



Detailed project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Final Detailed Project Report

**National Highways and Infrastructure Development Corporation
Limited (NHIDCL)**

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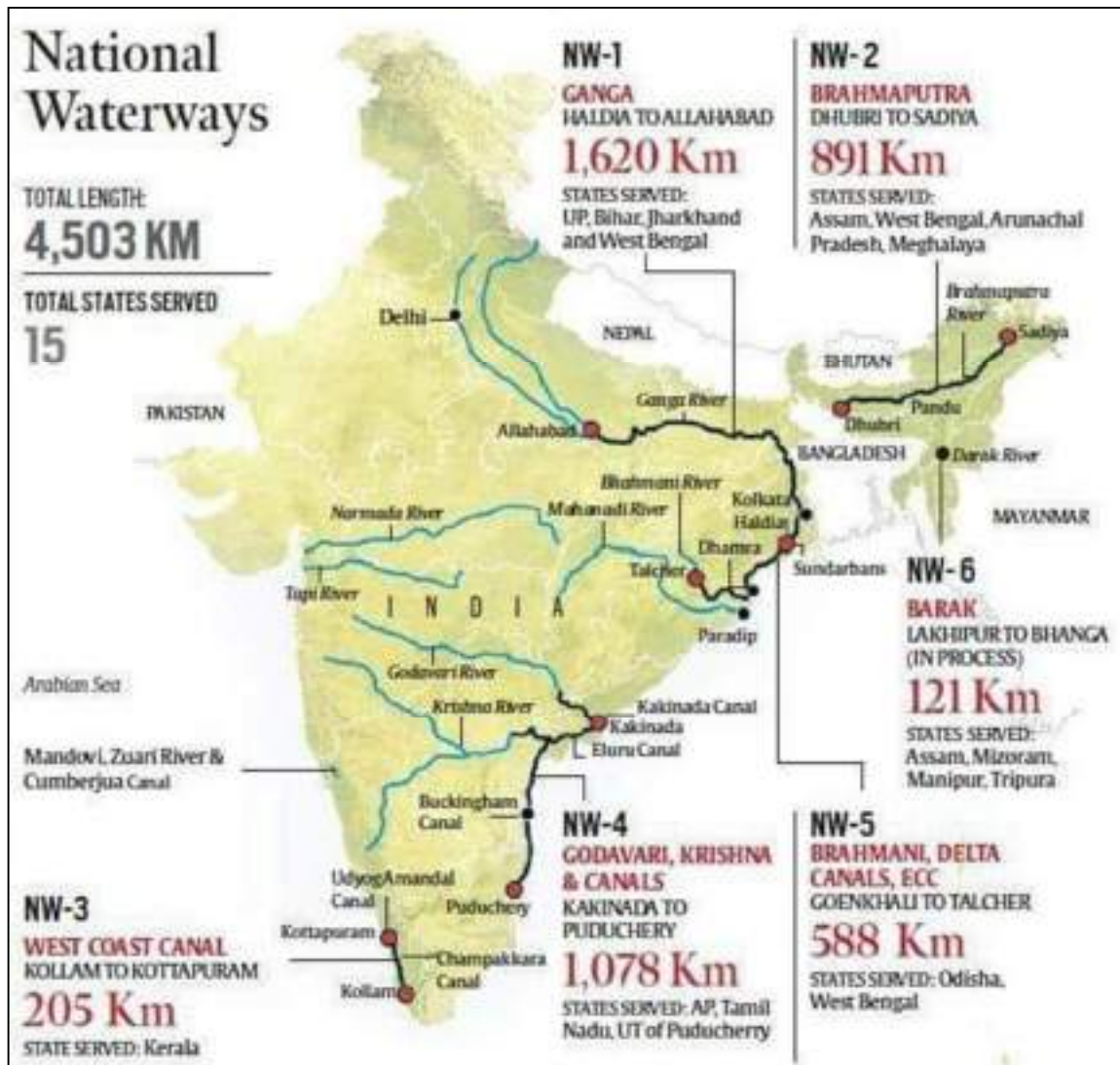
Annexure 3 – Detailed Cost Estimates

EXECUTIVE SUMMARY

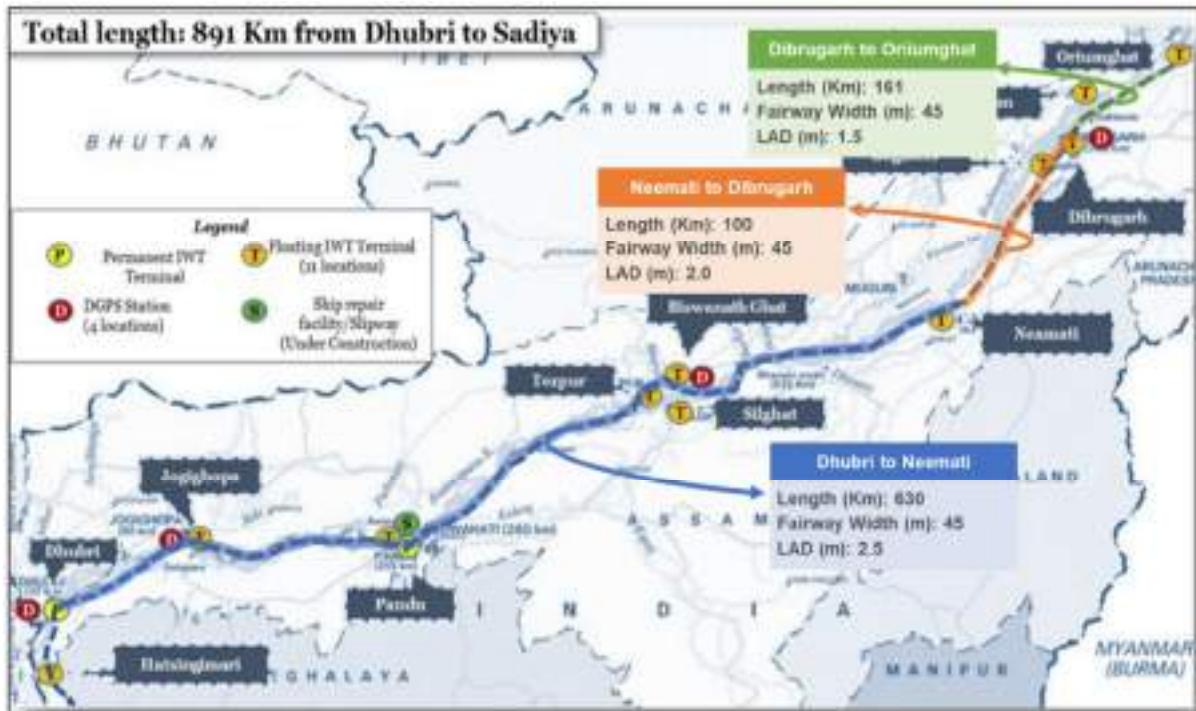
PROJECT BACKGROUND

Inland Waterways Authority of India (IWAI) is a statutory body of the Ministry of Ports, Shipping and Waterways, Government of India (GoI). IWAI is primarily responsible for development, maintenance and regulation of Inland Water Transport (IWT) on the National Waterways (NWs) in the country. Presently, there are 111 national waterways (NWs) in the country.

Sadiya to Dhubri (Bangladesh Border) stretch of River Brahmaputra (891 km) was declared as NW-2 in the year 1988 and since then, IWAI has been developing and maintaining basic IWT infrastructure thereon.



IWAI has so far developed permanent RCC terminals at two (2) locations viz. Pandu / Guwahati (both high & low-level jetties) and Dhubri on NW-2. In addition, there are floating jetties at eleven (11) locations viz. Hatsingimari, Jogighopa, Pandu, Tezpur, Silghat, Biswanathghat, Neamati, Bogibeel, Sengajan, Oakland / Dibrugarh and Oriumghat.



National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the development of 2/4 lane connectivity to these locations from the nearest National Highways (NHs), under Bharat Mala Pariyojana. NHIDCL has also been assigned the work of Development of Inland Water Transport (IWT) facility at Jogighopa (Assam) as part of Multi-Modal Logistic Park (MMLP) being developed at Jogighopa (Assam).

In this connection, NHIDCL have appointed M/s. AECOM India Private Limited (AECOM) for Preparation of DPR for “Development of Inland Water Transport (IWT) facility at Jogighopa on river Brahmaputra, National Waterway-2 (NW-2) in the state of Assam in India.”

SITE CONDITIONS

The Proposed IWT Terminal site is located on the banks of river Brahmaputra (NW-2) around 3 km to the south of MMLP site. It lies in the Jogighopa village in Bongaigaon district of Assam, which is bounded by Barpeta district in the east, Dhubri and Kokrajhar district towards the west, Brahmaputra river in the south, Goalpara district in the Southbank Brahmaputra river and Chirang district in the north. The Headquarters of the district is located at Bongaigaon town situated at the lower part of the Brahmaputra Valley which is 40 km away.

IWAI is in possession of 40.7 acres of land at the proposed IWT Terminal location. However, details of only 15 acres of demarcated land were received from IWAI. It is understood from site reconnaissance & topographic survey that being a low-lying area prone to flooding, almost twenty five (25) acres of the land is already submerged & hence all the developments have been planned at the available fifteen (15) acres of land. It may however be noted that there is a Cremation Ground in the middle and two (02) transmission towers in the land under possession of IWAI & these would need to be shifted prior/during construction.

Primary data was collected in respect of LAT/LONG Coordinates & available area by IWAI, water level data by CWC Shillong. All the available site data was collected and compiled. The data gaps were identified and the modalities for covering the data gaps, mainly the site specific geotechnical investigations, bathymetry surveys and water level data were finalised.

Climate in Jogighopa is temperate & average annual temperature is around 24.5°C. August is the warmest (28.5°C) & January is coldest (17.6°C) month of the year. In a year, the average rainfall is about 2745 mm. The summers are usually much rainier than the winters.

The high flood level (HFL) & lowest water level (LWL) of river Brahmaputra at Jogighopa as per the CWC records are 36.65 m & 28.28 m respectively. The highest observed discharge is 80,960 cum/sec & maximum velocity is about 5m/ sec. The peak and low flood values were used for fixing the finished floor level of Terminal land and levels of jetty. The discharge & velocity data has been used for determining shore protection works.



SITE INVESTIGATIONS

The land of approx. 15 acres in possession of IWAI was surveyed with the help of Total Station along with DGPS. Bank to bank hydrographic survey was also conducted Infront & along (1 km up & 1 km down) the proposed IWT terminal location & suitable benchmarks were established at site. The topography of the area proposed to be developed as IWT Terminal is uneven i.e. levels varies in the range of 34.0 m to 37.0 m.

Four number (04) of boreholes were undertaken at the site up to the maximum depth of 50.0 meters from the existing ground surface level to know the subsoil profile and engineering properties for carrying out the design of the structures. The soil is identified to be loose to medium/dense silty sand in the top layers and stiff to hard clayey silt/ silty clay in the layers below 40 m depth. The water contour of 28.28 m (+0.0 m CD) is observed at a distance of about 150 m from the existing shoreline.

TRAFFIC STUDY

Review of traffic projections, study and data collection from earlier reports was performed based on the DPR for Construction of IWT Terminal at Dhubri by L&T, Integrated National Waterways Transportation Grid Report, Statistics of Inland Water Transport (2017-18), IWAI's Stakeholder Conference at Kolkata, Annual Report on Traffic on National Waterways (FY 2019-20), ADB's Comments on Bangladesh Economy, Development of Multi Modal Logistic Park at Jogighopa carried

out by KPMG & VOYANT, & modal shift of cargo passing by E&Y (Aug. 2017). In additional primary data collected by AECOM was also utilised.

Based on examination of past studies and relevant data for estimation of traffic on proposed IWT Terminal at Jogighopa, the following projections have been made for the proposed terminal:

(Traffic In Million Tonnes Per Annum)

Year	2022	2027	2032	2037	2042	2047	2052
Traffic (MTPA)	1.10	1.33	1.55	1.81	1.89	1.98	2.08

Out of the above total projected cargo from year 2022 to year 2052, the Major commodity to be handled at Jogighopa IWT Terminal is projected to be of Stone chips.

Commodity Wise Origin & Destination details of the cargo identified for Jogighopa IWT Terminal are as follows:

Commodity	Origin	Destination
Stone Chips	Bhutan	Bangladesh
Food grains	Bihar, Burdwan, Dinajpur, Jharkhand, Kolkata, Maldah, Punjab, UP	Assam, Tripura Nagaland
Fly Ash	Kolkata	Assam
Fertilizers & FRM	Haldia	Assam
Tar Coal/ Bitumen	Haldia, Kolkata, Jharkhand	Assam
PoL & Crude	Kolkata, Haldia	Assam, Tripura, Manipur
Edible Oil	Kolkata, Punjab	Assam
Imported Coal	Haldia, Kolkata	Assam
Automobile Units	Delhi, Haryana, Maharashtra	Assam, Nagaland, Tripura, Meghalaya

PLANNING OF THE JOGIGHOPA IWT TERMINAL

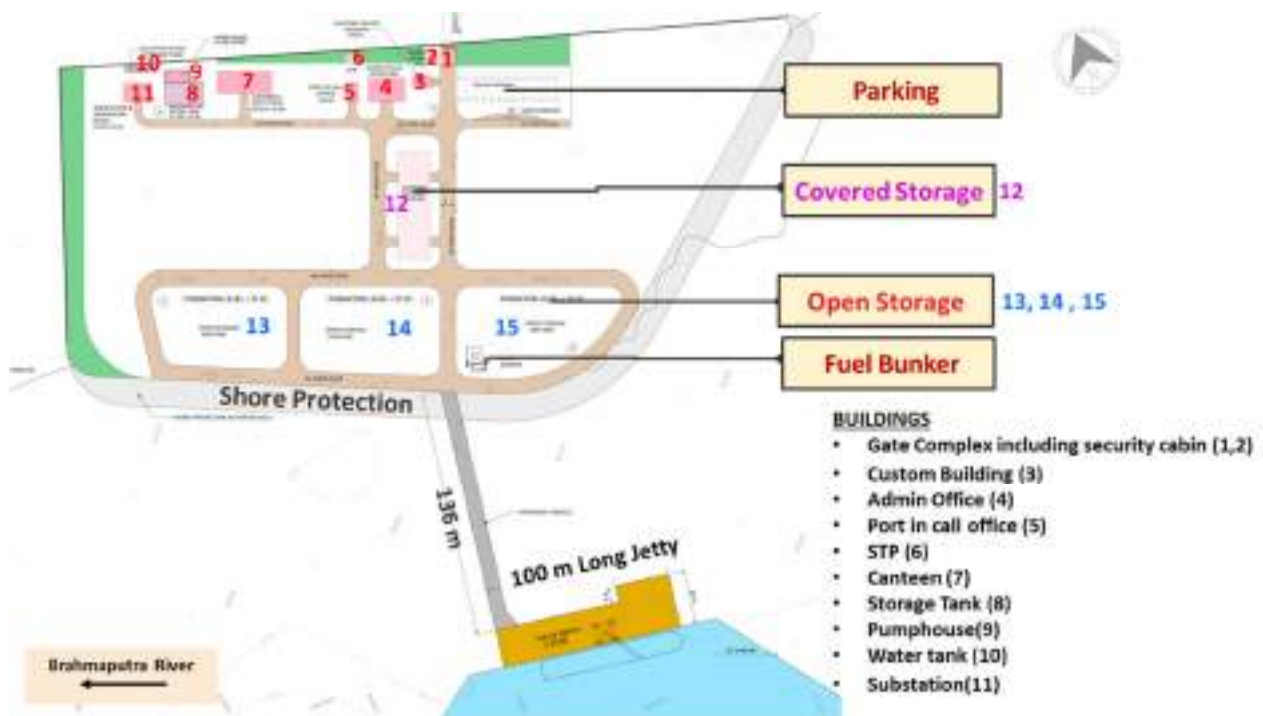
Based on the projected potential traffic, the IWT Terminal at Jogighopa is planned to be developed in 2 phases starting with the initial Phase-1A development (2022) and upgrading it by way of increasing the berth length, handling equipment and reducing the dwell time of cargo, based on the projected traffic till Master Plan phase (2052).

Considering the future development that could take place in the waterway over the period of master plan horizon, the Jetty of IWT terminal is designed for maximum vessel size of 2,000 DWT having draft of 2.5 m. The IWT operations are planned for 300 days (leaving 2 months of monsoon/flood) in a year.

It is proposed to provide a single level jetty for better cargo operation efficiency throughout the year. The IWT jetty of 100 m length is proposed alongwith sufficient cargo handling equipment & storage area in Phase 1A. The jetty would be extended by another 155 m length in the future phase of

development and provided with additional handling equipment as per the traffic handling requirements.

The 100 m long jetty would be connected to onshore terminal area by single approach trestle of 8.0 m width, having length of 136 m. Considering the operational requirement & equipment to be accommodated, the width of the Jetty is kept at 21 m with 9 m extension at the end for 30 m length accounting to smooth turning of vehicles. The onshore layout provides the open and covered storage areas, buildings for the terminal operations and other utility requirements.



Jogighopa IWT Terminal – Phase 1A

Phase 1 A	Phase 1 B
New 100 m IWT Jetty - IWT Jetty (100 m x 21 m) 1 Approach Trestle of 136 m length having width of 8 m. 0.14 lakh cum dredging & 0.70 Lakh cum reclamation 680 m of shore protection - Open storage area of 11,370 sqm - Covered storage area of 1,080 sqm 1 Mobile Harbour crane (MHC) 1 Mobile crane & 1 mobile loader for stone chips 8,600 sqm of Internal roads - Buildings, support facilities and Utilities	Additional 155 m IWT Jetty - Additional IWT Jetty (155 m x 21 m) - Additional 1 Approach Trestle of 178 m length having width of 8 m. 0.02 lakh cum dredging & 0.83 Lakh cum reclamation - Open storage area of 13,330 sqm - Covered storage area of 3,240 sqm - Workshop having 480 sqm area 1 MHC - Additional Internal roads of 7,000 sqm

The water and power requirements during phase 1A are estimated to be 50 cum/day & 575 KVA respectively.

COST ESTIMATES, FINANCIAL ASSESSMENT AND IMPLEMENTATION SCHEDULE

The capital investment required for Phase 1A and Phase 1B development of the proposed IWT Terminal is about INR 100.00 Crores and INR 77.56 crores respectively. The fixed O&M cost of INR 7.16 crores & variable O&M cost of INR 2.70 crores have been estimated per annum for Phase 1A development.

The project is proposed to be developed on the landlord model in which the basic infrastructure in terms of jetty, area development, shore protection, buildings etc. would be built by Owner (IWAI/NHIDCL), whereas the equipment, workshops and equipment shall be provided by the PPP operator who shall also be responsible for the operation and maintenance of the terminal.

	Phase 1 (INR in Crores)	
	Phase 1 A	Phase 1 B
Owner (IWAI / NHIDCL)	65.67	53.53
Concessionaire	26.90	18.30
Contingencies & Miscellaneous	7.41	5.75
Total	99.97	77.58
Grand Total (Phase 1A + Phase 1 B)	177.56	

With the above mentioned estimates and assumption, Pre-tax IRR for the Project comes out to be 3.20% for owner & 8.99% for concessionaire as per landlord model.

The project shall be completed in 2 years including appointment of PMC, construction and closure.

WAY FORWARD

The action plan for the project development is as follows:

1. Appointment of EIA consultant for preparation of EIA report and approval of MoEF.
2. Financial closure of the project.
3. Selection of operator for the terminal development.
4. Selection of EPC contractor for construction of the terminal facilities.

1. INTRODUCTION

1.1 Project Background

Inland Waterways Authority of India (IWAI) is a statutory body of the Ministry of Shipping, Government of India (GoI). IWAI was set up in 1986 for regulation and development of Inland Waterways for the purposes of shipping and navigation. IWAI is primarily responsible for development, maintenance and regulation of Inland Water Transport (IWT) on the National Waterways (NWs) in the country. Presently, there are 111 national waterways (NWs) in the country. NW-1 to NW-6 are presented in **Figure 1.1**.

Sadiya to Dhubri (Bangladesh Border) stretch of River Brahmaputra (891 km) was declared as NW-2 in the year 1988 and since then, IWAI has been developing and maintaining basic IWT infrastructure thereon as presented in **Figure 1.2**.



Figure 1.1: National Waterways of India (NW-1 to NW-6)



Figure 1.2: Brahmaputra River (NW-2)

IWAI has so far developed permanent RCC terminals at two (2) locations viz. Pandu / Guwahati (both high & low-level jetties) and Dhubri on NW-2. In addition, there are floating jetties at eleven (11) locations viz. Hatsingimari, Jogighopa, Pandu, Tezpur, Silghat, Biswanathghat, Neamati, Bogibeel, Sengajan, Oakland / Dibrugarh and Oriumghat.

National Highways & Infrastructure Development Corporation Limited (NHIDCL) has been entrusted with the development of 2/4 lane connectivity to these locations from the nearest National Highways (NHs). These highways shall be developed under Bharat Mala Pariyojana. NHIDCL has also been assigned the work of Development of Inland Water Transport (IWT) facility at Jogighopa (Assam) as part of Multi-Modal Logistic Park (MMLP) being developed at Jogighopa (Assam).

In this connection, NHIDCL have appointed M/s. AECOM India Private Limited (AIPL) through their letter of award for consultancy bearing no. NHIDCL/IWT/DPR/2020/1335 dated 04.06.2020 for Preparation of DPR for “Development of Inland Water Transport (IWT) facility at Jogighopa on river Brahmaputra, National Waterway-2 (NW-2) in the state of Assam in India.” This DPR is being prepared for the Inland Waterways Authority of India (IWAI) who in turn shall use this DPR for execution of the project on EPC basis.

1.2 Need for this Project

The economic development of north east region (NER) lacks on account of transport infrastructure connectivity with rest of the country. Major surface modes of transport i.e. rail and road traverse through the narrow Siliguri Corridor (Chicken Neck). This corridor is a narrow tract of land in India between the borders with Bangladesh, Nepal and Bhutan that cannot be expanded, and is the only connectivity between NER and rest of the country, leading to congestion and high transportation costs. This results into low productivity and reliability of transportation / logistics of goods (both raw materials and finished goods) and thereby increase the cost of goods and services meant for NER.

Although NER has long navigable inland waterways, it is connected to rest of India using Indo-Bangladesh Protocol (IBP) route. Similarly, in the air sector, certain flights are routed using Bangladesh airspace.

Multi-Modal Logistic Parks (MMLPs) are a key policy initiative of the Government of India to improve the country's logistics sector by lowering overall freight costs, reducing vehicular pollution and congestion, and cutting warehousing costs. The Ministry of Road Transport and Highways (MoRTH) is developing multi-modal logistics parks at various selected locations in the country under its Logistics Efficiency Enhancement Program (LEEP).

The government defines an MMLP as a freight-handling facility encompassing a minimum area of 100 acres (40.5 hectares), with various modes of transport access, and comprising mechanized warehouses, specialized storage solutions such as cold storage, and connected with road, rail, waterways and/or air transport facilities. The road ministry has shortlisted 35 MMLPs across India, of which four are being executed in collaboration with Asian Development Bank (ADB). Out of these four, one MMLP is proposed to be developed at Jogighopa owing to its strategic location in the North East Region (NER).

In the light of above, the MMLP at Jogighopa in Assam can become India's gateway to South-East Asia as well as the rest of the NER and will boost the overall regional economy. The proposed MMLP will include development of all the major modes of transport i.e. road, rail, air and inland waterways with adequate railway sidings, container depot, warehousing, non-cargo processing, truck bays, inter modal transfer facilities, support infrastructure and state of art equipment.

The Ministry of Road Transport and Highways (MoRTH) has signed an MoU (memorandum of understanding) between India and Bangladesh for developing Northeast Economic Corridor under the Bharatmala programme, the Dalu-Tura- Goalpara- Gelephu multimodal trade route, which further strengthens the Jogighopa's case for MMLP & thus for development of an IWT Terminal.

An efficient transport sector is vital for the economic development of any country. In a large country like India, efficient transportation becomes pivotal to stimulate competitive business environment. Indian transport system comprises various modes, viz. Railways, Roadways, Inland Waterways, Coastal Shipping and Airways. Inland Water Transport (IWT) is a fuel efficient, environment friendly and cost-effective mode of transport having potential to supplement the overburdened rail and congested roads and being environment friendly at the same time.



Figure 1.3: Cost to Transport for 1 Ton of Freight over 1 km (Source: World Bank)

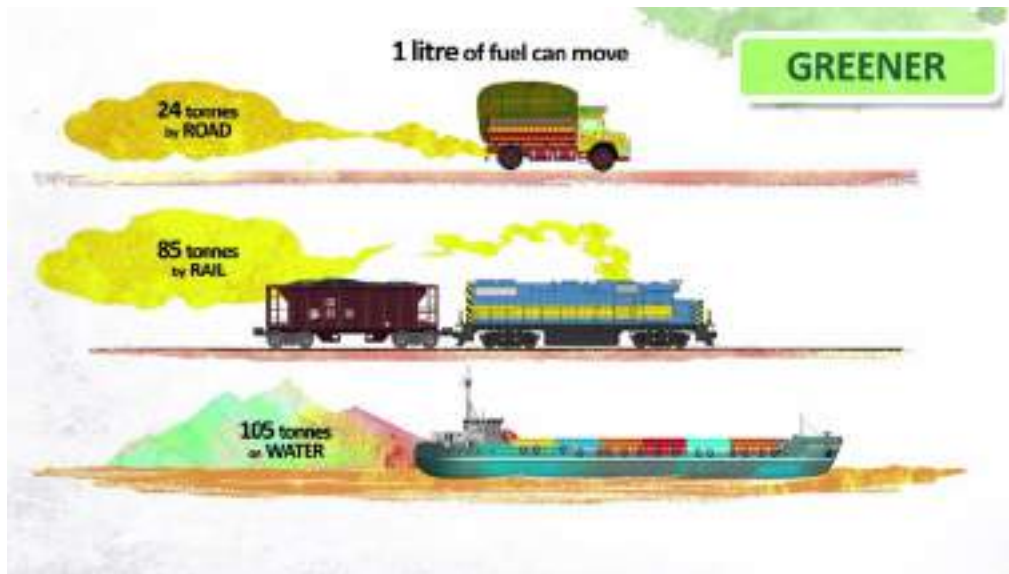


Figure 1.4: Fuel efficiency for different modes of Transport (Source: World Bank)

1.3 Project Site Location

The proposed MMLP at Jogighopa is one of the 35 state-of-the-art Multimodal Logistic Parks (MMLP). The Govt. of Assam has agreed to give 200 acres of land for the development of the proposed MMLP. IWAI is in possession of 143.37 acres of land along the river to the south of NH 17. Out of the 143.37 acres, only 40.7 acres of encumbrance free land is available for immediate development, while the remaining 102.67 acres is under litigation. Hence for an integrated development of the IWT Terminal, the available land of 40.7 acres will be considered. The map showing the locations of MMLP and IWT Terminal site is shown in the **Figure 1.5** below. However, we have received topographic survey details of only 15 acres of demarcated land from IWAI.



Figure 1.5: Proposed Location of IWT Terminal, Jogighopa, Assam

Source: (Vol I, DPR, MMLP study by M/s Voyants & KPMG Advisory Services Pvt. Ltd.)

1.4 DPR Objective & Outline

The objective of this study is to prepare a DPR for construction of an IWT terminal at Jogighopa to enable round the year berthing of the vessels, manual and mechanical handling of cargo. The terminal will have the facilities for open and covered storage of goods, internal roads, utilities including electricity, water supply, drainage, firefighting, landscaping and horticulture.

The envisaged IWT terminal shall be integrated with the proposed MMLP at Jogighopa. All external road connectivity with nearest National / State Highway etc. are being developed under Jogighopa and bids for civil works have also been invited. This DPR will inter-alia include all the technical details such as preliminary engineering design, technical specifications, bill of quantities (BoQ) etc. along with cost estimate sufficient enough for preparing tender document for execution of the project on Engineering, Procurement & Construction (EPC) mode.

The DPR is completed in the following stages:

- Stage 1: Inception Report – Already Submitted on 15th July 2020
- Stage 2: Draft Detailed Project Report – Already Submitted on 31st July 2020 along with Draft Tender Documents
- Stage 3: Draft Final Detailed Project Report & Tender Documents
- Stage 4: Final Detailed Project Report & Tender Documents

1.5 Scope of Work of The Assignment

The scope of work of the consultancy assignment awarded to AECOM by NHIDCL is given below:

1. To Undertake assessment of existing cargo movements from secondary source / studies made by IWA or NHIDCL to arise at the potential cargo (type and quantity) to be handle at Jogighopa IBP terminal in the base year- 2019-20 and also up to next 30 years.
2. To Undertake Hydrographic and hydrographic Surveys, Collect the lowest water level (LWL) and highest flood level (HFL) information, Record the current velocity measurements at least three locations on the terminal site at 0.5d (where d is depth of water) using standard current meter;
3. To undertake Geo-technical investigation (boreholes) on the terminal land above HFL (minimum two locations) as well as between highest & lowest waterline (minimum two locations) for the purpose of design of structures (i.e. total four bore holes).
4. To Collect and Review the available & reports relating to topographic surveys, hydrographic surveys, flow and discharge conditions, water level variations, soil (suspended sediment, bed and bank) conditions, geological, geomorphologic and all other conditions on the Brahmaputra river system
5. To fix the location and type of berthing jetty to ensure safe berthing of loaded as well as empty vessels during highest and leanest water level periods;
6. To examine the adequacy of the existing road linkages between the terminal and MMLP, to facilitate smooth two-way flow of trucks and trailers from / to the terminal and hinterland.
7. To examine the feasibility of providing rail connectivity to the terminal site.
8. Undertake and provide technical analysis together with preliminary engineering designs & drawings and component / sub-component wise cost estimates based on which development works of the terminal can be undertaken. Submit detailed design basis reports of all components / sub-components of the project which shall be got reviewed and vetted through IIT / NIT or other reputed Engineering Institute.

9. To Assess the environmental impacts due to development works and suggest suitable EMP to mitigate the adverse impacts, if any, including its cost. Assess & bring out in sufficient details along with supporting documents, the need of obtaining environmental clearances for construction of the terminal based on prevailing rules and regulations of Central & State Governments.
10. To prepare SIA report with the magnitude of Land Acquisition, Resettlement issues and the Mitigation of Impacts.
11. To prepare both the Capital as well as O&M expenses (CAPEX & OPEX) for the project in sufficient details in the DPR.
12. To prepare detailed & realistic construction time schedule indicating the sequence of activities duly considering the river characteristics in different seasons and priority of works.
13. To Prepare tender document(s) for execution of works proposed in the DPR on EPC mode which will inter-alia include all necessary detailed Technical Specifications, BoQ, Price Schedule and Special Conditions of Contract.
14. To Assist the Employer in replying any pre-bid queries or technical issues raised during the process of tendering for executing the work from time to time.

1.6 Present Submission

Present Submission is the Final Detailed Project Report (DPR), which is being submitted as the final deliverable as per the terms of reference of the assignment. The report has been organised in the following sections:

- Section 1:** Introduction (This section)
- Section 2:** Project Initiation
- Section 3:** Compilation of Project data & Assessment of Data Gaps
- Section 4:** Traffic Projection for Jogighopa IWT Terminal
- Section 5:** Terminal Facility Requirements
- Section 6:** Layout of the IWT Terminal
- Section 7:** Engineering Details
- Section 8:** Environmental Setting & Impact Evaluation
- Section 9:** Social Setting & Impact Evaluation
- Section 10:** Cost Estimates & Implementation Schedule
- Section 11:** Financial Assessment
- Section 12:** Way Forward

2. PROJECT INITIATION

2.1 Kick off Meeting

On award of the assignment, AECOM's representatives made a visit to the NHIDCL's head office at New Delhi on 11-06-2020 and held preliminary discussions with the officials to understand the data available with the client and key contact details at the office. The basic data required for the assignment and the support needed from IWAI office to accomplish various tasks of the assignment was also discussed.

A second meeting was conducted at the NHIDCL's head office on 22-06-2020 between higher authorities of AIPL & NHIDCL regarding the timelines of the project. It was decided during this meeting to expediate & prepone the submission of Inception report & Draft DPR as 15-07-2020 & 31-07-2020 respectively.

Subsequently, AECOM's representative also made a visit to the IWAI's head office on 30-06-2020 to collect all the readily available data related to this assignment. Detailed discussions were carried out on earlier developments and all necessary support was provided by IWAI. It was further informed that the data not available with IWAI head office can be collected from IWAI's Guwahati office or actual concerned agency having jurisdiction over the same.

2.2 Data Collection

As part of the initial assessment, review of scope and project requirements in detail, the consultants identified the list of data to be collected. The status of data collection is provided in **Table 2.1** below.

Table 2.1: Status of Data Collection

S. No.	Item	Status
1.	Detailed Project Report (DPR) for National Waterways-2 prepared by IWAI	Collected
2.	Modal Shift of Cargo Report prepared by E&Y, 2017	Collected
3.	MMLP study at Jogighopa prepared by M/s Voyants Solutions Pvt. Ltd. in JV with KPMG Advisory Services Pvt. Ltd.	Collected
4.	LAT/LONG Coordinates of the terminal	Collected from NHIDCL & IWAI.
5.	Location and level of survey of India Permanent benchmark	Collected during topographic surveys
6.	Available Topographic & Hydrographic details at & near the proposed terminal location	Collected from IWAI & Surveys conducted
7.	Geotechnical details of proposed new two-lane bridge next to Narnarayan setu	Collected from NHIDCL
8.	Historical water levels in river during lean and flood season over past years	Collected from CWC
9.	Observed data on peak river discharges	

S. No.	Item	Status
10.	Data on Currents, if any	
11.	Soil (suspended sediment, bed and bank) conditions, geological, geomorphologic and all other relevant conditions on the Brahmaputra river system, available with IWAI/ NHIDCL.	
12.	Distance of nearest rail head and route on local map	Collected
13.	Distance of nearest highway and route on local map	Collected

2.3 Site Visit/ Reconnaissance Survey

The consultants had planned a site visit for initial assessment of project site immediately after award of work. However, because of restrictions due to Covid-19 outbreak, the visit to site was delayed & was undertaken from 26th July 2020 to 28th July 2020. Some of the photographs taken during site visit are attached below.



Figure 2.1: From Left to Right: 1 (NH-17 Crossing Towards IWT Site), 2 (IWT Gate), 3 (Approach Road) & 4 (Pontoon at Site)



Figure 2.2: From Left to Right: 5, 6 (IWT Site), 7 (DGPS Room) & 8 (Security Cabin)

3. COMPILATION OF PROJECT DATA & ASSESSMENT

3.1 Project Location

The Proposed IWT Terminal site is located on the banks of River Brahmaputra around 3 km to the south of MMLP site. It lies in the Jogighopa village in Bongaigaon district of Assam, which is bounded by Barpeta district in the east, Dhubri and Kokrajhar district towards the west, Brahmaputra river in the south, Goalpara district in the Southbank Brahmaputra river and Chirang district in the north. The Headquarters of the district is located at Bongaigaon town situated at the lower part of the Brahmaputra Valley which is 40 km away.

Nearest towns of the village Jogighopa are Goalpara and Abhayapuri, situated at distance of 18 km and 24 km respectively. The village falls under Jogighopa panchayat. Boitamari is the sub district headquarter of the village.

For the purpose of developing the proposed IWT Terminal in the North-East region at Jogighopa, 143.37 acre of land along the river to the south of NH 17 has been identified which is in possession of IWAJ. Out of 143.37 acre only 40.7 acres of encumbrance free land is available for immediate development, remaining 102.67 acre is under litigation. Hence for an integrated development of the IWT Terminal, the available 40.7 acres will be considered for initial development. The project site location is shown in **Figure 3.1**. However, we have received details of only 15 acres of demarcated land with topographic survey from IWAJ.



Figure 3.1: Proposed IWT Location

There is also an existing jetty at the site which is presently defunct, and no activity currently takes place at this location.

It is also observed that the Narnarayan Setu plays a major role in the lives of people living in & around district of Bongaigaon, Assam. The Narnarayan Setu bridge connecting Pancharatna on the southern side & Jogighopa in the northern side is less than 1 km away from the project IWT site. The Narnarayan Setu is a double deck bridge with railway track on lower deck and road on the upper deck.

3.2 Land Details

The details of IWT land parcel has been shown in **Figure 3.2** below. As can be seen from above, only 40.7 acres of encumbrance free land is available for immediate development. However, we have received topographic survey details of only 15 acres demarcated land from IWAI. It is understood that being a low-lying area prone to flooding, almost 25 acres of the land is already submerged. It may however be noted that there is a Cremation Ground in the middle and two transmission towers in the 15 acres land under possession of IWAI and these would need to be shifted.

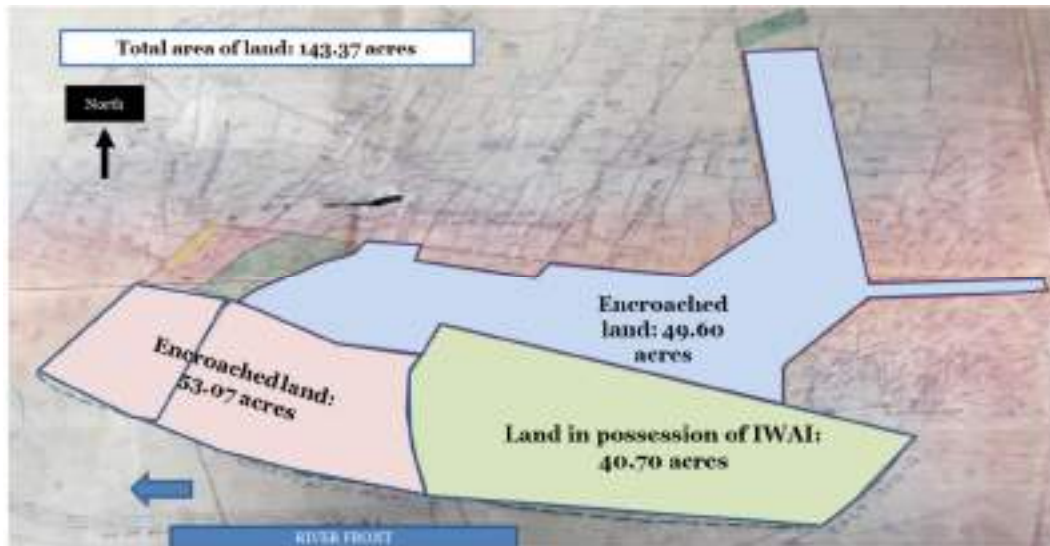


Figure 3.2: Land details of IWAI site at Jogighopa

(Source: Inland Waterways Authority of India)

3.3 Connectivity

3.3.1 Road

NH-31 connects Siliguri to Guwahati in Assam, which is one of the most critical highways in the region. Additionally, 4-lane East West Corridor passes through this corridor and connects Srirampur and Silchar in Assam, covering major industrial centres. The road connectivity map with key national Highways in North eastern region & road connectivity at the proposed IWT Terminal location is presented in **Figure 3.3** & **Figure 3.4** respectively. The detailed road connectivity has been provided at **Drawing No. 60636525 – DPR – 1026**.



Figure 3.3: Road Connectivity in North Eastern Region



Figure 3.4: Road Connectivity at The Proposed IWT Terminal Location

3.3.2 Rail

A double line broad gauge line connects lower Assam to parts of Bengal and other parts of the country. The connectivity within the region is facilitated through a single line broad gauge which extends up to Tripura. The rail network along with the important good sheds & rail connectivity at the proposed IWT Terminal location is presented in **Figure 3.5** & **Figure 3.6** respectively.



Figure 3.5: Rail Connectivity in North Eastern Region



Figure 3.6: Rail Connectivity at the Proposed IWT Terminal Location

3.3.3 Air

Lokpriya Gopinath Bordoloi Airport (IATA: GAU, ICAO: VEGT), also known as Guwahati Airport and formerly as 'Borjhar Airport', is the primary airport of the North-Eastern States of India and is nearest from the proposed IWT Terminal location at a distance of about 105 km away. Location of Airports in North-East Region is presented in **Figure 3.7**.



Figure 3.7: North East Airports

3.3.4 Waterway

Jogighopa is located on the NW-2 stretch from Dhubri to Sadiya on River Brahmaputra. It is directly connected to important ports like Haldia and Kolkata on the eastern coast via Bangladesh Protocol route. The Important river stations/commercial centres along the riverbank in NW-2 are Dhubri, Jogighopa, Pandu/Guwahati, Tezpur, Neamati, Dibrugarh, Sadiya and Saikhowa. Pandu/Guwahati is the most important river station on NW-2 and the stretch downstream of Pandu up to Bangladesh Border (260 kms) is the stretch where IWT operation is presently most active.



Figure 3.8: Location of Jogighopa on National Waterway – 2

3.4 Meteorological Conditions

3.4.1 Temperature & Rainfall

The climate in Jogighopa is warm and temperate. The summers are much rainier than the winters in Jogighopa. The average annual temperature is 24.5°C in Jogighopa.

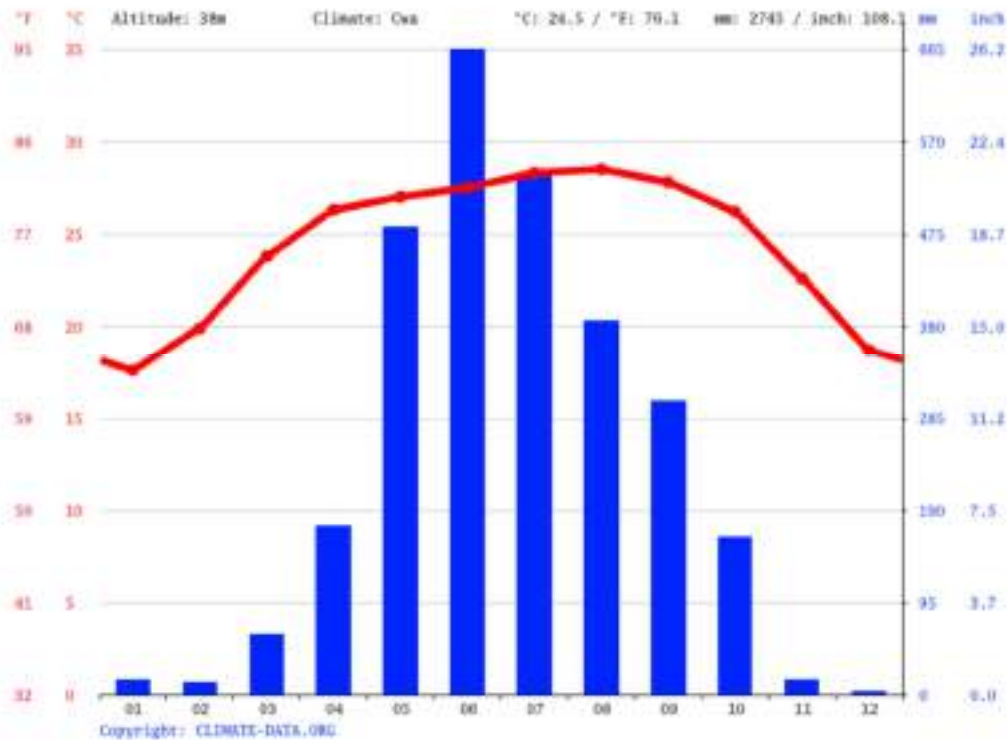


Figure 3.9: Jogighopa Climate Graph and Weather by Month

(Source: en.climate-data.org/asia/india/assam/jogighopa-174982/)

August is the warmest month of the year. The temperature in August averages 28.5°C | 83.3°F. The lowest average temperatures in the year occur in January, when it is around 17.6°C | 63.7°F. In a year, the rainfall is 2745 mm | 108.1 inch. August is the warmest month of the year. The temperature in August averages 28.5°C | 83.3°F. The lowest average temperatures in the year occur in January, when it is around 17.6°C | 63.7°F.

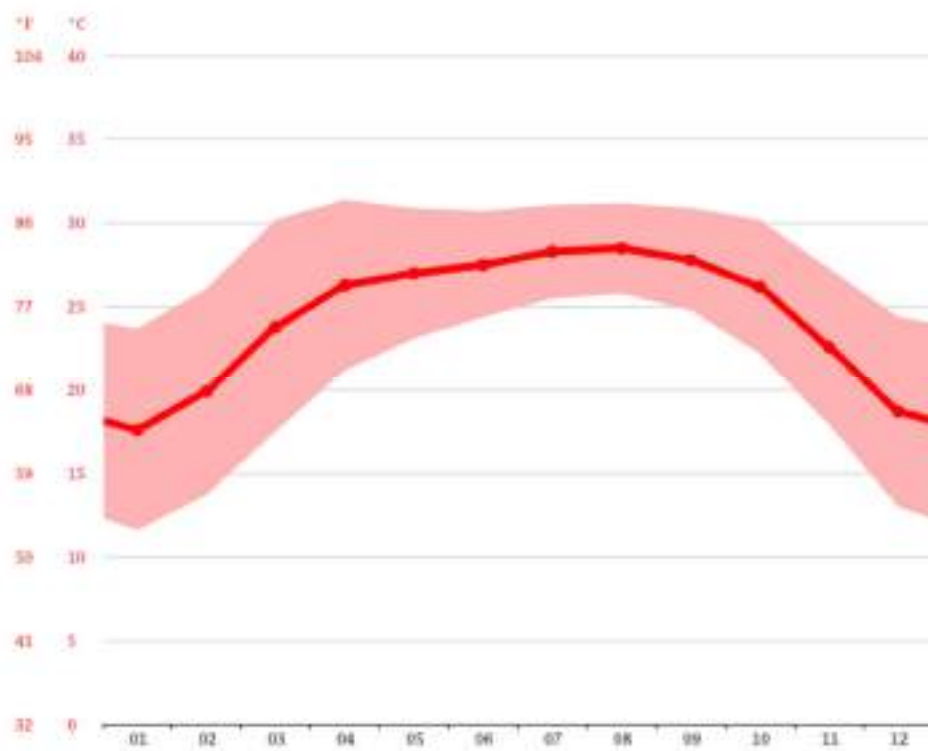


Figure 3.10: Jogighopa Average Temperature
(Source: en.climate-data.org/asia/india/assam/jogighopa-174982/)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	17.6	18.9	21.8	26.3	27	27.5	29.3	29.5	27.9	26.2	22.6	18.7
Min. Temperature (°C)	11.6	13.7	17.5	21.2	23.1	24.4	25.5	25.8	24.8	22.2	17.9	13
Max. Temperature (°C)	23.7	26.1	28.2	31.4	30.9	30.7	31.5	31.2	30.9	29.2	27.3	24.4
Avg. Temperature (°F)	63.7	67.8	74.8	79.3	80.6	81.5	82.9	83.3	82.0	79.2	72.7	65.7
Min. Temperature (°F)	52.9	56.7	63.5	70.2	73.6	75.9	77.9	78.4	76.6	72.0	64.2	55.4
Max. Temperature (°F)	74.7	79.0	83.4	88.5	87.6	87.3	88.8	88.2	87.5	85.4	81.1	75.9
Precipitation / Rainfall (mm)	14	12	60	170	470	848	521	377	295	158	14	3

Figure 3.11: Jogighopa Average Monthly Temperature
(Source: en.climate-data.org/asia/india/assam/jogighopa-174982/)

3.4.2 Wind

M/s Voyants Solutions Pvt. Ltd. in JV with KPMG Advisory Services Pvt. Ltd had carried out the study of the MMLP other than IWT, and the details are obtained from the reports submitted by them. Also, they have collected the Historical Meteorological data for a period of 29 years (1981-2010) from Indian Meteorological Data (IMD) Guwahati. They collected the micrometeorological conditions prevailing in the study area by installing a Micrometeorological Monitoring Station (MMS) at top of the highest roof. The baseline meteorological data was collected as per IS: 8829 and IMD guidelines, from 20, December 2018 to 22, January 2019. Average temperature during study period is find out to be 18.99°C and average wind speed is 1.08 Kmph whereas predominant wind direction is SSE.

Table 3.1: Meteorological Data (1981-2010)

Month	Daily Mean		Relative Humidity (%)	Rainfall (mm)	Cloud Amount (Oktas)	Mean Wind speed (kmph)
	Max	Min				
January I	23.6	11	88	12	2.4	1.6
II			70		3.3	
February I	26.3	12.8	78	22.3	2.5	2.2
II			56		3.2	
March I	29.8	16.4	68	58.4	2.8	3.2
II			50		3.4	
April I	30.6	20.3	75	187.8	4.2	4
II			62		4.1	
May I	31.4	22.9	79	243.1	5.2	3.3
II			70		4.8	
June I	32.2	25.2	83	295	6.3	2.8
II			77		5.9	
July I	32.1	25.8	84	326.2	6.7	2.6
II			80		6.2	
August I	32.6	25.8	83	265.7	6.2	2.6
II			80		6.1	
September I	31.8	24.9	83	197.8	5.8	2.2
II			81		5.7	
October I	30.6	22.3	83	121.3	4.4	2.1
II			79		4.3	
November I	28	17.3	84	16	3	1.8
II			77		3.2	
December I	24.9	12.5	87	6.2	2.2	1.5
II			76		2.9	
Annual Total/ Mean I	29.5	19.8	81	1751.8	4.3	2.5
Mean II			72		4.4	
Number of Years	30	30	30	30	30	30

Source: (Vol I, DPR, MMLP study by M/s Voyants & KPMG Advisory Services Pvt. Ltd.)

3.5 Site Seismicity

Jogighopa is in **Zone V** of Indian Map of Seismic zones (IS-1893 Part-1 2002) which is a severe intensity zone (**Figure 3.12**).

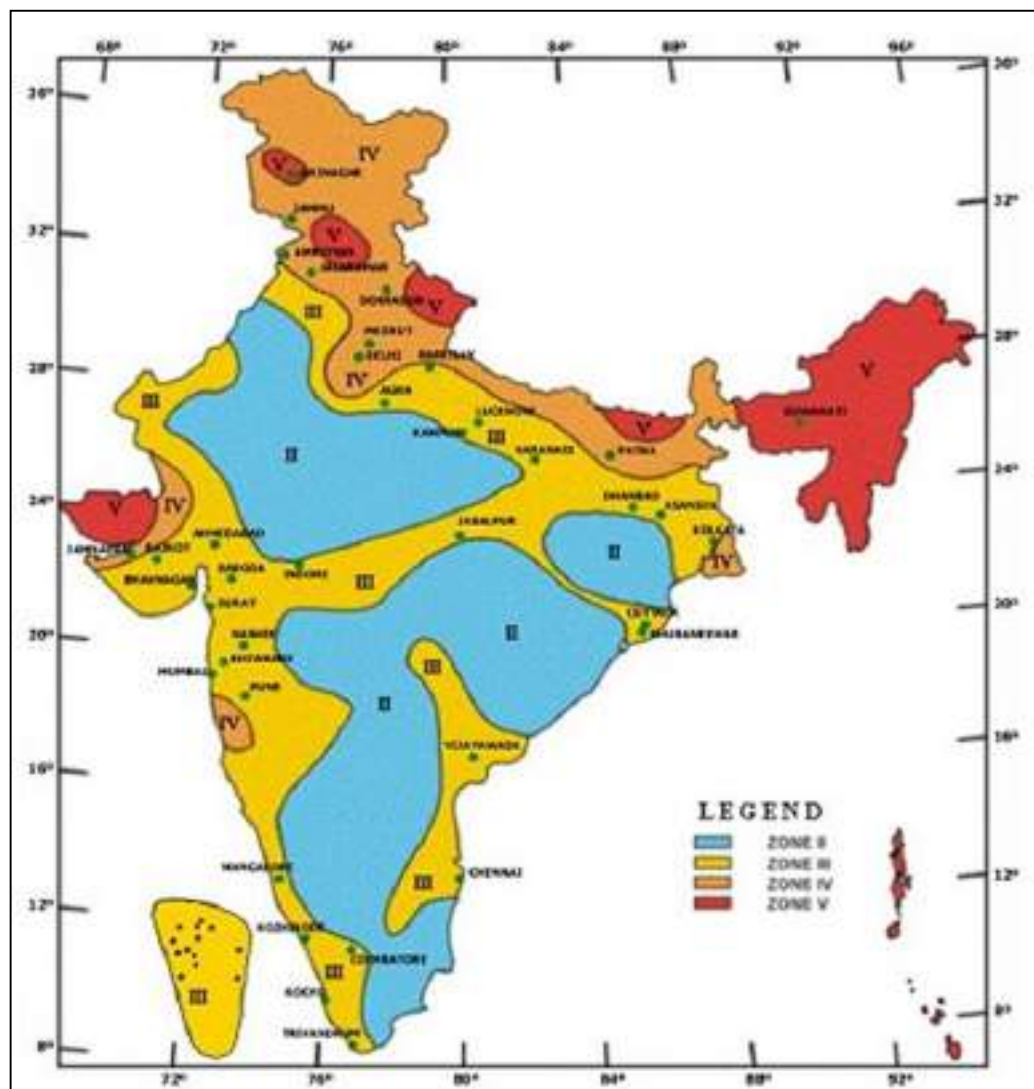


Figure 3.12: Seismic Zoning Map of India as per IS-1893 Part 1-2002

3.6 Hydrographic Survey Details

The hydrographic survey of river Brahmaputra was carried out during September 2020 as shown in **Figure 3.13**. The following water levels from the survey have been considered in the planning:

High Flood Level (HFL)	-	36.65 m
Lowest Water Level (LWL)	-	28.28 m

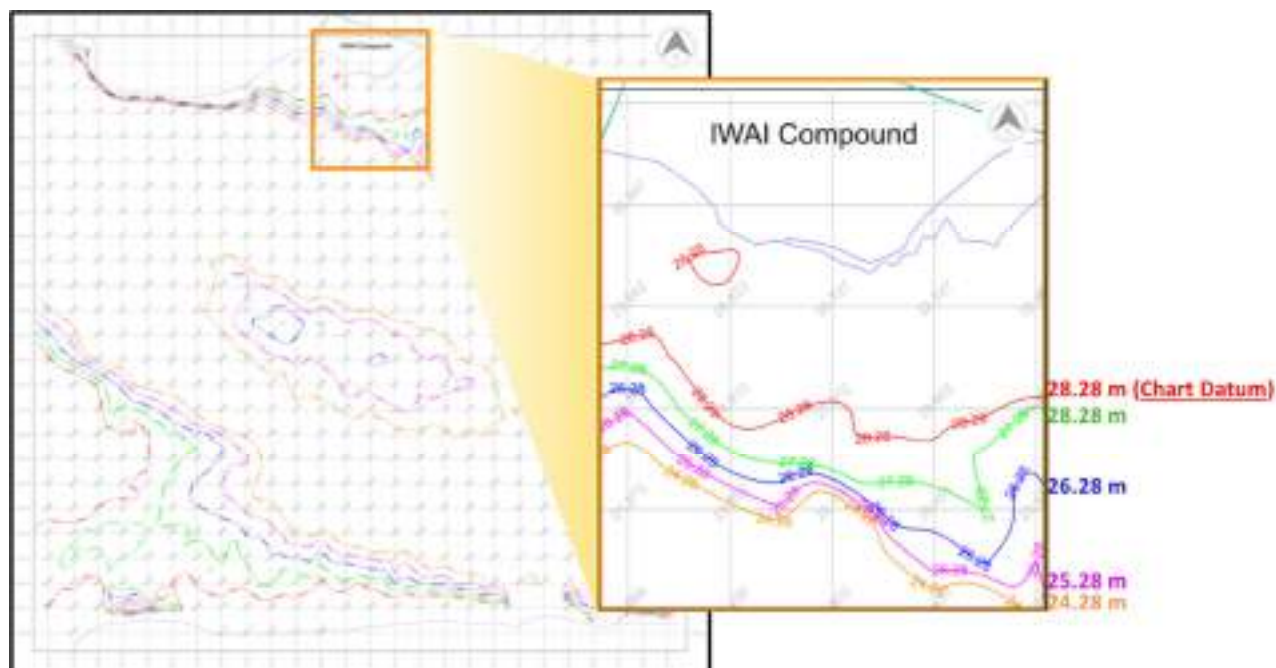


Figure 3.13: Hydrographic Survey Chart at the Project Location

The entire river width 1 km upstream & 1 km downstream was surveyed and the soundings were taken with respect to chart datum. The detailed hydrographic survey is presented at **Annexure-1**.

3.6.1 Methodology Adopted & Instruments Deployed for Hydrographic Survey

3.6.1.1 Reconnaissance Survey

Reconnaissance of the locations of the proposed location was carried out in detail to identify locations for setting up vertical control points and the tidal gauge.

3.6.1.2 Planimetric Control Survey

A pair of control points was established using DGPS at each of the locations. Due to the limited size of the locations a close traverse was not required. The coordinate of the starting location was based on the coordinates obtained from DGPS. The bearing was fixed based on the bearing provided by the DGPS coordinates of a second station.

3.6.1.3 Height Control Survey

Height control traverse was run by connecting the local Bench Mark (BM) available at the nearest railway station for each of the locations as provided in **Table 3.2**. The value of the BM as taken equal to the value provided in the station board. Double tertiary levelling was carried out to find out the closing error which was balanced and the error distributed as per standard practice. On completion of the level traverse temporary Bench Marks were kept for further detailing in height distribution and digital terrain modelling of the locations.

Table 3.2: Bench Mark Location

S. No.	Location	Bench Mark Value (MSL)
1.	Nar Narayan Bridge	43.83 m

3.6.1.4 Current Measurement

Current measurements (both magnitude and direction) using ADCP current meter have been carried out & the results are recorded & presented at **Annexure-1**.

3.6.1.5 Coordinate System

Unified co-ordinate system was adopted for the entire survey. The digital co-ordinate system used for survey is oriented to the grid system made for the purpose. At any stage, grid re-structuring/re-construction shall be possible by using the usual method for transformation.

3.6.1.6 Spot Height

Spot levels were recorded from river bank to river bank for an approximate length of 2.0 kilometre. Spot heights were taken along the entire area at 10m interval in orthogonal direction or at closer intervals. Coordinates and depth measurements were recorded using an echo sounder. The depth readings were converted to elevations by deducting the depth value from the water level elevation.

3.6.1.7 Instrument Deployed

The physical work of survey was undertaken at site using one GPS, one Electronic Total Station (viz. Sokkia 610) with one second least count, one Auto level, one Garmin GPSMAP 585 echo sounder and computer with necessary survey software for plotting the field drawings.

3.6.1.8 Presentation of Final Drawings

The coordinates for the pillars established for horizontal control point establishment are provided in **Table 3.3**. The coordinates of the Digital data in approved format was put in AutoCAD format. Complete information of the terrain, having X, Y & Z values was presented in the approved format. The drawings are provided in **Annexure-1**.

Table 3.3: Reference Pillar Details

S. No.	Field Marking	Northing (m)	Easting (m)	Elevation WRT MSL (m)
1.	P-1	2902320.000	257209.000	36.201
2.	P-2	2902355.715	257071.239	36.069
3.	P-3	2902384.354	257122.977	36.744

3.6.2 Water Sampling

Two (2) water samples were collected from river and analysed for percentage of sediment and ph. The results are provided in **Table 3.4**.

Table 3.4: River Water Sample Test Results

S. No.	Sample ID	Sediment (g/l)	pH
1.	J-1	3.12	6.92
2.	J-2	2.06	6.98

3.6.3 River Bed Sampling

Two (2) river bed samples were collected. The samples were analysed for grain size distribution, specific gravity, pH value, Sand, Silt & Clay percentage. The results are provided in **Table 3.5**. Graphs for grain size distribution is presented in **Annexure-1**.

Table 3.5: River Water Sample Test Results

S. No.	Sample ID	Specific Gravity	pH	Sand (%)	Silt (%)	Clay (%)
1.	J-1	2.66	6.92	13.2	73.3	13.5
2.	J-2	2.67	6.98	23.2	66.0	10.8

3.6.4 Velocity & Discharge Measurements

Velocity was measured at for three cross-sections. Along each cross-section three sets of velocity readings were obtained. These velocity readings along with the cross-sectional area were used to calculate the discharge at three cross-sections. The results are provided in **Table 3.6** and the cross-section is provided in **Figure 3.16** respectively. The cross-section drawings are provided in **Annexure-1**.

Table 3.6: Velocity and Discharge Results

Cross-section	Average Velocity (m/s)	Area of cross-section (sq. m)	Discharge (cum/s)
Upstream	2.7	23482	62919
Centreline	2.5	23786	59234
Downstream	2.6	23797	62212



Figure 3.14: Location of Velocity Measurements and Cross-section

3.6.5 Photographs

Selected images of surveying activities at site are provided below for the site location.



Figure 3.15: Selected Photographs – Hydrographic Survey

3.7 Topographic Survey Details

The topographic survey was carried out by M/s Fargo Consultants Pvt. Ltd., Kolkata in September 2020. The area behind the river bank is around 15 acres as shown in **Figure 3.16**. The topographic details are presented in **Appendix- 1**.



Figure 3.16: Topographic Survey Chart of the Backup Area of IWT Terminal

Detailed topographical survey of all the above ground were recorded. The survey covered the control points and all topographical features as follows:

- Buildings, hutments, sheds, structures
- Boundary features (if existing)
- Roads, tracks, footpaths etc.
- Drains (Kachha/pucca)
- Religious structures
- Trestles, pylons, poles of electric and telephone lines
- Optical fibre cable, water pipe line
- Individual solitary trees having girth 30cms and above.
- Cluster of trees, plantation area, forest area and their limits

- Agricultural land, barren land etc.
- Water bodies
- Rivers, streams, nallahs, reservoirs and their extent
- Bridges, culverts with their dimensions
- Limit of survey

3.7.1 Spot Heights

Spot heights were taken along the entire area at an interval of 5m in orthogonal directions.

3.7.2 Instruments Deployed

The physical work of survey was undertaken at site using one GPS and one Electronic Total Station (viz. Sokkia 610) with one second least count, one Auto level and computer with necessary survey software for plotting the field drawings.

3.7.3 Benchmarks for Future Reference

Three (3) benchmarks comprising of concrete pillars were constructed at each of the locations. Details of the Benchmarks are provided in **Table 3.7**.

Table 3.7: Benchmark Details

S. No.	Field Marking	Northing (m)	Easting (m)	Elevation w.r.t. MSL (m)
1	P-1	2902320.000	257209.000	36.201
2	P-2	2902355.715	257071.239	36.069
3	P-3	2902384.354	257122.977	36.744

3.7.4 Presentation of Final Drawings

Digital data in approved format has been put in AutoCAD format. Complete information of the terrain, having X, Y & Z values has been presented. The drawings are provided in **Appendix-1**.

3.7.5 Photographs

Selected images of surveying activities at site are provided below.



Figure 3.17: Selected Photographs – Topographic Survey

3.8 Geotechnical Investigation Details

As the geomorphology of the entire area is mainly older alluvium flood plain and denudated hillocks, the soil in this area is mainly alluvial in nature with good share of silt and loam in it. The Boitamari block has 64% of sandy loam soil and 20% of clay loam soil. For the purpose of initial planning the borehole data as obtained from M/s. Rodic Consultants at the proposed new bridge location about 1 km from the project site has been used. The proposed new bridge is 250m downstream from existing Rail Cum Road Bridge (Narnaranarayan Setu). The geotechnical investigations at the proposed location were carried out by M/s. Rodic Consultants from 01/04/19 to 25/04/19. As part of investigations, nine (09) boreholes were undertaken and samples were collected & analysed, and the details of the soil strata encountered are presented in **Table 3.8**.

Table 3.8: Boreholes Strata Details

Strata	Range (m)	Average (m)	Range (m)	Average (m)
Loose to medium dense fine sand	4-56	30	2-30	16
Dense grey silty sand	33-67	50	33-80	57
Boulders	11-80	45.5	47-100	73.5

The site-specific geotechnical investigations at the proposed terminal location are being carried out by M/s Fargo Consultants Pvt. Ltd. Kolkata. Total four (04) numbers of boreholes at the locations presented in **Table 3.9**, are being undertaken.

Table 3.9: Location of Boreholes

S. No.	Field Marking	Northing (m)	Easting (m)	R.L. Value (m)
1.	BH-1	2902478.019	256967.973	+35.190
2.	BH-2	2902374.181	257070.126	+34.742
3.	BH-3	2902348.240	256943.497	+34.719
4.	BH-4	2902254.208	257106.934	+35.208

The Bore log profile of all the boreholes is presented in **Drawing 60636525-DPR-1004**.

3.8.1 Photographs

Selected images of Geotechnical investigations are provided below.

**Figure 3.18: Selected Photographs – Geotechnical Investigations**

3.9 Data Collected From CWC

As per Hydro-meteorological Data Dissemination Policy, 2018, hydrological data of Brahmaputra river stands as classified. Therefore, Secrecy Undertaking was provided to CWC to obtain the data provided at Table 3.10 & all other guidelines were followed strictly.

Table 3.10: Discharge, Rainfall & Silt Data as Collected from CWC

Historical Max. Gauge (HFL with corresponding discharge) & Max. Discharge

S. No.	Historical Max. Gauge HFL (m)	Corresponding Discharge (Cum/s)	Date
1	36.65	65,714	06/09/1998
2	-	80,960	30/08/1988

Historical Maximum & Minimum Rainfall

S. No.	Rainfall	in (mm)	Date
1	Historical Max. Rainfall (mm)	231	22/09/2014
2	Historical Min. Rainfall (mm)	0.3	06/04/2010

Historical Maximum Silt

S. No.	Historical Maximum Silt		Date
1	Coarse g/l	0.11	17/07/2005
2	Medium g/l	0.18	
3	Fine g/l	0.77	
4	Total g/l	1.06	
5	Total M.T./day	4,870,244	

Note: It may be strictly noted that as per Hydro-meteorological Data Dissemination Policy, 2018, the data provided above remains classified & shall not be presented or produced without prior permission of CWC.

4. TRAFFIC PROJECTIONS FOR JOGIGHOPA IWT TERMINAL

4.1 General

The traffic assessment for proposed development of IWT terminal at Jogighopa has been carried out based on the data on existing cargo movements available from secondary sources and internal data bank of AECOM covering recent studies carried out in the area.

The Consultants have made an attempt to collect and examine all the relevant study reports and documents as well as in-house data available to arrive at the most realistic commodity wise cargo traffic estimates.

4.2 Analysis of Previous Study Reports & Documents

Following Study Reports & Documents have been examined in detail as part of this study and a brief on each is prepared, as discussed in the subsequent paragraphs.

1. DPR for Construction of IWT Terminal at Dhubri in Assam by L&T
2. Integrated National Waterways Transportation Grid Report
3. Statistics of Inland Water Transport (2017-18)
4. IWAI's Stakeholder Conference at Kolkata, (Dec. 2019)
5. Annual Report on Traffic on National Waterways (FY 2019-20) - IWAI
6. ADB's Comments on Bangladesh Economy
7. Report on Market Demand Assessment & Gap in Trunk Infrastructure - Development of Multi Modal Logistic Park at Jogighopa - June 20 carried out by KPMG & VOYANT.
8. Study for modal shift of cargo passing through Siliguri Corridor destined for North-east and neighbouring countries to IWT by E&Y (Aug. 2017).

4.2.1 DPR for Construction of IWT Terminal at Dhubri in Assam by L&T

In this report, the cargo potential assessment as per primary field data collected has been examined. Base year of the study considered was 2011-12. Average daily traffic estimated from/to Hat-Singimari in Assam, Phulbari & other places in Meghalaya and other river islands projected to be handled at Dhubri IWT Terminal is presented in **Table 4.1** below.

Table 4.1: Movement of Estimated IWT Traffic for Dhubri Ghat (2011-12)

S. No.	Commodity	Tons/Day
1.	Cashew, Ginger, Spices, Pineapples, Jute, Bamboo products, Rice, Dhall, oil and other consumable items.	700
2.	Hardware/Construction goods such as cement, steel and related commodities.	500
3.	Consumer goods other than food items.	500
4.	Fertilizer for agricultural use	200
5.	Other miscellaneous materials	200
	Total IWT traffic divertible T/day	2,100
	Total average IWT traffic, T/month	60,000
	Total Annual Traffic, T/year	7,20,000

The study assumed 60% of the estimated traffic to be divertible at the proposed Dhubri IWT terminal in the base year of the traffic estimation. To arrive at future volumes of the cargo to be handled at the terminal annual growth rate of 10% has been considered. Traffic estimated for the horizon period up to 2025-26 is presented in the **Table 4.2** below:

Table 4.2: Dhubri IWT Terminal Cargo Projections (in Million Tonnes per annum)

Year	2011-12	2014-15	2020-21	2025-26
Cargo throughput	0.4	0.53	0.85	1.37

Note: As Dhubri is the nearest developed IWT Terminal, Traffic projections approved to assess its financial & economic viability and actual traffic realization during the current period, provided basis for re-examination of the traffic projections made by other Consultants.

4.2.2 Integrated National Waterways Transportation Grid Report

The study was entrusted to RITES Ltd by the IWAI in 2011. Since, all the declared waterway systems cannot be joined to form a national waterway grid, the study envisaged connecting four out of the six national waterways to form a grid in the Eastern Region of the country i.e. NW-1 can be connected to NW-2 and NW-6 using protocol route through Bangladesh. Similarly, NW-5 that extends up to Paradip Port can also be joined in the National Waterway grid through backwaters of Hooghly and Hijilly tidal canal. The proposed connectivity would further increase the area of influence of each designated waterway system.

The National Waterways Grid involved overall rivers length of 3,220 km (excluding Indo-Bangladesh Protocol Route) and likely to serve 11 states namely; Uttar Pradesh, Bihar, Jharkhand, West Bengal, Assam, Meghalaya, Arunachal Pradesh, Tripura, Mizoram, Manipur and Odisha and 108 civil districts.

It was understood that it is important to develop an optimum multi-modal mix to offer cost effective transport solution at the national level, wherein IWT is also a significant part. To avail entire benefits of different modes, each mode should play a complimentary role. In the study an attempt has been made to link identified potential IWT terminal/locations with national rail and road network, to prepare inter-modal national transport grid. In the case of rail, nearest railheads were identified and for road, connectivity up to the nearest National or State Highways were established.

Amongst the five IWT Terminals on NW-2 recommended for both rail & road connectivity, Jogighopa was also one of the candidate locations, as can be seen from **Table 4.3** below:

Table 4.3: IWT Terminals on NW-2 Proposed with Rail and Road Connectivity

S. No.	National Waterway	Name of IWT Terminal	Nearest NH	Nearest Railhead	Gauge
1.	NW-2	Jogighopa	NH 31 B	Jogighopa	BG
2.	NW-2	Tezpur	NH- 37	Tezpur	BG
3.	NW-2	Neamati	NH-37	Jorhat	BG
4.	NW-2	Saikhuaghat/Dibrugarh	NH- 52	Dibrugarh	BG
5.	NW-2	Pandu (Guwahati)	NH 37	Kamakhya	BG

Note: The Report prepared an Integrated National Waterway Grid and its connectivity with other modes of transport i.e. rail and road to offer optimum unit cost of transportation on the selected corridors. Jogighopa was identified as one of the potential IWT terminal on NW2 for its inter-modal connectivity.

4.2.3 Statistics of Inland Water Transport (2017-18)

Statistics of Inland Water Transport (2017-18) was published by the Government of India, Ministry of Shipping, Transport Research Wing New Delhi, in March 2020. Statistics handbook defined the functions of the Inland Waterways Authority of India (IWAI) as under:

- To carry out surveys and investigations for the development, maintenance and better utilization of the National Waterways (NWs) and the appurtenant land for shipping and navigation by providing infrastructural facilities, conservancy & river training works,
- Controlling activities of dumping / removal of bed material,
- Removing / altering any obstruction / impediment,
- Regulating traffic and structure across / under NWs,
- Disseminating navigational meteorological information,
- Coordinating with other modes of transport, providing pilotage and Entering into joint ventures concerning inland shipping by equity participation.

The Authority will exercise the following functions with the prior approval of the Central Government.

- Advise Central Government on IWT matters,
- Study the transport requirement in relation to other modes,
- Conduct Hydrographic Surveys & publish river charts,
- Assist State Governments for development of IWT,
- Develop & provide consultancy services,
- Conduct research for craft design, mechanization of country crafts, techniques of towage, landing & terminal facilities, port installations & survey techniques,
- Classification of Inland Waterways
- Technical training of IWT personnel within & outside country.

Cargo movement on various operating Waterways for the past three years (2015/16 onwards) is tabulated as under:

Table 4.4: Cargo Movement on Waterways

S. No.	Details of Waterway	Cargo Moved (lakh tonnes)			Tonne Kms (in lakh)		
		2015-16	2016-17	2017-18	2015-16	2016-17	2017-18
1	NW - 1	62.37 (14.3)	45.05 (7.7)	54.79 (7.9)	26,995 (78.0)	24,598 (62.2)	27,773 (65.3)
2	NW - 2	25.84 (5.9)	25.91 (4.4)	26.01 (3.8)	505 (1.5)	503 (1.3)	504.36 (1.2)
3	NW - 3	10.61 (2.4)	10.33 (1.8)	4.28 (0.6)	105 (0.3)	109 (0.3)	81.14 (0.2)
	Sub Total NWs	98.82 (22.6)	81.29 (13.8)	85.08 (12.3)	27,605 (79.8)	25,210 (63.8)	28,358.5 (66.6)
4	Goa Waterways	49.75 (11.4)	157.68 (26.8)	111.62 (16.1)	1,987 (5.7)	7,884 (19.9)	5,581.06 (13.1)
5	Maharashtra Waterways	288.49 (66.0)	348.90 (59.4)	379.04 (54.9)	5,005 (14.5)	6,428 (16.3)	6,882 (16.2)
6	Gujarat Waterways (Oct' 17)	-	-	115.2 (16.7)	-	-	1,728 (4.1)
	Grand Total	437.0	587.87	690.9	34,597	39,522	42,549.5
Source: Inland Waterways Authority of India for National Waterways & Gujarat Waterways Data for Goa Waterways include the data received from Ports department, Govt of Goa and the data received from the Mormugao Port Trust (MPT). Maharashtra Maritime Board for Maharashtra Waterways.							

Note: Cargo handled in Kolkata-Bangladesh-Kolkata route is included in the traffic on NW-1. The route is a link between NW-1 & NW-2 through Bangladesh. Figure within brackets indicates percentage to the total.

As indicated in the Report, volume of freight movement on NW-1 increased from 45.05 lakh tones in 2016-17 to 54.79 lakh tonnes in 2017-18 due to steady increase in Indo – Bangladesh protocol route traffic on account of increase in fly ash consumption by cement plants in Bangladesh and general increase in traffic on NW-1.

The important commodities served by IWT on NW-1 in the past six years i.e. 2012-13 onwards are summarised in **Table 4.5** below.

Table 4.5: Composition of Cargo Moved on NW- 1 (In Tonnes)

Name of the Commodity	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Building Material	17,27,685 (63.6)	19,97,301 (59.6)	20,44,784 (40.5)	23,93,416 (38.4)	27,04,742 (60.0)	35,68,909 (65.1)
Fertilizers	52,000 (1.9)	36,800 (1.1)	1,32,299 (2.6)	1,24,000 (2.0)	7,26,260 (16.1)	0 (0.0)
Food items	3,45,179 (12.7)	3,94,935 (11.8)	5,27,048 (10.4)	4,99,024 (8.0)	1,37,730 (3.1)	38,340 (0.7)
Miscellaneous	13,842 (0.5)	11,476 (0.3)	17,690 (0.4)	8,010 (0.1)	59,478 (1.3)	2,816 (0.1)
Mix	21,800 (0.8)	8,250 (0.2)	65,312 (1.3)	0 (0.0)	0 (0.0)	16,94,196 (30.9)
Ore/Minerals	22,90,00 (8.4)	1,12,000 (3.3)	2,42,000 (4.8)	31,000 (0.5)	16,761 (0.4)	0 (0.0)
POL/POL products	2,47,341 (9.1)	2,12,063 (6.3)	2,50,418 (5.0)	2,73,684 (4.4)	1,62,520 (3.6)	0 (0.0)
Coal	79,590 (2.9)	5,61,456 (16.8)	17,36,492 (34.4)	28,43,001 (45.6)	6,68,740 (14.8)	1,60,262 (2.9)
Iron steel	-	14,857 (0.4)	34,166 (0.7)	64,989 (1.0)	29,146 (0.6)	14,839 (0.3)
Total NW-1	27,16,437 (100.0)	33,49,138 (100.0)	50,50,209 (100.0)	62,37,124 (100.0)	45,05,377 (100.0)	54,79,362 (100.0)

Source: Inland Waterways Authority of India for National Waterways.

Note: Figures within brackets indicate percentage to the total.

The market served by the proposed IWT terminal at Jogighopa is akin to NW-1.

Further cargo movement on India-Bangladesh route (National Waterway-I) during the years 2012-13 to 2017-18 indicating main commodities handled as presented in the report is shown in **Table 4.6**.

Table 4.6: Movement of Cargo on India- Bangladesh route of NW-1* (Tonnes)

Route	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	Commodities
India to Bangladesh	16,93,441	18,89,729	19,83,454	22,68,151	25,75,625	30,88,430	Flyash, Salt in bulk, Rice, Wheat POL, Coal, Slag Gypsum, HSD, Edible Oil, Iron Ingots, Cement, Bone crushed, Cement Clinker, Dolomite Powder
Source: Inland Waterways Authority of India *Data pertains to cargo carried on Indian registered vessels only.							

With regard to the National Waterway-2 from Dhubri to Sadiya (891 km) in the state of Assam, following information has been provided:

A navigable fairway of minimum 45 m width and 2.5 m Least Available Depth (LAD) was maintained in Dhubri-Pandu (255 km) and Pandu-Neamati (374 km) stretch. In Neamati-Dibrugarh stretch, 2.0 m LAD was maintained for 350 days. In Dibrugarh-Sadiya (Orumghat) stretch, LAD of 1.5 m was maintained for 365 days.

Apart from the channel maintenance, the projects for construction of Ro-Ro terminals at Dhubri & Hatsingimari is being implemented. The floating terminals provided at 11 locations can also be shifted to any other place based on demand.

Night navigation facilities provided between Dhubri and Silghat can be extended in a short period of time depending upon demand. DGPS station established at Dhubri, Jogighopa, Vishwanath Ghat and Dibrugarh is providing DGPS connectivity in entire NW- 2 and some portion of Protocol routes in Bangladesh.

The total cargo traffic on NW- 2 was 26.01 lakh tonnes during 2017-18 as against 24.26 lakh tonnes during 2012-13 showing an overall increase of 7.2%. Commodity-wise composition do not depict a clear picture, as all cargo is consolidated under 'Miscellaneous' as given below:

Table 4.7: Composition of Cargo Moved on NW-2 (In Tonnes)

Commodity	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Building Material	-	-	-	-	-	-
Food items	-	-	-	-	-	-
Miscellaneous	24,26,805 (100.0)	24,75,349 (100.0)	24,91,720 (100.0)	25,84,306 (100.0)	25,90,754 (100.0)	26,01,227 (100.0)
Mix	-	-	-	-	-	-
Ore/Minerals	-	-	-	-	-	-
POL/POL Products	-	-	-	-	-	-
Total NW II	24,26,805 (100.0)	24,75,349 (100.0)	24,91,720 (100.0)	25,84,306 (100.0)	25,90,754 (100.0)	26,01,227 (100.0)
% Increase		2.00%	0.66%	3.72%	0.25%	0.40%

Source: Inland Waterways Authority of India for National Waterways.

Note: Figures within bracket indicate percentage to the total

Different IWT Terminals on NW-2 are considered with different purposes, such as;

1. Dhubri: For completion of customs and immigration both for incoming and outgoing vessels on Protocol route in addition to handling of cargo vessels and passenger ferries.
2. Jogighopa: For transportation of Meghalaya coal/import of coal for NTPC power plant at Bongaigaon.
3. Pandu: Pandu is the major location on NW-2 as an entry point to NE States.
4. Tejpur: For handling of cargo vessels, local ferry service. ODC cargo is also expected at this terminal in view of upcoming hydro power projects.
5. Biswnath Ghat: Projected for handling of PDs cargo by FCI and ODC movement.
6. Silghat: For movement of POL of Numaligarh Refinery.
7. Neamati: For handling of cargo vessels, local ferry service. ODC cargo is also expected at this terminal in view of upcoming hydro power project.
8. Bogibil: For handling of FCI cargo.
9. Dibrugarh: For handling of cargo vessels, local ferry service. ODC cargo is also expected at this terminal in view of upcoming hydro power project.
10. Sengajan/ Panbari: Considered in view of regular movement of Indian army IWT fleet.
11. Oriumghat: To facilitate passengers connected to Arunachal /Assam, BSF / Army and link to southern bank like Dibrugarh. ODC and project cargo.

Infrastructure facilities available at various operating IWT terminals on NW-2 (as on 31-3-2018) are summarised in **Table 4.8** below:

Table 4.8: Infrastructure Facilities Available at various operating IWT terminals on NW-2

Stretch	Size of Vessels that can be accommodated (DWT)	No. of Berths	Cargo Handling Equip. and their Capacity	Type and Extent of Storage Facility Available	Remarks
1. Bangladesh Border-Pandu: (255 km), Depth - 2.5 m					
(a) Hatsingmari	600	Jetty	Crane pontoon		Ro-Ro Jetty is operational
(b) Dhubri	600	One (RCC Ro Jetty)	Crane pontoon	-	(i) Storage facility is developed
					(ii) DGPS station is commissioned.

Stretch	Size of Vessels that can be accommodated (DWT)	No. of Berths	Cargo Handling Equip. and their Capacity	Type and Extent of Storage Facility Available	Remarks
(c) Jogighopa	600	One (floating)	Pontoon	Open storage facility available	(i) DGPS station is commissioned
(d) Pandu	600	One low level RCC+ One High level RCC Jetty	One Container crane of 75 T capacity, two tyre mounted cranes of 20T, three crane pontoon and one pontoon	(i) 2 transit sheds of 75 x 21 m Each ii) Open storage facility also available	(i) BG siding is completed. (ii) Approach road available.
2. Pandu-Neamati: (374 km), Depth- 2.5 m					
(e) Tezpur	600	One (floating)	Pontoon	Open storage	
(f) Silghat	600	One (floating)	Pontoon	Open storage	DGPS station is commissioned.
(g) Biswanath	600	One (floating)			
(h) Neamati	600	One (floating)	Pontoon	-	
3. Neamati-Dibrugarh: (123 km), Depth-1.5					
(i) Bogibeel	600	One (floating)	Pontoon	-	
(j) Sengajan/ Panbari	600	One (floating)		-	
4. Dibrugarh-Sadiya (Oriumghat): (139 km), Depth 1.5 m					
(k) Oakland/ Dibrugarh	600	One (floating)	Pontoon	-	DGPS station is commissioned.
(l) Oriumghat	600	One (floating)	Pontoon	-	1.77 hect. land acquired for development of terminal.

Source: Statistics of Inland Water Transport, 2017-18.

- Floating pontoons can be provided at any location along waterway on demand.
- Night navigation facilities are available between Bangladesh Border and Silghat (440km).
- River notices issued on regular monthly/fortnightly basis.
- Different Global Positioning System (DGPS) Stations to cover entire waterway are provided at Dhubri, Jogighopa, Biswanath and Dibrugarh.

Note: The Report provided commodity wise traffic handled on different National Waterways and facilities available at IWT terminals in NW-2.

4.2.4 IWAI's Stakeholder Conference at Kolkata, (Dec. 2019)

A stakeholder conference was held in Kolkata on 17th Dec 2019 to discuss important issues with stakeholders. IWAI highlighted its Objectives and Key Functions to the stakeholders.

Objective:

Develop a self-sustainable, economical, safe & environment friendly supplementary mode of transport for the overall economic growth of the country, simultaneously contributing to de-congestion of already congested modes viz. roadways & railways.

Functions:

- (a) Infrastructure Development
- (b) Regulation
- (c) Technical Studies
- (d) Advise & Assistance
- (e) Training & Development

Key Interventions:

Fairway Development: Dredging, River training and conservancy works, bandalling, river marking, bank protection works

Navigational Aids: Installation of navigational aids like buoys, River Information System (RIS), Digital Global Positioning Systems (DGPS), Beacon Lights etc.

Terminal Development: Development of Multi-modal terminals (MMTs), Inter Modal Terminals (IMTs) and Ro-Ro Terminals

Other Riverine Structures: Construction of locks, ship repair facilities, bunkering stations etc.

Vessel Operations: Vessel designs and pilot runs

Important issues discussed in the presentation on NW2 and IBP route are as under:

Integrated IWT route:

Integrated IWT route including IBP route connects Indian rivers Ganga (NW-1), Brahmaputra (NW-2) and Barak (NW-16) with Bangladesh's rivers Jamuna, Padma, Gumti, Meghna and Kushiara and provides an integrated connectivity as shown in the **Figure 4.1** below:



Figure 4.1: Integrated IWT route including IBP route

Integrated waterways connectivity between India and Bangladesh will also open opportunities to explore waterways-based trade routes with Nepal and Bhutan. Kolkata is the focal point for integrated waterways development.

The Protocol on Inland Water Transit and Trade (PIWT&T) plays a key role to promote trade between India and Bangladesh. There are currently six (06) existing Ports of call on each side.

Indian Ports of Call are namely; Kolkata, Haldia, Dhubri, Pandu, Silghat and Karim Ganj.

Bangladesh Ports of Call are namely; Narayanganj, Khulna, Mongla, Sirajganj, Ashuganj and Pangaon.

In addition, following routes are agreed to be extended /included under PIWT&T

- Protocol route no.5 & 6 i.e. Rajshahi-Godagari- Dhulian (length: 78 km) to be extended up to Aricha (Bangladesh) (Dhulian-Aricha: 270 km).
- Inclusion of Daudkhandi -Sonamura stretch (98 km) on Gumti river as new route no. 9 & 10

Agreed Additional ports of call (5 nos. on each side)

Indian side: Kolaghat, Dhulian, Maia, Sonamura, Jogighopa

Bangladesh Side: Chilmari, Rajshahi, Sultanganj, Daudkhandi, Bahadurabad

Extended ports of call (2 nos. on each side)

Indian side: Badarpur (Karimganj), Tribeni (Kolkata)

Bangladesh side: Ghorasal (Narayanganj), Muktarpur (Pangaon)

On Bhutan –Bangladesh connectivity through India

The agreement on Trade, Commerce and Transit signed in July 2017 between Govt. of India and Royal Govt. of Bhutan, declares Dhubri on NW-2 as an agreed exit/ entry point in India for EXIM movement of Bhutan.

SoP for the MoU on use of Inland waterways for transportation of bilateral trade and transit cargoes between Govt. of Bangladesh and the Royal Govt. of Bhutan was signed in April 2019.

1,005 tonne of Bhutan's stone aggregates originating from Phuentsholing (Bhutan) was transported from Dhubri (NW-2) to Narayanganj (Bangladesh) using the IBP route in July 2019.

Use of Chattogram/ Mongla for India's Transit Cargo

Access to Chattogram and Mongla for India's transit cargo opens up synergistic opportunities for businesses in both countries.

- Agreement on the use of Chattogram and Mongla Ports in Bangladesh for transit cargo of India signed on 25th October 2018.
- SoP signed on 5th October 2019
- North East India based trade to benefit with faster access to Sea Ports
- Bangladesh will benefit with increase in demand for logistics services

Note: IWAI updated the stakeholders on its role & responsibilities, operations and achievements on NW2 & IBP Route. In the presentation, IWAI declared Jogighopa as one of the IBP Port of Call in India as well as additional and other ports of calls in India and Bangladesh.

4.2.5 Annual Report on Traffic on National Waterways (FY 2019-20) by IWAI

As per a World Bank study, IWT mode has the least operational cost of USD 0.015/ T- km, compared to USD 0.033/ T-km for Road and USD 0.02/ T-km for Rail. Globally, inland waterways have been recognized and developed as a mode of transportation to leverage these benefits. India has approximately 14,500 kms of navigable waterways which comprise of rivers, canals, backwaters, creeks, etc. with significant potential to be developed as an alternative mode of transportation. In the pre-independence years, IWT mode was used extensively in various parts of the country for transportation of both passengers and goods. However, post-independence, due to lack of adequate attention on developing the sector, the IWT mode lost recognition as a mode of transportation. As a result, despite the inherent advantages, the share of Inland waterway transport (IWT) mode in India is currently estimated to be only around 2%.

Inland waterways authority of India (IWAI), an authority under Ministry of Shipping, was established in 1986 to develop and regulate the inland waterways for shipping and navigation. Recognizing the benefits and importance of inland waterways and to increase its modal share, the Government of India declared 106 new waterways as National Waterways (NWs) through the National Waterways Act, 2016 taking the total number of NWs to 111.

This report carries out a detailed analysis of the traffic movement on the 16 operational NWs in FY-20 and covers the details such as traffic quantity and trend vis-à-vis previous year, commodity profile and key origin and destination jetties/ locations on the operational NWs.

4.2.5.1 Traffic on National Waterways

The total traffic movement on NWs in the FY-20 was recorded as 73.64 million tonnes against 72.3 million tonnes in FY-19 thereby recording a YoY growth of approx. 2%. Predominantly bulk commodities viz. coal & coke, iron ore, fly ash, limestone etc. are using the IWT mode in India and constitute more than 90% of the overall traffic.

4.2.5.2 Salient aspects of Traffic Movement on NW-2 (FY-2020)

In case of NW-2, movement of stone chips/ boulders originating from Bhutan and going to Bangladesh via the IBP route has gained traction. More than ten (10) shipments took place from IWAI's Dhubri (Assam) terminal using shallow draft vessels in FY-20 and these movements are expected to become regular.

Additionally, five (05) movements carrying coal and containerized cargo were successfully completed between Haldia and Guwahati during the year. These movements shall enhance the traffic to/ from north east region (NER) using IWT mode in the coming years.

With the nation-wide lockdown due to outbreak of Covid-19, the movement of vessels got suspended resulting in sharp fall in traffic in the month of March 2020.

4.2.5.3 The Indo-Bangladesh Protocol route

India and Bangladesh have signed the Protocol on Inland Water Transit and Trade (PIWT&T) under which inland vessels of one country can transit through the specified protocol routes of the other country. Six Ports of call have been declared in each country under the PIWT&T. The Ports of call in India are Haldia (West Bengal), Kolkata (West Bengal), Dhubri (Assam), Pandu (Assam), Karimganj (Assam) and Silghat (Assam). The Ports of call in Bangladesh are Narayanganj, Khulna, Mongla, Sirajganj, Ashuganj and Pangaon. With collaborative efforts of IWAI and BIWTA the traffic has been continuously increasing on the IBP route and both the countries have agreed to add 7 new ports of call on along with addition/ extension of waterway routes under PIWT&T. Approx. 3.5 million tonne of traffic moved on the IBP route in FY-20 and displayed a growth of approx. 7% over FY-19. Traffic on the IBP route predominantly consists of fly ash movement from Kolkata/Haldia to destinations based in Bangladesh. Fly ash movement to Bangladesh is driven by the requirement of Cement plants.

To allow round the year navigation, two stretches on the IBP route viz. Sirajganj – Daikhawa and Ashuganj - Zakiganj in Bangladesh are being developed (2.5 m LAD) at a total cost of approx. Rs 305.84 Cr. on 80:20 cost sharing basis (80% being borne by India & 20% by Bangladesh).

The development of these two stretches will provide seamless navigation to and from North East India through waterways via the IBP route. To enhance use of the IBP route for transshipment of traffic to/ from North East regions, IWAI has initiated consultations with stakeholders such as Customs, BIWTA etc. to relax documentation procedures and improve navigation assisting services in Bangladesh waterways.

4.2.5.4 National Waterway-2

IWAI maintains stretch-wise Least Available Depth (LAD) on NW-2 around the year, which has resulted in regular traffic movement. The traffic on NW-2 primarily consists of passengers, vehicles and goods movement taking place through ferries. Approx. 0.39 million tonnes of traffic moved on NW-2 in FY-20 between approx. 50 Origin-Destination pairs. The graph below presents the month wise traffic for FY-20 as compared to FY-19. The total traffic in FY-20 has decreased by approx. 22% from 0.5 million tonne in FY-19 to 0.39 million tonnes in FY-20. The decrease in traffic is due to the shift of traffic from

waterways to road after construction of the Bogibeel bridge over River Brahmaputra (NW-2) in December 2018. Due to the shift of traffic to road via Bogibeel bridge, NW-2 based cross river ferry movement at Bogibeel, Dibrugarh, Oriumghat and surrounding areas has stopped. In July 2019, movement of Bhutanese stone chips & boulders started using IWT mode from Dhubri to destinations in Bangladesh.

Passengers (51%) account for the highest share of traffic moving on NW-2 followed by goods (40%). The goods movement on NW-2 is unorganized in nature consisting of personal items, vegetables etc. The graph below presents the share of jetties at the origin and destination locations on NW-2 for FY-20. It can be observed that Dhubri is the major origin location accounting for 51.1% of the total traffic moving on NW-2. Traffic movement from Dhubri takes place to 17 destination locations. D hubri is followed by Neamati (21%) and Jogighopa (8%), and these 3 origin locations constitute 80% of the origin traffic in FY-20. The destination locations are highly fragmented with a total of 46 destination locations. Of these 46 locations, Kamalabari accounts for 17.1% and Neamati accounts for 5.1%. The remaining 44 locations handle less than 5% traffic each.

In FY-20, traffic on National Waterway-2 has been recorded at approx. 60 jetties. These jetties handle goods, vehicles and passengers primarily through ferries. Among the jetties on NW-2, Dhubri handled the maximum loaded traffic however, it saw a dip in traffic in FY-20 as compared to FY-19. Neamati and Goalpara saw a slight increase in the loaded traffic, whereas Jogighopa and Bhomoraguri saw a slight decrease in the loaded traffic compared to FY-19.

Considering the unloaded traffic on the jetties on NW-2, Kamalabari handled the maximum traffic and saw an increase in its traffic as compared to FY-19. Birsing Char saw a drastic increase in the unloaded traffic, while Krishnai, Phulbari and Salmara saw a decrease in the unloaded traffic compared to FY-19.

4.2.5.5 First ever containerized movement on NW-2

Successful completion of the first containerized movement on NW-2 marked FY-20 as a landmark year for Inland Waterway Transportation. In line with Government's focus on improving connectivity of the NER, a landmark container cargo consignment sailed from Haldia Dock Complex (HDC) to IWAI's Pandu Port (Guwahati) on NW-2 on 4th November 2019. Inland vessel MV Maheshwari carrying 48 TEUs (with food & beverage, edible oil etc.) for its voyage via NW-1, NW-97 (Sundarbans), IBP route and NW-2.

This initiative by IWAI (Ministry of Shipping) to commence containerized movement to North East via IWT mode has been appreciated by all stakeholders with great enthusiasm. IWAI is making concerted efforts to take up such movements to demonstrate the technical and commercial viability of Inland Waterways connectivity to NER to instil confidence in the industry for the modal shift of traffic and is at the same time engaging with stakeholders such as BIWTA, Customs authorities and Industry to address and resolve operational and procedural constraints.

4.2.5.6 Bhutan-Bangladesh trade via NW-2

Bhutan has been exporting significant quantity of stone aggregates through the land route for different construction projects in Bangladesh. Stone exporters have identified Inland waterways as an alternate mode of transportation considering the benefits associated with waterways mode such as lower transportation cost, larger shipment size compared to road, avoiding congestion on land routes etc.

In the first such movement of its kind, 1,005 tonnes of crushed stone aggregates originating from Bhutan was transported from IWAI's jetty at Dhubri (Assam) on NW-2 to Narayanganj, Bangladesh on 11th July 2019. Stone aggregates were transported using trucks from Bhutan based stone quarries to IWAI's Dhubri jetty and subsequently loaded on IWAI's vessel MV AAI using mechanized loading system.

This movement evinced confidence in the Bhutanese exporters to increasingly shift to waterways mode and increase the trade of stone aggregates and other commodities between Bhutan and Bangladesh. As a result of the success of the first movement, movement of stone aggregates has become regular between Dhubri and Chilmari (Bangladesh) and more than 10 shipments of approx. 100-300 tonne size have been completed in FY-20.

4.2.5.7 Initiatives for Growth of Traffic on National Waterways

To enhance the utilization of NWs for transportation of cargo and passengers, IWAI is pursuing multiple initiatives in consultation with different stakeholders. These initiatives are briefly summarized as follows.

1. **Fairway Development Works:** To improve the connectivity between NW-1 and NW-2/ NW-16 via the Indo Bangladesh protocol route, the critical and shallow stretches between Sirajganj and Daikhowa on protocol route No1 & 2 and Ashuganj and Zakiganj on protocol route no 3 & 4 in Bangladesh are being jointly developed by India and Bangladesh for round the year navigability (with targeted LAD of 2.5 m). Similarly, fairway development works are being carried out on NW-97 in Sunderbans to allow smooth navigation of vessels on the Indo-Bangladesh Protocol Route.
2. **Operations & Management of IWAI's Terminals by Private Operators:** IWAI is in the process of handing over its terminals on all NWs to private operators on PPP basis. Dhubri and Pandu (Guwahati) Terminals on NW-2 are in the process of PPP based operation and maintenance. Appointment of O&M operators will bring in necessary operations and marketing experience and shall contribute to increase in traffic on IWT mode.
3. **Policy for Development of Private Jetty/ Terminal:** With the growth of IWT traffic on NWs, private entities have exhibited interest to build and operate private terminals on NWs. Allowing private entities to build, operate and manage the terminals will enable rapid development of terminal network on NWs. In view of the advantages associated with private sector participation in development of terminals on NWs, IWAI has proposed to permit the private sector to develop their own jetties and operate them on commercial basis. This initiative is expected to bring in much needed participation of private sector in augmenting the development of infrastructure and modal shift of cargo in favour of IWT.
4. **Development of Portals FOCAL and LAD:** A dedicated portal named FOCAL (Forum of Cargo Owners and Logistics Operators) was developed by IWAI to connect cargo owners interested in moving their cargo using the IWT mode and vessel operators who are operating vessels on National Waterways (NWs). The portal allows registered users to share their transportation requirement and positioning of vessels on different NWs. Also, IWAI has internally developed a portal 'LAD' to facilitate the day-to-day operations of inland vessels plying on NWs and to avoid any hindrance in service and operation. The portal enhances credibility and efficiency of information sharing to achieve seamless operations on NWs, besides pre-empting problems that may occur during movement of vessels.
5. **Digital Portal for Dissemination of Information to IWT Users:** IWAI is currently developing a digital portal to disseminate key systematic and aggregated River and Navigational information related to NWs to various stakeholders. The portal shall provide detailed information on various NWs in India such as fairway (LAD, etc.), infrastructure facilities (jetties, pontoons, cargo handling equipment, storage facilities), cross river structures (bridges, locks, barrages, etc.), connectivity at jetties, emergency services, vessel sailing plan details etc. for facilitating transportation of cargo and other vessels through NWs. This will help different stakeholders to better understand the key features of the NWs that are essential for decision making on the use of IWT mode.

6. **Facilitation of Cargo Transportation by the Local Community:** IWT has been traditionally used by the local community for transportation of their produce and passengers. Facilitation of movement of goods on waterways at local level as part of the Arth Ganga vision will further enhance use of IWT.
7. **Enhanced Regional Trade using IWT mode:**
 - a. **Addition of New Ports of Call and Routes in India and Bangladesh under PIWT&T:** With 7 new ports of call agreed to be added on each side along with addition/ extension of waterway routes under PIWT&T between India and Bangladesh, the accessibility of IWT mode for trade between India and Bangladesh is expected to increase and result in growth of traffic on NWs. As per an assessment, approx. 2.5 million tonnes (MT) of traffic is expected to get diverted to IWT mode with the extension of Rajshahi-Dhuliyar route up to Aricha in Bangladesh.
 - b. **Inclusion of IWT mode in the Indo Nepal Trade Treaty:** Inland waterways mode has been agreed for inclusion in the trade treaty between India and Nepal. This will allow Nepal bound cargo (coming from 3rd country via Kolkata port and India's exports) to take waterway up to Sahibganj MMT (Jharkhand), proposed Kalughat terminal near Patna (Bihar) and Varanasi MMT (UP) and further movement to Nepal via road. The IWT route will provide an alternate option to the traffic, which currently faces significant challenges such as congestion and delays on the rail and road mode currently.
 - c. **Trade between Bhutan and Bangladesh:** Stone exporters from Bhutan have identified Inland waterways as an alternate mode of transportation considering the benefits associated with waterways mode such as lower transportation cost, larger shipment size compared to road, avoiding congestion on land routes etc. The first movement under supervision of IWAI was successfully executed in July 2019. This movement evinced confidence in the Bhutanese exporters to increasingly shift to waterways mode and increase the trade of stone aggregates and other commodities between Bhutan and Bangladesh. As a result of the success of the first movement, transportation of stone aggregates has become regular between Dhubri and Chilmari (Bangladesh) and more than 10 shipments of approx. 100-300 T size have been completed in FY-20. This trade using the IWT mode is expected to continue and reach a significant scale in the coming years.
8. **Delineation and Relaxation of Customs Procedures for Transportation of Transit Goods via Bangladesh through the IBP route:** To further facilitate use of the IWT mode for movements of goods to/ from North East states of India via the IBP route (under PIWT&T), IWAI held consultations with the Central Board of Indirect Taxes and Customs (CBIC), Ministry of Finance (GoI) to delineate the Customs procedure and consider possible relaxations. In view of this, CBIC has issued Transportation of Goods (Through Foreign Territory), Regulations, 2020 on 21st February 2020. These regulations delineate the procedures to be followed by the trade for transit goods passing through the IBP route and have also dispensed with the requirement of Cross Border Certificate for the purpose of the subject regulations.
9. **Facilitation of Ro-Ro/ Ro-PAX Traffic:** IWAI has procured Ro-Ro and Ro-PAX vessels for operations at NW-1, 2 and 3. Discussions are in progress with multiple State Governments to operate these vessels and to regularize the operations of informal sector.
10. **Container Movement between Cochin Port and Kottayam Port via IWT:** After the success of the pilot movement in 2019, containerized movement between Cochin port and Kottayam port via NW-3 and NW-9 is expected to become regular in the coming years, thereby shifting traffic from road to IWT mode and helping in reducing road congestion.

11. **Development of new National Waterways:** IWAI has identified 20-25 new National Waterways (NWs) through technoeconomic feasibility studies for undertaking technical interventions to make the waterways navigable for transportation purpose. Once ready, these new waterways will provide an alternate mode of transportation in respective geographies.
12. **Stakeholder Consultations:** IWAI carried out stakeholder consultations at six different locations (Kolkata, Kochi, Mumbai, Patna, Goa and Dhaka) in FY-20. These interactions helped in promoting waterways as a mode of transportation and understanding expectations and feedback of stakeholders. IWAI is undertaking targeted initiatives to address the expectation and feedback received to further enhance traffic on NWs.

The above initiatives shall promote ease of accessing and using the IWT system, besides enhancing the efficiency and safety of operations and shall result in traffic increase on the National Waterways in the coming years.

Note: This Annual Report provided latest information on Traffic handled at various National Waterways, in addition it also updated new ports of call between India and Bangladesh and highlighted new streams of traffic attracted on NW-2 as well as IWAI's initiatives in future to attract IWT traffic.

4.2.6 ADB's Comments on Bangladesh Economy

On 3/04/2020, ADB Published that Bangladesh economy is expected to remain strong. The Bangladesh economy is expected to remain strong in fiscal 2020, with a strong GDP growth rate of 7.8 per cent, according to the Asian Development Bank. The gross domestic product (GDP) of Bangladesh is expected to grow by 8.0% in FY-2021. These growth forecasts rest on assumptions of continued political calm, maintained consumer and investment confidence, depressed exports and imports in FY-2020 and recovery in FY-2021.

The forecasts do not reflect the impact of the COVID-19. "Bangladesh economy continued to perform well despite the global economic slowdown. However, there exists a downward risk due to the COVID-19 global pandemic,".

"ADB's preliminary estimates indicate that about 0.2% to 0.4% of Bangladesh GDP may be lost due to spill over effects of the global COVID-19 pandemic. If a significant outbreak occurs in Bangladesh, the impact could be more significant".

"The outlook will be updated as more information becomes available. To cope with and mitigate the impact of the COVID-19, ADB is committed to support and collaborate with Bangladesh.

Appreciating the government's recent interventions, "Addressing cash management challenges and broader resiliency issues due to COVID-19 related shutdowns and economic knock-ons could help minimize impact on Bangladesh economy."

During the first eight months of FY-2020, Bangladesh economy showed strong performance with growing domestic demand, supported by substantial increase in workers' remittances. Economic activity is expected to accelerate with higher government development spending; higher imports of liquefied natural gas, oil and construction materials; favourable power production, and government's policy support to boost exports. However, the COVID-19 pandemic could hamper such trend due to disruptions in export demands, suppressed consumption, and curbed remittances.

Note: ADB observation provides guidelines to arrive at future growth rates to be applied for cargo demand and supply estimation.

4.2.7 MMLP Report by KPMG & VOYANTS

Cargo demand estimation is based on:

- Demographic Profile which shall have a bearing on consumption of goods
- Industrial Development

4.2.7.1 Cargo Movement Pattern

Base Year: FY 2016

Base Year Estimated Traffic for NER

- Incoming 19.8 MMT - Road 7.5 MMT + Rail 12.3 MMT
- Outgoing 10.6 MMT - Road 5.1 MMT + Rail 5.5 MMT
- By Inland Water Transport (IWT) - 0.6 MMT and
- Air cargo - about 23,000 MT

Base Year total estimated cargo: 36.3 MMT - (Domestic : 30.4 MMT & EXIM : 5.9 MMT)

Source: Commissionerate of Tax (Govt. of Assam), DGCI and S, NEFR, ADB study team analysis

4.2.7.2 Jogighopa Goods Traffic

Traffic at Jogighopa MMLP is estimated under two (02) stages i.e., Stage-1 & Stage-2. The 1st stage provides the overall addressable cargo by Jogighopa and Guwahati region. Following assumptions are made to arrive at addressable cargo in Stage-1:

- Domestic commodities that do not need warehousing or logistics value added services are excluded; such commodities include limestone boulders, stone chips, coal etc.
- Domestic commodities that are produced or consumed in specific regions are excluded; such commodities include mineral fuel oils produced in the upper Assam, automobiles, dyes, pigments, minerals etc.
- As far as international trade is concerned, only those LCS that are in the vicinity of Jogighopa are included such as those from Dhubri division on Bangladesh border and Hatisar on the Bhutan border.
- Based on the primary interactions, estimations are made out of the total traffic, which can be catered through transshipment and distributions in the Jogighopa region.

This estimated traffic involves:

- Identification of all commodities originating in/destined to NER by analysing the total road and rail-based cargo.
- Identification of all regional trade commodities.
- Shortlisting of commodities (bulk / break-bulk and container) that would need warehousing and other value-added logistics services in the region.

- Assessment of commodity-wise, short-term traffic potential until FY-25 based on growth forecasts published by sector reports; and long-term traffic potential from FY-25 to FY-35 by tapering off the short-term growth in commodity traffic.

Estimated Base Year Jogighopa Cargo: 13.3 MMT

Jogighopa MMLP Traffic: Jogighopa MMLP traffic is estimated under two scenarios i.e. Base Case & High Case:

Assumptions used for deriving the cargo for the MMLP under various scenarios are provided is given below.

Base Case

- Specific connectivity infrastructure projects make Jogighopa as one of the locations for transshipment and distribution of commodities in the NER
- Specific policy support implementation is not expected in the foreseeable future
- Jogighopa MMLP will attract traffic into the region primarily due to the cost economics of using a water transport mode via the protocol route through Bangladesh

High Case

- Apart from the cost economics, specific connectivity infrastructure projects will help Jogighopa as a preferred location for transshipment and distribution of commodities in the NER.
- Specific policy support implementation expected in the foreseeable future.

The total cargo projection in the base case are presented in **Table 4.9** below:

Table 4.9: Composition of Total Cargo in Base Case – KPMG & VOYANT

Commodity Group	Estimated Cargo-MMLP(MMT)			
	FY 20	FY 25	FY 30	FY 35
Bulk/Break Bulk	1.21	1.81	2.50	3.15
Domestic	0.86	1.19	1.62	2.16
EXIM	0.35	0.62	0.88	1.00
Container	0.02	0.02	0.03	0.04
Domestic	0.014	0.017	0.020	0.021
EXIM	0.009	0.011	0.012	0.013
Total	1.23	1.83	2.53	3.19

Note:

- Source of collected Data to generate base year commodity wise O-D flows, may not cover low valued non-Taxable goods - potential IWT cargo.
- For generating base year Commodity wise incoming & outgoing distribution and Origin and Destination flows pattern by Road transport are given as based on - Primary interactions with

major road transport stakeholders and association members - highly biased and week base for goods traffic flows.

- c) Traffic estimates do not reflect place of origin or destination of the commodity, required to assess facilities at proposed IWT terminal at Jogighopa.
- d) Base Year traffic does not reflect important low valued bulk commodities like, fly-ash, stone chips & boulders.

Thus, traffic estimated cannot be used in the ongoing study.

4.2.8 Report on Modal shift of Cargo to IWT by E&Y

In view of understanding the potential of NW-2 (recognized in cognizance with Indo-Bangladesh Protocol Route), IWAH had awarded this study to assess the commodities transported through Siliguri Corridor and identify those that can be diverted to IWT.

4.2.8.1 The objective of the assignment was as follows:

- Identify existing cargo movement through Siliguri Corridor (Chicken's Neck) in all directions.
- Identification of potential cargo which can be diverted to IWT & destined for North-East and neighbouring countries.
- Identify disadvantages / bottlenecks of land-based movement which can be a contributing factor for diverting to IWT.
- Determine comparative economics vis-a-vis different modes of transportation.
- Based on vicinity to IWT mode of originating/ destination points and viable economics, assessment of cargo which can be shifted to IWT.
- Modalities to promote waterways transportation and road map to effect modal shift.
- Prepare projections for the corresponding cargo stream for the next 25 years.

4.2.8.2 Assumptions

It is important to note that realization of anticipated cargo volumes for the identified streams will be governed by various other factors. Some of the major ones are mentioned below:

- Competitive environment like development of other facilities in the region
- Dynamics in implementation of plans pertaining to development of waterways
- Industry dynamics like change in demand for imported coal or unavailability of natural gas impacting fertilizer production
- Social & political environment in the region
- Regulatory environment like restrictions on coal imports

The measures required to ensure the development of inland water transport as a continuous and sustained mode are as follows:

- Maintenance of fairways and navigation channels
- Inducing market confidence amongst players by running dedicated services Creation of a national operator like CONCOR which would focus entirely on vessel movement
- Measures to streamline movement of cargo along international protocol route
- Safety and security of cargo
- Round the clock navigability to increase vessel turnaround time
- Creation of terminals along waterway network which would act as cargo exchange points, consolidation centres along with value added services like warehousing, specialized handling etc.

4.2.8.3 The Project Influence Area (PIA)

With reference to NW-2, the PIA is divided into 6 clusters namely Jogighopa, Guwahati, Dibrugarh, Shillong, Arunachal Pradesh and Tripura.

The influence area is marked with the presence of fertilizers, cement & clinker, paper, bamboo, tea, oil refineries and food processing industries. It is also endowed with minerals like coal, limestone and oil reserves. In base year of the study i.e. 2017, total estimated cargo movement based on North-East Market Analysis is given as below:

- Inward - 25 MT + 90,000 Units of Cars & 2 Wheelers
- Outward - 24 MT
- Intra NER (PIA) - 30 MT
- International – 3 ~ 4 MT

Stream Wise Traffic, indicating volume break up and important origins and destinations of cargo, is presented in **Table 4.10** as under:

Table 4.10: Inward - Movement into North-East (2017)

Commodity	Volume (in MTPA)	Origin	Destination
Movement into the PIA			
Household Goods	~ 7-8	Delhi, Gujarat, West Bengal, Maharashtra	Assam as the distribution center (Guwahati, Jorhat, Tinsukia). Further distributed to other parts of North-East
Food grains	~ 3-4	Punjab, Delhi, West Bengal, Madhya Pradesh, Karnataka, Bihar, Chhattisgarh, Uttarakhand, Maharashtra	FCI sidings across North-East. Mandi players of Guwahati
Cement & Clinker	~ 1- 1.5	Chhattisgarh, Gujarat, Jharkhand, Maharashtra, West Bengal	Assam (Guwahati cluster)
Iron & Steel	~1.8- 2	Chhattisgarh, Karnataka, Odisha, Jharkhand, West Bengal	Guwahati cluster; further distributed to other parts of North-East
Fertilizers & FRM	~ 0.4- 0.5	Andhra Pradesh, West Bengal, Uttar Pradesh, Odisha	Guwahati and Dibrugarh cluster
Horticulture	~ 2.5- 3	Uttar Pradesh, Maharashtra, West Bengal,	Across North-Eastern states
PoL & Crude	~ 1	Delhi, Gujarat, West Bengal, Bihar, Uttar Pradesh	Refineries in Assam (Bongaigaon, Guwahati, Dibrugarh cluster)
Pharmaceuticals	~ 0.5	Uttarakhand, Himachal Pradesh, Gujarat	Guwahati as the main hub; further distributed to other North-eastern states
Auto parts	~ 0.5	Haryana, Maharashtra, Delhi, Punjab	Guwahati as the main hub; further distributed to other North-eastern states
Ballast	~ 0.7	Jharkhand, West Bengal	Bongaigaon, Guwahati and Dibrugarh cluster
Fly Ash	~ 1- 1.5	Power Plants in Bihar, West Bengal, Jharkhand	Guwahati cluster; further moved to serve cement & clinker plants in central Assam and Meghalaya
Tar Coal/Bitumen	~ 0.2	Maharashtra, West Bengal	Guwahati cluster
Automobiles	~ 120,000-	Maharashtra, Haryana, Tamil Nadu, Rajasthan, Uttarakhand, Andhra Pradesh	Guwahati cluster
	130,000 units		

Commodity	Volume (in MTPA)	Origin	Destination
Imported Coal	~ 0.05	West Bengal	Guwahati cluster; further moved to serve cement & clinker plants in central Assam and Meghalaya
Edible Oil	~ 0.3	West Bengal	Guwahati as the main hub; further distributed to other North-eastern states
Containers	~ 0.4	Jharkhand, Odisha, Punjab, Rajasthan West Bengal	CONCOR facility at Amingaon (Guwahati cluster)
Miscellaneous	~ 4-5	Andhra Pradesh, Delhi, Gujarat, Maharashtra, West Bengal	Across North-Eastern states
TOTAL	~ 25 MTPA + Automobile Units		

Table 4.11: Outward - Movement Outside North-East (2017)

Commodity	Volume (in MTPA)	Origin	Destination
Movement outside the PIA			
Limestone	~ 10- 11	Shillong cluster	Bangladesh
Cement & Clinker	~ 0.2- 0.3	Shillong & Guwahati cluster	Bihar, West Bengal
Fertilizers & FRM	~ 0.3- 0.4	Dibrugarh cluster	Bihar, West Bengal
Horticulture	~ 2- 2.5	Across North-Eastern states	Distributed across the country
PoL & Crude	~ 6	Dibrugarh, Guwahati, Bongaigaon cluster	Bihar and West Bengal
Ballast	~ 0.2	Bongaigaon cluster	West Bengal
Silicon	~ 1- 1.5	Shillong cluster	Distributed across the country
Tea	~ 0.6- 0.7	Dibrugarh, Guwahati, Shillong cluster	Auctioneers in West Bengal and across the country
Miscellaneous	~ 4- 5	Across North-eastern states	Distributed across the country
TOTAL	~ 24 MTPA		

Table 4.12: Movement within PIA (2017)

Commodity	Volume (in MTPA)	Origin	Destination
Food grains	~ 6- 7	Across North-East	Utilized for self-consumption and surplus sold in nearby markets
Cement & Clinker	~ 8- 9;	Guwahati and Shillong cluster	Across North-East
Fertilizers & FRM	~ 0.3 0.4	Dibrugarh cluster	Across North-East
Horticulture	~ 11	Across North-East	Utilized for self-consumption and surplus sold in nearby markets
PoL & Crude	~ 4- 5	Guwahati, Bongaigaon, Dibrugarh cluster	Across North-east
Coal	~ 0.05-1	Dibrugarh cluster (coal fields in upper Assam)	Guwahati cluster
Ballast	~ 0.4- 0.5	Guwahati, Bongaigaon, Dibrugarh cluster	Guwahati, Bongaigaon, Dibrugarh cluster
TOTAL	~ 30 MTPA		

<i>International - Movement outside North-East (2017)</i>			
Movement Outside PIA (2017)			
RBM & Stone Chips	~ 3-4	Bhutan	Bangladesh by IWT

4.2.8.4 Potential for Waterways

Suitability of cargo streams for IWT is assessed based on:

- Identification of O-D pairs of cargo,
- Analysing logistics cost of existing supply chain of the commodity in terms of commercials involved in the movement of cargo
- Identifying key logistics determinants which drive the supply chain.

Table 4.13: Hinterland Served by Jogighopa

Terminal	State/District	Nearest IWT terminal
Jogighopa	Upper Assam- Dhubri, Barpeta, Goalpara, Kokrajhar, Udalgiri, Nalbari, Bongaigaon, Chirang	Jogighopa
	Upper Assam- Sibsagar, Jorhat, Golaghat, Lakhimpur	Neamati
	Upper Assam- Kamrup, Kamrup Metro, Marigaon, Baksa, Darrang	Pandu
	Upper Assam- Dibrugarh, Tinsukia, Dhemaji	Sengajan/Dibrugarh

Terminal	State/District	Nearest IWT terminal
	Upper Assam- Nagaon, Sonitpur, Karbi Anglong	Silghat
	Meghalaya	Pandu
	Nagaland	Neamati
	Arunachal Pradesh	Tezpur

Table 4.14: Jogighopa Commodity Wise Estimated Potential Traffic and Value addition (2017)

Commodity	Volumes (in MTPA)	Value Added Services
Foodgrains	~ 1.12	Warehousing/ Provision for Silo facility
Fertilizers & FRM	~ 0.35	Warehousing at Jogighopa and then further movement to Dibrugarh terminal
Tar Coal/ Bitumen	~ 0.5	Warehousing facility
PoL & Crude	~ 0.11	Specialized storage in tanker form
Edible Oil	~ 0.23	Tinning facility in case of bulk movement otherwise warehousing facility. Jogighopa could potentially act as a distribution facility
Fly Ash	~ 0.75	Specialized handling and storage
Imported Coal	~ 0.05	Separate berth would be needed for handling coal. Warehousing facilities
Stone Chips	~ 3	Warehousing facilities
Automobiles	~ 11,000-12,000 units	Car park area. Jogighopa could potentially act as a distribution centre to cater to the PIA for the MMLP
TOTAL	~ 6 MTPA + Automobile Units	

Based on Type of Cargo Suitability Matrix has been developed, as under

Table 4.15: Cargo Suitability Matrix

Parameters	Low Suitability for IWT	Medium Suitability for IWT	High Suitability for IWT
Commodities	Horticulture products, Household Goods, Auto parts, Limestone, Pharmaceuticals, Iron & Steel, Ballast, Containers	Cement & clinker, Fly ash, Automobiles, Stone Chips	Food grains, Tar Coal/ Bitumen, Edible Oil, Imported Coal, Fertilizers & FRM, PoL products
Total Volumes	~ 3 MTPA	~ 7 MTPA +	~ 12 MTPA
		Automobiles is ~ 123,000 units	

Table 4.16: Commodity wise Potential Divertible cargo projection – FY2017- FY2041

Volumes	2017	2020	2023	2026	2029	2032	2035	2038	2041
Food grains (in MTPA)	1.55	1.56	1.58	1.59	1.61	1.63	1.65	1.67	1.69
Cement & Clinker (in MTPA)	-	1.11	1.33	1.44	1.44	1.44	1.44	1.44	1.44
Fertilizer & FRM (in MTPA)	0.37	0.41	0.46	0.52	0.57	0.64	0.7	0.77	0.85
Bitumen (in MTPA)	0.63	0.81	1.05	1.37	1.81	2.39	3.18	4.25	5.72
Fly Ash (in MTPA)	1.67	1.75	1.82	1.91	2	2.09	2.18	2.28	2.39
Edible Oil (in MTPA)	0.26	0.28	0.3	0.31	0.33	0.35	0.37	0.39	0.42
Imported Coal (in MTPA)	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
PoL products (in MTPA)	0.18	0.21	0.21	0.22	0.2	0.23	0.25	0.27	0.29
Stone Chips (in MTPA)	4	5	6	9	12	16	22	30	41
Total (MTPA)	8.71	11.18	12.8	16.42	20.02	24.83	31.84	41.14	53.87
Automobiles (in units)	17,220	18,007	18,829	19,689	20,589	21,529	22,512	23,541	24,616

For assessing the pre-feasibility, it is considered that the construction of the facility would begin in FY 2019. Assuming a construction period of three years, it would be operational in FY 2022. In terms of attractable cargo volumes, it is estimated that of the overall potential, the facility would attract:

- Outbound traffic- Moving out from the proposed IWT terminal. Around 30-35% of stone chips originating from the crushing units along Southern Bhutan using transit warehousing facility at the terminal for movement towards Bangladesh.
- Inbound traffic- Moving into the region via the proposed IWT terminal. Around 15-20% of the remaining cargo streams (for instance food grains, fertilizers & FRM, imported coal, PoL products, automobiles, edible oil etc.) originating from Haldia.

Attractable volumes for the terminal are presented in **Table 4.17**.

Table 4.17: Commodity Wise Traffic at Jogighopa IWT MMLP

<i>All figures in MTPA</i>						
Commodity	FY 2022	FY 2027	FY 2032	FY 2037	FY 2042	FY 2046
Food grains	0.34	0.35	0.35	0.36	0.37	0.37
Fertilizers & FRM	0.14	0.16	0.19	0.22	0.27	0.31
Tar Coal/ Bitumen	0.29	0.46	0.74	1.18	1.89	2.74
PoL & Crude	0.04	0.04	0.05	0.05	0.05	0.06
Edible Oil	-	0.09	0.09	0.1	0.12	0.12
Fly Ash	0.25	0.27	0.29	0.31	0.33	0.35
Imported Coal	0.02	0.02	0.02	0.02	0.02	0.02
Stone Chips	1.04	1.21	1.4	1.62	1.88	2.12
TOTAL	2.11	2.59	3.12	3.87	4.92	6.1
Automobile Units	5,565	5,995	6,459	6,958	7,496	7,956

The proposed terminal at Jogighopa would not only act as a warehousing centre but also a distribution hub for movement of cargo within the region. The distribution could be facilitated on various modes of transport viz rail, road, waterways.

As mentioned, for the purpose of distribution of cargo to the hinterlands- rail, road and waterways could be used. However, it is to be noted that railway is likely to be commercially unviable for short lead. As revealed in interactions, road freight for internal distribution of commodities is INR 7-9/T-km (end to end with two handlings). In case of rail, the freight is INR 1.8- 2.5/T-km which excludes last mile movement on road, multiple handling (unloading at terminal, loading on trucks and another set of handling at destination point). The cumulative cost of handling and transportation in case of railways would be INR 11-12.5/T-km. Thus, railway becomes more expensive than that of road, making it unattractive. Hence, for pre-feasibility only road and IWT mode is considered.

Note: Major findings of the study are adopted to estimate base year road traffic and estimation of traffic for proposed IWT terminal at Jogighopa.

4.3 Assessment of Potential Traffic

Keeping in view the importance of traffic in developing a proposed IWT terminal MMLP facility, which is likely to involve huge capital cost as well as pre-requisite for designing and preparing for required facilities for free and effective flow of goods, an attempt has been made to revalidate traffic estimated by different Consultancy agencies.

In the light of this, traffic collected by AECOM in other similar traffic studies encompassing project influence area likely to be served/captured by the proposed facility has been re-investigated. During the last financial year AECOM undertook primary surveys covering length and breadth of the country to estimate ongoing road origin - destination surveys at more than 100 locations covering all the important road goods carrying corridors of the country. Since, road transport is comparatively a costlier mode of

transport than rail and IWT, there is always a probability of shifting traffic to other competing modes of transport, more so in the case of inland water transport (IWT).

In the above study, to capture road goods traffic to and from north eastern states to rest of the country Paschim Madati Toll Plaza has been surveyed. Paschim Madati Toll Plaza is located on NH 31 between Sonapur - Ghoshpukur stretch in West Bengal. It is important because it lies between narrow Nepal and Bangladesh chicken-neck portion of the country.

Using the referred road origin - destination survey data collected with supportive traffic count as well as accounting for other field aberrations encountered by the field survey team, necessary steps have been taken to generate realistic base year commodity wise road O-D flows. By analyzing the road O-D survey data, an average daily cargo movement to the tune of 48,607 tons have been estimated. Annualized traffic passing through the check post worked out to 17.74 million tons.

Because of the check-post location, traffic to and from districts of Jalpaiguri, Kalimpong, Darjeeling, Alipurduar, Kooch Bihar of West Bengal, all the districts of Sikkim and Bhutan are segregated as these are not likely to form part of potential IWT cargo in the North Eastern Region. Although, the commodity contribution from these regions to NER remained uncaptured, has not been considered owing to their non effect/divertibility to the proposed IWT Terminal development. Export traffic from Bhutan, which is likely to be attracted by the proposed IWT Terminal, is considered as an induced traffic which is studied independently. Thus, while analyzing the collected road O-D survey data traffic, cargo movement from rest of India to these traffic regions and vice versa has not been considered, as it is not likely to affect the proposed IWT terminal traffic demand.

Goods vehicle O-D data collected at the check post indicated that nearly 15% of the vehicles recorded were empty, whereas about 54% of the loaded goods vehicles were recorded to be originating or terminating from the adjoining districts stated in the above paragraph. Therefore, the same were excluded from the onward processing.

Using the foregoing data, inter regional road goods flows between NER and Rest of India (excluding regions indicated above) have been estimated. All the states are considered as an independent traffic region, except West Bengal, which is further bifurcated to consider each civil district as a traffic region. Similarly, all the commodities are grouped to limit into manageable numbers, based on commodity and its handling characteristics. Some of the commodities of IWT importance are kept independent. Estimated annual goods traffic flow worked out to 8.11 million tons in the base year of the study i.e. 2019-20. Commodity wise breakup of the road flows are given in **Table 4.18**.

Table 4.18: Commodity wise Road Flows 2019-20 (tons) between NER & Rest of India

S. No.	Commodity	Tonnes (T)	% Share
1.	General Goods (Parcels)	1,645,369	20.27
2.	Iron & Steel (All Types)	795,831	9.81
3.	LPG	640,675	7.89
4.	Fruits & Vegetables	628,656	7.75
5.	Other Food grains	464,623	5.72
6.	Tea	452,138	5.57
7.	Coal	383,168	4.72
8.	Vehicles & Parts	304,561	3.75
9.	POL Products	268,817	3.31
10.	Household Goods (Provisions)	247,952	3.06

S. No.	Commodity	Tonnes (T)	% Share
11.	Chemicals	217,294	2.68
12.	Fish & Meat	196,854	2.43
13.	Rice, Poha, Etc.	164,998	2.03
14.	Ply Board & Items	138,676	1.71
15.	Machinery & Spare Parts	123,843	1.53
16.	Edible oils	117,083	1.44
17.	Building Materials	109,728	1.35
18.	Jute & Jute Items	103,965	1.28
19.	Limestone & Dolomite	102,821	1.27
20.	Cement & Cement Items	97,924	1.21
21.	Bamboo & Goods	88,722	1.09
22.	Eggs & Other Poultry Items	83,184	1.02
23.	Plastic & Items	81,450	1.00
24.	Fodder	78,877	0.97
25.	Wheat & Flour	65,143	0.80
26.	Railway Dep't. Goods	61,676	0.76
27.	Paper & Stationary	43,298	0.53
28.	Marbles & Stone	42,815	0.53
29.	Grams & Pulses	34,292	0.42
30.	Rubber & Items	33,452	0.41
31.	Sugar	32,585	0.40
32.	Marble & Stones	30,786	0.38
33.	Pipes & Fittings	26,795	0.33
34.	Furniture	25,733	0.32
35.	Gas Cylinders (Ld/Emp)	25,733	0.32
36.	Fertilizers	24,446	0.30
37.	Livestock	21,229	0.26
38.	Milk & Products	21,006	0.26
39.	Cotton (Raw & Cloth)	18,852	0.23
40.	Tobacco & Goods	15,440	0.19
41.	Ceramic Tiles	11,999	0.15
42.	Paints & Dyes	9,006	0.11
43.	Medicines	8,278	0.10
44.	Metals other than I&S	6,853	0.08
45.	Cylinders	5,147	0.06
46.	Fly ash	5,147	0.06
47.	Oil Seeds	5,147	0.06

S. No.	Commodity	Tonnes (T)	% Share
48.	Leather Goods	3,860	0.05
	Grand Total	8,115,924	100.00

Out of the total cargo traffic handled by road transport between NER and rest of the country, about 62% is incoming traffic while nearly 38% is outgoing. Cargo movement pattern from NER to Rest of India and Rest of India to NER is shown in the **Table 4.19** below:

Table 4.19: Road Traffic Movement Pattern - Between NER & Rest of India

From /To	Tonnes (2019-20)	% Share
NER to Rest of India	3,107,735.0	38.29
Rest of India to NER	5,008,188.7	61.71
Grand Total	8,115,923.7	100.00

The important locations receiving cargo from the outgoing traffic of NER to Rest of India are summarized with %share in the **Table 4.20** below:

Table 4.20: Base year Road O-D Traffic from NER to Rest of India (2019-20)

S. No.	Outside Traffic Regions	Tonnes (T)	% Share
1.	Kolkata (WB)	870,876	28.0
2.	Uttar Pradesh	338,021	10.9
3.	Bihar	316,762	10.2
4.	Delhi	251,001	8.1
5.	Maldah (WB)	160,549	5.2
6.	Maharashtra	153,194	4.9
7.	MP	116,161	3.7
8.	Dinajpur (W) WB	103,295	3.3
9.	Burdwan (WB)	102,036	3.3
10.	Haryana	85,476	2.8
11.	Jharkhand	72,416	2.3
12.	Haldia Port (WB)	70,737	2.3
13.	Gujarat	69,421	2.2
14.	Karnataka	53,171	1.7
15.	Punjab	49,087	1.6
16.	Orissa	42,234	1.4
17.	Rajasthan	41,592	1.3
18.	Murshidabad (WB)	41,172	1.3
19.	Andhra Pradesh	33,452	1.1
20.	Himachal Pradesh	30,852	1.0
21.	Tamil Nadu	25,928	0.8

S. No.	Outside Traffic Regions	Tonnes (T)	% Share
22.	Telangana	25,733	0.8
23.	Chhattisgarh	20,559	0.7
24.	Midnapur (E) WB	10,293	0.3
25.	Uttarakhand	7,495	0.2
26.	Birbhum (WB)	5,147	0.2
27.	Nadiad (WB)	5,147	0.2
28.	Puruliya (WB)	5,147	0.2
29.	Hubli (WB)	783	0.0
	Total Outgoing Traffic From NER	3,107,735	100.0

Similarly, state wise volumes of traffic received by NER is summarized with %share in the **Table 4.21** below.

Table 4.21: Base year Road O-D Traffic from Rest of India to NER (2019-20)

S. No.	Region/State	Tonnes (T)	% Share
1	Arunachal Pradesh	19,299	0.39
2	Assam	4,556,640	90.98
3	Manipur	57,674	1.15
4	Meghalaya	75,435	1.51
5	Mizoram	29,565	0.59
6	Nagaland	94,259	1.88
7	Tripura	175,317	3.50
	Total Outgoing NER	5,008,189	100.00

Commodity wise quantity of incoming traffic into the NER is tabulated in **Table 4.22** below:

Table 4.22: Commodity wise Incoming Traffic to NER (2019-20)

S. No.	Commodity	Tonnes (T)	% Share
1.	General Goods (Parcels)	957,291	19.11
2.	Iron & Steel (All Types)	662,132	13.22
3.	Fruits & Vegetables	569,918	11.38
4.	LPG	463,568	9.26
5.	Other Food grains	382,726	7.64
6.	Vehicles & Parts	273,710	5.47
7.	Fish & Meat	196,854	3.93
8.	Household Goods (Provisions)	178,726	3.57
9.	Rice, Poha, Etc.	159,852	3.19

S. No.	Commodity	Tonnes (T)	% Share
10.	POL Products	131,820	2.63
11.	Edible oils	117,083	2.34
12.	Machinery & Spare Parts	100,683	2.01
13.	Building Materials	88,722	1.77
14.	Eggs & Other Poultry Items	83,184	1.66
15.	Wheat & Flour	65,143	1.30
16.	Railway Dep't. Goods	61,676	1.23
17.	Chemicals	43,262	0.86
18.	Fodder	42,878	0.86
19.	Marbles & Stone	37,668	0.75
20.	Sugar	32,585	0.65
21.	Coal	30,852	0.62
22.	Marble & Stones	30,786	0.61
23.	Pipes & Fittings	26,795	0.54
24.	Paper & Stationary	26,152	0.52
25.	Furniture	25,733	0.51
26.	Gas Cylinders (Ld/Emp)	25,733	0.51
27.	Plastic & Items	23,999	0.48
28.	Ply Board & Items	23,774	0.47
29.	Milk & Products	21,006	0.42
30.	Grams & Pulses	18,852	0.38
31.	Livestock	16,726	0.33
32.	Cement & Cement Items	13,062	0.26
33.	Ceramic Tiles	11,999	0.24
34.	Fertilizers	10,293	0.21
35.	Rubber & Items	10,293	0.21
36.	Paints & Dyes	9,006	0.18
37.	Medicines	7,495	0.15
38.	Limestone & Dolomite	6,853	0.14
39.	Cotton (Raw & Cloth)	5,147	0.10
40.	Fly ash	5,147	0.10
41.	Oil Seeds	5,147	0.10
42.	Leather Goods	3,860	0.08
	Grand Total	5,008,189	100.00

In view of the fact that different commodities may show different levels of diversion to proposed IWT services, the commodity wise volumes of outgoing cargo traffic from Assam to West Bengal only are summarized in **Table 4.23** below:

Table 4.23: Commodity wise Outgoing Traffic from Assam to West Bengal (2019-20)

S. No.	Commodity	Tonnes (T)	% Share
1.	General Goods (Parcels)	667,521	22.69
2.	Tea	441,426	15.00
3.	Coal	352,316	11.97
4.	LPG	177,107	6.02
5.	Chemicals	167,179	5.68
6.	POL Products	126,285	4.29
7.	Ply Board & Items	114,902	3.91
8.	Iron & Steel (All Types)	114,847	3.90
9.	Jute & Jute Items	98,818	3.36
10.	Cement & Cement Items	84,863	2.88
11.	Limestone & Dolomite	83,968	2.85
12.	Bamboo & Goods	78,010	2.65
13.	Other Food grains	76,750	2.61
14.	Household Goods (Provisions)	69,226	2.35
15.	Fruits & Vegetables	54,878	1.87
16.	Plastic & Items	47,158	1.60
17.	Fodder	29,145	0.99
18.	Machinery & Spare Parts	23,159	0.79
19.	Building Materials	21,006	0.71
20.	Paper & Stationary	17,146	0.58
21.	Grams & Pulses	15,440	0.52
22.	Fertilizers	14,153	0.48
23.	Cotton (Raw & Cloth)	13,706	0.47
24.	Tobacco & Goods	10,293	0.35
25.	Vehicles & Parts	10,293	0.35
26.	Metals other than I&S	6,853	0.23
27.	Cylinders	5,147	0.17
28.	Marbles & Stone	5,147	0.17
29.	Rice, Poha, Etc.	5,147	0.17
30.	Rubber & Items	5,147	0.17
31.	Livestock	4,503	0.15
32.	Medicines	783	0.03
33.	Grand Total	2,942,319	100.00

Like commodity classification, place of origin of the cargo as well as place of final destination also play an important role in inter modal shift of mode of transport (i.e. from road to IWT in our case). With the smooth and uninterrupted movement of cargo using Indo-Bangladesh Protocol route, traffic from

various locations in West Bengal will be highly benefitted on one hand and major portion of Assam state on the other, because of their location advantage on interconnected waterfront of IBP route. In the light of this estimated road traffic between West Bengal and Assam has been segregated.

The traffic originating from Kolkata and Haldia Regions will have more advantage by the proposed IWT facility than other locations. In the total originating traffic of 1.67 million tons from West Bengal to NER, about 1.21 million tons (72.5%) are contributed by Kolkata and Haldia Regions. Commodity wise dispatched from various West Bengal traffic regions is given in **Table 4.24** below:

Table 4.24: Commodity wise Incoming Traffic to NER From Locations in West Bengal (2019-20)

S. No.	Commodity	Tonnes (T)
1.	Burdwan (WB)	326,529
2.	Fruits & Vegetables	9,006
3.	General Goods (Parcels)	9,006
4.	Household Goods (Provisions)	5,147
5.	Iron & Steel (All Types)	244,212
6.	Other Food grains	42,012
7.	Rice, Poha, Etc.	11,999
8.	Vehicles & Parts	5,147
9.	Dinajpur (N) WB	31,045
10.	Fruits & Vegetables	6,853
11.	General Goods (Parcels)	6,853
12.	LPG	2,349
13.	Other Food grains	10,293
14.	POL Products	4,698
15.	Dinajpur (W) WB	16,502
16.	General Goods (Parcels)	3,860
17.	Other Food grains	7,495
18.	Rice, Poha, Etc.	5,147
19.	Haldia Port (WB)	130,564
20.	Chemicals	5,147
21.	Coal	6,853
22.	Fruits & Vegetables	11,999
23.	General Goods (Parcels)	5,147
24.	LPG	74,400
25.	Other Food grains	5,147
26.	Pipes & Fittings	5,147
27.	POL Products	16,726
28.	Kharagpur (WB)	32,558
29.	General Goods (Parcels)	13,706

S. No.	Commodity	Tonnes (T)
30.	Iron & Steel (All Types)	13,706
31.	Machinery & Spare Parts	5,147
32.	Kolkata (WB)	1,078,761
33.	Building Materials	15,440
34.	Cement & Cement Items	2,349
35.	Chemicals	10,293
36.	Coal	6,853
37.	Edible oils	75,911
38.	Eggs & Other Poultry Items	3,860
39.	Fish & Meat	15,440
40.	Fly ash	5,147
41.	Fodder	20,586
42.	Fruits & Vegetables	9,006
43.	Furniture	5,147
44.	Gas Cylinders (Ld/Emp)	25,733
45.	General Goods (Parcels)	281,309
46.	Household Goods (Provisions)	49,505
47.	Iron & Steel (All Types)	94,316
48.	Leather Goods	3,860
49.	Livestock	2,573
50.	LPG	205,778
51.	Machinery & Spare Parts	5,147
52.	Marble & Stones	4,698
53.	Marbles & Stone	3,860
54.	Other Food grains	78,679
55.	Paints & Dyes	9,006
56.	Paper & Stationary	5,147
57.	Pipes & Fittings	7,495
58.	Plastic & Items	5,147
59.	Ply Board & Items	16,921
60.	POL Products	57,898
61.	Rice, Poha, Etc.	22,292
62.	Rubber & Items	5,147
63.	Vehicles & Parts	19,075
64.	Wheat & Flour	5,147
65.	Maldah (WB)	28,081
66.	Building Materials	3,860

S. No.	Commodity	Tonnes (T)
67.	Fruits & Vegetables	6,209
68.	General Goods (Parcels)	5,147
69.	Other Food grains	9,006
70.	Rice, Poha, Etc.	3,860
71.	Midinapur (E) WB	15,440
72.	Fertilizers	5,147
73.	Other Food grains	10,293
74.	Murshidabad) (WB)	3,860
75.	General Goods (Parcels)	3,860
76.	NADIA (WB)	3,860
77.	Other Food grains	3,860
	Grand Total	1,667,200

Similarly, commodity wise originating from Assam to various locations in West Bengal has been estimated. In the total estimated outgoing cargo of 3.1 million tons from NER, 1.27 million tons of cargo from Assam State is destined for various traffic regions in West Bengal. Like originating tonnage from Kolkata and Haldia traffic regions, 0.85 MT of cargo from Assam is terminating in these regions forming about 62% of the cargo destined for West Bengal. Commodity wise outgoing traffic from Assam to traffic regions in West Bengal is summarized in the **Table 4.25** below:

Table 4.25: Commodity wise outgoing traffic from Assam to traffic regions in West Bengal (2019-20)

S. No.	Commodity	Tons
1.	Birbhum (WB)	5,147
2.	Fruits & Vegetables	5,147
3.	Burdwan (WB)	91,743
4.	Chemicals	6,853
5.	Coal	10,293
6.	General Goods (Parcels)	44,585
7.	Iron & Steel (All Types)	5,147
8.	Limestone & Dolomite	6,853
9.	LPG	7,720
10.	Ply Board & Items	5,147
11.	POL Products	5,147
12.	Burdwan (WB)	5,147
13.	Other Food grains	5,147
14.	Dinajpur (W) WB	96,442
15.	Cement & Cement Items	11,999
16.	Coal	39,858

S. No.	Commodity	Tons
17.	General Goods (Parcels)	6,853
18.	LPG	21,873
19.	Marbles & Stone	5,147
20.	Other Food grains	3,860
21.	Tea	6,853
22.	Haldia Port (WB)	70,737
23.	Chemicals	6,853
24.	Coal	5,147
25.	Fertilizers	3,860
26.	Jute & Jute Items	5,147
27.	LPG	42,878
28.	POL Products	6,853
29.	Hubli (WB)	783
30.	Medicines	783
31.	Kolkata (WB)	785,596
32.	Tea	186,309
33.	General Goods (Parcels)	126,644
34.	Jute & Jute Items	69,031
35.	Coal	58,710
36.	Ply Board & Items	52,305
37.	LPG	41,592
38.	POL Products	41,172
39.	Iron & Steel (All Types)	34,292
40.	Other Food grains	29,145
41.	Chemicals	26,152
42.	Household Goods (Provisions)	19,299
43.	Plastic & Items	15,859
44.	Machinery & Spare Parts	14,153
45.	Fodder	11,999
46.	Fruits & Vegetables	11,999
47.	Limestone & Dolomite	11,999
48.	Fertilizers	10,293
49.	Bamboo & Goods	6,853
50.	Cement & Cement Items	6,853
51.	Vehicles & Parts	5,147
52.	Building Materials	3,860
53.	Livestock	1,930

S. No.	Commodity	Tons
54.	Maldah (WB)	160,549
55.	Cement & Cement Items	33,005
56.	Coal	86,596
57.	Fruits & Vegetables	10,293
58.	LPG	23,159
59.	Ply Board & Items	5,147
60.	POL Products	2,349
61.	Midnapur (E) WB	10,293
62.	General Goods (Parcels)	10,293
63.	Murshidabad (WB)	41,172
64.	Coal	3,860
65.	General Goods (Parcels)	9,006
66.	Livestock	2,573
67.	POL Products	25,733
68.	Nadiad (WB)	5,147
69.	Coal	5,147
	Grand Total	1,272,754

The traffic estimation carried out under “Study for modal shift of cargo passing through Siliguri Corridor destined for North-east and neighbouring countries to IWT” by the E&Y in 2017 has been examined. As indicated in the report, domestic cargo was assessed based on secondary data and market assessment surveys. The traffic is segregated under three streams i.e. Incoming into NER, Outgoing from NER and intra NER. Since, the data collected is based on Market Interactions and Analysis, a range of different commodities in each stream estimated has been indicated. An attempt has been made in this study to estimate commodity wise flows to be handled at the proposed IWT terminal using available data.

In E&Y Report, incoming traffic to the extent of 25 MT in the base year has been estimated. Using inter modal share for different commodities given in the report, rail and road traffic has been segregated. It shows that about 10.73 MT of incoming traffic is handled by rail and balance 14.27 MT by road, as shown in the **Table 4.26** below:

Table 4.26: Commodity Wise Domestic Cargo Assessment - E&Y Study (2017)

Commodity	Total MT	Rail Share (%)	Rail tons	Road tons
Household Goods	~ 7-8.0	0.5	3.5	3.5
Food grains	~ 3-4.0	0.8	2.4	0.6
Horticulture	~ 2.5- 3.0	0.1	0.25	2.25
Iron & Steel	~1.8- 2.0	0.4	0.72	1.08
Cement & Clinker	~ 1- 1.5	0.44	0.44	0.56
Fly Ash	~ 1- 1.5	0	0	1
PoL & Crude	~ 1.0	0.5	0.5	0.5

Commodity	Total MT	Rail Share (%)	Rail tons	Road tons
Ballast	~ 0.7	0.5	0.35	0.35
Pharmaceuticals	~ 0.5	0	0	0.5
Auto parts	~ 0.5	0	0	0.5
Fertilizers & FRM	~ 0.4- 0.5	0.3	0.15	0.35
Containers	~ 0.4	1	0.4	0
Edible Oil	~ 0.3	0.2	0.06	0.24
Tar Coal/Bitumen	~ 0.2	0.3	0.06	0.14
Imported Coal	~ 0.1	1	0.1	0
Miscellaneous (forest products, chemical products, military items, stone amongst various other commodities moved in small parcel sizes)	~ 4-5	0.4	1.8	2.7
Automobiles	~ 120,000			
	130,000 units			
TOTAL	~ 25 MTPA +		10.73	14.27

AECOM data pertained to 2019-20 surveys for estimating road O-D goods flows as against 2017 undertaken by E&Y. Since objective of E&Y study was to estimate average annual traffic crossing chicken neck portion near Siliguri, AECOM traffic estimates have been revised on pro-rata basis to account for Siliguri and other districts of West Bengal, Sikkim and Bhutan traffic not considered as NER traffic has been included. Comparative AECOM incoming traffic has been worked out to 10.95 million tons as against 14.27 million tons road traffic (2017) estimated by E&Y, indicating a gap of about 30.35%. This gap in traffic may further increase if E&Y traffic is raised for the period from 2017 to 2019 at an annual growth of 5%. The gap between E&Y and AECOM Studies is about 43.7% at a common base year.

As E&Y projections are based on detailed market studies, AECOM have followed commodity specific approach adopted by E&Y in traffic estimates to arrive at level of diversion to proposed IWT Terminal at Jogighopa as a second estimation.

As revealed from traffic estimation and projections for Construction of IWT Terminal at Dhubri, IWT terminal was estimated to handle 0.85 million tons in 2020-21 from 0.4 million tons in 2011-12. As given in "Inland Waterways Authority of India, Ministry of Shipping, Annual Report on Traffic on National Waterways: FY 2019-20, in the total traffic handled in NW2 of 392,767 tons, Dhubri contributed to the tune of 199,073 tons (0.20 million tons) indicating a decline of about 22% from its previous years throughput 233,735 tons (0.23 million tons) out of the total 502,003 tons handled in NW2 in FY 2019. Although, movement of stone chips/ boulders (since July 2019), originating from Bhutan and going to Bangladesh via the IBP route using Dhubri IWT Terminal was an unexpected cargo.

Similarly, E&Y estimates of outgoing traffic from NER to the tune of 24 million tons in the base year can be considered little optimistic. The traffic includes major streams of export of limestone from Meghalaya using road transport through Dwaki LCS (11 million tons) do not form a part of Siliguri corridor nor it is potential traffic to be transported using IWT in future.

In E&Y study, the IWT exports through Jogighopa Terminal envisaged movement of Stone & Stone chips originating from Bhutan for Bangladesh. It is important to note that, currently "the agreement on

Trade, Commerce and Transit signed in July 2017 between Govt. of India and Royal Govt. of Bhutan, declares Dhubri on NW-2 as an agreed exit/ entry point in India for EXIM movement of Bhutan. Secondly, SoP for the MoU on use of Inland waterways for transportation of bilateral trade and transit cargoes between Govt. of Bangladesh and the Royal Govt. of Bhutan signed in April 2019.

It is important to share that road distance from Phuentsholing, dispatch area for stone chips in Bhutan, to Dhubri IWT terminal by road is about 151 km, whereas distance with Jogighopa IWT terminal location is approximately 231 km. Since the road distance as well as IWT distance is in favour of Dhubri terminal, the Jogighopa IWT terminal can attract only overflow of stone & stone chips traffic, that may arise on account of limited Dhubri terminal capacity to handle such traffic, there is need to review E&Y outgoing traffic for the same. Further, to attract Bhutan stone & stone chips traffic via Jogighopa IWT terminal, necessary changes in policies needs to be incorporated at the national level.



Figure 4.2: Comparative Distance from Phuentsholing to Dhubri & Jogighopa IWT Terminals

4.4 AECOM's Traffic Projections

Study for modal shift of cargo passing through Siliguri Corridor destined for North-East and neighbouring countries to IWT and Pre-Feasibility for Development of proposed MMLP at Jogighopa undertaken by E&Y. Final Report submitted in August 2017 formed basis of the current study. E&Y studies finally concluded a cargo volume of 2.11 million tons plus 5,565 Automobile units in 2022, in the first year of Jogighopa IWT terminal operation. In the terminal year of the study i.e. 2046 overall cargo estimated as 6.1 million tons and 7,956 Automobile. Commodity wise projections estimated by E&Y are reproduced in the **Table 4.27**.

Table 4.27: Commodity Wise Projections estimated by - E&Y Study (2017)

<i>All figures in MTPA</i>						
Commodity	FY 2022	FY 2027	FY 2032	FY 2037	FY 2042	FY 2046
Food grains	0.34	0.35	0.35	0.36	0.37	0.37
Fertilizers & FRM	0.14	0.16	0.19	0.22	0.27	0.31
Tar Coal/ Bitumen	0.29	0.46	0.74	1.18	1.89	2.74
POL & Crude	0.04	0.04	0.05	0.05	0.05	0.06
Edible Oil	-	0.09	0.09	0.1	0.12	0.12
Fly Ash	0.25	0.27	0.29	0.31	0.33	0.35
Imported Coal	0.02	0.02	0.02	0.02	0.02	0.02
Stone Chips	1.04	1.21	1.4	1.62	1.88	2.12
TOTAL	2.11	2.59	3.12	3.87	4.92	6.1
Automobile Units	5,565	5,995	6,459	6,958	7,496	7,956

As discussed earlier, based on the traffic studied by AECOM from actual road O-D surveys and considering road as the major mode of transport, it seems like E&Y traffic is on a higher side i.e. representing estimations under optimistic scenario.

Base year commodity wise traffic recommended for proposed IWT services at Jogighopa by E&Y Report has been reviewed and projected at five-year intervals for the following 30 years as shown in **Table 4.28**, after commencement of proposed IWT Terminal operations. It is pertinent to note that commodity wise proportionate share of traffic estimated to be handled at the terminal is envisaged to remain constant in the overall demand, as in the base year traffic. IWT terminal is planned to commence its operation by 2022 i.e. considering two-year period for obtaining necessary approvals and construction.

With the revised AECOM suggested base year traffic and applying other traffic projections parameters as given in the E&Y Reports, estimated traffic at Jogighopa IWT terminal worked out to 1.10 million tonnes in 2022 plus 3,133 automobile units. In the corresponding terminal year of the study i.e. 2052 the estimated cargo to the tune of 2.08 million tonnes plus 5,351 automobiles units.

Table 4.28: Commodity Wise Traffic (in MT) to be Handled at Jogighopa IWT Terminal

Commodity	2022	2027	2032	2037	2042	2047	2052
Food grains	0.19	0.21	0.23	0.25	0.27	0.30	0.33
Fertilizers & FRM	0.08	0.09	0.10	0.11	0.12	0.13	0.14
Tar Coal/ Bitumen	0.07	0.08	0.10	0.12	0.15	0.18	0.22
Pol & Crude	0.02	0.03	0.03	0.03	0.04	0.04	0.05
Edible Oil	0.00	0.05	0.05	0.05	0.05	0.05	0.05
Fly Ash	0.14	0.15	0.16	0.18	0.19	0.20	0.22
Imported Coal	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Stone Chips	0.59	0.71	0.87	1.05	1.05	1.05	1.05
TOTAL	1.10	1.33	1.55	1.81	1.89	1.98	2.08
Automobile Units	3133	3425	3745	4094	4476	4894	5351

The origin & destination details are shown in **Table 4.29** below.

Table 4.29: Commodity Wise Origin & Destination details to be Handled at Jogighopa IWT Terminal

Commodity	Origin*	Destination*
Food grains	Bihar, Burdwan, Dinajpur, Jharkhand, Kolkata, Maldah, Punjab, UP	Assam, Tripura Nagaland
Fertilizers & FRM	Haldia	Assam
Tar Coal/ Bitumen	Haldia, Kolkata, Jharkhand	Assam
PoL & Crude	Kolkata, Haldia	Assam, Tripura, Manipur
Edible Oil	Kolkata, Punjab	Assam
Fly Ash	Kolkata	Assam
Imported Coal	Haldia, Kolkata	Assam
Stone Chips	Bhutan	Bangladesh
TOTAL		
Automobile Units	Delhi, Haryana, Maharashtra	Assam, Nagaland, Tripura, Meghalaya

* Tentative locations identified based on Road Goods O-D Survey Results. E&Y identified Guwahati as the main hub; further distributing to other North-eastern states

To highlight the volumes of estimated cargo, average daily quantum has been estimated assuming 300 operating days per year of the IWT terminal. Commodity wise average daily traffic (in tons) is depicted in the below:

Table 4.30: Commodity Wise average Daily Traffic to be handle at Jogighopa IWT Terminal

Commodity	2022	2027	2032	2037	2042	2047	2052
Food grains	638	698	763	834	912	997	1090
Fertilizers & FRM	263	290	320	354	390	431	476
Tar Coal/ Bitumen	230	280	340	414	504	613	746
PoL & Crude	75	85	96	109	123	139	157
Edible Oil	0	167	167	167	167	167	167
Fly Ash	469	505	544	587	632	681	733
Imported Coal	38	40	44	47	51	54	59
Stone Chips	1952	2375	2889	3515	3515	3515	3515
TOTAL	3664	4439	5163	6025	6293	6597	6942
Automobile Units	10.44	11.42	12.48	13.65	14.92	16.31	17.84

With respect to CAGR applied in the traffic estimates, each commodity has been discussed as under:

4.4.1 Food grains:

Food grains traffic estimated to be handled at the IWT terminal given in E&Y Report has been revised in the light of AECOM Road Survey data at overall basis to arrive at base year (2019) of the ongoing study. To arrive at future volumes, recorded annual population growth rate between 2001 and 2011 census of 1.8 per annum has been applied on the base year divertible traffic. Annualised estimated traffic up to 2052 are given in Table 4.28.

4.4.2 Fertilizers & FRM

Base year divertible fertilizers traffic as recommended by E&Y has been projected based on “Fertilizer demand for north-east is based on studies commissioned by Department of Fertilizers, Government of India” at CAGR of around 2.0 per cent for the entire study period up to 2052. It is anticipated that the share of divertible cargo in the stream of inward movement is likely to remain unchanged. Annualised estimated traffic up to 2052 are given in Table 4.28.

4.4.3 Tar Coal/ Bitumen

On commodity wise scrutiny of data, Coal tar/ Bitumen Traffic projected by E&Y does not seem to be realistic. 10th Asian Bitumen Conference 2015 (23rd and 24th Nov. 2015) was organized by the Ministry of Petroleum & Natural Gas. The “Overview of Indian Bitumen Market” indicated current demand of Bitumen at around 5 MTPA, of which 90% is used for road construction works. It was indicated in the conference that nearly 90% demand is met through domestic production and only 10% is dependent upon imports, mainly from Iran and UAE.

Keeping in view the increasing government expenditure on development of road sector, the demand of Bitumen is expected to grow at CAGR of 5.6% to 8 million tonnes in 2020-21.

Similarly, as given in the India Bitumen Market Outlook – 2026, demand of Bitumen is projected to increase at a CAGR of 2.8% from 2019 to 2026.

E&Y Coal tar & Bitumen estimates are revised in view of the following:

- I. Firstly, the current movement of Coal tar/Bitumen in NER is indicated as 0.2 MTPA is enhanced to 0.5 MTPA keeping in view the required quantities to augment infrastructure development in the region already incorporates likely growth.
- II. Secondly, the entire traffic cannot be diverted to IWT under the ongoing multi modal scenario, keeping in view the source of supply of Bitumen from Haldia and Nheva Sheva Ports. Current incoming Coal tar/Bitumen cargo by road is estimated as 7500 tonnes per month or 0.09 tonnes per annum.
- III. Thirdly, anticipated annual growth rate of 10%, applied in estimating Coal tar/Bitumen traffic as against maximum 2.8% to 5.6% recommended by commodity specific Planning agencies is on very high side.

In the light of above, Bitumen traffic has been revised as under:

- (i) Base year Bitumen demand estimated by E&Y (based on Market Surveys) 2017 – 0.63 MTPA
- (ii) India Bitumen Market Outlook (2026) envisaged CAGR of 2.8% at national level. Keeping in view the infrastructure requirement, comparatively higher demand of Bitumen in NER is

projected. A CAGR of 4% has been adopted keeping in view comparatively higher demand of road projects in NER.

- (iii) Keeping various sources of supply as indicated in the E&Y Report, only 30% of the NER estimated demand is divertible to IWT system (predominantly from Haldia Port & Refinery). It is important to note that total Bitumen imports (at all ports in India) was to the tune of 0.955 million tonnes in 2016.
- (iv) 30% of incoming bitumen traffic in IWT is envisaged to be handled at Jogighopa IWT Terminal for onward distribution.

Estimated Bitumen traffic is summarised as under:

Table 4.31: Estimation of Bitumen Traffic at Jogighopa IWT Terminal (MTPA)

Item	FY 2017	FY 2022	FY 2027	FY 2032	FY 2037	FY 2042	FY 2047	FY 2052
Bitumen Demand for North-East	0.63	0.77	0.93	1.13	1.38	1.68	2.04	2.49
Divertible to IWT in NER	0.19	0.23	0.28	0.34	0.41	0.50	0.61	0.75
Proportionate to be handled at Jogighopa IWT MMLP	0.06	0.07	0.08	0.10	0.12	0.15	0.18	0.22

4.4.4 POL Products

POL products incoming from Haldia Dock Complex form potential cargo stream for waterways. E&Y considered diversion of superior kerosene oil (SKO) and motor spirit (MS) and adopted growth rates as published by the Ministry of Petroleum and Natural Gas Statistics, available up to FY 2030. It is assumed that the growth pattern is likely to remain unchanged in the remaining project period. A CAGR of 2.5 per cent has been applied in the current projections. Annualised estimated POL traffic up to 2052 is given in **Table 4.28**.

4.4.5 Edible Oils

Edible oil is one of the important incoming commodities from Haldia Docks to North Eastern Region. Base year traffic estimated based on the Market Surveys undertaken by E&Y has been considered as it is, duly adjusted for overall estimation using road O-D survey results.

Since, edible oil is commodity of human consumption, population growth rate as adopted by E&Y has been followed. Further as edible oil is comparatively a high valued cargo, E&Y has recommended movement of Edible after three years of IWT Terminal operations. In this case AECOM has also followed the E&Y market survey observations and added edible oil traffic from 2027. Annualised estimated Edible oil traffic up to 2052 is given in **Table 4.28**.

4.4.6 Fly Ash

Demand of Fly ash is considered as an induced incoming traffic from Kolkata and Haldia Regions. Currently a huge quantity fly ash is exported to Bangladesh using IWT from Kolkata and Haldia Docks (3.13 million tonnes fly ash out of 3.22 million tonnes total cargo by IWT on IBP route).

Keeping in view the fly ash demand estimated based on the market surveys covering selected cement plants in NER, has been estimated for proposed IWT terminal at Jogighopa. The anticipated demand is linked to the augmentation of cement production plans in the region and accordingly a CAGR of 1.5 per cent, as proposed by E&Y, has been adopted. Annualised estimated fly ash traffic up to 2052 is given in **Table 4.28**.

4.4.7 Imported Coal

High quality imported coal is used in number of cement plants in NER. Currently, Haldia is the port of import to serve NER and supplies are made through rail. Based on market surveys undertaken by E&Y, coal traffic is highly amenable to proposed IWT services. Thus, entire movement currently facilitated on rail exhibits potential to get diverted on proposed waterways with requisite service offerings and freight incentives. For future projections, anticipated demand of imported coal is linked to the study period. Annualised estimated imported coal traffic up to 2052 is given in **Table 4.28**.

4.4.8 Stone Chips

Stone & Stone Chips is one of major commodities of exports from India to Bangladesh. Currently, six road based Integrated Check Posts (ICPs)/Land Custom Stations (LCSs) and four rail corridors between West Bengal (India) and Bangladesh are open to facilitate stone & stone chips traffic. The operating rail corridors are, namely; Petrapole - Benapole, Gede – Darsana, Singhabad – Rohanpur and Radhikapur – Birol.

Similarly road based ICP/LCS operating in West Bengal facilitating movement stone & stone chips are, namely; Petrapole (Ind.)- Benapole, Ghoadanga (Ind.) – Bhomra, Mahadipur in Malda district – Sona Masjid, Hilli, North Dinajpur - Hilli, Phulbari (Near Siliguri) District New Jalpaiguri, - Banglabandha, and Changrabandha in Cooch Bihar District – Burimari.

To meet Bangladesh stone & stone chips demand, Bhutan also exports by road transport through Indian Land Borders, predominantly from Changrabandha (Cooch Bihar District) – Burimari (Bangladesh) and Phulbari (Near Siliguri) District New Jalpaiguri, - Banglabandha (Bangladesh).

In 2019, Bhutan also exported Stone Chips using Dhubri IWT Terminal. Keeping in view the successful movement of Bhutan Stone Chips, using IWT to Bangladesh through Dhubri terminal, proposed Jogighopa IWT terminal is also envisaged as a candidate location for such traffic.

Dhubri IWT terminal offers a distance advantage to Bhutan Stone Chips Traffic both from source of supply in Bhutan to Dhubri by road transport and IWT distance from Dhubri to Bangladesh destinations, in comparison to proposed IWT terminal at Jogighopa.

Based on market studies as recommended by E&Y Dhubri IWT Terminal is designed to handle Stone & Stone Chips traffic in bulk, whereas proposed Jogighopa IWT terminal would be provided with state-of-the-art facilities to handle such cargo. Thus, stone & stone chips traffic is considered to be attracted at the proposed IWT terminal.

Using base year traffic as recommended by E&Y, to arrive at future volumes CAGR of 4% has been considered keeping in view the other road based ICP/LCS and rail competing mode available. Since, proposed IWT terminal is envisaged to attract Bhutan Traffic, traffic is projected for a period of 15 years

after commencement of terminal operation and kept constant for the following project period. Annualised estimated Stone & Stone Chips traffic up to 2052 is given in **Table 4.28**.

4.4.9 Automobiles

Based on market studies, E&Y considered 14 per cent of the overall automobile traffic exhibits potential to get diverted on waterways owing to various incentives offered. To arrive at future demand, rate of population growth observed in NER of 1.8 per cent has been adopted, as suggested by E&Y. Annualised estimated Stone & Stone Chips traffic up to 2052 is given in **Table 4.28**.

4.5 Conclusions & Recommendations

Based on examination of past studies and relevant data for estimation of traffic on proposed IWT Terminal at Jogighopa, following has been concluded:

- E&Y Study for modal shift of cargo passing through Siliguri Corridor destined for North-East and neighbouring countries to IWT' and "Pre-Feasibility for Proposed MMLP at Jogighopa" carried out detailed commodity wise market surveys to estimate potential and divertible traffic at the proposed Jogighopa MMLP & IWT Terminal. Since, commodity wise traffic flows are estimated based on market surveys which indicated a range of inward, outward and intra NER flows cannot be adopted for capital investment. In order to fill this data gap as well as to support commodity specific range arrived at by E&Y Study, AECOM used primary road O-D survey data collected by the Consultants at Paschim Madati Toll Gate near Siliguri on NH 31C, connecting NER with rest of India (June 2019).
- Since the major intermodal diversion to IWT is expected from road sector, on account of higher unit transportation cost, this data formed the basis. Although some diversion from rail to IWT is anticipated, mainly certain commodities originating from Kolkata and Haldia Ports.
- Based on the comparative traffic estimation studies, E&Y overall traffic was found to be nearly 43.7% higher, after updating the base year (2017) traffic estimates to 2019 level by applying annual growth rate of 5%, as AECOM surveys was undertaken in 2019.

After adjusting base year foregoing E&Y traffic estimates, AECOM has applied the same norms to arrive at comparative commodity wise forecasts for proposed IWT Terminal at Jogighopa, as reproduced in the **Table 4.32**.

Table 4.32: Commodity wise Traffic (in MT) to be Handled at Jogighopa IWT Terminal

Commodity	2022	2027	2032	2037	2042	2047	2052
Food grains	0.19	0.21	0.23	0.25	0.27	0.30	0.33
Fertilizers & FRM	0.08	0.09	0.10	0.11	0.12	0.13	0.14
Tar Coal/ Bitumen	0.07	0.08	0.10	0.12	0.15	0.18	0.22
PoL & Crude	0.02	0.03	0.03	0.03	0.04	0.04	0.05
Edible Oil	0.00	0.05	0.05	0.05	0.05	0.05	0.05
Fly Ash	0.14	0.15	0.16	0.18	0.19	0.20	0.22
Imported Coal	0.01	0.01	0.01	0.01	0.02	0.02	0.02
Stone Chips	0.59	0.71	0.87	1.05	1.05	1.05	1.05
TOTAL	1.10	1.33	1.55	1.81	1.89	1.98	2.08

Automobile Units	3133	3425	3745	4094	4476	4894	5351

In the light of this, Consultants suggest that E&Y estimated commodity wise traffic for proposed IWT Terminal at Jogighopa indicates an optimistic figure. The traffic derived by AECOM using primary survey data, is more realistic and reflects the most likely scenario of the traffic estimated to be handled at Jogighopa IWT Terminal.

The origin & destination details are shown in **Table 4.33** below.

Table 4.33: Commodity Wise Origin & Destination details to be Handled at Jogighopa IWT Terminal

Commodity	Origin*	Destination*
Food grains	Bihar, Burdwan, Dinajpur, Jharkhand, Kolkata, Maldah, Punjab, UP	Assam, Tripura Nagaland
Fertilizers & FRM	Haldia	Assam
Tar Coal/ Bitumen	Haldia, Kolkata, Jharkhand	Assam
PoL & Crude	Kolkata, Haldia	Assam, Tripura, Manipur
Edible Oil	Kolkata, Punjab	Assam
Fly Ash	Kolkata	Assam
Imported Coal	Haldia, Kolkata	Assam
Stone Chips	Bhutan	Bangladesh
TOTAL		
Automobile Units	Delhi, Haryana, Maharashtra	Assam, Nagaland, Tripura, Meghalaya

* Tentative locations identified based on Road Goods O-D Survey Results. E&Y identified Guwahati as the main hub; further distributing to other North-eastern states

5. TERMINAL FACILITY REQUIREMENTS

5.1 Introduction

The layout of any IWT Terminal will be based on the requirements in terms of number of berths, navigational requirements, material handling equipment, storage area for each type of cargo, road and rail access for the receipt and evacuation of cargo, and other utilities and service facilities. These requirements have to be worked out for development in a phased manner to enable preparation of the IWT Terminal's master plan.

The marine infrastructure and shore-based infrastructure shall be planned and developed to cater to the cargo forecast. Development of the terminal infrastructure shall also be suitably phased in such a way that the initial phases integrate well with subsequent phases.

Based on the future potential traffic projected in the Section-4, the terminal for Jogighopa shall be developed in phases starting with the Phase-I development and upgrading based on the projected traffic till Master Plan phase.

For the terminal planning based, following traffic forecast for 30 years from the base year FY 2022, has been considered as shown in **Table 5.1**.

Table 5.1: Traffic forecast for 30 years

Description	Reference year	Traffic Forecast
		(MTPA)
Phase 1	FY 2022	1.10
Master Plan	FY 2052	2.08

The terminal layout plan is proposed to be developed such that the phase 1 layout would be able to handle the master plan level throughput by way of increasing the handling equipment and reducing the dwell time of cargo.

5.2 Design Vessel Size

5.2.1 General

Sadiya to Dhubri (Bangladesh Border) stretch of River Brahmaputra (891 km) was declared as NW-2 in the year 1988 and since then, IWAI has been developing and maintaining basic IWT infrastructure thereon.

IWAI has developed significant level of IWT infrastructure on NW-2. This includes development and maintenance of fairway (navigation channel) of 45 m width with 2.5 m Least Available Depth (LAD) between Dhubri & Neamati (630 km), 2.0 m between Neamati & Dibrugarh/ Bogibeel (100 km) and 1.5 m between Dibrugarh/ Bogibeel & Sadiya/ Oriumghat (161 km) as presented in **Figure 5.1**.

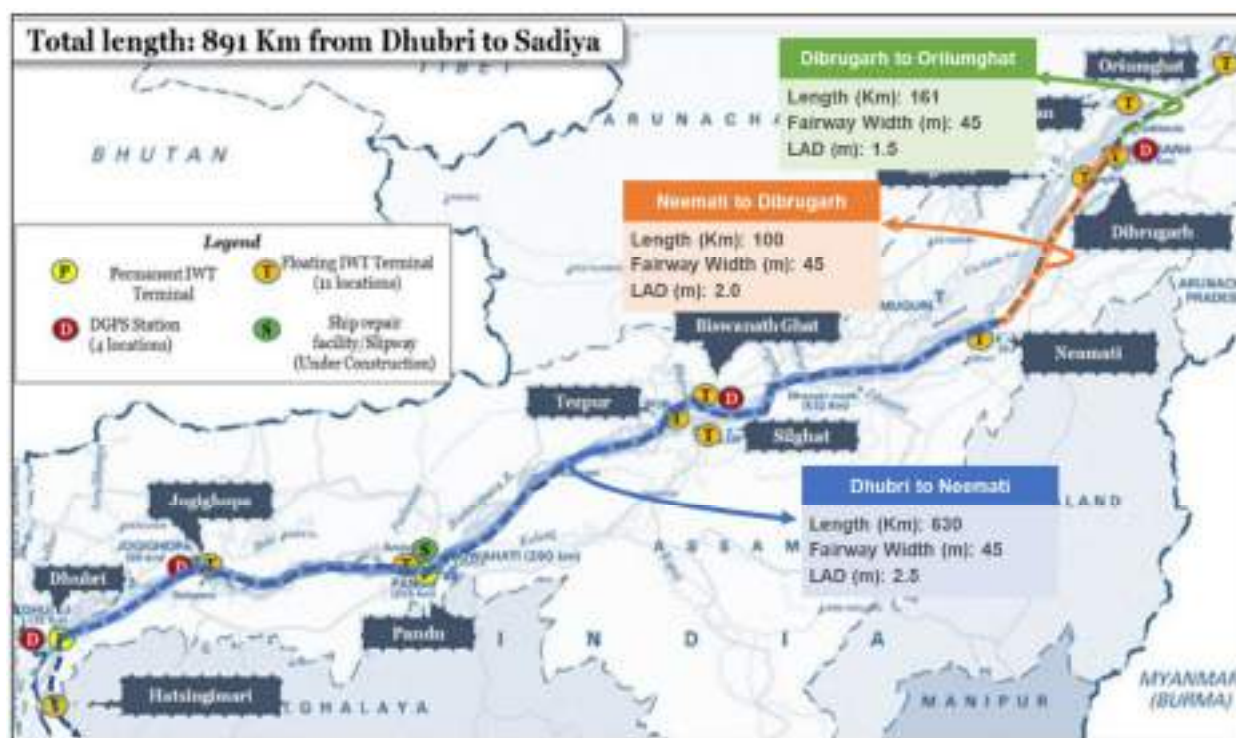


Figure 5.1: NW-2 Infrastructure , Declared Fairway Width & LAD

In case of NW-2, the movement of stone chips/ boulders originating from Bhutan and going to Bangladesh via the IBP route has gained traction. More than 10 shipments took place from IWA's Dhubri (Assam) terminal using shallow draft vessels in FY-20 and these movements are expected to become regular.

The observations made on the data / information collected have been presented in subsequent paragraphs:

1. As per Reports of IWT terminals on NW-1:

As per the recent reports prepared on development of IWT terminals on NW-1, the data on vessels that can ply on NW-1 and design vessel considered for planning have been provided below in **Table 5.2** & **Table 5.3**.

Table 5.2: Vessels that Can Ply Through Inland Waterway Route with LAD of 3.0 m

Tonnage (T)	Length (m)	Beam (m)	Draft (m)
Self-Propelled Motor Vessels			
650-1000	60-80	8.2	2.2
1000-1500	80-85	9.5	2.2
1500-3000	85-95	15	2.5

The design vessel is maximum size of vessel that would be handled at the IWT terminal and principal dimension of the design vessel considered for the preparation of the terminal layouts and design of marine structures in recent IWT terminals developed on NW-1 are presented in **Table 5.3** below:

Table 5.3: Design Vessel Considered in Development of recent Terminals on NW-1

Design Vessel Size (DWT)	Length (m)	Beam (m)	Draft (m)
2000	80	11	3.5

2. As per Dhubri Report by L&T:

Design vessels has been considered as Self-propelled type barge of 750 to 1000 T carrying capacity and with loaded draft of 2.50 meters is envisaged at the terminal.

However, study indicates fixing the location of berthing jetty so as to ensure safe berthing of loaded barges up to 2.50 m draft during leanest period.

3. Available vessel data at NW-2:

From the information collected from IWAI Guwahati office, it is understood that there are about 40 vessels plying on NW-2 with biggest vessel having LOA of 77.37 m, width of 15 m and depth of 5 m with around 1.6 m of loaded draft.

For Phase-1 planning, we propose to consider vessel with LOA of 77.37 m only. However, since the jetty shall be designed 30 years, the structural design of the same is proposed considering 3000 DWT vessels with 2.5 m loaded draft as planned in NW-1 considering future trend and also for continuation of vessel mobility from NW-1 to NW-2 and vice-versa.

Table 5.4: Vessel Wise Details and Specifications in NW-2

S. No.	Type of Crafts/ Vessels	Capacity / Details	Vessel Specifications					Speed (in Knots)	Number available	
			L (in m)	B (in m)	Depth (in m)	Draft (in m)	GRT (in T)			
A	Ro-Ro vessels									
1.	MV Gopinath Bordoloi	8 Loaded Trucks	46.50	13.30	3	1.5	388	10.75	3	
	MV Bhupen Hazarika	100 Passenger capacity								
2.	MV Sankardev	12 Loaded Trucks	57	15.20	3	1.60	572	11.02		
		200 Passenger capacity								
B	CSD Dredger Unit									

S. No.	Type of Crafts/ Vessels	Capacity / Details	Vessel Specifications					Speed (in Knots)	Number available
			L (in m)	B (in m)	Depth (in m)	Draft (in m)	GRT (in T)		
3.	CSD Mandovi	450 cum	42.7	9.48	2.28	1.5	194		2
4.	CSD Brahmani								
C	HSD Dredgers								
5.	HSD Dhansiri		28.25	10	2.8		185	6.55	2
6.	HSD Jiabhorali								
D	Work Boat Units								
7.	WB Saffron		26.5	7.75	2.75	1.4	137		2
8.	WB Iris								
E	Multi-Purpose Tug								
9.	MPT Khudiram Bose		28	7.2	2.6	1.2	146	10.08	1
F	Tug Unit								
10.	PT Bhagat Singh		21.5	6.5	2	1.4	73	10.15	1
G	Survey Launch								
11.	SL Kosi		21.5	5.5	1.7	0.8	63.58	10.6	6
12.	SL Barak		24.55	5.5	2.6	1	78		
13.	SL Lohit								
14.	SL Subansiri								
15.	SL Dibang		25	5.8	2.8	1.45	92	9.82	
16.	SL Burhidihing								
H	Accommodation Boat								
17.	AB Kalsubai		26.5	9	2.2	0.8	237		3
18.	AB Nilgiri								
19.	AB Rajrambha								
I	Crane Pontoons								
20.	CPB I		35	8	1.6	0.7	111		5
21.	CPB II		35	8	1.6	0.7	111		
22.	CPB III		35	8	1.6	0.7	117		
23.	CPB IV		35	8	1.6	0.7	117		
24.	CPB V		35	8	1.6	0.7	117		

S. No.	Type of Crafts/ Vessels	Capacity / Details	Vessel Specifications					Speed (in Knots)	Number available
			L (in m)	B (in m)	Depth (in m)	Draft (in m)	GRT (in T)		
J	F.J.B								
25.	FJB I		35	8	1.6	0.7	117		10
26.	FJB II		35	8	1.6	0.7	111		
27.	FJB IV		35	8	1.6	0.7	111		
28.	FJB VIII		35	8	1.6	0.7	111		
29.	FJB IX		35	8	1.6	0.7	111		
30.	FJB X		35	8	1.6	0.7	111		
31.	FJB XI		35	8	1.6	0.7	111		
32.	FJB XII		35	8	1.6	0.7	111		
33.	FJB XIII		35	8	1.6	0.7	111		
34.	F.J. Ganga		35	8	1.6	0.7	117		
K	SPV Cargo Vessels								
35.	MV AAI		77.37	15	5	2.8	1827		2
36.	MV Beki		77.37	15	5	2.8	1827		
L	Tug Barge Flotilla								
37.	Tug Trisul		26	7.75	3.2	2.5	159	12.02	2
	DB Ajay		59	11.5	3.5	2.5	718		
	DB Dikhu		59	11.5	3.5	2.5	718		
38.	Tug Ram Prasad Bismil		26	7.75	3.2	2.5	159	12.02	
	DB APJ Abdul Kalam		59	11.5	3.5	2.5	718		
	DB Kalpana Chawla		59	11.5	3.5	2.5	718		

Source: IWAJ

5.2.2 Average Parcel Sizes

With time, there shall be gradual increase in parcel sizes with improvement in technology and obsolescence of older vessels. Accordingly, the parcel sizes considered for phase 1 and master plan horizon has been provided in the **Table 5.5** below.

Table 5.5: Average Parcel Sizes

Commodity	Average Parcel Size (T)	
	Phase 1	Master Plan
Stone Chips (or RBM)	750	1000
Fly Ash	300	450
Imported Coal	400	600
Food Grains	300	450
Tar coal/ Bitumen	300	450
Fertilizers	300	450
POL	300	450

5.3 Cargo Handling Arrangements

For estimating the required number of berths, the handling arrangements assumed for various commodities are described below:

5.3.1 Stone Chips

As discussed in Chapter 4, the stone chips or the River-Bed Material (RBM) imported from Bhutan and destined for Bangladesh have been proposed to be transported through this IWT terminal. It shall be the main commodity to be handled at this terminal with roughly 50% commodity share.

The stone chips or RBM shall be brought in bulk through self-unloading dumper trucks and stacked at terminal in open storage earmarked for the same. For despatch, the dumpers shall bring the cargo to jetty where they shall be unloaded using grab attachment of the jetty crane and load into the barges.

5.3.2 Fly Ash

Fly Ash is usually handled either in loose bulk in form of slurry or in bagged form in 40 kg bags. Bulk fly ash is unloaded using pump/ pipelines to evacuate through specially designed trucks or conveyed to silos for storage. Bags can be unloaded using slings through jetty cranes and despatched through conventional trucks or stored in covered sheds. Transportation in slurry form is not considered in the present planning.

5.3.3 Imported Coal

The imported coal proposed to be transported through this IWT terminal shall be brought in bulk through barges. Separate grab attachment on the jetty crane shall be used for unloading coal. From barges the coal shall be loaded on to trucks positioned at jetty for further evacuation or transportation to the open storage area.

5.3.4 Food grains

Food grains are generally handled in bagged form. The bags are unloaded by the crane with net slings attachment and loaded into trucks at jetty for taking cargo to the storage area or directly despatched. Covered storage shall be provided at the terminal for storage of food grains. FLT's will be used for unloading and placing the bags in sheds as well as load the bags from sheds to the trucks for evacuation.

5.3.5 Edible Oil

Edible Oil will be handled in drums and unloaded from barge using same cranes at jetty but with different attachment. The drums shall be loaded on the truck waiting at jetty and taken to either the storage area for stacking or directly despatched. Forklift Trucks (FLT's) will be used for unloading and placing the drums at storage area as well as load the drums to the trucks for evacuation

5.3.6 Tar Coal / Bitumen

Tar coal or bitumen also will be handled in drums and shall unloaded with same attachment as used for edible oil through Mobile Harbour Cranes (MHC'r). And in similar way, the drums shall be loaded on the truck waiting at jetty and taken to either the storage area for stacking or directly despatched using FLT's for loading/ unloading and placing the drums at jetty & storage area.

5.3.7 Fertilizers

It is assumed that only bagged fertilisers shall be brought to this terminal for further distribution. No bulk fertilisers or raw material has been considered in the planning, however the same can be unloaded using the grabs through ELL cranes/MHCr.

Similar to food grains handling, fertilizer bags are unloaded by the crane with net slings attachment and loaded into trucks at jetty for taking cargo to either the storage area or directly despatched. Covered storage shall be provided at the terminal for storage. FLT's will be used for unloading and placing the bags in sheds as well as load the bags from sheds to the trucks for evacuation.

5.3.8 POL

POL cargo is generally handled in liquid bulk in tanker vessels having onboard pumps and some products are handled in drums as well in normal barges.

The liquid bulk cargo can be unloaded using flexible hoses provided at jetty using pumps on the vessel and taken to tanks provided for storage at the terminal through connected pipeline. From tanks, it shall be loaded into tankers for evacuation.

In case of the products handled in drums, the same will be unloaded from barges using cranes at jetty as proposed for edible oil and tar coal/ bitumen. As proposed above, the drums shall be loaded on the trucks waiting at jetty and taken to wither the storage area for stacking or directly despatched. FLT's will be used for unloading and placing the drums at storage area as well as load the drums to the trucks for evacuation.

5.4 Cargo Handling Rates

Based on the handling arrangements discussed above, the average cargo handling rates considered for planning purposes are presented in **Table 5.6** below:

Table 5.6: Cargo Handling Rates

Commodity	Average Handling Rate (TPH)	
	Phase 1	Master Plan
Export – Loading		
Stone Chips (or RBM)	300	540
Import – Unloading		
Fly Ash – Bulk	150	150
Fly Ash – Bagged	60	100
Imported Coal	70	125
Food Grains	60	100
Edible Oil	40	70
Tar coal/ Bitumen	40	70
Fertilizers	60	100
POL – Liquid Bulk	200	200
POL – Drums	40	70

It may be noted that higher handling rates have been considered in the master plan phase for general cargo by way of deploying two cranes simultaneously on one vessel and increase in efficiency of operations with time.

5.5 Berth Requirements

The required number of berths depends mainly on the cargo volumes and the handling rates as discussed in previous sections.

Other factors that influence the number of berths is:

- Number of operational days per year;
- Number of working hours per day;
- Time required for peripheral activities; and
- Berth occupancy levels.

These factors are discussed in subparagraphs hereunder:

5.5.1 Number of Operational Days in a Year

The terminal is assumed to be operational for around 300 days in a year allowing for weather downtime and holidays.

5.5.2 Number of Working Hours Per Day

The effective working of 20 hours a day has been assumed in berth requirements calculations to ensure faster turnaround of vessels.

5.5.3 Time Required for Peripheral Activities

Apart from the time involved in loading/unloading of cargo, additional time is required for peripheral activities such as berthing and de-berthing of the vessels, documentation, positioning and hook up of equipment, etc., which has been assumed to be on an average, 1 to 1.5 hours per vessel call.

5.5.4 Allowable Levels of Berth Occupancy

Berth occupancy is expressed as the ratio of the total number of days per year that a berth is occupied by a vessel (including the time spent in peripheral activities) to the number of operational days in a year.

High levels of berth occupancy will result in bunching of vessels resulting in undesirable pre-berthing detention. For limited number of berths and with random arrival of vessels, the berth occupancy levels have to be kept low to reduce this detention.

The norms generally followed for planning the number of berths in a port or IWT terminal to minimise the pre-berthing detention are indicated in the **Table 5.7** below:

Table 5.7: Recommended Berth Occupancy Factor

No. of Berths	Recommended Berth Occupancy Factor
1	60 %
2	65 %
3 & Above	75 %

5.5.5 Berth Requirement Calculations

The calculations for the required number of berths for the phase 1 and master plan phase of developments have been undertaken based on the factors discussed above as presented in **Table 5.8** & **Table 5.9** respectively.

As there is flexibility considered in equipment planning, most of the cargo can be interchangeably handled on any berth, a higher allowable berth occupancy of 75% can be considered for arriving at the overall throughput levels.

Table 5.8: Berth Requirements Calculation – Phase 1

Sl. No.	Particulars	Unit	Bulk				General cargoes				Liquid	
			Stones chips	Fly Ash		Imported Coal	Food Grains	Edible Oil	Tar coal/ Bitumen	Fertilizers	Bulk POL	Handled in Drums
1.	Traffic	MTPA	0.59	0.11	0.04	0.01	0.19	-	0.06	0.08	0.015	0.005
2.	Average Parcel size	T	750	300	300	400	300	-	300	300	300	300
3.	Nos. of Vessel Calls per Annum	No.	787	350	117	25	633	-	200	267	50	17
4.	Average Handling Rate	TPH	300	150	60	70	60	-	40	60	200	40
5.	No. of Average Working Hours per day	Hours	20	20	20	20	20	-	20	20	20	20
6.	Time Required at Berth Per Vessel											
a.	Handling Time	Days	0.13	0.10	0.25	0.29	0.25	-	0.38	0.25	0.08	0.38
b.	Berthing / Deberthing & Miscellaneous Time	Days	0.05	0.05	0.05	0.05	0.05	-	0.05	0.05	0.05	0.05
7.	Total Time per Vessel	Days	0.18	0.15	0.30	0.34	0.30	-	0.43	0.30	0.13	0.43
8.	Total Berth Days Required for Each Commodity	Days	138	53	35	8	190	-	85	80	6	7
9.	Berth Days Required	Days	602									
10.	Berth Days Available per berth	Days	300									
11.	No. of Berths		1	2	3	4	5	6	7	8	9	10
12.	Berth Occupancy	%	201%	100%	67%	50%	40%	33%	29%	25%	22%	20%
13.	Capacity of Berth using Berth Occupancy of 75%	MTPA	1.2									

Table 5.9: Berth Requirements Calculation – Master Plan Phase

S. No.	Particulars	Unit	Bulk				General cargoes				Liquid	
			Stones chips	Fly Ash		Imported Coal	Food Grains	Edible Oil	Tar coal/Bitumen	Fertilizers	Bulk POL	Handled in Drums
1.	Traffic	MTPA	1.05	0.17	0.06	0.02	0.33	0.05	0.22	0.14	0.04	0.01
2.	Average Parcel size	T	1,000	450	450	600	450	450	450	450	450	450
3.	Nos. of Vessel Calls per Annum	No.	1050	367	122	33	733	111	489	311	83	28
4.	Average Handling Rate	TPH	540	150	100	125	100	70	70	100	200	70
5.	No. of Average Working Hours per day	Hours	20	20	20	20	20	20	20	20	20	20
6.	Time Required at Berth Per Vessel											
a.	Handling Time	Days	0.09	0.15	0.23	0.24	0.23	0.32	0.32	0.23	0.11	0.32
b.	Berthing / Deberthing & Miscellaneous Time	Days	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
7.	Total Time per Vessel	Days	0.14	0.20	0.28	0.29	0.28	0.37	0.37	0.28	0.16	0.37
8.	Total Berth Days Required for Each Commodity	Days	150	73	34	10	202	41	182	86	14	10
9.	Berth Days Required	Days	800									
10.	Berth Days Available per berth	Days	300									
11.	No. of Berths		1	2	3	4	5	6	7	8	9	10
12.	Berth Occupancy	%	267%	133%	89%	67%	53%	44%	38%	33%	30%	27%
13.	Capacity of Berth using Berth Occupancy of 75%	MTPA	1.8									

It could be seen that with three Jetties, the berth occupancy has been limited to 67% only for the projected cargo traffic of 1.10 million tonnes in base year of FY 2022, while it reaches 89% for projected cargo traffic of 2.08 million tonnes in FY 2052. This means that the proposed terminal layout could accommodate the master plan phase traffic through increased handling rates with higher berth occupancy levels.

5.5.6 Size of Berths (Jetties)

Length of a berth depends on the number of vessels to be berthed at a time. In case of multiple berths, it is possible to optimise the total length based on the average LOA of the vessels visiting that berth. Considering that 77.37 m long vessels are berthed simultaneously, 255m length of berthing structure would be required.

The width of the berth depends on the material handling equipment and vehicular movement. Keeping allowing for the equipment and vehicles, the width of the jetty is proposed to be minimum 21 m.

5.6 Storage Requirement

The storage requirement at IWT Terminal for a particular commodity will be mainly determined by the dwell time of the cargo at the terminal. The other factors to be taken into account in determining the size of the storage areas are parcel size of the vessel, stacked densities, angle of repose, maximum and average stacking height, aisle space, reserve capacity factor, peaking factor etc.

As the major storage capacity planned at MMLP, the cargo transfer between IWT terminal and MMLP could take place in a planned manner just before arrival of the vessels of the corresponding commodity. This would help in reducing the dwell time of cargo at IWT terminal resulting in reduced requirement of storage area.

Storage area requirements have been calculated based on either maximum vessel size or dwell time. In first phase of development, a dwell time of 5 days have been considered however in master plan phase, dwell have been reduced to 3 days to check if the storage requirements can be accommodated in the same land parcel. The dwell time has been assumed uniform across all commodities while in actual it will vary, and the planned storage areas can be also used interchangeably.

Basis above the storage areas of various cargo have been worked out as presented in Table 5.10. As could be seen that the required storage area during phase 1 of development works out to 1.06 ha and that 1.71 ha over the master plan horizon.

Table 5.10: Storage Requirements

Commodity	Type of Storage	Land Area requirement (sqm)	
		Phase 1	Master Plan
Stone Chips (or RBM)	Open	2245	2397
Fly Ash	Silos	1039	1032
Imported Coal	Open	265	397
Food Grains	Covered	1735	1808
Edible Oil	Open	-	2640
Tar coal/ Bitumen	Open	3196	6027
Fertilizers	Covered	731	767
POL	Open	1371	2053
Total (hectares)		1.06	1.71

Table 5.11: Open and Closed Storage Requirements

Type of Storage	Phase 1	Master Plan
	(hectares)	
Open	0.71	1.35
Covered	0.35	0.36
Total	1.06	1.71

It may however be noted that the additional storage area calculated in **Table 5.10** is based on the consideration that the dwell time of the cargo remains same throughout the master plan horizon. However, in case the dwell time of the cargo could be reduced in master plan phase by way of utilising the storage area at MMLP to which the cargo could be transferred using the terminal dumpers. This would enable the terminal area developed in phase 1 to handle the master plan stage traffic also.

5.7 Water Requirement

Total water demand is broadly classified in the following categories:

- Potable water for consumption of terminal personnel.
- Potable water for vessels calling at the terminal.
- Static Water Storage for firefighting.
- Other uses like greenery etc.

Based on the requirements of facilities the water demand for the phase 1 development and master plan development works out to 50 cum/day and 100 cum/day respectively.

5.8 Power Requirement

The power is required at the terminal for the following activities:

- Mechanised cargo handling equipment, if any
- Lighting of the terminal area
- Offices and transit sheds
- Miscellaneous like water and fire pumps

Based on the above requirements the power demand for the terminal is calculated as 575 KVA. The power will be drawn from the main grid at available voltage level and brought up to the substation of the terminal and internal electrical distribution system shall be accordingly planned.

5.9 Office Space and Utilities

Size of Terminal Buildings has been worked out based on the assessment on the number of personnel likely to use the IWT terminal. The other building sizes are based on the requirement of utilities like water supply, firefighting and fuel Storage tank for supply of fuel to terminal equipment. The proposed building sizes over the master plan horizon are presented in **Table 5.12**.

Table 5.12: Size of Administrative Building & Other Buildings

S. No.	Building Name	Area (sqm)
1.	Gate Complex including Guard room	25
2.	Admin Office	828
3.	Custom Office Building	73
4.	Port In Call Office	73
5.	Workshop	480
6.	Substation	162
7.	Fuel Tank	100
8.	UG Water Reservoir with Pump House and OHT	336
9.	Canteen & Restroom	368

6. LAYOUT OF THE IWT TERMINAL

6.1 Planning Considerations

6.1.1 Waterfront Requirement for Locating Berthing Jetties

As mentioned in **Section 5.5**, there is a requirement provide a jetty with total length of 255 m to handle three vessels simultaneously. In case a high-level jetty and a low-level jetty are proposed to handle the vessels during low water and high-water levels, the total length of jetties will be 510 m. The waterfront should also be adequate to allow positioning of jetties to meet this requirement.

6.1.2 Seasonal Water Level

The proposed IWT terminal at Jogighopa is subjected to seasonal variation in water level of the order of 9 m. The layout of facilities has to be prepared such that vessels can access the berth at the maximum and minimum water levels round the year.

6.1.3 Topographic Information

The proposed terminal area is undulating, and the level varies from 16.0 m to 38.0 m above datum. The onshore facilities have to be planned such that the requirement for borrowed material for reclamation or the disposal of excess material as a result of site grading could be minimised.

6.1.4 Hydrographic Details

Based on the hydrographic data available at the terminal site it is observed that bed levels are at least 3.0 below the lowest water level, which is adequate for the design vessel. Hence no capital dredging is envisaged in case the berthing face is provided along the required natural water depth.

6.1.5 Rail Connectivity

The rail connectivity to the MMLP has already been provided. Therefore, it is not considered essential to provide the same at IWT terminal. The rail bound cargo shall be handled at the rail sidings of MMLP.

6.1.6 Road Connectivity

The road connectivity of IWT terminal to the hinterland and that with MMLP has been planned In line with road connectivity detailed in the **S6: Volume 2A (Main Report for External Roads & Trunk Infrastructure)** prepared by M/s Voyants Solutions Private Limited & KPMG as Consultant, March 2020.

6.1.7 Provision of Future Expansion

The layout shall be planned such that future expansion could be achieved suitably without acquiring additional land/waterfront area.

6.2 Alternative Terminal Layouts

6.2.1 General

The alternative terminal layouts have been prepared based on the planning consideration provided in **Section 6.1**. Basically, these are prepared to compare the arrangement of two-level jetty vs single level jetty.

6.2.2 Alternative Layout – 1

In alternative 1 it is proposed to provide two level jetties. The low-level jetties shall be used for handling cargo during the lean season when the water levels are low, and the high-level jetty shall be used for handling cargo when the water levels are over the low jetty level. As mentioned in para 6.1.1, there would be a requirement to provided two jetties of 255 m each along the waterfront. These shall be connected to the backup area through approach trestle. The proposed arrangement is shown in **Figure 6.1**.

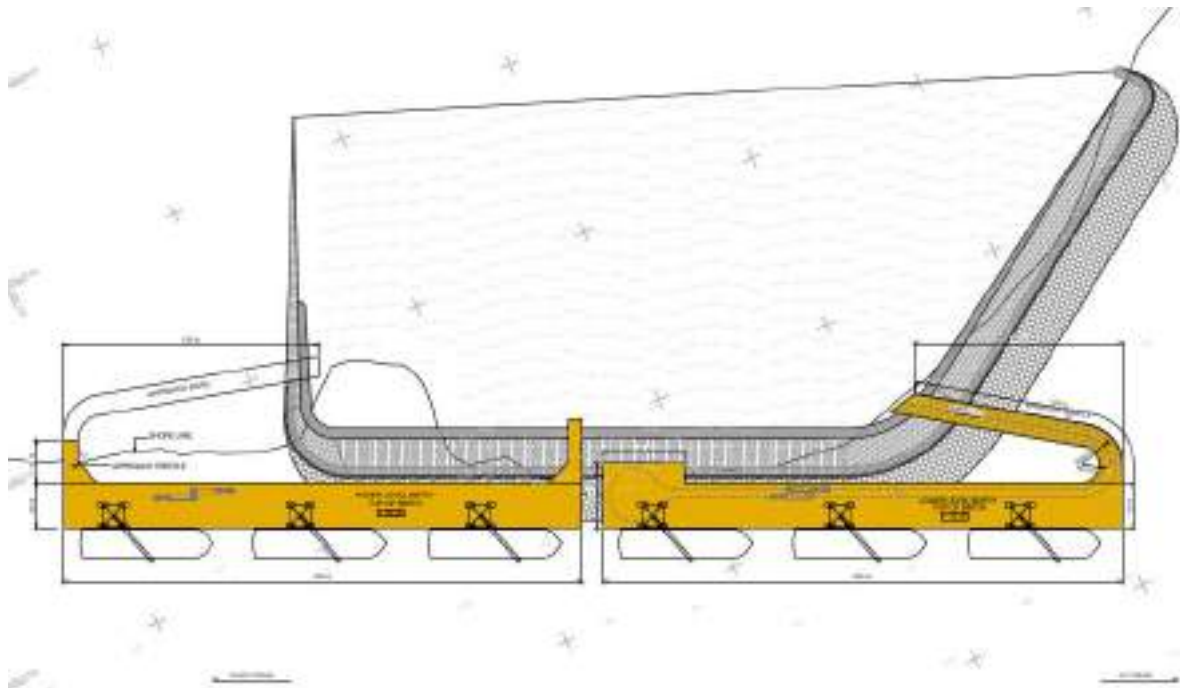


Figure 6.1: Alternative Layout - 1

6.2.3 Alternative Layout – 2

In alternative 2 it is proposed to provide a single level jetty. Accordingly, only a single jetty of length 255 will be required to be built. In this arrangement the cargo handling rates mainly while handling vessel at low water level, are lower as compared to alternative 1 using the similar equipment. Therefore, equipment of higher capacity would need to be provided. The proposed arrangement is shown in **Figure 6.2**.



Figure 6.2: Alternative Layout - 2

6.3 Evaluation of the Alternative Layouts

Both the alternative layouts have certain advantages as well as disadvantages as mentioned below:

1. Better cargo handling rates could be achieved during the lean season while handling cargo through low water level jetty. However, the equipment provided at low water level jetty would need to be shifted to high water level jetty which would result in limitation on the equipment types that could be deployed at low water level jetty. IN the case of single level jetty though the equipment supplied would be relatively costlier to match the cargo handling rates with that of low-level jetty but will have better flexibility in terms of deployment and efficient cargo handling operations.
2. Adequate waterfront opposite the backup land is not available in case of alternative 1, resulting longer travel time of equipment for transfer of cargo between jetty and the backup yard.
3. Cost of the jetty, which is the major cost item of IWT terminal, would also get doubled in case of alternative 1.

In view of the above **Alternative-2** is preferred alternative for development of IWT Terminal.

6.4 Recommended Terminal Layout

The 255 m long jetty would be connected to onshore terminal area by 2 approach trestles, each 7.0 m wide. Considering the operational requirement & equipment to be accommodated, the width of the Jetty is kept at 21 m.

The onshore layout provides the open and covered storage areas as per the planning requirements. The buildings for the terminal operations and other utilities are adequately placed in the terminal area. The terminal area is well connected with the jetty through approach trestles which together with the internal roads, provide adequate circulation space for cargo movement between storage area and jetty.

The recommended terminal layout is presented in **Figure 6.3**.

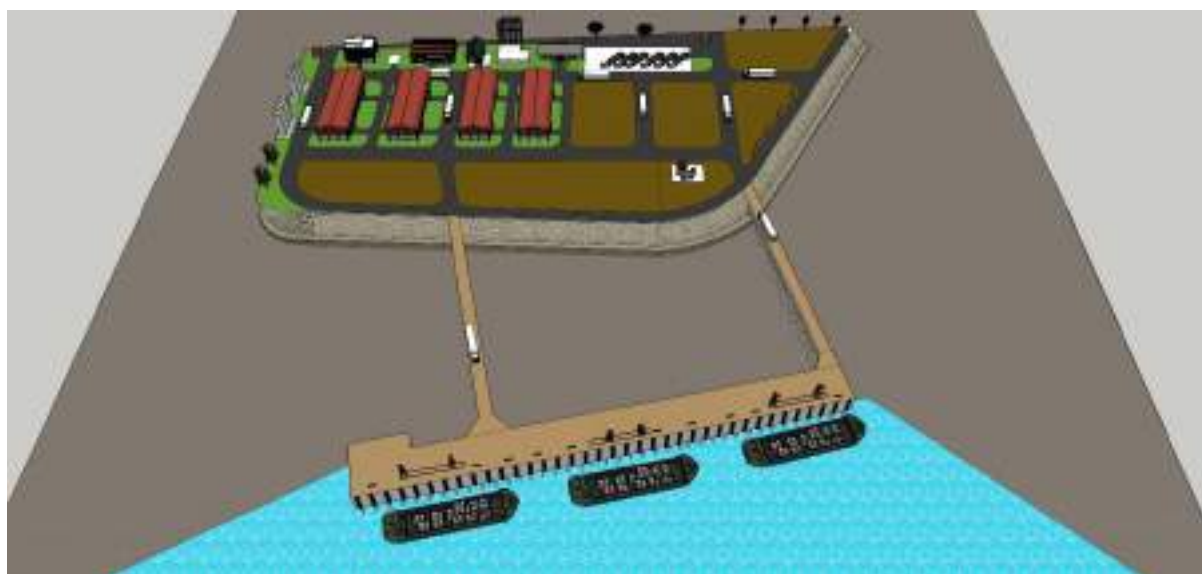


Figure 6.3: Recommended Terminal Layout

6.5 Phasing of the Terminal Facilities

Several IWT terminals have been built along the national waterways. The proposed facilities were based on the traffic forecast of the respective terminal. However, due to various reasons such as comparatively higher costs of handling through IWT mode, handling time, end to end logistics etc., these terminals are highly underutilized.

It is therefore prudent that terminal development be such as to minimize the initial investment with a provision to quickly ramp up the terminal capacity if warranted due to increased traffic. Initially it was proposed to build 190 m long jetty in phase 1A, However, IWA suggested to reduce the jetty size to accommodate one vessel only instead of two and therefore the initial jetty length is proposed to be 100 m. The capacity of this jetty would be limited to 0.41 MTPA. The jetty size would be increased in future once the terminal starts realising higher traffic.

It is therefore proposed to develop the phase 1 of the terminal in two stages i.e. Phase 1A (which shall be taken up initially as presented in **Drawing 60636525-DPR-1006**) and Phase 1B (additional facilities to complete phase 1 as presented in **Drawing 60636525-DPR-1007**).

The broad details of the key facilities to be taken up in Phase 1A and Phase 1B are given below:

Table 6.1: Broad Details of Key Facilities

Facilities		Phase 1A	Additional in Phase 1B
Dredging & Site Grading			
Dredging	cum	14,702	2,631
Site Grading	cum	70,358	82,703
Shore Protection Works		m	680
Jetty & Approach Trestle			
Jetty	sqm	2,370	3,255
Approach Trestle	sqm	1,088	1,424
Storage Areas			
Open Storage Areas	sqm	11,370	13,330
Transit Sheds	sqm	1,080	3,240
Equipment			
Mobile Loader for Stone Chips	No.	1	
Mobile Harbour Crane (MHCr)	No.	1	1
Mobile Crane	No.	1	
Trucks/ Dumpers	No.	8	6
Payloaders / FEL	No.	2	2
Forklifts	No.	4	4
Weigh Bridges	No.	1	
Buildings			
Gate Complex including security cabin	sqm	25	
Admin Office	sqm	828	
Custom Office	sqm	73	
Port In Call Office	sqm	73	
Workshop	sqm		480
Substation	sqm	162	
Fuel Tank	sqm	100	
UG Water Reservoir with Pump House and OHT	sqm	336	
Canteen & Restroom	sqm	368	
Utilities & Others			
Electric Supply and Distribution including Street lighting & earthing	LS	Fully Provided in Phase 1A	
Fire Fighting and Dust suppression	LS		
Water Supply System	LS		
Drainage	LS		
IT and Communication, CCTV, PAS	LS		
Environmental and Pollution Control	LS		
Internal Roads & Pavements	sqm	8,600	7,000
Compound Wall and Fencing	m	700	

7. ENGINEERING DETAILS

7.1 Codes and References

Table 7.1 provides a list of the primary codes and guidelines which will be used for the structural design of the riverine and onshore structures. A consistent set of standards along with their subsequent revisions have been used for each element of the works, with supplementary codes and guidelines used where additional requirements are needed.

Table 7.1: Codes & Standards

Code	Description
IS 456: 2000	Plain and Reinforced Concrete – Code of Practice, Fourth Revision
IS 800: 2007	General Construction in Steel – Code of Practice, Third Revision
IS 875 (Part 1): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 1, Dead Loads – Unit Weight of Building Materials and Stored Materials, Second Revision Incorporating Amendment No.1, Reaffirmed 1997
IS 875 (Part 2): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 2, Imposed Loads, Second Revision, Reaffirmed 1997
IS 875 (Part 3): 1987	Code of Practice for Design Loads (Other than Earthquake) for Building and Structures - Part 3, Wind Loads, Second Revision, Reaffirmed 1997
IS 1893 :1984	Criteria for Earthquake Resistant Design of Structures
IS 1893 (Part 1): 2002	Criteria for Earthquake Resistant Design of Structures - Part 1: General Provisions and Buildings, Fifth Revision
IS1893 (Part 4): 2005	Criteria for Earthquake Resistant Design of Structures - Part 4: Industrial Structures Including Stack-Like Structures
IS 3414: 1968	Code of Practice for Design and Installation of Joints in Buildings, Reaffirmed 2000
IS 4651 (Part II): 1989	Code of Practice for Planning and Design of Ports and Harbours, Part II Earth Pressures
IS 4651 (Part III): 1974	Code of Practice for Planning and Design of Ports and Harbours, Part III Loading, First Revision, Reaffirmed 2012
IS 4651 (Part IV): 2014	Code of Practice for Planning and Design of Ports and Harbours, Part IV, General Design Considerations, Second Revision, Reaffirmed 2005
IS 4651(Part V): 1980	Code for Planning and Design of Ports and Harbours Part V, Layout and Functional Requirements, Reaffirmed 2012
IS 2911 (Part 1/Sec2)	Code of Practice for Design and Construction of Bored Cast In situ Piles
IS 2911 (Part 4)	Load Test On Piles
IS 6403: 1981	Code of Practice for Determination of Bearing Capacity of Shallow Foundations
IS 3370: 2009	Code of Practice for Concrete Structures for the storage of liquids
BS 6349; Part 4: 1994	British Standard for Maritime Structures, Part 4: Code of Practice for Design of Fendering and Mooring Systems
IRC: 6-2010	Standard Specifications and Code of Practice for Road Bridges, Section II: Loads and Stresses, Fifth Revision

Code	Description
IRC 35	Code Of Practice For Road Markings
IRC: 37	Guideline for the Design of Flexible Pavements
IRC: 78-2000	Standard Specifications and Code of practice for Roads Bridges. Section VII- Foundations and Substructure.
IRC: 58-2002	Guidelines for the Design of Plain Jointed Rigid Pavements for Highways (Second Revision)
IRC: SP 50-2013	Guidelines on Urban Drainage
IRC: 67-2001	Code of Practice for Road Signs
IRC: 73-1980	Geometric design standards for rural (non-urban) highways
IRC: 86-1983	Geometric Design Standards for Urban Roads in Plains
IRC: 103-2012	Guidelines For Pedestrian Facilities
IS: 8237-1985	Code Of Practice for Protection of Slope for Reservoir Protection
IS: 14262-: 1995	Planning and Design of Revetments – Guidelines
PIANC	PIANC Guidelines for the Design of Fender System, 2002
PIANC	PIANC Guidelines for Seismic Design of Marine Structures
EM 1110-2-1100	Coastal Engineering Manual, US Army Corps of Engineers, 30 April 2002
IS: 12094: 2000	Guidelines for planning and design of river embankment (levees)
IS: 7894-1975	Code of practice for stability analysis of earthen dam
CIRIA	CIRIA Rock Manual 2007
CEM 2006	Coastal Engineering Manual 2006 (CEM 2006)
ISO 24409-3: 2014	Vessels and Marine Technology -- Design, location and use of shipboard safety signs, safety-related signs, safety notices and safety markings -- Part 3: Code of practice
CDOT	CDOT Drainage Design Manual
IS: 432 (Part 2)-1982	Specification for Mild Steel and Medium Tensile Steel Bars and Hard Drawn Steel Wire for Concrete Reinforcement – Hard Drawn Steel Wire
IS: 1893:2002	Criteria for Earthquake Resistant Design of Structures Part - 1 General Provisions and Buildings
IS: 13920	Ductile detailing of Reinforced Concrete Structures Subjected to Seismic Forces
IS 1080: 1985	Code of practice for design & construction of shallow foundations in soil
IS 1904: 1986	Code of practice for design & construction of foundations in soil general requirements
IS 2950, Part 1 1981	Code of practice for design & construction of raft Foundations, Part I – Design
IS 2911 Pt. 1 Section- I 1979	Code of Practice for Design and Construction of Pile Foundation.- Driven Cast in situ concrete pile
IS 2911 Pt. 1 Section- III 2010	Code of Practice for Design and Construction of Pile Foundation. – Driven Precast Concrete piles
IS 6403 1981	Code of Practice for determination of bearing capacity of shallow foundations

Code	Description
CPHEEO Manual	Central Public Health & Environmental Engineering Organisation Manual
IS 1367 (Part 13)	Hot-Dip Galvanised Coatings on Threaded Fasteners
IS2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel
IS4759	Hot-Dip Zinc coating on Structural Steel and other Allied products
IS8629 (Parts I to III)	Code of Practice for Protection of Iron and Steel Structures from Atmospheric Corrosion
ISO8504: 1992	Preparation of steel substrates before Application of Paints and Related Products
ISO8501-1: 1988	Preparation of steel substrates before Application of Paints and Related Products-Visual Assessment of surface cleanliness
SSPC-SP10	NACE No. 2, Near white blast cleaning (Sept 1, 2000) (SSPC: the Society for Protective Coatings – US
ISO - 17357-1: 2014 (E)	Floating Pneumatic Fenders
ISO 37: 2011	Rubber Testing - Tensile Strength and Elongation
ISO 188: 2011	Rubber Testing - Aging Rubber Testing
ISO 815-1: 2008	Rubber Testing - Compression Set
ISO 1431-1: 2012	Rubber Testing - Static Ozone Aging Test
ISO 7619-1: 2010	Rubber Testing – Hardness
IS 14593: 1998	Design and Construction of Bored Cast In Situ pile founded on rock
IS 8009 (Part-2): 1980	Code of practice for calculation of settlement of foundation
IS 12070: 1987	Code of Practice for Design and Construction of Shallow Foundations on Rocks
BY50	Concrete Code (based on EN 1992 and EN 206)
EN 1992: Eurocode 2	Design of Concrete Structures
EN 206	Concrete Design, specification performance, production and conformity
TR 15	Inspection product certification guide for pre-cast and pre-stressed concrete elements
EN 13163	Thermal insulation products for buildings and factory-made products of expanded polystyrene (EPS)
EN 826	Thermal insulating products for building applications. Determination of compression behaviour.
EN 1608	Thermal insulating products for building applications. Determination of tensile strength parallel to faces.
EN 12087	Thermal insulating products for building applications. Determination of long-term water absorption by immersion.
ISO 1461	Hot dip galvanized coatings on fabricated iron and steel articles. Specifications and test methods.
ISO 10684	Fasteners. Hot dip galvanized coatings.
ISO 5817	Welding. Fusion-welded joints in steel, nickel, titanium and their alloys.
ISO 13920	Welding. General tolerances for welded constructions.

Code	Description
ISO 2768	Machining: General tolerances.
ISO 3302	Rubber. Tolerances for products.
ISO 8062	Casting Geometrical Product Specifications (GPS). Dimensional and geometrical tolerances for moulded parts.
IS 2062: 2011	Hot rolled medium and high tensile structural steel — Specification
IS 1161	Steel tubes for structural purposes - Specification
IS 4000	High strength bolts in steel structures-Code of practice
IS 6623	High strength structural nuts — Specification
IS 6649	Specification for Hardened and Tempered Washers for High Strength Structural Bolts and Nuts
IS 1363	Hexagon Head bolts, screws and nuts of product grade 'C' Part 3 hexagon nuts (size range M5 to M64)
IS 1367	Technical supply conditions for threaded steel fasteners
IS 9595	Metal-arc welding of carbon and carbon manganese steels-Recommendations
IS 814	Covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel- Specification
IS 73	Paving Bitumen Specifications
IS 702	Specifications for Industrial Bitumen
IS 1322	Specifications for Bitumen felts for Water Proofing and Damp Proofing.
IS 2645	Specifications for Integral Cement Water Proofing Compounds
IS 3370: (Part -1)	Code of Practice for Concrete Structures for the Storage of Liquid: Part -1 General Requirements
IS 3384	Specifications for Bitumen Primer for Water Proofing and Damp Proofing
IS 7193	Specification for Glass Fibre Bitumen Felts
IS 12200	Provision of Water Stops at Transfers Construction Joints in Masonry and Concrete Dams - Code of Practice
IS 12432: (Part-3)	Application for Spray Applied Insulation-Code of Practice Part-3 Polyurethane/ Polyisocyanurate
IS 1566-1982	Hard drawn steel wire fabric for concrete reinforcement.
IS 6433-1972	Specification for guniting equipment.
IS 9012-1978	Recommended practice for shotcreting.
IS: 10558-2013	Aluminium Shore Gangways

Guidelines
BIS: Bureau of Indian Standard
IEC: International Electro technical Commission standards
IEEE: Institute of Electrical and Electronics Engineers standards
Regulations laid down by Indian Electricity Act and Rules
National Electrical Code (SP 30, 2011) of India
Indian Bureau of Energy Efficiency (BEE) Guidelines
Guidelines issued by Central Electricity Authority (CEA)
CBIP Publications
Any other regulations by the local or state/central government authorities,
Regulations issued by tariff advisory committee / fire insurance regulations

Electrical Codes	
IS 3043/IEEE-80	Code of Practice for Earthing
IS/IEC-60947	LV Switchgear
IEC 62271-202	HV Prefabricated Sub-Station (CSS)
IS 3427 / IEC-62271-200	Metal Clad Switchgear
IS 13118/ IEC-62271	HV Circuit Breakers
IS 11171/IEC 60076	Dry Type Transformer
IS 5578	Arrangement for Switchgear Bus bars, Main Connection and Auxiliary Wiring
IS 2705	Current transformer
IS 3156	Potential transformer
IS 2544	Bus bar support insulators
IS 3231	Electrical Relays for Power System Protection
IS 13703	HRC FUSES
IS 3646	Code of Practice for interior illumination
IS 1944	Code of Practice for road lighting
IS 2309	Protection of buildings and allied structures against Lightning code of practice
IS 7098	Specification for XLPE insulated PVC sheathed cables
IS 1554	Specification for PVC insulated cables
IEC: 62259	Secondary cells and batteries containing alkaline or other non-acid electrolytes-Nickel-cadmium prismatic secondary single cells with partial gas recombination
IEC: 60623 / IS 10918	Secondary cells and batteries containing alkaline or other non-acid electrolytes-vented Nickel Cadmium prismatic rechargeable single cells
IS 9000	For Basic climatic and mechanical durability tests for components for electronic and electrical equipment

Electrical Codes	
IS 6619	For Semiconductor rectifier equipment code
IS 2026	Power transformers
SP 72: 2010	National Lighting Code
1944 (Parts 1 Code of practice for lighting of and 2)	Public thoroughfares: Part 1 General principles; Part 2 Lighting of main roads
1944 (Part 5): 1981	Code of practice for lighting of public thoroughfares: Part 5 Lighting of grade separated junctions, bridges and elevated road (Group D)
1944 (Part 6): 1981	Code of practice for lighting of public thoroughfares: Part 6 Lighting of town and city centers and areas of civic importance (Group E)
CEA	Manual on Transmission planning Criteria
	National Building code of India 2005 Part IV 'Fire & Life Safety'
IS 903:1993	Specifications for Fire Hose delivery coupling, branch pipe, nozzles and nozzles spanner.
IS 5290: 1993	IS 5290:1993 Specification for landing valve,
NFPA: 14	NFPA:14 for stand post system
IS: 908	IS:908 Specification for fire hydrant, stand post type (second revision)
IS: 909	IS:909 Specification for underground fire hydrant Sluice valve type (third revision)

7.2 Road Connectivity

As discussed in **Chapter 6**, The MMLP project road has four important cardinal points including terminal points. These are:

Phase 1:

1. Major Intersection with NH 17 & MMLP Connectivity Road
2. Major Intersection with MMLP Connectivity Road & Port Connectivity Road
3. Major Intersection with NH 17 & Port Connectivity Road

Phase 2:

4. Major Intersection with Proposed Jogighopa Bypass & MMLP Connectivity Road

The "Port" mentioned in the MMLP report refers to the IWT, Terminal Jogighopa. The MMLP Connectivity Road starts from NH 17 at coordinate 26°13'33.18" N, 90°33'56.02" E. It enters the Ashoke Paper Mill area and follows along the existing bund and ends at MMLP entrance at coordinate 26°14'27.91" N, 90°33'17.47" E. It also connects the Jogighopa IWT Terminal at 26°13'09.76" N, 90°34'08.98" E. The alignment is shown in **Figure 7.1**.



Figure 7.1: Proposed Road Connectivity as Per MMLP DPR (Voyants & KPMG)

7.3 Capital Dredging

As per the hydrographic data it could be seen that minimum water depth of 3 m is not available at the berth location and therefore capital dredging of about 9,000 cum would need to be undertaken. The dredged material shall be pumped onshore for site grading purposes.

7.4 Jetty and Trestle

7.4.1 Design Criteria of Jetty and Trestle

7.4.1.1 Design Life

The permanent works shall be designed and constructed to give the following design lives:

- Jetty - 50 years
- Shore protection works - 50 years
- Fenders, Bollards and ladders - 8 years

Above design lives are defined as a period within which the asset will continue to be serviceable for design loads without collapse

7.4.1.2 Design Vessel Size

Though currently, vessel of lower DWT are plying in the channel, it is proposed to carry out structural design the jetty for the futuristic vessels having higher cargo handling capacity as mentioned in **Section 5.2** and as presented below:

Table 7.2: Design Vessel Size

DWT (T)	Length (m)	Beam (m)	Draft (m)
2000	80	11	3.5

7.4.1.3 Salient Levels

The salient levels for the proposed IWT terminal are given below:

High Flood Level (HFL)	:	+36.65 m
Low Water Level (LWL)	:	+28.28 m
Formation level of Onshore area	:	+37.5 m
Finished Deck Level	:	+38.0 m
Design Bed Level	:	+23.5 m
Scour Level	:	+3.59 m

7.4.1.4 Materials**Table 7.3: Material Specifications**

Structural Concrete	M-40
Levelling Concrete	M-15 of 100 mm thick
Reinforcement	Thermo-mechanically treated corrosion resistant steel of grade equivalent to Fe-500
Cement	Ordinary Portland Cement of minimum grade 53 as per IS:8112
Structural Steel	As per IS:2062 (Grade-A) with minimum thickness of 10 mm
Protective coating to structural steel	Minimum DFT of 240 microns after sand blasting to SA 2.5 grade

7.4.1.5 Minimum Cover

Clear cover to outermost reinforcement will be as mentioned here under in

Pile, Pile Muff	75 mm
Beams	50 mm
Slab	50 mm

7.4.1.6 Loads

7.4.1.6.1 Dead Load

The dead loads shall be assessed based upon the volume of the material using the following densities:

- Plain Concrete : 2.35 T/m³
- R.C.C. : 2.50 T/m³
- Reinforcement Steel : 7.85 T/m³
- Saturated Density of Compacted Earth Fill : 1.8 T/m³
- Bulk Density of Compacted Earth Fill : 0.8 T/m³
- Water : 1.0 T/m³

The unit weight of all other materials shall satisfy the requirements of IS: 875.

7.4.1.6.2 Superimposed Load

S. No.	Load Type	Multi-Modal Jetty
1.	Live Load	3 T/m ² (or) Single lane of IRC class AA vehicle (or) Loads due to lifting capacity crane whichever is more.

7.4.1.6.3 Equipment Load

The jetty shall be designed for crane for lifting capacity of 10 T @ 15 m radius. Crane loads during operating and Storm conditions shall be considered in conformance with crane manufacturer's recommendations.

7.4.1.6.4 Wind Load

Wind load on the exposed jetty structural elements is calculated considering wind speed as given below:

Basic Wind Speed in operating condition : 22 m/s

Basic Wind Speed in extreme condition : 50 m/s

Wind pressures shall be calculated in accordance with IS: 875 (Part 3).

7.4.1.6.5 Seismic Load

Seismic loads and design will be as per IS1893 (Part 1):2002.

Seismic Parameters

Zone	V
Zone Factor – Z (corresponding to seismic zone V)	0.36
Importance Factor – I	1.0
Response Reduction factor	3.0
Damping Factor	Steel - 2%, RCC – 5%

7.4.1.6.6 Current Load

The current velocity for design of structure shall be taken as 2 m/s and 5 m/s respectively for operating and extreme conditions. Water current forces shall be determined as per method recommended in Pile Design and Construction Practice by Tomlinson.

7.4.1.6.7 Berthing Loads

Berthing loads shall be determined in accordance with IS: 4651. For the purpose of calculating the Berthing energy, 2000DWT vessels under fully loaded condition is assumed to berth at an angular approach of maximum 10° with an approach velocity of 0.25 m/s. Berthing energy for design vessel size of 2,000 DWT has been calculated as 144 kNm.

Considering the water level variation of the order of 9 m between high flood level and low water level at the site and also the variation in the sizes of vessels to be handled at the jetty, the fendering system is designed such that sufficient contact area between the hull of the vessel and the fender face is ensured at all water levels. It is required to provide a suitable fender system, not only to absorb the design berthing energy of the vessel but also to keep the vessel's hull pressure below the limit of 40 T/m². To absorb the design Berthing energy of 144 kNm, it is proposed to provide suitable Arch fenders at each fender block. Fender blocks are provided @ 6.5 m c/c.

7.4.1.6.8 Mooring Load

Mooring Load shall be calculated based on the design vessel size with an operating speed corresponding to signal no. 7 on Beaufort scale, i.e. wind speed of 65 km/hr (18 m/s). It shall take into account the effect of currents also. In any case the jetty shall be designed for a minimum mooring load of 50 T. Mooring load shall be calculated considering following parameters:

- Normal condition- Wind Speed at 18 m/s & Current speed at 2 m/s
- Extreme Condition- For full Capacity of Bollard
- Current direction shall be taken parallel to jetty

50 T capacity bollards have been provided at 26m c/c and mooring load is applied at bollard location based on the calculations.

It is assumed that mooring loads will act on two bollards simultaneously from each vessel and therefore mooring load of half of the load calculated is considered for analysis. In case of extreme condition, mooring load equivalent to full capacity of provided bollards at single bollard is considered.

7.4.1.6.9 Temperature & Shrinkage Loads

- Mean Effective Temperature : 27.5 ° C
- Design Range of Effective Temperature Variation : ± 25 ° C
- The Co-efficient of Thermal Expansion for
- Reinforcing Steel and for Normal Weight Concrete : 11.7×10^{-6}

Temperature difference shall satisfy the codal provisions mentioned in IRC 6.

Shrinkage:

For shrinkage strain of $\epsilon = 0.0002$ & coefficient of thermal expansion of $\alpha = 12 \times 10^{-6} / ^\circ \text{C}$, equivalent temperature fall for temperature of $t = \epsilon / \alpha = 17^\circ \text{C}$ shall be considered additionally with temperature fall of 24°C .

7.4.1.7 Load Combinations

The load combinations shall be in accordance with IS:4561 (Part 4):2014 as presented in **Table 7.4** below:

Table 7.4: ULS Combinations

	LD comb	DL	LL (udl)	EP	CL(op)+ LL (udl)	CL-Non op + LL (udl)	WL op	WL st	Wc st	Wc op	BE op	BE ab	ML op	ML xt	EQ
Normal	1	1.5	1.5	1.2			1			1					
	2	1.5		1.2	1.5		1			1					
	3	1.5	1.5	1.2			1			1.2	1.5				
	4	1.5	1.5	1.2			1			1.2			1.5		
	5	1.5		1.2		1.5	1			1.2	1.5				
	6	1.5		1.2	1.5		1			1.2			1.5		
Extreme	9	1.2	1.2	1			1			1				1	
	10	1.2		1		1.2	1			1				1	
	11	1.2	1.2	1			1			1		1			
	12	1.2		1		1.2	1			1		1			
	13	1.2	1.2	1				1.2	1						
	14	1.2		1		1.2		1.2	1						
Seismic	15	1.5		1											1.5
	16	1.2	1.2	1			1			1					1.2
	17	1.2		1		1.2	1			1					1.2
	18	0.9	0.9	1			1			1					1.5

	LD comb	DL	LL (udl)	EP	CL(op)+ LL (udl)	CL-Non op + LL (udl)	WL op	WL st	Wc st	Wc op	BE op	BE ab	ML op	ML xt	EQ
	19	0.9		1		0.9	1			1					1.5
Reversal	20	1.2	1.2	1			1			1					
	21	1.2		1	1.2		1			1					
	22	0.9	0.9	1			1			1	1.5				
	23	0.9		1		0.9	1			1	1.5				
	24	0.9	0.9	1			1			1			1.5		
	25	0.9		1	0.9		1			1			1.5		
	26	0.9	0.9	1				1.5	1						
	27	0.9		1		0.9		1.5	1						

Table 7.5: SLS Combinations

	LD comb	DL	LL(udl)	EP	CL(op)+ LL (udl)	CL-Non op + LL (udl)	Wind op	Wind st	Cr st	Cr op	BL op	BL ab	ML op	M xt	T	S	EQ
Transient Short term for crack width chk	1	1	1	1			1			1	1						
	2	1	1	1			1			1			1				
	3	1	1	1			1			1							
	4	1		1		1.1	1			1	1						
	5	1		1	1.1		1			1							
	6	1		1	1.1		1			1			1				
Short term for deflection @ expansion jt	7	1	1	1			1			1							1
	8	1		1		1.1	1			1							1
Sustained Long term crack width and deflection check	9	1	0.5	1											1	1	
	10	1		1	0.5										1	1	

Note: 50% Live load shall be considered for seismic case

The loads and their abbreviations are described below:

DL	-	Dead Load
SIDL	-	Superimposed Dead load
LL	-	Uniform live load
WL	-	Operating wind load

WL(St)	-	Storm wind load
WC	-	Wave & Water current load
BL	-	Berthing load
ML	-	Mooring load
EQ	-	Earthquake load
T	-	Temperature variation
S	-	Shrinkage

7.4.1.8 Scour Calculations

Depth of Flow Below HFL	:	13.2	m
Silt Factor	:	0.8	m
Velocity Maximum as Per HFL	:	5.00	m/s
Design Discharge	:	80,960	cum/s
Level of H.F.L.	:	36.65	m
Level of L.F.L.	:	28.28	m
Bed Level (B.L.)	:	23.5	m

According to clause 7.4 of IRC:SP:116:2018, the mean depth of scour below HFL (D) shall be calculated in accordance to the provisions mentioned in IRC-SP-116-2018.

$$\text{Depth Of Scour Below H.F.L. (D)} = 0.473 \cdot (Q/f)^{1/3} = 22.04 \text{ m}$$

Scour Depth below H.F.L.(Dmax)	:	1.5 * D
Scour Depth below High Flood Level(HFL)	:	33.06 m (1.5 * dsm)
Scour Depth Level	:	3.59 m
Scour Depth below Bed Level	:	19.91 m

7.4.1.9 Deflection Limits

Deflection for individual members shall be limited to deflection limits as specified in IS 456: 2000, Clause 23.2. However, deflection shall not be checked for Berthing and Mooring load combinations as per clause 8.3.7 of IS 4651:2014 part IV.

7.4.1.10 Crack Width Limits

Crack width for reinforced concrete structures shall be as recommended in Table-3 of IS 4651: Part 4:2014 and presented in **Table 7.6**.

Table 7.6: Allowable Crack Width for Jetty

S. No.	Exposure Zone	Crack Width Limit (mm)	
		Sustained Load	Transient Load
1.	Atmospheric Zone – Zone above HWL	0.2	0.3
2.	Splash Zone – Zone between HWL and LWL	0.1	0.2

3.	Below splash Zone up to Bed level	0.2	0.3
4.	Below Bed level	0.3	0.3

Sustained Load = Dead Load + 50% LL + Earth pressure

Transient Load = Dead Load + Berthing Load + LL + Earth pressure

7.4.1.11 Design Approach

3 Dimensional models of Jetty shall be analysed after structural idealization in STAAD Pro V8i software to assess the behaviour of structures under all possible load combinations. Piles are modelled upto fixity level as beam members, after duly considering scour depth. All longitudinal and transverse beams are modelled as beam elements as per the sizes considered. The deck slab of the jetty is modelled to their respective thickness as meshed plate elements. The design of the structural elements shall be done either manually or using standardized excel sheets or using STAAD Pro software design module.

Jetty shall be analysed as 3D plate element framed structure using STAAD.Pro for the various loads and their combinations described in sections above. The design of the structural elements shall be done either manually or using standardized excel sheets or in-house software packages or using STAAD.Pro software design module.

All designs of RCC structures shall be carried out by limit state method.

Piles shall be analysed by modelling soil springs determined from the soil subgrade modulus (ks). Subgrade Modulus shall be calculated based on the following formulae as per "Foundation Analysis and Design" by H J Bowels

$$K_s = AS + BS \cdot Z^n$$

Where,

$$AS = Fw1 \cdot C_m \cdot C \cdot (c N_c + 0.5 \gamma D N_\gamma)$$

$$BS \cdot Z^n = Fw2 \cdot C_m \cdot C \cdot (\gamma N_q Z^n)$$

$$C_m = 1.25$$

$$C = 40$$

$$Fw1 = 1.5$$

$$Fw2 = 3.2$$

All designs of RCC structures shall be carried out by limit state method.

P-delta analysis has been performed using STAAD.Pro to account for the slenderness effect, hence additional slenderness moment in piles as per conventional method given in IS 456 – 2000 shall not be considered.

Pile axial load carrying capacity in soil shall be per the recommendation in IS 2911: Part1/sec 2.

7.4.2 Structural Arrangement of Jetty and Approach trestle

7.4.2.1 Foundation

7.4.2.1.1 Well Foundation

This is a type of foundation where a part of the structure is hollow, which is generally built in parts and sunk through ground or water to the prescribed depth by removing earth through dredge hole.

The following precautions are to be taken during sinking of the well:

- Cutting edge and the top of the well curb shall be placed truly horizontal.
- The methods adopted for placing of the well curb shall depend on the site conditions, and the cutting edge shall be placed on dry bed.
- Well steining shall be built in lifts and the first lift shall be laid after sinking the curb at least partially for stability.
- The steining shall be built in one straight line from bottom to top and shall always be at right angle to the plane of the curb. In no case, it shall be built plumb in intermediate stages when the well is tilted.
- In soft strata prone to settlement/creep, the construction of the abutment wells shall be taken up after the approach embankment for a sufficient distance near the abutment has been completed.
- When the wells have to be sunk close to each other and the clear distance is less than the diameter of the wells, they shall normally be sunk in such a manner that the difference in the levels of the sump and the cutting edge in the two wells do not exceed half the clear gap between them.
- During construction partially sunk wells shall be taken to a safe depth below the anticipated scour levels to ensure their safety during the ensuing floods.
- Tilts and Shifts of wells shall be taken care during the sinking appropriately.

Keeping in view of the above positive and limited criteria into consideration, the type of foundation is to be considered appropriately duly taking the Geotechnical properties and Hydrological properties along with the site requirements aspects.

7.4.2.1.2 Pile Foundation

This is a type of foundation where a Pile formed in the ground / water by boring hole in the ground and subsequently filling it with plain or reinforced concrete. This can be driven with a permanent or temporary casing or also placed at the location either by precast or cast-in-situ.

The basic ideology of the pile foundation is dependent on the resistance with its skin friction i.e., Piles transmit the load of a structure to competent sub-surface strata by the resistance developed from bearing at the toe or skin friction along the surface or both. The piles may be required to carry uplift and lateral loads besides direct vertical load.

- The construction of pile foundation requires a careful choice of piling system depending upon subsoil conditions and load characteristics of structures. The permissible limits of total and

differential settlement, unsupported length of pile under scour and any other special requirements of project are also equally important criteria for adoption.

- In the case of the piles in water bodies, scour conditions are properly to be established in addition to the Geotechnical properties of the site / location.
- Spacing of piles and tolerances are to be taken care according to the related codes.
- Differential Settlement of pile / piles are to be taken care at Pile cap level and to be nil or within the limits.

7.4.2.1.3 Recommended Foundation

The following factors are considered while arriving at the preferred foundation type:

- The Jogighopa site is having an advantage that the same is not under the direct hit with the flood flow (not in the middle of flood flow) and the hillock corner will protect the structure. Hence both type of foundations can provide a stable structure
- Pile foundations is expected to take about 18 months to complete as compared to 30 months in case of well foundations
- It is estimated that the cost of jetty structure with piled foundation would be about 30% cheaper as compared to well foundation.

Accordingly, the Pile Foundation is preferred at this location.

7.4.2.2 Superstructure

As mentioned above the Jetty deck structures shall be supported on bored cast in-situ piles. The longitudinal and transverse beams shall support the deck slab. Expansion joints shall be provided in the Jetty and also between the Jetty and Approach Trestles. Piles shall be provided at spacing of 6.5m c/c in longitudinal direction. Along transverse direction 4 piles shall be provided at suitable spacing to allow deck width of 20 m.

The jetty shall be provided with the following fixtures

- a. Fenders
- b. Bollards
- c. Handrails
- d. Edge protection of Jetty from rubbing of mooring ropes.

7.5 Shore Protection

7.5.1 General

The shore protection works are generally adopted on the riverbank against erosive action of river. The proposed shore protection should be able to withstand the high river discharge. Suitable stone pitching works shall be designed to protect riverbank along the jetty as per IS: 14262-1995 guidelines.

7.5.2 Design Criteria

7.5.2.1 Design Loads

The following loads shall be considered for the design of Shore protection works

- Current velocity (max) = 5 m/s
- Discharge of 80,960 m³ /s
- Surcharge load of 1.0 T/m² (assumed)
- Earth and Water pressure

Scour Depth shall be considered about 33.06 m below HFL i.e. at the level of +3.59 m as presented in para 7.4.1.8.

Soil properties shall be taken from actual geotechnical investigation report.

The density and water absorption of the rocks are considered as follows:

- Density of rock shall be considered as 2.6 T/m³
- Water absorption considered for design shall be 2.5% as per CIRIA Rock Manual 2007

7.5.2.2 Launching Apron

Launching apron shall be laid at normal water level or low water level. The stones in the apron shall be designed to launch along the slope of the scour and provide a strong layer that may prevent further scooping out of the riverbed material. The size and shape of the apron depends on the size of the stone, thickness of the launched apron, depth of scour and slope of launched apron. Weight and size of the stone for launching apron should be determined as

$$D_s = 0.124 \sqrt[3]{\frac{W}{S_s}}$$

where
 W = weight of stone in kg, and
 S_s = specific gravity of stones.

And thickness of launching apron shall be determined using

$$T = \frac{V^3}{2g(S_s - 1)}$$

where
 T = thickness of protection layer in m,
 V = velocity in m/s,
 g = acceleration due to gravity in m/s²,
 and
 S_s = specific gravity of stones.

7.5.3 General Design Aspects

The design of a ParaMesh Reinforced Soil wall follows the principals involved in conventional soil retaining structure, however, reinforced soil structures require additional consideration with respect to soil/ reinforcement interaction.

The design involves checks for external and internal stability. The external stability covers the basic stability of the reinforced soil structure as a unit, whilst internal stability analysis examines the effectiveness of the geosynthetic reinforcement to hold the reinforced soil mass together so that the geosynthetic layers and soil function as a monolithic block.

Design has been carried out using BS 8006 Code of Practice for Strengthened / reinforced soils and other fills. BS: 8006 advocates limit state principles for design of reinforced soil wall, wherein, partial factors are applied on materials and loads, and adequate safety margins are ensured under various load combinations.

7.5.4 Overall stability check

The overall stability check (also called global stability or basic stability) is the stability analysis of a reinforced or un-reinforced slope carried out by using the limit equilibrium method. It can be conducted to check the stability of a nonreinforced slope, prior to considering the reinforcements. For design purposes this stability analysis is required to evaluate the retaining work stability against potential deep-seated sliding mechanisms as well as sliding mechanism external to the reinforcing units.

7.5.5 Internal stability check

The internal stability check (or slope stability) allows the user to determine the design of the retaining structure that is the reinforcing units required (type, spacing between reinforcing unit, length, etc.). According to this type of stability analysis the surfaces of potential sliding originate from the toe of the reinforcing structure and, passing through the reinforcement, terminates uphill.

7.5.6 Wall stability check

In conducting this type of stability analysis, the entire retaining structure, or part of it, is considered as a monolithic wall consisting of blocks, which form the retaining structure, itself. During the stability analysis the wall may be considered as being formed by all structural blocks (considered as structural embankments) forming the retaining structure or by all blocks above the specified block.

The stability check of the structure as a retaining wall consists of the three classical stability analysis conducted on retaining walls: check against overturning, check against sliding and check against the foundation bearing capacity.

7.5.7 Proposed arrangement of Shore Protection

The Jetty location having total stretch of approx. 281m is susceptible to bank erosion due to flow in the Brahmaputra river. Also, the slopes to right and left of the Jetty location having stretch approx. 137m and 180m respectively need proper protection so as to make slope stable.

The scouring of the bed due to high flow at river Brahmaputra is also a key problem which needs proper attention and suitable solution.

7.5.7.1 Proposed Solution

The total stretch of the project is divided into two parts:

- Jetty location which alongside river and
- side slope portion

Table 7.7: Options for Suitable Shore Protection

Option-1
1. 0.5m thick Gabion mattress laid at the slope of 2H:1V with launching apron for scour protection 2. Non-woven Geotextile type-I to be placed below gabion mattress which will act as filter media.
Option-2
1. 0.5m thick Gabion mattress laid at the slope of 2H:1V with launching apron for scour protection

2. Non-woven Geotextile type-I to be placed below gabion mattress which will act as filter media.
3. Reinforced soil wall having suitable height at riverbed with slope protection gabion mattress formed on the slopes formed from the top of RE Wall to the backup yard

Table 7.8: Recommended Solution

Recommended Solution
1. Reinforced soil wall having height 8m above G.L. with launching apron at the toe for scour protection.

However, Out of the above options the most suitable option shall be worked out by EPC Contractor based on the site conditions.

7.5.7.2 Soil Properties

Shore protection system shall be designed based on the soil properties as per geotechnical report.

7.5.7.3 Revetment

Gabions mattress are rectangular cages made of hexagonal double-twist wire mesh filled with appropriately sizes cobbles or quarry stones. The difference between the Gabion unit and Gabion Mattress is in their thickness. In order to reinforce/retain the structure and reduce the surface erosion, all edges are selvedge with a wire having greater diameter. The gabion is divided into cells by means of diaphragms positioned at 1m centres. The Gabion mattress has the tendency to sustain wear and tear due to high flow velocity during monsoons. Typical mattress section is shown in

Figure 7.2.

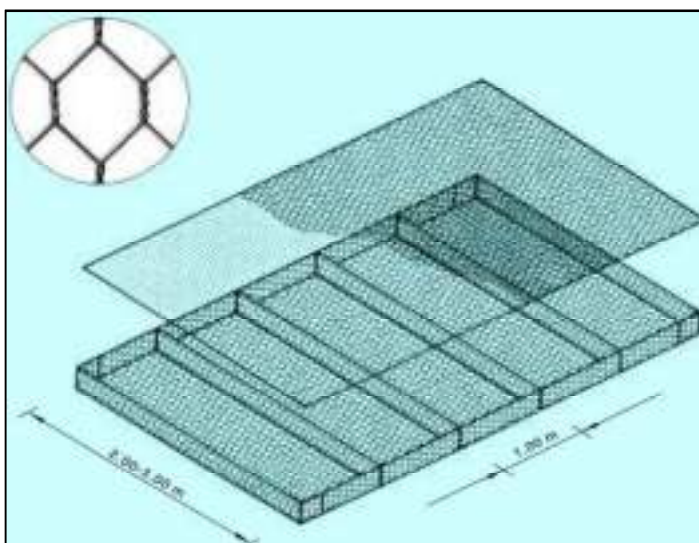


Figure 7.2: Typical Mattress Unit

7.5.7.4 Non-Woven Geotextile Unit

Non-Woven Geotextile is used as separator behind the Gabion retaining wall/ Gabion toe wall. It is made of virgin high tenacity polypropylene or polyester staple fibers which are UV stabilized. They are characterized by a high resistance to installation damage, high water permeability, resistance to ultraviolet degradation and to biological and chemical environments. Typical non-woven geotextile unit is shown in Figure 7.3.



Figure 7.3: Typical Non-Woven Geotextile unit

7.5.7.5 Soil Reinforcement system:

Composite Soil Reinforcement with flexible Gabion wall System: Composite soil reinforcement wall system combines high strength flexible geogrid(Paralink) as primary soil reinforcement and heavily galvanized Zn+10%Al+Polymer coated mechanically woven steel wire mesh panels as secondary reinforcement. The Gabion facia with secondary reinforcement should be monolithic with 100% connection strength and ready to use at site. Structure consisting of an external face, stone filled gabion, continued as a double twist mesh panel, both Zn+10%Al+Polymer coated. They can be built with a stepped or vertical/sloping face. They are specially designed for sites and situations where it is necessary to reconstitute the soil mass and where filling stone is scarce or expensive to obtain.

These structures demand special care with installation, mainly with respect to the foundation and with settlement of embankment across to the stone face, and they are especially suitable for works with large embankment movements.

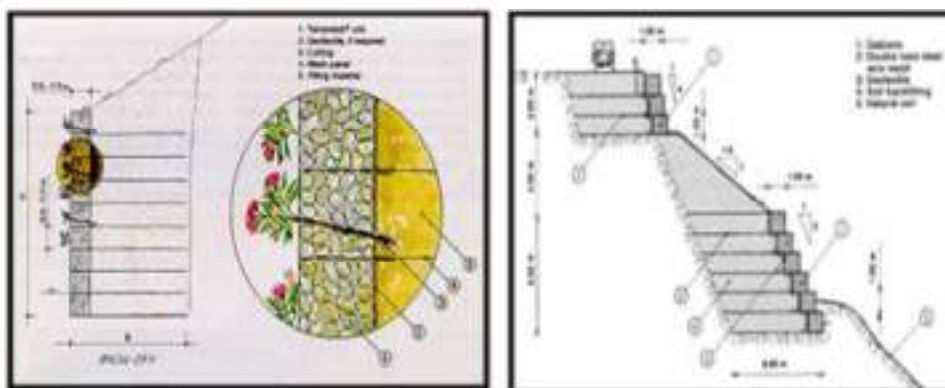


Figure 7.4: Reinforced soil wall with flexible Gabion facia (Terramesh-TMS)

7.5.7.6 Reinforcing Element – High Strength Flexible Geogrids

High Strength Flexible Geogrids are planar structure consisting of a monoaxial arrangement of composite Geosynthetic strips. Each strip shall have width that varies between 82mm to 91mm and a core comprising of discrete bundles of closely packed high tenacity polyester yarns, lying parallel to each other, encased in a linear low-density polyethylene sheath. The polyester fibres carry load while the sheath provides the shape to the composite strips and shall help to protect the yarns from mechanical damage, biological and chemical degradation. These strips are passed through rollers to give a knurled finish on the sheath. They are cooled and cut to length. The products are formed by heat bonding widely spaced composites of nominal strength across an array of the strips to produce a nominal 4.5-meter- wide planar structure. The density of the polyester yarns in the core governs the tensile strength of the geogrid, more the density more is the tensile strength. Specifications as suggested in IRC: 113-2013.

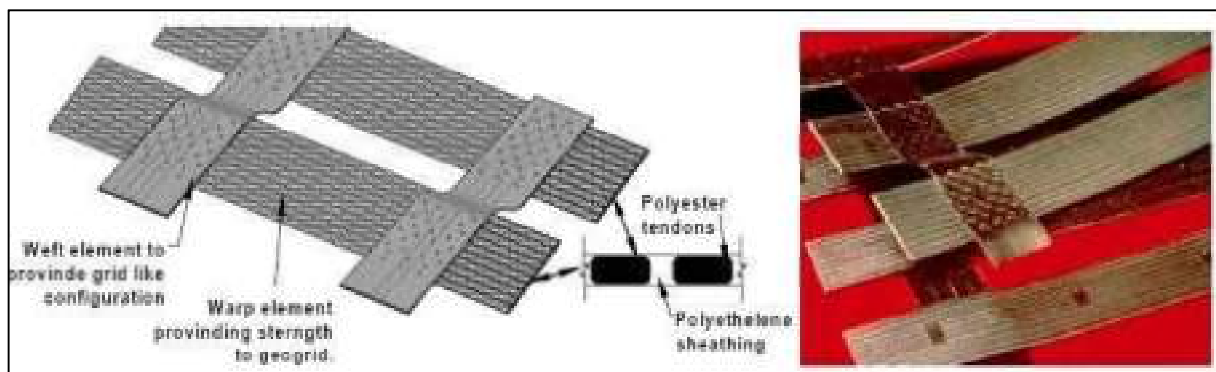


Figure 7.5: High Strength Flexible Geogrids

7.5.7.7 Drainage Composite

Drainage composite is a subset within the family of geosynthetic material. They are used as composite component in hydraulics and to containment applications, as well as in environmental, geotechnical and transportation applications. The main objective of drainage composite is to combine the best features of different materials in such a way that specific problems are solved in optimal manner providing optimum performance and minimum cost.

Drainage composite is a specifically designed to meet the drainage and protection requirements in structurally demanding water draining applications. It effectively eliminates hydrostatic pressure by collecting and conveying groundwater to a drainpipe for discharge. Drainage composites are prefabricated sub surface drainage products which directly replace the granular drainage layer.



Figure 7.6: Components of drainage composite

Considering the detailed criteria mentioned above, the shore protection is presented in **Drawing 60636525-DPR-1009**.

7.6 On-Shore Facilities

7.6.1 Design Life

The permanent works shall be designed and constructed to give the following design lives:

- Terminal Buildings - 50 years
- Access Road - 20 years
- Utilities - 20 years

Above design lives are defined as a period within which the asset will continue to be serviceable for design loads without collapse.

7.6.2 Design Criteria for Buildings and Covered Storage

7.6.2.1 General Design Considerations

7.6.2.1.1 General

The buildings shall be provided with adequate arrangements for plumbing, sanitary, electrical fittings, illumination, water distribution etc.

7.6.2.1.2 Foundations

Type of foundation system shall be decided based on locations and loading arrangement, load intensity and soil strata. Design of foundation at various levels shall be dependent up on the soil profile, which in turn shall be as per recommendation of soil investigation report. All foundations shall be designed as per limit state method of design. The design shall be updated after the geotechnical investigations on the Proposed IWT Terminal area.

7.6.2.1.3 Grade Slab

All ground floors for Terminal buildings shall be of R.C.C (M-20) with minimum thickness of 150mm over 100 mm thick PCC (M-10) base over well compacted earth.

DG room floor finish shall be 40mm thk including 13mm thk metallic hardener topping as per specification. Floor top shall be laid to slope minimum 1:100 towards floor drain for floor washing.

7.6.2.1.4 Staircase

- Minimum clear width : 0.8m
- Tread width : not less than 250mm
- Riser : not greater than 180mm

Continuous Handrail shall be provided.

7.6.2.1.5 Minimum Cover

Clear cover to any reinforcement shall be as mentioned here under but shall not be less than the diameter of such reinforcement.

For buildings

Top, bottom & side of footing (if any):	50 mm
Pedestal / column	
- Below ground	50 mm
- Above ground	40 mm
Beams	40 mm
Slab	30 mm
Face of walls & grade beam	50 mm (in contact with soil)
Face of walls not exposed to soil	25 mm (min.) or dia of main bar

7.6.2.1.6 Deflection Limits

Steel structures shall conform to IS 800: 2007, Clause 5.6.1, Table 6. Reinforced concrete structures shall conform to IS 456: 2000, Clause 23.2. Deflection of Pile at deck level shall be restricted to L/350

7.6.2.1.7 Crack width Limits

Crack width of all the structural elements shall be calculated wherever necessary as per IS: 456-2000.

7.6.2.1.8 Permissible Stresses

Permissible stresses and permissible increase or decrease of stresses shall be in accordance with the relevant IS codes, whichever is applicable.

7.6.2.1.9 Materials**Table 7.9: Material Specifications**

Structural Concrete	M-30
Levelling Concrete	M-15 of minimum 100 mm thick
Reinforcement	Thermo-mechanically treated corrosion resistant steel of grade equivalent to Fe-500/Fe 500D
Cement	Ordinary Portland Cement of minimum grade 53 as per IS:12269
Structural Steel	As per IS:2062 (Grade-A) with minimum thickness of 10 mm Or ASTM A-570, Grade 50 having minimum yield strength of 345 MPa shall be used for built up sections with minimum thickness of 10 mm as per IS:2062 (Grade-A) Angle /Rod bracing shall conform to IS codes and having minimum yield strength of 250 MPa.
Protective coating to structural steel	Minimum DFT of 240 micron after sand blasting to SA 2.5 grade.

Rolled steel Section & Plates up to 20mm thick	As per IS:2062 (Grade-A)
Rolled steel plates above 20mm thick	As per IS:2062 (Grade-B) Normalized
Chequered plate	Conform to IS: 3502-1994.
Pipes and hand rail	As per medium grade of IS: 1239.
Cold formed Tube Hollow section (SHS/RHS)	Conform to IS: 4923:1997.
Cold formed Circular Hollow section (CHC)	Conformed to IS: 1161:1998.

7.6.2.1.10 Material Density

Materials	Unit Weight (kN/m ³)
Steel	78.5
Plain Cement Concrete (PCC)	24.0
Reinforced Cement Concrete (RCC)	25.0
Cement Concrete Solid Block Work	20.0
Soil	18.0
Water	10.0
Cement Concrete Screed	24.0

7.6.2.1.11 Factor of Safety

- The factor of safety against Sliding, Overturning & Hydro-static uplift:

Sliding : 1.4

Overturning : 1.4

Hydro static uplift / Buoyancy : 1.2

(Dead weight of structures shall be considered as 0.9 times of actual and 20°wedge action of soil is considered in restoring the force.)

- Uplift of shallow Foundations : Minimum F.O.S. shall be 2.0

7.6.2.2 Design Loads**7.6.2.2.1 Dead Loads**

Dead load comprises of self-weight of all permanent construction, including walls, floors, grading concrete on floors roofs, ceilings, stairways, cable shaft, equipment etc. as applicable to the particular structure. The unit weight of all other materials shall satisfy the requirements of IS: 875.

7.6.2.2.2 Superimposed Loads

Table 7.10 Live Loads on Buildings

Load Description	UDL (kN/m ²)
Machine Loads	As per design

7.6.2.2.3 Live Loads

Live loads shall be as per IS: 875 (Part 2).

Load Description	UDL (kN/m ²)
Terraces with Access	1.50
Terrace without Access	0.75
Terminal Area	5
Staircase/Corridors	5.0
Electrical/Panel room	10.0
Data Storage/UPS /Battery Room	10.0

7.6.2.2.4 Design for Wind Load

Basic Wind Speed in operating condition: 22 m/s

Basic Wind Speed in extreme condition : 50 m/s

Wind pressures have been calculated in accordance with IS: 875 (Part 3)

7.6.2.2.5 Design for Seismic Load

Seismic loads and design will be as per IS1893 (Part 1):2002.

Table 7.11: Seismic Parameters

Zone	V
Zone Factor – Z	0.36
Importance Factor – I	1.0
Response Reduction factor	5.0
Damping Factor	Steel - 2%, RCC – 5%

7.6.2.2.6 Equipment Load

The building shall be designed to accommodate anticipated static and dynamic loading from electrical equipment. Where the uniform floor live load adequately accounts for the equipment weight, the weight of such equipment as a dead load need not be considered.

Impact Factor:

- For Manual monorail/Hoist design an impact factor of 1.20 shall be considered in design.

- For Electrical monorail/ Hoist design an impact factor of 1.25 shall be considered in design.

7.6.2.2.7 Temperature Loads

If expansion joints are proposed as per IS800:2007 requirements, no temperature loads shall be considered.

7.6.2.2.8 Load Combination

The Various loads specified above shall be combined in accordance with Cl: 8.0 of IS: 875 (Part- 5)-1987. The individual member of the frame shall be designed for Worst combination of forces Such as bending moment, axial force, shear force and torsion. Permissible stresses for Different load combination shall be taken as per IS 875 (part 5)-1987.

7.6.3 Design Criteria for Roads

7.6.3.1 Geometric Parameters

- Maximum longitudinal grade : 3.0%
- Cross slope : Unidirectional/ Bi-Directional 2.5% for All Roads
- Maximum super elevation : 3%
- Sight Distance : Intermediate sight distance
- Turning Radius at junction : Min. 25 m
- Design Speed : 40 km/hr

7.6.3.2 Pavement Design

- Traffic : 2 MSA

7.6.3.3 Specifications

Flexible Pavement

- Embankment : Min. Density shall be 1.6 T/cum
- Sub grade : density 1.75 T/cum, CBR as per Soil report
- Granular Subbase : Pavement Design shall be as per IRC: 37
- Granular Base : Pavement Design shall be as per IRC: 37
- Bituminous Surfacing
 - Binder course : Pavement Design shall be as per IRC: 37
 - Wearing course : Pavement Design shall be as per IRC: 37

The culverts, if any, required for the cross-drainage works shall be designed as per the relevant IRC codes.

7.6.4 Design Criteria for Storm Water Drains

The design rainfall intensity for the design of storm water drainage system shall be taken as 50 mm/hr. The drains shall be of Trapezoidal cross section with stone pitching interfiled with cement mortar grout with natural slope towards silt trap and ultimately discharge it to the river. All Indian codal provisions shall be considered while designing the storm water drain system.

The design of the structural components shall be carried out either using STAAD Pro or manually using standardized excel spreadsheets for the loads and their combinations. All designs of RCC structures shall be carried out by limit state method as per IS: 456 cracked section.

7.6.5 Design Criteria for Sewerage System

7.6.5.1 General

The sewerage system at terminal shall comprise of disposal system from buildings and toilet block to septic tank through a network of pipes and manholes and further to the Septic Tank which shall be RCC underground Tank. All Manholes shall be provided with heavy duty ductile iron or cast-iron covers.

7.6.5.2 Design Parameters

- Manholes in the sewerage collection system shall be installed. The channels in manholes at junctions and bends shall be smooth with gradual transitions to avoid turbulence and deposition/ Build-up of solids.
- Adequate ventilation arrangements shall be provided.
- Rate of Infiltration: Infiltration into the sewerage system occurs through defective sewers, manholes, etc. The rate of infiltration into sewers also depends upon the ground water table and permeability of the surrounding soil.
- Parameters to be adopted for sewage network design have been listed in **Table 7.12**.

Table 7.12: Parameters adopted for Sewage Network Design

S. No.	Parameters	Value
1.	Minimum outside diameter	200 mm
2.	Minimum Velocity for gravity network at initial peak flow	0.6 m/s
3.	Maximum Velocity for gravity network	3 m/s
4.	Peak Factors based on contributing population:	Peak Factor
	(i) Up to 20,000	3.00
	(ii) 20,000 to 50,000	2.50
	(iii) 50,000 to 7,50,000	2.25
	(iv) More than 7,50,000	2.0
5.	Maximum d/D Ratio	0.7 at peak flow

S. No.	Parameters	Value
6.	Design formula	Manning's Formula $V = 1/n R^{2/3} S^{1/2}$ Where V is velocity in m/sec S= Slope of conduit
7.	Manning's 'n'	As per CPHEEO Manual
8.	Manholes	RCC with removable cover.
9.	Minimum bed slopes	As per CPHEEO Manual
10.	Minimum depth of sewer	As per site condition for minimum cover requirements
11.	Maximum depth of sewer	As per site condition, maximum 4m

7.6.5.3 Typical Manhole Sizing

Manhole sizing shall be based on criteria as given in the **Table 7.13**:

Table 7.13: Manhole Sizing Criteria

S. No.	Range of Depths	Max. pipe dia. (mm)	Manhole Size dia. (mm)
1.	From 0.90 m and up to 1.65 m	300	900
2.	From 1.65 m and up to 2.30 m	600	1200
3.	From 2.30 m and up to 9.0 m	900	1500
4.	From 9.0 m and up to 14.0 m	1200	1800

7.6.5.4 Spacing of Manholes

- a) Spacing of manholes shall be based on criteria as given in the **Table 7.14** below:

Table 7.14: Criteria for Manhole Spacing

S. No.	Sewer Size	Manhole Spacing
1.	Sewer < 600 mm	up to 30 m
2.	Sewer ≥ 600 mm	45 m to 60 m

- b) Further, for inspection, cleaning and testing of sewers, manholes shall be provided at every change of alignment, gradient and diameter. The sewer shall be in a straight line between two manholes.

7.6.5.5 Flushing Manholes

Where self-cleansing velocities are not achieved due to flatness of gradients/less flow, a flushing arrangement shall be incorporated as per IS 4111 and CPHEEO.

7.6.5.6 Loads

Dead Load

The dead loads shall be assessed based upon the volume of the material using the following densities:

- Plain Concrete : 2.40 T/m³
- R.C.C. : 2.50 T/m³
- Reinforcement Steel : 7.85 T/m³

Live Load

Uniform Live load of 20 kN/m² on Precast Cover slab / Top slab

Lateral Earth Pressure

Earth Pressure shall be Active earth pressure considering -

Soil internal friction angle : 30°

Saturated Density of Compacted Earth Fill : 1.8 T/m³

Lateral Surcharge Pressure

A uniform Surcharge of 20 kN/m² shall be considered

Hydrostatic Pressure

Water level for calculating the hydrostatic pressure shall be taken at Ground level.

All Underground Tanks shall be checked for Uplift in empty condition. Minimum factor of safety against uplift shall be 1.2. For calculating Soil friction, the coefficient of Friction shall be taken as $\tan \phi$.

7.6.6 Design Criteria for Water Supply System

7.6.6.1 General

The water supply system includes the connecting pipeline from the Municipal water source and collection at the underground water tank and then pumping to the consumption areas by pipelines. All Manholes shall be provided with heavy duty ductile iron or cast-iron covers.

The design of the structural components shall be carried out either using STAAD Pro or manually using standardized excel spreadsheets for the loads and their combinations. All designs of RCC structures shall be carried out by limit state method as per IS: 456 cracked section.

7.6.6.2 Design Parameters

The broad design parameters for water supply system are given below:

- Wastage and leakage in system: 15% of the total theoretical demand.
- Hydraulic design of the pipeline shall be using Hazen-Williams formula.
- All pipelines shall be laid 1.2 m below ground.
- The residual pressure in the pipeline at the terminal point shall be 2 kg/sq.cm.
- Material of all piping shall be ductile iron. All valves in network shall be Resilient Seat mounted Sluice Valve of min. PN 16 rating in potable and treated sewage lines. For fire line the rating of valves shall be one higher than the pipe rating.
- The flow meter shall be provided in the pipeline tapped from the DI pipe and shall be electromagnetic type. All flow meters shall be provided with bypass arrangement with manual operated butterfly valves in the pipeline.
- RCC valve chambers (covered) shall be provided for installation of valve and flow meters along with bypassing, dismantling arrangements, workable space for operations and maintenance shall be provided.

7.6.6.3 Loads

Dead Load

The dead loads shall be assessed based upon the volume of the material using the following densities:

• Plain Concrete	: 2.40 T/m ³
• R.C.C.	: 2.50 T/m ³
• Reinforcement Steel	: 7.85 T/m ³

Live Load

Uniform Live load of 20 kN/m² on Precast Cover slab / Top slab

Lateral Earth Pressure

Earth Pressure shall be Active earth pressure considering -

Soil internal friction angle : 30°

Saturated Density of Compacted Earth Fill : 1.8 T/m³

Lateral Surcharge Pressure

A uniform Surcharge of 20 kN/m² shall be considered

Hydrostatic Pressure

Water level for calculating the hydrostatic pressure shall be taken at Ground level.

All Underground Tanks shall be checked for Uplift in empty condition. Minimum factor of safety against uplift shall be 1.2. For calculating Soil friction, the coefficient of Friction shall be taken as $\tan \phi$.

7.7 Handling Equipment

7.7.1 Equipment Proposed at the Terminal

7.7.1.1 Mobile Loader for Stone Chips

Mobile loader with in-built truck unloading hopper, as shown in **Figure 7.7**, have been proposed for the application. It consists of a conveyor installed on a crawler-mounted self-powered unit which makes it fully mobile and can rotate 360 degrees about that vertical axis. The equipment shall have a rated capacity of 500 TPH.

Materials for export are trucked to the jetty and dumped onto a special trap loader type feeder. The cargo is fed continuously and uniformly onto the conveyor's receiving chute.

The equipment elevates the bulk cargo over the vessel's deck to the hatch where it is discharged into the cargo hold. At the discharge, a special telescoping chute can also be provided, with rotating, pivoting spoon, to facilitate even and complete filling of the holds.

The proposed mobile loader shall be supplied with integrated control panel mounted on the equipment for operations with state-of-the-art control system.



Figure 7.7: Typical Mobile Loader for Stone Chips

7.7.1.2 Mobile Harbour Crane for Coal and General Cargoes

A mobile harbour crane has been proposed for handling of coal in bulk and general cargoes including fly ash, food grains, fertilisers in bagged form, tar coal/ bitumen, edible oil, etc. in drums as proposed in cargo forecast and shall be able work in conjunction with mobile loader for stone chips loading, for

unloading bulk fly ash and variety of other purposes as required. There are various types of cranes available in markets with wide range of equipment capabilities. The image of the type of crane proposed for this application has been shown in **Figure 7.8**.



Figure 7.8: Typical General Purpose Mobile Harbour Crane

7.7.1.3 Pneumatic Unloader for Bulk Fly Ash

In initial operations, it is proposed to handle bulk fly ash through grabs only. However, as traffic grows and warrants for a dedicated fly ash handling equipment, it is suggested to unload barges through pneumatic unloader as shown in the figure below. The self-contained equipment shall be able to unload fly ash with minimal dust. The pneumatic unloader shall be supplied as a tyre mounted mobile unit consisting of unloading arm, pressure tanks, feeders and rotary valves, piping, hoses etc.



Figure 7.9: Pneumatic Unloader for Bulk Fly Ash

7.7.1.4 Flexible Hoses

A set of Flexible hoses is proposed to be installed at the jetty for unloading tanker barges carrying POL in liquid bulk form connected with pipeline to transport the liquid to storage tanks planned in the terminal area.

The unloading hose considered shall be suitable for handling liquid POL with a handling rate of 300 TPH.

It is also considered that liquid handling arrangement, pipeline and tank farm shall be installed by the respective user based on his requirement.



Figure 7.10: Typical Flexible Hoses

7.7.1.5 Font-end Loader - FEL(s)

The front-end loader(s) shall be used for heaping up the stone chips within the stockyard as shown in **Figure 7.11** or other bulk cargo such as coal as well loading these cargo in to the dumper trucks for evacuation.



Figure 7.11: Typical Front-end Loader

7.7.1.6 Forklifts

A forklift (also called a lift truck, a fork truck, or a forklift truck) is a powered industrial truck used to lift and move materials short distances. A typical image is shown in **Figure 7.12**. Forklifts are rated for

loads at a specified maximum weight and a specified forward centre of gravity. Another critical characteristic of the forklift is its instability while negotiating a turn at speed with a raised load.



Figure 7.12: Typical Forklift

7.7.1.7 Trucks & Trailers

There are various types of trucks and trailers available in the market for different type of applications. It is considered that the transporters shall make their own arrangement for bringing the cargo to terminal for exports or taking their cargo to destination for imports. Their carriers shall also be allowed to come to the jetty for direct evacuation.

However, the terminal operator would also be required to keep their own fleet of vehicles for handling of cargo within the terminal.

The proposed fleet of vehicles comprises of dumper trucks, flatbed trailer trucks, bulker trucks, general 10T trucks, etc. Typical images of these vehicles have been shown in **Figure 7.13** below.



Figure 7.13: Trucks & Trailers

7.7.1.8 Road Weigh Bridge

One weighbridge has been proposed at the parking area for weighing of the cargo vehicles before the entry or exit of terminal. Pit less type Road Weighbridges has been proposed to avoid costly pit construction as well its maintenance. An RCC ramp work shall be required for at least 3 meters on both sides for easy movement of the vehicles. The structure shall be robust in construction with ample safety margin above the rated capacity.

The system shall be provided with communication facility with the main control room and a real time clock to print date and time on the printouts.

7.8 Design Basis / Details of Proposed Terminal Infrastructure

7.8.1 Boundary Wall/Fencing

It is proposed to provide boundary wall of 2.4 m height using brick masonry with barbed wire fencing of 1 m high. The boundary wall shall be provided all-round the boundary of the IWT Terminal.

7.8.2 Storage Facilities

The terminal has been provided with four covered storage sheds of size 36 m × 24 m each with suitable partitions for storage of food grains, fertilizers, etc.

Open storage area(s) has also been provided for bulk cargo such as stone chips & coal and other miscellaneous general cargo like drum which can be stacked in open. Area earmarked for open storage comprises of two plots of sizes 72 m × 44 m each, one plot of size 80 m x 50 m and one triangular plot (as available).

Typical images of covered and open storages have been shown in **Figure 7.14**.



Typical Covered Sheds



Typical Inside view of the Covered Shed



Typical Open Storage Area

Figure 7.14 Storage Provisions at Jogighopa IWT Terminal

7.8.3 Water Supply

The water demand for the Jogighopa IWT Terminal has been worked out in the **Table 7.15** below:

Table 7.15: Estimated Water Demand at Jogighopa IWT Terminal

1	Personnel and Users at IWT Terminal	Unit	FY 2022	FY 2052
1.1	Requirement	lpd/person	75	150
1.2	No. of persons		223	306
1.3	Water Requirement per Day	litres	16,725	45,900
2	Water Supply to Barges			
2.1	Average Requirement	litres per Barge	1,000	1,000
2.2	No. of Barges per annum	Nos.	2,445	3,350
2.3	Water Requirement per annum	litres	2,445,000	837,500
2.4	Water Requirement per Day (assuming 300 days)	litres	8,150	2,393
3	LAND SCAPING			
3.1	Requirement	litre/sqm/day	3	3
3.2	Area for Landscaping	sqm	6,000	6,000
3.3	Water Requirement per Day	litres	15,000	15,000
4	DUST SUPPRESSION			
4.1	Throughput of Dusty Cargo	MTPA	0.6	1.1
4.2	Water Requirement for Dust Sup. (@1%)	Cum/annum	3,000	10,700
4.3	Water Requirement per Day (assuming 300 days)	litres	8,571	30,571
4.4	TOTAL WATER REQUIREMENT	litres	48,446	93,864
4.5	Proposed capacity of raw water sump at IWT Terminal	cum	48.45	93.86

S. No.	Consumer	Water Demand (KLD)	
		Phase 1	Master Plan
1.	Raw Water (KLD)	23.57	45.57
2.	Potable Water (KLD)	24.88	48.29
Total Water Demand at IWT Terminal (KLD)		48.45	93.86
Say (Cum/day)		50	100

7.8.3.1 Sources of Water Supply

It is understood that ground water is being utilised to meet the requirements of local population. As the water requirements for the proposed IWT Terminal are very much limited, bore wells shall be installed for the receipt ground water and transferred to an underground reservoir located near the port entrance. This water after chlorination shall be distributed for potable purposes. Due approval of CGWB and other authorities shall be taken before undertaking boreholes.

7.8.3.2 Storage of Water

It is proposed to provide an underground water tank of 50 cum. Water from the underground tank shall be treated in the water treatment plant, consisting of chlorination, filtration and softening units (depends on the water quality test) and pumped to and an elevated water tank of 25 cum capacity from where it shall be distributed to various buildings.

7.8.4 Electrical Distribution System

7.8.4.1 Estimation of Electrical Load

Based on the proposed IWT facilities the total installed power load for the proposed Phase 1 development is estimated to be around 575 kVA. This would more or less same for the master plan horizon unless the additional equipment provided are with electrical drive.

S. No.	BUILDINGS/ EQUIPMENT	Qty.	UOM	Installed Load (KW)		Diversity	Demand Load (KW)
				Per Equip	Total		
A	Building Lighting, Aircon & Computer Load						
1.	Admin Office (Terminal Building)- 2-storey	539	Sqm	0.15	80.85	0.8	64.68
2.	Canteen & Rest Rooms	369	Sqm	0.08	29.52	0.7	20.66
3.	Substation/ Generator Room	163	Sqm	0.08	13.04	0.7	9.13
4.	Pump House	87	Sqm	0.04	3.48	0.7	2.44
5.	Guard Room (2 Nos)	50	Sqm	0.04	2.00	0.7	1.40
6.	Workshop	491	Sqm	0.04	19.64	0.7	13.75
7.	Covered Storage	4,320	Sqm	0.04	172.80	0.7	120.96
	Sub Total (A)				321.33		233.02
B	Utility load						
1.	Street Lights	2,000	m	0.02	40.00	1	40.00
2.	High Mast Light	8	Nos	6	48.00	1	48.00
3.	Water Supply pumps	2	Nos	5	10.00	0.4	4.00
4.	Fire Fighting Pumps	2	Nos	10	20.00	0.4	8.00
5.	Sewerage Treatment Plant	1	Nos	6	6.00	0.4	2.40
6.	Weigh Bridge	1	Nos	7.5	7.50	0.7	5.25
	Sub Total (B)				91.50		67.65
C	Equipment Load						
1.	Battery Charger for Substation	1	Nos	5	5.00	1	5.00
2.	IT and Communication, CCTV, PAS, FDAS	1	Nos	25	25.00	0.7	17.50
3.	Work shop Machinery Loads	1	Nos	50	50.00	0.4	20.00
4.	Fly ash Silos	3	Nos	15	45.00	0.4	18.00
5.	Fuel Bunkering Station	1	Nos	7.5	7.50	0.4	3.00
6.	Shore Supply	1	Nos	30	30.00	0.7	21.00
	Sub Total (C)				162.50		84.50
7.	Cumulative Load (A+B+C)				595.33		405.17
8.	Future Margin (20% Margin)						81.03
9.	Total Demand (KW)						486.20
10.	Power Factor						0.85
11.	Total Demand (KVA)						572.0

7.8.4.2 Source of Power Supply

Power supply to Jogighopa town is being managed by Assam Power Distribution Company Limited. It is assumed that they shall provide power connection at 11 KV up to the terminal substation from where the power shall be stepped down to 415 V using suitable transformer.

A DG set with rating of 365kVA has been considered to meet the emergency load demand.

7.8.4.3 Illumination

The illumination level in various areas will be maintained as per the industry standards and shall generally be as in **Table 7.16** below:

Table 7.16: Illumination Level in Various Areas

Area	Lux Level
Terminal Buildings	300
Substation, pump houses and fire houses	250
External illumination (Road Lightings), Parking	50
Open storage areas	50
Jetty and approach	100

7.8.4.4 Power Factor Improvement

Suitable rating HT capacitors with automatic power factor correction arrangement will be installed to maintain the overall power factor correction to 0.95.

7.8.5 Drainage and Sewerage System

7.8.5.1 Drainage System

Storm Water Drainage at the IWT Terminal will be through a system of underground covered drains provided to discharge the collected runoff. Surface drainage system shall be provided in the covered Areas through which water shall be diverted to the secondary covered drains, which shall ultimately discharge to the main drain.

7.8.5.2 Sewerage System

The sewerage system shall be in the form of septic tanks and connecting it to soak pits for disposal.

7.8.6 Fire Fighting System

The firefighting system shall be designed as per TAC stipulations. Hydrant system shall be provided at the terminal. A static storage capacity of 100 cum shall be additionally provided in the underground raw water tank for the purpose of firefighting. The hydrant system would comprise of hydrants placed at an interval of about 45 m within the yard and jetty through connecting pipelines and the water shall be supplied through the fire water pumps. 3.5 kg/cm² pressure shall be maintained at the most remote

point. The fire water shall be stored in the underground water tank from where it shall be pumped to the fire hydrants proposed at the appropriate locations in the terminal.

7.8.7 Pollution Control

One of the essential regulatory functions of an Authority is to ensure that the IWT Terminal waters are free from pollution. The main sources of pollution during operations in the terminal are:

- Discharge of oil by barges.
- Discharge of cargo overboard.
- Spillage of cargo during unloading / loading operations.
- Dust from cargo.
- Smoke from barges, vehicles.
- Noise from vehicles, machinery.

A simple manual water spray system shall be provided to contain dust particles before they become airborne.

7.8.8 Communication System

Communication system shall include telephonic and public address system. EPABX telephone exchange of 30 extensions to the various parts of the Terminal. It would be connected to public switched telephone network.

Public address system with talk back facility shall be provided around the terminal area.

7.8.9 CCTV Surveillance System

CCTV system shall be provided to ensure surveillance of required locations as well as create secured record for post event analysis. The system shall provide an online colour display of video images on LCD monitors located in Control Room at terminal building and cameras at various locations like Both In & Out Gate, terminal Building, pump house, substation, Jetty and other strategic locations of the IWT Terminal.

7.9 Navigational Aids

Navigational aids are required to be provided to ensure safe and efficient navigation of vessels to and from the terminal. These aids will assist in determining the position of vessel while transiting the navigational channel and manoeuvring inside the terminal.

It was ascertained that the Inland Waterways Authority of India (IWAI) is carrying out the River conservancy activities along with the provision of Day / Night Navigation in this stretch. It is proposed to provide jetty lights on either end to guide the navigation of the vessels.

8. ENVIRONMENTAL SETTINGS AND IMPACT EVALUATION

8.1 Introduction

The terminal at Jogighopa is proposed to be developed for Phase-1 initially catering to the traffic potential of 1.10 MTPA. The development of Phase-1 terminal includes construction of jetty, shore protection works, site grading, storage areas, internal roads, buildings, sewerage, water supply, and other utilities. This section briefly describes general environmental conditions of the project area i.e. physical environment, flora and fauna, etc.; broadly identifies the environmental issues that may arise due to the project their impacts and outlines the mitigation measures. This section also addresses the environmental policies and legislations applicable for the Project and the framework for obtaining Environmental Clearance. The section is based on the review of literature available, secondary data and information gathered during the study.

8.2 Site Setting

As mentioned in the **Chapter 2** Jogighopa in Bongaigon district of Assam has been considered for development of an IWT Terminal. The IWT is located on the banks of River Brahmaputra, at a distance of 3km south of the proposed MMLP. The proposed site is a low-lying area with contour levels varying from 16m to 36 m and prone to flooding. Almost about 15 acres of land is available, which is free of submergence.

8.3 Baseline Environmental Status

Baseline environmental condition in the vicinity of the site has been established using the Monitored data for the ESIA study of the MMLP Project, 3 km North of the Project site. As per the “Final Environmental & Social Study Report Stage VI - Volume 4 (March 2020)”, the following environmental attributes have been monitored for a period of December 2018-December 2019.

The monitored data serves as a basis for understanding the present environmental status of the aforementioned attributes and the results are presented in **Table 8.1** below:

Table 8.1: Summary of Environmental Baseline Status

S. No	Environmental Attribute	Summarised Data			
		Parameter	P98 $\mu\text{g}/\text{m}^3$	Maximum $\mu\text{g}/\text{m}^3$	Average $\mu\text{g}/\text{m}^3$
1.	AAQ	PM10	82.9	82.9	79.8
		PM2.5	48.0	48.5	43.7
		SO ₂	13.6	13.6	11.2
		NO _x	26.4	26.7	23.5
		CO	0.7	0.7	0.6
2.	Ambient Noise (Leq)	Max Leq Day Time dB(A) – 58.9 , Min Leq Day Time dB(A) – 50.9 Max Leq Night time dB(A) – 48.5 , Min Leq Day Time dB(A) – 44.7			
3.	GW	Total dissolved solid – 146.2- 198.6 mg/l , Total hardness -120 mg/l (max) Electrical conductivity – 266-361 $\mu\text{S}/\text{cm}$			

S. No	Environmental Attribute	Summarised Data
4.	SW	DO – 6.9 – 7.3 mg/L BOD (3 Day, 27°C) - 2.7 – 3.5 BOD mg/L TDS – 179.7 – 248.6 mg/L Total hardness – 116-152 mg/L Total coliform – absent
5.	Soil	Porosity – 52.2-61.2% pH – 6.92-7.21 SAR – 0.96-1.57
6.	Meteorology	Average temperature – 18.9 C Average Wind Speed – 1.08 kmph Pre-dominant Wind direction – SSE

Source: Final Environmental & Social Study Report Stage VI - Volume 4 (March 2020)

Information on baseline condition with respect to terrestrial and aquatic ecology is not available and needs to be collected for establishing the ecological baseline. Preliminary review of secondary data also indicated the presence of Gangetic Dolphins in Brahmaputra river in & around the project location.

8.4 Anticipated Environmental Impacts and Mitigation Measures

The environmental impacts that would arise due to the setting up of the proposed IWT project would be mostly contained within the core zone of the terminal facility and close surroundings of the site and a broad outline of the mitigation measures for each of such impacts are delineated in this section. Within the 10 km radius study area, the principal impact would be due to increase in traffic on the connecting approach road from NH 17 and nearest rail head.

Potential impacts on environment generated from the construction and operational activities within the proposed facility and the respective mitigations measures have been summarized in **Table 8.2** below.

Table 8.2: Potential Environmental Impacts and Mitigation Measures

Activities	Pre-construction//Construction		Operation	
	Potential Impacts	Mitigation Measures	Potential Impacts	Mitigation Measures
Land Levelling and clearing of vegetation	- Losses of trees/ vegetative cover leading to increase in soil erosion. - Shoreline erosion	- Vegetation clearance shall be confined to the minimum area required for the project. - Greenbelt development . will be done in 33% of the land area. - Shore protection will be provided to protect the shoreline from erosion. Details of the same has been furnished in Chapter 7.	-	-
Random disposal of solid waste from labour camps, run off from raw material stack yards, dredged material etc. during Construction period	Contamination of Soil & Groundwater due to spillage & indiscriminate dumping of solid waste (hazardous waste, i.e. waste oil or spent chemicals)	- The construction wastes would be disposed as per the C&D wastes Rules 2016, It would be ensured through proper management control that there is no random dumping of wastes. - The contractor will be held responsible to clean all debris before leaving the construction site and also to make necessary arrangements with scrap dealers to sell off the waste scraps.	Contamination of Soil & Groundwater due to spillage & indiscriminate dumping of solid waste, spillage of products handled (like tar, bitumen, crude, etc)	- Hazardous wastes like Waste Oil/ grease/ lubricants are stored as per Hazardous & Other waste Rules 2016 and handed over to CPCB authorised vendors. - There would be an Oil Spill management plan in place to deal with incidents of oil spillage.

Activities	Pre-construction//Construction		Operation	
	Potential Impacts	Mitigation Measures	Potential Impacts	Mitigation Measures
- Indiscriminate disposal and improper solid waste (Hazardous wastes, MSW, non-hazardous waste, etc) management system in the IWT - Dumping of Dredged (Maintenance) material (capital dredging is not anticipated)		The waste from labour camps and administrative activities during construction will all be disposed to a designated waste bins which will be colour coded for segregation.	Release fine sediments due to dredging, which would eventually be dispersed causing impact on aquatic ecosystem (discussed below),	
- Discharge of untreated effluents from labour camps, run-off from raw material yard. - Disposal of untreated effluents from the IWT including treated/untreated sewage, discharge - Oil spill/leakage from vessels	- Degradation of physical & microbiological parameters of River water quality like rise in turbidity, TSS, etc leading to adverse impact to health of downstream users, aquatic flora & fauna. - Discharge of about total of about 10 kl/day will be generated during construction phase at the site, which if discharged untreated will act as a source of water pollution.	- Workers shall be provided proper sanitation facilities including mobile toilets or 'Sulabh Shauchalayas'(community toilets) - Sewage will be treated in Septic Tanks and disposed using soak pits and sludge from soak pits will be cleaned periodically. - Avoid water stagnation/ ponding near work and camp sites to curb vector borne diseases. - Fuel/ oil storage will be stored away from the watercourses. - Surface runoff from machine operations, oil handling areas/devices will be treated for oil separation before being discharged into the river. - Hazardous wastes like Waste Oil/ grease/ lubricants are stored as per Hazardous & Other waste Rules 2016 and handed over to CPCB authorised vendors. - There would be an Oil Spill management plan in place to deal with incidents of oil spill.	- Degradation of physical & microbiological parameters of River water quality leading to adverse impact to health of downstream users, aquatic flora & fauna. - About total of about 30 kl/day will be generated at the site, which if discharged untreated will act as a source of water pollution.	- It is proposed to install modular STP at the site during operation for treatment of sewage. - There would be Oil spill management plan in place to be followed during any such incidents - The barges/ vessels will not be allowed to discharge their sewage in the water. - The International Convention Guidelines for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL, 73/78) will be strictly adhered at proposed jetty for prevention of marine/river pollution.
- Emission to Air from Operation of construction machinery, DG sets, fuel burning in labour camps and running of vehicles - Emission to air from Vehicular movement, operation of stand-by DG sets, intermittent emission from vessels during operation phase	Increased level of air pollutants namely Particulate matter, Sulphur dioxide and oxides of Nitrogen in the Ambient air leading to adverse impact on human health, flora & fauna	- DG sets to be used at site would conform to latest CPCB norms. Conditions of regulatory clearance (CTO) will be adhered to with respect to monitoring of Air pollutants. - Manual Water spraying will be done near the earth handling sites, asphalt mixing sites and other excavation areas to reduce the wind-blown fugitive dust emissions. - Earth moving equipment, such as bulldozer with a grader blade and ripper will be used for excavation work. - Excess idling of construction equipment as well as vehicles to be prohibited.	Generation of air pollutants namely Particulate matter, Sulphur dioxide and oxides of Nitrogen in the Ambient air leading to adverse impact on human health, flora & fauna	- DG sets to be used at site would conform to latest CPCB norms. - Greenbelt will be developed in 33% of total terminal area, which will help to contain fugitive dust through adsorption on the foliage. - Manual Water spraying will be practised to reduce the fugitive dust emissions from vehicular movement - Tyre-washing will be carried out for the vehicles to mitigate emission of wind-blown dust

Activities	Pre-construction//Construction		Operation	
	Potential Impacts	Mitigation Measures	Potential Impacts	Mitigation Measures
		• Vehicles and construction equipment will be fitted with internal devices i.e. catalytic converters to reduce CO and HC emissions. • All stationary machines/ DG sets / construction equipment emitting the pollutants will be inspected weekly for maintenance and shall be fitted with exhaust pollution control devices. • Regular maintenance will be taken up for the equipment and Vehicles to ensure their smooth operations and conformance to the Stipulated norms. • It would be ensured that all vehicles must possess Pollution under Control (PUC) Certificate and shall be renewed accordingly. • Temporary road, which are not paved shall be sprinkled with water at periodic intervals to mitigate fugitive dust emission. • The labourers shall be provided with clean fuel for cooking to ensure they neither cut the trees for fuel wood nor burn firewood.		• Transport logistics will be adopted in a way that idling of vehicles is avoided to the extent possible. • All stationary machines/ DG sets / construction equipment emitting the pollutants will be inspected weekly for maintenance and shall be fitted with exhaust pollution control devices. • It would be ensured that all vehicles must possess Pollution under Control (PUC) Certificate and shall be renewed accordingly. • •
• Generation & discharge of wastewater from Operation of construction machinery, vehicular movement and DG sets, • Generation & discharge of wastewater from Operation of vessels, vehicular movement and stand-by DG sets during operation phase	• continuous exposure to noise levels above 90 dBA affects the hearing acuity as well as well-being of the working personnel • Increased level of ambient noise adversely impacts the wellbeing of people in and around the project area.	• Noise levels of machineries used shall conform to relevant regulatory standards. Workers shall not be exposed to noise level more than permitted for industrial premises, i.e. 90 dBA (Leq) for 8 hours. • Work schedule will be drafted in such a manner to ensure that exposure of workers to high noise levels is minimum. Use of PPEs like ear plugs will be mandatory while working in high noise generating areas, Labour camps shall be established away from high noise generating area. Regular maintenance of all vehicles and machinery shall be made mandatory to keep noise under check. • Nearby communities will be notified of the construction schedule and construction works shall be structured to daylight working hours. • Any 'High Noise Area' shall be posted with warning signs and will have restricted access. • Noise levels from the construction equipment can be reduced by fitting of exhaust mufflers and the provision of damping on the steel tool. • Regular monitoring (as per conditions of EC/CTO) and	• Increased level of ambient noise adversely impacts the wellbeing of working personnel as well as nearby population	• It is proposed to develop a greenbelt within 33% of the terminal premises including along the road stretches to provide a buffer. • Regular monitoring (as per conditions of EC/CTO) and maintenance of DG sets shall be taken up to keep a note on noise levels and to take corrective actions.

Activities	Pre-construction//Construction		Operation	
	Potential Impacts	Mitigation Measures	Potential Impacts	Mitigation Measures
		maintenance of all the equipment and DG sets shall be taken up to keep a note on noise levels and to take corrective actions.		
- Construction activities involving dredging, piling, jetty construction, discharge of untreated effluent including sewage, etc - Vessel movement, berthing operation and maintenance dredging, discharge of untreated effluent (if any) from the operation of IWT	- Adverse impact on the aquatic ecosystem due to increase in the suspended solids in water from dispersing of bed sediment, disturbance in planktonic count, sunlight penetration, displacement of fish population etc, and discharge of untreated wastewater including 10 KL/day of sewage. - In case the presence of Gangetic Dolphins is established, vessel movement & operation causing degradation of water quality may have impact on Dolphins	- Dredging will be avoided during very low flow seasons so as to minimize the dispersion of fine sediments - Sewage from the toilets will be treated in septic tank and soak pit. - No construction activity will be allowed during the monsoon season so as to avoid breeding period of fishes. - Use of silt curtains is recommended to be used to confine areas of high turbidity during pile diving. - The piling activities will be carried out in shortest possible timeframe as possible. All the debris will be disposed away from river course as per debris management plan, developed for the project - Equipment shall be maintained in good condition to prevent noise, leaks or spills of potentially hazardous materials like hydraulic fluid, diesel, gasoline and other petroleum products - It will be ensured that Piling is stopped for some time, if any dolphin/RET species is sighted in activity area. - Measures for wastewater treatment & disposal will ensure that only treated wastewater, conforming to applicable norms is discharged to the river.	- Adverse impact on aquatic ecosystem from untreated effluent of IWT, dredging and oil spillage, affecting affect all planktons, benthos and Fishes. - In case the presence of Gangetic Dolphins is established, vessel movement & operation causing degradation of water quality may have impact on Dolphins	- Dredging will be avoided during very low flow seasons so as to minimize the dispersion of fine sediments - Regular servicing and maintenance of dredgers will be taken up so as to prevent any leakage of the dredged material. - Measures for wastewater treatment & disposal will ensure that only treated wastewater, conforming to applicable norms is discharged to the river. - Ship speed should be controlled to minimize aquatic fauna kill and the design of vessel and acoustic treatment should be done for vessel to minimize the sound exposure of aquatic fauna - In case, any accident with Dolphin happens, the same should be immediately reported to Terminal, who in turn would ensure measures for rescue of the dolphin and further treatment. .

Socio-economic scenario has been dealt separately in the next chapter on Social Impact assessment. It may be noted that the above impact assessment has been conducted based on initial understanding of the project and limited information of the present baseline environmental setting. On establishment of the present baseline environmental setting in the project area and its 10km radius, the impacts could be assessed in a definite manner.

8.5 Greenbelt Development Plan

It is proposed to develop green belt within the Terminal premises in an area of 33% of total site area. Greenbelt would not only provide noise barrier but is also capable of adsorbing air pollutants thereby reducing the concentration of air pollutants in the ambient air, as well as providing aesthetic improvement; and result in biodiversity enhancements through creation of habitats for fauna and

avifaunal species. During the development of greenbelt, native species with higher survival rate will be used. Landscaping will also be carried out within the site premises, wherever open space is available.

8.6 Statutory Clearance/Permits Requirement

The statutory permission/clearances that would be required for the proposed project are listed in the **Table 8.3** below:

Table 8.3: Statutory Clearance Requirement of the Project

S. No	Type of Clearance/Permits	Requirement	Authority Responsible
1.	Environmental Clearance (EC)	Umbrella Act for approval of new projects or modernization/expansion projects prior to commencement of construction activities under sector 8(a) and 7 (e) of MoEF&CC EIA notification, 2006	SEIAA, Assam
2.	CTE (Consent to Establish and CTO (Consent to Operate) under Air and Water Act)	CTE required prior to erection CTO required prior to inception of operation of Plants	Assam PCB
3.	Explosive License	For storing fuel oil, lubricants, diesel etc. Prior to storing fuel, lubricants and Diesel, etc	Chief Controller of Explosives
4.	Hazardous Waste Authorisation	For generation and storage of hazardous wastes	Assam PCB

The Schedule of the said EIA Notification, 2006 does not directly specify the category for development of inland waterways projects. However, Projects involving development of Ports, Harbours, Breakwaters and Dredging falls under Sl. No 7 (e) with ≥ 5 million TPA of cargo handling capacity (excluding fishing harbours) classified under Category A while < 5 million TPA of cargo handling capacity and/or ports/harbours & $\geq 10,000$ TPA of fish handling capacity under Category B. Considering that the IWT project involves construction & operation of Jetty and handling of 1.10 MTPA cargo, the proposed project may be classified under 7(e), Category B. Based on the categorisation, the project may require prior EC, issued by SEIAA. Also, based on the built-up area of the facility, if the total area of the proposed project is above 20,000 sqm, then EC would be required under sector 8 (a) of the Notification.

8.7 Environmental Management Cost

In order to mitigate the adverse environmental impact and carry out environmental monitoring during the construction and operational period for review of the environmental management measures adopted, about 1% of the project cost shall be earmarked for environmental management activities. The efficacy of the management measures adopted shall be monitored and if necessary, these shall be modified at periodic intervals for overall environmental protection of the site and its surroundings.

9. SOCIAL SETTINGS AND IMPACT EVALUATION

A socio-economic assessment is a procedure, in which the positive and negative impacts on the people likely to be directly and indirectly affected by the project was conducted. The assessment facilitated an understanding of the needs, demands, preferences, capacities and constraints of the people in the vicinity of the project operation. It was undertaken primarily to enhance the understanding of other relevant factors such as social organizations and networks, livelihood patterns, social infrastructure etc. The assessment attempts to predict and evaluate future impacts of project upon people, their physical and psychological health and well-being, their economic facilities, cultural heritage, lifestyle and other value system and helped in prioritizing NHIDCL's commitment towards the CSR initiatives. Inputs from the social assessment into the design phase facilitated in:

- Tracking potential adverse effects over different time frames and different activities
- Reviewing options to eliminate such adverse impacts through design changes or mitigate them through specific social protection or mitigation measures
- Reviewing options to extend or enhance benefits for the population in the vicinity of the project site.

9.1 Area of Influence (AOI)

Study area for present study has been divided in two part i.e. Core area and Buffer Area based on the impact type direct and indirect. Core area means the actual project location, where the local community and villages are mostly impacted both negative and positive manner. Buffer area is just outside (within 10 km radius of the proposed project) the core area where local community and villages might be impacted in a minimum scale.

Study area for present study has been determined as the 10 km radius from the proposed IWT boundary, towards north. The project location is situated in the village of Jogighopa which is considered as core area. All the villages, which are coming under the 10 km radius is considered as the buffer area village. Total 56 villages of Boitamari and Sijangram subdistrict of Bongaigaon District is coming under buffer area. The list of villages is given in **Table 9.1**.

Table 9.1: List of villages located within AOI

S. No.	Name of the villages	Sub districts	Districts
Core Area			
1.	Jogighopa	Boitamari	Bongaigaon
Buffer Area			
1.	Balapara	Boitamari	Bongaigaon
2.	Barghola Pt I	Boitamari	Bongaigaon
3.	Barjuli	Boitamari	Bongaigaon
4.	Barpara	Boitamari	Bongaigaon
5.	Bechimari	Srijangram	Bongaigaon
6.	Beltoli - Simlar Tol	Boitamari	Bongaigaon
7.	Bhairab Pahar N.C.	Boitamari	Bongaigaon
8.	Bhakuamari Pt I	Srijangram	Bongaigaon
9.	Bhatipara	Boitamari	Bongaigaon
10.	Bhatipara N.C.	Boitamari	Bongaigaon
11.	Bishnupur	Boitamari	Bongaigaon
12.	Borghola Pt II	Boitamari	Bongaigaon

S. No.	Name of the villages	Sub districts	Districts
13.	Chalantapara Pt I	Boitamari	Bongaigaon
14..	Chalantapara Pt II	Boitamari	Bongaigaon
15.	Chalantapara Pt III	Boitamari	Bongaigaon
16.	Chatpara	Boitamari	Bongaigaon
17.	Chatpara N.C.	Boitamari	Bongaigaon
18.	Chedamari	Boitamari	Bongaigaon
19.	Dolani Beel	Boitamari	Bongaigaon
20.	Ganakghuli	Boitamari	Bongaigaon
21.	Goraimari	Boitamari	Bongaigaon
22.	Hakodoba Pt I	Boitamari	Bongaigaon
23.	Hakodoba Pt II	Boitamari	Bongaigaon
24.	Hokodoba No. II N.C.	Boitamari	Bongaigaon
25.	Islampara	Boitamari	Bongaigaon
26..	Junjuna Beel	Boitamari	Bongaigaon
27.	Kabaitari Pt I	Boitamari	Bongaigaon
28.	Kabaitari Pt III	Boitamari	Bongaigaon
29.	Kabaitari Pt IV	Boitamari	Bongaigaon
30.	Kabaitari Pt V	Boitamari	Bongaigaon
31.	Kabaitari Pt VI	Boitamari	Bongaigaon
32.	Kanara Beel	Boitamari	Bongaigaon
33.	Katashbari Pt III	Boitamari	Bongaigaon
34.	Kharchimari N.C.	Boitamari	Bongaigaon
35.	Kherpuji Pt I	Boitamari	Bongaigaon
36.	Kherpuji Pt II	Boitamari	Bongaigaon
37.	Korea Pahar	Boitamari	Bongaigaon
38.	Korea Pt I	Boitamari	Bongaigaon
39.	Korea Pt II	Boitamari	Bongaigaon
40.	Kumurakata Pt I	Boitamari	Bongaigaon
41.	Kumurakata Pt II	Boitamari	Bongaigaon
42.	Kumurakata Pt III	Boitamari	Bongaigaon
43.	Kumurakata Pt IV	Boitamari	Bongaigaon
44.	Maijana Beel	Boitamari	Bongaigaon
45.	Majpara	Boitamari	Bongaigaon
46..	Manikjhara	Boitamari	Bongaigaon
47.	Pachania Pahar	Srijangram	Bongaigaon
48.	Pallirtol Chedamari	Boitamari	Bongaigaon
49.	Sakomura Pt I	Boitamari	Bongaigaon
50.	Sakomura Pt II	Boitamari	Bongaigaon
51.	Sakomura Pt III	Boitamari	Bongaigaon
52.	Sankarghola Pt I	Boitamari	Bongaigaon
53.	Sankarghola Pt II	Boitamari	Bongaigaon
54.	Simlaguri	Boitamari	Bongaigaon
55.	Sristipara	Boitamari	Bongaigaon
56.	Uttar Kharagaon Pt II	Srijangram	Bongaigaon

Source: Census 2011

9.2 Methodology for Socio-economic Study

The social assessment was primarily based on the analysis of the secondary data obtained from the census survey 2011.

9.3 Administrative set up

Bongaigaon District is located in western part of Assam and in northern Bank of the river Brahmaputra. Bongaigaon district is bounded by Barpeta district in the east Dhubri and Kokrajhar district towards the west, Goalpara district in the south and Chirang district in the north. The Headquarters of the district is located at Bongaigaon town situated at the lower part of the Brahmaputra Valley. As per census 2011 total area of Bongaigaon is 1,093 km² including 1,061.31 km² rural area and 31.69 km² urban area. Bongaigaon has a population of 7,38,804 resides in 1,50,018 houses.

Bongaigaon district possesses three subdivisions namely Bongaigaon, North Salmara and Bijni Subdivisions and 5 community development (CD) blocks namely, Bijni, Boitamari, Bongaigaon, Sidli, Srijangram.

Present project location is located in Boitamari CD. According to Census 2011 information total area of Boitamari is 301 km² including 298.12 km² rural area and 2.82 km² urban area. Boitamari has a population of 1,27,396 peoples resides in 24,641 houses. There are about 148 villages in Boitamari block.

Present project location is located in Jogighopa village of Boitamari CD Block. It is situated 40km away from district headquarter Boitamari. The total geographical area of village is 86.62 hectares. Abhayapuri is nearest town to Jogighopa which is approximately 24km away. Socio economic profile of the core area and buffer area villages is presented in following section.

9.4 Socio-economic Profile of AOI

9.4.1 Demographic Profile

9.4.1.1 Core area

Jogighopa village is considered to be the core area for the proposed IWT project. Total population of the village is accounted as 1167, with a household size of 4.54. The sex ratio of the Jogighopa village is accounted as 1047.37.

9.4.1.2 Buffer area

A total number of 57 villages are present within the 10 km radius of the project boundary. According to the census 2011, household size of the region ranges between 3.64 to 7.33. Chedamari village accounted the highest number of population as 4837, and the lowest populated village is Khachimari NC, with a population size of 66. The average sex ratio of the study area is accounted as 957.13, which is little lower than state sex ration of 958, and also lower than the district sex ration of 961.

9.4.2 SC/ST Communities

9.4.2.1 Core Area

SC population of the Jogighopa village is accounted as 35, which is almost 3 percent of the total population. Whereas no ST population is present in the Jogighopa village.

9.4.2.2 Buffer area

SC population accounts for 11.23 percent of the total population in the study area villages, which is higher than district SC population percentage (10.3 percent) of Bongaigaon district. Chalantapara Pt I in has the highest SC population (2030, in the study area villages).

The ST population of study area villages is only 1.72 percent of the total population, which is lower than the district percentage of 2.5 percent. Majpara showed the highest ST population, accounted as 240. Kaibarta is one of the largest fishing community present in the study area.

9.4.3 Educational profile

9.4.3.1 Core area

The literacy rate of the Jogighopa village is accounted as 73.21 percent, whereas male and female literacy rate accounted as 77.05 percent and 69.57 percent respectively. The literacy rate of the Jogighopa village is higher than the state and district literacy rate.

9.4.3.2 Buffer area

The average literacy rate in the study area villages is accounted as 65.71percent, which is lower than the Assam state literacy of 72.91 percent and also lower than the district literacy rate of 69.7 percent. Highest literacy among the stud area villages found in Sakomura Pt II, with 97 percent. The average male literacy of the study area villages accounted as 70.01percent, which is lower than the district male literacy rate of 74.9 percent, highest male literacy in the study area villages was found in Sakumora Pt II, as almost 99 percent. Average female literacy rate in the study area villages accounted as 61.15 percent, which is lower than the district female literacy rate of 64.4 percent. Highest female literacy rate in the study area villages was found in Sakumoa Pt II, accounted as 96 percent.

9.5 Occupation and Livelihood

9.5.1 Work Participation

Work Participation Ratio (WPR) is defined as percentage of total workers including main and marginal workers out of the total population of the study area.

9.5.1.1 Core Area

The WPR of the main concerned village, Jogighopa is accounted as 27.16 percent. Main worker population in the Jogighopa village is accounted as 50.47 percent and the marginal working population is accounted as 49.53 percent. In light of engagement category the other category has the highest number of percentage accounted as 90.54 percent.

9.5.1.2 Buffer Area

The WPR of the study area is accounted as 33.35 percent, which is little lower than the district WPR, which is accounted as 34.6 percent. Main worker population in the study area are accounted as 80.78 percent, where more of them are engaged in agriculture. Marginal workers are reported to be 19.22 percent. As per the engagement category the other category as office goers, industrial labour comes up with the highest percentage accounted as 44.33 percent, followed by cultivators, accounted as 37.95 percent.

9.5.2 Other farm-based Livelihood

Other than agriculture people of that region also engaged in fishing and sericulture.

9.6 Social Infrastructure

9.6.1 Educational Infrastructure

9.6.1.1 Core Area

In Jogighopa village one number of govt pre-primary and primary school is present, respectively. Two govt middle school are also present in Jogighopa village. In the concerned village of Jogighopa one secondary school is present, but no senior secondary school is present there.

9.6.1.2 Buffer Area

As per the Census 2011, Govt. Pre-primary school is present in 20 villages, whereas Govt primary school is present in 57 villages. In the study area only 18 villages has the facility of Govt. Middle school. Govt. Secondary school is present in only 6 villages, whereas no village has the facility of the Govt senior secondary school. Only one govt college is present in Chalandapara Pt III, in the study area.

9.6.2 Drinking Water

9.6.2.1 Core Area

The main concerned village of Jogighopa is dependent upon tap water and covered well. Both are present in adequate number in the particular village.

9.6.2.2 Buffer Area

The main drinking water source of this block is tube wells, storage tank and tap water. 48 villages of the stud area have the access to tube well, whereas 24 villages have the facility of covered well for drinking water usage. Some of the villages has the facility of both tube well and covered well, in the study area villages, tap water is only present in 24 number of villages.

9.6.3 Sanitation

9.6.3.1 Core Area

Jogighopa village is only dependent upon the open drainage sanitation, no closed drainage system is present in the particular village.

9.6.3.2 Buffer Area

In the study area only 2 villages has the closed drainage sanitation facility, and only 8 villages are only dependent upon the open drainage facility. Whereas 44 villages in the study area has no drainage facility available.

9.6.4 Community Health

9.6.4.1 Core Area

No health care facility is available in the Jogighopa village. But a primary healthcare facility is present within 5 km from the village.

9.6.4.2 Buffer Area

Only one village, Bishnupur in the study area has the facility of primary health centre. No community health centre or hospital is present in the study area of villages.

9.6.5 Post Offices, Roads and Banking Services

9.6.5.1 Core Area

One post office and one commercial bank is present in the Jogighopa village. Main transport system in the village is present as private and public bus service, auto and private cars.

9.6.5.2 Buffer Area

There are 2 post offices present in the study area villages. Almost all the villages has the access to land line telephone and mobile network. Private and public bus services along with private cars and bikes are used for the means of transport, in study area villages. National highway, state road, major district roads and water ways are used for transport. One commercial bank is present in Boitamari, in the study area.

9.7 Stakeholder Consultation

Stakeholder consultations are important processes through which a two-way dialogue is created between the project proponents and the stakeholders. Stakeholders are persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively. They can comprise of individuals, communities, social groups, organizations etc. By identifying and consulting all stakeholders, especially the poor and the vulnerable, it is essential to ensure that the project meets the need of all sections of the people. Stakeholder engagement is a continuous and inclusive process between a project proponent and those potentially impacted encompassing various activities and interactions over the entire life of the project.

For the proposed project, stakeholder consultations are planned to be held to make them aware of the project, understand their perception on the project and likely impacts anticipated by them. However, due to travel & other restrictions on the event of COVID-19, consultations with the stakeholders could not be conducted. It is expected that stakeholder consultation can be carried out at later stages, once the travel restrictions have been eased and the situation has normalized.

9.8 Assessment of Impacts & Mitigation Measures

Based on the understanding of the socio-economic condition of the Project area and its area of impact (10 km from the project boundary), the impacts anticipated during construction and operation stages of the project is presented below.

However, since the entire development of IWT Terminal has been planned solely on the land owned by Inland Waterways Authority of India (IWAI) and is free from any encumbrance, impact due to land acquisition & issues pertaining to R&R is not envisaged to be triggered.

The construction and operational phase of the project are likely to generate both adverse and beneficial impact which has been discussed in subsequent section.

9.8.1 Impact on Fishing Livelihood

The review of secondary data¹ indicates presence of fishing communities in and around the project area, who make their living by catching fishes from Brahmaputra River. Hence, there may be adverse impact on the fishing activity due to construction activities for setting up the terminal. However, it is not known if the project area is specifically used by the Fisherman. It would require detailed assessment in latter part of the project.

The construction activities also cause habitat disturbance of fish population in the river due to movement of vessels during construction, however the same could not be established due to absence of aquatic ecology baseline data.

9.8.1.1 Mitigation Measures

- Detailed stakeholder consultation and assessment need to be carried out during latter stage of the project.
- Livelihood restoration plan shall be taken up, in case the future studies & stakeholder consultation reveals loss of livelihood of fishermen.
- Both during the construction and operations phase, adequate stakeholder engagement measures will be put in place to ensure that the community's access to the river is not interrupted due to the movement of barges and vessels;
- Effluent generated in the project site should be completely treated before release so that the river water does not get polluted and fish population does not get reduced;
- Good management practices for compensation of fishermen in case of damage to equipment and/or any spillage in water.

9.8.2 Impact Due to Access Restriction

Proposed project site is located in between of Brahmaputra river and Jogighopa village. Google earth imagery clearly shown two mud walkway created due to frequent walking of local villagers to access the river daily household activity e.g. bathing, washing etc. and fishing and other activity. After construction of IWT Logistic Terminal, this temporary access way would be no longer accessible that might hamper the daily activity of the community.

9.8.2.1 Mitigation Measure

Project proponent would undertake a focussed group discussion with the local community before initiating implementation of the below mention mitigation measures.

- Construct a new access road for the local community just outside the logistic hub boundary
- Development of existing access road if present for easy access of local people

¹ <https://thebrahmaputra.in/aqua.php>

9.8.3 Conflict with Local Community

It is proposed that NHIDCL and/or its contractors would endeavour to provide maximum employment to the local people, there would be limitations in the employment potential due to the lack of required technical skills and expertise in the local population. So, certain percentage of semi-skilled and highly skilled migrant labourers may be used by contractors for manning these activities. It is anticipated that occasional conflicts would arise with the local community over the recruitment of migrant workers. Conflicts with the local population are also likely due to the cultural difference between migrant workers and nuisance caused by workers due to improper sanitation facilities etc, leading to temporary disruption of work. However, these may be managed with good labour practices. Also, this is a temporary situation and would resolve once the construction phase is over.

9.8.3.1 Mitigation Measures

It is proposed to develop an effective grievance redressal mechanism for prompt and fair addressal of grievances;

9.8.4 Impact on Community Health and Safety

The construction activities including the operation of equipment, DG sets, vehicular movement, etc would have adverse impact on the health & safety of the nearby population. Proposed project site and access road is surrounded by several rural settlements. Inhabitants residing close to site and access roads will get affected due to noise and dust generated from vehicular movements, site preparation operation of machineries, construction activities.

An increase in traffic during the peak construction activities and may create public safety issues for local residents. Potential impacts may include blocking access, congestion and traffic accidents along the approach road.

Influx of migrant labours during construction can cause mixing of the migrant workforce with the local people. This mixing of the groups may cause some adverse impacts to public health in the neighbouring villages with the potential for spread of infectious diseases like HIV and STD. Improper sanitation facilities and disposal of municipal solid waste in the construction labour camps can also trigger vector borne diseases.

9.8.4.1 Mitigation Measures

- Water sprinkling at periodic intervals at the construction sites and on the access road to reduce fugitive emission;
- Ensuring the vehicle driver adhere to safety practices, reduce the blowing of horns to reduce noise generation from the vehicles and speed control to reduce chances of accidents;
- Noise control measures will be adopted to keep Noise levels within 90 dB(A) at the construction site;
- Implementation of safe practices like proper collection, storage and disposal of MSW, installation of STP to prevent contamination of water resources from sanitary effluents generated from labour camps;

9.8.5 Impact Due to Increment in Cost of Living

The overall development of the area would also have some drawbacks especially on the quality of life. The employment generation would result in increase of expendable income in the areas. The resultant increased money flows in the area would increase the cost of living in the area which would have some

negative impacts. However, the economic development in the area would also increase the purchasing power of the people in the area hence the negative impacts of incremental cost of living would be insignificant.

9.8.6 Job Opportunity of the Local People

Other than direct employment in IWT and its associated project of MMLP, 3 km North of IWT, there will be In-direct employment opportunities primarily in the supply chain network as vendors which are anticipated to be set up to support the construction and operations. The local people are expected to be having options for such in-direct employment, even if they are not directly involved as construction labourers.

9.8.7 Improvement on Socio-economic condition

Employment opportunities created by the project is expected to attract large number of people from outside the district. The in-migration of long term or permanent staff will create demand for long-term housing and other support services. This is expected to create demand for housing and supply of other support services in turn resulting in the development of adjoining areas and having a positive impact on the quality of life in the area.

It is expected that the Project proponent would take up community development initiatives like livelihood restoration, income generation, education and provision of health care facilities under Peripheral Social Development initiatives, which can further improve the quality of life of the community in the vicinity.

10. COST ESTIMATES AND IMPLEMENTATION SCHEDULE

10.1 General

The capital cost estimates have been prepared for the proposed development of IWT Terminal at Jogighopa. These are based on the description of various components of IWT terminal as mentioned in this report. The basis of the costing is as follows:

- The cost estimates of civil works have been prepared on the basis of current rates for various items of work prevailing in the region and also on the past costs for similar works elsewhere.
- The costs of equipment and machinery are based on budgetary quotations and discussions held with the manufacturers and also in-house data. The costs include insurance, freight, installation etc. The price level used for the estimates is as of the first quarter of 2020
- All costs towards overheads, labour, tools, materials, insurance, supply, transport, installation, commissioning, financing costs and the taxes including GST are covered in the rates for individual items.
- The exchange rate has been assumed as 1 US \$ = Rs. 75/-, 1 Euro = Rs. 85/-.
- Provision towards contingencies and project management has been included separately.

10.2 Capital Cost Estimates

The capital cost estimates for phase 1A, 1B & Master Plan development of the IWT Terminal at Jogighopa are provided **Table 10.1** below:

Table 10.1: Capital Cost Estimates- Phase 1A, 1B & Master Plan

S. No.	Item	Capital Cost Phase -1A (Rs. In Lakhs)	Capital Cost Additional Phase -1B (Rs. In Lakhs)	Master Plan Additional (Rs. In Lakhs)
1.	Project Preliminaries and Site Development	350	-	-
2.	Dredging and Site Grading	653	678	-
3.	Shore Protection Works	884	-	-
4.	Jetty and Approach Trestle	2,345	3,186	-
5.	Storage Areas	611	1,210	-
6.	Equipment	2,375	1,720	6,380
7.	Buildings	1,030	110	-
8.	Utilities And Others	1,009	280	-

9.	TOTAL	9,257	7,184	6,380
10.	Contingencies @5%	463	359	319
11.	Detailed Engineering & Project Management Services @3%	278	216	191
12.	GRAND TOTAL COST (Rs. in Lakhs)	9,997	7,758	6,890

As per landlord model, the basic infrastructure in terms of Jetty, site grading, shore protection, terminal building, gate, fencing, external connectivity like road, water and power shall be provided by IWAI. However, the cargo handling equipment, area development for open cargo storage, transit sheds, utilities etc. within the terminal shall be provided by the PPP operator. The breakup of cost between IWAI/NHIDCL & operator for Phase -1 A is as mentioned at

Table 10.2: Capital Cost Estimates- Phase 1A – Landlord & PPP

S. No.	Item	Phase - 1A	
		Landlord	PPP
		Capital Cost Phase -1A (Rs. In Lakhs)	Capital Cost Phase -1A (Rs. In Lakhs)
1	PROJECT PRELIMINARIES AND SITE DEVELOPMENT	150	200
2	DREDGING AND SITE GRADING	653	0
3	SHORE PROTECTION WORKS	884	0
4	JETTY AND APPROACH TRESTLE	2,345	0
5	STORAGE AREAS	611	0
6	EQUIPMENT	0	2,375
7	BUILDINGS	1,030	0
8	UTILITIES AND OTHERS	894	115
9.	TOTAL	6,567	2,690
10.	Contingencies @5%	328	135
11.	Detailed Engineering & Project Management Services @3%	197	81
12.	GRAND TOTAL COST (Rs. in Lakhs)	7,092	2,905
	PHASE 1 A - GRAND TOTAL COST (Rs. in Lakhs)	9,997	

10.3 Operation and Maintenance Costs

10.3.1 General

Operation and maintenance costs have been calculated under various heads, as described in the subsequent paras. These costs do not include the following items:

- Lease rent to the state government
- Maintenance of Infrastructure outside the Terminal boundary

10.3.2 Repair and Maintenance Costs

The following norms have been used for estimating the annual maintenance and repair costs:

- 5% of Mechanical and Electrical Works
- 1% on Civil Works
- 3% on Utilities

10.3.3 Manpower Costs

The estimated number of personnel required for the terminal operations and maintenance have been arrived and their annual costs has been considered in O&M costs.

10.3.4 Operation Costs

The operation costs include the fuel, water and power costs. The operation costs for the equipment run by electrical power or diesel have been calculated based on the maximum throughput and utilisation of the equipment. The power and water maintenance costs have been estimated based on the estimated annual consumption at the terminal. Further, the operation costs of the following items have been estimated as a percentage of their capital cost, as given below:

Diesel Driven Equipment	-	5% per annum
Firefighting and Pollution Control	-	3% per annum

10.3.5 Annual Operation and Maintenance Costs

The cumulative annual operation and maintenance costs, in lakh rupees, for fixed and variable components of the terminal facilities in different phases work out to be as follows:

Description	Phase 1A	Phase 1B	Master Plan
Fixed (Rs. In Lakhs)	716	1,088	1,466
Variable (Rs. In Lakhs)	270	396	521

10.4 Project Implementation Schedule

10.4.1 General

The main components for the Development of IWT terminal at Jogighopa comprises of site grading for creation of the terminal back up area, construction of jetty and Shore Protection. The other components are equipment, terminal buildings and utilities. The schedule of the critical project items is discussed below.

10.4.2 Dredging and Site Grading

A small quantity of capital dredging would be needed in the berthing area so that vessels could be handled during low water levels also. The dredged material appears to be suitable for reclamation and therefore the same shall be pumped to the low lying onshore areas. Borrowed fill shall be used for the balance material required for site grading. The site grading could be completed within a period of around 9 months from the start of the activity. It shall be undertaken during the lean season when water levels are low.

10.4.3 Construction of Shore Protection Works

The construction of the Shore Protection works would be undertaken in synchronisation with the site grading works and the apron shall be placed during lean season. The entire works are likely to take about 18 months.

10.4.4 Jetty and Approach

The construction of jetty and approaches shall be undertaken once an access to the required area is provided through the part site grading. It is anticipated that two piling gantry shall be fabricated onshore and moved to the pile locations of approach from either side and then to the jetty piles. The superstructure would be mainly built using precast concrete elements to avoid soffit shuttering. However the superstructure construction will also have to be planned during lean season to enable placement of fender facia towards low water level. The jetty could be completed in a time frame of 18 months from the date of commencement.

10.4.5 Equipment and Onshore Development

It is envisaged that the delivery and installation of equipment and the development of onshore works can be carried out to match the implementation schedule of the project.

10.4.6 Implementation Schedule

The construction time of proposed IWT terminal at Jogighopa is expected to be around 24 months. This has been worked out taking into account all the items of the project, the various activities involved and the duration of each activity. The implementation schedule is presented in **Table 10.3**.

Table 10.3 Implementation Schedule for the Project

Year		2021												2022												2023															
S.No.	Task Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct						
A	Project Approvals and Award of Works	Zero Date																																							
1	Preparation of EIA Report and Approvals																																								
2	Selection of PMC Consultant																																								
3	Tendering Process																																								
4	Evaluation, Negotiations and Award of Contract to EPC Contractor																																								
B	Construction Activity																																								
1	Establishment at Site by Contractor																																								
2	Detailed Engineering by EPC contractor																																								
3	Site Grading																																								
4	Construction of Shore Protection Works																																								
5	Construction of Jetty & Approach																																								
6	Excavation for Clearing of Berth Pocket																																								
7	Yard and Pavement																																								
8	Buildings																																								
9	Onshore Infrastructure (Internal Roads, Fencing, Drainage, Utilities etc.)																																								
10	Supply and Installation of Mechanical Equipment																																								
11	Testing and Commissioning of WT Facilities																																								

11. FINANCIAL ASSESSMENT

11.1 Introduction

A profitability analysis for the proposed development of IWT terminal at Jogighopa, Assam has been carried out with the objective of assessing the viability of the project in terms of Financial Internal Rate of Return (FIRR).

11.2 Project Cost

11.2.1 Capital Cost

The capital investment for the IWT terminal for Phase-1A development is estimated to be **Rs. 100.00 Crores**. Out of this an amount of **Rs. 36.83 crores** shall be spent in first year and remaining in the second year. The investment in Phase 1B will include additional berthing structure including respective dredging, partial land development for onshore facilities, additional equipment.

Over the master plan phase the investment will be mainly in the additional equipment to increase the cargo throughput and their replacement needed.

11.2.2 O&M Costs

The cumulative annual operation and maintenance costs, in lakh rupees, for fixed and variable components of the terminal facilities in different phases work out to be as follows:

Description	Phase 1A	Phase 1B	Master Plan
Fixed (Rs. In Lakhs)	716	1,088	1,466
Variable (Rs. In Lakhs)	270	396	521

11.3 Traffic

The projected traffic for the IWT terminal has been provided in **Section 4.4**. The traffic for phase 1 development is 1.10 MTPA increasing to 2.08 MTPA over the master plan phase.

11.4 Tariff of IWT Terminal

Fixing proper tariff and port charges is one of the critical components of the financial analysis since the success of the project depends on the competitiveness and acceptability of the tariff to be charged to the users. In the present case, the tariff charged by the IWT Terminal as per IWA Notification, can be broadly classified under two (02) sub-heads:

- Vessel related charges
- Cargo related charges

11.4.1 Vessel Related Charges

Table 11.1: Vessel Related Charges

S. No.	Name of Service	Charges (₹)
1.	Berthing	I. 1000/- for Kolkata/Haldia for 24 hrs. or part thereof ~ 6AM to 6AM next day. II. 500/- for Patna/Guwahati and terminals on National Waterway-3 for 24 hrs. or part thereof ~ 6AM to 6AM next day. III. 100/- for temporary pontoons for 24 hrs. or part thereof ~ 6AM to 6AM next day.
2.	Towage	On specific request as per actual cost.
3.	Pilotage	750/- per day or part thereof per pilot.

11.4.2 Cargo Related Charges

The cargo related charges comprise the following:

- Terminal Charge (Per T)
- Cargo Handling Charges (Per T)
- Storage (Per T per Day)

Terminal Charges has been considered as Rs 21 per tonne while Cargo Handling Charges have been considered as Rs. 150 per tonne for the purpose of revenue estimates in financial analysis. Storage has not been considered for the purpose of analysis since storage charges are levied only after the expiration of free period i.e. of 7 Days (free Period).

The charges applicable at Kolkata and Kalughat i.e. Schedule III have been used. The rates applicable to the current location as per Schedule II are unrealistically low i.e. Rs. 1 per tonne, and hence not considered.

11.5 Revenue Estimate & Financial Viability of the Project

The following assumptions are made while carrying out the financial assessment:

- Financial analysis has been carried out up to year 2052.
- The Project is to be developed under various means of funding and structure as discussed in subsequent paragraphs.

Based on the assumptions stated above, Pre-tax FIRR for the Project for Option 1 , Option 2 & Option 3 are shown in **Table 11.2**, **Table 11.4** & **Table 11.6** respectively.

11.6 Alternative Means of Project Development

11.6.1 Option 1 – By Project Proponents

In this option, the project shall be executed by the public sector entity i.e. IWAI, who shall also arrange funds for the project, manage and operate the port.

11.6.2 Option 2 – Full Fledged Concession to Private Operator

In this option the entire project shall be allocated to a private developer. The advantage would be that the government's investment in the project would be minimal to the extent of the requirement to provide viability gap funding to the operator.

11.6.3 Option 3 – Landlord Model

In this option the basic infrastructure in terms of Jetty, site grading, shore protection, terminal building, gate, fencing, external connectivity like road, water and power shall be provided by IWAI.

However, the cargo handling equipment, area development for open cargo storage, transit sheds, utilities etc. within the terminal shall be provided by the PPP operator. The facilities developed by IWAI shall also be given on lease to PPP operator, who shall be responsible for operating and maintaining the entire terminal facilities during the concession period. The developer shall be allowed to levy cargo handling charges to the users and make revenue share payments to IWAI as per the concession agreement.

Table 11.2: Pre-tax IRR for various project development options

Pre-tax IRR			
	Option 1	Option 2	Option 3
IWAI	4.22%	-	3.20%
Concessionaire	-	5.77%	8.99%

Note:

Option 1: 100% Funding by IWAI/NHIDCL

Option 2: VGF by /NHIDCL to the tune of Rs. 40.00 crores (limited to 40% of the project cost)

Option 3: Landlord model: All basic infrastructure except equipment to be provided by IWAI

Detailed working sheets for IRR calculations for the Project for Option 1 , Option 2 & Option 3 are shown in **Table 11.3**, **Table 11.5** & **Table 11.7** respectively.

11.6.4 Recommended Option

The project requires substantial capital investment and considering very low FIRR for the project, it is recommended that this project is taken up as per **Option 3- landlord model**.

In this scenario the investment by the terminal operator would be very much limited but he shall be able to bring expertise of cargo handling and logistics to improve productivity. Further the operator would be able to better choose the right equipment for cargo handling as per his expertise.

Table 11.2 Revenue Estimates for the Project - Option 1

Particulars	Rate	Unit	Year																																																													
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052																														
Revenue																																																																
Vessels related Charges																																																																
Vessel related charges	500	Rs / per vessel	-	-	2.65	3.58	4.68	5.97	7.46	8.33	9.24	10.20	11.21	12.27	13.38	14.55	15.78	17.07	18.42	19.84	21.32	22.88	24.51	26.22	28.01	29.88	31.84	33.89	36.04	38.28	40.62	43.07	45.64	42.85																														
Pilotage Charges	750	Rs / per vessel	-	-	3.97	5.37	7.03	8.96	11.19	12.49	13.86	15.30	16.81	18.40	20.07	21.83	23.67	25.60	27.63	29.76	31.98	34.32	36.77	39.33	42.01	44.82	47.76	50.84	54.05	57.42	60.93	64.61	68.45	64.27																														
Cargo related Charges																																																																
Terminal charges	21	per T	-	-	62.78	83.06	106.73	134.05	284.10	304.33	325.51	347.70	370.92	388.04	415.10	443.43	473.09	504.13	517.87	539.84	562.67	586.37	611.00	679.22	706.23	734.25	763.31	793.45	878.83	915.77	954.13	993.96	1,035.33	1,124.80																														
Handling Charges	150	per T	-	-	448.46	593.26	762.34	957.51	2,029.29	2,173.78	2,325.11	2,483.56	2,649.42	2,771.68	2,964.97	3,167.36	3,379.23	3,600.96	3,699.07	3,856.01	4,019.04	4,188.37	4,364.25	4,851.57	5,044.49	5,244.61	5,452.20	5,667.52	6,277.36	6,541.19	6,815.19	7,099.74	7,395.24	8,034.26																														
Total Revenue			-	-	517.85	685.26	880.78	1,106.50	2,332.04	2,498.93	2,673.72	2,856.76	3,048.37	3,190.39	3,413.52	3,647.18	3,891.77	4,147.77	4,262.99	4,445.45	4,635.01	4,831.94	5,036.52	5,596.34	5,820.74	6,053.56	6,295.11	6,545.70	7,246.28	7,552.65	7,870.87	8,201.39	8,544.66	9,266.18																														

* Values are in Lakhs

Table 11.3 Financial Analysis for the Project -Option 1

Particulars	Rate	Unit	Year																																
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	
Annual Escalation	3%		103%	106%	109%	113%	116%	119%	123%	127%	130%	134%	138%	143%	147%	151%	156%	160%	165%	170%	175%	181%	186%	192%	197%	203%	209%	216%	222%	229%	236%	243%	250%	258%	
Capital Cost for the Project	9,997	Rs. in Lakhs	3793.35	6699.16	-	-	-	9,264	-	-	-	-	4,066	-	-	-	-	2,114	-	-	-	-	2,451	-	-	-	-	2,842	-	-	-	-	-	-	-
Total O&M Cost for IWT, Jogighopa			-	-	856	936.34	1025.23	1123.26	1388.68	1475.65	1566.58	1661.65	1761.00	1864.83	1973.30	2086.59	2204.91	2328.45	2457.42	2592.03	2732.51	2879.08	3031.99	3191.47	3357.81	3531.24	3712.07	3900.56	4097.02	4301.76	4515.10	4737.36	4968.90	5117.97	
Traffic Considered for Financial Analysis				1,100	1,146	1,192	1,238	1,284	1,330	1,374	1,418	1,462	1,506	1,550	1,600	1,650	1,700	1,750	1,800	1,818	1,836	1,854	1,872	1,890	1,906	1,922	1,938	1,954	1,970	1,992	2,014	2,036	2,058	2,080	
Total Revenue					518	685.3	880.8	1,106.5	2,332.0	2,498.9	2,673.7	2,856.8	3,048.4	3,190.4	3,413.5	3,647.2	3,891.8	4,147.8	4,263.0	4,445.4	4,635.0	4,831.9	5,036.5	5,596.3	5,820.7	6,053.6	6,295.1	6,545.7	7,246.3	7,552.6	7,870.9	8,201.4	8,544.7	9,266.2	
Cash Flow			-3793.3	-6699.2	-337.9	-251.1	-144.5	-9280.8	943.4	1023.3	1107.1	1195.1	-2779.0	1325.6	1440.2	1560.6	1686.9	-295.0	1805.6	1853.4	1902.5	1952.9	-446.6	2404.9	2462.9	2522.3	2583.0	-196.4	3149.3	3250.9	3355.8	3464.0	3575.8	4148.2	

Pre Tax Project IRR	4.22%

Table 11.4 Revenue Estimates for the Project - Option 2

Particulars	Rate	Unit	Year																															
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
Revenue																																		
Vessels related Charges																																		
Vessel related charges	500	Rs / per vessel	-	-	2.65	3.58	4.68	5.97	7.46	8.33	9.24	10.20	11.21	12.27	13.38	14.55	15.78	17.07	18.42	19.84	21.32	22.88	24.51	26.22	28.01	29.88	31.84	33.89	36.04	38.28	40.62	43.07	45.64	42.85
Pilotage Charges	750	Rs / per vessel	-	-	3.97	5.37	7.03	8.96	11.19	12.49	13.86	15.30	16.81	18.40	20.07	21.83	23.67	25.60	27.63	29.76	31.98	34.32	36.77	39.33	42.01	44.82	47.76	50.84	54.05	57.42	60.93	64.61	68.45	64.27
Cargo related Charges																																		
Terminal charges	21	per T	-	-	62.78	83.06	106.73	134.05	284.10	304.33	325.51	347.70	370.92	388.04	415.10	443.43	473.09	504.13	517.87	539.84	562.67	586.37	611.00	679.22	706.23	734.25	763.31	793.45	878.83	915.77	954.13	993.96	1,035.33	1,124.80
Handling Charges	150	per T	-	-	448.46	593.26	762.34	957.51	2,029.29	2,173.78	2,325.11	2,483.56	2,649.42	2,771.68	2,964.97	3,167.36	3,379.23	3,600.96	3,699.07	3,856.01	4,019.04	4,188.37	4,364.25	4,851.57	5,044.49	5,244.61	5,452.20	5,667.52	6,277.36	6,541.19	6,815.19	7,099.74	7,395.24	8,034.26
Total Revenue			-	-	517.85	685.26	880.78	1,106.50	2,332.04	2,498.93	2,673.72	2,856.76	3,048.37	3,190.39	3,413.52	3,647.18	3,891.77	4,147.77	4,262.99	4,445.45	4,635.01	4,831.94	5,036.52	5,596.34	5,820.74	6,053.56	6,295.11	6,545.70	7,246.28	7,552.65	7,870.87	8,201.39	8,544.66	9,266.18

* Values are in Lakhs

Table 11.5 Financial Analysis for the Project - Option 2

Particulars	Rate	Unit	Year																															
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2050	2050
Annual Escalation	3%		103%	106%	109%	113%	116%	119%	123%	127%	130%	134%	138%	143%	147%	151%	156%	160%	165%	170%	175%	181%	186%	192%	197%	203%	209%	216%	222%	229%	236%	243%	250%	258%
Capital Cost for the Project		Rs. In Lakhs	2145.77	4153.65	0.00	-	-	9.264	-	-	-	-	4.066	-	-	-	-	2.114	-	-	-	-	2.451	-	-	-	-	2.842	-	-	-	-	-	-
Total O&M Cost			-	-	856	936.34	1025.23	1123.26	1388.68	1475.65	1566.58	1661.65	1761.00	1864.83	1973.30	2086.59	2204.91	2328.45	2457.42	2592.03	2732.51	2879.08	3031.99	3191.47	3357.81	3531.24	3712.07	3900.56	4097.02	4301.76	4515.10	4737.36	4968.90	5117.97
Traffic Considered for Financial Analysis			0.000	1.100	1.146	1.192	1.238	1.284	1.330	1.374	1.418	1.462	1.506	1.550	1.600	1.650	1.700	1.750	1.800	1.818	1.836	1.854	1.872	1.890	1.906	1.922	1.938	1.954	1.970	1.992	2.014	2.036	2.058	2.080
Total Revenue			-	-	518	685.3	880.8	1,106.5	2,332.0	2,498.9	2,673.7	2,856.8	3,048.4	3,190.4	3,413.5	3,647.2	3,891.8	4,147.8	4,263.0	4,445.4	4,635.0	4,831.9	5,036.5	5,596.3	5,820.7	6,053.6	6,295.1	6,545.7	7,246.3	7,552.6	7,870.9	8,201.4	8,544.7	9,266.2
Revenue share of Concessionaire	100%																																	
Cash Flow			-2145.8	-4153.6	-337.9	-251.1	-144.5	-9280.8	943.4	1023.3	1107.1	1195.1	-2779.0	1325.6	1440.2	1560.6	1686.9	-295.0	1805.6	1853.4	1902.5	1952.9	-446.6	2404.9	2462.9	2522.3	2583.0	-196.4	3149.3	3250.9	3355.8	3464.0	3575.8	4148.2

Pre Tax Project IRR for Concessionnaire	5.77%

Table 11.6 Revenue Estimates for the Project - Option 3

Particulars	Rate	Unit	Year																																	
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052		
Revenue																																				
Vessels related Charges																																				
Vessel related charges	500	Rs / per vessel	-	-	2.65	3.58	4.68	5.97	7.46	8.33	9.24	10.20	11.21	12.27	13.38	14.55	15.78	17.07	18.42	19.84	21.32	22.88	24.51	26.22	28.01	29.88	31.84	33.89	36.04	38.28	40.62	43.07	45.64	42.85		
Pilotage Charges	750	Rs / per vessel	-	-	3.97	5.37	7.03	8.96	11.19	12.49	13.86	15.30	16.81	18.40	20.07	21.83	23.67	25.60	27.63	29.76	31.98	34.32	36.77	39.33	42.01	44.82	47.76	50.84	54.05	57.42	60.93	64.61	68.45	64.27		
Cargo related Charges																																				
Terminal charges	21	per T	-	-	62.78	83.06	106.73	134.05	284.10	304.33	325.51	347.70	370.92	388.04	415.10	443.43	473.09	504.13	517.87	539.84	562.67	586.37	611.00	679.22	706.23	734.25	763.31	793.45	878.83	915.77	954.13	993.96	1,035.33	1,124.80		
Handling Charges	150	per T	-	-	448.46	593.26	762.34	957.51	2,029.29	2,173.78	2,325.11	2,483.56	2,649.42	2,771.68	2,964.97	3,167.36	3,379.23	3,600.96	3,699.07	3,856.01	4,019.04	4,188.37	4,364.25	4,851.57	5,044.49	5,244.61	5,452.20	5,667.52	6,277.36	6,541.19	6,815.19	7,099.74	7,395.24	8,034.26		
Total Revenue			-	-	517.85	685.26	880.78	1,106.50	2,332.04	2,498.93	2,673.72	2,856.76	3,048.37	3,190.39	3,413.52	3,647.18	3,891.77	4,147.77	4,262.99	4,445.45	4,635.01	4,831.94	5,036.52	5,596.34	5,820.74	6,053.56	6,295.11	6,545.70	7,246.28	7,552.65	7,870.87	8,201.39	8,544.66	9,266.18		

* Values are in Lakhs

Table 11.7 Financial Analysis for the Project - Option 3

Particulars	Rate	Unit	Year																															
			2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2050	2050
Annual Escalation	3%		103%	106%	109%	113%	116%	119%	123%	127%	130%	134%	138%	143%	147%	151%	156%	160%	165%	170%	175%	181%	186%	192%	197%	203%	209%	216%	222%	229%	236%	243%	250%	258%
Capital Cost for Landlord		Rs. in Lakhs	3048.60	4384.13				5985.41																										
Capital Cost for PPP Operator		Rs. in Lakhs	744.75	2315.03				2360.44				1000					3000						1000					1000						
O&M Cost for IWT Jogighopa - to be born by PPP operator only			-	-	856	936.34	1025.23	1123.26	1388.68	1475.65	1566.58	1661.65	1761.00	1864.83	1973.30	2086.59	2204.91	2328.45	2457.42	2592.03	2732.51	2879.08	3031.99	3191.47	3357.81	3531.24	3712.07	3900.56	4097.02	4301.76	4515.10	4737.36	4968.90	5117.97
Traffic Considered for Financial Analysis				0.205	0.274	0.351	0.438	0.535	1.100	1.144	1.188	1.232	1.276	1.296	1.346	1.396	1.446	1.496	1.492	1.510	1.528	1.546	1.564	1.688	1.704	1.720	1.736	1.752	1.884	1.906	1.928	1.950	1.972	2.080
Total Revenue at IWT Jogighopa			-	-	518	685.3	880.8	1,106.5	2,332.0	2,498.9	2,673.7	2,856.8	3,048.4	3,190.4	3,413.5	3,647.2	3,891.8	4,147.8	4,263.0	4,445.4	4,635.0	4,831.9	5,036.5	5,596.3	5,820.7	6,053.6	6,295.1	6,545.7	7,246.3	7,552.6	7,870.9	8,201.4	8,544.7	9,266.2
Revenue Share of PPP operator	90%																																	
Landlord cashflows			(3,049)	(4,384)	52	69	88	111	233	250	267	286	305	319	341	365	389	415	426	445	464	483	504	560	582	605	630	655	725	755	787	820	854	927
Pre Tax Project IRR for Landlord			3.20%																															
Pre Tax Project IRR for PPP operator			8.99%																															

11.7 Sensitivity Analysis

The Sensitivity analysis for recommended has been carried out for following scenarios:

- **Scenario – 1:** With Costs Increased by 10% and all other parameters remain the same.
- **Scenario – 2:** With Traffic Decreased by 10% and all other parameters remain the same.
- **Scenario – 3:** With Costs Increased by 5% and Traffic Decreased by 5% and all other parameters remaining the same.

The analyses results are given in **Table 11.8**.

Table 11.8 Financial Analysis for the Project

Scenario	Cost Estimates	Traffic Estimates	IWAI Tax IRR	Concessionaire Tax IRR
Scenario – 1	+10%	-	2.63%	7.64%
Scenario – 2	-	-10%	2.62%	5.39%
Scenario – 3	+5%	-5%	2.41%	4.77%

12. WAY FORWARD

The action plan for the project development is as follows:

1. Finalisation of the Detailed Project Report for the Project.
2. Appointment of EIA consultant for preparation of EIA report and approval of MoEF.
3. Financial closure of the project.
4. Finalisation of the tender documents for development of facilities to be developed by IWA on EPC basis.
5. Selection of operator for the terminal development.
6. Selection of EPC contractor for construction of the terminal facilities.

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1	60636525-DPR-1001	OVERALL SITE PLAN
2	60636525-DPR-1002	BATHYMETRY SURVEY
3	60636525-DPR-1003	TOPOGRAPHIC SURVEY
4	60636525-DPR-1004	BORELOG PROFILES
5	60636525-DPR-1005	LAYOUT OF THE TERMINAL – PHASE 1
6	60636525-DPR-1006	LAYOUT OF THE TERMINAL – PHASE 1A
7	60636525-DPR-1007	LAYOUT OF THE TERMINAL – PHASE 1B
8	60636525-DPR-1008	GENERAL ARRANGEMENT OF JETTY AND APPROACH TRESTLE
9	60636525-DPR-1009	DETAILS OF SHORE PROTECTION WORK
10	60636525-DPR-1010	DETAILS OF TERMINAL ADMINISTRATION BUILDING
11	60636525-DPR-1011	DETAILS OF COVERED STORAGE SHEDS
12	60636525-DPR-1012	DETAILS OF GUARD ROOM
13	60636525-DPR-1013	DETAILS OF SUB-STATION
14	60636525-DPR-1014	DETAILS OF CANTEEN AND REST ROOM
15	60636525-DPR-1015	DETAILS OF UNDERGROUND WATER TANK & PUMPHOUSE
16	60636525-DPR-1016	DETAILS OF ELEVATED WATER STORAGE TANK
17	60636525-DPR-1017	DETAILS OF FUEL BUNKERING SYSTEM
18	60636525-DPR-1018	DETAILS OF CUSTOMS OFFICE BUILDING
19	60636525-DPR-1019	DETAILS OF PORT IN CALL OFFICE BUILDING
20	60636525-DPR-1020	PLAN AND SECTION OF BOUNDARY WALL
21	60636525-DPR-1021	LAYOUT OF INTERNAL ROADS AND SECTIONS
22	60636525-DPR-1022	LAYOUT OF STORM WATER DRAINAGE AND SEWERAGE
23	60636525-DPR-1023	SCHEMATIC LAYOUT OF WATER SUPPLY AND FIRE WATER SYSTEM
24	60636525-DPR-1024	LAYOUT PLAN OF HIGH MAST & LIGHTING POLES
25	60636525-DPR-1025	LAYOUT OF EXTERNAL ROAD CONNECTIVITY
26	60636525-DPR-1026	POWER DISTRIBUTION SINGLE LINE DIAGRAM (SLD)
27	60636525-DPR-1027	DREDGING AREA AND PROFILES

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OWNER:
 NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT:
DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE:

DIMENSIONS ARE IN:

PURPOSE:
DETAILED PROJECT REPORT

DRAWING TITLE:

DRAWING LIST

DRAWING NUMBER:
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PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: OVERALL SITE PLAN

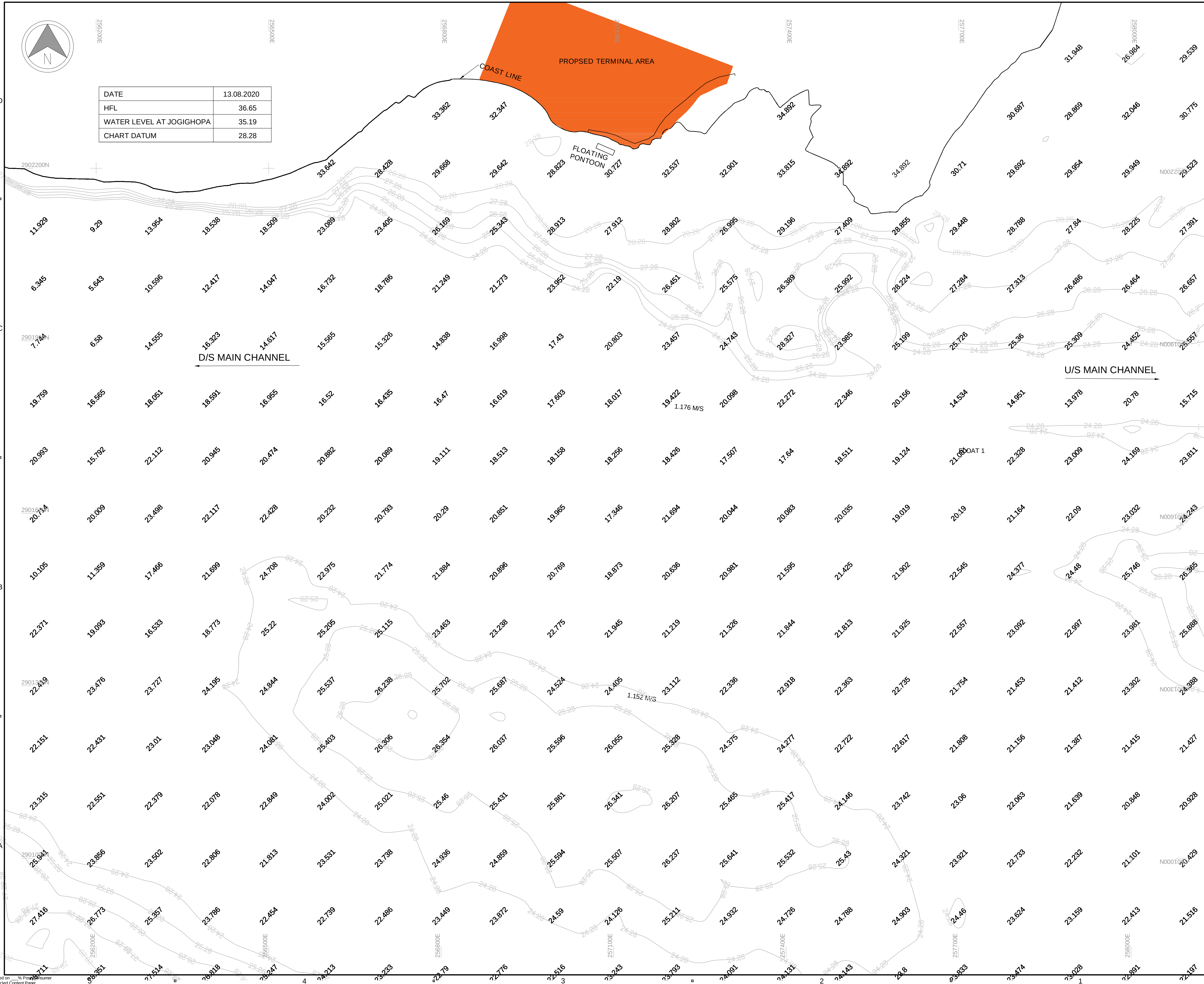
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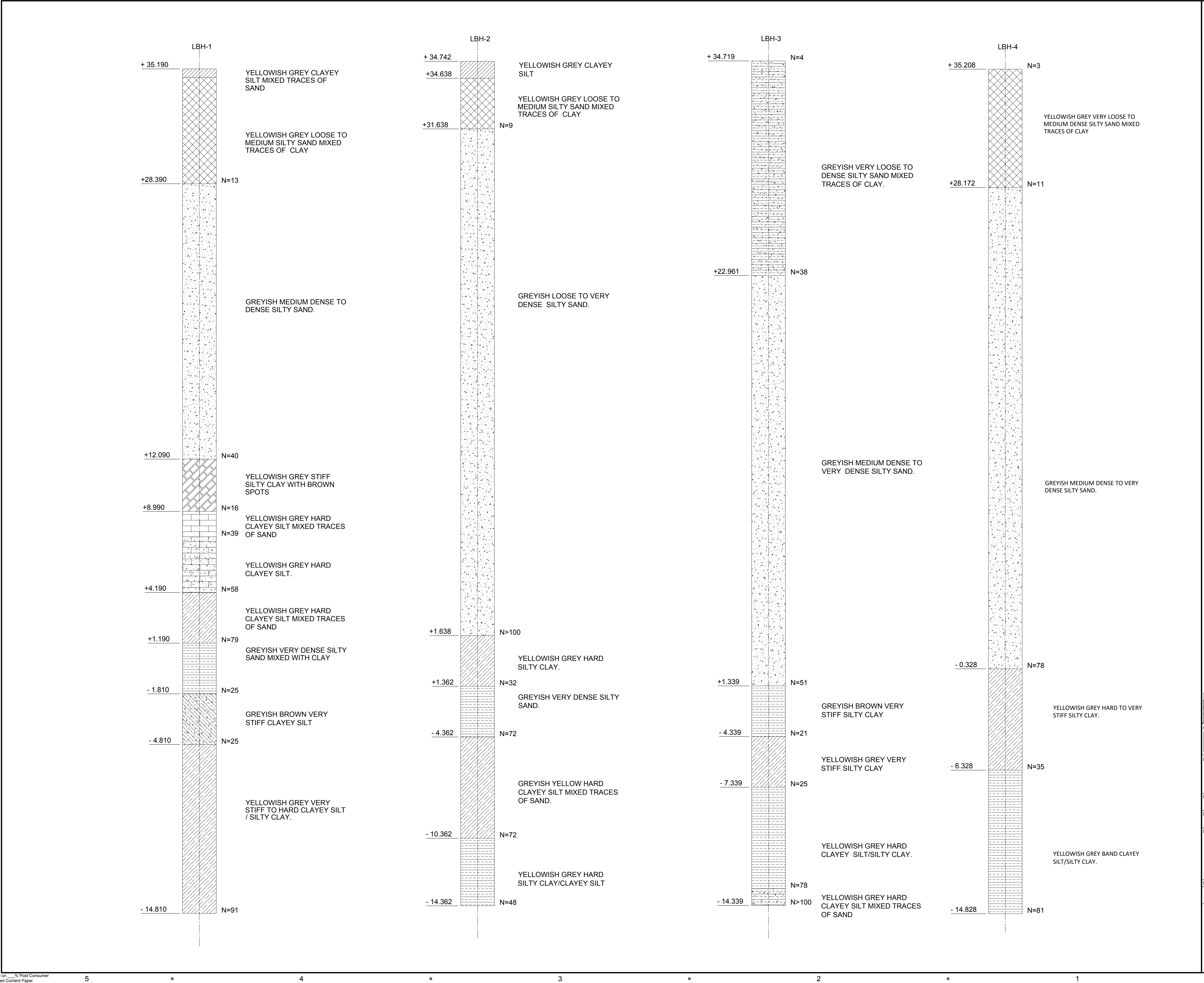
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PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM					
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PURPOSE: DETAILED PROJECT REPORT					
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REVISION DETAILS

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: BORELOG PROFILES

DRAWING NUMBER: 60636525 - DPR - 1004

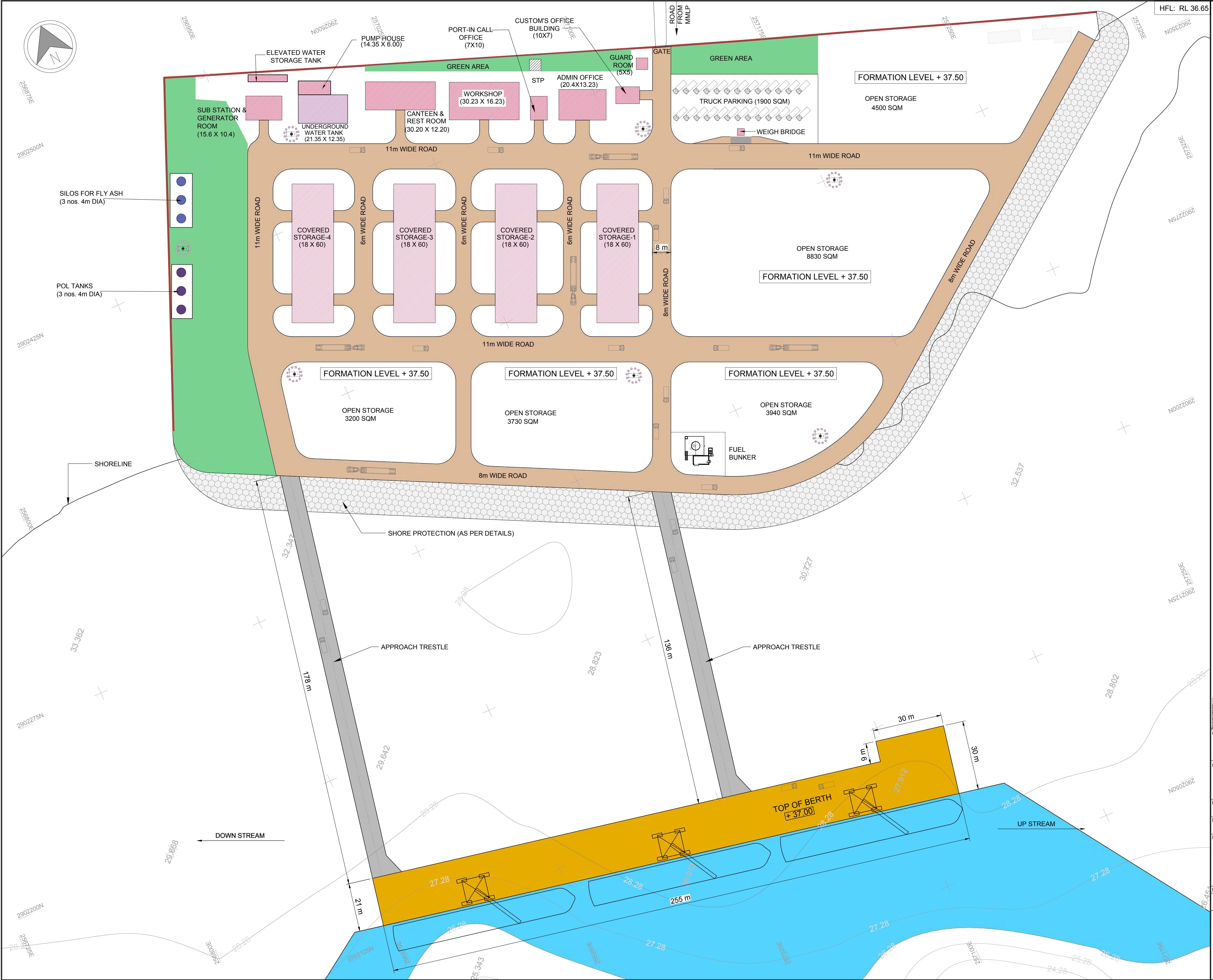
REV: 2

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SHEET 01 OF 01

ISO A1 594mm x 841mm
Approved: SS
Checked: SS
Designer: SV
Project Management Initials:
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Filename: D:\VERMA\PROJECTS\IWT\DRAWING\REVISED\60636525-DPR-1005-PHASE-1.DWG



NOTES:

- ALL LEVELS ARE IN METRES AND ARE W.R.T REDUCED LEVEL
- ALL DIMENSIONS ARE IN METRE.
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2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.

REVISION DETAILS

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: LAYOUT OF TERMINAL PHASE 1

DRAWING NUMBER: 60636525 - DPR - 1005

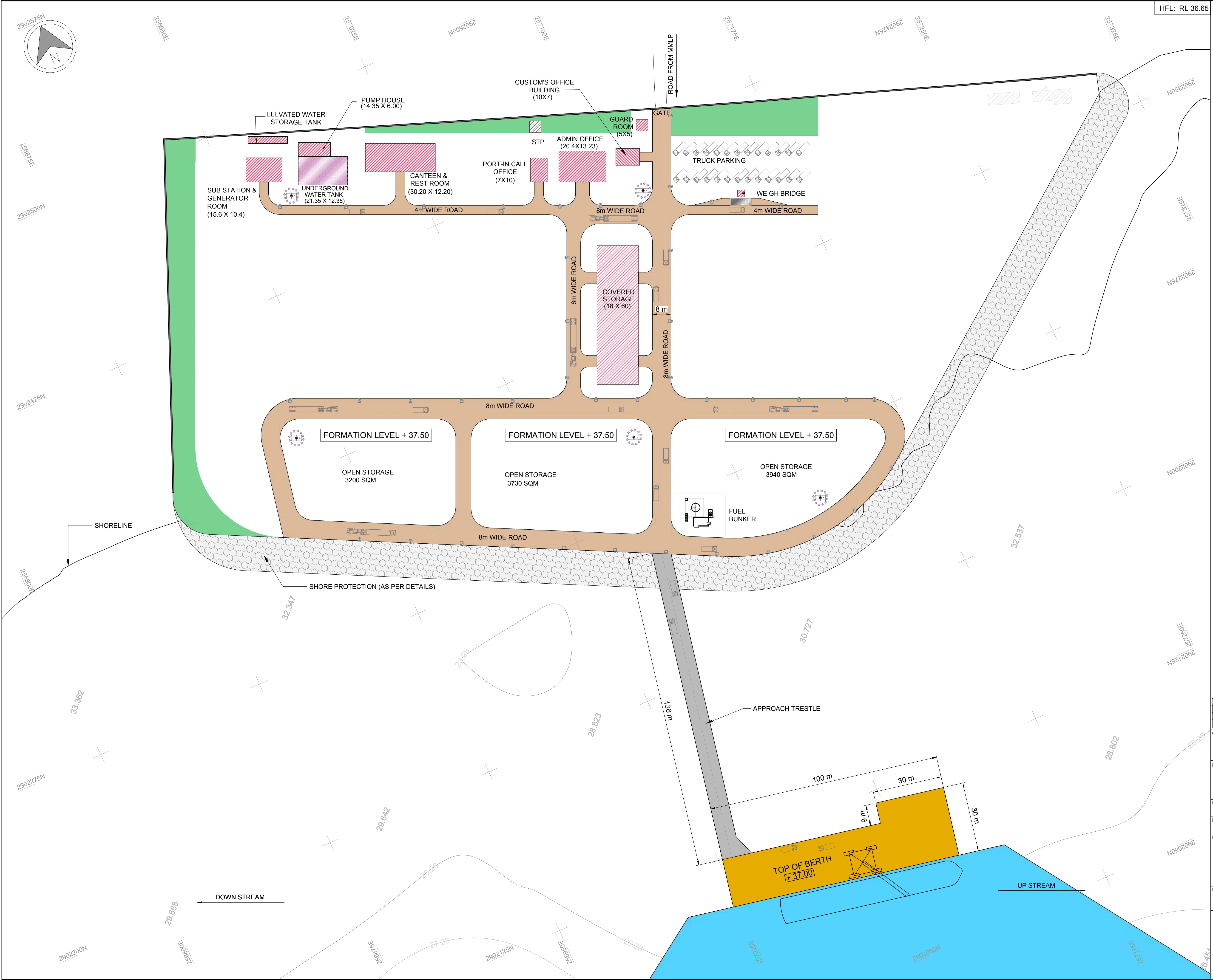
REV. 2

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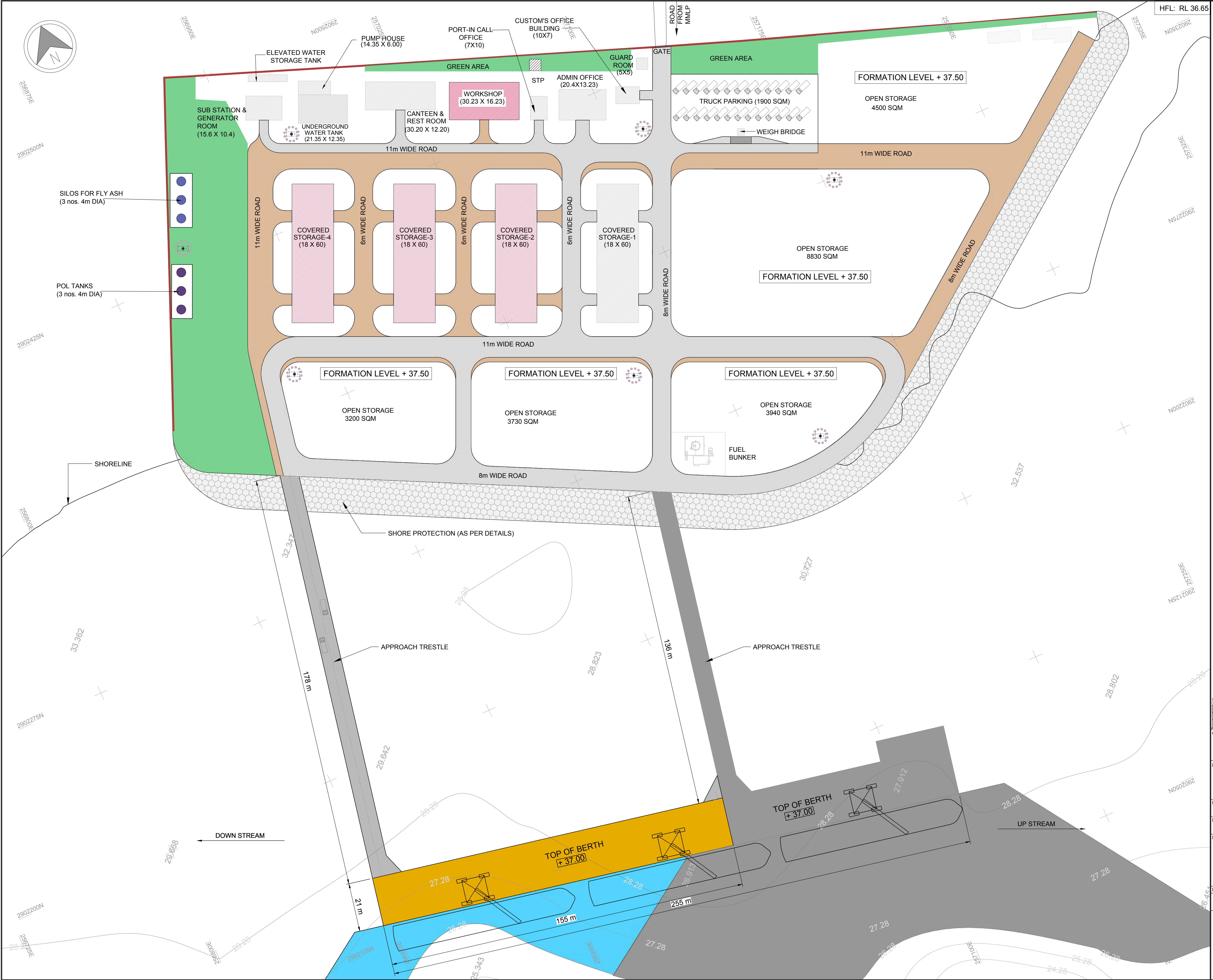
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SHEET 01 OF 01

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Approved: SS
Checked: SS
Designer: SV
Project Management Initials:
Last saved by: VERMAS2(2021.02.18) Last Plotted: 2021.02.25
Filename: D:\VERMA\PROJECTS\IWT\IWDRAFT\IWDPR-REVISED\60636525-DPR-1006-PHASE-1A.DWG



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Designer: SV
Project Management Initials:
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REV.	DATE	DESCRIPTION	DR.	CH.	APR.

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PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: LAYOUT OF TERMINAL PHASE 1B

DRAWING NUMBER: 60636525 - DPR - 1007

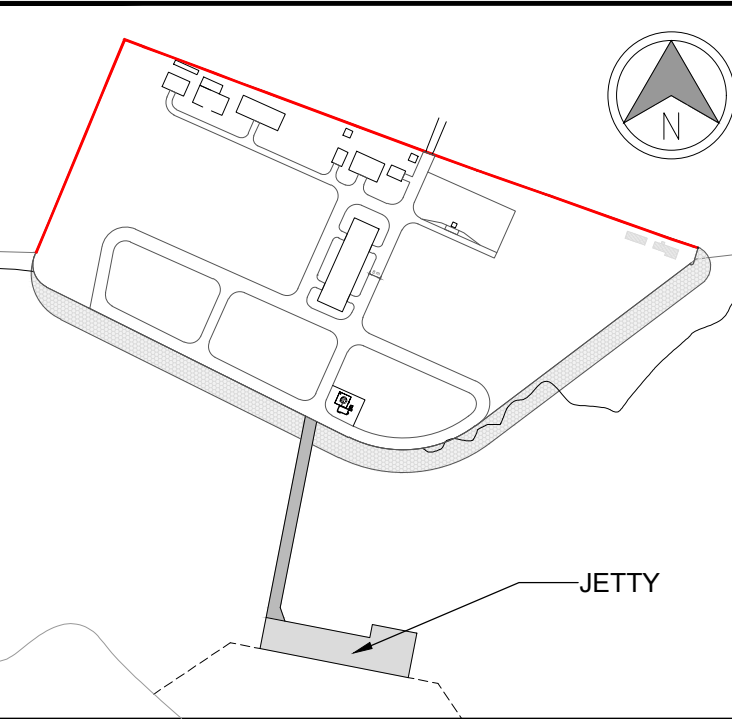
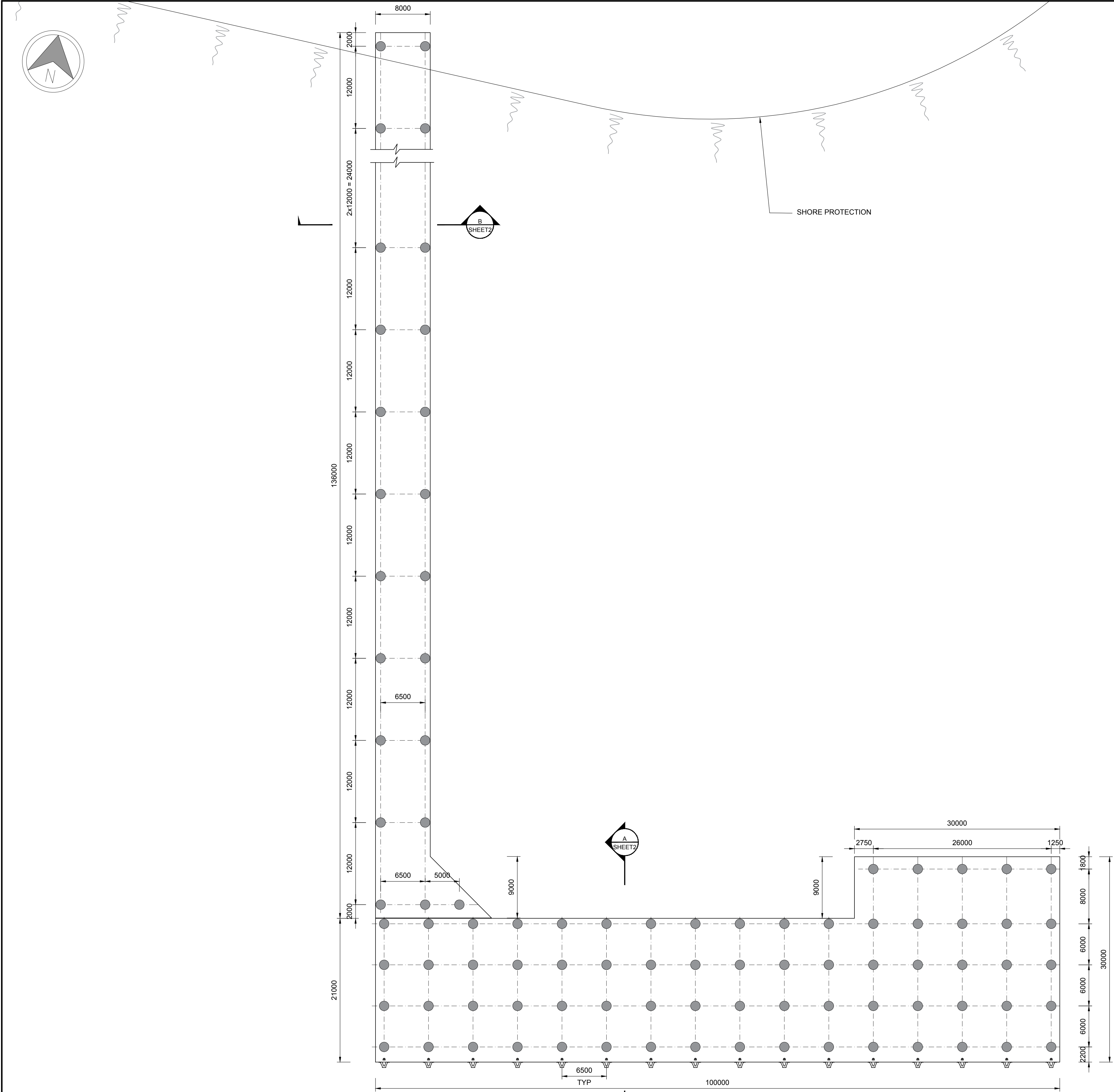
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SHEET 01 OF 01

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Approved: SS
Checked: SS
Designer: SV
Project Management Initials:
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Filename: D:\VERMA\PROJECTS\IWT\DRFT DPR-REVISED\60636525-DPR-1008.DWG



KEY PLAN

- NOTES:
- 1 ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED FORMATION LEVEL OF +37.50m RL.
 - 2 ALL DIMENSIONS ARE IN MILLIMETRES.
 - 3 ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.

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1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.

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PART/DISCIPLINE: DIMENSIONS ARE IN:

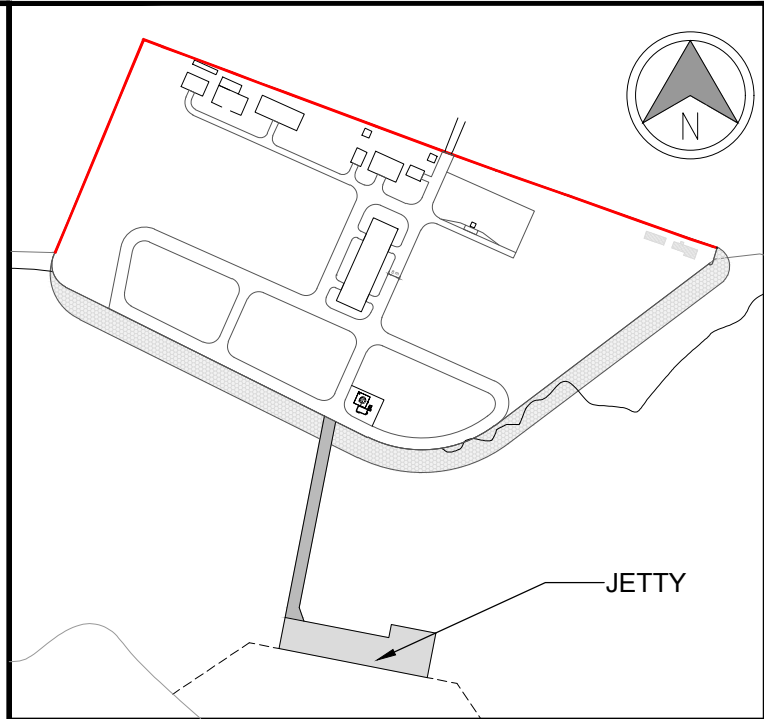
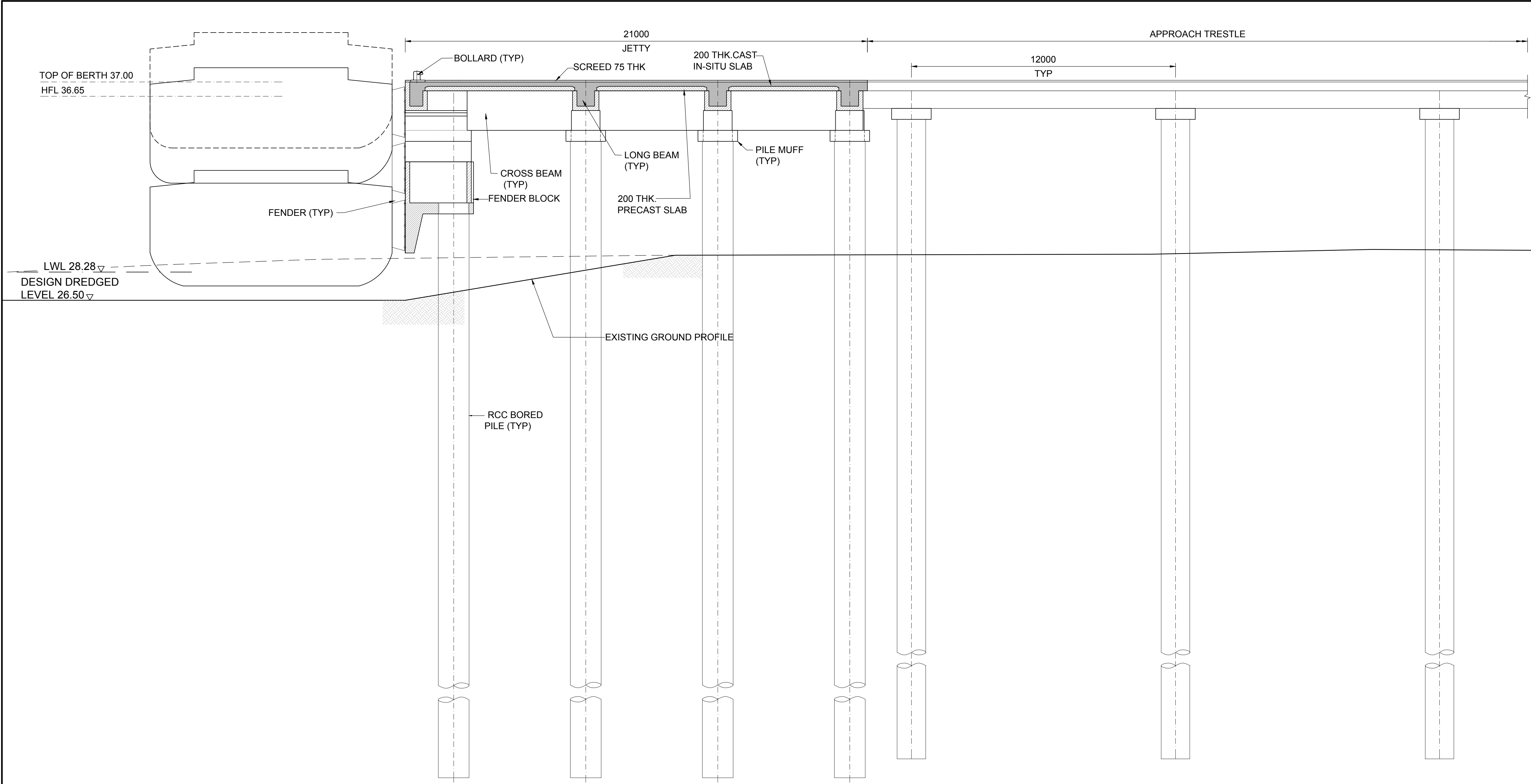
PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: GENERAL ARRANGEMENT OF JETTY AND APPROACH TRESTLE
SHEET 1 OF 2

DRAWING NUMBER:	REV.
60636525 - DPR - 1008	2

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Checked: SS
Designer: SV
Project Management Initials:
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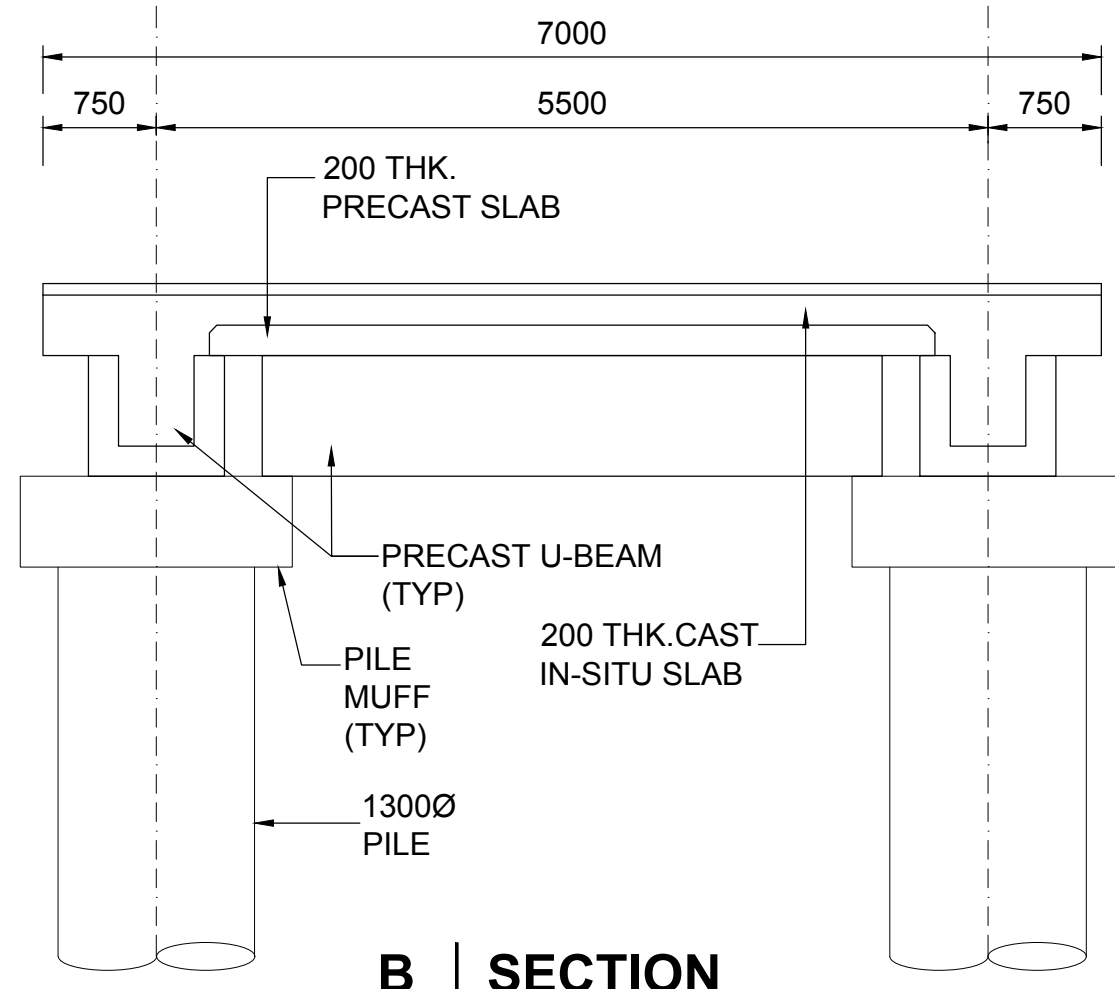


KEY PLAN

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A SECTION

Scale 1:100



B SECTION

Scale 1:50

2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.

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PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

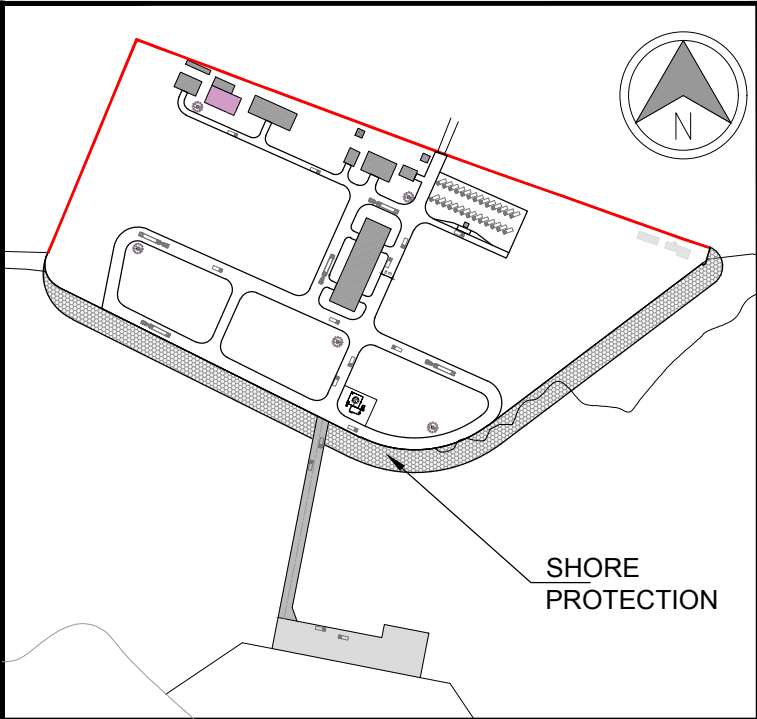
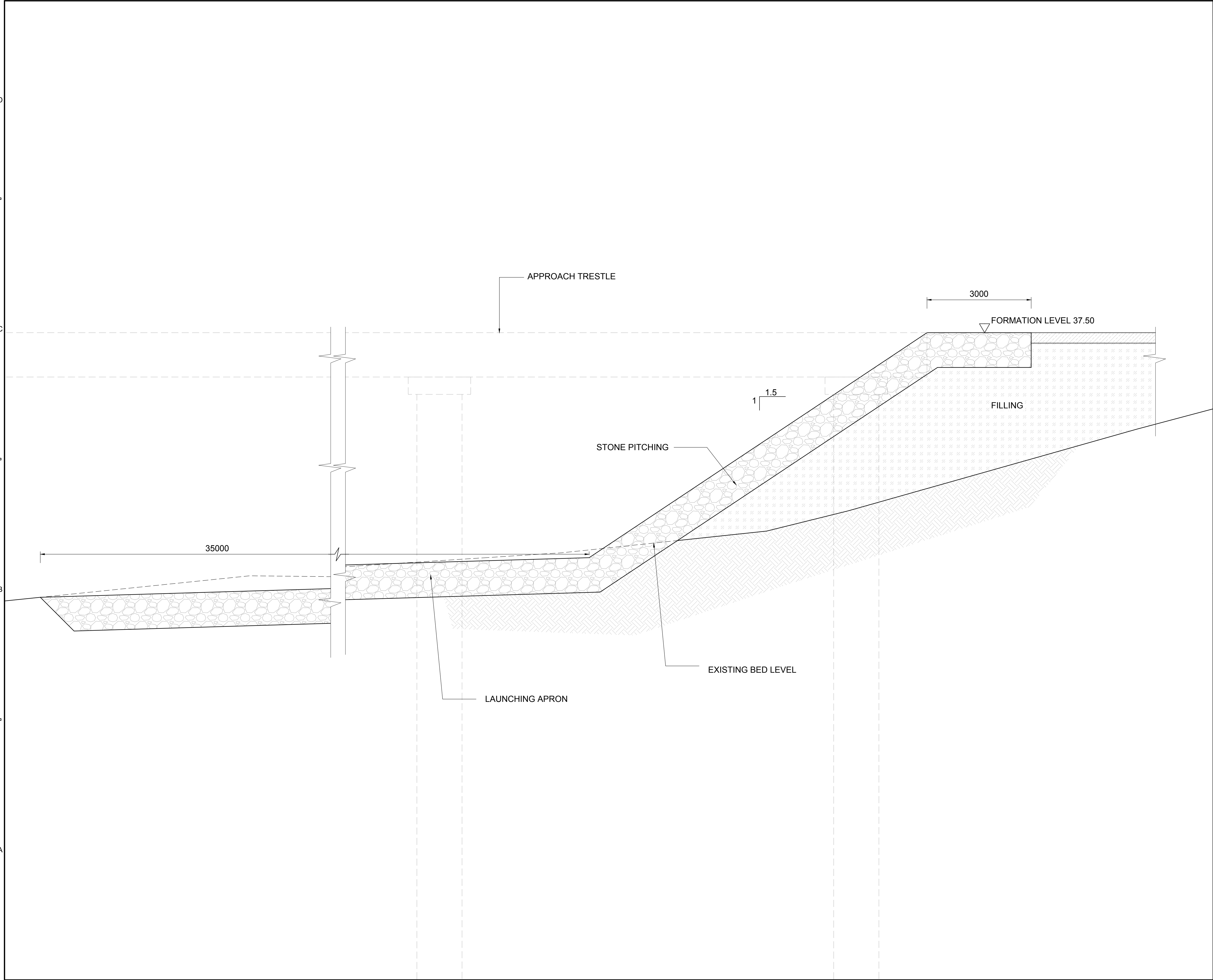
PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: GENERAL ARRANGEMENT OF JETTY AND APPROACH TRESTLE
SHEET 2 OF 2

DRAWING NUMBER: 60636525 - DPR - 1008
REV. 2

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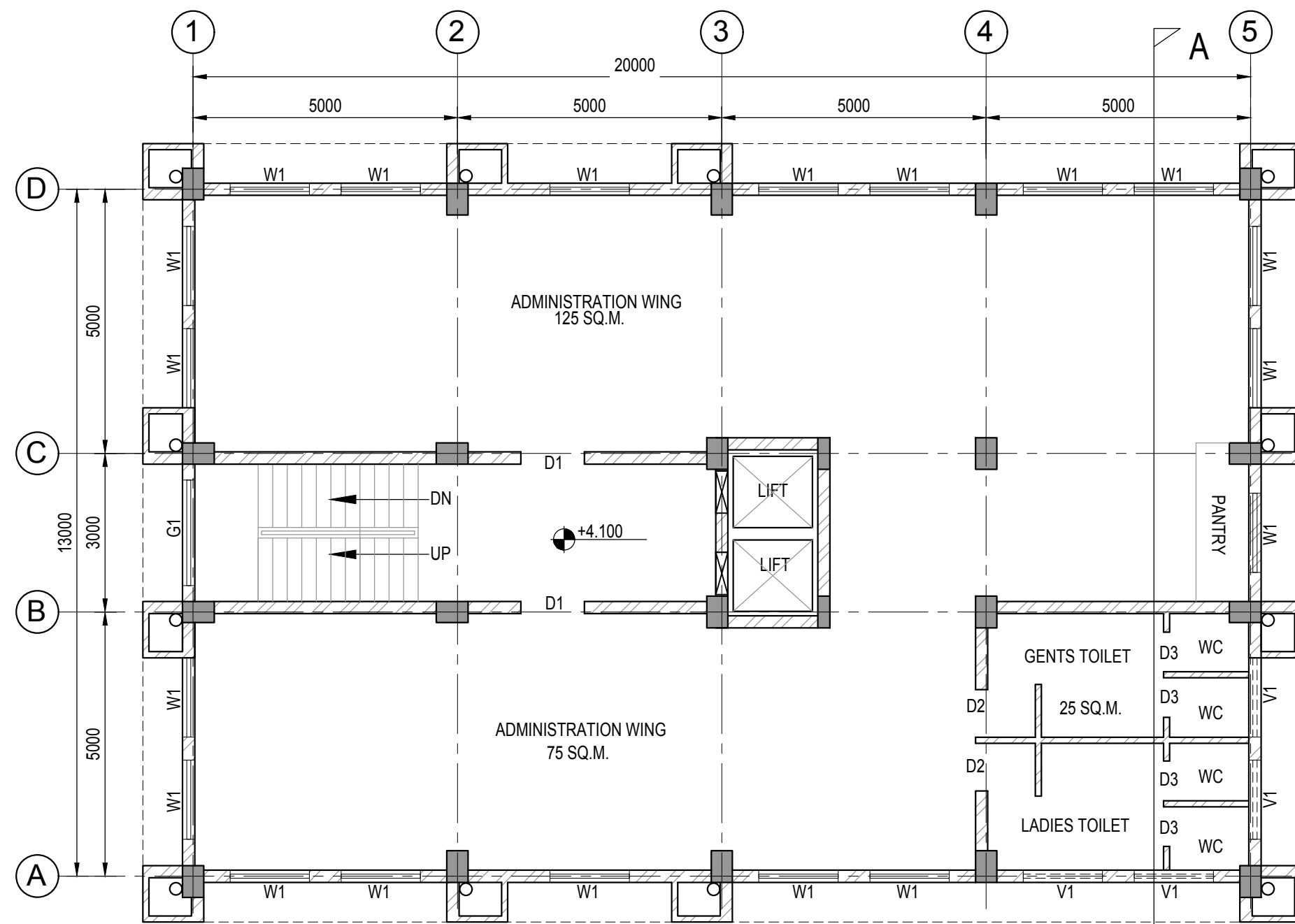
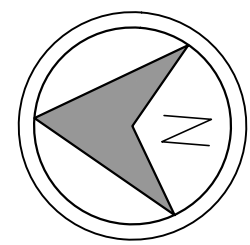
PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF SHORE PROTECTION WORK

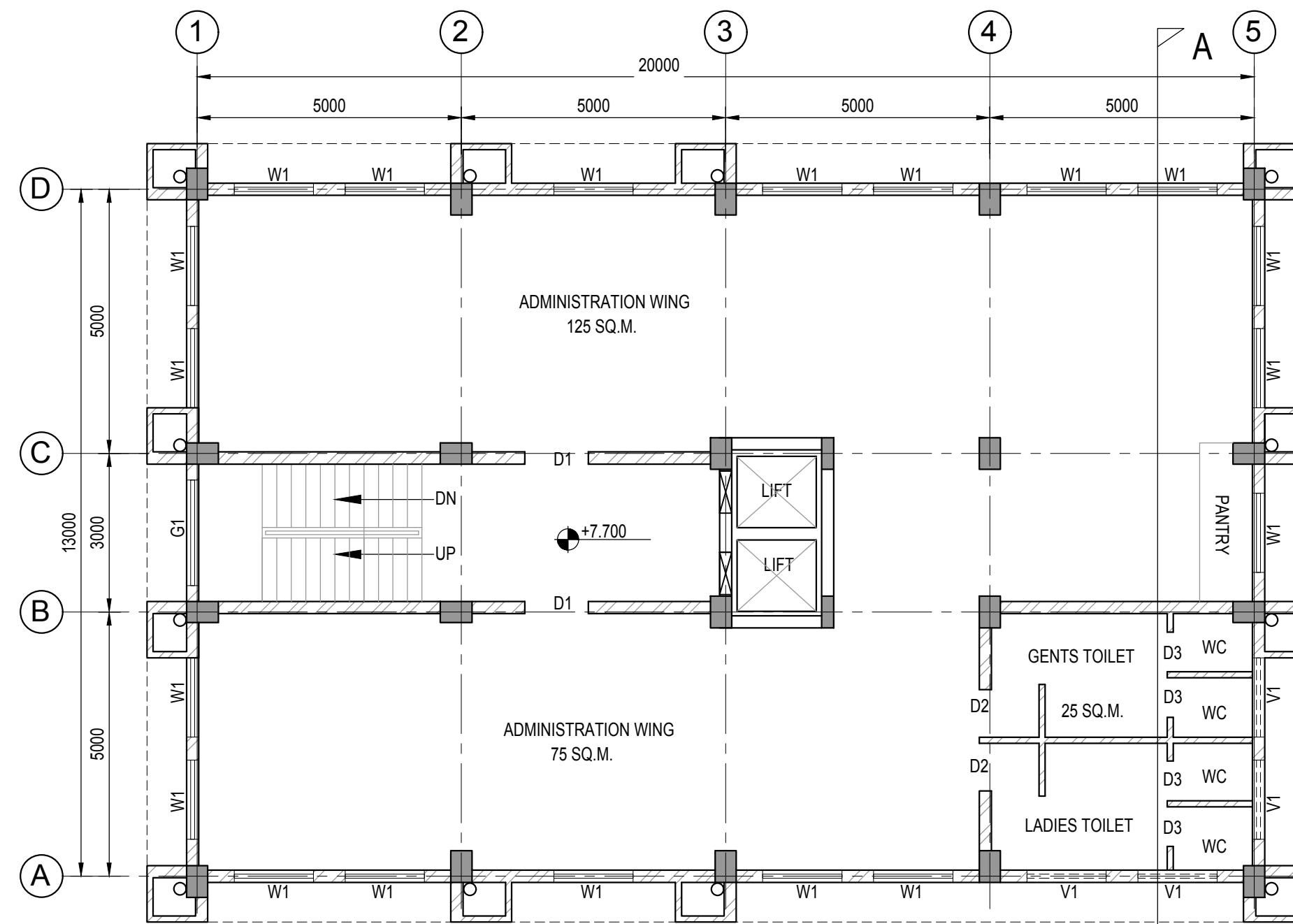
DRAWING NUMBER: 60636525 - DPR - 1009

REV. 2

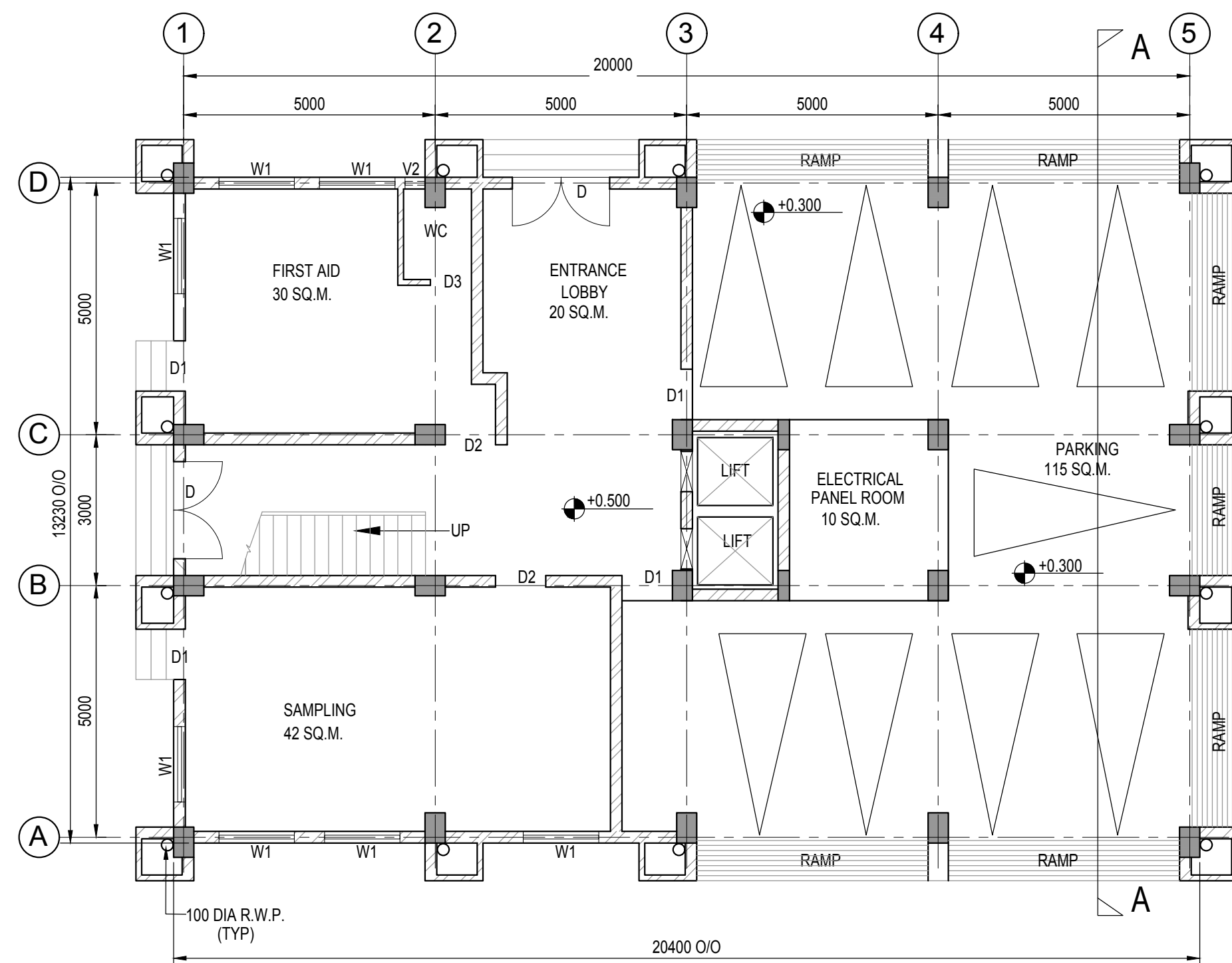
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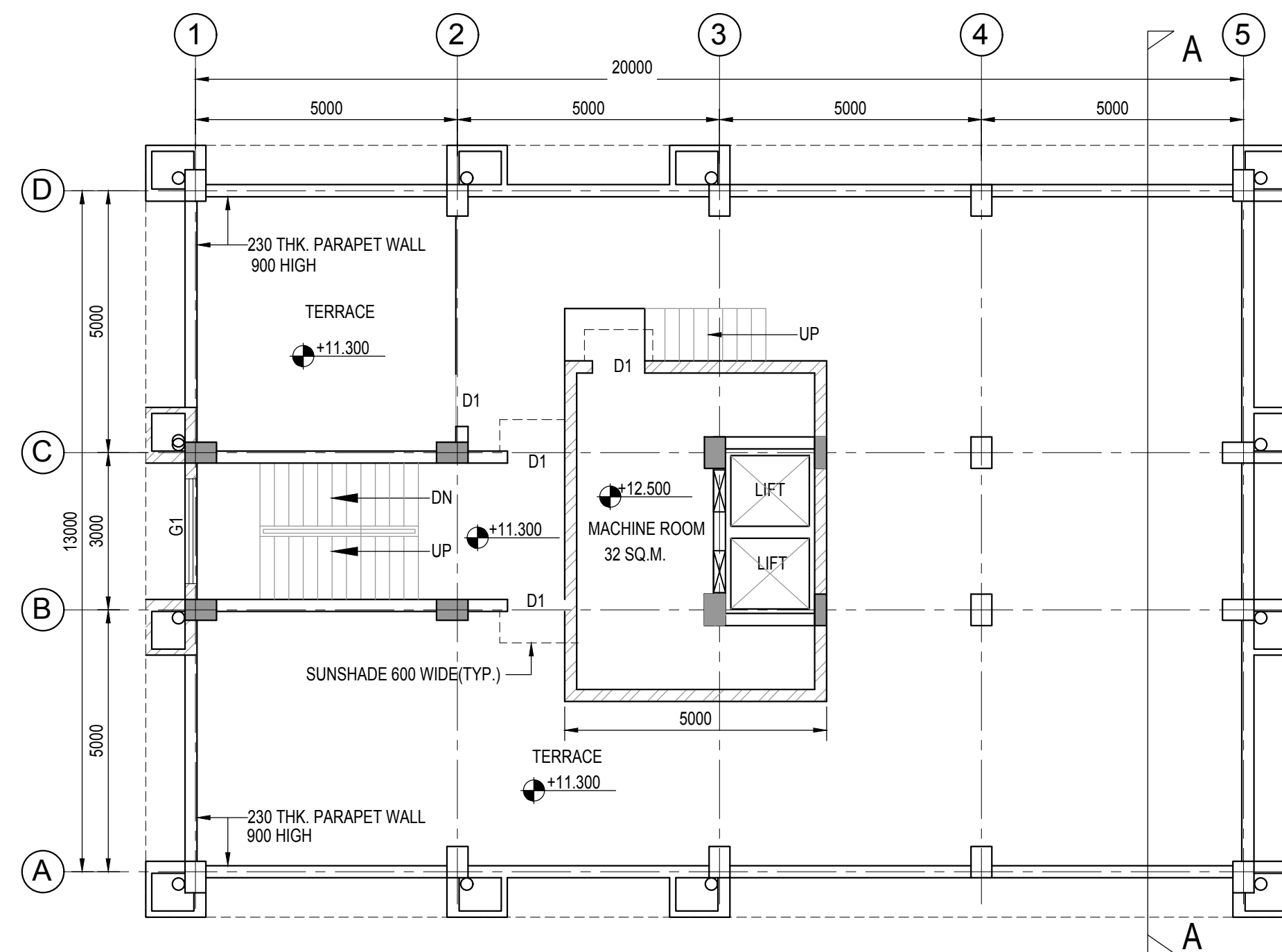
FIRST FLOOR PLAN



SECOND FLOOR PLAN



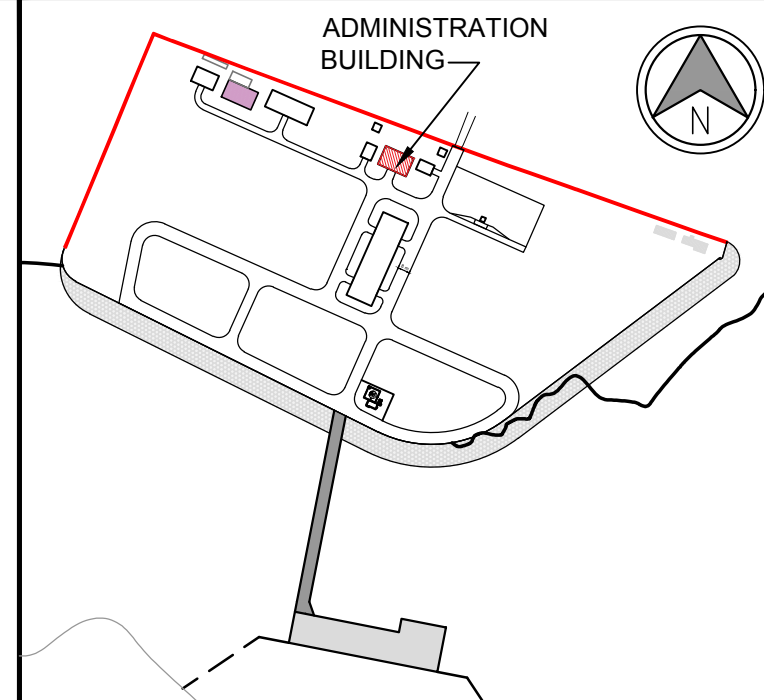
GROUND FLOOR PLAN



TERRACE FLOOR PLAN

OPENING SCHEDULE					
S.NO.	TYPE	WIDTH	HEIGHT	CILL LVL.	NOS.
1.	D	2000	3000	0	2
2.	D1	1200	2700	0	18
3.	D2	1000	2100	0	10
4.	D3	750	2100	0	17
5.	W1	1500	1800	900	64
6.	V1	1500	600	2100	16
7.	V2	400	600	2100	1
8.	G1	2000	1800	900	6

(* LEVELS FROM FINISHED FLOOR)



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2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG

REVISION DETAILS					
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PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM					

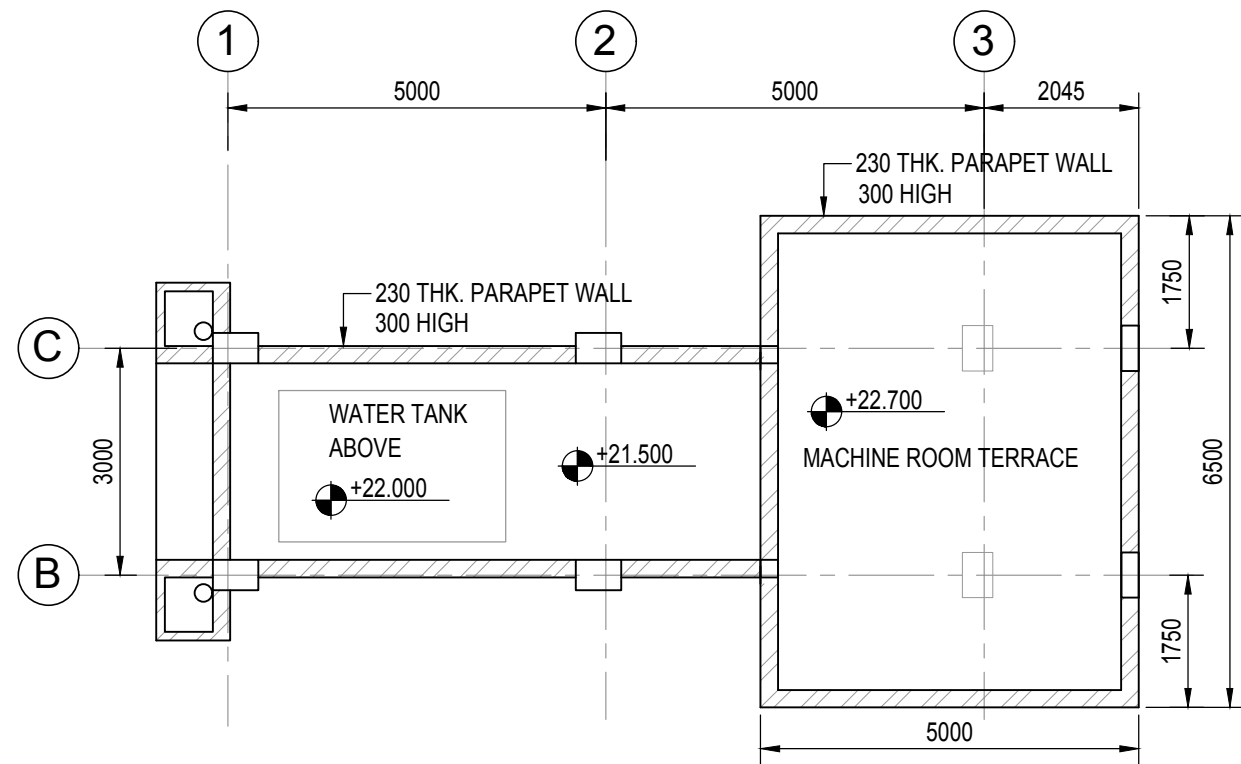
PART/DISCIPLINE:	DIMENSIONS ARE IN:

PURPOSE:	DETAILED PROJECT REPORT

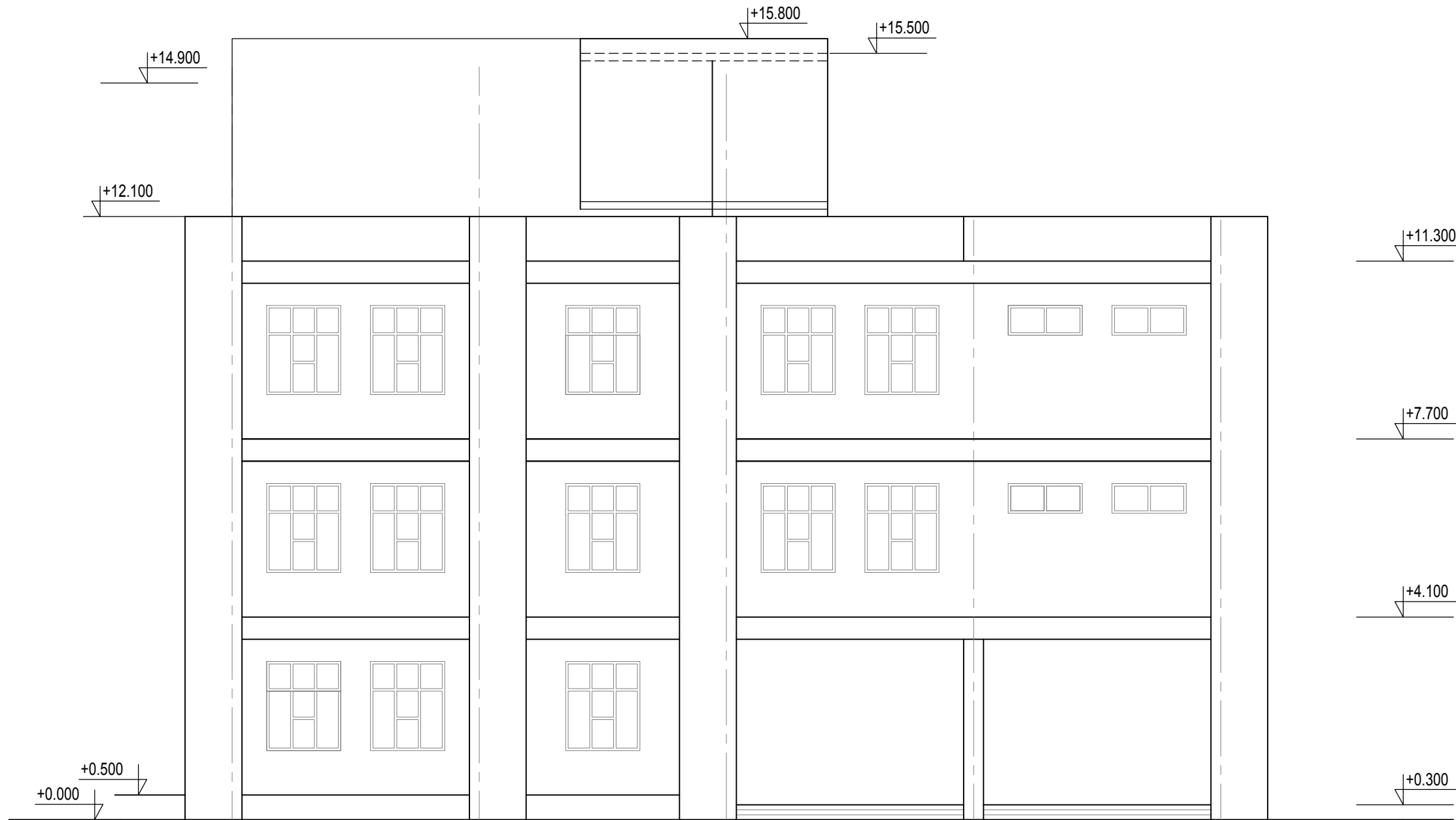
DRAWING TITLE:	DETAILS OF ADMINISTRATION BUILDING SHEET 1 OF 2

DRAWING NUMBER:	60636525 - DPR - 1010
REV.	2

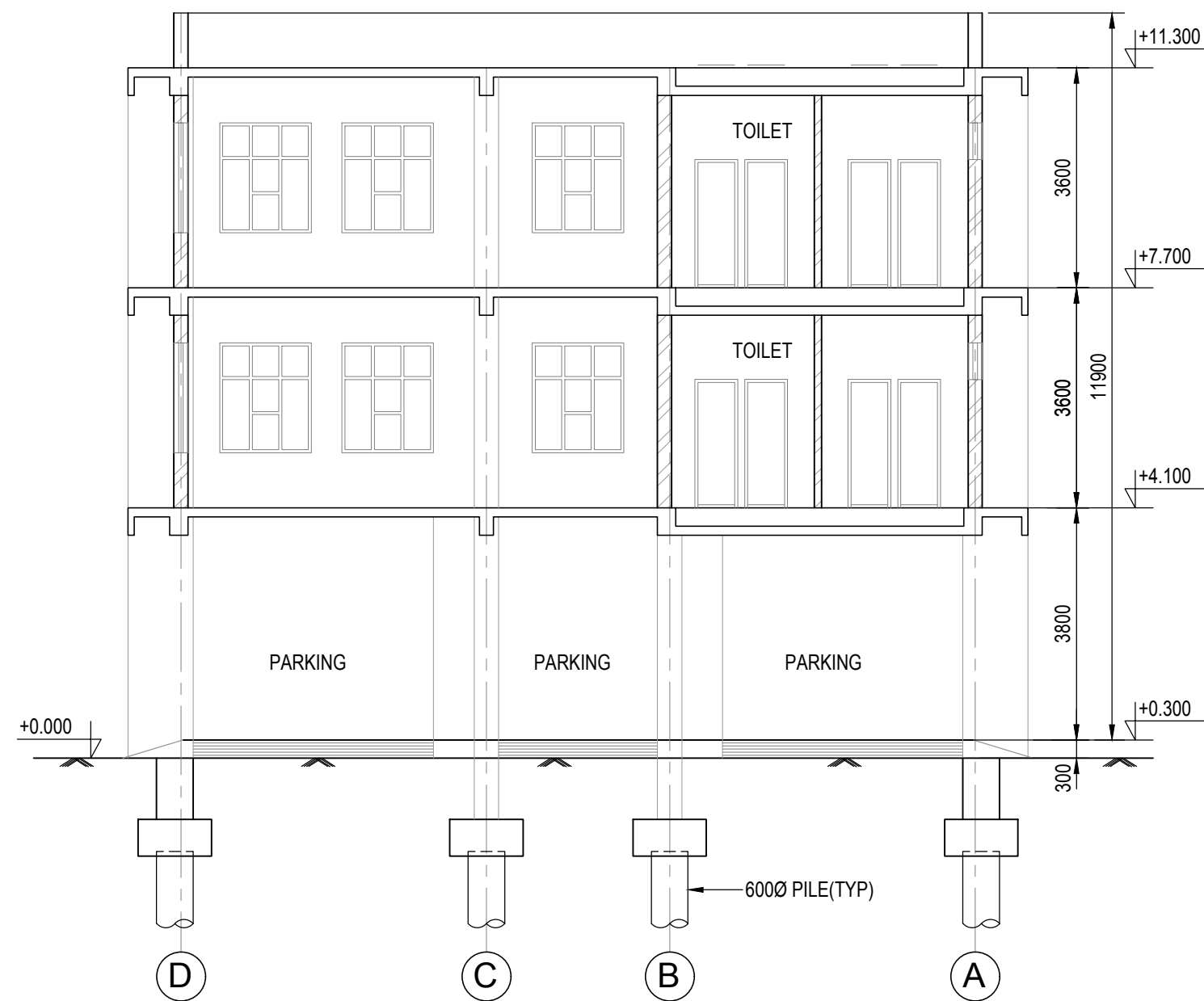
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MUMTY M/C ROOM ROOF PLAN

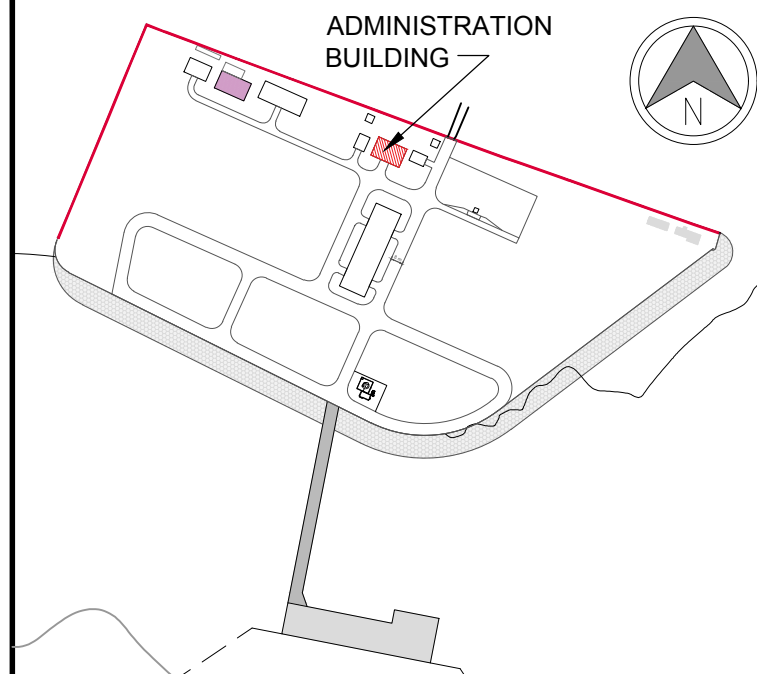


FRONT ELEVATION



SECTION A-A

PROPOSED SCHEDULE OF FINISHING MATERIALS					PROPOSED SCHEDULE OF FINISHING MATERIALS				
GROUND FLOOR	NO.	ROOM	FLOORING	WALLS	TERRACE FLOOR MUMTY/ M/C ROOM	NO.	ROOM	FLOORING	WALLS
	1	ENTRANCE LOBBY, LIFT LOBBY, OUTSIDE ENTRANCE, PLATFORM	ITALIAN MARBLE	PLASTIC EMULSION PAINT, GRANITE CLADDING ON LIFT WALL.		1	MAIN STAIRCASE	WHITE MARBLE	PLASTIC EMULSION PAINT
	2	MAIN STAIRCASE	WHITE MARBLE	DO		2	LIFT MACHINE ROOM	KOTA STONE	PLASTIC EMULSION PAINTS
	3	FIRST AID & SAMPLING	VITRIFIED PORCELAIN TILES	CERAMIC TILES	OUT SIDE FINISHING	3	TERRACE	BRICK TILES/ CHINA MOSAIC	
	4	TOILETS	WHITE MARBLE	FULL HEIGHT CERAMIC TILES.		1	CEMENT ROUGH PLASTERS IN TWO COATS WITH WEATHER PROOF PAINT.		
	5	STORE, ELECT. ROOM	KOTA STONE	PLASTIC EMULSION PAINT		2	FLIGHT OF STEPS IN THE FRONT FINISHED WITH WHITE MARBLE		
FIRST FLOOR	6	PARKING	KOTA STONE	PLASTIC EMULSION PAINT		3	COLOUR ANODIZED COATED ALUMINUM WINDOWS WITH 5 MM THICK FLOAT GLASS.		
	1	LIFT LOBBY, TOILETS, MAIN STAIRCASE, STORE, ELECT. ROOM	SAME AS GROUND FLOOR	SAME AS GROUND FLOOR		4	LARGE CLEAR GLAZING AS REQUIRED IN ELEVATION WITH COLOR ALUMINUM COATED ALUMINUM FRAMES IN CONTROL ROOMS.		
	2	SITTING AREA	VITRIFIED PORCELAIN TILES	PLASTIC EMULSION PAINTS					
SECOND FLOOR	3	PANTRY, KITCHEN, STORE	KOTA STONE COUNTER-BLACK GRANITE	CERAMIC TILES					
	1	LIFT LOBBY, TOILETS, MAIN STAIRCASE	SAME AS GROUND FLOOR	SAME AS GROUND FLOOR					
	2	PORT OPERATING WING	VITRIFIED PORCELAIN TILES	PLASTIC EMULSION PAINTS					
	3	PANTRY	KOTA STONE COUNTER-BLACK GRANITE	CERAMIC TILES					



KEY PLAN

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REVISION DETAILS

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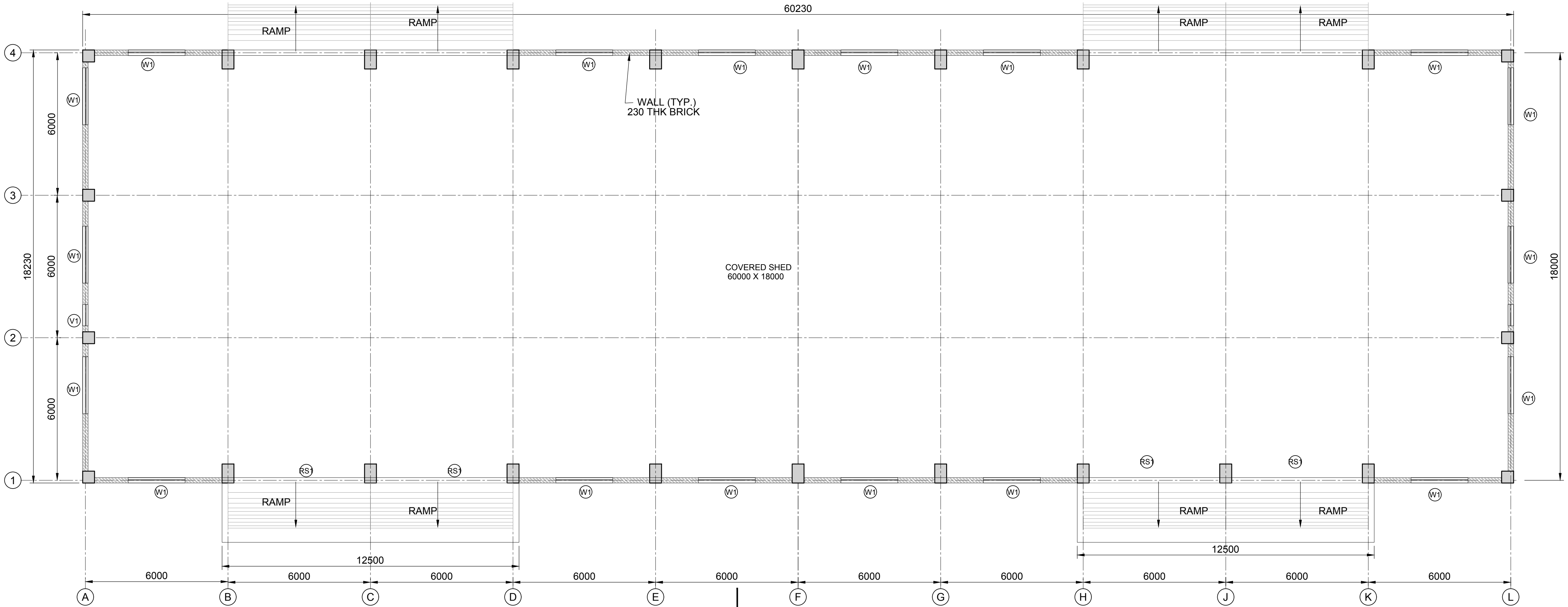
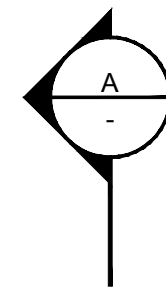
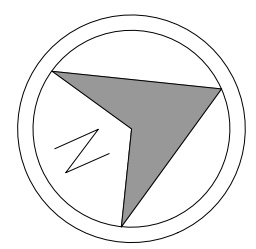
PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF ADMINISTRATION BUILDING SHEET 2 OF 2

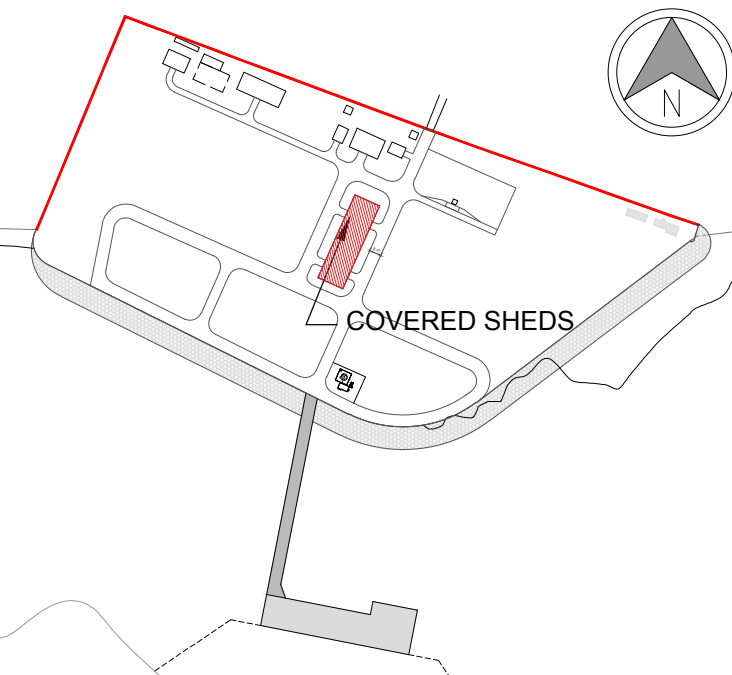
DRAWING NUMBER: 60636525 - DPR - 1010 REV. 2

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Project Management Initials:
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PLAN AT GROUND FLOOR
SCALE 1:100



KEY PLAN

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REV.	DATE	DESCRIPTION	DR.	CH.	APR.

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PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: COVERED SHED SHEET 1 OF 2 PLAN

DRAWING NUMBER: 60636525 - DPR - 1011 REV. 2

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REVISION DETAILS					

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PART/DISCIPLINE:	DIMENSIONS ARE IN

PURPOSE:	DETAILED PROJECT REPORT

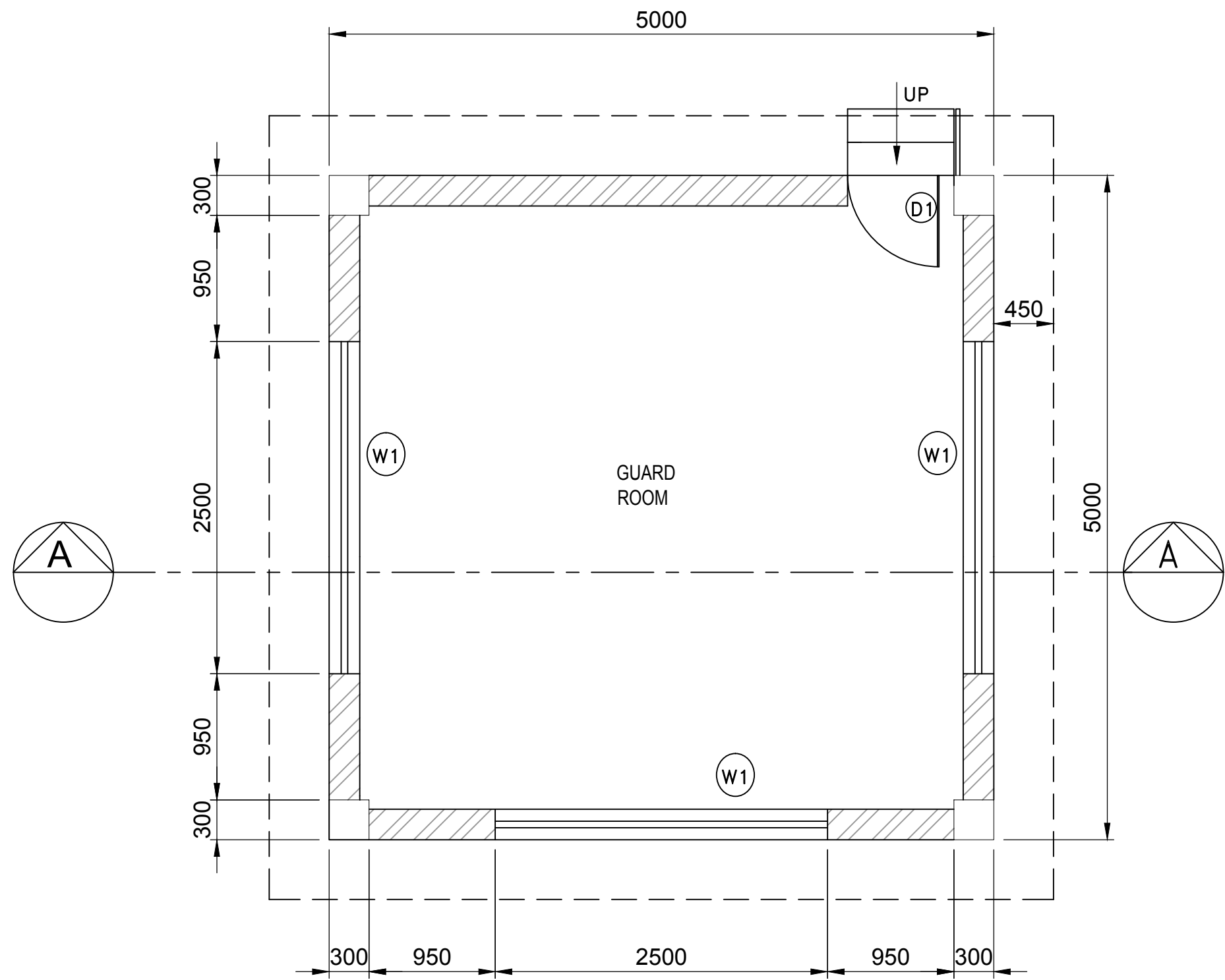
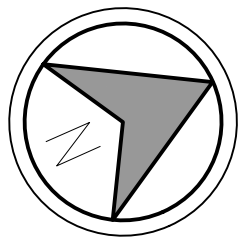
DRAWING TITLE:

COVERED SHED
SHEET 2 OF 2
TYPICAL CROSS SECTION

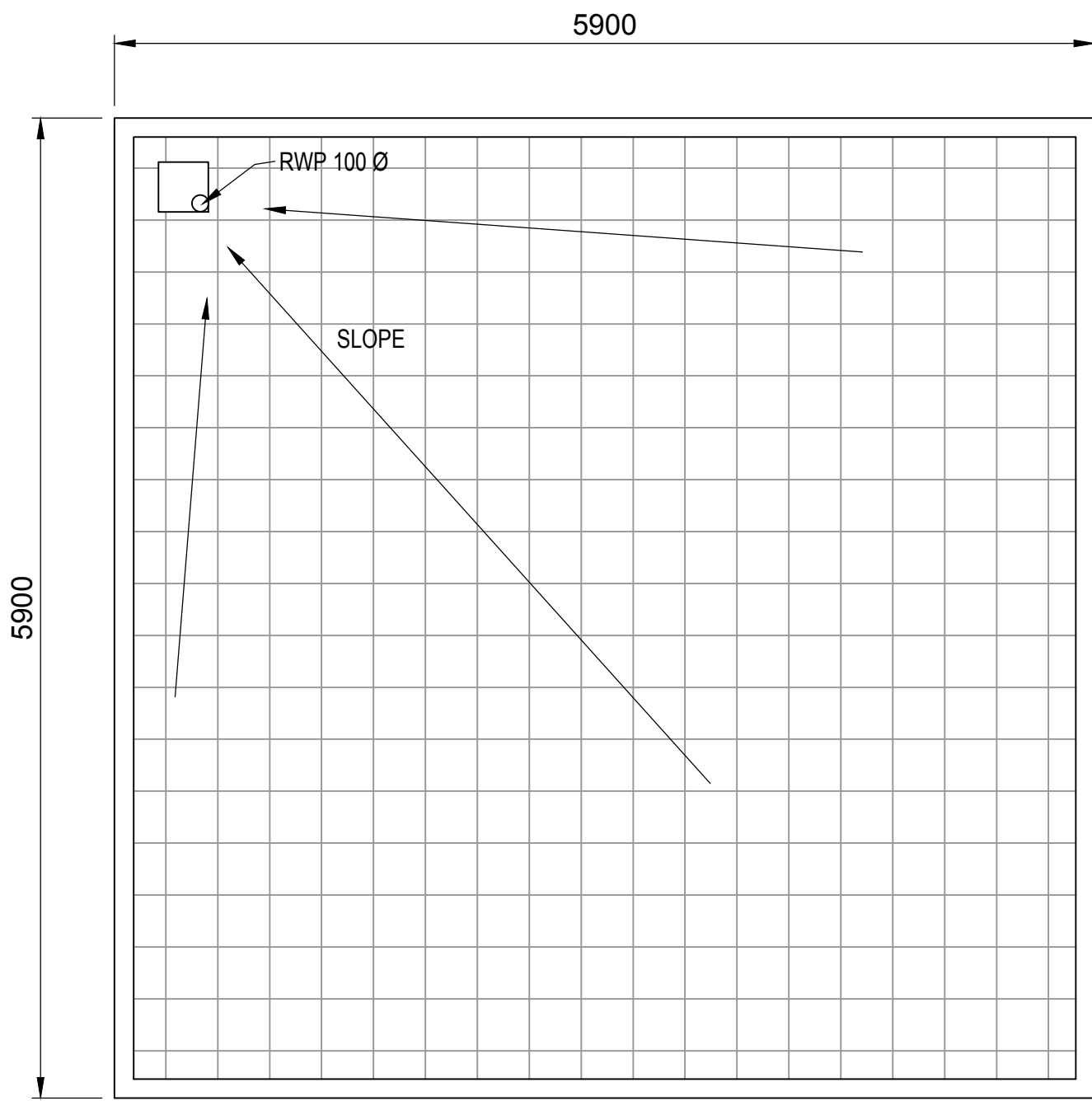
DRAWING NUMBER:	REV.
60636525 - DPR - 1011	2

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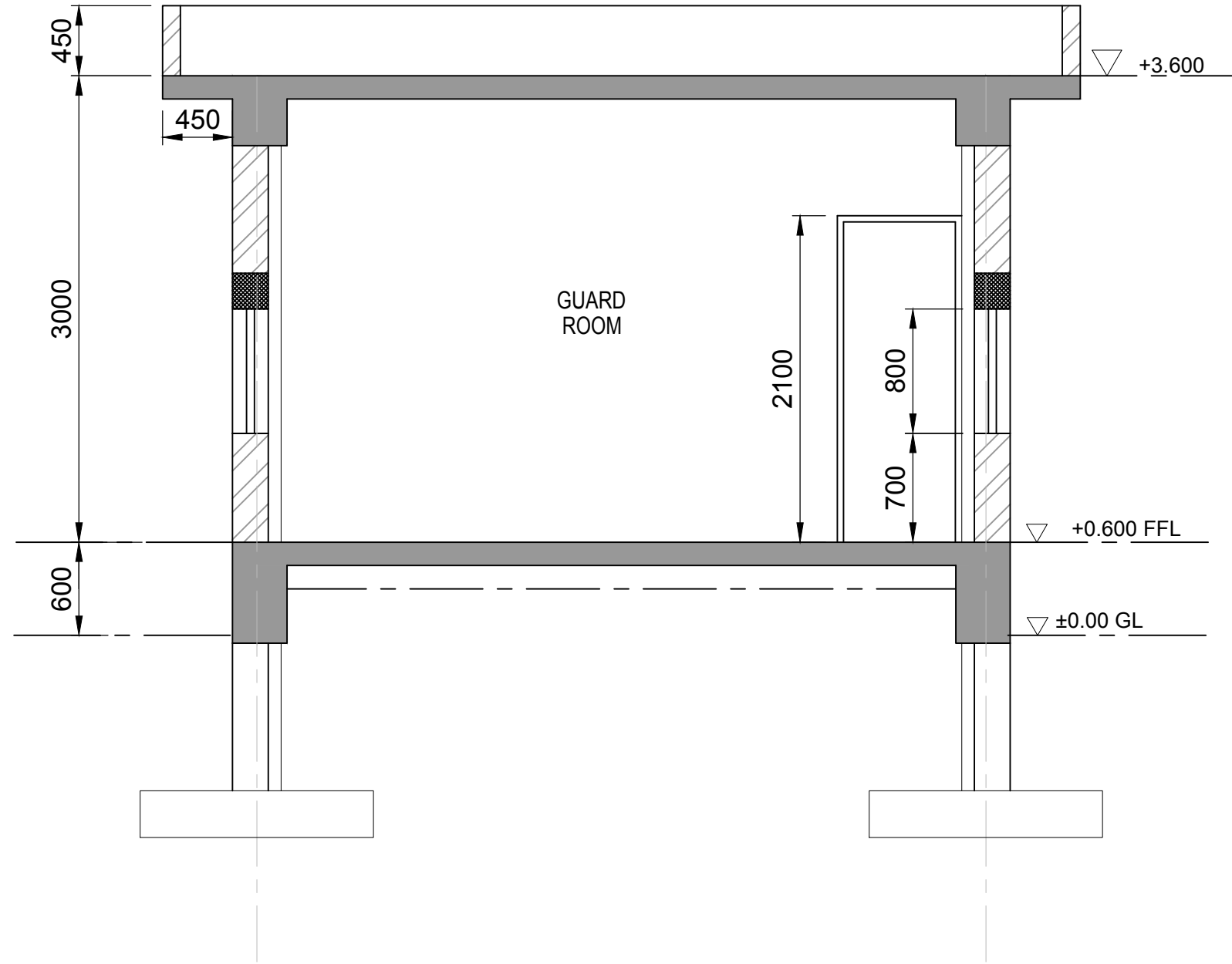
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Designer: SV
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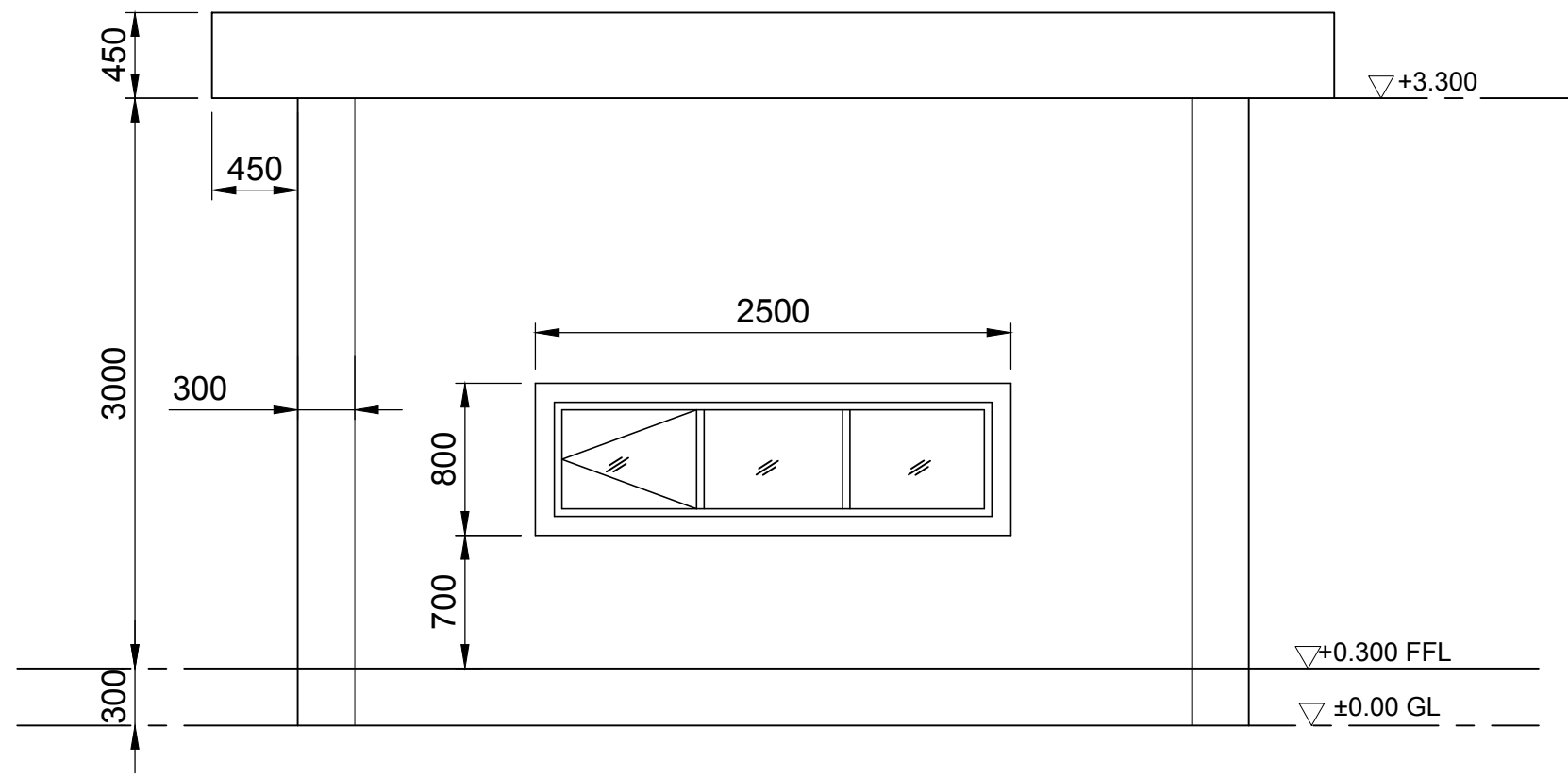
GROUND FLOOR PLAN
SCALE 1:50



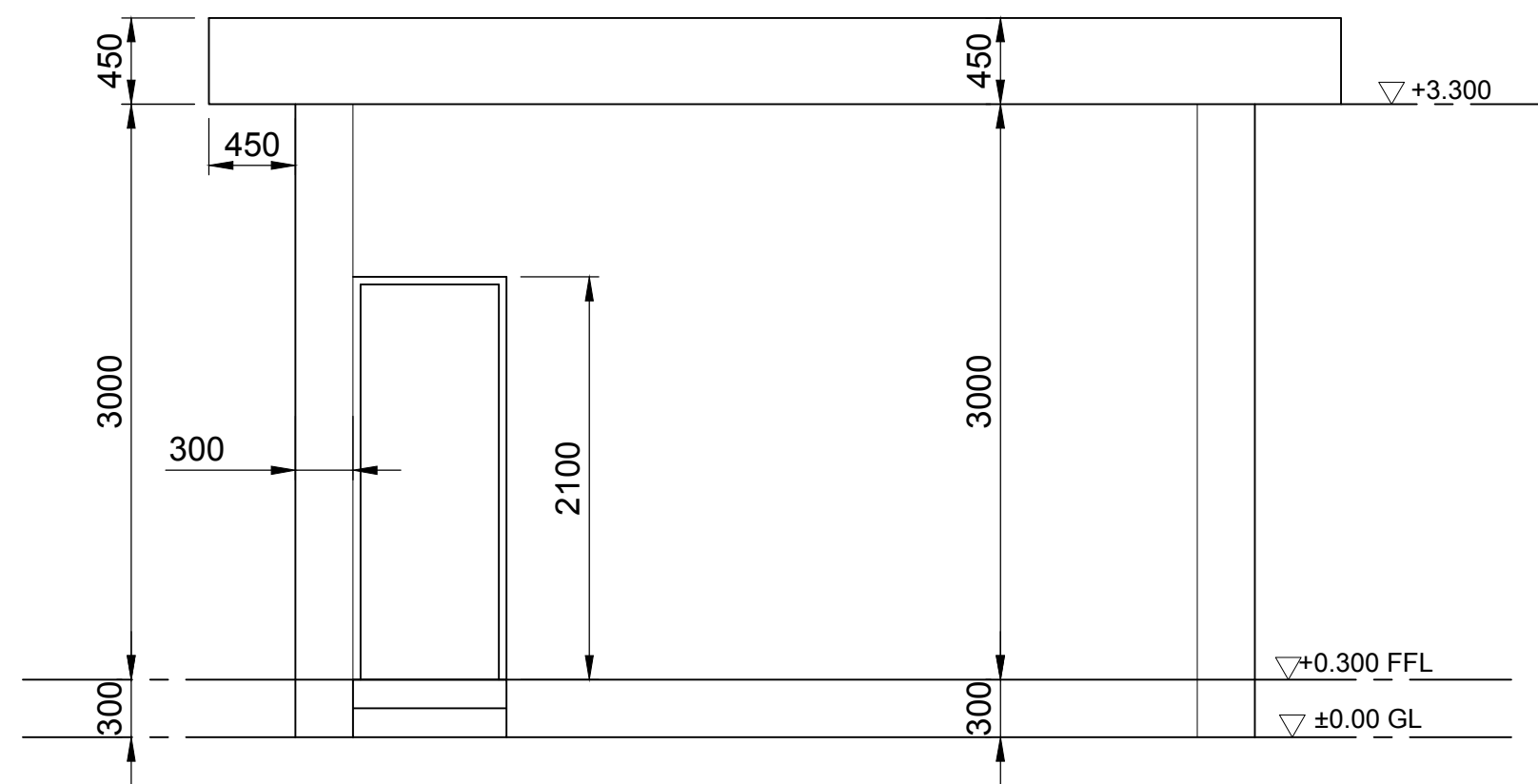
TERRACE PLAN
SCALE 1:50



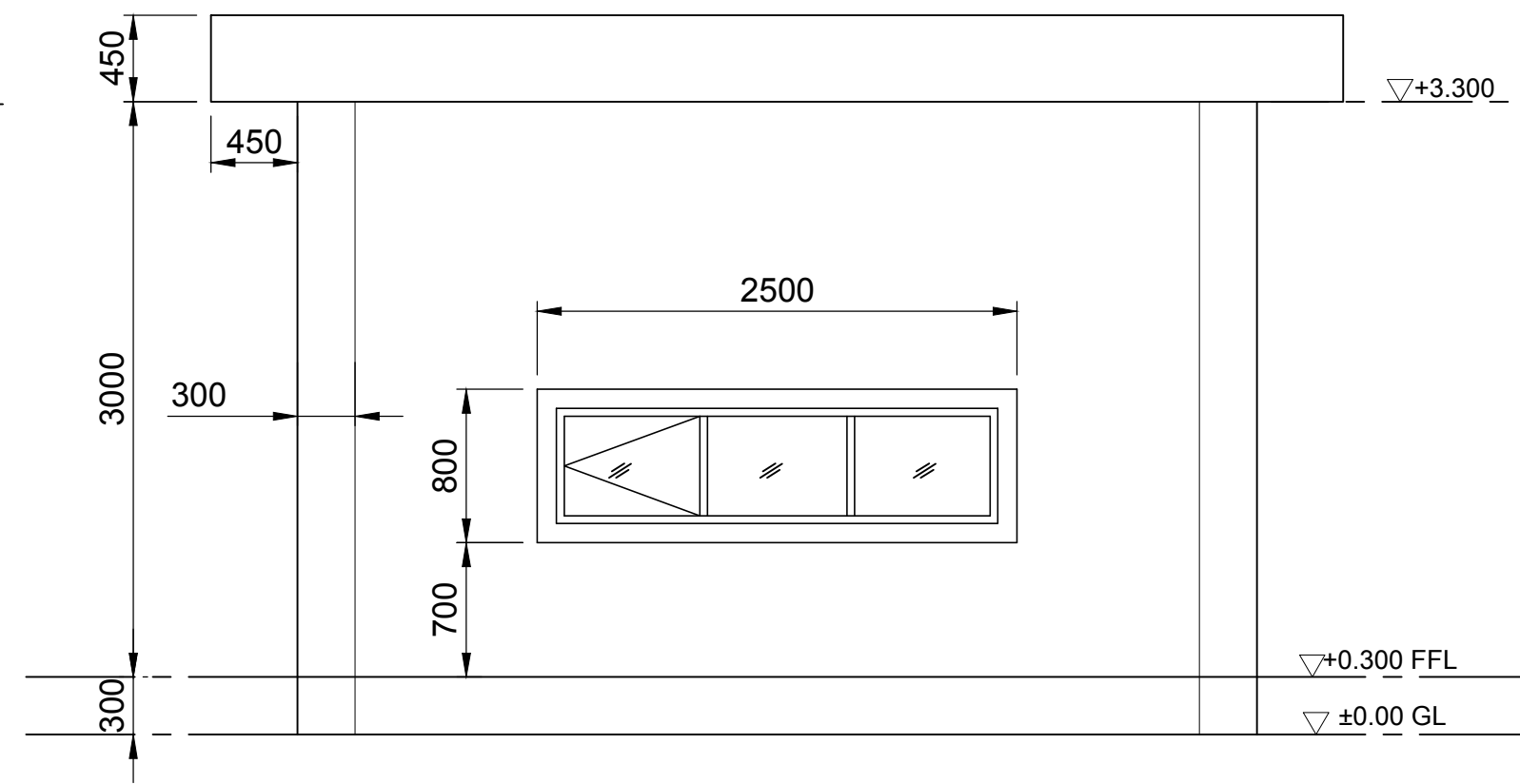
SECTION A-A
SCALE 1:50



FRONT ELEVATION
SCALE 1:50



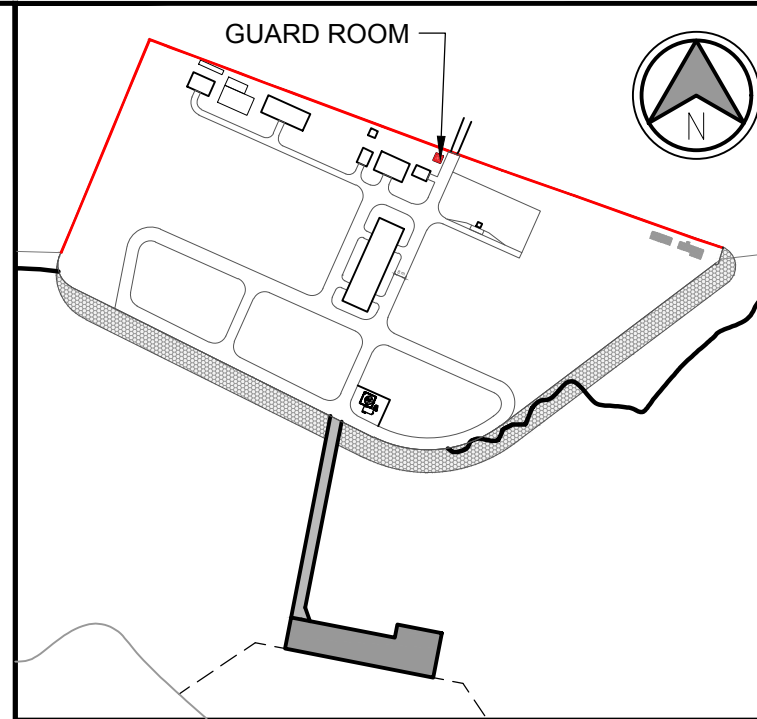
REAR ELEVATION
SCALE 1:50



SIDE ELEVATION
SCALE 1:50

FINISHING SCHEDULE				
ROOMS	FLOORING	WALLS	COUNTER	CEILING
GUARD ROOMS	FLOORING TILES 9 m.m THK. VITRIFIED PORCELAIN TILES 300X300 m.m. COLOUR-LIGHT BEIGE/ LIGHT CAMEL	PLASTIC EMULSION PAINT COLOUR-OFF-WHITE TO MATCH FLOORING COLOUR	GRANITE STONE (MAROON COLOUR)	OIL BOUND DISTEMPER COLOUR-WHITE
OUT SIDE FINISH	1. TEXTURED SPECTRUM PAINT FINISH ON THE WALL SURFACES. 2. PLAIN SPECTRUM PAINT FINISH ON THE BANDS AND MOULDINGS. 3. COLOUR OF SPECTRUM PAINT TO MATCH THE SHADE OF SANDSTONE CLADDING. 4. ROOFING TO BE FINISHED WITH SMOOTH FINISH SANDSTONE TILES. 5. PAVING IN PRECAST CEMENT BLOCKS.			

SCHEDULE OF DOOR/WINDOWS						
S.NO.	SYMBOL	NOS. REQD.	SIZE	CILL LVL.	LTL. LVL.	DESCRIPTION
1.	D1	1	800x2100	-	2100	PRESSED STEEL FRAME TO IS:4351 BPx21 B. FLUSH DOOR SHUTTER 35MM THK. TO IS:2202(PART-1) NON DECORATIVE TYPE CORE OF BLOCK BOARD WITH LIPPING OF SECOND CLASS TEAK WOOD BATTENS 25MM MIN. DEPTH ON ALL SIDES.
4.	W1	3	2500x800	700	1500	FIXED GLASS WITH ONE OPENABLE SHUTTER (ALUMINIUM WINDOW)



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OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)				

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

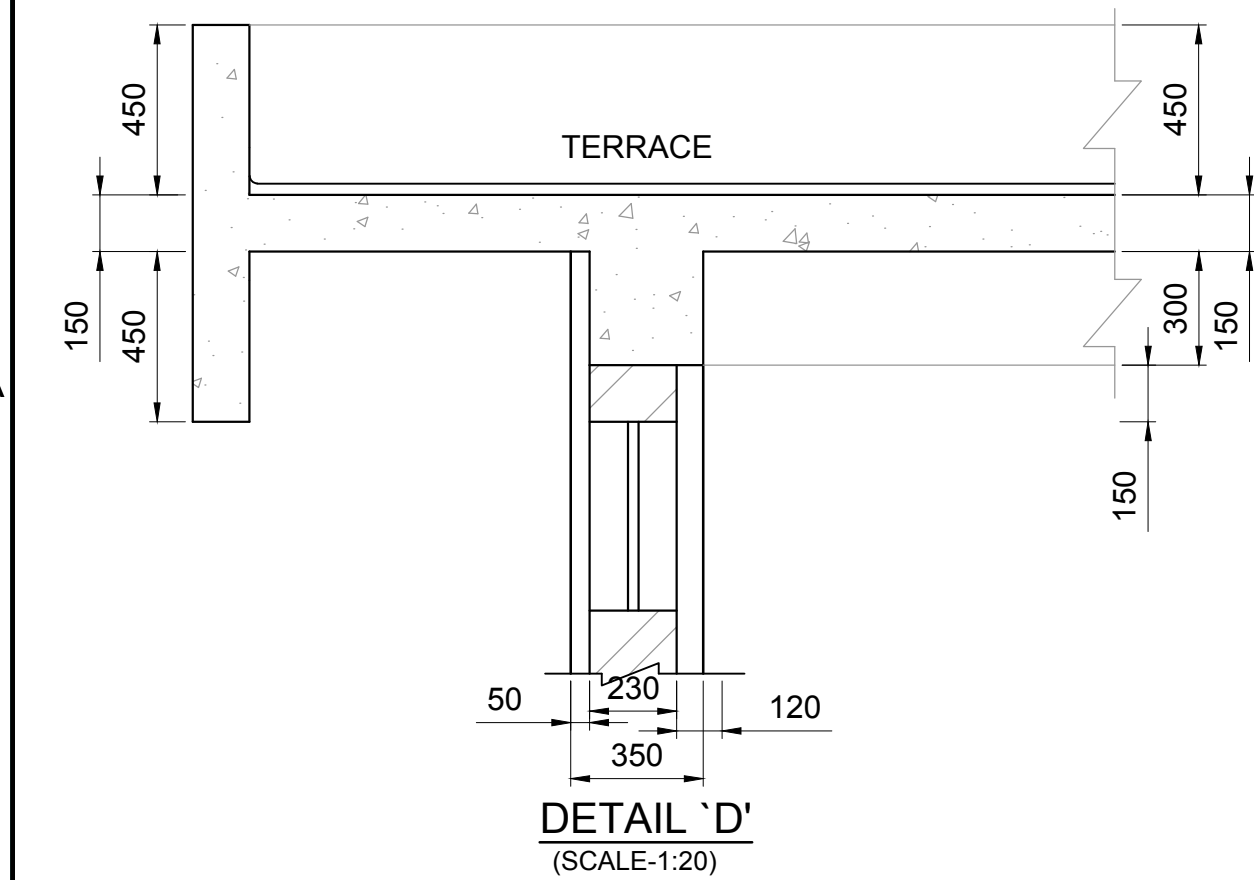
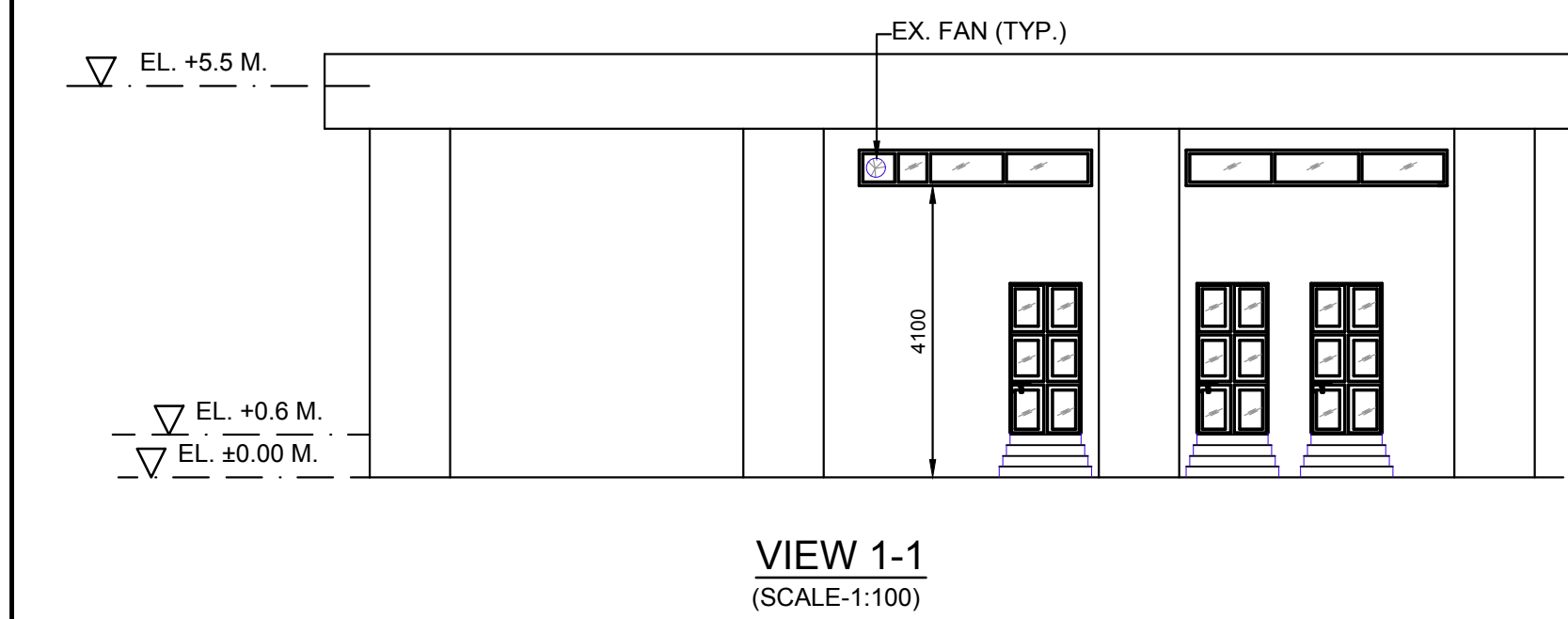
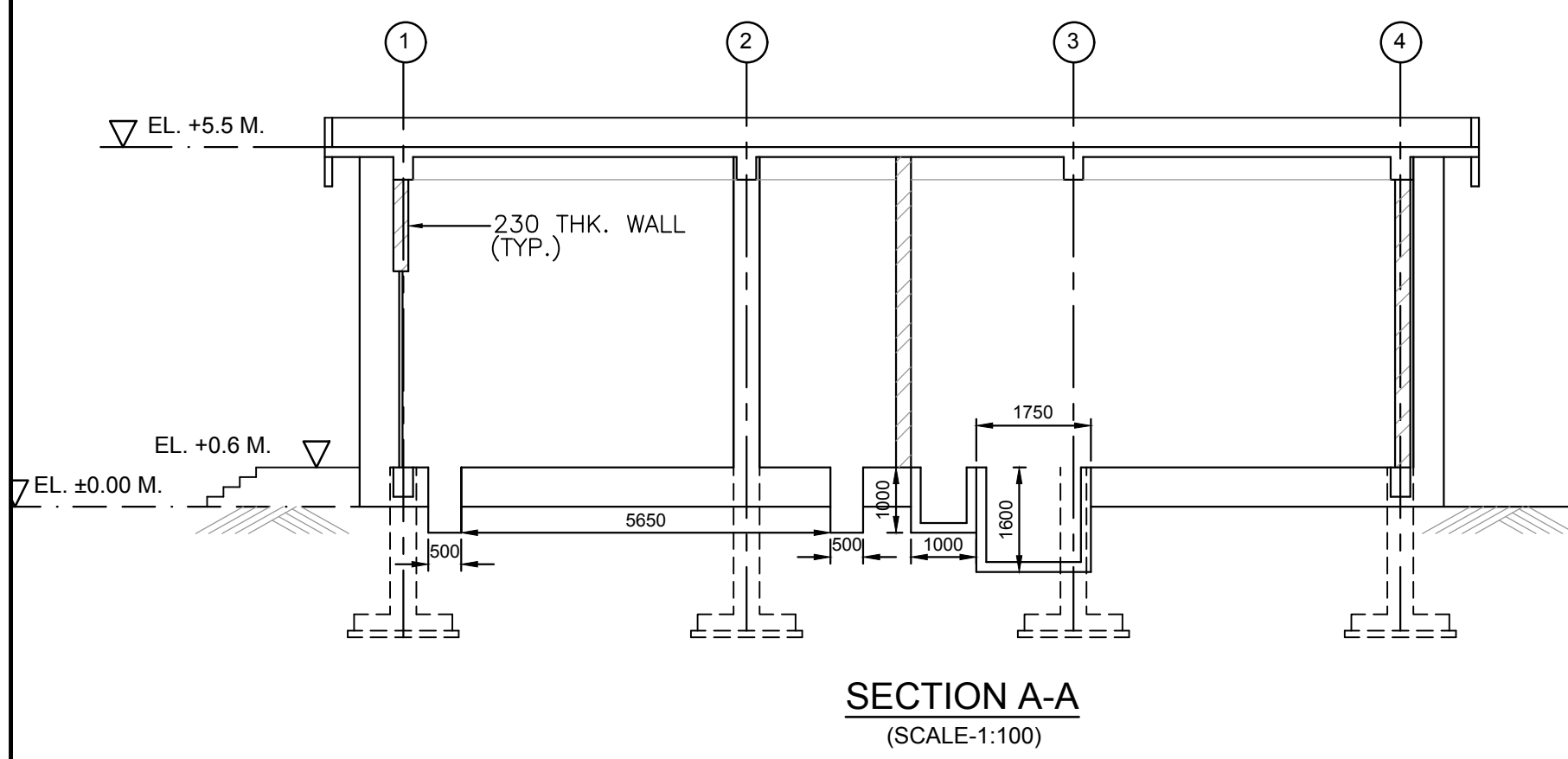
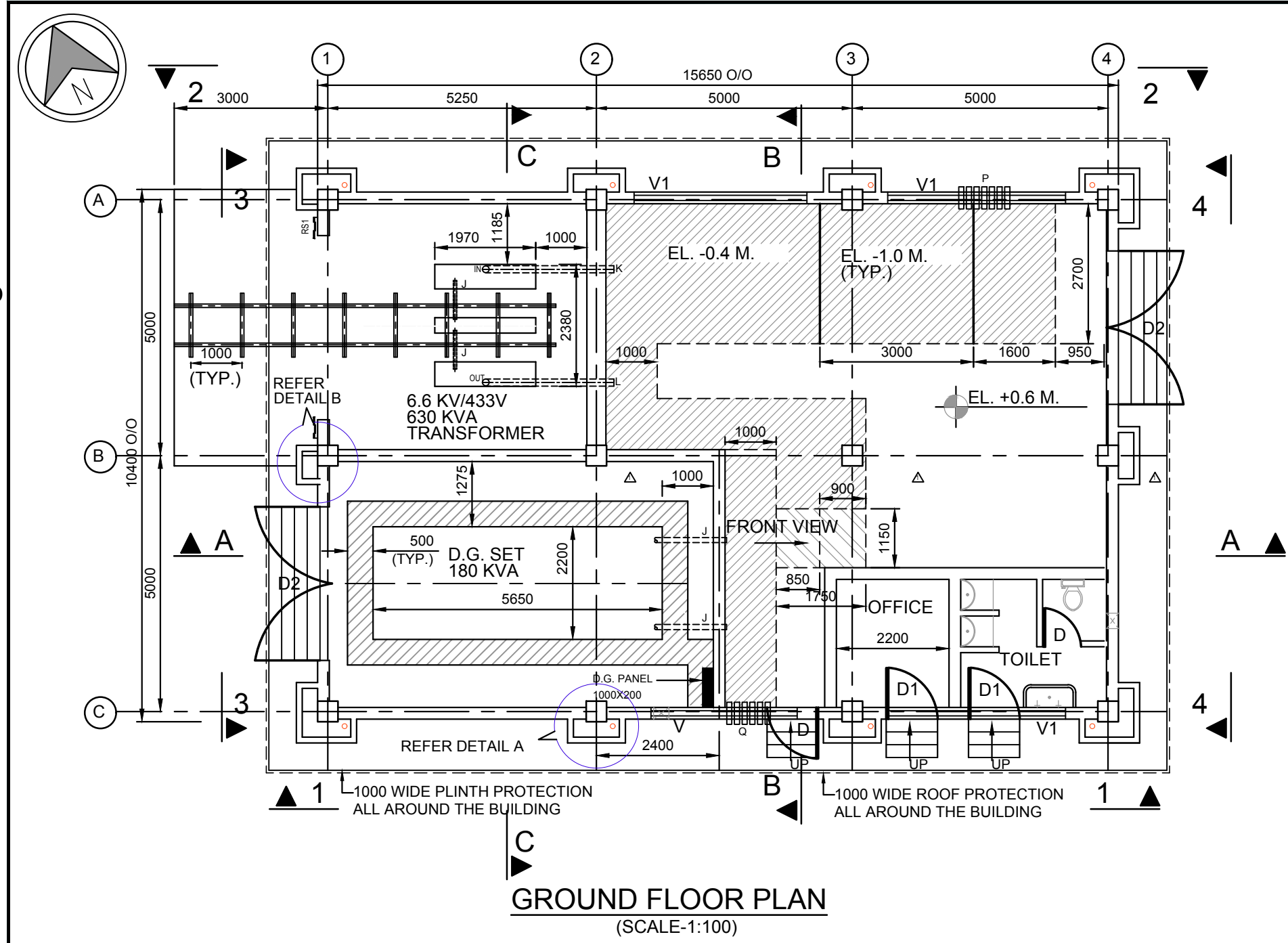
PART/DISCIPLINE:	DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF GUARD ROOM

DRAWING NUMBER:	REV.
60636525 - DPR - 1012	2

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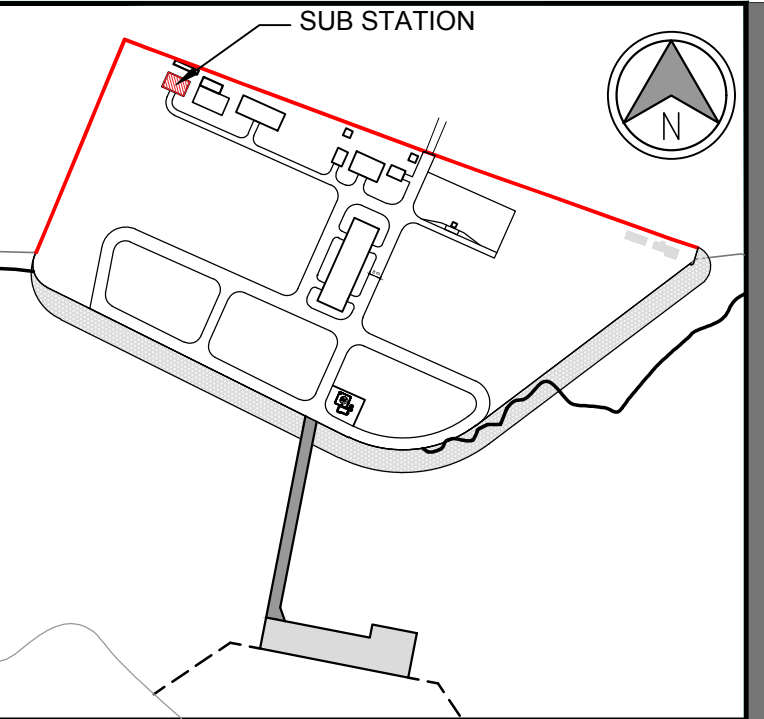
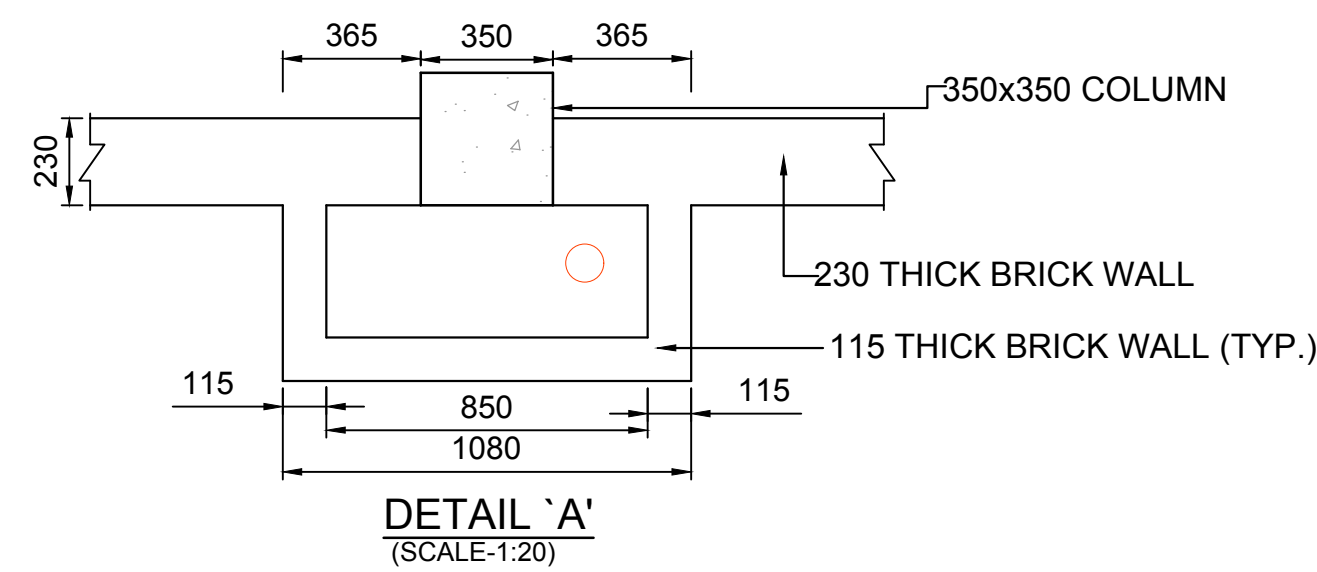
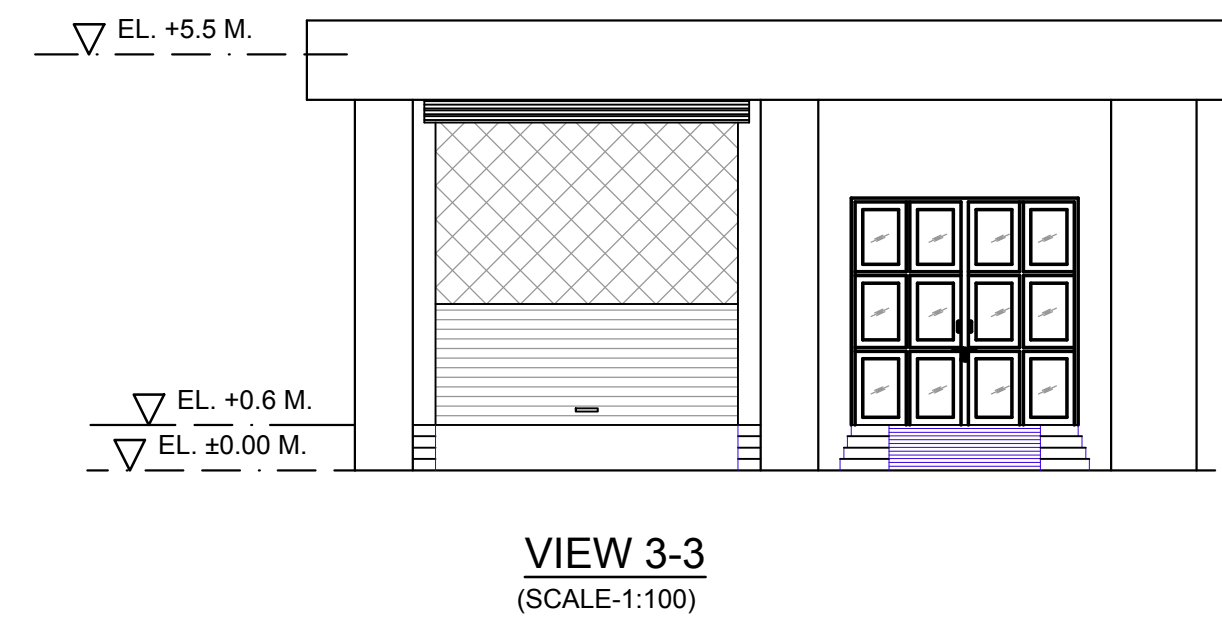
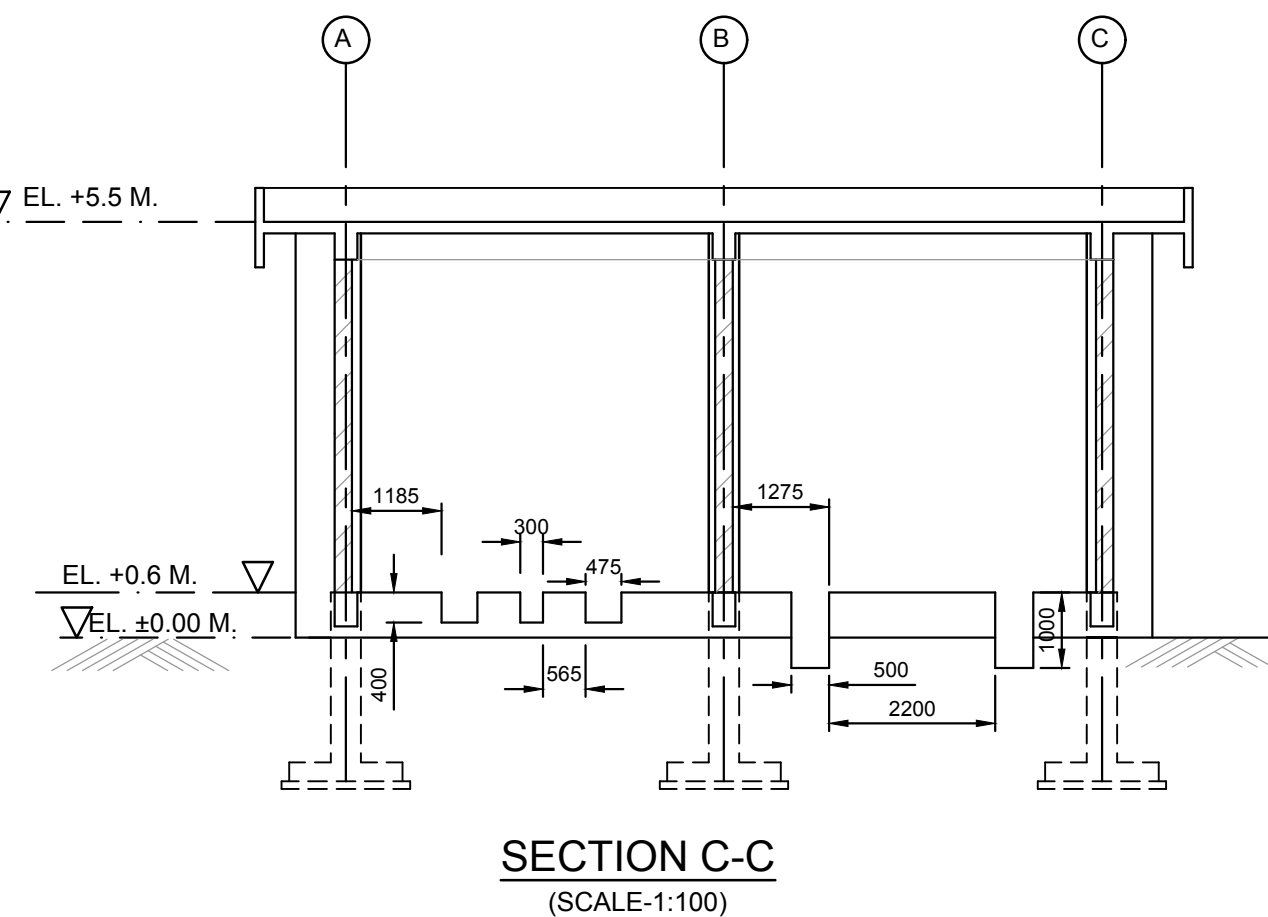
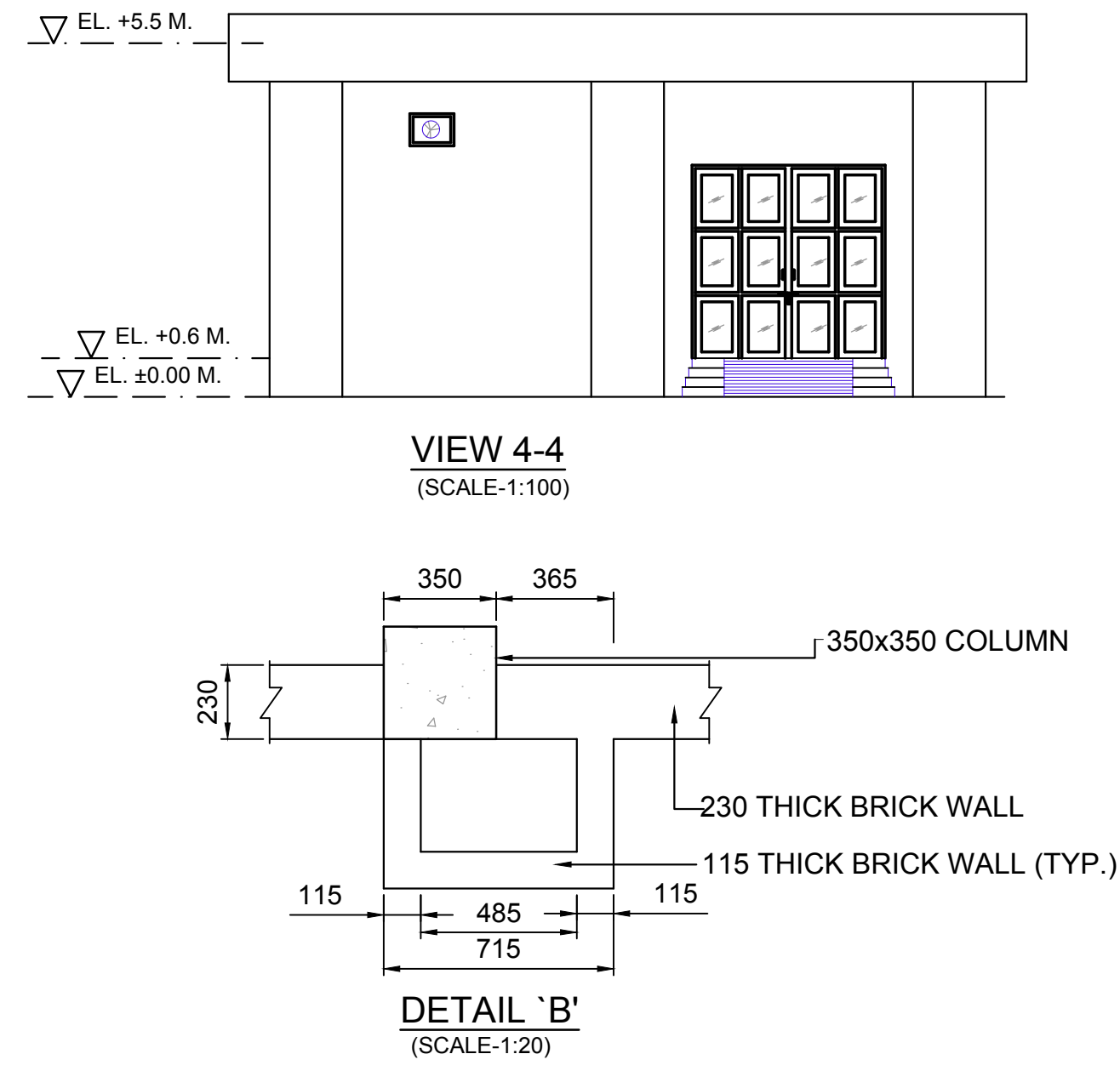
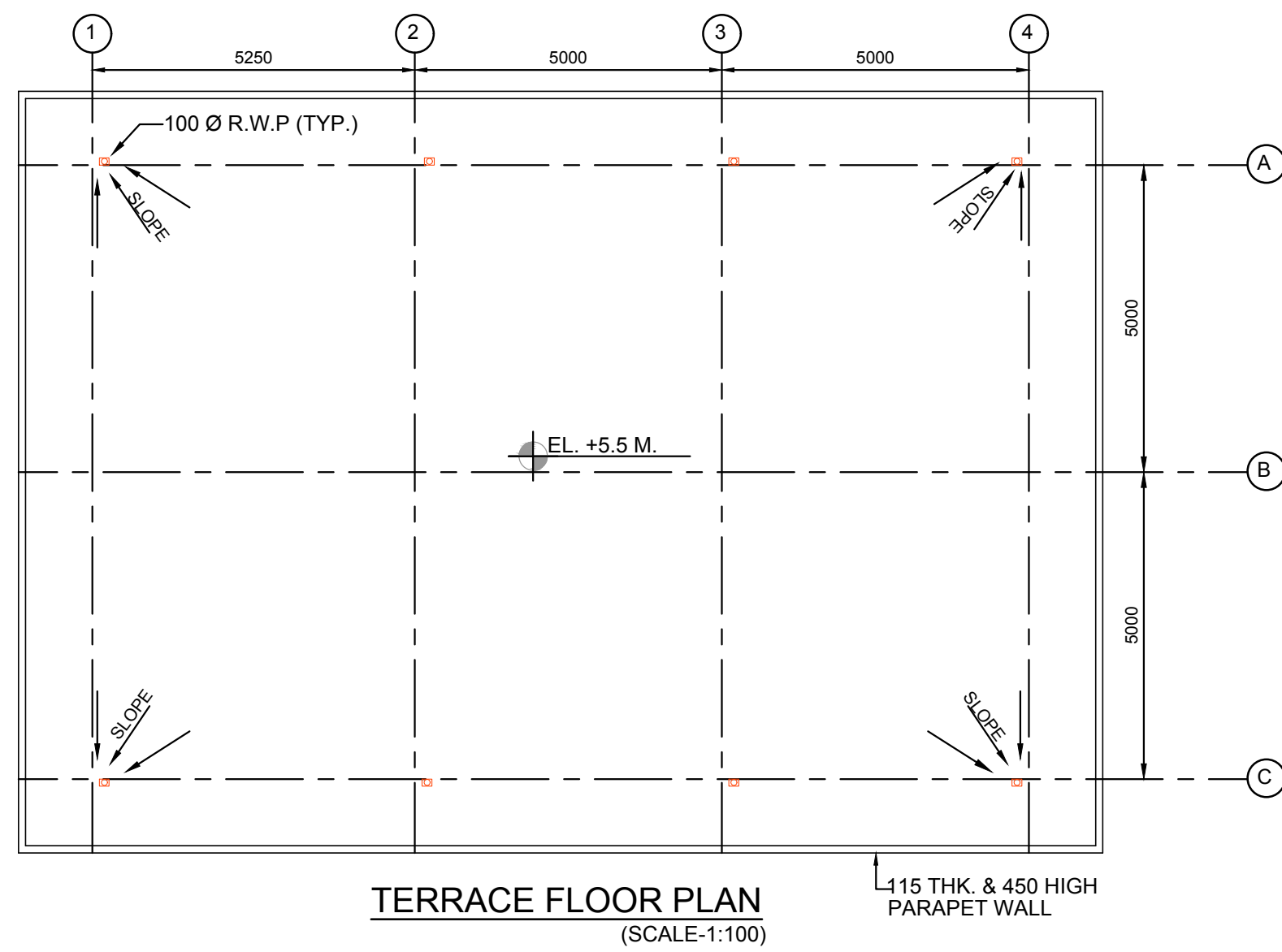
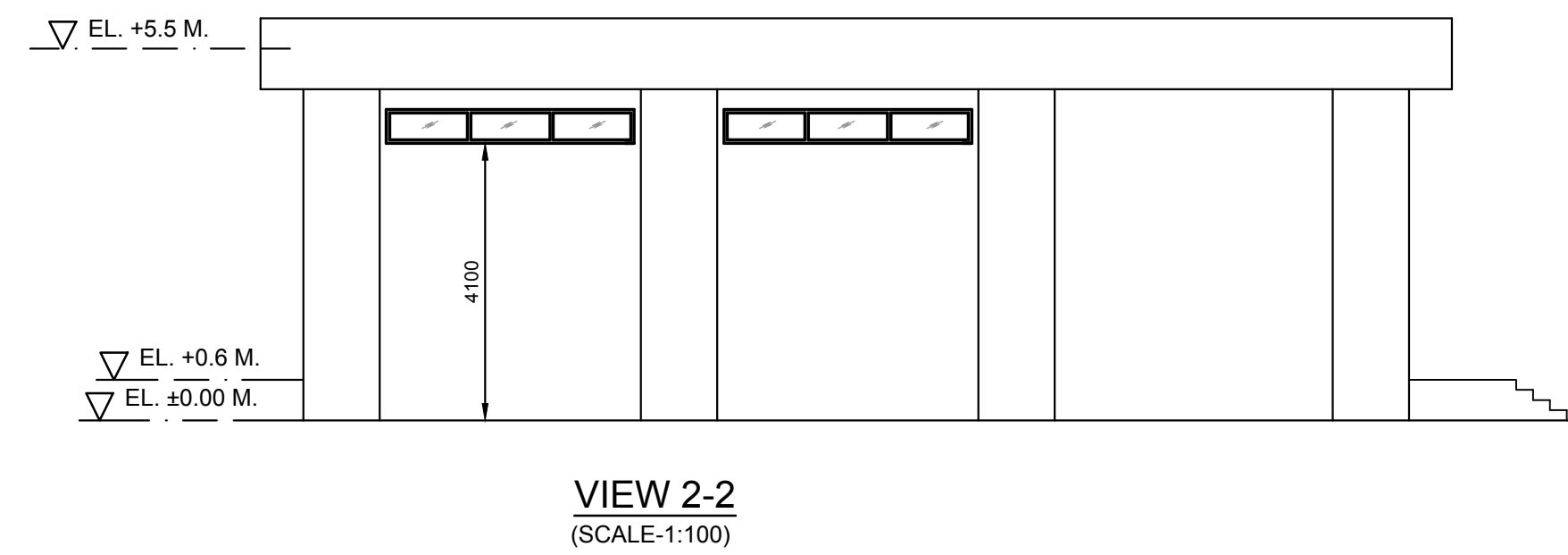
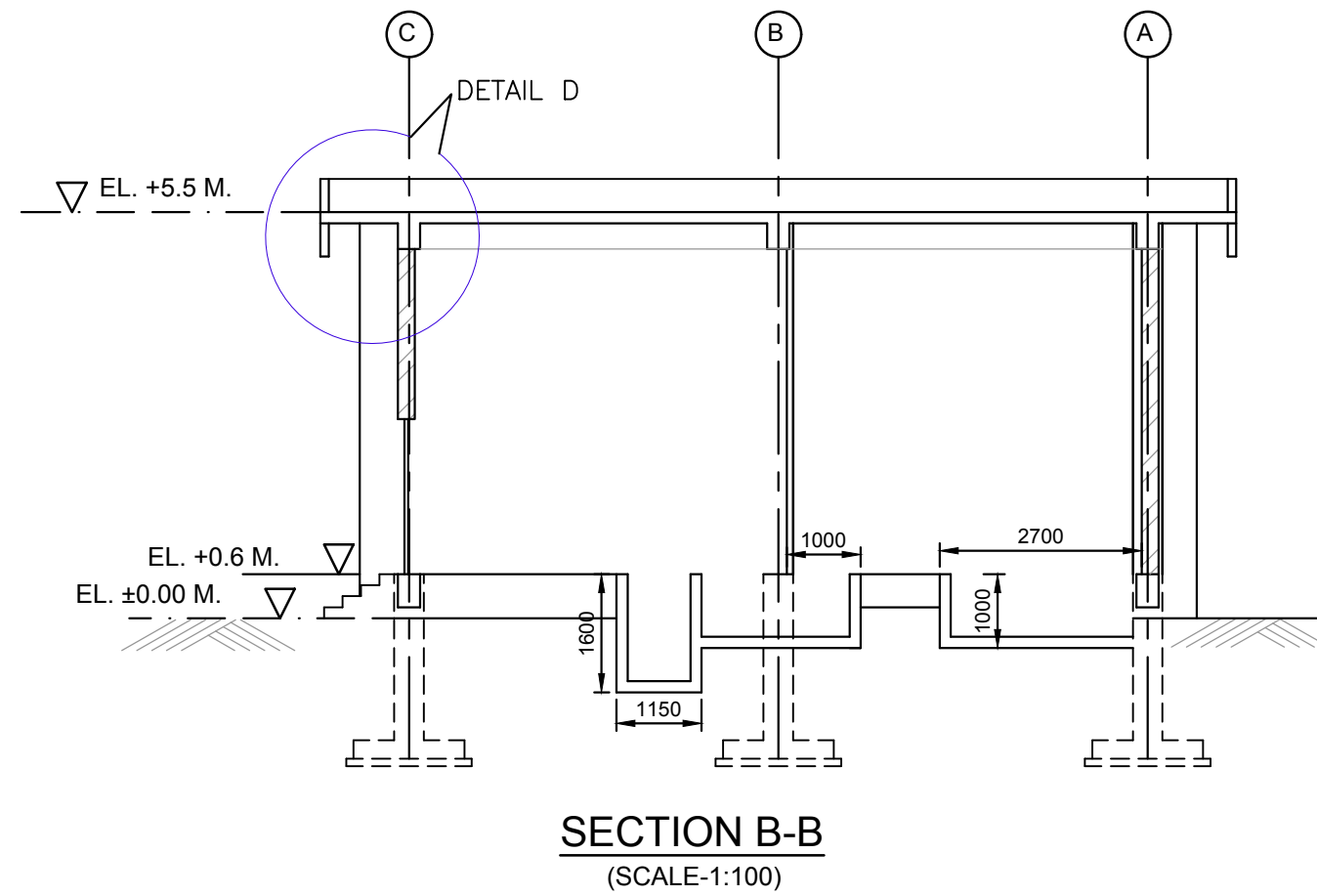


EMBEDDED PIPE SCHEDULE FOR ELECTRICAL CABLES :-

AS MKD.	NO. X DIA
J	1 x 100
K	2 x 100
L	3 x 100
P	100x100 L=400
Q	20x100 L=400

SCHEDULE OF DOOR & WINDOWS

ITEMS	MKD.	WIDTH & HEIGHT	NOS.	MATERIAL
DOOR	D	750 X 2100	1	WOODEN FLUSH DOOR
	D1	1000 X 2100	3	GLAZED ALUMINIUM DOOR
	D2	2X1500 X 3000	2	GLAZED ALUMINIUM DOOR
ROLLING SHUTTER	R.S.1	4000 X 4000	1	M.S. STEEL (60% OPENING)
SKY LIGHT	V	3270 X 500	1	FIXED GLAZED ALUMINIUM
	V1	3670 X 500	3	FIXED GLAZED ALUMINIUM
EXHAUST FAN	EX. FAN	300 DIA	2	



- NOTES:
- ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED FORMATION LEVEL OF +37.50m RL.
 - ALL DIMENSIONS ARE IN MILLIMETRES.
 - ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.

REV.	DATE	DESCRIPTION	SV	CHK	APR
2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF SUBSTATION BUILDING

DRAWING NUMBER: 60636525 - DPR - 1013

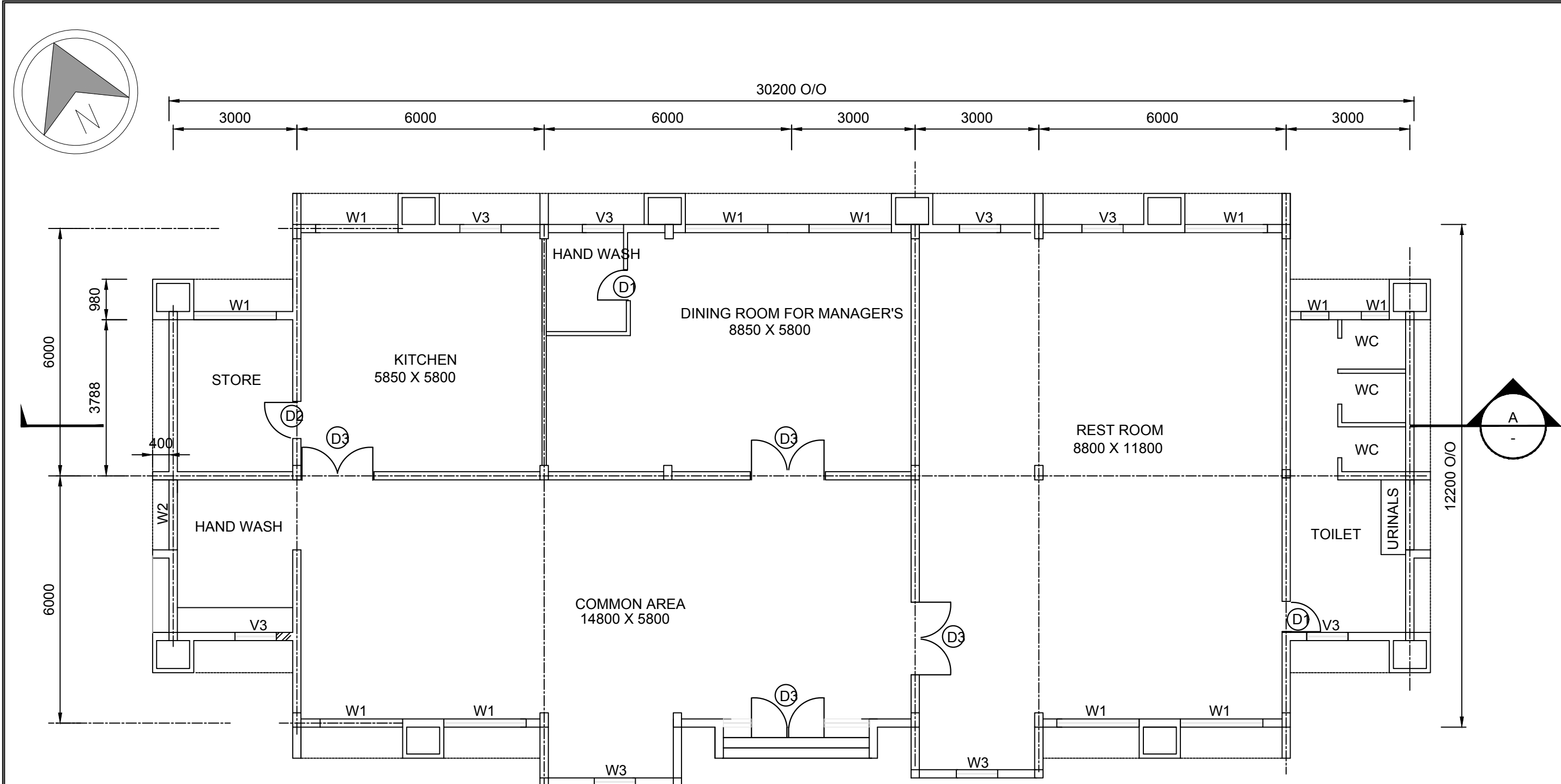
REV. 2

SHEET 01 OF 01

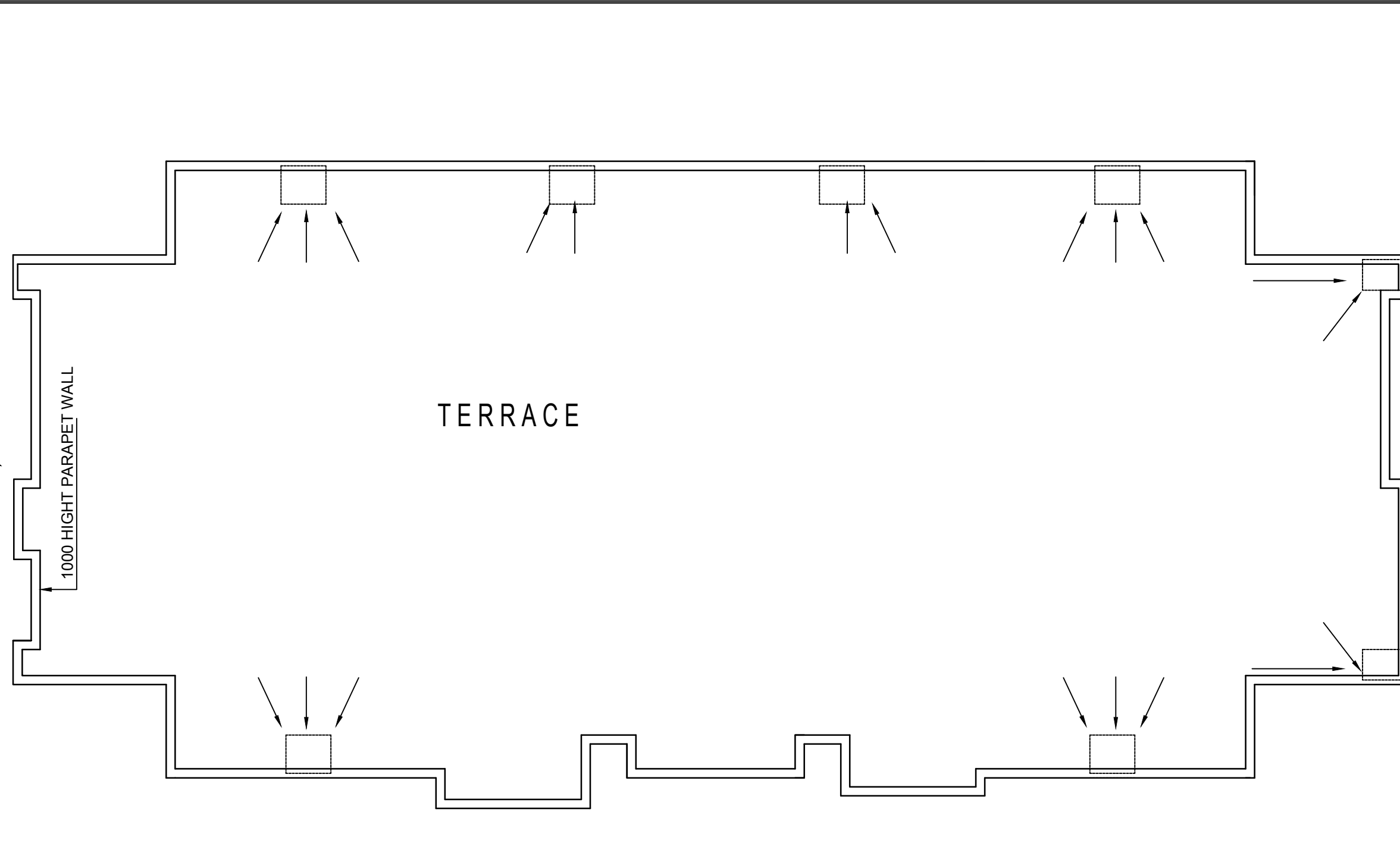
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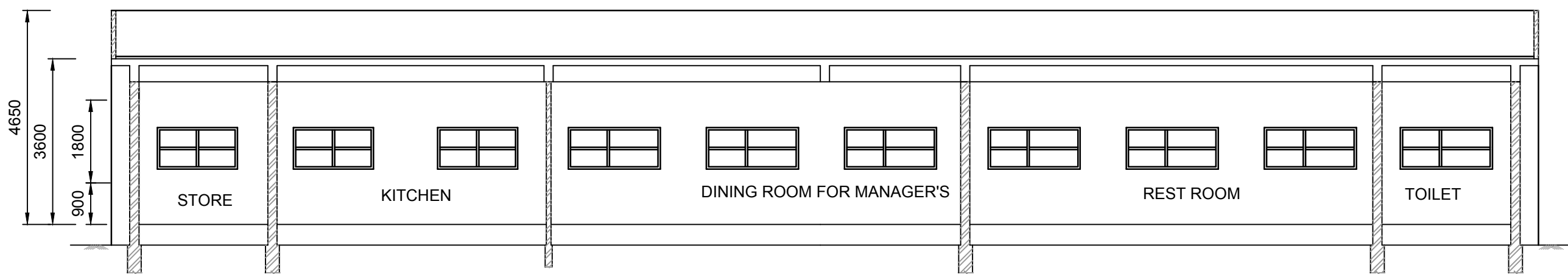
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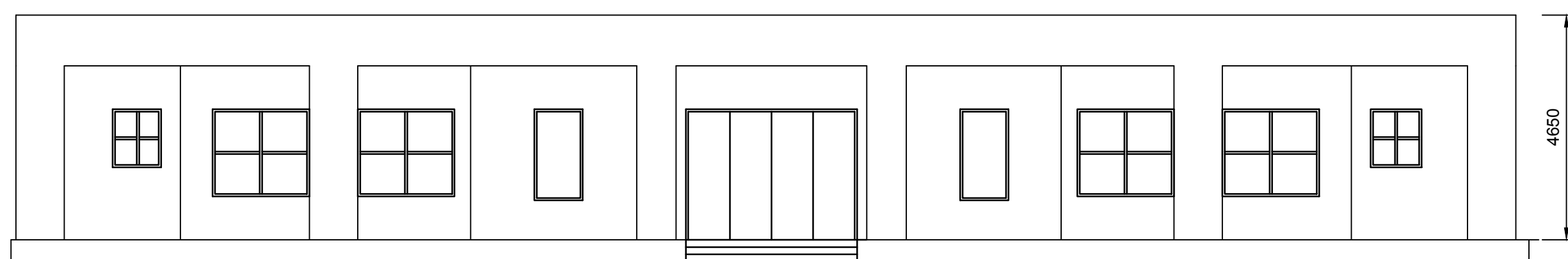
GROUND FLOOR PLAN
Scale 1:100



TERRACE FLOOR PLAN
Scale 1:100

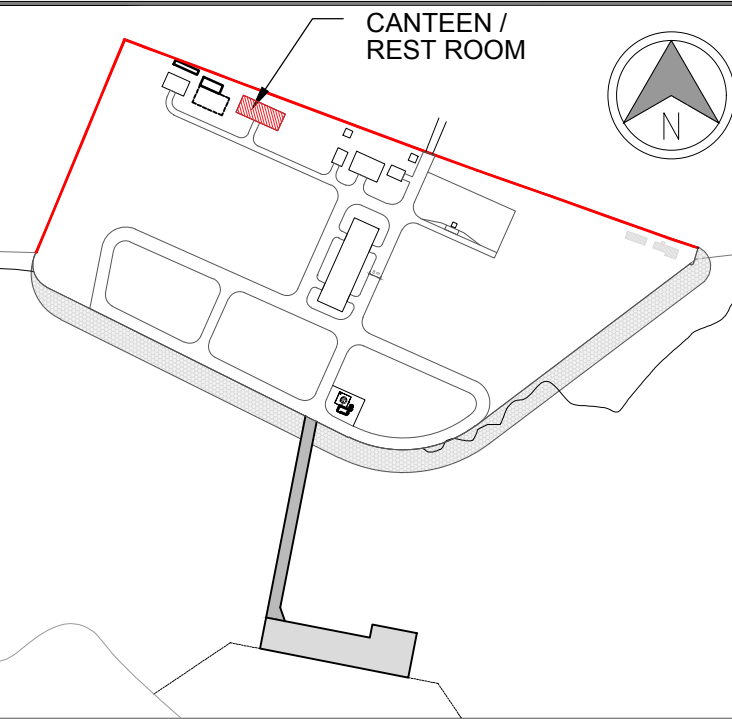


A SECTION
Scale 1:100



FRONT SIDE ELEVATION
Scale 1:100

SCHEDULE OF DOOR & WINDOW				
SNO.	TYPE	SIZE	CILL LEV.	LIN. LEV.
1	D1	750 X 2100		2100
2	D2	900 X 2100		2100
3	D3	3540 X 2700		2700
1	W1	2000 X 1800	900	2700
2	W2	1689 X 1800	900	2700
3	W3	1000 X 6000	300	6300
	V3	1000 X 1200	1500	2700



- NOTES:**
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 - ALL DIMENSIONS ARE IN MILLIMETRES.
 - ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.

2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

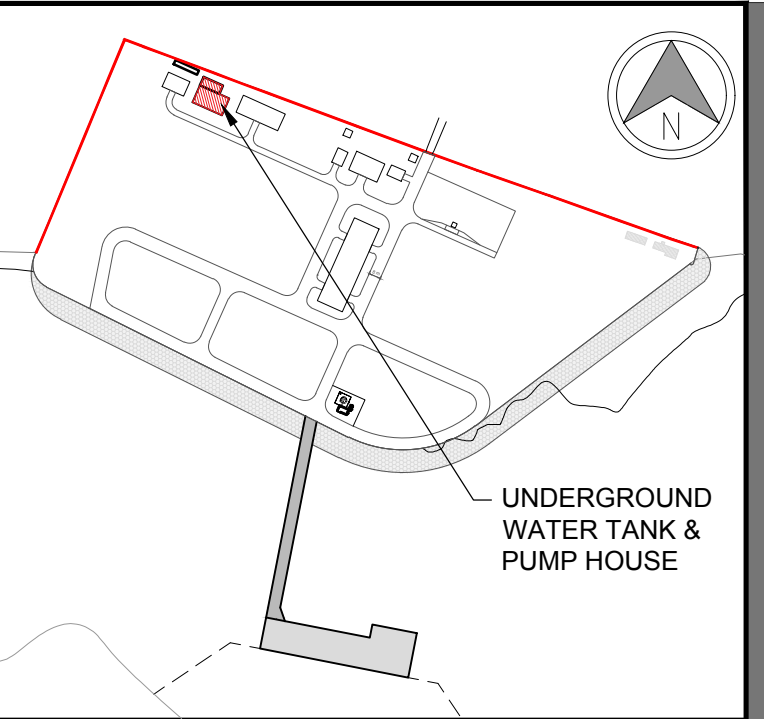
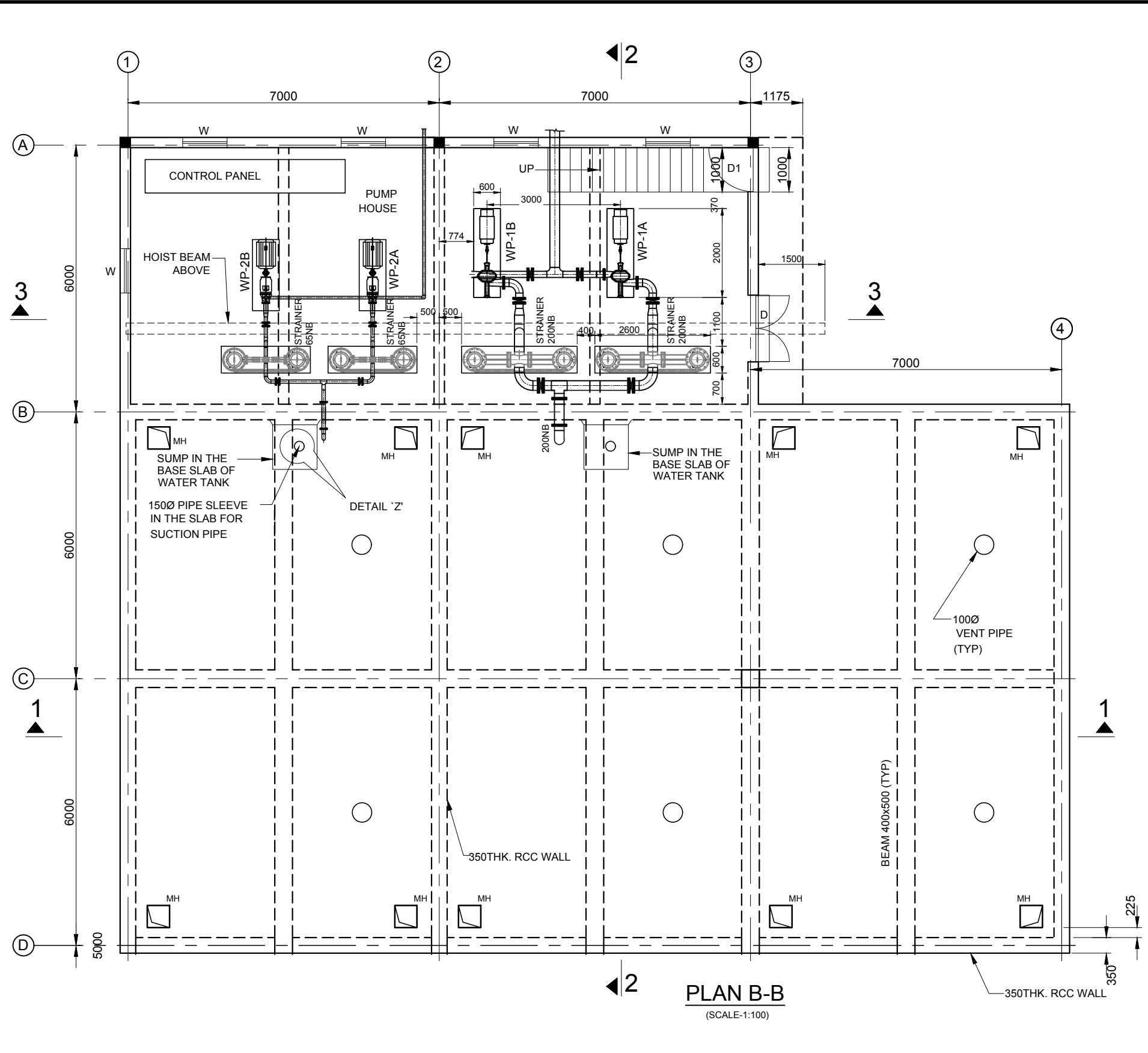
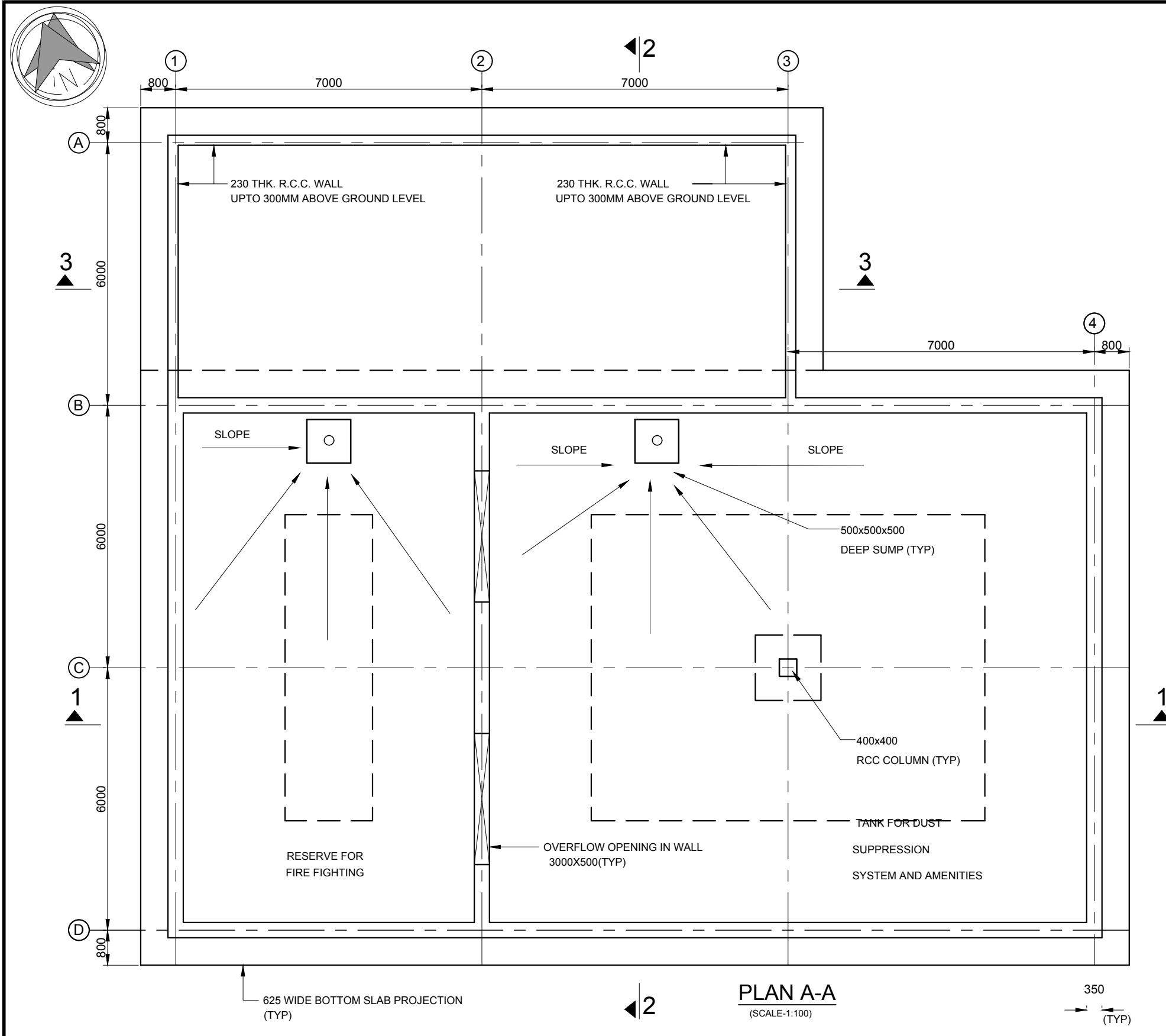
PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF CANTEEN AND REST ROOM BUILDING

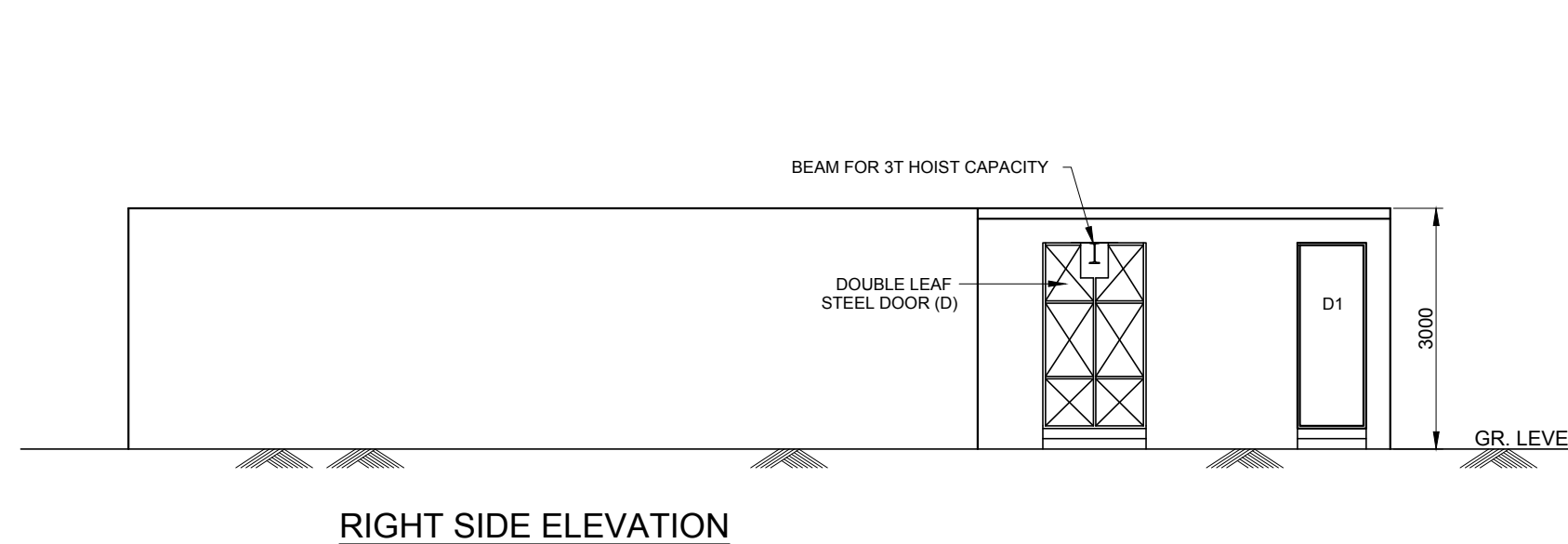
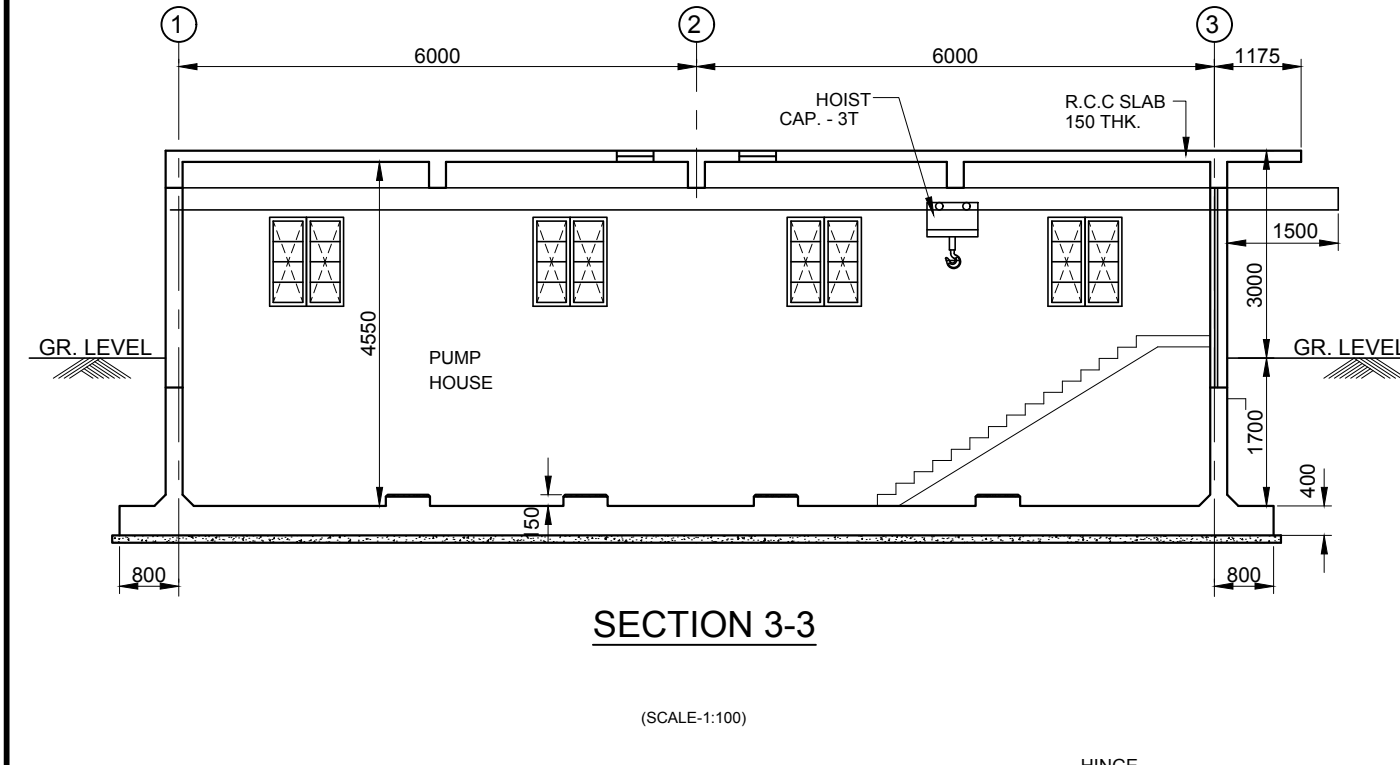
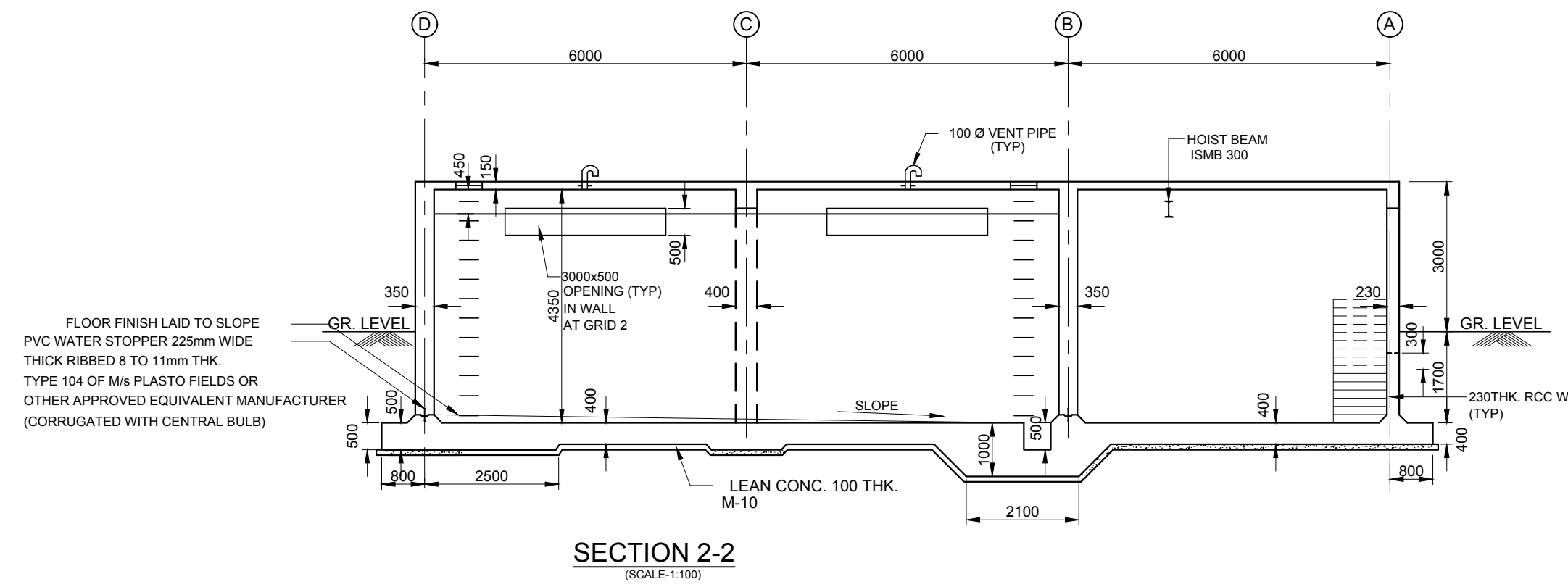
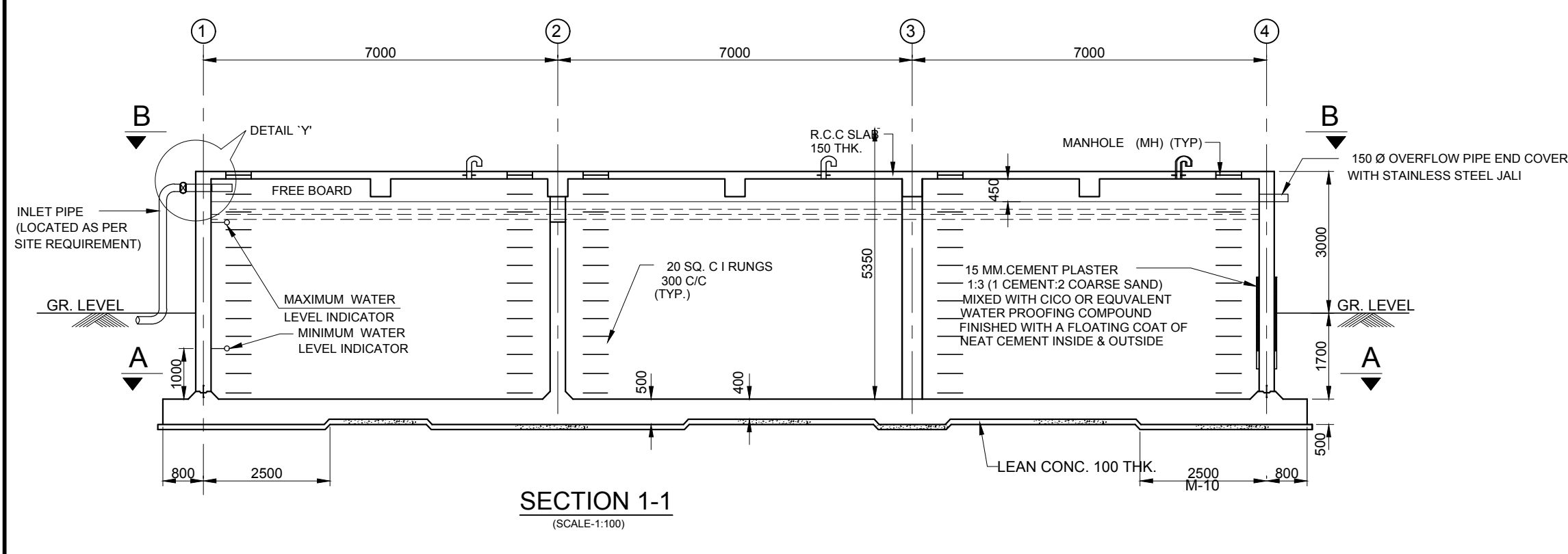
DRAWING NUMBER: 60636525 - DPR - 1014 REV. 2

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ISO A1 594mm x 841mm
Approved: SS
Checked: SS
Designer: SV
Project Management Initials:
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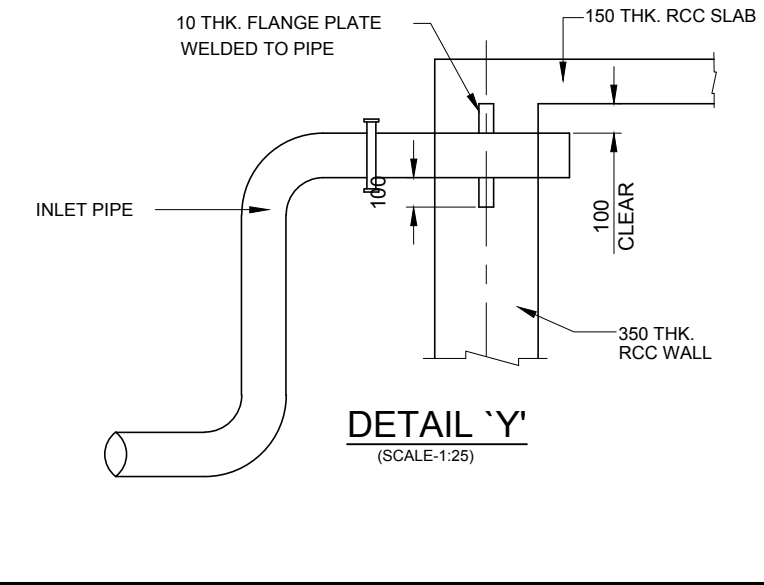
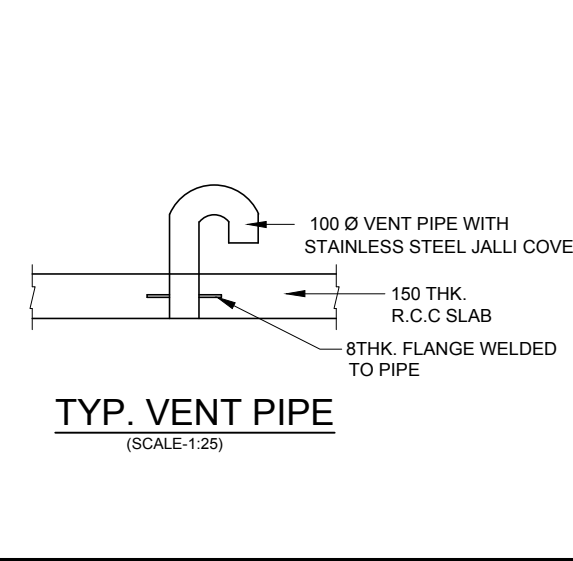
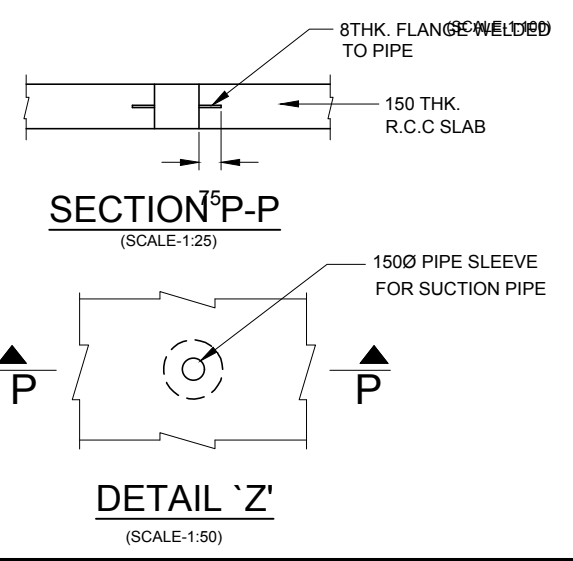
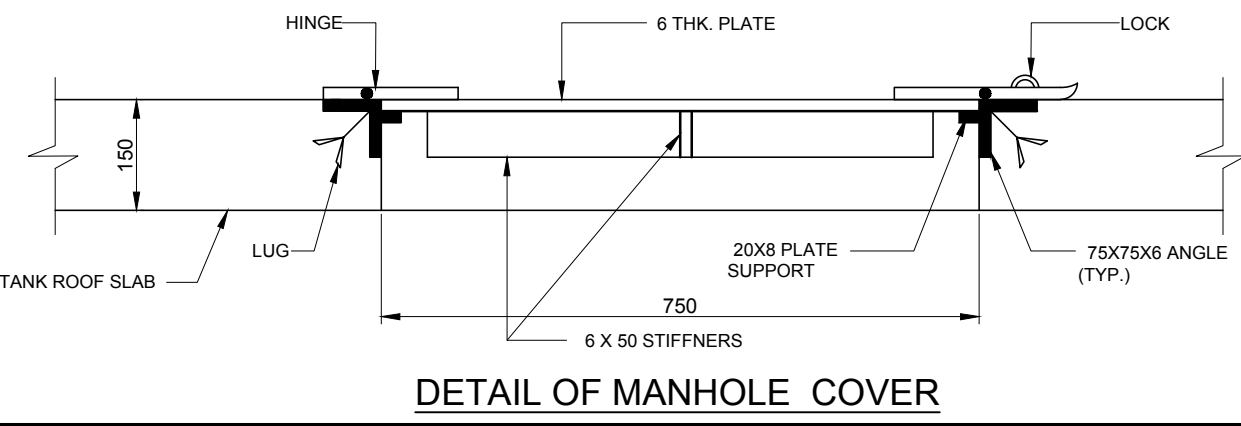


- NOTES:**
- ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED GROUND LEVEL OF +4.0m CD.
 - ALL DIMENSIONS ARE IN MILLIMETRE.
 - ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.
 - CLEAR COVER TO MAIN REINF. SHALL BE..
(a) BASE SLAB, TANK COL. & WALLS=50
(b) PUMP HOUSE BEAMS & COL.=30
 - ALL CONC. SHALL BE M-30 (U.N.O)
 - ALL REINF. STEEL SHALL BE H.Y.S.D BARS CONFORMING TO IS:1786.



SCHEDULE OF DOOR & WINDOWS

SL. NO.	MKD.	SIZE	NOS.	MATERIAL
1	D	1500x2700	1	STEEL DOOR
2	D1	1000x2700	1	STEEL DOOR
3	W	1000x1200	5	STEEL WINDOW (GLAZED)



2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.

REVISION DETAILS

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF UNDERGROUND WATER TANK & PUMPHOUSE

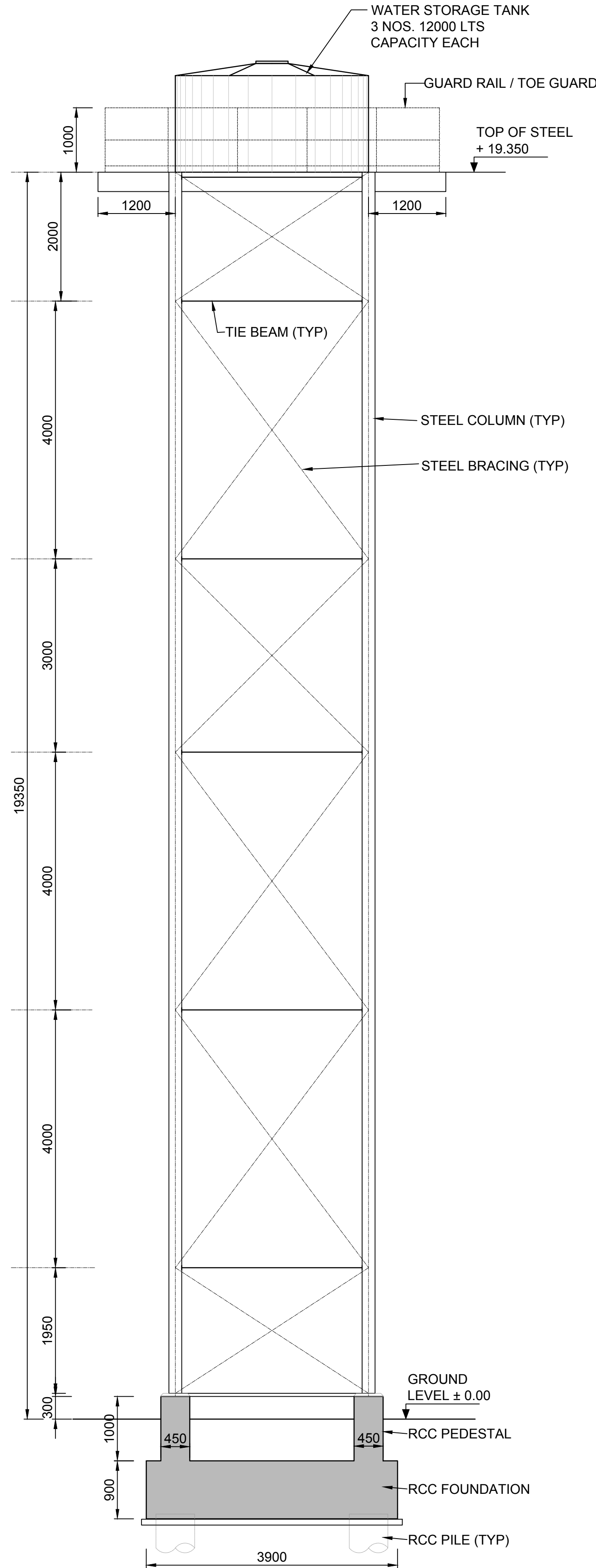
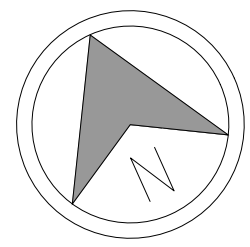
DRAWING NUMBER: 60636525 - DPR - 1015

REV. 2

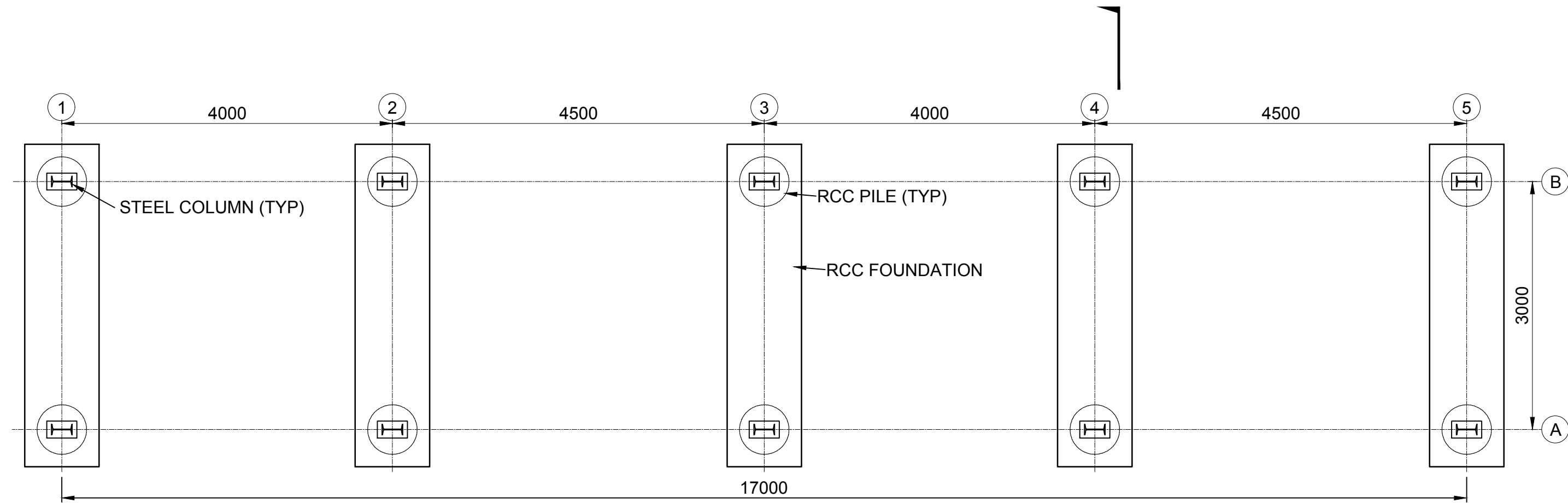
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SHEET 01 OF 01

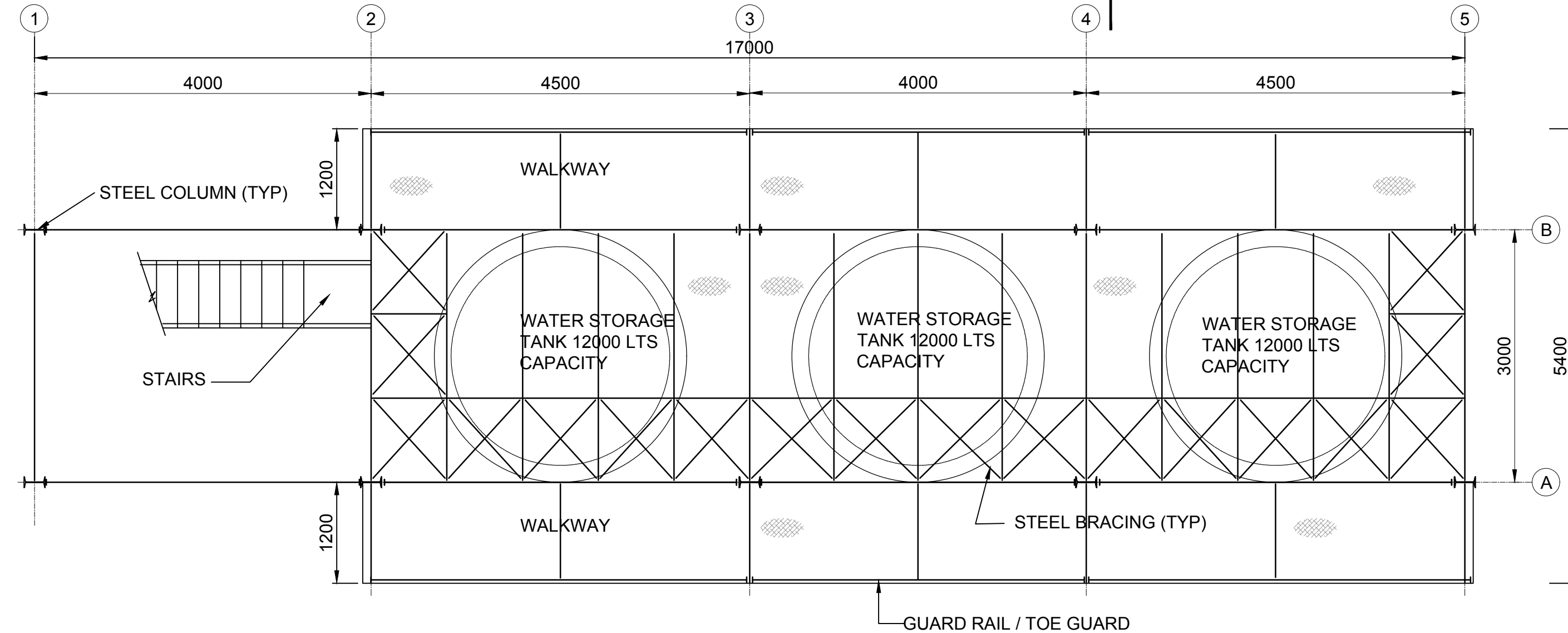
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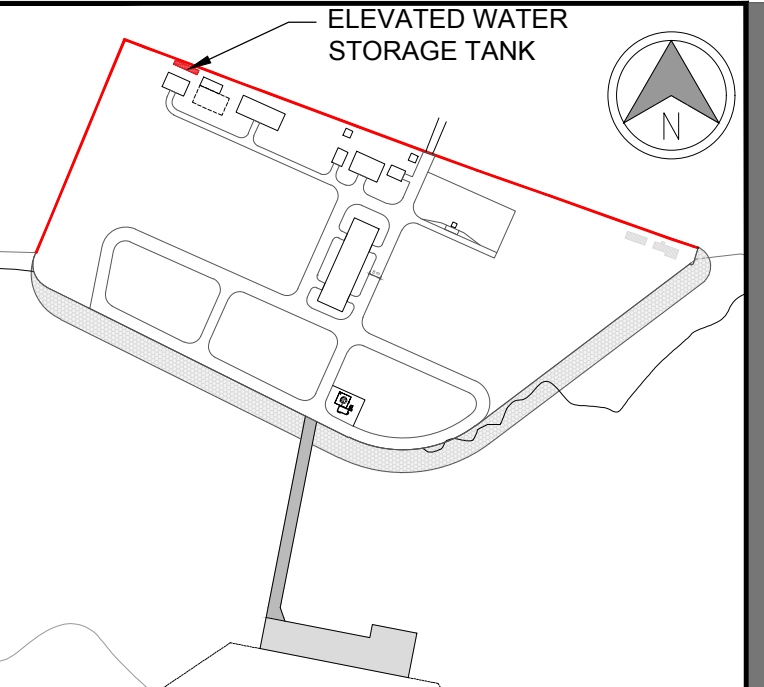
A SECTION
Scale 1:50



PLAN AT FOUNDATION LEVEL
SCALE 1:50



PLAN AT TOP LEVEL
SCALE 1:50



KEY PLAN

NOTES:

- 1 ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED FORMATION LEVEL OF +37.50m RL.
- 2 ALL DIMENSIONS ARE IN MILLIMETRES.
- 3 ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.

2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.

REVISION DETAILS

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

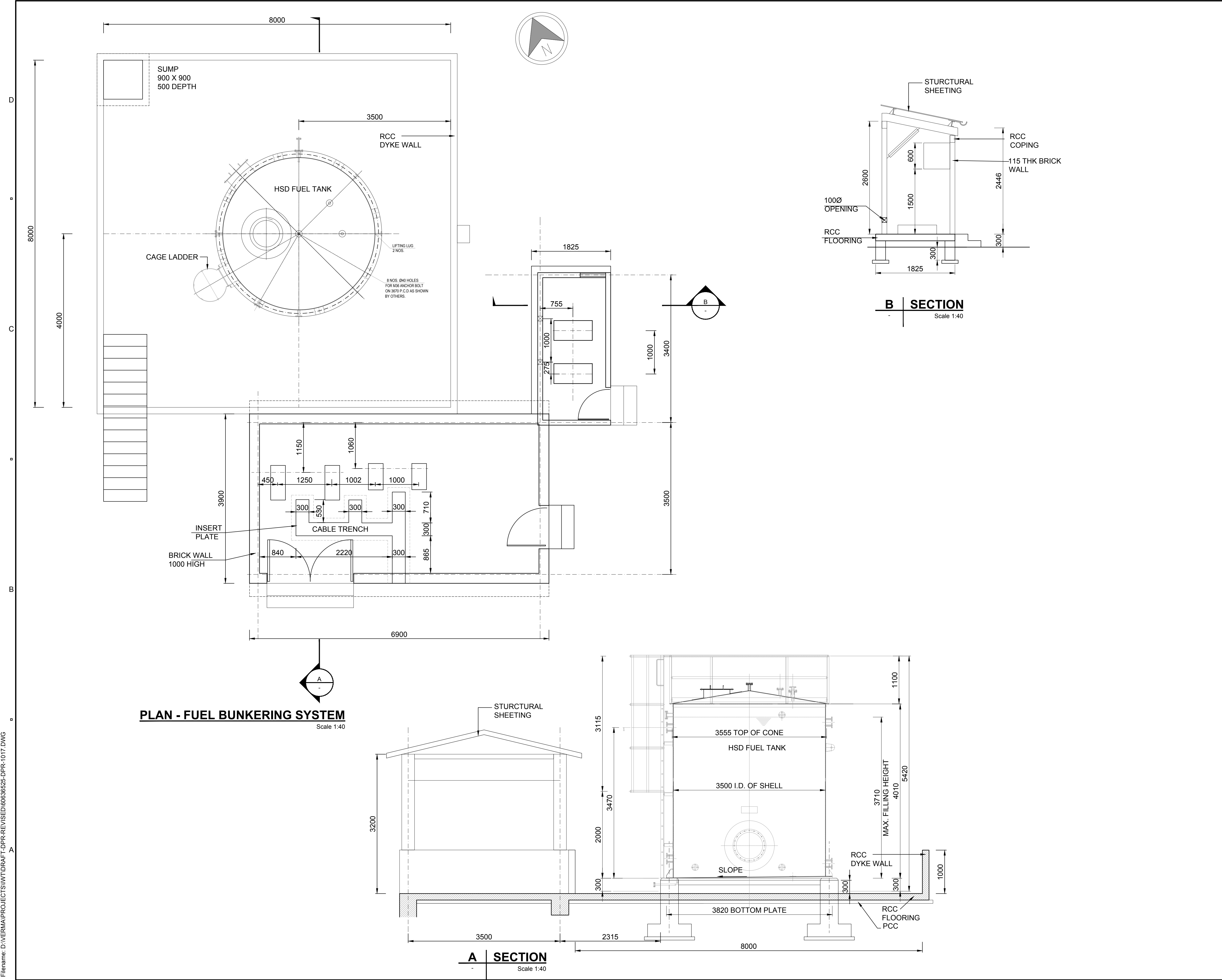
PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE:

DETAILS OF ELEVATED WATER STORAGE TANK

DRAWING NUMBER: 60636525 - DPR - 1016
REV. 2

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KEY PLAN

NOTES:

- ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED FORMATION LEVEL OF +37.50m RL.
- ALL DIMENSIONS ARE IN MILLIMETRES.
- ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.

2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG
REV.	DATE	DESCRIPTION	DR.	CH.	APR.
REVISION DETAILS					

OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)

PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM

PART/DISCIPLINE: DIMENSIONS ARE IN:

PURPOSE: DETAILED PROJECT REPORT

DRAWING TITLE: DETAILS OF FUEL BUNKERING SYSTEM

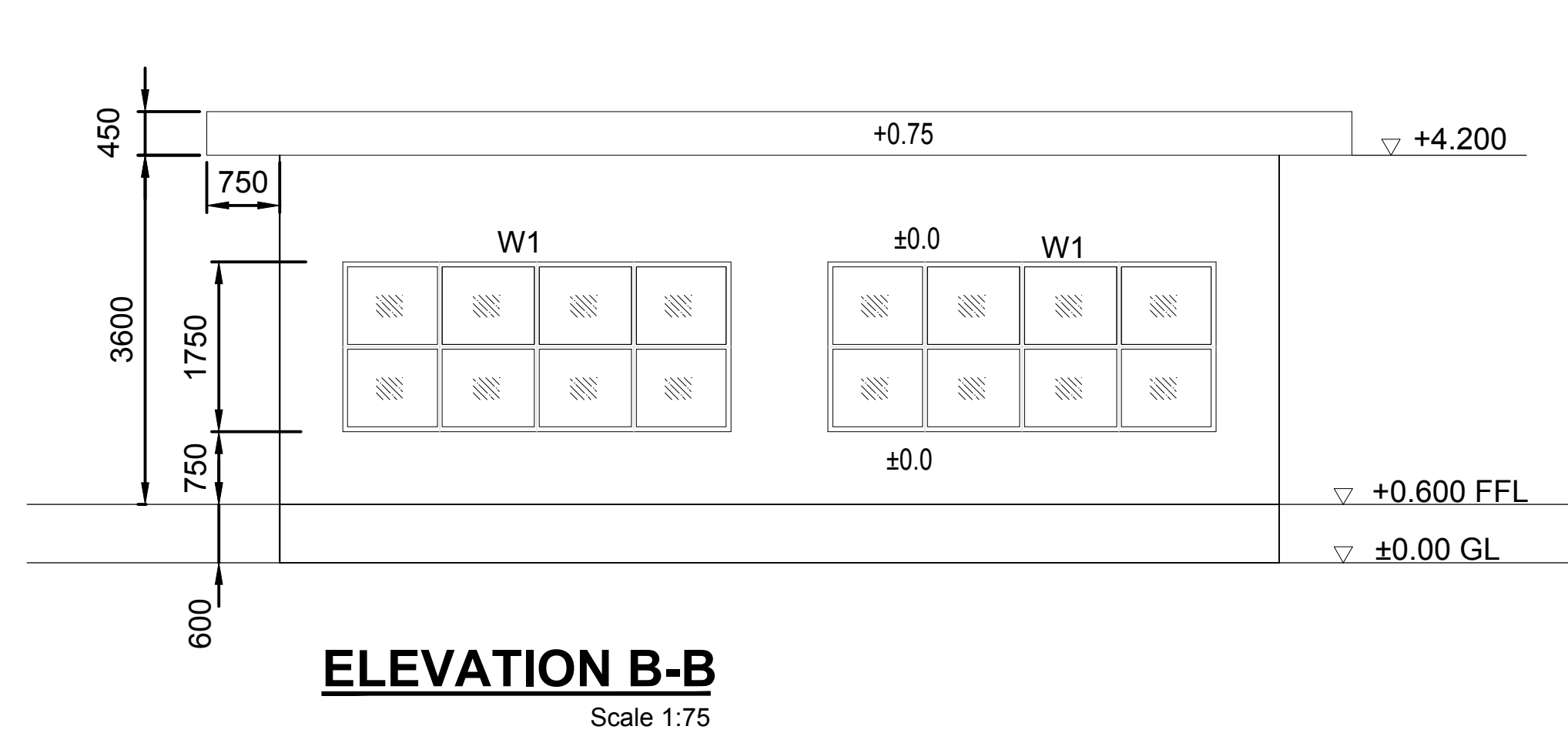
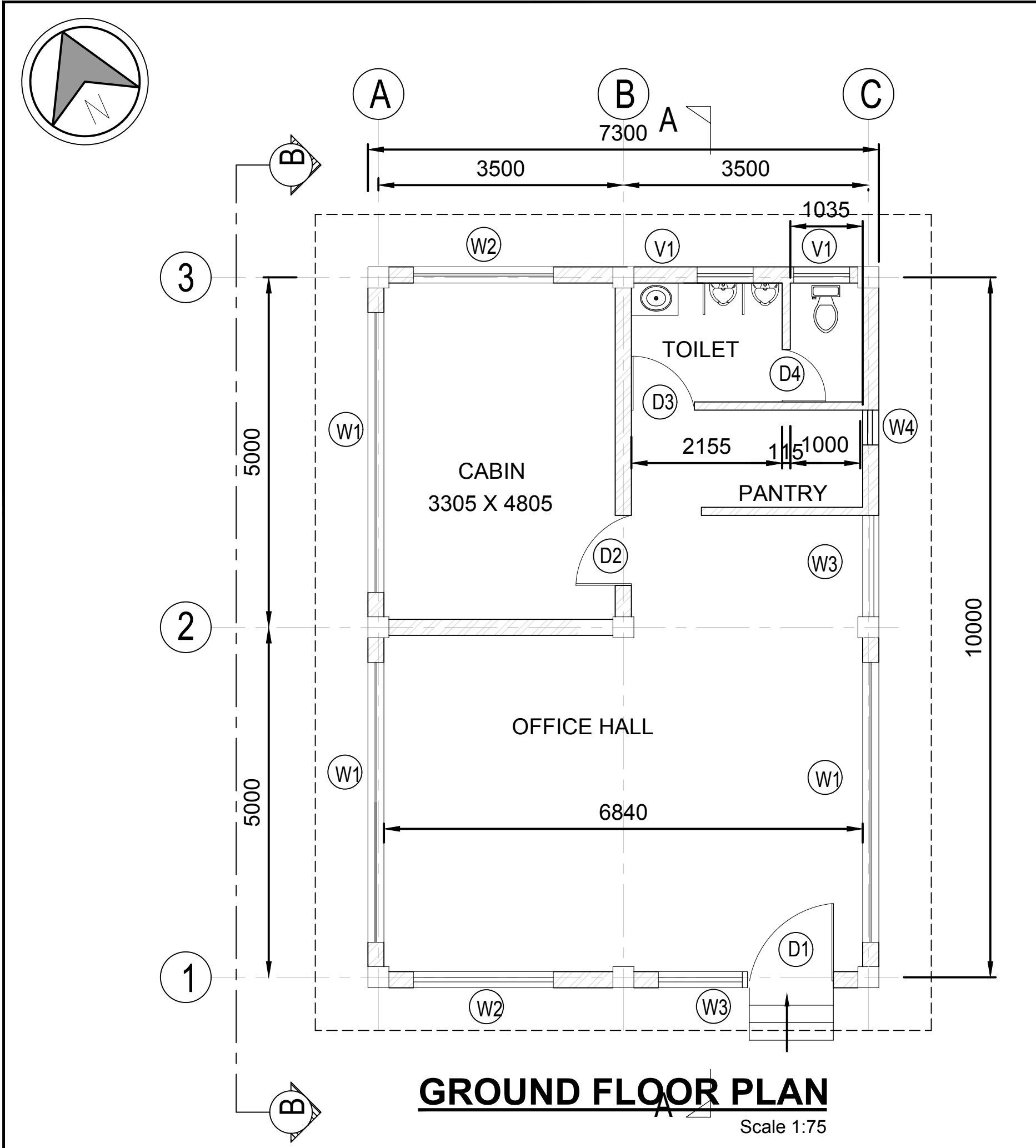
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REV. 2

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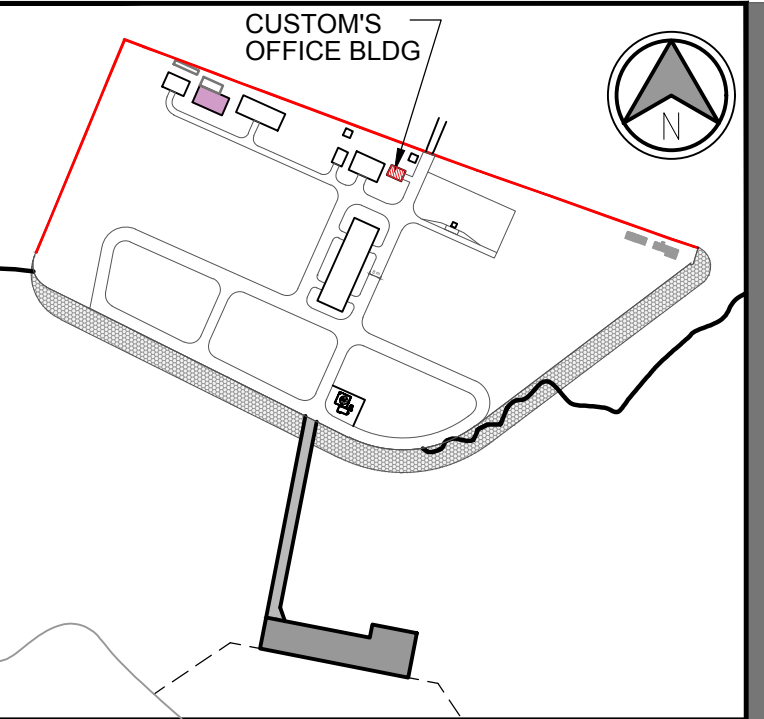
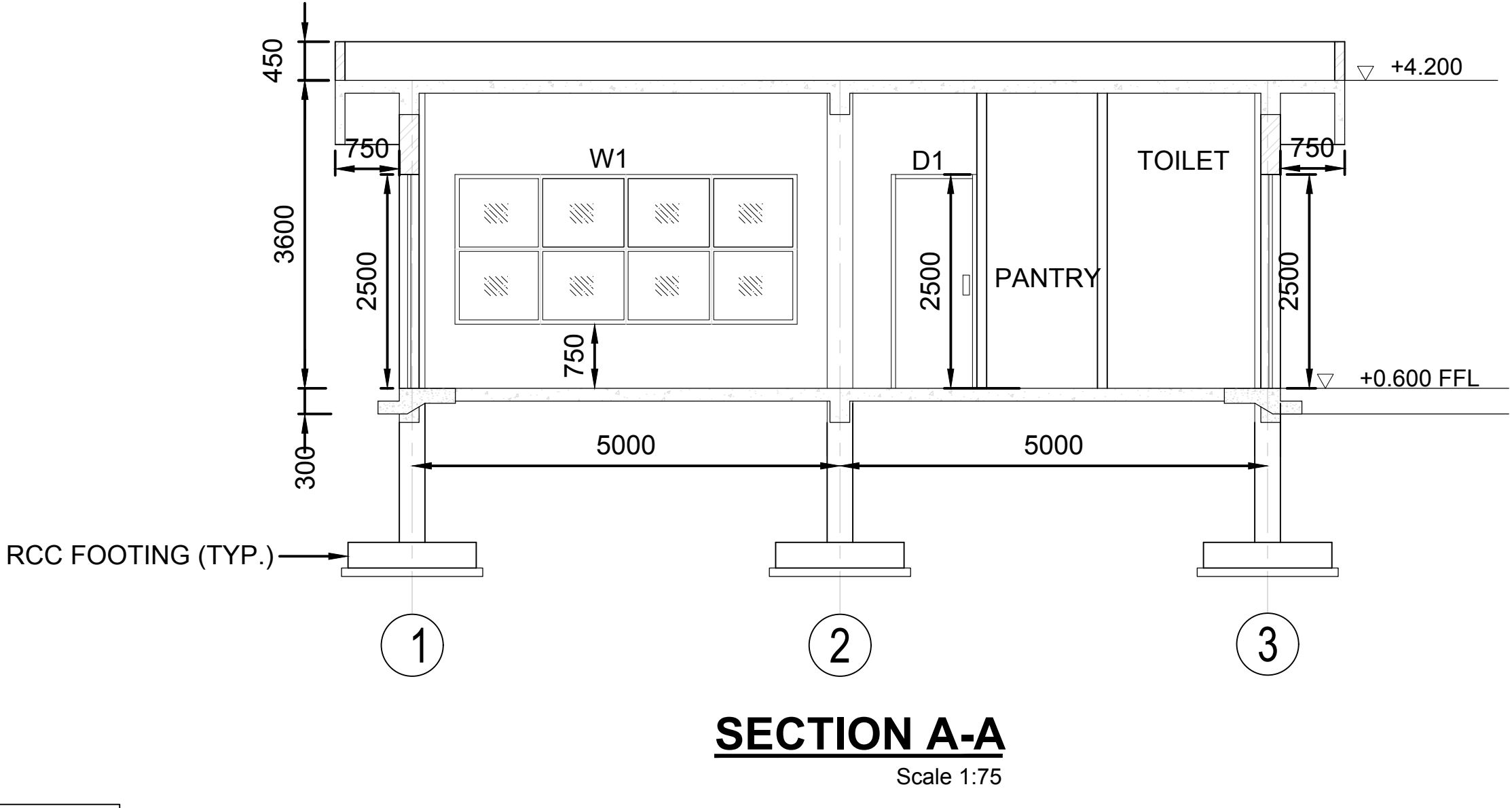
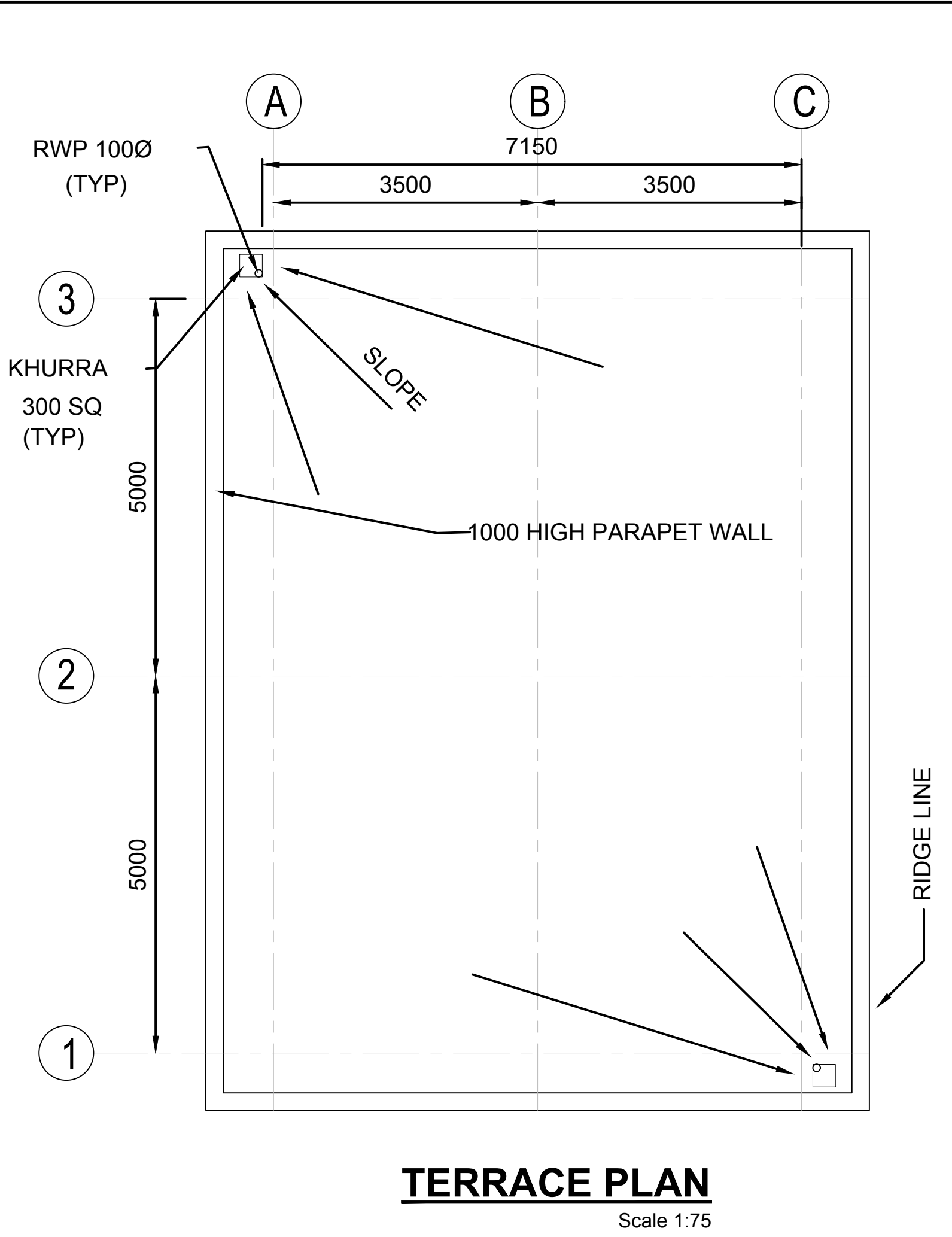
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Project Management Initials: Designer: SV Checked: SS Approved: SS
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PROPOSED SHEDULE OF FINISHING MATERIAL				
	NO.	ROOM	FLOORING	WALLS
GROUND FLOOR	1.	ENTRANCE LOBBY, OUTSIDE ENTRANCE, PLATFORM	ITALIAN MARBLE	PLASTIC EMULSION PAINT. GRANITE CLADDING ON LIFT WALL
	2.	TOILETS.	WHITE MARBEL	FULL HEIGHT CERAMIC TILES
	3.	HALL, CABINS	VITRIFIED TILES	CERAMIC TILES
	4.	PANTRY	COUNTER-BLACK GRANITE	CERAMIC TILES
OUT SIDE FINISHING	1.	CEMENT ROUGH PLASTERS INTWO COATS WITH WEATHER PROOF PAINT		
	2.	FLIGHT OF STEPS IN THE FRONT FINISHING WITH WHITE MARBLE		
	3.	COLOUR ANODIZED COATED ALUMINIUM WINDOW WITH 5MM THK. FLOAT GLASS		
	3.	LARGE CLEAR GLAZING AS REQUIRED IN ELEVATION WITH COLOR ALUMINIUM COATED ALUMINIUM FRAMES IN CONTROL ROOMS		

DOOR & WINDOW SCHEDULE			
	WIDTH	SILL HT.	LINTEL HT.
D1	1200	—	2500
D2	1000	—	2500
D3	900	—	2100
D4	750	—	2100
W1	4000	750	2500
W2	2000	750	2000
W3	1400	750	2000
W4	1000	750	2000
V1	800	900	2000

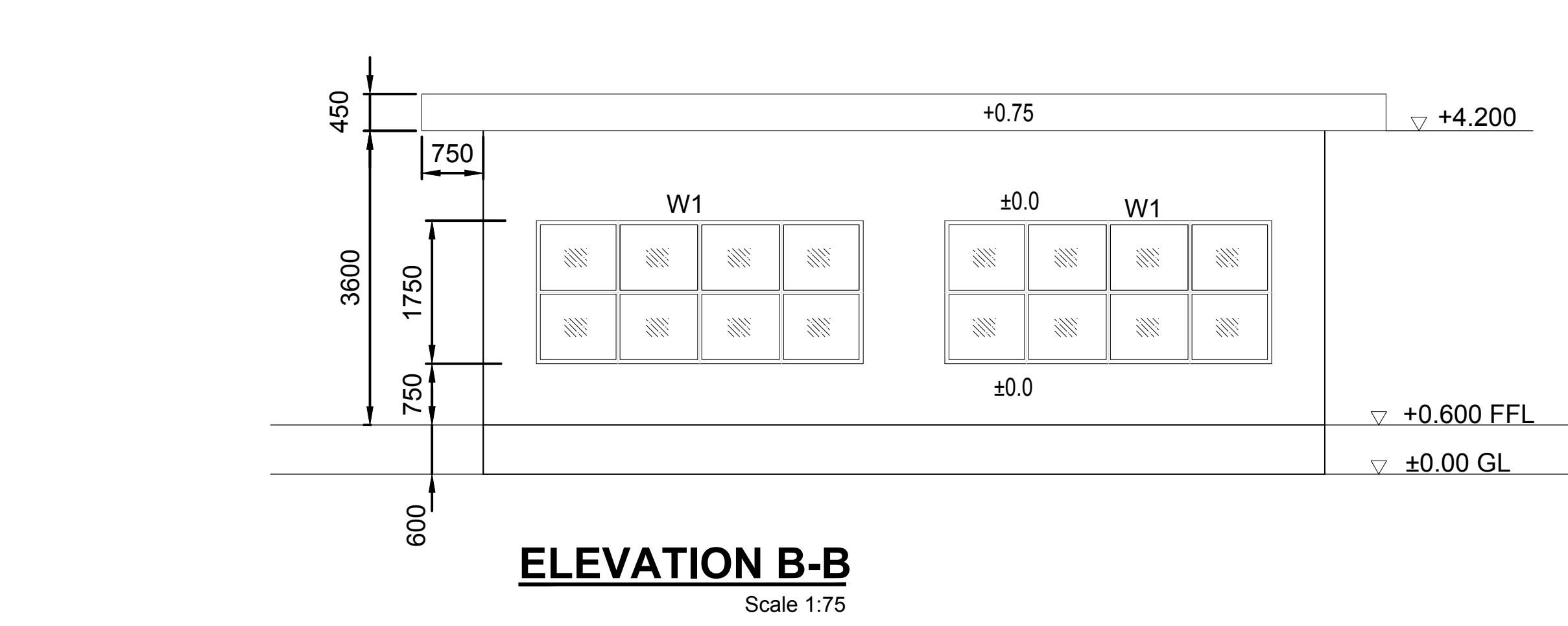
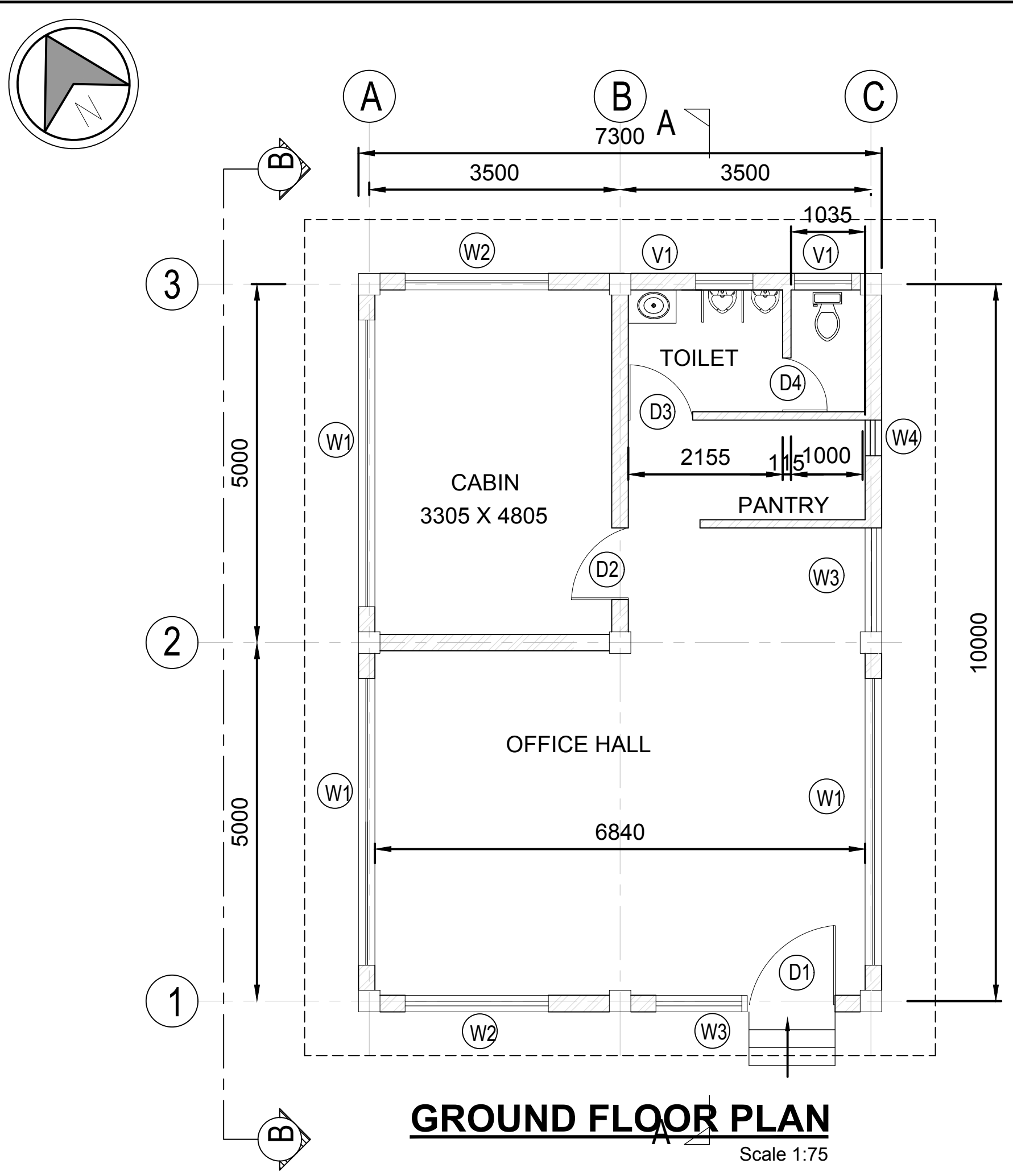


- NOTES:
- ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED FORMATION LEVEL OF +37.50m RL.
 - ALL DIMENSIONS ARE IN MILLIMETRES.
 - ALL SIZES SHOWN IN THE DRAWING ARE INDICATIVE.

2	19.02.2021	REVISED AS PER COMMENTS	SV	JKA	SG			
1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG			
REV.	DATE	DESCRIPTION	DR.	CH.	APR.			
REVISION DETAILS								
OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)								
PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM								
PART/DISCIPLINE:			DIMENSIONS ARE IN:					
PURPOSE: DETAILED PROJECT REPORT								
DRAWING TITLE: DETAILS OF CUSTOM'S OFFICE BUILDING								
DRAWING NUMBER: 60636525 - DPR - 1018					REV. 2			
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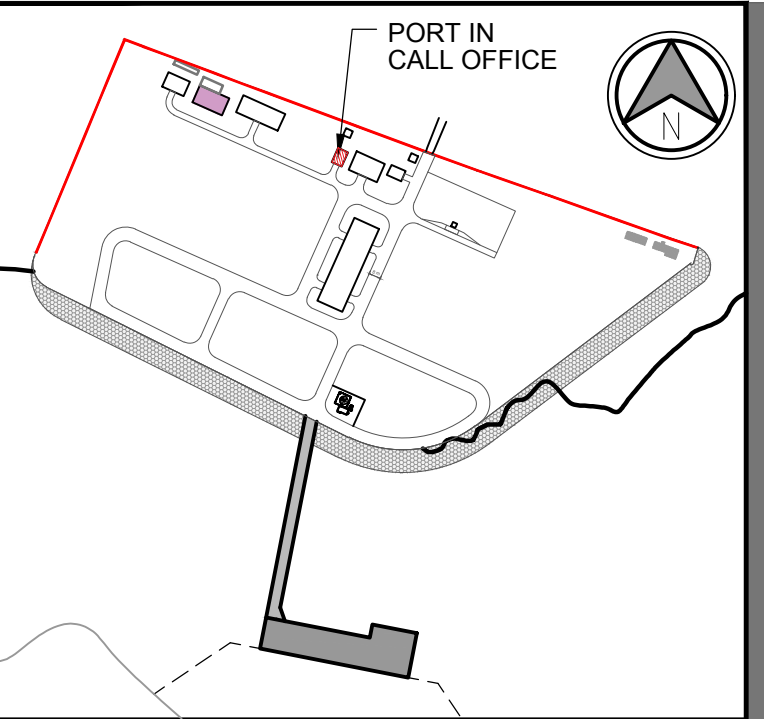
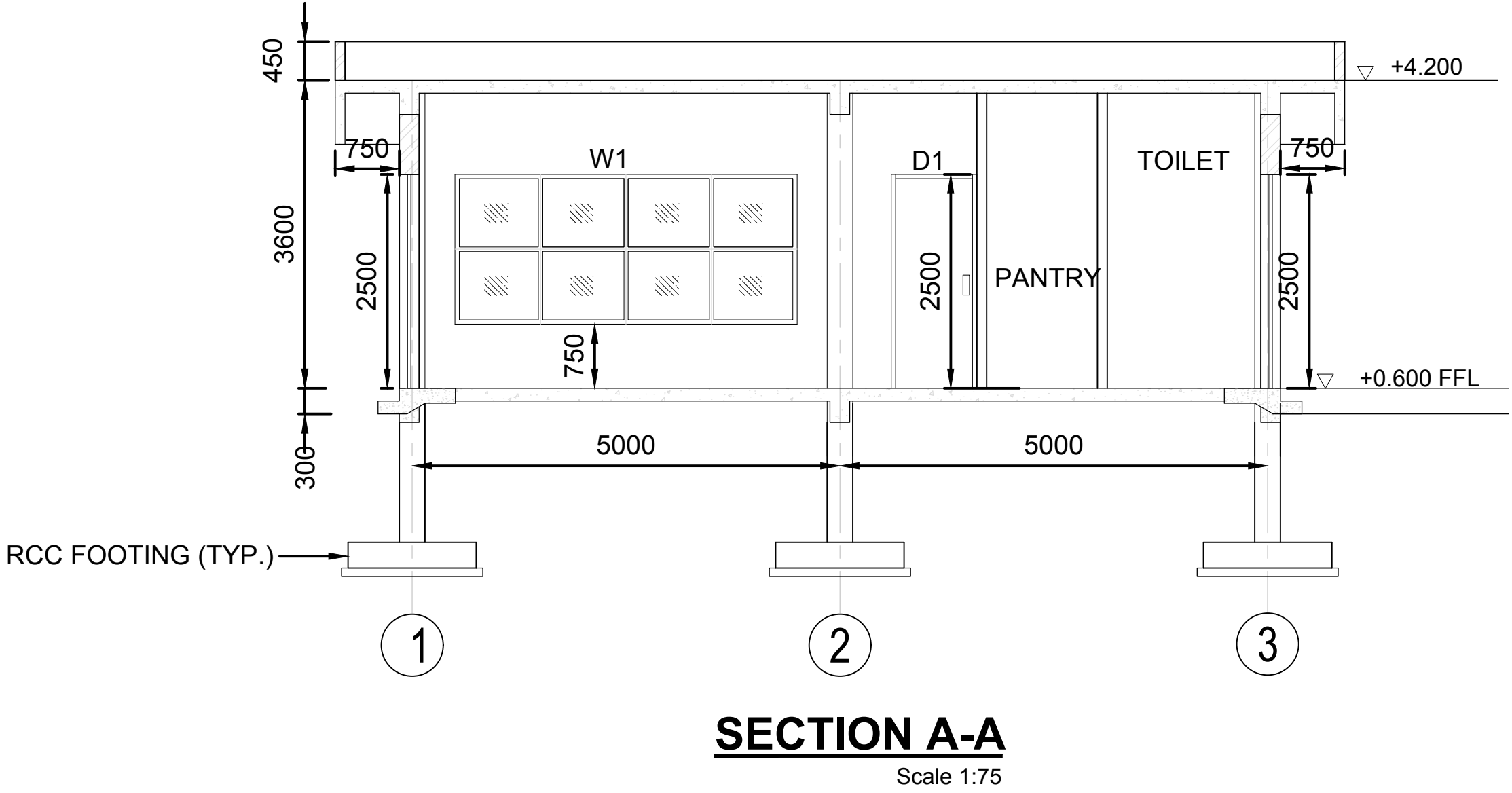
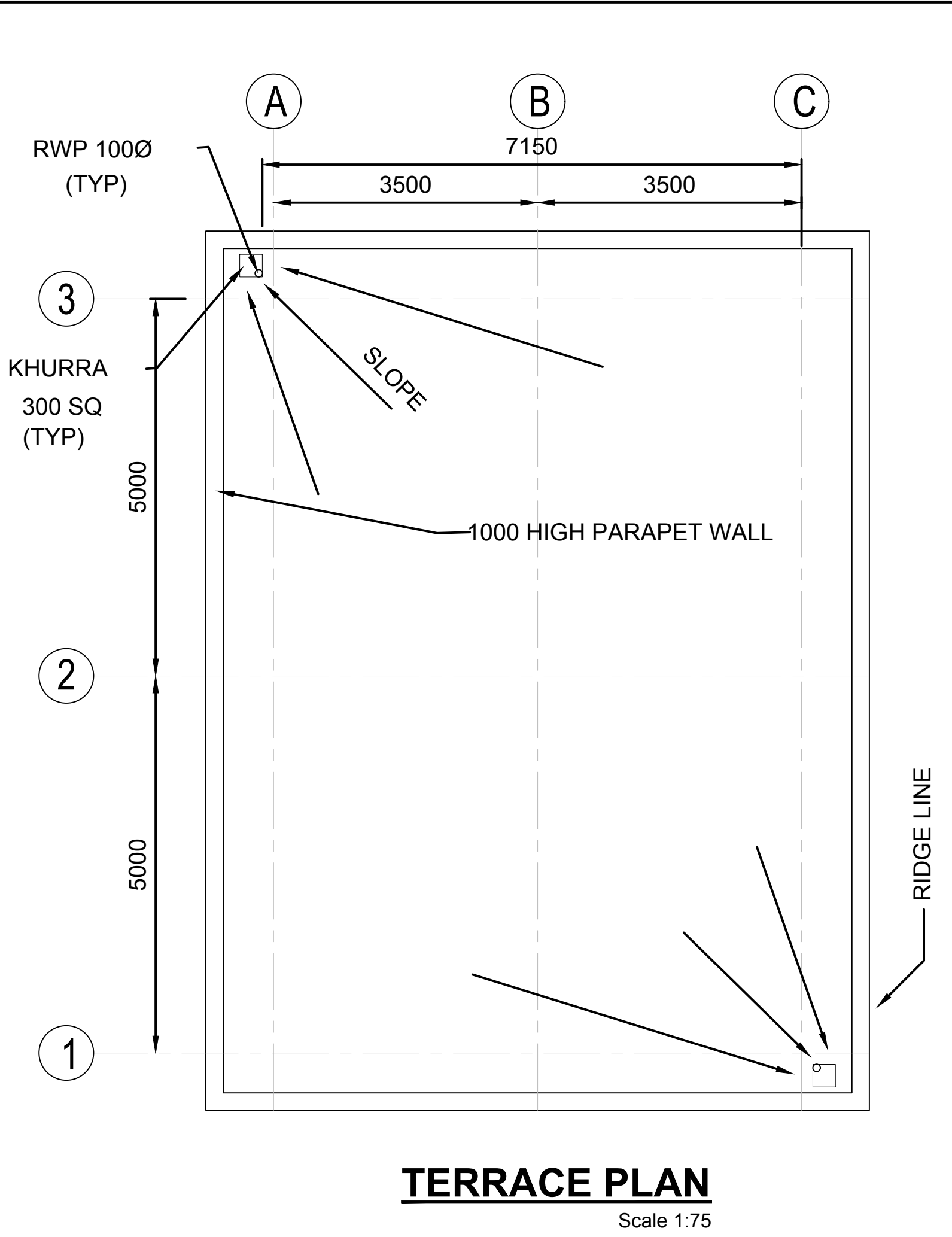
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ISO A1 594mm x 841mm
Project Management Initials: Designer: SV Checked: SS Approved: SS
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Filename: D:\VERMA\PROJECTS\IWT\DRAWING\PRP-REVISED\60636525-DPR-1019.DWG
Printed on: % Post-Consumer Recycled Content Paper



PROPOSED SHEDULE OF FINISHING MATERIAL				
	NO.	ROOM	FLOORING	WALLS
GROUND FLOOR	1.	ENTRANCE LOBBY, OUTSIDE ENTRANCE, PLATFORM	ITALIAN MARBLE	PLASTIC EMULSION PAINT. GRANITE CLADDING ON LIFT WALL
	2.	TOILETS.	WHITE MARBEL	FULL HEIGHT CERAMIC TILES
	3.	HALL, CABINS	VITRIFIED TILES	CERAMIC TILES
	4.	PANTRY	COUNTER-BLACK GRANITE	CERAMIC TILES
OUT SIDE FINISHING	1.	CEMENT ROUGH PLASTERS INTWO COATS WITH WEATHER PROOF PAINT		
	2.	FLIGHT OF STEPS IN THE FRONT FINISHING WITH WHITE MARBLE		
	3.	COLOUR ANODIZED COATED ALUMINIUM WINDOW WITH 5MM THK. FLOAT GLASS		
	3.	LARGE CLEAR GLAZING AS REQUIRED IN ELEVATION WITH COLOR ALUMINIUM COATED ALUMINIUM FRAMES IN CONTROL ROOMS		

DOOR & WINDOW SCHEDULE			
	WIDTH	SILL HT.	LINTEL HT.
D1	1200	—	2500
D2	1000	—	2500
D3	900	—	2100
D4	750	—	2100
W1	4000	750	2500
W2	2000	750	2000
W3	1400	750	2000
W4	1000	750	2000
V1	800	900	2000

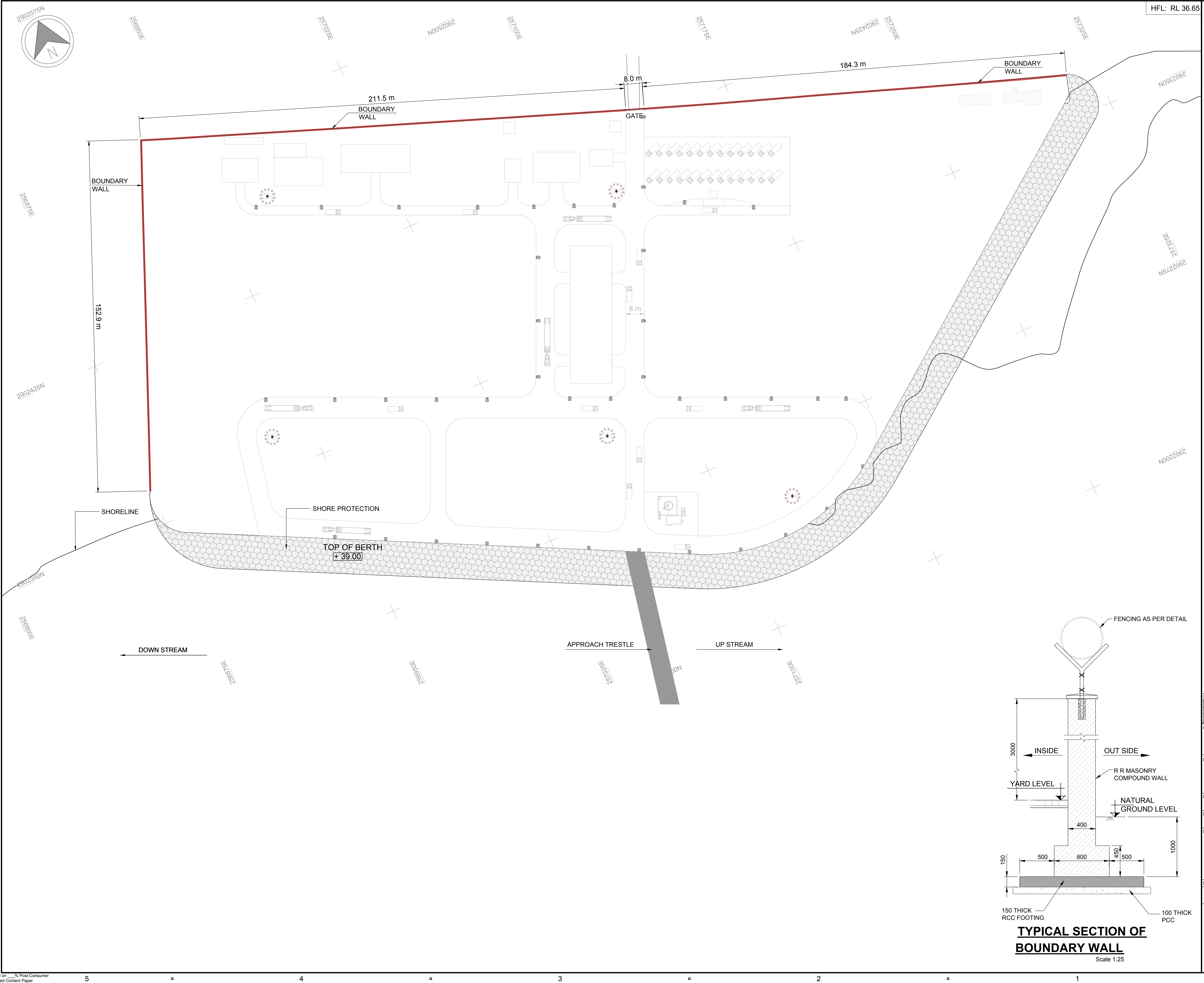


- NOTES:
- ALL LEVELS ARE IN METRES AND ARE W.R.T FINISHED FORMATION LEVEL OF +37.50m RL.
 - ALL DIMENSIONS ARE IN MILLIMETRES.
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1	22.11.2020	REVISED AS PER COMMENTS	SV	JKA	SG			
REV.	DATE	DESCRIPTION	DR.	CH.	APR.			
REVISION DETAILS								
OWNER: NATIONAL HIGHWAYS AND INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED (NHIDCL)								
PROJECT: DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JOGIGHOPA, ASSAM								
PART/DISCIPLINE:			DIMENSIONS ARE IN:					
PURPOSE: DETAILED PROJECT REPORT								
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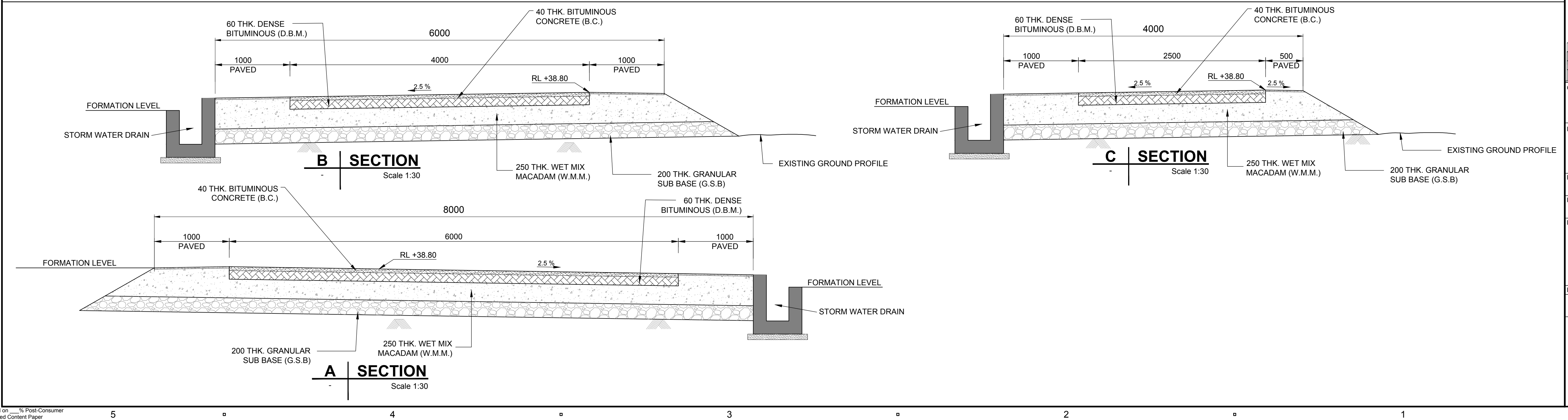
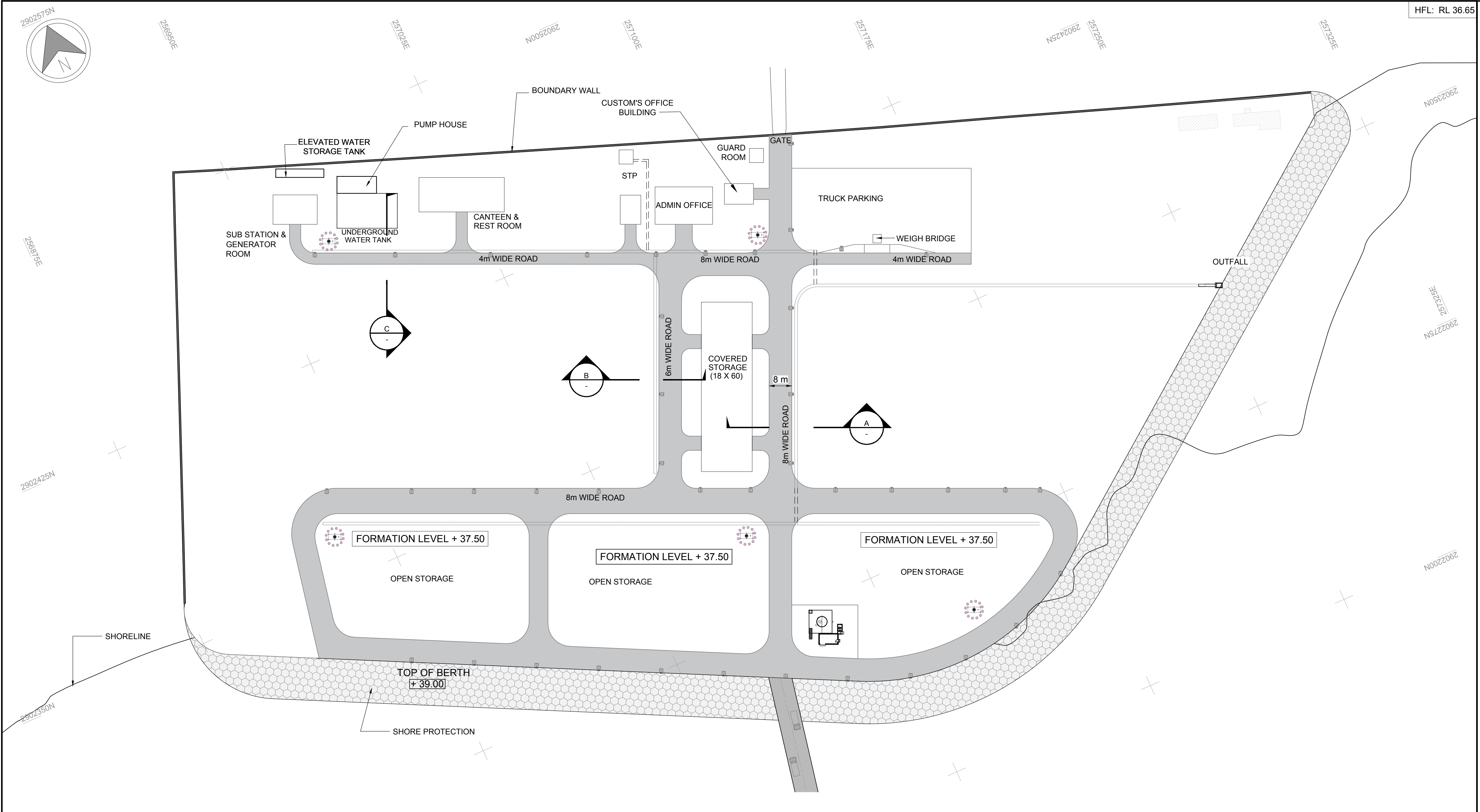
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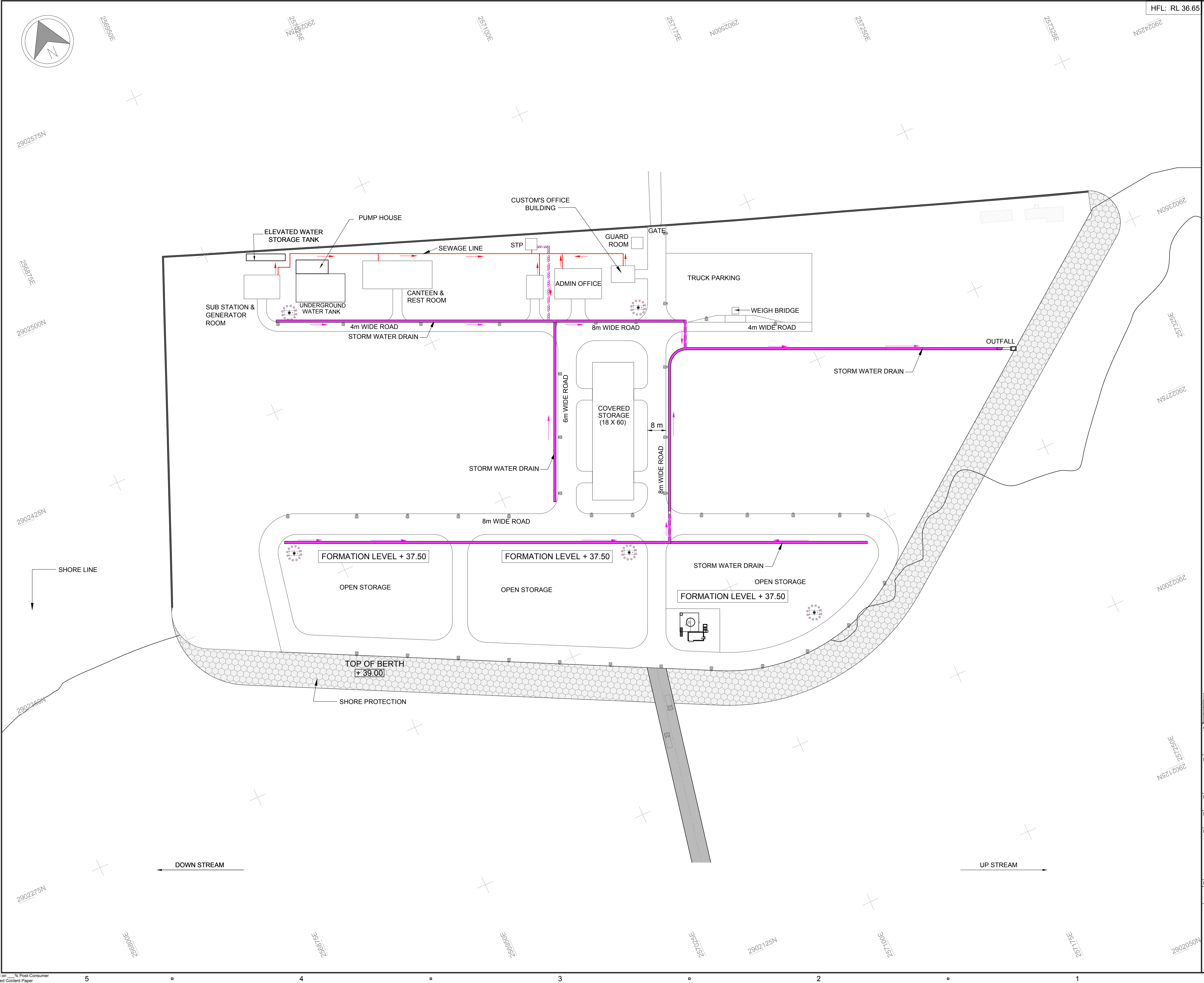
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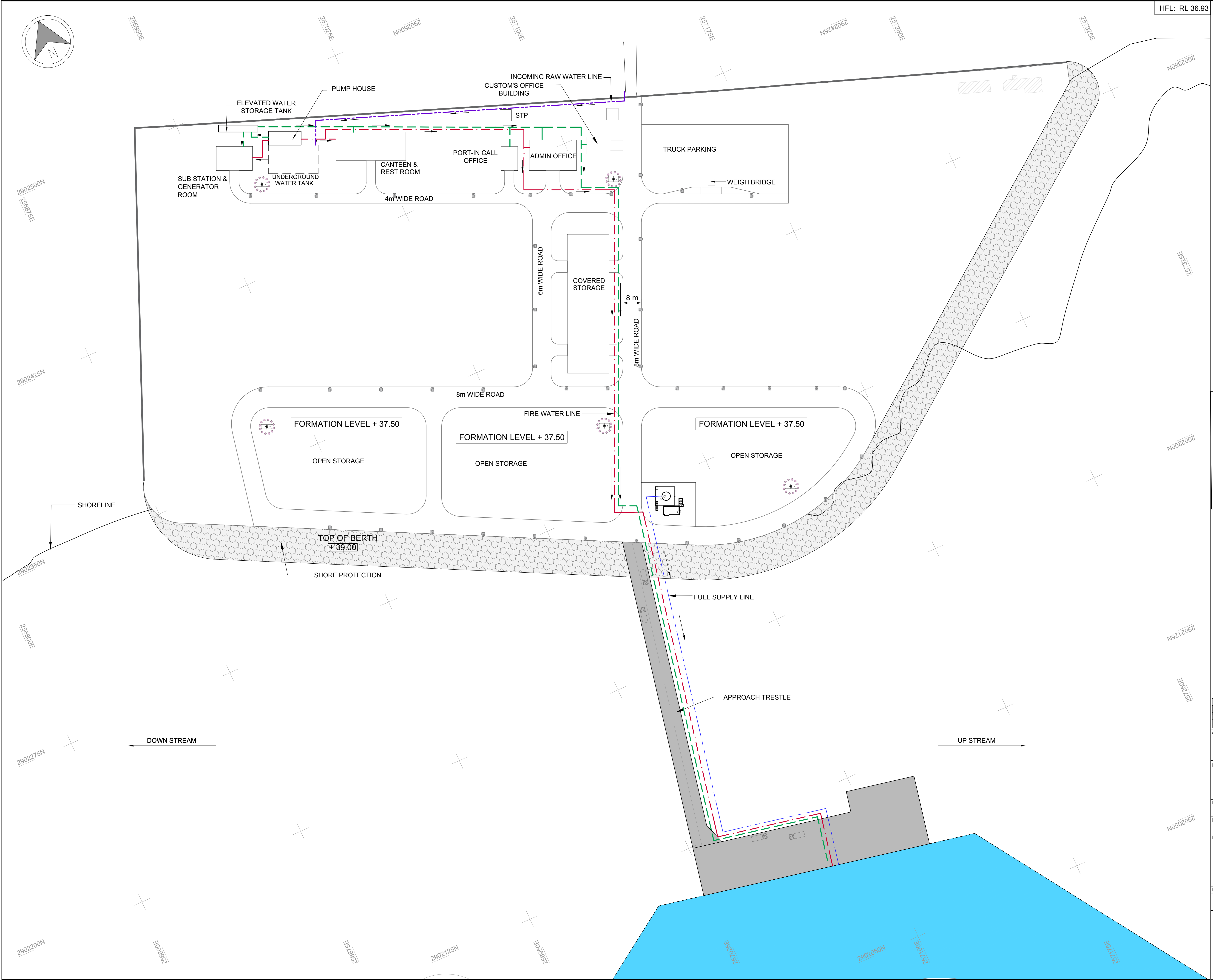
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LEGEND:

- RAW WATER LINE
- POTABLE WATER LINE
- FIRE WATER LINE
- FUEL SUPPLY LINE

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DRAWING TITLE: SCHEMATIC LAYOUT OF WATER SUPPLY AND FIRE WATER SYSTEM

DRAWING NUMBER: 60636525 - DPR - 1023

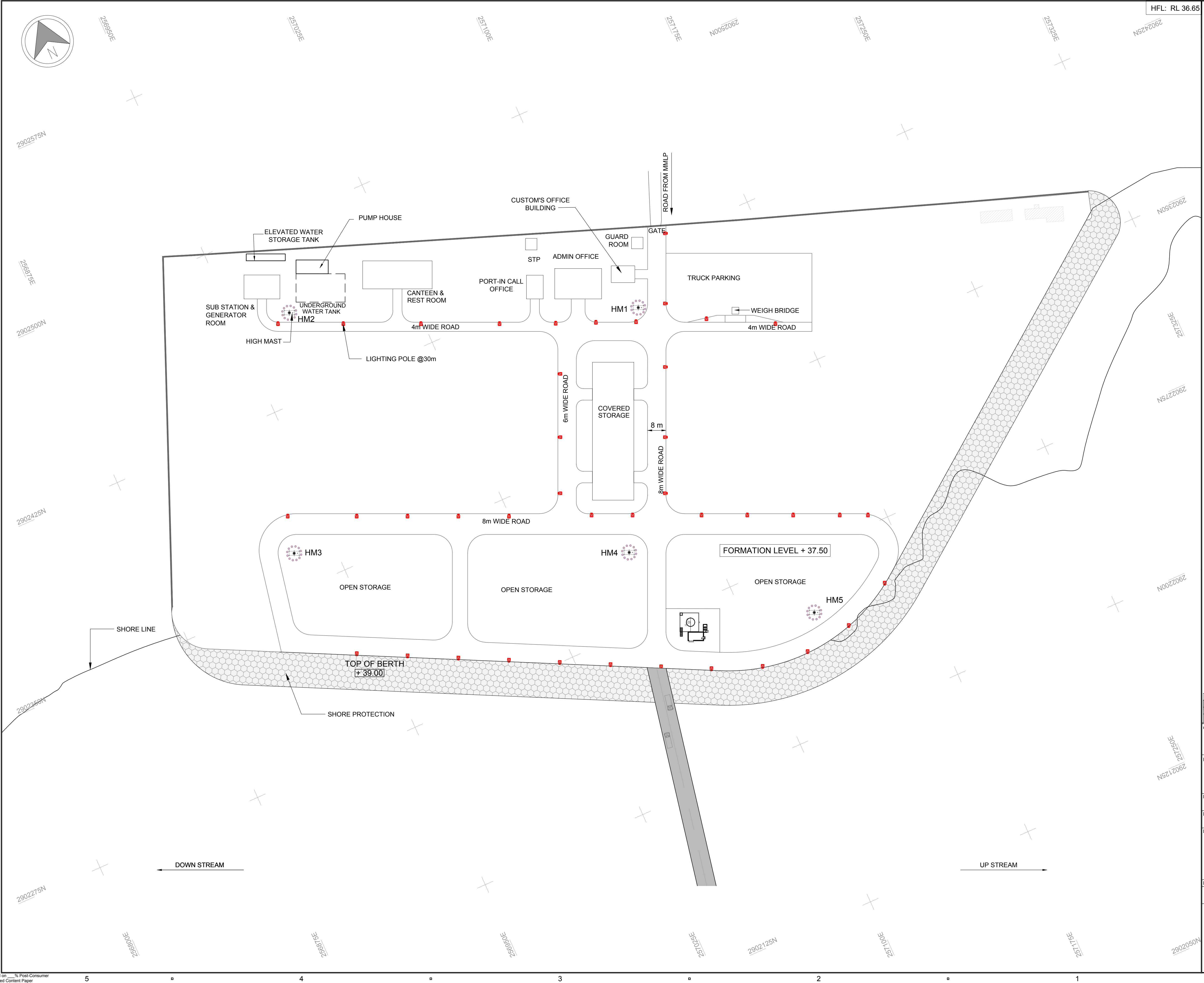
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LEGEND:

MMPL CONNECTIVITY ROAD

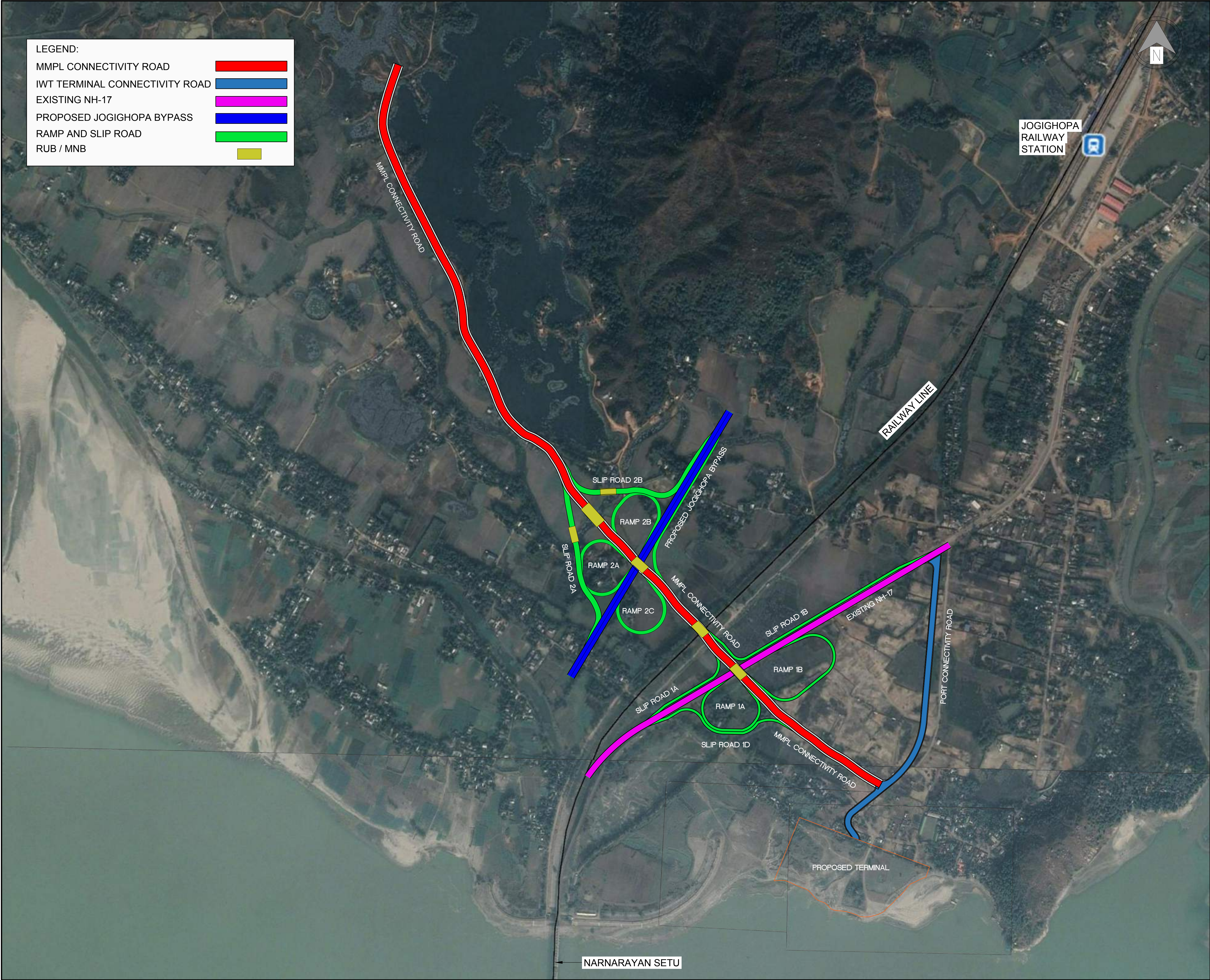
IWT TERMINAL CONNECTIVITY ROAD

EXISTING NH-17

PROPOSED JOGIGHOPA BYPASS

RAMP AND SLIP ROAD

RUB / MNB



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LEGEND

GENSET & SWITCH GEARS	
	DG SET
	VACCUUM CIRCUIT BREAKER
	AIR CIRCUIT BREAKER
	MCCB
	TRANSFORMER
	CURRENT TRANSFORMER
	POTENTIAL TRANSFORMER
	EARTH
	MCB
	FUSE
	D.O FUSE
	AB SWITCH

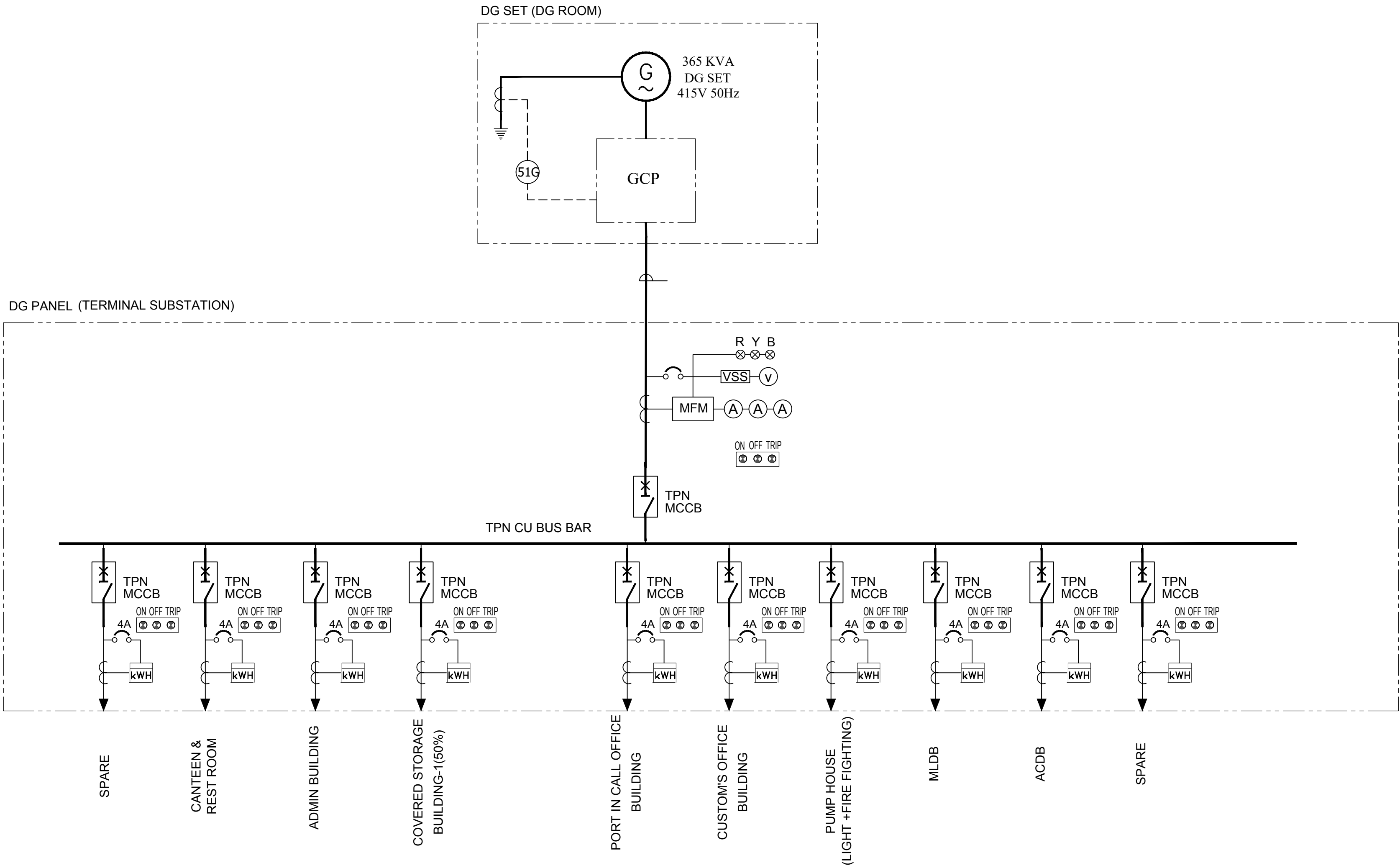
METERS & RELAYS	
	AMMETER
	AMMETER SELECTOR SWITCH
	VOLT METER
	VOLT METER SELECTOR SWITCH
	POWER FACTOR METER
	KILO WATT METER
	KILO WATT HOUR METER
	KILO VOLT AMPERE METER
	FREQUENCY METER
	TIME OF DAY METER (BI- DIRECTIONAL)
	Amp, Volt, pf, KW, kVA, kWH, F etc.

RELAYS	
27	UNDER VOLTAGE RELAY
46	NEGATIVE PHASE SEQUENCE RELAY
49O	OIL TEMPARATURE RELAY
49W	WINDING TEMPARATURE RELAY/ BEARING TEMPERATURE HIGH RELAY
50	INSTANTANEOUS EARTH FAULT RELAY
51	IDMT OVER CURRENT RELAY
51N	IDMT EARTH FAULT RELAY
50/51G	STAND-BY EARTH FAULT RELAY VOLTAGE CONTROLLED
51V	OVER CURRENT RELAY
59	OVER VOLTAGE RELAY
63	BUCHOLTZ RELAY
86	MASTER TRIP RELAY
64R	REF RELAY
32R	REVERSE POWER RELAY
50N	NEUTRAL INSTANTANEOUS OVER CURRENT RELAY
51G	GROUND TIME OVER CURRENT RELAY

NOTES:

- POWER SUPPLY SHALL BE TAPPED FROM THE NEAREST APDCL TAPPING POINT AT 11KV
- APDCL METERING SHALL BE OUTDOOR WHICH SHALL BE DESIGNED AS PER APDCL REQUIREMENT
- DURING NORMAL OPERATION BUSCOUPLER SHALL BE IN OFF CONDITION. EACH TRANSFORMER SHALL FEED INDIVIDUALLY (50% LOADING).
- IF ONE TRANSFORMER IS OFF, THE OTHER TRANSFORMER SHALL CARRY THE FULL LOAD CONNECTED IN THE MSB. THE TRANSFORMER SIZING SHALL BE DONE ACCORDINGLY
- MSB PANEL SHALL BE PROVIDED WITH CONTROL TRANSFORMER IN EACH BUS SECTION
- CO2 FLOODING SYSTEM TO BE PROVIDED IN THE MSB PANEL BOARD
- HIGH MAST, STREET LIGHTS, BUILDING LIGHTING (EXCEPT THE COVERED STORAGE BUILDING LIGHTS) SHALL HAVE 100% DG BACKUP
- 50% LIGHTS IN THE COVERED STORAGE SHALL HAVE DG BACK UP
- GUARD ROOMS SHALL RECEIVE SUPPLY FROM THE MLDB
- SUBSTATION LIGHTS & EXHAUST FANS (LDB) SHALL RECEIVE SUPPLY FROM MLDB
- MLDB SHALL RECEIVE SUPPLY FROM BOTH MSB & DGP VIA AUTO TRANSFER SWITCH(ATS)
- MLDB SHALL FEED SUPPLY TO HIGH MAST, STREET LIGHT & SUBSTATION LIGHTING
- 20% SPARE FEEDER TO BE CONSIDERED IN EACH PANEL BOARD
- SPACE HEATER SUPPLY TO BE TAPPED FROM THE MSB PANEL BOARD
- UPS SHALL RECEIVES SUPPLY FROM ACDB. SUITABLE RATING UPS TO BE CONSIDERED FOR CRITICAL LOADS
- LIGHTING & OTHER EMERGENCY SWITCH BOARD TO BE PROVIDED WITH ATS SWITCH TO RECEIVE POWER FROM DG SET
- THE SLD IS ONLY INDICATIVE KEY SLD. BASED ON THE SAME THE CONTRACTOR SHALL DEVELOP THE DETAILED SLD
- SUITABLE RATING APFC PANEL SHALL BE CONSIDERED IN EACH BUS SECTION
- CT/PT BURDEN TO BE CALCULATED BASED ON THE RELAY & INDICATION CIRCUITS
- FEDDERS TO BE CONSIDERED FOR FLY ASH SILOS, FUEL STATION & SHORE SUPPLY
- OUTDOOR TYPE FEEDER PILLAR BOXES TO BE CONSIDERED FOR EACH HIGH MAST
- HIGH MAST & STREET LIGHT SHALL BE PROVIDED WITH PHOTO SENSOR FOR AUTOMATIC ON/OFF
- ALL THE LIGHTING SHALL BE OF ENERGY EFFICIENT LED TYPE
- PANEL WHICH ARE RECEIVES SUPPLY FROM BOTH DGP & MSB SHALL HAVE ATS IN INCOMER
- 20% FUTURE MARGIN TO BE CONSIDERED WHILE SIZING THE EQUIPMENTS
- ALL THE PANEL BOARDS & DB SHALL BE EARTHED IN TWO POINTS
- ALL THE METERS SHALL BE PROVIDED WITH RS485 COMMUNICATION FACILITY TO INTERFACE WITH SCADA

MSB - OPERATION PHILOSOPHY				IC- INCOMER BC- BUS COUPLER
SCENARIO	IC1	BC	IC2	
SCENARIO-1	ON	OFF	ON	
SCENARIO-2	ON	ON	OFF	
SCENARIO-3	OFF	ON	ON	

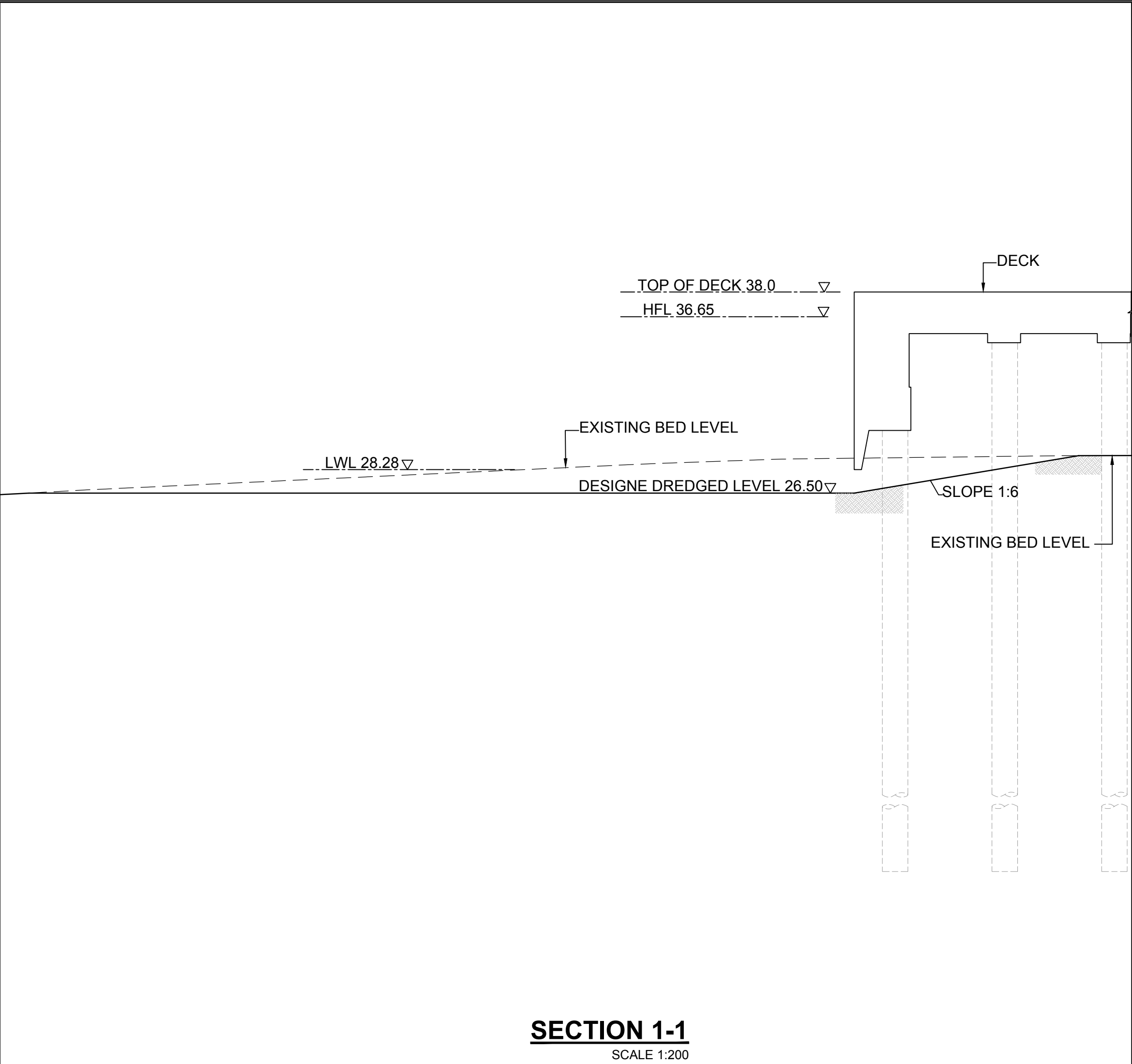
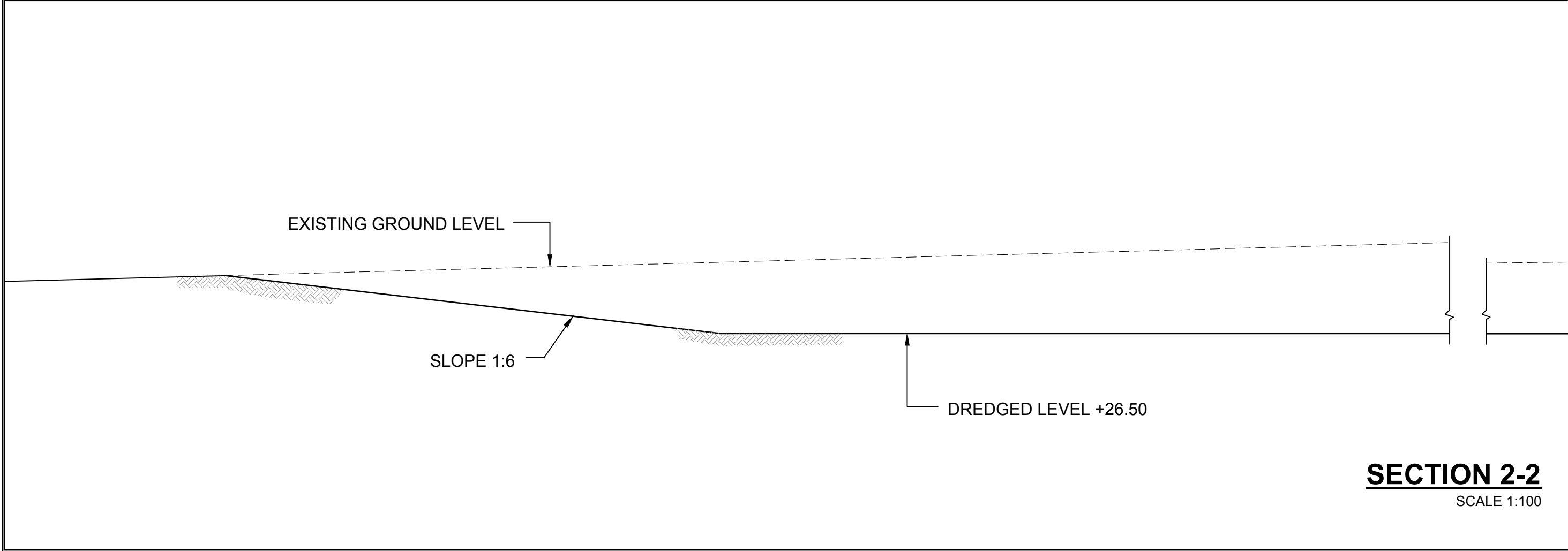
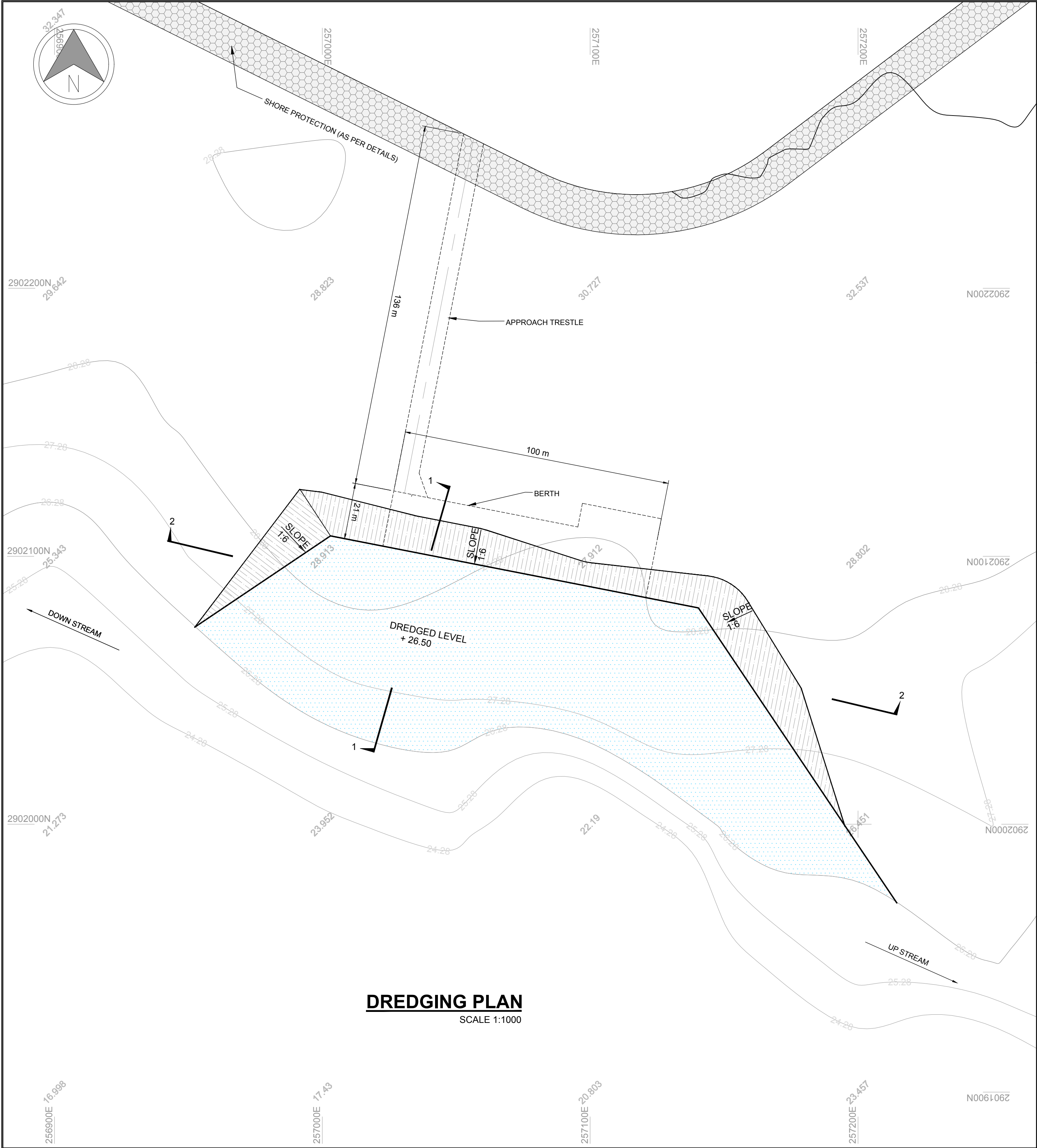


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ANNEXURE - 1

Topographic & Bathymetric Survey

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1. TOPOGRAPHIC SURVEY

1.1 Introduction

Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam was entrusted to Fargo Consultants Pvt. Ltd., CF-394 Sector-I, Salt Lake City, Kolkata 700064 by AECOM India Pvt. Ltd., 5th Floor, Tower B, Building No. 10, DLF Cyber City, DLF Phase II Gurgaon 122002, Haryana, India.

1.2 Scope of the Survey

The scope of work comprised of conducting topographical survey of the proposed jetty location using Total Station of two seconds accuracy and prepare Plans (Maps) on a scale of 1:1000 taking all physical features like existing trees, railway line, buildings, boundary wall, temples, well, canal, pipeline, roads (pucca and kuccha) etc. The spacing between two spot levels was limited to 5.0 m over area. The Level Survey was used to shall generate: (a) The location, layout and levels of all existing structures shall be presented (b) Spot levels at locations over area at an interval not exceeding 25 m. (c) Contour maps at site. The grids for the survey work shall be established in N-S & EW direction (Corresponding to magnetic North) and the survey reference was spheroid WGS 84 (d) Carrying out the Bench Mark (GTS/any other reference Bench Mark as approved by AECOM) to site/sites by double levelling, establishing and marking bench marks on existing structures in the field over the entire survey area.

The nearest airport is located at Guwahati in Assam. The Latitude and Longitude of the proposed jetty is provided in the **Table 1.1**. Location of the proposed jetty is shown in **Figure 1.1**.

The climate is tropical monsoon (summer max. at 38–40°C and winter min. at 28–33°C). The state's three seasons are: pre monsoon period (March – April), monsoon period (June – September) and during this pre-monsoon and monsoon period experiences 72% of annual rainfall, winter period (October - February). Average rainfall in this area is about 1715.7 mm.

Table 1.1: Proposed Jetty Location

S. No.	Latitude	Longitude
1	26°13'14.54"N	90°34'3.51"E



Figure 1.1: Locations for Topographical & Hydrographical Survey area in Brahmaputra river

1.3 Methodology adopted & Instruments Deployed for Topographical Survey

1.3.1 Reconnaissance Survey

Reconnaissance survey of the proposed location was carried out while conducting the main planimetric control traverses and height control traverses. The reconnaissance team considered the basic trend of the land, habitations and forest density. During reconnaissance survey the location of control points were fixed.

1.3.2 Planimetric Control Survey

Due to the limited size of the location a close traverse was not required. The coordinate of the starting location was based on the coordinates obtained from GPS. The bearing was fixed based on the bearing provided by the GPS coordinates of a second station.

1.3.3 Height Control Survey

Height control traverse was run by connecting the local Benchmark (BM) available at the Narayanan bridge located next to the proposed site. Double tertiary levelling was carried out to find out the closing error which was balanced, and the error distributed as per standard practice. On completion of the level traverse temporary Benchmark were kept for further detailing in height distribution and digital terrain modelling of the locations.

Table 1.2: Benchmark Location

S. No.	Location	Benchmark (BM) Value (MSL) (m)
1	Narayanan Bridge	43.183

1.3.4 Co-ordinate System

Unified co-ordinate system was adopted for the entire survey. The digital co-ordinate system used for survey is oriented to the grid system made for the purpose. At any stage, grid re-structuring/re-construction shall be possible by using the usual method for transformation.

1.3.5 Detailed Topographical Survey

Detailed topographical survey of all the above ground features man made features and natural features like houses, rivers/nallahs/drains, power lines, telephone lines, electric lines with posts were recorded.

The survey covered the control points and all topographical features as follows:

- Buildings, hutments, sheds, structures
- Boundary features (if existing)
- Roads, tracks, footpaths etc.
- Drains (Kancha/pucca)
- Religious structures
- Trestles, pylons, poles of electric and telephone lines
- Optical fibre cable, water pipe line
- Individual solitary trees having girth 30cms and above.
- Cluster of trees, plantation area, forest area and their limits
- Agricultural land, barren land etc.
- Water bodies
- Rivers, streams, nallahs, reservoirs and their extent
- Bridges, culverts with their dimensions
- Limit of survey

1.3.6 Spot Heights

Spot heights were taken along the entire area at an interval of 5m in orthogonal directions.

1.3.7 Instruments Deployed

The physical work of survey was undertaken at site using one GPS and one Electronic Total Station (viz. Sokkia 610) with one second least count, one Auto level and computer with necessary survey software for plotting the field drawings.

1.3.8 Monuments for Future Reference

Three (3) concrete monument pillar were constructed at each of the locations. Monuments will have X, Y & Z values assigned to them. The Z values are for the top of the monument. These are embedded on the ground by cement concrete and a number has been assigned to each. Details of the monuments are provided in **Table 1.3**.

Table 1.3: Reference Pillar Details

S. No.	Field Marking	Northing (m)	Easting (m)	Elevation w.r.t. MSL (m)
1	P-1	2902320.000	257209.000	36.201
2	P-2	2902355.715	257071.239	36.069
3	P-3	2902384.354	257122.977	36.744

1.3.9 Presentation of Final Drawings

Digital data in approved format will be put in AutoCAD format. Complete information of the terrain, having X, Y & Z values will be presented in the approved format. The drawings are provided in APPENDIX-A.

1.3.10 Photographs

Selected images of surveying activities at site are provided below.





Figure 1.2: Selected Photographs – Topographic Survey

2. BATHYMETRIC SURVEY

2.1 Scope of the Survey

The scope of work at the proposed jetty location comprised of (a) establishing at least two permanent reference points (permanent concrete marked structures), to fix level and position in relation to standard references. The reference points were referenced to suitable permanent structures in the vicinity. (b) Survey was carried out using necessary survey equipment (c) Echo sounding (bathymetry) of the survey area was carried out along the length of the river covering the width of the river (d) Survey by using Hand held GPS was carried out where Boat is inaccessible. (f) The water levels shall be presented with respect to Chart Datum. (g) Water samples were collected to analyse the same for suspended load content in the water column and particle size distribution. The samples were collected at 2 locations; at three depths viz. 0.5m above riverbed, mid-depth and 0.5m below water surface (h) Surface soil (bed) samples at 2 locations from the riverbed and analyse the same for the specified tests (i) Processed all the survey and oceanographic data and to prepare a draft and final reports including plotting / preparation of charts, maps etc.

2.2 Methodology Adopted & Instruments Deployed for Hydrographic Survey

2.2.1 Reconnaissance Survey

Reconnaissance of the locations of the proposed location was carried out in detail to identify locations for setting up vertical control points and the tidal gauge.

2.2.2 Planimetric Control Survey

A pair of control points was established using GPS at each of the locations. Due to the limited size of the locations a close traverse was not required. The coordinate of the starting location was based on the coordinates obtained from GPS. The bearing was fixed based on the bearing provided by the GPS coordinates of a second station.

2.2.3 Height Control Survey

Height control traverse was run by connecting the local Benchmark (BM) available at the Narayanan bridge located next to the proposed site. Double tertiary levelling was carried out to find out the closing error which was balanced, and the error distributed as per standard practice. On completion of the level traverse temporary Benchmark were kept for further detailing in height distribution and digital terrain modelling of the locations.

Table 2.1: Benchmark Location

S. No.	Location	Benchmark (BM) Value (MSL) (m)
1	Narayanan Bridge	43.183

2.2.4 Current Measurement

Current measurements using a current meter will be carried out shortly at two locations.

2.2.5 Co-ordinate System

Unified co-ordinate system was adopted for the entire survey. The digital co-ordinate system used for survey is oriented to the grid system made for the purpose. At any stage, grid re-structuring/re-construction shall be possible by using the usual method for transformation.

2.2.6 Spot Heights

Spot levels were recorded from river bank to river bank for an approximate length of 2.0 kilometre. Spot heights were taken along the entire area at 10m interval in orthogonal direction or at closer intervals. Coordinates and depth measurements were recorded using an echo sounder. The depth readings were converted to elevations by deducting the depth value from the water level elevation.

2.2.7 Instruments Deployed

The physical work of survey was undertaken at site using one GPS, one Electronic Total Station (viz. Sokkia 610,) with one second least count, one Auto level, one Garmin GPSMAP 585 echo sounder and computer with necessary survey software for plotting the field drawings.

2.2.8 Presentation of Final Drawings

The coordinates for the pillars established for horizontal control point establishment are provided in **Table 2.2**. The coordinates of the Digital data in approved format was put in AutoCAD format. Complete information of the terrain, having X, Y & Z values was presented in the approved format. The drawings are provided in APPENDIX-A.

Table 2.2: Reference Pillar Details

S. No.	Field Marking	Northing (m)	Easting (m)	Elevation w.r.t. MSL (m)
1	P-1	2902320.000	257209.000	36.201
2	P-2	2902355.715	257071.239	36.069
3	P-3	2902384.354	257122.977	36.744

2.2.9 Water Sampling

Two (2) water samples were collected from river and analysed for percentage of sediment and pH. The results are provided in **Table 2.3**.

Table 2.3: River Water Sample Test Results

Sample ID	Sediment (g/l)	pH
J-1	3.12	6.92
J-2	2.06	6.98

2.2.10 River Bed Sampling

Two (2) river bed samples were collected from the river bed. The samples were analysed for grain size distribution, specific gravity, pH value, Sand, Silt & Clay percentage. The results are provided in **Table 2.4**. Graphs for grain size distribution is presented in APPENDIX-B.

Table 2.4: River Bed Sample Test Results

Sample ID	Specific Gravity (-)	pH (-)	Sand (%)	Silt (%)	Clay (%)
J-1	2.66	6.92	13.2	73.3	13.5
J-2	2.67	6.98	23.2	66.0	10.8

PHOTOGRAPHS:

Selected images of hydrographic surveying activities at site are provided below.



Figure 2.1: Selected Photographs – Hydrographic Survey

2.2.11 Velocity and Discharge Measurement:

Velocity was measured at for three cross-sections. Along each cross-section three sets of velocity readings were obtained. These velocity readings along with the cross-sectional area were used to calculate the discharge at three cross-sections. The results are provided in **Table 2.5**. Locations for Velocity measurements and the cross-section is provided in **Figure 2.2**. The cross-section drawings are provided in Annexure-I.



Figure 2.2: Location of Velocity Measurements and Cross-section

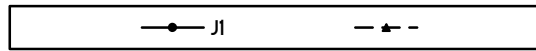
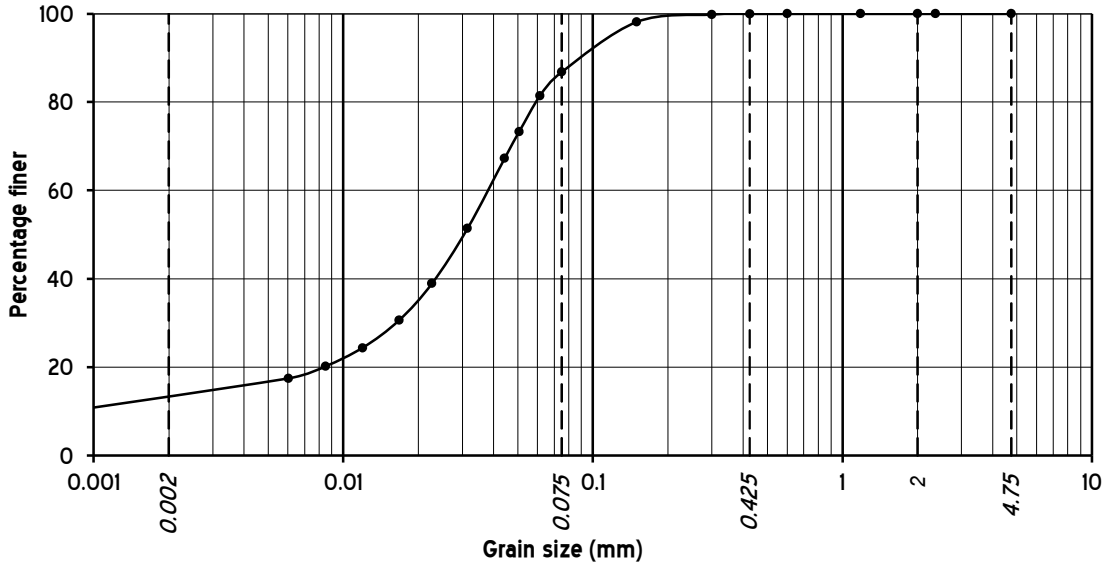
Table 2.5: Velocity and Discharge Results

Cross-section	Average Velocity (m/s)	Area of cross-section (sq. m)	Discharge (cum/s)
Upstream	2.7	23482	62919
Centreline	2.5	23786	59234
Downstream	2.6	23797	62212

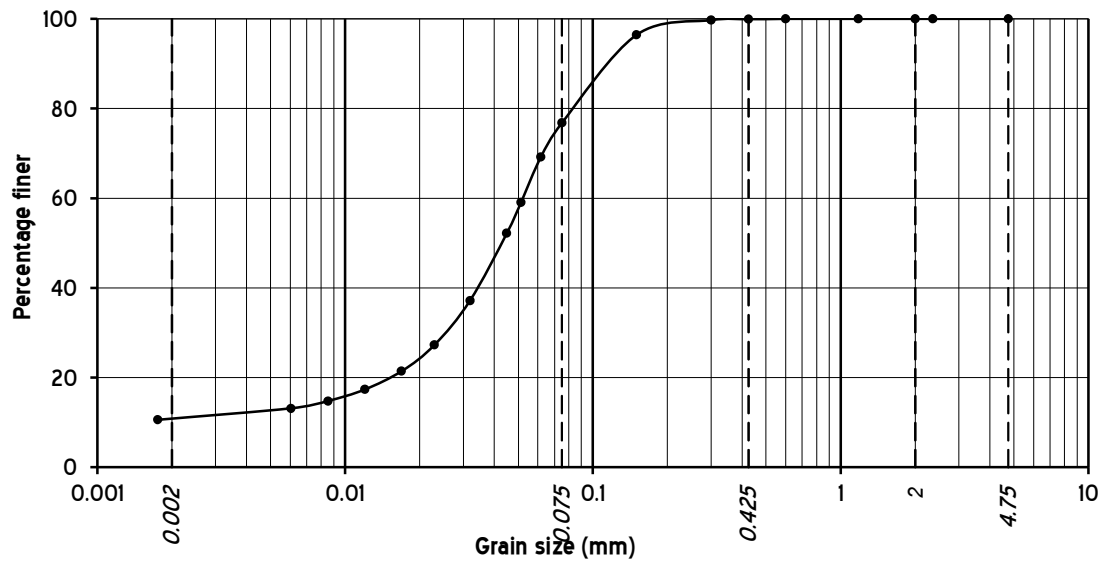
APPENDIX-A

TOPOGRAPHICAL SURVEY AND HYDROGRAPHIC SURVEY

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
J1	13.5	73.3	13.2	0.0	0.0	0.0



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
J2	10.8	66.0	23.1	0.1	0.0	0.0

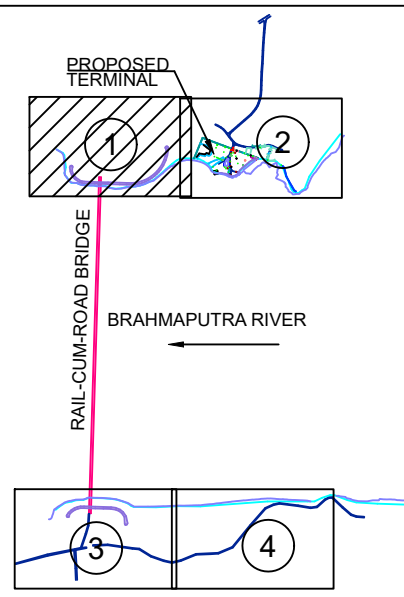
Project: Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.
2020402J

Fig. No.



INDEX MAP



LEGEND

SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL
1.	Building		8.	River		15.	Transformer		22.			29.		
2.	Cantilever		9.	Temporary Bench Mark		16.	Electric Pole		23.			30.		
3.	Bitumen Road		10.	Trees		17.	Pillar Point		24.			31.		
4.	Water Body		11.	Heightention Tower		18.	Grid Level		25.			32.		
5.	Boundary Wall		12.	Stone Wall		19.	Major Contour		26.			33.		
6.	Drain		13.	Railway line		20.	Minor Contour		27.			34.		
7.	Bridge		14.	Electric Box		21.	Water Line		28.			35.		

NOTES

1. All Dimensions are in metre unless otherwise stated.
 2. Survey was carried out as per hand held GPS coordinates.
 3. All elevations are with respect to M.S.L. Chart Datum is 28.28m
 4. Contours have been drawn at an interval of 1.0m
 5. Total Area Surveyed is 678.054 Hectares
 6. Reference Pillar Coordinates
- | ID | Northing | Easting | Elevation |
|------------|-------------|------------|-----------|
| TBM-1 | 2902360.189 | 257296.959 | 36.567 |
| TBM-2 | 2902426.292 | 257139.394 | 36.787 |
| STN-1(P-1) | 2902320.000 | 257209.000 | 36.201 |
| STN-2(P-2) | 2902355.715 | 257071.239 | 36.069 |
| STN-5(P-3) | 2902384.354 | 257122.977 | 36.744 |

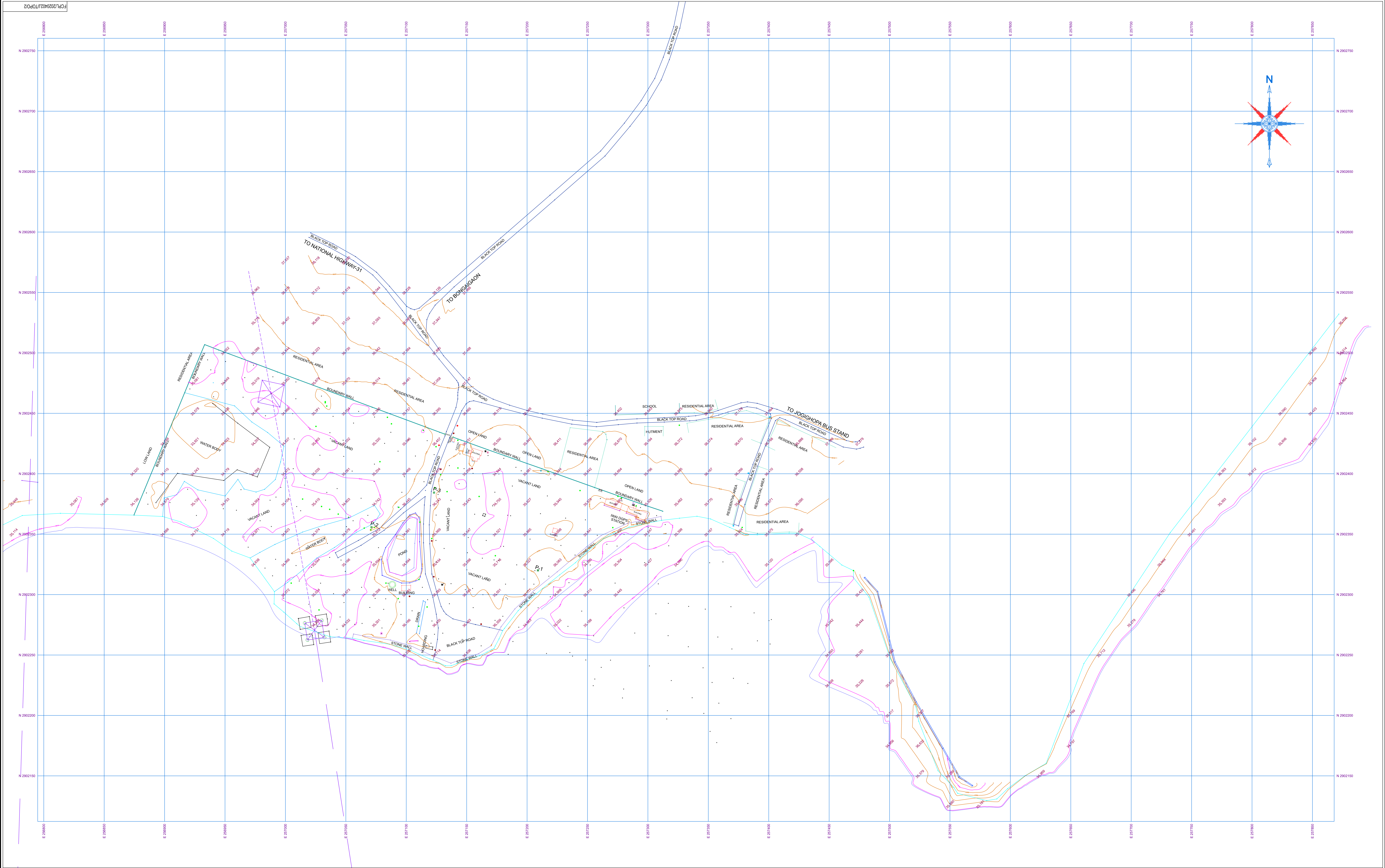
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AECOM LTD.

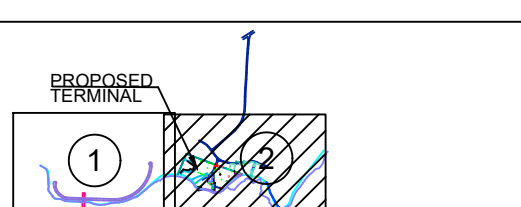
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DEVELOPMENT OF INLAND WATER TRANSPORT (IWT)
FACILITY AT JAGIGHOPA, ASSAM**

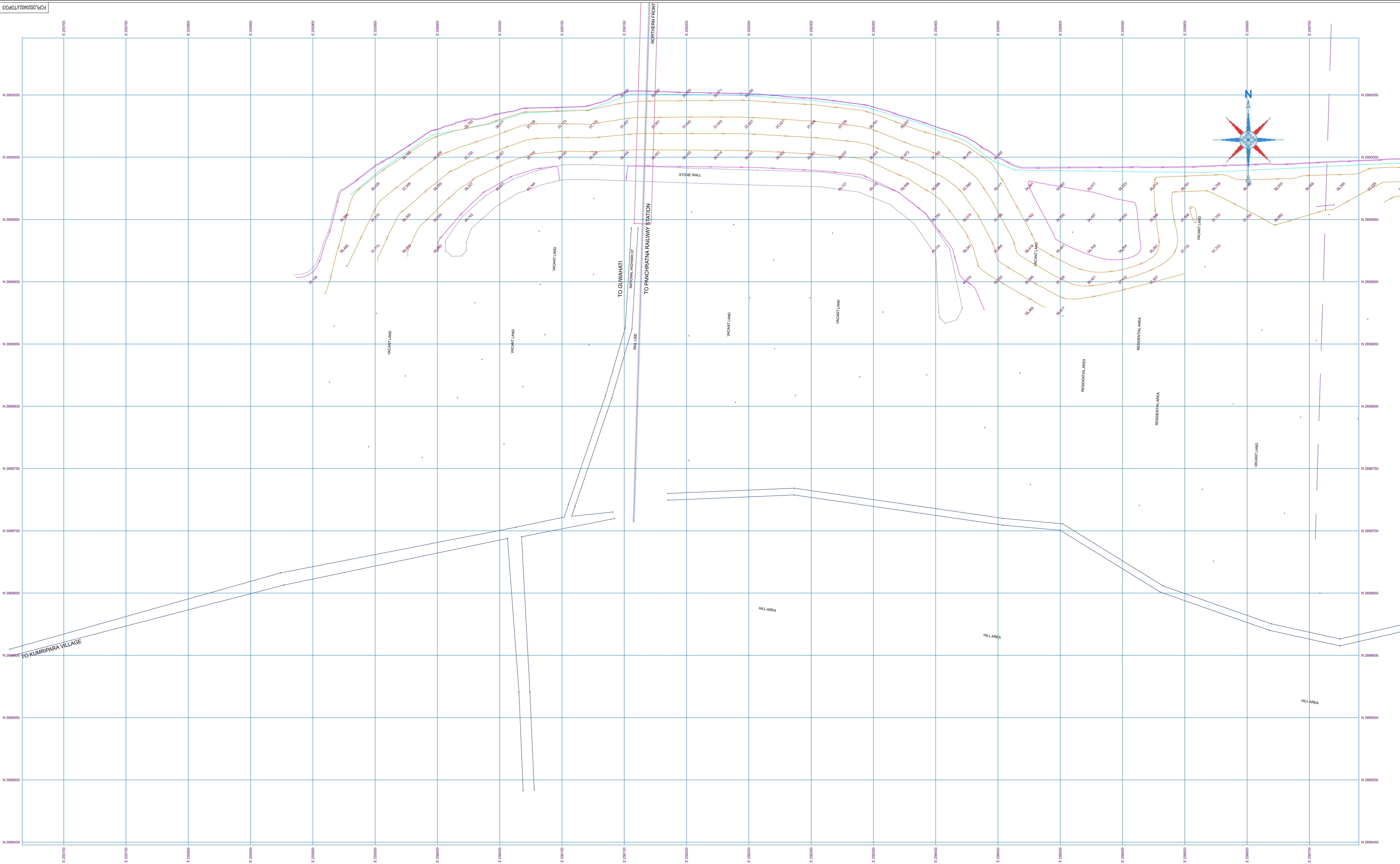
Site
TOPOGRAPHICAL SURVEY RIGHT BANK

Survey Agency
FARGO CONSULTANTS PVT. LTD.

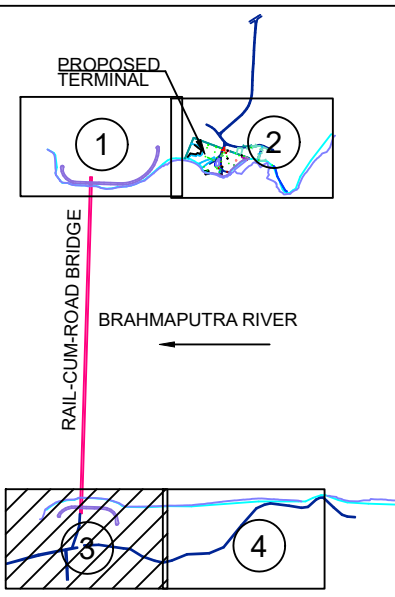
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Dwg No. FCPL/2020402J/TOPO/1	Scale 1:1000	Date 30.10.2020	REV. 2



INDEX MAP				LEGEND												NOTES				Client			
				SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL		
1.	Building		8.	River		15.	Transformer		22.			29.				1.	All Dimensions are in metre unless otherwise stated.						
2.	Cantilever		9.	Temporary Bench Mark		16.	Electric Pole		23.			30.				2.	Survey was carried out as per hand held GPS coordinates.						
3.	Bitumen Road		10.	Trees		17.	Pillar Point		24.			31.				3.	All elevations are with respect to M.S.L. Chart Datum is 28.28m						
4.	Water Body		11.	Heightation Tower		18.	Grid Level		25.			32.				4.	Contours have been drawn at an interval of 1.0m						
5.	Boundary Wall		12.	Stone Wall		19.	Major Contour		26.			33.				5.	Total Area Surveyed is 678.054 Hectares						
6.	Drain		13.	Railway line		20.	Minor Contour		27.			34.				6.	Reference Pillar Coordinates						
7.	Bridge		14.	Electric Box		21.	Water Line		28.			35.				ID.	Northing	Easting	Elevation				
																TBM-1				2902360.189	257296.959	36.567	
																TBM-2				2902426.292	257139.394	36.787	
																STN-1(P-1)				2902320.000	257209.000	36.201	
																STN-2(P-2)				2902355.715	257071.239	36.069	
																STN-5(P-3)				2902384.354	257122.977	36.744	
																1. All Dimensions are in metre unless otherwise stated.				Client			
																2. Survey was carried out as per hand held GPS coordinates.				Project			
																3. All elevations are with respect to M.S.L. Chart Datum is 28.28m				PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR			
																4. Contours have been drawn at an interval of 1.0m				DEVELOPMENT OF INLAND WATER TRANSPORT (IWT)			
																5. Total Area Surveyed is 678.054 Hectares				FACILITY AT JAGIGHOPA, ASSAM			
																6. Reference Pillar Coordinates				Site			
																ID.				TOPOGRAPHICAL SURVEY RIGHT BANK			
																TBM-1				Survey Agency			
																TBM-2				FARGO CONSULTANTS PVT. LTD.			
																STN-1(P-1)				C/O 344, Sector-1, Salt Lake City, Kolkata-700 064			
																STN-2(P-2)				Job No.			
																STN-5(P-3)				2020402J			
																Job No.				Drawn by			
																Job No.				B. PAL			
																Job No.				G. C. NASKAR			
																Job No.				P. BRAHMA			
																Job No.				Scale			
																Job No.				1:1000			
																Job No.				Date			
																Job No.				30.10.2020			
																Job No.				REV. 2			



INDEX MAP



LEGEND

SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL
1.	Building		8.	River		15.	Transformer		22.			29.		
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7.	Bridge		14.	Electric Box		21.	Water Line		28.			35.		

NOTES

- All Dimensions are in metre unless otherwise stated.
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 - Contours have been drawn at an interval of 1.0m
 - Total Area Surveyed is 678.054 Hectares
 - Reference Pillar Coordinates
- | ID | Northing | Easting | Elevation |
|------------|-------------|------------|-----------|
| TBM-1 | 2902360.189 | 257296.959 | 36.567 |
| TBM-2 | 2902426.292 | 257139.394 | 36.787 |
| STN-1(P-1) | 2902320.000 | 257209.000 | 36.201 |
| STN-2(P-2) | 2902355.715 | 257071.239 | 36.069 |
| STN-5(P-3) | 2902384.354 | 257122.977 | 36.744 |

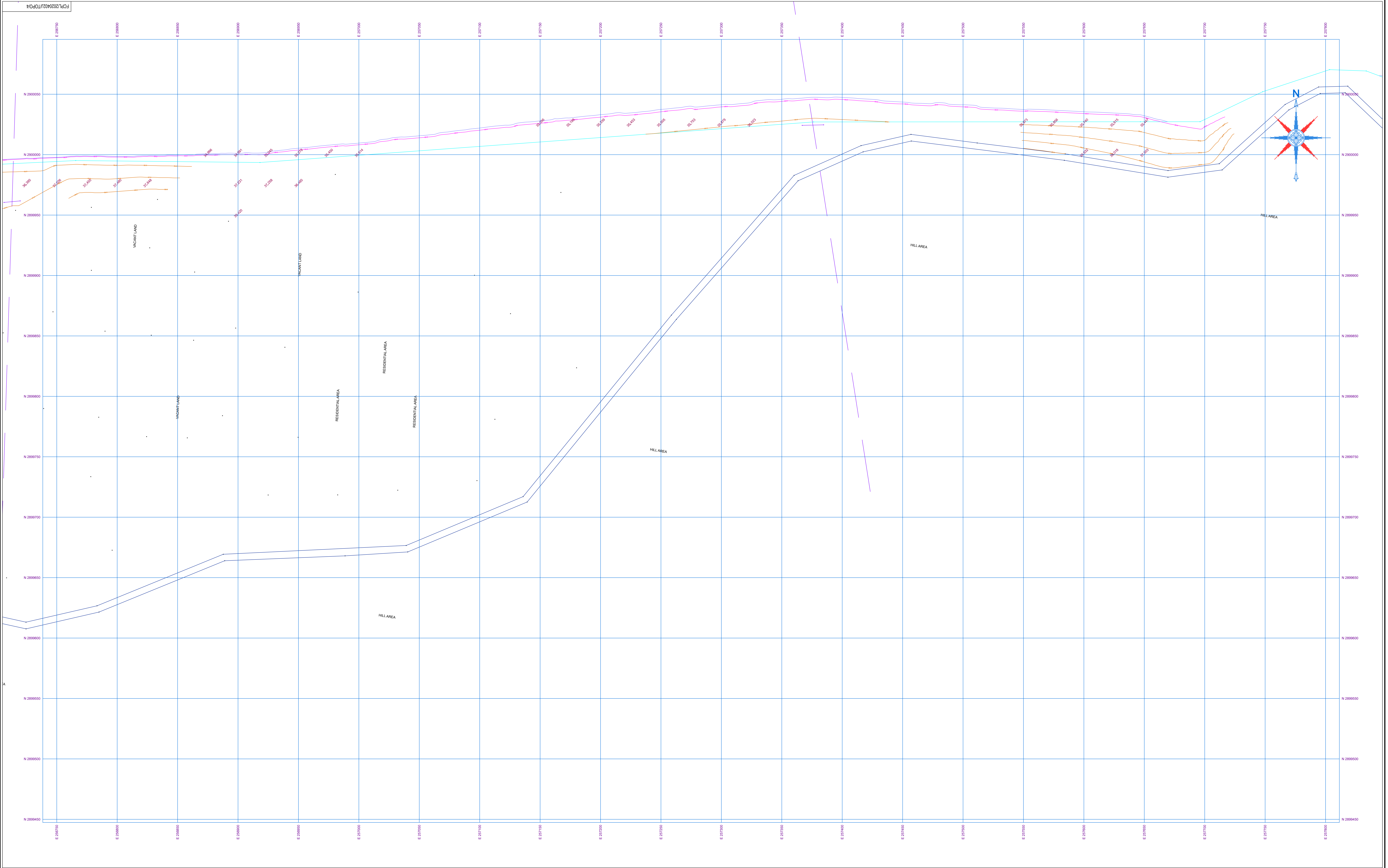
Client
AECOM LTD.

Project
PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JAGIGHOPA, ASSAM

Site
TOPOGRAPHICAL SURVEY LEFT BANK

Survey Agency
FARGO CONSULTANTS PVT. LTD.

Job No.	2020402J	Drawn by	B. P. L.	Chkd. by	G. C. NASKAR	Appvd. by	P. BRAHMA
Scale	1:1000	Date	30.10.2020	REV.	2		



INDEX MAP

LEGEND

SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL
1.	Building		8.	River		15.	Transformer		22.			29.		
2.	Cantilever		9.	Temporary Bench Mark		16.	Electric Pole		23.			30.		
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7.	Bridge		14.	Electric Box		21.	Water Line		28.			35.		

NOTES

- All Dimensions are in metre unless otherwise stated.
- Survey was carried out as per hand held GPS coordinates.
- All elevations are with respect to M.S.L. Chart Datum is 28.28m
- Contours have been drawn at an interval of 1.0m
- Total Area Surveyed is 678.054 Hectares
- Reference Pillar Coordinates

ID	Northing	Easting	Elevation
TBM-1	2902360.189	257296.959	36.567
TBM-2	2902426.292	257139.394	36.787
STN-1(P-1)	2902320.000	257209.000	36.201
STN-2(P-2)	2902355.715	257071.239	36.069
STN-5(P-3)	2902384.354	257122.977	36.744

Client

AECOM LTD.

Project

PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JAGIGHOPA, ASSAM

Site

TOPOGRAPHICAL SURVEY LEFT BANK

Survey Agency

FARGO CONSULTANTS PVT. LTD.

Job No

2020402J

Drawn by

B. PNL

Chkd. by

G. C. NASKAR

Apprd. by

P. BRAHMA

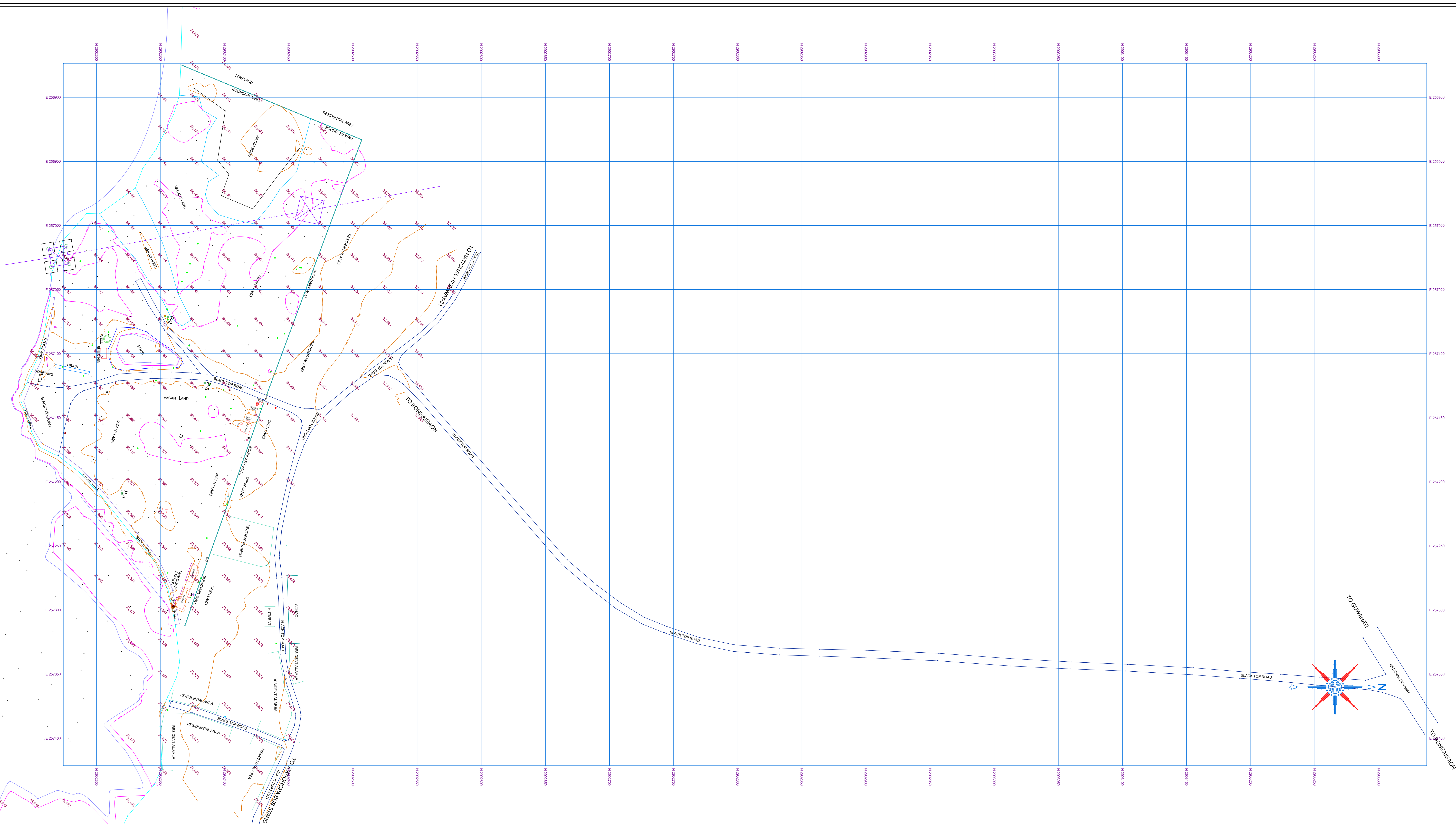
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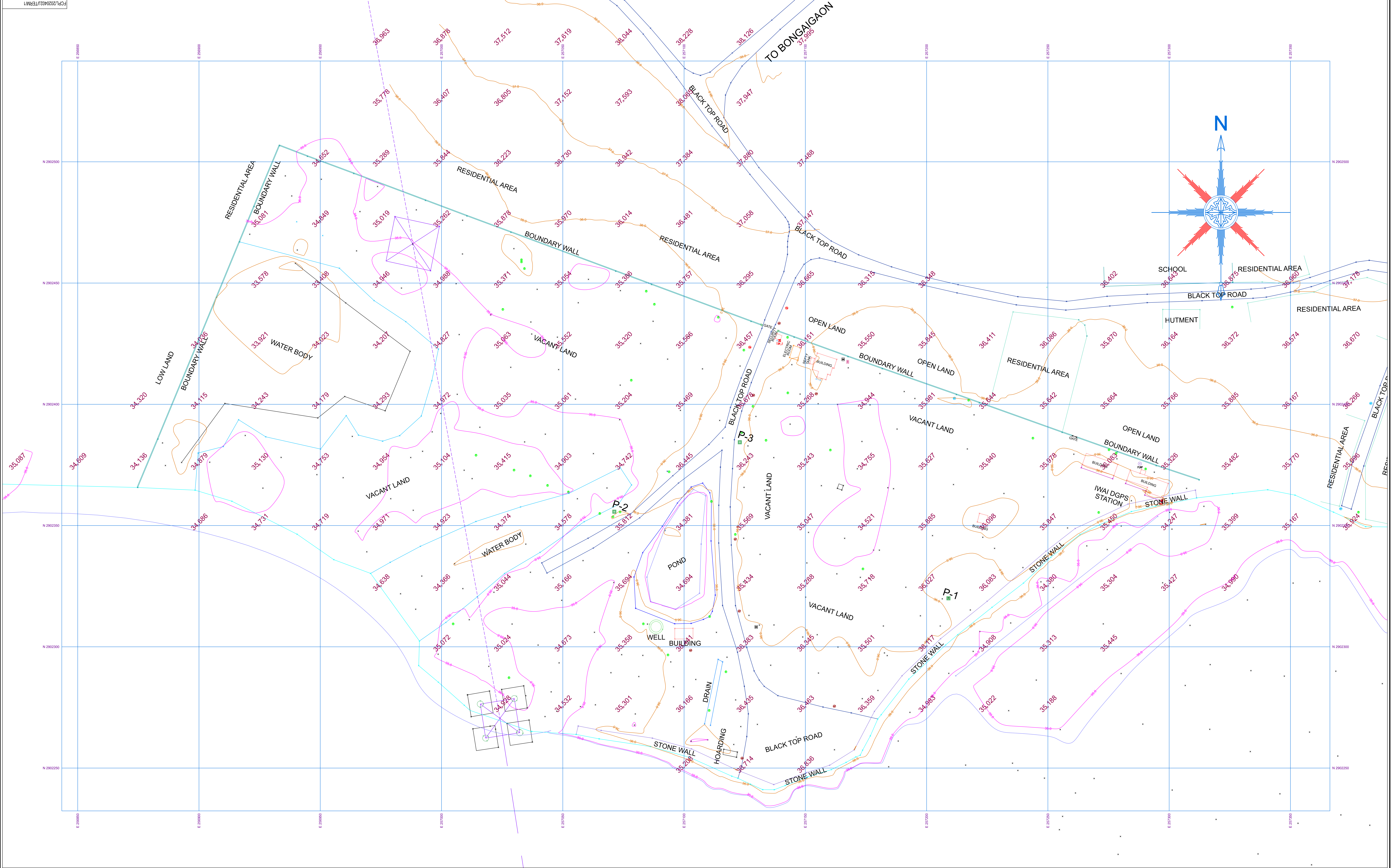
REV. 2



LEGEND		SYMBOL
S/LNO.	DESCRIPTION	
1.	Building	
2.	Canal/river	
3.	Burien Road	
4.	Water Body	
5.	Boundary Wall	
6.	Drain	
7.	Bridge	
8.	River	
9.	Temporary Bench Mark	
10.	Trees	
11.	Illumination tower	
12.	Stone Wall	
13.	Railway line	
14.	Electric Box	
15.	Transformer	
16.	Electric Pole	
17.	Pillar Point	
18.	Grid level	
19.	Major Contour	
20.	Minor Contour	
21.	Water Line	

NOTES

- All dimensions are in inches unless otherwise specified.
- Survey was carried out as per Indian Survey standards.
- All elevations are with respect to M.S.L. Chart Datum is 2.55m
- Contour have been drawn at an Interval of 1.0m
- Total Area Surveyed is 678.053 Hectares
- Reference Plan Coordinates
- Bearings
- Distances
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INDEX MAP

LEGEND											
SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL
1.	Building		8.	River		15.	Transformer		22.		
2.	Cantilever		9.	Temporary Bench Mark		16.	Electric Pole		23.		
3.	Bitumen Road		10.	Trees		17.	Pillar Point		24.		
4.	Water Body		11.	Hightention Tower		18.	Grid Level		25.		
5.	Boundary Wall		12.	Stone Wall		19.	Major Contour		26.		
6.	Drain		13.	Railway line		20.	Minor Contour		27.		
7.	Bridge		14.	Electric Box		21.	Water Line		28.		

NOTES

- All Dimensions are in metre unless otherwise stated.
- Survey was carried out as per hand held GPS coordinates.
- All elevations are with respect to M.S.L. Chart Datum is 28.28m
- Contours have been drawn at an interval of 1.0m
- Total Area Surveyed is 678.054 Hectares
- Reference Pillar Coordinates

ID	Northing	Easting	Elevation
TBM-1	2902360.189	257296.959	36.567
TBM-2	2902426.292	257139.394	36.787
STN-1(P-1)	2902320.000	257209.000	36.201
STN-2(P-2)	2902355.715	257071.239	36.069
STN-5(P-3)	2902384.354	257122.977	36.744

Client

AECOM LTD.

Project

PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JAGIGHOPA, ASSAM

Description

TERMINAL AREA DETAILS

Survey Agency

FARGO CONSULTANTS PVT. LTD.

Job No

2020402J

Drawn by

B. P. L.

Chkd. by

G. C. NASKAR

Appvd. by

P. BRAHMA

Date

30.10.2020

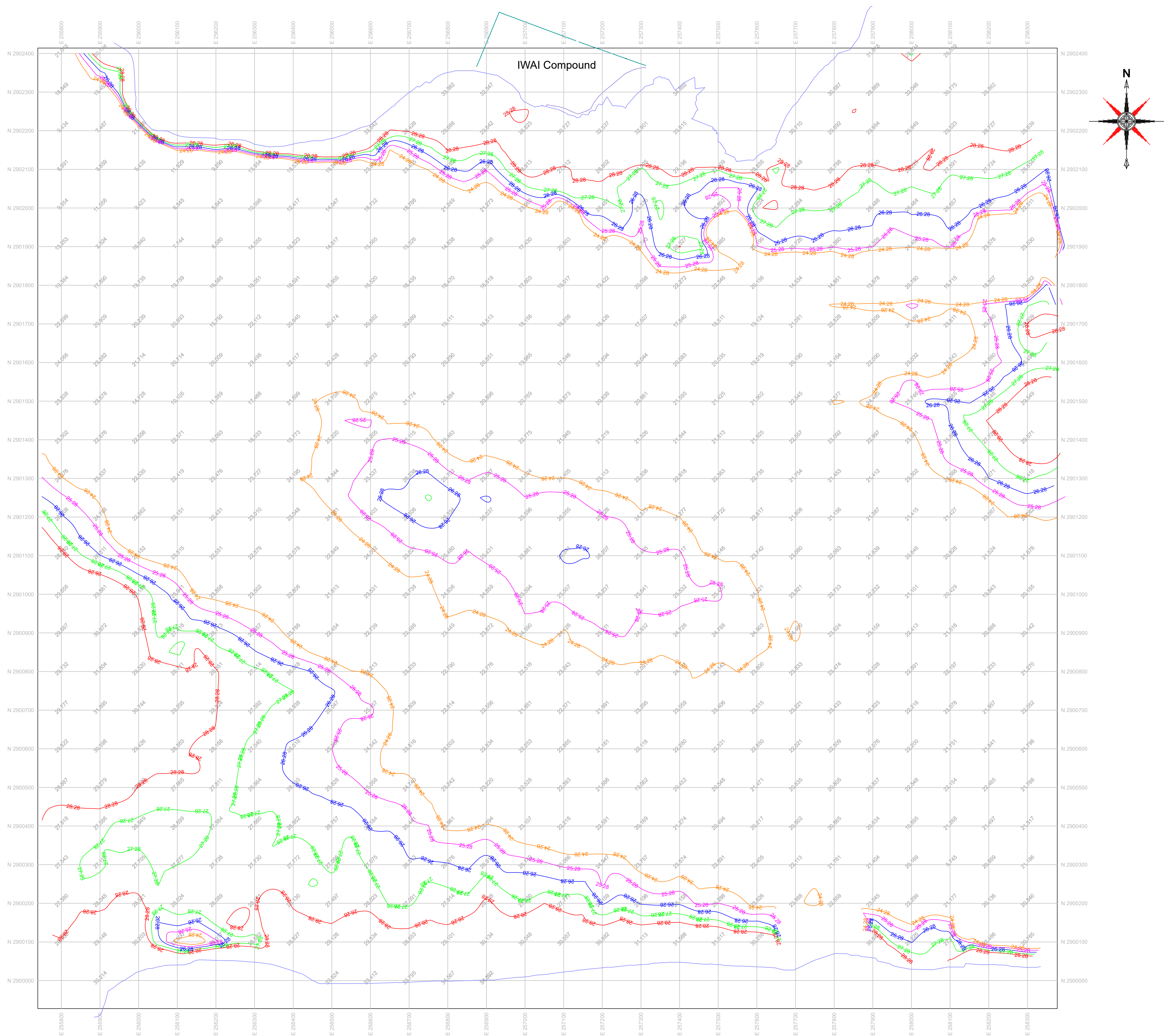
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REV.

2

HYDROGRAPHIC SURVEY AT JOGIGHOPA

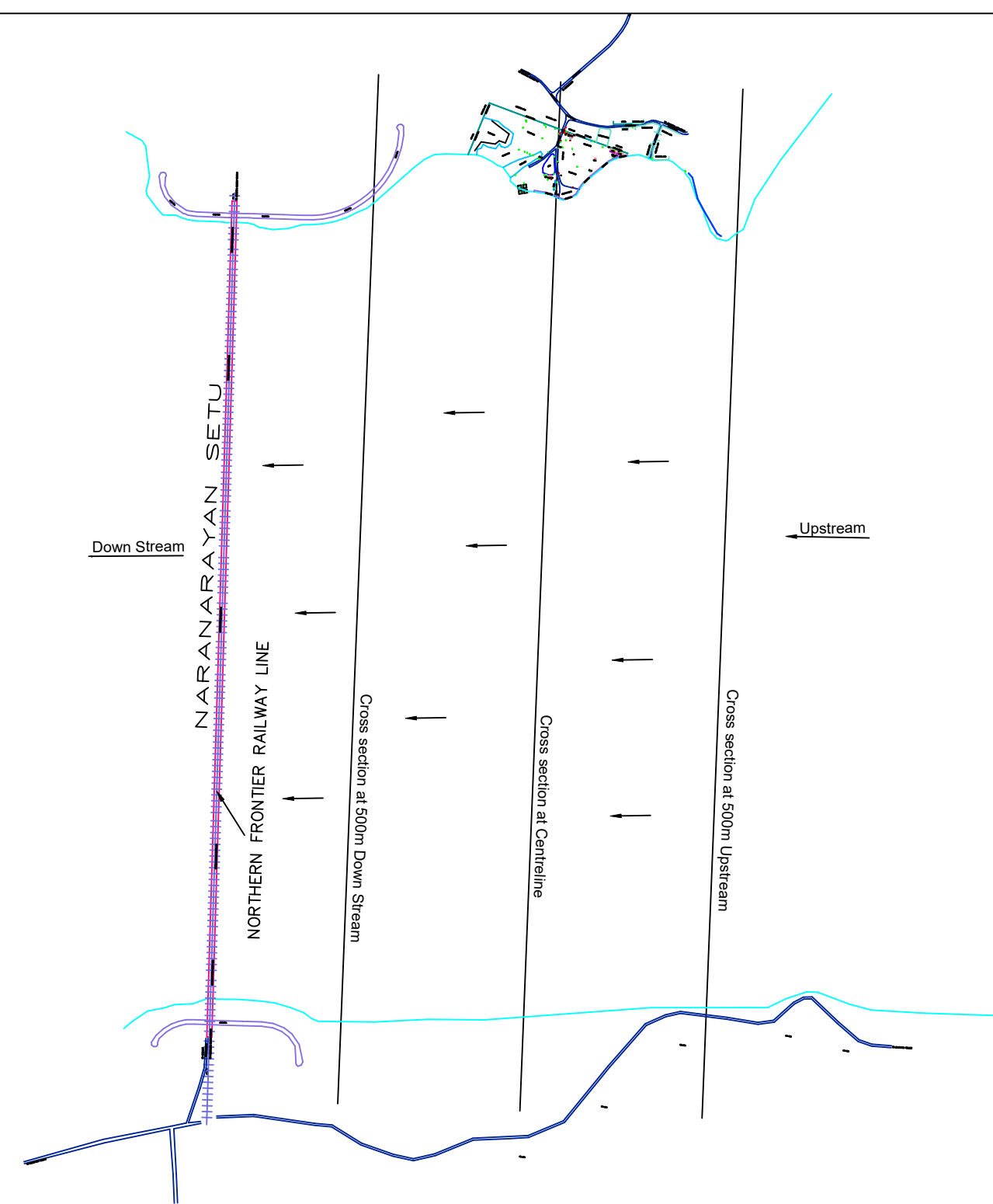
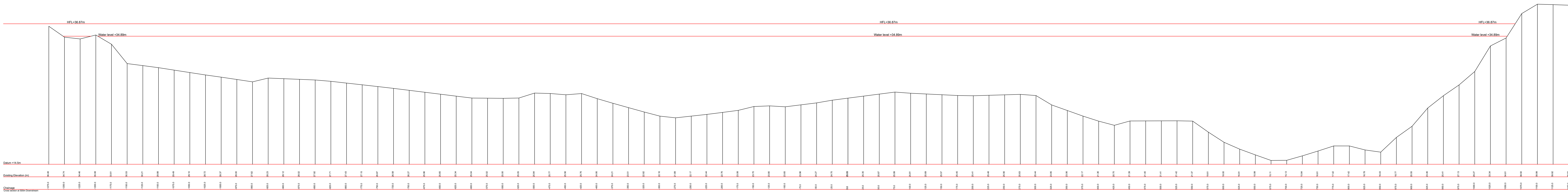
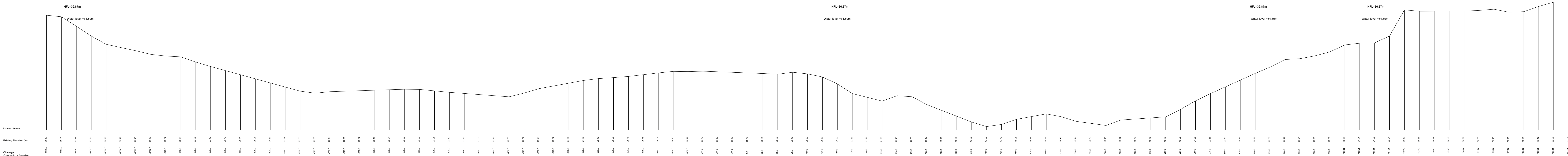
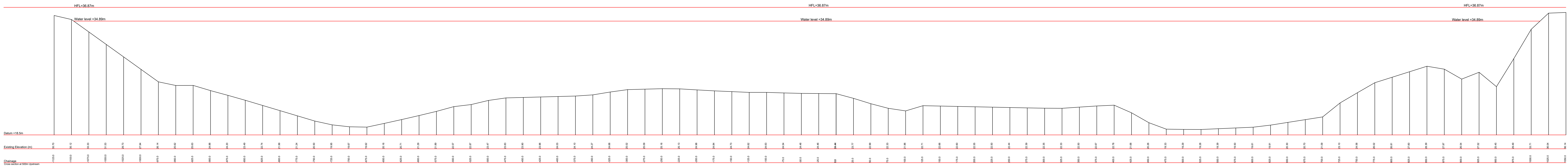


NOTE:
CHART DATUM = 28.28M
WATER LEVEL (MSL)=34.892M
ELEVATIONS AND CONTOURS ARE IN MSL

NOTES				Client	
1. All Dimensions are in metre unless otherwise stated. 2. Survey was carried out as per hand held GPS coordinates. 3. All elevations are with respect to M.S.L. Chart Datum is 28.28m 4. Contours have been drawn at an interval of 1.0m 5. Total Area Surveyed is 678.054 Hectares 6. Reference Pillar Coordinates				AECOM LTD.	
				Project PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JAGIGHOPA, ASSAM	
				Site TOPOGRAPHICAL SURVEY LEFT BANK	
				Survey Agency FARGO CONSULTANTS PVT. LTD. 27-28, Sector-1, Saket, New Delhi-110017, India	
				Job No 2020402J Drawn by G. P. BAL Checked by G. C. MASKAR Appd. by P. BRAHMA	
ID				Scale	
TBM-1				Date	
TBM-2				REV. 2	
STN-1(P-1)					
STN-2(P-2)					
STN-5(P-3)					

APPENDIX-B

GRAIN SIZE DISTRIBUTION GRAPH



Client			
AECOM LTD.			
Project			
PREPARATION OF DETAILED PROJECT REPORT (DPR) FOR DEVELOPMENT OF INLAND WATER TRANSPORT (IWT) FACILITY AT JAGIGHOPA, ASSAM			
Site			
JAGIGHOPA, ASSAM			
Survey Agency			
FARGO CONSULTANTS PVT. LTD.			
Job No.	Drawn by	Chkd. by	Appr'd. by
2020402J	B. PAL	G. C. NASKAR	P. BRAHMA
Drp. No.	Scale	Date	REV. 0
FCPL/2020402J/CS/1	H=1:2000 V=1:100	20.10.2020	

ANNEXURE - 2

Geotechnical Investigations

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1. GEOTECHNICAL INVESTIGATIONS

1.1 Introduction

Geotechnical investigation works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam was entrusted to Fargo Consultants Pvt. Ltd., CF-394 Sector-I, Salt Lake City, Kolkata 700064 by AECOM India Pvt. Ltd., 5th Floor, Tower B, Building No. 10, DLF Cyber City, DLF Phase II Gurgaon 122002, Haryana, India.

1.2 Scope of Work

The scope of the soil investigation work consisted of sinking four (4) boreholes in land location at Jogighopa locations. The boreholes will be terminated at a maximum depth of 50.00m. Soil borings included collection of undisturbed / disturbed soil samples and conducting Standard Penetration Tests. Rock drilling included collection of rock samples and determination of recovery and RQD.

The formation at the site is to be reported for various layers present at their respective depths along with their thickness. As ground water table location influences the method of construction of foundation at a site, its location also needs to be found out.

During sinking of boreholes soil samples both in disturbed and undisturbed conditions were to be collected for laboratory tests. The disturbed samples would be subjected to tests to obtain soil index properties. The undisturbed soil samples, however, would be used mainly for conducting tests to obtain bulk density, shear strength parameters as well as consolidation characteristics of the soil representing the strata. Rock samples are required to be tested for physical properties water absorption, unit weight, porosity and uniaxial compressive strength (UCS).

1.3 Location

The site is located in Brahmaputra River. The nearest airport is located at Guwahati. The Latitude and Longitude of the Jagighopa location for the proposed jettie is provided in the **Table 1.1**. Location of the proposed jetties are shown in **Figure 1.1**.

Table 1.1: Proposed Jetty Location

S. No.	Location	Latitude	Longitude
1	Jogighopa	26°13'9.68"N	90°34'7.89"E



Figure 1.1: Location for Proposed Jetty

1.4 Field Work in Progress

Selected images of soil investigation activities at site are provided below.





Figure 1.2: Selected Photographs – Geotechnical Investigation Works

1.5 Topography

The North East India region is physiographically not a homogenous unit and the present configuration of this region has taken shape during geologically recent time. But the ultimate result of various geological events took place through the geological past. North East India consists of very ancient Archaean and Shillong series rocks exposed in several parts of the Garo, Khasi, Jaintia and Karbi Hills. These rocks are similar to rocks exposed in the rest of the peninsular in Bengal and Bihar of which this was a part at one geological time. All these old rocks form the basement for very much younger Tertiary sediments in upper Assam.

A large part of this region was a landmass upto the formation of the Himalayas about 2,000 million years ago. Then the eastern part of the Khasi Hills, the Jaintia Hills and the Western part of the Karbi Hills became a basin of sedimentation in which sandstones and shales of the Shillong series were deposited. Due to tectonic reasons these were later uplifted and became a landmass.

Thus the geomorphological evolution of the North-eastern region of India is one of uplift and sinking in various parts during the past 100 million years.

Richard E Murphy has divided the landforms of North East India on the basis of both genetic and empirical factors and his physiographic divisions and sub-divisions are given below:

1. The Plateaus: Meghalaya plateau, Karbi Plateau
2. The Hill and Mountains Region: Himalayan Mountains Region, Inner Himalayan (Glacial and Periglacial) Lesser Himalayan Region, Eastern Hills, Dibong-Lohit Knot, Patkai-Hrap-Nagaland- and Manipur Hills, Mizoram-Tripura Range and Valley country

3. The Plains: Brahmaputra Plain, Bhabar-Tarai/Belt, Northern Built-Up strip, Brahmaputra Flood Plain, Southern Built-up Strip, Southern Foot-hill zone, Intermontane and Piedmont plains, Manipur Basin, Barak Plain, Tripura Plain.

But recent scholars have divided North East India into five physiographic units on the basis of lithology, age and mode of evolution. The physiographic divisions of the region are:

1. Karbi-Meghalaya Plateau
2. North-Eastern frontier mountain ranges or Arunachal Himalaya
3. Brahmaputra Valley
4. Barak Plain or Cachar Plain
5. South-Eastern Hill Ranges

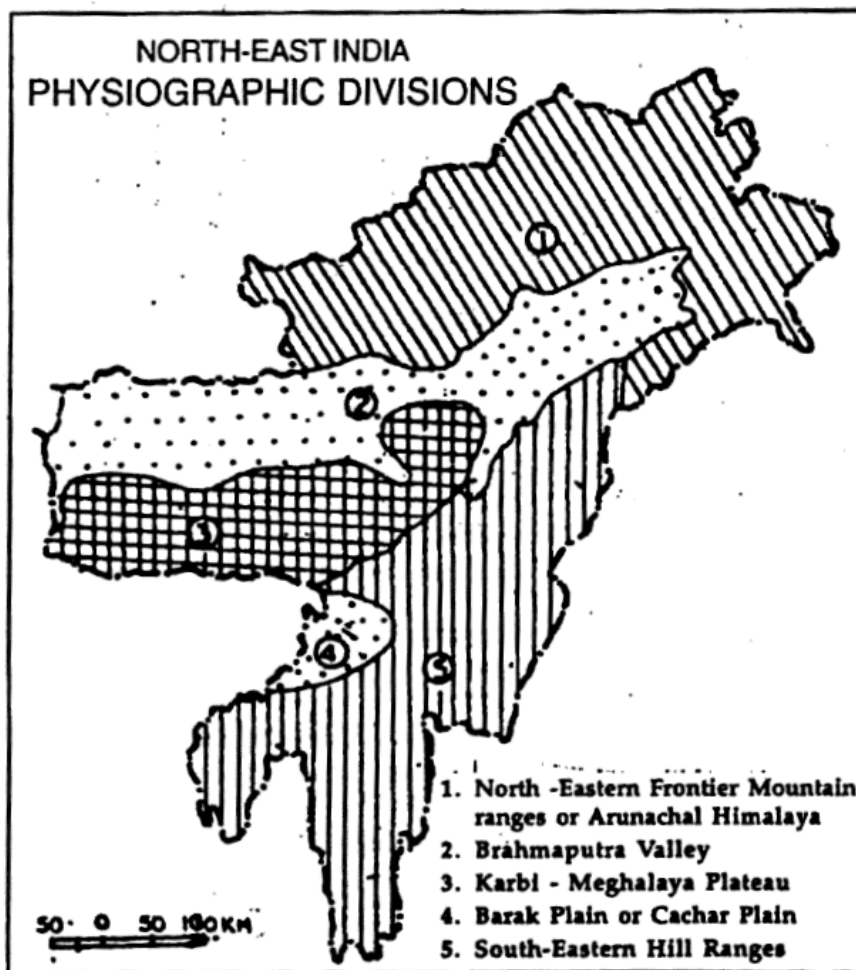


Figure 1.3: Map Showing Broad Physiographic Divisions of Assam

1.6 Geology

Hydrogeologically, the entire area of sediments of Recent to Sub-Recent age. The groundwater conditions as described below. Bongaigaon district is dominated by alluvial different geomorphic units represent separate The flood plain areas along the River Brahmaputra and River Manas are represented by different grades of sand, gravel and clay. Abandoned channel, natural levees, channel bars also represent the same constituents. Ground water occurs under semi-confined to water table condition within the depth range of 2 to 4 m bgl during pre-monsoon period. The younger alluvial plain comprising sand, gravel and clays occupies the central part in the district with similar ground water condition. The depth to water level ranges from 1.30 to 3.00 m bgl during post-monsoon period.

The older alluvium occupies the northern and north western parts of the district and is located at higher elevation. It comprises unconsolidated to semi-consolidated formations comprising limonitic clay, unsorted boulders, pebbles, gravels and sands. Ground water occurs under water table to semi-confined condition and depth to water table varies from 0.50 to 2.53 m bgl.

The denudational hills with weathered top associated with pediment occur as isolated patches in north, west, east, amongst the older and younger alluvium. The thickness of the pediment varies from 5 to 15 m with depth to water level from 1 to 9 m bgl. The denudational hills are composed of gneissic rocks with pegmatite veins as intrusion; the water level is very deep.

1.7 Field Investigation

The details of borehole locations are furnished in **Table 1.2**.

Table 1.2: Borehole Location Coordinates

S. No.	Location	Borehole	Zone	Easting	Northing	R.L.* (m)
1	Jogighopa	LBH1	46R	256967.000	2902478.000	34.962
		LBH2	46R	257070.000	2902374.000	34.485
		LBH3	46R	256943.000	2902348.000	34.903
		LBH4	46R	257114.000	2902264.000	34.203

Note: LBH – Land Boreholes, * R.L. – Elevation with respect to MSL

Field work was executed generally in accordance with IS specifications listed below:

- IS-1892: Code of practice for Subsurface Investigation of Foundations.
- IS-1904: Code of practices for design and construction of foundation in soil: general requirements
- IS-1498: Classification and Identification of soils for General Engineering
- IS-2131: Method for Standard Penetration Test for Soils
- IS-2132: Code for practice for Thin Walled Tube Sampling of Soils.

- f) IS-5313: Guide for Core Drilling Observations.
- g) IS-4078: Code of practice for indexing and storage of drill cores
- h) IS-4464: Code of practice for presentation of drilling information and core description in foundation investigation
- i) IS-6935: Method of determination of water level in borehole
- j) IS-7422: Symbols and abbreviations for use of geological maps, sections and subsurface exploratory logs
- k) IS-9640: Specification for split spoon sampler

Soil samples (disturbed & undisturbed) collected from boreholes were tested for their physical and engineering properties. Rock core samples were tested.

Table 1.3: Physical and Engineering Properties of Collected Soil Samples

Testing	IS-Code	Type of Matrix	Disturbed Sample	Undisturbed Sample
Sieve Analysis	2720 (Part-4)	Clay	☐	☐
		Sand	☐	☐
Hydrometer Analysis	2720 (Part-4)	Clay	☐	☐
		Sand	-	-
Atterberg Limits	2720 (Part-5)	Clay	☐	☐
		Sand	-	-
Natural Moisture Content	2720 (Part-2)	Clay	-	☐
		Sand	-	-
Bulk & Dry Density of Soil	2720 (Part-7, 8 & 9)	Clay	-	☐
		Sand	-	-
Specific Gravity	2720 (Part-3)	Clay	☐	☐
		Sand	☐	☐
Direct Shear Test	2720 (Part-13)	Clay	-	☐
		Sand	-	-
Tri-axial Shear Test (UD)	2720 (Part-12)	Clay	-	☐
		Sand	-	-
Permeability Test	2720 (Part-17)	Clay	-	☐
		Sand	-	-
Consolidation Test	2720 (Part-15)	Clay	-	☐

Testing	IS-Code	Type of Matrix	Disturbed Sample	Undisturbed Sample
		Sand	-	-
Unconfined Compression	2720 (Part-10)	Clay	-	□
		Sand	-	-
Swelling Pressure Test	2720 (Part-41)	Clay	-	□
		Sand	-	-
Free Swell Index Test	2720 (Part-40)	Clay	□	□
		Sand	-	-
Shrinkage Limit Test	2720 (Part-6)	Clay	□	□
		Sand	-	-

The boreholes of 150mm diameter were explored with the help of auger and mud rotary circulation as per IS 1892 - 1979. Here the auger was turned in the bottom of the hole through auger pipes. Due to this the soil cuttings were held in the auger and were drawn to the surface by pulling the auger out of the hole each time the auger was filled. In continuation to auger boring mud rotary boring method was employed. In this method the boring was advanced by a cutter fixed to drill pipes, which were rotated by means of pipe wrenches. Bentonite was pushed simultaneously by a mechanical pump. The slurry flowing out of cutter bottom mixes up with the cut soil and flows up to the ground surface and slurry tank after passing through setting pits and back to the slurry tank. The process was continuous and the same slurry can be used several times. The cutting tool was lowered slowly with the help of a double pulley system fixed on a tripod. This method of boring was followed upto the explored depth in each borehole.

Seamless flush jointed steel casing of 150mm internal diameter was used to prevent any caving of boreholes and it was inserted simultaneously with the advancement of boring operation whenever required.

The undisturbed samples were collected from the boreholes wherever possible, with the help of a thin walled sampler, as per the IS: 2132-1986 "Code of practice for thin walled tube sampling of soils". The area ratio of the sampler was of the order of twelve percent and the inside clearance was around two percent. The sample tube about 450mm long and 100mm inner diameter, was coupled with the sampler with a drive head, vent holes and ball check valve to complete the sampling assembly. While sampling below the water table inside the borehole, the entrapped water has the opportunity to escape through this valve at the top. The sampling assembly was then lowered inside the boreholes by connecting a string of 'A' / 'AW' size drill rods to it. The assembly was driven to a predetermined depth with the help of jarring link. On completion of sampling operation, the sampler was first rotated (so that the soil would shear off on a horizontal plane at the cutting shoe edge) and then raised to the surface. The undisturbed sample was waxed at both ends with proper identification mark on the tube sampler. Undisturbed samples were not collected from hard cohesive soils.

Standard Penetration Tests were conducted inside the boreholes at 3.0m intervals as per IS: 2131-1981 "Method of Standard Penetration Tests for soils". The split spoon sampler used was of standard design and dimension. The spoon was advanced by driving with a drop hammer weighing 63.5 kg

falling freely through a height of 75cm. A record of the number of blows required to penetrate every 15cm. to a depth of 45cm. was kept. The number of blows required for the last 30cm penetration of the split spoon sampler was recorded as 'N' – value. On completion of the test, the sampler was lifted to the ground, opened and the specimen of the soil sample was stored in double polythene bags with the proper identification mark. The penetration number, 'N', has been shown against the corresponding depths in the field bore logs. The distributions of field 'N' values with RL at different locations are shown in the attached figures.

Representative disturbed samples were collected regularly and wherever the stratum changed. These samples were taken from the cutting edge of the cutter and the split spoon samplers after standard penetration tests. These samples were labelled depth wise and used in the preparation of borehole log and for general identification and classification purposes.

The depth of water level in the boreholes was determined 24 hours after the completion of boring so that the water in the boreholes could come to equilibrium with the water table. No artesian condition was encountered in any borehole.

The completed boreholes were backfilled with excavated material with all the safety precaution in order to avoid any mishap.

The field investigation work commenced on 10th November 2020. Field work was completed on 21st November 2020.

1.8 Laboratory Testing

The following laboratory tests were carried out to ascertain the properties of the sub-soil and rock.

1.8.1 Tests on Soil Sample

- Grain size analysis – Sieve Analysis and Hydrometer Analysis
- Natural Moisture Content
- Bulk and Dry Density
- Atterberg Limits
- Specific Gravity
- Tri-axial Test – Unconsolidated Undrained (UU)
- Unconfined Compression Test
- One Dimensional Consolidation Test
- Swelling pressure/Free Swell
- Chemical Test

1.8.2 Tests on Water Samples

- Chemical Test

All these tests were conducted as per relevant I.S. Codes.

1.9 Discussion and Recommendation

The sub-soil formation in this area has been investigated by sinking four (4) boreholes explored upto a maximum depth of 50.45m below the existing ground level. The field investigation data and the results of laboratory test conducted on samples collected from the borehole indicate the presence of five (5) layers. The details of layer like layer no., description of layer and the thickness of each layer as encountered in the borehole are furnished below.

Table 1.4: Sub Soil Data

Layer No.	Description	Layer Thickness (m)			
		LBH-1	LBH-2	LBH-3	LBH-4
I	Yellowish grey silt clay mixed with sand	3.00	1.00	-	-
II	Yellowish grey/grey loose to very dense silty sand/sandy silt	20.10	33.00	37.00	35.5
III	Yellowish grey stiff to hard silty clay with brown spots	10.90	3.00	-	-
IV	Greyish very dense silty sand mixed with clay	3.00	3.00	-	-
V	Greyish brown/yellowish grey very stiff to hard silty clay with traces of sand	13.45*	10.45*	13.28*	14.95*
Note - * - Upto termination depth					

The ground water level has been found to exist between 3.30m to 3.50m below existing ground level during the period of field work. The borehole location plan, graphical representation of field 'N' values with depth, tabulated laboratory test results, laboratory test curves are provided in Annexure A.

On close scrutiny of field and laboratory test results and based on experience and judgement, necessary soil parameters for the purpose of design of foundation are tabulated in the following table.

Table 1.5: Sub Soil Data (N-value, Bulk Density and Share Strength)

Layer No.	Description	Thickness (m)	Average of N-Value	Bulk Density (t/m ³)	Shear Strength Parameter
I	Yellowish grey silt clay mixed with sand	-	7	1.785	c=4.7t/m ²
II	Yellowish grey/grey loose to very dense silty sand/sandy silt	35.5	14+	1.76 [#]	□=31.5 ^{o#}
III	Yellowish grey stiff to hard silty clay with brown spots	-	34	2.03 [#]	c=17.0t/m ^{2#}
IV	Greyish very dense silty sand mixed with clay	-	29+	1.93 [#]	□=35.0 ^{o#}

Layer No.	Description	Thickness (m)	Average of N-Value	Bulk Density (t/m ³)	Shear Strength Parameter
V	Greyish brown/yellowish grey very stiff to hard silty clay with traces of sand	14.95*	52	2.10 [#]	c=26.0t/m ^{2#}
* = Upto termination depth #=Suggested value + = Corrected N-value					

In view of the sub-soil formation encountered in this area deep foundation may be provided to carry the load of the superstructure. The pile load capacities of suggested piles are provided in the table below. Calculations as per relevant IS Codes [i.e. IS:2911(Part I/Sec II)] were carried out using the suggested soil parameters provided in the table above. A sample calculation is provided in Annexure – A. Pile centre-to-centre spacing of 3"D" should be maintained, where "D" is the pile diameter. It is suggested that the pile load capacities be checked by conducting pile load test as per IS Code.

Table 1.6: Pile Load Capacity

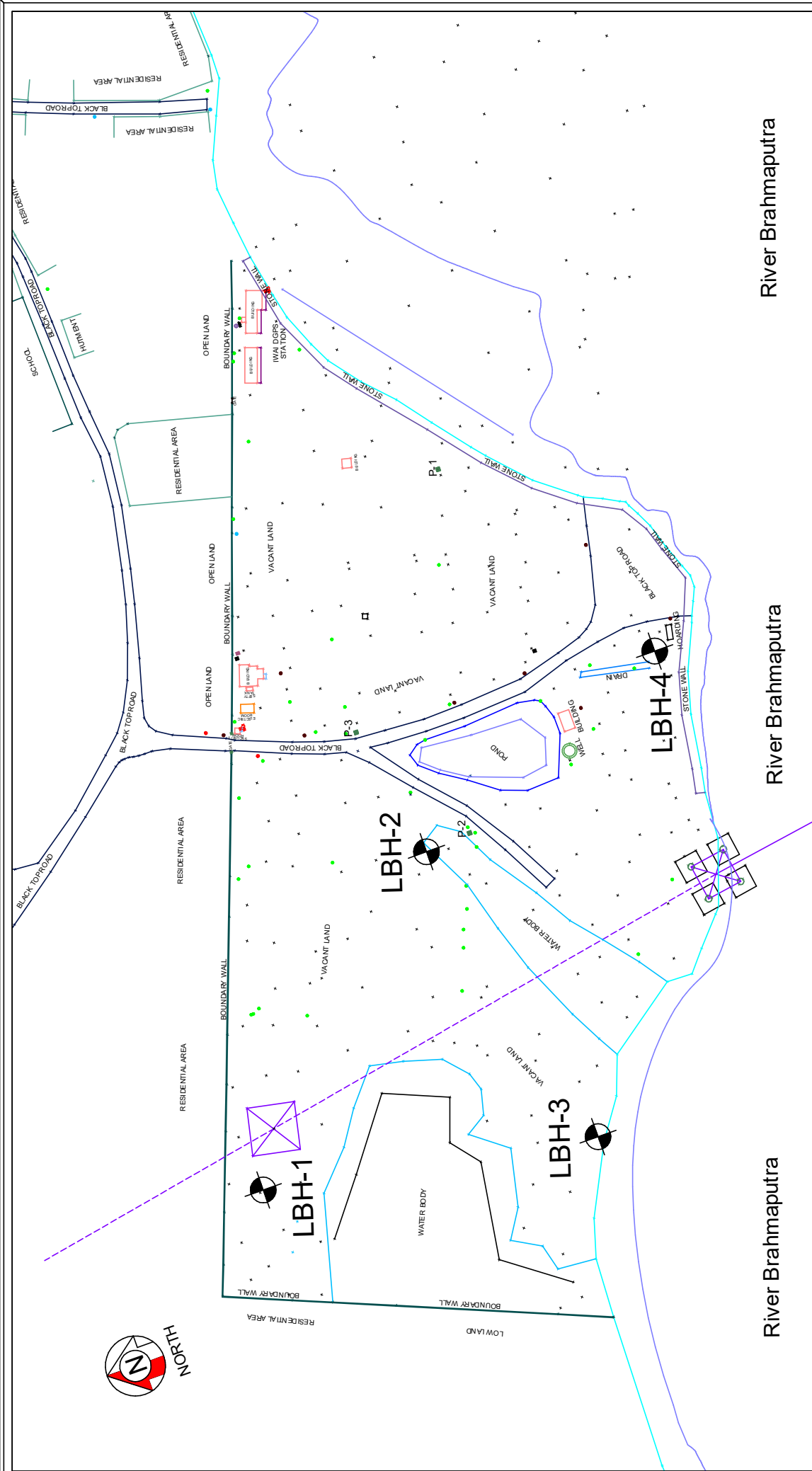
Dia. (mm)	Cut-off below Existing GL (m)	Pile Founding Depth below Existing GL(m)	Suggested Pile Vertical load Capacity (t)	Suggested Pile Uplift load Capacity (t)	Suggested Pile Lateral load Capacity (t)
0.75	2.00	20.00	92.7	53.6	5.4
0.75	2.00	25.00	116.8	73.3	5.4
0.75	2.00	30.00	138.2	92.9	5.4
0.75	2.00	35.00	165.1	112.6	5.4
1.00	2.00	20.00	159.4	80.7	8.5
1.00	2.00	25.00	178.9	114.5	8.5
1.00	2.00	30.00	204.5	140.9	8.5
1.00	2.00	35.00	273.2	173.5	8.5

1.10 General Recommendations

Proper care shall also be taken during construction, particularly during excavation and casting of pile caps. The sides of excavation shall be protected against possible collapse or caving in. The bottom of excavation shall be checked against any heaving. The stagnating water from the excavated pit shall be conveniently drained out. Chemical test results are included in Annexure-A. Chemical test results did not indicate the need of use of special cement.

APPENDIX-A:

GEOTECHNICAL INVESTIGATION



Bore hole location plan for preparation of Detailed Project Report (DPR) at Jogighopa, Assam

Note: All measurements are in metres		CONSULTANT:		FIG NO:
CIENT:	SCALE:	PROJECT:	Fargo Consultants Pvt. Ltd.	
AECOM India Pvt. Ltd. 9 Floor, Infinity Tower C, DLF Cyber City, Phase -2, Gurgaon-122002, Haryana, India	Not to scale	Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam	Mailing Address: CF-394 SALT LAKE CITY, SECTOR-1, KOLKATA - 700 064 PHONE:(033) 2337 3775 e-mail:fargoconsultants@gmailcom	
				1

FARGO CONSULTANTS PVT. LTD.**BORE / DRILL LOG**

Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Project No. : 2020406J

Bore Hole No. : LBH-1

Location : Jogighopa, Assam

Ground Elevation : +34.962m

Method of Boring / Drilling : R.M.C

Dia. of Boring/Drilling : 150mm

Boring / Drilling Equipment : Mechanical Winch

Casing Lowered : 4.50m

Water Level (Static) : 3.00m bgl.

Date : 10.11.2020 to 13.11.2020

Date	Sample and in-situ Test		Length (m)	Sample/Test Code	SPT			N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description	
	Time (Min)	DEPTH/RUN (m)			0cm-15cm	15cm-30cm	30cm-45cm						
		From											To
10.11.2020		0.00	0.50	0.50	D	-	-	-	-			Yellowish grey silt clay mixed with sand	
		1.50	1.95	0.45	U	-	-	-	-				
		3.00	3.45	0.45	P	3	3	4	7				
		4.50	4.95	0.45	P	2	3	4	7				
		6.00	6.45	0.45	P	3	5	8	13				
		7.50	7.95	0.45	P	3	5	9	14				
		9.00	9.45	0.45	P	5	5	8	13				
		10.50	10.95	0.45	P	5	6	7	13				
		12.00	12.45	0.45	P	6	9	10	19				
		13.50	13.95	0.45	P	5	9	13	22				
11.11.2020		15.00	15.45	0.45	P	9	10	10	20			3.00m Yellowish grey/grey loose to very dense silty sand	
		16.50	16.95	0.45	P	10	15	21	36				
		18.00	18.45	0.45	P	12	22	25	47				
		19.50	19.95	0.45	P	10	12	13	25				
		21.00	21.45	0.45	P	11	21	27	48				
		22.50	22.95	0.45	P	8	15	25	40				
		24.00	24.45	0.45	P	5	8	8	16				
		25.50	25.95	0.45	U	-	-	-	-				
		27.00	27.45	0.45	P	9	16	25	41				
		28.50	28.95	0.45	P	10	19	20	39				
12.11.2020		30.00	30.45	0.45	P	11	21	21	42			23.10m Yellowish grey stiff to hard silty clay with brown spots	
		31.50	31.95	0.45	P	12	20	38	58				
		33.00	33.45	0.45	P	14	24	48	72				
		34.50	34.95	0.45	P	14	36	43	79				
													34.00m Greyish very dense silty sand mixed with clay.

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water

Test Code P-Standard Penetration, V-Vane Shear

FARGO CONSULTANTS PVT. LTD.BORE / DRILL LOG

Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Project No. : 2020406J

Bore Hole No. : LBH-1

Location : Jogighopa, Assam

Ground Elevation : +34.962m

Method of Boring / Drilling : R.M.C

Dia. of Boring/Drilling : 150mm

Boring / Drilling Equipment : Mechanical Winch

Casing Lowered : 4.50m

Water Level (Static) : 3.00m bgl.

Date : 10.11.2020 to 13.11.2020

Date	Sample and in-situ Test		Length (m)	Sample/Test Code	SPT			N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description				
	Time (Min)	DEPTH/RUN (m)			0cm-15cm	15cm-30cm	30cm-45cm									
		From											To			
13.11.2020		36.00	36.45	0.45	P	15	44	49	93				Continued from previous page			
		37.50	37.95	0.45	P	10	12	13	25				37.00m			
		39.00	39.45	0.45	P	9	12	12	24				Greyish brown/yellowish grey very stiff to hard silty clay			
		40.50	40.95	0.45	P	7	12	13	25							
		42.00	42.45	0.45	P	8	13	13	26							
		43.50	43.95	0.45	P	14	24	33	57							
		45.00	45.45	0.45	P	22	30	40	70							
		46.50	46.95	0.45	P	20	30	43	73							
		48.00	48.45	0.45	P	23	31	49	80							
		50.00	50.45	0.45	P	21	40	51	91							
		Borehole Termination Depth = 50.45m														

FARGO CONSULTANTS PVT. LTD.BORE / DRILL LOG

Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Project No. : 2020406J

Bore Hole No. : LBH-2

Location : Jogighopa, Assam

Ground Elevation : +34.485m

Method of Boring / Drilling : R.M.C

Dia. of Boring/Drilling : 150mm

Boring / Drilling Equipment : Mechanical Winch

Casing Lowered : 4.50m

Water Level (Static) : 2.65m bgl.

Date : 16.11.2020 to 18.11.2020

Date	Sample and in-situ Test		Length (m)	Sample/Test Code	SPT			N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description	
	Time (Min)	DEPTH/RUN (m)			0cm-15cm	15cm-30cm	30cm-45cm						
		From											To
16.11.2020		0.50	0.95	0.45	U	-	-	-	-				Yellowish grey silty clay
		1.50	1.95	0.45	P	3	4	5	9				1.00m Yellowish grey/grey loose to very dense silty
		3.00	3.45	0.45	P	3	4	5	9				
		4.50	4.95	0.45	P	4	3	4	7				
		6.00	6.45	0.45	P	3	4	6	10				
		7.50	7.95	0.45	P	3	6	9	15				
		9.00	9.45	0.45	P	4	9	10	19				
		10.50	10.95	0.45	P	3	8	9	17				
		12.00	12.45	0.45	P	6	8	14	22				
		13.50	13.95	0.45	P	6	11	16	27				
17.11.2020		15.00	15.45	0.45	P	12	14	16	30				
		16.50	16.95	0.45	P	9	12	20	32				
		18.00	18.45	0.45	P	12	23	25	48				
		19.50	19.95	0.45	P	8	12	17	29				
		21.00	21.45	0.45	P	7	11	15	26				
		22.50	22.95	0.45	P	10	15	22	37				
		24.00	24.45	0.45	P	11	17	26	43				
		25.50	25.95	0.45	P	14	34	38	72				
		27.00	27.45	0.45	P	18	42	47	89				
		28.50	28.95	0.45	P	13	23	36	59				
		30.00	30.45	0.45	P	11	19	33	52				
		31.50	31.95	0.45	P	21	32	44	76				
		33.00	33.29	0.29	P	37	58 (14cm)	-	>100				
		34.50	34.95	0.45	P	10	15	20	35				34.00m Yellowish grey hard silty clay
18.11.2020													

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water

Test Code P-Standard Penetration, V-Vane Shear

FARGO CONSULTANTS PVT. LTD.**BORE / DRILL LOG**

Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Project No. : 2020406J

Bore Hole No. : LBH-3

Location : Jogighopa, Assam

Ground Elevation : +34.903m

Method of Boring / Drilling : R.M.C

Dia. of Boring/Drilling : 150mm

Boring / Drilling Equipment : Mechanical Winch

Casing Lowered : 4.50m

Water Level (Static) : 3.10m bgl.

Date : 13.11.2020 to 15.11.2020

Date	Sample and in-situ Test		Length (m)	Sample/Test Code	SPT			N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description	
	Time (Min)	DEPTH/RUN (m)			0cm-15cm	15cm-30cm	30cm-45cm						
		From											To
13.11.2020		1.50	1.95	0.45	P	2	2	2	4			Grey loose to very dense silty sand mixed traces of clay	
3.00		3.45	0.45	P	6	7	7	14					
4.50		4.95	0.45	P	5	6	5	11					
6.00		6.45	0.45	P	3	4	4	8					
7.50		7.95	0.45	P	3	4	6	10					
14.11.2020		9.00	9.45	0.45	P	5	8	11	19				
10.50		10.95	0.45	P	9	13	15	28					
12.00		12.45	0.45	P	10	18	20	38					
13.50		13.95	0.45	P	6	9	16	25					
15.00		15.45	0.45	P	9	9	10	19					
16.50		16.95	0.45	P	11	19	24	43					
18.00		18.45	0.45	P	15	25	30	55					
19.50		19.95	0.45	P	13	20	29	49					
21.00		21.45	0.45	P	12	19	27	46					
22.50		22.95	0.45	P	11	17	23	40					
24.00		24.45	0.45	P	10	16	17	33					
25.50		25.95	0.45	P	14	24	31	55					
27.00		27.45	0.45	P	16	30	36	66					
28.50		28.95	0.45	P	19	43	53	96					
30.00		30.29	0.29	P	22	60 (14cm)	-	>100					
31.50		31.95	0.45	P	24	30	48	78					
15.11.2020		33.00	33.45	0.45	P	18	28	39	67				
34.50		34.95	0.45	P	15	22	34	56					
36.00		36.45	0.45	P	13	21	30	51					
												37.00m	

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water

Test Code P-Standard Penetration, V-Vane Shear

FARGO CONSULTANTS PVT. LTD.**BORE / DRILL LOG**

Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Project No. : 2020406J

Bore Hole No. : LBH-4

Location : Jogighopa, Assam

Ground Elevation : +34.203m

Method of Boring / Drilling : R.M.C

Dia. of Boring/Drilling : 150mm

Boring / Drilling Equipment : Mechanical Winch

Casing Lowered : 4.50m

Water Level (Static) : 5.20m bgl.

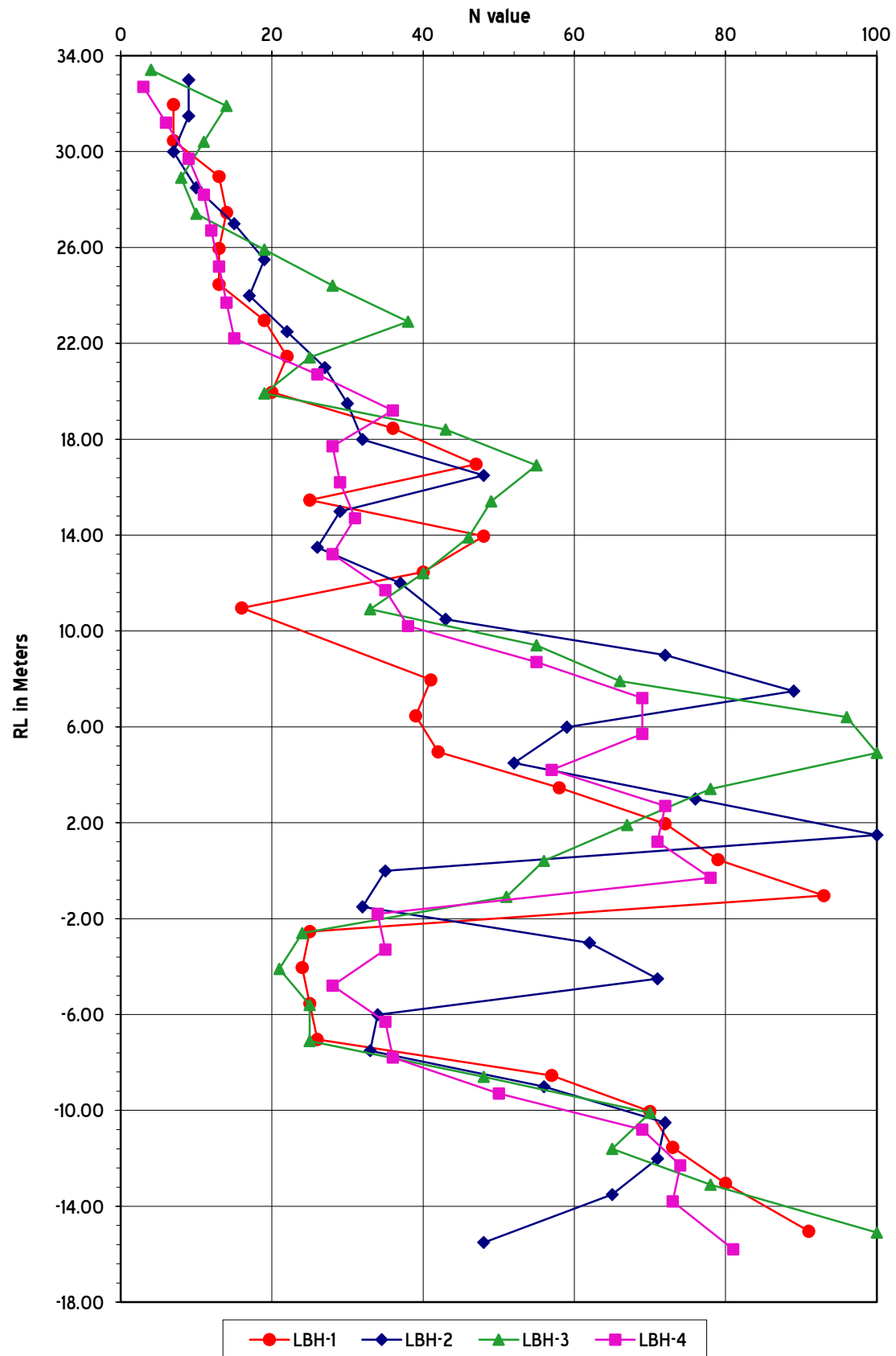
Date : 19.11.2020 to 21.11.2020

Date	Sample and in-situ Test		Length (m)	Sample/Test Code	SPT			N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description	
	Time (Min)	DEPTH/RUN (m)			0cm-15cm	15cm-30cm	30cm-45cm						
		From										To	
19.11.2020		1.50	1.95	0.45	P	1	1	2	3			Yellowish grey/grey very loose to very dense medium dense silty sand mixed traces of clay	
		3.00	3.45	0.45	P	2	3	3	6				
		4.50	4.95	0.45	P	3	4	5	9				
		6.00	6.45	0.45	P	5	5	6	11				
		7.50	7.95	0.45	P	4	6	6	12				
		9.00	9.45	0.45	P	5	6	7	13				
		10.50	10.95	0.45	P	4	6	8	14				
		12.00	12.45	0.45	P	5	7	8	15				
		13.50	13.95	0.45	P	7	10	16	26				
		15.00	15.45	0.45	P	10	14	22	36				
		16.50	16.95	0.45	P	10	13	15	28				
		18.00	18.45	0.45	P	11	14	15	29				
		19.50	19.95	0.45	P	10	14	17	31				
		21.00	21.45	0.45	P	9	12	16	28				
		22.50	22.95	0.45	P	11	14	21	35				
20.11.2020		24.00	24.45	0.45	P	11	15	23	38				
		25.50	25.95	0.45	P	13	22	33	55				
		27.00	27.45	0.45	P	17	29	40	69				
		28.50	28.95	0.45	P	14	27	42	69				
		30.00	30.29	0.29	P	16	21	36	57				
		31.50	31.95	0.45	P	20	31	41	72				
		33.00	33.45	0.45	P	19	28	43	71				
		34.50	34.95	0.45	P	15	34	44	78				
		36.00	36.45	0.45	P	12	15	19	34				
													35.50m Yellowish grey very stiff to hard silty clay

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water

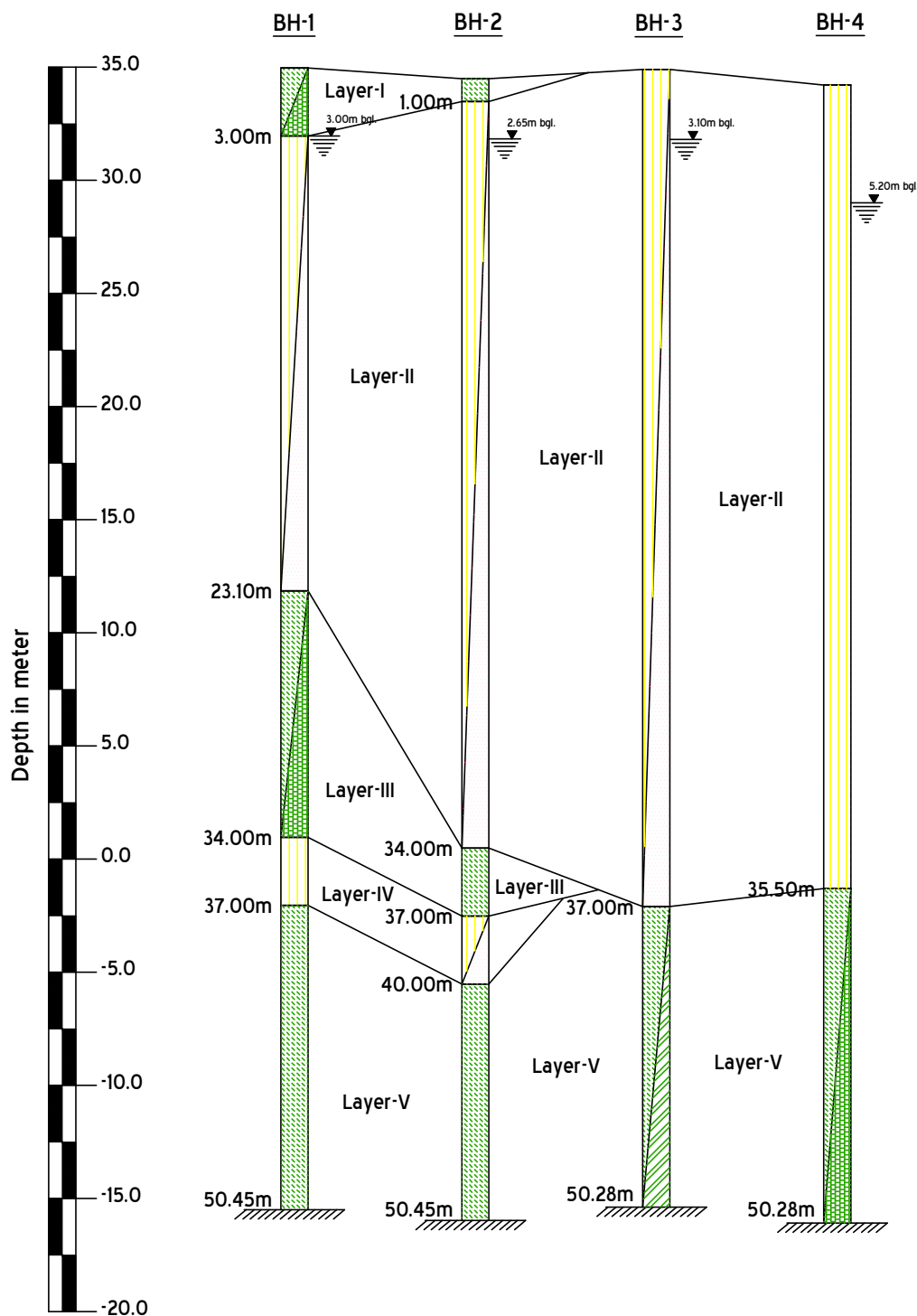
Test Code P-Standard Penetration, V-Vane Shear

**GRAPHICAL REPRESENTATION OF
FIELD N-VALUE WITH RL AT
PREPARATION OF DPR AT JOGIGHOPA, ASSAM**



Project :	Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam	Job No.:	2020406J
		Fig No.:	2

FARGO CONSULTANTS PVT. LTD., KOLKATA



- Layer - I - Yellowish grey silt clay mixed with sand
 Layer - II - Yellowish grey/grey loose to very dense silty sand/sandy silt
 Layer - III - Yellowish grey stiff to hard silty clay with brown spots
 Layer - IV - Greyish very dense silty sand mixed with clay
 Layer - V - Greyish brown/yellowish grey very stiff to hard silty clay with traces of sand

Generalized soil profile for preparation of Detailed Project Report (DPR) at Jogighopa, Assam

CLIENT:

AECOM India Pvt. Ltd.
 9 Floor, Infinity Tower C,
 DLF Cyber City, Phase -2,
 Gurgaon-122002, Haryana, India

SCALE:

Not to scale

PROJECT:

Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

CONSULTANT:



FARGO CONSULTANTS PVT. LTD.
 Mailing Address:
 CF-394, SALT LAKE CITY,
 SECTOR- I, KOLKATA - 700 064
 PHONE: (033)2337 3775
 e-mail: fargoconsultants@gmail.com

FIG. NO.

3

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID	Depth (m)	Sample Type	'N' value	Corrected 'N' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam: BH-1	I	0.50	D	-	-	0.0	30.3	53.5	16.2	-	-	-	38.1	23.6	14.5	UU	0.47	4.0	2.65	0.9166	0.27	1.62	0.3758	0.0381
	II	1.50	U	-	-	0.0	14.6	75.5	9.9	21.9	1.785	1.464	27.5	19.2	8.3	UU	-	-	-	-	-	-	-	-
		3.00	P	7	8	0.0	86.6	13.4*	-	-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-
		4.50	P	7	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		6.00	P	13	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		7.50	P	14	14	0.0	81.3	18.7*	-	-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-
		9.00	P	13	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		10.50	P	13	12	0.0	91.8	8.2*	-	-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-
		12.00	P	19	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		13.50	P	22	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		15.00	P	20	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		16.50	P	36	23	0.0	78.6	21.4*	-	-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-
	III	18.00	P	47	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		19.50	P	25	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		21.00	P	48	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		22.50	P	40	23	0.0	86.4	13.6*	-	-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-
		24.00	P	16	-	0.0	8.1	49.5	42.4	-	-	-	47.6	17.2	30.4	-	-	-	-	-	-	-	-	-
		25.50	U	-	-	0.0	2.3	81.9	15.8	22.6	1.952	1.592	32.6	21.7	10.9	UU	1.38	0.5	-	-	-	-	-	-
		27.00	P	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		28.50	P	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		30.00	P	42	-	0.0	2.2	83.6	14.2	-	-	-	31.9	22.0	9.9	-	-	-	-	-	-	-	-	-
		31.50	P	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IV	33.00	P	72	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		34.50	P	79	33	0.0	52.9	35.3	11.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note :

1. U-Undisturbed Sample

2. D-Disturbed Sample

3. P-Standard Penetration Test

4. UU : Unconsolidated Undrained Triaxial Test

5. UC : Unconfined Compression Test

6. CU : Consolidated Un-drained Test

7. CD : Consolidated Drained Test

8. DS : Direct Shear Test

9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID	Depth (m)	Sample Type	'N' value	Corrected 'N' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam: BH-1 (Continued)	V	36.00	P	93	37	.	.	.	.	.	.	.	48.8	18.8	30.0	.	.	.	.	.	.	.	.	.
		37.50	P	25	.	0.0	2.4	58.2	39.4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		39.00	P	24	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		40.50	P	25	.	0.0	0.4	80.4	19.2	.	.	.	36.5	23.7	12.8	.	.	.	.	.	.	.	.	.
		42.00	P	26	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		43.50	P	57	.	0.0	0.3	80.4	19.3	.	.	.	36.2	24.0	12.2	.	.	.	.	.	.	.	.	.
		45.00	P	70	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		46.50	P	73	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		48.00	P	80	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		50.00	P	91	.	0.0	0.3	81.0	18.7	.	.	.	36.0	23.4	12.6	.	.	.	.	.	.	.	.	.

Note :

1. U-Undisturbed Sample
2. D-Disturbed Sample
3. P-Standard Penetration Test

4. UU : Unconsolidated Undrained Triaxial Test
5. UC : Unconfined Compression Test
6. CU : Consolidated Un-drained Test

7. CD : Consolidated Drained Test
8. DS : Direct Shear Test
9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID	Depth (m)	Sample Type	'N' value	Corrected 'N' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam: BH-2	I	0.50	U	.	.	0.0	13.4	74.1	12.5	22.5	1.794	1.464	37.6	20.7	16.9	UU	0.51	4.0	2.65	0.8095	0.09	0.88	0.1395	0.0134
	II	1.50	P	9	.	0.0	49.3	41.2	9.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		3.00	P	9	.	0.0	31.9	58.5	9.6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		4.50	P	7	8	0.0	77.0	15.5	7.5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		6.00	P	10	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		7.50	P	15	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		9.00	P	19	17	0.0	90.0	10.0*	.	.	.	.	Non Plastic			.	.	.	.	.	.	.	.	.
		10.50	P	17	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		12.00	P	22	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		13.50	P	27	20	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		15.00	P	30	21	0.0	83.2	16.8*	.	.	.	.	Non Plastic			.	.	.	.	.	.	.	.	.
		16.50	P	32	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		18.00	P	48	28	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		19.50	P	29	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		21.00	P	26	18	0.0	79.3	20.7*	.	.	.	.	Non Plastic			.	.	.	.	.	.	.	.	.
		22.50	P	37	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		24.00	P	43	24	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		25.50	P	72	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		27.00	P	89	40	0.0	74.9	25.1*	.	.	.	.	Non Plastic			.	.	.	.	.	.	.	.	.
		28.50	P	59	29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		30.00	P	52	26	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		31.50	P	76	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		33.00	P	>100	>41	0.0	97.4	2.6*	.	.	.	.	Non Plastic			.	.	.	.	.	.	.	.	.
	III	34.50	P	35	.	0.0	9.3	61.2	29.5	.	.	.	47.6	18.0	29.6	.	.	.	.	.	.	.	.	.

Note :

1. U-Undisturbed Sample
2. D-Disturbed Sample
3. P-Standard Penetration Test

4. UU : Unconsolidated Undrained Triaxial Test
5. UC : Unconfined Compression Test
6. CU : Consolidated Un-drained Test

7. CD : Consolidated Drained Test
8. DS : Direct Shear Test
9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID		Depth (m)	Sample Type	'N' value	Corrected 'N' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
	III	IV																							
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam: BH-2 (Continued)	V		36.00	P	32	18	.	90.2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	IV		37.50	P	62	27	0.0	.	9.8*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			39.00	P	71	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			40.50	P	34	.	0.0	1.2	81.3	17.5	.	.	.	37.4	20.8	16.6	.	.	.	.	.	.	.	.	.
			42.00	P	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			43.50	P	56	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			45.00	P	72	.	0.0	1.5	80.0	18.5	.	.	.	37.5	20.9	16.6	.	.	.	.	.	.	.	.	.
			46.50	P	71	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
			48.00	P	65	.	0.0	1.3	79.6	19.1	.	.	.	37.7	22.5	15.2	.	.	.	.	.	.	.	.	.
			50.00	P	48	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Note :

1. U-Undisturbed Sample
2. D-Disturbed Sample
3. P-Standard Penetration Test

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6. CU : Consolidated Un-drained Test

7. CD : Consolidated Drained Test
8. DS : Direct Shear Test
9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID	Depth (m)	Sample Type	'N' value	Corrected 'N'' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam; BH-3	II	1.50	P	4	.	0.0	39.7	53.4	6.9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		3.00	P	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		4.50	P	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		6.00	P	8	.	0.0	35.6	56.6	7.8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		7.50	P	10	10	0.7	82.9	16.4*	.	Non Plastic	.	.	.	Non Plastic	.	.	.	.	.	.	.	.	.	.
		9.00	P	19	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		10.50	P	28	21	0.7	78.5	20.8*	.	Non Plastic	.	.	.	Non Plastic	.	.	.	.	.	.	.	.	.	.
		12.00	P	38	25	0.0	82.7	17.3*	.	Non Plastic	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		13.50	P	25	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		15.00	P	19	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		16.50	P	43	26	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		18.00	P	55	30	0.0	79.5	20.5*	.	Non Plastic	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		19.50	P	49	27	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		21.00	P	46	26	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		22.50	P	40	23	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		24.00	P	33	20	3.8	86.0	10.2*	.	Non Plastic	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		25.50	P	55	28	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		27.00	P	66	31	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		28.50	P	96	42	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		30.00	P	>100	>42	0.2	81.7	18.1*	.	Non Plastic	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		31.50	P	78	34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		33.00	P	67	30	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		34.50	P	56	26	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		36.00	P	51	24	0.0	77.7	22.3*	.	Non Plastic	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Note :

1. U-Undisturbed Sample
2. D-Disturbed Sample
3. P-Standard Penetration Test

4. UU : Unconsolidated Undrained Triaxial Test
5. UC : Unconfined Compression Test
6. CU : Consolidated Un-drained Test

7. CD : Consolidated Drained Test
8. DS : Direct Shear Test
9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID	Depth (m)	Sample Type	'N' value	Corrected 'N' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam: BH-3 (Continued)	V	37.50	P	24	.	0.0	2.2	72.6	25.2	.	.	.	56.3	22.0	34.3	.	.	.	.	.	.	.	.	.
		39.00	P	21	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		40.50	P	25	.	0.0	3.8	72.3	23.9	.	.	.	38.3	22.9	15.4	.	.	.	.	.	.	.	.	.
		42.00	P	25	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		43.50	P	48	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		45.00	P	70	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		46.50	P	65	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
		48.00	P	78	.	0.0	2.8	72.1	25.1	.	.	.	38.1	22.7	15.4	.	.	.	.	.	.	.	.	.
		50.00	P	>100	.	0.0	3.4	81.8	14.8	.	.	.	49.0	24.6	24.4	.	.	.	.	.	.	.	.	.

Note :
1. U-Undisturbed Sample
2. D-Disturbed Sample
3. P-Standard Penetration Test
4. UU : Unconsolidated Undrained Triaxial Test
5. UC : Unconfined Compression Test
6. CU : Consolidated Un-drained Test
7. CD : Consolidated Drained Test
8. DS : Direct Shear Test
9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Layer ID	Depth (m)	Sample Type	'N' value	Corrected 'N' Value	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Natural Moisture Content (%)	Bulk Density (gm/cc)	Dry density (gm/cc)	Liquid Limit(%)	Plastic Limit (%)	Plasticity Index (%)	Type of Test	Cohesion (kg/cm ²)	Angle of Friction (degree)	Sp.Gravity	e ₀	P ₀ (kg/cm ²)	P _c (kg/cm ²)	C _c	C _r
Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam; BH-4	II	1.50	P	3	4	0.3	69.5	30.2*						Non Plastic										
		3.00	P	6	7	-	-	-	-															
		4.50	P	9	9	-	-	-	-															
		6.00	P	11	11	0.2	73.0	26.8*						Non Plastic										
		7.50	P	12	11	0.0	83.4	16.6*						Non Plastic										
		9.00	P	13	12	-	-	-	-															
		10.50	P	14	12	-	-	-	-															
		12.00	P	15	13	0.0	80.2	19.8*						Non Plastic										
		13.50	P	26	18	-	-	-	-															
		15.00	P	36	22	0.0	73.7	26.3*						Non Plastic										
		16.50	P	28	19	-	-	-	-															
		18.00	P	29	19	-	-	-	-															
		19.50	P	31	19	-	-	-	-															
		21.00	P	28	18	0.0	70.1	29.9*						Non Plastic										
		22.50	P	35	20	-	-	-	-															
		24.00	P	38	21	-	-	-	-															
		25.50	P	55	27	-	-	-	-															
		27.00	P	69	31	-	-	-	-															
		28.50	P	69	31	-	-	-	-															
		30.00	P	57	26	-	-	-	-															
		31.50	P	72	31	-	-	-	-															
		33.00	P	71	30	-	-	-	-															
		34.50	P	78	32	-	-	-	-															
	V	36.00	P	34	-	0.0	2.8	75.0	22.2				39.3	18.7	20.6									

Note :

1. U-Undisturbed Sample
2. D-Disturbed Sample
3. P-Standard Penetration Test

4. UU : Unconsolidated Undrained Triaxial Test
5. UC : Unconfined Compression Test
6. CU : Consolidated Un-drained Test

7. CD : Consolidated Drained Test
8. DS : Direct Shear Test
9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam Location: Jogighopa, Assam: BH-4 (Continued) Bore Hole No.	Layer ID	V									
	Depth (m)	37.50	39.00	40.50	42.00	43.50	45.00	46.50	48.00	50.00	
	Sample Type	P	P	P	P	P	P	P	P	P	
	'N' value	35	28	35	36	50	69	74	73	81	
	Corrected "N" Value	.	.	.	.	.	.	.	.	.	
	Gravel (%)	.	.	.	0.0	.	.	.	.	0.0	
	Sand (%)	.	.	.	1.3	.	.	.	.	2.6	
	Silt (%)	.	.	.	82.1	.	.	.	.	58.8	
	Clay (%)	.	.	.	16.6	.	.	.	.	38.6	
	Natural Moisture Content (%)	.	.	.	.	.	.	.	.	.	
	Bulk Density (gm/cc)	.	.	.	.	.	.	.	.	.	
	Dry density (gm/cc)	.	.	.	.	.	.	.	.	.	
	Liquid Limit(%)	.	.	.	34.6	.	.	.	.	49.2	
	Plastic Limit (%)	.	.	.	19.8	.	.	.	.	17.3	
	Plasticity Index (%)	.	.	.	14.8	.	.	.	.	31.9	
	Type of Test	.	.	.	.	.	.	.	.	.	
Cohesion (kg/cm ²)	.	.	.	.	.	.	.	.	.		
Angle of Friction (degree)	.	.	.	.	.	.	.	.	.		
Sp.Gravity	.	.	.	.	.	.	.	.	.		
e ₀	.	.	.	.	.	.	.	.	.		
P ₀ (kg/cm ²)	.	.	.	.	.	.	.	.	.		
P _c (kg/cm ²)	.	.	.	.	.	.	.	.	.		
C _c	.	.	.	.	.	.	.	.	.		
C _r	.	.	.	.	.	.	.	.	.		

Note :

1. U-Undisturbed Sample	4. UU : Unconsolidated Undrained Triaxial Test	7. CD : Consolidated Drained Test
2. D-Disturbed Sample	5. UC : Unconfined Compression Test	8. DS : Direct Shear Test
3. P-Standard Penetration Test	6. CU : Consolidated Un-drained Test	9. * Combined % of Silt & Clay.

FARGO CONSULTANTS PVT. LTD.**Laboratory Test Results for Chemical Analysis**

Project Name: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Location: Jogighopa, Assam

Job No.:

2020406J

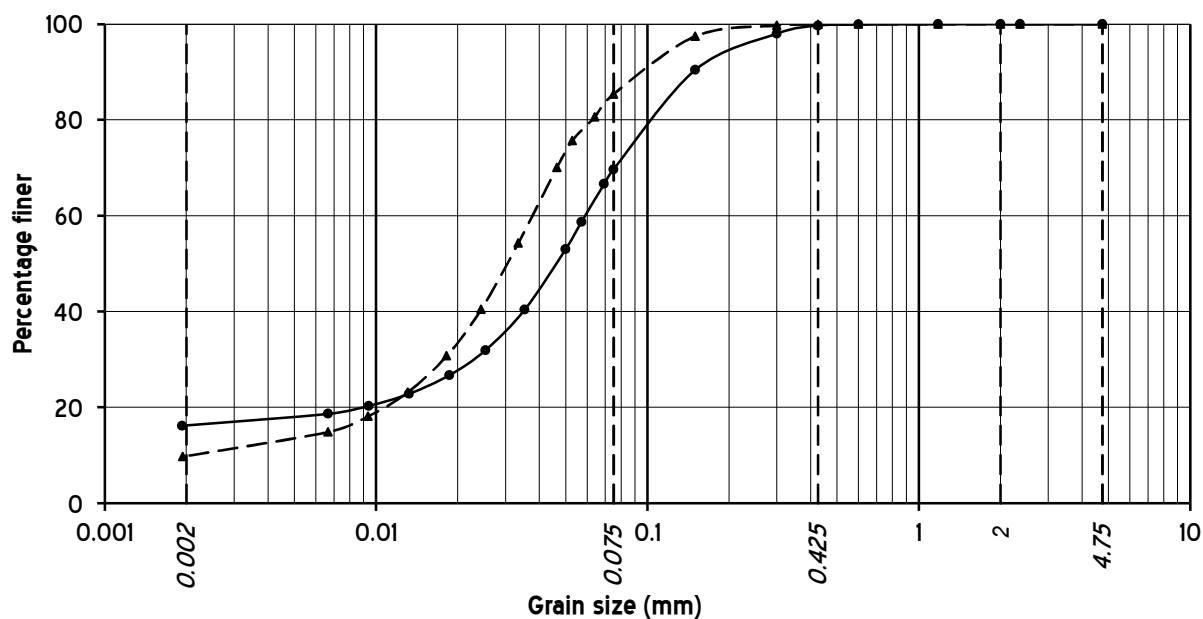
Analysis for WATER Sample

BH No. (#)	pH (-)	Sulphate Content				Chloride Content		Conductivity	Total Dissolved Solid
		SO ₃		SO ₄					(mg/l)
		(%)	(ppm)	(%)	(ppm)	(%)	(ppm)		
LBH-1	7.22	0.0034	34.18	0.0041	41.18	0.0090	90.09	533.3	320.0
LBH-2	7.16	0.0041	41.11	0.0036	35.91	0.0121	121.04	568.4	346.0
LBH-3	7.37	0.0063	62.87	0.0076	75.75	0.0199	199.50	766.7	460.0
LBH-4	7.26	0.0058	58.32	0.0062	61.84	0.0136	135.73	621.30	374.00

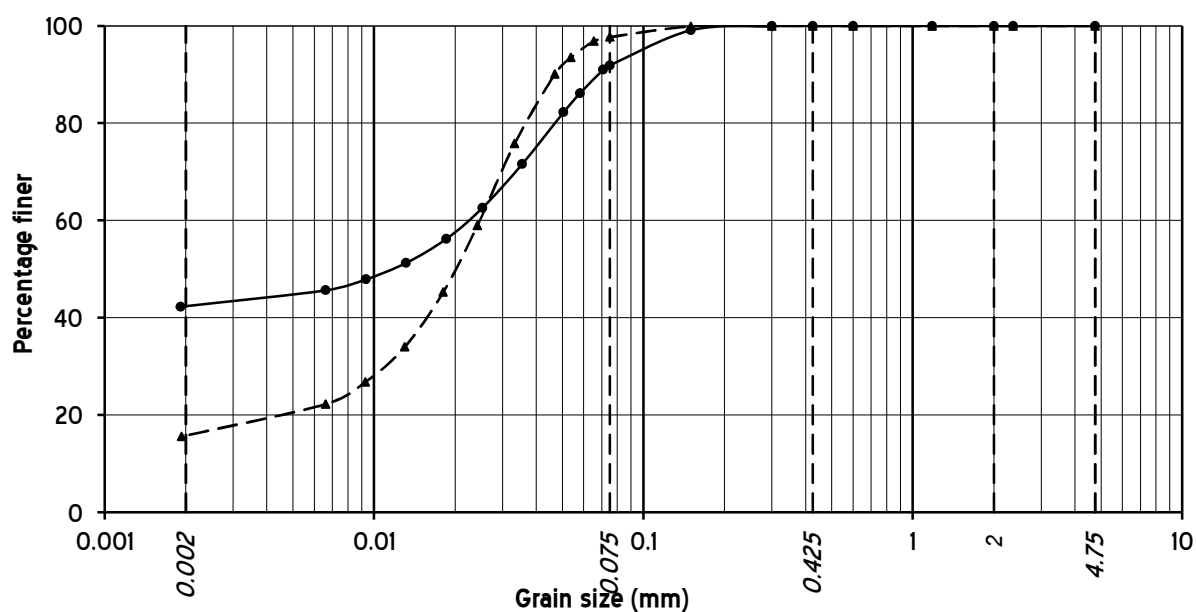
Analysis for SOIL Sample

BH No. (#)	Depth (m)	pH (-)	Sulphate Content				Chloride Content	
			SO ₃		SO ₄			
			(%)	(ppm)	(%)	(ppm)	(%)	(ppm)
LBH-1	24.00m	7.430	0.0044	43.58	0.0053	52.50	0.0099	98.96
LBH-2	12.00m	7.130	0.0007	7.26	0.0009	8.75	0.0107	106.90
LBH-3	36.00m	7.310	0.0032	32.21	0.0041	40.78	0.0112	111.67
LBH-4	6.00m	7.080	0.0028	28.32	0.0034	34.16	0.121	121.12

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-1, 0.50 m	16.2	53.5	30.0	0.3	0.0	0.0
LBH-1, 1.50 m	9.9	75.5	14.5	0.1	0.0	0.0



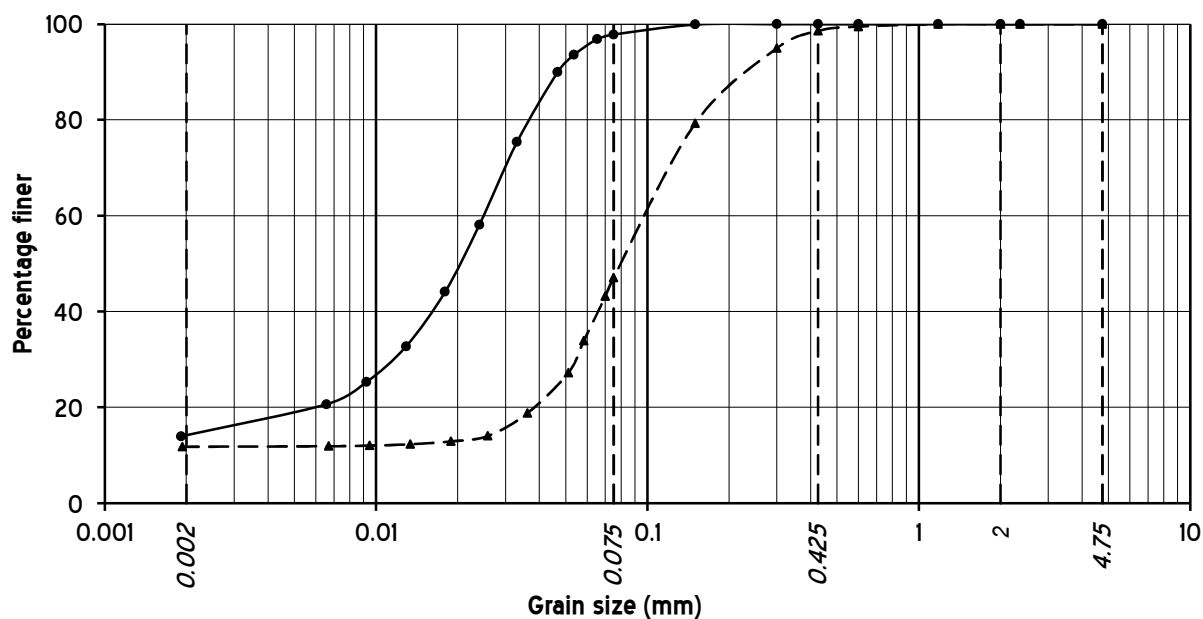
Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-1, 24.00 m	42.4	49.5	8.1	0.0	0.0	0.0
LBH-1, 25.50 m	15.8	81.9	2.3	0.0	0.0	0.0

Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

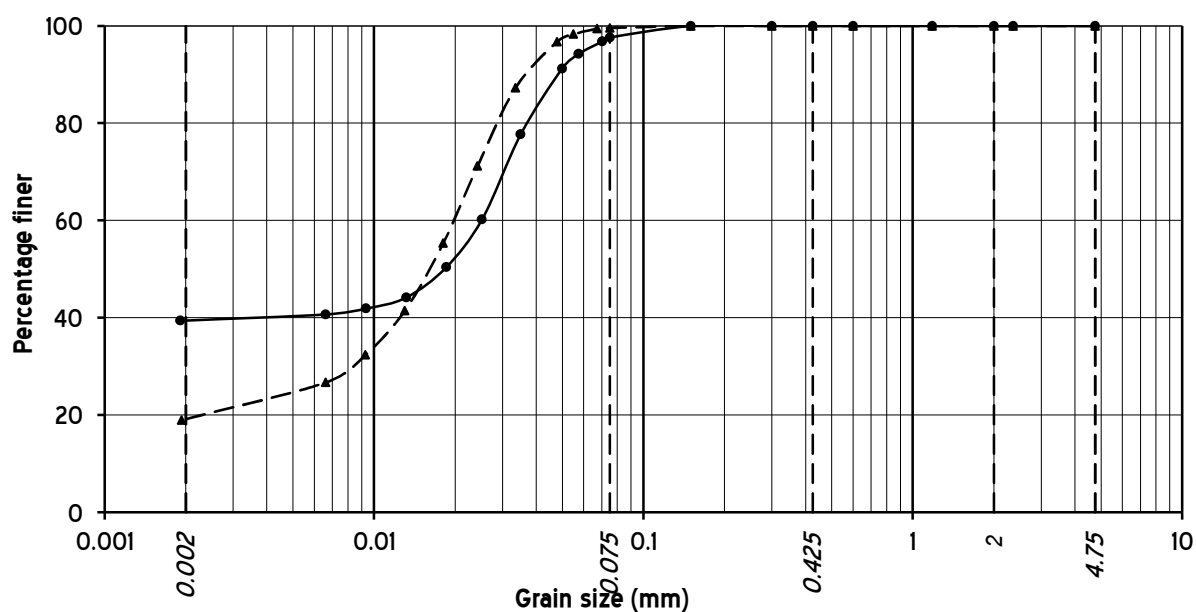
Job No.
2020406J

Fig. No.
4

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-1, 30.00 m	14.2	83.6	2.2	0.0	0.0	0.0
LBH-1, 34.50 m	11.8	35.3	51.5	1.4	0.0	0.0



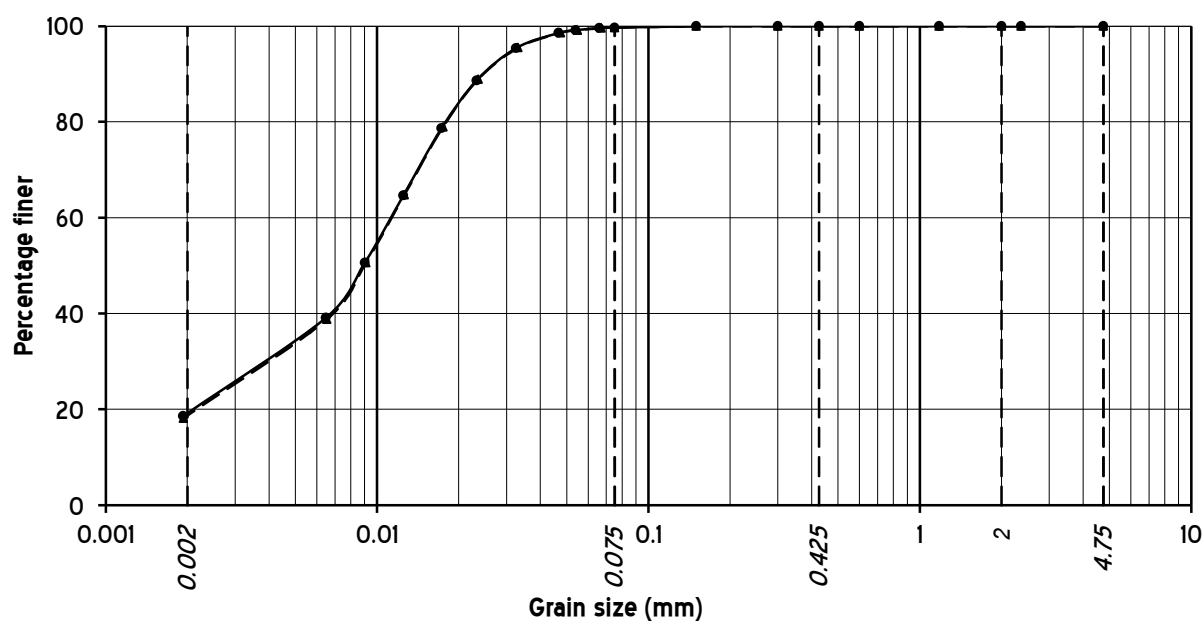
Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-1, 37.50 m	39.4	58.2	2.4	0.0	0.0	0.0
LBH-1, 40.50 m	19.2	80.4	0.4	0.0	0.0	0.0

Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

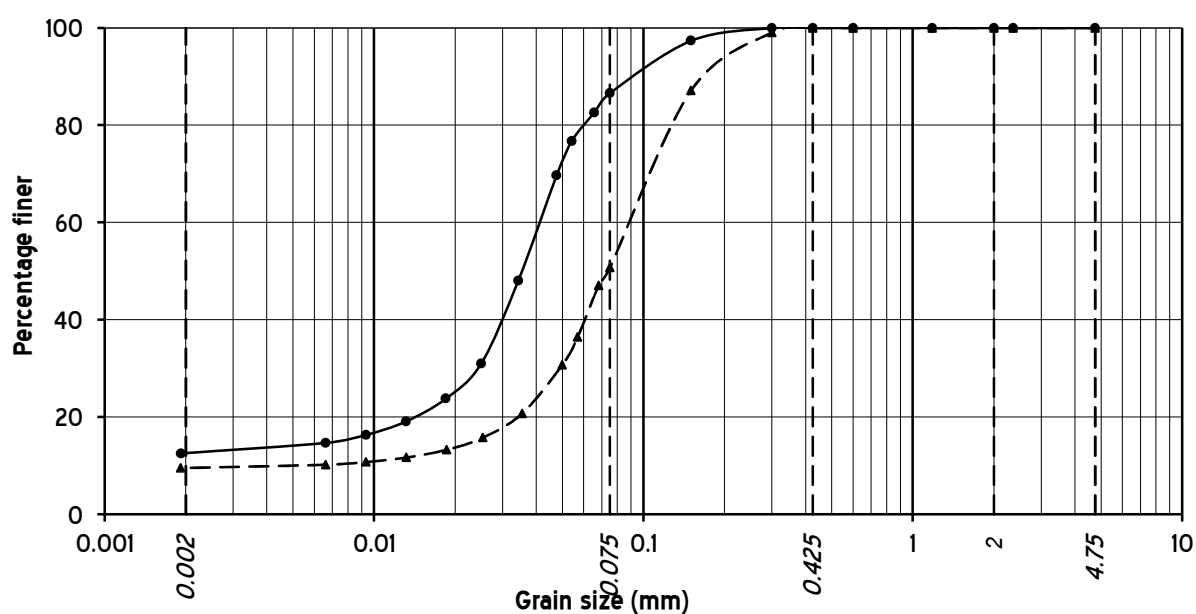
Job No.
2020406J

Fig. No.
5

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-1, 43.50 m	19.3	80.4	0.3	0.0	0.0	0.0
LBH-1, 50.00 m	18.7	81.0	0.3	0.0	0.0	0.0



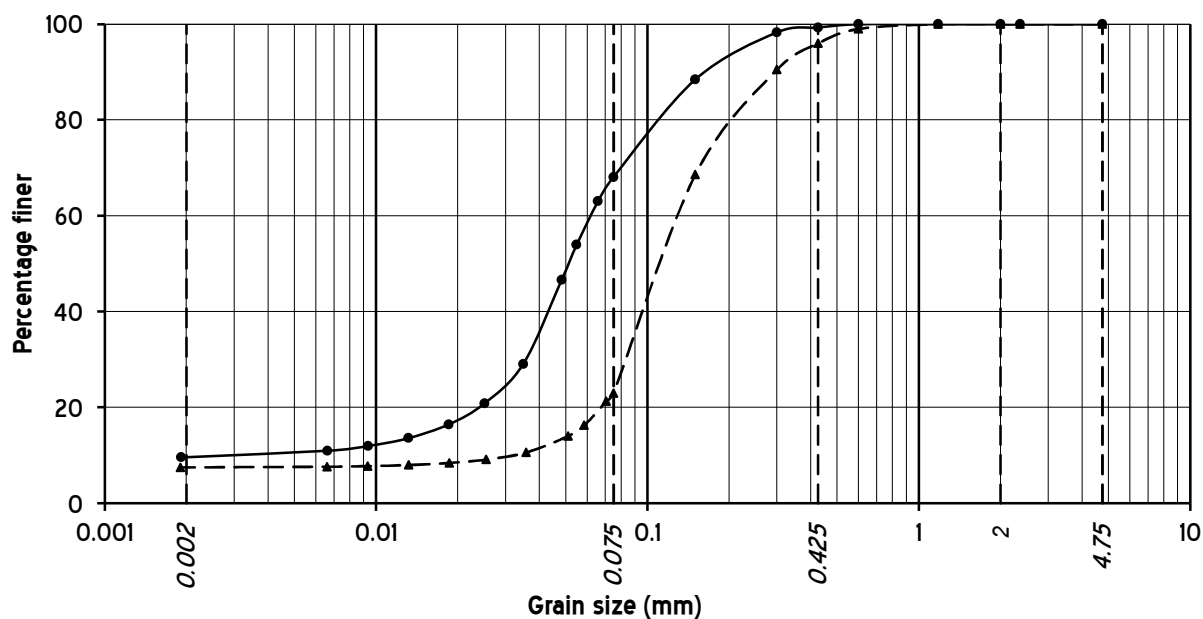
Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-2, 0.50 m	12.5	74.1	13.4	0.0	0.0	0.0
LBH-2, 1.50 m	9.5	41.2	49.3	0.0	0.0	0.0

Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.
2020406J

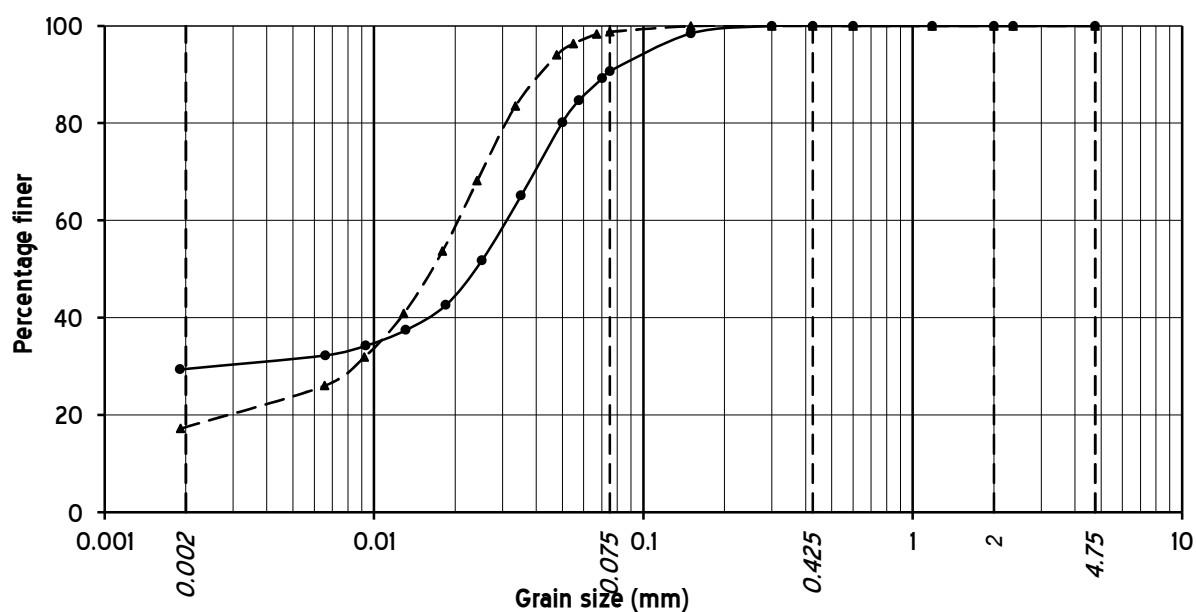
Fig. No.
6

GRAIN SIZE DISTRIBUTION CURVES



—●— LBH-2 , 3.00 m -▲- LBH-2 , 4.50 m

Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-2 , 3.00 m	9.6	58.5	31.2	0.7	0.0	0.0
LBH-2 , 4.50 m	7.5	15.5	73.0	4.0	0.0	0.0



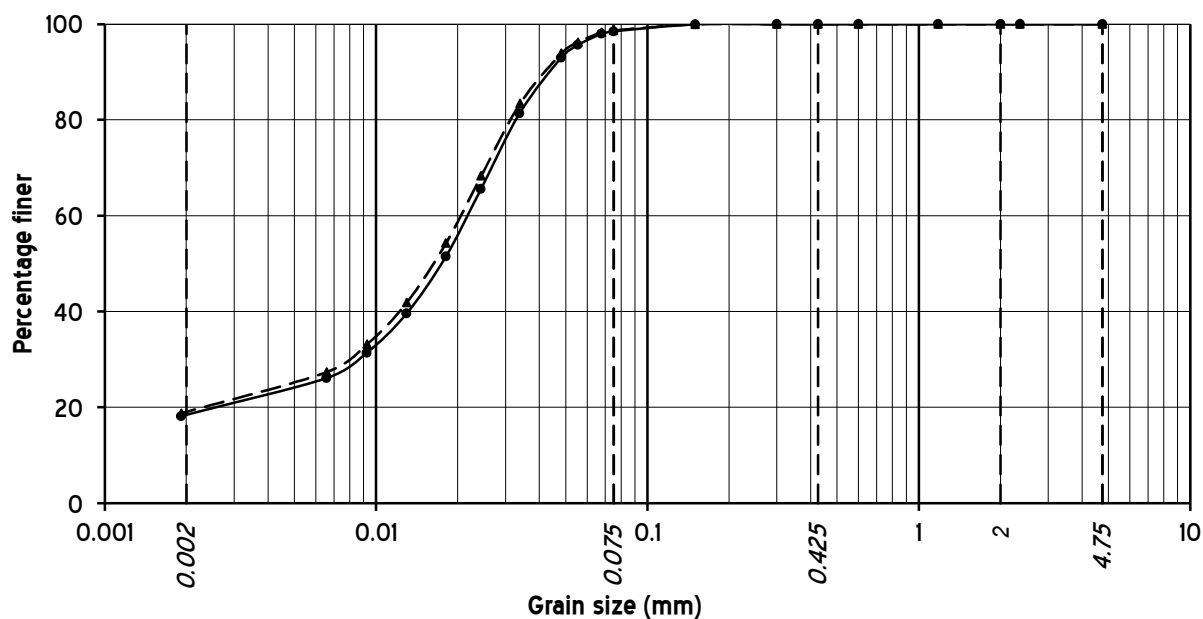
—●— LBH-2 , 34.50 m -▲- LBH-2 , 40.50 m

Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-2 , 34.50 m	29.5	61.2	9.3	0.0	0.0	0.0
LBH-2 , 40.50 m	17.5	81.3	1.2	0.0	0.0	0.0

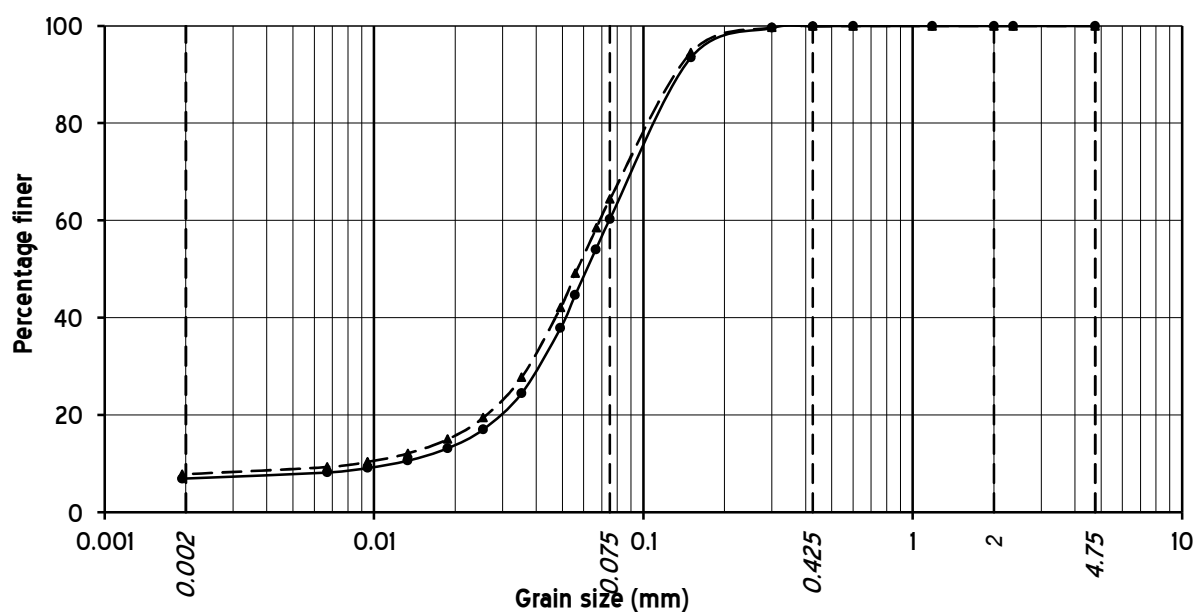
Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.
2020406J

Fig. No.
7

GRAIN SIZE DISTRIBUTION CURVES

Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-2 , 45.00 m	18.5	80.0	1.5	0.0	0.0	0.0
LBH-2 , 48.00 m	19.1	79.6	1.3	0.0	0.0	0.0



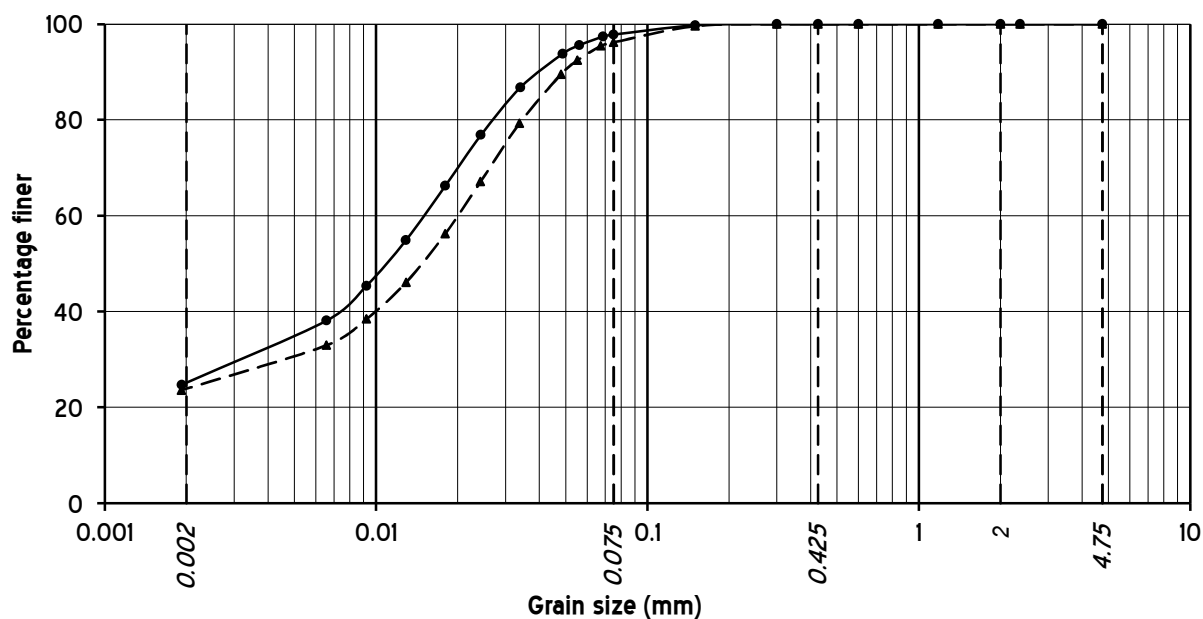
Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-3 , 1.50 m	6.9	53.4	39.6	0.1	0.0	0.0
LBH-3 , 6.00 m	7.8	56.6	35.5	0.1	0.0	0.0

Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

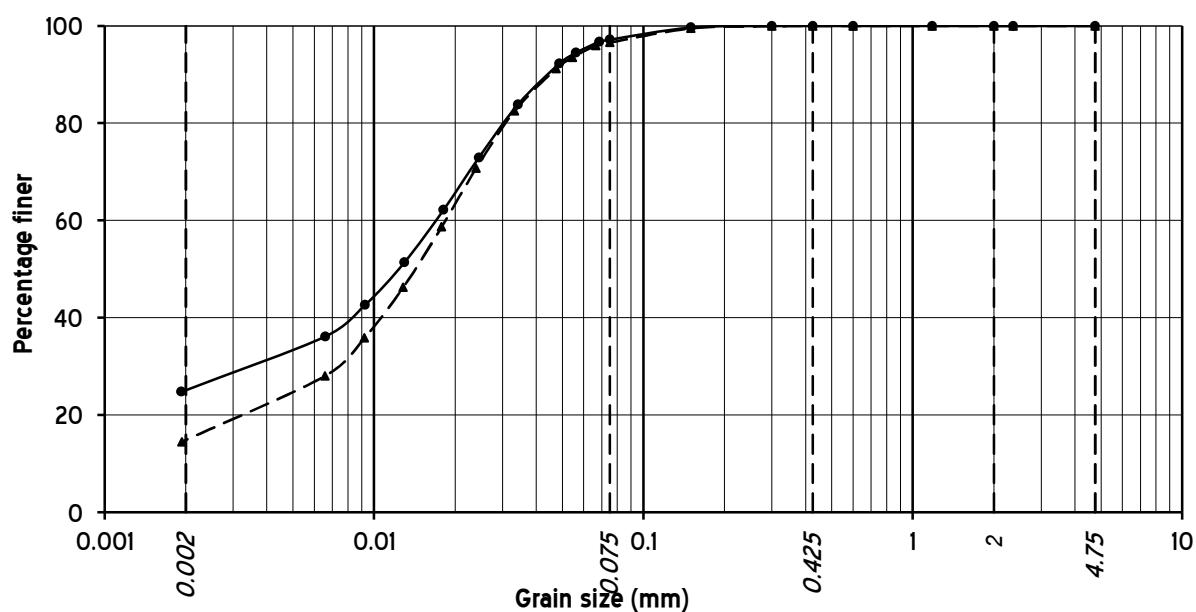
Job No.
2020406J

Fig. No.
8

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-3 , 37.50 m	25.2	72.6	2.2	0.0	0.0	0.0
LBH-3 , 40.50 m	23.9	72.3	3.8	0.0	0.0	0.0



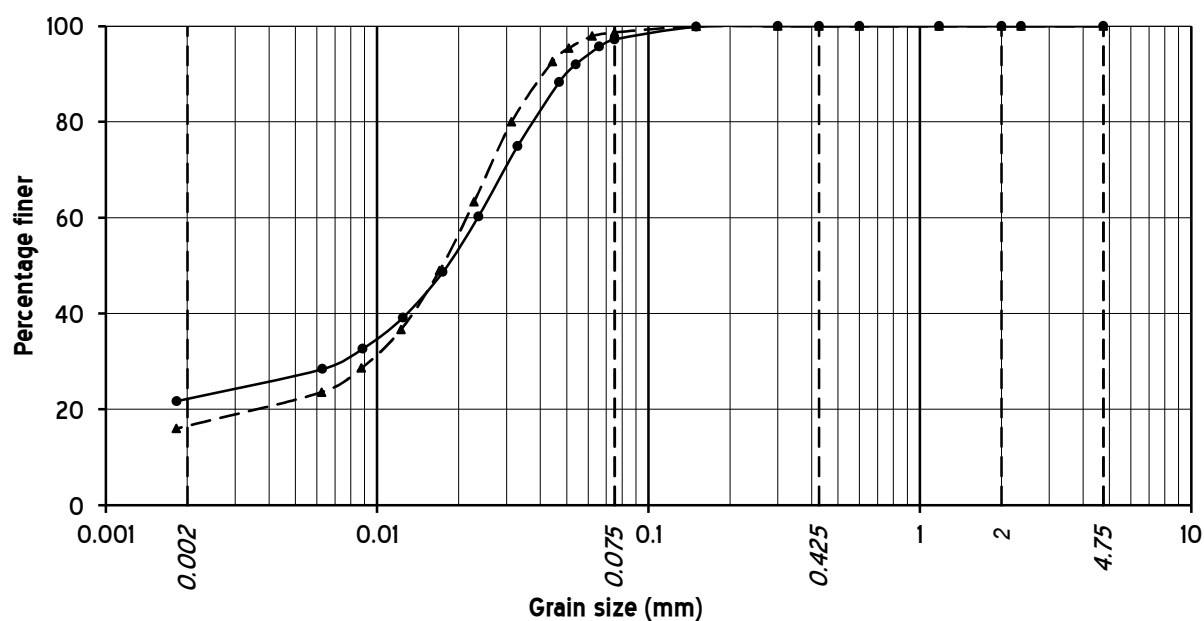
Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-3 , 48.00 m	25.1	72.1	2.8	0.0	0.0	0.0
LBH-3 , 50.00 m	14.8	81.8	3.4	0.0	0.0	0.0

Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

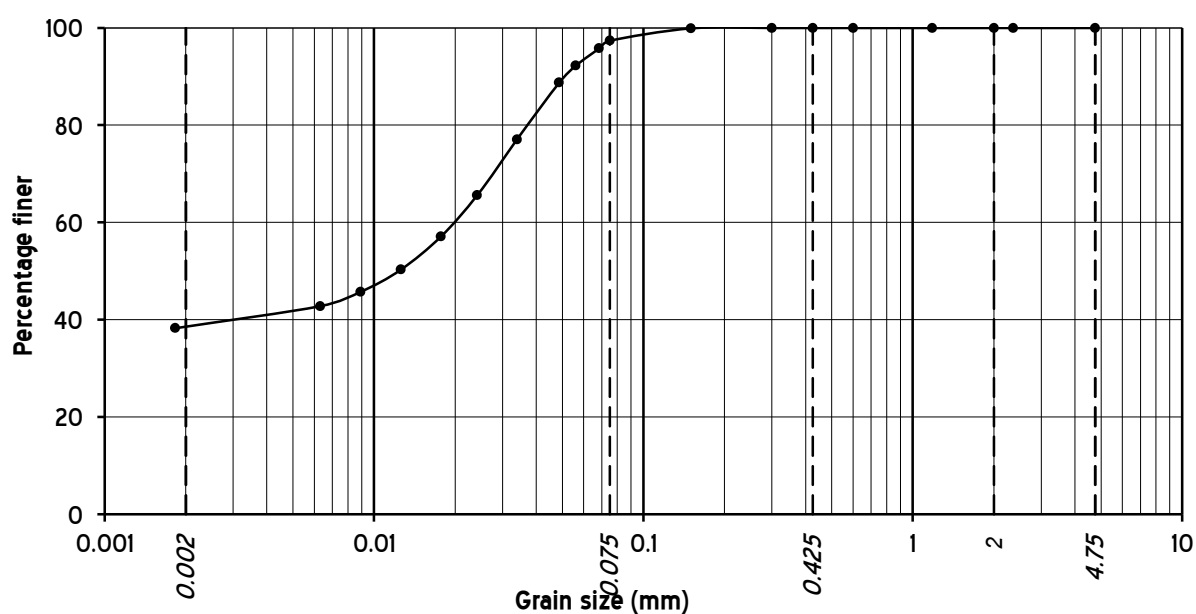
Job No.
2020406J

Fig. No.
9

GRAIN SIZE DISTRIBUTION CURVES



Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-4, 36.00 m	22.2	75.0	2.8	0.0	0.0	0.0
LBH-4, 42.00 m	16.6	82.1	1.3	0.0	0.0	0.0



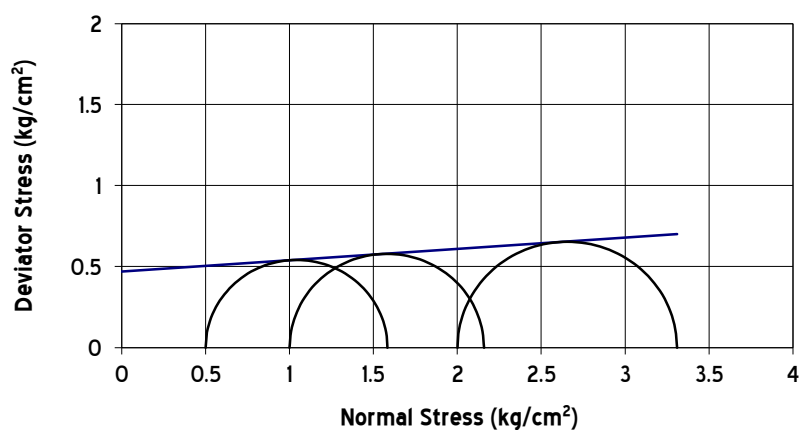
Grain size (mm)	< 0.002	0.002-0.075	0.075-0.425	0.425-2.0	2.0-4.75	> 4.75
Sample No.	Clay (%)	Silt (%)	Fine sand (%)	Medium sand (%)	Coarse sand (%)	Gravel (%)
LBH-4, 50.00 m	38.6	58.8	2.6	0.0	0.0	0.0

Project: Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.
2020406J

Fig. No.
10

Mohr-Diagram

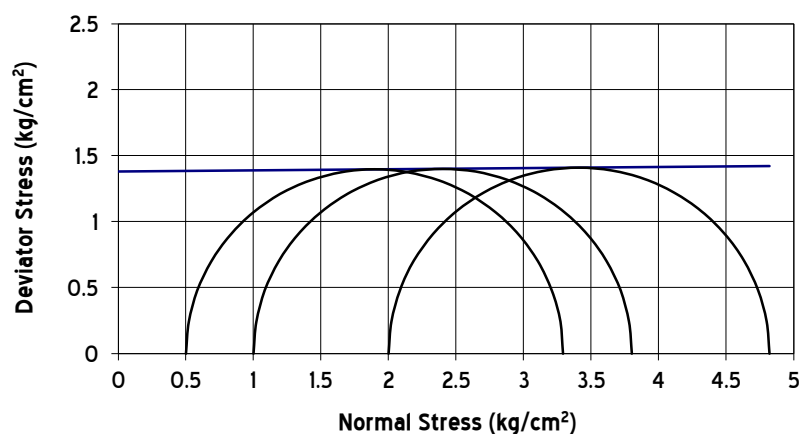


BH No.: BH-1
Depth: +1.50 m

Test Type: UU

c : 0.47 kg/sq. cm
 ϕ : 4 degree

Mohr-Diagram

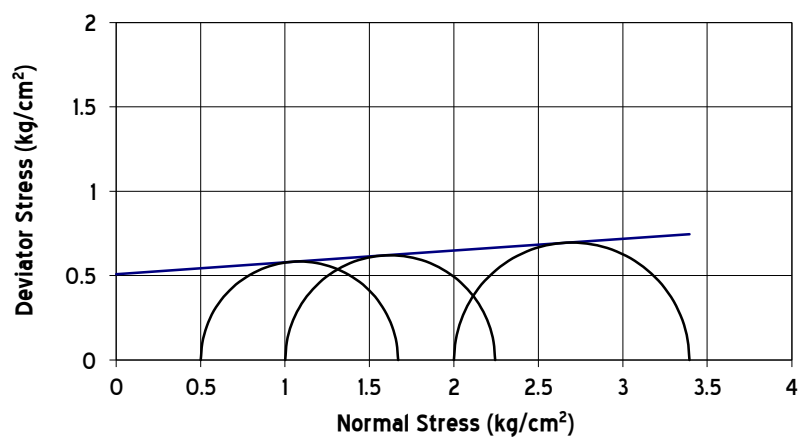


BH No.: BH-1
Depth: +25.50 m

Test Type: UU

c : 1.38 kg/sq. cm
 ϕ : 0.5 degree

Mohr-Diagram



BH No.: BH-2
Depth: +0.50 m

Test Type: UU

c : 0.51 kg/sq. cm
 ϕ : 4 degree

Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.

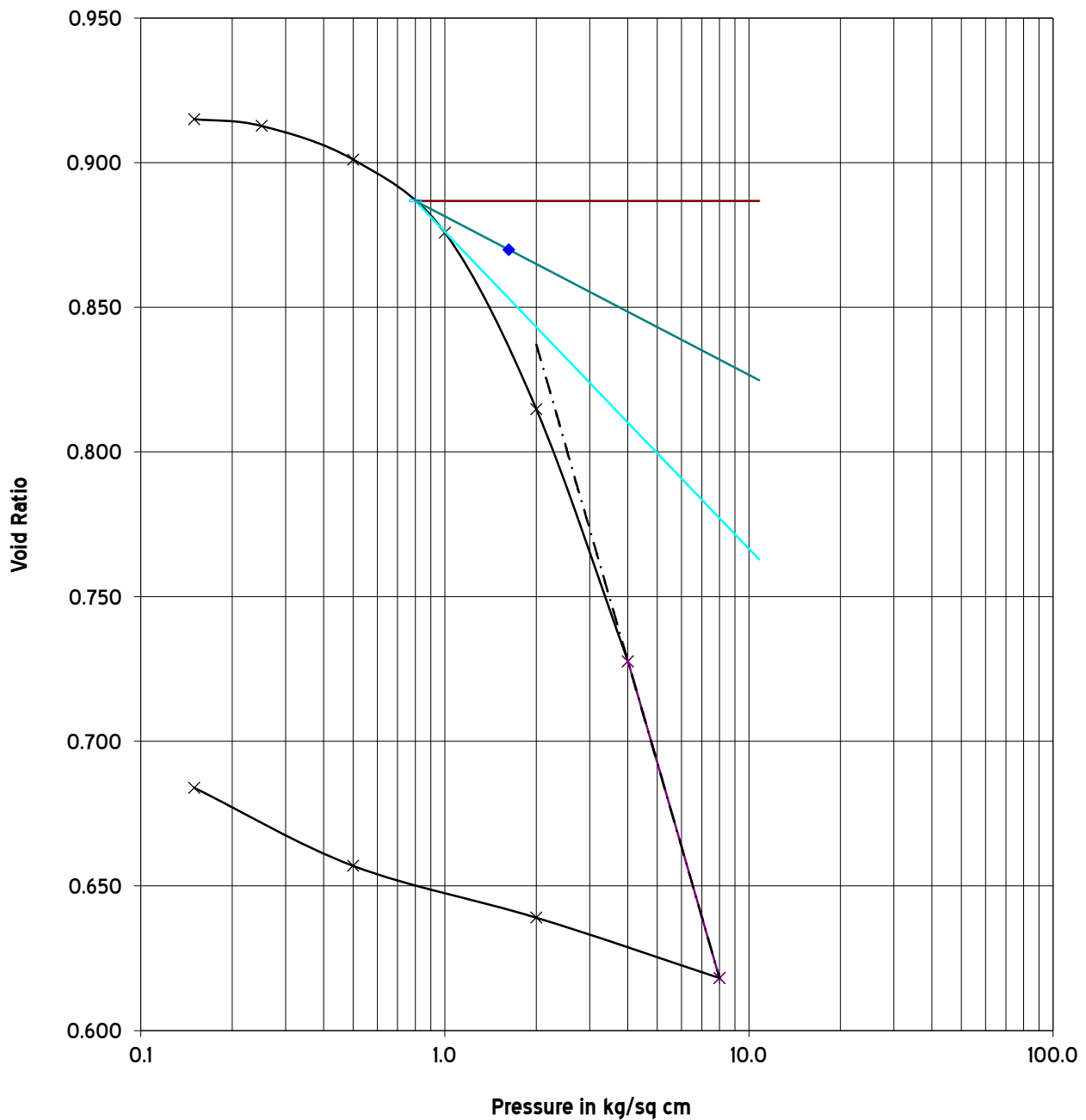
2020406J

Fig. No.

11

e-logp curve

BH-No. : BH-1	$C_c = 0.3636$	Pressure range (kg/sq. cm)	m_v (Lab) (sq. cm/kg)
Depth : 1.50m	$C_c/(1+e_0) = 0.1897$	0.25 - 0.50 :	0.0244
$e_0 = 0.9166$	$p_c =$	0.50 - 1.00 :	0.0263
$p_0 = 0.27 \text{ kg/cm}^2$	$C_s = 0.0381$	1.00 - 2.00 :	0.0318
	$C_r \gg 0.0381$	2.00 - 4.00 :	0.0227
		4.00 - 8.00 :	0.0143



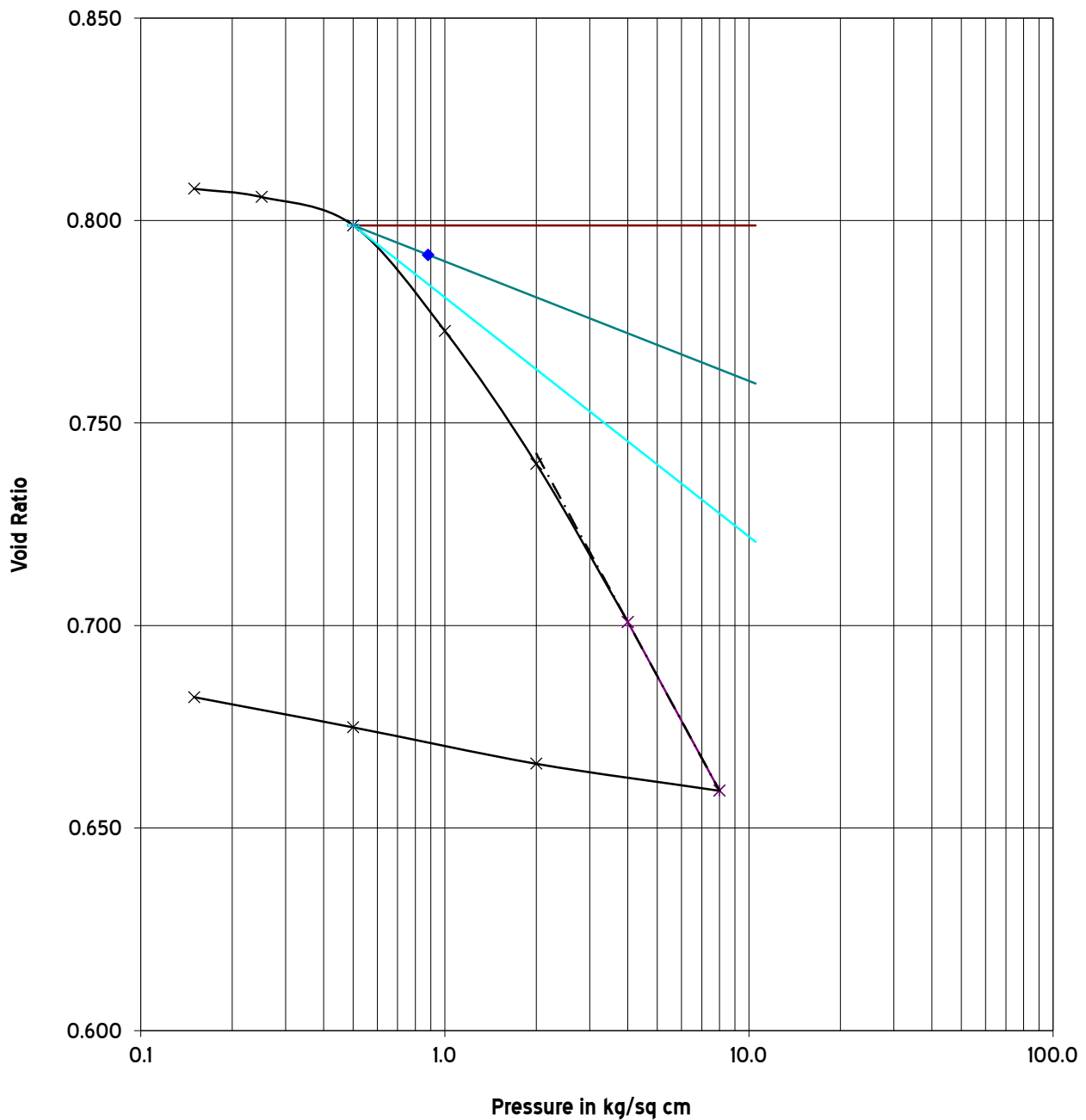
Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.:
2020406J

Fig No.
12

e-logp curve

BH-No. : BH-2	$C_c = 0.1381$	Pressure range (kg/sq. cm)	m_v (Lab) (sq. cm/kg)
Depth : 0.50m	$C_c/(1+e_0) = 0.0763$	0.25 - 0.50 :	0.0155
$e_0 = 0.8095$	$p_c =$	0.50 - 1.00 :	0.0288
$p_0 = 0.09 \text{ kg/cm}^2$	$C_s = 0.0134$	1.00 - 2.00 :	0.0181
	$C_r \gg 0.0134$	2.00 - 4.00 :	0.0108
		4.00 - 8.00 :	0.0057



Project : Geotechnical Investigation Works for Preparation of Detailed Project Report (DPR) for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Job No.:
2020406J

Fig No.
13

SAMPLE CALCULATIONS FOR PILE LOAD CAPACITY

Location: Proposed Jetty at Jogighopa, Assam
 Borehole No. : BH-4
 Existing Ground Level : +0.0 m
 Scour Level : -
 Groundwater Level : +0.0 m

Pile Diameter : +0.75 m
 Pile Cut-Off Level : -2.0 m
 Pile Founding Level : -20.0 m
 Pile Type : Bored
 Earth Pressure Coefficient, K : 1.0

LAYER INFORMATION

Layer	Design Sub-Layer	Starting Elevation (m)	Ending Elevation (m)	Length (m)	SPT Value	Angle of Friction (ϕ) Degrees	Cohesion (KN/m ²)	Bulk Density (KN/m ³)	Seismic Multiplier
	1	0	-35.5	35.5	14	28.5	0	17.6	
	2	-37	-50.5	13.5	52	0	260	21	

Modified layer data is presented below. Layer containing cut-off level, critical depth were sub-divided. Successive sand layer properties have been depth averaged for calculations.

LAYER INFORMATION

Layer	Design Sub-Layer	Starting Elevation (m)	Ending Elevation (m)	Length (m)	SPT Value	Angle of Friction (ϕ) Degrees	Cohesion (KN/m ²)	Bulk Density (KN/m ³)	Seismic Multiplier
	1	0	-2	2	14	28.5	0	17.6	
	2	-2	-13.3	11.3	14	28.5	0	17.6	
	3	-13.3	-35.5	22.3	14	28.5	0	17.6	
	4	-37	-50.5	13.5	52	0	260	21	

EFFECTIVE OVERBURDEN PRESSURE CALCULATIONS

$$P_{-2.0} = 2.0 \times 7.60 = 15.2 \text{ KN/m}^2$$

$$P_{-13.3} = 15.2 + 11.3 \times 7.60 = 100.7 \text{ KN/m}^2$$

$$P_{-20.0} = 100.7 + 6.8 \times 0.00 = 100.7 \text{ KN/m}^2$$

$$P_{-35.5} = 100.7 + 15.5 \times 0.00 = 100.7 \text{ KN/m}^2$$

$$P_{-50.5} = 100.7 + 13.5 \times 11.00 = 248.7 \text{ KN/m}^2$$

SKIN FRICTION CALCULATIONS

Formula for skin friction calculation is $Q_s = \sum K P_{di} \tan \delta A_s + \alpha C A_s$

$$Q_{s1} = 1.00 \times 0.5(15.2+100.7) \times (3.14159 \times 0.75 \times 11.3) \times \tan(28.5) = 834.0 \text{ KN}$$

$$Q_{s2} = 1.00 \times 0.5(100.7+100.7) \times (3.14159 \times 0.75 \times 6.8) \times \tan(28.5) = 869.6 \text{ KN}$$

$$\text{Total Skin Friction} = 834.0 + 869.6 = 1703.6 \text{ KN}$$

END BEARING CAPACITY CALCULATIONS

Formula for end bearing capacity is $Q_b = A_p (0.5 D \gamma N_\gamma + P_d N_q + N_c C)$

End Bearing capacity of founding layer

$$Q_{bc} = [100.7 \times 16.6 + 0.5 \times 0.75 \times 7.60 \times 17.9] \times (3.14159 \times 0.75 \times 0.75) / 4 = 761.0 \text{ KN}$$

CALCULATIONS FOR SELF WEIGHT OF PILE

$$\text{Self Weight of Pile} = 3.14159 \times (0.75 \times 0.75) / 4 \times [11.3 \times (25.0 - 17.60) + 6.8 \times (25.0 - 17.60)] = 58.8 \text{ KN}$$

VERTICAL LOAD CAPACITY OF PILE

$$\text{Design Load Capacity} = ((1703.6 + 761.0) / 2.5) - 58.8 = 927.0 \text{ KN}$$

UPLIFT CAPACITY OF PILE

$$\text{Total frictional resistance} = (834.0 + 869.6) = 1703.6 \text{ KN}$$

$$\text{Design Uplift Capacity} = ((1703.6) \times 0.7 / 2.5) + 58.8 = 535.9 \text{ KN}$$

Pile Lateral Load Capacity Calculations

Calculations as per Annex C of IS:2911 (Part 1/ Section 2) : 2010

Location: **Proposed Jetty at Jogighopa**
BH-4

Input data

Grade of Concrete	M-25
Diameter (d)	0.75 m
E	2.50E+07 kN/m ²
I	0.015532 m ⁴
Length above Ground Level (L1)	0 m
Embedment Length (Le)	18 m
Overburden Material Type *	NC
N-Value	7
Modulus of Subgrade Reaction	0.8 kN/m ³ x 10 ³
Stiffness Factor T	3.4 m
Le/T (-)	5.2

Long Pile (Le/T ≥ 4)	Fixed	Free
L1/T (-)	0.000	0.000
Lf/T (-)	2.190	1.925
Lf (m)	7.5	6.6
Q _{lat} for 5mm deflection (kN)	54.26	13.56
Short Pile (Le/T ≤ 2)**	Fixed	Free
Q _{lat} for 5mm deflection (kN)	-	-

Note: * NC-Non cohesive soil / Normally consolidated cohesive soil : PC-Preloaded cohesive soil

** Calculations for long pile are as per IS Code. Calculations for short pile has been done as per methods outlined "Soil Mechanics and Foundation Engg, V.N.S. Murthy, 2nd Ed. pp. 691-692"

Constants as provided in IS Code

Table 3 Modulus of Subgrade Reaction for Granular Soils, η_h , in kN/m ³			
Category	Description	(Blow/30 cm)	Range of η_h kN/m ³ x 10 ³
1	Very Loose	0-4	<0.2
2	Loose sand	4-10	0.2-1.4
3	Medium sand	10-35	1.4-5.0
4	Dense sand	>35	5.0-12.0

Table 4 Modulus of Subgrade Reaction for Cohesive Soil, k_1 in kN/m ³			
Category	Soil Consistency	q_u (i.e. $\approx 2c$) (kN/m ²)	Range of k_1 kN/m ³ x 10 ³
1	Soft	25-50	4.5-9.0
2	Medium Stiff	50-100	9.0-18.0
3	Stiff	100-200	18.0-36.0
4	Very Stiff	200-400	36.0-72.0
5	Hard	>400	>72.0

ANNEXURE - 3

DETAILED COST ESTIMATES

1

DREDGING AND SITE GRADING

1.1

DREDGING

DREDGING - PHASE 1A												
S. No.	A	B	C	D	E	F	G	H	I	J	K	L
	Plan No.	Designed Dredged Level (CD)	Existing Bed Level (CD)	Depth Of Dredging (m) (B-C)	Dredging tolerance (m)	Total Depth of Dredging (m) (D+E)	Plan Area (m2)	Plan Area Volume (m3) (FxG)	Slope Periphery (m)	Slope Area wrt Total Depth of Dredging (m2)	Slope Volume (m3) (GxH)	Total Volume (m3) (F+I)
APPROACH CHANNEL												
1	1	26.5	28.9	2.4	0.00	2.40	1206.15	2,895	8	17.28	138	3,033
2	2	26.5	28.28	1.78	0.00	1.78	209.00	372	0	9.51	-	372
3	3	26.5	27.78	1.28	0.00	1.28	7570.40	9,690	57	4.92	280	9,970
4	4	26.5	26.87	0.37	0.00	0.37	3463.74	1,282	110	0.41	45	1,327
								14,238				14,702
GRAND Total								14,238				14,702
Rate (in INR)								610				610
Amount (in INR)								8,685,476				8,968,261

1.2

SITE GRADING

Reclamation - Phase 1 A

S. NO	FORMATION LEVEL	GROUND LEVEL	DEPTH	PLAN AREA	VOLUME
1	37.5	35	2.5	946.876	2367.19
2	37.5	35	2.5	1896.565	4741.41
3	37.5	35.5	2	2055.497	4110.99
4	37.5	35.5	2	2467.622	4935.24
5	37.5	35.2	2.3	2445.748	5625.22
6	37.5	34.9	2.6	1129.887	2937.71
7	37.5	35.6	1.9	3254.536	6183.62
8	37.5	34.5	3	1100.358	3301.07
9	37.5	34.7	2.8	2220.5	6217.40
10	37.5	34.5	3	2954.676	8864.03
11	37.5	35	2.5	3250.851	8127.13
12	37.5	36	1.5	2896.69	4345.04
13	37.5	36.4	1.1	2700.976	2971.07
14	37.5	35	2.5	722.456	1806.14
15	37.5	34	3.5	1092.765	3824.68
Total					70,358
Rate (in INR)					800
Amount (in INR)					56,286,353

2

BERTH AND APPROACH TRESTLE

2.1

BERTH

BILL OF QUANTITIES OF BERTH

GRAND SUMMARY

S. No.	Description	Amount (Rs.)
1	SECTION 1 - MOBILISATION & DEMOBILISATION	11,839,088
2	SECTION 2 - PILE FOUNDATIONS	118,390,882
3	SECTION 3 - DECK	35,467,993
4	SECTION 4 : DECK FITTING AND MISCELLANEOUS	13,870,344
TOTAL		179,568,307

BILL OF QUANTITIES OF BERTH

SECTION 1 - MOBILISATION & DEMOBILISATION (Marine Works)

Sl. No	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	MOBILISATION & DEMOBLISATION Provide and bring on site sufficient numbers of piling rigs with necessary equipment and accessories for installing 1400 dia vertical so as to complete all works within the contract period.			l.s	15,000,000
2	Remove from site all piling plant & equipment after completion			l.s.	10,000,000
TOTAL OF SECTION 1 CARRIED TO SUMMARY					25,000,000

BILL OF QUANTITIES OF BERTH

SECTION 2 - PILE FOUNDATIONS (Marine Works)

Sl. No	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	PILING Shift and set up piling equipment at each pile location for: a) 1400 dia piles	69	no.	13700	945,300
2	LINER Providing, fabricating and delivery to Site cylindrical liners made from MS plates of the following thickness. (Quantity payable shall be from the bottom of driven length upto pile cut-off level). No wastages included. a) 10 mm thick for 1400 mm dia pile	391	T	66500	26007402.7
3	Lowering and pitching of fabricated liners at each pile location: a) 1400 dia piles	69	no.	20400	1407600
4	Driving of liners from river bed level to refusal. (Quantity payable shall be from 28 m to refusal). a) 1400 dia piles	1242	l.m.	1850	2297700
5	BORING Boring in all types of soil excluding rock from river bed level upto founding strata. a) 1400 dia piles	2277	l.m.	6139	13,978,503
6	REINFORCEMENT IN PILES Supply Cut, bend and fix in position according to drawings and as directed by the Employer/Engineer, "High Yield Strength Deformed" reinforcements of grade Fe 500 in piles. No wastage taken into account. a) 1400 dia piles	536	T	61680	33,037,803
7	CONCRETING – INSITU CONCRETE Prepare and Place concrete mix M40 in accordance with the Specification in piles using tremie concreting pipe from founding level to pile cut-off level. a) 1400 dia piles	3826	cu.m	10525	40,268,074
8	DRESSING Dressing of pile head. (Rate to include for cutting of steel liners and chipping of concrete above pile cut-off level): a) 1400 dia piles	69	no.	6500	448,500
9	PILE DYNAMIC LOAD TEST (10% OF TOTAL NO. OF PILES)	7	Nos	500000	3,500,000
10	PILE INTEGRITY TEST (20% OF TOTAL NO. OF PILES)	14	Nos	300000	4,200,000
TOTAL OF SECTION 2 CARRIED TO SUMMARY					118,390,882

BILL OF QUANTITIES OF BERTH

SECTION 3 - DECK (Marine Works)

S. No.	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	SHUTTERING Wrot shuttering for the insitu part of beams, slab, kerb etc.				
	a) Soffits	390	sq.m.	575	224,250
	b) Sides	130	sq.m.	625	81,250
2	REINFORCEMENT IN INSITU & PRECAST CONCRETE Supply, Cut, bend and fix in position according to drawings and as directed by the Employer/Engineer, "High Yield Strength Deformed" reinforcements of grade Fe 500 in piles. No wastage taken into account.				
	a) Beams	144	T	61680	8,853,202
	b) Deck slabs	99	T	61680	6,094,971
	c) Pile Muff	26	T	61680	1,634,273
3	STEEL INSERTS/EMBEDDED PARTS IN CONCRETE a) Mild Steel Fabricate and fix in position various steel inserts/embedded parts in insitu and precast concrete in accordance with the Drawings and as directed by the Engineer.	1	T	61680	61,680
4	PRECAST CONCRETING (Rate to include for shuttering) Concrete class M40 in:				
	a) Slab panels in-cluding making hole to suit 100 dia drain pipes	309	cu.m.	10500	3,242,400
	b) Beams	355	cu.m.	10500	3,726,996
	c) Pile Muff	83	cu.m.	10500	869,400
5	ERECTION OF PRECAST CONCRETE Collect the precast concrete elements from the storage yard, bring to the location of placement and place them to lines and levels according to the Drawings and as directed by the Engineer:				
	a) Precast slab panels	309	cu.m.	1650	509520
	b) Beams	355	cu.m.	1650	585670.8
	c) Pile Muff	83	cu.m.	1650	136620
7	INSITU CONCRETING Concrete class M40 in:				
	a) Insitu beams upto the soffit of deck slab.	489	cu.m.	9050	4428780.4
	b) Insitu portion of Deck Slab including areas over beam widths, Kerbs / upstands of the berth.	309	cu.m.	9050	2794640
	c) Pile Muff	83	cu.m.	9050	749340
8	SCREED (Wearing Coat) Concrete screed (1:1:2) including laying the screed to lines and levels on the deck slab of berth.	170	cu.m.	8000	1362000
9	DRAIN PIPE Supply and fix in position 100 mm dia drain pipes made of PVC in berth. a) 600 mm long	15	nos	600	9000
10	EXPANSION JOINTS Supply and place in position, according to the Drawings and Specification, strip seal type expansion joint for max movement of 100mm all complete.	10	l.m.	10400	104000
TOTAL OF SECTION 3 CARRIED TO SUMMARY					35,467,993

BILL OF QUANTITIES OF BERTH

SECTION 4 : DECK FITTING AND MISCELLANEOUS

S. No.	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	HAND RAIL POSTS & HAND RAILING Supply, Fabricate, painting and install in position, as shown on the drawings minimum 40 mm diameter N.B. (Heavy), M.S. tubes of grade conforming to IS: 1239 and toe plate (100 mm x 6 mm) of mild steel conforming to IS: 2062 Note :- Surface Coat: self priming aluminium containing high build epoxy with solids by volume content of not less than 85% dry film thickness 75-100 microns. Intermediate coat Polyurethane epoxy of minimum thickness of 75 microns solids by volume minimum 62%. Finish coat Polyurethane epoxy of minimum thickness of 75 microns solids by volume minimum 62%.	188	m	6438	1210344
2	BOLLARDS Supply and fix in position cast steel bollards of working load capacity 50 T, including holding down bolts, nuts, washers, and painting as per the specification or as recommended all complete.	4	no.	100,000	400,000
3	Fenders Design, supply, assemble and fix in position in the required Arch fenders of IRM or equivalent make with steel plates manufactured as per manufacturer's specifications, galvanised wrought iron chains, shackles, hooks, resin plugs, anchor bolts & all other necessary fittings required for fixing as per manufacturer's specifications including painting with one coat of red lead and two coat of anti corrosive paint as directed by the EIC.	80	no.	150,000	12,000,000
4	RUBBING STRIP Supply, fabricate and install in position galvanised rubbing strip as per drawing to the satisfaction of Employer/Engineer in front berthing face of the berth.	100	l.m.	2600	260000
	TOTAL OF SECTION 4 CARRIED TO SUMMARY				13,870,344

2.2

APPROACH TRESTLE

GRAND SUMMARY

Approach Trestle

Sl. No.	Description	Amount (Rs.)
1.	SECTION 1 - MOBILISATION & DEMOBILISATION	0
2.	SECTION 2 - PILE FOUNDATIONS	36,754,164
3.	SECTION 3 - DECK	14,976,709
4	SECTION 4 : DECK FITTING AND MISCELLANEOUS	1,751,136
TOTAL		53,482,009

BILL OF QUANTITIES OF APPROACH TRESTLE

SECTION 1 - MOBILISATION & DEMOBILISATION (Marine Works)

Sl. No	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	MOBILISATION & DEMOBILISATION Provide and bring on site sufficient numbers of piling rigs with necessary equipment and accessories for installing 1300 dia vertical so as to complete all works within the contract period.			I.s	
2	Remove from site all piling plant & equipment after completion			I.S.	
TOTAL OF SECTION 1 CARRIED TO SUMMARY					0

BILL OF QUANTITIES OF APPROACH TRESTLE

SECTION 2 - PILE FOUNDATIONS (Marine Works)

Sl. No	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	PILING Shift and set up piling equipment at each pile location for: a) 1300 dia piles	25	no.	13700	342,500
2	LINER Providing, fabricating and delivery to Site cylindrical liners made from MS plates of the following thickness. (Quantity payable shall be from the bottom of driven length upto pile cut-off level). No wastages included. a) 10 mm thick for 1300 mm dia pile	132	T	66500	8754676.11
3	Lowering and pitching of fabricated liners at each pile location: a) 1300 dia piles	25	no.	20400	510000
4	Driving of liners from river bed level to refusal. (Quantity payable shall be from 28m to refusal). a) 1300 dia piles	407.5	l.m.	1850	753875
5	BORING Boring in all types of soil excluding rock from sea bed level upto founding strata. a) 1300 dia piles	782.5	l.m.	6139	4,803,768
6	REINFORCEMENT IN PILES Supply Cut, bend and fix in position according to drawings and as directed by the Employer/Engineer, "High Yield Strength Deformed" reinforcements of grade Fe 500 in piles. No wastage taken into account. a) 1300 dia piles	143	T	61680	8,846,794
7	CONCRETING - INSITU CONCRETE Prepare and Place concrete mix M40 in accordance with the Specification in piles using tremie concreting pipe from founding level to pile cut-off level. a) 1300 dia piles	1195.25	cu.m	10525	12,580,051
8	DRESSING Dressing of pile head. (Rate to include for cutting of steel liners and chipping of concrete above pile cut-off level): a) 1300 dia piles	25	no.	6500	162,500
9	PILE DYNAMIC LOAD TEST (10% OF TOTAL NO. OF PILES)	3	Nos	500000	1,500,000
10	PILE INTEGRITY TEST (20% OF TOTAL NO. OF PILES)	5	Nos	300000	1,500,000
TOTAL OF SECTION 2 CARRIED TO SUMMARY					36,754,164

BILL OF QUANTITIES OF APPROACH TRESTLE

SECTION 3 - DECK (Marine Works)

Sl. No.	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	SHUTTERING Wrot shuttering for the insitu part of beams, slab, kerb etc. a) Soffits b) Sides	828 55	sq.m sq.m	575 625	476,100 34,500
2	REINFORCEMENT IN INSITU & PRECAST CONCRETE Supply, Cut, bend and fix in position according to drawings and as directed by the Employer/Engineer, "High Yield Strength Deformed" reinforcements of grade Fe 500 in piles. No wastage taken into account. a) Beams b) Deck slabs c) Pile Muff	44 49 8	T T T	61680 61680 61680	2,721,118 3,023,338 481,104
3	STEEL INSERTS/EMBEDDED PARTS IN CONCRETE a) Mild Steel Fabricate and fix in position various steel inserts/embedded parts in insitu and precast concrete in accordance with the Drawings and as directed by the Engineer.	0.5	T	61680	30,840
4	PRECAST CONCRETING (Rate to include for shuttering) Concrete class M40 in: a) Slab panels in-cluding making hole to suit 100 dia drain pipes b) Beams c) Pile Muff	194 119 30	cu.m cu.m cu.m	10500 10500 10500	2,034,375 1,244,880 315,000
5	ERECTION OF PRECAST CONCRETE Collect the precast concrete elements from the storage yard, bring to the location of placement and place them to lines and levels according to the Drawings and as directed by the Engineer: a) Precast slab panels b) Beams c) Pile Muff	194 119 30	cu.m cu.m cu.m	1650 1650 1650	319687.5 195624 49500
7	INSITU CONCRETING Concrete class M40 in: a) Insitu beams,slope tank etc upto the soffit of deck slab. b) Insitu portion of Deck Slab including areas over beam widths, Kerbs / upstands of the Approach. c) Pile Muff	183 141 30	cu.m cu.m cu.m	9050 9050 9050	1658865 1275597.5 271500
8	SCREED (Wearing Coat) Concrete screed (1:1:2) including laying the screed to lines and levels on the deck slab of Approach.	63	cu.m	8000	505680
9	DRAIN PIPE Supply and fix in position 100 mm dia drain pipes made of PVC in Approach. a) 600 mm long	45	nos	600	27000
10	EXPANSION JOINTS Supply and place in position, according to the Drawings and Specification, strip seal type expansion joint for max movement of 100mm all complete.	30	l.m.	10400	312000
TOTAL OF SECTION 3 CARRIED TO SUMMARY					14,976,709

BILL OF QUANTITIES OF APPROACH TRESTLE

SECTION 4 : DECK FITTING AND MISCELLANEOUS

Sl. No.	Description	Qty.	Unit	Rate Rs.	Amount Rs.
1	HAND RAIL POSTS & HAND RAILING Supply, Fabricate, painting and install in position, as shown on the drawings minimum 40 mm diameter N.B. (Heavy), M.S. tubes of grade conforming to IS: 1239 and toe plate (100 mm x 6 mm) of mild steel conforming to IS: 2062 Note :- Surface Coat: self priming aluminium containing high build epoxy with solids by volume content of not less than 85% dry film thickness 75-100 microns. Intermediate coat Polyurethane epoxy of minimum thickness of 75 microns solids by volume minimum 62%. Finish coat Polyurethane epoxy of minimum thickness of 75 microns solids by volume minimum 62%.	272	m	6438	1751136
TOTAL OF SECTION 4 CARRIED TO SUMMARY					1,751,136

3.

STORAGE AREA

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Covered Shed Building

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	351.00	323.90	113,689	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	661.33	219.65	145,261	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyriphos/Lindane E.C. 20% with 1% concentration	sqm	702.00	227.05	159,390	DSR 2.35.3.1
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Covered Shed Ground floor					
2.0200	Building area - 60m x 18m	sqm	1,080			
2.0300	Steel structure @ 80kg/sqm	Kg	86,400	90.00	7,776,000	Market rate
2.0400	Roof sheeting Providing and fixing precoated galvanised iron profile sheets (size, shape and pitch of corrugation as approved by Engineer-in-charge) 0.50 mm (+ 0.05 %) total coated thickness with zinc coating 120 grams per sqm as per IS: 277, in 240 mpa steel grade, 5-7 microns epoxy primer on both side of the sheet and polyester top coat 15-18 microns. Sheet should have protective guard film of 25 microns minimum to avoid scratches during transportation and should be supplied in single length upto 12 metre or as desired by Engineer-in-charge. The sheet shall be fixed using self drilling /self tapping screws of size (5.5x 55 mm) with EPDM seal, complete upto any pitch in horizontal/ vertical or curved surfaces, excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required.	sqm	1,080	627.55	677,754	DSR 12.50
2.0500	Side Sheeting	sqm	1,092	627.55	685,285	DSR 12.50
2.0600	Brick masonry @ 230Thick Brick work with non modular fly ash bricks conforming to IS:12894, class designation 10 average compressive strength in super structure above plinth level up to floor V level in : Cement mortar 1:6 (1 cement : 6 Coarse sand)	cum	109	7280.70	791,532	DSR 6.34.2

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
2.0700	Rolling shutter Supplying and fixing rolling shutters of approved make, made of required size M.S. laths, interlocked together through their entire length and jointed together at the end by end locks, mounted on specially designed pipe shaft with brackets, side guides and arrangements for inside and outside locking with push and pull operation complete, including the cost of providing and fixing necessary 27.5 cm long wire springs manufactured from high tensile steel wire of adequate strength conforming to IS: 4454 - part 1 and M.S. top cover of required thickness for rolling shutters.	sqm	109	2803.65	305,823	DSR 10.6.2
2.0800	Cement Concrete Flooring 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate 6 mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer's specifications. This includes cost of cement slurry, but excluding the cost of nosing of steps etc. complete.	sqm	1,080	787.50	850,500	DSR 11.4
2.0900	RCC Tie beams	cum	14	10884.38	156,213	DSR 5.33.2 & 5.9.5
2.1000	Reinforcement	cum	2,009	83.50	167,775	DSR 5.22.6
3.0000	PILE & PILE CAP WORK AS PER DSR					
3.0100	Boring & Concreting	RM	780	5,428.00	4,233,840	DSR 20.2A.1
3.0200	Reinforcement	Kg	51,277	83.50	4,281,614	DSR 5.22.6
3.0300	Liner	MT	24	75,000.00	1,800,000	Market Rate
3.0400	PCC for Pile Cap (100mm thick)	Cum	21.87	6,259.10	136,862	DSR 4.1.5
3.0500	Pile Cap (2.7m x 2.7m x 0.8m)	Cum	152	8,967.00	1,359,685	DSR 5.33 & 5.9.1
6.0000	INTERNAL FIRE FIGHTING SYSTEM					
6.0100	Wet riser and sprinkler system	sqm	1,080	1536.00	1,658,880	CPWD PAR 1.5.2
6.0200	Fire alarm system	sqm	1,080	768.00	829,440	CPWD PAR 1.6.2
GRAND TOTAL					26,129,543	

4. BUILDINGS

**DPR for Development of Inland Water Transport (IWT) facility at
Jogighopa, Assam**

Cost Estimate - Summary

S.No		Area	Unit	Amount
A.	Buildings			
1	Admin Building with parking	828	sqm	41,944,697
2	Guard Room	25	sqm	1,137,178
3	Pumphouse	84	sqm	4,417,297
4	Canteen & Restroom	315	sqm	13,543,778
5	Substation	162	sqm	6,030,698
6	Port in call	73	sqm	2,930,941
7	Customs Office	73	sqm	2,930,941
8	UG Sump	1184.4	cum	10,862,567
9	OHT (12000 Litres - 3 No.s)	36,000	Litres	16,123,307

4.1

ADMIN BUILDING

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Admin Building (G+2)

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	235.00	323.90	76,117	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	154.95	219.65	34,035	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	622.00	227.05	141,226	DSR 2.35.3.1
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Admin Building Ground floor					
	Parking	sqm	115.00	10240.00	1,177,600	CPWD PAR 1.8.1
	Building area	sqm	145.00	27776.00	4,027,520	CPWD PAR 1.2.1
2.0200	Extra for every additional floor height of 3 m or part thereof	sqm	260.00	27776.00	7,221,760	CPWD PAR 1.2.1
		sqm	260.00	27776.00	7,221,760	CPWD PAR 1.2.1
		sqm	47.50	27776.00	1,319,360	CPWD PAR 1.2.1
3.0000	PILE & PILE CAP WORK AS PER CPWD					
3.0100	Boring & Concreting (M40 grade concrete)	RM	330.00	5,428.00	1,791,240	DSR 20.2A.1
3.0200	Reinforcement for Pile & Pile cap (TMT-Fe 500D)	Kg	22,443.80	83.50	1,874,057	DSR 5.22.6
3.0300	Liner	MT	10.36	75,000.00	777,000	Market rate
3.0400	PCC for Pile Cap (100mm thick)	Cum	11.00	6,259.10	68,850	DSR 4.1.5
3.0500	RCC for Pile Cap (M40 Grade concrete including shuttering)	Cum	70.40	8,967.00	631,277	DSR 5.33 & 5.9.1
4.0000	MISCELLANEOUS BUILDING WORK					
4.0100	Supply and installation of passenger lift elevator with 8 person capacity as per specifications complete	No.s	2.00	2,304,000.00	4,608,000	CPWD PAR 3.1.1
5.0000	WATER SUPPLY					
5.0100	Internal water supply & sanitary installation @ 4%	LS			838,720	CPWD PAR 2.1
5.0000	ELECTRICAL SERVICES					
5.0100	Internal Electric installations @ 12.5%	LS			2,621,000	CPWD PAR 2.3
5.0200	Power wiring & plugs @ 4%	LS			838,720	CPWD PAR 2.4.1

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
5.0300	Lightning conductors @ 0.25%	LS			52,420	CPWD PAR 2.4.2
5.0400	Telephone Conduits @ 0.25%	LS			52,420	CPWD PAR 2.4.3
5.0500	Third Party Quality Assurance @1%	LS			209,680	CPWD PAR 2.4.4
6.0000	INTERNAL FIRE FIGHTING SYSTEM					
6.0100	Wet riser and sprinkler system	sqm	828	1536.00	1,271,040	CPWD PAR 1.5.2
6.0200	Fire alarm system	sqm	828	768.00	635,520	CPWD PAR 1.6.2
7.0000	HVAC					
7.0100	1.5TR Indoor and Outdoor Unit	No.s	25	56215.00	1,405,375	Market Rate
8.0000	FURNITURE					
8.0100	1st floor & 2nd floor	LS			3,050,000	Market Rate
GRAND TOTAL					41,944,697	

4.2

GUARD ROOM

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Guard Room (5m x 5m)

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	60.00	323.90	19,434	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	15.00	219.65	3,295	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	107.00	227.05	24,295	DSR 2.35.3.1
1.0400	Plinth Protection Supplying, filling, spreading & leveling stone boulders of size range 5 cm to 20 cm, in recharge pit, in the required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge.	cum	4.00	1326.55	5,307	DSR 23.5
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Guard room	sqm	25.00	27776.00	694,400	CPWD PAR 1.2.1
3.0000	SUBSTRUCTURE					
3.0100	Open foundation	sqm	25.00	1,024.00	25,600	CPWD PAR 1.3.6
4.0000	ELECTRICAL SERVICES					
4.0100	Internal Electric installations	LS			86,800	CPWD PAR 2.3
4.0200	Power wiring & plugs	LS			27,776	CPWD PAR 2.4.1
4.0300	Telephone Conduits	LS			1,736	CPWD PAR 2.4.3
4.0400	Third Party Quality Assurance @1%	LS			6,944	CPWD PAR 2.4.4
5.0000	INTERNAL FIRE FIGHTING SYSTEM					
5.0100	Wet riser and sprinkler system	sqm	25.00	1536.00	38,400	CPWD PAR 1.5.2
5.0200	Fire alarm system	sqm	25.00	768.00	19,200	CPWD PAR 1.6.2
6.0000	INTERNAL WATER SUPPLY AND DRAINAGE					
6.0100	Providing and laying of pipelines and sanitary fixtures	LS			27,776	CPWD PAR 2.1
7.0000	HVAC					
7.0100	Providing of Split air Conditioner	No.s	1.00	56215.00	56,215	Market Rate
8.0000	FURNITURE					
8.0100	Guard room	LS			100,000	Market Rate
GRAND TOTAL - Guard Room					1,137,178	

4.3

PUMP HOUSE

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Pumphouse

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	168.00	323.90	54,416	DSR 2.25 a
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	84.00	227.05	19,073	DSR 2.35.3.1
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Pumphouse	sqm	84	38400.00	3,225,600	CPWD PAR 1.4.1
4.0000	PILE & PILE CAP WORK AS PER DSR					
4.0100	Raft foundation - Pumphouse	sqm	84.00	6,592.00	553,728	CPWD PAR 1.3.5
5.0000	ELECTRICAL SERVICES					
5.0100	Power wiring & plugs for pump house	LS			129,024	CPWD PAR 2.4.1
5.0200	Internal Electric installations @ 12.5%	LS			403,200	CPWD PAR 2.3
#REF!	Third Party Quality Assurance @1% for pump house	LS			32,256	CPWD PAR 2.4.4
GRAND TOTAL FOR PUMP HOUSE					4,417,297	

4.4

CANTEEN & REST ROOM

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Canteen & Restroom Building

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	168	323.90	54,416	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	189	219.65	41,541	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	448	227.05	101,719	DSR 2.35.3.1
1.0000	SUPERSTRUCTURE					
1.0100	Construction of Canteen & restroom Building (Ground floor)	sqm	315	27776.00	8,754,996	CPWD PAR 1.2.1
2.0000	SUBSTRUCTURE					
2.0100	Open foundation	sqm	315	1,024.00	322,765	CPWD PAR 1.3.6
2.0200	Stronger structural element to take heavy load	sqm	315	2,124.80	669,737	CPWD PAR 1.3.9
3.0000	WATER SUPPLY					
3.0100	Internal water supply & sanitary installation @ 4%	LS			350,200	CPWD PAR 2.1
4.0000	ELECTRICAL SERVICES					
4.0100	Internal Electric installations	LS			1,094,375	CPWD PAR 2.3
4.0200	Power wiring & plugs	LS			350,200	CPWD PAR 2.4.1
4.0300	Telephone Conduits	LS			21,887	CPWD PAR 2.4.3
4.0400	Third Party Quality Assurance @1%	LS			87,550	CPWD PAR 2.4.4
5.0000	INTERNAL FIRE FIGHTING SYSTEM					
5.0100	Wet riser and sprinkler system	sqm	315	1536.00	484,147	CPWD PAR 1.5.2
5.0200	Fire alarm system	sqm	315	768.00	242,074	CPWD PAR 1.6.2
6.0000	HVAC					
6.0100	1.5TR Indoor and Outdoor Unit	No.s	5	56215.00	268,171	Market Rate
7.0000	FURNITURE					
7.0100	Canteen Building	LS			700,000	Market Rate
GRAND TOTAL					13,543,778	

4.5 SUBSTATION

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Substation Building

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	251.00	323.90	81,299	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	52.00	219.65	11,422	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	668.00	227.05	151,670	DSR 2.35.3.1
1.0400	Plinth Protection Supplying, filling, spreading & leveling stone boulders of size range 5 cm to 20 cm, in recharge pit, in the required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge.	cum	8.00	1326.55	10,613	DSR 23.5
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Substation	sqm	162	27776.00	4,506,379	CPWD PAR 1.8.1
3.0000	SUBSTRUCTURE					
3.0100	Open foundation	sqm	162.24	1,024.00	166,134	CPWD PAR 1.3.6
4.0000	ELECTRICAL SERVICES					
4.0100	Internal Electric installations	LS			563,297	CPWD PAR 2.3
4.0200	Power wiring & plugs	LS			180,255	CPWD PAR 2.4.1
4.0300	Lightning conductors	LS			11,266	CPWD PAR 2.4.2
4.0400	Telephone Conduits	LS			11,266	CPWD PAR 2.4.3
4.0500	Third Party Quality Assurance @1%	LS			45,064	CPWD PAR 2.4.4
5.0000	INTERNAL FIRE FIGHTING SYSTEM					
5.0100	Supply, installation testing and commissioning of Fire alarm complete with suitable accessories as per specification as required.	sqm	162	1200.00	194,688	CPWD PAR 1.5.2
5.0200	Fire alarm system	sqm	162	600.00	97,344	CPWD PAR 1.6.2
GRAND TOTAL					6,030,698	

4.6

PORT IN CALL

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Port In call building

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	29.00	323.90	9,394	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	44.00	219.65	9,665	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	159.00	227.05	36,101	DSR 2.35.3.1
1.0400	Plinth Protection Supplying, filling, spreading & leveling stone boulders of size range 5 cm to 20 cm, in recharge pit, in the required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge.	cum	6.00	1326.55	7,960	DSR 23.5
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Guard room	sqm	73.00	27776.00	2,027,648	CPWD PAR 1.2.1
3.0000	SUBSTRUCTURE					
3.0100	Open foundation	sqm	73.00	1,024.00	74,752	CPWD PAR 1.3.6
4.0000	ELECTRICAL SERVICES					
4.0100	Internal Electric installations	LS			253,456	CPWD PAR 2.3
4.0200	Power wiring & plugs	LS			81,106	CPWD PAR 2.4.1
4.0300	Telephone Conduits	LS			5,069	CPWD PAR 2.4.3
4.0400	Third Party Quality Assurance @1%	LS			20,276	CPWD PAR 2.4.4
5.0000	INTERNAL FIRE FIGHTING SYSTEM					
5.0100	Wet riser and sprinkler system	sqm	73.00	1536.00	112,128	CPWD PAR 1.5.2
5.0200	Fire alarm system	sqm	73.00	768.00	56,064	CPWD PAR 1.6.2
6.0000	INTERNAL WATER SUPPLY AND DRAINAGE					
6.0100	Providing and laying of pipelines and sanitary fixtures	LS			81,106	CPWD PAR 2.1
7.0000	HVAC					
7.0100	Providing of Split air Conditioner	No.s	1.00	56215.00	56,215	Market Rate
8.0000	FURNITURE					
8.0100	Guard room	LS			100,000	Market Rate
GRAND TOTAL - Port In call building					2,930,941	

4.7

CUSTOMS OFFICE

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam**Bill of Quantities - Customs Office building**

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	29.00	323.90	9,394	DSR 2.25 a
1.0200	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc. in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	cum	44.00	219.65	9,665	DSR 2.25
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	159.00	227.05	36,101	DSR 2.35.3.1
1.0400	Plinth Protection Supplying, filling, spreading & leveling stone boulders of size range 5 cm to 20 cm, in recharge pit, in the required thickness, for all leads & lifts, all complete as per direction of Engineer-in-charge.	cum	6.00	1326.55	7,960	DSR 23.5
2.0000	SUPERSTRUCTURE					
2.0100	Construction of Guard room	sqm	73.00	27776.00	2,027,648	CPWD PAR 1.2.1
3.0000	SUBSTRUCTURE					
3.0100	Open foundation	sqm	73.00	1,024.00	74,752	CPWD PAR 1.3.6
4.0000	ELECTRICAL SERVICES					
4.0100	Internal Electric installations	LS			253,456	CPWD PAR 2.3
4.0200	Power wiring & plugs	LS			81,106	CPWD PAR 2.4.1
4.0300	Telephone Conduits	LS			5,069	CPWD PAR 2.4.3
4.0400	Third Party Quality Assurance @1%	LS			20,276	CPWD PAR 2.4.4
5.0000	INTERNAL FIRE FIGHTING SYSTEM					
5.0100	Wet riser and sprinkler system	sqm	73.00	1536.00	112,128	CPWD PAR 1.5.2
5.0200	Fire alarm system	sqm	73.00	768.00	56,064	CPWD PAR 1.6.2
6.0000	INTERNAL WATER SUPPLY AND DRAINAGE					
6.0100	Providing and laying of pipelines and sanitary fixtures	LS			81,106	CPWD PAR 2.1
7.0000	HVAC					
7.0100	Providing of Split air Conditioner	No.s	1.00	56215.00	56,215	Market Rate
8.0000	FURNITURE					
8.0100	Guard room	LS			100,000	Market Rate
GRAND TOTAL - Customs Office building					2,930,941	

4.8

UG SUMP

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - UG Sump

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	EARTHWORK					
1.0100	Excavating, supplying and filling of local earth (including royalty) by mechanical transport upto a lead of 5km also including ramming and watering of the earth in layers not exceeding 20cm in trenches, plinth, sides of foundation etc. complete.	cum	572.00	323.90	185,271	DSR 2.25 a
1.0300	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1 :2 (1 cement : 2 Coarse sand) to match the existing floor: With Chlorpyrifos/Lindane E.C. 20% with 1% concentration	sqm	410.00	227.05	93,091	DSR 2.35.3.1
2.0000	UG SUMP - SUPERSTRUCTURE					
2.0100	Construction of UG Sump (21m x 12m x 4.7m)	Litres				
	Raft - 600thick	cum	176	8721.13	1,537,361	DSR 5.33.1
	wall -400thick	cum	130	9770.13	1,271,055	DSR 5.33.1
	slab-400thick	cum	113	9979.51	1,131,277	DSR 5.33.1
	column- 400x400mm	cum	1	10080.63	10,081	DSR 5.33.1
2.0200	REINFORCEMENT					
	Bottom slab	Kg	21,154	83.50	1,766,326	DSR 5.22.6
	Wall	Kg	19,514	83.50	1,629,453	DSR 5.22.6
	Top Slab	Kg	13,603	83.50	1,135,868	DSR 5.22.6
3.0000	FINISHING WORKS					
	Plastering					
3.0100	Internal	sqm	577.24	344.25	198,715	DSR 13.14
3.0200	External	sqm	604.28	416.55	251,713	DSR 13.12
3.0300	Waterproofing	sqm	1,181.52	1,398.50	1,652,356	DSR 22.7.1
GRAND TOTAL FOR UG SUMP					10,862,567	

4.9 Overhead Tank

DPR for Development of Inland Water Transport (IWT) facility at Jogighopa, Assam

Bill of Quantities - Overhead tank

S. No.	Description of Items	Unit	Quantity	Rate as per CPWD PAR 2019 with Cost Index of 1.28	Amount (Rs)	Remarks
1.0000	OVERHEAD TANK					
1.0100	Construction of Overhead Tank (12000 ltrs - 3 No.s)	Litres	36,000	38.40	1,382,400	CPWD PAR 4.2
2.0000	PILE & PILE CAP WORK AS PER DSR					
2.0100	Pile foundation - OHT					
	Boring & Concreting	RM	960	5,428.00	5,210,880	DSR 20.2A.1
	Reinforcement	Kg	63,110	83.50	5,269,679	DSR 5.22.6
	Liner	MT	30	75,000.00	2,250,000	Market Rate
	PCC for Pile Cap (100mm thick)	Cum	53.82	6,259.10	336,890	DSR 4.1.5
	Pile Cap (2.7m x 2.7m x 0.8m)	Cum	187	8,967.00	1,673,458	DSR 5.33 & 5.9.1
GRAND TOTAL FOR OHT					16,123,307	

RATE ANALYSIS

RATE ANALYSIS

S.No	DSR Item Code	Description of Items	Unit	Quantity	Rate	Amount
		PILE & PILE WORKS				
1		Boring, providing and installation bored cast-in-situ reinforced cement concrete piles of grade M-40 of specified diameter and length below pile cap, to carry a safe working load not less than specified, excluding the cost of steel reinforcement but including the cost of boring with bentonite solution and temporary casing of appropriate length for setting out and removal of same and the length of the pile to be embedded in the pile cap etc. by Crawler mounted, telescopic boom hydraulic piling Rig all complete, including removal of excavated earth with all its lifts and leads (length of pile for payment shall be measured up to bottom of pile cap). Note: Truck Mounted rotary/TMR/Tube well boring machine shall not be used.				
		600 mm dia piles				
		Details of Cost for 10 m length of pile				
		Sub Data for M-40 grade concrete				
	DSR 5.33.1	Providing and laying in position machine batched, machine mixed and machine vibrated design mix M-25 grade cement concrete Details of cost for 1 cum concrete				
		Material				
		Cost for One Cum				7,997.30
	DSR 5.34.3 & 5.35	Providing M-40 grade concrete instead of M-25 grade BMC/ RMC. (Note : Cement content considered in M-40 is @ 420 kg/ cum)				613.00
		Total cost for 1 cum M-40 grade concrete				8,610.30
		Main Data for 600 mm dia pile				
		Material Concrete 3.14/4x0.6 ² x10=2.83 Cum				
	5.33.1	Rate as per item no 5.33.1, 5.35 and 5.34.3	cum	2.83	8,610.30	24,345.05
	7183	Bentonite	tonne	0.33	2,960.00	976.80
	9999	Sundries	LS	317.43	2.00	634.86
	0024	Hire and running charges of hydraulic piling with power unit etc. including complete accessories and shifting at site	Day	0.75	30,000.00	22,500.00
	0025	Hire and running charges of light crane	Day	0.06	3,000.00	180.00
	0026	Hire and running charges of bentonite pump	Day	0.38	3,500.00	1,330.00
	0017	Hire and running charges of tipper	Day	0.30	1,700.00	510.00
	0018	Hire and running charges of loader	Day	0.30	5,000.00	1,500.00
	0130	Mistry	Day	0.12	738.00	88.56
	0114	Beldar	Day	3.00	558.00	1,674.00
						0.00
		Total				53,739.27
		Add water charges @ 1% on total			1.00%	537.39
		Total for material, machinery and labour including water				54,276.66
		Add GST multiplying factor				0.00
		Total				54,276.66
		Add Overhead and safety charges			10.00%	
		Total				54,276.66
		Add overheads additional for marine condition			20.00%	
		Total				54,276.66
		Add Contract Profit			10.00%	
		Total				54,276.66
		Add Cess				0.00
		Cost for 10 m pile				54,276.66
		Cost for 1 m pile				5,427.67
		Say				5,428.00
		Cost for 1 m pile				5,428.00
		Cost of Pile per metre length with Cost Index				5,151.71

2						
		LINER				
		Providing Steel Liner 10mm thick for Curbs and 6 mm thick for Steining of Wells including Fabricating and Setting out as per Detailed Drawing.				
	MORTH 12.22	a) Structural Steel including 5 per cent wastage (Material)				
	1007		tonne	1.05	46092.24	48396.85
		Carriage of steel	tonne	1.00	92.24	92.24
	M-179	b) Labour				
	L-12	Mate	Day	1.24	617	765.08
	L-08	Fitter	Day	6	738	4428.00
	L-01	Blacksmith (IInd class)	Day	5	679	3395.00
	L-02	Blacksmith	Day	5	738	3690.00
	L-13	Mazdoor	Day	10	558	5580.00
		Electrodes, cutting gas and other consumables @ 5 per cent			B*5/100	892.904
					Cost of 1.0 MT	67240.08
	DSR 5.33.1	Providing and laying in position machine batched, machine mixed and machine vibrated design mix M-25 grade cement concrete Details of cost for 1 cum concrete				
		Material				
		Stone Aggregate (Single size) : 20 mm nominal size	cum	0.570	1,350.00	769.50
		Stone Aggregate (Single size) : 10 mm nominal size	cum	0.280	1,350.00	378.00
		Carraige of Stone aggregate below 40 mm nominal size	cum	0.850	103.77	88.20
		Coarse sand (zone III)	cum	0.425	1,350.00	573.75
		Carraige of Coarse sand	cum	0.425	103.77	44.10
		Portland Cement	tonne	0.330	4,940.00	1,630.20
		Carraige of Cement	tonne	0.330	92.24	30.44
		Plasticizer / super plasticizer 0.50% OF cement	kg	1.650	36.00	59.40
		Machinery				
		Production cost of concrete by batch mix plant.	cum	1.000	350.00	350.00
		Pumping charges of concrete including Hire charges of pump, piping work & accessories etc.	cum	1.000	210.00	210.00
		Labour				
		Mason (average)	Day	0.170	709.00	120.53
		Beldar	Day	2.000	558.00	1,116.00
		Bhisti	Day	0.900	617.00	555.30
		Vibrator (Needle type 40mm)	Day	0.070	370.00	25.90
		Sundries	L.S.	13.000	2.00	26.00
		Total for material, machinery and labour				5,977.33
		Cost for One Cum				7,997.30
	DSR 5.34.3 & 5.35	Providing M-40 grade concrete instead of M-25 grade BMC/ RMC. (Note : Cement content considered in M-40 is @ 420 kg/ cum)				613.00
		Total cost for 1 cum M-40 grade concrete				8,610.30
		Shuttering	cum	8,610.30		8,610.30
			sqm	284.85		356.06
						8966.36

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