Peto MacCallum Ltd.
CONSULTING ENGINEERS

DETAIL FOUNDATION INVESTIGATION AND DESIGN REPORT

for

RETAINING WALLS
HOWARD AVENUE/CPR GRADE SEPARATION
GWP 3030-06-00
CITY OF WINDSOR, ONTARIO

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PML Ref.: 07TF022A-2
Index No.: 170FIR and 171FDR
GEOCRES No.: 40J6-26
May 5, 2009

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City of Windsor, Ontario

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1. INTRODUCTION

This report summarizes the results of the foundation investigation carried out for the proposed Retaining Walls for the Howard Avenue/Canadian Pacific Railway (CPR) Grade Separation in the City of Windsor, District 32, London, Ontario. Peto MacCallum Ltd. (PML) conducted the foundation investigation for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

The project includes the construction of earth retaining walls on east side of the Howard Avenue and north and south of Memorial Drive and four earth retaining wing walls at the grade separation structure site. MRC initially prepared the preliminary design drawing, (M633RL1_PLAN) Design Plan dated May 2008 showing the location of the retaining wall structures. Modifications to the length of retaining wall structures and surrounding site grading were observed on drawings dated November 19 and December 16, 2008.

A previous preliminary geotechnical investigation for the new CPR overhead and reconstruction of Howard Avenue south of the CPR tracks was conducted by Golder Associates Ltd. (Golder) in May of 1990 and August of 2006, Report Nos. 901-4047 and 06-1140-156, and the data is reused this report.

This report pertains to the retaining walls for the project. Other foundation facets of this project were reported separately to efficiently incorporate changes in the design.

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The following separate reports were prepared:

PML Ref. No.	Report Title
07TF022A-1	Canadian Pacific Railway Overhead
07TF022A-2	Retaining Walls
07TF022A-3	Road Cuts and Deep Sewers
07TF022A-4	Pumping Station
07TF022A-5	SWM Ponds
07TF022A-6	Watermain Tunnels

The Final Detail Foundation Investigation Report should be listed in SP 109F10.

All elevations in this report are expressed in metres.

2. SITE DESCRIPTION AND GEOLOGY

Two retaining walls and four wing walls are proposed. The walls were given the following designations:

Retaining Walls	Wall Number
North Retaining Wall	Wall # 6
South Retaining Wall	Wall # 3
Wing Walls	
Northeast Wing Wall	Wall # 5
Northwest Wing Wall	Wall # 2
Southeast Wing Wall	Wall # 4
Southwest Wing Wall	Wall # 1

The north retaining wall is to be situated in front of the Windsor Professional Centre and extending around the northeast corner of the intersection of Howard Avenue and Memorial Drive. The south wall is to be located in front of the Aversa Family Dentistry building.

Four earth retaining wing walls are planned for the CPR grade separation structure. The wing walls extend to the north and south of the proposed railway overhead along both sides of Howard Avenue.

The project site is about 5 km north of the Highway 401/Howard Avenue interchange in the City of Windsor. Land use in the vicinity of the site comprises transportation corridors of the existing Howard Avenue, Canadian Pacific Railway, Essex Terminal Railway, Memorial Drive and other residential streets. Land use also includes professional buildings such as the Windsor Professional Centre and Aversa Family Dentistry buildings, other commercial/industrial buildings to the east and west of Howard Avenue and residential use along Memorial Drive.

The local topography of the site is generally flat. The ground cover beyond the paved roads and parking lots comprises grassed and gravel areas with local stands of trees along Howard Avenue and Memorial Drive.

The project is situated within the deep clay till glacial deposits of the Essex Clay Plain, a sub region of the St. Clair Clay Plain. Bedrock comprises middle Devonian limestone of the Paleozoic Era. The soil/bedrock interface is typically level and generally about 35 m deep.

3. INVESTIGATION PROCEDURES

The subsurface investigation for the retaining walls remote from the bridges was carried out on October 15 to 17, 22, 23, 25, 26 and 29 to 31, 2007 and October 6 to 10 and 14, 2008. The current boreholes were numbered in the 100-series to distinguish from those previously drilled by Golder during the preliminary investigation. The borehole for the proposed pumping station was designated PS1.

A total of eight boreholes relevant to the design and construction of the two retaining walls and eight boreholes relevant to the overhead wing walls were put down at the site during these periods. Boreholes 112 to 116 were drilled along the alignment of the of the proposed north retaining wall in front of the Windsor Professional Centre. Boreholes 1(P), 102, 106 and 120 were drilled along the alignment of the proposed south retaining wall in front of the Aversa Family Dentistry building. The boreholes were drilled to depths of 1.5 to 8.4 m at the locations shown on Drawings RW-1 and RW-2.

Boreholes 1, 103 to 105, 107, 108, 119 and PS1 were drilled at or near the wing walls of the CP railway overhead and vehicular bridge. These boreholes were drilled to depths ranging from 6.6 to 45.4 m including 2.8 to 6.6 m long cores taken from the underlying of bedrock in boreholes 1, 105, 107, 108.

PML organized and carried out the clearance of various private and public underground services and utilities in the vicinity of borehole locations and laid out boreholes locations on site. Several of the boreholes needed relocation due to interference from underground services and lack of permission to enter some of the properties. After completion of the investigation Callon Dietz Ltd. (CD) referred all the boreholes locations vertically and horizontally. All elevations in this report are expressed in metres and are referred to the geodetic datum.

The PML boreholes were advanced using continuous flight hollow and solid stem augers and mud rotary drilling methods, powered by a truck mounted CME-55 and CME-75 drill rigs, supplied and operated by a specialist drilling contractor, working under the full-time supervision of Field Supervisor from PML engineering staff.

Representative samples of the soils were recovered in the boreholes at depth intervals of 0.75 and 1.5 m. The soil samples were obtained using a split spoon sampler in conjunction with standard penetration tests. Penetrometer and in situ vane shear tests were also performed to assess the shear strength of the cohesive soils. It is noted that the results of penetrometer tests may be lower than the actual values due to sample disturbance.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes. Piezometers installed in boreholes 107, 119 and PS1 provided additional confirmation of the groundwater level observations. The water level observations are noted on the attached record of boreholes.

All boreholes were backfilled in accordance with the MTO guidelines and MOE Reg. 903 for borehole abandonment procedures using a bentonite/cement mixture grout.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. Recovered soil samples were returned to our laboratory for detailed visual examination, soil classification and laboratory testing. The laboratory test program comprised the following tests:

- Natural moisture content determinations (141)
- Grain size analyses (39)
- Atterberg limits (38)
- Unconfined compression (5)
- Quick Triaxial (1)

The results of the laboratory natural moisture content determinations, grain size analyses and Atterberg limits are shown on the Record of Borehole sheets. The grain size distribution charts from south and north retaining walls are presented in Figures GS-RW-1 to GS-RW-2 and the Atterberg limits results are presented in Figures PC-RW-1 to PC-RW-2 and are listed in Table A. For the overhead wing walls the grain size distribution charts are presented in Figures GS-WW-1 and GS-WW-3, the Atterberg limits results are presented in Figures PC-WW-1 and PC-WW-2 and are listed in Table B.

4. SUMMARIZED SUBSURFACE CONDITIONS

4.1 General

Refer to the Record of Borehole sheets for the details of the subsurface conditions including soil classifications, inferred stratigraphy, soil boundary levels and groundwater observations.

The borehole locations and the layout of the north and south retaining wall structures are presented on the attached drawings RW-1 and RW-2.

4.2 North Retaining Wall – Windsor Professional Centre

The soil stratigraphy revealed in the boreholes 112 to 116 relevant to the proposed north retaining wall generally comprised of topsoil or fill overlying cohesive deposits of silty clay and/or clayey silt till.

4.2.1 Fill /Topsoil

A 600 and 700 mm thick fill unit was present in boreholes 113 and 112, respectively. The unit comprised dark brown clayey silt with topsoil inclusions. Brick fragments were noted within the fill in borehole 113. The fill extended to elevations 187.5 to 187.7. The consistency of the fill was stiff. N values were 10 and 13. The water content of the two representative samples of the fill was 12 and 37%.

A 300 and 400 mm thick surficial topsoil layer was present in boreholes 115 and 114, respectively. The topsoil layer extended to elevations 187.5 and 187.7. The topsoil consisted of dark brown to black clayey silt with organics. The moisture content values of two representative samples of topsoil were 18 and 24%.

In borehole 116, a 100 mm thick gravelly sand fill unit was encountered underlying the surficial asphalt layer and extended to 0.2 m depth, elevation 187.9. Borehole 116 was drilled within the Windsor Professional Center south parking lot/driveway.

4.2.2 Silty Clay Till / Clayey Silt Till

Deposits of cohesive glacial clayey silt till with local silty clay till layers was encountered below the fill or topsoil in all of the boreholes.

A 1.3 and 2.7 m thick localized silty clay till layer was present at 0.7 and 0.2 m depth (elevations 187.7 and 187.9) below the fill in boreholes 112 and 116. The till layer comprised silty clay with sand to sandy in borehole 112 and contained trace amounts of gravel. The layer extended to the underlying clayey silt till at 2.0 and 2.9 m depth (elevations 186.4 and 185.2).

A cohesive clayey silt till was encountered below the topsoil and fill at 0.3 to 0.6 m depth (elevations 187.5 and 187.7) in boreholes 113 to 115 and beneath the silty clay till at 2.0 and 2.9 m depth (elevations 186.4 and 185.2) in boreholes 112 and 116. A stratum with lower plasticity characteristics, about 1.2 m thick was locally contacted at 5.7 m depth (elevation 182.4) in borehole 116. The till deposit comprised clayey silt with sand becoming sandy in borehole 116 and contained trace amounts of gravel. The till deposit extended to termination depths of 4.3 to 8.1 m (elevations 179.7 to 184.1) in boreholes 112 to 116.

These cohesive deposits typically include an upper zone extending to approximately 5.5 to 7.0 m depths, elevations 181.0 to 182.0 with characteristically very stiff to hard consistency underlain by lower deposits which exhibit firm to stiff consistencies.

The grain size distribution charts of representative samples of the silty clay till are shown on Figure GS-RW-1. The Atterberg plasticity limits on the Plasticity Chart is presented on Figure PC-RW-1 and are listed in Table A. The liquid limit of the silty clay till was 38 and 40 the plastic limit 18, giving the plasticity index values of 20 and 22. The water content of representative samples of the silty clay till ranged from 14 to 23%.

The envelope of grain size distribution charts of representative samples of the clayey silt till is shown on Figure GS-RW-2. The grain size distribution chart of the sandy clayey silt till is shown on Figure GS-RW-2. The Atterberg plasticity limits on the Plasticity Chart is presented on Figure PC-RW-2 and are listed in Table A. The liquid limits of the clayey silt ranged from 25 to 33 and the plastic limits 14 and 16, giving the plasticity index values 11 to 17. The sandy clayey silt stratum with lower plasticity contacted at 5.7 m depth in borehole 116 had a liquid limit of 18 and plastic limit of 11, giving a plasticity index value of 7. Penetrometer test results conducted on select cohesive samples below 4.5 m depth (elevation 183.3) in boreholes 113 and 115 ranged from 50 to 113 kPa. The water content of the clayey silt till varied from 11 to 19%.

The test results indicate that these boreholes were terminated within the upper layer of desiccated clayey soils typical of the City of Windsor area.

4.2.3 Groundwater

No water was observed in any of the boreholes during or upon completion of drilling. However, it is noted that the groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.

4.3 South Retaining Wall – Aversa Family Dentistry

Boreholes 102, 106 and 120 were considered for the south retaining wall. The previous geotechnical pavement borehole 1(P) conducted by Golder at Sta. 10+222 in May of 1990, Report No. 901-4047, was considered for the subsoil conditions of the proposed south retaining wall.

The soil stratigraphy revealed in the boreholes comprised a pavement or granular structure over deposits of fill/topsoil overlying cohesive deposits of clayey silt till.

4.3.1 Pavement

A 250 mm thick concrete pavement structure was encountered in boreholes 106 and 120. In borehole 106, the concrete was overlain with 50 mm of asphaltic concrete. Underlying the pavement structures, 200 to 250 mm of sand to gravelly sand base materials were contacted. The underlying base materials extended to 0.5 m depth (elevations 186.9 to 187.0).

In borehole 102, crushed limestone was contacted from the surface to 0.2 m depth below grade (elevation 187.4).

The pavement borehole 1(P) found a 30 mm thick asphaltic concrete layer overlying granular base materials to 0.5 m depth (elevation 187.2).

4.3.2 Fill/Topsoil

Underlying the crushed limestone or pavement structure at 0.2 and 0.5 m depth in boreholes 102 and 120, respectively, a 200 to 600 mm thick topsoil or fill layer was contacted. The fill layer in

borehole 120 comprised silty clay with organics and topsoil inclusions and extended to elevation 186.3. The topsoil in borehole 102 extended to 0.5 m depth, elevation 187.2.

The pavement borehole 1(P) contacted fill underlying the granular base materials at 0.5 m depth (elevation 187.2). The silty clay with some sand fill layer was penetrated at 0.9 m depth (elevation 186.8) on the underlying deposit of till.

The consistency of the fill unit in borehole 120 was stiff. An N value of 13 was found. The water content of the fill ranged from 17 to 25%.

4.3.3 Sandy Clayey Silt Till

Continuous glacial till deposits of cohesive sandy clayey silt containing oxidized stains were encountered below the fill or topsoil in all of the boreholes.

A 3.8 to 7.9 m thick sandy clayey silt till deposit was present at 0.4 to 1.1 m depth (elevations 186.3 to 187.2). The till deposit comprised sandy clayey silt and contained trace amounts of gravel. A stratum with lower plasticity was locally contacted at approximately 3.0 m depth (elevation 184.4) in borehole 120. The sandy clayey silt till deposit extended to 4.2 to 8.4 m the termination depths of boreholes 102, 106 and 120 (elevations 179.1 to 183.4).

These cohesive deposits typically exhibit firm to hard consistencies becoming stiff to very stiff with increased depth. N values varied from 7 to 49 with average values around 20. Penetrometer test results on cohesive samples ranged from 38 to 113 kPa. An unconfined compressive strength test conducted on a representative sample of the sandy clayey silt till at borehole 120 found a shear strength of 144 kPa (strain at failure of 20%).

An envelope of grain size distributions charts of representative samples of the sandy clayey silt till are shown on Figure GS-RW-2. The grain size distribution chart of the less cohesive sample from borehole 120 is also shown on Figure GS-RW-2. The Atterberg plasticity limits on the Plasticity Chart is presented on Figure PC-RW-2 and are listed in Table A. The liquid limit of the sandy clayey silt till was 25 to 29, the plastic limit was 14 to 15, giving the plasticity index values

of 11 to 14. The less cohesive sandy clayey silt stratum at borehole 120 had a liquid limit of 19 and plastic limit of 12, giving a plasticity index value of 7. The water content of representative samples of the sandy clayey silt till ranged from 13 to 18%.

4.3.4 Groundwater

No water was observed in any of the boreholes during or upon completion of drilling. However, it is noted that the groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.

4.4 Overhead Wing Walls

Boreholes 103 to 105, 107, 108, 119, PS1 and previous foundation borehole 1 conducted by Golder in August 2006, Report No. 06-1140-156 were drilled at or near the proposed overhead wing walls.

The subsurface stratigraphy revealed in the boreholes generally comprised surficial fill or topsoil, locally a pavement structure, underlain by an extensive deposit of clayey silt till mantling limestone bedrock. The soil referred to as silty clay till in the preliminary investigation (foundation borehole 1) is described as clayey silt till in accordance with the MTO standard soil classification.

4.4.1 Pavement

A 250 to 270 mm thick concrete pavement was encountered in boreholes 104 and 103, respectively, drilled from Howard Avenue. Underlying the concrete, 330 mm of sand and gravel and 350 mm of crushed limestone base materials extended to 0.6 m depth (elevations 187.2 to 187.4).

At borehole PS1, the pavement surface consisted of gravel with silt which was contacted from the surface to 0.3 m depth below grade, placed over a 200 mm layer of silty clay to 0.5 m depth (elevation 187.7).

A pavement structure from a commercial parking lot consisting of 130 mm thick asphaltic concrete and 630 mm thick granular material was reported in borehole 1. This pavement extended to about 0.8 m depth elevation 187.8.

4.4.2 Fill / Topsoil

Underlying the gravel or pavement structure at 0.3 and 0.6 m depth in boreholes PS1 and 103, respectively, a 200 mm to 1.1 m thick fill layer was contacted. The fill layer in borehole PS1 comprised silty clay and extended to 0.5 m depth (elevation 187.7). The fill in borehole 103 comprised sand, some silt to clayey silt with topsoil inclusions and extended to 1.7 m depth (elevation 186.3). The relative density / consistency of the fill in the boreholes was compact / firm. N values of 13 and 24 were found and the water content of the fill in borehole PS1 was 32%.

Underlying the pavement structure in borehole 1, 760 mm of silty clay fill mixed with sand and gravel was encountered. The water content of the silty clay fill was 17%. The fill was penetrated at 1.5 m depth (elevation 187.0) in the foundation borehole 1.

Surficial fill composed of sandy silt over slag and cinder was present in borehole 105 and of topsoil over sandy silt with organic inclusions was present in borehole 108. The fill was loose in relative density (SPT-'N' values of 7, 9) and had a water content of 16 and 29%. The fill was 400 and 700 mm in thickness and penetrated at elevations 187.7 and 187.4 respectively.

A 200 and 300 mm surficial topsoil layer was present in boreholes 107 and 119, respectively. The layer comprised dark brown clayey sandy silt and was penetrated at elevations 187.4 and 187.5.

Underlying the gravel and fill in borehole PS1, a 200 mm thick topsoil layer was encountered. The topsoil was penetrated at 0.7 m depth, elevation 187.5.

4.4.3 Silty Clay Till

A 800 mm thick silty clay till deposit was contacted beneath the fill and topsoil in borehole PS1 at 0.7 m depth (elevation 187.5). The till deposit comprised silty clay with sand and contained trace amounts of gravel. The deposit extended to the underlying clayey silt till at 1.5 m depth (elevation 186.7).

The consistency of the silty clay was stiff. The N value found within the deposit was 12. The deposit was moist with water content of 20%.

4.4.4 Clayey Silt Till

Directly beneath the fill, topsoil or local silty clay till at depths of 0.2 to 1.7 m (elevations 186.3 to 187.7) in all the boreholes was a major deposit of cohesive clayey silt till. The deposit extended to the 6.6 to 22.6 m depth (elevations 165.6 to 181.4) of exploration in boreholes 103, 104, 119 and PS1 and was interlayered with silty sand till in borehole 107. This deposit had a total thickness of 36.9 to 39.0 m in boreholes 1, 105, 107, 108. The clayey silt till was penetrated at depths of 38.4 to 39.4 m (elevations 148.7 to 150.2), with boulders detected in borehole 105 just above bedrock at a depth of 38.8 m (elevation 149.3).

The consistency of the clayey silt till was typically stiff to hard in the upper 4 to 5 m thick zone and firm to stiff underneath. The results of in situ vane testing carried out in the lower zone of the deposit yielded undisturbed shear strength values in a typical range of 50 to 100 kPa (soil sensitivity of 2). Penetrometer tests on samples of the clayey silt till indicated a shear strength varying between 20 and 125 kPa. Unconfined compression testing on representative samples of the deposit typically gave undrained shear strength values of 31 to 85 kPa, locally 117 to 186 kPa around 5 m depth in boreholes 104 and PS1 (strain at failure of 11 to 20%).

Grain size distribution analyses conducted by Golder on till samples in borehole 1 are presented in Appendix A on Figure 3. The envelope of grain size distribution charts of representative samples of the clayey silt till is shown on Figures GS-WW-1 and GS-WW-2. The Atterberg plasticity limits on the plasticity chart is presented on Figures PC-WW-1 and PC-WW-2 and are listed in Table B. The liquid limit of the clayey silt till ranged from 16 to 33 and plastic limit from 10 to 18, with a corresponding range in the plasticity index of 6 to 15. The moisture content of the deposit varied between 12 and 24%, locally reaching 35 and 46%. The Atterberg limits and moisture content results are given in Table B.

4.4.5 Silty Sand Till

A discontinuous layer of cohesionless silty sand till was encountered within the clayey silt till at a depth of 5.4 m (elevation 182.2) in borehole 107. This layer was 1.5 m thick and penetrated at 6.9 m depth (elevation 180.7). The till was compact in relative density (SPT-'N' value of 21).

The silty sand till had a moisture content of about 16%. The results of grain size distribution analysis performed on this material are presented in Figure GS-WW-3.

4.4.6 Bedrock

Bedrock was contacted below the clayey silt till at depths of 38.4 to 39.4 m (elevations 148.7 to 150.2) in four of the boreholes. The bedrock surface is relatively flat, rising in the southeast direction from elevations 148.7 to 148.8 at boreholes 105, 107 and 108 to elevation 150.2 in borehole 1.

The bedrock comprises light grey Middle Devonian limestone. A detailed description of the bedrock is given in Table C.

The measured core recovery varied between 63 and 100%. The RQD determined from rock cores in the current study ranged from 53 to 100%, thus indicating a fair to excellent quality rock. The borehole 1 log shows a poor to very poor quality rock in the upper 1.4 m thick zone below the bedrock surface, improving with depth to a good quality rock.

4.4.7 Groundwater

Perched water was detected in the process of augering at a depth of 1.1 m (elevation 187.5) in borehole 1 and at 0.4 m depth (elevation 187.7) in borehole 105. Groundwater was not observed in any of the boreholes upon completion of drilling in October 2007 due to the relatively impervious nature of the clayey silt till and limited time available for observation. During completion of borehole 107 and for the duration of the fieldwork at boreholes 119 and PS1 in October 2008, piezometers were installed. Upper and lower piezometers were installed in borehole PS1. The water level readings in the piezometers were as follows.

Date	Piezometric Water Level, m							
	Borehole 107		Borehole 119		Borehole PS1 (Upper)		Borehole PS1 (Lower)	
	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation
October 8, 2008	19.3	168.3						
October 10, 2008	18.9	168.7						
October 14, 2008	17.7	169.9	6.2	181.6				
October 15, 2008	17.4	170.2	4.7	183.1	Dry		Dry	
October 16, 2008	17.0	170.6	2.6	185.2	8.0	180.2	20.8	167.4
October 17, 2008					7.2	181.0	20.6	167.6

The slow rise in the observed water levels indicated that the native clayey silt till subsoil is relatively impervious. The readings were discontinued due to the long time required for completion of groundwater level stabilization. Based on the water content profile of the soil samples, it is anticipated that the groundwater at the site is at about 5.4 m depth, elevation 182.2.

Groundwater levels are subject to seasonal fluctuations and precipitation patterns.

5. MISCELLANEOUS

The field work was carried out under the supervision of Mr. M. Rapsey, Senior Technician, and direction of Mr. C. M. P. Nascimento, P.Eng., Senior Project Engineer. The drilling equipment was supplied by Aardvark Drilling Ltd. The laboratory work was carried out in the PML laboratory in Toronto.

This Detail Foundation Investigation Report was prepared by Mr. C.M.P. Nascimento, P.Eng., with the assistance of Ms. N.S. Balakumaran, BSc. and Mr. M.J. Narduzzi, BEng., and was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.

Carlos M. P. Nascimento, P.Eng.
Senior Project Engineer

Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

CN/BRG:mn-mi

TABLE A

LIST OF ATTERBERG LIMITS AND MOISTURE CONTENT RESULTS
NORTH AND SOUTH RETAINING WALLS

SOIL TYPE	BOREHOLE NO.	SAMPLE NO.	SAMPLE DEPTH (m)	ELEVATION (m)	LIQUID LIMIT (W_L)	PLASTIC LIMIT (W_P)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (W)
Silty Clay Till to Sandy Silty Clay Till	112	2	0.8 to 1.3	187.6	38	18	20	24
	116	2	1.5 to 2.0	186.6	40	18	22	15
Clayey Silt Till to Sandy Clayey Silt Till	106	2	1.5 to 2.0	186.0	29	15	14	13
	106	4	4.6 to 5.1	182.9	28	14	14	15
	106	6	7.9 to 8.4	179.1	26	15	11	18
	112	6	3.8 to 4.3	184.6	28	16	12	14
	113	4	3.1 to 3.6	185.0	29	16	13	14
	113	7	6.1 to 6.6	182.0	26	14	12	16
	114	2	0.8 to 1.3	187.3	33	16	17	15
	116	4	4.6 to 5.1	183.5	25	14	11	14
	116	5	6.1 to 6.6	182.0	18	11	7	11
	120	3	3.1 to 3.6	184.3	19	12	7	15
	120	5	6.1 to 6.5	181.3	25	14	11	16

* Elevation listed is the top of sample.

TABLE B

LIST OF ATTERBERG LIMITS AND MOISTURE CONTENT RESULTS
OVERHEAD WING WALLS

SOIL TYPE	BOREHOLE NO.	SAMPLE NO.	SAMPLE DEPTH (m)	ELEVATION (m)	LIQUID LIMIT (W_L)	PLASTIC LIMIT (W_P)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
Clayey Silt Till	105	5	3.1 to 3.6	185.0	23	14	9	14
		10	7.6 to 8.1	180.5	25	14	11	19
		11	9.1 to 9.6	179.0	26	15	11	19
		14	13.7 to 14.2	174.4	25	14	11	18
		17	18.3 to 18.8	169.8	22	13	9	18
		23	36.6 to 37.3	151.5	33	18	15	24
	107	3	1.5 to 2.0	186.1	28	15	13	13
		10	9.1 to 9.6	178.5	26	14	12	20
		15	16.7 to 17.2	170.9	24	13	11	18
		18	24.4 to 24.9	163.4	30	15	15	20
	108	5	3.1 to 3.6	185.0	26	14	12	15
		9	7.6 to 8.1	180.5	25	14	11	19
		13	13.7 to 14.2	174.4	25	14	11	21
		15	16.7 to 17.2	171.4	16	10	6	16
		22	36.6 to 37.2	151.5	30	16	14	24

* Elevation listed is the top of sample.

TABLE B

LIST OF ATTERBERG LIMITS AND MOISTURE CONTENT RESULTS
OVERHEAD WING WALLS

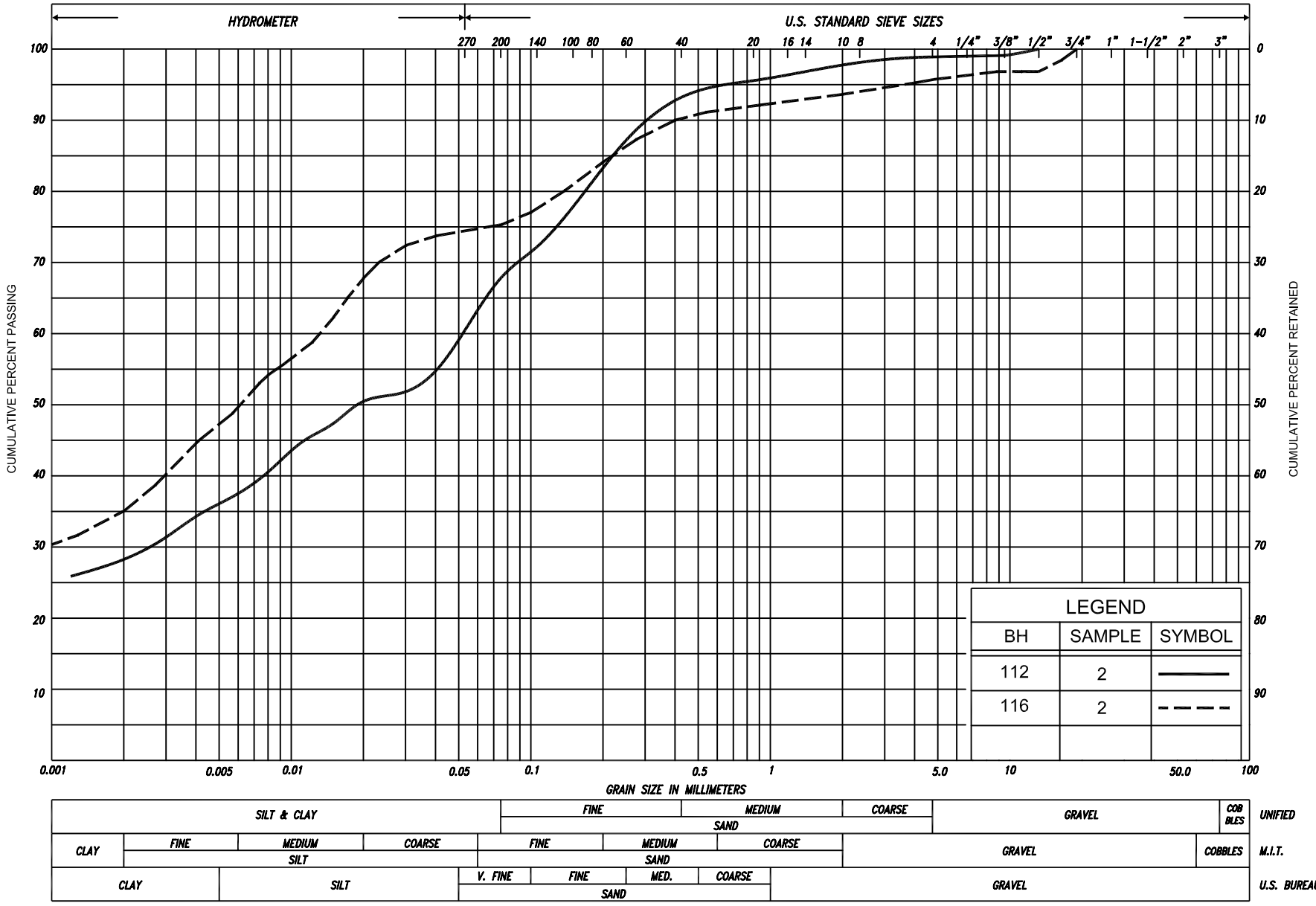
SOIL TYPE	BOREHOLE NO.	SAMPLE NO.	SAMPLE DEPTH (m)	ELEVATION (m)	LIQUID LIMIT (W_L)	PLASTIC LIMIT (W_P)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
Clayey Silt Till	103	2	3.1 to 3.6	184.9	28	16	12	18
	104	4	3.1 to 3.6	184.7	28	15	13	12
		6	6.1 to 6.6	181.7	22	13	9	15
	119	4	3.1 to 3.6	184.7	28	16	12	13
		7	7.6 to 8.1	180.2	23	14	9	15
		9	10.7 to 11.2	177.1	23	13	10	17
	PS1	5	4.6 to 5.2	183.6	25	14	11	14
		8	9.1 to 9.7	179.1	20	13	7	16
		9	10.7 to 11.3	177.5	25	14	11	18
		14	18.3 to 18.8	169.9	23	13	10	16

TABLE C
ROCK CORE DESCRIPTION

CORE RECOVERY					CORE DESCRIPTION	
BH	**RC**	**DEPTH (m)**	**REC (%)**	**RQD (%)**	**DEPTH (m)**	**DESCRIPTION**
105	24	39.4 – 40.7	100	90	39.4 – 43.3	LIMESTONE: Light grey, fine crystalline to aphanitic, with few styolitic partings, small chert nodules, occasional fossils, high strength, unweathered, close to moderate spaced flat partings, rough planar, tight, fair to good quality. (A 300 mm drop in core barrel and loss of water pressure was reported at 43 m depth during drilling. Some sand was observed near bottom of run. This is believed to be associated with an infilled vertical fissure rather than a continuous layer.)
	25	40.7 – 42.2	67	53		
	26	42.2 – 43.3	88	74		
107	22	38.8 – 39.3	100	100	38.8 – 39.4	LIMESTONE: Light grey, fine crystalline to aphanitic, with few styolitic partings, occasional fossils, high strength, unweathered, moderate spaced flat bedding layers, rough planar, tight, excellent quality.
	23	39.3 – 40.8	63	55		
	24	40.8 – 42.2	72	55	39.4 – 42.4	LIMESTONE WITH CLAY LAYERS: Limestone, as above, in 25 to 580 mm thick layers, interbedded with soft clay and/or sandy layers (typically 140 to 560 mm thick, total 990 mm), very close to moderate spaced flat bedding layers, rough planar, fair quality.
	25	42.2 – 43.9	98	98		
	26	43.9 – 45.4	100	100		
					42.4 – 45.4	LIMESTONE: Light grey to buff coloured, fine crystalline to aphanitic, occasional fossils, high strength, unweathered, wide spaced flat bedding layers, rough planar, tight, excellent quality.
108	23	39.3 – 40.5	100	100	39.3 – 42.1	LIMESTONE: Light grey becoming mottled brown, fine crystalline to aphanitic, with few styolitic partings, small chert nodules, high strength, unweathered, wide to moderate spaced flat partings, rough planar, tight, excellent quality.
	24	40.5 – 41.1	100	100		
	25	41.1 – 42.1	100	100		

RQD = Rock Quality Designation

Originated: JFW
Compiled: FP
Checked: GD / CN



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GRAIN SIZE DISTRIBUTION

SILTY CLAY, some sand to sandy, trace gravel
(TILL)

FIG No. GS-RW-1

PROJECT: HOWARD AVENUE

G.W.P. No. 3030-06-00

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Ontario

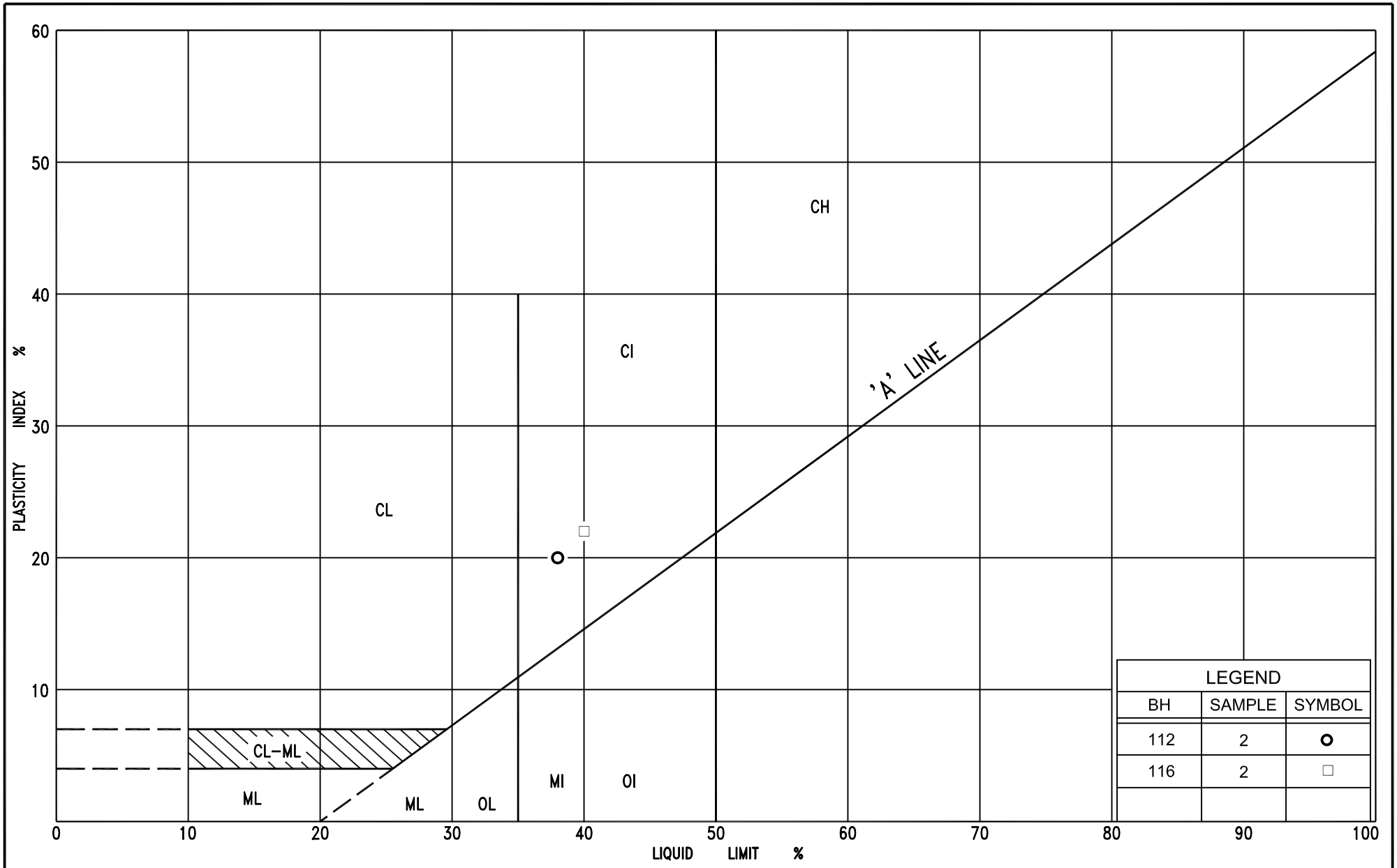
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, with sand to sandy, trace gravel
(TILL)

FIG No. GS-RW-2

PROJECT: HOWARD AVENUE

G.W.P. No. 3030-06-00



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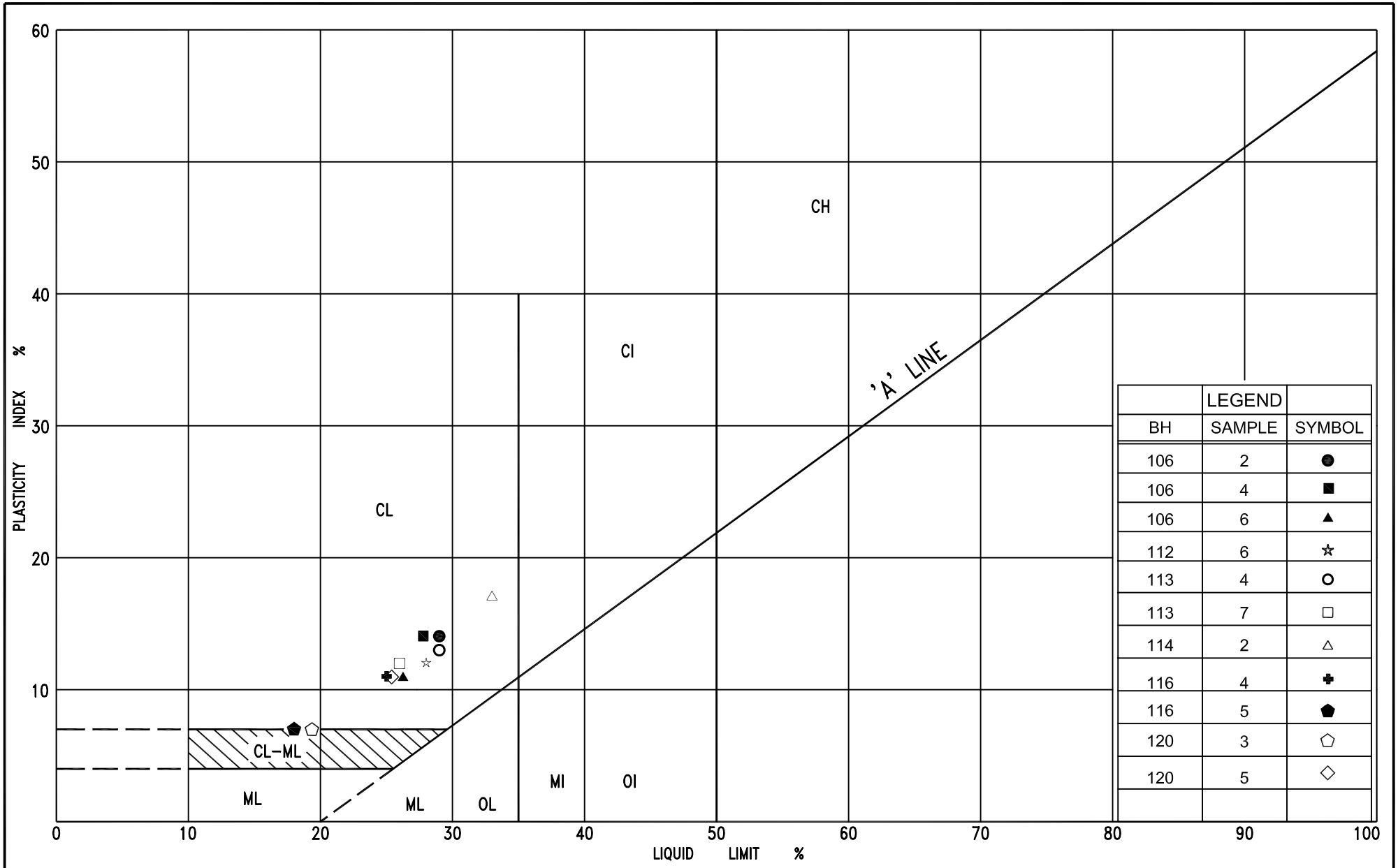
PLASTICITY CHART

SILTY CLAY, some sand to sandy, trace gravel
(TILL)

FIG No.	PC-RW-1
PROJECT:	HOWARD AVENUE
G.W.P. No.	3030-06-00



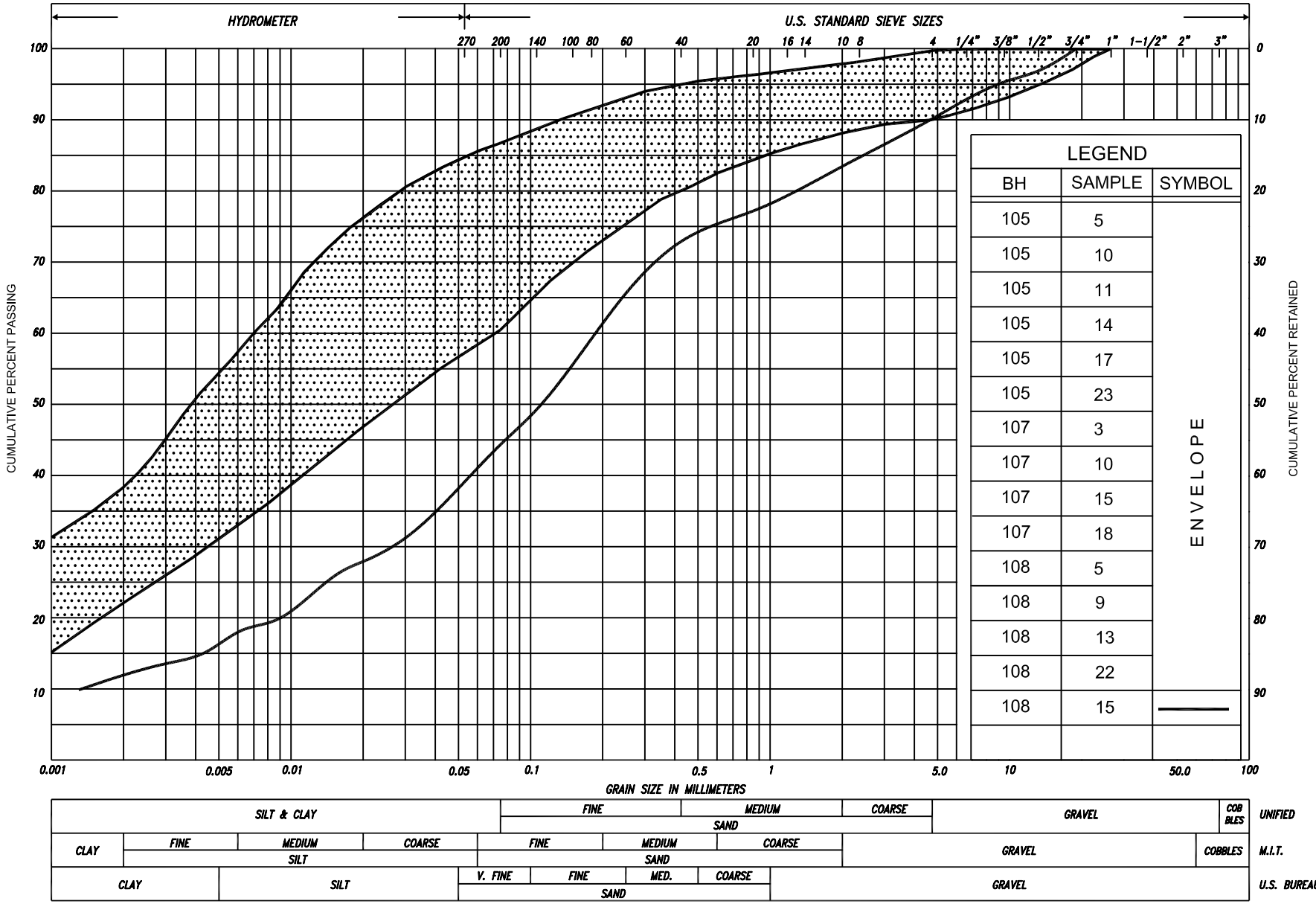
	LEGEND	
BH	SAMPLE	SYMBOL
106	2	●
106	4	■
106	6	▲
112	6	☆
113	4	○
113	7	□
114	2	△
116	4	✚
116	5	⬟
120	3	⬠
120	5	◇

Ministry of Transportation
Ontario

PLASTICITY CHART

CLAYEY SILT, with sand to sandy, trace gravel
(TILL)

FIG No.	PC-RW-2
PROJECT:	HOWARD AVENUE
G.W.P. No.	3030-06-00



Ministry of Transportation
Ontario

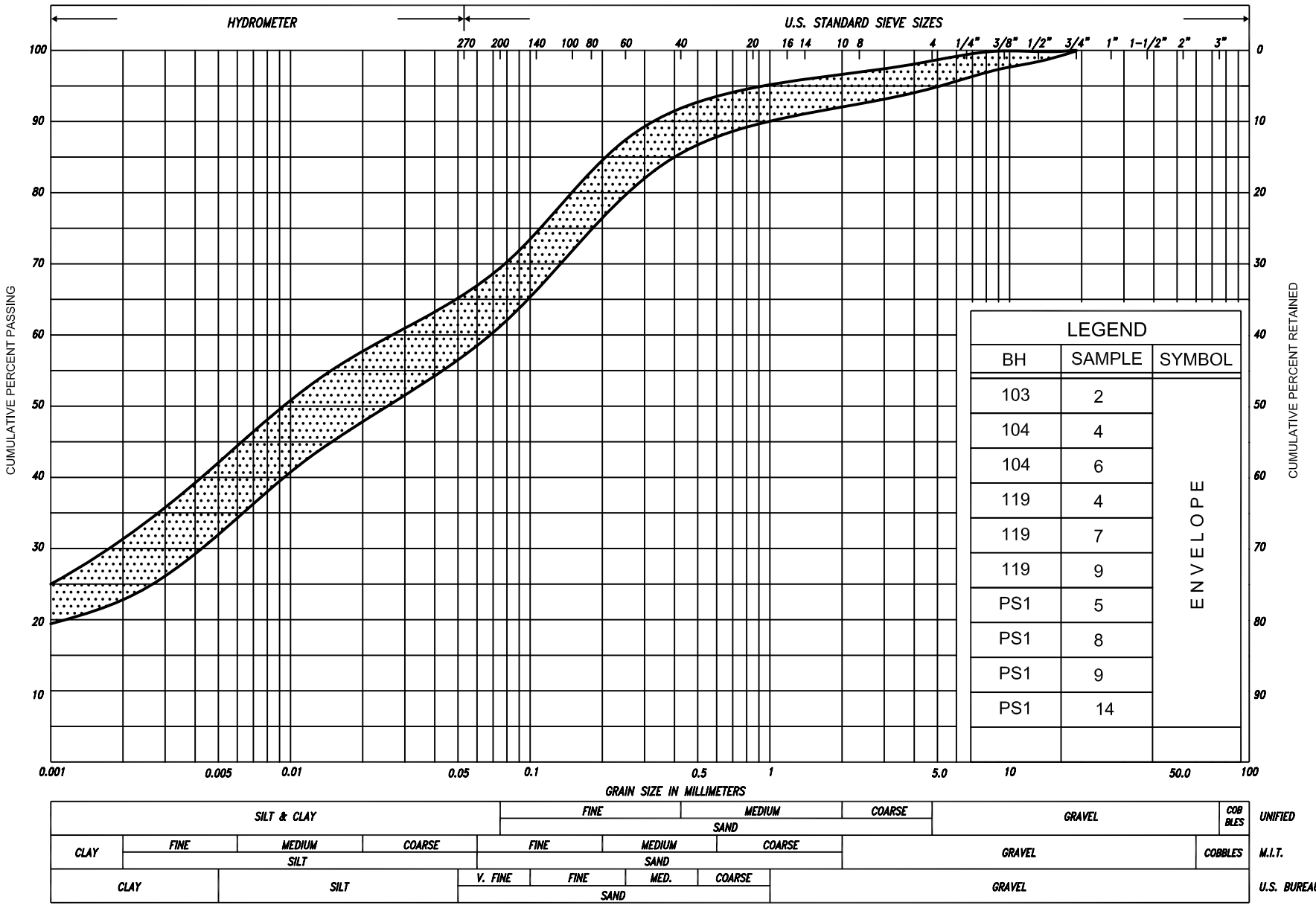
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand to sandy, trace gravel
(TILL)

FIG No. GS-WW-1

HWY: HOWARD AVENUE

G.W.P. No. 3030-06-00



Ministry of Transportation Ontario

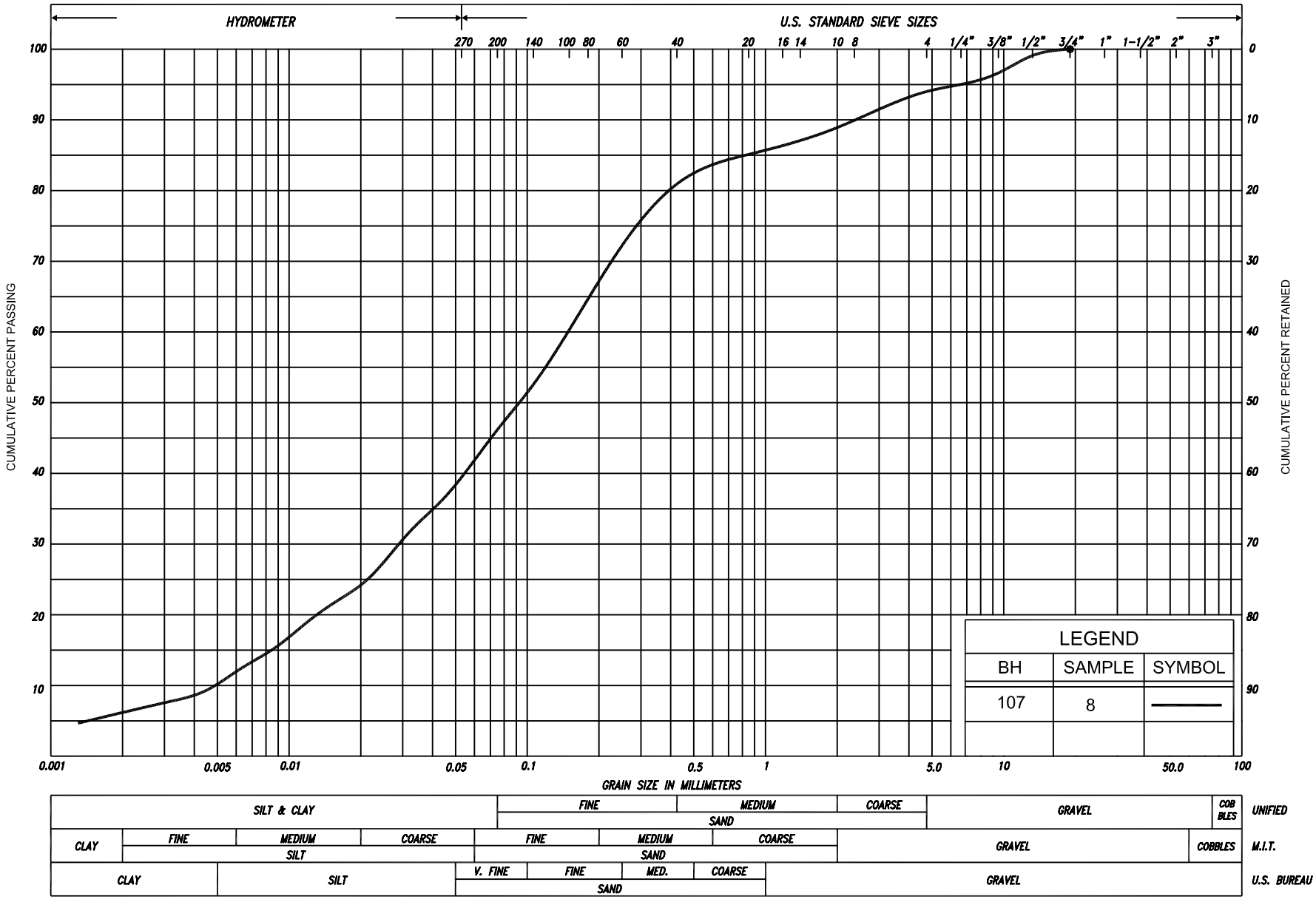
GRAIN SIZE DISTRIBUTION

CLAYEY SILT, some sand to sandy, trace gravel
(TILL)

FIG No. GS-WW-2

HWY: HOWARD AVENUE

G.W.P. No. 3030-06-00



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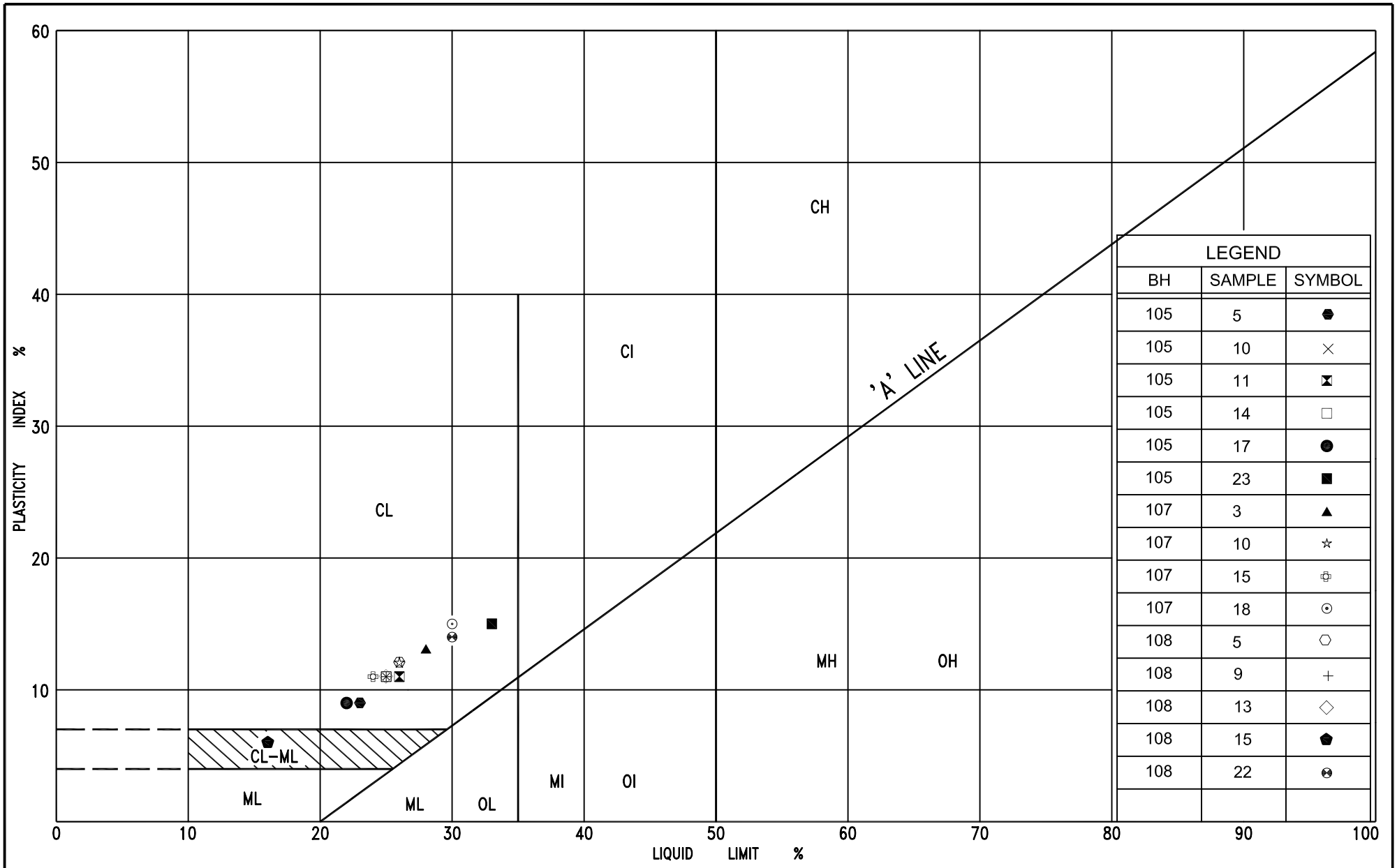
GRAIN SIZE DISTRIBUTION

SILTY SAND , trace clay, trace gravel
(TILL)

FIG No.	GS-WW-3
HWY:	HOWARD AVENUE
G.W.P. No.	3030-06-00



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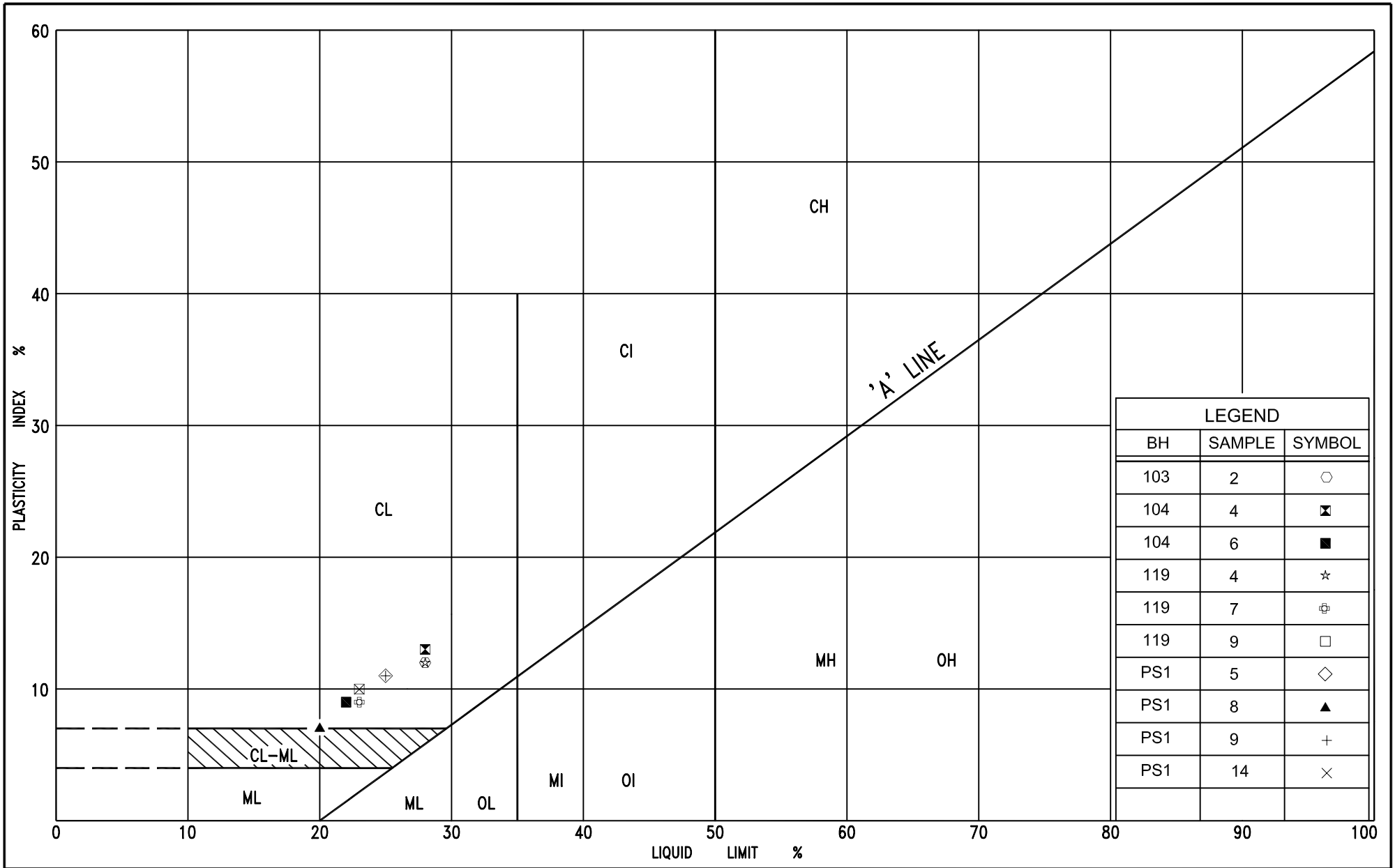
PLASTICITY CHART

CLAYEY SILT, some sand to sandy, trace gravel
(TILL)

FIG No. PC-WW-1

HWY: HOWARD AVENUE

G.W.P. No. 3030-06-00



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PLASTICITY CHART

CLAYEY SILT, some sand to sandy, trace gravel
(TILL)

FIG No.	PC-WW-2
HWY:	HOWARD AVENUE
G.W.P. No.	3030-06-00

EXPLANATION OF TERMS USED IN REPORT

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

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

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

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

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

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

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

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

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

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

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

JOINTING AND BEDDING:

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

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

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

STRESS AND STRAIN

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

MECHANICAL PROPERTIES OF SOIL

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

PHYSICAL PROPERTIES OF SOIL

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

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RECORD OF BOREHOLE No 102 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 683 885 N; 334 096 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 26, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.6 / 0.0	Ground Surface					*					
187.4 / 0.2	Sand and gravel										
	Brown Moist (FILL)										
187.2 / 0.4	Topsoil										
	Clayey silt, sandy trace gravel		1	SS	7		187				
	Firm to hard Brown Moist		2	SS	13		186				
	(TILL)		3	SS	34		185				
			4	SS	49		184				
	Grey		5	SS	17						
183.4 / 4.2	End of borehole										

* Borehole dry

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE (20 / 15 / 5 / 10)

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RECORD OF BOREHOLE No 103 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 683 933 N; 334 070 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B

DATUM Geodetic DATE October 25, 2007 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.0	Ground Surface					*					
0.0	270mm concrete over sand and gravel										
187.4	Brown Moist										
0.6	Sand, some silt						187				
	Clayey silt, some sand topsoil inclusions										
	Firm Brown Moist (FILL)		1	SS	13						
186.3							186				
1.7	Clayey silt with sand, trace gravel										
	Stiff to hard Brown Moist						185				
	(TILL)		2	SS	32						5 26 43 26
	Grey						184				
			3	SS	12		183	125 ■			
							182				
181.4			4	SS	12			■	○		
6.6	End of borehole										

* Borehole dry

■ Penetrometer test

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:17 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 104 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 683 975 N; 334 060 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 09, 2008 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.8	Ground Surface										
0.0	250mm concrete over crushed limestone										
187.2	Grey Moist										
0.6	(FILL)										
	Clayey silt with sand, trace gravel		1	SS	9		187				
	Firm to hard Brown Moist		2	SS	5		186				
	(TILL)		3	SS	32		185				
			4	SS	38						3 30 37 30
	Grey						184				
			5	SS	14		183			21.9	
							182				
			6	SS	9						3 29 42 26
							181				
179.7			7	SS	8		180				
8.1	End of borehole										

* Borehole dry

■ Penetrometer test

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:18 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 105 1 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 016 N; 334 030 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 29 to 31, 2007 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.1	Ground Surface						188		
0.0	Sandy silt, trace clay								
187.7	Loose Brown Moist		1	SS	7	▽			Perched water at 0.4m
0.4	(FILL)								
	Slag and cinder		2	SS	3		187		
	Black Wet								
	Clayey silt with sand, trace gravel		3	SS	4				
	Firm Brown Moist						186		
	(TILL) sandy		4	SS	12				
	Stiff to hard						185		
			5	SS	28				2 34 42 22
			6	SS	31		184		
	Mottled grey								
			7	SS	14		183		
	Grey								
			8	SS	10				
			9	SS	10		182		
				FV	2 176				
	Firm to stiff						181		
			10	TW	PH			21.7	2 32 39 27
							180		
			11	SS	5		179		3 31 38 28
				FV	2				
							178		
			12	SS	3				
				FV	2		177		
			13	SS	4		176		
				FV	2				
							175		
			14	SS	3				1 32 38 29
				FV	2		174		
173.1	Cont'd								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 20 40 60

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:20 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 105 2 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 016 N; 334 030 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 29 to 31, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
173.1 / 15.0	Clayey silt, sandy trace gravel Stiff Grey Moist (TILL)		15	SS	3		173				
			16	SS	4		172				
			17	SS	3		171				1 33 40 26
			18	SS	6		170				
			19	SS	8		169				
	trace sand lenses of silt silty clay layer Firm		20	SS	5		168				
	some sand, trace gravel Stiff Moist						167				
158.1	Cont'd						166				
							165				
							164				
							163				
							162				
							161				
							160				
							159				

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No 105 3 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 016 N; 334 030 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 29 to 31, 2007 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
158.1											
30.0	Clayey silt some sand, trace gravel Stiff to very stiff Grey Moist (TILL)		21	SS	10		158				
							157				
							156				
							155				
			22	SS	16		154				
							153				
							152				
			23	SS	9		151				1 16 45 38
	boulders						150				
148.7							149				
39.4	Limestone bedrock Unweathered High strength Fair to good quality		24	RC NQ	REC 100%		148				RQD 90%
	sand seams at depths of 41.9 and 43.0m		25	RC NQ	REC 67%		147				RQD 53%
			26	RC NQ	REC 88%		146				RQD 74%
144.8							145				
43.3	End of borehole										

Cont'd

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:20 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 105 4 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 016 N; 334 030 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 29 to 31, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	* 2007 10 29 ▽ Water level observed during drilling ** Borehole charged with drilling water ■ Penetrometer test C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers										

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:21 AM

+7, ×5 : Numbers refer to Sensitivity

20
15 — 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 106 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 683 963 N; 334 099 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 25, 2007 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.5	Ground Surface										
0.0 / 187.0	50mm asphaltic concrete over 250mm concrete over sand										
0.5	Brown Moist (FILL) Clayey silt, sandy trace gravel		1	SS	7		187		○		
	Firm to very stiff Brown Moist (TILL)		2	SS	25		186		○		2 31 39 28
			3	SS	38		185		○		
	Grey		4	SS	16		184	■	○		1 30 41 28
			5	SS	13		183	■	○		
179.1			6	SS	12		182		○		1 32 39 28
8.4	End of borehole						181				
							180				

* Borehole dry

■ Penetrometer test

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:22 AM

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE (20, 15, 5, 10)

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 107 1 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 048 N; 334 075 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY M.N.

DATUM Geodetic DATE October 15 to 17, 2007 and October 6 to 8, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.6	Ground Surface										
0.0	Topsoil										
187.4 / 0.2	Clayey silt with sand, trace gravel Stiff to hard Brown Moist (TILL)		1	SS	12		187				
			2	SS	13						
			3	SS	24		186				3 30 40 27
			4	SS	25		185				
			5	SS	37		184				
	Mottled grey		6	SS	30						
	Grey		7	SS	12		183				
182.2											
5.4	Silty sand trace clay, trace gravel Compact Grey Wet (TILL)		8	SS	21		182		Non-plastic		6 48 40 6
180.7							181				
6.9	Clayey silt with sand, trace gravel Firm to stiff Grey Moist (TILL)		9	SS	3		180	+2			
				FV							
			10	TW	PH		179			21.2	5 29 40 26
				FV			178	+2			
			11	SS	6		177				
				FV			176	+2			
			12	SS	4		175				
				FV				+2			
			13	SS	3		174				
				FV			173	+2			
172.6	Cont'd										

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:24 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 107 2 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 048 N; 334 075 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY M.N.

DATUM Geodetic DATE October 15 to 17, 2007 and October 6 to 8, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
172.6											
15.0	Clayey silt with sand, trace gravel Firm to stiff Grey Moist (TILL)		14	SS	4		172	+ 2			
				FV							
			15	SS	4		171		o		5 30 41 24
			16	SS	5		170		o		
							169				
							168				
			17	SS	7		167		o		
							166				
							165				
							164				
			18	SS	7		163		o		2 23 40 35
							162				
							161				
			19	SS	7		160		o		
							159				
							158				
157.6	Cont'd										

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:24 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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Foundation Design

RECORD OF BOREHOLE No 107 3 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 048 N; 334 075 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY M.N.

DATUM Geodetic DATE October 15 to 17, 2007 and October 6 to 8, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
157.6											
30.0	Clayey silt with sand, trace gravel Stiff to very stiff Grey Moist (TILL)		20	SS	11		157		○		
			21	SS	17		154		○		
148.8							149				
38.8	Limestone bedrock Unweathered High strength Fair to excellent quality		22	RC NQ	REC 100%						RQD 100%
			23	RC NQ	REC 63%		148				RQD 55%
			24	RC NQ	REC 72%		147				RQD 55%
			25	RC NQ	REC 98%		146				RQD 98%
			26	RC NQ	REC 100%		145				RQD 100%
142.6	Cont'd						144				
							143				

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:25 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 107 4 of 4 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 048 N; 334 075 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY M.N.

DATUM Geodetic DATE October 15 to 17, 2007 and October 6 to 8, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
142.6											
45.0											
142.2											
45.4	End of borehole										

* 2008 10 16

▼ Water level measured after drilling

■ Penetrometer test

Piezometer Legends :

- Bentonite seal
- Filter sand
- Screen
- Bentonite bed
- Native bed

Water Level Readings :

Date	Depth (m)	Elev.
10/08/2008	19.3	168.3
10/10/2008	18.9	168.7
10/14/2008	17.7	169.9
10/15/2008	17.4	170.2
10/16/2008	17.0	170.6

C.F.H.S.A: denotes Continuous Flight Hollow Stem Augers

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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Foundation Design

RECORD OF BOREHOLE No 108 1 of 3 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 049 N; 334 023 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 16 to 19, 2007 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.1 / 0.0	Ground Surface					188		
187.9 / 0.2	Topsoil							
	Sandy silt, trace clay organics, ashes, coal	1	SS	9				
187.4 / 0.7	Loose Mottled Moist black/brown (FILL)	2	SS	13		187		
	Clayey silt, sandy trace gravel							
	Stiff to hard Brown Moist (TILL)	3	SS	15				
		4	SS	14		186		
		5	SS	28		185		6 33 37 24
		6	SS	38				
	Very stiff Grey to stiff	7	SS	21		184		
		8	SS	11		183		
		9	SS	8		182		2 30 42 26
			FV			181		
		10	SS	8		180		
			FV			179		
		11	SS	5		178		
			FV			177		
		12	TW	PH		176		
			FV			175		
		13	TW	PH		174	23.1	10 29 37 24
			FV					
173.1	Cont'd							

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:27 AM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE: 20 / 15 / 10 / 5

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 108 2 of 3 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 049 N; 334 023 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 16 to 19, 2007 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.1							173				
15.0	Clayey silt, sandy trace gravel Stiff to very stiff Grey Moist (TILL)		14	SS	3						
				FV				5 165 +			
							172				
			15	SS	4				H		10 46 32 12
							171				
			16	SS	3		170		○		
							169				
							168				
							167				
			17	SS	12						
							166				
							165				
							164				
			18	SS	6				○		
							163				
	trace sand silty clay layer Firm						162				
							161		○	○	
			19	SS	5						
	some sand, trace gravel Stiff to very stif						160				
							159				
158.1	Cont'd										

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:27 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 108 3 of 3 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 049 N; 334 023 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE C.F.H.S.A. + Mud Rotary + NQ Coring COMPILED BY N.S.B

DATUM Geodetic DATE October 16 to 19, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	*					GR SA SI CL
158.1							158				
30.0	Clayey silt some sand, trace gravel Stiff to very stiff Grey Moist (TILL)		20	SS	11		157				
							156				
							155				
			21	SS	14		154				
							153				
							152				
			22	SS	13		151				1 12 55 32
148.8							150				
39.3	Limestone bedrock Unweathered High strength Excellent quality		23	RC NQ	REC 100%		149				RQD 100%
			24	RC NQ	REC 100%		148				RQD 100%
			25	RC NQ	REC 100%		147				RQD 100%
146.0							146				
42.1	End of borehole * Borehole charged with drilling water C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers										

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:28 AM

+7, ×5 : Numbers refer to Sensitivity

20
15 — 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 112 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 160 N; 334 008 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 23, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.4	Ground Surface					*					
0.0	Clayey silt topsoil inclusions		1	SS	10		188		○		
187.7	Stiff Dark brown Moist (FILL)										
0.7	Silty clay, sandy trace gravel		2	SS	10				○ w_P — w — w_L		1 31 40 28
	Stiff Brown Moist						187				
186.4	(TILL)		3	SS	14				○		
2.0	Clayey silt with sand, trace gravel						186				
	Hard Brown Moist		4	SS	32				○		
	(TILL)										
			5	SS	40		185		○		
184.1			6	SS	37				○ —		1 30 38 31
4.3	End of borehole										

* Borehole dry

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:29 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 113 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 137 N; 334 021 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 22, 2007 CHECKED BY G.D.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.1	Ground Surface										
0.0	Clayey silt, sandy topsoil inclusions and brick fragments		1	SS	13		188		○		
187.5											
0.6	Stiff Dark brown Moist (FILL)		2	SS	6		187		○		
	Clayey silt with sand, trace gravel										
	Firm to hard Brown Moist		3	SS	10		186		○		
	(TILL)										
			4	SS	34		185		○⊢		4 29 39 28
	Grey										
			5	SS	16		184		○		
			6	SS	18		183		○		
			7	SS	10		182	■	⊢○⊢		2 30 40 28
181.5											
6.6	End of borehole										

* Borehole dry

■ Penetrometer test

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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RECORD OF BOREHOLE No 114 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 140 N; 334 031 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 22, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.1	Ground Surface					*					
0.0 / 187.7	Topsoil		1	SS	4		188				
0.4	Clayey silt with sand, trace gravel Firm to hard Brown Moist (TILL)		2	SS	6		187				5 28 33 34
			3	SS	11		186				
			4	SS	55		185				
	Grey		5	SS	28		184				
			6	SS	14		183				
181.5			7	SS	11		182				
6.6	End of borehole										

* Borehole dry

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:31 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

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Foundation Design

RECORD OF BOREHOLE No 115 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 112 N; 334 051 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B

DATUM Geodetic DATE October 22, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.8	Ground Surface					*					
0.0 / 187.5	Topsoil		1	SS	6		187				
0.3	Clayey silt with sand, trace gravel Firm to hard Brown Moist (TILL)		2	SS	11						
			3	SS	19		186				
			4	SS	33		185				
			5	SS	37						
	Grey						184				
			6	SS	14		183	■	○		
							182				
			7	SS	8			■	○		
							181				
179.7			8	SS	9		180		○		
8.1	End of borehole										

* Borehole dry

■ Penetrometer test

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:31 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 116 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 117 N; 334 095 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 23, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
188.1	Ground Surface					*					
0.0	100mm asphaltic concrete						188				
187.9 0.2	over gravelly sand Brown Moist (FILL)										
			1	SS	9		187				
	Silty clay some sand, trace gravel Firm to stiff Brown Moist (TILL)		2	SS	10						5 20 40 35
185.2							186				
2.9	Clayey silt with sand, trace gravel lenses of silty sand Hard Brown Moist (TILL)		3	SS	53		185				
	Very stiff Grey		4	SS	25		184				2 30 38 30
	sandy Stiff		5	SS	15		183				4 46 33 17
180.0			6	SS	13		182				
8.1	End of borehole						181				
							180				

* Borehole dry

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:32 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 119 1 of 2 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 061 N; 334 057 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 10, 2008 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.8	Ground Surface										
0.0 / 187.5	Topsoil										
0.3	Clayey silt sandy, trace gravel Very stiff Brown Moist to hard (TILL)		1	SS	10		187				
			2	SS	20						
			3	SS	23		186				
						*	185				
			4	SS	38						2 30 36 32
	Stiff Grey						184				
			5	SS	13		183				
							182				
			6	SS	9			■			
							181				
			7	SS	9		180				2 30 38 30
				FV				+1			
							179				
			8	SS	6						
				FV			178	+3			
			9	SS	4		177				2 31 39 28
176.2				FV				+3			
11.6	End of borehole										

* 2008 10 16

▼ Water level measured after the drilling

■ Penetrometer test

Cont'd

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:34 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 119 2 of 2 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 061 N; 334 057 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 10, 2008 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
172.8											

Piezometer Legends :

Bentonite seal

Filter sand

Screen

Bentonite bed

Water Level Readings :

Date	Depth (m)	Elev.
10/14/2008	6.2	181.6
10/15/2008	4.7	183.1
10/16/2008	2.6	185.2

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No 120 1 of 1 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 683 921 N; 334 085 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 09, 2008 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
187.4	Ground Surface					*					
0.0	250mm concrete over sand and gravel						187				
186.9											
0.5	Brown Moist										
	Silty clay, organics topsoil inclusions		1	SS	13						
186.3											
1.1	Stiff Dark brown Moist (FILL)						186				
			2	SS	19						
	Clayey silt, sandy trace gravel oxidized stains						185				
	Very stiff Brown Moist to hard (TILL)										
			3	SS	31		184				
	Stiff Grey						183				
			4	SS	13			144		21.8	
							182				
180.9			5	SS	9		181				
6.5	End of borehole										

* Borehole dry

■ Penetrometer test

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:35 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No PS1 1 of 3 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 064 N; 334 015 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 14, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.2	Ground Surface										
0.0 / 187.7	Gravel, with silt over 0.2m Silty clay		1	SS	24		188				
0.5 / 187.5	Compact Grey/ brown Moist (FILL)										
0.7 / 187.0	Topsoil		2	SS	12		187				
	Silty clay with sand, trace gravel fissured, oxidized stains										
1.5 / 186.7	Stiff Brown Moist (TILL)		3	SS	14		186				
	Clayey silt with sand, trace gravel layers of silty sand										
	Stiff to very stiff Brown Moist (TILL)		4	SS	24		185				
	Grey						184				
			5	SS	12		183	186		21.6	2 30 38 30
			6	SS	11		182				
				FV				>100			
			7	SS	7		181			21.6	
				FV			180	>100			
	sandy layers of silty sand		8	SS	6		179				1 38 38 23
				FV				>100			
	some sand, trace gravel Grey Wet		9	SS	12		178				2 30 38 30
							177				
			10	SS	7		176				
							175				
			11	SS	8		174				
173.2	Cont'd										

ON_MOT VER3 07TF022A.GPJ ON_MOT.GDT 4/28/2009 11:52:37 AM

+7, ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No PS1 2 of 3 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 064 N; 334 015 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 14, 2008 CHECKED BY C.N.

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
173.2											
15.0	Clayey silt some sand, trace gravel Stiff to very stiff Grey Wet (TILL) Cont'd		12	SS	10		173				
				FV				+ 2			
							172				
			13	SS	13						
							171				
	sandy										
			14	SS	11		170				4 31 36 29
			15	SS	7		169				
			16	TW	PH	▼ *	168				
			17	SS	8						
							167	■ ○		25.7	
			18	TW	PH						
165.6			19	SS	11		166				
22.6	End of borehole										

* 2008 10 17

▼ Water level measured after drilling

■ Penetrometer test

Piezometer Legend :

- Bentonite seal
- Native cuttings
- Filter sand
- Screen
- Bentonite bed

Upper Water Level Readings :

Date	Depth (m)	Elev.
10/15/2008	Dry	...
10/16/2008	8.0	180.2
10/17/2008	7.2	181.0

Cont'd

+7, ×5 : Numbers refer to Sensitivity

(%) STRAIN AT FAILURE (20 / 15 5 / 10)

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
Foundation Design

RECORD OF BOREHOLE No PS1 3 of 3 METRIC

G.W.P. 3030-06-00 LOCATION Co-ords: 4 684 064 N; 334 015 E ORIGINATED BY M.R.

DIST 32 HWY Howard Avenue BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY M.N.

DATUM Geodetic DATE October 14, 2008 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH 158.2	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL

Lower Water Level Readings :

Date	Depth (m)	Elev.
10/15/2008	Dry	----
10/16/2008	20.8	167.4
10/17/2008	20.6	167.6

+7 , ×5 : Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

METRIC

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

CONT No
GWP No 3030-06-00

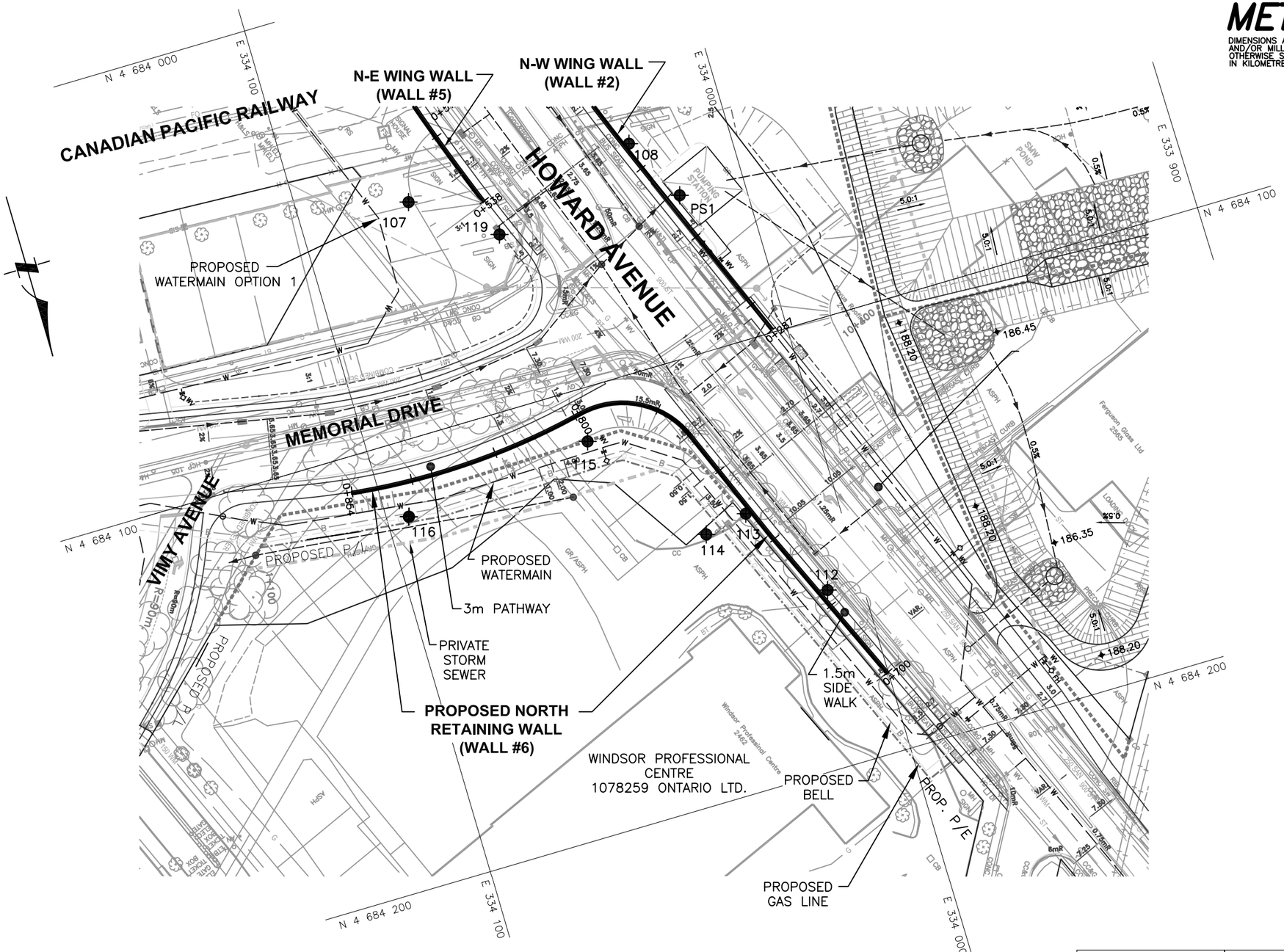
NORTH RETAINING WALL

HOWARD AVENUE/ CPR GRADE SEPARATION

BOREHOLE LOCATIONS

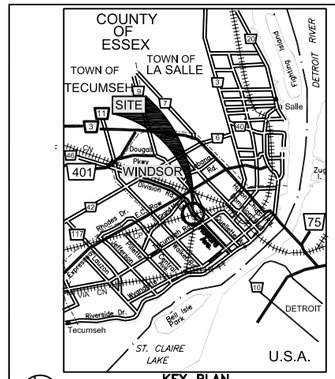
SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



PLAN

SCALE
10 0 10 20m



KEY PLAN
SCALE
2 0 2 4 6km

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- N Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Oct. 2007 and Oct. 2008
- Head ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	EASTINGS
107	187.6	4 684 048	334 075
108	188.1	4 684 049	334 023
112	188.4	4 684 160	334 008
113	188.1	4 684 138	334 021
114	188.1	4 684 140	334 031
115	187.8	4 684 112	334 051
116	188.1	4 684 117	334 095
PS1	188.2	4 684 064	334 015

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

REGISTERED PROFESSIONAL ENGINEER C M P Nascimento PROVINCE OF ONTARIO April 30, 2009

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY April 30, 2009 PROVINCE OF ONTARIO

REVISIONS

DATE	BY	DESCRIPTION

NOTE:

THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF No MRC DRAWINGS: H6933D02_DESIGN PLAN.dwg; H6933XA01.dwg; H6933XB01.dwg; H6933 Xd-prop-req.dwg; H6933XN01.dwg; H6933xu01.dwg and H6933XY2.dwg RECEIVED ON MAY 13, 2008 M6933RW_SH (ret wall profiles).dwg RECEIVED ON NOVEMBER 19, 2008

Geocres No. 40J6-26

HWY No	HOWARD AVENUE			DIST	32
SUBM'D	NSB	CHECKED MN	DATE APRIL 30, 2009	SITE	--
DRAWN	NA	CHECKED CN	APPROVED BRG	DWG	RW-1

METRIC

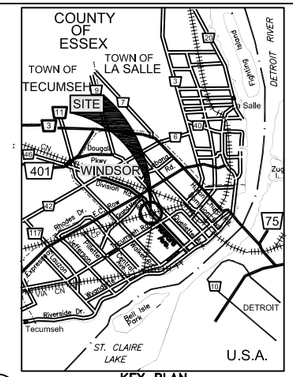
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 3030-06-00

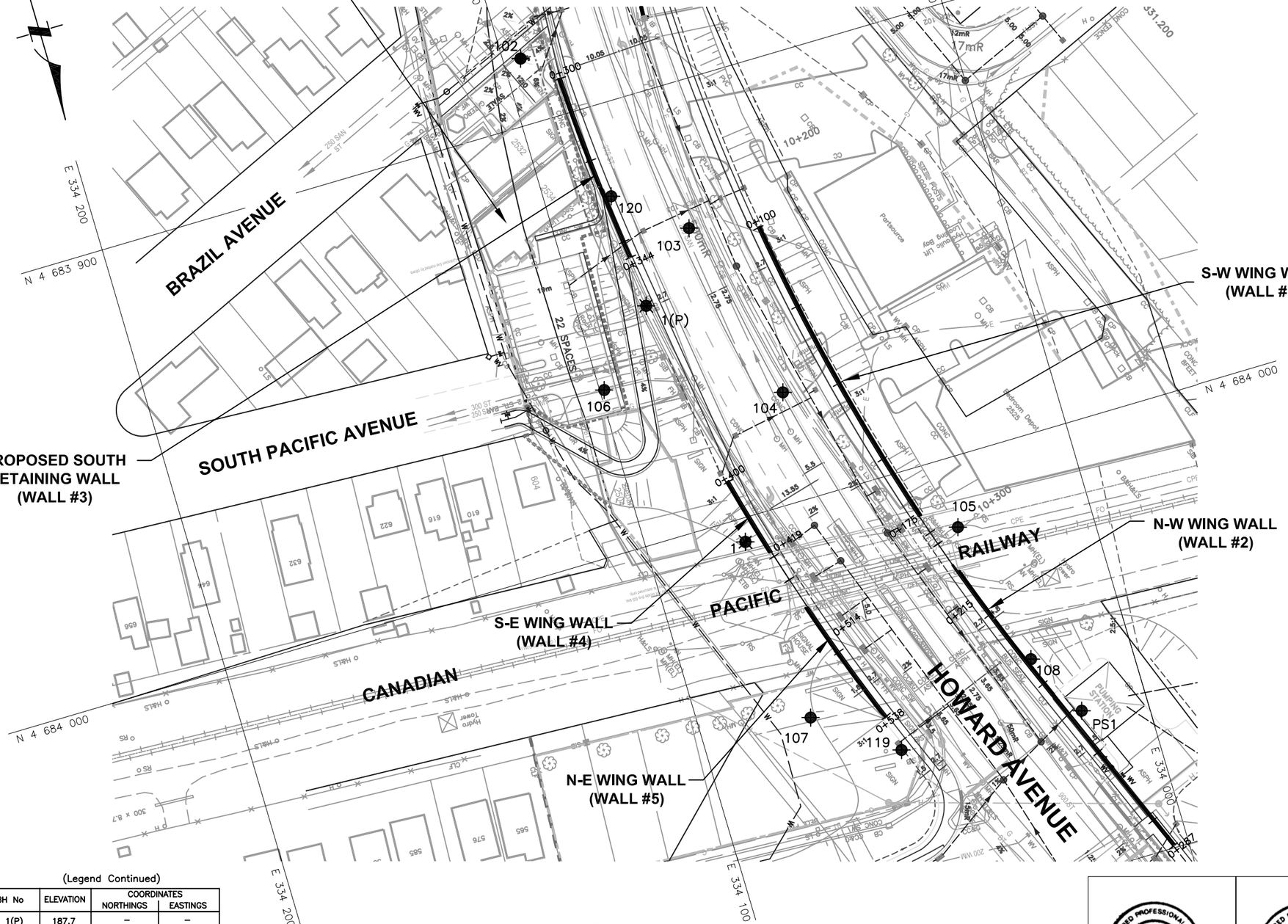
SOUTH RETAINING WALL AND WING WALLS
HOWARD AVENUE/ CPR GRADE SEPARATION
BOREHOLE LOCATIONS

SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS



KEY PLAN
SCALE
2 0 2 4 6km



PLAN
SCALE
10 0 10 20m

(Legend Continued)

BH No	ELEVATION	COORDINATES NORTHINGS	COORDINATES EASTINGS
1(P)	187.7	–	–
1	188.6	–	–

NOTE:

1. BOREHOLES 1(P) (FOR PAVEMENTS) AND 1 WERE PREVIOUSLY ADVANCED BY GOLDER ASSOCIATES LIMITED. CO-ORDINATES ARE NOT AVAILABLE.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

LEGEND

- Borehole
- Dynamic Cone Penetration Test (Cone)
- Borehole & Cone
- Borehole – Golder Associates Ltd.
- N — Blows/0.3m (Std. Pen Test, 475 J/blow)
- CONE — Blows/0.3m (60° Cone, 475 J/blow)
- W L at time of investigation Oct 2007 and Oct 2008
- Head
- ARTESIAN WATER Encountered
- PIEZOMETER

BH No	ELEVATION	COORDINATES NORTHINGS	COORDINATES EASTINGS
102	187.6	4 683 885	334 096
103	188.0	4 683 933	334 070
104	187.8	4 683 975	334 060
105	188.1	4 684 016	334 030
106	187.5	4 683 963	334 099
107	187.6	4 684 048	334 075
108	188.1	4 684 049	334 023
119	187.8	4 684 061	334 057
120	187.4	4 683 921	334 085
PS1	188.2	4 684 064	334 015

(Legend Continues)

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

REGISTERED PROFESSIONAL ENGINEER C M P Nascimento PROVINCE OF ONTARIO April 30, 2009

REGISTERED PROFESSIONAL ENGINEER B. R. GRAY April 30, 2009 PROVINCE OF ONTARIO

REVISIONS

DATE	BY	DESCRIPTION

REF No MRC DRAWINGS: H6933D02_DESIGN PLAN.dwg; H6933XA01.dwg; H6933XB01.dwg; H6933 Xd-prop-req.dwg; H6933XN01.dwg; H6933xu01.dwg and H6933XY2.dwg RECEIVED ON MAY 13, 2008 M6933RW_SH (ret wall profiles).dwg RECEIVED ON NOVEMBER 19, 2008

Geocres No. 40J6-26

HWY No	HOWARD AVENUE			DIST	32
SUBM'D	MN	CHECKED MN	DATE APRIL 30, 2009	SITE	--
DRAWN	NA	CHECKED CN	APPROVED BRG	DWG	RW-2

APPENDIX A

Data from the Preliminary Geotechnical Investigation by Golder Associates Ltd.

RECORD OF BOREHOLE 1

SHEET 1 of 1

LOCATION See figure 2a

BORING DATE May 14, 1990

DATUM Geodetic

SAMPLER HAMMER, 140lb; DROP, 30in

PENETRATION TEST HAMMER, 140lb; DROP, 30in

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (FT)	SAMPLES: NUMBER	TYPE	BLOWS/FT.	DYNAMIC PENETRATION RESISTANCE, BLOWS/FT; SHEAR STRENGTH Cu, LB/SQ.FT. nat.V.- + Q.- ● rem.V.- ⊕ U.- ○	HYDRAULIC CONDUCTIVITY, k, CM/SEC; WATER CONTENT, PERCENT Wp W Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		Pavement Surface		615.8							
		Asphalt		0.1							
1	Hand Augered	Granular Fill (Base)		614.3	1	AS	-		○		
2		Brown and Grey Mottled Silty Clay Some Sand Occs. Gravel (Fill)		1.5 612.8	2	AS	-		○		Water Seepage in Borehole During Drilling at 611.8 ft.
3		Brown and Grey Mottled Silty Clay Some Sand Occs. Gravel (Till)		3.0 611.8	3	AS	-		○		
4		Brown Silty Sand Trace of Clay		4.0 611.5	4	AS	-		○		
		Brown and Grey Mottled Silty Clay Some Sand Occs. Gravel (Till)		4.3 610.8	5	AS	-		○		
5		End of Borehole		5.0							
6											
7											
8											
9											
10											

0 14 10 PERCENT AXIAL STRAIN AT FAILURE

DEPTH SCALE

1 inch to 1 feet

Golder Associates

LOGGED C.C.

CHECKED

PROJECT: 06-1140-156

RECORD OF BOREHOLE 1

SHEET 1 OF 5

LOCATION: SEE LOCATION PLAN

BORING DATE: AUGUST 15/ 16, 2006

DATUM: GEODETIC

SAMPLER HAMMER, 63.5kg, DROP, 760mm

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + ● 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	INSTALLATION AND GROUNDWATER OBSERVATIONS
0	POWER AUGER / HOLLOW STEM	PAVEMENT SURFACE		188.55								
		ASPHALT		0.00								
		Grey, crushed granular base (FILL)		0.13	1	AS		188		○		
1		Soft, grey, silty clay, mixed with sand and gravel (FILL)		187.79 0.76	2	SS	2			○		
		Stiff, mottled brown and grey, SILTY CLAY, some sand, trace gravel, fissured with silt pockets (TILL)		187.03 1.52	3	SS	9	187		○		▽ August 15, 2006 Minor water seepage into borehole encountered at about elevation 187.48m during drilling on August 15, 2006
2												
				186.42 2.13	4	SS	33	186		○		
3		Hard, brown, SILTY CLAY, some sand, trace gravel, occ. silt pockets and fissures (TILL)			5	SS	51			○		
								185				
4					6	SS	40			○		
				184.28 4.27				184				
5					7	SS	20			○		
					8	SS	12	183		○		
6												
					9	SS	12			○		
								182	⊕ +			
7		Very stiff to stiff, grey, SILTY CLAY, some sand, trace gravel (TILL)							⊕ +			
								181				
8	MUD ROTARY / HW CASING				10	SS	10			⊢○⊣	MH	
	MUD ROTARY / HQ CASING							180				
9					11	SS	13			○		
		— CONTINUED NEXT PAGE —										

LDN_BHS 06-1140-156.GPJ GLDR_CAN.GDT 10/10/06 DATA INPUT: Tony Mastroianni

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: C.C.

CHECKED:

PROJECT: 06-1140-156

LOCATION: SEE LOCATION PLAN

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 1

BORING DATE: AUGUST 15/ 16, 2006

SHEET 2 OF 5

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + Q - ●, rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-4} 10^{-5} 10^{-6} 10^{-7}); WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —										
10	MUD ROTARY / HQ CASING	Very stiff to stiff, grey, SILTY CLAY, some sand, trace gravel (TILL)			12	SS	10	179				
11								178				
12					13	SS	10	177				
13								176				
14					14	75 TO	PH	175				
15					15	SS	8	174			MH	
10								173				
17					16	75 TO	PH	172				
18					17	SS	12	171				
19								170				
		— CONTINUED NEXT PAGE —										

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: CC.
CHECKED:

LDN_BHS 06-1140-156.GPJ GLDR_CAN.GDT 10/10/06 DATA INPUT: Tony Mastroianni

PROJECT: 06-1140-156

LOCATION: SEE LOCATION PLAN

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 1

BORING DATE: AUGUST 15/ 16, 2006

SHEET 3 OF 5

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ELEVATION	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa (nat V. + ○ - ●, rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-4} 10^{-3} 10^{-2} 10^{-1}); WATER CONTENT PERCENT (Wp, W, Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —										
20	MUD ROTARY / HQ CASING	Very stiff to stiff, grey, SILTY CLAY, some sand, trace gravel (TILL)			18	SS	11	169		○		
									⊕ +			
								168	⊕ +			
21				167.67 / 20.88	19	SS	25			○		
22								167				
					20	SS	14	166		○		
23		Stiff to very stiff, grey, SILTY CLAY, numerous silt pockets, some sand, trace gravel (TILL)										
24					21	SS	15	165		○		
25								164				
					22	SS	13	163		○		
26				162.11 / 26.44								
27					23	SS	11	162		○		
								161				
28		Stiff to very stiff, grey, SILTY CLAY, occ. silt seams or partings (TILL)							>06+			
									>06+			
					24	SS	11	160		○		
29												
		— CONTINUED NEXT PAGE —										

LDN_BHS 06-1140-156.GPJ GLDR_CAN.GDT 10/10/06 DATA INPUT: Tony Mastroianni

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: C.C
CHECKED

PROJECT: 06-1140-156

LOCATION: SEE LOCATION PLAN

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 1

BORING DATE: AUGUST 15/ 16, 2006

SHEET 4 OF 5

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ELEVATION	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^{-4} 10^{-5} 10^{-6} 10^{-7}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —										
				159.05 / 29.50				159	>96+			
30					25	SS	22		+			
								158				
31												
					26	SS	21	157				
32												
								156				
33		Very stiff, grey, SILTY CLAY, some sand, trace gravel, occ. sand seams (TILL)			27	SS	27					
								155				
34	MUD ROTARY											
	HQ CASING							154				
35					28	SS	28					
								153				
36												
					29	SS	20	152				
37				151.44 / 37.11								
		Very stiff, grey, SILTY CLAY, some sand, occ. gravel, numerous silt pockets or seams (TILL)						151				
38					30	SS	27					
				150.15 / 38.40								
		Limestone BEDROCK			31	NQ RC		150	TCR (%) 82 / RQD (%) 35			
39												
		— CONTINUED NEXT PAGE —										

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: C.C.

CHECKED:

LDN_BH5 06-1140-156.GPJ GLDR_CAN.GDT 10/10/06 DATA INPUT: Tony Mastroianni

PROJECT: 06-1140-156

LOCATION: SEE LOCATION PLAN

SAMPLER HAMMER, 63.5kg; DROP, 760mm

RECORD OF BOREHOLE 1

BORING DATE: AUGUST 15/ 16, 2006

SHEET 5 OF 5

DATUM: GEODETIC

PENETRATION TEST HAMMER, 63.5kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ELEVATION	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^{-4} 10^{-5} 10^{-6} 10^{-7}) / WATER CONTENT PERCENT (Wp, W, Wl) (10 20 30 40)	ADDITIONAL LAB. TESTING	INSTALLATION AND GROUNDWATER OBSERVATIONS
		— CONTINUED FROM PREVIOUS PAGE —										
40	MUD ROTARY, HQ CASING	Limestone BEDROCK			31	NQ RC		149	T.C.R. (%): 82; R.Q.D. (%): 35			
					32	NQ RC			T.C.R. (%): 100; R.Q.D. (%): 0			
41					33	NQ RC		148	T.C.R. (%): 100; R.Q.D. (%): 86			
				147.20								
		END OF BOREHOLE		41.35								
42												
43												
44												
45												
46												
47												
48												
49												

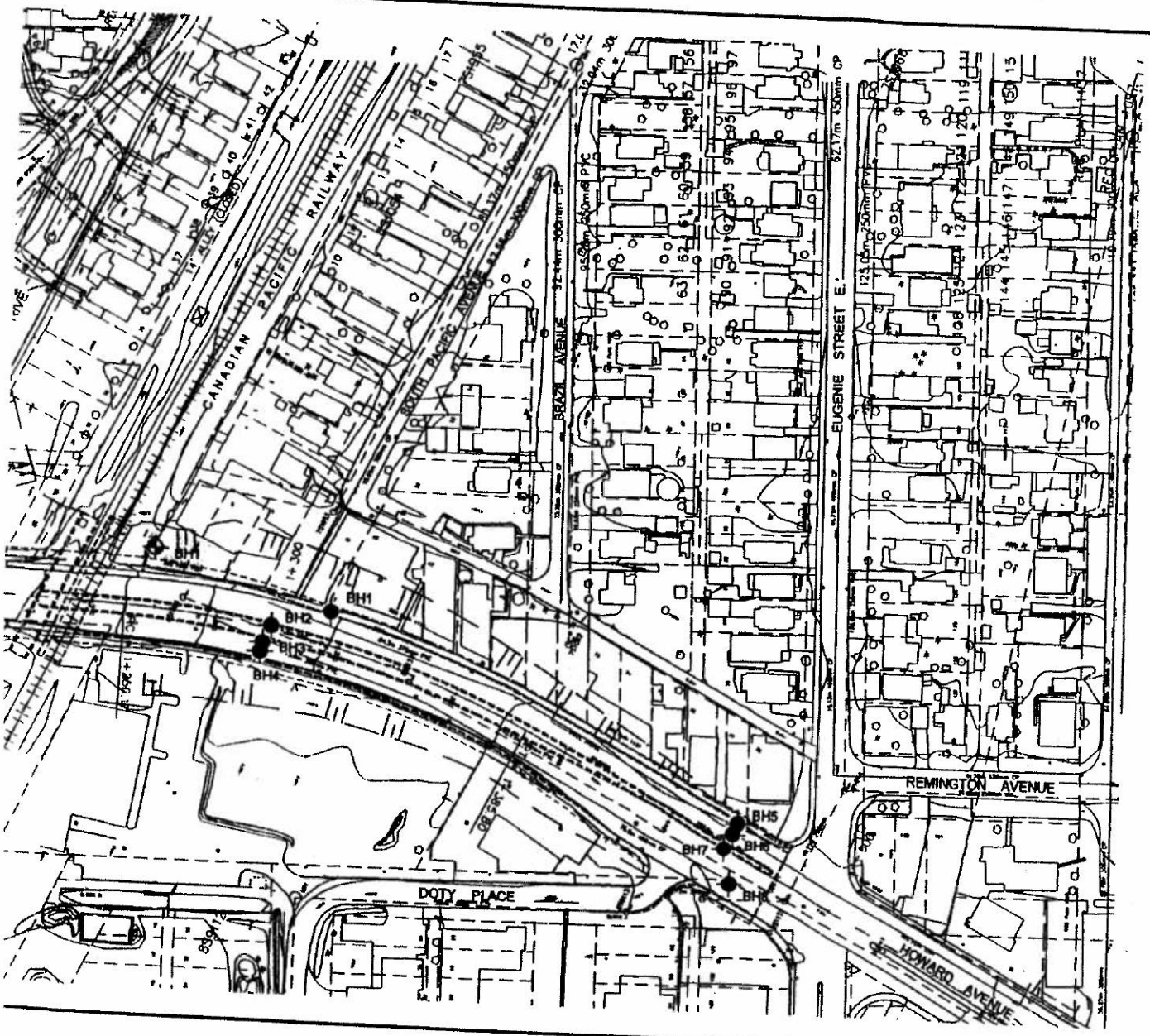
LDN_BHS 06-1140-156.GPJ GLDR_CAN.GDT 10/10/08 DATA INPUT: Tony Mastrolanni

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: C.C.

CHECKED:



LEGEND

BOREHOLE LOCATION (Current Investigation)

BOREHOLE LOCATION (Previous Investigation)
Report Number 901-4047

NOTES

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT.

ALL LOCATIONS APPROXIMATE.

REFERENCES

CAD PLAN SUPPLIED BY: DILLON CONSULTING LIMITED
RECEIVED: September 18, 2006

25 0 25
SCALE: 1:1250 METRES

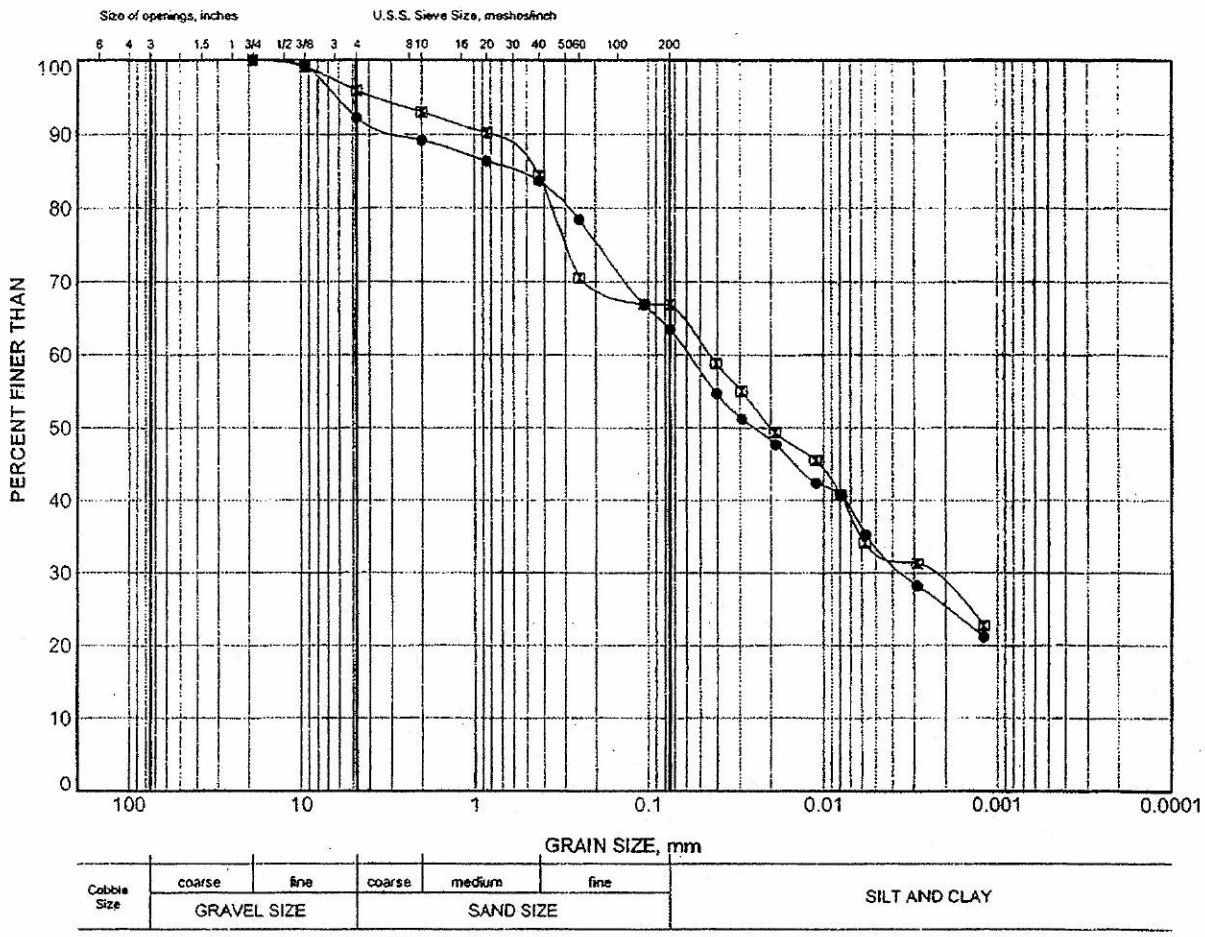
PROJECT: DILLON CONSULTING LIMITED
HOWARD AVENUE GRADE SEPARATION AT
CANADIAN PACIFIC RAILWAY, WINDSOR, ONTARIO

TITLE: LOCATION PLAN

Golder Associates
Windsor, Ontario

PROJECT No. 06-1149-195 | FILE No. 061149195001.dwg
DESIGN | SCALE AS SHOWN | REV. 0
CADD | DATE OCT/06/06
CHECK
REVIEW

FIGURE 2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	10	180.7
⊠	1	15	173.5

PROJECT
DILLON CONSULTING LIMITED
HOWARD AVENUE GRADE SEPARATION AT
CANADIAN PACIFIC RAILWAY, WINDSOR, ONTARIO

TITLE
GRAIN SIZE DISTRIBUTION
UPPER GREY SILTY CLAY (TILL)

Golder Associates
WINDSOR, ONTARIO

PROJECT No.		05-1140-156	FILE No.	05-1140-156.GPJ
			SCALE	N/A
DRAWN	T.H.	10/10/05	REV	
CHECK		10/10/05		

FIGURE 3

LDN_GSD_NEW GLDR_LDN.GDT

Peto MacCallum Ltd.
CONSULTING ENGINEERS

DETAIL FOUNDATION DESIGN REPORT

for

RETAINING WALLS
HOWARD AVENUE / CPR GRADE SEPARATION
CITY OF WINDSOR
GWP 3030-06-00
CITY OF WINDSOR, ONTARIO

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Distribution:
5 cc: McCormick Rankin Corporation (MRC) for distribution to MTO, Project Manager – WBIIG (London) + 1 digital copy (pdf)
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1 cc: MRC for distribution to MTO, Pavements and Foundations Section + 1 digital copy (pdf)
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PML Ref.: 07TF022A-2
Index No.: 171FDR
GEOCRES No.: 40J6-26
May 5, 2009

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DETAIL FOUNDATION DESIGN REPORT

Peto MacCallum Ltd.
CONSULTING ENGINEERS

DETAIL FOUNDATION DESIGN REPORT
for
Retaining Walls
Howard Avenue/CPR Grade Separation
GWP 3030-06-00
City of Windsor, Ontario

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1. INTRODUCTION

1.1 General

This report provides the foundation engineering recommendations regarding design and comments for construction of the proposed retaining wall structures for the Howard Avenue / CPR Grade separation. This report was prepared for McCormick Rankin Corporation (MRC) on behalf of the Ministry of Transportation of Ontario (MTO).

The project includes the construction of earth retaining walls on the east side of Howard Avenue north and south of Memorial Drive and four earth retaining wing walls at the grade separation structure site. MRC initially prepared the preliminary design drawing, (M633RL1_PLAN) Design Plan dated May 2008 showing the location of the retaining wall structures. Recommendations regarding the geotechnical design and comments for construction of the proposed retaining wall structures are based on the new drawings dated November 19 and December 16, 2008.

This report pertains to the earth retaining walls for the project. Two retaining walls and four wing walls are proposed. The walls were given the following chainages in the December 2008 drawings:

RETAINING WALLS	WALL #	STATIONS	LENGTH (m)
North Retaining Wall	Wall # 6	Sta. 0+700 to 0+854	154
South Retaining Wall	Wall # 3	Sta. 0+300 to 0+344	44
WING WALLS	**WALL #**	**STATIONS**	**LENGTH (m)**
Northeast Wing Wall	Wall # 5	Sta. 0+514 to 0+538	24
Northwest Wing Wall	Wall # 2	Sta. 0+215 to 0+287	72
Southeast Wing Wall	Wall # 4	Sta. 0+400 to 0+419	19
Southwest Wing Wall	Wall # 1	Sta. 0+100 to 0+175	75

All elevations in this report are expressed in metres.

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BARRIE, HAMILTON, KITCHENER, TORONTO

1.1.1 North and South Retaining Walls – Wall #'s 6 and 3

The locations of the north and south retaining walls are shown on the attached Drawings RW-1 and RW-2. Although retaining wall #3 was shortened after the field work was completed, borehole 106 was considered to be representative for the foundation recommendations.

The proposed north and south retaining walls are to be founded at a maximum depth of about 2.0 to 4.1 m below the existing grade elevations 187.3 to 188.5. The proposed founding levels for the north retaining wall will range from elevations 183.7 to 186.5, with the lowest point at about 4.1 m depth near the intersection of Howard Avenue and Memorial Drive. The proposed founding levels for the south retaining wall will range from elevations 184.2 to 185.3, about 3.3 to 2.2 m depths rising from the north to south end of the wall.

In summary, the soil stratigraphy revealed in the reference boreholes 1(P), 102, 106, 112 to 116 and 120 for the north and south retaining walls generally included fill (pavement structures) or topsoil overlying localized relatively thin deposits of cohesive silty clay and a deep and continuous deposit of clayey silt till. A localized stratum of sandy clayey silt with lower plasticity characteristics was locally interbedded within the clayey silt till. The cohesive soils in the upper about 6 m thick desiccated zone, which extends to about elevations 181.0 to 182.0, typically exhibited very stiff to hard consistencies with the underlying cohesive deposit typically exhibiting firm to stiff consistencies.

No groundwater was observed during and completion of drilling of the reference boreholes for the north and south retaining walls. However, it should be noted that groundwater levels are subject to fluctuations due to seasonal and rainfall patterns.

The construction of the north and south retaining walls will be straight forward, because the lowest proposed founding level for these walls will be approximately between 1.7 and 3.2 m higher then the typical lower limit of the upper desiccated zone of the clayey silt till.

1.1.2 Overhead Wing Walls – Wall #'s 1, 2, 4 and 5

The four earth retaining wing walls planned for the CPR grade separation structure will extend to the north and south of the proposed railway overhead along both sides of Howard Avenue. The locations of the wing walls are shown on the attached Drawing RW-2.

The proposed railway overhead wing walls are to be founded at a maximum depth of about 7.6 m to 4.3 m below the existing grade elevations 187.8 to 188.7. The proposed founding levels of the northwest and southwest wing walls will range from elevations 181.1 to 183.9, about 4.3 to 7.4 m depths. The proposed founding levels of the northeast and southeast wing walls will be at elevation 181.1, about 6.8 to 7.6 m depths.

In summary, the soil stratigraphy revealed in the reference boreholes 1, 103, 105, 107, 108, 119, and PS1 for the railway overhead wing walls generally comprised of fill or topsoil, locally a pavement structure, overlying an extensive deposit of clayey silt till mantling limestone bedrock. At the borehole 107 location, a layer of silty sand till was interbedded within the clayey silt till between 5.4 and 6.9 m depths. The consistency of the clayey silt till was typically stiff to hard in the upper desiccated 6 to 7 m thick zone, which typically extends to about elevations 181.0 to 182.0 and was typically stiff at depth.

Perched groundwater was observed during drilling at 0.4 and 1.1 m depth (elevations 187.5 and 187.7) at two borehole locations. It is anticipated that the groundwater at the site is at about elevation 182.2.

It is considered that the construction of the railway overhead wing walls is feasible at the site. The AREMA manual for Railway Engineering should also be followed for the design of the railway overhead wing walls, where applicable.

The sections of the proposed wing walls near the bridge site will be founded at the lower boundary of the upper desiccated zone that locally extends to about elevations 181.0 to 182.0. The wing walls local founding levels will be on the underlying firm to stiff zone of the native soils. The global soil stability was analyzed for the retained soil system (RSS) fill loading for Wall #2 at the location

of the maximum wall height. The results of the slope stability analysis indicated Factors of Safety of 1.5 and 1.6 for short-term and long-term stability, respectively. The results are presented in the attached Figures 2 and 3.

The construction of RSS walls for the southeast and southwest wing wall locations will likely require shoring along the railway diversion to facilitate the excavation to the lower level of the RSS wall tie-backs and fill.

The retaining walls should be designed and analyzed for bearing capacity, sliding, overturning and overall stability in accordance to the methods outlined in the Canadian Highway Bridge Design Code, 2006 Edition.

The **"**red flag**"** issues outlined in the preceding paragraphs and the recommended methods of overcoming these issues noted in the following sections of the report are intended to alert and aid the designer and the contractor. These comments and recommendations are based on the conditions revealed during the investigations and no responsibility is assumed by the consultants or the MTO for alerting the contractor to all critical issues for each foundation alternative. The requirements to deliver acceptable construction quality remain the responsibility of the contractor.

1.2 Foundations

1.2.1 General

A retained soil system (RSS) was the option selected by the designers and MTO for the retaining walls and wing walls at this project. Alternative retaining wall types including cast-in-place reinforced concrete walls bearing on spread footings or deep foundations are considered to be feasible. The net increase in pressure from the new wall backfill will be relatively small given that the proposed height of the structures will be at a maximum of about 1 m above existing grade. Consequently, it is considered that a scheme with pile foundations for the retaining wall structures will not be required. Therefore, discussion of deep foundation alternatives is considered unnecessary.

The foundation frost depth for structure foundations at this site is 1.2 m, according to OPSD-3090.101.

The seismic site coefficient for the stratigraphic conditions at this site is 1.0 [soil profile Type I, Canadian Highway Bridge Design Code (CHBDC) 2006 Edition, clause 4.4.6].

1.3 Retained Soil System Wall

The retained soil system (RSS) walls at the retaining wall and wing wall locations could be placed on native silty clay/clayey silt till soils, or alternatively where required on granular fill, discussed below.

It is envisioned that the earth retaining walls and wing walls will be constructed utilizing a series of steps in the founding level to meet the proposed site grading and construction requirements.

A high performance, high appearance rated RSS wall should be employed. The design, supply and construction of the RSS wall should conform to SP 599S22 and SP 599S23.

The RSS supplier should be responsible for specifying the type of backfill material employed, taking into consideration the engineering properties of the proprietary product, the design life of the structure, the pullout resistance required and drainage requirements.

The supplier of the RSS should also be responsible for the detail design of the structure and provide drawings to show pertinent information such as location, length, height, elevations, performance level, appearance, etc.

1.3.1 North Retaining Wall – Wall # 6

The existing ground surface level along the proposed north retaining wall ranges from elevations 187.7 to 188.5. The 154 m long north retaining wall will range from about 0.4 to 2.2 m in height, with the adjacent sidewalk levels sloping from elevations 184.9 to 188.1 and the top of wall from elevations 186.5 to 188.7. In order to achieve the proposed maximum wall height of

2.2 m, the existing grade will be modified through cut and fill operations behind the new wall. Accordingly, the top of north retaining wall will extend some 0.5 m above to 2.0 m below the current grades. The maximum wall height will occur near the intersection of Howard Avenue and Memorial Drive gradually decreasing as the wall base elevation rises towards the north and east ends.

Based on the records of boreholes 112 to 116, the anticipated native subgrade soil will range from stiff to hard silty clay to clayey silt till at the proposed founding levels, allowing for a minimum of 1.2 m foundation frost protection. The reference geotechnical resistances at ultimate and serviceability limit states (ULS and SLS) at the recommended founding level for the north retaining wall is summarized in the following table.

WALL SECTION (STATIONS)	REFERENCE FOUND ELEVATION (m)	REFERENCE BOREHOLE	FOUNDING CONDITIONS	FACTORED GEOTECHNICAL RESISTANCE AT ULS (kPa)	GEOTECHNICAL RESISTANCE AT SLS (kPa)
Howard Avenue (0+700 – 0+720)	186.0 – 187.0	112	Stiff Silty Clay/ Clayey Silt Till	225	150
Howard Avenue (0+720 – 0+760)	185.0 – 186.0	112, 113, 114	Very Stiff to Hard Clayey Silt Till	375	250
Corner of Howard Avenue and Memorial Drive (0+760 – 0+820)	183.5 – 184.5	115	Very Stiff to Hard Clayey Silt Till	375	250
Memorial Drive (0+820 – 0+854)	184.0 – 185.0	116	Hard Clayey Silt Till	450	300

The above geotechnical resistances are based on a minimum 600 mm wide footing supported at a minimum of 1.2 m below the surface with groundwater table at least 1.5 m below the base of the wall.

1.3.2 South Retaining Wall – Wall # 3

The existing ground surface elevation in proximity to the south retaining wall ranges from 187.3 to 187.5. The 44 m long south retaining wall will range from about 0.3 to 2.1 m in height, with the adjacent sidewalk levels sloping from elevations 185.4 to 186.9 from north to south and the top of wall elevation at 187.8. At the north end of the south retaining wall the proposed top of wall will

decrease from elevations from 187.8 to 185.7 in about 7 m of length. The decrease in wall height at the north end is due to a proposed 2.0 m cut of the current grade to the north and east of the wall location. Proposed fill amounting less than 0.5 m will be placed from the south end of the wall to about 38 m north. The top of the south retaining wall will extend some 0.5 m above to 1.8 m below existing grade. The maximum wall height will occur about 7 m south of the north end of the wall dropping off some 2.1 m further north and gradually decreasing towards the south end.

Based on the records of boreholes 102 and 120, the anticipated native subgrade soil will include very stiff to hard clayey silt till at founding levels, allowing for a minimum of 1.2 m foundation frost protection. Boreholes 1(P) and 106 beyond the northern limit of the south retaining wall also show similar soil type and consistency at the founding levels. The reference geotechnical resistances at ultimate and serviceability limit states (ULS and SLS) at the recommended founding level for the south retaining wall is summarized in the following table.

WALL SECTION (STATIONS)	REFERENCE FOUND ELEVATION (m)	REFERENCE BOREHOLE	FOUNDING CONDITIONS	FACTORED GEOTECHNICAL RESISTANCE AT ULS (kPa)	GEOTECHNICAL RESISTANCE AT SLS (kPa)
South to Middle (0+300 – 0+320)	184.5 – 185.5	102	Hard Clayey Silt Till	450	300
Middle to North (0+320 – 0+344)	184.0 – 185.0	120	Very Stiff to Hard Clayey Silt Till	375	250

The above geotechnical resistances are based on a minimum 600 mm wide footing supported at a minimum of 1.2 m below the surface with groundwater table at least 3.0 m below the base of the wall.

1.3.3 Northwest Wing Wall – Wall # 2

The existing ground surface level along the proposed northwest wing wall ranges from elevations 187.9 to 188.6. The 72 m long northwest wing wall will range from about 0.5 to 6.6 m in height, with the adjacent sidewalk levels sloping from elevations 182.4 to 185.6 from south to north and the top of wall from elevations 185.9 to 188.9. In order to achieve the proposed maximum wall height of 6.5 m, the existing grade will be modified through cut and fill operations behind the wall. Proposed fill amounting less than 0.5 m will be placed from the railway overhead

to about 30 m north, with a grade cut typically of about 1 m or less beyond this point. Within the final 10 m length at the north end of the wall, the height will decrease from elevations 187.3 to 185.9 which will result in a grade cut of 2.4 m. The maximum wall height will occur at the overhead structure with height gradually decreasing as the base of the wall rises towards the north end.

Based on the records of boreholes 105, 108 and PS1, the anticipated native subgrade soil will include stiff to very stiff clayey silt till at founding levels, allowing for a minimum of 1.2 m foundation frost protection. The reference geotechnical resistances at ultimate and serviceability limit states (ULS and SLS) at the recommended founding level for the northwest wing wall is summarized in the following table.

WALL SECTION (STATIONS)	REFERENCE FOUND ELEVATION (m)	REFERENCE BOREHOLE	FOUNDING CONDITIONS	FACTORED GEOTECHNICAL RESISTANCE AT ULS (kPa)	GEOTECHNICAL RESISTANCE AT SLS (kPa)
South (0+215 – 0+245)	181.0 – 182.5	105, 108	Stiff Clayey Silt Till	225	150
Middle (0+245 – 0+277)	182.5 – 183.5	108, PS1	Stiff to Very Stiff Clayey Silt Till	300	200
North (0+277 – 0+287)	183.5 – 184.0	PS1	Stiff to Very Stiff Clayey Silt Till	300	200

The above geotechnical resistances are based on a minimum 600 mm wide footing supported at a minimum of 1.2 m below the surface with groundwater table from 1.0 m above to 1.5 m below the base of the wall at about elevation 182.

1.3.4 Southeast and Northeast Wing Walls – Walls # 4 and 5

The existing ground surface level along the proposed southeast and northeast wing walls ranges from elevations 187.9 to 188.7. The 19 and 24 m long southeast and northeast wing walls will range from 0.3 to 5.7 m in height, with the adjacent sidewalk levels gradually sloping from elevation 182.3 at the railway overhead to elevations 182.8 and 183.0 at the south and north ends of the southeast and northeast wing walls. The top of walls will range from elevations 183.1 to

187.5 for the southeast wing wall and from elevations 183.3 to 188.0 for the northeast wing wall. The maximum wall height for both wing walls will occur at the railway overhead.

To achieve the proposed maximum wall height of 5.2 m for the southeast wing wall, 1.2 m of the existing grade will be cut behind the new wall from the railway overhead to about 3 m south and gradually increase to a grade cut of about 5 m as the new wall continues south.

To achieve the proposed maximum wall height of 5.7 m for the northeast wing wall, 1.0 m or less of the existing grade will be cut behind the new wall from the railway overhead to about 11 m north and gradually increase to a grade cut of 4.6 m as the new wall continues north.

Based on the records of boreholes 1, 107 and 119, the anticipated native subgrade soil will include stiff clayey silt till with a localized compact silty sand till layer, allowing for a minimum of 1.2 m foundation frost protection. The reference geotechnical resistances at ultimate and serviceability limit states (ULS and SLS) at the recommended founding level for the southeast and northeast wing walls is summarized in the following table.

WALL SECTION (STATIONS)	REFERENCE FOUND ELEVATION (m)	REFERENCE BOREHOLE	FOUNDING CONDITIONS	FACTORED GEOTECHNICAL RESISTANCE AT ULS (kPa)	GEOTECHNICAL RESISTANCE AT SLS (kPa)
Southeast (0+400 – 0+419)	181.0 – 182.0	1	Stiff Clayey Silt Till	225	150
Northeast (0+514 – 0+538)	181.0 – 182.0	107, 119	Compact Sandy Silt Till/ Stiff Clayey Silt Till	225	150

The above geotechnical resistances are based on a minimum 600 mm wide footing supported at a minimum of 1.2 m below the surface with groundwater table 1.0 m above or at the base of the wall at about elevation 182.

1.3.5 Southwest Wing Wall – Wall # 1

The existing ground surface level along the proposed southwest wing wall will range from elevations 187.8 to 188.5. The 75 m long southwest wing wall will range from about 0.4 to 5.2 m in height, with the adjacent sidewalk levels sloping from elevations 182.3 to 185.2 from north to south and the top of wall ranging from elevations 185.5 to 187.5. To achieve the proposed maximum wall height of 5.2 m for the southwest wing wall, 1.0 to 2.3 m of the existing grade will be cut behind the new wall starting at the railway overhead and gradually increasing as the new wall continues south. The maximum wall height will occur at the railway overhead with the height gradually decreasing as the base of the wall rises towards the south end.

Based on the records of boreholes 103, 104 and 105, the anticipated native subgrade soil will comprise stiff clayey silt till, allowing for a minimum of 1.2 m foundation frost protection. The reference geotechnical resistances at ultimate and serviceability limit states (ULS and SLS) at the recommended founding level for the southwest wing wall is summarized in the following table.

WALL SECTION (STATIONS)	REFERENCE FOUND ELEVATION (m)	REFERENCE BOREHOLE	FOUNDING CONDITIONS	FACTORED GEOTECHNICAL RESISTANCE AT ULS (kPa)	GEOTECHNICAL RESISTANCE AT SLS (kPa)
South (0+100 – 0+130)	182.0 – 183.5	103	Stiff Clayey Silt Till	225	150
Middle (0+130 – 0+160)	181.0 – 182.0	104	Stiff Clayey Silt Till	225	150
North (0+160 – 0+175)	181.0 – 182.0	105	Stiff Clayey Silt Till	225	150

The above geotechnical resistances are based on a minimum 600 mm wide footing supported at a minimum of 1.2 m below the surface with groundwater from 1.0 m above to 1.5 m below the base of the wall at about elevation 182.

1.4 Cast-in-Place Concrete Walls

Cast-in-place reinforced concrete walls bearing on spread footings are considered to be feasible. The geotechnical resistances recommended in Sections 1.3.1 to 1.3.5 for the RSS foundations placed on native soils for the retaining walls and wing walls constructed using RSS walls are considered to be appropriate for the cast-in-place concrete walls. The various founding levels for the concrete walls should also allow for a minimum of 1.2 m foundation frost protection.

Additional geotechnical parameters for the design of cast-in-place concrete walls are included in subsequent paragraphs.

1.5 Retaining Wall and Wing Wall Sliding Resistance

The following parameters should be used for sliding resistance of retaining wall and wing wall foundations.

North Retaining Wall – Wall # 6

PARAMETER	STIFF TILL	VERY STIFF TO HARD TILL
	(STA. 0+700 – 0+720)	(STA. 0+720 – 0+854)
Friction Angle, degrees	0	0
Cohesion, kPa	100	150
Unit Weight, kN/m^3	20.0	20.0

South Retaining Wall – Wall # 3

PARAMETER	VERY STIFF TO HARD TILL
	(STA. 0+300 – 0+344)
Friction Angle, degrees	0
Cohesion, kPa	150
Unit Weight, kN/m^3	20.0

Northwest Wing Wall – Wall # 2

PARAMETER	STIFF TILL	STIFF TO VERY STIFF TILL
	(STA. 0+215 – 0+245)	(STA. 0+245 – 0+287)
Friction Angle, degrees	0	0
Cohesion, kPa	100	125
Unit Weight, kN/m^3	20.0	20.0

Southeast and Northeast Wing Walls – Wall #'s 4 and 5

PARAMETER	STIFF TILL	STIFF TILL	COMPACT TILL
	(STA. 0+400 – 0+419)	(STA. 0+514 – 0+538)	
Friction Angle, degrees	0	0	33
Cohesion, kPa	100	100	0
Unit Weight, kN/m^3	20.0	20.0	20.0

Southwest Wing Wall – Wall # 1

PARAMETER	STIFF TILL
	(STA. 0+100- 0 +175)
Friction Angle, degrees	0
Cohesion, kPa	100
Unit Weight, kN/m^3	20.0

The structural designer should use appropriate factors on the tabled angle of friction and cohesion values for the sliding resistance check.

1.6 Structural Fill Pad

Where fill and/or otherwise deleterious materials are encountered at founding levels (such as, at existing or new service or sewer crossings) the excavation should extend down to firm/ compact native soil and be reinstated with a structural fill pad to subgrade level. The exposed subgrade should be inspected and approved by geotechnical personal.

The structural fill pad should comprise Granular A material placed in maximum 200 mm thick lifts, compacted to 100% of the ASTM D698 (standard Proctor) maximum dry density. The following geotechnical bearing resistances should be used for the design depending on the structural fill pad thickness:

STRUCTURAL FILL PAD THICKNESS (m)	FACTORED GEOTECHNICAL RESISTANCE AT ULS (kPa)	GEOTECHNICAL RESISTANCE AT SLS (kPa)
Minimum 1.0	225	150
Minimum 2.0	400	250
Minimum 3.0	900	350

The granular fill pad should extend a minimum of 1.0 m from the edge and below the structure to be supported. The width of the granular fill pad should increase at 1 horizontal to 1 vertical with depth. A schematic illustration of recommenced geometry is provided in the enclosed Figure 1.

The following parameters should be used for sliding resistance of retaining wall and wing wall foundations on a structural fill pad.

PARAMETER	GRANULAR A
Friction Angle, degrees	35
Cohesion, kPa	0
Unit Weight, kN/m^3	22.8

The structural designer should apply the appropriate factors to the tabled angle of friction and cohesion values for the sliding resistance check.

The fill should be placed and compacted in accordance with SP 105S10 and OPSS 501. The fill pad placement should be monitored on a full-time basis by geotechnical personal to examine and approve materials, to evaluate placement operation and to verify that the specified degree of compaction is achieved uniformly throughout the fill.

1.7 Lateral Earth Pressure

1.7.1 General

The retaining walls and wing walls should be designed to resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall. The lateral earth pressure, p (kPa) may be computed using the equivalent fluid pressure diagrams presented in Section 6.9 of the CHBDC or employing the following equation. The surcharge loads in the equation should consider the AREMA Manual for Railway Engineering loadings, where applicable.

$p = K(\gamma h + q) + Cp + Cs$

where K = coefficient of lateral earth pressure (dimensionless)
γ = unit weight of free-draining granular material, kN/m^3
h = depth below final grade, m
q = surcharge load, kPa, if present
Cp = compaction pressure, kPa (refer to clause 6.9.3 of CHBDC)
Cs = earth pressure induced by seismic events, kPa (refer to clause 4.6.4 of CHBDC)
where Ø = angle of internal friction of retained soil
δ = angle of friction between the soil and wall

Free-draining granular material should be used as backfill behind the wall. The following parameters are recommended for design:

PARAMETERS	GRANULAR A OR GRANULAR B TYPE II	GRANULAR B, TYPE I
Internal Friction Angle, Ø (degrees)	35	32
Unit weight, γ (kN/m^3)	22.8	21.0
Coefficient of Active Earth Pressure, K_a	0.27	0.31
Coefficient of Earth Pressure At Rest, K_o	0.43	0.47
Coefficient of Passive Earth Pressure, K_p	3.69	3.25

The coefficient of earth pressure at-rest should be used for design of rigid and unyielding walls, the active earth pressure coefficient for unrestrained structures. The earth pressure coefficients should be reviewed if the slope of the backfill exceeds 10^o to the horizontal. Alternatively, the material above the top of the wall could be treated as a surcharge load (q in the preceding equation).

The magnitude of the passive resistance is dependent on the actual lateral movement of the structure toward the retained soil. We refer to Figure C6.16 of the CHBDC for this computation. The subsoil/backfill should be considered as medium dense sand for the project.

The horizontal force at the base of the RSS will be resisted in part by the friction force developed through the granular backfill or along the interface between the granular backfill and the founding soil, subject to site specific design details. An unfactored friction factor of 0.6 is considered to be appropriate for development through the granular backfill and an unfactored friction factor of 0.45 for the interface between the granular backfill and founding soil.

1.8 Construction Considerations

1.8.1 Excavation

All excavation at the retaining wall and wing wall locations should be carried out in accordance with the Occupational Health and Safety Act (OHSA), local and MTO regulations. For this purpose, the encountered topsoil and fill as well as firm to stiff clayey till soils and compact silty sand till soil is considered Type 3. Very stiff to hard clayey silt till soil is considered Type 2.

1.8.2 Groundwater Control

No water was observed during the course of the field work at the majority of the borehole locations. It is considered that seepage from soil fissures or surface water run-off that enters the excavation should be readily handled by conventional sump pumping techniques. It is noted that groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.

The minimum founding elevation will occur at the overhead structure where the grade cut will be the greatest. As previously mentioned a localized layer of silty sand till was contacted in borehole 107 near the northeast and southeast wing wall locations. The relatively pervious wet silty sand layer contacted at elevation 182.2 within the relatively impervious clayey silt till deposit may provide additional seepage volumes. It is anticipated however that the construction of the overhead wing walls will commence after construction of the structure and associated sewer infrastructure. Accordingly, the perched groundwater level will likely be under control during construction and groundwater control should be readily handled by conventional sump pumping techniques.

1.9 Backfill and Drainage Control

The drainage behind the RSS walls should be designed by the RSS supplier.

The backfill behind the alternative cast-in-place retaining walls should consist of suitable free draining granular materials such as Granular A or B containing less than 5% fines and the backfill geometry should be according to OPSD-3121.150. The backfill should be placed and compacted to at least 95% of the standard Proctor maximum dry density.

Backfilling adjacent to retaining structures should be carried out in conformance with OPSS 501 and SP105S10. Operation of compaction equipment adjacent to retaining structures should be restricted to limit the compaction pressure noted in clause 6.9.3 of the CHBDC. Refer to SP 105S10 for additional information in this regard.

All backfilling and compaction operations should be supervised on a full-time basis by geotechnical personnel to examine and approve backfill materials, evaluate placement operations and verify that the specified degree of compaction is achieved uniformly throughout the fill.

A subdrain system (SP 405F03) and weep holes (OPSD-3190.100) should be installed to minimize the build-up of hydrostatic pressure behind the cast-in-place reinforced concrete walls. The subdrains tiles should be surrounded by a properly designed granular filter or non-woven Class II geotextile (with an FOS of 75 – 100 μm according to OPSS 1860) to prevent migration of fines into the system. The drainage pipes should be installed on a positive grade and lead to frost-free outlets.

The earth fill slopes should be protected against surface erosion by sodding and suitable vegetation. Refer to OPSS 571 or 572 for time constraints and the type of seed and mulch required.

The upper 600 mm of backfill against the wall should consist of relatively impermeable local clayey material to mitigate stormwater infiltration.

2. CLOSURE

This Detail Foundation Design Report was prepared by Mr. C.M.P. Nascimento, P.Eng., with the assistance of Ms. N.S. Balakumaran, BSc and Mr. M.J. Narduzzi, BEng, and was independently reviewed by Mr. B.R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.

Carlos M. P. Nascimento, P.Eng.
Senior Project Engineer

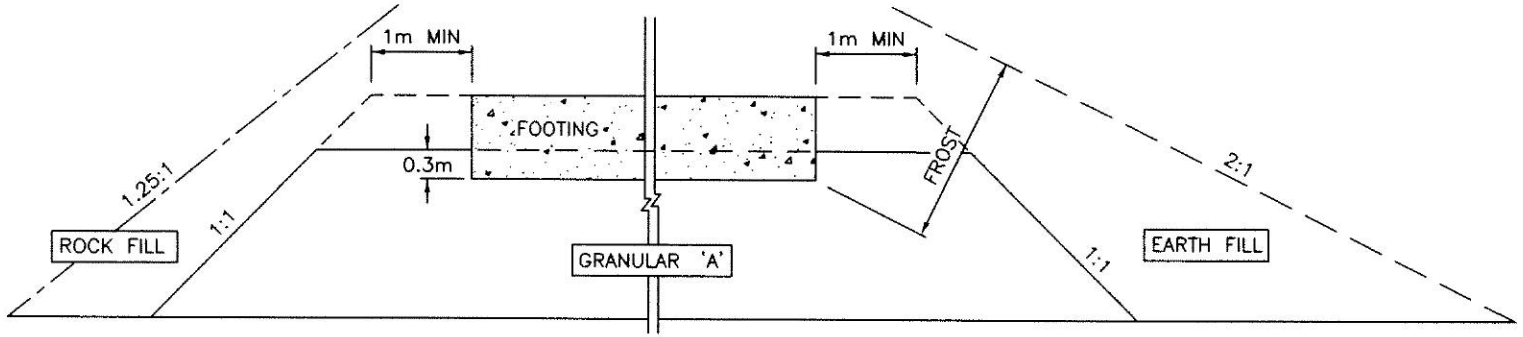
Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

CN/BRG:mn-mi

TABLE 1

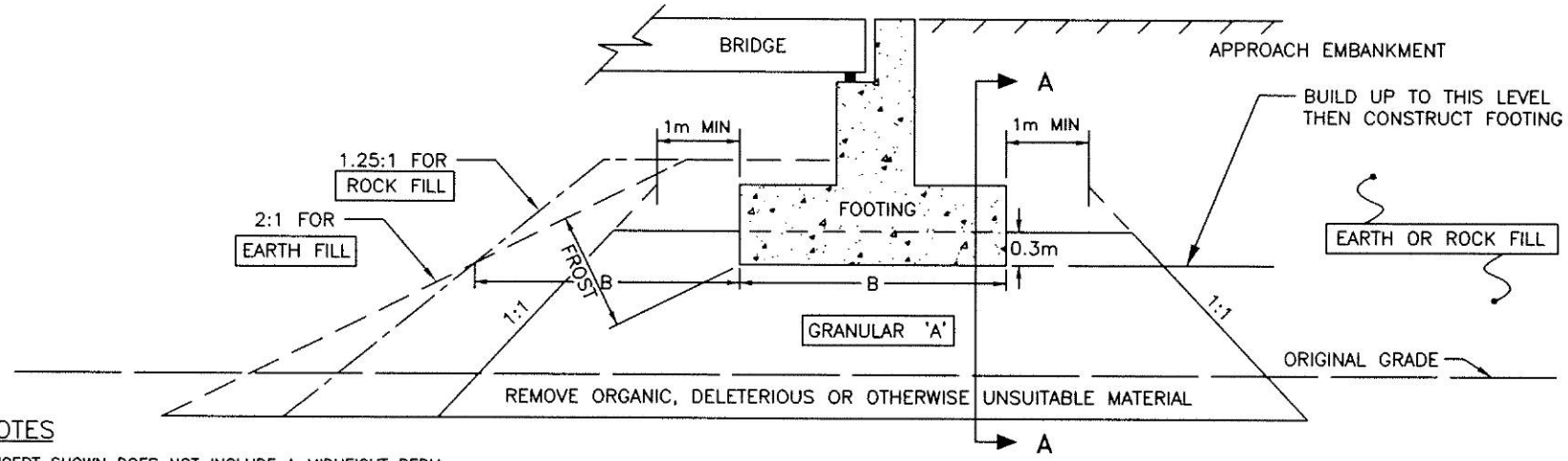
LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

DOCUMENT	TITLE
OPSS 501	Construction Specification for Compacting
OPSS 571	Construction Specification for Sodding
OPSS 572	Construction Specification for Seed and Cover
OPSS 1860	Material Specification for Geotextiles
SP 105S10	Construction Specification for Compaction
SP 109F10	Structural Reference Plans and Reports
SP 405F03	Construction Specification for Pipe Subdrains
SP 599S22	Requirements for The Design, Supply and Construction of Retaining Soil Systems (RSS)
SP 599S23	Requirements for Materials, Quality Control and Quality Assurance Testing and Acceptance Criteria for Precast Concrete Facing Elements Including Panels
OPSD-3090.101	Foundation Frost Depth for Southern Ontario
OPSD-3121.150	Minimum Granular Backfill Requirements – Retaining Walls
OPSD-3190.100	Retaining Wall and Abutment Wall Drain Detail



CROSS SECTION A–A

NOT TO SCALE



LONGITUDINAL SECTION

NOT TO SCALE

NOTES

1. CONCEPT SHOWN DOES NOT INCLUDE A MIDHEIGHT BERM.
2. LIMITS OF GRANULAR 'A' CORE TO BE DEFINED BY A SITE SPECIFIC SURVEY.
3. REMOVE ORGANIC, DELETERIOUS OR OTHERWISE UNSUITABLE MATERIAL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH OR ROCK FILL AS NOTED IN TEXT OF REPORT.
4. PLACE GRANULAR 'A' AND EARTH OR ROCK FILL ON APPROVED SUBGRADE TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO CURRENT M.T.O. STANDARDS.
5. CONSTRUCT CONCRETE FOOTING.
6. PLACE REMAINDER OF GRANULAR 'A' AND EARTH OR ROCK FILL INCLUDING MIDHEIGHT BENCHES, AS REQUIRED.
7. REFER TO TEXT OF REPORT FOR FROST DEPTH.

FIGURE 1: ABUTMENT ON COMPACTED FILL SHOWING GRANULAR 'A' CORE

SLOPE STABILITY ANALYSIS RESULTS

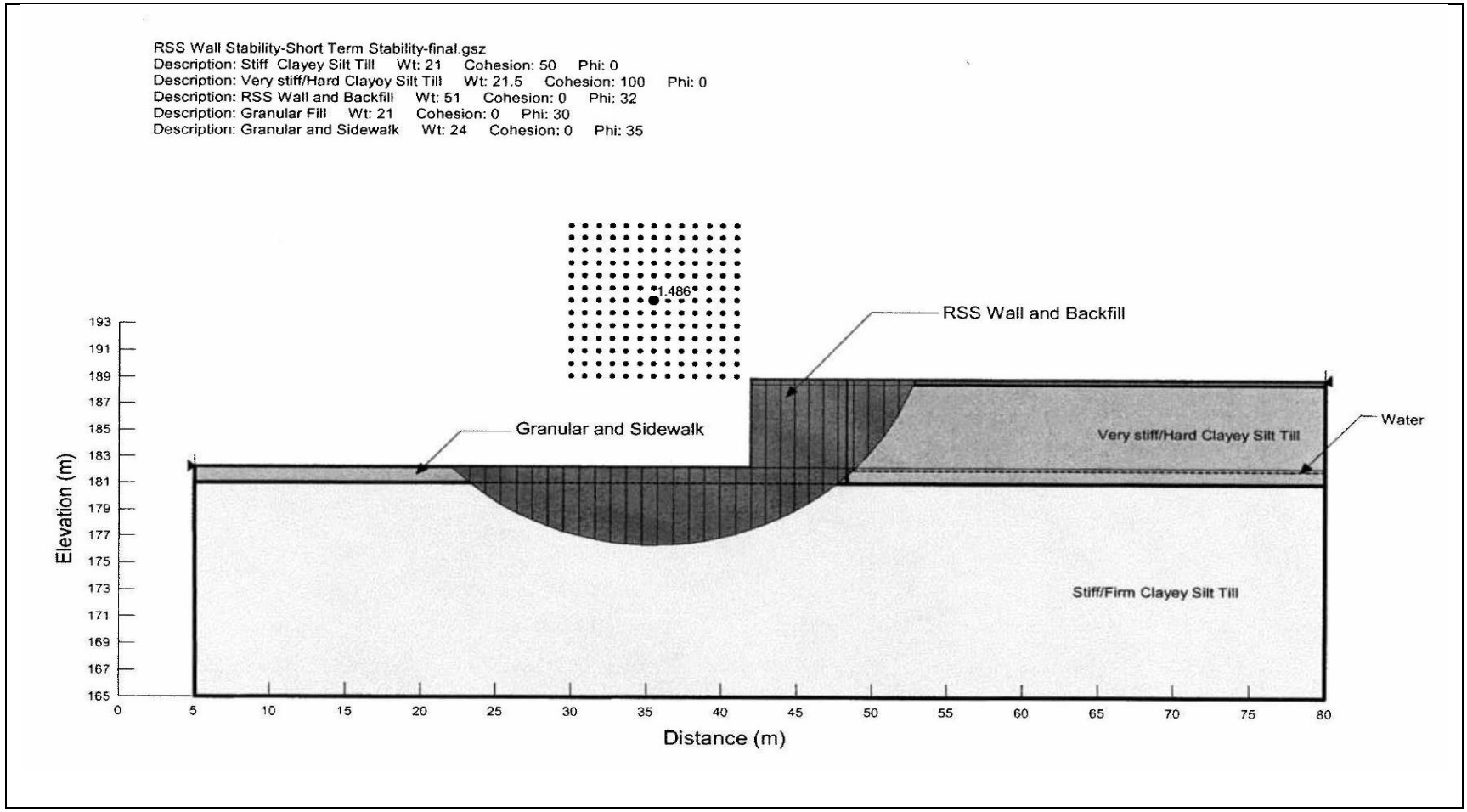


Figure 2

SLOPE STABILITY ANALYSIS RESULTS

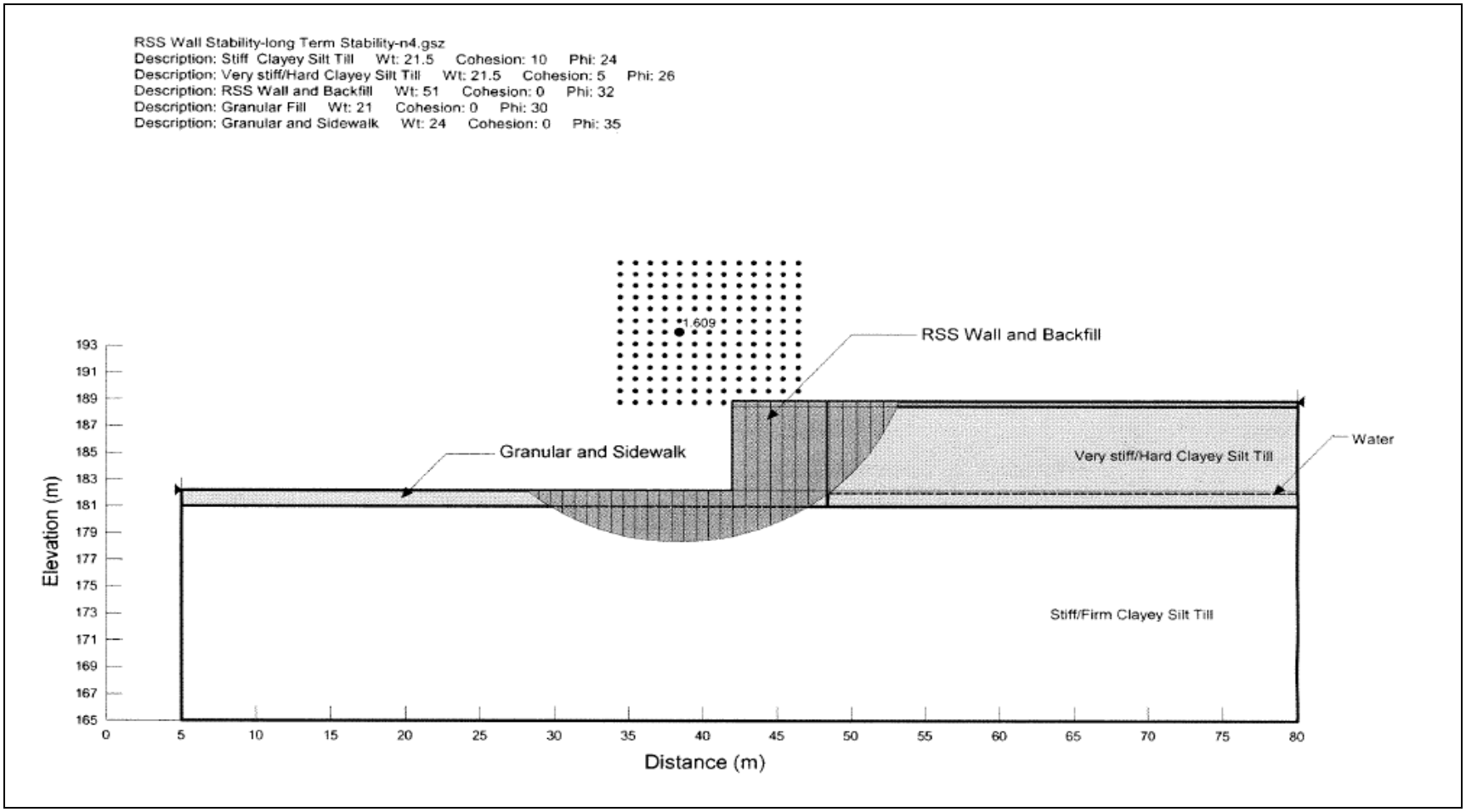


Figure 3