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FOUNDATION INVESTIGATION AND DESIGN REPORT FOR PROPOSED HIGH MAST LIGHTING HOGGS HOLLOW STRUCTURE INFILL G.W.P. 48-99-00 HIGHWAY 401/YONGE STREET AREA TORONTO, ONTARIO

Submitted To:

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Submitted By:

AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada

February 2000
TT99860

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA Earth &
Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

February 9, 2000.
Ref. No.: TT99860

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Attention: **Mr. Khaled El-Dalati, P. Eng.**

Dear Sir:

Re: **FOUNDATION INVESTIGATION AND DESIGN REPORT FOR PROPOSED HIGH MAST LIGHTING HOGGS HOLLOW STRUCTURE INFILL G.W.P. 48-99-00 HIGHWAY 401/YONGE STREET AREA TORONTO, ONTARIO**

We take pleasure in enclosing six (6) copies of our Foundation Investigation and Design Report for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

George S.W. Chow, P. Eng.,
Designated MTO Contact.

GSWC/dee

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1.0 INTRODUCTION

AGRA Earth & Environmental Limited (AGRA) has been retained by Delcan Corporation to carry out a subsurface investigation in the vicinity of the Highway 401/Yonge Street interchange area, in Toronto, from Station 20+795 to 22+000.

This purpose of this investigation is to obtain supplementary subsurface information at selected locations by means of exploratory boreholes, in-situ tests and laboratory tests. Based on our interpretation of previous and current data, recommendations are provided on the geotechnical aspects of foundation design. Comments are also provided on anticipated construction issues where they may affect the geotechnical design of the proposed foundations.

Preliminary layout plans showing the HML pole locations are provided to us by Delcan (part of a preliminary report prepared by Cole, Sherman & Associates for the Ontario Ministry of Transportation [MTO]). The following documents have also been referenced during the preparation of this report.

- Universal Geotechnique Limited report titled "*Report on Subsurface Exploration for Proposed Bridge at Don River & Highway 401, Toronto, Ontario*", W.P. 172-58, Report No. T.333/58, dated September 1958 (GEOCRES No. 30M14-135).
- Dominion Soil Investigation Limited report titled "*Soil Investigation for Proposed West Don Sanitary Trunk Sewer, from Wilket Creek to Bayview Ave.*", dated July 1959.
- Geocon Limited report titled "*Soil Borings, Proposed Extension to Hoggs Hollow Bridge, Existing Highway 401 - District 6, Toronto, Ontario*", W.P. 172-58-2, Contract 59-151, dated May 1960 (GEOCRES No. 30M14-138).
- William A. Trow and Associates Limited report titled "*Foundation Investigation Hwy. 401 & Yonge Street Interchange, District No. 6, Toronto*", W.P. 265-61, Project J838, dated April 1962 (GEOCRES No. 30M14-122).
- Dominion Soil Investigation Limited report titled "*Highway #401 Collector Roads, Hoggs Hollow, Toronto*", W.P. 264-61-1, 264-61-2, dated November 1962 (GEOCRES No. 30M14-121).
- Department of Highways, Ontario report titled "*Proposed Retaining Walls (Yonge - Bayview Vicinity*", W.P. 252-61-1, 252-61-2, dated June 1964 (GEOCRES No. 30M14-126).

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The proposed HML locations are distributed along a 1,200 m section of Highway 401, in the vicinities of the Hoggs Hollow structure and the Yonge Street interchange. The number of HML poles has not been finalized, but for the purpose of this investigation and design, 9 conventional HML poles and 1 tall HML pole are assumed. The tall HML pole is to be founded within the floodplain some 60 m west of the river channel, and to be extended between the eastbound collector and core lane structures.

Based on available geological information, the river floodplain is covered with recent sediments. At higher elevations, the valley walls consist of alternating till strata and river sediments, originating from and between substages of the Wisconsin glaciation, respectively. At the top of the valley, drifts from ground moraines, i.e. glacial tills of the Pleistocene Age, are present.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on October 12, 13 and 25, 1999 and consisted of drilling and sampling four (4) boreholes. Borehole 1 was put down within the West Don River floodplain, about 60 m west of the river flow channel. Boreholes 2 and 3 were drilled and sampled at locations within the northeast and northwest quadrants of the Highway 401 and Yonge Street interchange, respectively. Borehole 4 was located near the east end of Yonge Boulevard. The plan locations of the boreholes are shown on Drawing No. 1.

The investigation was carried out using track-mounted and truck-mounted power auger drill rigs supplied and operated by AtCost Soil Drilling Inc. under the full time supervision of a member of AGRA's engineering staff. Hollow stem augers were used to advance Boreholes 1 and 4, whereas solid stem augers were used to put down Boreholes 2 and 3.

Soil sampling in the boreholes was carried out at regular intervals of depth by the Standard Penetration Test (SPT), as specified in ASTM Standard D1586. This consists of freely dropping a 63.5 kg hammer for a vertical distance of 0.76 m to drive a 50 mm outside diameter split barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the 'N'-value of the soil, which gives an indication of the consistency or the compactness of the soil deposit. Groundwater conditions in the open boreholes were observed throughout and immediately after the drilling operations. Standpipe piezometers were installed in Boreholes 1, 2 and 4 to permit long term monitoring of the groundwater levels. All boreholes were backfilled and grouted. Water levels in piezometers were taken on October 25, 1999 (Boreholes 1 and 2) and on November 9, 1999 (Boreholes 1, 2 and 4).

The borehole locations for this investigation were established in the field by our engineering staff with reference to the tentative locations of the proposed HML poles (as shown in the Cole Sherman preliminary report) and previous boreholes. The as-drilled borehole locations were surveyed by

Rady-Pentek & Edward Surveying Ltd. with reference to MTO co-ordinates and the Geodetic datum. Co-ordinates were not available for the previously drilled boreholes.

The soil samples were identified in the field and shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification testing. A laboratory testing programme, consisting of natural moisture content determination, grain size analyses and Atterberg Limits tests, was performed on selected representative soil samples. The soils encountered in the boreholes are either water-bearing sands and silts, or very stiff to hard clayey silt glacial till. It is considered impractical, nor necessary, to obtain "undisturbed" samples of these soils. As such, triaxial and direct shear box tests were not carried out as part of the laboratory testing programme. The results of the laboratory tests are presented on the appropriate Record of Borehole sheets, and summarized on Figures 1 to 7.

4.0 SUBSURFACE CONDITIONS

The current investigation consists of four boreholes to supplement previous boreholes. The approximate locations of all current and relevant previous boreholes are shown on Drawing No.1. Co-ordinates and elevations of the current boreholes are shown on the Record of Borehole sheets.

In Borehole 1, a thin veneer of topsoil overlying some sand and gravel fill was found within shallow depth below ground surface. Sandy silt grading into sand and silt was encountered below the fill to about 9 m depth, below which a fine sand stratum was encountered to about 20 m depth. Groundwater level was measured at about 5 m below ground surface. In Boreholes 2 and 3, topsoil and fill overlie clayey silt glacial till which extends to a borehole termination depth of 11 m. In Borehole 4, topsoil and fill immediately overlie sandy silt till which is underlain by sand to silty sand, changing to clayey silt glacial till at depth.

Details of the subsurface conditions encountered in these boreholes are presented in the Record of Borehole sheets, Enclosure Nos. 1 to 4. The following paragraphs are intended to complement and summarize this data. Records of relevant previous boreholes are included in Appendix B.

4.1 TOPSOIL AND FILL

Topsoil of thickness ranging between 0.05 m and 0.15 m was encountered in all four boreholes.

Sand and gravel fill was encountered, below the topsoil, in Boreholes 1 and 4, to 1.5 m and 0.5 m depths, or Elevations 136.6 and 169.8 m respectively. SPT 'N'-values ranged from 11 to 52 blows per 0.3 m penetration indicating variable density of compact to very dense, although the high value may be attributed to cobbles encountered. A grain size distribution curve of a sample of this fill is shown on Figure 1. The analysis indicates 42% gravel, 44% sand and 14% silt and clay. Measured natural moisture contents ranged from 5% to 9%.

Clayey silt fill was encountered, below the topsoil, in Boreholes 2 and 3 to 1.1 m and 0.7 m, or

.../...

Elevations 174.2 and 172.7 m respectively. SPT 'N'-values ranged from 13 to 27 blows per 0.3 m penetration indicating a stiff to very stiff consistency. Measured natural moisture contents ranged from 8% to 15%.

4.2 SANDY SILT

Deposits of sandy silt, trace to some clay were encountered immediately below the fill at a depth of 1.5 m (Elevation 136.6 m), and at about 20 m depth (Elevation 118.8 m) in Borehole 1. The sandy silt is 1.6 m thick at shallow depth, but was not fully penetrated near the bottom of the borehole, at a depth of 23.5 m or Elevation 114.6m. The measured 'N'-values of the sandy silt varied typically between 19 and 25 blows for 0.3 m penetration, indicating a compact condition. A high value of 49 blows at shallow depth in Borehole 1 can be attributed to the cobbles encountered, whereas a very dense zone ('N'-value of 63 blows) was contacted at about 21 m depth. Grain size distribution curves for two samples of this soil are presented on Figure 2. The analyses indicate 0 to 1% gravel, 23 to 35% sand, 62 to 67% silt and 3 to 9% clay. The measured natural moisture contents ranged from 13 to 22%.

4.3 SAND AND SILT

Sand and silt was encountered from 3.1 m to 8.7 m depths, or Elevations 135.0 to 129.4 m, in Borehole 1. This cohesionless soil is typically a mixture of fine sand and coarse silt. Measured 'N'-values generally ranged from 30 blows to 61 blows per 0.3 m penetration, indicating dense to very dense condition. An occasional 'N'-value of 16 blows indicated the presence of a compact zone at the top surface of this deposit. Figure 3 shows grain size distribution curves of two samples of this soil. The analyses indicated 55 to 60% sand, 40 to 45% silt with no gravel or clay. The measured natural moisture content ranged from 6 to 25%. The relatively large increase in moisture contents corresponds to a soil colour change from brown to grey at about 5 m depth, which is also consistent with a measured groundwater level of 5.7 m (Elevation 132.4m).

4.4 SAND

Below the sand and silt, in Borehole 1, is an extensive deposit of fine sand with some silt. This sand extends from 8.7 m to 19.3 m depth, or from Elevation 129.4 to 118.8 m. Measured 'N'-values generally ranged from 34 blows to 88 blows per 0.3 m penetration, indicating dense to very dense condition. An occasional 'N'-value of 20 blows indicated the presence of a compact zone. Figure 4 shows grain size distribution curves of two samples of this soil. The analyses indicated 82 to 85% sand, 15 to 18% silt with no gravel or clay. The measured natural moisture content ranged from 16 to 22%.

4.5 SILTY SAND

In Borehole 4, a silty sand interlayer was encountered within the glacial till, extending from 4.4 m to 6.9 m depths, or from Elevations 165.9 to 163.4m. 'N'-values were measured or inferred to be greater than 100 blows per 0.3 penetration, indicating a very dense condition throughout the layer.

.../...

Figure 5 shows the grain size distribution curve of a sample of the silty sand, indicating 2% gravel, 71% sand, 21% silt and 6% clay. Measured moisture contents range from 6 to 9%.

4.6 CLAYEY SILT (GLACIAL TILL)

A glacial till deposit comprised of a clayey silt matrix with sand and trace gravel was encountered below the fill in Boreholes 2, 3 and 4, until termination of all three boreholes at about 11 m depth (or Elevations 164.4, 162.5 and 159.3m, repectively) . Water-bearing sands and silts interlayers were contacted within the till in Boreholes 2 and 4. Measured 'N'-values ranged from 15 blows to over 100 blows per 0.3 m penetration, with a majority of the values greater than 30 blows. These values indicated typically hard consistency with some very stiff zones.

Figure 6 shows grain size distribution curves of six samples of this soil. The analyses indicated 1 to 5% gravel, 24 to 57% sand, 31 to 53% silt and 7 to 23% clay. Atterberg limits test results, as shown on Figure 7, indicated that the clayey silt matrix is of low plasticity with liquid limits ranging between about 13 and 21%, and plasticity indices ranging from about 3 to 9%. The measured natural moisture contents ranged from about 6 to 12%. Occasional higher values are attributed to the wet cohesionless interlayers.

4.7 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed during the drilling and on completion of each borehole.

Groundwater was encountered during drilling at about 6 m depth in Borehole 1. A water level at 5.7 m (Elevation 132.4 m) was measured in the piezometer installed in Borehole 1, some two weeks after installation. Free standing groundwater was not encountered in Boreholes 2, 3 and 4 on completion of drilling. In Borehole 2, however, samples of the interlayering sands and silts were wet.

Water levels in the piezometers were taken on October 25, 1999 (Boreholes 1 and 2) and on November 9, 1999 (Boreholes 1, 2 and 4). The highest groundwater level may, however, be inferred by the location at which the soil changed from brown to grey colour.

It should be noted, however, that the groundwater at the site will fluctuate seasonally and can be expected to rise during the spring months or in response to heavy rains.

.../...

5.0 DISCUSSION AND RECOMMENDATIONS

The proposed works consist of a number of HML poles (assumed 10) to be located in the vicinity of the Hoggs Hollow, Highway 401 and Yonge Street area. All HML poles will be of conventional design except the tall one to be founded within the valley of West Don River. This tall HML may be up to 75 m in height. The conventional poles are to be located approximately at grade with the existing roadways. Preliminary information indicates that the conventional poles will be about 35 to 40 m in height.

For the purpose of discussion, the ten tentative HML poles are numbered from HML1 to HML10, inclusive. The tall pole is numbered HML7. The locations of these poles, based on the Cole, Sherman report. For design purposes, it is assumed that the soil condition at any HML pole location is similar to the soil condition encountered in the closest borehole(s) from previous or current investigations. For HML2, HML3 and HML7, Boreholes 1, 2 and 3 of the current investigation were drilled in close proximity to the proposed tentative locations. Borehole 4 was drilled in close proximity to HML9.

Additionally, for HML7, adjacent to the Don River, we understand that construction of the tall high mast light pole will require that a temporary bridge be constructed over the river for truck traffic.

Northings and eastings co-ordinates are not recorded for the previous boreholes. Northing and easting co-ordinates and Geodetic elevations of the current boreholes are shown on the Record of Boreholes and on Drawing No. 1. For consistency in presentation, co-ordinates inferred from the digital plan for relevant previous boreholes are also be shown on Drawing No. 1.

5.1 FOUNDATION DESIGN

Reference should be made to the Ontario Highway Bridge Design Code (O.H.B.D.C.), 3rd Edition (1991) and the Ministry of Transportation, Ontario "Procedures for the Design of High Mast Pole Foundations" dated June 1994.

5.1.1 Augered Caissons

All proposed conventional HML poles may be supported on augered caissons. Consideration may be given to supporting the tall HML pole on one or more larger diameter augered caissons. The recommended geotechnical design parameters for each HML location, along with the identification of referenced boreholes and subsurface conditions, are shown in Table 1. The future ground elevations for the preliminary HML locations are not available to us at the time of preparation of this report. Where the caissons will likely be fully or partially embedded within engineered fill, applicable geotechnical design parameters are also provided.

TABLE 1
GEOTECHNICAL DESIGN PARAMETERS

HML IDENTIFICATION	REFERENCE BOREHOLES	SIMPLIFIED STRATIGRAPHY	APPROXIMATE ELEVATION (or depth below existing ground surface) (m)	DESIGN PARAMETERS				
				q_u (kPa)	ϕ (degrees)	γ (kN/m³)	K_p	ELEVATION (depth to water) (m)
HML1	1, 2 (30M14-126)	very stiff to hard CLAYEY SILT TILL with Sand (dense sand interlayer at or below 7 m in boreholes 6 and 7)	173 - 168	300	32	20	3.2	172
	6, 7 (30M14-122)		175 - 167	300[1]	32	20	3.2	173
HML2	2 (current investigation)	hard CLAYEY SILT TILL with Sand, trace Gravel (compact to dense sand interlayer below 7 m depth)	174 - 164	300	32	20	3.2	172
HML3	3 (current investigation)	very stiff to hard CLAYEY SILT TILL with Sand, trace Gravel	172 - 162	300	32	20	3.2	170
HML4	5 (30M14-122)	very stiff to hard CLAYEY SILT TILL with Sand, trace Gravel	175 - 172	300	32	20	3.2	172
		dense to very dense / very stiff to hard interlayered Sands, Silts and Clayey Silts	172 - 162	---	32	20	3.2	

NOTES:

1. Use q_u = 0 below 7 m depth at the locations of Boreholes 6 and 7.

2. All elevations related to the stratigraphy quoted in this table are based on the assumption that the upper 1.5 m below ground surface is ignored for determining lateral resistances.

TABLE 1 (continued)
GEOTECHNICAL DESIGN PARAMETERS

HML IDENTIFICATION	REFERENCE BOREHOLES	SIMPLIFIED STRATIGRAPHY	APPROXIMATE ELEVATION (or depth below existing ground surface) (m)	DESIGN PARAMETERS				
				q_u (kPa)	ϕ (degrees)	γ (kN/m^3)	K_p	ELEVATION (depth to water) (m)
HML5	10 (30M14-122)	very stiff to hard CLAYEY SILT TILL with Sand, trace Gravel	175 - 170	300	32	20	3.2	174
		very stiff to hard CLAYEY SILT some sand, occ. gravel	170 - 163	300	30	20	3.0	
HML6	11, 12, 13 (30M14-121)	very stiff to hard CLAYEY SILT TILL with Sand, trace Gravel (occasional sand interlayers)	168 - 159	300	32	20	3.2	166
HML7	1 (current investigation)	dense to very dense with compact zones fine SAND and SILT some clay	136 - 129	---	34	21	3.5	133
		dense to very dense fine SAND some silt	129 - 115	---	35	21	3.7	
HML8	31, 32 (30M14-121)	very dense SANDY SILT TILL	166 - 161	---	35	21	3.7	162
		very dense fine SAND and SILT	161 - 157	---	34	21	3.5	
HML9 and HML10	4 (current investigation)	very stiff to hard CLAYEY SILT TILL with sand, trace gravel	169 - 159	300	32	20	3.2	168
	29, 35 (30M14-121)	very dense SANDS and SILTS	166 - 158	---	34	21	3.5	165

In order to account for frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caissons within the upper 1.5 m below final grade should be neglected in the foundation design. An equivalent caisson width equal to 3 times the caisson diameter may be assumed for lateral resistance calculations. When designing for caissons below the groundwater table, a water unit weight of 10 kN/m^3 may be assumed for calculating effective soil unit weights. Where an unconfined compressive strength, q_u, is provided, the undrained lateral resistance for the depth of the socket within the clayey silt/clayey silt till may be calculated assuming ϕ_u equals to zero. Appropriate load and resistance factors should be applied for caisson design.

5.1.2 Steel H-Piles

We understand that the design of this tall HML pole (HML7) is largely governed by the degree of rotation and lateral displacement of the superstructure, subjected to lateral forces and concentrated moments acting above the ground surface.

Consideration may be given to supporting the pole on deep foundations in the form of steel H-piles, driven to sufficient depth within the typically dense to very dense sands and silts. In order to adequately penetrate the very dense zones above the founding level, a heavier section such as HP310x110 with reinforced tips would be suitable for use.

We do not have details of the loading configuration and magnitudes at the time of preparation of this report. Based on the results of Borehole 1 of the current investigation, it is anticipated that the driven H-piles would penetrate through the dense to very dense, upper sand and silt into the underlying fine sand. For the purpose of discussion, it is assumed that the pile tip would be at 10 m below the underside of the pile cap, or at about 12 m below existing ground surface.

5.1.2.1 Resistance to Axial Loads

For HP310x110 steel H-piles driven to 12 m depth into the dense to very dense sand, the following axial resistances may be assumed for design.

Factored Axial Resistance at Ultimate Limit States (U.L.S.)	=	500 kN
Geotechnical Resistance at Serviceability Limit States (S.L.S.)	=	400 kN

In accordance with MTO standard practice, the piles should be driven to about 1 m to 2 m above the depth recommended above, after which driving should be monitored and controlled by a recognized pile driving formula, such as the Hiley formula. The estimated ultimate resistance of the piles driven to the above assumed depth into the dense to very dense sand is approximately 1,000 kN. The piles should be driven with a suitable hammer capable of delivering a rated capacity of between 40 and 50 kJ per blow.

Cobbles were inferred at shallow depth (1.4 m) just below the fill in Borehole 1. As a precaution, the pile tips should be reinforced as per MTO Standards (OPSD 3301.00) to minimize the risk of damage to the piles.

At least two piles should be re-tapped to check that relaxation has not occurred. Re-tapping should be carried out about 24 to 48 hours after driving. If relaxation has occurred, then all piles should be re-tapped.

The base of the pile cap should be provided with a minimum earth cover of 1.2 m for frost protection.

It is possible that some of the piles may penetrate to one to two metres below the estimated tip depths and this aspect should be taken into consideration when ordering piles.

The geotechnical resistance at Serviceability Limit States (S.L.S.) is dependent on the settlement of the pile group and, therefore, is governed by the size of the pile group. The pile group configuration is currently not available to us. Provided that the piles are designed and installed as recommended above, it is considered that the quoted S.L.S. value corresponds to no more than 25 mm of settlement for the pile group. We can confirm the estimated settlement once information on the pile group configuration is known.

5.1.2.2 Resistance to Lateral Loads

Laterally applied loads on the HML pole can be resisted geotechnically by the driven piles through passive pressure developed in the soil in which the piles are embedded. It is assumed that the piles will be in the order of 10 m in length below the pile cap. Lateral pile resistance may be considered in accordance with Section 6-9.8.1 of the O.H.B.D.C., 3rd Edition.

The recommended horizontal resistances for a HP 310x110 pile at this site are as follows:

Factored Horizontal Resistance at U.L.S.	=	120 kN
Horizontal Resistance at S.L.S.	=	50 kN

Unbalanced horizontal forces could be partially resisted by battering the piles.

For lateral soil-pile interaction analysis, the coefficient of horizontal subgrade reaction to the pile can be calculated from the expression:

$$k_s = n_h \times z/d$$

where
k_s = coefficient of horizontal subgrade reaction
n_h = coefficient related to soil density as given in Table 1
d = pile width
z = depth

Also presented in the same table are the estimated values for angles of internal friction and bulk

.../...

unit weights.

TABLE 2

REFERENCE BOREHOLE NO.	APPLICABLE DEPTH FROM EXISTING GROUND SURFACE	SUBSURFACE CONDITION	BULK UNIT WEIGHT (kN/m^3)	ANGLE OF INTERNAL FRICTION (ϕ) DEGREES	RECOMMENDED n_h VALUE (MN/m^3)
Tall HML Pole					
1	1.5 - 3.5 m	compact sandy silt	20	30	5
	3.5 - 9 m	dense to very dense sand and silt	21	34	11
	9 - 20 m	dense to very dense sand	21	35	11

For conventional piled foundations, group action for lateral loading should be considered when the pile spacing in the direction of loading is less than six to eight pile diameters. Group action can be evaluated by reducing the coefficient of horizontal subgrade reaction in the direction of loading by a reduction factor R as follows:

PILE SPACING IN DIRECTION OF LOADING d = PILE DIAMETER	SUBGRADE REACTION REDUCTION FACTOR R
8d	1.00
6d	0.70
4d	0.40
3d	0.25

5.2 TEMPORARY BRIDGE STRUCTURE

We understand that a temporary bridge is required to carry truck traffic to and from the tall HML pole during construction. It is also understood that the sheetpiling along the river banks has a retained height of about 3 m and that it has tie-backs with deadmans. There is, however, no available records on other sheetpiling details including the socket depth.

There is no existing subsurface information at the location of the proposed bridge. Interpolation between previous boreholes drilled for the adjacent piers indicates that the subsoils would likely consist of loose sand with some organics extending to between 3 and 5 m depth, overlying dense to very dense silts and sands. The groundwater level is at about 1.5 m below existing ground (floodplain) and is expected to be governed by the river water level.

.../...

The surficial sand with organics is loose and compressible, and is considered unsuitable for foundation support. It is recommended that the upper 1.5 m in the vicinity of the foundation footprint be sub-excavated and replaced with approved granular materials, preferably Granular ‘A’ or ‘B’, compacted to 98% of its Standard Proctor Maximum Dry Density. In order to account for a trapezoidal stress distribution under the footing, each dimension of the base of the granular pad should be 1.8 m larger than the corresponding dimension of the footing. The bridge may then be supported on shallow spread footings founded on the engineered granular pad. The following capacities may be used for foundation design

Factored Bearing Capacity at ULS	= 200 kPa
Bearing Capacity at SLS	= 100 kPa

We understand that construction will proceed during the spring to winter months. As such, a minimum earth cover of 1.2 m is required over the footing for frost protection. It is also understood that the temporary structure is capable of sustaining somewhat larger magnitudes of settlement than permanent structures. Based on existing information, it is estimated that the total elastic settlement would be of the order of 25 to 50 mm, and would occur during and shortly after bridge construction.

Due to the lack of information on the design and construction of the sheetpiling, it is prudent to locate the footings at sufficient distance away such that the potential lateral movement and/or instability of the sheetings induced by the surcharge can be minimized. We consider that a 5 m setback distance between the closest edge of footing and the sheetpiling is appropriate. An NSSP should be included in the contract documents to advise the contractor to locate the tie-back cables and deadmen prior to construction to avoid disturbance of the sheeting, and their location may warrant repositioning the bridge footing. It is also recommended that a pre-construction inspection of the sheeting be carried out to document the existing conditions, with emphasis on lateral displacement and adjacent ground settlement.

6.0 EXCAVATION AND DEWATERING

6.1 CONVENTIONAL HML POLES

Based on the available subsurface information obtained in the vicinities of HML1 to HML6, it is anticipated that the caisson construction would be carried out through very stiff to hard clayey silt glacial till. The open Boreholes 2 and 3 of the current investigation had typically no free standing water at the time of the investigation, except for some water seepage from the interlayering sands and silts at some locations.

To avoid “caving in” of the sides of the hole in case these water-bearing layers are encountered, it is recommended that a temporary liner be used to maintain stability of the hole when it is drilled and be withdrawn as concrete is placed. Water may have to be pumped from the hole prior to placing concrete. All concrete must be placed using the tremie method. Dewatering in the form of groundwater lowering is neither practical nor necessary in these type of ground conditions.

.../...

Although not directly encountered in the boreholes (inferred from increasing resistance to augering at some locations), glacial till inherently contains cobbles and/or boulders. Construction equipment and procedures should, therefore, be capable of handling and removing cobbles and boulders during caisson installation.

At the locations of the proposed HML8 to HML10, existing subsurface information indicates that the caissons would be installed through dense to very dense sandy silt till overlying very dense sand and silt, to silty sand. There was no free water in the open Borehole 4 at the time of the current investigation, and these soils appeared to have a temporary "stand-up" time during the removal of the augers.

The caisson construction techniques using temporary lining, as outlined previously, would be applicable.

6.2 TALL HML POLE

At the location of the proposed tall HML7, Borehole 1 of the current investigation and previous boreholes for other locations within the river floodplain indicate that the subsoils consist of predominantly dense to very dense water-bearing sands and silts. The groundwater level is at about 5 m depth below existing ground surface at the time of the investigation.

In unlined caisson holes formed at this location, it should be noted that sands and silts below the water table will rapidly deteriorate into "running" conditions. As such, a lining would be required for caisson installation. A steel liner may be driven, vibrated or oscillated through the sands and silts to depths below the proposed founding depth. The soil at the base of the caisson hole is subject to unbalanced hydrostatic head and seepage force, and is likely to "boil" and become disturbed.

In order to minimize the risk of "boiling" at the base, the liner should be advanced to a minimum depth below the base equal to the water head above the base. Water may have to be pumped from the hole prior to placing concrete. Consideration may also be given to the use of a head of balancing bentonite slurry inside the liner. Alternatively, the base of the hole may be stabilized with local dewatering by means of eductors and/or deep wells. All concrete should be placed by the tremie method. The contractor should maintain the stability of the soil at the sides and the base of any caisson hole at all times until concrete placement is completed. If dewatering is required, a specialist firm in this field should be consulted.

6.3 PILE CAP FOR DRIVEN PILES

Excavation for pile cap construction would likely be carried out through the upper compact to very dense sandy silt to sand and silt above the groundwater table. Temporary unsupported excavation side slopes not steeper 1 horizontal to 1 vertical would be stable provided that the excavation base is above the groundwater table. Shallower slope angles may be required for the fill encountered near ground surface.

.../...

All excavations should be carried out in accordance with the Ontario Occupational Health and Safety Act and its regulations.

No significant groundwater seepage into the temporary excavation is expected. It is anticipated that conventional sump pumping should be sufficient to control any groundwater seepage into the excavation. Surface water should be directed away from the open excavation.

7.0 CLOSURE

We recommend that once the details of the structures are finalized, our recommendations should be reviewed for their specific applicability.

The Limitations of Report, as quoted in Appendix A, is an integral part of this report.

Sincerely,

for Sydney Pang, Ph. D., P. Eng.

Andrew Drevininkas, P. Eng.

Eric Y. Chung, M. Eng., P. Eng.,
Designated MTO Contact.

AD

.../...

APPENDIX A

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

APPENDIX B

AGRA
ENGINEERING GLOBAL SOLUTIONS

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 64-F-40
W.P. 252-61-2
DATUM 574.0

LOCATION Ret. Wall on Hwy 401 N. Side Btwn Yonge & Bayview Ch. 7+60 ℄ 333'-0" Lt.
BORING DATE May 13, 1964.
BOREHOLE TYPE Pennsylvania Drill

[illegible]ATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY M.D.

SOIL PROFILE			SAMPLES			ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L; PLASTIC LIMIT w_P; WATER CONTENT w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT					
574.0	Groundlevel									
0.0	Clayey silt with sand Very Stiff to Hard					570				
			1	SS	23					
			2	SS	25					▼ W.L. Elev. 562.0 Observed in casing.
			3	SS	30	560				
552.5			4	SS	84					
21.5	End of borehol e.					550				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 64-F-40
W.P. 252-61-2
DATUM 570.0

LOCATION Ret Wall on Hwy 401 N. Side Btwn Yonge & Bayview Ch. 8+90 ℄ 260'-0" Lt.
BORING DATE May 14, 1964.
BOREHOLE TYPE Pennsylvania Drill

ORIGINATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	REMARKS
570.0	Groundlevel					
	Sandy silt.					
567.0	Fill					
566.0	Black org. topsoil					
4.0	Clayey silt with Sand stiff to hard.	1	SS	12		
					560	W.L. El. 561.2 Observed in borehole.
		2	SS	48		
		3	SS	25		
					550	
		4	SS	73		
21.5	End of borehole.					
					540	

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT

SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w

WATER CONTENT %

BULK DENSITY γ P.C.F.

WILLIAM A. TROW & ASSOCIATES LTD.

SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING No 5

PROJECT No J838

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 2" DIA. CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
- UNCONFINED COMPRESSION
- VANE TEST AND SENSITIVITY (S)

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X[LI]

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

BOREHOLE No. 4

PROJECT Hwy. 401 & Yonge Street Interchange

LOCATION Toronto, Ontario

HOLE LOCATION See Dwg. 1.

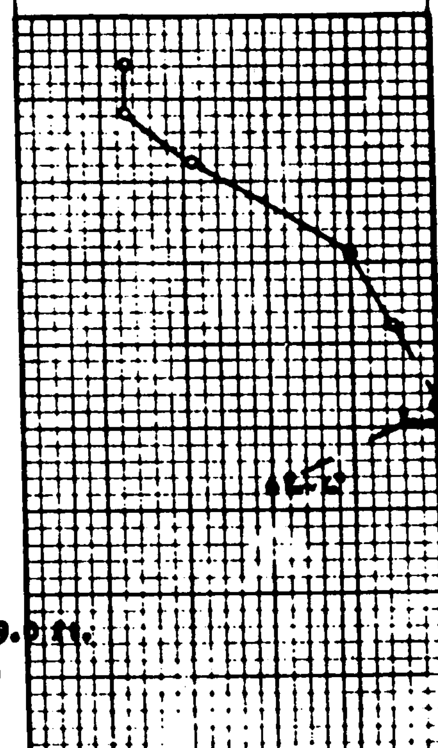
HOLE ELEVATION 575.4 ft.

DATUM See Hole 1.

SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No
Ground Surface	575.4	0	
~2 ins. topsoil and sod.			SS1
CLAYEY SANDY SILT TILL-brown, oxidized, medium dense above ~7 ft., dense below			SS2
-clayey at about 9 ft.		10	SS3
-grey below ~13 ft. & slightly higher sand content with depth.			SS4
	557.4		
	556.7		SS5
CLAY & SILT-hard grey brown clay with irregular silt intrusions - odd sand parting.		20	
	553.5		
SAND-med. to coarse brown grey very dense sand; some layers of silt. -[illegible] with numerous fine gravel sizes.			SS6
			SS7
End of Hole	546.4	30	
		40	

PENETRATION RESISTANCE 350 FT LB BLOWS/FT: 20, 40, 60, 80

SHEAR STRENGTH P.S.F.



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

NATURAL UNIT WEIGHT P.C.F.

Notes: 1) Hole augered & uncased to full depth.

2) Hole caving at 21 ft. during drilling. At completion, W.L. at 18.0 ft., open to 19.0 ft. also after 4 days, 8 days and 13 days.

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SITE INVESTIGATIONS   SOIL MECHANICS CONSULTATION

DRAWING No. 6
PROJECT No. J838

BOREHOLE No. 5
PROJECT: Hwy. 401 & Yonge Street Interchange
LOCATION: Toronto, Ontario
HOLE LOCATION: See Dwg. 1.
HOLE ELEVATION: 577.2 ft.
DATUM: See Hole 1.

LEGEND

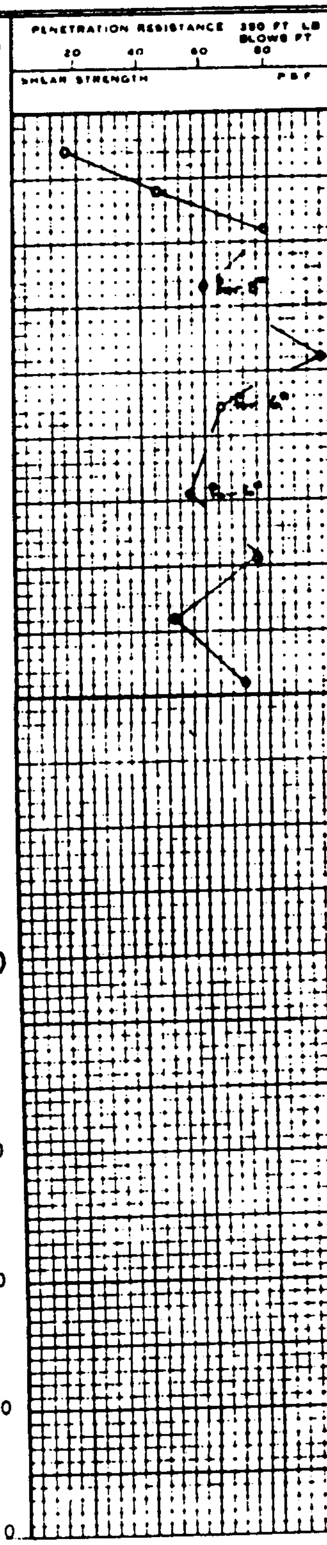
PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 2" DIA. CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
- UNCONFINED COMPRESSION
- VANE TEST AND SENSITIVITY (S)

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX
ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 3" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No.
Ground Surface	577.2	0	
-no topsoil, grass & sod cover CLAYEY SANDY SILT TILL-brown oxidised, very stiff, with fine to coarse gravel sizes.		10	SS1, SS2, SS3
SAND & SILT- ~12 in. thick med. sand seam, then sandy silt with gravel sizes, and numerous thin irregular silt partings and intrusions -clay interbeds up to 4 ins. thick with depth, very dense.	564.6 559.0	20	SS4, SS5, SS6
SAND-very dense, med. sand, wet, some layers or pockets of silt. -occasional fine gravel sizes.	554.7		SS7
CLAYEY SILT-very stiff - 12 ins. med. to coarse sand seam 31 to 32 ft.	548.2	30	
LAYERED SANDY SILT & CLAY-very dense & hard - irregularly layered to ~37 ft. -sandy silt phase contains fine gravel -rhythmic varving below ~37 ft., approx. phase thickness ½" to ¾".	~545	40	SS8, SS9
SANDY SILT TILL-very dense, with gravel sizes - silty clay intrusions.	536		SS10
End of Hole	532.8		



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

NATURAL UNIT WEIGHT P.C.F.

Notes:
1) Hole augered & uncased to 28.5 ft. caving at 22.5 ft.
Hole continued by running BX casing to 29 ft., and drilling ahead.

2) With hole at 28½ ft.,
At completion, wet cave at 22.5 ft.
After 3 days, moistcave at 16.2 ft.
" 7 days " " " 16.2 ft.

3) With hole at 45 ft.
At completion, W.L. at 14 ft., (drill water)
After 5 days, W.L. at 18.2 ft., open to 23.0 ft.

Conclusion: Stabilized level at 18.2 ft.

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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING No. 7
PROJECT No. J838

BOREHOLE No. 6
PROJECT Hwy. 401 & Yonge Street Interchange
LOCATION Toronto, Ontario
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 578.7 ft.
DATUM See Hole 1.

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 2" DIA. CONE

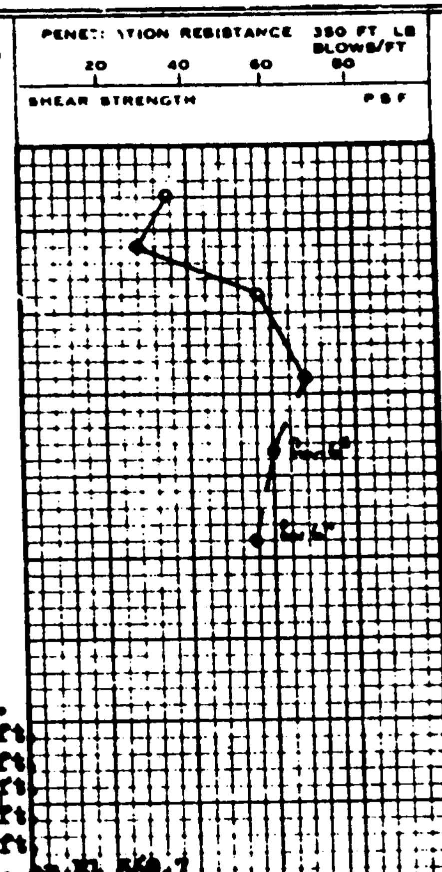
SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ●
- UNCONFINED COMPRESSION ●
- VANE TEST AND SENSITIVITY (S) +S

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X^{LI}

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No
	Ground Surface	578.7	0	
	-sand & gravel - highway shoulder FILL-sandy silt, odd clay pockets, odd gravel sizes.			SS1
	CLAYEY SANDY SILT TILL-very dense, oxidized brown with fine to coarse sand partings -grey below ~ 14 ft. -very sandy below 18 ft.	574.3 569.7	10 20	SS2 SS3 SS4 SS5
	SAND-dense, wet, fine to med. sand - a few fine gravel sizes.	555.7		SS6
	End of Hole	550.7	30	



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

NATURAL UNIT WEIGHT P.C.F.

Notes: 1) Hole augered & uncased to full depth.

2) At completion, W.L. at 23 ft. open to 24 ft.
After 5 hrs., W.L. at 20.5 ft. " " 2[illegible].5 ft
" 29 hrs., " " 15.5 ft. " " 2[illegible].5 ft
" 53 hrs., " " 12.2 ft. " " 1[illegible] ft
" 77 hrs., " " 10.1 ft. " " 1[illegible] ft
" 101 hrs., " " 9.6 ft. " " 1[illegible]2 ft

Conclusion: W.L. probably stabilizing at about 9.0 ft., or El. 569.7
Relatively slow initial rise believed to indicate minor seepage from sand seams noted in the till.

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SITE INVESTIGATIONS — SOIL MECHANICS CONSULTATION

DRAWING No. 10
PROJECT No. J838

BOREHOLE No. 9
PROJECT Hwy. 401 & Yonge Street Interchange
LOCATION Toronto, Ontario
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 578.9 ft.
DATUM See Hole 1.

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 2" DIA. CONE

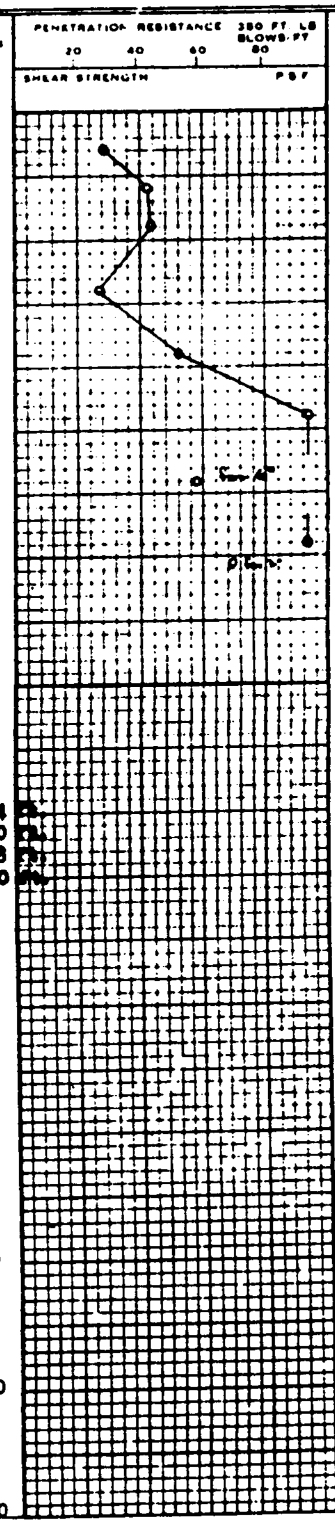
SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
- UNCONFINED COMPRESSION
- VANE TEST AND SENSITIVITY (S)

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No
	Ground Surface	578.9	0	
	-no topsoil, grass & sod cover			SS1
	CLAYEY SANDY SILT TILL-brown, oxidized, very stiff to hard.			SS2
	-grey below 9½ ft.		10	SS3
	-slightly less stiff at ~ 13 ft.			SS4
		563		
	-harder below ~ 15 ft., with higher sand content.	562.5	20	SS5
		558		
	CLAYEY SILT-very stiff to hard, grey, odd gravel size and occasional sandy silt layer or intrusion.			SS6
			30	SS7
		547.4		
	SAND-wet, grey, silty fine sand.	545.2		SS8
	CLAYEY SILT-grey, very stiff to hard.			SS9
	-augered ahead to 45 ft. and identified material on auger flights.		40	
	End of Hole	533.9		



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

NATURAL UNIT WEIGHT P.C.F.

Depth scale: 0, 10, 20, 30, 40, 50, 70, 80, 90, 100, 110

Notes:

1) Hole augered & uncased to full depth. Partially stabilized with bentonite but caving at ~ 34 ft.

2) At completion, W.L. at 16.5 ft., open to 31.4 ft.
After ½ hr., W.L. at 16.5 ft. " " 30.0 ft.
" 24 hrs. " " 16.4 ft. " " 23.8 ft.
" 48 hrs. " " 16.4 ft. " " 19.0 ft.
and after 6 days.

Conclusion: Water rising from sand seam at El 546 ft.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 11

Our Reference No. 2-8-18

Client: ONTARIO DEPARTMENT OF HIGHWAYS
Project: HWY. # 401 COLLECTOR ROADS
Location: HOGGS HOLLOW, TORONTO
Datum Elevation: 561.2

Method of Boring: AUGERING
Diameter of Borehole: 6"
Date: AUG 30 1962

Enclosure No. 13

Elevation ft	Depth ft	Stratification Description	Sample Number	Type	Blows / 6" (N)
561.2	0	GRAVEL, SAND FILL			
		BROWN DAMP HARD SANDY CLAYEY SILT TILL	1	SS	23
			2	SS	37
			3	SS	46
			4	SS	74/9"
		GREY DAMP HARD SANDY CLAYEY SILT TILL	5	SS	70/6"
			6	SS	80
			7	SS	67
			8	SS	69

Elevation scale: 561.2, 560.0, 555.0, 550.0, 545.0, 540.0, 535.0, 530.0
Depth scale: 0, 5, 10, 15, 20, 25, 30

Penetration Resistance (blows per foot): 0, 20, 40, 60, 80, 100 — Shear Strength
Consistency (water content %): L, W, P
Remarks

Vertical Scale 1 in. to 5 ft.

DOMINION SOIL INVESTIGATION LIMITED

Made: V.H. Checked: L.S.R.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 12

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY. # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 559.2

METHOD OF BORING: AUGERING
DIAMETER OF BOREHOLE: 6"
DATE: AUG 31 1962

ENCLOSURE NO 14

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N"	PENETRATION RESISTANCE blows per foot (plotted)	REMARKS
559.2	0	CRUSHED STONE FILL					
555.0	5	BROWN DAMP HARD SANDY CLAYEY SILT TILL	1	SS	30		
			2	SS	38		
550.0	10		3	SS	44		
			4	SS	104/10"		
545.0	15		5	SS	106		
540.0	20	GREY HARD DAMP SANDY CLAYEY SILT TILL	6	SS	45		
535.0	25		7	SS	56		
530.0			8	SS	5'		
	30						
525.0							

Column headings: PENETRATION RESISTANCE blows per foot 0 20 40 60 80 100; SHEAR STRENGTH lbs/sq ft; CONSISTENCY water content % PL W LL

VERTICAL SCALE 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE V.H. CH. L.S.R.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 13

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY. # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 551.7

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 2 7/8"
DATE: SEPT 7 1962

ENCLOSURE NO 15

Elevation ft	Depth ft	Stratification Description
551.7	0	ORGANIC CLAYEY TOPSOIL
	0 – approx. 8	BROWN SANDY SILT TILL (compact / very dense)
	approx. 8 – 17	HARD DAMP BROWN SANDY CLAYEY SILT TILL
	approx. 17 – 20	GREY-BROWN SILTY FINE SAND
	approx. 20 – 36	GREY SANDY CLAYEY SILT TILL (very stiff / hard)

Elevation scale: 551.7, 550.0, 545.0, 540.0, 535.0, 530.0, 525.0, 520.0, 515.0, 510.0
Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

Samples: Number	Type	No. of blows
1	SS	73
2	SS	59
3	SS	69
4	SS	46
5	SS	57
6	WS	
7	SS	37
8	SS	33
9	SS	19
10	SS	78/10"

PENETRATION RESISTANCE blows per foot: 0, 20, 40, 60, 80, 100
SHEAR STRENGTH lbs/sq ft
CONSISTENCY water content %: PL, W, LL
REMARKS

VERTICAL SCALE 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE V.H. [illegible] L.S.R.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 29

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION 551.0

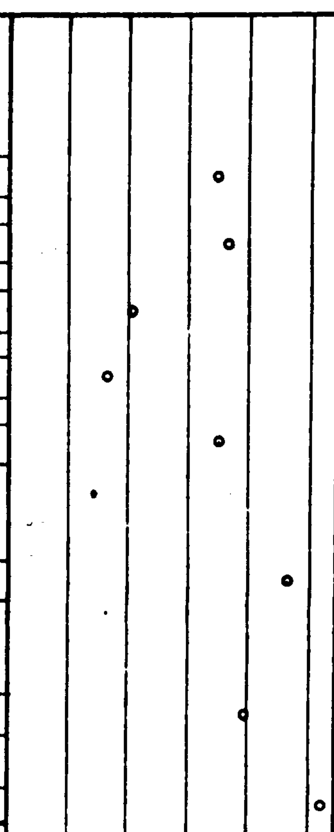
METHODE OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 2 7/8"
DATE: SEPT. 24. 1962.

ENCLOSURE NO 31

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	TYPE	N or Advancement of Sampler	REMARKS
551.0	0	TOPSOIL				
	5	BROWN DAMP HARD SANDY SILT TILL *slightly cemented*	1	SS	71	
545.0						
		VERY DENSE FINE SAND	2	SS	74	
	10		3	SS	41	
540.0						
			4	SS	33	
	15		5	SS	71	
535.0						
	20	*wet*	6	SS	93	
530.0						
	25	*silt layers*	7	SS	79	
525.0						
			8	SS	101/9"	
	30					
520.0						

PENETRATION RESISTANCE blows per foot: 0, 20, 40, 60, 80, 100
SHEAR STRENGTH lbs sq ft

CONSISTENCY water content %: PL, W, LL



VERTICAL SCALE 1 IN TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE V.H. CHKD L.S.R.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 31

OUR REFERENCE NO. 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 550.5

METHOD OF BORING: WASHBORING
DIAMETER OF BORE OUT: 2 7/8"
DATE: SEPT. 17, 1962.

ENCLOSURE NO 33

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" / Advancement of Sampler	PENETRATION RESISTANCE blows per foot (0–20–40–60–80–100) / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % (PL – W – LL)	REMARKS
550.5	0	TOPSOIL						
545.0	5	BUFF HARD DAMP SANDY SILT TILL *slightly cemented*	1	SS	76	o		
540.0	10		2	SS	97	o		
535.0	15	VERY DENSE DAMP FINE SAND *with layers of silt*	3	SS	91	o		
530.0	20	VERY DENSE FINE SAND *layered structure*	4	SS	134	o		
525.0	25		5	SS	91	o		
			6	SS	71	o		
520.0	30							

VERTICAL SCALE 1 IN TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE V H CHD L S R

GEOTECHNICAL DATA SHEET FOR BOREHOLE 32

OUR REFERENCE NO. 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY. # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 548.5

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 2 7/8"
DATE: SEPT. 18. 1962.

ENCLOSURE NO. 34

Depth ft.	Stratification Description	Sample Number	Type	"N" or Advancement of Sampler
0	TOPSOIL			
0–16	BROWN HARD SANDY SILT TILL *slightly cemented*	1	SS	72
		2	SS	92
		3	SS	82
		4	SS	141
		5	SS	174
16–31.5	VERY DENSE FINE SAND AND SILT *occasionally layered structure*	6	SS	101
		7	SS	112
		6	SS	72

PENETRATION RESISTANCE blows per foot: 0, 20, 40, 60, 80, 100
SHEAR STRENGTH lbs/sq ft
CONSISTENCY water content %: PL, W, LL
REMARKS

VERTICAL SCALE: 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE: V.H. CHD.: L.S.R.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 35

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 533.6

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 2 7/8"
DATE: SEPT 20 1962

ENCLOSURE NO 37

Elevation ft.	Depth ft.	Stratification Description	Samples Number	Type	N or Advancement of Sampler
533.6	0	TOPSOIL			
530.0	5	COMPACT BROWN GRAVELLY SAND; silty (probably fill)	1	SS	24
525.0			2	SS	23
	10		3	SS	19
520.0			4	SS	35
		BROWN HARD CLAYEY SILT TILL			
	15	BROWN DAMP VERY DENSE LAYERED SILT (cobble)	5	SS	51
515.0					
	20	BROWN HARD SANDY CLAYEY SILT TILL	6	SS	30
510.0					
	25	VERY DENSE DRY GREY SILT	7	SS	30
505.0			8	SS	63
	30				
500.0					

PENETRATION RESISTANCE blows per foot: 0, 20, 40, 60, 80, 100

SHEAR STRENGTH lbs/sq ft

CONSISTENCY water content %: PL, W, LL

REMARKS

APPENDIX C

AGRA
ENGINEERING GLOBAL SOLUTIONS

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY $= \frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

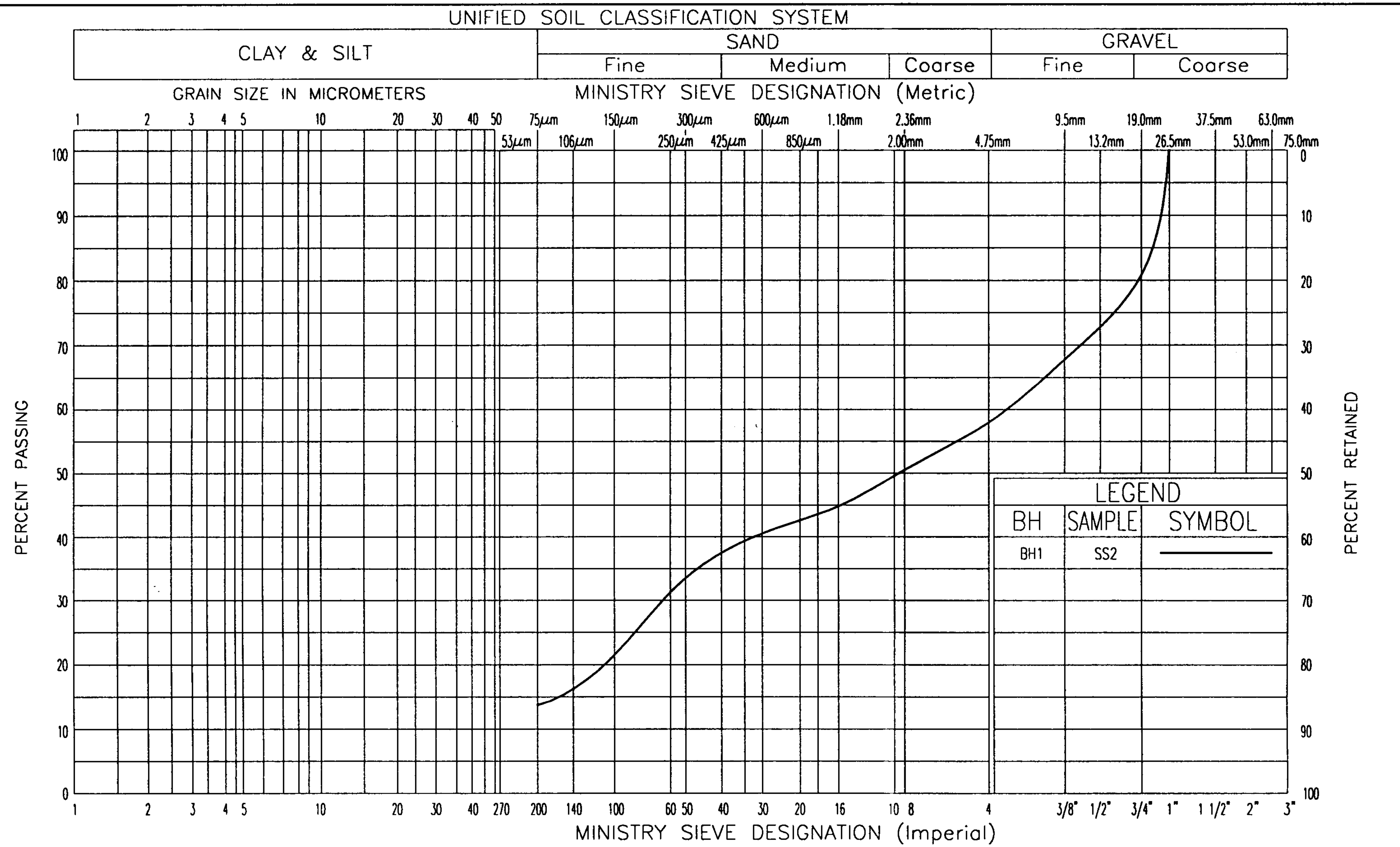
ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL

e	1,%	VOID RATIO
n	1,%	POROSITY
w	1,%	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX $= w_L - w_P$
I_L	1	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	1,%	VOID RATIO IN LOOSEST STATE

e_{min}	1,%	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_U	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FIGURES

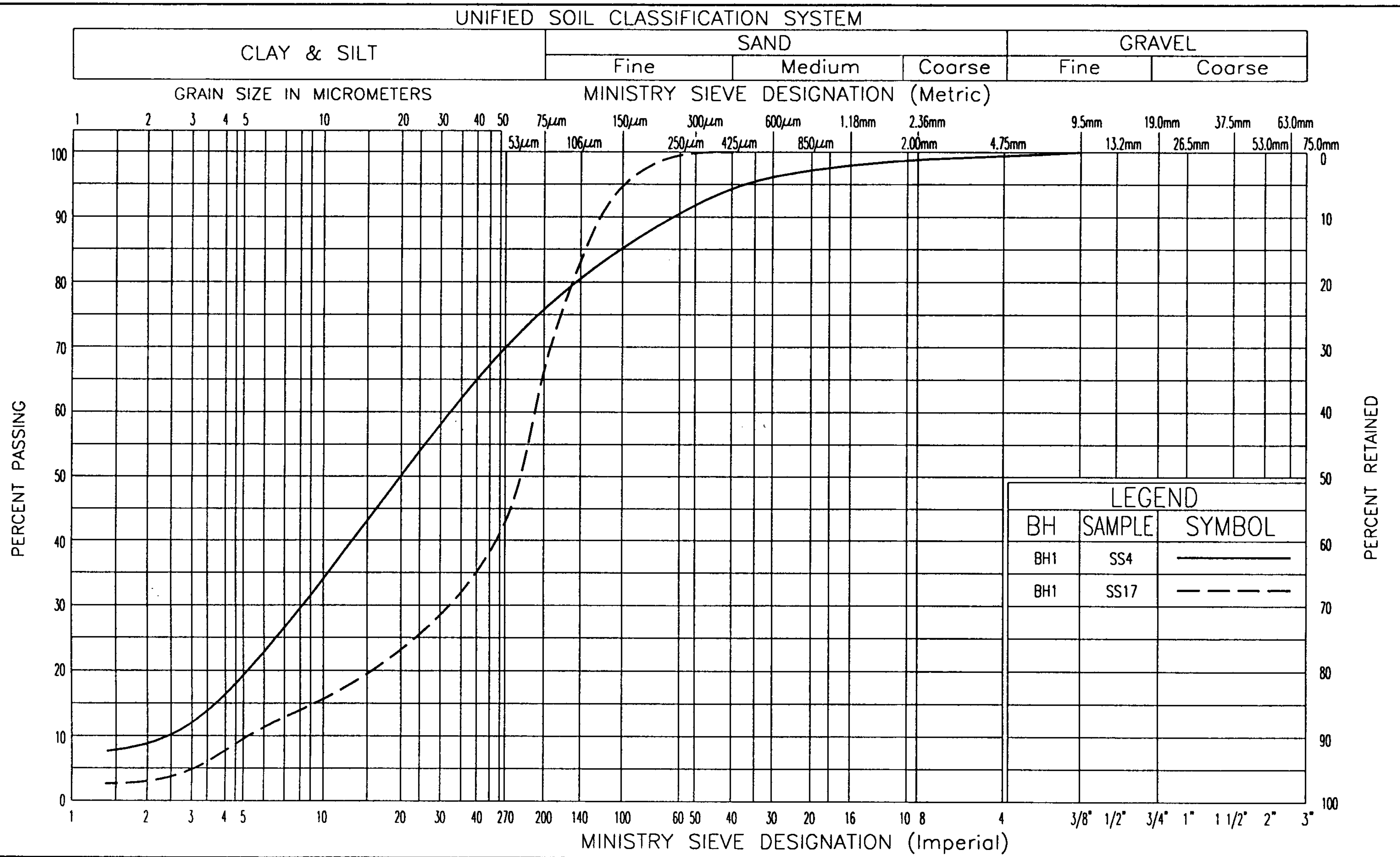
AGRA
ENGINEERING GLOBAL SOLUTIONS



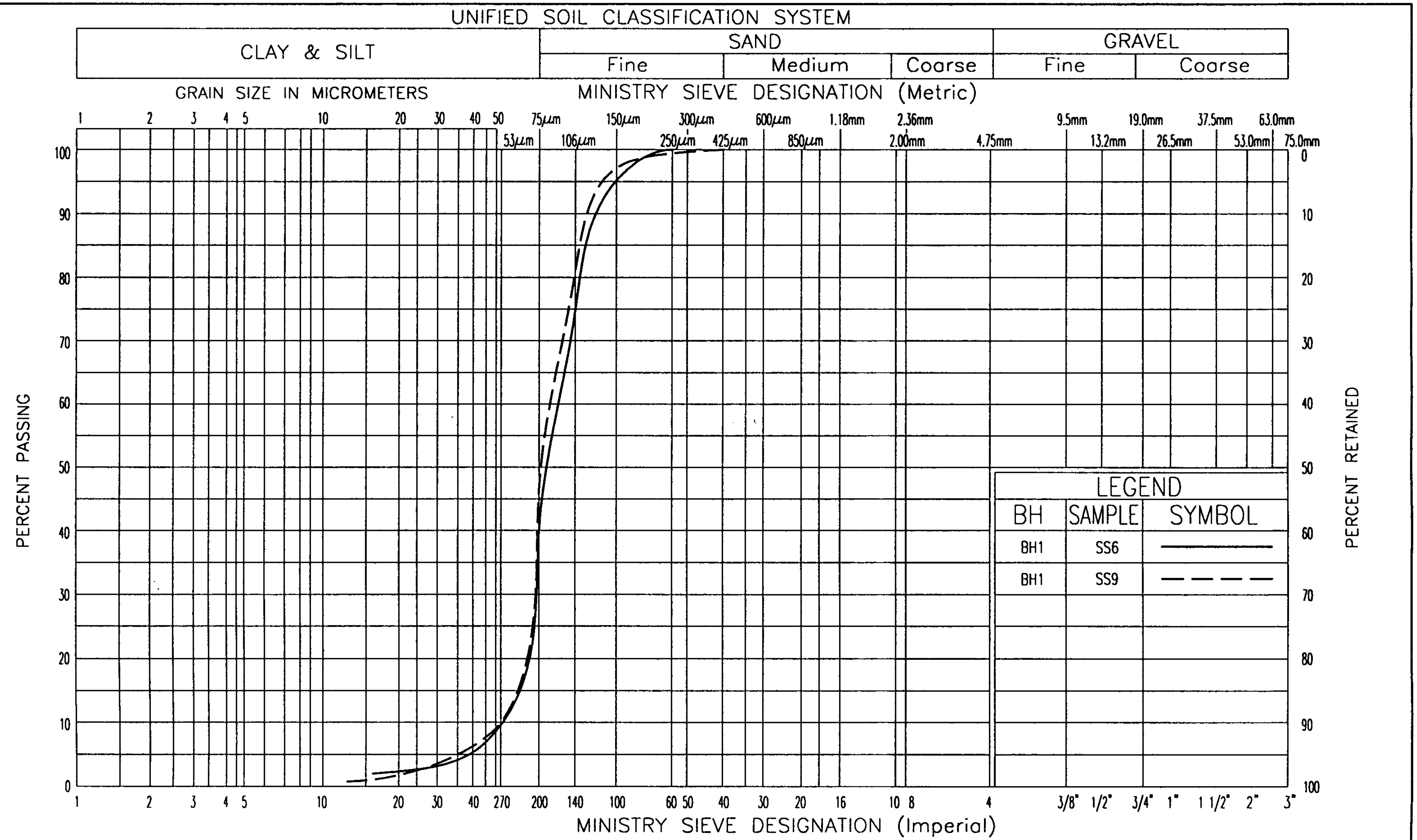
AGRA

GRAIN SIZE DISTRIBUTION
SAND & GRAVEL, some silt FILL

FIGURE No 1
W P 48-99-00



AGRA	FIGURE No 2
GRAIN SIZE DISTRIBUTION SANDY SILT, trace clay	W P 48-99-00

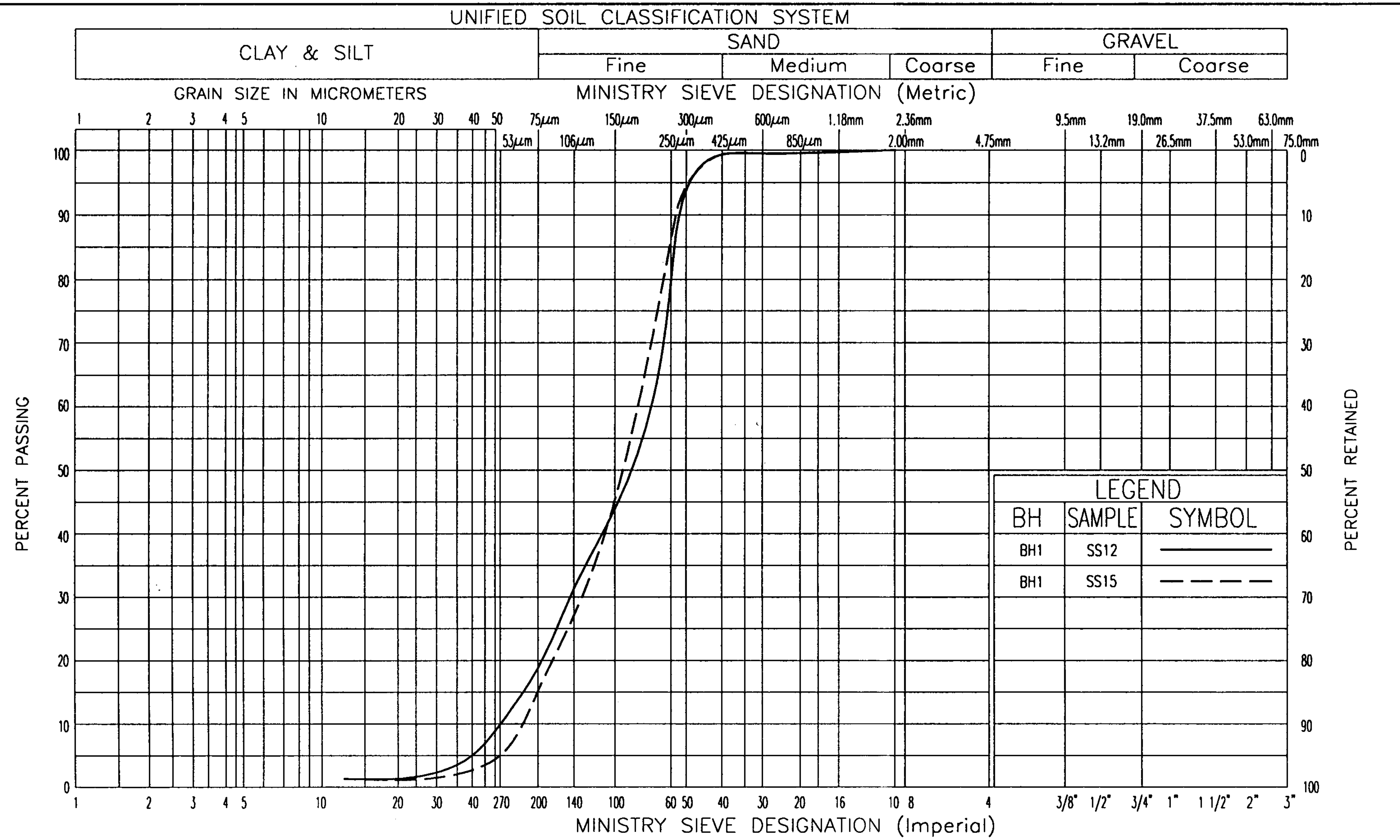


AGRA

GRAIN SIZE DISTRIBUTION
SAND & SILT

FIGURE No 3

W P 48-99-00

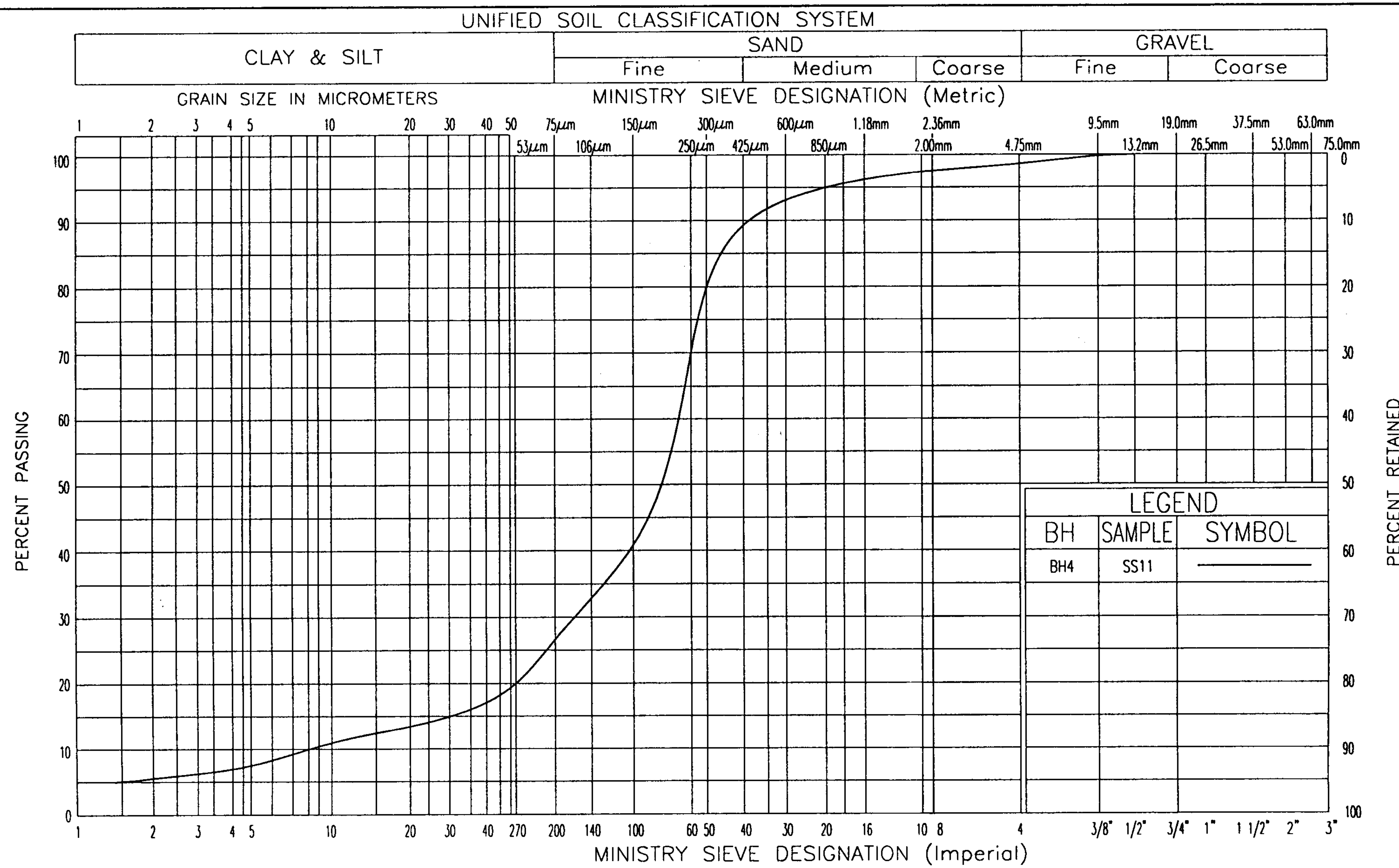


AGRA

GRAIN SIZE DISTRIBUTION
FINE SAND, some silt

FIGURE No 4

W P 48-99-00

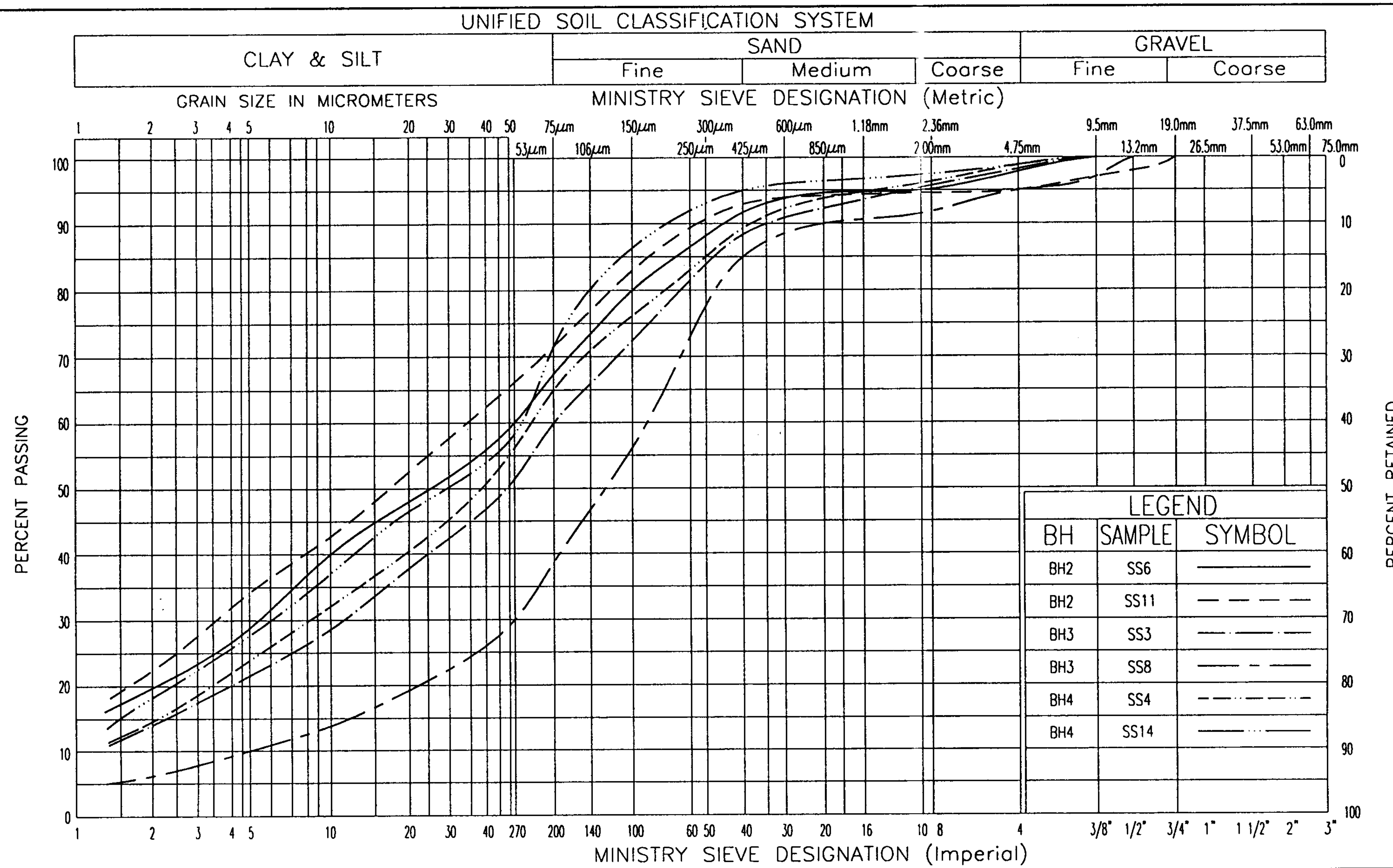


AGRA

GRAIN SIZE DISTRIBUTION
SILTY SAND, trace clay

FIGURE No 5

W P 48-99-00

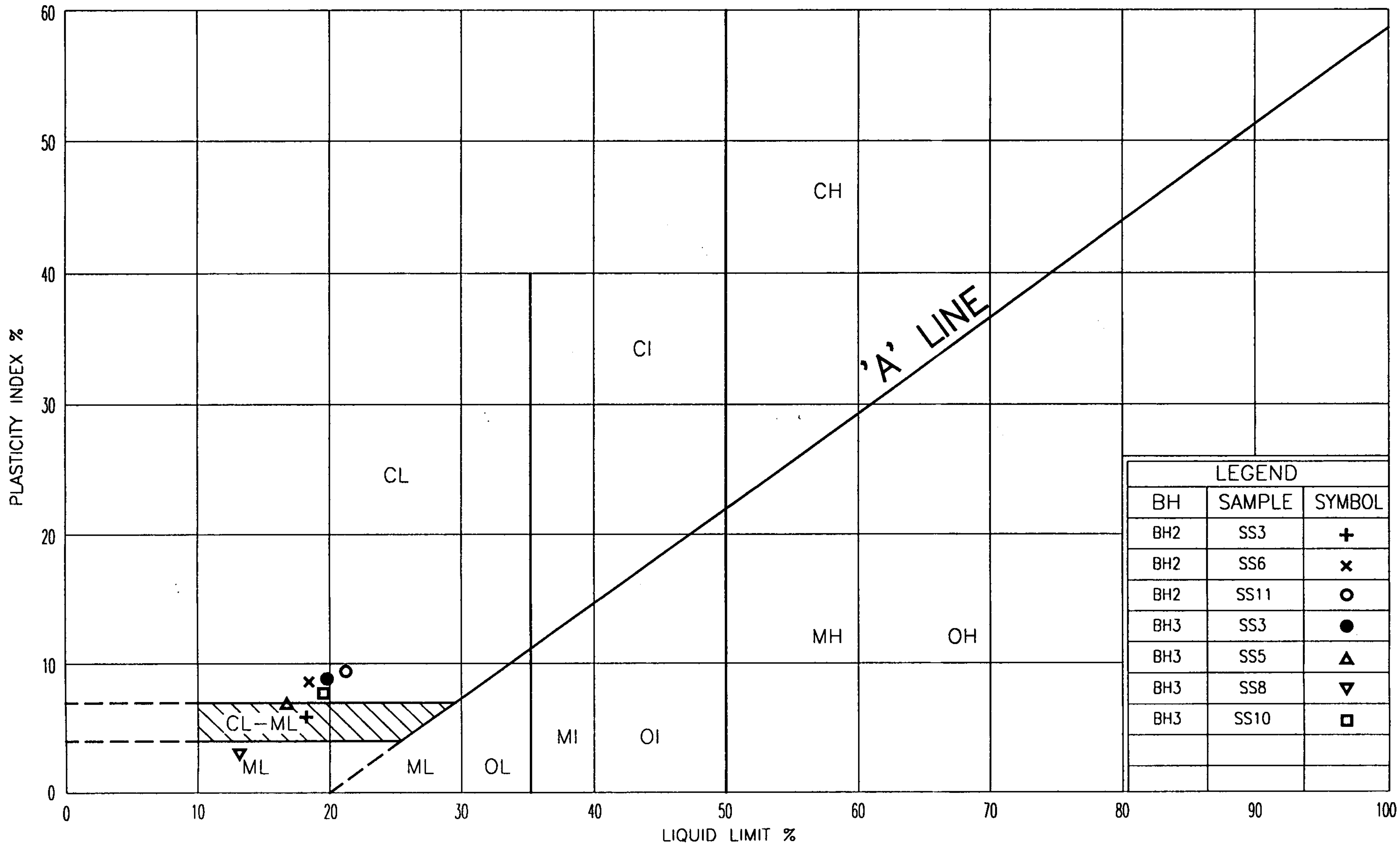


AGRA

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (GLACIAL TILL)

FIGURE No 6

W P 48-99-00



AGRA

PLASTICITY CHART
CLAYEY SILT

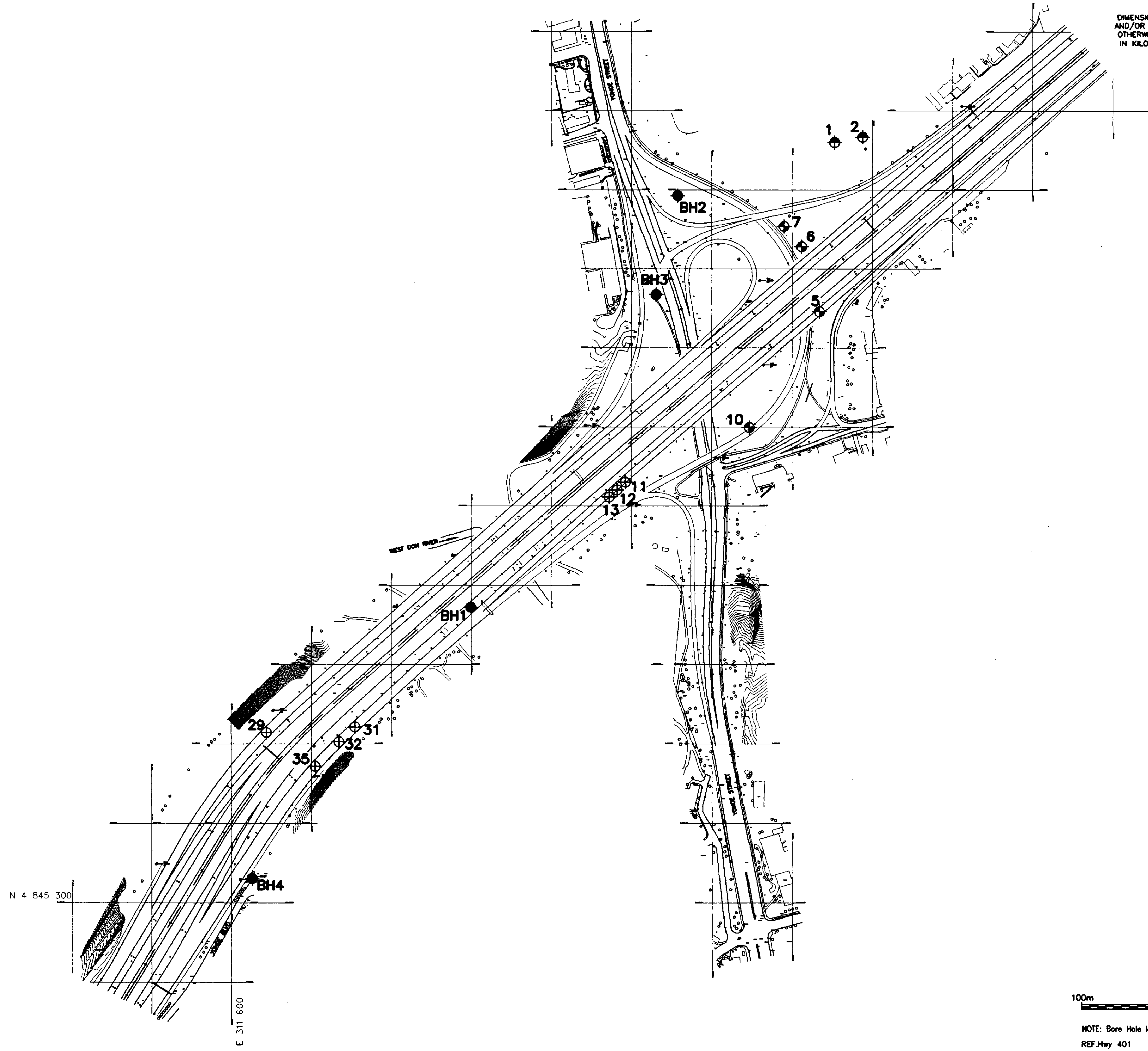
FIG No 7

W P 48-99-00

ENCLOSURES

AGRA
ENGINEERING GLOBAL SOLUTIONS

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES – METRES.



100m 0 100m

NOTE: Bore Hole locations are approximate.

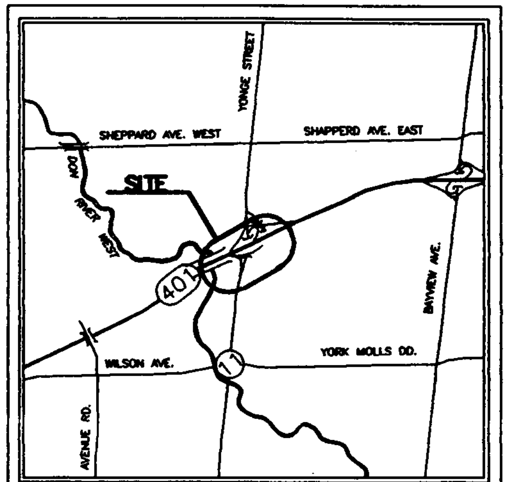
REF.Hwy 401

CONT. No.
W.P. No. 48-99-00

SHEET

HWY 401
BORE HOLE LOCATIONS FOR HIGH MAST LIGHTING POLES

AGRA Earth & Environmental Ltd.



KEY PLAN
N.T.S.

LEGEND

- Bore Hole (Current Investigation)
- Bore Hole (Geocres 30M14-121)
- Bore Hole (Geocres 30M14-122)
- Bore Hole (Geocres 30M14-126)

No	ELEVATION	CO-ORDINATES NORTH	EAST
BH1	138.14	4 845 672	311 900
BH2	175.29	4 846 192	312 158
BH3	173.34	4 846 067	312 131
BH4	170.34	4 845 331	311 625

-NOTE-
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION

HWY No 401			DIST
SUBM'D SP	CHECKED AD	DATE Oct.,1999	SITE
DRAWN MA	CHECKED GC	APPROVED	DWG 1

AGRA

Foundation Design

RECORD OF BOREHOLE No 1

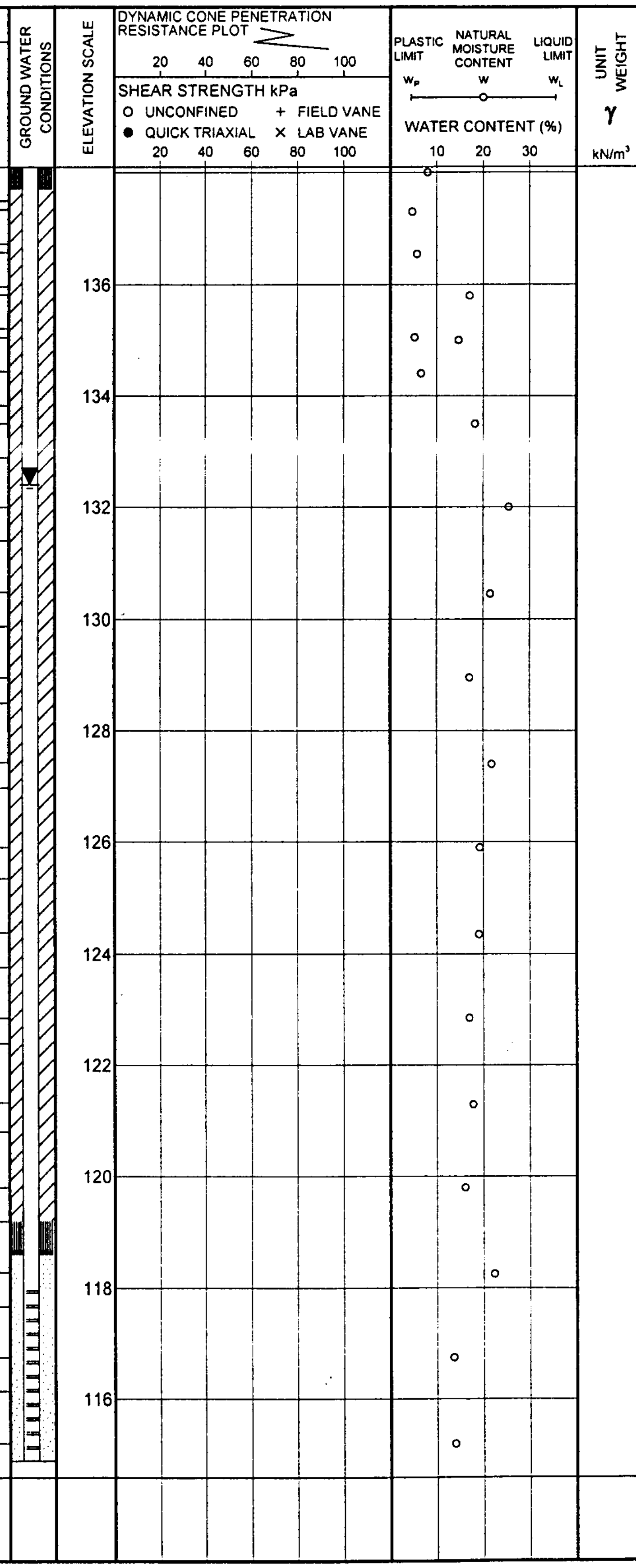
METRIC

W.P. 48-99-00 LOCATION N 4 845 672 E 311 900 ORIGINATED BY DT

DIST ______ HWY 401 BOREHOLE TYPE Hollow Stem Augering COMPILED BY MA

DATUM Geodetic DATE 12 October 1999 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
138.1 / 0.0	0.05m **TOPSOIL** brown Sand & Gravel **FILL** trace oxidized stains moist	1	SS	28	
		2	SS	52	42 44 (14)
136.6 / 1.5	grey brown **SANDY SILT** some clay, trace gravel dense to compact moist	3	SS	49	Inferred cobble at@1.4m depth.
		4	SS	19	1 23 67 9
135.0 / 3.1	brown **SAND & SILT** dense to very dense moist	5	SS	16	
		6	SS	51	0 60 40 0
	-------- grey wet	7	SS	61	
		8	SS	36	
		9	SS	30	0 55 45 0
129.4 / 8.7	grey fine **SAND** some silt dense to very dense moist to wet	10	SS	70	
		11	SS	45	
		12	SS	56	0 82 18 0
	-------- compact --------	13	SS	20	
		14	SS	88	
		15	SS	49	0 85 15 0
		16	SS	34	
118.8 / 19.3	grey **SANDY SILT to SILT** some sand, trace clay compact moist to wet	17	SS	25	0 35 62 3
	-------- very dense --------	18	SS	63	
		19	SS	22	
114.6 / 23.5	END OF BOREHOLE Water Level in Piezometer: Oct.25/99: 5.7m depth Nov.9/99: 5.7m depth Elev 132.4m				



+³, ×³: Numbers refer to Sensitivity   O³% STRAIN AT FAILURE

AGRA

RECORD OF BOREHOLE No 2

METRIC

W.P. 48-99-00		LOCATION N 4 846 192 E 312 158	ORIGINATED BY DT
DIST	HWY 401	BOREHOLE TYPE Solid Stem Augering	COMPILED BY MA
DATUM Geodetic		DATE 13 October 1999	CHECKED BY SP

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
175.3	
0.0	0.05m **TOPSOIL** grey brown Clayey Silt, some sand **FILL** some polyethilene fragments
174.2 / 1.1	grey brown **CLAYEY SILT** with sand, trace gravel occasional sand seams hard dry to moist **(GLACIAL TILL)** ------ grey moist ---------- fine to medium Sand trace gravel compact, wet ---------- ----------- Silty Sand, trace clay compact, wet ------------
164.4 / 10.9	END OF BOREHOLE Water Level in Piezometer: Oct.25/99: 6.8m depth Nov.9/99: 6.7m depth Elev.168.6m

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	27
2	SS	39
3	SS	95/28
4	SS	92/28
5	SS	70/15
6	SS	60/15
7	SS	50/14
9	SS	82/21
10	SS	19
11	SS	36
12	SS	50/10

STRAT PLOT · GROUND WATER CONDITIONS · ELEVATION SCALE (174, 172, 170, 168, 166)

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
3	29	49	19
4	24	49	23

Note: There is no sample No8.

$+^3, \times^3$: Numbers refer to Sensitivity

$O^{3\%}$ STRAIN AT FAILURE

AGRA

RECORD OF BOREHOLE No 3

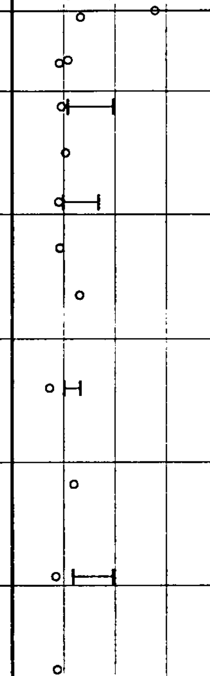
METRIC

W.P. 48-99-00	LOCATION N 4 846 067 E 312 131		ORIGINATED BY DT
DIST	HWY 401	BOREHOLE TYPE Solid Stem Augering	COMPILED BY MA
DATUM Geodetic	DATE 13 October 1999		CHECKED BY SP

SOIL PROFILE / SAMPLES

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.3					
0.0 / 172.7	0.13m **TOPSOIL** grey brown Clayey Silt **FILL**	1	SS	13	
0.7	grey brown **CLAYEY SILT** with sand, trace gravel some oxidized fissures very stiff to hard moist to dry **(GLACIAL TILL)**	2	SS	22	
		3	SS	45	2 38 46 14
		4	SS	44	
	---------- grey moist	5	SS	29	
		6	SS	25	
		7	SS	15	Inferred cobble below 5.5m depth.
	hard	8	SS	50/8	5 57 31 7
	some sand seams	9	SS	98/28	
		10	SS	50/11	
162.5		11	SS	50/14	
10.8	END OF BOREHOLE				

Columns: STRAT PLOT; GROUND WATER CONDITIONS; ELEVATION SCALE (172, 170, 168, 166, 164); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE; 20 40 60 80 100); PLASTIC LIMIT w_p, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ kN/m³.



+3, ×3: Numbers refer to Sensitivity   O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

METRIC

W.P. 48-99-00	LOCATION N 4 845 331 E 311 626		ORIGINATED BY PA
DIST	HWY 401	BOREHOLE TYPE Hollow Stem Augering	COMPILED BY MA
DATUM Geodetic	DATE 25 October 1999		CHECKED BY SP

SOIL PROFILE / SAMPLES

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
170.3 / 0.0	0.15m **TOPSOIL**	1	SS	-	170	
169.8 / 0.5	Sand with Gravel **FILL**	2	SS	11		
		3	SS			
	brown **CLAYEY SILT** wtih sand trace gravel very stiff to hard moist **(GLACIAL TILL)**	4	SS	25		2 34 50 14
		5	SS	43		
		6	SS	33	168	
	------ grey occ.clay seams	7	SS	15		
		8	SS	26		
165.9 / 4.4	grey brown **SILTY SAND** trace gravel, trace clay very dense moist	9	SS	96/25	166	
		10	SS			
		11	SS	103		2 71 21 6
		12	SS	62/15	164	
163.4 / 6.9	grey **CLAYEY SILT** with sand, trace gravel hard moist **(GLACIAL TILL)**	13	SS	101	162	
		14	SS	58/15		1 28 53 18
					160	
159.3 / 11.0	END OF BOREHOLE	15	SS	80/15		

Water Level in Piezometer:
Nov.9/99: 0.8m depth
Elev.169.5m

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED; + FIELD VANE; ● QUICK TRIAXIAL; X LAB VANE — 20 40 60 80 100

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

+ 3, X 3: Numbers refer to Sensitivity   O 3% STRAIN AT FAILURE

GEOCRES # 30M14-284

FOUNDATION INVESTIGATION REPORT
FOR
PROPOSED HIGH MAST LIGHTING
HOGGS HOLLOW STRUCTURE INFILL
G.W.P. 48-99-00
HIGHWAY 401/YONGE STREET AREA
TORONTO, ONTARIO

Submitted To:

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Submitted By:

AGRA
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada

February 2000
TT99860

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA
ENGINEERING GLOBAL SOLUTIONS

**AGRA Earth &
Environmental Limited**
104 Crockford Blvd.
Scarborough, Ontario
Canada M1R 3C6
Tel (416) 751-6565
Fax (416) 751-7592

February 8, 2000.
Ref. No.: TT99860

Delcan Corporation
133 Wynford Drive
North York, Ontario, M3C 1K1
Canada

Attention: Mr. Khaled El-Dalati, P. Eng.

Dear Sir:

**Re: FOUNDATION INVESTIGATION REPORT
FOR
PROPOSED HIGH MAST LIGHTING
HOGGS HOLLOW STRUCTURE INFILL
G.W.P. 48-99-00
HIGHWAY 401/YONGE STREET AREA
TORONTO, ONTARIO**

We take pleasure in enclosing six (6) copies of our Foundation Investigation Report for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

George S.W. Chow, P. Eng.,
Designated MTO Contact.

GSWC/dee

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3.0 INVESTIGATION PROCEDURES 2

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- 4.1 TOPSOIL AND FILL 3
- 4.2 SANDY SILT 4
- 4.3 SAND AND SILT 4
- 4.4 SAND 4
- 4.5 SILTY SAND 4
- 4.6 CLAYEY SILT (GLACIAL TILL) 5
- 4.7 GROUNDWATER CONDITIONS 5

5.0 CLOSURE 6

APPENDICES

APPENDIX A: **Limitations of Report**
APPENDIX B: **Records of Previous Boreholes**
APPENDIX C: **Explanation of Terms Used in Report**

FIGURES

GRAIN SIZE DISTRIBUTION CURVES Figures 1 - 6
PLASTICITY CHART Figure 7

ENCLOSURES

BOREHOLE LOCATIONS DWG. NO. 1
RECORD OF BOREHOLE SHEETS . . . . . ENCL. 1 - 4

1.0 INTRODUCTION

AGRA Earth & Environmental Limited (AGRA) has been retained by Delcan Corporation to carry out a subsurface investigation in the vicinity of the Highway 401/Yonge Street interchange area, in Toronto, from Station to .

This purpose of this investigation is to obtain supplementary subsurface information at selected locations by means of exploratory boreholes, in-situ tests and laboratory tests. Based on our interpretation of previous and current data, recommendations are provided on the geotechnical aspects of foundation design. Comments are also provided on anticipated construction issues where they may affect the geotechnical design of the proposed foundations.

Preliminary layout plans showing the HML pole locations are provided to us by Delcan (part of a preliminary report prepared by Cole, Sherman & Associates for the Ontario Ministry of Transportation [MTO]). The following documents have also been referenced during the preparation of this report.

- Universal Geotechnique Limited report titled "*Report on Subsurface Exploration for Proposed Bridge at Don River & Highway 401, Toronto, Ontario*", W.P. 172-58, Report No. T.333/58, dated September 1958 (GEOCRES No. 30M14-135).
- Dominion Soil Investigation Limited report titled "*Soil Investigation for Proposed West Don Sanitary Trunk Sewer, from Wilket Creek to Bayview Ave.*", dated July 1959.
- Geocon Limited report titled "*Soil Borings, Proposed Extension to Hoggs Hollow Bridge, Existing Highway 401 - District 6, Toronto, Ontario*", W.P. 172-58-2, Contract 59-151, dated May 1960 (GEOCRES No. 30M14-138).
- William A. Trow and Associates Limited report titled "*Foundation Investigation Hwy. 401 & Yonge Street Interchange, District No. 6, Toronto*", W.P. 265-61, Project J838, dated April 1962 (GEOCRES No. 30M14-122).
- Dominion Soil Investigation Limited report titled "*Highway #401 Collector Roads, Hoggs Hollow, Toronto*", W.P. 264-61-1, 264-61-2, dated November 1962 (GEOCRES No. 30M14-121).
- Department of Highways, Ontario report titled "*Proposed Retaining Walls (Yonge - Bayview Vicinity*", W.P. 252-61-1, 252-61-2, dated June 1964 (GEOCRES No. 30M14-126).

2.0 SITE DESCRIPTION AND PHYSIOGRAPHY

The proposed HML locations are distributed along a 1,200 m section of Highway 401, in the vicinities of the Hoggs Hollow structure and the Yonge Street interchange. The number of HML poles has not been finalized, but for the purpose of this investigation and design, 9 conventional HML poles and 1 tall HML pole are assumed. The tall HML pole is to be founded within the floodplain some 60 m west of the river channel, and to be extended between the eastbound collector and core lane structures.

Based on available geological information, the river floodplain is covered with recent sediments. At higher elevations, the valley walls consist of alternating till strata and river sediments, originating from and between substages of the Wisconsin glaciation, respectively. At the top of the valley, drifts from ground moraines, i.e. glacial tills of the Pleistocene Age, are present.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out on October 12, 13 and 25, 1999 and consisted of drilling and sampling four (4) boreholes. Borehole 1 was put down within the West Don River floodplain, about 60 m west of the river flow channel. Boreholes 2 and 3 were drilled and sampled at locations within the northeast and northwest quadrants of the Highway 401 and Yonge Street interchange, respectively. Borehole 4 was located near the east end of Yonge Boulevard. The plan locations of the boreholes are shown on Drawing No. 1.

The investigation was carried out using track-mounted and truck-mounted power auger drill rigs supplied and operated by AtCost Soil Drilling Inc. under the full time supervision of a member of AGRA's engineering staff. Hollow stem augers were used to advance Boreholes 1 and 4, whereas solid stem augers were used to put down Boreholes 2 and 3.

Soil sampling in the boreholes was carried out at regular intervals of depth by the Standard Penetration Test (SPT), as specified in ASTM Standard D1586. This consists of freely dropping a 63.5 kg hammer for a vertical distance of 0.76 m to drive a 50 mm outside diameter split barrel (split spoon) sampler into the ground. The number of blows of the hammer required to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance, or the 'N'-value of the soil, which gives an indication of the consistency or the compactness of the soil deposit. Groundwater conditions in the open boreholes were observed throughout and immediately after the drilling operations. Standpipe piezometers were installed in Boreholes 1, 2 and 4 to permit long term monitoring of the groundwater levels. All boreholes were backfilled and grouted. Water levels in piezometers were taken on October 25, 1999 (Boreholes 1 and 2) and on November 9, 1999 (Boreholes 1, 2 and 4).

The borehole locations for this investigation were established in the field by our engineering staff with reference to the tentative locations of the proposed HML poles (as shown in the Cole Sherman preliminary report) and previous boreholes. The as-drilled borehole locations were surveyed by

.../...

Rady-Pentek & Edward Surveying Ltd. with reference to MTO co-ordinates and the Geodetic datum. Co-ordinates were not available for the previously drilled boreholes.

The soil samples were identified in the field and shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification testing. A laboratory testing programme, consisting of natural moisture content determination, grain size analyses and Atterberg Limits tests, was performed on selected representative soil samples. The soils encountered in the boreholes are either water-bearing sands and silts, or very stiff to hard clayey silt glacial till. It is considered impractical, nor necessary, to obtain "undisturbed" samples of these soils. As such, triaxial and direct shear box tests were not carried out as part of the laboratory testing programme. The results of the laboratory tests are presented on the appropriate Record of Borehole sheets, and summarized on Figures 1 to 7.

4.0 SUBSURFACE CONDITIONS

The current investigation consists of four boreholes to supplement previous boreholes. The approximate locations of all current and relevant previous boreholes are shown on Drawing No. 1. Co-ordinates and elevations of the current boreholes are shown on the Record of Borehole sheets.

In Borehole 1, a thin veneer of topsoil overlying some sand and gravel fill was found within shallow depth below ground surface. Sandy silt grading into sand and silt was encountered below the fill to about 9 m depth, below which a fine sand stratum was encountered to about 20 m depth. Groundwater level was measured at about 5 m below ground surface. In Boreholes 2 and 3, topsoil and fill overlie clayey silt glacial till which extends to a borehole termination depth of 11 m. In Borehole 4, topsoil and fill immediately overlie sandy silt till which is underlain by sand to silty sand, changing to clayey silt glacial till at depth.

Details of the subsurface conditions encountered in these boreholes are presented in the Record of Borehole sheets, Enclosure Nos. 1 to 4. The following paragraphs are intended to complement and summarize this data. Records of relevant previous boreholes are included in Appendix B.

4.1 TOPSOIL AND FILL

Topsoil of thickness ranging between 0.05 m and 0.15 m was encountered in all four boreholes.

Sand and gravel fill was encountered, below the topsoil, in Boreholes 1 and 4, to 1.5 m and 0.5 m depths, or Elevations 136.6 and 169.8 m respectively. SPT 'N'-values ranged from 11 to 52 blows per 0.3 m penetration indicating variable density of compact to very dense, although the high value may be attributed to cobbles encountered. A grain size distribution curve of a sample of this fill is shown on Figure 1. The analysis indicates 42% gravel, 44% sand and 14% silt and clay. Measured natural moisture contents ranged from 5% to 9%.

Clayey silt fill was encountered, below the topsoil, in Boreholes 2 and 3 to 1.1 m and 0.7 m, or

.../...

Elevations 174.2 and 172.7 m respectively. SPT 'N'-values ranged from 13 to 27 blows per 0.3 m penetration indicating a stiff to very stiff consistency. Measured natural moisture contents ranged from 8% to 15%.

4.2 SANDY SILT

Deposits of sandy silt, trace to some clay were encountered immediately below the fill at a depth of 1.5 m (Elevation 136.6 m), and at about 20 m depth (Elevation 118.8 m) in Borehole 1. The sandy silt is 1.6 m thick at shallow depth, but was not fully penetrated near the bottom of the borehole, at a depth of 23.5 m or Elevation 114.6m. The measured 'N'-values of the sandy silt varied typically between 19 and 25 blows for 0.3 m penetration, indicating a compact condition. A high value of 49 blows at shallow depth in Borehole 1 can be attributed to the cobbles encountered, whereas a very dense zone ('N'-value of 63 blows) was contacted at about 21 m depth. Grain size distribution curves for two samples of this soil are presented on Figure 2. The analyses indicate 0 to 1% gravel, 23 to 35% sand, 62 to 67% silt and 3 to 9% clay. The measured natural moisture contents ranged from 13 to 22%.

4.3 SAND AND SILT

Sand and silt was encountered from 3.1 m to 8.7 m depths, or Elevations 135.0 to 129.4 m, in Borehole 1. This cohesionless soil is typically a mixture of fine sand and coarse silt. Measured 'N'-values generally ranged from 30 blows to 61 blows per 0.3 m penetration, indicating dense to very dense condition. An occasional 'N'-value of 16 blows indicated the presence of a compact zone at the top surface of this deposit. Figure 3 shows grain size distribution curves of two samples of this soil. The analyses indicated 55 to 60% sand, 40 to 45% silt with no gravel or clay. The measured natural moisture content ranged from 6 to 25%. The relatively large increase in moisture contents corresponds to a soil colour change from brown to grey at about 5 m depth, which is also consistent with a measured groundwater level of 5.7 m (Elevation 132.4m).

4.4 SAND

Below the sand and silt, in Borehole 1, is an extensive deposit of fine sand with some silt. This sand extends from 8.7 m to 19.3 m depth, or from Elevation 129.4 to 118.8 m. Measured 'N'-values generally ranged from 34 blows to 88 blows per 0.3 m penetration, indicating dense to very dense condition. An occasional 'N'-value of 20 blows indicated the presence of a compact zone. Figure 4 shows grain size distribution curves of two samples of this soil. The analyses indicated 82 to 85% sand, 15 to 18% silt with no gravel or clay. The measured natural moisture content ranged from 16 to 22%.

4.5 SILTY SAND

In Borehole 4, a silty sand interlayer was encountered within the glacial till, extending from 4.4 m to 6.9 m depths, or from Elevations 165.9 to 163.4m. 'N'-values were measured or inferred to be greater than 100 blows per 0.3 penetration, indicating a very dense condition throughout the layer.

.../...

Figure 5 shows the grain size distribution curve of a sample of the silty sand, indicating 2% gravel, 71% sand, 21% silt and 6% clay. Measured moisture contents range from 6 to 9%.

4.6 CLAYEY SILT (GLACIAL TILL)

A glacial till deposit comprised of a clayey silt matrix with sand and trace gravel was encountered below the fill in Boreholes 2, 3 and 4, until termination of all three boreholes at about 11 m depth (or Elevations 164.4, 162.5 and 159.3m, repectively) . Water-bearing sands and silts interlayers were contacted within the till in Boreholes 2 and 4. Measured 'N'-values ranged from 15 blows to over 100 blows per 0.3 m penetration, with a majority of the values greater than 30 blows. These values indicated typically hard consistency with some very stiff zones.

Figure 6 shows grain size distribution curves of six samples of this soil. The analyses indicated 1 to 5% gravel, 24 to 57% sand, 31 to 53% silt and 7 to 23% clay. Atterberg limits test results, as shown on Figure 7, indicated that the clayey silt matrix is of low plasticity with liquid limits ranging between about 13 and 21%, and plasticity indices ranging from about 3 to 9%. The measured natural moisture contents ranged from about 6 to 12%. Occasional higher values are attributed to the wet cohesionless interlayers.

4.7 GROUNDWATER CONDITIONS

Groundwater conditions in the open boreholes were observed during the drilling and on completion of each borehole.

Groundwater was encountered during drilling at about 6 m depth in Borehole 1. A water level at 5.7 m (Elevation 132.4 m) was measured in the piezometer installed in Borehole 1, some two weeks after installation. Free standing groundwater was not encountered in Boreholes 2, 3 and 4 on completion of drilling. In Borehole 2, however, samples of the interlayering sands and silts were wet.

Water levels in the piezometers were taken on October 25, 1999 (Boreholes 1 and 2) and on November 9, 1999 (Boreholes 1, 2 and 4). The highest groundwater level may, however, be inferred by the location at which the soil changed from brown to grey colour.

It should be noted, however, that the groundwater at the site will fluctuate seasonally and can be expected to rise during the spring months or in response to heavy rains.

.../...

5.0 CLOSURE

The Limitations of Report, as quoted in Appendix A, is an integral part of this report.

Sincerely,

for Sydney Pang, Ph.D., P. Eng.

Andrew Drevininkas, P. Eng.

Eric Y. Chung, M. Eng., P. Eng.
Designated MTO Contact.

AD

.../...

APPENDIX A

AGRA
ENGINEERING GLOBAL SOLUTIONS

AGRA

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AGRA accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

APPENDIX B

AGRA
ENGINEERING GLOBAL SOLUTIONS

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 64-F-40
W.P. 252-61-2
DATUM 574.0

LOCATION Ret. Wall on Hwy 401 N. Side Btwn Yonge & Bayview Ch. 7+60 ℄ 333'-0" Lt.
BORING DATE May 13, 1964.
BOREHOLE TYPE Pennsylvania Drill

ORIGINATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY M.D.

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L; PLASTIC LIMIT w_P; WATER CONTENT w — WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
574.0	Groundlevel									
0.0	Clayey silt with sand Very Stiff to Hard	hatched				570				
			1	SS	23					
			2	SS	25					▼ W.L. Elev. 562.0 Observed in casing.
						560				
			3	SS	30					
552.5			4	SS	84					
21.5	End of borehol e.					550				

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & RESEARCH DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 64-F-40
W.P. 252-61-2
DATUM 570.0

LOCATION Ret Wall on Hwy 401 N. Side Btwn Yonge & Bayview Ch. 8/90 ℄ 260'-0" Lt.
BORING DATE May 14, 1964.
BOREHOLE TYPE Pennsylvania Drill

ORIGINATED BY W.W.K.
COMPILED BY W.W.K.
CHECKED BY M.D.

ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT; SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L, PLASTIC LIMIT w_P, WATER CONTENT w; WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
570.0	Groundlevel									
567.0	Sandy silt. Fill									
566.0	Black org. topsoil									
4.0	Clayey silt with Sand stiff to hard.		1	SS	12					
			2	SS	48	560				W.L. El. 561.2 Observed in borehole.
			3	SS	25					
			4	SS	73	550				
21.5	End of borehole.									
						540				

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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING No 5

PROJECT No J838

LEGEND

PENETRATION RESISTANCE	
2" O.D. SPLIT TUBE	—o—o—o—
2" I.D. SHELBY TUBE	—+—+—+—
2" DIA. CONE	———
SHEAR STRENGTH	
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE	●
UNCONFINED COMPRESSION	●
VANE TEST AND SENSITIVITY (S)	+S

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX	X LI
ATTERBERG LIMITS	
LIQUID LIMIT	—o
PLASTIC LIMIT	⊢—
SAMPLE TYPE	
2" O.D. SPLIT TUBE	▮
2" I.D. SHELBY TUBE	▮
3" O.D. SHELBY TUBE	▮

BOREHOLE No. 4

PROJECT Hwy. 401 & Yonge Street Interchange

LOCATION Toronto, Ontario

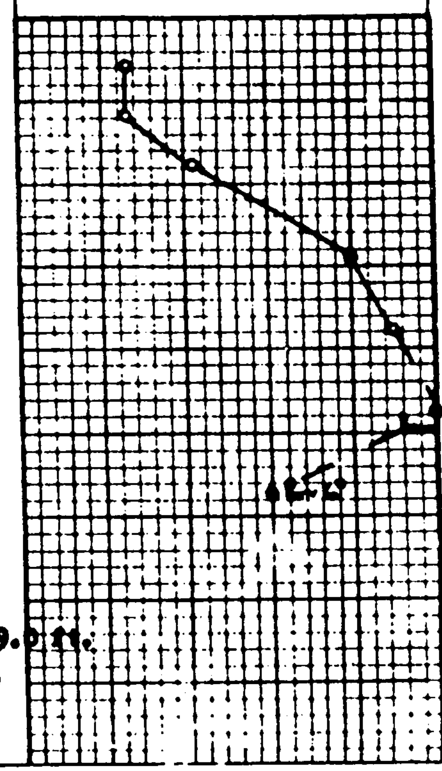
HOLE LOCATION See Dwg. 1.

HOLE ELEVATION 575.4 ft.

DATUM See Hole 1.

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No	NATURAL UNIT WEIGHT P.C.F.
	Ground Surface	575.4	0		
	~2 ins. topsoil and sod. CLAYEY SANDY SILT TILL-brown, oxidized, medium dense above ~7 ft., dense below -clayey at about 9 ft. -grey below ~13 ft. & slightly higher sand content with depth.	557.4	10	SS1, SS2, SS3, SS4	
	▽	556.7		SS5	
	CLAY & SILT-hard grey brown clay with irregular silt intrusions - odd sand parting.	553.5	20		
	SAND-med. to coarse brown grey very dense sand; some layers of silt. -becomes coarse with numerous fine gravel sizes.			SS6, SS7	
	End of Hole	546.4	30		
			40		

PENETRATION RESISTANCE 350 FT LB BLOWS/FT: 20, 40, 60, 80 — SHEAR STRENGTH PSF



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

Notes: 1) Hole augered & uncased to full depth.

2) Hole caving at 21 ft. during drilling. At completion, W.L. at 18.0 ft., open to 19.0 ft. also after 4 days, 8 days and 13 days.

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SITE INVESTIGATIONS — SOIL MECHANICS CONSULTATION

DRAWING No. 6
PROJECT No. 7838

BOREHOLE No. 5
PROJECT Hwy. 401 & Yonge Street Interchange
LOCATION Toronto, Ontario
HOLE LOCATION See Dwg. 1.
HOLE ELEVATION 577.2 ft.
DATUM See Hole 1.

LEGEND

PENETRATION RESISTANCE
2" O.D. SPLIT TUBE
3" I.D. SHELBY TUBE
2" DIA. CONE

SHEAR STRENGTH
UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
UNCONFINED COMPRESSION
VANE TEST AND SENSITIVITY (S)

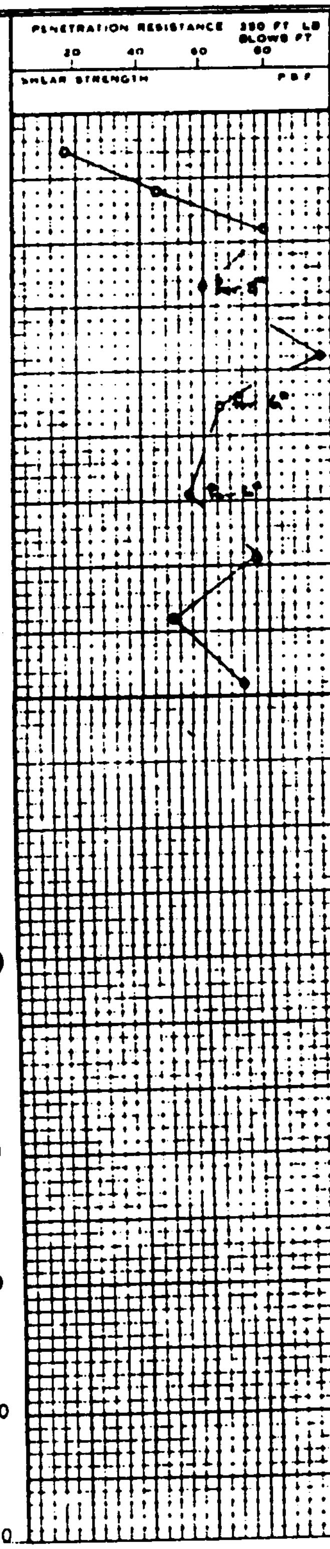
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X^{LI}

ATTERBERG LIMITS
LIQUID LIMIT
PLASTIC LIMIT

SAMPLE TYPE
2" O.D. SPLIT TUBE
3" I.D. SHELBY TUBE
3" O.D. SHELBY TUBE

SOIL DESCRIPTION	ELEV FEET	DEPTH FEET
Ground Surface	577.2	0
-no topsoil, grass & sod cover CLAYEY SANDY SILT TILL-brown oxidised, very stiff, with fine to coarse gravel sizes.	564.6	10
SAND & SILT- ~12 in. thick med. sand seam, then sandy silt with gravel sizes, and numerous thin irregular silt partings and intrusions -clay interbeds up to 4 ins. thick with depth, very dense.	559.0 (water level) 554.7	20
SAND-very dense, med. sand, wet, some layers or pockets of silt. -occasional fine gravel sizes.	548.2	
CLAYEY SILT-very stiff - 12 ins. med. to coarse sand seam 31 to 32 ft.	~545	30
LAYERED SANDY SILT & CLAY-very dense & hard - irregularly layered to ~37 ft. -sandy silt phase contains fine gravel -rhythmic varving below ~37 ft., approx. phase thickness ½" to ¾".	536	40
SANDY SILT TILL-very dense, with gravel sizes - silty clay intrusions.	532.8	
End of Hole		

Samples: SS1, SS2, SS3, SS4, SS5, SS6, SS7, SS8, SS9, SS10



Notes:

1) Hole augered & uncased to 28.5 ft, caving at 2?.5 ft.
Hole continued by running BX casing to 29 ft., and drilling ahead.

2) With hole at 28½ ft.,
At completion, wet cave at 22.5 ft.
After 3 days, moist cave at 16.2 ft.
" 7 days " " " 16.2 ft.

3) With hole at 45 ft.
At completion, W.L. at 14 ft., (drill water)
After 5 days, W.L. at 18.2 ft., open to 23.0 ft.

Conclusion: Stabilised level at 18.2 ft.

NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

SAMPLE TYPE AND No.

NATURAL UNIT WEIGHT P.C.F.

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SITE INVESTIGATIONS · SOIL MECHANICS CONSULTATION

DRAWING NO. 7

PROJECT NO. J838

BOREHOLE NO. 6

PROJECT Hwy. 401 & Yonge Street Interchange

LOCATION Toronto, Ontario

HOLE LOCATION See Dwg. 1.

HOLE ELEVATION 578.7 ft.

DATUM See Hole 1.

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE —o—o—o—
- 2" I.D. SHELBY TUBE —+—+—+—
- 2" DIA. CONE ———

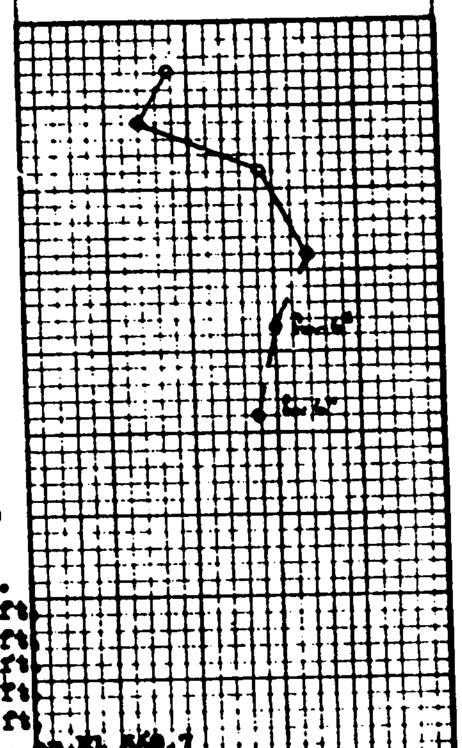
SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE ●
- UNCONFINED COMPRESSION ●
- VANE TEST AND SENSITIVITY (S) +S

NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX X LI

ATTERBERG LIMITS
- LIQUID LIMIT —o
- PLASTIC LIMIT |—

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

SYMBOL	SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	PENETRATION RESISTANCE 350 FT LB BLOWS/FT (20, 40, 60, 80) / SHEAR STRENGTH PSF	NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT	SAMPLE TYPE AND No	NATURAL UNIT WEIGHT P.C.F
	Ground Surface	578.7	0				
	-sand & gravel - highway shoulder FILL-sandy silt, odd clay pockets, odd gravel sizes.	574.3				SS1, SS2	
	CLAYEY SANDY SILT TILL-very dense, oxidized brown with fine to coarse sand partings -grey below ~ 14 ft. -very sandy below 18 ft.	569.7 (W.L.) 555.7	10, 20			SS3, SS4, SS5, SS6	
	SAND-dense, wet, fine to med. sand - a few fine gravel sizes.	550.7	30				
	End of Hole						



Notes: 1) Hole augered & uncased to full depth.

2) At completion, W.L. at 23 ft. open to 24 ft.
After 5 hrs., W.L. at 20.5 ft. " " 2[illegible]5 ft
" 29 hrs., " " 15.5 ft. " " 2[illegible]5 ft
" 53 hrs., " " 12.2 ft. " " 1[illegible]0 ft
" 77 hrs., " " 10.1 ft. " " 1[illegible] ft
" 101 hrs., " " 9.6 ft. " " 1[illegible]2 ft

Conclusion: W.L. probably stabilizing at about 9.0 ft., or El. [illegible]
Relatively slow initial rise believed to indicate minor seepage from sand seams noted in the till.

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SITE INVESTIGATIONS — SOIL MECHANICS CONSULTATION

DRAWING No. 10
PROJECT No. J838

BOREHOLE No. 9
PROJECT: Hwy. 401 & Yonge Street Interchange
LOCATION: Toronto, Ontario
HOLE LOCATION: See Dwg. 1.
HOLE ELEVATION: 578.9 ft.
DATUM: See Hole 1.

LEGEND

PENETRATION RESISTANCE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 2" DIA. CONE

SHEAR STRENGTH
- UNDRAINED TRIAXIAL AT OVERBURDEN PRESSURE
- UNCONFINED COMPRESSION
- VANE TEST AND SENSITIVITY (S)

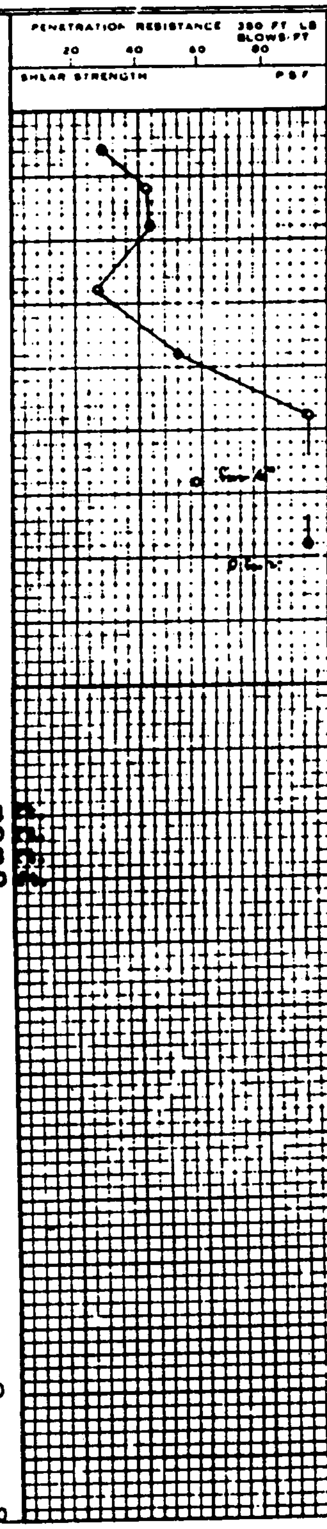
NATURAL MOISTURE CONTENT AND LIQUIDITY INDEX

ATTERBERG LIMITS
- LIQUID LIMIT
- PLASTIC LIMIT

SAMPLE TYPE
- 2" O.D. SPLIT TUBE
- 2" I.D. SHELBY TUBE
- 3" O.D. SHELBY TUBE

SOIL DESCRIPTION	ELEV FEET	DEPTH FEET	SAMPLE TYPE AND No.
Ground Surface	578.9	0	
-no topsoil, grass & sod cover			SS1
CLAYEY SANDY SILT TILL-brown, oxidized, very stiff to hard.			SS2
-grey below 9½ ft.		10	SS3
-slightly less stiff at ~13 ft.	563		SS4
-harder below ~15 ft., with higher sand content.	562.5		SS5
	558	20	
CLAYEY SILT-very stiff to hard, grey, odd gravel size and occasional sandy silt layer or intrusion.			SS6, SS7
	547.4	30	
SAND-wet, grey, silty fine sand.	545.2		SS8
CLAYEY SILT-grey, very stiff to hard.			SS9
-augered ahead to 45 ft. and identified material on auger flights.		40	
End of Hole	533.9		

Depth scale: 0, 10, 20, 30, 40, 50, 70, 80, 90, 100, 110



NATURAL MOISTURE CONTENT AND ATTERBERG LIMITS % DRY WEIGHT

NATURAL UNIT WEIGHT PCF

Notes:
1) Hol· augered & uncased to full depth. Partially stabilized with bentonite but ouving at ~34 ft.
2) At completion, W.L. at 16.5 ft., open to 31.4 ft.
After ½ hr., W.L. at 16.5 ft. " " 30.0 ft.
" 24 hrs. " " 16.4 ft. " " 23.8 ft.
" 48 hrs. " " 16.4 ft. " " 19.0 ft.
and after 6 days.

Conclusion: Water rising from sand seam at El 546 ft.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 11

JOB REFERENCE NO. 2-8-18
CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY. # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 561.2

METHOD OF BORING: AUGERING
DIAMETER OF BOREHOLE: 6"
DATE: AUG 30 1962

ENCLOSURE NO. 13

Elevation ft	Depth ft	Stratification Description	Sample Number	Type	Blows	Remarks
561.2	0	GRAVEL, SAND FILL				
	5	BROWN DAMP HARD SANDY CLAYEY SILT TILL	1	SS	23	
			2	SS	37	
	10		3	SS	46	
			4	SS	74/9"	
	15	GREY DAMP HARD SANDY CLAYEY SILT TILL	5	SS	70/6"	
	20		6	SS	80	
	25		7	SS	67	
			8	SS	69	
	30					

VERTICAL SCALE 1 INCH TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE: V H   CHECKED: L S R

GEOTECHNICAL DATA SHEET FOR BOREHOLE 12

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY. # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 559.2

METHOD OF BORING: AUGERING
DIAMETER OF BOREHOLE: 6"
DATE: AUG 31 1962.

ENCLOSURE NO 14

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	SAMPLE NUMBER	TYPE	"N" blows/ft
559.2	0	CRUSHED STONE FILL			
555.0	5	BROWN DAMP HARD SANDY CLAYEY SILT TILL	1	SS	30
			2	SS	38
550.0	10		3	SS	44
			4	SS	104/10"
545.0	15		5	SS	106
540.0	20	GREY HARD DAMP SANDY CLAYEY SILT TILL	6	SS	45
535.0	25		7	SS	56
530.0	30		8	SS	5'
525.0					

PENETRATION RESISTANCE blows per foot: 0, 20, 40, 60, 80, 100
SHEAR STRENGTH lbs-sq ft
CONSISTENCY water content %: PL, W, LL
REMARKS

VERTICAL SCALE 1 IN. TO 5 FT.

DOMINION SOIL INVESTIGATION LIMITED

MADE V.H. CHKD L.S.R

GEOTECHNICAL DATA SHEET FOR BOREHOLE 13

OUR REFERENCE NO 2-8-18

CLIENT ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT HWY. # 401 COLLECTOR ROADS
LOCATION HOGGS HOLLOW, TORONTO
DATUM ELEVATION 551.7

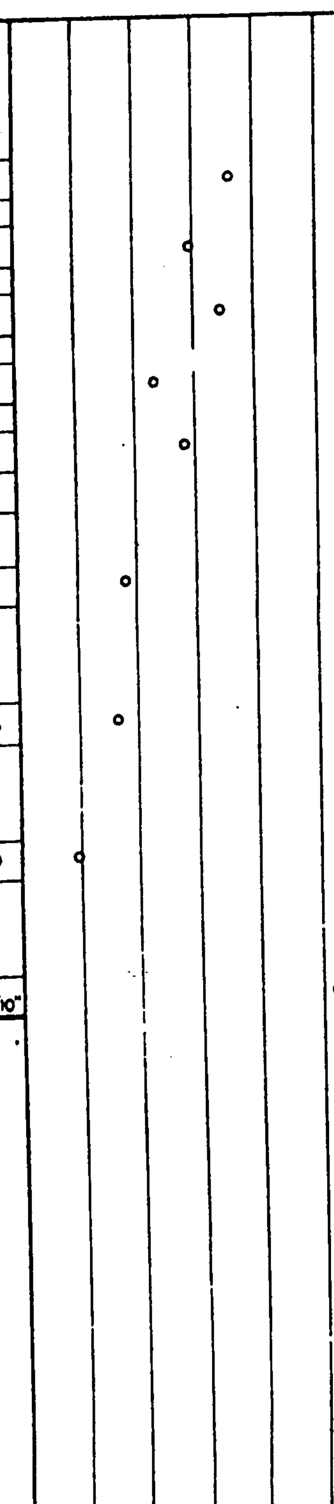
METHOD OF BORING WASHBORING
DIAMETER OF BOREHOLE 2 ⅞"
DATE SEPT 7. 1962

ENCLOSURE NO 15

Elevation ft	Depth ft	Stratification Description	Sample Number	Sample Type	N
551.7	0	ORGANIC CLAYEY TOPSOIL			
		BROWN SANDY SILT TILL (compact – very dense)			
	5		1	SS	73
			2	SS	59
	10	HARD DAMP BROWN SANDY CLAYEY SILT TILL	3	SS	69
			4	SS	46
	15		5	SS	57
		GREY-BROWN SILTY FINE SAND	6	WS	
	20		7	SS	37
		GREY SANDY CLAYEY SILT TILL			
	25		8	SS	33
	30		9	SS	19
		(very stiff – hard)			
	35		10	SS	78/10"

Elevation scale: 551.7, 550.0, 545.0, 540.0, 535.0, 530.0, 525.0, 520.0, 515.0, 510.0

PENETRATION RESISTANCE blows per foot (0, 20, 40, 60, 80, 100) / SHEAR STRENGTH lbs/sq ft



CONSISTENCY water content % (PL, W, LL)

REMARKS

VERTICAL SCALE 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE V H CHKD L S P

GEOTECHNICAL DATA SHEET FOR BOREHOLE . .29. .

OUR REFERENCE NO 2-8-18

CLIENT:	ONTARIO DEPARTMENT OF HIGHWAYS	METHOD OF BORING	WASHBORING
PROJECT:	HWY # 401 COLLECTOR ROADS	DIAMETER OF BOREHOLE	2 7/8"
LOCATION:	HOGGS HOLLOW, TORONTO	DATE	SEPT. 24. 1962.
DATUM ELEVATION	551.0	ENCLOSURE NO	31

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	SAMPLES NUMBER	SAMPLES TYPE	"N" or Advancement of Sampler	PENETRATION RESISTANCE blows per foot (0 20 40 60 80 100) / SHEAR STRENGTH lbs sq ft	CONSISTENCY water content % (PL W LL)	REMARKS
551.0	0	TOPSOIL						
		BROWN DAMP HARD SANDY SILT TILL *slightly cemented*						
	5							
545.0			1	SS	71			
		VERY DENSE FINE SAND	2	SS	74			
	10							
540.0			3	SS	41			
			4	SS	33			
	15							
535.0			5	SS	71			
	20	*wet*						
530.0			6	SS	93			
	25	*silt layers*						
525.0			7	SS	79			
			8	SS	101/9"			
	30							
520.0								

VERTICAL SCALE 1 IN TO 5 FT DOMINION SOIL INVESTIGATION LIMITED MADE V H CHD L S R

GEOTECHNICAL DATA SHEET FOR BOREHOLE 31

OUR REFERENCE NO. 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 550.5

METHOD OF BORING: WASHBORING
DIAMETER OF BORE OLT: 2 ⅞"
DATE: SEPT 17, 1962.

ENCLOSURE NO 35

ELEVATION ft.	DEPTH ft.	STRATIFICATION DESCRIPTION	STRATIFICATION SYMBOL	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES Advancement of Sampler (blows/ft)	PENETRATION RESISTANCE blows per foot (0, 20, 40, 60, 80, 100) / SHEAR STRENGTH lbs/sq ft	CONSISTENCY water content % (PL W LL)	REMARKS
[illegible]	0	TOPSOIL							
[illegible]	5	BUFF HARD DAMP SANDY SILT TILL *slightly cemented*		1	SS	76			
540.0	10			2	SS	97			
[illegible]	15	VERY DENSE DAMP FINE SAND *with layers of silt*		3	SS	91			
530.0	20	VERY DENSE FINE SAND *layered structure*		4	SS	134			
[illegible]	25			5	SS	91			
				6	SS	71			
[illegible]	30								

VERTICAL SCALE 1 IN TO 5 FT — DOMINION SOIL INVESTIGATION LIMITED — MADE V H — CHD L S R

GEOTECHNICAL DATA SHEET FOR BOREHOLE 32

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY. # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 348.5

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 2 7/8"
DATE: SEPT. 18, 1962.

ENCLOSURE NO 34

Depth ft.	Stratification Description	Samples Number	Type	N of Sampler	Remarks
0	TOPSOIL				
5	BROWN HARD SANDY SILT TILL *slightly cemented*	1	SS	72	
		2	SS	92	
10		3	SS	82	
		4	SS	141	
15		5	SS	174	
20	VERY DENSE FINE SAND AND SILT *occasionally layered structure*	6	SS	101	
25		7	SS	112	
30		8	SS	72	

PENETRATION RESISTANCE blows per foot: 0, 20, 40, 60, 80, 100
SHEAR STRENGTH lbs/sq ft
CONSISTENCY water content %: Pl W Ll

VERTICAL SCALE: 1 IN. TO 5 FT

DOMINION SOIL INVESTIGATION LIMITED

MADE V.H. CHD L.S.R.

GEOTECHNICAL DATA SHEET FOR BOREHOLE 35

OUR REFERENCE NO 2-8-18

CLIENT: ONTARIO DEPARTMENT OF HIGHWAYS
PROJECT: HWY # 401 COLLECTOR ROADS
LOCATION: HOGGS HOLLOW, TORONTO
DATUM ELEVATION: 533.6

METHOD OF BORING: WASHBORING
DIAMETER OF BOREHOLE: 2 7/8"
DATE: SEPT 20 1962

ENCLOSURE NO 37

Elevation ft.	Depth ft.	Stratification Description	Sample Number	Type	N – Advancement of Sampler	Penetration Resistance (blows per foot; 20, 40, 60, 80, 100) / Shear Strength lbs/sq ft	Consistency (water content % PL W LL)	Remarks
533.6	0	TOPSOIL						
530.0	5	COMPACT BROWN GRAVELLY SAND; silty (probably fill)	1	SS	24			
525.0			2	SS	23			
	10		3	SS	19			
520.0			4	SS	35			
		BROWN HARD CLAYEY SILT TILL						
	15	cobble; BROWN DAMP VERY DENSE LAYERED SILT	5	SS	51			
515.0								
	20	BROWN HARD SANDY CLAYEY SILT TILL	6	SS	30			
510.0								
	25	VERY DENSE DRY GREY SILT	7	SS	30			
505.0			8	SS	63			
	30							
500.0								

APPENDIX C

AGRA
ENGINEERING GLOBAL SOLUTIONS

EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY, IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

S S	SPLIT SPOON	T P	THINWALL PISTON
W S	WASH SAMPLE	O S	OSTERBERG SAMPLE
S T	SLOTTED TUBE SAMPLE	R C	ROCK CORE
B S	BLOCK SAMPLE	P H	T W ADVANCED HYDRAULICALLY
C S	CHUNK SAMPLE	P M	T W ADVANCED MANUALLY
T W	THINWALL OPEN	F S	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

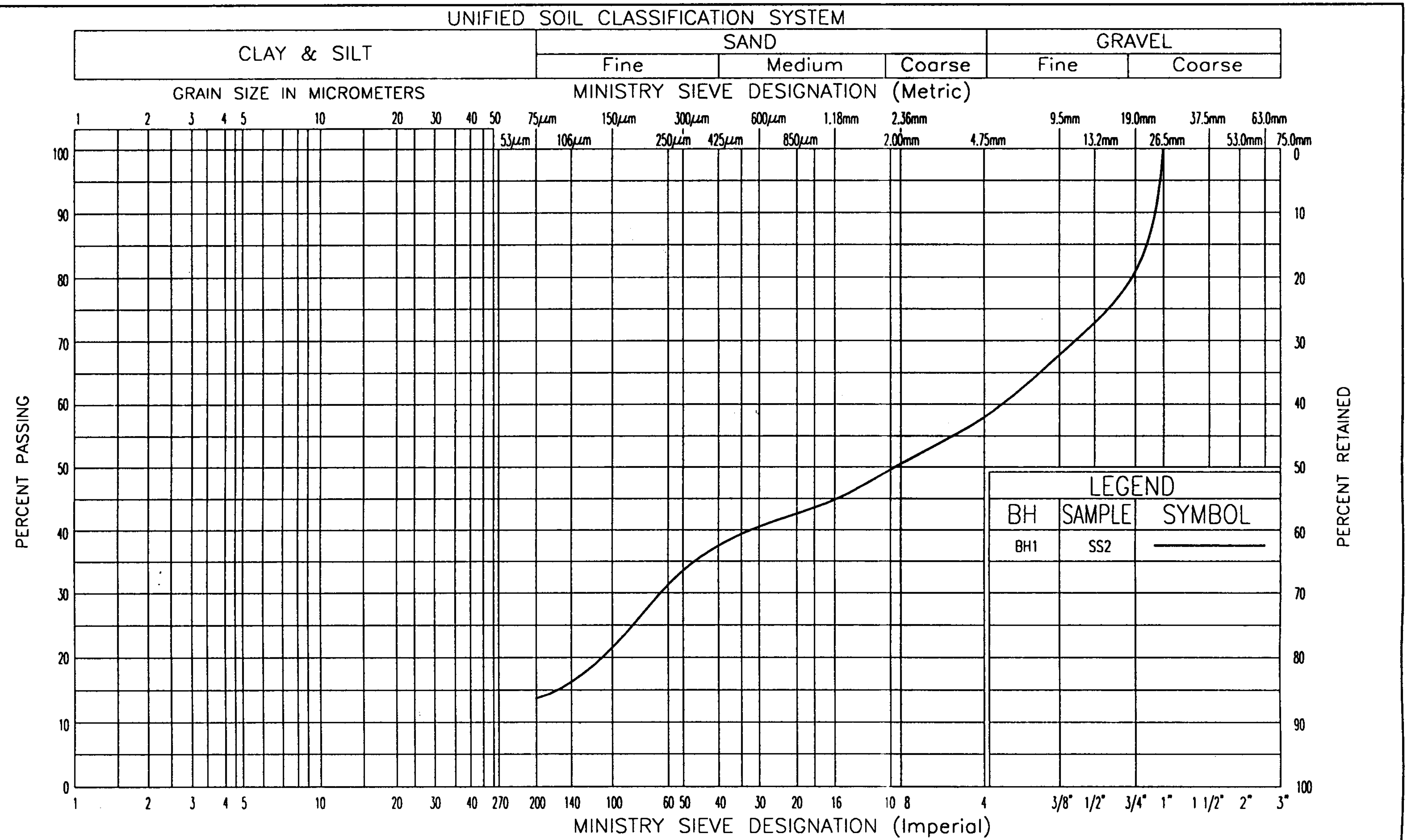
m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	-°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	-°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY $= \frac{c_u}{\tau_r}$

PHYSICAL PROPERTIES OF SOIL

ρ_s	kg/m^3	DENSITY OF SOLID PARTICLES
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES
ρ_w	kg/m^3	DENSITY OF WATER
γ_w	kN/m^3	UNIT WEIGHT OF WATER
ρ	kg/m^3	DENSITY OF SOIL
γ	kN/m^3	UNIT WEIGHT OF SOIL
ρ_d	kg/m^3	DENSITY OF DRY SOIL
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL
ρ_{sat}	kg/m^3	DENSITY OF SATURATED SOIL
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL
ρ'	kg/m^3	DENSITY OF SUBMERGED SOIL
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL
e	1, %	VOID RATIO
n	1, %	POROSITY
w	1, %	WATER CONTENT
S_r	%	DEGREE OF SATURATION
w_L	%	LIQUID LIMIT
w_P	%	PLASTIC LIMIT
w_S	%	SHRINKAGE LIMIT
I_P	%	PLASTICITY INDEX $= w_L - w_P$
I_L	1	LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$
I_C	1	CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$
e_{max}	1, %	VOID RATIO IN LOOSEST STATE
e_{min}	1, %	VOID RATIO IN DENSEST STATE
I_D	1	DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$
D	mm	GRAIN DIAMETER
D_n	mm	n PERCENT - DIAMETER
C_u	1	UNIFORMITY COEFFICIENT
h	m	HYDRAULIC HEAD OR POTENTIAL
q	m^3/s	RATE OF DISCHARGE
v	m/s	DISCHARGE VELOCITY
i	1	HYDRAULIC GRADIENT
k	m/s	HYDRAULIC CONDUCTIVITY
j	kN/m^3	SEEPAGE FORCE

FIGURES

AGRA
ENGINEERING GLOBAL SOLUTIONS

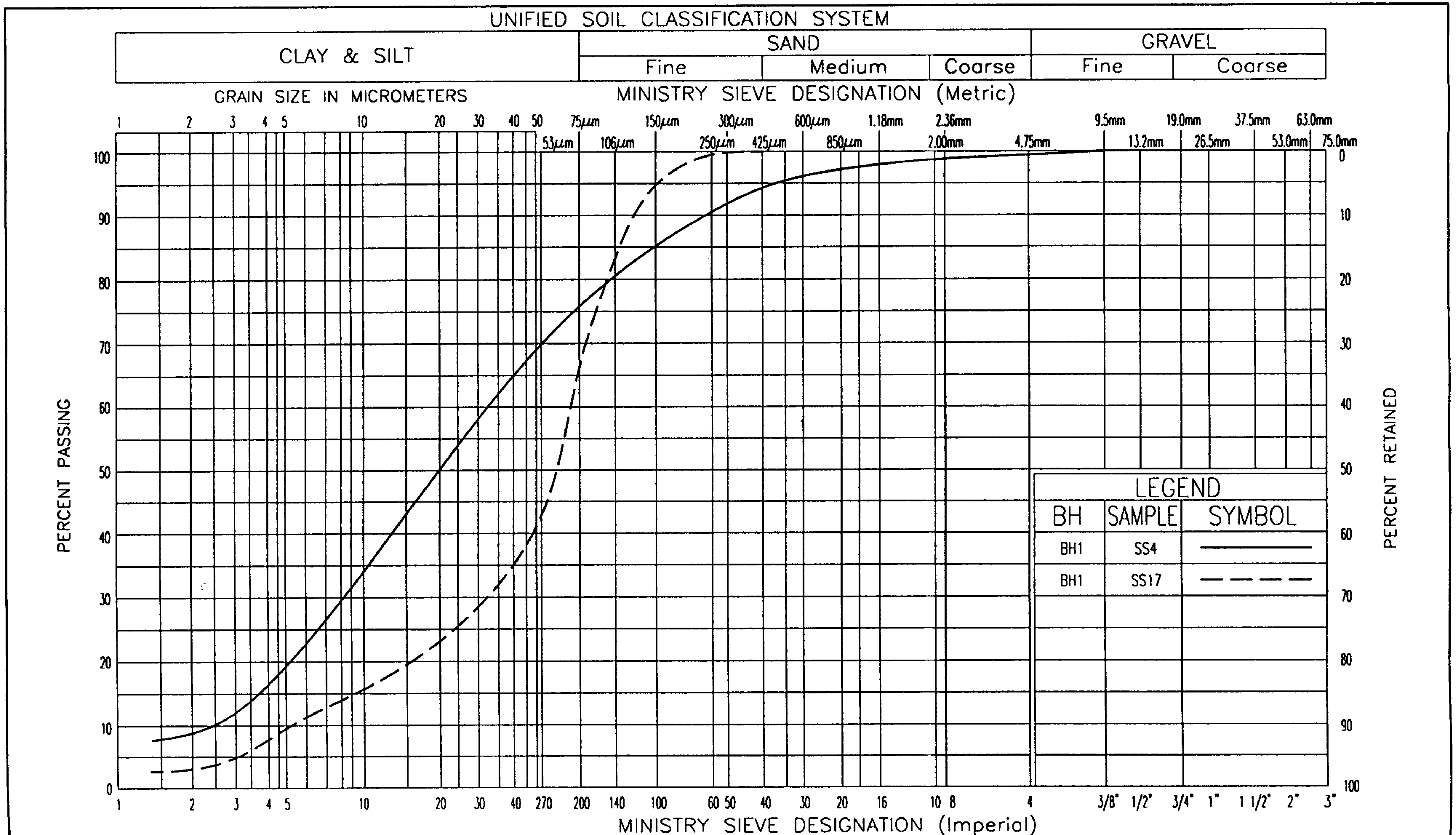


AGRA

GRAIN SIZE DISTRIBUTION
SAND & GRAVEL, some silt FILL

FIGURE No 1

W P 48-99-00

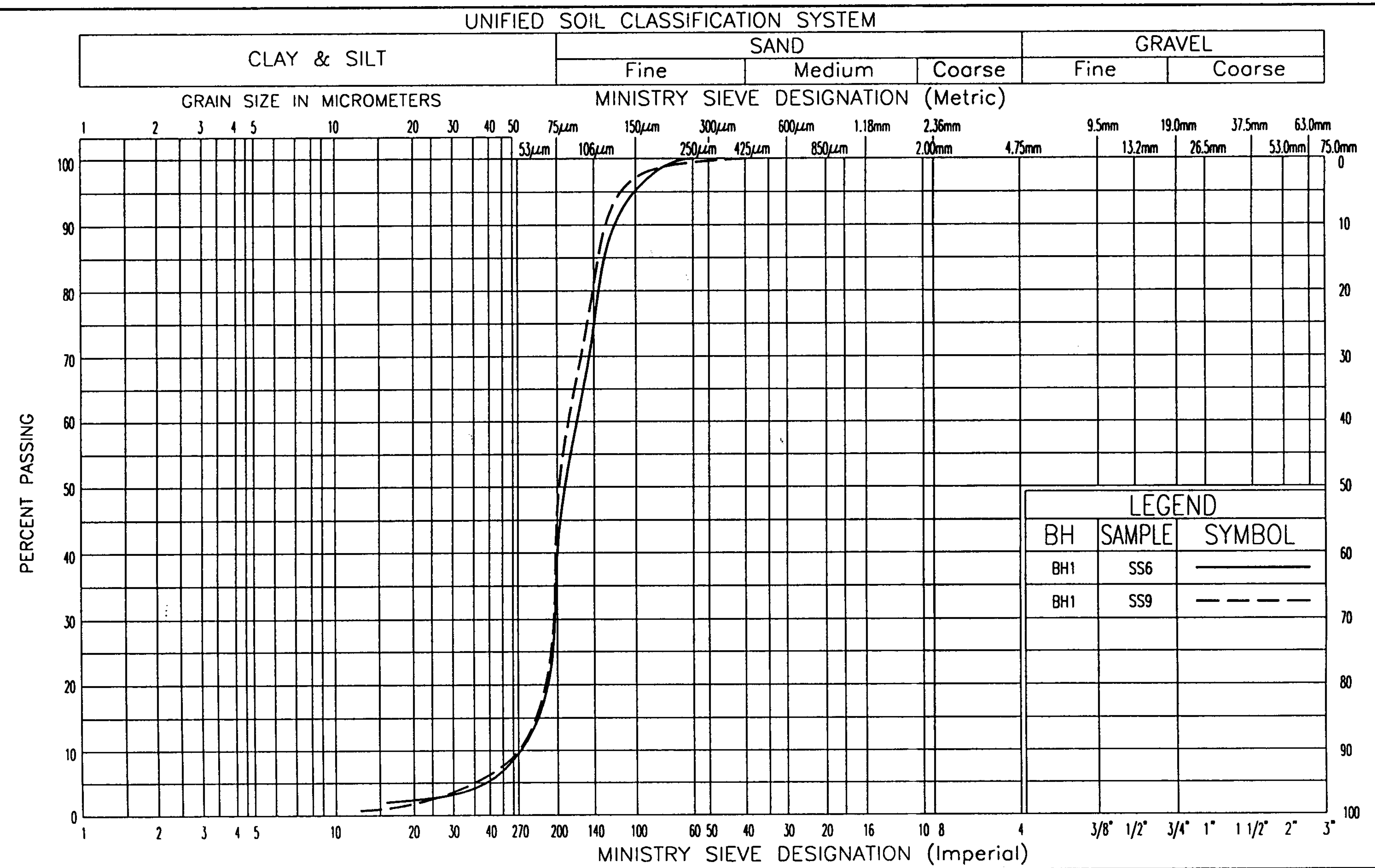


AGRA

GRAIN SIZE DISTRIBUTION
SANDY SILT, trace clay

FIGURE No 2

W P 48-99-00

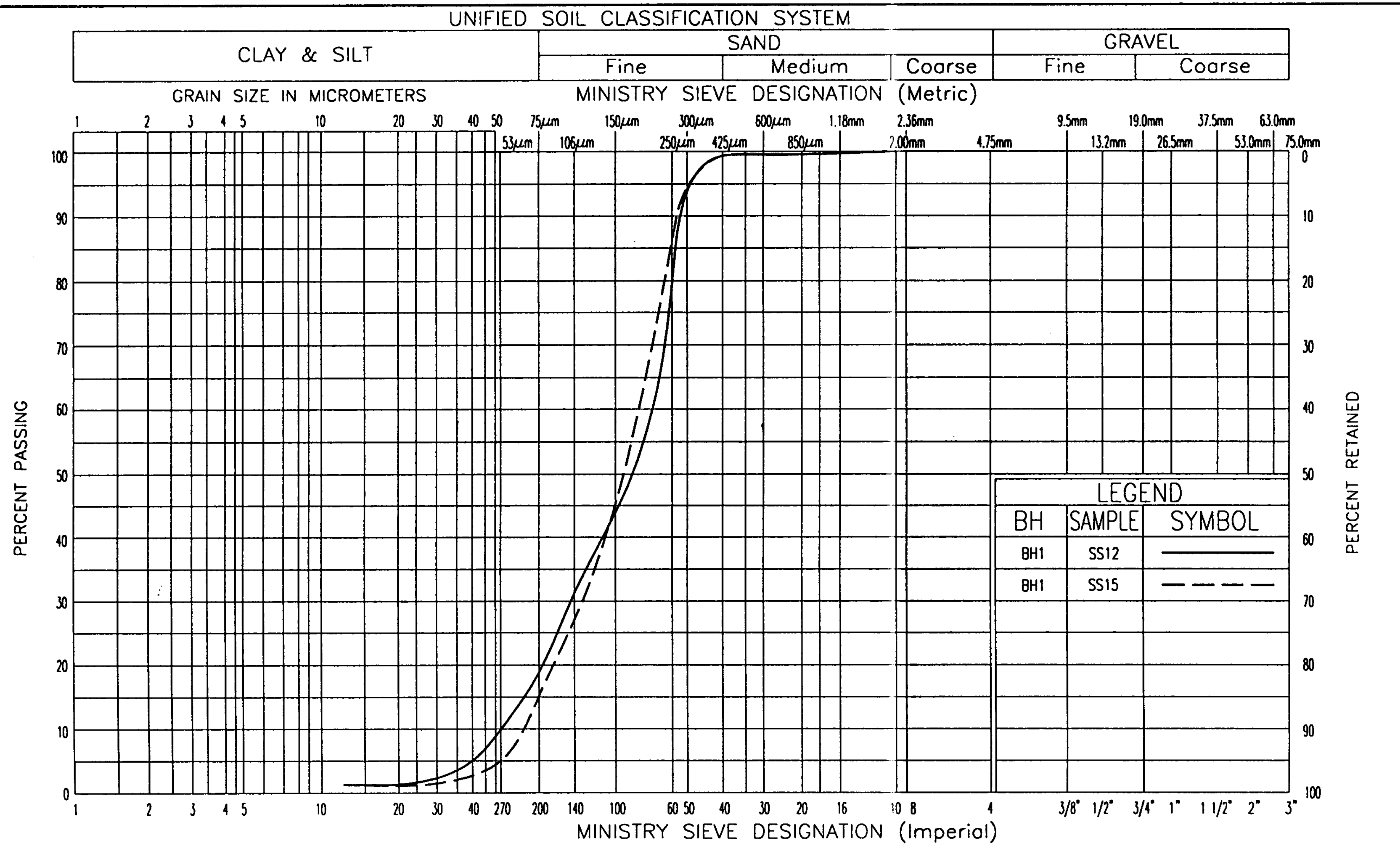


AGRA

GRAIN SIZE DISTRIBUTION
SAND & SILT

FIGURE No 3

W P 48-99-00

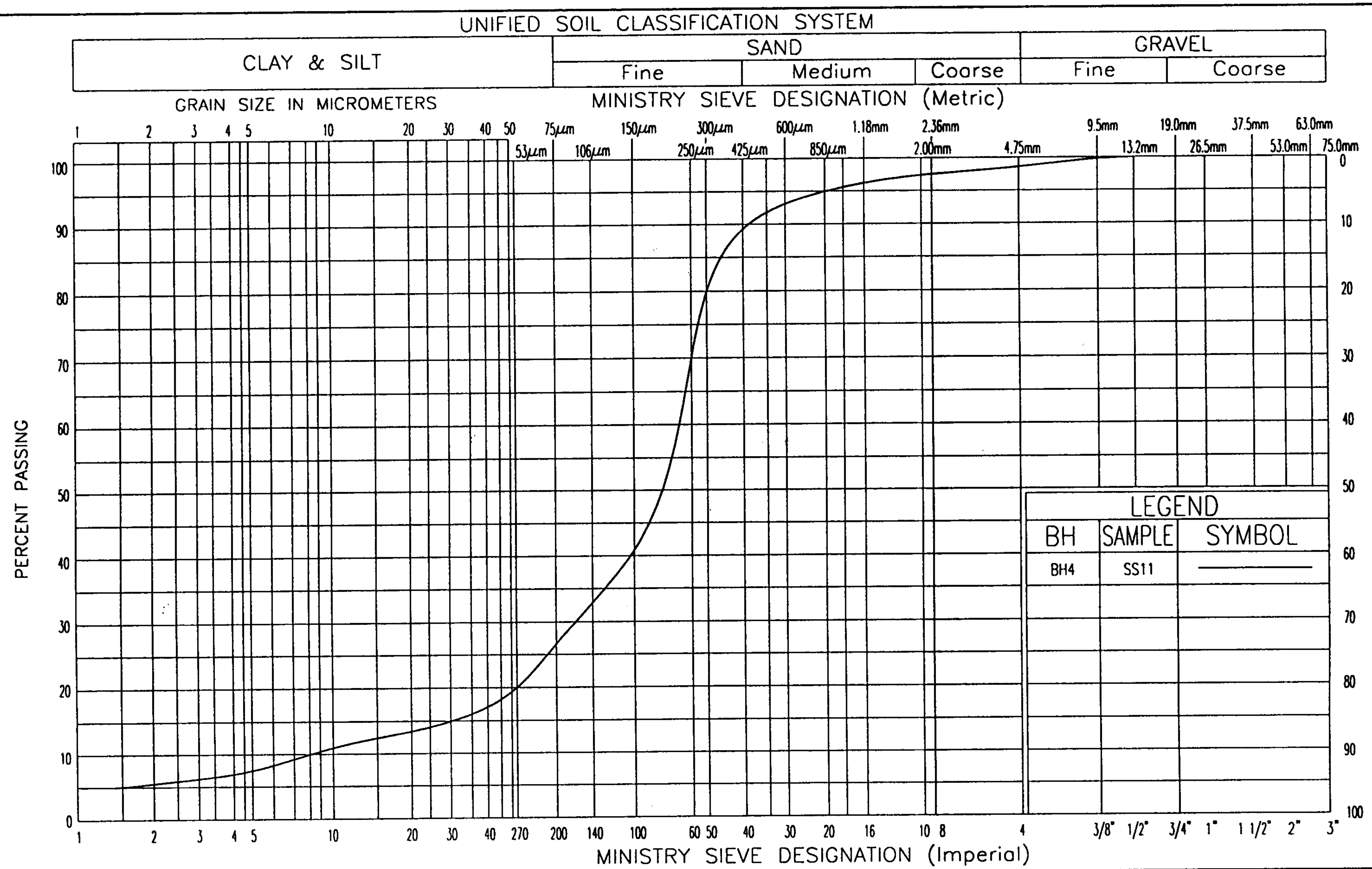


AGRA

GRAIN SIZE DISTRIBUTION
FINE SAND, some silt

FIGURE No 4

W P 48-99-00

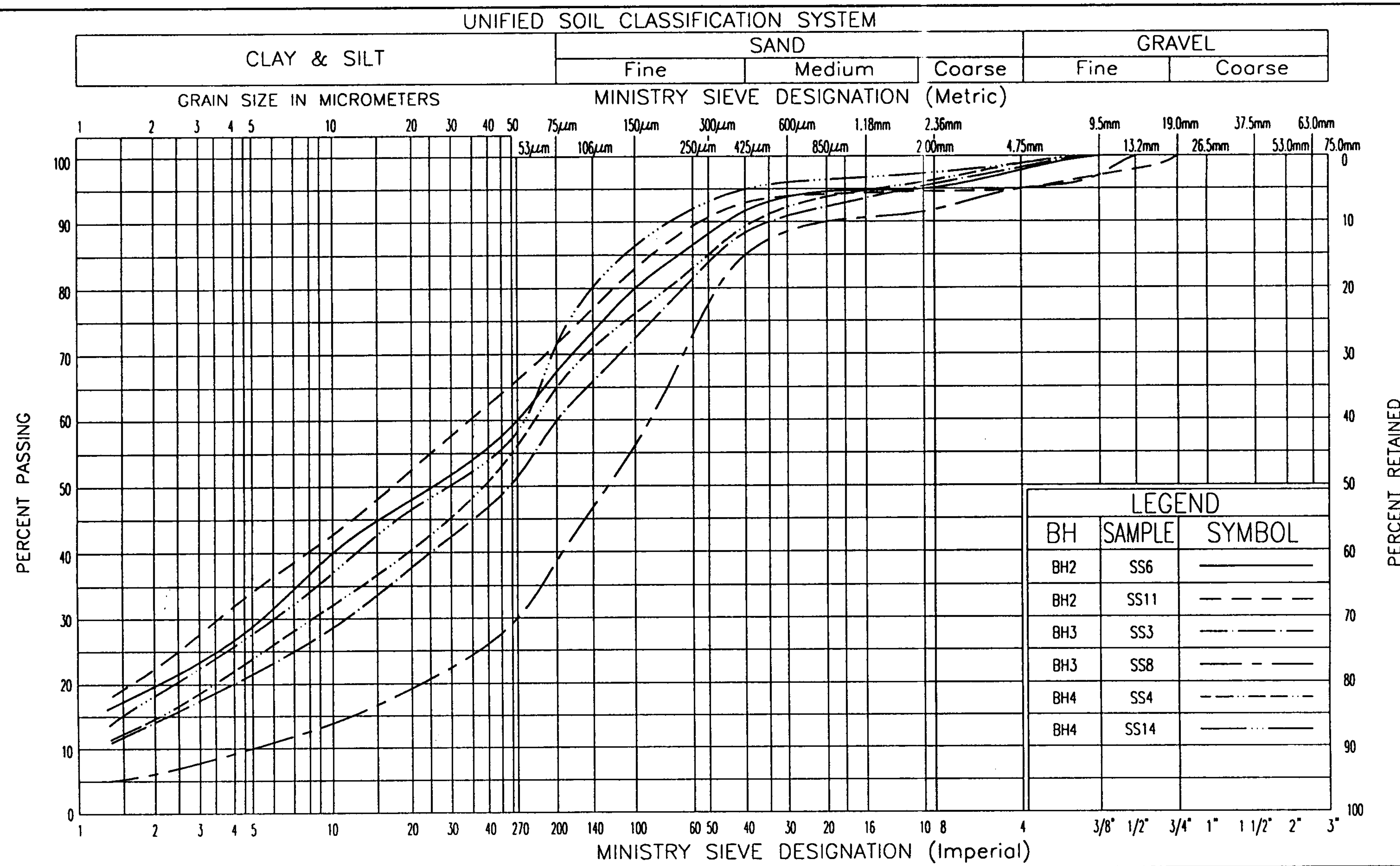


AGRA

GRAIN SIZE DISTRIBUTION
SILTY SAND, trace clay

FIGURE No 5

W P 48-99-00

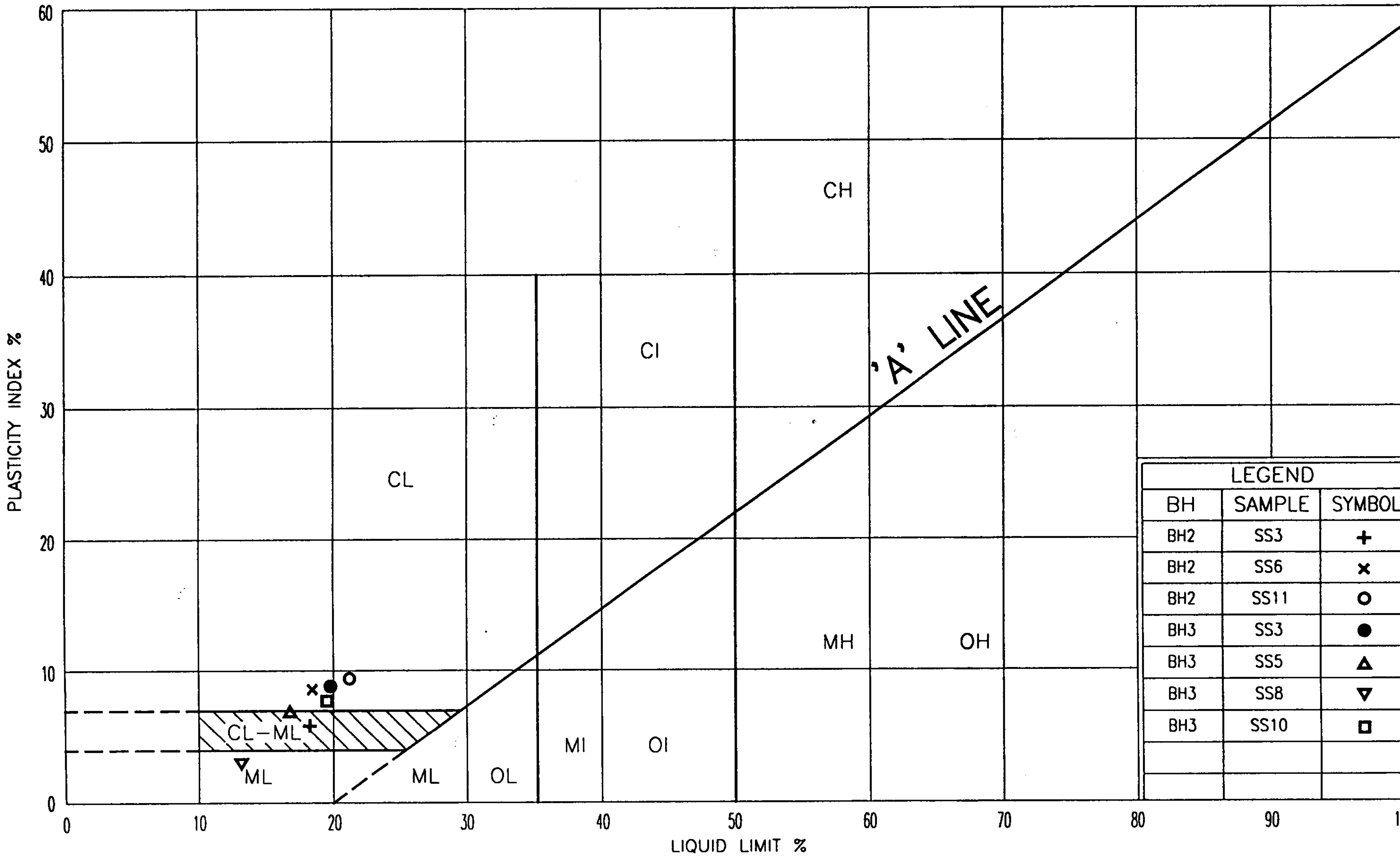


AGRA

GRAIN SIZE DISTRIBUTION
CLAYEY SILT (GLACIAL TILL)

FIGURE No 6

W P 48-99-00



LEGEND

BH	SAMPLE	SYMBOL
BH2	SS3	+
BH2	SS6	×
BH2	SS11	○
BH3	SS3	●
BH3	SS5	△
BH3	SS8	▽
BH3	SS10	□

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PLASTICITY CHART
CLAYEY SILT

FIG No 7

W P 48-99-00

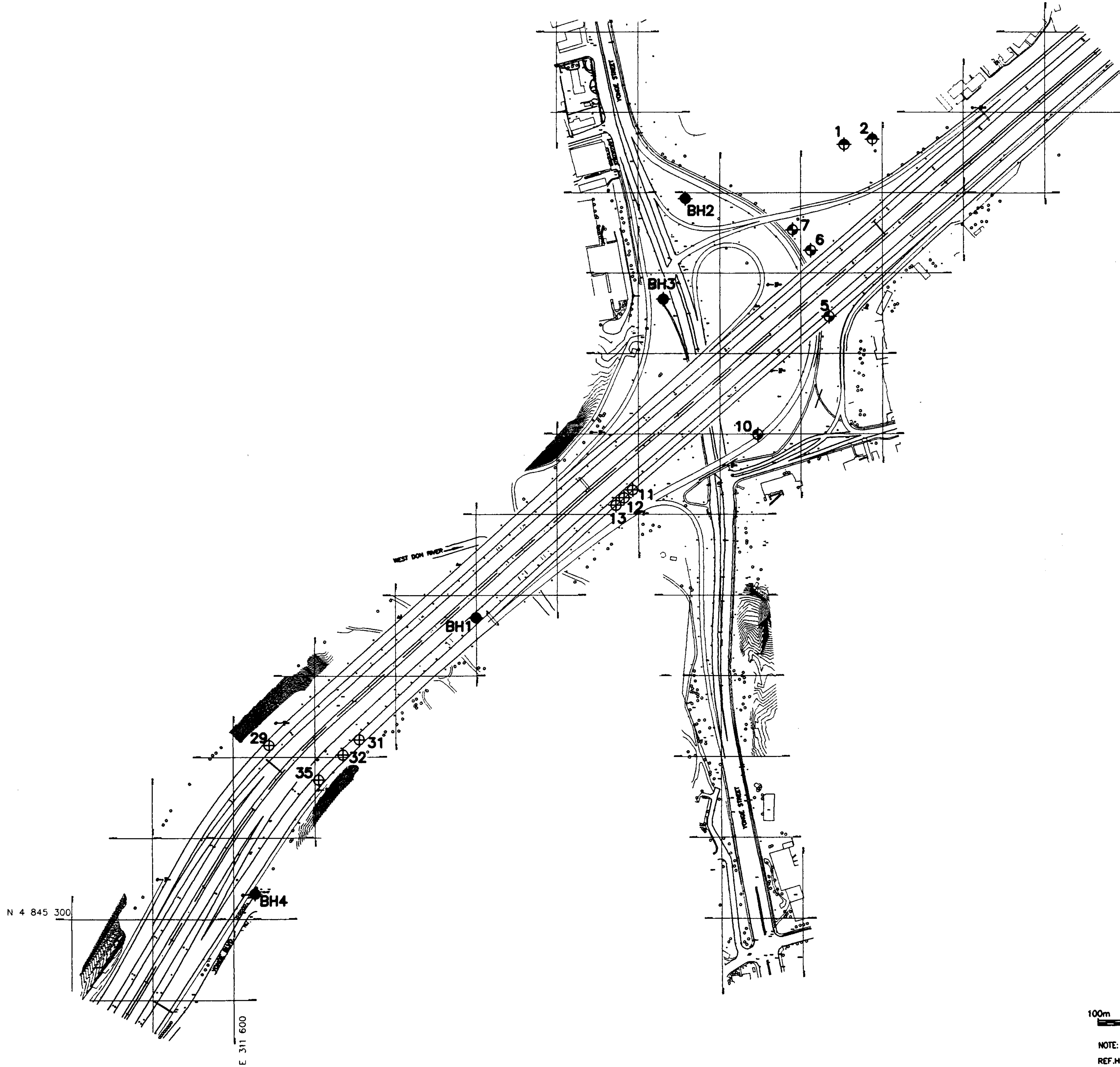
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES – METRES.

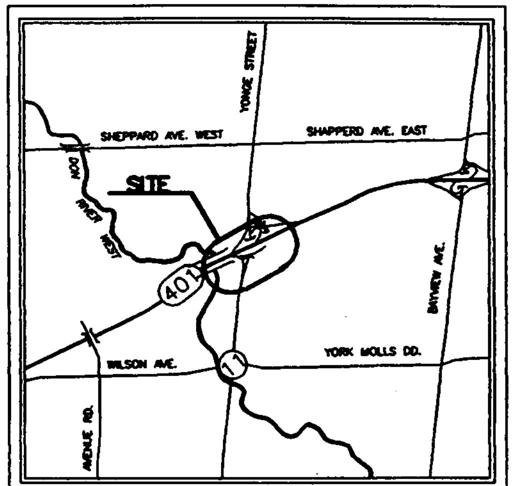
CONT. No.
W.P. No. 48-99-00

SHEET

HWY 401
BORE HOLE LOCATIONS FOR HIGH MAST LIGHTING POLES

AGRA Earth & Environmental Ltd.





KEY PLAN
N.T.S.

LEGEND

- Bore Hole (Current Investigation)
- Bore Hole (Geocres 30M14-121)
- Bore Hole (Geocres 30M14-122)
- Bore Hole (Geocres 30M14-126)

No	ELEVATION	CO-ORDINATES NORTH	CO-ORDINATES EAST
BH1	138.14	4 845 672	311 900
BH2	175.29	4 846 192	312 158
BH3	173.34	4 846 067	312 131
BH4	170.34	4 845 331	311 625

–NOTE–
The .boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

REV.	DATE	BY	DESCRIPTION

100m 0 100m

NOTE: Bore Hole locations are approximate.

REF.Hwy 401

HWY No 401			DIST
SUBM'D SP	CHECKED AD	DATE Oct.,1999	SITE
DRAWN MA	CHECKED GC	APPROVED	DWG 1

ENCLOSURES

AGRA

Foundation Design

Enclosure # 1

RECORD OF BOREHOLE No 1

1 OF 1 **METRIC**

W.P. 48-99-00	LOCATION N 4 845 672 E 311 900		ORIGINATED BY DT
DIST ____ HWY 401	BOREHOLE TYPE Hollow Stem Augering		COMPILED BY MA
DATUM Geodetic	DATE 12 October 1999		CHECKED BY SP

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
138.1	
0.0	0.05m **TOPSOIL** brown Sand & Gravel **FILL** trace oxidized stains moist
136.6 / 1.5	grey brown **SANDY SILT** some clay, trace gravel dense to compact moist
135.0 / 3.1	brown **SAND & SILT** dense to very dense moist; grey wet
129.4 / 8.7	grey fine **SAND** some silt dense to very dense moist to wet; compact
118.8 / 19.3	grey **SANDY SILT to SILT** some sand, trace clay compact moist to wet; very dense
114.6 / 23.5	END OF BOREHOLE Water Level in Piezometer: Oct.25/99: 5.7m depth Nov.9/99: 5.7m depth Elev 132.4m

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	28
2	SS	52
3	SS	49
4	SS	19
5	SS	16
6	SS	51
7	SS	61
8	SS	36
9	SS	30
10	SS	70
11	SS	45
12	SS	56
13	SS	20
14	SS	88
15	SS	49
16	SS	34
17	SS	25
18	SS	63
19	SS	22

ELEVATION SCALE: 136, 134, 132, 130, 128, 126, 124, 122, 120, 118, 116

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L — WATER CONTENT (%): 10 20 30

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

Sample	GR	SA	SI	CL
2	42	44	(14)	
3	Inferred cobble at@1.4m depth.			
4	1	23	67	9
6	0	60	40	0
9	0	55	45	0
12	0	82	18	0
15	0	85	15	0
17	0	35	62	3

+3, X3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE

AGRA

Foundation Design

Enclosure # 2

RECORD OF BOREHOLE No 2

METRIC

W.P. 48-99-00 — LOCATION N 4 846 192 E 312 158 — ORIGINATED BY DT

DIST ____ HWY 401 — BOREHOLE TYPE Solid Stem Augering — COMPILED BY MA

DATUM Geodetic — DATE 13 October 1999 — CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
175.3						
0.0	0.05m **TOPSOIL**; grey brown Clayey Silt, some sand **FILL**, some polyethilene fragments	1	SS	27		
174.2 / 1.1		2	SS	39	174	
	grey brown **CLAYEY SILT** with sand, trace gravel, occasional sand seams, hard, dry to moist **(GLACIAL TILL)**	3	SS	95/28		
		4	SS	92/28		
		5	SS	70/15	172	
		6	SS	60/15		3 29 49 19
	grey, moist	7	SS	50/14		Note: There is no sample No8.
					170	
		9	SS	82/21		
	fine to medium Sand, trace gravel, compact, wet				168	
		10	SS	19		
	Silty Sand, trace clay, compact, wet				166	4 24 49 23
		11	SS	36		
164.4		12	SS	50/10		
10.9	END OF BOREHOLE					

Water Level in Piezometer:
Oct.25/99: 6.8m depth
Nov.9/99: 6.7m depth, Elev. 168.6m

Chart headings: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100); PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10 20 30); UNIT WEIGHT γ kN/m³; STRAT PLOT; GROUND WATER CONDITIONS.

$+^3, \times^3$: Numbers refer to Sensitivity — $O^{3\%}$ STRAIN AT FAILURE

AGRA

Foundation Design

Enclosure # 3

RECORD OF BOREHOLE No 3

METRIC

W.P. 48-99-00 LOCATION N 4 846 067 E 312 131 ORIGINATED BY DT

DIST HWY 401 BOREHOLE TYPE Solid Stem Augering COMPILED BY MA

DATUM Geodetic DATE 13 October 1999 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.3					
0.0	0.13m **TOPSOIL**	1	SS	13	
172.7	grey brown Clayey Silt **FILL**				
0.7	grey brown **CLAYEY SILT** with sand, trace gravel some oxidized fissures very stiff to hard moist to dry **(GLACIAL TILL)**	2	SS	22	
		3	SS	45	2 38 46 14
		4	SS	44	
	grey moist	5	SS	29	
		6	SS	25	
		7	SS	15	Inferred cobble below 5.5m depth.
	hard	8	SS	50/8	5 57 31 7
	some sand seams	9	SS	98/28	
		10	SS	50/11	
162.5		11	SS	50/14	
10.8	END OF BOREHOLE				

Column headings: SOIL PROFILE; STRAT PLOT; SAMPLES; GROUND WATER CONDITIONS; ELEVATION SCALE (172, 170, 168, 166, 164); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT w, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

+³, ×³: Numbers refer to Sensitivity   O³% STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 OF 1 **METRIC**

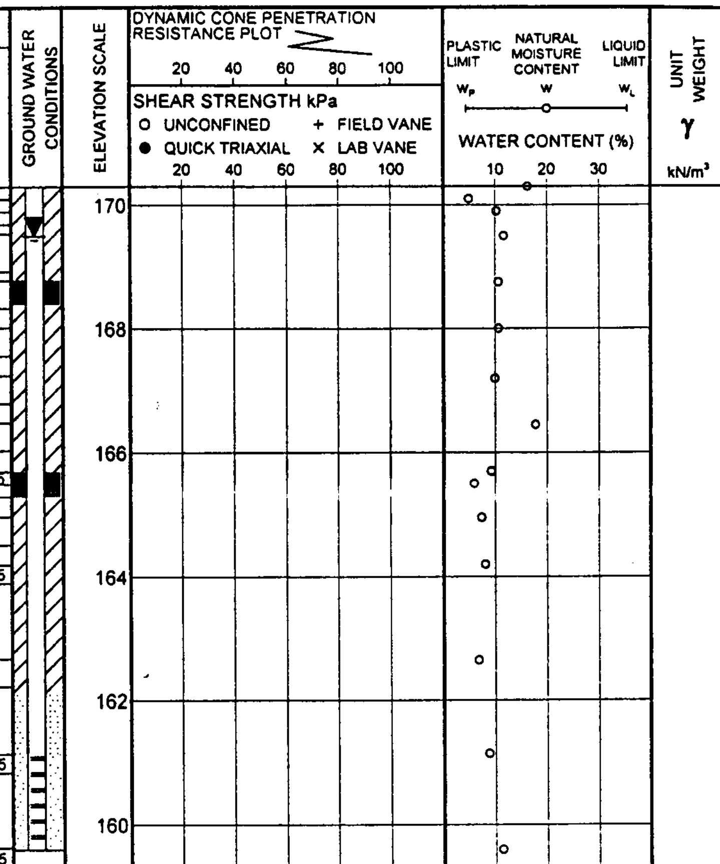
W.P. 48-99-00 LOCATION N 4 845 331 E 311 626 ORIGINATED BY PA

DIST HWY 401 BOREHOLE TYPE Hollow Stem Augering COMPILED BY MA

DATUM Geodetic DATE 25 October 1999 CHECKED BY SP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
170.3								
0.0	0.15m **TOPSOIL**	1	SS	-				
169.8	Sand with Gravel **FILL**	2	SS	11				
0.5		3	SS					
	brown **CLAYEY SILT** with sand, trace gravel, very stiff to hard, moist **(GLACIAL TILL)**	4	SS	25	2	34	50	14
		5	SS	43				
		6	SS	33				
	grey, occ.clay seams	7	SS	15				
165.9		8	SS	26				
4.4	grey brown **SILTY SAND** trace gravel, trace clay, very dense, moist	9	SS	96/25				
		10	SS					
		11	SS	103	2	71	21	6
163.4		12	SS	62/15				
6.9	grey **CLAYEY SILT** with sand, trace gravel, hard, moist **(GLACIAL TILL)**	13	SS	101				
		14	SS	58/15	1	28	53	18
159.3		15	SS	80/15				
11.0	END OF BOREHOLE							

Water Level in Piezometer:
Nov.9/99: 0.8m depth
Elev.169.5m



+3, X3: Numbers refer to Sensitivity O 3% STRAIN AT FAILURE