GEOTECHNICAL INVESTIGATION REPORT
MOUNTBATTEN EXTENSION PHASE 2
NEW STORM AND SANITARY SEWERS AND RESIDENTIAL DEVELOPMENT
WINDSOR, ONTARIO

Submitted to:

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1.0 INTRODUCTION

1.1 Background

Amec Foster Wheeler Environment & Infrastructure, a Division of Amec Foster Wheeler Americas Limited (”Amec Foster Wheeler”) has been retained by the Corporation of the City of Windsor (the “City”) to provide geotechnical services for proposed redevelopment of the former Tecumseh Water Treatment Plant located at the corner of Riverside Drive East and Martinique Avenue in the City of Windsor, Ontario. As part of this project, a geotechnical investigation was carried out to support the design for new sewers and foundations for the proposed residential structures. A Key Plan showing the general location of the site is provided on Figure 1, included at the end of the text.

This report is prepared based on the geotechnical investigation carried out at the site and includes information on soil and groundwater conditions obtained from the geotechnical investigation.

The purpose of the geotechnical investigation was to determine the subsurface soil and groundwater conditions and associated geotechnical parameters and to prepare an engineering report with recommendations for the geotechnical aspects of the design of the proposed new storm and sanitary sewers, and residential development.

The construction conditions discussed in this report are intended primarily to assist in the design decisions. Contractors should be aware that the data and their interpretations presented in this report may not be sufficient to assess all factors that may have an impact on the construction process.

This report is prepared with the assumption that the design and construction will be in accordance with all applicable standards, codes, regulations of authorities having jurisdiction and with good engineering practice. Further, the recommendations and opinions in this report are applicable only to the subject project described above.

There should be an ongoing liaison with Amec Foster Wheeler during both the design and construction phases of this project to ensure that the recommendations in this report have been interpreted and implemented as intended. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of this project, Amec Foster Wheeler should be contacted immediately.

The scope of this project is strictly limited to the geotechnical aspects of the proposed development. Any potential environmental concerns either already existing or arising from development at this site are beyond the scope of this investigation.

1.2 Project Description

The site is approximately 3 hectares in area and it is planned to redevelop the site with new storm and sanitary sewers, 19 single family homes and 5 blocks of town homes. The inverts of the new sewers will be approximately between elevation 172.25 m and 173.40 m. A new sanitary sewer will be installed along Martinique Avenue to service the new townhomes. The new residential homes will incorporate basements. The redevelopment will also incorporate the construction of new asphaltic pavement.

It was also requested that the existing fill left on site from the demolition of the former treatment plant be assessed to determine if it is suitable to support the new foundations for the residential structures. In addition, the composition of the fill placed in the southeastern portion of the site sometime in the past is to be determined.

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2.0 INVESTIGATION PROGRAM

2.1 Field Work

The scope of work included the advancement of nine (9) sampled boreholes designated as BH1 to BH9, inclusive, and six (6) test pits designated as TP1 to TP6, inclusive. The boreholes were drilled to depths ranging from 5.0 m to 8.4 m below the existing ground surface. The test pits were advanced to depths of 3.2 m to 4.8 m below the ground surface.

The locations of the boreholes and test pits are shown on Figure 2. The figure was prepared from a plan provided by the City. The coordinates of the borehole and test pit locations were determined in the field using a hand-held GPS with an accuracy of ±3 m. The coordinates of the boreholes and test pits are shown on the borehole and test pit logs attached in Appendix A.

The borehole drilling and test pitting program for the investigation was carried out between September 1 and 8, 2015. The boreholes were advanced using a self-propelled drilling machine equipped with hollow stem augers and conventional soil sampling tools. Soil samples were taken at frequent intervals of depth using a 50 mm diameter split spoon sampler following the Standard Penetration Test (ASTM D1586) procedure. The open excavation test pits were advanced using an excavator.

The drilling and test pitting were conducted under the full-time supervision of Amec Foster Wheeler's engineering staff who directed the drilling/test pitting and sampling operation, and logged the boreholes and test pits.

After completion of each borehole, the augers were extracted, the borehole was inspected for groundwater and caving, and backfilled using bentonite grout. The test pits were backfilled using the excavated soil generated by the test pit operation.

All samples were field logged, placed in airtight containers, and transported to Amec Foster Wheeler's Tecumseh laboratory for further examination and testing.

Ground surface elevations are referenced to the top elevations of the existing catch basins on the roadway. The top elevations of the catch basins were taken from the cut and fill layout plan provided by the City. Borehole BH1 was referenced to the top elevation of the catch basin at the north end of Mountbatten Crescent near the southwest corner of Lot 9, with a given elevation (El.) of 176.183 m. All other test holes were referenced to the top elevation of the catch basin on Martinique Avenue east of Block 2, with a given elevation of 175.579 m. It is understood that the elevations are referenced to geodetic datum. The elevations used in this report were obtained strictly for use by this office in the geotechnical design of the project. They should not be used by any other party for any other purpose.

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2.2 Laboratory Testing

Natural moisture content tests were carried out on all of the recovered soil samples in accordance with ASTM D2216. Grain size distribution tests were completed on two (2) selected soil samples in accordance with ASTM D422 and Atterberg limit tests were carried out on two (2) samples in accordance with ASTM D4318. The test results are included in Appendix B.

Soil sample collected from two boreholes was sent to Paracel Laboratories Ltd. in Ottawa, Ontario to determine the pH, resistivity etc. to assess corrosion potential. The results of the analytical testing are attached in Appendix B and summarized in Table 2.

3.0 SITE DESCRIPTION AND GEOLOGICAL BACKGROUND

3.1 Site Description

The site for the proposed redevelopment of the former Tecumseh Water Treatment Plant is located at the corner of Riverside Drive East and Martinique Avenue in the City of Windsor, Ontario. The location of the site is shown on Key Plan, Figure 1. The site is approximately 3 hectares in area and it is planned to redevelop the site with new storm and sanitary sewers, 19 single family homes and 5 blocks of town homes. A new sanitary sewer will be installed along Martinique Avenue to service the new townhomes. The topography of the land in the vicinity of the proposed site is generally variable as a result of previous development and the site is currently covered with grass.

3.2 Geological Background

The site is located within a geological feature known as Essex Clay Plain, which is an extensive clay plain with little relief and poor natural drainage. The plain is underlain by a relatively thick (30 m to 40 m) deposit of glaciolacustrine silty clay till. Occasional embedded pockets and lenses of sand and silt are present as well as occasional cobbles and / or boulders. The clay deposit is supported by limestone bedrock.

Along the Detroit River shoreline, it is common to encounter significant amounts of man-placed fill materials and buried abandoned structures.

The generally low permeability characteristics of the clay deposit render this deposit as an “aquitard” where the groundwater is stored in the soil pores and moves extremely slowly. Local sizeable fluctuations in the groundwater elevations can occur depending on the prevalent weather and precipitation conditions.

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4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Soil Conditions

The soil descriptions presented here are based on visual and tactile examinations, augmented with field tests and select laboratory tests. Details of the subsurface soil conditions at the borehole and test pit locations are given on the Record of Borehole logs and Test Pit logs, respectively, attached in Appendix A. The results of laboratory testing carried out on recovered soil samples are also shown on the borehole and test pit log sheets. The stratigraphic boundaries shown on the borehole and test pit logs are inferred from non-continuous samples and observations during drilling/test pitting, and therefore should be considered as approximate and not as precise planes of geologic change. The soil conditions may vary between and beyond the boreholes/test pits.

The subsurface soil conditions encountered in the boreholes and test pits at the site generally consisted of the topsoil, asphaltic pavement, fill materials and cohesive silty clay. The following descriptions are presented as a summary only.

Topsoil and Asphaltic Pavement

Test holes BH2, BH3, BH4, BH5, TP1, TP3, TP4 and TP6 were advanced through a layer of organic topsoil. The thickness of the topsoil layer was about 127 mm to 508 mm at the test hole locations. It should be noted that the thickness of the topsoil may vary over the site from that encountered at the test hole locations. It is therefore recommended that an allowance be made for possible variations in topsoil thickness when making construction estimates.

Borehole BH1 encountered pavement consisting of 127 mm of asphaltic concrete pavement with about 300 mm of crushed granular base materials.

Fill Materials

Boreholes BH4, BH5, BH6, BH7, BH8, BH9 and all test pits encountered fill materials at the ground surface or below the topsoil. The fill generally consisted of silty clay, mixed with organics and debris, to silty sand or sandy silt. The thickness of the fill was about 1.0 m to 4.9 m at the test locations. The measured “N” values from Standard Penetration Test obtained in the fill materials ranged from 3 blows to 12 blows per 0.3 m penetration. The moisture content of the tested fill samples varied from 9 percent to 25 percent.

A grain size distribution analysis and Atterberg limits tests were carried out on a recovered silty clay fill sample obtained from borehole BH8. The results of these tests are included on the borehole log sheet and plotted on the laboratory figures attached in Appendix B.

It should be noted that the thickness of the pavement and fill materials may vary between and beyond the test holes from that encountered at the test hole locations.

Silty Clay

Cohesive silty clay stratum was encountered directly underlying the topsoil or fill materials in all test holes advanced at the site. The silty clay was mottled brown and grey to grey in colouration.

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All boreholes advanced at the site were terminated in grey silty clay. The measured "N" values from Standard Penetration Tests in the silty clay ranged from 2 blows to 36 blows per 0.3 m penetration. A field vane test carried out in the grey silty clay yielded peak undrained shear strengths between 49 kPa and 70 kPa. Based on the "N" values and undrained shear strength obtained from the clay stratum, the cohesive silty clay can be considered to have a soft to hard consistency. The moisture content of the tested silty clay samples varied from 11 percent to 23 percent.

A grain size distribution analysis and Atterberg limits tests were carried out on a recovered native silty clay sample obtained from borehole BH9. The results of these tests are included on borehole log sheet and plotted on the laboratory figures attached in Appendix B.

4.2 Groundwater Conditions

Groundwater level observations and measurements in the boreholes, and in-situ moisture contents of recovered soil samples are recorded on the borehole logs.

Groundwater was encountered in boreholes BH6 and BH7 at depths of 4.3 m and 1.5 m from the ground surface, respectively. Groundwater seepage was also encountered in test pits TP1 to TP2, inclusive, at depths of 1.1 m to 3.4 m below the ground surface during the field investigation. Groundwater also encountered in test pit TP1 at a depth of about 4.2 m.

Groundwater was not encountered in remaining test holes during the field investigation. These test holes were left open and measured dry for the relatively brief period between withdrawal of the augers and backfilling of the boreholes. Due to the low permeability of the clayey soil at the site, it is inferred that insufficient time had passed to allow stabilization of groundwater levels in the open boreholes.

Typically, the grey colour of the soils noted between approximately 3.6 m and 4.6 m depth below grade is indicative of a permanent saturated condition, and therefore, the fluctuations of the long-term groundwater should be anticipated near this depth levels. However, during and after local precipitation events, groundwater that is 'perched' above the long-term levels may accumulate in the fill materials and weathered brown clays above the relatively impermeable clay. In addition, significant amounts of groundwater may be present within the pockets of granular soils known to occur randomly within the overburden soils and within any drainage tiles that may be present. In the absence of an active, engineered drainage system, the design should assume possible temporary groundwater levels rising to the ground surface. Any existing tile drainage system should not be considered "engineered" for the purposes of foundation design unless verified by the competent person.

4.3 Analytical Laboratory Testing

Select soil sample obtained from borehole was sent to Paracel Laboratories Ltd. in Ottawa, Ontario for determination of pH, electrical resistivity, chloride content and sulphate content. The laboratory reports are presented in Appendix B. The results of the test are summarized in Table 1.

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Table 1: Summary of Analytical Testing of Soil

Borehole ID and Sample No.	Sample Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Electrical Resistivity (Laboratory) (Ω-cm)
BH4, Sample No. 3	2.3 – 2.7	7.53	6	59	5310

The results of the analytical testing are discussed in Section 5.8 of this report.

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5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

It is understood that it is planned to redevelop the site with new storm and sanitary sewers, 19 single family homes and 5 blocks of town homes. The redevelopment will also include the construction of new asphaltic pavement. At this time, information on the finished elevation, foundation elevation and foundation loads are not available for all of the proposed structures. It is considered for the purpose of preparing this report that there will be no unusual foundation loads or settlement limitations for this residential development. Accordingly, general recommendations for foundations are provided in the following sections.

5.2 Foundations

5.2.1 General

As indicated in Section 4.1, boreholes BH4, BH5, BH6, BH7, BH8, BH9 and all test pits advanced at the site encountered fill materials at the ground surface or below the topsoil. The fill generally consisted of silty clay, mixed with organics and debris, to silty sand or sandy silt. The thickness of the fill was about 1.0 m to 4.9 m at the test locations. Based on the widespread presence of the fill across the site, it is inferred that the majority of the site area contains fill materials, with the exception of the area along Martinique Avenue to north of borehole BH4.

Based on the drawing (Drawing No. S-1625, revision 2 dated April 3, 2003) provided to us, It is understood that the finished floor elevation of the new homes will be at elevation 177.24 m. Therefore, it is estimated that the basement level will be at about elevation of 174.24 m. Based on this assumed basement level, the fill material in the north portion of the site (in the vicinity of boreholes BH6, BH7, BH8 and BH9) is estimated to extend about 1.0 m to 4.0 m below the basement level. The fill material in the south and east portions of the site (in the vicinity of boreholes BH1 to BH5), is expected to terminate above the assumed foundation elevation of 174.24 m.

The fill material and the overlying organic topsoil are not suitable to support residential foundations. Based on the soil conditions encountered in the boreholes, shallow conventional spread and/or strip foundations placed in the undisturbed native stiff/very stiff silty clay can be considered at this site.

Where fill is present below the foundation elevation, it will be necessary to subexcavate the fill and replace it with engineered fill to accommodate conventional strip/spread footing foundation construction. Engineered fill should consist of imported OPSS Granular “A”, or Granular “B” Type I material (OPSS 1010), placed in maximum 150 mm thick lifts and compacted to at least 98 percent of the material’s standard Proctor maximum dry density under full time supervision of qualified geotechnical staff. The engineered fill pad should extend at least 1 m beyond the edge of the footing and should slope downwards at 1 horizontal to 1 vertical, or flatter.

Extensive subexcavation (as much as 4 m below the foundation elevation) may be required at some locations to expose competent native soils. As an alternative to conventional strip/spread foundations constructed on native soils or engineered fill, caisson and/or helical pile foundations founded on the native soils below the fill can be considered for the lightly to moderately loaded structures, where the fill materials are present below the basement level. The bearing resistance of the foundation soils at the site will vary with the location and depth of the foundations.

5.2.2 Shallow Foundations for Single Family Homes and Town Homes

The soil bearing resistances have been provided for the structures based on the boreholes advanced as identified in Table 2. The shallow spread/strip foundations constructed in the native undisturbed soils or engineered fill in the vicinity of the associated boreholes may be designed using the corresponding factored bearing resistance at the Ultimate Limit State (ULS) and soil bearing reaction at the Serviceability Limit State (SLS) provided in Table 2. All foundations in the unheated area should have thermal insulation of 1.2 m of soil cover to prevent any frost penetration. The subsurface soil conditions encountered in the boreholes are varied broadly. Therefore, some variations from the given geotechnical resistance of the soils may be considered, subject to interaction between the structural and geotechnical engineers during the detailed design process.

Table 2: Recommended Geotechnical Net Bearing Resistance of the Native Soils for Shallow Spread/Strip Foundations

Structure	Boreholes Included	Foundation Elevation (m)	Founding Soils	Net Ultimate Bearing Capacity (kPa)	Factored Bearing Resistance at Ultimate Limit State (ULS)(1) (kPa)	Bearing Reaction at Serviceability Limit State (SLS) (kPa)
Single Family Homes	BH1, BH5 to BH9	Below 174.28	Native Silty Clay or Engineered Fill	230	115	75
Town Homes	BH2, BH3 and BH4	Below 174.28	Native Silty Clay	200	100	65

(1) A resistance factor of Φ = 0.5 has been applied to the given values.

*Groundwater is anticipated due to presence of sand seams and pockets randomly occurred in the silty clay. Dewatering may be required to lower the groundwater level below the foundation depth.

**Any fill or soft/firm silty clay soils encountered at the foundation depth must be removed before the foundation is built.

Limit states design of foundations, as required by the 2012 Ontario Building Code (OBC), is based on soil-structure interaction. The soil response will vary with the foundation dimensions, depth of embedment, and on the load combinations considered in the design. The bearing resistances recommended above are for vertical loads only (no inclination or no eccentricity). The SLS and ULS values will be less than stated where inclined or eccentric loading conditions exist. The foundation design must consider the actual footing embedment and the load inclinations and eccentricity as per the applicable principles presented in the Canadian Foundation Engineering Manual (CFEM). Amec Foster Wheeler would be pleased to provide detailed assistance in the required geotechnical calculations to satisfy these requirements.

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The total and differential settlements should not exceed the conventional limits of 25 mm and 20 mm, respectively for spread/strip foundations designed in accordance with the SLS recommendations provided in this report. If the design requires more stringent settlement limitations or if more accurate values are required, detailed analyses for SLS reaction values and SLS settlements will be required.

The unfactored resistance to horizontal sliding can be calculated as 35% of the acting footing normal load.

The recommended bearing resistances assume native undisturbed soils or approved engineered fill. The soil bearing capacity deteriorates dramatically when the soils are exposed to seepage, weathering and/or construction disturbance. The foundation subgrade soils should be protected from freezing, inundation and equipment traffic at all times. Typical methods to protect the subgrade are discussed later in the report. Prior to placing foundation concrete, the founding subgrade must be cleaned of all deleterious materials such as topsoil, softened, disturbed or caved materials, as well as any standing water.

All excavated foundation bases should be evaluated by the geotechnical engineer to ensure that the founding soils at the excavation base are consistent with the design bearing pressures.

5.2.3 Drilled Caisson and Helical Pile Foundations

As indicated, cast-in-place concrete caisson or helical pile foundations can be considered for the proposed structures where extensive fill materials are present below the foundation level. At this time, information on the finished grades, floor elevations and foundation elevations for the proposed structures is only preliminary. It is considered for the purpose of preparing this report that there will be no unusual foundation loads or settlement limitations for the residential structures. Accordingly, general recommendations for deep foundations are provided in the following paragraphs.

Based on the soil conditions encountered in the boreholes, the use of drilled caisson (i.e. cast-in-place) or helical pile foundations placed in native competent soils can be considered to support the residential structures at this site. However, a liner should be used for drilled concrete caissons to prevent caving of the surrounding soil and to control groundwater seepage into the excavation. The bearing resistance of the foundation soils at this site will vary with the depth of the foundation.

The drilled caisson or helical pile foundations placed in the native undisturbed soil in the vicinity of the boreholes identified below may be designed using the corresponding soil bearing reaction at the Serviceability Limit State (SLS) and factored bearing resistance at the Ultimate Limit State (ULS) provided in the Table 3.

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Table 3: Recommended Geotechnical Net Bearing Resistance of the Soils for Drilled Caisson and Helical Pile Foundations

Boreholes Included	**Approximate Foundation Elevation (m)**	**Average Design Undrained Shear Strength (S_u) (kPa)**	**Caisson Foundation of Diameter < 1.0 m**			**Helical Pile with a Single Helix**	
			Factored Shaft Resistance in Compression at Ultimate Limit State (ULS) (kPa)	**Factored Tip Resistance at Ultimate Limit State (ULS) (kPa)**	**Tip Reaction at Serviceability Limit State (SLS) (kPa)**	**Factored Tip Resistance at Ultimate Limit State (ULS) (kPa)**	**Tip Reaction at Serviceability Limit State (SLS) (kPa)**
BH6, BH7, BH8 and BH9	174.28 to 170.50	35	10	Not recommended in the fill	Not recommended in the fill	Not recommended in the fill	Not recommended in the fill
	170.50 to 167.00	50	12	120	75	100	65

Note: (1) Groundwater is anticipated due to presence of sand seams and pockets randomly occurred in the silty clay. Dewatering may be required to lower the groundwater level below the foundation depth.

It is understood that the foundation will be placed below the frost depth, therefore shaft and lateral resistances, and adfreeze uplift due to seasonal saturation and frost effects are not addressed in this report. The foundation design should account for groundwater levels reaching the ground surface periodically throughout the year.

Caisson foundation behaviour under lateral loads is strongly dependent on the foundation structural configuration, on the soils surrounding the caisson, and the type of the lateral loading (shear force vs. overturning moment). Amec Foster Wheeler will be happy to assist with the geotechnical design of the caissons under lateral loads once the foundation concepts and the load combinations are established.

The lateral capacity of a caisson can best be determined by field tests. The stress-deformation behaviour of caisson under lateral loads can be determined using the horizontal subgrade reaction method. In cohesive soils, the coefficient of horizontal subgrade reaction may be estimated by the following equation:

$$k_s = 67\, S_u / d \qquad \text{(cohesive soils)}$$

where, k_s = coefficient of horizontal subgrade reaction (kPa/m)
d = caisson diameter (m)
S_u = undrained shear strength (see Table 3).

In cohesionless soils, the coefficient of horizontal subgrade reaction may be estimated by the following equation:

$$k_s = n_h z / d \qquad \text{(cohesionless soils)}$$

where, k_s = coefficient of horizontal subgrade reaction (MPa/m)
z = depth (m) below finished grade
d = caisson diameter (m)
n_h = soil coefficient (5 to 10 MPa/m)

Alternatively, the response of a caisson foundation can be analyzed using the nonlinear “p-y” interaction method described in the Canadian Foundation Engineering Manual.

The conventional SLS resistance represents the lateral shear force applied on a free-head caisson that causes a lateral deflection of 10 mm measured at the ground surface. The ULS lateral resistance is defined as the lateral force applied to the caisson shaft causing unstabilized caisson displacements due to soil failure or caisson structural failure.

In the case of deeper caissons where an effective control of the quality of the subgrade at the bottom of the caisson is questionable, it should be noted that the caissons might experience higher than normal settlements under operation loads before the tip resistance will be mobilised.

Typical constructions consideration associated with this type of foundation are discussed in Section 5.12 of this report.

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Usually helical piles cannot provide significant lateral resistance (shear resistance) due to the relatively smaller cross section of the pile shaft. Lateral resistance can significantly be improved by the use of battered piles. Where the design relies on the lateral resistance, the design should also consider the cross-sectional properties of the pile shaft. In this case, the lateral resistance should be confirmed by field load tests.

Because the helical piles are proprietary systems, it is recommended that the piles be designed and installed by experienced specialist contractors. The bearing capacity should be confirmed by filed load tests and in writing by the installer.

5.3 Seismic Considerations

The 2012 Ontario Building Code (2012 OBC) contains updated seismic analysis and design methodology. The 2012 OBC uses a site classification system defined by the average soil/bedrock properties in the top 30 metres (100 feet) of the subsurface profile beneath the structure. Based on the limited site investigation and our experience in this area, a “Site Class D – Stiff Soil” designation could be used for design in accordance with the 2012 OBC methodology (Table 4.1.8.4.A).

The four values of the Spectral response acceleration S_a (T) for different periods and the Peak Ground Acceleration (PGA) should be obtained from 2012 OBC. The design values of F_a and F_v for the project site should be calculated in accordance to Table 4.1.8.4 B and C.

5.4 Frost Design Considerations

The upper stratigraphy of the soils is considered highly frost susceptible in the presence of water, and as such, frost effects should be considered for foundations or surface structures sensitive to movement.

In accordance with the Ontario Provisional Standard Drawing (OPSD 3090.101) the design frost depth below the ground surface for the general area is estimated to be 1.2 m. Therefore, a permanent soil cover of 1.2 m or equivalent thermal insulation is required for frost protection of foundations.

Where provision of the minimum depths of soil cover outlined above is not practical, rigid high density extruded polystyrene insulation could be used to reduce the required thickness of soil cover. Amec Foster Wheeler can provide recommended insulation details for specific development conditions upon request.

5.5 Excavation and Groundwater Control

All excavations should be carried out in accordance with the current Ontario Occupational Health and Safety Act and Regulations for Construction Projects (Regulation 234). Type 2 conditions are to be considered for the undisturbed, native very stiff or dense soils, and Type 3 conditions are to be considered for the undisturbed, native stiff to firm or compact to loose soils. However, consideration should be given to the possibility of down-rating of the soils if the excavation walls are exposed to weathering for several days without proper protection. Conditions for Type 4 soils may develop if excavations encounter flowing perched groundwater such as in live and abandoned utility trenches, in soft or very loose soils or are advanced below the groundwater table. The excavations may require flatter slopes if sand or silt seams are encountered, particularly if they are water-filled. Alternatively, a trench liner box could be used for temporary support of excavations. Trench liner boxes should be selected on the basis of the anticipated earth pressures determined according to the recommendations in Section 5.7.

Groundwater inflow into excavations in the clayey soils is expected to be low; however, significant 'perched' groundwater may be present within the topsoil and fill materials. This would especially be true during and after local precipitation events. In this case, the inflow into excavations may become significant.

The soils identified are sensitive to disturbance by water. In general, groundwater and surface water run-off can be removed from excavations by means of pumping from strategically placed open sumps. However, special dewatering system may be required at some locations to lower the water level below the foundation depth as identified in Tables 2 and 3.

The caisson excavation bottom should be free of any water. A proper dewatering system may be required to lower the water level below the caisson foundation depth.

Consideration must be given to the potential of ground settlements and/ or undermining induced by excavations and extended dewatering. The construction process should be carefully planned and staged to prevent uncontrolled disturbance of the foundation soils beneath the existing building. Excavations, dewatering and construction vibrations may cause severe damage to the existing structure.

Amec Foster Wheeler should be retained to review the proposed excavation procedures.

A permanent drainage system should be constructed for the basement by placing weeping tiles or drain board connected to gravity outlet or sump.

5.6 Backfill of Foundations

Foundations can be backfilled using OPSS Granular "A" and/or Granular "B", Type I material. This material should be placed in 200 mm thick loose lifts and compacted to 95% of the standard Proctor maximum dry density (SPMDD).

In some cases, the on-site native weathered brown silty clay can also be used as general backfill material providing they are free from any organics and deleterious materials. The existing fill materials are not suitable for general fill and can be used in non-settlement sensitive areas such as landscaped areas. The suitability of the on-site native soil and fill for use as backfill material should be determined in the field after completion of excavation. The backfill material should have the moisture content within 2% of the optimum moisture content at the time of backfilling. Clayey soil may be wetter than the optimum range for compaction purposes. Therefore, upon properly conditioned, the on-site soil should be placed in lifts not thicker than 200 mm in loose state and compacted to at least 95% of the standard Proctor maximum dry density (SPMDD).

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5.7 Earth Pressures

A distinction should be made between short-term earth pressures on temporary (during construction) retaining structures, and long-term retaining structures against compacted backfill.

As a preliminary guideline, the temporary shoring structures (if required for deep utility trenches) should be verified for conventional uniform earth pressures of at least 0.3 P_z, (P_z, in kPa, is the overburden pressure corresponding to the depth 'z' of excavation below the ground surface). For the in-situ soils a unit weight of 22 kN/m^3 should be used. Surcharges at the ground surface should be added in accordance with applicable soil mechanics methods such as described in the Canadian Foundation Engineering Manual.

For permanent structures, unfactored earth pressure coefficients and associated backfill unit weights are presented in Table 4.

Table 4: Soil Parameters for Earth Pressure Calculations

Backfill Type	Active Case	Passive Case	At Rest Case	Design Bulk Unit Weight (kN/m^3)
Select Crushed Limestone (Granular "A") (*)	0.27	3.7	0.42	22
Well Graded Sand (Granular "B", Type I) (*)	0.33	3	0.5 to 0.6	21
Silty Clay Fill (**)	0.45	2.2	0.7 to 0.8	20.5

(*) All granular compacted to at least 98% SPMDD
(**) Compacted to at least 95% SPMDD

The design earth pressures in compacted backfill should be augmented with the dynamic effects of the compaction efforts, which typically are taken as a uniform 12 kPa pressure over the entire depth below grade where the calculated earth pressure based on the above earth pressure factors is less than 12 kPa. However, this dynamic effect should be ignored when calculating the passive resistance for thrust blocks, or other instances where the general stability of the structure relies on the passive resistance.

Surcharges at the ground surface should be considered in all cases.

For the calculation of the long-term earth pressures, consideration should be given to using the submerged weight where the soil is below the groundwater table unless a permanent dewatering system is installed.

5.8 Corrosion Potential

Analytical testing was carried out on select soil sample obtained from borehole BH4. The results of the testing are summarized in Table 1.

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The test results indicate that concrete in contact with the tested soil would have a negligible degree of exposure to sulphate attack based on CSA-A23.1.

Based on the measured resistivity, pH etc., the tested soil samples would be considered noncorrosive to buried metallic elements in accordance with ANSI/AWWA C105/A21.5-05, Appendix A, Table A.1.

The above results and recommendations should be reviewed by a corrosion specialist.

5.9 Sewer Pipe Bedding and Cover

As indicated, it is planned to redevelop the site with new storm and sanitary sewers. The inverts of the new sewers will be approximately between elevations 172.25 m and 173.40 m. A new sanitary sewer will be installed along Martinique Avenue to service the new townhomes. The native-undisturbed silty clay sub-grade is competent to support the bedding for the intended sewer pipes. Once these competent soils are exposed and approved, the pipe bedding should be placed. The pipes should be supported under haunches and sides using the same material as for the bedding. The depth of the bedding should be a minimum of 150 mm; the pipe cover should be completed to at least 300 mm above the pipe crown. Bedding material should consist of Granular “A” compacted to 95% of its Standard Proctor maximum dry density (SPMDD). Cover material should also consist of Granular 'A' compacted to 95% of its SPMDD. Alternatively, 19-mm crushed stone (“clear stone”) may be used up to the spring line of the pipe, however, Amec Foster Wheeler recommends that non-woven geotextile be used as for separation between the clear stone and the native soils and backfill. Adjacent sheets of the geotextile should have a minimum overlap of at least 300 mm at the seams. The seams should be stitched where sand or silt lenses are encountered within the bedding and cover zone to prevent separation of the geotextile.

Care should be exercised to avoid compaction methods that may damage the pipe. The placement and thickness of the granular bedding should meet also the pipe manufacturer’s specifications.

Groundwater will tend to accumulate in the trench fill due to infiltration from the surface and leaks in the pipes therefore consideration should be given to the construction of clay (bentonite) collars at strategic locations to reduce the probability of uncontrolled groundwater flow within the pipe bedding.

5.10 Backfilling for Trench

In areas where some settlements may be tolerated, such as landscaping, site-generated native clayey soil compacted in maximum 300 mm loose lifts to at least 95% Standard Proctor Maximum Dry Density (SPMDD) may be used as general trench backfill.

Within pavement areas, trench backfill above the pipe cover material to within 1.0 m of pavement surfaces may be carried out using any approved compactable materials (clean imported granular fill or select site generated fill). The backfill below 1.0 m from the ground surface should be completed in maximum 200 mm loose lifts and compacted to at least 95% SPMDD. Backfill of trenches in the upper 1.0 m from finished grade should be compacted to a minimum of 98% SPMDD.

5.11 Pavement Design Recommendations

All topsoil and deleterious unsuitable fill materials should be removed to expose competent soils, which should be immediately inspected by the geotechnical consultant. The contractor should be prepared to conduct proof-rolling of the subgrade soils by a heavy roller. Any soft or loose spots revealed by the proof-rolling should be sub-excavated and replaced with imported granular fill meeting the requirements of Granular “B”, Type I or Granular “B”, Type II (OPSS 1010) placed in controlled lifts not exceeding 200 mm and compacted to 98% of its SPMDD. The use of geotextile may be required to provide subgrade support, depending upon conditions at the time of construction.

If raising of the grade is required, select granular fill such as Granular “B”, Type I (OPSS 1010) is recommended. The fill should be placed in controlled lifts not exceeding 200 mm and the material should be compacted to 98% of its SPMDD.

It is anticipated that new roads will be local roads. The following pavement design is recommended as a minimum for use at this site:

Table 5: Minimum Recommended Pavement Section

Material	**Local Roads Thickness**	
	Flexible	**Rigid**(1)
Concrete	-	200 mm
Hot Mix Asphaltic-Concrete HL3 Surface Course HL4 or HL8 Base Course	 40 mm 60 mm	 - -
Base - Granular ”A” (OPSS 1010)	150 mm	150 mm
Sub-base - Granular ”B”, Type II (OPSS 1010)	300 mm	200 mm

(1) Recommendation for rigid pavement is provided if warranted.

All granular base and sub-base materials must meet the corresponding OPSS Form 1010 requirements and be placed in lifts not greater than 200 mm thick, compacted to 100% of the material SPMDD. The asphaltic concrete should be compacted to the specifications of the City of Windsor. The placing and rolling of the asphalt mixtures should conform to OPS requirements. Concrete and concrete construction should conform to current CSA A23.1 requirements.

The above pavement structure table presents recommendations for the minimum thickness of asphalt, concrete, granular base and sub-base only. It does not include a comprehensive pavement design (e.g. asphalt mix design, asphalt cement type). Amec Foster Wheeler would be pleased to assist in the detailed design, if requested by the Client.

Continued……..

It should be noted that the above recommended pavement structures are based on the assumption that the roadway will be used by light trucks and occasional heavy trucks, cars, service and maintenance vehicles. In the areas of heavy truck, turnaround, etc. consideration can be given to using a rigid pavement surface.

5.11.1 Drainage

All granular base and sub-base materials should be fully drained at all times. The serviceability of the asphaltic pavement structure is largely dependent on drainage of the granular base and sub-base materials in order to minimize differential frost movements and variations in subgrade support.

All subgrade should be crowned to promote drainage of the sub-base. Sub-drainage should consist of full-length perforated subdrain pipes of 150 mm diameter to be installed along the perimeter of the paved areas, below the subgrade level, to ensure effective drainage in accordance with OPSD 216.021. The sub-drain pipes should be surrounded by a minimum drainage zone of 19 mm size clear stone of minimum 150 mm thickness and wrapped in suitable non-woven geotextile to provide separation from the surrounding soil. In parking areas, 'stub drains' should be provided at all catch basin locations. Stub drains should be keyed into the subgrade, radiating 3 m outward in four directions from the catch basin, and be constructed similar to the sub-drains described above.

Control of surface water is a significant factor in achieving good pavement life. Grading adjacent to pavement area must be designed so that water is not allowed to pond adjacent the outside edges of the pavement or curb. A minimum slope of 2% should be maintained across the paved sections to ensure proper surface drainage.

5.11.2 Pavement Construction Considerations

The above mentioned pavement design is based on the assumption that construction will take place under dry weather and subgrade conditions. If construction takes place under wet subgrade or weather conditions, the pavement design should be re-evaluated by the geotechnical engineer.

The above pavement designs are not intended to support construction traffic. All construction traffic should travel on temporary haul roads. Where these routes coincide with future pavement or slab-on-grade areas, the haul roads should be provided with a temporary increased thickness of granular material to protect the integrity of the subgrade. The use of geogrid reinforcement below the haul road base layer should be considered to reduce rutting under heavy traffic. A minimum thickness of 300 mm of granular fill should be spread before moderate construction traffic can proceed over this area. This does not include designated haul routes, which require a stronger base of at least 450 mm of crushed granular material of up to 75 mm minus gradation.

5.12 General Construction Considerations

The sub-grade soils identified in this report are extremely sensitive to disturbance from exposure to weathering and/or construction traffic (vehicular and pedestrian). Once the excavations have been completed to design elevations, the sub-grade soils should be immediately inspected by the geotechnical consultant. Upon approval, the sub-grade soil should be protected from further exposure. The excavation of the foundation and sub-grade soils should be carried out using excavating buckets equipped with a smooth lip (blade) to reduce disturbance of the bearing surfaces.

Vehicular traffic over prepared sub-grade soils, whether or not the granular fill is in place, should be strictly prohibited. Temporary construction routes should be established. If these routes coincide with future paved or slab on grade areas, adequately reinforced hauling roads should be prepared in order to reduce damages to sub-grade soils. The provisions are crucial particularly if the construction is scheduled during wet and/or cold seasons. The use of a separation fabric in conjunction with at least 450 mm of “0 – 50 mm” crushed limestone should be used for haul roads.

In the case of caisson foundations, no person should enter a caisson excavation unless the excavation is completely lined and all appropriate precautions for entry to confined spaces are taken. The depth of excavation must be verified by measurement and inspection performed by a representative of the Geotechnical Consultant. The bottom of the excavation shall be cleaned such that no loose material remains at the bottom of the shaft prior to the placement of caisson. The excavation bottom should be free of any water. A proper dewatering system may be required to lower the water level below the foundation depth. Steel reinforcement and concrete shall be placed immediately following completion of each shaft excavation and inspection. Concrete shall be placed in excavation through a suitable tube or tremie to prevent segregation of all materials. The top 3 meter of concrete shall be mechanically vibrated.

Caisson foundations should be constructed by an experienced contractor and include full-time inspection by the Geotechnical Consultant in order to document material encountered during excavations as well as proper diameter, depth, cleaning and placement and quality of materials. It is good practice to organise pre-construction meetings with the contractors and the Client’s consultants to discuss the detailed approach for the caisson construction.

Winter construction should include provisions to prevent freezing of the foundation subgrade at all times.

Consideration should be given to the potential construction impacts on the adjacent facilities. Among most frequent construction impacts related with the geotechnical setting are the ground settlements during excavations and vibration propagation though the foundation soils. If required, Amec Foster Wheeler can provide further assistance in this regard.

Continued……..

6.0 CLOSURE

The limitations of this report, as discussed in the Report Limitations attached in Appendix C, constitute an integral part of the report.

The recommendations included in this report, although site specific, have a general nature. Once the intended design details and construction methods are available, it is recommended that the geotechnical consultant be retained to review this information to ensure conformance with the assumptions and limitations considered.

We trust this report is complete within the terms of our reference. However, should there be any questions or if any point requires further clarification kindly contact our office at your convenience.

Sincerely,

Amec Foster Wheeler Environment & Infrastructure
a Division of Amec Foster Wheeler Americas Limited

Prepared By:

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Senior Geotechnical Engineer

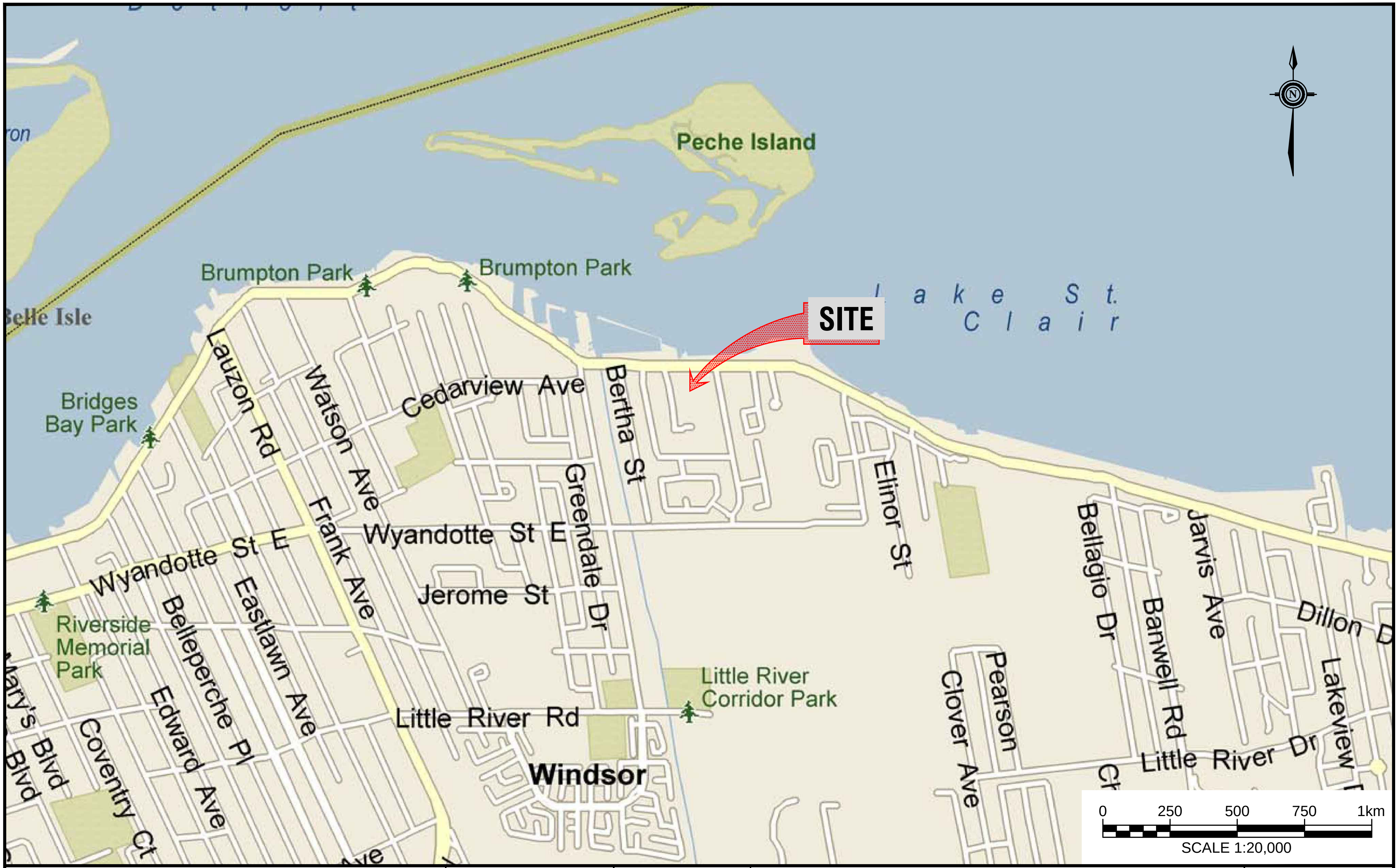
LICENSED PROFESSIONAL ENGINEER
N. Rahman
100086831
APR. 7, 2016
PROVINCE OF ONTARIO

Reviewed by:

Garde

Ty Garde, M.Eng., P.Eng.
Geotechnical Group Leader

FIGURES



CLIENT

THE CORPORATION OF
THE CITY OF WINDSOR

Amec Foster Wheeler
Environment & Infrastructure
11865 County Road 42, Tecumseh
Ontario, N8N 2M1

amec foster wheeler

DWN BY: ZF
CHK'D BY: SDM
DATUM: NAD 83
PROJECTION: UTM ZONE 17T
SCALE: AS SHOWN

PROJECT
GEOTECHNICAL INVESTIGATION
MOUNTBATTEN EXTENSION PHASE 2
WINDSOR, ONTARIO

TITLE
KEY PLAN

REV. NO.: A
DATE: SEPTEMBER 2015
PROJECT NO: SWW157362
FIGURE No. 1

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LEGEND:

⌖	BOREHOLE LOCATION
▚	TEST PIT LOCATION

NOTES:
THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE AMEC FOSTER WHEELER ENVIRONMENT & INFRASTRUCTURE REPORT No.SWW157362.
ALL LOCATIONS ARE APPROXIMATE.

REFERENCES:
GOOGLE EARTH PRO IMAGE, DATED 4/11/2015.

0 25 50 75 100m
SCALE 1:2,000

CLIENT
THE CORPORATION OF THE CITY OF WINDSOR

Amec Foster Wheeler
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Ontario, N8N 2M1

DWN BY: ZF
CHK'D BY: SDM
DATUM: NAD 83
PROJECTION: UTM ZONE 17T
SCALE: AS SHOWN

PROJECT
GEOTECHNICAL INVESTIGATION
MOUNTBATTEN EXTENSION PHASE 2
WINDSOR, ONTARIO

TITLE
BOREHOLE AND TEST PIT LOCATION PLAN

REV. NO.: A
DATE: SEPTEMBER 2015
PROJECT NO: SWW157362
FIGURE No. 2

R:\2015\Projects_Other\SWW157362_City of Windsor\SWW157362.dwg – Figure 2 – Sep. 17, 2015 3:40pm – zhanna.furman

APPENDIX A

BOREHOLE AND TEST PIT LOGS

RECORD OF BOREHOLE No. BH1

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4688980, E341278**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **1 Sep 15** Date Completed: **1 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 176.4 m

DESCRIPTION	Elevation / Depth
ASPHALT(127mm thick)	176.2
FILL Crushed granular	0.1 175.9
SILTY CLAY Trace sand, trace clay Weathered Mottled brown and grey Firm	0.4
Rootlets	
Brown Stiff	
Very stiff	
Grey Firm	171.0
END OF BOREHOLE (no refusal)	5.3

SOIL SAMPLING / FIELD TESTING / LAB TESTING

FIELD TESTING: PenetrationTesting ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; ■ Undrained Shear Strength (kPa) (from P. Penetrometer tests) 20 40 60 80

LAB TESTING: Atterberg Limits W_P W W_L Plastic Liquid; ✳ Passing 75 um (%); ○ Moisture Content (%); ★ Unit Weight (KN/m3) 20 40 60 80

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	Moisture Content (%)	COMMENTS
SS	1	54	5	1	15	
SS	2	17	7		13	-split spoon hitting rock
SS	3	72	6		15	
SS	4	100	9		14	
SS	5	100	20	4	12	
SS	6	100	7		14	
VT						

MTO Vane Intact: 70 (at VT)

DEPTH (m)	ELEVATION (m)
	176
1	175
2	174
3	173
4	172
5	171
6	170
7	169

INSTRUMENTATION INSTALLATION

▽ No freestanding groundwater observed in open borehole upon completion of drilling.

▚ Cave in measured at a depth of 3.8 m upon completion of drilling.

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RECORD OF BOREHOLE No. BH2

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4689152, E341405**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **1 Sep 15** Date Completed: **1 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 175.5 m

TOPSOIL(508mm thick)
175.0
0.5

SILTY CLAY
Trace sand, organics
Mottled brown and grey
Firm

Weathered
Stiff

Brown
Very stiff

Grey
Firm

169.4
6.1

END OF BOREHOLE
(no refusal)

SOIL SAMPLING / FIELD TESTING / LAB TESTING

FIELD TESTING – PenetrationTesting: ○ SPT ● DCPT; MTO Vane*: △ Intact ▲ Remould; Nilcon Vane*: ◇ Intact ◆ Remould; ■ Undrained Shear Strength (kPa) (from P. Penetrometer tests)

LAB TESTING – Atterberg Limits: W_P W W_L, Plastic Liquid; ✳ Passing 75 um (%); ○ Moisture Content (%); ★ Unit Weight (KN/m3)

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	MTO Vane Remould (kPa)	MTO Vane Intact (kPa)	Moisture Content (%)
SS	1	78	4			15
SS	2	39	3			18
SS	3	61	8			14
SS	4	119	17			12
SS	5	100	7			13
SS	6	100	4			14
VT				39	63	
SS	7	100	5			13
VT				35	56	

DEPTH (m): 1, 2, 3, 4, 5, 6, 7
ELEVATION (m): 175, 174, 173, 172, 171, 170, 169, 168

INSTRUMENTATION INSTALLATION

COMMENTS

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Fax: 519-735-9669
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No freestanding groundwater observed in open borehole upon completion of drilling.

▚ Cave in measured at a depth of 4.6 m upon completion of drilling.

Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. BH3

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4689073, E341417**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **1 Sep 15** Date Completed: **1 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 175.5 m

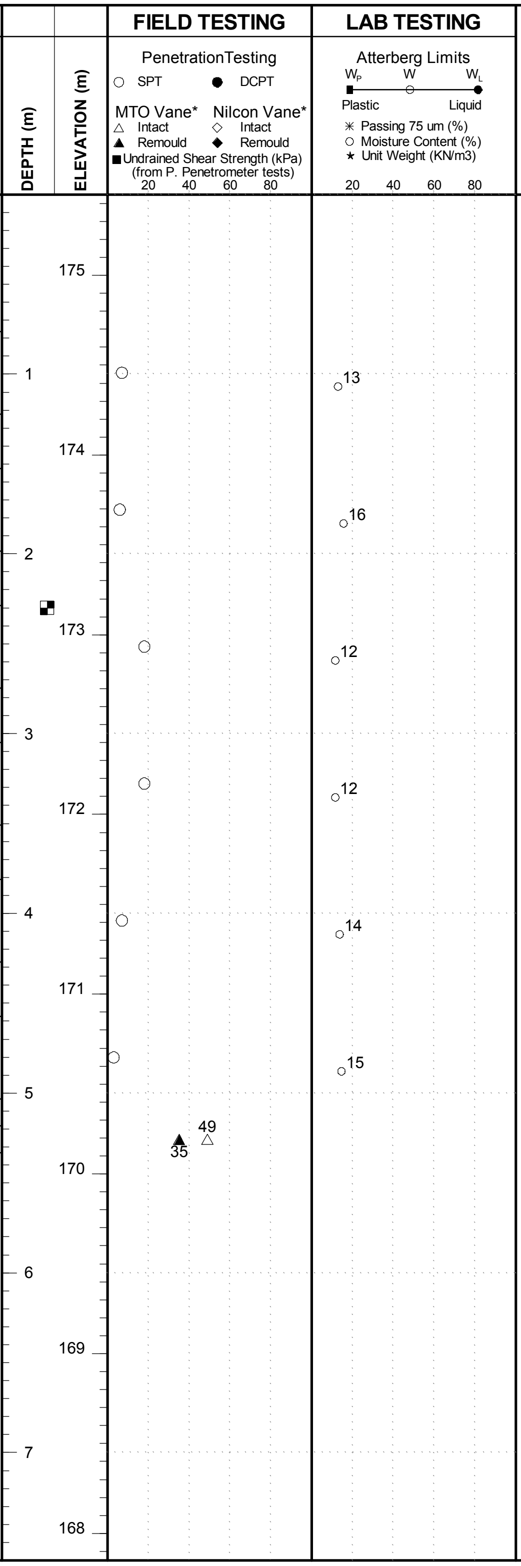
Lithology Plot	DESCRIPTION	Elevation / Depth (m)
⁘	**TOPSOIL**(381mm thick)	
▨	**SILTY CLAY** Trace sand, trace gravel Trace organics (rootlets) Mottled brown and grey Firm Oxidized Brown Very stiff Grey Firm	175.1 0.4
	END OF BOREHOLE (no refusal)	170.1 5.3

SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	67	7
SS	2	83	6
SS	3	100	18
SS	4	83	18
SS	5	89	7
SS	6	100	3
VT			

FIELD TESTING

LAB TESTING



INSTRUMENTATION INSTALLATION

COMMENTS

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▽ No freestanding groundwater observed in open borehole upon completion of drilling.

▚ Cave in measured at a depth of 2.3 m upon completion of drilling.

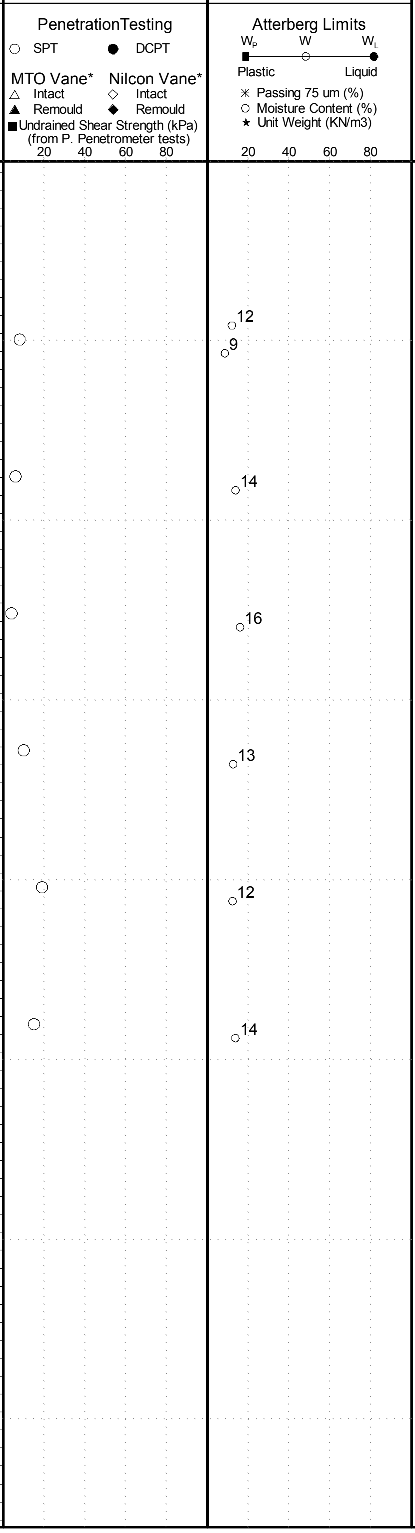
Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. BH4

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4688951, E341436**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **1 Sep 15** Date Completed: **1 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 176.8 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)			INSTRUMENTATION INSTALLATION	COMMENTS
	TOPSOIL(178mm thick) 176.6										
	FILL 0.2 Silty clay, sand layers/pockets, trace gravel Organics Brown						176				
		SS	1a b	94	8	1					
		SS	2	72	6		175				
	174.6					2					
	SILTY CLAY 2.1 Trace sand, trace gravel Mottled brown and grey Firm	SS	3	67	4						
							174				
	Brown Stiff	SS	4	83	10	3					
	Very stiff						173				
		SS	5	100	19	4					
		SS	6	100	15		172				
	171.7					5					
	END OF BOREHOLE 5.0 (no refusal)						171				
						6	170				
						7					



▽ No freestanding groundwater observed in open borehole upon completion of drilling.

▞ Cave in measured at a depth of 3.9 m upon completion of drilling.

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Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. BH5

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4688991, E341341**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **1 Sep 15** Date Completed: **1 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 176.0 m

DESCRIPTION	Elevation / Depth (m)
TOPSOIL(254mm thick)	175.8 0.3
FILL Sandy silt, trace to some clay Brown	174.6 1.4
SILTY CLAY Trace sand, trace gravel Mottled brown and grey Stiff Firm Weathered, rootlets Brown Very stiff Grey Firm	170.7 5.3
END OF BOREHOLE (no refusal)	

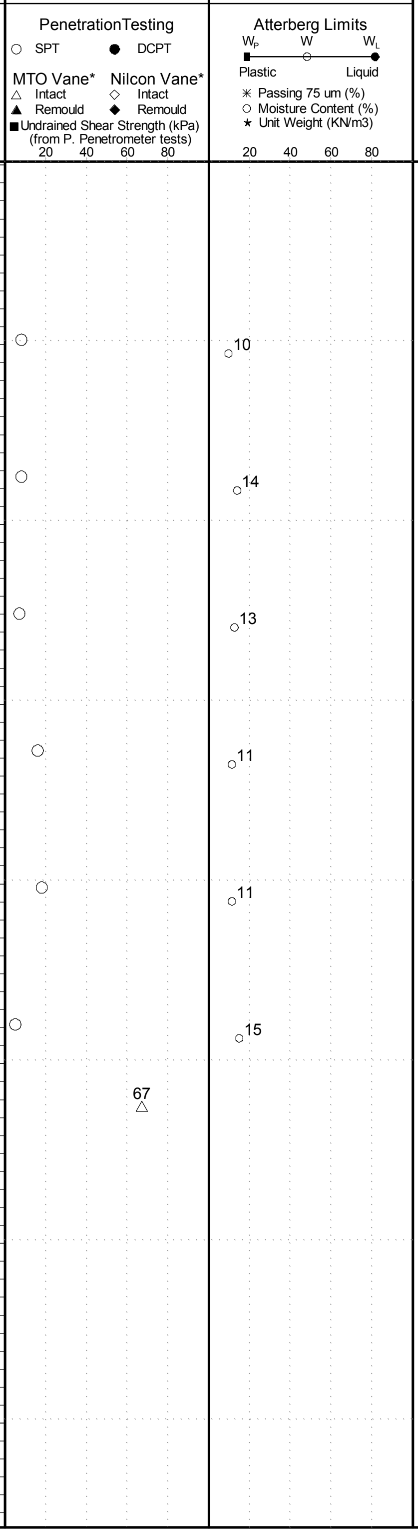
SOIL SAMPLING

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value
SS	1	61	8
SS	2	72	8
SS	3	72	7
SS	4	89	16
SS	5	100	18
SS	6	100	5
VT			

DEPTH (m)	ELEVATION (m)
1	175
2	174
3	173
4	172
5	171
6	170
7	169

FIELD TESTING

LAB TESTING



INSTRUMENTATION INSTALLATION

COMMENTS

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≚ No freestanding groundwater observed in open borehole upon completion of drilling.

▚ Cave in measured at a depth of 3.3 m upon completion of drilling.

Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. BH6

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4689057, E341333**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **1 Sep 15** Date Completed: **1 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING	INSTRUMENTATION INSTALLATION	COMMENTS
Lithology Plot	DESCRIPTION Geodetic Ground Surface Elevation: 175.3 m	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)	Penetration Testing (SPT) / MTO Vane	Moisture Content (%)		
▨	**FILL** Silty clay, trace sand, organics Dark grey to brown	SS	1	54	4		175	○	14		
▨		SS	2	62	4	1		○	16		
▨	Pieces of metal	SS	3	25	9		174	○	17		
▨		SS	4	62	4	2	173	○	20		
▨	Steel pieces	SS	5	29	8			○	20		
▨		SS	6	33	3	3	172	○	18		
▨		TW	7	51		4	171		15		
▨	Wet gravel Sewage odour 170.4 4.9	SS	8	67	12	∇		○	20		
▧	**SILTY CLAY** Trace sand, trace gravel Grey Firm	SS	9	33	4	5	170	○	19		
▧	Soft	SS	10	75	2	▚		○	16		
▧	168.8 6.4	VT				6	169	▲ 35 △ 49			
	END OF BOREHOLE (no refusal)					7	168				

Legend – Penetration Testing: ○ SPT ● DCPT; MTO Vane*: △ Intact ▲ Remould; Nilcon Vane*: ◇ Intact ◆ Remould; ■ Undrained Shear Strength (kPa) (from P. Penetrometer tests) 20 40 60 80

Atterberg Limits: W_P W W_L Plastic Liquid; ✳ Passing 75 um (%); ○ Moisture Content (%); ★ Unit Weight (KN/m3) 20 40 60 80

∇ Groundwater measured at a depth of 4.3 m upon completion of drilling.

▚ Cave in measured at a depth of 5.5 m upon completion of drilling.

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RECORD OF BOREHOLE No. BH7

Project Number:	**SWW157362**	Drilling Method:	**200 mm Hollow Stem Augers**		
Project Client:	**The Corporation of the City of Windsor**	Drilling Machine:	**CME 55**		
Project Name:	**Mountbatten Extension Phase 2**	Date Started:	**2 Sep 15**	Date Completed:	**2 Sep 15**
Project Location:	**Windsor, Ontario**	Logged by:	**SS**	Compiled by:	**SS**
Drilling Location:	**N4689108, E341325**	Reviewed by:	**SM**	Revision No.:	**0**

LITHOLOGY PROFILE

Geodetic Ground Surface Elevation: 175.3 m

FILL
Silty clay, organics
Trace sand and gravel

Concrete pieces

172.8
2.4

SILTY CLAY
Trace sand, trace gravel
Brown
Very stiff

Grey
Stiff

Firm

SOIL SAMPLING / FIELD TESTING / LAB TESTING

Penetration Testing: ○ SPT ● DCPT
MTO Vane*: △ Intact ▲ Remould
Nilcon Vane*: ◇ Intact ◆ Remould
■ Undrained Shear Strength (kPa) (from P. Penetrometer tests)
Atterberg Limits: W_P (Plastic) W W_L (Liquid)
✳ Passing 75 um (%)
○ Moisture Content (%)
★ Unit Weight (KN/m3)

Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Field Testing	Moisture Content (%)
SS	1	67	6		13
SS	2	62	6		13
SS	3	8	5		21
SS	4	41	5		14
SS	5	84	21		12
SS	6	79	18		13
SS	7	71	9		15
TW	8	100			12
SS	9	100	4		18
VT				▲ 32 △ 56	
SS	10	100	6		17

DEPTH (m)	ELEVATION (m)
	175
1	174
2	173
3	172
4	171
5	170
6	169
7	168

INSTRUMENTATION INSTALLATION

COMMENTS

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Fax: 519-735-9669
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∇ Groundwater measured at a depth of 1.5 m upon completion of drilling.

▚ Cave in measured at a depth of 5.4 m upon completion of drilling.

Continued on Next Page

RECORD OF BOREHOLE No. BH7

Project Number: **SWW157362**
Project Client: **The Corporation of the City of Windsor**
Project Name: **Mountbatten Extension Phase 2**
Project Location: **Windsor, Ontario**
Drilling Location: **N4689108, E341325**

Drilling Method: **200 mm Hollow Stem Augers**
Drilling Machine: **CME 55**
Date Started: **2 Sep 15** Date Completed: **2 Sep 15**
Logged by: **SS** Compiled by: **SS**
Reviewed by: **SM** Revision No.: **0**

FIELD TESTING — PenetrationTesting: ○ SPT ● DCPT; MTO Vane*: △ Intact ▲ Remould; Nilcon Vane*: ◇ Intact ◆ Remould; ■ Undrained Shear Strength (kPa) (from P. Penetrometer tests); 20 40 60 80

LAB TESTING — Atterberg Limits: W_P W W_L; Plastic Liquid; ✳ Passing 75 um (%); ○ Moisture Content (%); ★ Unit Weight (KN/m3); 20 40 60 80

LITHOLOGY PROFILE		SOIL SAMPLING						FIELD TESTING	LAB TESTING		
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	DEPTH (m)	ELEVATION (m)			INSTRUMENTATION INSTALLATION	COMMENTS
▨	**SILTY CLAY** Trace sand, trace gravel Grey Soft	SS	11	100	3			○	○ 18		
						8					
▨	166.9	VT					167	70 △			
	END OF BOREHOLE (no refusal) 8.4										
						9					
							166				
						10					
							165				
						11					
							164				
						12					
							163				
						13					
							162				
						14					
							161				
						15					

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▽ Groundwater measured at a depth of 1.5 m upon completion of drilling.

▚ Cave in measured at a depth of 5.4 m upon completion of drilling.

Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

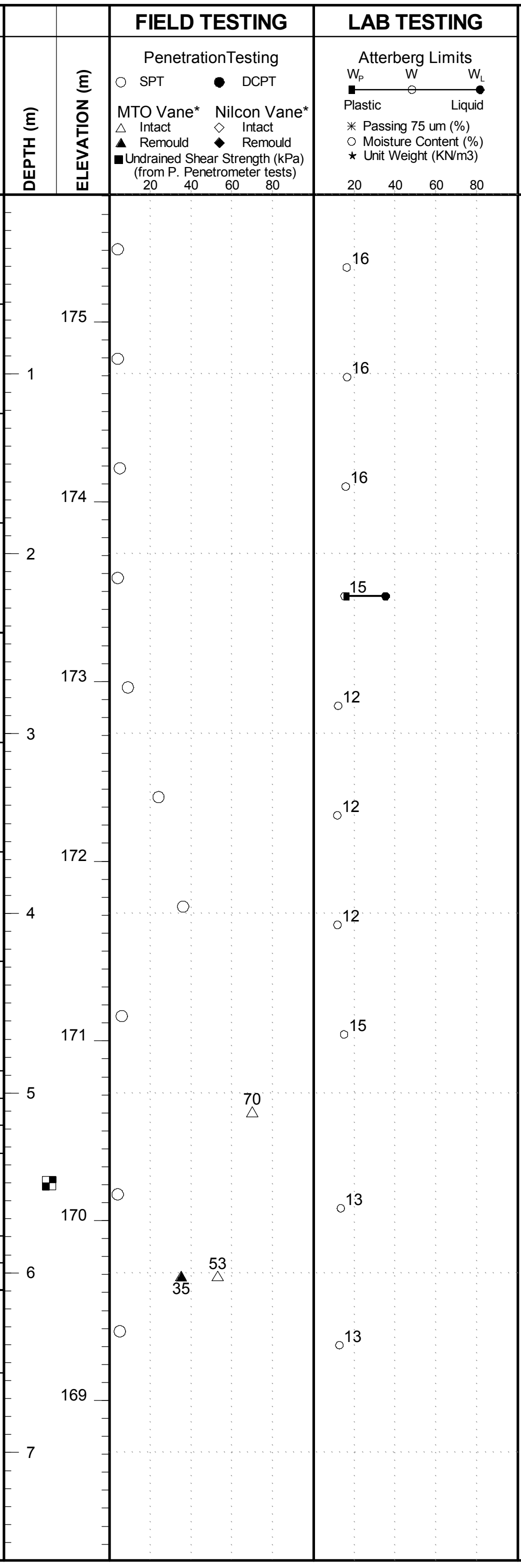
RECORD OF BOREHOLE No. BH8

Project Number:	SWW157362	Drilling Method:	200 mm Hollow Stem Augers
Project Client:	The Corporation of the City of Windsor	Drilling Machine:	CME 55
Project Name:	Mountbatten Extension Phase 2	Date Started:	2 Sep 15
		Date Completed:	2 Sep 15
Project Location:	Windsor, Ontario	Logged by:	SS
		Compiled by:	SS
Drilling Location:	N4689154, E341318	Reviewed by:	SM
		Revision No.:	0

LITHOLOGY PROFILE | **SOIL SAMPLING** | **FIELD TESTING** | **LAB TESTING** | **INSTRUMENTATION INSTALLATION** | **COMMENTS**

Geodetic Ground Surface Elevation: 175.7 m

Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	COMMENTS
▨	**FILL** Silty clay organics, trace sand Trace gravel Brown	SS	1	71	4	
▨		SS	2	84	4	
▨		SS	3	84	5	
▨	Sand layers/pockets, silt seams rootlets 173.3	SS	4	62	4	Grain Size Distribution: Gravel: 0.7% Sand: 27.1% Silt: 39.1% Clay: 33.1%
▨	**SILTY CLAY** 2.4 Tarce sand, trace gravel Brown Stiff	SS	5	100	9	
▨	Trace gravel Very stiff	SS	6	92	24	
▨	Hard	SS	7	21	36	Spoon hitting rock
▨	Grey Firm	SS	8	100	6	
▨		VT				
▨		SS	9	100	4	
▨		VT				
▨	169.2	SS	10	100	5	
	END OF BOREHOLE 6.6 (no refusal)					



▽ No freestanding groundwater observed in open borehole upon completion of drilling.

▞ Cave in measured at a depth of 5.5 m upon completion of drilling.

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Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

RECORD OF BOREHOLE No. BH9

Project Number: SWW157362
Project Client: The Corporation of the City of Windsor
Project Name: Mountbatten Extension Phase 2
Project Location: Windsor, Ontario
Drilling Location: N4689104, E341300

Drilling Method: 200 mm Hollow Stem Augers
Drilling Machine: CME 55
Date Started: 2 Sep 15 Date Completed: 2 Sep 15
Logged by: SS Compiled by: SS
Reviewed by: SM Revision No.: 0

LITHOLOGY PROFILE — **SOIL SAMPLING** — **FIELD TESTING** — **LAB TESTING** — **INSTRUMENTATION INSTALLATION** — **COMMENTS**

Field Testing: Penetration Testing ○ SPT ● DCPT; MTO Vane* △ Intact ▲ Remould; Nilcon Vane* ◇ Intact ◆ Remould; ■ Undrained Shear Strength (kPa) (from P. Penetrometer tests) 20 40 60 80

Lab Testing: Atterberg Limits W_P W W_L, Plastic – Liquid; ✳ Passing 75 um (%) ○ Moisture Content (%) ★ Unit Weight (KN/m3) 20 40 60 80

Geodetic Ground Surface Elevation: 175.3 m

Elevation (m) / Depth (m)	Description	Sample Type	Sample Number	Recovery (%)	SPT 'N' Value	Field Testing	Lab Testing	Comments
	FILL Silty clay, organics Rootlets, trace sand, trace gravel Brown and grey	SS	1	92	5	○	13	
		SS	2	75	5	○	24	
		SS	3	67	4	○	16	
173.4 1.8	**SILTY CLAY** Trace sand, trace gravel Weathered Mottled brown and grey Stiff	SS	4	59	14	○	15	
	Brown Very Stiff	SS	5	87	18	○	11	
		SS	6	84	20	○	12	
	Sand layers/pockets, silt seams Grey Firm	SS	7	92	7	○	15	Grain Size Distribution: Gravel: 1.2% Sand: 28.9% Silt: 37.5% Clay: 32.4%
		VT				70 △		
		SS	8	100	4	○	17	
		VT				53 △ 39 ▲		
		SS	9	100	4	○	16	
168.4 6.9		VT				53 △ 32 ▲		
	END OF BOREHOLE (no refusal)							

▞ Cave in at 5.7 m depth

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No freestanding groundwater observed in open borehole upon completion of drilling.

▞ Cave in measured at a depth of 5.7 m upon completion of drilling.

Borehole details, as presented, do not constitute a thorough understanding of all potential conditions present and requires interpretive assistance from a qualified Geotechnical Engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Borehole Log'.

TEST PIT STRATIGRAPHY LOG

Page 1 of 1

Project: Mountbatten Extension Phase 2
Project No.: SWW157362
Client: City of Windsor
Location: Field between Mountbatten and Martinique Ave

Contractor: Intrepid General Ltd.
Surface Elevation (m): 175.180
Test Pit Method: Open Excavation

Test Pit Designation: TP1
Date Started: 8-9-15
Date Completed:8-9-15
Supervisor: Steve Suurnakki

Location: UTM N4689061 E341327

Depth (m)			*Soil Description*	*Moisture Content*	*Sample No.*
From	*At*	*To*			
0.00	-	0.41	**TOPSOIL**	21	TP1-1
0.41	-	1.22	**FILL** Silty clay, Brown and dark grey	15	TP1-2
1.22	-	2.03	**FILL** Gravel layer		
2.03	-	4.75	**FILL** Silty clay, some bricks & steel, organics, black at depth of 1.27 m		
			FILL SIlty clay, organics, brown and dark grey at depth of 1.6 m	17	TP1-3
			FILL Silty clay, rebar and steel, brown at depth of 1.98 m		
			FILL Silty clay, bricks, brown at depth of 2.41 m		
			FILL Silty clay, brown at depth 2.92 m	16	TP1-4
			FILL Silty clay, debris (brick/pvc), brown at depth of 4.24 m		
			SILTY CLAY, trace sand and gravel, brown and grey at depth of 4.75 m	21	TP1-5

Photos

Notes:
1. Hand Vane turned at 1 m yielded Su = >100 kPa
2. Groundwater seepage at depth of 2.41 m
3. Grooundwater at depth of 4.24 m

TEST PIT STRATIGRAPHY LOG

Page 1 of 1

Project: Mountbatten Extension Phase 2	Contractor: Intrepid General Ltd.	Test Pit Designation: TP2
Project No.: SWW157362		Date Started: 8-9-15
Client: City of Windsor	Surface Elevation (m): 175.538	Date Completed:8-9-15
Location: Field between Mountbatten and Martinique Ave.	Test Pit Method: Open Excavation	Supervisor: Steve Suurnakki

Location: UTM N4689149 E341279

Depth (m)			*Soil Description*	*Moisture Content*	*Sample No.*
From	*At*	*To*			
0.00	-	0.05	**FILL** Silty clay, some gravel on surface, brown	12	TP2-1
0.05	-	1.83	**FILL** Silty caly, organics, dark grey and black	18	TP2-2
			Some bricks at depth of 1.02 m		
1.83	-	3.51	**FILL** Silty clay, brown (sample taken at depth of 3.48 m)	25	TP2-3

Photos

Notes:

1. Below depth of 1.83 m, east edge of excavation appears to be a containment pit made of brick and filled with gargabe. All others sides appear to be a silty clay fill. Graounwater seepage was originally through containment pit but was observed at depth of 3.05 m from both the west and east sides of the excavation.

TEST PIT STRATIGRAPHY LOG

Page 1 of 1

Project: Mountbatten Extension Phase 2
Project No.: SWW157362
Client: City of Windsor
Location: Field between Mountbatten and Martinique Ave

Contractor: Intrepid General Ltd.
Surface Elevation (m): 175.371
Test Pit Method: Open Excavation

Test Pit Designation: TP3
Date Started: 8-9-15
Date Completed:8-9-15
Supervisor: Steve Suurnakki
Location: UTM N4689106 E341364

Depth (m)			*Soil Description*	*Moisture Content*	*Sample No.*
From	*At*	*To*			
0.00	-	0.13	Topsoil		
0.13	-	0.38	**FILL** Silty clay, brown	11	TP3-1
0.38	-	1.12	**FILL** Silty clay, organics, black	18	TP3-2
1.12	-	2.67	**SILTY CLAY,** trace sand and gravel, mottled brown and grey	16	TP3-3
				13	Bulk
2.67	-	3.23	**SILTY CLAY**, trace sand and gravel, brown	23	TP3-4
				13	Bulk

Photos

Notes:
1. Groundwater seepage at depth of 1.12 m

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TEST PIT STRATIGRAPHY LOG

Page 1 of 1

Project: Mountbatten Extension Phase 2
Project No.: SWW157362
Client: City of Windsor
Location: Field between Mountbatten and Martinique Ave
Contractor: Intrepid General Ltd.
Surface Elevation (m): 176.921
Test Pit Method: Open Excavation
Test Pit Designation: TP4
Date Started: 8-9-15
Date Completed:8-9-15
Supervisor: Steve Suurnakki
Location: UTM N4688940 E341404

Depth (m)			*Soil Description*	*Moisture Content*	*Sample No.*
From	*At*	*To*			
0.00	-	0.23	**TOPSOIL**	17	TP4-1
0.23	-	0.56	**FILL** Silty clay, organics, dark grey		
0.56	-	1.35	**FILL** Silty sand, debris (concrete and steel), brown	13	TP4-2
1.35	-	1.93	**FILL** Silty clay, organics, black	20	TP4-3
1.93	-	2.44	**FILL** Silty clay, organics, dark grey	17	TP4-4
2.44	-	4.27	**SILTY CLAY**, trace sand and gravel, mottled brown and grey	17	TP4-5

Photos

Notes:
1. Groundwater seepage at depth of 2.44 m
2. Excavation walls started caving in at depth of 2.44 m

TEST PIT STRATIGRAPHY LOG

Page 1 of 1

Project: Mountbatten Extension Phase 2	Contractor: Intrepid General Ltd.	Test Pit Designation: TP5
Project No.: SWW157362		Date Started: 8-9-15
Client: City of Windsor	Surface Elevation (m): 176.568	Date Completed:8-9-15
Location: Field between Mountbatten and Martinique Ave	Test Pit Method: Open Excavation	Supervisor: Steve Suurnakki

Location: UTM N4689014 E341383

Depth (m)			*Soil Description*	*Moisture Content*	*Sample No.*
From	*At*	*To*			
0.00	-	0.56	**FILL** Sand, organics, dark brown	7	TP5-1
0.56	-	1.22	**FILL**, Silty clay, organics, black	13	TP5-2
1.22	-	2.13	**FILL** Silty clay, sand pockets, brown and dark grey	17	TP5-3
2.13	-	3.96	**SILTY CLAY**, trace sand and gravel, mottled brown and grey	19	TP5-4

Photo

Notes:

1. Groundwater seepage at depth of 3.35 m

TEST PIT STRATIGRAPHY LOG

Page 1 of 1

Project: Mountbatten Extension Phase 2
Project No.: SWW157362
Client: City of Windsor
Location: Field between Mountbatten and Martinique Ave

Contractor: Intrepid General Ltd.
Surface Elevation (m): 175.713
Test Pit Method: Open Excavation

Test Pit Designation: TP6
Date Started: 8-9-15
Date Completed:8-9-15
Supervisor: Steve Suurnakki

Location: UTM N4689155 E341346

Depth (m)			*Soil Description*	*Moisture Content*	*Sample No.*
From	*At*	*To*			
0.00	-	0.15	**TOPSOIL**		
0.15	-	0.91	**FILL** Silty clay, sand seams, brown	12	TP6-1
0.91	-	1.37	**FILL** Silty clay, organics, dark grey	19	TP6-2
1.37	-	2.74	**SILTY CLAY**, trace sand and gravel, mottled brown and grey	17	TP6-3
2.74	-	3.35	**SILTY CLAY,** trace sand and gravel, sand seams, brown	13	TP6-4

Photos

APPENDIX B

GEOTECHNICAL AND ANALYTICAL LABORATORY TESTS RESULTS

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GRAIN SIZE DISTRIBUTION
MTO LS 702 / ASTM D422

Project Number: SWW157362
Project Client: Windsor, The Corporation of the City of
Project Name: MountBatten Extension Phase 2
Project Location:

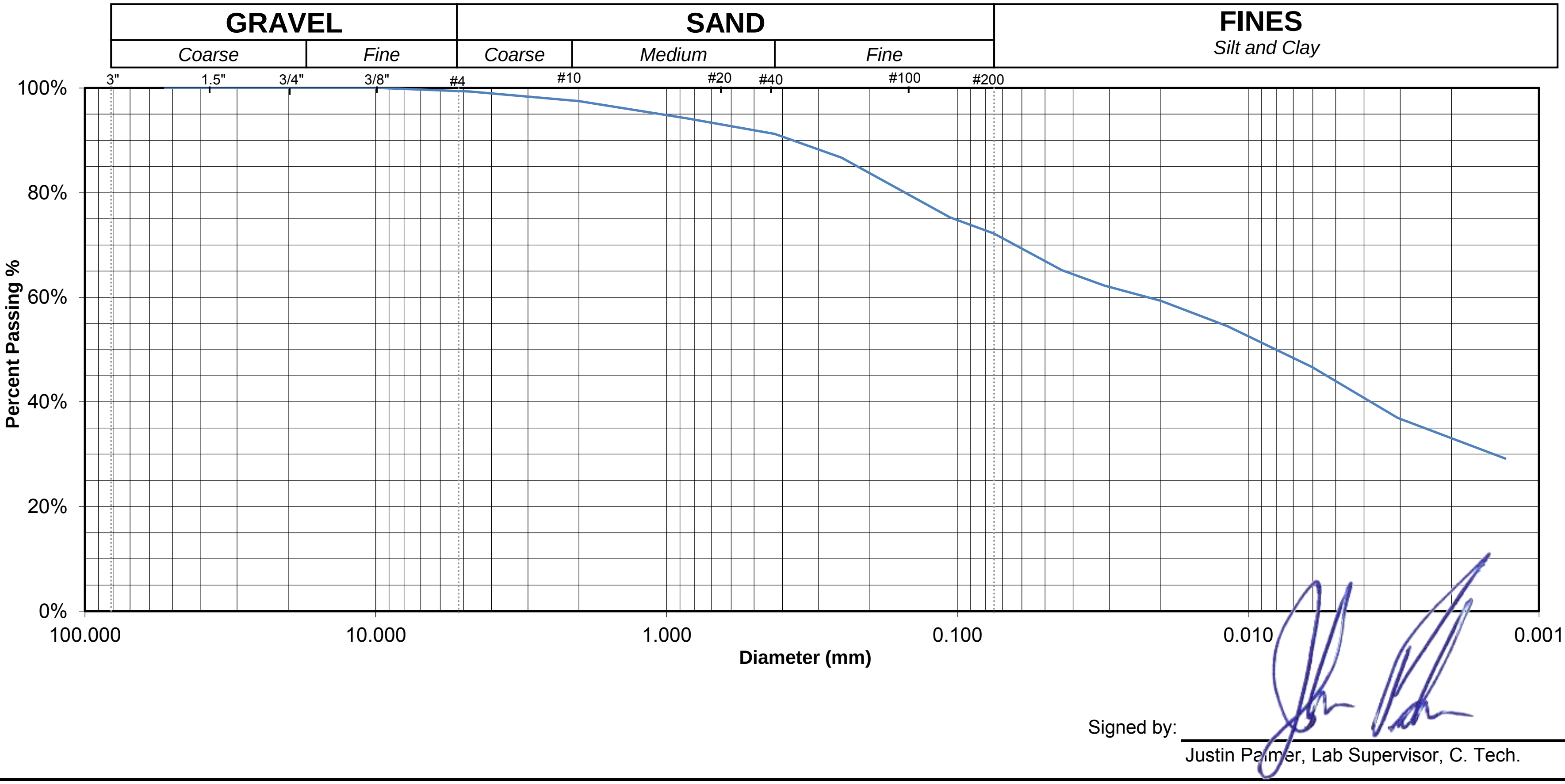
Sampled on: 1-Sep-2015
Received on: 1-Sep-2015
Tested on: 11-Sep-2015

Sampled by: SS
Received by: SS
Tested by: SS

Test Results

Sample Location: **BH 8 Sa.4**
Sample Identification: **534**

Gravel	Sand	Silt	Clay	Soil Classification
0.7%	27.1%	39.1%	33.1%	SILTY CLAY, sand layers/pockets, silt seams



Signed by:

Justin Palmer, Lab Supervisor, C. Tech.

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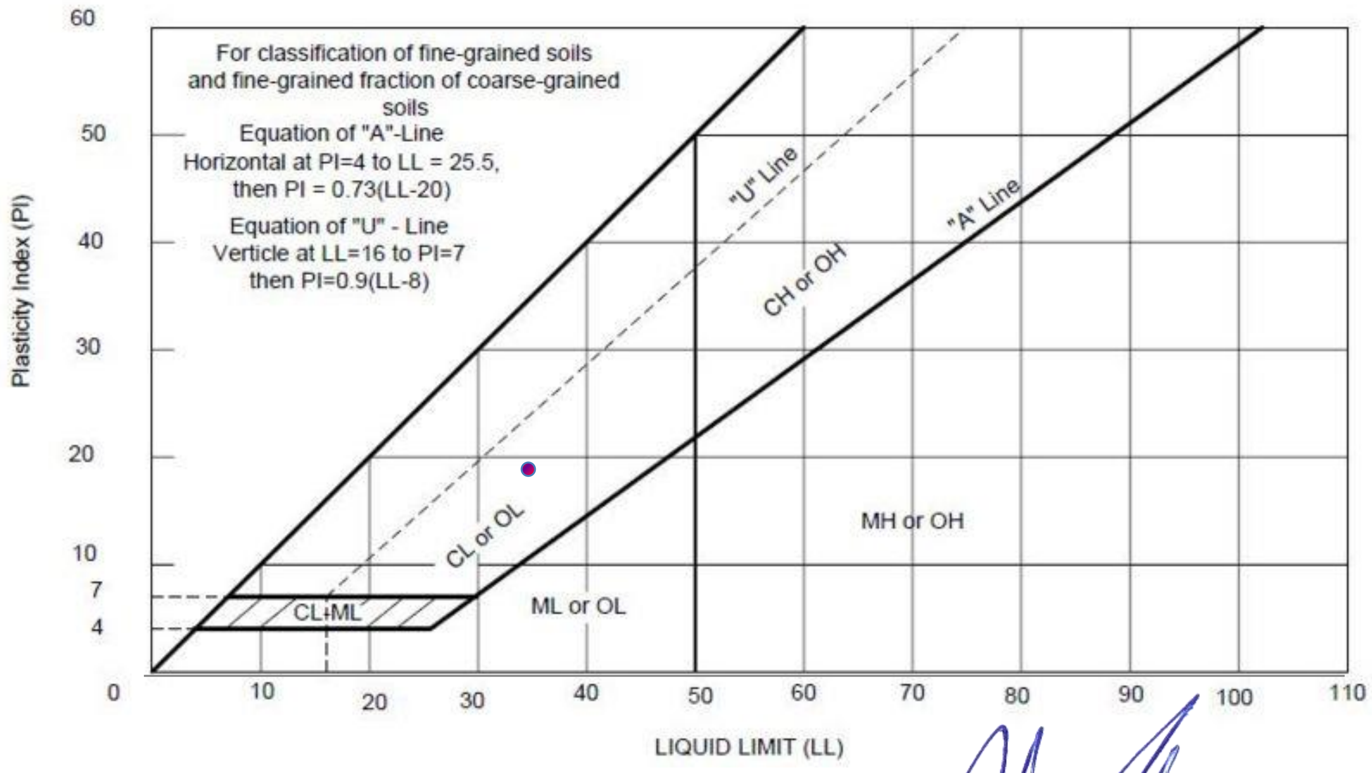
ATTERBERG LIMITS
ASTM D-4318 or LS-703 / 704

Project Number:	SWW157362	**Sampled on:**	1-Sep-2015	**Sampled by:**	SS
Project Client:	Windsor, The Corporation of the	**Received on:**	1-Sep-2015	**Received by:**	JP
Project Name:	MountBatten Extension Phase	**Tested on:**	11-Sep-2015	**Tested by:**	JP
Project Location:	Windsor, Ontario				

Test Results

LAB NUMBER	532
BOREHOLE	8
SAMPLE	4
DEPTH	1.8m

PLASTIC LIMIT	**16.0**
LIQUID LIMIT	**35.2**
PLASTIC INDEX	**19.3**



Signed by: ______________________
Justin Palmer, Lab Supervisor, C. Tech.

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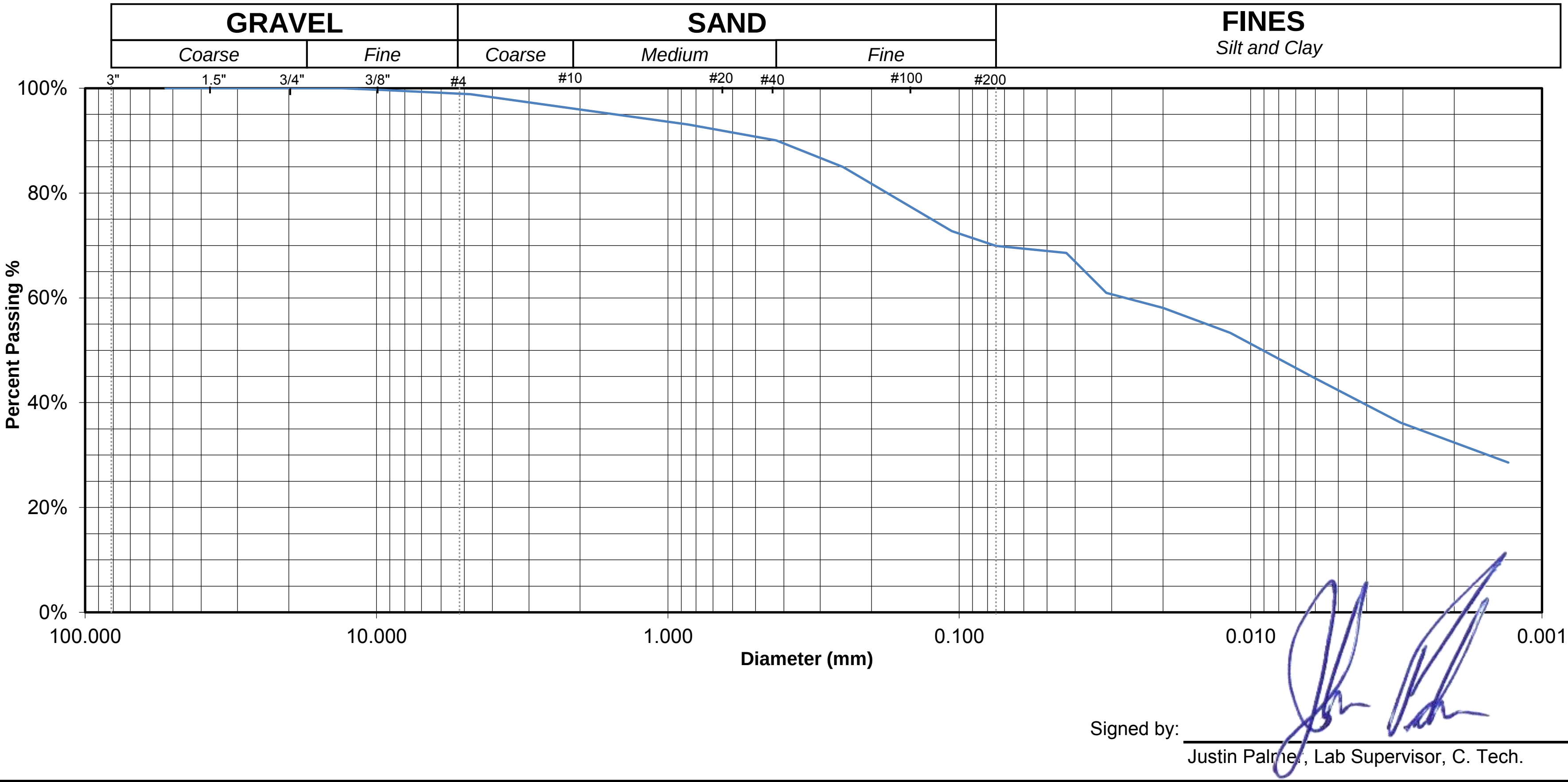
GRAIN SIZE DISTRIBUTION
MTO LS 702 / ASTM D422

Project Number:	SWW157362	**Sampled on:**	1-Sep-2015	**Sampled by:**	SS
Project Client:	Windsor, The Corporation of the City of	**Received on:**	1-Sep-2015	**Received by:**	SS
Project Name:	MountBatten Extension Phase 2	**Tested on:**	11-Sep-2015	**Tested by:**	SS
Project Location:					

Test Results

Sample Location: **BH 9 Sa.7**
Sample Identification: **535**

Gravel	**Sand**	**Silt**	**Clay**	**Soil Classification**
1.2%	28.9%	37.5%	32.4%	SILTY CLAY, sand layers/pockets, silt seams



Signed by:

Justin Palmer, Lab Supervisor, C. Tech.

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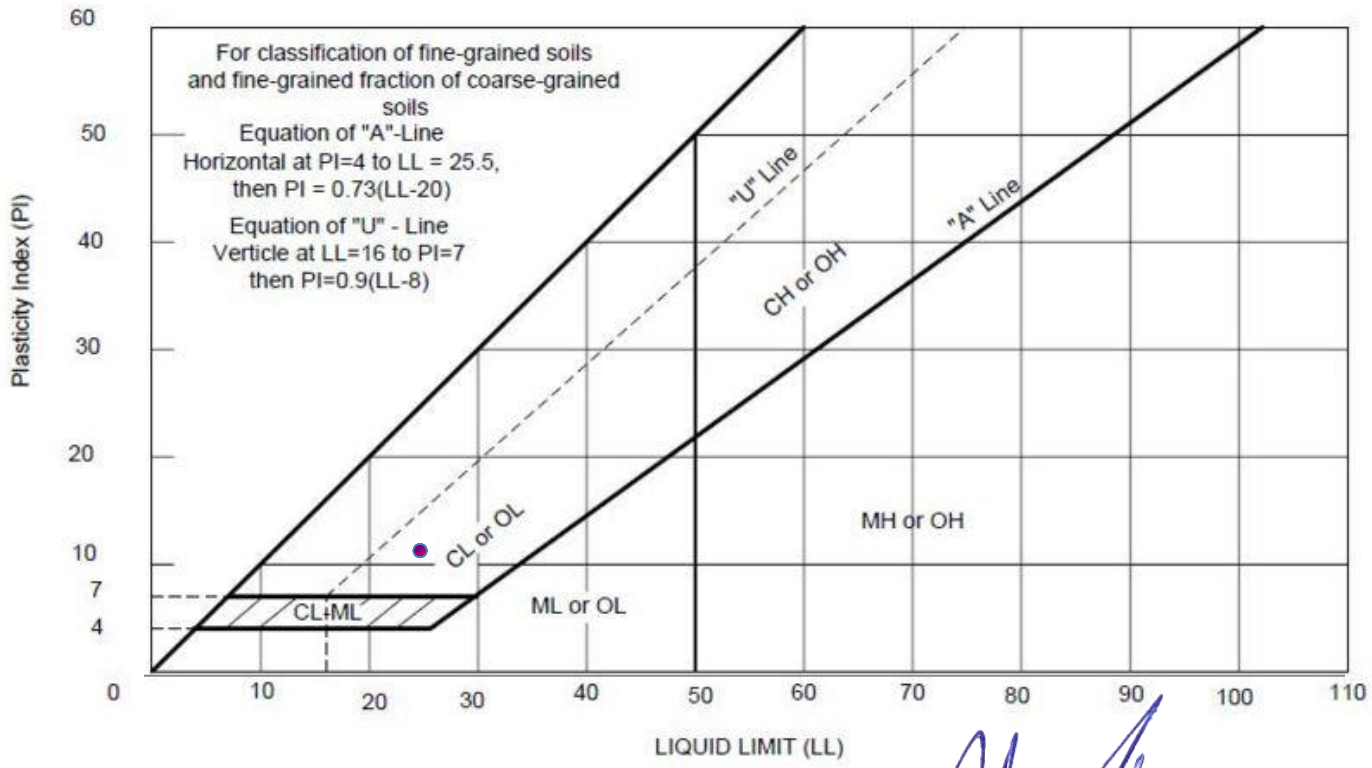
ATTERBERG LIMITS
ASTM D-4318 or LS-703 / 704

Project Number:	SWW157362	**Sampled on:**	1-Sep-2015	**Sampled by:**	SS
Project Client:	Windsor, The Corporation of the	**Received on:**	1-Sep-2015	**Received by:**	JP
Project Name:	MountBatten Extension Phase	**Tested on:**	11-Sep-2015	**Tested by:**	JP
Project Location:	Windsor, Ontario				

Test Results

LAB NUMBER	533
BOREHOLE	9
SAMPLE	7
DEPTH	3.65m

PLASTIC LIMIT	**13.6**
LIQUID LIMIT	**25.3**
PLASTIC INDEX	**11.7**



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Certificate of Analysis

Amec Foster Wheeler (Windsor)

11865 County Road 42
Tecumseh, ON N8N 2M1
Attn: Shane MacLeod

Client PO:
Project: SWW157362
Custody: 23673

Report Date: 16-Sep-2015
Order Date: 11-Sep-2015

Order #: 1538007

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
1538007-01	SS3 (7.5-9') BH4

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	15-Sep-15	15-Sep-15
pH	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	14-Sep-15	14-Sep-15
Resistivity	EPA 120.1 - probe, water extraction	16-Sep-15	16-Sep-15
Solids, %	Gravimetric, calculation	15-Sep-15	15-Sep-15

Certificate of Analysis

Report Date: 16-Sep-2015

Client: **Amec Foster Wheeler (Windsor)**

Order Date:11-Sep-2015

Client PO:

Project Description: SWW157362

	Client ID:	SS3 (7.5-9') BH4	-	-	-
	Sample Date:	09-Sep-15	-	-	-
	Sample ID:	1538007-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	85.0	-	-	-
General Inorganics					
pH	0.05 pH Units	7.53	-	-	-
Resistivity	0.10 Ohm.m	53.1	-	-	-
Anions					
Chloride	5 ug/g dry	6	-	-	-
Sulphate	5 ug/g dry	59	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	ND	5	ug/g						
Sulphate	ND	5	ug/g						
General Inorganics									
Resistivity	ND	0.10	Ohm.m						

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	7.7	5	ug/g dry	7.2			7.7	20	
Sulphate	81.9	5	ug/g dry	80.6			1.6	20	
General Inorganics									
pH	7.91	0.05	pH Units	7.91			0.0	10	
Resistivity	5.61	0.10	Ohm.m	5.68			1.2	20	
Physical Characteristics									
% Solids	89.3	0.1	% by Wt.	89.8			0.6	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	10.7		mg/L	0.7	100	78-113			
Sulphate	18.3		mg/L	8.06	102	78-111			

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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№ 23673

Page 1 of 1

Client Name: AMEC FOSTER WHEELER
Project Reference: SWW157362
Contact Name: SHANE MacLeod
Quote # 15-061
Address: 11865 County Road 42, Tecumseh, ON
PO #
Email Address: SHANE.MacLeod@AMECFW.COM
Telephone: 1(519)735-2499

TAT: ☒ Regular ☐ 3 Day ☐ 2 Day ☐ 1 Day
Date Required: ____________

Criteria: ☐ O. Reg. 153/04 (As Amended) Table __ ☐ RSC Filing ☐ O. Reg. 558/00 ☐ PWQO ☐ CCME ☐ SUB (Storm) ☐ SUB (Sanitary) Municipality: ________ ☐ Other: ________

Matrix Type: S (Soil/Sed.) **GW** (Ground Water) **SW** (Surface Water) **SS** (Storm/Sanitary Sewer) **P** (Paint) **A** (Air) **O** (Other)

Paracel Order Number: 1538007

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	**Sample Taken**		**Required Analyses**										
					Date	Time	Corrosion										
1	SS3 (7.5-9') BH4	Soil		1	9-9-15	12:15	X				120ml						
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Method of Delivery: Purolator

Relinquished By (Sign):
Received by Driver/Depot:
Received at Lab:
Verified By:

Relinquished By (Print): STEVE SUURNAKKI
Date/Time:
Date/Time: Sept 14/15 8:41a
Date/Time: Sept 14/15

Date/Time: 11-9-15 10:00 am
Temperature: ____ °C
Temperature: 16.9 °C
pH Verified ☐ By: N/A

8:57a

APPENDIX C

REPORT LIMITATIONS

REPORT LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environmental aspects of the Project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during the construction to confirm that the subsurface conditions across the site do not deviate materially from those encountered in the test holes.

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

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

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