অসম চৰকাৰ

GOVT. OF ASSAM
OFFICE OF THE DEPUTY COMMISSIONER,
KAMRUP METROPOLITAN DISTRICT, GUWAHATI
(MAGISTERIAL BRANCH)

KMJ. 76/2021/

To,

Date – 27/01/2023

The State Project Director,
Assam Inland Water Transport Development Society.

Sub : Regarding "No Objection' for construction of Passenger Ferry Terminals at Umananda IWT Ghat, Guwahati.

Sir,

With reference to the subject cited above, I am directed to state that, the office has no objection for construction of the Passenger Ferry Terminals at Umananda IWT Ghat, Guwahati, subject to the receipt of necessary feasibility certificate from the Water Resource Department, Assam and the Directorate of Inland Water Transport, Ulubari, Guwahati.

This is for favour of your kind information.

Yours faithfully,

27.1.23

Addl. District Magistrate,
Kamrup Metropolitan District,
Guwahati.

27/1/23

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GOVT. OF ASSAM
OFFICE OF THE CIRCLE OFFICER ::: NORTH GUWAHATI REV. CIRCLE
AMINGAON

No. NGC-2022/ 239 Dated: 07/02/2023

To

The Deputy Commissioner,
Kamrup, Amingaon

Sub:- Regarding availability of land for issue of NOC for construction of passenger ferry terminal at the existing North Guwahati Ferry Ghat of Inland Water Transport, Assam.

Ref:- Govt. Letter No. AIWTDS/57/2018/133; Dated : 18/01/2023.

Sir,

With reference to the subject cited above, I have the honour to inform you that suitable amount of govt. land covered by Govt. Dag No. 585 belonging to village North Guwahati Town of Sila Sindurighopa Mouza is available near the river Brahmaputra (Majgaon) for construction of passenger ferry terminal at the existing North Guwahati Ferry Ghat (Majgaon) of Inland Water Transport, Assam under North Guwahati Revenue Circle.

It may also be mentioned here that there is no zirat for the above mentioned plot of land.

This is for favour of your kind information and necessary action.

Enclosed : Chitha copy.

Yours faithfully,

Circle Officer
North Guwahati Rev. Circle
Amingaon

Circle Officer
North Guwahati Revenue Circle
Kamrup, Amingaon

Memo No. NGC-2022/239-A Dated: 07/02/2023

Copy to:

1. The State Project Director, Assam Inland Water Transport Dev. Society for favour of kind information.

Circle Officer
North Guwahati Rev. Circle
Amingaon

Circle Officer
North Guwahati Revenue Circle
Kamrup, Amingaon

19

भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण

(पत्तन, पोत परिवहन और जलमार्ग मंत्रालय, भारत सरकार)

INLAND WATERWAYS AUTHORITY OF INDIA

(Ministry of Ports, Shipping & Waterways, Govt. of India)

Head Office: A-13, Sector -1, NOIDA, Distt. Gautam Budh Nagar - 201 301 (U.P.)

Tele.: Code-95120-2544036, 2521684, 2521724 Fax : 2544041, 2543973, 2521764; E-mail:ahsnoida@gmail.com

No. IWAI/NOC-Online/NW-2/Jetty/Kamrup Metropolitan/2022 Dated 22.12.2022

To

The Director, IWAI Guwahati

Sub: NOC for construction of jetty at Panbazar, Metropolitan, Guwahati (Assam) on Brahmaputra River (Dhubri - Sadiya) of NW-2 - reg.

Ref.1) Online application ID 11102022339 dated 11.112022.

2) Drawing No. DI1530-RHD-ZZ-UA-DR-MA-2201dtd. April 2022

3) Your Letter no. IWAI/GHY/3(20)/NCL/2016-2017 Vol V/ dated 23.11.2022

Sir,

I am directed to state that this has reference to above application for subject work, regarding issuance of NOC for construction of jetty at Kamrup Metropolitan, Guwahati (Assam) on Brahmaputra River(Dhubri - Sadiya) of NW-2 and your recommendation letter at ref (3).

2. In this regard, it is to convey that IWAI has "No Objection" for construction of aforementioned Water Intake jetty as indicated in the prescribed format of IWAI along with GAD, submitted with the Proposal. It is also required to provide three sides rubber fenders and Night Nav Aids.

3. You are requested to obtain the information of the time of Commencement of the proposed construction (stage wise/ Periodical) to monitor and ensure the required Navigational clearances. The above may be conveyed to the concerned agency.

4. It is also requested that due procedures be followed while construction of above said structure across National Waterway.

This is being issued with the approval of Competent Authority.

Yours faithfully,

(P.Palani Raj)
Senior Hydrographic Surveyor
E-mail ID: ppraj@iwai.gov.in

Copy to:

1. Assam Inland Water Transport Development Society, 3rd Floor, Directorate of Inland Water, Ulubari Guwahati-781007

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भारतीय अन्तर्देशीय जलमार्ग प्राधिकरण

(पत्तन, पोत परिवहन और जलमार्ग मंत्रालय, भारत सरकार)

INLAND WATERWAYS AUTHORITY OF INDIA

(Ministry of Ports, Shipping & Waterways, Govt. of India)

Head Office: A-13, Sector -1, NOIDA, Distt. Gautam Budh Nagar - 201 301 (U.P.)

Tele.: Code-95120-2544036, 2521684, 2521724 Fax : 2544041, 2543973, 2521764; E-mail:ahsnoida@gmail.com

No. IWAI/NOC-Online/NW-2/Jetty/NorthGuwahati/2022 Dated 22.12.2022

To

The Director, IWAI Guwahati.

Sub: NOC for construction of floating passengers Jetty at North Guwahati (NW-2) - reg.

Ref. 1) Online application ID: 4102022338 dated 11.112022.
2) Drawing No. DI1530-RHD-ZZ-UA-DR-MA-2120 dtd. May 2022
3) Your Letter no. IWAI/GHY/3(20)/NCL/2016-2017 Vol V/ dated 23.11.2022

Sir,

I am directed to state that this has reference to above application for subject work, regarding issuance of NOC for construction of floating passengers Jetty at North Guwahati and your recommendation letter at ref (3).

2. In this regard, it is to convey that IWAI has "No Objection" for construction of aforementioned Water Intake jetty as indicated in the prescribed format of IWAI along with GAD, submitted with the Proposal. It is also required to provide three sides rubber fenders and Night Nav Aids.

3. You are requested to obtain the information of the time of Commencement of the proposed construction (stage wise/ Periodical) to monitor and ensure the required Navigational clearances. The above may be conveyed to the concerned agency.

4. It is also requested that due procedures be followed while construction of above said structure across National Waterway.

This is being issued with the approval of Competent Authority.

Yours faithfully,

(P. Palani Raj)
Senior Hydrographic Surveyor
E-mail ID: ppraj@iwai.gov.in

Copy to:

1. Assam Inland Water Transport Development Society, 3rd Floor, Directorate of Inland Water, Ulubari Guwahati-781007

PREPARATION OF DETAILED PROJECT REPORT (DPR) ALONG WITH ENGINEERING DESIGN, DRAWINGS, TENDER DOCUMENTS FOR CONSTRUCTION OF MODULAR TERMINAL AT FERRY SERVICE OF NW-2 AND NW-16 IN ASSAM

SOIL INVESTIGTION REPORT
FOR
NORTH GUWAHATI FERRY GHAT

Client :

ROYAL HASKONING DHV CONSULTING PVT. LTD.
PLATINUM TECHNO PARK,
502-505, 5TH FLOOR,
PLOT NO. 17 & 18 SECTOR 30A,
VASHI NAVI MUMBAI- 400703,
MAHARASHTRA, INDIA

APRIL, 2022

FARGO CONSULTANTS PVT. LTD.
CF-394, SECTOR-I, SALT LAKE CITY
Kolkata- 700064
Phone-(033) 2337-3775
E-mail: fargoconsultants@gmail.com
Website: www.fargoconsultants.com

TABLE OF CONTENTS

CHAPTER - I

1.0 GEOTECHNICAL INVESTIGATIONS

1.1 INTRODUCTION

- Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam was entrusted to Fargo Consultants Pvt. Ltd., CF-394, Sector-I, Salt Lake City, Kolkata- 700064 by Royal Haskoning DHV Consulting Pvt. Ltd.

1.2 SCOPE OF WORK

- The scope of the soil investigation work consisted of sinking one (1) borehole in land and one (1) borehole in underwater location at each of the thirteen (13) locations. The land boreholes shall be explored to a depth of 50m or 15m into very dense strata with SPT N = 100(Refusal) or 10m into rock with RQD>75%, whichever is earlier. The river borehole shall be explored to 80m or 10m into rock with RQD>75%, whichever is earlier. 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 Latitude and Longitude of the location for the proposed jetty is provided in the Table-1. Location of the proposed jetty is shown in Figure 1.

Table-1: Proposed Ferry Service Location

Sl. No.	Location	Northing	Easting
1	North Guwahati Ferry Ghat	26°11'10.05"	91°43'18.18"

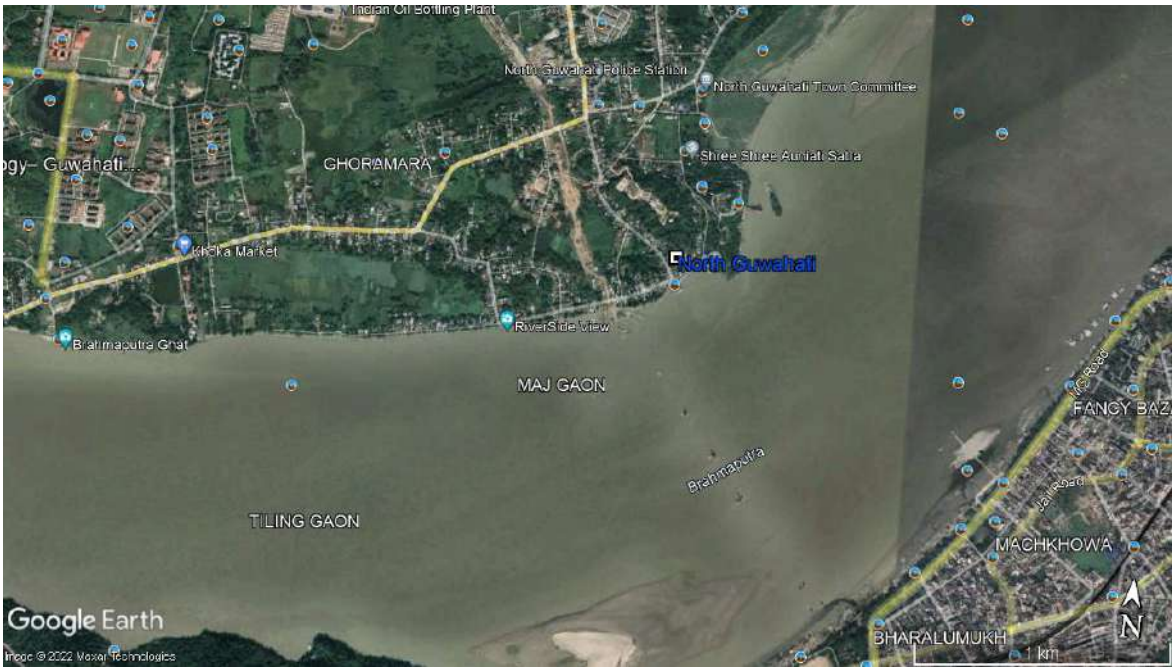


Figure 1: Location for Proposed Ferry Service of North Guwahati Ferry Ghat

CHAPTER - II

2.0 FIELD INVESTIGATION

2.1 BOREHOLES

- This report contains details of two (2) boreholes which have been completed as part of the investigation at North Guwahati Ferry Ghat beside in Brahmaputra River of Assam.

- The details of field work like, location, borehole no., termination depth, static water level and the dates of commencement and completion are furnished below.

Bore hole No.	Co-ordinates	Termination Depth (m)	Ground / Riverbed Elevation	**D.T.W. (m)	Commence-ment Date	Completion Date
BH-1 (Land)	Zone 46R E: 372280.162 N: 2896941.492	28.00	49.367m	4.30m bgl#	08.01.2022	12.01.2022
BH-2 (River)	Zone 46R E: 372311.390 N: 2896897.184	17.00	34.689m	3.40m agl$	29.01.2022	01.02.2022
Note:	**D.T.W. – Depth to water from borehole top #bgl. – below ground level $agl. – above ground level					

- The boreholes of 150/75 mm 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.

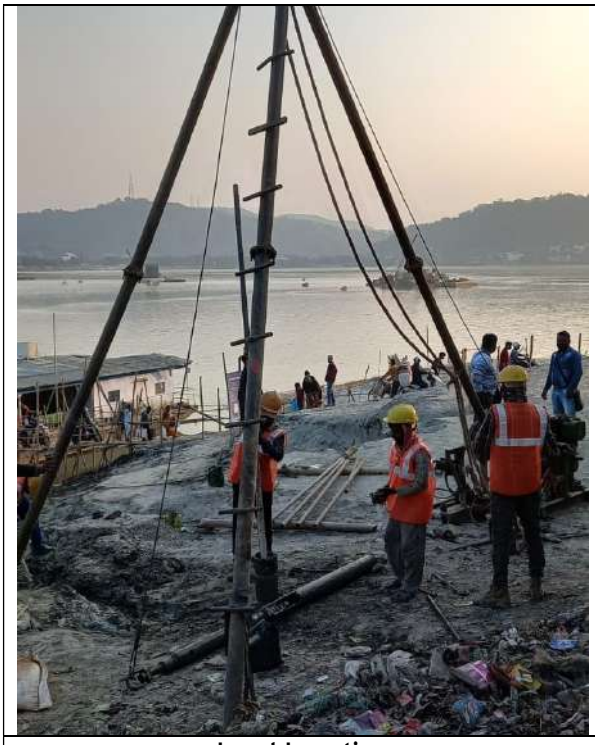
A record of the number of blows required to penetrate every 15cm. to a depth of 45cm. was kept. The number of blows required for the last 30cm penetration of the split spoon sampler was recorded as 'N' – value. On completion of the test, the sampler was lifted to the ground, opened and the specimen of 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.

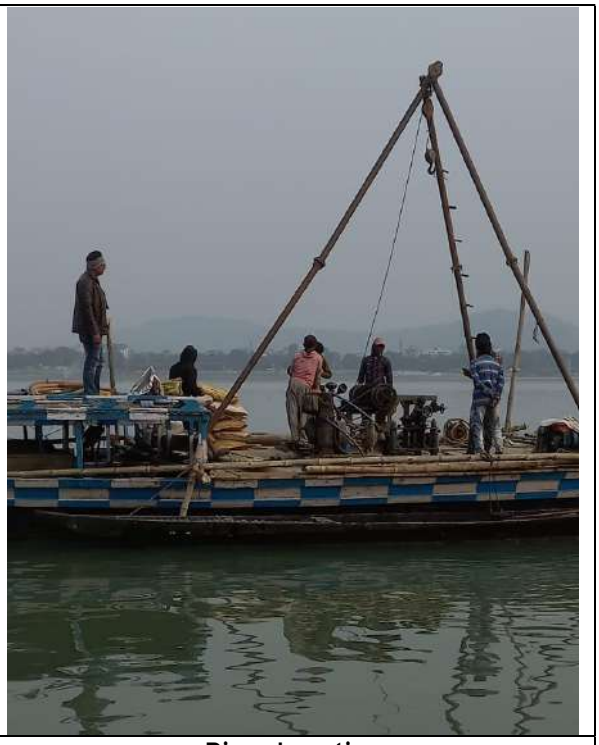
- For river boreholes, two country boats were joined together by bamboo, wooden planks and ropes. An opening was created in the platform for boring/drilling operations. The location of the proposed borehole was ascertained using field measurements. Once the opening in the platform was at the desired location the boats were anchored using at a minimum of six heavy anchors. The anchors were set by the boatmen. The anchors were loosened or tightened as the water level in the river varied during the work period.

- The field investigation work commenced on 08th January 2022 and was completed on 01st February 2022. The depth of water level in the boreholes were 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.

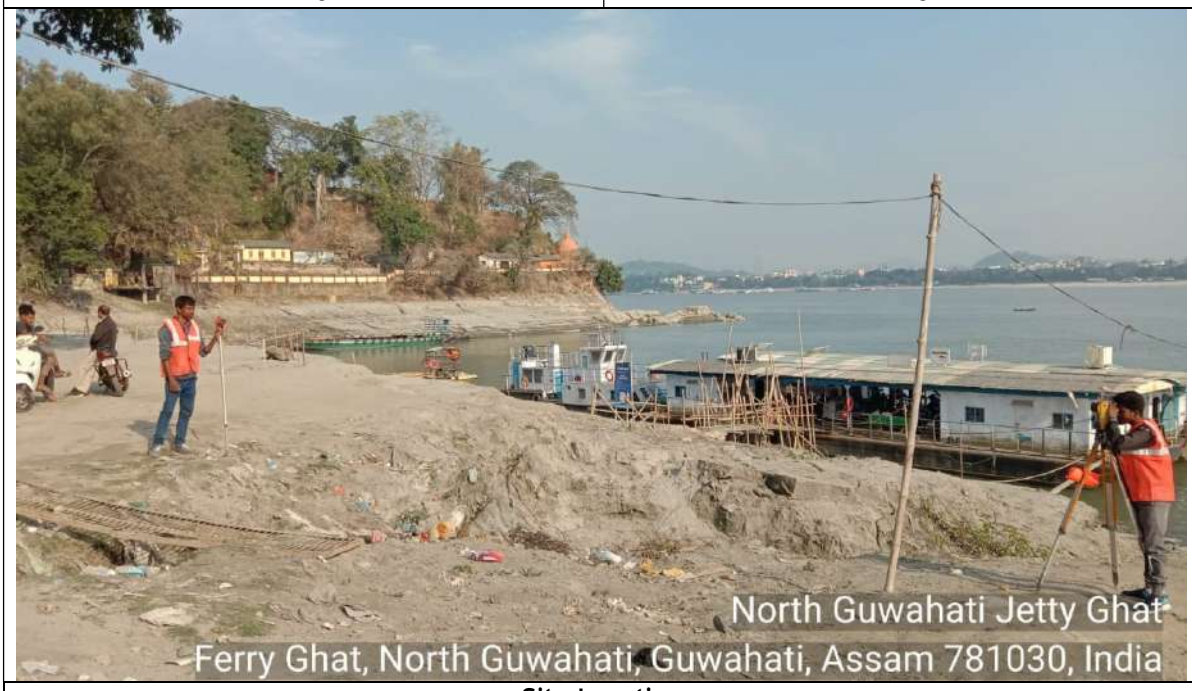
SITE PHOTOGRAPHS



Land Location



River Location



Site Location

CHAPTER - III

3.0 LABORATORY TESTING

The following laboratory tests were carried out to ascertain the properties of the sub-soil.

- Grain size analysis

  The particle size distribution of various soil samples collected from different subsoil deposits were determined by sieve analysis (dry method) or hydrometer analysis (wet method) or a combination of both, as was found necessary. From the test results, grain size distribution curves were generated to ascertain percentage of sand, silt, clay etc in each sample.

- Natural Moisture Content

  The natural moisture content (N. M. C) or water content of the samples were obtained by oven drying a quantity of soil for at least 24 hours at 1050C and recording their weights before and after drying.

- Atterberg Limits

  The Atterberg limits of the soil samples were determined by adopting standard procedure. The liquid limit was determined with the help of Cassagrande's apparatus. The plastic limit was ascertained by rolling the soil samples into threads.

- Specific Gravity

  The Specific Gravity of the soil samples were determined by adopting standard procedure. The soil sample was dried in oven dried for 24 hours and pulverished. The sample was then poured into a specific gravity bottle and topped up with distilled water. The specific gravity bottle was stirred and heated to eliminate air bubbles.

The weight of the specific gravity bottle was recorded along with the temperature of the sample.

- Unconfined Compression (UC)

Unconfined compression test was carried as per IS Code 2720 (Part 10). Three samples were tested and the average 'q_u' values was used to report the cohesion 'c' value. For hard soils, since undisturbed samples are not collected, the shear strength was estimated from correlations published in textbooks.

- Tri-axial Test (Unconsolidated Undrained)

The tri-axial test unconsolidated undrained (UU) test was carried as per IS Code IS Code 2720 (Part 11). Three samples were tested for three different confining pressures and the results were graphed to obtain 'c' and 'ϕ' values. For hard soils, since undisturbed samples are not collected, the shear strength was estimated from correlations published in textbooks.

- Direct Shear Test (Undrained)

The Direct Shear undrained test was carried out for non-cohesive soils as per IS Code 2720 (Part 39/Sec-I). The samples were prepared as per the procedure outlined in IS Code 2720 (Part -I). Three samples with three different vertical loads were tested and the results were graphed to obtain 'c' and 'ϕ' values.

- One Dimensional Consolidation Test

The One-dimensional consolidation test was carried as per IS Code. The sample was loaded upto 8kg/cm^2 incrementally and then unloaded. The data was used to evaluate the mv values. These values will be used for settlement calculations. For hard soils, since undisturbed samples are collected, the mv values were determined

from correlations published in "Manual for Estimating Soil Properties for Foundation Design" by F.H. Kulhawy and P.W. Mayne, 1990.

All these tests will be conducted as per relevant I.S. Codes and the test results are tabulated in Tables enclosed herewith.

CHAPTER - IV

4.0 DISCUSSION AND RECOMMENDATION

4.1 LAND LOCATION

4.1.1 The sub-soil formation in this area has been investigated by sinking one (1) borehole explored upto a maximum depth of 28.00m 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 four (4) 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.

Layer No.	From GL	To GL	Description	Layer Thickness (m)
				BH-1
I	49.367	46.367	Yellowish grey sandy silt with traces of mica	3.00
II	46.367	38.867	Bluish grey stiff silty clay with compacted silt	7.50
III	38.867	36.367	Bluish black medium dense silty sand with mica and kankar	2.50
IV	36.367	21.367	Dark grey completely to highly weathered rock	15.00*
* - Upto termination depth				

4.1.2 The ground water level has been found to exist at an average depth of 4.30m 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.

4.1.3 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. Boreholes with RQD tending to zero is treated as soil (ref.

pp279, Foundation Analysis and Design by J. Bowles). For these formations, a suitable value is used for calculation of the pile capacity.

Layer No.	From GL	To GL	Description	Thick-ness (m)	Average of N-Value	Bulk Density (t/m^3)	Shear Strength Parameter	
							c	ϕ
I	49.367	46.367	Yellowish grey sandy silt with traces of mica	3.00	4+	1.75#	0	28°#
II	46.367	38.867	Bluish grey stiff silty clay with compacted silt	7.50	10	1.881	5.1t/m²	0
III	38.867	36.367	Bluish black medium dense silty sand with mica and kankar	2.50	21+	1.86#	0	33.5°#
IV	36.367	21.367	Dark grey completely to highly weathered rock	15.00*	50+	2.06#	0	35°#
* = Upto termination depth #=Suggested value + = Corrected N-value								

4.1.4 Pile load capacities of suggested piles are provided in the tables 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 in 4.1.3. The pile load capacities of suggested piles are provided in the table below. The pile load capacities will require to be checked by conducting pile load test as per IS Code. The centre-to-centre distance between the piles should at least 3 times the diameter of pile. Sample calculations are provided in Annexure-A.

Pile Diameter	Pile Cut-off Depth below EGL	Pile Founding Depth below EGL	Suggested Pile Vertical load Capacity	Suggested Pile Uplift load Capacity	Suggested Pile Lateral Load Capacity (Fixed head)
(mm)	(m)	(m)	(t)	(t)	(t)
500	2.0	20.0	102.0	54.7	3.5
		30.0*	168.4	104.8	3.5
		40.0*	234.4	155.4	3.5
600		20.0	135.7	67.3	5.5
		30.0*	223.1	133.5	5.5
		40.0*	309.9	200.5	5.5
Note: * - The last layer is assumed to extend to a depth 10m more than the founding depth of the proposed pile.					

4.2 RIVER LOCATION

4.2.1 The sub-soil formation in this area has been investigated by sinking one (1) borehole explored upto a maximum depth of 17.00m below the existing bed level. The field investigation data and the results of laboratory test conducted on samples collected from the borehole indicate the presence of two (2) 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.

Layer No.	From GL	To GL	Description	Layer Thickness (m)
				BH-2
I	34.689	32.689	Dark grey medium dense silty sand	2.00
II	32.689	17.689	Dark grey highly to slightly weathered rock	15.00*
* - Upto termination depth				

4.2.2 The river water level has been found to exist at a height of 3.40m above bed 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 B.

4.2.3 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.

Layer No.	From GL	To GL	Description	Thick-ness (m)	Average of N-Value	Bulk Density (t/m^3)	Shear Strength Parameter	
							c/UCS	ϕ
I	34.689	32.689	Dark grey medium dense silty sand	2.00	22+	1.87#	0	33.5°#
II	32.689	17.689	Dark grey highly to slightly weathered rock	15.00*	-	2.23	185kg/cm^2	0
* = Upto termination depth #=Suggested value + = Corrected N-value								

4.2.4 Due to the presence of competent rock at a shallow depth below the bed level shallow foundation is suggested for this location. Safe Bearing capacity for open foundations in rock are evaluated as per IS:12070-1987. Sample calculations are provided in Annexure-B.

Foundation Width (m)	Foundation Length (m)	Founding Depth below Bed Level (m)	Suggested Safe Bearing Capacity (t/m^2)
4.0	6.0	4.0	45
4.0	8.0	4.0	45
4.0	10.0	4.0	45
5.0	8.0	4.0	45
5.0	6.0	4.0	45
5.0	8.0	4.0	45
Note: SBC is limited to structural strength of PCC for the foundation			

4.3 GENERAL RECOMMENDATIONS

Proper care shall also be taken during construction, particularly during excavation and casting of concrete pile cap for land location. The sides of excavation shall be protected

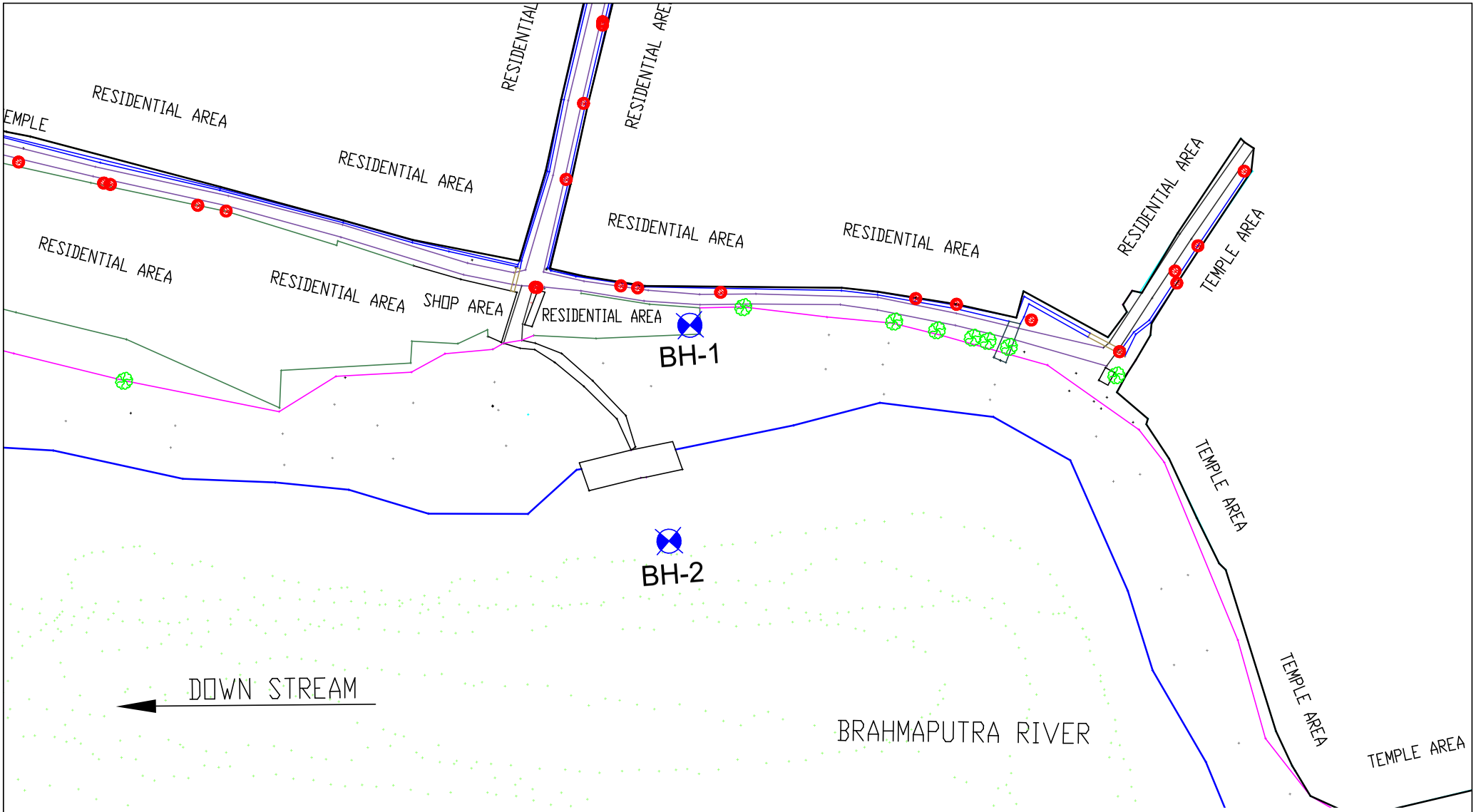
against possible collapse or caving in. The bottom of excavation shall be checked against any heaving. The stagnating water from the excavated pit shall be conveniently drained out. **Riverbank protection is recommended to prevent scouring of the river bank**. Effect of scouring has not been considered during pile load capacity evaluation.

For river location the foundation is proposed to be located 4.0m below existing bed level. Since water was present during investigation dewatering around the area of foundation will be required. **Due to absence of hydraulic data the scour depth could not be evaluated. Effect of scouring has not been taken into consideration in the safe bearing capacities provided above.**

Chemical test results does not indicate the need to use special cement to prevent sulphate attack as IS 456:2000 Table 4.

for **FARGO CONSULTANTS PVT. LTD.**

(P. BRAHMA)
B. Tech (Hons.), M.S. (USA), MIGS



Bore hole location plan for proposed ferry service at North Guwahati Ferry Ghat beside in River Brahmaputra, Assam

Note: All measurements are in metres

CLIENT:	SCALE:	PROJECT:	CONSULTANT:	FIG NO:
HaskoningDHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India	Not to scale	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam	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	1

Sheet No.: 15

ANNEXURE - A

LAND LOCATION

(BH-1)

FARGO CONSULTANTS PVT. LTD.

BORE / DRILL LOG

Client : **Royal Haskoning DHV Consulting Pvt. Ltd.**

Project : Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16

Location : North Guwahati Ferry Ghat (in Land Location) | Bore Hole No. : BH-1

Method of Boring / Drilling : Rotary Mud Circulation (R.M.C) | Ground Elevation : +49.367m

Boring / Drilling Equipment : Mechanical Winch | Dia. of Boring/Drilling : 150mm/75mm

Water Level (Static) : 4.30m bgl. | Casing Lowered : 17.00m | Date : 08.01.2022 to 12.01.2022

Date	Elevation	Sample and in-situ Test DEPTH/RUN (m) From	To	Length (m)	Sample/Test Code	SPT 0cm-15cm	15cm-30cm	30cm-45cm	N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description
08.01.2022	49.367	0.00	0.40	0.40	D	-	-	-	-				Yellowish grey sandy clayey silt/sandy silt with traces of mica
	47.867	1.50	1.95	0.45	P/D	1	1	2	3				
													3.00m
	46.367	3.00	3.45	0.45	P/D	2	4	6	10				Bluish grey stiff silty clay with compacted silt
	44.867	4.50	4.95	0.45	P/D	3	4	8	12				
	43.367	6.00	6.45	0.45	U	-	-	-	-				
	41.867	7.50	7.95	0.45	P/D	3	3	5	8				
	40.367	9.00	9.45	0.45	U	-	-	-	-				
													10.50m
	38.867	10.50	10.95	0.45	P/D	7	11	16	27				Bluish black medium dense silty sand with mica
	37.367	12.00	12.45	0.45	P/D	13	14	18	32				
													13.00m
	36.367	13.00	13.10	0.10	P	76 (10cm)	-	-	>100/R				
						Drilling Started from 13.00m							
	36.367	13.00	14.00	1.00	C	-	-	-	-	Nil	Nil	Nil	Dark grey completely to highly weathered rock
	35.367	14.00	14.07	0.07	P	65 (7cm)	-	-	>100/R				
	35.367	14.00	15.00	1.00	C	-	-	-	-	Nil	Nil	Nil	
	34.367	15.00	15.06	0.06	P	57 (6cm)	-	-	>100/R				
	34.367	15.00	16.00	1.00	C	-	-	-	-	Nil	Nil	Nil	
	33.367	16.00	16.05	0.05	P	54 (5cm)	-	-	>100/R				
	33.367	16.00	17.00	1.00	C	-	-	-	-	Nil	Nil	Nil	
	32.367	17.00	17.06	0.06	P	57 (6cm)	-	-	>100/R				
	32.367	17.00	18.00	1.00	C	-	-	-	-	Nil	Nil	Nil	
	31.367	18.00	18.05	0.05	P	51 (5cm)	-	-	>100/R				
	31.367	18.00	19.00	1.00	C	-	-	-	-	0.30	30	Nil	
	30.367	19.00	20.00	1.00	C	-	-	-	-	0.34	34	Nil	
	29.367	20.00	21.00	1.00	C	-	-	-	-	0.38	38	Nil	

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water agl.-Above Ground Level bgl.-Below Ground Level

Test Code: P-Standard Penetration, V-Vane Shear R-Refusal

FARGO CONSULTANTS PVT. LTD.

BORE / DRILL LOG

Client : **Royal Haskoning DHV Consulting Pvt. Ltd.**

Project : Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16

Location : North Guwahati Ferry Ghat (in Land Location) | Bore Hole No. : BH-1

Method of Boring / Drilling : Rotary Mud Circulation (R.M.C) | Ground Elevation : +49.367m

Boring / Drilling Equipment : Mechanical Winch | Dia. of Boring/Drilling : 150mm/75mm

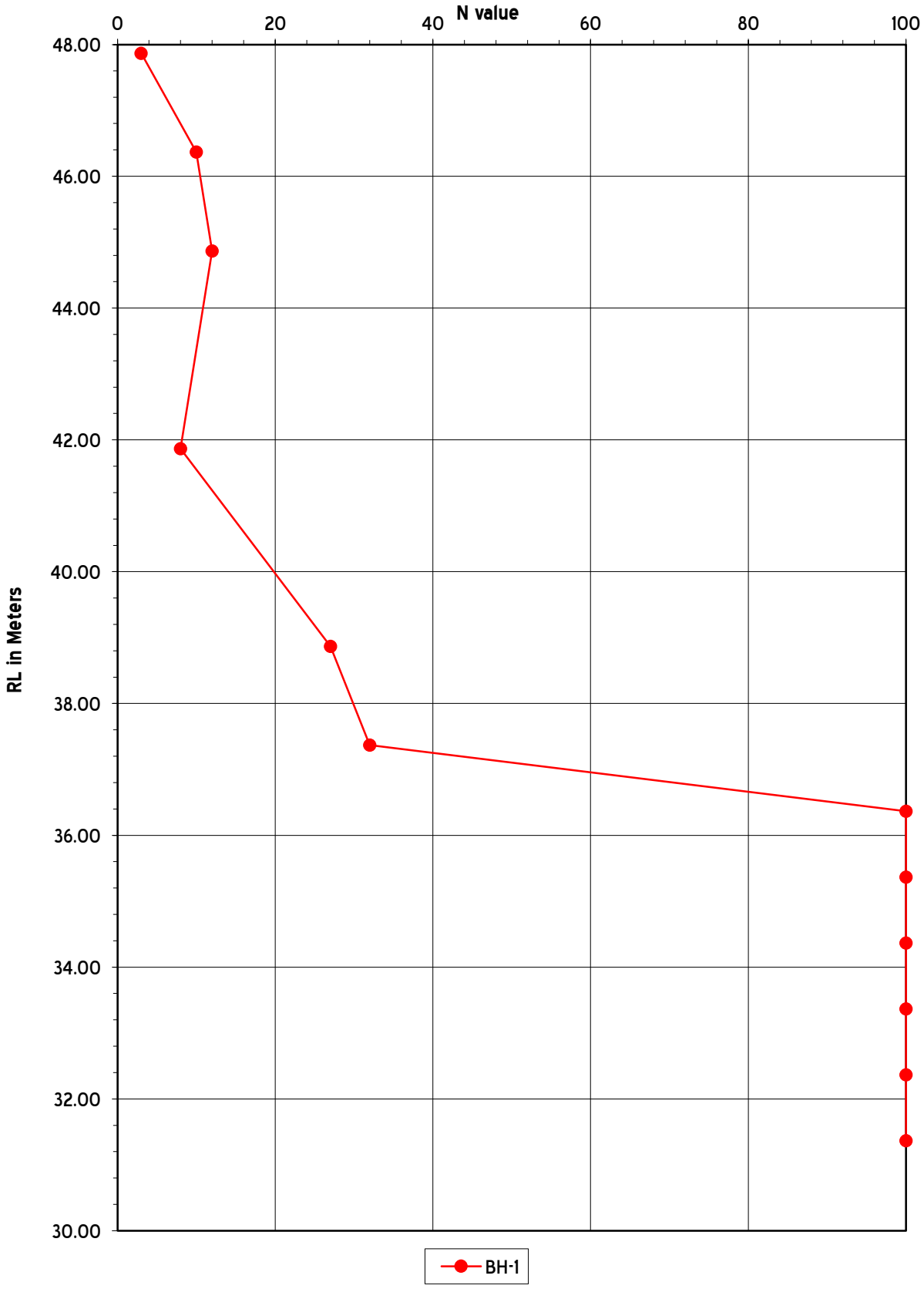
Water Level (Static) : 4.30m bgl. | Casing Lowered : 17.00m | Date : 08.01.2022 to 12.01.2022

Date	Elevation	Sample and in-situ Test DEPTH/RUN (m) From	To	Length (m)	Sample/Test Code	SPT 0cm-15cm	15cm-30cm	30cm-45cm	N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description
	28.367	21.00	22.00	1.00	C	-	-	-	-	0.41	41	14	Continued from previous page
	27.367	22.00	23.00	1.00	C	-	-	-	-	0.40	40	11	Dark grey completely to highly weathered rock
	26.367	23.00	24.00	1.00	C	-	-	-	-	0.42	42	Nil	
	25.367	24.00	25.00	1.00	C	-	-	-	-	0.45	45	13	
	24.367	25.00	26.00	1.00	C	-	-	-	-	0.42	42	Nil	
	23.367	26.00	27.00	1.00	C	-	-	-	-	0.40	40	12	
	22.367	27.00	28.00	1.00	C	-	-	-	-	0.44	44	11	
Borehole Termination Depth = 28.00m													

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water agl.-Above Ground Level bgl.-Below Ground Level

Test Code: P-Standard Penetration, V-Vane Shear R-Refusal

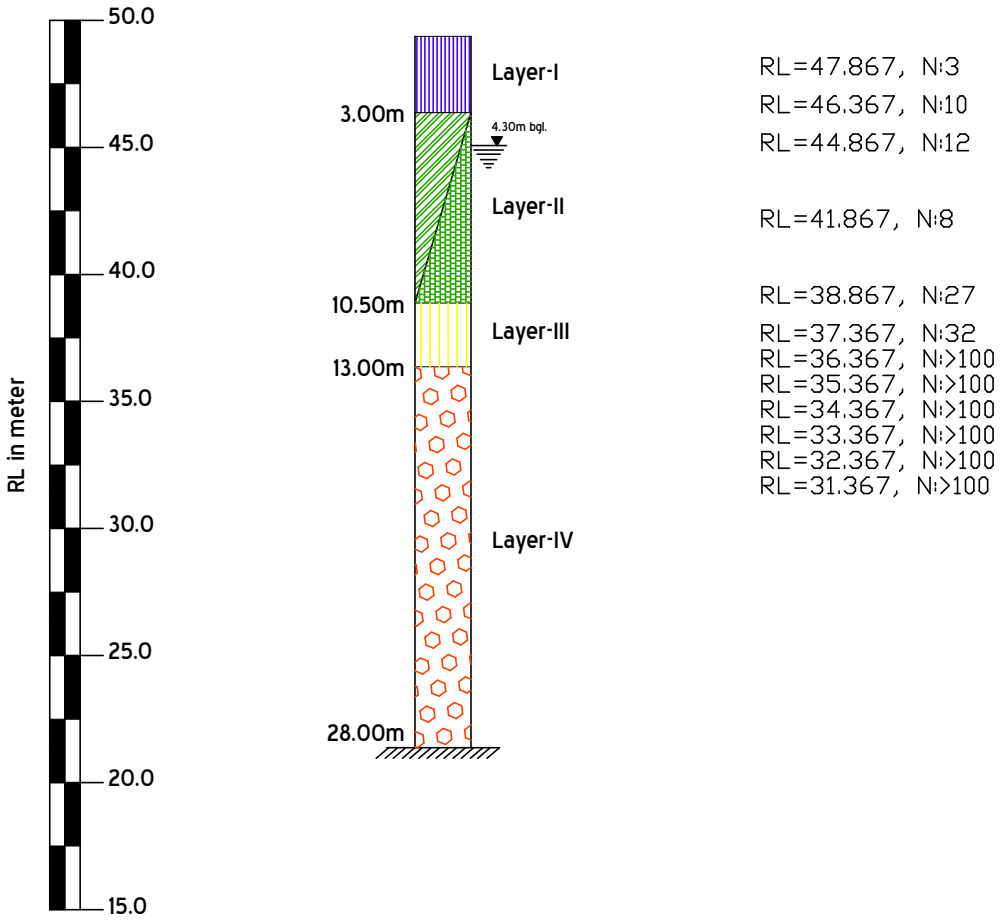
GRAPHICAL REPRESENTATION OF FIELD N-VALUE WITH RT AT PROPOSED FERRY SERVICE AT NORTH GUWAHATI GHAT (IN LAND), BESIDE OF BRAHMAPUTRA RIVER, ASSAM



Project :	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16	Job No.:	2021434J
		Fig No.:	2

FARGO CONSULTANTS PVT. LTD., KOLKATA

BH-1
(IN LAND)



Layer-I	: Yellowish grey sandy silt with traces of mica
Layer-II	: Bluish grey stiff silty clay with compacted silt
Layer-III	: Bluish black medium dense silty sand with mica and kankar
Layer-IV	: Dark grey completely to highly weathered rock

Generalized soil profile for proposed ferry service at North Guwahati Ghat (in Land location), beside in River Brahmaputra, Assam

CLIENT:	SCALE:	
Royal HaskoningDHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India	Not to scale	
PROJECT:	**CONSULTANT:**	**FIG. NO.**
Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam	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	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 (UU/DS)	Cohesion (kg/cm^2)	Angle of Friction (degree)	Sp.Gravity	Free Swell (%)	e_0	P_0 (kg/cm^2)	P_c (kg/cm^2)	C_c	C_r	Shrinkage Limit (%)
Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at North Guwahati (in Land), Assam: BH-1	I	0.40	D	-	-	0.0	5.8	85.1	9.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		1.50	P/D	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	II	3.00	P/D	10	-	0.0	3.3	84.0	12.7	-	-	-	34.3	22.5	11.8	-	-	-	2.65	-	-	-	-	-	-	-
		4.50	P/D	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		6.00	U	-	-	0.0	0.9	59.2	39.9	25.9	1.869	1.485	50.2	18.7	31.5	UU	0.58	0.5	2.66	-	-	-	-	-	-	-
		7.50	P/D	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	III	9.00	U	-	-	0.0	11.3	78.6	10.1	24.6	1.893	1.519	34.1	22.7	11.4	UU	0.43	3.5	2.64	-	-	-	-	-	-	-
		10.50	P/D	27	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	IV	12.00	P/D	32	22	0.0	86.5	13.5*		-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-	-	-
		13.00	P/D	>100	>52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		14.00	P/D	>100	>51	0.0	86.3	13.7*		-	-	-	Non Plastic			-	-	-	-	-	-	-	-	-	-	-
		15.00	P/D	>100	>51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		16.00	P/D	>100	>50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		17.00	P/D	>100	>49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		18.00	P/D	>100	>48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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.

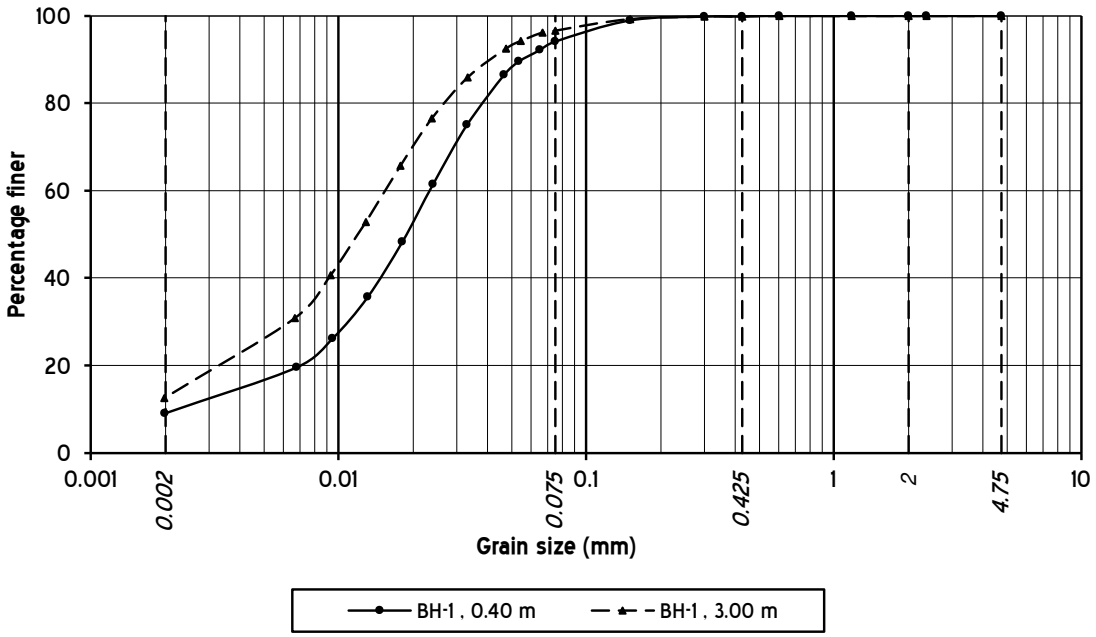
LABORATORY TEST RESULTS FOR ROCK SAMPLES

Project ID	Bore Hole No.	Depth (m)	T.C.R. (%)	R.Q.D. (%)	UCS (kg/cm^2)	Porosity (%)	Point Load Index (kg/cm^2)	Modulus of elasticity ($MPa \times 10^3$)	Dry Density (gm/cc)
Preparation of Detailed Project Report (DPR) along with Engineering Design. Drawings. Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at North Guwahati Ghat (in Land)	BH-1	18.00 - 19.00	30	-	-	1.22	6.80	-	2.52
	BH-1	21.00 - 22.00	41	14	125.0	1.57	6.40	10.50	2.56
	BH-1	22.00 - 23.00	40	11	160.0	0.84	7.80	8.03	2.62
	BH-1	23.00 - 24.00	42	-	-	0.91	9.40	-	2.71
	BH-1	24.00 - 25.00	45	13	170.0	1.02	8.20	10.40	2.64
	BH-1	25.00 - 26.00	42	-	-	1.41	8.90	-	2.56
	BH-1	26.00 - 27.00	40	12	180.0	2.30	8.80	9.24	2.51
	BH-1	27.00 - 28.00	44	11	210.0	0.71	10.10	7.70	2.70

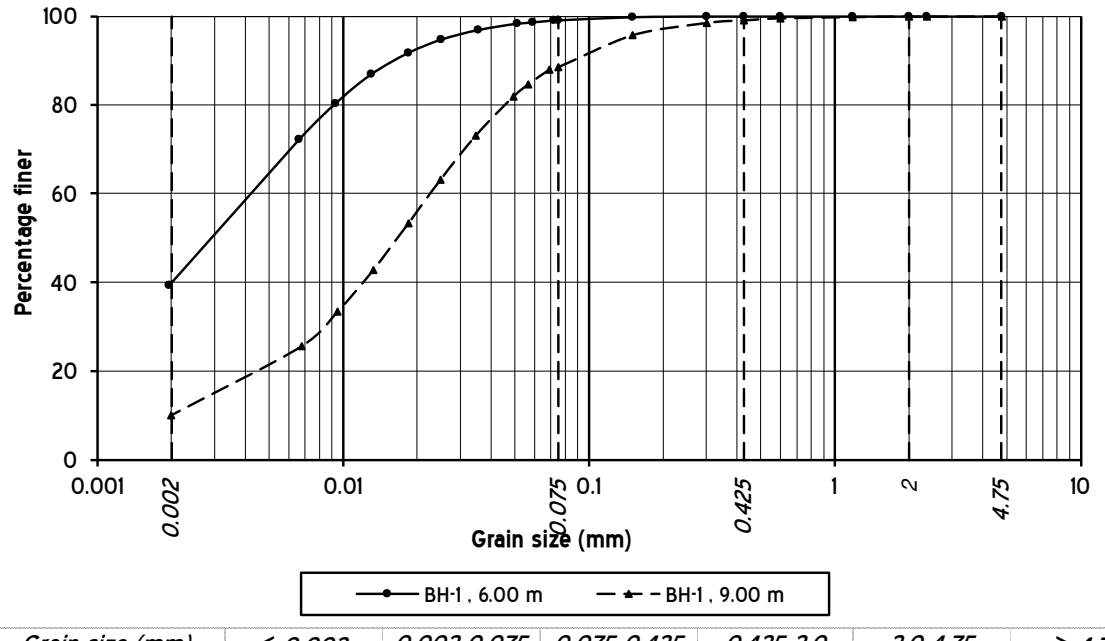
Note :

1. UCS - Uniaxial ComprEssion Strength
2. T.C.R. - Total Core Recovery
3. R.Q.D. - Rock Quality Designation

GRAIN SIZE DISTRIBUTION CURVES



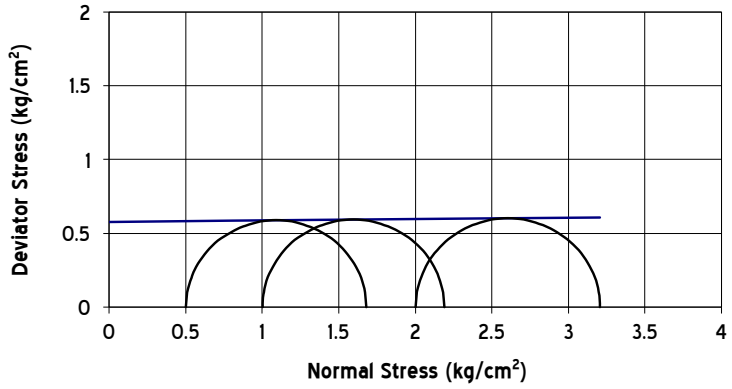
Sample No.	*Grain size (mm)* < 0.002 Clay (%)	0.002-0.075 Silt (%)	0.075-0.425 Fine sand (%)	0.425-2.0 Medium sand (%)	2.0-4.75 Coarse sand (%)	> 4.75 Gravel (%)
BH-1 , 0.40 m	9.1	85.1	5.8	0.0	0.0	0.0
BH-1 , 3.00 m	12.7	84.0	3.3	0.0	0.0	0.0



Sample No.	*Grain size (mm)* < 0.002 Clay (%)	0.002-0.075 Silt (%)	0.075-0.425 Fine sand (%)	0.425-2.0 Medium sand (%)	2.0-4.75 Coarse sand (%)	> 4.75 Gravel (%)
BH-1 , 6.00 m	39.9	59.2	0.9	0.0	0.0	0.0
BH-1 , 9.00 m	10.1	78.6	10.5	0.8	0.0	0.0

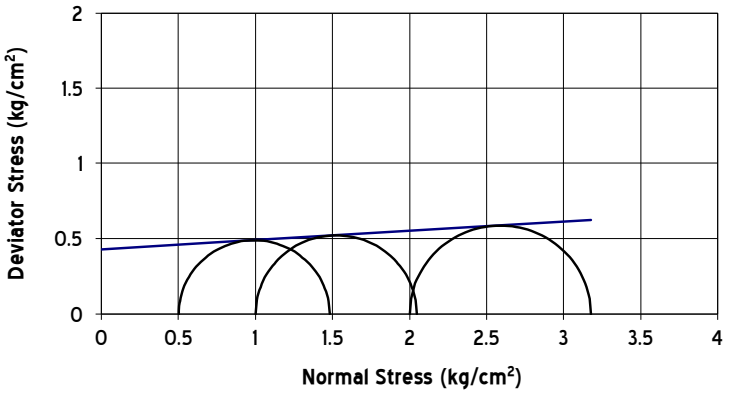
Project:Preparation of DPR along with Engg. Design, Drawings, Tender Documents for cons. of modular terminal at Ferry Service of NW-2 & NW-16; Location: North Guwahati Ghat	Job No. 2021434J	Fig. No. 4

Mohr-Diagram



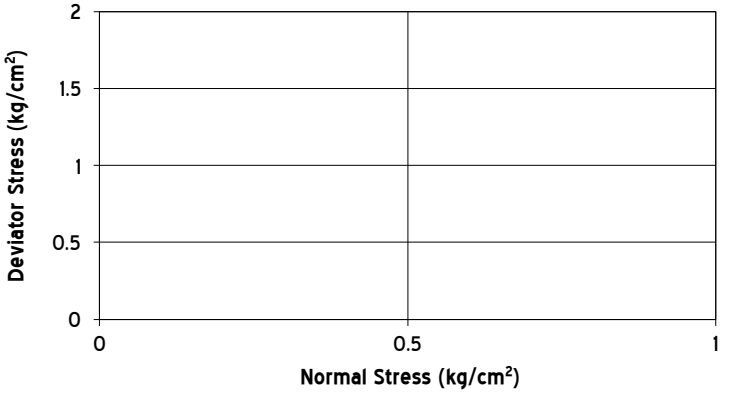
BH No.:	BH-1		c : 0.58 kg/sq. cm
Depth:	+6.00 m	Test Type: UU	ϕ : 0.5 degree

Mohr-Diagram



BH No.:	BH-1		c : 0.43 kg/sq. cm
Depth:	+9.00 m	Test Type: UU	ϕ : 3.5 degree

Mohr-Diagram



BH No.:			c :
Depth:		Test Type:	ϕ :

Preparation of DPR along with Engg. Design, Drawings, Tender Document for construction of modular terminal at Ferry Service of NW-2 & NW-16; Location: North Guwahati Ferry Ghat (in Land)	**Job No.**	**Fig. No.**
	2021434J	5

SAMPLE CALCULATIONS FOR PILE LOAD CAPACITY

Location:Proposed Jetty at North Guwahati Ghat, Assam		Pile Diameter	:+0.50 m
Borehole No.	:BH-1 (Land)	Pile Cut-Off Level	-2.0 m
Existing Ground Level	:+0.0 m	Pile Founding Level	-20.0 m
Scour Level	: -	Pile Type	: Bored
Groundwater Level	:+0.0 m	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)
	1	0	-3	3	4	25	0	17.5
	2	-3	-10.5	7.5	10	0	51	18.81
	3	-10.5	-13	2.5	21	30.5	0	18.6
	4	-13	-50	37	50	32	0	20.6

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)
	1	0	-2	2	4	25	0	17.5
	2	-2	-3	1	4	25	0	17.5
	3	-3	-10.5	7.5	10	0	51	18.81
	4	-10.5	-18.4	7.9	37	31.6	0	20.03
	5	-18.4	-50	31.6	37	31.6	0	20.03

EFFECTIVE OVERBURDEN PRESSURE CALCULATIONS

$P_{-2.0}$ = 2.0 x 7.50 = 15.0 KN/m²

$P_{-3.0}$ = 15.0 + 1.0 x 7.50 = 22.5 KN/m²

$P_{-10.5}$ = 22.5 + 7.5 x 8.81 = 88.6 KN/m²

$P_{-18.4}$ = 88.6 + 7.9 x 10.03 = 167.8 KN/m²

$P_{-20.0}$ = 167.8 + 1.6 x 0.00 = 167.8 KN/m²

SKIN FRICTION CALCULATIONS

Formula for skin friction calculation is $Q_s=\Sigma\ K\ P_{di}\ \tan\delta\ A_s + \alpha\ C\ A_s$

Qs_1 = 1.00 x 0.5(15.0+22.5) x (3.14159 x 0.50 x 1.0) x tan(25.0) = 13.7 KN

Qs_2 = 0.85 x 51.0 x (3.14159 x 0.50 x 7.5) = 510.7 KN

Qs_3 = 1.00 x 0.5(88.6+167.8) x (3.14159 x 0.50 x 7.9) x tan(31.6) = 978.7 KN

Qs_4 = 1.00 x 0.5(167.8+167.8) x (3.14159 x 0.50 x 1.6) x tan(31.6) = 259.5 KN

Total Skin Friction =13.7 + 510.7 + 978.7 + 259.5 = 1762.7KN

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

Qbc = [167.8 x 27.5 + 0.5 x 0.50 x 10.03 x 28.4]x(3.14159 x0.50 x 0.50)/4 = 920.2 KN

CALCULATIONS FOR SELF WEIGHT OF PILE

Self Weight of Pile = 3.14159x(0.50x0.50)/4 x[18.0x(25.0-10.0)] = 53.0KN

VERTICAL LOAD CAPACITY OF PILE
Design Load Capacity = ((1762.7+920.2)/2.5) - 53.0 = 1020.2 KN

UPLIFT CAPACITY OF PILE
Total frictional resistance = (13.7 + 510.7 + 978.7 + 259.5) = 1762.7 KN
Design Uplift Capacity = ((1762.7)*0.7/2.5) + 53.0 = 546.6 KN

Pile Lateral Load Capacity Calculations

Location: **Proposed Jetty at North Guwahati Ghat, Assam**
BH-1 (Land)

Input data

Grade of Concrete	M-35	
Diameter (d)	0.5	m
E	2.96E+07	kN/m^2
I	0.003068	m^4
Length above Ground/Scour Level (L1)	0	m
Embedment Length (Le) (below Scour)	18	m
Overburden Material Type *	NC	
N-Value	8	
Modulus of Subgrade Reaction	1	$kN/m^3 \times 10^3$
Stiffness Factor T	2.5	m
Le/T (-)	7.3	

Long Pile (Le/T > 4)	Fixed	Free
L1/T (-)	0.000	0.000
Lf/T (-)	2.190	1.925
Lf (m)	5.4	4.7
Q_{lat} for 1% of PileDia deflection (kN)	34.68	12.76

Short Pile (Le/T < 2)	Fixed	Free
Q_{lat} for 1% of PileDia deflection (kN)	-	-

Note: * NC-Non cohesive soil : C-Normally consolidated cohesive soil : PC-Preconsolidated 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	N (Blow/30 cm)	Submerged
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. =2c) (kN/m^2)	Range of k1 $kN/m^3 \times 10^3$
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 - B

RIVER LOCATION

(BH-2)

FARGO CONSULTANTS PVT. LTD.

BORE / DRILL LOG

Client : **Royal Haskoning DHV Consulting Pvt. Ltd.**

Project : Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16

Location : North Guwahati Ferry Ghat (In River Location) | Bore Hole No. : BH-2

Method of Boring / Drilling : Rotary Mud Circulation (R.M.C) | Ground Elevation : +34.689m

Boring / Drilling Equipment : Mechanical Winch | Dia. of Boring/Drilling : 150mm/75mm

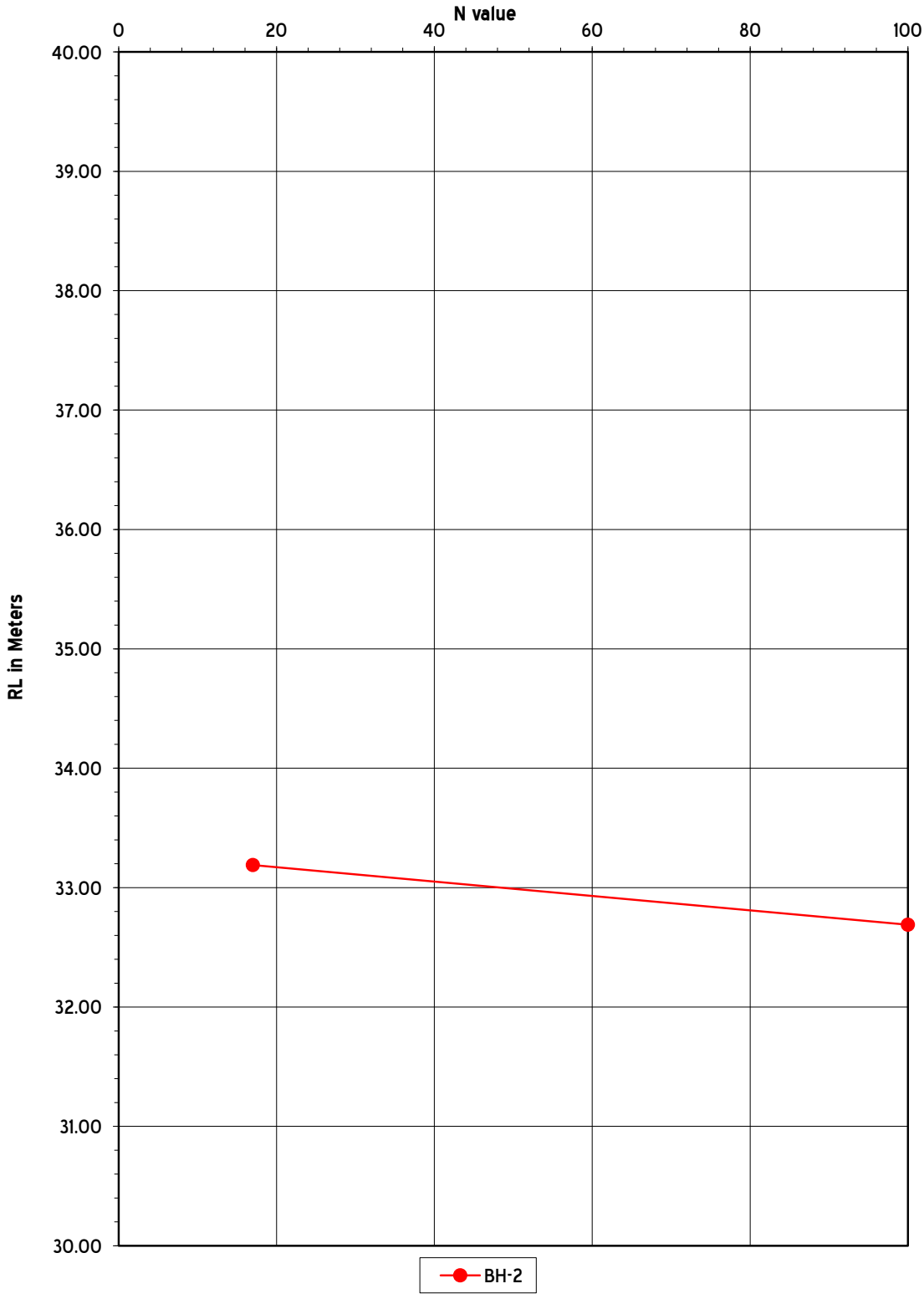
Water Level (Static) : 3.40m agl. | Casing Lowered : 15.00m | Date : 29.01.2022 to 01.02.2022

Date	Elevation	Sample and in-situ Test DEPTH/RUN (m) From	To	Length (m)	Sample/Test Code	SPT 0cm-15cm	15cm-30cm	30cm-45cm	N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description
29.01.2022	34.689	0.00	0.50	0.50	D	-	-	-	-				Dark grey medium dense silty sand
	33.189	1.50	1.95	0.45	P/D	7	8	9	17				
	32.689	2.00	2.06	0.06	P	52 (6cm)	-	-	>100/R				2.00m
					Drilling Started from 2.00m								
	32.689	2.00	3.00	1.00	C	-	-	-	-	0.34	34	Nil	Dark grey highly to slightly weathered rock
	31.689	3.00	4.00	1.00	C	-	-	-	-	0.62	62	61	
	30.689	4.00	5.00	1.00	C	-	-	-	-	0.48	48	31	
	29.689	5.00	6.00	1.00	C	-	-	-	-	0.72	72	72	
	28.689	6.00	7.00	1.00	C	-	-	-	-	0.56	56	46	
	27.689	7.00	8.00	1.00	C	-	-	-	-	0.78	78	24	
	26.689	8.00	9.00	1.00	C	-	-	-	-	0.77	77	34	
	25.689	9.00	10.00	1.00	C	-	-	-	-	0.74	74	36	
	24.689	10.00	11.00	1.00	C	-	-	-	-	0.76	76	40	
	23.689	11.00	12.00	1.00	C	-	-	-	-	0.75	75	48	
	22.689	12.00	13.00	1.00	C	-	-	-	-	0.81	81	36	
	21.689	13.00	14.00	1.00	C	-	-	-	-	0.74	74	42	
	20.689	14.00	15.00	1.00	C	-	-	-	-	0.78	78	47	
	19.689	15.00	16.00	1.00	C	-	-	-	-	0.76	76	45	
	18.689	16.00	17.00	1.00	C	-	-	-	-	0.80	80	40	
					The Bore hole Tarmination Depth 17.00m								

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water agl.-Above Ground Level bgl.-Below Ground Level

Test Code: P-Standard Penetration, V-Vane Shear R-Refusal

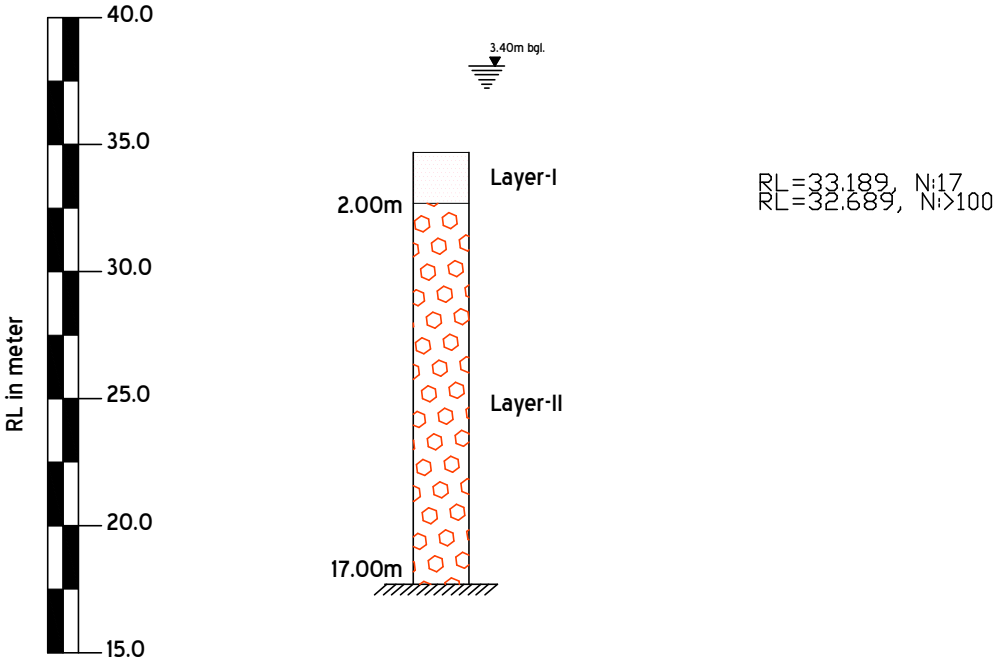
GRAPHICAL REPRESENTATION OF FIELD N-VALUE WITH RT AT PROPOSED FERRY SERVICE AT NORTH GUWAHATI GHAT (IN RIVER), BESIDE OF BRAHMAPUTRA RIVER, ASSAM



Project :	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16	Job No.:	2021434J
		Fig No.:	2

FARGO CONSULTANTS PVT. LTD., KOLKATA

BH-1
(IN RIVER)



Layer-I : Dark grey medium dense silty sand
Layer-II : Dark grey highly to slightly weathered rock

Generalized soil profile for proposed ferry service at North Guwahati Ghat (in River location), beside in River Brahmaputra, Assam

CLIENT:	SCALE:	
Royal HaskoningDHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India	Not to scale	
PROJECT:	CONSULTANT:	FIG. NO.
Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam	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	3

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at North Guwahati Ghat (in River), Assam: BH-1																								
Layer ID	I	II																							
Depth (m)	0.50	1.50	2.00																						
Sample Type	D	P/D	P/D																						
'N' value	.	17	>100																						
Corrected "N" Value	.	22	>90																						
Gravel (%)	.	0.0	.																						
Sand (%)	.	97.4	.																						
Silt (%)	.	2.6*	.																						
Clay (%)	.		.																						
Natural Moisture Content (%)	.	.	.																						
Bulk Density (gm/cc)	.	.	.																						
Dry density (gm/cc)	.	.	.																						
Liquid Limit(%)	.	.	.																						
Plastic Limit (%)	.	Non Plastic	.																						
Plasticity Index (%)	.		.																						
Type of Test (UU/DS)	.	.	.																						
Cohesion (kg/cm^2)	.	.	.																						
Angle of Friction (degree)	.	.	.																						
Sp.Gravity	.	.	.																						
Free Swell (%)	.	.	.																						
e_0	.	.	.																						
P_0 (kg/cm^2)	.	.	.																						
P_c (kg/cm^2)	.	.	.																						
C_c	.	.	.																						
C_r	.	.	.																						
Shrinkage Limit (%)	.	.	.																						

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 FOR ROCK SAMPLES

Project ID	Bore Hole No.	Depth (m)	T.C.R. (%)	R.Q.D. (%)	UCS (kg/cm^2)	Porosity (%)	Point Load Index (kg/cm^2)	Modulus of elasticity (MPa x 10^3)	Dry Density (gm/cc)
Preparation of Detailed Project Report (DPR) along with Engineering Design. Drawings. Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at North Guwahati Ghat (in River)	BH-2	3.00 - 4.00	62	61	220.0	1.05	10.70	47.58	2.46
	BH-2	7.00 - 8.00	78	24	200.0	1.07	9.60	18.24	2.51
	BH-2	11.00 - 12.00	75	48	130.0	0.87	6.50	36.48	2.60
	BH-2	16.00 - 17.00	80	40	190.0	1.00	9.10	32.00	2.53

Note :

1. UCS - Uniaxial ComprEssion Strength
2. T.C.R. - Total Core Recovery
3. R.Q.D. - Rock Quality Designation

ESTIMATES OF SAFE BEARING PRESSURES

TABLE 2 - NET SAFE BEARING PRESSURE (q_{ns}) BASED ON CLASSIFICATION (IS:12070 -1987)

Sl. No.	Material	q_{ns} (t/m^2)
1	Massive crystalline bedrock including granite, diorite, gneiss, trap rock	1000
2	Foliated rocks such as schist or slate in sound condition	400
3	Bedded limestone in sound condition	400
4	Sedimentary rock, including hard shales and sandstones	250
5	Soft or broken bedrock (excluding shale), and soft limestone	100
6	Soft shale	30

TABLE 3 - NET SAFE BEARING PRESSURE BASED ON RMR (IS:12070 -1987)

CLASSIFICATION NO.	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
q_{ns} (t/m^2)	600-448	440-288	280-141	135-48	45-30

ESTIMATE OF SAFE BEARING PRESSURE FROM THE CORE STRENGTH

qs = qc Nj

where

qs = safe bearing pressure (gross)

qc = average uniaxial compressive strength of rock cores

Nj = empirical coeeficient depending on the spacing of discontinuities (Table 4)

TABLE 4 - VALUES OF Nj (IS:12070 -1987)

SPACING OF DISCONTINUITY	Nj
(cm)	(-)
300	0.40
100-300	0.25
30-100	0.10

SAFE BEARING PRESSURE FROM VARIOUS METHODS

(I) Based on classification = 1000t/m^2

(ii) Based on RMR = 85t/m^2 where average RMR is 27

(iii) Based on core strength = 185t/m^2 where qc = 1850t/m^2 and Nj= 0.1

(Core strength obtained from IS 2911 Part-I Sec-II, based on N Value)

Safe bearing pressure 80t/m^2

As per clause 9 of IS 12070 the following factors are considered:

a) Submerged condition under water table Factor = 0.75 (can get submerged)

b) Cavities Factor = 1 (no cavities found)

c) Slope Factor = 0.75 (area is prone to slides)

Recommended safe bearing capacity 80 x 0.75 x 1 x 0.75 = 45.0t/m^2

ANNEXURE - C

CHEMICAL TEST RESULTS

FARGO CONSULTANTS PVT. LTD.

Laboratory Test Results for Chemical Analysis

Project Name: Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry

Location: Proposed North Guwahati Ferry Ghat **Job No.:** 2021434J

Analysis for SOIL Sample

BH No. (#)	Depth (m)	pH (-)	Sulphate	Carbonate	Chloride	Total Dissolved Solids
			(%)	(%)	(%)	(mg/L)
BH-1	3.00m	7.73	0.001	6.030	0.012	0.28
BH-2	1.50m	7.97	0.003	0.98000	0.012	0.0467
LIMIT		> 6	< 0.2	–	–	–

Analysis for WATER Sample

BH No. (#)	pH (-)	Sulphate	Chloride
		(%)	(%)
BH-1	6.76	46.51	102.39
LIMIT	> 6	300	2000

PREPARATION OF DETAILED PROJECT REPORT (DPR) ALONG WITH ENGINEERING DESIGN, DRAWINGS, TENDER DOCUMENTS FOR CONSTRUCTION OF MODULAR TERMINAL AT FERRY SERVICE OF NW-2 AND NW-16 IN ASSAM

SOIL INVESTIGTION REPORT
FOR
UMANANDA FERRY GHAT

Client :

ROYAL HASKONINGDHV CONSULTING PVT. LTD.
PLATINUM TECHNO PARK,
502-505, 5TH FLOOR,
PLOT NO. 17 & 18 SECTOR 30A,
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MAHARASHTRA, INDIA

APRIL, 2022

FARGO CONSULTANTS PVT. LTD.
CF-394, SECTOR-I, SALT LAKE CITY
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E-mail: fargoconsultants@gmail.com
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TABLE OF CONTENTS

CHAPTER - I

1.0 GEOTECHNICAL INVESTIGATIONS

1.1 INTRODUCTION

- Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam was entrusted to Fargo Consultants Pvt. Ltd., CF-394, Sector-I, Salt Lake City, Kolkata- 700064 by Royal Haskoning DHV Consulting Pvt. Ltd.

1.2 SCOPE OF WORK

- The scope of the soil investigation work consisted of sinking one (1) borehole in land and one (1) borehole in underwater location at each of the thirteen (13) locations. The land boreholes shall be explored to a depth of 50m or 15m into very dense strata with SPT N = 100(Refusal) or 10m into rock with RQD>75%, whichever is earlier. The river borehole shall be explored to 80m or 10m into rock with RQD>75%, whichever is earlier. 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 Latitude and Longitude of the location for the proposed jetty is provided in the Table-1. Location of the proposed jetty is shown in Figure 1.

Table-1: Proposed Ferry Service Location

Sl. No.	Location	Northing	Easting
1	Umananda Ferry Ghat	26° 11' 46.12" N	91° 44' 42.73" E

Figure 1: Location for Proposed Ferry Service of Umananda Ferry Ghat

CHAPTER - II

2.0 FIELD INVESTIGATION

2.1 BOREHOLES

- This report contains details of two (2) boreholes which have been completed as part of the investigation at Umananda Ferry Ghat beside in Brahmaputra river of Assam.

- The details of field work like, location, borehole no., termination depth, static water level and the dates of commencement and completion are furnished below.

Bore hole No.	Co-ordinates	Termination Depth (m)	Ground / Riverbed Elevation	**D.T.W. (m)	Commence-ment Date	Completion Date
BH-1 (Land)	Zone 46R E: 374636.000 N: 2898011.000	15.50	44.502m	N.E.	07.02.2022	09.02.2022
BH-2 (River)	Zone 46R E: 374630.732 N: 2897978.247	21.00	33.506m	3.50m agl$	03.02.2022	06.02.2022
Note:	**D.T.W. – Depth to water from borehole top #bgl. – below ground level $agl. – above ground level					

- The boreholes of 150/75 mm 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.

- For river boreholes, two country boats were joined together by bamboo, wooden planks and ropes. An opening was created in the platform for boring/drilling operations. The location of the proposed borehole was ascertained using field measurements. Once the opening in the platform was at the desired location the boats were anchored using at a minimum of six heavy anchors. The anchors were set by the boatmen. The anchors were loosened or tightened as the water level in the river varied during the work period.

- The field investigation work commenced on 03rd February 2022 and was completed on 09th February 2022. The depth of water level in the boreholes were 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.

SITE PHOTOGRAPHS

Land Location

River Location

Site Location

CHAPTER - III

3.0 LABORATORY TESTING

The following laboratory tests were carried out to ascertain the properties of the sub-soil.

- Grain size analysis

  The particle size distribution of various soil samples collected from different subsoil deposits were determined by sieve analysis (dry method) or hydrometer analysis (wet method) or a combination of both, as was found necessary. From the test results, grain size distribution curves were generated to ascertain percentage of sand, silt, clay etc in each sample.

- Natural Moisture Content

  The natural moisture content (N. M. C) or water content of the samples were obtained by oven drying a quantity of soil for at least 24 hours at 1050C and recording their weights before and after drying.

- Atterberg Limits

  The Atterberg limits of the soil samples were determined by adopting standard procedure. The liquid limit was determined with the help of Cassagrande's apparatus. The plastic limit was ascertained by rolling the soil samples into threads.

- Specific Gravity

  The Specific Gravity of the soil samples were determined by adopting standard procedure. The soil sample was dried in oven dried for 24 hours and pulverished. The sample was then poured into a specific gravity bottle and topped up with distilled water. The specific gravity bottle was stirred and heated to eliminate air bubbles.

The weight of the specific gravity bottle was recorded along with the temperature of the sample.

- Unconfined Compression (UC)

Unconfined compression test was carried as per IS Code 2720 (Part 10). Three samples were tested and the average 'q_u' values was used to report the cohesion 'c' value. For hard soils, since undisturbed samples are not collected, the shear strength was estimated from correlations published in textbooks.

- Tri-axial Test (Unconsolidated Undrained)

The tri-axial test unconsolidated undrained (UU) test was carried as per IS Code IS Code 2720 (Part 11). Three samples were tested for three different confining pressures and the results were graphed to obtain 'c' and 'ϕ' values. For hard soils, since undisturbed samples are not collected, the shear strength was estimated from correlations published in textbooks.

- Direct Shear Test (Undrained)

The Direct Shear undrained test was carried out for non-cohesive soils as per IS Code 2720 (Part 39/Sec-I). The samples were prepared as per the procedure outlined in IS Code 2720 (Part -I). Three samples with three different vertical loads were tested and the results were graphed to obtain 'c' and 'ϕ' values.

- One Dimensional Consolidation Test

The One dimensional consolidation test was carried as per IS Code. The sample was loaded upto 8kg/cm^2 incrementally and then unloaded. The data was used to evaluate the mv values. These values will be used for settlement calculations. For hard soils, since undisturbed samples are collected, the mv values were determined

from correlations published in "Manual for Estimating Soil Properties for Foundation Design" by F.H. Kulhawy and P.W. Mayne, 1990.

All these tests will be conducted as per relevant I.S. Codes and the test results are tabulated in Tables enclosed herewith.

CHAPTER - IV

4.0 DISCUSSION AND RECOMMENDATION

4.1 LAND LOCATION

4.1.1 The sub-soil formation in this area has been investigated by sinking one (1) borehole explored upto a maximum depth of 15.50m 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 three (3) 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.

Layer No.	From GL	To GL	Description	Layer Thickness (m)
				BH-1
I	44.502	43.002	Dark grey silty fine sand	1.50
II	43.002	40.002	Yellowish grey completely weathered to highly weathered rock	3.00
III	40.002	29.002	Yellowish grey moderately weathered to fresh rock	11.00*
* - Upto termination depth				

4.1.2 The ground water was not detected in the borehole 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.

4.1.3 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.

Layer No.	From GL	To GL	Description	Thick-ness (m)	Average of N-Value	Bulk Density (t/m^3)	Shear Strength Parameter c/UCS
I	44.502	43.002	Dark grey silty fine sand	1.50	-	1.75#	-
II	43.002	40.002	Yellowish grey completely weathered to highly weathered rock	3.00	360	2.65	c_u= 49kg/cm^{2}#
III	40.002	29.002	Yellowish grey moderately weathered to fresh rock	10.50*	-	2.69	UCS=250kg/cm^2
* = Upto termination depth #=Suggested value + = Corrected N-value							

4.1.4 Due to the presence of competent rock at a shallow depth below the bed level shallow foundation is suggested for this location. Safe Bearing capacity for open foundations in rock are evaluated as per IS:12070-1987. Sample calculations are provided in Annexure-B.

Foundation Width (m)	Foundation Length (m)	Founding Depth below Bed Level (m)	Suggested Safe Bearing Capacity (t/m^2)
4.0	6.0	3.0	30
4.0	8.0	3.0	30
4.0	10.0	3.0	30
5.0	8.0	3.0	30
5.0	6.0	3.0	30
5.0	8.0	3.0	30
Note: SBC is limited to structural strength of PCC for the foundation			

4.2 RIVER LOCATION

4.2.1 The sub-soil formation in this area has been investigated by sinking one (1) borehole explored upto a maximum depth of 21.00m 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 three (3) 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.

Layer No.	From GL	To GL	Description	Layer Thickness (m)
				BH-2
I	33.506	32.506	Dark grey silty fine sand	1.00
II	32.506	24.506	Yellowish brown completely to highly weathered rock	8.00
III	24.506	12.506	Yellowish brown slightly weathered to fresh rock	12.00*
* - Upto termination depth				

4.2.2 The ground water level has been found to exist at a height of 3.50m above existing bed 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 B.

4.2.3 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.

Layer No.	From GL	To GL	Description	Thick-ness (m)	Average of N-Value	Bulk Density (t/m^3)	Shear Strength Parameter c/UCS
I	33.506	32.506	Dark grey silty fine sand	1.00	-	1.75#	-
II	32.506	24.506	Yellowish brown completely to highly weathered rock	8.00	220	2.15	c_u= 23 kg/cm^{2}#
III	24.506	12.506	Yellowish brown slightly weathered to fresh rock	12.00*	-	2.77	UCS=225kg/cm^2
* = Upto termination depth #=Suggested value + = Corrected N-value							

4.2.4 Due to the presence of competent rock at a shallow depth below the bed level shallow foundation is suggested for this location. Safe Bearing capacity for open foundations in rock are evaluated as per IS:12070-1987. Sample calculations are provided in Annexure-B.

Foundation Width (m)	Foundation Length (m)	Founding Depth below Bed Level (m)	Suggested Safe Bearing Capacity (t/m^2)
4.0	6.0	3.0	15
4.0	8.0	3.0	15
4.0	10.0	3.0	15
5.0	8.0	3.0	15
5.0	6.0	3.0	15
5.0	8.0	3.0	15
Note: SBC is limited to structural strength of PCC for the foundation			

4.3 GENERAL RECOMMENDATIONS

Proper care shall also be taken during construction, particularly during excavation for land location. 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. **Riverbank protection is**

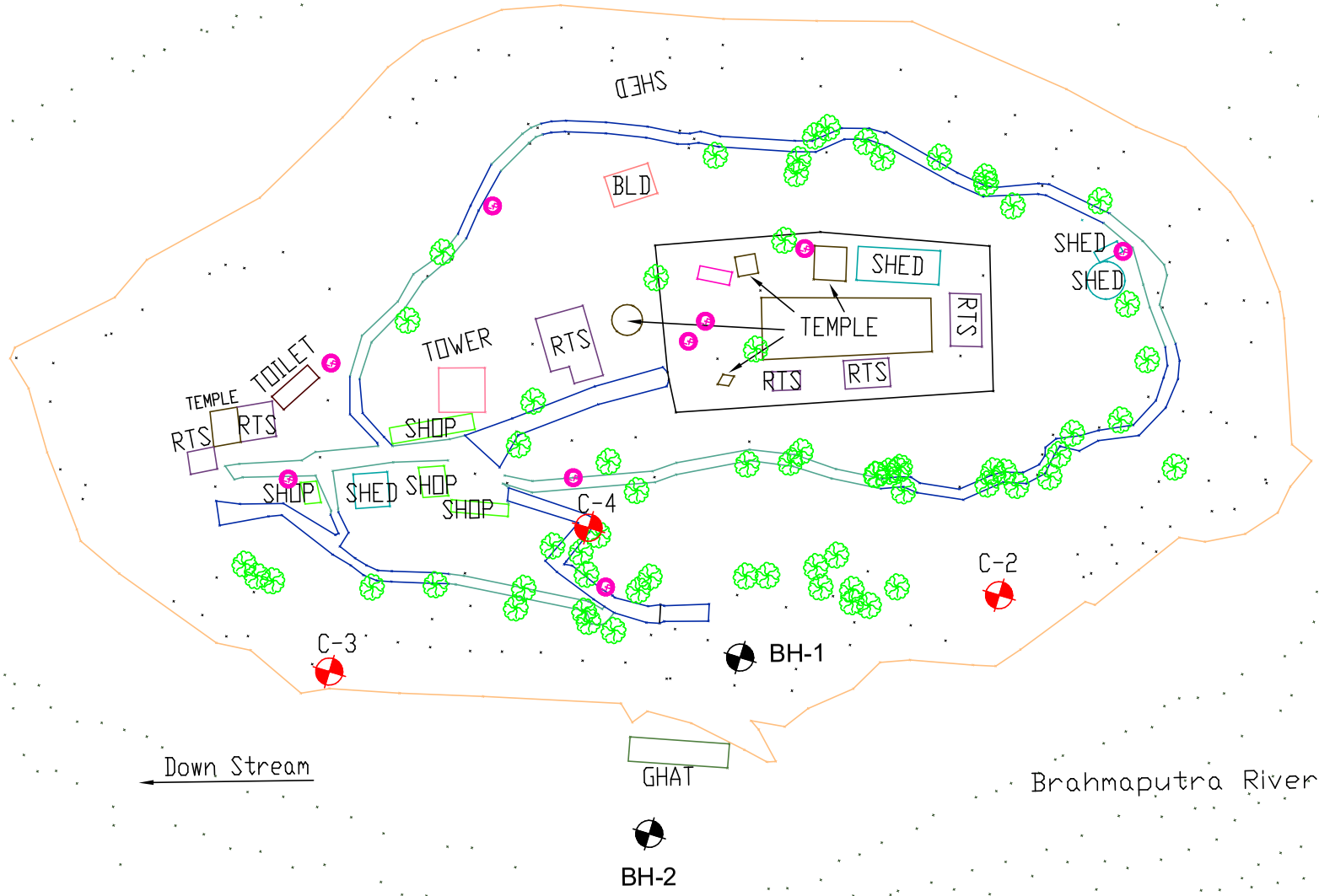
recommended to prevent scouring of the riverbank. Effect of scouring has not been considered during pile load capacity evaluation.

For river location the foundation is proposed to be located 3.0m below existing bed level. Since water was present during investigation dewatering around the area of foundation will be required. **Due to absence of hydraulic data the scour depth could not be evaluated. Effect of scouring has not been taken into consideration in the safe bearing capacities provided above.**

Chemical test results does not indicate the need to use special cement to prevent sulphate attack as IS 456:2000 Table 4.

for **FARGO CONSULTANTS PVT. LTD.**

(P. BRAHMA)
B. Tech (Hons.), M.S. (USA), MIGS



Note: All measurements are in metres

Bore hole location plan for proposed ferry service at Umananda Ferry Ghat beside in River Brahmaputra, Assam

CLIENT:	SCALE:	PROJECT:	CONSULTANT:	FIG NO:
HaskoningDHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India	Not to scale	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam	**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	1

Sheet No.: 15

ANNEXURE - A

LAND LOCATION

(BH-1)

FARGO CONSULTANTS PVT. LTD.

BORE / DRILL LOG

Client : **Royal Haskoning DHV Consulting Pvt. Ltd.**

Project : Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16

Location : Umananda Ferry Ghat (in Land Location) Bore Hole No. : BH-1

Method of Boring / Drilling : Rotary Mud Circulation (R.M.C) Ground Elevation : +44.502m

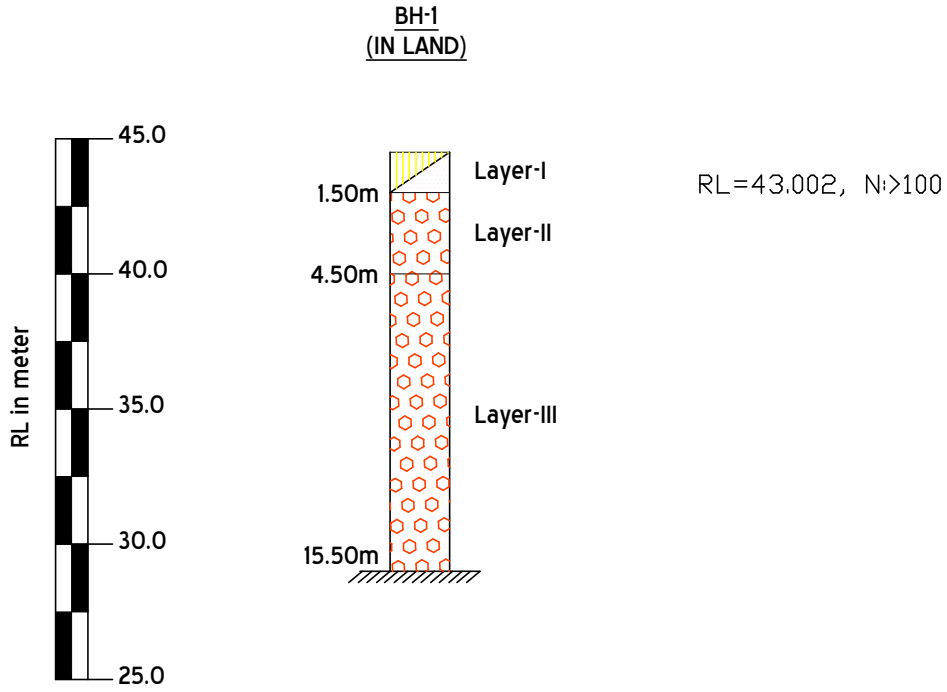
Boring / Drilling Equipment : Mechanical Winch Dia. of Boring/Drilling : 150mm/75mm

Water Level (Static) : Not Encountered Casing Lowered : 12.00m Date : 07.02.2022 to 09.02.2022

Date	Elevation	Sample and in-situ Test DEPTH/RUN (m) From	To	Length (m)	Sample/Test Code	SPT 0cm-15cm	15cm-30cm	30cm-45cm	N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description
07.02.2022	44.502	0.00	0.50	0.50	D	-	-	-	-				Dark grey silty fine sand
													1.50m
	43.002	1.50	1.55	0.05	P	60 (5cm)	-	-	>100/R				
						Drilling Started from 1.50m							
	43.002	1.50	2.50	1.00	C	-	-	-	-	0.22	22	Nil	Yellowish grey completely weathered to highly weathered rock
	42.002	2.50	3.50	1.00	C	-	-	-	-	0.26	26	Nil	
08.02.2022	41.002	3.50	4.50	1.00	C	-	-	-	-	0.41	41	33	
													4.50m
	40.002	4.50	5.50	1.00	C	-	-	-	-	0.71	71	52	Yellowish grey moderately weathered to fresh rock
	39.002	5.50	6.50	1.00	C	-	-	-		0.79	79	50	
	38.002	6.50	7.50	1.00	C	-	-	-	-	0.68	68	29	
	37.002	7.50	8.50	1.00	C	-	-	-		0.88	88	34	
	36.002	8.50	9.50	1.00	C	-	-	-	-	0.74	74	28	
	35.002	9.50	10.50	1.00	C	-	-	-		0.82	82	53	
	34.002	10.50	11.50	1.00	C	-	-	-	-	0.76	76	44	
	33.002	11.50	12.50	1.00	C	-	-	-	-	0.79	79	50	
09.02.2022	32.002	12.50	13.50	1.00	C	-	-	-	-	0.75	75	28	
	31.002	13.50	14.50	1.00	C	-	-	-	-	0.97	97	61	
	30.002	14.50	15.50	1.00	C	-	-	-	-	0.85	85	38	
						The Borehole Tarminated Depth at 15.50m							

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water agl.-Above Ground Level bgl.-Below Ground Level

Test Code: P-Standard Penetration, V-Vane Shear R-Refusal



Layer-I : Dark grey silty fine sand
Layer-II : Yellowish grey completely weathered to highly weathered rock
Layer-III : Yellowish grey moderately weathered to fresh rock

Generalized soil profile for proposed ferry service at Umananda Ghat (in Land location), beside in River Brahmaputra, Assam

CLIENT:	SCALE:	
Royal HaskoningDHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India	Not to scale	
PROJECT:	CONSULTANT:	FIG. NO.
Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam	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	2

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at Umanada Ferry Ghat (in Land), Assam: BH-1																								
Layer ID	I	II																							
Depth (m)	0.50	1.50																							
Sample Type	D	P																							
'N' value	-	>100																							
Corrected "N" Value	-	>80																							
Gravel (%)	0.0	-																							
Sand (%)	92.2	-																							
Silt (%)	7.8*	-																							
Clay (%)		-																							
Natural Moisture Content (%)	-	-																							
Bulk Density (gm/cc)	-	-																							
Dry density (gm/cc)	-	-																							
Liquid Limit(%)	Non Plastic	-																							
Plastic Limit (%)		-																							
Plasticity Index (%)		-																							
Type of Test (UU/DS)	-	-																							
Cohesion (kg/cm^2)	-	-																							
Angle of Friction (degree)	-	-																							
Sp.Gravity	-	-																							
Free Swell (%)	-	-																							
e_0	-	-																							
P_0 (kg/cm^2)	-	-																							
P_c (kg/cm^2)	-	-																							
C_c	-	-																							
C_r	-	-																							
Shrinkage Limit (%)	-	-																							

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 FOR ROCK SAMPLES

Project ID	Bore Hole No.	Depth (m)	T.C.R. (%)	R.Q.D. (%)	UCS (kg/cm^2)	Porosity (%)	Point Load Index (kg/cm^2)	Modulus of elasticity ($MPa \times 10^3$)	Dry Density (gm/cc)
Preparation of Detailed Project Report (DPR) along with Engineering Design. Drawings. Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at Umananda (in Land), Assam: BH-1	BH - 1	3.50 - 4.50	41	33	242.00	2.80	12.10	25.74	2.60
	BH - 1	6.50 - 7.50	68	29	250.0	2.87	12.50	20.30	2.68
	BH - 1	9.50 - 10.50	82	53	250.0	3.16	12.76	40.81	2.67
	BH - 1	12.50 - 13.50	75	28	260.0	2.57	13.20	22.12	2.59

Note :

1. UCS - Uniaxial ComprEssion Strength
2. T.C.R. - Total Core Recovery
3. R.Q.D. - Rock Quality Designation

ESTIMATES OF SAFE BEARING PRESSURES

TABLE 2 - NET SAFE BEARING PRESSURE (q_{ns}) BASED ON CLASSIFICATION (IS:12070 -1987)

Sl. No.	Material	q_{ns} (t/m^2)
1	Massive crystalline bedrock including granite, diorite, gneiss, trap rock	1000
2	Foliated rocks such as schist or slate in sound condition	400
3	Bedded limestone in sound condition	400
4	Sedimentary rock, including hard shales and sandstones	250
5	Soft or broken bedrock (excluding shale), and soft limestone	100
6	Soft shale	30

TABLE 3 - NET SAFE BEARING PRESSURE BASED ON RMR (IS:12070 -1987)

CLASSIFICATION NO.	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
q_{ns} (t/m^2)	600-448	440-288	280-141	135-48	45-30

ESTIMATE OF SAFE BEARING PRESSURE FROM THE CORE STRENGTH

qs = qc Nj

where

qs = safe bearing pressure (gross)

qc = average uniaxial compressive strength of rock cores

Nj = empirical coeeficient depending on the spacing of discontinuities (Table 4)

TABLE 4 - VALUES OF Nj (IS:12070 -1987)

SPACING OF DISCONTINUITY	Nj
(cm)	(-)
300	0.40
100-300	0.25
30-100	0.10

SAFE BEARING PRESSURE FROM VARIOUS METHODS

(I) Based on classification = 100t/m^2

(ii) Based on RMR = 85t/m^2 where average RMR is 27

(iii) Based on core strength = 49t/m^2 where qc = 490t/m^2 and Nj= 0.1

(Core strength obtained from IS 2911 Part-I Sec-II, based on N Value)

Safe bearing pressure 40t/m^2

As per clause 9 of IS 12070 the following factors are considered:

a) Submerged condition under water table Factor = 0.75 (can get submerged)

b) Cavities Factor = 1 (no cavities found)

c) Slope Factor = 1 (area is prone to slides)

Recommended safe bearing capacity 40 x 0.75 x 1 x 1 = 30.0t/m^2

ANNEXURE - B

RIVER LOCATION

(BH-2)

FARGO CONSULTANTS PVT. LTD.

BORE / DRILL LOG

Project : Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16

Project No. : 2021434J

Location : Umananda Ferry Ghat (In River Location)

Method of Boring / Drilling : R.M.C

Boring / Drilling Equipment : Machenical Winch

Water Level (Static) : 3.50m agl.

Bore Hole No. : BH-2

Ground Elevation : +33.506m

Dia. of Boring/Drilling : 150mm/75mm

Casing Lowered : 15.00m

Date : 03.02.2022 to 06.02.2022

Date	Sample and in-situ Test: Time (Min)	DEPTH/RUN (m): From	DEPTH/RUN (m): To	Length (m)	Sample/Test Code	SPT: 0cm-15cm	SPT: 15cm-30cm	SPT: 30cm-45cm	N' Value	Core Recovered (m)	Recovery (%)	R.Q.D. (%)	Description
03.02.2022		0.00	0.50	0.50	D	-	-	-	-				Dark grey silty fine sand
		1.00	1.05	0.05	P/D	60 (5cm)	-	-	>100				1.00m
		Drilling Started from 1.00m											
		1.00	2.00	1.00	C	-	-	-	-	0.40	40	Nil	Yellowish brown completely to highly weathered rock
		2.00	3.00	1.00	C	-	-	-	-	0.34	34	Nil	
		3.00	4.00	1.00	C	-	-	-	-	0.77	77	Nil	
		4.00	5.00	1.00	C	-	-	-	-	0.13	13	Nil	
		5.00	5.10	0.10	P/D	69 (10cm)	-	-	>100				
04.02.2022		5.00	6.00	1.00	C	-	-	-	-	Nil	Nil	Nil	
		6.00	6.07	0.07	P/D	55 (7cm)	-	-	>100				
		6.00	7.00	1.00	C	-	-	-	-	Nil	Nil	Nil	
		7.00	7.06	0.06	P/D	50 (6cm)	-	-	>100				
		7.00	8.00	1.00	C	-	-	-	-	0.29	29	Nil	
		8.00	9.00	1.00	C	-	-	-	-	0.30	30	13	
05.02.2022		9.00	10.00	1.00	C	-	-	-	-	0.40	40	Nil	
													9.00m
		10.00	11.00	1.00	C	-	-	-	-	0.73	73	38	Yellowish brown slightly weathered to fresh rock
		11.00	12.00	1.00	C	-	-	-	-	0.81	81	54	
		12.00	13.00	1.00	C	-	-	-	-	0.71	71	34	
		13.00	14.00	1.00	C	-	-	-	-	0.68	68	24	
		14.00	15.00	1.00	C	-	-	-	-	0.95	95	90	
		15.00	16.00	1.00	C	-	-	-	-	0.72	72	18	
06.02.2022		16.00	17.00	1.00	C	-	-	-	-	0.78	78	22	
		17.00	18.00	1.00	C	-	-	-	-	0.67	67	36	
		18.00	19.00	1.00	C	-	-	-	-	0.88	88	53	

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 : Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16

Project No. : 2021434J

Location : Umananda Ferry Ghat (In River Location)

Method of Boring / Drilling : R.M.C

Boring / Drilling Equipment : Machenical Winch

Water Level (Static) : 3.50m agl.

Bore Hole No. : BH-2

Ground Elevation : +33.506m

Dia. of Boring/Drilling : 150mm/75mm

Casing Lowered : 15.00m

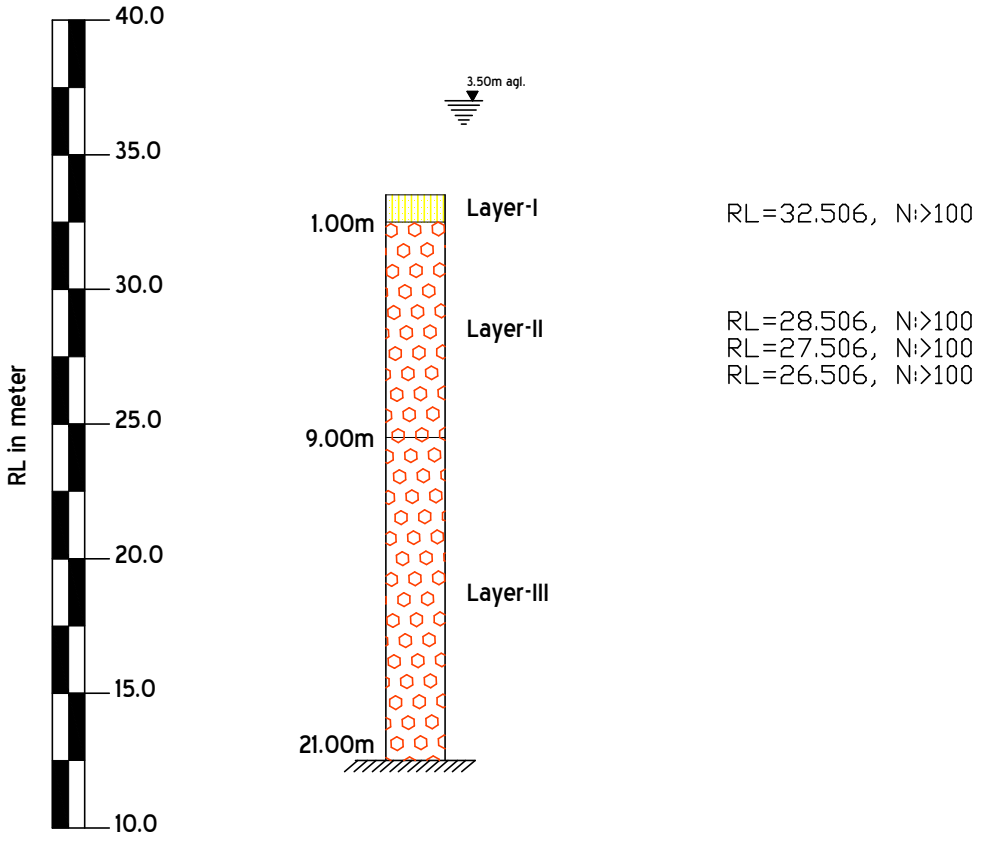
Date : 03.02.2022 to 06.02.2022

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) From	To			0cm-15cm	15cm-30cm	30cm-45cm					
		19.00	20.00	1.00	C	-	-	-	-	0.90	90	26	Continued from previous page
		20.00	21.00	1.00	C	-	-	-	-	0.76	76	38	Yellowish brown slightly weathered to fresh rock
	The Bore hole Tarmination Depth 21.00m												

Sample Code: U-Undisturbed, C-Core, D-Disturbed, W-Water

Test Code P-Standard Penetration, V-Vane Shear

BH-1
(IN RIVER)



Layer-I : Dark grey silty fine sand
Layer-II : Yellowish brown completely to highly weathered rock
Layer-III : Yellowish brown slightly weathered to fresh rock

Generalized soil profile for proposed ferry service at Umananda Ghat (in River location), beside in River Brahmaputra, Assam

CLIENT:	SCALE:	
Royal HaskoningDHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India	Not to scale	
PROJECT:	CONSULTANT:	FIG. NO.
Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam	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	2

FARGO CONSULTANTS PVT. LTD.

LABORATORY TEST RESULTS

Project Name & Bore Hole No.	Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at Umanada Ferry Ghat (in River), Assam; BH-2																						
Layer ID	I	II																					
Depth (m)	0.50	1.00	5.00	6.00	7.00																		
Sample Type	D	P	P	P	P																		
'N' value	-	>100	>100	>100	>100																		
Corrected "N" Value	-	>102	>75	>72	>69																		
Gravel (%)	0.0	-	-	-	-																		
Sand (%)	86.0	-	-	-	-																		
Silt (%)	14.0*	-	-	-	-																		
Clay (%)		-	-	-	-																		
Natural Moisture Content (%)		-	-	-	-																		
Bulk Density (gm/cc)		-	-	-	-																		
Dry density (gm/cc)		-	-	-	-																		
Liquid Limit(%)	Non Plastic		-	-	-																		
Plastic Limit (%)			-	-	-																		
Plasticity Index (%)			-	-	-																		
Type of Test (UU/DS)		-	-	-	-																		
Cohesion (kg/cm^2)		-	-	-	-																		
Angle of Friction (degree)		-	-	-	-																		
Sp.Gravity		-	-	-	-																		
Free Swell (%)		-	-	-	-																		
e_0		-	-	-	-																		
P_0 (kg/cm^2)		-	-	-	-																		
P_c (kg/cm^2)		-	-	-	-																		
C_c		-	-	-	-																		
C_r		-	-	-	-																		
Shrinkage Limit (%)		-	-	-	-																		

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 FOR ROCK SAMPLES

Project ID	Bore Hole No.	Depth (m)	T.C.R. (%)	R.Q.D. (%)	UCS (kg/cm^2)	Porosity (%)	Point Load Index (kg/cm^2)	Modulus of elasticity ($MPa \times 10^3$)	Dry Density (gm/cc)
Preparation of Detailed Project Report (DPR) along with Engineering Design. Drawings. Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 Location: Proposed Ferry service at Umananda (In River). Assam: BH-2	BH - 2	1.00 - 2.00	40	-	-	4.82	6.20	-	2.09
	BH - 2	4.00 - 5.00	13	-	-	2.11	7.40	-	2.71
	BH - 2	8.00 - 9.00	30	13	160.0	1.23	8.20	9.00	2.74
	BH - 2	12.00 - 13.00	71	34	200.0	2.21	10.30	26.00	2.78
	BH - 2	16.00 - 17.00	78	22	220.0	1.68	11.30	15.00	2.71
	BH - 2	20.00 - 21.00	76	38	260.0	2.57	12.80	27.00	2.74

Sheet No.: B-5

Note :

1. UCS - Uniaxial ComprEssion Strength
2. T.C.R. - Total Core Recovery
3. R.Q.D. - Rock Quality Designation

ESTIMATES OF SAFE BEARING PRESSURES

TABLE 2 - NET SAFE BEARING PRESSURE (q_{ns}) BASED ON CLASSIFICATION (IS:12070 -1987)

Sl. No.	Material	q_{ns} (t/m^2)
1	Massive crystalline bedrock including granite, diorite, gneiss, trap rock	1000
2	Foliated rocks such as schist or slate in sound condition	400
3	Bedded limestone in sound condition	400
4	Sedimentary rock, including hard shales and sandstones	250
5	Soft or broken bedrock (excluding shale), and soft limestone	100
6	Soft shale	30

TABLE 3 - NET SAFE BEARING PRESSURE BASED ON RMR (IS:12070 -1987)

CLASSIFICATION NO.	I	II	III	IV	V
Description of rock	Very Good	Good	Fair	Poor	Very Poor
RMR	100-81	80-61	60-41	40-21	20-0
q_{ns} (t/m^2)	600-448	440-288	280-141	135-48	45-30

ESTIMATE OF SAFE BEARING PRESSURE FROM THE CORE STRENGTH

qs = qc Nj

where

qs = safe bearing pressure (gross)

qc = average uniaxial compressive strength of rock cores

Nj = empirical coeeficient depending on the spacing of discontinuities (Table 4)

TABLE 4 - VALUES OF Nj (IS:12070 -1987)

SPACING OF DISCONTINUITY	Nj
(cm)	(-)
300	0.40
100-300	0.25
30-100	0.10

SAFE BEARING PRESSURE FROM VARIOUS METHODS

(I) Based on classification = 100t/m^2

(ii) Based on RMR = 85t/m^2 where average RMR is 27

(iii) Based on core strength = 23t/m^2 where qc = 230t/m^2 and Nj= 0.1

(Core strength obtained from IS 2911 Part-I Sec-II, based on N Value)

Safe bearing pressure 20t/m^2

As per clause 9 of IS 12070 the following factors are considered:

a) Submerged condition under water table Factor = 0.75 (can get submerged)

b) Cavities Factor = 1 (no cavities found)

c) Slope Factor = 1 (area is prone to slides)

Recommended safe bearing capacity 20 x 0.75 x 1 x 1 = 15.0t/m^2

ANNEXURE - C

CHEMICAL TEST RESULTS

FARGO CONSULTANTS PVT. LTD.

Laboratory Test Results for Chemical Analysis

Project Name: Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry

Location: Proposed Umananda Ferry Ghat **Job No.:** 2021434J

Analysis for SOIL Sample

BH No. (#)	Depth (m)	pH (-)	Sulphate	Carbonate	Chloride	Total Dissolved Solids
			(%)	(%)	(%)	(mg/L)
BH-1	0.50m	8.02	0.003	2.270	0.007	0.100
BH-2	0.50m	7.77	0.0015	1.840	0.0109	0.0317
LIMIT		> 6	< 0.2	–	–	–

Analysis for WATER Sample

BH No. (#)	pH (-)	Sulphate	Chloride
		(mg/L)	(mg/L)
BH-1	7.45	54.58	45.92
LIMIT	> 6	300	2000

PREPARATION OF DETAILED PROJECT REPORT (DPR) ALONG WITH ENGINEERING DESIGN, DRAWINGS, TENDER DOCUMENTS FOR CONSTRUCTION OF MODULAR TERMINAL AT FERRY SERVICE OF NW-2 AND NW-16 IN ASSAM

TOPOGRAPHICAL SURVEY REPORT

Client:

ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY.
3RD. FLOOR OF DIWT OFFICE BUILDING,
ULUBARI, GUWAHATI -781007

Consultant:
HASKONING DHV CONSULTING PVT. LTD.
PLATINUM TECHNO PARK,
502-505, 5TH FLOOR,
PLOT NO. 17 & 18 SECTOR 30A,
VASHI NAVI MUMBAI- 400703,
MAHARASHTRA, INDIA

Survey Agency:
FARGO CONSULTANTS PVT. LTD.
CF-394, SECTOR-I, SALT LAKE CITY
Kolkata- 700064
Phone-(033) 2337-3775
E-mail: fargoconsultants@gmail.com
Website: www.fargoconsultants.com

AUGUST, 2022

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1. TOPOGRAPHIC SURVEY

1.1 INTRODUCTION:

Preparation of Detailed Project Report (DPR) along with Engineering Design, Drawings, Tender Documents for construction of modular terminal at Ferry Service of NW-2 and NW-16 in Assam was entrusted to Haskoning DHV Consulting Pvt. Ltd., Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India. Fargo Consultants Pvt. Ltd., CF-394, Sector-I, Salt Lake City, Kolkata- 700064 was entrusted by Haskoning DHV Consulting Pvt. Ltd., to undertake the physical survey.

1.2 SCOPE OF THE SURVEY:

The scope of work comprised of conducting topographical survey of the proposed thirteen (13) jetty locations using Total Station of two seconds accuracy and prepare Plans (Maps) on a suitable scale by 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 10.0 m over area. The Level Survey was used to shall generate: (a) Location, layout and levels of all existing structures shall be presented (b) Spot levels at locations over area at an interval not exceeding 5 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 Benchmark (GTS/any other reference government Benchmark) to site/sites by double levelling, establishing and marking bench marks on existing structures in the field over the entire survey area.

The Latitude and Longitude of the thirteen locations for the proposed jetties is provided in the Table-1. Locations of the proposed jetties are shown in Figure 1.

With the tropical monsoon climate, Assam is temperate (summer max. at 35–38°C and winter min. at 6–8°C) and experiences heavy rainfall and high humidity. The climate is characterised by heavy monsoon downpours reducing summer temperatures and affecting foggy nights and mornings in winters, frequent during the afternoons. Spring (March–April) and autumn (September–October) are usually pleasant with moderate rainfall and temperature.

Table 1: Proposed Jetty Locations

Sl. No.	Location	Latitude	Longitude
1	Aphalamukh	26°54'57.13"N	94°17'57.80"E
2	Bahari	26°14'50.84"N	91°07'52.29"E
3	Dhubri	26°0'44.95"N	89°59'55.51"E
4	Disangmukh	27°03'01.35"N	94°31'55.59"E
5	Ghaghor	27°12'30.45"N	94°10'46.33"E
6	Goalpara	26°11'08.75"N	90°37'54.92"E
7	Guijan Site	27°33'30.85"N	95°19'16.36"E
8	Kurua	26°14'10.48"N	91°49'03.58"E
9	Matmora	27°08'00.00"N	94°29'56.27"E
10	Neemati	26°51'39.12"N	94°14'31.18"E
11	North Guwahati	26°11'12.85" N	91°43'17.65" E
12	Umananda	26°11'47.37"N	91°44'41.67"E
13	Uzan Bazaar	26°11'35.91"N	91°45'4.77"E

Figure 1: Locations for Proposed Jetties

1.3 METHODOLOGY ADOPTED & INSTRUMENTS DEPLOYED FOR TOPOGRAPHICAL SURVEY:

1.3.1 RECONNAISSANCE SURVEY

Reconnaissance of the entire proposed area will be carried out in detail 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. The reconnaissance

survey is expected to be completed within half a day. During reconnaissance survey the location of control points were fixed.

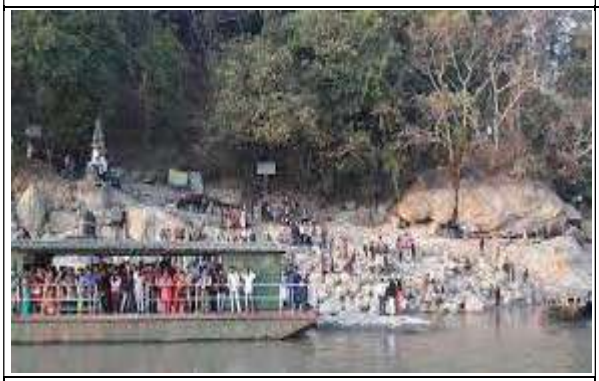
The land around the proposed ferry location had mixed ownership. Private land as claimed by the residents not only existed on the land side of the embankment but in some cases on the river side of the embankment. Permanent structures were not existed at these locations for the ferry operations. All the ferry locations were for passenger transport except for Neamati Ghat, Aflamukh Ghat, Disangmukh and Matmora where vehicles can be ferried. Near the Aflamukh Ghat a bridge across Brahmaputra is under construction. At the Uzan Bazar, Umananda and North Guwahati location a ropeway is operational. A bridge across Brahmaputra River is under construction near North Guwahati location. Photographs obtained during reconnaissance are provided below.

	
Aflamukh Ghat	Disangmukh Ghat
	
Ghagor Ghat	Guijan Ghat

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Matmora Ghat</td><td>Neamati Ghat</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Bahari Ghat</td><td>Kachari Ghat, Dhubri</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Goalpara Ghat</td><td>Kurua Ghat</td></tr>
</table>

Uzan Bazar Ghat

North Guwahati Ghat



Umananda Ghat

1.3.2 Planimetric Control Survey:

Adequate pair of control points will be established using DGPS at suitable locations near the river edge parallel to the river embankment.

1.3.3 Height Control Survey:

Height control traverse will be run by connecting the local BM as provided by the department or available GTS Benchmark. A loop will be run over the control points and the circuit will be closed to find out the closing error which will be balanced, and the error distributed as per standard practice. On completion of the level traverse temporary Benchmarks will be kept for further detailing in height distribution and digital terrain modeling of the entire study area.

Table 2: Benchmark Value and Description

Sl. No.	Proposed Site	Benchmark (BM) MSL Value (m)	Description	Approximate Coordinates (m)
1	Aphalamukh	86.415	PWD Pillar (with GPS-7 marking) near Proposed construction of Bridge	E:626960, N:2977155
2	Bahari	38.880	Marking from bridge on NH-427	E:302673, N:2913049
3	Dhubri	30.190	CWC BM Pillar	E:799240, N:2880794
4	Disangmukh	91.60	CWC BM Pillar	E:652059, N:2993062
5	Ghaghor (New)	87.952	Marking from CWC Pohumara office	E:604628, N:3009475
6	Goalpara	37.350	Marking from CWC pillar	E:263536, N:2898302
7	Guijan	122.246	Marking at Tinsukia Railway Station	E:732961, N:3042567
8	Kurua	49.576	PWD GPS Pillar (with RP-4 marking) near bridge construction at N. Guwahati	E:372394, N:2896988
9	Matmora 3	95.700	CWC BM Pillar	E:650283, N:3006151
10	Neemati	87.370	Marking from CWC office	E:624469, N:2971243
11	North Guwahati	49.576	PWD GPS Pillar (with RP-4 marking) near bridge construction at N. Guwahati	E:372394, N:2896988
12	Umananda	51.081	PWD Pillar (with PB12CP marking) near bridge construction at N. Guwahati	E:372830, N:2895450
13	Uzan Bazaar	51.081	PWD Pillar (with PB12CP marking) near bridge construction at N. Guwahati	E:372830, N:2895450
Note:	All locations are located in Zone 46Q except Dhubri which is Zone 45Q			

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 pipeline
- 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 at spacing of 10m in orthogonal directions or at closer intervals where the topography so requires. An area of approximately 2.0km in length and 300m width was surveyed. However, in some occasions the distance between the river bank to water edge was significantly high, in such scenario area for topographical survey increased significantly.

1.3.7 Instruments Deployed:

The physical work of survey was undertaken at site using DGPS, Electronic Total Stations with 1 second least count and Auto levels. Computer with necessary survey software for plotting the field drawing will also be utilized. Auto Level was field calibrated. Relevant calibration certificates are included in Annexure-A.

Table 3: List of Instruments used in Topographic Survey

Equipment	Model	Accuracy
DGPS	Sokkia GRX1	Static: L1 + L2 band H: 3mm + 0.5ppm V: 5mm + 0.5ppm
Electronic Total Station	Sokkia 620	Distance measurement: (2+2ppmXD) mm Angle measurement: 6" Minimum display: 1"
Auto Level	Sokkia C330	Levelling Accuracy: 2.0mm for 1Km double run levelling

1.3.8 PHOTOGRAPHS:

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

<table>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">Aphalamukh</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Bahari</td><td>Dhubri</td></tr>
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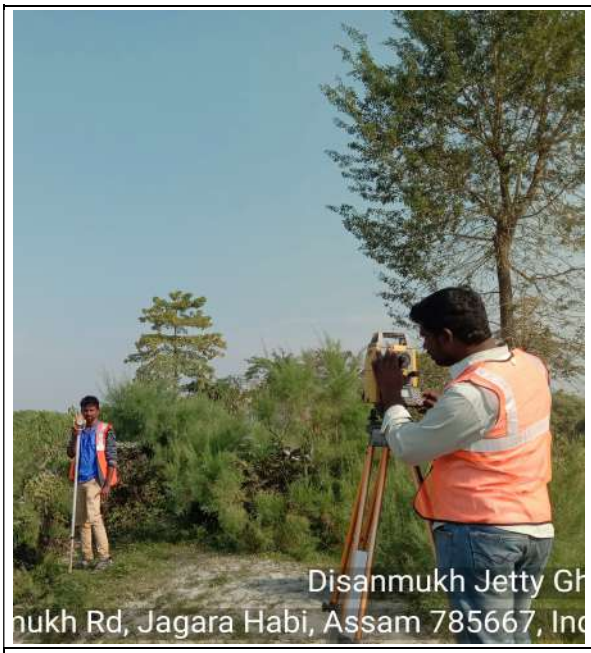
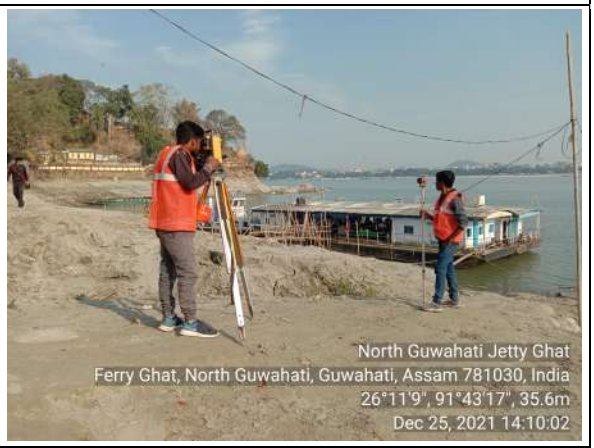
	
Disangmukh	Ghaghor
	
Matmora	Matmora (New)
	
Matmora 3	North Guwahati

	
Goalpara	Guijan
	
Kurua	Umananda
	
Uzan Bazaar	Neemati

2. BATHYMETRIC SURVEY

2.1 SCOPE OF THE SURVEY:

The scope of work at the proposed thirteen (13) jetty locations comprised of (a) establishing at least reference points (permanent objects), 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 properly connected to Differential Global Positioning equipment with a minimum of 12 channels. (c) Echo sounding (bathymetry) of the survey area was carried out along the length of the river covering the cross-section of 100m or width of the river.

2.2 METHODOLOGY ADOPTED & INSTRUMENTS DEPLOYED FOR HYDROGRAPHIC SURVEY:

2.2.1 SPOT HEIGHTS:

Spot levels will be recorded for at approximately 10m interval in orthogonal directions. Spot levels will be recorded for an area 1.0km upstream and 1.0km downstream of the selected location for a width of 100m. In locations where the depth of water is less than 1.50m the bed levels will be recorded using a total station. Coordinates and depth measurements will be recorded using an echo sounder. The depth readings will be converted to elevations by deducting the depth value from the water level elevation for that particular day. Since this part of the river does not experience tidal variations gauge station will not be required and water edge elevation will be assumed to be same on the day of survey.

2.2.2 INSTRUMENTS DEPLOYED:

The physical work of survey will been undertaken at site using one Sokkia GRX-1 DGPS, 1 nos. Electronic Total Station (viz. Sokkia 610/Sokkia 620,) with 1 second least count, 1 nos. Auto level, 1 no. Garmin GPSMAP 585 multi beam echosounder, computer with necessary survey software for plotting the field drawing. Echosounder and Auto Level will be field calibrated. Relevant calibration certificates are included in Annexure-A.

Table 4: List of Instruments used in Bathymetric Survey

Equipment	Model	Accuracy
DGPS	Sokkia GRX1	Static: L1 + L2 band H: 3mm + 0.5ppm V: 5mm + 0.5ppm
Electronic Total Station	Sokkia 620 Sokkia 520	Distance measurement: (2+2ppmXD) mm Angle measurement: 6"/5"/ Minimum display: 1"
Auto Level	Sokkia C330	Levelling Accuracy: 2.0mm for 1Km double run levelling
Echo Sounder	GPSMAP 585	Dual beam Vertical accuracy: 0.1m

2.2.3 PHOTOGRAPHS:

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

<table>
<tr><td> 
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</td></tr>
<tr><td>Aphalamukh</td><td>Bahari</td></tr>
<tr><td> 
</td><td> 
</td></tr>
<tr><td>Dhubri</td><td>Disangmukh</td></tr>
</table>

	
Ghaghor	Goalpara
	
Guijan	Kurua
	
Matmora	North Guwahati

Uzan Bazaar

Umananda

Nemati

3. DRAWINGS AND REFERENCE POINTS:

3.1 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 survey data will be provided in excel format for further use. The drawings has been prepared in a suitable scale and is presented in A0 size sheets.

3.2 BENCHMARKS and Reference Points for Future Use:

Reference points were marked on permanent objects at the site for future reference. X, Y & Z values assigned to these reference points. The reference point was marked with a paint dot. Details of the reference points are provided in Table-3.

Table 5: Reference Point Details

Sl. No.	Location	Field Marking	Easting (m)	Northing (m)	Elevation (m)
1	Aphalamukh	RP-1	628737.913	2977759.16	87.117
		RP-2	628583.033	2977829.537	86.935
2	Bahari	RP-1	314237.763	2904504.658	41.571
		RP-2	314208.038	2904586.761	41.823
		TBM-1	314204.511	2904610.263	41.762
		TBM-2	315124.125	2904396.227	40.764
3	Dhubri	RP-1	799470.824	2880957.909	29.973
		RP-2	799466.996	2880985.371	29.421
		TBM-1	799442.537	2880929.993	29.943
		TBM-2	799324.352	2880634.187	29.92
4	Disangmukh	RP-2	650516.162	2991628.892	90.565
		RP-3	651048.256	2991751.579	94.326
		RP-4	651193.160	2991861.643	93.868
		RP-5	649823.661	2990785.624	94.391
		RP-6	649856.487	2990791.228	89.513
		TBM-1	650614.83	2991740.655	90.788
5	Ghagor (New)	RP-1	617354.189	3013116.312	91.357
		RP-2	617303.621	3013138.444	91.313
		TBM-1	617210.037	3012975.603	90.982
6	Goalpara	RP-1	263141.086	2898277.228	38.474
		RP-2	263067.168	2898300.411	37.738
		TBM-1	263114.683	2898288.685	38.675
		TBM-2	263312.344	2898217.768	39.28

Sl. No.	Location	Field Marking	Easting (m)	Northing (m)	Elevation (m)
7	Guijan Site	RP-1	729503.212	3052580.513	116.087
		RP-2	729509.545	3052526.628	117.23
		RP-3	729337.686	3052365.774	117.173
		RP-4	729218.118	3052313.699	116.789
		TBM-1	730017.870	3052638.202	117.373
		TBM-2	730121.918	3052476.889	118.213
8	Kurua	RP-1	382264.656	2902380.818	52.325
		RP-2	382201.030	2902393.224	52.284
		TBM-1	382473.830	2902248.546	51.46
		TBM-3	382433.669	2902340.443	52.58
9	Matmora 3	RP-1	653382.919	3012299.224	98.057
		RP-2	653333.945	3012377.181	98.084
		TBM-4	652405.831	3011691.161	96.055
		TBM-5	652926.921	3011646.147	95.208
10	Neemati	GPS-1	623465.640	2971623.763	88.871
		GPS-2	623605.440	2971541.431	88.635
		RP-1	624056.180	2971354.145	85.88
		RP-2	624086.073	2971347.835	86.098
		RP-4	622302.87	2971494.563	88.898
		TBM-3	622391.459	2971585.266	89.255
11	North Guwahati	GPS-5	372223.431	2896875.41	48.834
		RP-1	372347.83	2896990.912	51.237
		RP-4	372407.572	2896987.572	49.576
		TBM-1	372243.913	2896928.799	51.312
12	Umananda	C-2	374674.803	2898033.826	46.393
		C-3	374570.276	2897988.503	43.256
		C-4	374605.113	2898024.527	60.754
13	Uzan Bazaar	RP-1	374620.374	2897793.571	46.35
		RP-2	375278.747	2897668.576	49.675
		RP-3	375289.288	2897639.254	54.196

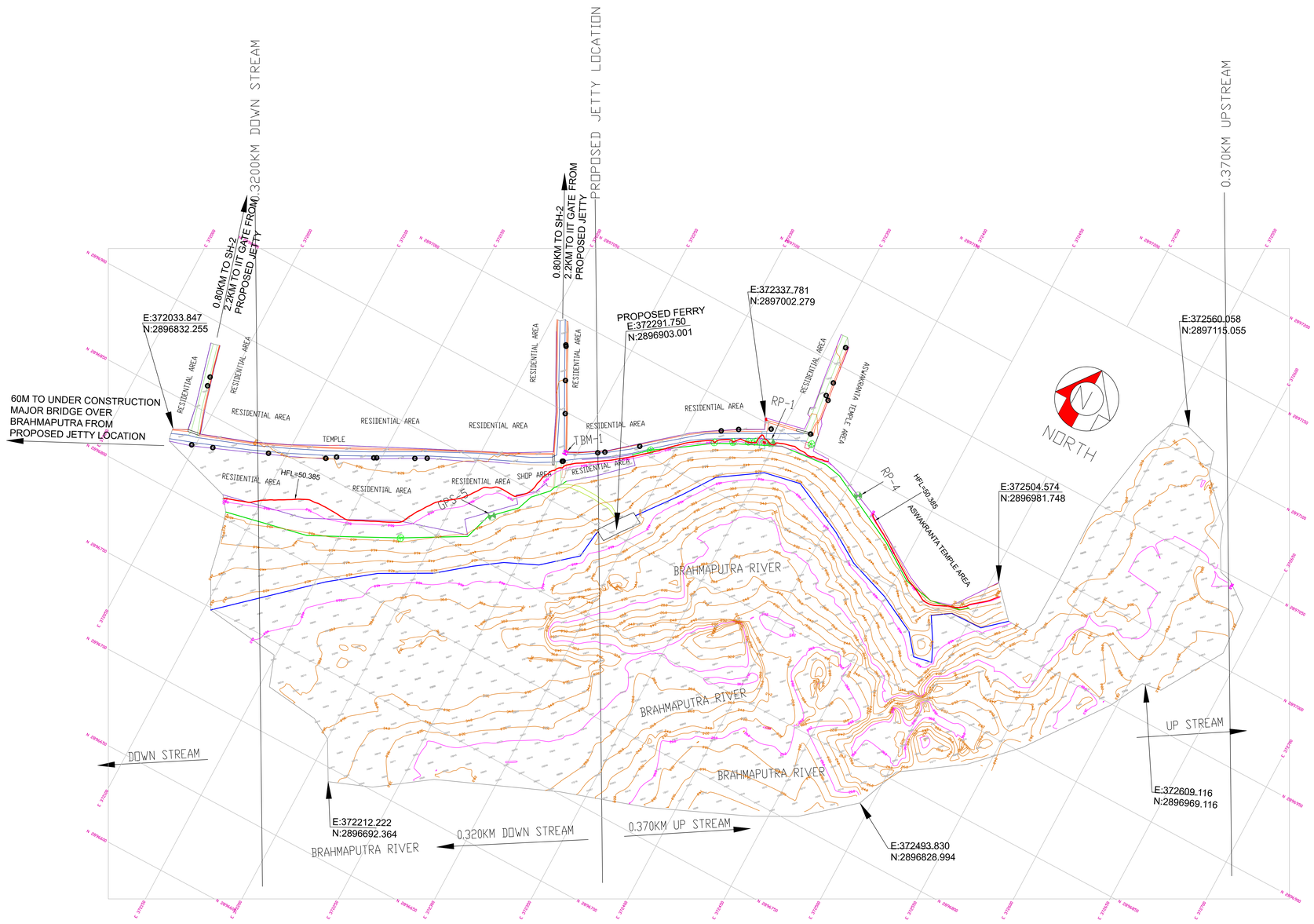
3.3 Brief SUMMARY of Site Data

Table 6: Miscellaneous Details

Location	LWL (m)	HFL (m)	River side Elevations (m)			Land Side Elevations (m)			Access Road Details
			Max	Min	Average	Max	Min	Average	
Aphalamukh	78.21	83.84	87.750	37.511	77.057	87.750	62.711	83.804	77km to Gogamukh Dhakuakhana Road
Bahari	33.80	38.88	41.143	30.100	33.035	43.122	33.553	39.751	5.1km to NH-427
Dhubri	22.48	27.00	32.980	23.434	29.348	32.980	-1.018	17.090	0.55km to NH-127B
Disangmukh	85.02	91.60	91.321	80.216	84.296	94.434	84.830	91.474	15.9km to NH-2 near Sivsagar
Ghaghor	84.91	87.95	90.772	82.547	86.464	91.675	84.520	89.246	9.2km to NH-15 North Lakhimpur
Goalpara	29.62	37.35	36.679	22.421	28.321	41.737	30.970	36.535	1.1km to SH-46
Guijan Site	111.66	122.25	113.760	102.462	108.199	119.173	105.662	115.732	7.7km to Makum Bypass
Kurua	41.98	51.43	50.129	19.580	39.328	83.640	42.035	51.254	10.0km to SH-2
Matmora3	92.98	95.97	92.577	82.077	87.672	99.160	90.831	94.703	11.1Km to Dhakuakhana Road
Neemati	81.13	87.37	89.076	53.425	70.177	90.576	82.018	86.461	10.5Km to NH-715 Bypass Flyover
North Guwahati	41.45	50.39	54.201	12.350	33.129	56.329	44.874	51.465	0.80km to SH-2
Umananda	41.55	48.38	42.554	22.050	34.061	74.843	41.440	59.583	0.7km to Uzan Bazar Ferry
Uzan Bazaar	41.55	48.38	55.578	15.750	40.051	82.470	42.479	54.411	0.2Km from MG Road, Guwahati

ANNEXURE-A

TOPOGRAPHICAL SURVEY AND BATHYMETRIC SURVEY



LEGEND

SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL
1.	ELECTRIC POST / LIGHT POST		8.	TREE / REFERENCE POINT	
2.	BOUNDARY WALL / FENCE LINE		9.	SPOT ELEVATION / GATE	28.275
3.	CULVERT / TEMPORARY BENCH MARK		10.	MAJOR CONTOUR	
4.	ROAD (METALLED / CONCRETE)		11.	MINOR CONTOUR	
5.	ROAD (KUTCHA) / TELEPHONE POST		12.	UNDER CONSTRUCTION BLDG	
6.	POND / LOW LAND		13.	WATER EDGE (ASSUMED LWL)	
7.	HUT / SEMI PUCCA BUILDING		14.	RIVER BANK / HIGH FLOOD LEVEL	

NOTES

1. All Dimensions are in metre unless otherwise stated.
2. GPS Coordinates has been used for this survey.
3. Reference RL obtained from PWD pillar marked RP-4 at N.Guwahati Bridge location HFL= 50.385m (Local), BM= 49.576m.
4. Contours are drawn at an interval of 2 mtrs.
5. Surveyed area: Topographical - 0.027sq km and Hydrographic - 0.076sq km
6. Water Level during hydrographic survey was 41.45m
7. Reference Pillar Co-ordinate & Level are.

Reference Point	Easting	Northing	Level
RP-1	372347.830	2896990.912	51.237
RP-4	372407.572	2896987.572	49.576
GPS-5	372223.431	2896875.410	48.834
TBM-1	372243.913	2896928.799	51.312

Client: ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY

Project: PREPARATION OF DETAILED PROJECT REPORT (DPR) ALONG WITH ENGINEERING DESIGN, DRAWINGS, TENDER DOCUMENTS FOR CONSTRUCTION OF MODULAR TERMINAL AT FERRY SERVICE OF NW-2 AND NW-16 IN ASSAM (NORTH GUWAHATI)

Consultant: HaskoningDHV Consulting Pvt. Ltd
Royal HaskoningDHV Nijmegen — Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 19 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India

Survey Agency: FARGO CONSULTANTS PVT. LTD.
CF-394, Sector-I, Salt Lake City, Kolkata 700 064

Job No.	Drawn by	Chkd. by	Apprvd. by
20211434J	B. PAL	G. NASKAR	P. BRAHMA

Drg. No.	Scale	Date	
FC/2021434/NGHY/01	1:1000	30/05/2022	REV. 2

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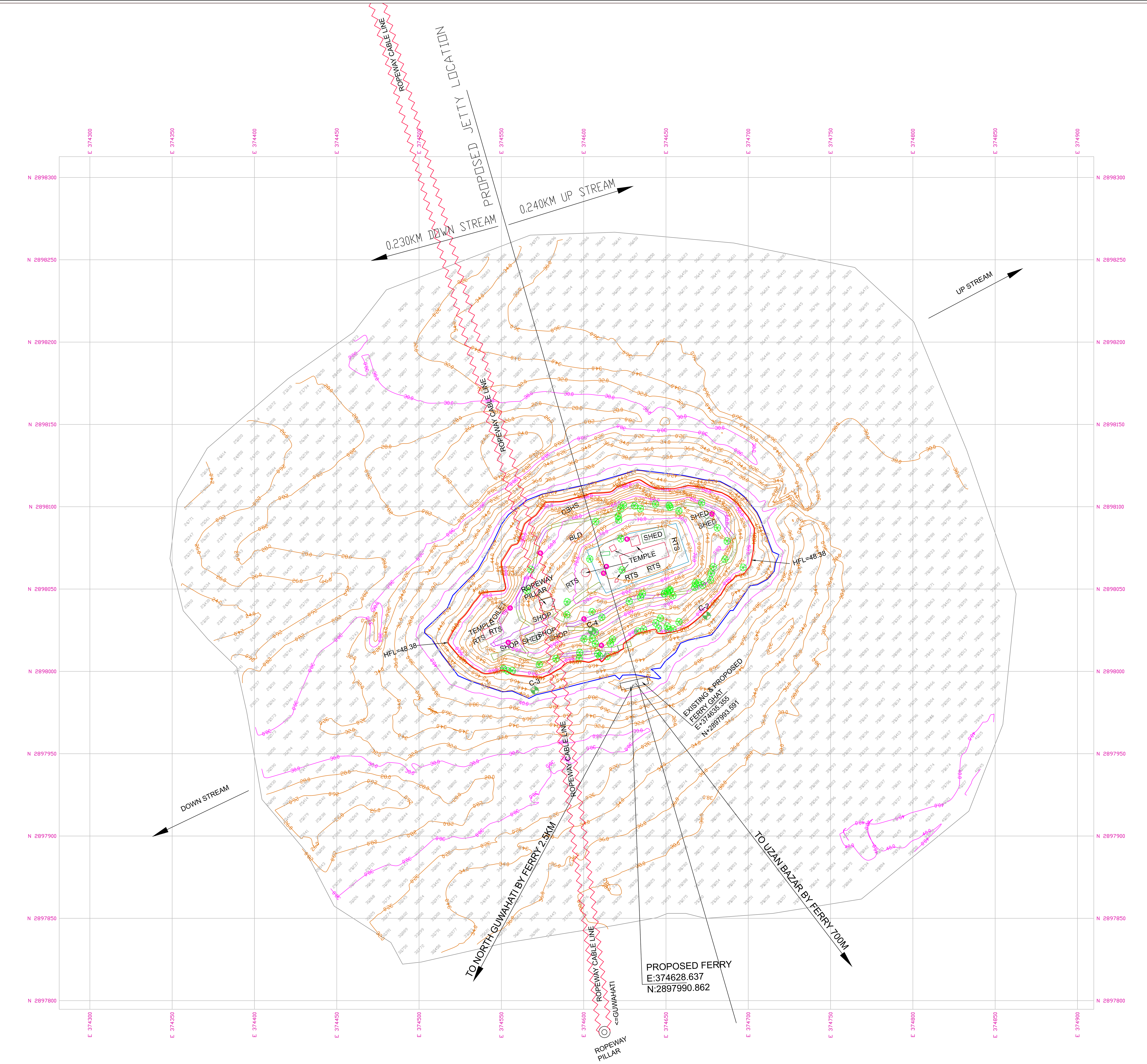

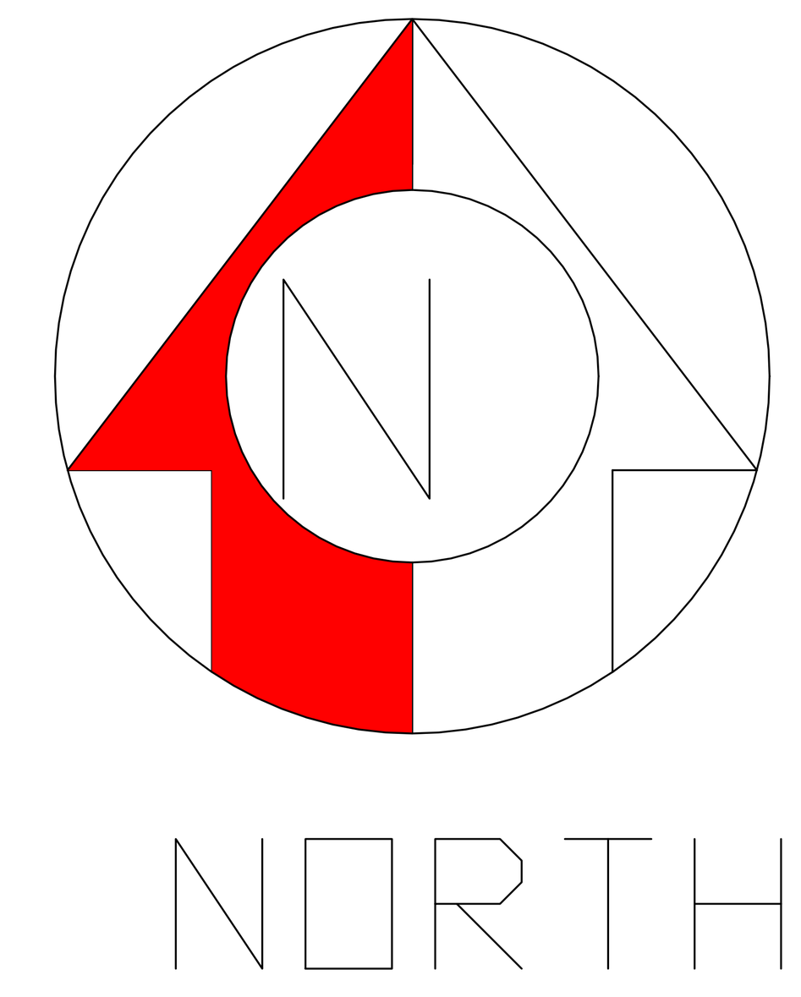

LEGEND					
SL.NO.	DESCRIPTION	SYMBOL	SL.NO.	DESCRIPTION	SYMBOL
1.	ELECTRIC POST / LIGHT POST	LP EP	8.	TREE / REFERENCE POINT	
2.	BOUNDARY WALL / FENCE LINE		9.	SPOT ELEVATION / GATE	93.927
3.	CULVERT / TEMPORARY BENCH MARK		10.	MAJOR CONTOUR	95.0
4.	ROAD (METALLED / CONCRETE)		11.	MINOR CONTOUR	92.0
5.	ROAD (KUTCHA) / ROPEWAY WARE		12.	UNDER CONSTRUCTION BLDG	
6.	POND / LOW LAND		13.	WATER EDGE (ASSUMED LWL)	
7.	HUT / SEMI PUCCA BUILDING		14.	RIVER BANK / HIGH FLOOD LEVEL	

NOTES

1. All Dimensions are in metre unless otherwise stated.
2. GPS Coordinates has been used for this survey.
3. Reference RL obtained from PWD office.
   HFL= 48.380m (Local). BM (PB12CP) = 51.081m
4. Contours are drawn at an interval of 2 mtrs.
5. Surveyed area: Topographical - 0.019sq km and Hydrographic - 0.148sq km
6. Water Level during hydrographic survey was 41.550m
7. Reference Pillar Co-ordinate & Level are.

Reference Point	Easting	Northing	Level
C-2	374674.803	2898033.826	46.393
C-3	374570.276	2897988.503	43.256
C-3	374605.113	2898024.527	60.754

Client: ASSAM INLAND WATER TRANSPORT DEVELOPMENT SOCIETY

Project: PREPARATION OF DETAILED PROJECT REPORT (DPR) ALONG WITH ENGINEERING DESIGN, DRAWINGS, TENDER DOCUMENTS FOR CONSTRUCTION OF MODULAR TERMINAL AT FERRY SERVICE OF NW-2 AND NW-16 IN ASSAM (UMANANDA TEMPLE GHAT)

Consultant: Royal HaskoningDHV Enhancing Society Together — HaskoningDHV Consulting Pvt. Ltd
Platinum Techno Park, 502-505, 5th Floor, Plot No. 17 & 18 Sector 30A, Vashi Navi Mumbai- 400703, Maharashtra, India

Survey Agency: FARGO CONSULTANTS — FARGO CONSULTANTS PVT. LTD.
CF-394, Sector-I, Salt Lake City, Kolkata 700 064

Job No.	Drawn by	Chkd. by	Appvd. by
2021434J	B. PAL	G. NASKAR	P. BRAHMA

Drg. No.	Scale	Date	
FC/20214342/UMANANDA/01	1:1000	30/05/2022	REV. 2

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