Preliminary Geotechnical Investigation
Empire St. George Lands
St. George, Ontario

Prepared For:
Empire Communities (St. George) Ltd.

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1. **INTRODUCTION**

SPL Consultants Limited (SPL) was retained by Empire Communities (St. George) Ltd. to conduct a Preliminary Geotechnical Investigation for the proposed subdivision located on County Highway No. 5, west of Scott Avenue in St. George, Ontario.

The site is approximately 66 hectares comprising of agricultural and undeveloped lands. It is understood that the proposed development will involve a mix of residential and mixed used commercial uses serviced by municipal sanitary sewers, storm sewers, watermains and roadways, parks and open spaces, and two (2) storm water management ponds located in the southern area of the site.

The purpose of this geotechnical investigation was to obtain information about the subsurface conditions by drilling twenty-three boreholes and from the findings in the boreholes to make recommendations pertaining to the geotechnical design parameters for the site grading, underground utilities, subdivision roads, storm water management ponds, and to comment on the foundation conditions for general house construction.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics and do not conform to generalized standards for services. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Empire Communities (St. George) Ltd. and their designers. Third party use of this report without SPL Consultants Limited consent is prohibited.

2. **FIELD AND LABORATORY WORK**

Twenty-three boreholes (BH14-01 to BH14-23) were drilled to depths varying between 6.2 m and 9.6 m below existing grade with solid or hollow stem continuous flight auger equipment by a drilling subcontractor under the direction and supervision of SPL Consultants Limited personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The samples were logged in the field and returned to the SPL Consultants Limited laboratory for detailed examination by the project engineer and for laboratory testing.
Depth and nature of topsoil were determined through hand dug test pits at additional 30 locations throughout the site (TP14-01 through TP14-30 as shown on Drawing 1).

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. Stabilized ground water levels were measured in monitoring wells installed in BH14-06, BH14-14, BH14-19, and BH14-23.

The borehole locations were staked out and ground surface elevations at the borehole locations were surveyed by Hunt Surveys Inc.

As well as visual examination in the laboratory, all soil samples were tested for moisture contents. Laboratory Grain Size Analyses were carried out on six samples (BH14-01/SS5, BH14-06/SS4, BH14-13/SS5, BH14-14/SS8, BH14-19/SS8, and BH14-23/SS8). Organic content of topsoil was determined for eight samples obtained from BH14-02, BH14-05, BH14-08, BH14-14, BH14-18, BH14-20, BH14-27, and BH14-29. Corrosivity parameters were tested for three samples (BH14-06/SS3, BH14-14/SS5, and BH14-23/SS6).

3. SITE AND SUBSURFACE CONDITIONS

The subject site is located on County Highway No. 5, west of Scott Avenue in St. George, Ontario.

The area under assessment is essentially rectangular parcel of land with an area of approximately 66 hectares and is currently in use as agricultural land. At the south east portion of the site, two houses, various outbuildings, and a barn/garage are situated. The remaining of the site is primarily crop land and can be characterized as gently rolling terrain generally rising in elevation from Highway 5 to Howell Road. An Imperial Oil pipeline easement traverses the site in a generally east-west direction approximately half-way between Highway 5 and Howell Road. In this area on the west side of the site, extending eastwards to about halfway of the site, the site rises steeply and features a wooded area.

3.1 Soil Conditions

The approximate borehole and test pit locations are shown on Drawing 1. Notes on sample descriptions and the general features of fill and native material are presented on Drawing 1A. Detailed subsurface conditions observed through BH14-01 to BH14-23 are presented on the Borehole Logs, Drawings 2 to 24.

The subsurface conditions in the boreholes and test pits are summarized in the following paragraphs.

Topsoil/Fill: In the boreholes and test pits, topsoil ranging from 100 mm to 500 mm in thickness was found at the surface. Table 3.1 below lists the topsoil thickness found at the borehole and test pit locations.
Table 3.1.1
Recorded Topsoil Depths at Borehole and Test Pit Locations

<table>
<thead>
<tr>
<th>Borehole/Test Pit No.</th>
<th>Topsoil Thickness (mm)</th>
<th>Borehole No.</th>
<th>Topsoil Thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH14-01</td>
<td>300</td>
<td>TP14-05</td>
<td>250</td>
</tr>
<tr>
<td>BH14-02</td>
<td>250</td>
<td>TP14-06</td>
<td>250</td>
</tr>
<tr>
<td>BH14-03</td>
<td>250</td>
<td>TP14-07</td>
<td>200</td>
</tr>
<tr>
<td>BH14-04</td>
<td>300</td>
<td>TP14-08</td>
<td>450</td>
</tr>
<tr>
<td>BH14-05</td>
<td>250</td>
<td>TP14-09</td>
<td>300</td>
</tr>
<tr>
<td>BH14-06</td>
<td>250</td>
<td>TP14-10</td>
<td>250</td>
</tr>
<tr>
<td>BH14-07</td>
<td>100</td>
<td>TP14-11</td>
<td>300</td>
</tr>
<tr>
<td>BH14-08</td>
<td>200</td>
<td>TP14-12</td>
<td>275</td>
</tr>
<tr>
<td>BH14-09</td>
<td>300</td>
<td>TP14-13</td>
<td>300</td>
</tr>
<tr>
<td>BH14-10</td>
<td>300</td>
<td>TP14-14</td>
<td>250</td>
</tr>
<tr>
<td>BH14-11</td>
<td>300</td>
<td>TP14-15</td>
<td>300</td>
</tr>
<tr>
<td>BH14-12</td>
<td>200</td>
<td>TP14-16</td>
<td>275</td>
</tr>
<tr>
<td>BH14-13</td>
<td>250</td>
<td>TP14-17</td>
<td>300</td>
</tr>
<tr>
<td>BH14-14</td>
<td>300</td>
<td>TP14-18</td>
<td>300</td>
</tr>
<tr>
<td>BH14-15</td>
<td>225</td>
<td>TP14-19</td>
<td>250</td>
</tr>
<tr>
<td>BH14-16</td>
<td>200</td>
<td>TP14-20</td>
<td>200</td>
</tr>
<tr>
<td>BH14-17</td>
<td>500</td>
<td>TP14-21</td>
<td>300</td>
</tr>
<tr>
<td>BH14-18</td>
<td>200</td>
<td>TP14-22</td>
<td>400</td>
</tr>
<tr>
<td>BH14-19</td>
<td>300</td>
<td>TP14-23</td>
<td>300</td>
</tr>
<tr>
<td>BH14-20</td>
<td>150</td>
<td>TP14-24</td>
<td>300</td>
</tr>
<tr>
<td>BH14-21</td>
<td>250</td>
<td>TP14-25</td>
<td>450</td>
</tr>
<tr>
<td>BH14-22</td>
<td>500</td>
<td>TP14-26</td>
<td>300</td>
</tr>
<tr>
<td>BH14-23</td>
<td>200</td>
<td>TP14-27</td>
<td>250</td>
</tr>
<tr>
<td>TP14-01</td>
<td>250</td>
<td>TP14-28</td>
<td>250</td>
</tr>
<tr>
<td>TP14-02</td>
<td>300</td>
<td>TP14-29</td>
<td>300</td>
</tr>
<tr>
<td>TP14-03</td>
<td>300</td>
<td>TP14-30</td>
<td>275</td>
</tr>
<tr>
<td>TP14-04</td>
<td>350</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The topsoil is generally dark brown in colour containing an appreciable amount of roots and humus. These materials are compressible under loads; therefore, the topsoil should not be re-used as structural fill, but can be used for general landscaping purposes.

Topsoil thickness varies in depth due to topography and from farming practices. Localized thick topsoil deposits may be encountered.
Table 3.2, shown below, summarizes the results from the moisture content and organic content tests performed on eight topsoil samples at the SPL Consultants Limited laboratory.

### Table 3.1.2

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>BH14-02</th>
<th>BH14-05</th>
<th>BH14-08</th>
<th>BH14-14</th>
<th>BH14-18</th>
<th>BH14-20</th>
<th>BH14-27</th>
<th>BH14-29</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample No.</td>
<td>SS1</td>
<td>SS1</td>
<td>SS1</td>
<td>SS1</td>
<td>SS1</td>
<td>SS1</td>
<td>SS1</td>
<td>SS1</td>
</tr>
<tr>
<td>Moisture Content %</td>
<td>23.3</td>
<td>20.5</td>
<td>22.1</td>
<td>19.4</td>
<td>24.2</td>
<td>18.6</td>
<td>17.8</td>
<td>22.2</td>
</tr>
<tr>
<td>Organic Matter %</td>
<td>4.2</td>
<td>2.6</td>
<td>2.7</td>
<td>2.8</td>
<td>5.0</td>
<td>2.7</td>
<td>2.8</td>
<td>3.2</td>
</tr>
</tbody>
</table>

A layer of fill was contacted below the topsoil at the location of BH14-07. The fill consisted of gravelly sand and extended to a depth of 1.5m below grade.

**Clayey Silt:** Underlying the topsoil, a layer of firm to hard clayey silt was contacted in the majority of the boreholes. The clayey silt was reworked containing rootlets and trace organics to depths varying between 0.8 m to 1.5 m depth.

**Gravelly Sand to Sand and Gravel Deposits:** Granular deposits of gravelly sand to sand and gravel deposits are encountered in most of the boreholes. Cobble/boulder sizes were observed throughout the granular deposits. Grain size analyses carried out on three samples from these deposits indicated 6 to 24 % fines (silt and clay content), 44 to 62 % sand content, and 31-41% gravel content. These results are presented in Figure A1 in Appendix A.

The measured natural moisture content of the samples from these deposits ranges from 7 to 22%, indicating moist to wet condition.

Standard Penetration Tests performed in this deposit yield ‘N’-values generally ranging from 15 to in excess of 50 blows/0.3 m, indicating a generally compact to very dense material. These deposits often contained cobble and boulder sizes resulting in auger refusals at various depths and high SPT results.

**Sand, Silty Sand to Sandy Silt, Silt:** sand, silty sand to sandy silt, and/or silt were encountered in most boreholes. These deposits contain trace to some gravel and are brown in colour becoming grey with depth.

Grain size analyses carried out on three samples from the silt or sand materials indicated clay content of 2 to 8 %, silt content of 26 to 83%, sand content of 11 to 66 %, and gravel content of 0 to 9 %. These results are presented in Figure A2 and A3 in Appendix A.
The measured natural moisture content of the samples from these deposits ranges from 6 to 30%, indicating a moist to wet condition. Furthermore, dilatancy of the silt deposits was observed and recorded in the field and during the sample examination in the laboratory.

Standard Penetration Tests performed in this unit yield ‘N’-values generally ranging from 11 to in excess of 50 blows/0.3 m, indicating a compact to very dense relative density.

Based on grain size distribution results (Figures A1 through A4), the hydraulic conductivity for each soil sample was evaluated based on Hazen method. Table 3.1.3 below summarizes the calculated hydraulic conductivity results:

<table>
<thead>
<tr>
<th>BH ID</th>
<th>SS ID</th>
<th>Dominant Lithology Across Screened Interval</th>
<th>Hydraulic Conductivity (K)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>k (m/day)</td>
</tr>
<tr>
<td>BH14-23</td>
<td>SS8</td>
<td>Gravely Sand trace silt</td>
<td>19.4</td>
</tr>
<tr>
<td>BH14-19</td>
<td>SS8</td>
<td>Silt, some Sand, trace Clay</td>
<td>2.00 x 10^-2</td>
</tr>
<tr>
<td>BH14-06</td>
<td>SS4</td>
<td>Silty Sand</td>
<td>2.50 x 10^-1</td>
</tr>
<tr>
<td>BH14-14</td>
<td>SS8</td>
<td>Silty Sand</td>
<td>2.16 x 10^-2</td>
</tr>
<tr>
<td>BH14-13</td>
<td>SS5</td>
<td>Sand and Gravel</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Note that the above assessment of the hydraulic conductivity value (k) is based on the grain size distribution curves. The correlation between the hydraulic conductivity and Soil Type is an estimate only as the permeability of the soil will vary according to gradation and in-situ conditions such as degree of compaction, inclusions, groundwater fluctuation, and degree of cementation of the material. For representative values of hydraulic conductivity, in-situ permeability tests should be performed at the site.

3.2 Groundwater Conditions

Groundwater measurements in the monitoring wells are shown on the attached borehole logs and are also summarized on Table 3.2.
### Table 3.2 - Measured Water Levels in Monitoring Wells

<table>
<thead>
<tr>
<th>BH No.</th>
<th>Ground Surface Elev. (m)</th>
<th>Soil Type at Screen Location (depth)</th>
<th>Date of Measurement</th>
<th>Depth / Water Level Elevation (m)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH14-06</td>
<td>259.2</td>
<td>Silty Sand to Sandy Silt (1.5 to 4.5m)</td>
<td>December 16, 2014</td>
<td>dry</td>
<td></td>
</tr>
<tr>
<td>BH14-14</td>
<td>256.3</td>
<td>Silty Sand (6.1 to 9.1m)</td>
<td>December 16, 2014</td>
<td>8.1 / 248.2</td>
<td></td>
</tr>
<tr>
<td>BH14-19</td>
<td>255.7</td>
<td>Sandy Silt (6.1 to 9.1m)</td>
<td>December 16, 2014</td>
<td>8.0 / 247.7</td>
<td></td>
</tr>
<tr>
<td>BH14-23</td>
<td>249.3</td>
<td>Gravelly Sand (4.9 to 7.9 m)</td>
<td>December 16, 2014</td>
<td>2.9 / 246.4</td>
<td></td>
</tr>
</tbody>
</table>

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events. We recommend that the piezometric levels be further monitored.

### 4. DISCUSSION AND RECOMMENDATIONS

The subject site is located on County Highway No. 5, west of Scott Avenue in St. George, Ontario. The site is approximately 66 hectares comprising of agricultural and undeveloped lands.

It is understood that the proposed development will involve a mix of residential and mixed used commercial uses serviced by municipal sanitary sewers, storm sewers, watermains and roadways, parks and open spaces, and two (2) storm water management ponds located in the southern area of the site.

#### 4.1 Roads

The investigation has shown that the predominant subgrade soil after stripping topsoil and loose surface material will generally consist of clayey silt to silt. These soils are considered frost susceptible. The exposed surface must be proof rolled and weak areas replaced with suitable compacted selected fill.

Based on the above and assuming that traffic usage will be residential minor local or local, the following minimum pavement thickness is recommended:

- 40 mm HL3 Asphaltic Concrete
- 65 mm HL8 Asphaltic Concrete
- 150 mm Granular ‘A’
- 300-350 mm Granular ‘B’
For bus routes and collector roads, the following minimum pavement thickness is recommended:

- 40 mm HL3 Asphaltic Concrete
- 80 mm HL8 Asphaltic Concrete
- 150 mm Granular ‘A’
- 350-400 mm Granular ‘B’

These values may need to be adjusted according to the Municipality’s Standards. The site subgrade and weather conditions (i.e. if wet) at the time of construction may necessitate the placement of geogrid/filter fabric and/or thicker granular sub-base layer in order to facilitate the construction. Furthermore, heavy construction equipment may have to be kept off the newly constructed roads before the placement of asphalt and/or immediately thereafter, to avoid damaging the weak subgrade by heavy truck traffic.

4.1.1 Stripping, Subexcavation and Grading

The site should be stripped of all topsoil, loose fill and any organic or otherwise unsuitable soils to the full depth of the roads both in cut and fill areas.

Following stripping, the site should be graded to the subgrade level and approved. The subgrade should then be proof-rolled, in the presence of the Geotechnical Engineer, by at least several passes of a heavy compactor having a rated capacity of at least 8 tonnes. Any soft spots thus exposed should be removed and replaced by select fill material, similar to the existing subgrade soil and approved by the Geotechnical Engineer. The subgrade should then be recompacted from the surface to at least 98% of its Standard Proctor Maximum Dry Density (SPMDD). The final subgrade should be cambered or otherwise shaped properly to facilitate rapid drainage and to prevent the formation of local depressions in which water could accumulate.

Owing to the clayey and silty (i.e. impervious) nature of the subsoils at the site, proper cambering and allowing the water to escape towards the sides (where it can be removed by means of subdrains) is considered to be beneficial for this project. Otherwise, any water collected in the granular sub-base materials could be trapped thus causing problems due to softened subgrade, differential frost heave, etc. For the same reason damaging the subgrade during and after placement of the granular materials by heavy construction traffic should be avoided. If the moisture content of the local material cannot be maintained at ±2% of the optimum moisture content, imported granular material may need to be used.

Any fill required for re-grading the site or backfill should be select, clean material, free of topsoil, organic or other foreign and unsuitable matter. It should be noted that some of the excavated native materials will have moisture content over the optimum and must be aerated and left to dry out before they can be used for backfill. The fill should be placed in thin layers and compacted to at least 95% of its SPMDD. The degree of compaction should be increased to 98% within the top 1.0 m of the subgrade, or as per the Municipality’s Standards. The compaction of the new fill should be checked by frequent field density tests.
4.1.2 Construction

Once the subgrade has been inspected and approved, the granular base and sub-base course materials should be placed in layers not exceeding 200 mm (uncompacted thickness) and should be compacted to at least 100% of their respective SPMDD. The grading of the material should conform to current OPS Specifications.

The placing, spreading and rolling of the asphalt should be in accordance with OPS Specifications or, as required by the local authorities.

Frequent field density tests should be carried out on both the asphalt and granular base and sub-base materials to ensure that the required degree of compaction is achieved.

4.1.3 Drainage

Installation of full-length subdrains is required on all roads. The subdrains should be properly filtered to prevent the loss of (and clogging by) soil fines.

All paved surfaces should be sloped to provide satisfactory drainage towards catchbasins. As discussed in Section 4.1.1, by means of good planning any water trapped in the granular sub-base materials should be drained rapidly towards subdrains or other interceptors.

4.2 Sewers

As a part of the site development, a network of new storm and sanitary sewers is to be constructed. Plans and profiles for the underground services was not available at the time of this investigation but we understand that deeper services will be required at the southern portion of the site.

The boreholes indicate that beneath the topsoil, the soils consist of compact to very dense sand and gravel/gravelly sand and/or silty sand to sandy silt. These soils are considered competent to support the sewers. It should be noted that the sand and gravel deposits will contain cobbles and boulders.

4.2.1 Trenching

Excavation of the overburden soil can be carried out with heavy hydraulic backhoes. Provisions must be made in the excavation contract for the removal of possible boulders.

It is expected that any seepage above the ground water table, which occurs during wet periods or from the wet sandy seams, can be removed by pumping from sumps. It should be noted, that sloughing of the excavation face might occur where wet sand layers are encountered or the silt is in a wet condition. This may require the use of oversized excavations or flatter than normal excavation slopes.

Ground water levels varying between 2.9 to 8.1 m below present grade were measured in the monitoring wells; therefore it is expected that some of the trench excavations will intercept the ground.
water table. Temporary positive dewatering such as well points will be required for excavations below the water table for the installation of underground services. The water table must be lowered to about 1.0 m below the excavation base. Excavations in the silt and sandy silt below the water table will also require positive dewatering. Otherwise, it will result in an unstable base and flowing sides. A contractor specializing in dewatering should be retained to design the dewatering systems.

Standard geotechnical site investigations may not determine dewatering or depressurizing requirements for situation where there is planned excavation or construction below the groundwater table. To quantify conditions for dewatering purposes and to apply for required permits, both for construction and long term drainage, carefully controlled pumping tests are necessary to adequately engineer a construction dewatering system and/or permanent groundwater control. SPL Consultants Limited advises that the geotechnical conditions at this site require such analysis. The company is qualified and prepared to undertake this analysis upon proper authorization.

It should be noted that a permit to take water, issued by the Ontario Ministry of the Environment, will be required if the dewatering system/sumps result in a water taking of more than 50,000 L/day.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the fill and compact/stiff native soils above the groundwater table can be classified as Type 3 soil. Soils below the water table can be classified as Type 4. The dense to very dense silt, sand and gravel/gravelly sand above the water table can be classified as Type 1 to 2.

If vertical excavation is to be carried out for the installation of the pipes, braced sheeting (closed or skeleton) should be provided for temporary shoring, as a minimum, unless other forms of shoring is required for stability. Excavations where the water bearing sands, silts and sand & gravel are encountered will be wet and slough, therefore, flatter side slopes and localized dewatering through the use of trench boxes and other such techniques should be considered.

All excavated spoil should be placed at least the depth of the trench away from the edge of the trench for safety reasons.

It is recommended that the excavations for service trenches below the groundwater table be carried out in short sections using a suitable ‘geofabric’ below the bedding (fine migration prevention) and backfilling the trench section immediately after service placement. Further detailed investigation is required to determine if positive de-watering will be required for deep excavations in areas with high groundwater levels.

4.2.2 Bedding

The overburden soils above the groundwater level, or properly dewatered if encountered below the groundwater level, will provide adequate support for the sewer pipes and allow the use of normal Class B type bedding. The recommended minimum thickness of granular bedding below the invert of the pipes is 200 mm. The thickness of the bedding may, however, have to be increased depending on the
Pipe diameter or in accordance with local standards or if wet or weak subgrade conditions are encountered. The bedding material should consist of well graded granular material such as Granular ‘A’ or equivalent. After installing the pipe on the bedding, a granular surround of approved bedding material, which extends at least 300 mm above the obvert of the pipe, or as set out by the local Authority, should be placed.

To avoid the loss of soil fines from the subgrade, uniformly graded clear stone should not be used unless, below the granular bedding material, a suitable, approved filter fabric (geotextile) is placed. The geotextile should extend along the sides of the trench and should be wrapped all around the poorly graded bedding material.

Localized, wet and unstable soils encountered within generally stable soil zones can be stabilized by ‘punching’ a 50 mm clear crushed limestone or 50 mm well graded crusher run limestone pad into the soft subgrade prior to bedding placement. The thickness of the ‘pad’ will depend on field conditions.

In areas where the soils become wet, unstable and dilatent (easily disturbed) such as saturated silts, sandy silt to silty sand and water bearing granular soils, careful construction techniques and dewatering should be followed, as discussed earlier. If the pipes are laid on disturbed, dilatent soil, significant post-construction settlements could occur after the trenches are backfilled. In such cases, the bottom of the trenches will have to be stabilized by dewatering.

Where the sewer pipe is placed in water bearing soils below the water table, the joints connecting the sewer sections should be very well sealed to prevent piping of fines into the sewer pipe and manhole catch basin risers.

### 4.2.3 Backfilling of Trenches

Based on visual and tactile examination, the onsite excavated inorganic silt/sand/sand and gravel deposits are considered to be suitable for re-use as backfill in the service trenches provided that they are aerated and their moisture contents at the time of construction are at or near optimum. The silts are poorly graded soils and are very sensitive to their moisture contents. As such, they will be very difficult to handle and to compact, especially when excavated below the water table. Under unfavourable conditions, they may not be suitable for trench backfill. The extent of silt is limited, as majority of the excavated soils are sand to sand and gravel.

It is preferable that the native soils be re-used from approximately the position at which they are excavated so that frost response characteristics of the soils after construction remain essentially similar to presently existing.

The backfill should be placed in maximum 200 mm thick layers at or near (±2%) their optimum moisture content and each layer should be compacted to at least 95% SPMDD. Unsuitable materials such as organic soils, boulders, cobbles, frozen soils, etc. should not be used for backfilling. Compaction to the specified densities can be achieved by using a vibratory ‘sheepsfoot’ roller. Vibration from the
‘sheepsfoot’ roller should be used sparingly (under the supervision of qualified geotechnical engineer or their representative) due to the sensitive nature of the sand and silt soils found on site (to prevent ‘pumping-up’ action). Static rollers may be required for compaction purposes.

Consideration may also be given to backfilling trenches with a well graded, compacted granular soil such as Granular ‘B’ material. The use of such material, if thoroughly compacted, would reduce the post construction settlements to a negligible amount and may also expedite the compaction process. In this instance, however, frost response characteristics of non-frost susceptible granular fill and the frost susceptible indigenous soils would be different giving rise to differential frost. In this case, it would be prudent to use as backfill the onsite excavated, naturally occurring soils to match the existing conditions within the frost zone (i.e. within about 1.5 m below the finished grade elevation) as well as to provide a frost taper zone (i.e. to provide a zone of taper to prevent a sudden change in frost heave characteristics to reduce the effects of frost heave).

The onsite excavated soils and especially the clayey soils should not be used in confined areas (e.g. around catch basins and laterals under roadways) where heavy compaction equipment cannot be operated. The use of imported granular fill together with an appropriate frost taper would be preferable in confined areas and around structures, such as catch basins.

In any case the degree of compaction of the trench backfill should be at least 95% of the material’s Standard Proctor Maximum Dry Density (SPMDD). This value should be increased to at least 98% within 1.5 m of the finished grade.

4.3 Engineered Fill

In the areas where earth fill is required for site grading purposes, an engineered fill may be constructed below house foundations, roads, boulevards, etc. General guidelines for the placement and preparation of engineered fill are presented on Appendix B.

A geotechnical reaction of 150 kPa at the serviceability limit states (SLS), and a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS) can be used on engineered fill, provided that all requirements on Appendix B are adhered to. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential. Despite full time supervision, it has been found that contractors frequently bulldoze loose fill into areas and compact only the surface. The inspector, either busy on other portions of the site or absent during “off hours” will be unaware of this condition. For this reason, we cannot guarantee the performance of the engineered fill, and this guarantee must be the responsibility of the contractor. The owner and his representatives must accept the risk involved in the use of engineered fill and offset this risk with the monetary savings of avoiding deep foundations. This potential problem must be recognized and discussed at a pre-construction meeting. Procedures can then be instigated to reduce the risk of settlement resulting from uncompacted fill.
The following is a recommended procedure for an engineered fill:

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and SPL Consultants Limited. Without this confirmation no responsibility for the performance of the structure can be accepted by SPL Consultants Limited. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all topsoil, loose fill (if any) and any organic or otherwise unsuitable soils. Subgrade must be proofrolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a SPL Consultants Limited engineer prior to placement of fill.

5. The approved engineered fill must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Granular Fill preferred. Engineered fill should not be placed (where it will support footings) during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur.

6. Full-time geotechnical inspection by SPL Consultants Limited during placement of engineered fill is required. Work cannot commence or continue without the presence of the SPL representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. A geotechnical reaction of 150 kPa at the serviceability limit states (SLS), and a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS) may be used provided that
all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings should be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

10. After completion of the pad a second contractor may be selected to install footings. All excavations must be backfilled under full time supervision by SPL Consultants to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of SPL Consultants.

11. After completion of compaction, the surface of the pad must be protected from disturbance from traffic, rain and frost.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

The inorganic silts, sands, and sand and gravel are considered suitable for use as engineered fill, provided that their moisture contents at the time of construction are at or near optimum. Soils excavated from below the groundwater level will have higher than optimum in-situ moisture content, and will have to be aerated prior to use as engineered fill. It is therefore imperative that the earth works are carried out in summer months, at favorable conditions, so there is an opportunity to aerate the soils prior to their re-use.

4.4 Foundation Conditions

The boreholes show that provided the foundation soil is undisturbed during the construction, a geotechnical reaction of 150 kPa at the serviceability limit states (SLS), and a factored geotechnical resistance of 225 kPa at the ultimate limit states (ULS) is feasible in the undisturbed inorganic natural (native) soils. This value would be suitable for the use of normal spread footing foundations to support normal single family dwellings.

Where the grade needs to be raised, the proposed structures can be supported by spread and strip footings founded on engineered fill for a geotechnical reaction of 150 kPa at SLS, and a factored geotechnical resistance of 225 kPa at ULS. For footings founded on engineered fill, a minimum footing width of 500 mm is suggested and footings must be provided with nominal steel reinforcement. The engineered fill supporting footings should be constructed in accordance with the guidelines presented in Appendix B. Other requirements of engineered fill are given in Section 4.3.

Variations in the soil conditions are expected in between the borehole locations, and during construction, the soil bearing pressures should be confirmed by the Geotechnical Engineer.
All footings exposed to seasonal freezing and thawing must be provided with a minimum earth cover of 1.2 meters or equivalent insulation to satisfy frost protection requirements.

Settlements induced by the recommended bearing pressures will be less than 25 mm total and 19 mm differential and within the tolerable limits of construction.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical lines drawn up from the base of the lower footing.

It is suggested that finalized basement floor elevations should be set above the local water table. Underfloor drains and upgraded level of water-proofing would be necessary in areas of the site if basements are proposed to be located below the local groundwater table and potentially water bearing soils. Under-floor-slab drainage may be required for basements under such conditions and these conditions should be identified in the field by SPL. The drainage tiles consisting of 100 mm diameter perforated pipes with filter fabric, should discharge into a positive frost-free outlet, as shown on Drainage and Backfill Recommendations, Drawing No. 25. Exterior basement walls should be damp-proofed above the water table and water-proofed below the water table. The backfill against the footing and foundation walls should consist of free-draining, non-frost-susceptible granular or equivalent. The on-site materials such as sandy silt have adfreezing potential; if these soils are used to backfill against the perimeter foundation walls, a polyethylene slip-membrane should be placed below ground surface on the perimeter foundation walls. Vertical drains should be installed at the window wells and connected to the perimeter tiles to reduce basement dampness. SPL recommends that ‘dimple board’ be used on all below ground surfaces.

4.5. Storm Water Management Ponds

We understand that storm water management ponds will be constructed in the general areas of BH14-16 and BH14-20. Based on the results of the boreholes, the soils consisted of sand and gravel underlain by silty sand in BH14-20. These soils are considered permeable. The depth of the ponds is not known, however, these materials are anticipated for the base and slopes of the ponds. The ground water levels in the monitoring wells installed on site varied between elevations 246.4 to 248.2 m. The base of the pond should be at least 1 m above the ground water level.

The storm water pond will require the installation of an impermeable liner (clayey silt to silty clay material with permeability in the order of $10^{-5}$ to $10^{-7}$ cm/s) with 3H:1V side slopes above the water table and 5H:1V side slopes below the water table in the pond compacted to at least 98 percent SPMDD. The thickness of the impermeable liner should be at least 600 mm and should be kept moist at all times. If the liner is left to dry out shrinkage will occur and the liner will crack thus inducing excessive seepage. The on-site materials are not considered suitable for use as an impermeable liner. The liner must be covered with a minimum of 300 mm of sand and gravel or other suitable material. The design must be reviewed by SPL.
4.6 Subsurface Concrete and Corrosivity

Three soil samples (BH14-06/SS3, BH14-14/SS5, and BH14-23/SS6) were tested for pH and water soluble sulphate content in order to evaluate the subsoil conditions for possible sulphate attack on concrete. The test results are presented attached in Appendix C and are also shown on the following Table 4.6.1:

<table>
<thead>
<tr>
<th>Borehole No.</th>
<th>Depth (m)</th>
<th>pH</th>
<th>Water Soluble Sulphate Content (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BH14-06</td>
<td>1.5-2.0</td>
<td>8.58</td>
<td>3</td>
</tr>
<tr>
<td>BH14-14</td>
<td>3.0-3.5</td>
<td>8.85</td>
<td>8</td>
</tr>
<tr>
<td>BH14-23</td>
<td>4.5-5.0</td>
<td>9.03</td>
<td>6</td>
</tr>
</tbody>
</table>

According to Table 3 of CSA Standard, CAN/CSA-A23.1-09 the degree of exposure to sulphate attack is negligible and therefore normal Portland cement can be used in the subsurface concrete.

Table 4.6.2 shows the numerical soil corrosion potential rating system developed by the AWWA/ANSI to make a preliminary assessment of the influence of certain soil properties on the potential for promoting corrosion in cast iron alloys. AWWA/ANSI suggests that soils with ratings of 10 or more are supportive of corrosion of iron alloys and require corrosion protection measures (such as cathodic protection).

Based solely on the AWWA/ANSI rating system, the soils tested in BH14-06, BH14-14, and BH14-23 are not supportive of corrosion.

More recent studies on the properties of local soils and their relationship with watermain corrosion, conducted by the University of Toronto\(^1\), have showed that the foregoing AWWA/ANSI rating system is not a reliable predictor of a soil's potential to support corrosion. The UofT work showed that, of the test parameters included in the AWWA/ANSI rating system, soil resistivity had the best correlation with external watermain pitting depth. UofT concluded that all soils with resistivity less than 2000 ohm-cm could be supportive of corrosion to ferrous metals. Based on that generalization, the soils tested in BH14-06, BH14-14, and BH14-23 are not considered to be corrosive.

Clayey soils are considered most likely to be supporting an environment for sulphate reducing bacteria and are also a corrosion risk from this perspective. The slightly alkaline pH of soils found in Southern Ontario, particularly glacial tills formed from carbonate parent rock; tend to support the development of sulphate reducing bacteria.

Other factors may come into play which may have an over-riding influence on corrosion of buried ferrous metals which are not considered in the rather simplistic AWWA/ANSI rating, such as stray currents, contact with sewage, and elevated chloride ion and electrical conductivity.

Table 4.6.2: Summary of Soil Parameters and ANSI/AWWA* Corrosion Potential Scores

<table>
<thead>
<tr>
<th>Parameter</th>
<th>AWWA/ANSI Scoring</th>
<th>BH14-06/SS3 Silty sand</th>
<th>BH14-14/SS5 Sand</th>
<th>BH14-23/SS6 Gravelly sand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistivity (ohm-cm)</td>
<td></td>
<td>BH14</td>
<td>BH14</td>
<td>BH14</td>
</tr>
<tr>
<td>&lt;700</td>
<td>10 points</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>700-1000</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1000-1200</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1200-1500</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500-2000</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;2000</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>BH14</td>
<td>BH14</td>
<td>BH14</td>
</tr>
<tr>
<td>0 to 2</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 to 4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 to 6.5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7.5 to 8.5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;8.5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redox Potential (mV)</td>
<td></td>
<td>BH14</td>
<td>BH14</td>
<td>BH14</td>
</tr>
<tr>
<td>&gt;100</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>50-100</td>
<td>3.5</td>
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<tr>
<td>0-50</td>
<td>4</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Neg</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphides %</td>
<td></td>
<td>BH14</td>
<td>BH14</td>
<td>BH14</td>
</tr>
<tr>
<td>Positive</td>
<td>3.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trace</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td></td>
<td>BH14</td>
<td>BH14</td>
<td>BH14</td>
</tr>
<tr>
<td>Poor drainage, wet</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair drainage, moist</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good drainage, dry</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>BH14</td>
<td>BH14</td>
<td>BH14</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* ANSI/AWWA C105/A21.5-10

5. GENERAL COMMENTS

SPL Consultants Limited should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, SPL Consultants Limited will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes and test pits required to determine the localized underground conditions between boreholes and test pits affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information in this report in no way reflects on the environmental aspects of the soil and has not been addressed in this report, since this aspect is beyond the scope and terms of reference. Should specific information be required, additional testing may be required.
6. LIMITATIONS OF REPORT

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to SPL Consultants Limited at the time of preparation. Unless otherwise agreed in writing by SPL Consultants Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

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 environment 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. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

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.

The comments made in this report on potential construction problems and possible methods 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. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. 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.

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. SPL Consultants Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.
We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

SPL CONSULTANTS LIMITED

Eva Papp, P.Eng.

Shabbir Bandukwala, P.Eng.
DRAWINGS

• BOREHOLE LOCATION PLAN (DRG. 1)
• LOG OF BOREHOLES (DRGS. 2 TO 24)
• DRAINAGE AND BACKFILL RECOMMENDATIONS (DRG. 25)
**Explanation of Terms Used in the Record of Borehole**

### Sample Type
- **AS**: Auger sample
- **BS**: Block sample
- **CS**: Chunk sample
- **DO**: Drive open
- **DS**: Dimension type sample
- **FS**: Foil sample
- **RC**: Rock core
- **SC**: Soil core
- **SS**: Spoon sample
- **ST**: Slotted tube
- **TO**: Thin-walled, open
- **TP**: Thin-walled, piston
- **WS**: Wash sample

### Penetration Resistance

**Standard Penetration Resistance (SPT), N:**
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

**WH** – Samples sinks under “weight of hammer”

**Dynamic Cone Penetration Resistance, N_d:**
The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter, 60° cone attached to “A” size drill rods for a distance of 300 mm (12 in).

### Textural Classification of Soils

**Classification**
- Boulders: > 200 mm
- Cobbles: 75 mm - 200 mm
- Gravel: 4.75 mm - 75 mm
- Sand: 0.075 mm – 4.75 mm
- Silt: 0.002 mm-0.075 mm
- Clay: <0.002 mm

**Coarse Grain Soil Description (50% greater than 0.075 mm)**

<table>
<thead>
<tr>
<th>Terminology</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>0-10%</td>
</tr>
<tr>
<td>Some</td>
<td>10-20%</td>
</tr>
<tr>
<td>Adjective (e.g. silty or sandy)</td>
<td>20-35%</td>
</tr>
<tr>
<td>And (e.g. sand and gravel)</td>
<td>&gt; 35%</td>
</tr>
</tbody>
</table>

### Soil Description

#### a) Cohesive Soils (*)

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Undrained Shear Strength (kPa)</th>
<th>SPT &quot;N&quot; Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very soft</td>
<td>&lt;12</td>
<td>0-2</td>
</tr>
<tr>
<td>Soft</td>
<td>12-25</td>
<td>2-4</td>
</tr>
<tr>
<td>Firm</td>
<td>25-50</td>
<td>4-8</td>
</tr>
<tr>
<td>Stiff</td>
<td>50-100</td>
<td>8-15</td>
</tr>
<tr>
<td>Very stiff</td>
<td>100-200</td>
<td>15-30</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt;200</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>

(*) Hierarchy of Shear Strength prediction
1. Lab triaxial test
2. Field vane shear test
3. Lab. Vane shear test
4. SPT "N" value
5. Pocket penetrometer

#### b) Cohesionless Soils

<table>
<thead>
<tr>
<th>Density Index (Relative Density)</th>
<th>SPT &quot;N&quot; Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very loose</td>
<td>&lt;4</td>
</tr>
<tr>
<td>Loose</td>
<td>4-10</td>
</tr>
<tr>
<td>Compact</td>
<td>10-30</td>
</tr>
<tr>
<td>Dense</td>
<td>30-50</td>
</tr>
<tr>
<td>Very dense</td>
<td>&gt;50</td>
</tr>
</tbody>
</table>

### Soil Tests

- **w**: Water content
- **w_l**: Plastic limit
- **w_i**: Liquid limit
- **C**: Consolidation (oedometer) test
- **CID**: Consolidated isotropically drained triaxial test
- **CIU**: Consolidated isotropically undrained triaxial test with porewater pressure measurement
- **D_r**: Relative density (specific gravity, Gs)
- **DS**: Direct shear test
- **ENV**: Environmental/ chemical analysis
- **M**: Sieve analysis for particle size
- **MH**: Combined sieve and hydrometer (H) analysis
- **MPC**: Modified proctor compaction test
- **SPC**: Standard proctor compaction test
- **OC**: Organic content test
- **U**: Unconsolidated Undrained Triaxial Test
- **V**: Field vane (LV-laboratory vane test)
- **γ**: Unit weight
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>ELEV DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>275.5</td>
<td>TOPSOIL: 300mm</td>
<td>1 SS 4</td>
</tr>
<tr>
<td>0.3</td>
<td>CLAYEY SILT: reworked, trace to some sand and gravel, trace organics, rootlets, dark brown, very moist, firm to hard</td>
<td>2 SS 36</td>
</tr>
<tr>
<td>274.1</td>
<td>GRAVELLY SAND: silty, grey, moist, compact</td>
<td>3 SS 20</td>
</tr>
<tr>
<td></td>
<td>very dense</td>
<td>4 SS 50/75mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 SS 50/150mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 SS 50/150mm</td>
</tr>
<tr>
<td>269.1</td>
<td>End of Borehole: No Detectable Gas: Notes: 1. Borehole dry on completion.</td>
<td>7 SS 50/150mm</td>
</tr>
</tbody>
</table>

**DRILLING DATA**

- **PROJECT:** Geotechnical Investigation - Empire St. George Lands
- **CLIENT:** Empire Communities (St. George) Ltd.
- **PROJECT LOCATION:** St. George, Ontario
- **DATUM:** Geodetic
- **BH LOCATION:** N 4789033.778 E 559397.8443
- **Diameter:** 100
- **Date:** Nov/14/2014
- **REF. NO.:** 10000499
- **ENCL NO.:** 2

**GROUNDWATER CONDITIONS**

- **DESCRIPTION**
  - "N" BLOWS
  - 0.3 m

**GROUNDWATER ELEVATIONS**

- **SHALLOW/SINGLE INSTALLATION**
- **DEEP/DUAL INSTALLATION**

**REMARKS AND GRAIN SIZE DISTRIBUTION (%)**

<table>
<thead>
<tr>
<th>SAMPLES</th>
<th>TYPE</th>
<th>GRAIN SIZE DISTRIBUTION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 SS 4</td>
<td>CL</td>
<td>Quick Triaxial</td>
</tr>
<tr>
<td>2 SS 36</td>
<td>SI</td>
<td>Field Vane &amp; Density</td>
</tr>
<tr>
<td>3 SS 20</td>
<td>SI</td>
<td>Lab Vane</td>
</tr>
<tr>
<td>4 SS 50/75mm</td>
<td>SI</td>
<td>Unconfined</td>
</tr>
<tr>
<td>5 SS 50/150mm</td>
<td>SI</td>
<td>Field Vane &amp; Density</td>
</tr>
<tr>
<td>6 SS 50/150mm</td>
<td>SI</td>
<td>Lab Vane</td>
</tr>
<tr>
<td>7 SS 50/150mm</td>
<td>SI</td>
<td>Unconfined</td>
</tr>
</tbody>
</table>

**GROUND GENERALITIES**

- **GROUND WATER CONDITIONS**
  - "N" BLOWS
  - 0.3 m

**EXAMPLE:**

1. **SAMPLES:**
   - 1 SS 4
   - 2 SS 36
   - 3 SS 20
   - 4 SS 50/75mm
   - 5 SS 50/150mm
   - 6 SS 50/150mm
   - 7 SS 50/150mm

2. **DESCRIPTION:**
   - TOPSOIL: 300mm
   - CLAYEY SILT: reworked, trace to some sand and gravel, trace organics, rootlets, dark brown, very moist, firm to hard
   - GRAVELLY SAND: silty, grey, moist, compact
   - very dense

3. **REMARKS:**
   - occasional auger gridding

4. **NOTES:**
   - 1. Borehole dry on completion.
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>270.9</td>
<td>TOPSOIL: 250mm</td>
<td></td>
</tr>
<tr>
<td>270.7</td>
<td>CLAYEY SILT: reworked, brown, very moist, firm</td>
<td>1 SS 6</td>
</tr>
<tr>
<td>269.4</td>
<td>SILTY SAND: trace to some gravel, brown, moist, compact</td>
<td>3 SS 17</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 SS 22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 SS 31</td>
</tr>
<tr>
<td></td>
<td>dense</td>
<td></td>
</tr>
<tr>
<td></td>
<td>very dense</td>
<td></td>
</tr>
<tr>
<td>264.7</td>
<td></td>
<td>7 SS 50</td>
</tr>
</tbody>
</table>

### End of Borehole:
No Detectable Gas:
Notes:
1. Borehole dry on completion.
### Soil Profile

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
<th>SOIL TYPE</th>
<th>GROUND WATER CONDITIONS</th>
<th>DYNAMIC CONE PENETRATION RESISTANCE PLOT</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>W</th>
<th>W</th>
<th>N</th>
<th>LIQUID LIMIT</th>
<th>NATURAL UNIT WT</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>REMARKS AND GRAIN SIZE DISTRIBUTION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>270.1</td>
<td>TOPSOIL: 250mm</td>
<td>1</td>
<td>SS</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>269.9</td>
<td>CLAYEY SILT: reworked, brown, very moist, firm to hard</td>
<td>2</td>
<td>SS</td>
<td>57</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>268.6</td>
<td>SILTY SAND: trace gravel, trace clay, brown, moist, compact</td>
<td>3</td>
<td>SS</td>
<td>16</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>267</td>
<td>very dense</td>
<td>4</td>
<td>GRAB</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>266</td>
<td>some gravel</td>
<td>5</td>
<td>SS</td>
<td>53</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>265</td>
<td></td>
<td>6</td>
<td>SS</td>
<td>50/25mm</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>264</td>
<td></td>
<td>7</td>
<td>SS</td>
<td>50</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>263.9</td>
<td>End of Borehole: No Detectable Gas: Notes: 1. Borehole dry on completion.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Groundwater Elevations

- Shallow/Single Installation
- Deep/Dual Installation

### Graph Notes

- Numbers refer to Sensitivity
- Strain at Failure

### Field Vane & Sensitivity

- Groundwater Elevations
- Shallow/Single Installation
- Deep/Dual Installation

### Dynamic Cone Penetration Resistance Plot

- Unconfined
- Quick Triaxial
- Field Vane
- Lab Vane

### Drilling Data

- Method: Hollow Stem Auger
- Diameter: 150
- Date: Nov/14/2014
- REF. NO.: 10000499
- ENCL. NO.: 4

### Project Information

- Project: Geotechnical Investigation - Empire St. George Lands
- Client: Empire Communities (St. George) Ltd.
- Project Location: St. George, Ontario
- Datum: Geodetic
- BH Location: N 4789146.9091 E 559768.8339
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>270.0</td>
<td>TOPSOIL: 300mm</td>
<td></td>
</tr>
<tr>
<td>270.1</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td>1 SS 3</td>
</tr>
<tr>
<td>0.8</td>
<td>SILTY SAND: trace to some gravel, brown, very moist, firm</td>
<td>2 SS 26</td>
</tr>
<tr>
<td></td>
<td>very dense</td>
<td>3 SS 36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 SS 61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 SS 41</td>
</tr>
<tr>
<td></td>
<td>gravelly</td>
<td>6 SS 26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 SS 76</td>
</tr>
</tbody>
</table>

### End of Borehole:
No Detectable Gas:
Notes:
1. Borehole dry on completion.

### Remarks and Grain Size Distribution (%)

- occasional auger grinding

### Graph Notes
+ 3: Numbers refer to Sensitivity
× 3: Strain at Failure
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>263.4</td>
<td>TOPSOIL: 250mm</td>
<td>SS 4</td>
</tr>
<tr>
<td>263.2</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td>SS 15</td>
</tr>
<tr>
<td>261.9</td>
<td>SILTY SAND: trace to some gravel, trace clay, brown, very moist, compact</td>
<td>SS 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 50/75mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 50/25mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS 50/00mm</td>
</tr>
<tr>
<td>257.0</td>
<td>End of Borehole: No Detectable Gas: Notes: 1. Borehole dry on completion.</td>
<td>SS 50/25mm</td>
</tr>
</tbody>
</table>

**DRILLING DATA**

- Method: Hollows Stem Auger
- Diameter: 150
- REF. NO.: 10000499
- ENCL NO.: 6

**GROUNDWATER CONDITIONS**

- "N" BLOWS
- DESCRIPTION
- UNCONFINED
- FIELD VANE & DENSITY
- QUICK TRIAXIAL
- LAB VANE

**DYNAMIC PENETRATION RESISTANCE PLOT**

<table>
<thead>
<tr>
<th>SHEAR STRENGTH (kPa)</th>
<th>20</th>
<th>40</th>
<th>60</th>
<th>80</th>
<th>100</th>
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</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

**PHYSICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Sample</th>
<th>TYPE</th>
<th>3</th>
<th>CL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SS</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

**GRAIN SIZE DISTRIBUTION (%)**

- 20
- 40
- 60
- 80
- 100

**GROUND WATER ((Mg/m^3))**

- UNCONFINED
- LAB VANE

**SAND GRAIN SIZE DISTRIBUTION (%)**

<table>
<thead>
<tr>
<th>SAND GRAIN SIZE DISTRIBUTION (%)</th>
<th>Quick Triaxial</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quick Triaxial</td>
</tr>
</tbody>
</table>

**LAB VANE**

- WATER CONTENT (%)
- ELEVATION

**FIELD VANE**

- GROUND WATER ELEVATION

**SHALLOW/SINGLE INSTALLATION**

- DEEP/DUAL INSTALLATION

**END OF BOREHOLE BH14-05**

- REF. NO.: 10000499
- ENCL NO.: 6
- Numbers refer to Sensitivity
- Strain at Failure

**GEOLOGIC LOGS**

- SPL SOIL LOG BOREHOLE GINT LOGS.GPJ SPL GDT 12/18/14

**GROUNDWATER ELEVATIONS**

- Shallow/Single Installation
- Deep/Dual Installation
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>ELEV</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
<th>STRATA PLOT</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>WATER CONTENT (%)</th>
<th>NATURAL UNIT WT</th>
<th>STRATA PLOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>259.2</td>
<td><strong>TOPSOIL</strong>: 250mm</td>
<td>1 SS 3</td>
<td>259</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>258.1</td>
<td><strong>CLAYEY SILT</strong>: reworked, rootlets, brown, very moist, firm to stiff</td>
<td>2 SS 15</td>
<td>258</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><strong>SILTY SAND to SANDY SILT</strong>: trace clay, trace gravel, brown, very moist, compact</td>
<td>3 SS 21</td>
<td>257</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><em><strong>wet, dilatant</strong></em></td>
<td>4 SS 20</td>
<td>257</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>256.2</td>
<td><strong>SILTY SAND</strong>: trace gravel, brown, very moist, very dense</td>
<td>5 SS 50/50mm</td>
<td>256</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><em><strong>grey</strong></em></td>
<td>6 SS 50/50mm</td>
<td>256</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><em><strong>dense</strong></em></td>
<td>7 SS 40</td>
<td>253</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**END OF BOREHOLE:**

No Detectable Gas:

Notes:
1. Borehole dry on completion.
2. 50 mm dia. monitoring well was installed upon completion, screened from 1.5 to 4.5m.
3. Water Level Measurements in Monitoring Well

Date: Dec. 16, 2014

Dry

**GROUNDWATER ELEVATIONS**

- **Shallow Single Installation**
- **Deep/Dual Installation**

**GRAPH NOTES**

- 3, 3: Numbers refer to Sensitivity
- 3%: Strain at Failure
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>264.2</td>
<td>TOPSOIL: 100mm</td>
<td>1 SS 22</td>
</tr>
<tr>
<td></td>
<td>fill: gravel, boulders, brown/grey, moist</td>
<td></td>
</tr>
<tr>
<td>262.7</td>
<td>GRAVELLY SAND: brown, moist to very moist, dense</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 SS 44</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 SS 48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 SS 60</td>
<td></td>
</tr>
<tr>
<td>259.7</td>
<td>SILTY SAND: trace gravel, brown, moist, dense</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 SS 48</td>
<td></td>
</tr>
<tr>
<td>258.2</td>
<td>GRAVELLY SAND: brown, moist, very dense</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 SS 50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8 SS 50</td>
<td></td>
</tr>
<tr>
<td>256.1</td>
<td>End of Borehole: No Detectable Gas:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Notes: 1. Borehole dry on completion.</td>
<td></td>
</tr>
</tbody>
</table>

### GROUNDWATER CONDITIONS

- *UNCONFINED* (field vane & density)
- *QUICK TRIAXIAL* (lab vane)

### GROUNDWATER ELEVATION

- **Shallow/Single Installation**
- **Deep/Dual Installation**

### DRILLING DATA

- Method: Solid Stem Auger
- Diameter: 100
- Date: Nov/25/2014
- REF. NO.: 10000499
- ENCL NO.: 8
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV (m)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>263.9</td>
<td>TOPSOIL: 200mm</td>
</tr>
<tr>
<td>262.5</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
</tr>
<tr>
<td>0.8</td>
<td>SILTY SAND: trace gravel, dark brown, very moist, compact</td>
</tr>
<tr>
<td></td>
<td>dense</td>
</tr>
<tr>
<td></td>
<td>very dense</td>
</tr>
<tr>
<td>6.6</td>
<td>End of Borehole: No Detectable Gas:</td>
</tr>
</tbody>
</table>

**Notes:**
1. Borehole dry on completion.

### SAMPLES

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>TYPE</th>
<th>GRAIN SIZE DISTRIBUTION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>263</td>
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<tr>
<td>262</td>
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<td>258</td>
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<tr>
<td>257</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### DRILLING DATA

- **PROJECT:** Geotechnical Investigation - Empire St. George Lands
- **CLIENT:** Empire Communities (St. George) Ltd.
- **PROJECT LOCATION:** St. George, Ontario
- **DATUM:** Geodetic
- **BH LOCATION:** N 4788773.5213 E 559441.4923
- **Method:** Solid Stem Auger
- **Diameter:** 100
- **Date:** Nov/17/2014
- **REF. NO.:** 10000499
- **ENCL NO.:** 9

### GROUNDWATER ELEVATIONS

- **Shallow Single Installation**
- **Deep/Dual Installation**

### GRAPH NOTES

- Numbers refer to Sensitivity
- Strain at Failure
### Project Details

**Project:** Geotechnical Investigation - Empire St. George Lands  
**Client:** Empire Communities (St. George) Ltd.  
**Project Location:** St. George, Ontario  
**Datum:** Geodetic  
**Location:** N 4788849.1172 E 559761.7031

### Drilling Data

- **Method:** Solid Stem Auger  
- **Diameter:** 100  
- **Ref. No.:** 10000499  
- **Encl. No.:** 10  
- **Date:** Nov/14/2014

### Soil Profile

<table>
<thead>
<tr>
<th>Elevation (m)</th>
<th>Description</th>
<th>Type</th>
<th>Depth</th>
<th>Lab Vane Water Content (%)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>Topsoil: 300mm</td>
<td>SS</td>
<td>3</td>
<td>259</td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>Silt: brown, wet, loose to compact</td>
<td>SS</td>
<td>1</td>
<td>257</td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Sandy silt: trace gravel, brown, very moist, compact</td>
<td>SS</td>
<td>3</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Silty sand: trace clay, brown, very moist, compact</td>
<td>SS</td>
<td>4</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Trace gravel, very dense</td>
<td>SS</td>
<td>5</td>
<td>254</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brownish grey</td>
<td>SS</td>
<td>6</td>
<td>253</td>
<td></td>
</tr>
</tbody>
</table>
| 6.2           | End of Borehole:  
No Detectable Gas:  
Notes:  
1. Borehole dry on completion. | SS   | 7     | 252 | 25 |   |

### Remarks and Grain Size Distribution

- **Percentage Distribution:** 20, 40, 60, 80, 100
- **Quick Triaxial Shear Strength (kPa):**
- **Unconfined:**
- **Quick Triaxial:**
- **Lab Vane:**

### Graph Notes

- Shallow Single Installation: \(\bigwedge\)
- Deep/Dual Installation: \(\bigwedge\)  
- Numbers refer to Sensitivity  
- \(\bigcirc\): Strain at Failure
**SOIL PROFILE**

<table>
<thead>
<tr>
<th>ELEV</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>254.8</td>
<td>TOPSOIL: 300mm</td>
<td>1 SS 5</td>
</tr>
<tr>
<td>254.5</td>
<td>CLAYEY SILT: rootlets, brown, moist, firm</td>
<td>2 SS 50/50mm</td>
</tr>
<tr>
<td>254.0</td>
<td>GRAVELLY SAND: some silt, grey, moist, very dense</td>
<td>3 SS 50/25mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 SS 50/25mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 SS 66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 SS 66</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 SS 50/20mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8 SS 50/25mm</td>
</tr>
<tr>
<td>247.0</td>
<td>End of Borehole:</td>
<td>7 SS 25mm</td>
</tr>
</tbody>
</table>

**End of Borehole:**
- No Detectable Gas:

**Notes:**
- Borehole dry on completion.

**GROUNDWATER ELEVATIONS**

- Shallow Single Installation
- Deep/Dual Installation

**GRAPH NOTES**

- Numbers refer to Sensitivity
- 6 = 3% Strain at Failure
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>TYPE</th>
<th>SAMPLE NUMBER</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>TOPSOIL: 300mm</td>
<td>SS</td>
<td>1</td>
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<tr>
<td>0.3</td>
<td>CLAYEY Silt: reworked, rootlets, brown, very moist, firm</td>
<td>SS</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>GRAVELLY SAND: trace to some silt, brown, moist, compact</td>
<td>SS</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SS</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>6.6</td>
<td>End of Borehole: No Detectable Gas:</td>
<td>SS</td>
<td>7</td>
<td>occasional auger grinding</td>
</tr>
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</table>

### DRILLING DATA

- **Method:** Solid Stem Auger
- **Diameter:** 100
- **Date:** Nov/17/2014
- **REF. NO.:** 10000499
- **ENCL NO.:** 12

### DYNAMIC CONE PENETRATION RESISTANCE

<table>
<thead>
<tr>
<th>ELEVATION (m)</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>GROUND WATER CONDITIONS</th>
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<tbody>
<tr>
<td>257</td>
<td>20 40 60 80 100</td>
<td>Field Vane &amp; Sensitivity</td>
</tr>
</tbody>
</table>

### GROUNDWATER ELEVATIONS

- **Shallow/Single Installation**
- **Deep/Dual Installation**

### STRATA PLOT

- **LAB VANE**
- **GROUND WATER CONDITIONS**

### NOTES

1. Borehole dry on completion.
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>STRATA PLOT TYPE</th>
<th>SAMPLE NUMBER</th>
<th>LAB VANE WATER CONTENT (%)</th>
<th>SHEAR STRENGTH (kPa)</th>
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<tr>
<td>254.0</td>
<td>TOPSOIL: 200mm</td>
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<td>254</td>
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<tr>
<td>253.9</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td>SS</td>
<td>2</td>
<td></td>
<td>254</td>
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<tr>
<td>253.1</td>
<td>GRAVELLY SAND: trace to some silt, brown, moist, compact</td>
<td>SS</td>
<td>3</td>
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<td></td>
<td>dense</td>
<td>SS</td>
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<td>254</td>
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<tr>
<td></td>
<td>very dense</td>
<td>SS</td>
<td>5</td>
<td></td>
<td>252</td>
</tr>
<tr>
<td></td>
<td>grey</td>
<td>SS</td>
<td>6</td>
<td></td>
<td>250</td>
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<tr>
<td>248.3</td>
<td>compact</td>
<td>SS</td>
<td>7</td>
<td></td>
<td>240</td>
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### Remarks

- **End of Borehole:**
  - **No Detectable Gas:**
  - **Notes:**
    - Borehole dry on completion.
### Soil Profile

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>GRADE</th>
<th>SOIL LOG</th>
<th>WATER CONTENT (%)</th>
<th>LIQUID LIMIT</th>
<th>PLASTIC LIMIT</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>259.7</td>
<td>TOPSOIL: 250mm</td>
<td>1</td>
<td>SS</td>
<td>8</td>
<td></td>
<td>10 20 30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>259.4</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td>2</td>
<td>SS</td>
<td>62</td>
<td></td>
<td>10 20 30</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>259.9</td>
<td>SAND AND GRAVEL: grey/brown, moist, very dense</td>
<td>3</td>
<td>SS</td>
<td>25/25mm</td>
<td></td>
<td>10 20 30</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4</td>
<td>SS</td>
<td>25/25mm</td>
<td></td>
<td>10 20 30</td>
<td></td>
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<td></td>
<td></td>
<td>5</td>
<td>SS</td>
<td>58</td>
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<td>10 20 30</td>
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<td>10 20 30</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>SS</td>
<td>50/50mm</td>
<td></td>
<td>10 20 30</td>
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<td></td>
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<td>8</td>
<td>SS</td>
<td>50/25mm</td>
<td></td>
<td>10 20 30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>251.8</td>
<td>End of Borehole: No Detectable Gas:</td>
<td></td>
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<td></td>
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</tr>
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<td>Notes:</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1. Borehole dry on completion.</td>
<td></td>
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</table>
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>STRATA PLOT</th>
<th>SAMPLES</th>
<th>LAB VANE</th>
<th>DYNAMIC CONE PENETRATION RESISTANCE PLOT</th>
<th>GROUND WATER CONDITIONS</th>
<th>PLASTIC LIMIT</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>LIQUID LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>250.2</td>
<td>Silt: trace clay, brown, wet, dense</td>
<td>6</td>
<td>SS 67</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>249</td>
<td>sand</td>
<td>8</td>
<td>SS 38</td>
<td></td>
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<tr>
<td>247</td>
<td></td>
<td>9</td>
<td>SS 38</td>
<td></td>
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<tr>
<td>246.7</td>
<td>End of Borehole: No Detectable Gas: Notes: 1. Water level 8.2m below grade on completion. 2. 50 mm dia. monitoring well was installed upon completion, screened from 6.1 to 8.1m. 3. Water Level Measurements in</td>
<td></td>
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### Monitoring Well

<table>
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<tr>
<th>Date</th>
<th>W.L. Depth (mbgs)</th>
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<tbody>
<tr>
<td>Dec. 16, 2014</td>
<td>8.1</td>
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### Field Vane & Sensitivity

- **ELEVATION:**
  - Shallow/Single Installation
  - Deep/Dual Installation

### Groundwater Elevation

- **REF. NO.: 10000499**
- **ENCL NO.: 15**

### Numbers refer to Sensitivity

- **Quick Triaxial**
- **Unconfined**
- **Field Vane & Sensitivity**
- **LAB Vane**

### Remarks and Grain Size Distribution (%)

- **GR:**
- **SA:**
- **SI:**
- **CL:**

### Project Details

- **PROJECT:** Geotechnical Investigation - Empire St. George Lands
- **CLIENT:** Empire Communities (St. George) Ltd.
- **PROJECT LOCATION:** St. George, Ontario
- **DATUM:** Geodetic
- **BH LOCATION:** N 4788499.9906 E 559675.0423

### Drilling Data

- **Method:** Solid Stem Auger
- **Diameter:** 100
- **Date:** Nov/19/2014

### Soil Profile

<table>
<thead>
<tr>
<th>ELEV (m)</th>
<th>DESCRIPTION</th>
<th>STRATA PLOT</th>
<th>SAMPLES</th>
<th>DYNAMIC PENETRATION RESISTANCE PLOT</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>GROUND WATER CONDITIONS</th>
<th>WATER CONTENT (%)</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>LIQUID LIMIT</th>
<th>NATURAL DENSITY</th>
<th>PLASTIC LIMIT</th>
<th>REMARKS AND GRAIN SIZE DISTRIBUTION (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
## SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>254.9</td>
<td>TOPSOIL: 225mm</td>
<td>1 SS 5</td>
</tr>
<tr>
<td>0.2</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td></td>
</tr>
<tr>
<td>254.1</td>
<td>SAND AND GRAVEL: brown, moist, compact to very dense</td>
<td>2 SS 27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 SS 50/60mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 SS 38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 SS 50/50mm</td>
</tr>
<tr>
<td>250.4</td>
<td>SILTY SAND: some gravel, brown, moist, very dense</td>
<td>6 SS 50/75mm</td>
</tr>
<tr>
<td>248.3</td>
<td>End of Borehole: No Detectable Gas: Notes: 1. Borehole dry on completion.</td>
<td></td>
</tr>
</tbody>
</table>

## DRILLING DATA

- **PROJECT**: Geotechnical Investigation - Empire St. George Lands
- **CLIENT**: Empire Communities (St. George) Ltd.
- **PROJECT LOCATION**: St. George, Ontario
- **DATUM**: Geodetic
- **BH LOCATION**: N 4788540.50 E 559846.6741

### GROUNDWATER ELEVATIONS
- **Shallow/Single Installation**: ` groundwater elevation` (ELEV)
- **Deep/Dual Installation**: ` groundwater elevation` (ELEV)

### GRAPH NOTES
- `+ 3` Numbers refer to Sensitivity
- `3%` Strain at Failure
### SOIL PROFILE

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Strata Plot</th>
<th>Type</th>
<th>Sample No.</th>
<th>Shear Strength (kPa)</th>
<th>Tyy</th>
<th>Plastic Limit</th>
<th>Natural Moisture Content</th>
<th>Liquid Limit</th>
<th>Ground Water Conditions</th>
<th>Remarks and Grain Size Distribution (%)</th>
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</thead>
<tbody>
<tr>
<td>254.0</td>
<td>TOPSOIL: 200mm</td>
<td></td>
<td></td>
<td>1</td>
<td>250</td>
<td>SS 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>253.9</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td></td>
<td></td>
<td>2</td>
<td>254</td>
<td>SS 59</td>
<td></td>
<td></td>
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<tr>
<td>252.0</td>
<td>SAND AND GRAVEL: brown, moist, very dense</td>
<td></td>
<td></td>
<td>3</td>
<td>253</td>
<td>SS 71</td>
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<td>occasional auger grinding</td>
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<tr>
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<td>4</td>
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<td>SS 46</td>
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<td>5</td>
<td>251</td>
<td>SS 60</td>
<td></td>
<td></td>
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<td>SS 26</td>
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<td>7</td>
<td>249</td>
<td>SS 50</td>
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<td>6.3</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1. Borehole dry on completion.</td>
</tr>
</tbody>
</table>

**Groundwater Elevations**

- Shallow/Dual Installation
- Deep/Dual Installation

**Notes**

- Numbers refer to Sensitivity
- ≠ 3% Strain at Failure
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV (m)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
<th>STRATA PLOT</th>
<th>TYPE</th>
<th>GRAVELY SAND</th>
<th>GRAVELLY SAND</th>
<th>NATURAL UNIT WT</th>
<th>WATER CONTENT (%)</th>
<th>LIQUID LIMIT</th>
<th>PLASTIC LIMIT</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>DYNAMIC CORE PENETRATION RESISTANCE PLOT</th>
<th>REMARKS AND GRAIN SIZE DISTRIBUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>256.0</td>
<td>TOPSOIL: 500mm</td>
<td>1 SS 5</td>
<td></td>
<td>Type</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>256.1</td>
<td>CLAYEY SILT: reworked, rootlets, brown, moist, firm</td>
<td>1 SS 50</td>
<td></td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>253.9</td>
<td>GRAVELLY SAND: some silt, brown/grey, moist, very dense</td>
<td>1 SS 50</td>
<td></td>
<td>Type</td>
<td></td>
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</tr>
<tr>
<td>3.0</td>
<td>SILTY SAND: trace gravel, brown, very moist, dense</td>
<td>1 SS 38</td>
<td></td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>249.3</td>
<td>SANDY SILT: dilatant, brown, wet, very dense</td>
<td>1 SS 60</td>
<td></td>
<td>Type</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>247.8</td>
<td>SILTY SAND: brown, wet, very dense</td>
<td>1 SS 68</td>
<td></td>
<td>Type</td>
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<td></td>
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</tr>
<tr>
<td>9.1</td>
<td>Silt: brown, wet, very dense</td>
<td>1 SS 68</td>
<td></td>
<td>Type</td>
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</tbody>
</table>

### End of Borehole:
No Detectable Gas:

**Notes:**
1. Water level 7.3m on completion.

**Remarks and Grain Size Distribution:**
- occasional auger grinding

---

**GROUNDWATER CONDITIONS**
- N–BLOWS 0.3 m
- Description

**LAB VANE**
- Water content (%)
- Natural moisture content
- Plastic limit
- Liquid limit
- Natural unit wt
- Pocket pen (Cu) (kPa)

**SPL SOIL LOGS BOREHOLE GINT LOGS.GPJ SPL.GDT 12/18/14**

---

**PROJECT:** Geotechnical Investigation - Empire St. George Lands
**CLIENT:** Empire Communities (St. George) Ltd.
**PROJECT LOCATION:** St. George, Ontario
**DATUM:** Geodetic
**BH LOCATION:** N 4788251.1668 E 559400.7345

**DRILLING DATA**
- Method: Solid Stem Auger
- Diameter: 100
- Date: Nov/24/2014

**REFERENCES NO.: 10000499**
**ENCL NO.: 18**
### SOIL PROFILE

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Description</th>
<th>Type</th>
<th>Sample Number</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>261.8</td>
<td><strong>TOPSOIL:</strong> 200mm</td>
<td>SS</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>261.0</td>
<td><strong>CLAYEY SILT:</strong> reworked, rootlets, brown, very moist, firm</td>
<td>SS</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td><strong>SILTY SAND:</strong> some gravel to gravelly, brown, very moist, firm</td>
<td>SS</td>
<td>50/75mm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>very dense</td>
<td>SS</td>
<td>50/60mm</td>
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<td></td>
<td>SS</td>
<td>50/00mm</td>
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</tr>
<tr>
<td>254.2</td>
<td>Trace gravel, wet, dense</td>
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<td>32</td>
<td></td>
</tr>
</tbody>
</table>

### End of Borehole:

No Detectable Gas:

**Notes:**
1. Water level 9.1m below grade on completion.

### DRILLING DATA

- **PROJECT:** Geotechnical Investigation - Empire St. George Lands
- **CLIENT:** Empire Communities (St. George) Ltd.
- **PROJECT LOCATION:** St. George, Ontario
- **DATUM:** Geodetic
- **BH LOCATION:** N 4788292.0455 E 559558.0066

- **Method:** Solid Stem Auger
- **Diameter:** 100
- **Date:** Nov/19/2014
- **REF. NO.:** 10000499
- **ENCL. NO.:** 19

### SOIL SAMPLES

<table>
<thead>
<tr>
<th>Number</th>
<th>Type</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SS</td>
<td>261</td>
</tr>
<tr>
<td>2</td>
<td>SS</td>
<td>260</td>
</tr>
<tr>
<td>3</td>
<td>SS</td>
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<td>SS</td>
<td>254</td>
</tr>
<tr>
<td>9</td>
<td>SS</td>
<td>253</td>
</tr>
</tbody>
</table>

### GROUNDWATER CONDITIONS

- **End of Borehole:**
  - **Water level:** 9.1m below grade on completion.

### DYNAMIC CONE PENETRATION RESISTANCE PLOT

- **UNCONFINED**
- **QUICK TRIAXIAL**
- **LAB VANE**

### SOIL PROFILE

- **GROUND WATER CONDITIONS**
  - **"N"**
  - **BLOWS**
  - **0.3 m**

### GRAPH NOTES

- **Numbers refer to Sensitivity**
- **6=3% Strain at Failure**
### Soil Profile

<table>
<thead>
<tr>
<th>ELEV DEPTH</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>TOPSOIL: 300mm</td>
<td></td>
</tr>
<tr>
<td>0.3</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, very stiff</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>GRAVELLY SAND: brown, moist, compact to very dense, occasional auger grinding</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>SILTY SAND: trace gravel, brown, moist, dense</td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>SILT: some sand, trace clay, brown, very moist, dense</td>
<td></td>
</tr>
<tr>
<td>8.6</td>
<td>End of Borehole: No Detectable Gas: Notes: 1. Water level 8.5m below grade on completion. 2. 50 mm dia. monitoring well was installed upon completion, screened from 6.1 to 9.1m. 3. Water Level Measurements in</td>
<td></td>
</tr>
</tbody>
</table>

### Dynamic Cone Penetration Resistance Plot

- **UNCONFINED**
- **FIELD VANE & DENSITY**
- **QUICK TRIAXIAL**
- **LAB VANE**

### Soil Sample Information

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>TYPE</th>
<th>WATER CONTENT (%)</th>
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<tbody>
<tr>
<td>1</td>
<td>SS 18</td>
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<tr>
<td>2</td>
<td>SS 27</td>
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<td>3</td>
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<td>4</td>
<td>SS 64</td>
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<td>5</td>
<td>SS 40</td>
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<td>6</td>
<td>SS 53</td>
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<td>7</td>
<td>SS 43</td>
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<td>8</td>
<td>SS 37</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>SS 39</td>
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</tr>
</tbody>
</table>

### Groundwater Conditions

- Shallow/Single Installation
- Deep/Dual Installation

- **GROUNDWATER ELEVATION**
  - W. L. 247.7 m Dec 16, 2014

### Notes

- Numbers refer to Sensitivity
- Strain at Failure

---

**continued on next page**
### Project Details
- **Project: Geotechnical Investigation - Empire St. George Lands**
- **Client:** Empire Communities (St. George) Ltd.
- **Project Location:** St. George, Ontario
- **Datum:** Geodetic
- **BH Location:** N 4788328.2332 E 559716.4958

### Drilling Data
- **Method:** Solid Stem Auger
- **Diameter:** 100
- **Date:** Nov/18/2014
- **Ref. No.:** 10000499
- **Encl. No.:** 20

### Soil Profile

<table>
<thead>
<tr>
<th>Elevation (m)</th>
<th>Description</th>
<th>Strata Plot</th>
<th>Samples</th>
<th>Dynamic Cone Penetration Resistance Plot</th>
<th>Shear Strength (kPa)</th>
<th>Plastic Limit</th>
<th>Natural Moisture Content</th>
<th>Liquid Limit</th>
<th>Remarks and Grain Size Distribution (%)</th>
<th>Remarks</th>
</tr>
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<tr>
<td>0</td>
<td>Monitoring Well Date W.L. Depth (mbgs)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dec. 16, 2014</td>
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<td></td>
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</tbody>
</table>
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV DEPTH (m)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
<th>DYNAMIC CONE PENETRATION RESISTANCE PLOT</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>GROUND WATER CONDITIONS</th>
<th>GROUND WATER ELEVATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>256.1</td>
<td>TOPSOIL: 150mm</td>
<td>1 SS 5</td>
<td>256</td>
<td>0.2</td>
<td>UNCONFINED</td>
<td>FIELD VANE</td>
</tr>
<tr>
<td>255.3</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
<td>2 SS 50/100mm</td>
<td>255</td>
<td>0.8</td>
<td>UNCONFINED</td>
<td>QUICK TRIAxAL</td>
</tr>
<tr>
<td>254.0</td>
<td>SAND AND GRAVEL: brown, moist, very dense</td>
<td>3 SS 50/25mm</td>
<td>254</td>
<td>0.8</td>
<td>UNCONFINED</td>
<td>LAB VANE</td>
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<tr>
<td>253.7</td>
<td>6 SS 50/00mm</td>
<td>253</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>252.0</td>
<td>7 SS 50/25mm</td>
<td>252</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>251.0</td>
<td>8 SS 47</td>
<td>251</td>
<td>0.8</td>
<td></td>
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<td></td>
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<tr>
<td>249.0</td>
<td>9 SS 46</td>
<td>249</td>
<td>0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>247.0</td>
<td>10 SS 50/25mm</td>
<td>247</td>
<td>0.8</td>
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### DRILLING DATA

- **Method:** Solid Stem Auger
- **Diameter:** 100
- **Date:** Nov/20/2014
- **ENCL NO.:** 21

### PROJECT

- **Project:** Geotechnical Investigation - Empire St. George Lands
- **Client:** Empire Communities (St. George) Ltd.
- **Project Location:** St. George, Ontario
- **Datum:** Geodetic
- **BH Location:** N 4788151.2932 E 559673.9272

### Remarks

- **End of Borehole:** No Detectable Gas
- **Notes:**
  1. Water level 8.6m below grade on completion.

### Graph Notes

- **Numbers refer to Sensitivity**
- **6% Strain at Failure**
### SOIL PROFILE

<table>
<thead>
<tr>
<th>ELEV (m)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>TOPSOIL: 250mm</td>
<td>255</td>
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<tr>
<td>0.3</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
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</tr>
<tr>
<td>0.6</td>
<td>SAND: some gravel, brown, wet, compact</td>
<td>255</td>
</tr>
<tr>
<td></td>
<td></td>
<td>255</td>
</tr>
<tr>
<td>2.0</td>
<td>SANDY SILT: trace clay, brown, moist, compact</td>
<td>255</td>
</tr>
<tr>
<td>6.1</td>
<td>SILTY SAND: gravely, grey/brown, wet, very dense</td>
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</tr>
<tr>
<td>9.5</td>
<td>End of Borehole: No Detectable Gas:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Notes:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Water level 7.0m below grade on completion.</td>
<td></td>
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</table>

### DRILLING DATA

**PROJECT:** Geotechnical Investigation - Empire St. George Lands  
**CLIENT:** Empire Communities (St. George) Ltd.  
**PROJECT LOCATION:** St. George, Ontario  
**DATUM:** Geodetic  
**BH LOCATION:** N 4787975.3241 E 559406.5116

**Method:** Solid Stem Auger  
**Diameter:** 100  
**Date:** Nov/24/2014  
**REF. NO.: 10000499**

**SAMPLES**

- **SS**
- **50/25mm**
- **50/75mm**

**GROUND WATER CONDITIONS**

- **UNCONFINED**
- **FIELD VANE & DEMOITY**
- **LAB VANE**

**DYNAMIC CONE PENETRATION RESISTANCE PLOT**

- **ELEVATION**
- **PLASTIC LIMIT**
- **NATURAL UNIVERSITY**
- **LIQUID LIMIT**
- **GRAIN SIZE DISTRIBUTION (%)**

**END OF BOREHOLE**

- **No Detectable Gas**

**Notes:**

1. Water level 7.0m below grade on completion.
<table>
<thead>
<tr>
<th>ELEV</th>
<th>DESCRIPTION</th>
<th>STRATA PLOT</th>
<th>NUMBER</th>
<th>TYPE</th>
<th>GRAIN SIZE DISTRIBUTION (%)</th>
<th>QUICK TRIAXIAL</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>DYNAMIC CONE PENETRATION RESISTANCE PLOT</th>
<th>SOIL PROFILE</th>
<th>DRILLING DATA</th>
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<td>252.8</td>
<td>TOPSOIL: 500mm</td>
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<td></td>
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<tr>
<td>252.3</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm</td>
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<td></td>
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<td>259.1</td>
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<td>3</td>
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<td>248.3</td>
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<td>4</td>
<td>SS</td>
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<td>59</td>
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</tbody>
</table>

**Remarks:**
1. Water level 4.5m below grade on completion.

**End of Borehole:**
No Detectable Gas.

**Notes:**
1. Water level 4.5m below grade on completion.
## Soil Profile

<table>
<thead>
<tr>
<th>ELEV (m)</th>
<th>DESCRIPTION</th>
<th>SAMPLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.49</td>
<td>TOPSOIL: 200mm</td>
<td></td>
</tr>
<tr>
<td>2.48</td>
<td>CLAYEY SILT: reworked, rootlets, brown, very moist, firm to stiff</td>
<td>1 SS 7</td>
</tr>
<tr>
<td>2.46</td>
<td></td>
<td>2 SS 14</td>
</tr>
<tr>
<td>2.45</td>
<td></td>
<td>3 SS 6</td>
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<td>2.47</td>
<td>SILTY SAND: brown, very moist, compact</td>
<td>4 SS 32</td>
</tr>
<tr>
<td>2.463</td>
<td>GRAVELLY SAND: trace silt, grey/brown, wet, very dense</td>
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</tr>
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<td></td>
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<td>6 SS 33</td>
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<td></td>
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<td>7 SS 18</td>
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<td></td>
<td></td>
<td>8 SS 35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 SS 15</td>
</tr>
</tbody>
</table>

### End of Borehole

- No Detectable Gas:

#### Notes:
1. Water level 4.5m below grade on completion.
2. 50 mm dia. monitoring well was installed upon completion, screened from 4.9 to 7.9m.
3. Water Level Measurements in
## Monitoring Well

<table>
<thead>
<tr>
<th>Date</th>
<th>W.L. Depth (mbgs)</th>
</tr>
</thead>
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<tr>
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## DRILLING DATA

- **Method:** Hollow Stem Auger
- **Diameter:** 150
- **Date:** Nov/20/2014
- **Ref. No.:** 10000499
- **Encl. No.:** 24

## SOIL PROFILE

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<th>(m)</th>
<th>ELEV</th>
<th>DESCRIPTION</th>
<th>STRATA PLOT</th>
<th>SAMPLES</th>
<th>DYNAMIC CORE PENETRATION RESISTANCE PLOT</th>
<th>SHEAR STRENGTH (kPa)</th>
<th>WATER CONTENT (%)</th>
<th>NATURAL UNIT WT</th>
<th>GROUND WATER CONDITIONS</th>
<th>PLASTIC LIMIT</th>
<th>NATURAL MOISTURE CONTENT</th>
<th>LIQUID LIMIT</th>
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</tr>
</tbody>
</table>

## Notes

- **Numbers refer to Sensitivity**
- **$\Theta=3\%$ Strain at Failure**
Notes
1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place 100 mm (4 inches) of stone below drain.
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Free Draining backfill - OPSS Granular B or equivalent compacted to the specified density. Do not use heavy compaction equipment within 450 mm (18") of the wall. Use hand controlled light compaction equipment within 1.8 m (6") of wall. The minimum width of the Granular 'B' backfill must be 1.0 m.
5. Impermeable backfill seal - compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Maximum thickness of seal to be 0.5 m.
6. Do not backfill until wall is supported by basement and floor slabs or adequate bracing.
7. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
8. Basement wall to be damp proofed /water proofed.
9. Exterior grade to slope away from building.
10. Slab on grade should not be structurally connected to the wall or footing.
11. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab.
12. Drainage tile placed in parallel rows 6 to 8 m (20 to 25") centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
13. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
14. Do not connect the underfloor drains to perimeter drains.
15. Review the geotechnical report for specific details.

DRAINAGE AND BACKFILL RECOMMENDATIONS
Basement with Underfloor Drainage
(not to scale)
APPENDIX A
RESULTS OF GRAIN SIZE ANALYSIS
GRAIN SIZE DISTRIBUTION
Silty Sand, Trace Gravel, trace Clay

Figure No: A2
Project No: 10000499
Date: December 04, 2014
GRAIN SIZE DISTRIBUTION
Silt, some Sand, trace Clay
APPENDIX B
REQUIREMENTS FOR ENGINEERED FILL
GENERAL REQUIREMENTS FOR ENGINEERED FILL

Compacted imported soil that meets specific engineering requirements and is free of organics and debris and that has been continually monitored on a full-time basis by a qualified geotechnical representative is classified as engineered fill. Engineered fill that meets these requirements and is bearing on suitable native subsoil can be used for the support of foundations.

Imported soil used as engineered fill can be removed from other portions of a site or can be brought in from other sites. In general, most of Ontario soils are too wet to achieve the 100% Standard Proctor Maximum Dry Density (SPMDD) and will require drying and careful site management if they are to be considered for engineered fill. Imported non-cohesive granular soil is preferred for all engineered fill. For engineered fill, we recommend use of OPSS Granular ‘B’ sand and gravel fill material only.

Adverse weather conditions such as rain make the placement of engineered fill to the required degree of density difficult or impossible; engineered fill cannot be placed during freezing conditions, i.e. normally not between December 15 and April 1 of each year.

The location of the foundations on the engineered soil pad is critical and certification by a qualified surveyor that the foundations are within the stipulated boundaries is mandatory. Since layout stakes are often damaged or removed during fill placement, offset stakes must be installed and maintained by the surveyors during the course of fill placement so that the contractor and engineering staff are continually aware of where the engineered fill limits lie. Foundations placed within the engineered soil pad must be backfilled with the same conditions and quality control as the original pad.

To perform satisfactorily, engineered fill requires the cooperation of the designers, engineers, contractors and all parties must be aware of the requirements. The minimum requirements as follows, however, the geotechnical report must be reviewed for specific information and requirements.

1. Prior to site work involving engineered fill, a site meeting to discuss all aspects must be convened. The surveyor, contractor, design engineer and geotechnical engineer must attend the meeting. At this meeting, the limits of the engineered fill will be defined. The contractor must make known where all fill material will be obtained and samples must be provided to the geotechnical engineer for review, and approval before filling begins.

2. Detailed drawings indicating the lower boundaries as well as the upper boundaries of the engineered fill must be available at the site meeting and be approved by the geotechnical engineer.

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and SPL Consultants Limited. Without this confirmation no responsibility for the performance of the structure can be accepted by SPL Consultants Limited. Survey drawing of the pre and post fill location and elevations will also be required.
4. The area must be stripped of all topsoil and fill materials. Subgrade must be proofrolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a SPL Consultants Limited engineer prior to placement of fill.

5. The approved engineered fill must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Granular Fill preferred. Engineered fill should not be placed (where it will support footings) during the winter months. Engineered fill compacted to 100% SPMDD will settle under its own weight approximately 0.5% of the fill height and the structural engineer must be aware of this settlement. In addition to the settlement of the fill, additional settlement due to consolidation of the underlying soils from the structural and fill loads will occur and should be evaluated prior to placing the fill.

6. Full-time geotechnical inspection by SPL Consultants Limited during placement of engineered fill is required. Work cannot commence or continue without the presence of the SPL Consultants Limited representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to sketches for minimum requirements. Take careful note that the projection of the compacted pad beyond the footing at footing level is a minimum of 2 m. The base of the compacted pad extends 2 m plus the depth of excavation beyond the edge of the footing.

8. An allowable bearing pressure of 0.150 MPa (3000 psf) may be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings must be provided with nominal steel reinforcement.

9. All excavations must be done in accordance with the Occupational Health and Safety Regulations of Ontario.

10. After completion of the pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from SPL Consultants Limited prior to footing concrete placements. All excavations must be backfilled under full time supervision by SPL Consultants Limited to the same degree as the engineered fill pad. Surface water cannot be allowed to pond in excavations or to be trapped in clear stone backfill. Clear stone backfill can only be used with the approval of SPL Consultants Limited.

11. After completion of compaction, the surface of the pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proofrolled and sloped/crowned at the end of each day, prior to weekends and any stoppage in work in order to promote rapid runoff of rainwater and to avoid any ponding surface water. Any stockpiles of fill intended for use as engineered fill must also be smooth-bladed to promote runoff and/or protected from excessive moisture take up.

12. If there is a delay in construction, the engineered fill pad must be inspected and accepted by the geotechnical engineer. The location of the structure must be reconfirmed that it remains within the pad.

13. The geometry of the engineered fill as illustrated in these General Requirements is general in nature. Each project will have its own unique requirements. For example, if perimeter sidewalks are to be constructed around the building, then the projection of the engineered fill beyond the foundation wall may need to be greater.
14. These guidelines are to be read in conjunction with SPL Consultants Limited report attached.
APPENDIX

RESULTS OF CHEMICAL ANALYSES
CLIENT NAME: SPL CONSULTANTS
180 SHEARSON CRESCENT, UNIT 1&2
CAMBRIDGE, ON N1T1P4
(519) 740-0065

ATTENTION TO: Vince Hicks

PROJECT: St.George

AGAT WORK ORDER: 14T922407

SOIL ANALYSIS REVIEWED BY: Elizabeth Polakowska, MSc (Animal Sci), PhD (Agri Sci), Inorganic Lab Supervisor

DATE REPORTED: Dec 09, 2014

PAGES (INCLUDING COVER): 4

VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (905) 712-5100

*NOTES

Results relate only to the items tested and to all the items tested.

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>BH14-06 SS3</th>
<th>BH14-14 SS5</th>
<th>BH14-23 SS6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfide</td>
<td>%</td>
<td>0.01</td>
<td>0.02</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Chloride (2:1)</td>
<td>µg/g</td>
<td>2</td>
<td>3</td>
<td>46</td>
</tr>
<tr>
<td>Sulphate (2:1)</td>
<td>µg/g</td>
<td>2</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>pH (2:1)</td>
<td>pH Units</td>
<td>NA</td>
<td>8.58</td>
<td>8.85</td>
</tr>
<tr>
<td>Electrical Conductivity</td>
<td>mS/cm</td>
<td>0.005</td>
<td>0.135</td>
<td>0.202</td>
</tr>
<tr>
<td>Resistivity (2:1)</td>
<td>ohm.cm</td>
<td>1</td>
<td>7410</td>
<td>4950</td>
</tr>
<tr>
<td>Redox Potential (2:1)</td>
<td>mV</td>
<td>5</td>
<td>274</td>
<td>267</td>
</tr>
</tbody>
</table>

RDL - Reported Detection Limit; G / S - Guideline / Standard

* Analyses were performed at AGAT Lab in Vancouver.

EC/Resistivity, pH, Chloride, Sulphate and Redox Potential were determined on the extract obtained from the 2:1 leaching procedure (2 parts DI water: 1 part soil).
## Quality Assurance

**CLIENT NAME:** SPL CONSULTANTS  
**PROJECT:** St. George  
**SAMPLING SITE:**

### Soil Analysis

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>Batch</th>
<th>Sample Id</th>
<th>Dup #1</th>
<th>Dup #2</th>
<th>RPD</th>
<th>Measured Value</th>
<th>Method Blank</th>
<th>Acceptable Limits</th>
<th>ACCEPTABLE LIMITS</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Recovery</td>
<td>Recovery</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Upper</td>
<td>Upper</td>
</tr>
<tr>
<td>Corrosivity Package</td>
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<tr>
<td>Sulfide</td>
<td>6146333</td>
<td>0.03</td>
<td>0.03</td>
<td>0.0%</td>
<td>&lt; 0.01</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Chloride (2:1)</td>
<td>6134784</td>
<td>171</td>
<td>171</td>
<td>0.4%</td>
<td>&lt; 2</td>
<td>95% 80% 120%</td>
<td>102% 80% 120%</td>
<td>103% 70% 130%</td>
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</tr>
<tr>
<td>Sulphate (2:1)</td>
<td>6134784</td>
<td>119</td>
<td>120</td>
<td>0.7%</td>
<td>&lt; 2</td>
<td>97% 80% 120%</td>
<td>102% 80% 120%</td>
<td>100% 70% 130%</td>
<td></td>
</tr>
<tr>
<td>pH (2:1)</td>
<td>6127816</td>
<td>8.03</td>
<td>8.09</td>
<td>0.7%</td>
<td>NA</td>
<td>100% 90% 110%</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Electrical Conductivity (2:1)</td>
<td>6137796</td>
<td>0.531</td>
<td>0.526</td>
<td>0.9%</td>
<td>&lt; 0.005</td>
<td>108% 90% 110%</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Redox Potential (2:1)</td>
<td>6134784</td>
<td>273</td>
<td>278</td>
<td>2.0%</td>
<td>&lt; 5</td>
<td>96% 70% 130%</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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</table>

Comments: NA signifies Not Applicable.

Certified By: [Signature]

Results relate only to the items tested and to all the items tested.
## Soil Analysis

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>AGAT S.O.P</th>
<th>LITERATURE REFERENCE</th>
<th>ANALYTICAL TECHNIQUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfide</td>
<td>INOR-93-6004</td>
<td>McKeague 4.12 &amp; SM 4110 B</td>
<td>GRAVIMETRIC</td>
</tr>
<tr>
<td>Chloride (2:1)</td>
<td>INOR-93-6004</td>
<td>McKeague 4.12 &amp; SM 4110 B</td>
<td>ION CHROMATOGRAPH</td>
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<tr>
<td>Sulphate (2:1)</td>
<td>INOR 93-6031</td>
<td>MSA part 3 &amp; SM 4500-H+ B</td>
<td>PH METER</td>
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<td>pH (2:1)</td>
<td>INOR-93-6036</td>
<td>McKeague 4.12, SM 2510 B</td>
<td>EC METER</td>
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<tr>
<td>Electrical Conductivity (2:1)</td>
<td>INOR-93-6036</td>
<td>McKeague 4.12, SM 2510 B</td>
<td>EC METER</td>
</tr>
<tr>
<td>Resistivity (2:1)</td>
<td>INOR-93-6036</td>
<td>McKeague 4.12 &amp; SM 2510 B</td>
<td>CALCULATION</td>
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<tr>
<td>Redox Potential (2:1)</td>
<td></td>
<td>McKeague 4.12 &amp; SM 2510 B</td>
<td>REDOX POTENTIAL ELECTRODE</td>
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</tbody>
</table>

Results relate only to the items tested and to all the items tested.
<table>
<thead>
<tr>
<th>Sample Information</th>
<th>Site/Parcel Information</th>
<th>Compliance Information</th>
<th>Reporting Information</th>
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<tbody>
<tr>
<td><strong>Sample Information</strong></td>
<td><strong>Site/Parcel Information</strong></td>
<td><strong>Compliance Information</strong></td>
<td><strong>Reporting Information</strong></td>
</tr>
<tr>
<td>Sample Site</td>
<td>Parcel No.</td>
<td>IAPL No.</td>
<td>Date Collected</td>
</tr>
<tr>
<td>123 Main St.</td>
<td>123</td>
<td>123456</td>
<td>01/01/2023</td>
</tr>
</tbody>
</table>

**Legend:**
- SW: Swirlers
- D: Dampers
- G: Ground Water
- P: Pumped Water
- S: Surface Water

**Report Information**
- Date: 01/01/2023
- Time: 12:00 PM
- Lab: AGAT Laboratories

**Client Information**
- Name: John Smith
- Address: 123 Main St.
- Phone: 555-1234

**Chain of Custody Record**
- Lab No.: 234567
- Date: 01/01/2023
- Analysis:重金属分析

**Regulatory Requirements**
- Compliance with EPA regulations
- Certification of testing equipment

**Notes:**
- Sample collected at 123 Main St.
- Analysis performed at AGAT Laboratories
- Report submitted on time