IIC TECHNOLOGIES™

Final Feasibility Report
National Waterway - 20,
Region VI - Bhavani River
Kaveri River Bridge to Bhavanisagar Dam (94.65 km)

SURVEY PERIOD: 14 Mar to 25 Apr 2016

Volume - I

Prepared for:

Inland Waterways Authority of India
(Ministry of Shipping, Govt. of India)
A-13, Sector – 1, NOIDA
Distt. Gautam Budh Nagar, Uttar Pradesh – 201 301

Document Distribution

Date	Revision	Distribution	Hard Copy	Soft Copy
30 Nov 2016	Rev – 0	**INLAND WATERWAYS AUTHORITY OF INDIA**	01	01
23 Jan 2017	Rev – 1.0	**INLAND WATERWAYS AUTHORITY OF INDIA**	01	01
27 Sep 2017	Rev – 1.1	**INLAND WATERWAYS AUTHORITY OF INDIA**	04	04
21 Dec 2017	Rev – 1.2	**INLAND WATERWAYS AUTHORITY OF INDIA**	01	01
22 Oct 2018	Rev – 1.3	**INLAND WATERWAYS AUTHORITY OF INDIA**	04	04

ACKNOWLEDGEMENT

IIC Technologies Ltd. expresses its sincere gratitude to IWAI for awarding the work of carrying out detailed hydrographic surveys in the New National Waterways in NW-20 in Region VI – Bhavani River from the confluence of Bhavani at Kaveri River to Bhavanisagar Dam.

We would like to use this opportunity to pen down our profound gratitude and appreciations to **Shri Pravir Pandey, IA&AS, Chairman IWAI** for spending his valuable time and guidance for completing this Project. IIC Technologies Ltd., would also like to thank, **Shri Alok Ranjan, ICAS, Member (Finance), Shri Shashi Bhushan Shukla, Member (Traffic), Shri S.K. Gangwar, Member (Technical)** for their valuable support during the execution of project.

IIC Technologies Ltd, wishes to express their gratitude to **Capt. Ashish Arya, Hydrographic Chief IWAI, Cdr. P.K. Srivastava ex-Hydrographic Chief and Shri SVK Reddy, Chief Engineer-I** for their guidance and inspiration for this project. IIC Technologies Ltd, would also like to thank **Sh. Rajiv Singhal, A.H.S., IWAI** for his invaluable support and suggestions provided throughout the survey period. IIC Technologies Ltd, is pleased to place on records its sincere thanks to other staff and officers of IWAI for their excellent support and cooperation throughout the survey period.

CONTENTS

List of Abbreviations

CD	Chart Datum
DGPS	Differential Global Positioning Systems
ETS	Electronic Total Station
GPS	Global Positioning Systems
BAV	Bhavani
LBM	Local Bench Mark
MSL	Mean Sea Level
RL	Reference Level
SD	Sounding Datum
SBAS	Satellite-Based Augmentation System
TBC	Trimble Business Center
FRP	Fiber Reinforced Plastic
PIA	Project Influence Area
CWC	Central Water Commission
NH	National Highway

SH	State Highway

SALIENT FEATURES AT A GLANCE

<table>
<tr><th>#</th><th>Particulars</th><th>Details</th></tr>
<tr><td>1.</td><td>Name of Consultant</td><td>IIC Technologies Limited, Hyderabad</td></tr>
<tr><td>2.</td><td>Region number & State(s)</td><td>Region – VI & Tamilnadu</td></tr>
<tr><td>3.</td><td>Waterway stretch, NW #
(from…. to; total length)</td><td>National Waterway No – 20
Kaveri River Bridge to Bhavanisagar Dam (94.65 km)</td></tr>
<tr><td>4.</td><td>Navigability Status</td><td>At present, the survey stretch of Bhavani River is non-navigable.</td></tr>
<tr><td>a)</td><td>Tidal & non tidal portions
(from… to, length, average tidal variation)</td><td>Bhavani River is Non-Tidal river</td></tr>
<tr><td>b)</td><td>LAD status (w.r.t. CD)
i) Survey period (.. to ..)
ii) < 1.2 m (km)
iii) 1.2 m to 1.4 m (km)
iv) 1.5 m to 1.7 m (km)
v) 1.8 m to 2.0 m (km)
vi) > 2.0 m (km)</td><td>
<table>
<tr><th>LAD (m)</th><th>0-29.23 (km)</th><th>29.23-61.8 (km)</th><th>61.8-94.65 (km)</th><th>Total</th></tr>
<tr><td>< 1.2</td><td>5.20</td><td>0.23</td><td>5.42</td><td>10.85</td></tr>
<tr><td>1.2 - 1.4</td><td>15.65</td><td>31.36</td><td>12.40</td><td>59.41</td></tr>
<tr><td>1.5 - 1.7</td><td>2.29</td><td>0.18</td><td>4.47</td><td>6.94</td></tr>
<tr><td>1.8 - 2.0</td><td>3.42</td><td>0.40</td><td>5.96</td><td>9.78</td></tr>
<tr><td>> 2</td><td>2.67</td><td>0.40</td><td>4.60</td><td>7.67</td></tr>
<tr><td>Total</td><td>29.23</td><td>32.57</td><td>32.85</td><td>94.65</td></tr>
</table>
</td></tr>
<tr><td>c)</td><td>Cross structures
i) Dams, weirs, barrages etc (total number; with navigation locks or not)
ii) Bridges, Power cables etc. [total number; range of horizontal and vertical clearances]</td><td>Cross Structures:
(i) Dams – 1Nos, Anicut – 02Nos
(ii) Bridges – 15Nos
HC range 6.75 to 26.458m
VC range 3.3 to 7.685m w.r.t HFL
(iii) Power Cables - 5Nos
Vertical Clearance range 12 to 33m w.r.t HFL
(iv) Telephone Line (wire) - 01Nos
Vertical Clearance = 7m w.r.t HFL
(v) High Tension Lines - 08Nos
Vertical Clearance range 21.37 to 42m w.r.t HFL</td></tr>
<tr><td>d)</td><td>Avg. discharge & no. of days</td><td>Discharge data not available from authorities.</td></tr>
</table>

<table>
<tr><th>#</th><th>Particulars</th><th>Details</th></tr>
<tr><td>e)</td><td>Slope (1 in ….)</td><td>
<table>
<tr><th colspan="2">Chainage (km)</th><th rowspan="2">Slope (A/B)</th></tr>
<tr><th>From</th><th>To</th></tr>
<tr><td>0.00</td><td>29.23</td><td>1 : 0.665</td></tr>
<tr><td>29.23</td><td>61.82</td><td>1 : 1.209</td></tr>
<tr><td>61.82</td><td>94.65</td><td>1 : 0.884</td></tr>
</table>
Average slope of Bhavani River is 1:0.928
</td></tr>
<tr><td>5.</td><td>Traffic potential</td><td>Non Navigable at present condition</td></tr>
<tr><td>a)</td><td>Present IWT operations, ferry services, tourism, cargo, if any</td><td>No IWT operations had been found. Local Ferry Service by small country boats or Parasals for passenger and Tourism.</td></tr>
<tr><td>b)</td><td>Important industries within 50 km</td><td>(a) Bhannari Amman Sugar Factory, Alathukombai, Satyamangalam,
(b) Shakti Sugars Limited, Apakudal
(c) Papers and Boards Pvt. Ltd. Ikkarai Thathapalli.</td></tr>
<tr><td>c)</td><td>Distance of Rail & Road from Industry</td><td>Well connected by road and railway networks</td></tr>
<tr><td>6.</td><td>Consultant’s recommendation for going ahead with TEF / DPR preparation</td><td>A major capital dredging for improvement of depth and channel design will be required to make the part of the Bhavani River as navigable.
The design of the waterway cannot be altered to a major extent as this is used mainly for irrigation purpose and drinking water supply. The Anicuts present in the river stretch is used for irrigation purpose, and the water through the side way canals are used at large extent for cultivation, thus detailed study on the impact of any change in the channel design needs to be carried out for the entire stretch of Bhavani River.</td></tr>
<tr><td>7.</td><td>Any other information/ comment</td><td>Rocky outcrops found along most part of the river stretch.</td></tr>
</table>

(Signature)

Date: Name of Consultant

1 Introduction

1.1 Background

Bhavani River is a perennial river originates from the Eastern slope of Nilagiri Hills. The survey stretch flows eastward through Coimbatore and Erode district of Tamilnadu. The Bhavani River, as a tributary contributes to enhance the water level of the Kaveri River. To assess the feasibility of water transportation, over this stretch of river a bathymetric survey and topographic survey were carried out by IIC Technologies Ltd. on behalf of IWAI.

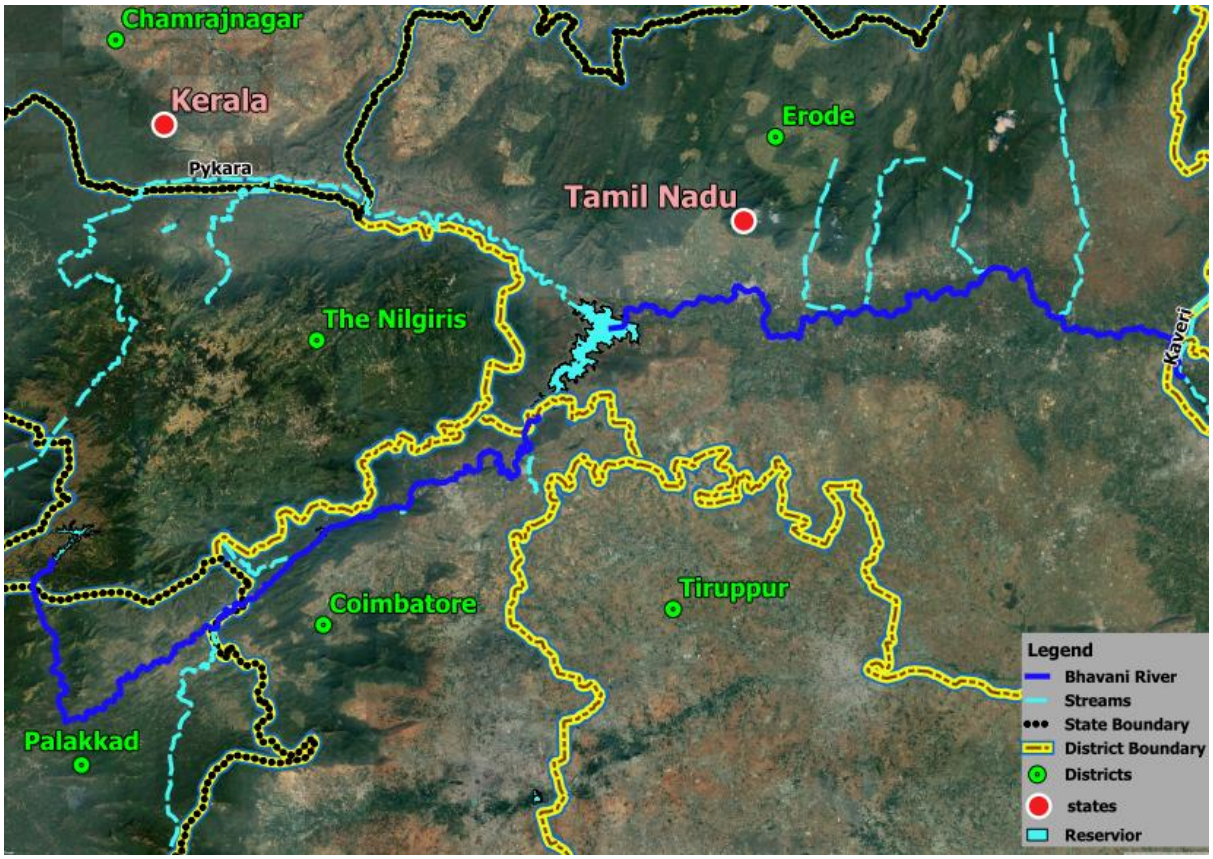


Figure 1 - Locations around the Survey Stretch

1.2 Tributaries of Bhavani River

The major tributaries of Bhavani River are Moyar, Siruvani and Kodungarapallam River, however there are no tributaries confluence on survey stretch for Bhavani River.

1.3 State/District through which river passes

The survey stretch of Bhavani River runs through the Erode district of Tamilnadu State.

State	Chainage (km)		Length (km)
	From	To	

Tamilnadu	0.0	94.65	94.65

Table 1 - State wise waterway

1.4 Map

1.4.1 Full Course of the Waterway

The map displaying the state boundary with road and rail network for the course of water way is represented as below:-

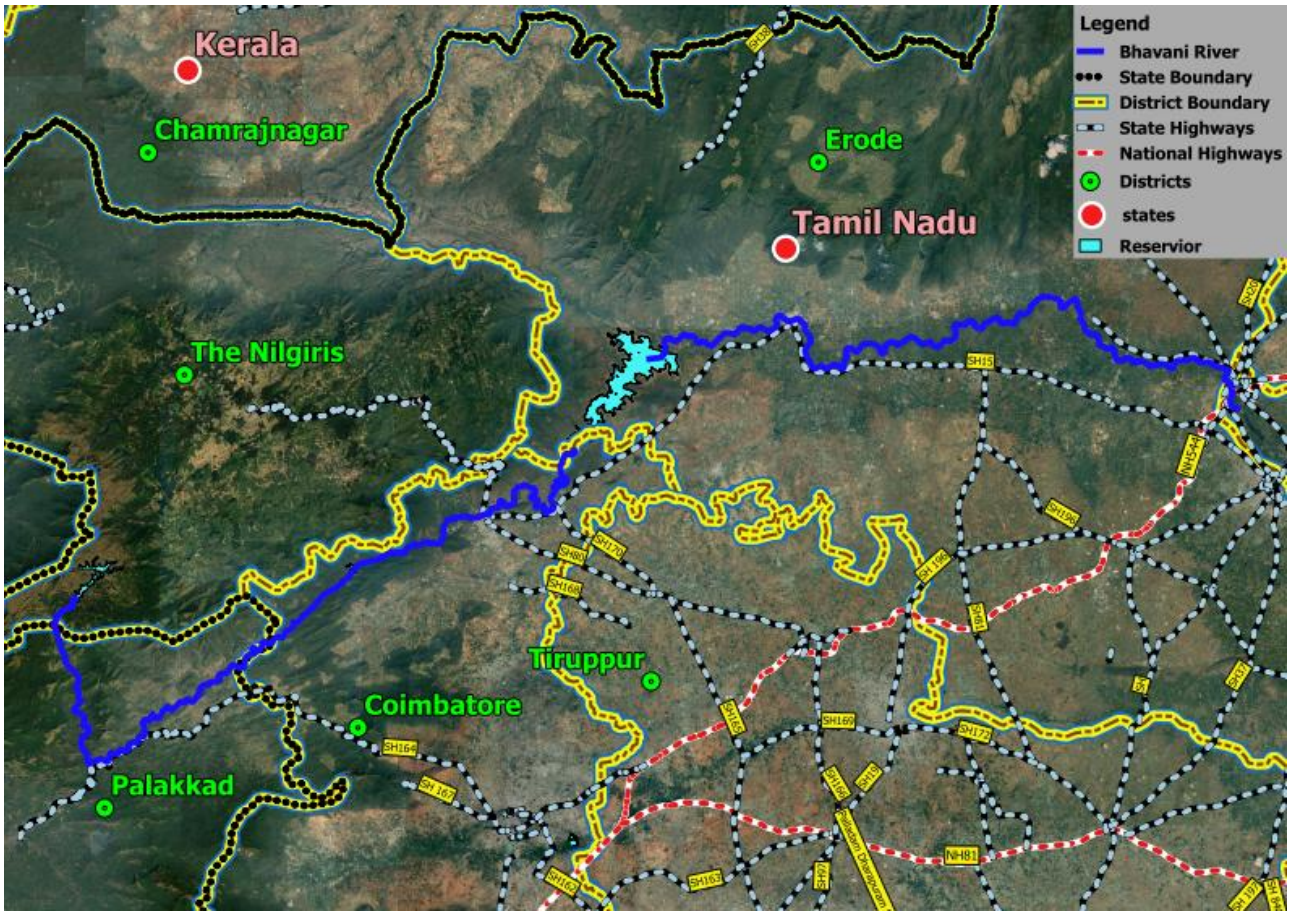


Figure 2 - Full Course of Bhavani River

1.4.2 Course of the Waterway under Study

The map displaying the state boundary with road and rail network for the course of water way is represented as below:-

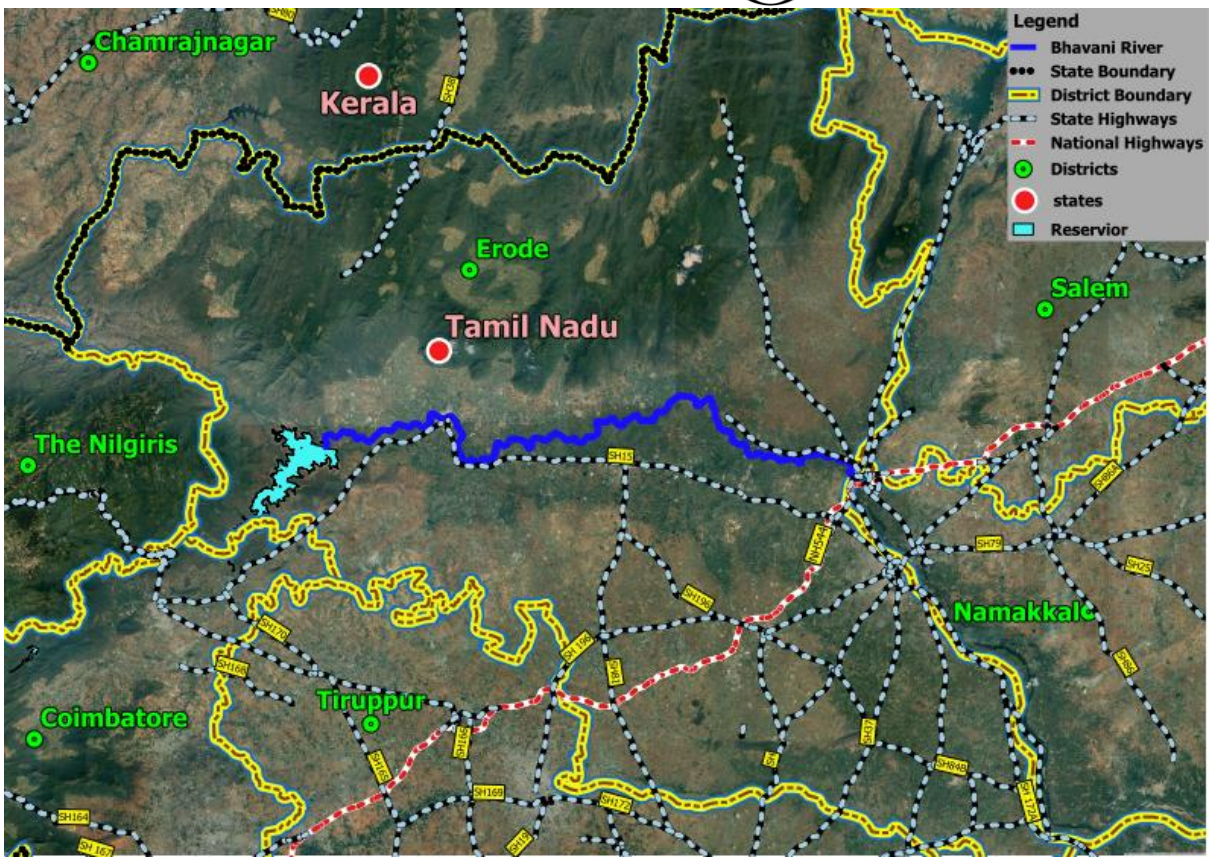


Figure 3 - Course of Waterway under Study

1.5 Scope of Work

IIC Technologies Ltd. conducted detailed hydrographic and topographic survey in the Bhavani River of 94.65 kms length from confluence of Bhavani & Kaveri Rivers at Kaveri River Bridge on Salem-Coimbatore Highway: NH-47 at Lat 11°25'54.41"N, Long 77°41'1.92"E to Bhavanisagar Dam, Sathyamangalam at Lat 11°28'16.21"N, Long 77°06'49.11"E.

The scope of the work for the conduct of the survey of the Bhavani River includes:

a. Undertake bathymetric and topographic survey of proposed waterway.
b. Establishing horizontal and vertical control stations
c. Construction of benchmark pillars and establishing its reduced level w.r.to MSL
d. Setting up and deployment of water level gauges
e. Current velocity and discharge measurements
f. Collection and analysis of water and bottom samples.
g. A collection of topographic features including existing cross structures.
h. Preparation of inventory of industries in the project influence area (PIA)
i. Analysis of survey data, including assessment of water availability for navigation.
j. Preparation of survey charts and feasibility report

2 Methodology Adopted to Undertake Study

2.1 Recce

Advance reece of the survey area was undertaken on 06 March 2016. Recce commenced from Bhavani Town and proceeded through upstream of the Bhavani River up to Bhavanisagar Dam. On primary observation, moderate amount of water is available throughout the area with many rock obstructions and the flow in the water also indicates the presence of continuous gradient on the river bed.

No boats are available for hire in the local area for the conduct of bathymetric survey. The small "Parasals" (Locally made circular floating object for transfer of person and material) are available in the area but these are not suitable for digital data collection. Presence of rocky outcrops is a possible threat to conducting safe sounding operations. Care and precaution needs to be taken for possible grounding or collision with a rock during sounding operation of survey boat.

Thick vegetation exists in many locations on either bank makes it difficult for taking spot leveling. The non-availability of continuous road access to the middle chainage of Bhavani River hampers the speed of the survey.

2.1.1 Survey Resources and Methodology

The survey was commenced on 14 March 2016 and completed on 25 Apr 2016. The survey was undertaken on a scale of 1:2000, with sounding line spacing kept at 100 m and plotted on UTM Projection at Zone 43N as directed in the contract specifications.

2.1.2 Survey Launch

The bathymetric survey was conducted by using IIC Survey Boat RS-01. The RS-01 is a shallow draft boat (small FRP boat fitted with OBM) suitable for shallow depth surveys. The maximum possible stretch of the Bhavani River was covered by bathymetric survey using single beam echo-sounder.

Figure 4 - Survey Boat, IIC RS-01

2.1.3 Survey Equipment

Following equipment were employed for the bathymetric and topographic survey.

Equipment	Make	Eqpt. Serial No.	Qty. Employed
Echosounder	ELAC Hydrostar Digital Echosounder	308	1
Current Meter	Valeport801	-	1
Tide Gauge	Manual (Pole type)	-	3
Grab Sampler	Vanveen	-	1
Water sampler	Niskin Water Sampler	-	1
DGPS	Trimble DSM212L Differential GPS	0220294574	1
GPS Sets	Trimble R3/R4	-	06
Auto Level	Sokkia Auto level & Accessories	120775, 120595	02
ETS	Trimble M3	-	01
E/S Calibration	Bar Check	-	1
Software	HYPACK Survey	Version 15	1
Software	AUTOCAD	2012	1
Software	Microsoft Office	2013	1
Software	Trimble Business Center	Version – 12	1

Table 2 - Survey Equipment Used

2.1.4 Topographic Survey

The survey was commenced on 14 March 2016 and completed on 25 April 2016.The weather was sunny throughout the survey operations. The weather was very favorable for boat operations and various topographic surveys, which includes lot of man efforts. The weather condition remains same for the entire duration of the survey.

The survey was undertaken as per the line plan provided and the spot level points in the cross line were spaced at 20m interval. The plotting of the chart was done on UTM Projection at Zone 43N as directed in the contract specifications. The spot levels along the river were obtained by using Trimble DGPS. The data was post processed using Trimble Business Center to get the precise position and MSL height values of the rover locations. The topographic survey was conducted to collect the following data:-

- Spot levels
- Delineation of Islands
- Fixing of bridges and marks
- Assess the type of river bank
- Extending the vertical and horizontal control throughout the survey area
- Collection of local information along the river Banks

Figure 5 - Spot Leveling and River Bank of Bhavani River (89.5 km chainage)

2.1.5 Bathymetric Survey

ELAC Hydrostar was used to obtain soundings on-board the survey boat. The working frequency of 210 KHz was used for sounding operations. The digital output from the echo sounder was automatically fed to the HYPACK data logging software on a real time basis for acquisition of survey data. No breakdown of equipment was reported and the performance of the equipment was found to be satisfactory during the entire duration of the survey.

The sound velocity was set to 1500 m/s on single beam echo sounder during acquisition. The sounding lines were run using a survey boat to identify the Thalweg line of the Bhavani River for the possible stretch. The cross lines were run perpendicular to the orientation of river flow (i.e. perpendicular to the orientation of depth contours) in respective stretches. To check the validity of sounding data logged, the cross line and Thalweg lines were run as perpendicular as possible. The spot sounding was also carried out in the area where the survey boat cannot be operated due to low depth.

Figure 6 - Boat Sounding

2.1.6 Calibration

The equipment used for the survey was calibrated by the equipment supplier. The equipment calibration certificates are placed at Annexure - 14 to this report. The daily calibration of echo sounder was carried out prior to the sounding operation and on completion of sounding operation for the day. Being very shallow depths, the echo sounder depths were also cross-checked in between by using demarcated sounding poles during the conduct of the survey.

2.2 Description of Benchmarks (BM) and Reference Level

The details of CWC MTBM at Savanadapur Gauge station were obtained from the CWC office, Coimbatore. The details are as tabulated below:-

Sl. No.	Station	Latitude	Longitude	Chainage
01	CWC site, Savanadapur	11°31'21.19"N	77°30'23.58"E	29.998km
The Details of CWC Site at Savanadapur:-				
(a)	Zero of Tide gauge	179.000 m	Source:- Executive Engineer, Central Water Commission, Southern Rivers Division, Coimbatore	
(b)	Value of MTBM (RBS)	188.150 m		
(c)	Highest Flood Level	190.270 m (05-11-1978)		
(d)	Minimum Water Level observed so far	180.210 m (16-08-2003)		

Table 3 - Reference Level Value of MTBM at CWC Site, Savanadapur

This reference value was used as the initial reference for vertical control and the Reference Level value of the same was transferred to station BAV-01 through Auto Level (optical leveling method). The leveling data for establishing the reference Level for the newly Established stations are placed at Annexure – 10 to this report. The final accepted WGS 84 coordinates and details of stations established for setting up of the daily reference station during the conduct of the survey are as follows:-

Sl. No.	Station	Chainage (km)	Latitude	Longitude	Ht. above MSL (m)	Source/ Type
01	BAV_01	91.489	11°28'58.2186"N	77°07'37.2328"E	241.948	Online Processing
02	BAV_02	81.452	11°29'38.0837"N	77°11'57.5241"E	238.497	Baseline Processing
03	BAV_03	64.315	11°27'21.8693"N	77°17'20.0687"E	220.056	

Table 4 - Accepted Station Co-ordinates (WGS-84)

Figure 7 - MTBM at CWC Site Savanadapur (29.9 km chainage)

2.3 Tidal influence Zone and Tidal Variation

Bhavani River is non-tidal river and the survey stretch start from the confluence of Kaveri River to Downstream of Bhavanisagar Dam. The water level in the river is found to be stable throughout the survey period. This stability in the water level is observed due to the controlled charging of the river from Bhavanisagar Dam. There are no major inlets and out-let streams in between the survey stretch of the river.

2.3.1 Methodology to fix Chart Datum / Sounding Datum

The total stretch of Bhavani River is 94.65 km and the Savanadapur CWC Tide Gauge is located on the 29.9 km Chainage of Bhavani River. Due to the Topographic condition the Bhavani River does not follow even slope throughout the river stretch. To fix the chart Datum/Sounding Datum the slope of the river is calculated by erecting tide pole for water level reading at intermediate locations. The locations for the slope

calculation were chosen such a way that major variations in the slope behavior of the river are covered adequately. The slope calculation is carried out by the Optical leveling method and the height difference in the survey stretch of Bhavani River is found to be 91mtrs.The difference between water level and Chart Datum at Savanadapur CWC Tide Gauge was transferred to the other tide gauges for establishing a realistic Sounding Datum. The 31.5 km to 61.8 km Chainage and area downstream of Kalingarayan Anicut was covered by topographic method due to non-availability of sufficient water level and the Least MSL value for every km is considered as the datum.

2.3.2 Sounding Datum

The average minimum water level of last six years (2009-2014) for the CWC gauge located at Savanadapur is provided by IWAI as 180.742m from MSL and the Savanadapur CWC Tide Gauge falls on the 29.9 km chainage of the Bhavani River. The average minimum water level value of 180.742m is accepted as the chart datum value for the stretch and there are no other source of CD value is available in the survey stretch of Bhavani River. The CD value obtained from Savanadapur CWC Tide Gauge was transferred to other chainages for computing the CD values of the entire survey stretch.

2.4 Average of 06 years minimum Water Levels to arrive at Chart Datum (CD)

The yearly minimum and maximum water level values at the CWC tide gauge at Savanadapur for the last six years are as below:-

Years		2009	2010	2011	2012	2013	2014
Month	**Min/Max**	**Gauge**	**Gauge**	**Gauge**	**Gauge**	**Gauge**	**Gauge**
Jan	min	180.900	181.290	180.920	181.010		180.780
	max	181.120	181.650	181.160	181.250		181.120
Feb	min	180.800	181.290	181.070	180.870		180.680
	max	181.420	181.540	181.160	181.140		181.020
Mar	min	180.790	181.270	181.015	181.060		180.700
	max	182.050	181.550	181.140	181.180		180.950
Apr	min	181.040	180.800	180.820	181.060		180.700
	max	181.290	181.290	181.400	181.270		180.840
May	min	180.790	180.820	180.830	180.720		180.700
	max	181.800	181.430	181.290	181.070		180.930
Jun	min	180.910	180.945	180.980		180.670	
	max	181.130	181.700	181.220		180.870	
Jul	min	181.020	180.990	180.940		180.650	
	max	181.220	181.480	181.140		181.020	
Aug	min	180.870	180.900	180.810		180.950	
	max	181.440	181.365	181.200		181.670	
Sep	min	180.950	180.885	180.900		180.875	
	max	181.710	181.340	181.330		181.450	

Years		2009	2010	2011	2012	2013	2014
Month	**Min/Max**	**Gauge**	**Gauge**	**Gauge**	**Gauge**	**Gauge**	**Gauge**
Oct	min	181.200	180.960	181.050		180.900	
	max	182.800	183.070	181.470		181.920	
Nov	min	181.300	180.960	181.000		180.780	
	max	182.100	183.375	182.600		181.270	
Dec	min	181.470	181.030	180.960		180.930	
	max	181.550	181.430	181.520		181.180	
Years		**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Average	min	180.790	180.800	180.810	180.720	180.650	180.680
	max	182.800	183.375	182.600	181.270	181.920	181.120
	Chart Datum	**180.742**					

Table 5 - Yearly Minimum and Maximum Water Level – CWC Savanadapur

2.5 Transfer of Sounding Datum

The chart datum for the CWC tide gauge at the Savanadapur site at 29.998 km chainage of Bhavani River is accepted as 180.742 m above MSL. During on field observation, the water level in Bhavani River is found to be same for the duration of the survey. The water level detail on the Bhavani River was discussed with the Asst. Engineers of CWC Savanadapur, Bhavanisagar Dam and Kalingarayan Anicut. The water level on the survey stretch is confirmed to be the same due to the controlled charging of the Bhavani River from Bhavanisagar Dam.

The difference between the MSL value of water level and the Chart Datum at 29.9 km Chainage is computed as 0.138 m. This difference from the water level and Chart Datum is distributed for the stretches from 0 to 31.5 km chainage (Starting chainage to upstream extent of Kalingarayan Anicut) and 61.8 km to 94.65 km chainage (Upstream of Kodiveri Anicut to Downstream of Bhavanisagar Dam).

Steep gradient in river slope is observed for the stretches between 31.5 km to 61.8 km and sufficient water level is not available for the conduct of hydrographic survey by operating survey boat. The stretches between 31.5 km to 61.8 km were covered by topographic survey method and the datum is calculated from the least bed level value w.r.t. MSL, obtained for the 01 km stretch of the river.

2.6 Table indicating Tidal Variation at Different Observation Points

The Bhavani River is non-tidal river and no variation in the water level was found during the conduct of the survey.

2.7 Salient Features of Dam, Barrages etc.

The details of Dam and barrages are as follows:-

Salient Features of Bhavanisagar Reservoir				
Attribute	**Value**		**Attribute**	**Value**

Name of Reservoir	Bhavanisagar Reservoir		Status	Operational
State	Tamil Nadu		Basin	Cauvery
River	Bhavani			
Maximum Water Level (m)	280.42		Live Storage Capacity (MCM)	908
Full Reservoir Level (m)	280.42		Dead Storage Capacity (MCM)	-
Minimum Draw Down Level(m)	256.03		Submergence Area (Th.Ha.)	7.822
Gross Storage Capacity (MCM)	929		Catchment Area (Sq. km.)	4200
Towns and Villages Affected	6		Number of Families Affected -	1045
Salient Features of Lower Bhavani Dam				
Attribute	**Value**		**Attribute**	**Value**
Name of the Dam	Lower Bhavani Dam		Dam Status	Operational
River	Bhavani		Purpose	Hydroelectric, Irrigation
Nearest City	Sathyamangalam		Commencement Year	-
District	Erode		Completion Year	1955
State	Tamil Nadu		Operating and Maintenance Agency	WRD-TN
Basin Name	Cauvery		Seismic Zone	Seismic Zone-II
Dam Type	Earthen / Masonry		Max Height above Foundation(m)	62
Length of Dam (m)	8797		Total Volume content of Dam (TCM)	4960
Type of Spillway	OG		Type of Spillway Gates	VL
Length of Spillway (m)	121		Number of Spillway Gates	9
Crest Level of Spillway	274.32		Size of Spillway Gates (m X m)	10.97 x 6.10
Spillway Capacity (cumec)	3455		Design Flood (cumec)	3455

Table 6 - Salient Feature of Bhavanisagar Dam

Salient Features of Kalingarayan Anicut				
Name of the Structure	Kalingarayan Anicut		Design flood (Cumec)	3590
District	Erode		Width of the river (m)	903
State	Tamil Nadu		Length of Barrage and Anicut(m)	902.5
Basin	Cauvery		Height up to crest (m)	1
Name of River	Bhavani		No. of bays	3
Year of commencement	1869		Type of spillway gate	Other
Year of completion	1879		Spillway gates - Number	3

Under sluice bay -	1		Crest Level (ft)	541.15

Table 7 - Salient Feature of Kalingarayan Anicut

Salient Features of Kodiveri Anicut				
Name of the Structure	Kodiveri Anicut		No. of bays (i.e. number of openings)	1
District	Erode		Width of Bay (m)	10
State	Tamil Nadu		Type of spillway gate	Other
Basin	Cauvery		Spillway gates – Number	1
Name of River	Bhavani		Crest Level (m)	220
Width of the river (m)	185		Gates for under sluice - Number	1
Length of Barrage and Anicut (m)	121.2		Status of BWA Construction	Completed

Table 8 - Salient Feature of Kodiveri Anicut

Kodiveri Anicut (61.75 km chainage)

Canal of Kalingarayan Anicut (1.61 km chainage)

2.8 Erected IWAI Benchmark Pillars

New Bench Mark Pillars (IWAI-BM-Pillars) were constructed (10 no's) as per specification and erected at different intervals between the start and end chainage of the river. The value of these benchmarks w.r.t. MSL was obtained by leveling them to the local bench mark established earlier. The description of all benchmarks are placed at Annexure - 10 to this report. The final accepted co-ordinates and reduced level (R.L) values of these Bench Marks are as below:-

Sl. No.	Station Name	Chainage (km)	Position		Ellipsoidal Height (m)	Height above MSL (m)	SD w.r.t. MSL (m)	Height above SD (m)
			Latitude (N) Longitude (E)	Easting Northing				
1	IWAI_BM_BAN_01	1.424	N11°26'27.62155" E77°40'39.52818"	792171.639 1268762.196	67.895	160.292	157.067	3.225
2	IWAI_BM_BAN_02	7.226	N11°27'55.35811" E77°38'42.83330"	788607.553 1274342.114	73.858	166.800	164.016	2.784
3	IWAI_BM_BAN_03	17.534	N11°27'51.26968"	780078.468	85.317	175.473	169.493	5.980

			E77°34'01.54971"	1268559.322				
4	IWAI_BM_BAN_04	29.099	N11°31'01.16966" E77°30'35.03777"	773765.095 1274342.114	87.366	183.356	180.720	2.636
5	IWAI_BM_BAN_05	39.306	N11°30'11.64231" E77°26'32.46116"	766423.706 1272756.101	101.758	193.267	188.176	5.091
6	IWAI_BM_BAN_06	44.213	N11°29'49.51502" E77°24'30.87965"	762743.296 1272044.766	107.883	199.736	195.076	4.660
7	IWAI_BM_BAN_07	61.216	N11°28'36.90307" E77°17'57.80875"	750844.317 1269715.181	130.169	223.850	212.579	11.271
8	IWAI_BM_BAN_08	71.160	N11°28'54.05770" E77°15'37.33129"	746581.189 1270208.727	138.722	226.554	223.127	3.427
9	IWAI_BM_BAN_09	84.038	N11°29'22.35324" E77°10'46.52846"	737758.541 1271010.380	148.319	239.278	234.784	4.494
10	IWAI_BM_BAN_10	93.922	N11°28'35.86455" E77°06'50.77717"	730622.462 1269528.213	164.826	251.825	241.764	10.061

Table 9 - Accepted Coordinates (WGS-84) of Established IWAI BM Pillars

2.9 Chart Datum / Sounding Datum and Reductions details

The Tide Gauges were erected at intermediate points to find the actual behavior/ variation of water level for the entire stretch of the Bhavani River for the duration of sounding operations. The tide gauges remained vertical for the duration of the survey and no shift (vertical/ horizontal) was observed in the gauges during the observation period. The gauges were leveled to Temporary Bench Marks/ Bench Marks set up in the respective stretches. MSL heights of the BM/TBMs were used to obtain the value of zero of gauge w.r.t MSL.

Sl. No.	Bench Mark / Tide Gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation w.r.t. SD (m)
	A	B	C (50% stretch is to be selected on both side of tide gauge)	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
1	TIDE_01	94.3	93.0-94.65	241.764	241.764		
2	TIDE_02	91.5	89.3-93.0	240.727	240.727		
3	TIDE_04	87.6	87.5-89.3	238.859	238.859		
4	TIDE_05	85.7	85.7-87.5	235.388	235.388		
5	TIDE_06	85.2	83.7-85.7	234.784	234.784		
6	TIDE_07	81.5	79.6-83.7	231.921	231.921		
7	TIDE_08	76.9	76.5-79.6	228.464	228.464		
8	TIDE_09	74.5	74.5-76.5	225.197	225.197		
9	TIDE_10	74.3	73.7-74.5	224.740	224.740		
10	TIDE_11	73.6	73.5-73.7	224.508	224.508		
11	TIDE_12	73.5	72.2-73.5	224.290	224.290		
12	TIDE_13	71.2	68.2-72.2	223.127	223.127		
13	TIDE_14	67.6	66.9-68.2	220.788	220.788		
14	TIDE_15	66.0	64.6-66.9	220.537	220.537		

Sl. No.	Bench Mark / Tide Gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation w.r.t. SD (m)
	A	B	C (50% stretch is to be selected on both side of tide gauge)	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
15	TIDE_16	61.9	61.8-64.6	220.356	220.356	Details at Annexure - 4	Bhavani_Topo_Levels_Reduced_For_Dredging.xyz
16	-	-	60.5 - 61.8	212.579	212.579		
17	-	-	59.5 - 60.5	212.169	212.169		
18	-	-	58.5 - 59.5	210.602	210.602		
19	-	-	57.5 - 58.5	210.602	210.602		
20	-	-	56.5 - 57.5	210.602	210.602		
21	-	-	55.5 - 56.5	209.951	209.951		
22	-	-	54.5 - 55.5	208.341	208.341		
23	-	-	53.5 - 54.5	207.954	207.954		
24	-	-	52.5 - 53.5	207.354	207.354		
25	-	-	51.5 - 52.5	207.219	207.219		
26	-	-	50.5 - 51.5	202.64	202.64		
27	-	-	49.5 - 50.5	198.746	198.746		
28	-	-	48.5 - 49.5	197.75	197.75		
29	-	-	47.5 - 48.5	197.239	197.239		
30	-	-	46.5 - 47.5	196.346	196.346		
31	-	-	45.5 - 46.5	195.79	195.79		
32	-	-	44.5 - 45.5	195.252	195.252		
33	-	-	43.5 - 44.5	195.076	195.076		
34	-	-	42.5 - 43.5	194.776	194.776		
35	-	-	41.5 - 42.5	194.343	194.343		
36	-	-	40.5 - 41.5	192.753	192.753		
37	-	-	39.5 - 40.5	188.176	188.176		
38	-	-	38.5 - 39.5	188.176	188.176		
39	-	-	37.5 - 38.5	187.849	187.849		
40	-	-	36.5 - 37.5	187.849	187.849		
41	-	-	35.5 - 36.5	183.177	183.177		
42	-	-	34.5 - 35.5	182.777	182.777		
43	-	-	33.5 - 34.5	182.001	182.001		
44	-	-	32.5 - 33.5	182.07	182.07		
45	-	-	31.5 - 32.5	181.636	181.636		
46	TIDE_18A	30.0	29.2-31.5	180.742	180.742		
47	TIDE_19	30.0	28.8-29.2	180.720	180.720		
48	TIDE_20	29.0	27.7-28.8	180.190	180.190		
49	TIDE_21	27.0	26.7-27.7	178.346	178.346		
50	TIDE_22	26.1	25.6-26.7	176.791	176.791		
51	TIDE_23	24.9	24.3-25.6	176.772	176.772		
52	TIDE_24	24.0	22.3-24.3	173.962	173.962		
53	TIDE_25	20.4	20.2-22.3	171.049	171.049		
54	TIDE_26	20.1	19.4-20.2	170.542	170.542		
55	TIDE_27	18.7	18.0-19.4	169.843	169.843		
56	TIDE_28	17.6	17.4-18.0	169.493	169.493		
57	TIDE_29	17.2	15.5-17.4	168.046	168.046		

Sl. No.	Bench Mark / Tide Gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)	Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge w.r.t. MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data to be converted as depth for volume calculation w.r.t. SD (m)
	A	B	C (50% stretch is to be selected on both side of tide gauge)	D +ve indicates above MSL -ve indicates below MSL	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
58	TIDE_30	14.0	13.2-15.5	166.441	166.441		
59	TIDE_31	12.1	11.7-13.2	165.781	165.781		
60	TIDE_32	11.2	10.9-11.7	165.677	165.677		
61	TIDE_33	10.6	8.8-10.9	164.518	164.518		
62	TIDE_38	1.6	1.5-8.8	164.016	164.016		
63	-	-	1.2 - 1.5	157.067	157.067		
64	-	-	0 - 1.2	153.148	153.148		

Table 10 - CD /SD and Reductions

2.10 HFL/MHWS values of Bridges/Cross Structures

The details of established HFL values for the Bhavani River were obtained from the CWC Savanadapur site as 190.27m from the regional office. The HFL of Kalingarayan Anicut was obtained as 167.00m from the indication marking shown by PWD Assistant engineer. The details of HFL marking or record for Kodiveri Anicut was available with the PWD office, however with input from anicut staff the value of 224.90 m from MSL was derived by auto levelling and the same was used for computation of HFL. The HFL level at different cross structures were computed and the details for the entire stretches are as follows:-

Sl. No.	Location and Description of CWC gauge /Dam /Barrages /Weirs /Anicut /Locks /Aqueducts /BM	Cross-structure Details	Ch. (km)	Established HFL / MHWS / FSL / MWL / FRL w.r.t. MSL (m)	Computed HFL at Cross-Structures w.r.t. MSL (m)
1	Bhavani Town	Kaveri Main Bridge (NH47)	0.09	-	156.429
2	Bhavani Town	Bhavani Main Bridge	0.84	-	156.429
3	Bhavani Town	Kalingarayan Anicut	1.54	167.00	-
4	Thalavapettai	Thalavapettai Bridge	11.09	-	175.244
5	Perundalaiyur	Perundalaiyur Bridge	17.51	-	180.600
6	Keelavani	Keelavani Bridge	24.46	-	186.400
7	Savanadapur	Savanadapur Bridge	29.25	-	186.700
8	Savanadapur	Savanadapur CWC Site	29.90	190.27	-
9	Gobichettipalayam	Gobichettipalayam Bridge	39.33	-	198.900
10	Bungalowpudur	Bungalowpudur Bridge	44.14	-	203.000
11	Kodiveri	Kodiveri Bridge(u/s)	61.66	-	217.900
12	Kodiveri	Kodiveri Anicut(u/s)	61.81	224.90	-
13	Sathyamangalam Town	Sathyamangalam Bridge-1	74.43	-	233.800
14	Sathyamangalam Town	Sathyamangalam Bridge-2	74.44	-	233.800
15	Velliyampalayam	Velliyampalayam Bridge	87.50	-	243.300
16	Bhavanisagar	Bhavanisagar Bridge	94.33	-	248.000

Table 11 - HFL/MHWS values of Bridges/Cross Structures

2.11 Graph: Sounding Datum and HFL v/s Chainage

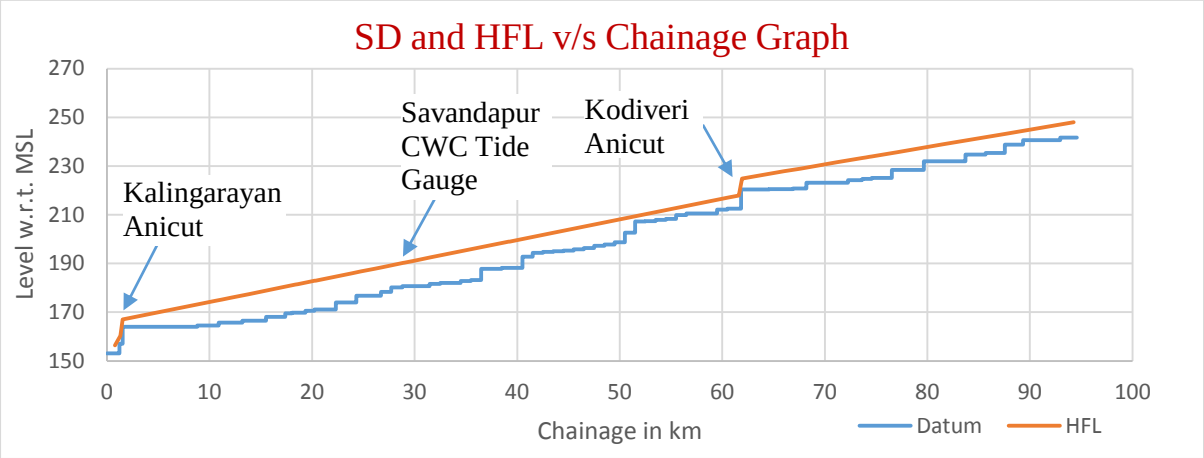


Figure 8 - SD and HFL v/s Chainage

2.12 Average Bed Slope

Reach and River-bed Level (RBL)		River-bed Level Change (m) (A)	Distance (km) (B)	Slope (A/B)
From	To			
Ch. 0 - RBL_163.148	Ch. 29.23 - RBL_182.572	19.424	29.23	1 : 0.665
Ch. 29.23 - RBL_182.572	Ch. 61.8 - RBL_221.986	39.414	32.59	1 : 1.209
Ch. 61.8 - RBL_221.986	Ch. 94.65 - RBL_250.873	28.887	32.68	1 : 0.884

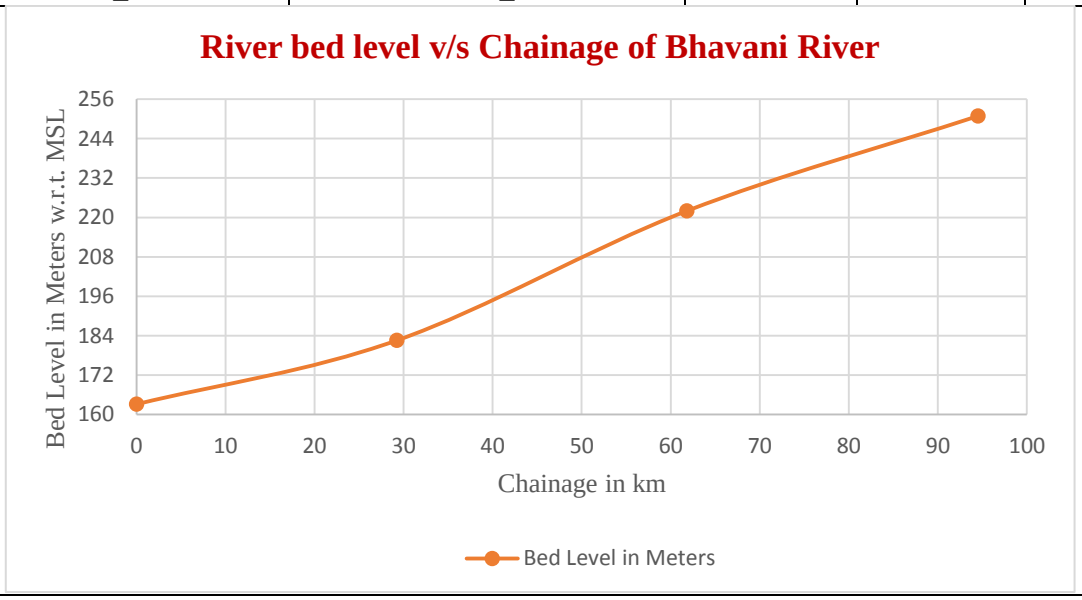


Table 12 - Average Bed Slope

2.13 Details of Dam, Barrages, Weirs, Anicut, etc

The details of Dams and Anicut present in the survey stretch of Bhavani River are as follows:-

Sl.	Structure	Ch.	Location	Position (Lat	Position	Leng th (m)	Width (m)	Ht.	Present

No.	Name	(km)		Long)	(UTM)			w.r.t MSL (m)	Condition
				Left Bank/Right Bank	Left Bank/Right Bank				
1	Kalingarayan Anicut	1.61	Bhavani	**Left Bank:** 11°26'31.38"N 77°40'34.41"E **Right Bank:** 11°26'36.08"N 77°40'37.77"E	**Left Bank:** 792015.332 1266211.459 **Right Bank:** 792115.901 1266356.911	902.5	5	164.3	Operational
2	Kodiveri Anicut	61.75	Kodiveri	**Left Bank:** 11°28'24.50"N 77°17'45.50"E **Right Bank:** 11°28'22.42"N 77°17'49.90"E	**Left Bank:** 750474.178 1269330.958 **Right Bank:** 750608.090 1269268.087	121.2	3	221.07	Operational
3	Bhavanisagar Dam	94.65	Bhavanisagar	**Left Bank:** 11°28'18.53"N 77°6'43.45"E **Right Bank:** 11°28'12.24"N 77°6'57.37"E	**Left Bank:** 730407.08 1268986.26 **Right Bank:** 730827.659 1268803.595	8797	50	274.3	Operational

Table 13 - Details of Dams, Anicuts

2.14 Details of Locks

There are no Locks present in the survey stretch of Bhavani River.

2.15 Details of Aqueducts

There are no Aqueducts present in the survey stretch of Bhavani River.

2.16 Details of existing Bridges and Crossings over Waterway

There exist 14 Bridges in the survey stretch of Bhavani River. The details of crossovers of Bhavani River are as tabulated below:-

Sl. No.	Structure Name	Ch. (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance w.r.t HFL (m)
				Right Bank Left Bank	Right Bank Left Bank					
1	Kaveri Main Bridge	0.00	Kaveri main Bridge	**Right Bank:** 11°25'51.76"N 77°41'16.06"E **Left Bank:** 11°25'54.51"N 77°40'52.61"E	**Right Bank:** 793290.83 1265005.65 **Left Bank:** 792578.94 1265083.43	675	12.07	29	21.500	4.423
2	Kaveri Main Bridge (NH47)	0.09	Kaveri main Bridge (NH47)	**Right Bank:** 11°25'53.88"N 77°41'16.06"E **Left Bank:** 11°25'56.00"N 77°40'52.90"E	**Right Bank:** 793289.32 1265070.21 **Left Bank:** 792586.24 1265128.87	675	9.03	29	21.462	3.926
3	Bhavani Main Bridge	0.84	Bhavani Main Bridge	**Right Bank:** 11°26'18.92"N 77°40'55.56"E **Left Bank:** 11°26'18.04"N 77°40'50.73"E	**Right Bank:** 792660.37 1265834.32 **Left Bank:** 792514.00 1265806.00	145.0	13.58	8	16.153	3.300

Sl. No.	Structure Name	Ch. (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance w.r.t HFL (m)
				Right Bank Left Bank	Right Bank Left Bank					
4	Thalavapettai Bridge	11.09	Thalavapettai	**Right Bank:** 11°27'28.41"N 77°37'1.96"E **Left Bank:** 11°27'23.25"N 77°36'59.52"E	**Right Bank:** 785483.38 1267746.33 **Left Bank:** 785555.80 1267905.61	172.5	12.2	6	12.500	5.476
5	Perundalaiyur Bridge	17.51	Perundalaiyur	**Right Bank:** 11°27'51.24"N 77°34'1.39"E **Left Bank:** 11°27'48.05"N 77°33'58.85"E	**Right Bank:** 780073.57 1268558.38 **Left Bank:** 779997.62 1268459.69	123.94	8.62	14	6.750	3.523
6	Keelavani Bridge	24.46	Keelavani	**Right Bank:** 11°30'12.25"N 77°31'53.16"E **Left Bank:** 11°30'12.13"N 77°31'48.71"E	**Right Bank:** 776147.00 1272859.00 **Left Bank:** 776012.00 1272854.00	143.22	8.6	6	11.014	4.283
7	Savanadapur Old Bridge	29.23	Savanadapur	**Right Bank:** 11°31'05.72"N 77°30'33.06"E **Left Bank:** 11°31'06.03"N 77°30'39.40"E	**Right Bank:** 773703.91 1274481.48 **Left Bank:** 773896.04 1274492.69	192.57	5.9	9	17.525	7.252
8	Savanadapur New Bridge	29.25	Savanadapur	**Right Bank:** 11°31'6.90"N 77°30'39.65"E **Left Bank:** 11°31'6.10"N 77°30'32.99"E	**Right Bank:** 773903.53 1274519.56 **Left Bank:** 773701.71 1274493.17	211.65	12.75	11	16.68	7.347
9	Gobichettipalayam Bridge	39.33	Gobichettipalayam	**Right Bank:** 11°30'11.94"N 77°26'31.68"E **Left Bank:** 11°30'7.86"N 77°26'32.60"E	**Right Bank:** 766400.00 1272765.00 **Left Bank:** 766429.00 1272640.00	135.62	7.52	7	15.035	5.907
10	Bungalowpudur Bridge	44.14	Bungalowpudur	**Right Bank:** 11°29'54.26"N 77°24'33.39"E **Left Bank:** 11°29'49.20"N 77°24'33.43"E	**Right Bank:** 762818.13 1272191.40 **Left Bank:** 762820.60 1272035.84	170.90	7.22	6	20.215	7.124
11	Under Construction near Kodiveri	61.66	Under Construction near Kodiveri	**Right Bank:** 11°28'24.04"N 77°17'54.16"E **Left Bank:** 11°28'27.48"N 77°17'47.10"E	**Right Bank:** 750737.00 1269319.00 **Left Bank:** 750522.00 1269423.00	242.53	-	8	26.458	4.871
12	Sathyamangalam Bridge-2	74.44	Sathyamangalam	**Right Bank:** 11°30'13.28"N 77°14'43.07"E **Left Bank:** 11°30'9.95"N 77°14'44.66"E	**Right Bank:** 744917.00 1272631.00 **Left Bank:** 744966.00 1272529.00	110.28	11.10	5	15.652	4.155
13	Sathyamangalam Bridge-1	74.43	Sathyamangalam	**Right Bank:** 11°30'14.06"N 77°14'43.30"E **Left Bank:** 11°30'9.52"N 77°14'45.51"E	**Right Bank:** 744924.00 1272655.00 **Left Bank:** 744992.00 1272516.00	96.75	6.52	4	17.120	6.861

Sl. No.	Structure Name	Ch. (km)	Location	Position (Lat Long)	Position (UTM)	Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance w.r.t HFL (m)
				Right Bank Left Bank	Right Bank Left Bank					
14	Velliyampalayam Bridge	87.50	Velliyampalayam	**Right Bank:** 11°28'50.20"N 77°9'18.17"E **Left Bank:** 11°28'47.11"N 77°9'14.16"E	**Right Bank:** 735087.52 1270002.05 **Left Bank:** 734966.68 1269905.97	198.74	10.45	5	18.663	5.448
15	Bhavanisagar Bridge	94.33	Bhavanisagar Dam	**Right Bank:** 11°28'23.30"N 77°6'57.20"E **Left Bank:** 11°28'24.33"N 77°6'52.79"E	**Right Bank:** 730820.11 1269143.48 **Left Bank:** 730686.00 1269174.00	146.21	8.27	11	8.943	7.685

Table 14 - Details of Bridges

2.17 Details of other cross structures, pipe-lines, under water cables

There are no other cross structures, pipelines and underwater cables in the survey stretch of Bhavani River.

2.18 High Tension Lines / Electric lines / Tele-communication lines

The details of high tension line/electric line and telecommunication lines are as tabulated below:-

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)	Position (UTM)	Vertical clearance w.r.t. HFL(m)	Remarks (complete / under - construction)
				Left Bank / Right Bank	Left Bank / Right Bank		
1	Electric Line	1.22	Madapur	**Left Bank:** 11°26'25.28"N 77°40'42.12"E **Right Bank:** 11°26'28.83"N 77°40'48.68"E	**Left Bank:** 792250.92 1266026.08 **Right Bank:** 792449.86 1266137.93	18	Complete
2	High Power Line	3.34	Andikulam	**Left Bank:** 11°27'7.45"N 77°40'32.80"E **Right Bank:** 11°27'17.60"N 77°40'36.12"E	**Left Bank:** 791956.23 1267320.10 **Right Bank:** 792054.00 1267632.98	21.37	Complete
3	High Power Line	4.08	Thippichettipalayam	**Left Bank:** 11°27'15.88"N 77°40'8.70"E **Right Bank:** 11°27'24.53"N 77°40'13.17"E	**Left Bank:** 791222.89 1267572.43 **Right Bank:** 791355.99 1267839.64	25	Complete
4	Electric Line	6.35	Seethapalayam	**Left Bank:** 11°27'34.98"N 77°39'4.21"E **Right Bank:** 11°27'38.50"N 77°39'4.92"E	**Left Bank:** 789261.63 1268141.66 **Right Bank:** 789282.00 1268250.00	21	Complete
5	High Power Line	15.65	Kuttipalayam	**Left Bank:** 11°27'47.73"N 77°34'47.84"E **Right Bank:**	**Left Bank:** 781483.21 1268463.04 **Right Bank:**	31	Complete

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long) Left Bank / Right Bank	Position (UTM) Left Bank / Right Bank	Vertical clearance w.r.t. HFL(m)	Remarks (complete / under - construction)
				11°27'51.05"N 77°34'59.39"E	781832.56 1268568.25		
6	High Power Line	18.05	Perundalaiyur	**Left Bank:** 11°28'8.97"N 77°33'39.75"E **Right Bank:** 11°28'1.39"N 77°33'56.12"E	**Left Bank:** 779412.55 1269097.61 **Right Bank:** 779911.16 1268869.08	33	Complete
7	High Power Line	25.38	Mevani	**Left Bank:** 11°30'38.16"N 77°31'46.41"E **Right Bank:** 11°30'44.17"N 77°31'49.95"E	**Left Bank:** 775935.24 1273653.74 **Right Bank:** 776040.94 1273839.46	42	Complete
8	Electric Line	26.34	Rakkanampalayam	**Left Bank:** 11°31'9.36"N 77°31'37.87"E **Right Bank:** 11°31'9.30"N 77°31'41.59"E	**Left Bank:** 775667.73 1274610.71 **Right Bank:** 775780.57 1274609.80	26	Complete
9	CWC Steel Wire	30.02	Savanadapur	**Left Bank:** 11°31'21.50"N 77°30'23.14"E **Right Bank:** 11°31'25.38"N 77°30'24.48"E	**Left Bank:** 773398.91 1274963.96 **Right Bank:** 773438.41 1275083.59	12	Complete
10	High Power Line	31.18	Savanadapur	**Left Bank:** 11°31'28.11"N 77°29'46.53"E **Right Bank:** 11°31'31.37"N 77°29'47.15"E	**Left Bank:** 772287.22 1275157.48 **Right Bank:** 772305.14 1275257.86	29	Complete
11	High Power Line	84.76	Baguthampalayam	**Left Bank:** 11°29'15.82"N 77°10'30.32"E **Right Bank:** 11°29'20.43"N 77°10'18.01"E	**Left Bank:** 737268.71 1270805.86 **Right Bank:** 736894.46 1270944.73	35	Complete
12	Telephone line (Wire)	91.30	Kothamangalam	**Left Bank:** 11°28'55.77"N 77° 7'39.25"E **Right Bank:** 11°28'58.26"N 77° 7'37.44"E	**Left Bank:** 732325.60 1270324.71 **Right Bank:** 732037.94 1270360.08	7	Complete
13	Electric Line	91.49	Kothamangalam	**Left Bank:** 11°29'1.37"N 77° 7'47.15"E **Right Bank:** 11°29'2.59"N 77° 7'37.67"E	**Left Bank:** 732087.39 1270150.83 **Right Bank:** 732032.00 1270227.00	33	Complete
14	High Power Line	92.11	Bhavanisagar	**Left Bank:** 11°28'52.39"N 77°7'18.76"E **Right Bank:** 11°29'1.37"N 77°7'23.37"E	**Left Bank:** 731467.03 1270042.43 **Right Bank:** 731604.75 1270319.41	40	Complete

Table 15 - Details of High Tension Lines

2.19 Current Meter and Discharge details

Valeport801 Velocity meter was used to log the flow rates of the river. The locations of current meter deployment are as follows:-

Sample No.	Chainage (km)	Position		Observed Depth (m) (D)	Velocity (m/sec.)	Average Velocity (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m.)
		Lat/Long	Easting/ Northing (m)		0.5 D			
BAN-01	91.743	11°28′52.8″N 77°07′31.8″E	731862.223 1270057.876	0.8	0.4	0.807	60.156	48.546
BAN-02	84.030	11°29′21.3″N 77°10′46.6″E	737760.955 1270978.024	0.9	0.45	1.904	2.39	4.551
BAN-03	71.139	11°28′53.5″N 77°15′36.3″E	746550.058 1270191.340	1.2	0.6	0.446	35.525	15.844
BAN-04	61.234	11°28′34.7″N 77°17′56.4″E	750802.147 1269647.122	0.7	0.45	0.703	4.05	2.847
BAN-05	44.224	11°29′50.8″N 77°24′30.7″E	762737.518 1272084.221	1.3	0.7	0.35	3.35	1.173
BAN-06	39.296	11°30′09.4″N 77°26′33.6″E	766458.820 1272687.464	1.2	0.65	0.545	1.8	0.981
BAN-07	29.124	11°31′02.4″N 77°30′38.3″E	773863.669 1274380.804	0.8	0.5	0.547	5.64	3.085
BAN-08	17.558	11°27′51.3″N 77°34′00.1″E	780034.496 1268559.863	0.7	0.45	1.065	2.62	2.790
BAN-09	7.241	11°27′54.2″N 77°38′41.5″E	788567.445 1268726.218	1.3	0.65	0.254	6.065	1.541
BAN-10	1.344	11°26′28.7″N 77°40′42.0″E	792246.302 1266131.195	0.6	0.45	0.338	1.65	0.558

Table 16 - Current Meter Deployment Locations

2.20 Soil and Water Sample Locations

(a) Soil Sample Locations

River bed soil sampling was undertaken using Vanveen Grab at respective locations and the details of sampling locations are as follows:

Sample No.	Location	Chainage (km)	Latitude Longitude	Easting (m) Northing (m)	Depth (m)
1	Bhavanisagar	91.743	11°28′52.8″N 77°07′31.8″E	731862.223 1270057.876	0.80
2	Ramapuram	84.030	11°29′21.3″N 77°10′46.6″E	737760.955 1270978.024	0.90
3	Ondiyur	71.139	11°28′53.5″N 77°15′36.3″E	746550.058 1270191.34	1.20
4	Kodiveri	61.234	11°28′34.7″N 77°17′56.4″E	750802.147 1269647.122	0.70
5	N Pullampatti	44.224	11°29′50.8″N 77°24′30.7″E	762737.518 1272084.221	1.30
6	Kallippatti	39.296	11°30′09.4″N 77°26′33.6″E	766458.82 1272687.464	1.20
7	Andikaadu	29.124	11°31′02.4″N 77°30′38.3″E	773863.669 1274380.804	0.80
8	Perundalaiyur	17.558	11°27′51.3″N 77°34′00.1″E	780034.496 1268559.863	0.70
9	Jambai	7.241	11°27′54.2″N 77°38′41.5″E	788567.445 1268726.218	1.30

Sample No.	Location	Chainage (km)	Latitude Longitude	Easting (m) Northing (m)	Depth (m)
10	Palaipuam	1.344	11°26′28.7″N 77°40′42.0″E	792246.302 1266131.195	0.60

Table 17 - Soil Sample Locations

(b) Water Sample Locations

The water sampling of Bhavani River was undertaken by deploying Niskin Sampler at respective locations and the details are as follows.

Sample No.	Location	Chainage (km)	Latitude Longitude	Easting (m) Northing (m)	Total Depth (d) (m)	Mid-Depth (0.5d) (m)
1	Bhavanisagar	91.743	11°28′52.8″N 77°07′31.8″E	731862.223 1270057.876	0.80	0.5
2	Ramapuram	84.030	11°29′21.3″N 77°10′46.6″E	737760.955 1270978.024	0.90	0.5
3	Ondiyur	71.139	11°28′53.5″N 77°15′36.3″E	746550.058 1270191.34	1.20	0.6
4	Kodiveri	61.234	11°28′34.7″N 77°17′56.4″E	750802.147 1269647.122	0.70	0.5
5	N Pullampatti	44.224	11°29′50.8″N 77°24′30.7″E	762737.518 1272084.221	1.30	0.6
6	Kallippatti	39.296	11°30′09.4″N 77°26′33.6″E	766458.82 1272687.464	1.20	0.6
7	Andikaadu	29.124	11°31′02.4″N 77°30′38.3″E	773863.669 1274380.804	0.80	0.5
8	Perundalaiyur	17.558	11°27′51.3″N 77°34′00.1″E	780034.496 1268559.863	0.70	0.5
9	Jambai	7.241	11°27′54.2″N 77°38′41.5″E	788567.445 1268726.218	1.30	0.6
10	Palaipuam	1.344	11°26′28.7″N 77°40′42.0″E	792246.302 1266131.195	0.60	0.5

Table 18 - Water Sample Locations

Figure 9 - Soil and water samples of Bhavani River

2.20.1 **Analysis**

The collected samples were analyzed for following properties:-

a) **Soil Samples**
- Grain size
- Specific gravity
- PH Value
- Cu, Cc
- Clay Silt percentage

b) **Water samples**
- Sediment Concentration

A detailed report on sample analysis is placed in Annexure – 12 and 13 to this report.

3 Description of Waterway

The waterway of Bhavani River within survey limits are divided into three stretches in accordance with the availability of water and geographical characteristics. The details are as follows:-

3.1 Sub-Stretch-1: Bhavani Town to Downstream of Athani Bridge (Chainage 0 to 29.23km)

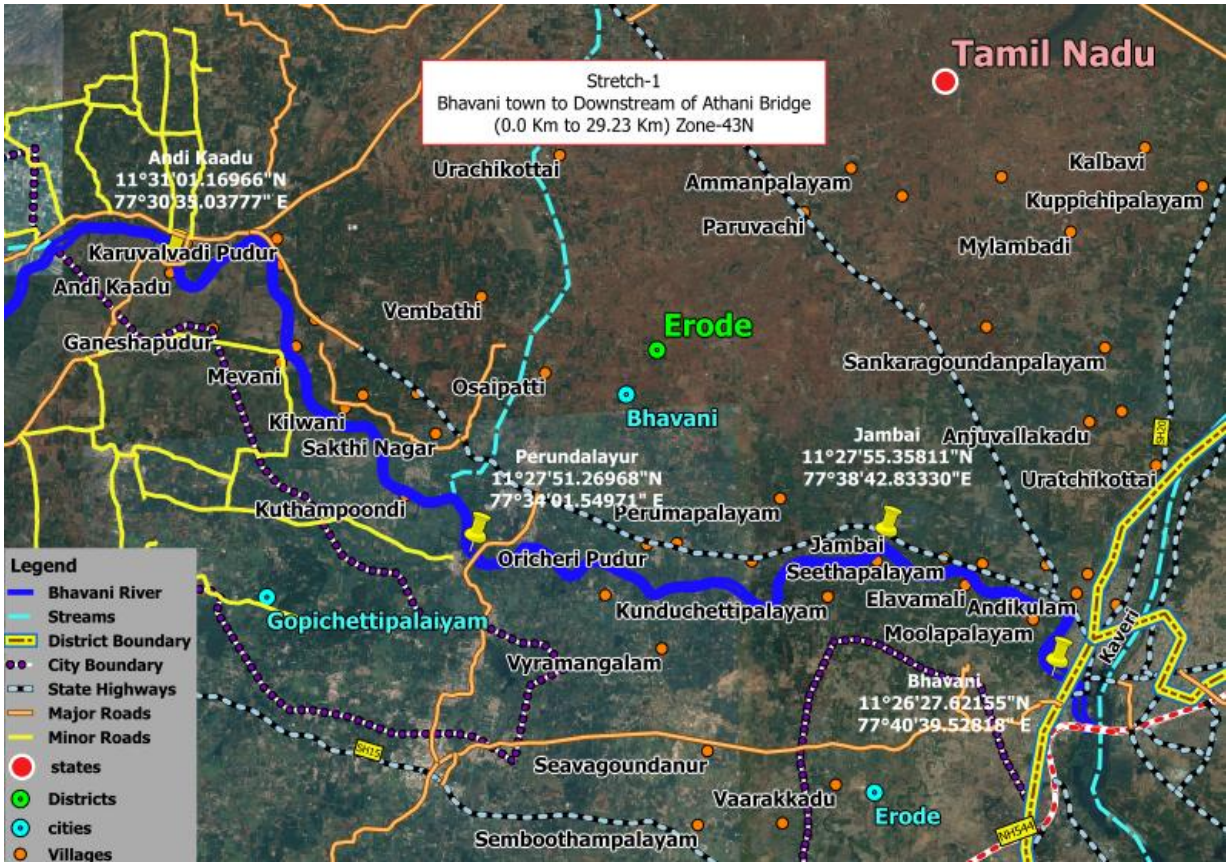


Figure 10 - Stretch-01 Bhavani Town to Downstream of Athani Bridge

- **Bathymetry Survey**
  a) 21.162km of bathymetric survey has been carried out in this stretch.
- **Topographic Survey**
  b) 8.068km of topographic survey has been carried out in this stretch.

The prominent areas nearby are Savanadapur, Mevani, Apakoodai, Jambai and Bhavani Town. The gradient level of the Bhavani River in this stretch is less with almost even near Kalingarayan Anicut. Several settlements are found near to the river banks and this stretch is well connected by road and most of the bridges across the river are situated on this stretch. The Shakti Sugar mill is situated 2.5km from the river bank at Apakoodai. Paddy cultivation is very prominent in this region. Sugarcane and Banana cultivation are also found in this area.

The Kalingarayan Anicut is the only check dam present in this stretch. Isolated sand mining is found in the upstream of the Kalingarayan Anicut. The area upstream and downstream of Kalingarayan Anicut is inaccessible for boat sounding due to the presence of water plants in the area.

Figure 11 - Water Plants on Upstream and Downstream of Kalingarayan Anicut (1.61 km chainage)

Figure 12 - Sand Mining in Progress (4.9 km chainage)

Classes	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	0	1.6	0	0	1600	66,508.90	66,508.90	-0.3	0	1600	85,424.49	85,424.49
I	1.6	29.23	0	10.7	12402	391,682.67	458,191.57	-0.3	10.56	14050	538,807.06	624,231.55
II	0	1.6	0	0	1600	101,310.58	101,310.58	-0.3	0	1600	125,586.43	125,586.43
II	1.6	29.23	0	10.7	14702	730,177.32	831,487.90	-0.3	10.56	16340	958,981.42	1,084,567.85
III	0	1.6	0	0	1600	153,108.36	153,108.36	-0.3	0	1600	183,162.84	183,162.84
III	1.6	29.23	0	10.7	18272	1,379,097.08	1,532,205.44	-0.3	10.56	19760	1,713,096.77	1,896,259.61
IV	0	1.6	0	0	1600	184,674.03	184,674.03	-0.3	0	1600	216,023.27	216,023.27
IV	1.6	29.23	0	10.7	21669	1,849,025.80	2,033,699.83	-0.3	10.56	22429	2,214,539.60	2,430,562.87

Table 19 - Stretch 01 Dredging Quantity

3.1.1 Observed and Reduced River-bed Profile

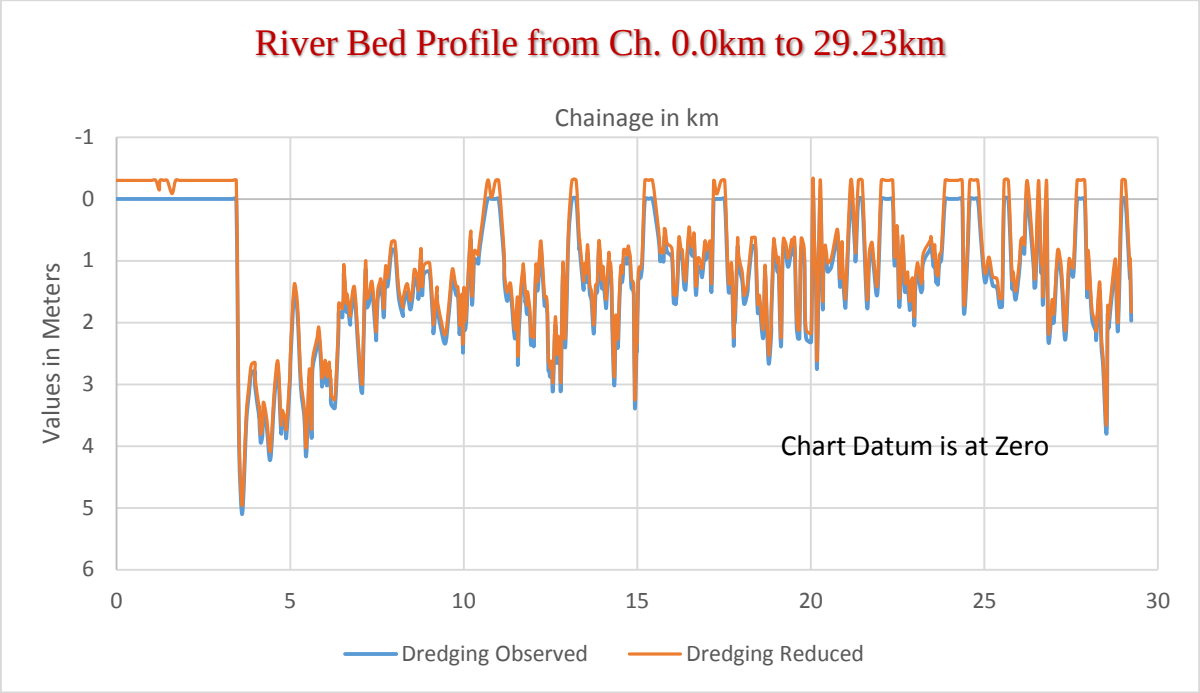


Figure 13 - Stretch 01 River-bed Profile

3.2 Sub-Stretch-2: Upstream of Athani Bridge to Kodiveri Anicut (Chainage 29.23 to 61.8km)

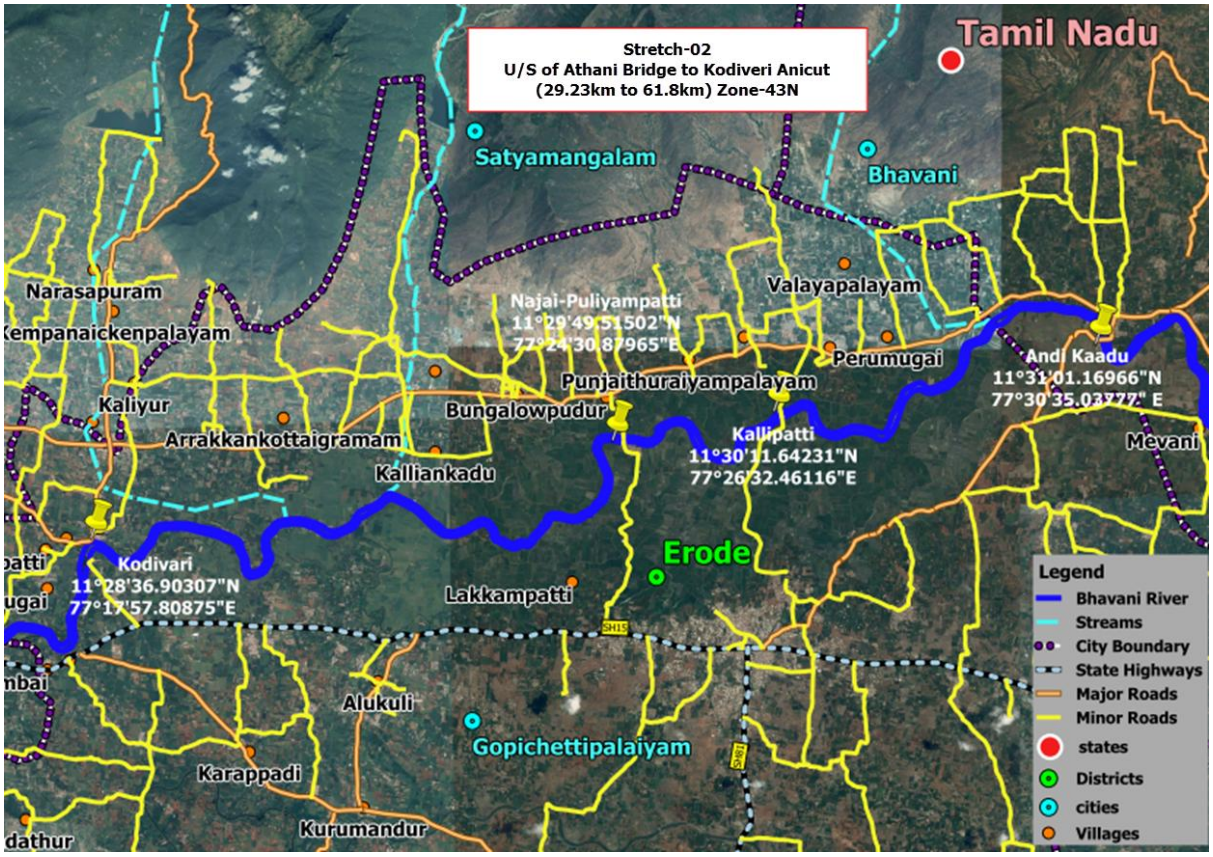


Figure 14 - Stretch-02 Athani Bridge to Kodiveri Anicut

- **Bathymetry Survey**
  a) 1.87km of bathymetric survey has been carried out in this stretch.
- **Topographic Survey**
  b) 30.7km of topographic survey has been carried out in this stretch.

The prominent areas nearby are Kodiveri and Athani Town. This river stretch is inaccessible to survey boat for bathymetric operation due to the presence of rock outcrops and steep gradient of the river bed. This area is poorly connected with road transportation and only one small group of settlements is found in the entire stretch.

The area adjacent to the river banks is primarily used for agricultural purpose. The paddy, sugarcane and banana cultivation are primarily grown in this region.

The canal irrigation facility from Kodiveri Anicut is the primary source of water for this area. There is no check dam/barrage in this stretch; however, various extreme gradients and several rock outcrops are found in this area. The width of the river is narrow throughout this stretch. The construction of new bridge across the river is in progress on the downstream of Kodiveri Anicut.

Figure 15 - View of Bhavani River – Stretch-02

Classes	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	29.23	61.8	0	3	31310	1,299,898.52	1,758,090.09	-0.3	2.86	31360	1,658,537.94	2,282,769.49
II	29.23	61.8	0	3	31440	1,990,432.69	2,821,920.59	-0.3	2.86	31535	2,457,388.57	3,541,956.42
III	29.23	61.8	0	3	31810	3,033,748.59	4,565,954.03	-0.3	2.86	31940	3,619,152.27	5,515,411.88
IV	29.23	61.8	0	3	32272	3,679,954.14	5,713,653.97	-0.3	2.86	32340	4,293,343.77	6,723,906.64

Table 20 - Stretch 02 Dredging Quantity

3.2.1 Observed and Reduced River-bed Profile

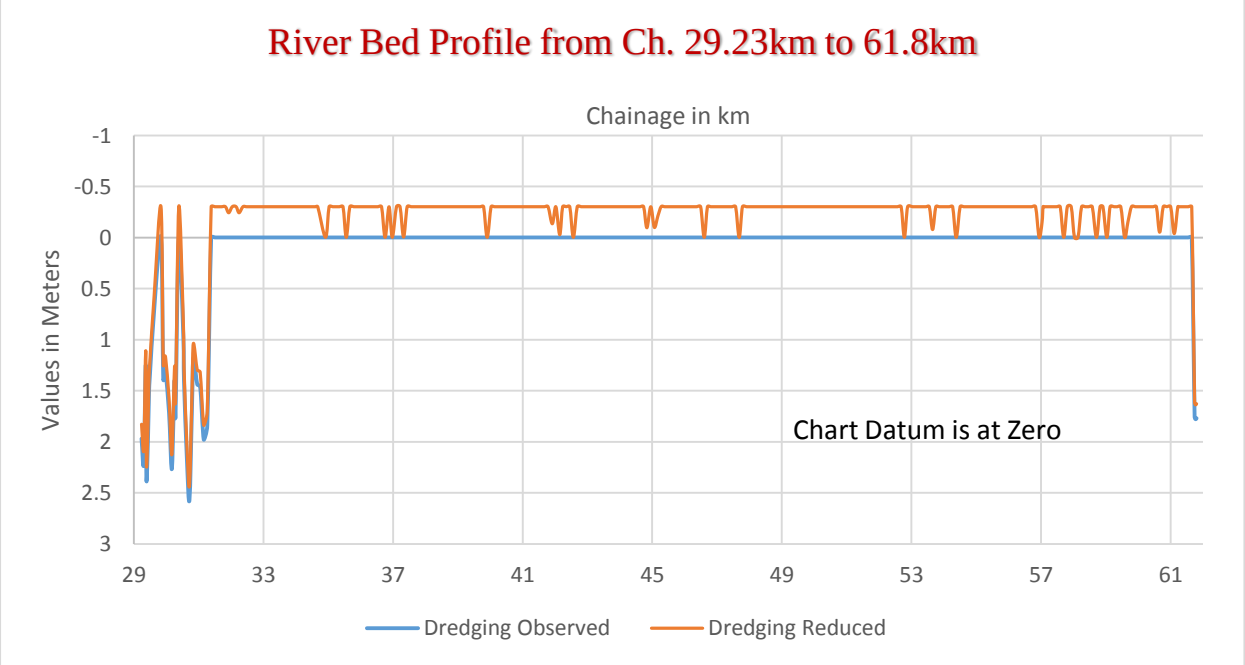


Figure 16 - Stretch 02 River-bed Profile

3.3 Sub-Stretch-3: Kodiveri Anicut Dam to Bhavanisagar Dam (Chainage 61.8 to 94.65km)

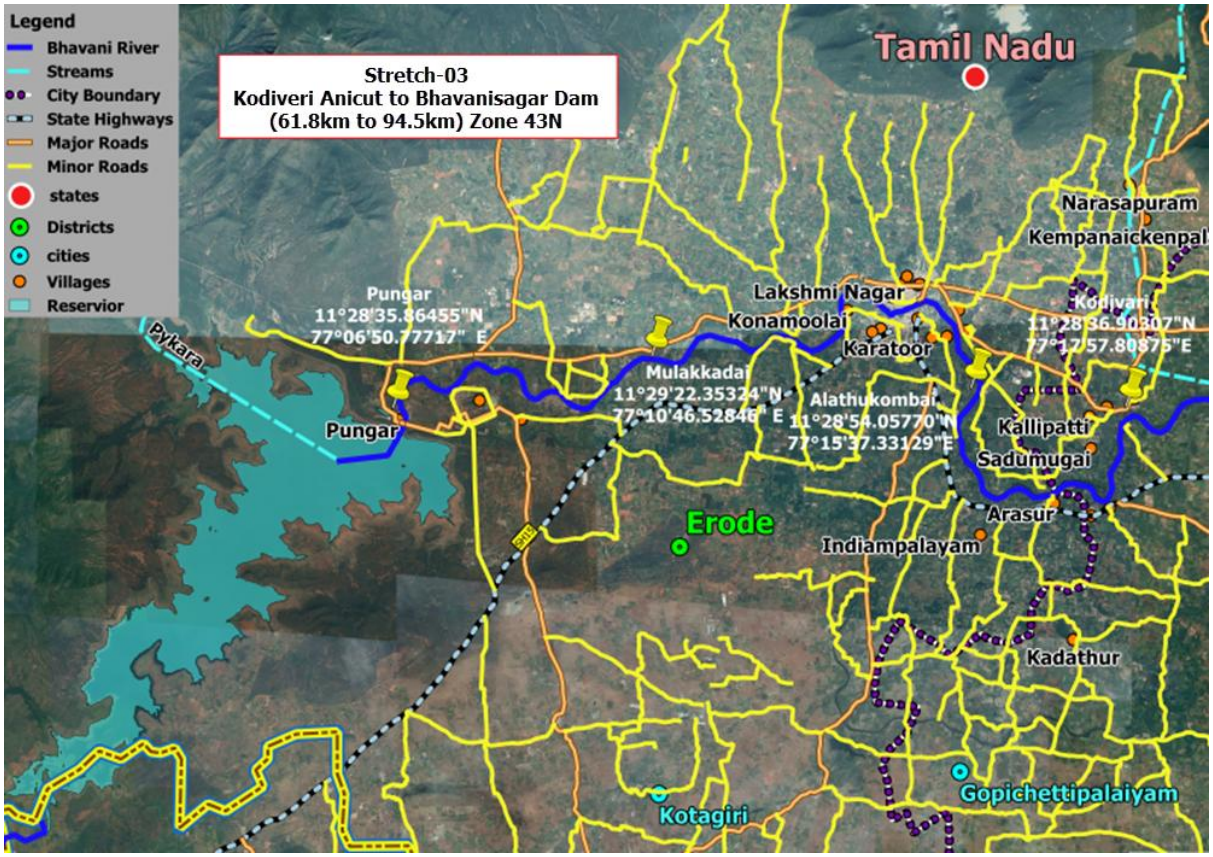


Figure 17 - Stretch-03 Kodiveri Anicut to Bhavanisagar Dam

- **Bathymetry Survey**
  a) 27.607km of bathymetric survey has been carried out in this stretch.
- **Topographic Survey**
  b) 5.243km of topographic survey has been carried out in this stretch.

The prominent areas nearby are Bhavanisagar Dam, Sathyamangalam and Kodiveri Anicut. This stretch covers the downstream of the Bhavanisagar Dam and the river bank is moderately populated with several clusters of small towns situated on the river bank. The major town, Sathyamangalam is situated on the right bank side of Bhavani River.

The area near to the river banks are also used for the agricultural purposes such as, Paddy, Banana, Sugar cane and Jasmine flowers. The cultivation of Banana and Jasmine flower are more prominent in this stretch due to the condition of soil and limitation in irrigational facilities.

The Kodiveri Anicut is the only obstruction/check dam in this stretch and the flow of the river is continuous for this stretch. The river banks are elevated in nature and are able to withstand the flood level of the river. The major tourist attractions in this stretch are Bhavanisagar Dam and Kodiveri Anicut. The “Parasals” (Small circular

country boat) is available for crossing the river near Kothamangalam (11°28´58´´N, 77°07´38´´E). No other boat operates in this stretch of Bhavani River.

Figure 18 - View of Bhavani River – Stretch-03

Classes	Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
	From	To	Min. depth (m)	Max. depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
I	61.8	94.65	0	9.19	9853	386,167.13	2,144,257.22	-0.3	9.05	12397	536,462.27	2,819,231.76
II	61.8	94.65	0	9.19	14400	739,683.84	3,561,604.43	-0.3	9.05	16865	982,994.80	4,524,951.22
III	61.8	94.65	0	9.19	20360	1,445,872.67	6,011,826.70	-0.3	9.05	22825	1,809,249.61	7,324,661.49
IV	61.8	94.65	0	9.19	25140	1,966,094.03	7,679,748.00	-0.3	9.05	27430	2,370,100.61	9,094,007.25

Table 21 - Stretch 03 Dredging Quantity

3.3.1 Observed and Reduced River-bed Profile

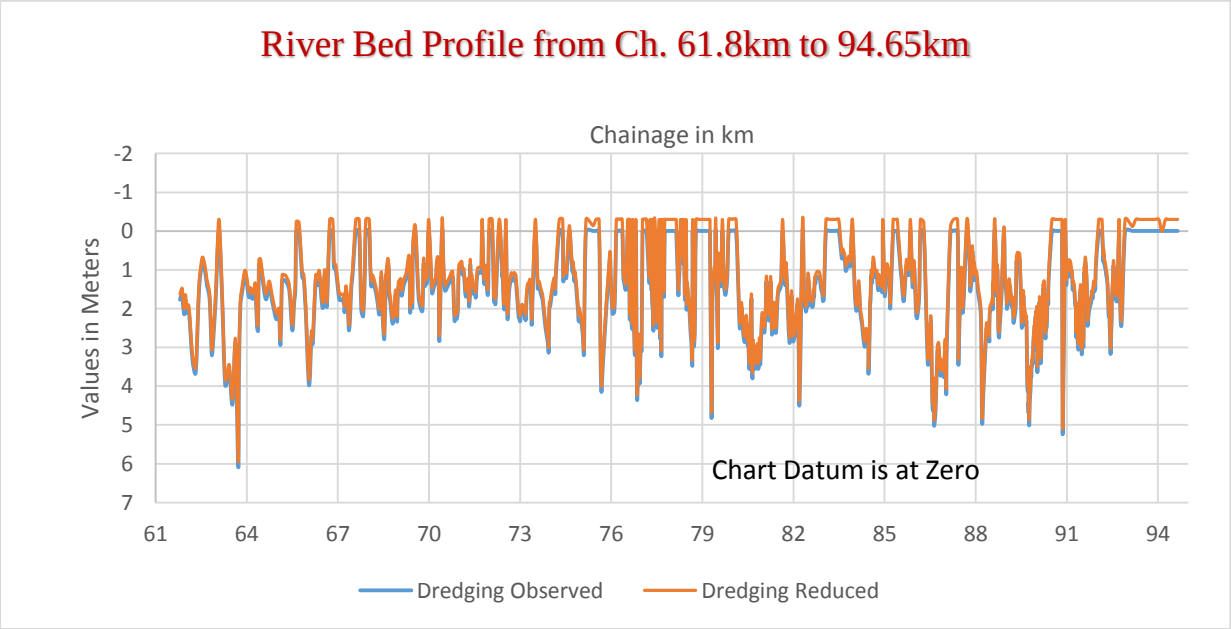


Figure 19 - Stretch 03 River-bed Profile

3.4 Other Aspects of Waterway

3.4.1 Fishing

The Bhavani River is perennial in nature, but no major inland fishing activities are observed in the entire stretch of the Bhavani River.

3.4.2 Industries

The sugar factories and Paper Mills are the major industries located near to the Bhavani River. The details of major industries situated near the Bhavani River are as follows:-

Sl. No.	Industry	Chainage (km)	Position
01	Bhannari Amman Sugar Factory, Alathukombai, Sathyamangalam	71.6	11°29'9.29"N 77°16'7.16"E
02	Shakti Sugars Limited, Apakudal	18.6	11°28'24.67"N 77°34'18.85"E
03	Senthil Papers and Boards Pvt. Ltd. Ikkarai Thathapalli, Sathy	86.0	11°29'59.06"N 77° 9'33.66"E

Table 22 - Major Industries near Bhavani River

3.4.3 Crops

The Bhavani River bank and adjacent land are primarily used for agricultural purposes only. There are plenty of coconut trees through the river bank. The crops generally cultivated near to the Bhavani River are Paddy, Sugarcane, Maze, Jasmine Flower and Banana. The sugarcane cultivation is widely spread in the areas near to the sugarcane factories. More cultivable, fertile agricultural lands are noticed along the river, Banana & Sugarcane are the common wet crops.

Figure 20 - Thick Coconut Trees on Bank of Bhavani River (21 km chainage)

3.4.4 Settlements

The cluster formation of settlements is predominantly found near the Bhavani River. The bank sides of Bhavani River are not densely populated and the settlements are generally formed at a safe distance from the river bank and the nearby settlements are formed only on elevated river banks.

3.4.5 Irrigation/Drinking water

The Bhavani River water is primarily utilized for canal irrigation projects for Paddy and Banana cultivation. The local pumping of water for agricultural purpose is in plenty along the river banks. Several pumping stations are also located near the river banks to meet the drinking water supply to the nearby towns.

Figure 21 - Pump Houses for Drinking Water on Bhavani River (73.44 km Chainage)

3.4.6 Important cities/towns

The Major town situated near to Bhavani River is Sathyamangalam and Bhavani Town near starting chainage. No other major cities are located nearby, however the area adjoining is moderately developed at various locations. These are capable to sustain for all day to day needs of the population nearby. The areas are well connected by road and public transport system. Local taxis and autos are available occasionally along the entire Bhavani Stretch.

3.4.7 Road Network

The river banks of Bhavani River are connected with good road transport network and private vehicles are also available in the nearby area. The public transport buses are frequently operated by Tamilnadu State government and the area is well connected with nearby cities.

3.4.7.1 National Highway

The National highway – NH544 from Salem to Kochi is running near to the survey stretch of the Bhavani River and the survey stretch of the Bhavani River starts from the Bridge on Salem-Coimbatore Highway.

3.4.7.2 State Highway

The Bhavani River is well connected with state highway on both sides of river banks. The SH-82 and SH-15 runs almost parallel to the river banks of Bhavani River. The various district roads and bridges across the Bhavani River at intermediate stretches also contributes to good road transport network throughout the survey stretch of Bhavani River.

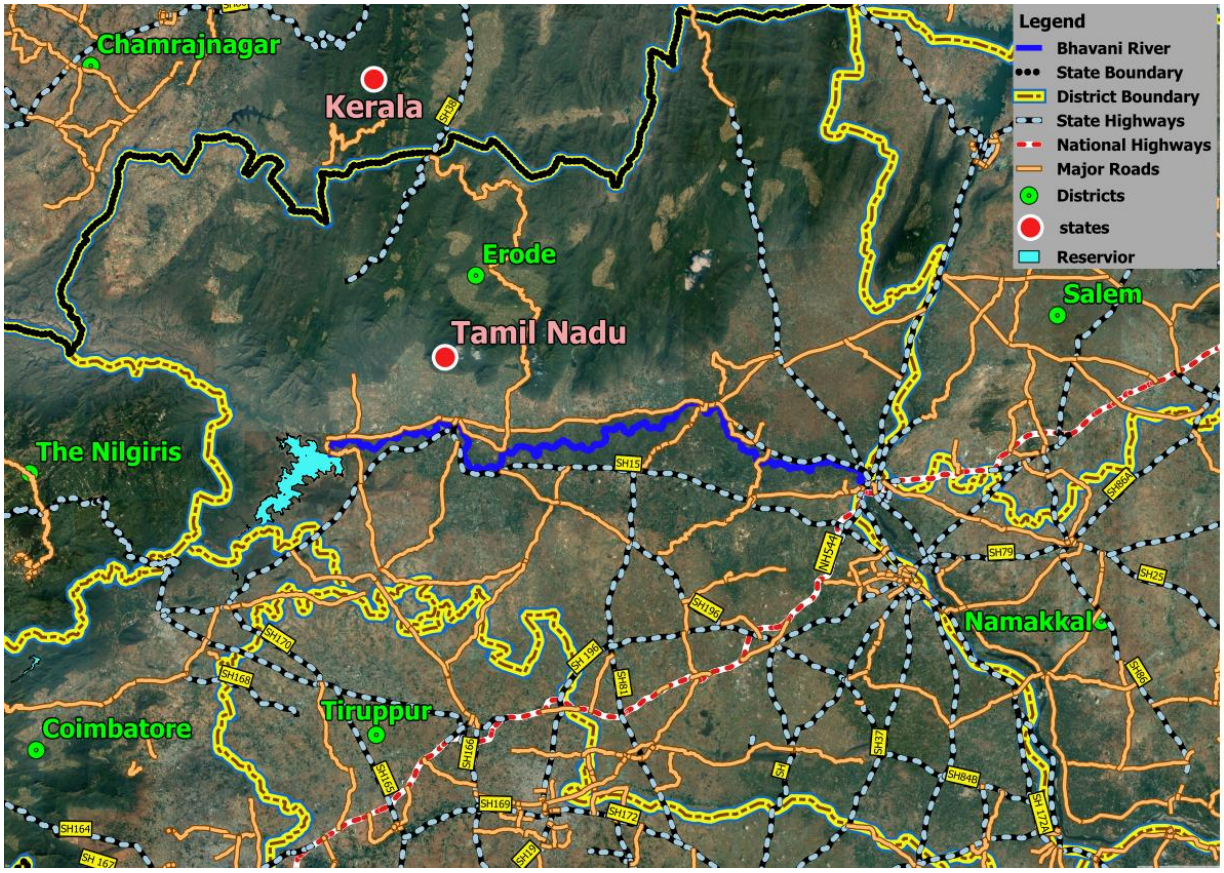


Figure 22 - Road Network

3.4.7.3 Rail Network

The important railway stations and distance from the survey stretch of Bhavani River are Coimbatore (80 km), Tiruppur (52km) Erode (18 km) and Salem (76km).

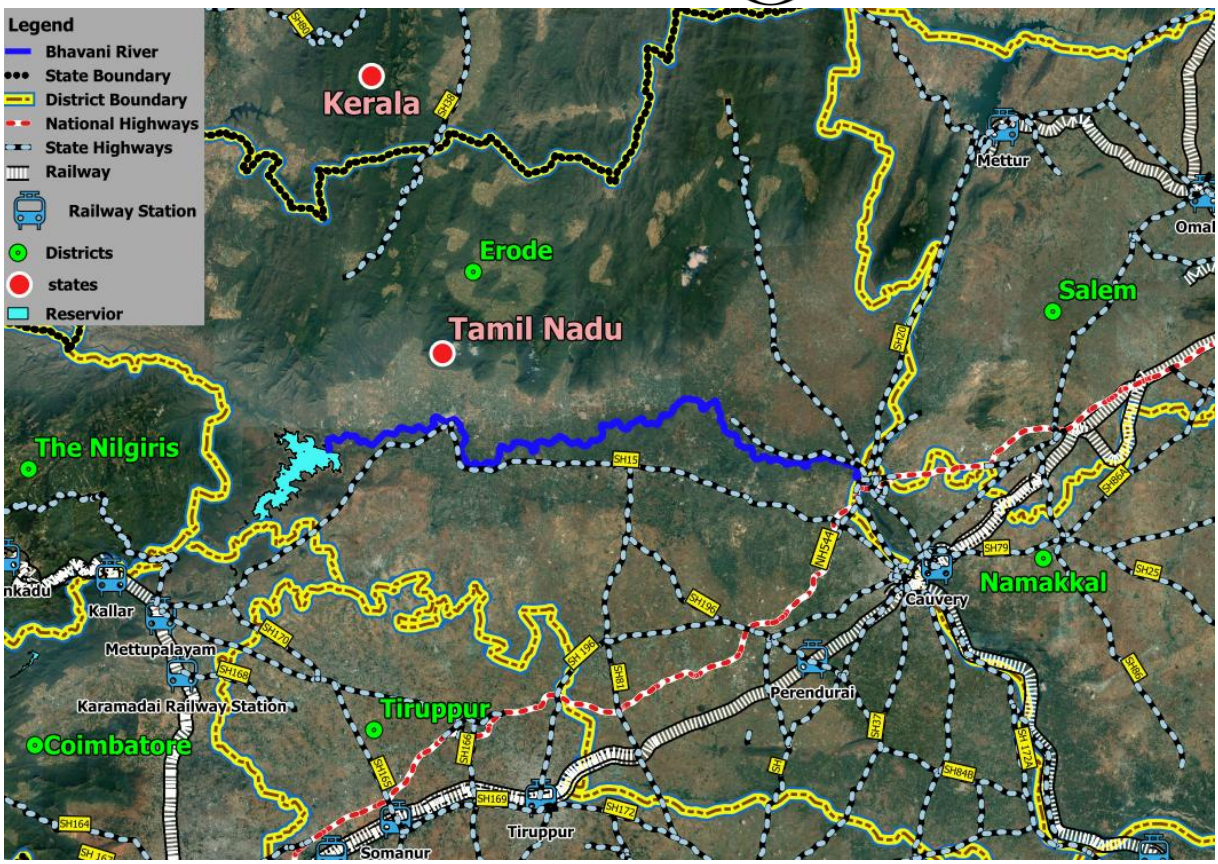


Figure 23 - Rail Network

3.4.8 Land Use

The settlements are present near the Bhavani Town situated on the starting chainage and near Sathyamangalam town between 74 to 78km chainage of Bhavani River. The areas adjacent to Bhavani River are intensively irrigated and are used for agricultural purpose. Some of the sparsely irrigated areas are effectively utilized by using groundwater system.

3.4.9 Construction Material

The survey stretch of Bhavani River is well connected with Coimbatore, Erode and Tiruppur cities. The river banks are having a good road network and hence any types of construction material are available at ease. The houses and buildings well-ordered in the survey area are concrete constructed.

3.4.10 Cargo Movement

The major industries with potential cargo movement situated near the Bhavani River are the sugar mills. The cargo movement (sugar cane) by road transport is observed near the sugar mills, however, a large volume of cargo movement or passenger movement is not envisaged through Bhavani River due to existing road connectivity.

3.4.11 Passenger Ferry Services

There are no Passenger Ferry services available in the entire stretch of Bhavani River. The only available means of water transportation are the Parasals, which are used by local people for crossing the river banks.

3.4.12 Historic Importance

Bhavani Sangameswarar Temple is located at the confluence of two rivers, Bhavani and Kaveri. It is known as South Prayag and is having a Pagoda of 120 inch in height. It is believed that Bhavani and Amudha (not visible now) join Kaveri River. It is said to have existed even before the days of the first King Mahendravarma of Pallava dynasty.

Bannari Mariamman Temple is about 15km from Bhavanisagar town on the road to Mysore. It is a place of pilgrimage during the annual festival known as "Kundam" which takes place in the middle of March every year.

3.4.13 Tourism

The major tourist attraction near Bhavani River is Bhavanisagar Dam. The Kodiveri and Kalingarayan Anicut in the Bhavani are also proposed to develop as major tourist attractions. There are limited facilities for the tourist in Kodiveri Anicut. A small garden and local boating (Small country boat - Parasal) on the upstream of the Kodiveri is available for tourists.

The Kalingarayan Anicut is situated near to Bhavani Town and it is one of the tourist spot situated on the Bhavani River. This area is indented to be developed for other tourism activities. The construction work for the proposed children's park is in progress on the downstream right banks side of Kalingarayan Anicut.

Figure 24 - Kodiveri Anicut (61.75km) and Kalingarayan Anicut (1.61 km)

3.4.14 Irrigation Canals and Outlets

Several inlet and outlet canals are present in the Bhavani River. All inlet canals are found to be dry during the survey period and these canals are likely to be charged only during the rainy season. The outlet canals are located near to Kodiveri and Kalingarayan Anicut. The details of prominent inlet and outlet canals are as below:-

Sl. No.	Position	Location	Remarks
01	11°29'15.23"N 77° 8'30.59"E	Thayirpallam	Small in-let Creek in dry condition on upstream
02	11°29'2.87"N 77° 6'53.78"E	Karachikorai	Small in-let Creek in dry condition on upstream
03	11°29'45.34"N 77°12'27.61"E	Thandam Palayam	Small in-let Creek in dry condition on upstream
04	11°28'22.23"N 77°17'47.10"E	Kodiveri Spillage	02 Irrigational Canal outlet with control valves near Kodiveri Anicut. These canals are situated on both sides of the river banks and are running through the agricultural land.
05	11°29'10.92"N 77°21'36.79"E	Kalliankadu	Small in-let Creek in dry condition on upstream
06	11°26'31.36"N 77°40'34.46"E	Kalingarayan Anicut	The Irrigational Canal outlet with control valves near Kalingarayan Anicut

Table 23 - Details of Irrigational Canals and Outlets

4 Terminals

There are no existing jetties and terminals for public use in the survey stretch of the Bhavanisagar, however a motor boat is present on the CWC site at Savanadapur for daily field observations at Bhavani River. The step leading from the CWC office to Bhavani River side is used as the terminal for securing this boat. The details existing facility used by CWC is as follows:-

Sl. No.	Location	Lat	Long	Remarks
01	Savanadapur	11°31'22.00"N	77°30'23.50"E	CWC site Savanadapur

Table 24 - SayandapurTerminal Detail on Bhavani River

Figure 25 - CWC Savandapur Site (29.9 km chainage)

4.1 Proposed Locations for Construction of New Terminals

The Bhavani River is 94.5 km stretch and the river is having most of the places with Parasals to cross the river operated by local persons. The river banks are un-protected in nature with several bathing steps build up. The details of the proposed locations for the terminal construction are as tabulated below:

Sl. No.	Location	Lat	Long	Land Use	Owner
01	Kothamangalam/ Bhavanisagar	11°28'55.92"N	77° 7'39.19"E	Terminal for Parasals	Govt. Land
	The proposed location is near Bhavanisagar and this terminal is used by local people for crossing the river by small parasols. 02 parasols are operated by local authority for transferring persons from Bhavanisagar to Kothamangalam and back. The proposed location is 3.5 km from Bhavanisagar Dam and is 1 km from Mettupalayam-Bhavanisagar Road. The Depth in the area is sufficient for operating small boats and proposed location is near to the Bathing space and have sufficient depth throughout the year for securing small boats. There is no industries situated near to the proposed location thus scope of development in cargo movement aspect is very less.				
Sl. No.	**Location**	**Lat**	**Long**	**Land Use**	**Owner**
02	Kodiveri Anicut (up-stream)	11°28'21.64"N	77°17'49.27"E	Terminal for Parasals	Govt. Land
	The proposed location is on upstream of Kodiveri Anicut and is 1.8 km from the Tamilnadu State Highway-15. The area is well connected with road network and the area is one of the important tourist place. There are many local Parasals operating in the area, mainly for tourist purpose. The Depth in the area is sufficient for operating small boats sufficient depth will be available throughout the year for operating small boats. A bridge is under construction on the downstream of Kodiveri check dam, thus the boat terminals will not be useful for personnel transfer. There are no industries situated near to the proposed location, thus the scope of development in the cargo movement aspect is very less. The proposed location is only to be considered only for local tourism activities only.				
Sl. No.	**Location**	**Lat**	**Long**	**Land Use**	**Owner**
03	Athani Pirivu/ Rakkanampalayam	11°31'23.26"N	77°31'26.59"E	Terminal for Parasals	Gov. Land/ River Bank
	The proposed location is 150 m from Athani Pirivu Bus stop situated on Tamilnadu State Highway-28. The area is well connected with road network and is used as a local terminal by parasols operating between Athani Pirivu and Rakkanampalayam for transfer of personnel. The Depth in the area is sufficient for operating small boats sufficient depth will be available throughout the year for operating small boats. There are no tourism importance area or industries situated near to the proposed location thus scope of development in tourism and cargo movement aspect is very less.				
Sl. No.	**Location**	**Lat**	**Long**	**Land Use**	**Owner**
04	Kalingarayan Anicut	11°26'35.02"N	77°40'37.44"E	Terminal for Parasals	Gov. Land
	The proposed location is on the upstream of Kalingarayan Anicut and is 1 km from the Tamilnadu State Highway-82. The location is near to the park situated on the upstream of Kalingarayan Anicut. There are no industries situated near to the proposed location, thus the scope of development in the cargo movement aspect is very less. The proposed location is to be considered only for local tourism activities only.				

Table 25 - Proposed Locations for Terminal Construction

5 Fairway Development

The Bhavani River is East flowing river with major curves and several sharp diversions throughout the stretch.

5.1 Design Channel of the Waterway

The Bhavani River flows with a river chainage of 94.5 km for the aerial distance of 54 km. the canal is as it is best suitable for the purpose of irrigation. No major alteration in design is possible due to High Rise River banks, elevated landscapes adjacent to the river and wide spread of settlement near to the river bank of Bhavani River.

5.2 Fairway Dimensions

As per the specification of the survey, dredging quantity is required to be estimated for different channel classifications along the deepest route. Class-I channel with dimension 30m width, 1.2m depth and side slop of 1:5 is shown below.

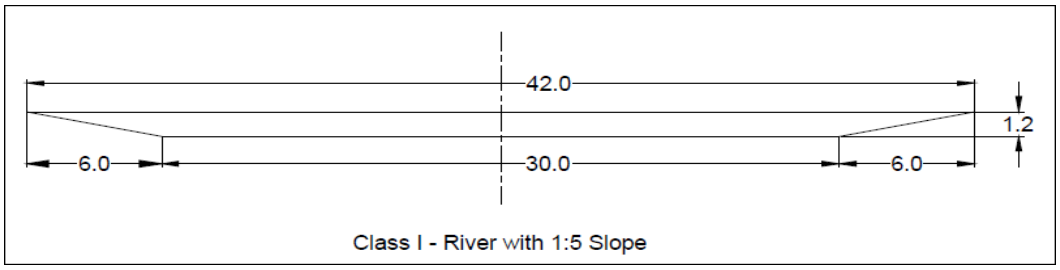
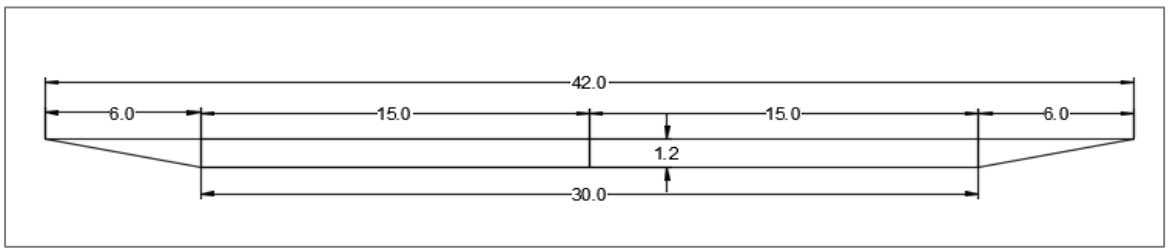


Figure 26 - Fairway Channel Dimensions

5.3 Calculation of Dredging Quantity

The dredge volume calculations were accomplished using the HYPACK dredge volume computation utility. The channel template was created as per the different classification and kilometer wise dredging calculation was carried out. (Enclosed at Annexures 3) The Hypack Standard volume algorithm was used to calculate the dredge volume in each segment. The stretch wise summary of the dredge volume for different class of fairway is as follows:-

Class I

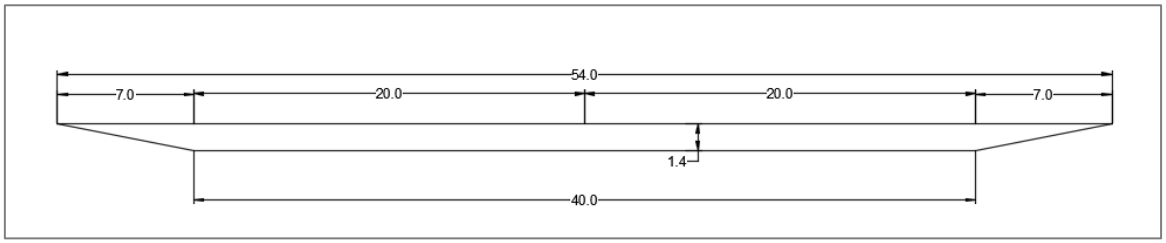


Class I			
Location	**Chainage (km)**	**Observed**	**Reduced w.r.t. Sounding Datum**

From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Bhavani Town	Kalingarayan Anicut	0	1.6	0	0	1600	66,508.90	66,508.90	-0.3	0	1600	85,424.49	85,424.49
Kalingarayan Anicut	U/S Athani Bridge	1.6	29.23	0	10.7	12402	391,682.67	458,191.57	-0.3	10.56	14050	538,807.06	624,231.55
D/S Athani Bridge	Kodiveri Anicut	29.23	61.8	0	3	31310	1,299,898.52	1,758,090.09	-0.3	2.86	31360	1,658,537.94	2,282,769.49
Kodiveri Anicut	Bhavanisagar Dam	61.8	94.65	0	9.19	9853	386,167.13	2,144,257.22	-0.3	9.05	12397	536,462.27	2,819,231.76
					Total	**55165**	**2,144,257.22**	**2,144,257.22**		**Total**	**59407**	**2,819,231.76**	**2,819,231.76**

Table 26 - Dredge Volumes Class-I

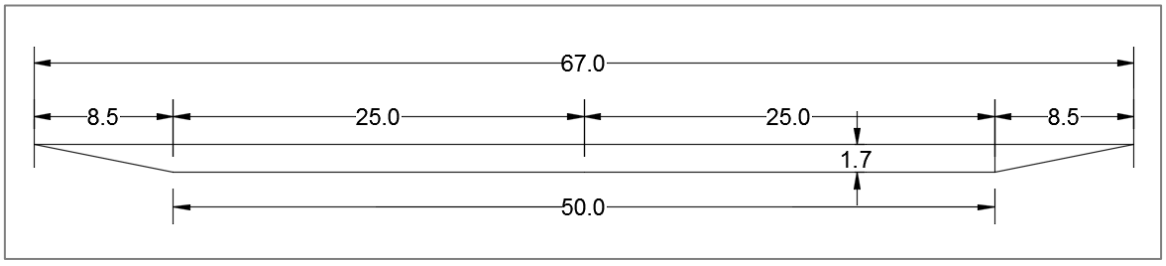
Class II



Class II													
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Bhavani Town	Kalingarayan Anicut	0	1.6	0	0	1600	101,310.58	101,310.58	-0.3	0	1600	125,586.43	125,586.43
Kalingarayan Anicut	U/S Athani Bridge	1.6	29.23	0	10.7	14702	730,177.32	831,487.90	-0.3	10.56	16340	958,981.42	1,084,567.85
D/S Athani Bridge	Kodiveri Anicut	29.23	61.8	0	3	31440	1,990,432.69	2,821,920.59	-0.3	2.86	31535	2,457,388.57	3,541,956.42
Kodiveri Anicut	Bhavanisagar Dam	61.8	94.65	0	9.19	14400	739,683.84	3,561,604.43	-0.3	9.05	16865	982,994.80	4,524,951.22
					Total	**62142**	**3,561,604.43**	**3,561,604.43**		**Total**	**66340**	**4,524,951.22**	**4,524,951.22**

Table 27 - Dredge Volumes Class-II

Class III

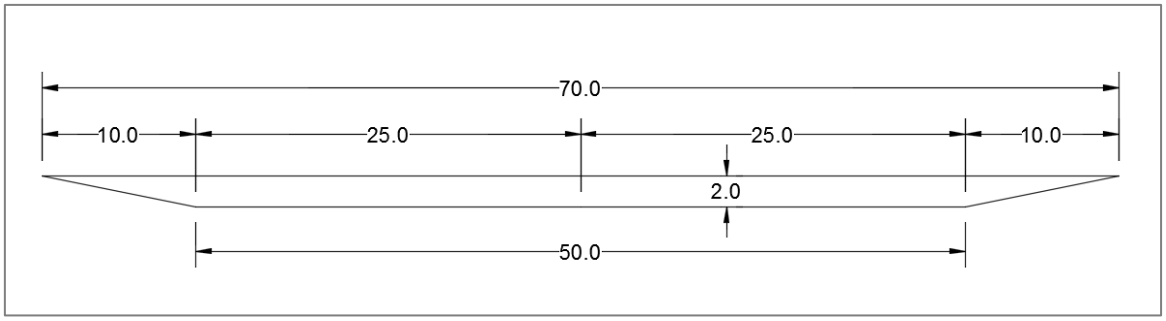


Class III													
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Bhavani Town	Kalingarayan Anicut	0	1.6	0	0	1600	153,108.36	153,108.36	-0.3	0	1600	183,162.84	183,162.84

Class III													
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Kalingarayan Anicut	U/S Athani Bridge	1.6	29.23	0	10.7	18272	1,379,097.08	1,532,205.44	-0.3	10.56	19760	1,713,096.77	1,896,259.61
D/S Athani Bridge	Kodiveri Anicut	29.23	61.8	0	3	31810	3,033,748.59	4,565,954.03	-0.3	2.86	31940	3,619,152.27	5,515,411.88
Kodiveri Anicut	Bhavanisagar Dam	61.8	94.65	0	9.19	20360	1,445,872.67	6,011,826.70	-0.3	9.05	22825	1,809,249.61	7,324,661.49
				Total		**72042**	**6,011,826.70**	**6,011,826.70**	**Total**		**76125**	**7,324,661.49**	**7,324,661.49**

Table 28 - Dredge Volumes Class-III

Class IV



Class IV													
Location		Chainage (km)		Observed					Reduced w.r.t. Sounding Datum				
From	To	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.	Min. Depth (m)	Max. Depth (m)	Length of Shoal (m)	Dredging Qty. (cu.m.)	Accumulated Qty.
Bhavani Town	Kalingarayan Anicut	0	1.6	0	0	1600	184,674.03	184,674.03	-0.3	0	1600	216,023.27	216,023.27
Kalingarayan Anicut	U/S Athani Bridge	1.6	29.23	0	10.7	21669	1,849,025.80	2,033,699.83	-0.3	10.56	22429	2,214,539.60	2,430,562.87
D/S Athani Bridge	Kodiveri Anicut	29.23	61.8	0	3	32272	3,679,954.14	5,713,653.97	-0.3	2.86	32340	4,293,343.77	6,723,906.64
Kodiveri Anicut	Bhavanisagar Dam	61.8	94.65	0	9.19	25140	1,966,094.03	7,679,748.00	-0.3	9.05	27430	2,370,100.61	9,094,007.25
				Total		**80681**	**7,679,748.00**	**7,679,748.00**	**Total**		**83799**	**9,094,007.25**	**9,094,007.25**

Table 29 - Dredge Volumes Class-IV

6 Conclusion

The aim is to undertake bathymetric survey, topographic survey, collection of data on cargo movement, industry survey, tourism facilities etc. in the project area; prepare detailed hydrographic survey charts, topographic survey charts, and feasibility report.

6.1 Description of Waterways

The surveyed stretch of Bhavani River is non-tidal with 94.65km in length and the entire survey stretch is not explored for any type of navigation possibilities. The river chainage starts from the confluence with Kaveri near Bhavani Town to Bhavanisagar Dam. The Kalingarayan Anicut (1.54km chainage) and Kodiveri Anicut (61.81km chainage) are present in the survey stretch of Bhavani River. The river width of the Bhavani River varies from 110 to 20 meters and the water is available throughout the year. The stretch wise minimum and maximum width range, average width and average slope of the waterway are as below:-

Sl. N.	Location		Chaiange (km)		Width Range of the Waterway (m)		Average Width (m)	Average Slope (in m/km)
	From	To	From	To	Min	Max		
1	Bhavani Town	D/S Athani Bridge	0	29.23	95.34	214.14	117.28	1 : 0.665
2	U/S Athani Bridge	Kodiveri Anicut	29.23	61.8	90.71	218.92	118.90	1 : 1.209
3	Kodiveri Anicut	Bhavanisagar Dam	61.8	94.65	89.47	213.87	109.93	1 : 0.884

Table 30 - Stretch wise Average width and slope of waterway

The Bhavani River bed is mostly rocky nature and the presence of rocks on the slopes make the boat sounding not possible on the river slopes. All slopes in the area and the portion near the crossover bridges are generally shallow in nature. The water availability between 31.5km to 61.8km is very less and the navigation through this area is not possible due to very shallow and exposed rocks on the river bed.

Figure 27 - Condition of River bed - Bhavani River

6.2 Methods for Making Waterway Feasible

Improvement measures for design and depth improvement is required on first phase of the development. River banks being very prominent and the water is available in all seasons, small country made "Parasals" are used for crossing the River. There are no existing terminals, ferry service or Ro-Ro facility in the survey stretch. The class-wise details of reduced dredging quantities of the waterways are as tabulated below:-

Class	0-29.23(km)	29.23-61.8	61.8-94.65 (km)	Total
I	624,231.55	1,658,537.94	536,462.27	**2,819,231.76**
II	1,084,567.85	2,457,388.57	982,994.80	**4,524,951.22**
III	1,896,259.61	3,619,152.27	1,809,249.61	**7,324,661.49**
IV	2,430,562.87	4,293,343.77	2,370,100.61	**9,094,007.25**

Table 31 - Class-wise Reduced Dredging quantity

The design of the waterway cannot be altered to a major extent as this is used mainly for irrigation purpose and drinking water supply. The Anicuts present in the survey stretch is used for irrigation purpose, and the water through the side way canals are used at large extent for cultivating, thus detailed study on the impact of any change in the channel design needs to be carried out for the entire stretch of Bhavani River. The Bhavani River is being tributary of Kaveri River and is extensively used for several irrigation and drinking water purpose. The detailed study is required to ascertain the impact of modification to the ongoing purpose of the river. The class-wise details of reduced depth at different stretches of the waterways are as tabulated below:-

Sl. No.	Chaiange (km)		< 1.2		1.2 - 1.4		1.5 - 1.7		1.8 - 2.0		> 2.0	
	From	To	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability	Availability of Depth (km)	% of availability
1	0	29.23	5.2	18%	15.65	54%	2.29	8%	3.42	12%	2.67	9%
2	29.23	61.8	0.23	1%	31.36	96%	0.18	1%	0.41	1%	0.4	1%
3	61.8	94.65	5.42	16%	12.4	14%	4.47	6%	5.96	6%	4.61	5%
Total			**10.85**	**11.46%**	**59.41**	**62.77%**	**6.94**	**7.33%**	**9.79**	**10.34%**	**7.68**	**8.11%**

Table 32 - Class-wise availability of reduced depth of the waterway

6.3 Modifications/ Improvement Measures

The survey stretch of Bhavani River is an east flowing river with many curves or deviation throughout the river stream. A major capital dredging for improvement of depth and the dredging feasibility is limited due to presence of rocky river bed. The barrage with navigational channel and lock will be required to retain the

sufficient water level in the channel. The class-wise modification details of cross structure and high tension line clearance are as tabulated below:-

Bridges Clearances less than Class			High Tension lines Clearances less than Class	
Class	**Horizontal**	**Vertical**	**Horizontal**	**Vertical**
I	15	3	0	0
II	15	7		
III	15	11		
IV	15	15		

Table 33 - Bridges and HTL Clearances less than Class no.

6.4 Recommendation

No cargo movement or passenger movement is envisaged through this canal. However, if adequate depth and width is maintained with bank protection measures, the upstream stretches of Kodiveri and Kalingarayan Anicut can be developed for navigation. The tourism aspect of the river is limited to the stretches near Kodiveri and Kalingarayan Anicut. The major industries situated near river banks of Bhavani River are sugar factories and paper mills; however, consistent amount of cargo movement is not expected through the river. The river banks are moderately connected with road network. The settlements are clustered from of distribution and are primarily located near Bhavani and Sathyamangalam Town. No scope for the future development of the river was recommended for navigational purpose and the survey stretch is not-viable for development as navigable channel.

The purpose of the survey was for assessing the river stretch from Bhavanisagar Dam to confluence with Kaveri near Bhavani Town for proposed new national waterways of India (NW-20). The areas have been adequately spot leveled and all conspicuous objects within and in the vicinity of the survey area have been fixed. The deliverable sheets contain mean sea level values of elevation information and soundings for bathymetric information. The survey is considered complete in all respects.

7 Details of Annexures

Volume - II