GEOSERVICES
MARITIME PVT. LTD.

REPORT ON TOPOGRAPHIC & BATHYMETRIC SURVEY FOR ASSESSMENT OF RESERVOIR CAPACITY & SEDIMENTATION IN DAMANGANGA_MADHUBAN RESERVOIR, GUJARAT, INDIA UNDER NATIONAL HYDROLOGY PROJECT

GMPL REPORT NUMBER: P-SUR-BATHY-004-2020-WRD-DAMANGANGA_MADHUBAN
SURVEY PERIOD: 04 NOV TO 13 DEC 2020

Prepared for:	**Water Resources Investigation Division, Ahmedabad (Govt. of Gujarat) Narmada Water Resources, Water Supply and Kalpsar Department**	Equity Efficiency Sustainability WRD
Client Reference:	**Executive Engineer Water resources investigation Division Ahmedabad.** **Deputy Executive Engineer River Gauging Sub Division Navsari.**	

LOCATION MAP

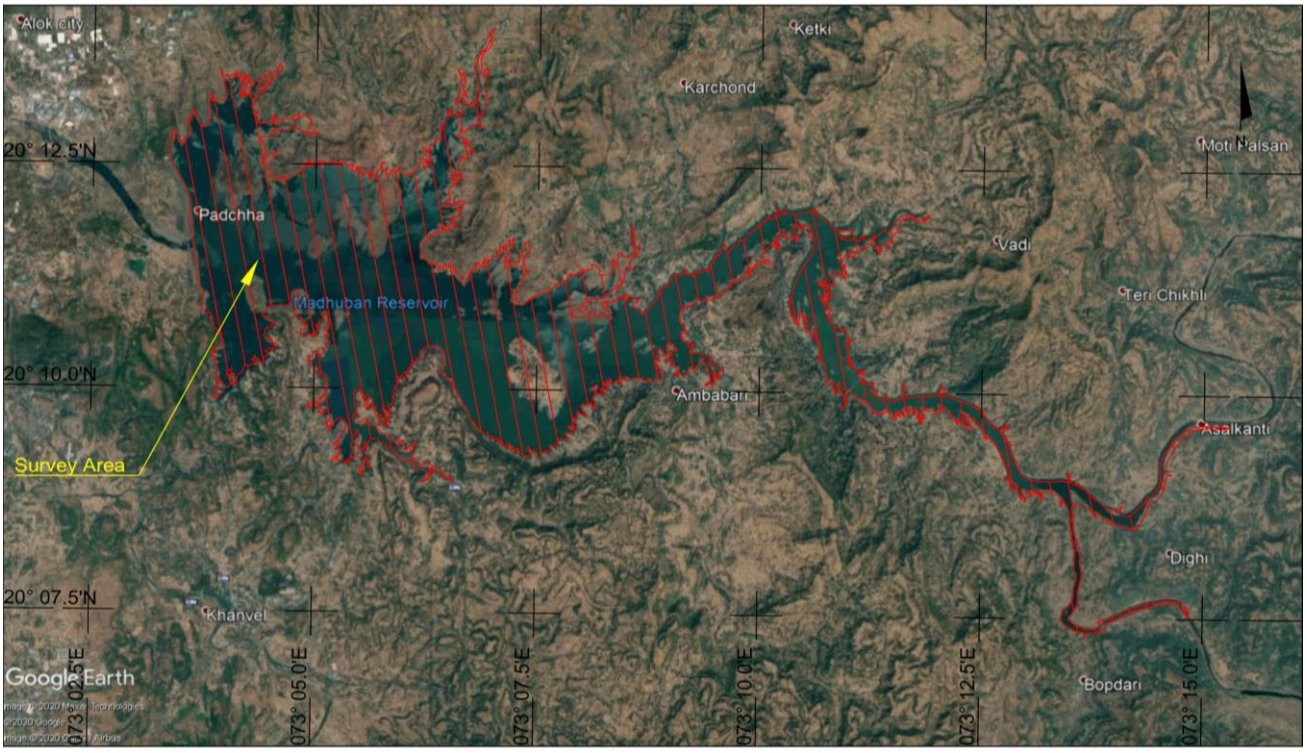

Figure 1.1-1 LOCATION MAP

LOCATION MAP SHOWING SURVEY AREA "DAMANGANGA_MADHUBAN RESERVOIR", GURAJAT, INDIA

DOCUMENT ARRANGEMENT

REPORT OF SURVEY WITH CHART / DRAWING

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1 INTRODUCTION, OBJECTIVE & SCOPE OF WORK

1.1 General

Water Resources Investigation Division (WRD) has awarded the contract to Geoservices Maritime Pvt Ltd (GMPL), Navi Mumbai for carrying out Topographic and Bathymetric Survey at Damanganga_Madhuban Reservoir, Gujarat. The survey services provided by GMPL comprise of the provision of well-qualified survey personnel and equipment in order to obtain, interpret and report on acquired topographic & bathymetric survey data at the client specified locations.

This report contains the results of survey as against the scope of work and the methodology adopted to achieve the specifications and schedule of the survey work undertaken at Damanganga_Madhuban Reservoir.

1.1.1 LIST OF ABBREVIATIONS USED

CM	Central Meridian
DGPS	Differential Global Positioning System
CSRS	Canadian Spatial Reference System
FRL	Full Reservoir Level
GMPL	Geoservices Maritime Private Limited
GPS	Global Positioning System
HDOP	Horizontal Dilution of Precision
KHz	Kilohertz
HSE	Health Safety Environment
MSL	Mean Sea Level
m	metre
M Cu. m	Million Cubic metre
Sq. Km	Square Kilometre
MDDL	Minimum Draw Down Level
m/s	meter per second
ms	milliseconds
MWL	Maximum Water Level
QA/QC	Quality Assurance / Quality Control
Rev	Revision
RTK	Real Time Kinematic
SBES	Single Beam Echo Sounder
TBM	Temporary Bench Mark
UTM	Universal Transverse Mercator
WGS 84	World Geodetic System 1984
WRD	Water Resources Investigation Division

1.1.2 Units

- UTM grid coordinates and all linear measurements expressed in metres (m).
- Angular values expressed in degrees (°).
- Time and dates expressed as "09:00 on 24 Jan 2021".

1.2 Objective

The main objective of the topographic and bathymetric survey of reservoir is as follow:

i) To estimate and study the sedimentation behaviour of reservoir in different zones including horizontal zones throughout the reservoir as well as vertical zones namely dead storage, live storage and flood storage if any.

ii) To upgrade Elevation-Area-Capacity table and curves of the reservoir at regular intervals.

iii) To emphasize on the importance of conducting hydrographic surveys at regular intervals for better operation and water management of the reservoir.

1.3 Scope of Work

The Scope of work for Geoservices Maritime Pvt Ltd was to mobilise, install, interface, operate all survey systems and provide all required survey personnel to undertake Topographic and Bathymetric survey services at Keliya Reservoir.

The detailed scope of work was:

i) To measure the water depth of the Keliya Reservoir at with respect to MSL.

ii) Line spacing shall be 25 m with continues echo sounding.

iii) Reservoir for water level changes during survey shall be tabulated.

iv) Data processing using HYPACK software.

v) Topographic survey shall be conducted from FRL water level with reasonable overlap with hydrographic survey.

vi) The area not covered under Hydrographic survey up to Maximum Water Level (MWL) shall be surveyed by taking levels at 25 m interval (25 m x 25 m grid).

vii) To carry out the data processing and interpretation of data and preparing of results, charts, drawings and report.

viii) Estimation of Sedimentation in the Reservoir.

ix) Gross and Live storage capacity of the Reservoir at every 0.10 m interval shall be provided.

x) Cross Sections showing the bed profile at 100 m interval shall be prepared.

xi) L-Section of the Reservoir may be prepared with lowest bed level at every survey line.

2 SALIENT FEATURES OF DAMANGANGA_MADHUBAN RESERVOIR PROJECT

Damanganga_Madhuban Reservoir project envisage construction of Dam across river Damanganga near village Madhuban of Kaparada Taluka of Valsad district in Gujarat. The scheme was impounded in the year 1983.

The total Catchment Area of Damanganga_Madhuban Reservoir is 1813 Sq. Km. The Full Reservoir Level (FRL) is 79.86 m and Minimum Draw Down Level (MDDL) is 61.60 m. The gross storage capacity at time of impounding was 567.00 M Cu. m, dead storage was 65 M Cu. m and live storage was M Cu. m.

I.	**LOCATION**	
	1. Name of River	Damanganga.
	2. Near Village	Madhuban
	3. Taluka/District	Kaparada/Valsad.
	4. Location of DAM	Lat.$20^0$10' N Long. $73^0$5' E
	5. Distance from nearest Railway station	Vapi – 30 Kms.
II	**HYDROLOGY**	
	1.Catchment area upto Dam site	1813 Sq.Km.
	Total upto Sea	2290 Sq.km.
	C.A.in Gujarat C.A. in Maharastra. C.A. in U.T & D.N.H. Total	376 Sq.km. 1318 Sq.km 119 Sq.km. 1813 Sq.Km.
	Elevation at Origin of the river	930.5 mt.
	Average elevation at Dam site	40.0 mt.
	2. Average Annual Rainfall. Maximum Rainfall. Mean Annual Runoff. Yield at 50 % Reliability 75 % Min.recorded flow Maxi Observed flood Design flood. Routed flood Discharge	 2382 mm. 3782 mm. 3771.60 M Cu. m 3771.60 M Cu. m 3150.40 M Cu. m 0.014 cumecs. 18075 cumecs (6.38 lacs cusecs) observed on 3.8.2004. 26850 cumecs (9.48 Lac cusecs) 22040 cumecs (7.78 cusecs)
III	**RESERVOIR**	
	Full Reservoir level	79.86 M.
	Maximum Water level (H.F.L.)	82.40 M.
	Lowest Water level (M.D.D.L)	61.60 M
	Tail Water level	55.00 M
	Gross Capacity at F.R.L.	567.00 M Cu. m
	Dead Storage at R.L.61.60 M.	65 M Cu. m
	Live storage	502.00 M Cu. m

	Area at F.R.L.	4935 Ha.
	Evaporation losses	57.10 MCM
IV	**DAM**	
	Type of Dam	Composite
	Total length	2870.36 mt.
	Earth Dam Right Bank Left Bank Left Saddle Dam. TOTAL.	 1633.00 Mt. 755.00 Mt. 130.0 Mt. 2518.00 Mt.
	Masonry Dam Total Length (a) Spillway (b) Right N.O.F.incl. power Dam (c) Left N.O.F. **Total**	 352.36 Mt. 191.11 Mt. 104.55 Mt. 56.70 Mt. 352.36 Mt.
	Total Length of Dam. Earth Dam. Masonary Dam	 2518.00 Mt. 352.36 Mt. 2870.36 Mt.
	Maximum Height of Dam from deepest foundation. (a) Earth Dam (b) Masonry Dam	 58.60 mt. 49.84 mt.
	Top of Dam	85.60 Mt. (Plus 1.0 mt. high solid parapet on U/S)
	Width of Masonry dam. Width of Earth dam	7.77 Mt. 6.80 Mt.
	Free board above Maximum Water level. H.F.L.	4.20 Mt.
	SPILLWAY :	
	Type and Location	Ogee shaped gated Spillway in Gorge.
	Crest R.L.	65.83 Mt.
	Length Clear	155.54 Mt.
	Overall.	191.11 Mt.
	No and size of Gate	10 Nos. 15.55 x 14.02 M size Taintor Gates.
	Maximum head Over crest.	14.02 + 2.54 (Flood lift) 16.56 Mt.
	Type of D/s Protective works	Roller Bucket with horizontal apron and recovery slope bucket radius – 17.0 M. Invert R.L. – 31.50 M.
	Gate Operation	Electrically operated rope drum type hoist with stand by Diesel Generator sets -2 Nos. 250 KVA capacity & D.H.U. Provided.
	OUTLETS. Bye pass outlets for water supply	2 Nos. of R.C.C. barrles of size 1.22 x 1.52 mt. at R.L.57.00 mt. pier No.9 and R.L.55 mt. in peir No.8.
	Pen stocks	2 Nos. of 1.52 x 1.52 m. size at Sill R.L. 54.26 mt.

	MAIN CANAL (LINED)	**R.B.M.C.**	**L.B.M.C.**
	Capacity	34.76 cumecs 1230 cusecs	11.46 cumecs. 405 cusecs.
	Length	45.54 km.	33.40 kms.
	Section	4.50 m. x 2.60 m	3 x 1.35 m
	Gradient	1 in 2500	1 in 1000
	HEAD REGULATOR.		
	Right bank head regulator		
	Location.	Right Bank Earth dam at ch.2675 mt.	
	Design Discharge	34.80 1230 cusecs.	
	Sill R.L.	59.46 mt.	
	Size of R.C.C. Barrel	2.74 m x 2.74 m	
	Size of Gate	1.83 x 2.44 m.	
	Left Bank Head Regulator		
	Location	Left Bank Earth Dam ast ch.75.0 mt.	
	Design Discharge	2.26 cumecs (80 cusecs)	
	Sill R.L.	61.00 mt.	
	Size of R.C.C. Barrel	1.20 x 1.50 mt.	
	Size of Gates	1.0 M x 1.0 M	
	Submergence Detail.		
	Area under submergence	5144 Ha. (Including Dam seat borrow Area & river bed)	
	Forest	1202.30 Ha.	
	Private	2747.70 Ha.	
	Government land	418.00 Ha.	
	Borrow Area & River bed	776.00 Ha.	
	No.of Villages affected	36 (22 from Gujarat & 14 From Union Territory)	
	Fully submerged	8 in Gujarat & 4 inU.T.of Dadra & Nagar Haveli	
	Partly submerged	14 in Gujarat & 10 in U.T.of Dadra & Nagar Haveli	
	Total effected families	2361	
	Total expenditure for Rehabilitation & Resettlement	176.36 Lacs.	
	Command Area		
	Gross command area	77905 Ha.	
	C.C.A.	51138 ha.	
	Talukawise 1. Pardi Taluka 2. Umergaon Taluka 3. Kaparada Taluka 4. U.T of D & N.H. 5. U.T.of Daman	No.of villages C.C.A. 78 } 41023 ha. 37 6 24 7044 26 3071 171 51138 ha	
	Water Supply. 1. Gujarat 2. Dadra & Nagar Haveli 3. Daman.	 40.00 MGD 12.75 MGD 5.25 MGD	

	Total	58.00 MGD	
	Power generation Small Hydropower project for river bed and Canal bed power house is taken up under B.O.T.Basis. Details are as below.	River bed	Canal bed
	Power Generation Capacity	2 Unit of 1.50 MW each	1 Unit of 2.60 MW
	Design Discharge	13.55 cumecs	24.39 cumecs
	Energy generation 75 % dependable year.	12.95 Milli.Units	11.63 Mili. Units
	Rated Hydraulic head	27 mt.	13 mt.

Table 2-1 SALIENT FEATURES OF THE RESERVOIR

3 EXECUTIVE SUMMARY OF RESULTS

GMPL had mobilised their survey team, equipment and Survey Boat "Aqua Marina (Boat 1) and Fibre boat (Boat 2)" which was deployed in the Damanganga_Madhuban Reservoir survey area from 04 Nov to 13 Dec 2020 to acquire bathymetric survey data and Topographic data as per mutually agreed scope and relevant survey specifications.

Geomax and Trimble DGPS system, Reson Navisound Echo sounder & SonarMite (215 kHz) were utilised to acquire the bathymetric data within the Damanganga_Madhuban Reservoir area. A value of 1500 m/s was used as the average velocity of sound in water, which was applied in the setup during acquisition. The data so obtained was then processed and contouring was done using Hypack software. Geomax RTK / Auto level and Tripod were used for topographic survey in the area.

Topographic and bathymetric data was reduced to Mean Sea Level (MSL). All the data is plotted on scale of 1:5000 for Damanganga_Madhuban reservoir area.

Four (4) hours of DGPS observation was carried out on OBS MADHUBAN (Levelling was carried out from Water gauge top to above mention observation point and level of Water gauge was provided by Dam Authority). Sixteen (16) Temporary Bench Marks, TBM 1 to TBM 16 were established to cover whole reservoir.

The values depicted in the charts are the elevation with respect to MSL.

- The Minimum elevation within Damanganga_Madhuban reservoir is 42.3m above MSL
- The Maximum depth within Damanganga_Madhuban reservoir is 36.7 m.
- Area covered by bathymetric survey is 41.722 Sq. Km.
- Area covered by topographic survey is 6.738 Sq. Km.

According to recent survey, total area of reservoir at FRL 79.86 m is 42.509 Sq. Km, corresponding storage capacity is 521.553 M Cu. m, and Dead storage at 61.60 m is 48.698 M Cu. m.

The comparison between 1983 and 2020(30 years) data results in a rate of siltation (silt index) of 6.775 Ham/100 Sq. Km/year. Annual percentage loss of gross storage capacity, live storage capacity and dead storage capacity is 0.22%, 0.16% and .68 % respectively for FRL 79.86 m.

The comparison of 2008 and 2020 data with respect to 1983 impounding data at FRL 79.86 m results in silt index of 9.298 Ham/100 Sq. Km/year and 6.775 Ham/100 Sq. Km/year respectively.

4 RESOURCES FOR SURVEY WORK

4.1 Personnel

Following staff were involved during the survey work.

Offshore Survey Personnel	
Name	**Function**
Amit Singh	Party Chief
Jomon MJ	Surveyor
Pruthviraaj Mohile	Surveyor
Vishnu S	Land Surveyor
Abhijith KS	Surveyor
Vimal Joseph	Jr. Surveyor
Onshore Project Management and Data QC	
Sudhir Walia	Project Manager
KSN Murthy	Survey Manager
Dhaval Patel	Data Processor

Table 4.1-1 LIST OF PERSONNEL

4.2 Details of Equipment used

Following equipment and survey sensors were mobilised for the Topographic and Bathymetric survey data acquisition carried out at Damanganga_Madhuban reservoir. The equipment setup and configuration diagram has been presented in Figure 4.1.

Survey Equipment/Systems Used for the Data Acquisition	
Equipment/System	**Description/Make/Model**
Software / Navigation	HYPACK Navigation and Data Acquisition Software
Positioning	Geomax DGPS and Trimble DGPS
Single Beam Echo Sounder	Reson Navisound and SonarMite Echo sounder with Accessories
RTK	Geomax RTK system
Auto Level	Geomax Auto Level & Tripod
Survey Boat	Aqua Marine(boat 1) & Fibre Boat (Boat 2)
Laptop	Dell Laptops
Power Supply	12v Battery & Inverter

Table 4.2-1 LIST OF EQUIPMENT USED FOR SURVEY

4.3 Survey Vessel

Survey Boat Aqua Marine(boat 1) & Fibre Boat (Boat 2) was utilised for carrying out the bathymetric survey.

4.3.1 Survey Boat Specifications

Survey Boat Specifications		
	Aqua Marine (Boat 1)	**Fibre Boat (Boat 2)**
Length overall	3.56m	3.75m
Breadth moulded	1.88m	1.55m
Draft	0.50m	0.5m

Table 4.3-1 SURVEY BOAT SPECIFICATIONS

4.3.2 Survey Boat Offset Diagram

The location of the various survey sensors on the survey boats is given in the vessel-offset diagram on the chart accompanying this report.

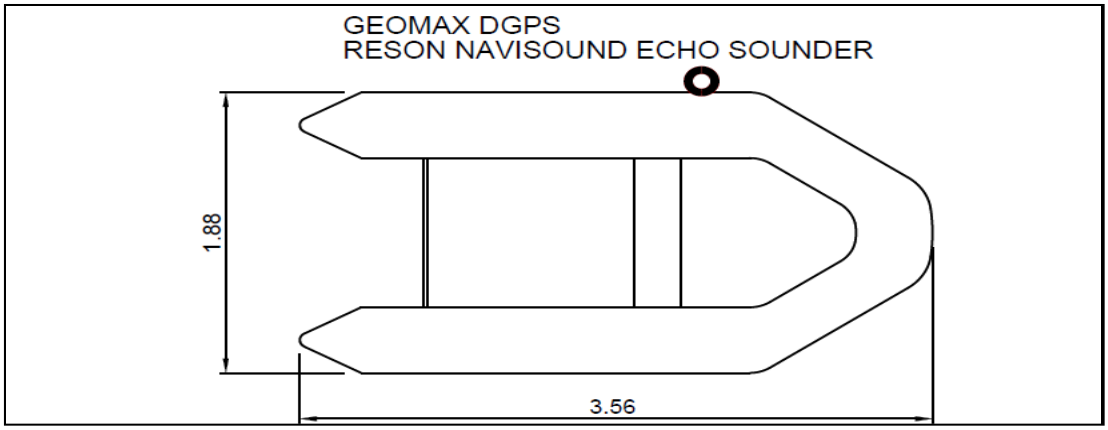


Figure 4.3-1 SURVEY BOAT ‘ AQUA MARINE’ OFFSET DIAGRAM

5 DETAILED METHODOLOGY OF SURVEY

5.1 Mobilisation

The bathymetric survey equipment were mobilised on board “Boat 1” on 05 Nov 2020 and “Boat 2” on 11 Nov 2020. After successful installation, testing and calibrations of survey equipment, the team proceeded for Data acquisition.

Geomax RTK, auto level, Tripod and necessary supporting equipment/tools were mobilised for Topographic survey.

All survey equipment was installed and configured for bathymetric Survey on board Aqua Marine(boat 1) & Fibre Boat (Boat 2) as per figure given below.

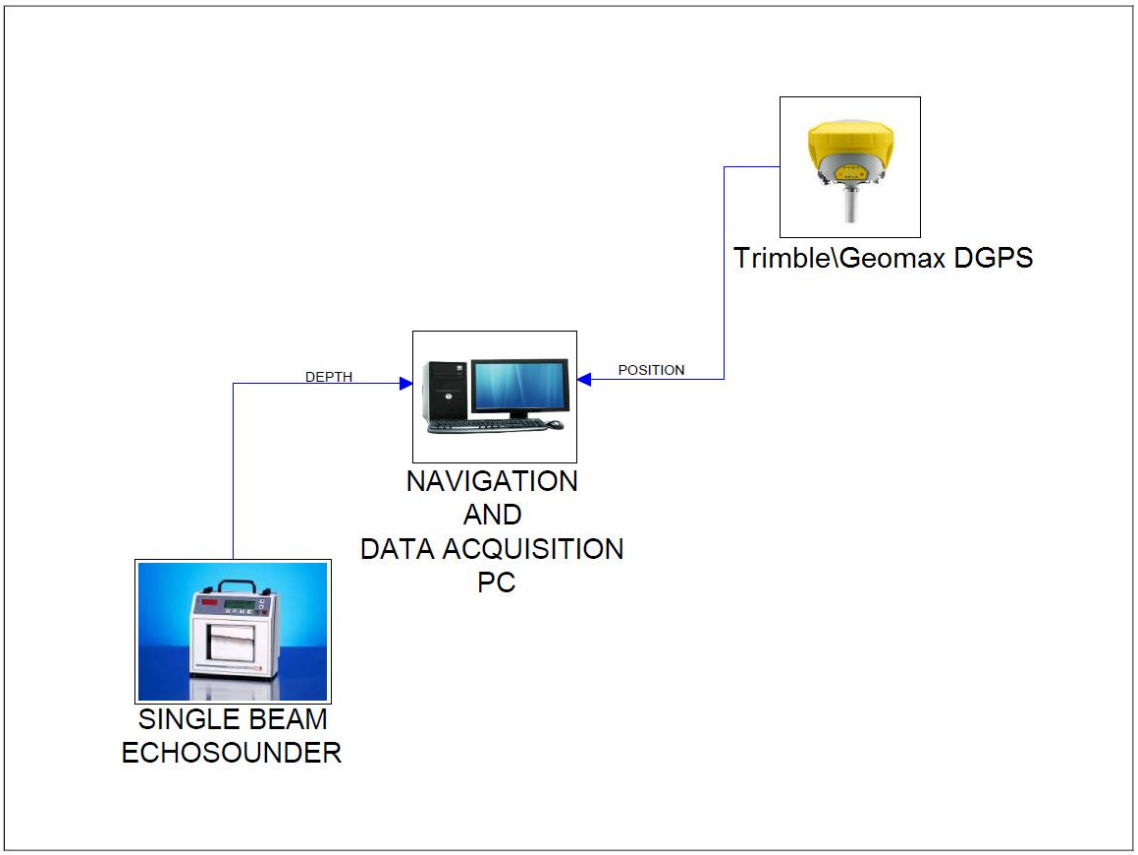


Figure 5.1-1 SBES SURVEY EQUIPMENT CONFIGURATION DIAGRAM ON BOARD

5.2 Geodesy

The survey operations were conducted in WGS 84 spheroid, Universal Transverse Mercator projection system based on following Geodetic parameters:-

Global Positioning System Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Semi minor axis:	b = 6 356 752.314 245 m
Inverse Flattening:	$^1/_f$ = 298.257 223 563
Local Datum Geodetic Parameters	
Datum:	World Geodetic System 1984 (WGS84)
Spheroid:	World Geodetic System 1984
Semi major axis:	a = 6 378 137.000 m
Inverse Flattening:	$^1/_f$ = 298.257 223 563
Local Projection and Grid Parameters	
Map Projection:	Universal Transverse Mercator
Grid System:	UTM Zone 43 N
Central Meridian:	075° 00’ 00” East
Latitude of Origin:	0° 00’ 00” North
False Easting:	500 000 m
False Northing:	0 m

Table 5.2-1 GEODETIC PARAMETERS

5.3 Survey work at Field

5.3.1 Benchmark and Base station setup

RTK DGPS Base station was set up at OBS MADHUBAN made by GMPL and configured to transmit the correction.
Four (4) hours of DGPS observation was carried out on OBS MADHUBAN (Levelling was carried out from Water Gauge Top to above mention observation point and level of Water Gauge Top was provided by Dam Authority).

Levelling From Water Gauge Top to OBS MADHUBAN				
BS	**FS**	**HI**	**RL**	**Remark**
2.078		87.078	85	Water Gauge Top (Provided by Dam Authority)
	1.42		85.658	OBS MADHUBAN
Levelling From OBS MADHUBAN to Water Gauge Top (Closing Loop)				
1.4		87.058	85.658	OBS MADHUBAN
	2.058		85	Water Gauge Top

Table 5.3-1 LEVELLING FROM BC LINE TO OBS MADHUBAN

The details of Bench Marks are presented in the table below:

T.BM. Information - Damanganga_Madhuban Reservoir, South Gujarat					
Location	**Latitude (N)**	**Longitude (E)**	**Easting (m)**	**Northing (m)**	**Elevation w.r.t MSL (m)**
OBS MADHUBAN	20°11'40.172035"	73°3'36.456192"	297299.807	2234188.929	85.658
T.B.M. 1	20°11'43.150766"	73°3'36.085552"	297290.117	2234280.66	86.407
T.B.M. 2	20°12'31.076663"	73°3'21.070972"	296871.464	2235759.636	85.777
T.B.M. 3	20°12'33.711174"	73°3'18.65278"	296802.211	2235841.479	117.245
T.B.M. 4	20°10'53.549133"	73°4'46.163626"	299307.086	2232731.599	80.153
T.B.M. 5	20°10'17.016493"	73°4'49.153188"	299380.903	2231607.116	88.956
T.B.M. 6	20°9'37.44316"	73°5'19.125037"	300237.221	2230380.096	81.327
T.B.M. 7	20°9'34.671505"	73°5'19.237239"	300239.499	2230294.823	90.502
T.B.M. 8	20°10'11.814459"	73°6'21.23882"	302053.04	2231416.442	132.734
T.B.M. 9	20°9'27.535535"	73°6'56.300476"	303055.711	2230043.187	92.206
T.B.M. 10	20°10'18.615417"	73°8'53.64626"	306480.918	2231575.684	82.904
T.B.M. 11	20°10'34.020902"	73°9'9.387208"	306943.257	2232044.34	82.225
T.B.M. 12	20°11'44.350179"	73°10'26.720347"	309212.493	2234182.237	86.423
T.B.M. 13	20°10'47.664778"	73°10'51.406804"	309910.09	2232431.207	110.76
T.B.M. 14	20°9'5.812796"	73°12'45.892323"	313200.472	2229263.062	91.804
T.B.M. 15	20°8'14.766937"	73°13'35.271839"	314617.707	2227678.01	89.545
T.B.M. 16	20°8'30.086842	73°14'2.725343"	315420.022	2228140.625	115.142

Table 5.3-2 BENCH MARK DETAILS

Figure 5.3-1 DGPS Observation at Dam top

5.3.2 Topographic and Bathymetric Survey

For topographic survey, Geomax RTK base was used for DGPS observation on OBS MADHUBAN. Four (4) hours of DGPS observation was carried out on OBS MADHUBAN (Levelling was carried out from Water Gauge Top to above mention observation point and level of Water Gauge Top was provided by Dam Authority)and configured to transmit the correction. Two rovers receiving RTK corrections from the base took spot level from water level to HFL.

For bathymetric survey, boat-1 and boat-2 were mobilised as shown in Figure 5.1-1. Plan line for survey was prepared parallel to dam axis and at 25 m intervals. Survey boat was run on afore mentioned plan line to acquire position as well as depth.

5.4 Survey Systems

5.4.1 GEOMAX DGPS:

GEOMAX DGPS and Trimble DGPS system was used during survey.

• Differential correction signals received on board during survey operations continuously from the Satellite based augmentation system.

• The positioning data as well as heading data received with high reliability and integrity.

GEOMAX DGPS and Trimble DGPS was the primary positioning system currently used for all the surveys. GMPL has provided, install, operate and maintain a Differential Global Positioning System (DGPS) acceptable to the EIC, which fully covered the site of the works and was constantly in operation during the all the surveys. The age of pseudo- range correctors used in position computation was not exceeded 20 seconds; however, any horizontal positioning interpolation was never exceeded the accuracy. Horizontal Dilution of Precision (HDOP) was monitored, and was never exceeded 2 nominally. Satellite geometry alone is not a sufficient statistic for determining horizontal positioning accuracy. Other variables, including satellite pseudo range residual, were used in conjunction with HDOP to estimate horizontal accuracy. A minimum of four satellites were used to compute all positions, Horizontal and Vertical offsets between the GPS antenna and transducer(s) were observed and applied with a precision better than 0.01m. The system was consisting of master receiving reference station (Base) and DGPS Navigator unit (Rover). The navigator's units (Rover) were installed on Survey launch. The composition was consisting navigational software, track plotters, data storage facilities, echo sounders, sufficient spares to enable uninterrupted operation of the system to the accuracy specified and on-board computers.

5.4.2 Single beam Echo sounder

The single beam echo sounder 'Reson Navi Sound' and 'SonarMite' with an accuracy of 0.02m was deployed and in principle, higher frequency of 215 kHz was operated. Echo Sounder equipment was calibrated daily before and after use, by means of a bar-check in the survey area. The calibration results were found satisfactory.

5.4.3 HYPACK Software

HYPACK is a Windows™-based software package used primarily for hydrographic surveying and data processing.

HYPACK performs all of the tasks necessary to complete Single Beam Echo sounder data acquisition /processing from beginning to end. This all-in- one module provides the surveyor with all of the tools needed to design their survey, collect data, process it, reduce it to w.r.t MSL, and generate final products. Whether collecting hydrographic survey data or environmental data, or positioning a vessel in an engineering project, HYPACK provides the tools needed to complete the job.

This software can be interfaced simultaneously to Echo sounders and attitude sensors.

5.4.4 RTK System

Geomax RTK system consists of one Base and Rover Module was used for Topographic Survey.

- Geomax RTK Base station was set up at the OBS MADHUBAN and configured to transmit the corrections.
- Geomax RTK Rover was used for Topographic survey and 16 TBM were established to cover whole area.

5.5 Data Acquisition and Quality Control

5.5.1 Online Data Quality Control

The online navigation computer was interfaced to Reson Navisound Echo Sounder system. Laptop connected to the Navigation network were time synchronized with the GPS (high precision) time signal allowing all data to be precisely time stamped.

Navigation

The DGPS system performed well at all times and the performance of the system was continuously monitored.

Echo Sounder

The digital output from the Reson Navisound Echo Sounder was satisfactory throughout the duration of the survey. The quality of obtained soundings were verified by running suitable cross lines and depths were found to be matching.

5.5.2 Data Processing

The bathymetric survey data was logged using Hypack on Navigation System. The quality of the bathymetric data acquired in the field was monitored continuously onboard the survey boat. Survey data was processed in office and handed over to the client.

5.6 Quality Assurance and HSE Procedures

GMPL has fully documented and self-audited Quality Assurance and Health, Safety and Environmental System procedures in place. The same were followed during all surveying tasks, which was undertaken by the company and its personnel.

Competent field survey staffs were deployed by GMPL to constantly monitor acquired data quality whilst the survey progressing, and was duly documented.

5.7 Demobilisation

Upon successful completion of topographic and bathymetric survey at Damanganga_Madhuban Reservoir with due, consent from Client Representative, the survey equipment on board were demobilised on 13 December 2020.

5.8 SURVEY DATA PROCESSING AND INTERPRETATION METHODS

5.8.1 General

The survey data was logged and was processed using the HYPACK Software. Position and depth data were processed and checked to ensure good data quality. The same was used for the automated and manual processing of logged data sets.

5.8.2 Navigation and Positioning

The measured offsets for various survey sensors used during the survey were entered into the navigation system and post processed using Hypack processing to enable track charts to be plotted and the 'corrected' navigation files to be integrated with other sensor data at a later stage.

5.8.3 Bathymetry Data Processing and Analysis

- The SBES bathymetry survey data was logged using HYPACK and further processed.
- Corrected SBES offset position (computed from vessel antenna) was merged into single beam data for true horizontal positioning.
- Average velocity value of 1490 m/s was used in the survey area.
- SBES data was further corrected for the transducer draft from water level.
- The depth sounding obtained from SBES were reduced to MSL with the help of observed water level in the reservoir.
- The data was filtered, cleaned, and combined to create geographically positioned bathymetric data set that has been corrected for tides and sound speed.
- The water level were observed during the entire period of survey. The details are as follows:-

Date	Time	Water Level (meters)
04/11/2020	0700	79.7
04/11/2020	1900	79.7

05/11/2020	0700	79.7
05/11/2020	1900	79.7
06/11/2020	0700	79.7
06/11/2020	1700	79.7
06/11/2020	1800	79.65
06/11/2020	1900	79.65
07/11/2020	0700	79.65
07/11/2020	1900	79.65
08/11/2020	0700	79.6
08/11/2020	1900	79.6
09/11/2020	0700	79.6
09/11/2020	1900	79.6
10/11/2020	0700	79.6
10/11/2020	1500	79.6
10/11/2020	1600	79.55
10/11/2020	1900	79.55
11/11/2020	0700	79.55
11/11/2020	1700	79.55
12/11/2020	0700	79.55
12/11/2020	1300	79.55
12/11/2020	1400	79.5
12/11/2020	1700	79.5
13/11/2020	0700	79.5
13/11/2020	1700	79.5
14/11/2020	0700	79.5
14/11/2020	1600	79.5
14/11/2020	1700	79.45
14/11/2020	1900	79.45
15/11/2020	0700	79.45
15/11/2020	1900	79.45
16/11/2020	0700	79.45
16/11/2020	1900	79.45
17/11/2020	0700	79.45
17/11/2020	1900	79.45
18/11/2020	0700	79.4
18/11/2020	1900	79.4
19/11/2020	0700	79.4
19/11/2020	1900	79.4
20/11/2020	0700	79.4
20/11/2020	1900	79.4
21/11/2020	0700	79.35

21/11/2020	1900	79.35
22/11/2020	0700	79.35
22/11/2020	1900	79.35
23/11/2020	0700	79.3
23/11/2020	1900	79.3
24/11/2020	0700	79.3
24/11/2020	1900	79.3
25/11/2020	0700	79.25
25/11/2020	1900	79.25
26/11/2020	0700	79.2
26/11/2020	1900	79.2
27/11/2020	0700	79.2
27/11/2020	1900	79.2
28/11/2020	0700	79.15
28/11/2020	1900	79.15
29/11/2020	0700	79.1
29/11/2020	1900	79.1
30/11/2020	0700	79.05
30/11/2020	1900	79.05
01/12/2020	0700	79
01/12/2020	1900	79
02/12/2020	0700	78.95
02/12/2020	1900	78.95
03/12/2020	0700	78.9
03/12/2020	1900	78.9
04/12/2020	0700	78.9
04/12/2020	1900	78.9
05/12/2020	0700	78.85
05/12/2020	1900	78.85
06/12/2020	0700	78.8
06/12/2020	1900	78.8

Table 5.8-1 WATER LEVEL

5.8.4 Topographic Data Processing and Analysis

The topographic survey data was cleaned and converted into xyz format. The converted data was merged with the bathymetric data using TIN module of Hypack software and Gridded data (25 x 25 m) was created. This data was used for volume calculations.

5.8.5 Preparation of Drawings

After the data processing phase, eleven drawings has been prepared for Damanganga_Maduban Reservoir, the details of which are presented in the table below:

Sr. No	Drawing Name	Description	Hard Copy format	Soft Copy format
1	P-SUR-004-MADHUBAN-BATHY-01	Chart contains bathy , contour and cross section segments Sheet 1	42" Roll (1:5000)	PDF & CAD
2	P-SUR-004-MADHUBAN-BATHY-02	Chart contains bathy , contour and cross section segments Sheet 2	42" Roll (1:5000)	PDF & CAD
3	P-SUR-004-MADHUBAN-BATHY-03	Chart contains bathy , contour and cross section segments Sheet 3	42" Roll (1:5000)	PDF & CAD
4	P-SUR-004-MADHUBAN-BATHY-04	Chart contains bathy , contour and cross section segments Sheet 4	42" Roll (1:5000)	PDF & CAD
5	P-SUR-004-MADHUBAN-BATHY-05	Chart contains bathy , contour and cross section segments Sheet 5	42" Roll (1:5000)	PDF & CAD
6	P-SUR-004-MADHUBAN-BATHY-06	Chart contains bathy , contour and cross section segments Sheet 6	42" Roll (1:5000)	PDF & CAD
7	P-SUR-004-MADHUBAN-BATHY-07	Chart contains bathy , contour and cross section segments Sheet 7	42" Roll (1:5000)	PDF & CAD
8	P-SUR-004-MADHUBAN-CONTOUR-07	Chart contains contour	Paper Size A0 (1:25000)	PDF & CAD
9	Area Capacity Curve MADHUBAN-2020	Area capacity curve of reservoir	Paper Size A3	CAD
10	MADHUBAN Cross sections	199 Cross Section at 100m interval	Only Soft copy	CAD
11	MADHUBAN L sections	L-section of reservoir	Paper Size A3	CAD

Table 5.8-2 LIST OF CHARTS

6 DETAILED TOPOGRAPHIC AND BATHYMETRIC SURVEY RESULTS

6.1 General:

Kindly refer to drawings in conjunction with the following:

Topographic and bathymetric data was reduced to the water level w.r.t MSL. All the data is plotted on scale of 1:5000 for Damanganga_Madhuban reservoir.

The values depicted in the charts are the elevation with respect to MSL.

- The Minimum elevation within Damanganga_Madhuban reservoir is 42.3m above MSL and
- The Maximum depth within Damanganga_Madhuban reservoir is 36.7 m.

6.2 Capacity and Area Calculation:

Hypack software's TIN (Triangulated Irregular Network) MODEL was used to calculate capacity and area of the reservoir at intervals of 10 cm. In addition, volume was also calculated using prismoidal formula as given below:

$$V=h/3\{A1+A2+\text{Square Root } (A1 * A2)\}$$

where V is volume in M Cu. m between two levels,

h is difference between two level and

A1 & A2 is area in Sq. Km of successive levels

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
42.30	0.000	0.000	0.000	0.000	0.000	
42.40	0.000	0.000	0.000	0.000	0.000	
42.50	0.000	0.000	0.000	0.000	0.002	
42.60	0.000	0.000	0.000	0.000	0.005	
42.70	0.001	0.000	0.001	0.001	0.008	
42.80	0.002	0.000	0.002	0.002	0.011	
42.86	0.003	0.000	0.003	0.003	0.014	
42.90	0.003	0.000	0.003	0.003	0.016	
43.00	0.005	0.000	0.005	0.005	0.026	
43.10	0.008	0.000	0.008	0.009	0.039	
43.20	0.013	0.000	0.013	0.013	0.051	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
43.30	0.019	0.000	0.019	0.019	0.063	
43.40	0.026	0.000	0.026	0.026	0.081	
43.50	0.035	0.000	0.035	0.035	0.097	
43.60	0.045	0.000	0.045	0.045	0.110	
43.70	0.057	0.000	0.057	0.056	0.118	
43.80	0.069	0.000	0.069	0.069	0.126	
43.86	0.076	0.000	0.076	0.076	0.130	
43.90	0.082	0.000	0.082	0.082	0.133	
44.00	0.095	0.000	0.095	0.095	0.141	
44.10	0.110	0.000	0.110	0.110	0.148	
44.20	0.125	0.000	0.125	0.125	0.155	
44.30	0.141	0.000	0.141	0.141	0.162	
44.40	0.157	0.000	0.157	0.157	0.169	
44.50	0.175	0.000	0.175	0.175	0.178	
44.60	0.193	0.000	0.193	0.193	0.189	
44.70	0.212	0.000	0.212	0.212	0.200	
44.80	0.233	0.000	0.233	0.233	0.211	
44.86	0.246	0.000	0.246	0.246	0.219	
44.90	0.255	0.000	0.255	0.255	0.224	
45.00	0.278	0.000	0.278	0.278	0.240	
45.10	0.303	0.000	0.303	0.303	0.257	
45.20	0.329	0.000	0.329	0.329	0.277	
45.30	0.358	0.000	0.358	0.358	0.298	
45.40	0.389	0.000	0.389	0.389	0.316	
45.50	0.421	0.000	0.421	0.421	0.333	
45.60	0.455	0.000	0.455	0.455	0.348	
45.70	0.491	0.000	0.491	0.491	0.366	
45.80	0.529	0.000	0.529	0.528	0.381	
45.86	0.552	0.000	0.552	0.552	0.390	
45.90	0.567	0.000	0.567	0.567	0.397	
46.00	0.608	0.000	0.608	0.608	0.412	
46.10	0.650	0.000	0.650	0.650	0.429	
46.20	0.694	0.000	0.694	0.693	0.443	
46.30	0.739	0.000	0.739	0.739	0.462	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
46.40	0.786	0.000	0.786	0.786	0.478	
46.50	0.834	0.000	0.834	0.834	0.494	
46.60	0.884	0.000	0.884	0.884	0.508	
46.70	0.936	0.000	0.936	0.936	0.521	
46.80	0.989	0.000	0.989	0.988	0.532	
46.86	1.021	0.000	1.021	1.021	0.538	
46.90	1.042	0.000	1.042	1.042	0.542	
47.00	1.097	0.000	1.097	1.097	0.552	
47.10	1.153	0.000	1.153	1.153	0.563	
47.20	1.210	0.000	1.210	1.210	0.577	
47.30	1.268	0.000	1.268	1.268	0.587	
47.40	1.327	0.000	1.327	1.327	0.596	
47.50	1.387	0.000	1.387	1.387	0.605	
47.60	1.448	0.000	1.448	1.448	0.615	
47.70	1.510	0.000	1.510	1.510	0.624	
47.80	1.573	0.000	1.573	1.573	0.634	
47.86	1.611	0.000	1.611	1.611	0.640	
47.90	1.637	0.000	1.637	1.637	0.644	
48.00	1.702	0.000	1.702	1.702	0.656	
48.10	1.768	0.000	1.768	1.768	0.669	
48.20	1.836	0.000	1.836	1.835	0.684	
48.30	1.905	0.000	1.905	1.905	0.698	
48.40	1.975	0.000	1.975	1.975	0.715	
48.50	2.048	0.000	2.048	2.048	0.732	
48.60	2.122	0.000	2.122	2.121	0.746	
48.70	2.197	0.000	2.197	2.197	0.760	
48.80	2.274	0.000	2.274	2.273	0.773	
48.86	2.320	0.000	2.320	2.320	0.781	
48.90	2.352	0.000	2.352	2.351	0.787	
49.00	2.431	0.000	2.431	2.431	0.800	
49.10	2.512	0.000	2.512	2.511	0.814	
49.20	2.594	0.000	2.594	2.593	0.827	
49.30	2.677	0.000	2.677	2.677	0.839	
49.40	2.761	0.000	2.761	2.761	0.852	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
49.50	2.847	0.000	2.847	2.847	0.865	
49.60	2.935	0.000	2.935	2.934	0.880	
49.70	3.023	0.000	3.023	3.023	0.897	
49.80	3.114	0.000	3.114	3.114	0.920	
49.86	3.170	0.000	3.170	3.170	0.936	
49.90	3.207	0.000	3.207	3.207	0.946	
50.00	3.303	0.000	3.303	3.303	0.968	
50.10	3.401	0.000	3.401	3.401	0.987	
50.20	3.501	0.000	3.501	3.500	1.006	
50.30	3.602	0.000	3.602	3.602	1.026	
50.40	3.706	0.000	3.706	3.706	1.046	
50.50	3.811	0.000	3.811	3.811	1.066	
50.60	3.919	0.000	3.919	3.919	1.086	
50.70	4.029	0.000	4.029	4.028	1.106	
50.80	4.140	0.000	4.140	4.140	1.127	
50.86	4.208	0.000	4.208	4.208	1.139	
50.90	4.254	0.000	4.254	4.254	1.147	
51.00	4.370	0.000	4.370	4.370	1.169	
51.10	4.488	0.000	4.488	4.488	1.192	
51.20	4.608	0.000	4.608	4.608	1.216	
51.30	4.731	0.000	4.731	4.731	1.242	
51.40	4.856	0.000	4.856	4.856	1.268	
51.50	4.985	0.000	4.985	4.985	1.295	
51.60	5.116	0.000	5.116	5.116	1.324	
51.70	5.249	0.000	5.249	5.249	1.354	
51.80	5.386	0.000	5.386	5.386	1.387	
51.86	5.470	0.000	5.470	5.470	1.408	
51.90	5.527	0.000	5.527	5.527	1.422	
52.00	5.671	0.000	5.671	5.671	1.460	
52.10	5.819	0.000	5.819	5.819	1.501	
52.20	5.971	0.000	5.971	5.971	1.545	
52.30	6.128	0.000	6.128	6.128	1.592	
52.40	6.290	0.000	6.290	6.290	1.640	
52.50	6.456	0.000	6.456	6.456	1.686	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
52.60	6.627	0.000	6.627	6.627	1.732	
52.70	6.802	0.000	6.802	6.802	1.777	
52.80	6.982	0.000	6.982	6.982	1.824	
52.86	7.093	0.000	7.093	7.093	1.852	
52.90	7.167	0.000	7.167	7.167	1.871	
53.00	7.357	0.000	7.357	7.357	1.918	
53.10	7.551	0.000	7.551	7.551	1.966	
53.20	7.750	0.000	7.750	7.750	2.015	
53.30	7.954	0.000	7.954	7.954	2.065	
53.40	8.163	0.000	8.163	8.163	2.117	
53.50	8.377	0.000	8.377	8.377	2.170	
53.60	8.597	0.000	8.597	8.597	2.224	
53.70	8.822	0.000	8.822	8.822	2.277	
53.80	9.052	0.000	9.052	9.052	2.332	
53.86	9.193	0.000	9.193	9.193	2.366	
53.90	9.288	0.000	9.288	9.288	2.388	
54.00	9.530	0.000	9.530	9.530	2.441	
54.10	9.777	0.000	9.777	9.777	2.494	
54.20	10.029	0.000	10.029	10.029	2.548	
54.30	10.286	0.000	10.286	10.286	2.605	
54.40	10.550	0.000	10.550	10.550	2.664	
54.50	10.819	0.000	10.819	10.819	2.726	
54.60	11.095	0.000	11.095	11.095	2.788	
54.70	11.377	0.000	11.377	11.377	2.851	
54.80	11.665	0.000	11.665	11.665	2.915	
54.86	11.841	0.000	11.841	11.841	2.954	
54.90	11.960	0.000	11.960	11.960	2.978	
55.00	12.260	0.000	12.260	12.261	3.037	
55.10	12.567	0.000	12.567	12.567	3.096	
55.20	12.880	0.000	12.880	12.880	3.156	
55.30	13.198	0.000	13.198	13.199	3.217	
55.40	13.523	0.000	13.523	13.523	3.280	
55.50	13.854	0.000	13.854	13.855	3.344	
55.60	14.192	0.000	14.192	14.192	3.409	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
55.70	14.536	0.000	14.536	14.536	3.475	
55.80	14.887	0.000	14.887	14.887	3.543	
55.86	15.101	0.000	15.101	15.101	3.585	
55.90	15.245	0.000	15.245	15.245	3.612	
56.00	15.610	0.000	15.610	15.610	3.682	
56.10	15.981	0.000	15.981	15.982	3.752	
56.20	16.360	0.000	16.360	16.360	3.824	
56.30	16.746	0.000	16.746	16.746	3.896	
56.40	17.139	0.000	17.139	17.139	3.968	
56.50	17.540	0.000	17.540	17.540	4.039	
56.60	17.947	0.000	17.947	17.947	4.109	
56.70	18.362	0.000	18.362	18.362	4.181	
56.80	18.783	0.000	18.783	18.783	4.252	
56.86	19.040	0.000	19.040	19.040	4.296	
56.90	19.212	0.000	19.212	19.212	4.324	
57.00	19.648	0.000	19.648	19.648	4.396	
57.10	20.091	0.000	20.091	20.091	4.469	
57.20	20.542	0.000	20.542	20.542	4.540	
57.30	20.999	0.000	20.999	20.999	4.610	
57.40	21.464	0.000	21.464	21.464	4.679	
57.50	21.935	0.000	21.935	21.935	4.748	
57.60	22.413	0.000	22.413	22.414	4.819	
57.70	22.899	0.000	22.899	22.899	4.889	
57.80	23.391	0.000	23.391	23.391	4.959	
57.86	23.690	0.000	23.690	23.690	5.000	
57.90	23.891	0.000	23.891	23.891	5.028	
58.00	24.397	0.000	24.397	24.397	5.098	
58.10	24.910	0.000	24.910	24.910	5.169	
58.20	25.431	0.000	25.431	25.431	5.240	
58.30	25.958	0.000	25.958	25.958	5.314	
58.40	26.493	0.000	26.493	26.494	5.388	
58.50	27.036	0.000	27.036	27.036	5.466	
58.60	27.587	0.000	27.587	27.587	5.544	
58.70	28.145	0.000	28.145	28.145	5.621	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
58.80	28.711	0.000	28.711	28.711	5.698	
58.86	29.054	0.000	29.054	29.054	5.745	
58.90	29.284	0.000	29.284	29.285	5.777	
59.00	29.866	0.000	29.866	29.867	5.861	
59.10	30.457	0.000	30.457	30.457	5.943	
59.20	31.055	0.000	31.055	31.055	6.028	
59.30	31.662	0.000	31.662	31.663	6.117	
59.40	32.279	0.000	32.279	32.279	6.214	
59.50	32.905	0.000	32.905	32.905	6.315	
59.60	33.542	0.000	33.542	33.542	6.423	
59.70	34.190	0.000	34.190	34.190	6.534	
59.80	34.849	0.000	34.849	34.849	6.645	
59.86	35.250	0.000	35.250	35.250	6.713	
59.90	35.519	0.000	35.519	35.519	6.759	
60.00	36.201	0.000	36.201	36.201	6.873	
60.10	36.894	0.000	36.894	36.894	6.988	
60.20	37.598	0.000	37.598	37.598	7.103	
60.30	38.314	0.000	38.314	38.315	7.218	
60.40	39.042	0.000	39.042	39.042	7.334	
60.50	39.781	0.000	39.781	39.781	7.448	
60.60	40.532	0.000	40.532	40.532	7.562	
60.70	41.293	0.000	41.293	41.294	7.678	
60.80	42.067	0.000	42.067	42.067	7.797	
60.86	42.537	0.000	42.537	42.537	7.869	
60.90	42.853	0.000	42.853	42.853	7.918	
61.00	43.651	0.000	43.651	43.651	8.039	
61.10	44.461	0.000	44.461	44.461	8.159	
61.20	45.283	0.000	45.283	45.283	8.281	
61.30	46.117	0.000	46.117	46.117	8.408	
61.40	46.964	0.000	46.964	46.965	8.537	
61.50	47.825	0.000	47.825	47.825	8.669	
61.60	**48.698**	**0.000**	**48.698**	**48.698**	**8.799**	**MDDL**
61.70	48.698	0.886	49.584	49.585	8.928	
61.80	48.698	1.786	50.484	50.484	9.063	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
61.86	48.698	2.332	51.030	51.030	9.144	
61.90	48.698	2.699	51.397	51.397	9.199	
62.00	48.698	3.626	52.324	52.324	9.336	
62.10	48.698	4.566	53.264	53.265	9.479	
62.20	48.698	5.522	54.220	54.220	9.627	
62.30	48.698	6.492	55.190	55.190	9.781	
62.40	48.698	7.478	56.176	56.176	9.941	
62.50	48.698	8.480	57.178	57.178	10.093	
62.60	48.698	9.496	58.194	58.195	10.239	
62.70	48.698	10.528	59.226	59.226	10.381	
62.80	48.698	11.572	60.270	60.271	10.519	
62.86	48.698	12.206	60.904	60.904	10.606	
62.90	48.698	12.632	61.330	61.330	10.663	
63.00	48.698	13.705	62.403	62.403	10.804	
63.10	48.698	14.792	63.490	63.491	10.944	
63.20	48.698	15.894	64.592	64.592	11.085	
63.30	48.698	17.009	65.707	65.708	11.227	
63.40	48.698	18.139	66.837	66.838	11.372	
63.50	48.698	19.284	67.982	67.982	11.519	
63.60	48.698	20.443	69.141	69.141	11.667	
63.70	48.698	21.617	70.315	70.315	11.813	
63.80	48.698	22.806	71.504	71.504	11.958	
63.86	48.698	23.526	72.224	72.224	12.044	
63.90	48.698	24.009	72.707	72.707	12.103	
64.00	48.698	25.226	73.924	73.925	12.253	
64.10	48.698	26.460	75.158	75.158	12.409	
64.20	48.698	27.708	76.406	76.407	12.571	
64.30	48.698	28.974	77.672	77.672	12.732	
64.40	48.698	30.255	78.953	78.953	12.892	
64.50	48.698	31.552	80.250	80.250	13.054	
64.60	48.698	32.866	81.564	81.564	13.221	
64.70	48.698	34.196	82.894	82.895	13.392	
64.80	48.698	35.544	84.242	84.242	13.564	
64.86	48.698	36.361	85.059	85.059	13.666	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
64.90	48.698	36.909	85.607	85.607	13.735	
65.00	48.698	38.291	86.989	86.989	13.905	
65.10	48.698	39.690	88.388	88.388	14.075	
65.20	48.698	41.106	89.804	89.805	14.250	
65.30	48.698	42.540	91.238	91.238	14.427	
65.40	48.698	43.992	92.690	92.690	14.606	
65.50	48.698	45.461	94.159	94.160	14.789	
65.60	48.698	46.950	95.648	95.648	14.977	
65.70	48.698	48.457	97.155	97.155	15.166	
65.80	48.698	49.983	98.681	98.681	15.355	
65.86	48.698	50.908	99.606	99.606	15.470	
65.90	48.698	51.528	100.226	100.226	15.547	
66.00	48.698	53.092	101.790	101.790	15.734	
66.10	48.698	54.675	103.373	103.373	15.918	
66.20	48.698	56.276	104.974	104.974	16.105	
66.30	48.698	57.896	106.594	106.594	16.293	
66.40	48.698	59.534	108.232	108.233	16.483	
66.50	48.698	61.192	109.890	109.891	16.676	
66.60	48.698	62.870	111.568	111.568	16.875	
66.70	48.698	64.567	113.265	113.266	17.080	
66.80	48.698	66.286	114.984	114.984	17.290	
66.86	48.698	67.327	116.025	116.026	17.418	
66.90	48.698	68.026	116.724	116.724	17.508	
67.00	48.698	69.788	118.486	118.487	17.738	
67.10	48.698	71.573	120.271	120.272	17.973	
67.20	48.698	73.382	122.080	122.081	18.202	
67.30	48.698	75.214	123.912	123.913	18.434	
67.40	48.698	77.069	125.767	125.768	18.666	
67.50	48.698	78.947	127.645	127.646	18.897	
67.60	48.698	80.849	129.547	129.547	19.136	
67.70	48.698	82.774	131.472	131.473	19.373	
67.80	48.698	84.723	133.421	133.422	19.613	
67.86	48.698	85.905	134.603	134.603	19.756	
67.90	48.698	86.697	135.395	135.395	19.851	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
68.00	48.698	88.694	137.392	137.392	20.093	
68.10	48.698	90.715	139.413	139.414	20.338	
68.20	48.698	92.762	141.460	141.460	20.585	
68.30	48.698	94.832	143.530	143.531	20.829	
68.40	48.698	96.927	145.625	145.626	21.069	
68.50	48.698	99.046	147.744	147.745	21.307	
68.60	48.698	101.189	149.887	149.887	21.545	
68.70	48.698	103.355	152.053	152.053	21.780	
68.80	48.698	105.545	154.243	154.243	22.016	
68.86	48.698	106.870	155.568	155.568	22.157	
68.90	48.698	107.758	156.456	156.456	22.251	
69.00	48.698	109.995	158.693	158.693	22.489	
69.10	48.698	112.256	160.954	160.954	22.728	
69.20	48.698	114.540	163.238	163.239	22.965	
69.30	48.698	116.849	165.547	165.547	23.197	
69.40	48.698	119.180	167.878	167.878	23.427	
69.50	48.698	121.534	170.232	170.232	23.654	
69.60	48.698	123.911	172.609	172.609	23.880	
69.70	48.698	126.310	175.008	175.008	24.103	
69.80	48.698	128.731	177.429	177.429	24.322	
69.86	48.698	130.194	178.892	178.893	24.455	
69.90	48.698	131.174	179.872	179.873	24.544	
70.00	48.698	133.640	182.338	182.338	24.764	
70.10	48.698	136.127	184.825	184.826	24.987	
70.20	48.698	138.637	187.335	187.335	25.208	
70.30	48.698	141.169	189.867	189.867	25.427	
70.40	48.698	143.722	192.420	192.421	25.647	
70.50	48.698	146.298	194.996	194.996	25.867	
70.60	48.698	148.896	197.594	197.594	26.087	
70.70	48.698	151.515	200.213	200.214	26.303	
70.80	48.698	154.156	202.854	202.855	26.517	
70.86	48.698	155.751	204.449	204.449	26.646	
70.90	48.698	156.819	205.517	205.517	26.731	
71.00	48.698	159.503	208.201	208.201	26.944	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
71.10	48.698	162.208	210.906	210.906	27.158	
71.20	48.698	164.934	213.632	213.632	27.373	
71.30	48.698	167.682	216.380	216.381	27.591	
71.40	48.698	170.452	219.150	219.151	27.810	
71.50	48.698	173.245	221.943	221.943	28.030	
71.60	48.698	176.058	224.756	224.756	28.248	
71.70	48.698	178.894	227.592	227.592	28.460	
71.80	48.698	181.750	230.448	230.448	28.670	
71.86	48.698	183.474	232.172	232.172	28.792	
71.90	48.698	184.627	233.325	233.325	28.873	
72.00	48.698	187.525	236.223	236.223	29.077	
72.10	48.698	190.443	239.141	239.141	29.279	
72.20	48.698	193.381	242.079	242.079	29.480	
72.30	48.698	196.339	245.037	245.037	29.680	
72.40	48.698	199.317	248.015	248.015	29.881	
72.50	48.698	202.315	251.013	251.013	30.081	
72.60	48.698	205.333	254.031	254.031	30.282	
72.70	48.698	208.371	257.069	257.069	30.483	
72.80	48.698	211.430	260.128	260.128	30.684	
72.86	48.698	213.274	261.972	261.972	30.805	
72.90	48.698	214.508	263.206	263.206	30.886	
73.00	48.698	217.607	266.305	266.305	31.090	
73.10	48.698	220.726	269.424	269.424	31.294	
73.20	48.698	223.866	272.564	272.564	31.498	
73.30	48.698	227.026	275.724	275.724	31.702	
73.40	48.698	230.206	278.904	278.904	31.905	
73.50	48.698	233.407	282.105	282.105	32.108	
73.60	48.698	236.628	285.326	285.325	32.308	
73.70	48.698	239.868	288.566	288.566	32.505	
73.80	48.698	243.128	291.826	291.826	32.700	
73.86	48.698	245.094	293.792	293.792	32.815	
73.90	48.698	246.408	295.106	295.106	32.893	
74.00	48.698	249.707	298.405	298.405	33.085	
74.10	48.698	253.025	301.723	301.723	33.275	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
74.20	48.698	256.362	305.060	305.060	33.467	
74.30	48.698	259.718	308.416	308.416	33.654	
74.40	48.698	263.093	311.791	311.790	33.839	
74.50	48.698	266.486	315.184	315.184	34.024	
74.60	48.698	269.898	318.596	318.595	34.211	
74.70	48.698	273.328	322.026	322.026	34.392	
74.80	48.698	276.776	325.474	325.474	34.572	
74.86	48.698	278.854	327.552	327.551	34.680	
74.90	48.698	280.242	328.940	328.940	34.752	
75.00	48.698	283.726	332.424	332.424	34.931	
75.10	48.698	287.229	335.927	335.926	35.111	
75.20	48.698	290.749	339.447	339.446	35.289	
75.30	48.698	294.286	342.984	342.984	35.467	
75.40	48.698	297.842	346.540	346.540	35.644	
75.50	48.698	301.415	350.113	350.113	35.820	
75.60	48.698	305.006	353.704	353.704	35.996	
75.70	48.698	308.614	357.312	357.312	36.168	
75.80	48.698	312.240	360.938	360.937	36.339	
75.86	48.698	314.423	363.121	363.121	36.441	
75.90	48.698	315.882	364.580	364.579	36.508	
76.00	48.698	319.541	368.239	368.239	36.675	
76.10	48.698	323.217	371.915	371.914	36.839	
76.20	48.698	326.909	375.607	375.606	37.003	
76.30	48.698	330.618	379.316	379.315	37.169	
76.40	48.698	334.343	383.041	383.040	37.336	
76.50	48.698	338.085	386.783	386.782	37.505	
76.60	48.698	341.844	390.542	390.541	37.675	
76.70	48.698	345.620	394.318	394.317	37.843	
76.80	48.698	349.413	398.111	398.110	38.013	
76.86	48.698	351.696	400.394	400.394	38.114	
76.90	48.698	353.222	401.920	401.920	38.180	
77.00	48.698	357.049	405.747	405.746	38.344	
77.10	48.698	360.891	409.589	409.588	38.504	
77.20	48.698	364.749	413.447	413.447	38.663	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
77.30	48.698	368.624	417.322	417.321	38.823	
77.40	48.698	372.514	421.212	421.211	38.982	
77.50	48.698	376.420	425.118	425.118	39.142	
77.60	48.698	380.342	429.040	429.040	39.300	
77.70	48.698	384.280	432.978	432.977	39.454	
77.80	48.698	388.233	436.931	436.930	39.608	
77.86	48.698	390.612	439.310	439.310	39.700	
77.90	48.698	392.202	440.900	440.899	39.761	
78.00	48.698	396.185	444.883	444.883	39.910	
78.10	48.698	400.183	448.881	448.881	40.055	
78.20	48.698	404.196	452.894	452.894	40.202	
78.30	48.698	408.224	456.922	456.921	40.348	
78.40	48.698	412.266	460.964	460.963	40.490	
78.50	48.698	416.322	465.020	465.019	40.630	
78.60	48.698	420.392	469.090	469.089	40.772	
78.70	48.698	424.477	473.175	473.174	40.928	
78.80	48.698	428.577	477.275	477.274	41.067	
78.86	48.698	431.043	479.741	479.740	41.149	
78.90	48.698	432.690	481.388	481.387	41.205	
79.00	48.698	436.817	485.515	485.514	41.337	
79.10	48.698	440.957	489.655	489.655	41.466	
79.20	48.698	445.110	493.808	493.808	41.595	
79.30	48.698	449.276	497.974	497.974	41.723	
79.40	48.698	453.455	502.153	502.152	41.853	
79.50	48.698	457.647	506.345	506.344	41.985	
79.60	48.698	461.853	510.551	510.550	42.127	
79.70	48.698	466.073	514.771	514.770	42.273	
79.80	48.698	470.307	519.005	519.005	42.419	
79.86	**48.698**	**472.855**	**521.553**	**521.552**	**42.509**	**FRL**
79.90	48.698	474.557	523.255	523.254	42.570	
80.00	48.698	478.821	527.519	527.519	42.724	
80.10	48.698	483.101	531.799	531.799	42.882	
80.20	48.698	487.398	536.096	536.095	43.042	
80.30	48.698	491.710	540.408	540.408	43.211	

Level (m)	Dead Storage Capacity (M cu. m)	Live Storage Capacity (M cu. m)	Gross Storage Capacity by TIN model (M cu. m)	Gross Storage Capacity by Prismoidal formula (M cu. m)	Spread Area (Sq. Km)	Remarks
80.40	48.698	496.040	544.738	544.738	43.390	
80.50	48.698	500.389	549.087	549.087	43.585	
80.60	48.698	504.757	553.455	553.455	43.791	
80.70	48.698	509.147	557.845	557.845	44.013	
80.80	48.698	513.560	562.258	562.258	44.245	
80.86	48.698	516.219	564.917	564.917	44.382	
80.90	48.698	517.996	566.694	566.694	44.473	
81.00	48.698	522.454	571.152	571.152	44.691	
81.10	48.698	526.934	575.632	575.631	44.891	
81.20	48.698	531.432	580.130	580.130	45.074	
81.30	48.698	535.948	584.646	584.646	45.251	
81.40	48.698	540.482	589.180	589.180	45.427	
81.50	48.698	545.034	593.732	593.731	45.603	
81.60	48.698	549.603	598.301	598.300	45.777	
81.70	48.698	554.189	602.887	602.887	45.954	
81.80	48.698	558.794	607.492	607.491	46.133	
81.86	48.698	561.565	610.263	610.262	46.242	
81.90	48.698	563.416	612.114	612.114	46.315	
82.00	48.698	568.057	616.755	616.754	46.503	
82.10	48.698	572.717	621.415	621.414	46.695	
82.20	48.698	577.396	626.094	626.094	46.894	
82.30	48.698	582.096	630.794	630.793	47.102	
82.40	**48.698**	**586.817**	**635.515**	**635.515**	**47.321**	**HFL**

Table 6.2-1 Capacity and Area

6.3 Comparative Statement of Damanganga_Madhuban Reservoir

RL in m	Impounding Year 1983		As per 2008 Survey		As per 2020 survey		Remarks
	Gross Capacity in M Cu. m	Area in Sq. Km	Gross Capacity in M Cu. m	Area in Sq. Km	Gross Capacity in M Cu. m	Area in Sq. Km	
59.86	-	-	34.087	6.298	35.250	6.713	
60.86	-	-	40.949	7.402	42.537	7.869	
61.6	**65.000**	**11.300**	**46.770**	**8.337**	**48.698**	**8.799**	**MDDL**
61.86	70.200	11.690	48.984	8.665	51.030	9.144	
62.86	85.200	13.190	58.283	9.920	60.904	10.606	
63.86	103.200	14.690	68.884	11.257	72.224	12.044	
64.86	119.200	16.390	80.894	12.734	85.059	13.666	
65.86	139.200	18.120	94.539	14.560	99.606	15.470	
66.86	156.800	19.920	110.262	16.862	116.025	17.418	
67.86	181.200	21.800	128.367	19.288	134.603	19.756	
68.86	203.200	23.720	148.872	21.577	155.568	22.157	
69.86	224.800	25.640	171.582	23.738	178.892	24.455	
70.86	248.800	28.040	196.508	26.003	204.449	26.646	
71.86	276.800	30.020	223.673	28.145	232.172	28.792	
72.86	305.800	32.040	252.989	30.255	261.972	30.805	
73.86	336.400	34.120	284.450	32.384	293.792	32.815	
74.86	369.400	36.120	318.176	34.637	327.552	34.680	
75.86	402.400	38.320	354.288	36.979	363.121	36.441	
76.86	441.000	40.630	392.915	39.305	400.394	38.114	
77.86	482.400	43.130	434.071	41.636	439.310	39.700	
78.86	522.400	45.630	477.923	44.086	479.741	41.149	
79.86	**567.000**	**48.870**	**524.857**	**47.029**	**521.553**	**42.509**	**FRL**

Table 6.3-1 Comparative statement of Damanganga_Madhuban reservoir

6.4 Gross Storage Capacity in M Cu. m of the Reservoir - Year 2020:

RL (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.86	0.9
42	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.003
43	0.005	0.008	0.013	0.019	0.026	0.035	0.045	0.057	0.069	0.076	0.082
44	0.095	0.110	0.125	0.141	0.157	0.175	0.193	0.212	0.233	0.246	0.255
45	0.278	0.303	0.329	0.358	0.389	0.421	0.455	0.491	0.529	0.552	0.567
46	0.608	0.650	0.694	0.739	0.786	0.834	0.884	0.936	0.989	1.021	1.042
47	1.097	1.153	1.210	1.268	1.327	1.387	1.448	1.510	1.573	1.611	1.637
48	1.702	1.768	1.836	1.905	1.975	2.048	2.122	2.197	2.274	2.320	2.352
49	2.431	2.512	2.594	2.677	2.761	2.847	2.935	3.023	3.114	3.170	3.207
50	3.303	3.401	3.501	3.602	3.706	3.811	3.919	4.029	4.140	4.208	4.254
51	4.370	4.488	4.608	4.731	4.856	4.985	5.116	5.249	5.386	5.470	5.527
52	5.671	5.819	5.971	6.128	6.290	6.456	6.627	6.802	6.982	7.093	7.167
53	7.357	7.551	7.750	7.954	8.163	8.377	8.597	8.822	9.052	9.193	9.288
54	9.530	9.777	10.029	10.286	10.550	10.819	11.095	11.377	11.665	11.841	11.960
55	12.260	12.567	12.880	13.198	13.523	13.854	14.192	14.536	14.887	15.101	15.245
56	15.610	15.981	16.360	16.746	17.139	17.540	17.947	18.362	18.783	19.040	19.212
57	19.648	20.091	20.542	20.999	21.464	21.935	22.413	22.899	23.391	23.690	23.891
58	24.397	24.910	25.431	25.958	26.493	27.036	27.587	28.145	28.711	29.054	29.284
59	29.866	30.457	31.055	31.662	32.279	32.905	33.542	34.190	34.849	35.250	35.519
60	36.201	36.894	37.598	38.314	39.042	39.781	40.532	41.293	42.067	42.537	42.853
61	43.651	44.461	45.283	46.117	46.964	47.825	**48.698**	49.584	50.484	51.030	51.397
62	52.324	53.264	54.220	55.190	56.176	57.178	58.194	59.226	60.270	60.904	61.330
63	62.403	63.490	64.592	65.707	66.837	67.982	69.141	70.315	71.504	72.224	72.707
64	73.924	75.158	76.406	77.672	78.953	80.250	81.564	82.894	84.242	85.059	85.607
65	86.989	88.388	89.804	91.238	92.690	94.159	95.648	97.155	98.681	99.606	100.226
66	101.790	103.373	104.974	106.594	108.232	109.890	111.568	113.265	114.984	116.025	116.724

RL (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.86	0.9
67	118.486	120.271	122.080	123.912	125.767	127.645	129.547	131.472	133.421	134.603	135.395
68	137.392	139.413	141.460	143.530	145.625	147.744	149.887	152.053	154.243	155.568	156.456
69	158.693	160.954	163.238	165.547	167.878	170.232	172.609	175.008	177.429	178.892	179.872
70	182.338	184.825	187.335	189.867	192.420	194.996	197.594	200.213	202.854	204.449	205.517
71	208.201	210.906	213.632	216.380	219.150	221.943	224.756	227.592	230.448	232.172	233.325
72	236.223	239.141	242.079	245.037	248.015	251.013	254.031	257.069	260.128	261.972	263.206
73	266.305	269.424	272.564	275.724	278.904	282.105	285.326	288.566	291.826	293.792	295.106
74	298.405	301.723	305.060	308.416	311.791	315.184	318.596	322.026	325.474	327.552	328.940
75	332.424	335.927	339.447	342.984	346.540	350.113	353.704	357.312	360.938	363.121	364.580
76	368.239	371.915	375.607	379.316	383.041	386.783	390.542	394.318	398.111	400.394	401.920
77	405.747	409.589	413.447	417.322	421.212	425.118	429.040	432.978	436.931	439.310	440.900
78	444.883	448.881	452.894	456.922	460.964	465.020	469.090	473.175	477.275	479.741	481.388
79	485.515	489.655	493.808	497.974	502.153	506.345	510.551	514.771	519.005	**521.553**	523.255
80	527.519	531.799	536.096	540.408	544.738	549.087	553.455	557.845	562.258	564.917	566.694
81	571.152	575.632	580.130	584.646	589.180	593.732	598.301	602.887	607.492	610.263	612.114
82	616.755	621.415	626.094	630.794	**635.515**						

Table 6.4-1 Gross Storage Capacity in M cu. m year -2020

Note: Gross storage capacity for FRL at 79.86 m is 521.553 M Cu. m, dead storage at 61.60 m is 48.698 M Cu. m and HFL at 82.40 m is 635.515 M Cu. m.

6.5 Live Storage Capacity in M Cu. m of the Reservoir - Year 2020:

RL (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.86	0.9
61							0.000	0.886	1.786	2.332	2.699
62	3.626	4.566	5.522	6.492	7.478	8.480	9.496	10.528	11.572	12.206	12.632
63	13.705	14.792	15.894	17.009	18.139	19.284	20.443	21.617	22.806	23.526	24.009
64	25.226	26.460	27.708	28.974	30.255	31.552	32.866	34.196	35.544	36.361	36.909
65	38.291	39.690	41.106	42.540	43.992	45.461	46.950	48.457	49.983	50.908	51.528
66	53.092	54.675	56.276	57.896	59.534	61.192	62.870	64.567	66.286	67.327	68.026
67	69.788	71.573	73.382	75.214	77.069	78.947	80.849	82.774	84.723	85.905	86.697
68	88.694	90.715	92.762	94.832	96.927	99.046	101.189	103.355	105.545	106.870	107.758
69	109.995	112.256	114.540	116.849	119.180	121.534	123.911	126.310	128.731	130.194	131.174
70	133.640	136.127	138.637	141.169	143.722	146.298	148.896	151.515	154.156	155.751	156.819
71	159.503	162.208	164.934	167.682	170.452	173.245	176.058	178.894	181.750	183.474	184.627
72	187.525	190.443	193.381	196.339	199.317	202.315	205.333	208.371	211.430	213.274	214.508
73	217.607	220.726	223.866	227.026	230.206	233.407	236.628	239.868	243.128	245.094	246.408
74	249.707	253.025	256.362	259.718	263.093	266.486	269.898	273.328	276.776	278.854	280.242
75	283.726	287.229	290.749	294.286	297.842	301.415	305.006	308.614	312.240	314.423	315.882
76	319.541	323.217	326.909	330.618	334.343	338.085	341.844	345.620	349.413	351.696	353.222
77	357.049	360.891	364.749	368.624	372.514	376.420	380.342	384.280	388.233	390.612	392.202
78	396.185	400.183	404.196	408.224	412.266	416.322	420.392	424.477	428.577	431.043	432.690
79	436.817	440.957	445.110	449.276	453.455	457.647	461.853	466.073	470.307	**472.855**	474.557
80	478.821	483.101	487.398	491.710	496.040	500.389	504.757	509.147	513.560	516.219	517.996
81	522.454	526.934	531.432	535.948	540.482	545.034	549.603	554.189	558.794	561.565	563.416
82	568.057	572.717	577.396	582.096	**586.817**						

Table 6.5-1 Gross Storage Capacity in M cu. m year -2020

Note: Live storage capacity for FRL at 79.86 m is 472.855 M Cu. m and for HFL at 82.40 m is 586.817 M Cu. m.

6.6 Spread Area in Sq.Km of the Reservoir - Year 2020:

RL (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.86	0.9
42	0.000	0.000	0.000	0.000	0.000	0.002	0.005	0.008	0.011	0.014	0.016
43	0.026	0.039	0.051	0.063	0.081	0.097	0.110	0.118	0.126	0.130	0.133
44	0.141	0.148	0.155	0.162	0.169	0.178	0.189	0.200	0.211	0.219	0.224
45	0.240	0.257	0.277	0.298	0.316	0.333	0.348	0.366	0.381	0.390	0.397
46	0.412	0.429	0.443	0.462	0.478	0.494	0.508	0.521	0.532	0.538	0.542
47	0.552	0.563	0.577	0.587	0.596	0.605	0.615	0.624	0.634	0.640	0.644
48	0.656	0.669	0.684	0.698	0.715	0.732	0.746	0.760	0.773	0.781	0.787
49	0.800	0.814	0.827	0.839	0.852	0.865	0.880	0.897	0.920	0.936	0.946
50	0.968	0.987	1.006	1.026	1.046	1.066	1.086	1.106	1.127	1.139	1.147
51	1.169	1.192	1.216	1.242	1.268	1.295	1.324	1.354	1.387	1.408	1.422
52	1.460	1.501	1.545	1.592	1.640	1.686	1.732	1.777	1.824	1.852	1.871
53	1.918	1.966	2.015	2.065	2.117	2.170	2.224	2.277	2.332	2.366	2.388
54	2.441	2.494	2.548	2.605	2.664	2.726	2.788	2.851	2.915	2.954	2.978
55	3.037	3.096	3.156	3.217	3.280	3.344	3.409	3.475	3.543	3.585	3.612
56	3.682	3.752	3.824	3.896	3.968	4.039	4.109	4.181	4.252	4.296	4.324
57	4.396	4.469	4.540	4.610	4.679	4.748	4.819	4.889	4.959	5.000	5.028
58	5.098	5.169	5.240	5.314	5.388	5.466	5.544	5.621	5.698	5.745	5.777
59	5.861	5.943	6.028	6.117	6.214	6.315	6.423	6.534	6.645	6.713	6.759
60	6.873	6.988	7.103	7.218	7.334	7.448	7.562	7.678	7.797	7.869	7.918
61	8.039	8.159	8.281	8.408	8.537	8.669	8.799	8.928	9.063	9.144	9.199
62	9.336	9.479	9.627	9.781	9.941	10.093	10.239	10.381	10.519	10.606	10.663
63	10.804	10.944	11.085	11.227	11.372	11.519	11.667	11.813	11.958	12.044	12.103
64	12.253	12.409	12.571	12.732	12.892	13.054	13.221	13.392	13.564	13.666	13.735
65	13.905	14.075	14.250	14.427	14.606	14.789	14.977	15.166	15.355	15.470	15.547
66	15.734	15.918	16.105	16.293	16.483	16.676	16.875	17.080	17.290	17.418	17.508
67	17.738	17.973	18.202	18.434	18.666	18.897	19.136	19.373	19.613	19.756	19.851
68	20.093	20.338	20.585	20.829	21.069	21.307	21.545	21.780	22.016	22.157	22.251
69	22.489	22.728	22.965	23.197	23.427	23.654	23.880	24.103	24.322	24.455	24.544

RL (m)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.86	0.9
70	24.764	24.987	25.208	25.427	25.647	25.867	26.087	26.303	26.517	26.646	26.731
71	26.944	27.158	27.373	27.591	27.810	28.030	28.248	28.460	28.670	28.792	28.873
72	29.077	29.279	29.480	29.680	29.881	30.081	30.282	30.483	30.684	30.805	30.886
73	31.090	31.294	31.498	31.702	31.905	32.108	32.308	32.505	32.700	32.815	32.893
74	33.085	33.275	33.467	33.654	33.839	34.024	34.211	34.392	34.572	34.680	34.752
75	34.931	35.111	35.289	35.467	35.644	35.820	35.996	36.168	36.339	36.441	36.508
76	36.675	36.839	37.003	37.169	37.336	37.505	37.675	37.843	38.013	38.114	38.180
77	38.344	38.504	38.663	38.823	38.982	39.142	39.300	39.454	39.608	39.700	39.761
78	39.910	40.055	40.202	40.348	40.490	40.630	40.772	40.928	41.067	41.149	41.205
79	41.337	41.466	41.595	41.723	41.853	41.985	42.127	42.273	42.419	**42.509**	42.570
80	42.724	42.882	43.042	43.211	43.390	43.585	43.791	44.013	44.245	44.382	44.473
81	44.691	44.891	45.074	45.251	45.427	45.603	45.777	45.954	46.133	46.242	46.315
82	46.503	46.695	46.894	**47.102**							

Table 6.6-1 SPREAD AREA IN SQ. KM YEAR -2020

Note: Spread Area for FRL at 79.86 m is 42.509 Sq. Km and HFL at 82.40 m is 47.102 Sq. Km.

6.7 Sediment Analysis:

6.7.1 Observed Rate of Sedimentation

The reservoir was impounded during the year 1983. As per original project report, FRL is 79.86m. As per original project report, total area of reservoir at FRL 79.86m is 48.87 Sq. Km, corresponding storage capacity is 567 M Cu. m, and Dead storage at 61.60m is 65 M Cu. m.

The reservoir was surveyed by Remote Sensing Technique in the year 2008. As per survey of the year 2008, total area of reservoir at FRL 79.86m was 47.029 Sq. Km and corresponding storage capacity was 524.857 M Cu. m, and Dead storage at 61.60m was 46.77 M Cu. m.

The reservoir was recently surveyed by means of integrated bathymetric and topographic survey in year 2020. As per recent survey, total area of reservoir at FRL 79.86m is 42.509 Sq. Km, corresponding storage capacity is 521.553 M Cu. m, and Dead storage at 79.86m is 48.698 M Cu. m.

The rate of siltation in the reservoir (up to FRL 79.86m) during the last 37 years (1983-2020) according to survey of the year 2020 was found to be 1.228 M Cu. m / year.

Original Reservoir data:

Year of Impounding : 1983
Catchment Area : 1813 Sq. Km
Surface area at 79.86m : 48.87 Sq. Km
Live storage at 79.86m : 502 M Cu. m
Dead storage at 61.60m : 65 M Cu. m
Gross storage at 79.86m : 567 M Cu. M

Rate of Sedimentation (at FRL 167.50) with respect to impounding year 1990													
Sr. No	**Year of Survey**	**Capacity in M Cu. m**			**Period in years**	**Silt Deposited in M Cu. m**	**Silt Rate in M Cu. m/year**	**Loss in Capacity in M Cu. m and percentage**			**Silt Index ham/100 Sq. Km/Yr.**	**Annual % loss**	**Remarks**
		Dead	**Live**	**Gross**				**Dead**	**Live**	**Gross**			
1	1983	65	502	567	-	-	-	-	-	-	5.6	-	
2	2008 By Remote Sensing	46.77	478.087	524.857	25	42.143	1.686	18.23 28.05%	23.913 4.76%	42.143 7.43%	9.298	0.30%	**Significant Category**
3	2020 by integrated Bathymetric and Topographic survey	48.698	472.855	521.553	37	45.447	1.228	16.302 25.08%	29.145 5.81%	45.4487 8.02%	6.775	0.22%	**Significant Category**

Table 6.7-1 RATE OF SEDIMENTATION

<u>According to IS -12182 (1987)</u>

Annual % loss	-	**Class of Reservoir**
Up to 0.1	-	Insignificant
0.1 to 0.5	-	Significant
Above 0.5	-	Serious

Rate of Silt = Loss in Gross Capacity in M Cu. m/No of Years
Silt Index = (Silt Rate/Catchment area) x 10000
Annual % Loss = Loss in % of Gross Capacity/No of years

6.8 Conclusion

- By above table we can conclude that the capacity of reservoir is decreased significantly due to deposition of sediments in the reservoir. The annual percentage loss from survey of the year 2008 and 2020 is observed to be 0.30% and 0.22% respectively.
- The decrease in annual percentage loss from 0.30% (2008 survey) to 0.22% (2020 survey) is because at initial stage after dam construction sedimentation takes place at higher rate compare to later on.
- The increase in storage capacity (1.928 M Cu. m increased in dead storage capacity) in 2020 survey data compared to 2008 survey data is due to difference in method used to acquire survey data of the reservoir during 2008 and 2020.
- Remote Sensing method used in previous survey works on estimations of water spread area. In remote sensing method, the difference between water spread area between year of survey and earlier survey year is a real extent of silting at these levels. This change in water spread area at that water level is used to calculate storage capacity. This is the disadvantage of this method as it can only estimate area. In addition, this method is time consuming, as we will have to wait for water level to change from MDDL (lowest water level reservoir has recorded) to FRL. Also data acquired by this method is less reliable as compared to recent survey method.

6.9 Methods for controlling the sedimentation

According to IS-6518:2017 there are several factors involved in controlling sedimentation in reservoirs and they relate to aspects on,

a) Design of reservoir.
b) Control of sediment inflow.
c) Control of sediment deposition.
d) Removal of sediments.

All these aspects are to be simultaneously taken note of and appropriate measures be adopted.

6.9.1 Design of Reservoirs

The capacity of reservoirs is governed by a number of factors which are covered in IS 5477 (Parts 1 to 4). From the point of view of sediment deposition, the following points may be given due consideration:

a) The sediment yield which depends on the topographical, geological and geomorphological set up, meteorological factors, land use/land cover, intercepting tanks, etc.;
b) Sediment delivery characteristics of the channel system;
c) The efficiency of the reservoir as sediment trap;
d) The ratio of capacity of reservoir to the inflow;
e) Configuration of reservoir;
f) Method of operation of reservoir; and
g) Provisions for silt exclusion.

- The rate of sediment delivery increases with the quantum of discharge.

- The percentage of sediment trapped by a reservoir with a given drainage area increases with the increased capacity. In some cases an increased capacity will however, result in greater loss of water due to evaporation. However, with the progress of sedimentation, there is decrease of storage capacity which in turn lowers the trap efficiency of the reservoir.
- The capacity of the reservoir and the size and characteristics of the reservoir and its drainage area are the most important factors governing the annual rate of accumulation of sediment. Periodical reservoir sedimentation surveys provide guidance on the rate of sedimentation. In the absence of observed data for the reservoir concerned, data from other reservoirs of similar capacity and catchment characteristics may be adopted.
- Sedimentation takes place not only in the dead storage but also in the live storage space in the reservoir. The practice for design of reservoir is to use the observed suspended sediment data available from key hydrologica1 networks and also the data available from hydrographic surveys of other reservoirs in the same region.

This data may be used to simulate sedimentation status over a period of reservoir life as mentioned in IS 12182.

- Raising the Dam at Periodic Intervals:

Engineering economic analysis of some reservoir projects probably would show that it is cheaper to build a substantially lower dam initially, and to raise it at intervals unti1 its ultimate height for the given original capacity so that long useful life may result. Stage-wise construction also provides lower trapping efficiency and less evaporation in the initial stages.

However, this method may not be feasible in all the existing dams. Wherever this method is contemplated, proper consideration should be given on the strength.

6.9.2 Control of Sediment Inflow

There are many methods for controlling sediment inflows and they can be divided as follows:

1. Watershed management/soil conservation measures to check production and transport of sediment in the catchment area

1.1. The engineering methods

1.1.1. Check Dams

a) They help to arrest degradation of stream bed thereby arresting the slope failure; and

b) They reduce the velocity of stream flow, thereby causing the deposition of the sediment load.

Check dams become necessary, where the channel gradients are steep and there is a heavy inflow of sediment from the watershed. They are constructed of local material like earth, rock, timber, etc. These are suitable for small catchment varying in size from 40 to 400 hectares. It is necessary to provide small check dams on the subsidiary streams flowing into the main streams besides the check dams in the main stream. Proper consideration should be given to the number and location of check dams required. It is preferable to minimize the height of the check dams. If the stream has, a very-steep slope, it is desirable to start with a smaller height for the check dams than may ultimately be necessary.

Check dams may generally cost more per unit of storage than the reservoirs they protect.

Therefore, it may not always be possible to adopt them as a primary method of sediment control in new reservoirs. However, feasibility of providing check dams at later date should not be overlooked while planning the construction of a new reservoir

1.1.2. Contour Bunding and Trenching

These are important methods of controlling soil erosion on the hills and sloping lands, where gradients of cultivated fields or terraces are flatter, say up to 10 percent. By these methods the hill side is split up into small compartments on which the rain is retained and surface run-off is modified with prevention of soil erosion. In addition to contour bunding, side trenching is also provided as per requirement.

1.1.3. Gully Plugging

This is done by small rock fill dams. These dams will be effective in filling up the gullies with sediment coming from the upstream of the catchment and also prevent further widening of the gully.

1.1.4. Bank Protection

This is achieved by terracing, revetment, retaining walls, gabions and spurs.

1.2. Agronomy

The agronomic measures include establishment of vegetative screen, contour farming, strip cropping and crop rotation.

1.3. Forestry

Forestry measures include forest conservancy, control on grazing, lumbering, operations and forest fires along with management and protection of forest plantations.

2. Preventive measures to check inflow of sediment into the reservoir

2.1. Restricting the waste/sediment entering into the reservoirs due to agricultural and infrastructural activities surrounding the submergence.

2.2. Construction of by-pass channels or conduits.

The various methods in this category require the construction of some type of diversion dam or weir at the head of the reservoir basin, and a canal, tunnel or conduit leading around the reservoir to a point below the dam where the flow may re-enter the main channels. In such cases the flood flows of sediment laden water are by-passed to the downstream of the dam. In some cases where topography permits construction of new off channel reservoirs can be considered. These reservoirs will invariably have a forebay and check dam on the upstream for trapping the sediment. The stored water in the fore bay is led to the reservoir and the sediment trapped is flushed through by by-pass channel/ conduit/tunnel to the main channel downstream of the dam.

6.9.3 Control of Sediment Deposition

The deposition of sediment in a reservoir may be controlled to a certain extent by designing and operating gates or other outlets in the dam in such a manner as to permit selective withdrawals of water having a higher than average sediment content. The suspended sediment content of the water in reservoirs is higher during and just after flood flow. Thus, more the

water wasted at such times, the smaller will be the percentage of the total sediment load to settle into permanent deposits. There are generally three methods:

- **Density current**

Water at various levels of a reservoir often contains radically different concentrations of suspended sediment particularly during and after flood flows. If all wastewater could be withdrawn at those levels where the concentration is highest, a significant amount of sediment might be removed from the reservoir. Because a submerged outlet draws water towards it from all directions, the vertical dimension of the opening should be small with respect to the thickness of the layer and the rate of withdrawal also should be low.

- **Waste-water release**

Controlling the sedimentation by controlling waste- water release is obviously possible only when water can be or should be wasted. This method is applicable only when a reservoir is of such size that a small part of large flood flows will fill it.

In the design of the dam, sediment may be passed through or over it as an effective method of silt control by placing a series of outlets at various elevations. The percentage of total sediment load that might be ejected from the reservoir through proper gate control will differ greatly with different locations. It is probable that as much as 20 percent of the sediment inflow could be passed through many reservoirs by venting through outlets designed and controlled.

- **Scouring Sluicing**

This method is somewhat similar to both the control of waste-water release and the draining and flushing methods

The distinctions amongst them are the following:

a) The waste-water release method ejects sediment laden flood flows through deep spillway gates or large under-sluices at the rate of discharge that prevents sedimentation.

b) Drainage and flushing method involves the slow release of stored water from the reservoir through small gates or valves making use of normal or low flow to entrain and carry the sediment, and

c) Scouring sluicing depends for its efficiency on either the scouring action exerted by the sudden rush of impounded water under a high head through under-sluices or on the scouring action of high flood discharge coming into the reservoir

Scouring sluicing method can be used in the following:

i. Small power dams that depend to a great extent on pondage but not on storage;

ii. Small irrigation reservoirs, where only a small fraction of the total annual flow can be stored;

iii. Any reservoir in narrow channels, gorges, etc, where water wastage can be afforded; and

iv. When the particular reservoir under treatment is a unit in an interconnected system so that the other reservoirs can supply the water needed.

6.9.4 Removal of Sediment Deposit

The most practical means of maintaining the storage capacity are those designed to prevent accumulation of permanent deposits as the removal operations are extremely expensive, unless the material removed is usable. Therefore, the redemption of lost storage by removal should be adopted as a last resort. The removal of sediment deposit implies in general, that the deposits are sufficiently compacted or consolidated to act as a solid and, therefore, are unable to flow along with the water. The removal of sediment deposits may be accomplished by a variety of mechanical and hydraulic or methods, such as excavation, dredging, siphoning, draining, flushing, flood sluicing, and sluicing aided by such measures as hydraulic or mechanical agitation or blasting of the sediment. The excavated sediments may be suitably disposed off so that, these do not find the way again in the reservoir.

1. Excavation

The method involves draining most of or all the water in the basin and removing the sediment by hand or power operated shovel, dragline scraper or other mechanical means.

The excavation of silt and clay, which constitute most of the material in larger reservoirs, is more difficult than the excavation of sand and gravel. Fine-textured sediment cannot be excavated easily from larger reservoirs unless it is relatively fluid or relatively compact.

2. Dredging

This involves the removal of deposits from the bottom of a reservoir and their conveyance to some other point by mechanical or hydraulic means, while water storage is being maintained.

Dredging practices are grouped as:

a) Mechanical dredging by bucket, ladder, etc.;
b) Suction dredging with floating pipeline and a pump usually mounted on a barge; and
c) Siphon dredging with a floating pipe extending over the dam or connected to an opening in the dam and usually with a pump on a barge.

NOTES

1) Practicality of the two methods, namely, excavation and dredging, requires to be carefully considered in any particular case.
2) Suitable measures to prevent deposition of the dredged silt in the natural channel where it is discharged need to be adopted.

3. Draining and Flushing

The method involves relatively slow release of all stored water in a reservoir through gates or valves located near bottom of the dam and the maintenance thereafter of open outlets for a shorter or longer period during which normal stream flow cuts into or directed against the sediment deposits. Therefore, this method may be adopted in flood control reservoirs.

4. Sluicing with Controlled Water

This method differs from the flood sluicing in that the controlled water supply permits choosing the time of sluicing more advantageously and that the water may be directed more effectively against the sediment deposits. While the flood sluicing depends either on the occurrence of flood or on being able to release rapidly all of a full or nearly full supply of water

in the main reservoir is empty. The advantage of this method is that generally more sediment can be removed per unit of water used than in flood scouring or draining and flushing.

5. Sluicing with Hydraulic and Mechanical Agitation

Methods that stir up break up or move deposits of sediment into a stream current flowing through a drained reservoir basin or into a lake current moving through and out of a full reservoir will tend to make the removal of sediment from the reservoir more complete. Wherever draining, flushing or sluicing appear to be warranted, the additional use of hydraulic means for stirring up the sediment deposits, or sloughing them off, into a stream flowing through the reservoir basin should be considered. It has, however, limited application.

6.10 Area – Capacity – Curve of Damanganga_Madhuban Reservoir

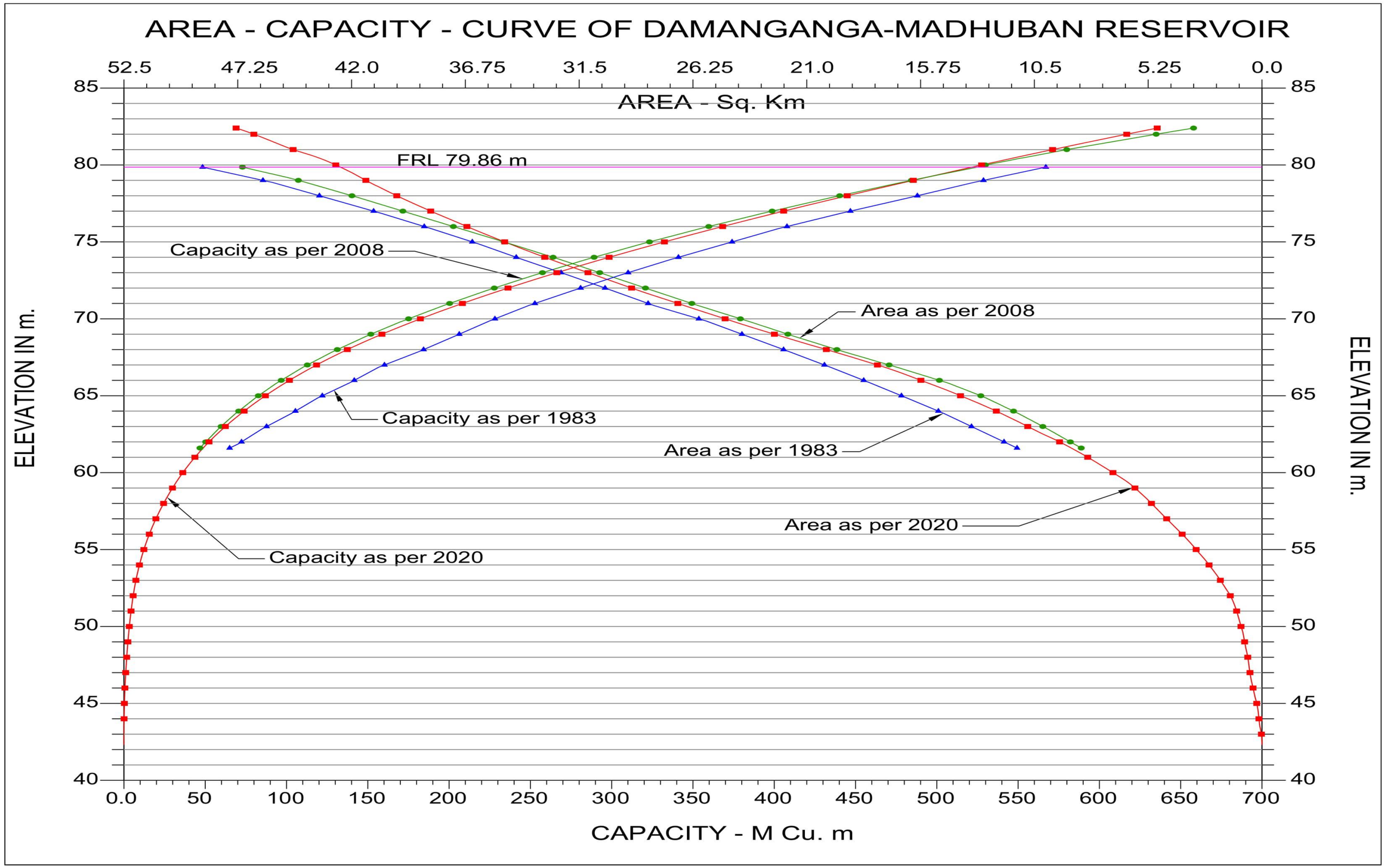


Figure 6.10-1 AREA – CAPACITY – CURVE

6.11 Segment Map, Contour Map , Wire frame Map and L Section

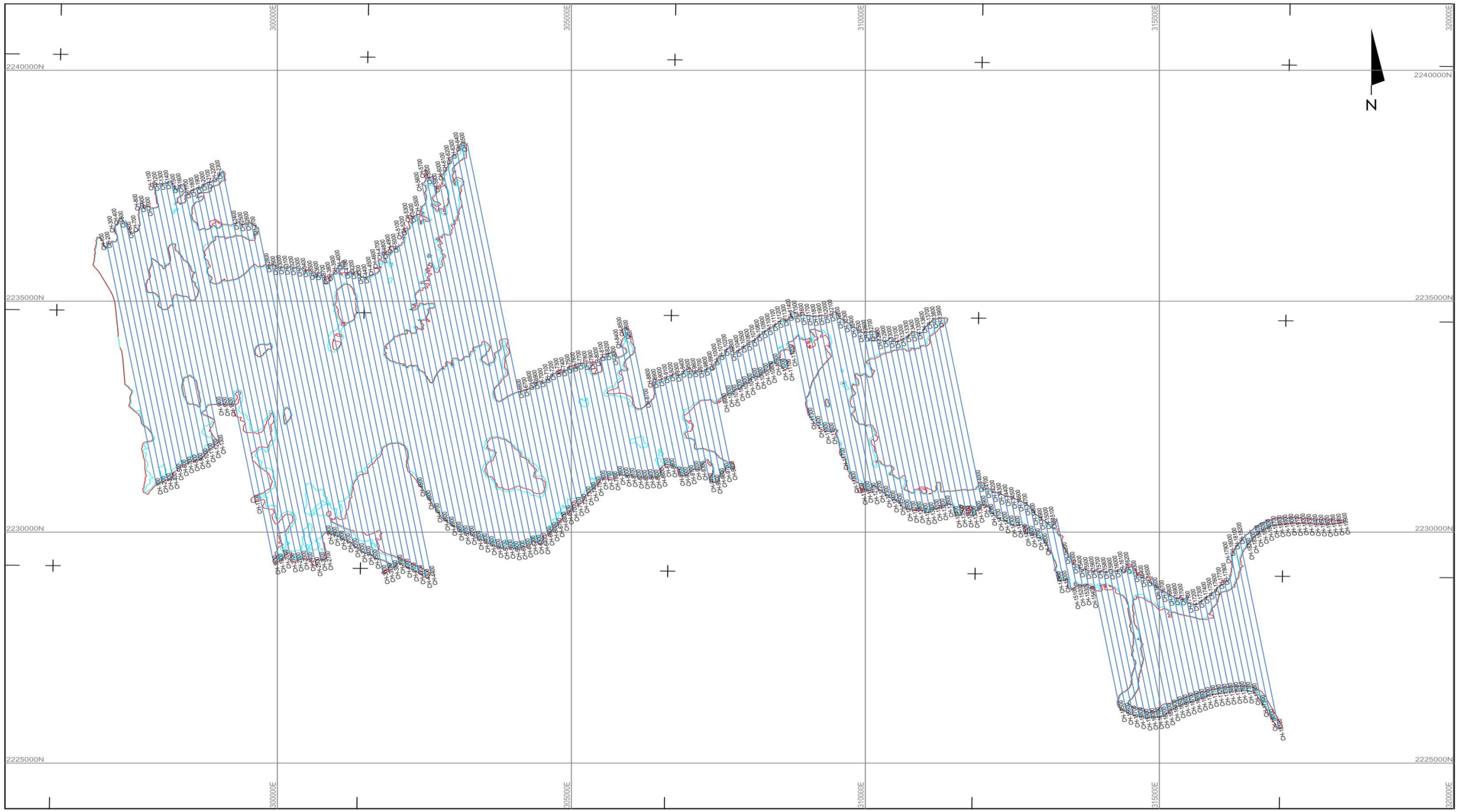


Figure 6.11-1 SEGMENT MAP FOR CROSS SECTION

Cross sections showing bed profile at 100m interval were prepared and are provided as soft copy in CD/Hard Disc. Total 199 cross section profiles were prepared.

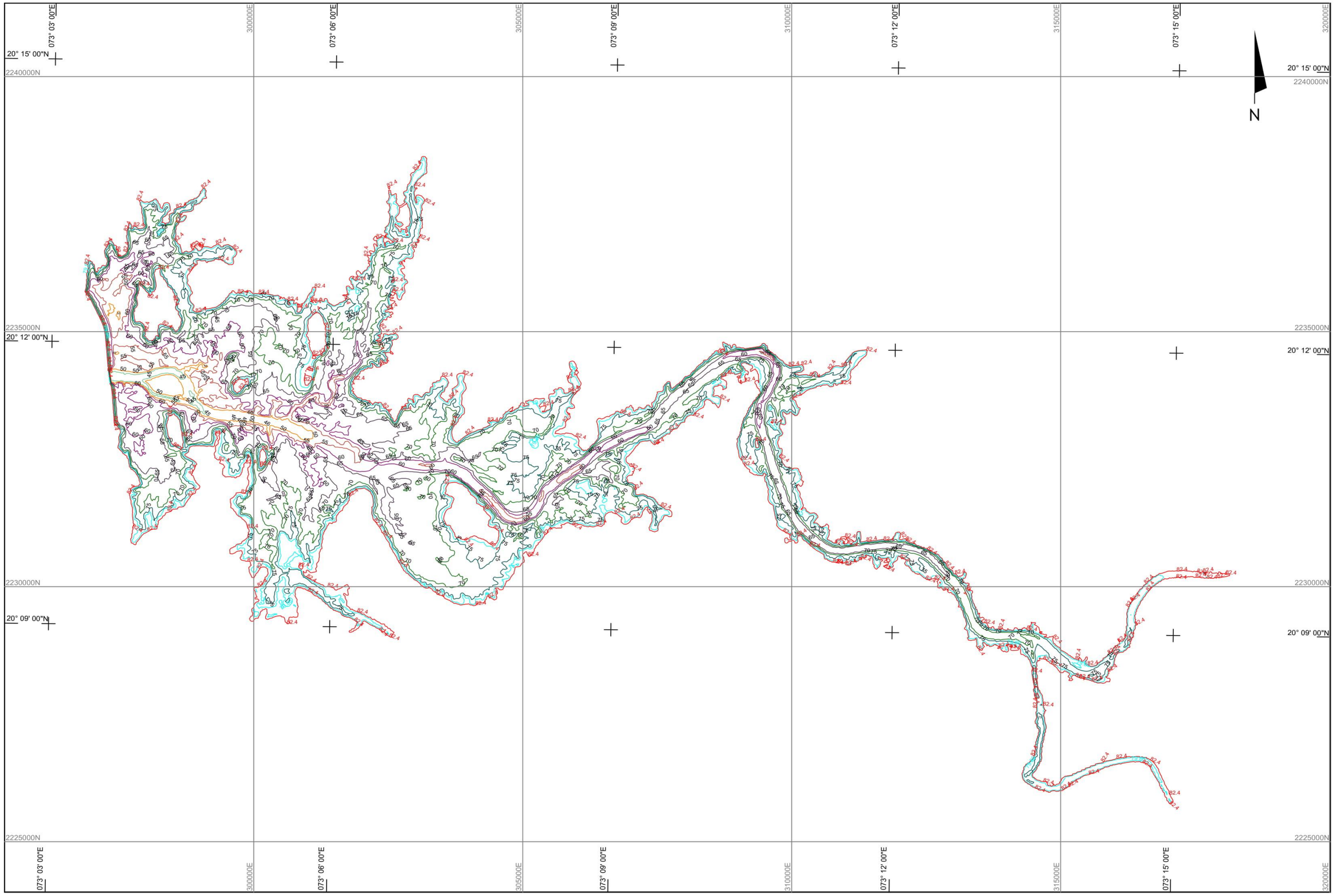


Figure 6.11-2 CONTOUR MAP

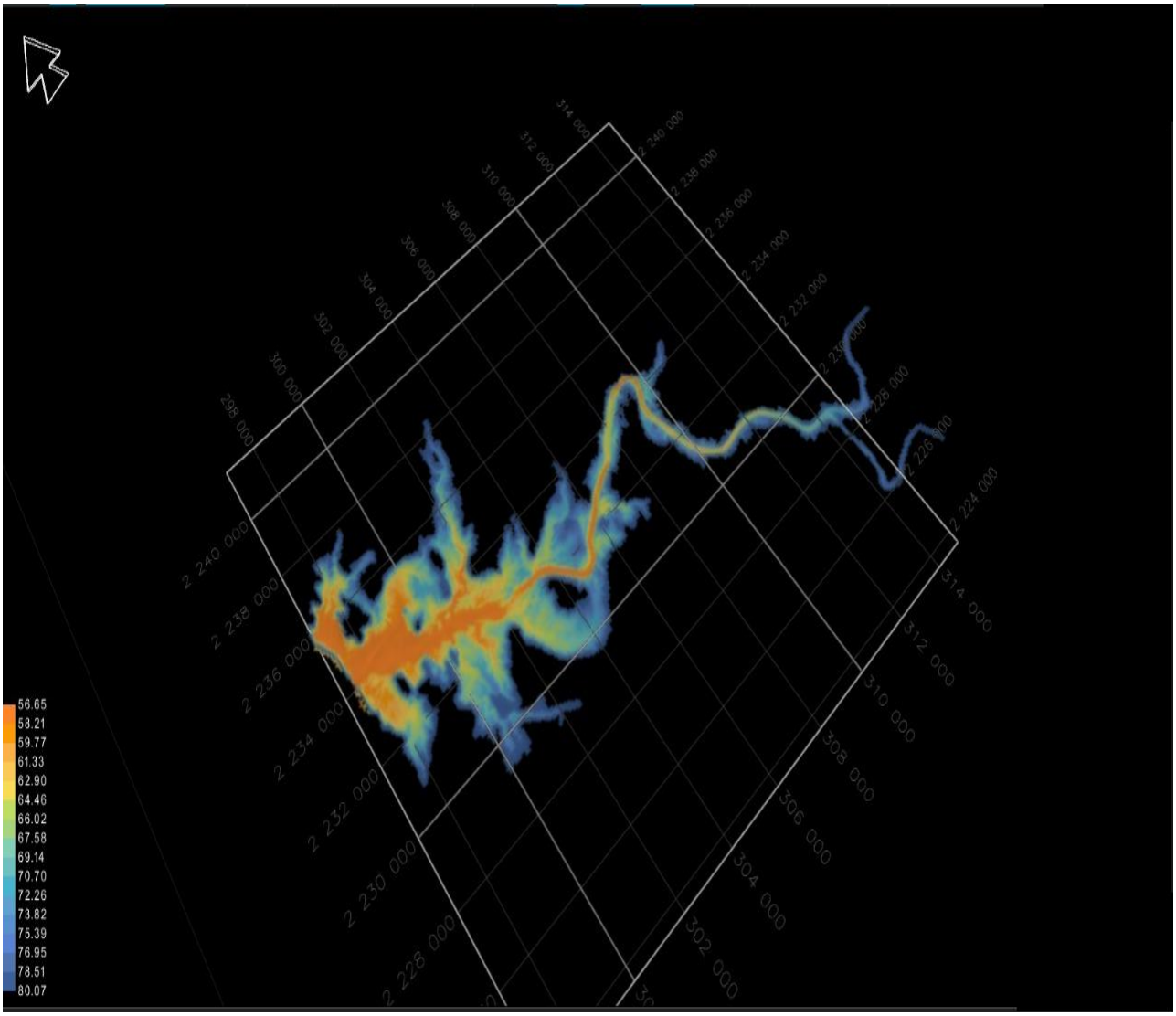


Figure 6.11-3 WIRE FRAME MAP

Figure 6.11-4 L Section

7 DGPS OBSERVATION REPORT

CSRS-PPP 3.45.0 (2020-07-08)

OBS_Madhuban.20o
MADH

Data Start	Data End	Duration of Observations
2020-11-04 02:34:35.00	2020-11-04 06:47:35.00	4:13:00
Processing Time		**Product Type**
14:40:18 UTC 2020/11/04		NRCan Ultra-rapid
Observations	**Frequency**	**Mode**
Phase and Code	Double	Static

Elevation Cut-Off	Rejected Epochs	Fixed Ambiguities	Estimation Steps
7.5 degrees	0.00 %	96.69 %	5.00 sec

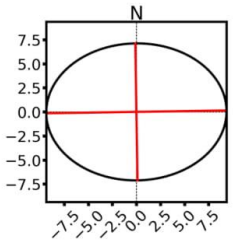
Antenna Model	APC to ARP	ARP to Marker
GMXZENITH35	L1 = 0.125 m L2 = 0.132 m	H:1.626m / E:0.000m / N:0.000m

(APC = antenna phase center; ARP = antenna reference point)

Estimated Position for OBS_Madhuban.20o

	Latitude (+n)	Longitude (+e)	Ell. Height
NAD83(CSRS) (2020.8)	20° 11' 40.17204"	73° 3' 36.45620"	18.542 m
Sigmas(95%)	0.006 m	0.007 m	0.032 m
A priori*	20° 11' 40.25062"	73° 3' 36.50395"	20.896 m
Estimated – A priori	-2.416 m	-1.386 m	-2.354 m

95% Error Ellipse (mm)
semi-major: 9 mm
semi-minor: 7 mm
semi-major azimuth: 89° 6' 12.31"



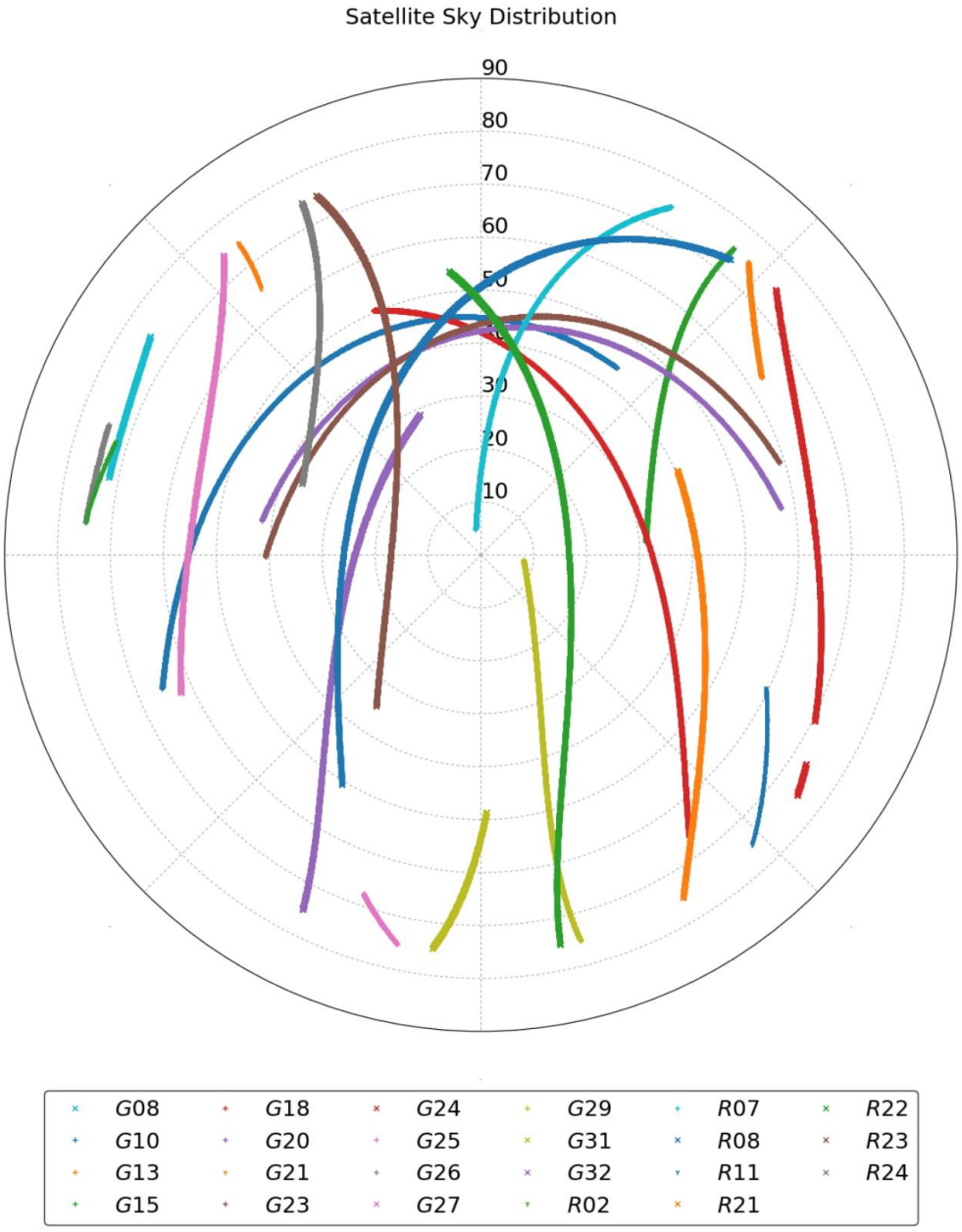
UTM (North)
Zone 43

2234188.929 m (N)
297299.807 m (E)

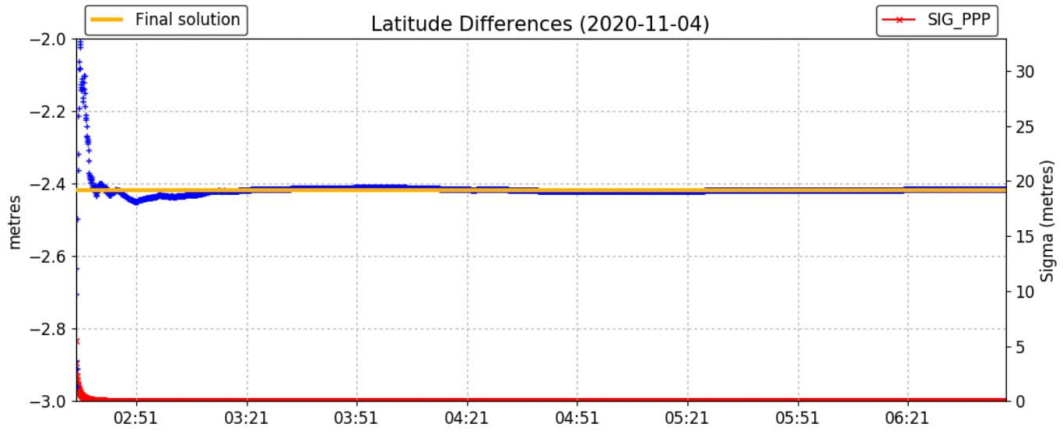
Scale Factors
1.00010784 (point)
1.00010492 (combined)

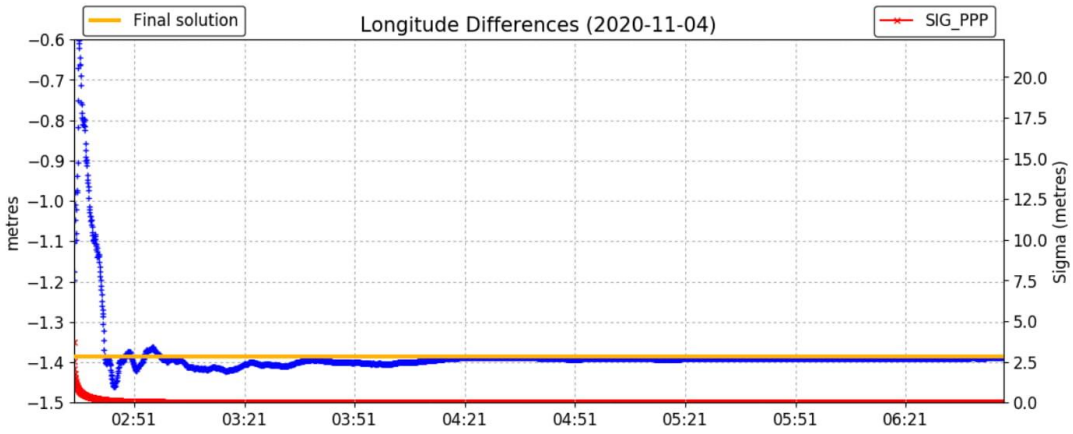
*(Coordinates from RINEX header used as a priori position)

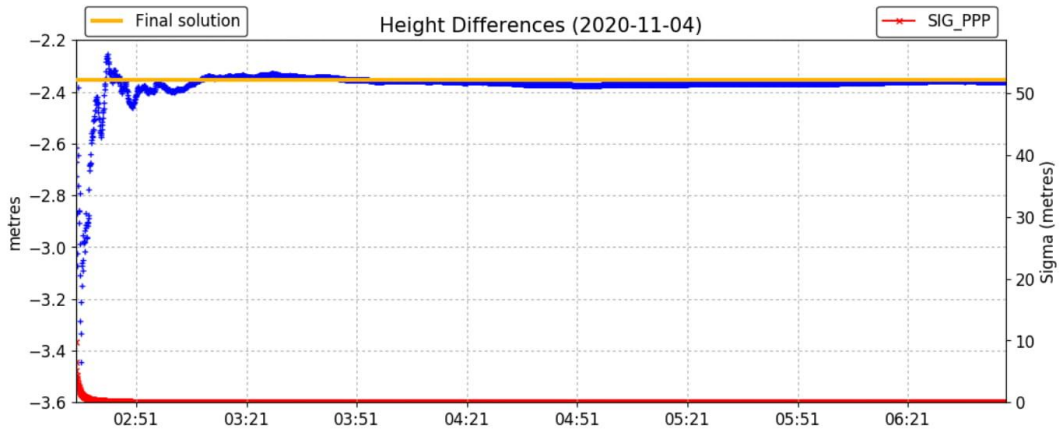
1

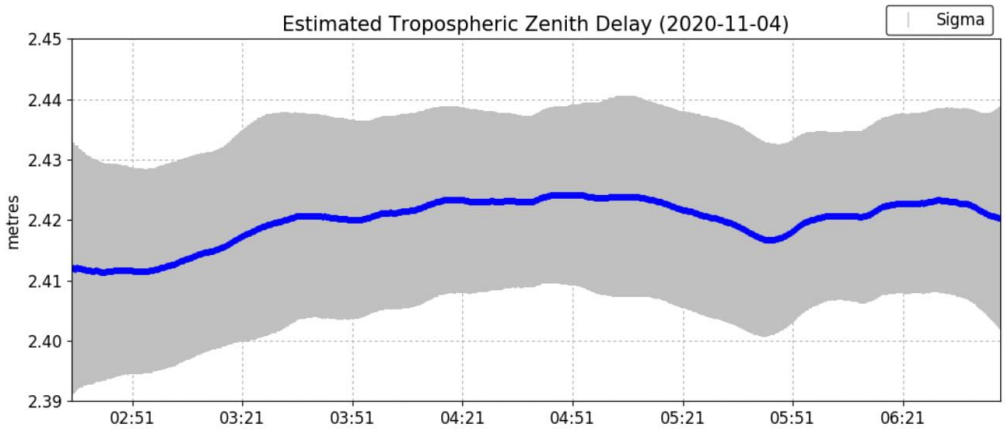

Satellite Sky Distribution
90
80
70
60
30
20
10
G08 G18 G24 G29 R07 R22
G10 G20 G25 G31 R08 R23
G13 G21 G26 G32 R11 R24
G15 G23 G27 R02 R21

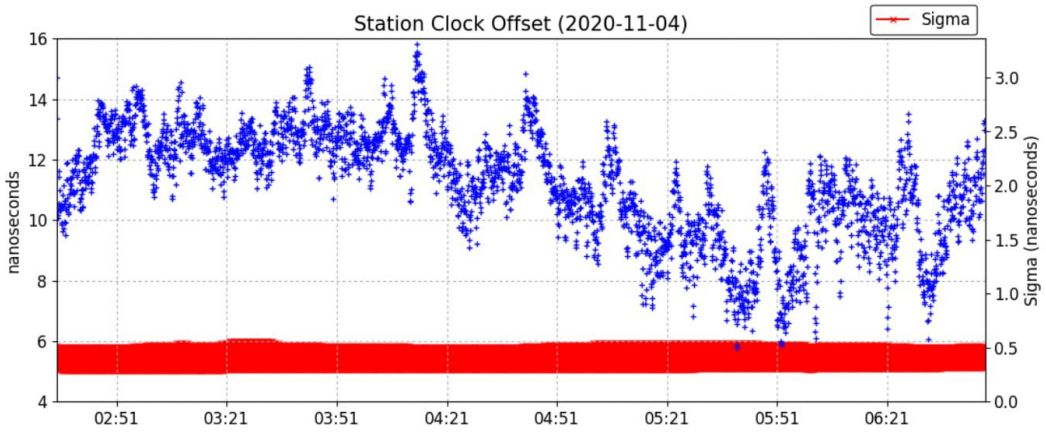
2

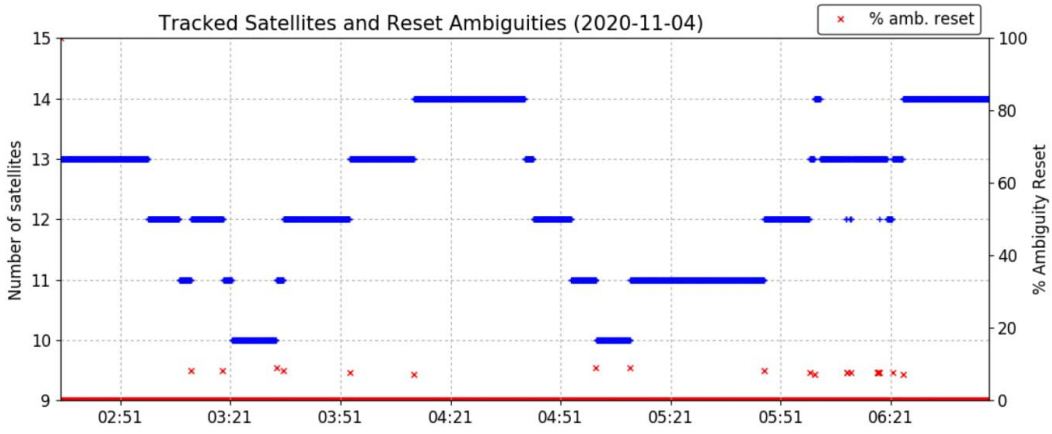

Final solution
Latitude Differences (2020-11-04)
SIG_PPP
metres
Sigma (metres)
−2.0
−2.2
−2.4
−2.6
−2.8
−3.0
30
25
20
15
10
5
0
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21


Final solution
Longitude Differences (2020-11-04)
SIG_PPP
metres
Sigma (metres)
−0.6
−0.7
−0.8
−0.9
−1.0
−1.1
−1.2
−1.3
−1.4
−1.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21

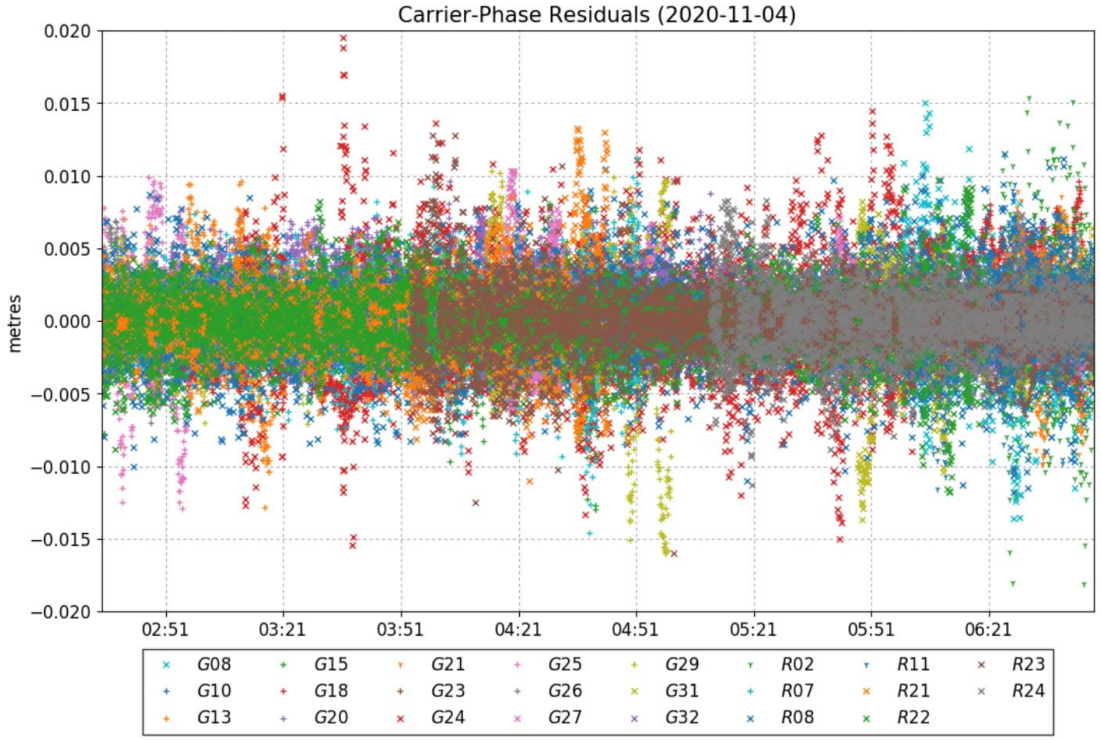

Final solution
Height Differences (2020-11-04)
SIG_PPP
metres
Sigma (metres)
−2.2
−2.4
−2.6
−2.8
−3.0
−3.2
−3.4
−3.6
50
40
30
20
10
0
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21

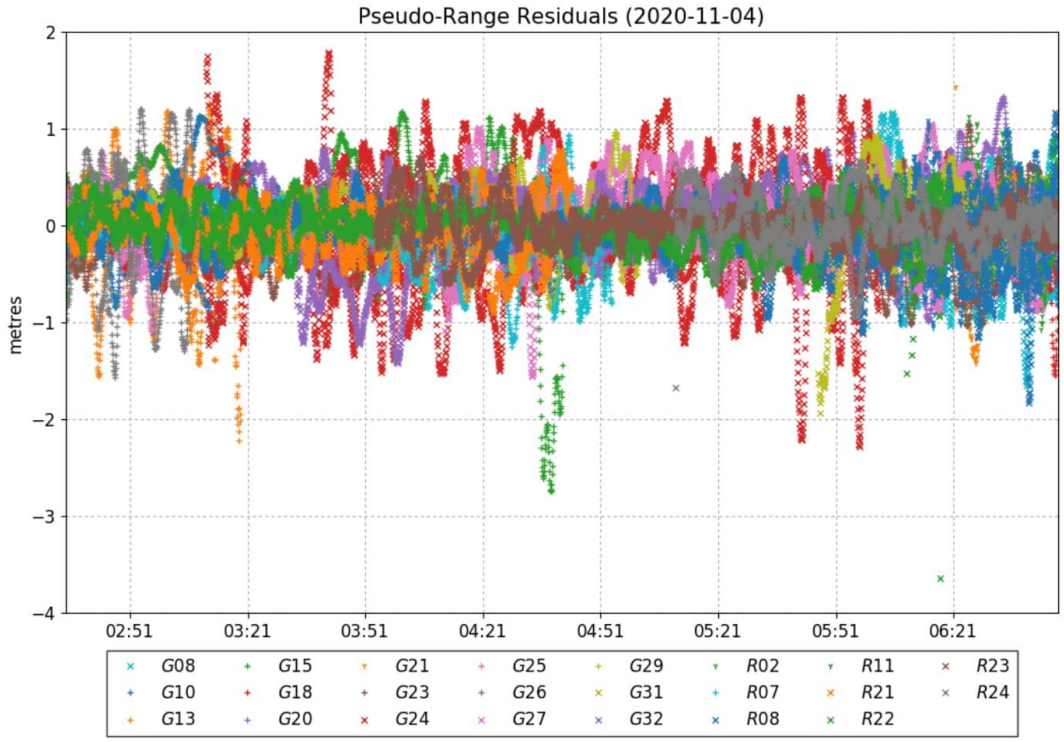

Estimated Tropospheric Zenith Delay (2020-11-04)
Sigma
metres
2.45
2.44
2.43
2.42
2.41
2.40
2.39
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21


Station Clock Offset (2020-11-04)
Sigma
nanoseconds
Sigma (nanoseconds)
16
14
12
10
8
6
4
3.0
2.5
2.0
1.5
1.0
0.5
0.0
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21


Tracked Satellites and Reset Ambiguities (2020-11-04)
% amb. reset
Number of satellites
% Ambiguity Reset
15
14
13
12
11
10
9
100
80
60
40
20
0
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21

4


Carrier-Phase Residuals (2020-11-04)
metres
0.020
0.015
0.010
0.005
0.000
−0.005
−0.010
−0.015
−0.020
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21
G08 G15 G21 G25 G29 R02 R11 R23
G10 G18 G23 G26 G31 R07 R21 R24
G13 G20 G24 G27 G32 R08 R22


Pseudo-Range Residuals (2020-11-04)
metres
2
1
0
−1
−2
−3
−4
02:51
03:21
03:51
04:21
04:51
05:21
05:51
06:21
G08 G15 G21 G25 G29 R02 R11 R23
G10 G18 G23 G26 G31 R07 R21 R24
G13 G20 G24 G27 G32 R08 R22

8 SINGLE BEAM ECHOSOUNDER BAR CHECK RESULTS

BOAT 1

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
05-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	8	7.98	0.02
4	3.99	0.01	6	6.02	-0.02
6	6.01	-0.01	4	4.02	-0.02
8	7.98	0.02	2	1.99	0.01

	Average	0.0025	Average	-0.0025
	Std. Dev	0.0150	Std. Deviation	0.0206
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0040

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
06-Nov-20	**12.10hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01

	Average	-0.0017	Average	-0.0033
	Std. Dev	0.0133	Std. Deviation	0.0151
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
07-Nov-20	**10.20hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.98	0.02
3	2.99	0.01	6	6.01	-0.01
4	4.02	-0.02	5	4.99	0.01
5	4.99	0.01	4	4.01	-0.01
6	6	0	3	3.02	-0.02
7	6.98	0.02	2	1.99	0.01

	Average	0.0017	Average	0.0000
	Std. Dev	0.0147	Std. Deviation	0.0155
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0005

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
08-Nov-20	**8.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01

	Average	-0.0017	Average	-0.0033
	Std. Dev	0.0133	Std. Deviation	0.0151
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
09-Nov-20	**14.45hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	8	7.98	0.02
4	3.99	0.01	6	6.02	-0.02
6	6.01	-0.01	4	4.02	-0.02
8	7.98	0.02	2	1.99	0.01

	Average	0.0025		Average	-0.0025
	Std. Dev	0.0150		Std. Deviation	0.0206
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0040

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
10-Nov-20	**15.45hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	2.99	0.01	9	8.98	0.02
4	3.99	0.01	8	7.98	0.02
5	5.01	-0.01	7	6.99	0.01
6	6.02	-0.02	6	6	0
7	6.99	0.01	5	5	0
8	8.01	-0.01	4	3.99	0.01
9	9	0	3	3.01	-0.01
10	10	0	2	1.98	0.02
	Average	-0.0022		Average	0.0089
	Std. Dev	0.0109		Std. Deviation	0.0105
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0003

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
11-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**15**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	2.99	0.01	9	8.98	0.02
4	3.99	0.01	8	7.99	0.01
5	5.01	-0.01	7	6.99	0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	3.99	0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	1.98	0.02

	Average	-0.0033	Average	0.0056
	Std. Dev	0.0100	Std. Deviation	0.0124
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0017

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
12-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	7.99	0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	4.01	-0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	2.01	-0.01

	Average	-0.0078	Average	-0.0022
	Std. Dev	0.0067	Std. Deviation	0.0120
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0038

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
13-Nov-20	**12.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**16**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**15**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7.01	-0.01	5	4.99	0.01

Average	-0.0100	Average	0.0017
Std. Dev	0.0000	Std. Deviation	0.0133
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0094

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
14-Nov-20	**13.45hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01
8	7.99	0.01	1	0.99	0.01

Average	0.0000	Average	-0.0014
Std. Dev	0.0129	Std. Deviation	0.0146
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
15-Nov-20	**11.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01
8	7.99	0.01	1	0.99	0.01

Average	0.0000	Average	-0.0014
Std. Dev	0.0129	Std. Deviation	0.0146
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban**
Date:	Time:	Client:	
16-Nov-20	**11.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reason Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1500**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.98	0.02
3	2.99	0.01	6	6.01	-0.01
4	4.02	-0.02	5	4.99	0.01
5	4.99	0.01	4	4.01	-0.01
6	6	0	3	3.02	-0.02
7	6.98	0.02	2	1.99	0.01

	Average	0.0017	Average	0.0000
	Std. Dev	0.0147	Std. Deviation	0.0155
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0005

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban dam**
Date:	Time:	Client:	
17-Nov-20	**10.20hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.98	0.02
3	2.99	0.01	6	6.01	-0.01
4	4.02	-0.02	5	4.99	0.01
5	4.99	0.01	4	4.01	-0.01
6	6	0	3	3.02	-0.02
7	6.98	0.02	2	1.99	0.01

Average	0.0017	Average	0.0000
Std. Dev	0.0147	Std. Deviation	0.0155
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0005

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
18-Nov-20	**12.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				1490	11
Barcheck Frequency selected		Survey Frequency:		Manufacturer's Accuracy	
210		210		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01

	Average	-0.0017	Average	-0.0033
	Std. Dev	0.0133	Std. Deviation	0.0151
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
19-Nov-20	**14.45hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	8	7.98	0.02
4	3.99	0.01	6	6.02	-0.02
6	6.01	-0.01	4	4.02	-0.02
8	7.98	0.02	2	1.99	0.01

	Average	0.0025	Average	-0.0025
	Std. Dev	0.0150	Std. Deviation	0.0206
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0040

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
20-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	8	7.98	0.02
4	3.99	0.01	6	6.02	-0.02
6	6.01	-0.01	4	4.02	-0.02
8	7.98	0.02	2	1.99	0.01

	Average	0.0025		Average	-0.0025
	Std. Dev	0.0150		Std. Deviation	0.0206
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0040

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
21-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**15**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				1490	10
Barcheck Frequency selected		Survey Frequency:		Manufacturer's Accuracy	
210		210		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	2.99	0.01	9	8.98	0.02
4	3.99	0.01	8	7.99	0.01
5	5.01	-0.01	7	6.99	0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	3.99	0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	1.98	0.02
	Average	-0.0033		Average	0.0056
	Std. Dev	0.0100		Std. Deviation	0.0124
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0017

The Echosounder Barcheck Values are Negligible for Application

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
22-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	8	7.98	0.02
4	3.99	0.01	6	6.02	-0.02
6	6.01	-0.01	4	4.02	-0.02
8	7.98	0.02	2	1.99	0.01

	Average	0.0025	Average	-0.0025
	Std. Dev	0.0150	Std. Deviation	0.0206
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0040

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
23-Nov-20	**09.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01
8	7.99	0.01	1	0.99	0.01

Average	0.0000	Average	-0.0014
Std. Dev	0.0129	Std. Deviation	0.0146
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
24-Nov-20	**11.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**16**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**15**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7.01	-0.01	5	4.99	0.01

	Average	-0.0100		Average	0.0017
	Std. Dev	0.0000		Std. Deviation	0.0133
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0094

The Echosounder Barcheck Values are Negligible for Application

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
25-Nov-20	**13.10hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.01	-0.01	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01
8	7.99	0.01	1	0.99	0.01

Average	0.0014	Average	-0.0014
Std. Dev	0.0107	Std. Deviation	0.0146
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0028

The Echosounder Barcheck Values are Negligible for Application

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
30-Nov-20	**13.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.02	-0.02
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	6.01	-0.01	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01
8	7.99	0.01	1	0.99	0.01

Average	0.0014	Average	-0.0014
Std. Dev	0.0107	Std. Deviation	0.0146
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0028

The Echosounder Barcheck Values are Negligible for Application

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
01-Dec-20	**11.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.99	0.01
3	2.99	0.01	6	6.01	-0.01
4	3.99	0.01	5	4.99	0.01
5	5.02	-0.02	4	4.02	-0.02
6	6.02	-0.02	3	3.01	-0.01
7	6.99	0.01	2	1.99	0.01

	Average	-0.0033	Average	-0.0017
	Std. Dev	0.0151	Std. Deviation	0.0133
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0012

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
02-Dec-20	**12.00hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**11**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2	0	7	6.99	0.01
3	2.99	0.01	6	6.01	-0.01
4	3.99	0.01	5	4.99	0.01
5	5.01	-0.01	4	4.02	-0.02
6	5.99	0.01	3	3.01	-0.01
7	6.99	0.01	2	2	0
8	8.01	-0.01	1	0.99	0.01

	Average	0.0029	Average	-0.0014
	Std. Dev	0.0095	Std. Deviation	0.0121
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0019

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Boat-1**	**Madhuban Dam**
Date:	Time:	Client:	
03-Dec-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	8	7.98	0.02
4	3.99	0.01	6	6.02	-0.02
6	6.01	-0.01	4	4.02	-0.02
8	7.98	0.02	2	1.99	0.01

	Average	0.0025		Average	-0.0025
	Std. Dev	0.0150		Std. Deviation	0.0206
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0040

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

BOAT 2

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
11-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**15**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				1490	10
Barcheck Frequency selected		Survey Frequency:		Manufacturer's Accuracy	
210		210		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	2.99	0.01	9	8.98	0.02
4	3.99	0.01	8	7.99	0.01
5	5.01	-0.01	7	6.99	0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	3.99	0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	1.98	0.02

	Average	-0.0033	Average	0.0056
	Std. Dev	0.0100	Std. Deviation	0.0124
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0017

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
12-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Amit Singh		**Reson Navisound 215**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	7.99	0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	4.01	-0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	2.01	-0.01
	Average	-0.0078		Average	-0.0022
	Std. Dev	0.0067		Std. Deviation	0.0120
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0038

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
13-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**16**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.45				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7.01	-0.01	5	4.99	0.01
8	8.01	-0.01	4	4.01	-0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	2.01	-0.01
	Average	-0.0100		Average	-0.0022
	Std. Dev	0.0000		Std. Deviation	0.0120
				Cumulative Average	-0.01
				Cumulative Std. Deviation	0.0085

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
14-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**16**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**15**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7.01	-0.01	5	4.99	0.01

Average	-0.0100		Average	0.0017
Std. Dev	0.0000		Std. Deviation	0.0133
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0094

The Echosounder Barcheck Values are Negligible for Application

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
15-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**14**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**15**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7.01	-0.01	5	5.01	-0.01
8	8.02	-0.02	4	4.01	-0.01

Average	-0.0114	Average	-0.0029
Std. Dev	0.0038	Std. Deviation	0.0125
		Cumulative Average	-0.01
		Cumulative Std. Deviation	0.0062

The Echosounder Barcheck Values are Negligible for Application

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QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
16-Nov-20	**15.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**13**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				1490	15
Barcheck Frequency selected		Survey Frequency:		Manufacturer's Accuracy	
210		210		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7.01	-0.01	5	5.01	-0.01
8	8.02	-0.02	4	4.01	-0.01
9	9.01	-0.01	3	3.02	-0.02
10	10.01	-0.01	2	2.01	-0.01

Average	-0.0111	Average	-0.0056
Std. Dev	0.0033	Std. Deviation	0.0124
		Cumulative Average	-0.01
		Cumulative Std. Deviation	0.0064

The Echosounder Barcheck Values are Negligible for Application

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GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
17-Nov-20	**13.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**13**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**14**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.03 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2	0	10	9.99	0.01
3	3.02	-0.02	9	8.98	0.02
4	4.01	-0.01	8	8.01	-0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	7	0	5	5.01	-0.01
8	8.02	-0.02	4	4.01	-0.01

	Average	-0.0100	Average	-0.0029
	Std. Dev	0.0082	Std. Deviation	0.0125
			Cumulative Average	-0.01
			Cumulative Std. Deviation	0.0031

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
18-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	7.99	0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	4.01	-0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	2.01	-0.01

	Average	-0.0078		Average	-0.0022
	Std. Dev	0.0067		Std. Deviation	0.0120
				Cumulative Average	0.00
				Cumulative Std. Deviation	0.0038

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban Dam**
Date:	Time:	Client:	
19-Nov-20	**14.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**20**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**10**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.04 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	10	9.99	0.01
3	3.01	-0.01	9	8.98	0.02
4	4.01	-0.01	8	7.99	0.01
5	5.01	-0.01	7	7.01	-0.01
6	6.01	-0.01	6	6.01	-0.01
7	6.99	0.01	5	5.01	-0.01
8	8.01	-0.01	4	4.01	-0.01
9	9.01	-0.01	3	3.01	-0.01
10	10.01	-0.01	2	2.01	-0.01

	Average	-0.0078	Average	-0.0022
	Std. Dev	0.0067	Std. Deviation	0.0120
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0038

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
20-Nov-20	**10.20hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	2.01	-0.01	7	6.98	0.02
3	2.99	0.01	6	6.01	-0.01
4	4.02	-0.02	5	4.99	0.01
5	4.99	0.01	4	4.01	-0.01
6	6	0	3	3.02	-0.02
7	6.98	0.02	2	1.99	0.01

	Average	0.0017	Average	0.0000
	Std. Dev	0.0147	Std. Deviation	0.0155
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0005

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
21-Nov-20	**1.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	1.99	0.01	7	6.99	0.01
3	2.98	0.02	6	6.01	-0.01
4	4.01	-0.01	5	4.98	0.02
5	4.99	0.01	4	4	0
6	6	0	3	3.02	-0.02
7	6.99	0.01	2	1.99	0.01

Average	0.0067		Average	0.0017
Std. Dev	0.0103		Std. Deviation	0.0147
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0031

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
22-Nov-20	**11.00hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	1.98	0.02	7	6.99	0.01
3	2.99	0.01	6	6	0
4	3.99	0.01	5	5.01	-0.01
5	5.01	-0.01	4	4	0
6	6	0	3	3.02	-0.02
7	6.99	0.01	2	2.01	-0.01

	Average	0.0067	Average	-0.0050
	Std. Dev	0.0103	Std. Deviation	0.0105
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0001

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

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Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
23-Nov-20	**11.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	Upto Depth
0.4				1490	11
Barcheck Frequency selected		Survey Frequency:		Manufacturer's Accuracy	
210		210		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	1.99	0.01	7	7	0
3	2.98	0.02	6	5.99	0.01
4	4.01	-0.01	5	5.01	-0.01
5	5.01	-0.01	4	4.01	-0.01
6	6	0	3	3	0
7	7	0	2	1.98	0.02

	Average	0.0017	Average	0.0017
	Std. Dev	0.0117	Std. Deviation	0.0117
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0000

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
24-Nov-20	**1.00hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	1.98	0.02	7	6.99	0.01
3	2.99	0.01	6	5.99	0.01
4	4	0	5	5	0
5	5.01	-0.01	4	4.02	-0.02
6	6	0	3	3.02	-0.02
7	7	0	2	2.01	-0.01

Average	0.0033	Average	-0.0050
Std. Dev	0.0103	Std. Deviation	0.0138
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0024

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
25-Nov-20	**10.30hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	1.99	0.01	7	7	0
3	2.98	0.02	6	6	0
4	4.01	-0.01	5	5.01	-0.01
5	5	0	4	4.01	-0.01
6	6	0	3	3	0
7	6.99	0.01	2	1.99	0.01

	Average	0.0050	Average	-0.0017
	Std. Dev	0.0105	Std. Deviation	0.0075
			Cumulative Average	0.00
			Cumulative Std. Deviation	0.0021

The Echosounder Barcheck Values are Negligible for Application

GMPL Party Chief

GEOSERVICES MARITIME PVT. LTD.

QUALITY MANUAL AND PROCEDURE

Singlebeam Echosounder Barcheck Correction Table

Project No.	Project Title:	Vessel:	Place:
	Bathymetric Survey	**Aqua Marina**	**Madhuban dam**
Date:	Time:	Client:	
01-Dec-20	**10.00hrs**	**Water Resources Investigation division**	
Observed By:		Echosounder Model and SL. No.	Area Depth
Jomon mj		**Sonar Mite**	**10**

Echosounder Settings

Draft HI	Index "k" HI	Draft LO	Index "k" LO	Sound Velocity	
				Average	**Upto Depth**
0.4				**1490**	**11**
Barcheck Frequency selected		**Survey Frequency:**		Manufacturer's Accuracy	
210		**210**		0.20 % of Depth	0.02 m

Observations while lowering			Observations while hoisting		
Bar Depth (m)	ES Reading (m)	Difference (m)	Bar Depth (m)	ES Reading (m)	Difference (m)
2	1.99	0.01	7	7	0
3	3	0	6	5.99	0.01
4	4.01	-0.01	5	4.99	0.01
5	5.01	-0.01	4	4.01	-0.01
6	6	0	3	3	0
7	6.98	0.02	2	1.98	0.02

Average	0.0017	Average	0.0050
Std. Dev	0.0117	Std. Deviation	0.0105
		Cumulative Average	0.00
		Cumulative Std. Deviation	0.0009

The Echosounder Barcheck Values are Negligible for Application

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GMPL Party Chief

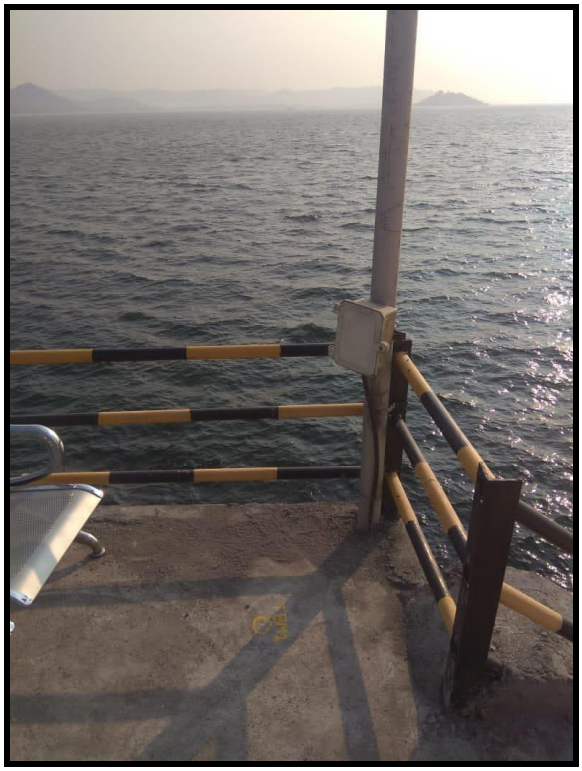
9 PHOTOGRAPHS

The following Photographs showing the Survey activities and features available at site

Level transfer from Top of Water Gauge to OBS MADHUBAN

Observation at OBS

RTK Base setup on OBS MADHUBAN



TBM 1

TBM 2

BASE SETUP AT TBM 3

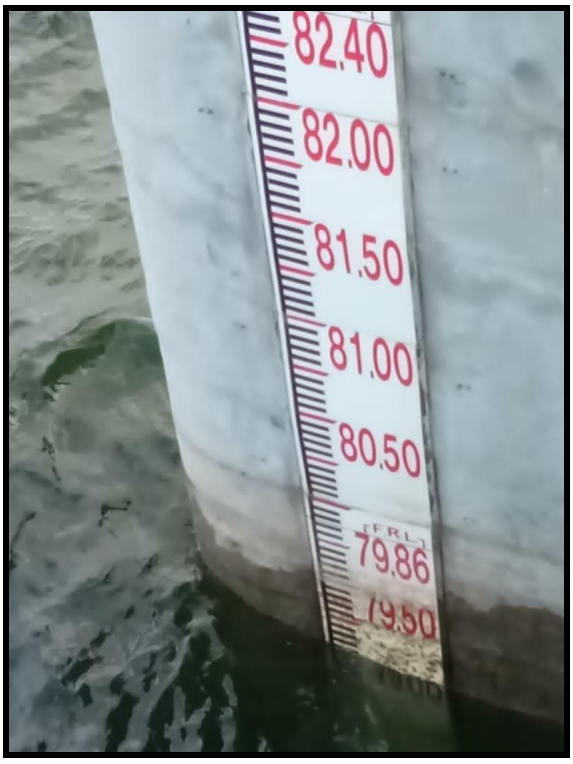
TBM 4

TBM 5

BASE SETUP AT TBM 6

BATHY SURVEY ON BOAT 1

BATHY SURVEY ON BOAT 2



WATER GAUGE

END OF REPORT