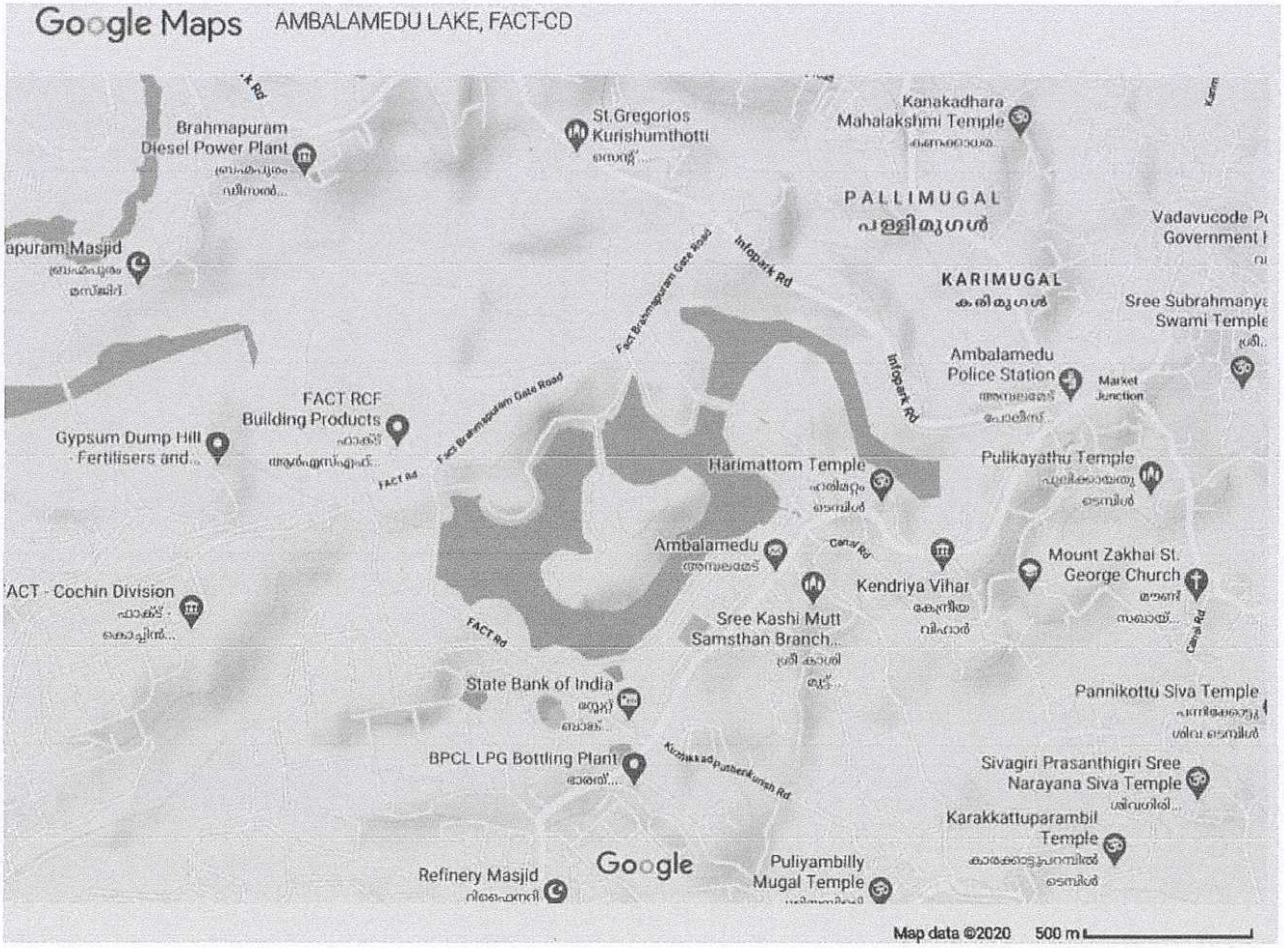
CORRIGENDUM

Sl No	Page No	Title	Reason for issuing corrigendum	Corrigendum
1	**Page No. 58 & 59**	**Annexure C & D**	The annexures were missing in the soft copy of RFS uploaded along with tender documents.	Missing pages 58 & 59 (Annexure C & D) are published separately. The documents shall be read in conjunction with the RFS Documents.
2	**New**	**Bathymetry Survey Reports**	Queries by probable bidders seeking for bathymetry survey reports in pre-bid meeting and by email. Hence, the reports and drawings of tests conducted by FACT-CD is published.	The bathymetry survey report and attached documents conducted by FACT is published for bidder's reference. The reports shall be used only for reference purpose for bidding. Any survey required for installation and commissioning the project shall be under the scope of the bidder.
3	**New**	**Indicative Cable Route**	Queries from probable bidders regarding cable route for power evacuation	Indicative cable route for power evacuation is issued.

ANNEXURE C: SITE DETAILS



Location Latitude & Longitude: **9°59'05.0"N 76°23'03.2"E**

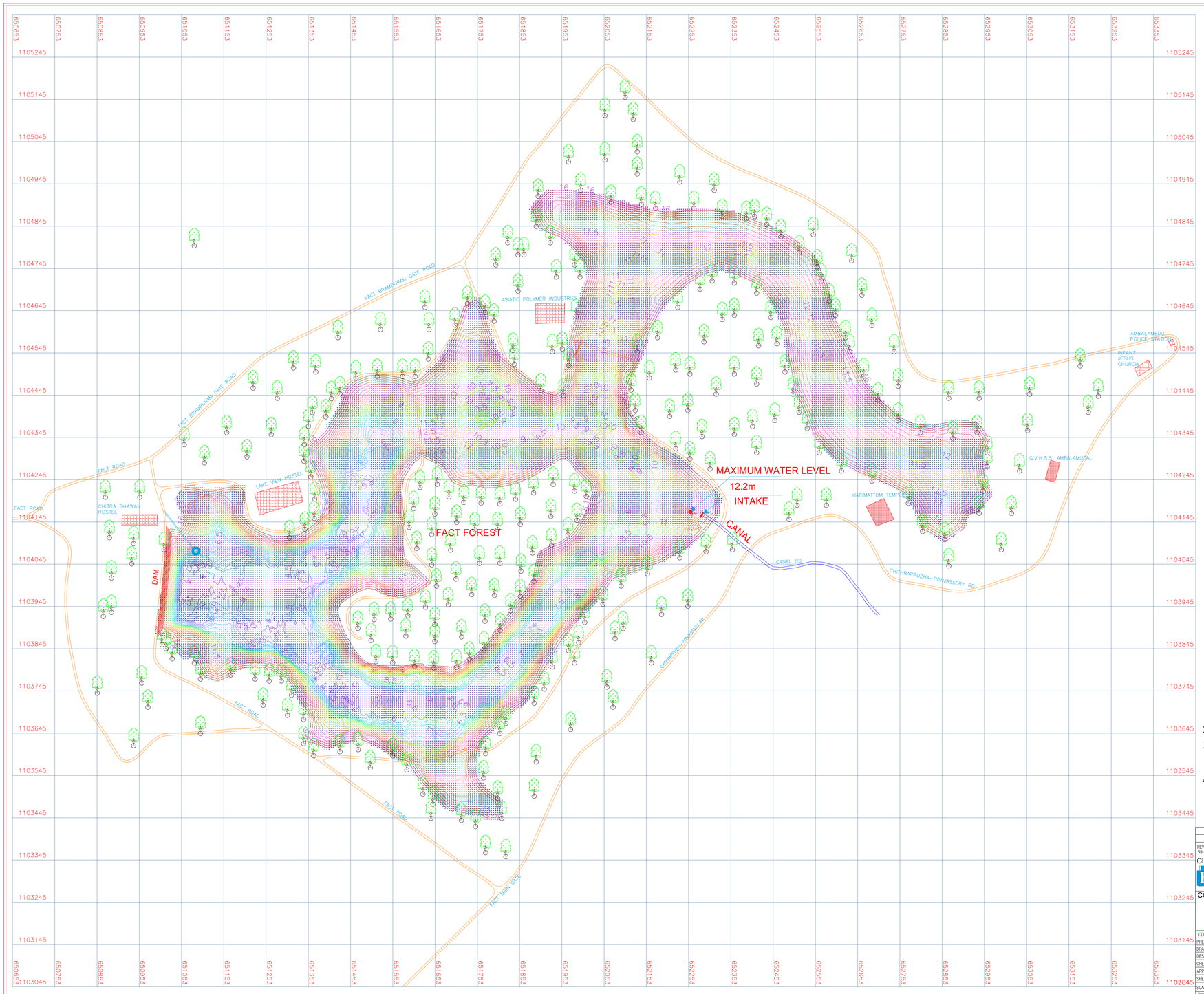
ANNEXURE D: BILLING SCHEDULE FOR SOLAR GENERATION

The following shall be the method of preparation of Annual Bill for the solar electricity generated and supplied to FACT during an operational year of 12 months. The payment will be effected monthly, based on a Projected Annual Bill (PAB) prepared progressively over the 12-month period. The methodology followed for preparation of PAB shall be as per the table given below:

Sl. No	PAGE Deviation from GAGE, %	Annual Billing for Generation of Electricity (PAB/ Actual Annual Bill)				Remarks
		Base Element of Annual Payment (A), ₹	Element of Bill for Excess Generation (B), ₹	Deduction for Shortfall in Generation (C), ₹	Total Annual Receivable (P), ₹ (A + B – C)	
1.	PAGE < 75%	PAGE x PRE	NA	(GAGE – PAGE) x PRE x 0.40	A - C	Shortfall is penalised at 40% of PRE
2.	75 < PAGE < 90	PAGE x PRE	NA	(GAGE – PAGE) x PRE x 0.35	A – C	Shortfall is penalised at 35% of PRE
3.	90 < PAGE < 96	PAGE x PRE	NA	(GAGE – PAGE) x PRE x 0.25	A – C	Shortfall is penalised at 25% of PRE
4.	96 < PAGE < 104	PAGE x PRE	NA	NA	A	Normal acceptable range of generation
5.	104 < PAGE < 110	PAGE x PRE up to 104% of GAGE	(PAGE – 1.04 x GAGE) x PRE x 0.98	NA	A + B	Excess up to 110% of GAGE gets a payment at 98% of PRE
6.	PAGE > 110	PAGE x PRE up to 104% of GAGE	0.06 x GAGE x PRE x 0.98	NA	A + B	Excess over 110% gets no payment

Legend:

a. PAGE: Projected Annual Generation of Electricity (As calculated monthly, considering average monthly generation)
b. GAGE: Guaranteed Annual Generation of Electricity (Quoted by the bidder during tender submission)
c. PRE: Purchase Rate of Electricity (Quoted by the bidder during tender submission)



N

W E

S

S.No.	Water Level (m)	Area (Sqm)	Volume (Cum)	Remarks
1	14.85	956,956	4,640,441	
2	14.5	927,657	4,307,807	
3	13.5	835,377	3,426,721	
4	12.5	746,732	2,476,481	
5	11.5	655,463	1,558,586	
6	10.5	341,968	1,058,556	
7	9.5	259,639	745,102	
8	8.5	201,112	506,150	
9	7.5	168,953	319,778	
10	6.5	129,263	171,117	
11	5.5	82,425	65,443	
12	4.5	32,230	11,138	

LEGEND

TBM	
Reservoir Boundary	
Houses	
Bore Hole	
Gauge post	
Pillar	
Fungus Grass	
Electric line	
Road	
Cart track	
River/Drain	

Note:-

1. All Dimensions are in meter Otherwise define
2. Grid Level Intervals 5x5m
3. Survey has been done in Reference to CORS Network Established by Survey of India
4. The Maximum Water Level has been considered as 14.853m, Corresponding to Top of Gauge as Established Near Intake Canal Structure

REV. No.	DATE	MECH.	CIVIL	ELEC.	RE	DESCRIPTION
		CHECKED				

CLIENT: THE FERTILISERS AND CHEMICALS TRAVANCORE LIMITED

CONSULTANT : THE DESIGNERS CONSORTIUM

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Ph: 0120 4176259, 9958233117
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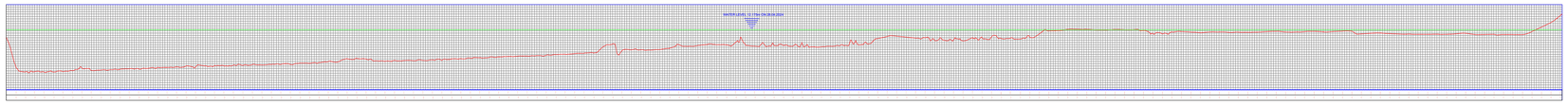
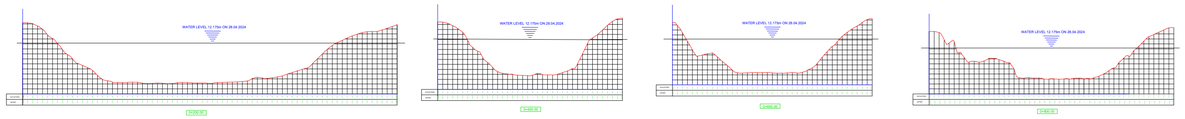
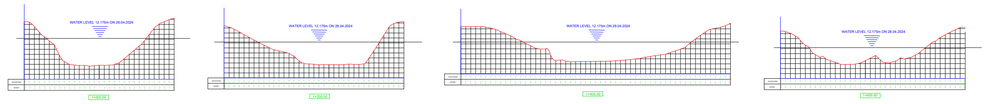
CONTRACT NO :		PROJECT :	HYDROSTATIC STUDY SURVEY & CAPACITY ANALYSIS FOR AMBALAMEDU RESERVOIR
PREPARED	NAME	DATE	
DRAWN BY	AS	06.05.24	
DESIGNED BY	RS	06.05.24	DRAWING TITLE : CONTOUR AND GRID LEVEL TOPOGRAPHICAL SURVEY PLAN
CHECKED BY	AK	06.05.24	
APPROVED BY			
SHEET SIZE	A1		DRAWING NO : DC/FACT/LAKE/FLT/01
SCALE	1:4000		REV. 00 / SHEET 01

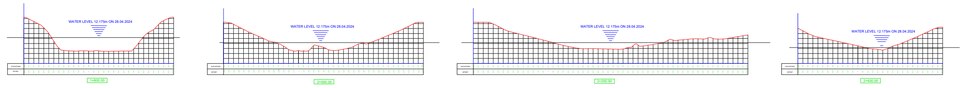
Station

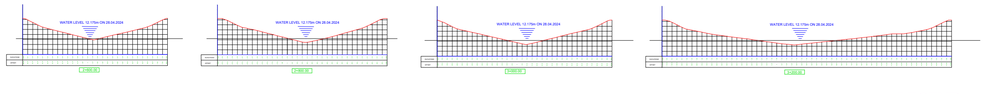
Alignment 01 PROFILE



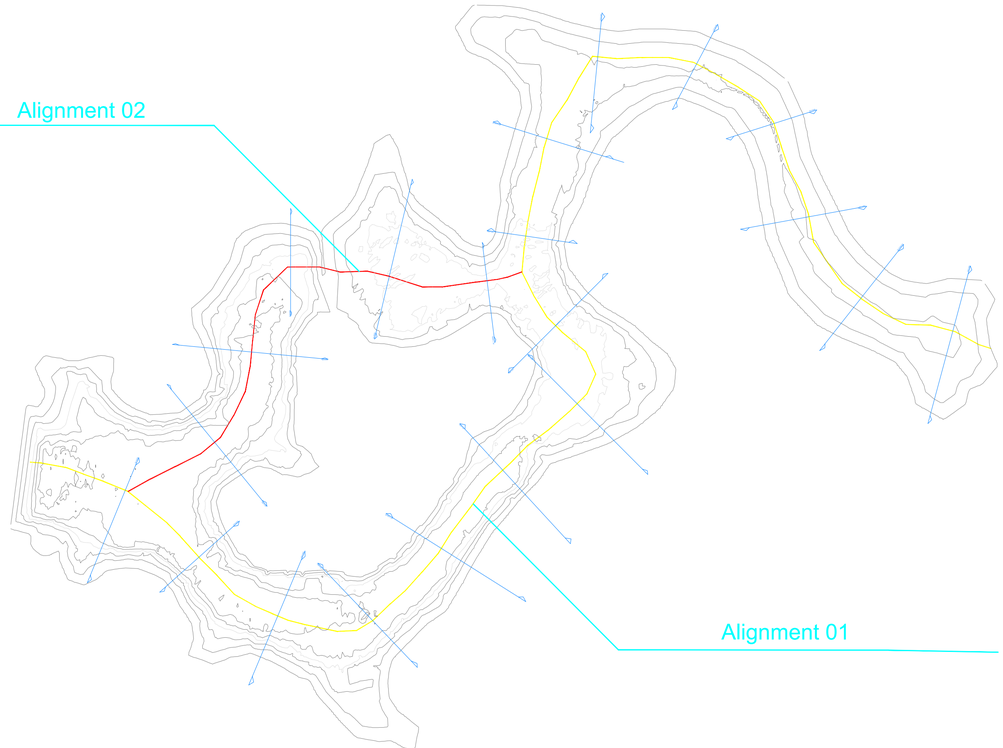








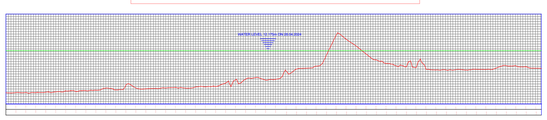
Alignment 02

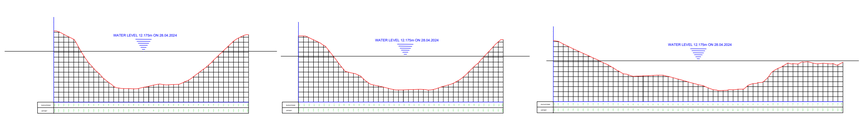


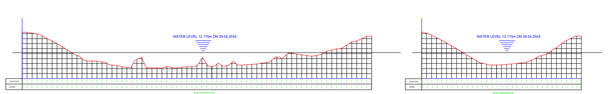
Alignment 01

Station

Alignment 02 PROFILE







LEGEND

TBM	
Reservoir Boundary	
Houses	
Bore Hole	
Gauge post	
Pillar	
Fungus Grass	
Electric line	
Road	
Cart track	
River/Drain	

Note:-

1. All Dimensions are in meter Otherwise define
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3. Survey has been done in Reference to CORS Network Established by Survey of India
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DRAWN BY	AS	06.05.24	
DESIGNED BY	RS	06.05.24	DRAWING TITLE : LONGITUDINAL & CROSS SECTIONAL PROFILE OF AMBALAMEDU RESERVOIR
CHECKED BY	AK	06.05.24	
APPROVED BY			
SHEET SIZE	A1		DRAWING NO : DC/FACT/LAKE/FLT/03
SCALE	1:4000		REV. 00 / SHEET 01

THE FERTILISERS AND CHEMICALS TRAVANCORE LIMITED

REPORT ON HYDROSTATIC SURVEY AND CAPACITY ANALYSIS FOR AMBALAMEDU RESERVOIR AT FACT COCHIN DIVISION, KOCHI, KERELA

Doc No. TDC/FACT/AMB/01
Date: 08.05.2024
Rev. 01

Survey Consultants

THE DESIGNERS' CONSORTIUM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ANNEXURES

LIST OF ACRONYMS

ATG	:	Automatic Tide Gauge
CD	:	Chart Datum
CM	:	Central Meridian
Ch	:	Channel
CVT	:	Calibration, Verification & Test
CWC	:	Central Water Commission

CWC	:	Central Water Commission
DGPS	:	Differential Global Positioning System
DF	:	Dual Frequency
DPR	:	Daily Progress Report
DS	:	Disturbed Soil Samples
GPS	:	Global Positioning System
HSE	:	Health, Safety and Environment
kHz	:	Kilohertz
km	:	kilometer
KP	:	Kilometer Post
m	:	meter
m/s	:	meter per second
ms	:	milliseconds
MP	:	Multi-Purpose
QA/QC	:	Quality Assurance / Quality Control
QMS	:	Quality Management System
Rel	:	Release
Rev	:	Revision
SBES	:	Single Beam Echo Sounder
SOI	:	Survey of India
SoW	:	Scope of Work
Sr	:	Senior
UDS	:	Undisturbed Soils Samples
UTM	:	Universal Transverse Mercator
WGS	:	World Geodetic System
WRD	:	Water Resource Department

UNITS

UTM grid coordinates and all linear measurements are expressed in meters [m].

Angular values are expressed in degrees (°).

Time and dates are expressed as “18:00 on 25 March 2010”

EXECUTIVE SUMMARY

With the increasing demand of solar energy generating capacity, floating solar PV plants provide new opportunities for scaling up solar energy generating capacity, specifically where high population density and land are the major constraints. Having advantage of potentially better energy yield due to cooling effect of water and presence of low dust, floating solar PV plants are now dominating over ground-mounted PV plants in areas where use of land and constructability are the major concerns.

In an effort to further to the cause, FACT has decided to setup a floating solar power plant at Ambalamedu Reservoir in Kochi district of Kerela.

In view of the above, it is proposed to conduct a hydrostatic survey and capacity analysis of its reservoir to determine the available depth of water to get the bed level contours information of the waterbed and alongside the banks of the reservoir to plan and design suitable floating solar power platforms & total installation capacity.

The findings of hydrographic survey in the form for contour drawings is enclosed in the report and based on the same the feasibility of installation capacity is planed & calculated and produced below:

CAPACITY OF AMABALAMEDU RESERVOIR		
Dam Details		
Top of Dam Elevation	16.50	m
Max Water Level (MSL) (Top of Gauge)	14.85	m
Submergence Area at Max Water Level	95.7	Hec
Gross Storage Capacity at Max Water Level	4.64	mcm
Lowest Reservoir Bed Level (MSL)	3.42	m

1. INTRODUCTION

1.1. Background

Solar is one of the best choices among all renewable energy sources. It is not as heavy in terms of the capital costs as tidal and geothermal (and much less risky); it is simple, but, unlike wind and waves, quite predictable. The change is already happening. From utility-scale grid-connected solar PV plants, solar-powered airports, railways, temples and cricket stadiums, to tiny villages with no electricity access, we are seeing cost-efficient and environmentally friendly solar power projects springing up everywhere.

India, being a tropical country, is blessed with good sunshine over most parts, and the number of clear sunny days over the year is also quite high. As per the Ministry of New and Renewable Energy (MNRE), Government of India (GoI), the country receives solar energy equivalent of more than 5000 trillion kWh per year with a daily average solar energy incident varying from 4.0 to 7.0kWh/m2 depending upon the location. India's equivalent solar energy potential is about 6000 million GWh of energy per year. The hot and dry climatic regions in the country have the best solar radiations with around 300 sunny days; which makes these the appropriate locations for harnessing solar energy.

With the increasing demand of solar energy generating capacity, floating solar PV plants provide new opportunities for scaling up solar energy generating capacity, specifically where high population density and land are the major constraints. Having advantage of potentially better energy yield due to cooling effect of water and presence of low dust, floating solar PV plants are now dominating over ground-mounted PV plants in areas where use of land and constructability are the major concerns.

With a vision *"To build 'Green India' through harnessing abundant solar radiation and to achieve energy security for the country"*, The Fertilisers and Chemicals Travancore Limted (FACT) a public sector unit has taken initiative to promote and scale up solar energy generating capacity throughout the country through floating solar power plants.

In an effort to further to the cause, FACT has decided to setup a floating solar power plant at Ambalamedu Reservoir in Kochi district of Kerela.

The Designers Consortium has been engaged by FACT as the Survey Consultant (hereinafter, the "Consultant" or TDC) carry out site related survey for general information about topographical and hydrographical characteristics of the proposed reservoir area along for analysis of an efficient and economical installation of floating solar PV plant at proposed reservoir.

In view of the above, it is proposed to conduct a hydrostatic survey and capacity analysis of its reservoir to determine the available depth of water.

Specially equipped vessels, measuring gauges and instruments, skilled man powers were involved to complete the survey. Quality control, processing and preliminary data interpretation was undertaken in the field for ensuring that the survey scope and specifications are fully complied with.

Intent of this report is to describe the scope of services, methodologies adopted for collecting the data, interpretation and reporting of the results obtained from the survey.

1.2. Objective

The aim of these studies shall be to get the bed level contour information of the waterbed and alongside the banks of the reservoir to plan and design suitable foundation systems like pile, anchor etc.

The purpose of the hydrographic survey is to prepare the bed contour plans at specified contour interval with reference to Datum level, collection of data for depth of water and capacity assessment.

1.3. Scope of Services

The scope of services includes carrying out detailed hydrographic survey at Ambalamedu Dam reservoir for installation of floating solar PV projects in the State of Jharkhand. In summary, the scope comprised of, but not limited to the following:

- Reservoir Capacity Assessment: Determining the maximum storage capacity of the reservoir with respect to the maximum water level marked by accurately measuring its dimensions and using appropriate calculation methods.
- Depth Profile Analysis: Conducting a detailed survey to establish the depth profile of the reservoir at various points. This will involve taking measurements at regular intervals to create a comprehensive depth profile map.
- Area Calculation at Present Water Level and max water level: Estimating the area covered by the reservoir at the present water level as well as the maximum water level. This will involve mapping the respective shoreline and calculating the areas using precise surveying techniques.

1.4. Site Location

FACT Cochin Division reservoir is situated at Ambalamedu 8km from Tripunithura, Ernakulam.

To meet the high demand of water in manufacturing fertilizer, over 250 acres (1 km²) of paddy fields were converted into a lake by constructing an earthen dam and water brought in through a canal from Bhoothathankettu dam, near Kothamangalam.

The co-ordinates (in Latitude and Longitude) of the site are 9°59'4.31"N 76°22'46.00"E. The Ambalamedu Dam is said to cover an area of approximately 150 acres of land.

Figure 1: Google image of Ambalamedu Reservoir

Figure 2: Glimpse of Ambalamedu Reservoir Area

1.5. Climate

The climate here is tropical. Ernakulam has significant rainfall most months, with a short dry season. According to Köppen and Geiger, this climate is classified as Am. In Ernakulam, the mean yearly temperature amounts to 26.5 °C | 79.8 °F. Approximately 2882 mm | 113.5 inch of rainfall occurs on a yearly basis.

The mean monthly maximum temperature ranges from 28.1 to 31.4oC and the minimum ranges from 23.2 to 26 oC. The maximum temperature occurs during March and April months and the minimum temperature occurs during December and January months.

The district receive on an average 3359.2 mm (based on 1901-99 data) of rainfall annually. The annual rainfall ranges from 3233 to 3456 mm at different places of the district.

The wind speed ranges from 6.7 to 10.9 km/hour with mean speed of 9.1 km/hour. The wind speed is high during the period from March to September.

1.6. Geology

Geologically two distinct lithounits are discernible in the area. The eastern part is occupied by hard rocks representing Precambrian metamorphosed rocks while the coastal tract in the west is covered by soft rock or the unconsolidated coastal alluvium. Major part of the district is occupied by charnockite and moigmatite groups of rocks of Precambrian age. The charnockite group is composed of pyroxene granulite, magnetite quartzite and charnockite. Charnockite, which is very widely distributed, is coarse-grained, granulitic and dark coloured. Pyroxene granulite and magnetite quartzite occur as linear bands. Calc-gneiss and quartzite of khondalite group are the oldest rocks of the area and they are seen as linear lensoidal bodies within the charnockites. The migmatite group includes biotite gneiss and quartzofeldspathic gneiss which are next to charnockite in abundance. These older rocks are intruded by both acid (syenite) and basic (gabbro and dolerite) intrusive. Patchy outcrops of Warkalli beds, consisting of pebble bed, grit, friable sandstone and variegated clay is seen in the western part around Edappalli, kalamasseri areas. Both the Warkalli beds as well as the basement rocks are subjected to intense lateritisation, which is confined to the midland region only. The coastal tract

is covered by Quaternary sediments like beach sand, palaeo-beach ridge deposits (sand), flood plain deposits (sand, silt, clay) and tidal deposits (clay, mud).

1.7. Geomorphology & Physiography

The district is divisible into three physiographic zones as (i) the coastal plains in the west, the midland region in the east and the steep to very steep hills in the easternmost part. The coastal plain is a low lying area, with a maximum elevation of around 10m towards the eastern part, characterised by backwater bodies, marshy lands, sandy flats and alluvial plains, which are liable for flooding during the monsoon. The midland region has a rolling topography with low hills and narrow valleys. The hills are generally covered with laterite or lateritic soils and the valleys are alleviated. The region has a very gentle to moderate slope from east to west. The easternmost part is a rugged terrain with steep sloped hills and small summits. It actually forms the foothills of the Western Ghats. Elevation of this terrain is generally more that 300m above mean sea level. As the area is covered by forest soil, thick forest and cultivation of cash crops like rubber and pepper can be seen in the area

1.8. Soils

On the basis of morphological features and physico-chemical properties, the soils of the district are classified as Lateritic, Hydromorphic saline, Brown hydromorphic, Riverine alluvium and Coastal alluvium.

Lateritic soil is the most predominant soil type of the district. In Muvattupuzha, Kothamangalam, Kunnathunadu and parts of Aluva taluks lateritic soil is encountered. These soils are well drained, low in organic matter and plant nutrients. The major crops grown are coconut, tapioca, rubber, areacanut, pepper, cashew and spices. Small patches of hydromorphic saline soil are encountered in the coastal tracts of the district in Kanayannur and Cochin taluk. The tidal backwaters contribute to the salinity of the soil. Coconut is grown in these soils.

Brown hydromorphic soil is the second most prevalent soil type of the district and they are encountered in valley bottoms. The soil is enriched in clay content and plant nutrients. The soil is suited for paddy cultivation.

Riverine alluvium is restricted to the banks of rivers and their tributaries. They are composed of sandy to clayey loam and are enriched in plant nutrients. It is suited for a large variety of crops like coconut, paddy arecanut, pepper, vegetables etc. In Cochin taluk and the western parts of Paravur and Aluva taluk coastal alluvium is encountered and is composed of sand and clay. Coconut is the major crop in these soils.

2. HYDROLOGY STUDY

2.1. Salient Feature of Ambalamedu Dam

Parameter	Value
Location	
Longitude	9°59'4.31"N
Latitude	76°22'46.00"E
Top of Dam (RL) (MSL)	16.50m
Max Water Level (MSL) (Top of Gauge)	14.85m
Submerged Area at Max Water Level	95.7 Hec
Gross Storage Capacity at Max Water Level	4.64 mcm

Table 1: Salient features of Ambalamedu Reservoir

2.2. Water Gauge

The maximum water level has been considered as 14.853m, corresponding to top of Gauge as established by the authorities near the intake canal structure.

Figure 3: Water Level Gauge at Ambalamedu Dam

3. HYDROGRAPHIC SURVEY

The survey work was conducted in accordance with the specifications and scope of work which comprised of topographical survey of reservoir banks using DGPS and bathymetry survey of water bound area using single beam echosounder, the details of which is narrated in following paragraphs.

Figure 4: Bathymetric Survey in progress

3.1. Equipment

Following equipment and systems were mobilized for the survey work.

Equipment / System	Description / Make / Model / Resolution /Accuracies
Software / Navigation	Hypack Ver 1.18' and 'Topcon Magnet Ver 4.0' PC based data acquisition and survey boat navigation package
Positioning	TOPCON Hyper-V DGPS system with 226 channel Dual Frequency GPS System + associated consumables and spares. Differential correction signals were provided from TOPCON worldwide network
Single beam Echo Sounder	Seafloor HydroLite-DFX Ping Rate 6Hz dual frequency echo sounder recorder Dual Frequency (33 / 210 kHz Transducer)
Land Survey	TOPCON Hyper-V DGPS system with 226 channel Dual Frequency GPS System + associated consumables and spares. Differential correction signals were provided from TOPCON worldwide network

Table 2: List of Survey Equipment

3.2. Survey Operation

3.2.1. Mobilization

The survey equipment was mobilized at site on 26th of April 2024 and the bathymetric survey equipment were set up on board on 27th April 2024. After calibration of all survey equipment, the hydrographic survey of the reservoir was commenced from 27th April 2024.

3.2.2. Reconnaissance

A reconnaissance survey was carried out before the starting of the actual survey work to ascertain the traverse station, location of benchmark for carrying the level to project site, location for fabrication of grid & reference pillars etc. Other available drawings / maps were also collected during reconnaissance.

A survey plan was completed prior to conducting field work. This process ensured the most efficient use of survey time in the field, helped avoid missing data, and minimized the collection of overlapping or redundant data.

3.2.3. Geodetic and Projection Parameters

The survey was conducted in WGS84 Datum and the results were plotted in Universal Transverse Mercator (UTM) Projection. Details of Spheroid and Grid system used for this survey are as follows:

Global Positioning System Geodetic Parameters	
Datum: Spheroid: Semi major axis: Flattening:	World Geodetic System 1984 (WGS84) World Geodetic System 1984 a = 6 378 137.000 m Inverse 1/f = 298.257 223 563
Local Datum Geodetic Parameters	
Datum: Spheroid: Semi major axis: Inverse Flattening:	World Geodetic System 1984 (WGS84) World Geodetic System 1984 a = 6 378 137.000 m 1/f = 298.257 223 563
Datum Transformation Parameters from WGS84 to WGS84	
Shift dX: Scale Factor: Shift dY: Shift dZ:	0.0 m Rotation rX: 0.000 arcsec 0.0000 ppm 0.0 m Rotation rY: 0.000 arcsec 0.0 m Rotation rZ: 0.000 arcsec
Local Projection and Grid Parameters	
Map Projection: Grid System: Central Meridian:	Universal Transverse Mercator UTM Zone 43 P 084° 00’ 00” East

Global Positioning System Geodetic Parameters	
Latitude of Origin:	0° 00’ 00” North
False Easting:	500 000 m
False Northing:	0 m
Scale factor on Central Meridian:	0.9996
Units:	Meter

Table 3: Geodetic Parameters

3.2.4. Control of Survey

3.2.4.1. HORIZONTAL CONTROL

In general, traversing or triangular or combination of the both methods is adopted for the purpose of establishing horizontal control and to determine the exact relationship between various existing points on the ground. The horizontal control at site for onward progress of survey work was based using CORS network established by Survey of India.

Continuously Operating Reference Station (CORS) is an infrastructure that can solve the problem of accuracy and real-time data acquisition. CORS network is geodetic quality GNSS receivers and antennas that are permanently installed at a Reference Station (RS) having very accurately pre-determined coordinates.

Survey of India has established a network of Continuously Operating Reference Stations (CORS), which not only capable of providing Real Time Positioning Service through RTK/NRTK with an accuracy of ±3cm, but also host an array of different positioning services targeted to cater requirements for different segments of Geospatial and scientific Community.

Origin of Survey

Prior to commence the survey, the horizontal control was established on CORS network using duel frequency DGPS with UTM (GPS) coordinate of so that all the coordinates of the proposed area to be surveyed can be well connected with Google or any other maps available in UTM coordinate system.

Vessel Positioning

RTK DGPS Positioning System was used for positioning the survey vessel during this survey. Navigation of the survey vessel was controlled by TOPCON Field Magnet TAB based system software.

3.2.4.2. VERTICAL CONTROL

The reduced Level (elevation) is established using Differential Global Positioning System by taking continuous ready for 2 hours of the base point and is considered as reference for the vertical control of this study. Accordingly, other bench marks are established as per standard method for this both bathymetric as well topographic survey.

3.2.4.3. CHART DATUM

A chart datum is generally a tidal datum; that is, a datum derived from some phase of the tide. Common chart datums are lowest astronomical tide and mean lower low water. However, as the proposed project area is not being govern by any tidal data rather the reservoir water level.

3.2.5. Calibration of Survey Equipment

All survey equipment used for the survey were calibrated and bench tested prior to their mobilization for this task. In addition, after installation of these equipment on the survey vessel, extensive calibration, verification and tests were carried out in the field and results were recorded in standard mobilization report, before the survey equipment were deployed for data acquisition. Standard survey methods were used for carrying out these calibrations, as described in the following sections.

The results of field calibrations / verifications obtained for the survey equipment were recorded in the mobilization report.

3.2.5.1. DGPS CALIBRATIONS

The DGPS systems was bench tested against a known point at workshop, prior to mobilization on to the survey vessel, and found to be satisfactory.

3.2.5.2. SINGLE BEAM ECHOSOUNDER

Seafloor HydroLite-DFX dual frequency single beam echo sounder, with transducer operating at 33 kHz & 210 kHz frequencies was used for measuring water depths. Bar check calibration were carried out on a regular basis daily two times, one in morning and one in evening for the entire duration of bathymetry survey. Digitized data was confirmed by inspection of analogue records. The summary of the results of 'Bar check' is produced at ***Annexure 'B'.***

The offsets of the echo sounder transducer from Central Reference Point on the survey vessel were measured, recorded and reported in the mobilization report. On completion of successful Mobilization, Calibration, Verification, and Testing of all equipment as per the relevant work practices, the bathymetry survey task was commenced.

3.2.6. Setting Up

The first step is to attach the transducer bracket to the vessel. When mounting the bracket, a location on the starboard side of the motor between the ribs and away from any other obstructions to normal water movement was chosen. Bracket was adjusted, so that the bottom of the transducer is situated parallel (or in the same plane) to the water surface and extends slightly below (~1 cm) the hull. It is critical that the transducer should be mounted at the proper angle to ensure accurate readings. Before launching the boat, transducer and bracket was removed to avoid any damage due to obstruction. After launching the boat, transducer was placed in water after rubbed the bottom surface of the transducer to remove air bubbles and then clamped the bracket in location on the vessel. It was ensured that the transducer is mounted in its correct position.

GPS stand or antenna was clamped to the vessel at a convenient location at the back / side of the boat, near the transducer. Portable computer / tablet was the screen, through which the survey can been seen and accessible during navigation. Since this screen was the primary navigation aid, hence it must be clearly visible from the driver's seat. The 12-volt marine batteries were placed in a convenient location near the middle of the boat to help distribute weight.

General setup of the hardware were chosen depending on the size and style of the boat and the type of equipment used. Figure below provides an example of a typical hardware setup for bathymetric data collection.

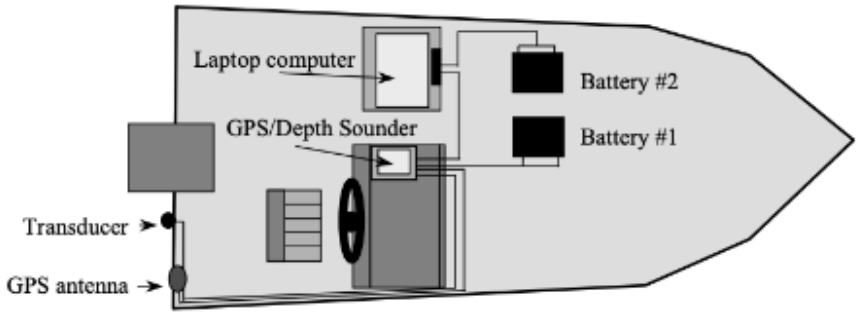


Figure 5: Typical hardware setup for Bathymetric survey

3.2.7. Data Acquisition and Quality Control

3.2.7.1. SAMPLING METHODS

Safety and potential water spray / humidity to sensitive electronic equipment are important factors that must be considered in the daily planning of a survey. Rough water can also affect the operation of the depth sounder. It may cause turbulence which could cause loss of signal or result in erroneous readings due to pitching or rolling of the boat which affects the angle of the signal. It is recommended that not attempt to conduct a bathymetry survey if wave height (trough to crest) exceeds 0.5 meters.

On large waterbodies it may be necessary to divide the survey area into many sections. These should be small enough to allow for complete sampling coverage of a section in a given day. Typically, a survey crew should be able to cover around 100 ha area in one day. However, areas with complex shorelines, numerous islands, critical local issues and widely deviating bathymetry may require more time. Water levels in reservoirs, and particularly in rivers, may fluctuate naturally depending on the season. Although not entirely necessary, it is recommended that once a bathymetry survey is started, sampling should continue to ensure completion within the same general timeframe/season. This will help minimize corrections that may be required to compensate for changing water levels. Also, river systems with hydro-electric development(s) can fluctuate significantly even within periods as short as an hour. The water level at the time of sampling should be compared to a local benchmark in order to ensure consistent sampling when gathering data over extended periods of time or in areas where short-term

fluctuations may occur. This benchmark should be noted for further reference. The bathymetry survey uses a systematic approach to sampling which involves a combination of shoreline perimeter cruises and cross-reservoir transects.

Figure 6: Example of bathymetry data collection pattern showing shoreline cruises and offshore transects

3.2.7.2. SURVEY LINE KEEPING

Following the information gathered (including historical water level) during the site visits conducted end of April 2024, and preliminary analysis has been further performed based on historical bathymetric survey. This analysis has been done for the bathymetric survey of grid sizing 5mx5m for the proposed FSPV site of Ambalamedu Reservoir. During the measurement, the vessel will travel along the north-south track capturing continuous data, while the traversal distance between each north-south track will be 10m. From the captured data, a data with grid size of 10mx10m will be generated, including post-processing data of at least 2 measurement points for each meter along the north-south track.

Hence, digital pre-plots of survey lines with a grid of 10mx10m of the reservoir were prepared prior to commencement of survey. Additional survey lines were also considered longitudinally with a spacing of 100m for the quality control of the cross-sectional data. These lines were shown on the navigational computer all the time during entire duration of the survey to guide the survey vessel to navigate properly along the planned survey line only.

3.2.7.3. ONLINE DATA QUALITY CONTROL

The online navigation computer was interfaced to the Topcon's server system to provide regular navigation updates and fix annotation strings. All computers connected to the navigation network were synchronized with the GPS (high precision) 1 PPS time signal by means of the Topcon's Timing Module, allowing all data to be time stamped. The quality of echosounder data being recorded was

constantly monitored in real time and fine-tuned to obtain the best quality data. The data was logged in raw format for replay under various parameters required. In addition to this, the side scan sonar data were recorded in XTF for immediate availability of the data for interpretation.

Navigation

The DGPS system performed well during entire duration of the survey. The performance of the TOPCON DGPS system was continuously monitored using the TOPCON's field Magnet navigation suite.

Echo Sounder

Seafloor HydroLite-DFX dual frequency single beam echo sounder performed well throughout the duration of the survey.

3.2.7.4. PROCESSING OF DATA

The survey data pertaining to the bathymetry survey was logged using Hypack and Magnet module, which was further processed in Hypack software. The topographical data was processed and interpreted in AutoCAD Civil3D software. Hydrographical and topographical survey data were finally presented in drawing form using the Auto CAD for presentation purpose.

3.2.7.5. QUALITY ASSURANCE AND HSE PROCEDURE

HSE is fully documented and duly audited Quality Assurance and Health, Safety and Environmental System procedures are in place. The same were followed during all surveying tasks undertaken by the company.

Competent field survey staffs were provided by the company to constantly monitor data quality as the survey progressed, and duly documented.

3.2.7.6. DEMOBILIZATION

Upon completion of all survey activities, equipment and all survey sensors were retrieved, and the vessels were demobilized on 29th April 2024.

3.2.8. Survey Data Processing

The survey data were logged in .csv format and processed using the Civil 3D software. Position data were processed and checked to ensure good data quality. The position data for the various geophysical instruments were processed and plotted to allow commencement of the interpretation of the geophysical data.

3.2.8.1. NAVIGATION AND POSITIONING

The measured offsets for all survey sensors were entered into the navigation software system and processed using Hypack software to enable charts to be plotted and corrected navigation files to be integrated with other sensor data during post processing.

These included:

- Absolute GPS position of the primary positioning system
- Common Reference Point
- Single beam echo sounder
- Side scan sonar layback derived position

3.2.8.2. BATHYMETRY

Hypack and Topcon's Magnet was used to import and process the navigation, bathymetry, water gauge and sound velocity data to the expected quality. The data was filtered, cleaned, and combined to create geographically positioned bathymetric data set that has been corrected for water level variation and sound speed.

3.2.8.3. LAND SURVEY

With the DGPS spot levels both in plan and elevation of all natural and artificial features of the area like pipe lines, waterways, trees, structures, houses, fences, road, tracks, drains including culverts and crossings, foot tracks, other permanent objects like electric posts, watch towers, etc. were taken and recorded in the electronic field book of instrument.

Data from total station were progressively downloaded into computer and processed through suitable software on AutoCAD platform. Easting, Northing, Elevation and feature codes of all points observed were plotted at their respective locations. All the natural features are shown on survey maps by means of conventional symbols, which are preferably the symbols of 'Survey of India' Maps.

3.2.9. Survey Drawings

Based on the processed data of land survey and bathymetric survey, topographical contour survey maps of the proposed project area have been developed. As per scope of works, contours have been plotted at an interval of 0.5m. In a separate drawing, the grid level at regular interval of 20m has also been generated by using survey data in Civil3D software. Other than this, the cross-section of the reservoir @100m interval along the longitudinal sections are have been plotted. The following drawings are enclosed with the report.

Sl. No	Description	Drawing No.
1.	Reservoir Bed Level & Contour Plan	DC/FACT/LAKE/FLT/01
2.	Floating Solar PV Capacity	DC/FACT/LAKE/FLT/02

Table 4: List of Drawings

4. CAPACITY ANALYSIS

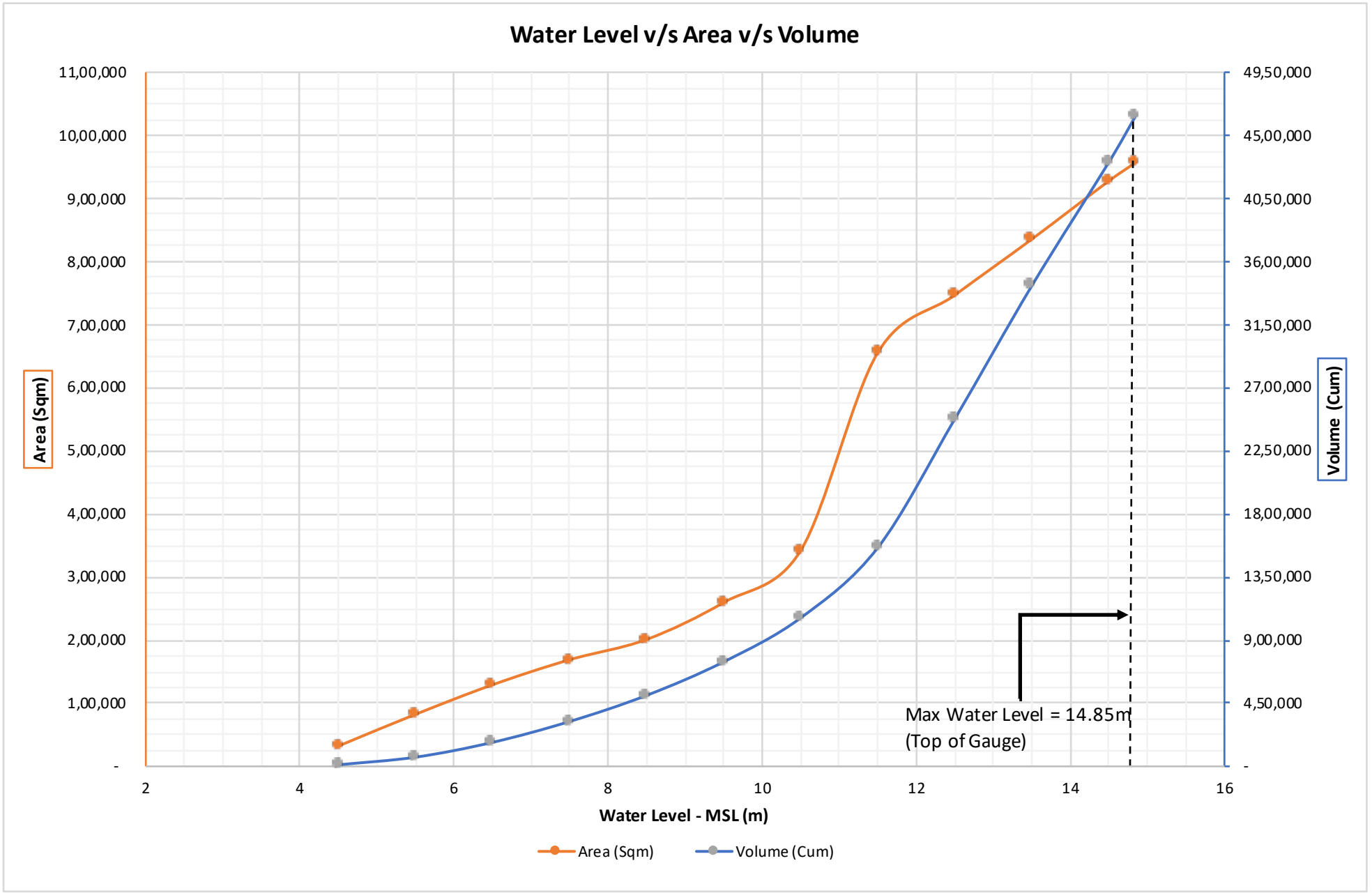
The maximum water level has been considered as 14.853m (MSL), corresponding to top of Gauge as established by the authorities near the intake canal structure.

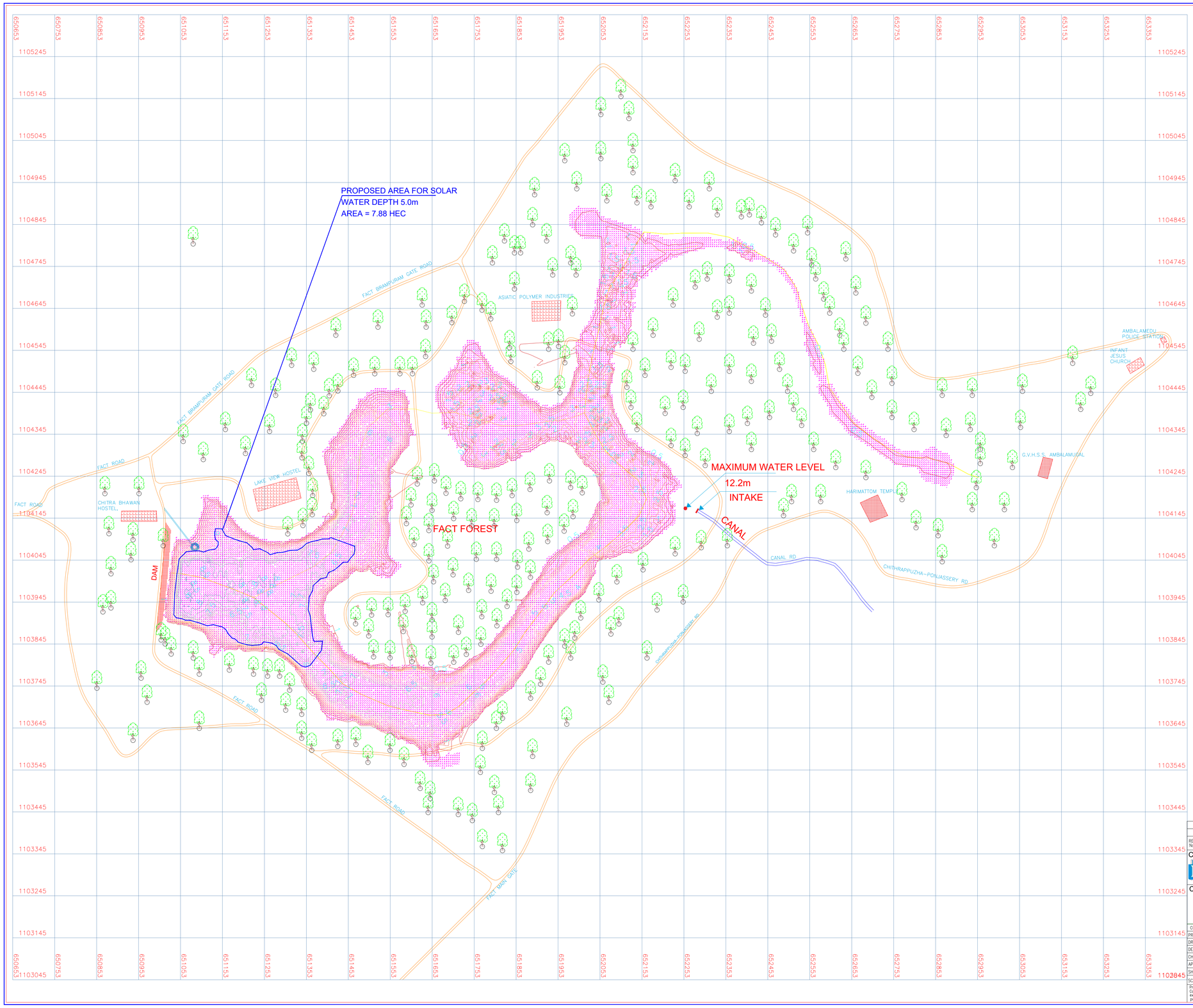
Based on this, the calculations have been made to provide the total capacity of the reservoir and the submerged area at the maximum water level. Additionally, the details of submerged area with volume of water at every 1-meter decrement in water level has also been calculated and reproduced below in tabular form & graphically shown at **Annexure C-I & C-II.**

Reservoir Capacity and corresponding Submerged Area & Volume				
Max Water (Top of Gauge) (MSL) =			**14.85m**	
Submerged Area at Max Water Level =			**95.7 hec**	
Volume at Max Level =			**4640438 cum**	
Lowest Reservoir Bed Level (MSL) =			**3.42m**	
Details of submerged area & volume of water at every 1-meter decrement				
S.No.	**Water Level (m) (MSL)**	**Area (Sqm)**	**Volume (Cum)**	**Remarks**
1	14.85	9,56,956	46,40,441	
2	14.5	9,27,657	43,07,807	
3	13.5	8,35,377	34,26,721	
4	12.5	7,46,732	24,76,481	
5	11.5	6,55,463	15,58,586	
6	10.5	3,41,968	10,58,556	
7	9.5	2,59,639	7,45,102	
8	8.5	2,01,112	5,06,150	
9	7.5	1,68,953	3,19,778	
10	6.5	1,29,263	1,71,117	
11	5.5	82,425	65,443	
12	4.5	32,230	11,138	

FACT AMBALAMEDU RESERVOIR					
DAILY BARCHECK FOR BATHYMETRY SURVEY					
Date	**Time**	**Depth from Echosounder (meter)**	**Depth from Measurement Tape (meter)**	**Difference in Measurements (meter)**	**Remarks**
27/04/24	13:54	1.53	1.55	0.02	
27/04/24	17:09	1.97	1.92	-0.05	
28/04/24	09:32	2.46	2.41	-0.05	
28/04/24	17:17	1.42	1.45	0.03	

Annexure 'C'


Water Level v/s Area v/s Volume
11,00,000
10,00,000
9,00,000
8,00,000
7,00,000
6,00,000
5,00,000
4,00,000
3,00,000
2,00,000
1,00,000
-
Area (Sqm)
49,50,000
45,00,000
40,50,000
36,00,000
31,50,000
27,00,000
22,50,000
18,00,000
13,50,000
9,00,000
4,50,000
-
Volume (Cum)
2
4
6
8
10
12
14
16
Water Level - MSL (m)
Max Water Level = 14.85m
(Top of Gauge)
Area (Sqm)
Volume (Cum)



S.No.	Water Level (m)	Area (Sqm)	Volume (Cum)	Remarks
1	14.85	956,956	4,640,441	
2	14.5	927,657	4,307,807	
3	13.5	835,377	3,426,721	
4	12.5	746,732	2,476,481	
5	11.5	655,463	1,558,586	
6	10.5	341,968	1,058,556	
7	9.5	259,639	745,102	
8	8.5	201,112	506,150	
9	7.5	168,953	319,778	
10	6.5	129,263	171,117	
11	5.5	82,425	65,443	
12	4.5	32,230	11,138	

LEGEND

TBM	
Reservoir Boundary	
Houses	
Bore Hole	
Gauge post	
Pillar	
Fungus Grass	
Electric line	
Road	
Cart track	
River/Drain	

Note:-

1. All Dimensions are in meter Otherwise define
2. Grid Level Intervals 5x5m
3. Survey has been done in Reference to CORS Network Established by Survey of India
4. The Maximum Water Level has been considered as 14.853m, Corresponding to Top of Gauge as Established Near Intake Canal Structure

REV No.	DATE	MECH.	CIVIL	ELEC.	RE	DESCRIPTION
		CHECKED				

CLIENT: THE FERTILISERS AND CHEMICALS TRAVANCORE LIMITED

CONSULTANT : THE DESIGNERS CONSORTIUM

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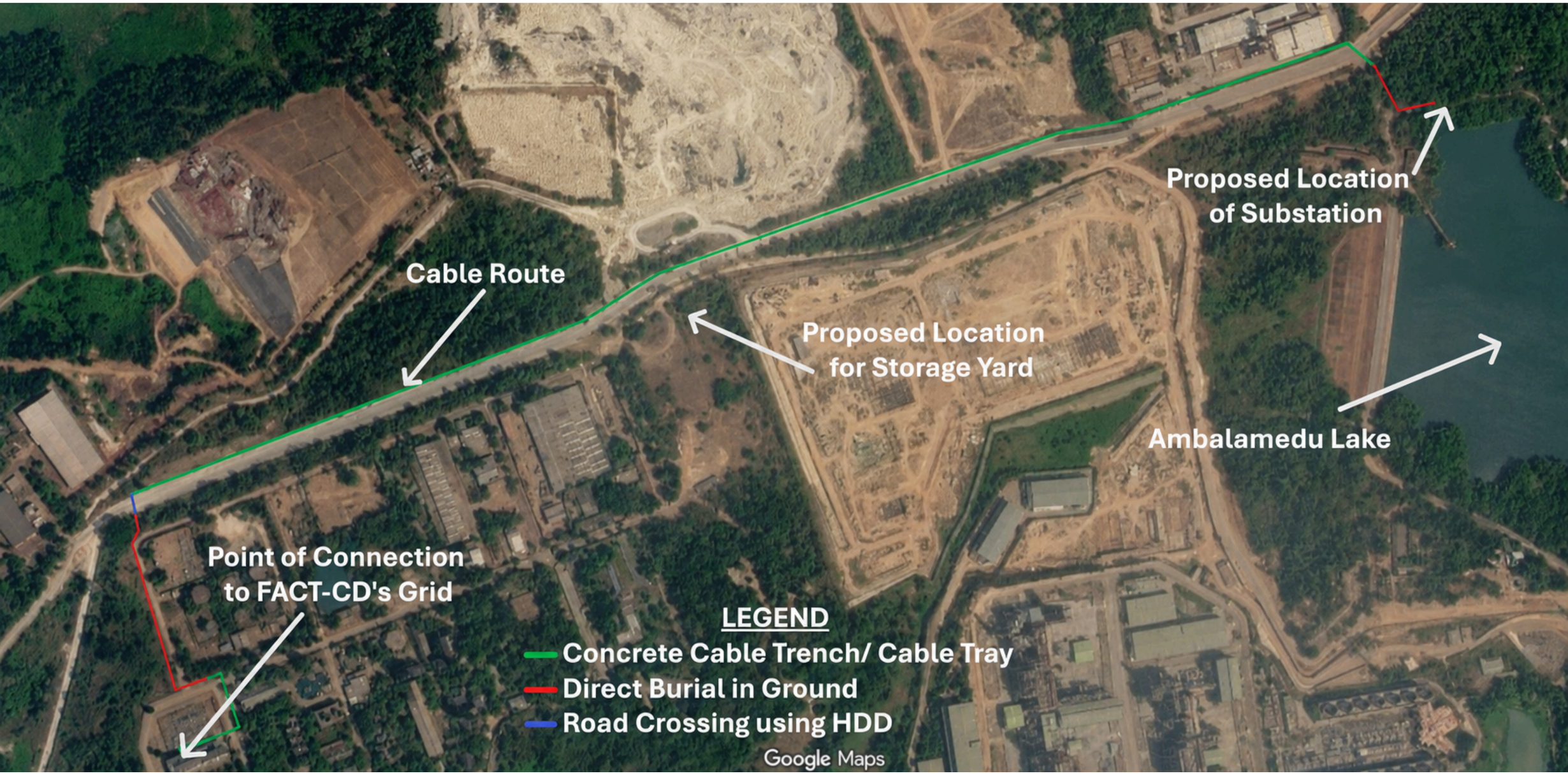
CONTRACT NO :		
PREPARED	NAME	DATE
DRAWN BY	AS	06.05.24
DESIGNED BY	RS	06.05.24
CHECKED BY	AK	06.05.24
APPROVED BY		
SHEET SIZE	A1	
SCALE	1:4000	

PROJECT : HYDROSTATIC STUDY SURVEY & CAPACITY ANALYSIS FOR AMBALAMEDU RESERVOIR

DRAWING TITLE : TOPOGRAPHICAL SURVEY PLAN OF GRID WATER LEVEL & CONTOUR

DRAWING NO : DC/FACT/LAKE/FLT/02 | REV. 00 | SHEET 01


Proposed Location
of Substation
Cable Route
Proposed Location
for Storage Yard
Ambalamedu Lake
Point of Connection
to FACT-CD's Grid
LEGEND
Concrete Cable Trench/ Cable Tray
Direct Burial in Ground
Road Crossing using HDD
Google Maps