Preliminary Geotechnical Investigation
And Slope Stability Assessment
3455 Milton Road
Navan, Ontario
Submitted to:

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3455 Milton Road
Navan, Ontario

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1.0 INTRODUCTION

Plans are being prepared to develop a vacant parcel of land located on the east side of Milton Road in the village of Navan, Ontario. The site is bordered on the south by a former rail line and on the north by a vacant parcel of land. An existing residential subdivision is located to the east of the subject site. The parcel of land consists of approximately 12.57 hectares (31.06 acres) of land. An east-west aligned slope divides the southern portion of the site from the northern portion. The northern portion of the site is heavily treed (see Key Plan, Figure 1).

The proposed development plans include a residential subdivision consisting of twenty one (21) village residential lots serviced with on-site septic disposal systems and water supply wells. The proposed lots will be serviced by an internal roadway system. The proposed layout of the development is shown on the Test Pit Location Plan, Figure 2.

This report presents the results of a preliminary geotechnical investigation and slope stability assessment carried out for the site. Test pits were advanced at the site in September 2013 to identify the subsurface conditions. Based on the results of these test pits, preliminary engineering guidelines and recommendations are provided on the geotechnical design aspects of this project, along with construction considerations that could influence design decisions. This investigation is considered preliminary and, as such, a supplemental detailed investigation is required prior to development.

The analyses provided herein were carried out in accordance with our proposal dated May 2, 2014.

2.0 SITE OVERVIEW

2.1 Site Description and Review of Geology Maps

The subject site is located on a vacant parcel of land located at 3455 Milton Road in the Village of Navan, Ontario. The site is bounded by a former railway on the south, a vacant parcel of land on the north, Milton Road on the west and an existing residential subdivision on the east.

An east-west aligned slope divides the southern portion of the site from the northern portion. The northern portion of the site is heavily treed. A channel is located within a north-south aligned internal ravine that runs from Meteor Avenue and outlets at the east-west aligned slope.

Published geology maps of the area indicate that the subsurface conditions are expected to consist of marine deposits of silty clay. The underlying bedrock is mapped as shale bedrock of the Billings formation at depths of between 15 and 25 metres.
2.2 Description of Slopes

A site reconnaissance was carried out on May 30, 2014 by a member of our engineering staff. At that time, the geometry of the slopes throughout the site was measured at a total of seven (7) locations using level surveying techniques. The cross sections were positioned at the site by Houle Chevrier Engineering Ltd. personnel at key locations based on slope geometry and height. Sections ‘A-A’ to ‘D-D’, inclusive, are located along the east-west aligned slope and Sections ‘E-E’ to ‘G-G’, inclusive were positioned along the ravine side slopes. The locations of the seven (7) cross sections considered are provided on the Cross Section Location Plan, Figure 3. Cross sections of the slopes are provided in Appendix B.

The geometries of the cross sections considered are summarized in the following table:

<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Slope Height (metres)</th>
<th>Overall inclination from horizontal (Degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-A</td>
<td>3.5</td>
<td>24</td>
</tr>
<tr>
<td>B-B</td>
<td>7.0</td>
<td>16</td>
</tr>
<tr>
<td>C-C</td>
<td>4.5</td>
<td>16</td>
</tr>
<tr>
<td>D-D</td>
<td>6.5</td>
<td>18</td>
</tr>
<tr>
<td>E-E</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>F-F</td>
<td>5.5</td>
<td>21</td>
</tr>
<tr>
<td>G-G</td>
<td>3.0</td>
<td>18</td>
</tr>
</tbody>
</table>

In general, the east-west aligned slopes (i.e., Sections ‘A-A’ to ‘D-D’, inclusive) are vegetated with shrubs and small to large trees. No signs of slope instability were observed at the time of the site visit.

A channel is located within the internal ravine that runs from Meteor Avenue and outlets at the east-west aligned slope (i.e. Sections ‘E-E’ to ‘G-G’, inclusive). Active soil erosion was
observed along the bottom (toe) of the adjacent slopes. No signs of overall slope instability (i.e., rotational failures) were observed at the time of the site visit.

3.0 SUBSURFACE INVESTIGATION

The test pit investigation was carried out at the site on September 26, 2013 as part of a previous investigation. At that time, a total of eighteen (18) test pits, numbered 13-01 to 13-18, inclusive, were excavated using a mini excavator supplied and operated by the property owner. The test pits were advanced to depths ranging between 2.1 and 2.6 metres below ground surface.

The subsurface conditions in the test pits were identified by visual and tactile examination of the materials exposed on the sides and bottom of the test pits. The short-term groundwater conditions in the open test pits were observed on completion of excavating.

The test pit locations were determined by Novatech Engineering Consultants Ltd. The field work was observed throughout by a member of our engineering staff, who directed the excavation and logged the test pits. Following the field work, the soil samples were returned to our laboratory for examination by a geotechnical engineer. Selected samples of the soil were tested for grain size distribution.

Descriptions of the subsurface conditions logged in the test pits are provided on the Record of Test Pit sheets in Appendix A. The approximate locations of the test pits are shown on the Test Pit Location Plan, Figure 2.

4.0 SUBSURFACE CONDITIONS

4.1 General

The soil and groundwater conditions logged in the test pits are given on the Record of Test Pit sheets in Appendix A. The logs indicate the subsurface conditions at the specific test locations only. Boundaries between zones on the logs are often not distinct, but rather are transitional and have been interpreted. The precision with which subsurface conditions are indicated depends on the frequency and recovery of samples, the method of sampling and the uniformity of the subsurface conditions. Subsurface conditions at locations other than the test locations may vary from the conditions encountered in the test holes.

The soil descriptions in this report are based on commonly accepted methods of classification and identification employed in geotechnical practice. Classification and identification of soil involves judgement and Houle Chevrier Engineering Ltd. does not guarantee descriptions as exact, but infers accuracy to the extent that is common in current geotechnical practice.

The following presents an overview of the subsurface conditions encountered in the test pits advanced during the September 2013 investigation.
4.2 Topsoil

A surficial layer of topsoil was encountered at all of the test pit locations. The topsoil is generally composed of dark brown sandy silt with trace to some organic material and has a thickness ranging between about 30 and 250 millimetres.

4.3 Sand

Deposits of reddish grey brown and brown to grey brown sand were encountered in test pits 13-01 to 13-04, inclusive, 13-10, and 13-12 to 13-18, inclusive, at depths ranging from about 0.15 to 0.25 metres below ground surface. The sand deposits contain trace to some silt and have a thickness ranging between about 0.4 to 1.6 metres.

A layer of grey silty sand was encountered in test pit 13-01 below the sand layer at a depth of about 1.0 metre below ground surface and extends to a depth of about 1.8 metres.

Three (3) grain size distribution tests were undertaken on samples of the sand from test pits 13-10, 13-15 and 13-17. The test results are provided on Figure C1 in Appendix C.

4.4 Silty Clay

Native deposits of silty clay were encountered in all test pits below the topsoil, sand and silty sand at depths ranging between about 30 millimetres and 1.8 metres below ground surface.

The upper part of the silty clay is weathered and reddish grey brown. Where fully penetrated the weathered crust has a thickness of 0.4 to 1.8 metres and extends to depths ranging from 1.5 to 2.3 metres below ground surface. No weathered crust was encountered in test pit 13-16. Based on tactile examination of the soils exposed in the test pits, the weathered silty clay crust has a very stiff consistency.

Test pits 13-01, 13-02, 13-04, 13-10 and 13-12 were terminated within the weathered silty clay crust at depths ranging between 2.1 to 2.4 metres below ground surface.

Grey silty clay was encountered below the weathered silty clay crust and sand deposits at some test pit locations at depths ranging from about 1.5 to 2.3 metres below ground surface. Based on tactile examination of the soils exposed in the test pits, the grey silty clay has a very stiff to stiff consistency.

Test pits 13-03, 13-05 to 13-09, inclusive, 13-11, 13-13 to 13-15, inclusive and 13-17 and 13-18 were terminated within the grey silty clay at depths ranging between 2.4 to 2.6 metres below ground surface.

Three (3) grain size distribution tests were undertaken on samples of the grey silty clay from test pits 13-05, 13-08 and 13-17. The test results are provided on Figure C2 in Appendix C.
4.5 Groundwater Conditions

Groundwater seepage was observed in test pits 13-02, 13-06, 13-08, 13-13, 13-15, 13-17 and 13-18 at depths of about 0.9 to 2.5 metres below ground surface. It should be noted that the groundwater inflow was only observed during the relatively short period of time that the test pits were left open following excavation.

The groundwater levels are expected to vary seasonally and may be higher during wet periods of the year such as the early spring or following periods of precipitation, particularly within the upper sand deposits.

5.0 PRELIMINARY GEOTECHNICAL GUIDELINES

5.1 General

This section of the report provides engineering guidelines on the preliminary geotechnical design aspects of the project based on our interpretation of the available test pit information, and the project requirements. It is stressed that the information in the following sections is provided for the guidance of the designers and is intended for this project only. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data as it affects their construction techniques, schedule, safety and equipment capabilities.

The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at this site. The presence or implications of possible surface and/or subsurface contamination resulting from previous uses or activities of this site or adjacent properties, and/or resulting from the introduction onto the site from materials from off site sources are outside the terms of reference for this report and have not been investigated or addressed.

5.2 Single Family Houses

5.2.1 Excavation

The excavations for the foundations should be taken through any surficial fill, topsoil, or otherwise deleterious material to expose undisturbed native deposits of sand and silty clay. The sides of the excavations should be sloped in accordance with the requirements in Ontario Regulation 213/91 under the Occupational Health and Safety Act. According to the Act, the shallow native overburden deposits can be classified as Type 3 and, accordingly, allowance should be made for excavation side slopes of 1 horizontal to 1 vertical extending upwards from the base of the excavation.

Groundwater seepage was observed in some test pits at depths ranging between about 0.9 and 2.5 metres below ground surface. It should be noted that the groundwater inflow was only
observed during the relatively short period of time that the test pits were left open following excavation. Assuming that the groundwater levels will be at a similar depth at the time of construction we do not anticipate significant groundwater seepage within the excavation for the proposed buildings. Groundwater inflow from the overburden deposits, if any, should be controlled by pumping from filtered sumps within the excavation. It is not expected that short term pumping during excavation will have a significant effect on nearby structures and services.

5.2.2 Placement of Engineered Fill

In areas where the proposed founding level is above the level of the native soil, or where subexcavation of disturbed material is required below proposed founding level, imported granular material (engineered fill) should be used. The engineered fill should consist of granular material meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type II and should be compacted in maximum 200 millimetre thick lifts to at least 95 percent of the standard Proctor maximum dry density. In areas where groundwater inflow is encountered, pumping should be carried out from sumps in the excavation during placement of the engineered fill. To allow spread of load beneath the footings, the engineered fill should extend horizontally at least 0.2 metres beyond the footings and then down and out from the edges of the footings at 1 horizontal to 1 vertical, or flatter. The excavations for the residential dwellings should be sized to accommodate this fill placement. Since the source of recycled material cannot be determined, it is suggested that for environmental reasons any granular materials used below founding level be composed of virgin material only. The engineered fill should be place in accordance with the site grade raise restrictions, where applicable.

5.2.3 Foundations and Grade Raise Restrictions

The site is underlain by deposits of sensitive grey silty clay, which have an apparent stiff to very stiff consistency. However, based on other investigations in this general area, deposits of soft, very sensitive silty clay are known to exist in this vicinity. The placement of fill material across the site must be controlled so that the stress imposed by the fill material does not result in excessive consolidation of the grey silty clay deposits. The settlement response of the silty clay deposits due to the increase in stress caused by fill material is influenced by variables such as the existing effective overburden pressure, the past preconsolidation pressure for the silty clay, the compressibility characteristics of the silty clay, and the presence or absence of drainage paths, etc. It is well established that the settlement response of silty clay deposits can be significant when the stress increase is near or above the preconsolidation pressure.

For preliminary design purposes, the grade raise fill restriction across the site could be about 1 metre, assuming that conventional earth fill is used around the proposed houses. Further investigation with deeper boreholes which are capable of measuring the strength of the silty clay deposit to depths below that which is practical with test pits should be carried out.
The allowable bearing pressure used to size the footings will depend on the depth of the grey silty clay below the footings, the shear strength and consolidation characteristics of the silty clay and the amount of grade raise fill placed around the house and in the garage, all of which are not known at this time. Given that silty clay is expected, the allowable bearing pressures used to size the footings for houses should be about 100 kilopascals. Provided that any loose or disturbed soil is removed from the bearing surfaces, the settlement of the footings should be less than 25 millimetres.

It should be noted that these are preliminary guidelines. It is recommended that a detailed geotechnical investigation be carried out and that the grade raise fill restriction and bearing capacity be reassessed.

5.2.4 Frost Protection of Foundations

All exterior footings and those in any unheated parts of the structures should be provided with at least 1.5 metres of earth cover for frost protection purposes. If 1.5 metres of earth cover is not practicable (for example for walkout type basements) a combination of earth cover and polystyrene insulation could be considered. Further details regarding the insulation of foundations could be provided upon request.

5.2.5 Basement Foundation Wall Backfill and Drainage

In accordance with the Ontario Building Code, the following alternatives could be considered for drainage of the basement foundation walls:

- Damp proof the exterior of the foundation walls and backfill the walls with free draining, non-frost susceptible sand or sand and gravel such as that meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type I or II. OR

- Damp proof the exterior of the foundation walls and install an approved proprietary drainage material on the exterior of the foundation walls and backfill the walls with native material or imported soil.

A perforated drain should be installed around the basement area at the level of the bottom of the footings. The drain should outlet to a sump from which the water is pumped or should drain by gravity to a storm sewer.

5.2.6 Garage Foundation and Pier Backfill

To avoid adfreeze and possible jacking (heaving) of the foundation walls, between the unheated garage foundation walls and the wall backfill, the interior and exterior of the garage foundation walls should be backfilled with free draining, non-frost susceptible sand or sand and gravel such as that meeting Ontario Provincial Standard Specifications (OPSS) requirements for Granular B Type I or II. The backfill within the garage should be compacted in maximum 300 millimetres.
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thick lifts to at least 95 percent of the standard Proctor dry density value using suitable vibratory compaction equipment. Alternatively, 19 millimetre clear crushed stone could be used as backfill within garages. Compaction of the clear stone is not essential.

The backfill against isolated (unheated) walls or piers should consist of free draining, non-frost susceptible material, such as sand meeting OPSS Granular B Type I or II requirements. Other measures to prevent frost jacking of these foundation elements could be provided, if required.

5.2.7 Seismic Site Class
The 2010 National Building Code stipulates that the following two (2) approaches can be used in determining the seismic Site Class:

- Correlation based on the average of the standard penetration test values or in-situ vane shear strengths obtained in the upper 30 metres of the overburden; OR

- Direct measurement of the average shear wave velocity within 30 metres of ground surface. Typically, this is done using surficial or downhole geophysical methods.

The above information is not known at this time; however, based on the results of the preliminary subsurface investigation, together with our experience in the area and published geology maps, in our opinion, seismic Site Class E could be used for preliminary design purposes.

5.2.8 Effects of Trees on the Foundations
The results of this preliminary investigation indicate that sensitive silty clay exists. This material is known to be susceptible to shrinkage with a change/reduction in moisture content. Research by the Institute for Research in Construction (formerly the Division of Building Research) of the National Research Council of Canada has shown that trees can cause a reduction of moisture content in the sensitive clays in the Ottawa area, which can result in significant settlement/damage to nearby buildings supported on shallow foundations. Therefore, no deciduous trees should be permitted closer to the buildings (or any ground supported structures which may be affected by settlement) than the ultimate height of the trees. For groups of trees or trees in rows, the separation distance should be increased to 1.5 times the ultimate height of the trees.

The effects of existing and future trees on proposed buildings, services and other ground supported structures should be considered in the landscaping design.
5.3 Access Roadways

5.3.1 Subgrade Preparation
In preparation for roadway construction at this site, all surficial topsoil and any soft, wet or deleterious materials should be removed from the proposed roadways. Any subexcavated areas could be filled with compacted earth borrow or well shattered and graded rock fill material. Similarly, should it be necessary to raise the roadway grades at this site, material which meets OPSS specifications for Select Subgrade Material, earth borrow or well shattered and graded rock fill material may be used. In low, wet areas, well shattered and graded rock fill material is preferred. The select subgrade material or earth borrow should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the standard Proctor maximum dry density value using vibratory compaction equipment. Rock fill should also be placed in thin lifts and suitably compacted either with a large drum roller, the haulage and spreading equipment, or a combination of both. Prior to placing granular material for the roadway, the exposed subgrade should be heavily proof rolled and inspected and approved by geotechnical personnel. Any soft areas evident from the proof rolling should be subexcavated and replaced with suitable earth borrow or rock fill approved by the geotechnical engineer.

The subgrade should be shaped and crowned to promote drainage of the roadway granular materials.

5.3.2 Pavement Design
For the roadways within this residential development, the following minimum pavement structures are suggested:

Local Roads
- 80 millimetres of hot mix asphaltic concrete
- 150 millimetres of OPSS Granular A base over
- 375 millimetres of OPSS Granular B, Type II subbase

Minor Collector Roads
- 90 millimetres of hot mix asphaltic concrete
- 150 millimetres of OPSS Granular A base over
- 450 to 500 millimetres of OPSS Granular B, Type II subbase

The above pavement structure assumes that any trench backfill is adequately compacted and that the roadway subgrade surface is prepared as described in this report. If the roadway subgrade surface is disturbed or wetted due to construction operations or precipitation, the granular thickness given above may not be adequate and it may be necessary to increase the thickness of the Granular B Type II subbase and/or to incorporate a woven geotextile separator between the roadway subgrade surface and the granular subbase material. The adequacy of
the design pavement thickness should be assessed by geotechnical personnel at the time of construction.

5.3.3 Granular Material Placement
The pavement granular materials should be compacted in maximum 300 millimetre thick lifts to at least 98 percent of standard Proctor maximum dry density using suitable vibratory compaction equipment.

5.3.4 Asphaltic Concrete Types
For all pavements, the asphaltic concrete should consist of a 40 millimetre surface layer of Superpave 12.5 or OPSS HL3 over one 40 or 50 millimetre lift of Superpave 19.0 or OPSS HL8 asphaltic concrete. Performance grade PG 58-34 asphaltic concrete should be specified in accordance with City of Ottawa standards.

5.3.5 Transition Treatments
In areas where the new pavement structure will abut existing pavements, the depths of the granular materials should taper up or down at 5 horizontal to 1 vertical, or flatter, to match the depths of the granular material(s) exposed in the existing pavement.

5.3.6 Pavement Drainage
The subgrade surface should be shaped and crowned to promote drainage of the roadway granular materials.

In order to provide drainage of the granular subbase, it is suggested that catch basins be provided with perforated stub drains extending about 3 metres out from the catch basins in two directions parallel to the roadway. These drains should be installed at the bottom of the subbase layer.

5.4 Effects of Construction Induced Vibration
Some of the construction operations (such as granular material compaction, excavation, etc.) will cause ground vibration on the site. The vibrations will attenuate with distance from the source but may be felt at nearby structures. It is suggested therefore that preconstruction surveys be carried out on any existing, nearby structures and water supply wells.

5.5 Preliminary Slope Stability Analysis
5.5.1 General
The purpose of this preliminary stability assessment is to establish the ‘Erosion Hazard Limit’ for the site. This limit constitutes a safe setback for any proposed development at the site with respect to slope stability. The Erosion Hazard Limit was determined based on the Natural Hazard Policies set forth in Section 3.1 of the Provincial Policy Statements of the Planning Act of Ontario. Current regulations restrict development within the Erosion Hazard Limit.
The slope stability analyses were carried out at Sections ‘A-A’ to ‘G-G’, inclusive, using SLIDE, a state of the art, two dimensional limit equilibrium slope stability program. The results of the slope stability analyses are provided in Appendix B.

5.5.2 Soil Strength Parameters

The soil conditions used in the stability analyses were based, in part, on the results of the test pits advanced across the site. The slope stability analyses were carried out using silty clay strength parameters based on site specific studies in the Ottawa area. To determine the existing factor of safety against overall rotational failure, the slope stability analyses were carried out using drained soil parameters, which reflect long term conditions.

The following table summarizes the soil parameters used in the analyses:

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Effective Angle of Internal Friction, $\phi$ (degrees)</th>
<th>Effective Cohesion, $c'$ (kilopascals)</th>
<th>Unit Weight, $\gamma$ kN/m$^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>32</td>
<td>0</td>
<td>19</td>
</tr>
<tr>
<td>Silty Clay</td>
<td>30</td>
<td>10</td>
<td>17.5</td>
</tr>
</tbody>
</table>

The results of a stability analysis are highly dependent on the assumed groundwater conditions. No information is available on the long term groundwater levels throughout the year; however, as a conservative approach, we have assumed full hydrostatic saturation with the groundwater level at ground surface and groundwater flow horizontally towards the slope.

The slope stability analyses were carried out using soil parameters, groundwater conditions and a slope profile that attempt to model the slopes in question but do not exactly represent the actual conditions. For the purposes of this study, a computed factor of safety of less than 1.0 to 1.3 is considered to represent a slope bordering on failure to marginally stable, respectively; a factor of safety of 1.3 to 1.5 is considered to indicate a slope that is less likely to fail in the long term and provides a degree of confidence against failure ranging from marginal (1.3) to adequate (1.4 and greater) should conditions vary from the assumed conditions. A factor of safety of 1.5, or greater, is considered to indicate adequate long term stability.

5.5.3 Existing Conditions

The slope stability analyses indicated that the existing slopes, in their current configurations, have the following factors of safety against overall rotational failure:
<table>
<thead>
<tr>
<th>Cross Section</th>
<th>Existing Factor of Safety</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-A</td>
<td>2.1</td>
<td>B1</td>
</tr>
<tr>
<td>B-B</td>
<td>1.8</td>
<td>B2</td>
</tr>
<tr>
<td>C-C</td>
<td>2.1</td>
<td>B3</td>
</tr>
<tr>
<td>D-D</td>
<td>1.7</td>
<td>B4</td>
</tr>
<tr>
<td>E-E</td>
<td>2.2</td>
<td>B5</td>
</tr>
<tr>
<td>F-F</td>
<td>1.7</td>
<td>B6</td>
</tr>
<tr>
<td>G-G</td>
<td>2.6</td>
<td>B7</td>
</tr>
</tbody>
</table>

Based on the results of the analyses, the east-west aligned slopes (i.e., Sections ‘A-A’ to ‘D-D’, inclusive), are considered stable under “worst case” conditions. The ravine side slopes (i.e., Sections ‘E-E’ to G-G’, inclusive) are considered stable under “worst case” conditions. The results of the stability analyses agree with our field observations on May 30, 2014.

5.5.4 Setback Requirements

For unstable slopes, the distance from the unstable slope to the safe setback line is called ‘Erosion Hazard Limit’. In accordance with the Ministry of Natural Resources (MNR) Technical Guide “Understanding Natural Hazards” dated 2001, the Erosion Hazard Limit consists of three components: (1) Stable Slope Allowance, (2) Toe Erosion Allowance, and (3) Erosion Access Allowance.

5.6 Slope

The Stable Slope Allowance, as described in the MNR procedures, is the area where a factor of safety of less than 1.5 against overall rotational failure is calculated. At Sections ‘A-A’, to ‘D-D’, inclusive, the slope stability analyses indicate that the existing east-west aligned slopes, in their current configurations, have a factor of safety against failure of greater than 1.5 (refer to Figures B1 to B4, inclusive, in Appendix B). Therefore, the Stable Slope Allowance described in the MNR procedures is not required. At Sections ‘E-E’ to ‘G-G’, inclusive, the slope stability analyses indicate that the existing creek slopes, in their current configurations, have a factor of safety against failure of greater than 1.5 (refer to Figures B5 to B7, inclusive, in Appendix B). Therefore, the Stable Slope Allowance described in the MNR procedures is not required.
As indicated above, active soil erosion was observed along the bottom (toe) of the ravine side slopes (i.e. Sections ‘E-E’ to ‘G-G’, inclusive). In accordance with the MNR documents, a minimum Toe Erosion Allowance of between 5.0 to 8.0 metres is required for clay soils and a minimum Erosion Allowance of between 5.0 to 15.0 metres is required for sandy soils. Given the potential for soil erosion, a Toe Erosion Allowance of 6.0 metres should be used at the location of Sections ‘E-E’ to ‘G-G’, inclusive (refer to Figures B5 to B7, inclusive, in Appendix B). The Toe Erosion Allowance is applied at the crest of the slope.

The MNR procedures also include the application of a 6 metre wide Erosion Access Allowance beyond the Toe Erosion Allowance to allow for access by equipment to repair a possible failed slope. However, based on the preliminary development plans, the Erosion Access Allowance is not required (i.e., for cases where rear lot lines of residential lots are not constructed right up to the Erosion Hazard Limit).

The east-west aligned slopes are relatively flat with no watercourse located at the toe. As such, no setback, from a slope stability perspective, is required from the east-west aligned slopes. The Erosion Hazard Limit (setback) for the ravine side slopes (i.e., Sections ‘E-E’ to ‘G-G’, inclusive) is located about 6.0 metres from the crest of the existing slopes.

It may be possible for the existing ravine to accept additional storm flows from the upstream development. However, for this case, we suggest that the channel and side slopes be protected from erosion (e.g. by installing suitably sized rip rap). It is noted that if the toe of the side slopes are protected from erosion, it may be possible to reduce or eliminate the 6 metre setback from the crest of the ravine side slopes.

5.7 Additional Investigation

This preliminary geotechnical investigation is based on widely spaced, relatively shallow test pits together with available subsurface information. It is recommended, therefore, that a detailed final design stage geotechnical investigation be carried out for the development.
We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report, please do not hesitate to contact our office.

Lauren Ashe, M.A.Sc., E.I.T.

Craig Houle, M.Sc., P.Eng., Principal
N.T.S
LEGEND

APPROXIMATE TEST PIT LOCATION IN PLAN, PREVIOUS INVESTIGATION BY HOULE CHEVRIER ENGINEERING LTD.

PROPERTY BOUNDARY

TEST PIT LOCATION PLAN

Geotechnical Investigation
3455 Milton Road
Ottawa, Ontario

Scale 1:2000

File No. 14-185

Revision No. 0

D.J.R. August 2014
L.A.
LEGEND

#11 APPROXIMATE TEST PIT LOCATION IN PLAN, PREVIOUS INVESTIGATION BY HOULE CHEVRIER ENGINEERING LTD.

#1: Approximate crest of slope
#2: Approximate toe of slope

Erosion Hazard Limit (setback - 6 m)

Approximate crest of slope
Approximate toe of slope

Project
3455 MILTON ROAD
OTTAWA, ONTARIO

Drawing
CROSS SECTION LOCATION PLAN

Scale
1:1000

Metres

File No. 14-185
Drawing 3
Revision No. 0

Checked By
C.H.

J.C.

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August 2014

Calculations By
J.C.

Drawn By
J.C.

Checked By
C.H.

Calculations By
J.C.

Drawn By
J.C.

Checked By
C.H.
APPENDIX A

Record of Test Pit Sheets
September 2013 Investigation
Native Backfill

Dark brown sandy silt (TOPSOIL)

Reddish grey brown, fine grained SAND, trace to some silt

Grey SILTY SAND, trace clay

Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)

End of Test Pit

Notes:
- No groundwater inflow observed at time of excavation
**RECORD OF TEST PIT 13-02**

**PROJECT:** 12-562  
**LOCATION:** See Test Pit Location Plan, Figure 2  
**DATE OF EXCAVATION:** September 26, 2013  
**DATUM:** Geodetic  
**TYPE OF EXCAVATOR:**

<table>
<thead>
<tr>
<th>DEPTH SCALE METRES</th>
<th>DESCRIPTION</th>
<th>ELEV DEPTH (m)</th>
<th>STRATA PLOT</th>
<th>SHEAR STRENGTH, Cu (kPa)</th>
<th>WATER CONTENT (PERCENT)</th>
<th>ADDITIONAL LAB TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ground Surface</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dark brown silty sand with organic material (TOPSOIL)</td>
<td>0.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brown to grey brown, fine grained SAND, trace to some silt</td>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td>2.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>End of Test Pit</td>
<td>2.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Minor groundwater inflow observed at about 1.46m below ground surface
Native Backfill

Dark brown sandy silt, some roots (TOPSOIL)

Grey brown to grey, fine SAND, trace to some silt

Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)

Notes:
- No groundwater inflow observed at time of excavation

End of Test Pit

DATE OF EXCAVATION: September 26, 2013

PROJECT: 12-562
LOCATION: See Test Pit Location Plan, Figure 2
DATUM: Geodetic
TYPE OF EXCAVATOR:

SOIL PROFILE

DEPTH SCALE METRES

DESCRIPTION

ELEV
DEPTH (m)

SAMPLE NUMBER

SHEAR STRENGTH, Cu (kPa)

Natural, V - Remoulded, V -

WATER CONTENT (PERCENT)

Wp  W  WI

ADDITIONAL LAB TESTING

WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION

Native Backfill

1  to 15
<table>
<thead>
<tr>
<th>Depth Scale (m)</th>
<th>Soil Profile Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>1</td>
<td>Dark brown sandy silt, some organic material (TOPSOIL)</td>
</tr>
<tr>
<td>0.18</td>
<td>Grey brown to grey, fine grained SAND, trace to some silt</td>
</tr>
<tr>
<td>0.56</td>
<td>Very stiff, reddish grey brown to grey SILTY CLAY, trace fine sand (Weathered Crust)</td>
</tr>
<tr>
<td>2.44</td>
<td>End of Test Pit</td>
</tr>
</tbody>
</table>

Notes:
- No groundwater inflow observed at time of excavation

**Additional Testing:**
- Native Backfill
Native Backfill

Grey brown silty clay, some organic material (TOPSOIL)

Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)

Very stiff, grey SILTY CLAY, trace fine sand

End of Test Pit

Notes:
- No groundwater inflow observed at time of excavation
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Stratigraphic Description</th>
<th>Sample Number</th>
<th>ELEV DEPTH (m)</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grey brown silty clay, some organic material (TOPSOIL)</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Very stiff, grey SILTY CLAY, trace fine sand</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>End of Test Pit</td>
<td>2.44</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Groundwater pooled at 1.96m below ground surface
- Groundwater sample taken

---

**RECORD OF TEST PIT 13-06**

**PROJECT:** 12-562  
**LOCATION:** See Test Pit Location Plan, Figure 2  
**DATE OF EXCAVATION:** September 26, 2013  
**DATUM:** Geodetic  
**TYPE OF EXCAVATOR:**

---

**WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION**

**ADDITIONAL LAB TESTING**

---

**RECORD OF TEST PIT 13-06 WITH LAB WC 12-562 GINT LOGS.GPJ  8-6-14**
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Water Content (%)</th>
<th>Shear Strength (kPa)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td>Dark brown silty clay with organic material (TOPSOIL)</td>
<td>20 40 60 80</td>
<td>20 40 60 80</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td>20 40 60 80</td>
<td>20 40 60 80</td>
<td></td>
</tr>
<tr>
<td>1.91</td>
<td>Very stiff, grey SILTY CLAY, trace fine sand</td>
<td>20 40 60 80</td>
<td>20 40 60 80</td>
<td></td>
</tr>
<tr>
<td>2.44</td>
<td>End of Test Pit</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- No groundwater observed at time of excavation
Native Backfill

Hydrometer (See Fig. C1)

Grey brown silty clay with organic material (TOPSOIL)

Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)

Very stiff, grey SILTY CLAY, trace fine sand

End of Test Pit

Notes:
- Groundwater pooled at 1.40m below ground surface
- Groundwater sample taken
### Soil Profile

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Sample Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface: Grey brown silty clay, some organic material (TOPSOIL)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td></td>
</tr>
<tr>
<td>2.44</td>
<td>End of Test Pit</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- No groundwater observed at time of excavation

---

### Soil Properties

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Natural V</th>
<th>Remoulded V</th>
<th>Cu (kPa)</th>
<th>Water Content (Percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.88</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.44</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**DATE OF EXCAVATION:** September 26, 2013

**LOCATION:** See Test Pit Location Plan, Figure 2

**PROJECT:** 12-562

**DATUM:** Geodetic

**TYPE OF EXCAVATOR:**

**SHEET 1 OF 1**

---

**RECORD OF TEST PIT 13-09**

**SOIL PROFILE**

**DESCRIPTION**

**SHEAR STRENGTH, Cu (kPa)**

**WATER CONTENT (PERCENT)**

**ADDITIONAL LAB TESTING**

**WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION**

**RECORD OF TEST PIT 13-09**

**SHEAR STRENGTH, Cu (kPa)**

**WATER CONTENT (PERCENT)**

**ADDITIONAL LAB TESTING**

**WATER LEVEL IN OPEN TEST PIT OR STANDPIPE INSTALLATION**

---

**Houle Chevrier Engineering**
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Elevation</th>
<th>Water Content (%)</th>
<th>Shear Strength, Cu (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.23</td>
<td>Dark brown silty sandy silt, some organic material (PEAT)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.23</td>
<td>Brown to grey, fine grained SAND, trace to some silt</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.27</td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.13</td>
<td>End of Test Pit</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- No groundwater observed at time of excavation
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DEPTH SCALE METRES</th>
<th>DESCRIPTION</th>
<th>ELEV DEPTH (m)</th>
<th>STRATA PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dark brown silty sand, some organic material (TOPSOIL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>1.83</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>2.44</td>
<td></td>
</tr>
</tbody>
</table>

**End of Test Pit**

**Notes:**
- No groundwater observed at time of excavation

**TABLE: SHEAR STRENGTH, Cu (kPa)**

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Natural V. Remoulded V.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

**TABLE: WATER CONTENT (PERCENT)**

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Wp</th>
<th>W</th>
<th>WI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</table>

**ADDITIONAL LAB TESTING**

Native Backfill
## SOIL PROFILE

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>0.18</td>
<td>Dark brown silty sand, some organic material (TOPSOIL)</td>
</tr>
<tr>
<td>1</td>
<td>Brown to grey, fine grained SAND, trace to some silt</td>
</tr>
<tr>
<td>1.60</td>
<td>Very stiff, reddish grey SILTY CLAY, trace fine sand (Weathered Crust)</td>
</tr>
<tr>
<td>2.44</td>
<td>End of Test Pit</td>
</tr>
</tbody>
</table>

**Notes:**
- No groundwater observed at time of excavation

---

## WATER CONTENT (PERCENT)

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Wp</th>
<th>W</th>
<th>WI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.44</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

## ADDITIONAL LAB TESTING

- Native Backfill

---

## OTHER

- 19mm diameter, 0.61m slotted PVC Pipe
- No groundwater observed at time of excavation
### Soil Profile

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
</tr>
<tr>
<td>1</td>
<td>Dark brown sandy silt with organic material (TOPSOIL)</td>
</tr>
<tr>
<td>0.15</td>
<td>Brown to grey, fine grained SAND, trace to some silt</td>
</tr>
<tr>
<td>1.12</td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
</tr>
<tr>
<td>1.58</td>
<td>Stiff, grey SILTY CLAY, trace fine sand</td>
</tr>
<tr>
<td>2.44</td>
<td>End of Test Pit</td>
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</table>

### Notes:
- Minor groundwater inflow observed at 0.94m below ground surface
<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Water Content (%)</th>
<th>Additional Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface, dark brown sandy silt, some organic material (TOPSOIL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Grey brown to grey, fine grained SAND, trace to some silt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.05</td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Very stiff to stiff, grey SILTY CLAY, trace fine sand</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- No groundwater observed at time of excavation

- No groundwater observed at time of excavation
**RECORD OF TEST PIT 13-15**

**SOIL PROFILE**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>ELEV DEPTH (m)</th>
<th>STRATA PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Surface</td>
<td>0</td>
<td>Native Backfill</td>
</tr>
<tr>
<td>Dark brown, silty clay with organic material (TOPSOIL)</td>
<td>0.25</td>
<td>Sieve (See Fig. C1)</td>
</tr>
<tr>
<td>Brown to grey, fine grained SAND, trace to some silt</td>
<td>1.12</td>
<td></td>
</tr>
<tr>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)</td>
<td>1.96</td>
<td></td>
</tr>
<tr>
<td>Stiff, grey SILTY CLAY, trace fine sand</td>
<td>2.44</td>
<td></td>
</tr>
<tr>
<td>End of Test Pit</td>
<td>2.44</td>
<td></td>
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</tbody>
</table>

**WATER CONTENT (PERCENT)**

<table>
<thead>
<tr>
<th>Water Level in Open Test Pit or Standpipe Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wp</td>
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</table>

**ADDITIONAL LAB TESTING**

**PROJECT:** 12-562

**LOCATION:** See Test Pit Location Plan, Figure 2

**DATE OF EXCAVATION:** September 26, 2013

**DATUM:** Geodetic

**TYPE OF EXCAVATOR:**

**RECORD OF TEST PIT 13-15 WITH LAB WC 12-562 GINT LOGS.GPJ 8-6-14**

**LOGGED:** A.N.

**CHECKED:**
Native Backfill

Dark brown sandy silt, some organic material (TOPSOIL)

Brown to grey, fine grained SAND, trace to some silt

Stiff, grey SILTY CLAY, trace fine sand

End of Test Pit

Notes:
- No groundwater observed at time of excavation
<table>
<thead>
<tr>
<th>DEPTH SCALE (m)</th>
<th>DESCRIPTION</th>
<th>WATER CONTENT (PERCENT)</th>
<th>SHEAR STRENGTH, Cu (kPa)</th>
<th>ADDITIONAL LAB TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Ground Surface</td>
<td>Natural, Remoulded</td>
<td>Wp 20 40 60 80</td>
<td>Native Backfill</td>
</tr>
<tr>
<td></td>
<td>Dark brown silty sand with organic material (TOPSOIL)</td>
<td>Wp 20 40 60 80</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grey brown to grey, fine grained SAND, trace to some silt</td>
<td>Wp 20 40 60 80</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very stiff, reddish grey brown SILTY CLAY, trace fine grained sand (Weathered Crust)</td>
<td>Wp 20 40 60 80</td>
<td>2.59</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Stiff, grey SILTY CLAY, trace fine grained sand</td>
<td>Wp 20 40 60 80</td>
<td>2.03</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>End of Test Pit</td>
<td>Wp 20 40 60 80</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- Groundwater pooled at 2.54m below ground surface
- Groundwater sample taken
Native Backfill

Dark brown silty sand with organic material (TOPSOIL)

Grey brown to grey, fine grained SAND, trace to some silt

Very stiff, reddish grey brown SILTY CLAY, trace fine sand (Weathered Crust)

Stiff, grey SILTY CLAY, trace fine sand

End of Test Pit

Notes:
- Minor groundwater inflow observed at 2.13m below ground surface
LIST OF ABBREVIATIONS AND TERMINOLOGY

SAMPLE TYPES

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AS</td>
<td>auger sample</td>
</tr>
<tr>
<td>CS</td>
<td>chunk sample</td>
</tr>
<tr>
<td>DO</td>
<td>drive open</td>
</tr>
<tr>
<td>MS</td>
<td>manual sample</td>
</tr>
<tr>
<td>RC</td>
<td>rock core</td>
</tr>
<tr>
<td>ST</td>
<td>slotted tube</td>
</tr>
<tr>
<td>TO</td>
<td>thin-walled open Shelby tube</td>
</tr>
<tr>
<td>TP</td>
<td>thin-walled piston Shelby tube</td>
</tr>
<tr>
<td>WS</td>
<td>wash sample</td>
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</table>

SOIL DESCRIPTIONS

<table>
<thead>
<tr>
<th>Relative Density</th>
<th>'N' Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0 to 4</td>
</tr>
<tr>
<td>Loose</td>
<td>4 to 10</td>
</tr>
<tr>
<td>Compact</td>
<td>10 to 30</td>
</tr>
<tr>
<td>Dense</td>
<td>30 to 50</td>
</tr>
<tr>
<td>Very Dense</td>
<td>over 50</td>
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<table>
<thead>
<tr>
<th>Consistency</th>
<th>Undrained Shear Strength (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very soft</td>
<td>0 to 12</td>
</tr>
<tr>
<td>Soft</td>
<td>12 to 25</td>
</tr>
<tr>
<td>Firm</td>
<td>25 to 50</td>
</tr>
<tr>
<td>Stiff</td>
<td>50 to 100</td>
</tr>
<tr>
<td>Very Stiff</td>
<td>over 100</td>
</tr>
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LIST OF COMMON SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>c_u</td>
<td>undrained shear strength</td>
</tr>
<tr>
<td>e</td>
<td>void ratio</td>
</tr>
<tr>
<td>C_c</td>
<td>compression index</td>
</tr>
<tr>
<td>c_v</td>
<td>coefficient of consolidation</td>
</tr>
<tr>
<td>k</td>
<td>coefficient of permeability</td>
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<tr>
<td>I_p</td>
<td>plasticity index</td>
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<tr>
<td>n</td>
<td>porosity</td>
</tr>
<tr>
<td>u</td>
<td>pore pressure</td>
</tr>
<tr>
<td>w</td>
<td>moisture content</td>
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<tr>
<td>w_l</td>
<td>liquid limit</td>
</tr>
<tr>
<td>w_p</td>
<td>plastic limit</td>
</tr>
<tr>
<td>(\phi^1)</td>
<td>effective angle of friction</td>
</tr>
<tr>
<td>(\gamma_u)</td>
<td>unit weight of soil</td>
</tr>
<tr>
<td>(\gamma_u^1)</td>
<td>unit weight of submerged soil</td>
</tr>
<tr>
<td>(\sigma)</td>
<td>normal stress</td>
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SOIL TESTS

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
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<tr>
<td>C</td>
<td>consolidation test</td>
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<tr>
<td>H</td>
<td>hydrometer analysis</td>
</tr>
<tr>
<td>M</td>
<td>sieve analysis</td>
</tr>
<tr>
<td>MH</td>
<td>sieve and hydrometer analysis</td>
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<tr>
<td>U</td>
<td>unconfined compression test</td>
</tr>
<tr>
<td>Q</td>
<td>undrained triaxial test</td>
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<tr>
<td>V</td>
<td>field vane, undisturbed and remoulded shear strength</td>
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</table>
APPENDIX B

Slope Stability Analyses
Figures B1 to B7
Loading Conditions: Static
Soil Properties: Drained
Loading Conditions: Static
Soil Properties: Drained

SLOPE STABILITY ANALYSIS
SECTION B-B
3455 MILTON ROAD
EXISTING CONDITIONS

FIGURE B2

PROJECT: 14-185
DATE: August 2014
Loading Conditions: Static
Soil Properties: Drained
Loading Conditions: Static
Soil Properties: Drained
SLOPE STABILITY ANALYSIS
SECTION E-E
3455 MILTON ROAD
EXISTING CONDITIONS

Loading Conditions: Static
Soil Properties: Drained
Loading Conditions: Static
Soil Properties: Drained

Elevation (metres, geodetic datum)

Metres

Material: Silty Clay
Strength Type: Mohr-Coulomb
Unit Weight: 17.5 kN/m³
Cohesion: 10 kPa
Friction Angle: 30 degrees

Material: Sand
Strength Type: Mohr-Coulomb
Unit Weight: 19 kN/m³
Cohesion: 0 kPa
Friction Angle: 32 degrees

Erosion Hazard Limit (6 metres)
Loading Conditions: Static
Soil Properties: Drained

Elevation (metres, geodetic datum)

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6

Metres


SLOPE STABILITY ANALYSIS
SECTION G-G
3455 MILTON ROAD
EXISTING CONDITIONS

FIGURE B7

PROJECT: 14-185
DATE: August 2014
APPENDIX C

Grain Size Distribution Curves
Figures C1 and C2
FIGURE C1

GRAIN SIZE DISTRIBUTION
SAND

Test pit | Sample | Depth (m) | Legend
--- | --- | --- | ---
13-10 | 2 | 0.2 - 0.5 | ●
13-15 | 2 | 0.3 - 0.6 | □
13-17 | 2 | 0.2 - 0.5 | ▲

Unified Soil Classification System

Sieve Size, mm

% Passing

Grain Size, mm

Project: 12-562
Date: August 2014
**GRAIN SIZE DISTRIBUTION**  
Silty Clay  

**FIGURE C2**

**Test pit** | **Sample** | **Depth (m)** | **Legend**  
--- | --- | --- | ---  
13-05 | 2 | 1.8 - 2.4 |  
13-08 | 3 | 1.5 - 2.4 |  
13-17 | 4 | 2.0 - 2.3 |  

Unified Soil Classification System

<table>
<thead>
<tr>
<th>Coarse</th>
<th>Fine</th>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
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<tbody>
<tr>
<td>Gravel</td>
<td>Sand</td>
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</table>

Date: August 2014  
Project: 12-562
geotechnical
environmental
hydrogeology
materials testing & inspection