FINAL FEASIBILITY REPORT ON DETAILED HYDROGRAPHIC SURVEY

VARUNA RIVER

FROM GANGA CONFLUENCE AT SARAY MOHANA

(CH 0 KM), TO ROAD BRIDGE NEAR KURU (CH 52.83 KM)

NATIONAL WATERWAY NO- 108

VOLUME – I

Submitted To

	INLAND WATERWAYS AUTHORITY OF INDIA **A-13, Sector-1,NOIDA** **DIST-Gautam Buddha Nagar** **UTTAR PRADESH** **PIN- 201 301(UP)** **Email: hc.iwai@nic.in** **Web: www.iwai.nic.in**

Submitted By

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ACKNOWLEDGEMENT

STRABAG India Pvt. Ltd. (SIPL) express their gratitude to **Shri S. K. Gangwar, Member (Technical)** and Ms**. Nutan Guha Biswas, IAS, Ex-Chairperson, IWAI** for providing us the opportunity for "Detailed Hydrographic and Topography Survey of Varuna River in Region VII of National waterways, a dream and very important part of **Nation Development**".

SIPL would also like to thank **Shri Pravir Pandey, IA & AS, Chairman, Shri Alok Ranjan, ICAS, Member (Finance) and Shri Shashi Bhushan Shukla, Member (Traffic).**

SIPL wishes to express their gratitude to **Capt. Ashish Arya, Hydrographic Chief and Cdr. P.K. Srivastava, Ex Hydrographic Chief, IWAI** for his guidance and technical inputs in this project. SIPL would also like to thank **Sh. Rajiv Singhal, A.H.S., IWAI** for his valuable support and suggestions provided through out the survey period. SIPL is pleased to place on record their sincere thanks to other staff and officers of IWAI and CWC Department.

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List of Abbreviations

SD	Sounding Datum
CD	Chart Datum
RTK	Real time Kinematic
DGPS	Differential Global Positioning Systems
TS	Total Station
GPS	Global Positioning Systems
BM	Bench Mark
MSL	Mean Sea Level
RL	Reference Level
HFL	Highest Flood Level
HTL	High Tension Line
CH	Chainage
WGS	World Geodetic System
UTM	Universal Transverse Mercator
LAD	Least Available Depth

SALIENT FEATURES AT A GLANCE

REGION-VII					
Consultant: STRABAG INDIA PVT LTD					
Name	VARUNA RIVER		**NW - 108**		
Length	52.83 km from **Ganga confluence** at Saray Mohana to road Bridge near Kuru				
State	Uttar Pradesh				
Survey Period	08th December 2015 to 06th January 2016				
Tidal / Non-tidal	Non tidal				
Availability of Depth (reduced) (mtrs)					
	0-4.95 km	**4.95-30 km**	**30-52.83 km**	**TOTAL**	
<1.2	4.95	10.3	11.53	26.78	
1.2-1.4	0	2.50	3.45	5.95	
1.5-1.7	0	3.15	3.25	6.4	
1.8-2	0	2.50	2.15	4.65	
>2.0	0	6.60	2.45	9.05	
TOTAL	4.95	25.05	22.83	52.83	
Average Slope per KM(m)	0.404	0.079	0.161		
Width Range (m)	30-35	30-40	20-30		
Bathy Survey conducted for Length (Km)	**44.47 km**				
Dredging Quantity (Observed) Cu.m					
	0-4.95 km	**4.95-30 km**	**30-52.83 km**	**TOTAL**	
Class 1	1,44,520.20	2,12,085.30	5,40,047.00	8,96,652.50	
Class 2	2,29,508.40	3,12,891.30	8,51,450.80	13,93,850.50	
Class 3	3,73,633.10	6,63,994.90	14,46,827.00	24,84,455.00	
Class 4	4,65,702.80	9,53,625.80	18,37,791.00	32,57,119.60	
Dredging Quantity (Reduced) Cu.m					
	0-4.95 km	**4.95-30 km**	**30-52.83 km**	**TOTAL**	
Class 1	2,33,419.00	3,45,161.20	7,13,519.70	12,92,099.90	
Class 2	3,49,226.40	4,94,293.90	10,88,948.40	19,32,468.70	
Class 3	5,16,534.26	9,77,259.99	17,65,477.31	32,59,271.56	

Class 4	6,13,404.38	13,27,345.21	21,77,924.40	41,18,673.99	
No. of Bridge					
19 permanent and 01 pipe line bridge					
Clearances less than Class (no.)					
Class	**Horizontal**	**Vertical**			
Class 1	**20**	**5**			
Class 2	**20**	**13**			
Class 3	**20**	**17**			
Class 4	**20**	**19**	**+03 nos. temporary bamboo bridges**		
No. of Dams, Barrages, Weirs, Anicut etc.					
1					
Chainage (km)	**Structure Name**		**Location**		**Remarks**
4.95	Puranapul Barrage		Dindayalpur		
Number of days Water not available					
CWC Gauge	No CWC gauge observed				
Cargo availability					
Nil					
Passenger Movement					
Yes					
Present IWT use					
Nil					
Recommendation of the Consultant					
1. The surveyed stretch of Varuna River is utilized by small boat for ferry/crossing the river. 2. Shallow patch is prominent in most of the places. However, U.P. Govt. has undertaken dredging work in some stretches after completion of the survey. 3. The availability of navigable water is only during monsoon season. 4. Average width of the whole river corridor is 40m – 45m and at Ganga confluence widening of river is required, as river is very narrow. 5. No major cargo available along the river. 6. Major tourist city and Ghat are available on bank of river. Ghats: - Sikraul ghat, Tariya ghat Maszidia ghat and Surva ghat. 7. Some major cities are Varanasi, Sarnath, Kashi and Mughalsarai. 8. Puranapul Barrage at Ch. 4.95 km requires navigational lock for navigation.					
Viable or not-viable					
DPR study may be carried out.					

(Signature)

Date: Name of Consultant

SECTION – I: INTRODUCTORY CONSIDERATIONS

1.1 **River Course**. Inland Waterways Authority of India has awarded contract of detailed Hydrographic Survey and feasibility report in Region VII, the National Waterways including assessment of river training works and further development cost, for eco-friendly navigation in the waterways, to STRABAG India Pvt. Ltd.

The Varuna River is a minor tributary of the Ganga. After flowing towards south east for about 70 km, it meet two more tributaries of Ganga namely Morawa river and Basuhi river. Both tributaries originates near Phulpur (about 100 km North West of Varanasi). Finally flowing through Varanasi city, the river meetsriver Ganga at Saray Mohana. Detailed hydrographic and topographic survey of Varuna River was carried out from confluence at Ganga near Saray Mohana to bridge at SH 98, Kuru.

Kashi, Benaras or Varanasi city is situated at Lat $25^0$18'N, Long $82^0$58'E, is well known for its pilgrim and educational endowments worldwide. The city is encompassed by by three rivers viz. Ganges, Varuna and Assi. The name of the city is believed to be derived from the two-river bordering the city i.e. Varuna & Assi.

Varuna is the Hindu God of water and the celestial ocean, as well as a god of law of the underwater world. The VarunaRiver is a minor tributary of the Ganga, originates from Nigoh Tehsil enactment area Gopiganj, Suriyawa and Jangiganjin district Sant Ravidas Nagar. It had its source from over-flooding of the Basuhi River and Morwa River, water reservoirs, tanks, storm water and irrigation nalas. It runs through the city of Varanasi from west and run the cross-section of city towards east convergence into Ganga. As the river reaches near Varanasi city it is observed that, flow in the river gradually reduces as the river water is extensively drawn for various purposes such as irrigation of the crops along both bank of river, for water supply to village and also to small industries situated along the bank. It is observed that many temporary residential structure have come up along the bank of the river within the flood path of the river. With the depletion in the river flow and the

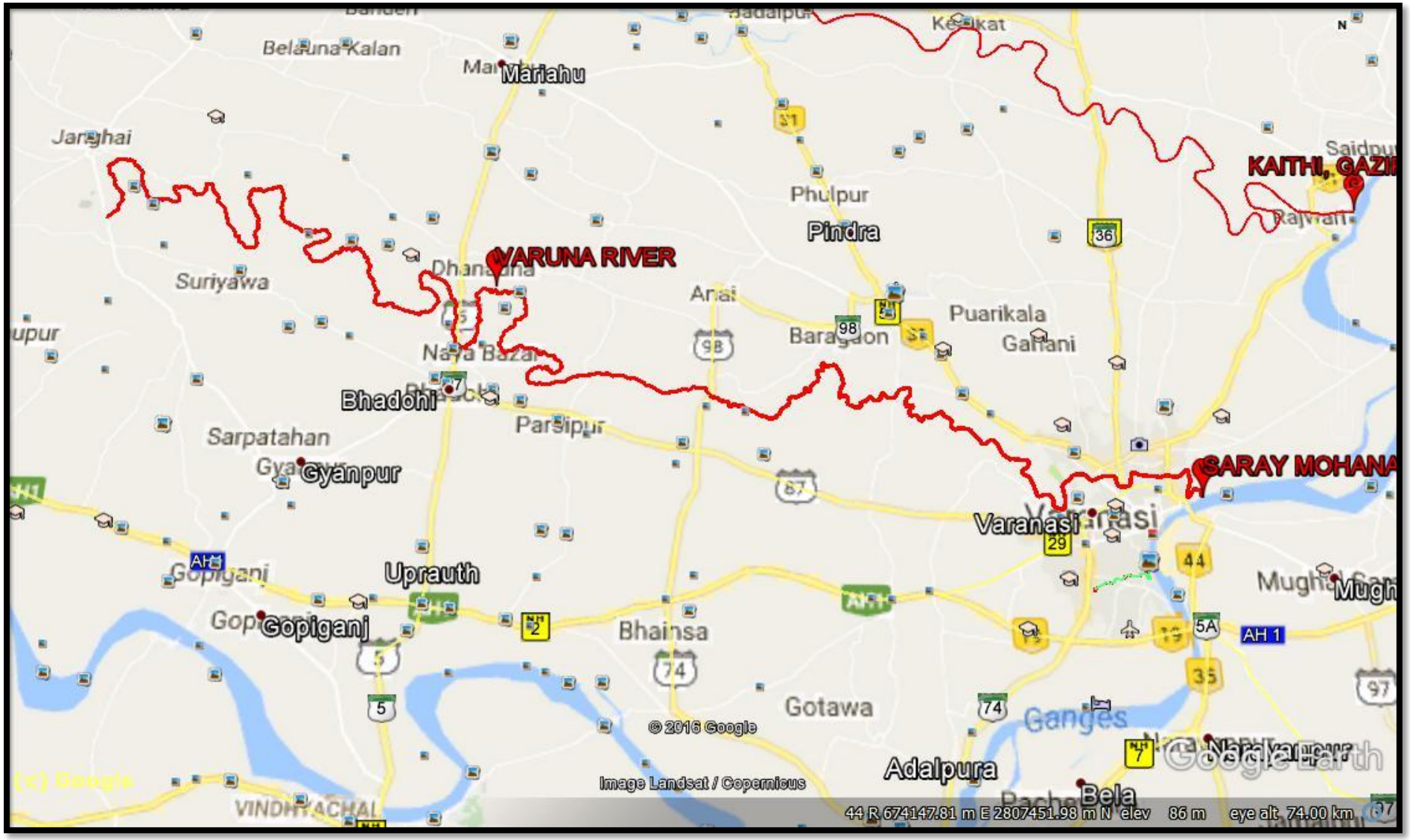
quality of water in the Varuna River after it enters Varanasi city, the condition of water quality worsens further as city drains are seen let into the river at many location is untreated

The feasibility study of Varuna River being envisaged for the development the waterway navigation and expected to provide the much-needed encouragement to various activities under vogue in and around Varanasi city which will give impetus to the tourism industry as well as provide a boost to the living standard of the local populace

1.2 **Tributaries**. No tributary was noticed in the surveyed river stretch.

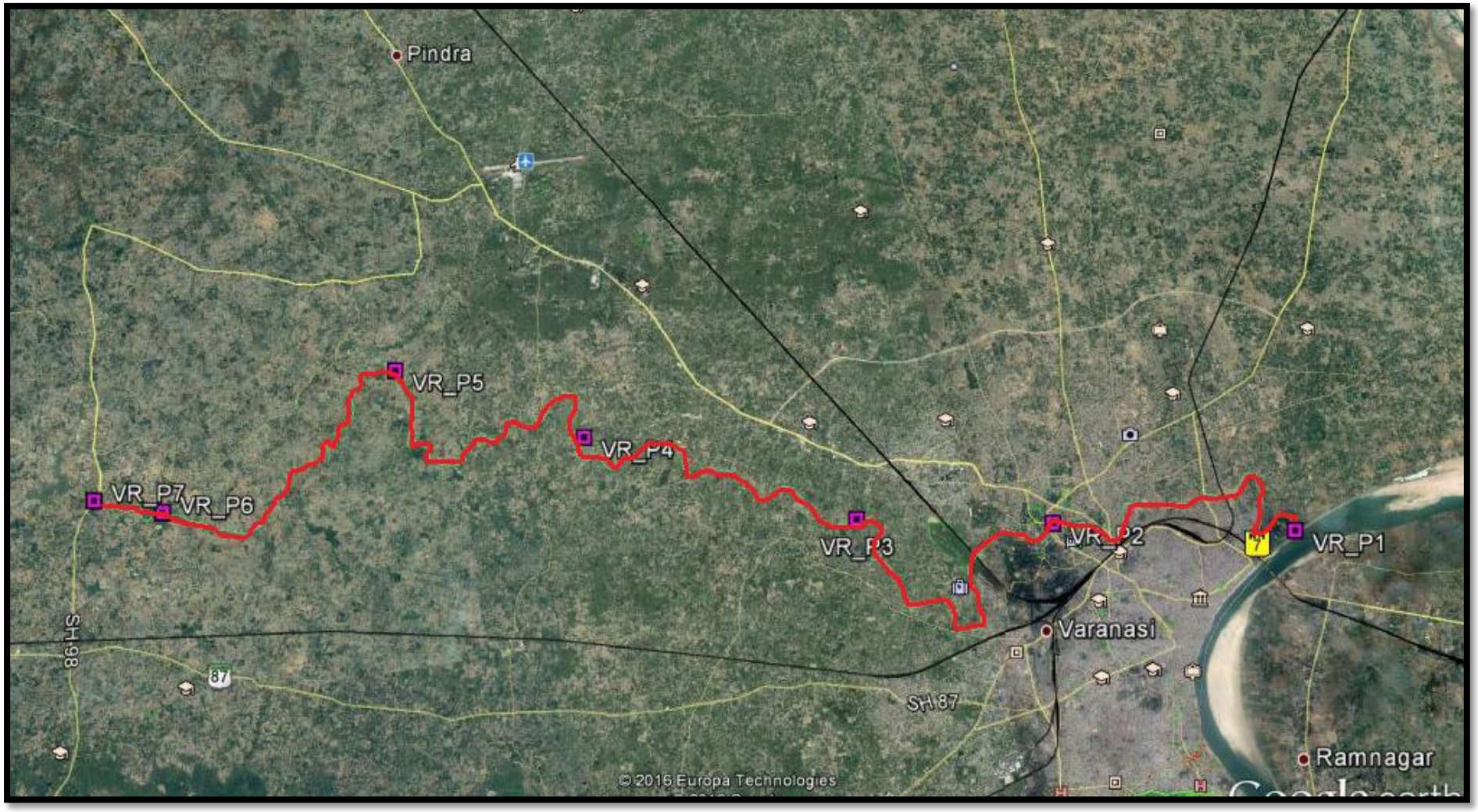
1.3 **States & Districts**. Varuna Riveroriginates from Nigoh Tehsil enactment area Gopiganj, Suriyawa and Jangiganjin district Sant Ravidas Nagar. It had its source from over-flooding of the Basuhi River and Morwa River, water reservoirs, tanks, storm water and irrigation nalas. It runs through the city of Varanasi from west and run the cross-section of city towards east convergence into Ganga. The course of waterway understudy of Varuna River is 52.83 km length of the river from Ganga confluence to upstream.

1.4 (a) **Full Course of Waterway**.



IWAI - NW-108, Varuna River (Saray Mohana to Bridge on SH 98 at Kuru)

1.4 (b) **Course of Waterway under study**.



1.5 **Scope of Works**. Strabag India Pvt Ltd. conducted hydrographic and topographic survey of Varuna River from Ganga confluence at Saray Mohana (Ch. 0 km) Lat 25°19’45.150” Long 83°02'40.09"E to Bridge on SH 98, Kuru (Ch. 52.83 km), Lat- 25°23'18.77"N, Long- 85° 44'06.69"E was carried out 08th Dec 2015 to 06thJan 2016. The scope of the work for the conduct of survey of Varuna River includes: -

- Undertake bathymetric and topographic survey of National waterway.
- Establishing horizontal and vertical control stations
- Construction of benchmark pillars and establishing its reduced level w.r.to Mean Sea Level
- Setting up and deployment of water level gauges
- Current velocity and discharge measurements
- Collection and analysis of water and bottom samples.
- A collection of topographic features including existing cross structures.
- Analysis of survey data, including assessment of water availability for navigation.
- Preparation of survey charts and feasibility report

SECTION – 2: METHODOLOGY ADOPTED TO UNDERTAKE STUDY

2.1 **Methodology**. The detailed bathymetric and topographic survey of Varuna river (52.83 km) from Ganga confluence at Saray Mohana (Ch. 0 km)Lat- 25°19’45.150” Long 83°02'40.09"E to Bridge on SH 98, Kuru (Ch.52.83 km),Lat 25°23'18.77"N, Long- 85° 44'06.69"E was carried out 08th Dec 2015 to 06thJan 2016. Details of Horizontal and Vertical Control adopted for the survey of Varuna river is placed at Annexure 7 to this report. The survey was undertaken with cross-section corridor of 100m and line spacing of 50m.The plotting of chart was done on UTM projection at zone 44N as per specification. Details of survey chart scheming and sample fair sheet is placed at Annexure 15 to this report.

2.1(a) **Personnel and Resources.** Total 32 personnel were involved which includes Party Chief, Sr. Surveyors, surveyors, helpers, cooks and drivers for the task in addition to resources viz. vehicles, logistics, etc.

2.1(b) **Equipment Used**. Various equipment's were used during the survey operations which is tabulated below as well as elaborately described in the succeeding paragraphs.

HYDROGRAPHIC SURVEY EQUIPMENTS

Equipment	Make	Qty. Deployed
Echo sounder	500 DF dual Frequency	2
DGPS	Trimble SPS 356/461	2
Current Meter	Vertical Axis-Cup Type	1
Grab Sampler	Vanveen grab	1
Software	HYPACK data acquisition	1
Tide Pole	Manual	06

TOPOGRAPHIC SURVEY EQUIPMENTS

Equipment	Make	Qty. Deployed
GPS Sets	Trimble Spectra	5
Auto Level	Leica	2
Total Station	Topcon	1
Total Station	Leica	1
Software	HYPACK data acquisition	1
Software	Autocad	1
Software	Trimble Spectra Survey office v.8	1

2.1(c) **Topographic Survey.** The Topographic survey was carried out between 08th Dec 2015 to 06thJan 2016. The weather was cold and fog, for most of the survey period. The survey was undertaken as per the approved line provided by IWAI. The spot level points in the crossline were spaced at 5 m interval. The plotting of the chart was done on UTM Projection at Zone 44N. The spot levels along the river banks and dry river beds were obtained by using Trimble DGPS in RTK mode. The topographic survey for the entire survey stretch was conducted to collect the following data: -

- Spot levels of the River bed and Banks
- 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

Topographic Spot Levelling by Trimble DGPS

The details of all spot levels are provided in the respective sheets being presented along with this report. The details of bank protection and features across the river are Placed at Annexure 5 & 6 respectively. Additionally, a soft copy of the same in XYZ format is being handed over as deliverable data.

2.1(d) **Bathymetric Survey.** Bathy 500 DF Echo Sounder was used to obtain soundings onboard the survey boat. The working frequency of 210 and 33 kHz was used for sounding operations. Trimble SP 461/ 356 DGPS was used for positioning. The digital output from the echo sounder and DGPS were automatically fed to the HYPACK data logging software on a real-time basis for the 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 cross lines were run perpendicular to the orientation of river flow (i.e. perpendicular to the orientation of depth contours) in respective stretches. The spot sounding/Topographic Spot leveling was also carried out in the area where the survey boat cannot be operated due to the low depth.

Bathymetric Survey operation

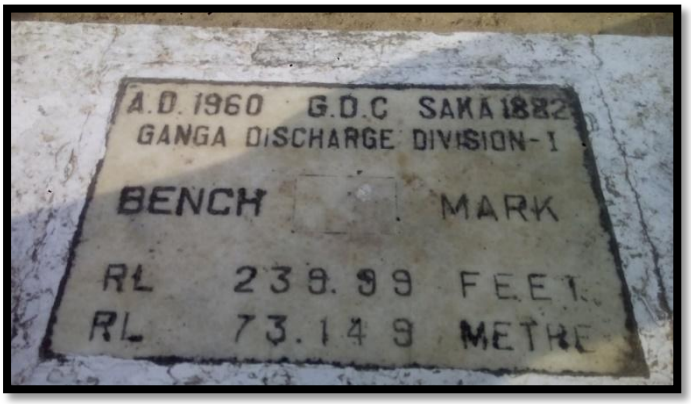
2.1(d) Calibration. The equipment used for the survey was calibrated by the equipment supplier. The equipment calibration certificates are placed at Annexure - 13 to this report.

2.2 **Description of Bench Mark**. Trimble Spectra Precision GPS system was used in standalone static observation mode for 24 hrs at Ishan Tower Hotel Building rooftop (Approx. 300m distance from Madruadih Railway Station at Varanasi U.P) which is also denoted as **Base at roof top** (Control Point). Extension of the geodetic control was achieved by setting up BM pillars throughout the river stretches at every 10km chainage. Co-ordinates of such pillars were established by simultaneous static

observations between established and new stations. The data was processed using Spectra Precision Survey Office software. Details of these BM pillars along with stationed recovery descriptions is mentioned at **Annexure 9**. CWC Benchmark was recovered near Rajghat, Varanasi, UP. Simultaneous GPS observation and levelling were carried out for establishing vertical control.

Local Bench Mark was established near Central water commission, leveling and simultaneous GPS observation were carried out with the help of Trimble Spectra Precision Positioning System for transferring of Benchmark. Tide gauges were established at 10 km interval approximately. Bench Marks were connected with the '0' of the tide pole by leveling using Auto Level. After discussion with the IWAI authorities, sounding datum were established for the total surveyed length.

Tide poles were erected at every 10 Km interval along the river for the entire duration of bathymetric survey. Tide poles were connected to the nearest Bench Mark pillars by levelling and its datum value was established w.r.t. MSL & Sounding Datum. Details of tidal observation and levelling data are placed at Annexure 4 & 11respectively.



CWC Bench Mark at Rajghat

NAME OF BM	VALUE OF CWC BM (m)	Latitude	Longitude	SD
RAJGHAT	73.149	25°19'33.37"N	83° 2'9.44"E	58.038

2.3 **Tidal Influence Zone and Tidal Variation**. Total 52.83 km length of river stretch was completely non-tidal. Water level data being attached at **Annexure- 3**along with this report.

2.4 **Methodology to Fix Sounding Datum**. The datum is adopted as per the gradient of the River and the average water level observed for the River. Sounding datum for all the tide gauge was fixed after consulting the IWAI department. In dry areas, Sounding Datum was established as per deepest bed level of the river. Level u/s & d/s of barrage is taken as datum. Datum of Ganga confluence was provided by IWAI. The details of established datum value for stretches are as tabulated below:-

Stretch (KM)		**Established SD wrt MSL (m)**
From	**To**	
0.00	1.80	58.038
1.80	5.00	60.500
5.00	8.10	66.400
8.10	15.20	66.500
15.20	25.30	66.600
25.30	35.50	66.700
35.50	45.60	66.800
45.60	51.70	66.900
51.70	52.75	67.000

2.5 **Maximum and Minimum Water Level**. No CWC gauge observed in the study stretch.

2.6 **Salient Features of Dam, Barrages, Weirs, Anicut, Locks and Aqueducts, etc**. Puranapul Barrage is located at Ch. 4.95 km. Salient features of the barrage being tabulated below:-

SALIENT FEATURES

Name of the Structure	Puranapull Barrage
Nearest city	Varanasi
District	Varanasi
State	Uttar Pradesh
Name of River	Varuna
Basin	Ganga
Size of Spillway Gates (m x m)	16.14m X 9.1m
Length of Barrage and Anicut (m)	75.10m
Width	6.5m
No of Regulator locks	07
Status of Construction	Completed

2.7 **Description of Erected Bench Mark Pillars**. New Bench Mark Pillar (07 Nos) were constructed as per the Specification of Tender Documents. The Extension of Horizontal and Vertical Control was carry out by base line processing with the nearest reference station. Details of erected BM pillars is Place at **Annexure 9**.The final accepted co-ordinate and Reference Level value of Varuna BM Pillar are as below: -

Name	Chainage (km)	Location	Latitude	Longitude	Northing (m)	Easting (m)	Height above MSL(M)	BM Ht above SD (m)
Base at roof top	-		25°17'40.976"N	82°58'25.0755"E	2799044.505	698706.071	95.658	-
VR_P1	0.01	Saray Mohana	25°19'46.08"N	83° 2'37.44"E	2803000.590	705707.353	68.547	10.509

Name	Chainage (km)	Location	Latitude	Longitude	Northing (m)	Easting (m)	Height above MSL(M)	BM Ht above SD (m)
VR_P2	10.25	ShastfriGhat	25°20'27.81"N	82°58'55.89"E	2804191.079	699492.885	69.13	2.63
VR_P3	20.3	Ahiran	25°21'4.31"N	82°55'54.62"E	2805240.194	694407.475	71.017	4.417
VR_P4	30.28	Ausanpur	25°22'49.52"N	82°51'52.24"E	2808381.145	687585.110	71.215	4.515
VR_P5	40.8	Fatehpur	25°24'18.37"N	82°49'1.50"E	2811049.276	682775.870	71.471	4.671
VR_P6	50.7	Patere	25°22'54.86"N	82°45'7.10"E	2808392.068	676258.538	74.577	7.677
VR_P7	52.6	Kalika	25°23'9.21"N	82°44'13.31"E	2808814.205	674749.046	73.702	6.702

2.8 **Description of Erected Tide Gauges**. Tide gauges were erected throughout the river stretch. Water level reading as per prescribed format along with chainage is mentioned at **Annexure 3**. The Detail of erected tide pole which are used for reduction of Sounding is as follows.

Tide Gauge No	Location	Chainage (km)	Easting/Northing (m)	Zero of Tide Gauge W.r.t MSL (m)	Period of Observation
TP1	Rajghat	0	705730.602 2803011.409	58.708	During the Conduct of Bathy Survey
TP1A	Konia	3.5	704843.966 2804664.841	60.921	During the Conduct of Bathy Survey
TP1B	Ashok Nagar	6.5	702061.373 2804270.240	66.411	During the Conduct of Bathy Survey
TP2	Sikraul	10.25	699509.880 2804189.213	66.592	During the Conduct of Bathy Survey

Tide Gauge No	Location	Chainage (km)	Easting/Northing (m)	Zero of Tide Gauge W.r.t MSL (m)	Period of Observation
TP3	Ahiran village	20.15	694376.326 2805146.610	66.493	During the Conduct of Bathy Survey
TP4	Ausanpur	30.31	687550.871 2808382.851	66.513	During the Conduct of Bathy Survey
TP5	Fateahpur	40.61	682771.803 2811035.784	66.469	During the Conduct of Bathy Survey
TP6	Patere	50.61	676235.287 2808378.643	66.84	During the Conduct of Bathy Survey
TP7	Kuru	52.75	674824.385 2808829.371	66.91	During the Conduct of Bathy Survey

Tidal Observation at Ch. 20.15 km &Ch. 30.3 km

2.9 **Chart Datum/ Sounding Datum and Reduction Details.** Sounding Datum reduction table being mentioned below:-

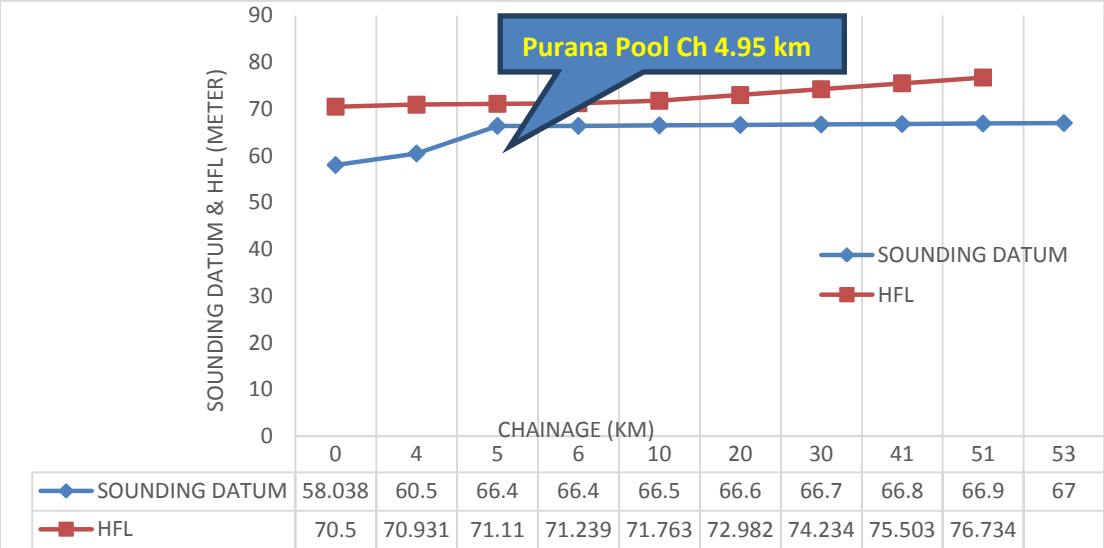
SOUNDING DATUM AT VARUNA RIVER

Location of CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and topo levels (km)		Established Sounding Datum w.r.t. MSL (m) at col. A.	Sounding Datum of Tide Gauge wrt MSL (m)	Correction in WL data for Bathymetric survey (m)	Topo level data converted as depth for volume calculation wrt SD (m)	HFL (m)
A	B	C		D +ve indicates above MSL	E	F = (E- WL data in MSL)	G = (E- topo levels in MSL)	
		FROM	To	-ve indicates below MSL				
Ganga Confl. (1262)	0.000			58.038		**Details at Annexure.**	**A separate xyz file is created.**	70.5
VR_P1	0.0	0.0	1.8		58.038			70.5
VR_P1 'A'	3.5	1.8	5.0		60.500			70.931
VR_P1 'B'	6	5.0	8.10		66.400			71.239
VR_P2	10.25	8.10	15.20		66.500			71.763
VR_P3	20.15	15.2	25.3		66.600			72.982
VR_P4	30.31	25.3	35.5		66.700			74.234
VR_P5	40.61	35.5	45.6		66.800			75.503
VR_P6	50.6	45.60	51.7		66.900			76.734
VR_P7	52.75	51.7	52.83		67.000			76.999

2.10 **HFL at Gauge Stations and Cross-Structures**. HFL at CWC Gauge station Rajghat has already been established by the CWC department and HFL for the waterway was derived as per change in the ground profile of the river.

Sl	Location and Description of CWC Gauge/ Dam/etc.	Cross-Structure Details	Chainage (km)	Established HFL wrt MSL (m)	Computed HFL at Cross – Structure wrt MSL (m)
	A	B	C	D	E
1	Ganga Confl.	Rajghat		70.500	
2	Konia Bridge	Konia	4.4		71.042
3	Konia Rail Bridge	Konia	4.45		71.048
4	PurnaPul/Barrage	Dindayalpur	4.95		71.110
5	NakkiPul	Nakki	6.35		71.282
6	Chaukaghat Bridge	Chaukaghat	8.35		71.529
7	Varuna Bridge	Sikraul	10.25		71.763
8	New Varuna Bridge	Sikraul	10.37		71.778
9	Rail Bridge	Azad Nagar	12.87		72.086
10	Rail Bridge	Azad Nagar	12.8		72.077
11	Pissaur Bridge	Pissaur	17.17		72.615
12	Koriyat Bridge	Koriyat Bridge	22.94		73.326
13	Rameshwar Old bridge	Rameshwar	33.42		74.61
14	Rameshwar New bridge	Rameshwar	33.62		74.618
15	Newada Bridge	Newada	40.81		75.503
16	Sattanpur Bridge	Sattanpur	44.35		75.995
17	Baluwa Bridge	Baluwa	49.75		76.72
18	Kalika Bridge	Kuru	52.83		77

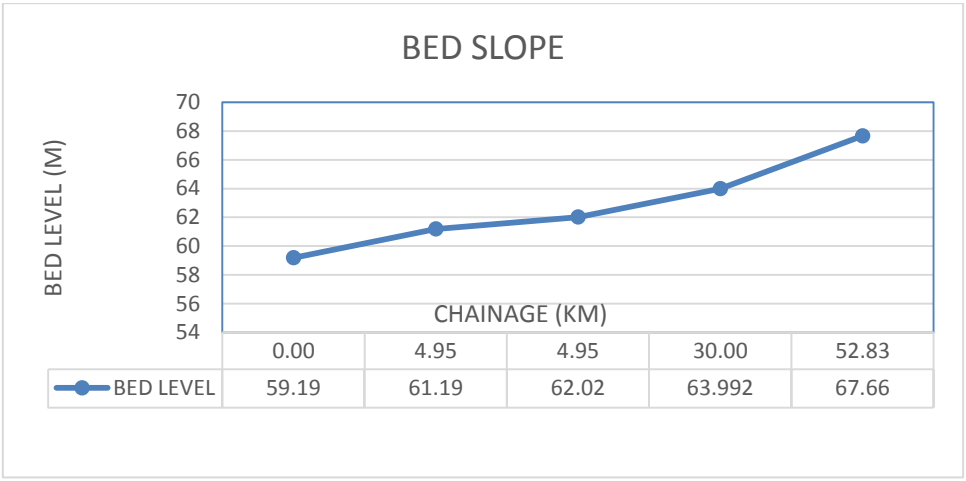
2.11 **Graph: Sounding Datum and HFL vs Chainage**.



2.12 **Average Bed Slope**. Average bed slope of the whole river stretch being tabulated below: -

Chainage (KM)		River Bed Level (m)		River Bed Level Change (m)	Distance (km)	Slope
From (km)	To (m)	From(m)	To(m)			
Ch. 0.0 km	Ch. 4.95 km	59.19m	61.19m	2.00	4.95	1:2475
Ch. 4.95 km	Ch. 30.00 km	62.02m	63.992m	1.972	25.05	1:12703
Ch. 30.00 km	Ch. 52.83 km	63.992m	67.660m	3.668	22.83	1:6224

BED SLOPE VS CHAINAGE GRAPH



2.13 **Details of Dam, Barrages, Weirs, Anicut, etc**. There is only one barrage i.e. Puranapul Barrage at Ch. 4.95 km.

Sl No	Structure Name	Chainage (km)	Location	Position (Lat Long)		Position (UTM)		ength (m)	Width (m)	Height w.r.t HFL (m)	Present condition
				Left Bank	Right Bank	Left Bank	Right Bank				
01	Puranapul Barrage	4.95	Dindayalpur	25°20'28.71"N 83° 1'22.70"E	25°20'31.90"N 83° 1'22.32"E	703597.852E 2804280.175N	703585.477E 2804378.270N	75.10	6.5	5.54	Completed

Purnapul/Barrage at Ch 4.95 km

2.14 **Details of Locks**. There is no lock observed in this portion of the river.

2.15 **Details of Aqueducts**. There is no aqueduct in this portion of the river.

2.16 **Details of Existing Bridges & Crossings**. There are total 11 in nos bridges are present across the river. Details is tabulated below: -

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance wrt HFL (m)	Remarks (Completed or not-completed)
			Left Bank	Right Bank	Left Bank	Right Bank						
1	Bamboo Bridge	0.05	25°23'11.62"N 83°02'42.47"E	25°23'11.61"N 083°02'43.32"E	705750.958E 2802983.773N	705774.783E 2803007.471N	33.6	1.5	13	2.8	-0.6	Temporary Bridge
2	U/C Bridge	0.14	25°23'11.67"N 83°02'39.14"E	25°23'11.63"N 083°02'41.68"E	705657.94E 2803044.316N	705729.050E 2803080.336N	79.7	8.07	5	25.21	-	Under Construction
3	Water Pipeline Bridge	2.11	25 23 12.0474 N 83 02 11.9503 E	25 23 12.0197 N 83 02 13.95 E	704897.651E 2803486.081N	704953.562E 2803470.177N	82.92	3	7	12.62	4.2	Completed
4	Bamboo Bridge	2.32	25°23'12.02"N 83°02'14.24"E	25°23'12.02"N 83°02'13.95"E	704961.684E 2803683.032N	705004.424N 2803670.116N	44.64	1.6	18	2.62	-0.5	Temporary Bridge
5	konia bridge	4.4	25°20'24.93"N 83° 1'42.13"E	25°20'28.36"N 83° 1'41.36"E	704142.784E 2804172.521N	704119.615E 2804277.0110N	107	6.6	6	20.2	4.528	Completed

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance wrt HFL (m)	Remarks (Completed or not-completed)
			Left Bank	Right Bank	Left Bank	Right Bank						
6	Konia Rail Bridge	4.45	25°20'24.88"N 83° 1'41.05"E	25°20'28.08"N 83° 1'40.32"E	704112.215E 2804170.089N	704090.814E 2804268.227N	101	4	6	16.7	5.144	Completed
7	Purnapul/Barrage	4.95	25°20'28.71"N 83° 1'22.70"E	25°20'31.90"N 83° 1'22.32"E	703597.852E 2804280.175N	703585.477E 2804378.270N	75.1	9.1	08	9.35	5.54	Completed
8	Nakkipul	6.35	25°20'28.08"N 83° 0'33.41"E	25°20'30.94"N 83° 0'33.53"E	702219.474E 2804240.506N	702221.775E 2804328.246N	80.4	7.5	04	25	4.739	Completed
9	Chaukaghat Bridge	8.35	25°20'4.18"N 82°59'46.85"E	25°20'6.69"N 82°59'46.71"E	700928.879E 2803485.981N	700923.912E 2803562.903N	87	19.2	4	27.2	4.499	Completed
10	Varuna Bridge	10.25	25°20'24.77"N 82°58'55.41"E	25°20'27.80"N 82°58'54.24"E	699480.068E 2804097.927N	699446.782E 2804190.980N	82	9	4	24.63	6.082	Completed
11	New Varuna Bridge	10.37	25°20'20.11"N 82°58'53.72"E	25°20'26.13"N 82°58'50.82"E	699435.183E 2803953.404N	699351.238E 2804137.100N	120	10.5	5	28.4	6.316	Completed
12	Rail Bridge	12.87	25°20'13.74"N 82°57'36.20"E	25°20'17.25"N 82°57'33.79"E	697270.279E 2803725.336N	697201.730E 2803832.704N	127	6	07	17.66	5.436	Completed
13	Rail Bridge	12.8	25°20'13.45"N 82°57'35.62"E	25°20'16.93"N 82°57'33.25"E	697254.459E 2803716.056N	697186.485E 2803822.337N	127	6	07	17.66	5.352	Completed
14	Pissaur Bridge	17.17	25°19'49.29"N 82°56'23.14"E	25°19'49.96"N 82°56'26.19"E	695238.509E 2802943.149N	695323.038E 2802965.746N	87.5	7.7	04	27.76	4.666	Completed
15	Bamboo Bridge	19.75	25°20'52.20"N 82°56'11.27"E	25°20'52.17"N 82°56,13.44"E	694878.043E 2804963.493N	694938.629E 2804958.334N	52.48	1.7	15	3.74	-0.75	Temporary
16	Koriyat Bridge	22.94	25°19'49.32"N 82°56'23.25"E	25°19'49.96"N 82°56'26.19"E	695241.010E 2802944.021N	695323.038E 2802965.746N	87.7	7.5	04	27.83	4.433	Completed
17	Rameshwar Old Bridge	33.42	25°23'14.82"N 82°51'15.42"E	25°23'15.51"N 82°51'14.25"E	686545.455E 2809145.970N	686512.781E 2809166.183N	39.85	3.8	06	6.17	1.45	Completed
18	Rameshwar New Bridge	33.62	25°23'10.94"N 82°51'8.50"E	25°23'13.80"N 82°51'8.61"E	686353.072E 2809023.566N	686355.146E 2809111.446N	87.9	7.8	4	27.9	4.643	Completed
19	Newada Bridge	40.81	25°24'19.09"N 82°48'58.22"E	25°24'21.08"N 82°49'0.07"E	682683.972E 2811070.946N	682734.127E 2811132.430N	79.3	7.8	4	25.03	3.056	Completed
20	Sattanpur Bridge	44.35	25°23'24.42"N 82°47'57.79"E	25°23'25.83"N 82°47'57.13"E	681017.970E 2809365.303N	680998.264E 2809408.469N	47.5	3.1	07	6.12	0.15	Completed
21	Baluwa Bridge	49.75	25°22'41.42"N 82°45'38.21"E	25°22'43.88"N 82°45'39.03"E	677133.990E 2807990.540N	677155.039E 2808066.474N	78.8	7.6	04	25.06	1.446	Completed
22	Kalika Bridge	52.83	25°23'13.88"N 82°44'5.69"E	25°23'16.16"N 82°44'8.12"E	674534.722E 2808955.900N	674601.594E 2809026.740N	97.4	7.7	05	23.15	2.544	Completed

2.17 **Details of Other Cross Structures**. There is only one pipe Line Bridge at Ch.2.110 km. and no underwater cable present in this river stretch.

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance wrt HFL (m)	Remarks (Completed or not-completed)
			Left Bank	Right Bank	Left Bank	Right Bank						
1	Water Pipeline Bridge	2.11	25 23 12.0474 N 083 02 11.9503 E	25 23 12.0197 N 083 02 13.95 E	704897.651E 2803486.081 N	704953.562E 2803470.177N	82.92	3	7	12.62	4.2	Completed

Water Pipe Line Bridge at Ch 2.11 km

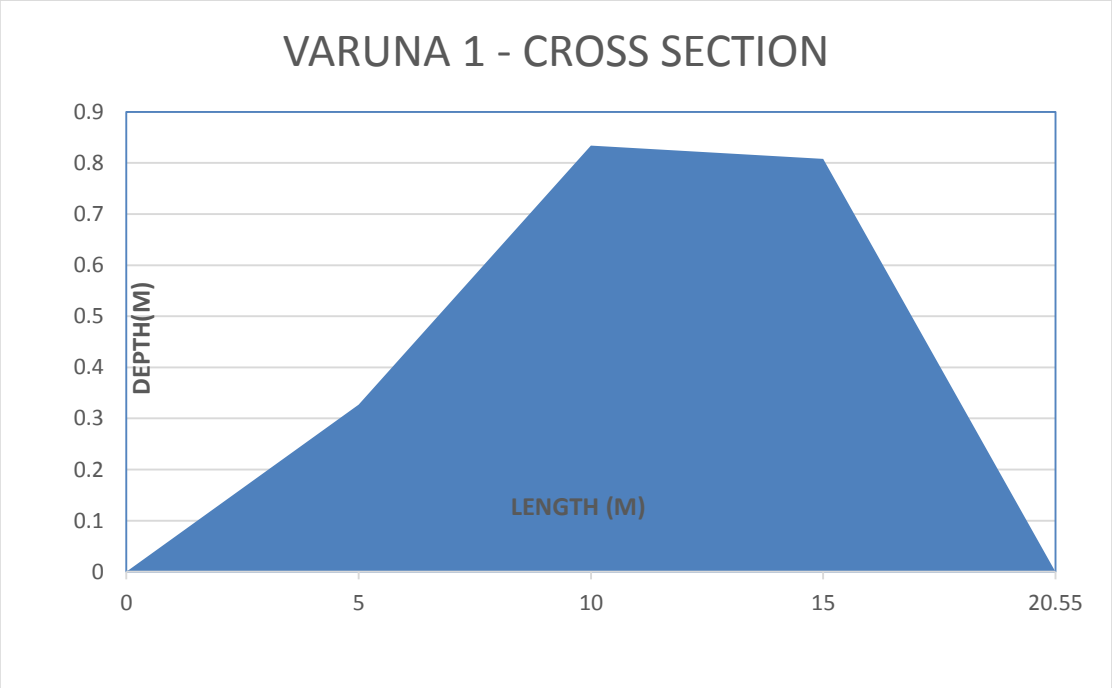
2.18 **High Tension Lines / Electric Lines / Tele-Communication Lines**. Details of HT lines and electric pole is tabulated below:-

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Vertical clearance w.r.t HFL (m)	Remarks (Completed or not-completed)
			Left Bank	Right Bank	Left Bank	Right Bank		
1	HT Line	13.25	25°20'5.58"N 82°57'28.63"E	25°20'8.00"N 82°57'22.48"E	697062.553E 2803471.986N	696889.651E 2803543.080N	19.40	Completed
2	HT Line	31.00	25°22'54.91"N 82°51'32.01"E	25°22'57.84"N 82°51'41.78"E	687017.014E 2808539.570N	687289.173E 2808633.518N	20.30	Completed
3	HT Line	31.25	25°23'4.63"N 82°51'34.19"E	25°23'3.78"N 82°51'42.87"E	687074.149E 2808839.089N	687317.445E 2808816.339N	20.50	Completed
4	Electric Line	50.86	25°22'52.40"N 82°45'3.02"E	25°22'58.31"N 82°45'3.71"E	676145.796E 2808315.834N	676162.249E 2808497.747N	7.60	Completed

2.19 **Current Meter and Discharge Details**. Current meter observations and discharge calculations were undertaken at every 10 km interval approximately. Details of the same is tabulated below:-

Sr.No	Chainage (Km)	Position				Observed Depth(m)	Velocity Mtrs/sec	X-Sectional Area (sq. m)	Discharge M^3/Sec
							0.5 D		
		Easting (m)	Northing (m)	Latitude	Longitude				
1	0.1	705694.33	2803076.81	25°19'48.56"N	83° 2'37.02"E	0.8	0.32	10.067	3.22
2	9.5	700215.07	2804180.16	25°20'27.11"N	82°59'21.73"E	2.91	0	96.316	0.00
3	20.5	694234.85	2805161.46	25°21'1.83"N	82°55'48.39"E	1.88	0.22	65.617	14.44
4	30.5	687609.16	2808546.59	25°22'54.87"N	82°51'53.18"E	2.75	0	43.244	0.00
5	38.5	682924.45	2809034.09	25°23'12.83"N	82°49'5.85"E	1.41	0	15.069	0.00
6	49.6	677293.34	2807981.48	25°22'41.06"N	82°45'43.92"E	0.8	0	9.427	0.00

VARUNA 1- CROSS SECTION



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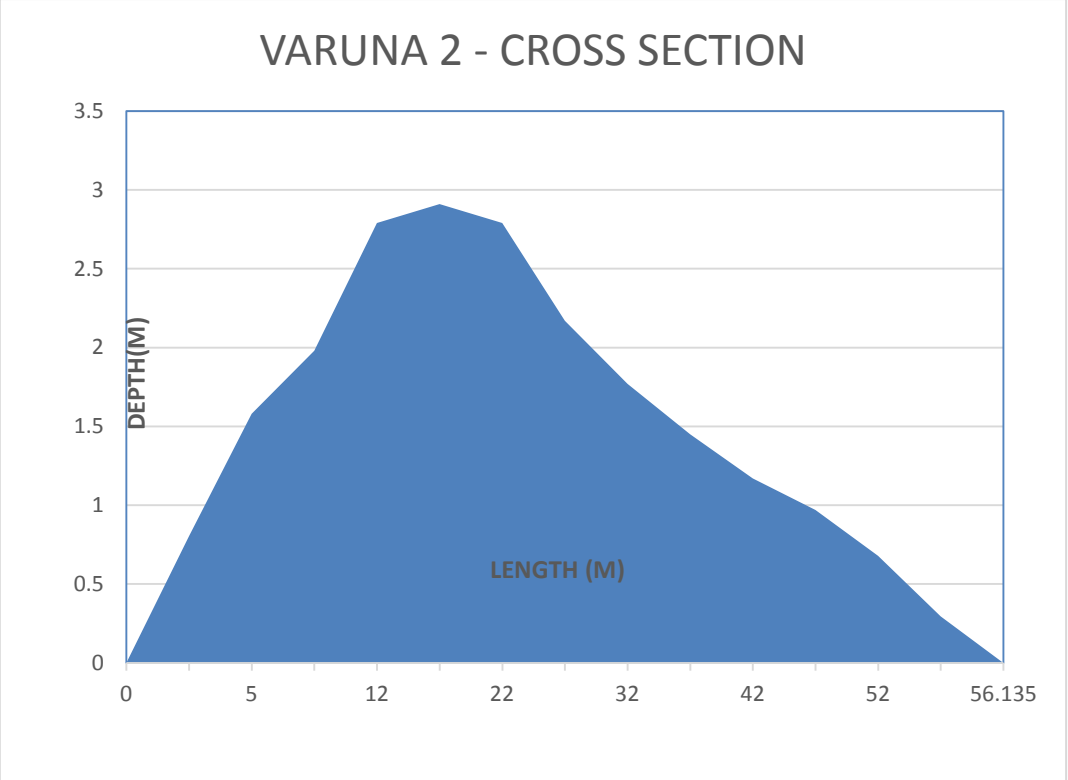

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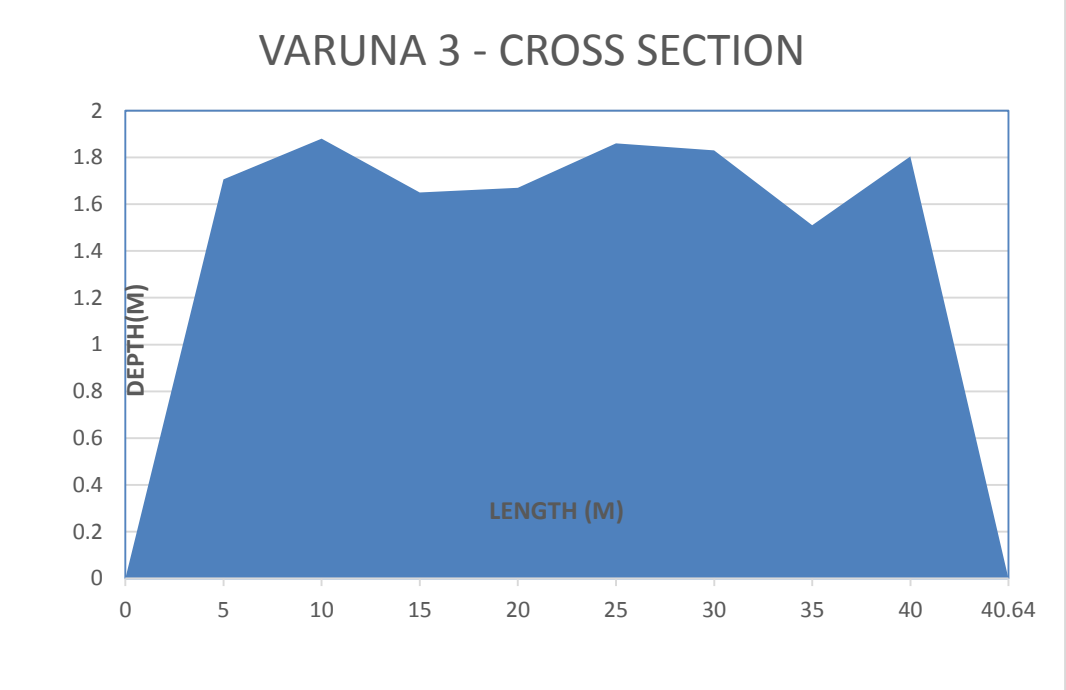

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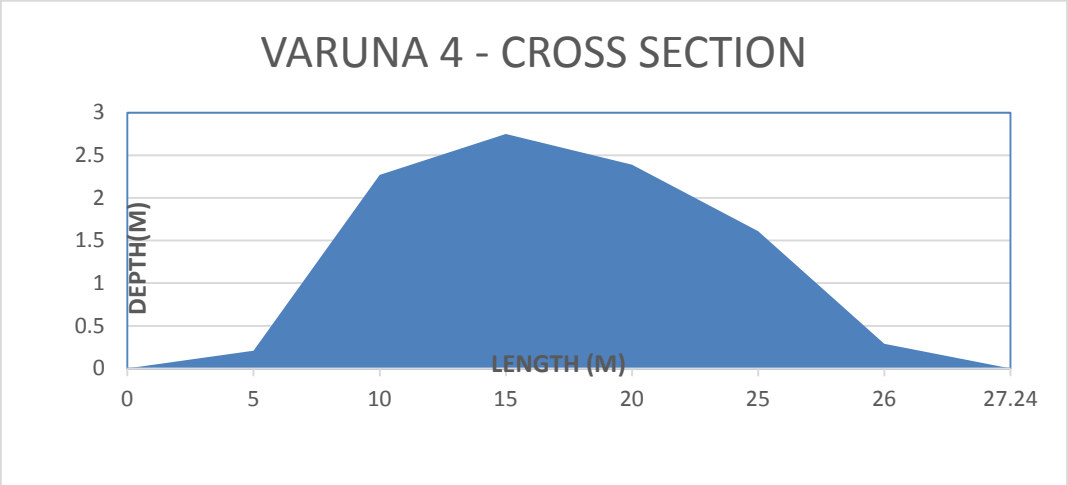

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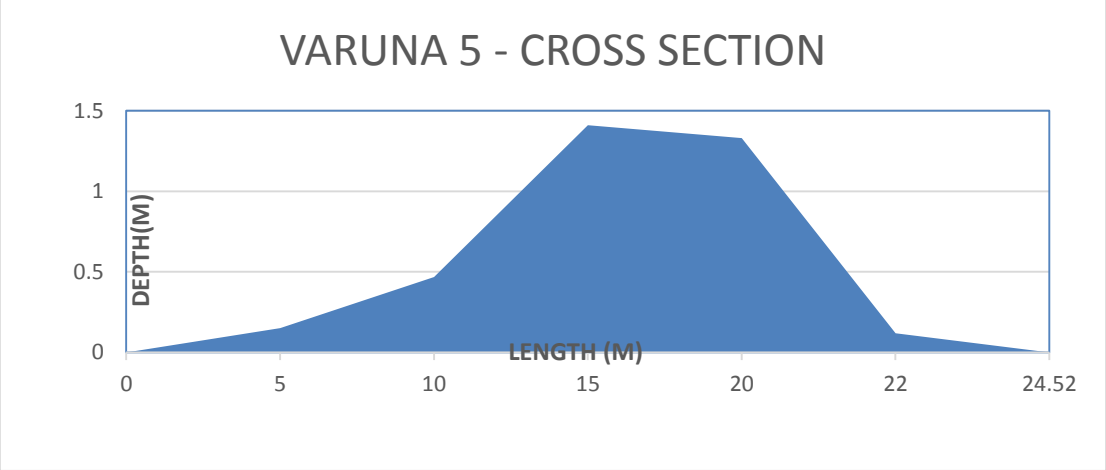

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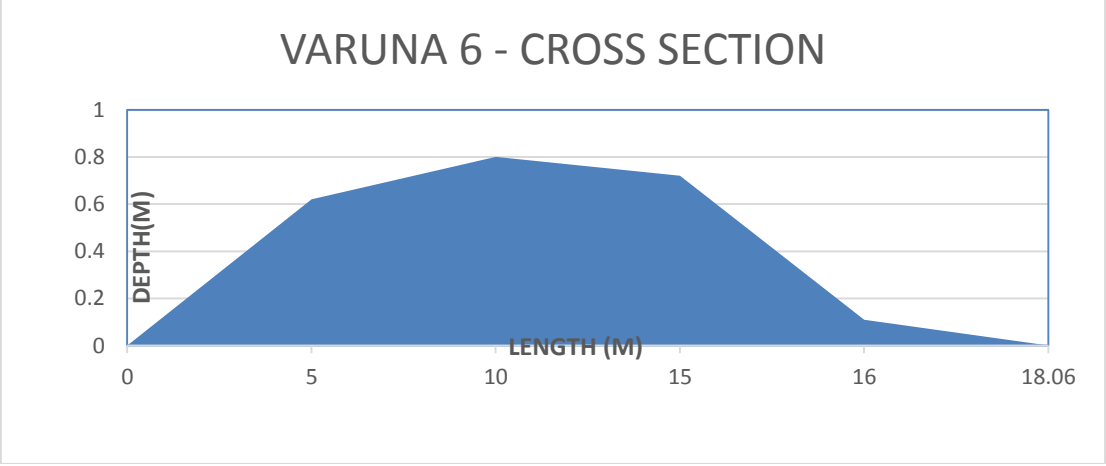


2.20(a) **Soil Sample Locations**. Details of soil sample location being appended below:-

S.No	Chainage (Km)	Easting	Northing	Latitude	Longitude	Depth (m)
1	0	705755.310	2802996.820	25°19'45.93"	83° 2'39.15"	0.8
2	10.25	699468.720	2804154.840	25°20'26.62"	82°58'55.01"	2.4
3	20.3	694433.830	2805129.064	25°21'0.70"	82°55'55.49"	3.4
4	30.31	687547.690	2808389.060	25°22'49.80"	82°51'50.89"	3.2
5	40.72	682767.510	2811016.414	25°24'17.30"	82°49'1.20"	1.4
6	50.78	676217.801	2808392.016	25°22'54.88"	82°45'5.63"	0.7
7	52.75	674629.422	2808918.407	25°23'12.64"	82°44'9.07"	0.1

2.20(b) **Water Samples**. Water sample locations are tabulated below:-

S.No	Chainage (Km)	Easting	Northing	Latitude	Longitude	Depth (m)	Mid-Depth (0.5d) (m)
1	0	705755.310	2802996.820	25°19'45.93"	83° 2'39.15"	0.8	0.4
2	10.25	699468.720	2804154.840	25°20'26.62"	82°58'55.01"	2.4	1.2
3	20.3	694433.830	2805129.064	25°21'0.70"	82°55'55.49"	3.4	1.7
4	30.31	687547.690	2808389.060	25°22'49.80"	82°51'50.89"	3.2	1.6
5	40.72	682767.510	2811016.414	25°24'17.30"	82°49'1.20"	1.4	0.7
6	50.78	676217.801	2808392.016	25°22'54.88"	82°45'5.63"	0.7	0.35
7	52.75	674629.422	2808918.407	25°23'12.64"	82°44'9.07"	0.1	0.05

SECTION-3

3.**Description of Waterway**.

3.1 **Sub-Stretch 1: From Ch 0 km to Ch 4.950 km**. This stretch of the surveyed river is having length of 4.950 km and average width of 30 m to 35 m. Current meter observation and discharge measurement were carried out at Ch. 0.10 km. There is neither any forest zone nor restricted zone. Farmers were seen engaging in agricultural activities. Primary crops are mustard, wheat, cauliflower, potato, tomato, cabbage, carrot, radish, etc.

From Ch 0 km to 4.950 km

Dredging quantity for substretch-1

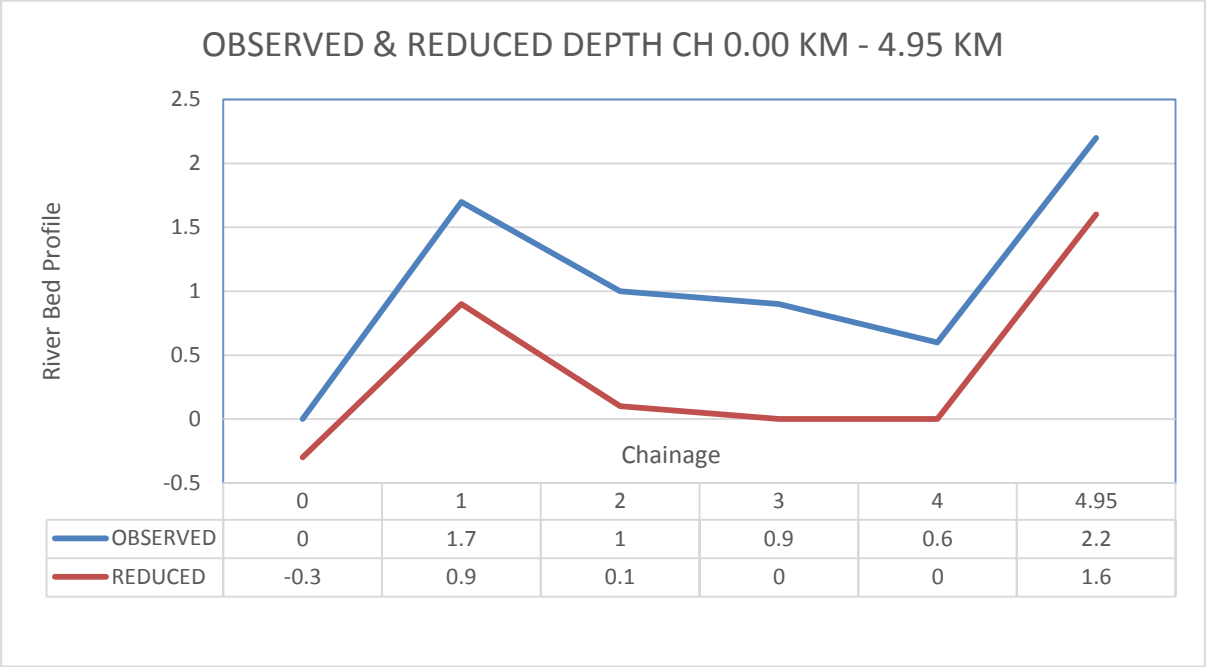
	Chainage (km)		Observed				Reduced wrt Sounding Datum			
Type	**From**	**To**	**Min Depth (m)**	**Max Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (cu.m)**	**Min Depth (m)**	**Max Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (cu.m)**
Class-I	0	4.95	0	2.3	4,500	1,44,520.20	-0.3	2.3	4,900	2,33,419.00
Class-II	0	4.95	0	2.3	4,500	2,29,508.40	-0.3	2.3	4,800	3,49,226.40
Class-III	0	4.95	0	2.3	4,500	3,73,633.10	-0.3	2.3	4,800	5,16,534.26
Class-IV	0	4.95	0	2.3	4,600	4,65,702.80	-0.3	2.3	4,800	6,13,404.38

(a) **Bathymetry Survey & Topographic Survey**.

SUB-STRETCH-1 (0-4.95 KM)		
Type of Survey	**Chainage (km)**	**Remarks**
Bathymetry Survey	0.50 km to 0.75 km	covered by bathymetric survey
	1.43 km to 2.08km	covered by bathymetric survey
	2.34 km to 4.35km	covered by bathymetric survey
Topographic Survey	0.0 km to 0.50 km	Being Dry/Very Shallow covered by topographic method
	0.75 km to 1.43 km	Being Dry/Very Shallow covered by topographic method
	2.08 km to 2.34 km	Being Dry/Very Shallow covered by topographic method
	2.34 km to 4.95 km	Being Dry/Very Shallow covered by topographic method
	0.0 km to 4.95 km	Riverbank, prominent features along the bank.

Ganga Confluence at Ch 0 km

(c) **Observed & Reduced Depth Profile of the Stretch**.Both observed and reduced depth along with slope being mentioned below:-



Chainage (km)		River Bed Level (m)		River Bed Level Change (m)	Slope
From	To	From	To		
0.0	4.95	59.19	61.19	2.00	1:2475

(d) **Prominent Dam/ Barrage**. There is only one barrage, i.e. Puranapool Barrage at Ch 4.95 km.

(d) **Tidal Stretch**. This 4.95 km of river stretch is completely non-tidal.

(e) **Bank**. The river bank of Varuna is unprotected throughout the river. But in some places, partial protection of bank was noticed especially, in and around the bridges (Konia Rail Bridge at Ch. 4.35 km, these types of protection of banks at bridges and Ghats cannot be considered as bank protection.

(f) **Hindrances**. Puranapul barrage to Saray Mohana (Ch. 4.95 km to Ch. 0 km), river is having very low depth and narrow width. Bamboo bridges across the river at Ch. 0 km and Ch. 2.11 km are also prominent, which may cause navigational interference for boats and vessels.

(g) **Encroachment**. There are no any Encroachment.in this Stretch

(h) **Protected Area**. There is no wildlife, Defence, Atomic power plant and any other procted areas in this stretch.

(i) **NH/ SH**. Only NH 29 is a cross the River in this strech.

(j) **Railway Station**. Railway stations in this stretch are Varanasi Jn, Sarnath Jn, Manduadih, Kashi and Mughalsarai station.

(k) **Land Use Pattern**. Land on either banks of the river being utilised for either agricultural or residential purpose.

(l) **Crops**. Both the banks of Varuna River are very fertile except the portion passing through the Varanasi city area. Primary crops are mustard and wheat but seasonal vegetable crops are also cultivated viz. cauliflower, potato, tomato, cabbage, carrot, radish, etc. (winter crops).

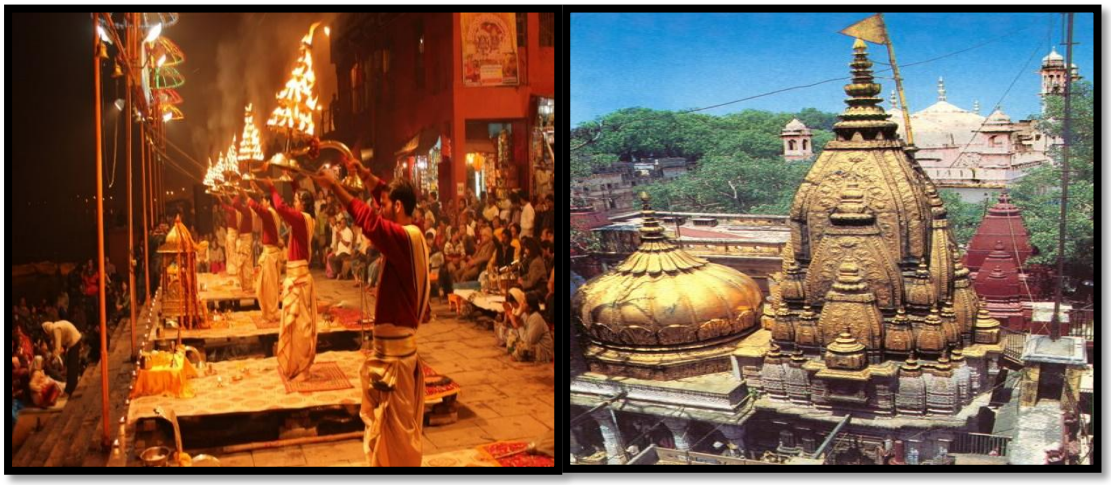
(m) **Bulk Construction Material**. There is neither any factory for construction material nor any raw material available along the corridor of the river stretch.

(n) **Existing Industry**. Major industries are silk, handloom. Handicrafts, Carpet, BHEL, Diesel Locomotive Works, Banarasi Saree, Brassware, Copperware, Wooden& Clay toys and Musical Instruments, etc.

o) **Existing Ghats, Jetties and Terminals**. There is no jetty and terminal was observed in this portion.

(p) **Cargo Movement**. There is no cargo movement observed in this portion of the water way during the course of survey.

(q) **Prominent City/ town or Place of Worship**. The only city Varanasi is situated on the bank of river Varuna. It has been a cultural center of North India for several thousand years, and is closely associated with the Ganges. This city is well connected by road and rail route.



Dashashwamedh Ghat& Kashi Vishwanath Temple

(r) **Ferry**. There are no any ferry services in this stretch

(s) **Water Sports Recreational Facilities**. There is no facility for water sports along the surveyed river stretch. In future, developed of the same is not viable throughout the river stretch. However, at Ganga confluence it can be developed due to water availability throughout the year.

(t) **Fishing Activity**. Small wooden boats were seen engaging in fishing activity in this river portion.

(u) **Sand Mining**. No sand mining activity was found in this stretch.

(v) **Tributaries**. There is no tributary is present in this portion.

(w) **Details of Irrigational Canals**. There is no irrigational canal present in this section.

(x) **Details of Nalas**. There are no any nala present in this stretch.

(y) **Usage of Water**. Water in this portion primarily irrigation purpose.

(Z) **Details of Cross-Structures**. There are total 07 in no's bridges/ cross structures are present across the river. Details is tabulated below:-

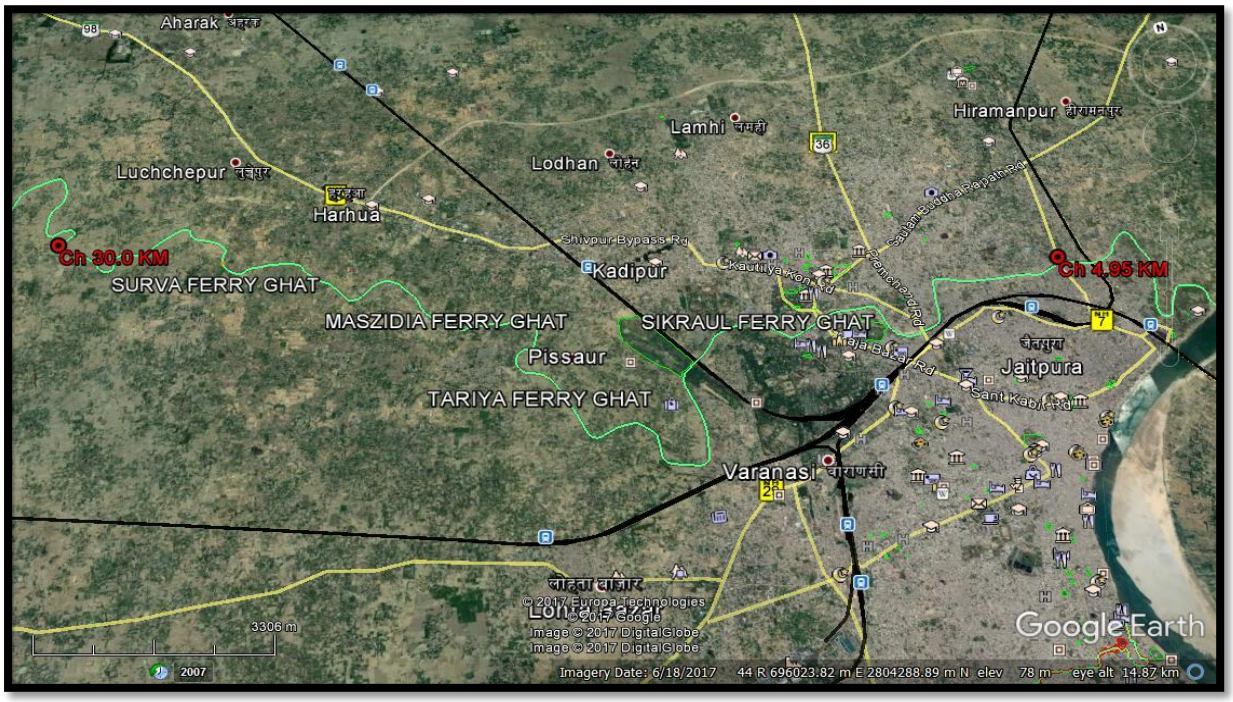
Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance wrt HFL (m)
			Left Bank	Right Bank	Left Bank	Right Bank					
1	Bamboo Bridge	0.05	25°23'11.62"N 083°02'42.47"E	25°23'11.61"N 083°02'43.32"E	705750.958E 2802983.773N	705774.783E 2803007.471N	33.6	1.5	13	2.8	-0.6
2	U/C Bridge	0.14	25°23'11.67"N 083°02'39.14"E	25°23'11.63"N 083°02'41.68"E	705657.94E 2803044.316N	705729.050E 2803080.336N	79.7	8.07	05	25.21	-
3	Water Pipeline Bridge	2.11	25 23 12.0474 N 083 02 11.9503 E	25 23 12.0197 N 083 02 13.95 E	704897.651E 2803486.081N	704953.562E 2803470.177N	82.92	3	07	12.62	4.2
4	Bamboo Bridge	2.32	25°23'12.02"N 083°02'14.24"E	25°23'12.02"N 083°02'13.95"E	704961.684E 2803683.032N	705004.424N 2803670.116N	44.64	1.6	15	2.62	-0.5
5	Konia Bridge	4.4	25°20'24.93"N 83° 1'42.13"E	25°20'28.36"N 83° 1'41.36"E	704142.784E 2804172.521N	704119.615E 2804277.0110N	107	6.6	06	20.20	4.528
6	Konia Rail Bridge	4.45	25°20'24.88"N 83° 1'41.05"E	25°20'28.08"N 83° 1'40.32"E	704112.215E 2804170.089N	704090.814E 2804268.227N	101	4	06	16.70	5.144
7	PurnaPul/Barrage	4.95	25°20'28.71"N 83° 1'22.70"E	25°20'31.90"N 83° 1'22.32"E	703597.852E 2804280.175N	703585.477E 2804378.270N	79.50	6.5	08	9.35	5.54

Waterpipe line Bridge at Ch 2.11 km and U/C Construction Bridge at ch 0.140 km

Konia Loha & Rail Bridge at Ch 4.4 km

Puranapul Barrage at Ch 4.95 km

3.2**Sub-Stretch 2: From Ch 4.95 km to Ch 30 km**. This stretch of the surveyed river is having length of 25.05 km and average width of 30 m to 40 m. Current meter observation and discharge measurement were carried out at Ch.9.50 km and Ch.20.50 km chainage. Small wooden boats were engaging in ferry service and fishing activities at Ch. 11.4 km (Sikraul Ghat), Ch. 18.3 km (Tariya Ferry Ghat),Ch. 21.15 km (Maszidia Ferry Ghat) and Ch.26.0 Km (Surva ferry Ghat). Significant untreated water discharge is prominent in this section. In this river stretch, there is neither any forest zone nor restricted zone. Farmers were seen engaging in agricultural activities. Primary crops are mustard, wheat, cauliflower, potato, tomato, cabbage, carrot, radish, etc.



From Ch 4.95 km to 30.0 km

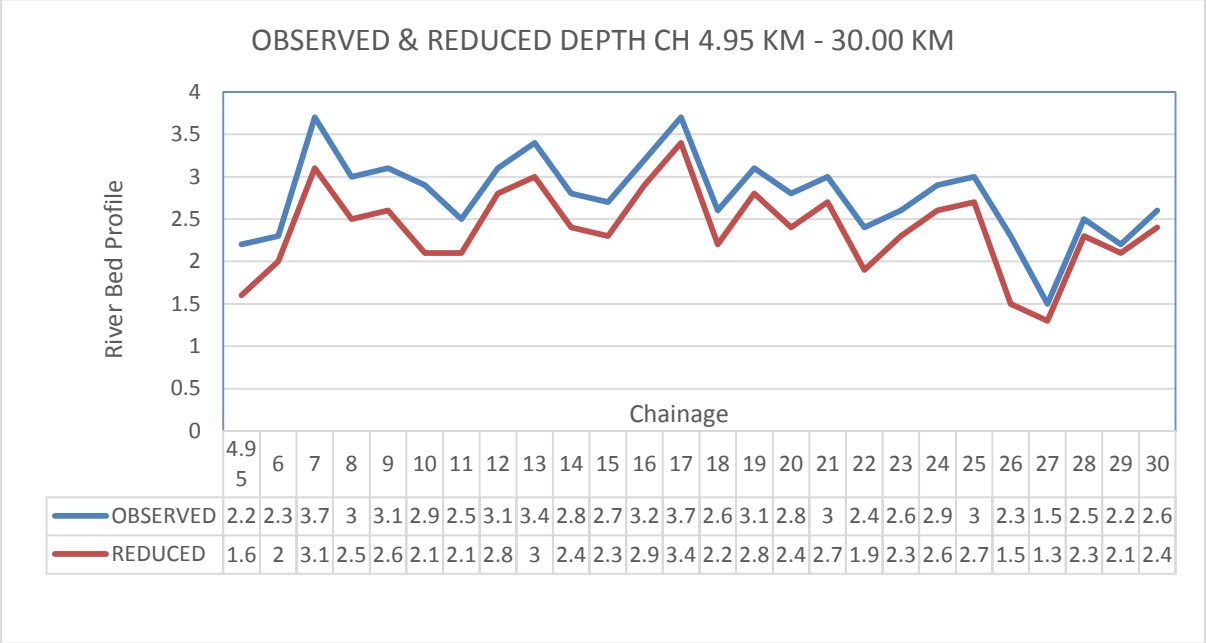
Dredging quantity for substretch-2

	Chainage (km)		Observed				Reduced w.r.t Sounding Datum			
Type	**From**	**To**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (cu.m)**	**Min Depth (m)**	**Max Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (cu.m)**
Class-I	4.95	30	0	6.5	5,200	2,12,085.30	-0.3	6.2	8,300	3,45,161.20
Class-II	4.95	30	0	6.5	5,100	3,12,891.30	-0.3	6.2	7,700	4,94,293.90
Class-III	4.95	30	0	6.5	7,100	6,63,994.90	-0.3	6.2	9,800	9,77,259.99
Class-IV	4.95	30	0	6.5	8,300	9,53,625.80	-0.3	6.2	11,600	13,27,345.21

(a) **Bathymetry Survey & Topographic Survey**.

SUB-STRETCH-1 (4.95-30.00 KM)		
Type of Survey	**Chainage (km)**	**Remarks**
Bathymetry Survey	4.95 km to 8.33 km	covered by bathymetric survey
	8.96 km to 30.00 km	covered by bathymetric survey
Topographic Survey	8.33 km to 8.96 km	Being Dry/Very Shallow covered by topographic method
	4.95 km to 30.00 km	Riverbank, prominent features along the bank.

(c) **Observed & Reduced Depth Profile of the Stretch**.Both observed and reduced depth along with slope being mentioned below:-



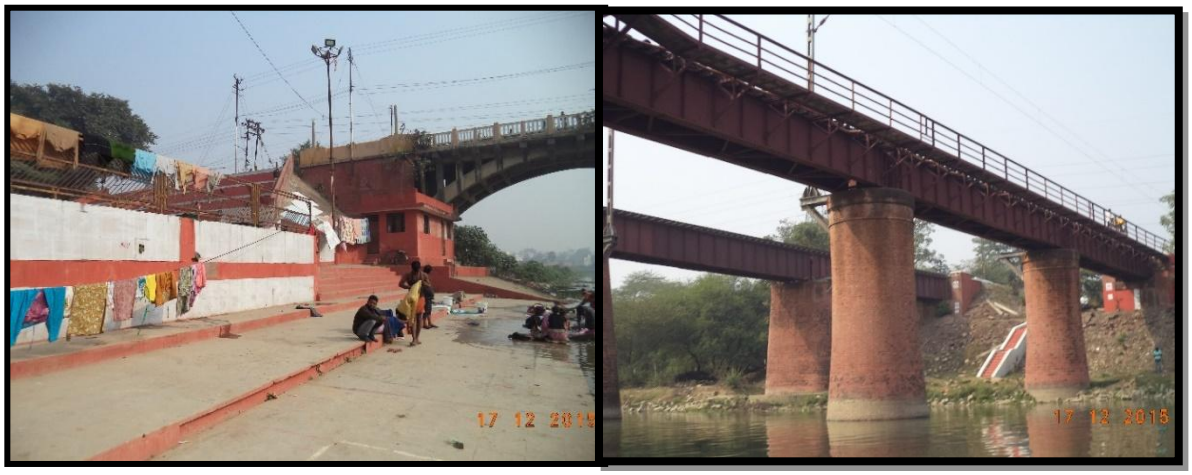
Chainage	4.95	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
OBSERVED	2.2	2.3	3.7	3	3.1	2.9	2.5	3.1	3.4	2.8	2.7	3.2	3.7	2.6	3.1	2.8	3	2.4	2.6	2.9	3	2.3	1.5	2.5	2.2	2.6
REDUCED	1.6	2	3.1	2.5	2.6	2.1	2.1	2.8	3	2.4	2.3	2.9	3.4	2.2	2.8	2.4	2.7	1.9	2.3	2.6	2.7	1.5	1.3	2.3	2.1	2.4

Chainage (km)		**River Bed Level (m)**		**River Bed Level Change (m)**	**Slope**
From	**To**	**From**	**To**		
4.95	30.00	62.02	63.992	1.972	1:12703

(d) **Prominent Dam/ Barrage**. There is only one barrage, i.e. Puranapool Barrage at Ch 4.95 km.

(d) **Tidal Stretch**. This 25.05 km of river stretch is completely non-tidal.

(e) **Bank**. The river bank of Varuna is unprotected throughout the river. But in some places, partial protection of bank was noticed especially, in and around the Koirawa Rail Bridge at Ch. 12.85 km, Pissaur Bridge at Ch. 17.2 km, Koriyat Bridge at Ch. 22.9 km) and Ghat (Lal Bahadur ShastriGhat, Ch. 10.3 km). However, these type of protection of banks at bridges and Ghats cannot be considered as bank protection.



Lal Bhadur Shastri Ghat at Ch 10.3 km & Koirawa Rail Bridge at Ch12.85 km

Pitch Portected under Bridge at Ch. 17.2 km

(f) **Hindrances**. Under water plants & heavy water cabbages were seen in many places which may cause significant hindrance for navigation. There is considerable garbage discharge in Varuna River, especially from Chaukaghat Bridge (Ch. 8.35 km) to NakhiBridge (Ch. 6.35 km). Under the Chaukaghat Bridge, stagnant water, heavy water cabbage and huge garbage dumping can be noticed and due the same, this river portion is unapproachable. Bamboo bridges across the river at Ch. 19.75 km. which may cause navigational interference for boats and vessels.

Unapproachable Part at Chauka ghat Bridge Ch. 8.35 km

Water Cabbage at Ch. 14.5 km &Ch. 17.2 km

Bamboo Bridge at Ch. 19.75 km

(g) **Encroachment**. Encroachment on the river bank is prominent on numerous ocassions.

Houses at Ch 7.2 km & Ch 7.8 km

(h) **Protected Area**. There is no wildlife, Defence, Atomic power plant and any other procted areas in this stretch.

(i) **NH/ SH**. NH 7, NH 29, NH 56, NH 73 and SH 36 are located around the river strech.

(j) **Railway Station**. Railway stations in this stretch are Varanasi Jn, Sarnath Jn, Manduadih, Kashi and Mughalsarai station.

(k) **Land Use Pattern**. Land on either banks of the river being utilised for either agricultural or residential purpose.

(l) **Crops**. Both the banks of Varuna River are very fertile except the portion passing through the Varanasi city area. Primary crops are mustard and wheat but seasonal vegetable crops are also cultivated viz. cauliflower, potato, tomato, cabbage, carrot, radish, etc. (winter crops).

Crop Cultivation on the Bank of Varuna at Ch. 18.5 km and Ch. 25 km

(m) **Bulk Construction Material**. There is neither any factory for construction material nor any raw material available along the corridor of the river stretch.

(n) **Existing Industry**. Major industries are silk, handloom. Handicrafts, Carpet, BHEL, Diesel Locomotive Works, Banaras Saree, Brassware, Copperware, Wooden& Clay toys and Musical Instruments, etc.

o) **Existing Ghats, Jetties and Terminals**. There is no jetty and terminal was observed in this portion. Ghats located in this river portion isShastriGhat.

ShastriGhat at Ch. 10.3 km

(p) **Cargo Movement**. There is no cargo movement observed in this portion of the water way during the course of survey.

(q) **Prominent City/ town or Place of Worship**. The only city Varanasi is situated on the bank of river Varuna. It has been a cultural center of North India for several thousand years, and is closely associated with the Ganges. This city is well connected by road and rail route. Prominent railway stations are Varanasi Cant, Varanasi Junction, ManduadihJn, the holy city of India, is also known by the name of Kashi and Benaras on the bank of river of Varuna. The city is having rich mythological and pilgrimage value. The famous temples are Kashi Vishwanath Temple, Sankat Mochan Temple, Annapurna Temple, Kamakhya Devi Temple, Dedareshwar Temple, Sarnath, new Biswanath Temple at BHU, etc. The city is also famous for the ghats on Ganges viz. DashashwamedhGhat, Harish Chandra Ghat, Panchaganga Ghat, Assi Ghat, Trilochan Ghat, Dr.Rajendra Prasad Ghat, Raj Ghat, etc. Remarkable tourist influx including foreign tourists can be noticed in the city.

Sarnath Temple &Sankatmochan Temple

(r) **Ferry**. Total four in nos. ferry Ghats were observed at Ch. 11.4 km (Sikraul Ferry Ghat), Ch. 18.3 km (Tariya Ferry Ghat), Ch. 21.15 km (Maszidia Ferry Ghat) and Ch.26.0 Km (Surva ferry Ghat). Small wooden boats were utilised for the ferry services across the river.

Tariya Ferry Ghat at Ch 18.3 km& Maszidiya FerrybGhat at Ch 21.15 km

(s) **Water Sports Recreational Facilities**. There is no facility for water sports along the surveyed river stretch. In future, developed of the same is not viable throughout the river stretch. However, at Ganga confluence it can be developed due to water availability throughout the year.

(t) **Fishing Activity**. Small wooden boats were seen engaging in fishing activity in this river portion.

(u) **Sand Mining**. No sand mining activity was found in this stretch.

(v) **Tributaries**. There is no tributary is present in this portion.

(w) **Details of Irrigational Canals**. There is no irrigational canal present in this section.

(x) **Details of Nalas**. There is considerable garbage discharge and untreated wastage discharge by the factories in river, especially from Chauka ghat Bridge to Nakhi Bridge. Major untreated discharge to Varuna River was observed at Ch. 5.25 km &Ch. 7.15 km. In addition to these two discharge points, there two nallas at Ch. 25.2 km and Ch. 29.75 km, which are depicted on the chart.

Sewage Discharge at Ch. 5.25 km & Sewage Discharge at Ch. 7.15 km

(y) **Usage of Water**. Water in this portion primarily irrigation purpose.

(z) **Details of Cross-Structures**. There are total 16 in nos bridges/ cross structures are present across the river. Details is tabulated below:-

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance wrt HFL (m)
			Left Bank	Right Bank	Left Bank	Right Bank					
1	PurnaPul/Barrage	4.95	25°20'28.71"N 83° 1'22.70"E	25°20'31.90"N 83° 1'22.32"E	703597.852E 2804280.175N	703585.477E 2804378.270N	79.5	6.5	08	9.35	5.54
2	NakkiPul	6.35	25°20'28.08"N 83° 0'33.41"E	25°20'30.94"N 83° 0'33.53"E	702219.474E 2804240.506N	702221.775E 2804328.246N	80.4	7.5	04	25.00	4.739
3	Chaukaghat Bridge	8.35	25°20'4.18"N 82°59'46.85"E	25°20'6.69"N 82°59'46.71"E	700928.879E 2803485.981N	700923.912E 2803562.903N	87	19.2	04	27.20	4.499
4	Varuna Bridge	10.25	25°20'24.77"N 82°58'55.41"E	25°20'27.80"N 82°58'54.24"E	699480.068E 2804097.927N	699446.782E 2804190.980N	82	9	04	24.63	6.082
5	New Varuna Bridge	10.37	25°20'20.11"N 82°58'53.72"E	25°20'26.13"N 82°58'50.82"E	699435.183E 2803953.404N	699351.238E 2804137.100N	120	10.5	05	28.40	6.316
6	Rail Bridge	12.87	25°20'13.74"N 82°57'36.20"E	25°20'17.25"N 82°57'33.79"E	697270.279E 2803725.336N	697201.730E 2803832.704N	127	6.0	07	17.66	5.436
7	Rail Bridge	12.86	25°20'13.45"N 82°57'35.62"E	25°20'16.93"N 82°57'33.25"E	697254.459E 2803716.056N	697186.485E 2803822.337N	127	6.0	07	17.66	5.436
8	Pissaur Bridge	17.17	25°19'49.29"N 82°56'23.14"E	25°19'49.96"N 82°56'26.19"E	695238.509E 2802943.149N	695323.038E 2802965.746N	87.5	7.7	04	27.76	4.666
9	Bamboo Bridge	19.75	25°20'52.20"N 082°56'11.27"E	25°20'52.17"N 082°56,13.44"E	694878.043E 2804963.493N	694938.629E 2804958.334N	52.48	1.7	15	3.74	-0.75
10	Koriyat Bridge	22.94	25°19'49.32"N 82°56'23.25"E	25°19'49.96"N 82°56'26.19"E	695241.010E 2802944.021N	695323.038E 2802965.746N	87.7	7.5	04	27.83	4.433

Nakkighat Bridge at Ch 6.35 km & Chaukaghat Bridge at Ch 8.35 km

Varuna Old Bridge at Ch 10.25 km & Varuna New Bridge at Ch 10.37 km

Koirawa Rail Bridge at Ch 12.86 & 12.87 km & Pissaur Bridge at Ch 17.17 km

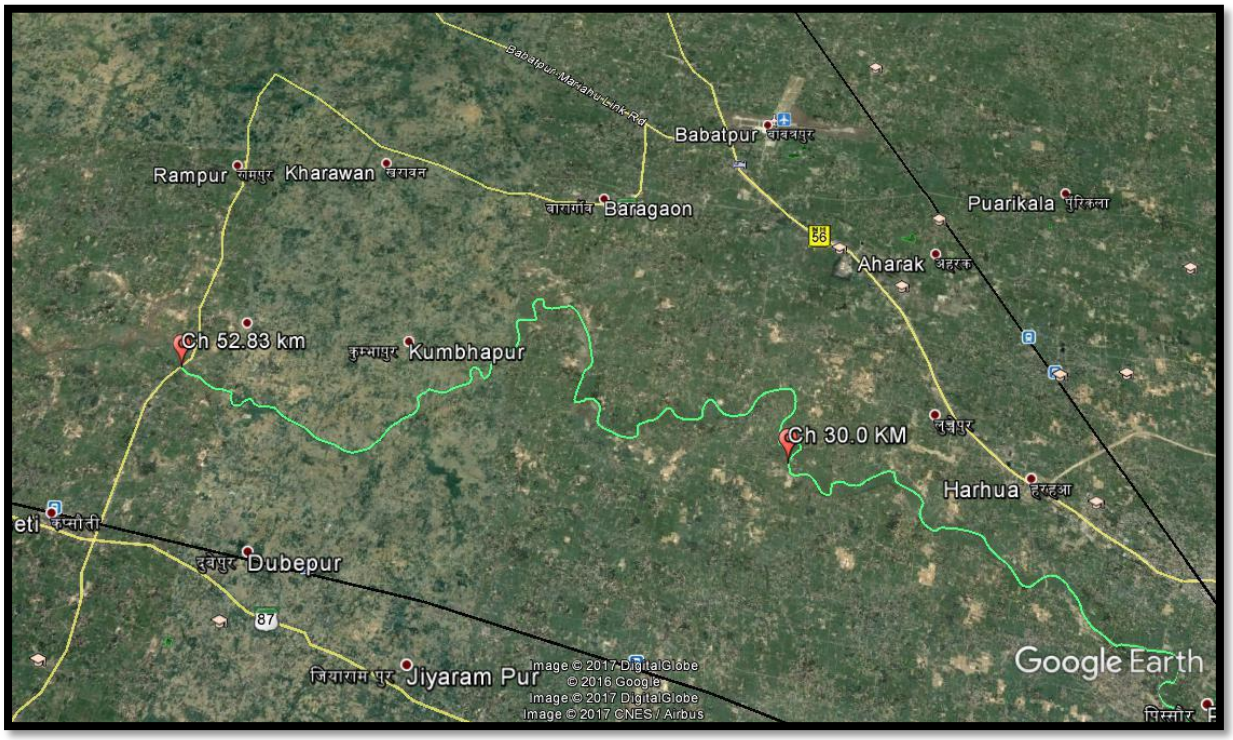
Koriyat Bridge at Ch 22.9 km

Only one HT line was present in this section. Details of HT line is tabulated below:-

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Vertical clearance w.r.t HFL (m)	Remarks (Completed or not-completed)
			Left Bank	Right Bank	Left Bank	Right Bank		
1	HT Line	13.25	25°20'5.58"N 82°57'28.63"E	25°20'8.00"N 82°57'22.48"E	697062.553E 2803471.986N	696889.651E 2803543.080N	19.40	Completed

HT Line at Ch 13.25 km

3.3 **Sub-Stretch 3: From Ch 30 km to Ch 52.83 km**. This stretch of the river is having length of 22.83 km and average width of 20m to 30m. Current meter observation and discharge measurement were carried out at Ch.30.50 km, Ch.38.50 km andCh.49.60 km. There is neither any forest zone nor restricted zone in this stretch. Cultivated crops are mustard, wheat, cauliflower, potato, tomato, cabbage, carrot, radish, etc.



Ch. 30 km to Ch. 52.83 km

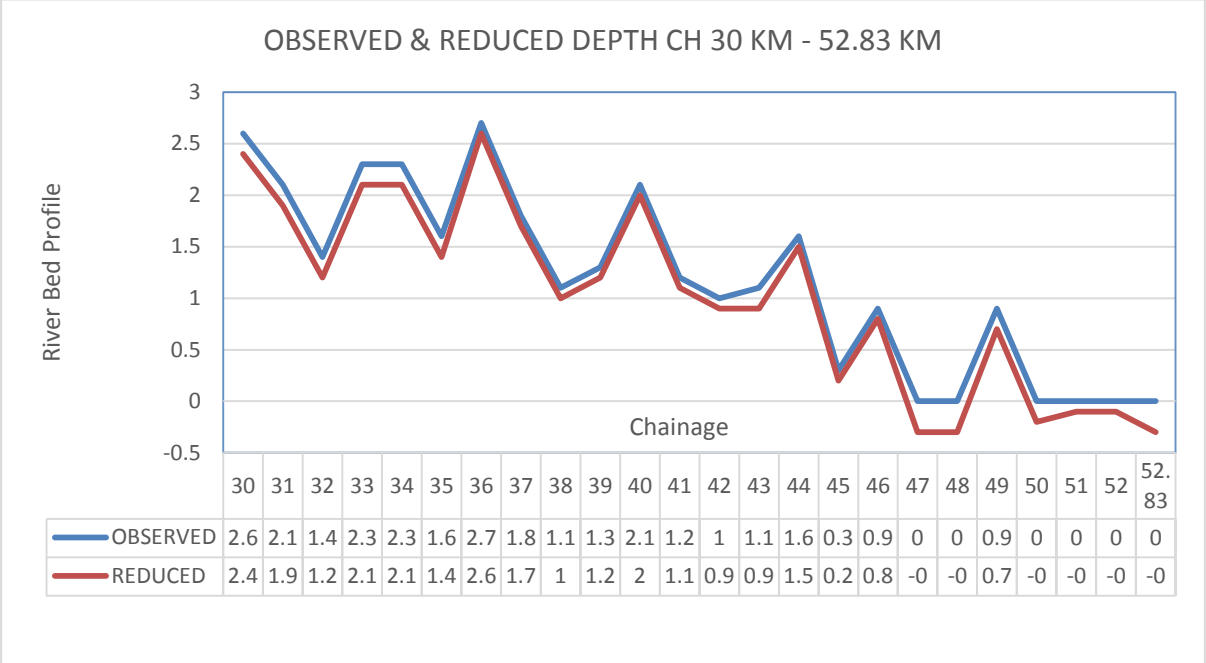
Dredging quantity for substretch-3

	Chainage (km)		Observed				Reduced wrt Sounding Datum			
Type	**From**	**To**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (cu.m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (cu.m)**
Class-I	30	52.83	0	7.2	13,400	5,40,047.00	-0.3	7.0	16,200	7,13,519.70
Class-II	30	52.83	0	7.2	13,800	8,51,450.80	-0.3	7.0	16,300	10,88,948.40
Class-III	30	52.83	0	7.2	15,300	14,46,827.00	-0.3	7.0	17,700	17,65,477.31
Class-IV	30	52.83	0	7.2	16,500	18,37,791.00	-0.3	7.0	18,300	21,77,924.40

(a) **Bathymetry Survey & Topographic Survey**.

SUB-STRETCH-1 (30.00-52.83 KM)		
Type of Survey	**Chainage (km)**	**Remarks**
Bathymetry Survey	30.00 km to 44.35 km	covered by bathymetric survey
	44.50 km to 45.80 km	covered by bathymetric survey
	48.81 km to 49.70 km	covered by bathymetric survey
Topographic Survey	44.35 km to 44.50 km	Being Dry/Very Shallow covered by topographic method
	45.80 km to 48.81 km	Being Dry/Very Shallow covered by topographic method
	49.70 km to 52.83 km	Being Dry/Very Shallow covered by topographic method
	30.0 km to 52.83 km	Riverbank, prominent features along the bank.

(c) **Observed & Reduced Depth Profile of the Stretch**.Both observed and reduced depth along with slope being mentioned below:-



	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	52.83
OBSERVED	2.6	2.1	1.4	2.3	2.3	1.6	2.7	1.8	1.1	1.3	2.1	1.2	1	1.1	1.6	0.3	0.9	0	0	0.9	0	0	0	0
REDUCED	2.4	1.9	1.2	2.1	2.1	1.4	2.6	1.7	1	1.2	2	1.1	0.9	0.9	1.5	0.2	0.8	-0	-0	0.7	-0	-0	-0	-0

Chainage (km)		River Bed Level (m)		River Bed Level Change (m)	Slope
From	To	From	To		
30.00	52.83	63.992	67.660	3.668	1:6224

(d) **Prominent Dam/ Barrage**. There is neither any dam nor any barrage exists in this stretch.

(d) **Tidal Stretch**. This river stretch is completely non-tidal.

(e) **Bank**. The river bank of this portion is unprotected. But in some places, partial bank protection was noticed especially in and around the bridge (Rameshwar Bridge at Ch. 33.65 km) and Ghat (Rameshwar Ghat, Ch.33.4 km). However, this type of protection cannot be considered as bank protection.

(f) Hindrances. Under water plankton from **Ch. 35 km to Ch. 40 km** and dry areas from **Ch. 45 km to Ch. 52.83 km** are very much prominent, which may cause navigational interference for boats and vessels.

Underwater phytoplankton at Ch. 35.5 km &Ch. 39.7 km

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Dry Areas from Ch. 45.7 to Ch. 52.83 km

(g) **Encroachment**. No encroachment was observed in this stretch.

(h) **Protected Area**. There is no wildlife, Defence, Atomic power plant and any other protected area present in this river stretch.

(i) **NH/ SH**. NH 2, NH 56, SH 87 and SH 98 are located around the river strech.

(j) **Railway Station**. There is no prominent railway station situated in this section.

(k) **Land Use Pattern**. Land on either banks of the river being utilised for either agricultural or residential purpose.

(l) **Crops**. Both the banks of Varuna River are very fertile except the portion passing through the Varanasi city area. Primary crops are mustard and wheat but seasonal vegetable crops are also cultivated viz. cauliflower, potato, tomato, cabbage, carrot, radish, etc. (winter crops).

Cultivation at Ch 27.5 km & Ch 37 km

(m) **Bulk Construction Material**. There is neither any factory for construction material nor any raw material available along the corridor of the river stretch.

(n) **Existing Industry**. There are no any existing industry in this stretch.

(o) **Existing Ghats, Jetties and Terminals**. There is no jetty and terminal was observed in this portion. Ghats located in this river portion is Rameshwar Ghat.

Rameshwar Ghat at Ch. 33.4 km

(p) **Cargo Movement**. There is no cargo movement observed in this portion of the water way during the course of survey.

(q) **Prominent City/ town or Place of Worship**. Varanasi is the prominent city for its pilgrimage value. Rameshwar Temple and Kalika Dham are also prominent tourist destination in this stretch.

(r) **Ferry**. There are no any ferry Ghat in this Stretch.

(s) **Water Sports Recreational Facilities**. There is no facility for water sports along the surveyed river stretch. In future, developed of the same is not viable throughout the river stretch.

(t) **Fishing Activity**. Small wooden boats were seen engaging in fishing activity in this river portion.

(u) **Sand Mining**. No sand mining activity was found in this stretch.

(v) **Tributaries**. There is no tributary is present in this portion.

(w) **Details of Irrigational Canals**. There is no irrigational canal present in this section.

(x) **Details of Nalas**. There are no any Nala in This Stretch.

(y) **Usage of Water**. Water in this portion primarily irrigation purpose.

(z) **Details of Cross-Structures**. There are total 06 in nos bridges are present across the river. Details is tabulated below:-

l No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (Distance Between piers) (m)	Vertical clearance wrt HFL (m)
			Left Bank	Right Bank	Left Bank	Right Bank					
1	Rameshwar Old Bridge	33.42	25°23'14.82"N 82°51'15.42"E	25°23'15.51"N 82°51'14.25"E	686545.455E 2809145.970N	686512.781E 2809166.183N	39.85	3.8	06	6.17	1.45
2	Rameshwar New Bridge	33.62	25°23'10.94"N 82°51'8.50"E	25°23'13.80"N 82°51'8.61"E	686353.072E 2809023.566N	686355.146E 2809111.446N	87.9	7.8	04	27.90	4.643
3	Newada Bridge	40.81	25°24'19.09"N 82°48'58.22"E	25°24'21.08"N 82°49'0.07"E	682683.972E 2811070.946N	682734.127E 2811132.430N	79.3	7.8	04	25.03	3.056
4	Sattanpur Bridge	44.35	25°23'24.42"N 82°47'57.79"E	25°23'25.83"N 82°47'57.13"E	681017.970E 2809365.303N	680998.264E 2809408.469N	47.5	3.1	07	6.12	0.15
5	Baluwa Bridge	49.75	25°22'41.42"N 82°45'38.21"E	25°22'43.88"N 82°45'39.03"E	677133.990E 2807990.540N	677155.039E 2808066.474N	78.8	7.6	04	25.06	1.446
6	Kalika Bridge	52.83	25°23'13.88"N 82°44'5.69"E	25°23'16.16"N 82°44'8.12"E	674534.722E 2808955.900N	674601.594E 2809026.740N	97.4	7.7	05	23.15	2.544

Rameshwar Old Bridge at Ch. 33.42 km & Rameshwar New Bridge at Ch. 33.62 km

Newada Bridge at Ch 40.81 kmSattanpur Bridge Ch 44.35 km

Baluwa Bridge Ch 49.75 km & Kalika Dham Bridge Ch 52.83 km

There are 02 HT lines and one Electric Pole is present in this section.

Sl No	Cross-Structure Name	Chainage (km)	Position (Lat Long)		Position (UTM)		Height of vertical clearancewrt HFL (m)
1	HT Line	31	25°22'54.91"N 82°51'32.01"E	25°22'57.84"N 82°51'41.78"E	687017.014E 2808539.570N	687289.173E 2808633.518N	20.30
2	HT Line	31.25	25°23'4.63"N 82°51'34.19"E	25°23'3.78"N 82°51'42.87"E	687074.149E 2808839.089N	687317.445E 2808816.339N	20.50
3	Electric Line	50.86	25°22'52.40"N 82°45'3.02"E	25°22'58.31"N 82°45'3.71"E	676145.796E 2808315.834N	676162.249E 2808497.747N	7.60

HT Line at Ch 31.00 & Ch 31.25 km

HT Line at Ch 50.86

SECTION – 4

4.1**Terminals.** There is no terminal present in this waterway. However, development of terminal at Puranapul barrage is strongly recommended due to depth availability throughout the year proximity to the road rail networks. NH 29 is passing across the Varuna River over the barrage. Varanasi City & Varanasi Cant. Railway stations are located 2.5 km and 6 km away from the proposed terminal respectively. This proposed terminal will cater for passenger as well as cargo movement throughout the river. Details of the proposed terminal being tabulated below: -

Sl No	Ch (km)	Location	Position (Lat/ long)		Position (UTM)		Length (m)	Width (m)	Area (sq.m)	Present Land Use
			Start	End	Start	End				
01	5.1	Puranapul Barrage	25°20'30.26" N 83° 1'16.40"E	25°20'31.50" N 83° 1'20.82"E	703420.29E 2804325.25 N	703543.60E 2804365.13 N	125	20	2500	Agricultural Land

Proposed Terminal at Ch. 5.1 km

SECTION – 5

5.1 Fairway Development

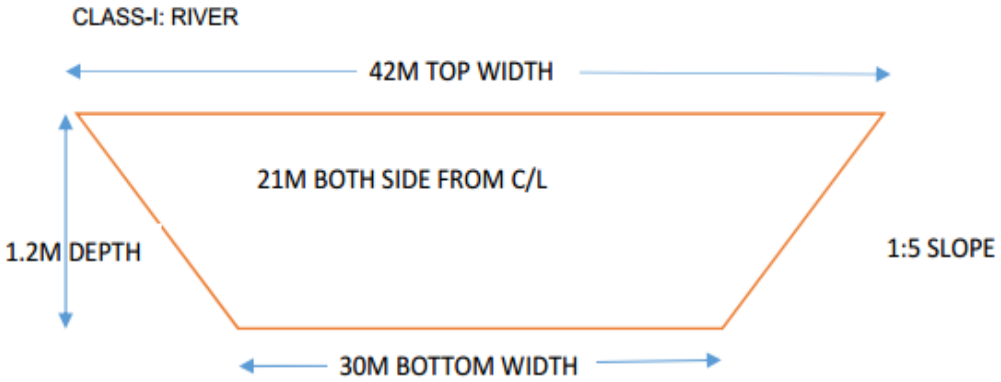
The dredging channel is designed by linking deepest sounding of each cross sections and the dredging quantity is estimated for developing a navigable channel with the following dimension. The best suitable dredging channel class for the survey stretch of Varuna River is identified as Class-II and the dredge volume for the Class I to Class-IV were also calculated for the entire survey stretch. The details of Fairway channel dimension used for the dredging calculation are as follows: -

Class of Channel Depth (m) Bottom	Depth (m)	Bottom width (m)	Slope
Class -I	1.2	30	1:5
Class -II	1.4	40	1:5
Class -III	1.7	50	1:5
Class -IV	2	50	1:5

5.2 Calculation of Dredging Quantity The dredge volume calculations were accomplished using the HYPACK dredge volume computation utility. For clarity and ease of calculations, the complete channel profile was divided into segments of 1 km

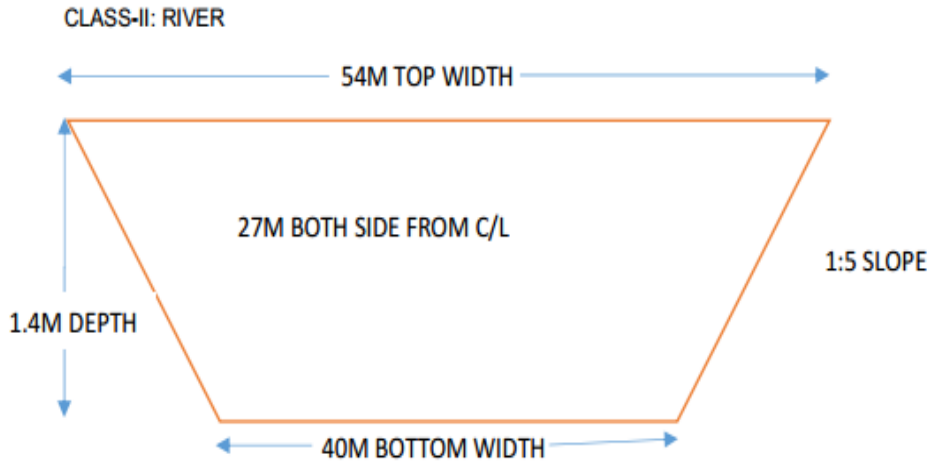
each (enclosed at Annexure-2). The Tin v/s Channel volume with Hypack Standard algorithm was used to calculate the dredge volume. The stretch wise summary of the dredge volume for a different class of fairway is as follows: -

1) 30m x 1.2m with side slope 1:5, along the deepest route.



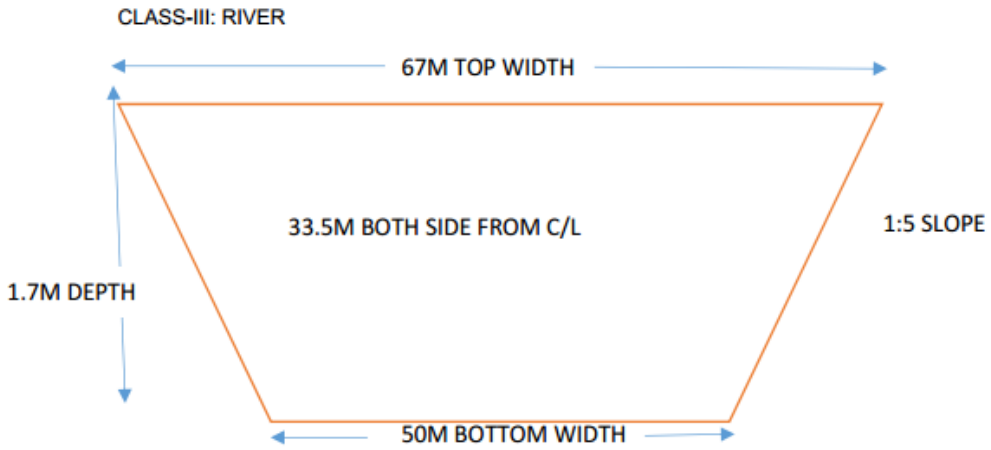
CLASS - I											
Chainage (km)		**Observed**					**Reduced w.r.t Sounding Datum**				
From	**To**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (Cu.m)**	**Cumulative Drg. Qty. (cu.m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (Cu.m)**	**Cumulative Drg. Qty. (cu.m)**
Rajghat Ch.0.0 km	Dindayalpur Ch. 4.95 km	0	2.3	4,500	1,44,520.22	1,44,520.22	-0.3	2.3	4,900	2,33,419.00	2,33,419.00
Dindayalpur Ch. 4.95 km	Ausanpur Ch.30.0 km	0	6.5	5,200	2,12,085.33	3,56,605.55	-0.3	6.2	8,300	3,45,161.20	5,78,580.20
Ausanpur Ch.30.0 km	Kuru Ch. 52.83 km	0	7.2	13,400	5,40,047.00	8,96,652.55	-0.3	7	16,200	7,13,519.70	12,92,099.90

2) 40m x 1.4m with side slope 1:5, along the deepest route.



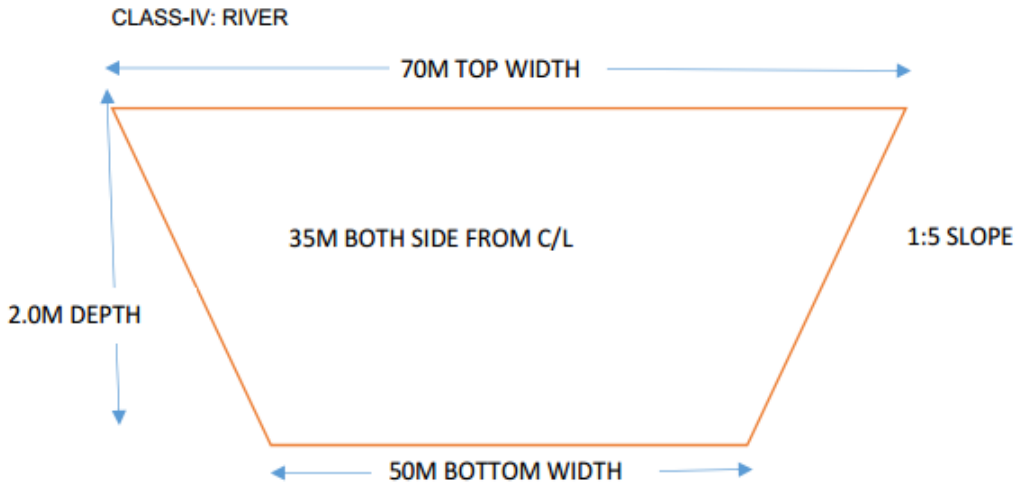
CLASS - II											
Chainage (km)		**Observed**					**Reduced w.r.t Sounding Datum**				
From	**To**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (Cu.m)**	**Cumulative Drg. Qty. (cu.m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (Cu.m)**	**Cumulative Drg. Qty. (cu.m)**
Rajghat Ch.0.0 km	Dindayalpur Ch. 4.95 km	0	2.3	4,500	2,29,508.40	2,29,508.40	-0.3	2.3	4,800	3,49,226.40	3,49,226.40
Dindayalpur Ch. 4.95 km	Ausanpur Ch.30.0 km	0	6.5	5,100	3,12,891.30	5,42,399.70	-0.3	6.2	7,700	4,94,293.90	8,43,520.20
Ausanpur Ch.30.0 km	Kuru Ch. 52.83 km	0	7.2	13,800	8,51,450.80	13,93,850.50	-0.3	7	16,300	10,88,948.40	19,32,468.60

3) 50m x 1.7m with side slope 1:5, along the deepest route.



CLASS - III											
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)**	**Cumulative Drg. Qty. (cu.m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (Cu.m)**	**Cumulative Drg. Qty. (cu.m)**
Rajghat Ch.0.0 km	Dindayalpur Ch. 4.95 km	0	2.3	4,500	3,73,633.14	3,73,633.14	-0.3	2.3	4,800	5,16,534.26	5,16,534.26
Dindayalpur Ch. 4.95 km	Ausanpur Ch.30.0 km	0	6.5	7,100	6,63,994.90	10,37,628.04	-0.3	6.2	9,800	9,77,259.99	14,93,794.25
Ausanpur Ch.30.0 km	Kuru Ch. 52.83 km	0	7.2	15,300	14,46,827.12	24,84,455.16	-0.3	7	17,700	17,65,477.31	32,59,271.56

4) 50m x 2.0m with side slope 1:5, along the deepest route.



CLASS - IV											
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)**	**Cumulative Drg. Qty. (cu.m)**	**Min. Depth (m)**	**Max. Depth (m)**	**Length of Shoal (m)**	**Dredging Qty (Cu.m)**	**Cumulative Drg. Qty. (cu.m)**
Rajghat Ch.0.0 km	Dindayalpur Ch. 4.95 km	0	2.3	4,600	4,65,702.83	4,65,702.83	-0.3	2.3	4,800	6,13,404.38	6,13,404.38
Dindayalpur Ch. 4.95 km	Ausanpur Ch.30.0 km	0	6.5	8,300	9,53,625.83	14,19,328.66	-0.3	6.2	11,600	13,27,345.21	19,40,749.59
Ausanpur Ch.30.0 km	Kuru Ch. 52.83 km	0	7.2	16,500	18,37,790.67	32,57,119.33	-0.3	7	18,300	21,77,924.40	41,18,673.99

SECTION – 6

6.1**Conclusion**. The river corridor consists of a length of 52.83 km from Saray Mohana, Varanasi at Ganga confluence (Ch. 0 km) to Bridge on SH 98, Kuru (Ch. 52.83 km). The whole river is non-tidal (Ch. 0.0 to Ch. 52.83km) and is one of the tributary of Ganga. The surveyed stretch of Varuna River is utilized by small boat for ferry services and the waterway can be best utilized for cargo transfer and passenger ferry services on improving the depth of existing waterway. There are many cross structures exist in the waterway, which are presently in use. The dredging on the Waterway of Varuna River will improve the depth of the channel for navigational requirement.

Shallow patch is prominent in most of the places. Total length of the waterway is having different range of depths below 1.2 m total length is 26.78km. Depth of 5.95 km of river is 1.2 m to 1.4 m. Length of the river with a depth range 1.5 m to 1.7 m is 6.4 km. There is a length of 4.65 km of river which has a depth range 1.8 m to 2 m. The length of the river having depth more than 2 m is 9.05 km. The only barrage, i.e. Puranapul Barrage is located at Ch.4.95 km. The Minimum & Maximum Vertical and horizontal clearance of the cross structure is 2.62m to 28.4m and -0.75m to 6.316m.The Minimum & Maximum Vertical clearance of the cross structure power cable is 7.6m to 20.5 m.

There is neither any protected area (Atomic/ Port/ Wildlife/ Research) nor any hindrance exist in the whole waterway. Information gathered from local populace that, the availability of maximum water is only during monsoon season. There is no cargo, passenger ferry and tourism facility is available in the river stretch. Both banks of the Varuna River is very much fertile. Cultivation of wheat, mustard, peas, potato and carrot etc. has been noticed during the course of survey. Land along the river is mainly utilized for agricultural purpose. However, in some places, it is also used as residential purposes. The whole river stretch is well connected with the rail and road networks within 2 to 7 Km. Major Railway stations in this stretch are Varanasi Jn, SarnathJn, Manduadih, Kashi and Mughalsarai station. Presently, small wooden boats are engaging for ferry services viz. Sikraul Ferry Ghat (Ch. 11.4 km), Tariya Ferry Ghat (Ch. 18.3 km), Maszidia Ferry Ghat (Ch. 21.15 km) and Surva Ferry Ghat (Ch. 26 km).

The only city Varanasi is situated on the bank of river Varuna. The famous temples are Kashi Vishwanath Temple, SankatMochan Temple, Annapurna Temple, Kamakhya Devi Temple, Dedareshwar Temple, Sarnath, new Biswanath Temple at BHU, etc. The city is also famous for the ghats on Ganges viz. Dashashwamedh Ghat, Harish Chandra Ghat, Panchaganga Ghat, Assi Ghat, Trilochan Ghat, Dr. Rajendra Prasad Ghat, Raj Ghat, etc.

There is no terminal and jetty is present in the river stretch. However, development of terminals near Puranapul barrageis strongly recommended due to depth availability throughout the year and proximity to the road/rail networks. This proposed terminal at Ch. 5.10 km will cater for passenger as well as cargo movement throughout the river.

The feasibility survey was carried out at river Varuna from Ganga confluence to Kalikadham Bridge, a length of about 52.83 km. The Dredging quantity being tabulated below: -

	Drg. Qty. (cu.m)
Class I	12,92,099.88
Class II	19,32,468.60
Class III	32,59,271.60
Class IV	41,18,674.00

Average width of the whole river corridor is 40m – 45m and hence development of dredging channel as per Class I being strongly recommended.

Consultant Recommendation

- Average width of the river is 40-45 m.
- Average discharge of the river is 2.94 Cu.m/s.
- Total 20 (19+01 Pipeline Pul) numbers of bridges were found and 20 no's of bridges required to be modified for development of declared watereway in Class-I.
- No cargo movement or IWT operation is observed along the entire stretch.

- The availability of navigable water is only during monsoon seasion.
- Major tourist city and Ghats are available on bank of river. Ghats: - Sikraul ghat, Tariya ghat, Maszidia ghat and Surva ghat.
- Some major cities are Varanasi, Sarnath, Kashi and Mughalsarai.
- The dredging required for different classes are as follow.

Class	Reduced (Cu.m)
Class I	12,92,099.90

Conclusion of feasibility study.

A DPR was prepared by Varanasi Development Authority during 2009-10 for 18 km stretch near Varanasi.

DPR may be updated / prepared for 25 km stretch from Ganga river confluence.