FEASIBILITY REPORT ON DETAILED HYDROGRAPHIC SURVEY IN INDUS RIVER (34.67 KM) FROM BRIDGE ON HIGHWAY AT UPSHI VILLAGE TO BRIDGE ON SHEY-CHUCHOT ROAD NEAR SHEY VILLAGE (REGION-I, NW- 46)

Submitted To

INLAND WATERWAYS AUTHORITY OF INDIA
A-13, Sector-1,
NOIDA
DIST-Gautam Buddha Nagar
UTTAR PRADESH
PIN- 201 301(UP)
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VOLUME – I
MAIN REPORT

23 December 2017

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MAIN REPORT

Survey Period: 16 May 2016 to 31 May 2016
23 December 2017

ACKNOWLEDGEMENT

Tojo Vikas International Pvt. Ltd. (TVIPL) express their gratitude to **Ms. Nutan Guha Biswas, IAS, Chairman,** for spending their valuable time and guidance for completing this Project of "Detailed Hydrographic Survey in Indus 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/IND/FD/01	01 of 01	1:35000
Detailed Hydrographic & Topographic Survey	TVIPL/IWAI/IND/FD/02	01 to 19	1:2,000

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- Indus River Waterway Name- NW- 46 Waterway Description- Bridge on Highway at Upsi Village Lat 33°49' 42.69"N, Long 77°48'56.23"E to Bridge on Shey-Chuchol Road near Shey Village Lat 34°3' 35.41"N, Long 77°38'33.14"E Total Length- 34.67 km
4.	Navigability status	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)	

	0–9 km	9– 18 km	18– 27 km	27- 34.67 km	Total
Survey Period	29th April to 15th May 2016				
< 1.2 m (km)	9	9	9	7.67	34.67
1.2 m to 1.4 m (km)	0.0	0.0	0.0	0.0	0.0
1.5 m to 1.7 m (km)	0.0	0.0	0.0	0.0	0.0
1.8 m to 2.0 m (km)	0.0	0.0	0.0	0.0	0.0
> 2.0 m (km)	0.0	0.0	0.0	0.0	0.0
				Grand Total	34.67

c)	Cross structures i) Dams, weirs, barrages etc. (total number; with navigation locks or not) ii) Bridges, Power cables etc. [total number; range of horizontal and vertical clearances]	Dams- Not Present Weirs- 1 No (Not in Working Condition) Barrages- Not Present Navigational Lock- Not Present Bridges- 7 Nos. Vertical Clearance w.r.t to HFL- 1.3 m to 2 m Horizontal Clearance- 18.0- 48.0 m Power Cable- 10 Vertical Clearance w.r.t to HFL - 15 m to 10 m
d)	Avg. discharge & no. of days	50.18 Cu.m/Sec
e)	Slope	Average bed Slope- 1:231
5.	Traffic potential	Not Available
a)	Present IWT operations, ferry services, tourism, cargo, if any	Not Present
b)	Important industries within 50 km	Not Present
c)	Distance of Rail & Road from Industry	Not Applicable
6.	Consultant's recommendation for going ahead with TEF / DPR preparation	Recommendation for not going ahead with TEF/ DPR Preparation.
7.	Any other information/ comment	

(Signature)

Date: Name of Consultant

1. INTRODUCTION

Country	Pakistan (93%) India (5%) China (2%)
Tributaries	**Left**:- Zanskar River, Chenab River, Sutlej River, Soan River, Beas River, Ravi River, Dras River, Suru River, Jhelum River, Kishanganga River **Right**: - Shyok River, Gilgit River, Kabul River, Kurram River, Gomal River
Cities	Leh, Sukkur, Hyderabad, Dera Ismail Khan
Primary source	Sênggê, Zangbo in Tibetan Plateau
Secondary source	Gar in Tibetan Plateau
Mouth	Arabian Sea in Indus River Delta, Pakistan Elevation- 0 m (0 ft.) Coordinates-23°59′40″N 67°25′51″E
Length	3,200 km (1,988 mi)
Basin	1,165,000 km^2 (449,809 sq mi)
Discharge Average	6,600 m^3/s (233,077 cu ft/s)

1.1 Map of River and Waterway

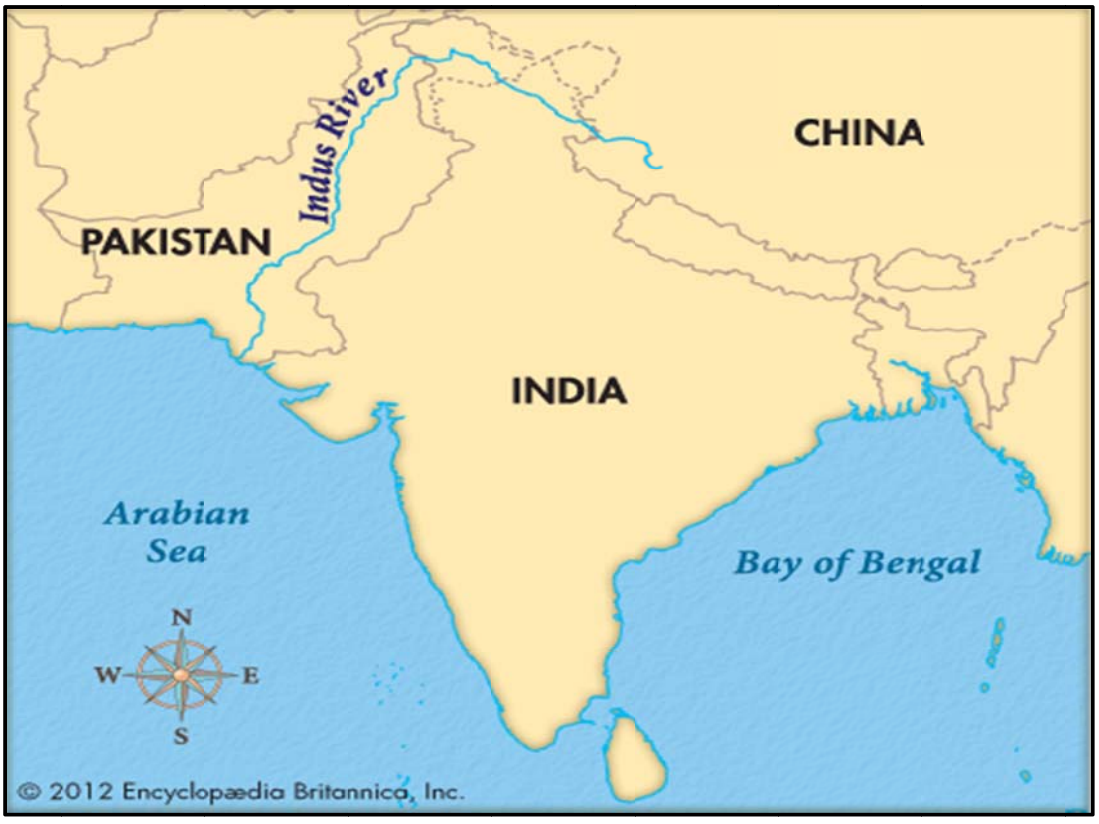


Figure 1 – Map of Indus River

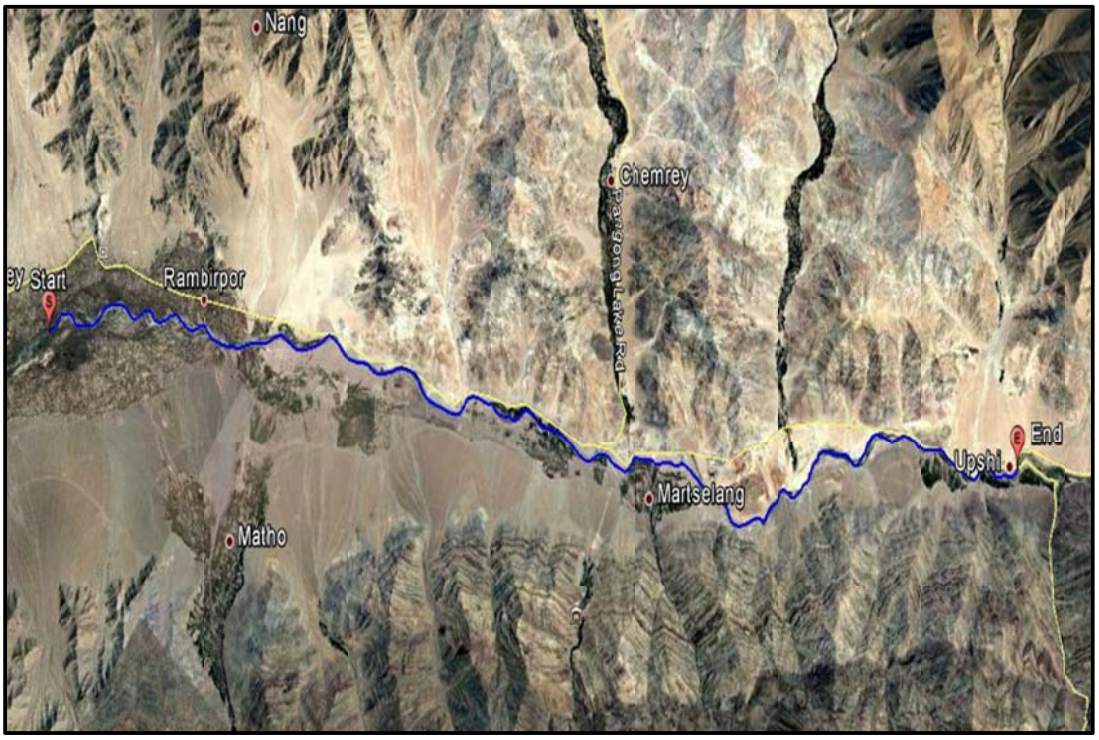


Figure 2 – Map of Waterway in Indus River

1.2 Background Information

The Indus River is one of the longest rivers in Asia. It flows through Pakistan, Jammu and Kashmir and western Tibet. Originating in the Tibetan Plateau in the vicinity of Lake Mansarovar, the river runs a course through the Ladakh region of Jammu and Kashmir, towards Gilgit-Baltistan and then flows in a southerly direction along the entire length of Pakistan to merge into the Arabian Sea near the port city of Karachi in Sindh. The total length of the river is 3,180 km (1,980 mi). It is Pakistan's longest river.

In the plains, its left bank tributary is the Chenab which itself has four major tributaries, namely, the Jhelum, the Ravi, the Beas and the Sutlej. Its principal right bank tributaries are the Shyok, the Gilgit, the Kabul, the Gomal and the Kurram. Beginning in a mountain spring and fed with glaciers and rivers in the Himalayas, the river supports ecosystems of temperate forests, plains and arid countryside.

The Indus forms the delta of present-day Pakistan mentioned in the Vedic Rigveda as *Sapta Sindhu* and the Iranian Zend Avesta as *Hapta Hindu* (both terms meaning "seven rivers"). The river has been a source of wonder since the Classical Period, with King Darius of Persia sending his Greek subject Scylax of Caryanda to explore the river as early as 510 BC.

The word "Indus" is the romanised form of the ancient Greek word "Indós" , borrowed from the old Persian word "Hinduš", which in turn was derived from the Sanskrit word "Sindhu". The word "Sindhu" or "Sindh" is still the local appellation of the Indus River. The original Sanskrit word "Sindhu" is an amalgamation of two words, "sim" (region or entirety or border) and "dhu" (to tremble or shake) and means "a body of trembling water, river, stream or ocean".

1.3 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) To prepare feasibility report
i) Collection of Topographical Features

2. METHODOLOGY ADOPTED

2.1 Survey by Tojo Vikas International Pvt. Ltd.

Tojo Vikas International Pvt. Ltd conducted a Topographic Survey in stretch of about 34.67 KM of Indus River from Bridge on Highway at upshi village to bridge on shey-Chuchot road near shey village (NW-46). Bathymetry Survey was not possible in same area due to less quantity of water.

The survey was carried out from 16 May, 2016 and completed on 31 May, 2016.

The water depths encountered in the survey area varied from 0.1 m to 0.8 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

Bathymetry Survey was not possible in this Waterway Stretch due to insufficient quantity of water for hydrography Survey.

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

Bathy 500 DF and C- Nav 1010 DGNSS was not used on field.

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

2.2.4 Calibration

Echo Sounder – Eco 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 Eco 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-

Grab Sampler- Van Veen Grab Sampler was used for collecting Silt Samples from Ravi 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

There was no reference Bench Mark (BM)/ GTS/CWC gauge available at site. So the reference point was set at 24 hours continue reading on Pillar No. 1 with the help of DGPS. Further this point (Pillar 1) was used to transfer levels to other Pillars and for measuring levels in river.

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

As per discussion with IWAI officials, minimum bottom level has fix as chart Datum/Sounding Datum on each km for Dry River.

2.5 Yearly minimum and maximum Water Levels

There was no CWC gauge or any other department gauge in waterway Stretch. So the yearly minimum and maximum water levels were not present.

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 Bench Mark of Pillar 1 on Indus River. Bathymetry Survey was not done due to less quantity of water. The value of Pillar 1 Bench Mark was used to transfer of datum (MSL) to the BMs. New bench Mark Pillars (Naming as INDUS) 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

S. No.	Station	Chainage (KM)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Ellipsoidal Height (m)	Height above MSL (m)	Sounding Datum	Height w.r.t. SD (m)
1	INDUS 1	3.57	34°2' 35.6695"	77°40' 15.7992"	3770169.475	746574.708	3236.638	3261.045	3257.53	-3.51
2	INDUS 2	12.11	33°58' 43.0498"	77°42' 27.6858"	3763090.845	750147.183	3298.919	3298.919	3287.32	-11.60
3	INDUS 3	23.56	33°53' 31.208"	77°45' 44.4481	3753617.003	755456.821	3426.449	3450.540	3333.29	-117.25
4	INDUS 4	31.60	33°50' 59.8363"	77°48' 6.7882"E	3749051.925	759241.632	3351.537	3375.462	3375.33	-0.13

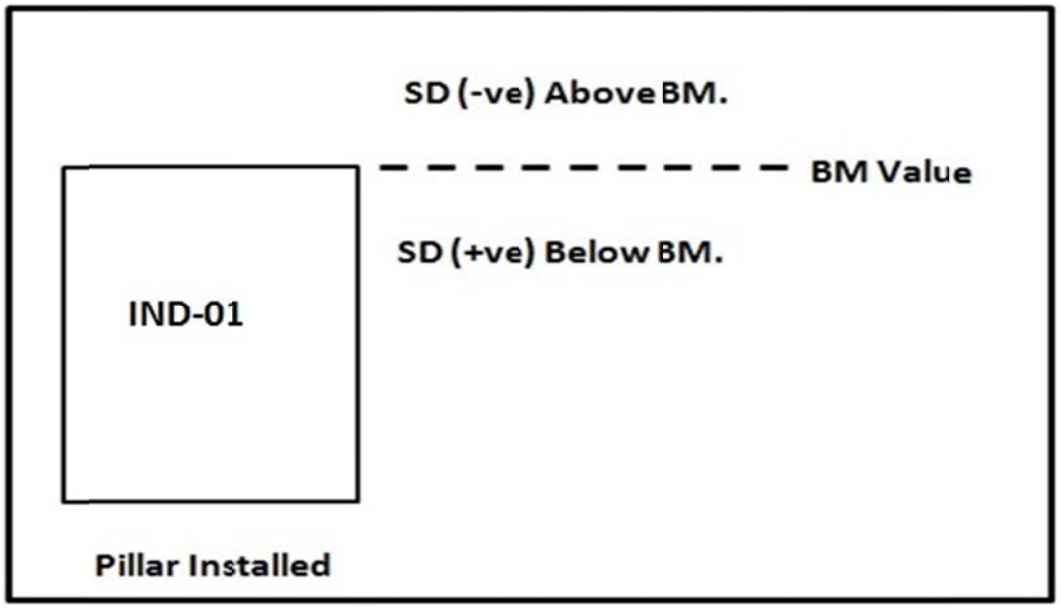


Figure 3 – Height of Bench Mark (BM) w.r.t. Sounding Datum (SD)

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 Indus 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 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)	Sounding Datum (m) from MSL	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	To	D	E	F = (E- WL data in MSL)	G = ((E- topo levels in MSL)
1		0	0	0.5		3239.65	Not Present.	A separate xyz file is to create (not to plot).
2		1	0.5	1.5		3244.67		
3		2	1.5	2.5		3258.48		
4		3	2.5	3.5		3257.53		
5		4	3.5	4.5		3262.57		
6		5	4.5	5.5		3264.84		
7		6	5.5	6.5		3269.19		
8		7	6.5	7.5		3271.06		
9		8	7.5	8.5		3274.24		
10		9	8.5	9.5		3276.96		
11		10	9.5	10.5		3280.54		
12		11	10.5	11.5		3283.38		
13		12	11.5	12.5		3287.32		
14		13	12.5	13.5		3290.51		
15		14	13.5	14.5		3293.33		
16		15	14.5	15.5		3298.69		
17		16	15.5	16.5		3302.36		
18		17	16.5	17.5		3306.94		
19		18	17.5	18.5		3311.06		
20		19	18.5	19.5		3317.64		
21		20	19.5	20.5		3322.65		
22		21	20.5	21.5		3325.75		
23		22	21.5	22.5		3328.50		
24		23	22.5	23.5		3333.29		
25		24	23.5	24.5		3336.62		
26		25	24.5	25.5		3344.55		
27		26	25.5	26.5		3351.10		
28		27	26.5	27.5		3354.68		
29		28	27.5	28.5		3359.11		
30		29	28.5	29.5		3363.85		
31		30	29.5	30.5		3368.75		
32		31	30.5	31.5		3375.33		
33		32	31.5	32.5		3378.56		
34		33	32.5	33.5		3386.47		
35		34	33.5	34.67		3239.65		

2.11 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 Indus River is purely based on field observations.

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

Sl No	Structure Name	Chainage (kms)	Position (Lat Long)		Position (UTM)		Bridge Bottom Level	High Flood Level (HFL) in m from MSL (Based on Field Observation)	Minimum Water Level (MWL) in m from MSL	Remarks
			Left Bank	Right Bank	Left Bank	Right Bank				
1	Bridge	0.00	34°3' 34.6312"N 77°38' 32.2636"E	34°3' 36.397"N 77°38' 33.7401"E	743872.123 3771917.222	743908.580 3771972.608	3245.08	3242.59	3240.86	Good condition and in use
2	Bridge	8.11	34°0' 25.5385"N 77°41' 18.3628"E	34°0' 27.1703"N 77°41' 20.1389"E	748284.801 3766201.884	748329.056 3766253.358	3275.86	3273.68	3271.49	Good condition and in use
3	Bridge	18.10	33°55' 58.4333"N 77°43' 44.8934"E	33°55' 59.0673"N 77°43' 47.1949"E	752264.115 3758071.198	752322.705 3758092.304	3312.22	3309.63	3308.23	Good condition and in use
4	Bridge	19.69	33°55' 14.508"N 77°44' 4.3231"E	33°55' 14.5985"N 77°44' 6.0462"E	752844.338 3756737.403	752799.000 3756733.000	3322.16	3318.92	3317.95	Good condition and in use
5	Bridge	19.83	33°55' 10.3124"N 77°44' 4.3231"E	33°55' 10.2198"N 77°44' 5.8312"E	752802.664 3756601.768	752841.477 3756599.946	0.00	0.00	0.00	Abandoned
6	Bridge	27.18	33°52' 26.481"N 77°46' 23.1074"E	33°52' 27.1389"N 77°46' 23.72"E	756504.066 3751649.375	756519.264 3751670.072	3357.80	3355.62	3353.15	Abandoned
7	Bridge	34.67	33°49' 41.3003"N 77°48' 56.8443"E	33°49' 42.9716"N 77°48' 56.0075"E	760594.803 3746667.172	760571.874 3746718.083	3395.26	3393.95	3390.66	Good condition and in use

2.12 Graph between Sounding Datum and HFL v/s Chainage

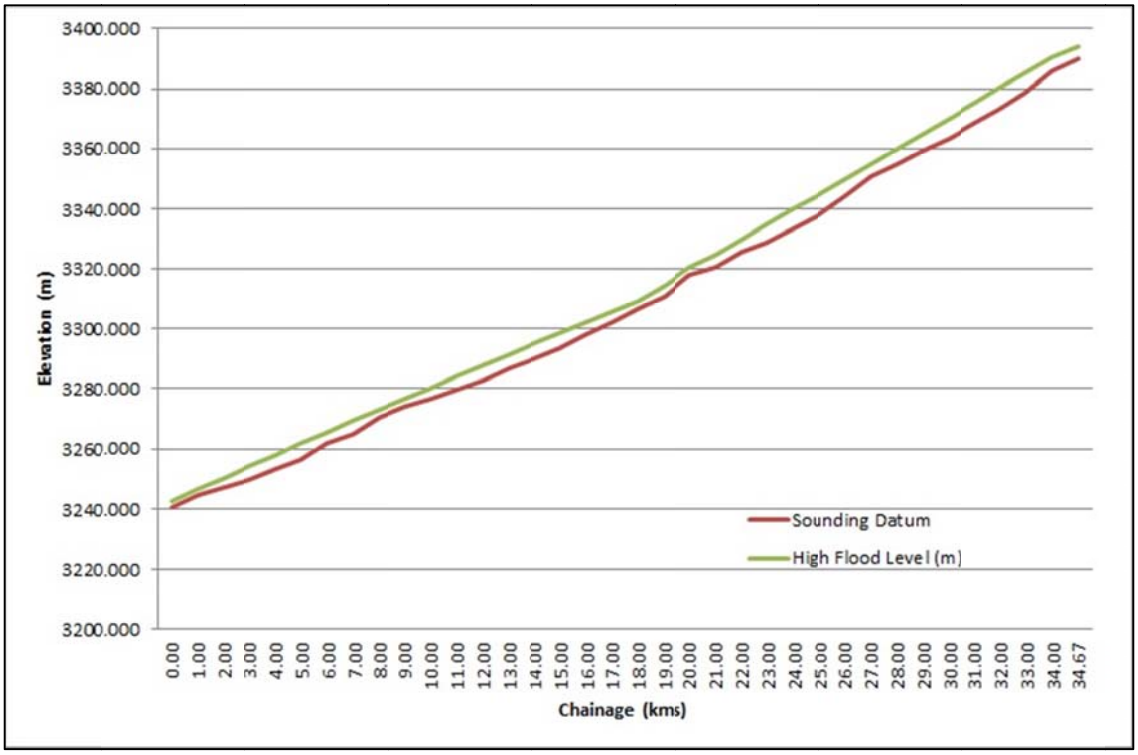


Figure 4 – Graphs between Chainage and Sounding Datum (SD) in Indus River

2.13 Average Bed Slope

Table 5 – Average Bed Slope

Reach (km)		River / Canal Bed Level Change (m)	Distance (km)	Slope
From	To			
0	9	33.60	9.00	1:268
9	18	32.81	9.00	1:274
18	27	43.74	9.00	1:206
27	34.67	37.01	7.67	1:207

2.14 Details of Dam, Barrages, Weirs, Anicut

Table 6 – Details of Dam, Barrages, Weirs, Anicut

S. No.	Structure Name	Chainage (Km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	Height w.r.t. Bed Level (m)	Present condition
			Left Bank	Right Bank	Left Bank	Right Bank				
1	Ugu wier	27.12	33°52' 24.7553"N 77°46' 20.9424"E	33°52' 27.8604"N 77°46' 20.4261"E	756449.857 3751594.701	756434.006 3751690.019	96	2		Abandoned

2.15 Details of Locks

No Lock Present in this stretch of waterway.

2.16 Details of Aqueducts

No Aqueduct Present in this stretch of waterway.

2.17 Details of Cross-structures in Indus River

Table 7 – Bridges and Cross Structure in Indus River

S. No.	Structure Name	Chainage (Km)	Position (Lat Long)		Position (UTM)		Length (m)	Width (m)	No. of Piers	Horizontal clearance (m)	Vertical Clearance w.r.t HFL (m)	Remarks
			Left Bank	Right Bank	Left Bank	Right Bank						
1	Shashe Bridge	0.00	34°3' 34.6312"N 77°38' 32.2636"E	34°3' 36.397"N 77°38' 33.7401"E	743872.123 3771917.222	743908.580 3771972.608	66.00	5.00	2	45.3	2.49	Good condition and in use
2	Stakna Village Bridge	8.11	34°0' 25.5385"N 77°41' 18.3628"E	34°0' 27.1703"N 77°41' 20.1389"E	748284.801 3766201.884	748329.056 3766253.358	67.00	3.00	2	48.0	2.18	Good condition and in use
3	Bridge	18.10	33°55' 58.4333"N 77°43' 44.8934"E	33°55' 59.0673"N 77°43' 47.1949"E	752264.115 3758071.198	752322.705 3758092.304	62.00	2.60	2	42.43	2.59	Good condition and in use
4	Birdge	19.69	33°55' 14.508"N 77°44' 4.3231"E	33°55' 14.5985"N 77°44' 6.0462"E	752844.338 3756737.403	752799.000 3756733.000	45.00	5.00	2	35.35	3.50	Good condition and in use
5	Karu Birdge	19.83	33°55'10.3124"N 77°44' 4.3231"E	33°55' 10.2198"N 77°44' 5.8312"E	752802.664 3756601.768	752841.477 3756599.946	38.00	4.00	2	28.1	3.24	Abandoned
6	Wood bridge	27.18	33°52' 26.481"N 77°46' 23.1074"E	33°52' 27.1389"N 77°46' 23.72"E	756504.066 751649.375	756519.264 3751670.072	25.00	2.00	2	18.0	2.18	Abandoned
7	Upshi Bridge	34.67	33°49' 41.3003"N 77°48' 56.8443"E	33°49' 42.9716"N 77°48' 56.0075"E	760594.803 3746667.172	760571.874 3746718.083	56.00	7.50	2	40.0	1.32	Good condition and in use

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

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

2.19 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 8 – Electric Lines in Indus River

S. No.	Features Name	Chainage (Km)	Position (Lat, Long)		Position (UTM)		Vertical Clearance w.r.t HFL (m)
			Left Bank	Right Bank	Left Bank	Right Bank	
1	Electric Line Cross	7.23	34°0' 44.6378"N 77°40' 52.4328"E	34°0' 46.6277"N 77°40'55.8782"E	747604.0043 3766772.9228	747690.8040 3766836.5540	15.00
2	Electric Line Cross	8.45	34°0' 15.82"N 77°41' 20.0836"E	34°0' 16.1968"N 77°41'24.5926"E	748336.8220 3765903.5930	748452.2248 3765918.2427	12.00
3	Electric Line Cross	8.45	34°0' 15.7705"N 77°41' 20.0844"E	34°0' 16.0435"N 77°41'24.6253"E	748336.8830 3765902.0680	748453.1881 3765913.5413	14.00
4	Electric Line Cross	10.45	33°59' 24.9802"N 77°41' 52.1278"E	33°59' 24.868"N 77°41'57.8393"E	749200.4003 3764358.7344	749347.0821 3764359.1394	10.00
5	Electric Line Cross	19.86	33°55' 9.2997"N 77°44' 3.6473"E	33°55' 9.1204"N 77°44' 7.8658"E	752786.1360 3756570.1020	752894.6442 3756567.4654	10.00
6	Electric Line Cross	19.94	33°55' 6.6893"N 77°44' 5.3246"E	33°55' 6.7838"N 77°44' 9.1919"E	752831.3650 3756490.8170	752930.6289 3756496.3787	11.00
7	Electric Line Cross	23.91	33°53' 19.834"N 77°44' 57.0376"E	33°53' 9.3405"N 77°45' 3.6537"E	754247.9493 3753233.8448	754418.3678 3753223.1906	12.00
8	Electric Line Cross	23.93	33°53' 19.7152"N 77°44' 56.9389"E	33°53'18.4949"N 77°45' 3.2814"E	754245.5090 3753230.1170	754409.4986 3753196.8809	10.00
9	Electric Line Cross	26.21	33°52' 38.5737"N 77°45' 53.5115"E	33°52'38.9246"N 77°45'57.2967"E	755733.3790 3752001.4750	755830.3708 3752014.9086	12.00
10	Electric Line Cross	27.08	33°52' 25.0624"N 77°46' 19.3927"E	33°52'26.7916"N 77°46'19.6897"E	756409.7740 3751603.0890	756415.9699 3751656.5763	12.00

2.20 Current Meter and Discharge details

Table 9 – Current Meter and Discharge Details

Stretch No.	Chainage (km)	Position				Observed Depth (m)	Velocity (m/sec.)			Average Velocity (m/sec.)	Area (Sq.m)	Discharge (Cu.m/sec)
		Latitude (N)	Longitude (E)	Easting (m)	Northing (m)		0.3 D	0.5 D	0.9 D			
1	3.55	34°2'23.9209"	77°39'57.1513"	746105.832	3769794.996	0.75	1.88	2.00	1.78	1.88	25.30	47.56
2	12.11	33°58'39.8493"	77°42' 25.1317"	750084.227	3762990.497	0.61	1.55	1.56	1.53	1.54	26.00	40.04
3	23.51	33°53'32.4713"	77°45' 2.819"	754386.079	3753627.209	0.94	1.35	1.40	1.33	1.35	41.85	56.50
4	31.60	33°50'58.9131"	77°48' 5.3305"	759204.933	3749022.456	0.89	1.18	1.20	1.15	1.17	48.40	56.63

2.21 (A) Soil Sample Locations

Table 10 – Soil and Water Sample Locations in Indus River

S. No.	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Depths (m)
1	3.55	34°2' 23.9209"	77°39' 57.1513"	746105.832	3769794.996	0.75
2	12.11	33°58' 39.8493"	77°42' 25.1317"	750084.227	3762990.497	0.61
3	23.51	33°53' 32.4713"	77°45' 2.819"	754386.079	3753627.209	0.94
4	31.60	33°50' 58.9131"	77°48' 5.3305"	759204.933	3749022.456	0.89

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

(B) Water Sample Locations

Table 11 – Water Sample: Location in Indus River

S. No.	Chainage (km)	Latitude (N)	Longitude (E)	Easting (m)	Northing (m)	Total Depth (d)	Mid-Depth (0.5d)
1	3.55	34°2' 23.9209"	77°39' 57.1513"	746105.832	3769794.996	0.75	0.38
2	12.11	33°59.8493"	77°42' 25.1317"	750084.227	3762990.497	0.61	0.31
3	23.51	33°53' 32.4713"	77°45' 2.819"	754386.079	3753627.209	0.94	0.47
4	31.60	33°50' 58.9131"	77°48' 5.3305"	759204.933	3749022.456	0.89	0.45

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

3. DESCRIPTION OF WATERWAY FOR INDUS RIVER

Hydrographic Survey was not done due to very less quantity of water flowing in the Indus River. Only topographic survey was possible due to insufficient quantity. So we have divided our survey area of Indus River into 4 different stretches and details of stretches given below from Para 3.1 to 3.4.

3.1 Bridge at Shey Village to Stakna Village (Ch. 00.00 km – 9.00 km)

Figure 5 – Bridge at Shey Village to Stakna Village

Table 12 – Minimum – Maximum Reduce Depths, Bridge at Shey Village to Stakna 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	0	9	-0.3	**0.6**	9	474093.53
2	0	9	-0.3	**0.5**	9	705428.98
3	0	9	-0.3	0.7	9	1038566.58
4	0	9	-0.3	0.7	9	1229387.64

Table 13 - Minimum – Maximum Observe Depths, Bridge at Shey Village to Stakna Village

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	0	9	0	**0.6**	9	374947.200
2	0	9	0	**0.5**	9	575567.74
3	0	9	0	0.7	9	874804.84
4	0	9	0	0.7	9	1057702.83

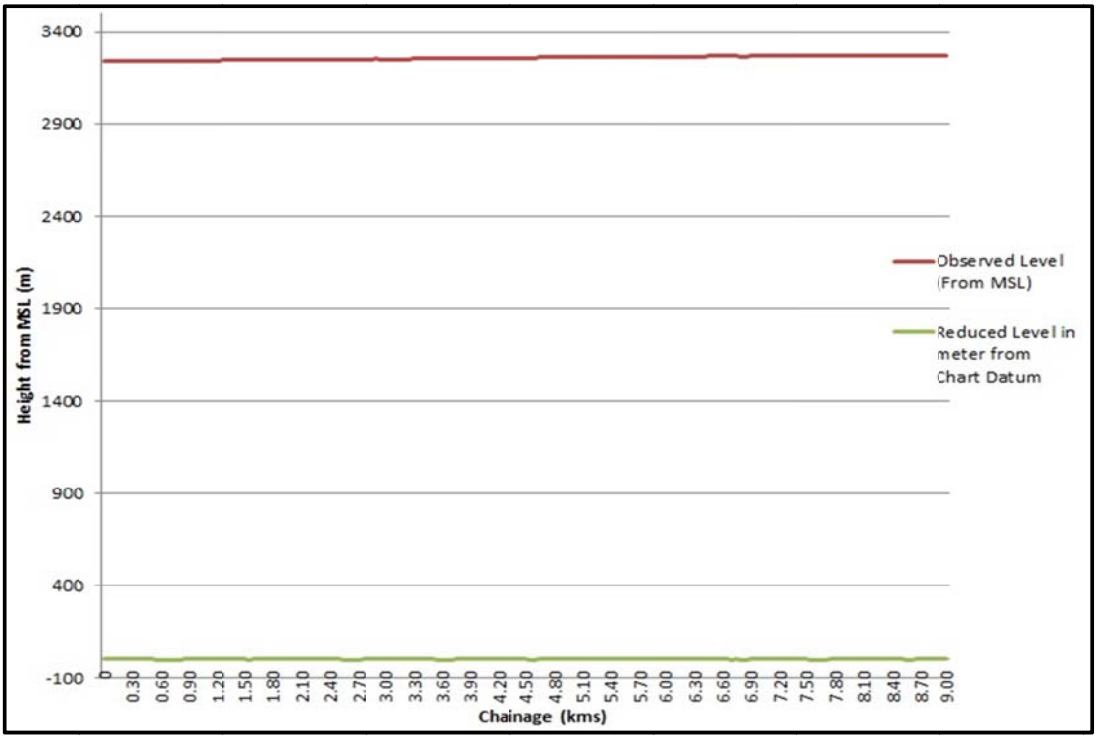


Figure 6 – Observed and Reduced Bed Profile of Bridge at Shey village to Stakna Village

First stretch (Ch. 0.00 to 9.00 km) start from Bridge at Shey Village to Stakna Village. Two bridges are present in this stretch of River. Height of these bridges varies between 2.5 m to 3.0m from maximum flood level. Main city is Leh (downstream of Ch. 0.00 km). Main villages in this stretch are Shey, Thiksey and Stakna. Manali-Leh Highway runs along this stretch of River. All the transportation and tourist going through this road. Manali-Leh Highway closed in winter due to snowfall and opened in summer in month of May. Also this stretch is well connected to Leh-Srinagar Highway. River banks in this stretch are manly not 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

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 are many tourist places in vicinity of this stretch also the connectivity of these places from this stretch of river through road is very 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 7 – Ch.0.00 Km Shashe Bridge on Shey Chuchot Road at Shey Village

Figure 8 – Ch-0.50 Km River View

Figure 9 – Ch.3.90 Km Topographic Survey in Progress in Main River Flow

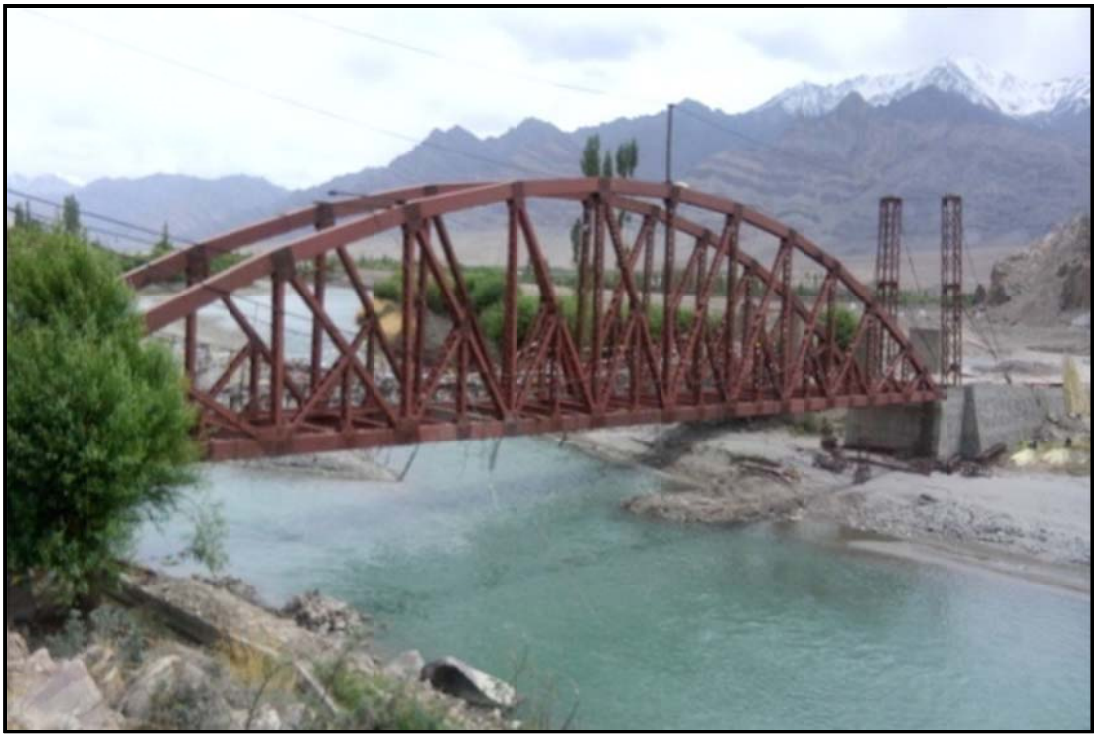


Figure 10 – Ch.8.11 Km Stakna Village Bridge

3.2 Stakna Village to Karu Village (Ch. 9.00 km – 18.00 km)

Figure 11 – Stakna Village to Karu Village

Table 14 – Minimum – Maximum Reduce Depths, Bridge at stakna Village to Karu 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	-0.3	**0.6**	**9.0**	940370.95
2	9	18	-0.3	**0.5**	**9.0**	1402406.36
3	9	18	-0.3	0.7	**9.0**	2068921.93
4	9	18	-0.3	0.7	**9.0**	2450710.93

Table 15 – Minimum – Maximum Observe Depth Bridge at Stakna Village to Karu Village

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	9	18	0	**0.6**	**9.0**	747330.970
2	9	18	0	**0.5**	**9.0**	1148541.08
3	9	18	0	0.7	**9.0**	1747344.13
4	9	18	0	0.7	**9.0**	2113288.56

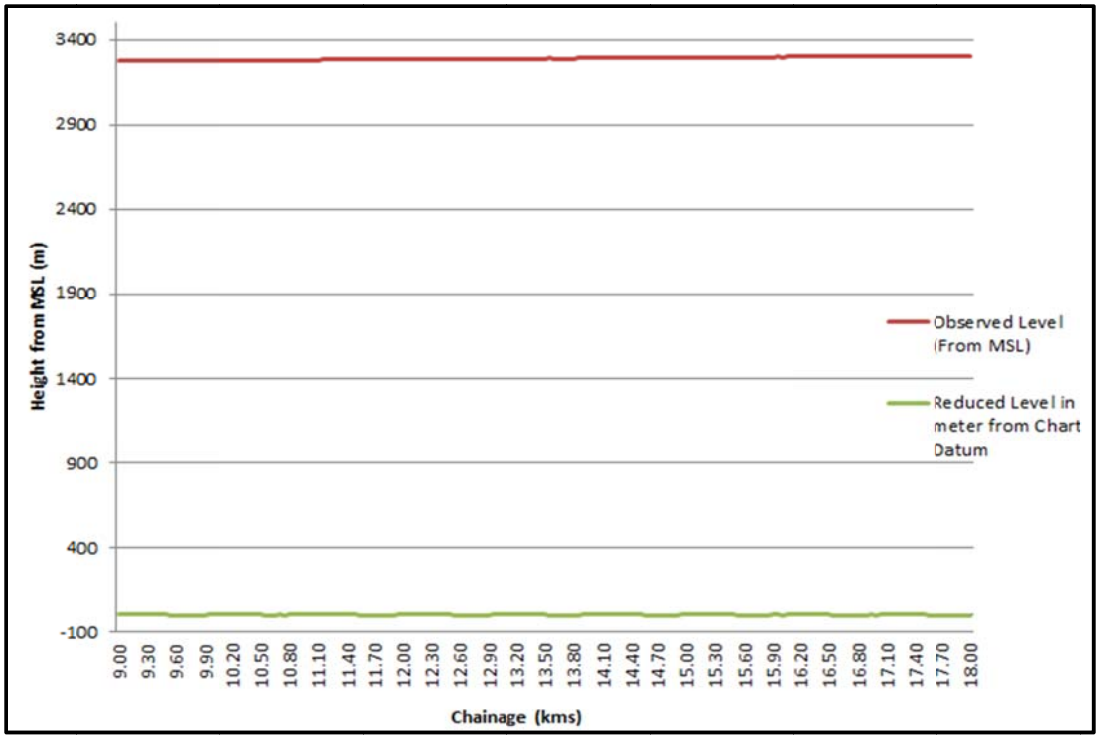


Figure 12 – Observed and Reduced Bed Profile of Stakna Village to Karu Village

Second stretch (Ch. 9.00 to 18.00 km) start from Stakna Village to Karu Village. No bridge is present in this stretch of River. Main villages in this stretch are Changa and Karu. Manali-Leh Highway runs along this stretch of River. All the transportation and tourist going through this road. River banks in this stretch are manly not 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. 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 are many tourist places in vicinity of this stretch also the connectivity of these places from this stretch of river through road is very 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 13 – Ch.12.20Km River & Channel View

Figure 14 – Ch. 16.50 Km Rock Formation on Bank of Reservoir

3.3 Karu Village to Kharoo Nala (Ch. 18.00 km – 27.00 km)

Figure 15 – Karu Village to Kharoo Nala Village

Table 16 – Minimum – Maximum Reduce Depths, Karu Village to Kharoo

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	-0.3	**0.6**	9.0	1413956.51
2	18	27	-0.3	**0.5**	9.0	2108174.72
3	18	27	-0.3	0.7	9.0	3109194.67
4	18	27	-0.3	0.7	9.0	3682467.93

Table 17 – Minimum – Maximum Observe Depths, Karu Village to Kharoo Nala

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	18	27	0	**0.6**	9.0	1121907.460
2	18	27	0	**0.5**	9.0	1724149.21
3	18	27	0	0.7	9.0	2623016.14
4	18	27	0	0.7	9.0	3172391.80

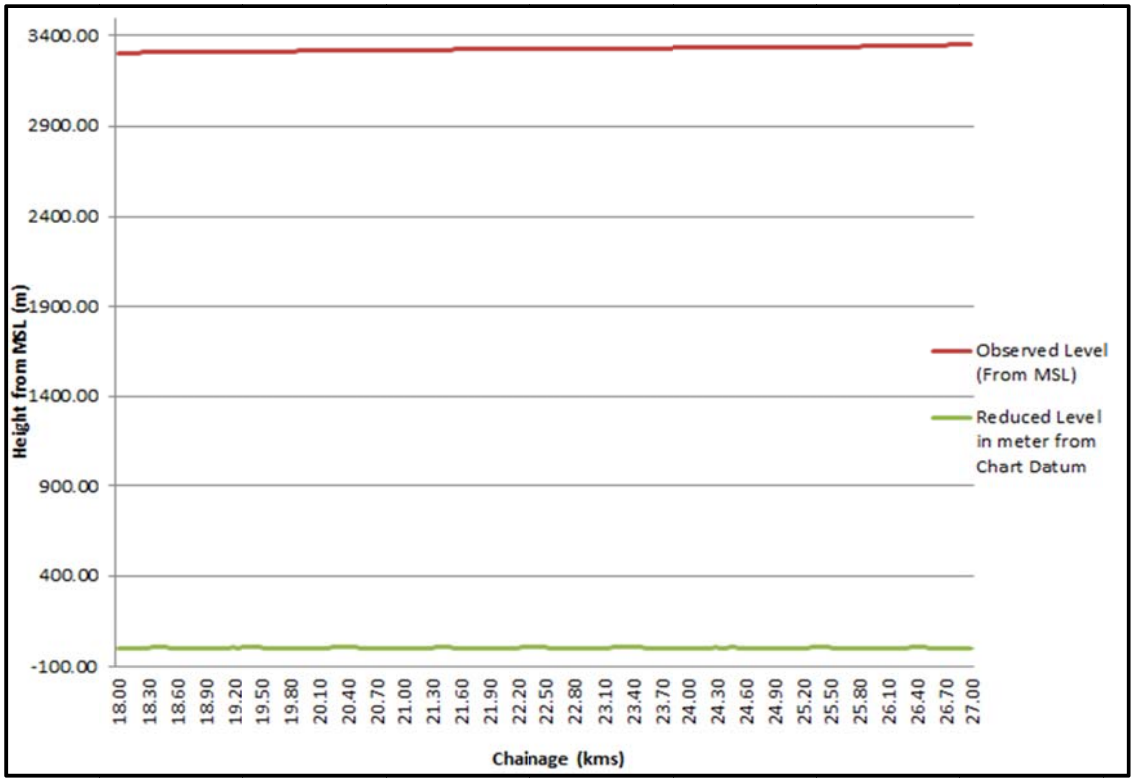


Figure 16 – Observed and Reduced Bed Level Karu Village to Kharoo Nala Village

Third stretch (Ch. 18 to 27 km) start from Karu Village to Kharoo Nala. Three bridges are present in this stretch of River. Height of these bridges varies between 2.5 m to 3.5 m from maximum flood level. Main village in this stretch is Hemis. Cantonment area present on left bank of this stretch of river. Manali-Leh Highway runs along this stretch of River. All the transportation and tourist going through this road. 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 are many tourist places in vicinity of this stretch also the connectivity of these places from this stretch of river through road is very 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 17 – Ch. 19.83 Km Karu Bridge

Figure 18 – Ch.- 26.80 Km Water Controlling Gate

3.4 Kharoo Nala to Upsi Village (Ch. 27.00 km – 34.67 km)

Figure 19 – Kharoo Nala to Upsi Village

Table 18 – Minimum – Maximum Reduce Depths, Kharoo Nala to Upsi 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	27	34.67	-0.3	**0.6**	7.0	1825682.46
2	27	34.67	-0.3	**0.5**	7.0	2721122.24
3	27	34.67	-0.3	0.7	7.0	4012797.02
4	27	34.67	-0.3	0.7	7.0	4752915.14

Table 19 – Minimum – Maximum Observe Depths, Kharoo Nala to Upsi Village

Class	Chainage		Observed			
	From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)
1	27	34.67	0	**0.6**	7.0	1447065.690
2	27	34.67	0	**0.5**	7.0	2224020.37
3	27	34.67	0	0.7	7.0	3384131.80
4	27	34.67	0	0.7	7.0	4093498.00

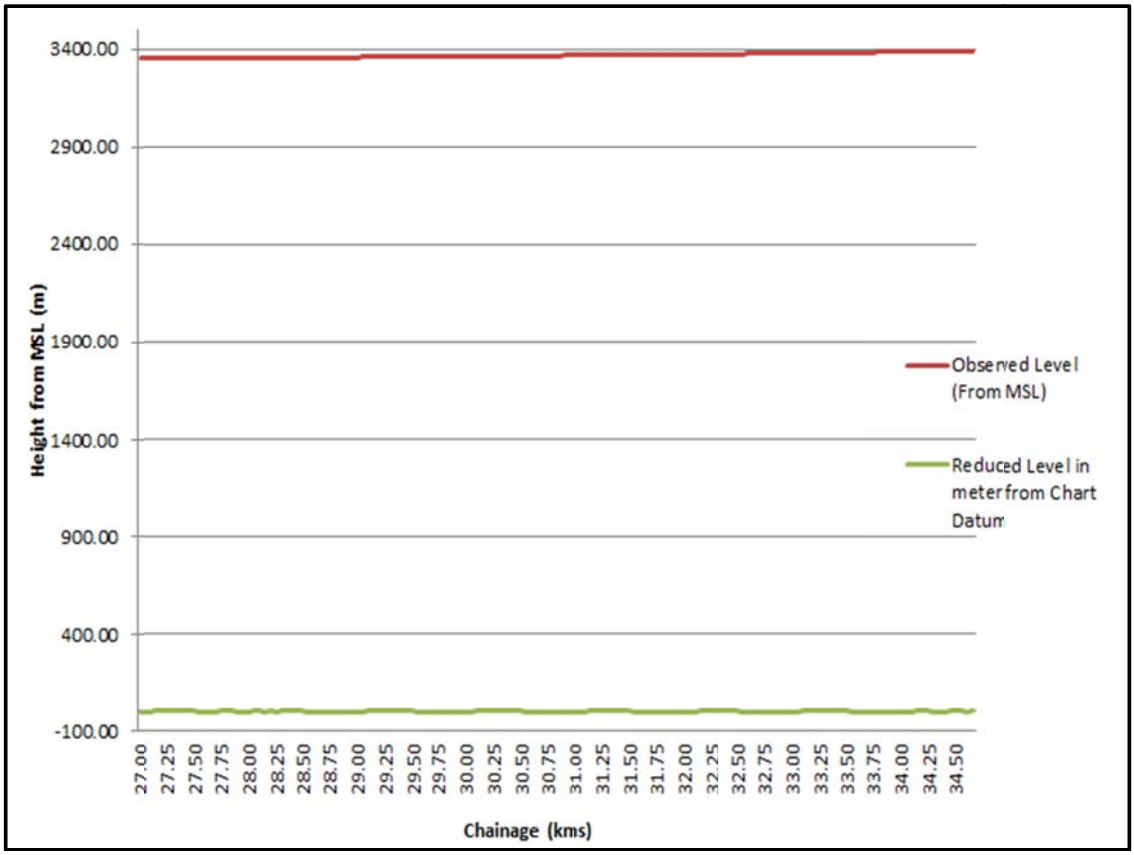


Figure 20 – Observed and Reduced Bed Profile

Fourth stretch (Ch. 27 to 34.67 km) start from Kharoo Nala to Upsi Village. Two bridges and 1 weir are present in this stretch of River. Height of these bridges varies between 1.0 m to 2.0 m from maximum flood level. Weir is not in working condition. Main village in this stretch is Upsi. Manali-Leh Highway runs along this stretch of River. At the end of Stretch one road is going to Pangong Lake. 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 are many tourist places in vicinity of this stretch also the connectivity of these places from this stretch of river through road is very 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 21 – Ch. – 27.60 Km Water Controlling Gate and Wooden

Figure 22 – Ch.- 289.90 Km River Bank

Figure 23 – Ch- 34.672 Km Upshi Bridge

4. LOCATIONS FOR TERMINAL CONSTRUCTION

Total 02 (two) locations are proposed for construction of terminals along the IG 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

Figure 24 – Overview, Terminal Locations

Table 20 – Terminal Locations

Stretch No.	Chainage (km)	Location	Position			
			Latitude (N)	Longitude (E)	Easting (m)	Northing (m)
1	0.26	Shashe Bridge on Shey-Chuchot Road	34°3' 32.5388"N	77°38' 42.7756"E	E 744143.3650	N 3771859.7206
2	34.00	Upshi	33°49' 55.1364"N	77°48' 38.4922"E	E 760111.2170	N 3747080.5922

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

4.1 Terminal 1 (Near Shashe Bridge on Shey-Chuchot Road of Ch. 0.26 km):

The suggested location is near to Shashe Bridge on Shey-Chuchot Road. The location is well connected to Keylong-Leh road 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.

Figure 25 – Terminal 1

4.2 Terminal 2 (Upshi village at Ch. 34 km):

Upshi village terminal is situated on right bank of Indus River. The place is well connected to main Manali-Leh Highway and has the potential to be developed into industrial hub.

Figure 26 – Terminal 2 (Upshi Village)

5. FAIRWAY DEVLOPMENTS

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.

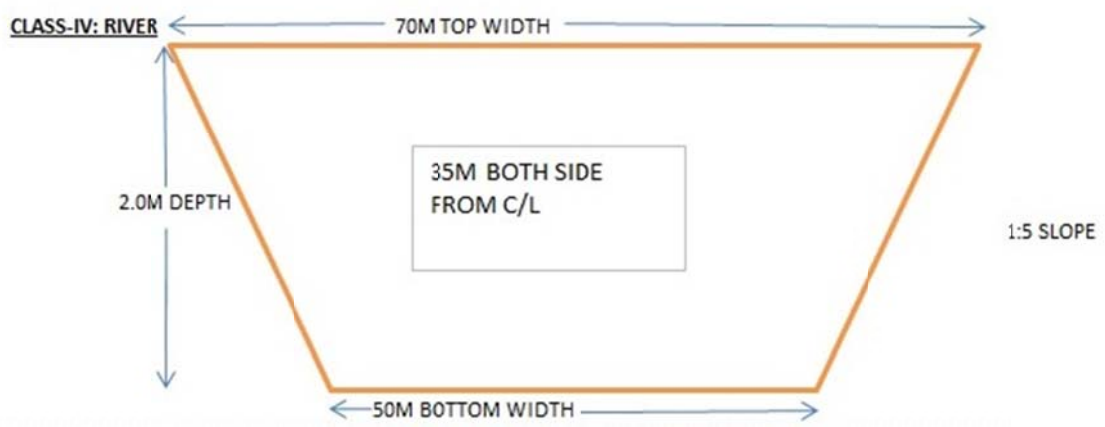


Table 21 – Dredging Volume Summary in Indus River at 2.0m

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	1057702.83	1057702.83	-0.3	0.6	9	1229387.64	1229387.64
9	18	0	0	9	1173686.370	2231389.20	-0.3	0.5	9	1358418.470	2587806.11
18	27	0	0	9	941002.600	3172391.80	-0.3	0.7	9	1094661.820	3682467.93
27	34.67	0	0	7	921106.200	4093498.00	-0.3	0.7	7	1070447.210	4752915.14
			Total		**4,093,498.00**			Total		**4,752,915.14**	

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

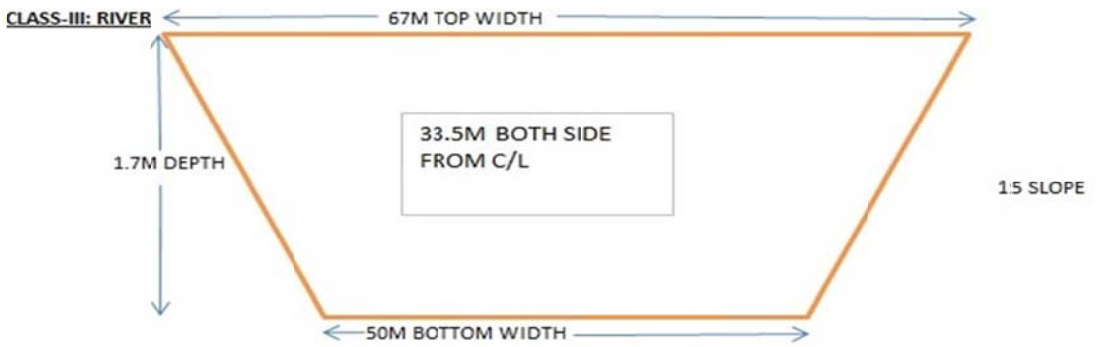


Table 22 – Dredging Volume Summary in Indus River at 1.7m

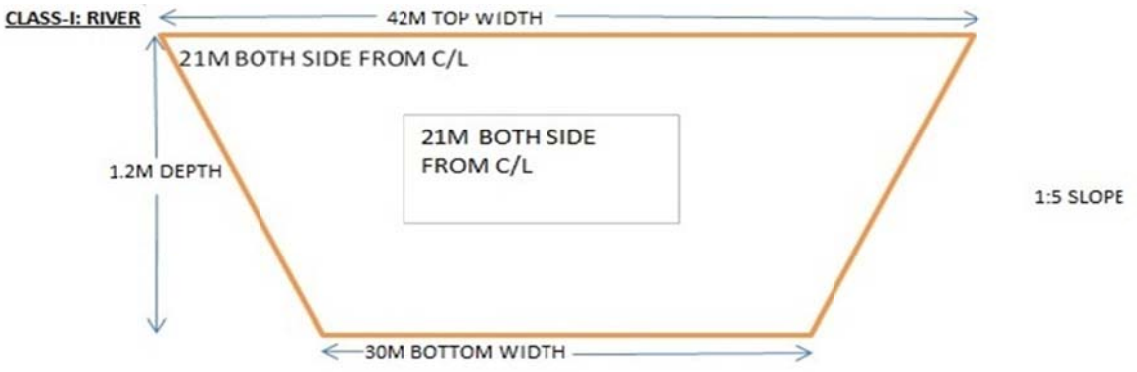
Chainage		Observed					Reduced w.r.t. Sounding Datum				
From	To	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. qty. (cu.m.)	Min. Depth (m)	Max. Depth (m)	Length of Shoal (km)	Dredging Qty. (cu.m.)	Cumulative Drg. qty. (cu.m.)
0	9	0	0.6	9	874804.84	874804.84	-0.3	0.6	9	1038566.58	1038566.58
9	18	0	0.5	9	970131.66	1844936.50	-0.3	0.5	9	1146046.63	2184613.21
18	27	0	0.7	9	778079.64	2623016.14	-0.3	0.7	9	924581.46	3109194.67
27	34.67	0	0.7	7	761115.66	3384131.80	-0.3	0.7	7	903602.35	4012797.02
			Total		**3,384,131.80**			**Total**		**4,012,797.02**	

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

Table 23 – Dredging Volume Summary in Indus River at 1.4 m

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	0.6	9	575567.74	575567.74	-0.3	0.6	9	705428.98	705428.98
9	18	0	0.5	9	572973.340	1148541.08	-0.3	0.5	9	696977.380	1402406.36
18	27	0	0.7	9	575608.130	1724149.21	-0.3	0.7	9	705768.360	2108174.72
27	34.67	0	0.7	7	499871.160	2224020.37	-0.3	0.7	7	612947.520	2721122.24
			Total		**2,224,020.370**			**Total**		**2,721,122.240**	

4) 30m x 1.2m 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 24 – Dredging Volume Summary in Indus 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	0.6	9	374947.200	374947.200	-0.3	0.6	9	474093.53	474093.53
9	18	0	0.5	9	372383.770	747330.970	-0.3	0.5	9	466277.420	940370.95
18	27	0	0.7	9	374576.490	1121907.460	-0.3	0.7	9	473585.560	1413956.51
27	34.67	0	0.7	7	325158.230	1447065.690	-0.3	0.7	7	411725.950	1825682.46
			Total		**1,447,065,690**			**Total**		**1,825,682.460**	

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-46) from Bridge on Highway at Upshi Village to Bridge on Shey-Chuchot road near Shey Village for the stretch of 34.67 km of length.

The aim of survey was to conduct a survey for assessing the river stretch from Bridge on Highway at Upshi Village to Bridge on Shey-Chuchot road near Shey Village, 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. Only Topographic survey was possible due to Shallow water flowing in the river.

In the present form, the river is not navigable in whole surveyed area. To assess the feasibility of navigation, capital dredging would be required. Recommendation for no Need of Detailed Project Report and Geotechnical Survey.

2 Terminal may be developed on Indus River for facilitation of cargo.

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	34.67	0	0.6	34.67	1447065.690	-0.3	0.6	34.67	1825682.46
2	00	34.67	0	0.5	34.67	2224020.37	-0.3	0.5	34.67	2721122.24
3	00	34.67	0	0.7	34.67	3384131.80	-0.3	0.7	34.67	4012797.02
4	00	34.67	0	0.7	34.67	4093498.00	-0.3	0.7	34.67	4752915.14

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	Soil Sample Report
Annexure – XI	Water Sample Report
Annexure – XII	Calibrations Certificates
Annexure - XIII	Field Photographs