NATIONAL HOMES (PLAINS ROAD) LP

GEOTECHNICAL INVESTIGATION
PROPOSED MIXED-USE DEVELOPMENT
484 - 490 PLAINS ROAD EAST, BURLINGTON, ONTARIO

OCTOBER 25, 2017

WSP

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NATIONAL HOMES (PLAINS ROAD) LP

Report

Project nº : 161-09479-00
Date : October 25, 2017

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1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by National Homes (Plains Road) LP, herein referred to as National Homes to undertake geotechnical investigations for the site located at 484 - 490 Plains Road East, Burlington, Ontario.

Based on the Conceptual Site Plan provided, the site is proposed for a mixed-use of residential and commercial development consisting of eight-storey buildings and three-storey stacked townhomes. One level of underground parking is designed across the majority of the site.

In 2016, a preliminary geotechnical investigation was conducted by WSP for the then proposed townhome with no basement development during the due-diligence period. Additional boreholes were drilled in 2017, at the south part of the site where the proposed six-storey buildings are located.

This report is provided 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. 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 National Homes and its designers. Third party use of this report without WSP's consent is prohibited. The limitation conditions presented in this report form an integral part of the report and they must be considered in conjunction with this report

2 FIELD AND LABORATORY WORK

The field work for the above noted investigations were carried out on June 29 to 30, 2016 and April 17 to 18, 2017 at which time thirteen (13) boreholes were advanced to depths ranging from 6.7 m to 17.2 m below the existing ground surface at the locations shown on the Borehole and Monitoring Location Plan, Drawing No. 1. Boreholes BH16-1 to BH16-8 were drilled during 2016 investigation while Boreholes BH17-7 to BH17-11 were drilled during 2017 investigation.

The boreholes were carried out using a track mounted drilling machine provided by a drilling sub-contractor under the direction and supervision of WSP personnel. Soil samples were retrieved at regular intervals of depth from the boreholes with a 50 mm O.D. split-barrel sampler driven into the undisturbed ground with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The number of blows required to advance the sampler 300 mm were recorded as the STP 'N' values which then were used to infer the compactness conditions of the cohesionless, granular soils and the consistency of cohesive clayey soils. Notes on sample descriptions are presented on Enclosure No. 1-A. Explanation of terms used in the record of boreholes is presented on Enclosure No. 1-B.

Water level observations were made during drilling in the open boreholes and upon the completion of the drilling operations. 50 mm diameter monitoring wells were installed in Boreholes BH16-2, BH16-3, BH16-

4, BH16-6, BH16-7 and BH17-9 to permit further monitoring of the groundwater levels as well as for the environmental study and potential hydrogeological study.

The borehole locations were laid out on site by WSP. The locations and ground surface elevations of the boreholes were surveyed by WSP using a Global Positioning System (GPS) device. It should be noted that the locations and elevations at the as-drilled borehole locations were not provided by a professional surveyor and should be considered to be approximate.

In addition to the visual examination of the recovered soil samples in the laboratory, all samples were tested for natural water contents. Three (3) and one (1) selected soil samples were subjected to grain size analyses and Atterberg limit testing, respectively. The results are shown on the borehole logs and presented on Figure Nos. 1 to 4.

3 SITE AND SUBSURFACE CONDITIONS

The subject site is an existing commercial plaza consisting of a roughly rectangular shaped parcel of land located at 484-490 Plains Road East, about 100 m southwest of the intersection of Plains Road East and Sanford Drive, Burlington, Ontario. It is understood that the existing plaza will be demolished. On three sides the property is bordered by existing residential subdivisions, and by Plains Road on the fourth.

3.1 SOIL CONDITIONS

The subsurface conditions in the boreholes (BH16-1 to BH16-8 and BH17-7 to BH17-11) are presented in the individual borehole logs (Enclosure Nos. 2 to 14 inclusive). The following is a summarized account of the subsurface conditions encountered in the boreholes, followed by more detailed descriptions of the major soil strata and the groundwater conditions encountered in the boreholes drilled at the site.

Summary

Underlying the asphalt pavement and fill materials, the native soils encountered at the site are predominantly silty sand underlain by silty clay (till). Groundwater measured in the monitoring wells was about 3.5 to 4.9 m below the existing ground surface, corresponding to Elev. 92.4 to 94.3 m.

Existing Pavement Structure

All boreholes were advanced through the existing pavement structure at the site. The thickness of the asphalt ranged from 50 mm to 180 mm, with an average of about 115 mm. The average thickness of the granular base was about 180 mm with a range of 80 to 400 mm.

Fill Material

Fill materials consisting of silty sand was encountered in all boreholes and extended to depths ranging from 2.2 m to 3.4 m (average 2.8 m) below the existing ground surface. SPT carried out within the fill material gave ‘N’ values ranging from 0 to 16 blows per 300 mm penetration, indicating a very loose to compact state but generally loose with an average ‘N’ value of less than 5. The in-situ water contents of the soil samples ranged from approximately 6 % to 26 %.

Silty Sand to Sandy Silt

Deposits of silty sand to sandy silt were encountered in all boreholes and extended to the depths ranging from 6.5 m to 17.2 m below the existing ground surface. Boreholes BH16-1, BH16-5, BH17-7 and BH17-9 were terminated in these deposits. The silty sand to silty sand deposits were in a very loose to very dense condition with measured SPT 'N' values ranging from 4 to greater than 100 blows per 300 mm penetration. The natural water contents of the soil samples ranged from about 9 % to 30 %.

Grain size analysis of one (1) soil sample (BH16-3/SS6) gave the result presented on Figure No. 1 indicating the following soil fractions:

Grain Size Distribution

Borehole No.	Sample No.	Grain Size Distribution			
		%Gravel	%Sand	%Silt	%Clay
BH16-3	SS6	0	76	19	5

Sand

Sand was encountered in Borehole BH17-9 and extended to a depth of 7.1 m below ground surface. SPT carried out within the cohesionless sand gave an "N" value of 14 blows per 0.3 m penetration, indicating a compact density. The natural water content is about 22 %.

Grain size analysis of one (1) soil sample (BH17-9/SS5) gave the result presented on Figure No. 4 indicating the following soil fractions:

Grain Size Distribution

Borehole No.	Sample No.	Grain Size Distribution			
		%Gravel	%Sand	%Silt	%Clay
BH17-9	SS5	1	88	7	4

Silty Clay Till

Deposits of silty clay till were encountered in all boreholes with the exception of Borehole BH16-1 and BH16-5 and extended to depths ranging from 8.2 m to 15.7 m below the existing ground surface. Boreholes BH16-2 to BH16-4, BH16-6 to BH16-8 and BH17-8 were terminated in these deposits. SPT 'N' values ranging from 17 blows to greater than 100 blows per 300 mm penetration indicate a very stiff to hard consistency. The natural water contents of the soil samples ranged from about 10 % to 22 %.

The result of one (1) grain size analysis is shown on the borehole logs and on Figure No. 2 and is also summarized in the following table:

Grain Size Distribution

Borehole No.	Sample No.	Grain Size Distribution			
		%Gravel	%Sand	%Silt	%Clay
BH17-8	SS10	6	12	47	35

Atterberg limits test was carried out on the same sample. The result is presented on Figure No. 3 as well as shown on the borehole logs. It is also summarized in the following table:

Plasticity Indices

BH No.	Sample No.	Atterberg Limits		
		Liquid Limit (WL)	Plastic Limit (WP)	Plasticity Index (PI)
BH17-8	SS10	30	16	14

Silty Clay

Silty clay deposits were encountered in Boreholes BH17-7 and BH17-9 to BH17-11 and extended to depths ranging from 13.9 m to 15.7 m below the existing ground surface. Boreholes BH17-10 and BH17-11 were terminated in these deposits. SPT 'N' values ranging from 29 blows to 77 blows per 300 mm penetration indicate a very stiff to hard consistency. The natural water contents of the soil samples ranged from about 16 % to 32 %.

3.2 GROUNDWATER CONDITIONS

During the drilling of the boreholes groundwater was encountered at depths ranging from approximately 3 m to 4.6 m below the existing grade in all boreholes. The groundwater tables measured in the monitoring wells are shown in the following table:

Groundwater Levels Measured in Monitoring Wells

Borehole No.	Date of Observation	Depth of Groundwater(m)	Elevation of Groundwater(m)	Note
BH16-2	July 11, 2016	4.78	92.5	50 mm dia. monitoring well
	October 24, 2016	4.94	92.4	
BH16-3	July 11, 2016	4.58	93.1	50 mm dia. monitoring well
	October 24, 2016	4.75	93.0	
	December 10, 2016	4.79	92.9	
	February 7, 2017	4.74	93.0	
BH16-4	July 11, 2016	3.90	93.9	50 mm dia. monitoring well
	October 24, 2016	4.07	93.7	
	December 10, 2016	4.15	93.7	
	February 7, 2017	4.13	93.7	
BH16-6	July 11, 2016	3.86	92.8	50 mm dia. monitoring well
	October 24, 2016	4.03	92.7	
	December 10, 2016	4.10	92.6	
	February 7, 2017	3.97	92.7	
BH16-7	July 11, 2016	3.50	94.3	50 mm dia. monitoring well
	October 24, 2016	3.65	94.2	
	December 10, 2016	3.75	94.1	

	February 7, 2017	3.72	94.1	
BH17-9	May 25, 2017	4.06	94.0	50 mm dia. monitoring well

It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to weather events. Due to the presence of highly pervious sandy deposits, a sudden significant rise in the ground water level could occur after heavy precipitation or snow melt.

4 GEOTECHNICAL RECOMMENDATIONS

In this section, the subsurface conditions are interpreted as they relate to the design of the proposed mixed-use of residential and commercial development consisting of eight-storey buildings and stacked three-storey townhouses. Anticipated construction conditions are also evaluated for the guidance of the designer to establish constructability.

The construction methods described in this report must not be regarded as being specifications or direct recommendations to the contractors, or as being the only suitable methods. Prospective contractors should evaluate all of the factual information, obtain additional subsurface information as they might deem necessary and should select their construction methods, sequence and equipment based on their own experience in similar ground and groundwater conditions. Readers of this report are also reminded that the conditions are known only at the borehole location and subsurface conditions may be significantly different in the unexplored parts of the site.

4.1 SITE PREPARATION, REGRADING, ENGINEERED FILLS

It is understood that the existing buildings presently occupying the site will be demolished to make room for the proposed eight-storey building and three-storey townhomes. It is, therefore, anticipated that cut and fill operations would be required to establish appropriate uniform subgrade levels throughout the site.

It is recommended that the foundation walls and footings of the existing structures be completely removed in order to prevent these becoming “hard points” under future buildings and thus cause excessive differential settlements. Similarly the existing fill material should be removed in areas where settlements cannot be tolerated.

In the areas where earth fill is required for site grading purposes, engineered fill may have to be utilized to support pavements and utilities.

For the preparation of subgrade prior to the placement of the engineered fill, all existing pavement structure, fill material, existing foundations and softened native soils must be removed and the exposed subgrade proof rolled. Any soft spots revealed during proof rolling must be sub-excavated and re-engineered, and the excavation base must be inspected and approved by this office prior to the placement of backfill. It is noted that the existing fill material extended to between about 2.2 m and 3.4 m below existing ground surface and may be even deeper in places between the boreholes. The extent of the existing fill materials must be inspected at the time of construction to assure that all fill material is removed prior to the placement of the engineered fill. Materials for the use of engineered fill must be approved by WSP prior to placement. Some of the excavated fill and native soils from the site, free of significant amounts of organics and other deleterious materials, may be reused as engineered fill.

It should also be noted that due to the fine-grained nature of the soils encountered at the site, their workability is sensitive to moisture conditions and some difficulty would be expected in achieving adequate compaction during wet weather. In this regard, imported materials may have to be used for engineered fill.

The materials used for engineered fill must be approved by WSP at the source(s), prior to hauling to the site. The engineered fill consisting of approved inorganic material should be placed in maximum 300 mm loose lifts and uniformly compacted to 100 % Standard Proctor Maximum Dry Density (SPMDD) throughout.

The excavated soils are not considered to be free draining. Where free draining backfill is required, imported granular fill such as OPSS Granular B should be used.

General guidelines for the placement and preparation of engineered fill are presented in Appendix A and will not be discussed further here.

4.2 FOUNDATIONS

As per the Conceptual Site Plan, eight-storey buildings with one level of underground parking, numbered as Buildings 'A' and 'B', are proposed at the north part of the site. Three-storey stacked back to back townhomes with one level of underground parking, numbered as Buildings 'C' to 'H', are proposed at the middle and south portion of the site. Based on the borehole information, the types of proposed structures, and the anticipated excavation depth for one level of underground parking, the proposed eight-storey building is recommended to be supported by deep foundation (i.e. caisson); while the three-storey townhomes can be supported by conventional shallow foundations.

4.2.1 FOUNDATIONS FOR TOWNHOMES

The existing very loose to loose fills are not suitable for supporting any settlement sensitive structures. The proposed townhome foundation bases can be supported by spread/strip footings founded on the compact native silty sand encountered below the fills. The bearing resistances of the native silty sand at the Serviceability Limit States (SLS) and the factored geotechnical resistances at the Ultimate Limit States (ULS), together with the corresponding founding elevations at the borehole locations, are summarized in the following table.

Bearing Soils and Founding Levels of Footings

Borehole No.	Ground Surface Elevation (m)	Bearing Resistance at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth below Existing Ground* (m)	Approximate Minimum Founding Elevations (m)	Anticipated Bearing Soil	Groundwater Level/Elevation
BH16-2	97.3	100	150	3.6	93.7	Silty Sand	4.8/92.5
BH16-3	97.7	100	150	2.3	95.4	Silty Sand	4.6/93.1
BH16-5	97.5	100	150	3.6	93.9	Silty Sand	-
BH16-6	96.7	100	150	3.1	93.6	Silty Sand	3.9/92.8
BH16-8	97.0	100	150	2.5	94.5	Silty Sand	-

Footings bearing in approved engineered fill should have a minimum width of 500 mm and may be designed using bearing resistance of 100 kPa at SLS, for 25 mm of settlement, and factored geotechnical resistance of 150 kPa at Ultimate Limit States (ULS), provided that all requirements on Appendix A are adhered to.

4.2.2 FOUNDATIONS FOR EIGHT-STOREY BUILDINGS

The proposed eight-storey building can be supported by caissons founded on the silty clay till for a geotechnical resistance of 800 kPa at Serviceability Limit States (SLS) and for a factored geotechnical resistance of 1,200 kPa at Ultimate Limit State (ULS). The founding elevations are summarized in the following table.

Borehole No.	Ground Surface Elevation	Bearing Capacity at SLS (kPa)	Factored Geotechnical Resistance at ULS (kPa)	Minimum Depth below Existing Ground (m)	Founding Level At or Below Elevation (m)
BH17-7	97.6	800	1200	10.7	87.0
BH17-8	98.0	800	1200	11.0	87.0
BH17-9	98.0	800	1200	11.0	87.0
BH17-10	97.8	800	1200	10.8	87.0
BH17-11	97.1	800	1200	10.1	87.0

It should be noted that the caissons will be drilled through the water bearing sandy deposits into the silty clay till deposits. The caissons will require temporary liners for the installations to help prevent the soils from caving and to help control groundwater expected from the sandy deposits. The liner should be socketed into silty clay till for a sufficient depth to form a seal.

Potential difficulty should be expected during the installation of the caissons due to the presence of cobbles/boulders. Appropriate equipment and procedures will be required to penetrate obstructions (cobbles and boulders) that are encountered during drilling for caisson foundations.

4.2.3 OTHER COMMENTS ON FOUNDATIONS

Foundations designed to the specified bearing capacities at the serviceability limit states (SLS) are expected to settle less than 25 mm total and 19 mm differential.

All footing bases must be inspected by this office prior to pouring concrete.

Where it is necessary to place footings in soils 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 footing.

All foundations exposed to seasonal freezing conditions must have at least 1.2 m of soil cover for frost protection or equivalent insulation for frost protection.

It should be noted that the recommended bearing capacities have been calculated by WSP from the borehole information for the preliminary design stage only. The investigation and comments are necessarily on-going as new information of the underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes when foundation construction is underway. 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.

4.3 EARTH PRESSURES

The lateral earth pressures acting on rigid basement walls may be calculated from the following expression:

$$p = K(\gamma h + q)$$

where p = Lateral earth pressure in kPa acting at depth h

K = Earth pressure coefficient equal to 0.45 for vertical walls and horizontal backfill.

γ = Unit weight of backfill, a value of 20.5 kN/m3 may be assumed

h = Depth to point of interest in metres

q = Equivalent value of surcharge on the ground surface in kPa

The above expression assumes that the perimeter drainage system prevents the buildup of any hydrostatic pressure behind the wall.

4.4 FLOOR SLAB AND PERMANENT DRAINAGE

The floor slab can be supported on grade provided all fill materials and surficially softened native soils are removed and the base thoroughly proof rolled.

The fill required to raise the grade can consist of inorganic soil, placed in shallow lifts and compacted to 98 percent of Standard Proctor Maximum Dry Density (SPMDD). A moisture barrier consisting of at least 200 mm of 19 mm clear crushed stone should be installed under the floor slab.

A drainage system will be required around the exterior basement walls and an underfloor drainage will be required beneath the parking floor slab. Typical drainage and backfill recommendations are illustrated on Drawing No.2 for open cut excavation and on Drawing No. 3 for shored basement wall. All openings including the slab subgrade must be covered or wrapped with filter fabric, typically a Class II non-woven geotextile with a filtration opening size (F.O.S.) of 50 to 100 µm.

4.5 EXCAVATIONS AND GROUNDWATER CONTROL

For one level of underground parking, it is anticipated that excavations will excavate through the fill materials into native sand to silty sand where it is near groundwater levels. Should the excavation be extended into the water bearing sand to silty sand deposits, significant groundwater inflow/seepage should be expected from these water bearing deposits, some forms of positive (pro-active) groundwater control or depressurization may be required to maintain the stability of the base and side slopes of the excavations. It should be noted that groundwater control measures that extract more than 50,000 L/day of water are subject to a Permit to Take Water (PTTW), as regulated by the MOECC.

All excavations for the foundation must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the existing fill materials can be classified as Type 3 soil; the native sand to silty sand can be classified as Type 3 Soil above groundwater level and as Type 4 soil below groundwater level.

It is anticipated that all excavations at the site will consist of temporary open cuts with side slopes not steeper than 1 horizontal to 1 vertical (1H:1V) or as recommended by OHSA. However, depending on the construction procedures adopted by the contractor and weather conditions at the time of construction, some local flattening of the slopes may be required.

4.6 TEMPORARY SHORING

Excavations to the one level of underground paring could be carried out without support using side slopes not steeper than 1 horizontal to 1 vertical (1H:1V) in the native silty sand. Within the fill the slopes should be flattened to 1.5H: 1V. Where the excavations at these angles extend beyond the property lines, or close to existing structures, the ground should be supported by an appropriate engineered shoring system such as soldier piles and timber lagging or caisson wall to support adjacent structures, if required.

The shoring system must be designed in accordance with the Fourth Edition of the Canadian Foundation Engineering Manual. The soil parameters estimated to be applicable for this design are as follows:

1) Earth Pressure Coefficients

   (a) where movement must be minimal K=0.45

   (b) where minor movement (.002H) can be tolerated K=0.25

   (c) passive earth pressure for soldier piles (unfactored) Kp=3

2) For stability check

   $\Phi = 32^{\circ}$

   c= 0

   γ = 21 kN/m3

   Surcharge is to be determined by shoring contractor.

The soldier piles should be installed in pre-augered holes taken below the deepest excavation. The holes should be filled with concrete below the excavation level and half bag mix above the base of the excavation. The concrete strength must be specified by the shoring designer. Temporary liners may be required to help prevent the sandy/silty layers/zones from caving during the installation period. The potential for obstructions due to cobbles and boulders in the tills that may impact the soldier pile/caisson installations should be considered by the shoring contractor.

Positive measures may be required to prevent the loss of soil through the spaces between the lagging boards. This could probably be achieved by placing well-graded sand and gravel behind the lagging boards or by installing a geotextile filter cloth.

Movement of the shoring system is inevitable. Vertical movements will result from the vertical load on the soldier piles resulting from the inclined tiebacks and inward horizontal movement resulting from earth and possibly water pressures. The magnitude of this movement can be controlled by sound construction practices, and it is anticipated that the horizontal movement will be in the range of 0.1 to 0.25%H.

To ensure that movements of the shoring are within an acceptable range, monitoring must be carried out. Vertical and horizontal targets on the soldier piles must be located and surveyed before excavation begins.

Weekly readings during excavation should show that the movements will be within those predicted; if not, the monitoring results will enable directions to be given to improve the shoring.

4.7 EARTHQUAKE CONSIDERATIONS

Based on the existing borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed buildings with one level of underground parking can be classified as 'Class D' for seismic site response. It might be possible to upgrade the seismic site class to 'Class C' for the proposed buildings, however, shear wave velocity testing would be needed to bear this out.

4.8 ROAD AND PARKING LOT

The investigation has shown that the predominant subgrade soil, after removing the existing pavement structure, fills and any other organic and otherwise unsuitable subsoil, will generally consist of silty sand.

Based on the subsurface soil conditions encountered at the site and the assumed traffic usage for residential local and collector streets, the following pavement designs are recommended for the proposed road and parking lot:

MATERIAL		THICKNESS OF PAVEMENT ELEMENTS (MM)	
		LOCAL ROAD, LIGHT DUTY PARKING	COLLECTOR, HEAVY DUTY PARKING
Asphaltic Material (OPSS 1150)	HL 3 Surface Course	40	40
	HL 8 Binder Course	50	80
Granular Material (OPSS 1010)	Granular 'A' Crushed Limestone Base	150	150
	Granular 'B'	200	300
		Prepared and Approved Subgrade	

The site subgrade and weather conditions (i.e. if wet) at the time of construction may necessitate the placement of thicker granular sub-base layer in order to facilitate the construction. The need for filter fabric/geo-grid can be evaluated during construction stage. Furthermore, heavy construction equipment 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.

4.8.1 STRIPPING, SUB-EXCAVATION AND GRADING

The site should be stripped of all existing pavement structure, fills and any organic or otherwise unsuitable soils to the full depth of the roads.

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 re-compacted 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.

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 existing fills, organic or other foreign and unsuitable matter. 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 Town Standards. The compaction of the new fill should be checked by frequent field density tests.

4.8.2 CONSTRUCTION

Once the subgrade has been inspected and approved, the granular base and sub-base course materials should be placed in layers not exceeding 300 mm (uncompacted thickness) and should be compacted to at least 98% 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.

4.8.3 DRAINAGE

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

The sub-drains system should consist of 100 mm or 150 mm diameter geotextile wrapped perforated pipe, placed inside a 300 mm X 300 mm trench and surrounded on all sides by 20 mm clear stone (minimum 50 mm at the bottom side), wrapped in filter cloth (Terrafix 270R or approved alternative), overlap to be at least 150 mm as shown on subdrain detail, Drawing No. 2. The pipes should be placed such that the top of the sand filter is at subgrade level and connected to a catchbasins or some other permanently frost free outlet to provide positive drainage. In addition, the subgrade should be graded at a slope of minimum 2% downwards towards the subdrains to promote the drainage.

All paved surfaces should be sloped to provide satisfactory drainage towards catchbasins. The finished pavement surface and underlying subgrade should be free of depressions and should be crowned and sloped in accordance with local municipal design standards to provide effective drainage. As discussed above, by means of good planning any water trapped in the granular base materials should be drained rapidly towards subdrains or other interceptors.

4.9 SITE SERVICING

It should be noted that the design alignments and invert elevations of the sewers and watermains are not known at this time. Once the design underground service pipe alignments and invert depths are available, the following recommendations should be reviewed and amended by the geotechnical engineer, as required. Additional investigation should be carried out in identified areas of insufficient subsurface information.

The native soils and properly constructed engineered fills are considered to be suitable for supporting the pipes, provided the integrity of the base of the trench can be maintained during construction.

4.9.1 TRENCHING EXCAVATION AND DEWATERING

Based on the results of this investigation, the site servicing excavation may be subexcavated through the existing pavement structure, existing sandy fills and silty sand depending on the inverts of the service pipes.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA) (refer to Section 4.5).

4.9.2 BEDDING

The bedding for the underground service pipes should be compatible with local municipality Standards. Where granular bedding is deemed to be acceptable, it should consist of at least 150 mm of OPSS Granular A. 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, depending upon the success of the contractor's groundwater control methods. Where the subgrade is loose, a Geoweb reinforced base can be constructed at the trench base.

Clear stone bedding material should not be used in any case for pipe bedding or to stabilize the base unless it is fully wrapped in a non- woven geotextile. The use of clear stone bedding material should be directed by geotechnical engineer during construction.

Suitable trench backfill materials, preferably sand, for the protection of the sewer and manholes against squeezing shale should be used.

4.9.3 BACKFILLING OF TRENCHES

The excavated materials at suitable water contents may be reused as trench backfill provided they are free of topsoil, organics or other deleterious material, and are placed and compacted as outlined below. Some drying of the wetter silty sand deposits below groundwater table may be required prior to placement. It should also be noted that due to the predominantly fine-grained, silty nature of the majority of the native soils, some difficulty would be expected in achieving adequate compaction during wet weather.

The backfill should be placed in maximum 300 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, frozen soils, etc. should not be used for backfilling.

5 GENERAL COMMENTS AND LIMITATIONS OF REPORT

WSP Canada Inc. should be retained for a general review of the detailed design and specifications to verify that this report has been properly interpreted and implemented. Based on that review the scope of the additional works (boreholes, laboratory tests, analyses) can be determined. If not accorded the opportunity of making this review, WSP will assume no responsibility for interpretation of the recommendations in the report.

This report deals with geotechnical issues only. The Phase One and Phase Two Environmental Site Assessments (ESA) have been carried out and will be reported separately.

The comments given in this report are intended only for the guidance of design engineers. This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to WSP at the time of preparation. Unless otherwise agreed in writing by WSP, 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 widely spaced borehole locations. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations and conditions which were not detected or could be anticipated at the time of the site investigation may exist. 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. This work has been undertaken in accordance with normally accepted geotechnical engineering practices and for site assessments.

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

6 CLOSURE

Once the final development plans are available, the information in this report should be reviewed by the geotechnical engineer to ensure that the recommendations provided in this report are compatible with the actual proposed development plans for the site.

We trust that the information contained in this report is complete within our terms of reference. Should you have any questions, please do not hesitate to contact this office.

SIGNATURES

PREPARED BY

For 李文涛

Jack Li, E.I.T.
Geotechnical Group

PREPARED BY

For

Michael Hu, E.I.T.
Geotechnical Group

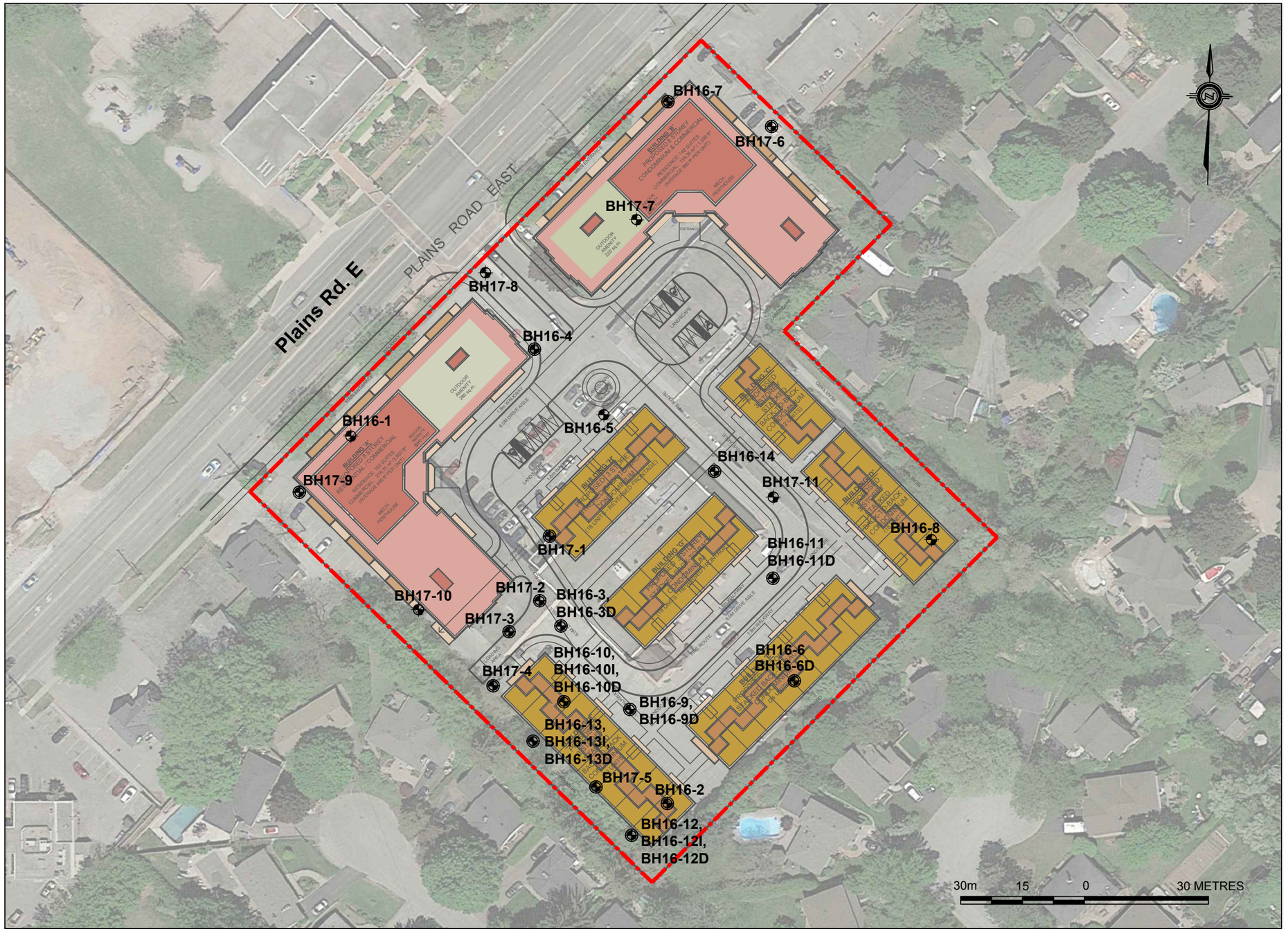
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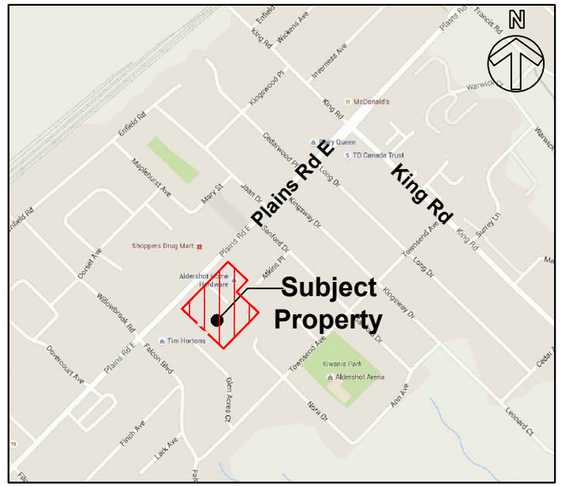
Derek Wang, P.Eng.
Geotechnical Manager

LICENSED PROFESSIONAL ENGINEER
P.S. WANG
100134957
PROVINCE OF ONTARIO

DRAWINGS

DRAWING 1	BOREHOLE LOCATION PLAN
DRAWING 2	DRAINAGE AND BACKFILL RECOMMENDATIONS (OPEN CUT)
DRAWING 3	DRAINAGE RECOMMENDATIONS (SHORED WALL)





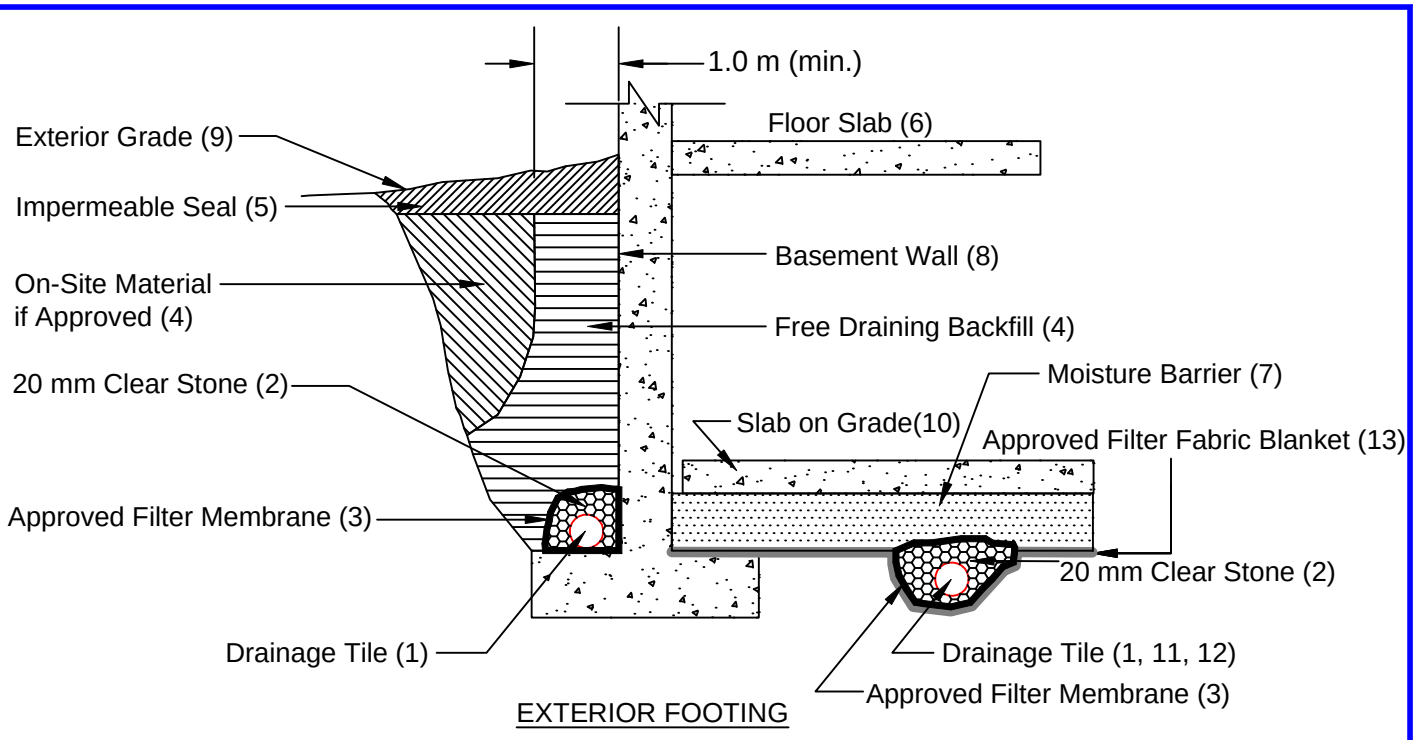
Key Plan
N.T.S.

Legend:

- Subject Property
- Monitoring Well
- Borehole

351 STEELCASE ROAD, UNITS 9-12
MARKHAM, ONTARIO CANADA L3R 4H9
TEL.: 905-475-0065 | FAX: 905-475-0045 | WWW.WSP.COM

Client:	National Homes (Plains Road) LP			Project No.: 161-09479-00	Drawing No.: 1
Drawn:	LWS	Approved:	DW	Discipline:	GEOTECHNICAL
Date:	June 2017	Scale:	As Shown	Title:	Borehole and Monitoring Well Location Plan
Original Size:	Tabloid	Rev:	N/A	Project:	Geotechnical Investigation for Proposed Development 484-490 Plains Road East, Burlington, Ontario

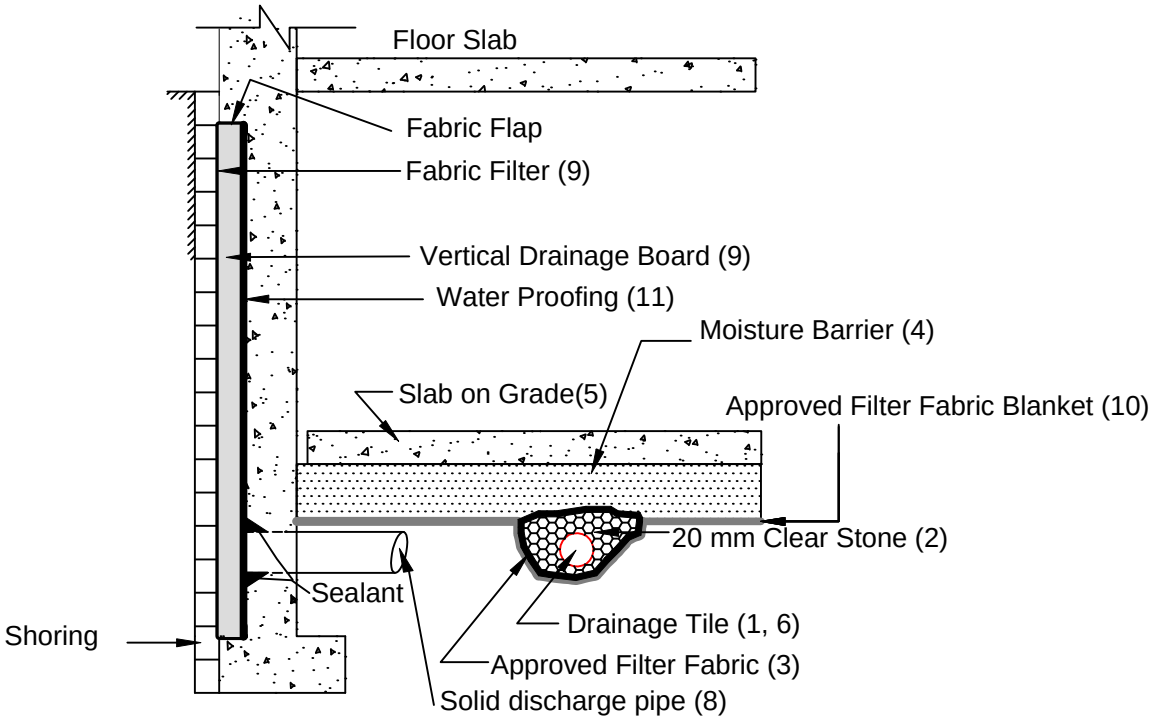


Notes

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)



EXTERIOR FOOTING

Notes

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns.
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. 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.
5. Slab on grade should not be structurally connected to the wall or footing.
6. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab. 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).
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the solider piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board with filter cloth should be kept a minium of 1.2 m below exterior finished grade.
10. The entire subgrade to be sealed with approved filter fabric (Terrafix 270R or equivalent) if non-cohesive (sandy) soils below ground water table encountered.
11. The basement walls should be water proofed using bentonite or equivalent water-proofing system.
12. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable.

DRAINAGE RECOMMENDATIONS
Shored Basement wall with Underfloor Drainage System
(not to scale)

ENCLOSURES

ENCLOSURES 1A NOTES ON SAMPLE DESCRIPTIONS
ENCLOSURES 1B EXPLANATION OF TERMS USED IN THE RECORD OF BOREHOLE
ENCLOSURES 2-14 BOREHOLE LOGS

Enclosure 1-A: Notes on Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by WSP also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that, with the exception of those samples where a grain size analysis and/or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Enclosure 1-B: 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
NR	No recovery
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube 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 (ASTM D2487-10)

Classification	Particle Size
Boulders	> 300 mm
Cobbles	75 mm - 300 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(*)

(*) Canadian Foundation Engineering Manual (4th Edition)

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

Terminology	Proportion
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

Soil Description

a) Cohesive Soils(*)

Consistency	Undrained Shear Strength (kPa)	SPT "N" Value
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) 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

Density Index (Relative Density)	SPT "N" Value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	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

LOG OF BOREHOLE BH16-1

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796798 E 594288

DRILLING DATA
Method: Solid Stem Auger
Diameter: 115mm
Date: Jun/29/2016

REF. NO.: 161-09479-00
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
98.0							
97.8 0.2	**ASPHALT** (150 mm) **GRANULAR BASE** (80 mm) **FILL:** silty sand, trace clay, redish brown, moist, very loose.		1	AUGER			
			2	SS	0		97
			3	SS	2		96
95.0 3.0			4	SS	3		
	SILTY SAND: contains clayey silt layers, redishbrown, moist to wet, compact.		5	SS	14		95
			6	SS	14		94
			7	SS	14		93
91.3 6.7	**END OF BOREHOLE** Notes: 1). Water was encountered at 4.6 m below ground surface (bgs) during drilling. 2). Water was at 4.3 m bgs upon completion of drilling. 3). Borehole caved in to a depth of 4.4 m bgs upon completion of drilling.						92

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-2

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796711 E 594366

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Jun/30/2016

REF. NO.: 161-09479-00
ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.3												
0.0	**ASPHALT** (120 mm)											
97.0	**GRANULAR BASE** (210 mm)											
0.3	**FILL:** silty sand, trace clay, redish brown, moist, very loose to loose.		1	AUGER			97					
			2	SS	5							
							96					
			3	SS	6		Bentonite					
			4	SS	2		95					
93.9			5	SS	8		94					
3.4	**SILTY SAND:** trace clay, redishbrown, moist to wet, loose to compact.						Sand					
			6	SS	14		93					
							W. L. 92.4 m Oct 24, 2016					
							92					
							Screen					
			7	SS	27		91					
							90					
			8	SS	30							
89.2												
88.2	**SILTY CLAY TILL:** grey, moist, very stiff.											
8.2	**END OF BOREHOLE**											

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling;
2). 2" well was installed in the borehole upon completion of drilling.

Water Level Reading:

Date	Depth (m)
July 11, 2016	4.78
Oct 24, 2016	4.94

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε_f=3% Strain at Failure

WSP SOIL LOG 161-09479-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-3

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario DATUM: NAD83, ZONE 17
BH LOCATION: N 4796753 E 594339

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Jun/30/2016

REF. NO.: 161-09479-00
ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.7												
0.0 / 97.5	**ASPHALT** (180 mm) **GRANULAR BASE** (100 mm)											
0.3	**FILL:** silty sand, trace clay, redish brown, moist, very loose to loose.		1	AUGER								
			2	SS	4		97					
			3	SS	11		96					
							Bentonite					
95.5												
2.2	**SILTY SAND:** trace clay, redishbrown, moist to wet, loose to compact.		4	SS	14		95					
			5	SS	11							
							94					
							Sand					
			6	SS	20	▽	93					0 76 19 5
							W. L. 93.0 m Feb 07, 2017					
							92					
							Screen					
			7	SS	24		91					
89.9												
7.8 / 89.5	**SILTY CLAY TILL:** grey, moist, very stiff.		8	SS	22		90					
8.2	sand and gravel layer											
	END OF BOREHOLE											

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling;
2). 2" well was installed in the borehole upon completion of drilling.

Water Level Reading:

Date	Depth (m)
July 11, 2016	4.58
Oct 24, 2016	4.75
Dec 10, 2016	4.79
Feb 7, 2017	4.74

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-4

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796820 E 594329

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Jun/29/2016

REF. NO.: 161-09479-00
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.8												
0.0 / 97.5	**ASPHALT** (100 mm) **GRANULAR BASE** (200 mm)											
0.3	**FILL:** silty sand, trace clay, contains clayey silt layer, redish brown, moist, very loose.		1	AUGER								
			2	SS	4		97					
			3	SS	3		Bentonite 96					
			4	SS	2		95					
3 / 94.8												
3.0	**SILTY SAND:** trace clay, redishbrown, moist to wet, loose to compact.		5	SS	17		Sand 94					
							W. L. 93.7 m Feb 07, 2017					
			6	SS	22		93					
							Screen					
			7	SS	15		92					
							91					
7 / 90.7												
7.2	**SILTY CLAY TILL:** grey, moist, very stiff.		8	SS	23		90					
8 / 89.6												
8.2	**END OF BOREHOLE**											

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling;
2). 2" well was installed in the borehole upon completion of drilling.

Water Level Reading:

Date	Depth (m)
July 11, 2016	3.90
Oct 24, 2016	4.07
Dec 10, 2016	4.15
Feb 7, 2017	4.13

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-5

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796805 E 594348

DRILLING DATA
Method: Solid Stem Auger
Diameter: 115mm
Date: Jun/29/2016

REF. NO.: 161-09479-00
ENCL NO.: 6

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS "N" 0.3 m	ELEVATION
97.5 / 0.0	**ASPHALT** (90 mm)				
97.2 / 0.3	**GRANULAR BASE** (160 mm)				
	FILL: silty sand, trace clay, redish brown, moist, very loose.	1	AUGER		
		2	SS	0	97
		3	SS	3	96
		4	SS	2	95
94.5 / 3.0	**SILTY SAND:** trace clay, redishbrown, moist to wet, loose to compact.	5	SS	8	94
		6	SS	18	93
		7	SS	11	92
90.8 / 6.7	**END OF BOREHOLE**				91

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling;
2). 2" well was installed in the borehole upon completion of drilling.

GROUND WATER CONDITIONS

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED
● QUICK TRIAXIAL
+ FIELD VANE & Sensitivity
× LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-6

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796741 E 594395

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Jun/30/2016

REF. NO.: 161-09479-00
ENCL NO.: 7

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
96.7								20 40 60 80 100	10 20 30			
0.0	**ASPHALT** (100 mm)											
96.4	**GRANULAR BASE** (210 mm)											
0.3	**FILL:** silty sand, trace clay, redish brown, moist, very loose to compact.		1	AUGER								
			2	SS	3		96					
			3	SS	4							
93.7			4	SS	11		Bentonite					
3.0	**SILTY SAND:** trace clay, redishbrown, moist to wet, compact.		5	SS	19		94					
							93 Sand					
							W. L. 92.8 m Feb 07, 2017					
			6	SS	11		92					
							Screen					
			7	SS	18		90					
89.6												
7.2	**SILTY CLAY TILL:** grey, moist, very stiff.		8	SS	20		89					
88.5												
8.2	**END OF BOREHOLE**											

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling;
2). 2" well was installed in the borehole upon completion of drilling.

Water Level Reading:

Date	Depth (m)
July 11, 2016	3.86
Oct 24, 2016	4.03
Dec 10, 2016	4.10
Feb 7, 2017	3.97

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-7

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796881 E 594363

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Jun/29/2016

REF. NO.: 161-09479-00
ENCL NO.: 8

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.8												
97.6 0.2	**ASPHALT** (110 mm) **GRANULAR BASE** (90 mm) **FILL:** silty sand, trace clay, redish brown, moist, very loose to compact.		1	AUGER								
			2	SS	8		97					
			3	SS	4		96					
94.8 3.0	**SILTY SAND:** contains clayey silt layers, redishbrown, wet, very lose to compact.		4	SS	4		Bentonite					
			5	SS	10		95					
			6	SS	4		W. L. 94.1 m Feb 07, 2017 Sand					
			7	SS	11		93					
			8	SS	5		92					
			9	SS	15		Screen					
90.1 7.7	**SILTY CLAY TILL:** grey, moist, very stiff.		10	SS	19		91					
89.6 8.2	**END OF BOREHOLE** Notes: 1). Water was encountered at 3 m below ground surface (bgs) during drilling; 2). 2" well was installed in the borehole upon completion of drilling. Water Level Reading: Date Depth (m) July 11, 2016 3.50 Oct 24, 2016 3.65 Dec 10, 2016 3.75 Feb 7, 2017 3.72						90					

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON 20170529.GPJ SPL.GDT 29/5/17

LOG OF BOREHOLE BH16-8

PROJECT: Phase Two and Preliminary Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD83, ZONE 17
BH LOCATION: N 4796775 E 594428

DRILLING DATA
Method: Solid Stem Auger
Diameter: 115mm
Date: Jun/29/2016

REF. NO.: 161-09479-00
ENCL NO.: 9

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
97.0							
0.0 / 96.7	**ASPHALT** (120 mm) **GRANULAR BASE** (150 mm)						
0.3	**FILL:** silty sand, trace clay, redish brown, moist, very loose to compact.		1	AUGER			
			2	SS	14		96
			3	SS	8		95
94.8							
2.3	**SILTY SAND:** trace clay, redishbrown, moist to wet, compact.		4	SS	9		94
			5	SS	9		93
			6	SS	15		92
			7	SS	5		91
89.8							90
7.2	**SILTY CLAY TILL:** grey, moist, very stiff.		8	SS	29		89
88.8							
8.2	**END OF BOREHOLE**						

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling.
2). Water was at 4.3 m bgs upon completion of drilling.
3). Borehole caved in to a depth of 4.4 m bgs upon completion of drilling.

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε_f=3% Strain at Failure

LOG OF BOREHOLE BH17-7

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796850.502 E 594358.633

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/17/2017

REF. NO.: 161-09479-00
ENCL NO.: 10

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.6												
0.0 / 97.4	**ASPHALT** (100 mm) **GRANULAR BASE** (170 mm)											
0.3	**FILL:** silty sand, trace clay, reddish brown, moist to wet, very loose.		1	SS	8		97					
1			2	SS	3							
			3	SS	2		96					
2			4	SS	3		95					
94.7												
2.9	**SILTY SAND:** trace gravel, reddish brown, wet, compact to dense.		5	SS	13		94					
4												
	- Spoon wet		6	SS	26		93					
5												
6			7	SS	32		92					
7												
90.5							91					
7.1	**SILTY CLAY TILL:** trace gravel, some sand, trace silty clay zones, grey, moist, very stiff to hard.		8	SS	23		90					
8												
							89					
9			9	SS	45							
10							88					

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GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON-BH17-7 TO BH17-11 20170602.GPJ SPL.GDT 2/6/17

LOG OF BOREHOLE BH17-7

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796850.502 E 594358.633

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/17/2017

REF. NO.: 161-09479-00
ENCL NO.: 10

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY TILL: trace gravel, some sand, trace silty clay zones, grey, moist, very stiff to hard.(Continued)		10	SS	50/ 150mm		87	○	○			
11												
12			11	SS	59		86		○			
13							85					
84.4												
13.2	**SILTY CLAY:** trace sand, trace silt zones, grey, moist, hard.											
14			12	SS	36		84		○			
82.9												
14.7	**SANDY SILT:** trace gravel, trace clay, trace silty clay zones, brown, wet, very dense.						83					
15			13	SS	68/ 250mm				○			
16							82					
							81					
17			14	SS	55				○			
80.4												
17.2	**END OF BOREHOLE**											

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling.
2). Water was at 13.7 m bgs upon completion of drilling.
3). Borehole was open upon completion of drilling.

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε_f=3% Strain at Failure

LOG OF BOREHOLE BH17-8

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796837.702 E 594319.883

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/17/2017

REF. NO.: 161-09479-00
ENCL NO.: 11

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
98.0												
0.0 / 97.6	**ASPHALT** (120 mm) **GRANULAR BASE** (240 mm)		1	SS	16							
0.4	**FILL:** silty sand, trace clay, reddish brown, moist to wet, very loose to loose.		2	SS	6		97					
			3	SS	4		96					
95.1			4	SS	2							
2.9	**SILTY SAND:** reddish brown, wet, loose to compact.		5	SS	6		95					
	- Spoon wet		6	SS	9		94					
91.5			7	SS	19		93					
6.5	**SILTY CLAY TILL:** trace gravel, some sand, trace silty clay zones, reddish brown to grey, moist, very stiff to hard.		8	SS	24		92					
			9	SS	37		91					
							90					
							89					

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+3, ×3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON-BH17-7 TO BH17-11 20170602.GPJ SPL.GDT 2/6/17

LOG OF BOREHOLE BH17-8

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796837.702 E 594319.883

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/17/2017

REF. NO.: 161-09479-00
ENCL NO.: 11

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY TILL: trace gravel, some sand, trace silty clay zones, reddish brown to grey, moist, very stiff to hard.(Continued)											
11			10	SS	53		87					6 12 47 35
12			11	SS	36		86					
13							85					
14			12	SS	42		84					
15							83					
82.3			13	SS	40							
15.7	**END OF BOREHOLE** Notes: 1). Water was encountered at 4.6 m below ground surface (bgs) during drilling. 2). Water was at 12.8 m bgs upon completion of drilling. 3). Borehole was open upon completion of drilling.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON-BH17-7 TO BH17-11 20170602.GPJ SPL.GDT 2/6/17

LOG OF BOREHOLE BH17-9

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796784.401 E 594276.799

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/18/2017

REF. NO.: 161-09479-00
ENCL NO.: 12

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
98.0								
0.0 / 97.7	**ASPHALT** (120 mm) **GRANULAR BASE** (170 mm)							
0.3	**FILL:** silty sand, trace clay, reddish brown, moist to wet, very loose.		1	SS	8		97	
			2	SS	5		96	
95.5								
2.5	**SILTY SAND:** reddish brown, wet, compact.		3	SS	18		95	
	- Spoon wet		4	SS	14	▽	94	
92.5								
5.6	**SAND:** trace gravel, trace silt, trace clay, reddish brown, wet, compact.		5	SS	14		93	1 88 7 4
90.9							92	
7.1	**SILTY CLAY TILL:** trace gravel, some sand, grey, moist, very stiff to hard.		6	SS	31		91	
			7	SS	27		90	
							89	

Bentonite
W. L. 94.0 m May 25, 2017
Sand Screen

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%): 10 20 30
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH17-9

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796784.401 E 594276.799

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/18/2017

REF. NO.: 161-09479-00
ENCL NO.: 12

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY TILL: trace gravel, some sand, grey, moist, very stiff to hard.(Continued)											
11			8	SS	39		87		○			
86.4							Bentonite					
11.6	**SILTY CLAY:** trace gravel, trace sand, grey, moist, hard.											
12			9	SS	45		86		○			
13							85					
84.1												
14 13.9	**SILTY SAND:** trace gravel, trace clay, reddish brown to grey, moist to wet, very dense.		10	SS	43		84		○			
15							83					
			11	SS	34				○			
82.3												
15.7	**END OF BOREHOLE**											

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling.
2). Water was at 13.7 m bgs upon completion of drilling.
3). Borehole was open upon completion of drilling.
Water Level Readings:

Date	W. L. Depth (m bgs)
May 25, 2017	4.06

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

LOG OF BOREHOLE BH17-10

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796751.233 E 594311.141

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/18/2017

REF. NO.: 161-09479-00
ENCL NO.: 13

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION
97.8					
0.0 / 97.5	**ASPHALT** (120 mm) **GRANULAR BASE** (160 mm)				
0.3	**FILL:** silty sand, trace to some gravel, reddish brown, moist to wet, very loose to loose.	1	SS	12	
		2	SS	5	97
		3	SS	2	96
94.9		4	SS	3	
2.9	**SILTY SAND:** trace gravel, reddish brown, wet, compact.	5	SS	14	95
	- Spoon wet	6	SS	25	94
		7	SS	31	93
90.0	- Gravelly sand zone				92
7.8	**SILTY CLAY TILL:** trace gravel, some sand, grey, moist, very stiff to hard.	8	SS	24	91
		9	SS	34	90
					89
					88

SAMPLES: NUMBER, TYPE, BLOWS 0.3 m "N"
GROUND WATER CONDITIONS

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED
● QUICK TRIAXIAL
+ FIELD VANE & Sensitivity
× LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES
+ 3, × 3: Numbers refer to Sensitivity
○ ε=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON-BH17-7 TO BH17-11 20170602.GPJ SPL.GDT 2/6/17

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796751.233 E 594311.141

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/18/2017

REF. NO.: 161-09479-00
ENCL NO.: 13

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY TILL: trace gravel, some sand, grey, moist, very stiff to hard.(Continued)											
			10	SS	39		87		○			
			11	SS	76/ 280mm		86		○			
			12	SS	76		85		○			
83.1 / 14.7	**SILTY CLAY:** trace sand, grey, moist, very stiff.		13	SS	29		84		○			
82.1 / 15.7	**END OF BOREHOLE**						83					

Notes:
1). Water was encountered at 4.6 m below ground surface (bgs) during drilling.
2). Water was at 12.2 m bgs upon completion of drilling.
3). Borehole was open upon completion of drilling.

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε_f=3% Strain at Failure

LOG OF BOREHOLE BH17-11

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796783.016 E 594391.601

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/18/2017

REF. NO.: 161-09479-00
ENCL NO.: 14

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
97.1												
0.0 / 96.7	**ASPHALT** (50 mm) **GRANULAR BASE** (400 mm)		1	SS	12		97					
0.5 / 94.6	**FILL:** silty sand, trace gravel, reddish brown, moist, compact.		2	SS	12		96					
2.5 / 90.0	**SILTY SAND:** trace gravel, reddish brown, moist to wet, compact. - Spoon wet		3	SS	14		95					
			4	SS	16		94					
			5	SS	27		93					
7.1	**SILTY CLAY TILL:** trace gravel, some sand, grey, moist, very stiff to hard.		6	SS	17		92					
			7	SS	53		91					
							90					
							89					
							88					

Continued Next Page

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε_f=3% Strain at Failure

WSP SOIL LOG 161-0947900-00 484 PLAINS RD E, BURLINGTON-BH17-7 TO BH17-11 20170602.GPJ SPL.GDT 2/6/17

PROJECT: Geotechnical Investigation
CLIENT: National Homes (Plains Road) LP
PROJECT LOCATION: 484 Plains Road East, Burlington, Ontario
DATUM: NAD 83, ZONE 17
BH LOCATION: N 4796783.016 E 594391.601

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 150 mm
Date: Apr/18/2017

REF. NO.: 161-09479-00
ENCL NO.: 14

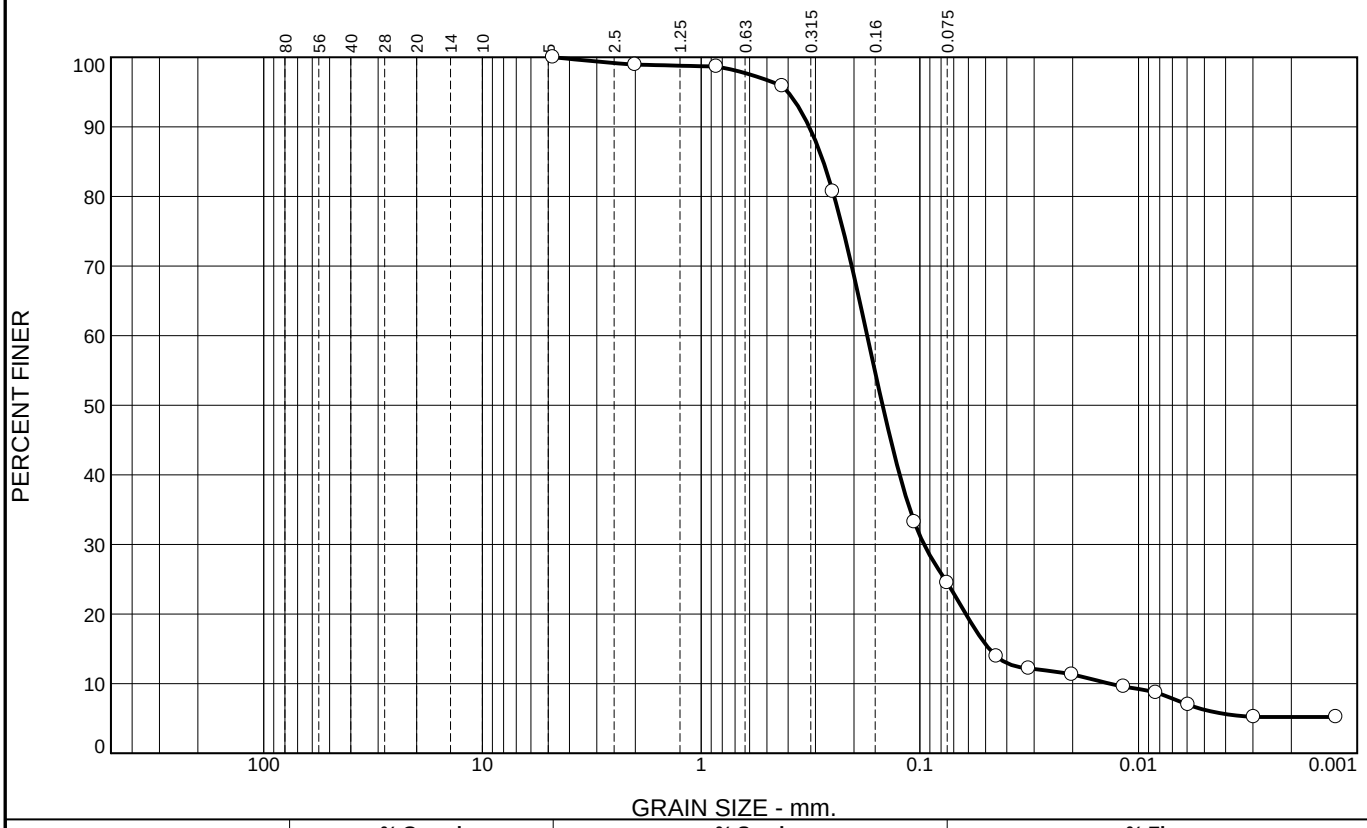
(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	SILTY CLAY TILL: trace gravel, some sand, grey, moist, very stiff to hard.(Continued)						87					
11			8	SS	47		86		○			
12			9	SS	61		85		○			
13							84					
14			10	SS	90/ 250mm		83		○			
82.4												
14.7	**SILTY CLAY:** trace sand, grey, moist, hard.											
15			11	SS	77		82		○			
81.4												
15.7	**END OF BOREHOLE** Notes: 1). Water was encountered at 4.6 m below ground surface (bgs) during drilling. 2). Water was at 15.2 m bgs upon completion of drilling. 3). Borehole was open upon completion of drilling.											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

FIGURES

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	1.1	3.0	71.4	19.3	5.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
4.75mm	100.0		
2mm	98.9		
0.850mm	98.7		
0.425mm	95.9		
0.250mm	80.7		
0.106mm	33.2		
0.075mm	24.5		
0.0446 mm.	13.9		
0.0317 mm.	12.2		
0.0201 mm.	11.3		
0.0117 mm.	9.6		
0.0083 mm.	8.7		
0.0059 mm.	7.0		
0.0030 mm.	5.2		
0.0012 mm.	5.2		

* (no specification provided)

Soil Description

Silty sand, trace clay

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.3203 D_{85}= 0.2762 D_{60}= 0.1740
D_{50}= 0.1480 D_{30}= 0.0956 D_{15}= 0.0481
D_{10}= 0.0135 C_u= 12.89 C_c= 3.89

Classification

USCS= AASHTO=

Remarks

Sampled by Jack
F.M.=0.66

Location: BH16-3 SS6
Sample Number: MM-2775

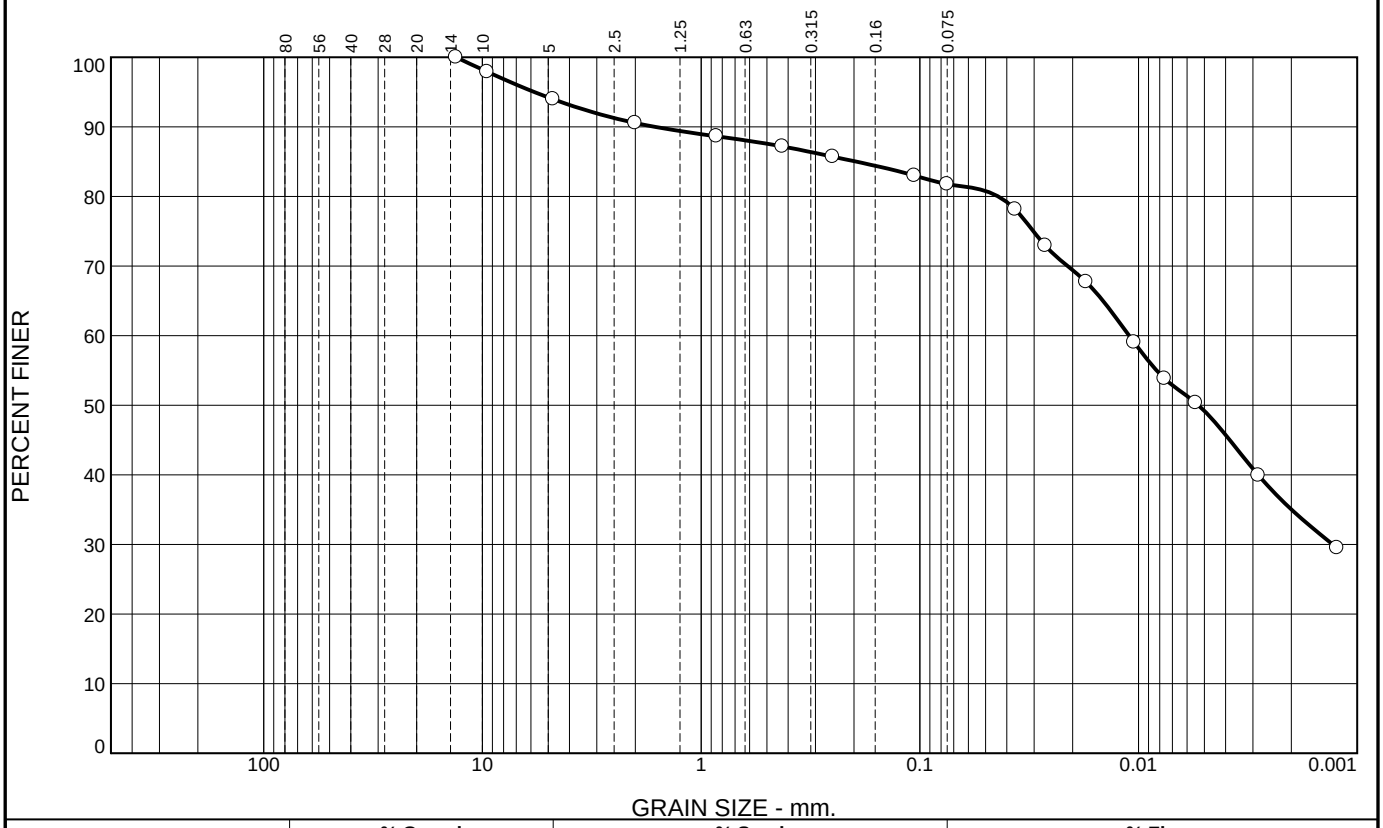
Date:

WSP

Client: National Homes (Plains Road) LP
Project: Geotechnical Investigation,Ph1&2, 484 Plains Road East, Burlington

Project No: 161-09479-00 **Figure** 1

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	6.0	3.4	3.4	5.4	46.8	35.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
13.2mm	100.0		
9.5mm	97.9		
4.75mm	94.0		
2mm	90.6		
0.850mm	88.6		
0.425mm	87.2		
0.250mm	85.7		
0.106mm	83.0		
0.075mm	81.8		
0.0366 mm.	78.1		
0.0267 mm.	72.9		
0.0174 mm.	67.7		
0.0105 mm.	59.0		
0.0076 mm.	53.8		
0.0055 mm.	50.4		
0.0028 mm.	39.9		
0.0012 mm.	29.5		

* (no specification provided)

Soil Description

Silty clay till, some sand, trace gravel

Atterberg Limits

PL= 16 LL= 30 PI= 14

Coefficients

D_{90}= 1.6253 D_{85}= 0.1951 D_{60}= 0.0110
D_{50}= 0.0053 D_{30}= 0.0013 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-6(10)

Remarks

Sampled by Michael Hu on April 2017
F.M.=0.69

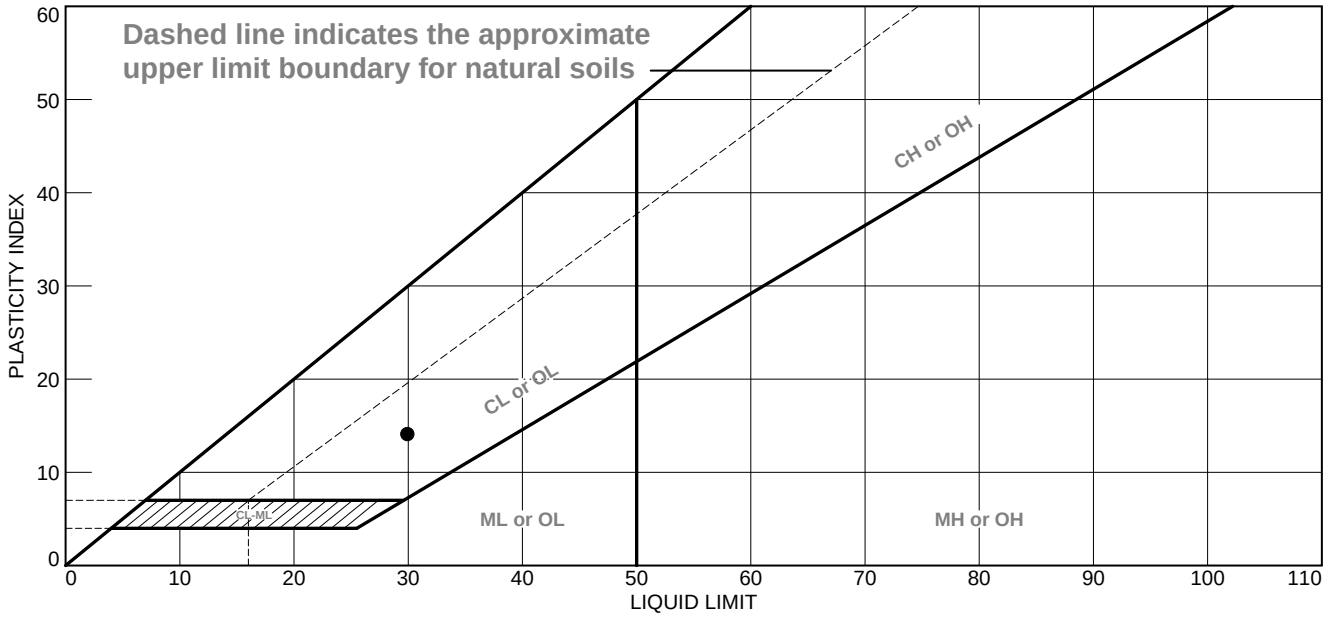
Location: BH17-8 SS10
Sample Number: MM-4227

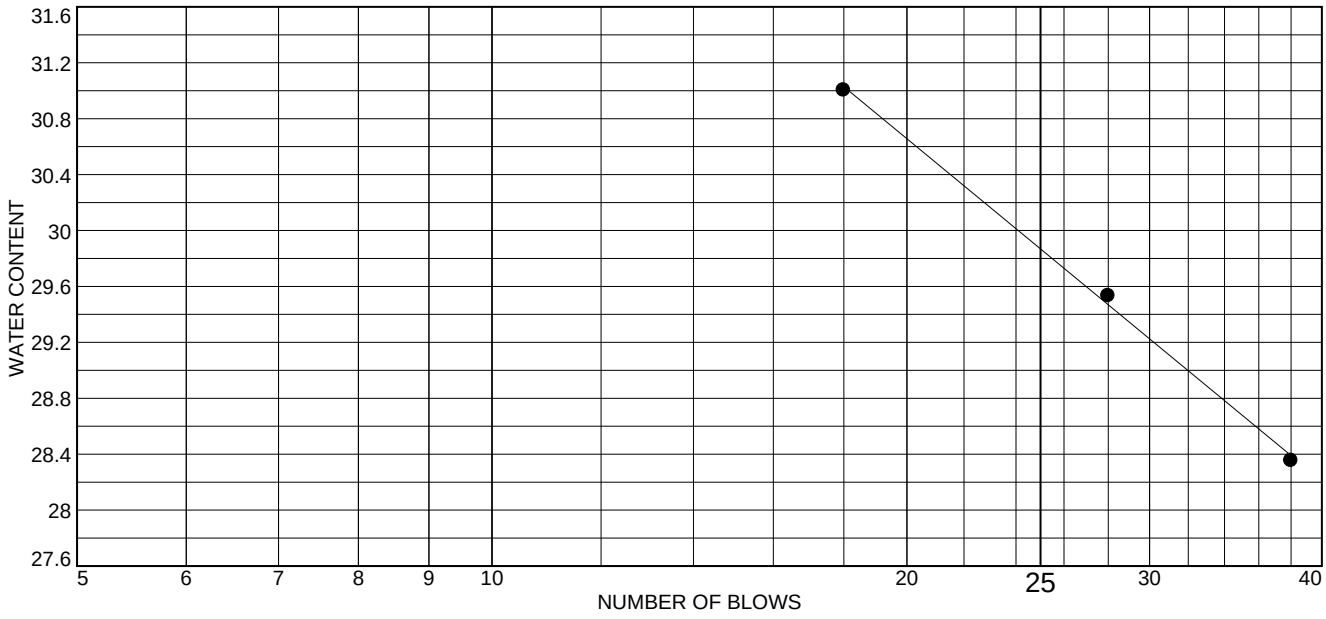
Date: 20/04/17

Client: National Homes (Plains Road) LP
Project: Geotechnical Investigation,Ph1&2, 484 Plains Road East, Burlington

Project No: 161-09479-00 **Figure 2**

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Silty clay till, some sand, trace gravel	30	16	14	87.2	81.8	CL

Project No. 161-09479-00 **Client:** National Homes (Plains Road) LP

Project: Geotechnical Investigation,Ph1&2, 484 Plains Road East, Burlington

Location: BH17-8 SS10
Sample Number: MM-4227

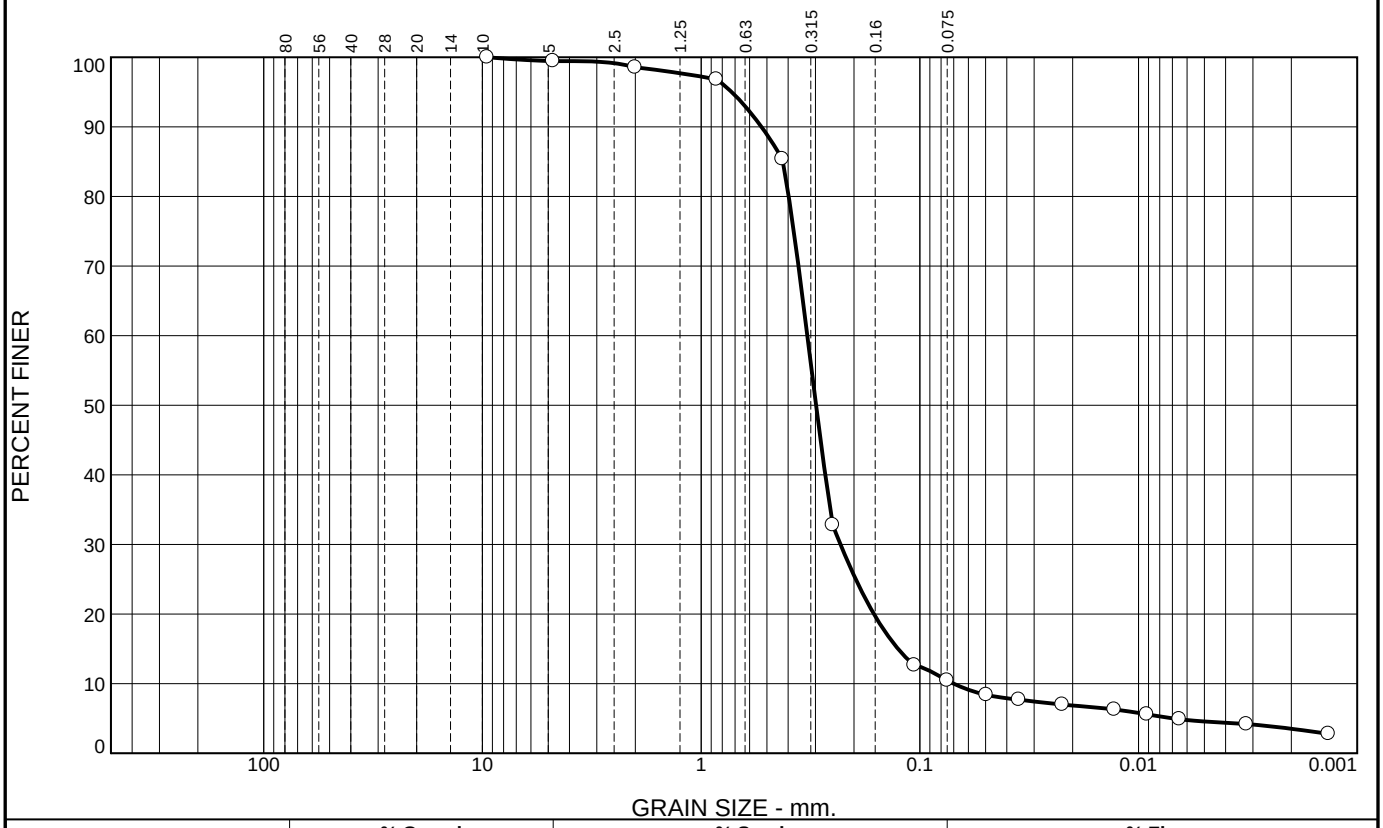
Remarks:

●Sampled by Michael Hu on April 2017

WSP

Figure 3

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.5	0.9	13.2	74.9	7.0	3.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
9.5mm	100.0		
4.75mm	99.5		
2mm	98.6		
0.850mm	96.8		
0.425mm	85.4		
0.250mm	32.8		
0.106mm	12.7		
0.075mm	10.5		
0.0496 mm.	8.4		
0.0352 mm.	7.7		
0.0223 mm.	7.0		
0.0129 mm.	6.3		
0.0092 mm.	5.6		
0.0065 mm.	4.9		
0.0032 mm.	4.2		
0.0014 mm.	2.8		

* (no specification provided)

Soil Description

Sand, trace silt, trace clay, trace gravel

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 0.5297 D_{85}= 0.4228 D_{60}= 0.3268
D_{50}= 0.2983 D_{30}= 0.2305 D_{15}= 0.1258
D_{10}= 0.0699 C_u= 4.67 C_c= 2.32

Classification

USCS= AASHTO=

Remarks

Sampled by Michael Hu on April 2017
F.M.=1.43

Location: BH17-9 SS5
Sample Number: MM-4226

Date: 21/04/2017

Client: National Homes (Plains Road) LP
Project: Geotechnical Investigation,Ph1&2, 484 Plains Road East, Burlington

Project No: 161-09479-00 **Figure** 4

APPENDIX A

General 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.

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. (WSP). Without this confirmation no responsibility for the performance of the structure can be accepted by WSP. Survey drawing of the pre and post fill location and elevations will also be required.

4. The area must be stripped of all existing pavement structure 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 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 during placement of engineered fill is required. Work cannot commence or continue without the presence of the WSP 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 100 KPa at SLS (150 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.

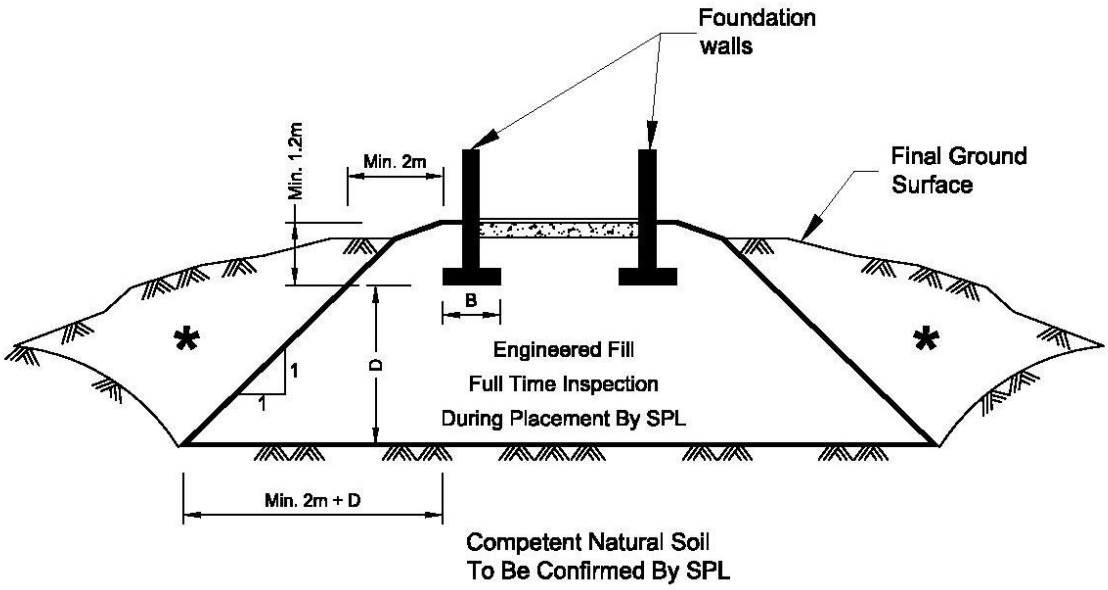
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from WSP prior to footing concrete placements. All excavations must be backfilled under full time supervision by WSP to the same degree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

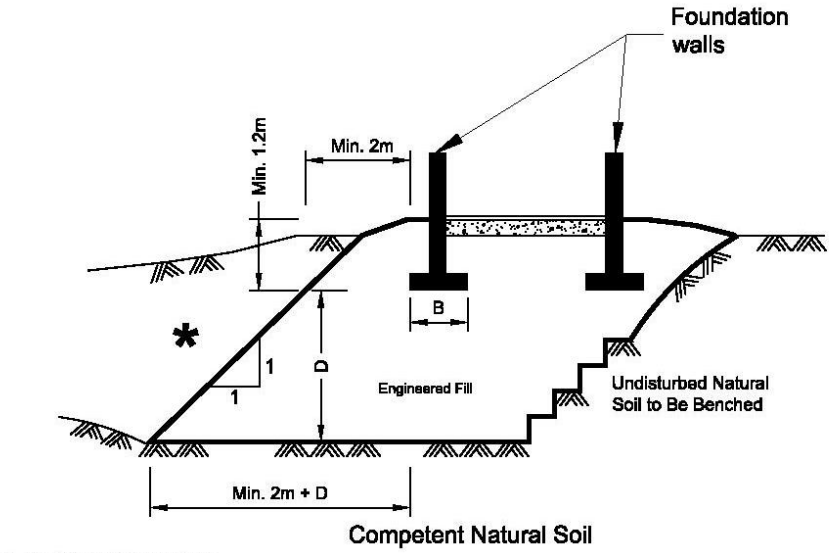
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any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





* Backfill in this area to be as per the SPL report.