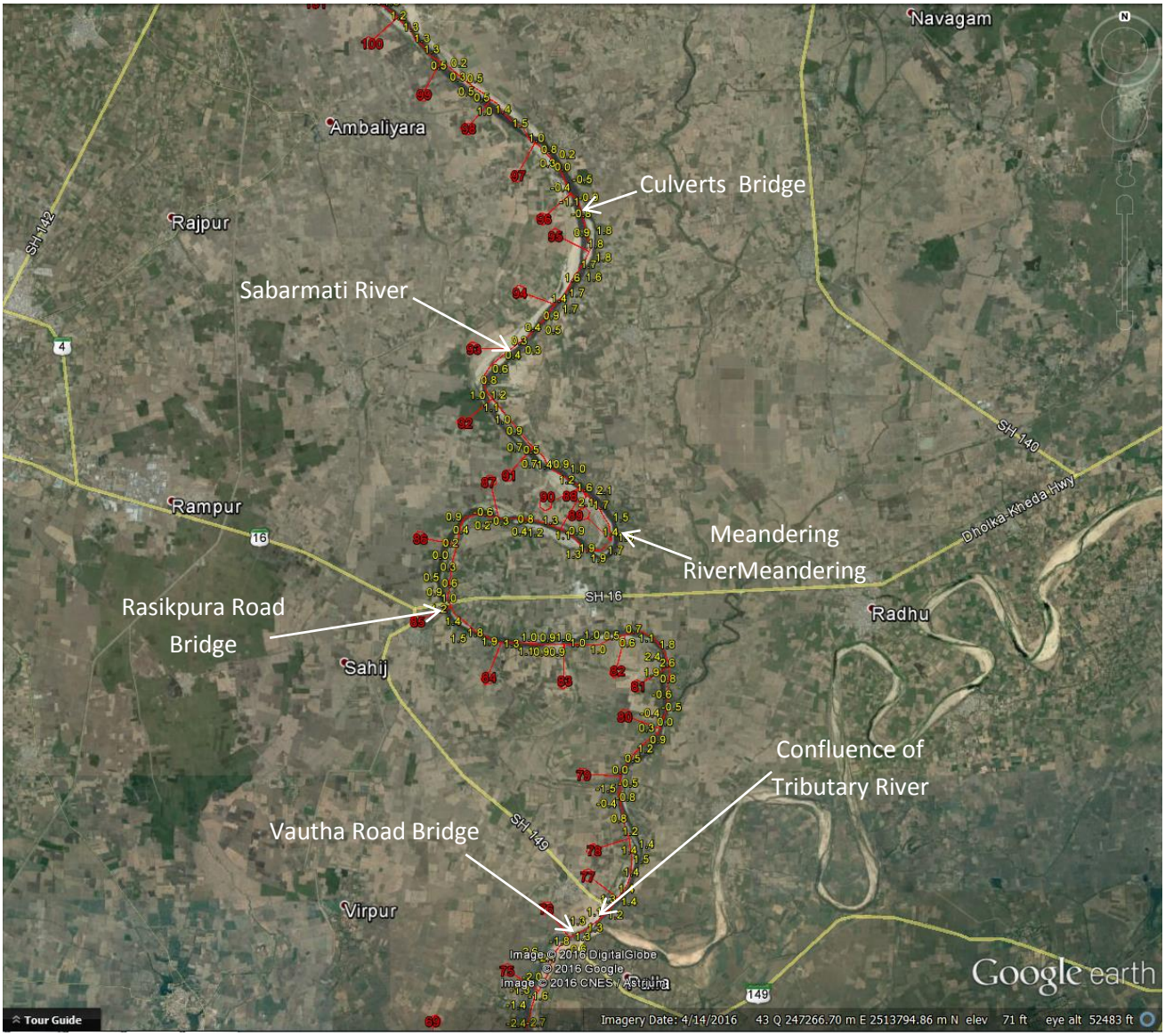
River Stretch (From CH 50.0 to CH 75.0)

Agricultural fields are found on both banks of the river. Sand patches are present on the both side of river bank. Sabarmati River has meandering feature from CH 65.0 to CH 77.0. The reduced water depth in this section minimum is 0 m (CH 74.018) and the maximum is 5.462 m (CH 58.363).



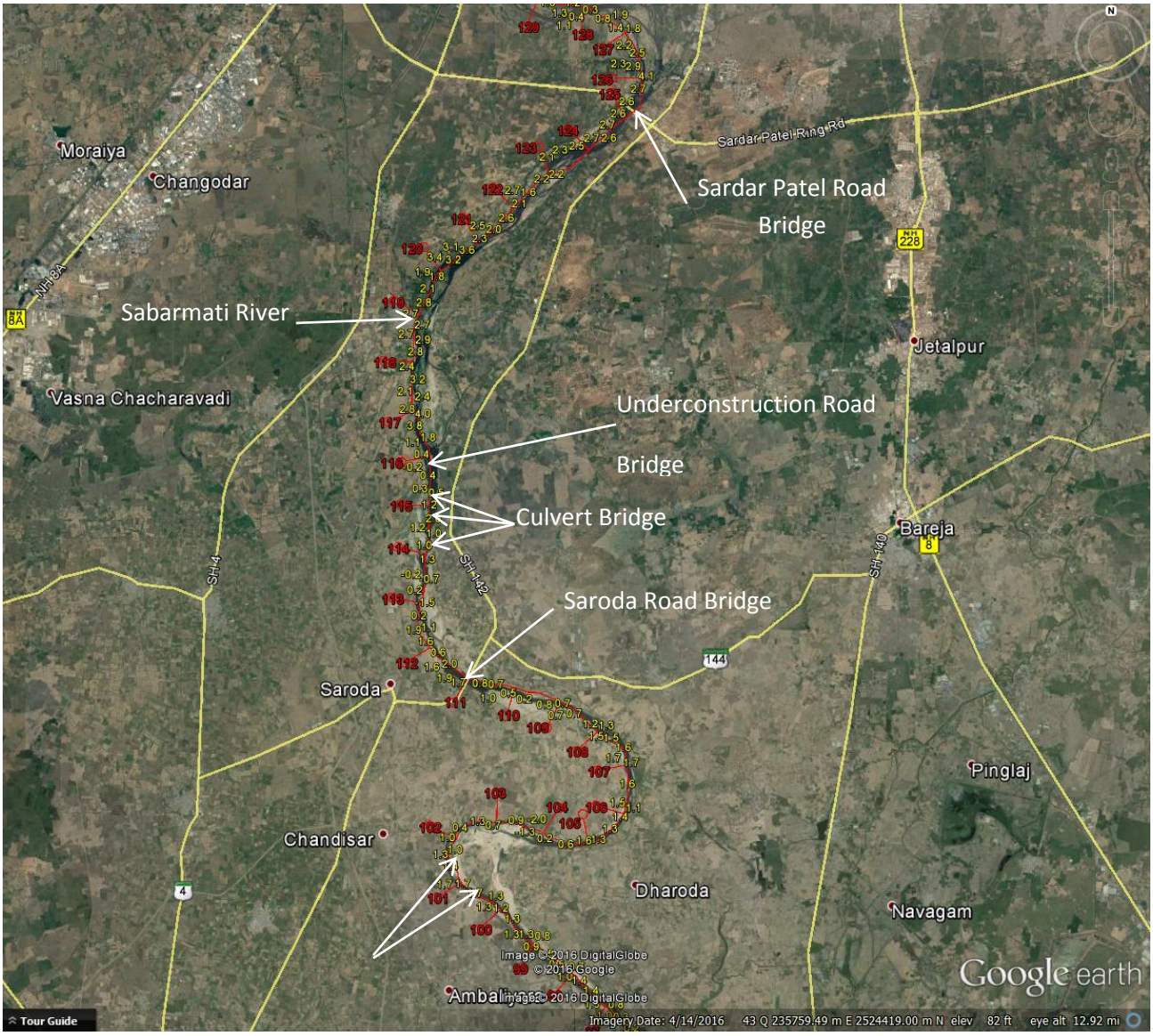
River Stretch (From CH 75.0 to CH 100.0)

Agricultural fields are found on both banks of the river. Sand patches are present on the both side of river bank. River is meandering in this section and one tributary joining the river at CH 80.5. One of the tributary rivers joins Sabarmati River at CH 76.5. Culvert bridges are present at CH 95.3 and 101.3. Vautha Village on the West bank and Palla on the East bank are connected by Vautha Road Bridge at CH 76.0.
The reduced water depth in this section minimum is 0 m (CH 75.518) and the maximum is 2.904 m (CH 86.738).



River Stretch (From CH 100.0 to CH 125.0)

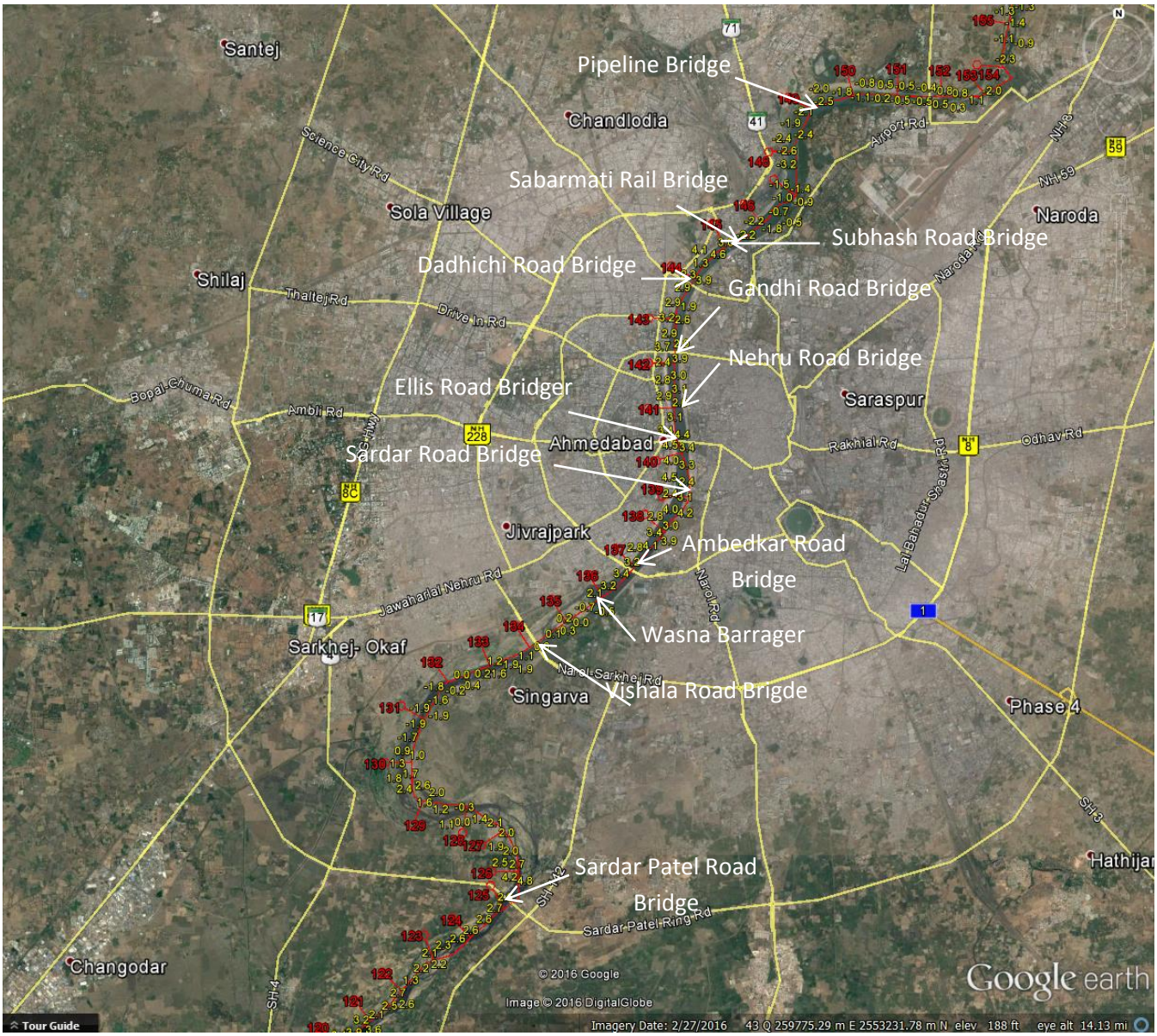
Agricultural fields are found on both banks of the river. River is meandering at CH 106 Saroda Road Bridge at CH 110.9. Six culvert bridges are seen on the river at CH 114.5, 114.9, 115.5, 117.5, 119.1, 119.3 and 122.8. A bridge is currently under construction on the river at CH 115.8. Ashapur Village on the West bank and kamod on the East bank are connected by Sardar Patel Ring Road Bridge at CH 125.2.
The reduced water depth in this section minimum is 0 m (CH 103.163) and the maximum is 4.255 m (CH 120.737).



River Stretch (From CH 125.0 to CH 150.0)

Agricultural fields are found on both banks of the river. Patches of vegetation are also seen along the river bank. Sardar Patel Ring Road Bridge at CH 125.2. One more bridge (Vishala Bridge) crossing the river at Ch 134.1. One barrage at CH 135.7 is also seen across the river. Seven Road bridges and one railway bridge are crossing the river and connects east and west part of the Ahmadabad at CH 136.8, 139.0, 140.2, 140.4, 140.7,142.2, 143.8, 145.0 and 145.4.

The reduced water depth in this section minimum is 0 m (CH 167.446) and the maximum depth is 6.973 m (CH 171.733).



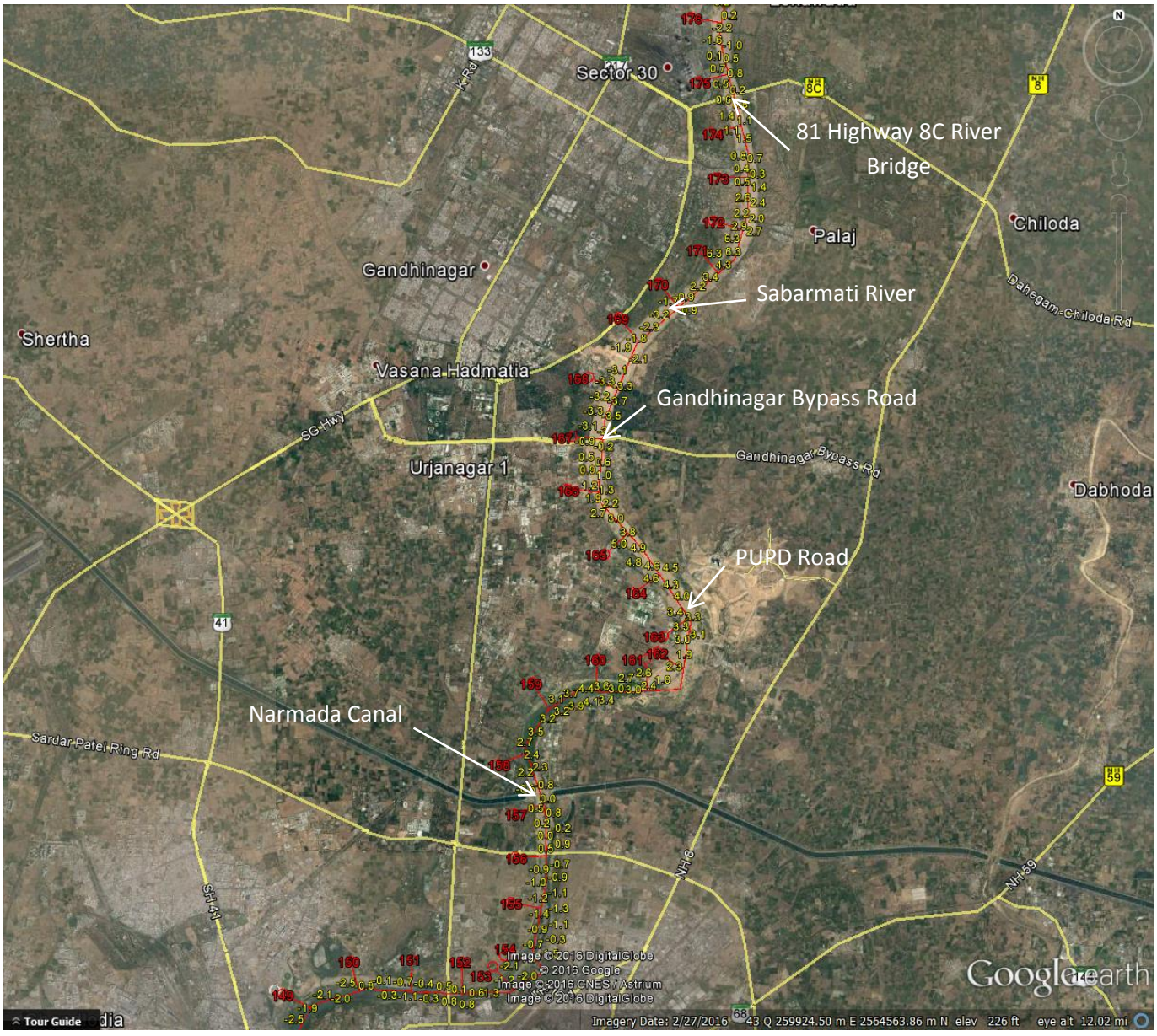
River Stretch (From CH 150.0 to CH 175.0)

Agricultural fields are found on both banks of the river. Valad Village on the East bank and Bhaijipura on the West bank are connected by PDPU Road Bridge at CH 162.5. Shahpur Village on the East bank and Dholakuva on the West bank are connected by Gandhinagar Bypass Road Bridge at CH 166.9.

Chiloda Village on the East bank and Kolavada on the West bank are connected by Sabarmati River Bridge, Near Sector 30 at CH 174.6. Nabhoi Village on the West bank and Karai on the East bank are connected by Narmada Canal at CH 157.2. Water intake tanks are present at CH 168.9 and CH 174.3.

Sabarmati River is meandering between CH 159 and CH 167.

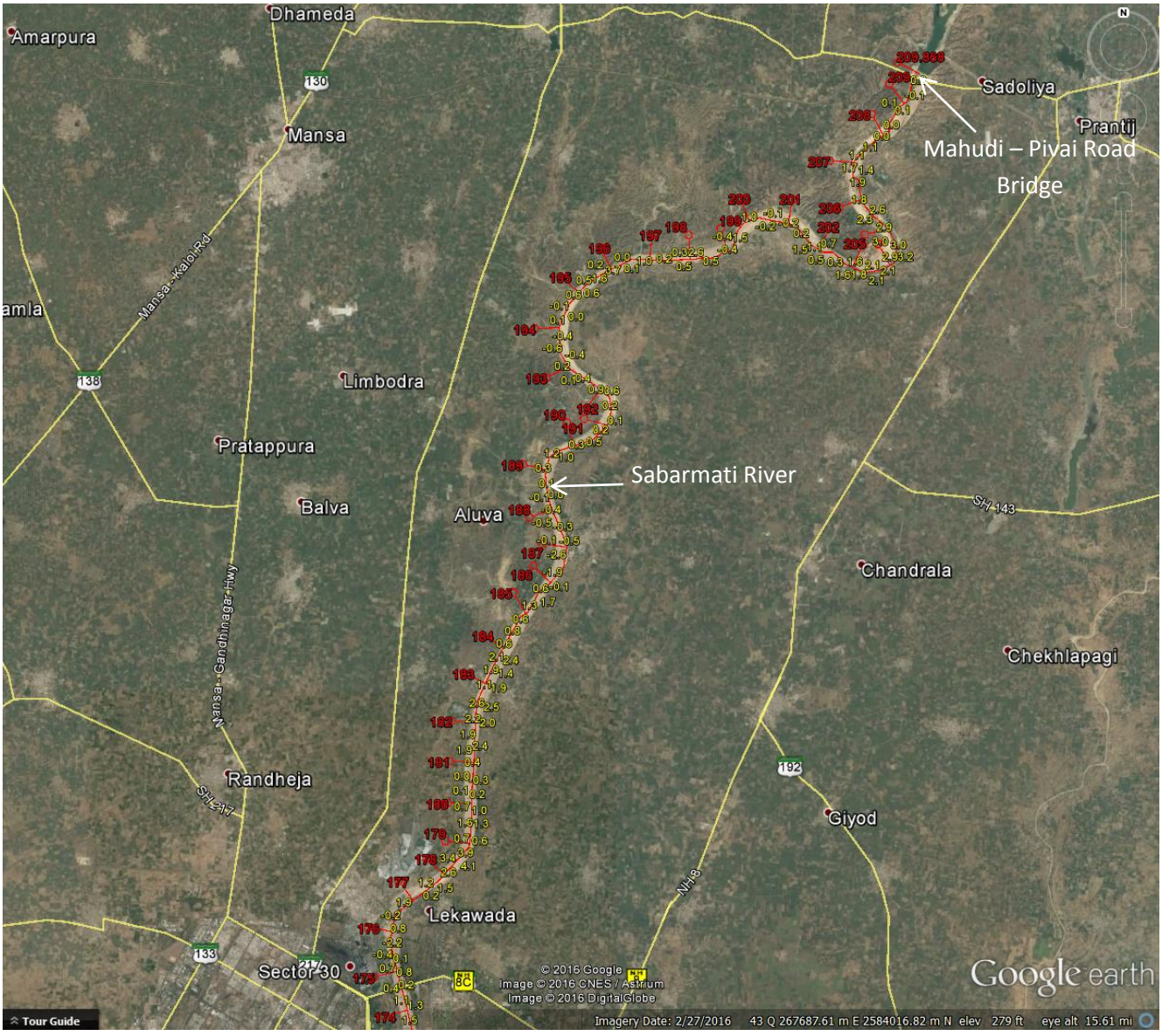
The reduced water depth in this section minimum is 0 m (CH 147.864) and the maximum is 5.473 m (CH 139.033).



River Stretch (From CH 175.0 to CH 209.868)

Agricultural fields are found on both banks of the river. Marshy land is observed from CH 176.0 to CH 177.0. Sadoliya Village on the East bank and Anodiya on the West bank are connected by Mahudi – Pivai Road Bridge at CH 162.5. Sabarmati River is meandering between CH 200 and CH 207.

The Reduced water depth in this section minimum is 0 m (CH 186.540) and the maximum is 5.270 m (CH 176.901).



d) Water levels Bathymetric survey (Tidal)

Chainage (Km)	Type of Survey	Observed Water Depth (m)	Tide (m)	Reduced Water Depth (m)
A	B	C	D	E=C-D
-0.583	Bathy	15.160	8.302	6.858
-0.540	Bathy	15.650	8.266	7.384
-0.487	Bathy	16.130	8.226	7.904
-0.428	Bathy	16.240	8.184	8.056
-0.346	Bathy	16.000	8.137	7.863
-0.267	Bathy	15.330	8.091	7.239
-0.187	Bathy	13.820	8.045	5.775
-0.112	Bathy	12.780	8.000	4.78
-0.048	Bathy	12.580	7.959	4.621
0.026	Bathy	12.370	7.914	4.456
0.105	Bathy	12.190	7.867	4.323
0.189	Bathy	11.860	7.820	4.04
0.270	Bathy	11.660	7.771	3.889
0.362	Bathy	11.420	7.718	3.702
0.462	Bathy	11.140	7.664	3.476
0.554	Bathy	11.030	7.614	3.416
0.635	Bathy	10.930	7.568	3.362
0.715	Bathy	10.810	7.523	3.287
0.793	Bathy	10.850	7.479	3.371
0.872	Bathy	10.810	7.434	3.376
0.952	Bathy	10.810	7.389	3.421
1.030	Bathy	10.700	7.344	3.356
1.108	Bathy	10.750	7.299	3.451
1.185	Bathy	10.630	7.255	3.375
1.282	Bathy	10.600	7.203	3.397
1.382	Bathy	10.560	7.150	3.41
1.481	Bathy	10.430	7.095	3.335
1.576	Bathy	10.320	7.040	3.28
1.658	Bathy	10.300	6.987	3.313
1.734	Bathy	9.900	6.935	2.965
1.813	Bathy	9.340	6.882	2.458
1.894	Bathy	9.230	6.827	2.403
1.981	Bathy	9.640	6.771	2.869
2.066	Bathy	10.580	6.715	3.865
2.150	Bathy	11.020	6.659	4.361
2.235	Bathy	11.280	6.603	4.677
2.325	Bathy	10.960	6.545	4.415
2.418	Bathy	10.310	6.487	3.823
2.514	Bathy	9.930	6.430	3.5
2.597	Bathy	9.890	6.380	3.51
2.673	Bathy	9.610	6.331	3.279

Chainage (Km)	Type of Survey	Observed Water Depth (m)	Tide (m)	Reduced Water Depth (m)
A	B	C	D	E=C-D
2.744	Bathy	9.490	6.285	3.205
2.819	Bathy	9.260	6.237	3.023
2.890	Bathy	9.160	6.189	2.971
3.003	Bathy	9.190	6.128	3.062
3.084	Bathy	9.170	6.077	3.093
3.167	Bathy	8.990	6.027	2.963
3.267	Bathy	9.040	5.968	3.072
3.361	Bathy	8.990	5.909	3.081
3.446	Bathy	9.170	5.852	3.318
3.516	Bathy	9.270	5.800	3.47
3.578	Bathy	9.290	5.749	3.541
3.629	Bathy	9.390	5.703	3.687
3.674	Bathy	9.260	5.657	3.603
3.726	Bathy	8.990	5.609	3.381
3.783	Bathy	8.940	5.559	3.381
3.837	Bathy	8.870	5.511	3.359
3.883	Bathy	8.830	5.466	3.364
4.018	Bathy	8.110	7.024	1.086
4.020	Bathy	8.260	7.011	1.249
4.022	Bathy	7.810	6.999	0.811
4.025	Bathy	7.740	6.984	0.756
4.028	Bathy	7.600	6.966	0.634
4.031	Bathy	8.130	7.027	1.103
4.032	Bathy	7.410	6.949	0.461
4.039	Bathy	7.010	6.928	0.082
4.048	Bathy	6.850	6.907	0
4.056	Bathy	8.240	7.025	1.215
4.090	Bathy	8.060	7.020	1.04
4.133	Bathy	8.190	7.012	1.178
4.181	Bathy	8.210	7.001	1.209
4.242	Bathy	8.010	6.986	1.024
4.310	Bathy	8.120	6.968	1.152
4.389	Bathy	8.100	6.947	1.153
4.483	Bathy	7.980	6.922	1.058
4.579	Bathy	8.070	6.898	1.172
4.667	Bathy	7.770	6.877	0.893
4.757	Bathy	7.750	6.858	0.892
4.857	Bathy	7.600	6.836	0.764
4.957	Bathy	7.660	6.812	0.848
5.057	Bathy	7.610	6.788	0.822
5.157	Bathy	7.430	6.763	0.667
5.257	Bathy	7.360	6.739	0.621
5.357	Bathy	7.740	6.713	1.027

Chainage (Km)	Type of Survey	Observed Water Depth (m)	Tide (m)	Reduced Water Depth (m)
A	B	C	D	E=C-D
5.457	Bathy	8.300	6.685	1.615
5.582	Bathy	8.040	6.650	1.39
5.672	Bathy	7.920	6.629	1.291
5.756	Bathy	8.060	6.613	1.447
5.837	Bathy	8.170	6.599	1.571
5.916	Bathy	7.910	6.584	1.326
6.004	Bathy	7.950	6.564	1.386
6.095	Bathy	7.730	6.541	1.189
6.186	Bathy	8.010	6.519	1.491
6.274	Bathy	7.690	6.498	1.192
6.360	Bathy	7.860	6.480	1.38
6.447	Bathy	7.970	6.459	1.511
6.532	Bathy	7.900	6.436	1.464
6.616	Bathy	7.790	6.413	1.377
6.707	Bathy	8.250	6.387	1.863
6.807	Bathy	9.050	6.357	2.693
6.910	Bathy	11.060	6.325	4.735
7.005	Bathy	9.540	6.297	3.243
7.099	Bathy	8.300	6.269	2.031
7.191	Bathy	7.870	6.241	1.629
7.283	Bathy	7.870	6.214	1.656
7.373	Bathy	8.080	6.187	1.893
7.461	Bathy	8.110	6.161	1.949
7.556	Bathy	8.050	6.132	1.918
7.656	Bathy	7.820	6.101	1.719
7.748	Bathy	7.460	6.073	1.387
7.829	Bathy	7.270	6.049	1.221
7.901	Bathy	7.200	6.027	1.173
7.964	Bathy	7.120	6.008	1.112
8.028	Bathy	6.950	5.986	0.964
8.094	Bathy	6.790	5.964	0.826
8.168	Bathy	6.630	5.939	0.691
8.244	Bathy	6.640	5.914	0.726
8.321	Bathy	6.860	5.888	0.972
8.400	Bathy	7.330	5.862	1.468
8.481	Bathy	7.370	5.834	1.536
8.562	Bathy	7.500	5.807	1.693
8.637	Bathy	7.680	5.782	1.898
8.718	Bathy	7.870	5.755	2.115
8.817	Bathy	8.170	5.722	2.448
8.907	Bathy	8.240	5.691	2.549
8.981	Bathy	8.120	5.667	2.453
9.050	Bathy	8.410	5.644	2.766

Chainage (Km)	Type of Survey	Observed Water Depth (m)	Tide (m)	Reduced Water Depth (m)
A	B	C	D	E=C-D
9.120	Bathy	8.130	5.621	2.509
9.191	Bathy	8.030	5.597	2.433
9.270	Bathy	7.860	5.570	2.29
9.351	Bathy	7.780	5.543	2.237
9.427	Bathy	7.640	5.518	2.122
9.496	Bathy	7.620	5.491	2.129
9.570	Bathy	7.530	5.464	2.066
9.645	Bathy	7.420	5.435	1.985
9.723	Bathy	7.590	5.406	2.184
9.775	Bathy	7.260	5.386	1.874
9.852	Bathy	7.080	5.357	1.723
9.929	Bathy	7.140	5.329	1.811
10.020	Bathy	6.890	5.295	1.595
10.120	Bathy	6.820	5.259	1.561
10.218	Bathy	6.710	5.223	1.487
10.310	Bathy	6.630	5.190	1.44
10.399	Bathy	6.500	5.157	1.343
10.487	Bathy	6.440	5.125	1.315
10.575	Bathy	6.370	5.092	1.278
10.660	Bathy	6.300	5.061	1.239
10.745	Bathy	6.250	5.030	1.22
10.835	Bathy	6.150	4.997	1.153
10.929	Bathy	6.000	4.963	1.037
11.024	Bathy	5.830	4.928	0.902
11.119	Bathy	5.810	4.893	0.917
11.214	Bathy	5.890	4.856	1.034
11.307	Bathy	5.990	4.819	1.171
11.401	Bathy	6.170	4.783	1.387
11.495	Bathy	6.210	4.746	1.464
11.589	Bathy	6.020	4.709	1.311
11.681	Bathy	5.860	4.673	1.187
11.772	Bathy	5.790	4.637	1.153
11.863	Bathy	5.820	4.601	1.219
11.958	Bathy	5.990	4.563	1.427
12.054	Bathy	6.050	4.526	1.524
12.151	Bathy	6.190	4.488	1.702
12.247	Bathy	6.390	4.450	1.94
12.344	Bathy	6.270	4.412	1.858
12.440	Bathy	5.950	4.375	1.575
12.540	Bathy	5.360	4.336	1.024
12.632	Bathy	5.320	4.300	1.02
12.714	Bathy	5.320	4.268	1.052
12.783	Bathy	5.430	4.239	1.191

Chainage (Km) A	Type of Survey B	Observed Water Depth (m) C	Tide (m) D	Reduced Water Depth (m) E=C-D
12.853	Bathy	5.330	4.211	1.119
12.929	Bathy	5.200	4.180	1.02
12.999	Bathy	5.120	4.151	0.969
13.065	Bathy	5.030	4.121	0.909
13.126	Bathy	5.040	4.092	0.948
13.182	Bathy	4.940	4.065	0.875
13.239	Bathy	5.080	4.037	1.043
13.303	Bathy	4.870	4.007	0.863
13.348	Bathy	4.170	3.545	0.625
13.366	Bathy	4.860	3.978	0.882
13.417	Bathy	3.930	3.519	0.411
13.423	Bathy	4.920	3.950	0.97
13.481	Bathy	4.800	3.922	0.878
13.486	Bathy	3.640	3.493	0.147
13.537	Bathy	4.750	3.895	0.855
13.560	Bathy	3.460	3.465	0
13.626	Bathy	3.300	3.436	0
13.694	Bathy	3.040	3.407	0
13.766	Bathy	2.860	3.377	0

4.5.2 Topographic Survey

a) Length of stretch for which topographic survey has been carried out

Since the water depth is shallow in the following reaches and bathymetry survey was not possible, therefore water depth & river bed levels are taken by topography survey manually.

From (Km)	To (Km)
33.459	35.922
39.911	41.379
43.09	46.755
81.293	135.903
145.573	209.716

All the above stretches are already shown in google images in Para 4.5.1 (b). However, where the topographic survey has been perform continuously for more than 5 km are given below for more clarity.

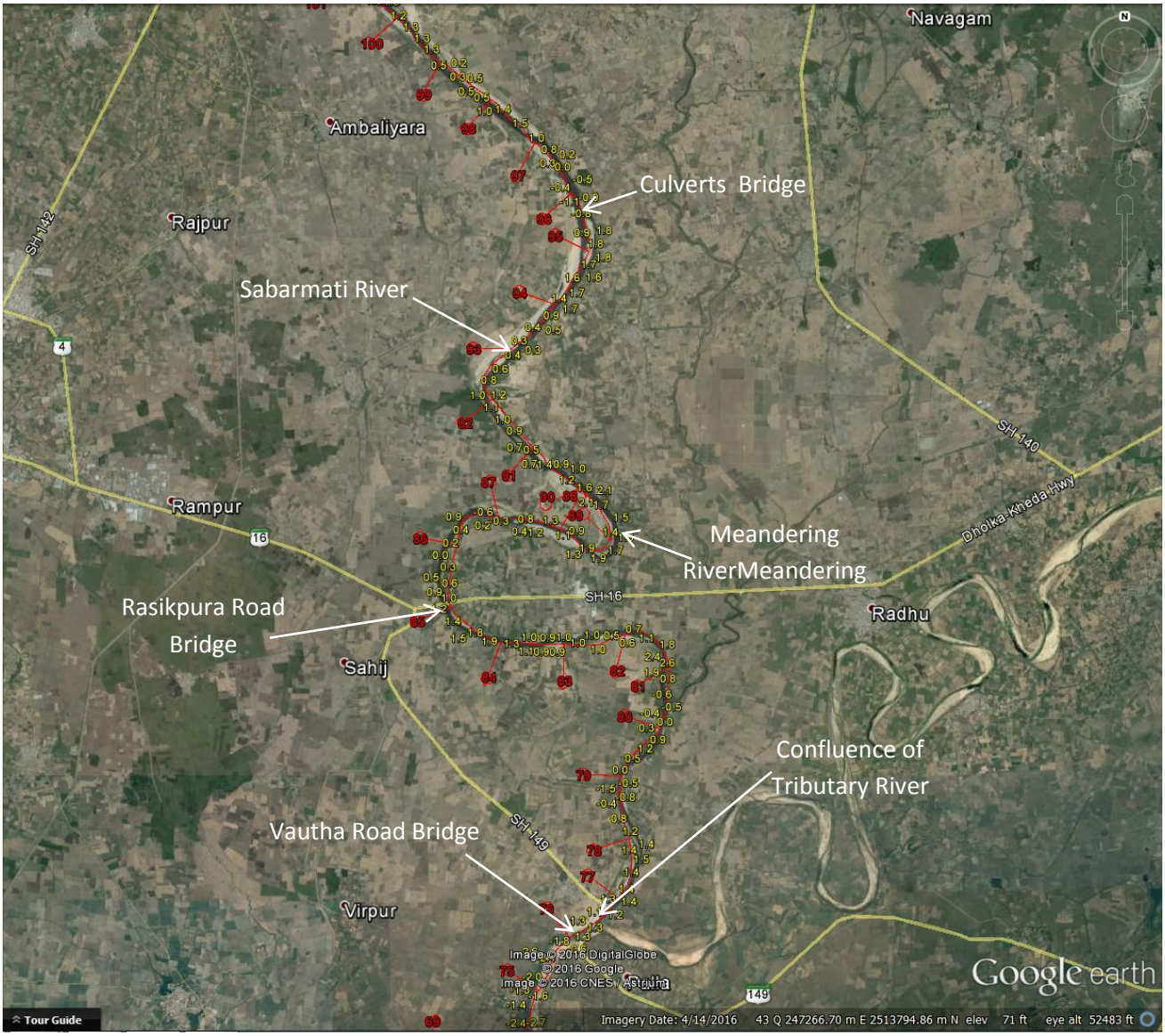
b) Minimum and Maximum Depths

As per IWAI suggestion, following sign convention is adopted

(+) : Riverbed below CD
(-) : Riverbed above CD
(+) : Water Depth below CD
(-) : Water Depth above CD

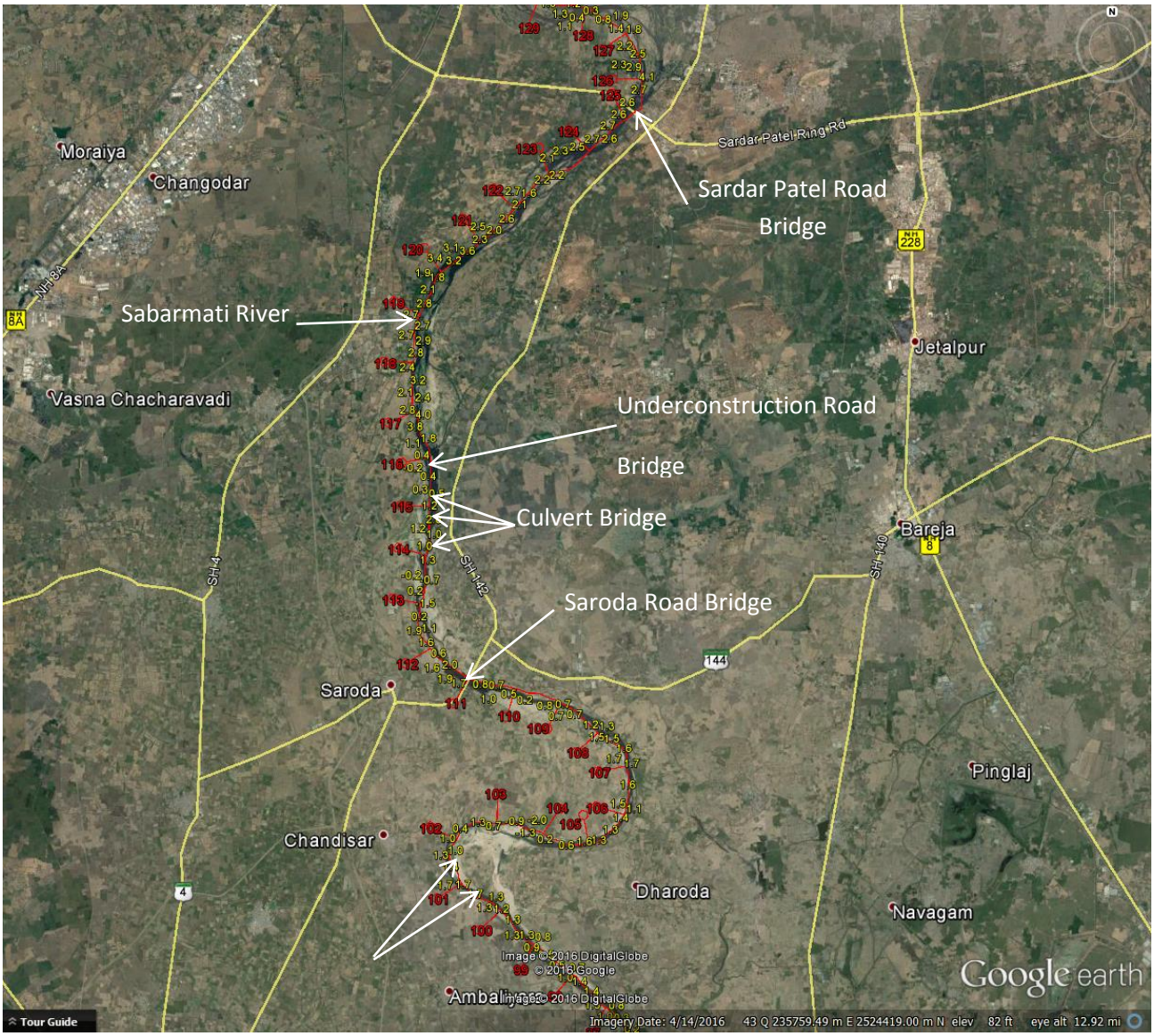
River Stretch (From CH 81.293 to CH 100.0)

Agricultural fields are found on both banks of the river. Sand patches are present on the both side of river bank. Culvert bridges are present at CH 95.3 and 101.3. Vautha Village on the West bank and Palla on the East bank are connected by Vautha Road Bridge at CH 76.0.



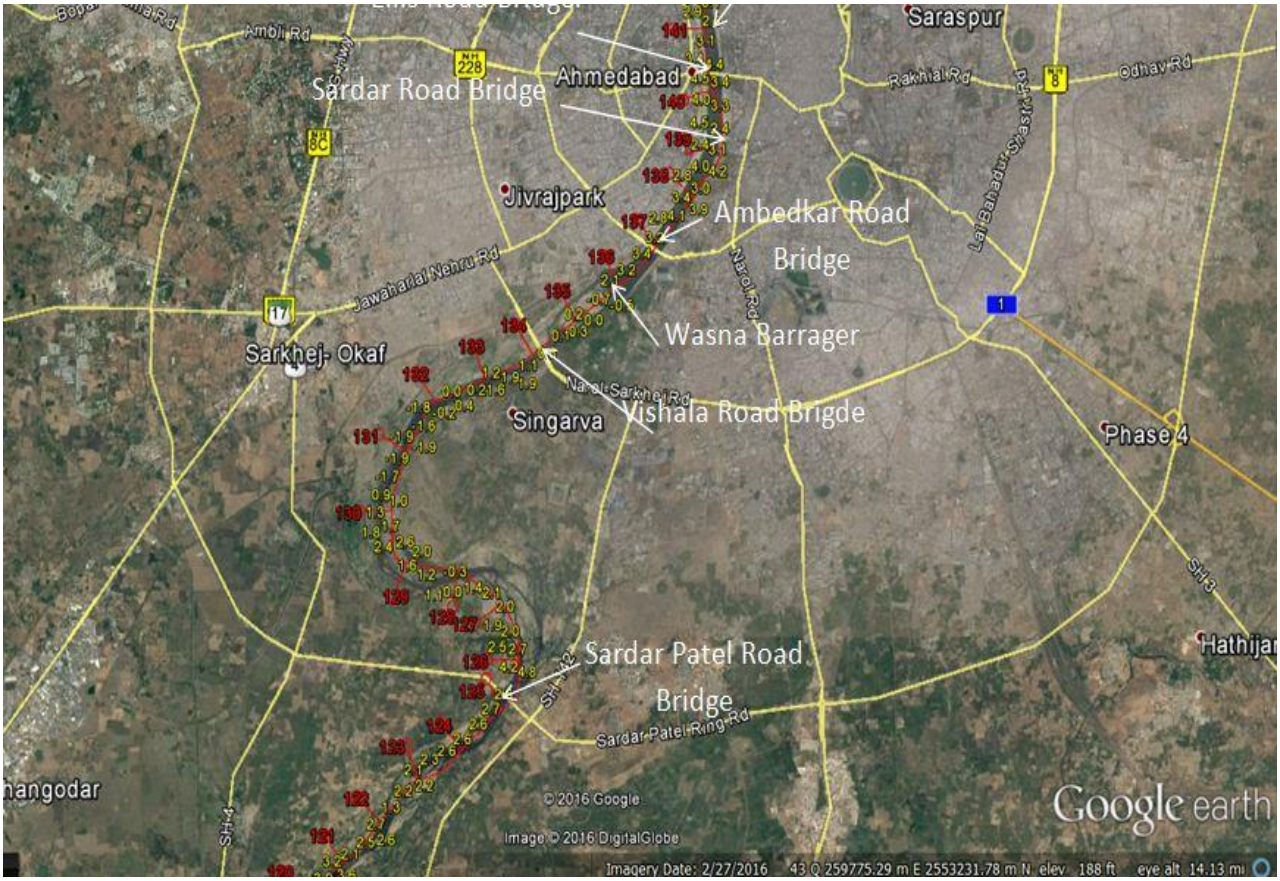
River Stretch (From CH 100.0 to CH 125.0)

Agricultural fields are found on both banks of the river. River is meandering at CH 106, Saroda Road Bridge at CH 110.9. Six culvert bridges are seen on the river at CH 114.5, 114.9, 115.5, 117.5, 119.1, 119.3 and 122.8. A bridge is currently under construction on the river at CH 115.8. Ashapur Village on the West bank and kamod on the East bank are connected by Sardar Patel Ring Road Bridge at CH 125.2.



River Stretch (From CH 125.0 to CH 135.903)

Agricultural fields are found on both banks of the river. Patches of vegetation are also seen along the river bank. Sardar Patel Ring Road Bridge at CH 125.2. One more bridge (Vishala Bridge) crossing the river at Ch 134.1. One barrage at CH 135.7 is also seen across the river.

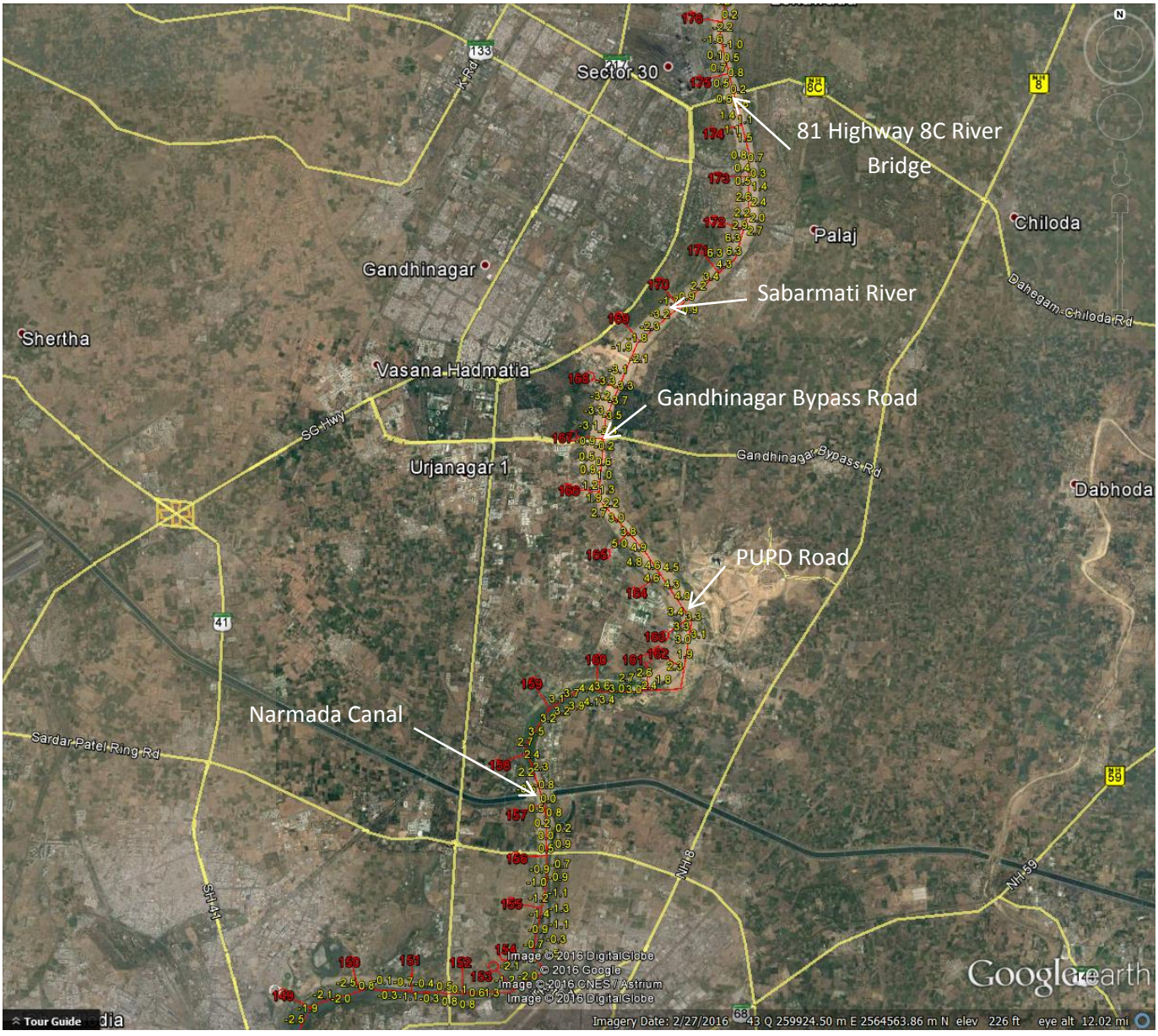


River Stretch (From CH 145.573 to CH 175.0)

Agricultural fields are found on both banks of the river. Valad Village on the East bank and Bhaijipura on the West bank are connected by PDPU Road Bridge at CH 162.5. Shahpur Village on the East bank and Dholakuva on the West bank are connected by Gandhinagar Bypass Road Bridge at CH 166.9.

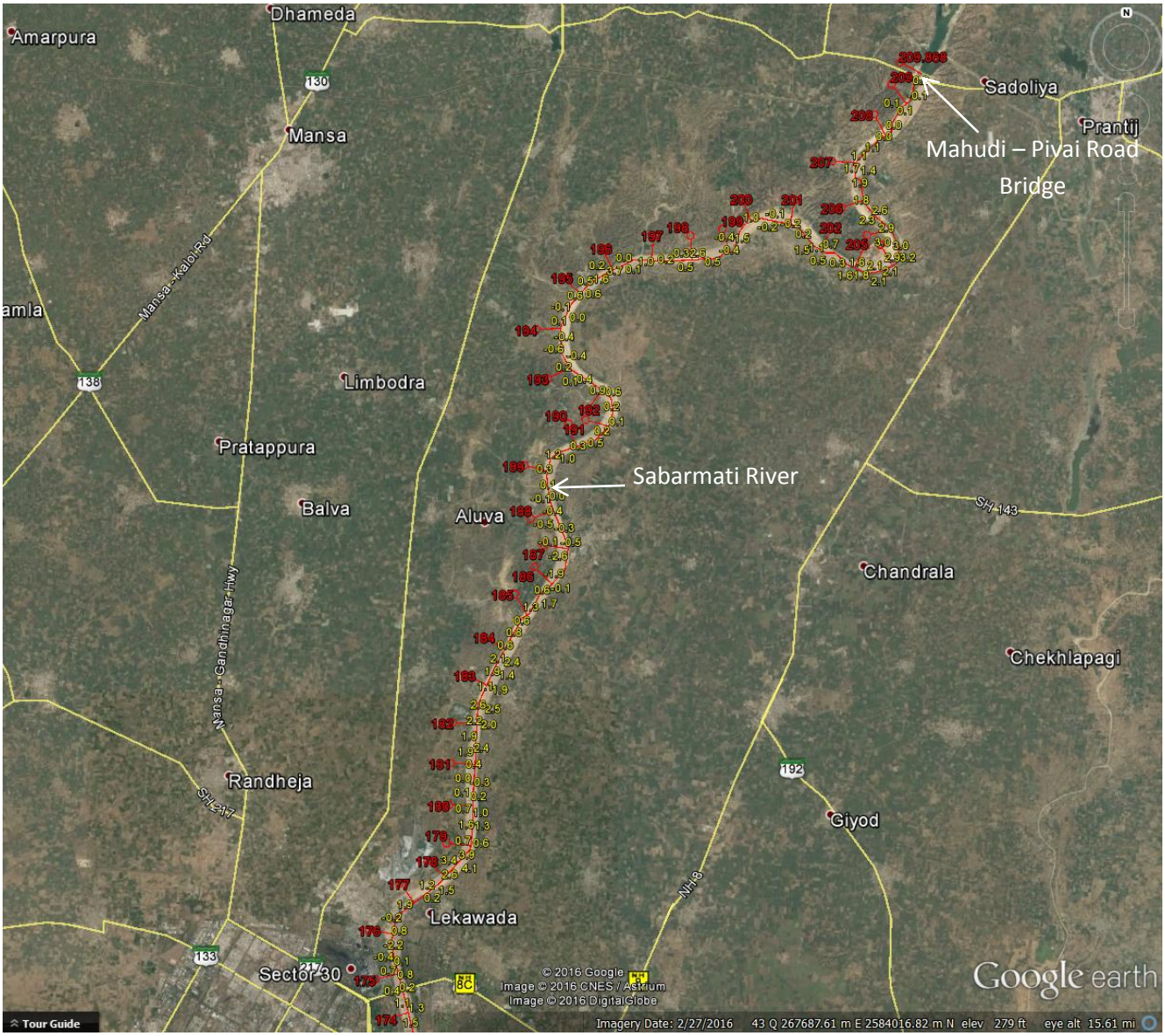
Chiloda Village on the East bank and Kolavada on the West bank are connected by Sabarmati River Bridge, Near Sector 30 at CH 174.6. Nabhoi Village on the West bank and Karai on the East bank are connected by Narmada Canal at CH 157.2. Water intake tanks are present at CH 168.9 and CH 174.3.

Sabarmati River is meandering between CH 159 and CH 167.



River Stretch (From CH 175.0 to CH 209.868)

Agricultural fields are found on both banks of the river. Marshy land is observed from CH 176.0 to CH 177.0. Sadoliya Village on the East bank and Anodiya on the West bank are connected by Mahudi – Pivai Road Bridge at CH 162.5. Sabarmati River is meandering between CH 200 and CH 207.



c) *Water levels during reconnaissance survey*

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
13.835	Bathy	4.958	2.79	7.002	2.044
13.900	Bathy	5.190	2.62	7.004	1.814
13.966	Bathy	5.201	2.55	7.006	1.805
14.069	Bathy	5.319	2.49	7.008	1.689
14.126	Bathy	5.422	2.39	7.010	1.588
14.179	Bathy	5.270	2.54	7.011	1.741
14.250	Bathy	5.424	2.38	7.013	1.589
14.328	Bathy	5.357	2.44	7.016	1.659
14.420	Bathy	5.434	2.40	7.018	1.584
14.518	Bathy	5.425	2.36	7.021	1.596
14.613	Bathy	5.593	2.20	7.024	1.431
14.709	Bathy	5.693	2.12	7.026	1.333
14.808	Bathy	5.743	2.03	7.029	1.286
14.908	Bathy	5.933	1.89	7.032	1.099
15.006	Bathy	5.869	1.90	7.034	1.165
15.099	Bathy	5.878	1.90	7.037	1.159
15.179	Bathy	5.950	1.84	7.039	1.089
15.254	Bathy	5.899	1.90	7.041	1.142
15.343	Bathy	5.865	1.87	7.044	1.179
15.439	Bathy	5.879	1.93	7.046	1.167
15.537	Bathy	5.850	1.92	7.049	1.199
15.633	Bathy	5.783	2.00	7.052	1.269
15.728	Bathy	5.751	1.99	7.054	1.303
15.824	Bathy	5.728	2.09	7.057	1.329
15.924	Bathy	5.578	2.15	7.060	1.482
16.024	Bathy	5.574	2.20	7.063	1.489
16.124	Bathy	5.446	2.32	7.065	1.619
16.220	Bathy	5.361	2.40	7.068	1.707
16.314	Bathy	5.460	2.31	7.071	1.611
16.405	Bathy	5.431	2.27	7.073	1.642
16.494	Bathy	5.512	2.24	7.076	1.564
16.584	Bathy	5.567	2.13	7.078	1.511
16.676	Bathy	5.638	2.10	7.081	1.443
16.768	Bathy	5.647	2.07	7.083	1.436
16.859	Bathy	5.659	2.06	7.086	1.427
16.951	Bathy	5.681	2.09	7.088	1.407
17.046	Bathy	5.618	2.07	7.091	1.473
17.139	Bathy	5.725	2.06	7.094	1.369
17.230	Bathy	5.640	2.11	7.096	1.456
17.315	Bathy	5.626	2.18	7.099	1.473
17.391	Bathy	5.467	2.32	7.101	1.634
17.505	Bathy	5.467	2.32	7.101	1.634
17.632	Bathy	5.739	2.03	7.111	1.372
17.776	Bathy	5.739	2.03	7.111	1.372

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
17.874	Bathy	5.927	1.86	7.114	1.187
17.973	Bathy	5.961	1.76	7.117	1.156
18.072	Bathy	6.110	1.70	7.120	1.01
18.172	Bathy	6.146	1.65	7.122	0.976
18.243	Bathy	6.199	1.53	7.124	0.925
18.299	Bathy	5.600	2.23	7.126	1.526
18.352	Bathy	5.937	1.79	7.127	1.19
18.452	Bathy	6.163	1.67	7.130	0.967
18.537	Bathy	6.152	1.60	7.132	0.98
18.617	Bathy	6.096	1.75	7.135	1.039
18.697	Bathy	6.072	1.68	7.137	1.065
18.791	Bathy	6.119	1.78	7.140	1.021
18.874	Bathy	5.815	1.97	7.142	1.327
18.962	Bathy	5.824	2.05	7.144	1.32
19.049	Bathy	5.672	2.16	7.147	1.475
19.142	Bathy	5.399	2.42	7.149	1.75
19.238	Bathy	6.368	1.45	7.152	0.784
19.334	Bathy	6.322	1.52	7.155	0.833
19.431	Bathy	6.310	1.51	7.157	0.847
19.531	Bathy	6.363	1.43	7.160	0.797
19.631	Bathy	6.958	1.38	7.163	0.205
19.730	Bathy	7.088	1.25	7.166	0.078
19.824	Bathy	7.165	1.17	7.168	0.003
19.893	Bathy	7.194	1.15	7.170	0
19.928	Bathy	7.208	1.14	7.171	0
19.940	Bathy	6.767	1.83	7.171	0.404
19.955	Bathy	6.708	1.85	7.172	0.464
19.959	Bathy	7.541	1.03	7.172	0
20.015	Bathy	6.586	1.99	7.174	0.588
20.024	Bathy	7.546	1.01	7.174	0
20.089	Bathy	6.531	2.04	7.176	0.645
20.098	Bathy	7.550	1.04	7.176	0
20.143	Bathy	7.572	0.99	7.177	0
20.173	Bathy	6.291	2.06	7.178	0.887
20.265	Bathy	5.822	2.28	7.180	1.358
20.318	Bathy	5.592	2.47	7.182	1.59
20.403	Bathy	5.347	2.52	7.184	1.837
20.503	Bathy	5.174	2.55	7.187	2.013
20.603	Bathy	4.590	2.99	7.190	2.6
20.703	Bathy	3.816	3.57	7.193	3.377
20.802	Bathy	3.484	3.68	7.195	3.711
20.902	Bathy	3.364	3.90	7.198	3.834
21.001	Bathy	3.020	4.23	7.201	4.181
21.101	Bathy	2.974	4.29	7.204	4.23
21.201	Bathy	3.082	4.17	7.206	4.124
21.301	Bathy	3.147	4.12	7.209	4.062
21.398	Bathy	3.185	4.08	7.212	4.027

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
21.495	Bathy	3.222	4.04	7.215	3.993
21.591	Bathy	3.289	3.97	7.217	3.928
21.688	Bathy	3.331	3.91	7.220	3.889
21.783	Bathy	3.370	3.87	7.223	3.853
21.879	Bathy	3.439	3.79	7.225	3.786
21.959	Bathy	3.477	3.75	7.228	3.751
21.994	Bathy	5.713	1.51	7.228	1.515
22.050	Bathy	3.530	3.68	7.230	3.7
22.063	Bathy	5.664	1.55	7.230	1.566
22.135	Bathy	5.409	1.79	7.232	1.823
22.207	Bathy	5.186	2.02	7.234	2.048
22.276	Bathy	4.943	2.25	7.236	2.293
22.347	Bathy	4.610	2.59	7.238	2.628
22.417	Bathy	4.274	2.91	7.240	2.966
22.494	Bathy	4.215	2.96	7.242	3.027
22.575	Bathy	4.179	2.99	7.245	3.066
22.667	Bathy	4.194	2.95	7.247	3.053
22.765	Bathy	4.126	3.02	7.250	3.124
22.864	Bathy	4.144	3.00	7.253	3.109
22.964	Bathy	3.657	3.48	7.255	3.598
23.064	Bathy	4.014	3.12	7.258	3.244
23.164	Bathy	3.593	3.55	7.261	3.668
23.264	Bathy	3.913	3.26	7.264	3.351
23.364	Bathy	4.472	2.69	7.266	2.794
23.463	Bathy	4.894	2.28	7.269	2.375
23.561	Bathy	4.811	2.35	7.272	2.461
23.660	Bathy	4.231	2.93	7.275	3.044
23.759	Bathy	4.662	2.50	7.277	2.615
23.859	Bathy	4.613	2.56	7.280	2.667
23.959	Bathy	3.169	3.99	7.283	4.114
24.059	Bathy	4.119	3.02	7.286	3.167
24.158	Bathy	4.577	2.55	7.289	2.712
24.256	Bathy	4.722	2.40	7.291	2.569
24.353	Bathy	4.640	2.45	7.294	2.654
24.449	Bathy	4.360	2.72	7.297	2.937
24.546	Bathy	3.841	3.23	7.299	3.458
24.641	Bathy	4.113	2.94	7.302	3.189
24.711	Bathy	5.215	1.85	7.304	2.089
24.711	Bathy	5.145	1.91	7.304	2.159
24.711	Bathy	5.150	1.92	7.304	2.154
24.711	Bathy	5.051	2.01	7.304	2.253
24.711	Bathy	4.411	2.71	7.304	2.893
24.751	Bathy	5.222	1.89	7.305	2.083
24.849	Bathy	5.271	1.84	7.308	2.037
24.949	Bathy	5.272	1.84	7.311	2.039
25.039	Bathy	5.424	1.68	7.313	1.889
25.139	Bathy	5.521	1.58	7.316	1.795

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
25.229	Bathy	5.551	1.55	7.318	1.767
25.323	Bathy	5.315	1.78	7.321	2.006
25.423	Bathy	4.357	2.73	7.324	2.967
25.519	Bathy	4.297	2.83	7.326	3.029
25.603	Bathy	4.595	2.54	7.329	2.734
25.676	Bathy	4.963	2.18	7.331	2.368
25.745	Bathy	5.232	1.91	7.333	2.101
25.810	Bathy	5.501	1.64	7.334	1.833
25.870	Bathy	5.728	1.40	7.336	1.608
25.903	Bathy	6.021	1.10	7.337	1.316
25.952	Bathy	6.161	0.96	7.338	1.177
25.998	Bathy	6.266	0.93	7.340	1.074
26.041	Bathy	6.226	0.94	7.341	1.115
26.087	Bathy	6.223	0.96	7.342	1.119
26.134	Bathy	6.039	1.13	7.343	1.304
26.187	Bathy	5.338	1.83	7.345	2.007
26.260	Bathy	5.222	1.95	7.347	2.125
26.344	Bathy	4.653	2.51	7.349	2.696
26.433	Bathy	5.138	2.07	7.352	2.214
26.525	Bathy	4.912	2.29	7.354	2.442
26.623	Bathy	4.906	2.30	7.357	2.451
26.724	Bathy	5.086	2.14	7.360	2.274
26.824	Bathy	5.207	2.01	7.363	2.156
26.924	Bathy	5.336	1.89	7.365	2.029
27.022	Bathy	5.603	1.63	7.368	1.765
27.121	Bathy	5.597	1.64	7.371	1.774
27.221	Bathy	5.662	1.58	7.374	1.712
27.320	Bathy	5.835	1.41	7.376	1.541
27.417	Bathy	5.887	1.35	7.379	1.492
27.516	Bathy	5.946	1.30	7.382	1.436
27.615	Bathy	6.059	1.20	7.385	1.326
27.632	Bathy	5.991	1.26	7.385	1.394
27.685	Bathy	6.024	1.24	7.387	1.363
27.702	Bathy	5.915	1.35	7.387	1.472
27.785	Bathy	5.618	1.61	7.389	1.771
27.801	Bathy	5.537	1.70	7.390	1.853
27.879	Bathy	4.876	2.36	7.392	2.516
27.897	Bathy	5.042	2.20	7.392	2.35
27.974	Bathy	5.637	1.60	7.395	1.758
27.994	Bathy	5.552	1.63	7.395	1.843
28.071	Bathy	5.340	1.82	7.397	2.057
28.093	Bathy	5.426	1.74	7.398	1.972
28.171	Bathy	5.600	1.55	7.400	1.8
28.192	Bathy	5.278	1.81	7.401	2.123
28.270	Bathy	4.798	2.27	7.403	2.605
28.292	Bathy	4.955	2.10	7.403	2.448
28.370	Bathy	5.498	1.53	7.406	1.908

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
28.391	Bathy	4.952	2.04	7.406	2.454
28.470	Bathy	5.763	1.22	7.408	1.645
28.490	Bathy	4.707	2.27	7.409	2.702
28.570	Bathy	5.678	1.28	7.411	1.733
28.589	Bathy	5.397	1.55	7.412	2.015
28.666	Bathy	5.902	1.03	7.414	1.512
28.688	Bathy	5.709	1.19	7.414	1.705
28.763	Bathy	5.157	1.72	7.416	2.259
28.785	Bathy	4.937	1.92	7.417	2.48
28.854	Bathy	5.054	1.77	7.419	2.365
28.878	Bathy	4.877	1.75	7.420	2.543
28.944	Bathy	4.917	1.61	7.421	2.504
28.975	Bathy	5.547	0.89	7.422	1.875
29.035	Bathy	4.749	1.51	7.424	2.675
29.047	Bathy	4.578	1.57	7.424	2.846
29.093	Bathy	4.656	1.38	7.426	2.77
29.122	Bathy	4.514	1.42	7.426	2.912
29.189	Bathy	4.381	1.46	7.428	3.047
29.486	Bathy	4.000	2.150	7.437	3.437
29.584	Bathy	4.030	2.330	7.439	3.409
29.684	Bathy	4.100	2.480	7.442	3.342
29.784	Bathy	4.250	2.450	7.445	3.195
29.884	Bathy	4.350	2.890	7.448	3.098
29.983	Bathy	4.500	3.150	7.450	2.95
30.083	Bathy	4.600	3.260	7.453	2.853
30.183	Bathy	4.670	3.460	7.456	2.786
30.283	Bathy	4.730	3.690	7.459	2.729
30.383	Bathy	4.830	3.810	7.461	2.631
30.482	Bathy	4.950	4.010	7.464	2.514
30.529	Bathy	5.010	4.030	7.465	2.455
30.620	Bathy	5.030	3.750	7.468	2.438
30.711	Bathy	5.050	3.670	7.470	2.42
30.801	Bathy	5.070	3.660	7.473	2.403
30.892	Bathy	5.090	3.690	7.476	2.386
30.983	Bathy	5.110	3.640	7.478	2.368
31.026	Bathy	5.450	3.100	7.479	2.029
31.072	Bathy	5.550	2.100	7.481	1.931
31.168	Bathy	5.650	1.600	7.483	1.833
31.265	Bathy	5.750	1.450	7.486	1.736
31.362	Bathy	5.850	1.010	7.489	1.639
31.459	Bathy	5.950	0.810	7.491	1.541
31.547	Bathy	6.300	0.450	7.494	1.194
31.606	Bathy	6.100	0.490	7.495	1.395
31.706	Bathy	5.900	0.710	7.498	1.598
31.805	Bathy	5.700	0.870	7.501	1.801
31.905	Bathy	5.500	0.960	7.504	2.004
32.004	Bathy	5.300	1.200	7.506	2.206

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
32.104	Bathy	5.100	1.590	7.509	2.409
32.192	Bathy	4.900	1.780	7.512	2.612
32.295	Bathy	4.900	1.780	7.512	2.612
32.408	Bathy	4.700	1.910	7.518	2.818
32.507	Bathy	4.500	2.060	7.520	3.02
32.556	Bathy	4.520	2.110	7.522	3.002
32.640	Bathy	4.940	1.920	7.524	2.584
32.723	Bathy	5.250	1.670	7.526	2.276
32.865	Bathy	5.250	1.670	7.526	2.276
33.016	Bathy	5.500	1.430	7.535	2.035
33.113	Bathy	5.890	1.180	7.537	1.647
33.211	Bathy	6.190	0.920	7.540	1.35
33.309	Bathy	6.380	0.660	7.543	1.163
33.359	Bathy	6.490	0.520	7.544	1.054
33.459	Topo	6.570	0.410	7.547	0.977
33.559	Topo	6.650	0.380	7.550	0.9
33.659	Topo	6.730	0.430	7.552	0.822
33.759	Topo	6.770	0.310	7.555	0.785
33.859	Topo	6.820	0.360	7.558	0.738
33.959	Topo	6.860	0.260	7.561	0.701
34.009	Topo	6.770	0.310	7.562	0.792
34.108	Topo	6.560	0.450	7.565	1.005
34.208	Topo	6.340	0.390	7.568	1.228
34.308	Topo	6.110	0.470	7.570	1.46
34.407	Topo	5.900	0.590	7.573	1.673
34.507	Topo	5.720	0.430	7.576	1.856
34.607	Topo	5.510	0.690	7.579	2.069
34.706	Topo	5.320	0.730	7.581	2.261
34.860	Topo	5.230	0.850	7.586	2.356
34.922	Topo	5.010	0.720	7.587	2.577
35.022	Topo	4.780	0.630	7.590	2.81
35.122	Topo	4.480	0.540	7.593	3.113
35.222	Topo	4.220	0.450	7.596	3.376
35.322	Topo	3.910	0.390	7.599	3.689
35.422	Topo	3.650	0.250	7.601	3.951
35.522	Topo	3.400	0.250	7.604	4.204
35.613	Topo	3.210	0.150	7.607	4.397
35.670	Topo	3.300	0.220	7.608	4.308
35.766	Topo	3.390	0.210	7.611	4.221
35.860	Topo	3.390	0.210	7.611	4.221
35.922	Topo	3.466	0.460	7.615	4.149
36.022	Bathy	3.550	0.660	7.618	4.068
36.121	Bathy	3.620	0.720	7.621	4.001
36.221	Bathy	3.680	0.790	7.624	3.944
36.321	Bathy	3.750	0.850	7.626	3.876
36.421	Bathy	3.820	0.860	7.629	3.809
36.520	Bathy	3.900	0.900	7.632	3.732

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
36.845	Bathy	3.979	0.820	7.641	3.662
36.926	Bathy	4.090	0.860	7.643	3.553
37.007	Bathy	4.190	0.910	7.645	3.455
37.088	Bathy	4.235	0.930	7.648	3.413
37.176	Bathy	4.330	0.980	7.650	3.32
37.267	Bathy	4.400	0.820	7.653	3.253
37.351	Bathy	4.450	0.910	7.655	3.205
37.450	Bathy	4.530	0.950	7.658	3.128
37.549	Bathy	4.630	1.000	7.660	3.03
37.649	Bathy	4.680	1.000	7.663	2.983
37.748	Bathy	4.748	1.000	7.666	2.918
37.847	Bathy	4.830	1.000	7.669	2.839
37.930	Bathy	4.870	1.000	7.671	2.801
38.017	Bathy	4.960	1.000	7.673	2.713
38.117	Bathy	5.030	1.000	7.676	2.646
38.217	Bathy	5.110	1.000	7.679	2.569
38.317	Bathy	5.190	1.000	7.682	2.492
38.417	Bathy	2.540	1.000	7.684	5.144
38.513	Bathy	5.240	1.000	7.687	2.447
38.609	Bathy	5.230	1.000	7.690	2.46
38.705	Bathy	5.220	1.000	7.692	2.472
38.818	Bathy	5.200	1.000	7.696	2.496
38.918	Bathy	5.190	1.000	7.698	2.508
38.985	Bathy	5.180	1.000	7.700	2.52
39.068	Bathy	5.611	1.000	7.703	2.091
39.167	Bathy	6.043	1.000	7.705	1.663
39.267	Bathy	6.474	1.000	7.708	1.234
39.366	Bathy	6.905	0.950	7.711	0.806
39.466	Bathy	7.340	0.840	7.714	0.374
39.566	Bathy	7.768	0.730	7.716	0
39.666	Bathy	8.112	0.600	7.719	0
39.766	Bathy	8.452	0.570	7.722	0
39.815	Bathy	8.610	0.520	7.723	0
39.911	Topo	8.550	0.420	7.726	0
40.045	Topo	8.500	0.430	7.730	0
40.142	Topo	8.450	0.390	7.732	0
40.239	Topo	8.400	0.260	7.735	0
40.336	Topo	8.370	0.240	7.738	0
40.432	Topo	8.330	0.280	7.740	0
40.532	Topo	8.280	0.150	7.743	0
40.632	Topo	8.240	0.190	7.746	0
40.731	Topo	8.190	0.100	7.749	0
40.831	Topo	8.160	0.080	7.752	0
40.910	Topo	8.110	0.050	7.754	0
40.981	Topo	7.990	0.150	7.756	0
41.081	Topo	7.815	0.250	7.758	0
41.180	Topo	7.710	0.350	7.761	0.051

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
41.280	Topo	7.590	0.400	7.764	0.174
41.379	Topo	7.450	0.450	7.767	0.317
41.479	Bathy	7.300	0.550	7.770	0.47
41.578	Bathy	7.180	0.750	7.772	0.592
41.678	Bathy	7.010	0.950	7.775	0.765
41.740	Bathy	6.910	1.050	7.777	0.867
41.840	Bathy	6.860	1.050	7.780	0.92
41.940	Bathy	6.810	1.050	7.782	0.972
42.040	Bathy	8.770	1.050	7.785	0
42.140	Bathy	6.715	1.050	7.788	1.073
42.240	Bathy	6.670	1.050	7.791	1.121
42.340	Bathy	6.630	1.050	7.793	1.163
42.440	Bathy	6.590	1.050	7.796	1.206
42.540	Bathy	6.540	1.050	7.799	1.259
42.590	Bathy	6.500	1.050	7.800	1.3
42.690	Bathy	6.400	1.050	7.803	1.403
42.790	Bathy	6.310	1.050	7.806	1.496
42.890	Bathy	6.240	0.950	7.809	1.569
42.990	Bathy	6.110	0.730	7.811	1.701
43.090	Topo	6.010	0.510	7.814	1.804
43.190	Topo	5.890	0.400	7.817	1.927
43.290	Topo	5.760	0.370	7.820	2.06
43.389	Topo	5.680	0.290	7.823	2.143
43.489	Topo	5.810	0.200	7.825	2.015
43.587	Topo	6.130	0.150	7.828	1.698
43.685	Topo	6.590	0.100	7.831	1.241
43.783	Topo	6.920	0.040	7.833	0.913
43.881	Topo	7.350	0.010	7.836	0.486
43.979	Topo	7.770	0.000	7.839	0.069
44.029	Topo	8.240	0.000	7.840	0
44.127	Topo	8.070	0.000	7.843	0
44.226	Topo	7.890	0.000	7.846	0
44.325	Topo	7.740	0.000	7.849	0.109
44.424	Topo	7.610	0.000	7.851	0.241
44.523	Topo	7.480	0.000	7.854	0.374
44.573	Topo	7.100	0.000	7.855	0.755
44.673	Topo	6.510	0.000	7.858	1.348
44.773	Topo	6.005	0.000	7.861	1.856
44.873	Topo	5.303	0.000	7.864	2.561
44.966	Topo	4.600	0.000	7.866	3.266
45.023	Topo	4.690	0.000	7.868	3.178
45.122	Topo	4.810	0.000	7.871	3.061
45.222	Topo	4.930	0.000	7.873	2.943
45.314	Topo	5.070	0.000	7.876	2.806
45.414	Topo	5.190	0.000	7.879	2.689
45.514	Topo	5.270	0.100	7.882	2.612
45.614	Topo	5.370	0.200	7.884	2.514

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
45.664	Topo	5.420	0.300	7.886	2.466
45.764	Topo	5.400	0.380	7.888	2.488
45.863	Topo	5.380	0.450	7.891	2.511
45.963	Topo	5.350	0.520	7.894	2.544
46.063	Topo	5.330	0.650	7.897	2.567
46.163	Topo	5.320	0.780	7.900	2.58
46.263	Topo	5.290	0.940	7.902	2.612
46.309	Topo	5.460	0.900	7.904	2.444
46.401	Topo	5.820	0.700	7.906	2.086
46.492	Topo	6.180	0.500	7.909	1.729
46.584	Topo	6.535	0.400	7.911	1.376
46.631	Topo	6.680	0.300	7.913	1.233
46.755	Topo	6.620	0.600	7.916	1.296
46.854	Bathy	6.570	1.000	7.919	1.349
46.954	Bathy	6.510	1.400	7.922	1.412
47.053	Bathy	6.480	1.600	7.924	1.444
47.122	Bathy	6.430	2.000	7.926	1.496
47.146	Bathy	6.740	2.000	7.927	1.187
47.246	Bathy	7.400	2.000	7.930	0.53
47.346	Bathy	8.080	2.050	7.932	0
47.396	Bathy	8.480	2.080	7.934	0
47.496	Bathy	8.500	2.130	7.937	0
47.596	Bathy	8.520	2.230	7.939	0
47.695	Bathy	8.560	2.280	7.942	0
47.794	Bathy	8.585	2.290	7.945	0
47.892	Bathy	8.600	2.300	7.948	0
47.991	Bathy	8.620	2.320	7.950	0
48.089	Bathy	8.640	2.330	7.953	0
48.188	Bathy	8.680	2.350	7.956	0
48.237	Bathy	8.600	2.370	7.957	0
48.337	Bathy	8.420	2.380	7.960	0
48.437	Bathy	8.240	2.390	7.963	0
48.537	Bathy	8.015	2.410	7.965	0
48.635	Bathy	7.800	2.430	7.968	0.168
48.743	Bathy	7.510	2.450	7.971	0.461
48.841	Bathy	7.390	2.490	7.974	0.584
48.890	Bathy	7.210	2.700	7.975	0.765
48.989	Bathy	6.920	3.100	7.978	1.058
49.087	Bathy	6.660	3.700	7.981	1.321
49.159	Bathy	6.460	4.000	7.983	1.523
49.236	Bathy	6.350	3.850	7.985	1.635
49.336	Bathy	6.210	3.750	7.988	1.778
49.436	Bathy	6.050	3.600	7.990	1.94
49.536	Bathy	5.850	3.450	7.993	2.143
49.636	Bathy	5.670	3.300	7.996	2.326
49.736	Bathy	5.580	3.100	7.999	2.419
49.786	Bathy	5.627	2.950	8.000	2.373

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
49.885	Bathy	5.861	2.850	8.003	2.142
49.994	Bathy	6.094	2.750	8.006	1.912
50.094	Bathy	6.328	2.650	8.028	1.7
50.193	Bathy	6.562	2.550	8.050	1.488
50.293	Bathy	6.796	2.450	8.072	1.276
50.392	Bathy	7.029	2.300	8.094	1.064
50.492	Bathy	7.263	2.100	8.116	0.853
50.541	Bathy	7.390	1.950	8.127	0.737
50.641	Bathy	7.400	1.850	8.149	0.749
50.741	Bathy	7.420	1.780	8.171	0.751
50.840	Bathy	7.450	1.700	8.193	0.743
50.945	Bathy	7.460	1.650	8.216	0.756
51.044	Bathy	7.480	1.590	8.238	0.758
51.144	Bathy	7.510	1.510	8.259	0.749
51.193	Bathy	7.520	1.550	8.270	0.75
51.293	Bathy	7.490	1.650	8.292	0.802
51.393	Bathy	7.480	1.750	8.314	0.834
51.492	Bathy	7.470	1.850	8.336	0.866
51.592	Bathy	7.450	1.950	8.358	0.908
51.690	Bathy	7.440	2.020	8.380	0.94
51.775	Bathy	7.430	2.150	8.399	0.969
51.880	Bathy	7.410	2.250	8.422	1.012
51.977	Bathy	7.390	2.350	8.443	1.053
52.039	Bathy	7.380	2.500	8.457	1.077
52.120	Bathy	7.390	2.490	8.475	1.085
52.212	Bathy	7.400	2.400	8.495	1.095
52.308	Bathy	7.410	2.200	8.516	1.106
52.411	Bathy	7.430	2.000	8.539	1.109
52.510	Bathy	7.440	1.800	8.561	1.121
52.610	Bathy	7.450	1.600	8.583	1.133
52.710	Bathy	7.460	1.400	8.605	1.145
52.811	Bathy	7.470	1.200	8.627	1.157
52.901	Bathy	7.480	1.000	8.647	1.167
52.960	Bathy	7.600	1.500	8.660	1.06
53.063	Bathy	7.720	1.900	8.683	0.963
53.173	Bathy	7.880	2.500	8.707	0.827
53.270	Bathy	8.040	3.000	8.729	0.689
53.370	Bathy	8.193	3.640	8.751	0.558
53.473	Bathy	8.370	4.600	8.773	0.403
53.522	Bathy	8.480	5.000	8.784	0.304
53.620	Bathy	8.600	5.000	8.806	0.206
53.719	Bathy	8.700	5.000	8.827	0.127
53.817	Bathy	8.810	5.000	8.849	0.039
53.916	Bathy	8.910	4.700	8.871	0
54.002	Bathy	9.020	5.000	8.890	0
54.101	Bathy	9.120	5.000	8.912	0
54.149	Bathy	9.190	5.000	8.922	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
54.248	Bathy	9.300	5.000	8.944	0
54.362	Bathy	9.420	5.000	8.969	0
54.451	Bathy	9.510	5.000	8.989	0
54.469	Bathy	9.490	4.800	8.993	0
54.533	Bathy	9.440	4.600	9.007	0
54.734	Bathy	9.400	4.100	9.051	0
54.830	Bathy	9.370	3.800	9.072	0
54.927	Bathy	9.320	3.200	9.094	0
55.023	Bathy	9.290	2.100	9.115	0
55.119	Bathy	9.250	1.700	9.136	0
55.168	Bathy	9.150	1.400	9.147	0
55.265	Bathy	8.950	1.200	9.168	0.218
55.362	Bathy	8.758	1.000	9.190	0.432
55.460	Bathy	8.520	0.900	9.211	0.691
55.567	Bathy	8.350	0.860	9.235	0.885
55.666	Bathy	8.150	0.820	9.257	1.107
55.766	Bathy	7.910	0.760	9.279	1.369
55.866	Bathy	7.700	0.740	9.301	1.601
55.966	Bathy	7.450	0.720	9.323	1.873
56.038	Bathy	7.340	0.700	9.339	1.999
56.112	Bathy	7.590	0.900	9.355	1.765
56.206	Bathy	7.990	1.100	9.376	1.386
56.302	Bathy	8.450	1.300	9.397	0.947
56.401	Bathy	8.780	1.500	9.419	0.639
56.479	Bathy	9.260	1.900	9.436	0.176
56.528	Bathy	9.360	1.900	9.447	0.087
56.624	Bathy	9.120	1.800	9.468	0.348
56.719	Bathy	8.910	1.750	9.489	0.579
56.808	Bathy	8.680	1.700	9.509	0.829
56.895	Bathy	8.455	1.600	9.528	1.073
56.994	Bathy	8.210	1.500	9.550	1.34
57.092	Bathy	8.040	1.400	9.571	1.531
57.188	Bathy	7.870	1.300	9.592	1.722
57.298	Bathy	7.650	1.200	9.617	1.967
57.387	Bathy	7.460	1.000	9.636	2.176
57.471	Bathy	4.450	1.000	9.655	5.205
57.566	Bathy	4.440	1.000	9.676	5.236
57.661	Bathy	4.430	1.000	9.697	5.267
57.759	Bathy	4.430	1.000	9.718	5.288
57.858	Bathy	4.420	1.000	9.740	5.32
57.963	Bathy	4.410	1.000	9.763	5.353
58.057	Bathy	4.410	1.000	9.784	5.374
58.156	Bathy	4.400	1.000	9.806	5.406
58.263	Bathy	4.400	1.000	9.830	5.43
58.363	Bathy	4.390	1.000	9.852	5.462
58.413	Bathy	7.420	1.000	9.863	2.443
58.511	Bathy	7.540	1.000	9.884	2.344

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
58.609	Bathy	7.630	1.000	9.906	2.276
58.708	Bathy	7.710	1.000	9.928	2.218
58.806	Bathy	7.820	1.000	9.949	2.129
58.905	Bathy	7.920	1.000	9.971	2.051
59.003	Bathy	8.050	1.000	9.993	1.943
59.102	Bathy	8.170	1.000	10.015	1.845
59.202	Bathy	8.268	1.000	10.037	1.769
59.301	Bathy	8.360	1.000	10.059	1.699
59.401	Bathy	8.480	1.000	10.080	1.6
59.490	Bathy	8.560	1.000	10.100	1.54
59.550	Bathy	8.550	1.000	10.113	1.563
59.650	Bathy	8.540	1.000	10.135	1.595
59.750	Bathy	8.530	1.000	10.158	1.628
59.852	Bathy	8.510	1.000	10.180	1.67
59.983	Bathy	8.490	1.000	10.209	1.719
60.068	Bathy	8.470	1.000	10.228	1.758
60.165	Bathy	8.460	1.000	10.249	1.789
60.263	Bathy	8.450	1.000	10.271	1.821
60.361	Bathy	8.440	1.000	10.292	1.852
60.468	Bathy	8.430	1.000	10.316	1.886
60.568	Bathy	8.410	1.000	10.338	1.928
60.617	Bathy	8.450	1.000	10.349	1.899
60.715	Bathy	8.550	1.000	10.370	1.82
60.812	Bathy	8.780	1.000	10.392	1.612
60.907	Bathy	8.940	1.000	10.413	1.473
61.000	Bathy	9.060	1.000	10.433	1.373
61.099	Bathy	9.210	1.000	10.455	1.245
61.198	Bathy	9.350	1.000	10.477	1.127
61.297	Bathy	9.510	1.000	10.499	0.989
61.395	Bathy	9.620	1.000	10.520	0.9
61.462	Bathy	9.730	1.000	10.535	0.805
61.544	Bathy	9.730	1.000	10.553	0.823
61.643	Bathy	9.740	1.000	10.575	0.835
61.743	Bathy	9.750	1.000	10.597	0.847
61.842	Bathy	9.750	1.000	10.619	0.869
61.941	Bathy	9.760	1.000	10.641	0.881
62.041	Bathy	9.770	1.000	10.663	0.893
62.140	Bathy	9.780	1.000	10.685	0.905
62.239	Bathy	9.780	1.000	10.706	0.926
62.338	Bathy	9.780	1.000	10.728	0.948
62.438	Bathy	9.790	1.000	10.750	0.96
62.487	Bathy	9.750	1.000	10.761	1.011
62.587	Bathy	9.520	1.000	10.783	1.263
62.686	Bathy	9.250	1.000	10.805	1.555
62.786	Bathy	9.010	1.000	10.827	1.817
62.885	Bathy	8.790	1.000	10.849	2.059
62.942	Bathy	8.510	1.000	10.861	2.351

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
63.032	Bathy	8.310	1.000	10.881	2.571
63.128	Bathy	8.150	1.000	10.902	2.752
63.250	Bathy	8.150	1.000	10.902	2.752
63.343	Bathy	8.000	1.000	10.950	2.95
63.429	Bathy	7.750	1.000	10.969	3.219
63.517	Bathy	7.590	1.000	10.988	3.398
63.620	Bathy	7.500	1.000	11.011	3.511
63.670	Bathy	7.550	1.000	11.022	3.472
63.766	Bathy	7.810	1.000	11.043	3.233
63.866	Bathy	8.080	1.000	11.065	2.985
63.965	Bathy	8.350	1.000	11.087	2.737
64.065	Bathy	8.510	1.000	11.109	2.599
64.164	Bathy	8.750	1.000	11.131	2.381
64.264	Bathy	8.920	1.000	11.153	2.233
64.363	Bathy	9.120	1.000	11.175	2.055
64.413	Bathy	9.160	1.100	11.186	2.026
64.512	Bathy	9.050	1.200	11.208	2.158
64.612	Bathy	8.950	1.260	11.230	2.28
64.711	Bathy	8.815	1.320	11.252	2.437
64.810	Bathy	8.660	1.400	11.273	2.613
64.902	Bathy	8.510	1.440	11.294	2.784
65.113	Bathy	8.450	1.480	11.340	2.89
65.150	Bathy	8.483	1.500	11.348	2.866
65.232	Bathy	8.608	1.500	11.366	2.759
65.314	Bathy	8.733	1.500	11.384	2.652
65.396	Bathy	8.858	1.500	11.403	2.545
65.469	Bathy	8.990	1.500	11.419	2.429
65.569	Bathy	9.110	1.500	11.441	2.331
65.669	Bathy	9.220	1.500	11.463	2.243
65.798	Bathy	9.340	1.500	11.491	2.151
65.897	Bathy	9.630	1.450	11.513	1.883
65.992	Bathy	10.025	1.350	11.534	1.509
66.088	Bathy	10.410	1.250	11.555	1.145
66.184	Bathy	10.850	1.180	11.576	0.726
66.280	Bathy	11.235	1.110	11.598	0.363
66.375	Bathy	11.660	1.050	11.619	0
66.424	Bathy	11.820	1.200	11.629	0
66.520	Bathy	11.790	1.600	11.651	0
66.618	Bathy	11.770	2.000	11.672	0
66.715	Bathy	11.730	2.400	11.694	0
66.830	Bathy	11.700	2.800	11.719	0.019
66.930	Bathy	11.653	3.100	11.741	0.088
67.030	Bathy	11.610	3.350	11.763	0.153
67.070	Bathy	11.720	3.300	11.772	0.052
67.170	Bathy	12.005	3.100	11.794	0
67.269	Bathy	12.300	2.800	11.816	0
67.360	Bathy	12.510	2.300	11.836	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
67.458	Bathy	12.750	1.900	11.858	0
67.557	Bathy	12.960	1.700	11.879	0
67.664	Bathy	13.250	1.500	11.903	0
67.717	Bathy	13.450	1.500	11.915	0
67.810	Bathy	13.660	1.500	11.935	0
67.903	Bathy	13.850	1.500	11.956	0
67.997	Bathy	14.070	1.500	11.976	0
68.109	Bathy	14.200	1.500	12.001	0
68.208	Bathy	14.340	1.500	12.023	0
68.328	Bathy	14.540	1.500	12.049	0
68.428	Bathy	14.780	1.500	12.071	0
68.528	Bathy	14.940	1.500	12.093	0
68.589	Bathy	14.940	1.500	12.093	0
68.680	Bathy	15.110	1.500	12.127	0
68.715	Bathy	15.290	1.500	12.135	0
68.797	Bathy	15.110	1.500	12.153	0
68.896	Bathy	14.940	1.500	12.174	0
68.994	Bathy	14.750	1.500	12.196	0
69.092	Bathy	14.570	1.500	12.218	0
69.219	Bathy	14.390	1.500	12.246	0
69.306	Bathy	14.210	1.500	12.265	0
69.360	Bathy	14.050	1.500	12.277	0
69.458	Bathy	13.910	1.500	12.299	0
69.556	Bathy	13.830	1.500	12.320	0
69.655	Bathy	13.710	1.500	12.342	0
69.753	Bathy	13.600	1.500	12.364	0
69.846	Bathy	13.490	1.500	12.384	0
69.945	Bathy	13.340	1.500	12.406	0
70.061	Bathy	13.200	1.500	12.432	0
70.161	Bathy	13.050	1.500	12.454	0
70.240	Bathy	12.905	1.500	12.471	0
70.339	Bathy	12.780	1.500	12.493	0
70.486	Bathy	12.660	1.500	12.525	0
70.573	Bathy	12.540	1.500	12.544	0.004
70.616	Bathy	12.462	1.600	12.554	0.092
70.703	Bathy	12.445	1.800	12.573	0.128
70.795	Bathy	12.429	1.900	12.593	0.164
70.895	Bathy	12.429	1.900	12.593	0.164
70.961	Bathy	12.413	2.000	12.630	0.217
71.061	Bathy	12.396	2.160	12.652	0.256
71.227	Bathy	12.380	2.300	12.689	0.309
71.309	Bathy	12.364	2.500	12.707	0.343
71.385	Bathy	12.347	2.700	12.724	0.376
71.468	Bathy	12.331	2.900	12.742	0.411
71.558	Bathy	12.315	3.100	12.762	0.447
71.658	Bathy	12.298	3.400	12.784	0.486
71.707	Bathy	12.284	3.500	12.794	0.51

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
71.803	Bathy	12.273	3.500	12.816	0.543
71.899	Bathy	12.262	3.500	12.837	0.575
71.961	Bathy	12.250	3.500	12.851	0.6
72.060	Bathy	12.239	3.500	12.872	0.633
72.152	Bathy	12.228	3.500	12.893	0.665
72.228	Bathy	12.217	3.500	12.909	0.693
72.328	Bathy	12.205	3.500	12.931	0.726
72.420	Bathy	12.194	3.500	12.952	0.758
72.515	Bathy	12.183	3.500	12.973	0.79
72.609	Bathy	12.171	3.500	12.993	0.822
72.688	Bathy	12.160	3.500	13.011	0.851
72.762	Bathy	12.498	3.300	13.027	0.529
72.879	Bathy	12.837	3.100	13.053	0.216
72.979	Bathy	13.175	2.900	13.075	0
73.078	Bathy	13.514	2.700	13.097	0
73.169	Bathy	13.852	2.500	13.117	0
73.269	Bathy	14.191	2.200	13.139	0
73.318	Bathy	14.465	2.000	13.150	0
73.418	Bathy	14.675	2.000	13.172	0
73.518	Bathy	14.885	2.000	13.194	0
73.618	Bathy	15.095	2.000	13.216	0
73.718	Bathy	15.305	2.000	13.238	0
73.768	Bathy	15.700	2.100	13.249	0
73.868	Bathy	16.280	2.300	13.271	0
73.968	Bathy	16.860	2.500	13.293	0
74.018	Bathy	17.026	2.500	13.304	0
74.118	Bathy	16.778	2.500	13.326	0
74.193	Bathy	16.530	2.500	13.343	0
74.265	Bathy	16.289	2.500	13.359	0
74.362	Bathy	16.047	2.500	13.380	0
74.463	Bathy	15.806	2.500	13.402	0
74.560	Bathy	15.565	2.500	13.424	0
74.657	Bathy	15.323	2.500	13.445	0
74.751	Bathy	15.082	2.500	13.466	0
74.847	Bathy	14.841	2.500	13.487	0
74.895	Bathy	14.853	2.450	13.498	0
74.954	Bathy	15.119	2.380	13.511	0
75.050	Bathy	15.384	2.330	13.628	0
75.168	Bathy	15.650	2.250	13.678	0
75.267	Bathy	15.916	2.180	13.720	0
75.419	Bathy	16.181	2.100	13.784	0
75.518	Bathy	16.447	2.030	13.826	0
75.567	Bathy	16.399	1.970	13.847	0
75.607	Bathy	16.038	1.900	13.864	0
75.691	Bathy	15.676	1.830	13.899	0
75.786	Bathy	15.315	1.750	13.939	0
75.857	Bathy	14.953	1.650	13.969	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
75.943	Bathy	14.592	1.580	14.006	0
76.022	Bathy	14.230	1.500	14.039	0
76.085	Bathy	13.766	0.900	14.066	0.3
76.174	Bathy	13.301	0.700	14.104	0.802
76.260	Bathy	12.837	0.500	14.140	1.303
76.316	Bathy	12.884	0.700	14.164	1.28
76.414	Bathy	12.930	0.900	14.205	1.274
76.511	Bathy	12.977	1.100	14.246	1.269
76.601	Bathy	13.024	1.400	14.284	1.26
76.662	Bathy	13.152	1.000	14.310	1.158
76.691	Bathy	13.257	0.500	14.322	1.065
76.792	Bathy	13.208	0.500	14.365	1.157
76.891	Bathy	13.159	0.500	14.407	1.247
76.990	Bathy	13.110	0.500	14.448	1.338
77.088	Bathy	13.061	0.500	14.490	1.428
77.137	Bathy	13.070	0.600	14.511	1.441
77.208	Bathy	13.127	1.000	14.541	1.414
77.280	Bathy	13.155	0.900	14.571	1.417
77.380	Bathy	13.182	0.800	14.613	1.431
77.475	Bathy	13.210	0.700	14.654	1.444
77.564	Bathy	13.237	0.500	14.691	1.454
77.619	Bathy	13.283	0.500	14.715	1.431
77.695	Bathy	13.329	0.500	14.747	1.417
77.785	Bathy	13.375	0.500	14.785	1.409
77.885	Bathy	13.422	0.500	14.827	1.405
77.966	Bathy	13.468	0.500	14.861	1.394
78.058	Bathy	13.514	0.500	14.900	1.386
78.106	Bathy	13.752	0.500	14.920	1.168
78.204	Bathy	14.182	0.500	14.962	0.78
78.306	Bathy	14.612	0.500	15.005	0.393
78.385	Bathy	15.042	0.500	15.038	0
78.470	Bathy	15.472	0.500	15.074	0
78.570	Bathy	15.902	0.500	15.117	0
78.669	Bathy	16.332	0.500	15.158	0
78.759	Bathy	16.762	0.500	15.197	0
78.809	Bathy	16.739	0.500	15.218	0
78.908	Bathy	16.262	0.500	15.260	0
79.008	Bathy	15.785	0.500	15.302	0
79.100	Bathy	15.309	0.500	15.341	0.032
79.196	Bathy	14.832	0.500	15.381	0.549
79.295	Bathy	14.355	0.500	15.423	1.068
79.343	Bathy	14.166	0.500	15.444	1.278
79.446	Bathy	14.263	0.500	15.487	1.224
79.544	Bathy	14.361	0.500	15.529	1.168
79.642	Bathy	14.458	0.500	15.570	1.112
79.705	Bathy	14.679	0.500	15.597	0.918
79.791	Bathy	15.024	0.500	15.633	0.609

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
79.877	Bathy	15.368	0.500	15.669	0.301
79.985	Bathy	15.713	0.500	15.715	0.003
80.084	Bathy	16.057	0.500	15.757	0
80.137	Bathy	16.166	0.500	15.779	0
80.236	Bathy	16.275	0.500	15.821	0
80.334	Bathy	16.384	0.500	15.863	0
80.444	Bathy	16.493	0.500	15.909	0
80.540	Bathy	16.602	0.500	15.950	0
80.589	Bathy	16.166	0.500	15.970	0
80.688	Bathy	15.183	0.500	16.012	0.83
80.787	Bathy	14.200	0.500	16.054	1.854
80.874	Bathy	13.217	0.500	16.091	2.874
80.936	Bathy	13.524	0.500	16.117	2.594
81.088	Bathy	13.830	0.500	16.182	2.351
81.178	Bathy	14.137	0.450	16.220	2.083
81.293	Bathy	14.444	0.400	16.268	1.825
81.343	Bathy	14.655	0.400	16.289	1.634
81.441	Bathy	14.771	0.350	16.331	1.56
81.529	Bathy	14.887	0.300	16.368	1.481
81.620	Bathy	15.119	0.300	16.406	1.287
81.792	Bathy	15.352	0.300	16.479	1.128
81.884	Bathy	15.584	0.350	16.518	0.934
81.980	Bathy	15.816	0.350	16.559	0.742
82.076	Bathy	16.049	0.400	16.599	0.551
82.171	Bathy	16.281	0.400	16.640	0.359
82.210		16.337	0.400	16.656	0.319
82.298	Topo	16.217	0.400	16.693	0.476
82.391	Topo	16.097	0.400	16.732	0.635
82.535	Topo	15.977	0.400	16.794	0.817
82.578	Topo	15.857	0.400	16.812	0.955
82.673	Topo	15.890	0.400	16.852	0.962
82.772	Topo	15.880	0.400	16.894	1.014
82.871	Topo	15.870	0.400	16.936	1.066
82.971	Topo	15.860	0.400	16.978	1.118
83.021	Topo	15.917	0.400	16.999	1.082
83.120	Topo	16.037	0.350	17.041	1.004
83.220	Topo	16.157	0.300	17.083	0.926
83.269	Topo	16.220	0.300	17.104	0.884
83.369	Topo	16.230	0.300	17.146	0.916
83.469	Topo	16.250	0.300	17.189	0.939
83.569	Topo	16.240	0.300	17.231	0.991
83.669	Topo	16.230	0.300	17.273	1.043
83.719	Topo	16.148	0.300	17.294	1.146
83.819	Topo	16.010	0.300	17.337	1.327
83.919	Topo	15.872	0.300	17.379	1.507
84.021	Topo	15.734	0.350	17.422	1.688
84.117	Topo	15.596	0.350	17.462	1.866

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
84.163	Topo	15.592	0.400	17.482	1.89
84.261	Topo	15.721	0.400	17.524	1.802
84.361	Topo	15.851	0.400	17.566	1.715
84.445	Topo	15.981	0.450	17.601	1.621
84.542	Topo	16.110	0.450	17.642	1.532
84.640	Topo	16.240	0.450	17.684	1.444
84.744	Topo	16.369	0.450	17.728	1.358
84.843	Topo	16.499	0.450	17.770	1.271
84.897	Topo	16.629	0.450	17.792	1.164
84.984	Topo	16.758	0.450	17.829	1.071
85.083	Topo	16.888	0.450	17.871	0.984
85.146	Topo	17.017	0.500	17.898	0.88
85.191	Topo	17.147	0.500	17.917	0.77
85.262	Topo	17.307	0.500	17.947	0.64
85.348	Topo	17.467	0.450	17.983	0.516
85.445	Topo	17.627	0.450	18.024	0.397
85.512	Topo	17.787	0.400	18.052	0.265
85.594	Topo	17.867	0.400	18.087	0.22
85.694	Topo	17.947	0.400	18.130	0.183
85.772	Topo	18.027	0.400	18.163	0.136
85.868	Topo	18.107	0.400	18.203	0.096
85.925	Topo	18.187	0.400	18.227	0.04
86.017	Topo	18.057	0.400	18.266	0.209
86.115	Topo	17.927	0.400	18.307	0.38
86.207	Topo	17.797	0.400	18.346	0.549
86.284	Topo	17.667	0.400	18.379	0.712
86.351	Topo	17.477	0.400	18.407	0.93
86.481	Topo	17.287	0.400	18.462	1.175
86.531	Topo	16.747	0.400	18.483	1.736
86.630	Topo	16.207	0.400	18.525	2.318
86.738	Topo	15.667	0.400	18.571	2.904
86.787	Topo	16.410	0.400	18.592	2.182
86.887	Topo	18.435	0.350	18.634	0.2
86.937	Topo	19.288	0.300	18.655	0
87.032	Topo	18.970	0.300	18.695	0
87.128	Topo	18.652	0.300	18.736	0.084
87.225	Topo	18.334	0.300	18.777	0.443
87.322	Topo	18.016	0.300	18.818	0.802
87.371	Topo	17.809	0.300	18.839	1.03
87.469	Topo	17.713	0.350	18.880	1.167
87.572	Topo	17.617	0.400	18.924	1.307
87.632	Topo	17.651	0.400	18.949	1.298
87.731	Topo	17.685	0.350	18.991	1.306
87.841	Topo	17.719	0.350	19.038	1.319
87.941	Topo	17.753	0.300	19.080	1.327
88.026	Topo	17.787	0.300	19.116	1.329
88.109	Topo	18.044	0.300	19.151	1.107

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
88.206	Topo	18.300	0.300	19.192	0.892
88.298	Topo	18.557	0.300	19.231	0.674
88.357	Topo	18.265	0.300	19.256	0.991
88.456	Topo	17.973	0.350	19.298	1.325
88.505	Topo	17.761	0.400	19.318	1.557
88.611	Topo	17.630	0.400	19.363	1.733
88.699	Topo	17.498	0.400	19.401	1.902
88.777	Topo	17.367	0.400	19.434	2.067
88.777	Topo	17.565	0.400	19.434	1.869
88.857	Topo	17.697	0.400	19.467	1.77
88.954	Topo	17.829	0.400	19.508	1.679
89.015	Topo	17.961	0.400	19.534	1.573
89.020	Topo	18.093	0.400	19.536	1.443
89.117	Topo	18.225	0.400	19.577	1.352
89.209	Topo	18.357	0.400	19.616	1.259
89.251	Topo	18.248	0.400	19.634	1.386
89.319	Topo	18.139	0.400	19.663	1.524
89.419	Topo	18.029	0.400	19.705	1.676
89.518	Topo	17.920	0.400	19.747	1.827
89.603	Topo	17.811	0.400	19.783	1.972
89.703	Topo	17.702	0.400	19.825	2.123
89.752	Topo	17.775	0.400	19.846	2.071
89.839	Topo	18.030	0.400	19.883	1.852
89.939	Topo	18.285	0.350	19.925	1.639
90.039	Topo	18.541	0.350	19.967	1.426
90.128	Topo	18.796	0.350	20.005	1.208
90.227	Topo	19.052	0.300	20.047	0.995
90.287	Topo	19.307	0.300	20.072	0.765
90.375	Topo	19.187	0.300	20.109	0.922
90.474	Topo	19.067	0.350	20.151	1.084
90.589	Topo	18.947	0.354	20.200	1.253
90.656	Topo	18.827	0.400	20.228	1.401
90.717	Topo	19.210	0.400	20.254	1.044
90.834	Topo	19.594	0.350	20.303	0.71
90.894	Topo	19.977	0.300	20.329	0.352
90.983	Topo	19.905	0.300	20.366	0.461
91.079	Topo	19.834	0.300	20.407	0.573
91.179	Topo	19.762	0.300	20.449	0.687
91.279	Topo	19.690	0.300	20.491	0.801
91.379	Topo	19.619	0.300	20.534	0.915
91.467	Topo	19.547	0.300	20.571	1.024
91.529	Topo	19.550	0.300	20.597	1.047
91.629	Topo	19.550	0.350	20.639	1.089
91.728	Topo	19.550	0.350	20.681	1.131
91.828	Topo	19.560	0.400	20.724	1.164
91.878	Topo	19.569	0.400	20.745	1.176
91.975	Topo	19.612	0.350	20.786	1.174

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
92.073	Topo	19.655	0.300	20.827	1.172
92.123	Topo	19.738	0.300	20.848	1.11
92.201	Topo	19.859	0.300	20.881	1.022
92.278	Topo	19.981	0.350	20.914	0.933
92.459	Topo	20.102	0.350	20.991	0.888
92.556	Topo	20.224	0.350	21.032	0.808
92.709	Topo	20.345	0.400	21.096	0.751
92.762	Topo	20.467	0.400	21.119	0.652
92.858	Topo	20.578	0.400	21.159	0.581
92.957	Topo	20.689	0.400	21.201	0.512
93.055	Topo	20.800	0.400	21.243	0.443
93.154	Topo	20.911	0.400	21.284	0.374
93.257	Topo	21.022	0.400	21.328	0.306
93.306	Topo	21.071	0.400	21.349	0.278
93.396	Topo	21.059	0.400	21.387	0.328
93.496	Topo	21.047	0.350	21.429	0.382
93.595	Topo	21.035	0.350	21.471	0.436
93.690	Topo	21.023	0.300	21.511	0.488
93.737	Topo	20.904	0.300	21.531	0.627
93.837	Topo	20.677	0.350	21.573	0.896
93.937	Topo	20.450	0.400	21.616	1.165
94.046	Topo	20.224	0.450	21.662	1.438
94.119	Topo	19.997	0.500	21.693	1.696
94.196	Topo	20.046	0.500	21.725	1.679
94.280	Topo	20.095	0.450	21.761	1.665
94.379	Topo	20.145	0.450	21.802	1.658
94.477	Topo	20.194	0.400	21.844	1.65
94.593	Topo	20.243	0.400	21.893	1.65
94.693	Topo	20.292	0.400	21.935	1.643
94.742	Topo	20.320	0.350	21.956	1.636
94.827	Topo	20.300	0.350	21.992	1.692
94.927	Topo	20.290	0.350	22.034	1.744
95.027	Topo	20.270	0.300	22.066	1.796
95.060	Topo	20.271	0.300	22.076	1.805
95.108	Topo	20.300	0.300	22.091	1.791
95.204	Topo	20.328	0.300	22.121	1.793
95.254	Topo	20.357	0.300	22.137	1.78
95.301	Topo	21.237	0.350	22.152	0.915
95.326	Topo	22.117	0.400	22.160	0.043
95.426	Topo	22.427	0.400	22.191	0
95.526	Topo	22.737	0.400	22.223	0
95.625	Topo	23.047	0.400	22.254	0
95.704	Topo	23.357	0.400	22.279	0
95.775	Topo	23.248	0.400	22.302	0
95.865	Topo	23.139	0.350	22.330	0
95.957	Topo	23.030	0.350	22.359	0
96.084	Topo	22.930	0.300	22.399	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
96.184	Topo	22.812	0.300	22.430	0
96.233	Topo	22.700	0.300	22.446	0
96.332	Topo	22.586	0.300	22.477	0
96.431	Topo	22.472	0.350	22.508	0.036
96.505	Topo	22.358	0.350	22.531	0.173
96.601	Topo	22.244	0.400	22.562	0.318
96.650	Topo	22.070	0.400	22.577	0.507
96.761	Topo	21.837	0.400	22.612	0.775
96.860	Topo	21.604	0.400	22.644	1.04
96.933	Topo	21.370	0.400	22.667	1.296
97.026	Topo	21.137	0.400	22.696	1.559
97.145	Topo	21.213	0.400	22.733	1.521
97.237	Topo	21.288	0.400	22.762	1.474
97.312	Topo	21.350	0.400	22.786	1.436
97.410	Topo	21.439	0.400	22.817	1.378
97.459	Topo	21.480	0.400	22.832	1.352
97.572	Topo	21.500	0.350	22.868	1.368
97.672	Topo	21.520	0.350	22.899	1.379
97.777	Topo	21.550	0.300	22.933	1.383
97.823	Topo	21.670	0.300	22.947	1.277
97.933	Topo	21.950	0.350	22.982	1.032
98.027	Topo	22.290	0.350	23.011	0.721
98.126	Topo	22.540	0.400	23.042	0.502
98.181	Topo	22.640	0.400	23.060	0.42
98.281	Topo	22.620	0.400	23.091	0.471
98.379	Topo	22.610	0.400	23.122	0.512
98.429	Topo	22.661	0.400	23.138	0.476
98.527	Topo	22.770	0.400	23.169	0.399
98.626	Topo	22.879	0.350	23.200	0.321
98.726	Topo	22.988	0.300	23.232	0.244
98.778	Topo	23.097	0.300	23.248	0.151
98.875	Topo	22.810	0.350	23.279	0.469
98.969	Topo	22.500	0.350	23.308	0.808
99.064	Topo	22.420	0.400	23.338	0.918
99.159	Topo	22.097	0.400	23.368	1.271
99.259	Topo	22.123	0.400	23.400	1.277
99.357	Topo	22.149	0.400	23.431	1.282
99.431	Topo	22.175	0.400	23.454	1.279
99.571	Topo	22.201	0.400	23.498	1.297
99.666	Topo	22.227	0.400	23.528	1.301
99.714	Topo	22.250	0.400	23.543	1.293
99.798	Topo	22.290	0.400	23.570	1.28
99.908	Topo	22.310	0.400	23.604	1.294
100.007	Topo	22.400	0.400	23.636	1.236
100.079	Topo	22.427	0.400	23.658	1.231
100.151	Topo	22.410	0.400	23.681	1.271
100.234	Topo	22.420	0.400	23.707	1.287

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
100.327	Topo	22.400	0.400	23.736	1.336
100.375	Topo	22.250	0.400	23.751	1.501
100.475	Topo	22.210	0.400	23.783	1.573
100.611	Topo	22.290	0.400	23.826	1.536
100.707	Topo	22.190	0.400	23.856	1.666
100.756	Topo	22.170	0.400	23.871	1.701
100.853	Topo	22.160	0.400	23.902	1.742
100.951	Topo	22.260	0.350	23.933	1.673
101.045	Topo	22.240	0.350	23.963	1.723
101.104	Topo	22.220	0.300	23.981	1.761
101.147	Topo	22.310	0.300	23.995	1.685
101.295	Topo	22.410	0.400	24.041	1.631
101.371	Topo	22.630	0.400	24.065	1.435
101.409	Topo	22.680	0.400	24.077	1.397
101.505	Topo	22.820	0.350	24.108	1.288
101.599	Topo	22.910	0.350	24.137	1.227
101.689	Topo	23.080	0.300	24.166	1.086
101.738	Topo	23.180	0.300	24.181	1.001
101.810	Topo	23.190	0.300	24.204	1.014
101.909	Topo	23.220	0.300	24.235	1.015
101.979	Topo	23.237	0.300	24.257	1.02
102.045	Topo	23.290	0.350	24.278	0.988
102.133	Topo	23.370	0.400	24.306	0.936
102.172	Topo	23.560	0.400	24.318	0.758
102.243	Topo	23.910	0.400	24.340	0.43
102.336	Topo	24.500	0.400	24.370	0
102.433	Topo	25.400	0.400	24.400	0
102.482	Topo	25.120	0.400	24.416	0
102.583	Topo	24.380	0.400	24.447	0.067
102.660	Topo	23.987	0.400	24.472	0.485
102.732	Topo	23.430	0.400	24.494	1.064
102.790	Topo	23.257	0.400	24.513	1.256
102.873	Topo	23.630	0.400	24.539	0.909
102.947	Topo	23.857	0.400	24.562	0.705
103.009	Topo	24.250	0.400	24.582	0.332
103.098	Topo	26.150	0.350	24.610	0
103.163	Topo	27.647	0.300	24.630	0
103.240	Topo	26.190	0.300	24.655	0
103.326	Topo	25.197	0.300	24.682	0
103.371	Topo	25.600	0.350	24.696	0
103.426	Topo	25.897	0.400	24.713	0
103.511	Topo	26.720	0.400	24.740	0
103.611	Topo	26.120	0.400	24.771	0
103.658	Topo	26.790	0.400	24.786	0
103.751	Topo	25.450	0.400	24.816	0
103.842	Topo	25.130	0.400	24.844	0
103.887	Topo	24.777	0.400	24.858	0.081

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
104.016	Topo	24.680	0.400	24.899	0.219
104.112	Topo	24.750	0.400	24.929	0.179
104.159	Topo	24.580	0.400	24.944	0.364
104.244	Topo	24.390	0.350	24.971	0.581
104.343	Topo	24.210	0.350	25.002	0.792
104.417	Topo	24.007	0.300	25.026	1.019
104.483	Topo	23.960	0.300	25.046	1.086
104.561	Topo	23.997	0.300	25.071	1.074
104.646	Topo	24.260	0.350	25.098	0.838
104.713	Topo	24.507	0.400	25.119	0.612
104.785	Topo	24.099	0.400	25.141	1.042
104.879	Topo	23.691	0.400	25.171	1.48
104.940	Topo	23.582	0.400	25.190	1.608
105.038	Topo	23.772	0.350	25.221	1.449
105.141	Topo	23.962	0.350	25.254	1.292
105.191	Topo	24.100	0.300	25.269	1.169
105.357	Topo	24.050	0.350	25.322	1.272
105.434	Topo	24.060	0.400	25.346	1.286
105.482	Topo	24.100	0.400	25.361	1.261
105.581	Topo	24.120	0.350	25.393	1.273
105.684	Topo	24.050	0.330	25.425	1.375
105.760	Topo	24.037	0.300	25.449	1.412
105.833	Topo	24.090	0.360	25.472	1.382
105.909	Topo	24.107	0.400	25.496	1.389
105.991	Topo	24.250	0.400	25.522	1.272
106.086	Topo	24.350	0.400	25.552	1.202
106.134	Topo	24.420	0.400	25.567	1.147
106.233	Topo	24.090	0.400	25.598	1.508
106.314	Topo	23.777	0.400	25.623	1.846
106.380	Topo	23.810	0.300	25.644	1.834
106.475	Topo	23.990	0.300	25.674	1.684
106.572	Topo	23.980	0.300	25.705	1.725
106.620	Topo	24.100	0.300	25.720	1.62
106.719	Topo	24.180	0.350	25.751	1.571
106.815	Topo	24.150	0.350	25.781	1.631
106.910	Topo	24.190	0.400	25.811	1.621
106.959	Topo	24.190	0.400	25.827	1.637
107.058	Topo	24.250	0.350	25.858	1.608
107.153	Topo	24.200	0.300	25.888	1.688
107.200	Topo	24.230	0.350	25.903	1.673
107.330	Topo	24.260	0.350	25.944	1.684
107.400	Topo	24.267	0.400	25.966	1.699
107.483	Topo	24.410	0.400	25.992	1.582
107.559	Topo	24.380	0.350	26.016	1.636
107.678	Topo	24.540	0.300	26.053	1.513
107.727	Topo	24.590	0.300	26.069	1.479
107.819	Topo	24.580	0.400	26.098	1.518

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
107.866	Topo	24.680	0.400	26.113	1.433
107.975	Topo	24.820	0.350	26.147	1.327
108.073	Topo	24.990	0.300	26.178	1.188
108.138	Topo	25.097	0.300	26.198	1.101
108.217	Topo	25.060	0.300	26.223	1.163
108.263	Topo	25.190	0.300	26.238	1.048
108.360	Topo	25.310	0.350	26.268	0.958
108.456	Topo	25.420	0.350	26.299	0.879
108.542	Topo	25.527	0.400	26.326	0.799
108.597	Topo	25.610	0.400	26.343	0.733
108.712	Topo	25.690	0.400	26.379	0.689
108.805	Topo	25.757	0.400	26.409	0.652
108.860	Topo	25.740	0.400	26.426	0.686
108.960	Topo	25.720	0.400	26.458	0.738
109.016	Topo	25.687	0.400	26.475	0.788
109.101	Topo	25.730	0.350	26.502	0.772
109.222	Topo	25.760	0.350	26.540	0.78
109.271	Topo	25.800	0.300	26.556	0.756
109.345	Topo	25.850	0.300	26.579	0.729
109.441	Topo	25.910	0.350	26.609	0.699
109.626	Topo	25.980	0.400	26.668	0.688
109.673	Topo	26.170	0.400	26.682	0.512
109.716	Topo	26.500	0.400	26.696	0.196
109.815	Topo	26.660	0.400	26.727	0.067
109.876	Topo	26.810	0.400	26.746	0
109.976	Topo	26.590	0.400	26.778	0.188
110.076	Topo	26.310	0.350	26.809	0.499
110.209	Topo	26.170	0.350	26.851	0.681
110.258	Topo	26.070	0.300	26.867	0.797
110.358	Topo	26.130	0.300	26.898	0.768
110.428	Topo	26.120	0.350	26.920	0.8
110.506	Topo	26.147	0.400	26.945	0.798
110.580	Topo	26.070	0.400	26.968	0.898
110.676	Topo	25.993	0.400	26.999	1.006
110.772	Topo	25.916	0.400	27.029	1.113
110.868	Topo	25.839	0.400	27.059	1.22
110.936	Topo	25.762	0.400	27.080	1.318
111.027	Topo	25.685	0.400	27.109	1.424
111.127	Topo	25.608	0.400	27.141	1.533
111.217	Topo	25.531	0.400	27.169	1.638
111.316	Topo	25.454	0.400	27.200	1.746
111.372	Topo	25.377	0.400	27.218	1.841
111.465	Topo	25.350	0.350	27.247	1.897
111.548	Topo	25.320	0.300	27.273	1.953
111.591	Topo	25.297	0.300	27.287	1.99
111.678	Topo	25.690	0.350	27.314	1.624
111.767	Topo	25.870	0.350	27.342	1.472

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
111.889	Topo	26.220	0.400	27.381	1.161
111.939	Topo	26.440	0.400	27.396	0.956
112.038	Topo	26.790	0.350	27.428	0.638
112.127	Topo	26.520	0.300	27.456	0.936
112.220	Topo	25.890	0.300	27.485	1.595
112.286	Topo	25.890	0.300	27.485	1.595
112.380	Topo	25.700	0.350	27.536	1.836
112.479	Topo	25.680	0.350	27.567	1.887
112.571	Topo	25.687	0.400	27.596	1.909
112.658	Topo	26.510	0.350	27.623	1.113
112.742	Topo	27.420	0.300	27.650	0.23
112.778	Topo	28.369	0.300	27.661	0
112.853	Topo	29.193	0.350	27.685	0
112.944	Topo	30.017	0.400	27.713	0
112.999	Topo	28.790	0.400	27.731	0
113.078	Topo	27.560	0.350	27.756	0.196
113.126	Topo	27.249	0.300	27.771	0.522
113.261	Topo	27.912	0.350	27.813	0
113.349	Topo	28.575	0.400	27.841	0
113.445	Topo	28.083	0.350	27.871	0
113.544	Topo	27.259	0.300	27.903	0.644
113.594	Topo	26.800	0.350	27.918	1.118
113.690	Topo	26.750	0.350	27.949	1.199
113.753	Topo	26.707	0.400	27.968	1.261
113.837	Topo	26.940	0.400	27.995	1.055
113.928	Topo	27.190	0.350	28.023	0.833
114.002	Topo	27.707	0.300	28.047	0.34
114.086	Topo	27.310	0.350	28.073	0.763
114.177	Topo	27.060	0.400	28.102	1.042
114.288	Topo	27.090	0.350	28.137	1.047
114.386	Topo	27.050	0.300	28.168	1.118
114.485	Topo	27.090	0.350	28.199	1.109
114.548	Topo	27.007	0.400	28.219	1.212
114.635	Topo	26.500	0.400	28.246	1.746
114.734	Topo	26.250	0.350	28.278	2.028
114.834	Topo	27.120	0.300	28.309	1.189
114.881	Topo	27.350	0.300	28.324	0.974
114.970	Topo	27.120	0.300	28.352	1.232
115.019	Topo	27.190	0.300	28.367	1.177
115.118	Topo	27.850	0.300	28.399	0.549
115.198	Topo	28.137	0.400	28.424	0.287
115.267	Topo	28.090	0.400	28.445	0.356
115.367	Topo	28.042	0.400	28.477	0.435
115.467	Topo	27.995	0.400	28.509	0.514
115.560	Topo	27.947	0.400	28.538	0.591
115.613	Topo	28.116	0.400	28.555	0.439
115.708	Topo	28.284	0.400	28.585	0.3

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
115.802	Topo	28.453	0.400	28.614	0.162
115.849	Topo	28.750	0.300	28.629	0
115.960	Topo	28.907	0.300	28.664	0
116.074	Topo	28.261	0.300	28.700	0.439
116.174	Topo	27.614	0.400	28.731	1.117
116.322	Topo	26.968	0.400	28.778	1.81
116.369	Topo	26.452	0.400	28.793	2.341
116.467	Topo	26.066	0.400	28.824	2.757
116.541	Topo	25.681	0.300	28.847	3.166
116.617	Topo	25.295	0.300	28.871	3.576
116.688	Topo	25.107	0.300	28.893	3.786
116.786	Topo	24.919	0.300	28.924	4.005
116.835	Topo	25.103	0.350	28.940	3.837
116.936	Topo	25.659	0.350	28.972	3.313
117.017	Topo	26.215	0.400	28.997	2.782
117.125	Topo	26.588	0.400	29.031	2.443
117.254	Topo	26.962	0.400	29.072	2.11
117.330	Topo	27.335	0.400	29.096	1.761
117.402	Topo	27.003	0.400	29.119	2.116
117.501	Topo	26.671	0.400	29.150	2.479
117.598	Topo	26.280	0.350	29.180	2.9
117.694	Topo	25.950	0.350	29.211	3.261
117.792	Topo	26.005	0.300	29.241	3.236
117.891	Topo	26.425	0.300	29.273	2.848
117.972	Topo	26.845	0.400	29.298	2.453
118.060	Topo	26.940	0.400	29.326	2.386
118.159	Topo	26.420	0.400	29.357	2.937
118.209	Topo	26.530	0.400	29.373	2.843
118.308	Topo	26.510	0.400	29.404	2.894
118.407	Topo	26.670	0.400	29.436	2.766
118.507	Topo	26.660	0.350	29.467	2.807
118.570	Topo	26.775	0.300	29.487	2.712
118.660	Topo	26.810	0.300	29.515	2.705
118.758	Topo	26.820	0.300	29.546	2.726
118.828	Topo	26.815	0.400	29.568	2.753
118.902	Topo	26.820	0.400	29.592	2.772
119.002	Topo	26.950	0.400	29.623	2.673
119.102	Topo	26.960	0.300	29.655	2.695
119.152	Topo	27.010	0.300	29.670	2.66
119.252	Topo	26.950	0.300	29.702	2.752
119.351	Topo	27.076	0.300	29.733	2.657
119.448	Topo	27.399	0.300	29.764	2.365
119.543	Topo	27.721	0.300	29.793	2.072
119.662	Topo	28.044	0.400	29.831	1.787
119.759	Topo	27.948	0.400	29.862	1.914
119.853	Topo	27.434	0.400	29.891	2.458
119.925	Topo	26.919	0.400	29.914	2.995

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
120.024	Topo	26.405	0.400	29.945	3.54
120.119	Topo	26.534	0.400	29.975	3.441
120.218	Topo	26.663	0.400	30.006	3.343
120.318	Topo	26.792	0.400	30.038	3.245
120.418	Topo	26.921	0.400	30.069	3.148
120.517	Topo	27.050	0.400	30.101	3.05
120.567	Topo	26.875	0.400	30.116	3.241
120.667	Topo	26.395	0.300	30.148	3.753
120.737	Topo	25.915	0.300	30.170	4.255
120.817	Topo	26.290	0.300	30.195	3.905
120.917	Topo	26.664	0.300	30.227	3.562
121.017	Topo	27.039	0.300	30.258	3.219
121.116	Topo	27.413	0.300	30.289	2.876
121.215	Topo	27.788	0.300	30.320	2.533
121.264	Topo	28.044	0.300	30.336	2.292
121.376	Topo	28.181	0.300	30.371	2.19
121.472	Topo	28.319	0.400	30.401	2.083
121.568	Topo	28.456	0.400	30.432	1.975
121.616	Topo	28.427	0.400	30.447	2.02
121.713	Topo	28.230	0.400	30.478	2.248
121.811	Topo	28.033	0.400	30.508	2.475
121.860	Topo	27.910	0.400	30.524	2.614
121.960	Topo	27.920	0.300	30.555	2.635
122.068	Topo	27.865	0.300	30.589	2.724
122.149	Topo	27.890	0.300	30.615	2.725
122.238	Topo	27.900	0.300	30.643	2.743
122.276	Topo	27.900	0.400	30.655	2.755
122.360	Topo	28.610	0.400	30.681	2.071
122.459	Topo	29.210	0.300	30.712	1.502
122.558	Topo	29.414	0.300	30.744	1.33
122.658	Topo	29.151	0.300	30.775	1.625
122.758	Topo	28.888	0.300	30.807	1.919
122.847	Topo	28.625	0.300	30.835	2.21
122.909	Topo	28.661	0.300	30.854	2.193
122.988	Topo	28.698	0.300	30.879	2.181
123.046	Topo	28.734	0.300	30.898	2.164
123.116	Topo	28.770	0.400	30.920	2.149
123.185	Topo	28.807	0.400	30.941	2.135
123.251	Topo	28.820	0.400	30.962	2.142
123.397	Topo	28.810	0.400	31.008	2.198
123.485	Topo	28.810	0.400	31.008	2.198
123.608	Topo	28.790	0.400	31.075	2.285
123.704	Topo	28.810	0.400	31.105	2.295
123.798	Topo	28.750	0.400	31.135	2.385
123.890	Topo	28.650	0.400	31.164	2.514
123.982	Topo	28.640	0.400	31.193	2.553
124.029	Topo	28.620	0.400	31.208	2.588

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
124.126	Topo	28.540	0.400	31.238	2.698
124.223	Topo	28.550	0.400	31.269	2.719
124.256	Topo	28.525	0.400	31.279	2.754
124.354	Topo	28.680	0.400	31.310	2.63
124.472	Topo	28.710	0.400	31.347	2.637
124.572	Topo	28.810	0.400	31.379	2.569
124.671	Topo	28.840	0.400	31.410	2.57
124.760	Topo	28.885	0.400	31.438	2.553
124.841	Topo	28.790	0.400	31.464	2.674
124.934	Topo	28.920	0.400	31.493	2.573
125.025	Topo	28.900	0.400	31.522	2.622
125.174	Topo	28.930	0.400	31.568	2.638
125.192	Topo	28.960	0.400	31.574	2.614
125.305	Topo	28.960	0.400	31.574	2.614
125.455	Topo	28.970	0.300	31.704	2.734
125.604	Topo	28.970	0.300	31.704	2.734
125.685	Topo	28.980	0.300	31.730	2.75
125.743	Topo	29.035	0.300	31.748	2.713
125.807	Topo	28.365	0.300	31.768	3.403
125.895	Topo	27.695	0.400	31.796	4.101
125.960	Topo	27.025	0.400	31.816	4.791
126.041	Topo	27.625	0.400	31.842	4.217
126.129	Topo	28.225	0.400	31.869	3.644
126.168	Topo	28.673	0.400	31.882	3.208
126.240	Topo	28.970	0.400	31.904	2.934
126.371	Topo	29.267	0.400	31.946	2.679
126.416	Topo	29.505	0.400	31.960	2.455
126.549	Topo	29.685	0.400	32.002	2.317
126.649	Topo	29.865	0.400	32.033	2.168
126.753	Topo	30.045	0.400	32.066	2.021
126.823	Topo	30.225	0.400	32.088	1.863
126.878	Topo	30.405	0.400	32.106	1.701
126.947	Topo	30.323	0.400	32.127	1.805
127.050	Topo	30.241	0.400	32.160	1.919
127.146	Topo	30.158	0.400	32.190	2.032
127.241	Topo	30.076	0.400	32.220	2.144
127.339	Topo	30.326	0.400	32.251	1.925
127.439	Topo	30.908	0.400	32.282	1.374
127.537	Topo	31.491	0.400	32.313	0.823
127.634	Topo	32.073	0.400	32.344	0.271
127.727	Topo	32.655	0.400	32.373	0
127.796	Topo	32.353	0.400	32.395	0.042
127.866	Topo	32.050	0.400	32.417	0.367
128.063	Topo	31.748	0.400	32.479	0.731
128.139	Topo	31.445	0.400	32.503	1.058
128.206	Topo	31.400	0.400	32.524	1.124
128.310	Topo	31.365	0.300	32.557	1.192

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
128.409	Topo	31.375	0.300	32.588	1.213
128.508	Topo	31.385	0.300	32.619	1.234
128.592	Topo	31.395	0.400	32.646	1.251
128.678	Topo	31.405	0.400	32.673	1.268
128.771	Topo	31.089	0.400	32.702	1.613
128.850	Topo	30.774	0.400	32.727	1.953
128.929	Topo	30.458	0.400	32.752	2.294
129.068	Topo	30.143	0.400	32.796	2.653
129.116	Topo	30.063	0.400	32.811	2.749
129.235	Topo	30.063	0.400	32.811	2.749
129.372	Topo	30.218	0.400	32.892	2.674
129.484	Topo	30.373	0.400	32.927	2.554
129.563	Topo	30.528	0.400	32.952	2.425
129.596	Topo	30.689	0.400	32.962	2.274
129.658	Topo	30.856	0.400	32.982	2.126
129.720	Topo	31.023	0.400	33.001	1.978
129.805	Topo	31.190	0.400	33.028	1.838
129.905	Topo	31.357	0.400	33.060	1.703
130.005	Topo	31.524	0.500	33.091	1.567
130.061	Topo	31.691	0.500	33.109	1.417
130.109	Topo	31.851	0.500	33.124	1.273
130.206	Topo	32.002	0.500	33.155	1.153
130.293	Topo	32.154	0.500	33.182	1.028
130.394	Topo	32.305	0.500	33.214	0.909
130.486	Topo	33.185	0.500	33.243	0.058
130.585	Topo	34.065	0.400	33.274	0
130.670	Topo	34.945	0.400	33.301	0
130.734	Topo	35.048	0.400	33.321	0
130.832	Topo	35.151	0.400	33.352	0
130.932	Topo	35.254	0.400	33.383	0
130.982	Topo	35.350	0.400	33.399	0
131.082	Topo	35.330	0.400	33.431	0
131.182	Topo	35.330	0.300	33.462	0
131.269	Topo	35.340	0.300	33.490	0
131.342	Topo	35.400	0.300	33.513	0
131.433	Topo	35.410	0.300	33.541	0
131.530	Topo	35.320	0.300	33.572	0
131.625	Topo	35.350	0.300	33.602	0
131.696	Topo	35.380	0.400	33.624	0
131.729	Topo	35.390	0.400	33.635	0
131.788	Topo	35.279	0.400	33.653	0
132.028	Topo	35.008	0.400	33.729	0
132.126	Topo	34.736	0.300	33.760	0
132.213	Topo	34.465	0.300	33.787	0
132.275	Topo	34.257	0.300	33.807	0
132.375	Topo	34.049	0.300	33.838	0
132.475	Topo	33.841	0.300	33.870	0.029

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
132.575	Topo	33.633	0.400	33.901	0.268
132.658	Topo	33.425	0.400	33.927	0.502
132.725	Topo	33.576	0.400	33.948	0.372
132.824	Topo	33.728	0.400	33.980	0.252
132.924	Topo	33.879	0.400	34.011	0.132
132.974	Topo	33.801	0.400	34.027	0.226
133.074	Topo	33.493	0.400	34.059	0.566
133.174	Topo	33.184	0.400	34.090	0.906
133.274	Topo	32.876	0.400	34.122	1.246
133.374	Topo	32.568	0.400	34.153	1.586
133.474	Topo	32.259	0.400	34.185	1.926
133.524	Topo	32.192	0.400	34.200	2.008
133.624	Topo	32.366	0.400	34.232	1.866
133.723	Topo	32.540	0.400	34.263	1.723
133.793	Topo	32.714	0.400	34.285	1.571
133.892	Topo	32.888	0.400	34.317	1.428
133.991	Topo	33.062	0.400	34.348	1.285
134.090	Topo	33.236	0.400	34.379	1.142
134.190	Topo	33.411	0.400	34.410	1
134.290	Topo	33.585	0.400	34.442	0.857
134.389	Topo	33.759	0.400	34.473	0.715
134.488	Topo	33.933	0.400	34.504	0.572
134.587	Topo	34.107	0.400	34.536	0.429
134.686	Topo	34.281	0.400	34.567	0.286
134.783	Topo	34.455	0.400	34.597	0.142
134.884	Topo	34.500	0.400	34.629	0.129
134.983	Topo	34.460	0.400	34.660	0.2
135.083	Topo	34.480	0.400	34.692	0.212
135.181	Topo	34.410	0.300	34.723	0.313
135.279	Topo	34.490	0.300	34.754	0.264
135.378	Topo	34.520	0.300	34.785	0.265
135.427	Topo	34.605	0.300	34.800	0.196
135.525	Topo	34.804	0.300	34.831	0.027
135.623	Topo	35.003	0.300	34.862	0
135.710	Topo	35.202	0.300	34.890	0
135.775	Topo	35.402	0.300	34.910	0
135.839	Topo	35.601	0.300	34.930	0
135.903	Topo	35.800	0.300	34.950	0
135.968	Bathy	35.999	1.500	34.971	0
136.052	Bathy	35.828	4.500	38.100	2.272
136.150	Bathy	35.977	4.500	38.113	2.136
136.200	Bathy	35.750	4.200	38.119	2.369
136.292	Bathy	34.931	5.420	38.132	3.201
136.389	Bathy	34.650	5.200	38.144	3.494
136.437	Bathy	34.590	5.200	38.151	3.561
136.528	Bathy	34.996	5.240	38.163	3.167
136.626	Bathy	34.940	5.320	38.176	3.236

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
136.726	Bathy	34.826	5.370	38.189	3.363
136.774	Bathy	34.707	5.740	38.195	3.488
136.829	Bathy	34.810	5.500	38.202	3.392
136.926	Bathy	34.791	5.360	38.215	3.424
137.026	Bathy	35.459	5.340	38.228	2.769
137.126	Bathy	34.870	5.640	38.241	3.371
137.228	Bathy	35.010	5.400	38.255	3.245
137.276	Bathy	35.060	5.300	38.261	3.201
137.366	Bathy	35.150	5.200	38.273	3.123
137.447	Bathy	35.481	4.870	38.283	2.802
137.512	Bathy	35.380	4.900	38.292	2.912
137.560	Bathy	35.150	5.050	38.298	3.148
137.639	Bathy	34.594	5.300	38.309	3.715
137.700	Bathy	33.960	5.900	38.317	4.357
137.746	Bathy	33.210	6.100	38.323	5.113
137.824	Bathy	34.223	5.750	38.333	4.11
137.890	Bathy	34.260	5.360	38.342	4.082
137.938	Bathy	34.460	5.600	38.348	3.888
138.027	Bathy	34.449	5.550	38.360	3.911
138.090	Bathy	34.890	5.200	38.368	3.478
138.128	Bathy	35.010	5.010	38.373	3.363
138.201	Bathy	35.515	4.510	38.382	2.867
138.260	Bathy	35.410	4.400	38.390	2.98
138.305	Bathy	35.570	4.430	38.396	2.826
138.380	Bathy	35.630	4.450	38.406	2.776
138.430	Bathy	35.270	4.400	38.412	3.142
138.581	Bathy	35.618	4.520	38.432	2.814
138.636	Bathy	34.870	5.500	38.440	3.57
138.685	Bathy	34.280	5.950	38.446	4.166
138.769	Bathy	34.480	5.680	38.457	3.977
138.816	Bathy	35.180	4.700	38.463	3.283
138.846	Bathy	35.260	4.300	38.467	3.207
138.955	Bathy	35.260	4.300	38.467	3.207
139.033	Bathy	33.019	4.750	38.492	5.473
139.100	Bathy	34.240	4.810	38.500	4.26
139.146	Bathy	35.360	4.500	38.507	3.147
139.219	Bathy	36.155	3.830	38.516	2.361
139.290	Bathy	36.450	3.800	38.526	2.076
139.339	Bathy	36.000	3.800	38.532	2.532
139.452	Bathy	36.737	3.680	38.547	1.81
139.525	Bathy	36.160	4.100	38.556	2.396
139.661	Bathy	34.090	5.000	38.574	4.484
139.759	Bathy	34.120	6.500	38.587	4.467
139.837	Bathy	34.920	5.600	38.597	3.677
139.903	Bathy	35.260	4.700	38.606	3.346
139.996	Bathy	34.650	5.200	38.618	3.968
140.095	Bathy	35.210	5.700	38.631	3.421

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
140.186	Bathy	35.260	5.400	38.643	3.383
140.261	Bathy	35.256	5.040	38.653	3.397
140.339	Bathy	34.190	6.000	38.663	4.473
140.436	Bathy	33.470	6.600	38.676	5.206
140.534	Bathy	34.160	6.300	38.689	4.529
140.585	Bathy	34.280	5.300	38.696	4.416
140.676	Bathy	35.354	4.850	38.708	3.354
140.746	Bathy	35.874	4.490	38.717	2.843
140.812	Bathy	35.670	4.500	38.725	3.055
140.908	Bathy	35.210	4.400	38.738	3.528
140.961	Bathy	35.232	4.160	38.745	3.513
141.057	Bathy	34.808	4.580	38.758	3.95
141.157	Bathy	35.454	4.230	38.771	3.317
141.198	Bathy	35.724	4.120	38.776	3.052
141.291	Bathy	36.150	4.200	38.788	2.638
141.340	Bathy	36.060	4.300	38.795	2.735
141.440	Bathy	35.950	4.420	38.808	2.858
141.540	Bathy	35.210	4.470	38.821	3.611
141.598	Bathy	35.747	4.510	38.829	3.082
141.698	Bathy	36.123	4.510	38.842	2.719
141.797	Bathy	36.060	4.200	38.855	2.795
141.897	Bathy	35.837	4.450	38.868	3.031
141.997	Bathy	35.830	4.460	38.881	3.051
142.097	Bathy	35.805	4.520	38.894	3.089
142.196	Bathy	36.493	3.870	38.907	2.414
142.270	Bathy	34.991	4.380	38.917	3.926
142.332	Bathy	35.670	4.100	38.925	3.255
142.393	Bathy	36.797	4.120	38.933	2.136
142.456	Bathy	35.013	4.550	38.941	3.928
142.532	Bathy	35.290	4.350	38.951	3.661
142.567	Bathy	36.130	4.150	38.956	2.826
142.599	Bathy	36.990	4.000	38.960	1.97
142.690	Bathy	37.453	3.710	38.972	1.519
142.747	Bathy	37.150	3.800	38.980	1.83
142.828	Bathy	36.130	4.000	38.990	2.86
142.881	Bathy	35.039	5.210	38.997	3.958
142.947	Bathy	35.290	4.500	39.006	3.716
142.992	Bathy	36.160	4.000	39.012	2.852
143.062	Bathy	37.095	3.140	39.021	1.926
143.130	Bathy	36.480	3.800	39.030	2.55
143.177	Bathy	35.880	4.500	39.036	3.156
143.240	Bathy	35.993	4.700	39.044	3.051
143.304	Bathy	37.150	4.100	39.053	1.903
143.350	Bathy	34.710	3.100	39.059	4.349
143.441	Bathy	37.180	3.300	39.071	1.891
143.529	Bathy	36.190	3.900	39.082	2.892
143.629	Bathy	35.670	4.400	39.096	3.426

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
143.722	Bathy	35.390	4.600	39.108	3.718
143.821	Bathy	36.370	4.400	39.121	2.751
143.930	Bathy	36.270	3.950	39.135	2.865
144.028	Bathy	35.650	4.500	39.148	3.498
144.121	Bathy	35.292	5.310	39.160	3.868
144.162	Bathy	37.269	2.420	39.166	1.897
144.228	Bathy	36.920	4.000	39.174	2.254
144.278	Bathy	36.990	4.500	39.181	2.191
144.351	Bathy	37.869	3.020	39.190	1.321
144.416	Bathy	37.010	3.700	39.199	2.189
144.465	Bathy	36.230	4.500	39.205	2.975
144.560	Bathy	35.104	5.430	39.218	4.114
144.660	Bathy	34.853	5.690	39.231	4.378
144.727	Bathy	34.938	4.730	39.240	4.302
144.825	Bathy	36.979	3.510	39.253	2.274
144.920	Bathy	36.228	4.270	39.265	3.037
145.016	Bathy	34.725	5.720	39.289	4.564
145.116	Bathy	35.430	4.890	39.314	3.884
145.221	Bathy	36.377	4.010	39.341	2.964
145.313	Bathy	37.441	4.760	39.363	1.923
145.365	Bathy	38.487	3.000	39.376	0.889
145.474	Bathy	39.533	1.000	39.404	0
145.573	Topo	40.150	0.400	39.429	0
145.673	Topo	40.670	0.400	39.453	0
145.722	Topo	41.250	0.400	39.466	0
145.821	Topo	41.670	0.400	39.491	0
145.920	Topo	41.190	0.300	39.515	0
146.026	Topo	41.320	0.300	39.542	0
146.068	Topo	41.760	0.300	39.552	0
146.145	Topo	41.290	0.300	39.571	0
146.216	Topo	41.870	0.400	39.589	0
146.216	Topo	42.250	0.400	39.589	0
146.277	Topo	41.880	0.400	39.604	0
146.385	Topo	41.880	0.400	39.604	0
146.500	Topo	40.155	0.400	39.660	0
146.628	Topo	40.233	0.400	39.692	0
146.708	Topo	40.311	0.400	39.712	0
146.788	Topo	40.390	0.400	39.732	0
146.864	Topo	40.468	0.400	39.751	0
146.955	Topo	40.546	0.400	39.774	0
147.020	Topo	40.675	0.400	39.790	0
147.117	Topo	40.855	0.400	39.814	0
147.214	Topo	41.035	0.400	39.839	0
147.311	Topo	41.215	0.400	39.863	0
147.408	Topo	41.395	0.300	39.887	0
147.504	Topo	41.575	0.300	39.911	0
147.615	Topo	41.755	0.300	39.939	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
147.714	Topo	42.213	0.300	39.964	0
147.814	Topo	42.948	0.400	39.989	0
147.864	Topo	43.222	0.400	40.001	0
147.963	Topo	43.035	0.400	40.026	0
148.063	Topo	42.848	0.400	40.051	0
148.148	Topo	42.662	0.400	40.072	0
148.185	Topo	42.475	0.400	40.082	0
148.276	Topo	42.517	0.400	40.104	0
148.376	Topo	42.559	0.400	40.129	0
148.476	Topo	42.601	0.400	40.154	0
148.576	Topo	42.643	0.400	40.179	0
148.680	Topo	42.685	0.400	40.205	0
148.774	Topo	42.160	0.400	40.229	0
148.872	Topo	42.120	0.400	40.253	0
148.970	Topo	42.560	0.400	40.278	0
149.055	Topo	42.650	0.400	40.299	0
149.118	Topo	42.420	0.400	40.315	0
149.215	Topo	42.610	0.400	40.339	0
149.312	Topo	42.350	0.300	40.363	0
149.409	Topo	42.280	0.300	40.388	0
149.498	Topo	42.405	0.300	40.410	0
149.607	Topo	42.950	0.300	40.437	0
149.707	Topo	42.460	0.300	40.462	0
149.807	Topo	42.250	0.300	40.487	0
149.907	Topo	41.950	0.300	40.512	0
150.004	Topo	41.620	0.300	40.536	0
150.100	Topo	41.340	0.300	40.560	0
150.171	Topo	41.930	0.300	40.578	0
150.220	Topo	41.996	0.300	40.590	0
150.320	Topo	41.439	0.300	40.615	0
150.420	Topo	40.881	0.300	40.640	0
150.520	Topo	40.324	0.300	40.665	0.341
150.570	Topo	40.160	0.300	40.678	0.518
150.669	Topo	40.810	0.400	40.703	0
150.763	Topo	41.045	0.400	40.726	0
150.869	Topo	41.280	0.400	40.753	0
150.969	Topo	41.290	0.400	40.778	0
151.067	Topo	41.515	0.400	40.802	0
151.169	Topo	41.970	0.400	40.828	0
151.269	Topo	41.720	0.300	40.853	0
151.366	Topo	41.375	0.300	40.877	0
151.469	Topo	41.280	0.300	40.902	0
151.568	Topo	41.190	0.300	40.927	0
151.668	Topo	40.870	0.300	40.952	0.082
151.718	Topo	40.160	0.300	40.965	0.805
151.818	Topo	40.520	0.300	40.990	0.47
151.915	Topo	40.210	0.300	41.014	0.804

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
152.013	Topo	40.670	0.400	41.039	0.369
152.111	Topo	40.954	0.400	41.063	0.109
152.209	Topo	40.740	0.400	41.088	0.348
152.257	Topo	40.280	0.400	41.099	0.819
152.348	Topo	40.270	0.400	41.122	0.852
152.440	Topo	40.510	0.400	41.145	0.635
152.531	Topo	40.570	0.300	41.168	0.598
152.623	Topo	40.138	0.300	41.191	1.053
152.725	Topo	39.875	0.300	41.216	1.341
152.800	Topo	40.210	0.300	41.235	1.025
153.001	Topo	40.270	0.400	41.286	1.016
153.099	Topo	41.722	0.400	41.310	0
153.193	Topo	42.516	0.400	41.333	0
153.287	Topo	43.311	0.400	41.357	0
153.379	Topo	43.357	0.400	41.380	0
153.481	Topo	43.491	0.400	41.405	0
153.577	Topo	43.515	0.400	41.429	0
153.665	Topo	43.527	0.400	41.451	0
153.772	Topo	43.689	0.400	41.478	0
153.867	Topo	43.809	0.400	41.502	0
153.960	Topo	43.954	0.400	41.525	0
154.059	Topo	44.105	0.400	41.550	0
154.188	Topo	43.516	0.400	41.582	0
154.284	Topo	43.123	0.400	41.606	0
154.381	Topo	42.730	0.400	41.630	0
154.477	Topo	42.338	0.400	41.655	0
154.583	Topo	41.945	0.400	41.681	0
154.673	Topo	42.263	0.400	41.704	0
154.773	Topo	42.580	0.400	41.729	0
154.873	Topo	42.898	0.400	41.754	0
154.986	Topo	43.215	0.400	41.782	0
155.070	Topo	43.177	0.400	41.803	0
155.166	Topo	43.139	0.400	41.827	0
155.262	Topo	43.102	0.400	41.851	0
155.358	Topo	43.064	0.400	41.875	0
155.455	Topo	43.026	0.400	41.899	0
155.550	Topo	42.988	0.400	41.923	0
155.644	Topo	42.951	0.400	41.946	0
155.740	Topo	42.913	0.400	41.970	0
155.812	Topo	42.875	0.400	41.988	0
155.886	Topo	42.930	0.400	42.007	0
155.985	Topo	42.759	0.400	42.031	0
156.082	Topo	42.368	0.400	42.056	0
156.179	Topo	41.977	0.400	42.080	0.103
156.276	Topo	41.586	0.400	42.104	0.518
156.362	Topo	41.195	0.400	42.126	0.931
156.423	Topo	41.678	0.400	42.141	0.463

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
156.522	Topo	42.162	-	42.166	0.004
156.597	Topo	42.645	-	42.184	0
156.667	Topo	42.360	-	42.202	0
156.762	Topo	42.075	-	42.226	0.151
156.856	Topo	41.790	-	42.249	0.459
156.953	Topo	41.505	-	42.274	0.769
157.039	Topo	41.797	-	42.295	0.498
157.139	Topo	42.088	-	42.320	0.232
157.239	Topo	42.380	-	42.345	0
157.339	Topo	42.672	-	42.370	0
157.438	Topo	42.963	-	42.395	0
157.523	Topo	43.255	-	42.416	0
157.624	Topo	43.150	-	42.441	0
157.756	Topo	40.260	0.300	42.474	2.214
157.855	Topo	40.210	0.300	42.499	2.289
157.954	Topo	40.100	0.300	42.524	2.424
158.045	Topo	39.870	0.300	42.546	2.676
158.165	Topo	39.870	0.300	42.546	2.676
158.277	Topo	39.640	0.300	42.604	2.964
158.367	Topo	39.280	0.300	42.627	3.347
158.445	Topo	39.025	0.300	42.646	3.621
158.508	Topo	39.116	0.300	42.662	3.547
158.608	Topo	39.206	0.300	42.687	3.481
158.707	Topo	39.297	0.300	42.712	3.415
158.807	Topo	39.387	0.300	42.737	3.35
158.925	Topo	39.387	0.300	42.737	3.35
158.995	Topo	39.478	0.300	42.784	3.306
159.094	Topo	39.569	0.300	42.809	3.24
159.194	Topo	39.659	0.300	42.834	3.175
159.294	Topo	39.750	0.300	42.859	3.109
159.392	Topo	39.690	0.300	42.883	3.193
159.489	Topo	39.481	0.300	42.908	3.426
159.586	Topo	39.272	0.300	42.932	3.66
159.803	Topo	39.063	0.300	42.986	3.923
159.895	Topo	38.854	0.300	43.009	4.155
159.989	Topo	38.645	0.300	43.033	4.388
160.086	Topo	38.923	0.300	43.057	4.134
160.184	Topo	39.200	0.300	43.081	3.881
160.282	Topo	39.478	0.300	43.106	3.628
160.378	Topo	39.755	0.300	43.130	3.375
160.476	Topo	39.953	0.300	43.154	3.201
160.571	Topo	40.151	0.300	43.178	3.027
160.666	Topo	40.349	0.300	43.202	2.853
160.762	Topo	40.547	0.300	43.226	2.679
160.849	Topo	40.745	0.300	43.247	2.502
160.906	Topo	40.250	0.300	43.262	3.012
161.004	Topo	40.710	-	43.286	2.576

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
161.102	Topo	40.705	-	43.311	2.606
161.200	Topo	40.905	-	43.335	2.43
161.298	Topo	41.105	-	43.360	2.255
161.397	Topo	41.305	-	43.385	2.08
161.910	Topo	41.750	-	43.513	1.763
161.983	Topo	41.250	-	43.531	2.281
162.055	Topo	41.410	-	43.549	2.139
162.099	Topo	41.210	-	43.560	2.35
162.197	Topo	41.280	-	43.584	2.304
162.295	Topo	41.750	-	43.609	1.859
162.392	Topo	41.190	-	43.633	2.443
162.438	Topo	41.053	-	43.645	2.592
162.528	Topo	40.950	-	43.667	2.717
162.624	Topo	40.847	-	43.691	2.845
162.721	Topo	40.743	-	43.716	2.972
162.819	Topo	40.640	-	43.740	3.1
162.916	Topo	40.537	-	43.764	3.228
162.971	Topo	40.482	-	43.778	3.296
163.069	Topo	40.476	-	43.803	3.327
163.167	Topo	40.510	-	43.827	3.317
163.265	Topo	40.464	-	43.852	3.388
163.363	Topo	40.390	-	43.876	3.486
163.413	Topo	40.361	-	43.888	3.527
163.513	Topo	40.180	-	43.913	3.733
163.613	Topo	39.970	-	43.938	3.968
163.713	Topo	39.640	-	43.963	4.323
163.813	Topo	39.609	-	43.988	4.379
163.862	Topo	39.710	-	44.001	4.291
163.955	Topo	39.515	-	44.024	4.509
164.055	Topo	39.410	-	44.049	4.639
164.151	Topo	39.650	-	44.073	4.423
164.248	Topo	39.450	-	44.097	4.647
164.345	Topo	39.470	-	44.122	4.652
164.410	Topo	39.535	-	44.138	4.603
164.493	Topo	39.370	-	44.158	4.788
164.601	Topo	39.480	-	44.186	4.706
164.701	Topo	39.510	-	44.211	4.701
164.801	Topo	39.300	-	44.235	4.935
164.851	Topo	39.350	-	44.248	4.898
164.951	Topo	39.250	-	44.273	5.023
165.051	Topo	39.710	-	44.298	4.588
165.113	Topo	39.925	-	44.313	4.388
165.124	Topo	40.305	-	44.316	4.011
165.208	Topo	40.520	-	44.337	3.817
165.308	Topo	40.710	-	44.362	3.652
165.408	Topo	40.910	-	44.387	3.477
165.508	Topo	41.200	-	44.412	3.212

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
165.557	Topo	41.436	-	44.424	2.989
165.649	Topo	41.737	-	44.447	2.71
165.740	Topo	42.039	-	44.470	2.431
165.845	Topo	42.039	-	44.470	2.431
165.934	Topo	42.340	-	44.519	2.178
166.025	Topo	42.642	-	44.542	1.9
166.117	Topo	42.943	-	44.564	1.621
166.179	Topo	43.245	-	44.580	1.335
166.257	Topo	43.410	-	44.600	1.19
166.354	Topo	43.290	-	44.624	1.334
166.451	Topo	43.665	-	44.648	0.983
166.550	Topo	43.810	-	44.673	0.863
166.619	Topo	43.985	-	44.690	0.705
166.698	Topo	44.060	-	44.710	0.65
166.796	Topo	44.280	-	44.734	0.454
166.894	Topo	44.423	-	44.759	0.336
166.993	Topo	44.994	-	44.783	0
167.092	Topo	45.732	-	44.808	0
167.191	Topo	46.470	-	44.833	0
167.290	Topo	47.209	-	44.858	0
167.371	Topo	47.947	-	44.878	0
167.446	Topo	48.685	-	44.897	0
167.555	Topo	48.420	-	44.924	0
167.655	Topo	48.210	-	44.949	0
167.755	Topo	48.370	-	44.974	0
167.860	Topo	48.685	-	45.000	0
167.955	Topo	48.250	-	45.024	0
168.055	Topo	48.370	-	45.049	0
168.155	Topo	48.420	-	45.074	0
168.260	Topo	48.385	-	45.100	0
168.353	Topo	48.177	-	45.124	0
168.452	Topo	47.969	-	45.148	0
168.551	Topo	47.761	-	45.173	0
168.650	Topo	47.553	-	45.198	0
168.749	Topo	47.345	-	45.222	0
168.848	Topo	47.137	-	45.247	0
168.942	Topo	46.929	-	45.271	0
169.026	Topo	47.096	-	45.292	0
169.122	Topo	47.639	-	45.316	0
169.218	Topo	48.182	-	45.340	0
169.324	Topo	48.725	-	45.366	0
169.413	Topo	48.610	-	45.388	0
169.513	Topo	48.420	-	45.413	0
169.613	Topo	48.690	-	45.438	0
169.726	Topo	48.725	-	45.467	0
169.809	Topo	48.010	-	45.488	0
169.858	Topo	47.208	-	45.500	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
169.956	Topo	46.874	-	45.524	0
170.055	Topo	46.539	-	45.663	0
170.161	Topo	46.205	-	45.813	0
170.253	Topo	45.045	-	45.943	0.898
170.353	Topo	43.885	-	46.084	2.199
170.453	Topo	43.261	-	46.225	2.964
170.552	Topo	43.173	-	46.366	3.193
170.652	Topo	43.085	-	46.506	3.421
170.751	Topo	42.997	-	46.647	3.65
170.851	Topo	42.909	-	46.787	3.878
170.900	Topo	42.560	-	46.856	4.296
170.996	Topo	42.730	-	46.992	4.262
171.093	Topo	42.865	-	47.129	4.264
171.181	Topo	41.500	-	47.254	5.754
171.227	Topo	40.990	-	47.319	6.329
171.296	Topo	41.085	-	47.415	6.33
171.374	Topo	41.080	-	47.526	6.446
171.545	Topo	41.060	-	47.768	6.708
171.639	Topo	41.040	-	47.900	6.86
171.733	Topo	41.060	-	48.033	6.973
171.829	Topo	41.872	-	48.168	6.296
171.927	Topo	43.445	-	48.306	4.861
172.024	Topo	45.018	-	48.444	3.426
172.123	Topo	45.870	-	48.583	2.713
172.221	Topo	45.840	-	48.722	2.882
172.320	Topo	46.530	-	48.861	2.331
172.360	Topo	46.939	-	48.919	1.98
172.460	Topo	46.890	-	49.059	2.169
172.560	Topo	46.870	-	49.200	2.33
172.659	Topo	46.903	-	49.341	2.438
172.759	Topo	46.920	-	49.481	2.561
172.859	Topo	47.385	-	49.622	2.237
172.959	Topo	48.385	-	49.763	1.378
173.058	Topo	49.385	-	49.904	0.519
173.108	Topo	49.910	-	49.974	0.064
173.208	Topo	49.810	-	50.115	0.305
173.308	Topo	49.820	-	50.256	0.436
173.405	Topo	49.860	-	50.394	0.534
173.502	Topo	49.820	-	50.530	0.71
173.552	Topo	49.780	-	50.600	0.82
173.652	Topo	49.570	-	50.741	1.171
173.752	Topo	49.360	-	50.883	1.523
173.852	Topo	49.448	-	51.024	1.576
173.951	Topo	49.834	-	51.165	1.331
174.051	Topo	50.219	-	51.306	1.086
174.153	Topo	50.605	-	51.449	0.844
174.250	Topo	50.450	-	51.587	1.137

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
174.337	Topo	50.295	-	51.708	1.413
174.449	Topo	50.760	-	51.868	1.108
174.564	Topo	51.225	-	52.030	0.805
174.649	Topo	51.568	-	52.149	0.581
174.749	Topo	51.912	-	52.290	0.379
174.835	Topo	52.255	-	52.413	0.158
174.948	Topo	52.060	-	52.571	0.511
175.059	Topo	51.945	-	52.639	0.694
175.152	Topo	51.945	-	52.695	0.75
175.247	Topo	52.082	-	52.752	0.67
175.347	Topo	52.219	-	52.813	0.594
175.447	Topo	52.356	-	52.874	0.517
175.496	Topo	52.754	-	52.903	0.15
175.593	Topo	53.412	-	52.962	0
175.690	Topo	54.069	-	53.021	0
175.824	Topo	54.727	-	53.102	0
175.917	Topo	55.385	-	53.158	0
176.013	Topo	53.010	-	53.217	0.207
176.104	Topo	52.500	-	53.272	0.772
176.175	Topo	51.755	-	53.315	1.56
176.246	Topo	52.540	-	53.358	0.818
176.318	Topo	53.995	-	53.401	0
176.396	Topo	53.670	-	53.449	0
176.426	Topo	52.990	-	53.467	0.477
176.525	Topo	51.630	-	53.527	1.897
176.618	Topo	50.150	-	53.583	3.433
176.709	Topo	49.925	-	53.638	3.713
176.804	Topo	49.205	-	53.696	4.491
176.901	Topo	48.485	-	53.755	5.27
176.996	Topo	50.131	-	53.812	3.682
177.092	Topo	51.776	-	53.871	2.094
177.188	Topo	53.422	-	53.929	0.507
177.286	Topo	54.114	-	53.988	0
177.384	Topo	53.853	-	54.048	0.195
177.483	Topo	53.591	-	54.107	0.516
177.582	Topo	53.330	-	54.167	0.837
177.680	Topo	53.069	-	54.227	1.158
177.781	Topo	52.807	-	54.288	1.481
177.876	Topo	52.546	-	54.345	1.8
177.924	Topo	52.319	-	54.374	2.056
178.023	Topo	52.126	-	54.435	2.308
178.123	Topo	51.934	-	54.495	2.561
178.222	Topo	51.741	-	54.555	2.814
178.272	Topo	51.500	-	54.585	3.085
178.372	Topo	51.210	-	54.646	3.436
178.472	Topo	50.920	-	54.706	3.786
178.572	Topo	50.630	-	54.767	4.137

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
178.672	Topo	50.340	-	54.828	4.488
178.771	Topo	51.009	-	54.888	3.879
178.869	Topo	52.637	-	54.947	2.31
178.956	Topo	54.265	-	55.000	0.735
179.055	Topo	54.390	-	55.060	0.67
179.155	Topo	54.390	-	55.121	0.731
179.255	Topo	54.560	-	55.181	0.621
179.355	Topo	54.370	-	55.242	0.872
179.405	Topo	54.210	-	55.272	1.062
179.504	Topo	54.020	-	55.332	1.312
179.600	Topo	53.840	-	55.390	1.55
179.700	Topo	53.850	-	55.451	1.601
179.799	Topo	53.941	-	55.511	1.57
179.897	Topo	54.292	-	55.570	1.278
179.995	Topo	54.644	-	55.629	0.986
180.096	Topo	54.995	-	55.691	0.696
180.192	Topo	55.203	-	55.749	0.546
180.289	Topo	55.412	-	55.808	0.396
180.388	Topo	55.620	-	55.868	0.248
180.487	Topo	55.828	-	55.928	0.099
180.586	Topo	56.037	-	55.988	0
180.673	Topo	56.245	-	56.040	0
180.735	Topo	56.390	-	56.078	0
180.835	Topo	56.180	-	56.138	0
180.934	Topo	56.670	-	56.198	0
181.034	Topo	56.810	-	56.259	0
181.133	Topo	56.310	-	56.319	0.009
181.183	Topo	55.935	-	56.349	0.414
181.283	Topo	55.495	-	56.410	0.915
181.396	Topo	55.055	-	56.478	1.423
181.485	Topo	54.615	-	56.532	1.917
181.585	Topo	54.175	-	56.593	2.418
181.683	Topo	54.076	-	56.652	2.576
181.778	Topo	54.318	-	56.710	2.392
181.874	Topo	54.840	-	56.768	1.928
181.969	Topo	54.803	-	56.825	2.023
182.061	Topo	55.045	-	56.881	1.836
182.163	Topo	54.978	-	56.943	1.965
182.261	Topo	54.820	-	57.002	2.182
182.359	Topo	54.470	-	57.062	2.592
182.520	Topo	54.777	-	57.160	2.383
182.619	Topo	54.710	-	57.219	2.509
182.717	Topo	54.643	-	57.279	2.636
182.815	Topo	54.576	-	57.338	2.763
182.913	Topo	54.509	-	57.398	2.889
183.012	Topo	54.868	-	57.458	2.59
183.112	Topo	55.654	-	57.518	1.864

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
183.211	Topo	56.439	-	57.578	1.139
183.307	Topo	57.225	-	57.636	0.411
183.411	Topo	56.803	-	57.699	0.896
183.510	Topo	56.381	-	57.759	1.378
183.619	Topo	55.959	-	57.825	1.866
183.718	Topo	55.537	-	57.885	2.348
183.805	Topo	55.115	-	57.938	2.823
183.867	Topo	55.547	-	57.975	2.429
183.967	Topo	55.978	-	58.036	2.058
184.067	Topo	56.410	-	58.097	1.687
184.167	Topo	56.842	-	58.157	1.315
184.267	Topo	57.273	-	58.218	0.944
184.336	Topo	57.705	-	58.259	0.554
184.417	Topo	57.160	-	58.308	1.148
184.516	Topo	57.820	-	58.369	0.549
184.616	Topo	57.510	-	58.429	0.919
184.715	Topo	57.670	-	58.489	0.819
184.815	Topo	57.119	-	58.550	1.431
184.936	Topo	57.735	-	58.623	0.888
185.009	Topo	57.893	-	58.667	0.775
185.091	Topo	58.070	-	58.717	0.647
185.190	Topo	58.208	-	58.777	0.57
185.284	Topo	58.365	-	58.834	0.469
185.390	Topo	58.013	-	58.898	0.886
185.490	Topo	57.660	-	58.959	1.299
185.589	Topo	57.308	-	59.019	1.711
185.711	Topo	56.955	-	59.093	2.138
185.807	Topo	57.515	-	59.151	1.636
185.901	Topo	58.075	-	59.208	1.133
186.003	Topo	58.635	-	59.270	0.635
186.051	Topo	59.388	-	59.298	0
186.144	Topo	60.335	-	59.355	0
186.238	Topo	61.282	-	59.412	0
186.332	Topo	62.228	-	59.469	0
186.540	Topo	63.175	-	59.595	0
186.642	Topo	63.190	-	59.657	0
186.691	Topo	62.910	-	59.686	0
186.790	Topo	62.380	-	59.747	0
186.890	Topo	61.850	-	59.807	0
186.989	Topo	61.320	-	59.867	0
187.163	Topo	60.790	-	59.972	0
187.210	Topo	60.461	-	60.001	0
187.310	Topo	60.334	-	60.061	0
187.409	Topo	60.206	-	60.122	0
187.491	Topo	60.015	-	60.171	0.156
187.561	Topo	60.215	-	60.214	0
187.660	Topo	60.415	-	60.274	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
187.760	Topo	60.615	-	60.334	0
187.859	Topo	60.870	-	60.394	0
187.907	Topo	60.901	-	60.423	0
188.003	Topo	60.873	-	60.481	0
188.100	Topo	60.845	-	60.540	0
188.198	Topo	60.817	-	60.599	0
188.295	Topo	60.750	-	60.658	0
188.345	Topo	60.670	-	60.688	0.018
188.460	Topo	60.770	-	60.758	0
188.558	Topo	60.810	-	60.818	0.008
188.657	Topo	60.780	-	60.878	0.098
188.756	Topo	60.790	-	60.937	0.147
188.854	Topo	60.820	-	60.997	0.177
188.972	Topo	60.870	-	61.068	0.198
189.071	Topo	60.950	-	61.128	0.178
189.160	Topo	61.015	-	61.183	0.168
189.250	Topo	60.980	-	61.237	0.257
189.415	Topo	60.780	-	61.337	0.557
189.515	Topo	60.490	-	61.397	0.907
189.619	Topo	60.245	-	61.461	1.216
189.692	Topo	60.390	-	61.505	1.115
189.790	Topo	60.520	-	61.564	1.044
189.889	Topo	60.780	-	61.624	0.844
189.988	Topo	61.110	-	61.684	0.574
190.086	Topo	61.410	-	61.744	0.334
190.186	Topo	61.260	-	61.804	0.544
190.285	Topo	61.340	-	61.864	0.524
190.384	Topo	61.390	-	61.924	0.534
190.511	Topo	61.430	-	62.001	0.571
190.610	Topo	61.530	-	62.061	0.531
190.710	Topo	61.760	-	62.121	0.361
190.810	Topo	61.940	-	62.182	0.242
190.888	Topo	62.305	-	62.229	0
190.950	Topo	62.330	-	62.267	0
191.089	Topo	62.260	-	62.351	0.091
191.189	Topo	62.360	-	62.412	0.052
191.289	Topo	62.370	-	62.472	0.102
191.413	Topo	62.420	-	62.547	0.127
191.502	Topo	62.430	-	62.601	0.171
191.545	Topo	62.490	-	62.627	0.137
191.628	Topo	62.360	-	62.678	0.318
191.797	Topo	62.200	-	62.780	0.58
191.896	Topo	62.360	-	62.840	0.48
191.994	Topo	62.240	-	62.900	0.66
192.074	Topo	62.095	-	62.948	0.853
192.143	Topo	62.200	-	62.990	0.79
192.248	Topo	62.670	-	63.053	0.383

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
192.347	Topo	62.980	-	63.114	0.134
192.447	Topo	63.090	-	63.174	0.084
192.546	Topo	63.290	-	63.234	0
192.595	Topo	63.240	-	63.264	0.024
192.693	Topo	63.250	-	63.323	0.073
192.791	Topo	63.210	-	63.382	0.172
192.888	Topo	63.220	-	63.441	0.221
192.936	Topo	63.316	-	63.470	0.154
193.075	Topo	63.558	-	63.555	0
193.175	Topo	63.799	-	63.615	0
193.274	Topo	64.041	-	63.675	0
193.427	Topo	64.283	-	63.767	0
193.521	Topo	64.524	-	63.825	0
193.570	Topo	64.560	-	63.854	0
193.669	Topo	64.530	-	63.915	0
193.769	Topo	64.480	-	63.975	0
193.874	Topo	64.645	-	64.038	0
193.968	Topo	64.525	-	64.095	0
194.122	Topo	64.405	-	64.189	0
194.216	Topo	64.285	-	64.246	0
194.322	Topo	64.165	-	64.310	0.145
194.408	Topo	64.289	-	64.362	0.073
194.508	Topo	64.390	-	64.422	0.032
194.607	Topo	64.560	-	64.483	0
194.722	Topo	64.661	-	64.552	0
194.783	Topo	64.785	-	64.589	0
194.870	Topo	64.640	-	64.642	0.002
194.968	Topo	64.495	-	64.702	0.207
195.067	Topo	64.350	-	64.762	0.412
195.146	Topo	64.205	-	64.809	0.604
195.215	Topo	64.220	-	64.851	0.631
195.313	Topo	64.180	-	64.910	0.73
195.378	Topo	64.205	-	64.950	0.745
195.463	Topo	64.538	-	65.001	0.463
195.563	Topo	64.860	-	65.062	0.202
195.662	Topo	65.205	-	65.122	0
195.758	Topo	65.538	-	65.180	0
195.806	Topo	65.038	-	65.209	0.171
195.901	Topo	63.705	-	65.267	1.562
195.996	Topo	62.372	-	65.324	2.952
196.044	Topo	61.680	-	65.353	3.673
196.145	Topo	62.455	-	65.415	2.96
196.219	Topo	64.095	-	65.459	1.364
196.294	Topo	64.591	-	65.505	0.914
196.394	Topo	65.087	-	65.565	0.478
196.493	Topo	65.583	-	65.625	0.042
196.631	Topo	66.079	-	65.709	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
196.700	Topo	66.575	-	65.751	0
196.777	Topo	65.728	-	65.797	0.07
196.876	Topo	64.880	-	65.858	0.978
196.978	Topo	64.033	-	65.919	1.887
197.047	Topo	63.185	-	65.961	2.776
197.102	Topo	63.185	-	65.994	2.809
197.175	Topo	64.114	-	66.038	1.925
197.272	Topo	65.042	-	66.097	1.055
197.378	Topo	65.971	-	66.162	0.191
197.471	Topo	66.420	-	66.218	0
197.517	Topo	66.490	-	66.246	0
197.616	Topo	66.450	-	66.306	0
197.716	Topo	66.490	-	66.366	0
197.786	Topo	66.475	-	66.409	0
197.866	Topo	66.331	-	66.457	0.127
197.966	Topo	66.200	-	66.518	0.318
198.066	Topo	66.042	-	66.578	0.536
198.163	Topo	65.897	-	66.637	0.74
198.212	Topo	65.010	-	66.667	1.657
198.285	Topo	63.885	-	66.711	2.826
198.366	Topo	64.210	-	66.760	2.55
198.444	Topo	64.335	-	66.808	2.473
198.488	Topo	64.345	-	66.834	2.489
198.561	Topo	65.049	-	66.879	1.83
198.661	Topo	65.752	-	66.939	1.186
198.771	Topo	66.456	-	67.005	0.549
198.867	Topo	67.160	-	67.064	0
198.969	Topo	67.863	-	67.125	0
199.055	Topo	67.598	-	67.177	0
199.125	Topo	67.598	-	67.177	0
199.210	Topo	66.363	-	67.272	0.909
199.255	Topo	65.828	-	67.299	1.471
199.344	Topo	65.994	-	67.353	1.359
199.436	Topo	66.159	-	67.408	1.249
199.506	Topo	66.325	-	67.451	1.126
199.579	Topo	66.162	-	67.495	1.333
199.709	Topo	65.998	-	67.574	1.575
199.775	Topo	65.835	-	67.614	1.779
199.894	Topo	66.275	-	67.686	1.411
199.994	Topo	66.715	-	67.747	1.032
200.094	Topo	67.155	-	67.807	0.652
200.193	Topo	67.595	-	67.867	0.272
200.312	Topo	68.035	-	67.939	0
200.386	Topo	68.475	-	67.984	0
200.494	Topo	68.451	-	68.050	0
200.594	Topo	68.427	-	68.110	0
200.694	Topo	68.403	-	68.171	0

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
200.794	Topo	68.379	-	68.231	0
200.898	Topo	68.355	-	68.294	0
200.988	Topo	68.493	-	68.349	0
201.081	Topo	68.631	-	68.405	0
201.180	Topo	68.768	-	68.465	0
201.279	Topo	68.906	-	68.525	0
201.329	Topo	68.789	-	68.555	0
201.429	Topo	68.418	-	68.616	0.198
201.529	Topo	68.047	-	68.676	0.629
201.629	Topo	67.676	-	68.737	1.061
201.706	Topo	67.305	-	68.784	1.479
201.775	Topo	67.550	-	68.826	1.276
201.882	Topo	67.794	-	68.890	1.096
201.981	Topo	68.039	-	68.951	0.912
202.081	Topo	68.283	-	69.011	0.728
202.178	Topo	68.528	-	69.070	0.542
202.263	Topo	68.773	-	69.121	0.348
202.302	Topo	68.723	-	69.145	0.421
202.402	Topo	68.723	-	69.145	0.421
202.490	Topo	68.380	-	69.259	0.879
202.590	Topo	68.037	-	69.319	1.282
202.639	Topo	67.840	-	69.349	1.509
202.740	Topo	67.735	-	69.410	1.675
202.800	Topo	67.870	-	69.447	1.577
202.897	Topo	67.940	-	69.506	1.566
202.976	Topo	67.745	-	69.553	1.808
203.042	Topo	67.810	-	69.594	1.784
203.142	Topo	67.790	0.300	69.654	1.864
203.241	Topo	67.710	0.300	69.714	2.004
203.355	Topo	67.730	0.300	69.783	2.053
203.449	Topo	67.765	0.300	69.840	2.075
203.542	Topo	67.811	0.300	69.896	2.086
203.642	Topo	67.856	0.300	69.957	2.1
203.742	Topo	67.890	0.300	70.017	2.127
203.835	Topo	67.793	0.300	70.074	2.281
203.934	Topo	67.530	0.300	70.134	2.604
204.032	Topo	67.267	0.300	70.193	2.926
204.078	Topo	67.210	0.300	70.221	3.011
204.214	Topo	67.230	0.300	70.303	3.073
204.307	Topo	67.270	0.300	70.359	3.089
204.354	Topo	67.210	0.300	70.388	3.178
204.454	Topo	67.200	0.300	70.449	3.249
204.498	Topo	67.280	0.300	70.475	3.195
204.583	Topo	67.410	0.300	70.527	3.117
204.692	Topo	67.475	0.300	70.593	3.118
204.780	Topo	67.602	0.300	70.647	3.044
204.880	Topo	67.730	0.300	70.707	2.977

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
205.002	Topo	67.857	0.300	70.781	2.924
205.097	Topo	67.984	0.300	70.838	2.854
205.192	Topo	68.111	0.300	70.896	2.784
205.258	Topo	68.670	0.200	70.936	2.266
205.337	Topo	69.031	-	70.984	1.953
205.437	Topo	68.783	-	71.044	2.261
205.526	Topo	68.535	-	71.098	2.563
205.633	Topo	69.175	-	71.163	1.988
205.726	Topo	69.352	-	71.219	1.868
205.825	Topo	69.528	-	71.280	1.751
205.915	Topo	69.705	-	71.334	1.629
206.012	Topo	69.641	-	71.393	1.752
206.111	Topo	69.577	-	71.453	1.876
206.156	Topo	69.680	-	71.480	1.8
206.217	Topo	69.885	-	71.517	1.632
206.334	Topo	69.880	-	71.588	1.708
206.433	Topo	69.780	-	71.648	1.868
206.513	Topo	69.910	-	71.696	1.786
206.549	Topo	70.005	-	71.718	1.713
206.832	Topo	70.465	-	71.889	1.424
206.932	Topo	70.925	-	71.950	1.025
207.025	Topo	70.925	-	71.950	1.025
207.117	Topo	71.385	-	72.063	0.678
207.187	Topo	71.845	-	72.105	0.26
207.245	Topo	70.965	0.100	72.140	1.175
207.285	Topo	70.995	0.100	72.164	1.169
207.366	Topo	71.030	0.100	72.213	1.183
207.465	Topo	71.140	0.100	72.273	1.133
207.563	Topo	71.250	0.100	72.332	1.082
207.657	Topo	71.290	0.100	72.389	1.099
207.754	Topo	71.210	0.200	72.449	1.239
207.863	Topo	71.450	0.200	72.514	1.064
207.963	Topo	71.360	0.200	72.575	1.215
208.063	Topo	71.395	0.300	72.635	1.24
208.178	Topo	71.970	0.300	72.705	0.735
208.253	Topo	72.705	0.300	72.751	0.046
208.392	Topo	72.810	0.300	72.834	0.024
208.491	Topo	72.630	0.300	72.895	0.265
208.590	Topo	72.810	0.400	72.955	0.145
208.692	Topo	72.770	0.400	73.017	0.247
208.790	Topo	72.950	0.400	73.076	0.126
208.839	Topo	73.190	0.400	73.106	0
208.944	Topo	73.290	0.200	73.169	0
209.058	Topo	73.365	0.200	73.238	0
209.144	Topo	73.360	0.200	73.290	0
209.244	Topo	73.280	0.200	73.351	0.071
209.344	Topo	73.290	0.200	73.412	0.122

Chainage (km)	Type of Survey	River Bed Level w.r.t MSL (m)	Observed Water Depth (m)	Chart Datum w.r.t. MSL (m)	Reduced Water Depth (m)
209.446	Topo	73.270	0.200	73.474	0.204
209.543	Topo	73.300	0.200	73.532	0.232
209.664	Topo	73.340	0.200	73.606	0.266
209.716	Topo	73.350	0.200	73.637	0.287

4.6 Observed and reduced bed profile along the river

4.6.1 Observed bed profile along the river

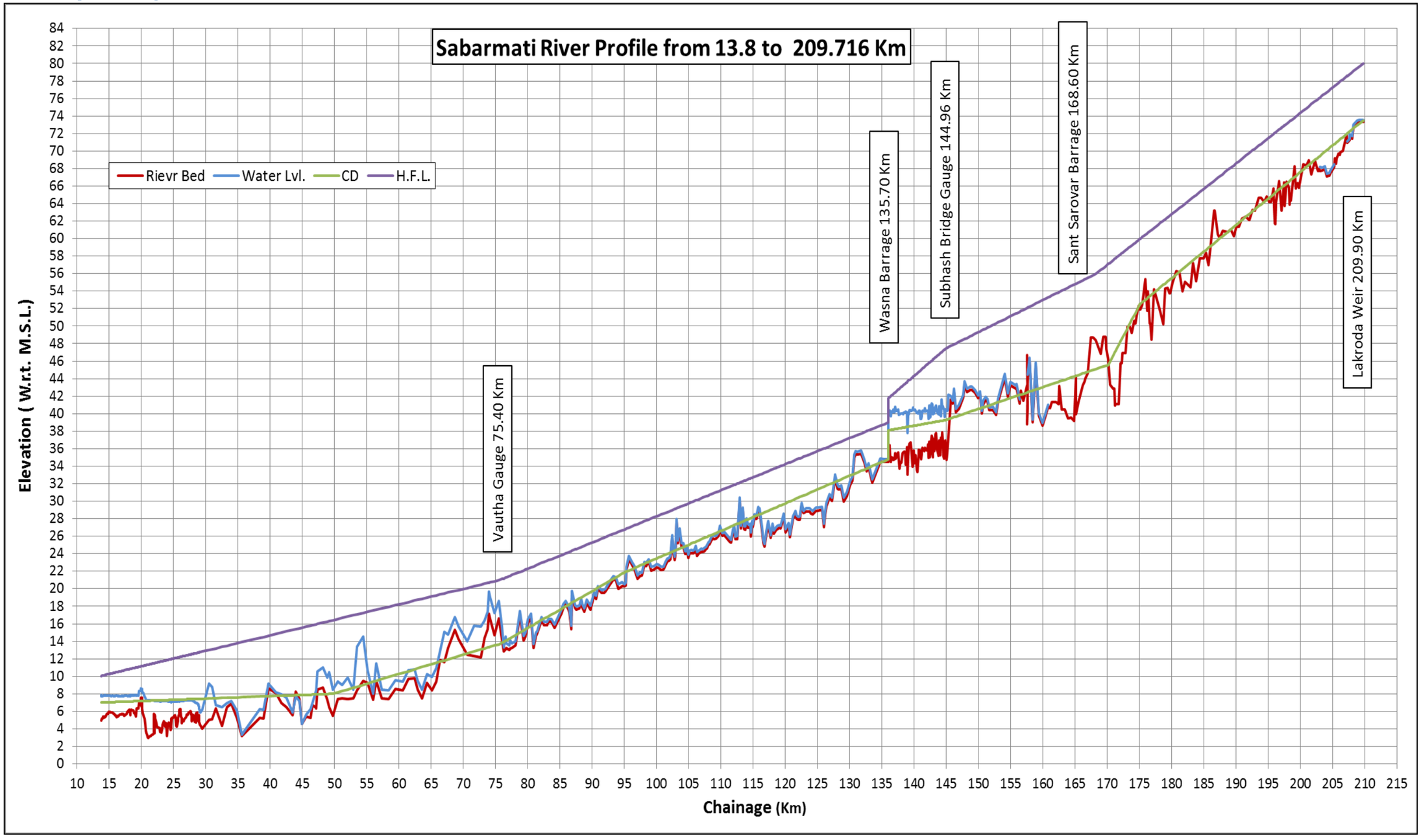


Figure 12: Riverbed profile from the river mouth till the end of 212 Km stretch.

(Source: Actual single line longitudinal survey carried out at site during April and May 2016, CWC Gauge discharge data)

4.6.2 Reduced bed profile along the river

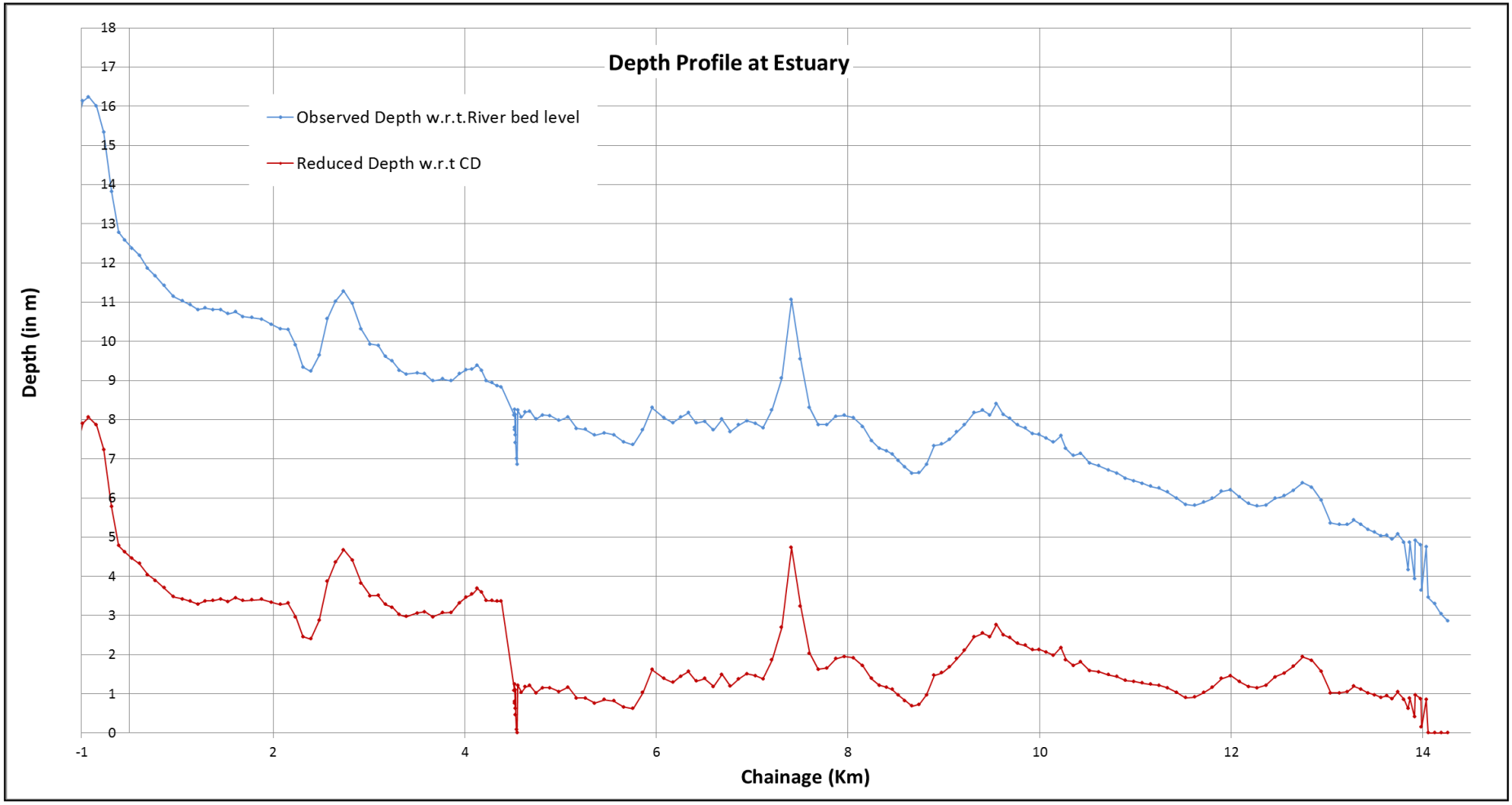


Figure 13: Depth profile at the Estuary (Kp 0 to Kp 13.8)

(Source: Actual single line longitudinal survey carried out at site during April and May 2016 and Admirality Tide Table (ATT- Vol 3))

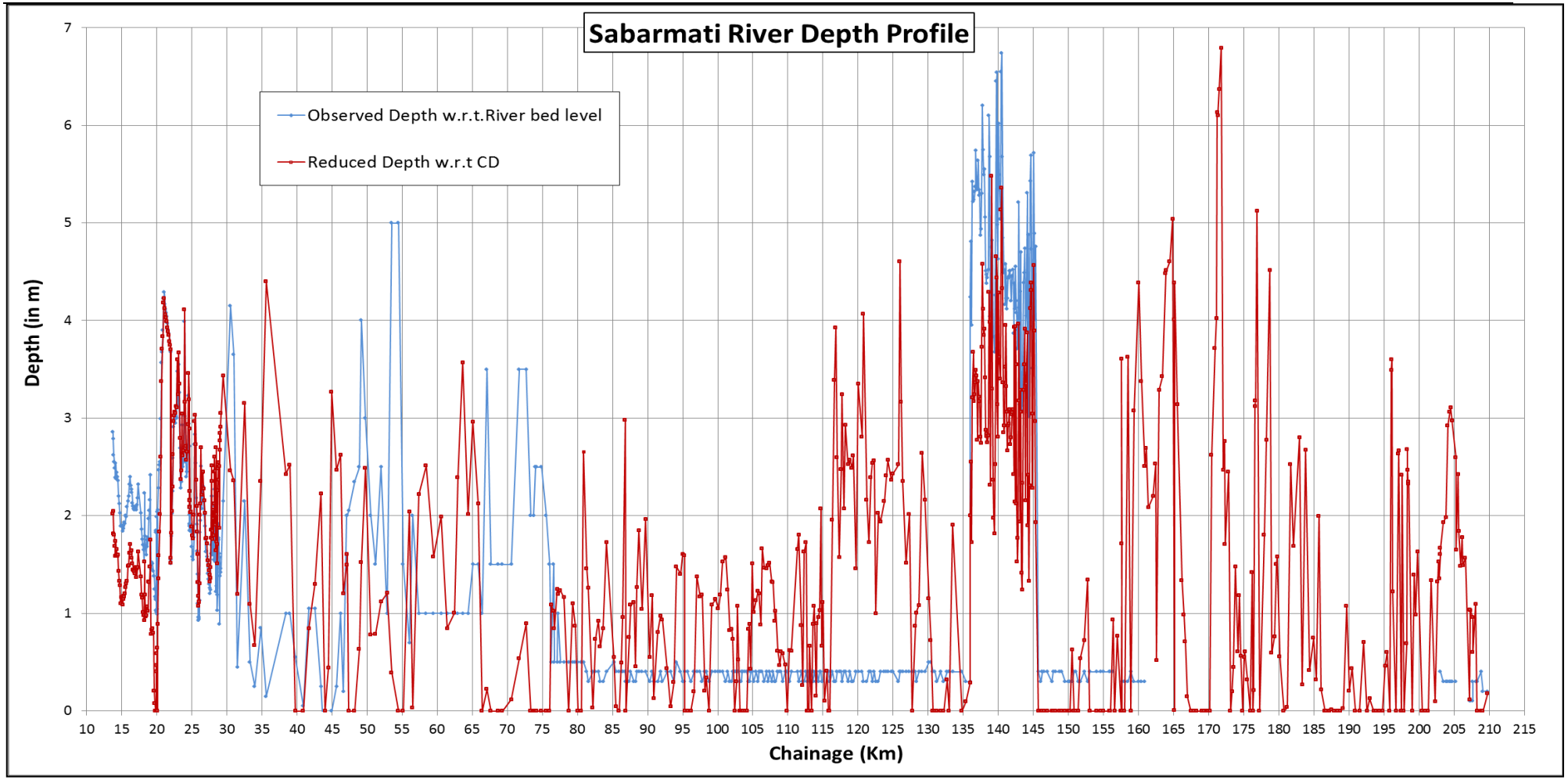


Figure 14: Depth profile at the river (Kp 13 to Kp 212)

(Source: Actual single line longitudinal survey carried out at site during April and May 2016, CWC Gauge discharge data)

4.7 Results from Hydrographic/Topographic Survey

The tidal effect was predominant up to chainage 13.7 km from river mouth. Bathymetry Survey has been carried out in this reach.

Bathymetry survey has also been carried out in the following Non-Tidal Reaches:

From (km)	To (km)
13.835	33.359
36.022	39.815
41.479	42.99
46.854	81.178
135.968	145.474

Topography survey has been carried out in the following reaches as the depths are shallow or where the river is dry.

From (Km)	To (Km)
33.459	35.922
39.911	41.379
43.09	46.755
81.293	135.903
145.573	209.716

4.8 Soil characteristics

As per the Reconnaissance surve there has been no rocky strata has been found near the river or at the river bed.

At twenty two (22) locations soil samples were collected and the details of CH vs soil textures are tabulated below:

Table 17: Soil characteristics of Sabarmati River

Sl No.	Chainage (Km)	Soil Texture
1	0	Fine sand
2	10	Fine sand
3	20	Fine sand
4	30	Fine sand & clay
5	40	Fine sand & clay
6	50	Fine sand
7	60	Fine sand
8	70	Sand
9	80	Sand
10	90	Sand
11	98	Sand
12	108	Muddy sand
13	119	Sand
14	130	Sand
15	140	Muddy sand
16	151	Sand

17	161	Sand with gravels
18	170	Sand with gravels
19	182	Fine sand
20	193	Sand with gravels
21	201	Sand with gravels
22	210	Sand with gravels

4.9 Water characteristics

From visual observation, clear water was found from chainage 0 to 10 km and after 10 km, water mixed with sand was observed at some places and clear water was observed at most of places up to 212 km.

4.10 Condition of banks

Natural banks were observed from chainage 0 to 212 km. The condition of banks was found to be good. The photographs showing river banks during Stage-1 survey are also attached at the end.

4.11 Details of collected water level and Discharge data

The details of collected data as detailed in chapter 2 (refer 2.2.3 and 2.2.4):

Table 18: Location details of gauging stations

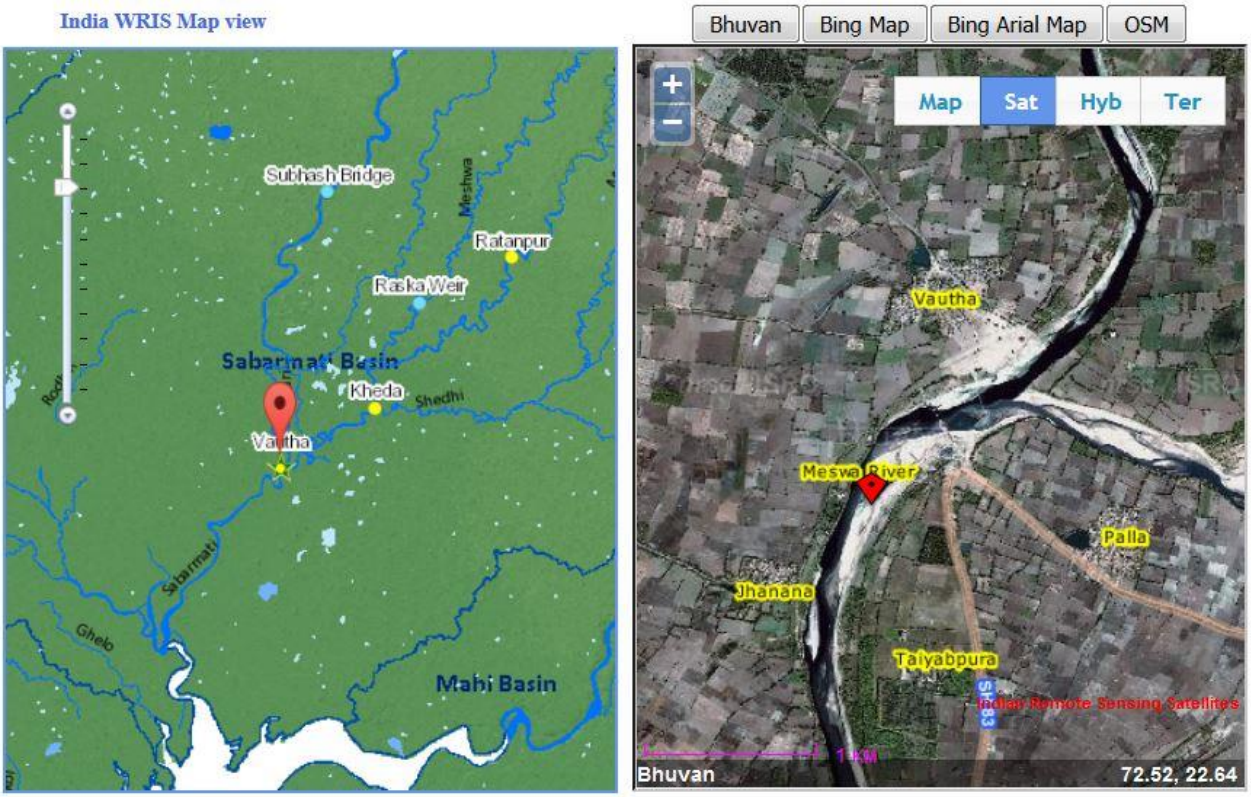
Name	Chainage	Location	
		Lat.	Long.
Vautha, Dholka, Ahmadabad, Gujarat	75.4 Km	22^0 38′ 58” N	72^0 32′ 02” E
Subhash Bridge, Ahmadabad city, Ahmadabad, Gujarat	144.96 km	23^0 03′ 39” N	72^0 35′ 08” E

Salient Features and Map

Salient Features			
General Information			
Site Name	:Vautha	**Activity**	:HO
Station Type	:GDQ	**Other Activities**	:Rf(T)/Mt
Operational Status	:Existing		
State	:Gujarat	**District**	:Ahmedabad
Basin	:Sabarmati	**Independent River**	:Sabarmati
Tributary	:	**Sub Tributary**	:
Local River	:Sabarmati		
Circle	:S.E. (C), Gandhinagar	**Division**	:Mahi Division, Gandhinagar
Sub-Division	:Sabarmati Sub-Division Ahmedabad	**Drainage Area (Sq. km.)**	:19636
Zero of Gauge(m)	:12	**Bank**	:Left

Parameters	Opening Date	Closing Date
Gauge	:05-AUG-99	:-
Discharge	:24-JUN-00	:-
Sediment	:-	:-
Water Quality	:01-JUN-00	:-

India WRIS Map view

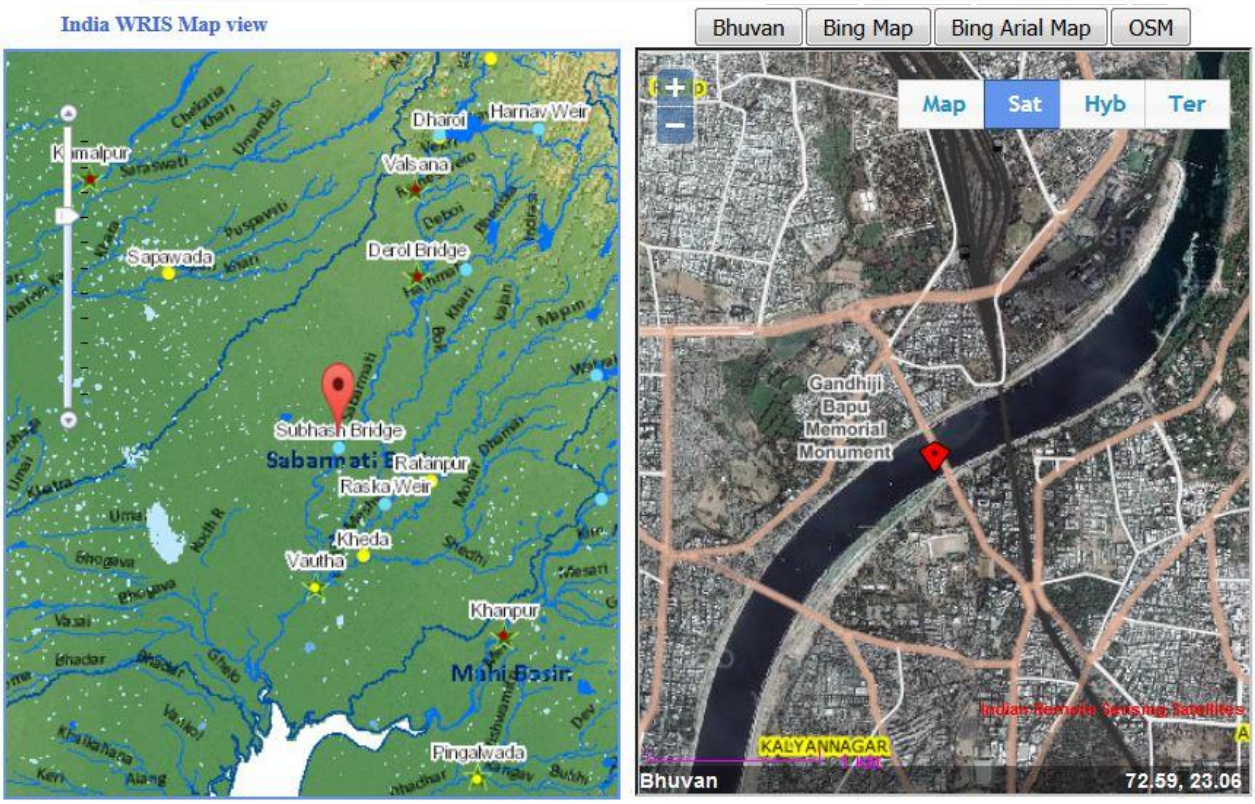


Salient Features and location map of Vautha Gauge Site

Salient Features and Map

Salient Features			
General Information			
Site Name	:Subhash Bridge	**Activity**	:HO/FF
Station Type	:G	**Other Activities**	:Rf/Rf(T)
Operational Status	:Existing		
State	:Gujarat	**District**	:Ahmedabad
Basin	:Sabarmati	**Independent River**	:Sabarmati
Tributary	:	**Sub Tributary**	:
Local River	:Sabarmati		
Circle	:S.E. (C), Gandhinagar	**Division**	:Mahi Division, Ahmedabad
Sub-Division	:Sabarmati Sub Div., Ahmedabad	**Drainage Area (Sq. km.)**	:10674
Zero of Gauge(m)	:41	**Bank**	:Left
Parameters	**Opening Date**		**Closing Date**
Gauge	:01-APR-80		:-
Discharge	:-		:-
Sediment	:-		:-
Water Quality	:-		:-

India WRIS Map view



Salient Features and location map of Subhash Bridge Gauge Site

The details of Gauge station, jurisdiction, establishment and data availability (Source: CWC WRIS Site) are presented in the figures below:

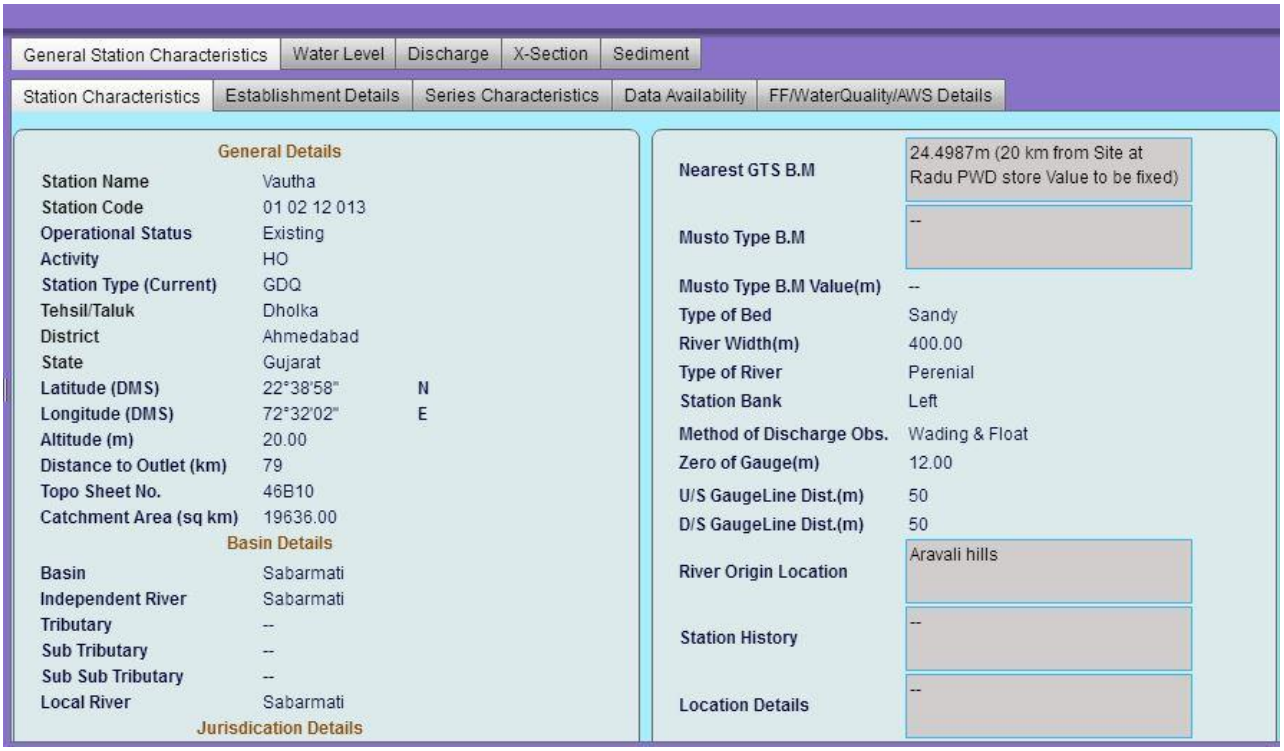


Figure 15: Vautha GD site- General, basin and jurisdiction details

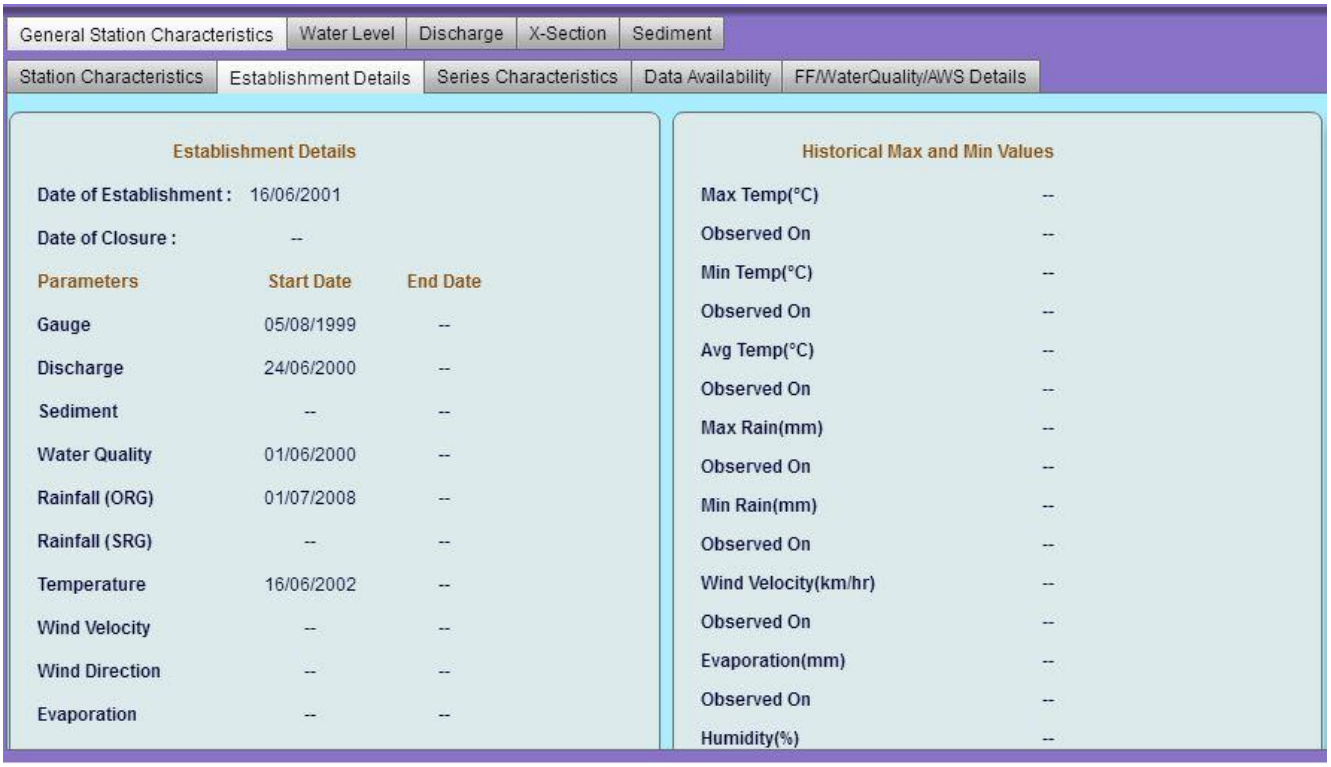


Figure 16: Vautha GD site- Establishment details

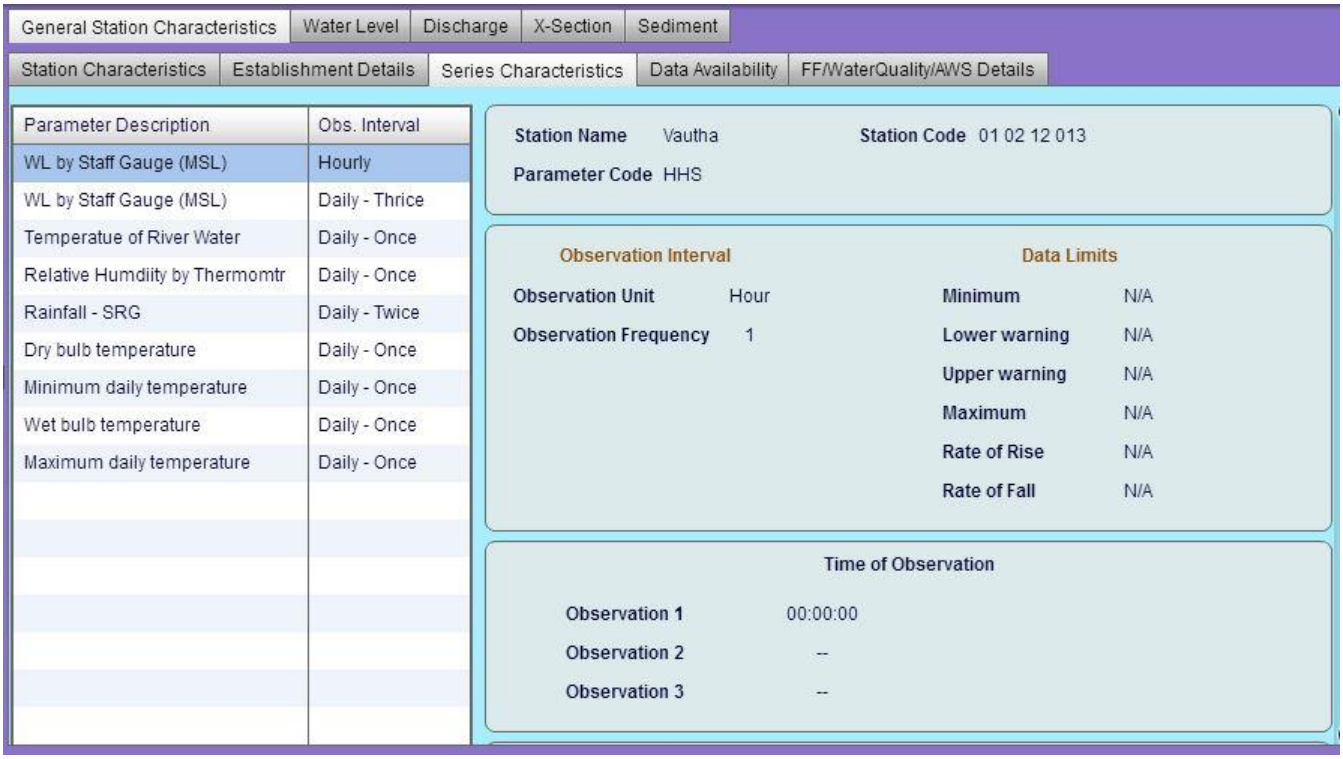


Figure 17: Vautha G.D. Site : series characteristics

Figure 18: Vautha G.D. site: Data availability

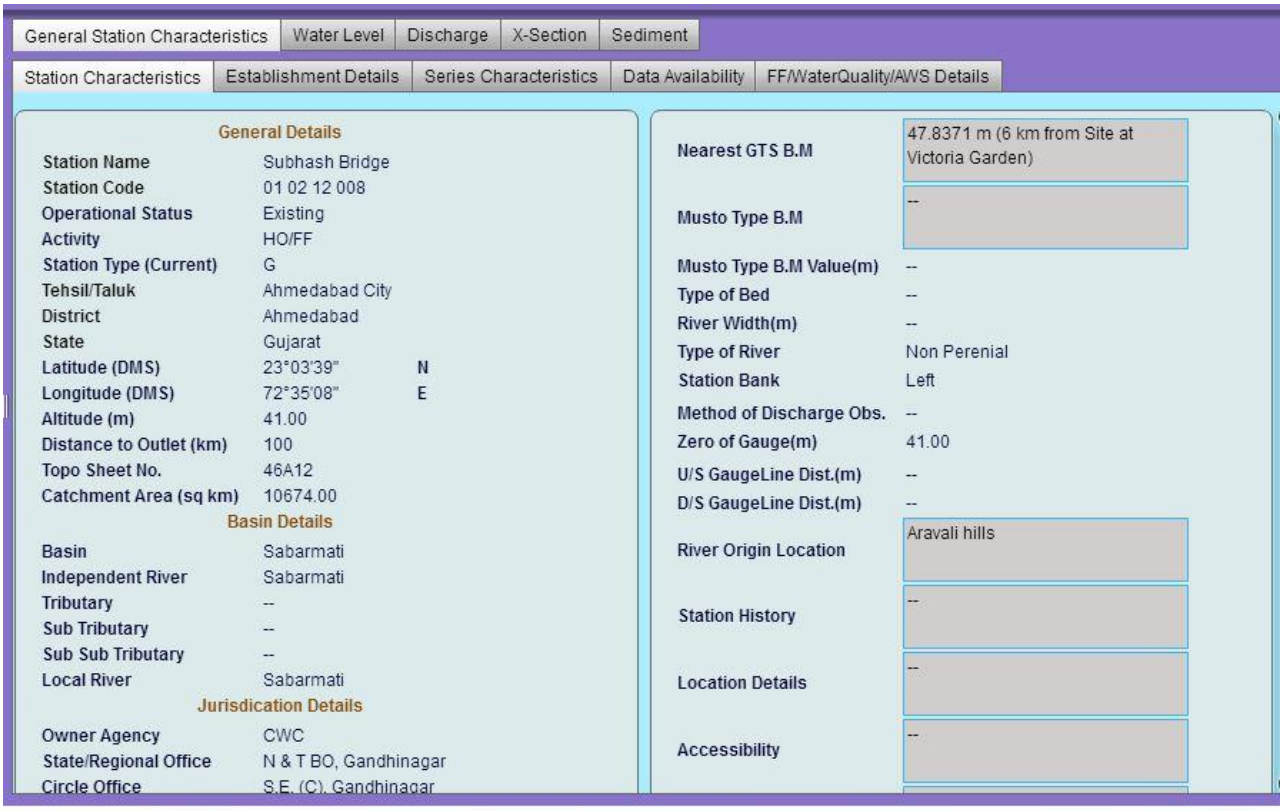


Figure 19: Subhash Bridge GD site- General, basin and jurisdiction details

Figure 20: Subhash Bridge GD site- Establishment details

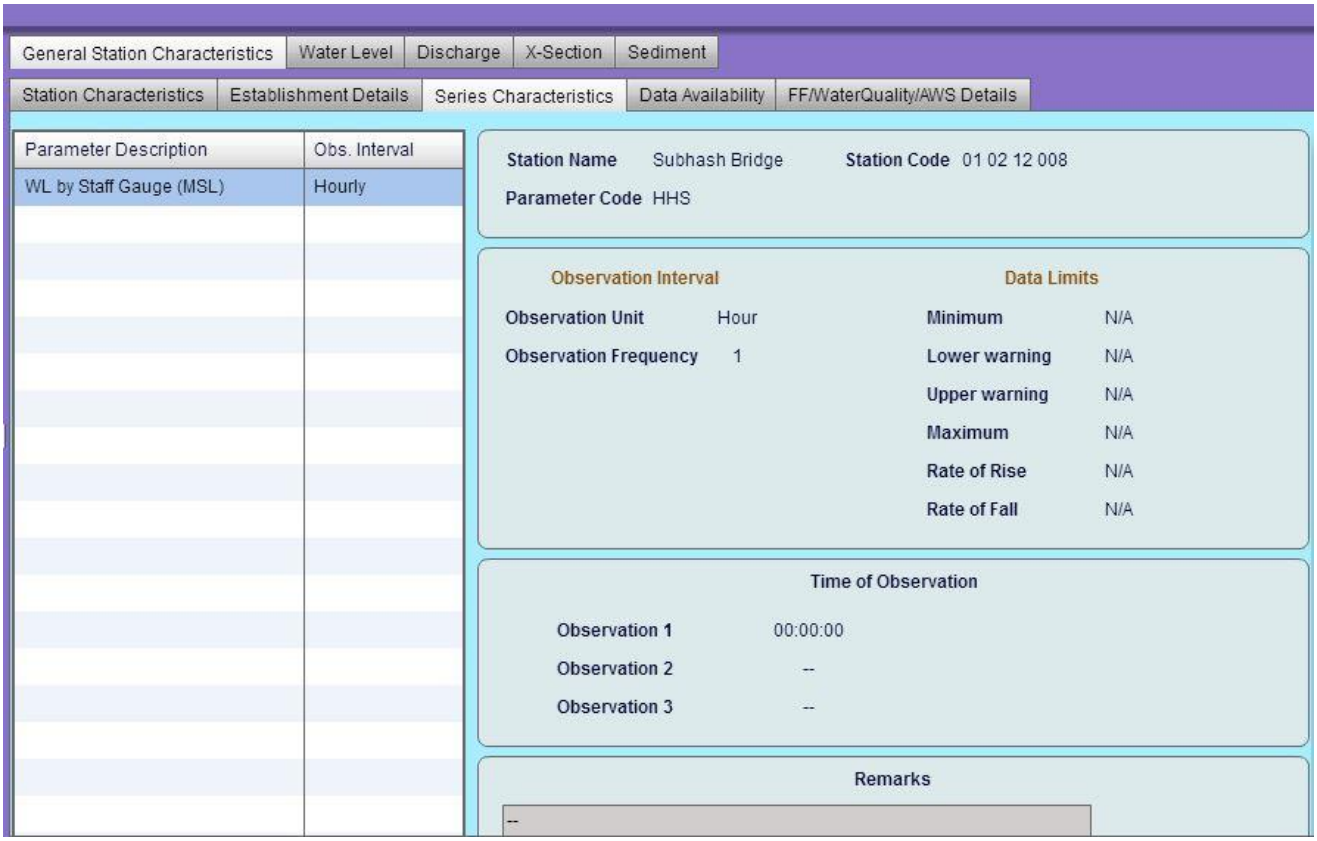


Figure 21: Subhash Bridge G.D. Site : series characteristics

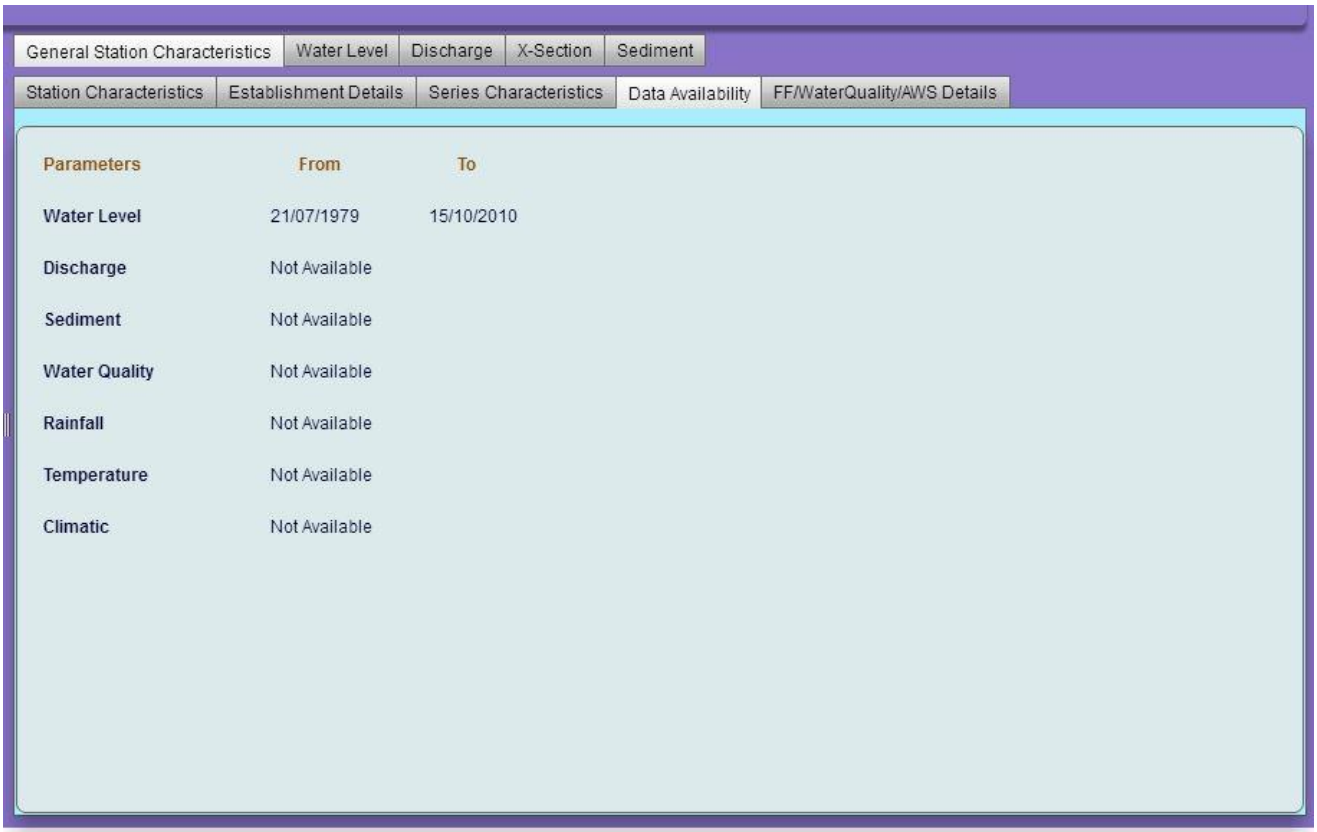


Figure 22: Subhash Bridge G.D. site: Data availability

4.12 Methodology for analysis of Gauge- Discharge Data

The gauge-discharge data available for number of years for these gauging stations was analyzed in different ways as given below:

10 Daily average discharges

The ten daily average discharges in each month for each year were worked out and then the average of average 10 daily discharges over the entire period of data were worked out to get idea about availability of 10 daily average discharge during different months of the year. Based on these average 10 daily discharges it will be possible to work out available depth of flow for natural or design cross section of river. These data analysis will be helpful for navigation feasibility in given stretch of river. The outcome from this analysis will also be useful for mathematical model studies (to be carried out in stage II) to predict longitudinal water surface profiles for different discharges along given reach of river and also to design section of navigation channel on river bed.

Maximum minimum discharges and water levels

The yearly maximum discharge and water level for the entire period of data were extracted and then these data were statistically analysed using Gumbel extreme value distribution to estimate flood discharges for different return periods such as 2,5, 10, 25 ,50 and 100 years. Similarly high flood levels were analysed. The minimum flow and minimum water level data was also analysed. The estimated HFLs and Minimum water levels will be useful for planning navigation as well as for design of terminals for cargo and passenger traffic.

Gauge discharge curves

Using available gauge discharge data G-Q curves were developed for each gauge station. These will be helpful to compute water level for any discharge. Also for calibration and validation of mathematical model (studies required in stage II) this data will be very useful.

Comparison of River Cross Section Data:

The Sabarmati river cross sections at gauging stations on different sites were not available for different years. For a given gauging station the cross sections for different years including the latest cross section could be superimposed to study changes in river bed levels and shifting of the deep channel if any over the period of data.

Period of availability for range of water depths above CD

For a navigation channel to be feasible it is necessary that adequate discharge is available to maintain required depth/draft for fairly longer duration during the year. The water level data for each gauge station was analysed to find out period of availability for the different range of water depths. Based on past 20 to 30 years of data, average number of days in a year for availability of different range of depths were worked out. These data will be very useful to estimate number of days for which minimum depth required to facilitate navigation will be available in different rivers.

Discharge- sediment flow data

These data can be analyzed to prepare discharge v/s sediment concentration plot for each gauging station. This analysis will be useful to understand sediment concentration in reach for range of discharges. These sediment data were not available for Sabarmati River.

4.13 Bed Slope

The average bed slopes for Sabarmati River for the reach under consideration is about 1/2560. Details of reach wise slopes are given in table below:

Table 19: Bed Slope of Sabarmati River

River	Reach		River Bed Level Change	Distance	Slope
	From	To			
Sabarmati	Sadolia dam RBL 79 m	Subhash Bridge RBL 38 m	41 m	68 km	1/1660
	Subhash Bridge RBL 38 m	Vautha RBL 11 m	27 m	70 km	1/2592
	Vautha RBL 11 m	Mouth RBL -2.0 m	13 m	65 km	1/5000

RBL – River Bed Level (These are taken from CWC river cross sections at gauging sites)

4.14 River Cross sections

The data of river cross sections at gauging sites was not available. However, the river widths, bank levels, nature of river bed and deep channel was studied on the basis of topo-sheets and google images. In general the bank to bank river width varied between 280 to 300 m in the reach from Sadolia dam to Ahmadabad city. On downstream of Wasna barrage (near Ahmadabad) up to Kheda confluence width is 150 to 200 m and in lower reach from Kheda confluence the width is 250 to 300 m. The bank levels are about 5 to 10 higher than the river bed levels in most of teach up to Vasana barrage and 4 to 6 m in lower reach. The deep channel meanders within the defined high level banks.

The river bed material is mostly coarse to fine mixed sand in upper reaches and medium and fine sand in lower reaches. In tidal reach clay is also present in bed material.

4.15 Ten- Daily average Discharges

Vautha

Analysis of 10 daily average flows at Vautha is presented in *Table 20*. The results of this analysis indicate range of average of average 10 daily flows in different period of year as following.

- June to September - From 15 to 250 m^3/s
- October to December - From 80 to 25 m^3/s
- January to May - From 25 to 15 m^3/s

The gauge- discharge curve for Vautha gauging station derived from the daily flow data during periods of high floods is presented vide Figure 23: Gauge discharge curve for River Sabarmati at Vautha gauge station

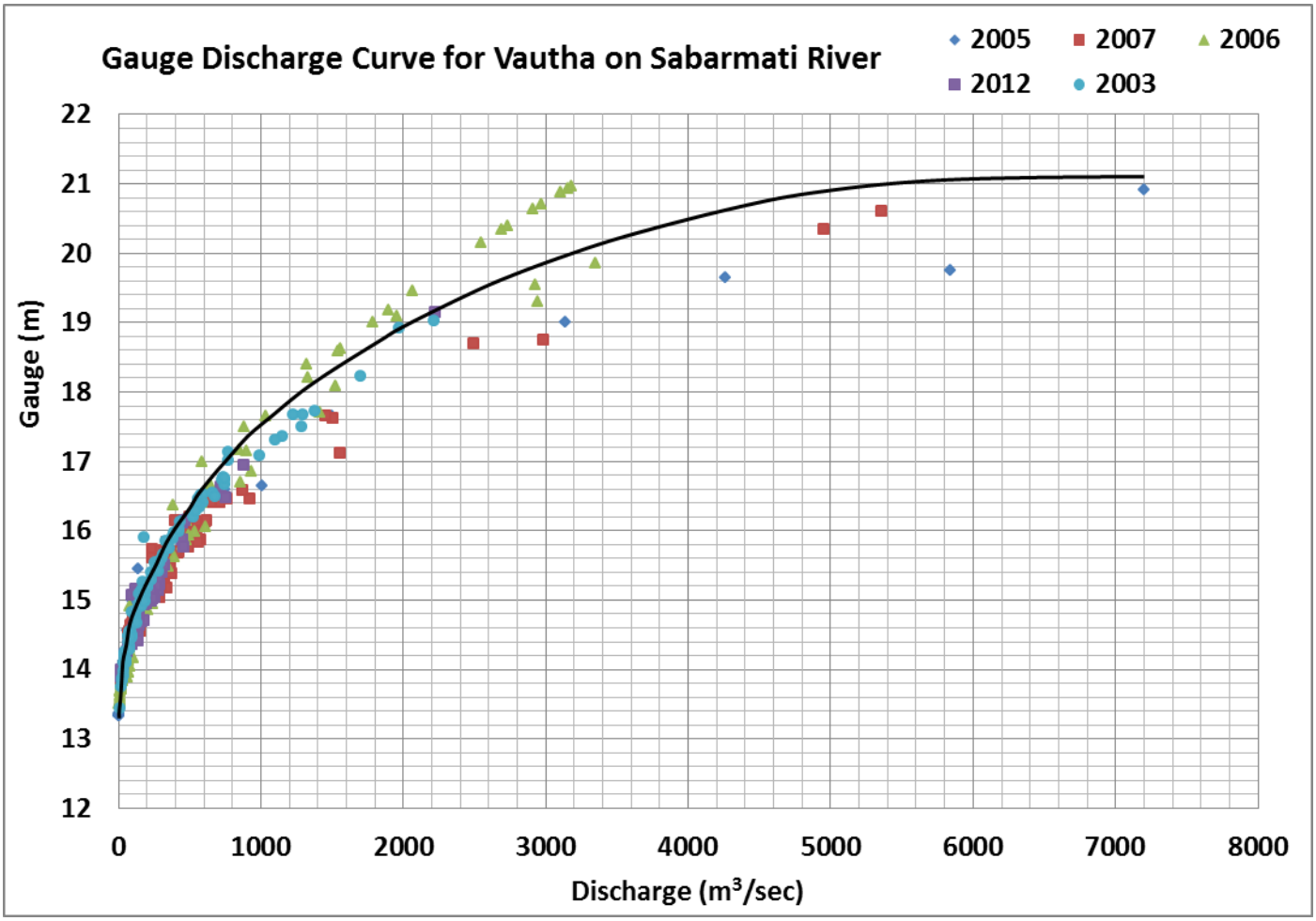


Figure 23: Gauge discharge curve for River Sabarmati at Vautha gauge station

Table 20: Mean 10 daily discharges in cumecs at Vautha gauge station (Cumecs)

YEAR	JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER			JANUARY			FEBRUARY			MARCH			APRIL			MAY		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1999-2000	NA	NA	NA	NA	NA	NA	20.23	12.02	10.72	10.12	13.86	12.46	15.26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000-2001	NA	NA	3.50	4.99	63.58	8.76	3.85	1.91	2.69	1.82	1.61	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2001-2002	0.00	11.65	5.49	16.91	20.64	7.56	44.36	85.86	9.10	0.39	0.00	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	1.57	1.86	1.88	1.74	1.54	1.34	0.95
2002-2003	2.50	3.10	5.54	8.59	1.27	0.41	0.25	0.00	26.95	70.62	14.08	8.06	4.91	4.42	5.12	6.63	13.00	6.17	7.08	7.37	6.84	5.13	3.09	4.02	9.10	9.50	7.91	4.92	5.75	5.83	4.35	3.72	3.35	3.28	0.95	0.00
2003-2004	2.77	1.97	6.58	8.39	23.48	355.37	680.96	481.98	1146.81	360.09	58.68	252.03	174.13	162.57	141.01	60.04	41.50	45.80	45.00	32.36	7.81	4.48	4.84	3.51	14.45	7.01	5.52	8.09	41.31	66.82	15.77	16.97	5.81	10.38	10.88	3.39
2004-2005	19.25	48.30	35.82	10.99	6.79	12.18	493.62	385.66	34.90	88.32	154.24	120.56	169.56	305.32	198.04	29.50	90.20	20.90	65.15	108.17	87.00	65.56	60.90	25.12	29.31	18.25	19.51	45.50	38.67	25.27	7.64	4.85	4.85	5.12	6.25	6.00
2005-2006	4.66	5.05	226.99	2277.74	36.45	209.51	588.63	26.83	32.33	35.20	162.90	483.97	83.99	44.16	33.30	31.94	14.59	29.21	23.47	35.60	34.54	23.89	30.91	20.41	18.49	23.34	16.72	28.53	39.85	23.52	12.64	9.46	19.03	24.98	22.88	26.44
2006-2007	26.38	14.32	14.25	58.79	8.50	377.62	1231.76	2360.75	1121.16	745.84	285.02	234.09	89.13	63.38	52.61	31.10	23.62	27.67	47.06	34.92	9.35	34.57	60.77	35.66	38.63	61.31	40.53	52.81	34.09	43.55	40.73	27.84	22.06	23.05	19.82	17.76
2007-2008	7.64	11.00	17.62	884.43	1195.34	183.14	707.85	485.64	390.61	458.68	149.24	293.10	206.94	151.06	167.04	122.98	38.27	42.79	115.14	112.61	98.24	62.77	45.68	32.09	37.41	25.93	24.52	30.14	32.11	64.09	62.41	59.53	30.85	22.35	12.48	7.20
2008-2009	14.39	27.11	24.39	30.06	17.77	41.58	76.95	220.64	47.60	22.62	155.71	110.52	29.38	71.46	41.70	26.94	20.65	17.69	27.38	23.27	24.11	17.58	17.55	10.39	9.65	10.04	25.26	36.72	47.00	80.96	23.15	26.27	23.76	26.44	23.77	22.10
2009-2010	26.99	24.62	30.18	32.31	46.24	160.06	17.23	21.19	65.49	51.17	23.95	35.21	36.99	32.76	28.84	20.38	20.32	14.30	14.98	17.80	19.27	17.57	29.83	15.09	24.51	20.80	21.22	27.67	21.32	14.55	13.75	18.33	13.09	18.84	13.81	20.81
2010-2011	40.08	12.28	9.44	15.48	10.10	47.43	274.68	100.71	47.08	117.67	297.91	42.87	16.68	19.16	17.45	24.54	14.61	13.95	18.79	17.78	17.10	19.79	24.12	17.76	24.77	17.75	16.56	15.21	17.49	15.41	23.34	16.00	13.12	21.92	16.82	16.50
2011-2012	11.88	9.99	9.62	10.89	28.55	13.41	12.34	137.38	291.14	571.14	789.50	390.49	237.74	77.01	85.56	59.68	57.37	65.74	75.94	87.64	99.22	72.60	70.81	43.25	20.97	14.83	14.93	15.72	20.28	11.42	11.88	12.20	14.54	14.69	28.54	19.19
2012-2013	16.58	18.07	18.01	20.54	18.64	14.80	38.30	179.73	236.09	511.65	407.16	148.53	82.49	89.52	45.48	17.62	12.45	11.04	12.90	13.00	13.21	14.91	13.48	14.49	16.25	14.19	15.14	21.09	21.59	18.51	15.91	12.96	16.01	13.31	12.93	12.93
MAXIMUM	40.08	48.30	226.99	2277.74	1195.34	377.62	1231.76	2360.75	1146.81	745.84	789.50	483.97	237.74	305.32	198.04	122.98	90.20	65.74	115.14	112.61	99.22	72.60	70.81	43.25	38.63	61.31	40.53	52.81	47.00	80.96	62.41	59.53	30.85	26.44	28.54	26.44
MINIMUM	0.00	1.97	3.50	4.99	1.27	0.41	0.25	0.00	2.69	0.39	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	1.57	1.86	1.88	1.74	1.54	0.95	0.00
AVERAGE	14.43	15.62	31.34	260.01	113.64	110.14	299.36	321.45	247.33	217.52	179.56	152.38	88.25	85.07	68.01	35.94	28.88	24.61	37.74	40.88	34.72	28.24	30.16	18.48	20.30	18.58	17.32	23.87	26.69	30.96	19.45	17.50	14.02	15.49	14.20	12.77

NA : - Stands for DATA NOT AVAILABLE

4.16 Monthly minimum and maximum Water levels

Table 21: Monthly Minimum and Maximum Water levels at Vautha gauge station

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	22.405	22.405	22.290	26.500	22.460	23.100	22.460	22.750	22.480	22.860	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	13.480	13.480	13.365	17.600	13.325	13.580	13.265	13.385	NA	NA	NA	NA	NA	NA
2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	12.000	13.830	13.410	14.220	13.305	15.197	12.000	13.510	12.000	12.000	12.000	13.075	13.075	13.075
2002	13.075	13.075	13.075	13.090	13.030	13.320	13.310	13.330	13.260	13.310	13.260	13.577	13.065	14.095	13.035	14.430	13.280	15.047	13.250	13.320	13.250	13.940	13.260	13.470
2003	13.110	13.342	13.240	13.580	13.190	13.410	13.120	13.190	12.970	13.120	13.100	13.600	13.165	17.725	15.845	19.025	14.190	17.075	14.100	15.300	13.790	14.670	13.220	13.850
2004	13.080	13.340	13.080	13.690	13.150	14.240	13.180	13.710	13.100	13.610	13.120	14.665	13.080	14.400	13.780	17.810	13.810	15.750	14.010	16.400	13.500	15.300	13.410	14.600
2005	13.420	14.420	13.340	13.940	13.330	14.450	13.230	13.360	13.250	13.280	13.250	16.655	13.840	20.920	13.680	18.070	13.770	17.930	13.500	14.715	13.500	14.500	13.490	14.300
2006	13.400	14.100	13.380	13.680	13.400	13.950	13.300	14.020	13.440	13.880	13.430	14.120	13.500	19.180	14.760	20.970	14.590	20.630	13.900	14.640	13.650	13.990	13.520	14.600
2007	13.600	14.350	13.750	14.300	13.800	14.550	13.750	14.100	13.700	13.840	13.750	14.070	13.920	20.600	15.120	18.700	14.550	16.190	14.100	15.510	14.000	14.850	14.400	15.050
2008	14.000	14.610	14.000	14.450	13.800	14.850	13.840	14.480	13.700	14.090	13.750	14.250	13.810	15.260	14.090	17.170	13.980	16.105	14.020	14.800	13.820	14.100	13.860	14.120
2009	13.700	14.090	13.630	14.380	14.000	14.830	13.830	14.200	13.920	14.060	13.910	14.130	13.930	16.500	13.970	15.650	13.960	14.840	13.900	14.450	13.650	14.120	13.700	14.020
2010	13.700	14.500	13.720	14.250	13.630	14.380	13.600	14.010	13.660	14.340	13.730	14.630	13.650	14.990	14.010	16.550	13.910	15.750	13.880	14.850	13.760	14.450	13.600	13.770
2011	13.580	14.030	13.590	13.790	13.570	13.680	13.550	14.020	13.550	14.020	13.600	13.760	13.700	14.490	13.730	16.160	15.790	18.710	14.480	16.190	14.460	14.730	14.750	14.930
2012	13.700	14.850	13.690	14.100	13.690	14.050	13.710	13.850	13.760	14.340	13.740	13.970	13.700	14.100	13.750	15.360	14.500	19.145	13.950	15.100	13.700	13.930	13.770	13.800
2013	13.780	13.970	13.780	13.910	13.800	14.050	13.780	13.890	13.770	13.800	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Min	13.075	13.075	13.075	13.090	13.030	13.320	13.120	13.190	12.970	13.120	12.000	13.480	13.065	14.095	13.035	13.580	12.000	13.385	12.000	12.000	12.000	13.075	13.075	13.075
Max	14.000	14.850	14.000	14.450	14.000	14.850	13.840	14.480	13.920	14.340	22.405	22.405	22.290	26.500	22.460	23.100	22.460	22.750	22.480	22.860	14.460	15.300	14.750	15.050

NA : - Stands for DATA NOT AVAILABLE

Table 22: Monthly Minimum and Maximum Water levels at Subhash Bridge gauge station

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
1979	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	42.600	42.820	41.990	43.830	42.830	43.440	NA	NA	NA	NA	NA	NA
1980	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.580	42.380	41.130	42.280	41.130	42.030	41.130	41.980	41.130	41.180	NA	NA	NA	NA
1981	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.490	41.650	41.300	43.200	41.200	43.200	41.300	41.650	41.250	41.800	NA	NA	NA	NA
1982	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.870	41.050	41.070	43.000	41.020	42.050	41.200	41.550	41.490	41.600	NA	NA	NA	NA
1983	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.400	41.650	41.200	42.390	41.240	42.820	40.960	41.810	41.040	42.180	NA	NA	NA	NA
1984	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.850	41.320	41.210	41.900	41.160	43.570	41.130	41.840	41.070	41.540	NA	NA	NA	NA
1985	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.020	41.350	41.040	41.510	41.050	41.090	41.060	42.930	NA	NA	NA	NA
1986	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.510	41.070	41.650	41.040	41.650	41.010	41.180	NA	NA	NA	NA	NA	NA
1987	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.000	41.000	41.000	41.000	41.000	41.000	41.000	NA	NA	NA	NA	NA	NA
1988	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.100	41.800	41.000	43.000	41.000	41.350	41.000	41.300	NA	NA	NA	NA
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.150	41.000	42.050	41.000	41.300	41.000	41.000	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.000	41.000	41.550	41.000	42.500	41.000	42.500	41.000	41.300	NA	NA	NA	NA
1991	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.000	41.000	42.850	41.000	42.400	41.000	41.600	41.000	41.000	NA	NA	NA	NA
1992	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.000	41.000	41.000	41.000	41.650	41.000	44.600	41.100	41.400	NA	NA	NA	NA
1993	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.000	40.150	45.450	40.000	41.050	40.700	41.300	40.000	40.750	NA	NA	NA	NA
1994	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	41.000	41.000	41.000	41.500	41.000	42.950	41.200	43.900	41.000	41.450	NA	NA	NA	NA
1995	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.150	41.000	40.000	41.200	40.000	41.000	40.000	41.150	41.000	41.250	NA	NA	NA	NA
1996	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.850	40.040	40.040	41.350	40.180	40.900	40.080	40.500	40.000	40.080	NA	NA	NA	NA
1997	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.000	43.100	40.000	41.400	40.000	41.450	40.000	41.400	41.000	41.350	NA	NA	NA	NA
1998	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.000	39.000	39.000	41.500	40.000	40.950	40.000	42.800	40.000	41.250	NA	NA	NA	NA
1999	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.000	41.000	40.600	41.300	40.500	40.900	40.400	40.500	41.400	41.400	NA	NA	NA	NA
2000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.000	40.000	40.000	40.300	40.000	40.100	40.000	40.000	40.000	40.000	NA	NA	NA	NA

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEP		OCT		NOV		DEC	
	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
2001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.000	40.500	40.000	40.400	40.000	40.280	40.050	40.250	40.050	40.050	NA	NA	NA	NA
2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.800	40.000	39.800	40.000	39.800	42.100	41.870	42.180	41.960	42.040	NA	NA	NA	NA
2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.450	41.200	40.050	41.610	41.380	41.880	40.790	41.670	41.420	41.800	NA	NA	NA	NA
2004	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.400	41.050	40.630	42.090	39.970	41.780	41.000	42.310	41.780	42.220	NA	NA	NA	NA
2005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.320	41.800	40.100	42.140	40.270	41.680	40.360	40.910	NA	NA	NA	NA
2006	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	40.340	40.900	40.540	41.610	39.000	47.450	39.440	44.600	41.270	41.630	NA	NA	NA	NA
2007	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.030	44.380	39.570	41.470	40.150	41.330	40.580	40.780	NA	NA	NA	NA
2008	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.500	41.030	39.980	41.470	40.070	41.150	40.550	41.850	40.600	41.330	NA	NA	NA	NA
2009	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.000	41.530	40.730	41.600	40.660	41.870	41.140	41.940	41.860	41.950	NA	NA	NA	NA
2010	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	39.000	40.700	40.170	41.470	39.000	41.110	39.000	41.670	39.000	41.650	NA	NA	NA	NA
Min	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**39.000**	**39.000**	**39.000**	**40.000**	**39.000**	**40.100**	**39.000**	**40.000**	**39.000**	**40.000**	**NA**	**NA**	**NA**	**NA**
Max	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**41.580**	**43.100**	**42.600**	**45.450**	**41.990**	**47.450**	**42.830**	**44.600**	**41.960**	**42.930**	**NA**	**NA**	**NA**	**NA**

NA : - Stands for DATA NOT AVAILABLE

4.17 Yearly minimum and maximum Water levels

Table 23: Yearly minimum and maximum Water Levels at Vautha gauge station

YEAR	MAXIMUM WATER LEVEL (m)	MINIMUM WATER LEVEL (m)
1999	26.500	22.290
2000	17.600	13.265
2001	15.197	12.000
2002	15.047	13.030
2003	19.025	12.970
2004	17.810	13.080
2005	20.920	13.230
2006	20.970	13.300
2007	20.600	13.600
2008	17.170	13.700
2009	16.500	13.630
2010	16.550	13.600
2011	18.710	13.550
2012	19.145	13.690
2013	14.050	13.770
MINIMUM	**14.050**	**12.000**
MAXIMUM	**26.500**	**22.290**

Table 24: Yearly minimum and maximum Water Levels at Subhash Bridge gauge station

YEAR	MAXIMUM WATER LEVEL (m)	MINIMUM WATER LEVEL (m)
1979	43.830	41.990
1980	42.380	41.130
1981	43.200	41.200
1982	43.000	40.870
1983	42.820	40.960
1984	43.570	40.850
1985	42.930	41.020
1986	41.650	41.000
1987	41.000	41.000
1988	43.000	41.000
1989	42.050	41.000
1990	42.500	41.000
1991	42.850	41.000
1992	44.600	41.000
1993	45.450	40.000
1994	43.900	41.000
1995	41.250	40.000

YEAR	MAXIMUM WATER LEVEL (m)	MINIMUM WATER LEVEL (m)
1996	41.350	39.850
1997	43.100	40.000
1998	42.800	39.000
1999	41.400	40.000
2000	40.300	40.000
2001	40.500	40.000
2002	42.180	39.800
2003	41.880	40.050
2004	42.310	39.970
2005	42.140	40.100
2006	47.450	39.000
2007	44.380	39.030
2008	41.850	39.500
2009	41.950	39.000
2010	41.670	39.000
MINIMUM	40.300	39.000
MAXIMUM	47.450	41.990

4.18 Chart Datum/ Sounding Datum

As per discussion with IWAI, Chart Datum has been taken as following for different reaches

Tidal Reach:

C.D. is taken as C.D. of nearest port from Admiralty Tide Table (ATT- Volume 3)

Non Tidal Reach:

A) As per discussion with IWAI, Sounding datum in rivers is taken as Average of minimum yearly water level for Last six years at all gauging sites. The gauge-discharge data of CWC G.D. sites was collected from CWC. Accordingly, the C.D. at these G.D sites has been arrived as below:

C.D. at Vautha G.D. Site

(Although CWC data from 1999-2013 was available for Vautha, Data for the recent years 2007, 2008, 2009,2010, 2011 and 2012 was used for computing C.D. since the data for above years only was available for the maximum period in a year)

= [13.6 + 13.7 + 13.63 + 13.6 + 13.55 + 13.69] / 6

= **13.628 m**

C.D. at Subhash Bridge G.D. Site

(Although CWC data from 1979-2010 was available for Subhash Bridge, Data for the recent years 2005, 2006, 2007, 2008, 2009,and 2010 was used for computing C.D. since the data for above years only was available for the maximum period in a year)

= [40.1 + 39.0 + 39.03 + 39.5 + 39.0 + 39.0] / 6

= **39.272 m**

Chainage	CD Value at the Gauge Station	Gauge Station Position	
		Latitude	Longitude
75.4 km	Vautha 13.628 meters above MSL	22^0 38′ 58” N	72^0 32′ 02” E
144.96 km	Subhash Bridge 39.272 meters above MSL	23^0 03′ 39” N	72^0 35′ 08” E

B) In case of Dams/ Weir/ Barrages/ Check Dam, the C.D. is taken as Minimum draw down level (from CWC data).

4.19 High Flood Levels

Tidal Reach

In Tidal reach, MHWS at port Dahej Bander as per ATT- Vol 3 has been adopted as High Flood Level.

MHWS : 7.9 (w.r.t. C.D.)
MSL : 4.90 (W.r.t. C.D.)
MHWS (w.r.t. M.S.L.) : 7.9 - 4.90 = 3.0 m (w.r.t. M.S.L.)

At Gauge discharge sites

High flood levels are computed from last twenty years Gauge discharge data collected from CWC for Vautha and Subhash Bridge. The maximum water level in last twenty years from the collected data has been adopted as H.F.L. The values for Vautha and Subhash bridge G.D. Sites values are adopted as under:

Chainage	Structure	H.F.L (m)
75.4 km	Vautha Gauge	20.970
144.96 km	Subhash Bridge	47.450

At Dams/weir/Barrages

In case of dams, weir and barrages, maximum observed water level of last twenty years or Maximum Water level as mentioned in CWC data has been adopted as H.F.L.

Chainage	Structure	H.F.L (m)
135.7 km	Wasna Bararrge	41.770

4.20 Monthly minimum and maximum Discharges

Table 25: Monthly Minimum and Maximum Discharges in Cumecs at Vautha gauge station (Cumecs)

YEAR	JUNE		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER		JANUARY		FEBRUARY		MARCH		APRIL		MAY	
	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN
1999-2000	NA	NA	NA	NA	26.97	7.309	17.112	9.047	20.639	10.683	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2000-2001	3.5	3.5	165	1.5	5.5	0.703	1.9	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2001-2002	18.5	0	47.5	3.2	167.996	2.429	5.285	0	0	0	0	0	0	0	0	0	0	0	1.8	0	1.9	1.7	1.7	0.95
2002-2003	10.805	2.5	33.958	0	62.567	0	145.304	5.131	5.718	2.7	26.5	3	9.6	5.559	9.387	1.821	19.6	5.2	8.327	4.25	4.856	3.33	3.33	0
2003-2004	13.405	0	1379.265	5.025	2220	334.96	995.349	42.424	230	50	128.184	28	55	5.687	9.158	3.359	38	3	97.5	4.5	40	4.878	30	3.25
2004-2005	84.48	0	82.646	2.5	1205	4.113	259.3	6.116	502.5	28	165	11	135	14.5	111	15.5	56.5	10.5	95.826	10	11	4.163	7	4.358
2005-2006	1008.805	3.857	7201.6	16.323	1919	13.897	1770	25.43	154.101	10.4	79	10.4	73.834	18.306	60.087	8.854	32.197	10.448	49.789	12.174	54.593	5.384	44.98	10.471
2006-2007	50.96	5.343	1893	3.565	3350.93	179.97	2907	74.866	140.7	31.32	58.322	12.1	132.8	5.647	144.304	10.39	93.113	20.98	123.2	22.56	53.15	16.834	27.091	15.23
2007-2008	32.081	6.546	5359.97	16.859	2498.53	184.246	615.57	79.049	355.192	51.117	201.031	22.635	198.362	66.669	93.585	10.424	74.057	13.657	149.381	9.938	78.699	12.019	30.295	5.683
2008-2009	52.023	11.794	141.761	9.093	704.216	18.249	357.087	16.157	99.965	25.469	40.301	14.789	32.033	16.67	29.976	9.882	75.415	7.516	103.946	24.256	37.89	15.248	32.925	19.729
2009-2010	38.827	22.023	972.868	22.694	375.231	15.99	116.186	18.921	50.38	21.9	32.21	10.189	39.845	11.279	53.4	13.91	38.99	15.4	46.27	11.45	26.86	10.46	43.98	12.48
2010-2011	89.2	8.715	147.564	5.275	880.074	20.35	380.936	14.814	23.328	11.283	60.795	11.26	24.69	14.025	45.134	14.107	33.347	14.74	26.759	7.337	43.569	12.423	43.08	12.172
2011-2012	15.926	6.296	69.514	6.868	439.466	10.71	1744.056	297.3	424.832	54.55	79.63	53.103	104.88	58.68	94.19	11.9	33.421	11.61	33.092	7.492	18.16	7.458	43.28	13.45
2012-2013	31.958	9.337	39.273	7.72	288.01	17.377	2223	83.841	147	20.748	23.9	7.106	15.572	8.706	20.66	10.341	22.25	8.001	34.98	14.21	20.66	9.324	14.2	12.3
MAX	1008.805	22.023	7201.6	22.694	3350.93	334.96	2907	297.3	502.5	54.55	201.031	53.103	198.362	66.669	144.304	15.5	93.113	20.98	149.381	24.256	78.699	16.834	44.98	19.729
MIN	3.5	0	33.958	0	5.5	0	1.9	0	0	0	0	0	0	0	0	0	0	0	1.8	0	1.9	1.7	1.7	0
NA : - Stands for DATA NOT AVAILABLE																								

4.21 Yearly minimum and maximum Discharges

Table 26: Yearly minimum and maximum Discharges at Vautha gauge station

YEAR	MAXIMUM DISCHARGE (m3/sec)	MINIMUM DISCHARGE (m3/sec)
1999-2000	26.97	7.309
2000-2001	165	0
2001-2002	167.996	0
2002-2003	145.304	0
2003-2004	2220	0
2004-2005	1205	0
2005-2006	7201.6	3.857
2006-2007	3350.93	3.565
2007-2008	5359.97	5.683
2008-2009	704.216	7.516
2009-2010	972.868	10.189
2010-2011	880.074	5.275
2011-2012	1744.056	6.296
2012-2013	2223	7.106
MAXIMUM	**7201.6**	**10.189**
MINIMUM	**26.97**	**0**

5. Preliminary Traffic studies and Market Analysis

The objective of preliminary Traffic studies and Market Analysis is assessment of cargo movement at lower transport cost, Land use pattern, crops, agriculture, existing industries, jetties and terminals, passenger ferry services on 212 km stretch of Sabarmati River in the state of Gujarat.

5.1 Land use pattern along waterway

5.1.1 Land utilization:

Of the total area in the Ahmadabad district, a vast proportion or 66% comes under the net sown area category. This is followed by Non agriculture land and Fallow land, each at 9%.Forest take up less than 2% of the total land in Ahmadabad district. The district has more than 5, 80,000 farmers. Out of these, more than 32% have only less than 1 hectare lands each. The combined area held by these farmers is 30,317 hectares or 5% of the total area. About 81% of total area is held by farmers who have an area more than 2 hectares each.

Table 27: Land Utilization

District	Forest	Non Agriculture	Net Sown Area	Uncultivable Barren Land	Fallow Lands	Cultivable Waste	Others	Total Area
Ahmadabad	13	70	527	66	74	28	15	793
Gandhinagar	2	22.6	164	1.5	6.9	5.9	12.1	215
Sabarkantha	126	42	445	35	34	15	33	730

In Gandhinagar, more than 76% of area is net sown area. This is followed by Non agriculture land 11%.The district also has fallow lands and cultivable waste lands 3% each. The district has less than 1% of area occupied by forests. With respect to the land distribution pattern the land holdings is contrast of that of Ahmadabad district. About 20% of land area is occupied by farmers having land holding area less than 1 hectare. About 18% of the total farmers or 85,830 having land holding more than 2 hectares occupy more than 54% of total cultivable land.

Of the total area in the Sabarkantha district, a vast proportion or 61% comes under the net sown area category. Forest takes up less than 17% of the total land in Sabarkantha district. The district has highest forest cover compared to other districts alongside the Sabarmati River. The district has more than 4, 40,000 farmers. Out of these, more than 45% have only less than 1 hectare lands each. The combined area held by these farmers is 55,924 hectares or 13% of the total area. About 62% of total area is held by farmers who have an area more than 2 hectares each.

5.1.2 Districts along River:

Ahmadabad District:

The District is surrounded on the north by Mehsana and Gandhinagar district, on the South by Gulf of Cambay and Bhavnagar district, on the East by Kheda district and on the West by Surendranagar district. The total Geographical area of Ahmadabad District is 8087.59 Sq.K.M.

Gandhinagar District:

Gandhinagar is located approximately 23 km north of Ahmadabad, on the west central point of the Industrial corridor between Delhi, the political capital of India, and Mumbai, the financial capital of India. Gandhinagar district is bounded by the districts of Sabarkantha and Aravalli to the northeast, Kheda to the southeast, Ahmadabad to the southwest, and Mehsana to the northwest.

Sabarkantha District:

The district is bounded by Panchmahals district in the east, by Ahmadabad, Kheda and Gandhinagar district in the South and Banasakantha and Mehsana in the West and Rajsthan state in the North. Total geographical area of the district is 7390 Sq.Km which is 4.2% of the Gujarat state. Himmatnagar is a district headquarters, and talukas Prantij and Talod are major industrial locations in Sabarkantha.

5.2 Crops/Agriculture in the region

5.2.1 Agriculture

Ahmadabad:

Wheat, Rice, Cotton are the major crops in Ahmadabad district. Besides cucurbits, cabbage, cumin and citrus fruits are grown in the district. The principal crops are Cotton, Wheat, Paddy, Cumin, Castor, Jowar and Pulses. The main cash crop is Cotton. The district is also selected for cultivation of oil seed crops such as Groundnut, Rapeseed, Mustard, Soyabean, Sunflower, Sesamum, Sunflower and Castor under Oil Seeds production Programme. Castor & Mustard are the main oil seeds in the district. Fruit crops are grown in Dholka taluka.

Table 28: Major crops for Ahmadabad District

Major Crops	Area	Production
Rice	1190	3110
Bajri	129	181
Castor	360	807
Cotton	2219	3916
Wheat	1898	4739
Gram	297	208
Cummin	266	183

Ahmadabad district is having extreme climate with wide variation in temperature during different seasons. Highest temperature is 45’ degree centigrade in summer and lowest

temperature comes down to 9' degree Centigrade in winter season. Dandhuka and Viramgam taluka frequently faces drought problems due to meagre rain. Average 612 m.m. rainfall remains in the district during the monsoon season.

Soil of Ahmadabad district is quite medium black known as Goradu in the Northern part and some areas of Sanand, Dascroi, Dholka and North Eastern part of Viramgam taluka have alluvial deposits which is considered as very good fertile soil with good moisture retention capacity. Other type land is found in the district such as loam and sandy loam in the district. "Kyari" type soil is also found in Southern part. While the soil of Dascroi and Sanand taluka are best for paddy crop. Some area in Dholka and Viramgam taluka having alluvial deposits in soil is highly fertile with abundant moisture covered by "rocky Soil" which is most suitable for pre monsoon crops like Cotton, Bajra and Jowar etc.
Gandhinagar

Wheat, Rice, Cotton, Castor and Bajra are the major crops in Gandhinagar district. Besides brinjal, Okra and Chili are grown in the district. The principal crops are Cotton, Wheat, Paddy, Castor, Bajra and Pulses. The main cash crop is Cotton.

Table 29: Major crops for Gandhinagar District

Major Crops	Area(00)	Production(00)	% Of total Sown area
Wheat	359	1172	17%
Bajra	151	298	7%
Rice	160	369	7%
Castor	303	669	14%
Cotton(Lint)	304	1130	14%

Wheat contributes nearly 17%of the total sown area in the district. Followed by wheat, Castor and Cotton occupy 14% each of the total sown area in the district.

The average maximum temperature is around 29 °C (84 °F), the average minimum is 14 °C (57 °F), and the climate is extremely dry. The southwest monsoon brings a humid climate from mid-June to mid-September. The average annual rainfall is around 803.4 mm (31.63 in).

The soils in the district are generally sandy loam type with grey to brown color. As per the studies carried out during UNDP project, they are generally deep and have moderate to good permeability and drain ability. In the western part of the district the soils are alkali type and saline. They are typically deep, grey, calcareous sandy loam of very low permeability.

Sabarkantha

Maize, Cotton, Castor, wheat, Groundnut and Pulses are the major crops in Sabarkantha district. Besides brinjal, Okra, cucurbits, tomato and cluster bean are grown in the district. The principal crops are Cotton, Wheat, Paddy, Castor, Groundnut and Pulses. The main cash crop is Cotton. Wheat contributes nearly 21%of the total sown area in

the district. Followed by the wheat, Maize and Cotton occupy 13% and 15% each of the total sown area in the district.

Table 30: Major crops for Sabarkantha District

Major Crops	Area(00)	Production(00)	% Of total Sown area
Wheat	1501	4026	21%
Groundnut	775	1222	11%
Maize	942	1546	13%
Castor	734	1257	10%
Pulses	490	310	7%
Cotton(Lint)	1071	3468	15%

The climate of the district is marked with large variation in temperature from 8 c to 48c with an average rain fall for 1035 mm in the Sabarkantha district. Sabarkantha district is located in east of Gujarat, comes under normal rainfall areas in Gujarat, having sub-tropical climate with moderately low humidity. The main seasons prevailing in the district are (a) monsoon - mid of June to October, (b) winter- November to February, and (c) summer – March to June. The maximum daily temperature during the year ranges from 31.0 °C in January to 48.5 °C in May while minimum temperature ranges from 11.5 °C in January to 27.5°C in May. Maximum humidity ranges from 81.0% to 25.5%.

Sand, goradu and medium black are the three main types of soil found in almost all talukas. Sandy soil is chiefly found in the central part of the district covering mostly Modasa, Meghraj, Malpur, Himmatnagar, Bhiloda and Idar talukas. The goradu soil covers Modasa, Prantij, Himmatnagar, Bhiloda and Malpur talukas and the medium black soil covers Khedbrahma, Vijaynagar, Bayad and Idar talukas.

5.3 Availability of bulk/construction material

River transportation would be viable for the movement of bulk commodities like coal and minerals. Minerals can be broadly classified as major minerals like iron ore, lignite, gypsm, bauxite etc and minor minerals like sand, limestone, silica, blacktrap etc. The minor minerals can be extensively used in construction industry while major minerals in manufacturing industry. Gujarat is endowed with rich minerals like petroleum& natural gas, lignite, bauxite, limestone, bentonite, fire-clay, china-clay, fluorspar, marble, agate, chalk, gypsum and decorative &dimension stones with which, the state possesses a prominent place in mineral production in India.

Railway would be ideal mode of transport incase of the minor minerals and major minerals for lead distance of 100 km but the availability of rakes is the concern, so the present movement is done by road transport. The increasing restriction on load carrying capacity of trucks have made the road transport uneconomical for bulk materials like sand, gravel, limestone etc as these are low value commodities. Hence there is ample of scope movement of these mentioned bulk commodities by waterways.

5.3.1 Minerals Profile of Ahmadabad District

Although district is not rich in minerals, deposits of minerals like brick earth, black trap, limestone and sand have been located in the district. There are 82 Leases in Ahmadabad District. The leases scattered in Dascroi, Dholka, Ranpur, City, and Mndal & Barwala talukas. As per the Commissioner letter dated 09/05/2009 the block system is adopted in Dascroi Taluka's villages - Mahijada, Kasindra, Visalpur, and Navapura and also in Ranpur Taluka's village Devaliya, other blocks identified in Dascroi, Dholka and Ranpur Taluka. All leases covering the Sabarmati River also and Bhadar river area.

Table 31: Major minerals and Minor minerals in Ahmadabad District

Sr.No.	Name Of Mineral	Production In Tones 2010-2011
	MAJOR MINERAL	
1	NIL	NIL
	MINOR	
1.	Ordinary Sand	3,199,772
2.	Black Trap	1,73,080
3.	Ordinary Clay.	2,349,510

5.3.2 Minerals Profile of Gandhinagar District

There is no main minerals are lying in any of the geographical area in the district. Minor minerals such as Common clay, Common Sand and Brick clay are found the district and, which are commonly used in the construction of residential buildings and industrial houses and business complexes or huge Shopping Centers.

Table 32: Major minerals and Minor minerals in Gandhinagar District

Sr. No.	Name of Mineral	Production (M. T.)
	MAJOR MINERALS	
1.	There is no main minerals production in the district.	
	MINOR MINERALS	
1.	Common Sand	67,64,250
2.	Brick clay	8,15,983
3.	Common clay	2,59,443
4	Gravel	2300

Source: Department of Mines & Geology, Gandhinagar.

5.3.3 Minerals Profile of Sabarkantha District

The district is rich in respect of mineral resources. The important minerals in the district are like, Lime stone, China clay, Sand stone, Bauxite, fire clay and Granite etc.. The minerals are mainly found in Khedbrahma, Idar, bhiloda, Himatnagar, Meghraj,

Vijaynagar, Malpur talukas. Available resources provide the scope of mineral based Industries. At present many minerals based industries are functioning in the district.

Table 33: Major minerals and Minor minerals in Sabarkantha District

S.No	Name Of Mineral	Production In Tones 2010-2011
MAJOR MINERAL		
1	Bauxite	10395.00
2.	China Clay Pro	14669.00
3	China Clay Cru	600.00
4	Limestone	10301.00
5	Sillica Sand	15319.00
6	Pipe Clay/Fire Clay	500.00
7	Sop Stone	2315.00
8	Felspar	410.00
MINOR		
1.	Black Trap	9543923.00
2.	Sand Stone	97134.00
3.	Quartzite	171803.00
4.	Granite Block	16638.00
5.	Granite Rubble	44131.00
6.	Bentonite	1675.00
7.	Limestone	44056.00
8	Ordinary Sand	2077334.00
9	Gravel	16845.00
10.	Other Building stone	13792.00

Source: Department of Mines & Geology, Himmatnagar.

5.3.4 Commodities Opportunities

Black trap

Black trap is abundantly produced in the Sabarkantha District. The use of black trap is in building roads and other infrastructure. As the cities like Ahmadabad and Gandhinagar are expanding day by day requirement of Black trap is good in this region. It may be potential commodity to be transported by waterways.

Granite

Granite is produced in Sabarkantha district. But as the volumes are low moving granite on waterways may not be feasible.

Sand

Sand is abundantly extracted in Gandhinagar district. But it is used for local consumption only hence not feasible for water transport.

Limestone

Lime stone is basically used in cement industries as well has steel industries. Limestone reserves are found in Sabarkantha district. However these have significantly low volume hence cannot be considered for movement via river.

Bauxite

Bauxite is mineral used for producing aluminium. There are reserves of aluminum in Sabarkantha. Basically bauxite mines in west coast of India have inferior quality of ores hence are exported to countries like Malaysia, China and Australia. The nearest port is Dahej, but due to small amount of production not feasible for water transport.

Table 34: District wise minerals production and opportunity for Sabarmati River

District	Location	Minerals	Unit	Production	Nearby port /Market	Distance From Mine in (KM)			Opportunity	Reasoning
						To River	River-Market/Port	Direct to Market/Port		
Ahemadabad	Dholka	Ordinary sand	Tons	3,199,772	Ahemadabad	10.2	30	39	No	Local consumption only
	Daskroi	Oridanry sand	Tons		Ahemadabad	15	17	22	No	Local consumption only
	Daskroi	Ordinary Clay	Tons	2,349,510	Ahemadabad	15	17	22	No	Local consumption only
	Sanand	Ordinary Clay	Tons		Ahemadabad	14	NA	24	No	Local consumption only
	Dholka	Ordinary Clay	Tons		Ahemadabad	10.2	30	39	No	Local consumption only
	Bale	Ordinary Clay	Tons		Ahemadabad	16	30	31	No	Local consumption only
Gandhinagar	Gandhi nagar	Ordinary Sand	Tons	67,64,250	Ahemadabad	NA	NA	30	No	Local consumption only
	Kalol	Ordinary Sand	Tons		Ahemadabad	NA	NA	32	No	Local consumption only
	Manias	Ordinary Sand	Tons		Ahemadabad	NA	NA	30	No	Local consumption only
Sabarkantha	Bayad	Bauxite		10,395	Dahej	83	229	260	No	In small quantity, not feasible on waterways.
	Himmat nagar	Quartzite		171,803	Dahej	24	229	304	No	In small quantity, not feasible on waterways.
	Modasa	Quartzite			Dahej	56	229	305	no	In small quantity, not feasible on waterways.
	Idar	Quartzite			Dahej	48	229	332	No	In small quantity, not feasible on waterways.
	Bhiloda	Quartzite			Dahej	65	229	349	No	In small quantity, not feasible on waterways.
	Himmat nagar	Sand Stone		97,134	Ahemadabad	24	229	304	No	In small quantity, not feasible on waterways.
	Prantij	Ordinary Sand		2,077,334	Ahemadabad	4	63	65	No	In small quantity, not feasible on waterways.

District	Location	Minerals	Unit	Production	Nearby port /Market	Distance From Mine in (KM)			Opportunity	Reasoning
	Idar	Ordinary Sand			Ahemadabad	12	116	116	no	In small quantity, not feasible on waterways.
	Khedbrahma	Ordinary Sand			Ahemadabad	65	75	140	No	In small quantity, not feasible on waterways.
	Khanpura	Black Trap		9,543,923	Ahemadabad	44	75	100	May be	Required for contraction and available in Abundant quantity
	Talod	Black Trap			Ahemadabad	7	60	70	May be	Required for contraction and available in Abundant quantity
	Bayad	Black Trap			Ahemadabad	53	35	83	May be	Required for contraction and available in Abundant quantity
	IDAR	China Clay		14,669	Ahemadabad	55	75	116	No	In small quantity, not feasible on waterways.
	Khedbrahma	Limestone		44,056	Ahemadabad	65	75	140	No	In small quantity, not feasible on waterways.

Flyash:

It is the essential commodity for manufacturing of the cement. With Gandhinagar thermal power plant near the stretch it is suitable to transport the fly ash waste from power plants to the cement manufacturing plants. Though the majority of fly ash is not being consumed locally in cement and brick manufacturing industries there is surplus of 0.65 mmtpa of fly ash which could be transported to cement plants in Ahemadabad by IWAI movement. The same has been considered for IWAI movement and the growth will be in accordance with the demand of the cement plants. The stretch considered is about 30 km.

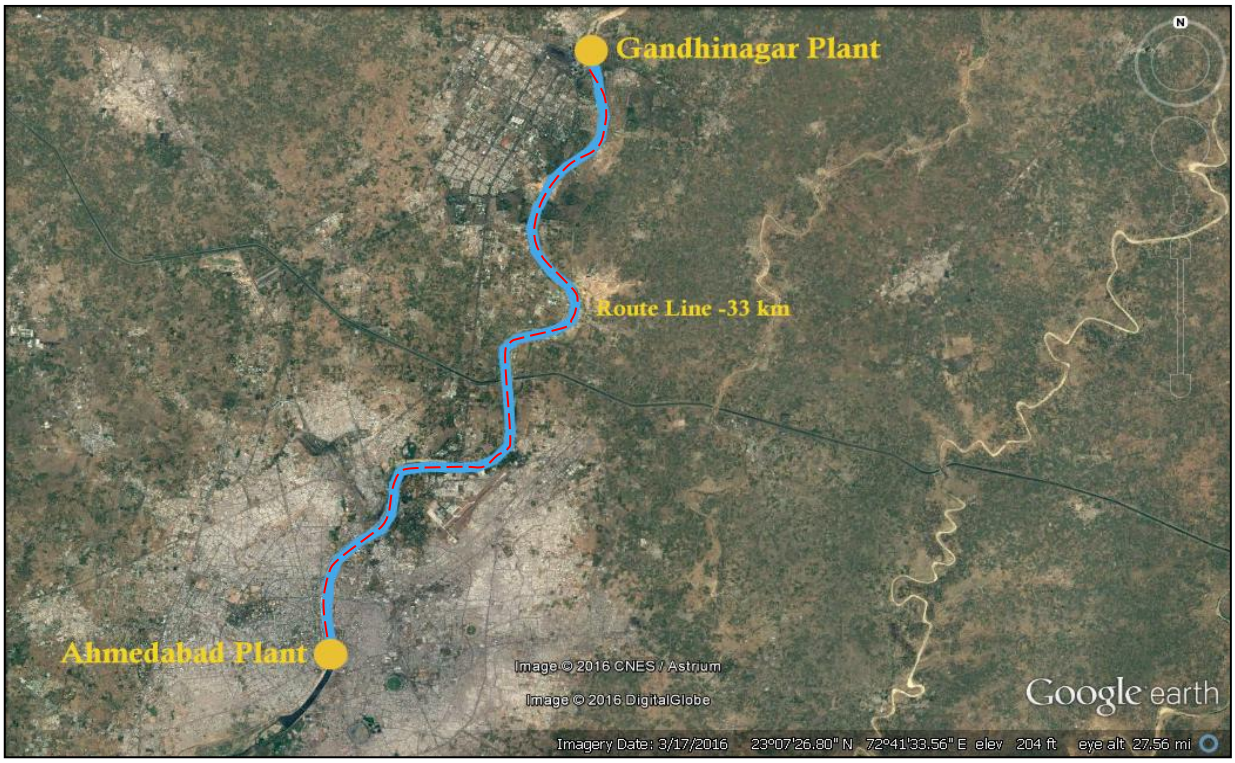


Figure 24: Flyash oppurtunity

Figure 25: Condition of river stretch for Fly ash transport, Thermal power plant site.

Cement:

Global Cement Production has continued to be expanding at an average rate of 6.4% in the last five years from 2568 million tonnes in 2006 to 3294 million tonnes in 2010. Around 56% of production originates in China. China (with an average annual growth of 11.4%) and India (with an average annual growth of 9.8%) have been the drivers of the growth in global cement output. India is the second largest cement producer in world after China. Except India and China, other major producers are in the range of 45 - 65 million tones production (as against 52 - 86 million tonnes in 2008). Cement being a low value high volume output has a very limited international trade. In 2010, international trade was 151 million tonnes and just 5% of the global cement output. During the primary survey it was found that there is a Cement manufacturing plant near Ahmedabad, the capacity being 1MMTPA. As the plant is crushing plant the raw material required is fly ash. Fly ash is sourced from the thermal power plant and the clinker is sourced from the integrated plant. If the is to be sourced from Gandhinagar Thermal power plant. Hence there is possible movement of 0.668 MMTPA of Flyash from Gandhinagar to Ahmedabad. Similarly there is opposite movement of finished cement to the cities like Gandhinagar is possible.

Figure 26: Condition of river stretch for Cement transport between Ahmadabad and Gandhinagar.

5.4 Existing Industries along waterways

The industrial area in Gujarat is located nearby to the ports. Many of the companies own captive jetties taking the advantage of the coastal movement of the raw materials for cost effective logistics. The port nearest to the Sabarmati River proposed stretch is Dahej. In this section, we shall discuss the strategic location and infrastructural advantages of coastal movement of goods through identified river stretch to the nearby port.

Table 35: District wise Industries and opportunity for Sabarmati River

District	Industrial Area	Nearby Port	Distance from Industrial Area(km)			Opportunity
			To River	River-Market/Port	Direct to Market/Port	
Ahemadabad	Apparel Park	Dahej	3.5	188	229	No
	Vatva	Dahej	7	188	230	Maybe
	Naroda	Dahej	10	198	235	Maybe
	Kathwada	Dahej	14	188	231	Maybe
	Odhav	Dahej	12	188	228	Maybe
	Kerala	Dahej	26	150	272	Maybe
	Dholka	Dahej	10.2	188	236	Maybe
	Viramgam	Dahej	52	188	297	Maybe
	Zone- D. Ahmadabad City Indl. Estate	Dahej	4	188	234	Maybe
	Sanand	Dahej	14	188	259	Maybe
Gandhinagar	Gandhinagar Electronics Estate	Dahej	4	200	255	No
	Gandhinagar SEZ Park	Dahej	4	200	255	No
	Gandhinagar IT Park	Dahej	4	200	255	No
	Gandhinagar Housing	Dahej	4	200	255	No
	Gandhinagar Engineering Estate	Dahej	4	200	255	May be
	Mansa Industrial Estate	Dahej	10	238	281	May be
	Dehgam Industrial Estate	Dahej	15	200	261	May be
	Chhatral	Dahej	23	200	261	May be
	Kalol	Dahej	15	200	260	May be
Sabarkantha	Himatnagar	Dahej	24	229	304	maybe
	Modasa	Dahej	56	229	305	maybe
	Idar	Dahej	48	229	332	No
	Talod	Dahej	25	229	279	No
	Malpur	Dahej	80	229	284	No
	Bhiloda	Dahej	65	229	349	No

5.4.1 Industrial Profile of the Gandhinagar District:

Gandhinagar is a capital city of Gujarat State. And, it is hardly 20 km away from Ahmadabad city. It is well connected with Ahmadabad city by rail, road and international airport. It has seven Special Economic Zones and ten Industrial Estates along with creative IT Park and Gujarat International Finance Tech City (GIFT); which are backbone and peacock feathers which keep pulses of economic heart of the district for persistent economic growth and in improving the living standard in the district.

Table 36: Industrial Profile of the Gandhinagar District

Name of Indl. Area	Land Developed (Hec.)	Prevailing Rate per Sq. Mtr. (Rs.)	No. of Plots	No. Of Allotted Plots	No. of Vacant Plots	No. of Units in Production
Gandhinagar Electronics estate	182.61	3590/-	528	521	07	470
GandhinagarSEZ Park	26.95	2400/-	39	20	19	---
Gandhinagar IT Park	22.26	3500/-	11	01	09	---
Gandhinagar Housing	31.57	5385/-	800	707	93	707
Gandhinagar Engineering Estate	35.43	3590/-	233	232	01	228
Mansa Industrial Estate	17.77	350/-	105	105	---	102
Dehgam Industrial Estate	17.65	350/-	94	94	---	89
Bhat Industrial Estate	26.12	3280/-	09	09	---	---
Chhatral	195.78	195.78	435/	850	850	---
Kalol	55.3	55.3	550	270	270	---

Major Exportable Items:

Textile goods, Urea, Ammonia, Rolled MS Sheets, Milk Products, Fertilisers & Pesticides, Auto gears & accessories, TMT Bars and Ceramic products are major exportable items manufactured by the Large and Medium Scale enterprises in the district.

Table 37: List of Large and Medium scale units operating in Gandhinagar district and nearby Area

Name of Unit	Tehsil	Item manufactured
Arvind mills	Kalol	Textile goods
Syntex Industries Ltd.	Kalol	Fabricated household Water Storage Tanks
Indian Farmers Fertilisers Co-	Kalol	Urea, Ammonia
Shah Alloys Ltd.	Kalol	Rolled MS Sheets
Parekh Platinum Ltd.	Dehgam	Gold Plating
Mother Dairy	Dehgam	Milk Products
At & T Switching Systems	Gandhinagar	Telephone & Telephonic Switching apparatus
Gen Tek Technology	Gandhinagar	Wiring Harness
Multimedia Frontiers Ltd.	Gandhinagar	Compact Disks
Pramukh Agro Foods Pvt. Ltd.	Kalol	Refined Rap seed Oil and Cottonseed Oil
IFFCO	Kalol	Fertilisers & Pesticides

Name of Unit	Tehsil	Item manufactured
C. M. Smiths & Sons Ltd.	Zak-Dehgam	Auto gears & accessories
Vinayat TMT Bar	Barot na Mosampura-Dehgam	TMT Bars
Circuit Systems Pvt. Ltd.	Gandhinagar	Electronic Circuits
Kalptaru Transformers	Gandhinagar	Electric Transformers
Akash Ceramic Pvt. Ltd.	Mansa	Ceramic products

Road Connectivity:

NH-8 and 8C passes through the district and connects it with other major cities of the States and also worth the whole of India. It is well connected with Ahmadabad on Sarkhej-Gandhinagar Highway Z (28 km) and Vadodara on Ahmadabad Vadodara Expressway (129 km). It is also well connected with other industrial centers in the State like Rajkot (249 km), Jamnagar (337 km), Valsad (373 km), Ankleshwar (223 km), Bhavnagar (228 km), Mehsana (68 km) and Surat (306 km). It is also well connected with other major cities in India: Mumbai (573 km), Delhi (943 km), Kolkata (1952 km) and Chennai (1854 km).

Rail Connectivity:

Western Railways connects the district with major cities in India such as Delhi and Mumbai via Ahmadabad.

Population Demographics:

Gandhinagar has geographical spread of 2163 sq.kms. The district has a total population of 13.87 lakhs. Significant portion of district population lives in urban areas with these regions accounting for 43.32 per cent of the total population. Population spread in the district is significantly high with a density of 660 persons per sq.km. As per 2011 estimates, district has registered an overall literacy rate of 85.78 per cent. Being the state capital, growth in commercial activities has resulted in higher penetration of tertiary and secondary activities. Non agrarian sectors account for nearly 60 per cent of overall workforce indicating the level of progress Gandhinagar has achieved in terms of reducing dependency on agriculture.

5.4.2 Industrial Profile of the Ahmadabad District:

A large number of industries related to textiles, chemicals, machinery, metal products, pharmaceutical, engineering, plastics, electrical appliances, electronics, passenger cars etc. are located in the district. There are 12 main Industrial Estates, 12 Special Economic Zones, and 10 Industrial Parks/Developers in Ahmadabad district. Several business conglomerates such as Adani Group, Reliance Industries, Nirma Group of Industries, Arving Mills, Claris Life Sciences, Cadila Pharmaceuticals, Shell, Vadilal Industries Ltd., Rasna, bosch Rexroth (Germany), Stock and Rollepal (Netherland) are present in the district.

10 Industrial Parks in Ahmadabad

- Industrial Parks / Developers
- M/s G.N.F.C. Ltd.
- M/s Ganesh Housing Co. Ltd.
- M/s Gujarat Pharma Techno Park
- M/s Shree Rang Infrastructure Pvt. Ltd. M/s Gujarat (Bhal) Construction Ltd.
- M/s Soham Integrated Textile Park, Ahmadabad Pvt. Ltd. M/s Devraj Infrastructure Ltd.
- M/s Jayni Project Ltd.
- M/s Sanblue Infrastructure Pvt. Ltd. M/s Pradip Overseas Ltd.

Table 38: Industrial Estates in Ahmadabad Districts

S.No.	Name of Ind. Area
1	Apparel Park
2	Vatva Indl. Estate
3	Naroda Indl. Estate
4	Kathwada Indl. Estate
5	Odhav Indl. Estate
6	Kerala Indl. Estate
7	Dholka Indl. Estate
8	Viramgam Indl. Estate
9	Dhandhuka Indl. Estate
10	Zone- D. Ahmadabad City Indl.

Major Exportable Items:

Automobile, Engineering/ Electronics, Pharmaceutical, Gems & Jewellery

Road Connectivity:

National Highway 8 passes through the district connecting it to major industrial centres, which includes Gandhinagar (28 km), Vadodara, Bharuch (182 km), Surat (278 km), Anand (73 km), Navsari (301 km) and Mumbai (516 km) ß As a part of Golden Quadrilateral, the 95 km Ahmadabad- Vadodara Express way connects the two districts.

Rail Connectivity:

A broad gauge rail line of 111 km is present in the district. Total length of metre gauge rail line is 245 km. In total, there are 60 railway stations in Ahmadabad district ß Ahmadabad is directly connected by rail to several cities of India which includes Mumbai, Delhi, Kolkata, Chennai, Trivandrum and Varanasi.

Population Demographics:

Ahmadabad has a geographical spread of 8087 sq.km. As per 2011 census estimates, it has a population of around 72.08 lakhs. It is among the most densely populated regions in the state with a population density of 890 persons per sq.km. It is predominantly urban with an 84.05 per cent share of urban population in the overall district population. Organized industrial employment in registered factories and service enterprises has contributed to significant share of secondary sector employment in the district. MSME remained a major contributor in terms of employment generation over the years

There are at present 42 medium and large scale industries in Sabarkantha district. Some of the major medium and large scale players present in district are mentioned in list below

- Bayer Crop Science Ltd., P.No.66/67,GIDC Estate, Himatnagar
- Asian Granito India Ltd., 147-A, Ceramic Zone, Dalpur, Pratij
- Gujarat Ambuja Export Ltd., Block No.468, Dalpur, Pratij
- Oracle Granito Ltd., Block No.386, sabar Dairy, Talod Road, Himatnagar
- Regent Granito (I) Ltd., Hasipur, Nr.Sabar dairy, N.H.8, Himatnagar
- Tudor India Ltd., P.No.10/1, Kamalpur, Tal.Pratij
- Asian Granito India Ltd., Opp. Sardar Plant, Idar
- Century Tiles Ltd., Block No.212,Nr.Sabar Dairy, Gadhoda, Himatnagar
- Samay Tiles Ltd., Block No.1018, At Berna, Himatnagar
- City Tiles Ltd., Block No.121, Dalpur, Pratij
- Sabarkantha Dist. Co.Op.Milk Producers Ltd., (Sabar Dairy), Boriya,Himatnagar
- Gujarat Ambuja Protins Ltd., Dalpur Pratij.

Table 39: Medium and large scale industries in Sabarkantha district

S. No.	Name of Ind. Area	Land acquired (In hect)	Land developed (In hectare)	Prevailing Rate Per Sqm (In Rs.)	No. of Plots	No. of allotted Plots	No. of Vacant Plots	No. of Units in Production
1	Himatna	27.88	21.50	690/-	163	163	-	162
2	Modasa	19.14	13.08	395/-	116	116	-	93
3	Idar	2.73	2.00	200/-	37	37	-	34
4	Talod	25.95	21.30	200/-	169	169	-	25
5	Malpur	1.00	0.44	70/-	16	12	4	8
6	Bhiloda	15.14	10.22	335/-	101	82	19	1

Source: - GIDC, Himatnagar

Walls & floor tiles (ceramics), chemicals, plastic & plastic products and commercial office and household equipment are some of the major small scale industry sectors of the district. Sabarkantha houses over 8,000 Small Scale Industries, employing close to 34,200 people.

Table 40: Major Exportable

Sr.No	Major Exportable Item
1)	Aluminium Unethical
2)	Agriculture Equipment
3)	tiles Ceramic
4)	Denim Fabrics

Roads:

NH 8 passes through the district connecting it with major cities of the State and also with the rest of India. It connects Sabarkantha with Ahmadabad (79 km), Vadodara (190 km), Surat (357 km), Gandhinagar (55 km) and Mumbai (583 km).Distance (in Km) from major industrial centres in the State: Rajkot (304), Jamnagar (392), Valsad (424), Ankleshwar (274), Bhavnagar (279), Mehsana (64). Distance (in Km) from major Indian cities: Kolkata (1829), Chennai (1646), Hyderabad (1100) and Delhi (739) Road .

Rail:

24 railway stations in the district connects Sabarkantha with major cities in the State and with the State Rajasthan

Population Demographics:

An official Census 2011 detail of Sabarkantha, a district of Gujarat has been released by Directorate of Census Operations in Gujarat. Enumeration of key persons was also done by census officials in Sabarkantha District of Gujarat.

In 2011, Sabarkantha had population of 2,428,589 of which male and female were 1,244,231 and 1,184,358 respectively. In 2001 census, Sabarkantha had a population of 2,082,531 of which males were 1,069,554 and remaining 1,012,977 were females. Sabarkantha District population constituted 4.02 per cent of total Maharashtra population. In 2001 census, this figure for Sabarkantha District was at 4.11 per cent of Maharashtra population. As per 2011 census, 85.02 % population of Sabarkantha districts lives in rural areas of villages. Average literacy rate in Sabarkantha district as per census 2011 is 84.58 % of which males and females are 91.18 % and 77.59 % literate respectively.

5.5 Existing Commodity Identification:

The O-D movement of commodities by rail has been studied and will be further analyzed on cost basis to determine the modal shift. The data regarding freight railway shades nearby the identified stretches have been collected.

The identified stretch of Sabarmati River has been surveyed and present ferry or cargo movement has been observed. There no current boat movement in Sabarmati River. It

was also observed that there are some multimodal cargo potential locations for e.g. Pratinj railway station which are well connected with cities like Ahmadabad.

As per survey conducted the commodities have been categorized in to following categories

- Domestic movement- Fertilizers, Fly ash and cement.
- EXIM Movement- Rock phosphate

5.5.1 Fertilizer:

Sabarkantha district is agricultural district. Majority of the population is engaged in the farming activities. There is ample of sugarcane production and wheat and groundnut production. There is no major sugar producing plant nearby. The fertilizer requirement is 0.5 million tons per annum for agriculture. Pratinj could be is a large distribution centre for the fertilizers and has good connectivity with Ahmedabad. Hence the river stretch from Ahmedabad to Pratinj is the stretch where fertilizer movement is expected.

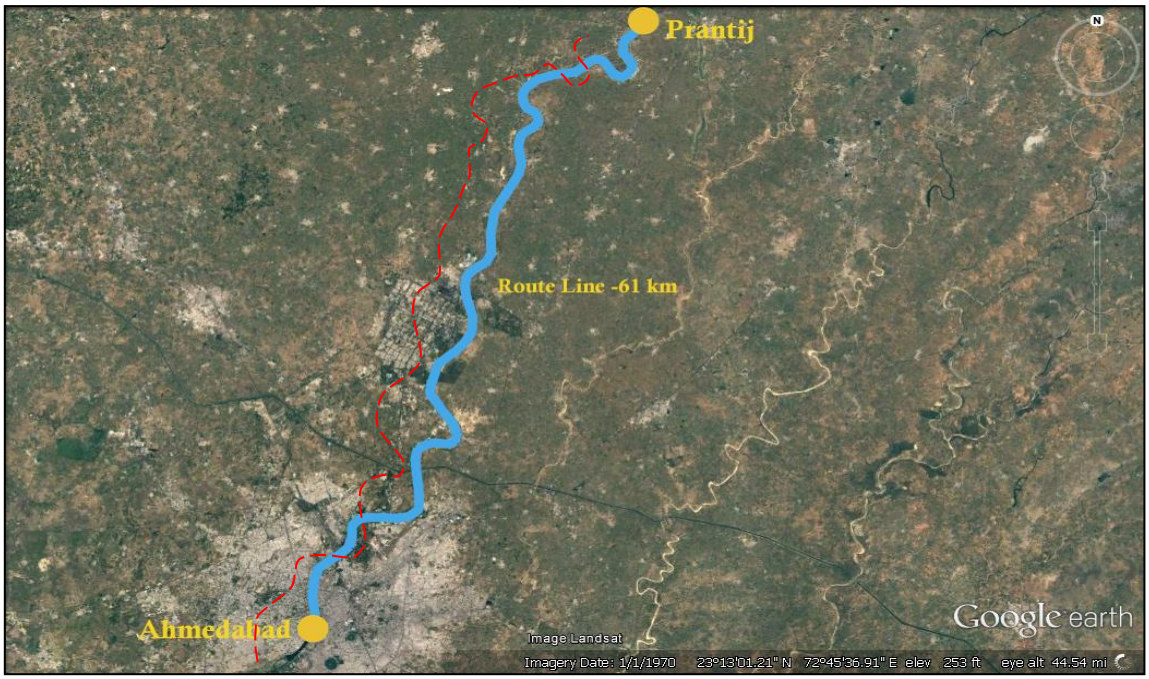


Figure 27: Fertilizers

Figure 28: Prantinj Railway Station

5.5.2 Rock Phosphate:

The use of rock phosphate is basically used in the production of the fertilizers. The Ahmadabad is production centre of the fertilizers. There are major fertilizers manufacturing industries in Ahmadabad. As per OD analysis the rock phosphate is sourced from Dahej port. It may indicated that the 187 km stretch between Dahej port and the Ahmadabad can be utilized for transportation of the imported items like Rock phosphate and coal for industries in Ahmadabad and Gandhinagar. The annual amount of Rock Phosphate that can be sourced from Dahej to the district of Ahmadabad is 2 million tons per annum keeping in view the industrial requirement. The demand is not constant and has peak and troughs on demand curve. The requirement of the rock phosphate is projected by growth percentage requirement in fertilizers production.

Figure 29: Rock Phosphate

Figure 30: Stretch before entering the Ahmadabad city

5.6 Existing Jetties and Terminals (with conditions and Facilities)

5.6.1 Dahej Port:

Dahej port is deep water, multi-cargo port which is also the only solid cargo handling commercial port, strategically located in the Gulf of Khambhat. With a capacity to handle 20 MMTPA cargos, it has two dry and break bulk berths and dedicated facilities for handling Project Cargo.

Table 41: Major commodities handled at Dahej port in Lakh tonnes

Commodity	2012	2013	2014	2015	2016
Coal	75.50	79.58	126.76	126.76	84.12
Copper	12.48	11.86	14.30	14.30	14.37
LNG	103.10	96.14	102.86	102.86	112.42
Rock Phosphate	7.29	5.86	6.28	6.28	5.72

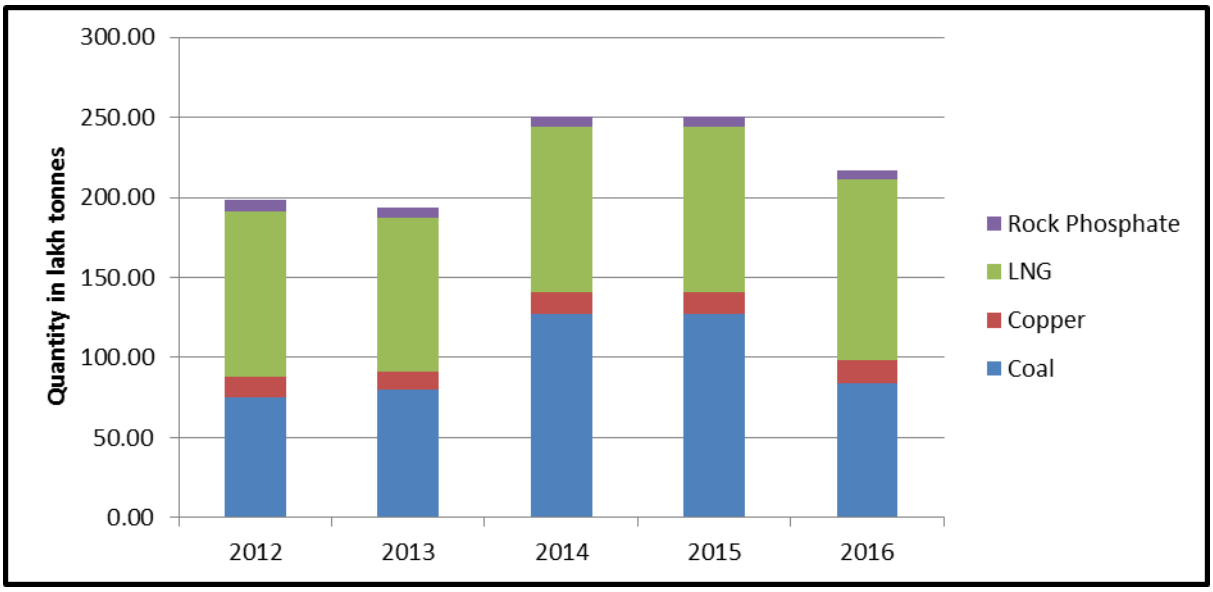


Figure 31: Major commodities handled at Dahej Port

Dahej port is strategically situated on international maritime routes and provides easy access to the dense industrial hubs of Gujarat, Maharashtra and Madhya Pradesh. This makes it the preferred port for the cargo hubs functioning in the Northern and Western states and union territories of India.

Table 42: Opportunities for river movement of commodities handled at Dahej port.

Commodity	Volume(MMTPA)	Attractive	Reasoning
Coal	8.4	May be	It could be moved to industrial areas of Anand and Vadodara.
Copper	1.4	No	It is captive cargo and hence not mobilized.
LNG	11.2	No	Liquid and gas commodities evacuate from port using pipeline hence shifting is not possible.

Commodity	Volume(MMTPA)	Attractive	Reasoning
Rock Phosphate	0.572	May be	It could be moved to industrial areas of Anand and Vadodara.

5.7 Preliminary Traffic identified-within 50 Km:

Sabarmati River flows in the north of the Dahej port and the coastal distance is about 74 km from the port. Sabarmati River has two important Industrial districts of Gujarat along its stretch. There are several industrial areas located near the river. Dahej port can act as gateway for exim trade to most of the locations. There are also several mines located nearby the river stretch. The thermal power plant of Gandhinagar is located on the bank of the river which attracts the coal and fly ash movement. The cement plant near to the river stretch in Ahmadabad is also potential for cargo movement of cement, cement being finished product for markets in Gandhinagar and Sabarkantha.

5.8 Existing cargo movement:

Mines of bauxite in Sabarkantha district, Sand in Gandhinagar district have good proximity to the river. Majority of Gravel and sand mines are located very nearer to stretch. But due to quantity being produced and the locations of the markets it is not feasible to move them on the river stretch.

The projected Traffic demand for the mentioned stretch is as follows:

Table 43: Traffic Demand

Commodity	MMTPA
Rock Phosphate(Dahej to Ahemadabad)	2.0
Fly ash (Gandhinagar thermal plant to Ahemadabad)	0.7
Fertilizers from Ahemadabad to Pratinj	2.9
Cement From Ahemadabad to Gandhinagar	1.0

SOURCE: Dispatch data available by Dahej port Authority for year 2014-15.

At present there is no cargo movement happening on the river stretch. The majority of goods movement is by roads and some by rail. The Thermal power plant in Gandhinagar is located near to the river stretch are potential sources for movement of cement and fly ash. Black trap has its market in Ahmadabad and Gandhinagar which have proximity to the river stretch.

5.9 Prominent city/Town/Places of worship/Historical places for tourism:

The Ahmadabad district is home to one of the famous World Heritage Site, the Adalaj Vav (Step well). The steps descend five stories, passing beams, columns and brackets that are elaborately carved with geometric, floral and animal designs.

The Calico museum in Ahmadabad is one of the best textile museums in the world, comprising marvelous and well-labelled collection of textile, aircrafts, designs and technology.

Science City, located off Sarkhej-Gandhinagar Highway promotes science education through hands on learning in the Hall of Science and also has an Energy Park that promotes renewed energy sources

The lake in Nalsarovar Bird Sanctuary in the district is a freshwater body, having rich biodiversity of wide variety of fishes, various vegetation, algae, and medicinal plants and over 250,000 birds

Sarkhej Roza is a mosque, tomb and royal complex that witnesses a blend of Hindu and Islamic designing

Other tourist spots in the district are pairs of Shaking Minarets, Gandhi Ashram, Swaminarayan Temple, and City Museum

Idar Hill, Clock Tower, Ruthi Rani no Mahal (Palace of Sulking Queen), The Shantinath Temple and Shrimad Rajchandra Vihar are some of the attractions in the Sabarkantha.

Idar is a significant town in Sabarkantha and is a good base for excursions to areas such as Khedbrahma, Vijaynagar and Poshina.

The Shamlaji Temple in the district stands in honour of Lord Vishnu and is one of Gujarat's main pilgrimage sites. The magnificence of the temple is enhanced by exquisite stone carvings, idols of Gods, nymphs, beautiful domed ceilings and a towering spire.

Polo forests and the ruins of old Hindu and Jain temples in Vijaynagar are known for their natural beauty and historical significance

Sir Pratap Singh Palace is more than a century old and houses portraits of English royalty, hunting scenes, trophies etc.

5.10 Availability of Passenger Ferry Services:

There are no passenger ferry services available on the proposed stretch of Sabarmati River. The areas along the waterways are well connected by roadways and it won't be possible for passenger to shift from roadways to waterways. Also the proposed stretch is dried out in summer hence no possible passenger movement can take place.

5.11 Availability and probable water sport Recreational:

The water sports and walk way are set up as a part of the Sabarmati riverfront project. According to the Ahmadabad Municipal Corporation (AMC) office bearers, 26 water rides will also be started in Sabarmati river front. Ticket rate for a ride in speed boat (total four) will be Rs 100, water craft (one) Rs 100, motor boat (four) Rs 20, Jet ski water scooter (one) Rs 200, pedal boat (15 minutes, total ten) Rs 15, Zorbing-water bubbles (five) Rs 60.

6. Observations, Inferences and Conclusions

6.1 Waterway

The total length of the river under present studies is detailed below:

212 km length of the river from Barrage near Sadoliya to confluence with Gulf of Khambhat near Khambhat (National Waterway 87)	**From:** **23°26'49.66"N 72°48'34.85"E**	**Up to:** **22°9'17.99"N 72°27'27.81"E**

6.2 Length

The length of waterway under present studies under consideration is 212 km.

6.3 LAD

	Chainage (Km)					
LAD (m)	**0-13.7**	**13.7-25**	**25-50**	**50-75**	**75-100**	**Total (km)**
<1	2.06	1.32	7.08	14.44	14.28	39.18
1-1.2	2.00	1.38	1.82	1.34	5.16	11.71
1.2-1.4	1.50	0.91	1.59	0.60	2.00	6.59
1.4-1.7	1.73	2.59	1.34	1.09	1.44	8.19
1.7-2.0	1.17	0.60	1.11	0.88	2.05	5.81
>2	5.96	4.40	13.20	6.03	0.53	30.13
Total (Km)	**14.42**	**11.20**	**26.14**	**24.38**	**25.46**	**101.60**

LAD	100-125	125-150	150-175	175-200	200-210	Total (km)
<1	9.72	9.76	14.20	17.01	4.31	55.00
1-1.2	2.02	1.11	0.22	0.42	0.52	4.29
1.2-1.4	1.10	0.18	0.60	0.76	0.85	3.49
1.4-1.7	3.38	0.58	0.34	2.11	2.02	8.43
1.7-2.0	1.54	2.39	0.44	0.65	0.96	5.98
>2	7.63	10.78	9.15	4.29	1.33	33.18
Total (Km)	**25.39**	**24.80**	**24.95**	**25.24**	**9.99**	**110.37**

6.4 Cross-Structures

There are 2 barrages namely Wasna Barrage and Sant Sarovar or Indroda Barrage, one weir (Lakroda weir) and seven check dams over Sabarmati River in its 212 km stretch.

Twenty three road bridges, one rail bridge (Sabarmati Rail Bridge), one water pipeline bridge, 27 high tension lines and 2 electric lines exist over sabarmati in the present study stretch.

6.5 Water availability

Subhash Bridge

It is located at 135.7 km upstream of river mouth. Daily gauge- data for period 1979 to 2010 was collected from WRIS and analyzed. Only water level gauge data for period June to October is available. The Ahmadabad city experienced heavy flood in August 2006 when high flood level of 47.45 m MSL was reported at this gauge for highest observed flood discharge.

In **Monsoon period** depths in the range of 0.5 m to 2m above CD will be available for periods as below.

0.50 m to 1 m and above : 114 days
1.0 m to 1.5 m and above : 75 days
1.5 m to 2.0 m and above : 36 days

The data for months November to May was not available. However, from some data of early June and late October indicate that water levels at this gauge during November to May remain close to CD or slightly above. This may be due to back water of Wasna Barrage and some releases from escape of Narmada canal.

Vathua Gauge

Daily gauge- discharge data for period 1999 to 2013 was analysed. This gauge is located near bridge just downstream of Kheda-Sabarmati confluence at about 67 km upstream of river mouth. The river bed level at this location is about 11 m MSL.

From Subhash bridge to Vathua the river bed level lowers by about 28 m in a distance of about 70 km. The river bed slope in this reach becomes flatter (1/2592) as compared to the bed slope in upstream reach. Considering the results presented above and Tables in chapter4, following conclusions have been drawn:

Water depths in the range of 0.5 m to 2m above CD will be available for periods as below.

0.00 m to 0.50m and above : 170 days in a year
0.50 m to 1.2 m : 43 days in a year
More than 1 m : 74 days in a year

Depths of about 0.50 m-1.0 m above CD are mostly available in monsoon period during June to November. For periods from December, water level is nearly at C.D. for most of the times.

6.6 Cargo / Passenger / Tourism / Ro-Ro Facility

As can be seen in para 5.2, Cotton, Rice and Wheat are the major crops in Ahmadabad and wheat, Cotton and Castor are the major crops in Gandhinagar district. These crops are consumed locally. From para 5.3, Ordinary sand, Ordinary clay are the minor minerals in Ahmadabad and Sand, Brick clay and Common clay used in brick construction are the main minor minerals produced. The local demand of these minor minerals does not favor their transport.

However, a large no. of industries related to textiles, chemicals, machinery, metal products, pharmaceutical, engineering, plastics, passenger cars such as Adani, Reliance, Nirma, Arvind, Cadila Healthcare, Vadilal, Shell, Rasna, bosch rextroth etc. are located in 12 main industrial estates, 12 special economic zones and 10 industrial parks in Ahmadabad and Gandhinagar district in the vicinity of Sabarmati River.

Flyash is the main commodity for cement manufacturing and is generated as waste by Thermal plants in Gandhinagar. The Total flyash is not consumed locally and there is a surplus of about 0.7 MMTPA that could be required in Ahmadabad for the production of Cement. In Ahmadabad, Cement is produced with capacity 1 MMTPA which requires Flyash. Hence there is opportunity of Movement of Flyash from Gandhinagar to Ahmadabad and Cement from Ahmadabad through Inland Navigation.

The fertilizer requirement is 0.5 MTTPA for agriculture. Pratinj could be a distribution center for fertilizers and has good connectivity with Ahmadabad where fertilizers are produced. The river stretch from Ahmadabad to Pritinj offers a good opportunity for movement of fertilizer through Sabarmati River.

The Ahmadabad is production centre of the fertilizers. There are major fertilizers manufacturing industries in Ahmadabad. Rock phosphate is basically used in the production of the fertilizers. As per O-D analysis the rock phosphate is sourced from Dahej port. It may indicated that the 187 km stretch between Dahej port and the Ahmadabad can be utilized for transportation of the imported items like Rock phosphate and coal for industries in Ahmadabad and Gandhinagar. The annual amount of Rock Phosphate that can be sourced from Dahej to the district of Ahmadabad is 2 million tons per annum.

6.7 Classification of waterway: Suitable for Navigation

Reach: River Mouth to 30.0 km (Ch 0.0 to 30.0 km)

Tidal reach of Sabarmati River is 30 km. Reduced water depths of around 2 m are easily available upto 14 km from mouth since tidal effect is dominant. From 14 km to 30 km, depths are available in the range of 1-1.5 m expect for a small stretch. Prima facie, this reach is Prima facie feasible for navigation Class I with a little capital dredging. Port Dahej bander also exists at river mouth that creates a lot of opportunity for cargo movement.

Reach: Ch 30.0 to Vautha Gauge (at Ch 75.4 km)

Depths of 0 – 0.5 m (above C.D.) and above are available for around 170 days in a year.
Depths of 0.5 – 1.2 m and more are available for around 120 days during monsoon.
Reduced Depths in the range of 4.40 m to -0.91 m exist in this stretch. Reduced Depths in the range of 4.40 m to -0.91 m exist in this stretch. Reduced depths of <1 m exist for 18 m length in this stretch of 45.4 km. With capital dredging in this 18 km stretch, this stretch has the potential for navigation for class I.

Reach: Vautha Gauge (at Ch 75.4 m) to Wasna Barrage (Ch 135.7 km)

Depths of 0.5 – 1.0 m (above C.D.) are available for around 170 days.
Depths above 1.0 m are available for around 75-90 days during monsoon.

Depths above 0.5 m (from 0.5 to above 1 m) are available for a period of 170-200 days. This stretch starts from Downstream of Wasna Barrage. Hence this stretch can be developed for navigation class I with additional measures.

Reach: Wasna Barrage (Ch 135.7 km) to Sardar Patel Ring Road Bridge (Ch 156 km)

Depths of 0.5 – 1.0 m (above C.D.) are available for all round the year-360 days.
Depths of 1.0 – 1.5 m are available for around 75-90 days during monsoon (75 days)
The C.D. at Subhash Bridge is nearly 2.5 m above River bed level at Subhash Bridge gauging site. A part of this stretch near sadar bazaar up to Wasna Barrage had already developed as Sabarmati waterfront by Govt of Gujarat. At upstream of Indira Bridge, Released water from Narmada canal ensures all round the year availability of water in this stretch and downstream. This stretch is feasible for navigation class II waterway.

Reach: Sardar Patel Ring Road Bridge (Ch 156 km) to Lakroda Bridge (210 km)

This reach is at the upstream of siphon over Narmada Canal where water from Narmada canal is released into Sabarmati River. There is practically no flow in this reach except during monsoon season for 4-5 months or Narmada canal release at upstream. Hence this stretch is not suitable for navigation.

6.8 Proposed alternative methods for making waterway feasible

Reach: River Mouth to 30.0 km (Ch 0.0 to 30.0 km)

A little capital dredging is required at some places where the reduced depths are less than 1m.

Reach: Ch 30.0 to Vautha Gauge (at Ch 75.4 km) & upto Wasna Barrage (Ch 135.7 km)

With little capital dredging this stretch has the potential for navigation class I. To tap the releases from Wasna barrage, a barrage may require to be constructed to improve depths in this stretch just before start of tidal effect near chainage 30 km.

Reach: Wasna Barrage (Ch 135.7 km) to Sardar patel Ring Road Bridge (Ch 156 km)

The depths in this reach can be further improved by improving the flow releases from Narmada canal. Wasna Barrage also exist in downstream and the depths of 0.5-1.0 m above C.D. (C.D. is 2.2 m above river bed) are already available for around 75-90 days. The improvement of parameters of Wasna barrage may improve depth and duration. This strtch can be further developed to increase tourism and recreational activities.
Further, It is necessary to study in phase II whether some dredging and release of some flows from Narmada canal and Vasana barrage and Kheda dam will improve flow conditions and duration for navigation in the reach from Subhash bridge to Vathua and further downstream. Feasibility of releases of flows will have to be studied in consultation of state water resource department.

Reach: Sardar Patel Ring Road Bridge (Ch 156 km) to Lakroda Bridge (210 km).

This reach is at the upstream of siphon over Narmada Canal. Practically there is no flow during non-monsoon period. By construction of a barrage or weir to store water during monsoon season the navigation for 120-150 days may be developed.

6.9 SWOT Analysis

Strength:	Weakness
• Availability of water round the year due to Tidal reach (0-30 km) • Existing riverfront in Ahmedabad with depth of 2-2.5 m (w.r.t. River Bed) round the year and having tourism and recreational facilities. • Dahej Port is located at the Outfall of Sabarmati River.	• Availability of water is due to the release of water from Narmada Canal to Sabarmati River
Opportunities	**Threats**
• Possibility of Tourism, recreational and local ferry services • There is Possibility for the movement of Flyash, Rock phosphate, cement and Fertilizers through the Sabarmati River.	• No Law and order ans social problems have been faced during reconnaissance survey.

वाप्कोस लिमिटेड
WAPCOS LIMITED
(भारत सरकार का उपक्रम)
जल संसाधन, नदी विकास व गंगा संरक्षण मंत्रालय
(A Government of India Undertaking)
Ministry of Water Resources, River Development & Ganga Rejuvenation

NO: WAP/P&H/04 NW-IWAI/CWC/2016/05- 01 Date: 02.05.2016

To,
The Chief Engineer
Narmada & Tapi Basin Organization
Central Water Commission,
101, Narmada Tapi Bhavan, 1st Floor, Sector-10A,
Gandhinagar-382010
Phone:079-23245427
centbo-cwc@nic.in

Sub: Requirement of Gauge/Discharge Data and other hydrological data for Preparation of Two Stage DPR of Proposed 04 Inland Waterways (Mahi, Sabarmati, Tapi, Narmada) in the State of Gujarat & Maharashtra.

Sir,

Ministry of Shipping (MoS), Govt. of India had directed IWAI to identify the viable waterways In India for their phased development; accordingly, 106 new waterways were identified and intimated to MoS. These rivers are in the process of being declared as National Waterway and a bill to this effect has already been passed in the lok Sabha during this winter season. Inland Waterways Authority of India (IWAI) a statutory body under the Ministry of Shipping, Govt. of India has been entrusted with the responsibility for conducting preparation of Detailed Project Report of the proposed waterway. In order to assess the latest hydro-morphological condition of the rivers, IWAI has awarded the work of preparation of Detailed Projcet Reports of below mentioned rivers to M/s WAPCOS Limited.

Sl. No.	Name of the River / Canal	Name of the River / Canal Description of Inland Waterway
1.	MAHI RIVER	248 kms length of the river from Kadana Dam at Lat 23°18'22.35"N, Long 73°49'37.45"E to confluence with Gulf of Khambhat near Kavi railway station at Lat 22°10'34.71"N, Long 72°30'36.31"E
2.	NARMADA RIVER	227 km length of the river from Pandhariya at Lat 21°57'10.37"N, Lon 74° 8'27.46"E to confluence of Narmada with Arabian Sea at Gulf of Khambhat Lat 21°38'26.81"N, Lon 72°33'28.24"E
3.	SABARMATI RIVER	212 kms length of the river from Barrage near Sadoliya at Lat 23°26'49.66"N, Long 72°48'34.85"E to confluence with Gulf of Khambhat near Khambhat at Lat 22°9'17.99"N,

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		Long 72°27'27.81"E
4.	TAPI RIVER	436 kms length of the river from Hatnur Dam near Mangalwadi at Lat 21° 4'21.99"N,Long 75°56'44.88"E to confluence with Gulf of Khambhat (Arabian Sea) at Lat 21°2'15.51"N, Long 72°39'29.63"E

M/s WAPCOS LIMITED is a "MINI RATNA-Category I" Public Sector Enterprise under the aegis of the Union Ministry of Water Resources, River Development & Ganga Rejuvenation has appointed M/s Fugro Survey (India) Pvt. Ltd., Fugro House, D-222/30, ITC. Indl Area, MIDC, Nerul, Navi Mumbai - 400706, Maharashtra as their survey agency for carrying out field work and data collection .

The following data is required to carry out the studiies:

1) Water Level, Discharge, Sediment, cross-section data, Salient features (Ponding Level HFL, Sill levels etc) at **Guage locations**

--- List of Guage stations attached as **Annex.1**

2) Details/ Salient features of **Dams/Weirs and Barrages** (Year of construction, capacity, ponding level, H.F.L., sill levels, Guage Discharge data, hydrological features etc.)

---- Dams/Weirs and Barrages attached as **Annex.2**

It is therefore requested to kindly provide the requisite data to M/s Fugro Survey (India) Pvt. Ltd. on behalf of WAPCOS.

An early action will be highly appreciated.

Thanking you and with best regards,

(Jatinder Kumar)
Chief (Civil)
(Ports & Harbours)
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(भारत सरकार का उपक्रम/A Govt. of India Undertaking)
76–सी, सैक्टर–18, गुड़गाँव–122015 (हरियाणा)
76-C, Sector-18, Gurgaon-122015 (Haryana)

Annexue-1

(a) Guage locations and data requirement

River	CWC GD Sites	Data requirement Period				Type of Data
		Water Level	Discharge	Sediment	Cross-section	
Mahi	Kadana Dam	2011- 2016	Last 30 Years	Last 30 Years	Last 30 Years	Guage, Discharge, Sediment, Water quality, Cross-section and Salient Features (Ponding level, HFL, Sill levels etc)
	Khanpur	2013- 2016	2013-2016	2013-2016	Last 30 Years	-do-
	Panam Dam	Last 30 Years	Last 30 Years	Last 30 Years	Last 30 Years	-do-
	Wanakbori	2011- 2016	Last 30 Years	Last 30 Years	Last 30 Years	-do-
Narmada	Bharuch	Last 30 Years	Last 30 Years	Last 30 Years	Last 30 Years	-do-
	Chandawad	2013- 2016	2013-2016	2013-2016	Last 30 Years	-do-
	Garudeshwar	2013- 2016	2013-2016	2013-2016	Last 30 Years	-do-
Tapi	Bhusawal	2012- 2016	Last 30 Years	Last 30 Years	Last 30 Years	-do-
	Ghala	2012- 2016	2005-2016	Last 30 Years	Last 30 Years	-do-
	Gidhade	2012- 2016	2012-2016	Last 30 Years	Last 30 Years	-do-
	Hathnur Dam	2012- 2016	Last 30 Years	Last 30 Years	Last 30 Years	-do-
	Kakrapar	2004- 2016	Last 30 Years	Last 30 Years	Last 30 Years	-do-
	Sarangkheda	2013- 2016	2013-2016	2013-2016	Last 30 Years	-do-
	Savkheda	2012- 2016	2004-2016	2004-2016	Last 30 Years	-do-
	Surat	2011- 2016	Last 30 Years	Last 30 Years	Last 30 Years	-do-
	Ukai dam	2011- 2016	Last 30 Years	Last 30 Years	Last 30 Years	-do-
Sabarmati	Kheda	2013- 2016	2013-2016	Last 30 Years	Last 30 Years	-do-
	Subhash Bridge	2010- 2016	Last 30 Years	Last 30 Years	Last 30 Years	
	Vautha	2013- 2016	2013-2016	Last 30 Years	Last 30 Years	

Annexue-2

(a) Dams/Weirs/Barrages locations for data requirement

Sl. No.	Name	Location (Lat. Long)
Tapi River		
1	Causeway cum Weir, Sultaniya Rander Surat, Gujarat 395005	21°13'09"N 72°48'17"E
2	Weir/Barrage (+Offtake Canal), Vill.-Kakrapar, Tal.-Mandvi, Dist.-Surat, Gujarat-394160	21°16'09"N 73°21'53"E
3	Ukai Dam, Tal.-songadh, Dist.-Surat, Gujarat-394680	21°15'02"N, 73°35'29"E
4	Prakasha Barrage Dam,Praksha, Dist-Nandurbar, Maharashtra	21°30'40"N 74°20'43"E
5	Sarangkheda Barrage, Shahada, Dist-Nandurbar, Maharashtra	21°25'37"N 74°31'55"E
6	Sulwade Barrage,Sindhkheda, Dist-Dhule, Maharashtra	21°18'12"N 74°48'07"E
7	Lower Tapi Dam (or Padalse Dam)near Amalner,Dist-Dhule, Maharashtra	21°11'18"N 75°00'02"E
8	Hathnur Dam near Bhusawal,Dist-Jalgaon, Maharashtra	21° 4'21.99"N 75°56'44.88"E
Narmada River		
1	Sardar Sarover Dam Navagam, Gujarat- 393155	21°49'49"N 73°44'50"E
Mahi River		
1	Sindhrot Check Dam Mahi River,Village- Sindhrot, District-Vadodara Gujarat 391330	22°19'49.93"N 73°03'22.76"E
2	Aquaduct near village Sangol, District Kheda, Gujarat 388235	22°50'56.68"N 73°22'55.87"E
3	Wanakbori Dam, Kheda, Wanakbori, Gujarat 388235	22°56'52.98"N 73°25'41.79"E
4	Dam/Barrage near Tantroli village ,Mahisagar district,Gujarat	23°15'54.16"N 73°43'57.75"E
5	Kadana Dam Mahisagar district, Gujarat,-389240	23°18'22.35"N 73°49'37.45"E
Sabarmati River		
1	Wasna Barrage, Ahemdabad	22°59'22.93"N 72°33'22.78"E
2	Barrage near Sadoliya Village/hamlet in Prantij Taluka in Sabar Kantha District of Gujarat State, India.	23°26'49.66"N 72°48'34.85"E

Wasna Barrage B00580

Salient Features	
Name of the Structure	Wasna Barrage
Nearest city	Ahmadabad City
District	Ahmadabad
State	Gujarat
Name of River	Sabarmati
Basin	Sabarmati
Year of commencement	1971
Year of completion	1976
Mean annual rainfall (mm)	
Total annual yield of catchment (MCM)	
Design flood (Cumec)	21000
Width of the river (m)	610.67
Length of Barrage and Anicut (m)	610.67
Height upto crest (m)	20.75
No. of bays (i.e. number of openings)	24
Width of Bay (m)	18.29
Type of spillway gate	Others
Spillway gates - Number	30
Pond level (m)	41.77
Means for dissipating energy (Hydraulic)	energy breaking cone block

Date	Crest R.L. (M.)	F.R.L. (M)	H.F.L. (M)	Top of Dam R.L.(M)	Gross Capacity at F.R.L. (MCM)	Dead storage (MCM)	Live storage (MCM)	Lenth of Spillway (M)
18/07/1993	38.1	41.76	41.76	46.02	5.34	-	5.34	610.5

Salient Features of Wasna Barrage

Lakroda Weir W00933

Salient Features	
Name of the Structure	Lakroda Weir
Nearest city	Vijapur
District	Gandhinagar
State	Gujarat
Name of River	Sabarmati
Basin	Sabarmati
Mean annual rainfall (mm)	
Total annual yield of catchment (MCM)	
Type of spillway gate	Others
Status of BWA Construction	Underconstruction

Salient Features of Lakroda Weir