GEOTECHNICAL INVESTIGATION REPORT for the Proposed Factory Complex at UPSIDC Mega Food Park, Baheri, Bareily, Uttar Pradesh

EXECUTIVE SUMMARY

Space Geo Tech, are the Consultants for the proposed project at UPSIDC Mega Food Park, Baheri, Bareily, Uttar Pradesh.

The proposed structures are Factory Buildings.

To obtain adequate information regarding the subsoil conditions, for the design of the substructures for the proposed structures, a detailed geotechnical investigation programme has been undertaken at the site.

The scope of work consisted of conducting boreholes in soil strata down to 10m depth at twenty locations. However, out of 20 boreholes, one borehole BH13 had been conducted down to 13m depth below the existing ground level.

The results of the investigations indicate that the subsoil strata consists of clayey sandy silt/ sandy clayey silt down to about 2m to 3m depth beyond which the subsoil strata predominantly consists of sandy soils down to the maximum depth investigated i.e 13m below the existing ground level.

The N-values (N-values 4 - 23) indicate that the subsoil is loose to medium dense down to about 9m depth below which the subsoil is medium dense (N-values 20 - 28) down to the maximum depth investigated.

Ground water table had been encountered at a depth of about 2m below the existing ground level, during the period of field investigations i.e February 2023

The subsoil down to about 10m depth below the existing ground level, has been considered to be susceptible to liquefaction due to which shallow foundations are not feasible.

Considering the type of structures involved and the subsoil characteristics as determined from the geotechnical investigations, **Straight Bored Pile foundations** have been recommended.

The following safe pile capacities have been recommended for various diameters and 15m effective length of pile.

Pile Dia (mm)	***Pile Effective Length (m)***	***Pile Vertical Load Capacity (tons)***
450	*15*	*20*
600	*15*	*40*

Precaution :

For After reaching the required depth in the pile bore, 15cm thick layer of gravel should be placed and compacted at the bottom so that the slush formed at the bottom is diminished. can subsequently be placed over such a prepared surface.

Note :The investigations have been conducted down to 10m depth below the existing ground level except for one borehole which has been progressed down to 13m depth below the existing ground level which is inadequate to provide the recommendations for Straight bored pile. As the piles of 15m effective length will rest at a depth of about 16m below the existing ground level, the recommendations for the same have been provided considering the similar subsoil conditions down to a minimum depth of about 20m below the existing ground level. However, for the confirmation of the subsoil conditions at deeper depths, conducting additional few boreholes down to a minimum depth of about 20m is advisable.

1.0 INTRODUCTION

1.1 Space Geo Tech, "Sri Guru Krupa", #985, 18th A Main, 66th Cross, 5th Block, Rajajinagar, Bangalore - 560010 are the consultants for the proposed Factory Complex at UPSIDC Mega Food Park, Baheri, Bareily, Uttar Pradesh.

1.2 To design the substructures for the proposed structures, adequate information regarding the subsoil conditions is required. For this purpose, detailed geotechnical investigations had been undertaken.

1.3 This report contains the details of the geotechnical investigations conducted along with the results and analysis of the investigations and the recommendations thereof.

1.4 Geotechnical investigations for this purpose have been carried out as per the verbal authorization of the authorities of Space Geo Tech. This authorization has been given in response to our offer no NCD/Q/SGT/159/2022 dated 24th January 2023.

2.0 PROJECT DETAILS

2.1 Site Location

2.1.1 The site for the proposed project is located at Village Mundiya, Mukarrampur, UPSIDC Mega Food Park, Baheri, Bareily, Uttar Pradesh - 243201 and is situated at a distance of about 8 km from Kichha bus - station (Uttarakhand) towards Bareily, Uttra Pradesh.

2.2 Site Layout and Topography

2.2.1 A schematic site plan showing the dimensions and other details of the site is enclosed in this report (fig.1a).

2.2.2 Maximum level differences of about 0.5m had been observed at the site and the general level of the site had been observed to be about 0.5m below the adjacent road level, during the period of field investigations.

2.2.3 Vegetation in the form of grass and bushes had been observed at the site, during the period of field investigations.

2.2.4 The colour of the surface earth had been observed to be Yellowish brown.

2.3 Seismic Zone

The present site is located in the Seismic Zone - IV which is the zone of highest seismic intensity, as per the seismic zoning map of India given in BIS code IS:1893 (Part1)-2016.

2.4 The Structure/s

2.4.1 The proposed structures are Factory Buildings.

2.4.2 The structures are understood to be framed ones and the construction to be of Reinforced Cement Concrete.

3.0 OBJECT OF INVESTIGATIONS

3.1 For designing the foundation system of the proposed structures, the following data are required :

a) Type of foundation

b) Depth below the ground level at which the foundation system is to be laid.

c) Allowable bearing pressure at the foundation level.

3.2 To determine the above factors, the following information would be required:

a) The subsoil profile indicating thicknesses of the various soil strata, to a depth within the influence zone below the foundations

b) Engineering properties of the soil strata at various levels

c) Physical characteristics of the soil strata

d) Variation of strength of soil strata with depth

3.3 For evaluating the above parameters, field investigations and laboratory investigations on the soil samples collected during the field investigations, have been carried out.

3.4 The results from these investigations have been analysed to provide the recommendations for the design of foundations.

4.0 SCOPE OF INVESTIGATIONS

4.1 The final scope of investigations as stipulated by the client consists of :

a) Conducting boreholes in soil/ refusal strata down to 10m depth at twenty locations.

b) Conducting chemical analysis on soil samples.

c) Conducting relevant laboratory tests on soil samples recovered.

d) Preparation and submission of a technical report in three copies containing the details of the tests carried out, their analysis and recommendations regarding the foundation system to be adopted.

4.2 The following operations were to be undertaken while progressing the boreholes:

a) Conducting standard penetration tests at regular intervals in soil strata.

b) Recovering undisturbed soil samples from various levels of the subsoil strata.

c) Recording ground water table levels, if met with.

5.0 FIELD INVESTIGATIONS

5.1 Preliminary Details

5.1.1 Field investigations had been carried out between 31st January 2023 and 8th February 2023.

5.1.2 A schematic site plan showing the test locations has been given in fig. 1a.

5.1.3 Photographs showing view of the site and work under progress have been given in fig. 1b. of the report.

5.2 Boreholes

5.2.1 Boreholes were progressed by shell and auger method. Casing pipe were used to stabilize the sides of the boreholes below the water table level.

5.2.2 All the boreholes (BH1 to BH20) had been conducted down to the stipulated depth of 10m below the existing ground level except for borehole BH13 which had been conducted down to 13m depth below the existing ground level.

5.2.3 The diameter of the boreholes was 150/100mm.

5.2.4 Standard penetration tests were conducted at 1.5/3m intervals. Disturbed soil samples recovered from split spoon samplers were retained for identification purposes.

5.2.5 Undisturbed soil samples were recovered by thin walled Shelby tubes conforming to IS : 2132. These tubes had an area ratio of less then 10%.

5.2.6 The diameter of undisturbed soil samples was 50mm and the length was 45cm.

5.2.7 The ends of sample tubes were sealed by wax to prevent loss / ingress of moisture. Disturbed soil samples were enclosed in polythene bags.

5.2.8 The samples thus recovered were transported to the laboratory for testing purposes

5.2.9 Ground water table had been encountered in all the boreholes at a depth varying between 1.7m and 2.5m below the existing ground level, during the period of field investigations i.e February 2023.

6.0 LABORATORY INVESTIGATIONS

6.1 Tests on Soil Samples From Boreholes

6.1.1 The soil samples brought to the laboratory were subjected to various tests to determine the following properties :

a) Type of soil and its gradation

b) Consistency limits

c) Natural Bulk Density & Water Content

d) Strength parameters like cohesion, angle of shearing resistance

6.1.2 In order to determine the above properties, the following tests have been conducted :

a) Sieve analysis on coarse grained soil fraction

b) Hydrometer analysis on fine grained soil fraction

c) Liquid and plastic limits tests

d) Natural Density and Water Content determination

e) Triaxial compression tests

6.2 Chemical Analysis

6.2.1 The soil samples collected from the boreholes have been tested to determine the pH-value and the presence of salts harmful to reinforced cement concrete construction namely Chloride and Sulphate contents.

7.0 RESULTS & ANALYSIS

7.1.1 The results of the boreholes investigations have been presented in the form of soil profile tables.

7.1.2 The soil profile tables indicate the following:

a) Standard penetration test values at various depths

b) Soil description identifying the type of soil

c) Grain size analysis indicating composition of subsoil

d) Atterberg limits

e) Natural density and water content

f) Triaxial compression test results

7.2 Soil Profile

7.2.1 A perusal of the data presented in the soil profile tables indicates that the subsoil mainly consists of the following three strata in the twenty boreholes:

a) Stratum - I : Clayey sandy silt with occasional gravel/ sandy clayey silt

b) Stratum - II : Sand with silt

c) Stratum - III : Silty sand

7.2.2 The thickness of the three strata in the twenty boreholes are as follows :

BH. No.	Strata (depth in m : from : to)		
	Stratum - I	Stratum - II	Stratum - III
1	0 - 2.2 6.4 - 6.9	2.2 - 6.4 6.9 - 10	N.E.
2	0 - 2	2 - 10	N.E.
3	6.4 - 6.6	3 - 6.4 6.6 - 10	0 - 3
4	0 - 2.2 6.7 - 6.9	2.2 - 6.7 6.9 - 10	N.E.
5	0 - 0.5 6.6 - 6.9	0.5 - 6.6 6.9 - 10	N.E.
6	0 - 2 3.4 - 3.9 7.3 - 7.8	2 - 3.4 3.9 - 7.3 7.8 - 10	N.E.
7	0 - 0.9 6.4 - 6.7	0.9 - 6.4 6.7 - 10	N.E.
8	0 - 2 6.4 - 6.7	2 - 6.4 6.7 - 10	N.E.
9	0 - 1.3 6.5 - 6.7	1.3 - 6.5 6.7 - 10	N.E.
10	0 - 3.9 6.5 - 6.8	3.9 - 6.5 6.8 - 10	N.E.
11	0 - 1.5 6.6 - 6.9	1.5 - 6.6 6.9 - 10	N.E.

BH. No.	Strata (depth in m : from : to)		
	Stratum - I	Stratum - II	Stratum - III
12	0 - 3.5 6.7 - 6.9	3.5 - 6.7 6.9 - 10	N.E.
13	0 - 2.4 6.3 - 6.7	2.4 - 6.3 6.7 - 13	N.E.
14	0 - 2 6.4 - 6.6	2 - 6.4 6.6 - 10	N.E.
15	0 - 1.8 6.7 - 6.9	1.8 - 6.7 6.9 - 10	N.E.
16	0 - 1.5 6.5 - 6.7	1.5 - 6.5 6.7 - 10	N.E.
17	0 - 1.5 6.4 - 6.6 8 - 9	1.5 - 6.4 6.6 - 8 9 - 10	N.E.
18	0 - 2 6.7 - 6.9	3.5 - 6.7 6.9 - 10	2 - 3.5
19	0 - 2.4 6.4 - 6.6	2.4 - 6.4 6.6 - 10	N.E.
20	0 - 2 5 - 5.4	2 - 5 5.4 - 10	N.E.

N.E. : not encountered

7.2.3 The above results show that :

a) Stratum - I consisting predominantly of silty soils with varying percentage of clay and sand, has been encountered down to the maximum depth of about 2.4m below the existing ground level.

b) Stratum - II consisting predominantly of sandy soils, is predominant beyond a depth of about 2m down to the maximum depth investigated i.e 13m below the existing ground level.

c) Stratum - III consisting predominantly of sandy soils with significant percentages of silt, has been encountered in occasional thin layers beyond a depth of about 3.5m below the existing ground level in occasional boreholes.

7.3 Soil Composition

7.3.1 The grain size distributions of the soil samples collected from various depths in the twenty boreholes have been presented in the form of grain size analysis curves in figs. 5a to 5q.

7.3.2 The variations in the grain size distributions in each of the three strata in the twenty boreholes are as follows:

a) Stratum - I : Clayey sandy silt with occasional gravel/ sandy clayey silt

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0	3	70	27
2	0	7	71	22
3	2	58	32	8
4	0	6	59	35
5	-	-	-	-
6	0 - 2	3 - 14	54 - 55	29 - 43
7	-	-	-	-
8	0	3	59	38
9	0	10	71	19
10	0	3 - 29	63 - 69	8 - 28
11	0	3	72	25
12	0 - 2	4 - 46	48 - 68	6 - 26
13	0	3	72	25
14	0	6	67	27
15	3	6	65	26
16	-	-	-	-

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
17	0	3 - 33	42 - 71	25 - 26
18	0	5	70	25
19	0	4	68	28
20	0	27	64	9

b) Stratum - II : Sand with traces of silt and occasional gravel/ sand with silt

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
1	0 - 18	78 - 98	2 - 5	0
2	0 - 6	92 - 98	2 - 5	0
3	0	96 - 98	2 - 4	0
4	0 - 16	87 - 95	2 - 13	0
5	0 - 12	79 - 98	2 - 9	0
6	0 - 2	95 - 97	2 - 4	0
7	0 - 3	94 - 98	2 - 5	0
8	0 - 3	93 - 97	2 - 5	0
9	0 - 4	94 - 98	2 - 4	0
10	0 - 3	86 - 95	5 - 11	0
11	0 - 7	85 - 94	2 - 15	0
12	0 - 8	89 - 97	3 - 7	0
13	0 - 2	91 - 98	2 - 9	0
14	0 - 3	94 - 98	2 - 4	0
15	0	86 - 98	2 - 14	0
16	0 - 8	89 - 98	2 - 5	0
17	0 - 4	85 - 98	2 - 15	0
18	0 - 2	95 - 96	3 - 5	0
19	0 - 2	89 - 98	2 - 11	0
20	0 - 3	88 - 97	2 - 10	0

This stratum has been encountered only in these boreholes.

c) Stratum - III : Silty sand with occasional clay and gravel

BH. No.	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
3	0 - 2	58 - 71	29 - 32	0 - 8
18	0	65	35	0

This stratum has been encountered only in these two boreholes.

7.4 The above results indicate that :

a) Stratum - I consists of about 31% to 72% of silt, 3% to 58% of sand and 8% to 43% of clay with occasional gravel.

b) Stratum - II consists of an average of about 95% of sand and 5% of silt.

c) Stratum - III consists of about 58% to 71% of sand, 29% and 35% of silt with occasional gravel.

7.5 Natural Density and Water Content

7.5.1 The natural bulk densities, water contents and dry densities of soil samples collected at various depths in twenty boreholes vary as follows :

BH. No.	Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
1	1.88 - 1.90	20.7 - 25.0	1.50 - 1.57
2	1.82 - 1.94	22.1 - 26.5	1.44 - 1.59
3	1.64 - 1.90	5.1 - 22.4	1.34 - 1.61
4	1.89 - 1.95	18.9 - 27.1	1.52 - 1.59
5	1.68 - 1.88	8.5 - 22.6	1.53 - 1.55
6	1.92 - 1.98	18.6 - 36.6	1.43 - 1.62
7	1.77 - 1.91	15.3 - 20.5	1.54 - 1.59
8	1.90 - 1.96	25.5	1.51 - 1.56

BH. No.	Bulk Density (g/cm^3)	Water Content (%)	Dry Density (g/cm^3)
9	1.90 - 1.94	22.6 - 22.9	1.55 - 1.58
10	1.88 - 1.92	18.9 - 27.9	1.49 - 1.58
11	1.89 - 1.90	24.2 - 27.5	1.49 - 1.52
12	1.86 - 1.92	25.9 - 26.0	1.48 - 1.53
13	1.86 - 1.93	20.6 - 24.8	1.49 - 1.60
14	1.87 - 1.89	18.3 - 25.3	1.49 - 1.60
15	1.88 - 1.97	19.5 - 27.2	1.48 - 1.65
16	1.88 - 1.93	23.0 - 25.5	1.50 - 1.57
17	1.88 - 2.09	15.9 - 26.7	1.49 - 1.80
18	1.95 - 1.97	23.4 - 26.2	1.55 - 1.60
19	1.87 - 1.96	24.1 - 26.9	1.47 - 1.58
20	1.90 - 1.92	22.3 - 23.5	1.54 - 1.56

7.5.2 The dry densities of the soil have also been presented in the form of plots of dry density vs depth for the twenty boreholes conducted, in figs 3a to 3d.

7.5.3 The above results indicate that the subsoil is in a loose to medium dense state down to about 9m depth below which the subsoil is in a medium dense state down to the maximum depth investigated.

7.6 Atterberg Limits

7.6.1 The Atterberg limits indicate that the subsoil is generally low plastic to medium plastic down to about 2m depth below which the subsoil is predominantly non-plastic down to the maximum depth investigated.

7.7 Standard Penetration Tests Values (N-values)

7.7.1 The observed Standard Penetration Test values (N-values) vary between 4 and 28 as indicated in the soil profile tables and as also shown in the figs. 3a to 3d wherein the observed N-values have been plotted with respect to depth.

7.7.2 The above results indicate that the subsoil is in a loose to medium dense state down to about 9m depth below which the subsoil is in a medium dense state down to the maximum depth investigated.

7.8 Triaxial Test Results

7.8.1 The results of triaxial tests are indicated in the respective soil profile tables. These results have been considered in providing the recommendations.

7.9 Free Swell Index Tests

7.9.1 As occasional layers of soil with significant percentages of clay have been observed at shallow depths in some boreholes, free swell index tests have been conducted on selected soil samples at these depths of different boreholes to assess the swelling characteristics of the subsoil.

7.9.2 The results of the free swell index tests are given below :

Borehole No	Depth (m)	FSI (%)
1	0.9	Nil
2	1.5	Nil
8	1.5	Nil
13	0.9	Nil
17	0.9	Nil

7.9.3 The above results indicate that the silty soil at shallow depths has shown nil free swelling index.

7.10 Chemical Analysis

7.10.1 The results of the chemical analysis conducted on soil samples collected from the twenty boreholes, for determining the presence of any harmful salts which can have adverse effects on concrete construction, are as follows :

Borehole no./ Depth (m)	pH value	Chloride Content (ppm)	Sulphate Content (ppm)
BH1/0.9m	6.5	13	26
BH2/1.5m	6.5	18	28
BH3/2.4m	6.5	18	25
BH4/3m	6.5	21	32
BH5/4.5m	7	23	14
BH6/6m	6	31	25
BH7/7.5m	6	27	42
BH8/9m	6.5	25	28
BH9/10m	7	13	32
BH10/1.5	6.5	17	37
BH11/3m	6	15	35
BH12/3.9m	6	18	31
BH13/4.5m	6	22	30
BH14/5.4m	6.5	21	44
BH15/6m	6.5	23	45
BH16/6.9m	6.5	18	42
BH17/7.5m	6.5	14	52
BH18/8.4m	6.5	21	61
BH19/9m	6.5	20	37
BH20/6.9m	7	23	34

IS LIMITS	
pH value	*Not less than 6*
Chloride content (ppm)	*Maximum 500 ppm*
Sulphate content (ppm)	*Maximum 400 ppm*

7.10.2 The above results of chemical analysis are within the IS limits indicating that the soil encountered in the boreholes shall not have any aggressive effect on normal concrete construction work.

7.11 Compiled Soil Profile

7.11.1 An overview of the results and their analysis has been presented in the form of a compiled soil and rock profile (figs. 2a & 2b).

7.11.2 The above figure shows the various strata encountered and their thicknesses in each of the boreholes and also gives the soil composition and the observed N - values at various depths.

8.0 ANALYSIS OF LIQUEFACTION SUSCEPTIBILITY

8.1 Analysis of the susceptibility to liquefaction of the subsoil at the site has been carried out in the form of a comparison of the shear stress induced/developed in event of an earthquake with the in-situ shear resistance of the subsoil at various depths in the different boreholes.

8.1.1 This method has been found to be very reliable and is used as one of the main criteria in almost all countries. The shear stress induced/developed at different depths during an earthquake depends upon the overburden pressure and the soil characteristics while the shear resistance is calculated based on the N-values and other soil properties for a maximum repeated strain of 2%.

8.1.2 The shear stress induced/developed and the shear resistance offered by the soil are evaluated in terms of the Cyclic Stress Ratio (CSR) and the Cyclic Resistance Ratio (CRR) respectively. The CSR is the ratio of the shear stress developed to the effective overburden pressure at various depths while the CRR is the ratio of the shear resistance of the soil to the effective overburden pressure at various depths. The analysis of variation of the CSR and the CRR with depth based on the results of each of the boreholes conducted, have been given in figs. C1 to C20 of this report.

8.1.3 The soil will liquefy in the depth zones where the CSR exceeds the CRR i.e. where the shear stress developed exceeds the shear resistance or in other words, where the factor of safety defined as the ratio of the CRR to CSR, is less than 1.

8.1.4 From the above analysis, it can be observed that subsoil down to about 10m depth is susceptible to liquefaction.

8.1.5 Considering the above and also that the site is located in Seismic Zone - IV of seismic zoning map of India, the subsoil down to about 10m depth has been considered to be susceptible to liquefaction. Hence shallow foundations are not feasible, the proposed structures shall have to be supported over ***Straight Bored Pile foundations***.

9.0 DESIGN CRITERIA

9.1 Design Parameters

9.1.1 The parameters required for the design of the foundation system for the proposed structures are:

a) Type of foundation to be adopted

b) Depth at which the foundations have to be laid

c) Allowable bearing pressure on the soil/rock at the foundation level

9.1.2 On the basis of the analysis of the results of the investigations, the required design parameters have been arrived at as given in the following sections.

9.2 Type of Foundation

9.2.1 The type of foundation depends upon the following :

a) Subsoil/rock conditions

b) Type of structure

c) Configuration of loading points

d) Loading intensity on each column at the foundation level

9.2.2 The proposed structures are Factory Buildings.

9.2.3 Considering the above, medium heavy loads can be anticipated on the foundations.

9.2.4 The results of the investigations have shown that the subsoil below the likely founding is in a loose to medium dense state down to about 9m depth below which the subsoil is medium dense state down to the depth investigated.

9.2.5 As mentioned in the earlier sections, the subsoil strata down to about 10m depth has been considered to be susceptible to liquefaction.

9.2.6 In view of the above, the proposed structures can be supported over ***Straight Bored Pile foundations.***

9.3 Depth of Pile Foundation

9.3.1 The minimum depth of pile foundations depends upon the following factors :

a) Top filled-up strata / loose soil, if any

b) Adequate depth of soil strata below the founding level of the pile foundations of requisite strength to mobilize the safe end bearing capacity

c) Adequate depth of soil strata above the founding level of the pile foundations of requisite strength to mobilize the safe friction capacity.

9.3.2 Taking the above into consideration, the pile foundations for the proposed structures shall be made to rest at a depth greater than 16m below the existing ground level. Accordingly,

considering the cut-off level of the piles as 1m below the existing ground level and effective length of piles of 15m, the founding levels of the piles will be about 16m below the existing ground level.

9.3.3 The soil encountered at the founding levels of the pile foundations has been considered to be ***Grey sand with traces of silt***

9.4 Pile Capacities

9.4.1 Load carrying capacities of bored pile foundation have been analysed and given for piles having various diameters and effective length.

9.4.2 The parameters considered for the analysis of the pile capacities are given below :

S. No.	Parameter	Value/s
1	Effective length (m)	15
2	Cohesion (kg/cm^2)	0.05
3	Angle of shearing resistance	26°
4	Submerged density (g/cm^3)	0.8
5	SPT Value at pile tip	20
6	Factor of safety	3

9.4.3 Considering the above parameters, the following safe pile capacities have been recommended for various diameters of 15m effective length of piles.

Pile Dia (mm)	*Pile Effective Length (m)*	*Pile Vertical Load Capacity (tons)*
450	15	20
600	15	40

9.4.4 As the subsoil down to about 10m depth below the existing ground level has been considered to be susceptible to liquefaction, the frictional component down to this depth has been neglected for evaluating the above recommended pile capacities.

9.4.5 The typical calculations of safe pile capacity and safe uplift pile capacity have been given in Appendix - A.

9.4.6 The group action of piles depends upon the number of piles in the group and their arrangement. Therefore, the efficiency factor for each pile group can be considered and checked as per the relevant BIS codes.

9.5 Special Note

9.5.1 The investigations have been conducted down to 10m depth below the existing ground level except for one borehole which has been progressed down to 13m depth below the existing ground level which is inadequate to provide the recommendations for Straight bored pile. As the piles of 15m effective length will rest at a depth of about 16m below the existing ground level, the recommendations for the same have been provided considering the similar subsoil conditions down to a minimum depth of about 20m below the existing ground level. However, for the confirmation of the subsoil conditions at deeper depths, conducting additional few boreholes down to a minimum depth of about 20m is advisable.

9.5.2 After reaching the required depth in the pile bore, 15cm thick layer of gravel should be placed and compacted at the bottom so that the slush formed at the bottom is diminished.

10.0 RECOMMENDATIONS

10.1 Type of Foundations

Straight Bored Pile foundations

10.2 Depth of Foundations

Considering the cut-of level of the piles as 1m below the existing ground level and for effective length of pile of 15m *, the pile shall rest at a depth of about 16m below the existing ground level.*

10.3 Safe Pile capacities

Pile Dia (mm)	*Pile Effective Length (m)*	*Pile Vertical Load Capacity (tons)*
450	15	20
600	15	40

10.4 Note

10.4.1 As the subsoil down to about 10m depth below the existing ground level has been considered to be susceptible to liquefaction, the frictional component down to this depth has been neglected for evaluating the pile capacities.

10.4.2 The above recommended safe pile capacities have been arrived at on the basis of provisions given in the BIS code IS:2911 (Part1/Sec2) - 2010 and can therefore, be used for design purposes. These pile capacities should be confirmed / validated by carrying out initial pile load test/s as per the provisions given in BIS code IS:2911 (Part-4) - 2013, prior to finalizing the working loads on the pile foundations.

10.4.3 For straight bored pile foundations, after reaching the required depth in the pile bore, 15cm thick layer of gravel should be placed and compacted at the bottom so that the slush formed at the bottom is diminished.

10.5 Appendices

10.5.1 An appendix sheet showing the typical analysis of vertical pile capacity and uplift pile capacity calculations have been given in Appendix - A of this report.

10.5.2 An appendix sheet showing the typical procedure for liquefaction analysis is given in Appendix -B of this report.

10.5.3 A list of IS Codes referred for providing the recommendations and that which might be required to implement the same is also enclosed in this report in Appendix - B.

10.6 NOTE

The recommendations given in this report have been arrived at on the basis of design parameters which have been judiciously adopted by giving due consideration to the results of field and laboratory investigations as well as NAGADI's experience of over four decades in working in various types of soil and rock conditions all over India.

10.7 LIMITATIONS

This geotechnical investigations have been carried out at locations in the site chosen by the clients so as to represent the entire site. The recommendations provided in this report are hence valid only for these test locations. However, if there is any change in subsoil conditions and properties at places between or beyond chosen test locations, fresh investigations will have to be carried out at such locations.

Dr. N. Santosh Rao

Technical Director

*For **Nagadi Consultants Pvt. Ltd***

Appendix -A

(refer para no. 10.5.1)

CALCULATIONS FOR PILE CAPACITY

A.1 Methodology

A.1.1 A typical calculation for the pile capacity has been given hereunder for a pile of diameter 'D' = 600mm and for a length of pile 'L' = 15m.

A.1.2 The pile is designed primarily as an end bearing cum friction pile.

A.1.3 The end bearing capacity has been determined based on observed N-values while the friction capacity has been determined as per the relevant provisions of the BIS code IS:2911(part1/sec4).

A.1.4 For determining the end bearing capacity, the N- value at the level of the pile tip has been taken as 20.

A.1.5 For determining the friction capacity, the average angle of shearing resistance ϕ has been taken as 26° and the frictional resistance developed in the top 10m length (i.e. L_1) of the pile foundation is neglected on account of the possibility of liquefaction of the subsoil.

A.2 DETERMINATION OF PILE CAPACITY

A.2.1 Pile end bearing capacity based on N-values

A.2.1.1 The ultimate end bearing capacity of the Bored pile foundation is determined as given below:

$$Q_{bu} = 13 \cdot N \cdot A_p$$

where N = N-value at the level of the pile tip

$A_p = \frac{\pi \cdot D^2}{4}$ = cross - sectional area of pile toe = 2827 cm^2

D = diameter of pile shaft = 600 mm

A.2.1.2 Therefore, the ultimate end bearing capacity of the bored pile foundation is :

Q_{bu} = 73.5 tons

A.2.2 Pile friction capacity based on IS:2911 (Part 1/Sec 4)

A.2.2.1 The ultimate friction capacity of the pile is :

$$Q_{fu} = \pi \cdot D \cdot (L - L_1) \cdot \alpha \cdot c + \sum_{1}^{n} K \cdot P_{Di} \cdot \tan\delta \cdot A_{si}$$

where c = cohesion of the soil along the pile shaft = 0.05 kg/cm^2

α = adhesion factor = 1

K = coefficient of earth pressure = 1

P_{Di} = effective overburden pressure at for the ith layer = $\gamma.d_i$

γ = submerged unit weight of soil below water table = 0.8 g/cm^3

d_i = depth of the ith layer from ground level

A_{si} = surface area of the pile stem in the ith layer

δ = angle of wall friction between pile and soil

= ϕ = angle of shearing resistance of the soil = 26^o

A.2.2.2 For calculation purposes, the submerged unit weight of the soil has been taken as the effective unit weight of the soil. The submerged unit weight considered is 0.8 g/cm^3.

A.2.2.3 As per the IS provisions, the effective overburden pressure P_{Di} is limited to a value equivalent to a depth of overburden equal to 15 times the diameter of the pile.

A.2.2.4 The skin friction capacity 'Q_{fu}' is determined as :

$$Q_{fu} = \pi \cdot d \cdot (L - L_1) \cdot \alpha \cdot c + K \cdot \tan\delta \cdot \left[\begin{array}{l} \frac{1}{2} \cdot (\gamma \cdot 15 \cdot D) \cdot (15 \cdot D) \cdot (\pi \cdot D) + \\ (\gamma \cdot 15 \cdot D) \cdot (L - 15 \cdot D) \cdot (\pi \cdot D) - \\ \frac{1}{2} \cdot (\gamma \cdot L_1) \cdot (L_1) \cdot (\pi \cdot D) \end{array} \right]$$

For $L_1 > 15$ *times the pile diameter D*

$$Q_{fu} = \pi \cdot D \cdot (L - L_1) \cdot \alpha \cdot c + K \cdot \tan\delta \cdot \left[(\gamma \cdot 15 \cdot D) \cdot (L - L_1) \cdot (\pi \cdot D) \right]$$

A.2.2.5 The skin friction capacity 'Q_{fu}' of the Bored pile foundation is :

Q_{fu} = 45.3 tons

A.3 SAFE PILE CAPACITY

A.3.1 The safe pile capacity is determined by applying appropriate factors of safety to the ultimate values determined above. A factor of safety of 3 has been adopted for determination of the safe pile capacity.

A.3.2 Therefore, the safe pile capacity of Bored pile foundation is :

$$Q_s = \frac{Q_{bu} + Q_{fu}}{3}$$

Hence,

Q_s = 39.6 tons say 40 tons

Appendix - B

(refer para no. 10.5.2)

STANDARD PROCEDURE FOR LIQUEFACTION ANALYSIS

(Reference : Annex F of IS 1893 Part 1- 2016)

B.1 EVALUATION OF CYCLIC STRESS RATIO (CSR)

$$CSR = (\tau_{av} / \sigma'_{vo}) = 0.65(a_{\max} / g).(\sigma_{vo} / \sigma'_{vo}).r_d \qquad \textit{(i)}$$

where, $r_d = (1.0 - 0.00765z), for, (z \le 9.15m)$

$r_d = (1.174 - 0.0267z), for, (9.15m < z \le 23m)$

B.2 EVALUATION OF LIQUEFACTION RESISTANCE (CRR)

$$CRR_{7.5} = f(N_1)_{60} \qquad \textit{(ii)}$$

$$\textit{i.e. } CRR_{7.5} = \frac{1}{34 - (N_1)_{60}} + \frac{(N_1)_{60}}{135} + \frac{50}{[10.(N_1)_{60} + 45]^2} - \frac{1}{200}$$

B.2.1. Influence of Fine Content

$(N_1)_{60cs} = \alpha + \beta(N_1)_{60}$

where, $\alpha = 0, for, (FC \le 5\%)$

$\alpha = \exp[1.76 - (190 / FC^2)], for, (5\% < FC < 35\%)$

$\alpha = 5, for, (FC \ge 35\%)$

$\beta = 1, for, (FC \le 5\%)$

$\beta = [0.99 + (FC^{1.5} / 1{,}000)], for, (5\% < FC < 35\%)$

$\beta = 1.2, for, (FC \ge 35\%)$

B.2.1. Other Corrections

$$(N_1)_{60} = N_m C_N C_E C_B C_R C_S$$

B.3 *NOTATIONS*

Notation	Description
CSR	Cyclic Stress Ratio
CRR	Cyclic Resistance Ratio
σ_{vo}	Total Vertical Overburden Stresses
σ'_{vo}	Effective vertical overburden stresses
τ_{av}	Average horizontal shear stress acting on soil layer during shaking generated by given earthquake
a_{max}	Peak horizontal acceleration at ground surface
g	Acceleration of gravity
r_d	Stress reduction coefficient to account for flexibility in soil profile
z	Depth below ground surface (m)
$CRR_{7.5}$	Cyclic resistance ratio for M_w = 7.5 earthquakes
$(N_1)_{60}$	Corrected standard penetration resistance
$(N_1)_{60cs}$	$(N_1)_{60}$ adjusted to equivalent clean-sand value
N_m	Measured standard penetration resistance
C_N	Correction factor for overburden pressure applied to SPT
C_E	Correction factor for hammer energy
C_B	Correction factor for borehole diameter
C_R	Correction factor for drilling rod length
C_S	Correction factor for split spoon sampler without liners
α, β	Coefficients, that are functions of fines content, used to correct $(N_1)_{60}$ to $(N_1)_{60cs}$

Appendix - C

(refer para no. 10.5.3)

LIST OF IS CODES

Field Investigation

1. IS : 1892 - 2021 : Code of practice for sub surface investigations for foundations (First revision)
2. IS : 2131 - 1981 : Method of Standard Penetration Tests for soils (First revision)
3. IS : 2132 - 1986 : Code of practice for thin walled tube sampling of soils (Second revision)

Laboratory Tests

1. IS : 2720 - 1983 (Part 1) : Methods of test for soils: Preparation of dry soil samples for various tests (Second revision)
2. IS : 2720 - 1980 (Part 2) : Method of test for soils: Determination of water content (Second revision) Amendment 1
3. IS : 2720 - 1980 (Part 3/sec 1) : Method of Test for Soils : Determination of Specific Gravity : Fine Grained Soils. (First Revision)
4. IS : 2720 - 1980 (Part 3/Sec 2) : Method of test for soils : Determination of Specific Gravity : Fine, Medium & Coarse grained soils. (First revision).

5.	IS : 2720 - 1985 (Part 4) :	Method of test for soils : Grain size analysis (Second revision)
6.	IS : 2720 (Part 8) -1983:	Determination of water content - dry density relation using heavy compaction. (First revision)
7.	IS : 2720 - 1985 (Part 5) :	Method of test for soils : Determination of liquid and plastic limit (Second revision)
8.	IS 2720-1981 Part 12:	Method of tests for soils : Determination of shear strength parameters using triaxial apparatus.
9.	IS : 2720 -1987 (Part 26):	Methods of tests for soils: Determination of pH value (Second revision).
10.	IS :2720 - 1977 (Part 27):	Methods of tests for soils: Determination of total soluble sulphate (First revision).

Foundation Construction

1.	IS : 2911 - 1979 (P1/Sec 1):	Code of practice for design and construction of pile foundations : concrete piles - Driven cast insitu (First revision) Amendment 2

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Job No. : G(D)4525

Sheet No. : C1

Analysis of Susceptibility to Liquefaction for Borehole BH1

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	5	1.70	1	1	0.75	1	6	97	5.00	1.200	12	**0.131**	***0.84***
2.4	0.24	1.250	0.998	**0.195**	9	1.52	1	1	0.8	1	11	5	0.00	1.000	11	**0.122**	***0.63***
3.9	0.24	1.471	0.997	**0.229**	7	1.30	1	1	0.85	1	8	3	0.00	1.000	8	**0.096**	***0.42***
5.4	0.24	1.591	0.996	**0.247**	6	1.16	1	1	0.95	1	7	3	0.00	1.000	7	**0.088**	***0.35***
6.9	0.24	1.667	0.995	**0.259**	7	1.06	1	1	0.95	1	7	4	0.00	1.000	7	**0.088**	***0.34***
8.4	0.24	1.719	0.994	**0.266**	11	0.98	1	1	0.95	1	10	2	0.00	1.000	10	**0.113**	***0.42***
9.9	0.24	1.757	0.910	**0.249**	18	0.92	1	1	1	1	17	4	0.00	1.000	17	**0.181**	***0.73***

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Job No. : G(D)4525

Sheet No. : C2

Analysis of Susceptibility to Liquefaction for Borehole BH2

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.038	0.999	**0.162**	5	1.70	1	1	0.8	1	7	93	5.00	1.200	13	**0.141**	***0.87***
3	0.24	1.388	0.998	**0.216**	12	1.43	1	1	0.85	1	15	5	0.00	1.000	15	**0.160**	***0.74***
4.5	0.24	1.552	0.997	**0.241**	15	1.25	1	1	0.95	1	18	2	0.00	1.000	18	**0.192**	***0.80***
6	0.24	1.646	0.995	**0.256**	14	1.12	1	1	0.95	1	15	2	0.00	1.000	15	**0.160**	***0.63***
7.5	0.24	1.708	0.994	**0.265**	16	1.03	1	1	0.95	1	16	3	0.00	1.000	16	**0.170**	***0.64***
9	0.24	1.751	0.993	**0.271**	21	0.96	1	1	1	1	20	2	0.00	1.000	20	**0.215**	***0.79***

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Job No. : G(D)4525

Sheet No. : C3

Analysis of Susceptibility to Liquefaction for Borehole BH3

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	8	1.70	1	1	0.75	1	10	40	5.00	1.200	17	**0.181**	***1.16***
2.4	0.24	1.250	0.998	**0.195**	12	1.52	1	1	0.8	1	15	29	4.64	1.146	22	**0.242**	***1.24***
3.9	0.24	1.471	0.997	**0.229**	13	1.30	1	1	0.85	1	14	4	0.00	1.000	14	**0.150**	***0.66***
5.4	0.24	1.591	0.996	**0.247**	15	1.16	1	1	0.95	1	17	2	0.00	1.000	17	**0.181**	***0.73***
6.9	0.24	1.667	0.995	**0.259**	14	1.06	1	1	0.95	1	14	3	0.00	1.000	14	**0.150**	***0.58***
8.4	0.24	1.719	0.994	**0.266**	15	0.98	1	1	0.95	1	14	2	0.00	1.000	14	**0.150**	***0.56***
9.9	0.24	1.757	0.910	**0.249**	20	0.92	1	1	1	1	18	3	0.00	1.000	18	**0.192**	***0.77***

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Job No. : G(D)4525

Sheet No. : C4

Analysis of Susceptibility to Liquefaction for Borehole BH4

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.270	0.999	**0.198**	8	1.70	1	1	0.8	1	11	94	5.00	1.200	18	**0.192**	***0.97***
3	0.24	1.565	0.998	**0.244**	11	1.49	1	1	0.85	1	14	13	1.89	1.037	16	**0.170**	***0.70***
4.5	0.24	1.690	0.997	**0.263**	14	1.29	1	1	0.95	1	17	3	0.00	1.000	17	**0.181**	***0.69***
6	0.24	1.759	0.995	**0.273**	19	1.15	1	1	0.95	1	21	3	0.00	1.000	21	**0.228**	***0.84***
7.5	0.24	1.803	0.994	**0.280**	19	1.05	1	1	0.95	1	19	3	0.00	1.000	19	**0.203**	***0.73***
9	0.24	1.833	0.993	**0.284**	22	0.97	1	1	1	1	21	2	0.00	1.000	21	**0.228**	***0.80***

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Sheet No. : C5

Analysis of Susceptibility to Liquefaction for Borehole BH5

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	9	1.70	1	1	0.75	1	11	4	0.00	1.000	11	**0.122**	***0.78***
2.4	0.24	1.357	0.998	**0.211**	11	1.55	1	1	0.8	1	14	7	0.12	1.009	14	**0.150**	***0.71***
3.9	0.24	1.556	0.997	**0.242**	15	1.33	1	1	0.85	1	17	4	0.00	1.000	17	**0.181**	***0.75***
5.4	0.24	1.660	0.996	**0.258**	17	1.18	1	1	0.95	1	19	3	0.00	1.000	19	**0.203**	***0.79***
6.9	0.24	1.725	0.995	**0.268**	20	1.07	1	1	0.95	1	20	2	0.00	1.000	20	**0.215**	***0.80***
8.4	0.24	1.769	0.994	**0.274**	22	0.99	1	1	0.95	1	21	3	0.00	1.000	21	**0.228**	***0.83***
9.9	0.24	1.801	0.910	**0.256**	20	0.93	1	1	1	1	19	9	0.56	1.017	20	**0.215**	***0.84***

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Sheet No. : C6

Analysis of Susceptibility to Liquefaction for Borehole BH6

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.388	0.999	**0.216**	9	1.70	1	1	0.8	1	12	97	5.00	1.200	19	**0.203**	***0.94***
3	0.24	1.646	0.998	**0.256**	7	1.51	1	1	0.85	1	9	4	0.00	1.000	9	**0.104**	***0.41***
4.5	0.24	1.751	0.997	**0.272**	15	1.31	1	1	0.95	1	19	5	0.00	1.000	19	**0.203**	***0.75***
6	0.24	1.808	0.995	**0.281**	18	1.17	1	1	0.95	1	20	3	0.00	1.000	20	**0.215**	***0.77***
7.5	0.24	1.844	0.994	**0.286**	10	1.06	1	1	0.95	1	10	84	5.00	1.200	17	**0.181**	***0.63***
9	0.24	1.868	0.993	**0.289**	21	0.98	1	1	1	1	21	2	0.00	1.000	21	**0.228**	***0.79***

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Sheet No. : C7

Analysis of Susceptibility to Liquefaction for Borehole BH7

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	10	1.70	1	1	0.75	1	13	5	0.00	1.000	13	**0.141**	***0.90***
2.4	0.24	1.481	0.998	**0.231**	7	1.60	1	1	0.8	1	9	4	0.00	1.000	9	**0.104**	***0.45***
3.9	0.24	1.649	0.997	**0.257**	10	1.36	1	1	0.85	1	12	3	0.00	1.000	12	**0.131**	***0.51***
5.4	0.24	1.735	0.996	**0.270**	19	1.20	1	1	0.95	1	22	2	0.00	1.000	22	**0.242**	***0.90***
6.9	0.24	1.787	0.995	**0.277**	21	1.09	1	1	0.95	1	22	2	0.00	1.000	22	**0.242**	***0.87***
8.4	0.24	1.822	0.994	**0.282**	22	1.00	1	1	0.95	1	21	3	0.00	1.000	21	**0.228**	***0.81***
9.9	0.24	1.847	0.910	**0.262**	24	0.94	1	1	1	1	22	2	0.00	1.000	22	**0.242**	***0.92***

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Job No. : G(D)4525

Sheet No. : C8

Analysis of Susceptibility to Liquefaction for Borehole BH8

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.270	0.999	**0.198**	8	1.70	1	1	0.8	1	11	97	5.00	1.200	18	**0.192**	***0.97***
3	0.24	1.565	0.998	**0.244**	9	1.49	1	1	0.85	1	11	5	0.00	1.000	11	**0.122**	***0.50***
4.5	0.24	1.690	0.997	**0.263**	14	1.29	1	1	0.95	1	17	3	0.00	1.000	17	**0.181**	***0.69***
6	0.24	1.759	0.995	**0.273**	15	1.15	1	1	0.95	1	16	3	0.00	1.000	16	**0.170**	***0.62***
7.5	0.24	1.803	0.994	**0.280**	13	1.05	1	1	0.95	1	13	2	0.00	1.000	13	**0.141**	***0.50***
9	0.24	1.833	0.993	**0.284**	20	0.97	1	1	1	1	19	3	0.00	1.000	19	**0.203**	***0.72***

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Job No. : G(D)4525

Sheet No. : C9

Analysis of Susceptibility to Liquefaction for Borehole BH9

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	5	1.70	1	1	0.75	1	6	90	5.00	1.200	12	**0.131**	***0.84***
2.4	0.24	1.396	0.998	**0.217**	12	1.57	1	1	0.8	1	15	4	0.00	1.000	15	**0.160**	***0.74***
3.9	0.24	1.586	0.997	**0.247**	16	1.34	1	1	0.85	1	18	2	0.00	1.000	18	**0.192**	***0.78***
5.4	0.24	1.685	0.996	**0.262**	20	1.19	1	1	0.95	1	23	2	0.00	1.000	23	**0.257**	***0.98***
6.9	0.24	1.746	0.995	**0.271**	20	1.08	1	1	0.95	1	21	2	0.00	1.000	21	**0.228**	***0.84***
8.4	0.24	1.787	0.994	**0.277**	21	1.00	1	1	0.95	1	20	3	0.00	1.000	20	**0.215**	***0.78***
9.9	0.24	1.816	0.910	**0.258**	22	0.93	1	1	1	1	20	2	0.00	1.000	20	**0.215**	***0.84***

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Job No. : G(D)4525

Sheet No. : C10

Analysis of Susceptibility to Liquefaction for Borehole BH10

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.038	0.999	**0.162**	7	1.70	1	1	0.8	1	10	97	5.00	1.200	17	**0.181**	***1.12***
3	0.24	1.388	0.998	**0.216**	2	1.43	1	1	0.85	1	2	70	5.00	1.200	7	**0.088**	***0.41***
4.5	0.24	1.552	0.997	**0.241**	7	1.25	1	1	0.95	1	8	11	1.21	1.026	9	**0.104**	***0.43***
6	0.24	1.646	0.995	**0.256**	8	1.12	1	1	0.95	1	9	5	0.00	1.000	9	**0.104**	***0.41***
7.5	0.24	1.708	0.994	**0.265**	17	1.03	1	1	0.95	1	17	3	0.00	1.000	17	**0.181**	***0.68***
9	0.24	1.751	0.993	**0.271**	23	0.96	1	1	1	1	22	2	0.00	1.000	22	**0.242**	***0.89***

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Job No. : G(D)4525

Sheet No. : C11

Analysis of Susceptibility to Liquefaction for Borehole BH11

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	4	1.70	1	1	0.75	1	5	97	5.00	1.200	11	**0.122**	***0.78***
2.4	0.24	1.320	0.998	**0.206**	14	1.54	1	1	0.8	1	17	15	2.50	1.048	20	**0.215**	***1.05***
3.9	0.24	1.526	0.997	**0.237**	9	1.32	1	1	0.85	1	10	7	0.12	1.009	10	**0.113**	***0.48***
5.4	0.24	1.637	0.996	**0.254**	15	1.18	1	1	0.95	1	17	4	0.00	1.000	17	**0.181**	***0.71***
6.9	0.24	1.705	0.995	**0.265**	17	1.07	1	1	0.95	1	17	3	0.00	1.000	17	**0.181**	***0.68***
8.4	0.24	1.752	0.994	**0.272**	19	0.99	1	1	0.95	1	18	3	0.00	1.000	18	**0.192**	***0.71***
9.9	0.24	1.786	0.910	**0.253**	23	0.92	1	1	1	1	21	2	0.00	1.000	21	**0.228**	***0.90***

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Job No. : G(D)4525

Sheet No. : C12

Analysis of Susceptibility to Liquefaction for Borehole BH12

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.079	0.999	**0.168**	6	1.70	1	1	0.8	1	8	94	5.00	1.200	15	**0.160**	***0.95***
3	0.24	1.421	0.998	**0.221**	6	1.44	1	1	0.85	1	7	54	5.00	1.200	13	**0.141**	***0.64***
4.5	0.24	1.578	0.997	**0.245**	9	1.26	1	1	0.95	1	11	7	0.12	1.009	11	**0.122**	***0.50***
6	0.24	1.668	0.995	**0.259**	15	1.13	1	1	0.95	1	16	3	0.00	1.000	16	**0.170**	***0.66***
7.5	0.24	1.726	0.994	**0.268**	18	1.03	1	1	0.95	1	18	3	0.00	1.000	18	**0.192**	***0.72***
9	0.24	1.767	0.993	**0.274**	21	0.96	1	1	1	1	20	3	0.00	1.000	20	**0.215**	***0.79***

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Job No. : G(D)4525

Sheet No. : C13

Analysis of Susceptibility to Liquefaction for Borehole BH13

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	5	1.70	1	1	0.75	1	6	97	5.00	1.200	12	**0.131**	***0.84***
2.4	0.24	1.284	0.998	**0.200**	3	1.52	1	1	0.8	1	4	9	0.56	1.017	5	**0.072**	***0.36***
3.9	0.24	1.498	0.997	**0.233**	16	1.31	1	1	0.85	1	18	3	0.00	1.000	18	**0.192**	***0.82***
5.4	0.24	1.613	0.996	**0.251**	16	1.17	1	1	0.95	1	18	4	0.00	1.000	18	**0.192**	***0.77***
6.9	0.24	1.686	0.995	**0.262**	19	1.06	1	1	0.95	1	19	3	0.00	1.000	19	**0.203**	***0.78***
8.4	0.24	1.735	0.994	**0.269**	21	0.98	1	1	0.95	1	20	3	0.00	1.000	20	**0.215**	***0.80***
9.9	0.24	1.771	0.910	**0.251**	27	0.92	1	1	1	1	25	2	0.00	1.000	25	**0.292**	***1.16***
11.4	0.24	1.799	0.870	**0.244**	28	0.87	1	1	1	1	24	2	0.00	1.000	24	**0.273**	***1.12***
12.9	0.24	1.820	0.830	**0.236**	24	0.82	1	1	1	1	20	2	0.00	1.000	20	**0.215**	***0.91***

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Job No. : G(D)4525

Sheet No. : C14

Analysis of Susceptibility to Liquefaction for Borehole BH14

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.122	0.999	**0.175**	5	1.70	1	1	0.8	1	7	94	5.00	1.200	13	**0.141**	***0.80***
3	0.24	1.455	0.998	**0.226**	7	1.45	1	1	0.85	1	9	4	0.00	1.000	9	**0.104**	***0.46***
4.5	0.24	1.604	0.997	**0.249**	9	1.26	1	1	0.95	1	11	3	0.00	1.000	11	**0.122**	***0.49***
6	0.24	1.690	0.995	**0.262**	14	1.14	1	1	0.95	1	15	3	0.00	1.000	15	**0.160**	***0.61***
7.5	0.24	1.745	0.994	**0.271**	21	1.04	1	1	0.95	1	21	3	0.00	1.000	21	**0.228**	***0.84***
9	0.24	1.783	0.993	**0.276**	23	0.96	1	1	1	1	22	2	0.00	1.000	22	**0.242**	***0.88***

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Job No. : G(D)4525

Sheet No. : C15

Analysis of Susceptibility to Liquefaction for Borehole BH15

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	5	1.70	1	1	0.75	1	6	91	5.00	1.200	12	**0.131**	***0.84***
2.4	0.24	1.481	0.998	**0.231**	11	1.60	1	1	0.8	1	14	14	2.20	1.042	17	**0.181**	***0.78***
3.9	0.24	1.649	0.997	**0.257**	17	1.36	1	1	0.85	1	20	5	0.00	1.000	20	**0.215**	***0.84***
5.4	0.24	1.735	0.996	**0.270**	19	1.20	1	1	0.95	1	22	2	0.00	1.000	22	**0.242**	***0.90***
6.9	0.24	1.787	0.995	**0.277**	21	1.09	1	1	0.95	1	22	2	0.00	1.000	22	**0.242**	***0.87***
8.4	0.24	1.822	0.994	**0.282**	23	1.00	1	1	0.95	1	22	2	0.00	1.000	22	**0.242**	***0.86***
9.9	0.24	1.847	0.910	**0.262**	25	0.94	1	1	1	1	23	2	0.00	1.000	23	**0.257**	***0.98***

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Job No. : G(D)4525

Sheet No. : C16

Analysis of Susceptibility to Liquefaction for Borehole BH16

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.217	0.999	**0.190**	9	1.70	1	1	0.8	1	12	10	0.87	1.022	13	**0.141**	***0.74***
3	0.24	1.526	0.998	**0.238**	15	1.47	1	1	0.85	1	19	4	0.00	1.000	19	**0.203**	***0.86***
4.5	0.24	1.660	0.997	**0.258**	15	1.28	1	1	0.95	1	18	5	0.00	1.000	18	**0.192**	***0.74***
6	0.24	1.735	0.995	**0.269**	19	1.15	1	1	0.95	1	21	2	0.00	1.000	21	**0.228**	***0.85***
7.5	0.24	1.783	0.994	**0.277**	17	1.05	1	1	0.95	1	17	2	0.00	1.000	17	**0.181**	***0.65***
9	0.24	1.816	0.993	**0.281**	21	0.97	1	1	1	1	20	3	0.00	1.000	20	**0.215**	***0.77***

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Job No. : G(D)4525

Sheet No. : C17

Analysis of Susceptibility to Liquefaction for Borehole BH17

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	4	1.70	1	1	0.75	1	5	97	5.00	1.200	11	**0.122**	***0.78***
2.4	0.24	1.396	0.998	**0.217**	10	1.57	1	1	0.8	1	13	15	2.50	1.048	16	**0.170**	***0.78***
3.9	0.24	1.586	0.997	**0.247**	7	1.34	1	1	0.85	1	8	9	0.56	1.017	9	**0.104**	***0.42***
5.4	0.24	1.685	0.996	**0.262**	11	1.19	1	1	0.95	1	12	3	0.00	1.000	12	**0.131**	***0.50***
6.9	0.24	1.746	0.995	**0.271**	17	1.08	1	1	0.95	1	17	2	0.00	1.000	17	**0.181**	***0.67***
8.4	0.24	1.787	0.994	**0.277**	4	1.00	1	1	0.95	1	4	67	5.00	1.200	10	**0.113**	***0.41***
9.9	0.24	1.816	0.910	**0.258**	25	0.93	1	1	1	1	23	2	0.00	1.000	23	**0.257**	***1.00***

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Job No. : G(D)4525

Sheet No. : C18

Analysis of Susceptibility to Liquefaction for Borehole BH18

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.079	0.999	**0.168**	8	1.70	1	1	0.8	1	11	95	5.00	1.200	18	**0.192**	***1.14***
3	0.24	1.421	0.998	**0.221**	10	1.44	1	1	0.85	1	12	35	5.00	1.200	19	**0.203**	***0.92***
4.5	0.24	1.578	0.997	**0.245**	7	1.26	1	1	0.95	1	8	4	0.00	1.000	8	**0.096**	***0.39***
6	0.24	1.668	0.995	**0.259**	16	1.13	1	1	0.95	1	17	3	0.00	1.000	17	**0.181**	***0.70***
7.5	0.24	1.726	0.994	**0.268**	21	1.03	1	1	0.95	1	21	5	0.00	1.000	21	**0.228**	***0.85***
9	0.24	1.767	0.993	**0.274**	22	0.96	1	1	1	1	21	3	0.00	1.000	21	**0.228**	***0.83***

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Job No. : G(D)4525

Sheet No. : C19

Analysis of Susceptibility to Liquefaction for Borehole BH19

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
0.9	0.24	1.000	0.999	**0.156**	4	1.70	1	1	0.75	1	5	96	5.00	1.200	11	**0.122**	***0.78***
2.4	0.24	1.438	0.998	**0.224**	10	1.58	1	1	0.8	1	13	11	1.21	1.026	15	**0.160**	***0.72***
3.9	0.24	1.617	0.997	**0.252**	12	1.35	1	1	0.85	1	14	7	0.12	1.009	14	**0.150**	***0.60***
5.4	0.24	1.710	0.996	**0.266**	14	1.20	1	1	0.95	1	16	2	0.00	1.000	16	**0.170**	***0.64***
6.9	0.24	1.766	0.995	**0.274**	20	1.08	1	1	0.95	1	21	2	0.00	1.000	21	**0.228**	***0.83***
8.4	0.24	1.804	0.994	**0.280**	23	1.00	1	1	0.95	1	22	2	0.00	1.000	22	**0.242**	***0.87***
9.9	0.24	1.832	0.910	**0.260**	22	0.93	1	1	1	1	21	2	0.00	1.000	21	**0.228**	***0.88***

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Sheet No. : C20

Analysis of Susceptibility to Liquefaction for Borehole BH20

Depth (m)	a_{max}/g	σ_{vo}/σ'_{vo}	r_d	CSR	N_{obs}	C_N	C_E	C_B	C_R	C_S	$(N)_{60}$	FC (%)	α	β	$(N)_{60CR}$	CRR	*FOS*
1.5	0.24	1.038	0.999	**0.162**	6	1.70	1	1	0.8	1	8	73	5.00	1.200	15	**0.160**	***0.99***
3	0.24	1.388	0.998	**0.216**	13	1.43	1	1	0.85	1	16	10	0.87	1.022	17	**0.181**	***0.84***
4.5	0.24	1.552	0.997	**0.241**	10	1.25	1	1	0.95	1	12	3	0.00	1.000	12	**0.131**	***0.54***
6	0.24	1.646	0.995	**0.256**	15	1.12	1	1	0.95	1	16	2	0.00	1.000	16	**0.170**	***0.67***
7.5	0.24	1.708	0.994	**0.265**	20	1.03	1	1	0.95	1	20	2	0.00	1.000	20	**0.215**	***0.81***
9	0.24	1.751	0.993	**0.271**	24	0.96	1	1	1	1	23	2	0.00	1.000	23	**0.257**	***0.95***

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.5m | Term. Depth : 10m | B.H. No.: 1

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg Limits		In-situ properties		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
5	0.9	Yellowish brown sandy clayey silt	0	3	70	27	48	26					
	1.5								1.88	25.0	-		
	2.2	Change of the strata											
9	2.4	Br. grey sand with traces of silt and gravel	3	92	5	0	Non	Plastic					
	3.0								1.90	20.7	-		
7	3.9	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	4.5								Sample	slip			
6	5.4	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	6.0								Sample	slip			
	6.4	Brownish grey clayey sandy silt											
7	6.9	Grey sand with traces of silt and gravel	2	94	4	0	Non	Plastic					
	7.5								Sample	slip			
11	8.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	9.0								Sample	slip			
18	10.0	Grey sand with traces of silt and gravel	18	78	4	0	Non	Plastic					
		Observed 'N' Values											

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Job No. G(D)4525

Sheet No. : 1

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.4m | Term. Depth : 10m | B.H. No.: 2

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.82	26.5			
5	1.5	Yellowish brown sandy clayey silt	0	7	71	22	39	26					
	2.0	Change of the strata											
	2.4								1.94	22.1	CD	0.02	25
12	3.0	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	3.9								Sample	slip			
15	4.5	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	5.4								Sample	slip			
14	6.0	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.9								Sample	slip			
16	7.5	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	8.4								Sample	slip			
21	9.0	Grey sand with traces of silt and gravel	6	92	2	0	Non	Plastic					
	10.0								Sample	slip			

Observed 'N' Values

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Job No. G(D)4525

Sheet No. : 2

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.5m | Term. Depth : 10m | B.H. No.: 3

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	Φ (°)
	0.0												
8	0.9	Yellowish brown clayey silty sand with gravel	2	58	32	8							
	1.5								1.69	5.1			
12	2.4	Grey silty sand	0	71	29	0	Non	Plastic					
	3.0	Change of the strata							1.64	22.4	CD	0.03	25
13	3.9	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	4.5								1.90	22.3			
15	5.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.0												
	6.4	Brownish grey clayey sandy silt							Sample	slip			
	6.6	Change of the strata											
14	6.9	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	7.5								Sample	slip			
15	8.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	9.0								Sample	slip			
20	10.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 3

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 1.9m | Term. Depth : 10m | B.H. No.: 4

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.90	25.4	CD	0.18	22
8	1.5	Yellowish brown sandy clayey silt	0	6	59	35	48	29					
	2.2	Change of the strata											
	2.4								1.95	27.1			
11	3.0	Grey sand with silt	0	87	13	0	Non	Plastic					
	3.9								1.89	18.9	CD	0.02	24
14	4.5	Grey sand with traces of silt and gravel	8	89	3	0	Non	Plastic					
	5.4								Sample	slip			
19	6.0	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	6.7	Brownish grey clayey sandy silt											
	6.9	Change of the strata							Sample	slip			
19	7.5	Grey sand with traces of silt and gravel	16	81	3	0	Non	Plastic					
	8.4								Sample	slip			
22	9.0	Grey sand with traces of silt and gravel	12	89	2	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 4

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.2m | Term. Depth : 10m | B.H. No.: 5

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0	Yellowish brown clayey sandy silt											
	0.5	Change of the strata											
9	0.9	Brownish grey sand with traces of silt	0	96	4	0	Non	Plastic					
	1.5								1.68	8.5			
11	2.4	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	3.0								1.88	22.6	CD	0.02	24
15	3.9	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	4.5								Sample	slip			
17	5.4	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	6.0								Sample	slip			
	6.6	Brownish grey clayey sandy silt											
20	6.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	7.5								Sample	slip			
22	8.4	Grey sand with traces of silt and gravel	7	90	3	0	Non	Plastic					
	9.0								Sample	slip			
20	10.0	Grey sand with traces of silt and gravel	12	79	9	0	Non	Plastic					

Observed ‘N’ Values

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Job No. : G(D)4525

Sheet No. : 5

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 1.7m | Term. Depth : 10m | B.H. No.: 6

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.98	30.5	CD	0.22	18
9	1.5	Yellowish brown sandy clayey silt	0	3	54	43	60	35					
	2.0	Change of the strata											
	2.4								1.92	18.6			
7	3.0	Brownish grey sand with traces of silt	0	96	4	0	Non	Plastic					
	3.4	Brownish grey clayey sandy silt											
	3.9	Change of the strata							1.96	36.6			
15	4.5	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	5.4								Sample	slip			
18	6.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	6.9								Sample	slip			
	7.3	Change of the strata											
10	7.5	Brownish grey sandy clayey silt with gravel	2	14	55	29	41	25					
	7.8	Change of the strata											
	8.4								Sample	slip			
21	9.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	10.0								Sample	slip			
		Observed ‘N’ Values											

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Job No. : G(D)4525

Sheet No. : 6

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 1.9m | Term. Depth : 10m | B.H. No.: 7

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	Φ (°)
	0.0	Yellowish brown clayey sandy silt											
10	0.9	Brownish grey sand with traces of silt	0	95	5	0	Non	Plastic					
	1.5								1.77	15.3	-	-	-
7	2.4	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	3.0								1.91	20.5	-	-	-
10	3.9	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	4.5								Sample	slip			
19	5.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.0												
	6.4	Brownish grey clayey sandy silt							Sample	slip			
	6.7	Change of the strata											
21	6.9	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	7.5								Sample	slip			
22	8.4	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	9.0								Sample	slip			
24	10.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					

Observed 'N' Values

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Job No. : G(D)4525

Sheet No. : 7

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 1.9m | Term. Depth : 10m | B.H. No.: 8

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.90	25.5	-	-	-
8	1.5	Yellowish brown sandy clayey silt	0	3	59	38	54	33					
	2.0	Change of the strata							1.96	25.5	-	-	-
	2.4												
9	3.0	Brownish grey sand with traces of silt	0	95	5	0	Non	Plastic					
	3.9								Sample	slip			
14	4.5	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	5.4								Sample	slip			
15	6.0	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	6.4	Brownish grey clayey sandy silt											
	6.7	Change of the strata							Sample	slip			
	6.9												
13	7.5	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	8.4								Sample	slip			
20	9.0	Grey sand with traces of silt and gravel	4	93	3	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 8

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.1m | Term. Depth : 10m | B.H. No.: 9

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	Φ (°)
	0.0												
5	0.9	Yellowish brown sandy clayey silt	0	10	71	19	39	24					
	1.3	Change of the strata							1.90	22.9			
	1.5												
12	2.4	Brownish grey sand with traces of silt	0	96	4	0	Non	Plastic					
	3.0								1.94	22.6	CD	0.02	25
16	3.9	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	4.5								Sample	slip			
20	5.4	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	6.0								Sample	slip			
	6.5	Brownish grey clayey sandy silt											
	6.7	Change of the strata											
20	6.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	7.5								Sample	slip			
21	8.4	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	9.0								Sample	slip			
22	10.0	Grey sand with traces of silt and gravel	4	94	2	0	Non	Plastic					

Observed 'N' Values

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Job No. : G(D)4525

Sheet No. : 9

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.4m | Term. Depth : 10m | B.H. No.: 10

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	ϕ (°)
	0.0												
	0.9								1.91	27.9	-	-	-
7	1.5	Yellowish brown sandy clayey silt	0	3	69	28	50	30					
	2.4								1.92	23.4	-	-	-
2	3.0	Yellowish brown clayey sandy silt	0	29	63	8	28	19					
	3.9	Change of the strata							1.88	18.9	-	-	-
7	4.5	Brownish grey sand with silt and gravel	3	86	11	0	Non	Plastic					
	5.4								Sample	slip			
8	6.0	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	6.5	Brownish grey clayey sandy silt											
	6.8	Change of the strata											
	6.9								Sample	slip			
17	7.5	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	8.4								Sample	slip			
23	9.0	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	10.0								Sample	slip			

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Sheet No. : 10

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.3m | Term. Depth : 10m | B.H. No.: 11

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
4	0.9	Yellowish brown sandy clayey silt	0	3	72	25	44	27					
	1.5	Change of the strata							1.90	27.5	-	-	-
14	2.4	Brownish grey sand with silt	0	85	15	0	Non	Plastic					
	3.0								1.89	24.2	-	-	-
9	3.9	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	4.5								Sample	slip			
15	5.4	Grey sand with traces of silt and gravel	2	94	4	0	Non	Plastic					
	6.0								Sample	slip			
	6.6	Brownish grey clayey sandy silt											
17	6.9	Br. grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	7.5								Sample	slip			
19	8.4	Grey sand with traces of silt and gravel	7	90	2	0	Non	Plastic					
	9.0								Sample	slip			
23	10.0	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					

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Job No. : G(D)4525

Sheet No. : 11

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.3m | Term. Depth : 10m | B.H. No.: 12

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	ϕ (°)
	0.0												
	0.9								1.86	26.0	-	-	-
6	1.5	Yellowish brown sandy clayey silt with gravel	2	4	68	26	47	29					
	2.4								1.92	25.9	-	-	-
6	3.0	Brownish grey clayey sandy silt	0	46	48	6	24	18					
	3.5	Change of the strata											
	3.9								Sample	slip			
9	4.5	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	5.4								Sample	slip			
15	6.0	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	6.7	Brownish grey clayey sandy silt							Sample	slip			
	6.9	Change of the strata											
18	7.5	Grey sand with traces of silt and gravel	4	93	3	0	Non	Plastic					
	8.4								Sample	slip			
21	9.0	Grey sand with traces of silt and gravel	8	89	3	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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Job No. G(D)4525

Sheet No. : 12

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.4m | Term. Depth : 13m | B.H. No.: 13

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	Φ (°)
	0.0												
5	0.9	Yellowish brown sandy clayey silt	0	3	72	25	44	25					
	1.5								1.86	24.8	-	-	-
3	2.4	Brownish grey sand with traces of silt	0	91	9	0	Non	Plastic					
	3.0								1.93	20.6	-	-	-
16	3.9	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	4.5								Sample	slip			
16	5.4	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	6.0								Sample	slip			
	6.3	Brownish grey clayey sandy silt											
	6.7	Change of the strata											
19	6.9	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	7.5								Sample	slip			
21	8.4	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	9.0								Sample	slip			
27	9.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	10.5								Sample	slip			
28	11.4	Grey sand with traces of silt	0	96	2	0	Non	Plastic					
	12.0								Sample	slip			
34	13.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					

Observed 'N' Values

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Job No. : G(D)4525

Sheet No. : 13

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.2m | Term. Depth : 10m | B.H. No.: 14

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.87	25.3	-	-	-
5	1.5	Yellowish brown sandy clayey silt	0	6	67	27	44	27					
	2.0	Change of the strata											
	2.4								1.89	18.3	-	-	-
7	3.0	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	3.9								Sample	slip			
9	4.5	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	5.4								Sample	slip			
14	6.0	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	6.4	Brownish grey clayey sandy silt											
	6.6	Change of the strata											
	6.9								Sample	slip			
21	7.5	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	8.4								Sample	slip			
23	9.0	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 14

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 1.9m | Term. Depth : 10m | B.H. No.: 15

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
5	0.9	Yellowish brown sandy clayey silt	3	6	65	26	47	28					
	1.5								1.88	27.2			
	1.8	Change of the strata											
11	2.4	Brownish grey sand with silt	0	86	14	0	Non	Plastic					
	3.0								1.97	19.5	CD	0.03	26
17	3.9	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	4.5								Sample	slip			
19	5.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.0								Sample	slip			
	6.7	Brownish grey clayey sandy silt											
21	6.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	7.5								Sample	slip			
23	8.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	9.0								Sample	slip			
25	10.0	Grey sand with traces of silt	0	98	2	0	Non	Plastic					

Observed 'N' Values

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Job No. : G(D)4525

Sheet No. : 15

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2m | Term. Depth : 10m | B.H. No.: 16

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water	Type	c (kg/cm^2)	ϕ (°)
	0.0	Yellowish brown clayey sandy silt											
	0.9								1.88	25.5	-	-	-
9	1.5	Brownish grey sand with traces of silt	0	98	2	0	Non	Plastic					
	2.4								1.93	23.0	-	-	-
15	3.0	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	3.9								Sample	slip			
15	4.5	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	5.4								Sample	slip			
19	6.0	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	6.5	Brownish grey clayey sandy silt											
	6.7	Change of the strata							Sample	slip			
	6.9												
17	7.5	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	8.4								Sample	slip			
21	9.0	Grey sand with traces of silt and gravel	8	89	3	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 16

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.1m | Term. Depth : 10m | B.H. No.: 17

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	ϕ (°)
	0.0												
4	0.9	Yellowish brown sandy clayey silt	0	3	71	26	42	28					
	1.5	Change of the strata							1.89	26.7	-	-	-
10	2.4	Grey sand with silt	0	85	15	0	Non	Plastic					
	3.0								1.88	22.9	-	-	-
7	3.9	Grey sand with traces of silt	0	91	9	0	Non	Plastic					
	4.5								Sample	slip			
11	5.4	Grey sand with traces of silt and gravel	3	94	3	0	Non	Plastic					
	6.0								Sample	slip			
	6.4	Brownish grey clayey sandy silt											
	6.6	Change of the strata											
17	6.9	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	7.5								Sample	slip			
	8.0	Change of the strata											
4	8.4	Brownish grey clayey sandy silt	0	33	42	25	30	21					
	9.0	Change of the strata							2.09	15.9			
25	10.0	Grey sand with traces of silt and gravel	4	94	2	0	Non	Plastic					
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 17

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.3m | Term. Depth : 10m | B.H. No.: 18

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
	0.9								1.95	26.2	-	-	-
8	1.5	Yellowish brown sandy clayey silt	0	5	70	25	41	26					
	2.0	Change of the strata											
	2.4								1.97	23.4	-	-	-
10	3.0	Brownish grey silty sand	0	65	35	0	Non	Plastic					
	3.5	Change of the strata											
	3.9								Sample	slip			
7	4.5	Grey sand with traces of silt	0	96	4	0	Non	Plastic					
	5.4								Sample	slip			
16	6.0	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	6.7	Brownish grey clayey sandy silt											
	6.9	Change of the strata							Sample	slip			
21	7.5	Grey sand with traces of silt	0	95	5	0	Non	Plastic					
	8.4								Sample	slip			
22	9.0	Grey sand with traces of silt and gravel	2	95	3	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 18

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2m | Term. Depth : 10m | B.H. No.: 19

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	Φ (°)
	0.0												
4	0.9	Yellowish brown sandy clayey sil	0	4	68	28	46	27					
	1.5								1.87	26.9			
10	2.4	Brownish grey sand with traces of silt	0	89	11	0	Non	Plastic					
	3.0								1.96	24.1	CD	0.02	24
12	3.9	Grey sand with traces of silt	0	93	7	0	Non	Plastic					
	4.5								Sample	slip			
14	5.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	6.0								Sample	slip			
	6.4	Brownish grey clayey sandy silt											
	6.6	Change of the strata											
20	6.9	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	7.5								Sample	slip			
23	8.4	Grey sand with traces of silt	0	98	2	0	Non	Plastic					
	9.0								Sample	slip			
22	10.0	Grey sand with traces of silt	0	96	2	0	Non	Plastic					
		Observed 'N' Values											

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Job No. : G(D)4525

Sheet No. : 19

SOIL PROFILE

Project : Proposed UPSIDC Mega Food Park Baheri Bareily, Uttar Pradesh

B.H. Location : | Water Table : 2.4m | Term. Depth : 10m | B.H. No.: 20

N - Value	Depth (m)	Soil Description	Grain Size Analysis				Atterberg		In-situ		Triaxial Test		
			Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Liquid (%)	Plastic (%)	Density (g/cm^3)	Water Cont (%)	Type	c (kg/cm^2)	ϕ (°)
	0.0												
	0.9								1.90	23.5	-	-	-
6	1.5	Yellowish brown clayey sandy silt	0	27	64	9	31	21					
	2.0	Change of the strata											
	2.4								1.92	23.2	-	-	-
13	3.0	Grey sand with traces of silt and gravel	2	88	10	0	Non	Plastic					
	3.9								1.91	22.3	-	-	-
10	4.5	Grey sand with traces of silt	0	97	3	0	Non	Plastic					
	5.0	Brownish grey clayey sandy silt											
	5.4	Change of the strata							Sample	slip			
15	6.0	Grey sand with traces of silt and gravel	2	96	2	0	Non	Plastic					
	6.9								Sample	slip			
20	7.5	Grey sand with traces of silt and gravel	3	95	2	0	Non	Plastic					
	8.4								Sample	slip			
24	9.0	Grey sand with traces of silt sand gravel	3	95	2	0	Non	Plastic					
	10.0								Sample	slip			
		Observed 'N' Values											

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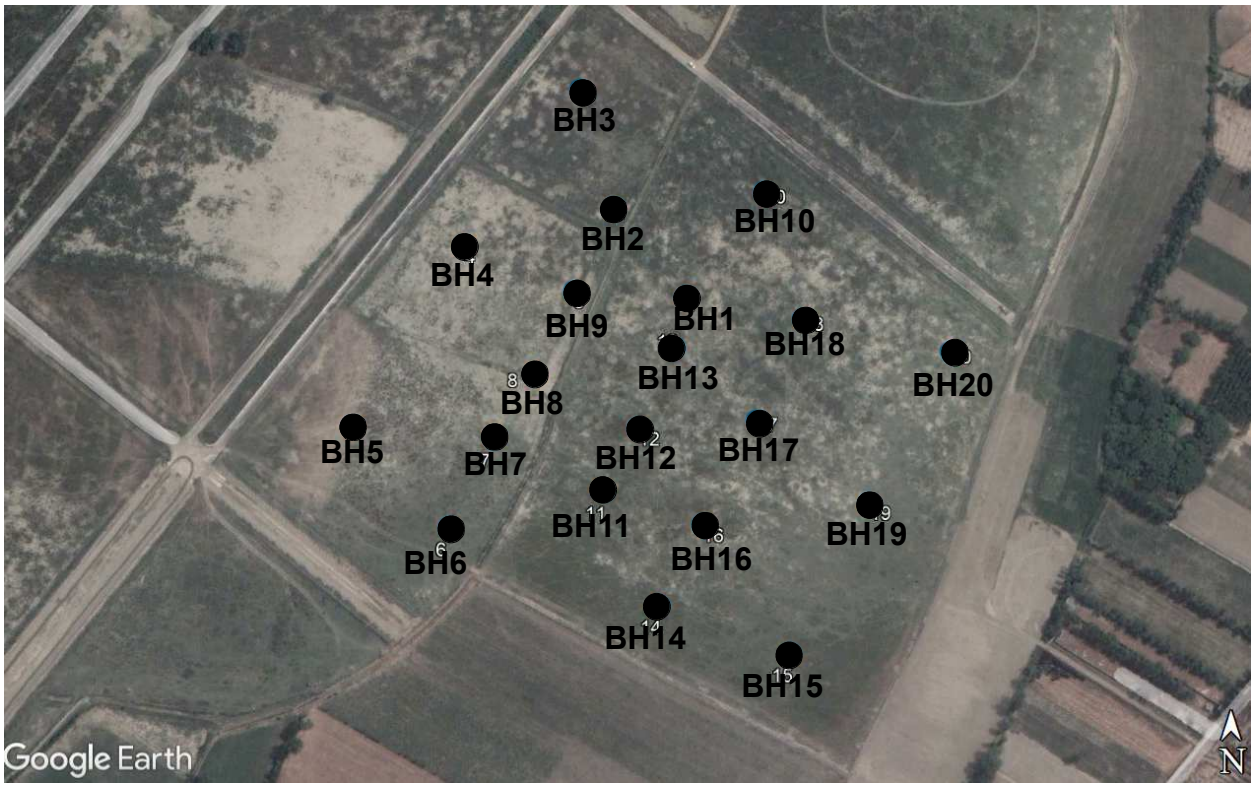
Sheet No. : 20



Legend

● Borehole (BH)

SCHEMATIC SITE PLAN

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Job No. : G(D)4525

Sheet No. : 1a

PHOTOGRAPH SHOWING
VIEW OF THE SITE & BOREHOLE UNDER PROGRESS

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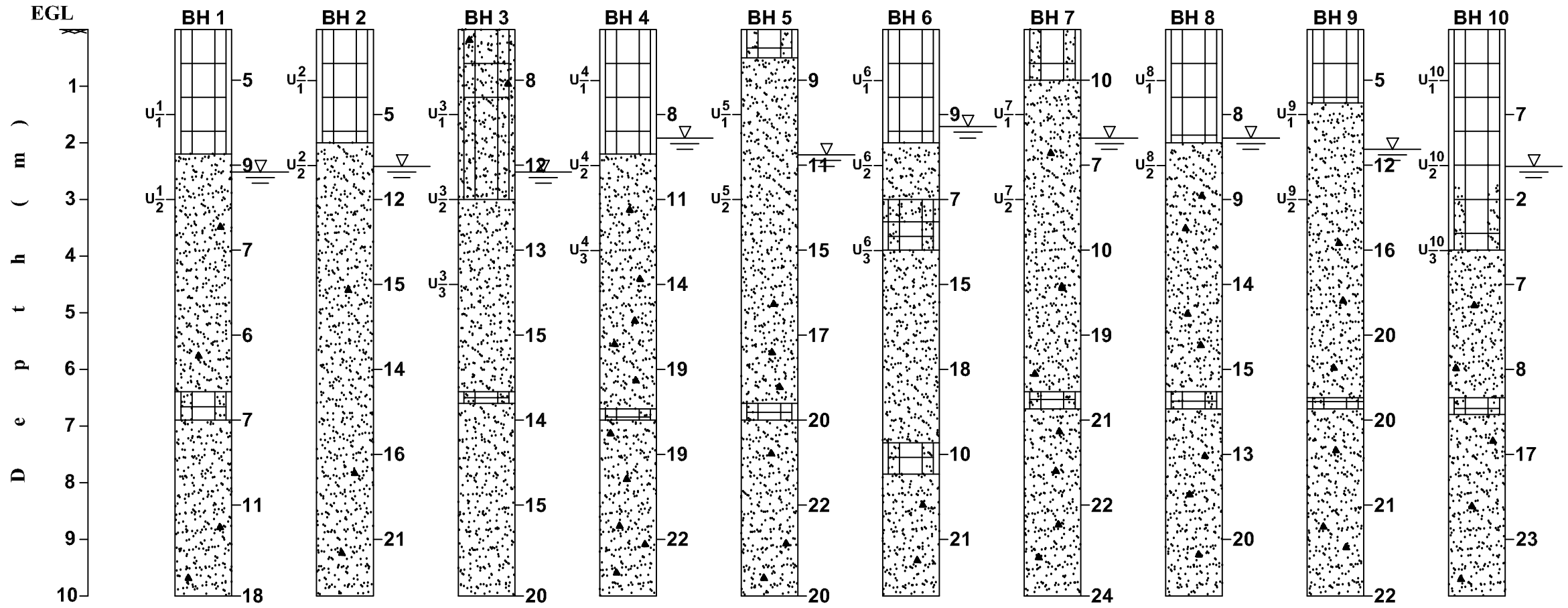
Job No. : G(D)4525

Sheet No. : 1b



LEGEND

Yellowish brown clayey sandy silt with occasional gravel / sandy clayey silt
(6-43)% (3-46)% (32-71)% (0-2)%

Grey/ brownish grey sand with silt and occasional gravel/ sand with silt
(78-98)% (2-15)% (0-4)%

Brownish grey silty sand with occasional clay and gravel
(29-35)% (58-71)% (0-8)% (0-2)%

22 Observed ' N ' Values

U_2^1 2nd undisturbed soil sample of BH 1

Ground Water table has been encountered as on February 2023

COMPILED SOIL PROFILE

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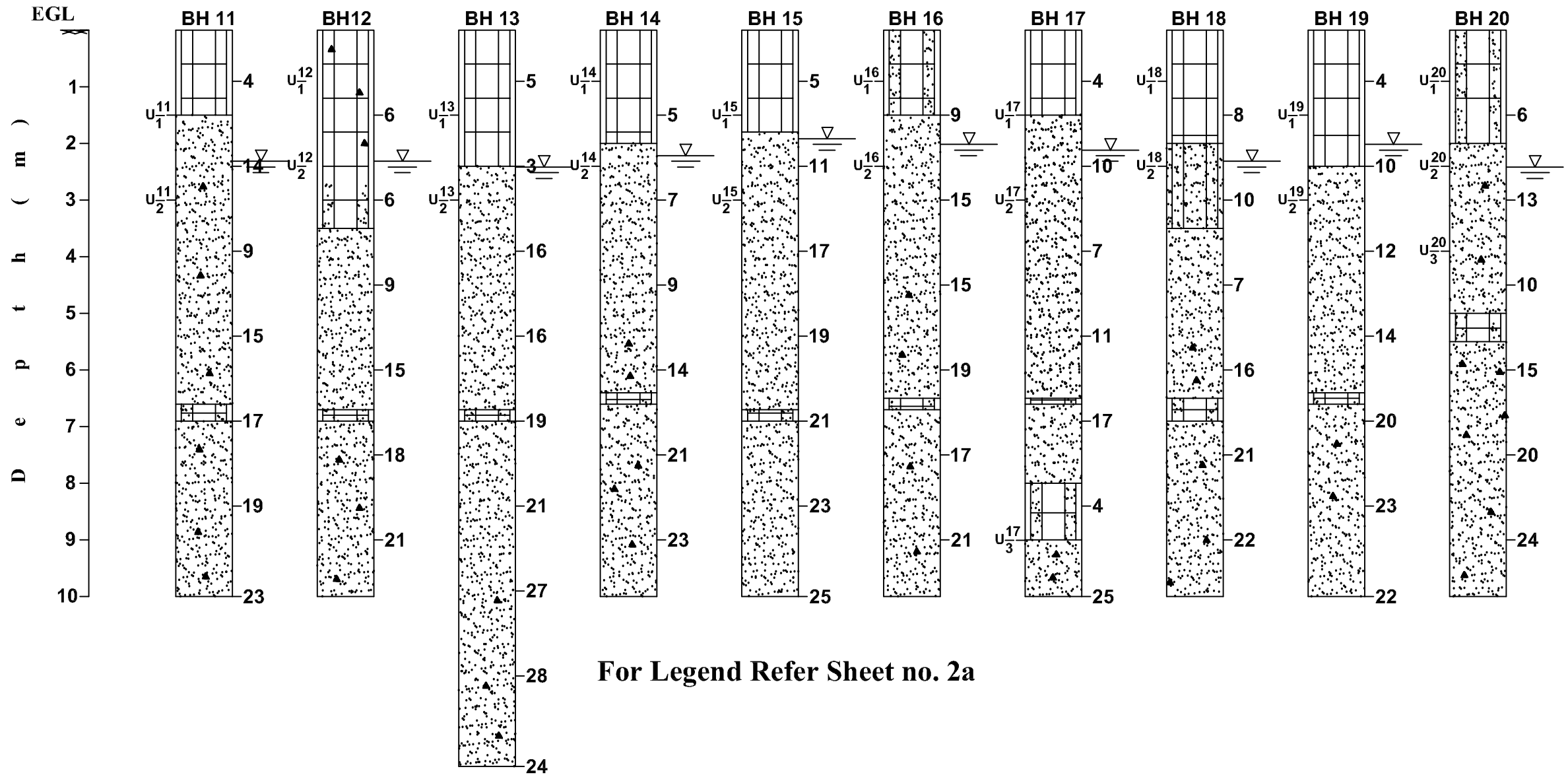
GEOTECHNICAL INVESTIGATION FOR THE PROPOSED UPSIDC MEGA FOOD PARK AT BAHERI BAREILY, UTTAR PRADESH

Job No: G(D) 4525

Sheet No: 2a



For Legend Refer Sheet no. 2a

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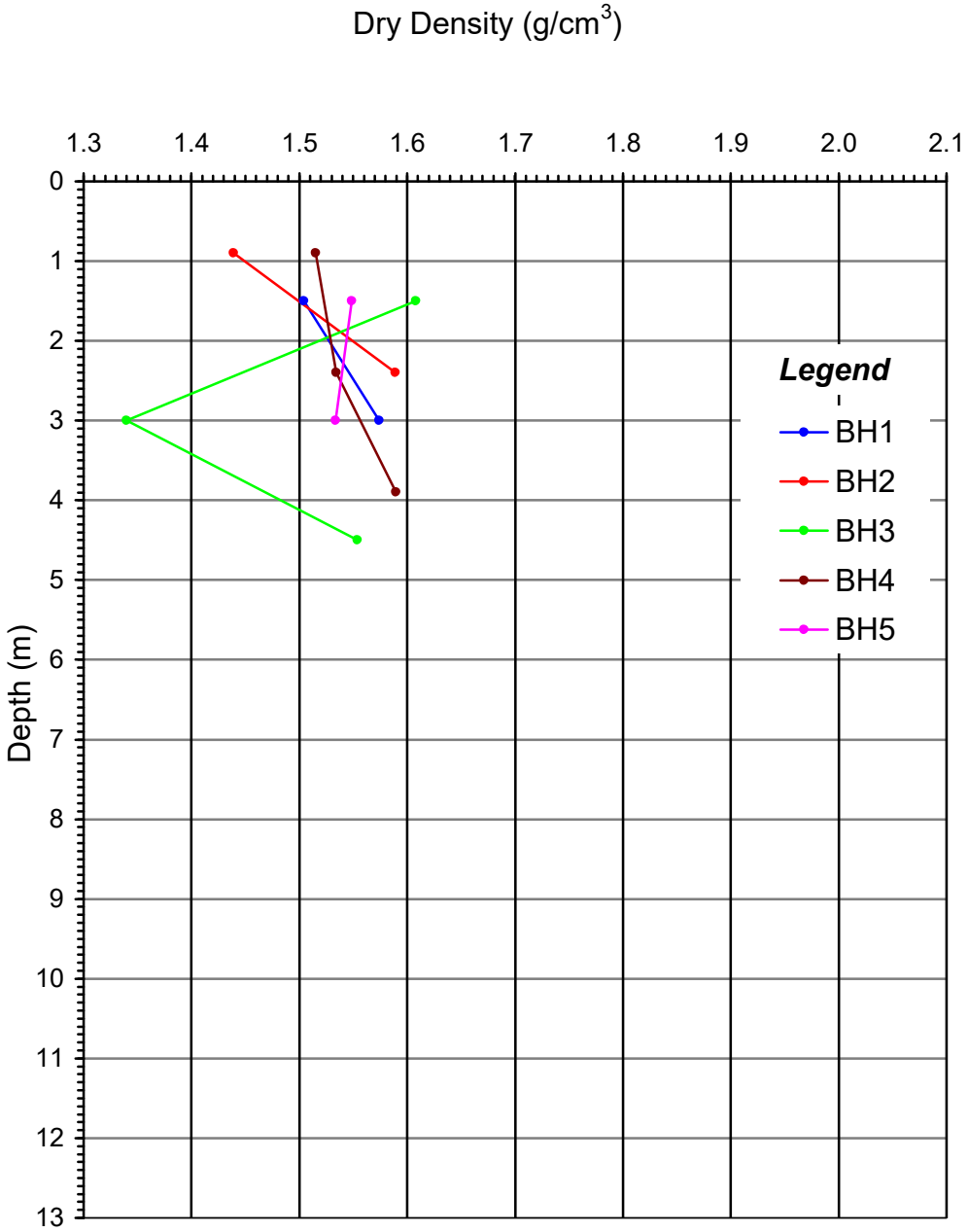
GEOTECHNICAL INVESTIGATION FOR THE PROPOSED UPSIDC MEGA FOOD PARK AT BAHERI BAREILY, UTTAR PRADESH

Job No: G(D) 4525

Sheet No: 2b



Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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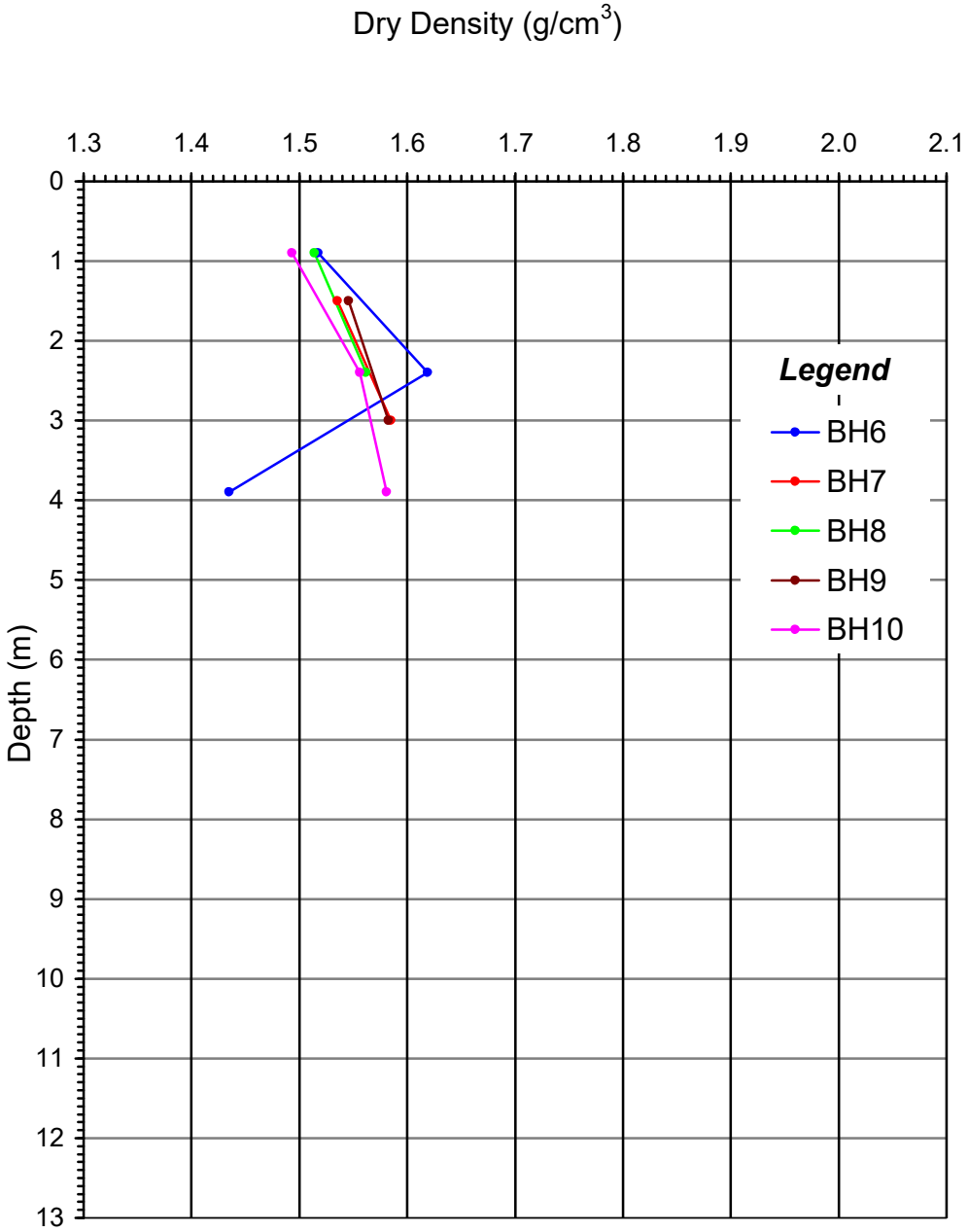
Job No. G(D)4525

Sheet No. : 3a



Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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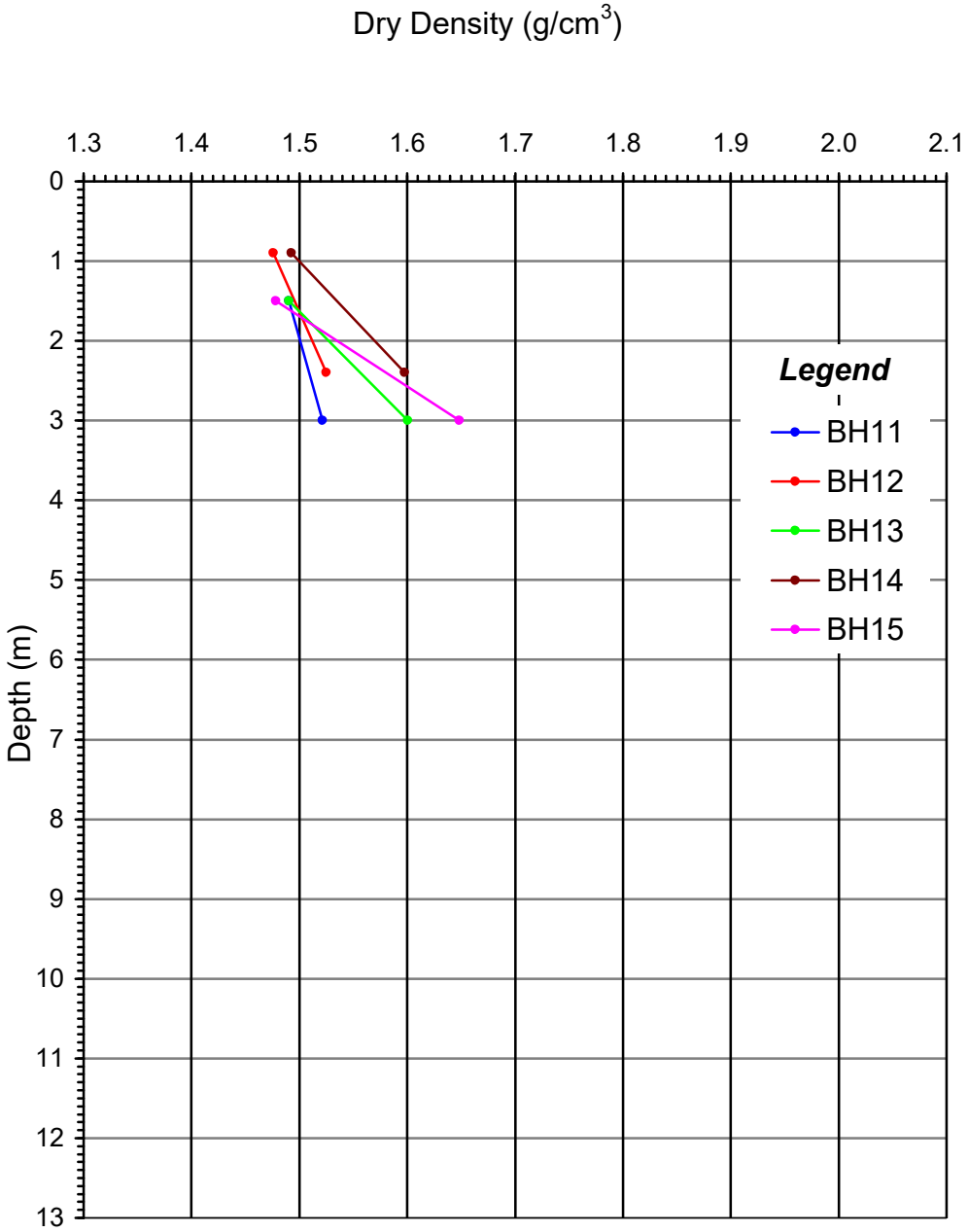
Job No. G(D)4525

Sheet No. : 3b



Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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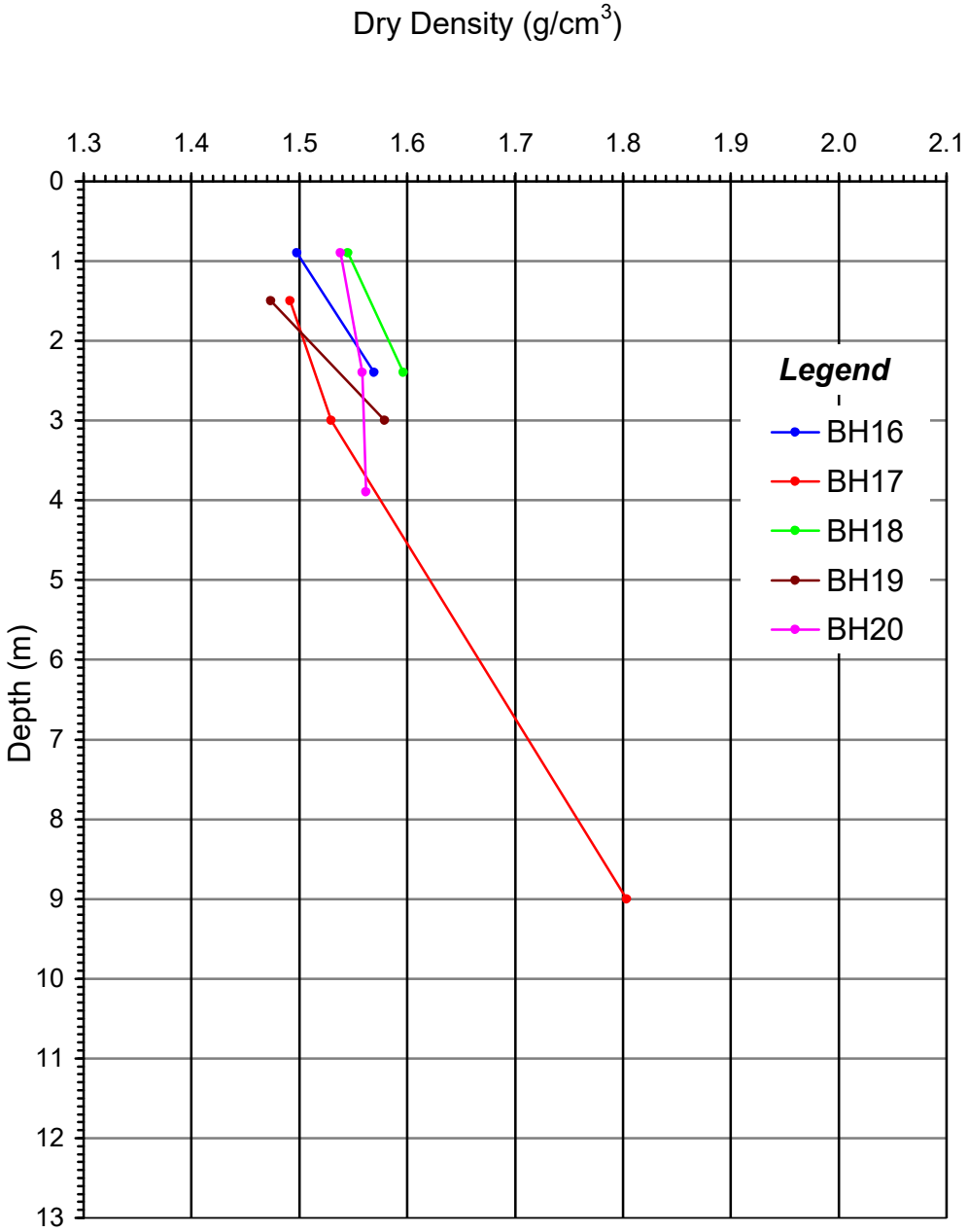

Dry Density vs Depth Curves

(Refer paragraph no. 7.4.2)

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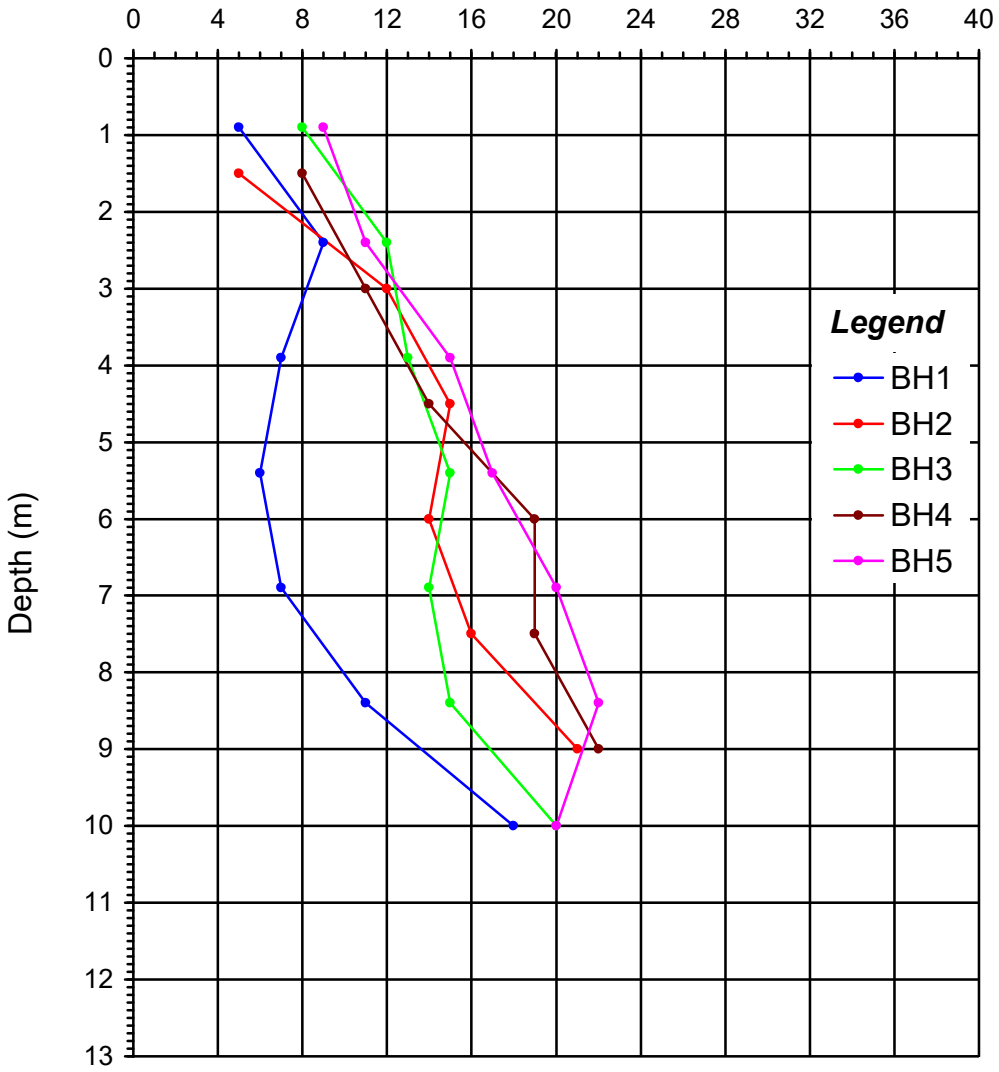
Job No. G(D)4525

Sheet No. : 3d

N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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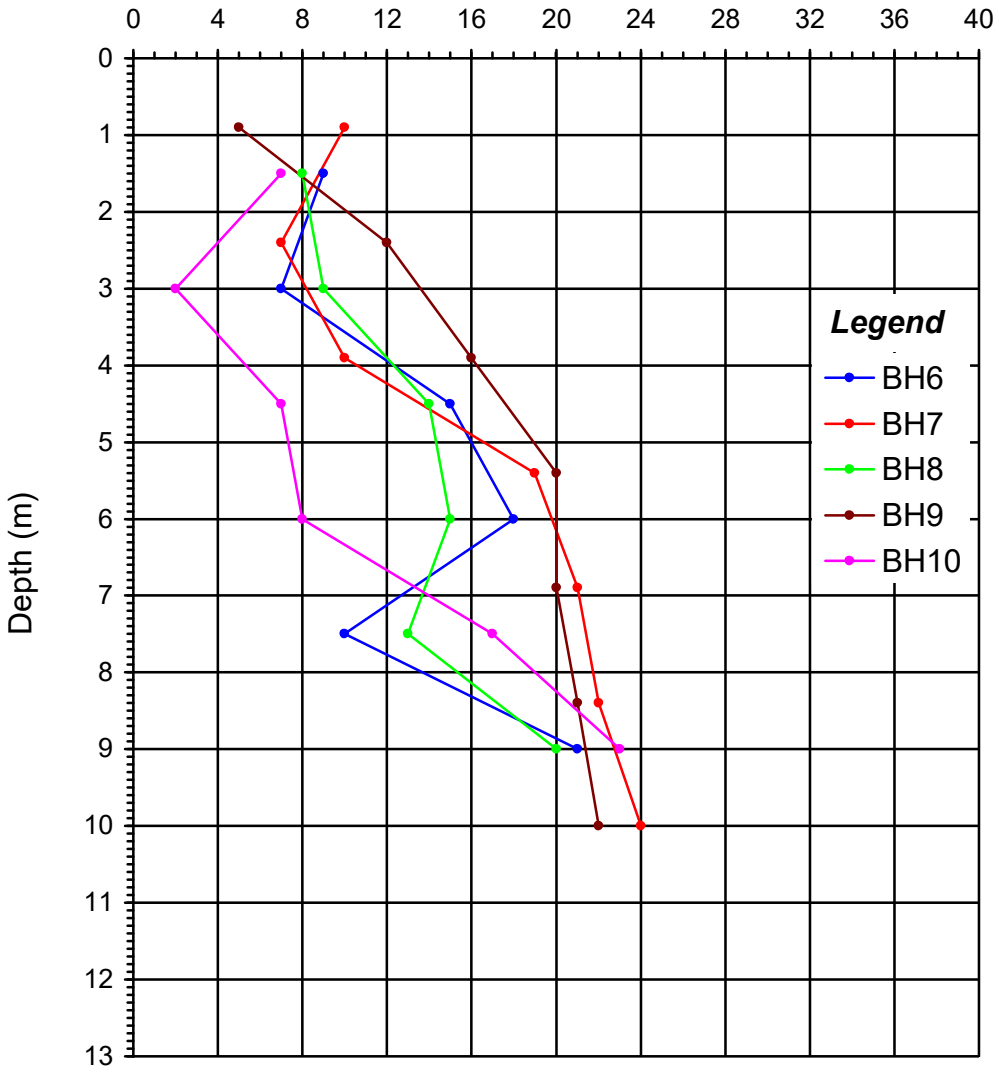
Job No. : G(D)4525

Sheet No. : 4a

N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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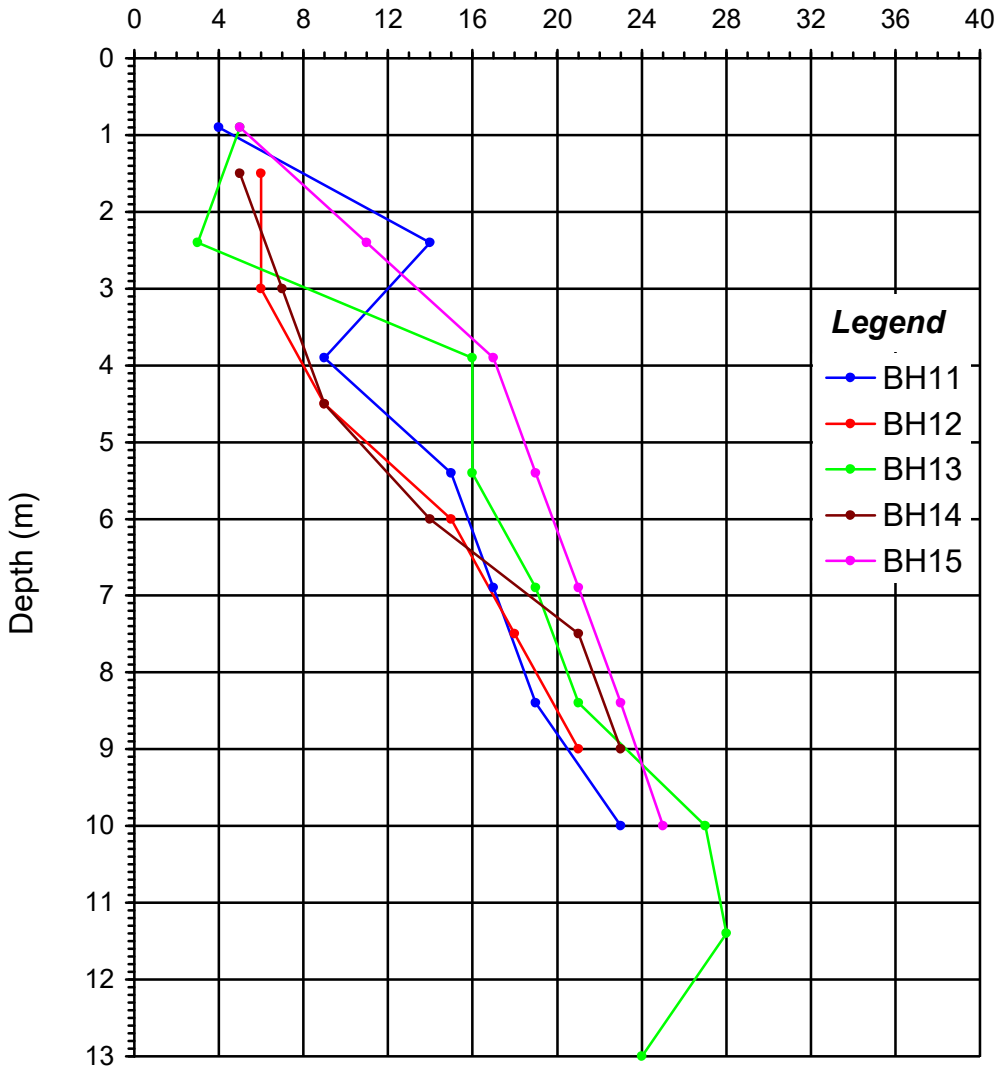
Job No. : G(D)4525

Sheet No. : 4b

N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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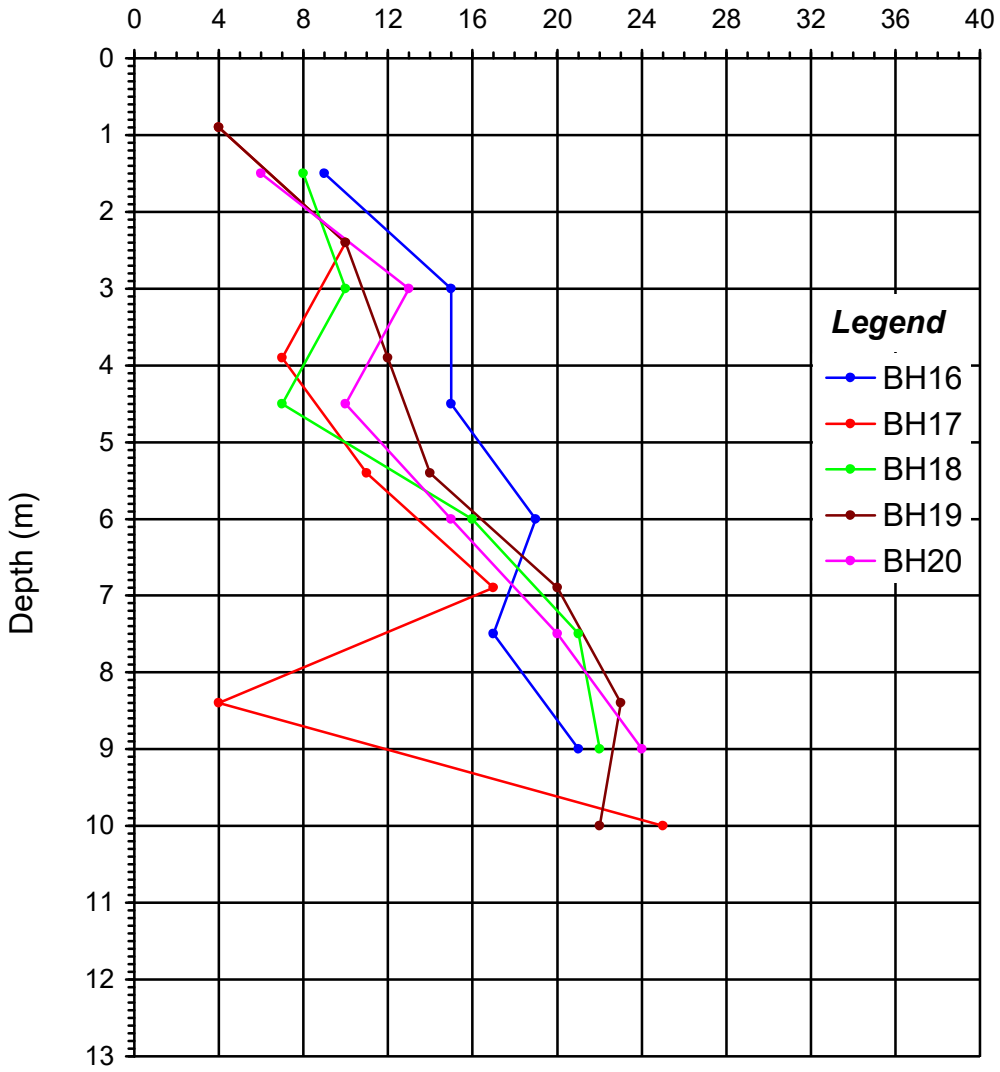
Job No. : G(D)4525

Sheet No. : 4c

N - Values (Observed)



N - Values vs Depth Curves

(Refer paragraph no. 7.6.1)

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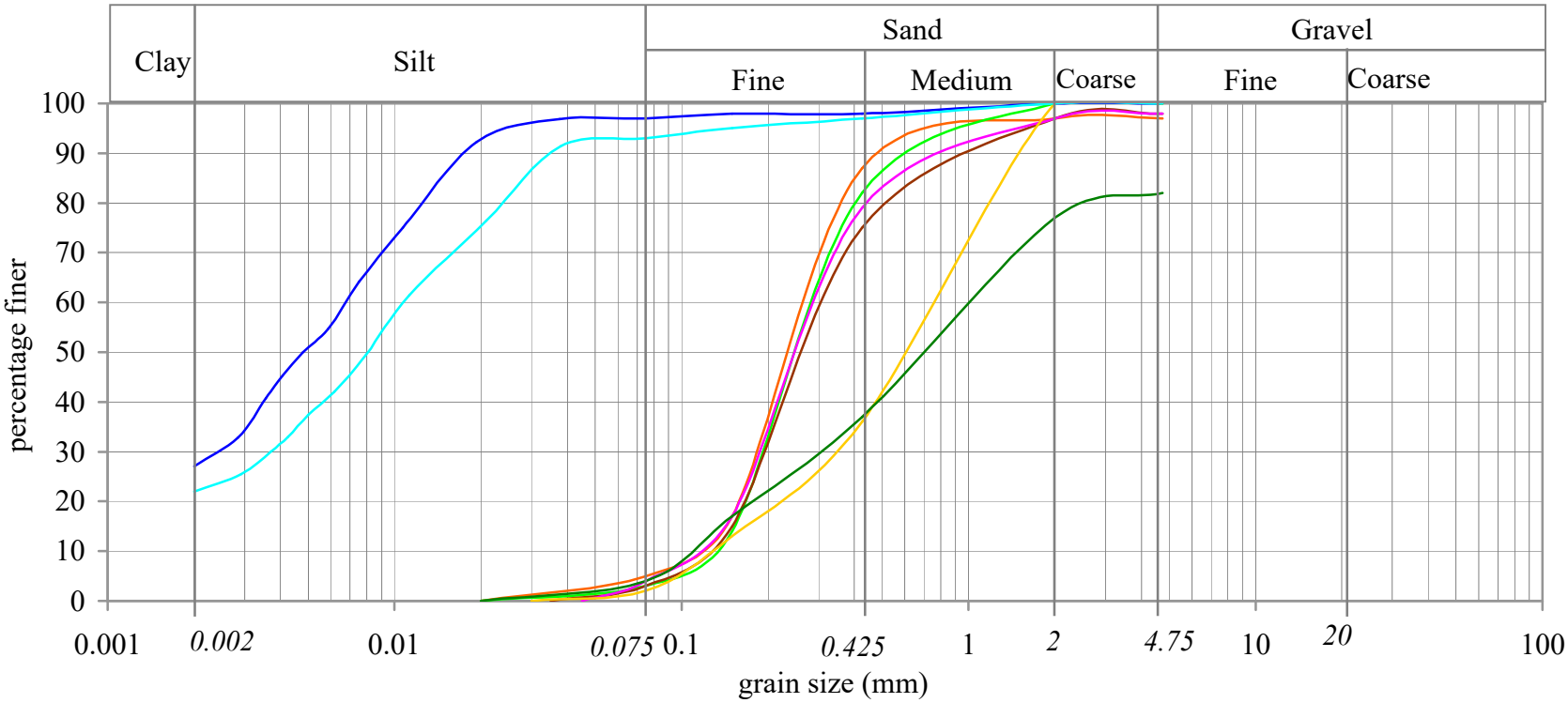
Job No. : G(D)4525

Sheet No. : 5a

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	1	0.9	Sandy clayey silt	0	3	70	27	0.0069	-	-
	1	2.4	Sand with traces of silt and gravel	3	92	5	0	0.026	0.13	0.2
	1	3.9	Sand with traces of silt	0	97	3	0	0.027	0.13	0.2
	1	5.4	Sand with traces of silt and gravel	2	95	3	0	0.31	0.12	2.6
	1	6.9	Sand with traces of silt and gravel	2	94	4	0	0.29	0.13	2.2
	1	8.4	Sand with traces of silt	0	98	2	0	0.75	0.14	5.4
	1	10	Sand with traces of silt and gravel	18	78	4	0	1	0.14	7.1
	2	1.5	Sandy clayey silt	0	7	71	22	0.011	0.13	0.1

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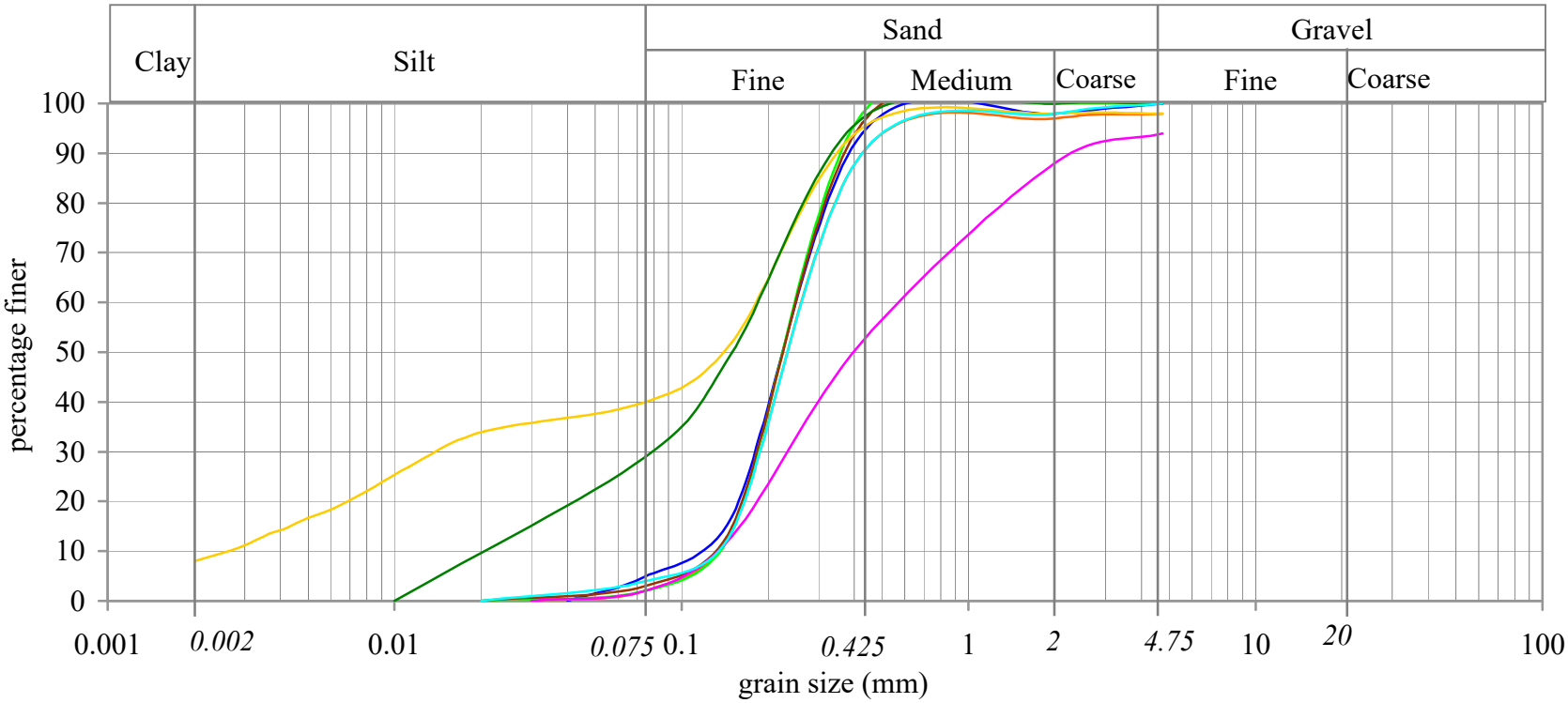
Job No. : G(D)4525

Sheet No. : 5b

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	2	3	Sand with traces of silt	0	95	5	0	0.25	0.12	2.1
	2	4.5	Sand with traces of silt and gravel	2	96	2	0	0.24	0.13	1.8
	2	6	Sand with traces of silt	0	98	2	0	0.25	0.14	1.8
	2	7.5	Sand with traces of silt	0	97	3	0	0.25	0.15	1.7
	2	9	Sand with traces of silt and gravel	6	92	2	0	0.58	0.15	3.9
	3	0.9	Clayey silty sand	2	58	32	8	0.17	0.0025	68.0
	3	2.4	Silty sand	0	71	29	0	0.18	0.021	8.6
	3	3.9	Sand with traces of silt	0	96	4	0	0.25	0.15	1.7

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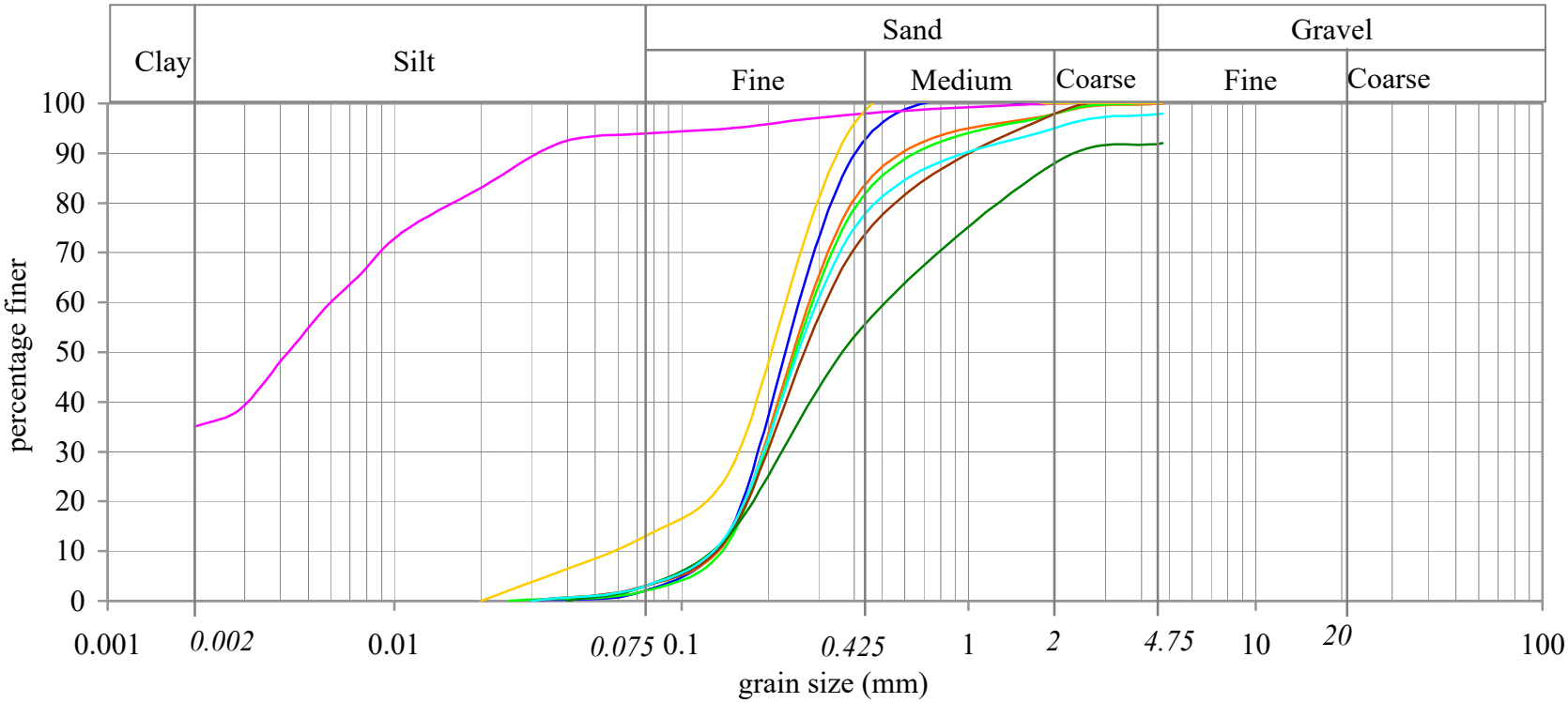
Job No. : G(D)4525

Sheet No. : 5c

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	3	5.4	Sand with traces of silt	0	98	2	0	0.25	0.15	1.7
	3	6.9	Sand with traces of silt	0	97	3	0	0.27	0.14	1.9
	3	8.4	Sand with traces of silt	0	98	2	0	0.29	0.15	1.9
	3	10	Sand with traces of silt	0	97	3	0	0.31	0.14	2.2
	4	1.5	Sandy clayey silt	0	6	59	35	0.0061	-	-
	4	3	Sand with silt	0	87	13	0	0.23	0.059	3.9
	4	4.5	Sand with traces of silt and gravel	8	89	3	0	0.51	0.15	3.4
	4	6	Sand with traces of silt and gravel	2	95	3	0	0.29	0.15	1.9

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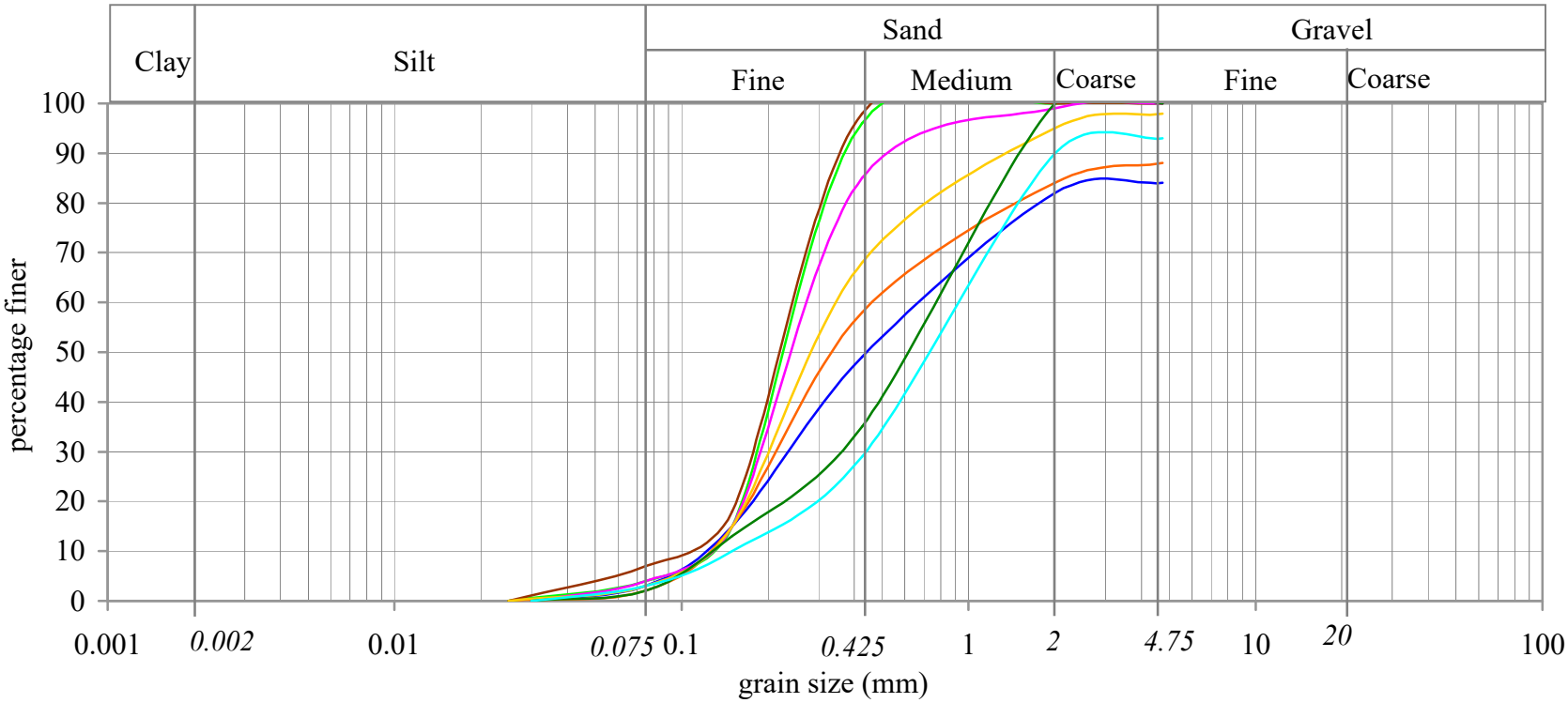
Job No. : G(D)4525

Sheet No. : 5d

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	4	7.5	Sand with traces of silt and gravel	16	81	3	0	0.69	0.13	5.3
	4	9	Sand with traces of silt and gravel	12	86	2	0	0.43	0.13	3.3
	5	0.9	Sand with traces of silt	0	96	4	0	0.25	0.12	2.1
	5	2.4	Sand with traces of silt	0	93	7	0	0.25	0.11	2.3
	5	3.9	Sand with traces of silt	0	96	4	0	0.27	0.13	2.1
	5	5.4	Sand with traces of silt and gravel	2	95	3	0	0.35	0.15	2.3
	5	6.9	Sand with traces of silt	0	98	2	0	0.75	0.14	5.4
	5	8.4	Sand with traces of silt and gravel	7	90	3	0	0.9	0.15	6.0

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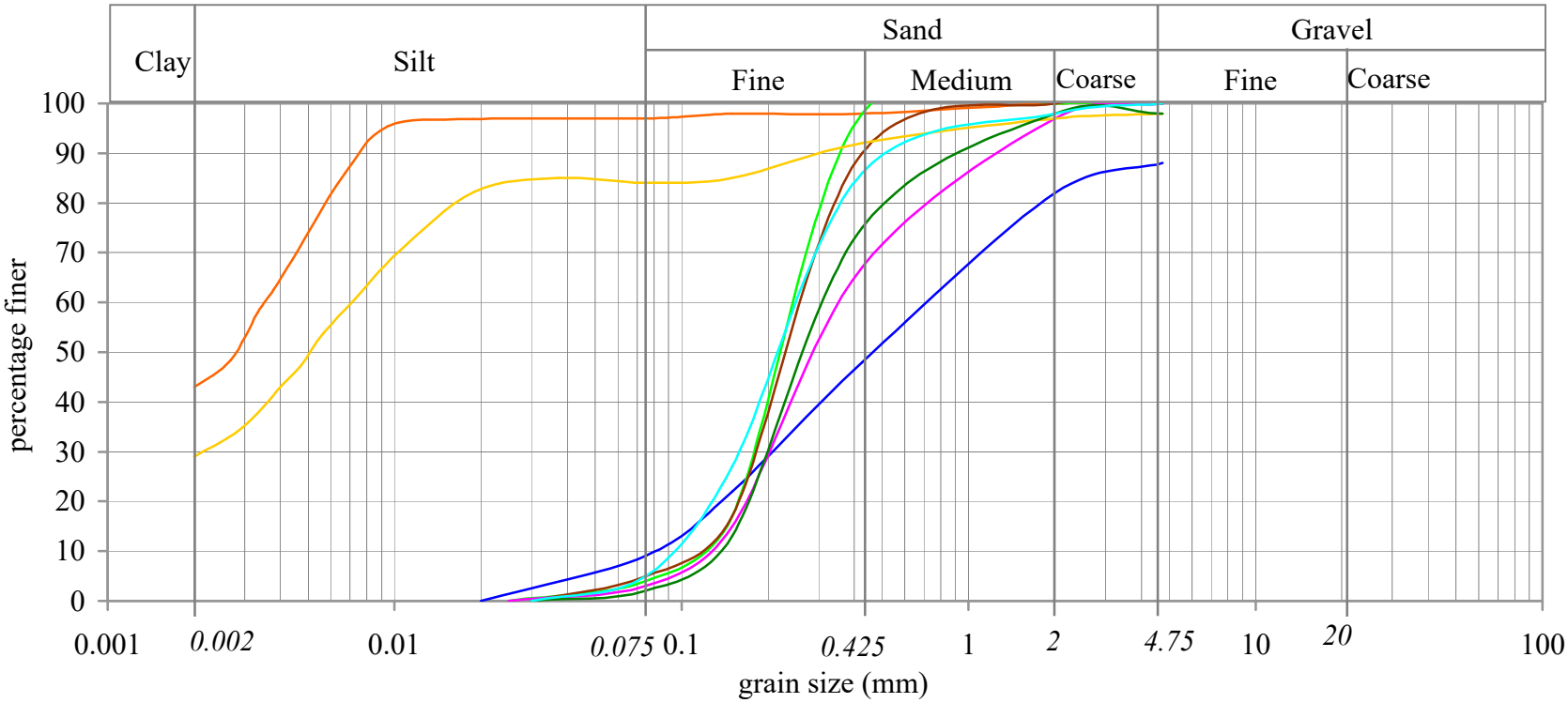
Job No. : G(D)4525

Sheet No. : 5e

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	5	10	Sand with traces of silt and gravel	12	79	9	0	0.71	0.09	7.9
	6	1.5	Sandy clayey silt	0	3	54	43	0.0035	-	-
	6	3	Sand with traces of silt	0	96	4	0	0.25	0.091	2.7
	6	4.5	Sand with traces of silt	0	95	5	0	0.25	0.12	2.1
	6	6	Sand with traces of silt	0	97	3	0	0.35	0.13	2.7
	6	7.5	Sandy clayey silt with gravel	2	14	55	29	0.0071	-	-
	6	9	Sand with traces of silt and gravel	2	96	2	0	0.21	0.14	1.5
	7	0.9	Sand with traces of silt	0	95	5	0	0.25	0.091	2.7

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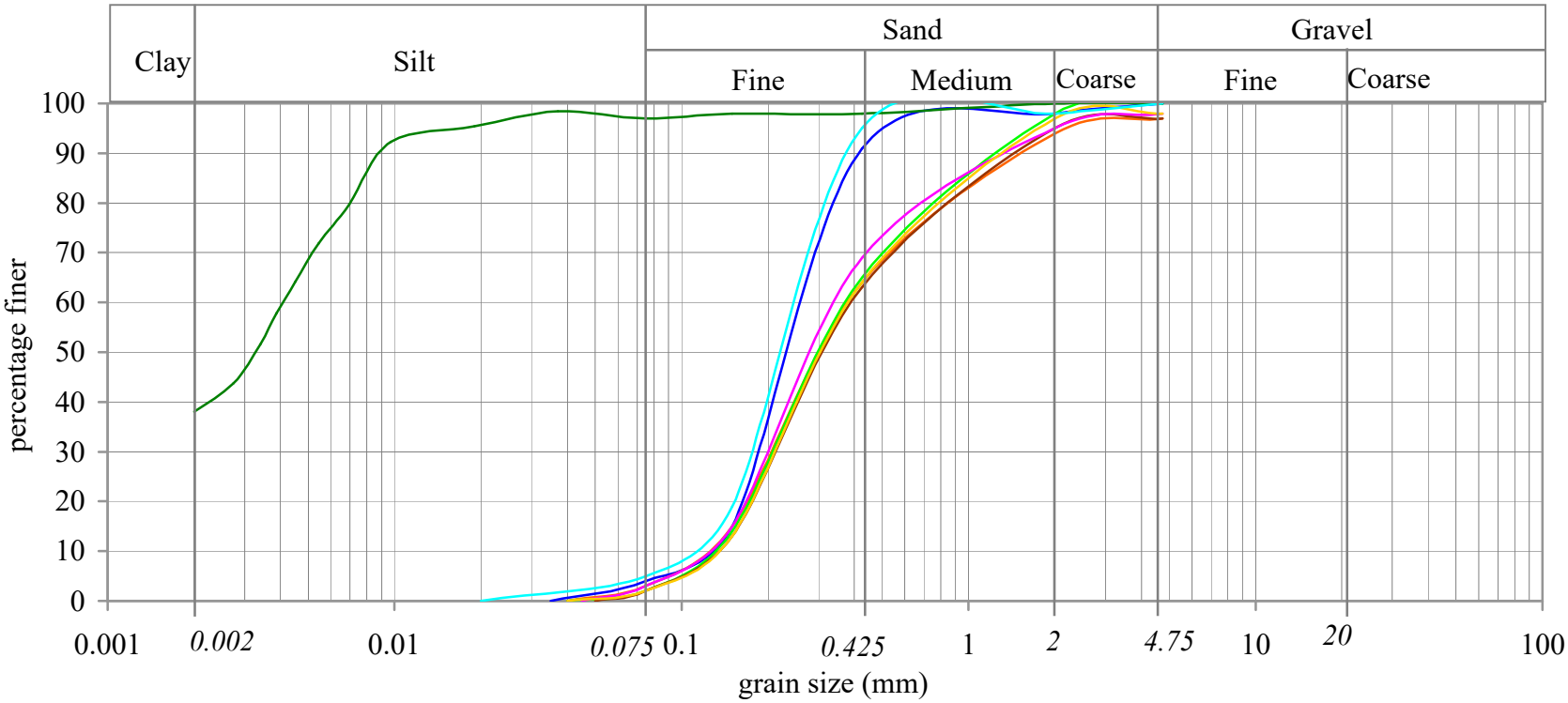
Job No. : G(D)4525

Sheet No. : 5f

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	7	2.4	Sand with traces of silt	0	96	4	0	0.26	0.14	1.9
	7	3.9	Sand with traces of silt with gravel	3	94	3	0	0.38	0.14	2.7
	7	5.4	Sand with traces of silt	0	98	2	0	0.37	0.15	2.5
	7	6.9	Sand with traces of silt with gravel	3	95	2	0	0.39	0.13	3.0
	7	8.4	Sand with traces of silt with gravel	2	95	3	0	0.33	0.14	2.4
	7	10	Sand with traces of silt with gravel	2	96	2	0	0.37	0.14	2.6
	8	1.5	Sandy clayey silt	0	3	59	38	0.0041	-	-
	8	3	Sand with traces of silt	0	95	5	0	0.25	0.11	2.3

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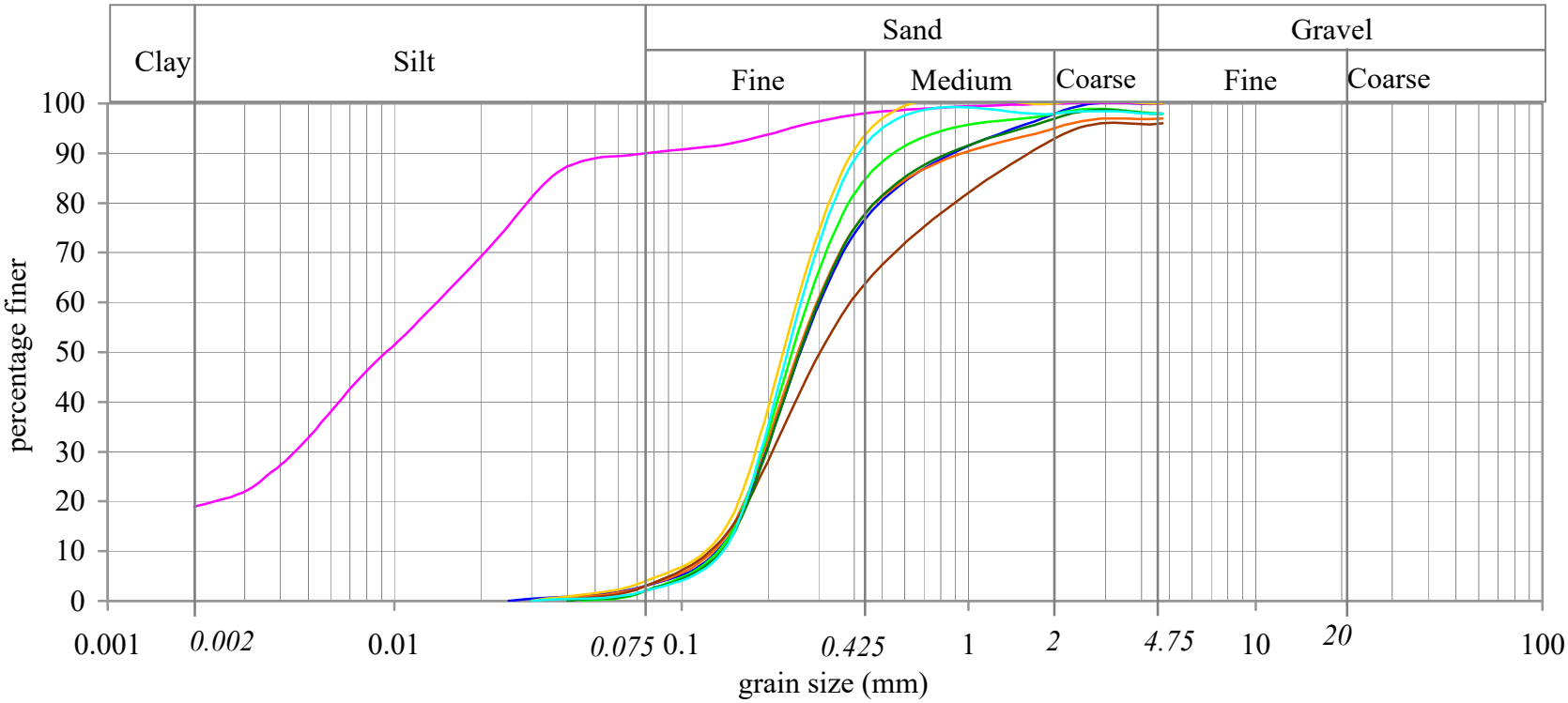
Job No. : G(D)4525

Sheet No. : 5g

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	8	4.5	Sand with traces of silt	0	97	3	0	0.31	0.15	2.1
	8	6	Sand with traces of silt and gravel	3	94	3	0	0.31	0.14	2.2
	8	7.5	Sand with traces of silt and gravel	2	96	2	0	0.28	0.15	1.9
	8	9	Sand with traces of silt and gravel	4	93	3	0	0.39	0.14	2.8
	9	0.9	Sandy clayey silt	0	10	71	19	0.015	-	-
	9	2.4	Sand with traces of silt	0	96	4	0	0.25	0.13	1.9
	9	3.9	Sand with traces of silt and gravel	2	96	2	0	0.31	0.12	2.6
	9	5.4	Sand with traces of silt and gravel	2	96	2	0	0.28	0.15	1.9

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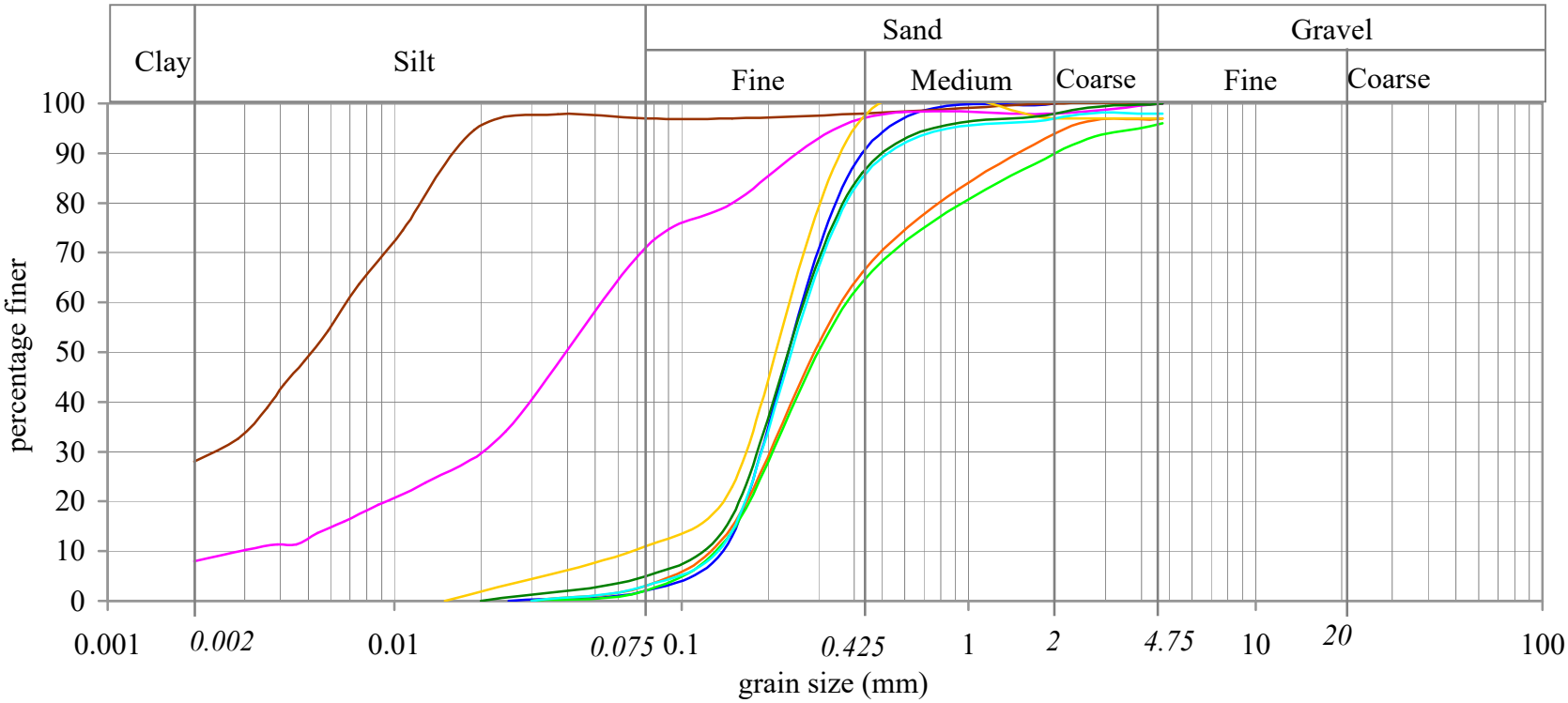
Sheet No. : 5h

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	9	6.9	Sand with traces of silt	0	98	2	0	0.26	0.13	2.0
	9	8.4	Sand with traces of silt and gravel	3	94	3	0	0.35	0.14	2.5
	9	10	Sand with traces of silt and gravel	4	94	2	0	0.36	0.15	2.4
	10	1.5	Sandy clayey silt	0	3	69	28	0.0069	-	-
	10	3	Clayey sandy silt	0	29	63	8	0.051	0.0028	18.2
	10	4.5	Sand with silt and gravel	3	86	11	0	0.23	0.061	3.8
	10	6	Sand with traces of silt	0	95	5	0	0.25	0.11	2.3
	10	7.5	Sand with traces of silt and gravel	2	95	3	0	0.26	0.13	2.0

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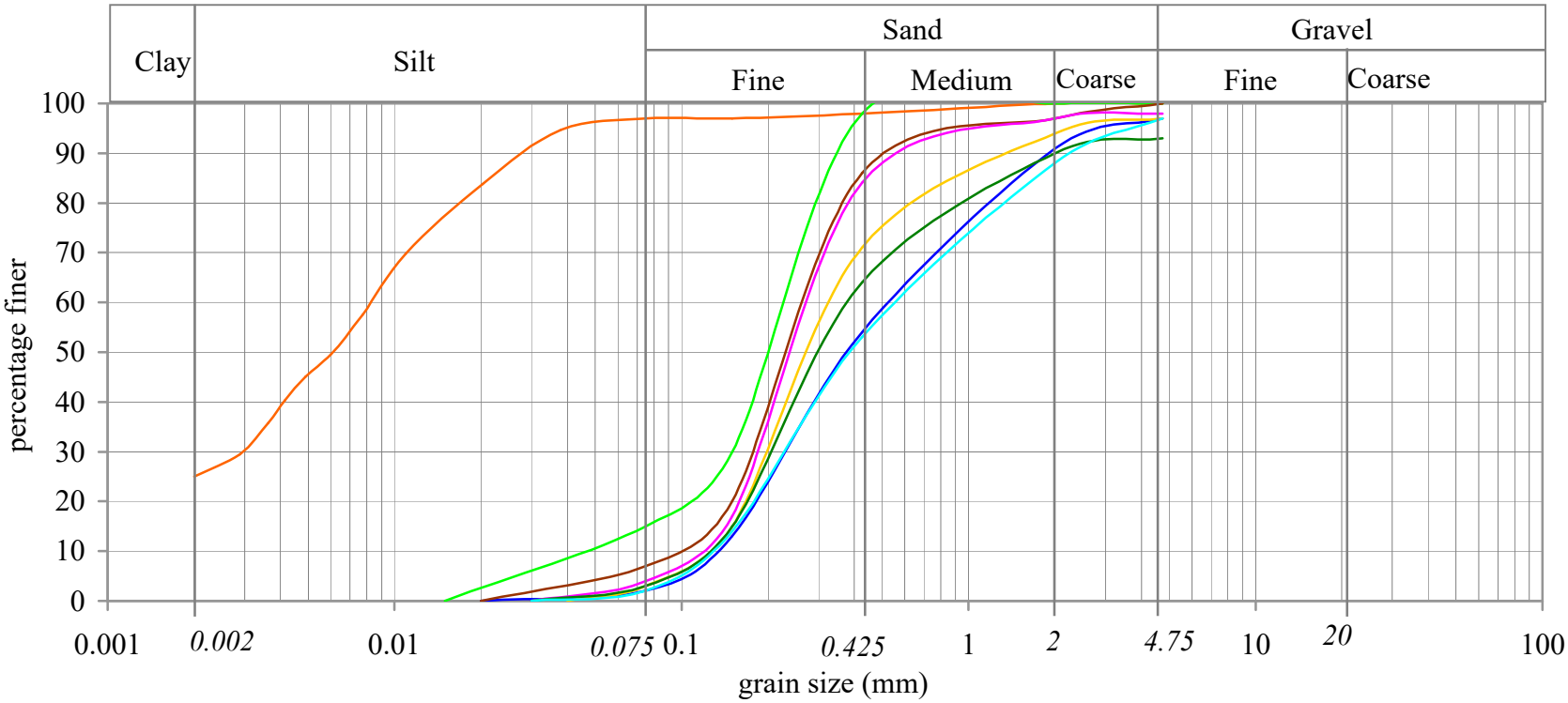
Job No. : G(D)4525

Sheet No. : 5i

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	10	9	Sand with traces of silt and gravel	3	95	2	0	0.51	0.12	4.3
	11	0.9	Sandy clayey silt	0	3	72	25	0.0081	-	-
	11	2.4	Sand with silt	0	85	15	0	0.22	0.045	4.9
	11	3.9	Sand with traces of silt	0	93	7	0	0.25	0.1	2.5
	11	5.4	Sand with traces of silt and gravel	2	94	4	0	0.26	0.12	2.2
	11	6.9	Sand with traces of silt and gravel	3	94	3	0	0.32	0.13	2.5
	11	8.4	Sand with traces of silt and gravel	7	90	3	0	0.37	0.15	2.5
	11	10	Sand with traces of silt and gravel	3	95	2	0	0.61	0.14	4.4

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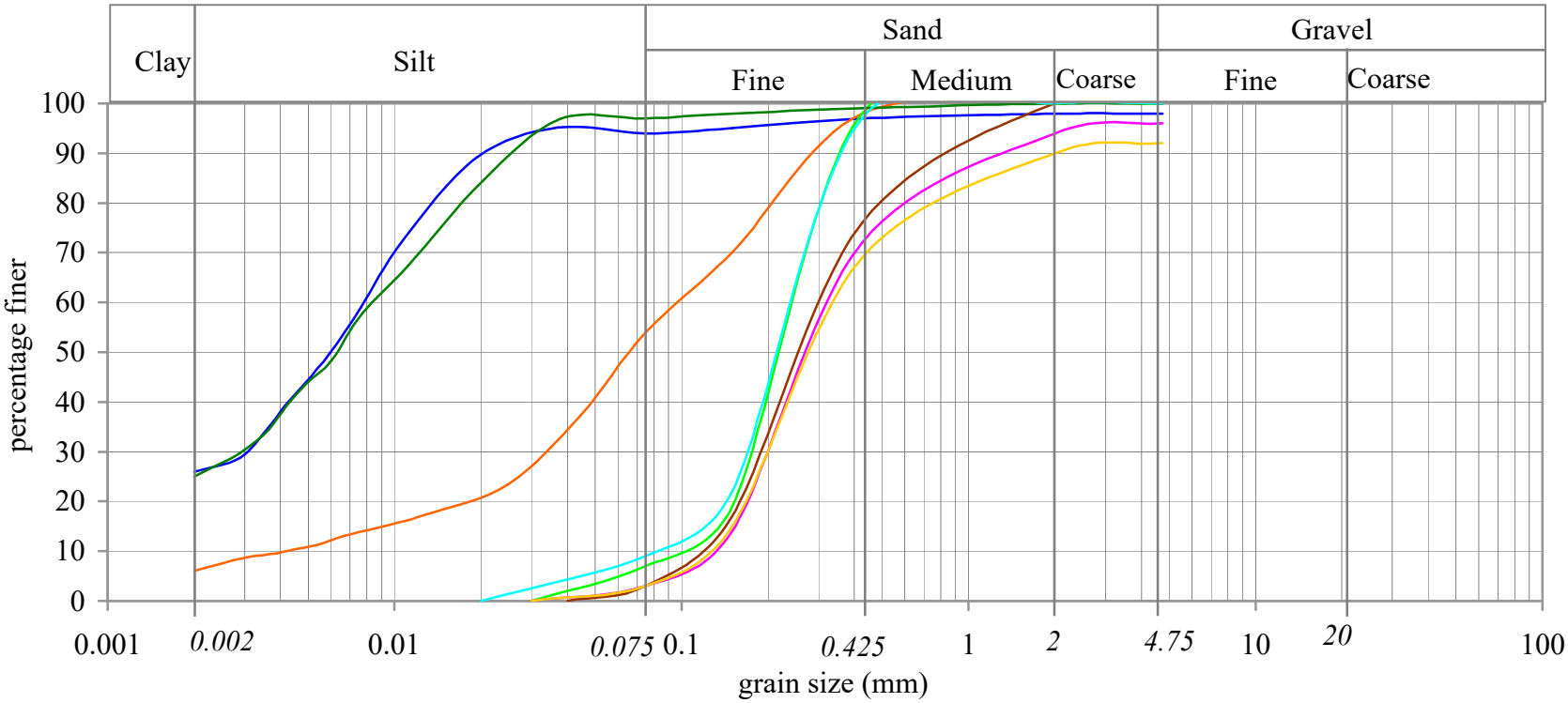
Sheet No. : 5j

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	12	1.5	Sandy clayey silt with gravel	2	4	68	26	0.0079	-	-
	12	3	Clayey sandy silt	0	46	48	6	0.085	0.0039	21.8
	12	4.5	Sand with traces of silt	0	93	7	0	0.25	0.1	2.5
	12	6	Sand with traces of silt	0	97	3	0	0.3	0.12	2.5
	12	7.5	Sand with traces of silt with gravel	4	93	3	0	0.31	0.13	2.4
	12	9	Sand with traces of silt with gravel	8	89	3	0	0.32	0.13	2.5
	13	0.9	Sandy clayey silt	0	3	72	25	0.0081	-	-
	13	2.4	Sand with traces of silt	0	91	9	0	0.25	0.081	3.1

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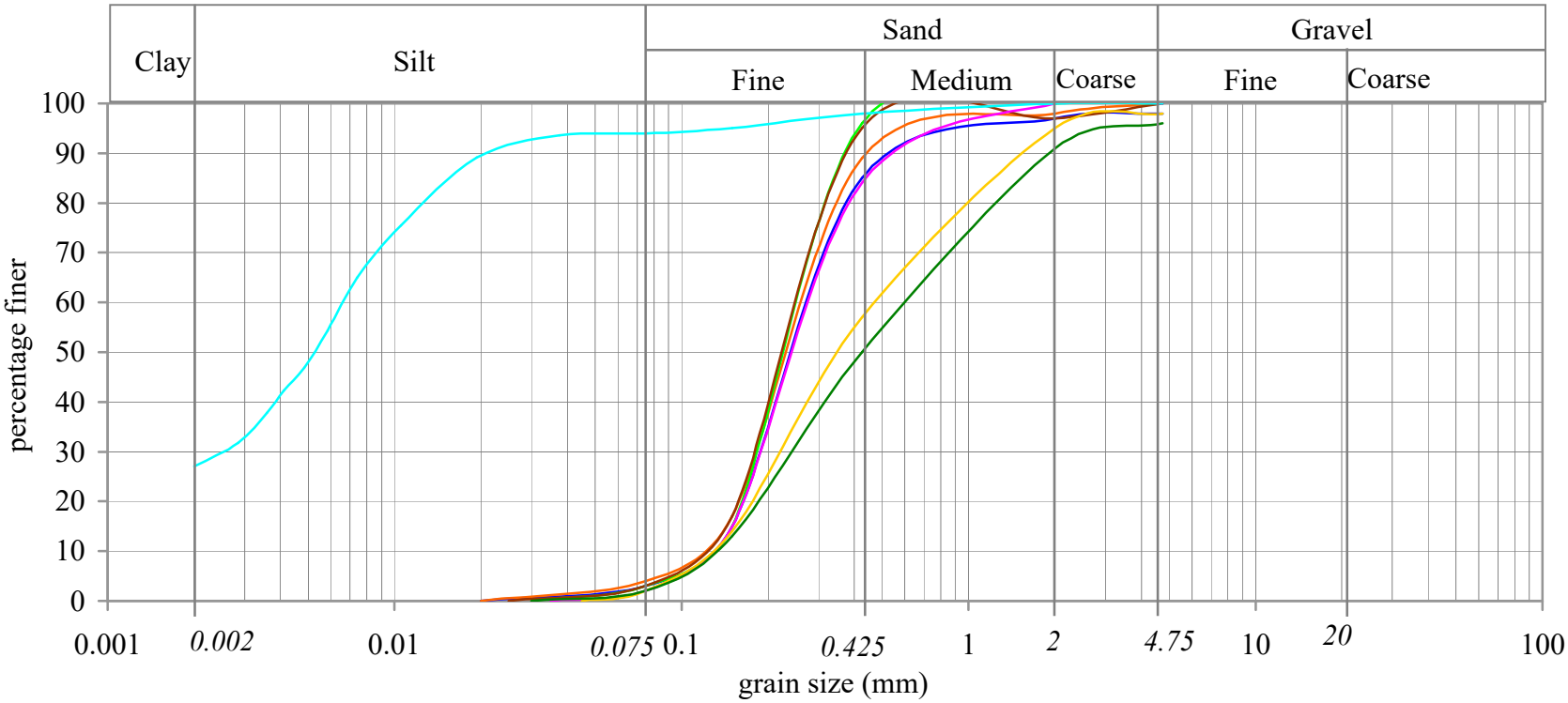
Job No. : G(D)4525

Sheet No. : 5k

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	13	3.9	Sand with traces of silt and gravel	2	95	3	0	0.28	0.12	2.3
	13	5.4	Sand with traces of silt	0	96	4	0	0.26	0.13	2.0
	13	6.9	Sand with traces of silt	0	97	3	0	0.25	0.13	1.9
	13	8.4	Sand with traces of silt	0	97	3	0	0.24	0.13	1.8
	13	9.9	Sand with traces of silt	0	98	2	0	0.26	0.14	1.9
	13	13	Sand with traces of silt and gravel	2	96	2	0	0.45	0.13	3.5
	13	11.4	Sand with traces of silt and gravel	4	94	2	0	0.6	0.14	4.3
	14	1.5	Sandy clayey silt	0	6	67	27	0.0065	-	-

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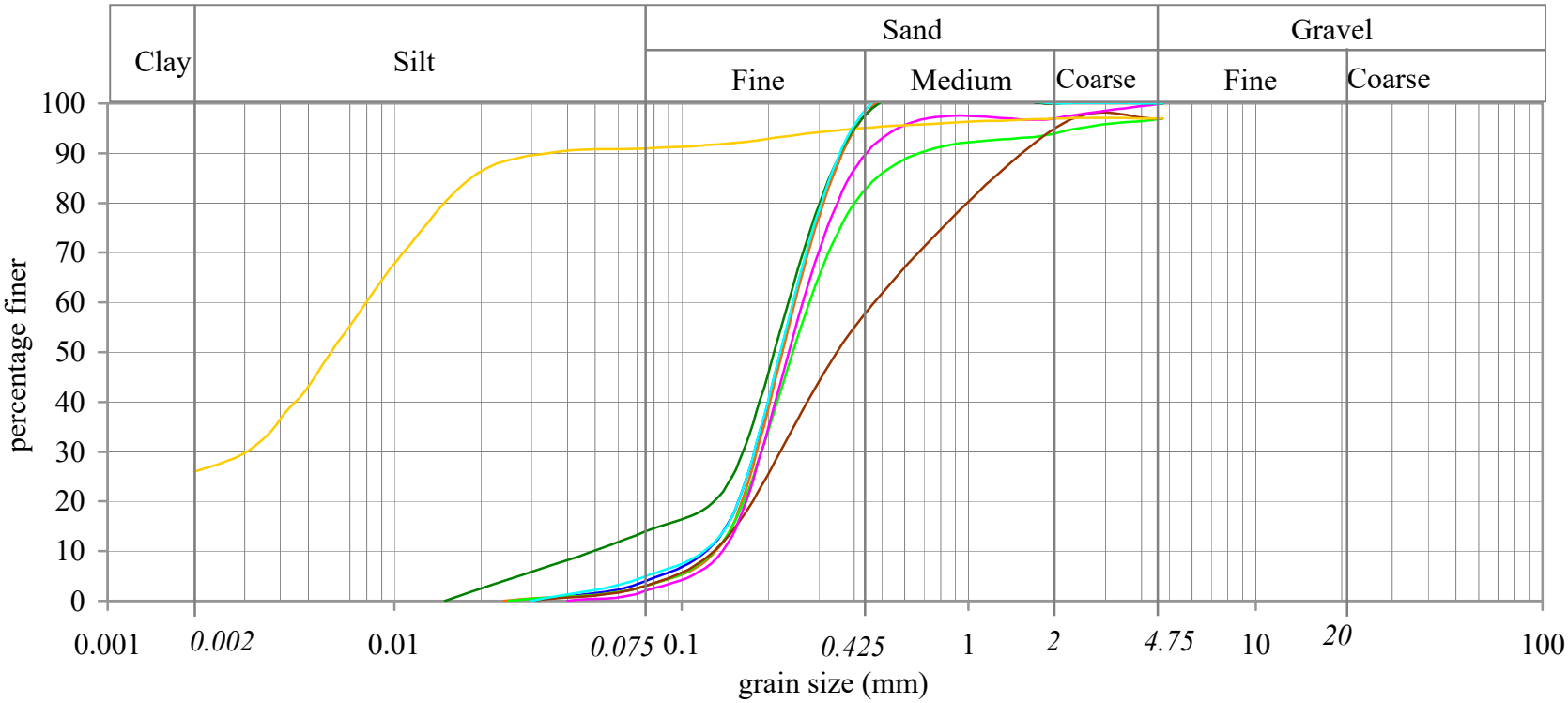
Job No. : G(D)4525

Sheet No. : 51

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	14	3	Sand with traces of silt	0	96	4	0	0.25	0.13	1.9
	14	4.5	Sand with traces of silt	0	97	3	0	0.25	0.13	1.9
	14	6	Sand with traces of silt and gravel	3	94	3	0	0.28	0.14	2.0
	14	7.5	Sand with traces of silt and gravel	3	94	3	0	0.55	0.14	3.9
	14	9	Sand with traces of silt	0	98	2	0	0.26	0.14	1.9
	15	0.9	Sandy claeyy silt with gravel	3	6	65	26	0.0081	-	-
	15	2.4	Sand with silt	0	86	14	0	0.24	0.049	4.9
	15	3.9	Sand with traces of silt	0	95	5	0	0.23	0.13	1.8

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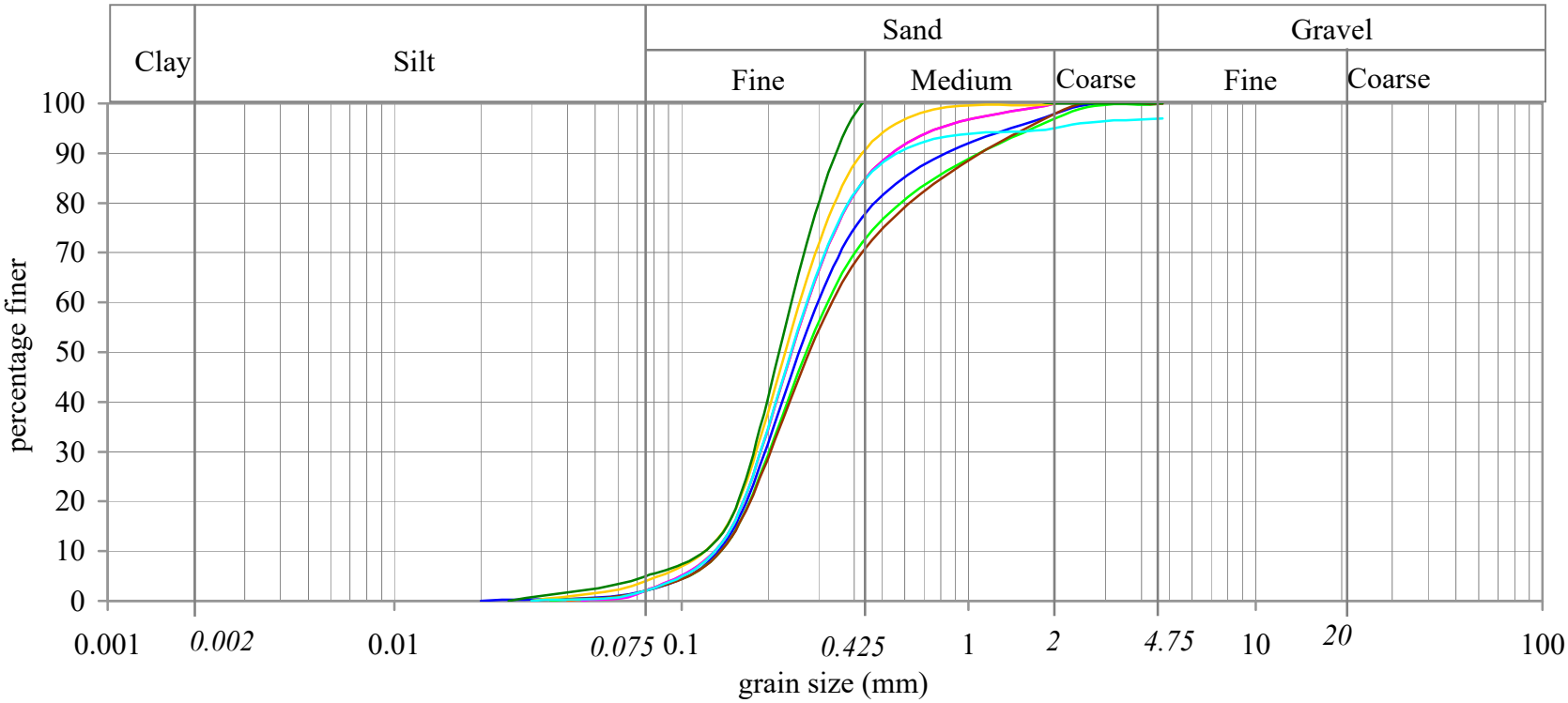
Sheet No. : 5m

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	15	5.4	Sand with traces of silt	0	98	2	0	0.3	0.13	2.3
	15	6.9	Sand with traces of silt	0	98	2	0	0.38	0.14	2.7
	15	8.4	Sand with traces of silt	0	98	2	0	0.31	0.13	2.4
	15	10	Sand with traces of silt	0	98	2	0	0.32	0.15	2.1
	16	1.5	Sand with traces of silt	0	98	2	0	0.29	0.14	2.1
	16	3	Sand with traces of silt	0	96	4	0	0.25	0.14	1.8
	16	4.5	Sand with traces of silt	0	95	5	0	0.24	0.13	1.8
	16	6	Sand with traces of silt and gravel	3	95	2	0	0.26	0.14	1.9

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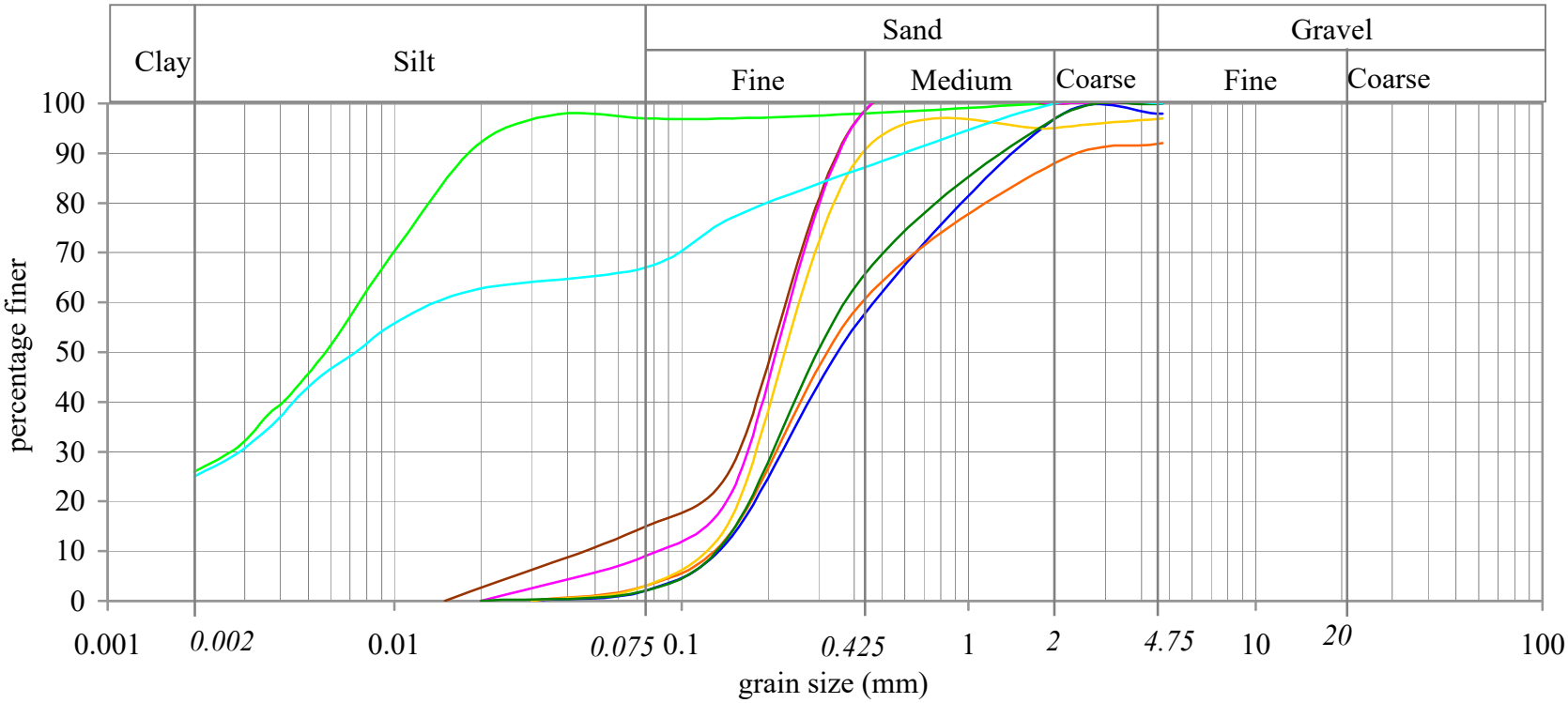
Sheet No. : 5n

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	16	7.5	Sand with traces of silt and gravel	2	96	2	0	0.45	0.14	3.2
	16	9	Sand with traces of silt and gravel	8	89	3	0	0.425	0.13	3.3
	17	0.9	Sandy clayey silt	0	3	71	26	0.0075	-	-
	17	2.4	Sand with silt	0	85	15	0	0.23	0.045	5.1
	17	3.9	Sand with traces of silt	0	91	9	0	0.23	0.085	2.7
	17	5.4	Sand with traces of silt and gravel	3	94	3	0	0.25	0.13	1.9
	17	6.9	sand with traces of silt	0	98	2	0	0.38	0.14	2.7
	17	8.4	Clayey sandy silt	0	33	42	25	0.015	-	-

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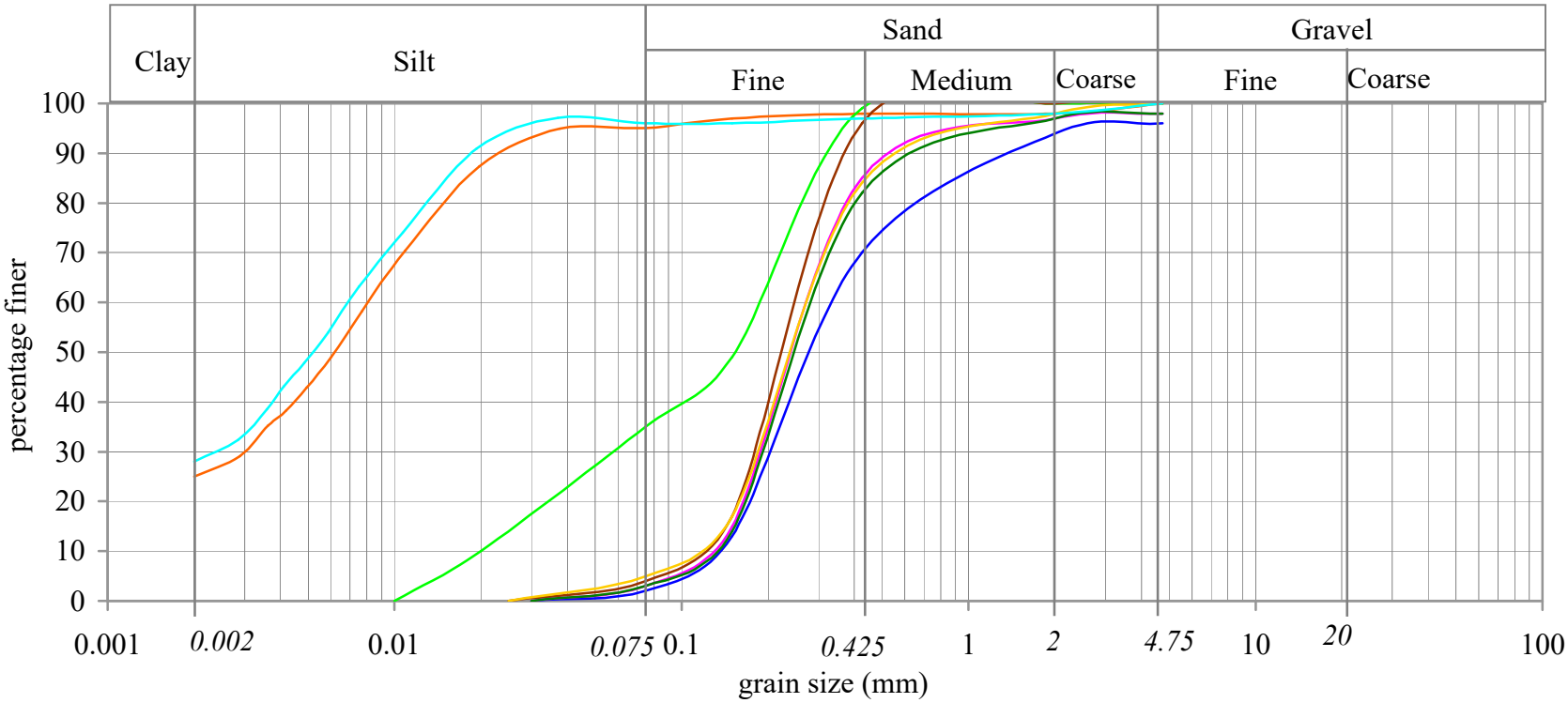
Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	17	10	Sand with traces of silt and gravel	4	94	2	0	0.32	0.14	2.3
	18	1.5	Sandy clayey silt	0	5	70	25	0.0081	-	-
	18	3	Silty sand	0	65	35	0	0.19	0.02	9.5
	18	4.5	Sand with traces of silt	0	96	4	0	0.24	0.13	1.8
	18	6	Sand with traces of silt and gravel	2	95	3	0	0.27	0.14	1.9
	18	7.5	Sand with traces of silt	0	95	5	0	0.28	0.14	2.0
	18	9	Sand with traces of silt and gravel	2	95	3	0	0.27	0.15	1.8
	19	0.9	Sandy clayey silt	0	4	68	28	0.0069	-	-

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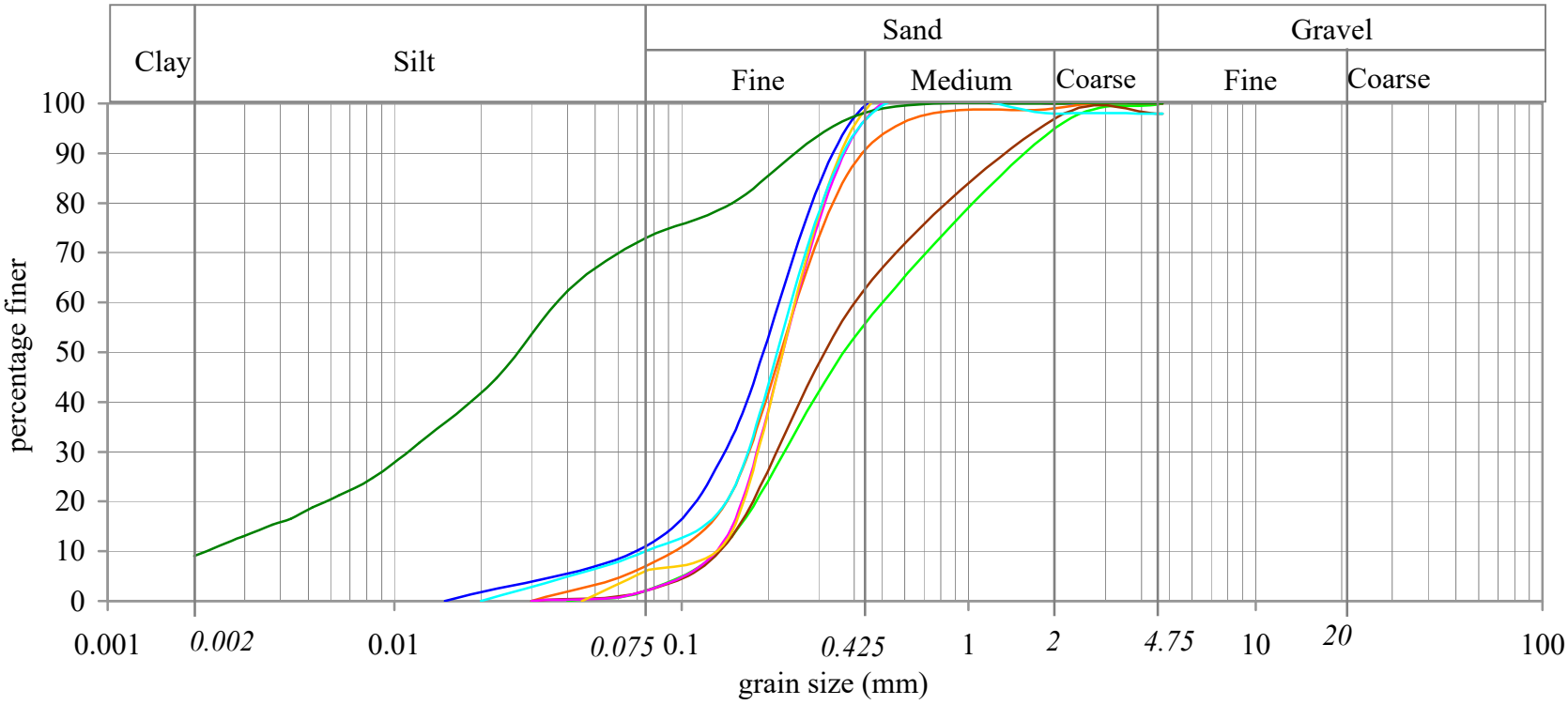
Sheet No. : 5p

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	19	2.4	Sand with silt	0	89	11	0	0.22	0.071	3.1
	19	3.9	Sand with traces of silt	0	93	7	0	0.25	0.091	2.7
	19	5.4	Sand with traces of silt	0	98	2	0	0.5	0.15	3.3
	19	6.9	Sand with traces of silt with gravel	2	96	2	0	0.42	0.15	2.8
	19	8.4	Sand with traces of silt	0	98	2	0	0.25	0.14	1.8
	19	10	Sand with traces of silt	0	94	6	0	0.25	0.14	1.8
	20	1.5	Clayey sandy silt	0	27	64	9	0.036	0.0022	16.4
	20	3	Sand with traces of silt with gravel	2	88	10	0	0.24	0.075	3.2

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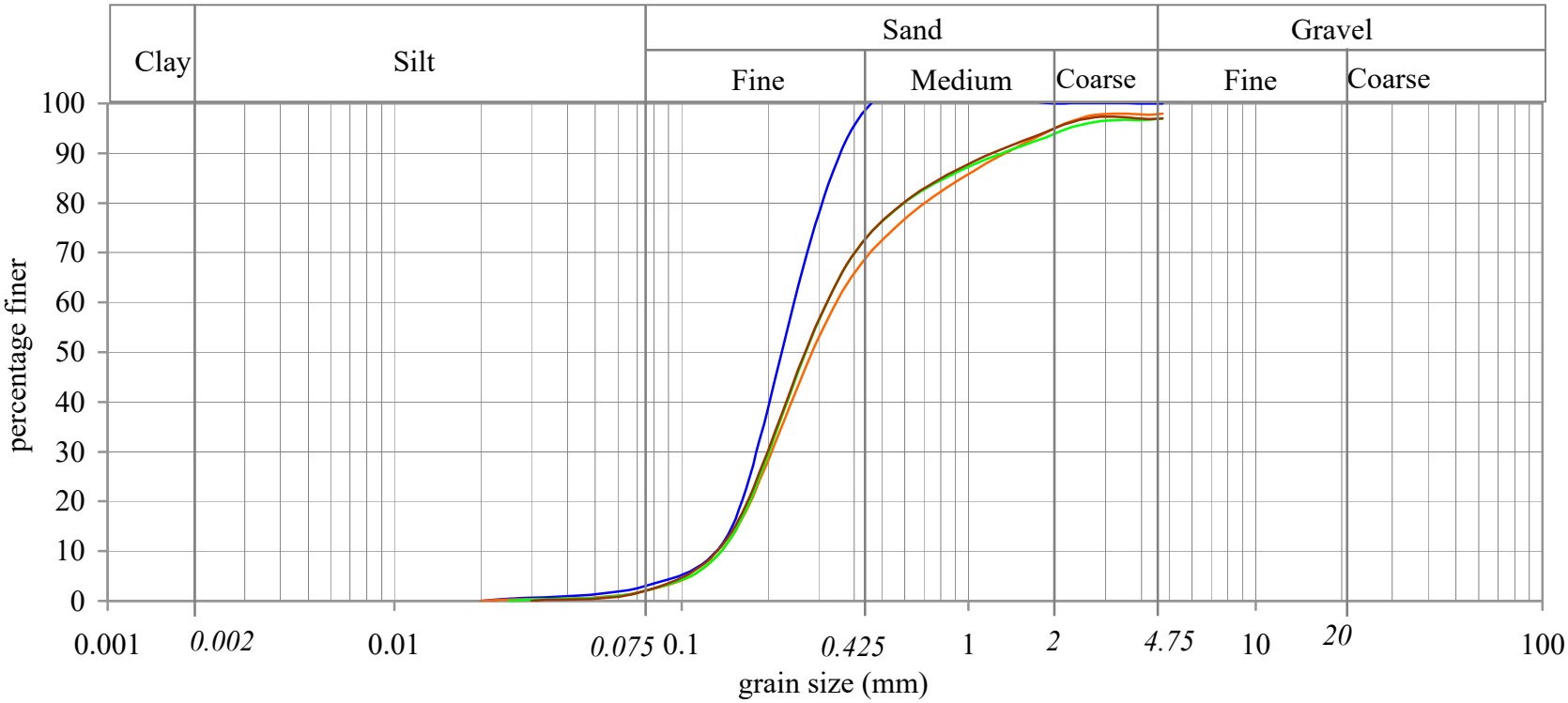
Sheet No. : 5q

Grain Size Analysis Curves *(refer paragraph no. 7.3.1)*



Line Style	Bore hole	Depth (m)	Description	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	d_{60}	d_{10}	C_u
	20	4.5	Sand with traces of silt	0	97	3	0	0.25	0.15	1.7
	20	6	Sand with traces of silt and gravel	2	96	2	0	0.23	0.16	1.4
	20	7.5	Sand with traces of silt and gravel	3	95	2	0	0.22	0.15	1.5
	20	9	Sand with traces of silt and gravel	3	95	2	0	0.21	0.14	1.5