

**FOUNDATION INVESTIGATION AND DESIGN REPORT
RETAINING WALLS
HIGHWAY 403 UNDERPASS
HIGHWAY 403 AND OAK PARK ROAD
INTERCHANGE IMPROVEMENTS
GWP 3950-01-00, AGREEMENT NO. 3005-E-0067
MINISTRY OF TRANSPORTATION - WEST REGION**

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PART A – FOUNDATION INVESTIGATION REPORT

**RETAINING WALLS
HIGHWAY 403 UNDERPASS
HIGHWAY 403 AND OAK PARK ROAD INTERCHANGE IMPROVEMENTS
GWP 3950-01-00, AGREEMENT NO. 3005-E-0067
MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION**

October 2008

07-1130-204-1-R01

1.0 INTRODUCTION

Golder Associates Ltd. (Golder Associates) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to carry out foundation investigations as part of the detail design work for GWP 3950-01-00. The detail design for the interchange improvements at the Highway 403 and Oak Park Road Interchange includes:

- Reconstruction of the interchange to a Parclo A-4;
- Widening of Oak Park Road;
- Conventional illumination;
- Signalization at the W-N/S and E-N/S Ramp terminals;
- Retaining walls at both Oak Park Road Underpass and the Trans Canada Trail Underpass; and,
- Rehabilitation of the Oak Park Road Underpass.

This report was prepared for the design of retaining walls at the Oak Park Road Underpass (Site 1-139) which will be constructed in conjunction with the proposed works. Prior to preparation of this report, five retaining wall designs were proposed and evaluated. A technical memorandum, evaluating the merits and shortfalls of each retaining wall design from a geotechnical standpoint, was issued on May 13, 2008. The retaining wall alternative selected by the MTO is Alternative 3 described briefly as the modified loop ramp with reduced shoulder width design. Shoulder widths will vary between 1.0 and 2.5 metres and the retaining wall will be about 3.2 metres ahead of the abutment footings. Options for the retaining wall design are a gravity wall (Alternative 3a), a retained soil system (RSS) wall (Alternative 3b) or a cantilever wall (Alternative 3c).

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed works by drilling boreholes and carrying out in situ testing and laboratory testing on selected samples. The terms of reference for the scope of work are outlined in the MTO's Request for Proposal, Golder Associates' proposal P61-3107 dated October 17, 2007 and our modified Innovation Plan as described in a letter dated June 20, 2008. The work was carried out in accordance with our revised Quality Control Plan for Foundation Engineering dated January 30, 2008 and our Innovation Plan modification letter June 20, 2008.

Dillon provided Golder Associates with preliminary drawings for this project in digital format.

2.0 SITE DESCRIPTION

Detail design of reconstruction of the Highway 403 and Oak Park Road Interchange to a Parclo A-4 configuration is the focus of GWP 3950-01-00. This improvement will require widening of Oak Park Road, construction of retaining walls at the Oak Park Road Underpass (Site 1-139) and Trans Canada Trail Underpass (Site 1-158) and illumination and traffic control improvements. At the Oak Park Road Underpass, reconfiguration of the ramps would entail local widening of the Highway 403 platform and partial removal/regrading of the slope paving on both forward slopes beneath the underpass structure. The retaining walls will be approximately 55 metres long and about 1.1 metres high.

The site is situated in Brantford, Ontario approximately one kilometre east of the Grand River and 3.2 kilometres west of Paris Road. The site location is shown in the Key Plan, Figure 1. Site photographs are presented in Appendix C.

Highway 403 is a divided highway with two lanes and a speed change lane in each direction. The existing interchange with Oak Park Road is currently a diamond configuration. Oak Park Road is a two lane undivided road. The existing Oak Park Road Underpass was constructed in 1976. The bridge is a concrete post-tensioned solid slab bridge with two 30.5 metres long spans and a total deck width of 17.1 metres. The centre pier and both abutments are founded on spread footings. According to the Ontario Department of Transportation and Communications (ODTC) General Plan for W.P. 157-60-00 dated April 1975 (Geocres No.40P1-56), the design underside of footing elevation for the centre piers was 238.73 metres. The design underside of footing elevations for the north and south abutments were 242.16 metres and 242.32 metres, respectively. Examination of the ODTC Drawing No 71-11111 A entitled "Borehole Location and Soil Strata, County Road 27, Highway 403 Line 'K'" indicated that Highway 403 was constructed in a 8.2 to 10.7 metre cut. The cut slopes reportedly consisted of very dense gravely sand to sandy gravel. Boreholes from Geocres No. 40P1-56 are included in Appendix B for reference but have not been incorporated in the report since none of the boreholes extend below elevation 241 metres, the approximate elevation of Highway 403.

The topography within the project area features gentle slopes with elevations ranging between 235 and 244 metres. The interchange area is surrounded by former gravel pits. Land use is predominantly industrial and commercial. South of Highway 403, the former pits have been redeveloped into the North West Industrial Subdivision. North of Highway 403, the Oak Park North Industrial Subdivision is being developed.

2.1 Site Geology

The Oak Park Road Interchange is situated in the physiographic region of southern Ontario known as the Norfolk Sand Plain¹. This wedge shaped area extends from the shoreline of Lake Erie to Brantford. Sand and silt was deposited as a delta in glacial Lakes Whittlesey and Warren when meltwater discharge from the Grand River entered the lakes between the icefront and the moraines to the northwest. The Galt Moraine and other nearby moraines are partly buried by sand.

The surficial soils are primarily composed of glaciofluvial outwash and deltaic deposits of gravel and gravely sand. In several places the gravely deposits are overlain by several metres of sand. These advanced and recessional outwash deposits are derived from meltwaters of the Wentworth Ice. The largest gravel masses are found in Brantford and Paris.²

The underlying bedrock surface lies between elevations 198 and 213 metres.³ The bedrock is reported to be tan dolomite and grey mudstone of the Salina Formation.⁴

¹ L.J. Chapman and D.F. Putnam: The Physiography of Southern Ontario, Third Edition. Ontario Geological Survey, Special Volume 2, 1984.

² Ontario Department of Mines and Northern Affairs: Pleistocene Geology of the Brantford Area, Southern Ontario, 1972. Preliminary Map 2240. Scale 1:63, 360.

³ Karrow, P.F. and Sprague, D.J.: Bedrock Topography Series, Brantford Area, Southern Ontario, 1975. Preliminary Map 1049. Ontario Division of Mines. Scale 1:50, 000.

⁴ Sandford, B.V. Bedrock Geology Toronto-Windsor Area. 1969. Geological Survey of Canada Map 1263 A. Scale 1:250, 000.

3.0 INVESTIGATION PROCEDURES

Field work for this project was completed in two stages. The first stage involved drilling two boreholes, numbered 1 and 2, immediately behind the south and north abutments respectively. These boreholes were drilled on March 6 and 7, 2008 to provide information for the engineering review of the retaining wall design alternatives. Two additional boreholes (numbered 3 and 4), and six test pits (numbered 101 to 106) were completed on July 3, 2008. Test pits 101 through 104, inclusive were excavated adjacent to the abutment footings. Boreholes 3 and 4 and the remaining test pits were advanced to provide additional information for the retaining wall foundation design.

The boreholes were advanced using a truck mounted CME 55 power auger and an all-terrain mounted CME 750 power auger supplied and operated by specialist drilling contractors. Samples of the overburden were obtained at 0.75 to 1.5 metre intervals of depth using 50 millimetre outside diameter split spoon sampling equipment in accordance with the standard penetration test (SPT) procedures. The test pits were excavated using a JD 590 D excavator operated by a local excavating contractor. Chunk samples of the excavated materials from the test pits were taken at suitable intervals.

Groundwater conditions in the boreholes and test pits were observed throughout the drilling or excavating operations and these observations are provided on the corresponding Record of Borehole or Test Pit sheets. All of the boreholes were backfilled in accordance with current MTO procedures and Ontario Regulation 128/03.

The field work was supervised on a full-time basis by experienced members of our engineering staff who arranged for utility locates, directed the drilling, sampling and in-situ testing operations, logged the boreholes, cared for the samples obtained and surveyed the borehole and test pit elevations. The soil samples were identified in the field, placed in labelled containers and transported to Golder Associates' London laboratory for further examination and testing. Index and classification tests consisting of water content determinations and grain size distribution analyses were carried out on selected samples. The results of the field and laboratory testing are given on the Record of Borehole and Record of Test Pit sheets in Appendix A. The areas disturbed by the test pits were regraded and seeded on completion of sampling.

The table below summarizes the locations, ground surface elevations and depths of the boreholes:

<u>BOREHOLE</u>	<u>LOCATION (m)</u>		<u>GROUND SURFACE ELEVATION</u>	<u>BOREHOLE DEPTH</u>
	<u>Northing</u>	<u>Easting</u>	<u>(m)</u>	<u>(m)</u>
1	4 781 196.3	236 650.3	246.96	12.65
2	4 781 257.5	236 622.7	246.81	12.44
3	4 781 252.5	236 646.0	241.18	3.51
4	4 781 200.2	236 625.6	240.78	3.12

The table below summarizes the locations, ground surface elevations and depths of the test pits:

<u>TEST PIT</u>	<u>LOCATION (m)</u>		<u>GROUND SURFACE ELEVATION</u>	<u>TEST PIT DEPTH</u>
	<u>Northing</u>	<u>Easting</u>	<u>(m)</u>	<u>(m)</u>
101	4 781 255.6	236 620.0	244.39	2.30
102	4 781 258.4	236 636.8	244.44	2.65
103	4 781 198.3	236 653.3	244.66	2.60
104	4 781 195.5	236 636.5	244.49	2.55
105	4 781 246.6	236 610.7	241.12	1.68
106	4 781 205.5	236 665.4	240.85	1.55

The borehole and test pit locations are shown in plan on Drawing 1 and noted on the Record of Borehole and Record of Test Pit sheets.

4.0 SUBSURFACE CONDITIONS

4.1 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes and test pits together with the results of the in situ and laboratory testing carried out on selected samples, are given on the attached Record of Borehole sheets following the text of this report and in Appendix A. The stratigraphic boundaries shown on the Record of Borehole and Record of Test Pit sheets are inferred from non-continuous sampling and observations of drilling resistance and represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

The locations of the boreholes are shown on the attached Drawing 1 and a stratigraphic profile along each retaining wall is shown on Drawing 2. A detailed description of the subsurface conditions encountered in the boreholes is provided on the Record of Borehole sheets and is summarized in the following sections.

4.1.1 Pavement Structure

Boreholes 1 and 2 encountered 70 to 90 millimetres of asphalt overlying 270 to 310 millimetres of concrete approach slab. The concrete surface was found at elevation 246.9 metres at borehole 1 and 246.7 metres at borehole 2.

4.1.2 Topsoil and Fill

Topsoil layers 70 to 300 millimetres thick were encountered at ground surface in boreholes 3 and 4 and test pits 105 and 106.

Fill materials were found at the surface of test pits 101 to 104 inclusive and below the pavement structure from approximate elevation 246.6 metres in boreholes 101 and 102. With the exception of test pit 101, where the fill material was found to be sand, the fill generally consisted of sand and gravel. The sand fill at borehole 101 was 2.1 metres thick and contained cobbles. The sand and gravel fill layers were sometimes silty and were 2.4 metres thick in the retaining wall areas.

The fill materials were 4.0 to 4.2 metres thick in the abutment areas with N values ranging from 12 to over 100 blows per 0.3 metres. The water content of a single sample of sand and gravel fill was 4 per cent. The results of a grain size distribution test conducted on a single sample of sand and gravel fill is shown on Figure A-1.

4.1.3 Sand and Gravel

In the abutment areas, sand and gravel deposits were encountered from elevations 242.0 to 242.5 metres beneath the fill in boreholes 1 and 2 and test pits 101 to 104, inclusive. From elevations 240.6 and 241.1 metres, the topsoil layers in boreholes 3 and 4 and test pits 105 and 106 were also underlain by sand and gravel. Where fully penetrated, the upper sand and gravel layer was 2.6 to 4.3 metres thick. Borehole 1 was terminated in a lower sand and gravel layer after exploring some 5.3 metres below elevation 239.6 metres.

The sand and gravel contained cobbles and was very dense with N values of 66 to over 100 blows per 0.3 metres. Although boulders were not specifically found in the boreholes and test pits, they may be encountered as adjacent gravel pit operations infrequently expose boulders. The water content of the sand and gravel ranged from about 1 to 5 per cent. Grain size distribution curves showing the results of testing of eleven samples of sand and gravel recovered from the standard penetration testing and test pits are shown on Figures A-2 and A-3.

Visual examinations of the face of a probably now abandoned gravel pit immediately west of the proposed crossing were conducted for Geocres Report No. 40P1-56. At that time, it was noted that the gravely sands and sandy gravels extended to the base of the gravel pit at approximate elevation 235.0 metres.

4.1.4 Sandy Silt

Sandy silt was found in borehole 2 from elevation 238.0 metres. The sandy silt layer was 1.2 metres thick and very dense with an N value of over 100 blows per 0.3 metres and a water content of 18 per cent. The results of the grain size distribution testing for a single sample of sandy silt are presented on Figure A-4.

4.1.5 Sand

Sand layers were found between the sand and gravel layers in borehole 1 from elevation 240.0 metres and below the sandy silt layer in borehole 2 from elevation 236.8 metres. The sand was dense to very dense with N values of 38 to over 100 blows per 0.3 metres. A water content of one per cent was measured on a single sample. The results of grain size testing for a sample of sand retrieved from the standard penetration testing are presented on Figure A-5.

4.2 Groundwater Conditions

All boreholes and test pits were dry during and upon completion of drilling or excavation. Since grey soils were not encountered, particularly in the deepest boreholes 1 and 2, the groundwater

table has been inferred to be below elevation 234.3 metres, the lowest elevation to which the boreholes extended. Groundwater was not encountered in any of the boreholes for the original structure (Geocres 40P1-56). Information from our files for the area indicates that the groundwater level is at about elevation 233 metres.

4.3 Abutment Footing Elevations

Test pits 101 to 104 were excavated to investigate the founding conditions at each abutment. The underside of footing elevations and approximate thickness of each footing is summarized in the following table:

<u>Location</u>	<u>Test Pit</u>	<u>Underside of Footing Elevation</u> (m)	<u>Footing Thickness</u> (m)
North Abutment – west side	101	242.29	0.78
North Abutment – east side	102	242.04	0.85
South Abutment – east side	103	242.24	0.86
South Abutment – west side	104	242.13	0.87

5.0 MISCELLANEOUS

This investigation was carried out using equipment supplied and operated by Lantech Drilling Services Inc. and Aardvark Drilling Inc., both of which are Ontario Ministry of Environment licensed well contractors. The test pits were excavated using equipment supplied and operated by Bellhouse Excavating. The field operations were supervised by Mr. Tyson Pitt and Mr. David J. Mitchell. The laboratory testing was carried out at Golder Associates' London laboratory under the direction of Mr. Chris M. Sewell. The laboratory is an accredited participant in the MTO Soil and Aggregate Proficiency Program and is certified by the Canadian Council of Independent Laboratories for testing Types C and D aggregates. This report was prepared by Ms. Dirka U. Prout, P. Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P. Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

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PART B – FOUNDATION DESIGN REPORT

RETAINING WALLS

HIGHWAY 403 UNDERPASS

HIGHWAY 403 AND OAK PARK ROAD INTERCHANGE IMPROVEMENTS

GWP 3950-01-00, AGREEMENT NO. 3005-E-0067

MINISTRY OF TRANSPORTATION - SOUTHWESTERN REGION

6.0 ENGINEERING RECOMMENDATIONS

6.1 General

This section of the report provides our recommendations on the foundation aspects of the design of retaining walls to be constructed between approximate stations 16+695 and 17+020 on the north and south sides of Highway 403 with the Oak Park Road Interchange. The recommendations are based on our interpretation of the factual information obtained during the investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction they are provided only in order to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The retaining walls will be approximately 1.065 metres high. The footing of the retaining (toe) walls will be 1.20 metres wide with a footing depth of 0.5 metres or near elevation 240.5 metres. A pavement subdrain is to be installed in front of the walls. The height of backfill on the walls will be 1.04 metres with a 1.5 horizontal to 1.0 vertical backslope. As discussed in Section 1.0, five alternative retaining wall scenarios were originally proposed. The selected alternative was Alternative 3 described as the modified loop ramp with reduced shoulder width option. With this alternative, shoulder widths will vary from 1.00 to 2.50 metres and the retaining wall will be positioned about 3.2 metres in front of the abutment footings. Options for the retaining wall design are a gravity wall (Alternative 3a), a retained soil system wall (RSS) (Alternative 3b) or a cantilever wall (Alternative 3c).

6.2 Retaining Wall Foundations

The subsurface conditions encountered in the retaining wall areas typically consist of surficial topsoil and fill overlying very dense sand and gravel from elevation 240.6 to 242.5 metres. The groundwater level has been confirmed to be below elevation 234.3 metres and is likely near elevation 233 metres based on information from adjacent sites. The very dense, coarse granular materials are suitable for shallow foundations for RSS, gravity and cantilever walls. The following proposed wall designs are considered to be geotechnically feasible based on the encountered subsurface conditions:

- Cast-in-place concrete cantilever or gravity retaining wall with temporary tied protection system (designed by the contractor);
- Soldier pile with timber lagging and a cast-in-place concrete facing, tied back with grouted earth anchors; or
- RSS wall with temporary tied protection (designed by the contractor).

Table I provides a summary of the pros/cons and risks/consequences, from a foundation engineering perspective of the retaining wall alternatives.

6.2.1 Shallow Foundations

6.2.2 Geotechnical Resistance

Strip or spread footings for gravity and cantilever walls founded in the very dense sand and gravel near elevation 240.5 metres can be designed using a factored geotechnical resistance at Ultimate Limit States of 500 kilopascals and 350 kilopascals at Serviceability Limit States (SLS). The SLS value allows for 25 millimetres of settlement. The geotechnical resistances provided are based on a minimum 1.0 metre wide footing.

Alternatively, an RSS wall footing designed with the geotechnical resistances given above may be founded on a 0.3 metre thick compacted Granular A leveling pad constructed on the surface of the very dense sand and gravel. It is anticipated that the reinforced width of the RSS wall would be approximately 75 per cent of the wall height.

6.2.3 Resistance to Lateral Forces

The lateral pressures acting on the retaining walls will depend on the backfill soils, the type and method of placement of the backfill materials behind the wall, the subsequent lateral movement of the structure and the provision of reinforcement grids if an RSS wall is constructed. The use of Granular A or coarse free draining granular material as backfill is recommended due to the 1.5 horizontal to 1 vertical slope above the wall.

The resistance to lateral forces/sliding resistance between the compacted granular fill (assumed to be Granular A) and the subgrade soils should be calculated in accordance with Section 6.7.5 of the Canadian Highway Bridge Design Code (CHBDC). Also, the retaining wall shall be checked for overturning. Assuming that the founding soils are not loosened/disturbed during excavation and footing construction, the following angles of friction and corresponding unfactored coefficient of interface friction, $\tan \delta$, may be used for the interaction between the concrete and the founding soil:

Footings on sand and gravel	angle of friction	34°
	$\tan \delta$	0.67
Footings on Granular A (RSS wall)	angle of friction	33°
	$\tan \delta$	0.65

In accordance with the CHBDC, a factor of 0.8 is to be applied in calculating the horizontal resistance.

If an RSS wall is to be constructed, the internal stability of the mechanically-reinforced soil walls should be checked by the RSS supplier/designer. The Factor of Safety related to the global stability under static loading for properly designed and constructed RSS walls at this site is greater than 1.3. The design and construction of the RSS wall should be carried out in accordance with the manufacturer's design recommendations and MTO Special Provisions SP599S22 and SP599S23.

6.2.4 Construction Considerations

The chief design challenges with installation of the retaining walls are the very dense coarse grained soils containing cobbles, the necessity to work in an area with low headroom, and the requirement to excavate in close proximity to the existing abutment footings. Depending on the wall option selected, a carefully designed and constructed shoring system will be required to maintain the integrity of the foundations for the Oak Park structure. Shoring is discussed further in Section 6.6.

Frost Protection

The abutment footings should be provided with a minimum of 1.2 metres of earth cover or equivalent thermal insulation for frost protection purposes. However, the footings for the new retaining walls (toe walls) will have a cover of only 0.5 metres. The results of the geotechnical investigation have confirmed that the groundwater table is deep and the soils in the area of the retaining wall are free draining. Noting the high permeability of the native sand and gravel, and a groundwater depth of more than 6 metres below the anticipated footing depth, the potential for frost heave is very low provided there is adequate surface drainage.

6.3 Existing Foundation Conditions Oak Park Road Underpass

The abutments for the Oak Park Road Underpass are founded on shallow footings. Test pits 101 through 104 inclusive were excavated to confirm the founding conditions at the abutments. Exploration of the founding conditions at the central pier was not required. The design and actual footing details are summarized as follows:

<u>North Abutment</u>		<u>South Abutment</u>	
<u>Underside of Footing Elevation</u> (m)	<u>Footing Thickness</u> (m)	<u>Underside of Footing Elevation</u> (m)	<u>Footing Thickness</u> (m)
<u>Design</u>			
242.16	0.76	242.32	0.76
<u>Actual</u>			
West 242.29	0.78	242.13	0.87
East 242.04	0.85	242.24	0.86

The abutment footings are founded on very dense sand and gravel with cobbles. The design footing elevation for the piers was elevation 238.73 metres. Based on the proposed front slope at an inclination of 1.5 horizontal to 1 vertical, the abutment footings can be evaluated using a factored geotechnical resistance of 600 kilopascals is available at ULS and a geotechnical resistance of 400 kilopascals is available at SLS. The SLS value corresponds to 25 millimetres of settlement for the existing footing width of 2.1 metres.

6.4 Front Slope Modifications

The inclinations of the existing front slopes at each abutment will be increased from 2 horizontal to 1 vertical to 1.5 horizontal to 1 vertical. Stability analyses carried out based on the results of the recent boreholes indicate that an adequate factor of safety exists for the steepened slopes both for overall slope stability and for the abutment foundations.

6.5 Lateral Earth Pressures

The lateral pressures acting on the retaining walls will depend on the wall type, the type and method of placement of the backfill materials, on the nature of the soils behind the backfill, on the freedom of lateral movement of the structure, and on the drainage conditions behind the walls. The following recommendations are made concerning the design of the retaining wall in accordance with the CHBDC:

- Select, free-draining granular fill meeting the specifications of Ontario Provincial Standard Specifications (OPSS) Granular A but with less than 5 per cent passing the 75 micron sieve should be used as backfill behind the wall. The granular fill should be placed in accordance with Ontario Provincial Standard Drawing (OPSD) 3121.150 and compacted in loose lifts not greater than 200 millimetres in thickness in accordance with SP105 S10. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the granular backfill requirements with respect to subdrains should be in accordance with OPSD 3190.100.
- A compaction surcharge equal to 12 kilopascals should be included in the lateral earth pressures for the structural design of the abutment wall, in accordance with CHBDC, Figure 6.9.3. Compaction equipment should be used in accordance with SP105 S10.
- The granular fill may be placed either in a zone with a width equal to at least 1.2 metres behind the back of the stem (Case a from Commentary on CHBDC Clause C6.9.1) or within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical extending up and back from the rear face of the footing (Case b from Commentary on CHBDC Clause C6.9.1).
- For Cases a and b, the pressures are based on compacted Granular A fill and the following parameters (unfactored) may be assumed:

GRANULAR A

Soil unit weight:	22 kN/m ³
Coefficients of lateral earth pressure:	
Active, K_a	0.53

GRANULAR A

At rest, K_o	0.72
Passive, K_p	0.88

- If the wall support and superstructure allow lateral yielding of the stem, active earth pressures may be used in the geotechnical design of the structure. If the wall support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design.

It should be noted that the above design parameters assume a backfill inclination of 1.5 horizontal to 1 vertical and a horizontal surface in front of the wall. A statement of this effect should be included in the Contract Documents. If the final design slopes differ, these parameters should be adjusted in accordance with CHDBC C6.9.1 (e).

6.6 Excavations and Temporary Cut Slopes

Excavations for the retaining wall footings will extend through the existing surficial topsoil and fill materials into the underlying very dense sand and gravel. Temporary open cut slopes within the fill materials should be maintained no steeper than 1 horizontal to 1 vertical. In no case should the 1 horizontal to 1 vertical temporary excavation slope encroach onto the bearing surface soils of the abutment footings.

Sumps should be maintained outside of the actual footing limits. Surface water runoff should be directed away from the excavations at all times. The appropriate Non Standard Special Provision (NSSP) should be included in the contract documents.

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects. The fill materials at this site would be classified as Type 3 soils. The native granular soils would be classified as Type 1 soil.

Temporary Shoring

The new ramp configuration will require localized widening within the Oak Park Road Interchange, cutting into the existing front slopes of the overpass structures and construction of the proposed retaining walls in relatively close proximity to the existing abutment footings. Depending on the wall type selected, temporary shoring, which can be designed by a contractor, will be required to construct the new retaining walls. Various shoring alternatives such as soil nail walls, sheet piling, soldier piles with rib and lagging and tieback shoring were considered. Support to the system could be in the form of rakers and anchors. The raker/anchor support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system.

The temporary excavation support system should be designed and constructed in accordance with MTO's Special Provision 105S19. The lateral movement of the temporary shoring system should meet Performance Level 2.

The very dense sand and gravel deposits contain cobbles and occasional boulders were observed in the nearby gravel pits. Although it was possible during the field investigation to advance the boreholes using hollow stem augers and conduct standard penetration testing, excavation and tieback installation activities are expected to be difficult. For this reason, the selection of a specialist shoring contractor experienced in working in such ground conditions is important. Sheet piling cannot be installed in the very dense sand and gravel materials. Therefore it will be necessary to use a soldier pile and lagging system for temporary shoring with the piles preferably installed in predrilled holes. The sands and gravel materials are dry and will be subject to running if left unsupported and, as such, the lagging should be installed immediately as the excavation proceeds. The low headroom will require the contractor to use equipment specially adapted for such purposes.

Installation of a soil nail wall would be difficult and would require use of hollow core nails and a cement drilling grout due to the limited standup time of the generally very dense native deposits. There is a potential for raveling as the sand and gravel materials have a low water content and no cohesion. It will be necessary to very carefully expose a minimal length of face at any one time. In addition, a structural concrete facing would be required. These special measures will increase the construction costs.

The design of braced soldier pile and lagging walls should be based on rectangular earth pressure distribution using the design parameters given below. Where the support to the wall is provided by anchors or rakers, the wall design should be based on a triangular earth pressure distribution using the design parameters given below. The raker/anchor support must be designed to accommodate the loads applied from pressures and surcharge pressures from area, line or point loads as well as the impact of sloping ground behind the system. Passive toe restraint to the soldier piles may be determined using a triangular pressure distribution acting over an equivalent width equal to three times the pile socket diameter.

The unfactored triangular earth pressure distribution (p in kN/m^2 ; increasing with depth), can be calculated as follows:

	p	=	$K_a (\gamma H + q)$
where	H	=	the height of the excavation at any point in metres
	K_a	=	active coefficient of earth pressure
	γ	=	soil unit weight
	q	=	surcharge for traffic and other loading

For the granular fill, the unfactored rectangular earth pressure distribution (p in kN/m^2 ; constant with depth), can be calculated as follows:

$$p = 0.65 (K_a \gamma H + q)$$

where H = the total height of the excavation
 K_a = active coefficient of earth pressure
 γ = soil unit weight
 q = surcharge for traffic and other loading

The support systems may be designed using the following parameters:

<u>SOIL TYPE</u>	<u>COEFFICIENT OF EARTH PRESSURE</u>			<u>INTERNAL ANGLE OF FRICTION (degrees)</u>	<u>UNIT WEIGHT (kN/m^3)</u>
	<u>Active, K_a</u>	<u>At Rest, K_o</u>	<u>Passive, K_p</u>		
Granular Fill	0.53	0.72	0.88	35.0	21
Sand and Gravel	0.50	0.70	0.91	35.5	21

The earth pressure coefficients noted above are based on a 1.5 horizontal to 1.0 vertical slope behind the walls and a horizontal surface in front of the walls. If differently sloped surfaces are present, the coefficients should be adjusted accordingly.

7.0 MISCELLANEOUS

This report was prepared by Ms. Dirka U. Prout, P.Eng. under the direction of the Project Manager, Mr. Philip R. Bedell, P. Eng. This report was reviewed by Mr. Fintan J. Heffernan, P.Eng., the Designated MTO Contact and Quality Control Auditor for this assignment.

GOLDER ASSOCIATES LTD.

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DUP/PRB/FJH/cr
n:\active\2007\1130 - geotechnical\1130-2000\07-1130-204-1 dillon - gwp 3950-01-00 - fdn - hwy 403 & oak park rd\reports\0711302041-r01\0711302041-r01 oct 10 08 - part a & b ret wall oak park up.doc

TABLE I

COMPARISON OF RETAINING WALL ALTERNATIVES

Retaining Walls at Highway 403 Underpass
 Highway 403 and Oak Park Road Interchange Improvements
GWP 3950-01-00, Agreement No. 3005-E-0067

WALL OPTION	ADVANTAGES	DISADVANTAGES	RISKS/ CONSEQUENCES
Soldier pile with timber lagging and a cast-in-place concrete facing, tied back with grouted earth anchors	<ul style="list-style-type: none"> • Since protection system is permanent, the working space, extent of subexcavation into the front slope and construction time is minimized • Backfilling not required • Least expensive option 	<ul style="list-style-type: none"> • Installation of soldier piles may necessitate drilling using specially adapted equipment due to low headroom and very dense sand and gravel soils with cobbles and boulders 	<ul style="list-style-type: none"> • Lowest overall risk of damage to overpass structure due to excessive movement • Risk of ground loss and excessive ground movement if timber lagging not installed quickly due to low stand-up time for sand and gravels • Anchors may intercept and damage existing buried utilities
RSS wall with temporary tied protection	<ul style="list-style-type: none"> • Eliminates need for large construction equipment and expensive concrete work for construction of permanent wall • RSS wall requires less work space in front of wall than gravity or cantilever wall • More rapid construction than gravity or cantilever permanent wall 	<ul style="list-style-type: none"> • Two step process requiring separate construction of temporary wall then permanent wall • Requires additional excavation into front slope for placement of temporary excavation support • Possibility of insufficient space behind wall to develop sufficient stability • Most flexible wall system 	<ul style="list-style-type: none"> • Highest overall risk of damage to overpass structure due to excessive movement • Tie-backs may intercept and damage existing buried utilities • Potential for project delays if temporary support moves excessively during construction of permanent wall
Cast-in-place concrete cantilever or gravity retaining wall with temporary tied protection system	<ul style="list-style-type: none"> • Relatively stiff for resisting movement 	<ul style="list-style-type: none"> • Two step process requiring separate construction of temporary wall and permanent wall; • Requires additional excavation into front slope for placement of temporary excavation support • Most expensive solution 	<ul style="list-style-type: none"> • Tie-backs may intercept and damage existing buried utilities • Potential for project delays if temporary support moves excessively during construction of permanent wall

NOTE: 1. Table to be read in conjunction with accompanying report

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

III. SOIL DESCRIPTION

(a) Cohesionless Soils

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Consistency

	<u>kPa</u>	<u>psf</u>
Very soft	0 to 12	0 to 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1,000
Stiff	50 to 100	1,000 to 2,000
Very stiff	100 to 200	2,000 to 4,000
Hard	over 200	over 4,000

(b) Cohesive Soils

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

IV. SOIL TESTS

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

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

LIST OF SYMBOLS

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

I. General

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

RECORD OF BOREHOLE No 2

1 OF 1


METRIC

PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781257.5 ; E 236622.7 ORIGINATED BY DJM
DIST HWY 403 BOREHOLE TYPE Power Auger (HOLLOW STEM) COMPILED BY WDF
DATUM GEODETIC DATE March 7, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
246.81	GROUND SURFACE																
0.07	ASPHALT																
	CONCRETE																
0.34	FILL, sand and gravel, trace silt, with cobbles Very Dense to Compact Brown		1	SS	65		246										
			2	SS	100/ 275mm		245										
			3	SS	44		244										
			4	SS	37		243										
			5	SS	20		242										
242.24	SAND AND GRAVEL, trace silt, with cobbles Very Dense Brown		6	SS	75		241										
			7	SS	100/ 100mm		240										
			8	SS	108		239										
			9	SS	100/ 150mm		238										
			10	SS	100/ 125mm		237										
			11	SS	100/ 75mm		236										
237.97	SANDY SILT, with silt layers Very Dense Brown		12	SS	107/ 225mm		235										
236.75	SAND, fine to coarse, trace gravel Very Dense Brown		13	SS	68												
10.06																	
234.37	END OF BOREHOLE		14	SS	105/ 250mm												
12.44	Borehole dry during drilling March 7, 2008.																

LDN_MTO_01_0711302041.GPJ LDN_MTO.GDT 10/14/08

PROJECT <u>07-1130-204-1</u>		RECORD OF BOREHOLE No 3		1 OF 1		METRIC	
G.W.P. <u>3950-01-00</u>		LOCATION <u>N 4781252.5 ; E 236646.0</u>		ORIGINATED BY <u>T.P.</u>			
DIST <u> </u> HWY <u>403</u>		BOREHOLE TYPE <u>Power Auger (HOLLOW STEM)</u>		COMPILED BY <u>BRS</u>			
DATUM <u>GEODETIC</u>		DATE <u>July 3, 2008</u>		CHECKED BY <u> </u>			

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			w _p	w	w _L		GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE	WATER CONTENT (%)						
241.18	GROUND SURFACE																	
0.07	TOPSOIL, sandy Brown SAND AND GRAVEL, trace silt with cobbles Very dense Brown																	
			1	SS	100													
			2	SS	78												60 31 (9)	
			3	SS	77												52 38 (10)	
			4	SS	87													
237.67	END OF BOREHOLE																	
3.51	Borehole dry during drilling on July 3, 2008.																	

LDN_MTO_01_0711302041.GPJ LDN_MTO.GDT 10/14/08

RECORD OF BOREHOLE No 4

1 OF 1

METRIC

PROJECT 07-1130-204-1

G.W.P. 3950-01-00

LOCATION N 4781200.2 ; E 236625.6

ORIGINATED BY T.P.

DIST HWY 403

BOREHOLE TYPE Power Auger (HOLLOW STEM)

COMPILED BY BRS

DATUM GEODETIC

DATE July 3, 2008

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
240.78	GROUND SURFACE																
0.00	TOPSOIL, sandy Brown																
0.15	SAND AND GRAVEL, trace silt with cobbles Very dense Brown		1	SS	66		240										
			2	SS	100		239										51 38 (11)
			3	SS	105		238										
237.66	END OF BOREHOLE		4	SS	100/75mm												
3.12	Borehole dry during drilling on July 3, 2008.																

RECORD OF TEST PIT No 101

1 OF 1

METRIC

PROJECT 07-1130-204-1

G.W.P. 3950-01-00

LOCATION N 4781255.6 ; E 236620.0

ORIGINATED BY D.J.M.

DIST HWY 403

TEST PIT TYPE Backhoe Dug

COMPILED BY BRS

DATUM GEODETIC

DATE July 3, 2008

CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
244.39	GROUND SURFACE																
0.00	FILL, Sand, trace gravel with cobbles, trace silt Brown						244										
							243										
242.29																	
2.10	SAND AND GRAVEL Brown		1	CS													
2.30	END OF TEST PIT																
	Test pit dry during excavation on July 3, 2008.																
	Bottom of footing elev. 242.29,																

RECORD OF TEST PIT No 102

1 OF 1

METRIC

PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781258.4 ; E 236636.8 ORIGINATED BY D.J.M.
DIST HWY 403 TEST PIT TYPE Backhoe Dug COMPILED BY BRS
DATUM GEODETIC DATE July 3, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
244.44	GROUND SURFACE																
0.00	FILL, silty sand and gravel Brown																
0.20	FILL, sand and gravel, with cobbles, trace silt Brown		1	CS			244										
							243										
242.04																	
2.40	SAND AND GRAVEL Brown		2	CS			242						o				44 52 (4)
2.65	END OF TEST PIT																
	Test pit dry during excavation on July 3, 2008.																
	Bottom of footing elev. 242.04m																

LDN_MTO_01_0711302041.GPJ LDN_MTO.GDT 10/14/08

RECORD OF TEST PIT No 103

1 OF 1

METRIC

PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781198.3 ; E 236653.3 ORIGINATED BY D.J.M.
DIST HWY 403 TEST PIT TYPE Backhoe Dug COMPILED BY BRS
DATUM GEODETIC DATE July 3, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
244.66	GROUND SURFACE																
0.00	FILL, silty sand and gravel Brown																
244.26																	
0.40	FILL, sand and gravel, with cobbles, trace silt Brown						244										
							243										
242.24																	
2.42	SAND AND GRAVEL with cobbles Brown		1	CS													
2.60	END OF TEST PIT																
	Test pit dry during excavation on July 3, 2008.																
	Bottom of footing elev. 242.24m																

LDN_MTO_01_0711302041.GPJ LDN_MTO.GDT 10/14/08

RECORD OF TEST PIT No 104

1 OF 1

METRIC

PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781195.5;E 236636.5 ORIGINATED BY D.J.M.
DIST HWY 403 TEST PIT TYPE Backhoe Dug COMPILED BY BRS
DATUM GEODETIC DATE July 3, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
244.49	GROUND SURFACE																
0.00	FILL, silty sand and gravel																
0.15	Dark brown																
	FILL, sand and gravel, with cobbles, trace silt																
	Brown																
			1	CS			244										
							243										
242.14																	
2.35	SAND AND GRAVEL with cobbles		2	CS			242										42 56 (2)
2.55	Brown																
	END OF TEST PIT																
	Test pit dry during excavation on July 3, 2008.																
	Bottom of footing elev. 242.13m																

RECORD OF TEST PIT No 105

1 OF 1

METRIC

PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781246.6 ; E 236610.7 ORIGINATED BY D.J.M.
DIST HWY 403 TEST PIT TYPE Backhoe Dug COMPILED BY BRS
DATUM GEODETIC DATE July 3, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
241.12	GROUND SURFACE																
0.00	TOPSOIL, silty, trace gravel Black						241										
0.25	SAND AND GRAVEL, with cobbles Brown		1	CS			240										82 17 (1)
239.44			2	CS													
1.68	END OF TEST PIT Test pit dry during excavation on July 3, 2008.																

LDN_MTO_01 0711302041.GPJ LDN_MTO.GDT 10/14/08

RECORD OF TEST PIT No 106

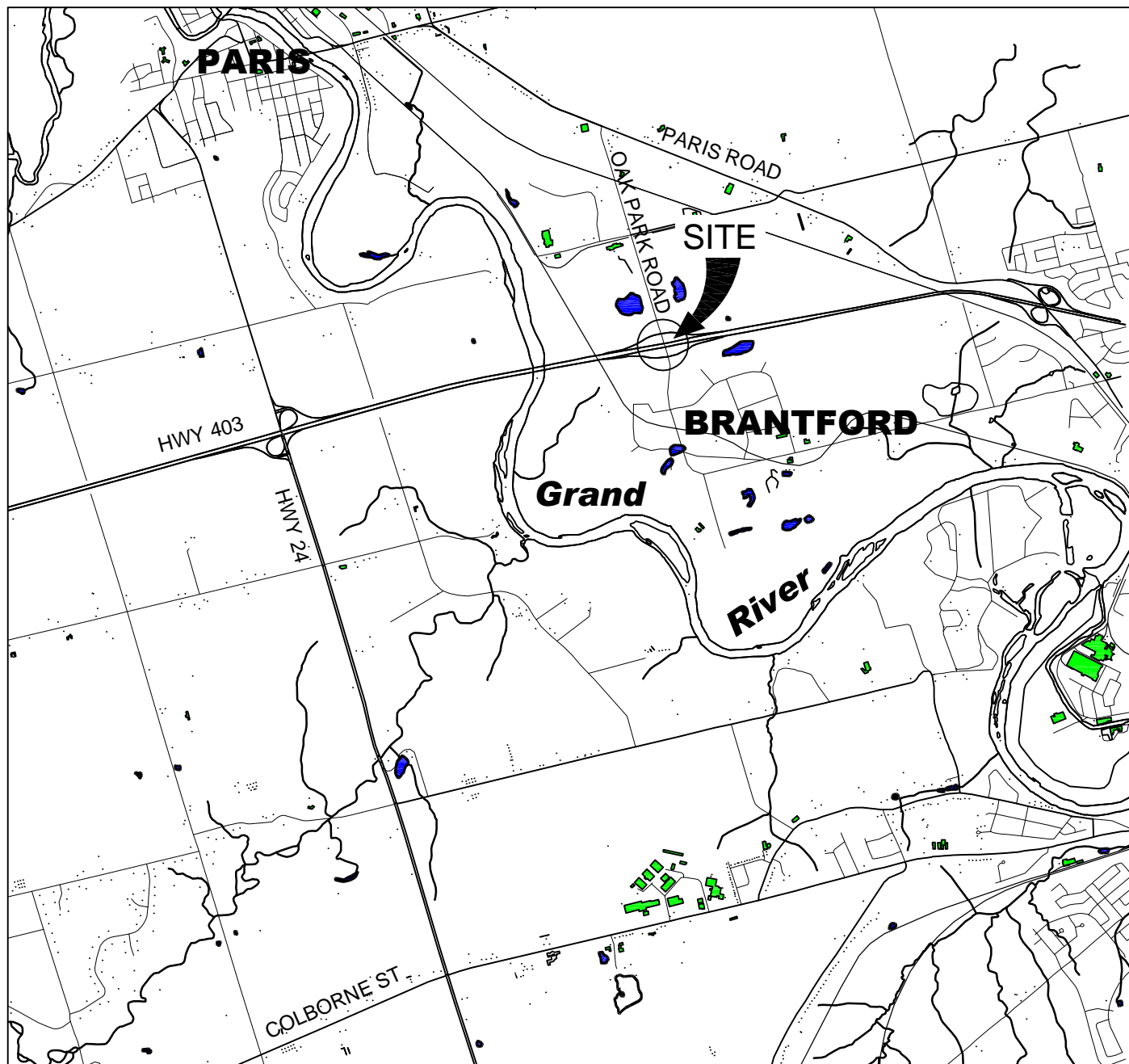
1 OF 1

METRIC

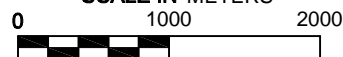
PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781205.5 ; E 236665.4 ORIGINATED BY D.J.M.
DIST HWY 403 TEST PIT TYPE Backhoe Dug COMPILED BY BRS
DATUM GEODETIC DATE July 3, 2008 CHECKED BY

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
240.85	GROUND SURFACE																
0.00	TOPSOIL, silty Black																
0.30	SAND AND GRAVEL, with cobbles Brown		1	CS			240						o				59 38 (3)
239.30			2	CS													
1.55	END OF TEST PIT Test pit dry during excavation on July 3, 2008.																

LDN_MTO_01_0711302041.GPJ LDN_MTO.GDT 10/14/08



SCALE IN METERS



1:50000

PROJECT HIGHWAY 403 / OAK PARK ROAD UNDERPASS
HIGHWAY 403 & OAK PARK ROAD INTERCHANGE
IMPROVEMENTS
GWP 3950-01-00

TITLE

KEY PLAN



**Golder
Associates**
LONDON, ONTARIO

PROJECT No. 07-1130-204-1

FILE No. 0711302041-F01001

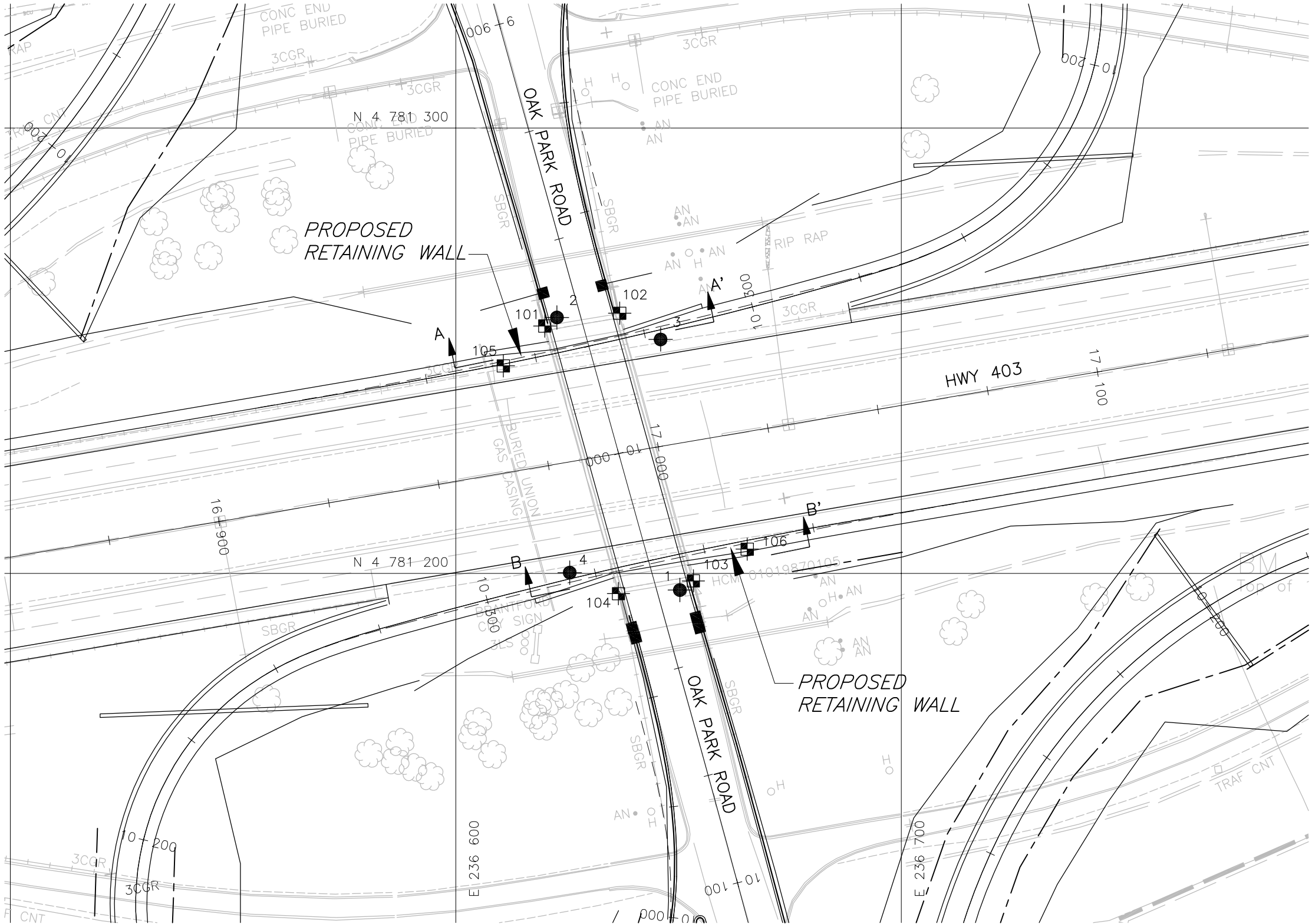
CADD WDF Aug. 13/08

CHECK

SCALE AS SHOWN REV. 0

FIGURE 1

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



PLAN

SCALE
10 0 10 m

CONT No.
WP No. 3950-01-00

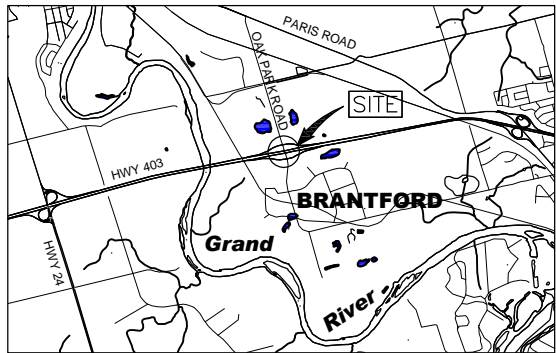


SHEET

OAK PARK ROAD UNDERPASS
HIGHWAY 403 AND OAK PARK ROAD
INTERCHANGE IMPROVEMENTS
BOREHOLE / TEST PIT LOCATIONS



Golder Associates Ltd.
LONDON, ONTARIO, CANADA



KEY PLAN

SCALE IN KILOMETRES
0 1 2

LEGEND

- Borehole - Current Investigation
- Test Pit - Current Investigation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
1	246.96	4 781 196.3	236 650.3
2	246.81	4 781 257.5	236 622.7
3	241.18	4 781 252.5	236 646.0
4	240.78	4 781 200.2	236 625.6
101	244.39	4 781 255.6	236 620.0
102	244.44	4 781 258.4	236 636.8
103	244.66	4 781 198.3	236 653.3
104	244.49	4 781 195.5	236 636.5
105	241.12	4 781 246.6	236 610.7
106	240.85	4 781 205.5	236 665.4

NOTES

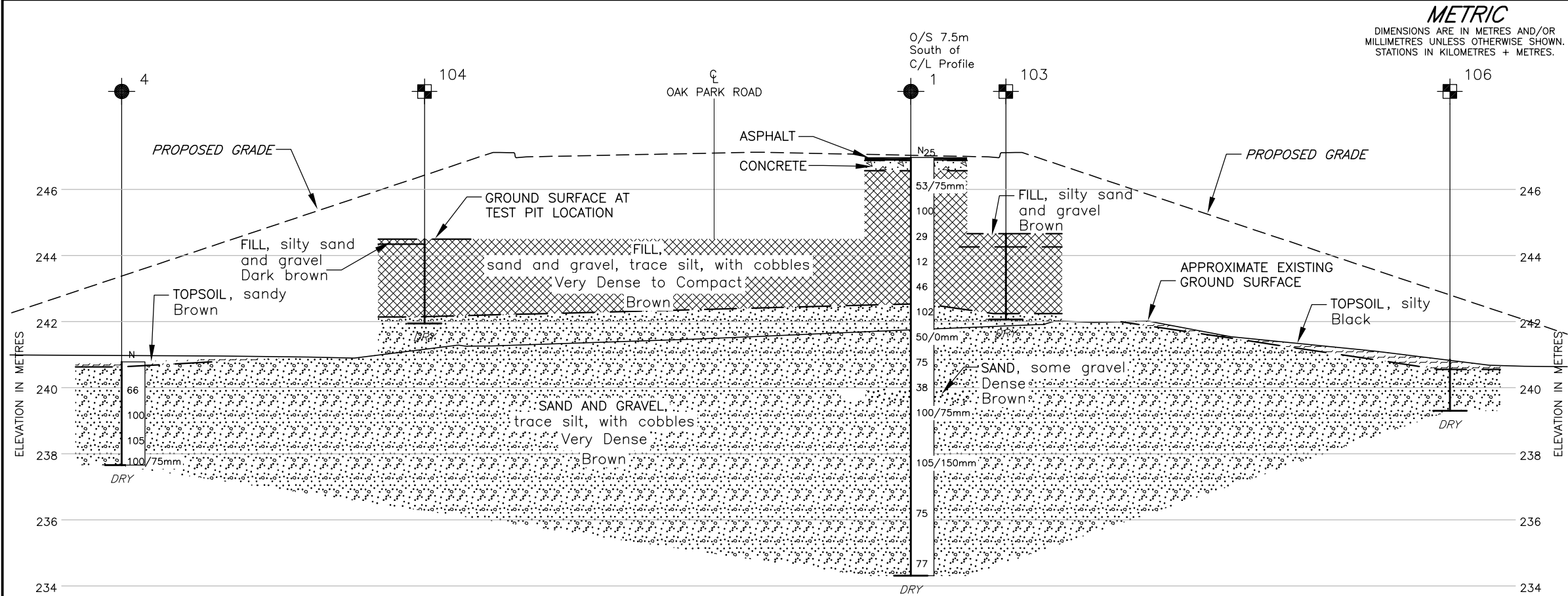
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

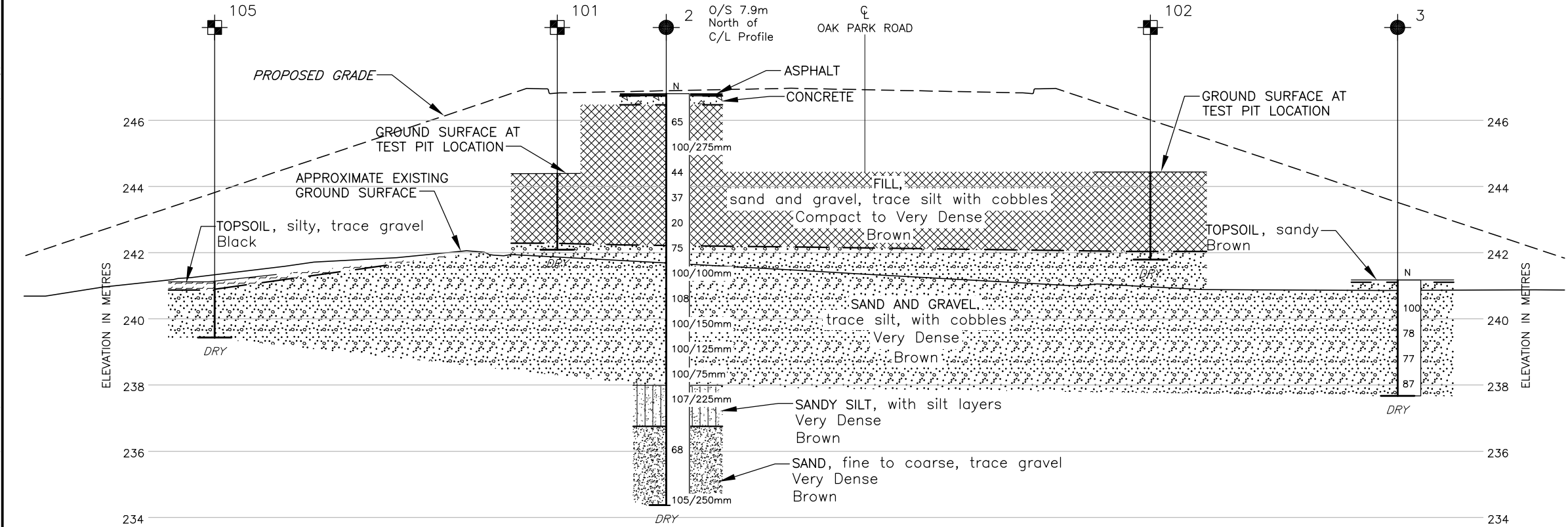
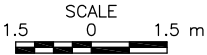
REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.

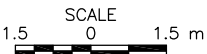
NO.	DATE	BY	REVISION
Geocres No. 40P1-96			
HWY.	403	PROJECT NO.	07-1130-204-1
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08
DRAWN:	LMK	CHKD.	APPD.
DIST.		SITE: 1-139	
DWG.		1	



PROFILE ALONG SOUTH RETAINING WALL



PROFILE ALONG NORTH RETAINING WALL



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

CONT No.
WP No. 3950-01-00

OAK PARK ROAD UNDERPASS
HIGHWAY 403 AND OAK PARK ROAD
INTERCHANGE IMPROVEMENTS
SOIL STRATA

SHEET

Golder Associates Ltd.
LONDON, ONTARIO, CANADA

LEGEND

Borehole – Current Investigation
 Test Pit – Current Investigation
N Standard Penetration Test Value
16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)
DRY Borehole / Test Pit dry during drilling / excavation

No.	ELEVATION	CO-ORDINATES (MTM ZONE 10)	
		NORTHING	EASTING
1	246.96	4 781 196.3	236 650.3
2	246.81	4 781 257.5	236 622.7
3	241.18	4 781 252.5	236 646.0
4	240.78	4 781 200.2	236 625.6
101	244.39	4 781 255.6	236 620.0
102	244.44	4 781 258.4	236 636.8
103	244.66	4 781 198.3	236 653.3
104	244.49	4 781 195.5	236 636.5
105	241.12	4 781 246.6	236 610.7
106	240.85	4 781 205.5	236 665.4

NOTES

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

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

REFERENCE

Base plans provided in digital format by Dillon Consulting Limited.

NO.	DATE	BY	REVISION
Geocres No. 40P1-96			
HWY.	403	PROJECT NO.	07-1130-204-1
SUBM'D.	DUP	CHKD.	DATE: OCT. 8/08
DRAWN:	LMK	CHKD.	APPD.
DIST.		SITE: 1-139	
DWG.		2	

RECORD OF BOREHOLE No 1

1 OF 1

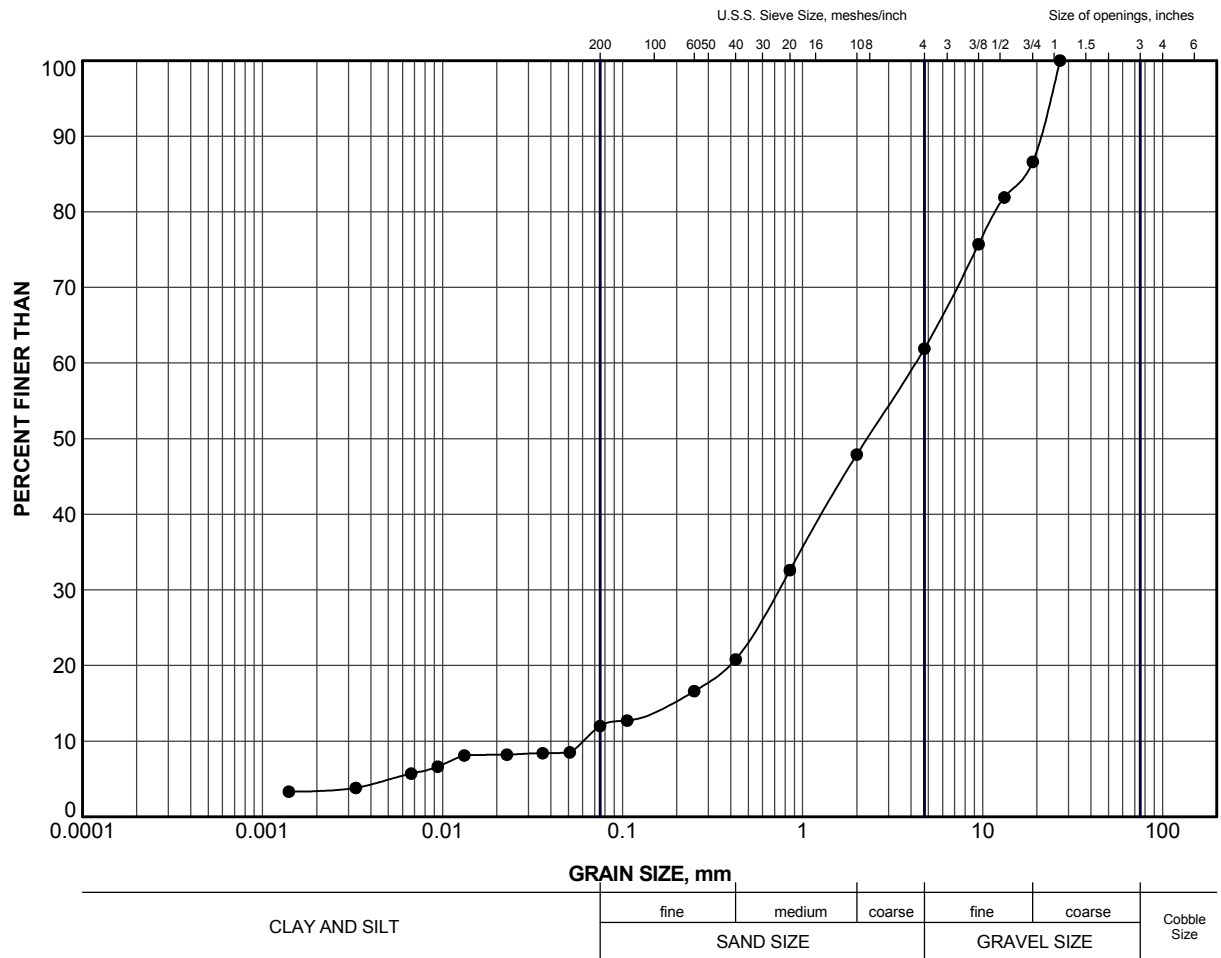
METRIC

PROJECT 07-1130-204-1
G.W.P. 3950-01-00 LOCATION N 4781196.3 ; E 236650.3 ORIGINATED BY DJM
DIST HWY 403 BOREHOLE TYPE Power Auger (HOLLOW STEM) COMPILED BY WDF
DATUM GEODETIC DATE March 6, 2008 CHECKED BY


SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)			GR	SA	SI	CL
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE												
246.96	PAVEMENT SURFACE							20	40	60	80	100											
0.09 246.56	ASPHALT CONCRETE																						
0.40	FILL, sand and gravel, trace silt, with cobbles Very Dense to Compact Brown		1	SS	53/ 75mm		246																
			2	SS	100		245																
			3	SS	29		244						○				38	50	9 3				
			4	SS	12		243																
			5	SS	46		242																
242.54	SAND AND GRAVEL, trace silt, with cobbles, layered Very Dense Brown		6	SS	102		241																
			7	SS	50/ 0mm		240																
			8	SS	75		239						○				35	56	6 3				
239.95	SAND, some gravel Dense Brown		9	SS	38		238																
7.01 239.61	SAND AND GRAVEL, trace silt, with cobbles, layered Very Dense Brown		10	SS	100/ 75mm		237																
7.35			11	SS	105/ 150mm		236																
			12	SS	75		235						○				59	33	6 2				
234.31	END OF BOREHOLE		13	SS	77																		
12.65	Borehole dry during drilling March 6, 2008.																						

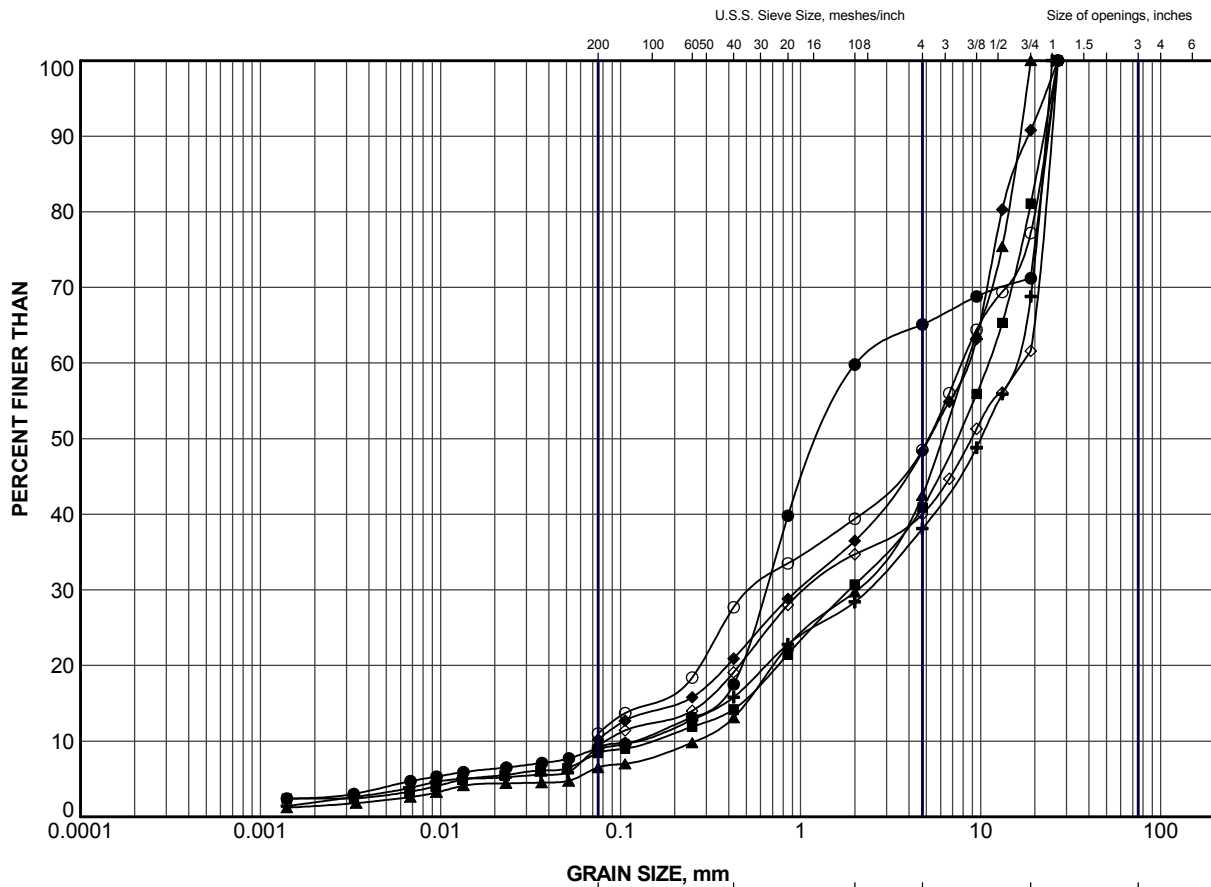
+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

APPENDIX A
LABORATORY TEST DATA



LEGEND			
SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	3	244.4

PROJECT	HIGHWAY 403 / OAK PARK ROAD UNDERPASS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00		
TITLE	GRAIN SIZE DISTRIBUTION FILL		
 Golder Associates LONDON, ONTARIO	PROJECT No.	07-1130-204-1	FILE No. 0711302041-R010A1
	DRAWN	WDF	Aug. 13/08
	CHECK		
			SCALE N/A REV.
			FIGURE A-1

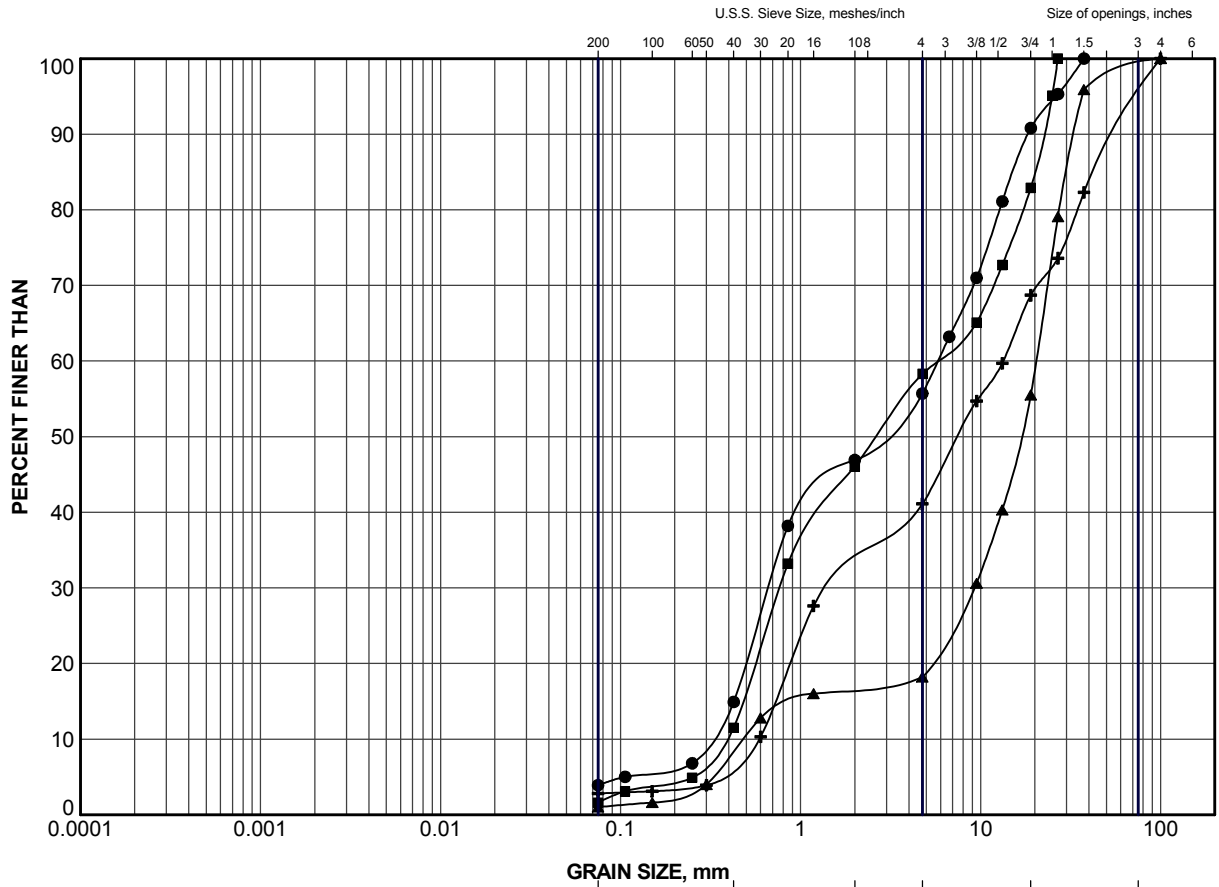


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	1	8	240.6
■	1	12	236.1
▲	2	6	242.0
+	2	8	240.5
◆	3	3	239.8
◇	3	2	238.7
○	4	2	239.1

PROJECT	HIGHWAY 403 / OAK PARK ROAD UNDERPASS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00			
TITLE	GRAIN SIZE DISTRIBUTION SAND and GRAVEL			
 Golder Associates LONDON, ONTARIO	PROJECT No.	07-1130-204-1	FILE No.	0711302041-R010A2
	DRAWN	LMK	Aug 15/08	SCALE N/A REV.
	CHECK			
			FIGURE A-2	

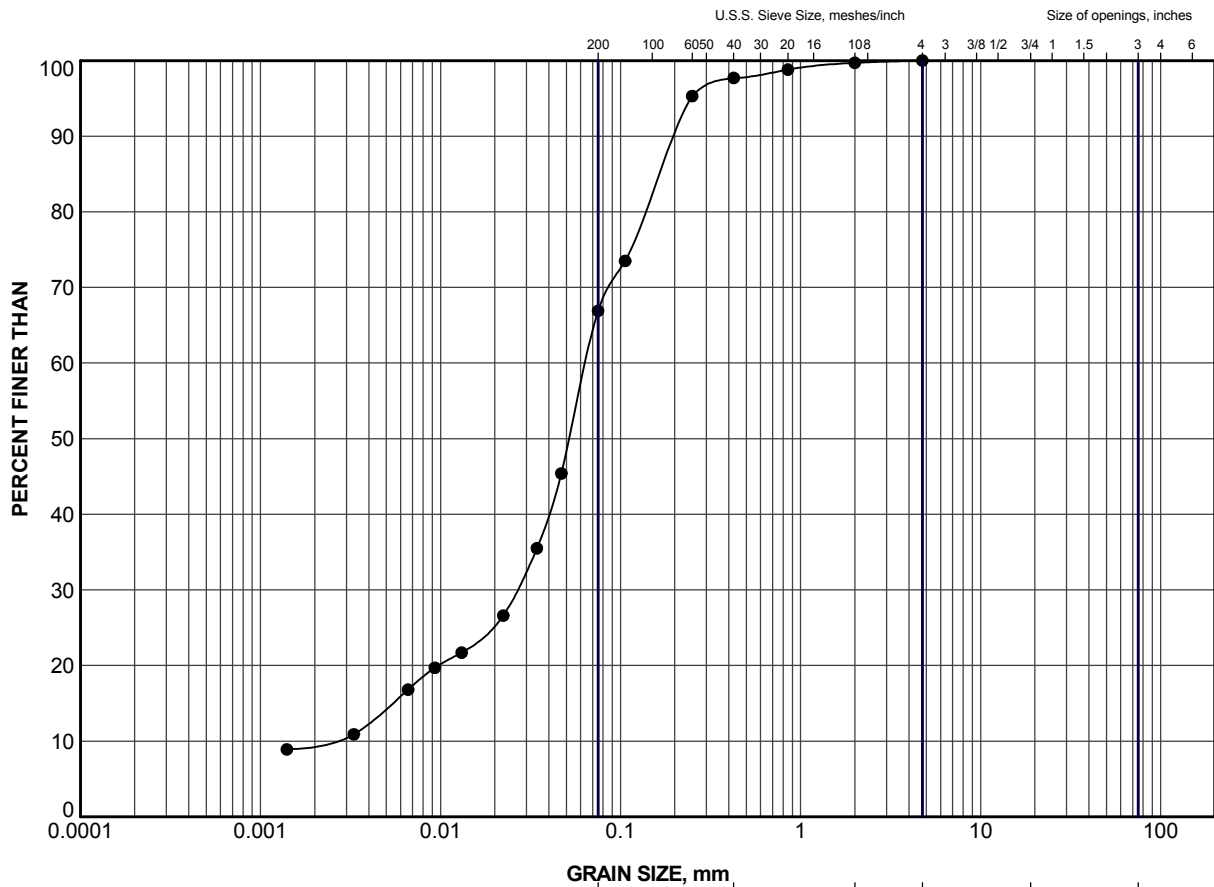


CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	TEST PIT	SAMPLE	ELEV (m)
●	102	2	241.9
■	104	2	242.0
▲	105	1	240.3
+	106	1	239.9


PROJECT	HIGHWAY 403 / OAK PARK ROAD UNDERPASS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00				
TITLE	GRAIN SIZE DISTRIBUTION SAND and GRAVEL				
 Golder Associates LONDON, ONTARIO	PROJECT No.	07-1130-204-1	FILE No.	0711302041-R010A3	
	DRAWN	LMK	Aug 19/08	SCALE	N/A
	CHECK			REV.	
			FIGURE A-3		

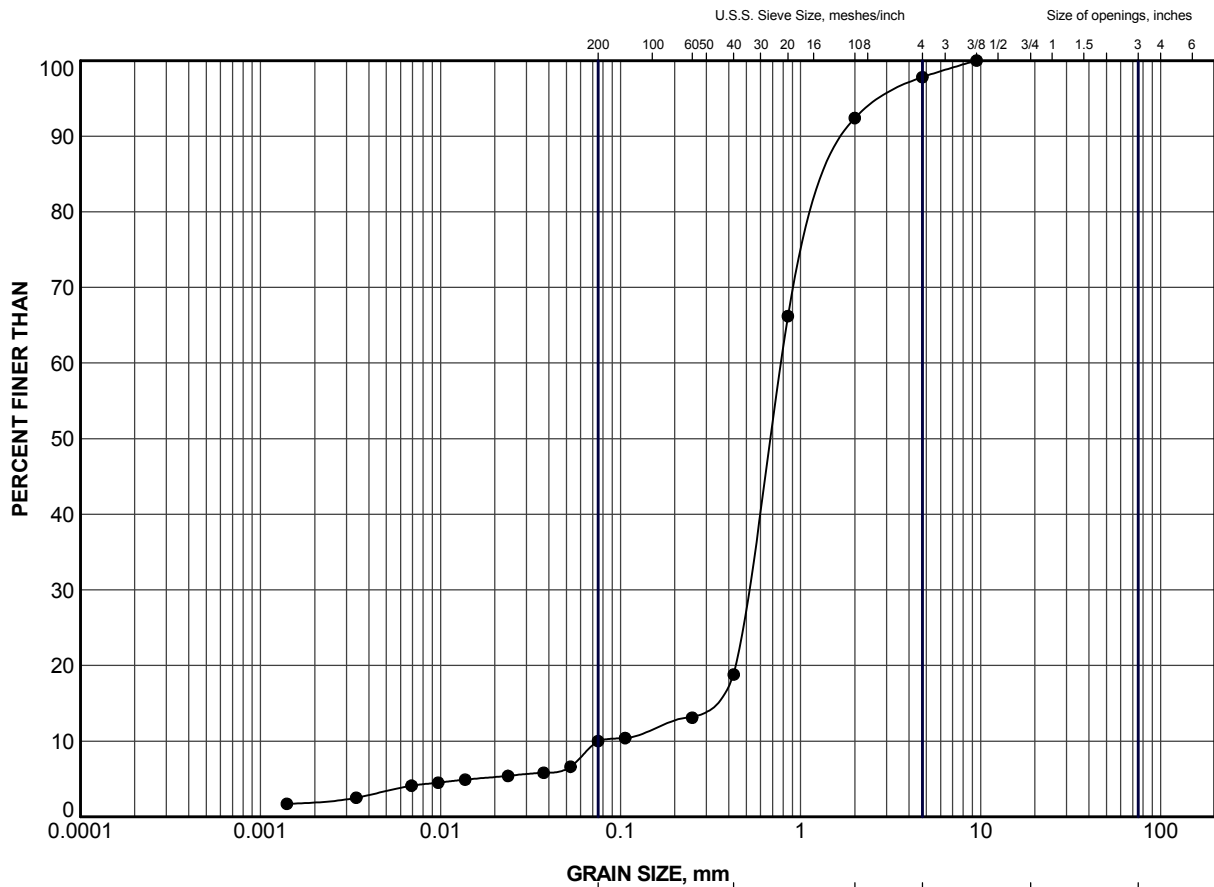


CLAY AND SILT	SAND SIZE, mm					Cobble Size
	fine	medium	coarse	fine	coarse	
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	2	12	237.6


PROJECT	HIGHWAY 403 / OAK PARK ROAD UNDERPASS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00				
TITLE	GRAIN SIZE DISTRIBUTION SANDY SILT				
 Golder Associates LONDON, ONTARIO	PROJECT No.	07-1130-204-1	FILE No.	0711302041-R010A4	
	DRAWN	WDF	Aug. 13/08	SCALE	N/A
	CHECK			REV.	
			FIGURE A-4		



CLAY AND SILT	fine	medium	coarse	fine	coarse	Cobble Size
	SAND SIZE			GRAVEL SIZE		

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	2	13	235.9

PROJECT				HIGHWAY 403 / OAK PARK ROAD UNDERPASS HIGHWAY 403 & OAK PARK ROAD INTERCHANGE IMPROVEMENTS GWP 3950-01-00			
TITLE				GRAIN SIZE DISTRIBUTION SAND			
PROJECT No.		07-1130-204-1		FILE No.		0711302041-R010A5	
DRAWN		WDF		SCALE		N/A	
CHECK				REV.			
 Golder Associates LONDON, ONTARIO				FIGURE A-5			

APPENDIX B

PREVIOUS BOREHOLES DATA
(GEOCRES NO. 40P1-56)

DEPARTMENT OF HIGHWAYS-ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUNDATION SECTION

JOB 71-11111

LOCATION

Sta. 20 + 11 26' Rt. (Co. Rd. 27)

ORIGINATED BY FK

W.P. 157-60-09

BORING DATE

Jan. 12, 1972

COMPILED BY AKG

DATUM Geodetic

BOREHOLE TYPE

Hollow Stem Auger

CHECKED BY S.K.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION BLOWS/FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	LIQUID LIMIT PLASTIC LIMIT WATER CONTENT W _p — W _L 10 20 30	BULK DENSITY P.C.F. GR.SA.SI.CL.	REMARKS
EV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER					
316.3	Ground Level							
312.3	Silty sand, some gravel & organics.		1	SS	5			
4.0	Sandy gravel, some silt		2	SS	10			
506.2	Very Dense		3	SS	100			
9.5	End of Borehole							

47 40 (13)

DEPARTMENT OF HIGHWAYS- ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 2

FOUNDATION SECTION

JOB 71-11111

LOCATION

Sta. 19 + 76 27' Rt. (Co. Rd. 27)

ORIGINATED BY FK

W.P. 157-60-CO

BORING DATE

Jan. 12, 1972

COMPILED BY AKB

DATUM Geodetic

BOREHOLE TYPE

Cone Test Only

CHECKED BY S.R.

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	LIQUID LIMIT w_L PLASTIC LIMIT w_p WATER CONTENT w WATER CONTENT % $w_p - w_L$	BULK DENSITY γ P.C.F. GR. SA. SI. CL.	REMARKS
DEPTH Ground Level	STRAT. PLOT	NUMBER	TYPE					
0.0								
6.4	End of Cone Test			81.0				

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
 MATERIALS & TESTING OFFICE
 JOB 72-11111
 W.P. 157-60-00
 DATUM Geodetic

LOCATION Sta. 18 + 97 28' Rt. (Co. Rd. 27)
 BORING DATE Jan. 12, 1972
 BOREHOLE TYPE Hollow Stem Auger

RECORD OF BOREHOLE No. 3

ORIGINATED BY FK
 COMPILED BY AKB
 CHECKED BY J.R.

FOUNDATION SECTION

SOIL PROFILE		SAMPLES		ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F. ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB. VANE	LIQUID LIMIT ——— PLASTIC LIMIT ——— WATER CONTENT ——— W _p ——— W _L WATER CONTENT % 10 20 30	BULK DENSITY P.C.F. γ	REMARKS
DESCRIPTION	STRAT. PLOT	NUMBER	TYPE					
0.0 EV. PTH Ground Level								
318.5 Silty sand, some gravel & organics.		1	SS	100				
3.8 Sandy gravel, some silt		2	SS	101				
311.8 Very Dense								
10.5 End of Borehole				810				50 33 (17)

FOUNDATION SECTION

ORIGINATED BY PK

COMPILED BY AKB

CHECKED BY S. F.

[illegible]

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 5

FOUNDATION SECTION

JOB 71-1111

LOCATION

Sta. 17 + 82 28' Rt. (Co. Rd. 27)

ORIGINATED BY FR

W.P. 157-60-00

BORING DATE

Jan 12-13, 1972

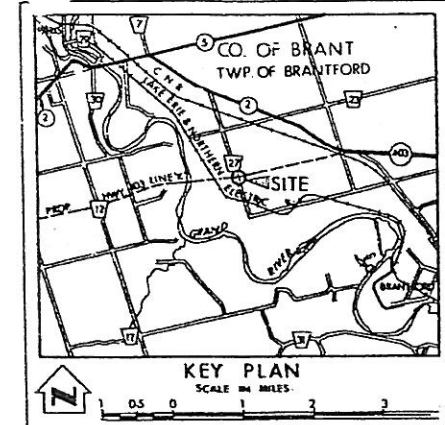
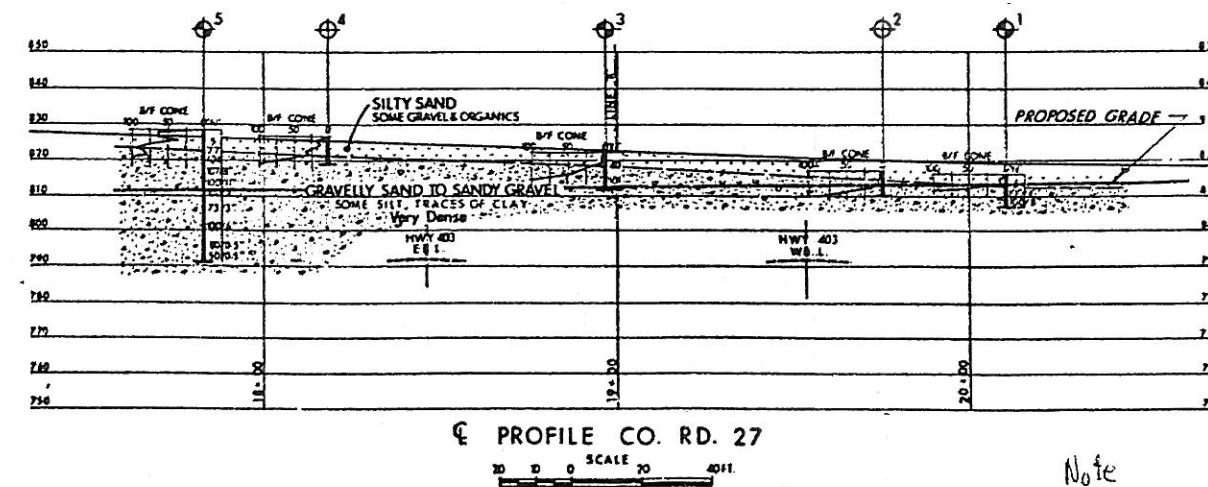
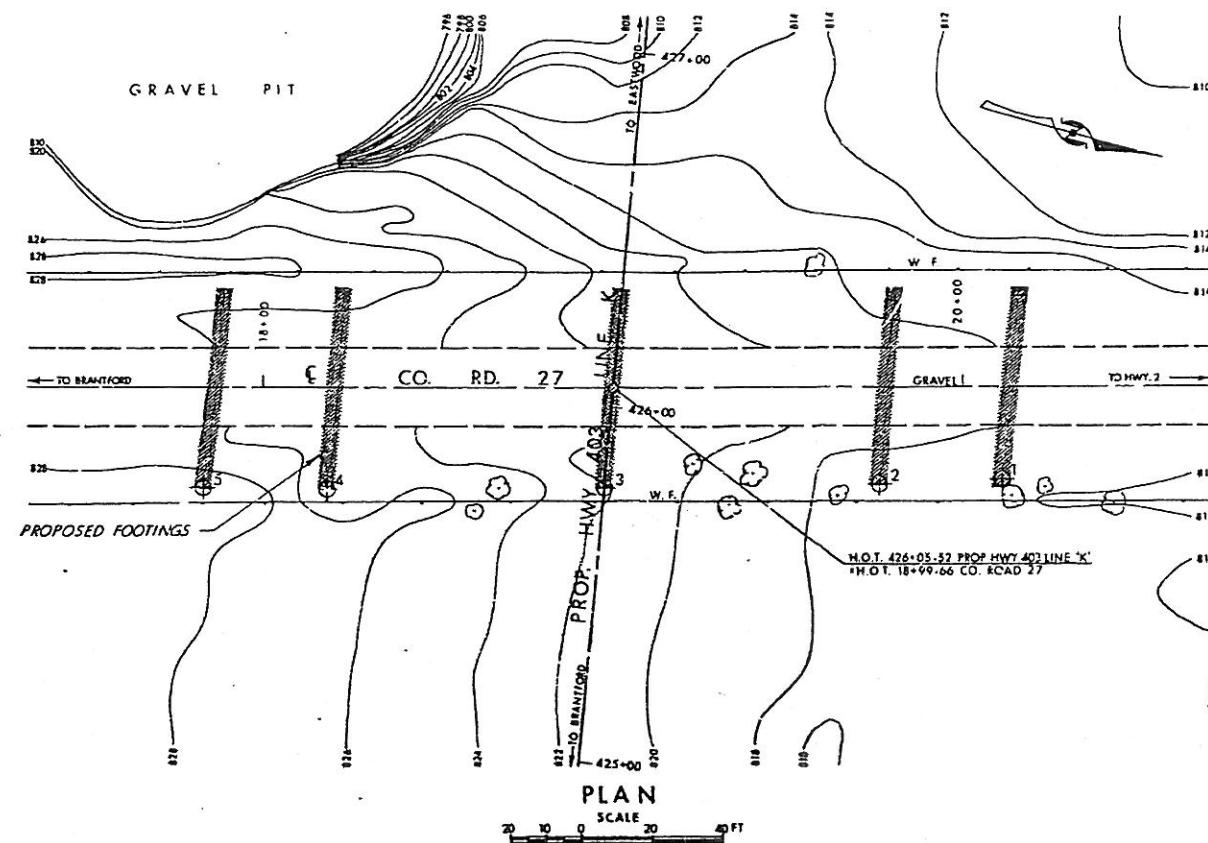
COMPILED BY AKB





DATUM Geodetic

BOREHOLE TYPE Hollow Stem Auger

CHECKED BY V.V.

E.V. DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES		BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE		LIQUID LIMIT		WATER CONTENT %	BULK DENSITY	REMARKS
			NUMBER	TYPE			BLOWS / FOOT	RESISTANCE	PLASTIC LIMIT	WATER CONTENT			
5.8	Gravelly sand to sand & organics.		1	SS	5	820							32 46 (22)
5.8			2	SS	77								
5.8			3	SS	101								
5.8			4	SS	107								
5.8			5	SS	110								
5.8	Gravelly sand to sand & organics.		6	SS	111								
5.8	Gravelly sand to sand & organics.		7	SS	112								
5.8	Gravelly sand to sand & organics.		8	SS	113								
5.8	Gravelly sand to sand & organics.		9	SS	114								
5.8	Gravelly sand to sand & organics.		10	SS	115								
5.8	Gravelly sand to sand & organics.		11	SS	116								
5.8	Gravelly sand to sand & organics.		12	SS	117								
5.8	Gravelly sand to sand & organics.		13	SS	118								
5.8	Gravelly sand to sand & organics.		14	SS	119								
5.8	Gravelly sand to sand & organics.		15	SS	120								
5.8	Gravelly sand to sand & organics.		16	SS	121								
5.8	Gravelly sand to sand & organics.		17	SS	122								
5.8	Gravelly sand to sand & organics.		18	SS	123								
5.8	Gravelly sand to sand & organics.		19	SS	124								
5.8	Gravelly sand to sand & organics.		20	SS	125								
5.8	Gravelly sand to sand & organics.		21	SS	126								
5.8	Gravelly sand to sand & organics.		22	SS	127								
5.8	Gravelly sand to sand & organics.		23	SS	128								
5.8	Gravelly sand to sand & organics.		24	SS	129								
5.8	Gravelly sand to sand & organics.		25	SS	130								
5.8	Gravelly sand to sand & organics.		26	SS	131								
5.8	Gravelly sand to sand & organics.		27	SS	132								
5.8	Gravelly sand to sand & organics.		28	SS	133								
5.8	Gravelly sand to sand & organics.		29	SS	134								
5.8	Gravelly sand to sand & organics.		30	SS	135								
5.8	Gravelly sand to sand & organics.		31	SS	136								
5.8	Gravelly sand to sand & organics.		32	SS	137								
5.8	Gravelly sand to sand & organics.		33	SS	138								
5.8	Gravelly sand to sand & organics.		34	SS	139								
5.8	Gravelly sand to sand & organics.		35	SS	140								
5.8	Gravelly sand to sand & organics.		36	SS	141								
5.8	Gravelly sand to sand & organics.		37	SS	142								
5.8	Gravelly sand to sand & organics.		38	SS	143								
5.8	Gravelly sand to sand & organics.		39	SS	144								
5.8	Gravelly sand to sand & organics.		40	SS	145								
5.8	Gravelly sand to sand & organics.		41	SS	146								
5.8	Gravelly sand to sand & organics.		42	SS	147								
5.8	Gravelly sand to sand & organics.		43	SS	148								
5.8	Gravelly sand to sand & organics.		44	SS	149								
5.8	Gravelly sand to sand & organics.		45	SS	150								
5.8	Gravelly sand to sand & organics.		46	SS	151								
5.8	Gravelly sand to sand & organics.		47	SS	152								
5.8	Gravelly sand to sand & organics.		48	SS	153								
5.8	Gravelly sand to sand & organics.		49	SS	154								
5.8	Gravelly sand to sand & organics.		50	SS	155								
5.8	Gravelly sand to sand & organics.		51	SS	156								
5.8	Gravelly sand to sand & organics.		52	SS	157								
5.8	Gravelly sand to sand & organics.		53	SS	158								
5.8	Gravelly sand to sand & organics.		54	SS	159								
5.8	Gravelly sand to sand & organics.		55	SS	160								
5.8	Gravelly sand to sand & organics.		56	SS	161								
5.8	Gravelly sand to sand & organics.		57	SS	162								
5.8	Gravelly sand to sand & organics.		58	SS	163								
5.8	Gravelly sand to sand & organics.		59	SS	164								
5.8	Gravelly sand to sand & organics.		60	SS	165								
5.8	Gravelly sand to sand & organics.		61	SS	166								
5.8	Gravelly sand to sand & organics.		62	SS	167								
5.8	Gravelly sand to sand & organics.		63	SS	168								
5.8	Gravelly sand to sand & organics.		64	SS	169								
5.8	Gravelly sand to sand & organics.		65	SS	170								
5.8	Gravelly sand to sand & organics.		66	SS	171								
5.8	Gravelly sand to sand & organics.		67	SS	172								
5.8	Gravelly sand to sand & organics.		68	SS	173								
5.8	Gravelly sand to sand & organics.		69	SS	174								
5.8	Gravelly sand to sand & organics.		70	SS	175								
5.8	Gravelly sand to sand & organics.		71	SS	176								
5.8	Gravelly sand to sand & organics.		72	SS	177								
5.8	Gravelly sand to sand & organics.		73	SS	178								
5.8	Gravelly sand to sand & organics.		74	SS	179								
5.8	Gravelly sand to sand & organics.		75	SS	180								
5.8	Gravelly sand to sand & organics.		76	SS	181								
5.8	Gravelly sand to sand & organics.		77	SS	182								
5.8	Gravelly sand to sand & organics.		78	SS	183								
5.8	Gravelly sand to sand & organics.		79	SS	184								
5.8	Gravelly sand to sand & organics.		80	SS	185								
5.8	Gravelly sand to sand & organics.		81	SS	186								
5.8	Gravelly sand to sand & organics.		82	SS	187								
5.8	Gravelly sand to sand & organics.		83	SS	188								
5.8	Gravelly sand to sand & organics.		84	SS	189								
5.8	Gravelly sand to sand & organics.		85	SS	190								
5.8	Gravelly sand to sand & organics.		86	SS	191								
5.8	Gravelly sand to sand & organics.		87	SS	192								
5.8	Gravelly sand to sand & organics.		88	SS	193								
5.8	Gravelly sand to sand & organics.		89	SS	194								
5.8	Gravelly sand to sand & organics.		90	SS	195								
5.8	Gravelly sand to sand & organics.		91	SS	196								
5.8	Gravelly sand to sand & organics.		92	SS	197								
5.8	Gravelly sand to sand & organics.		93	SS	198								
5.8	Gravelly sand to sand & organics.		94	SS	199								
5.8	Gravelly sand to sand & organics.		95	SS	200								
5.8	Gravelly sand to sand & organics.		96	SS	201								
5.8	Gravelly sand to sand & organics.		97	SS	202								
5.8	Gravelly sand to sand & organics.		98	SS	203								
5.8	Gravelly sand to sand & organics.		99	SS	204								
5.8	Gravelly sand to sand & organics.		100	SS	205								
5.8	Gravelly sand to sand & organics.		101	SS	206								
5.8	Gravelly sand to sand & organics.		102	SS	207								
5.8	Gravelly sand to sand & organics.		103	SS	208								
5.8	Gravelly sand to sand & organics.		104	SS	209								
5.8	Gravelly sand to sand & organics.		105	SS	210								
5.8	Gravelly sand to sand & organics.		106	SS	211								
5.8	Gravelly sand to sand & organics.		107	SS	212								
5.8	Gravelly sand to sand & organics.		108	SS	213								
5.8	Gravelly sand to sand & organics.		109	SS	214								
5.8	Gravelly sand to sand & organics.		110	SS	215								
5.8	Gravelly sand to sand & organics.		111	SS	216								
5.8	Gravelly sand to sand & organics.		112	SS	217								
5.8	Gravelly sand to sand & organics.		113	SS	218								
5.8</													



LEGEND			
	Bore Hole		
	Cone Penetration Test		
	Bore Hole & Cone Test		
	Water Levels established at time of field investigation.		
	No Water Encountered in Bore Holes - 12 Jan. 1972.		
NO.	ELEVATION	STATION	OFFSET
1	816.3	20+11	26' RT.
2	817.4	19+76	27' RT.
3	822.3	18+97	28' RT.
4	826.9	18+18	28' RT.
5	828.7	17+82	28' RT.

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

REVISION	DATE	BY	DESCRIPTION

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS
DESIGN SERVICES BRANCH — FOUNDATION OFFICE

COUNTY ROAD 27

HIGHWAY NO. 403 LINE 'K' DIST. NO. 4
CO. BRANT
TWP. BRANTFORD LOT 18 & 19 CON. 2

BORE HOLE LOCATIONS & SOIL STRATA

SUBMIT P.E.	CHECKED <u>JP</u>	DATE <u>157-60-00</u>	DRAWING NO. <u>71-11111A</u>
DRAWN <u>JP</u>	CHECKED <u>JP</u>	JOB NO. <u>71-11111</u>	BORE DRILLING NO.
DATE <u>FEB 16, 1972</u>	SITE NO.	APPROVED <u>[Signature]</u>	CONT. NO.

NOTE
NO ENCOUNTERED
WAS ENCOUNTERED
IN ANY OF THE
SIGHT LINES

Note

REF NO. E-4862-1

APPENDIX C
SITE PHOTOGRAPHS

SITE PHOTOGRAPHS



Photo 1: Oak Park Road Underpass. View of south abutment from westbound lanes.



Photo 2: Highway 403 Eastbound. Existing E-N/S ramp on left.

Golder Associates

SITE PHOTOGRAPHS



Photo 3: North Abutment Footing – West Side (Test Pit 101).



Photo 4: North Abutment Footing – East Side (Test Pit 102).

Golder Associates

SITE PHOTOGRAPHS



Photo 5: South Abutment Footing – East Side (Test Pit 103).



Photo 6: South Abutment Footing – West Side (Test Pit 104).