PLANNERS CONSULTANTS ENGINEERS

REPORT# 10543/GSK

GEOTECHNICAL INVESTIGATION REPORT

Location	District Attock.
Project	Construction of GBHS No. 02 Hazro
No. of Exploratory points	02
Date of Exploration	7th August, 2023
Reporting Officer	Engr. Ghassan Sattar Khan
Submitted to:	UNHCR
Ground Water Table Depth	Not Encountered
Recommended footing type	Strip Footing.
Recommended net bearing Capacity	0.60 TSF

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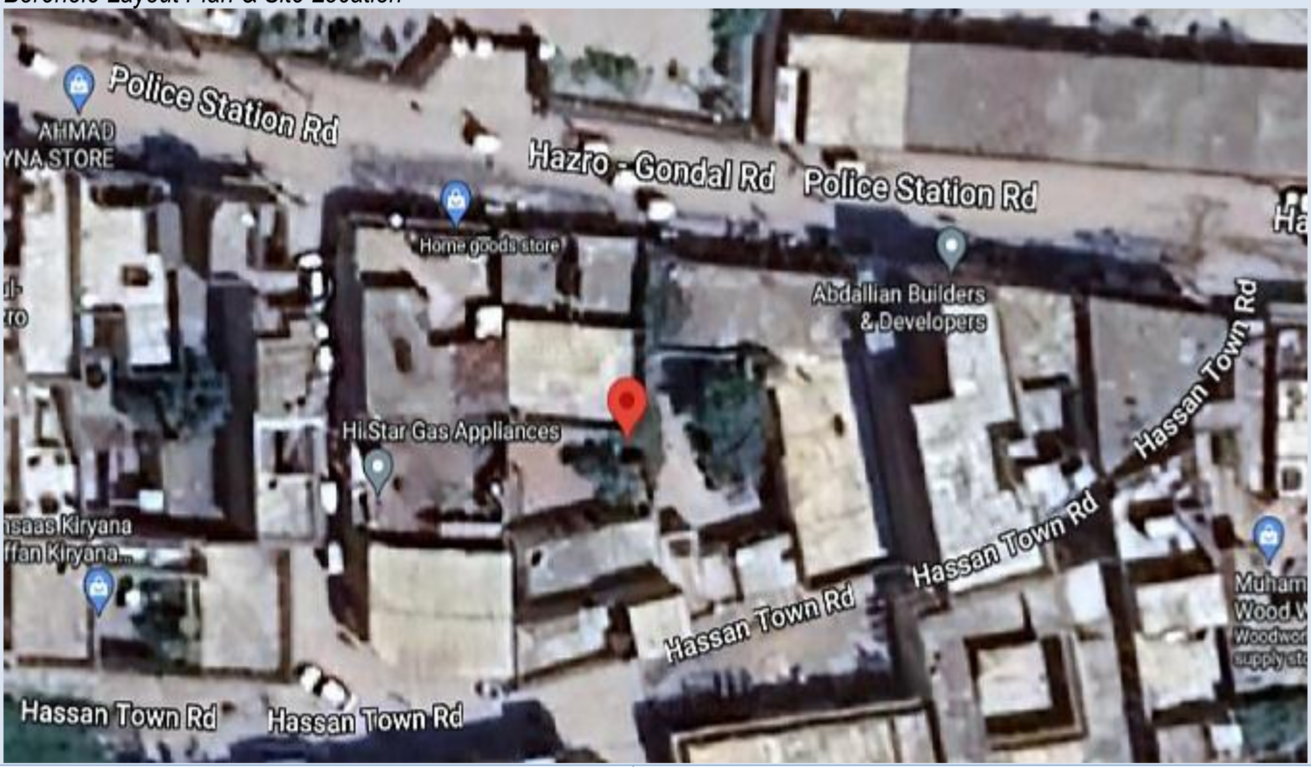
Table 1.00 – INTRODUCTION	
Table 1.10 – GENERAL	
Client Name	UNHCR
Hiring of services By	UNHCR
Location/ Address	Hazara District.
Borehole Layout Plan & Site Location	



Name of Project	Construction of Government Boys High School No. 02.
No. of Stories	Single story
Task To be Performed	Geotechnical Investigation
Scope of Work/ Work executed	02 Bore Holes (up to 08ft depth)
Purpose of activity	Geotechnical Investigation
Arial Conditions of the site	Plot level was 5ft below Road level.

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Table 1.20 – ACTIVITY DETAILS			
Coordinates of excavation area		(33.910677, 72.485587)	
Field Tests performed		i. Drilling of Bore Holes ii. Conduction of SPT	02 Each at 4ft interval
Observed telephone lines, sewer lines, electric poles, water pipes etc.		None	
Laboratory Tests performed		i. Atterberg's limits *ASTM D-4318-10.* ii. Particle Size *ASTM D422, D1140.* iii. Unconfined Compression tests *ASTM D-2166* iv. Direct shear tests *ASTM D-3060*	02 02 02 01
Ground Water Table from N.S.L	Nil	Ground Water Table from R.L	Nil
Encountered Rocky Strata depth	Nil	Seepages	Not recorded

Table 2.00 – EVALUATION			
S. No.	**Depth (ft.)**	**Discussion on encountered strata**	
01	0 – 02	Fill material was encountered up to 02ft depth.	
02	03 - 08	According to USCS classification the strata was mainly comprise of lean clay with medium plasticity. Percentage of fines were found exceeding 85%.	
03	Tests performed to measure the shear strength parameters of soil according to the ASTM, to analyze the bearing capacity of the strata.		Unconfined Compression & Direct Shear tests

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Table 3.00 - CONCLUSION

3.10 Bearing Capacity (In-situ Condition)

S. No	Depth (ft.)	Foundation Type	Footing Width (ft.)	Ultimate Bearing Capacity TSF	Gross Allowable Bearing Capacity TSF	Net Allowable Bearing Capacity TSF
01	05	Strip footing	05	2.25	0.75	0.60

3.20 Site Class

Soil Profile Type	Soil Profile Name/ Generic Description	Average Properties for Top 30 M (100 ft) of Soil Profile		
		Shear Wave Velocity, v_s m/sec (ft/sec)	Standard Penetration Tests, N [or N_{CH} for cohesionless soil layers] (blows/foot)	Undrained Shear Strength, s_u kPa (psf)
S_A	Hard Rock	>1,500 (>4,920)	–	–
S_B	Rock	750 to 1,500 (2,460 to 4,920)		
S_C	Very Dense Soil and Soft Rock	350 to 750 (1,150 to 2,460)	>50	>100 (>2,088)
S_D	Stiff Soil Profile	175 to 350 (575 to 1,150)	15 to 50	50 to 100 (1,044 to 2,088)
S_E[1]	Soft Soil Profile	<175 (<575)	<15	<50 (<1,044)
S_F	Soil requiring Site-specific Evaluation. See 4.4.2			

1 Soil Profile Type S_E also includes any soil profile with more than 3 m (10 ft) of soft clay defined as a soil with a plasticity index, $PI > 20$, $w_{mc} \geq 40$ percent and $s_u < 25$ kPa (522 psf). The Plasticity Index, PI, and the moisture content, w_{mc}, shall be determined in accordance with the latest ASTM procedures.

Site Class	From 03ft - 08ft S_D
Ref: Pakistan Building Code 2007	
3.30 Seismic Zone	Zone : 2B PGA of 0.16g to 0.24g.
Ref: Pakistan Building Code 2007	

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Table 4.00 - RECOMMENDATION
i. Compact the surface prior to laying foundation.
4.10 Backfill Material
In general, materials for the backfilling should be granular, not containing rocks or lumps over 15 cm in greatest dimension, free from organic matter, with plasticity index (PI) not more than 6%. The backfill material should be laid in lifts not exceeding 25 cm in loose thickness and compacted to at least 95 percent of the maximum dry density at optimum moisture content as determined by modified compaction test (Proctor) (ASTM D-1557).
4.20 Site Drainage
It is recommended to design an effective rainwater drainage system to get rid of the consequences of the rainwater percolation into the layers *(i.e. provision of parametric drains)*. The site should be graded so as to direct rainwater and water away from all planned structures. Under no circumstances, the foundation shall get inundated during the whole period of construction. Utmost care shall be taken not to allow drainage water to seep into the soil. For this specific water logged site, simultaneous dewatering activity must be carried out along with excavation. This may be done using test pits or filter piles / boreholes.

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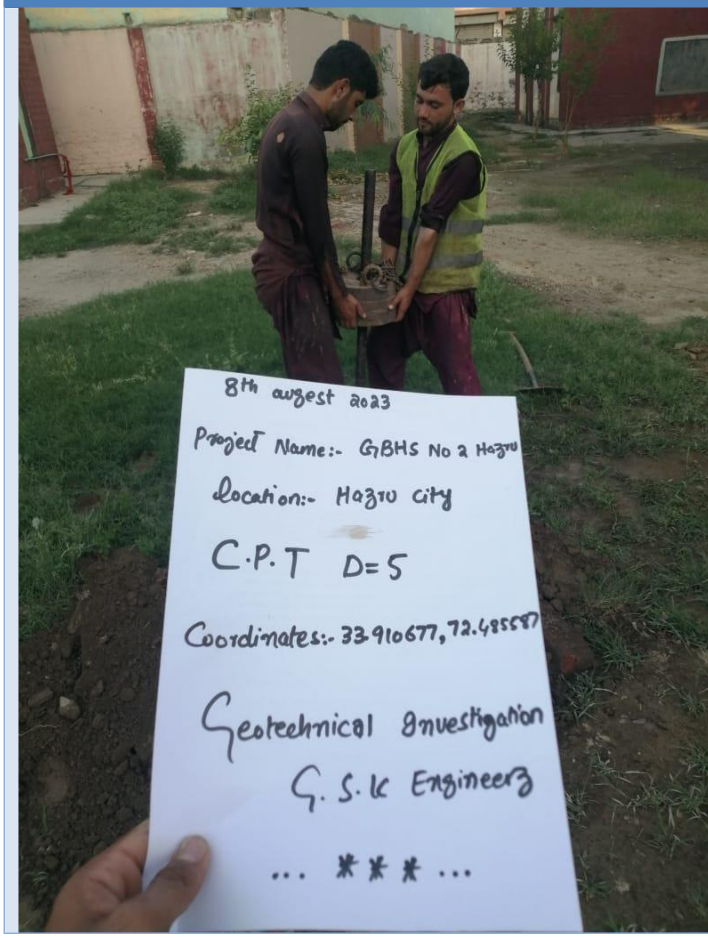
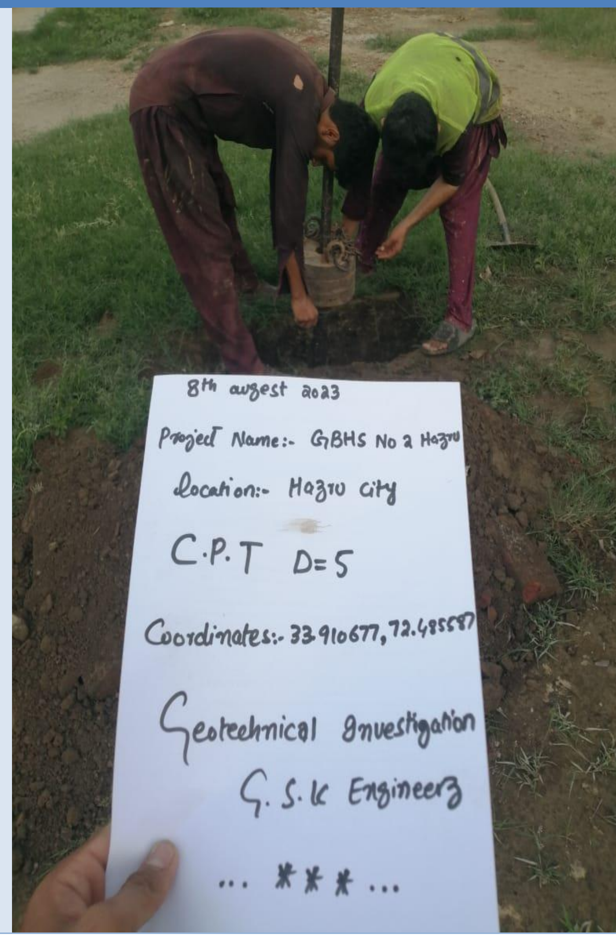
Table 5.00 - SITE PICTURES





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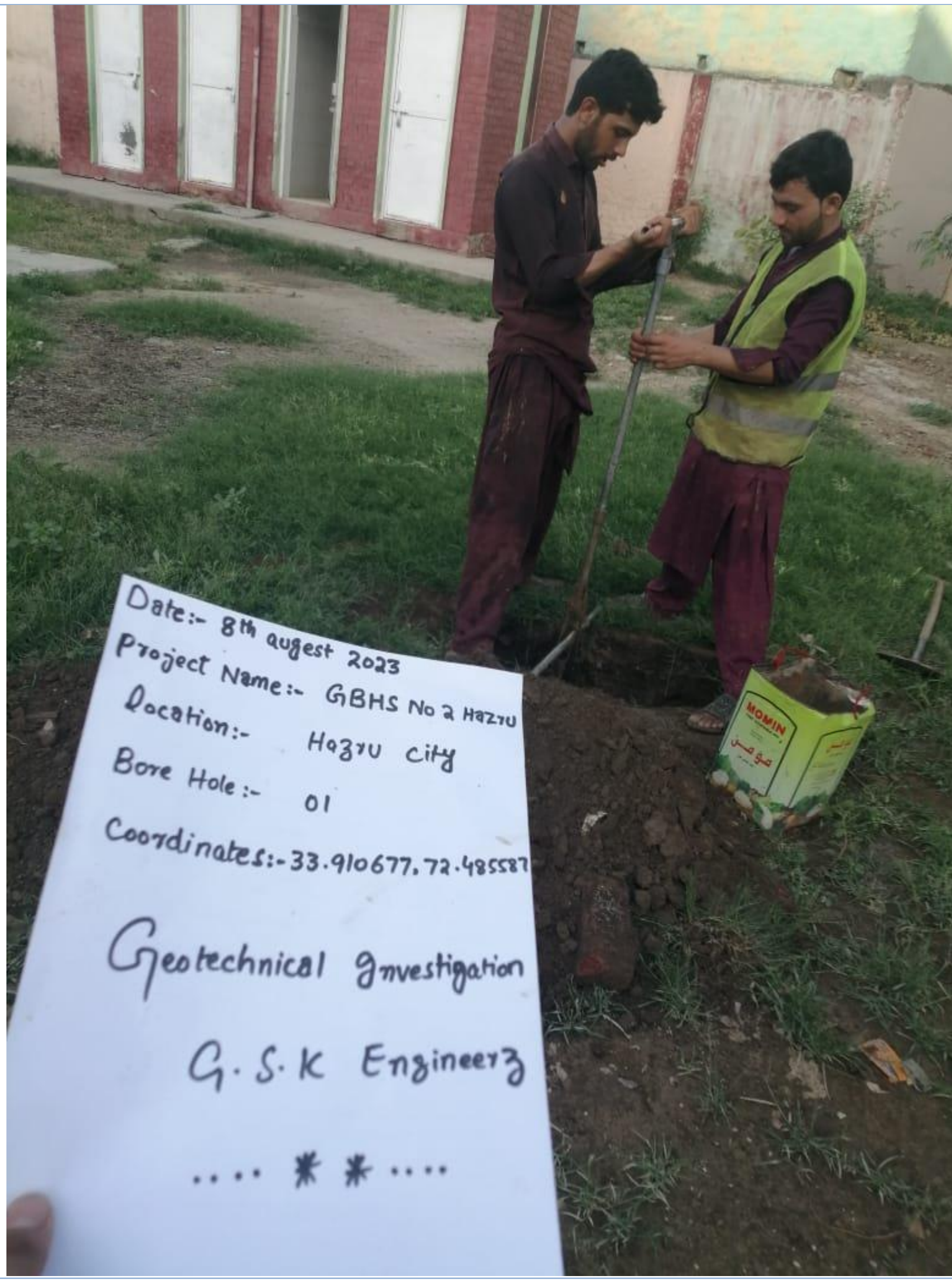

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ANNEXURE-A

SCOPE OF WORK & METHODOLOGY

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A.1.0 PURPOSE OF GEOTECHNICAL INVESTIGATION

The very main purpose of Geotechnical investigation is to conduct soil investigation for the site where building construction needs to take place.

The activity comprises of soil exploration and determines suitability of the site for the proposed construction. It mainly helps in knowing which type of foundation is required or what safety measures shall be taken. The effort and detail of geotechnical site investigation is to obtain sufficient and correct site information so as to select and design a foundation for a building that is most economical and appropriate.

In general, the purpose of this site investigation was to provide the following:

1- Information to determine the type of foundation required (shallow or deep).

2- Information to allow the geotechnical consultant to make a recommendation on the allowable bearing capacity of the soil.

3- Sufficient data/ laboratory tests to make settlement and swelling predictions.

4- Location of the groundwater level

5- Information so that the identification and solution of excavation problems can be made.

A.2.0 METHODOLOGY

A.2.1 Field Work

a. Preliminary survey

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Preliminary survey was conducted by the team to identify exploration points location based on master plan for the building.

b. Drilling

As per scope of work, the site investigation program included the exploration of site subsurface conditions through the drilling of **two bore holes**, up to 10ft deep below the existing ground level.

c. Sampling

Samples collected:

✓ Disturbed samples; for identification and index property testing purposes at various depths as elucidated in the scope of work.

✓ Undisturbed samples; for the computation of shear strength parameters of soil. The samples were collected using Block Sampling method.

Representative samples were placed in sealed plastic bags and core boxes, to be transported to the laboratory for further testing.

A.2.2 Laboratory Work

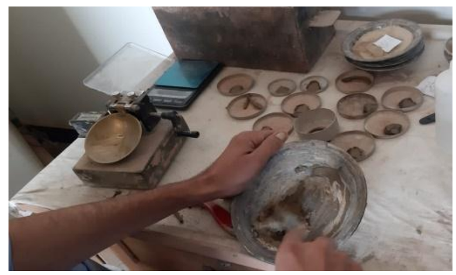
A.2.2.1 Moisture Content & Bulk Density

To determine the moisture content of soils, the soil sample was dried at a temperature of 105°C to 110°C for about 24 hours. The loss in weight of the soil sample represented the weight of moisture in the soil. The moisture content of the soil to the dry weight of soil in percentage is the moisture content of the testing soil. This test was performed in accordance with BS 1377: Part 2: 1990.The bulk density of a soil, i.e. the mass per unit volume of the soil deposit including any water it contains was determined at the laboratory by using the linear measurement method approached by BS 1377: Part 2: 1990.

A.2.2.2 Particle Size Distribution

Particle size distribution was determined by means of sieving. Sieves of standard sizes were used as per ASTM E11-09e1. The percentage of weight of the various particle sizes were determined by sieving through a set of these standard sieves. This test was performed to determine the percentage of different grain sizes contained within a soil sample. This test was performed as per ASTM D422, D1140. Graphs obtained are attached in the appendices.

A.2.2.3 Atterberg's Limits



Following ASTM D4318-10, the liquid limit and plastic limit of required sample that is cohesive in nature, was computed. The Atterberg's limits refer to arbitrarily defined boundaries between the liquid and plastic states (i.e., liquid limit, W_L) and between the plastic and brittle states (ie, plastic limit, W_P), of fine grained soils. They are expressed in percentage water content. The range of water contents over which a soil behaves plastically is termed the Plastic Index and corresponds to the numerical difference between the liquid and plastic limit (ie, W_rW_P).

The liquid limit (LL) is arbitrarily known as the water content, in percent, at which a pat of soil in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm (1/2 in.) when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of two shocks per second. The typical cassagrande's apparatus was used in determination of Liquid Limit.

The plastic limit (PL) is the water content, in percent, at which a soil can no longer be deformed by rolling into 3.2 mm (1/8 in.) diameter threads without crumbling

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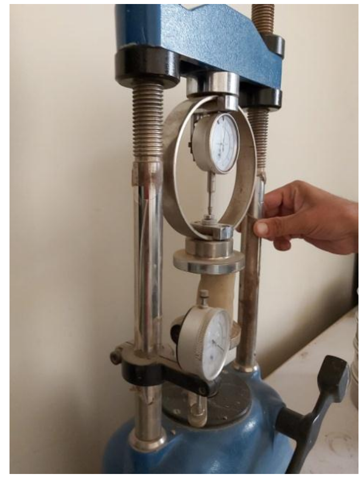
A.2.2.4 Unconfined Compression Test:

The test was conducted as per ASTM-D2166. In this test Method, a cylindrical soil specimen is unconfined laterally while loaded axially at an axial strain rate between 0.5 to 2 %/min. Measurements are made of elapsed time, axial deformation, and axial load. The unconfined compressive stress, qu, is calculated as the compressive stress at failure. The undrained cohesion, cu, is one half of the unconfined compressive strength. The primary purpose of the unconfined Compression test is to quickly obtain a measure of compressive strength for those soils that possess sufficient cohesion to permit testing in the unconfined state.



B.1.0 BEARING CAPACITY CALCULATION:

The bearing capacity of soil is the average contact stress between a foundation and the soil which will cause shear failure in the soil. Allowable bearing stress is the bearing capacity divided by a factor of safety.

Following method was adopted to compute the bearing capacity values;

i. From c &ϕ
ii. From SPT (In-Situ Testing)

B.1.1 Bearing Capacity from c &ϕ

Terzaghi's equation has been used to calculate the bearing capacity for cohesive soils. A factor of safety of '03' is used in calculation of Allowable bearing capacity. Data received from direct shear test has been used in the following equation.

$$Qu = 1.3cNc + qNqRw_1 + 0.4\,\gamma BN\gamma Rw_2$$

C = Cohesion of soil, γ = unit weight of soil, D = depth of footing, B= width of footing

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C,Ø - Strength parameters of the soil below foundation level.L - Length of foundation.

Nc, Nq, N_γ - Bearing capacity coefficients dependent on the angle of internal friction of the soil.

$$Nc = \cot\phi\,(Nq - 1),$$

$$N_q = e^{\pi \tan\phi} \tan^2(45+\phi/2)]$$

$$N_\gamma = (Nq - 1)\tan(1.4\phi)$$

$$,Kp = \tan^2(45 + \phi/2)$$

Mayerhoff's Bearing Capacity Factors			
Ø	**Nc**	**Nq**	**Ny**
0	5.1	1	0
5	6.5	1.6	0.1
10	8.3	2.5	0.4
15	11	3.9	1.2
20	14.9	6.4	2.9
25	20.7	10.7	6.8
30	30.1	18.4	15.1
35	46.4	33.5	34.4
40	75.3	64.1	79.4

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