

**FEASIBILITY REPORT ON
DETAILED HYDROGRAPHIC SURVEY IN
CHENAB RIVER (34.22 KM) FROM CHENAB ROAD BRIDGE TO BRIDGE NEAR
BHARDA KALAN (REGION-I, NW- 26)**

Submitted To



INLAND WATERWAYS AUTHORITY OF INDIA
A-13, Sector-1,
NOIDA
DIST-Gautam Buddha Nagar
UTTAR PRADESH
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Submitted By



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**VOLUME – I
MAIN REPORT**

23 December 2017

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**Survey Period: 25 Nov 2016 to 6 Jan 2017
23 December 2017**

ACKNOWLEDGEMENT

Tojo Vikas International Pvt. Ltd. (TVIPL) express their gratitude to **Ms. Nutan Guha Biswas, IAS, Chairperson**, for spending their valuable time and guidance for completing this Project of "Detailed Hydrographic Survey in Chenab River". We would also like to thanks **Shri Pravir Pandey, Vice-Chairman (IA&AS), Shri Alok Ranjan, Member (Finance) and Shri S.K.Gangwar, Member (Technical)**.

TVIPL wishes to express their gratitude to **Shri S.V.K. Reddy Chief Engineer-I, Cdr. P.K. Srivastava, Ex-Hydrographic Chief, IWAI** for his guidance and inspiration for this project. We would also like to thank **Shri Rajiv Singhal, A.H.S.** for invaluable support and suggestions provided throughout the survey period. TVIPL is pleased to place on record their sincere thanks to other staff and officers of IWAI for their excellent support and co-operation through out the survey period.

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List of Abbreviations:

BM	- Bench Mark
CD	- Chart Datum
DGPS	- Differential Geo Positioning System
GTS	- Great Trigonometric Survey
LAD	- Least Available Depth
MSL	- Mean Sea Level
PPK	- Post Processing Kinematics
SD	- Sounding Datum
RTK	- Real Time Kinematics
TBM	- Temporary Bench Mark
TS	- Total Station

VOLUME –II: DRAWINGS

Drawing Title	Drawing Number	Sheet No.	Scale
Composite Map	TVIPL/IWAI/CNB/DD/01	01 of 01	1:25,000
Detailed Hydrographic & Topographic Survey	TVIPL/IWAI/CNB/DD/01	01 to 07	1:5,000

SALIENT FEATURES AT A GLANCE

#	Particulars	Details																																																
1.	Name of Consultant	Tojo Vikas International Pvt. Ltd.																																																
2.	Region number & State(s)	Region- I State- Jammu & Kashmir																																																
3.	Waterway stretch, NW Number (From.... To, total length)	Waterway Stretch- Chenab River Waterway Name- NW- 26 Waterway Description- Chenab Road Bridge 33°5' 7.34"N, Long 74°48'6.16"E to bridge near Bhardakalan Village Lat 32°48' 12.42"N, Long 74°34'53.24"E Total Length- 53 km as per Work Order but 34.22 km length was done on field due to Sensitive area near Indo-Pak Border.																																																
4.	<u>Navigability status</u>	Not Navigable on Present Condition of River																																																
a)	Tidal & non tidal portions	Non Tidal																																																
b)	LAD status (w.r.t. CD)																																																	
	i) Survey period																																																	
	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)																																																	
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Grand Total					34.22																																													

<p>c) Cross structures</p> <p>i) Dams, weirs, barrages etc. (total number; with navigation locks or not)</p> <p>ii) Bridges, Power cables etc. [total number; range of horizontal and vertical clearances]</p>	<p>Dams- Not Present</p> <p>Weirs- Not Present</p> <p>Barrages- Not Present</p> <p>Navigational Lock- Not Present</p> <p>Bridges- 4 Nos.</p> <p>Vertical Clearance- w.r.t to HFL 3.65 m to 33.50 m</p> <p>Horizontal Clearance- 16.0m - 150.0 m</p> <p>Power Cable- 2 Nos.</p> <p>Vertical Clearance w.r.t to HFL - 25 m to 30 m</p> <p>Horizontal Clearance- 300 m - 400 m</p>
<p>d) Avg. discharge & no. of days</p>	<p>448.692 Cu.m/Sec</p>
<p>e) Slope</p>	<p>Average bed Slope- 1:231</p>
<p>5. <u>Traffic potential</u></p>	<p>Not Available</p>
<p>Present IWT operations, ferry services, tourism, cargo, if any</p> <p>a)</p>	<p>Not Present</p>
<p>Important Industries within 50 km</p> <p>b)</p>	<p>Not Present</p>
<p>Distance of Rail & Road from Industry</p> <p>c)</p>	<p>Not Applicable</p>
<p>Consultant's recommendation for going ahead with TEF / DPR preparation</p> <p>6.</p>	<p>Recommendation for not going ahead with TEF/ DPR Preparation.</p>
<p>Any other information/ comment</p> <p>7.</p>	

Date:

(Signature)
Name of Consultant

1. INTRODUCTION

1.1 River Course

Name of River- Chenab

Origin – Bara Lacha Pass

End - Mithankot

Length of River – 960 km

Chenab River is a major river of India and Pakistan. It forms in the upper Himalayas in the Lahaul and Spiti district of Himachal Pradesh, India, and flows through the Jammu region of Jammu and Kashmir into the plains of the Punjab, Pakistan. The waters of the Chenab are allocated to Pakistan under the terms of the Indus Waters Treaty.

The waters of the Chenab start from snow melt from the Bara Lacha Pass, 32°44'N 77°26'E, in Himachal Pradesh. The waters flowing south from the pass are known as the Chandra River and those that flow north are called the Bhaga River. Eventually the Bhaga flows around to the south joining the Chandra at the village of Tandi. A motorable road runs along the Bhaga River, from Khokhsar to Tandi. The Chandra and Bhaga meet to form the Chandrbhaga River at Tandi. It becomes the Chenab when it joins the Marau River at Bhandera Kot, 12 km from Kishtwar Town in Jammu and Kashmir.

It flows from the Jammu region of Jammu and Kashmir into the plains of the Punjab, forming the boundary between the Rechna and Jech interfluves (Doabs in Persian). It is joined by the Jhelum River at Trimmu and then by the Ravi River Ahmedpur Sial. It then merges with the Sutlej River near Uch Sharif, Pakistan to form the Panjnad or the 'Five Rivers', the fifth being the Beas River which joins the Sutlej near Ferozepur, India. The Chenab then joins the Indus at Mithankot. The total length of the Chenab is approximately 960 kilometres.

The river was known to Indians in the Vedic period as Chandrabhaga also Ashkini or Iskmati and as Acesines to the Ancient Greeks. In 325 BC, Alexander the Great allegedly founded the town of Alexandria on the Indus (present day Uch Sharif or Mithankot or Chacharan in Pakistan) at the confluence of the Indus and the combined stream of Punjab rivers (currently known as the Panjnad River).

The Chenab has the same place in the consciousness of the people of the Punjab as, say, the Rhine holds for the Germans or the Danube for the Austrians and the Hungarians. It is the iconic river around which Punjabi consciousness revolves, and plays a prominent part in the tale of Heer Ranjha, the Punjabi national epic and the legend of Sohni Mahiwal.

1.2 Tributaries / Network of Rivers / Basin

The tributaries of the Chenab River include Miyar Nalla, Sohal, Thiroth, Bhut Nalla, Marusudar and Lidrari. Marusudar is regarded as the biggest tributary of Chenab and joins Chenab in Bhandalkot. Kalnai, Neeru, Bichleri, Raghi and join the Chenab between Kishtwar and the Akhnoor region. Chenab is joined by Tawi as well as Manawar Tawi within Pakistan.

Two streams namely Chandra and Bhaga rise on the opposite sides of the Baralacha pass at an elevation of 4,891 metres and meet at Tandi at an elevation of 2,286 metres to form the river Chenab. The Chenab rises from the South-East and Bhaga from the North-West of the Baralacha pass. It enters Pangli valley of Chamba district near Bhujind and leaves the district at Sansari Nala to enter Podar valley of Kashmir. It flows in Himachal for 122 km. With its total length of 1,200 km., it has a catchment area of 61,000 sq. km., out of which 7,500 sq. km. lie in Himachal Pradesh. It is the largest river of Himachal Pradesh in terms of volume of waters. The Chenab valley is a structural trough formed by the great Himalayan and Pir Panjal ranges.

Bhaga River:

This river originates from the Lahaul valley. A number of Snow fed Rivers join it during its course, before it joins the Chandra stream at Tandi. From its origin it flows in South-South-Westerly direction as a raging torrent before joining the river Chandra. U shaped valleys, waterfalls, glaciers and moraines characterize the upper catchment of the Bhaga River. The entire tract is devoid of a vegetative cover. The discharge of this river increases during the summer months, when the snow on the high mountains starts melting.

Chandra River:

It rises in the snows lying at the base of the main Himalayan range in Lahaul-Spiti district. Thereafter it flows for a considerable distance along the base of thin range in the South-East direction, before making a 180° turn and taking a South-West course in Spiti valley. The entire area is a vast cold desert that receives little or no rain as it lies in the rain shadow of the Pir Panjal range lying towards South. The important human settlement along the river is Koksar.

1.3 State/ District through which River Passes

Chenab River flows from India to Pakistan. It flows through Lahaul and Spiti District of Himachal Pradesh, Keylong, Tholang, Udaipur, Kishtwar, Doda, Chanderkote, Ramban, Dharmkund, Sawalkot, Salal, Reasi and Akhnoor, Jammu and Kashmir.

1.4 Map of River and Waterway

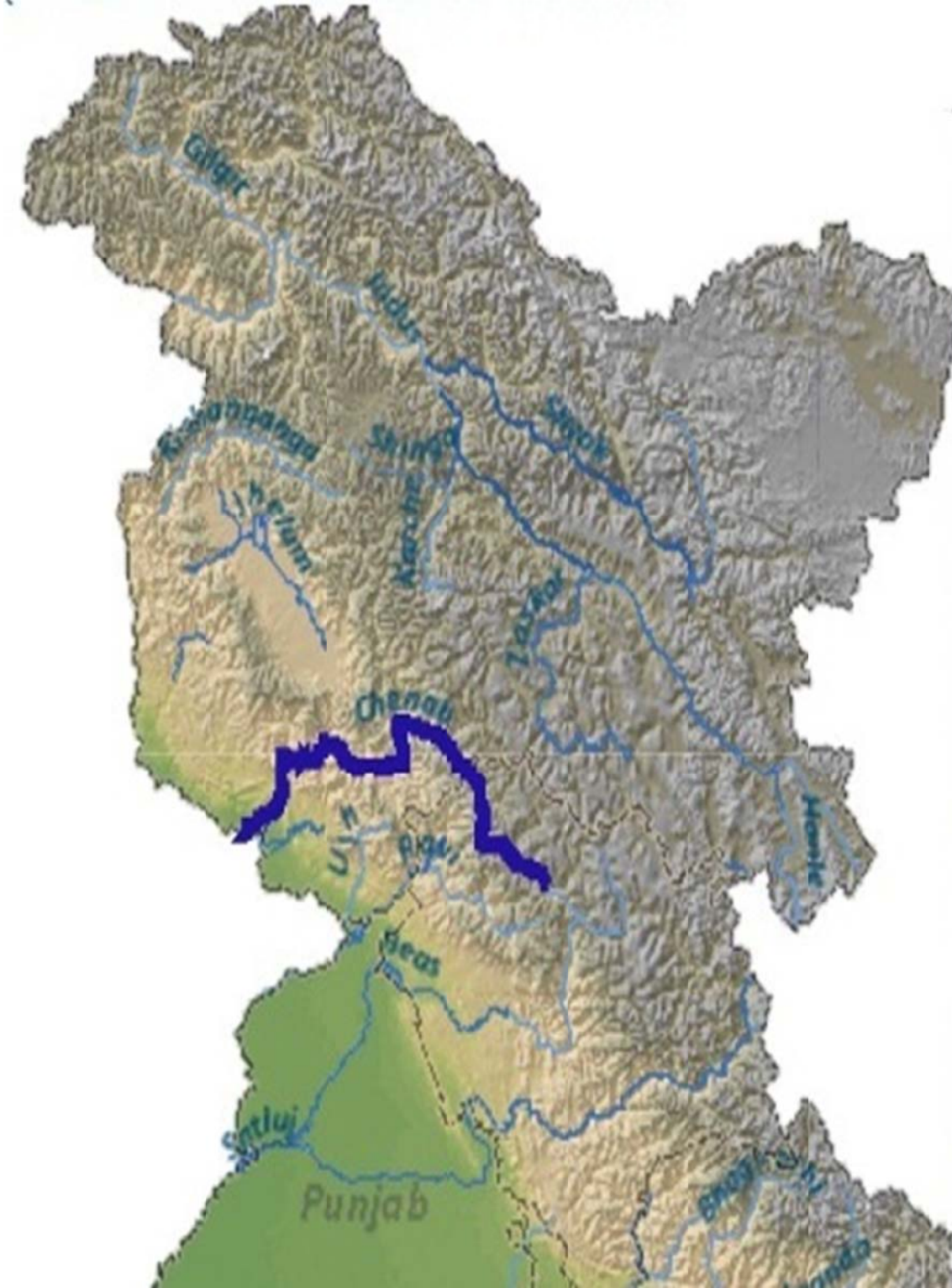


Figure 1 – Map of Chenab River

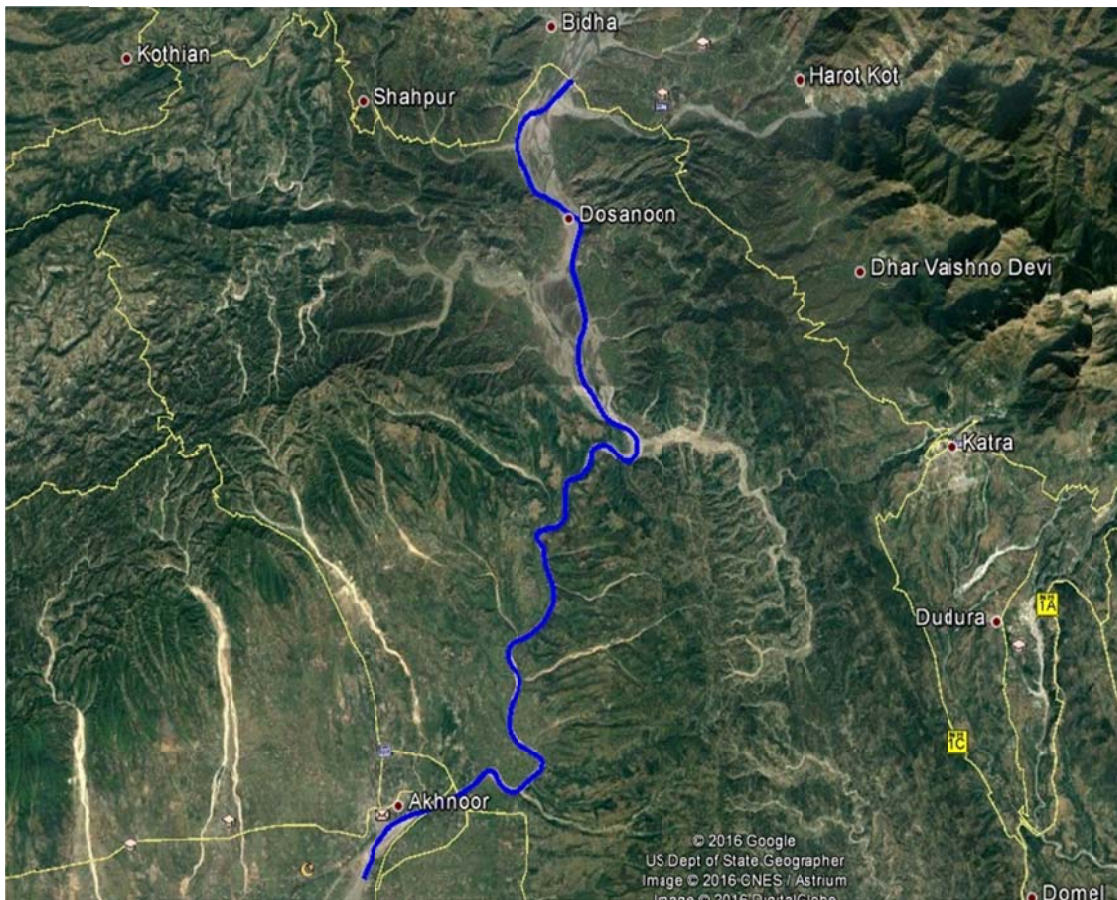


Figure 2 – Map of Waterway in Chenab River

1.5 Scope of Work

- a) The detailed Hydrographic Survey to assess the Navigability of the River.
- b) Estimate the Dredging Quantity for developing a Navigational river for Depths less than Class 1 (1.2m), Class 2 (1.4m), Class 3 (1.7m) and Class 4 (2.0m) (Stretch-wise).
- c) Topographical Survey to assess the extent of land acquisition for 100m Wide corridor and to locate the permanent structure within the corridor.
- d) Construction of BMs at every 10 km and connecting the same with nearest GTS.
- e) Measurement of Speed and Direction of River Water.
- f) Collection and analysis of the Water and bottom samples at every 10 km interval along the river.
- g) To carry out tidal observation during the survey period.
- h) Collection of Topographical Features
- i) To prepare feasibility report

2. METHODOLOGY ADOPTED

2.1 Survey by Tojo Vikas International Pvt. Ltd.

Tojo Vikas International Pvt. Ltd conducted a Hydrographic Survey in stretch of about 34.22 KM of Chenab Road Bridge to bridge near Bharda Kalan (NW-26). Bathymetry Survey was possible only for 2 km length of river due to insufficient depth for bathymetry survey in whole stretch of river and remaining portion was surveyed with Topographic Survey. Also as per work order length of river stretch was 53 km but 34.22 km length was done on field due to Sensitive area near Indo-Pak Border.

The survey was carried out from 25 Nov 2016 to 06 Jan 201706.

The water depths encountered in the survey area varied from 0.2 m to 0.9 m.

2.2 Methodology to be Elaborated

2.2.1 Topographic Survey

The topographic survey was conducted to ascertain following in the survey area:-

- Spot levels
- High bank Line
- Fixing of bridges and marks
- Assess the type of river bank
- Collection of local information along the river Banks

The spot levels along the River were obtained by using RTK and Electronic Total station. Local terrain and limitation of line of sight visibility prohibited the use of optical techniques for obtaining spot levels. GPS control was extended using the co-ordinates and height of the recovered from Bench Marks (BM), to various BMs in the respective stretches. These BMs were then used as reference stations for deriving the spot levels of the rover locations in the Stop-Go method and Electronic Total Station. The data was post processed using Sokkia Spectrum Survey office software to get the correct position and height values of the rover locations visited during the day. The details of all spot levels are provided in the respective sheets being presented along-with this report. Additionally, a soft copy of the same in XYZ format is being handed over as deliverable data.

2.2.2 Bathymetry Survey

Bathy-500 DF was used to obtain soundings onboard the survey boat. A working frequency of 210 KHz was used for sounding operations. The digital output from the echo sounder was fed to the HYPACK data logging software for acquisition of survey data in real time. The performance of the echo sounder was found to be satisfactory during the entire duration of the survey.

Sound velocity set on the echo sounder was set to a range of 1468 to 1529 meters per second. The echo sounder transducer was mounted on the side of the boat, in all cases.

The DGPS Receiver Antenna was mounted exactly above the transducer without any offset to ensure accuracy in the position of soundings. The bar-checks were carried out before/after each sounding session. On all such occasions the error observed was zero or near zero. Therefore, no corrections were necessary.

The sounding 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 by normal lines, Cross lines were run on an opportunistic basis wherever feasible.

2.2.3 Equipment

Table 1 – Equipment Used

Equipment	Make	Qty. Deployed
Echo Sounder	Bathy 500 DF	1
DGNSS (Attached with Eco Sounder for Position)	C-Nav 1010	1
Tide Gauge	Manual (Pole type)	4
Grab Sampler	Van Veen	1
Bar Check Plate	Manual	1
Current Meter	River flow meter (Roorkee make)	1
DGPS Sets (TS Survey)	Sokkia GRX1	4
Auto Level	Leica	1
Software	HYPACK data acquisition	1
Software	AUTOCAD	1
Software	Microsoft Office	1
Software	Spectrum Survey office v.8	1

Photographs of equipment are placed at **Annexure-08** of this report

2.2.4 Calibration

Echo Sounder – Echo Sounder was calibrated on field every day evening and morning with the help of bar check plate. Bar check plate was lowered in water from 1 m, 2m.....and so on to maximum depth. Value of depth in Echo Sounder on every meter was checked and to be corrected with the help of **Sound velocity** adjustment. The same procedure was followed up to maximum depth reaches.

C-Nav 1010 DGNSS- No need of Calibration

Grab Sampler-Van Veen Grab Sampler was used for collecting Silt Samples from Chenab River. Calibration was not needed for Grab Sampler.

Current Meter- The equipment's used for the survey was calibrated by the equipment supplier. Tojo Vikas International Pvt. Ltd. using Cup Type Magnetic Current Meter Strd. (S. No. 1225) and it was calibrated from Hydraulic Research Station, Malikpur (Pathankot) under Irrigation and Power Research Institute, Department of Irrigation under Government of Punjab, PWD (I.B.)

DGPS- DGPS equipment's used for the survey was also calibrated by the equipment supplier. Tojo Vikas International Pvt. Ltd. using Sokkia GRX1.

Auto Level- Auto Level equipment used for the survey was also calibrated by the equipment supplier. Tojo Vikas International Pvt. Ltd. using Leica made Current Meter.

No Need of Calibration for other equipment and Software's.

Currently the equipment calibration certificates are placed at **Annexure-12** of this report.

2.3 Description of Bench Marks/ Authentic Reference Level used

The reference Bench Mark for Hydrography survey, Topographic survey and Pillars establishment is based on the information provided by officials of Center Water Commission (CWC) Akhnoor. The reference bench mark was installed at Left bank of Chenab River by CWC with Lat 32°54' 4.1646"N Long 74°45' 41.3007"E and level erected (322.385m from MSL) on Bench Mark provided. Tide pole was set up at chainage 34.20 km, for the duration of survey. The tide poles remained vertical during the course of survey and no shift was observed in the poles for the duration of survey. New bench Mark Pillars (Naming as CNB01 to 03 IWAI) were constructed and erected along the River stretches from Akhnoor to Reasi. MSL was the vertical datum used for deducing the heights for spot levels obtained as part of the topographic survey.



Figure 3 – CWC Reference Bench

2.4 Methodology to fix Chart Datum / Sounding Datum in Tidal and Non-Tidal area

As per discussion with IWA officials, Observed data (Topographic data) is all set to zero value and calculate its dredging quantity while for reduced data all value are to be set to -0.3 m and then calculate dredging quantity.

2.5 Yearly minimum and maximum Water Levels

CWC	Akhnoor	
Zero of gauge	305.19	
	Max	Min
HFL	321.19	
CD		309.6933333

Details given in Annexure-01.

2.6 Transfer of Sounding Datum table for tidal rivers / canals

River is Non Tidal so there is no need to transfer of sounding datum for tidal river.

2.7 Table indicating tidal variation at different observation points

River is Non Tidal so there is no need of indicating tidal variation at different observation points.

2.8 Salient features of Dam, Barrages, Weirs, Anicut, Locks, Aqueducts

No Dam, Barrages, Weirs, Anicut, Locks, Aqueducts was present on site.

2.9 Description of Bench Marks/ Authentic Reference Level used

The Bench Marks of the survey area for Topographic survey is based on the datum level erected on CWC Bench Mark Akhnoor. Bathymetry Survey was done only for 2 km of length Shallow depths of water. The value of CWC Bench Mark Akhnoor was used to transfer of datum (MSL) to the BMs. New bench Mark Pillars (Naming as CNB) were constructed and erected along the River stretches.

The final co-ordinates of these Bench Marks are shown in Table -2.

Table 2 – Final BM Coordinates

BM No.	Location	Chainage (KM)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Height above MSL (m)	Sounding Datum	Height w.r.t. SD (m)
CNB 1	Ambaran	3.57	32°54'41.17"	74°45'58.58"	478158.03	3641523.98	349.85	310.4	-39.45
CNB 2	Moond Meira	12.11	32°58'17.01"	74°47'32.23"	480604.78	3648162.26	369.96	325.12	-44.84
CNB 3	Reasi	23.56	33° 5'2.61"	74°48'11.14"	481629.88	3660637.58	401.97	374.16	-27.81

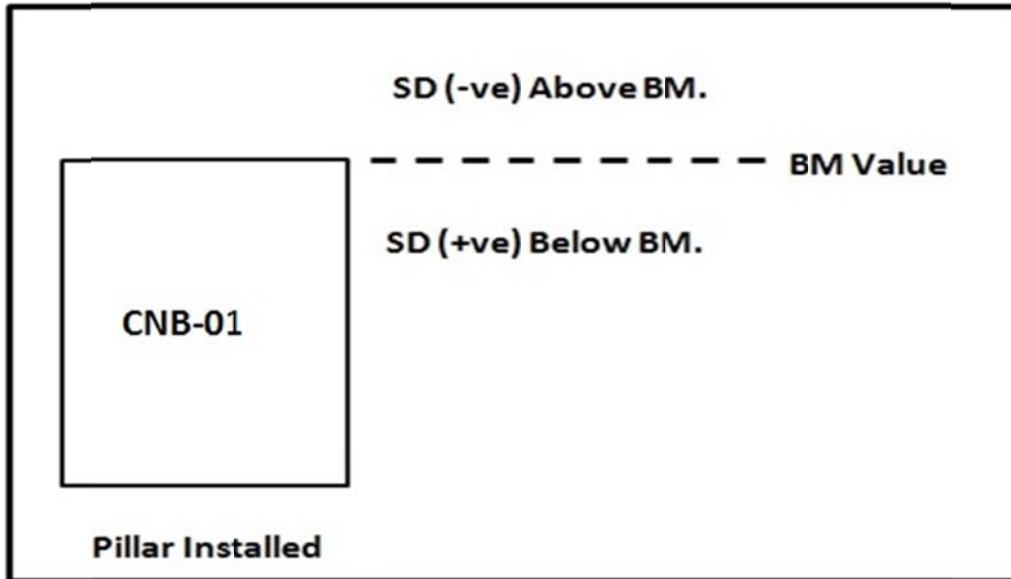


Figure 4 – Height of Bench Mark (BM) w.r.t. sounding Datum (SD)

Note: - Height of Bench Mark (BM) w.r.t. sounding Datum (SD) indicates

- A) Positive value indicates that BM value below SD value
- B) Negative value indicates that BM value above SD Value

Station description of all bench marks in Chenab River is placed at **Annexure- 09** of this report.

MSL was the vertical datum used for deducing the heights for spot levels obtained as part of the topographic survey.

2.10 Description of erected Tide Gauges

2 nos. of gauge was set during survey period. Details given below:-

Tide Gauge no.	Location	Chainage (km)	Easting	Northing	Zero of Tide Gauge w.r.t. MSL (m)	Period of observation
1	Zero Mor	32.40	480009.60	3659663.79	371.52	19, Dec 2016
2	Reasi Bridge	34.20	481575.06	3660676.29	375.47	18, 19 Dec 2016

2.11 Chart Datum / Sounding Datum and Reductions details

As per discussion with IWAI officials, Bottom level is assumed as Sounding Datum (SD) at each km of survey area.

Table 3 – Chart Datum / Sounding Datum

S.No.	CWC gauge / Dam / Barrage / Weir / Anicut / Bench Mark / tide gauges	Chainage (km)	Stretch for corrected soundings and Topo levels (km) C		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 to be converted as depth for volume calculation wrt SD (m)
	A		B	From				
1		0	0	0.5		304.13	Details at Annexure-3.	A separate xyz file is to create (not to plot).
2		1	0.5	1.5		305.02		
3		2	1.5	2.5		306.41		
4		3	2.5	3.5		307.16		
5		4	3.5	4.5		308.40		
6		5	4.5	5.5		310.40		
7		6	5.5	6.5		312.09		
8		7	6.5	7.5		313.27		
9		8	7.5	8.5		314.25		
10		9	8.5	9.5		315.43		
11		10	9.5	10.5		316.64		
12		11	10.5	11.5		317.55		
13		12	11.5	12.5		319.31		
14		13	12.5	13.5		321.04		
15		14	13.5	14.5		322.32		
16		15	14.5	15.5		323.07		
17		16	15.5	16.5		325.08		
18		17	16.5	17.5		325.12		
19		18	17.5	18.5		329.12		
20		19	18.5	19.5		333.36		
21		20	19.5	20.5		335.60		
22		21	20.5	21.5		336.17		
23		22	21.5	22.5		340.09		
24		23	22.5	23.5		342.23		
25		24	23.5	24.5		345.16		
26		25	24.5	25.5		350.37		
27		26	25.5	26.5		352.52		
28		27	26.5	27.5		357.37		
29		28	27.5	28.5		359.02		
30		29	28.5	29.5		359.59		
31		30	29.5	30.5		361.20		
32		31	30.5	31.5		364.26		
33		32	31.5	32.2		369.42		
34		32.4	32.2	33.1		371.52		
35		34.2	33.1	34.22		375.47		

2.12 High Flood Level (H.F.L.) and Maximum WL/Full Reservoir Level (MWL/FRL)

Data collected (Maximum Flood Level (MFL) and Minimum Water Levels (MWL) at Cross Structures in Chenab River is purely based on field observations.

Table 4 – Maximum Flood Level (MFL) and Minimum Water Levels (MWL) at Cross Structures in Chenab River

S. No.	Location and description of CWC gauge / Dam / Barrages / Weirs / Anicut / Locks / Aqueducts / BM	Cross-structure details	Chainage (km)	Established HFL / MHWS / FSL / MWL / FRL w.r.t. MSL (m)	Computed HFL at Cross-Structures w.r.t. MSL (m)
	A	B	C	D	E
1	OLD BRIDGE AKHNOOR	State Road Bridge	3.028	-	320.87
2	CWC Akhnoor	Gauge	3.952	321.19	-
3	NEW BRIDGE AKHNOOR	State Road Bridge	4.165	-	322.35
4	CHENAB ROAD BRIDGE	Village Road Bridge	16.043	-	338.66
5	CHENAB ROAD BRIDGE	State Road Bridge	34.22	-	380.97

2.13 Graph between Sounding Datum and HFL v/s Chainage

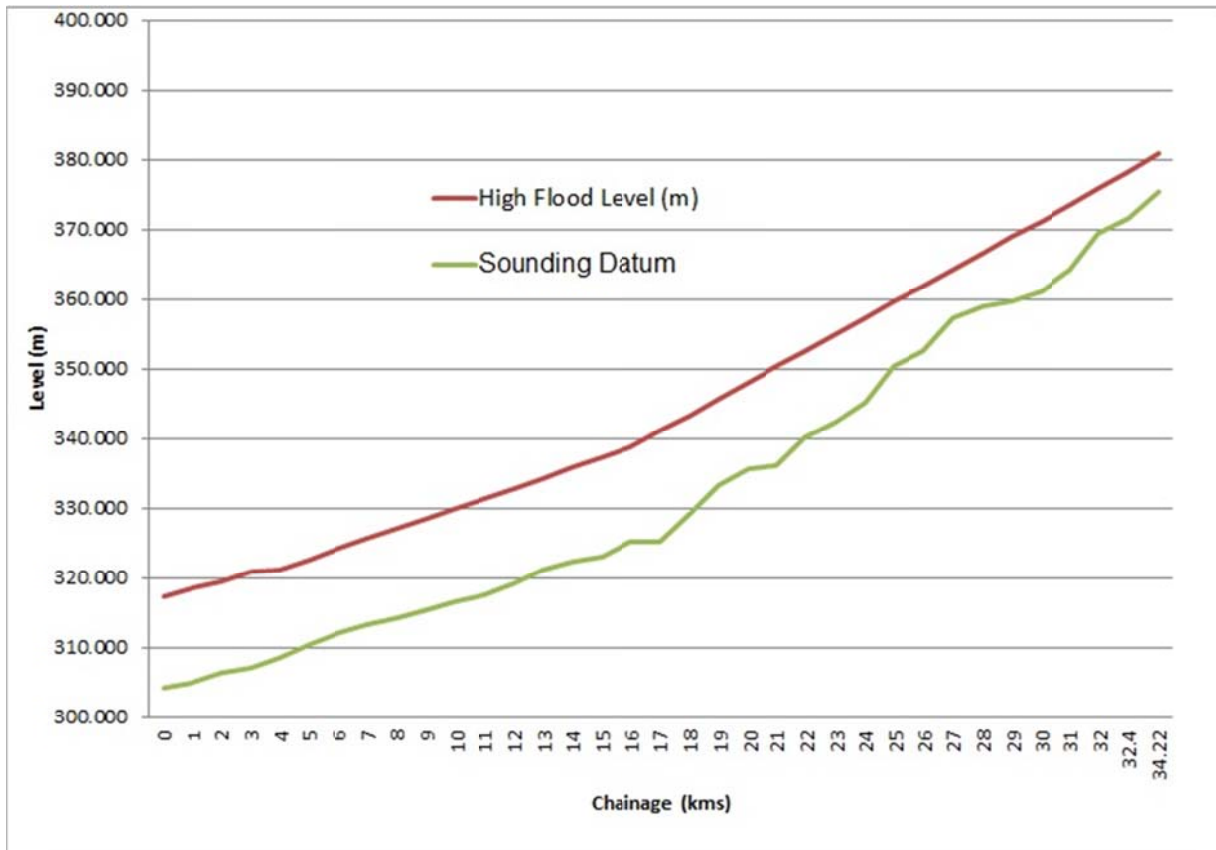


Figure 5 – Graphs between Sounding Datum and HFL v/s Chainage in Chenab River

2.14 Average Bed Slope

Table 5 – Average Bed Slope

Reach (km)		River / Canal Bed Level Change (m)	Distance (km)	Slope
From	To			
0	9	11.30	9	1:796
9	18	13.69	9	1:657
18	27	28.25	9	1:319
27	34.22	19.10	7.22	1:378

2.15 Details of Dam, Barrages, Weirs, Anicut

Dam, Barrages, Weirs, Anicut was not Present in this whole stretch of waterway.

2.16 Details of Locks

No Lock Present in this whole stretch of waterway.

2.17 Details of Aqueducts

No Aqueduct Present in this whole stretch of waterway.

2.18 Details of Cross-structures in Chenab River

Table 6 – Bridges and Cross Structure in Chenab River

SI No	Structure Name and for road / rail	Chainage (km)	Type of Structure (RCC / Iron / Wooden)	Location	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction), in use or not, condition
					Left Bank	Right Bank	Left Bank	Right Bank						
1	Old Bridge Akhnoor	3.028	IRON	Akhnoorr Bridge	32°53' 51.98"N 74°45' 8.10"E	32°53' 58.45"N 74°45' 6.91"E	476829.67, 3639981.27	476799.20, 3640180.70	140	4.5	3	70	3.65	Good condition and in use
2	New Bridge Akhnoor	4.165	RCC	Akhnoor By Pass Bridge	32°54' 4.26"N 74°45' 50.60"E	32°54' 13.30"N 74°45' 44.55"E	477934.50, 3640357.12	477778.12, 3640635.62	140	11.5	3	70	17.88	Good condition and in use
3	Chenab Road Bridge	16.043	RCC	Gordah Village	32°58' 10.63"N 74°47' 34.48"E	32°58' 16.47"N 74°47' 31.21"E	480648.075 3647938.15	480563.66,3 648118.08	200	7.5	8	25	33.50	Good condition and in use
4	Chenab Road Bridge	34.22	RCC	Reasi	33°5' 4.87"N 74°48' 10.5"E	33°5' 17.5038"N 74°47' 50.4588"E	481607.56, 3660692.62	481088.09, 3661082.63	680	8	17	40	9.50	Good condition and in use

2.19 Details of other Cross structures, pipe-lines, underwater

There are no cross structures other than Dam, Road Bridges, Power Cable and High Tension Line.

2.20 Details of High Tension Lines / Electric lines / Tele-communication lines

HFL data collected at cross structures based on field observation is interpolated at each chainage of electric line crossings for the vertical clearance.

Table 7 – Electric Lines in Chenab River

Sl No	Type of line	Chainage (km)	Location	Position (Lat Long)		Position (UTM)		No of Piers	Horizontal clearance (clear distance Between piers) (m)	Vertical clearance w.r.t. HFL / MHWS (m)	Remarks (complete / under - construction)
				Left Bank	Right Bank	Left Bank	Right Bank				
1	Electric Line Cross	0.709	AKHNOOR	32°53' 10.49"N 74°44' 3.20"E	32°53' 15.71"N, 74°43' 52.52"E	475140.34, 3638707.99	474863.34, 3638869.30	-	300	25	Complete
2	Electric Line Cross	29.319	RASIALAN PEYI	33°3' 23.30"N 74°47' 55.76"E	33°3' 7.318"N, 74°47' 42.05"E	481218.94, 3657565.52	480862.34, 3657074.00	-	400	30	Complete

2.21 Current Meter and Discharge details

Table 8 - Current Meter and Discharge Details

Stretch No.	Chainage (km)	Observed Depth (m) (D)	Velocity (m/sec.)	Average Velocity (m/sec.)	X-Sectional area (sq. m.)	Discharge (Cu.m)
			0.5 D			
1	5.111	1.11	2.020	2.020	150.76	304.535
2	16.069	0.63	2.080	2.080	130.23	270.878
3	34.22	1.16	2.100	2.100	120.11	252.231

2.22 (A) Soil Sample Locations

Table 9 - Soil Sample Locations in Chenab River

Chainage (km)	Latitude	Longitude	Easting (m)	Northing (m)	Depth (m)
5.111	32°54' 27.4992"N	74°46' 16.3584"E	478605.191	3641071.036	1.17
16.069	32°58' 14.1795"N	74°47' 33.9135"E	480633.485	3648047.322	0.63
34.221	33°5' 5.0086"N	74°48' 9.1673"E	481572.348	3660696.915	1.21

A detailed report on Soil sample analysis is placed at **Annexure-10** of this report.

(B) Water Sample Locations

Table 10 – Water Sample: Location in Chenab River

Sample No.	Chainage (km)	Latitude	Longitude	Easting (m)	Northing (m)	Total Depth (d) (m)	Mid-Depth (0.5d) (m)
1	5.111	32°54' 27.4992"N	74°46' 16.3584"E	478605.191	3641071.036	1.17	0.59
2	16.069	32°58' 14.1795"N	74°47' 33.9135"E	480633.485	3648047.322	0.63	0.32
3	34.221	33°5' 5.0086"N	74°48' 9.1673"E	481572.348	3660696.915	1.21	0.61

A detailed report on Water sample analysis is placed at **Annexure -11** of this report.

3. DESCRIPTION OF WATERWAY FOR CHENAB RIVER

Hydrographic Survey was done only for 2 km of length due to very shallow depth of water flowing in the Chenab River. Further all survey was done with topographic equipment. We have divided our survey area of Chenab River into 4 different stretches and details of stretches given below from Para 3.1 to 3.4.

3.1 Akhnoor City to Chandergarh Village (Ch. 00.00 km – 9.00 km)

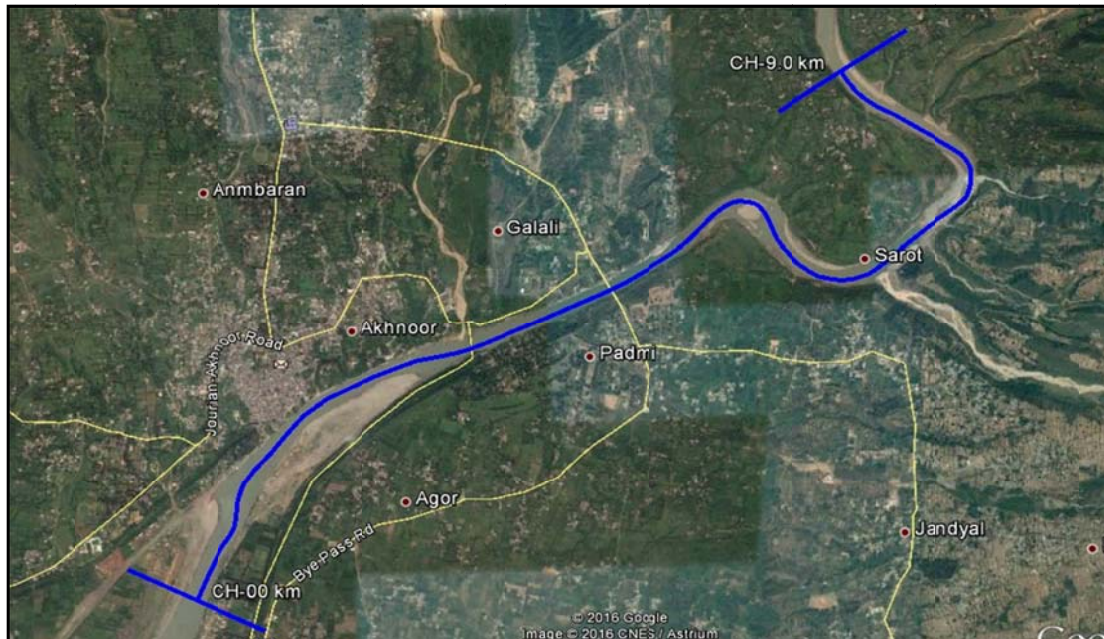


Figure 6 – Akhnoor City to Chandergarh

Table 11 – Minimum – Maximum Reduce Depths, Akhnoor City to Chandergarh

Class	Chainage		Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	0	9	-0.30	0.00	9	548905.12
2	0	9	-0.30	0.00	9	806730.52
3	0	9	-0.30	0.00	9	1176302.76
4	0	9	-0.30	0.00	9	1387399.09

Table 12 – Minimum – Maximum Observe Depths Akhnoor city to Chandergarh

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	0	9	0	0	9	424959.91
2	0	9	0	0	9	647353.66
3	0	9	0	0	9	978532.25
4	0	9	0	0	9	1180771.78

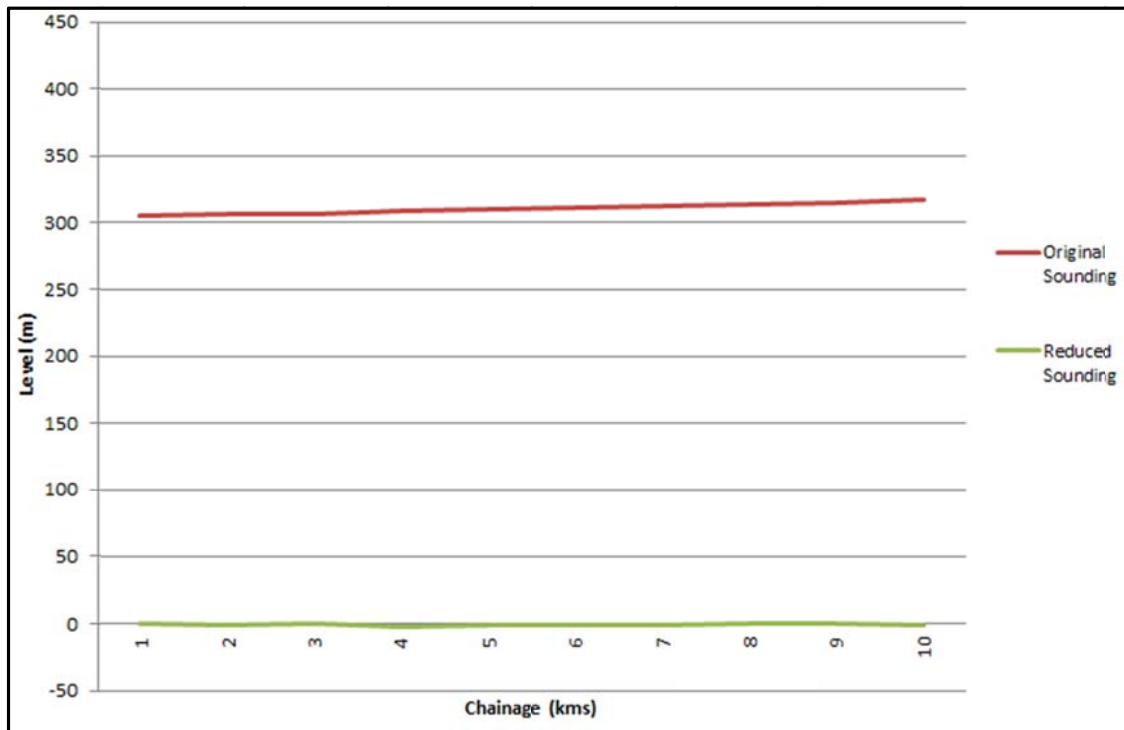


Figure 7 – Original and Reduced Bed Profile of Akhnoor City to Chandergarh

First stretch (Ch. 0.00 to 9.00 km) start from Akhnoor City to Chandergarh Village. Two bridges are present in this stretch of River. Height of these bridges varies between 9.5 m to 33.5 m from High flood level (HFL). Main city near to this stretch is Akhnoor. Main villages in this stretch are Galali, Padmi Sarot and Chandigarh. This stretch is well connected to state highway from Jammu to Punch. All the transportation going through this road. River banks in this stretch are mainly unprotected where some locations banks are naturally protected and main compositions are Sand, Boulder, Gravel and Pebbles. In Vicinity of this stretch hilly area is present. Crops and Agriculture land mainly along the river. Hyacinth, rocks, and rapid waterfalls are present in many areas of this stretch of River. Forest area exists on near to bank of river. There is no wild life Sanctuary. There is no security issue. There are no Jetties and Terminals seen in this stretch. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Jammu is the nearest railway station of this stretch.



Figure 8 – Iron Bridge and By Pass Bridge in Akhnoor



Figure 9 – Ch.4.165 Km Akhnoor by Pass Bridge

3.2 Chandergarh Village to Tanda Village (Ch. 9.00 km – 18.00 km)

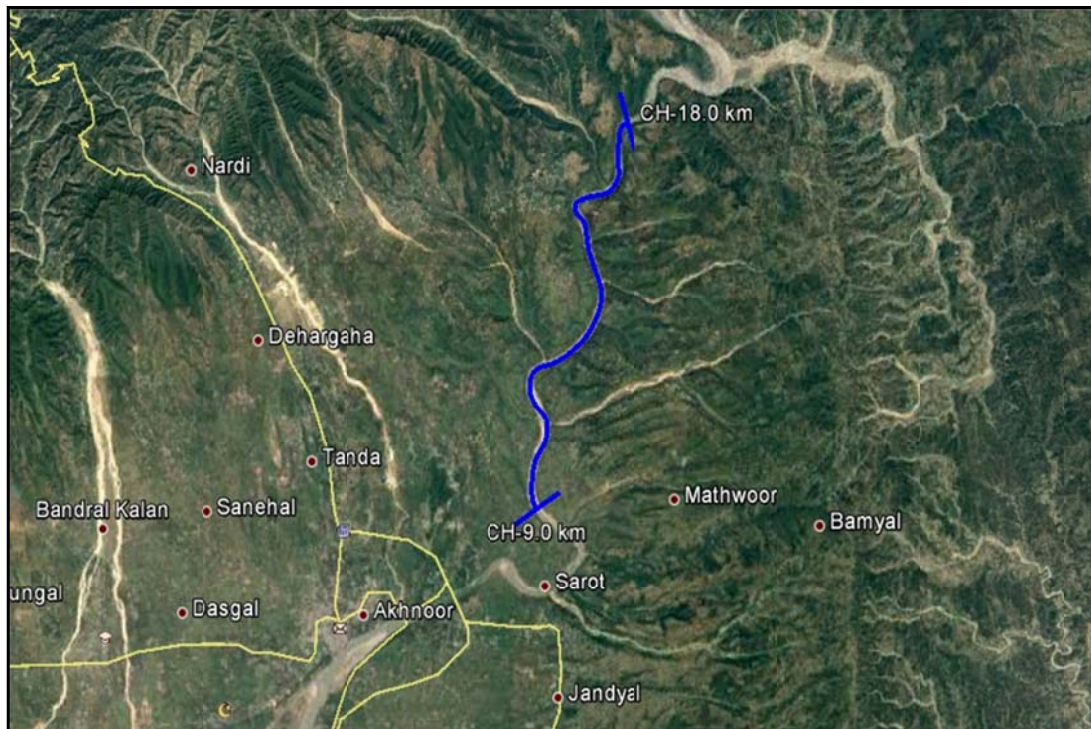


Figure 10 – Chandergarh Village to Tanda Village

Table 13 Minimum – Maximum Reduce Depths, Chandergarh Village to Tanda Village

Class	Chainage		Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	9	18	-0.30	0.00	9	497770.73
2	9	18	-0.30	0.00	9	731573.93
3	9	18	-0.30	0.00	9	1160877.44
4	9	18	-0.30	0.00	9	1258143.72

Table 14 – Minimum – Maximum Observe Depth Chandergarh Village to Tanda Village

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	9	18	0	0	9	385371.22
2	9	18	0	0	9	587044.13
3	9	18	0	0	9	887374.79
4	9	18	0	0	9	1070766.43

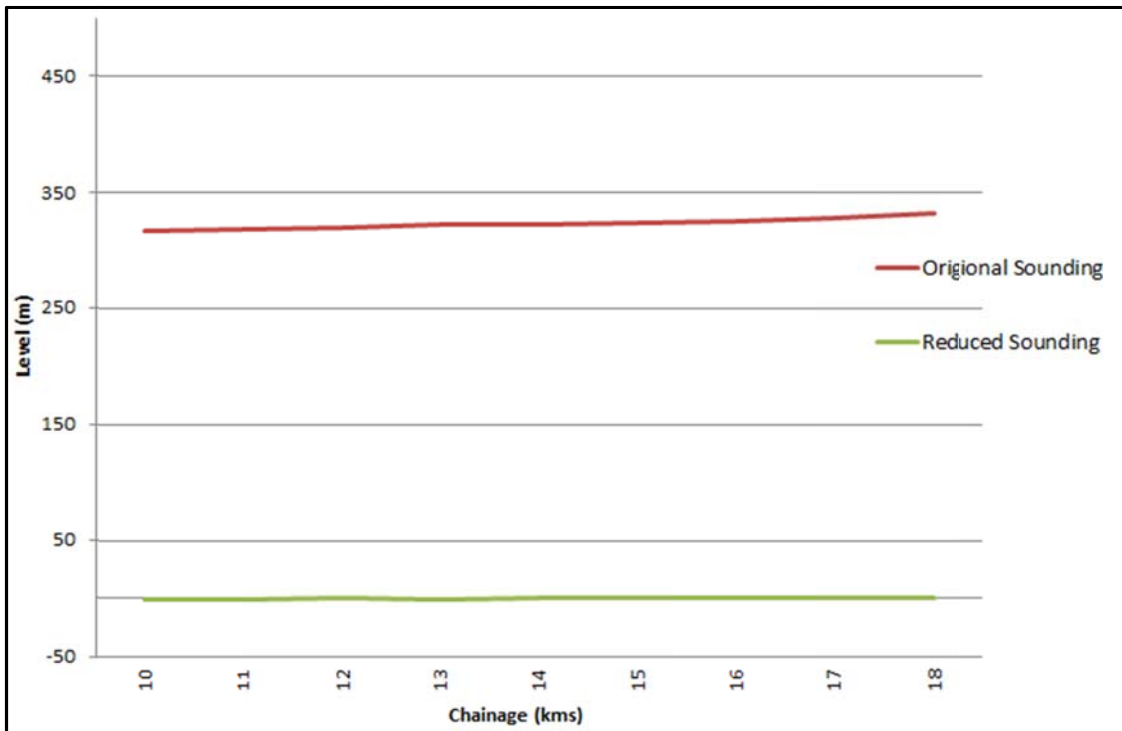


Figure 11 – Original and Reduced Bed Profile of Chandergarh Village to Tanda Village

Second stretch (Ch. 9.00 to 18.00 km) start from Chandergarh Village to Tanda Village. 1 No. of bridge is present in this stretch of River this bridge is present on village road. Main villages in this stretch are Keri, Dhanoon, Gordah and Tanda. River banks in this stretch are manly protected. In Vicinity of this stretch hilly area is present. Crops and Agriculture land mainly along the river. Hyacinth, rocks, and rapid waterfalls are present in many areas of this stretch of River. There is no wild life Sanctuary. There is no security issue. There are no Jetties and Terminals seen in this stretch. There are no tourist places in vicinity of this stretch also the connectivity of these places from this stretch of river through road is not good. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Not any Railway Line and Railway station in Vicinity of this stretch.



Figure 12 – Ch.16.00 Km Village Road Bridge Crossing River



Figure 13 – Ch. 17.00 Km Topographic Surveys on Progress with Small Boat

3.3 Tanda Village to Dosanoon Village (Ch. 18.00 km – 27.00 km)

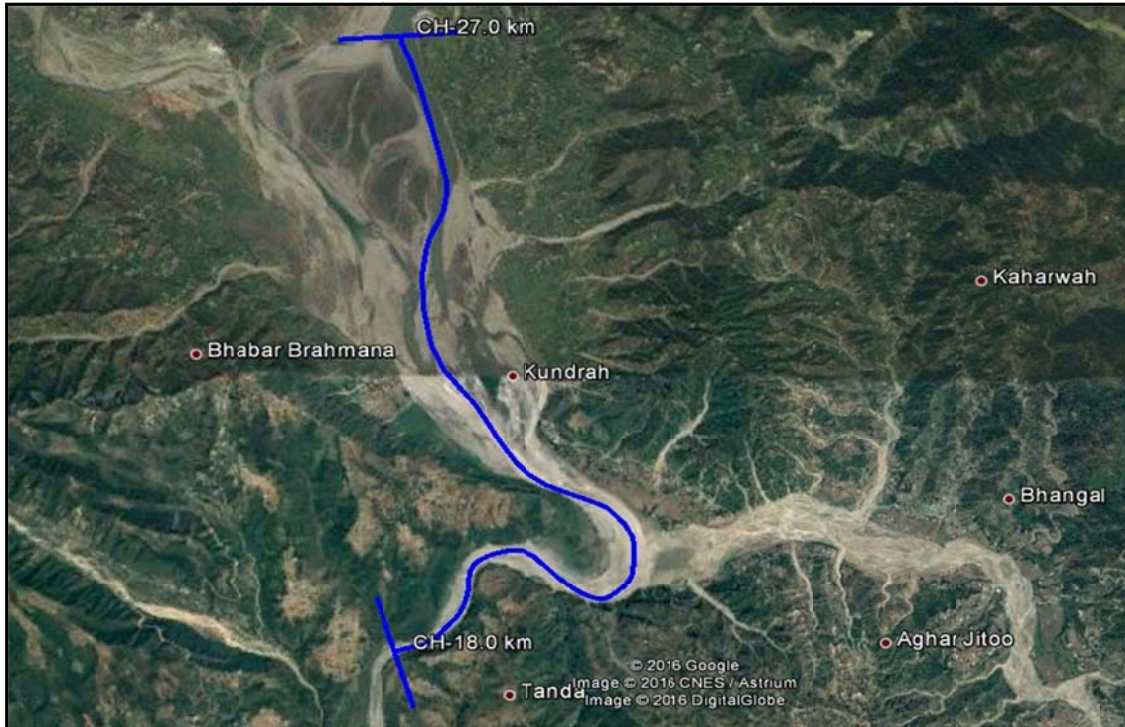


Figure 14 – Tanda Village to Dosanoon Village

Table 15 – Minimum – Maximum Reduce Depths, Tanda Village to Dosanoon Village

Class	Chainage		Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	18	27	-0.30	0.00	9	498986.05
2	18	27	-0.30	0.00	9	733202.73
3	18	27	-0.30	0.00	9	1160877.44
4	18	27	-0.30	0.00	9	1260571.08

Table 16 – Minimum – Maximum Observe Depths, Tanda Village to Dosanoon Village

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	18	27	0	0	9	386312.38
2	18	27	0	0	9	588351.33
3	18	27	0	0	9	889139.79
4	18	27	0	0	9	1072831.13

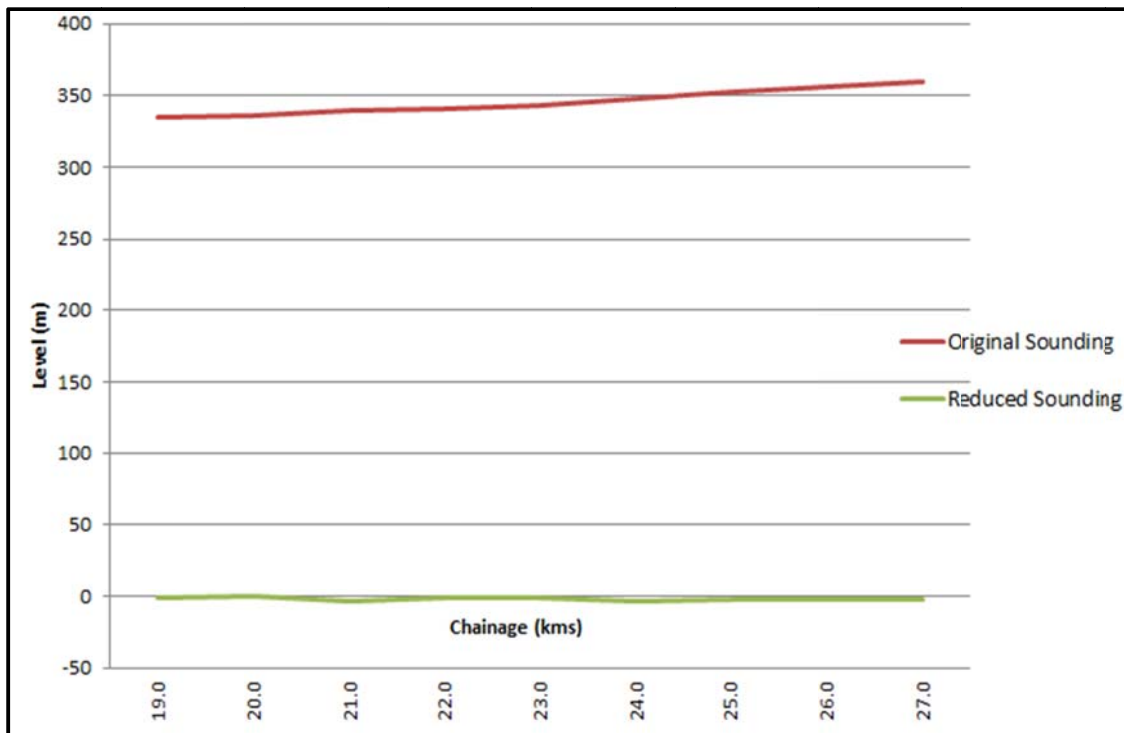


Figure 15 – Original and Reduced Bed Profile of Tanda Village to Dosanoon Village

Third stretch (Ch. 18 to 27 km) start from Tanda Village to Dosanoon Village. Not any bridge is crossing this stretch of River. Main village in this stretch are Kundrah and Bhabar Brahmana. River banks in this stretch are manly unprotected and main compositions are Sand, Boulder, Gravel and Pebbles. In Vicinity of this stretch hilly area is present. Crops and Agriculture land mainly along the river. Hyacinth, rocks, and rapid waterfalls are present in many areas of this stretch of River. Forest land exists on some areas. There is no wild life Sanctuary. There is no security issue. There are no Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There is no tourist place in vicinity of this stretch. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Not any Railway Line and Railway station in Vicinity of this stretch.



Figure 16 – Ch. - 20.00 Km Topographic Survey on Progress



Figure 17 – Ch.-24.00 Km Topographic Survey on Progress

3.4 Dosanoon Village to Reasi Bridge (Ch. 27.00 km – 34.22 km)

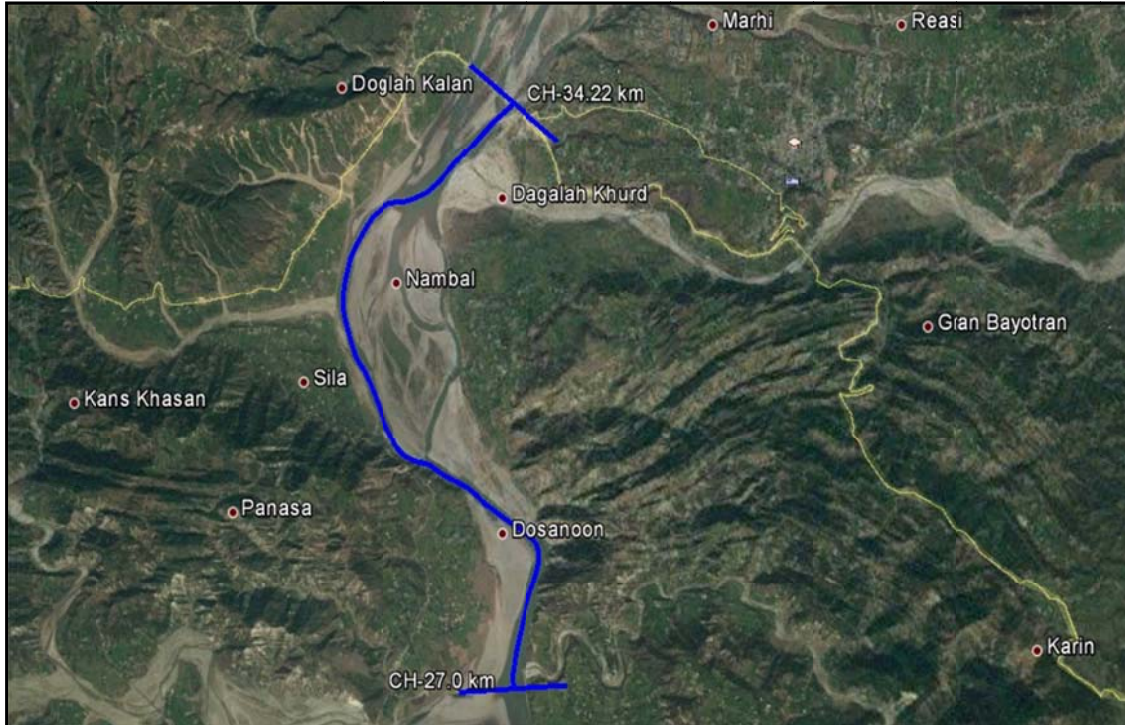


Figure 18 – Dosanoon Village to Reasi Bridge

Table 17 – Minimum – Maximum Reduce Depths, Dosanoon Village to Reasi Bridge

Class	Chainage		Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	27	34.22	-0.23	2.49	7.22	313188.52
2	27	34.22	-0.23	2.49	7.22	464597.69
3	27	34.22	-0.23	2.49	7.22	690126.35
4	27	34.22	-0.23	2.49	7.22	823107.25

Table 18 – Minimum – Maximum Observe Depths, Dosanoon Village to Reasi Bridge

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	27	34.22	0.97	3.08	7.22	211860.77
2	27	34.22	0.97	3.08	7.22	326284.02
3	27	34.22	0.97	3.08	7.22	505891.53
4	27	34.22	0.97	3.08	7.22	623195.07

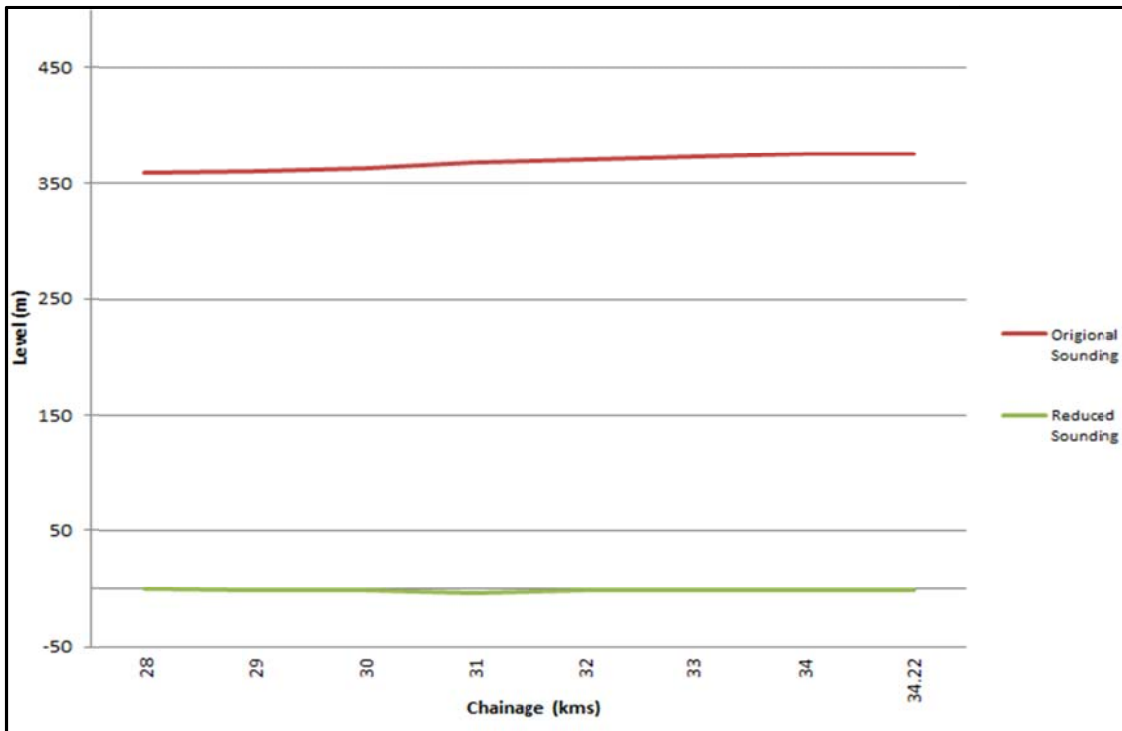


Figure 19 – Original and Reduced Bed Profile of Dosanoon Village to Reasi Bridge

Fourth stretch (Ch. 27 to 34.22 km) start from Dosanoon Village to Reasi Bridge. One No. of bridge is present at the end of this stretch of River. Main village in this stretch are Bijipur, Dagla Khurd and Reasi. River banks in this stretch are manly unprotected and main compositions are Sand, Boulder, Gravel and Pebbles. In Vicinity of this stretch hilly area is present. Crops and Agriculture land mainly along the river. Hyacinth, rocks, and rapid waterfalls are present in many areas of this stretch of River. Forest land exists on some areas. There is no wild life Sanctuary. There is no security issue. There are no Industries along this stretch of waterway. There are no Jetties and Terminals seen in this stretch. There is no ferry Passenger ferry services and no water sport recreational facilities are present in this stretch of waterway. Not any Railway Line and Railway station in Vicinity of this stretch.



Figure 20 – Ch.- 30.00Km Bed of River as boulders



Figure 21 – Ch.- 33 Km Boat Stuck on Exposed Boulders



Figure 22 – Ch.- 33 Km Bathymetry Survey



Figure 23 – Ch.-34.22 Km Bridge on Chenab River in Reasi District

4. LOCATIONS FOR TERMINAL CONSTRUCTION

Total 02 (two) locations are proposed for construction of terminals along the Chenab River stretch. The locations have been proposed based on following considerations:-

- Availability of suitable depths for vessel berthing
- Availability of land for construction of terminal
- Connectivity to hinterland
- Distance from city traffic limits
- Possibility of future expansion
- Possibility of new Industrial setup along the river stretch in future

Table 19 – Terminal Locations

Stretch No.	Chainage (km)	Location	Position			
			Latitude (N)	Longitude (E)	Easting (m)	Northing (m)
1	2.6	AKHNOOR	32°53'45.02"N	74°44'53.78"E	476457.02	3639767.82
4	34.0	AGHAR BALIAN	33° 4'52.81"N	74°48'10.58"E	481608.27	3660321.2

A brief discussion on the proposed locations is presented below:-

4.1 Terminal 1 (Near Akhnoor City at Ch. 2.6 km):

The suggested location is near to Old Iron Bridge on Akhnoor- Jammu Highway. The location is well connected to Akhnoor City and can be developed as a start/end point terminal for IWT. The location has potential to be developed into a major terminal in future. Dredging required at terminal location for Vessel Berthing. Land in mainly belongs to forest department. Terminal is near to city so this location is good for future expansion.



Figure 24 – Terminal 1

4.2 Terminal 2 (Near Reasi Bridge at Ch. 34 km):

Proposed Terminal 2 is on left bank of Chenab River near Reasi Bridge of district Reasi. The place is well connected to main Katra-Punch Highway. Dredging required for vessel berthing at Terminal 2. Construction material is available, stone crusher present near to this location. It has the possibility for future expansion.

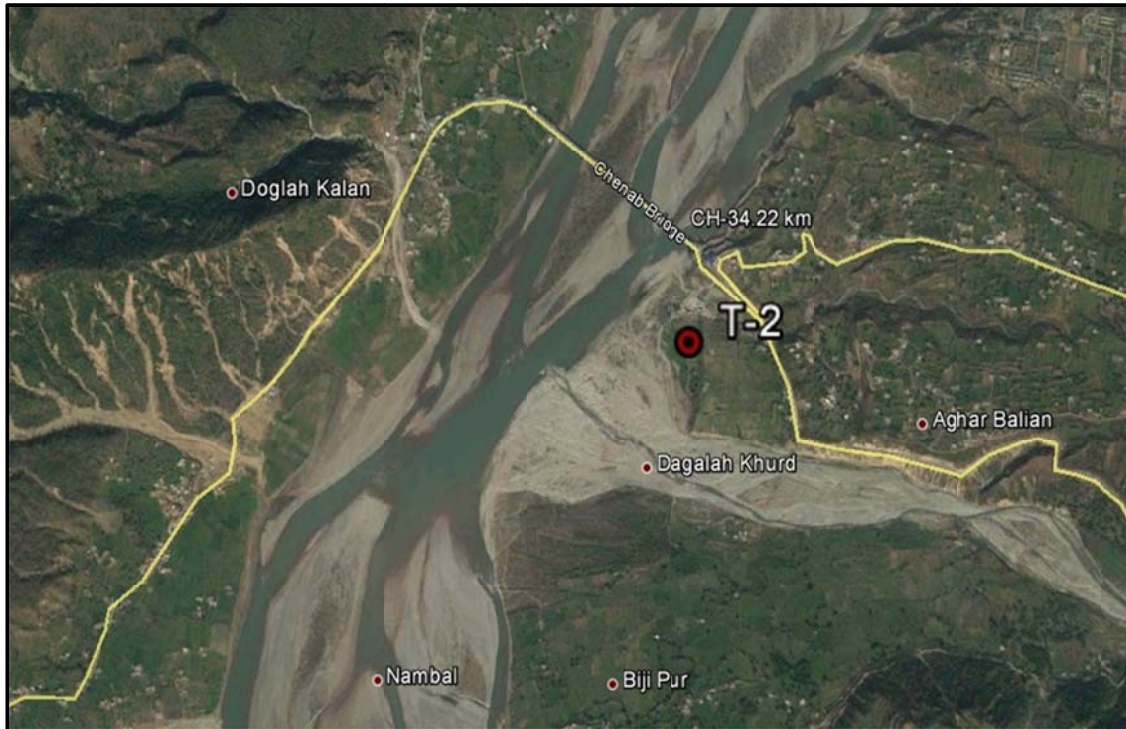
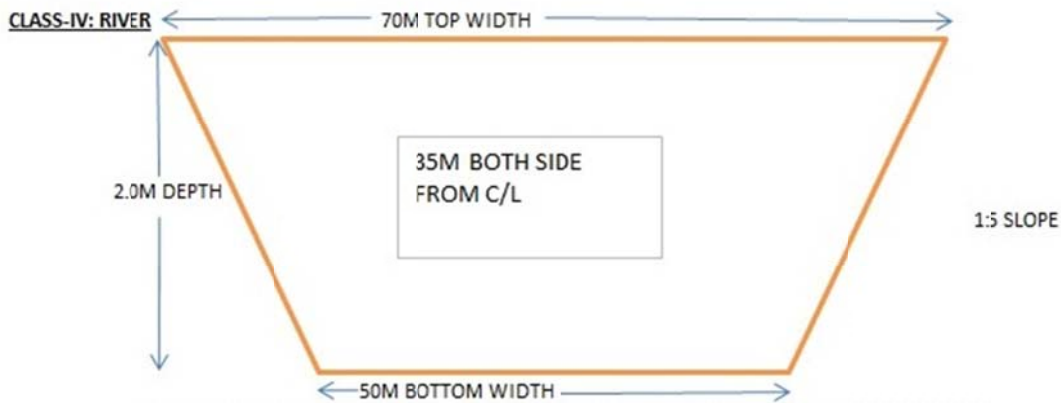


Figure 25 – Terminal 2 (Upshi Village)

5. FAIRWAY DEVELOPMENTS

As per the client requirement, fairway dimension of channel has made of 4 types.

- 1) 50m x 2.0m with Side slope of 1:5, along the deepest route.



Dredging quantity for the depths of **2.0, 1.7 m, 1.4 m and 1.2 m** is calculated stretch wise. The dredge volume calculations were accomplished using the HYPACK dredge volume computation utility (Standard Hypack method). The stretch wise results of the dredge volume are as given:-

Table 20 – Dredging Volume Summary in Chenab River at 2.0m

Chainage		Observed					Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. qty. (cu.m.)
0	9	0	0	9	1180771.78	1180771.78	-0.3	0.0	9	1387399.09	1387399.09
9	18	0	0	9	1070766.43	2251538.21	-0.3	0.0	9	1258143.72	2645542.81
18	27	0	0	9	1072831.13	3324369.34	-0.3	0.0	9	1260571.08	3906113.89
27	34.22	0.97	3.08	7.22	623195.07	3947564.41	-0.23	2.49	7.22	823107.25	4729221.14
Total					3,947,564.41		Total			4,729,221.14	

- 2) 50m x 1.7m with Side slope of 1:5, along the deepest route.



Table 21 – Dredging Volume Summary in Chenab River at 1.7m

Chainage		Observed					Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative drg. qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. qty. (cu.m.)
0	9	0	0	9	978532.25	978532.25	-0.3	-0.3	9	1176302.76	1176302.76
9	18	0	0	9	887374.79	1865907.04	-0.3	-0.3	9	1160877.44	2337180.20
18	27	0	0	9	889139.79	2755046.83	-0.3	-0.3	9	974686.09	3311866.29
27	34.22	0.97	3.08	7.22	505891.53	3260938.36	-0.23	2.49	7.22	690126.35	4001992.64
Total					3,260,938.36		Total			4,001,992.640	

3) 40m x 1.4m with Side slope of 1:5, along the deepest route.



Table 22 – Dredging Volume Summary in Chenab River at 1.4m

Chainage		Observed					Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. Qty. (cu.m.)
0	9	0	0	9	647353.66	647353.66	-0.3	-0.3	9	806730.52	806730.52
9	18	0	0	9	587044.13	1234397.79	-0.3	-0.3	9	731573.93	1538304.45
18	27	0	0	9	588351.33	1822749.12	-0.3	-0.3	9	733202.73	2271507.18
27	34.22	0.97	3.08	7.22	326284.02	2149033.14	-0.23	2.49	7.22	464597.69	2736104.87
Total					2,149,033.140		Total			2,736,104.870	

4) 30m x 1.2m with Side slope of 1:5, along the deepest route.

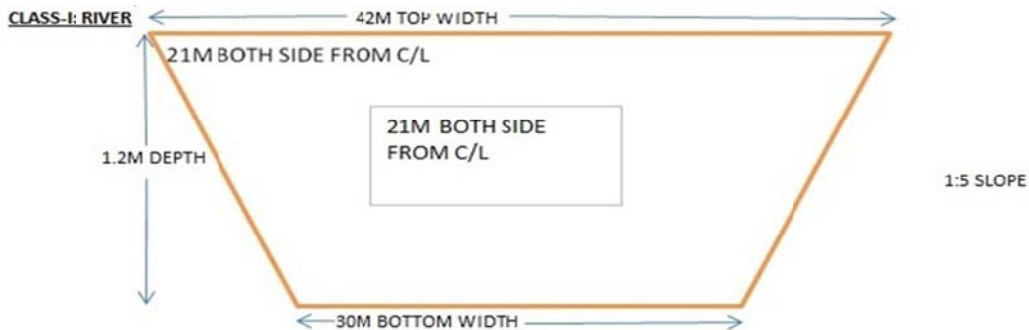


Table 23 – Dredging Volume Summary in Chenab River at 1.2m

Chainage		Observed					Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. Qty. (cu.m.)
0	9	0	0	9	424959.91	424959.91	-0.3	0.0	9	548905.12	548905.12
9	18	0	0	9	385371.22	810331.13	-0.3	0.0	9	497770.73	1046675.85
18	27	0	0	9	386312.38	1196643.51	-0.3	0.0	9	498986.05	1545661.90
27	34.22	0.97	3.08	7.22	211860.77	1408504.28	-0.23	2.49	7.22	313188.52	1858850.42
		Total			1,408,504.280		Total			1,858,850.420	

Dredging quantity, minimum & maximum depths and length of shoal have been calculated per km wise and the same is at Annexure-2.

6. CONCLUSION

IWAI has marked as National Waterways (NW-26) from Chenab Toad Bridge to Bridge at Bharda Kalan for the stretch of 53 km of length but due to security issues length of waterway shorten to 34.22 km.

The aim of survey was to conduct a survey for assessing the river stretch from Chenab Toad Bridge to Bridge at Bharda Kalan, for surface navigation by vessels. The area has been adequately sounded and all conspicuous objects within and in the vicinity of the survey area has been fixed. The deliverable sheets contain Topographic data, important landmarks with state of the river banks. The survey is considered complete in all respects. Bathymetry survey was possible only for length of 2 km from ch.32.2km to 34.2 km.

In the present form, the river is not navigable in whole surveyed area. To assess the feasibility of navigation, capital dredging would be required. 2 Terminal may be developed on Chenab River for facilitation of cargo if navigation possible.

Class	Observed						Reduced w.r.t. Sounding Datum			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	00	34.22	0.97	3.08	34.22	1,408,504.280	-0.23	2.49	34.22	1,858,850.420
2	00	34.22	0.97	3.08	34.22	2,149,033.140	-0.23	2.49	34.22	2,736,104.870
3	00	34.22	0.97	3.08	34.22	3,260,938.360	-0.23	2.49	34.22	4,001,992.640
4	00	34.22	0.97	3.08	34.22	3,947,564.41	-0.23	2.49	34.22	4,729,221.140

7. DETAILS OF ANNEXURES

Annexure - I	Data Collected From Various Agencies
Annexure - II	Dredge Volume
Annexure - III	Details of Collected Water Level
Annexure - IV	Details of Bathymetric And Topographic Surveys Carried Out
Annexure - V	Details of Bank Protection
Annexure - VI	Details of Features Across the Bank
Annexure – VII	Detailed Methodology for Horizontal and Vertical Control
Annexure – VIII	Photographs of Equipment
Annexure – IX	Details of Bench Marks
Annexure – X	Leveling Data
Annexure – XI	Soil Sample Report
Annexure – XII	Water Sample Report
Annexure – XIII	Calibrations Certificates
Annexure - XIV	Field Photographs