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REPORT ON

GEOTECHNICAL / HYDROGEOLOGICAL ASSESSMENT
YORK RAPID TRANSIT PLAN
VAUGHAN NORTH-SOUTH SUBWAY LINK
ENVIRONMENTAL ASSESSMENT
REGIONAL MUNICIPALITY OF YORK, ONTARIO

Submitted to:

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TABLE OF CONTENTS

SECTION PAGE

LIST OF DRAWINGS

LIST OF APPENDICES

1.0 INTRODUCTION

Golder Associates Ltd. (“Golder”) was retained by the York Consortium 2002 (the “Consortium”), on behalf of York Region Transit (“York Transit”), to assist in the completion of a geotechnical and hydrogeological assessment for the proposed subway connection between the York Rapid Transit system along Highway 7 and the future Spadina Subway Extension. At the time this report was prepared, planning for the Spadina Subway Extension included a terminal station near the north edge of the York University campus at Steeles Avenue in Toronto, Ontario. This report has been prepared as part of the requirement for the final Environmental Assessment that is to be submitted for this proposed Vaughan North-South Subway Link.

This report supplements an earlier report submitted to the Region of York in August 2005, in which the York Rapid Transit Plan defined several potential transit corridors within York Region for alleviation of traffic congestion including two major corridors: Yonge Street and Highway 7. Several potential Highway 7 transitway route options have also been identified in earlier study stages and *Route Alternative B1* was identified as a preferred subway alignment to connect the future Steeles Subway Station on the proposed Spadina Subway Extension (located at York University/Steeles Avenue) to the Vaughan Centre, near Highway 7/Jane Street.

The purpose of this report is to provide preliminary geotechnical information on the subsurface conditions (soil and groundwater) along the proposed subway alignment, preliminary hydrogeological assessment of potential construction dewatering that may take place at or near one of the proposed subway station locations, and recommendations and comments on the geotechnical aspects of design and construction of the works. Preliminary soil design parameters are provided, together with discussion and comments on relevant design and construction aspects such as excavations, method of ground support and backfilling.

2.0 PROJECT AND SITE DESCRIPTION

The location of the project is illustrated on Drawing 1. The subway alignment is proposed to run from the future Steeles Subway Station on the Spadina Subway Extension, extend northwest across Steeles Avenue, then turn north to run along the west side of Jane Street, cross beneath Black Creek and Highway 407, and terminate near the intersection of Highway 7 and Millway Avenue. The proposed subway will run parallel to Jane Street for most of the alignment.

Two underground subway stations have been proposed for the alignment at the following locations:

- Approximately 100 m west of Jane Street between Highway 407 and its west-south exit ramp onto Jane Street; and

- Approximately 225 m west of Jane Street at the intersection of Highway 7 and Millway Avenue.

3.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

3.1 Regional Geology

The Quaternary-age deposits of York Region consist predominantly of glacial till, glaciolacustrine sand, silt, and clay deposits, and shallow post-glacial lacustrine sediments. These deposits were laid down by glacial ice sheets and associated rivers and lakes. Recent deposits of alluvium are found in the river and stream valleys and their flood plains. Typically, bedrock is expected to be below a significant thickness of the sedimentary overburden (depths greater than 30 m).

The Quaternary soil deposits overlying the bedrock in the study area are believed to have been deposited over the course of two glaciations and one interglacial (i.e. warmer) stage. The oldest soil deposits identified in the Greater Toronto Area are the Illinoian tills that immediately overlie bedrock, where they are present. These tills are overlain by interglacial lacustrine sands, silts, and clays that are, in turn, overlain by the most recent glacial deposits.

3.1.1 Paleozoic Bedrock

The Paleozoic bedrock in the area consists primarily of the Georgian Bay Formation. This sedimentary rock formation includes shale, siltstone, sandstone and interbeds of limestone. Within the area of the planned project, it is expected that the bedrock will be at depths exceeding those necessary for foundations or excavations.

3.1.2 “Lower Drift”

The “Lower Drift” includes a series of deposits, interpreted by some as interbedded glacial tills and interglacial lacustrine (lake-deposited) sediments, and by others as interbedded lacustrine deltaic sediments that include diamict. Diamict sediments are characterized by inclusions of angular coarse sand and gravel within finer-grained soils (either silt and sand or silt and clay), producing units that, overall, can be poorly graded (a mix of different grain sizes). Glacial till, or sediments deposited at the contact between the overriding ice sheets and the underlying strata, are characteristically diamict units. Diamict can also be deposited in a near-ice lacustrine environment (with the coarse material “raining” into the sediments from the base of floating ice to the bottom of water bodies) rather than by glacial contact with the underlying sediments. This “Lower Drift” includes the following formations, from oldest to youngest:

- **Don Formation:** The Don Formation, where present, consists primarily of bedded silt and sand deposits that are in direct contact with the underlying bedrock formations.

- **Scarborough Formation:** The Scarborough Formation also consists primarily of bedded silt and sand deposits overlying the Don Formation, but these sediments were deposited at a later stage than the Don Formation.

- **Sunnybrook Formation:** The Sunnybrook Formation consists predominantly of fine-grained sediments that appear locally as layered diamict, massive diamict or layered fine-grained sediments more characteristic of lacustrine deposits. The composition and hard consistency of this material has resulted in this material being identified as a basal glacial till unit by some reference sources.

- **Thorncliffe Formation:** The Thorncliffe Formation consists primarily of granular sediments including varying proportions of silt and sand.

3.1.3 Newmarket Till

The Newmarket Till is a regional glacial till sheet generally characterised by its predominantly fine-grained composition. In most areas this glacial till is relatively hard and, due to its fine-grained composition, forms a regional aquitard (deposit inhibiting flow of groundwater). The Newmarket Till also contains cobbles and boulders. In some areas, “boulder pavements” can be encountered where boulders are nested or concentrated in a layer within the till unit or near the interfaces with other geologic deposits. Experience on other construction projects in this deposit suggests that boulders may typically form about 0.1 to 0.5 per cent of the total deposit volume, though in some areas, boulders can form up to 2 per cent of the total deposit volume.

3.1.4 Oak Ridges Moraine Complex

The Oak Ridges Moraine Complex (ORMC) is a well-known and important geologic feature within the region. It is believed that the moraine was formed between the Lake Simcoe and Lake Ontario lobes of regionally extensive glacial ice sheets. In most areas, the ORMC is composed primarily of fine sand, though there are also local deposits of coarse, stratified sand and gravel; these coarse deposits have historically been mined for construction uses. In most of the study area, the ORMC has been overridden by the Halton Till and, therefore, may be compact to very dense.

3.1.5 Halton Till

The Halton Till is generally considered a fine-grained diamicton with minor fine-grained lacustrine sediments incorporated within the body of the unit, likely from glacial reworking of underlying lacustrine sediments. The Halton Till is typically stiff to hard in consistency, though near the ground surface, weathering can result in it being degraded to consistencies ranging from soft to firm. The Halton Till also contains cobbles and boulders. In some areas, "boulder pavements" can be encountered where boulders are nested or concentrated in a layer within the till unit. Experience on other construction projects in this deposit suggests that boulders may typically form about 0.1 to 0.5 per cent of the total deposit volume, though in some areas, boulders can form up to 2 per cent of the total deposit volume.

3.1.6 Upper Deposits

Based on local experience, "Upper Deposits" generally include two types of materials: more recent natural post-glacial deposits; and deposits placed for construction or disposal of unwanted materials during development of the area.

- **Fill:** Fill generally consists of reworked native soil and/or rock materials, refuse, construction and demolition debris, and other assorted random materials placed during development of the area to level the ground in preparation for building or as a disposal site for unwanted materials. Typically, older fill materials were placed with little control over the materials or how they were placed.

- **Recent Alluvial Deposits:** In the areas of watercourses, erosion and redeposition of soil materials has occurred since the last glacial period. Geologically recent deposits from watercourses are typically soft or loose in consistency. Within the boundaries of the watercourse floodplains, the subsurface conditions can be expected to vary significantly as the alignment of the watercourse has likely shifted over time. The shifting positions of watercourses produces localized and in-filled meander channels and possible organic deposits (organic silt and clay or peat from the growth, burial, and decomposition of plant materials).

- **Recent Glaciolacustrine Deposits:** During the retreat of the last glacial ice sheet from the region, low areas in the surface topography became small water bodies (locally named the "Peel Ponds"). Sediments carried by surface water runoff and watercourses were deposited in these water bodies. In many areas, the sediments are characterized by alternating layers of soft to firm silt and clay resting on the underlying dense or hard glacial till, with overlying loose silt and sand deposits near the surface.

Recent Alluvium should be expected in all areas adjacent to the existing watercourse, regardless of the interpreted native deposit type. The extent of such deposits should be identified only on the basis of additional field exploration in areas that will be critical for pavement or transitway design.

3.2 Regional Groundwater Considerations

Several water-bearing deposits that consist predominantly of cohesionless soils (silt, sand, and gravel) are present within the study area. These include the following:

- Recent Glaciolacustrine Deposits – where these deposits include granular soils;
- Oak Ridges Moraine Complex;
- Thorncliffe Formation; and
- Scarborough Formation.

Of these deposits, the Oak Ridges Moraine Complex and Thorncliffe Formation will be the primary groundwater aquifers (major water-bearing stratigraphic units) influencing the design and construction of the project. Although these units will be the largest continuous aquifers, the presence of layers of low-permeability materials (silt and clay) between granular soils will create areas of groundwater that are "perched" above the main aquifers. Each of the glacial till strata identified on the simplified geologic profile will act as an aquitard and groundwater should be expected above the interfaces of any of these till units and overlying granular soils.

3.3 Subsurface Conditions Along the Proposed Alignment

As part of the subsurface investigation for the Environmental Assessment of this proposed subway connection, three boreholes (Boreholes Y-140 to Y-142) were advanced near the two proposed subway stations along the alignment on the Vaughan North-South Subway Link. The borehole locations are shown on Drawing 1, and the results of the geotechnical investigations (including borehole records and laboratory test results) are included in Golder's Geotechnical Investigation Report that is provided in Appendix A. In addition to the three boreholes advanced in the autumn of 2006, geotechnical data from the following reports or information were compiled to assess the subsurface conditions along the proposed alignment:

- Borehole data for the Highway 7/Jane Street Intersection Subsidence by GeoTerre Limited, Project No. TG06-009, dated February 2006.

- "Addendum to Report on Geotechnical Investigation, Spadina Subway Extension, Environmental Assessment, City of Toronto" by Golder Associates Ltd., Project No. 04-1111-054, dated July 2006.

- "Report on Geotechnical Investigation, Spadina Subway Extension, Environmental Assessment, City of Toronto" by Golder Associates Ltd., Project No. 04-1111-054, dated January 2006.

- “Piezometer and Settlement Point Installations at Jane Street Sanitary Sewer, Town of Vaughan, Ontario” by Golder Associates Ltd., Project No. 861-1109, dated June 1986.

- “Geotechnical Services for Proposed Flood Control Structure and Pond at Jane Street and Highway 7, Town of Vaughan, Ontario” by Golder Associates Ltd., Project No. 861-1056, dated May 1986.

- “Geotechnical and Hydrogeological Investigation for Proposed Jane Street Sewer, Town of Vaughan” by Golder Associates Ltd., Project No. 851-1136, dated September 1985.

- “Geotechnical Investigation for Proposed Jane Street Sanitary Trunk Sewer, Town of Vaughan, Ontario” by Golder Associates Ltd., Project No. 811-1156, dated September 1981.

The stratigraphic boundaries shown on the borehole record are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

The soil types described on the Record of Borehole sheets, drawings and figures in this report are given twelve different classifications and graphic symbols (Types 1 through 12) consistent with the range of soil deposits anticipated to be encountered for subway construction in the Greater Toronto Area. The classification system that has been used is listed below:

- Fill (Type 1);
- Organics (Type 2);
- Gravel to Sand and Gravel (Types 3 and 4);
- Sand to Silty Sand (Types 5 and 6);
- Sandy Silt to Silt (Types 7 and 8);
- Clayey Silt to Clay (Types 9 and 10);
- Clayey Silt Till (Type 11); and
- Sandy Silt Till (Type 12).

The graphical representations of these material types are supplemented by colour to facilitate visualization of the geologic and material characteristics of the soil deposits. It is to be noted that Deposit Types 11 and 12 are interpreted as a till deposit (lodgement or basal till) on the basis of their heterogeneous structure, the relatively broad grain size distribution and the documented local geology.

In general, the area is underlain by two till sheets, considered to be substages of the Wisconsin glaciation. The till sheets are underlain and/or separated by variable thicknesses of interstadial deposits of sand, silt and silty clay of glaciofluvial and glaciolacustrine origin. Bedrock was not encountered in any of the boreholes.

Within this report, the naming convention includes “Upper” and “Middle”, depending on the relative elevations and grain size characteristics of the deposits. This convention has been adopted to be consistent with work completed for the Sheppard Subway and Spadina Subway and is used to avoid geologic unit classifications based on geologic age or stage of glacial advance. In some instances, geologic nomenclature, although correct in defining the geologic origin and age of a particular deposit, does not necessarily convey indications of material type or potential engineering behaviour. Precedence in this report has therefore been given to naming the different soil units based on relative elevation and grain size composition.

In general, the stratigraphy along the proposed alignment is defined by two sheets of predominantly cohesive glacial till (Upper and Middle Till) encountered from near the ground surface to depths of approximately 30 m. Deposits of relatively uniform glaciolacustrine or glaciofluvial sand and silt (Upper Sand/Silt (North)) were encountered just below the Upper Till around the Highway 7 station with a thickness of about 9 m. A similar Upper Sand/Silt (South) was encountered at the southernmost part of the proposed subway extension in the area of Steeles Subway Station. There appears to be an area around the middle portion of the subway alignment, near Black Creek, its tributaries, and Highway 407, where the Upper Sand/Silt deposits may not exist. Instead the Upper and Middle Till appear to converge around that area and this will require further field exploration and testing.

Within all of the soil deposits there are smaller zones of compositionally different materials. For example, within the Upper Till, there can be found zones of uniform sand and silt, and within the Upper Sand/Silt, there are zones or layers of silty clay or clayey silt. During deposition, the base of the glacial ice sheets in this area overrode relatively weak glaciolacustrine and deltaic deposits of sand, silt, and clay. Thus, materials from these interstadial deposits became incorporated into the basal glacial till. The Upper Sand/Silt deposit encountered at the Highway 407 site is noted to be very close to the ground surface and any potential construction dewatering within this deposit may affect the Black Creek and its tributaries.

For final design, it will be necessary to complete more boreholes in the areas where such variation may be important for determining aquifer continuity characteristics for dewatering or groundwater cut-off.

It should be noted that the interpreted stratigraphy illustrated on Drawing 2 is a simplification of the subsurface conditions based on widely-spaced boreholes. Variation in the stratigraphic boundaries between boreholes will exist and are to be expected. The interpreted stratigraphy also does not necessarily represent a direct borehole-to-borehole linking of similar soil types. In some areas, borehole off-set distances (away from the centre-line interpretation), descriptions of soil types on the original boreholes, and overall geologic considerations suggests that a departure from individual sample descriptions on the borehole logs is appropriate for description of the overall geologic deposit. It should be expected that future investigation findings will result in refinements to the interpreted stratigraphy along the subway alignment.

4.0 HYDROGEOLOGY

The proposed alignment is located adjacent to Black Creek and passes beneath two tributaries that converge just north of the CN Rail tracks, west of Jane Street. Surface drainage of the study area is toward Black Creek via tributary streams. The hydrogeology of the glacial deposits in the area can be relatively complex. The lower-permeability glacial till deposits tend to impede groundwater flow, whereas the interstadial deposits of silt and sand serve as local shallow aquifers.

Details of the monitoring well installations and water level measurements are shown on the interpreted stratigraphic profile shown on Drawing 2. It should be expected that the groundwater level along the alignment will be subject to seasonal fluctuations, particularly during spring flows and precipitation events around Black Creek and its tributaries.

Though the Highway 407 Station is located in close proximity to Black Creek and two of its tributaries, distinct sand and silt deposits were not encountered at the investigation locations. Therefore, a full-scale dewatering test was not carried out as anticipated and, instead, rising head tests were carried out within the glacial till. Layers of coarse material within the zone of the sand-pack may have unduly influenced the test at this location. On the basis of the subsurface conditions encountered to date at the Highway 407 station, water-bearing deposits that would require extensive dewatering systems are not anticipated to be present.

In the Highway 7 Station vicinity, near Millway Avenue, several significant granular layers are present over the depth of the station excavation (Upper Sand/Silt). Based on the available information, it appears that this deposit may grade into coarse deposits of sand and gravel near the interface with the underlying cohesive glacial till. The overall characteristics of this deposit suggest a wide range of grain size distributions may be likely, as illustrated by Drawings 2 and 3. The recent sinkhole incident at the intersection of Highway 7 and Jane Street also indicates that a significant thickness of sand and silt exists at the location that may constrain the proposed station excavation and require that groundwater control be provided.

Between the proposed Steeles West and Highway 407 Stations and between the proposed Highway 407 and Highway 7 Stations, the Upper and Lower Till Deposits converge. For the tunnelled sections between these stations and for any supplementary structures (cross passages, emergency exit buildings, firefighter access buildings, etc.), the groundwater conditions in and around these convergence areas will require detailed investigation at specific design locations. Groundwater trapped in granular layers overlain by low permeability silt and clay soils can be under pressures such that any wells or excavations that puncture the granular layers could exhibit a pressure head elevation above the interface of the granular and low-permeability units and, in some cases, this pressure head may be higher than the ground surface resulting in “artesian” conditions (wells under such conditions will flow at the ground surface). Hydrostatic conditions (i.e., a single groundwater table) should not be assumed for any location along the alignment. Although artesian conditions were not encountered during the investigations for this report, they were encountered during investigations for the Jane Street sewer south of Highway 7, and may be encountered during future drilling or construction in the valley between Highway 7 and Steeles Avenue.

5.0 MAN-MADE FEATURES SIGNIFICANT TO DESIGN AND CONSTRUCTION

5.1 Adjacent Properties and Structures

The subway alignment is proposed to continue northward from the crossover tracks of the future Steeles Subway Station, under the existing CN Rail (Halton) tracks, towers in the hydro right-of-way, Black Creek and its two tributaries, and Highway 407, and will terminate near Highway 7. The tunnel will also pass under a “light maintenance” warehouse building, which belongs to Toromont CAT. It is understood from the Consortium that the affected company has indicated that this building can be demolished when the subway is being constructed.

In addition to the above structures, there are numerous utilities that will potentially be affected by the proposed construction; these are generally located within the Jane Street road allowance, just north of the CN Rail tracks and in the Highway 7 road allowance where the Highway 7 Station will be constructed.

6.0 INFLUENCE OF SUBSURFACE CONDITIONS ON DESIGN AND CONSTRUCTION

Fill, placed for past urban development activities, may be encountered throughout the proposed alignment, particularly in the immediate vicinity of the Black Creek tributaries, the rail line, Highway 407, and Highway 7. In general, the fill should be considered to be uncontrolled in both material and placement and should, therefore, be considered unsuitable for foundation support. In some areas, particularly the right-of-way at the existing Highways 7 and 407, some of the fill materials may have been placed in a more controlled manner for highway construction. However, the support capabilities of these materials, outside of the main roadways, should not be relied upon until detailed reviews of construction records are completed in further design stages.

The Upper Till Deposit (believed to be Halton Till) is likely to be the primary native deposit encountered along the proposed alignment. This deposit is relatively dense or hard and should be suitable for both foundation support and pavement subgrades, if necessary. Any permanent cut or fill slopes with slopes steeper than 3 horizontal to 1 vertical (3H:1V) and a height or depth greater than 3 m should be further evaluated during final design.

It is anticipated that running tunnel construction in this area could be accomplished using conventional cut-and-cover techniques in which a deep excavation to the proposed subgrade elevation is made. Based on the prevailing ground conditions, temporary cuts for open-cut construction may be made with side slopes in the range of 1H:1V to 1.5H:1V. It is expected, however, that in most instances, vertical excavation sides will be required, particularly in the Highway 7 Station area; these excavations will require temporary shoring. Shoring could consist of either soldier-piles and lagging or contiguous caisson (cast-in-place secant pile) walls, depending on the requirements for groundwater control and the need to limit ground movement adjacent to the shoring system.

The ground conditions along the proposed alignment are also considered to be favourable for machine-bored tunnelling, provided that groundwater is adequately controlled. Use of a tunnel boring machine (TBM) would be feasible and likely economically viable for tunnel lengths that are expected to be greater than 600 m. The TBMs used on the Sheppard Subway were designed as earth-pressure-balance (EPB) machines so as to assist in controlling ground displacements and groundwater levels, and also included both rock and soil cutting tools on the machine face to limit difficulties associated with encountering boulders.

The sequential excavation method, in which a number of short-length stages of mechanically-assisted and unsupported excavation are followed immediately by steel ribs and shotcrete lining construction, may also be a suitable technique for relatively short sections of tunnel as may be required to initiate tunnelling work from launch shaft. It is generally recommended, however, that this technique not be considered where the tunnels will pass beneath the watercourses or in areas where extensive sand and silt deposits are identified.

Where the tunnels or cut-and-cover structures pass directly beneath or adjacent to existing structures or highways (e.g. Highway 407), additional ground control measures may be necessary. It is generally recommended that any tunnelling that is to be carried out beneath buildings or highways be at a depth that leaves a distance of at least twice the tunnel diameter between the crown of the tunnel and the underside of any building foundations. Detailed settlement evaluations should be completed for any areas where it is contemplated that tunnelling will be completed beneath or adjacent to structures, railways, or roadways.

The Upper Sand/Silt (believed to be Oak Ridges Moraine Complex) underlies the Upper Till in parts of this area, and groundwater pressures in this stratum may have to be controlled to facilitate construction. Groundwater lowering may require dewatering systems or cut-off wall technologies to limit the influence of groundwater on both the construction and the effects of groundwater lowering on the adjacent properties. The information compiled to date suggests that granular deposits that would require extensive dewatering are not in direct hydraulic connection with Black Creek and its tributaries.

Based on previous construction for Toronto subway projects, station excavations or dewatering may be accomplished using deep wells, eductor well systems or well-points installed from within the excavation. The influence of dewatering on settlement of the surrounding ground should be relatively minimal.

Based on the subsurface information gathered during the recent investigations, groundwater will have to be controlled for the Highway 7 Station. In the vicinity of the proposed station, the aquifers (saturated granular deposits) typically consist of fine sand and silt, and some gravelly sand to sand and gravel, particularly near the base of the Upper Sand/Silt (see Drawings 1 and 3)

The recent investigations suggest that the Upper Sand/Silt is not present in significant thicknesses in the vicinity of the Highway 407 Station, indicating that extensive dewatering may not be necessary in this area. It should be noted, however, that in the complex glacial environment, conditions may change significantly between boreholes. Prior to final design, the presence or absence of the Upper Sand/Silt in the vicinity of this station must be further investigated with a number of closely spaced boreholes around the perimeter of the planned excavation.

7.0 RECOMMENDATIONS FOR DESIGN

This section of the report includes an interpretation of the geotechnical data with respect to design of geotechnical aspects of the works. It should be noted that the subsurface data is available at isolated borehole locations along the alignment. Conditions will vary between and beyond the boreholes and the design and construction must allow for reasonable variations.

7.1 Cut-and-Cover Construction

7.1.1 Subway Structure Design Aspects

7.1.1.1 Foundations

From the stratigraphic profile shown on Drawing 2, the typical founding soils for the two proposed subway station base slabs are summarized as follows:

Station	Estimated Elevation of Base Slab (m)*	Anticipated Founding Material	Soil Type
Highway 407	173	Silty Clay Till; Silty Clay	11; 10
Highway 7	183	Sand; Sand and Gravel; Silty Clay Till	5; 4; 11

* Elevation of base slab is estimated from the subway vertical alignment profile provided by York Consortium in November 2006 ; this is to be reviewed as required with the final EA alignment.

7.1.1.2 Flotation/Uplift

Potential uplift pressures acting on base slabs and hydrostatic pressures on walls is expected for permanent structures along the subway alignment. The measured water levels below ground surface in the three boreholes drilled along the alignment ranged from about 11 m depth (at Highway 407 Station) to 5 m depth (at Highway 7 Station). The expected water head difference using the latest measured water levels and the expected elevation of station base slab are summarized below.

Station	Base Slab Elevation (m)	Nearest Reference Borehole	Head Difference to Base Slab (Piezometer) (m)
Highway 407	173	Y-140, Y-141	+12
Highway 7	183	Y-142	+15

Notes: 1) Elevation of base slab is estimated from the subway vertical alignment profile as provided by the York Consortium in November 2006 ; to be reviewed as required with the final EA alignment.
2) The head difference is obtained using the latest water level measurements in piezometers.
3) (+) refers to water head (in metres) above the elevation of base slab at the proposed station.

7.1.1.3 Lateral Earth Pressures

Geotechnical literature suggests that in situ horizontal stresses, often described in terms of the ratio of in situ horizontal to vertical stress (K_o), within heavily over-consolidated glacial tills may be high with K_o values on the order of 1 or more. Because of excavation processes, such high lateral stresses will likely be relieved to some degree. Although active stresses may be developed during excavation, relieving the in situ stresses, the permanent structures will likely be restrained against displacement and there may be some long-term reestablishment of in situ stresses that are closer to the initial conditions. Therefore, for preliminary design of underground structures, lateral pressures may be assumed to be approximately half of the vertical stress. For preliminary design, the horizontal stresses, $\sigma^1{}_h$, can be assumed to be equivalent to:

$\sigma^1{}_h =$ 0.5(z)21 kPa, where z is the depth from the ground surface to a maximum equal to the depth to the groundwater level

$\sigma^1{}_h =$ 0.5(z)21 + 0.5(z_w)11 kPa, where z_w is the depth below the groundwater level

For preliminary design, groundwater pressure may be assumed to be equivalent to $9.81z_w$.

Lateral stresses for final design must be refined from these estimates based on additional exploration and testing. It is considered, however, that the stresses given above should be sufficient for preliminary proportioning of structure sizes for initial planning or costing purposes.

7.1.1.4 Backfill to Structures

Backfill for the stations should consist of well-compacted fill that is compatible with the hydrogeologic conditions of the surrounding ground at each station site. It is generally recommended that the in situ permeability of mass backfill be similar to that of the surrounding ground.

This is particularly of concern where granular backfill is used for large excavations for station construction that pass through native cohesive ground. The pore space within the granular backfill will become saturated with time, and may exacerbate undesirable leakage in the permanent structure or undesirable groundwater flow patterns. Furthermore, if the surrounding ground is suspected to or shown to be affected by contamination, it will be necessary to use low permeability backfill materials to limit the potential for aquifer cross-contamination.

The available subsurface data collected along the alignment indicate that the existing native till deposits should be generally suitable for placement and compaction as backfill for cut and cover excavations.

7.1.2 Excavations

Cut-and-cover construction may be carried out by either creating a wide open cut with sloped sides or, if space is restricted, by providing structural support to excavations with vertical walls.

Based on the prevailing ground conditions, temporary cuts for open-cut construction may be made with side slopes in the range of 1H:1V to 1.5H :1V. It is expected, however, that in most instances, vertical excavation sides will be required and that these excavations will require some form of temporary shoring. The shoring may take the form of soldier-piles and wood lagging walls, drilled secant pile (caisson) walls, or soil-nail ground support. Horizontal support may be provided by internal braces or drilled anchors that extend into the ground behind the supporting walls.

Where temporary or permanent easements can be obtained from neighbouring property owners, it may be assumed that ground anchors or soil nails will extend horizontally (or at some shallow angle) into the ground a distance of up to twice the depth of the excavation. For soil nail supported excavations, this distance may be less (approximately equal to the excavation depth) but for planning purposes, the greater extent should be used since the actual or likely support systems are unknown at this time.

7.1.2.1 Temporary Ground Support Systems

For temporary ground support of deep excavations, soldier pile and lagging walls are typically used where groundwater conditions are favourable or where dewatering is carried out and wall and ground displacement are permitted to some degree. Where ground displacement must be minimized and the ground support system must be closely controlled, contiguous bored and cast-in-place concrete pile (secant pile) walls are often used.

In some instances, depending on cost and ground/groundwater condition considerations, soil nail walls or concrete diaphragm walls may also be appropriate. It is anticipated that sheet pile walls will have limited application, if any, for this project since the ground is too dense for driven sheet pile installation to the depth required. Concrete diaphragm walls are also seldom used in the Greater Toronto Area since continuous concrete walls can be constructed in situ using the secant pile wall technique, for which many local contractors are equipped.

Lateral pressures for design of the temporary structures will depend on the temporary structure design. For flexible walls, such as soldier piles and lagging or sheet piles, the distribution of lateral pressure may take on a trapezoidal shape, whereas for stiffer walls, such as secant pile or concrete diaphragm walls, the lateral pressure distribution may be similar to a more common triangular active earth pressure distribution with magnitudes to up to half of those given above for design of permanent structures.

For final design and construction, recommended lateral pressure distributions for temporary shoring walls should be developed for each particular construction situation.

7.1.2.2 Evaluation of Settlement Adjacent to Shored Excavations

During construction, the ground surrounding the excavations which are supported by soldier piles and lagging walls may deform up to about 0.2 per cent of the excavation depth in both the horizontal and vertical directions. Ground displacements for secant pile walls or well-constructed soil-nail supported walls can be about half of this value, depending on design and workmanship.

In general, the maximum displacements occur very near to the edge of the excavation and dissipate to nominal values at distances ranging from approximately equal to the excavation depth or up to twice this distance for relatively poor ground conditions. Displacements on the order of 0.2 per cent of the excavation depth, or about 30 mm for a 15 m deep excavation, can be damaging to buildings or utilities that are within the “zone of influence”.

A detailed examination of the geometry of the site, ground conditions, and nearby structures should be completed for all buildings and utilities that are within a distance of about 1.5 to 2.0 times the depth to the base of the excavation, as per the requirements of the TTC Design Manual (if applicable).

7.2 Tunnelling Methods

In general, the anticipated ground conditions along the proposed alignment should be favourable to tunnel construction. A brief summary of possible techniques is provided below.

- **Tunnel Boring Machine (TBM):** For relatively long lengths of tunnel, generally greater than about 600 m as anticipated for this proposed alignment, it is considered feasible and likely economically suitable to use a tunnel boring machine. Tunnel boring machines are generally not suited to construction of underground transit stations. The recently-built Sheppard Subway was constructed using TBMs specifically designed for and purchased by the TTC. These TBMs were designed as earth-pressure-balance (EPB) machines so as to assist in controlling ground displacements in potentially difficult ground conditions below groundwater levels. Boulders may present difficulties for machine tunnelling, but the TBMs designed and used for the Sheppard Subway performed well with a head configured with both rock and soil cutting tools.

- **Sequential Excavation Method (SEM):** The sequential excavation method (sometimes called NATM), in which a number of short-length stages of mechanically-assisted and unsupported excavation are followed immediately by steel ribs and shotcrete lining construction, may also be a suitable technique for relatively short sections of tunnel or the

Highway 407 Station. Although soft-ground SEM/NATM has not been used frequently in the Toronto area, it is becoming a more common technique and may prove economically and technically suitable for portions of the Vaughan Subway Link. Ground conditions, particularly those where the till deposits are extensive, should be generally favourable for such construction provided that groundwater in granular deposits is adequately controlled and that the tunnel and/or station has a depth of cover at least equal to the diameter of the tunnel.

- In addition to the use of TBMs and the SEM, tunnels or mined stations (if such might be considered) could be completed with a number of other techniques, depending on the required tunnel or station geometry. Such techniques could include use of large or irregularly-shaped tunnelling shields (as used for University Station in Toronto), jacked pipe arches, and hand-mining with steel plates for temporary liner construction. As with the SEM techniques, groundwater control would be critical for successful construction using such alternative methods. Additional information and recommendations on alternative methods should be further developed as the project progresses through preliminary design.

Construction of running tunnels or mined stations using tunnelling techniques will also induce ground displacements. Typically, during construction of the Sheppard Subway using a tunnel boring machine, displacement of ground similar to that which may be encountered along the Vaughan Subway Link was limited to about 30 mm or less, though instances of greater settlement should be expected depending on the depth to the tunnel, workmanship, and local conditions. Where the ground conditions consisted of hard cohesive soils in the bottom of the tunnel and saturated granular soils in or near the top of the tunnel, larger settlements and ground losses occurred. An instrumentation program carried out in conjunction with tunnel construction should assist in identifying locations of higher than acceptable ground loss allowing remedial grouting to be completed to minimize the effects of tunnelling on surface features or foundations.

Where the tunnels pass directly beneath existing structures (eg. Jane Street overpass at Highway 407), additional ground control measures may be necessary. Such measures could include underpinning or various forms of grouting. It is generally recommended that any tunnelling that is to be carried out beneath buildings be at a depth that leaves a distance of at least twice the tunnel diameter between the crown of the tunnel and the underside of any building foundations.

Tunnelling beneath buildings is feasible and has been accomplished successfully on many projects throughout Canada and world-wide, though special construction measures may be needed to limit potential risks and consequent costs. Detailed settlement and building damage potential evaluations should be completed for any areas where it is contemplated that tunnelling will be completed beneath buildings that are to remain in place during construction. Typically, ground displacements often occur at a maximum over the centreline of the tunnel and dissipate to nominal values over a distance perpendicular (in each direction) to the centreline approximately equal to the depth to the tunnel.

A detailed examination of the geometry of the site, ground conditions, and nearby structures should also be completed if any buildings are within a horizontal distance of about 1.5 times the depth to the centreline of the tunnel (the “zone of influence”), as per the requirements of the TTC Design Manual (if applicable).

Use of some tunnel construction methods may necessitate groundwater control by active dewatering. The water-bearing granular soils, if exposed, will flow into tunnel faces unless the water is removed. If active dewatering is not permitted, other measures may be necessary to facilitate construction. If earth pressure balance or slurry machines are used for tunnel excavation, dewatering may not be necessary except at certain shafts or isolated construction incidents or locations.

The selection of the primary tunnel lining will have an influence on whether or not dewatering is required or groundwater is drawn down. Use of a precast, segmented, and gasketed concrete liner will minimize effects on local groundwater conditions whereas use of a ribs and lagging liner wall create a large horizontal drain within the water bearing deposits and create an extensive zone of groundwater influence beyond the tunnel alignment.

Alternatively, if tunnels are constructed by other methods (e.g. SEM/NATM) ground improvement using grouting techniques (permeation or jet grouting) to effectively plug the pore space in the soil or replace the soil may be used to limit flows of water through the ground and into the tunnels. Other groundwater control measures may be feasible depending on the details of the design and local subsurface conditions. Additional design and subsurface investigations will be required, however, prior to further assessment of groundwater control needs. Further discussion on dewatering is presented below.

7.3 Dewatering

Dewatering of the interstadial granular soils (Upper Sand/Silt) will be necessary for cut-and-cover stations, running track, or crossover track structures. In addition, it is anticipated that dewatering may be required for the start and end shafts for tunnels constructed with tunnel boring machines, and for ventilation/emergency exits. Based on previous construction for Toronto subway projects, such dewatering may be accomplished using deep wells, eductor well systems or well-points installed within excavations. It is anticipated that active dewatering for lengths of tunnel constructed using closed-face tunnel boring machines would not be required.

For the purpose of this Environmental Assessment, an outline assessment of potential dewatering conditions was conducted. This dewatering assessment, limited in its scope, considered the following:

- Construction of an underground station near Highway 407, Jane Street and Black Creek, with subsurface conditions consisting of water-bearing granular deposits (Upper Sand/Silt), up to 2 m thick, near the ground surface above the cohesive deposit (Upper Till).

- Construction of an underground station at Highway 7 and Millway Avenue, with subsurface conditions consisting of water-bearing granular deposits with a thickness on the order of about 8 m to 10 m.

- Construction was assumed to be completed using conventional cut-and-cover methods without implementation of any groundwater control measures except for dewatering using wells or well points.

- The permeability (hydraulic conductivity) of the granular deposits around Highway 7 station was assumed to be between $5x10^{-3}$ and $5x10^{-5}$ cm/s.

Based on these assumptions, it is anticipated that nominal dewatering is expected at the site of the Highway 407 Station to control the stormwater and residual flows during construction. The lateral extent of the groundwater drawdown at the site of Highway 7 Station could be on the order of 500 m to 1,500 m from the dewatering system to where the drawdown is on the order of about 1 m. Typical flows extracted from a dewatering system installed for construction of the hypothetical station conditions assumed above are estimated to range between 1,000 and 5,000 litres per minute for the 150 m long stations. Should cross-overs or tail track structures be dewatered concurrently with the station, discharge flows will be greater. These values are consistent with the magnitudes of dewatering discharge from station construction work on the Sheppard and Eglinton Subway projects. Given that the granular soils are typically very dense and the cohesive soils range between firm to hard, the influence of dewatering on settlement of the surrounding ground should be relatively minimal.

Further investigations and analyses will be required to better define estimated dewatering quantities and drawdown radius values for final design and final permitting. At each of the station areas noted above, the available information suggests that continuous excavation support walls (e.g. secant pile or concrete diaphragm walls) may be constructed to pass through and cut off the aquifers since the aquifers appear to be confined with the base of the granular soils above the bottom of the excavation with relatively thick cohesive (aquitard) deposits below.

Where groundwater taking is carried out near potentially contaminated sites or at the Highway 407 site where there had been ongoing agricultural activities, the groundwater extracted during dewatering may require treatment prior to disposal.

8.0 LIMITATIONS AND USE OF REPORT

This report was prepared for the exclusive use of the Consortium and York Transit and the reader is referred to the “Important Information and Limitations of This Report”. 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 the third party. The report is based on data and information collected during the assessment of the Highway 7 transitway route options and the geotechnical investigation conducted by Golder in 2006. The report is based solely on the conditions observed at the time of limited visual reconnaissance, supplemented by a review of historical and publicly available information and field data obtained by Golder as described in this report.

This report is intended to be used for planning purposes only as consistent with the feasibility and selected alignment at the time this report was prepared. Additional explorations of subsurface conditions will need to be carried out to better define the local geologic stratigraphy, groundwater levels, and the engineering properties of the subsurface materials for design.

9.0 CLOSURE

We trust this report provides the information required. However, should you have any questions, please do not hesitate to contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Original to be signed by Lisa Coyne for:

Beng Lay Teh
Geotechnical Group

Original to be signed by:

Storer J. Boone, P.Eng., Ph.D.
Associate

Original to be signed by:

John Westland, P.Eng.
Principal

BLT/SJB/JW/sm/al

n:\active\2006\1111\06-1111-040 york consortium vaughan n-s link ea vaughan york\reports\in progress\06-1111-040 rpt 07jan08 vnsl assessment report.doc

IMPORTANT INFORMATION AND LIMITATIONS
OF THIS REPORT

Standard of Care: Golder Associates Ltd. (Golder) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

Basis and Use of the Report: This report has been prepared for the specific site, design objective, development and purpose described to Golder by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. Golder can not be responsible for use of this report, or portions thereof, unless Golder is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without Golder's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, Golder may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to Golder. The report, all plans, data, drawings and other documents as well as all electronic media prepared by Golder are considered its professional work product and shall remain the copyright property of Golder, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available the report or any portion thereof to any other party without the express written permission of Golder. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client can not rely upon the electronic media versions of Golder's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to Golder by the Client, communications between Golder and the Client, and to any other reports prepared by Golder for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. Golder can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Groundwater Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.

IMPORTANT INFORMATION AND LIMITATIONS
OF THIS REPORT (cont'd)

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. **The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report.** The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

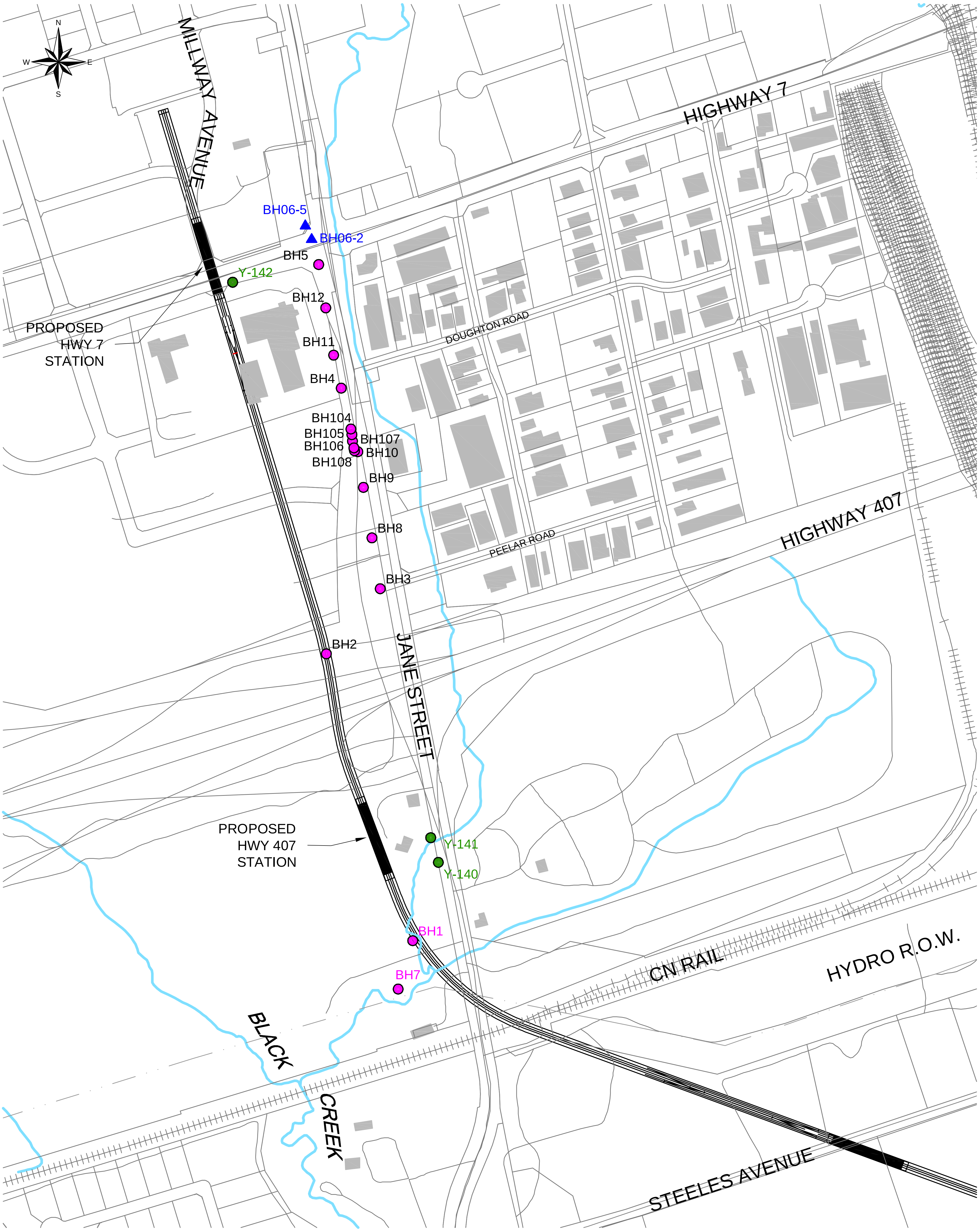
Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

PLOT DATE: December 27, 2006
FILENAME: T:\Projects\2006\06-1111-040 (Delcan, Vaughan)\-AA- (GeoTech Hyd Inv Vaughan N-S Link)\061111040AA001.dwg



NOTES:

1. PROJECTION IS UTM NAD83, ZONE 17.
2. BASE MAPPING PROPOSED ALIGNMENT AND STATION LOCATIONS ARE AS PROVIDED BY YORK CONSORTIUM DATED DECEMBER 5, 2006.

LEGEND:

●	BOREHOLES (GOLDER - 2006)
●	EXISTING BOREHOLES (GOLDER - 1980's)
▲	EXISTING BOREHOLES (BY OTHERS - 2006)

150 0 150 300
SCALE 1:7500 METRES

Golder Associates
Mississauga, Ontario, Canada

SCALE	AS SHOWN
DATE	DEC. 14, 2006
DESIGN	
CAD	MSM
CHECK	BLT
REVIEW	SJB

FILE No. 061111040AA001.dwg
PROJECT No. 06-1111-040 REV.

TITLE

BOREHOLE LOCATION PLAN

VAUGHAN NORTH-SOUTH LINK

DRAWING NO.
1

BOREHOLE MATERIAL SYMBOLS:

1	FILL	5	SAND	9	CLAYEY SILT
2	ORGANICS	6	SILTY SAND	10	CLAY/SILTY CLAY
3	GRAVEL	7	SANDY SILT/ SAND AND SILT	11	SILTY CLAY TILL / CLAYEY SILT TILL
4	SAND AND GRAVEL/ GRAVELLY SAND	8	SILT	12	SANDY SILT/SILTY SAND/ SAND AND SILT TILL

NOTES:

1. CONTINUITY AND CONSISTENCY OF STRATIGRAPHIC BOUNDARIES ARE A FUNCTION OF LIMITED SITE SPECIFIC DATA AND SIMPLIFICATIONS ARISING FROM GEOLOGIC MODELLING.

2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE REPORT TITLED "GEOTECHNICAL/HYDROGEOLOGICAL ASSESSMENT, YORK RAPID TRANSIT PLAN, VAUGHAN NORTH-SOUTH SUBWAY LINK, ENVIRONMENTAL ASSESSMENT, REGIONAL MUNICIPALITY OF YORK", DATED JANUARY 2007.

3. BOREHOLE DIAMETERS IN PLAN AND PROFILE ARE NOT TO SCALE.

REFERENCES:

1. ALIGNMENT PROFILE PROVIDED BY YORK CONSORTIUM DATED NOVEMBER 28, 2006. THE PROFILES ARE APPROXIMATE AND ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

GENERAL LEGEND:

— — — —	INTERPRETED MAJOR DEPOSIT BOUNDARY
▽	WATER LEVEL MEASURED (LATEST WHERE AVAILABLE)
Y-140	Y-SERIES BOREHOLE BY GOLDER (2006)
BH1	BH-SERIES BOREHOLE BY GOLDER (1980's)
BH108	(ALL OTHERS FROM CITY OF TORONTO DATABASE)
BH06-7	BH-SERIES BOREHOLE BY OTHERS (2006)

Golder Associates
Mississauga, Ontario, Canada

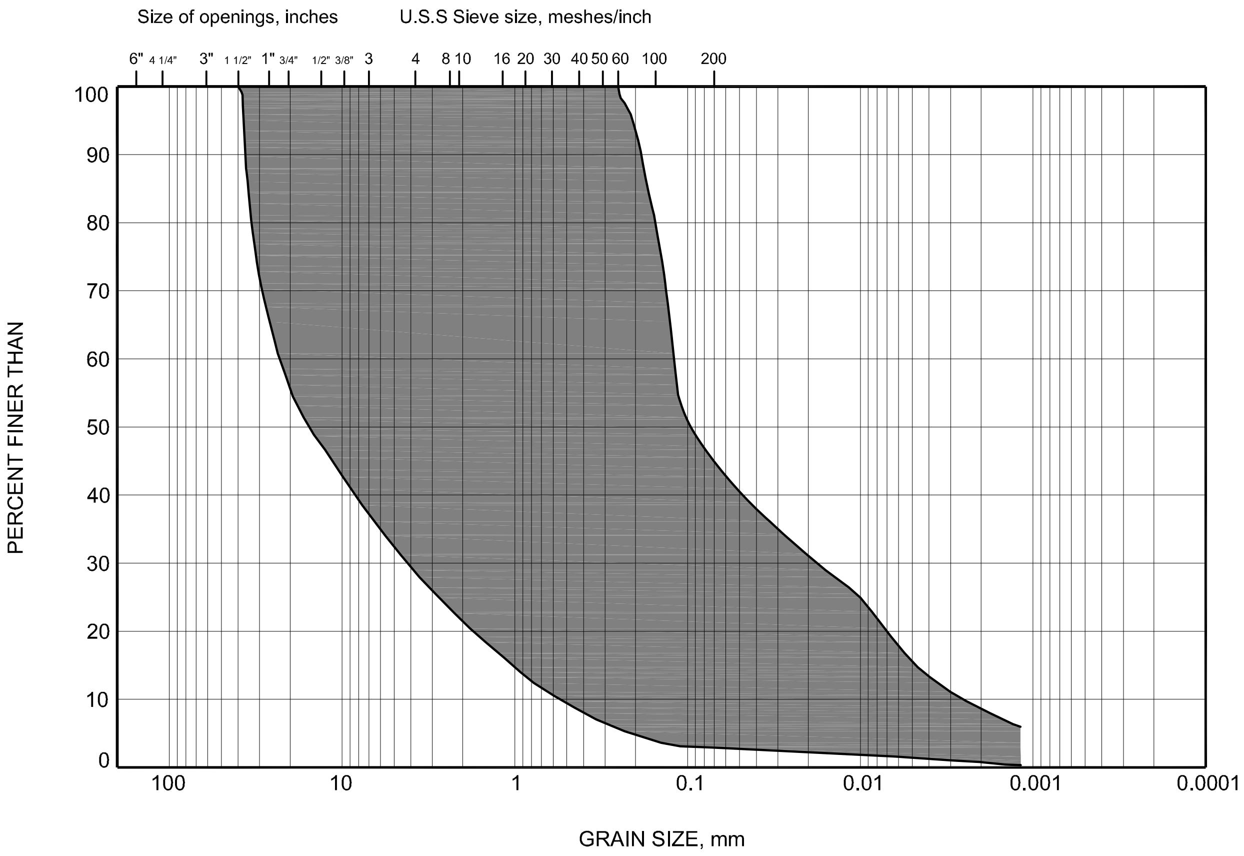
FILE No.	061111040AA002.dwg		
PROJECT No.	06-1111-040	REV.	
SCALE	AS SHOWN		
DATE	Jan. 8, 2007		
DESIGN	BLT		
CAD	MSM		
CHECK	BLT		
REVIEW	SJB/JW		

TITLE

STRATIGRAPHIC PROFILE CHAINAGE 0+500 to 3+300

GEOTECHNICAL/HYDROGEOLOGICAL
INVESTIGATION AND REPORTING
FOR VAUGHAN NORTH-SOUTH LINK

DRAWING
2



COBBLE	GRAVEL SIZE		SAND SIZE			SILT AND CLAY SIZES
SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

NOTE:

1. ASSUMPTION - THIS GRAIN SIZE DISTRIBUTION ENVELOPE IS BASED ON THE RESULTS OF SAMPLES OBTAINED FROM THE ALIGNMENT AREA AT THE HIGHWAY 7 STATION SITE. FOR SPECIFIC SAMPLE RESULTS, REFER TO THE GEOTECHNICAL INVESTIGATION REPORT BY GOLDER ASSOCIATES DATED JANUARY 2007 AND APPENDIX B.

PLOT DATE: January 8, 2007
FILENAME: T:\Projects\2006\06-1111-040 (Delcan, Vaughan)\-AA- (GeoTech Hyd Inv Vaughan N-S Link)\061111040AA003.dwg

Golder Associates
Mississauga, Ontario, Canada

FILE No. 061111040AA003.dwg
PROJECT No. 06-1111-040 REV. A

SCALE AS SHOWN
DATE Jan. 8, 2007
DESIGN BLT
CAD MSM
CHECK BLT
REVIEW SJB/JW

TITLE

GRAIN SIZE DISTRIBUTION ENVELOPE UPPER SAND/SILT (NORTH)

GEOTECHNICAL/HYDROGEOLOGICAL
INVESTIGATION AND REPORTING
FOR VAUGHAN NORTH-SOUTH LINK

DRAWING
3

APPENDIX A

GEOTECHNICAL INVESTIGATION REPORT
BY
GOLDER ASSOCIATES LTD.

Golder Associates Ltd.

2390 Argentia Road
Mississauga, Ontario, Canada L5N 5Z7
Telephone: (905) 567-4444
Fax: (905) 567-6561

GEOTECHNICAL INVESTIGATION REPORT

YORK RAPID TRANSIT PLAN
VAUGHAN NORTH-SOUTH SUBWAY LINK
SUPPLEMENTARY TO ENVIRONMENTAL ASSESSMENT
REGIONAL MUNICIPALITY OF YORK, ONTARIO

Submitted to:

York Consortium 2002
1 West Pearce Street, 6th Floor
Richmond Hill, Ontario
L4B 3K3

January 2007 06-1111-040

TABLE OF CONTENTS

LIST OF DRAWINGS

LIST OF FIGURES

LIST OF ATTACHMENTS

1.0 INTRODUCTION

Golder Associates Ltd. (“Golder”) was retained by the York Consortium 2002 (the “Consortium”), on behalf of York Region Transit (“York Transit”), to assist in the completion of a geotechnical investigation to supplement the subsurface data for the Environmental Assessment of the proposed subway connection with the future Spadina Subway Extension located at York University campus, just south of Steeles Avenue in Toronto, Ontario.

The purpose of this factual report is to provide preliminary information on the subsurface conditions (soil and groundwater) at the two proposed stations of the subway alignment.

2.0 PROJECT AND SITE DESCRIPTION

The location of the project is illustrated on Drawing 1. The subway alignment is proposed to run from the future Steeles Subway Station on the Spadina Subway Extension, extend northwest across Steeles Avenue, then turn north to run along the west side of Jane Street, cross beneath Black Creek and Highway 407, and terminate near the intersection of Highway 7 and Millway Avenue. The proposed subway will run parallel to Jane Street for most of the alignment.

Two underground subway stations have been proposed for the alignment at the following locations:

- Approximately 100 m west of Jane Street between Highway 407 and its west-south exit ramp onto Jane Street; and

- Approximately 225 m west of Jane Street at the intersection of Highway 7 and Millway Avenue.

3.0 INVESTIGATION PROCEDURES

The field work for the Vaughan North-South Subway Link was carried out from October 25, 2006 to November 7, 2006, at which time three boreholes (Boreholes Y-140 to Y-142) were advanced to depths of between 30.6 m and 35.5 m below ground surface. These boreholes were advanced in the general vicinity of the proposed stations. The borehole and well locations are shown on Drawing 1.

The borehole investigation and well installations were carried out using a track-mounted and truck-mounted drill rigs, both supplied and operated by Walker Drilling of Utopia, Ontario. The borehole investigation was carried out using 108 mm internal diameter continuous flight hollow stem augers. Soil samples were obtained at intervals of 0.76 m for depths up to 4.6 m, and at intervals of 1.5 m for the remaining depth of the boreholes, using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure.

Groundwater conditions were observed in the open boreholes during and after the drilling operations. Each borehole included an observation well, which consisted of a 1.5 m long, 50 mm diameter slotted screen installed within a filter sand pack. All boreholes were terminated within a till deposit and backfilled above the sand pack to the ground surface with bentonite pellets; flush-mounted protective casings were installed. The installation details are shown on the Record of Borehole sheets for Boreholes Y-140 to Y-142.

The field work was supervised throughout by a member of Golder’s technical staff, who located the boreholes in the field, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples obtained. The samples were identified in the field, placed in appropriate containers, labelled and transported to Golder’s Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. Classification tests (water content determinations, Atterberg limit tests and grain size distribution analyses) were carried out on selected soil samples. All of the laboratory tests were carried out to applicable ASTM Standards.

Rising head tests were performed on two of the monitoring wells to determine the hydraulic conductivity of the overburden soils. For each test, approximately 2 litres of groundwater was removed rapidly from the observation well and the water level recovery was monitored manually using an electronic water level meter over a period of time. The results are included in Attachment 1.

The northings, eastings and elevations of the as-drilled borehole locations were surveyed by J&R Surveys Ltd. of Mississauga, and are summarized below. The borehole locations are based on the UTM NAD83 (Zone 17) coordinate system, and the ground surface elevations at the borehole locations are referenced to the geodetic datum.

Borehole Number	Locations	Northing (m)	Easting (m)	Ground Surface Elevation (m)
Y-140	Jane and 407 – South	4,848,814.9	618,935.8	195.39
Y-141	Jane and 407 – North	4,848,864.6	618,920.5	196.93
Y-142	Highway 7 and Millway Ave	4,849,983.9	618,521.5	202.94

3.1 Groundwater Testing

A groundwater sample was obtained from Borehole Y-140 and submitted to AGAT Analytical Laboratories for analysis in accordance to the York Region Storm Sewer Use By-Law. The well was bailed with a Waterra foot valve and developed in order to obtain a representative sample of the aquifer water quality. However, due to the construction and well yield of Borehole Y-140, the sampled groundwater contained a high degree of suspended solids.

The laboratory test results are included in Attachment 2. The results indicate that there are elevated concentrations of some metal parameters (such as manganese, aluminium, iron and titanium) and nitrogen.

3.2 Soil Testing and Disposal

In order to characterize the chemical quality of the subsurface material for the disposal of soil cuttings, composite samples from boreholes were collected and submitted to AGAT Analytical Laboratories for Toxicity Characteristic Leaching Procedure (TCLP) testing. The laboratory test results are included in Attachment 2. No visual or olfactory evidence of environmental impact was encountered during this geotechnical investigation.

Based on the results of the testing, the subsurface materials at the investigated locations were characterized and managed as non-hazardous materials according to the definition provided by Ontario Regulation 347 (as amended), and were disposed of as non-hazardous waste (daily cover) at the PSE Taro Landfill site.

4.0 SUBSURFACE CONDITIONS ENCOUNTERED DURING INVESTIGATION

The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations. Bedrock was not encountered in any of the boreholes.

The soil types described on the Record of Borehole sheets and the laboratory test results included in this report are given twelve different classifications and graphic symbols (Types 1 through 12), which are consistent with the range of soil deposits anticipated to be encountered for subway construction in the Greater Toronto Area.

The classification system generally utilized is listed below:

- Fill (Type 1)
- Organics (Type 2)
- Gravel to Sand and Gravel (Types 3 and 4)
- Sand to Silty Sand (Types 5 and 6)
- Sandy Silt to Silt (Types 7 and 8)
- Clayey Silt to Clay (Types 9 and 10)
- Clayey Silt Till (Type 11)
- Sandy Silt Till (Type 12)

Note that Deposit Types 11 and 12 are interpreted as glacial till deposits on the basis of their heterogeneous structure, the relatively broad grain size distribution and the documented local geology.

The results of the laboratory tests have been grouped by Deposit Types (Figures 1 to 6) and also Borehole Locations (Figures 7 to 12).

A brief discussion of the materials encountered in the boreholes advanced during this investigation is provided in the subsections that follow.

4.1 Asphalt

A 0.1 m thick layer of asphalt was encountered in Boreholes Y-140 and Y-141, as these were drilled within roadways.

4.2 Topsoil

A 0.2 m thick layer of topsoil was encountered at the ground surface in Borehole Y-142, which was drilled on the landscaped area adjacent to the roadway.

4.3 Fill

Fill material, which forms the embankment for Jane Street approaching Highway 407, was encountered beneath the asphalt in Boreholes Y-140 and Y-141. The upper fill layer consisted of sand and gravel to sand that ranged in thickness from 1.1 m to 1.4 m, and the lower fill layer consisted of clayey silt that ranged in thickness from 3.4 m to 6.1 m.

The measured Standard Penetration Test (SPT) “N” values in the sand fill ranged from 6 to 14 blows per 0.3 m of penetration, indicating a loose to compact relative density. The measured SPT “N” values in the clayey silt fill ranged from 9 to 23 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency.

Measured water contents obtained from the twelve selected samples of the fill material were between 4 and 17 per cent.

4.4 Sand and Gravel (Type 4)

A 1.5 m thick layer of sand and gravel containing trace to some silt was encountered at about Elevation 186.7 m, toward the base of Borehole 142.

The measured SPT “N” value within the sand and gravel layer was 24 blows per 0.3 m of penetration, indicating a compact relative density. The measured natural water content of the sample obtained was 9 per cent.

4.5 Sand (Type 5)

A granular deposit consisting mainly of grey sand with some silt and trace clay was encountered within the glacial till deposit in Borehole Y-142. The upper surface of the granular deposit was encountered at about Elevation 193.3 m and it had a thickness of about 7.6 m.

The measured SPT “N” values within the sand deposit ranged from 13 to 37 blows per 0.3 m of penetration, indicating a compact to dense relative density.

Grain size distribution analyses were carried out on two selected samples of the granular deposit and an envelope of the grain size distribution test results is shown on Figure 1. The uniformity coefficient (Uc) of this granular layer is estimated to be between 3 and 40. The measured natural water contents of five selected samples obtained within the sand layer ranged from 17 to 23 per cent.

4.6 Sandy Silt (Type 7)

An interstadial granular layer, which consists of sandy silt containing trace clay and gravel, was encountered at about Elevation 189.8 m, underlying the clayey silt deposit in Borehole Y-140; the layer had a thickness of about 1.7 m.

The measured SPT “N” value within the sandy silt layer was 44 blows per 0.3 m of penetration, indicating a dense relative density.

A grain size distribution analysis was carried out on one sample of the granular deposit and the grain size distribution test result is shown on Figure 2. The uniformity coefficient (Uc) of the sandy silt is estimated to be approximately 15.

The measured natural water content of the selected sample was 11 per cent.

4.7 Silty Clay to Clay (Types 9 and 10)

Interlayers of cohesive soils were encountered within the glacial till in all three boreholes: four such interlayers were encountered within the glacial till at Borehole Y-140, three were encountered in Borehole Y-141 and one was encountered in Borehole Y-142. The composition of the interlayers ranged from clayey silt through to clay, with the variation reflecting differences in clay content and plasticity. The interlayers were typically between 1 m and 1.5 m thick, with the exception of Borehole Y-140 where the silty clay layer encountered at Elevation 180.7 m was about 4.6 m thick.

The measured SPT “N” values in the cohesive interlayers ranged from 7 to 93 blows per 0.3 m of penetration, indicating a firm to hard consistency. The majority of the tests were above 30 blows per 0.3 m of penetration, indicative of a generally hard consistency. The measured water contents obtained from selected samples of the cohesive deposit were between 15 and 29 per cent.

Grain size distribution analyses were carried out on seven selected samples of the deposit and the results are shown on Figure 3. Atterberg limit testing was carried out on six selected samples, and measured plastic limits between 16 and 23 per cent, liquid limits between 24 and 56 per cent, and corresponding plasticity indices between 8 and 33 per cent. The test results are plotted on a plasticity chart on Figure 4.

4.8 Clayey Silt to Silty Clay Till (Type 11)

Glacial till, containing interlayers of granular/cohesive soil, was the predominant soil type encountered in all three boreholes (Boreholes Y-140 to Y-142).

In Boreholes Y-140 and Y-141, the surface of the till deposit was encountered between Elevations 188.1 and 189.8 m. In Borehole Y-142, the till deposit was encountered immediately beneath the topsoil at about Elevation 202.8 m. The glacial till deposit consists mainly of brown to grey clayey silt containing trace to some sand and gravel; seams of grey silt were observed within the glacial till in Boreholes Y-140 and Y-141 below depths of 27.4 m to 29.0 m. Oxidizing stains were observed within the top portion of this deposit.

This cohesive till is differentiated from those materials classified as clayey silt to silty clay/clay (Types 9 and 10) on account of the more massive, heterogeneous structure and the presence of embedded angular coarse sand and fine gravel.

The measured Standard Penetration Test (SPT) “N” values ranged from 12 blows to more than 100 blows per 0.3 m pf penetration, indicating a stiff to hard consistency.

Grain size distribution analyses were carried out on three samples of the till deposit and the results are shown on Figure 5. Atterberg limit testing was carried out on five selected samples of the glacial till, and measured plastic limits between 11 and 16 per cent, liquid limits between 17 and 32 per cent, and corresponding plasticity indices between 7 and 15 per cent, indicative of a low plasticity. The test results are plotted on a plasticity chart on Figure 6.

Measured water contents on selected samples of the clayey silt till typically ranged from 9 to 31 per cent, with an average of approximately 18 per cent.

4.9 Groundwater Conditions

The water levels within the open boreholes were noted after the drilling operations and are recorded on the borehole records. A standpipe piezometer was installed in each of the boreholes. Details of the piezometer installations are shown in the Record of Borehole sheets. The water levels measured in the piezometers are summarized in the following table:

Borehole Number	Ground Surface Elevation (m)	Water Level Depth (m)	Water Level Elevation (m)	Most Recent Date Measured
Y-140	195.39	11.12	184.27	December 10, 2006
Y-141	196.93	11.45	185.48	November 14, 2006
Y-142	202.94	4.80	198.14	November 14, 2006

It should be noted that the ground surfaces at Boreholes Y-140 and Y-141, which were drilled on the Jane Street embankment, are approximately 3 m to 4 m higher than the expected ground elevation of the proposed Highway 407 station.

The groundwater levels at the site are expected to fluctuate seasonally and are expected to rise during wet periods of the year, especially in proximity to Black Creek and its tributaries.

4.9.1 Rising Head Tests

The results of the single well response tests are presented in Attachment 1 and the calculated hydraulic conductivity values are summarized below. It should be noted that the calculated hydraulic conductivity values are only representative of the general soil mass between the top and bottom elevations of the sand-pack around the well screen or piezometer and for a limited distance within the soil deposit. The calculated hydraulic conductivity values should only be considered an indicator of the layer hydraulic properties and not a definitive measure of the overall formation behaviour. Layers of coarse material within this zone may unduly influence such tests and for final design and prior to construction, field pumping tests should be conducted in any areas in which dewatering or groundwater flow issues may be critical.

SUMMARY OF RISING HEAD TEST RESULTS

Location	Well Reference	Depth of Well (m)	Elevation of Well (m)	Calculated Hydraulic Conductivity (cm/s)
Highway 407 Station	Y-140	35.05	160.34	$1.9 \text{ X } 10^{-5}$
Highway 7 Station	Y-142	16.76	198.01	$3.1 \text{ X } 10^{-5}$

5.0 CLOSURE

We trust this report provided the information required. However, should you have any questions, please do not hesitate to contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Original to be signed by Lisa Coyne for:

Beng Lay Teh
Geotechnical Group

Original to be signed by:

Storer J. Boone, P.Eng., Ph.D.
Associate

Original to be signed by:

John Westland, P.Eng.
Principal

NK/BLT/SJB/JW/sm/al

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LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60º cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

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III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index (Relative Density)	N Blows/300 mm or Blows/ft.
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils

Consistency	c_u,s_u kPa	psf
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. General

π	3.1416
in x,	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\ \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
v	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$-u)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1+\sigma_2+\sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_1	liquid limit
w_p	plastic limit
l_p	plasticity index = $(w_1 - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p)/I_p$
I_C	consistency index = $(w_1 - w)\ /I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e)\ /\ (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
c_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio = σ'_p/σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 + \sigma_3)$
S_t	sensitivity

Notes:
1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2
* density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity)

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-140

SHEET 1 OF 4

LOCATION: N 4848814.9 ;E 618935.8

BORING DATE: November 3 - 6, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, O.D. 108 mm Augers; Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	195.39
ASPHALT	0.00
Compact, heterogeneous, moist, brown sand, trace gravel; FILL (SP)	0.09
Stiff to very stiff, heterogeneous, moist, brown and grey clayey silt, trace sand, trace gravel; FILL (CL-ML)	194.17 1.22
Firm, heterogeneous, moist, grey clayey SILT, trace sand, trace gravel, trace organics; (CL-ML)	190.90 4.50
Dense, heterogeneous, moist to wet, brown and grey sandy SILT, trace clay, trace gravel; (np)	189.75 5.64
Hard, becoming stiff at depth, heterogeneous, wet, grey clayey SILT, trace to some sand, trace to some gravel; TILL (CL-ML)	188.07 7.32

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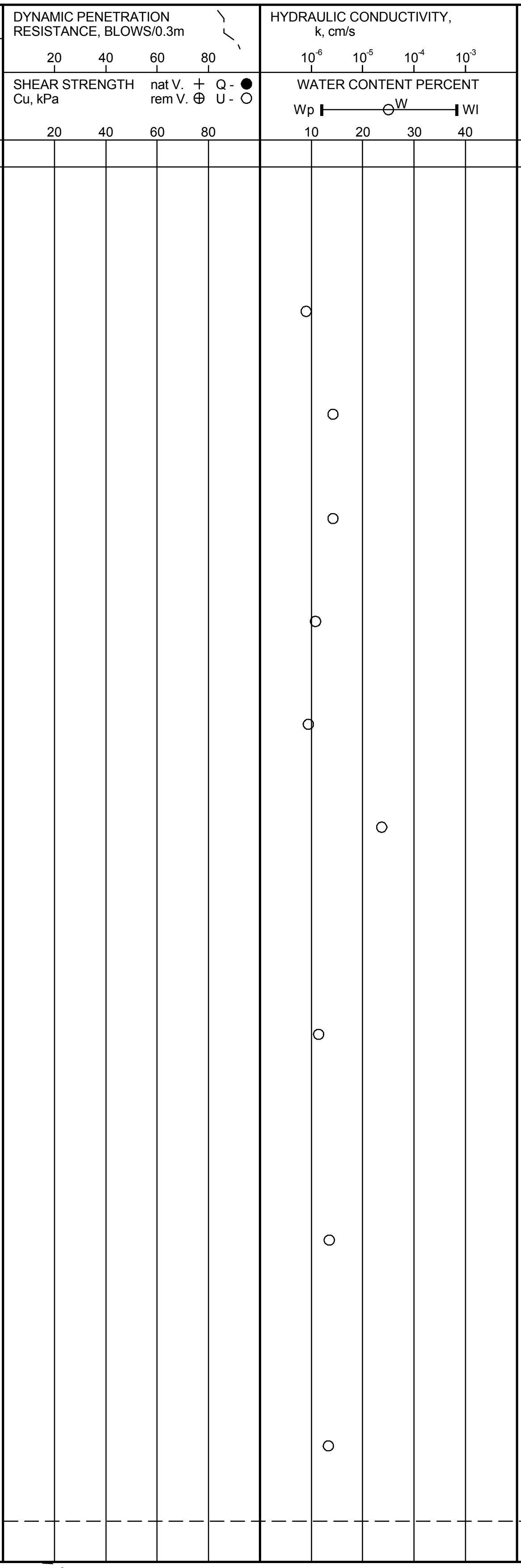
SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	14	
2	50 DO	12	
3	50 DO	11	
4	50 DO	14	
5	50 DO	23	
6	50 DO	7	
7	50 DO	44	MH
8	50 DO	76	
9	50 DO	52	



PIEZOMETER OR STANDPIPE INSTALLATION

Flush mount protective casing

Concrete

50 mm PVC Pipe

Hole Plug

DEPTH SCALE

1 : 50

LOGGED: SB

CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-140

SHEET 2 OF 4

LOCATION: N 4848814.9 ;E 618935.8

BORING DATE: November 3 - 6, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, O.D. 108 mm Augers; Hollow Stem Augers

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DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	Hard, becoming stiff at depth, heterogeneous, wet, grey clayey SILT, trace to some sand, trace to some gravel; TILL (CL-ML)						
11			10	50 DO	66	MH	Dec. 10, 2006
12			11	50 DO	35		
14			12	50 DO	12		50 mm PVC Pipe
	Compact to hard, wet, grey silty CLAY; (CL)	180.69 14.70					
15							Hole Plug
			13	50 DO	14	MH	
17			14	50 DO	38		
18			15	50 DO	74		
	Hard, homogeneous, wet, grey CLAY; (CH)	176.14 19.25					
20			16	50 DO	89		

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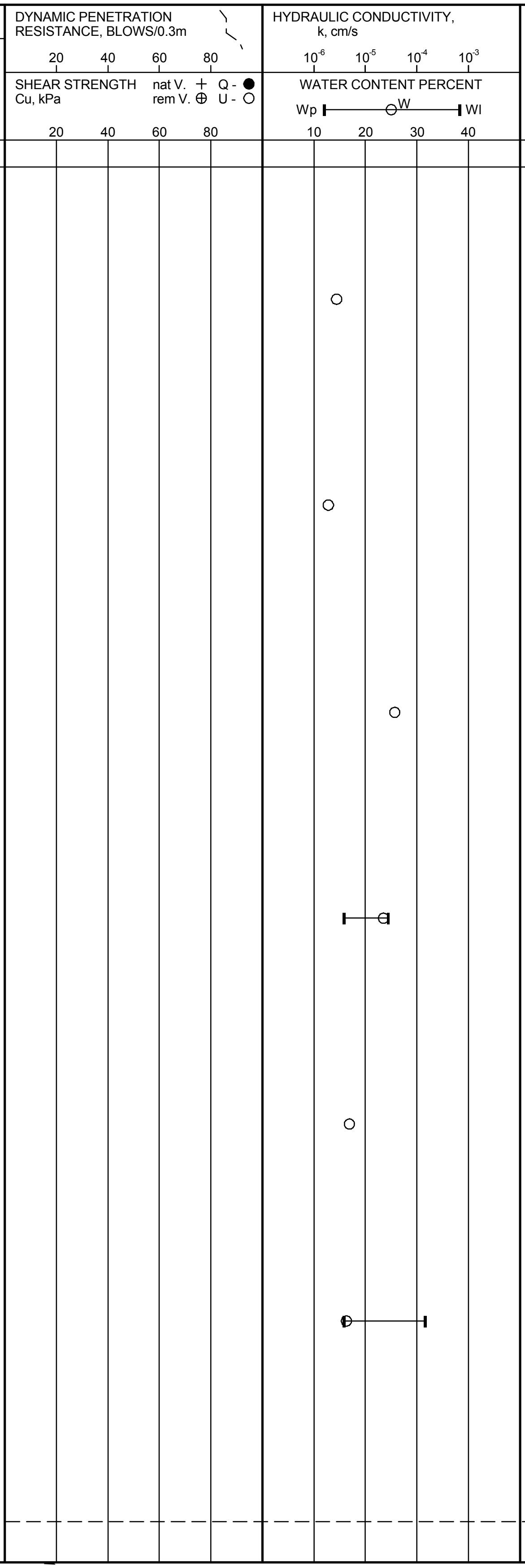

DEPTH SCALE

1 : 50

LOGGED: SB

CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-140

SHEET 3 OF 4

LOCATION: N 4848814.9 ;E 618935.8

BORING DATE: November 3 - 6, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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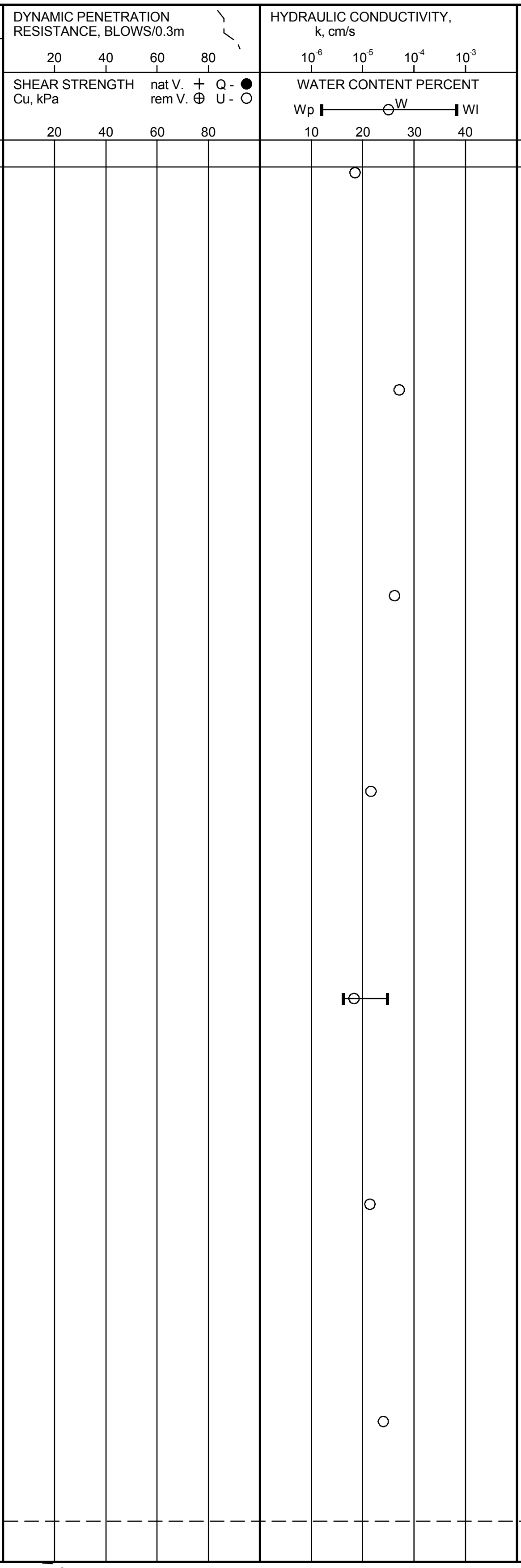
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20	Power Auger, O.D. 108 mm Augers Hollow Stem Augers	Hard, homogeneous, wet, grey CLAY; (CH)		16	50 DO	89	MH	
		Very stiff to hard, heterogeneous, wet, grey silty CLAY, trace sand, trace gravel; TILL (CL)	174.59 20.80					
21				17	50 DO	25		
22								50 mm PVC Pipe
23				18	50 DO	23		
24				19	50 DO	50		Hole Plug
25								
26				20	50 DO	67		
27		Thin layers of grey silt noted below 27.5 m depth.		21	50 DO	50		
28								
29				22	50 DO	38		Sand Pack
30								



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DEPTH SCALE
1 : 50

LOGGED: SB
CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-140

SHEET 4 OF 4

LOCATION: N 4848814.9 ;E 618935.8

BORING DATE: November 3 - 6, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---						
30	Power Auger; O.D. 108 mm Augers Hollow Stem Augers	Very stiff to hard, heterogeneous, wet, grey silty CLAY, trace sand, trace gravel; TILL (CL)		23	50 DO	32		
31			163.89 31.50					Sand Pack
32		Hard, heterogeneous, wet, grey silty CLAY; (CL)		24	50 DO	37	MH	
33		Hard, heterogeneous, wet, grey silty CLAY, trace sand, trace gravel; (TILL) (CL)	162.29 33.10					3.0 m Screen
34				25	50 DO	38		
35				26	50 DO	30		50 mm Well
		END OF BOREHOLE	159.73 35.66					

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ├──○W──┤ Wl 10 20 30 40

Depth scale: 36 37 38 39 40

NOTES:

1. Monitoring well installed at 35.05 m depth (Elev. 160.34 m).

Water level measurements

Date	Depth (m)	Elev (m)
On completion	1.45	193.94
10/11/06	10.43	184.96
14/11/06	11.15	184.24
10/12/06	11.12	184.27

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: SB

CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-141

SHEET 1 OF 4

LOCATION: N 4848864.6 ;E 618920.5

BORING DATE: October 30, 31, November 1, 2006

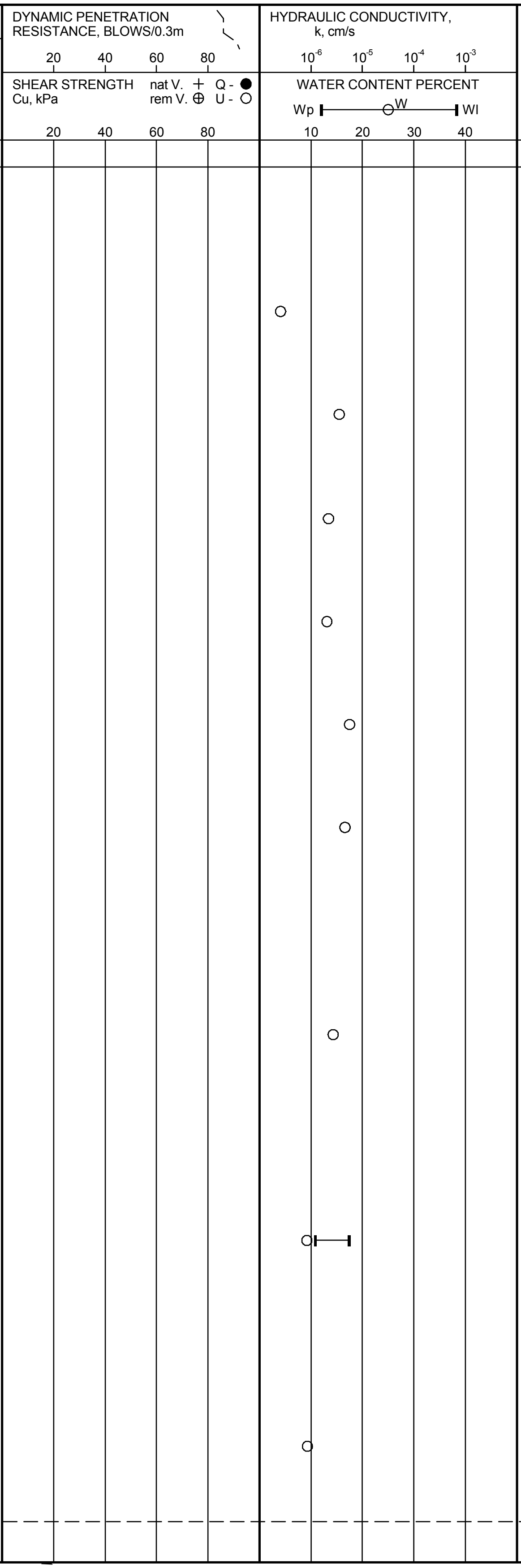
DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, O.D. 108 mm Augers
Hollow Stem Augers

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE		196.93				
ASPHALT		0.00				
Compact, heterogeneous, moist, brown sand and gravel; FILL (SW)		0.09				
Loose, heterogeneous, moist, brown sand, trace gravel, trace silt; FILL (SP)		196.17 0.76	1	50 DO	6	
Stiff to very stiff, heterogeneous, moist, brown and grey clayey SILT, trace sand, trace gravel, trace organics; FILL (CL-ML)		195.49 1.45	2	50 DO	12	
			3	50 DO	15	
			4	50 DO	17	
			5	50 DO	9	
			6	50 DO	18	
			7	50 DO	12	
Hard, heterogeneous, moist to wet, grey clayey SILT, trace sand, trace gravel; TILL (CL-ML)		189.77 7.17	8	50 DO	63	
			9	50 DO	85	MH



PIEZOMETER OR STANDPIPE INSTALLATION

Flush mount protective casing

Concrete

50 mm PVC Pipe

Hole Plug

DEPTH SCALE METRES: 0 – 10

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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: SB

CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-141

SHEET 2 OF 4

LOCATION: N 4848864.6 ;E 618920.5

BORING DATE: October 30, 31, November 1, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

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DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	Power Auger, O.D. 108 mm Augers Hollow Stem Augers	Hard, heterogeneous, moist to wet, grey clayey SILT, trace sand, trace gravel; TILL (CL-ML)						Nov. 14, 2006
11				10	50 DO	70		
		Hard, heterogeneous, wet, grey silty CLAY; (CL)	185.28 11.65					
12								50 mm PVC Pipe
				11	50 DO	92	MH	
13		Hard, moist, grey silty CLAY, trace sand, trace gravel; TILL (CL)	183.78 13.15					
14				12	50 DO	88		
15								Hole Plug
				13	50 DO	100		
16								
17				14	50 DO	92		
18				15	50 DO	105		
19								
20				16	50 DO	88		

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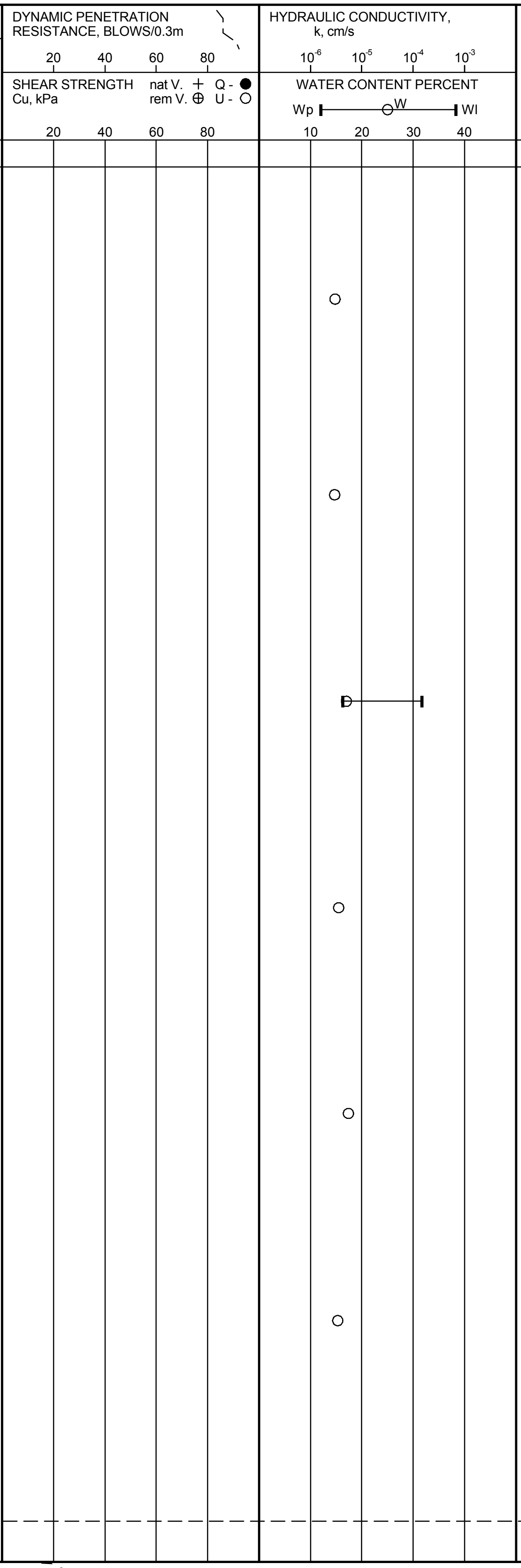


DEPTH SCALE
1 : 50

LOGGED: SB
CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-141

SHEET 3 OF 4

LOCATION: N 4848864.6 ;E 618920.5

BORING DATE: October 30, 31, November 1, 2006

DATUM: Geodetic

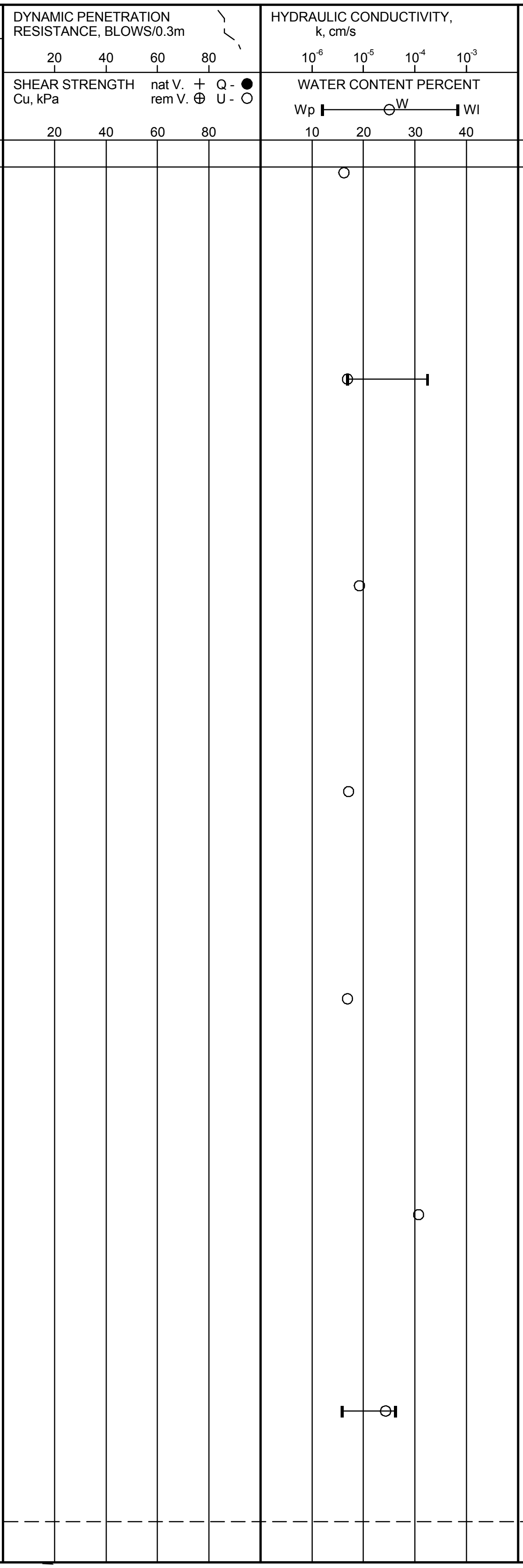
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, O.D. 108 mm Augers; Hollow Stem Augers

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20	Hard, moist, grey silty CLAY, trace sand, trace gravel; TILL (CL)		16	50 DO	88		
21	Hard, heterogeneous, wet, grey silty CLAY; (CL)	176.03 20.90	17	50 DO	62	MH	
22	Hard, heterogeneous, moist, grey silty CLAY, trace sand, trace gravel; TILL (CL)	174.63 22.30					50 mm PVC Pipe
23			18	50 DO	61		
24			19	50 DO	63		
25							Hole Plug
26			20	50 DO	67		
27			21	50 DO	35		
29	Thin layers of grey silt noted below 29.0 m depth		22	50 DO	85		
30							Sand Pack



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DEPTH SCALE
1 : 50

Golder Associates

LOGGED: SB

CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-141

SHEET 4 OF 4

LOCATION: N 4848864.6 ;E 618920.5

BORING DATE: October 30, 31, November 1, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

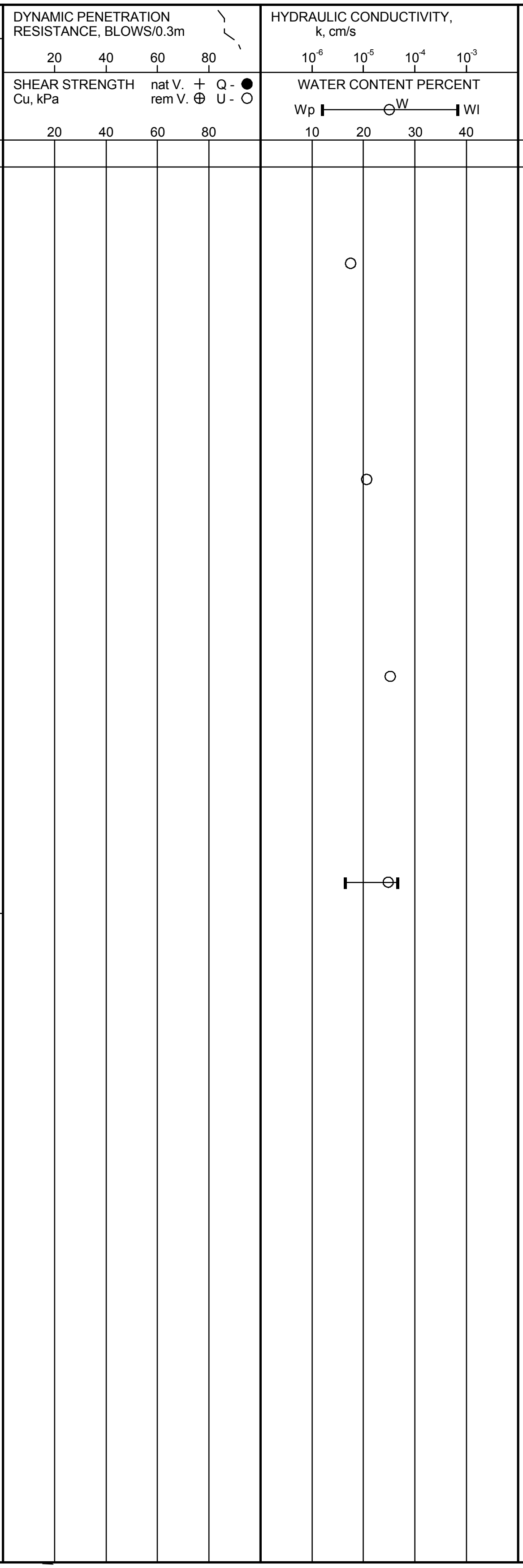
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- *CONTINUED FROM PREVIOUS PAGE* ---							
30	Power Auger, O.D. 108 mm Augers Hollow Stem Augers	Hard, heterogeneous, moist, grey silty CLAY, trace sand, trace gravel; TILL (CL)							50 mm PVC Pipe
					23	50 DO	69		
31									Sand Pack
32					24	50 DO	42		
33									3.0 m Screen
					25	50 DO	63		
34				162.43 34.50					
		Hard, heterogeneous, wet, grey silty CLAY; (CL)							
35									50 mm Well
					26	50 DO	93	MH	
		END OF BOREHOLE		161.42 35.51					
36									
37									
38									
39									
40									

NOTES:

1. Monitoring well installed at 35.05 m depth (Elev. 161.88 m).

Water level measurements

Date	Depth (m)	Elev (m)
On completion	6.1	190.83
3/11/06	9.3	187.63
10/11/06	10.43	185.64
14/11/06	11.15	185.48



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: SB
CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-142

SHEET 1 OF 4

LOCATION: N 4849983.9 ;E 618521.5

BORING DATE: October 25 - 27, 2006

DATUM: Geodetic

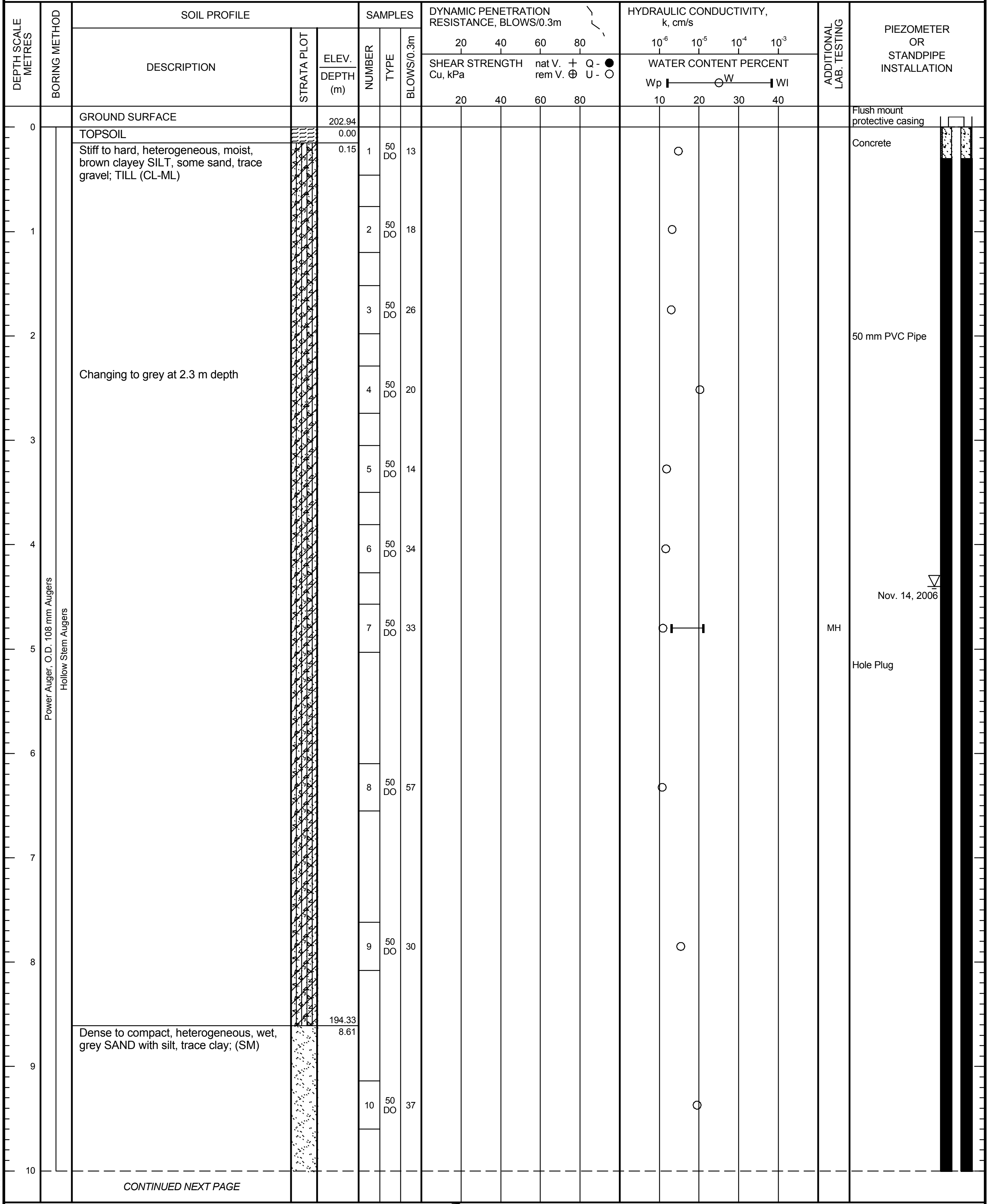
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, O.D. 108 mm Augers; Hollow Stem Augers

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	202.94
TOPSOIL	0.00
Stiff to hard, heterogeneous, moist, brown clayey SILT, some sand, trace gravel; TILL (CL-ML)	0.15
Changing to grey at 2.3 m depth	
Dense to compact, heterogeneous, wet, grey SAND with silt, trace clay; (SM)	194.33 8.61

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	13	
2	50 DO	18	
3	50 DO	26	
4	50 DO	20	
5	50 DO	14	
6	50 DO	34	
7	50 DO	33	MH
8	50 DO	57	
9	50 DO	30	
10	50 DO	37	



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DEPTH SCALE

1 : 50

Golder Associates

LOGGED: GD/SB

CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-142

LOCATION: N 4849983.9 ;E 618521.5

BORING DATE: October 25 - 27, 2006

DATUM: Geodetic

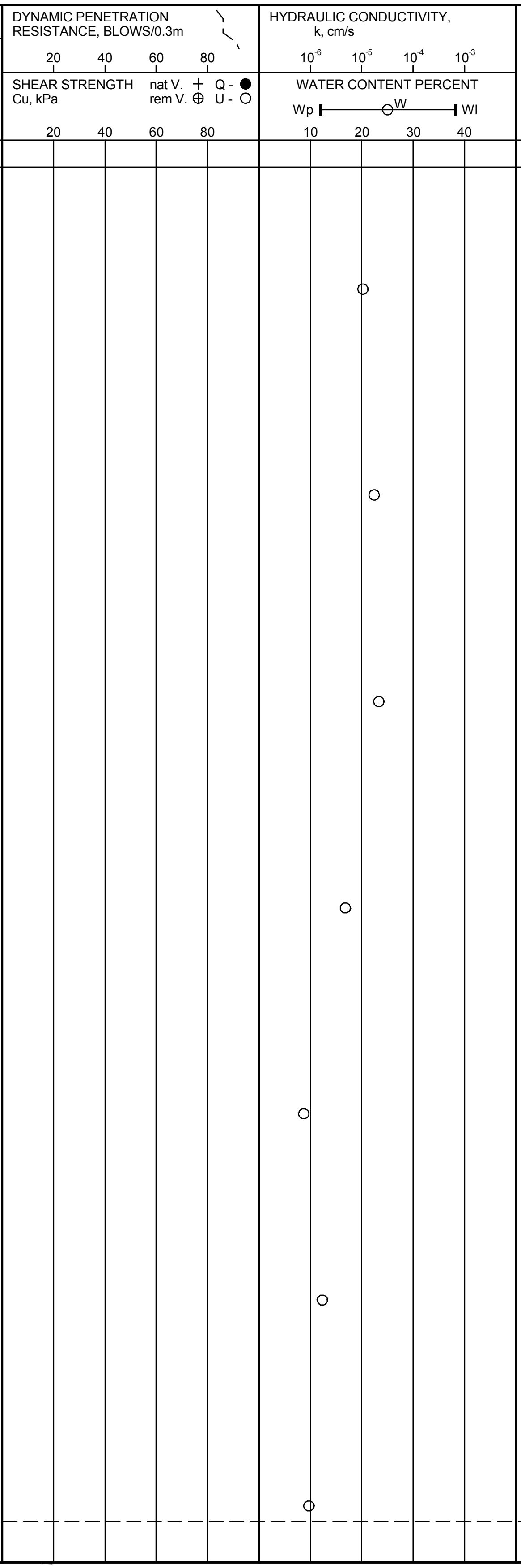
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger, O.D. 108 mm Augers — Hollow Stem Augers

--- CONTINUED FROM PREVIOUS PAGE ---

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
10	Dense to compact, heterogeneous, wet, grey SAND with silt, trace clay; (SM)					
11			11	50 DO	36	MH
12			12	50 DO	23	
14			13	50 DO	13	
15			14	50 DO	24	MH
16	Compact, heterogeneous, wet, grey SAND and GRAVEL, trace silt; (SW)	186.71 16.23				
17			15	50 DO	24	
18	Hard, heterogeneous, moist to wet, grey silty CLAY, trace sand, trace gravel; TILL (CL)	185.19 17.76				
			16	50 DO	70/ 0.15	
20			17	50 DO	104/ 0.15	



PIEZOMETER OR STANDPIPE INSTALLATION

- 50 mm PVC Pipe
- Hole Plug
- Sand Pack
- 2.0 m Screen
- 50 mm Well
- Backfill

CONTINUED NEXT PAGE

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: GD/SB
CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-142

SHEET 3 OF 4

LOCATION: N 4849983.9 ;E 618521.5

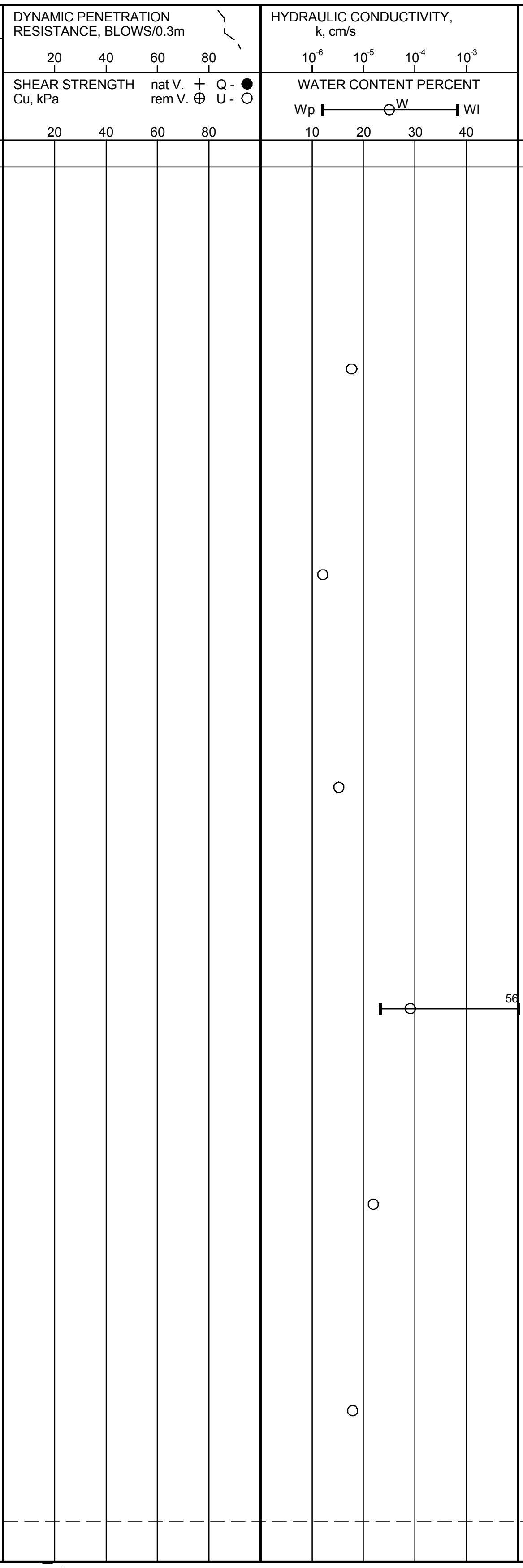
BORING DATE: October 25 - 27, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---							
20	Power Auger, O.D. 108 mm Augers Hollow Stem Augers	Hard, heterogeneous, moist to wet, grey silty CLAY, trace sand, trace gravel; TILL (CL)							
21					18	50 DO	78/ 0.15		
22									
23					19	50 DO	102/ 0.15		
24					20	50 DO	160/ 0.25		
25		Hard, homogeneous, wet, grey CLAY; (CH)		177.60 25.35					
26					21	50 DO	42	MH	
27		Hard, heterogeneous, wet, grey silty CLAY, trace sand, trace gravel; TILL (CL)		175.97 26.98	22	50 DO	89		
28									
29					23	50 DO	72		
30		*CONTINUED NEXT PAGE*							



DEPTH SCALE
1 : 50

Golder Associates

LOGGED: GD/SB
CHECKED: BLT

PROJECT: 06-1111-040

RECORD OF BOREHOLE: Y-142

SHEET 4 OF 4

LOCATION: N 4849983.9 ;E 618521.5

BORING DATE: October 25 - 27, 2006

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		--- CONTINUED FROM PREVIOUS PAGE ---									
30		Hard, heterogeneous, wet, grey silty CLAY, trace sand, trace gravel; TILL (CL)	▨	172.31 30.63	24	50 DO	71		○		
		END OF BOREHOLE									
31											
32											
33											
34											
35											
36											
37											
38											
39											
40											

NOTES:

1. Monitoring well installed at 16.76 m depth (Elev. 186.18 m).

Water level measurements

Date	Depth (m)	Elev (m)
On completion	0	202.94
3/11/06	4.3	198.64
10/11/06	4.4	198.54
14/11/06	4.8	198.14

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: GD/SB

CHECKED: BLT

Project Code: 06-1111-040
Project Name: York Consortium/Vaughan Link EA/Vaughan
Date Tested: November, 2006

SUMMARY OF WATER CONTENT AND ATTERBERG LIMITS

Borehole No.	Sample No.	Depth (m)	Elevation (m)	Water Content (%)	Atterberg Limits		
					LL	PL	PI
Y-140	1	1.1	194.3	9.0%			
	2	1.8	193.6	14.2%			
	3	2.6	192.8	14.2%			
	4	3.4	192.0	10.8%			
	5	4.1	191.3	9.4%			
	6	4.9	190.5	23.7%	Organics		
	7	6.4	189.0	11.4%	Non-Plastic, Non-Liquid		
	8	7.9	187.5	13.5%			
	9	9.4	185.9	13.3%			
	10	11.0	184.4	14.4%			
	11	12.5	182.9	12.8%			
	12	14.0	181.4	25.7%			
	13	15.5	179.8	23.5%	24.3	15.8	8.5
	14	17.1	178.3	16.9%			
	15	18.5	176.9	16.3%	31.5	15.8	15.7
	16	20.0	175.3	18.5%			
	17	21.6	173.7	27.1%			
	18	23.2	172.2	26.2%			
	19	24.6	170.8	21.6%			
	20	26.1	169.2	18.3%	24.7	16.1	8.6
	21	27.7	167.7	21.4%			
	22	29.3	166.1	24.0%			
	23	30.8	164.6	22.8%			
	24	32.3	163.1	25.7%	30.6	16.4	14.2
	25	33.8	161.6	27.5%			
	26	35.4	160.0	27.7%			

Project Code: 06-1111-040
Project Name: York Consortium/Vaughan Link EA/Vaughan
Date Tested: November, 2006

SUMMARY OF WATER CONTENT AND ATTERBERG LIMITS

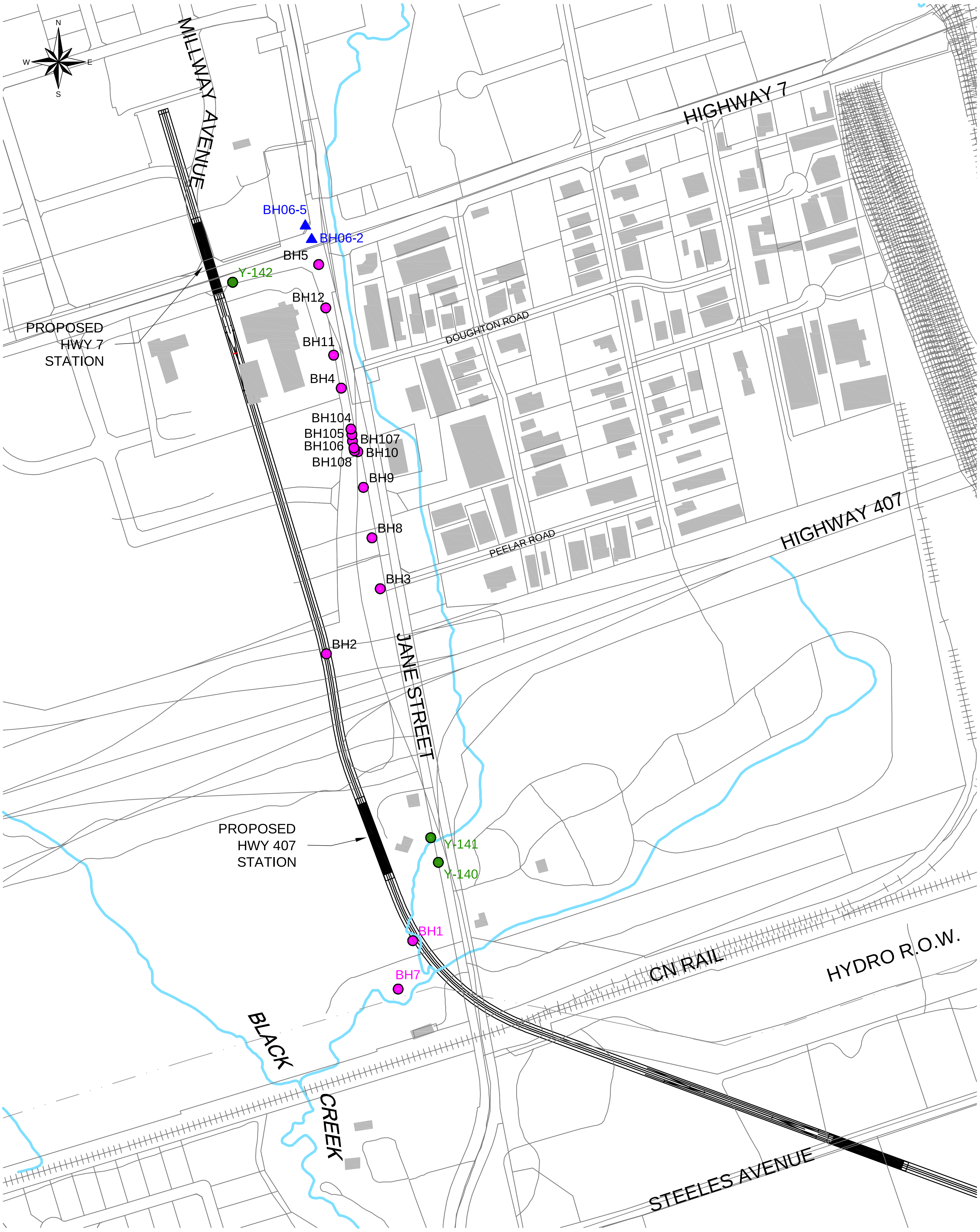
Borehole No.	Sample No.	Depth (m)	Elevation (m)	Water Content (%)	Atterberg Limits		
					LL	PL	PI
Y-141	1	1.1	195.9	4.1%			
	2	1.8	195.1	15.5%			
	3	2.6	194.3	13.4%			
	4	3.4	193.6	13.1%			
	5	4.1	192.8	17.5%			
	6	4.9	192.1	16.6%			
	7	6.4	190.5	14.3%			
	8	7.9	189.0	9.2%	17.3	10.7	6.6
	9	9.4	187.5	9.3%			
	10	10.9	186.0	14.8%			
	11	12.4	184.5	14.7%			
	12	13.9	183.0	17.0%	31.6	16.2	15.4
	13	15.5	181.5	15.5%			
	14	17.0	179.9	17.4%			
	15	18.5	178.4	15.3%			
	16	20.0	176.9	16.2%			
	17	21.6	175.4	16.9%	32.3	16.8	15.5
	18	23.1	173.8	19.2%			
	19	24.6	172.3	17.1%			
	20	26.1	170.8	16.9%			
	21	27.7	169.2	30.7%			
	22	29.2	167.7	24.3%	26.1	15.8	10.3
	23	30.6	166.3	17.5%			
	24	32.3	164.6	20.6%			
	25	33.7	163.3	25.2%			
	26	35.2	161.7	24.8%	26.6	16.3	10.3

Project Code: 06-1111-040
Project Name: York Consortium/Vaughan Link EA/Vaughan
Date Tested: November, 2006

SUMMARY OF WATER CONTENT AND ATTERBERG LIMITS

Borehole No.	Sample No.	Depth (m)	Elevation (m)	Water Content (%)	Atterberg Limits		
					LL	PL	PI
Y-142	1	0.2	202.9	14.8%	Organics		
	2	1.1	202.9	13.2%			
	3	1.8	202.9	13.0%			
	4	2.5	202.9	20.2%			
	5	3.3	202.9	11.8%			
	6	4.0	202.9	11.6%			
	7	4.8	202.9	10.9%	21.0	13.0	8.0
	8	6.3	202.9	10.7%			
	9	7.9	202.9	15.4%			
	10	9.4	202.9	19.5%	Free Water		
	11	10.9	202.9	20.2%			
	12	12.4	202.9	22.4%			
	13	13.9	202.9	23.3%	Free Water		
	14	15.5	202.9	16.8%			
	15	17.0	202.9	8.7%			
	16	18.5	202.9	12.3%			
	17	19.9	202.9	9.7%			
	18	21.5	202.9	17.7%			
	19	23.0	202.9	12.1%			
	20	24.8	202.9	15.2%			
	21	26.2	202.9	29.1%	56.4	23.1	33.3
	22	27.7	202.9	21.9%			
	23	29.2	202.9	17.9%			
	24	30.3	202.9	21.9%			

PLOT DATE: December 27, 2006
FILENAME: T:\Projects\2006\06-1111-040 (Delcan, Vaughan)\-AA- (GeoTech Hyd Inv Vaughan N-S Link)\061111040AA001.dwg



NOTES:

1. PROJECTION IS UTM NAD83, ZONE 17.
2. BASE MAPPING PROPOSED ALIGNMENT AND STATION LOCATIONS ARE AS PROVIDED BY YORK CONSORTIUM DATED DECEMBER 5, 2006.

LEGEND:

●	BOREHOLES (GOLDER - 2006)
●	EXISTING BOREHOLES (GOLDER - 1980's)
▲	EXISTING BOREHOLES (BY OTHERS - 2006)

150 0 150 300
SCALE 1:7500 METRES

Golder Associates
Mississauga, Ontario, Canada

SCALE	AS SHOWN	TITLE	
DATE	DEC. 14, 2006		
DESIGN			
CAD	MSM		
CHECK	BLT		
REVIEW	SJB		

FILE No. 061111040AA001.dwg
PROJECT No. 06-1111-040 REV.

BOREHOLE LOCATION PLAN

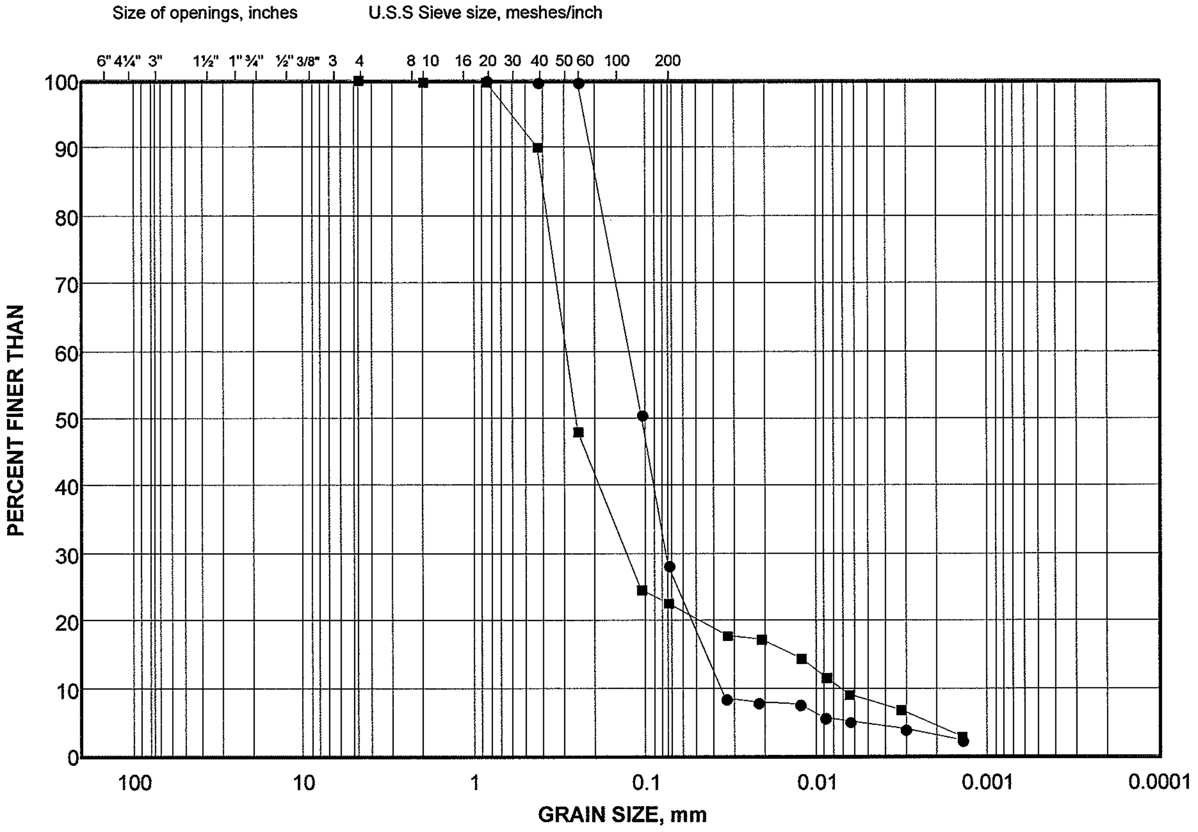
VAUGHAN NORTH-SOUTH LINK

DRAWING NO.
1

GRAIN SIZE DISTRIBUTION TEST RESULTS

Sand
(Type 5)

FIGURE 1



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-142	11	192.0
■	Y-142	14	187.4

Project Number: 06-1111-040

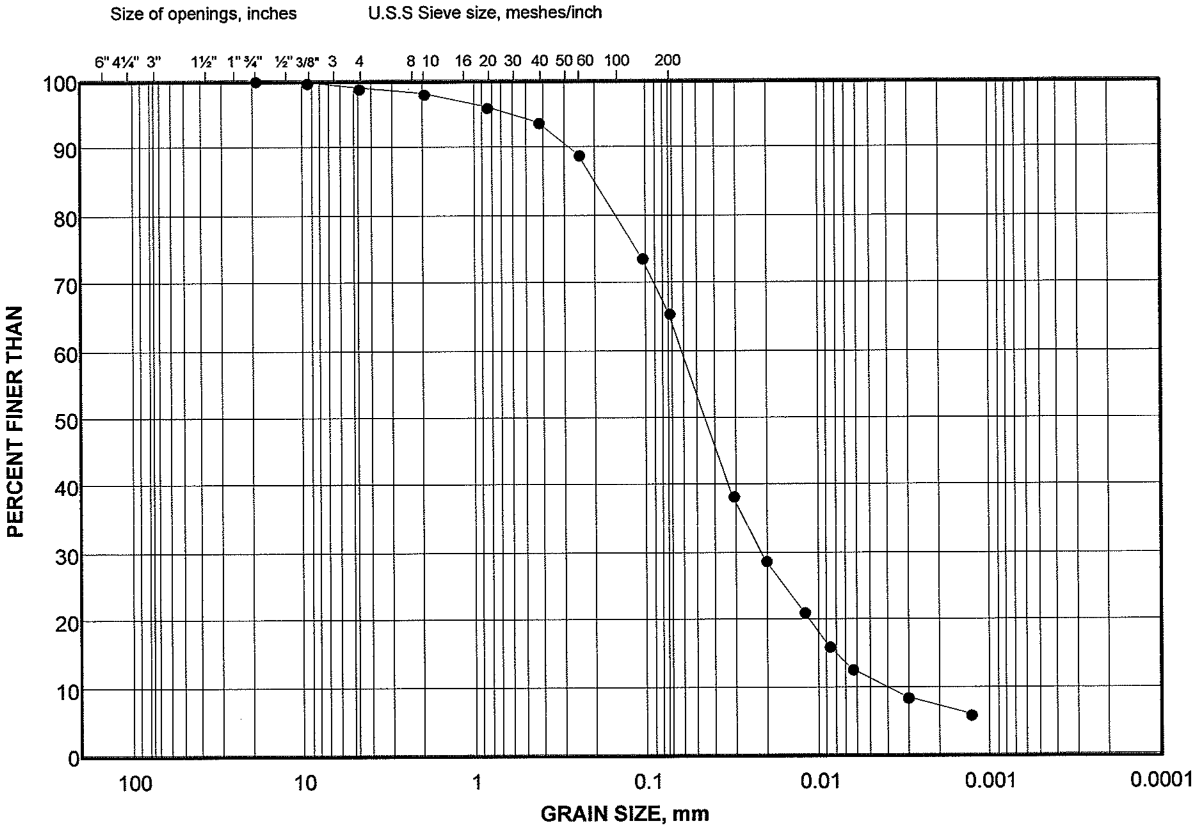
Checked By: ____________

Golder Associates

Date: 02-Jan-07

GRAIN SIZE DISTRIBUTION TEST RESULT
Sandy Silt
(Type 7)

FIGURE 2



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-140	7	189.0

Project Number: 06-1111-040

Checked By: ____________

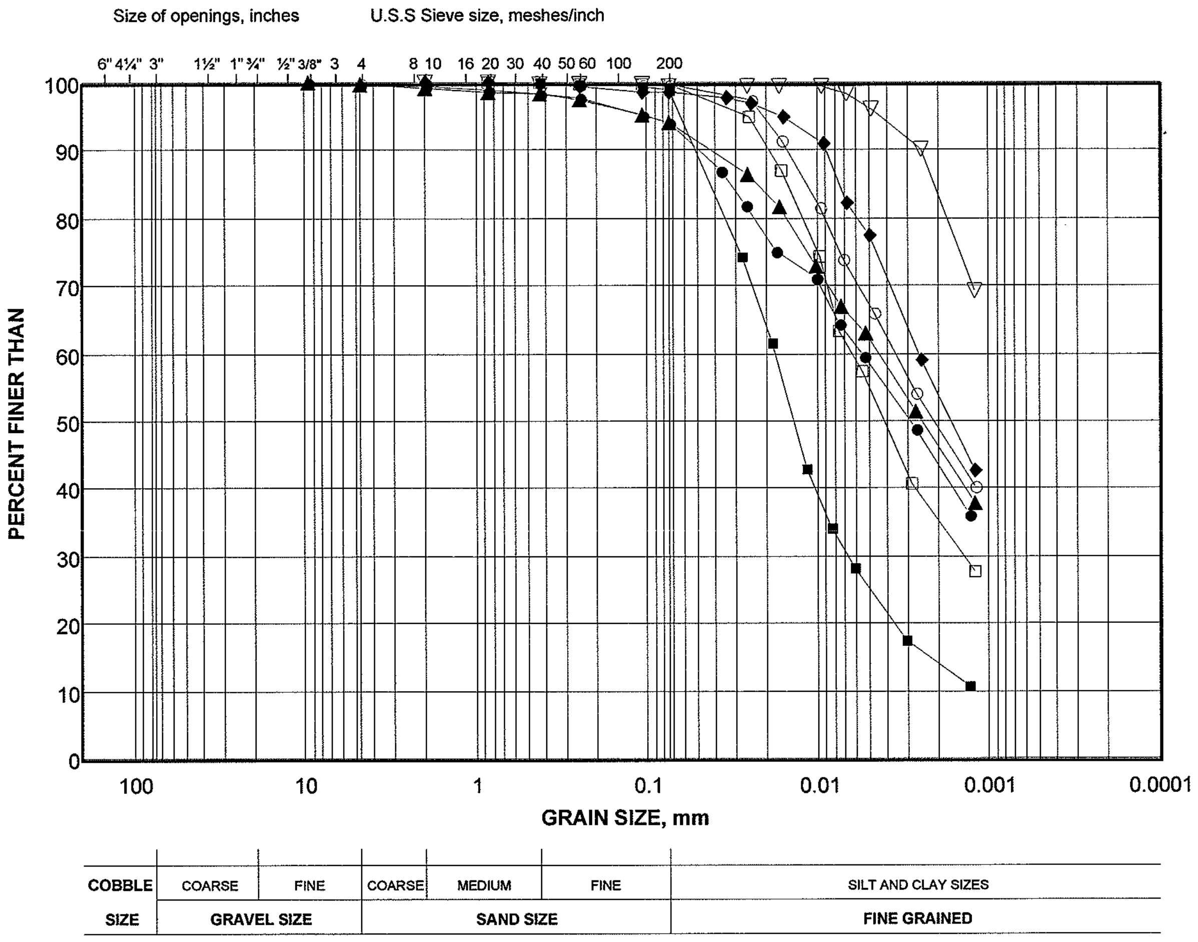
Golder Associates

Date: 02-Jan-07

GRAIN SIZE DISTRIBUTION TEST RESULTS

Silty Clay to Clay
(Types 9 and 10)

FIGURE 3



LEGEND

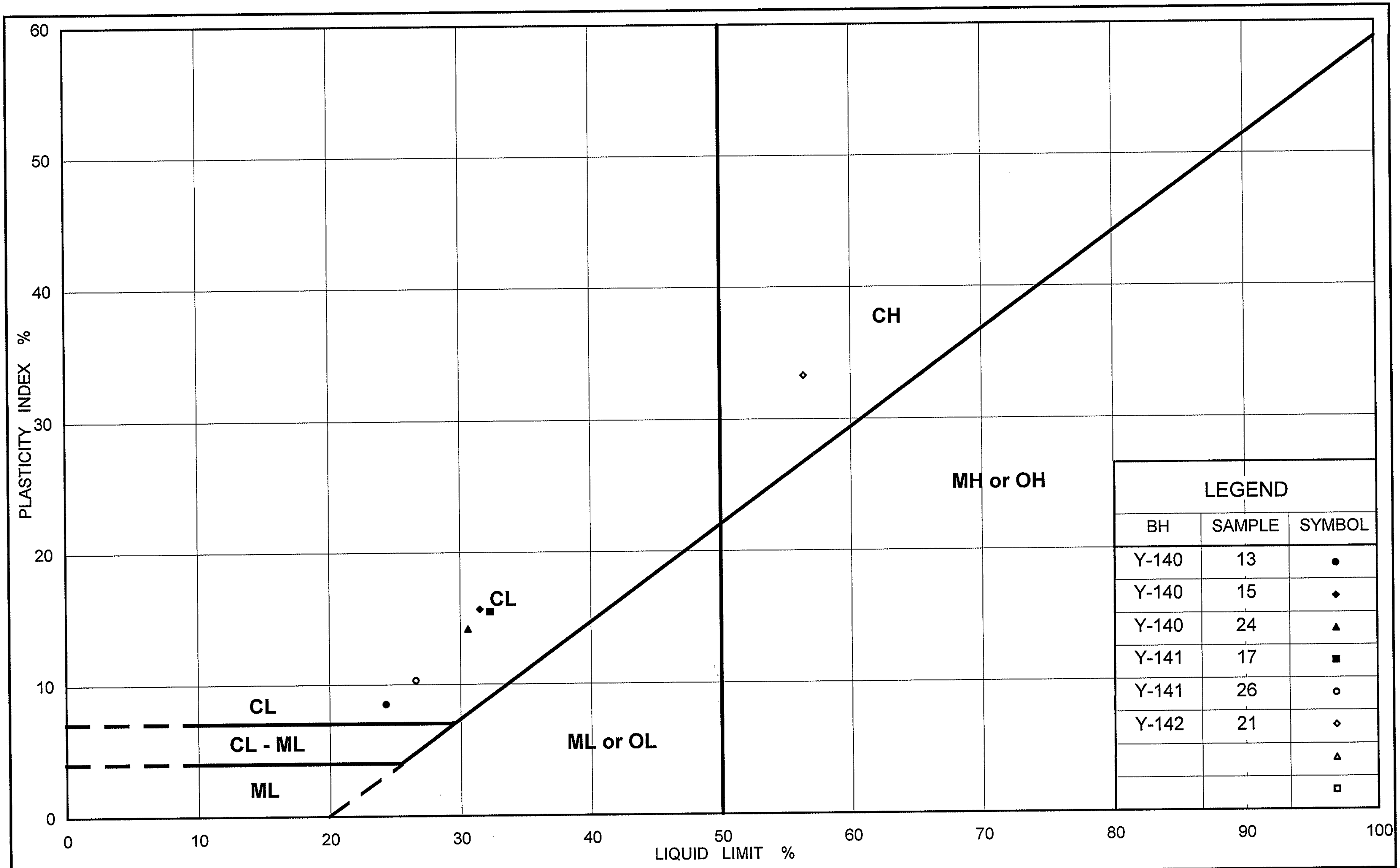
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-141	11	184.5
■	Y-140	13	179.9
◆	Y-140	16	175.3
▲	Y-141	17	175.4
▽	Y-142	21	176.7
○	Y-140	24	163.1
□	Y-141	26	161.6

Project Number: 06-1111-040

Checked By:

Golder Associates

Date: 02-Jan-07



Golder Associates

PLASTICITY CHART
Silty Clay to Clay
(Types 9 and 10)

FIG No. 4

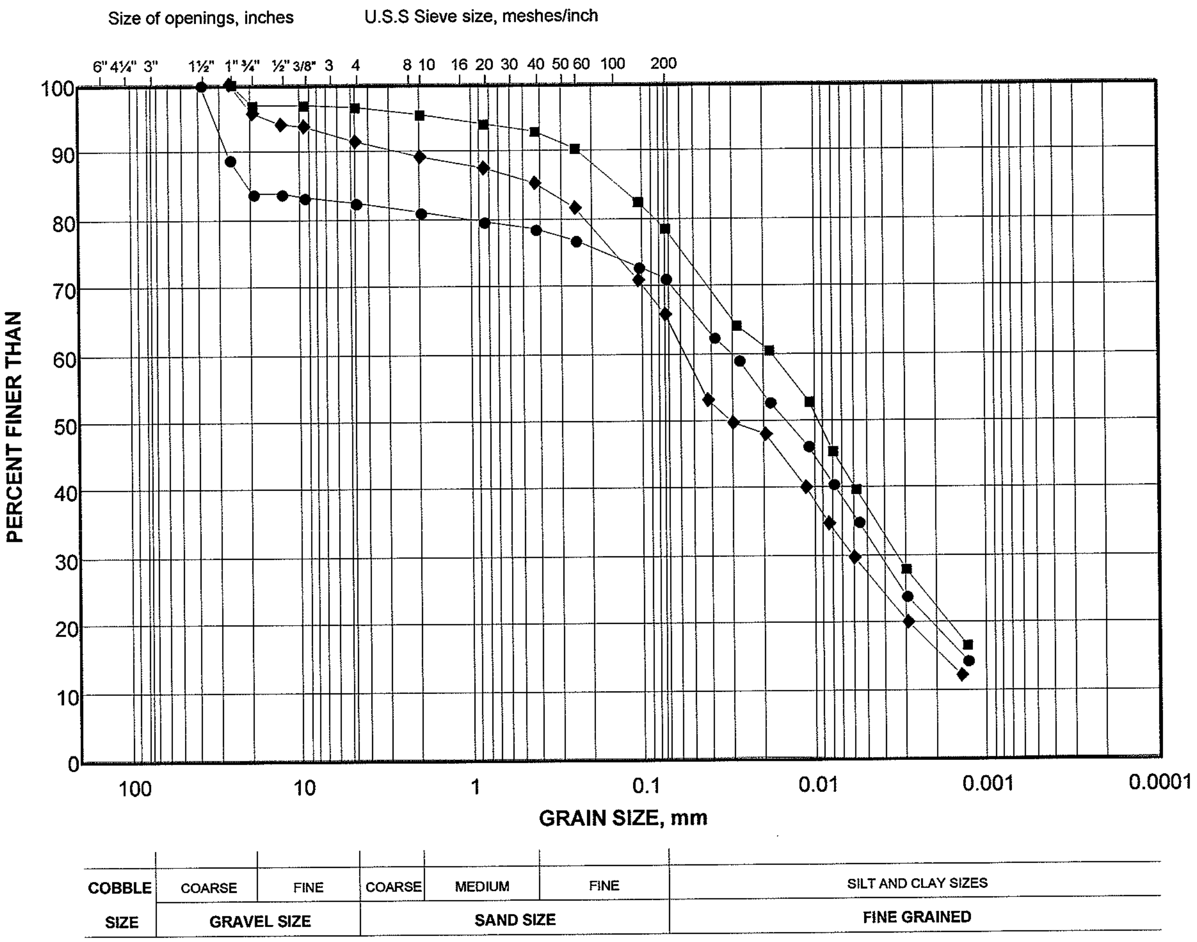
Project No. 06-1111-040

Checked by

GRAIN SIZE DISTRIBUTION TEST RESULTS

Clayey Silt to Silty Clay Till
(Type 11)

FIGURE 5



LEGEND

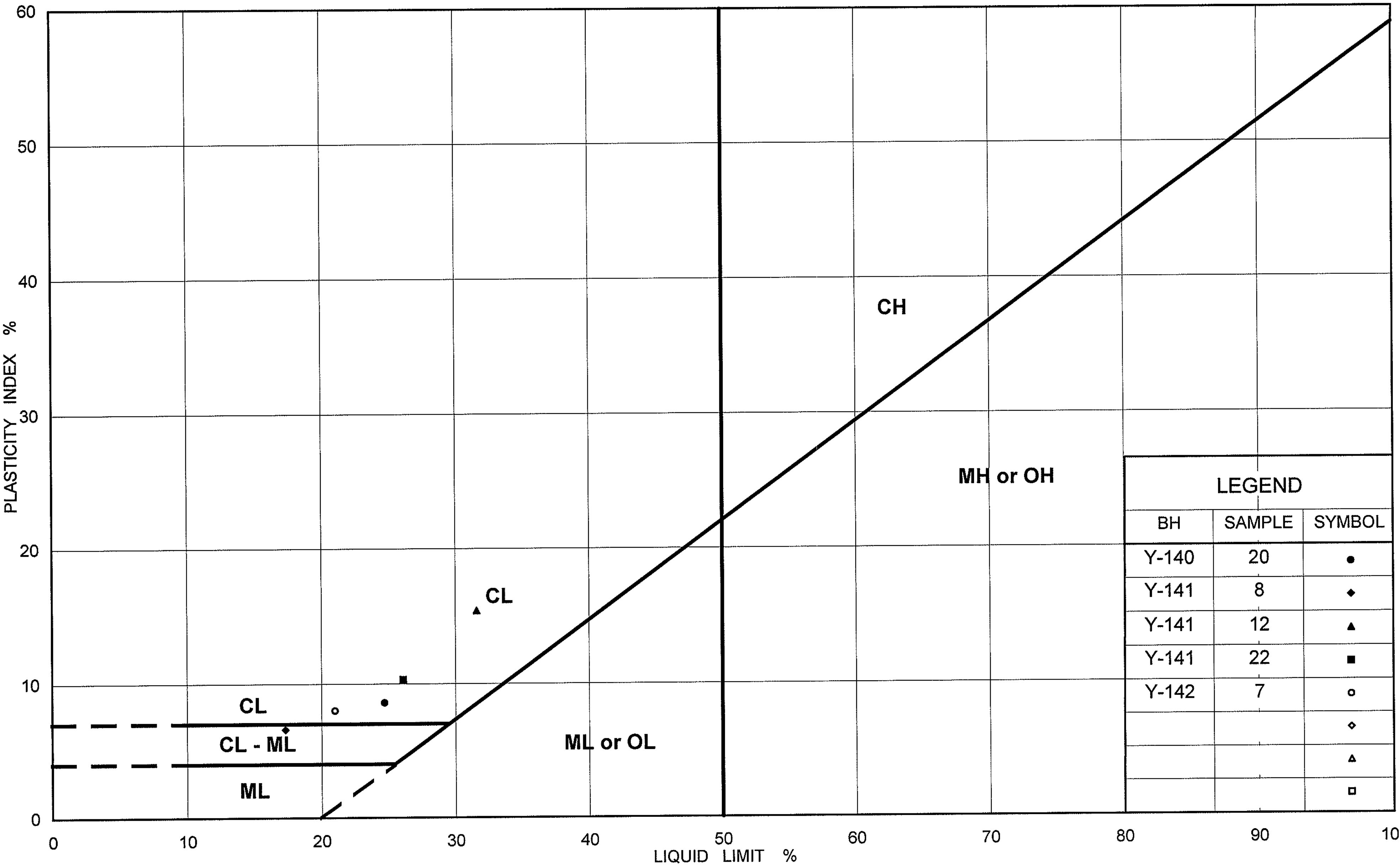
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-140	10	184.4
■	Y-142	7	198.1
◆	Y-141	9	187.5

Project Number: 06-1111-040

Checked By: ____________

Golder Associates

Date: 02-Jan-07



PLASTICITY CHART
Clayey Silt to Silty Clay
(Type 11)

FIG No. 6

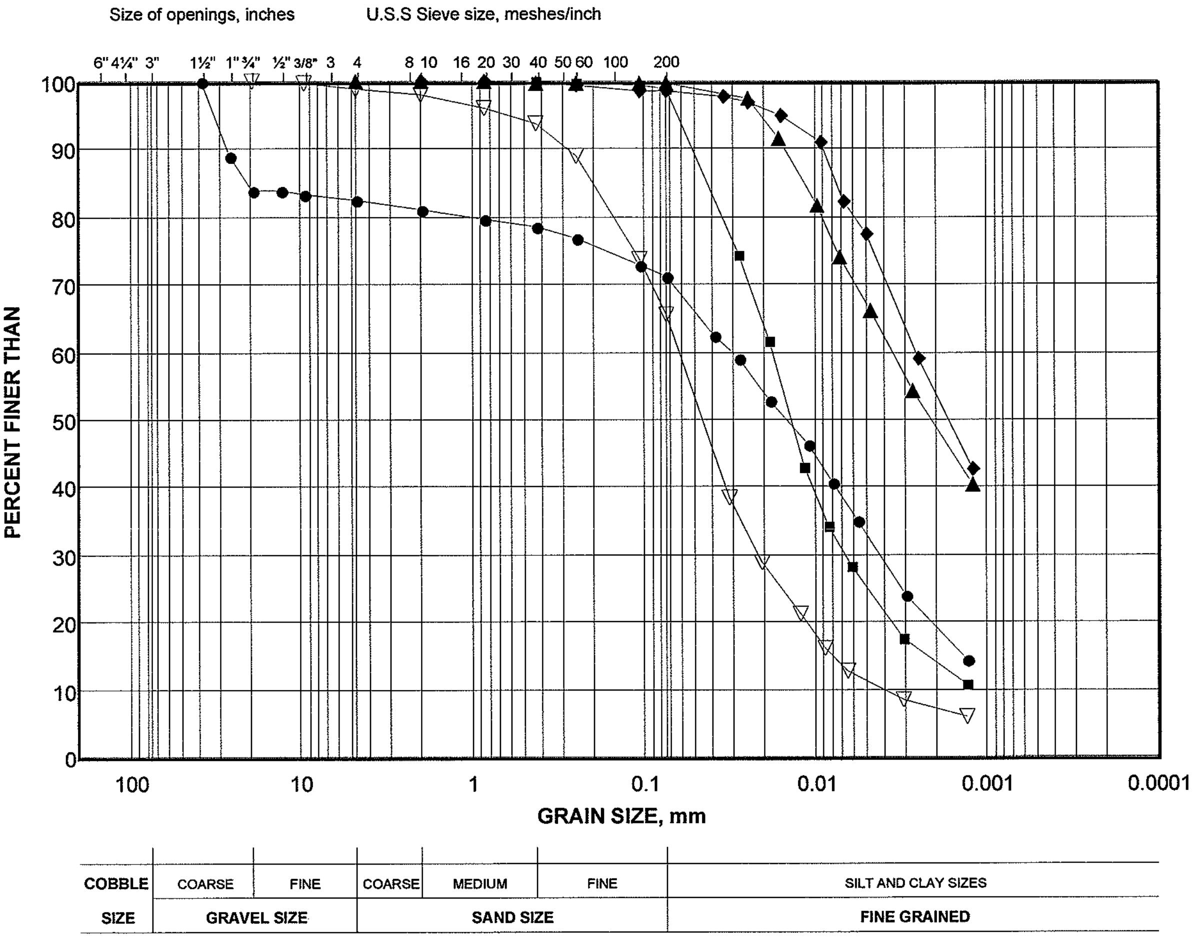
Project No. 06-1111-040

Checked by

GRAIN SIZE DISTRIBUTION TEST RESULTS

Borehole Y-140

FIGURE 7



LEGEND

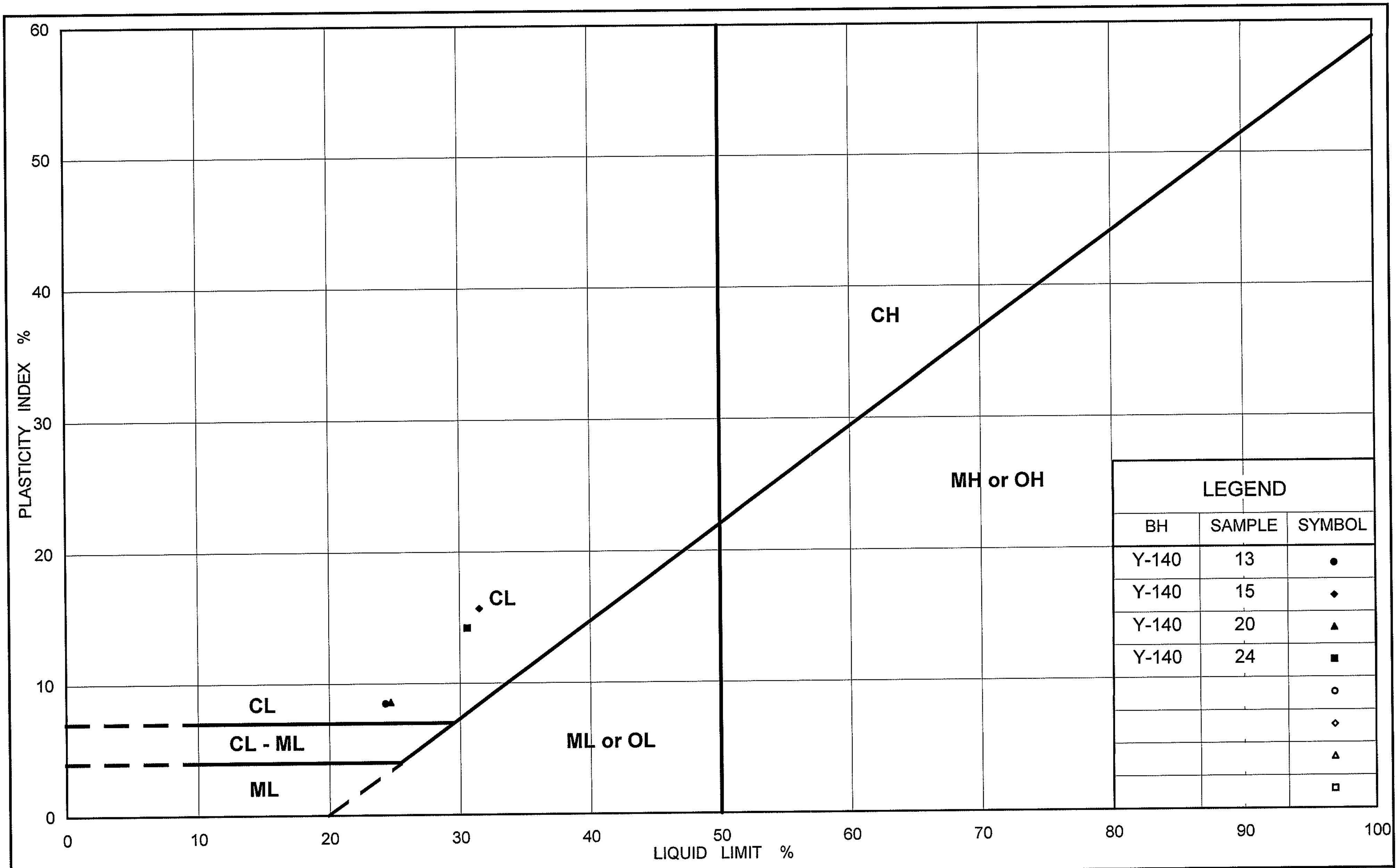
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-140	10	184.4
■	Y-140	13	179.9
◆	Y-140	16	175.3
▲	Y-140	24	163.1
▽	Y-140	7	189.0

Project Number: 06-1111-040

Checked By: lel

Golder Associates

Date: 02-Jan-07



BH	SAMPLE	SYMBOL
Y-140	13	●
Y-140	15	◆
Y-140	20	▲
Y-140	24	■
		○
		◇
		△
		□

Golder Associates

PLASTICITY CHART
Borehole Y-140

FIG No. 8

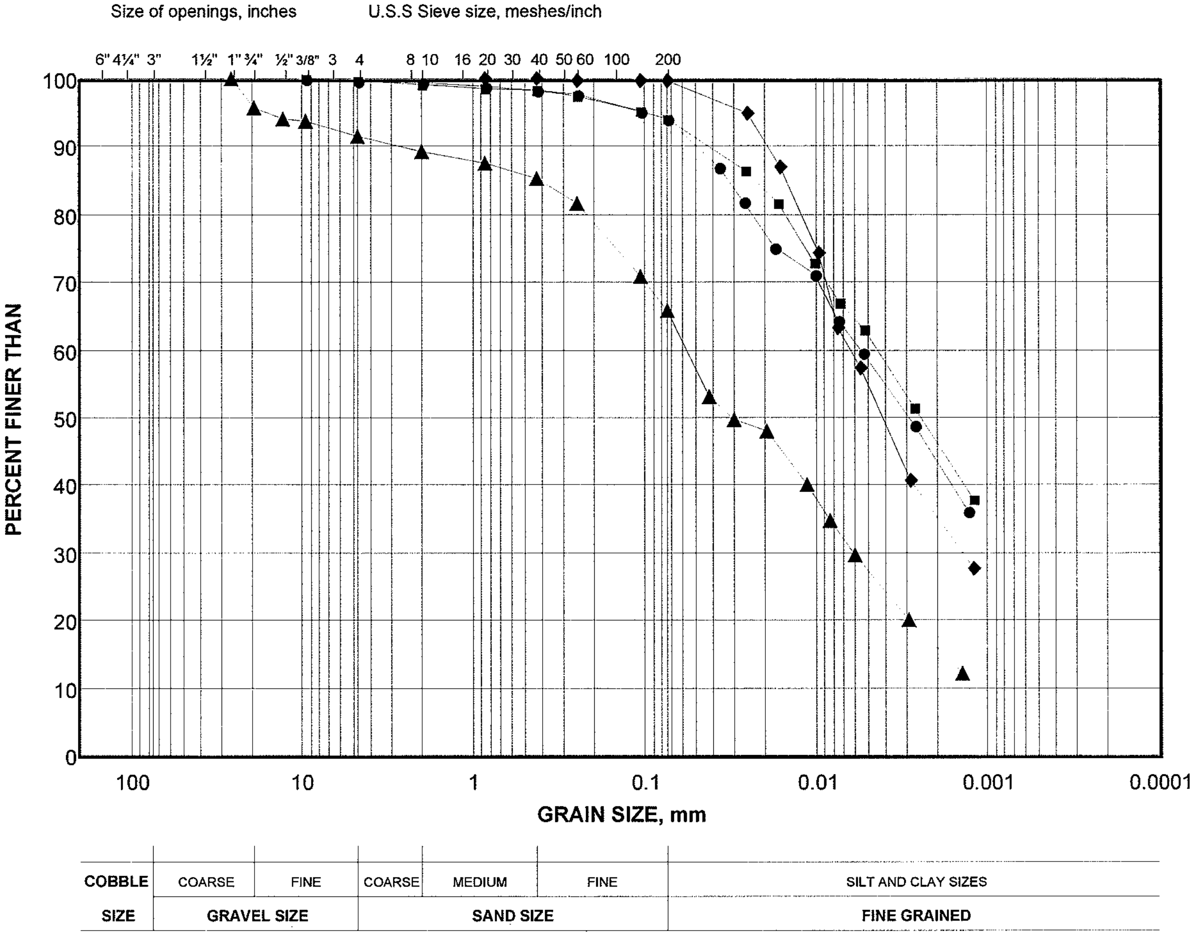
Project No. 06-1111-040

Checked by

GRAIN SIZE DISTRIBUTION TEST RESULTS

Borehole Y-141

FIGURE 9



LEGEND

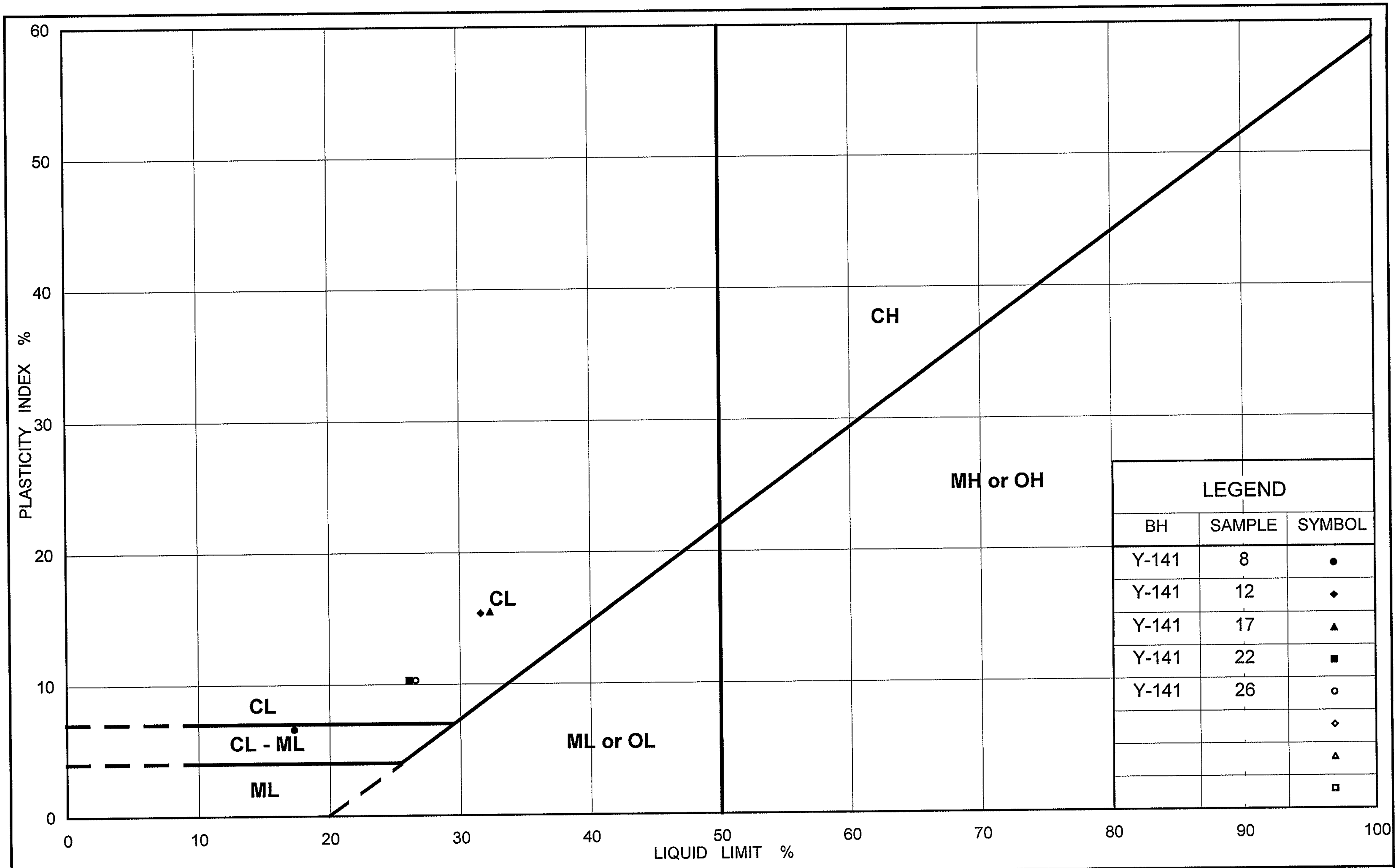
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-141	11	184.5
■	Y-141	17	175.4
◆	Y-141	26	161.6
▲	Y-141	9	187.5

Project Number: 06-1111-040

Checked By: ______

Golder Associates

Date: 09-Jan-07



Golder Associates

PLASTICITY CHART
Borehole Y-141

FIG No. 10

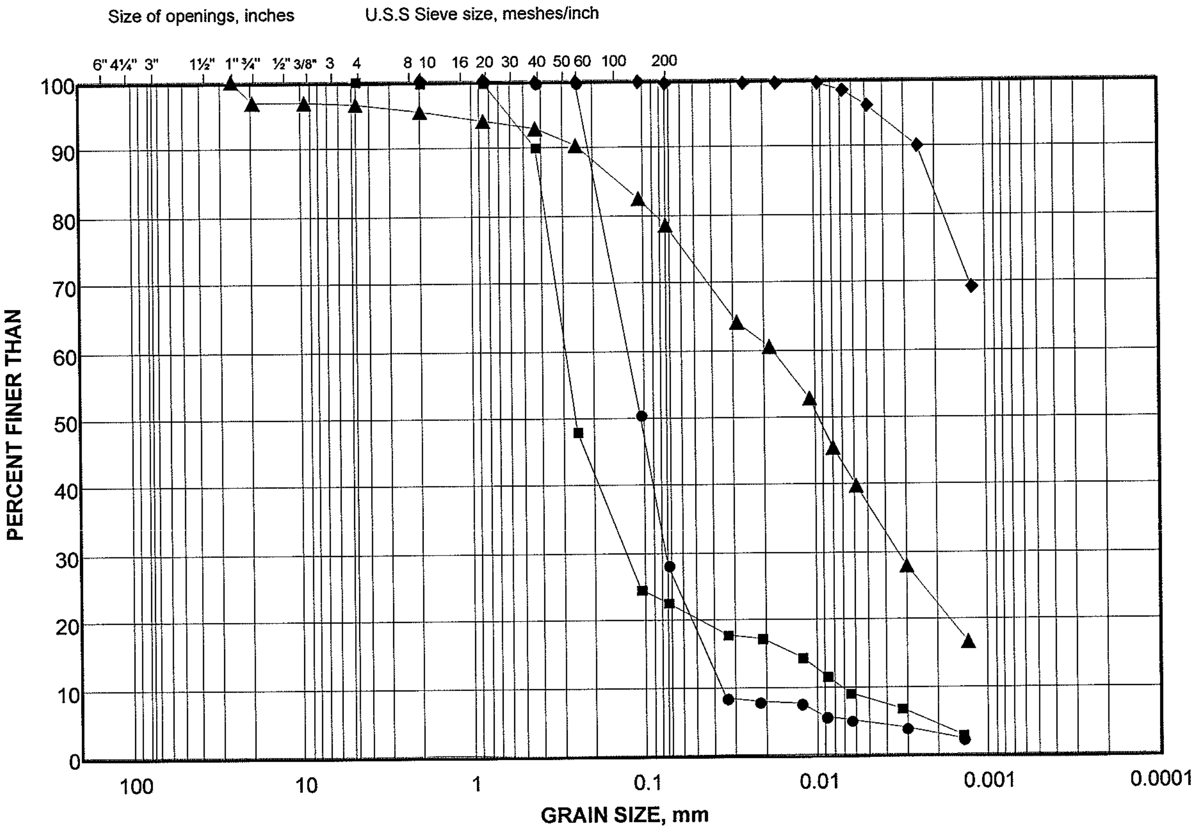
Project No. 06-1111-040

Checked by

GRAIN SIZE DISTRIBUTION TEST RESULTS

Borehole Y-142

FIGURE 11



COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

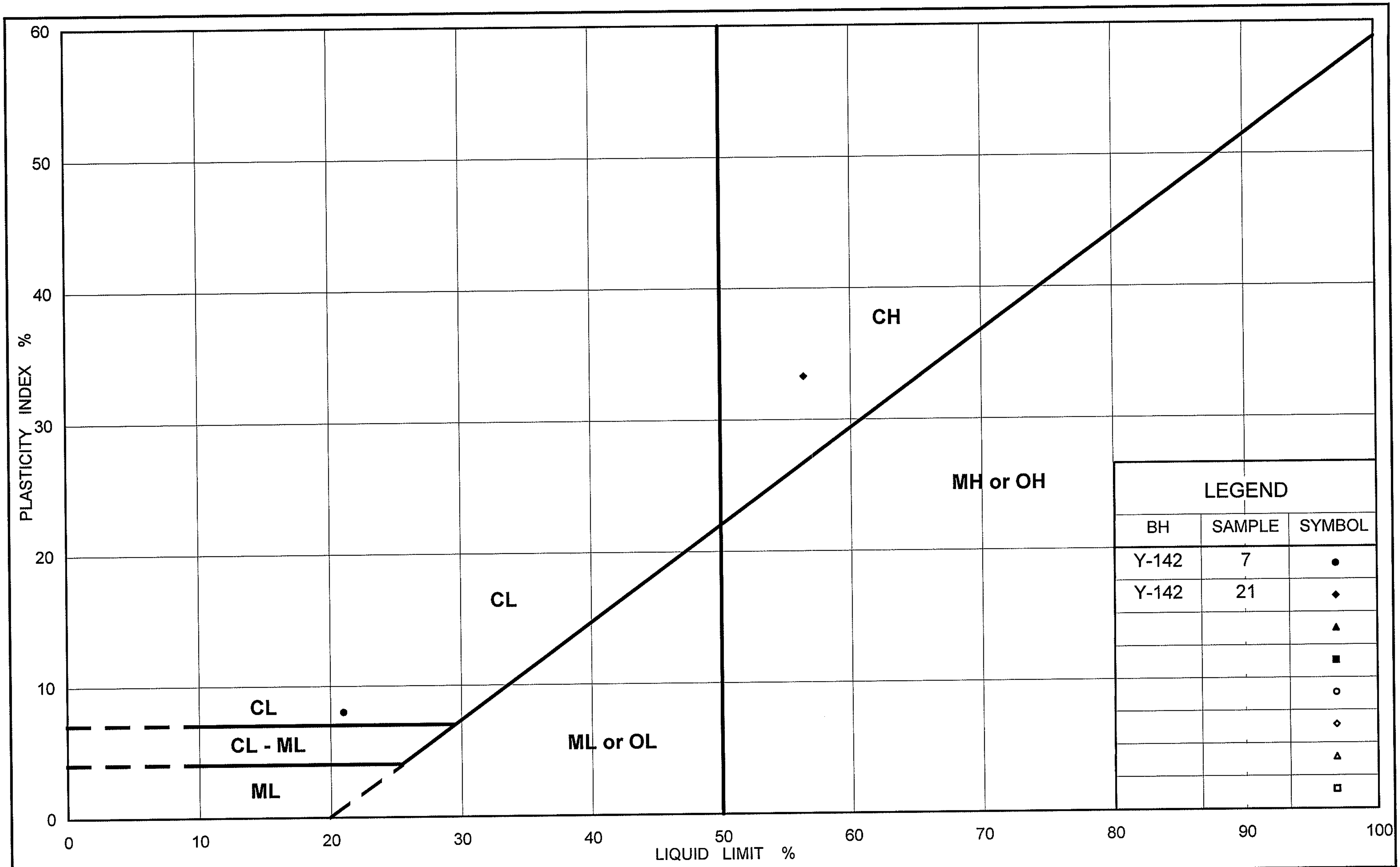
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	Y-142	11	192.0
■	Y-142	14	187.4
◆	Y-142	21	176.7
▲	Y-142	7	198.1

Project Number: 06-1111-040

Checked By: ____________

Golder Associates

Date: 02-Jan-07



Golder Associates

PLASTICITY CHART
Borehole Y-142

FIG No. 12

Project No. 06-1111-040

Checked by

ATTACHMENT 1

RISING HEAD TESTS
RECORDS AND CALCULATIONS
(BOREHOLES Y-140 TO Y-142)

Project Code: 06-1111-040
Project Name: York Consortium/Vaughan Link EA/Vaughan
Borehole: Y-140

Test Date : Nov. 12, 2006
Elevation : 195.39 m
Well Installation : 35.05 m depth (Elevation 160.34 m)
Silty Clay Till (Borehole material symbol *11*)

Static Water Level = 10.76 m
H = 184.63 m
Ho = 180.54 m

Δt (min)	Reading (m BGS)	h	H-h/H-Ho
0	14.85	180.54	1.00
0.5	14.83	180.56	1.00
1	14.81	180.58	0.99
1.5	14.80	180.59	0.99
2	14.78	180.61	0.98
2.5	14.77	180.62	0.98
3	14.74	180.65	0.97
3.5	14.73	180.66	0.97
4	14.71	180.68	0.97
4.5	14.69	180.70	0.96
5	14.68	180.71	0.96
6	14.66	180.73	0.95
7	14.63	180.76	0.95
8	14.61	180.78	0.94
9	14.59	180.80	0.94
10	14.56	180.83	0.93
12	14.52	180.87	0.92
14	14.46	180.93	0.90
16	14.43	180.96	0.90
18	14.40	180.99	0.89
20	14.35	181.04	0.88
25	14.22	181.17	0.85
30	14.12	181.27	0.82
35	14.06	181.33	0.81
40	13.95	181.44	0.78
45	13.90	181.49	0.77
50	13.79	181.60	0.74
60	13.66	181.73	0.71
65	13.63	181.76	0.70
70	13.58	181.81	0.69
75	13.50	181.89	0.67
80	13.42	181.97	0.65
85	13.38	182.01	0.64
90	13.30	182.09	0.62
100	13.20	182.19	0.60
110	13.15	182.24	0.58
120	13.05	182.34	0.56
1051.5	11.10	184.29	0.08

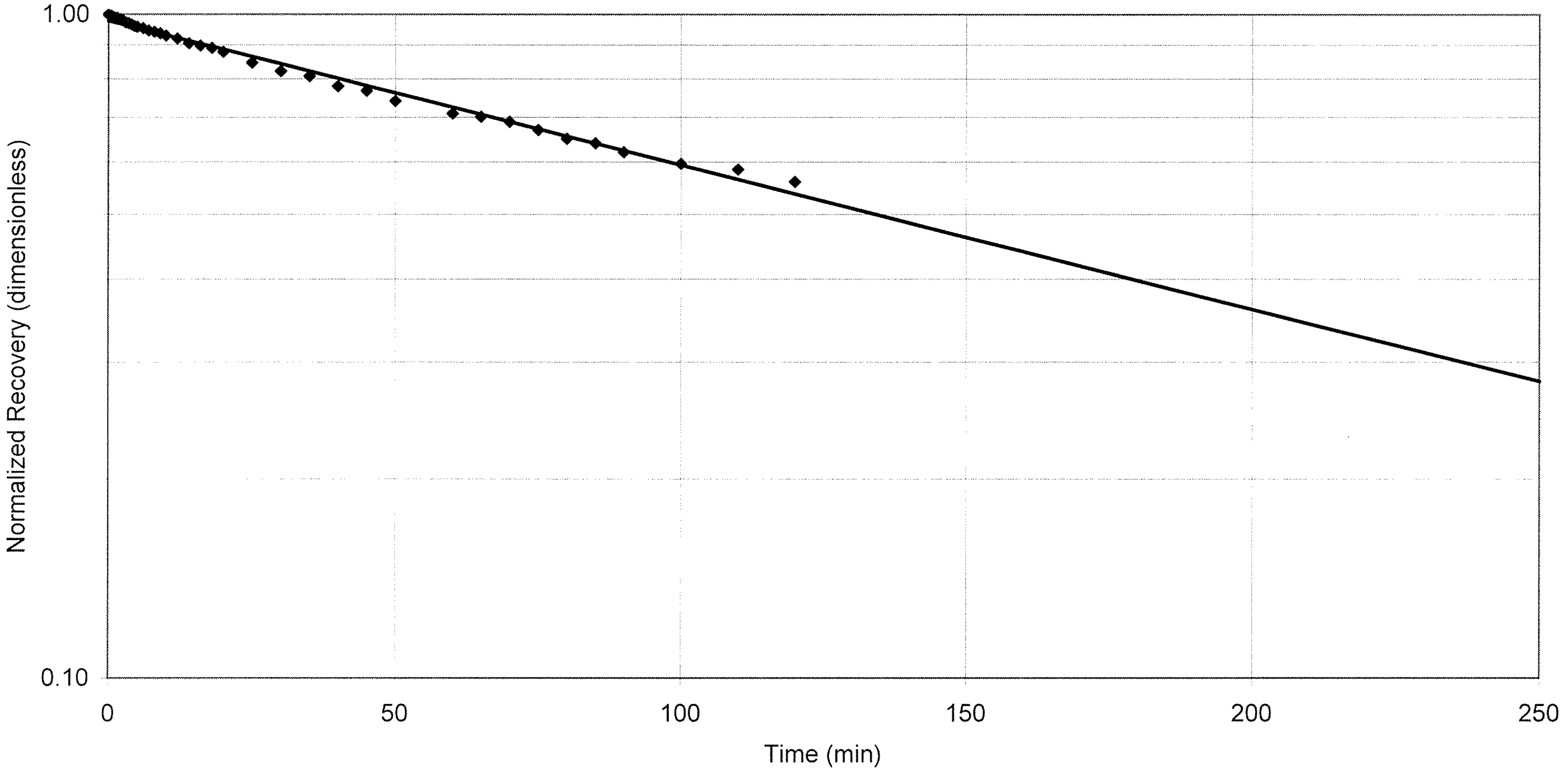
▨ point not included in analysis

Refer to Figure 1 for hydraulic conductivity value

Hydraulic Conductivity Test Report

Borehole BH Y-140

FIGURE 1



Using Hvorslev's Law: $K = \dfrac{r^2 \ln\left(\dfrac{Le}{R}\right)}{2LeT_0}$

r = 0.0508 m
Le = 1.524 m
R = 0.10795 m
To = 194.50 min

K= 1.15E-05 m/min
1.92E-05 cm/s

CAD: NK
CHK: BLT

Golder Associates

Project Code: 06-1111-040
Project Name: York Consortium/Vaughan Link EA/Vaughan
Borehole: Y-142

Test Date : Nov. 12, 2006
Elevation : 202.94 m
Well Installation : 16.76 m depth (Elevation 186.18m)
Sand (Borehole material symbol 5)

Static Water Level = 4.6 m
H = 198.34 m
Ho = 193.84 m

Δt (min)	Reading (m BGS)	h	H-h/H-Ho
0	9.10	193.84	1.00
0.5	9.08	193.86	1.00
1	9.07	193.87	0.99
1.5	9.06	193.88	0.99
2	9.04	193.90	0.99
2.5	9.03	193.91	0.98
3	9.00	193.94	0.98
3.5	8.99	193.95	0.98
4	8.98	193.96	0.97
4.5	8.97	193.97	0.97
5	8.95	193.99	0.97
6	8.90	194.04	0.96
7	8.88	194.06	0.95
8	8.84	194.10	0.94
9	8.83	194.11	0.94
10	8.79	194.15	0.93
12	8.74	194.20	0.92
14	8.70	194.24	0.91
16	8.63	194.31	0.90
18	8.60	194.34	0.89
20	8.55	194.39	0.88
25	8.42	194.52	0.85
30	8.28	194.66	0.82
35	8.10	194.84	0.78
40	7.92	195.02	0.74
45	7.80	195.14	0.71
50	7.71	195.23	0.69
55	7.53	195.41	0.65
60	7.36	195.58	0.61
65	7.18	195.76	0.57
70	6.99	195.95	0.53
75	6.83	196.11	0.50
80	6.65	196.29	0.46
85	6.50	196.44	0.42
90	6.36	196.58	0.39
100	6.07	196.87	0.33
110	5.76	197.18	0.26
120	5.55	197.39	0.21
1209	4.76	198.18	0.04

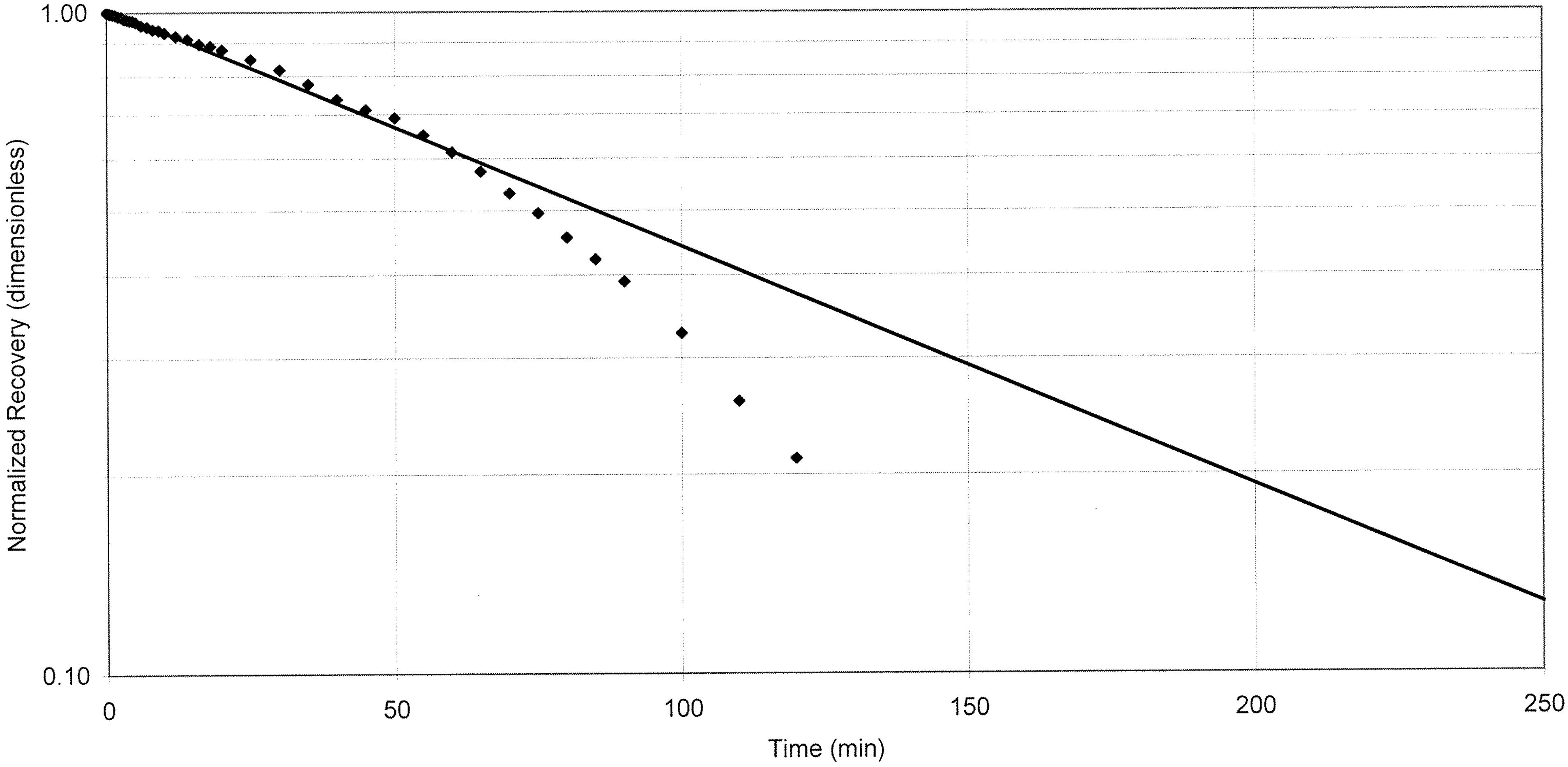
▨ point not included in analysis

Refer to Figure 2 for hydraulic conductivity value

Hydraulic Conductivity Test Report

Borehole BH Y-142

FIGURE 2



Using Hvorslev's Law: $K = \frac{r^2 \ln\left(\frac{Le}{R}\right)}{2LeT_0}$

r = 0.0508 m
Le = 1.524 m
R = 0.10795 m
To = 121.23 min

K= 1.85E-05 m/min
3.08E-05 cm/s

CAD: NK
CHK: BLT

ATTACHMENT 2

RESULTS OF WATER QUALITY TEST AND SOIL CHEMICAL TESTS

Certificate of Analysis

AGAT WORK ORDER: 06T196034
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Beng Lay Teh

York Region Storm Sewer Use By-Law

DATE SAMPLED: November 13 2006 DATE RECEIVED: November 13 2006 DATE REPORTED: November 21 2006 SAMPLE TYPE: Water

	Unit	G / S	M.D.L.	Y-140 613727
pH	N/A	6.0-9.0	N/A	8.10
Total Suspended Solids	mg/L	15	12	95
Biochemical Oxygen Demand	mg/L	15	5	13
Ammonia as N	mg/L	1.0	0.05	1.02
Total Phosphorus	mg/L	0.3	0.05	0.17
Total Kjeldahl Nitrogen	mg/L	1.0	0.05	1.34
Fluoride	mg/L	2	0.05	0.21
Chloride	mg/L	500	0.10	274
Sulphate	mg/L	500	0.10	102
Total Antimony	mg/L	0.05	0.020	<0.020
Total Arsenic	mg/L	0.001	0.001	0.003
Total Aluminum	mg/L	1.0	0.020	2.04
Total Bismuth	mg/L	0.05	0.010	<0.010
Total Cadmium	mg/L	0.001	0.001	<0.001
Total Chromium	mg/L	0.200	0.020	<0.020
Total Cobalt	mg/L	0.050	0.020	<0.020
Total Copper	mg/L	0.010	0.010	<0.010
Total Iron	mg/L	1.0	0.050	2.57
Total Lead	mg/L	0.050	0.020	<0.020
Total Manganese	mg/L	0.200	0.020	0.274
Total Mercury	mg/L	0.001	0.0002	<0.0002
Total Molybdenum	mg/L	0.050	0.020	0.025
Total Nickel	mg/L	0.050	0.015	<0.015
Total Selenium	mg/L	0.100	0.020	<0.020
Total Silver	mg/L	0.100	0.020	<0.020
Total Tin	mg/L	0.100	0.025	<0.025
Total Titanium	mg/L	0.050	0.020	0.068
Total Vanadium	mg/L	0.050	0.020	<0.020
Total Zinc	mg/L	0.050	0.020	0.045

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to York Storm

Certified By: Jody Takeuchi

AGAT® Laboratories

Certificate of Analysis

AGAT WORK ORDER: 06T194366
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.
ATTENTION TO: Beng Lay Teh

ON Regulation 558 Metals and Inorganics

DATE SAMPLED: October 03 2006
DATE RECEIVED: November 01 2006
DATE REPORTED: November 10 2006
SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	Hwy 407/Jane St. 607975
Arsenic Leachate	mg/L	2.5	0.010	<0.010
Barium Leachate	mg/L	100	0.100	0.646
Boron Leachate	mg/L	500	0.050	0.073
Cadmium Leachate	mg/L	0.5	0.005	<0.005
Chromium Leachate	mg/L	5	0.005	<0.005
Lead Leachate	mg/L	5	0.007	<0.007
Mercury Leachate	mg/L	0.1	0.005	<0.005
Selenium Leachate	mg/L	1	0.010	<0.010
Silver Leachate	mg/L	5	0.005	<0.005
Uranium Leachate	mg/L	10	0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.21
Cyanide Leachate	mg/L	20	0.05	<0.05
Nitrate + Nitrite as N Leachate	mg/L	1000	0.70	<0.70

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558
607975 Cyanide Leachate is reported as Free Cyanide determined by Technicon Autoanalyser.

Certified By: Jocky Takeuchi

Certificate of Analysis

AGAT WORK ORDER: 06T194366
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.
ATTENTION TO: Beng Lay Teh

ON Regulation 558 PCBs

DATE SAMPLED: October 03 2006
DATE RECEIVED: November 01 2006
DATE REPORTED: November 10 2006
SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	Hwy 407/Jane St. 607975
Polychlorinated Biphenyls	mg/L	0.3	0.005	<0.005

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

607975 The soil sample was leached using the Regulation 558 procedure. Analysis was performed on the leachate.
Results relate only to the items tested.

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 06T194366
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Beng Lay Teh

ON Regulation 558 SVOCs

DATE SAMPLED: October 03 2006 DATE RECEIVED: November 01 2006 DATE REPORTED: November 10 2006 SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	Hwy 407/Jane St. 607975
Pyridine	mg/L	5.0	0.010	<0.010
Cresols	mg/L	200	0.012	<0.012
Ortho-Cresol	mg/L	200	0.004	<0.004
Meta & Para-Cresol	mg/L	200	0.008	<0.008
Hexachloroethane	mg/L	3.0	0.004	<0.004
Nitrobenzene	mg/L	2.0	0.004	<0.004
Hexachlorobutadiene	mg/L	0.5	0.004	<0.004
2,4,6-Trichlorophenol	mg/L	0.5	0.05	<0.05
2,4,5-Trichlorophenol	mg/L	400	0.004	<0.004
2,4-Dinitrotoluene	mg/L	0.13	0.004	<0.004
2,3,4,6-Tetrachlorophenol	mg/L	10.0	0.004	<0.004
Hexachlorobenzene	mg/L	0.13	0.004	<0.004
Dinoseb	mg/L	1.0	0.004	<0.004
Benzo(a)pyrene	mg/L	0.001	0.001	<0.001

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

607975 The sample was leached according to Regulation 558 protocol. Analysis was performed on the leachate.
Surrogate recovery for 2,4,6-Tribromophenol: 76%.
Results relate only to the items tested.

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 06T194366
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Beng Lay Teh

ON Regulation 558 VOCs

DATE SAMPLED: October 03 2006 DATE RECEIVED: November 01 2006 DATE REPORTED: November 10 2006 SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	Hwy 407/Jane St. 607975
Vinyl Chloride	mg/L	0.2	0.030	<0.030
1,1-Dichloroethene	mg/L	1.4	0.020	<0.020
Dichloromethane	mg/L	5.0	0.030	<0.030
Methyl Ethyl Ketone	mg/L	200	0.090	<0.090
Chloroform	mg/L	10.0	0.020	<0.020
1,2-Dichloroethane	mg/L	0.5	0.020	<0.020
Carbon Tetrachloride	mg/L	0.5	0.020	<0.020
Benzene	mg/L	0.5	0.020	<0.020
Trichloroethene	mg/L	5.0	0.020	<0.020
Tetrachloroethene	mg/L	3.0	0.010	<0.010
Chlorobenzene	mg/L	8.0	0.010	<0.010
1,2-Dichlorobenzene	mg/L	20	0.010	<0.010
1,4-Dichlorobenzene	mg/L	0.5	0.010	<0.010

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

607975 Surrogate Recovery for Toluene-d8: 96%
Surrogate recovery for 4-Bromofluorobenzene: 93%
Sample was prepared using Regulation 558 protocol and a zero headspace extractor.
Results relate only to the items tested.

Certified By:

Certificate of Analysis

AGAT WORK ORDER: 06T193211
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.
ATTENTION TO: Beng Lay Teh

ON Regulation 558 Metals and Inorganics

DATE SAMPLED: October 25 2006 DATE RECEIVED: October 26 2006 DATE REPORTED: November 01 2006 SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	HWY 7 603438
Arsenic Leachate	mg/L	2.5	0.010	<0.010
Barium Leachate	mg/L	100	0.100	1.24
Boron Leachate	mg/L	500	0.050	0.053
Cadmium Leachate	mg/L	0.5	0.005	<0.005
Chromium Leachate	mg/L	5	0.005	<0.005
Lead Leachate	mg/L	5	0.007	<0.007
Mercury Leachate	mg/L	0.1	0.005	<0.005
Selenium Leachate	mg/L	1	0.010	<0.010
Silver Leachate	mg/L	5	0.005	<0.005
Uranium Leachate	mg/L	10	0.050	<0.050
Fluoride Leachate	mg/L	150	0.05	0.25
Cyanide Leachate	mg/L	20	0.05	<0.05
Nitrate + Nitrite as N Leachate	mg/L	1000	0.70	<0.70

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558
603438 Cyanide Leachate is reported as Free Cyanide determined by Technicon Autoanalyser.

Certified By: Elizabeth Rolakowska

Certificate of Analysis

AGAT WORK ORDER: 06T193211
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.

ATTENTION TO: Beng Lay Teh

ON Regulation 558 PCBs

DATE SAMPLED: October 25 2006

DATE RECEIVED: October 26 2006

DATE REPORTED: November 01 2006

SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	HWY 7 603438
Polychlorinated Biphenyls	mg/L	0.3	0.005	<0.005

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

603438 The soil sample was leached using the Regulation 558 procedure. Analysis was performed on the leachate.
Results relate only to the items tested.

Certified By: Jody Takeuchi

Certificate of Analysis

AGAT WORK ORDER: 06T193211
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD.
ATTENTION TO: Beng Lay Teh

ON Regulation 558 SVOCs

DATE SAMPLED: October 25 2006
DATE RECEIVED: October 26 2006
DATE REPORTED: November 01 2006
SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	HWY 7 603438
Pyridine	mg/L	5.0	0.010	<0.010
Cresols	mg/L	200	0.012	<0.012
Ortho-Cresol	mg/L	200	0.004	<0.004
Meta & Para-Cresol	mg/L	200	0.008	<0.008
Hexachloroethane	mg/L	3.0	0.004	<0.004
Nitrobenzene	mg/L	2.0	0.004	<0.004
Hexachlorobutadiene	mg/L	0.5	0.004	<0.004
2,4,6-Trichlorophenol	mg/L	0.5	0.05	<0.05
2,4,5-Trichlorophenol	mg/L	400	0.004	<0.004
2,4-Dinitrotoluene	mg/L	0.13	0.004	<0.004
2,3,4,6-Tetrachlorophenol	mg/L	10.0	0.004	<0.004
Hexachlorobenzene	mg/L	0.13	0.004	<0.004
Dinoseb	mg/L	1.0	0.004	<0.004
Benzo(a)pyrene	mg/L	0.001	0.001	<0.001

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

603438 The sample was leached according to Regulation 558 protocol. Analysis was performed on the leachate.
Surrogate recovery for Chrysene-12: 69%.
Results relate only to the items tested.

Certified By: Jocky Takeuchi

AGAT® Laboratories

Certificate of Analysis

AGAT WORK ORDER: 06T193211
PROJECT NO: 06-1111-040

CLIENT NAME: GOLDER ASSOCIATES LTD. ATTENTION TO: Beng Lay Teh

ON Regulation 558 VOCs

DATE SAMPLED: October 25 2006 DATE RECEIVED: October 26 2006 DATE REPORTED: November 01 2006 SAMPLE TYPE: Soil

	Unit	G / S	M.D.L.	HWY 7 603438
Vinyl Chloride	mg/L	0.2	0.030	<0.030
1,1-Dichloroethene	mg/L	1.4	0.020	<0.020
Dichloromethane	mg/L	5.0	0.030	<0.030
Methyl Ethyl Ketone	mg/L	200	0.090	<0.090
Chloroform	mg/L	10.0	0.020	<0.020
1,2-Dichloroethane	mg/L	0.5	0.020	<0.020
Carbon Tetrachloride	mg/L	0.5	0.020	<0.020
Benzene	mg/L	0.5	0.020	<0.020
Trichloroethene	mg/L	5.0	0.020	<0.020
Tetrachloroethene	mg/L	3.0	0.010	<0.010
Chlorobenzene	mg/L	8.0	0.010	<0.010
1,2-Dichlorobenzene	mg/L	20	0.010	<0.010
1,4-Dichlorobenzene	mg/L	0.5	0.010	<0.010

Comments: M.D.L. - Method Detection Limit; G / S - Guideline / Standard: Refers to Regulation 558

603438 Surrogate Recovery for Toluene-d8: 106%
Surrogate recovery for 4-Bromofluorobenzene: 104%
Sample was prepared using Regulation 558 protocol and a zero headspace extractor.
Results relate only to the items tested.

Certified By: Jody Takeuchi

APPENDIX B

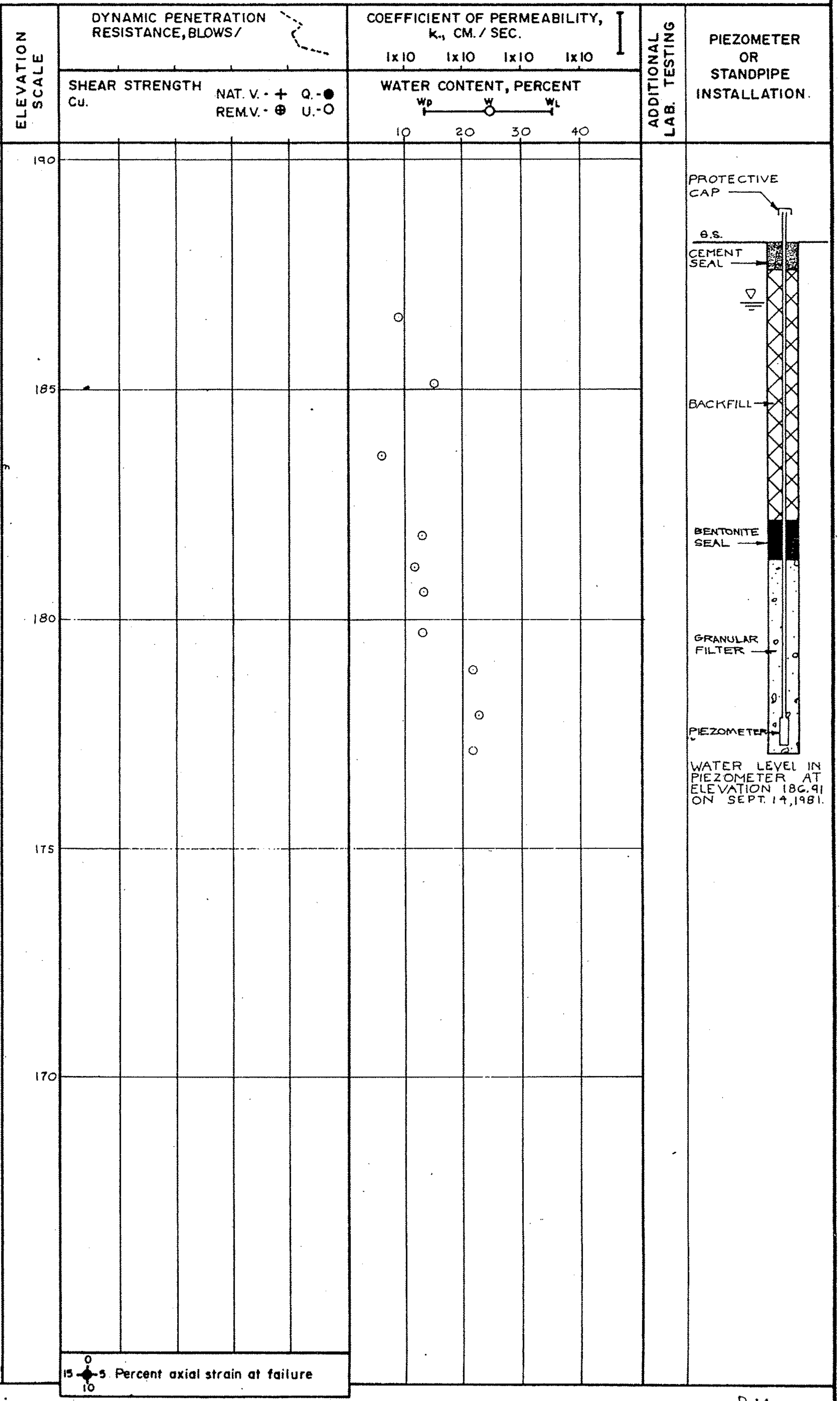
PREVIOUS BOREHOLE RECORDS

BOREHOLES 1 TO 12 – 1981 BY GOLDER ASSOCIATES LTD.
BOREHOLES 104 TO 109 – 1985
BOREHOLES 06-2 AND 06-5 – 2006 BY OTHERS

RECORD OF BOREHOLE 1

LOCATION See Figure 2
BORING DATE JULY 9, 1981
DATUM GEODETIC
SAMPLER HAMMER WEIGHT 62.5 kg DROP 760 mm.
PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE ELEV'N. / DEPTH (m)	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/0.3m
	188.21	GROUND SURFACE				
POWER AUGER BORING 170 mm. DIAM. HOLLOW-STEM AUGERS	188.00	TOPSOIL	③			
	0.21 186.96	COBBLES AND BOULDERS WITH SILTY SAND	④			
	1.25	COMPACT TO DENSE, GREY SANDY SILT WITH TRACE CLAY AND GRAVEL (TILL)	⑤	1	50mm D.O.	57
				2	"	13
	182.88			3	"	100/200 mm
	5.33	VERY HARD, GREY CLAYEY SILT WITH TRACE SAND (TILL)	⑥	4	"	
				5	"	118
				6	"	111
				7	"	143
				8	"	94
				9	"	62
	177.08			10	"	64
	11.13	END OF HOLE				



WATER LEVEL IN PIEZOMETER AT ELEVATION 186.91 ON SEPT. 14, 1981.

VERTICAL SCALE 1:100 (METRIC)

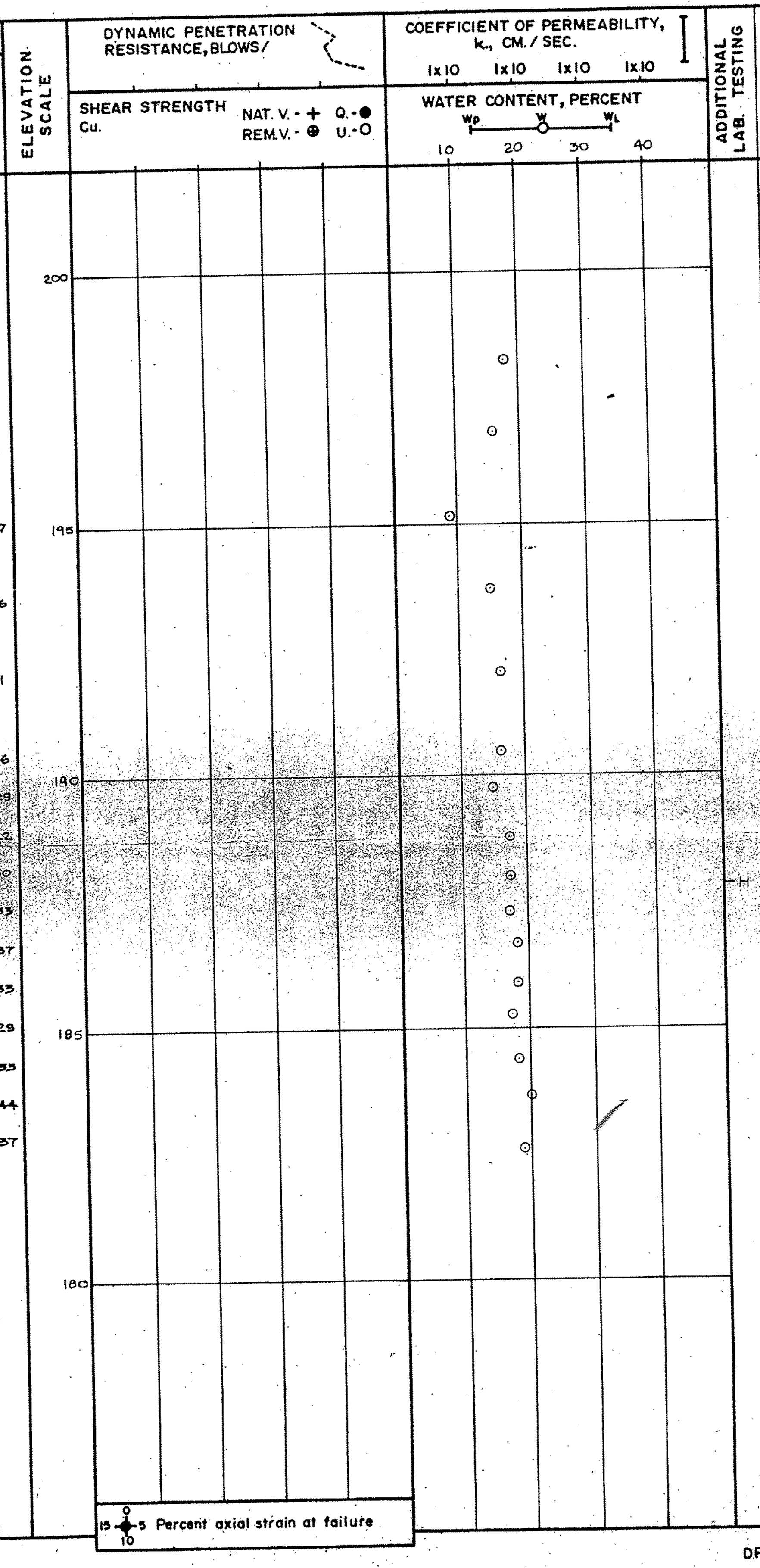
Golder Associates

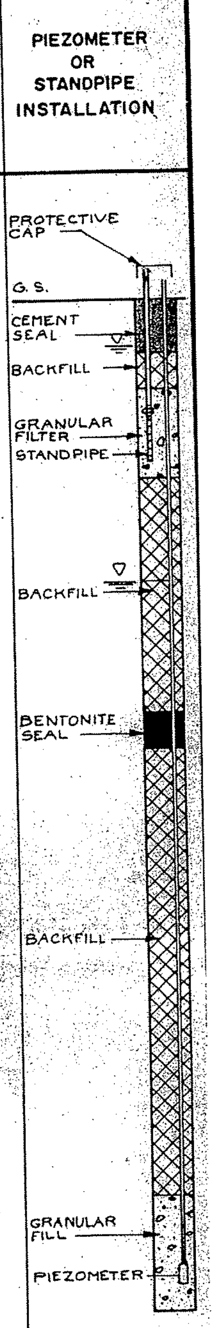
DRAWN D.M.
CHECKED MT

RECORD OF BOREHOLE 2

LOCATION See Figure 2
BORING DATE JULY 6, 1981
DATUM GEODETIC
SAMPLER HAMMER WEIGHT 0.62 Kg. DROP 760 mm
PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m
	199.91	GROUND SURFACE				
POWER AUGER BORING 170 mm DIAM. HOLLOW-STEM AUGERS	0.00	TOPSOIL	③			
	0.34	COMPACT, BROWN SILTY FINE SAND WITH TRACE CLAY AND FINE GRAVEL	⑦	1	50mm D.O.	13
	197.17 2.74	VERY STIFF TO VERY HARD, GREY CLAYEY SILT WITH TRACE SAND AND SOME FINE GRAVEL (TILL)	⑥	2	"	14
				3	"	57
				4	"	56
				5	"	51
				6	"	46
				7	"	29
				8	"	22
				9	"	50
				10	"	33
				11	"	37
				12	"	33
				13	"	29
				14	"	33
				15	"	44
				16	"	37
	182.69 17.22	END OF HOLE				





WATER LEVEL IN STANDPIPE AT ELEVATION 199.11 ON SEPT. 14, 1981.

WATER LEVAL IN PIEZOMETER AT ELEVATION 195.11 ON SEPT. 14, 1981

VERTICAL SCALE
1:100 (METRIC)

Golder Associates

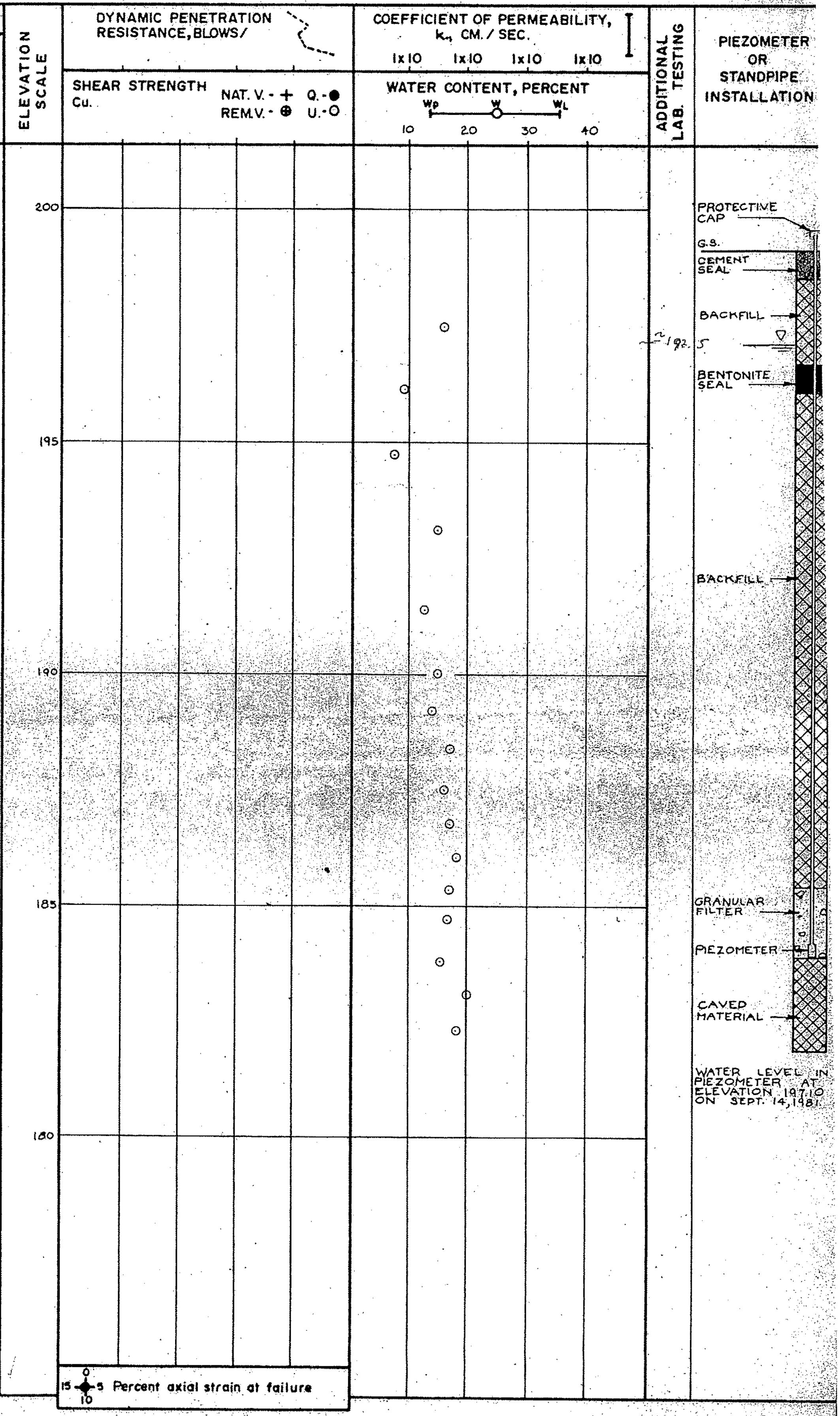
DRAWN G.P.
CHECKED M.T.

RECORD OF BOREHOLE 3

LOCATION See Figure 2 BORING DATE JULY 7, 1981 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 0.62 Kg. DROP 760 mm PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m
	199.10	GROUND SURFACE				
POWER AUGER BORING 170 mm DIAM. HOLLOW STEM AUGERS	0.00 198.83 0.27	TOPSOIL	③			
		HARD CLAYEY SILT WITH TRACE SAND AND SOME FINE GRAVEL (TILL) BROWN GREY	⑥	1	50 mm D.O	28
				2	"	116
				3	"	62
				4	"	56
				5	"	62
				6	"	56
				7	"	49
				8	"	54
				9	"	47
				10	"	43
				11	"	37
				12	"	40
				13	"	39
				14	"	44
				15	"	37
				16	"	34
	181.88 17.22	END OF HOLE				



WATER LEVEL IN PIEZOMETER AT ELEVATION 197.10 ON SEPT. 14, 1981

VERTICAL SCALE
1:100 (METRIC)

Golder Associates

DRAWN G.P.
CHECKED M.T.

RECORD OF BOREHOLE 4

LOCATION See Figure 2

BORING DATE JULY 3, 1981

DATUM GEODETIC

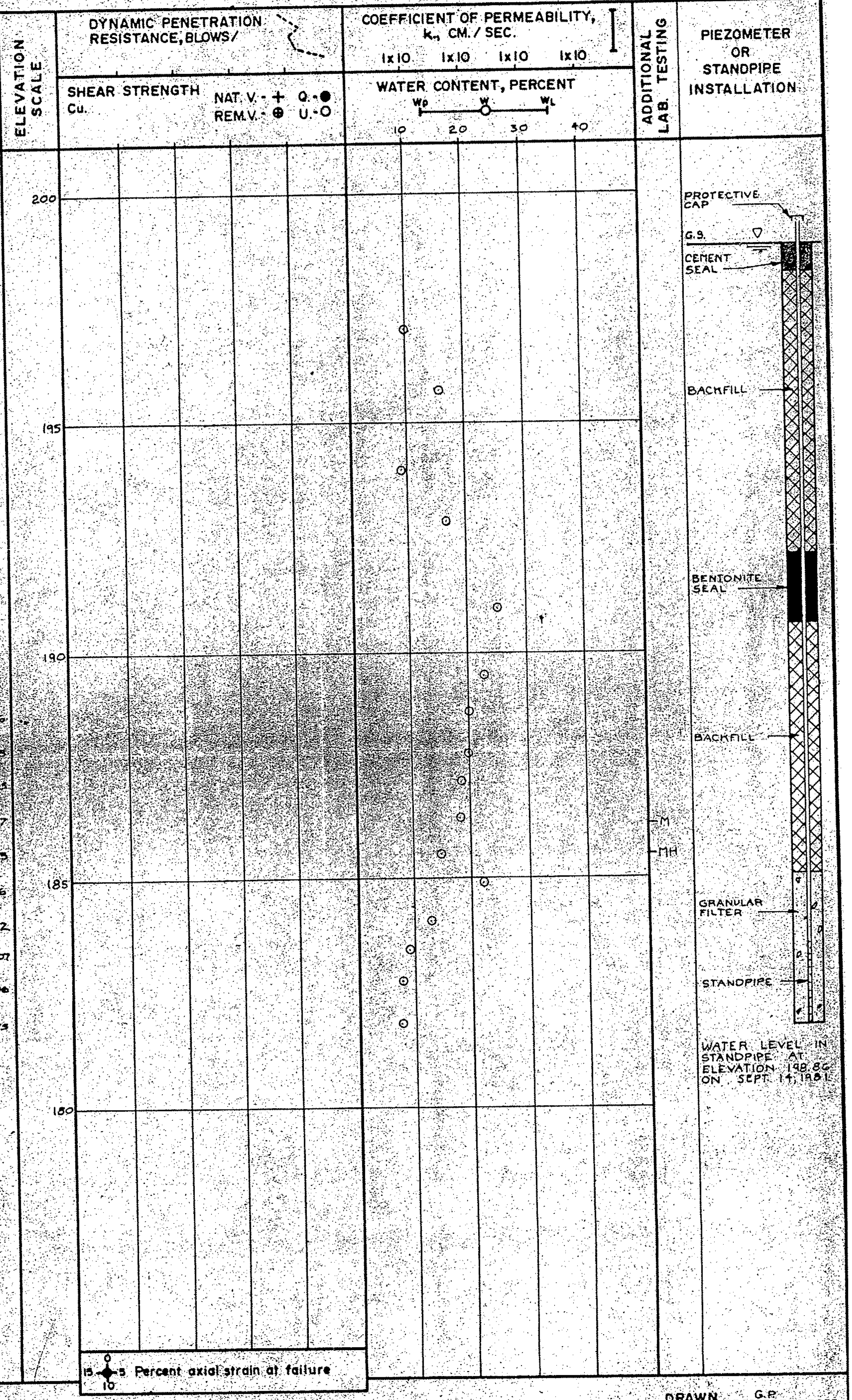
SAMPLER HAMMER WEIGHT 62 Kg. DROP 760 mm

PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD: POWER AUGER BORING
170 mm DIAM. HOLLOW-STEM AUGERS

ELEV'N. DEPTH (m)	DESCRIPTION	STRAT. PLOT
198.86	GROUND SURFACE	
0.00	COMPACT, BROWN SAND AND GRAVEL (FILL)	①
197.95 0.91	STIFF, GREY SANDY SILT WITH SOME CLAY AND TRACE FINE GRAVEL (TILL)	Ⓢ
190.33 8.53	DENSE GREY SAND, MEDIUM TO FINE GRAINED WITH OCCASSIONAL THIN LAYERS OF FINE GRAVEL AND SILTY SAND	⑦
181.79 17.07	END OF HOLE	

NUMBER	TYPE	BLOWS/0.3m
1	50mm	21
2	″	23
3	″	14
4	″	14
5	″	4
6	″	15
7	″	46
8	″	78
9	″	105
10	″	77
11	″	115
12	″	66
13	″	92
14	″	107
15	″	96
16	″	73



WATER LEVEL IN STANDPIPE AT ELEVATION 198.86 ON SEPT. 14, 1981.

VERTICAL SCALE
1:100 (METRIC)

Golder Associates

DRAWN G.P.

CHECKED MT

RECORD OF BOREHOLE 5

LOCATION See Figure 2

BORING DATE JULY 8, 1981

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 0.62 Kg. DROP 760 mm.

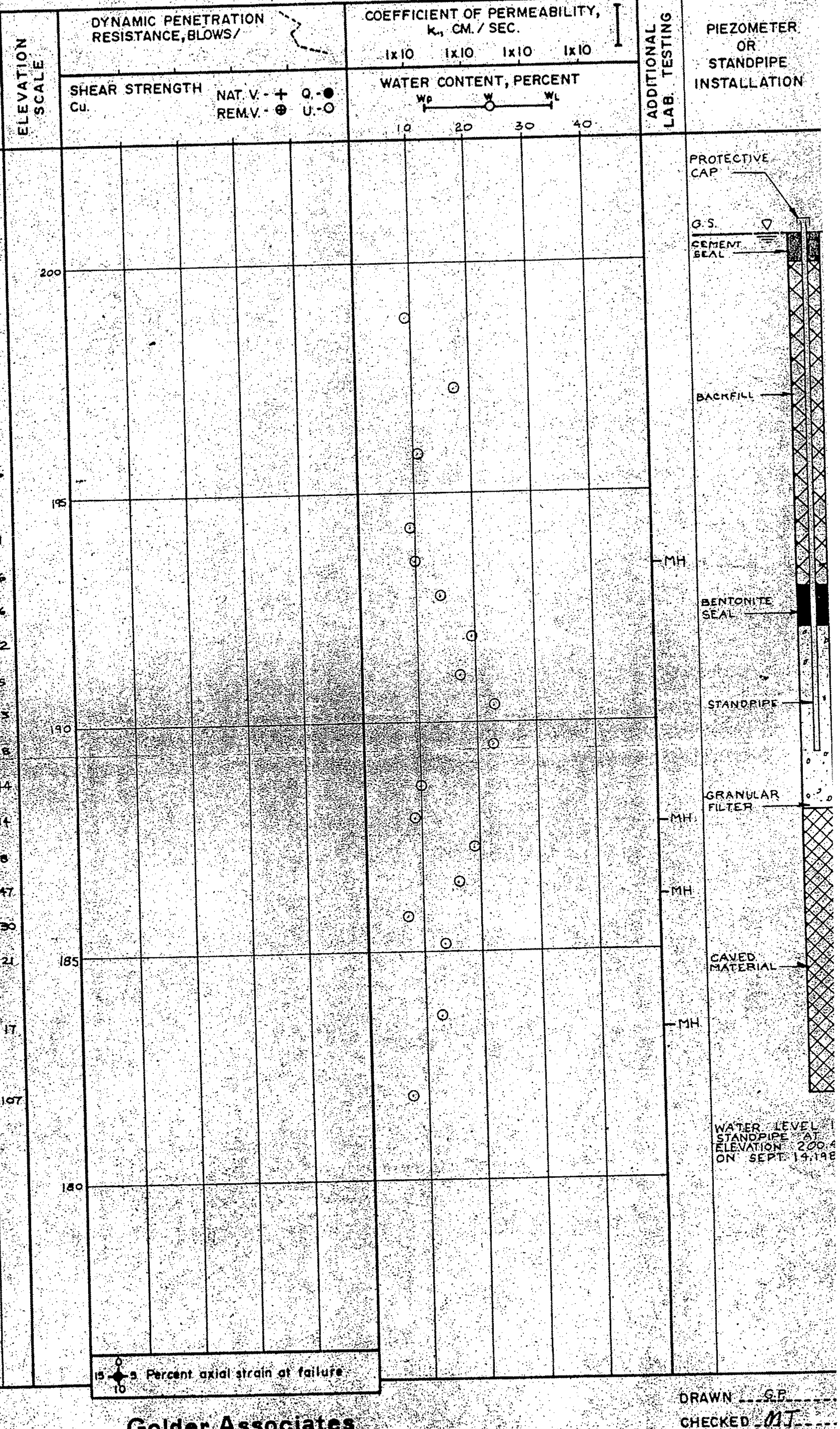
PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD: POWER AUGER BORING 170mm DIAM. HOLLOW - STEM AUGERS

ELEV'N. / DEPTH (m)	DESCRIPTION	STRAT. PLOT
200.47	GROUND SURFACE	
0.00	COMPACT GREY SAND AND GRAVEL (FILL)	①
198.03 2.44	STIFF GREY SANDY SILT WITH SOME CLAY AND TRACE GRAVEL (TILL)	⑤
190.72 9.75	COMPACT TO DENSE, GREY SAND WITH SOME GRAVEL AND SILT AND OCCASSIONAL THIN LAYERS OF GRAVEL AND SILTY SAND	⑦
186.14 14.33	COMPACT TO DENSE GREY SANDY GRAVEL WITH SOME SILT	⑧
181.72 18.75	END OF HOLE	

SAMPLES

NUMBER	TYPE	BLOWS/0.3m
1	50mm DO	18
2	"	5
3	"	16
4	"	21
5	"	16
6	"	16
7	"	12
8	"	15
9	"	13
10	"	18
11	"	44
12	"	14
13	"	8
14	"	47
15	"	30
16	"	21
17	"	17
18	"	107



VERTICAL SCALE 1:100 (METRIC)

Golder Associates

DRAWN G.F.

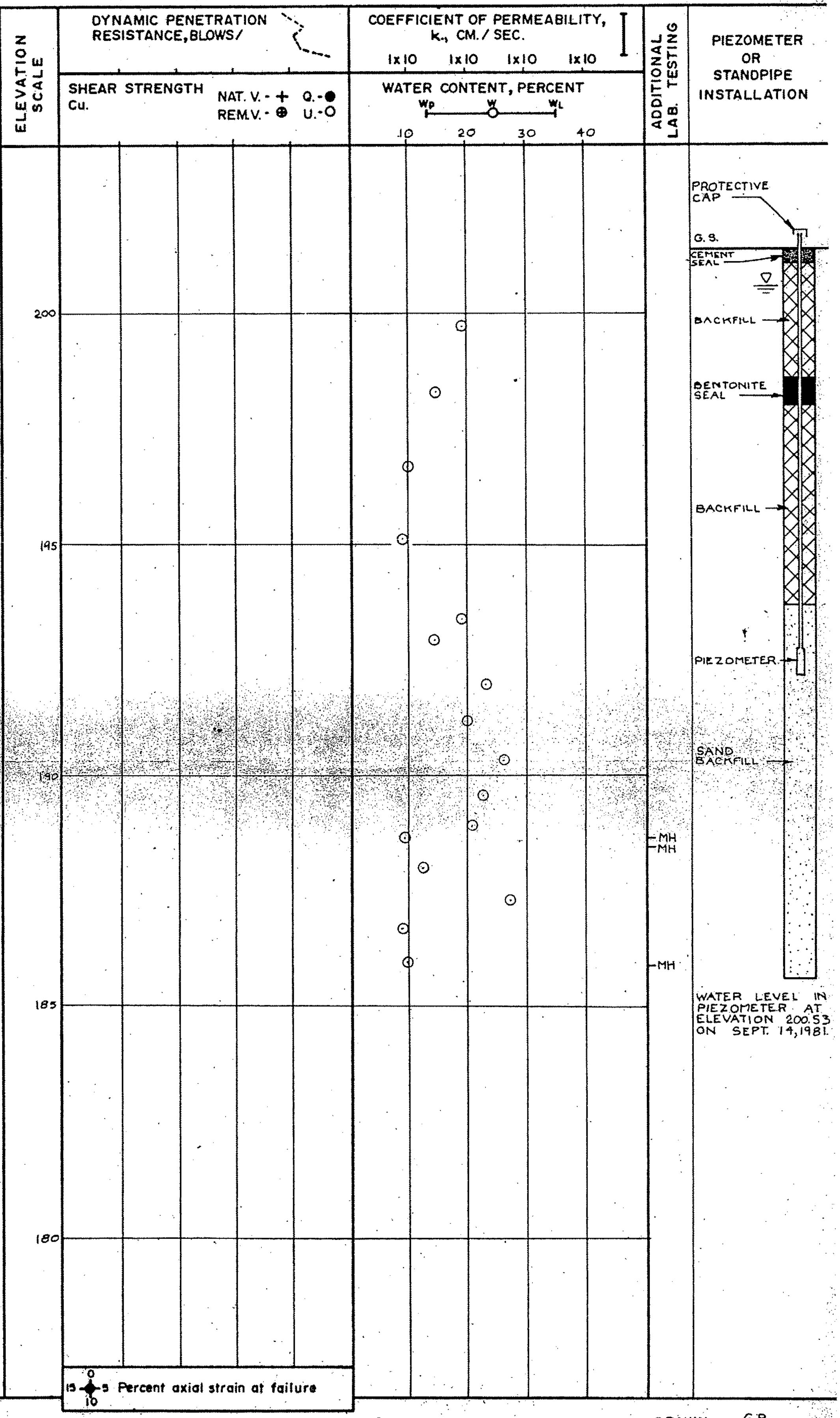
CHECKED MJ

RECORD OF BOREHOLE 6

LOCATION See Figure 2　　BORING DATE JULY 2, 1981　　DATUM GEODETIC

SAMPLER HAMMER WEIGHT 0.62 Kg. DROP 760 mm.　　PENETRATION TEST HAMMER WEIGHT —　DROP —

BORING METHOD	ELEV'N. / DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/0.3 m
	201.33	GROUND SURFACE				
POWER AUGER BORING 170mm DIAM. HOLLOW-STEM AUGERS	0.0.0	FIRM, BROWN-GREY CLAYEY SILT (FILL)	②	1	50mm D.O	5
	198.13 3.20	VERY STIFF, GREY CLAYEY SILT WITH TRACE SAND AND GRAVEL (TILL)	⑤	2	"	19
	197.06 4.27	HARD, GREY SANDY SILT WITH SOME CLAY AND TRACE GRAVEL (TILL)	⑤	3	"	52
				4	"	38
				5	"	35
	193.10 8.23	COMPACT GREY SAND WITH OCCASSIONAL THIN LAYERS OF CLAYEY SILT AND COARSE SAND TO FINE GRAVEL	⑦	6	"	14
				7	"	10
				8	"	6
				9	"	5
				10	"	7
				11	"	26
				12	"	11
				13	"	9
				14	"	71
	185.63 15.70	END OF HOLE		15	"	20



WATER LEVEL IN PIEZOMETER AT ELEVATION 200.53 ON SEPT. 14, 1981.

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

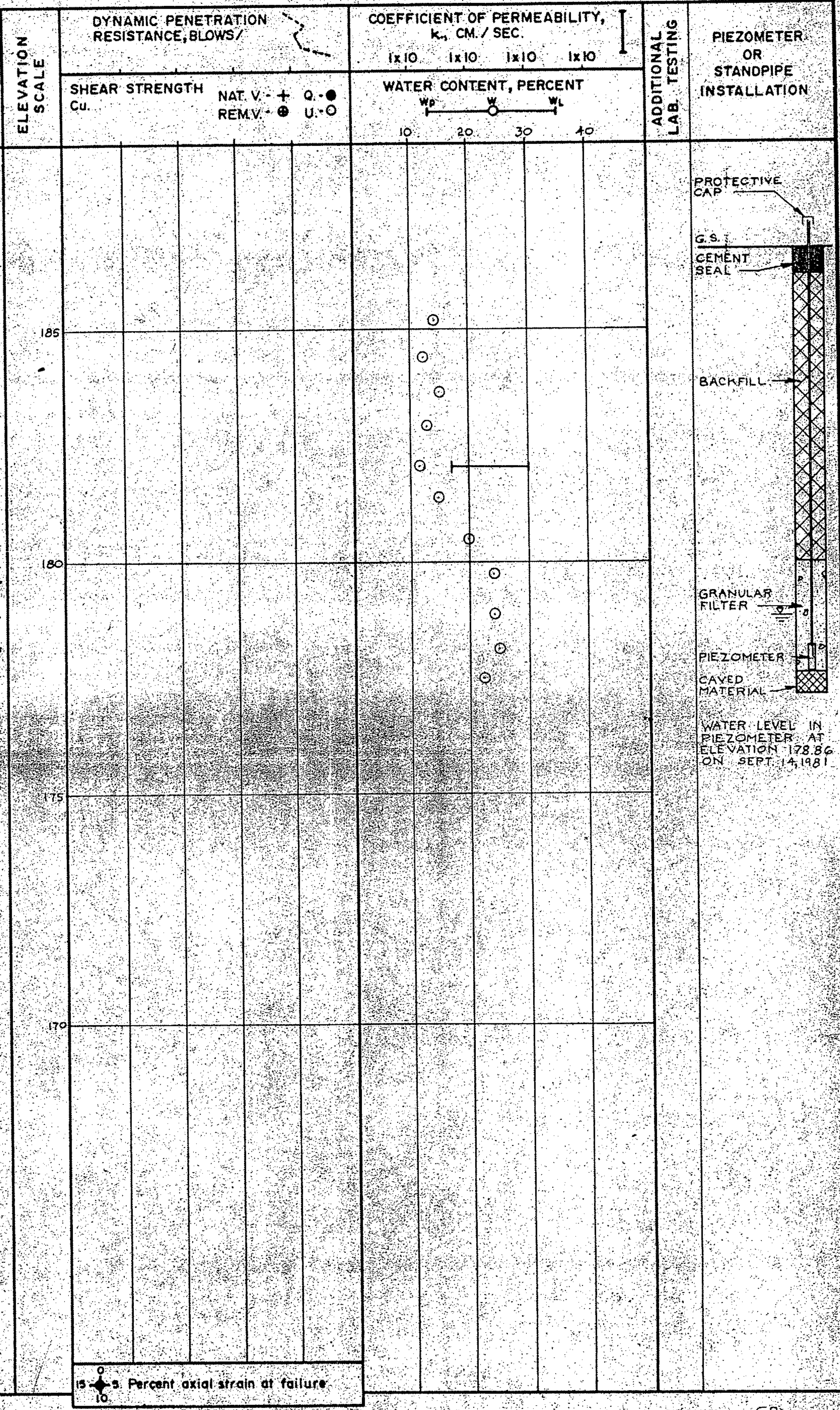
DRAWN G.P.
CHECKED M.T.

RECORD OF BOREHOLE 7

LOCATION See Figure 2
BORING DATE JULY 10, 1981
DATUM GEODETIC
SAMPLER HAMMER WEIGHT 0.62 Kg. DROP 760 mm
PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD: POWER AUGER BORING 170 mm DIAM. HOLLOW STEM AUGERS

ELEV'N. / DEPTH (m)	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	TYPE	BLOWS/0.3 m
186.76	GROUND SURFACE				
0.00	TOPSOIL	③			
0.15	COMPACT, BROWN SILTY SAND	④			
185.54 1.22	VERY HARD, GREY CLAYEY SILT WITH TRACE SAND AND GRAVEL (TILL)	⑥	1	50mm D.O.	79
			2	"	63
			3	"	69
			4	"	86
			5	"	79
			6	"	75
			7	"	71
			8	"	33
			9	"	33
			10	"	35
			11	"	31
177.16 9.60	END OF HOLE				



WATER LEVEL IN PIEZOMETER AT ELEVATION 178.86 ON SEPT. 14, 1981

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

DRAWN G.P.
CHECKED MT

RECORD OF BOREHOLE 8

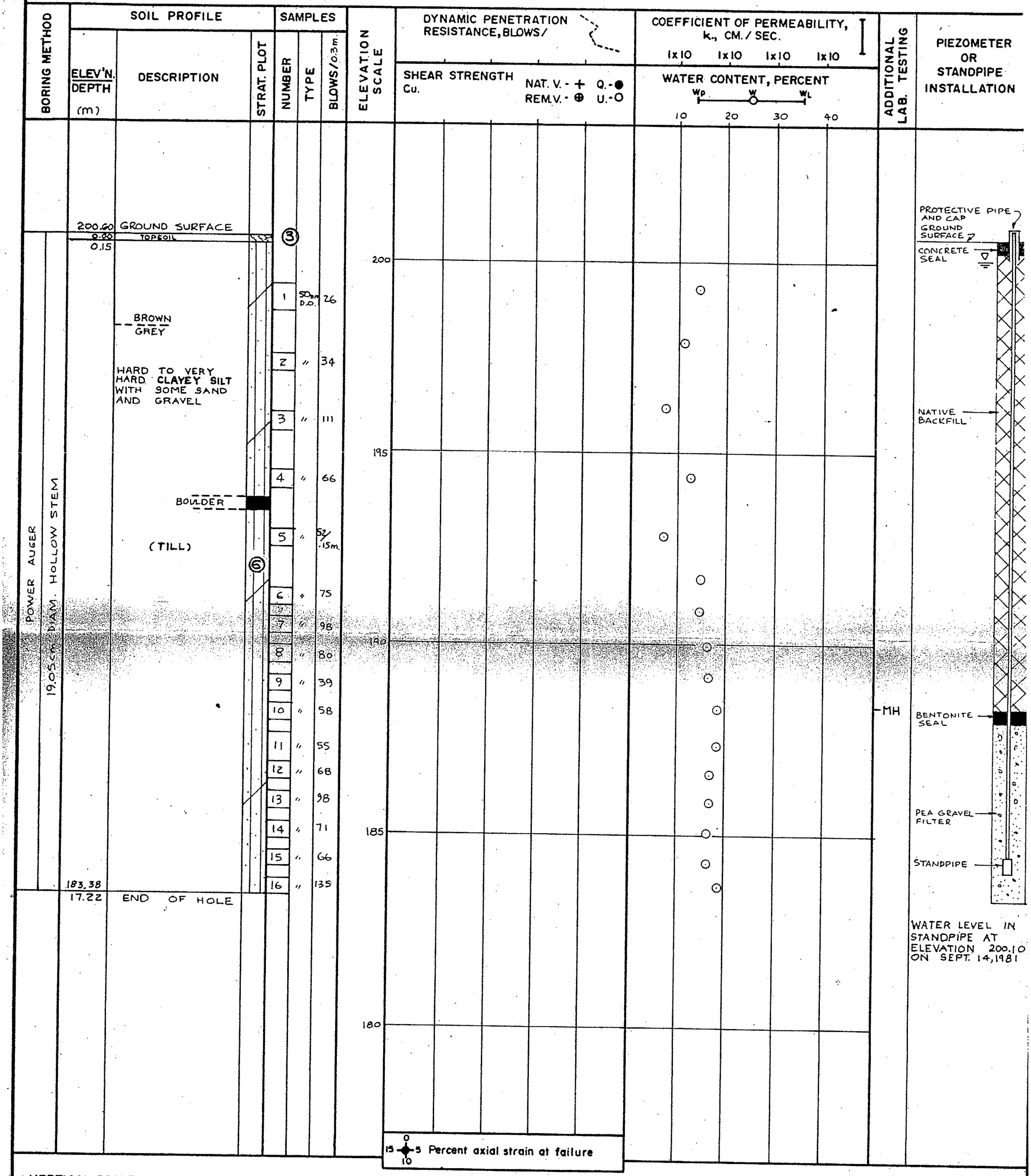
LOCATION See Figure 2

BORING DATE JULY 20, 1981

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 62.5kg DROP 760mm.

PENETRATION TEST HAMMER WEIGHT — DROP —



NUMBER	TYPE	BLOWS/0.3m.
1	50mm D.O.	26
2	"	34
3	"	111
4	"	66
5	"	52/.15m.
6	"	75
7	"	98
8	"	80
9	"	39
10	"	58
11	"	55
12	"	68
13	"	98
14	"	71
15	"	66
16	"	135

WATER LEVEL IN STANDPIPE AT ELEVATION 200.10 ON SEPT. 14, 1981

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

DRAWN D.M.

CHECKED MT

RECORD OF BOREHOLE 9

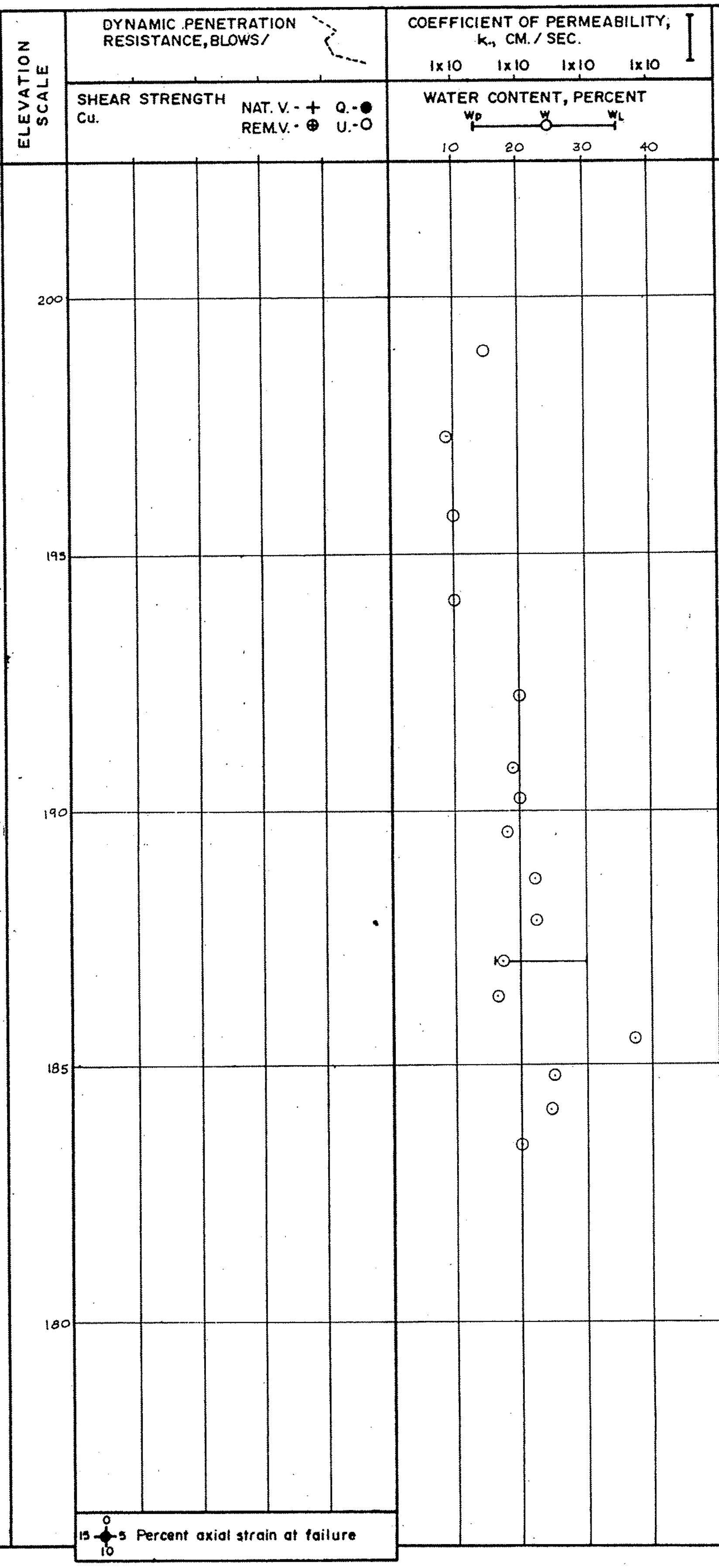
LOCATION See Figure 2
BORING DATE JULY 22, 1981
DATUM GEODETIC

SAMPLER HAMMER WEIGHT 62.5 kg DROP 760 mm.
PENETRATION TEST HAMMER WEIGHT — DROP —

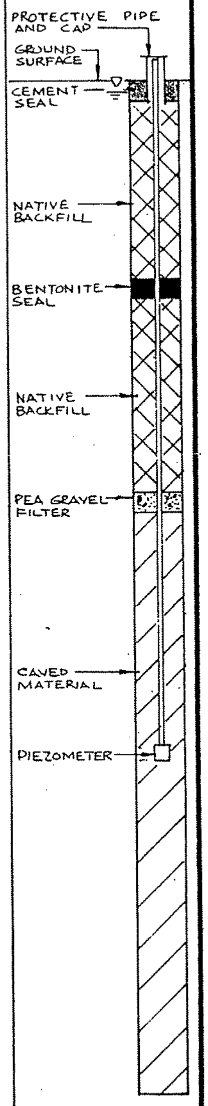
BORING METHOD: POWER. AUGER 170 mm. DIAM. HOLLOW STEM

ELEV'N. DEPTH (m)	DESCRIPTION	STRAT. PLOT
200.40	GROUND SURFACE	
0.00	TOPSOIL	③
0.21	STIFF TO VERY STIFF, GREY **SANDY SILT** WITH SOME CLAY AND FINE GRAVEL (TILL)	⑤
193.69 6.71	COMPACT GREY **SILTY FINE SAND** WITH TRACE GRAVEL.	⑦
188.09 12.31	HARD, GREY **CLAYEY SILT** WITH TRACE SAND AND GRAVEL. (TILL)	⑥
183.18 17.22	END OF HOLE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m.	ADDITIONAL LAB. TESTING
1	50mm D.O.	28	
2	"	29	
3	"	20	
4	"	13	
5	"	12	
6	"	16	
7	"	23	
8	"	13	
9	"	10	MH
10	"	39-	
11	"	38	MH
12	"	80	
13	"	43	
14	"	55	
15	"	56	
16	"	48	



PIEZOMETER OR STANDPIPE INSTALLATION



WATER LEVEL IN PIEZOMETER AT ELEVATION 200.20 ON SEPT. 14, 1981

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

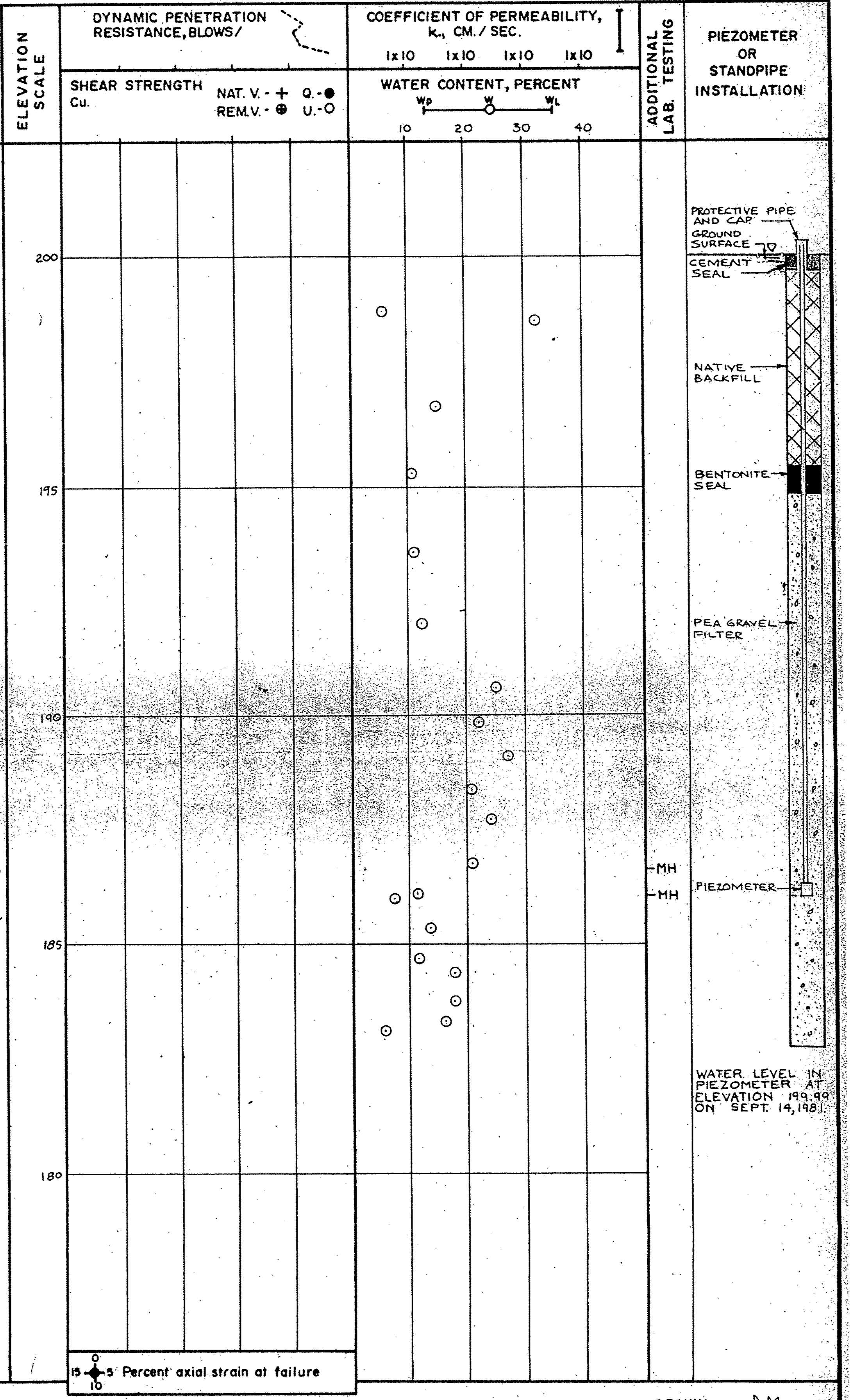
DRAWN D.M.
CHECKED

RECORD OF BOREHOLE 10

LOCATION See Figure 2 BORING DATE JULY 23, 1981 DATUM GEODETIC

SAMPLER HAMMER WEIGHT 62.5 kg DROP 760 mm. PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m	ADDITIONAL LAB. TESTING
	199.99	GROUND SURFACE					
POWER AUGER 170 mm HOLLOW STEM AUGER	0.00	LOOSE, BROWN **SAND AND GRAVEL** (FILL)	①				
	198.25 1.74	**TOPSOIL**	③	1	50mm D.O.	9	
	197.95 2.04	BROWN GREY VERY STIFF TO VERY HARD **SANDY SILT** WITH SOME CLAY AND GRAVEL (TILL)	⑤	2	"	17	
				3	"	16	
				4	"	91	
				5	"	47	
	191.46 8.53	COMPACT, GREY **SILTY FINE SAND** WITH OCCASSIONAL THIN LAYERS OF COARSE SAND, GRAVEL AND CLAYEY SILT	⑦	6	"	7	
				7	"	4	
				8	"	2	
				9	"	13	
				10	"	13	
				11	"	5	MH
	186.12 13.87	DENSE, GREY **SANDY GRAVEL** WITH OCCASSIONAL THIN LAYERS OF CLAYEY SILT	⑧	12	"	108	MH
				13	"	52	
				14	"	42	
				15	"	89	
				16	"	47	
	182.77 17.22	END OF HOLE					



WATER LEVEL IN PIEZOMETER AT ELEVATION 199.99 ON SEPT. 14, 1981.

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

DRAWN D.M.

CHECKED M.T.

RECORD OF BOREHOLE 11

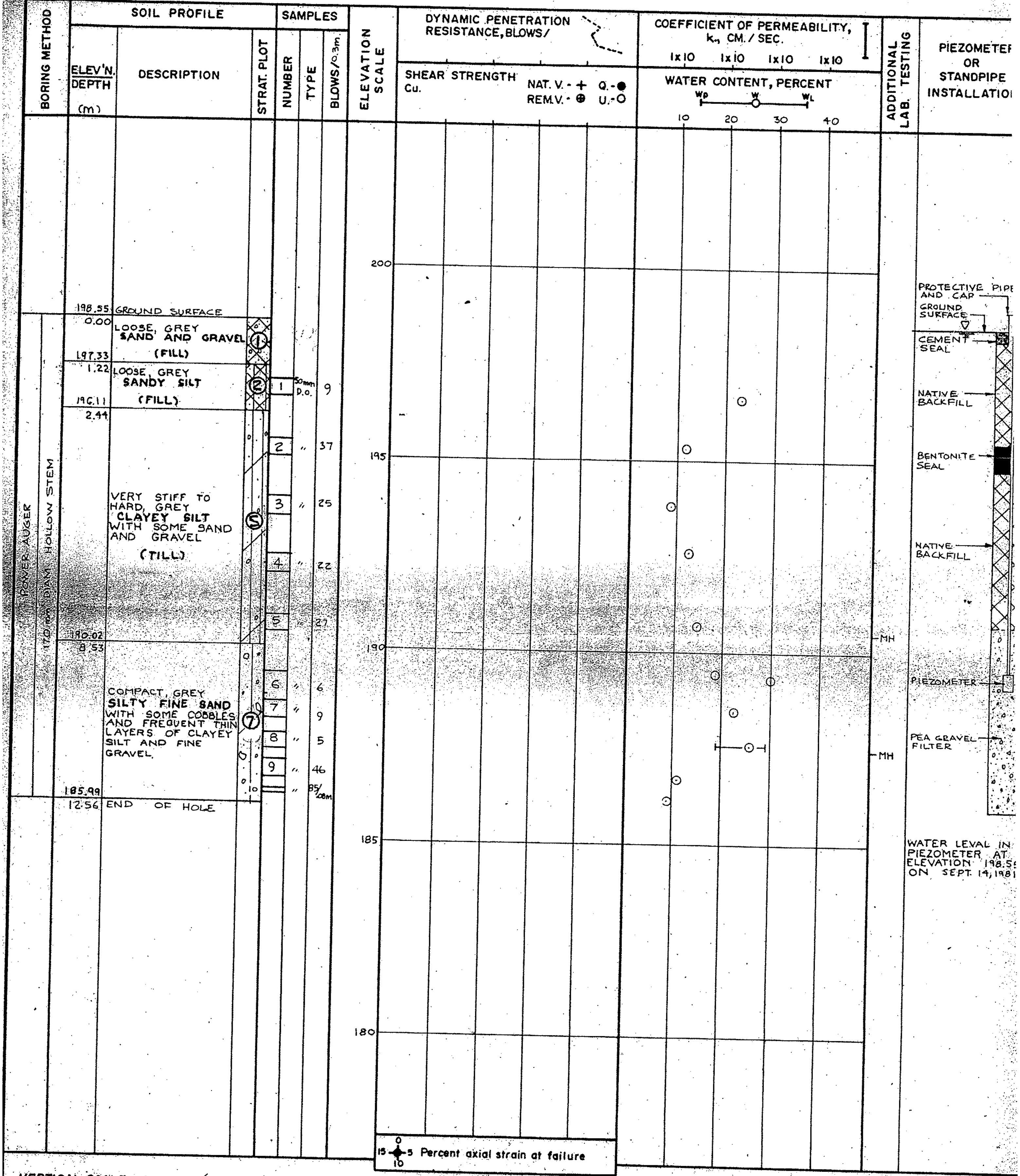
LOCATION See Figure 2

BORING DATE JULY 24, 1981

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 62.5 kg DROP 760 mm.

PENETRATION TEST HAMMER WEIGHT — DROP —



BORING METHOD	ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m.
	198.55	GROUND SURFACE				
POWER AUGER 170 mm DIAM. HOLLOW STEM	0.00	LOOSE, GREY **SAND AND GRAVEL** (FILL)	①			
	197.33 1.22	LOOSE, GREY **SANDY SILT** (FILL)	②	1	50mm D.O.	9
	196.11 2.44	VERY STIFF TO HARD, GREY **CLAYEY SILT** WITH SOME SAND AND GRAVEL (TILL)	⑤	2	"	37
				3	"	25
				4	"	22
				5	"	27
	190.02 8.53	COMPACT, GREY **SILTY FINE SAND** WITH SOME COBBLES AND FREQUENT THIN LAYERS OF CLAYEY SILT AND FINE GRAVEL.	⑦	6	"	6
				7	"	9
				8	"	5
				9	"	46
				10	"	85/.08m
	185.99 12.56	END OF HOLE				

WATER LEVAL IN PIEZOMETER AT ELEVATION 198.5 ON SEPT. 14, 1981

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

DRAWN D.M.

CHECKED MJ

RECORD OF BOREHOLE 12

LOCATION See Figure 2

BORING DATE JULY 27 AND 28, 1981

DATUM GEODETIC

SAMPLER HAMMER WEIGHT 62.5 kg DROP 760 mm.

PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m	ADDITIONAL LAB. TESTING
POWER AUGER 170 mm. DIAM. HOLLOW STEM	199.14	GROUND SURFACE					
	0.00	LOOSE, GREY **SAND AND GRAVEL** **(FILL)**	①				
	197.92 1.22	STIFF, GREY **SANDY SILT** WITH SOME CLAY AND GRAVEL **(TILL)**	⑤	1	50mm D.O.	10	
				2	"	14	
				3	"	16	
				4	"	13	
	192.13 7.01	COMPACT TO DENSE, GREY **SILTY SAND** WITH OCCASSIONAL THIN LAYERS OF CLAYEY SILT, COARSE SAND, AND FINE GRAVEL.	⑦	5	"	10	
				6	"	5	
				7	"	4	
				8	"	16	
				9	"	16	MH
				10	"	5	
				11	"	17	
				12	"	41	
				13	"	50/.13m	
				14	"	74	MH
				15	"	48	
	182.99 16.15	END OF HOLE					

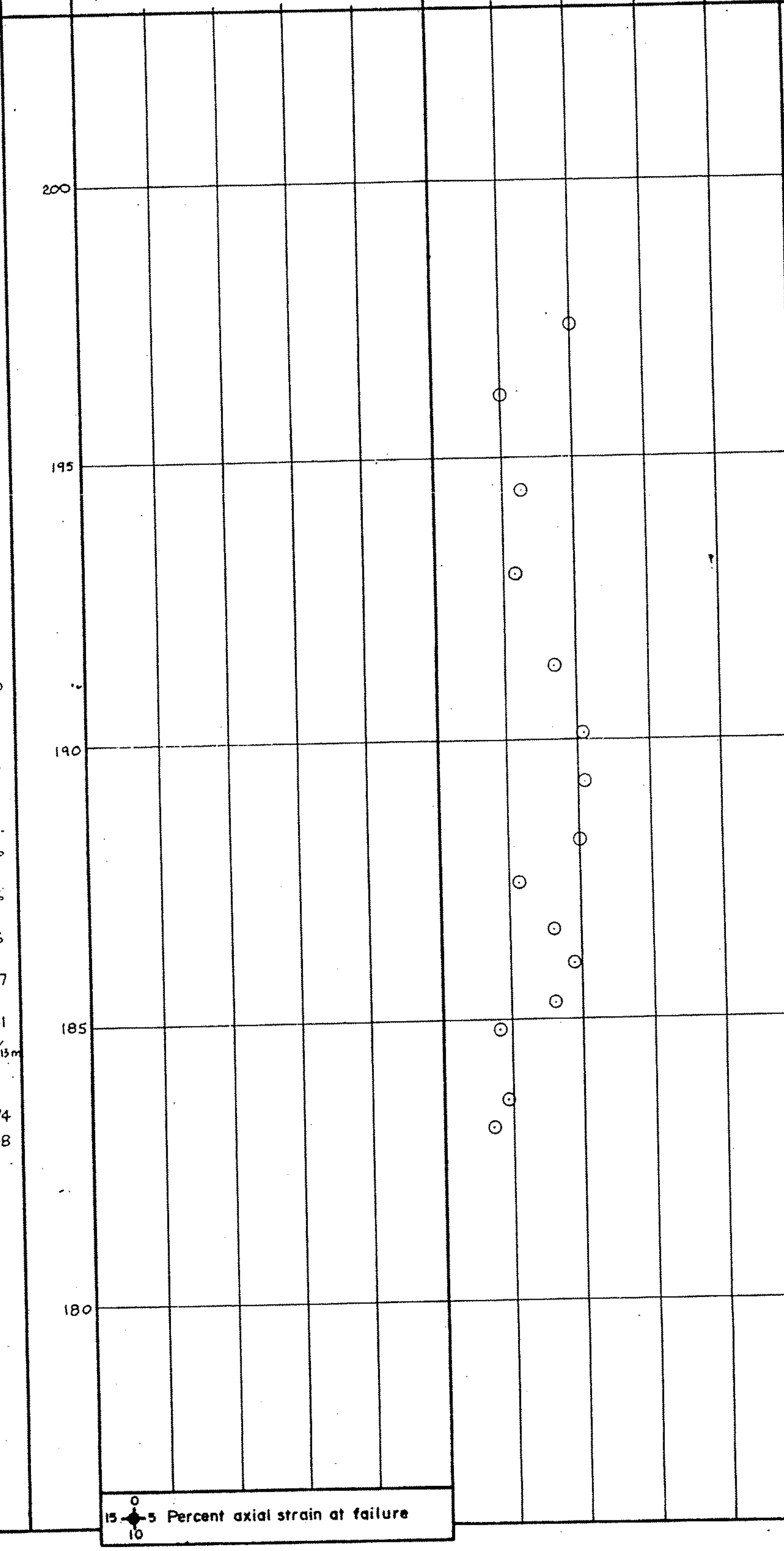
ELEVATION SCALE

DYNAMIC PENETRATION RESISTANCE, BLOWS/

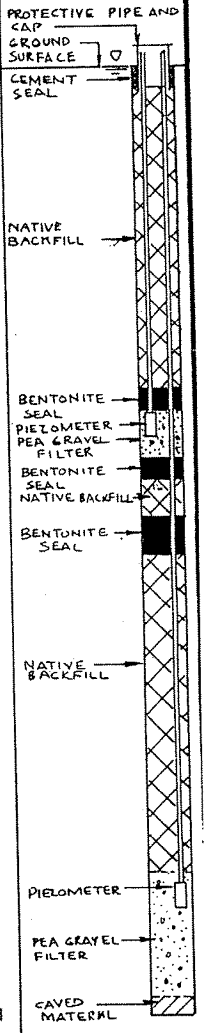
SHEAR STRENGTH Cu. NAT. V. - + Q. - ● REM.V. - ⊕ U. - O

COEFFICIENT OF PERMEABILITY, k, CM./SEC. 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT W_p W W_L



PIEZOMETER OR STANDPIPE INSTALLATION



WATER LEVEL IN UPPER PIEZOMETER AT ELEVATION 199.14 ON SEPT. 19, 1981.

WATER LEVEL IN LOWER PIEZOMETER AT ELEVATION 199.14 ON SEPT. 14, 1981.

VERTICAL SCALE 1:100 (METRIC)

Golder Associates

DRAWN D.M.

CHECKED M.T.

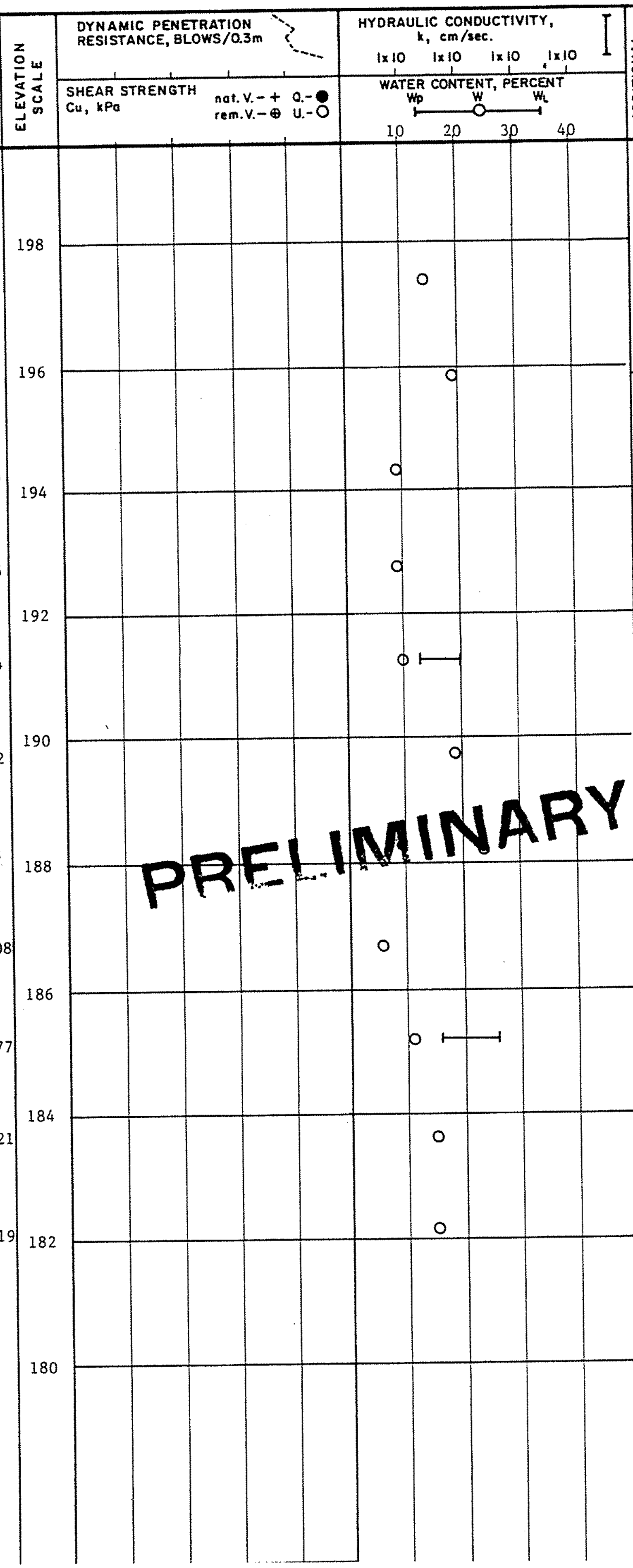
RECORD OF BOREHOLE 104

LOCATION See Figure 2 BORING DATE August 19, 1985 DATUM GEODETIC

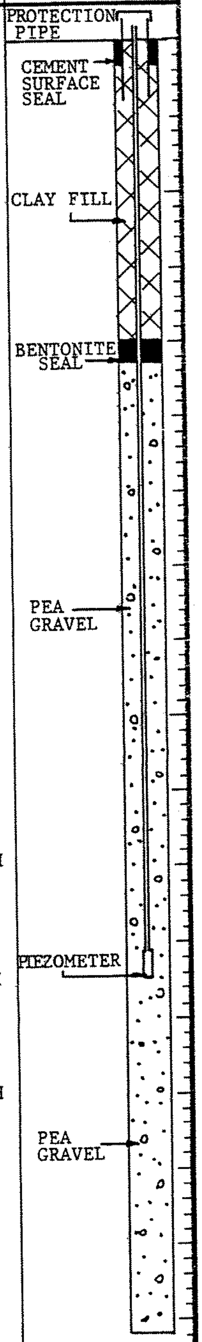
SAMPLER HAMMER, 63.6 kg.; DROP, 760 mm PENETRATION TEST HAMMER, 63.6 kg; DROP, 760 mm

BORING METHOD: POWER AUGER BORING (0 – 11.3 m); WASH BORING (11.3 – 17.2 m); 190 mm DIA. HOLLOW STEM AUGERS

ELEV'N. DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS/0.3 m	ADDITIONAL LAB. TESTING
199.10	GROUND SURFACE					
0.15	TOPSOIL					
	Very stiff, mottled Brown fissured CLAYEY SILT, some sand. Trace gravel. (TILL)	⑤	1	50 mm D.O.	23	
196.66 2.44	Compact, Grey stratified. SILTY FINE SAND.	⑦	2	"	28	MH
195.14 3.96	Hard Grey SANDY SILT. some clay to CLAYEY SILT. some sand. Trace gravel. (TILL)	⑤	3	"	60	
			4	"	36	
			5	"	44	MH
190.56 8.54	Compact Grey stratified SILTY FINE SAND with some silt zones.	⑦	6	"	12	
			7	"	8	MH
187.52 11.58	Very Dense Grey Coarse GRAVEL with some sand occ. boulders.	⑧	8	"	108	MH
186.00 13.10	Hard Grey clayey silt to SILTY CLAY. Trace sand occasional fine gravel. (TILL)	⑥	9	"	177	MH
			10	"	121	
			11	"	119	
181.90 17.20	END OF BOREHOLE					



PRELIMINARY



RECORD OF BOREHOLE 105

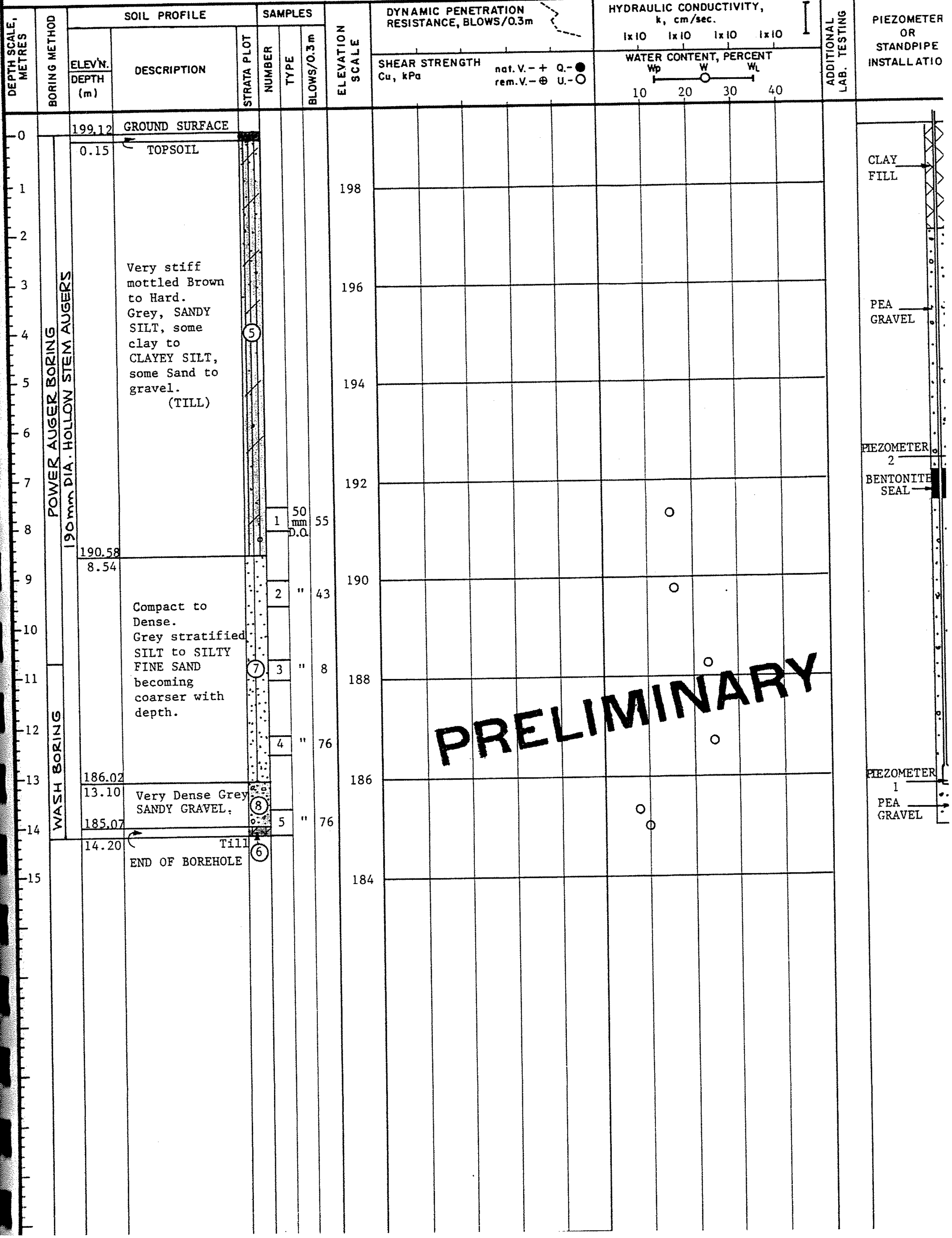
LOCATION See Figure 2

BORING DATE August 19 & 20, 1985

DATUM GEODETIC

SAMPLER HAMMER, 63.6 kg.; DROP, 760 mm

PENETRATION TEST HAMMER, 63.6 kg; DROP, 760 mm



ELEV'N. DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS/0.3 m
199.12	GROUND SURFACE			
0.15	TOPSOIL			
	Very stiff mottled Brown to Hard. Grey, SANDY SILT, some clay to CLAYEY SILT, some Sand to gravel. (TILL)	1	50 mm D.O.	55
190.58 8.54	Compact to Dense. Grey stratified SILT to SILTY FINE SAND becoming coarser with depth.	2	"	43
		3	"	8
		4	"	76
186.02 13.10	Very Dense Grey SANDY GRAVEL.	5	"	76
185.07	Till			
14.20	END OF BOREHOLE			

RECORD OF BOREHOLE 106

LOCATION See Figure 2

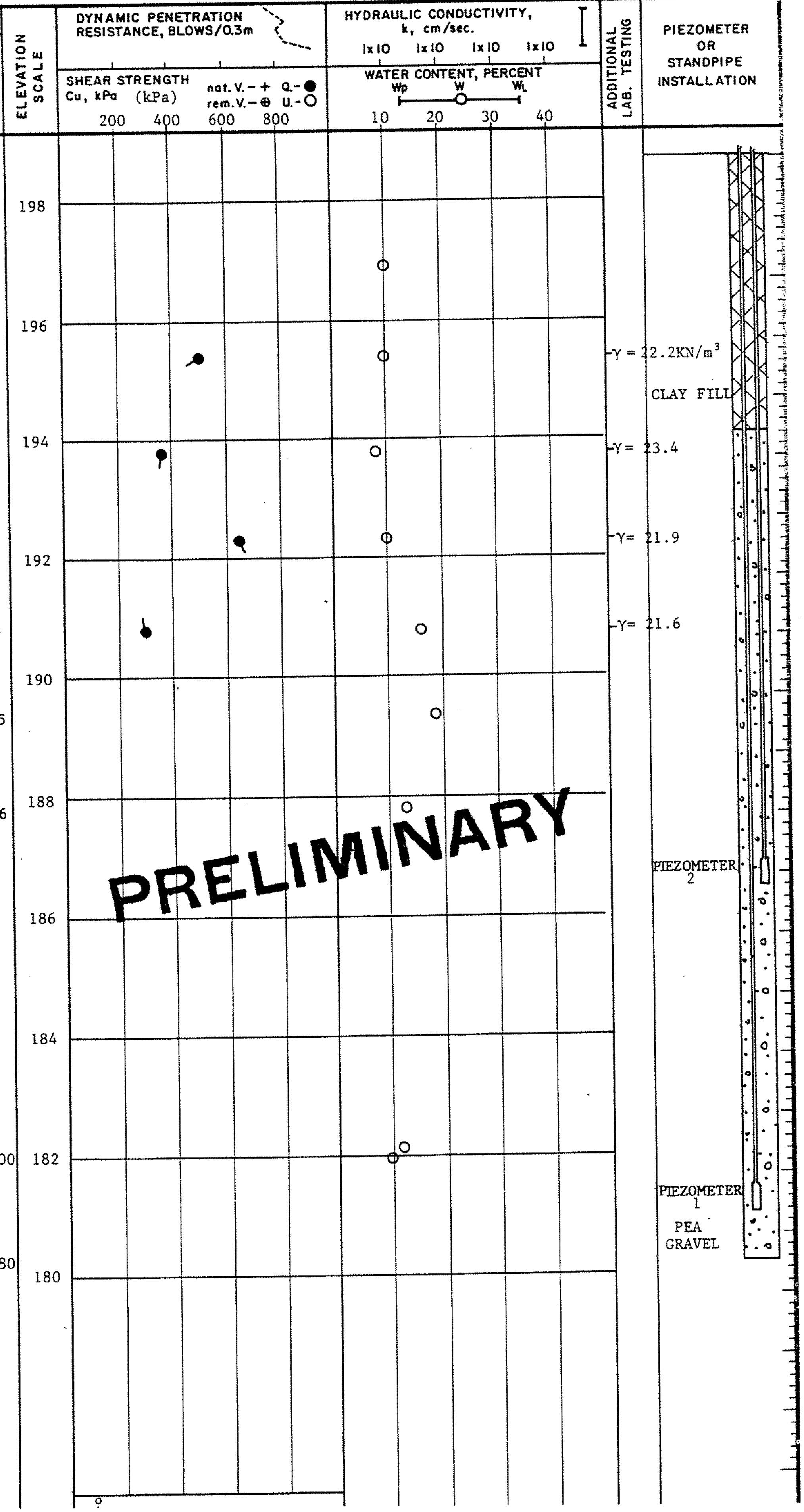
BORING DATE August 21, 1985

DATUM GEODETIC

SAMPLER HAMMER, 63.6 kg.; DROP, 760 mm

PENETRATION TEST HAMMER, 63.6 kg; DROP, 760mm

BORING METHOD	SOIL PROFILE ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m
	198.67	GROUND SURFACE				
POWER AUGER BORING 190mm DIA. HOLLOW STEM AUGERS	0.15	TOPSOIL				
		Stiff to Hard		1	50 mm D.O.	34
	196.23 2.44	Brown mottled to Grey (below elev. 196.23 m) SANDY SILT some clay to CLAYEY SILT some sand. Trace to some gravel. (TILL)	⑤	2	73 mm TO	-
				3	"	-
				4	"	-
WASH BORING	190.47			5	75 mm TO	-
	8.20	Compact, Grey stratified SILTY SAND.	⑦	6	50 mm D.O.	15
	187.39			7	"	26
	11.28	Dense Grey SANDY GRAVEL trace silt.	⑧			
	181.90			8	"	100
	16.77	Hard Grey CLAYEY SILT TO SILTY CLAY. Trace sand gravel. (TILL)	⑥			
	180.27			9	100/ 100 mm	180
	18.40	END OF BOREHOLE				



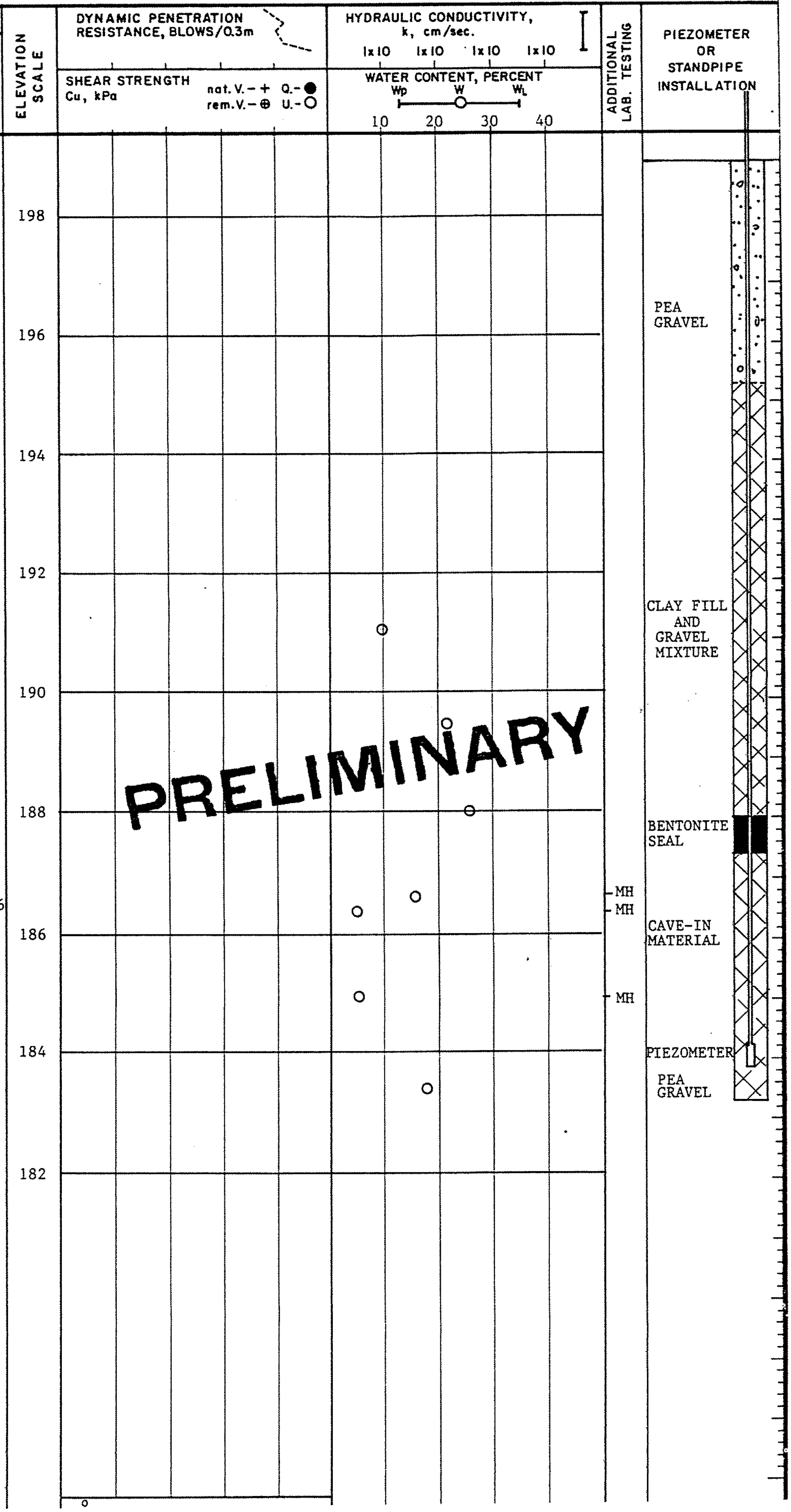
PRELIMINARY

RECORD OF BOREHOLE 107

LOCATION See Figure 2 BORING DATE August 21, 1985 DATUM GEODETIC

SAMPLER HAMMER, 63.6 kg.; DROP, 760 mm PENETRATION TEST HAMMER, 63.6 kg; DROP, 760 mm

BORING METHOD	ELEV'N. DEPTH (m)	SOIL PROFILE DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3 m
POWER AUGER BORING 190mm DIA. HOLLOW STEM AUGERS	198.88	GROUND SURFACE				
	0.15	TOPSOIL				
		Stiff to Hard mottled Brown to Grey. CLAYEY SILT Trace sand & gravel. (TILL)	⑤	1	50 mm D.O.	52
WASH BORING	191.04 8.84	Loose/compact stratified SILTY SAND with numerous silty clay interlayers.	⑦	2	"	2
				3	"	6
				4	"	116
	186.38 12.5	Very Dense Grey, SANDY GRAVEL trace Silt.	⑧	5	"	98
	183.94 14.94	Hard Grey SILTY CLAY. (TILL)	⑥	6	"	53
	183.18 15.7	END OF BOREHOLE				



RECORD OF BOREHOLE 108

LOCATION See Figure 2

BORING DATE August 20, 1985

DATUM GEODETIC

SAMPLER HAMMER, 63.6 kg.; DROP, 760 mm

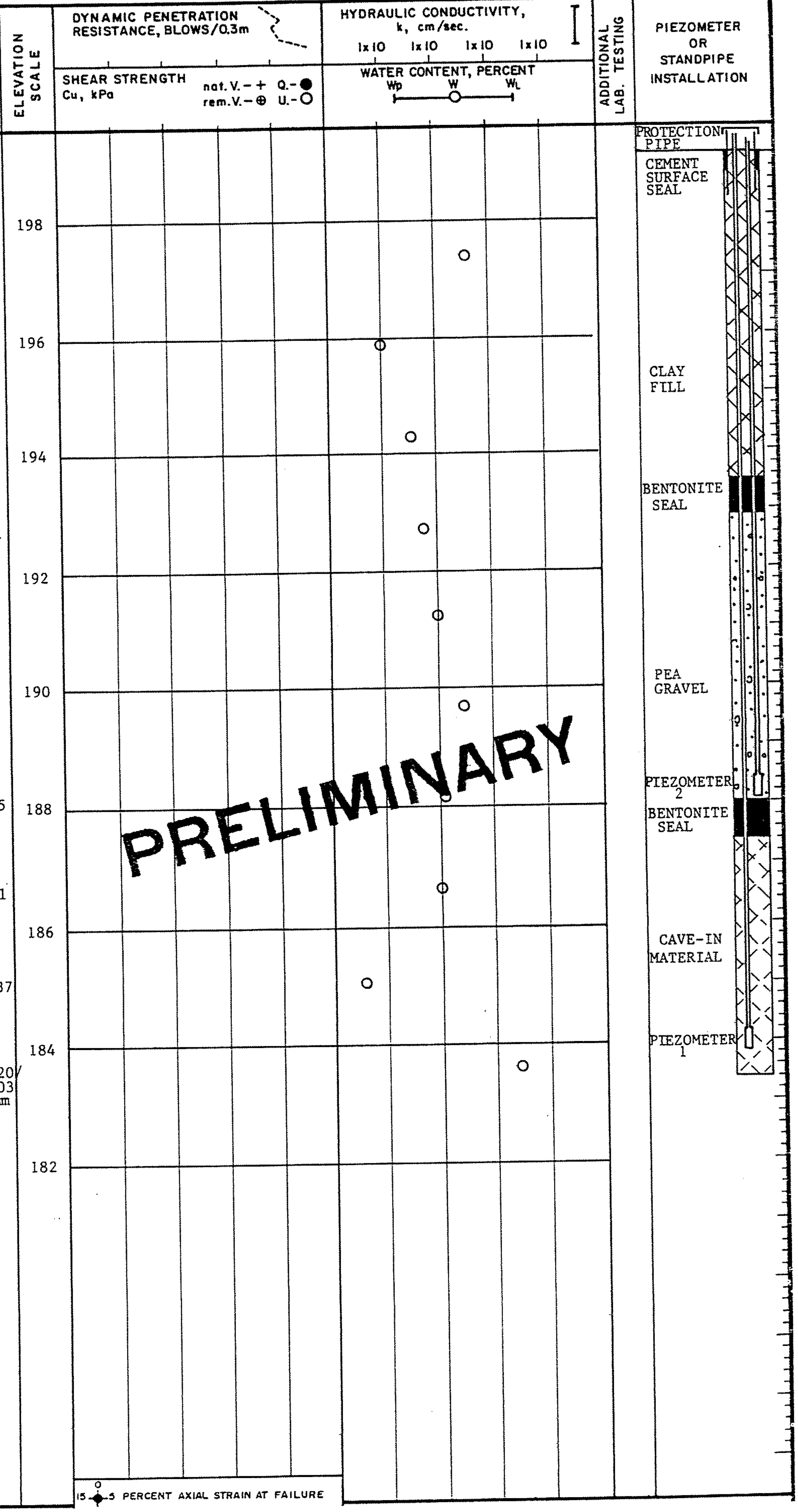
PENETRATION TEST HAMMER, 63.6 kg; DROP, 760 mm

BORING METHOD: POWER AUGER BORING; 190 mm DIA. HOLLOW STEM AUGERS; WASH BORING

DEPTH SCALE, METRES: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

ELEV'N. DEPTH (m)	DESCRIPTION	STRATA PLOT
199.06	GROUND SURFACE	
0.15	TOPSOIL	
196.62 2.44	Stiff Brown mottled fissured To Grey (below elev. 196.62 m) SANDY SILT, some clay to CLAYEY SILT. Some sand trace gravel (TILL)	⑤
192.66 6.40	Compact to Dense Grey	
189.61 9.45	Stratified SILTY SAND with some thin silty clay interlayers at about elev. 189.61 m.	⑦
185.96 13.1	Very Dense Grey SANDY GRAVEL, some boulders.	⑧
184.16 14.9	Hard Grey CLAYEY SILT TO SILTY CLAY. Trace sand & gravel. (TILL)	⑥
183.46 15.6	END OF BOREHOLE	

NUMBER	TYPE	BLOWS/0.3 m
1	50 mm D.O.	16
2	"	14
3	"	14
4	"	24
5	"	7
6	"	5
7	"	15
8	"	31
9	"	137
10	"	120/203 mm



RECORD OF BOREHOLE 109

LOCATION See Figure 2

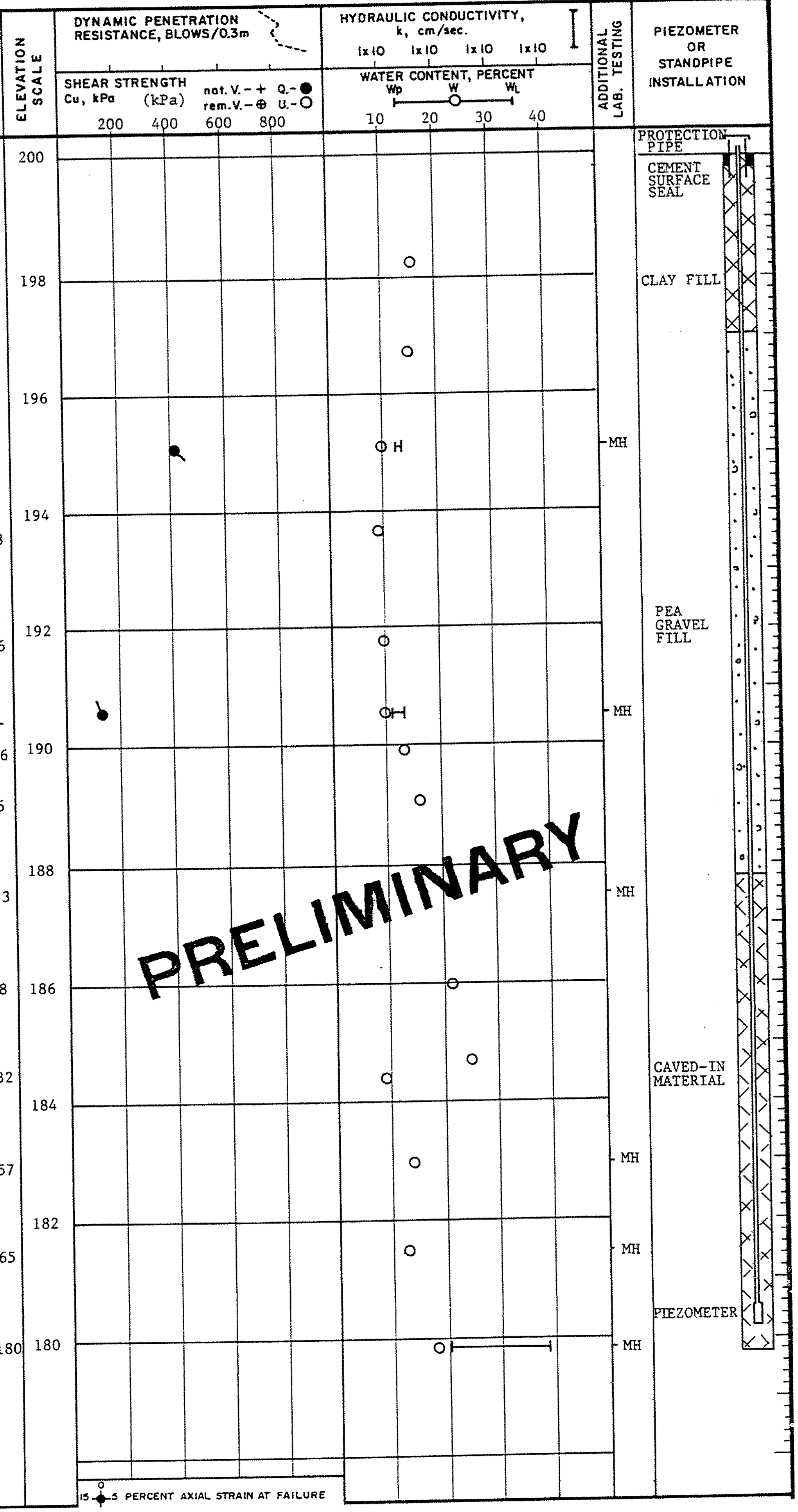
BORING DATE August 23 & 26, 1985

DATUM GEODETIC

SAMPLER HAMMER, 63.6 kg.; DROP, 760 mm

PENETRATION TEST HAMMER, 63.6 kg; DROP, 760 mm

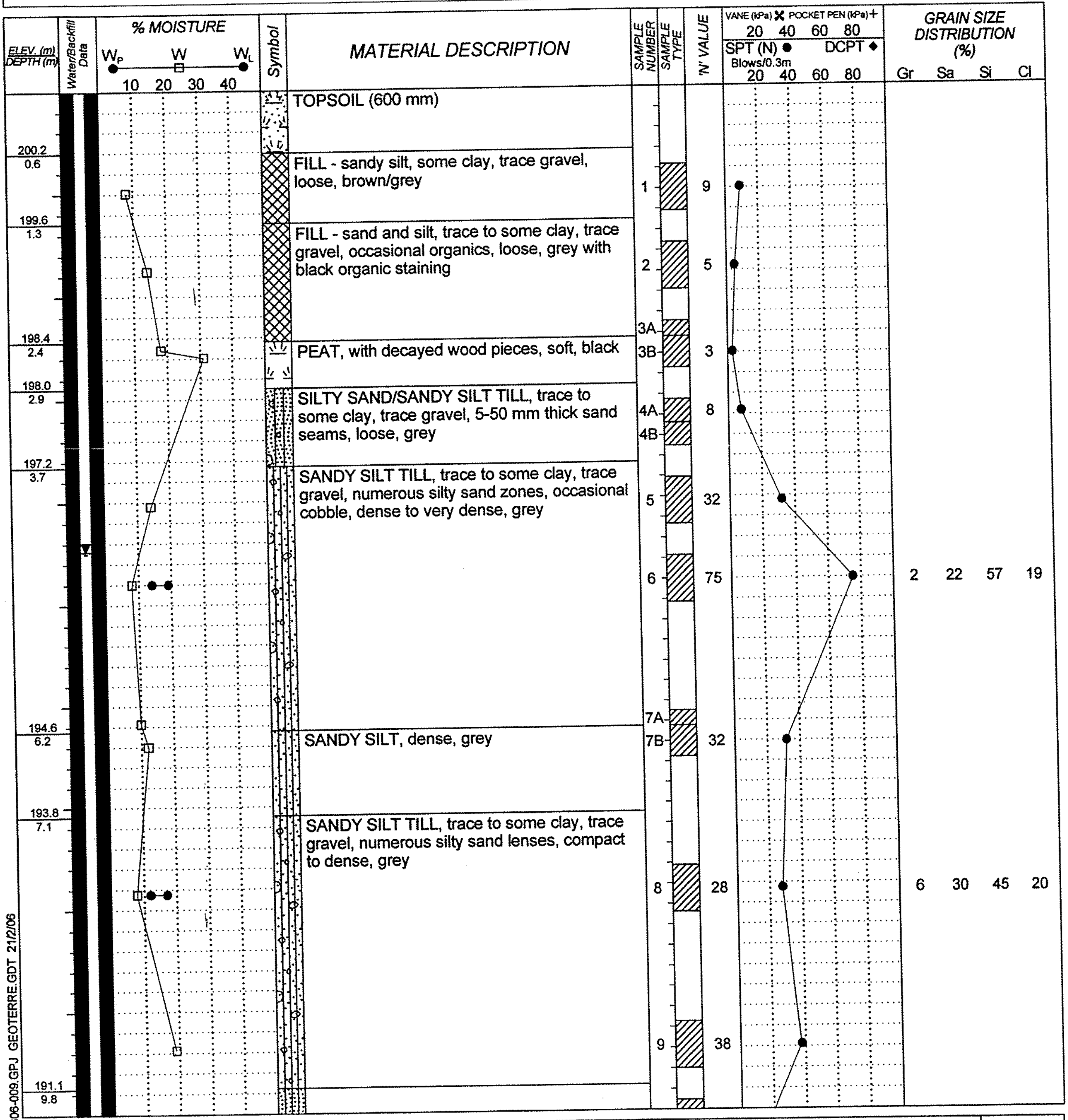
BORING METHOD	ELEV'N. DEPTH (m)	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS/0.3 m
	199.95	GROUND SURFACE				
POWER AUGER BORING 190mm DIA. HOLLOW STEM AUGERS	0.15	TOPSOIL				
		Very stiff mottled Brown Fissured.		1	50 mm D.O.	20
	197.51 2.44	To Grey (below Elev. 197.51 m)		2	76 mm TO	–
		SANDY SILT Trace to some clay. Trace gravel and occasional boulders. (TILL)	⑤	3	"	–
				4	50 mm D.O.	38
				5	76 mm TO	–
				6	50 mm D.O.	56
				7	76 mm TO	–
				8	50 mm D.O.	16
WASH BORING	189.59 10.36	Compact Grey stratified SILT TO SILTY FINE SAND.	⑦	9	"	6
				10	"	13
				11	"	8
				12	"	32
	184.40 15.55	Very dense Grey SANDY GRAVEL.	⑧	13	"	57
				14	"	65
	180.75 19.20	Hard Grey SILTY CLAY. Trace sand, gravel. (TILL)	⑥	15	"	180
	179.65 20.30	END OF BOREHOLE				



LOG OF BOREHOLE BH06-2

PROJECT No.: **TG06-009**
CLIENT: **York Region**
PROJECT: **Highway 7 / Jane Street**
LOCATION: **Vaughan, Ontario**
SURFACE ELEV.: **200.85 metres**

Drilling Data
METHOD: **Wash Boring**
DIAMETER: **75 mm**
PREP. BY: **TW** APPR. BY: **IC**
DATE: **February 15 2006**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	'N' VALUE	GRAIN SIZE DISTRIBUTION (%) Gr	Sa	Si	Cl
	TOPSOIL (600 mm)						
200.2 0.6	FILL - sandy silt, some clay, trace gravel, loose, brown/grey	1	9				
199.6 1.3	FILL - sand and silt, trace to some clay, trace gravel, occasional organics, loose, grey with black organic staining	2 3A	5				
198.4 2.4	PEAT, with decayed wood pieces, soft, black	3B	3				
198.0 2.9	SILTY SAND/SANDY SILT TILL, trace to some clay, trace gravel, 5-50 mm thick sand seams, loose, grey	4A 4B	8				
197.2 3.7	SANDY SILT TILL, trace to some clay, trace gravel, numerous silty sand zones, occasional cobble, dense to very dense, grey	5	32				
		6	75	2	22	57	19
		7A					
194.6 6.2	SANDY SILT, dense, grey	7B	32				
193.8 7.1	SANDY SILT TILL, trace to some clay, trace gravel, numerous silty sand lenses, compact to dense, grey	8	28	6	30	45	20
		9	38				
191.1 9.8							

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SAMPLE TYPE AND BACKFILL LEGEND

- ▤ Auger Sample
- ▨ Split Spoon Sample
- ☐ 70mm Thin Wall Tube
- ☒ Rock Core
- ▧ Side Sampler
- ☐ 75mm Split Spoon
- ▥ Pionjar Sample
- ▩ Bulk Sample
- ☒ Grout
- ■ Bentonitic Plug
- ⁘ Filter Sand
- ▦ Cuttings

LOG OF BOREHOLE BH06-2

PROJECT No.: **TG06-009**
CLIENT: **York Region**
PROJECT: **Highway 7 / Jane Street**
LOCATION: **Vaughan, Ontario**
SURFACE ELEV.: **200.85 metres**

Drilling Data
METHOD: **Wash Boring**
DIAMETER: **75 mm**
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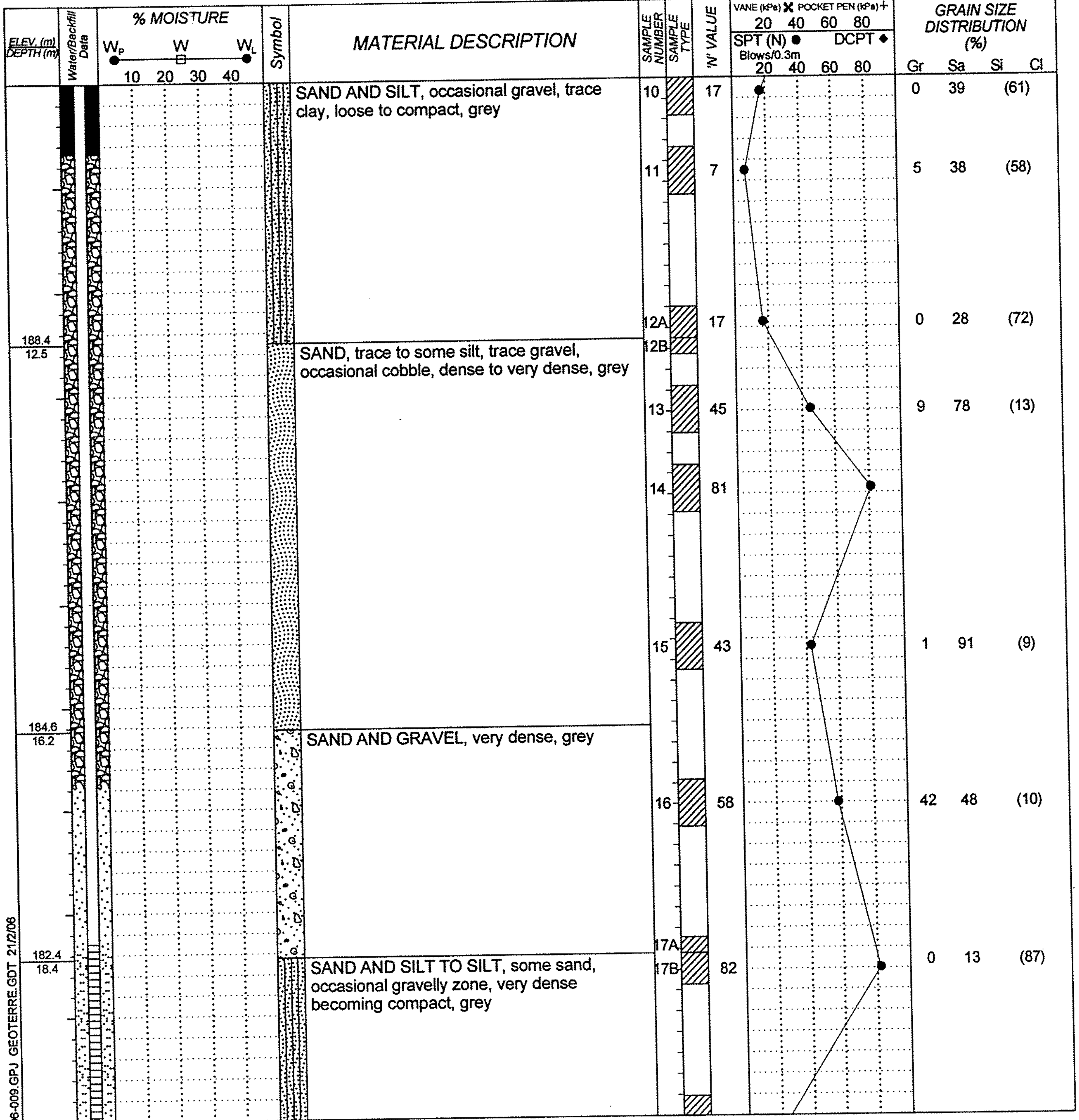

ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE	Gr	Sa	Si	Cl
	SAND AND SILT, occasional gravel, trace clay, loose to compact, grey	10	▨	17	0	39	(61)	
		11	▨	7	5	38	(58)	
		12A	▨	17	0	28	(72)	
188.4 12.5	SAND, trace to some silt, trace gravel, occasional cobble, dense to very dense, grey	12B	▨					
		13	▨	45	9	78	(13)	
		14	▨	81				
		15	▨	43	1	91	(9)	
184.6 16.2	SAND AND GRAVEL, very dense, grey	16	▨	58	42	48	(10)	
182.4 18.4	SAND AND SILT TO SILT, some sand, occasional gravelly zone, very dense becoming compact, grey	17A	▨					
		17B	▨	82	0	13	(87)	

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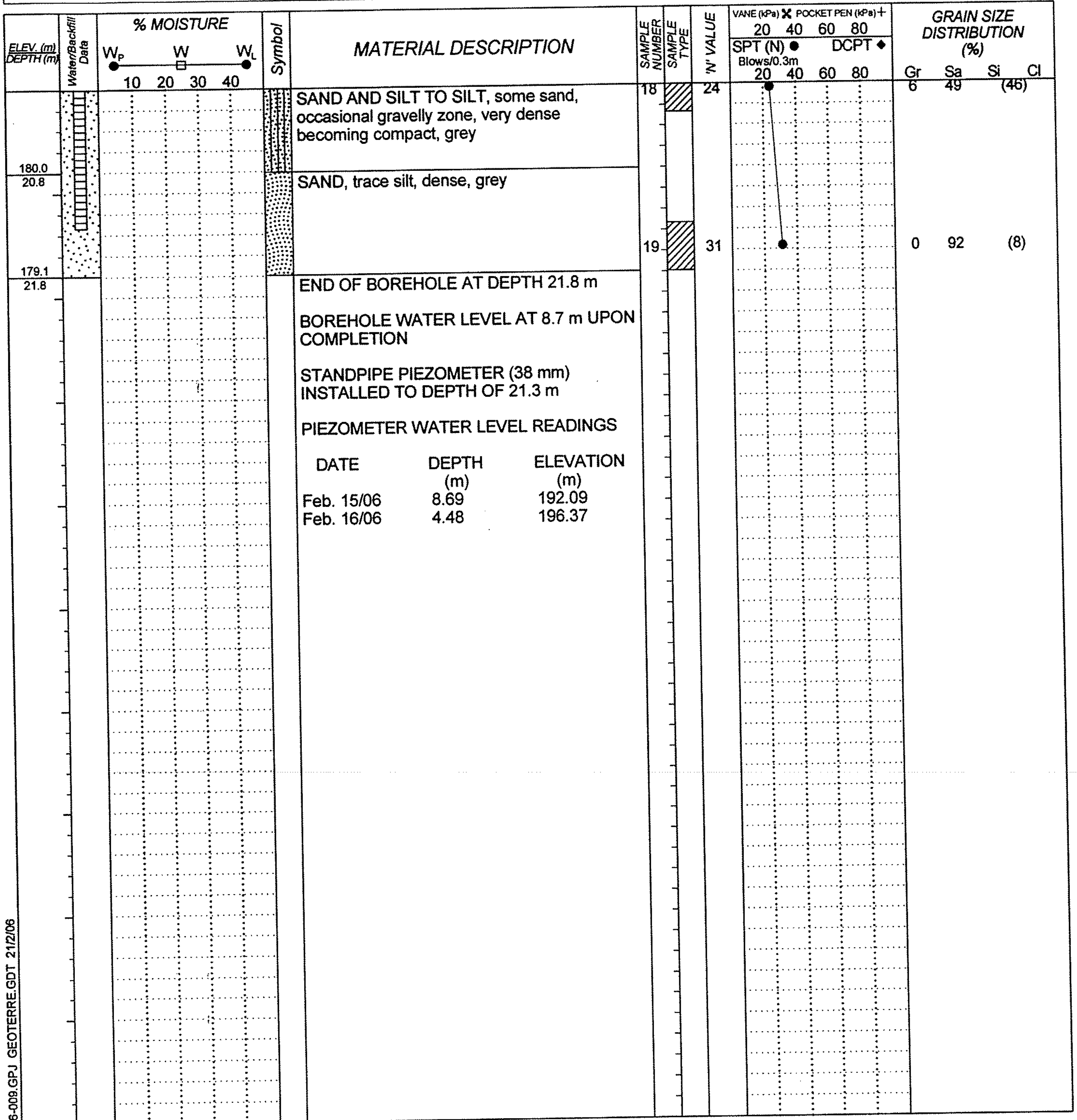
SAMPLE TYPE AND BACKFILL LEGEND

☰ Auger Sample	☒ Rock Core	▥ Pionjar Sample	■ Bentonitic Plug
▨ Split Spoon Sample	▧ Side Sampler	▦ Bulk Sample	⁘ Filter Sand
☐ 70mm Thin Wall Tube	▯ 75mm Split Spoon	☒ Grout	▩ Cuttings

LOG OF BOREHOLE BH06-2

PROJECT No.: **TG06-009**
CLIENT: **York Region**
PROJECT: **Highway 7 / Jane Street**
LOCATION: **Vaughan, Ontario**
SURFACE ELEV.: **200.85 metres**

Drilling Data
METHOD: **Wash Boring**
DIAMETER: **75 mm**
PREP. BY: **TW** APPR. BY: **IC**
DATE: **February 15 2006**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE	GRAIN SIZE DISTRIBUTION (%) Gr	Sa	Si	Cl
	SAND AND SILT TO SILT, some sand, occasional gravelly zone, very dense becoming compact, grey	18	▨	24	6	49	(46)	
180.0 20.8	SAND, trace silt, dense, grey	19	▨	31	0	92	(8)	
179.1 21.8	END OF BOREHOLE AT DEPTH 21.8 m							

BOREHOLE WATER LEVEL AT 8.7 m UPON COMPLETION

STANDPIPE PIEZOMETER (38 mm) INSTALLED TO DEPTH OF 21.3 m

PIEZOMETER WATER LEVEL READINGS

DATE	DEPTH (m)	ELEVATION (m)
Feb. 15/06	8.69	192.09
Feb. 16/06	4.48	196.37

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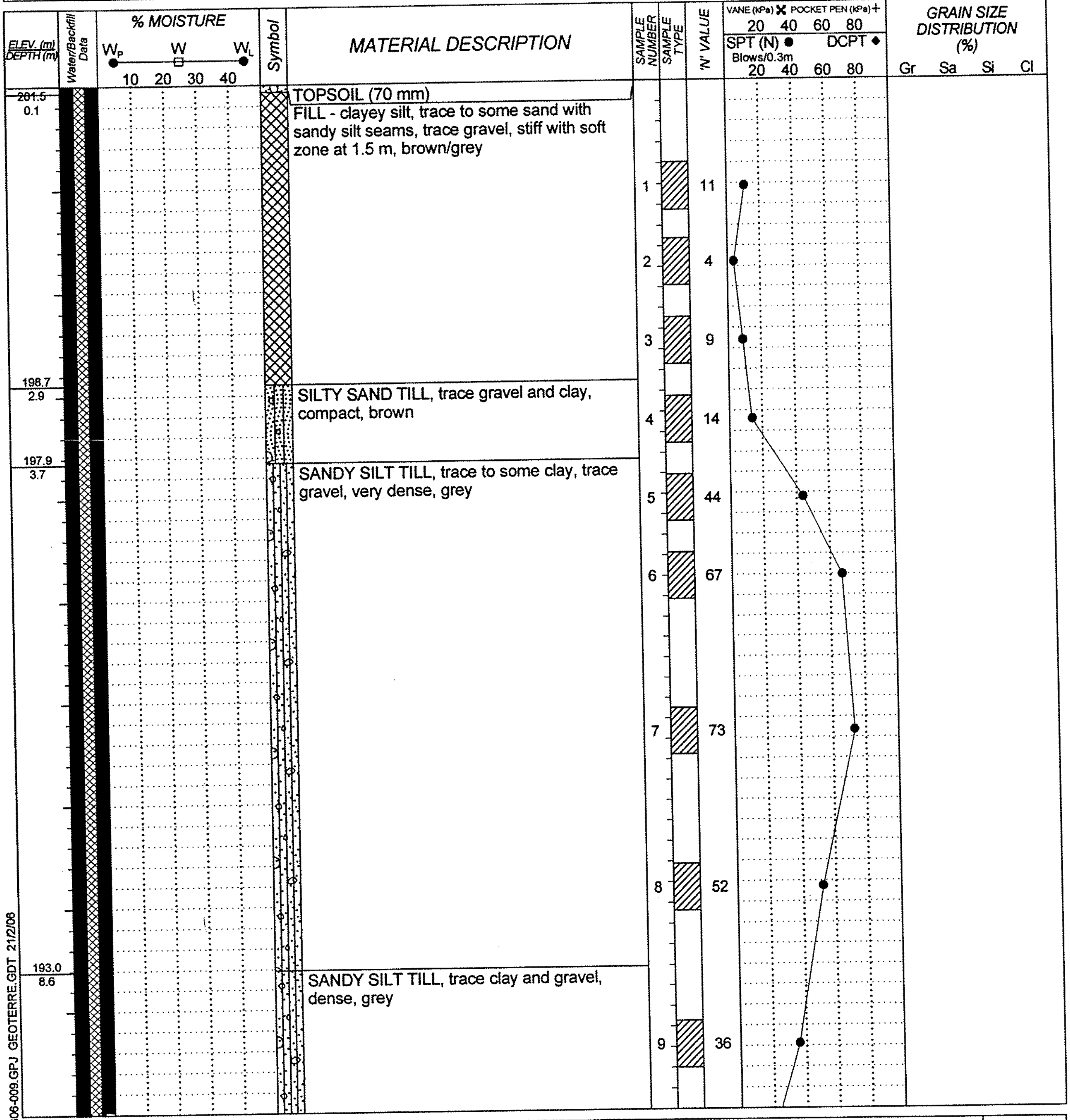
SAMPLE TYPE AND BACKFILL LEGEND

☰ Auger Sample	☒ Rock Core	▥ Pionjar Sample	■ Bentonitic Plug
▨ Split Spoon Sample	▧ Side Sampler	▩ Bulk Sample	⁘ Filter Sand
☐ 70mm Thin Wall Tube	☐ 75mm Split Spoon	☒ Grout	▦ Cuttings

LOG OF BOREHOLE BH06-5

PROJECT No.: **TG06-009**
CLIENT: **York Region**
PROJECT: **Highway 7 / Jane Street**
LOCATION: **Vaughan, Ontario**
SURFACE ELEV.: **201.58 metres**

Drilling Data
METHOD: **Hollow Stem Auger**
DIAMETER: **200 mm**
PREP. BY: **TW** APPR. BY: **IC**
DATE: **February 17 2006**



ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION
201.5 0.1	TOPSOIL (70 mm) FILL - clayey silt, trace to some sand with sandy silt seams, trace gravel, stiff with soft zone at 1.5 m, brown/grey
198.7 2.9	SILTY SAND TILL, trace gravel and clay, compact, brown
197.9 3.7	SANDY SILT TILL, trace to some clay, trace gravel, very dense, grey
193.0 8.6	SANDY SILT TILL, trace clay and gravel, dense, grey

SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE
1	▨	11
2	▨	4
3	▨	9
4	▨	14
5	▨	44
6	▨	67
7	▨	73
8	▨	52
9	▨	36

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SAMPLE TYPE AND BACKFILL LEGEND

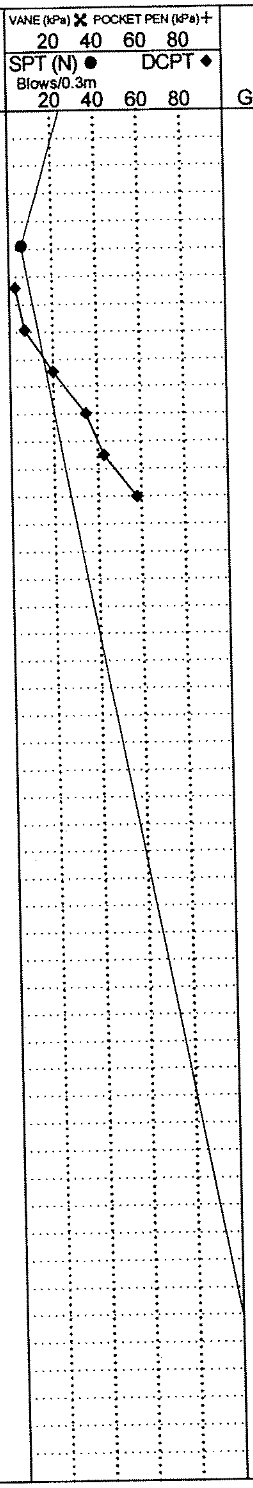
☰ Auger Sample	☒ Rock Core	▥ Pionjar Sample	■ Bentonitic Plug
▨ Split Spoon Sample	▧ Side Sampler	▩ Bulk Sample	⁙ Filter Sand
☐ 70mm Thin Wall Tube	☐ 75mm Split Spoon	☒ Grout	▦ Cuttings

LOG OF BOREHOLE BH06-5

PROJECT No.: **TG06-009**
CLIENT: **York Region**
PROJECT: **Highway 7 / Jane Street**
LOCATION: **Vaughan, Ontario**
SURFACE ELEV.: **201.58 metres**

Drilling Data
METHOD: **Hollow Stem Auger**
DIAMETER: **200 mm**
PREP. BY: **TW** APPR. BY: **IC**
DATE: **February 17 2006**

ELEV. (m) DEPTH (m)	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE
	SANDY SILT TILL, trace clay and gravel, dense, grey	10A	▨	
190.8 10.8	SILTY SAND, loose becoming dense, grey END OF SAMPLING	10B	▨	6
190.5 11.1	Dynamic Cone Penetration Test (DCPT) completed from 11.28 m to 13.11 m PRESUMED SILTY SAND, loose to compact			
189.7 11.9	PRESUMED SAND, dense to very dense			
188.8 12.8	NOT SAMPLED, presumed sand based on drilling observations			
187.9 13.7	NOT SAMPLED, presumed sand and gravel based on drilling observations			
183.0 18.6	NOT SAMPLED, presumed sand based on drilling observations			



% MOISTURE: W_P W W_L — 10 20 30 40

GRAIN SIZE DISTRIBUTION (%): Gr Sa Si Cl

LOG OF BOREHOLE TG06-009.GPJ GEOTERRE.GDT 21/2/06

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SAMPLE TYPE AND BACKFILL LEGEND

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▨ Split Spoon Sample	▧ Side Sampler	▩ Bulk Sample	⁙ Filter Sand
☐ 70mm Thin Wall Tube	☐ 75mm Split Spoon	☒ Grout	▦ Cuttings

LOG OF BOREHOLE BH06-5

PROJECT No.: **TG06-009**
CLIENT: **York Region**
PROJECT: **Highway 7 / Jane Street**
LOCATION: **Vaughan, Ontario**
SURFACE ELEV.: **201.58 metres**

Drilling Data
METHOD: **Hollow Stem Auger**
DIAMETER: **200 mm**
PREP. BY: **TW** APPR. BY: **IC**
DATE: **February 17 2006**

ELEV. (m) DEPTH (m)	Water/Backfill Data	% MOISTURE W_P W W_L 10 20 30 40	Symbol	MATERIAL DESCRIPTION	SAMPLE NUMBER	SAMPLE TYPE	'N' VALUE	VANE (kPa) ✕ POCKET PEN (kPa) + 20 40 60 80 SPT (N) ● DCPT ◆ Blows/0.3m 20 40 60 80	GRAIN SIZE DISTRIBUTION (%) Gr Sa Si Cl
	■			NOT SAMPLED, presumed sand based on drilling observations					
179.6 21.9	■			CLAYEY SILT TILL, trace sand and gravel, hard, grey	11	▨	>99	150 ●	
178.5 23.1				END OF BOREHOLE AT DEPTH 23.1 m SLOPE INDICATOR INSTALLED TO DEPTH OF 22.86 m					

LOG OF BOREHOLE TG06-009.GPJ GEOTERRE.GDT 21/2/06

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SAMPLE TYPE AND BACKFILL LEGEND

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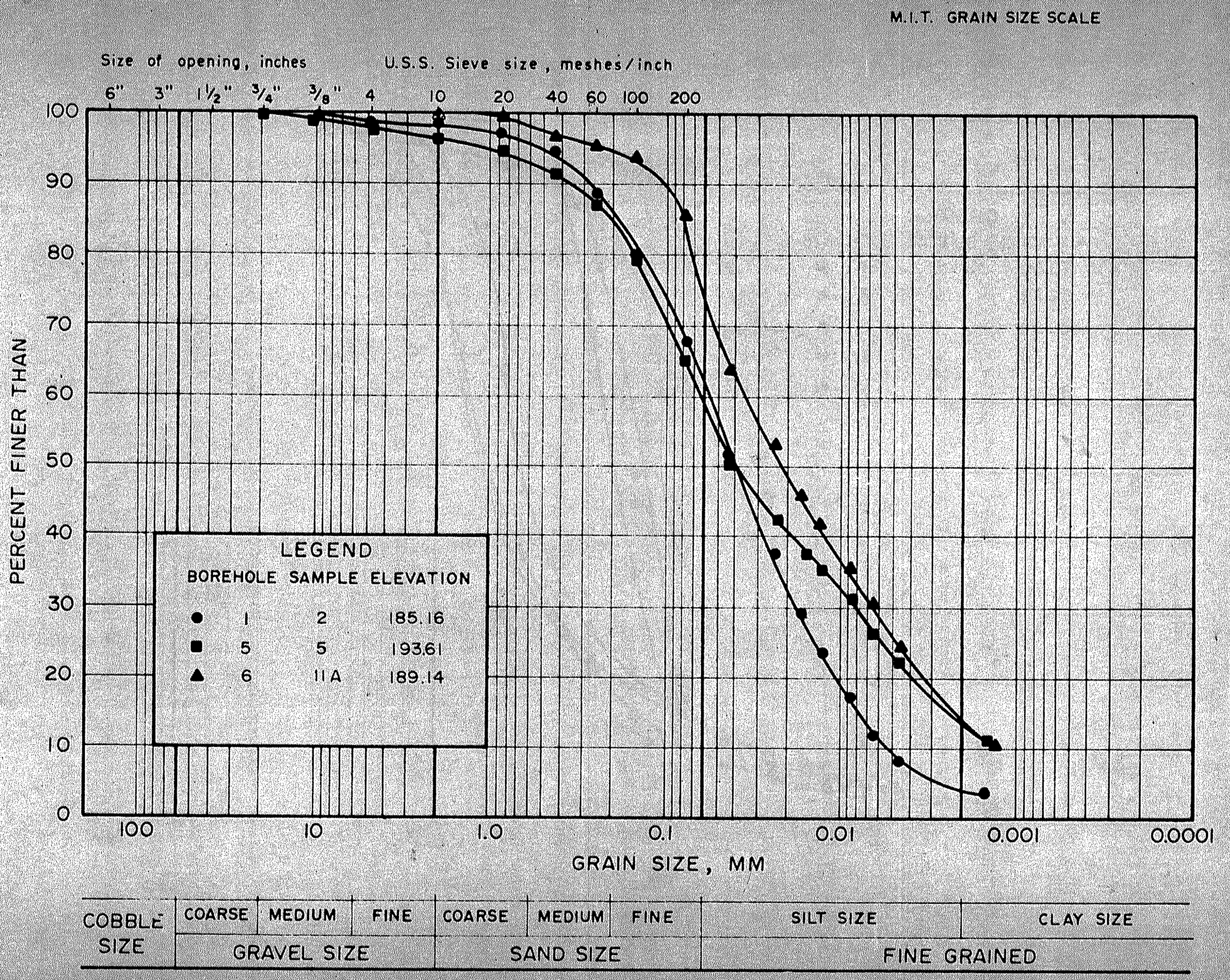
- ▨ Split Spoon Sample
- ☐ 70mm Thin Wall Tube
- ☒ Rock Core
- ▩ Side Sampler
- ☐ 75mm Split Spoon
- ▥ Pionjar Sample
- ▩ Bulk Sample
- ☒ Grout
- ■ Bentonitic Plug
- ⁚ Filter Sand
- ▦ Cuttings

GRAIN SIZE DISTRIBUTION
SANDY SILT (TILL)

FIGURE 5



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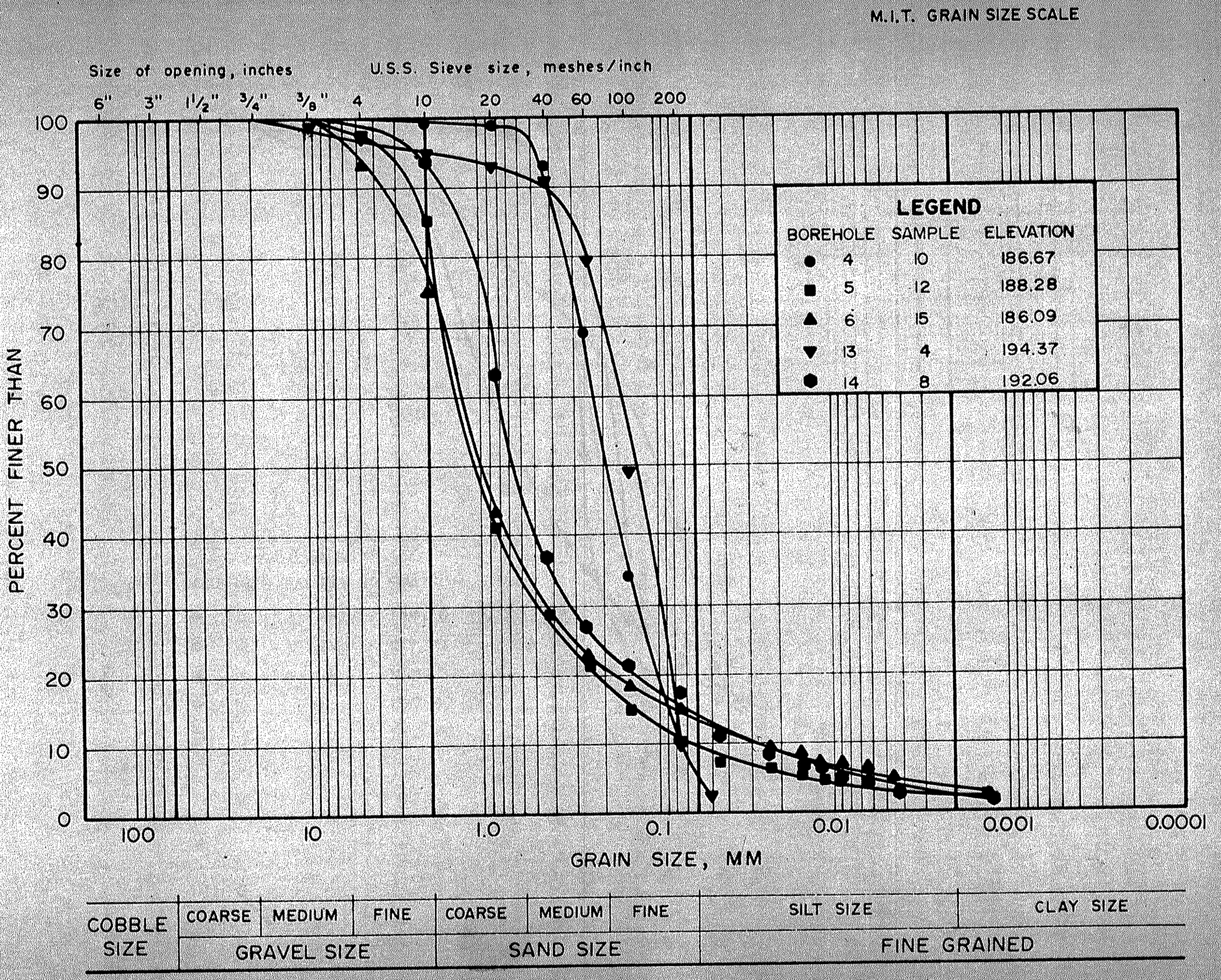
GRAIN SIZE DISTRIBUTION
SAND

FIGURE **6**



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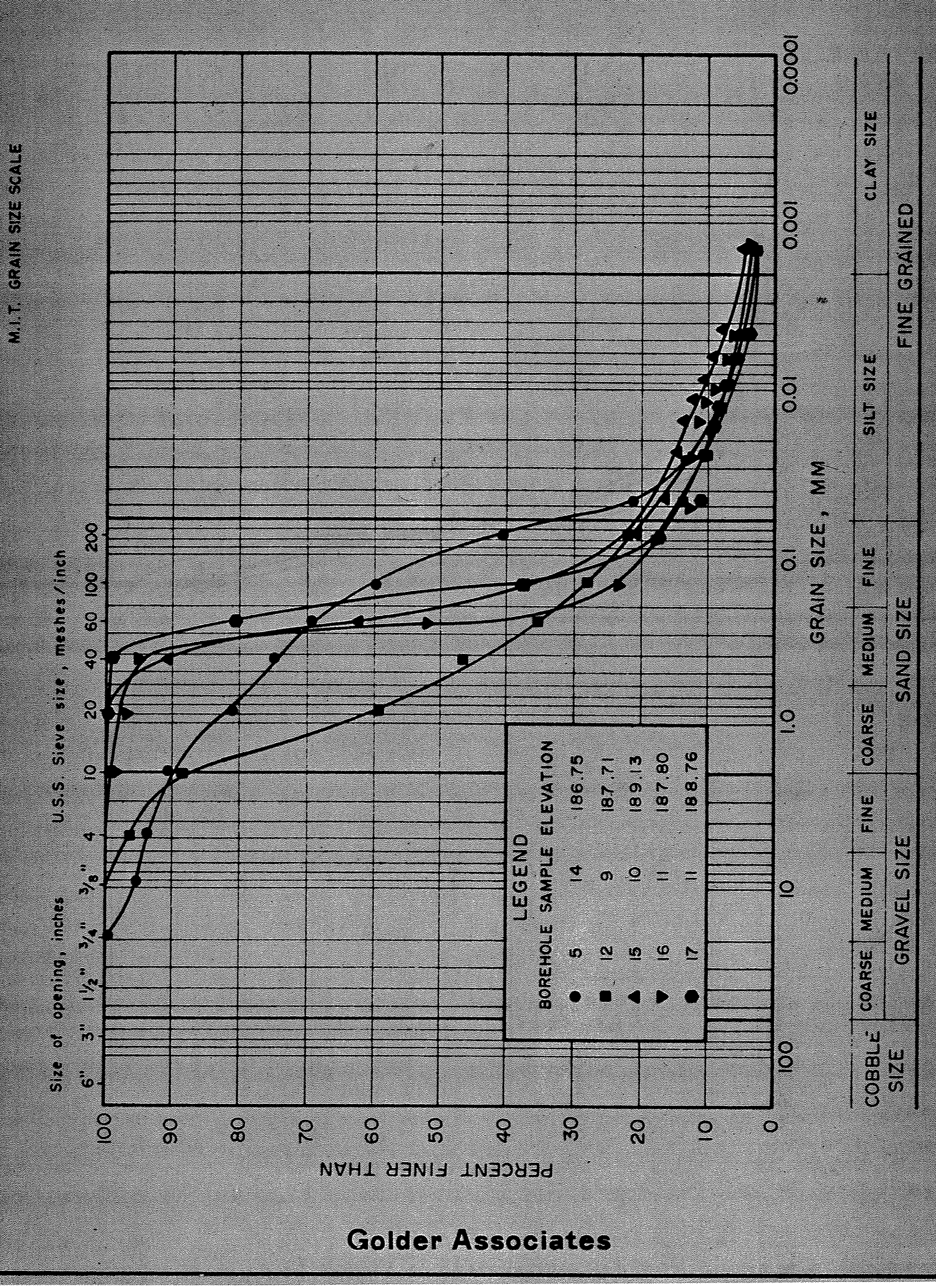
GRAIN SIZE DISTRIBUTION
SAND, SOME SILT

FIGURE 7



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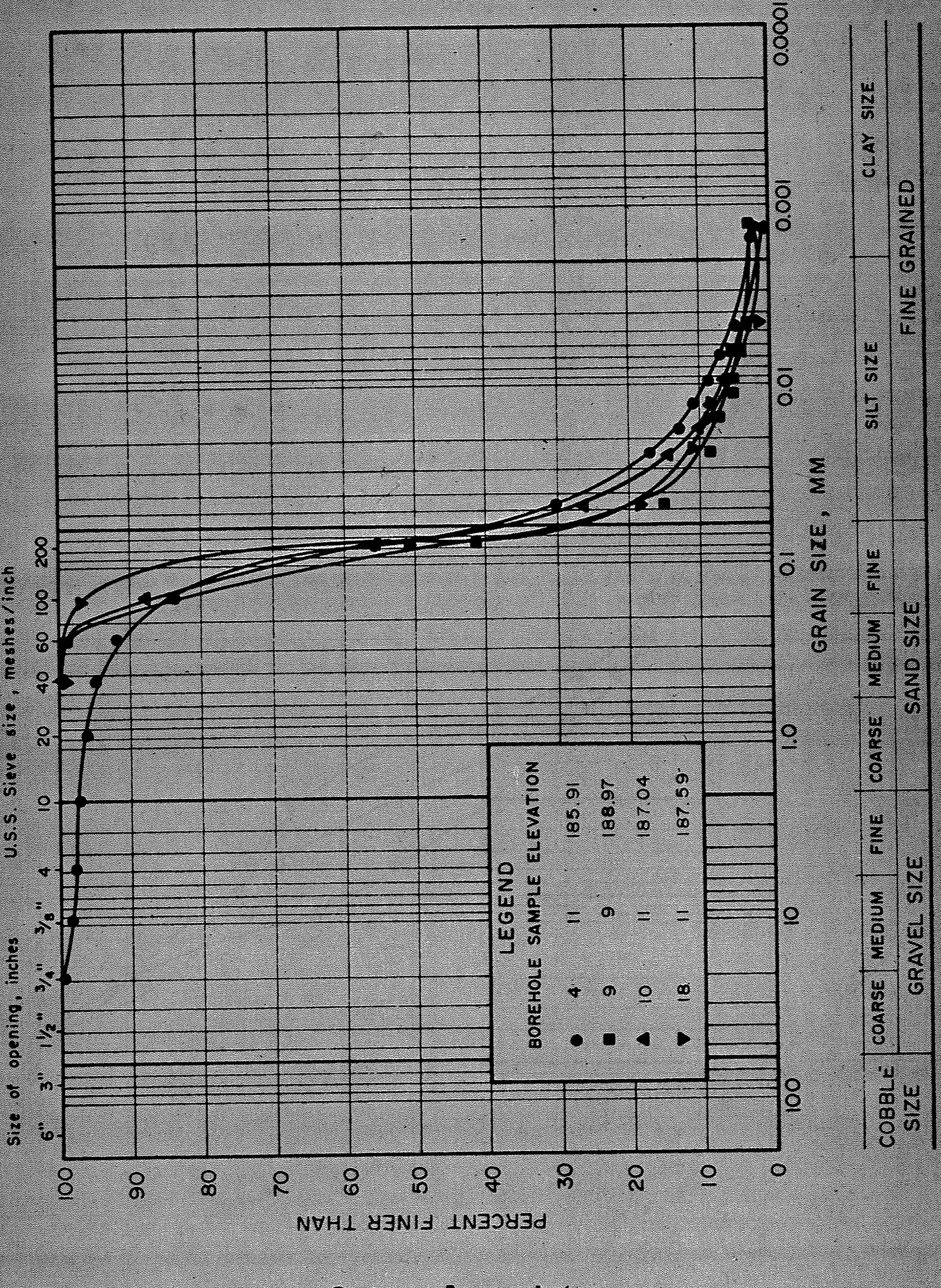
GRAIN SIZE DISTRIBUTION
SILTY SAND

FIGURE 8



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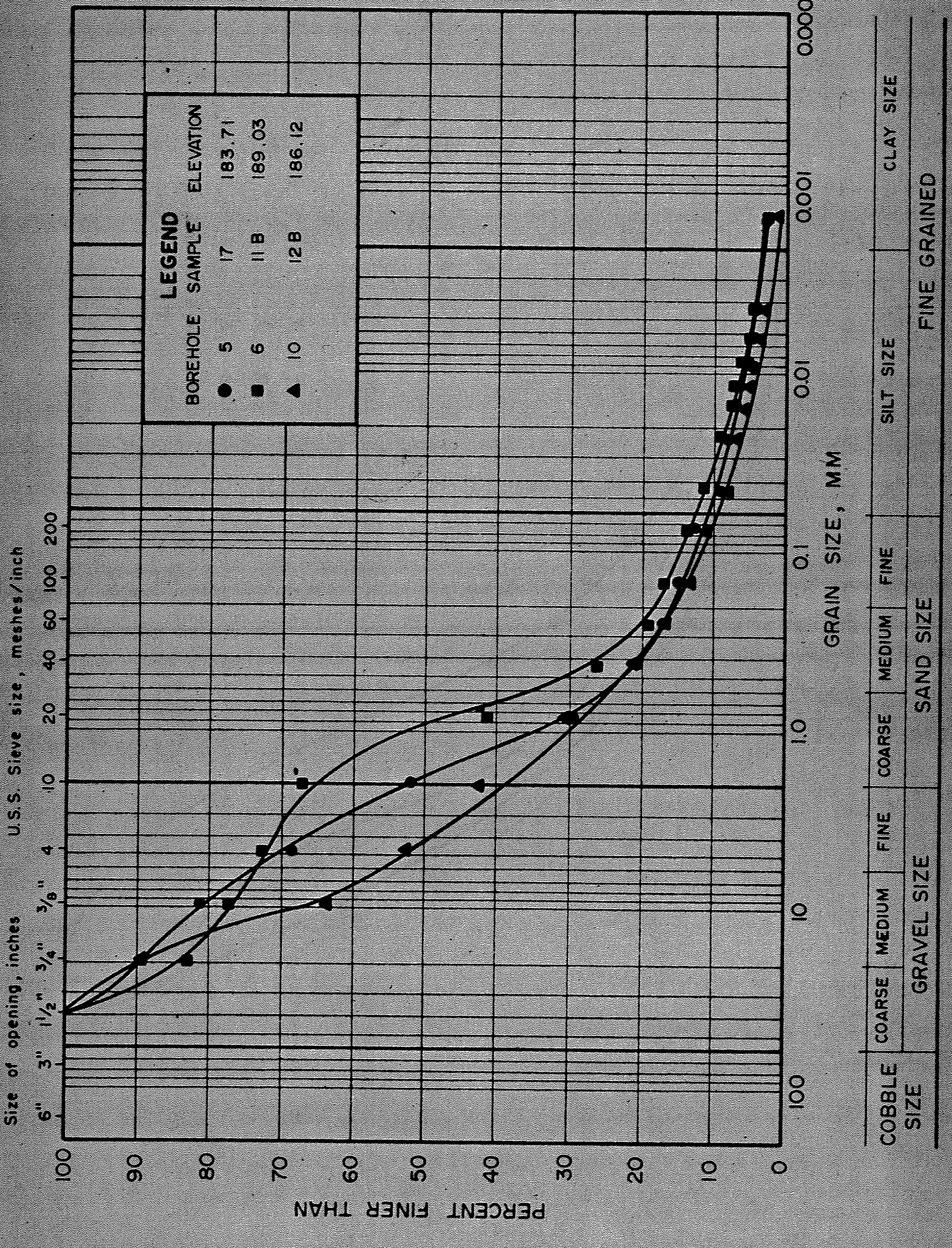
GRAIN SIZE DISTRIBUTION
SANDY GRAVEL

FIGURE 9



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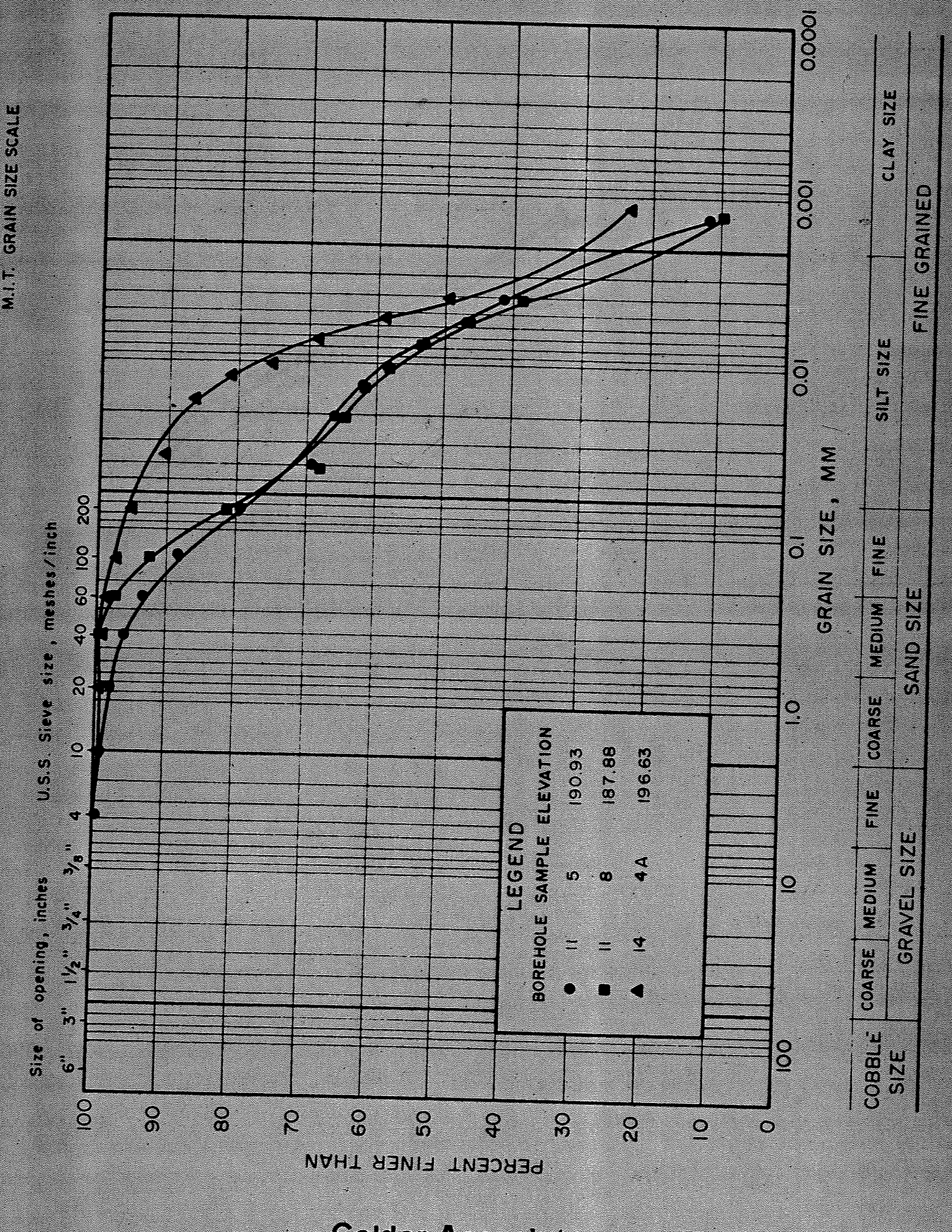
GRAIN SIZE DISTRIBUTION
CLAYEY SILT (TILL)

FIGURE 11



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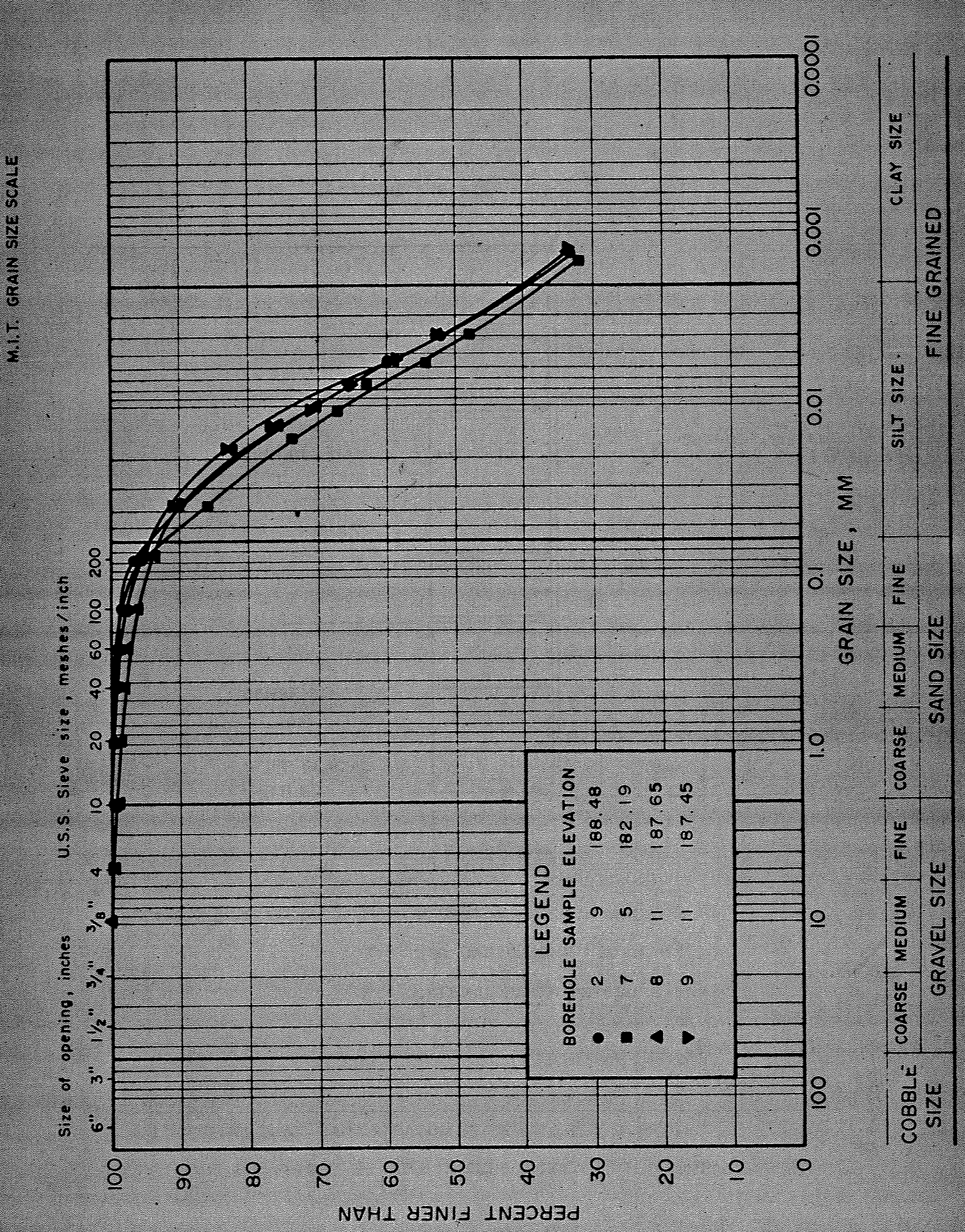
GRAIN SIZE DISTRIBUTION
CLAYEY SILT (TILL)

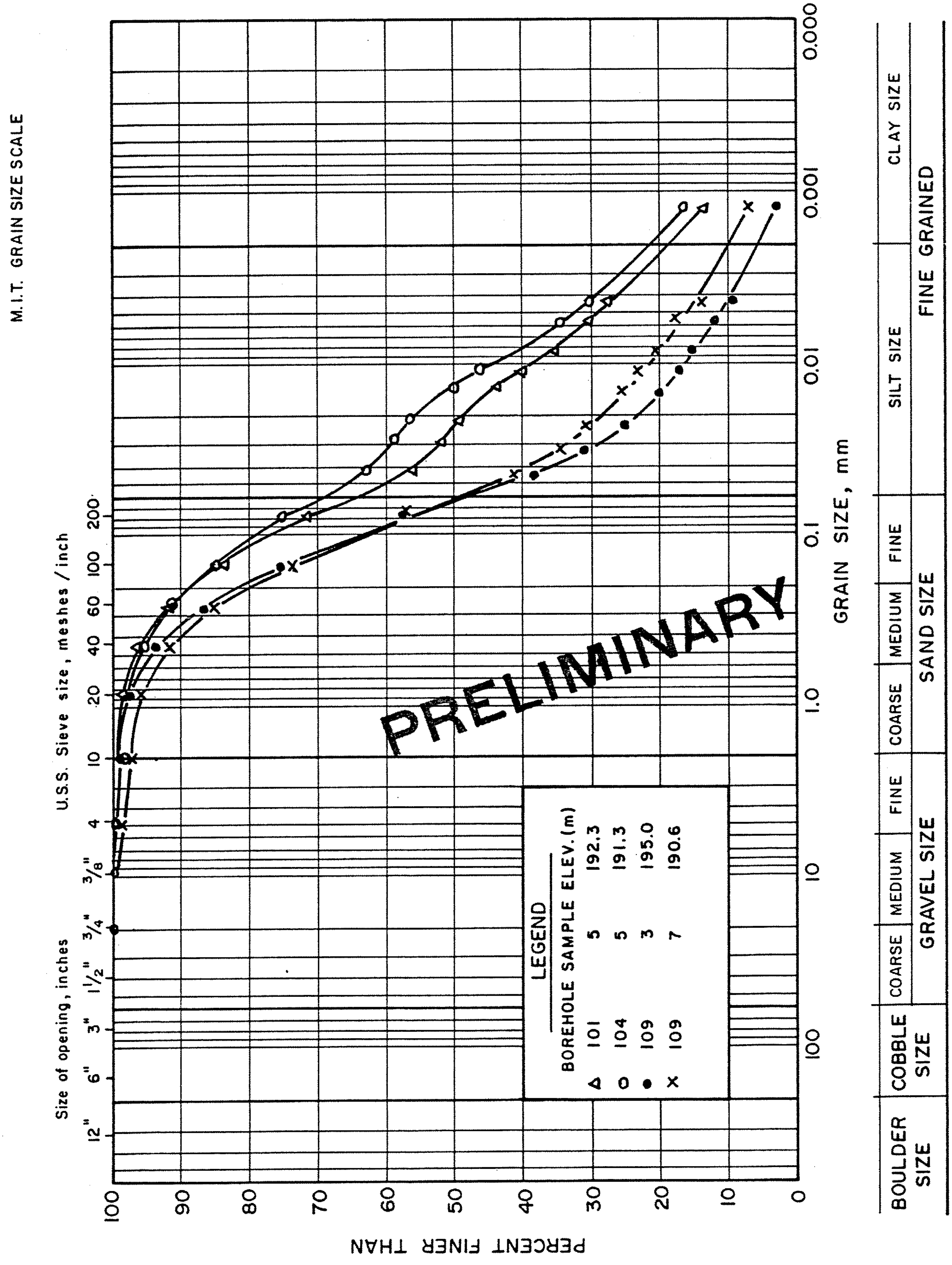
FIGURE 12



GRAIN SIZE DISTRIBUTION

SOIL TYPE ⑤ SANDY SILT OR CLAYEY SILT (TILL)

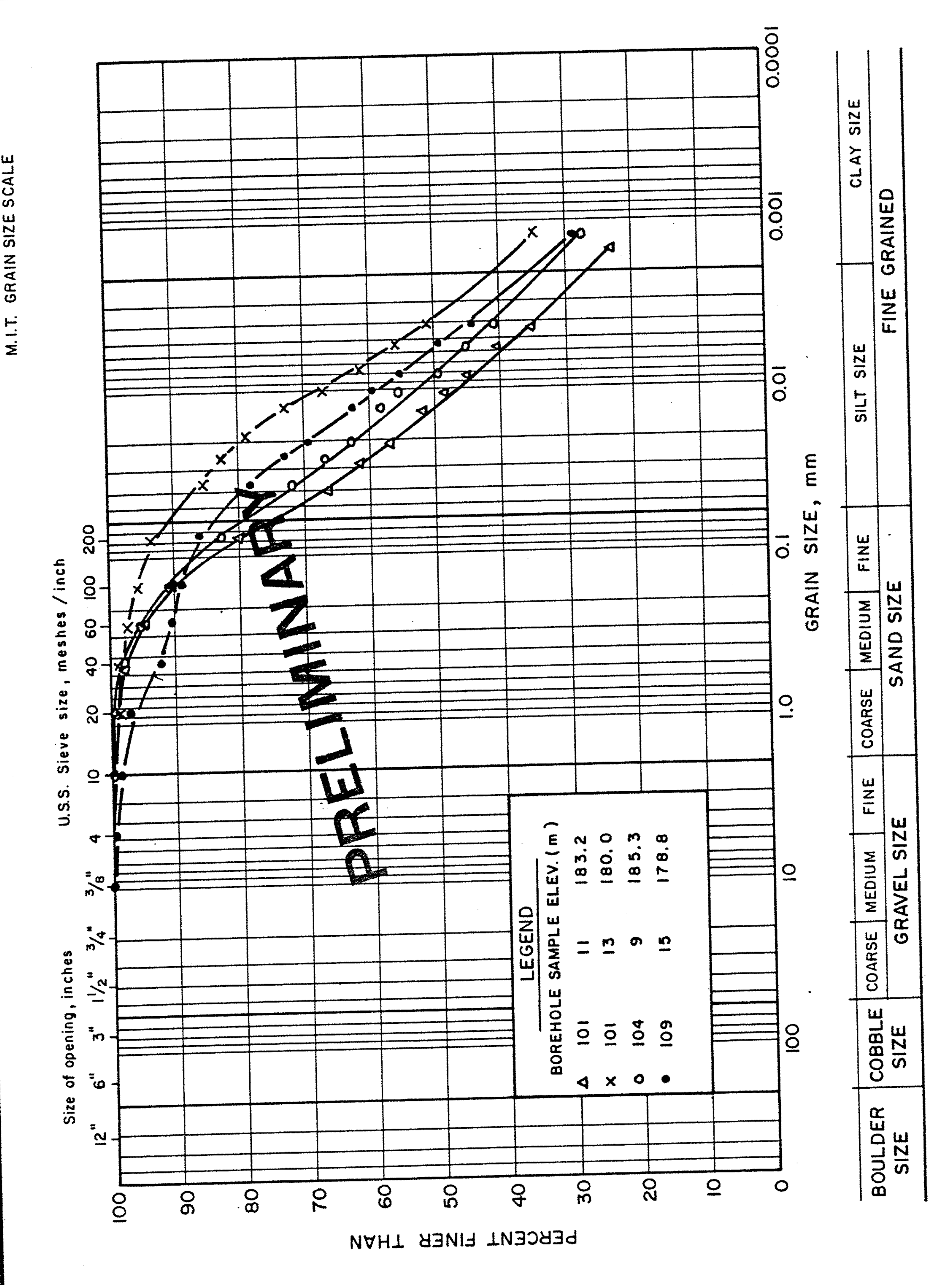
FIGURE ~~8~~ 10



	BOREHOLE	SAMPLE	ELEV. (m)
△	101	5	192.3
○	104	5	191.3
●	109	3	195.0
×	109	7	190.6

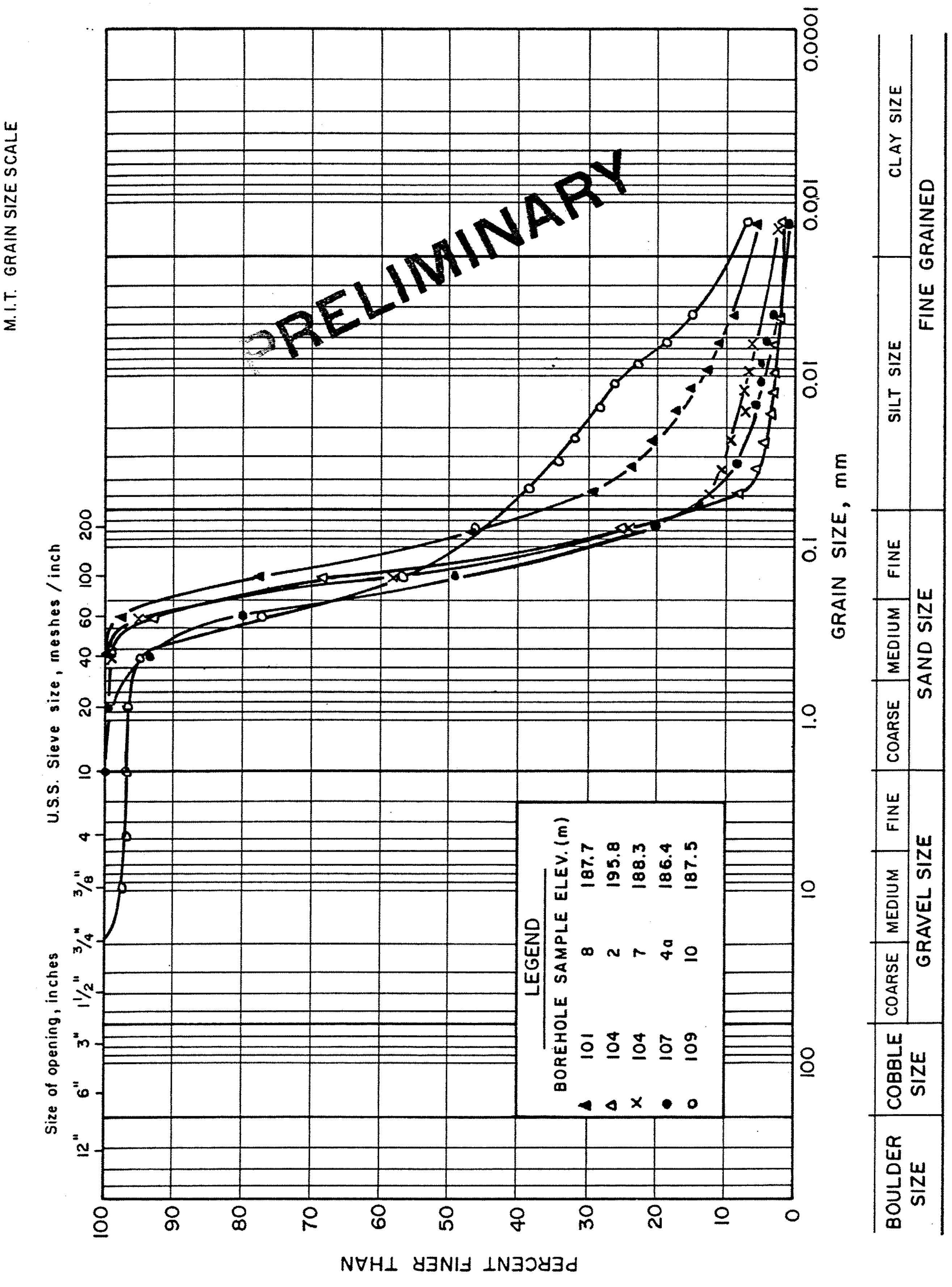
GRAIN SIZE DISTRIBUTION
SOIL TYPE ⑥ CLAYEY SILT TO SILTY CLAY (TILL)

FIGURE ~~9~~ ~~10~~ 11



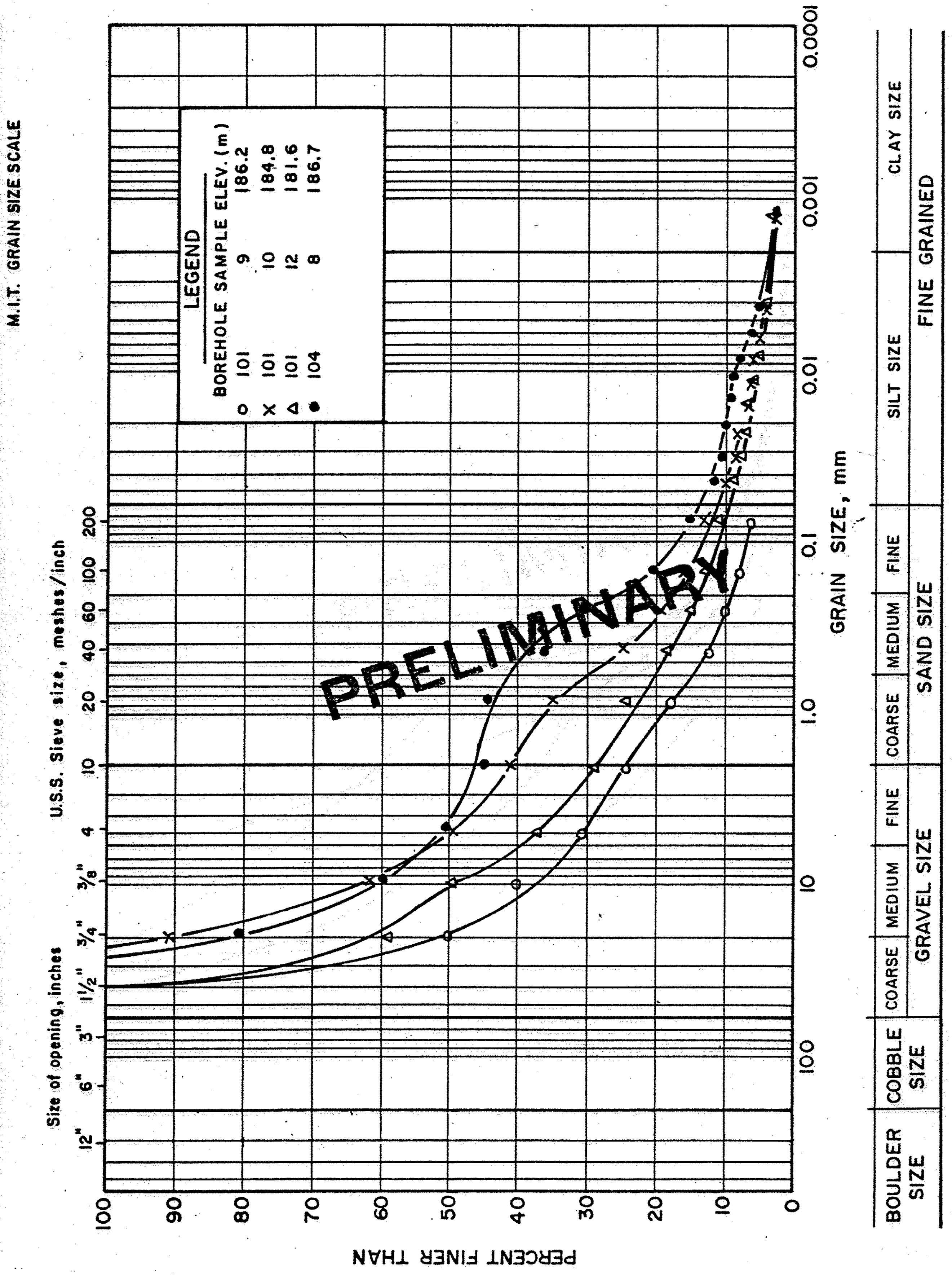
GRAIN SIZE DISTRIBUTION
SOIL TYPE ⑦ SILTY SAND

FIGURE ~~10~~ ~~11~~ 12



GRAIN SIZE DISTRIBUTION
SOIL TYPE ⑧ SANDY GRAVEL

FIGURE ~~11-8~~ 19



GRAIN SIZE DISTRIBUTION
SOIL TYPE ⑧ SANDY GRAVEL

FIGURE ~~12~~ 13 15

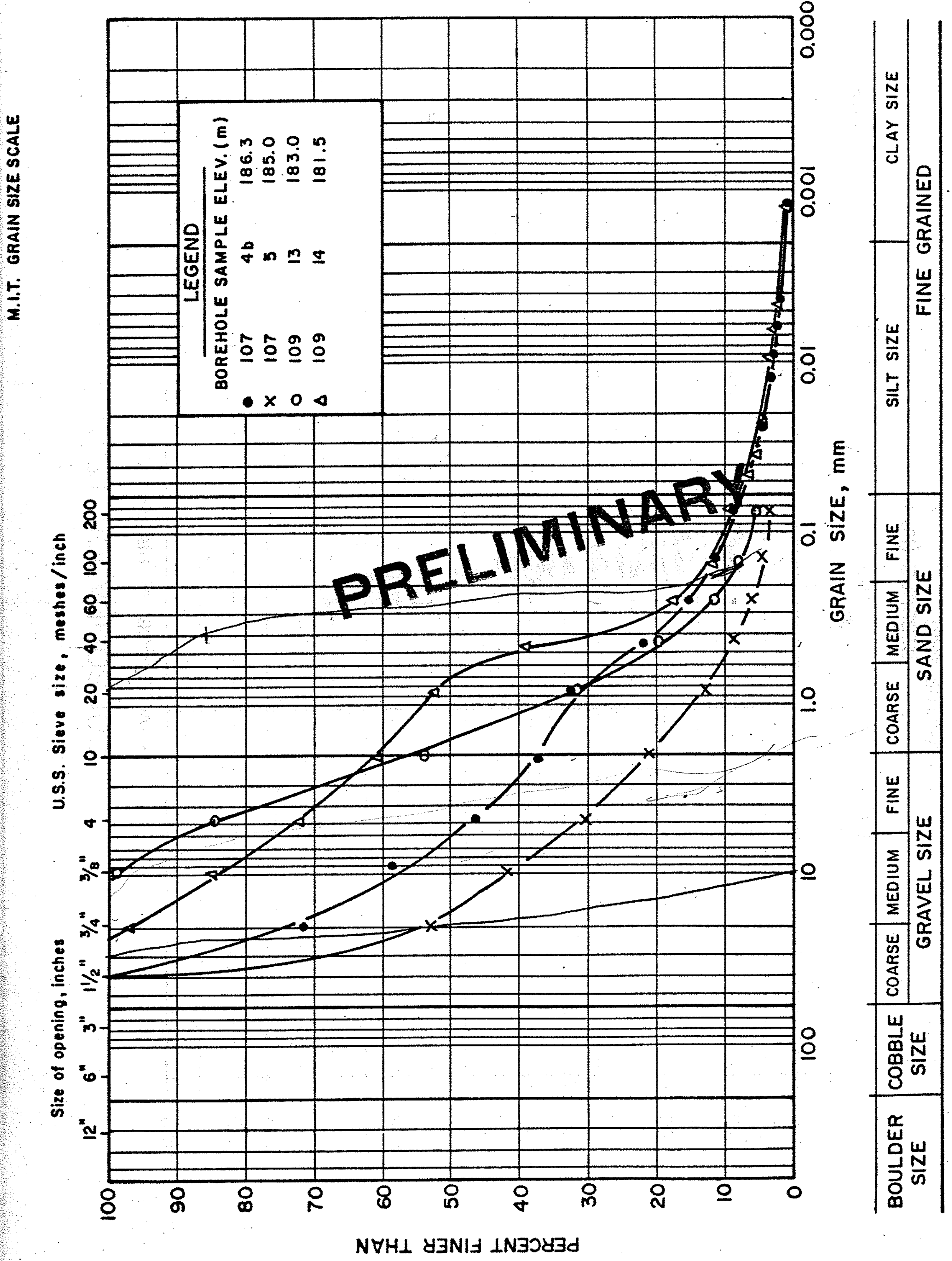
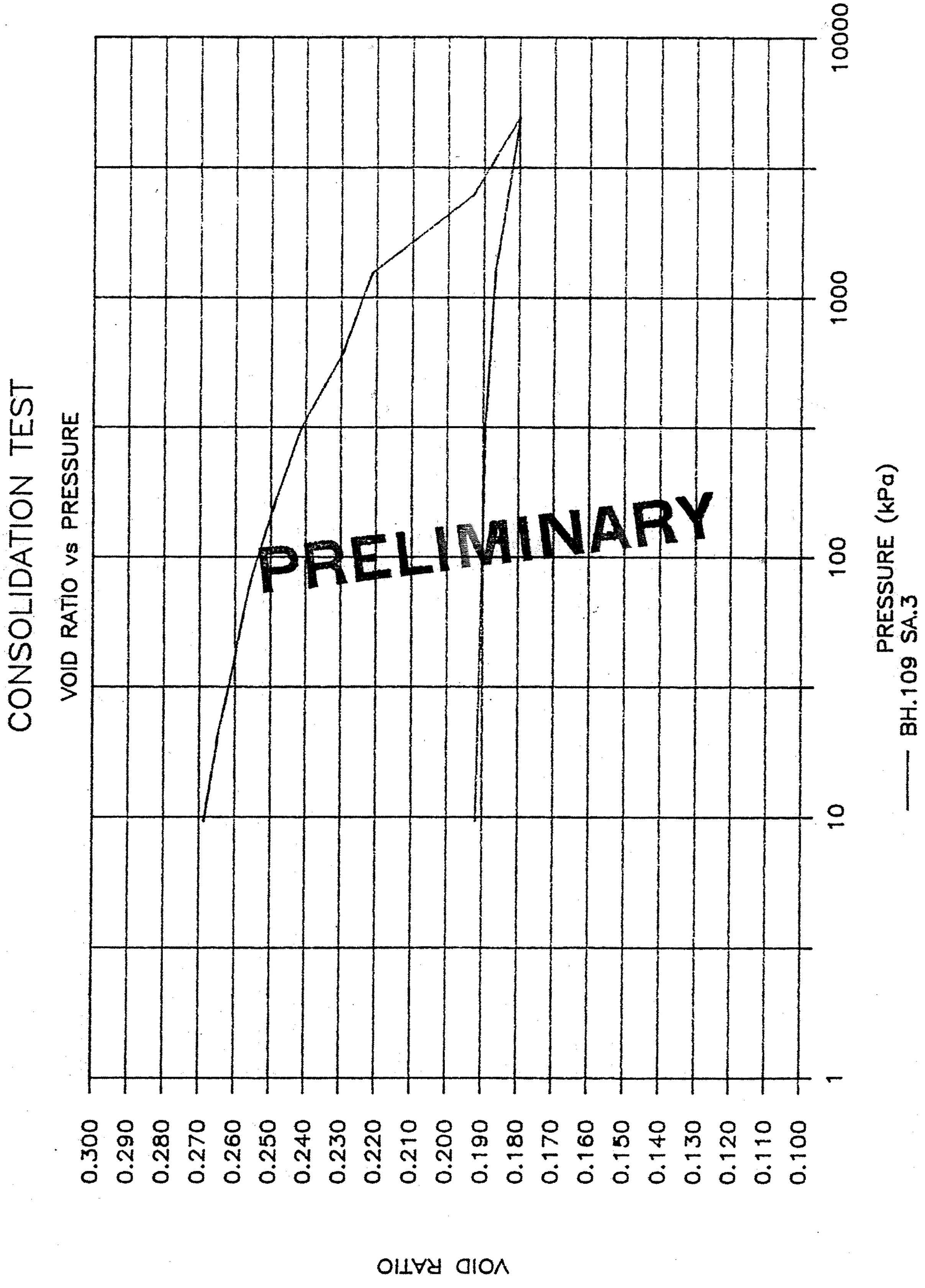


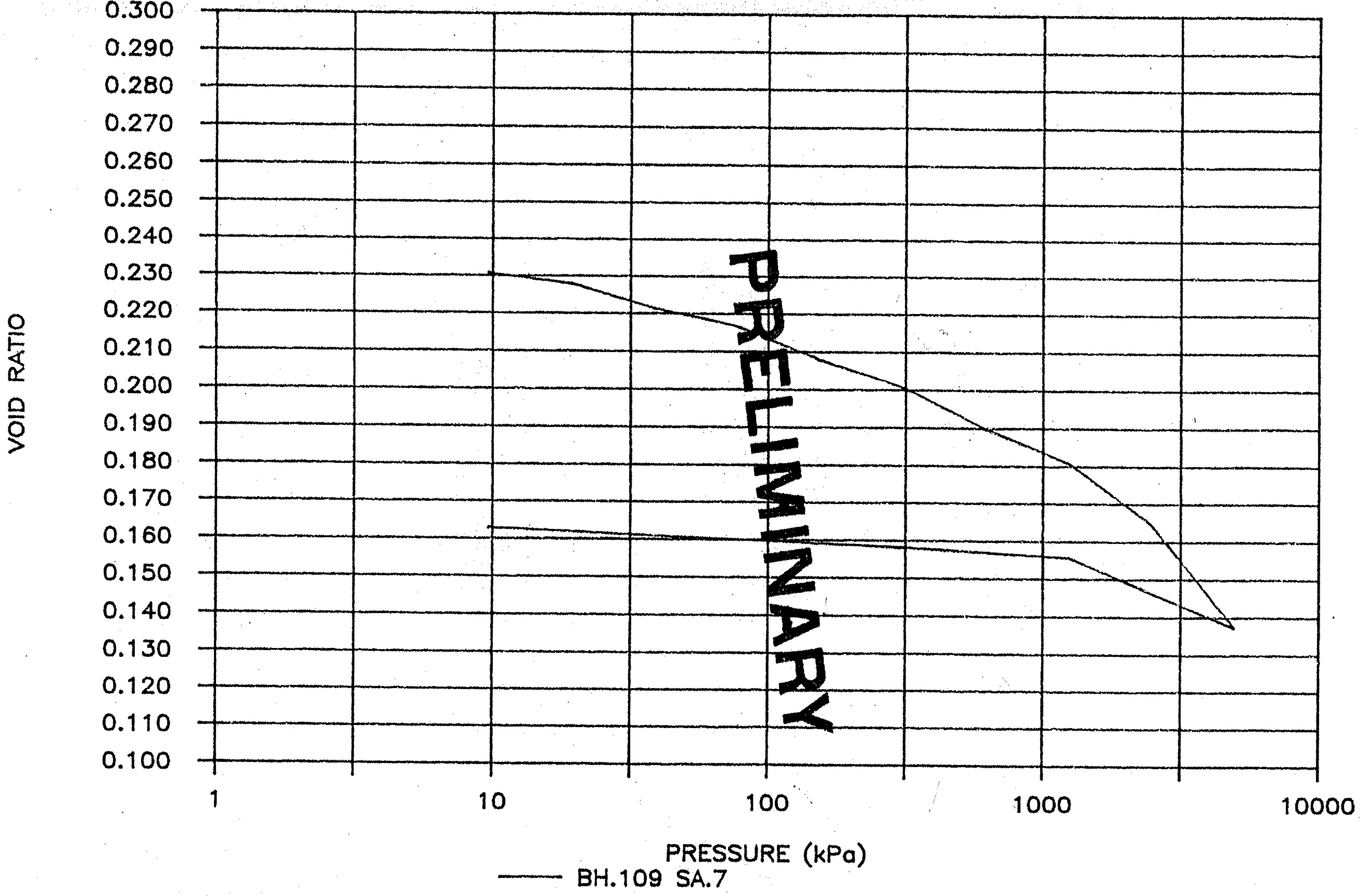
FIGURE ~~14~~ 16

SHEET OF



CONSOLIDATION TEST

VOID RATIO vs PRESSURE



PRELIMINARY

SHEET OF

FIGURE 5 17