Appendix E

Geotechnical Investigations

alston associates inc.
consulting engineers

geotechnics
construction materials testing

DRAFT
PRELIMINARY GEOTECHNICAL INVESTIGATION STUDY
STORMWATER MANAGEMENT PONDS
VAUGHAN, ONTARIO

Ref. No. 11-159
22 February 2012

Prepared for:

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1.0 INTRODUCTION

Alston Associates Inc. has been retained by The Municipal Infrastructure Group to carry out a geotechnical investigation pertaining to four candidate sites for stormwater management pond construction in the City of Vaughan. Authorization to proceed with this study was given by Abraham Khademi, P.Eng. of The Municipal Infrastructure Group.

The purpose of this study has been to develop preliminary geotechnical data pertaining to each of the four candidate sites and based on those data, to present preliminary design data for stormwater pond design.

2.0 FIELDWORK

The fieldwork for this study involved advancing two sampled boreholes at each of the candidate stormwater management sites. The boreholes were advanced to depths ranging from 7.7 to 8.2 m below the existing ground surface at each of the site locations. The borehole locations are shown on the Site Plans, Drawing Nos. 1, 2, 3 and 4.

Standard penetration tests were carried out at frequent intervals of depth in each of the boreholes to take representative soil samples and to measure penetration index values (N-values) of the in situ soils. The N-values are used as a basis for estimating the compactness condition of the soil materials.

Observations were made of the groundwater conditions occurring in each of the boreholes at the time of their advancement. This included recording the depth of cave occurring in the sides of unlined boreholes at the time of completion of boreholes and withdrawal of augers.

3.0 SITE DESCRIPTION AND SUBSURFACE CONDITIONS

Full details of the subsurface conditions contacted in the course of advancing the boreholes are given on the Log Sheets for Borehole Nos. 1 through 8. The following notes provide a commentary on the engineering properties of the various materials contacted in the boreholes.

3.1 Northwest Pond, West of Edgely Boulevard, South of Portage Parkway (Boreholes 1 and 2)

3.1.1 Site Description

The site is located in the northeast quadrant of the intersection of Highway 400 with Regional Road 7. The site is presently used for agricultural purposes and for growing crops. It is sensibly level.

3.1.2 Topsoil

Topsoil was contacted at the ground surface in both boreholes. The layer thickness was found to be about 0.6 and 0.3 m in Boreholes 1 and 2, respectively.

3.1.3 Sandy Silty Clay

The topsoil is underlain by a layer of sandy silty clay which includes a trace of embedded gravel. This soil deposit is intersected by fissures which exhibit oxidized material on the fracture faces. The portion of the soil deposit which lies above a depth of about 2 m is coloured brown and veined grey. Below 2 m, the soil is grey to greyish-brown.

Standard penetration tests carried out in the sandy silty clay soil deposit measured N-values ranging from 9 to 24 blows/300 mm, indicating stiff to very stiff soil conditions. Typically, the upper 1± m of the soil layer is stiff. Below the upper sub-unit, the consistency of the soil material is stiff to very stiff.

Water content values of 12 to 16% were measured on samples of the sandy silty clay. The results of a set of Atterberg limit tests which were carried out on a sample of this material

indicates that it is of low plasticity (CL designation). The result of this test is given in the Plasticity Chart, Figure 1.

The base of the sandy silty clay layer was found to lie at a depth of about 3 m.

3.1.4 Silt and Sand

The sandy silty clay is in turn underlain by a deposit consisting of silt and fine sand, the soil fractions are present in varying proportions. The soil includes a trace of clay, a trace of embedded gravel is present in some horizons. Occasionally, the clay content in the soil is sufficient to impart a weak plasticity to the soil. The varying proportions of the soil fractions result in the characteristics of the soil being represented by descriptions ranging from weakly plastic silt with some fine sand to silt and fine sand to silty fine sand. Generally, the near-surface sub-unit of the stratum was found to be in a moist condition, however below a depth of about 3.5 to 4 m below the ground surface, the soil was generally found to be saturated. There are occasional seams of coarser material lying within the lower portion of the soil deposit.

Standard penetration tests carried out in the silt to fine sand soil recorded N-values ranging from 17 to more than 50 blows/300 mm, which in turn indicates that the soils are compact to dense, to very dense.

The water content of the silt and fine sand soils was found to range from 7 to 16%. The results of a grain size distribution test carried out on a sample of the finer materials contacted in the boreholes is presented in Figure 2.

Representative samples of the sand and silt soils were placed in a compaction permeameter mould for a falling head permeability test; the result of this test measured a hydraulic conductivity of 2.3×10^{-6} cm/s, and is given on Figure 11.

3.2 Interchange Pond, Site Lying North of Highway 407 and East of Highway 400 (Boreholes 5 and 6)

3.2.1 Site Description

The site lies north and east of the slip road carrying vehicles from Highway 407 to northbound Highway 400. The land is presently vacant. It is grassed over with some shrubs and small trees. The site is sensibly level.

3.2.2 Surface Cover

The site is surfaced with a thin layer of clayey topsoil which is typically about 250 to 250 mm thick. At the location of Borehole 5, the topsoil layer rests on a layer of sandy silty clay fill. This layer includes occasional pockets of sand. A trace of topsoil was found to lie within the basal sub-unit of the soil deposit.

Standard penetration tests carried out in the granular fill materials recorded N-values of 23 and 26 blows/300 mm, which indicates that the material is densely compact.

Water content values measured on samples of this sandy silty clay soil ranges between 7 and 13%.

The base of the fill was observed to lie at a depth of about 2 m at the location of Borehole 5.

The topsoil layer at Borehole 6 rests on a 400 mm thick silty sand soil layer with some clay to impart a weakly plastic character. Standard penetration tests recorded an N-value of 15 blows/300 mm, which indicates a compact soil condition.

3.2.3 Sandy Silty Clay

The topsoil and fill lie on a native soil layer consisting of sandy silty clay which includes a trace of embedded gravel. A trace of rootlets was observed to be present in the near-surface sub-unit of the soil stratum. Evidence of disturbance of the near surface soils could also be seen in soil samples, which may have resulted from previous agricultural activities.

Standard penetration tests carried out in the sandy silty clay soils measured N-values ranging from 22 to more than 30 blows/300 mm, which indicates a very stiff to hard soil consistency. Typically, the soils which lie above a depth of about 2 m are very stiff in consistency, and the soils which lie below that depth are very stiff to hard.

The soil is generally coloured brown above a depth of about 2 to 3 m and is coloured grey to greyish-brown below that depth. Occasional thin silty sand seams were observed in samples taken from the lower sub-unit of the sandy silty clay soil stratum; seams which are about 0.6 m thick were contacted at depths of about 3 and 6 m.

The water content of the samples of silty sandy clay soils ranges from 7 to 9%.

This soil deposit continues beyond the depth of termination of the boreholes.

The results of the grain size distribution test carried out on a sample of the sandy silty clay soil is given on Figure 3. The results of the grain size distribution tests carried out on a sample of the silt and sand layers is given in Figure 4.

3.2.4 Groundwater

Both Boreholes 5 and 6 were dry and open at completion of the borings. However, it was noted that the silty sand soils present in the soil layer lying at the approximately 4 m depth are saturated. Based on inspection of the soil samples, it is inferred that the position of saturation in the soil profile lies at a depth of about 3 m.

3.3 Northeast of Peelar Road and East of Jane Street (Boreholes 3 and 4)

3.3.1 Site Description

Two alternative sites are under consideration for the Southeast Pond. The prime candidate site lies south of Peelar Road and west of Interchange Way; the alternative site lies on the north side of Peelar Road. Both sites are unused, grass covered, and with some tree cover. Both are relatively flat. At the time of carrying out this investigation,

access was not available to the prime site and therefore, the exploratory boreholes were advanced on the site situated north of Peelar Road.

3.3.2 Topsoil and Site Cover

The site is overlain with a layer of topsoil which ranges in thickness from about 100 to 150 mm. The topsoil lies on a layer of fill materials which extend to a depth of about 0.6 to 1 m below the existing ground surface. The fill consists of gravel. The topsoil layer rests on a layer of sand to gravelly sand fill, with some silt.

Standard penetration tests carried out in the fill recorded N-values of 14 and 16 blows/300 mm, which in turn indicate that the soil material is moderately well compacted.

The water content of a sample of the fill was found to be 5%.

The presence of a granular layer overlying low permeability soils (see below) results in a site situation which has a propensity to develop a perched water table at shallow depth.

3.3.3 Silty Sandy Clay

The topsoil and fill are underlain by a layer of silty clay soils which includes a variable sand fraction (trace sand to sandy), a trace of gravel and occasional thin silt seams. A trace of rootlets was observed in the near surface zone of this deposit. The deposit includes some seams of silt and sand layers which were contacted at depths of about 4 and 7.5 m, respectively.

Standard penetration tests carried out in the silty sandy clay material measured N-values ranging from 12 to more than 50 blows/300 mm, which in turn indicate that the soil consistency ranges from stiff to hard. In general, the soils which lie above a depth of about 4 m are stiff to very stiff; the underlying soils are hard.

Water content values ranging from 6 to 14% were measured on samples of this soil. The results of grain size distribution tests carried out on the sandy silty clay soil in Borehole 5 is shown on Figure 5 and the silt and sand layers in Borehole 5 are given in Figure Nos. 6 and 7, respectively.

This soil layer continues below the depth of termination of both of the boreholes.

3.4 Northeast (Edgely Pond) Site, East of Jane Street, North of Regional Road 7 (Boreholes 7 and 8)

3.4.1 Site Description

The site lies to the east of Jane Street and north of Regional Road 7. The land is presently unused. It is grassed over with significant areas of vegetation, scrub and trees. Two ponds with a water level close to the surrounding ground surface occupy parts of the site.

3.4.2 Site Cover

The site cover consists of a thin layer of topsoil which varies in thickness at the borehole locations from 120 to 300 mm. The topsoil lies on a layer of fill which consists of sandy silt clay which includes a trace of topsoil. It is possible that this layer consists of the native soil material which has been disturbed by agricultural activity.

Standard penetration tests of 4 and 8 were measured in the fill materials which indicates that the equivalent consistency is generally firm or firm to stiff.

Water content values of 13 and 22 were measured on the silty clay fill and the topsoil, respectively.

The fill materials were found to extend to depths of about 0.7 m at the borehole locations.

3.4.3 Silty Clay

The topsoil and fill are underlain by a stratum of silty clay which includes a trace of sand, a trace of gravel, and occasional silt seams. A significant (300 to 800 mm) layer of silty sand was found to be included in the silty clay soil stratum at a depth of about 3 to 3.5 m. Generally, the soil is coloured brown in the upper 2 to 2.5 m of the soil stratum and is coloured grey below that depth.

Standard penetration tests carried out in the silty clay soil materials recorded N-values ranging from 16 to more than 30 blows/300 mm, which indicates that the consistency of the soil is stiff to very stiff in the near-surface zone and very stiff, becoming hard below a depth of about 2 to 4 m below the ground surface.

The water content of samples of the silty clay was found to range from 8 to 12%. The results of grain size distribution tests carried out on samples of the silty clay soil are recorded in Figure 8. The results of the grain size distribution test carried out on the sample of the sandy silt layer within the clay deposit is shown on Figure 9.

The base of the silty clay layer was found to lie at depths of about 5.5 and 7 m in Boreholes 7 and 8, respectively.

3.4.4 Silt and Fine Sand

Below the silty clay and extending beyond the depth of termination of the boreholes, both boreholes contacted a layer of silt and fine sand which includes a trace to some clay and a trace of gravel. The clay fraction present in the soil matrix is sufficient to impart a weak plasticity to this soil. The soil is coloured grey. The soil deposit includes occasional seams of coarse sand.

Standard penetration tests carried out in the silt and sand soil recorded N-values of 43 to more than 50 blows/300 mm, indicating that the soil is generally very dense. However, there are zones of dense soil lying within the soil deposit.

A water content value of 8% was measured on a sample of this soil. The results of the grain size analysis carried out on a sample of the sand and silt soil is shown on Figure 10.

3.4.5 Groundwater

Both boreholes were dry and open at completion. However, based on the results of an inspection of the soil samples, it is inferred that the elevation of saturation of the soil materials lies at a depth of generally 2 to 3 m below the existing ground surface.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 General

It is expected that the stormwater ponds will extend to a maximum depth of about 5 m below the existing ground surface. There will be two pond components at each location, consisting of a dry cell and a wet cell. The proposed side slope gradient of each pond cell will be 25% (1V:4H).

4.2 Pond P2

The borehole data indicate that the upper silty sandy clay layer extends to a depth of about 3 m where it is underlain by a deposit of silty fine sand to sandy silt; the water level is expected to lie at a level which is approximately at the base of the silty sandy clay layer, subject to seasonal fluctuations.

The proposed design of the facility incorporates a forebay which is dry and which will have an excavation base positioned at a depth of about 2 m below the ground surface; for this situation, the base of the excavation is expected to lie in the low permeability silty clay soil stratum. This design does not result in any unusual geotechnical controls.

Positioning the base of the wet cell at a depth of about 5 m will locate the base of the excavation in the silty sand to sandy silt soil stratum. This material is in a saturated condition and can be expected to flow into an open excavation where excavations are carried out below the water table. The results of a permeability test carried out on a

sample of this material indicates that the saturated hydraulic conductivity (permeability) of the silty sand to sandy silt will be about $2x10^{-6}$ cm/s.

In order to provide stability to the sides and base of the excavation, it will be necessary to provide a liner which consists of a manufactured flexible concrete mat with a geotextile backing or alternatively, rip-rap laid on a suitable non-woven needle-punched geotextile.

4.3 Interchange Pond

The subsurface profile at the location of the interchange pond consists of fill materials overlying stiff, becoming hard silty clay. The silty clay includes seams and lenses of silty sand to silty fine sand. Based on the geotechnical data developed at the boreholes, it is reasonable to consider a facility with excavated side slopes profiled to a 25% gradient. The geotechnical data indicate that the base of the excavations for both the forebay and the wet cell will be satisfactory and stable at the design profiles. It is noted that the silty clay includes seams and lenses of saturated silty sand and silt to fine sand which can be expected to exhibit some propensity to flow on excavation. The pond liners should provide a retention of these materials with an overlay of geotextile and an erosion resistant liner.

4.4 Pond P1

The borehole data indicate that the soil profile consists of silty clay with included layers of silty sand. The inferred depth of the water table would be at a depth of about 2.5 to 3 m. However, it is noted that the native soils are of low permeability and the rate of release of water from these soils would be relatively slow.

A facility with design side slopes at a 25% gradient is expected to be satisfactory. It is noted that the base of the wet pond will be at a depth of about 5 m which is within close proximity of the underlying layer of silt and sand in Borehole 7. There is a possibility of uplift occurring in the base of the deeper excavation when the wet cell is in a dry condition. This propensity for uplift would be mitigated by drilling a set of "simple relief wells" to contact the base of the cell to the underlying sand stratum and thereby provide pressure

relief. The relief wells would consist of bores (say 150 to 200 mm diameter) filled with a clean sand soil. An erosion resistant liner should be installed in the stormwater management pond facility.

4.5 Southeast Pond

The subsurface conditions at the location of the southeast pond are substantially similar to the northeast pond. The recommendations given in Section 4.3 are applicable.

5.0 LIMITATIONS OF REPORT

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

ALSTON ASSOCIATES INC.

Demetra Matthews, P.Eng. Colin Alston, P.Eng.

/jt

APPENDIX 'A'

Appendix 'A'

LIMITATIONS OF REPORT

The conclusions and recommendations in this report are based on information determined at the test hole locations. Soil and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the soil investigation.

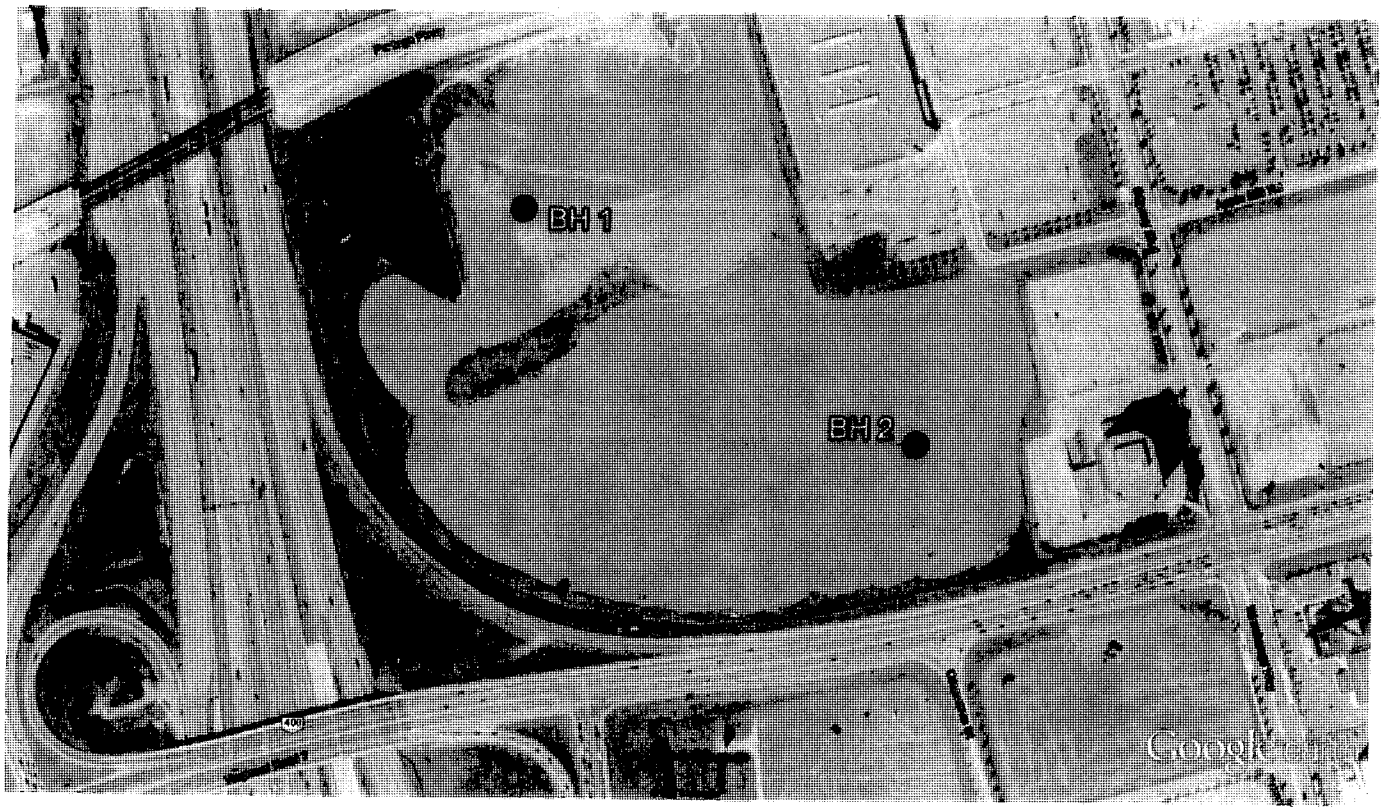
The design recommendations given in this report are applicable only to the project described in the text, and then only if constructed substantially in accordance with details of alignment and elevations stated in the report. Since all details of the design may not be known to us, in our analysis certain assumptions had to be made as set out in this report. The actual conditions may, however, vary from those assumed, in which case changes and modifications may be required to our recommendations.

This report was prepared for The Municipal Infrastructure Group by Alston Associates Inc. The material in it reflects Alston Associates Inc. judgement in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions which the Third Party may make based on it, are the sole responsibility of such Third Parties.

We recommend, therefore, that we be retained during the final design stage to review the design drawings and to verify that they are consistent with our recommendations or the assumptions made in our analysis. We recommend also that we be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the test holes. In cases where these recommendations are not followed, the company's responsibility is limited to accurately interpreting the conditions encountered at the test holes, only.

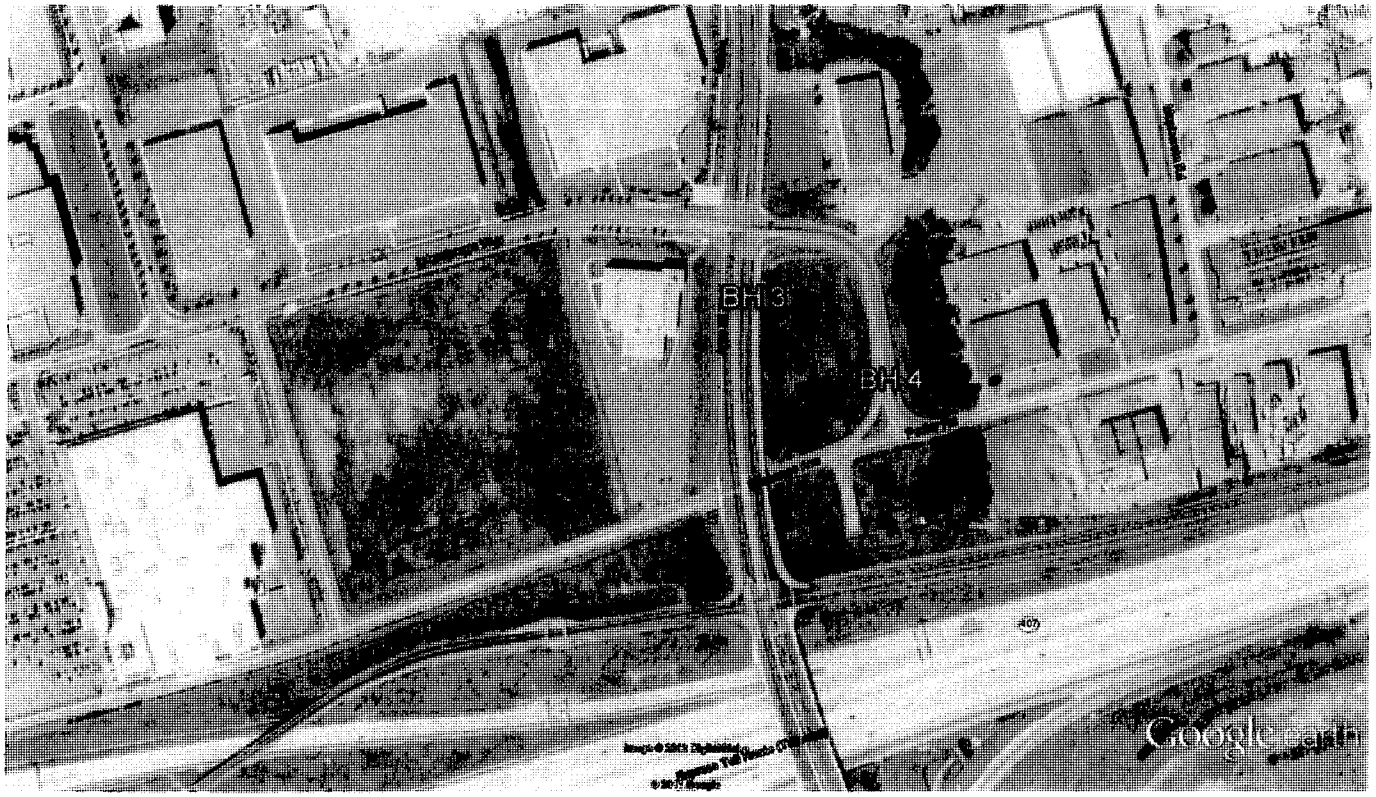
The comments given in this report on potential construction problems and possible methods are intended for the guidance of the design engineer, only. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work.

ENCLOSURES



See Borehole Log Sheets for borehole coordinates

Borehole Location Plan Storm Water Management Pond West of Edgely Boulevard, South of Portage Parkway Vaughan, ON	Drawing No. 1 Ref. No: 11-159 January 2012 Scale: as shown

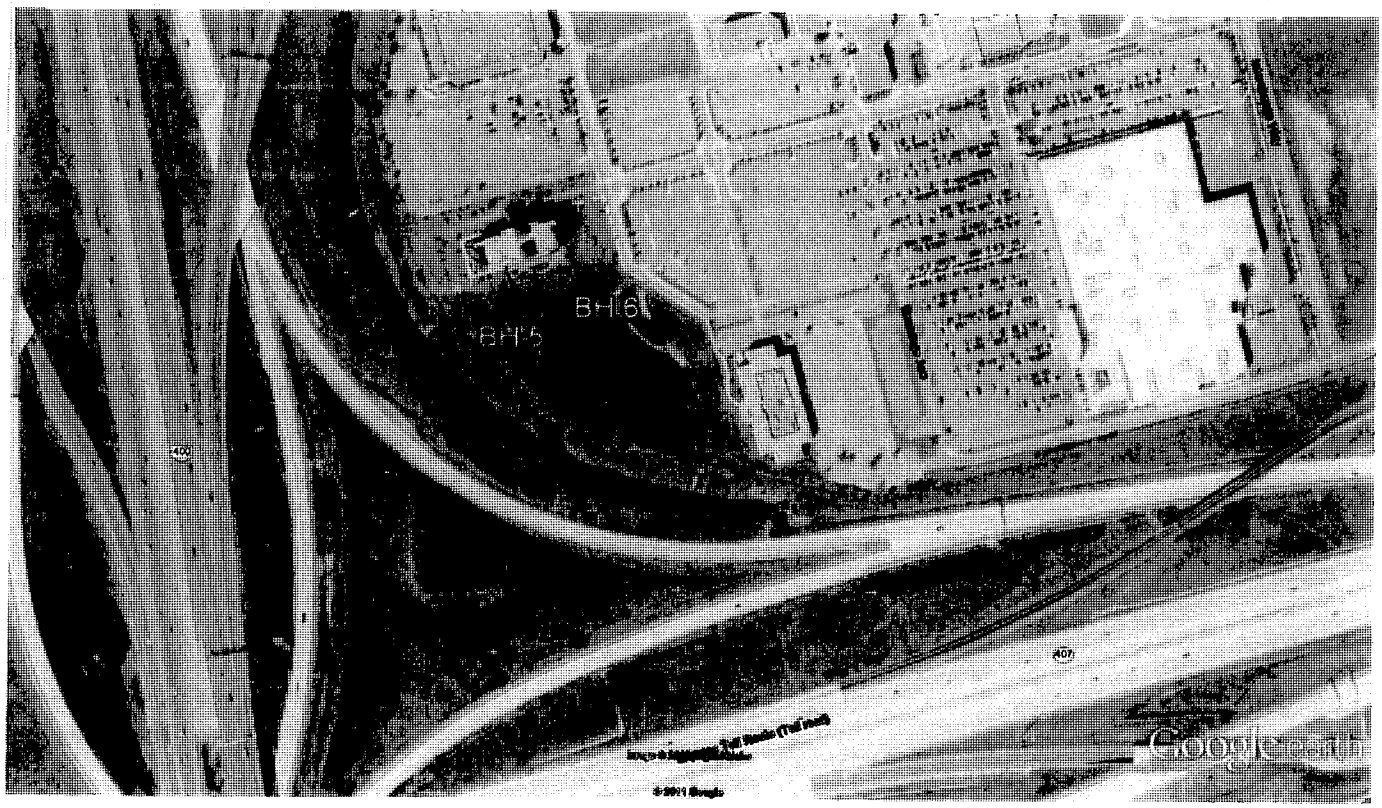


Google earth

feet 1000
meters 500

See Borehole Log Sheets for borehole coordinates

Borehole Location Plan Storm Water Management Pond West of Peelar Rd., East of Jane St., North of Exchange Ave. Vaughan, ON	Drawing No. 2 Ref. No: 11-159 January 2012 Scale: as shown

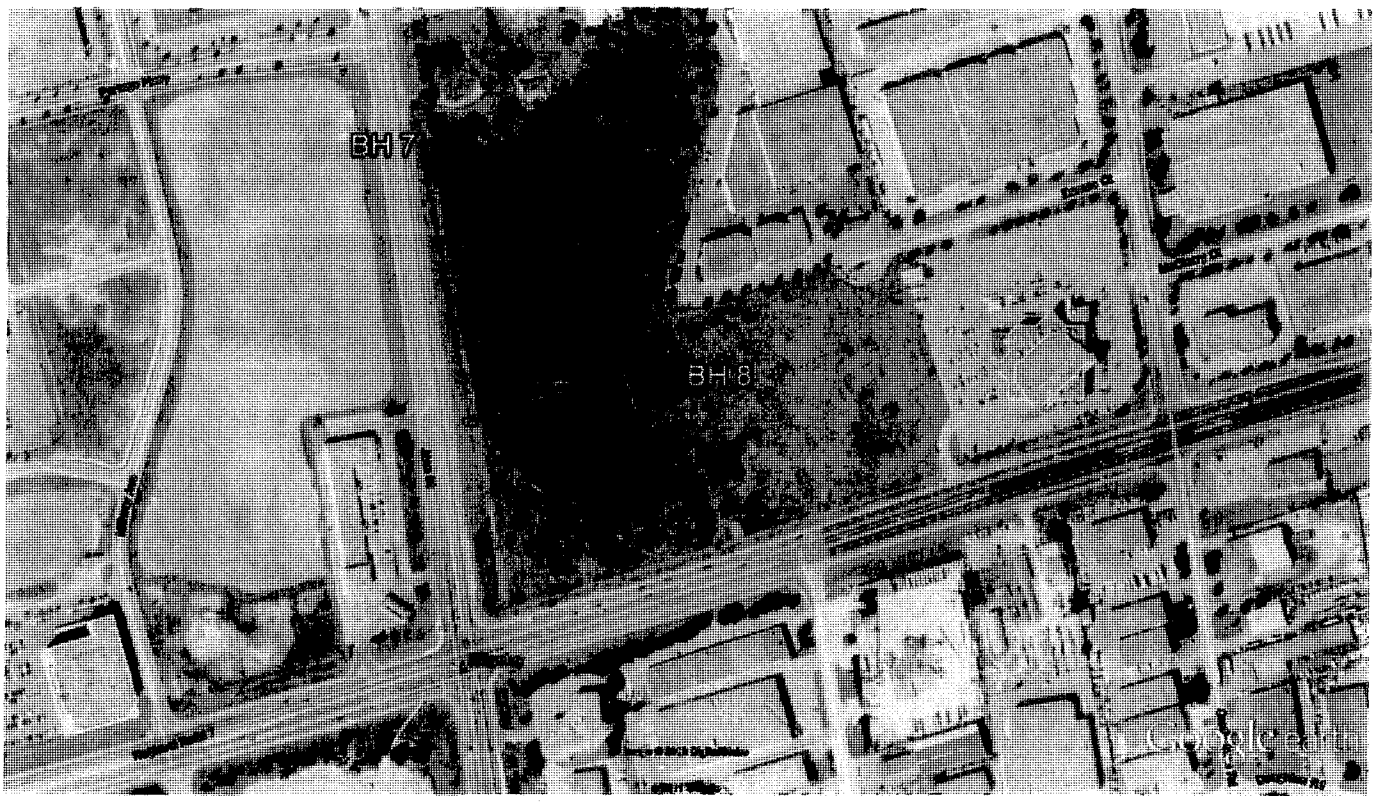


Google earth

feet 1000
meters 500

See Borehole Log Sheets for borehole coordinates

Borehole Location Plan Storm Water Management Pond Vacant Lot, Northeast of Hwy 407 N/B Ramp from Hwy 407 W/B Vaughan, ON	Drawing No. 3 Ref. No: 11-159 January 2012 Scale: as shown

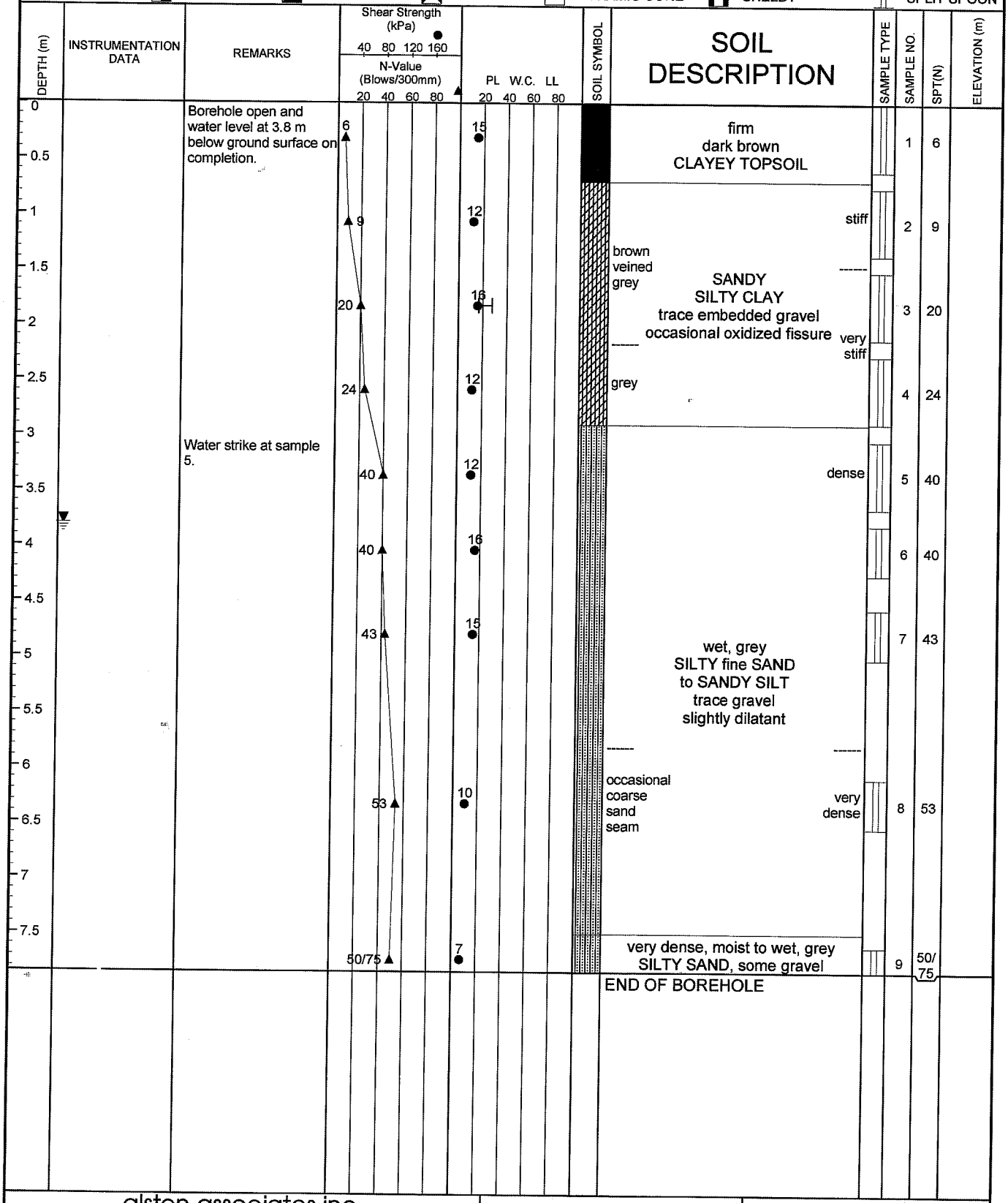


See Borehole Log Sheets for borehole coordinates

Borehole Location Plan Storm Water Management Pond East of Jane Street, North of Regional Road 7 Vaughan, ON	Drawing No. 4 Ref. No: 11-159 January 2012 Scale: as shown

CLIENT: The Municipal Infrastructure Group	METHOD: Augering and Split Spoon sampling		**BH No.: 1**
PROJECT: Storm Water Management Ponds	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Vaughan, ON	NORTHING: 4850126	EASTING: 617673	PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON



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CLIENT: The Municipal Infrastructure Group | METHOD: Augering and Split Spoon sampling | **BH No.: 2**

PROJECT: Storm Water Management Ponds | PROJECT ENGINEER: CA | ELEV. (m)

LOCATION: Vaughan, ON | NORTHING: 4849966 | EASTING: 617959 | PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole dry and cave-in at 6.2 m below ground surface on completion.	10			280 mm TOPSOIL				
0.5						stiff		1	10	
1			16			brown, trace grey; very stiff		2	16	
1.5		Bulk sample obtained at 1.5 m depth.				SANDY SILTY CLAY trace embedded gravel trace oxidization				
2			18					3	18	
2.5			16			greyish brown		4	16	
3						compact, moist, grey weakly plastic SILTY SAND trace clay, trace embedded gravel		5	17	
3.5			17							
4			17			compact, wet, grey slightly dilatant SILT, some fine sand		6	17	
4.5										
5			29			compact		7	29	
5.5										
6						wet, grey SILTY fine SAND to SILT and fine SAND trace gravel				
6.5			48			dense		8	48	
7										
7.5										
8			56			hard, grey SILTY CLAY some sand, trace embedded gravel		9	56	
						END OF BOREHOLE				

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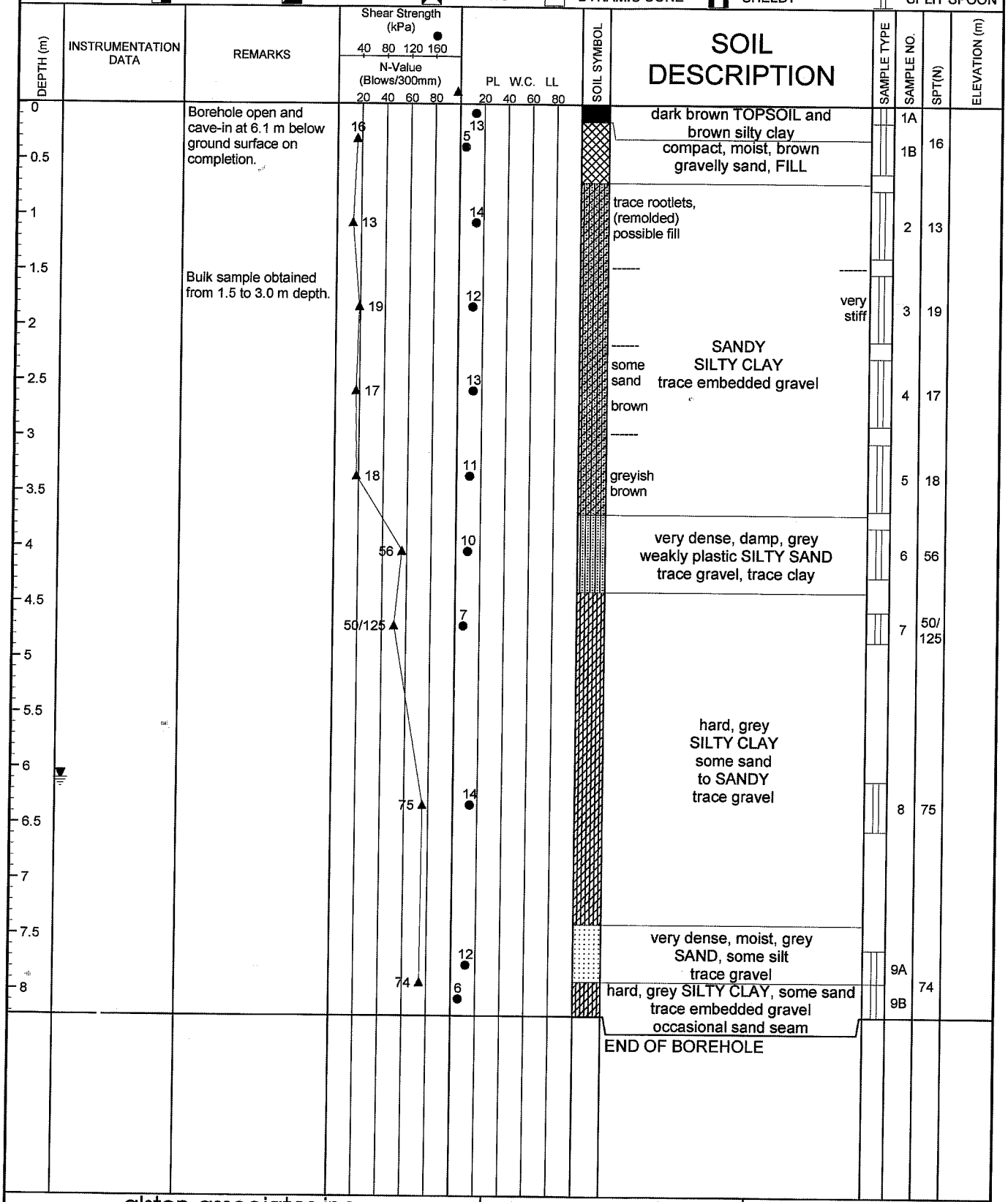
CLIENT: The Municipal Infrastructure Group	METHOD: Augering and Split Spoon sampling		**BH No.: 3**
PROJECT: Storm Water Management Ponds	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Vaughan, ON	NORTHING: 4849486	EASTING: 618817	PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON



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	REVIEWED BY: DM	Page 1 of 1

CLIENT: The Municipal Infrastructure Group | METHOD: Augering and Split Spoon sampling | **BH No.: 4**

PROJECT: Storm Water Management Ponds | PROJECT ENGINEER: CA | ELEV. (m)

LOCATION: Vaughan, ON | NORTHING: 4849423 | EASTING: 618839 | PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole dry and open on completion.	14			CLAYEY TOPSOIL		1A		
0.5						compact, moist, brown sand, some gravel, some silt (PROBABLE FILL)		1B	14	
1			19					2A		
1.5								2B	19	
2			12			stiff		3	12	
2.5			222+			brown veined grey SANDY SILTY CLAY trace embedded gravel		4	21	
3			21			very stiff		5A		
3.5			17			greyish brown, occasional sand seams		5B	17	
4			50/75			very dense, moist, grey SILTY SAND some gravel trace rock pieces		6	50/75	
4.5										
5			32	9				7	32	
5.5										
6						hard dark grey faintly layered SILTY CLAY trace gravel				
6.5			52					8	52	
7										
7.5										
8			43					9	43	
						END OF BOREHOLE				

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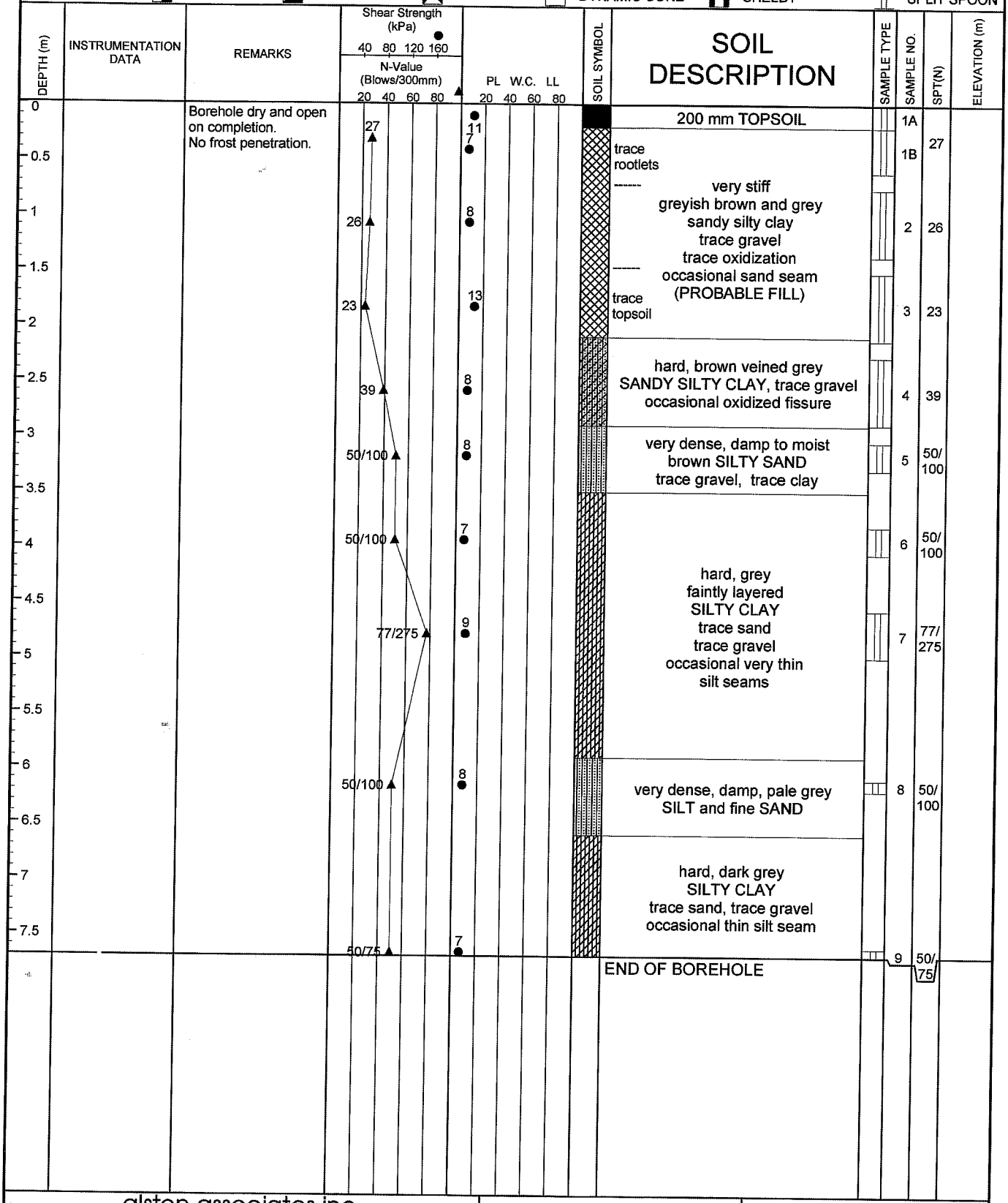
CLIENT: The Municipal Infrastructure Group | METHOD: Augering and Split Spoon sampling | **BH No.: 5**

PROJECT: Storm Water Management Ponds | PROJECT ENGINEER: CA | ELEV. (m)

LOCATION: Vaughan, ON | NORTHING: 4849255 | EASTING: 617876 | PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON



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LOGGED BY: KC | DRILLING DATE: 20 Dec. 2011

REVIEWED BY: DM |

CLIENT: The Municipal Infrastructure Group	METHOD: Augering and Split Spoon sampling	**BH No.: 6**
PROJECT: Storm Water Management Ponds	PROJECT ENGINEER: CA / ELEV. (m)	
LOCATION: Vaughan, ON	NORTHING: 4849248 / EASTING: 617991	PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON

DEPTH (m)	INSTRUMENTATION DATA	REMARKS	Shear Strength (kPa) 40 80 120 160 / N-Value (Blows/300mm) 20 40 60 80	PL W.C. LL 20 40 60 80	SOIL SYMBOL	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	SPT(N)	ELEVATION (m)
0		Borehole dry and open on completion.	15			250 mm TOPSOIL		1A		
0.5						compact, moist, brown weakly plastic SILTY SAND trace gravel, trace rootlets		1B	15	
1			22			trace rootlets	very stiff	2	22	
1.5										
2			33					3	33	
2.5			31				very stiff to hard	4	31	
3										
3.5			30					5	30	
4			30			grey SILTY CLAY trace sand occasional silty layers		6	30	
4.5										
5			29					7	29	
5.5										
6						faintly layered to layered				
6.5			28					8	28	
7										
7.5										
8			25					9	25	
						END OF BOREHOLE				

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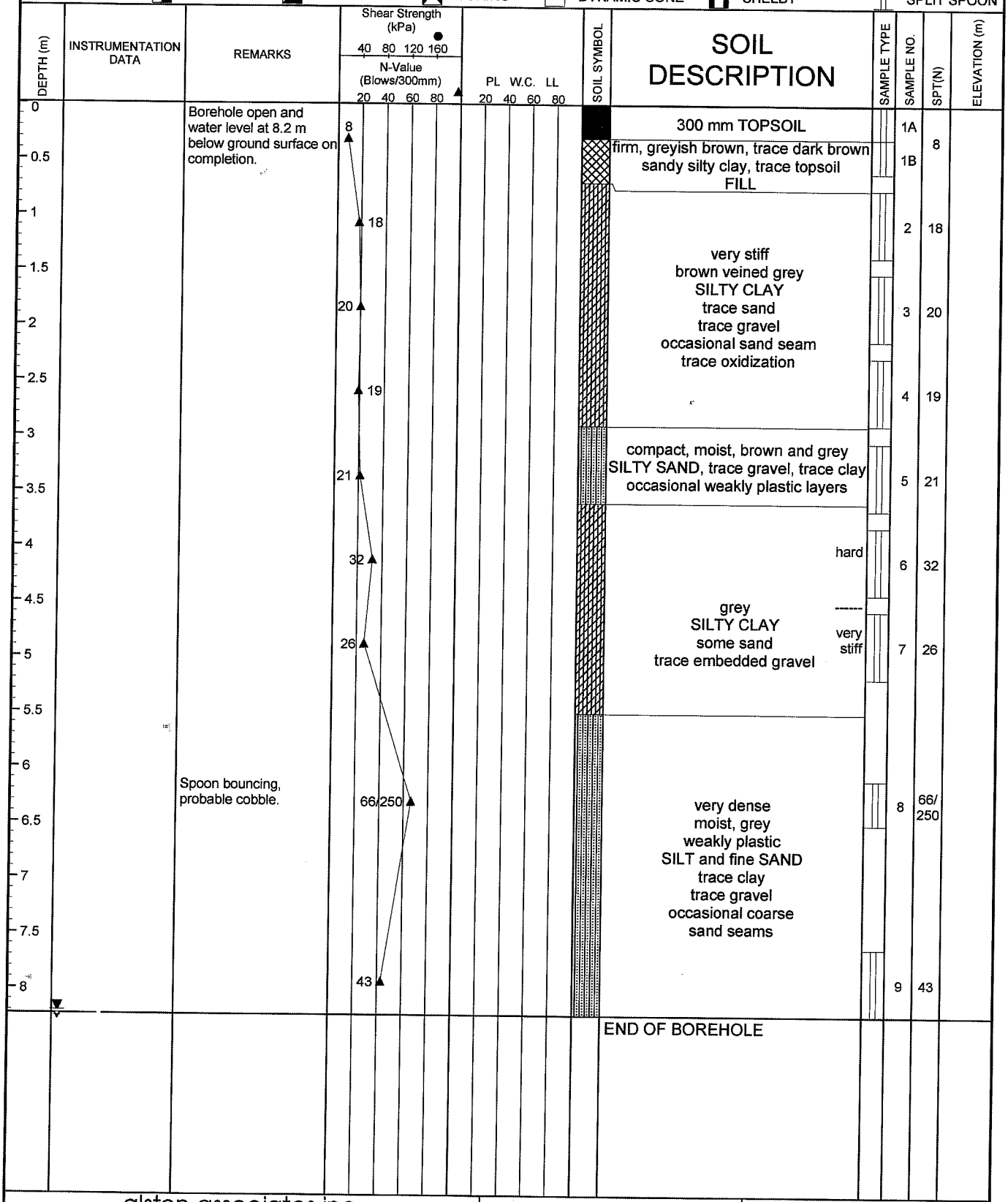
	REVIEWED BY: DM	Page 1 of 1

CLIENT: The Municipal Infrastructure Group	METHOD: Augering and Split Spoon sampling		**BH No.: 7**
PROJECT: Storm Water Management Ponds	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Vaughan, ON	NORTHING: 4850445	EASTING: 618668	PROJECT NO.: 11-159

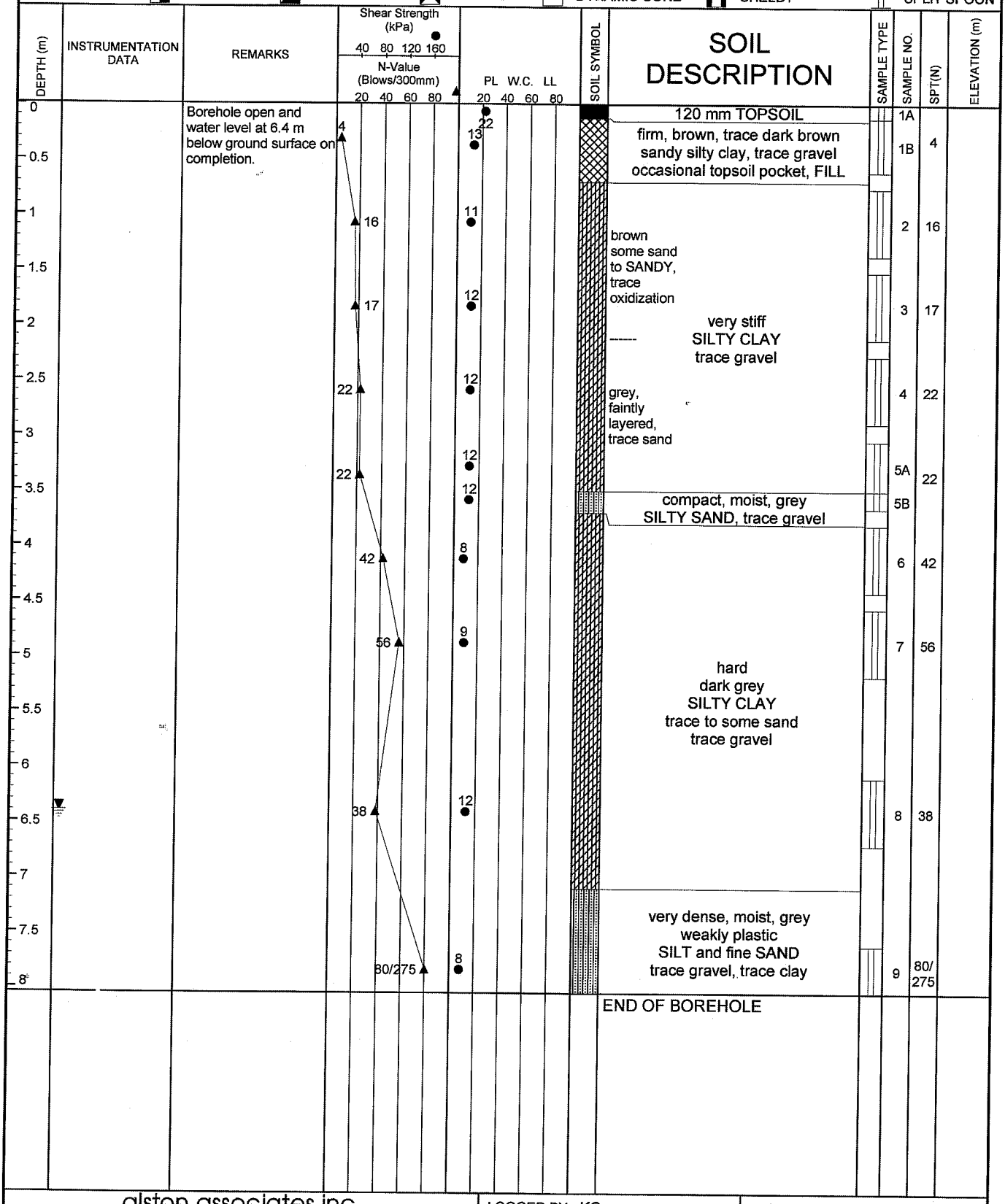
SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON



alston associates inc. consulting engineers	LOGGED BY: KC	DRILLING DATE: 20 Dec. 2011
	REVIEWED BY: DM	Page 1 of 1

CLIENT: The Municipal Infrastructure Group	METHOD: Augering and Split Spoon sampling		**BH No.: 8**
PROJECT: Storm Water Management Ponds	PROJECT ENGINEER: CA	ELEV. (m)	
LOCATION: Vaughan, ON	NORTHING: 4850276	EASTING: 618852	PROJECT NO.: 11-159

SAMPLE TYPE: AUGER | DRIVEN | CORING | DYNAMIC CONE | SHELBY | SPLIT SPOON



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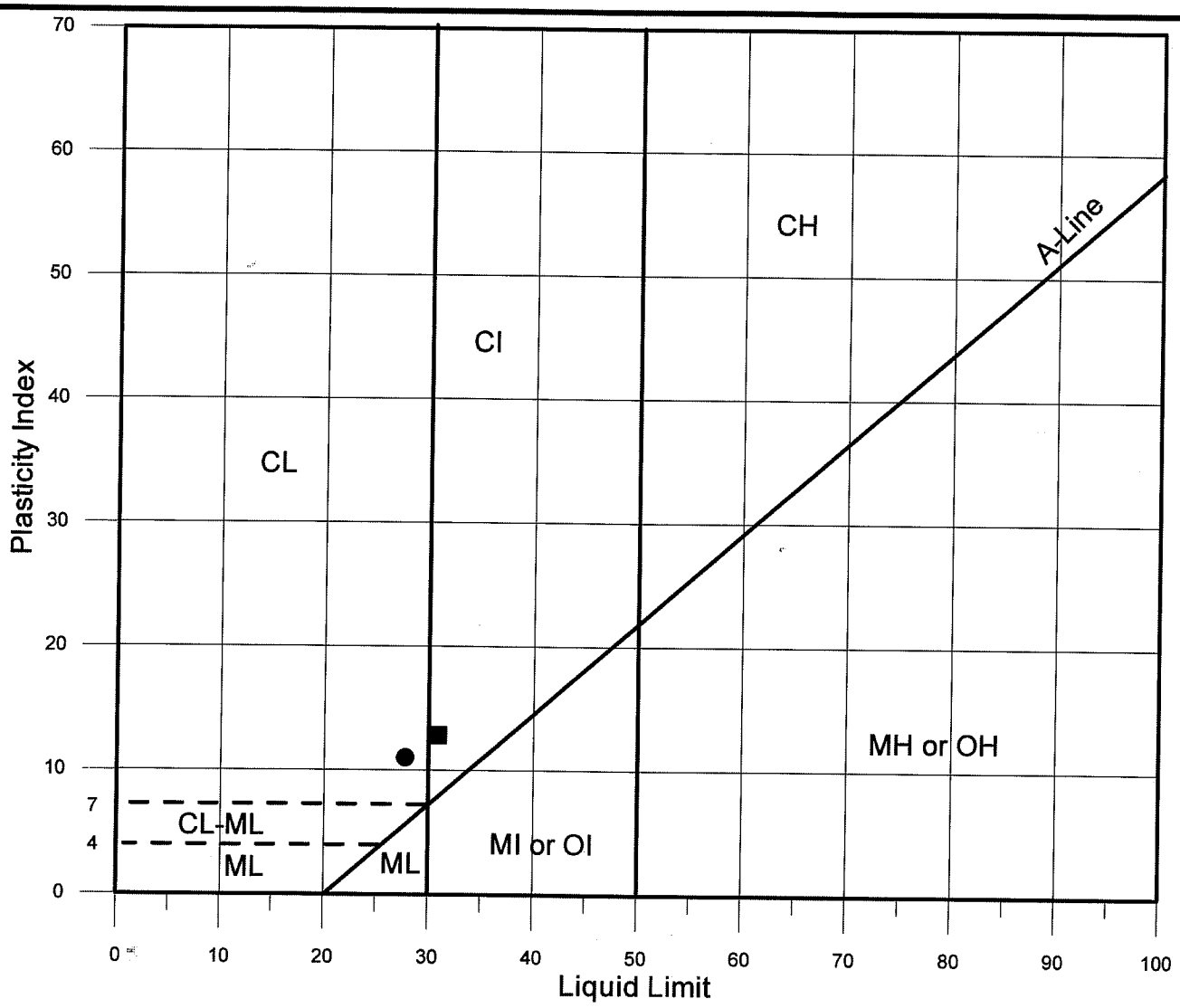
	REVIEWED BY: DM	Page 1 of 1

PLASTICITY CHART



Client: The Municipal Infrastructure Group
Project: Storm Water Management Pond, Vaughan, ON
Ref. No.: 11-159

Sample	Symbol
Borehole 1, Sample 3	●
Borehole 4, Sample 7	■

Remarks:

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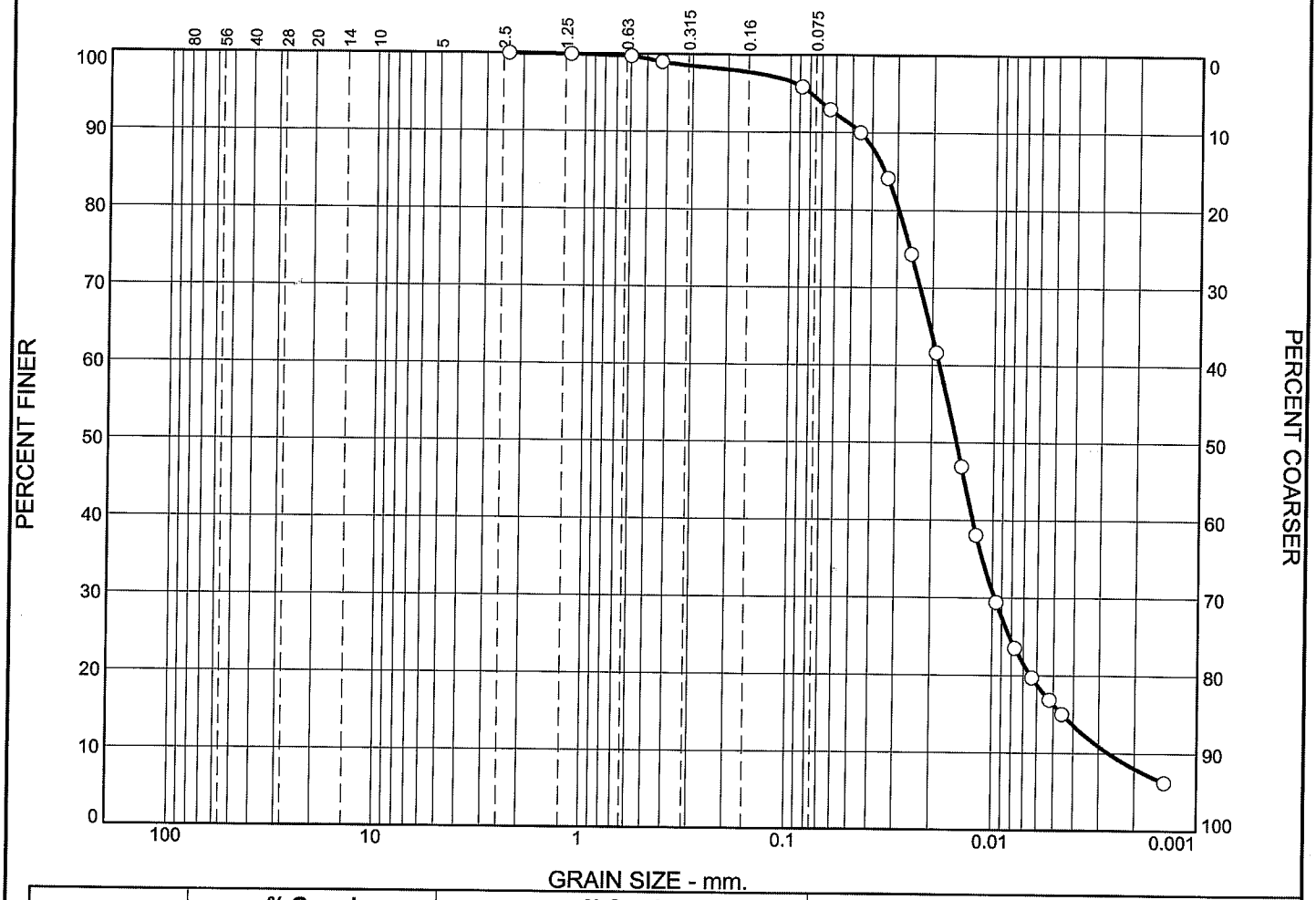
Figure No. 1

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	0	1	5	86	8

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.0346	0.0185	0.0152	0.0098	0.0045	0.0027	1.92	6.88

Material Description	USCS	AASHTO
○ SILT, trace clay, trace sand		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 1, Sample 6

Remarks:

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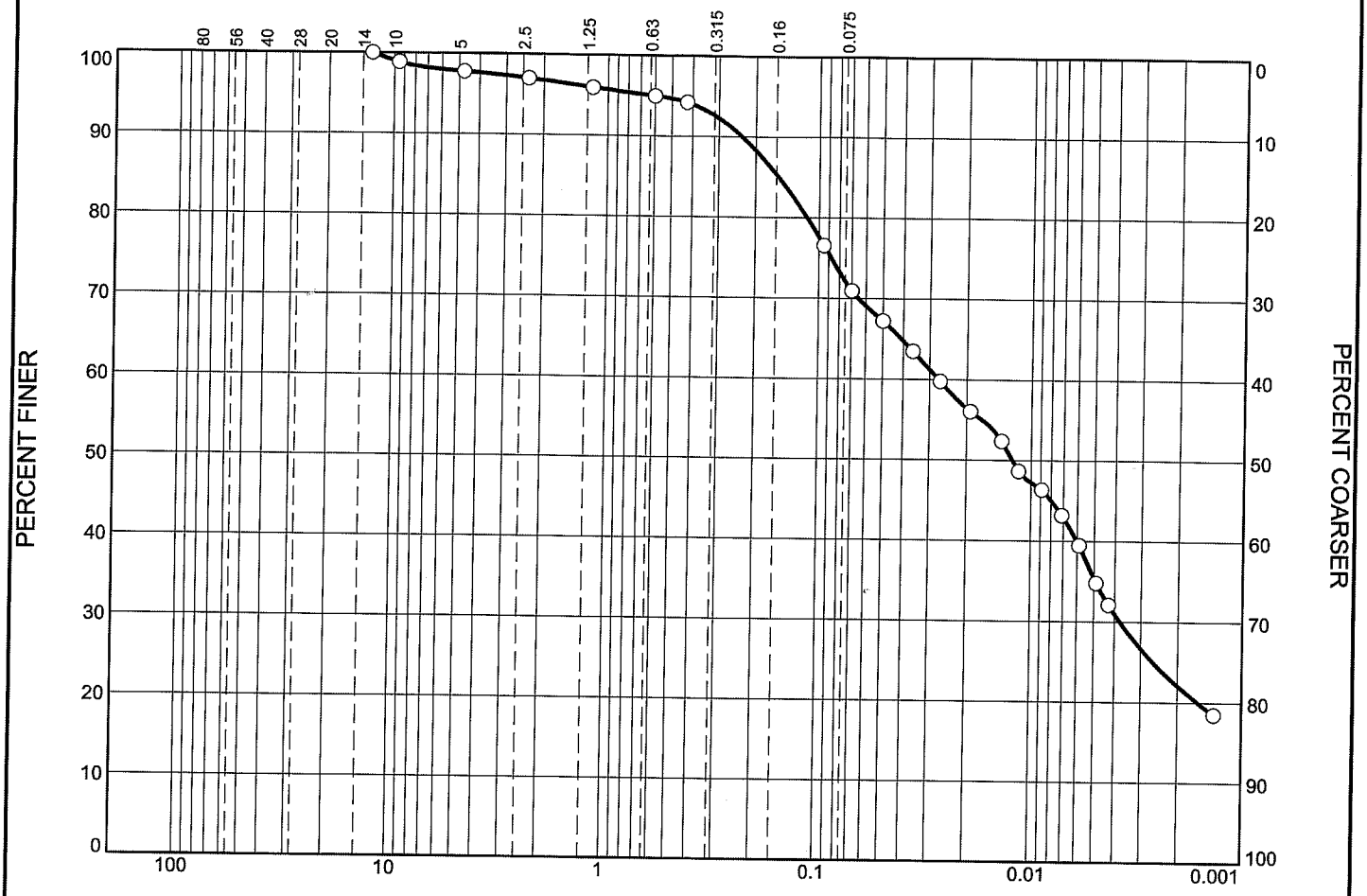
Figure 2

Tested By: GL/GL **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	2	1	3	22	50	22

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1561	0.0273	0.0123	0.0038				

Material Description	USCS	AASHTO
○ SANDY SILTY CLAY, trace gravel		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 5, Sample 5

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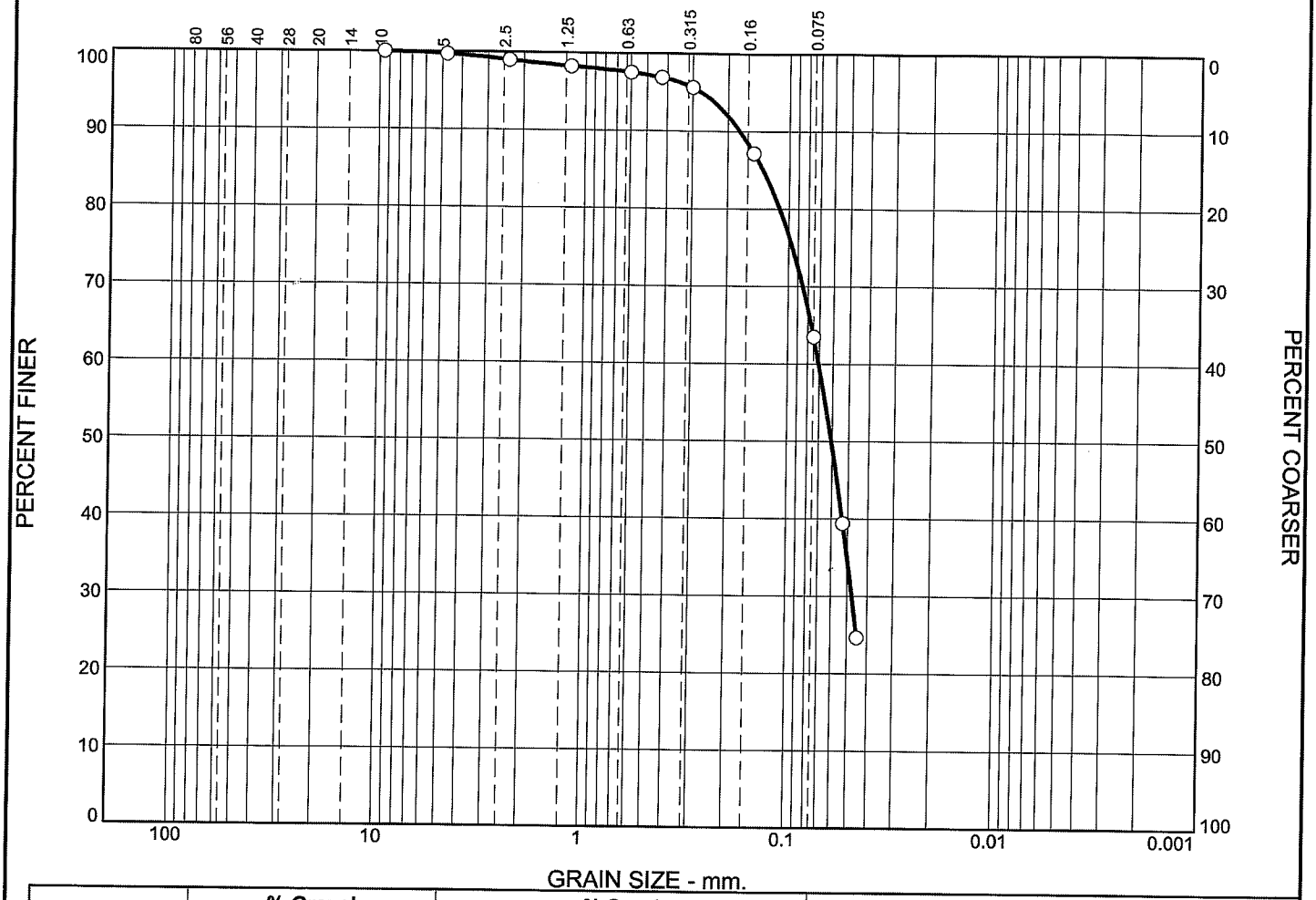
Remarks:

Figure 3

Tested By: RP/GL **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	1	2	34	63	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1351	0.0706	0.0606	0.0477				

Material Description	USCS	AASHTO
○ SILT and fine SAND		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 5, Sample 8

Remarks:

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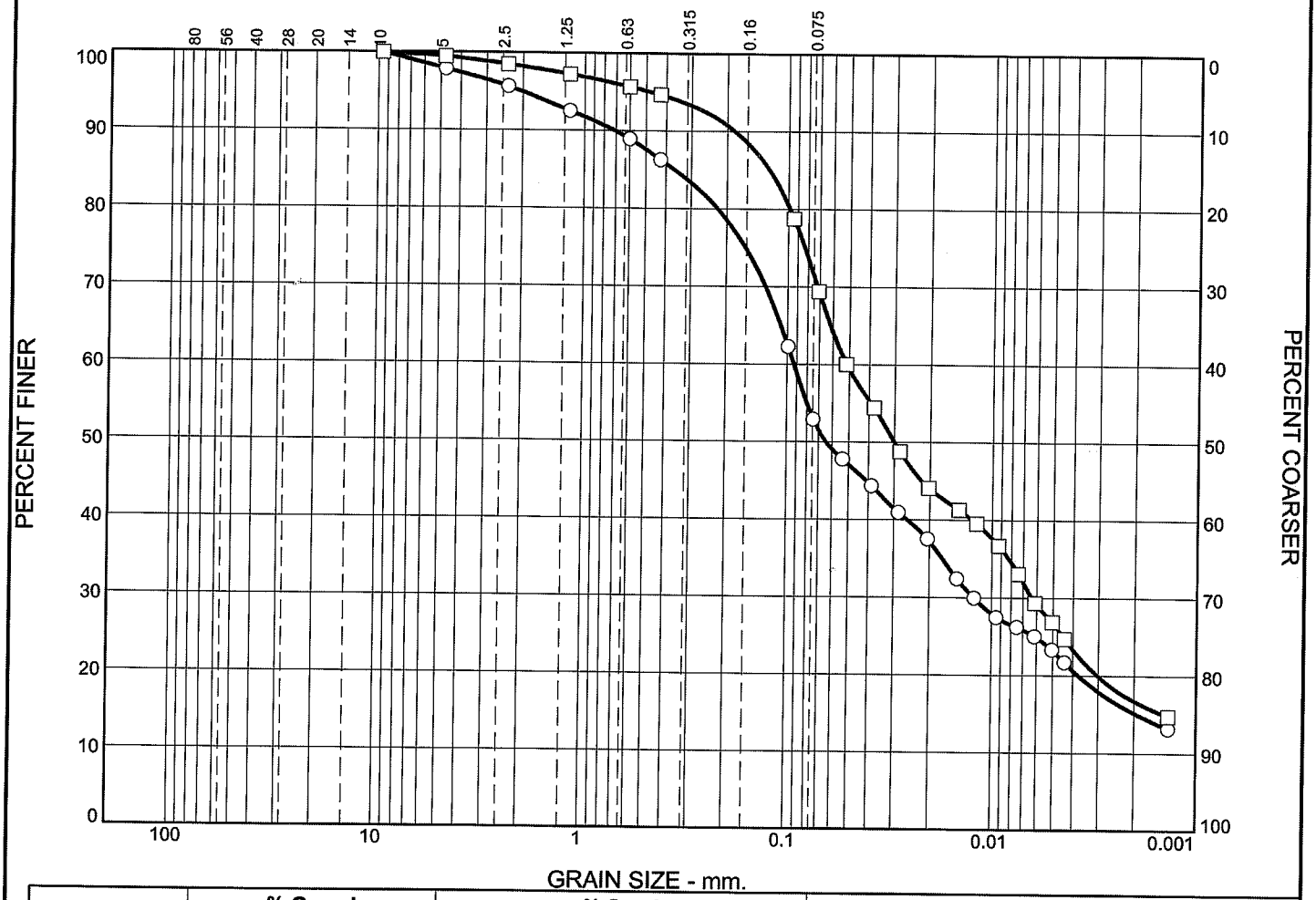
Figure 4

Tested By: RP **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	2	3	9	33	38	15
□	0	0	1	1	3	24	54	17

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3636	0.0930	0.0646	0.0122	0.0019			
□			0.1240	0.0517	0.0299	0.0064	0.0014			

Material Description	USCS	AASHTO
○ SANDY SILTY CLAY, trace gravel		
□ SANDY SILTY CLAY, trace gravel		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 3, Sample 5

□ **Sample Number:** BH 3, Sample 7

Remarks:

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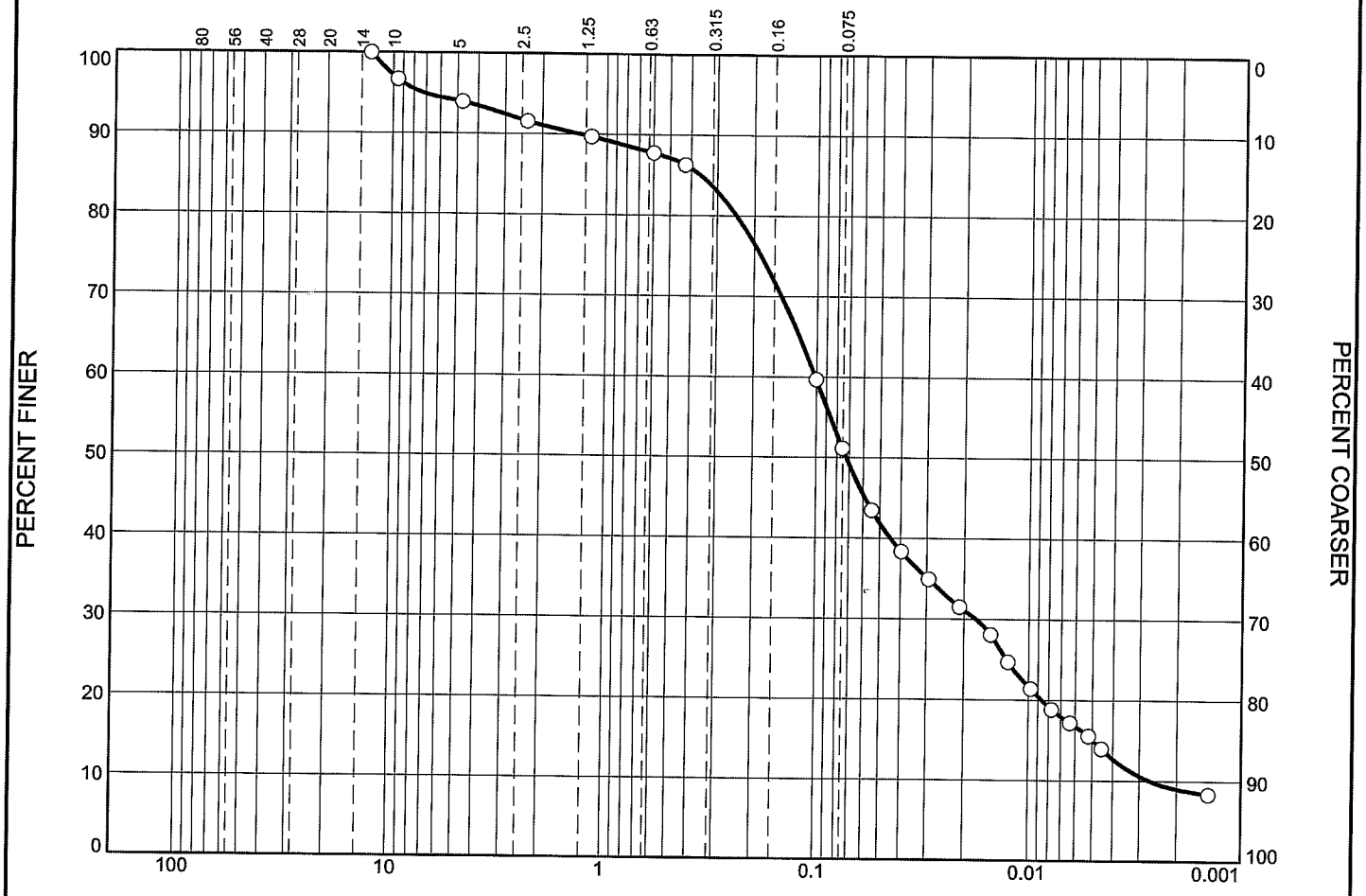
Figure 5

Tested By: ● GL/GL ■ AR/GL **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	6	3	5	35	42	9

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3606	0.1020	0.0724	0.0177	0.0050	0.0027	1.14	37.98

Material Description	USCS	AASHTO
○ SILT and fine SAND, trace clay, trace gravel		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 3, Sample 6

Remarks:

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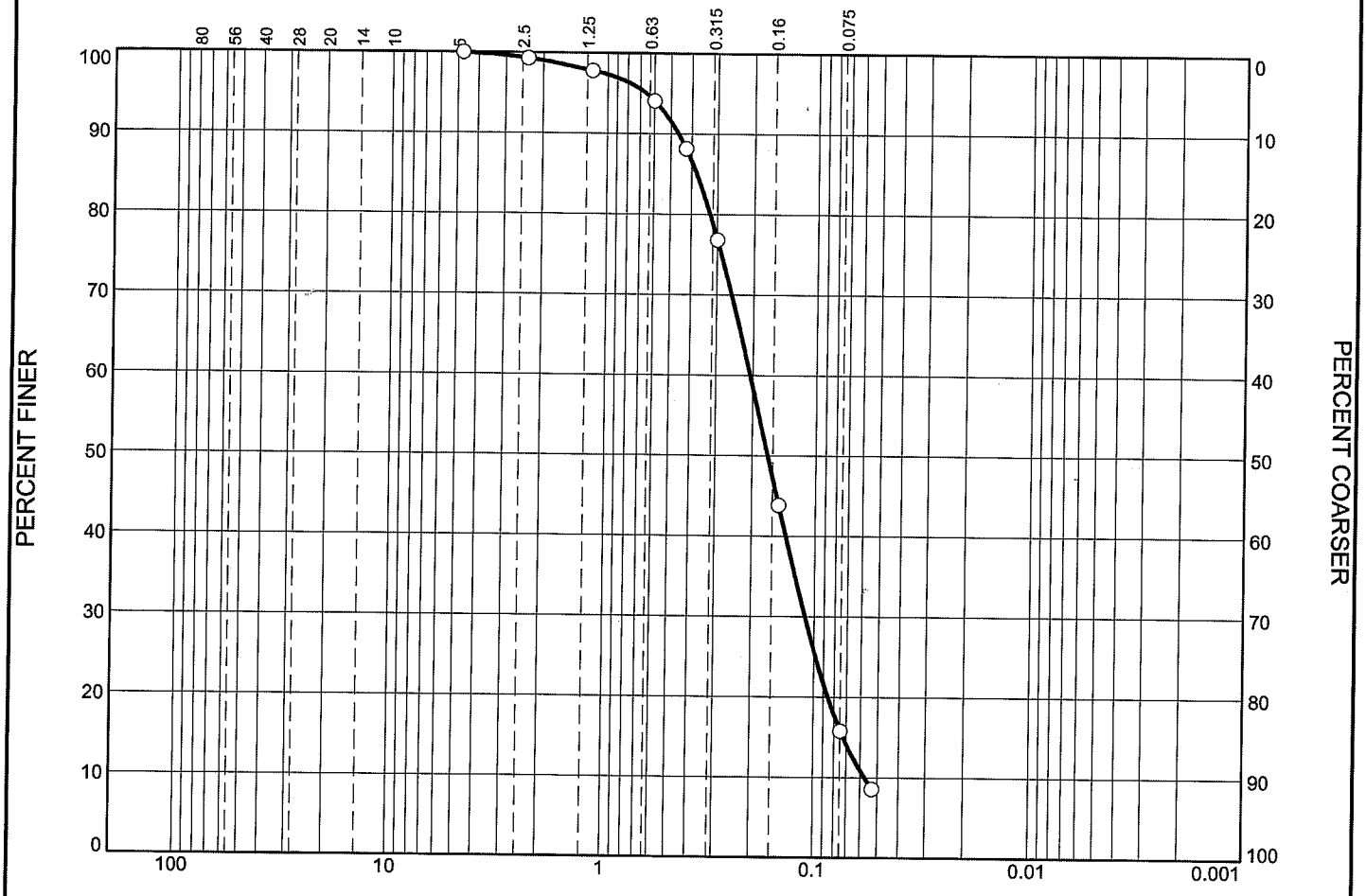
Figure 6

Tested By: RP/GL **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	1	11	72	16	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.3785	0.2072	0.1697	0.1115	0.0728	0.0574	1.04	3.61

Material Description	USCS	AASHTO
○ fine SAND, some silt		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 3, Sample 9A

Remarks:

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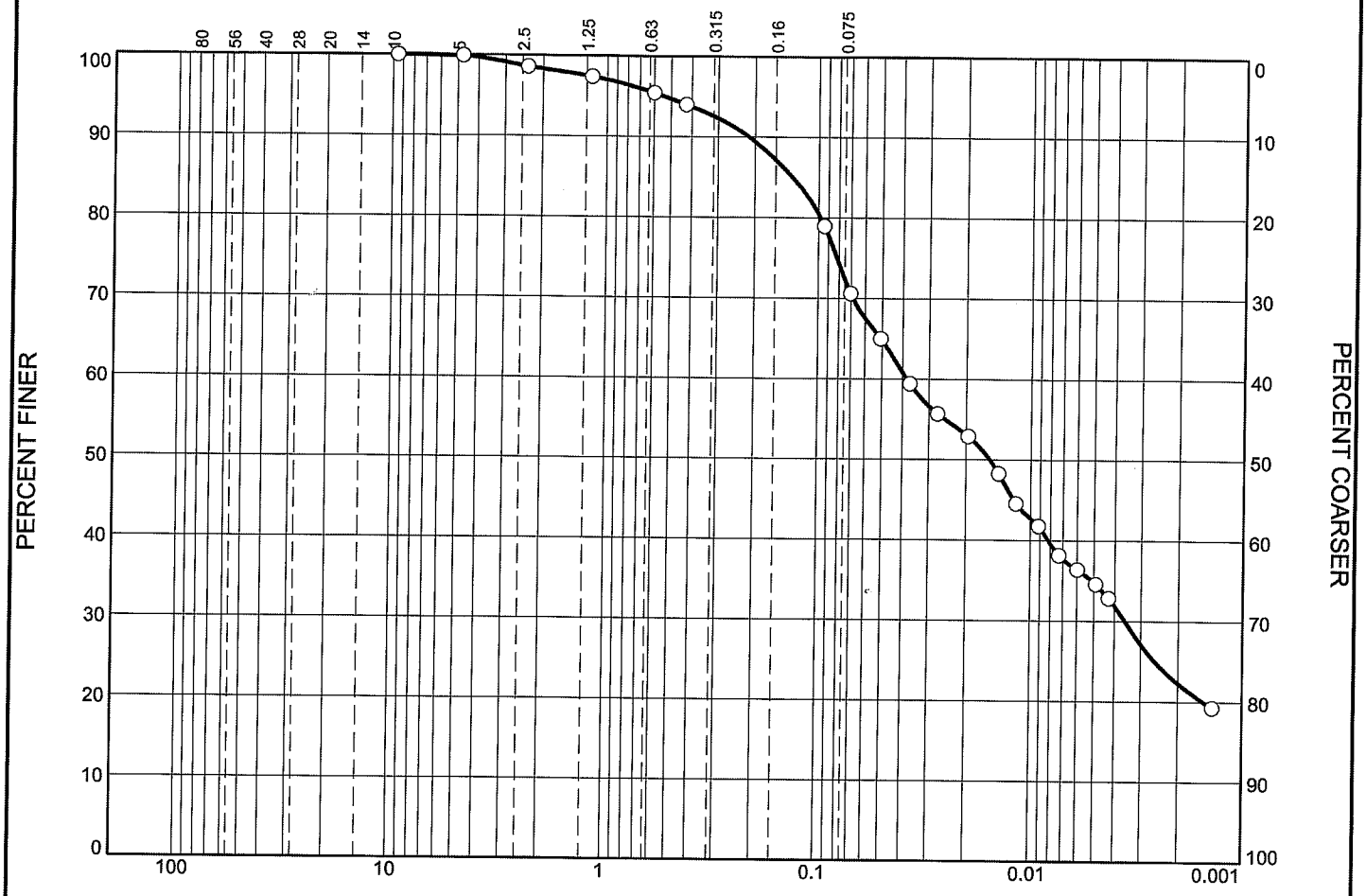
Figure 7

Tested By: AR **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	2	4	22	50	22

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.1335	0.0383	0.0156	0.0036				

Material Description	USCS	AASHTO
○ SANDY SILTY CLAY		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 8, Sample 5A

Remarks:

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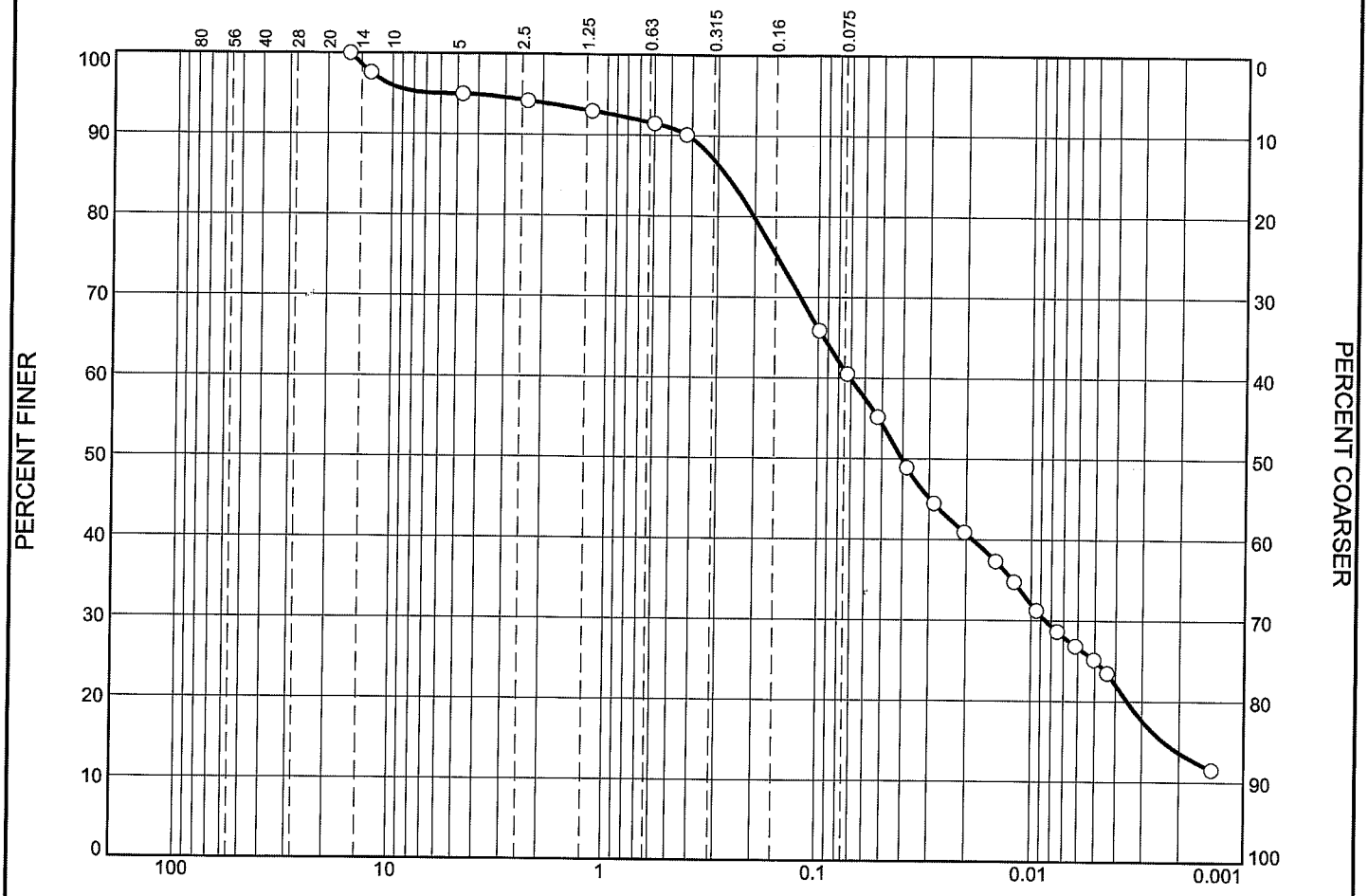
Figure 8

Tested By: GL/GL **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	5	1	4	29	47	14

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2727	0.0707	0.0405	0.0086	0.0024			

Material Description	USCS	AASHTO
○ fine SANDY SILT, some clay, trace gravel		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 7, Sample 5

Remarks:

alston associates inc.
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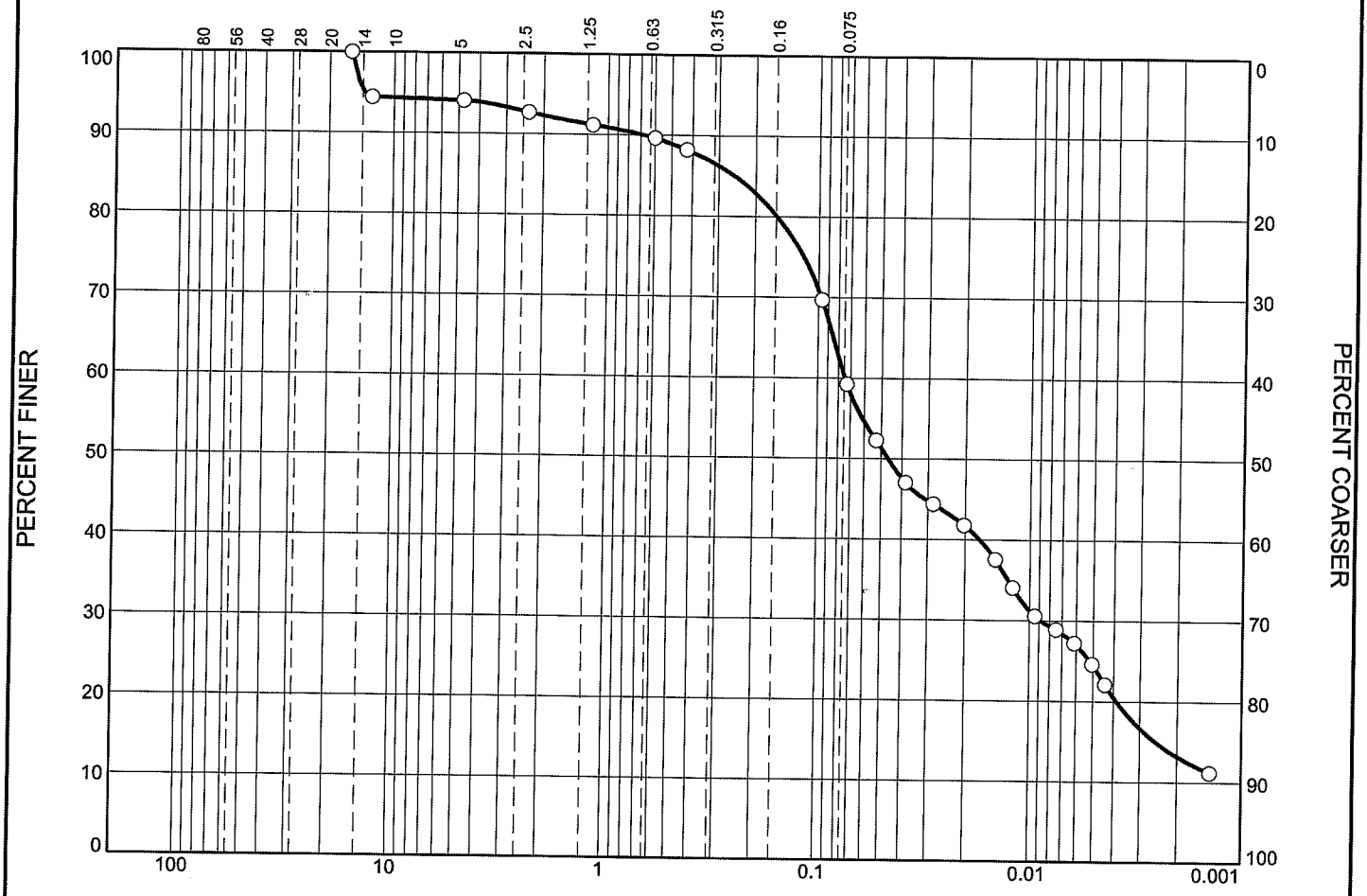
Figure 9

Tested By: AR/GL **Checked By:** JB

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	6	2	4	28	47	13

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.2523	0.0747	0.0466	0.0089	0.0025			

Material Description	USCS	AASHTO
○ SILT and fine SAND, some clay, trace gravel		

Project No. 11-159 **Client:** The Municipal Infrastructure Group

Project: Storm Water Management Ponds

○ **Sample Number:** BH 7, Sample 8

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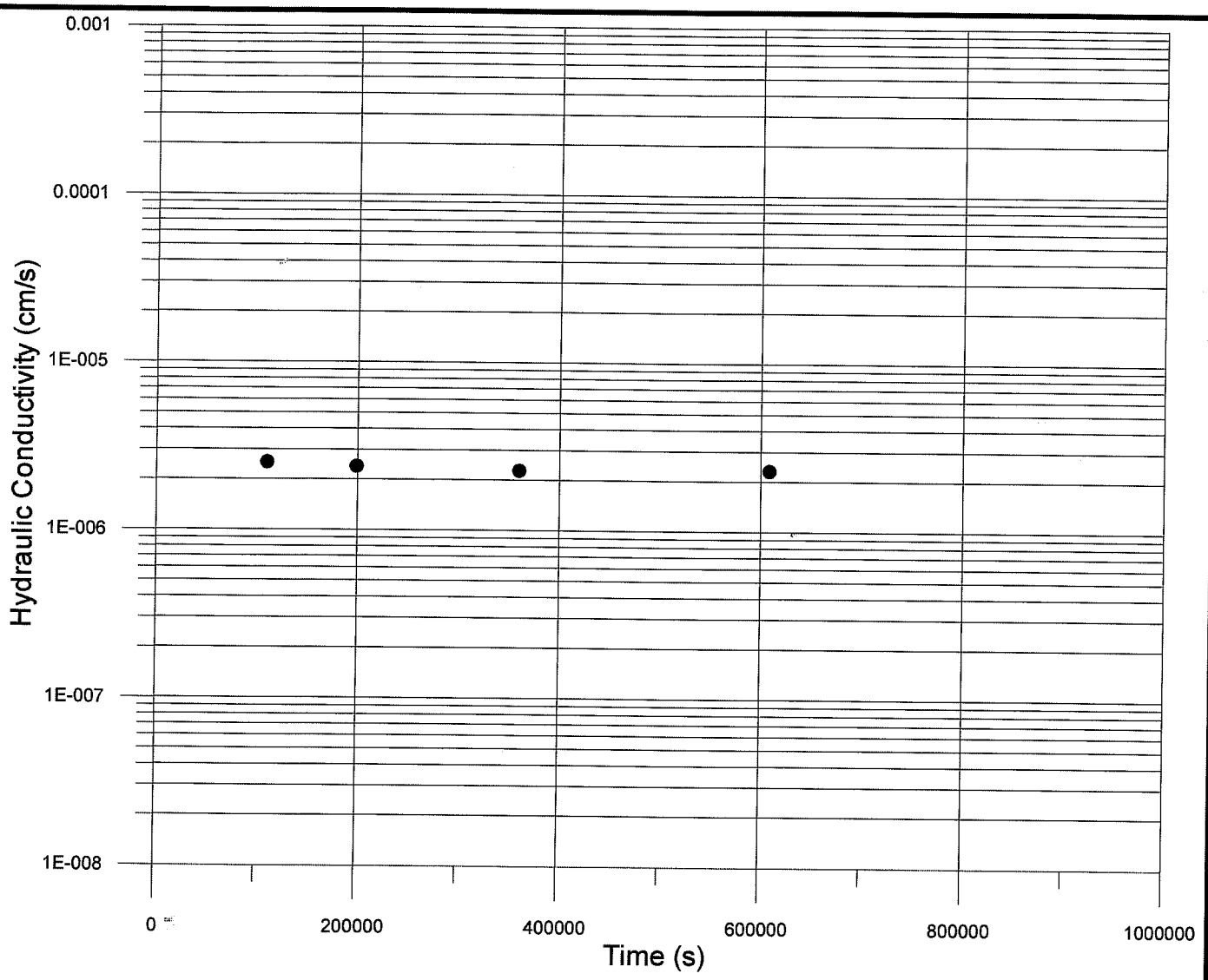
Remarks:

Figure 10

Tested By: AR/GL **Checked By:** JB

HYDRAULIC CONDUCTIVITY TEST REPORT



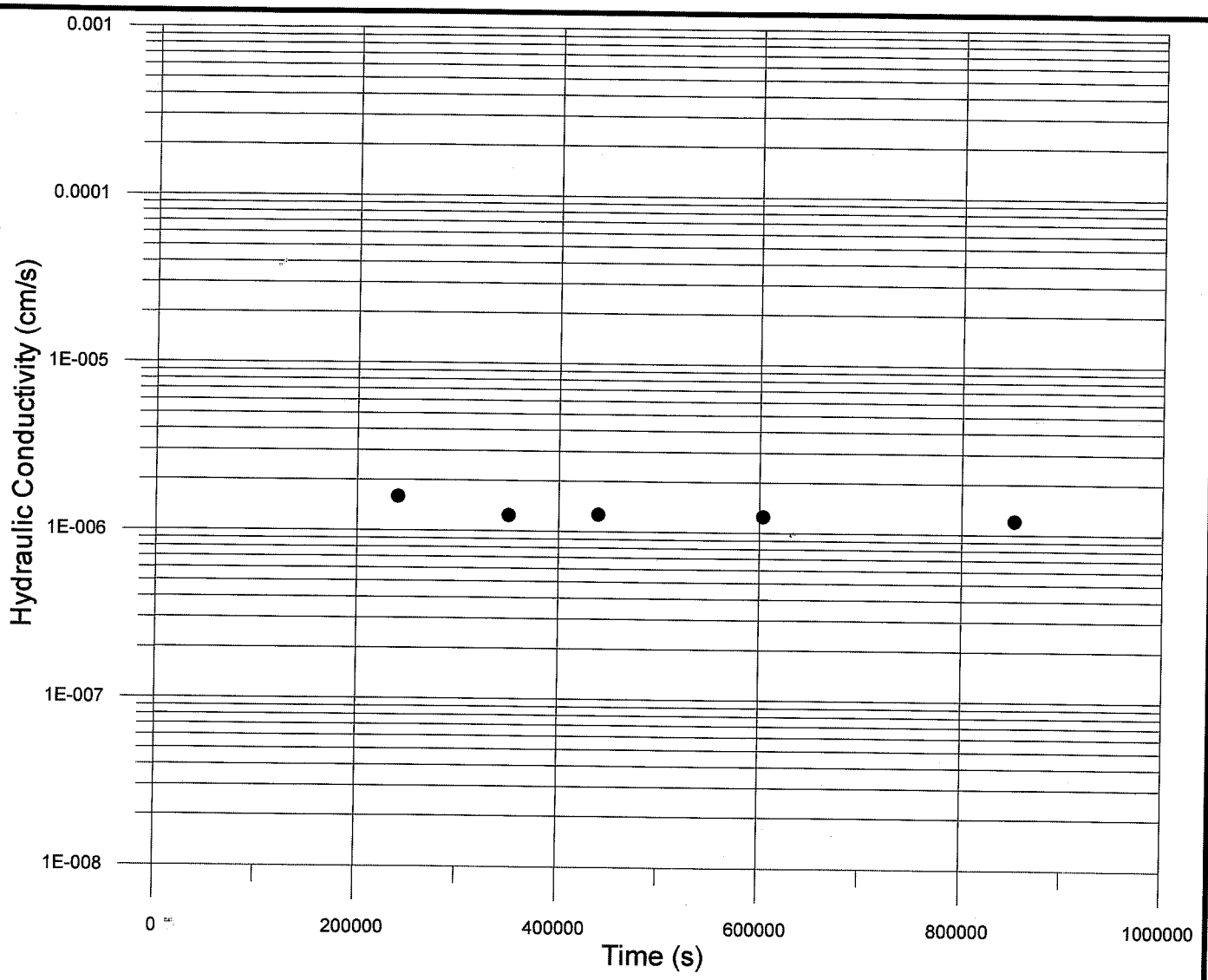
Client: The Municipal Infrastructure Group
Project: Storm Water Management Ponds, Vaughan
Alston Associates Inc. Ref. No.: 11-159
Material Description: grey fine SAND and SILT
Sample Location: Borehole 1, Samples 5, 6, 7 and 8 combined
Final Hydraulic Conductivity Reading (cm/s): 2.3×10^{-6}

Remarks:

alston associates inc.

Figure No. 11

HYDRAULIC CONDUCTIVITY TEST REPORT



Client: The Municipal Infrastructure Group
Project: Storm Water Management Ponds, Vaughan
Alston Associates Inc. Ref. No.: 11-159
Material Description: grey fine SAND and SILT, trace clay
Sample Location: Boreholes 7 and 8, Samples 8 and 9 combined
Final Hydraulic Conductivity Reading (cm/s): 1.2×10^{-6}

Remarks:

alston associates inc.

Figure No. 12