SOLCORP DEVELOPMENTS (PEAKS RIDGE) INC.

RIDGE ESTATES, CLARKSBURG, ONTARIO

GEOTECHNICAL INVESTIGATION

SEPTEMBER 19, 2018

RIDGE ESTATES, CLARKSBURG, ONTARIO

GEOTECHNICAL INVESTIGATION

SOLCORP DEVELOPMENTS (PEAKS RIDGE) INC.

PROJECT NO.: 181-07496-00
DATE: SEPTEMBER 2018

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September 19th, 2018

SOLCORP DEVELOPMENTS (PEAKS RIDGE) INC.
#122 - 1 Benvenuto Place
Toronto, Ontario
M4V 2L1

Attention: Mr. Glenn Solomon

Dear Mr. Solomon,

Subject: Geotechnical Investigation - Ridge Estates, Clarksburg, Ontario

WSP Canada Inc. was retained to complete a geotechnical investigation at the above noted property. The purpose of the geotechnical investigation is to identify the subsurface conditions at select borehole locations and to provide design recommendations toward the design of the proposed development, as well as identify any potential constraints which may be encountered during construction.

Kind regards,

Dan Demmings, C.Tech.
Senior Field Technician

Kent Malcolm, P.Eng.
Senior Geotechnical Engineer

DD/KM/ham

WSP ref.: 181-07496-00

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1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by Glenn Solomon to undertake a geotechnical investigation for a proposed residential development located in the Town of Blue Mountains (Clarksburg), Ontario. The location of the proposed development is shown on the attached ***Site Location Plan - Figure 1.***

The scope of this geotechnical investigation was to obtain information about the subsurface conditions through the advancement of four (4) boreholes and based upon the findings of the boreholes ultimately provide recommendations herein pertaining to the following:

- Soil coefficients / parameters as input to pressures for earth retention systems;
- Appropriate foundation type, geotechnical resistances (ULS and SLS) and founding depth;
- Frost susceptibility of native soils;
- General excavation, backfill and bedding requirements, and groundwater control;
- Pavement structure for internal roadways; and
- Percolation rates of native soils.

This report deals with geotechnical issues only.

This report is provided based on 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.

The site investigation and recommendations follow generally accepted practice for Geotechnical Consultants in Ontario. Laboratory testing follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Solcorp Developments Inc. Third party use of this report without WSP consent is prohibited.

2 SITE BACKGROUND AND PROJECT DESCRIPTION

The proposed site is located at the western terminus of George McRae Road in the Town of Blue Mountains (Clarksburg), Ontario. Based on the information provided to our office, the site is about 5.9 acres in size; an intermittent flowing watercourse exists parallel to the eastern boundary of the site. The site is currently vacant. It is noted that a stockpile of material exists at the site; the volume of the stockpile is estimated to be between 3,500m^3 and 4,000m^3. A soil quality analysis of the material stockpile was completed by WSP and submitted on July 31, 2018 to Mr. Glenn Solomon.

The site concept includes the construction of 34 single residential units; the units will have full basements and one common recreational centre with pool. The roadway will be constructed to an urban design with underground services.

3 INVESTIGATION METHODOLOGY

The field investigation consisted of drilling four (4) boreholes (BH18-01 to BH18-04) at the site on July 5, 2018. Boreholes BH18-01, BH18-02 and BH18-04 were advanced within areas of proposed residential housing; Borehole BH18-03 was advanced along the proposed alignment of the internal roadway. The borehole locations are shown on the attached ***Borehole Location Plan - Figure 2***.

The boreholes were advanced to depths ranging between of 4.7 meters below existing ground surface (mbgs) to 5.0 mbgs. The boreholes were drilled with solid stem continuous flight auger equipment.

Drilling equipment was supplied and operated by a drilling sub-contractor under the direction and supervision of WSP personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer in accordance with the Standard Penetration Test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler a 0.3 m depth into the undisturbed soil (SPT 'N' values) gives an indication of the compactness condition or consistency of the sampled soil material. The SPT 'N' values are indicated on the ***Borehole Logs - Enclosures 1-4***.

Soil samples were visually classified in the field and re-evaluated by a senior engineer in our laboratory. All soil samples were tested for moisture contents. Laboratory Grain Size Analyses were carried out on representative samples and the results are provided in ***Enclosures 5, 6 and 7***.

Water level observations were made during the drilling and in the open boreholes upon the completion of drilling operations. A monitoring well / standpipe was installed in BH18-1, BH18-2 and BH18-4; WSP returned to the site on July 13, 2018 to obtain groundwater levels at the site.

4 SITE AND SUBSURFACE CONDITIONS

Details of the subsurface conditions encountered are presented on the Borehole Logs and summarized in the following sections. It is noted that subsurface conditions can change between boreholes and the details provided below refer to soil conditions that were encountered at the borehole locations only.

4.1 GENERAL SUBSURFACE CONDITIONS

Based on the results of the field investigation, the subsurface conditions at the borehole locations generally comprised topsoil overlying layers of silty clay, sandy silt, gravel and sand, gravelly clay and clayey silt. Possible weathered shale was encountered in the last sample of each borehole.

4.1.1 TOPSOIL

Topsoil was encountered in all four (4) of the boreholes, the topsoil was measured to range between 10 cm at BH18-1 and 30 cm in thickness at BH18-3 and BH18-4.

It should be noted that topsoil quantities should not be calculated from the borehole information, as large variations in depth may exist between boreholes. A detailed organic layer thickness survey is required to determine an accurate evaluation of quantity. The organic matter is generally dark brown to black in colour and moist.

4.1.2 COHESIVE DEPOSITS

A native silty clay deposit was encountered underlying the topsoil and extending to a depth of 0.7 mbgs in three (3) of the boreholes advanced at the site. The silty clay was brown to reddish brown, moist, and generally contains trace amounts of sand and gravel. The measured SPT 'N' values in the silty clay ranged from 5 blows per 0.3 m to 19 blows per 0.3 m, indicating that the silty clay varied from firm to very stiff. The natural moisture content of the silty clay ranged between 8% and 27%.

A deposit of gravelly clay was encountered in BH 18-1 at depths between 2.1 and 2.9 mbgs. The gravelly clay was reddish brown, wet and contained some silt. The measured SPT 'N' values in the gravelly clay was 48 blows per 0.3 m, indicating that it is a hard material. The natural moisture content of the gravelly clay was 17%.

Clayey silt deposits were encountered in each of the four (4) boreholes below depths between 1.4 (BH 18-2 and BH18-4) and 2.9 mbgs (BH18-1) with each borehole terminating in the clayey silt. The measured SPT 'N' values in the clayey silt ranged from 18 blows per 0.3 m to 50 blows per 0.08 m, indicating that the clayey silt varied from very stiff to hard. Possible weathered shale was encountered at the terminus of each borehole from 4.57 mbgs to 5.03 mbgs. This caused each borehole to terminate in hard material.

Grain size analyses of two (2) samples of the clayey silt was completed and the gradation curve is presented in ***Enclosure 5 and 6***. A review of the grain size analyses indicates the following ranges of clay, silt, sand and gravel percentages:

- Gravel: 2-4%
- Sand: 6-12%
- Silt: 51-54%
- Clay: 33-38%

4.1.3 NON-COHESIVE DEPOSITS

Non-cohesive deposits were encountered in each of the boreholes. The non-cohesive deposits are variable but generally consist of gravel and sand to sandy silt. The non-cohesive deposits were brown and reddish brown and contained trace to some silt and clay.

The measured SPT 'N' values in the non-cohesive deposits ranged from 10 blows per 0.3 m to 57 blows per 0.3 m, indicating that the non-cohesive deposits varied from compact to very dense.

The natural moisture content of the non-cohesive deposits ranged between 6% and 12%.

A grain size analysis of one (1) sample of the native non-cohesive deposits was completed and the gradation curve is presented in ***Enclosure 7***. A review of the grain size analyses indicates the following ranges of clay, silt, sand and gravel percentages:

- Gravel: 41%
- Sand: 38%
- Fines (Silt and Clay): 21%

4.2 GROUNDWATER

Groundwater was encountered in each of the boreholes on completion of drilling as well as in the monitoring wells after the field investigation. A summary of the groundwater levels measured at the site are summarized below.

BOREHOLE	DATE	GROUNDWATER DEPTH (MBGS)	GROUNDWATER ELEVATION (M)	MEASUREMENT SOURCE
BH18-01	July 5, 2018	4.3	232.5	Open Borehole
	July 13, 2018	1.5	235.3	Monitoring Well
	August 9, 2018	1.6	235.2	Monitoring Well
BH18-02	July 5, 2018	4.0	227.8	Open Borehole
	July 13, 2018	1.7	230.1	Monitoring well
	August 9, 2018	1.9	230.0	Monitoring well
BH18-03	July 5, 2018	3.5	226.6	Open Borehole
BH18-04	July 5, 2018	3.0	224.9	Open Borehole
	July 13, 2018	1.8	226.1	Monitoring well
	August 9, 2018	1.9	226.0	Monitoring well

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to major weather events. In this regard, WSP is continuing with a groundwater monitoring program at the site through April 2019.

5 DISCUSSIONS/RECOMMENDATIONS

5.1 GENERAL

The following recommendations for the proposed site development are based on the information obtained from the borehole investigation and laboratory testing, which we believe fairly represents the subsurface conditions of the site. These recommendations are intended for the guidance of the design engineer to establish constructability and should not be construed as instructions to contractors. If significant differences in the subsurface conditions described above are found, we request to be contacted immediately to review and revise our findings and recommendations, if necessary.

The construction methods described in this report must not be considered as being specifications or recommendations to the prospective contractors, or as being the only suitable methods. Prospective contractors should evaluate all the information, obtain additional subsurface information as they might deem necessary and should select their construction methods, sequencing and equipment based on their own experience in similar ground conditions. The readers of this report are also reminded that the conditions are known only at the borehole locations and in view of the generally wide spacing of the boreholes, conditions may vary significantly between boreholes.

It is noted that, as no detailed design information was available at the time of this investigation, the information and recommendations provided below should be considered preliminary in nature only.

5.2 SITE BACKGROUND

Based on the information provided to our office, the proposed development is about 5.9 acres in size. The development will comprise 32 lots, 31 developed as single family residential lots and one lot developed as a community center. Detailed grading drawings were not provided for review. The subject site slopes gently from the south towards the north. A large stockpile of fill soil, approximately four (4) meters in height is in the north quarter of the site. Chemical testing of the fill pile was reported separately.

The results of the geotechnical investigation indicate that the subsurface conditions at the site comprise topsoil overlying a deposit comprised of layers of both cohesive and non-cohesive soil. The soil is generally compact or stiff increasing in the degrees of compactness or consistency with depth.

Groundwater was measured at a depth as high as 1.5 mbgs in the monitoring wells installed within one (1) week of field drilling operations.

5.3 SITE PREPARATION AND GRADING

Removal of all topsoil, as well as any organic material or fill that may be encountered will be required to facilitate the proposed development on the site. Following tree removal, it is recommended that a topsoil and fill test pit program be completed at the site by WSP prior to construction to refine the topsoil and fill thicknesses. Regarding the reuse of the site topsoil, the topsoil may be reused in landscaping applications or other non-structural fill applications. WSP should be contacted to review all proposed topsoil reuse on site. The reuse of fill on site should be reviewed by WSP.

After the completion of the required stripping and removal of unsuitable materials (fill, topsoil, etc.), the sub-grade should be proof-rolled and inspected by experienced WSP geotechnical engineering personnel. The proof-rolling and compaction of the exposed sub-grade is recommended to be conducted using a vibratory compactor with a minimum static weight of 10 tonnes. The proof-rolling program should consist of a minimum of six (6) passes per unit area and be tested to assure that the sub-grade is compacted to a minimum of 98% of the exposed material's Standard Proctor Maximum Dry Density (SPMDD). Any loose/soft or wet areas identified at the time of proof-rolling that cannot be uniformly compacted are recommended to be sub-excavated and backfilled with approved engineered fill consistent with the recommendations provided in ***Appendix A***.

Where engineered fill is required to develop the design grades and elevations or for use in backfilling excavations created through the removal of unsuitable materials or soils as described above, the excavated on-site materials may be re-used, subject that these are free of organic and other unsuitable materials and have appropriate moisture content. Boulders or cobbles greater than 200 mm in size should be removed from the fill prior to or during placement.

Alternatively, Ontario Provincial Standard Specification (OPSS) Granular B – Type I, OPSS Select Subgrade Material (SSM) or approved equal may be used.

All fill materials imported to the site must meet all applicable municipal, provincial and federal guidelines and requirements associated with environmental characterization of the materials.

Engineered fill is to be placed in maximum 200 mm thick loose lifts under full time supervision of qualified geotechnical personnel. Each lift is to be uniformly compacted to achieve a minimum of 100% of the material's SPMDD. Additional information related to the placement and compaction of engineered fill can be found in ***Appendix A***.

5.4 PRELIMINARY FOUNDATION RECOMMENDATIONS

Details of the proposed residential development such as underside of footing elevations were not available at the time when this report was prepared. When this information is available, the recommendations provided below should be reviewed by WSP to confirm that the recommendations are still valid based on the design information.

Based on the soil conditions encountered in the boreholes and provided that the site is prepared in accordance with the recommendations presented in this report, footings that are founded on the compact to dense native gravel and sand or stiff clayey silt soils at a minimum depth of 1.5 mbgs below final site grades may be designed based on a preliminary factored ultimate geotechnical resistance at Ultimate Limit States (ULS) of 150 kPa. A preliminary serviceability geotechnical resistance at Serviceability Limit States (SLS) of 100 kPa may be used in the design of the foundations.

Alternatively, if footings are required to be constructed within engineered fill, these may be designed based on a preliminary factored ultimate geotechnical resistance at ULS of 150 kPa; a preliminary serviceability geotechnical resistance at SLS of 100 kPa may be used in the design of the foundations.

Foundations designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 13 mm differential.

5.4.1 GENERAL FOUNDATION COMMENTS

All footings exposed to seasonal freezing conditions should be provided with at least 1.5 m of earth cover or equivalent thermal insulation against frost. It is recommended to keep footings as high as possible to avoid or minimize penetration below groundwater levels while considering the minimum frost cover requirement.

Variations in the soil conditions are expected in between the borehole locations, and during construction, the geotechnical resistances should be confirmed by experienced WSP site personnel.

Where it is necessary to place footings at different levels, the upper footing must be founded below an imaginary 10 horizontal to 7 vertical line drawn up from the base of the lower footing. The lower footing must be installed first to help minimize the risk of undermining the upper foundations.

The clayey silt soils at the base of footings can be easily disturbed by construction machinery and foot traffic or lose their strength in contact with surface water. We recommend that an allowance be made for placing a 50-mm thick skim coat of low-strength concrete on the founding subgrade immediately after its approval, to prevent its disturbance by construction activities and from ground or surface water, where necessary. The recommendation for the low-strength concrete should be made on a lot-by-lot basis during excavation and construction.

During winter construction, foundations and slab on grades must not be poured on frozen soil. Foundations must be adequately protected always from cold weather and freezing conditions.

In the vicinity of the existing buried utilities, all footings must be lowered to undisturbed native soils, or alternatively the services must be structurally bridged.

It should be noted that the recommended geotechnical resistances have been calculated by WSP from the borehole information for the preliminary design stage only. Additional input may be required as new design information becomes available and is refined. For example, more specific information is available with respect to conditions between boreholes when construction is underway. In this regard, the interpretation between boreholes and the recommendations of this report must therefore be checked through field inspections provided by WSP to validate the information for use during the construction stage.

5.5 FLOOR SLAB CONSTRUCTION AND DRAINAGE

The native soils or engineered fill soils are suitable to support the basement floor slabs provided they are founded at least 60 cm above the high annual water level. Monitoring of the groundwater levels in the wells will be reported separately and must be reviewed prior to final design.

We do not recommend the construction of the slabs on the existing fill stockpile soil at the site. For bedding and moisture barrier purposes, a 200-mm thick layer of 19 mm clear crushed stone must be provided under the concrete basement floor slab. Where wet and/or fine-grained soil conditions exist, the subdrains and moisture barrier should be separated from the subgrade by a geotextile fabric to avoid loss of soil/fines and settlement problems.

Depending on the site grading and groundwater levels, underfloor and perimeter drainage may be required in the basements. The perimeter drains can consist of 100 mm diameter perforated pipes surrounded by a 150-mm thick layer of 19 mm clear stone on all sides. The pipe and bedding stone are to be completely wrapped in a non-woven geotextile with a minimum 600 mm overlap. The subfloor and perimeter drainage system are to be hydraulically connected. The adjacent filter fabric sheets are to be overlapped by not less than 400 mm. In areas where gravity drainage is not feasible, the water collected by the perimeter drain pipes are to be channelled into a sump from where the water could be removed by pumping. A figure which illustrates the drainage recommendations noted above is included as ***Figure 3.***

5.6 LATERAL EARTH PRESSURES

The lateral earth pressure for the design of retaining walls, foundation walls, shoring, or trench boxes can be estimated from the following expressions:

Above groundwater table: $p = K(\gamma z + q)$

Below groundwater table: $p = K\{\gamma h_1 + \gamma_1(z - h_1) + q\} + p_w$

Where:

p	=	Lateral earth and water pressure in kPa acting at depth z;
z	=	Depth below ground surface, in meters;
K	=	Active earth pressure coefficient, (K_a);
γ	=	Unit weight of soil above groundwater table, in kN/m3;
γ1	=	Submerged unit weight of soil below water table;
h	=	Thickness of soil above groundwater table, in meters;
q	=	Value of Surcharge (kPa);
pw	=	Hydrostatic water pressure

The suggested soil parameters (unfactored) for the retaining wall design and/or ground support systems are summarized below.

SOIL TYPE	UNIT WEIGHT γ(KN/M^3)	EFFECTIVE ANGLE OF INTERNAL FRICTION (Φ')	COEFFICIENT OF EARTH PRESSURE		
			ACTIVE K_A	AT REST K_O	PASSIVE K_P
Granular A	22	35	0.27	0.43	3.69
Granular B	21	32	0.31	0.47	3.25
Native Compact Gravel and Sand	21	32	0.31	0.47	3.25
Native Stiff / Hard Clayey Silt	21.5	32	0.31	0.55	3.25

It is essential that imported free-draining OPSS Granular 'B' type fill be used as backfill against foundation walls. Backfilling of the footing wall excavations is recommended to be placed in 200 mm thick lifts, uniformly compacted to 100% SPMDD to proposed sub-grade elevations.

5.7 TEMPORARY EXCAVATIONS AND GROUNDWATER CONTROL

The details for the proposed services installations are not available at the time of preparing this report. The recommendations provided below assume that conventional depths for services will be carried out (up to approximately 4 mbgs).

Based upon the subsurface conditions at the borehole locations, excavations can be carried out with heavy hydraulic back-hoes. It is recommended that provision be carried in the contract for the excavation and disposal of obstructions on site, including cobbles and boulders.

All temporary excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). In accordance with OHSA, the non-cohesive soil would be classified as a Type 3 soil. If space limitations exist due to adjacent structures or facilities, consideration could be given to the construction of a temporary support system to provide protection to the structures and/or facilities. All excavated spoil should be placed at least the depth of the trench away from the edge of the trench for safety reasons.

We reiterate, each of the monitoring wells installed at the site encountered groundwater at depths ranging between 1.5 and 1.8 mbgs. In this regard, groundwater is anticipated in shallow temporary excavations but should be controlled with filtered sump pumps. There is the potential for dewatering to be required at the site and an Environmental Activity and Sector Registry (EASR) or a Permit to Take Water (PTTW) may be required for the excavations in areas of the site. It should be noted that the requirements for a PTTW, issued by the Ontario Ministry of the Environment, Conservation and Parks (MECP) have been established so that daily water takings of 50 m^3/day require registration of the MECP EASR database, and daily water takings of 400 m^3/day require a PTTW. Both the EASR and the PTTW require a hydrogeological assessment report to support the specific application. In addition, a permit to discharge the collected water to the sewer system/water body will be required from the applicable agency.

It is recommended that a hydrogeological assessment be completed at the site by WSP to determine if an EASR or a PTTW will be required for the development of this site. In this regard, it is recommended to continue monitoring groundwater levels in the monitoring wells that were installed as part of the geotechnical investigation, for one year, to obtain seasonal groundwater fluctuations, and to complete groundwater sampling and testing. A PTTW application requires a minimum of 90 days for the MECP to process; in this regard, appropriate lead time should be factored into the overall project schedule to accommodate the PTTW process, if required.

5.8 PIPE BEDDING AND COVER

The native 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 150 mm. The thickness of the bedding may, however, may have to be increased depending on the pipe diameter or in accordance with local

standards or if wet or weak subgrade conditions are encountered, especially when the soil at the trench base level consists of wet, dilatant silt. 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 or municipality, should be placed. It is recommended that WSP be on site during excavations to assess the suitability of the subgrade materials to support the pipes.

If localized wet trench conditions are encountered, a uniformly graded clear stone may be used provided a suitable, approved filter fabric (geotextile) is placed in conjunction with the clear stone. The geotextile must extend underneath the clear stone, along the sides of the trench, and wrapped on top of the clear stone such that **the clear stone is fully wrapped by the geotextile.** A minimum geotextile overlap of 1 m is required; alternatively stitching of the geotextile could be considered.

Localized, wet and unstable soils encountered within generally stable soil zones can be generally stabilized by 'punching' a 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 and should be examined by WSP personnel during the construction operations.

Alternatively, if longer stretches of unstable soils are encountered, Class 'A' bedding could be considered. The rigid concrete bedding (lean mix concrete) should be laid from manhole to manhole to mitigate the potential for differential settlement.

As noted above, it is recommended that geotechnical personnel from WSP be on site on a full-time basis during the excavation operations to confirm the suitability of the subgrade materials for supporting the sewers / services.

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. In areas where the services will be constructed beneath the groundwater table, to limit the volume and rate of groundwater travelling through the pipe bedding, trench plugs should also be considered.

5.9 TRENCH BACKFILL

The excavated soils can be used as construction backfill provided their moisture content at the time of placement is within 2% of the optimum moisture content and that the soils do not contain organic content. Boulders or cobbles greater than 200 mm in size should be removed from the trench backfill. WSP should be on site during all trench backfilling operations to confirm the suitability of the material being used.

For the granular soils, smooth drum type vibratory rollers are recommended. Cohesive soils, if encountered, should be compacted with sheepsfoot type vibratory compactors. The trench backfill should be placed in maximum 0.3 m lift thickness and compacted to at least 98 percent of its SPMDD. Trench backfilling operations should be avoided during freezing weather.

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. If required, consideration may also be given to backfilling trenches with a well graded, compacted granular soil such as Granular 'B' material.

It should be noted that the excavated soils are subject to moisture content increase during wet weather which would make these materials too wet for the compaction requirements noted above. Stockpiles should therefore be covered with tarpaulins to help minimize moisture increases.

5.10 INFILTRATION CHARACTERISTICS

Graphical depictions of the laboratory grain size analysis performed on a sample recovered from the boreholes is attached as ***Enclosure 5***. Based on the gradation results, the material encountered is tabulated below.

MATERIAL	BOREHOLE SAMPLE	PERCOLATION TIME PERMEABILTY (MIN/CM)
Gravel and Sand	BH18-4, Sample 2	10 to 20
Clayey Silt	BH18-1 & BH 18-3, Samples 5 & 4	>50

We note that the Percolation Time ("T" time) or Permeability of the subsoil sampled was estimated. The non-cohesive soil material, as defined in the Ministry of the Environment Manual of Policy, Procedures and Guidelines for Onsite Sewage Systems, in the appendices 6.3.1 and 6.3.2, mostly resembles the soil with medium permeability; while the cohesive soil would be considered to exhibit an unacceptable permeability for infiltration. We must state that the values are strictly for an unsaturated sample.

The values are also solely based on the grain size distribution analysis shown in appendices 6.3.1 and 6.3.2 in the Ministry of the Environment Manual of Policy, Procedures and Guidelines for Onsite Sewage Systems. Furthermore, the estimate provided is indicative of the samples in a disturbed state only. We must emphasize that factors between boreholes such as, but not limited to, structure, consistency, density, organic content and degree of saturation influence the estimates.

An accurate analysis of soil infiltration characteristic is best determined with on-site permeameter testing at the location and level of the proposed infiltration condition.

5.11 PRELIMINARY PAVEMENT DESIGN

The investigation has shown that the predominant subgrade soils encountered at the site, after stripping any topsoil / organic soils and loose surficial / fill soils, will be comprise silty clay, sandy silt or possibly gravel and sand.

Prior to the placement of granular materials as part of the pavement structure, the subgrade should be prepared and heavily proof-rolled under the supervision of WSP. Any poorly performing areas should be sub-excavated and replaced with either granular earth fill approved by WSP or imported Granular B, Type I material conforming to the requirements of OPSS.

Based on the above and if traffic usage will be residential local, in accordance with the Town of Blue Mountains, the following minimum pavement thickness is recommended:

PAVEMENT LAYER	COMPACTION REQUIREMENTS	LOCAL
Asphaltic Concrete	92.0 to 96.5% Maximum Relative Density (MRD)	40 m HL3
		40 mm HL4
OPSS Granular A Base	100% SPMDD	150 mm
OPSS Granular B Type 'I'	100% SPMDD	450 mm

We note that the pavement design noted above should be considered preliminary only. If required, a more refined pavement structure design can be performed based on specific traffic data and design life requirements and will involve specific laboratory tests to determine frost susceptibility and strength characteristics of the subgrade soils, as well as specific data input from the client.

5.12 DESIGN REVIEW, TESTING AND INSPECTIONS

WSP requests to be afforded the opportunity to complete a final review of the proposed development discussed in this report to verify that geotechnical recommendations are appropriate. If not given this opportunity, we cannot assume liability for omissions, misinterpretations or deficiencies in our recommendations.

WSP should be contacted to provide geotechnical testing and inspections during construction operations. Exposed subgrade soils for all structures are to be inspected to confirm the material is stable and competent. Inspections of seepage and groundwater conditions during construction are also required, as discussed in this report. Testing and inspections for general QA/QC are to include sampling and laboratory testing of fill materials and asphalt, compaction testing for the placement of fill materials and asphalt, and field and laboratory testing of concrete (including mix design reviews).

FIGURES

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PROJECT: GEOTECHNICAL INVESTIGATION, RIDGE ESTATES, CLARKSBURG, ONTARIO

CLIENT: SOLCORP DEVELOPMENTS

TITLE: SITE LOCATION PLAN

SCALE: 1:4000

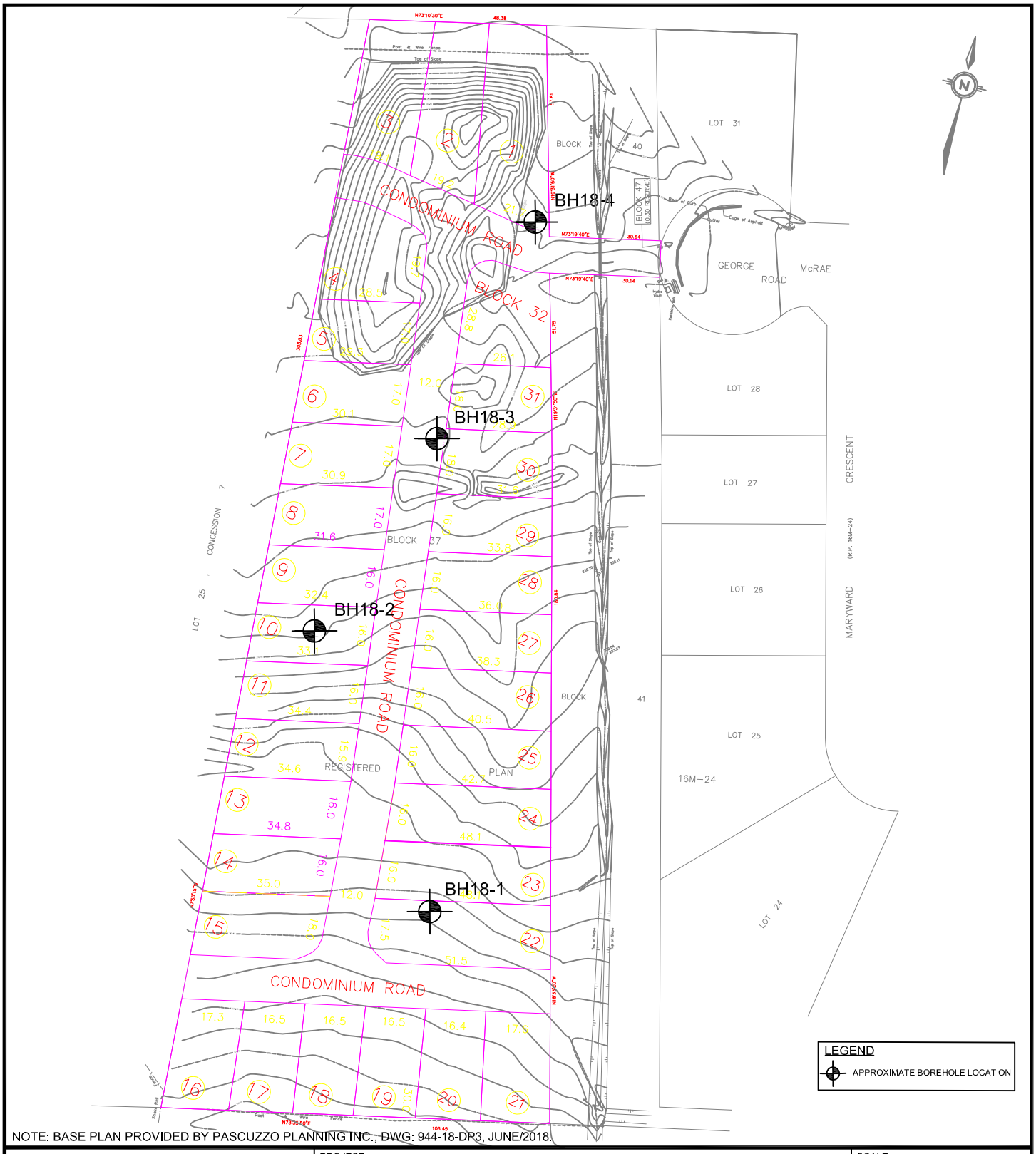
DATE: JUNE / 2018

PROJECT NO: 181-07496-00

FIGURE NO: 1

REV. #

K:\PROJECTS\2018\181-07496-00 ridge estates\SITE LOCATION PLAN_181-07496-00.dwg Aug 13, 2018-12:48pm BY:(kaurel.tamasauskas)



NOTE: BASE PLAN PROVIDED BY PASCUZZO PLANNING INC., DWG: 944-18-DR3, JUNE/2018.

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PROJECT:

GEOTECHNICAL INVESTIGATION
RIDGE ESTATES, CLARKSBURG, ONTARIO

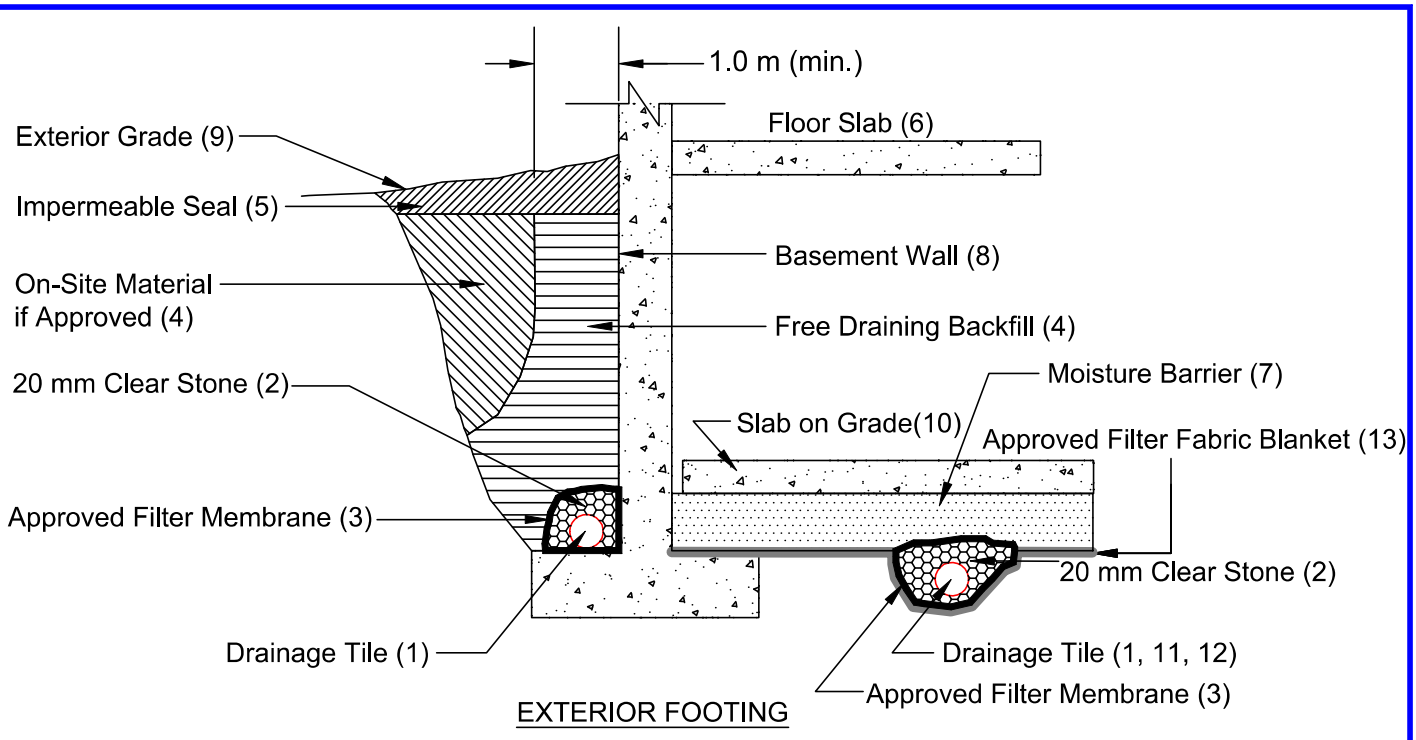
TITLE:

BOREHOLE LOCATION PLAN

SCALE:	1:1500
DRAWN BY:	KMT
PROJECT NO:	181-07496-00
DATE:	JUNE / 2018
FIGURE NO:	2
REV. #.	-

K:\PROJECTS\2018\181-07496-00 ridge estates\BH LOCATION PLAN.dwg Aug 16, 2018-11:06am BY:(kaurel.tamasauskas)

Project: Drawing No. 3



Notes

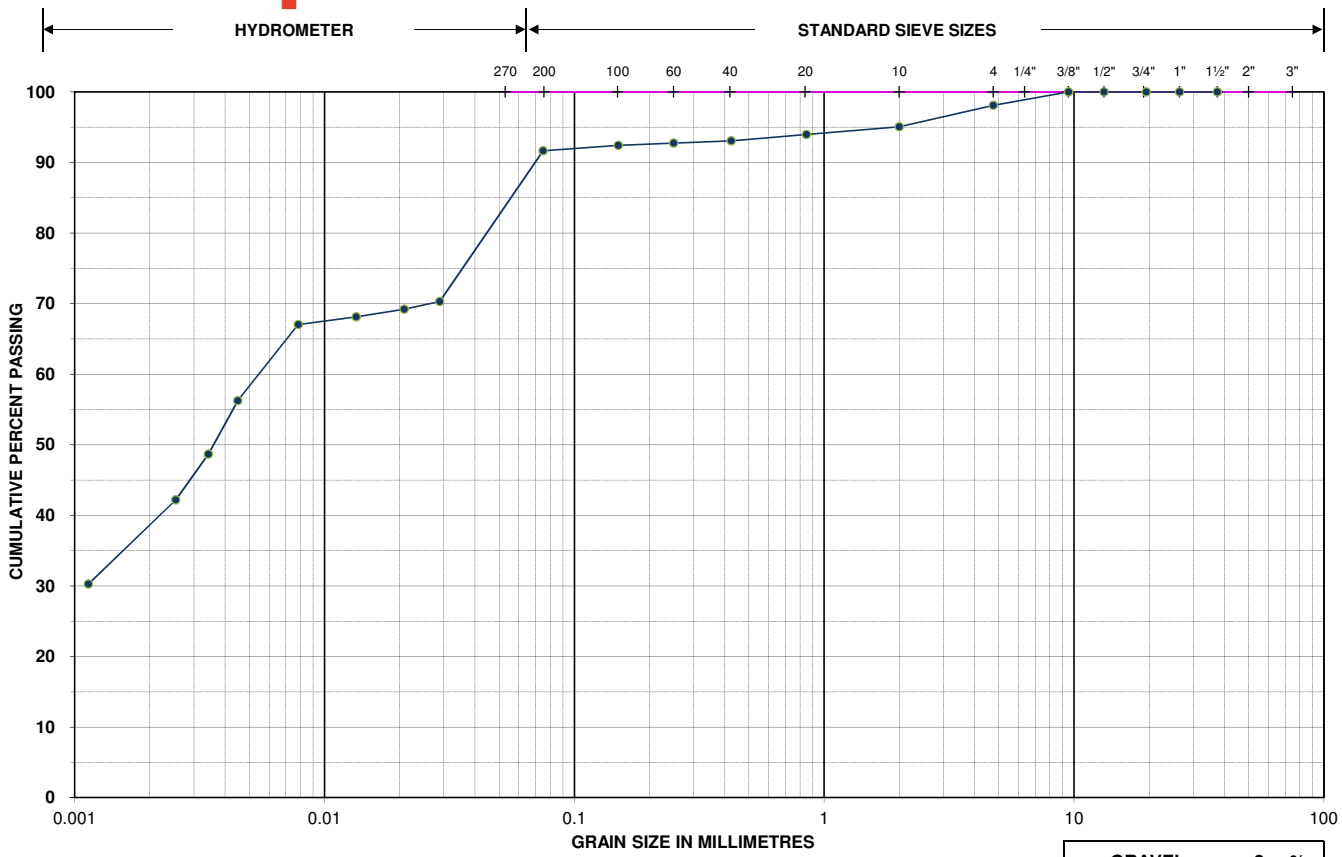
1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with 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)

ENCLOSURES

ENCLOSURES 1 - 4: BOREHOLE LOGS
ENCLOSURES 5 - 7: LABORATORY ANALYSES

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

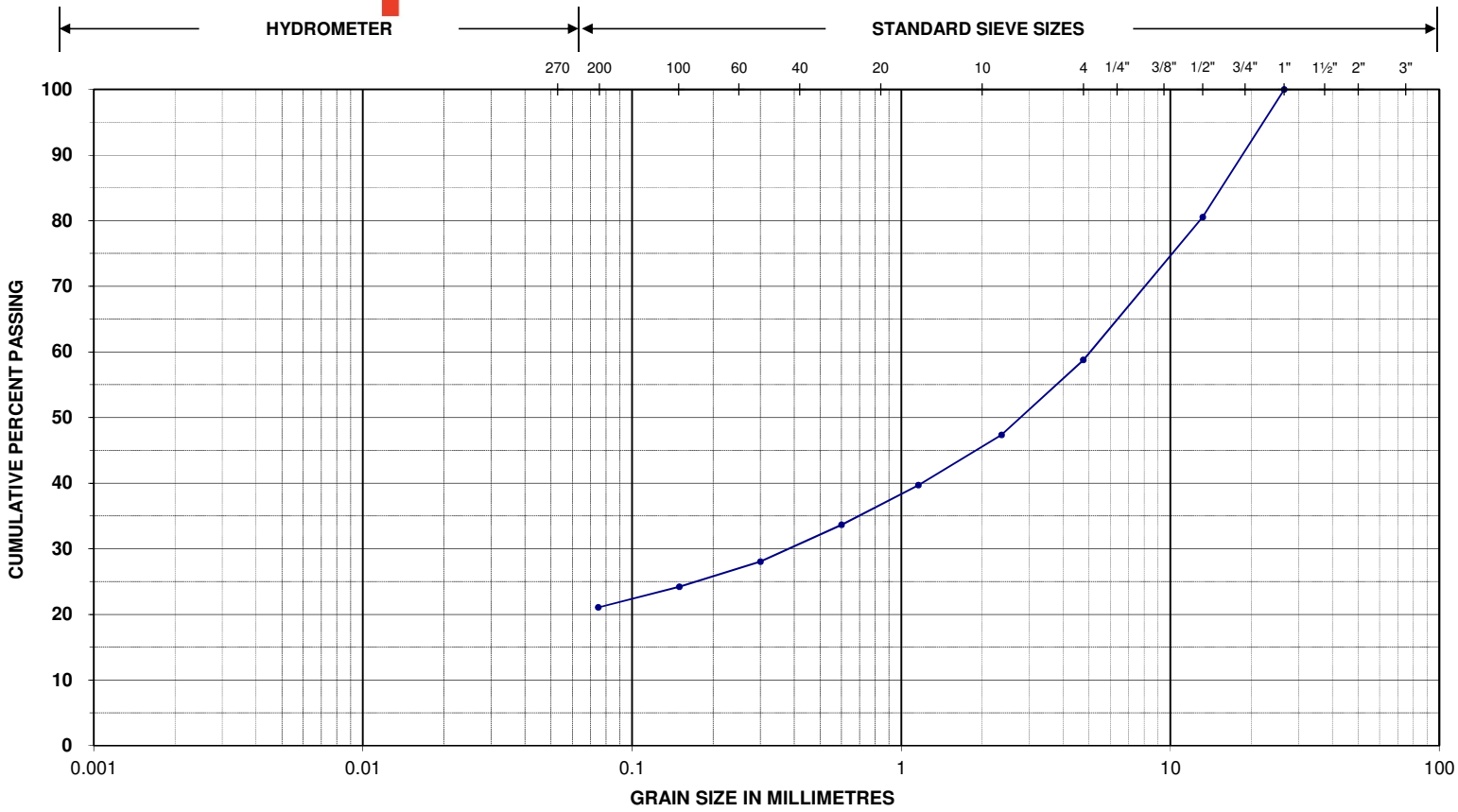
GRAVEL	**2**	**%**
SAND	**6**	**%**
SILT	**54**	**%**
CLAY	**38**	**%**

Project Name:	Ridge Estates	**Project No.:**	181-07496-00
Location ID.:	BH18-1	**Sample No./Depth:**	SS5 / 1.5-2.0 m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
26.5 mm	100.0	**0.850 mm**	93.9	**0.029**	70.3
13.2 mm	100.0	**0.425 mm**	93.1	**0.013**	68.1
9.50 mm	100.0	**0.250 mm**	92.7	**0.004**	56.2
4.75 mm	98.1	**0.106 mm**	92.4	**0.003**	42.2
2.00 mm	95.0	**0.075 mm**	91.6	**0.001**	30.3

Enclosure No.:

PARTICLE SIZE DISTRIBUTION



Unified Classification System

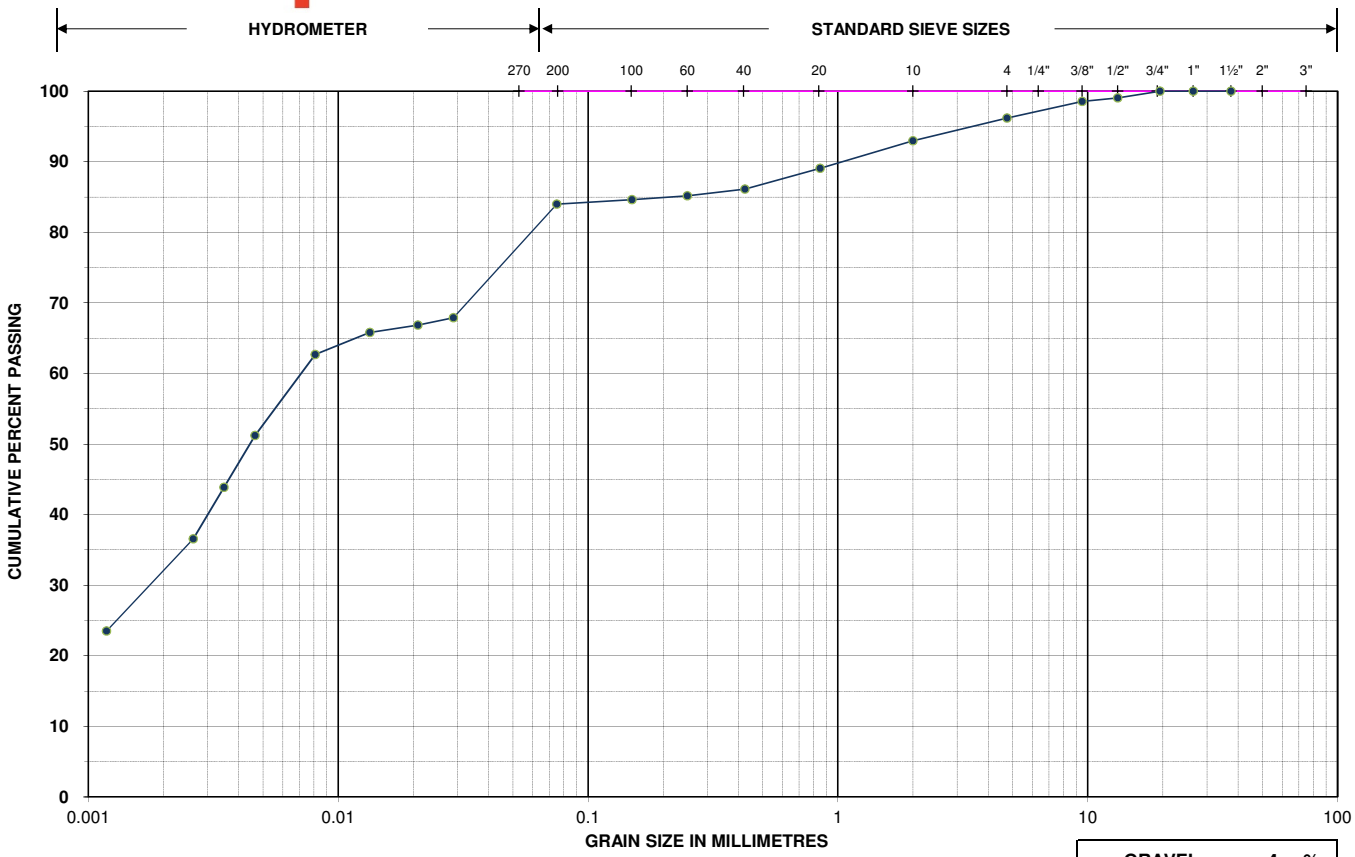
SILT AND CLAY	SAND	GRAVEL

Project Name:	Ridge Estates	**Project No.:**	181-07496-00
Location ID.:	BH18-4	**Sample No./Depth:**	SS2, 0.8-1.2 m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine
37.5 mm	100.0	**1.16 mm**	39.7
26.5 mm	100.0	**0.60 mm**	33.6
13.2 mm	80.5	**0.30 mm**	28.0
4.75 mm	58.8	**0.15 mm**	24.2
2.36 mm	47.3	**0.075 mm**	21.1

Enclosure No.:

PARTICLE SIZE DISTRIBUTION ASTM D422



Unified Classification System

SILT AND CLAY	SAND	GRAVEL

GRAVEL	**4**	**%**
SAND	**12**	**%**
SILT	**51**	**%**
CLAY	**33**	**%**

Project Name:	Ridge Estates	**Project No.:**	181-07496-00
Location ID.:	BH18-3	**Sample No./Depth:**	SS4 / 2.3-2.7 m

Sieve Size	% Passing Coarse	Sieve Size	% Passing Fine	Hydrometer (mm)	% Passing
26.5 mm	100.0	**0.850 mm**	89.1	**0.029**	67.9
13.2 mm	99.1	**0.425 mm**	86.1	**0.013**	65.8
9.50 mm	98.5	**0.250 mm**	85.2	**0.005**	51.2
4.75 mm	96.2	**0.106 mm**	84.6	**0.003**	36.6
2.00 mm	93.0	**0.075 mm**	84.0	**0.001**	23.5

Enclosure No.:

APPENDIX A

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.

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 fill 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. Excavations within the engineered fill 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 are 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 from 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 WSP Canada Inc. Without this confirmation no responsibility for the performance of the structure can be accepted by WSP Canada Inc. 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 proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a WSP Canada Inc. engineer prior to placement of fill.

5. The approved engineered fill material must be compacted to 100% Standard Proctor Maximum Dry Density throughout. Engineered fill should not be placed 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 WSP Canada Inc. during placement of engineered fill is required. Work cannot commence or continue without the presence of the WSP Canada Inc. representative.

7. The fill must be placed such that the specified geometry is achieved. Refer to the attached 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 bearing capacity of 150 kPa at SLS (225 kPa at ULS) can 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.

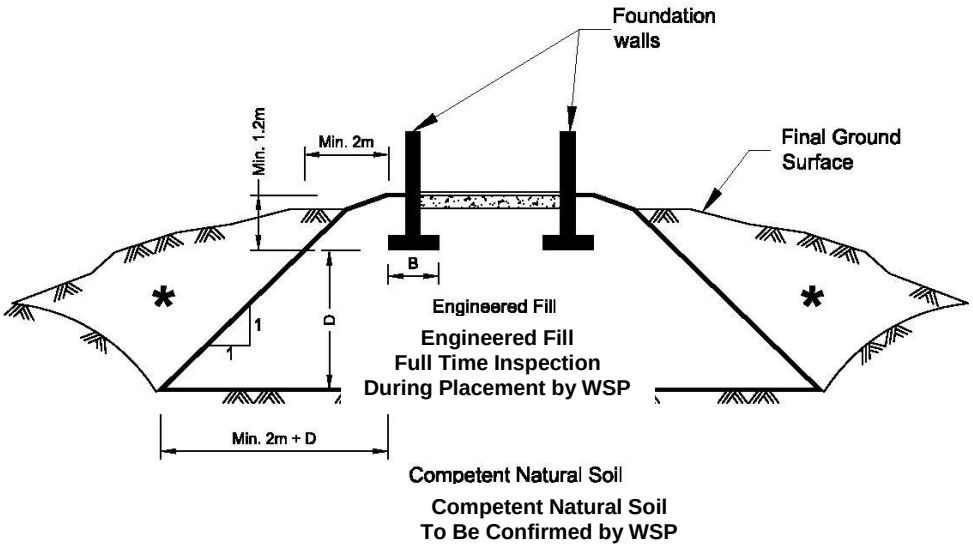
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from WSP Canada Inc. prior to footing concrete placements. All excavations must be backfilled under full time supervision by WSP Canada Inc. 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 WSP Canada Inc.

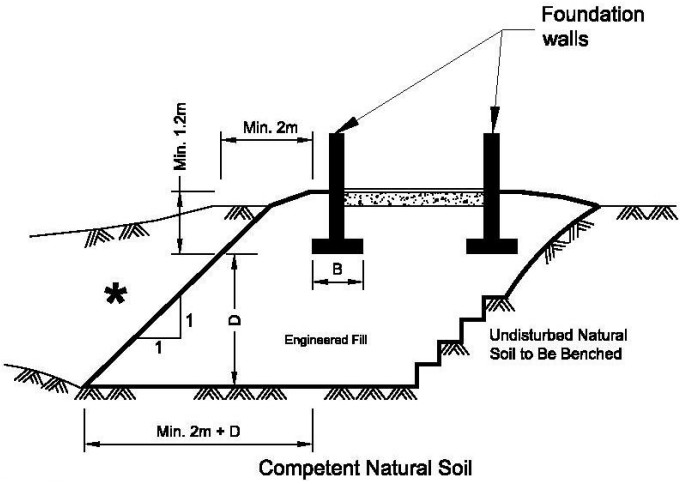
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any 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 WSP Canada Inc. report attached.





* **Backfill in this area to be as per WSP report.**