UPDATED REPORT ON

PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL SUBDIVISION
ERIN HEIGHTS GOLF COURSE
5525 8TH LINE
ERIN, ONTARIO

PREPARED FOR:
EMPIRE HOMES

PREPARED BY:
DS CONSULTANTS LTD.

DS Project No : 21-129-300
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1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Empire Homes to undertake a preliminary geotechnical investigation for the proposed development located at 5525 8th Line in Erin, Ontario.

Based on the design information (Preliminary Grading Plan, Drawing No. 2.2B, dated July 2023) provided to us, the proposed development will consist of a residential subdivision with roads, storm and sanitary sewers and watermains, and a dry stormwater management pond with an underground storage tank or stone infiltration trench.

DS carried out environmental assessments at the subject site and the reports are documented under separate covers. This report deals only with the geotechnical aspects of the site.

The purpose of this geotechnical investigation was to obtain information about the subsurface conditions by means of a limited number of boreholes and from the findings in the boreholes to make preliminary recommendations pertaining to the geotechnical design of underground utilities and subdivision roads and to comment on the foundation conditions for general house construction.

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

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

This report has been prepared for Empire Homes and its designers. Third party use of this report without DS consent is prohibited.

2. FIELD AND LABORATORY WORK

A total of ten (10) boreholes (MW21-1 to MW21-3, BH21-4 to BH21-9, and MW21-10, see Drawing 1 for borehole locations) were drilled between April 15 and 19, 2021 to depths of 7.7 m to 11.0 m below ground surface. The borehole locations were selected to serve both environmental and geotechnical purposes.

The boreholes were drilled with solid and hollow stem continuous flight augers equipment by a drilling sub-contractor under the direction and supervision of DS personnel. Samples were retrieved at regular intervals with a 50 mm O.D. split-barrel sampler driven with a hammer weighing 624 N and dropping 760 mm in accordance with the Standard Penetration Test (SPT) method. The samples were logged in the field and returned to the DS laboratory for detailed examination by the project engineer and for laboratory testing.

As well as visual examination in the laboratory, all soil samples from the boreholes were tested for moisture contents. Grain size analyses of fourteen (14) selected soil samples were conducted and the results are presented in Drawings 14 to 17.

Water level observations were made during and upon completion of drilling. Four (4) monitoring wells of 50mm diameter were installed in boreholes MW21-1 to MW21-3, and MW21-10 for the long-term groundwater monitoring.

The geodetic ground surface elevations at the locations of the boreholes/monitoring wells were established by DS using differential GPS system. It should be noted that the elevations at the as-drilled borehole/well locations were not provided by a professional surveyor and should be considered to be approximate. Contractors performing any work referenced to the borehole/well elevations should confirm the borehole elevations for their work.

3. SITE AND SUBSURFACE CONDITIONS

The subject site is situated on 8th Line north of Erin Heights Drive in the Town of Erin, Ontario. We understand that the property is 13.8 hectares in area and currently is an active golf course.

The approximate borehole locations are shown on Drawing 1. Notes on sample descriptions and the general features of fill and native material are presented on Drawing 1A. Detailed subsurface conditions observed in the boreholes are presented on the Borehole Logs, Drawings 2 to 11. Generalized Sub-Surface Profiles are presented on Drawings 12 and 13.

The subsurface conditions in the boreholes are summarized in the following paragraphs.

3.1 Soil Conditions

Topsoil/Fill:

Granular fill of 50 mm to 250 mm in thickness was encountered at the surface of MW21-1 and MW21-10. A surficial topsoil layer was encountered at MW21-2, MW21-3, and BH21-4 to BH21-9. The measured topsoil thickness at the borehole locations ranges from 100 mm to 350 mm. Localized thick topsoil deposits and soils rich in organic content may be encountered, especially in depressed areas and/or near water courses. Topsoil quantities should not be calculated from the borehole information, as large variations in depth may exist between boreholes.

Underlying the topsoil or granular fill, fill materials were contacted extending to a depth of 1.5 m to 3.0 m below grade in BH21-3 to BH21-5, BH21-9, and MW21-10. The fill materials consisted of sand, silty sand to sandy silt, with some gravel, trace to mixed with organics/topsoil, and were found to be in a very loose to compact state, with measured SPT 'N' values ranging from 2 to 23 blows per 300mm penetration. The natural moisture content measured in the test samples from these materials ranged from 8% to 36%.

Grain size analyses of five samples from the fill materials (MW21-3/SS2, BH21-4/SS2, BH21-5/SS2, BH21-9/SS1, and MW21-10/SS2) were carried out and gradation curves for the results are provided on **Drawing 14**, with following fractions:

Clay:	4 to 9%
Silt:	15 to 51%
Sand:	41 to 67%
Gravel:	0 to 24%

Silty Sand, Silt and Sand:

Below the topsoil, granular fill at MW21-1, or gravelly sand in BH21-8, silt and sand to silty sand with trace gravel, trace clay was encountered in MW21-1, to MW21-3, BH21-5, BH21-8, and MW21-10, and extended to depths varying between 2.1 m to 7.6 m below grade. The cohesionless deposits were moist becoming water bearing with depth and were present in a loose to dense state, with measured SPT 'N' values of 8 to 35 blows per 300 mm of penetration. Moisture content of the tested samples from these deposits varied between 6 to 21 percent.

Grain size analyses of five samples from the silt and sand to silty sand deposits (MW21-1/SS1, MW21-2/SS1, MW21-2/SS6, MW21-3/SS6, MW21-10/SS4) were carried out and gradation curves for the results are provided on **Drawing 15**, with following fractions:

Clay:	5 to 9%
Silt (or Fines):	22 to 37%
Sand:	45 to 69%
Gravel:	4 to 10%

Sand and Gravel, Gravelly Sand to Sandy Gravel

Cohesionless deposits consisting of sand and gravel, or sandy gravel to gravelly sand, with some silt were contacted below the topsoil in BH21-6 to BH21-8 and extended to depths varying between 1.5 m to 4.6 m below grade. The cohesionless deposits were moist and were present in a very loose to very dense state, with measured SPT 'N' values of 3 to in excess of 100 blows per 300 mm of penetration. Moisture content of the tested samples from these deposits varied between 4 to 13 percent.

Grain size analyses of three samples from the sand and gravel deposits (BH21-6/SS2, BH21-7/SS2, BH21-8/SS2) were carried out and gradation curves for the results are provided on **Drawing 16**, with following fractions:

Fines (Silt and Clay):	13 to 17%
Sand:	32 to 53%
Gravel:	34 to 54%

Silty Sand Till:

Below the cohesionless materials, glacial deposits consisting silty sand till were encountered and generally extended to the entire depth explored in the boreholes, i.e. to 7.7 m to 11 m below grade. The till contained some gravel, some clay, cobble/boulder sizes, was brown in colour becoming grey with depth, and became water bearing with depth.

The cohesionless silty sand till deposits were in a compact to very dense state with measured SPT 'N' value of 12 to in excess of 100 blows per 300 mm penetration. Moisture contents in the tested samples of till deposits ranged between 5 to 13 percent.

Grain size analysis of one sample from the silty sand till deposit (MW21-1/SS8) was carried out and gradation curve for the results is provided on **Drawing 17**, with following fractions:

Clay:	13%
Silt:	31%
Sand:	45%
Gravel:	11%

3.2 Groundwater Conditions

Short-term groundwater levels encountered during the borehole drilling are indicated in the borehole logs. Groundwater levels measured in the monitoring wells on April 28, 2021 were at depths ranging from 1.2 to 6.3 m below grade, corresponding to Elev. 397.6 m to 417.8 m. **Table 3.2** summarizes the depth and elevation of water level readings in monitoring wells.

Table 3.2: Groundwater Levels Observed in Monitoring Wells

BH No.	Ground Surface Elev. (m)	Date of Drilling	Date of Observation	Depth of Groundwater (m)	Elevation of Groundwater (m)
MW21-1	422.8	April 15, 2021	April 28, 2021	5.0	417.8
MW21-2	398.8	April 15, 2021	April 28, 2021	1.2	397.6
MW21-3	405.7	April 15, 2021	April 28, 2021	6.3	399.3
MW21-10	419.1	April 15, 2021	April 28, 2021	1.7	417.4

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

4. DISCUSSION AND RECOMMENDATIONS

It is proposed to develop the site as a residential subdivision. The lots will therefore be serviced by roads, parking lot, storm and sanitary sewers and watermains, and a storm water management pond.

4.1 ROADS

The investigation has shown that the predominant subgrade soils, after stripping the topsoil, fill and any other organic and otherwise unsuitable subsoil, will generally consist of silt and sand, silty sand, silty sand till, sandy gravel to gravelly san, or sand and gravel.

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

40 mm HL3 Asphaltic Concrete
50 mm HL8 Asphaltic Concrete
150 mm Granular 'A'
350 mm Granular 'B'

These values are in accordance with the Town of Erin Standards. 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. Furthermore, heavy construction equipment may have to be kept off the newly constructed roads before the placement of asphalt and/or immediately thereafter, to avoid damaging the weak subgrade by heavy truck traffic.

4.1.1 STRIPPING, SUB-EXCAVATION AND GRADING

The site should be stripped of all topsoil and any organic, weathered or otherwise unsuitable soils to the full depth of the roads, both in cut and fill areas. Fill material encountered in the areas of MW21-3, BH21-4, BH21-5, BH21-9, and MW21-10 should be removed. Any buried concrete from former structures should be removed. Following stripping and removal of existing fill, 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.

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

Any fill required for re-grading the site or backfill should be select, clean material, free of topsoil, organic or other foreign and unsuitable matter. The fill should be placed in thin layers and compacted to at least 95% of its SPMDD. The degree of compaction should be increased to 98% within the top 1.0 m of the subgrade, or as per the Town of Erin Standards. The compaction of the new fill should be checked by frequent field density tests.

4.1.2 ROAD CONSTRUCTION

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

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

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

4.1.3 DRAINAGE

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

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

4.2 SEWERS

As a part of the site development, new watermain, storm and sanitary sewers is to be constructed. Based on the design drawings (Sanitary Drainage Plan, Drawing No. 7.1, dated July 2023), trenches are generally within 0.5 to 2.5 m below the existing grade at the south portion of site (i.e. at grade raise area). While the trench excavations are up to 7.5 m below the existing grade at the area where the grade cut is proposed (e.g. the southwest corner of the site).

4.2.1 TRENCHING

Based on the boreholes, the trenches in most of the boreholes will be dug mainly through in engineered fill, sand and silt, silty sand, sandy gravel to gravelly sand, sand and gravel, and silty sand till deposits. Above the groundwater table (Elevations vary between 397.6 m and 417.8 m), the sides of excavations in the natural strata or in compacted engineered fill above groundwater can be expected to be temporarily stable at relatively steep side slopes for short periods of time but they should be cut back at slopes no steeper than 1:1 in order to comply with the safety regulations. Any excavation below groundwater table will require positive dewatering using well points/eductors. Otherwise, it will result in an unstable base and flowing sides. The groundwater table should be lowered to a minimum depth of 1 m below the base of the excavation. It is recommended to carry out test pits to determine dewatering requirements in areas where excavations are proposed through sand or silt below the groundwater table.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, fill and cohesionless soils (silts and sands) can be classified as Type 3 soil above the groundwater table and as Type 4 soil below groundwater table.

4.2.2 BEDDING

The engineered fill and undisturbed native compact to very dense soils above the groundwater level will provide adequate support for the 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, 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, should be placed.

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

Localized, wet and unstable soils encountered within generally stable soil zones can be stabilized by 'punching' 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.

4.2.3 BACKFILLING OF TRENCHES

Based on visual and tactile examination, the on-site excavated inorganic fill and native soils are considered to be suitable for re-use as backfill in the service trenches provided their moisture contents at the time of construction are within 2 percent of their optimum moisture content. Significant aeration of the wet silty sand excavated from below the water table will be required prior to their use as backfill material.

Imported granular fill, which can be compacted with handheld equipment, should be used in confined areas.

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.

The backfill should be placed in maximum 200 mm thick layers at or near (±2%) their optimum moisture content and each layer should be compacted to at least 95% SPMDD. In the upper 1.0 m, underneath the road base, the compaction should be increased to 98% SPMDD. Unsuitable materials such as organic soils, boulders, cobbles, frozen soils, etc. should not be used for backfilling.

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 adequate compaction. Stockpiles should be compacted at the surface or be covered with tarpaulins to minimize moisture uptake.

The topsoil or fill materials mixed with organics/topsoil encountered at the site can be used for landscaping fill to raise the grades. Topsoil cannot be reused as foundation and trench backfill material.

4.3 ENGINEERED FILL

In the areas where earth fill is required for site grading purposes, engineered fill can be constructed below house foundations, roads, boulevards, etc.

Based on the Preliminary Grading Plan (Drawing No. 2.2B, dated July 2023), grade raise is required for the majority of site except for the southwest of site where grade cut up to 3 m is proposed . The depth of grade raise is gradually increased towards the east and north of the site. At the east boundary of the site, the grade raise up to 7.5 m above the existing grade is proposed.

Prior to the construction of engineered fill, all of the existing topsoil, fill, and surficially weathered/disturbed soils, loose sand, or buried concrete from former structures must be removed. The base must be thoroughly proof-rolled. The stripped native subgrade must be examined and approved by a DS engineer prior to placement of fill.

Engineered fill compacted to 100% of SPMDD will settle under its own weight approximately 0.5% to 0.75% of the fill thickness. The designer and the structural engineer must be aware of this settlement. For example, where the engineered fill is 7 m in thickness, the settlement of fill under its own weight is expected to be in the range of 40 mm on a non-yielding subgrade. The settlement of the engineered fill will occur with time. For engineered fill consisting of sandy silt to silty sand material, about 75% of the settlement is expected to occur within 3-6 months after the placement of the fill. For engineered fill consisting of clayey silt material, about half (50%) of this settlement should be completed within 3 to 6 months, and about 75% of the settlement is expected to occur within one year after the placement of the fill.

Engineered fill which consists of Granular B material (sand and gravel) will undergo less self-weight settlement (say about 0.3% to 0.5% of the fill thickness). In addition, the settlement of engineered Granular B fill will be completed in a shorter period of time. For engineered fill consisting of Granular B material compacted to 100% of SPMDD, a major portion (80% or higher) of the settlement due to the self weight is expected to be completed during the construction stage before the placement of the structures.

Depending on the type of soil used for engineered fill (refer to the recommendations above), a waiting period of at least 6 months for sandy silt to silty sand material and 1 year for clayey silt material, is required after placing the engineered fill to pre-grade level, prior to the construction of settlement sensitive structures. No waiting time is required for engineered fill using Granular B material (sand and gravel).

General guidelines for the placement and preparation of engineered fill are presented on **Appendix A**. Bearing capacity values of 150 kPa at SLS and 225 kPa at ULS can be used on engineered fill, provided that all requirements on **Appendix A** are adhered to. To reduce the risk of improperly placed engineered compacted fill, full-time supervision of the contractor is essential.

The following is a recommended procedure for an engineered fill:

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

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

3. The building footprint and base of the pad, including basements, garages, etc. must be defined by offset stakes that remain in place until the footings and service connections are all constructed. Confirmation that the footings are within the pad, service lines are in place, and that the grade conforms to drawings, must be obtained by the owner in writing from the surveyor and DS. Without this confirmation no responsibility for the performance of the structure can be accepted by DS. 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 and loose native soils. Any buried concrete from former structures must be removed. Subgrade must be proof-rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by a DS engineer prior to placement of fill.

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

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

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

8. Bearing capacity values of 150 kPa at SLS and 225 kPa at ULS may be used provided that all conditions outlined above are adhered to. A minimum footing width of 500 mm (20 inches) is suggested and footings should be provided with nominal steel reinforcement.

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

10. After completion of the pad a second contractor may be selected to install footings. All excavations must be backfilled under full time supervision by DS 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 DS.

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

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

The inorganic silty sand to sandy silt and clayey silt (till) are considered suitable for use as engineered fill, provided that their moisture contents at the time of construction are at or near optimum. As mentioned before in Section 4.2.3 of this report, the clayey tills are likely to be excavated in cohesive chunks or blocks and will be difficult to compact. They should be pulverized and placed in thin layers not exceeding 150 to 200 mm and compacted using heavy equipment suitable for these types of soils (e.g. heavy sheepsfoot compactors).

4.4 FOUNDATION CONDITIONS

The proposed dwellings can be supported by spread and strip footings founded on the undisturbed native soils or engineered fill material. Any excavation in the cohesionless deposits below groundwater table will require positive dewatering using well points/eductors. Otherwise, it will result in an unstable base and flowing sides. The groundwater table should be lowered to a minimum depth of 1 m below the base of the excavation.

Based on the borehole information, footings founded on native soils or engineered fill (see Section 4.3) can be designed for bearing capacity values of 150 kPa at SLS (Serviceability Limit State) and 225 kPa at ULS (Ultimate Limit State). This value would be suitable for the use of normal spread footing foundations to support normal single-family dwellings. However; higher bearing capacities on native soils are available and can be analysed, if required.

For footings founded on engineered fill, a minimum footing width of 500 mm is suggested, and footings must be provided with nominal steel reinforcement. The engineered fill supporting footings should be constructed in accordance with the guidelines presented in Appendix A. Other requirements of engineered fill are given in Section 4.3.

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 footings exposed to seasonal freezing conditions must have at least 1.4 metres of soil cover for frost protection.

All footings bases must be inspected by this office to confirm the bearing capacity values, prior to pouring concrete.

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 footing.

It should be noted that the recommended bearing capacities have been calculated by DS 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 DS to validate the information for use during the construction stage.

4.5 EARTH PRESSURES

The lateral earth pressures acting on foundation and basement walls or retaining 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, assumed to be 0.40 for vertical walls and horizontal backfill for permanent construction

γ = Unit weight of backfill, a value of 21 kN/m^3 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 build up of any hydrostatic pressure behind the wall.

4.6 FLOOR SLAB AND PERMANENT DRAINAGE

The floor slab can be supported on grade provided that the site is properly dewatered and all topsoil, fill, and surficially softened 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 perimeter drainage system will be required around the exterior basement walls. The perimeter drainage system shown on **Drawing 18** is recommended for the basement walls where open cut procedures are used.

4.7 STORMWATER MANAGEMENT FACILITY

Based on the design information (Preliminary Grading Plan, Drawing No. 2.2B, dated July 2023) provided to us, a dry stormwater management pond with an underground storage tank or stone infiltration trench at the pond bottom is proposed in Block 27 (northwest part of the site).

Grade raise will be required to achieve the proposed pond geometry, inorganic fill material encountered at the site can be used. Prior to placing the fill, the topsoil and any surficially softened soil should be removed. After stripping is completed and the surface of the subgrade is approved, approved fill should be compacted to at least 100 percent standard Proctor maximum dry density and be placed in shallow lifts not exceeding 200 mm (uncompacted thickness).

As per design information, berms (embankments) with slope inclinations of 5H:1V to 3H:1V are designed along the north and east sides of the dry pond. Any pond water should not be allowed to seep through the berms/embankments to prevent undermining the stability of berms/embankments. Once the final design information is available, the geotechnical recommendations for the berms/embankments can be provided, if required.

Additional boreholes should be considered at the stormwater management Block 27 for the design of underground storage tank or stone infiltration trench.

5. GENERAL COMMENTS AND LIMITATIONS OF REPORT

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

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

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

DS CONSULTANTS LIMITED

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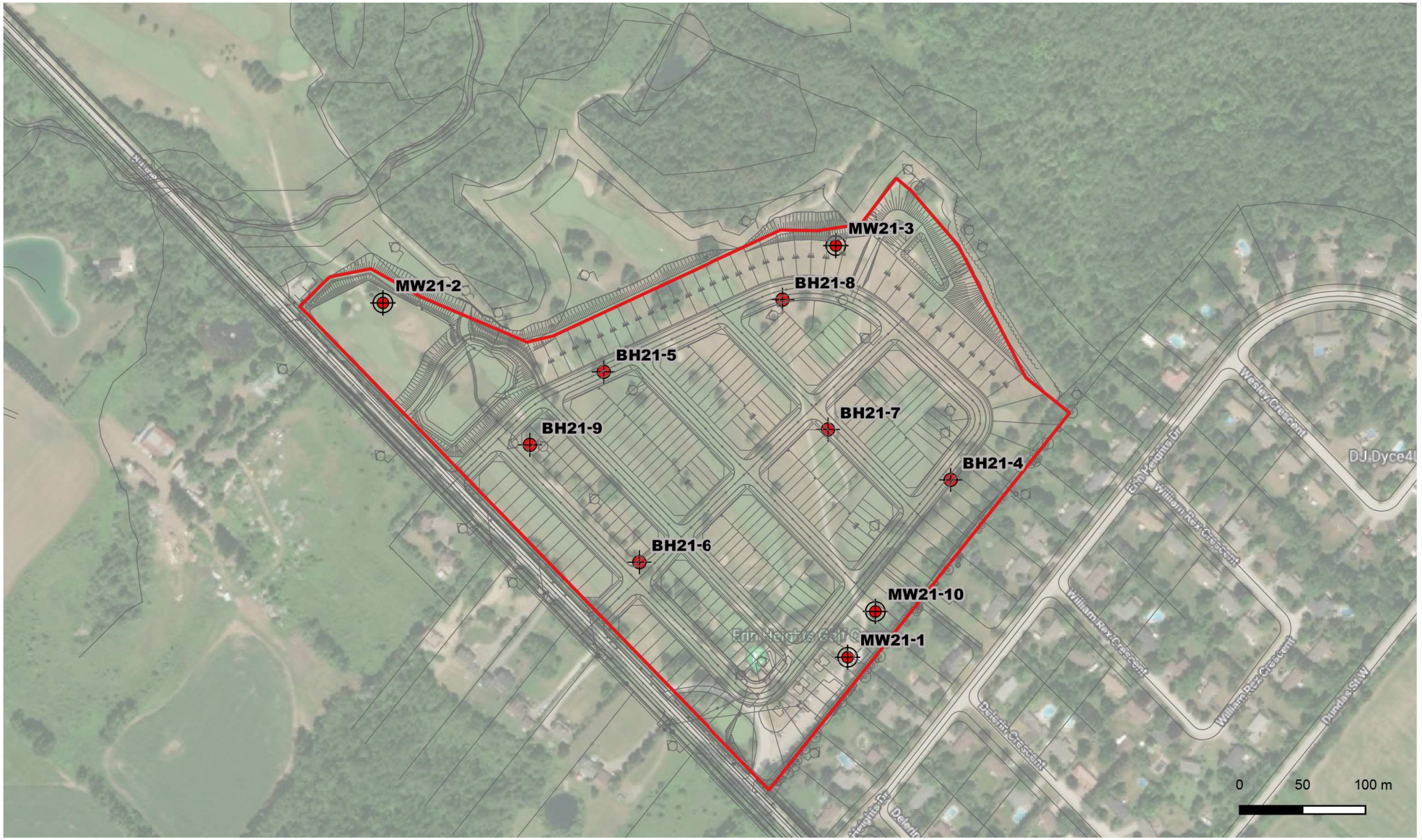
Drawings

J:\-GIS\2021 PROJECTS\21-129-300 Enviro Erin Heights Golf Course\1-QGIS\Geo\Figure 1 - Borehole Location Plan.qgs Sep-06 07:34



Legend

- Approx Property Boundary
- Borehole
- Monitoring Well

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Client: EMPIRE COMMUNITIES

Project: GEOTECHNICAL INVESTIGATION
Erin Heights Golf Course, 5525 8 Line, Erin, ON

Title: **BOREHOLE/MONITORING WELL LOCATIONS**

N

Size:	Approved By:	Drawn By:	Date:
8.5 x 11	E.P	S.Y	September 2023
Rev: 0	Scale: As Shown	Project No.: 21-219-300	Figure No.: 1

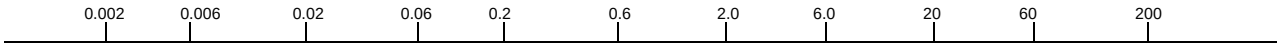
Image/Map Source: *Esri Satellite Image*

Figure 1A: Notes on Soil Sample Descriptions

1. All sample descriptions included in this report generally follow the Unified Soil Classification. Laboratory grain size analyses provided by DS 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.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

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.

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE MW21-1

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846537.081 E 573786.33

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-15-2021

REF. NO.: 21-129-300
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION
422.8					
422.7 / 0.1	**GRANULAR FILL:** 50mm				
	SILT AND SAND: trace gravel, trace clay, brown, moist, loose to compact	1	SS	9	
		2	SS	15	422
		3	SS	22	421
420.7 / 2.1	**SILTY SAND TILL:** some gravel, some clay, cobble/boulder sizes, brown, moist, very dense	4	SS	76	420
		5	SS	50/ 25mm	
					Bentonite 419
		6	SS	50/ 50mm	418
					W. L. 417.8 m Apr 28, 2021
					417
		7	SS	50/ 50mm	
					416
	wet below 7.6m	8	SS	87	415
					Filter Pack
		9	SS	50/ 25mm	Slotted Pipe
					413
411.8 / 11.0	**END OF BOREHOLE:**	10	SS	50/ 75mm	412

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water level Reading:

Date:	Water Level (mbgl):
April 28, 2021	5.0

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
1	9	46	37	8
8	11	45	31	13

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

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LOG OF BOREHOLE MW21-2

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846813.344 E 573411.482

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-19-2021

REF. NO.: 21-129-300
ENCL NO.: 3

(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)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
398.8												
0.0 / 398.4	**TOPSOIL:** 350mm		1	SS	10							1 58 35 6
0.4	**SILTY SAND:** trace to some gravel, trace clay, brown, moist, loose to compact		2	SS	13		398					
	wet below 1.5m		3	SS	8		W. L. 397.6 m Apr 28, 2021 / 397 Bentonite					
			4	SS	12		396					
			5	SS	17		395					
			6	SS	31		394 Filter Pack / Slotted Pipe					10 69 (22)
392.7 / 6.1	**SILTY SAND TILL:** some clay, cobble/boulder sizes, brown, moist, very dense		7	SS	62		392					
390.9			8	SS	50/ 25mm		391					
7.9	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water level Reading: Date: Water Level (mbgl): April 28, 2021 1.18											

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

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LOG OF BOREHOLE MW21-3

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846862.76 E 573771.456

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION
405.7					
0.0 / 405.4	**TOPSOIL:** 250mm	1	SS	4	
0.3	**FILL**: sand, some silt to silty, some gravel, trace clay, trace organics, brown, moist, loose to compact	2	SS	6	405
		3	SS	8	404
		4	SS	22	403
402.7					
3.0	**SILTY SAND:** trace gravel, trace clay, brown, moist to wet, compact to dense	5	SS	15	402
	wet below 4.6m	6	SS	31	401
399.6					400
6.1	**SILTY SAND TILL:** gravelly, brown, wet, compact	7	SS	12	
	layer of sand, medium to coarse	8	SS	12	398
397.5					
8.2	**END OF BOREHOLE:**				

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water level Reading:

Date:	Water Level (mbgl):
April 28, 2021	6.33

Bentonite
Filter Pack
Slotted Pipe
W. L. 399.3 m
Apr 28, 2021

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
1	14	67	15	4
5	4	59	32	5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

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LOG OF BOREHOLE BH21-4

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846678.156 E 573864.767

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-15-2021

REF. NO.: 21-129-300
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
414.1							414
0.0 / 413.8	**TOPSOIL:** 250mm		1	SS	2		
0.3	**FILL**: silty sand, some gravel, trace clay, brown, moist, loose		2	SS	6		413
1			3	SS	9		
2 / 411.8							412
2.3	**SILTY SAND TILL:** cobble/boulder sizes, brown, moist to wet, very dense		4	SS	50/ 25mm		
3			5	SS	50/ 50mm		411
4	wet below 4.6m		6	SS	50		410
5							409
6			7	SS	50/ 75mm		408
7 / 406.4							407
7.7	**END OF BOREHOLE:**		8	SS	50/ 50mm		

Notes:

1) Water level in open borehole:

Date:	Water Level (mbgl):
on completion	4.6

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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
16	44	32	8

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

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LOG OF BOREHOLE BH21-5

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846760.737 E 573587.463

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 6

(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)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
404.9												
404.7	**TOPSOIL:** 200mm											
0.2	**FILL**: silty sand, gravelly, trace clay, brown, wet, loose		1	SS	4							
1			2	SS	4		404					24 41 29 6
403.4												
1.5	**SILTY SAND**: trace gravel, brown, moist to wet, compact		3	SS	11		403					
2	wet below 2.3m		4	SS	15							
3			5	SS	25		402					
400.3												
4.6	**SILTY SAND TILL:** cobble/boulder sizes, brown to grey, moist, very dense		6	SS	50		401					
5							400					
6			7	SS	50/ 50mm		399					
7							398					
396.9			8	SS	50/ 100mm		397					
8.0	**END OF BOREHOLE:**											

Notes:

1) Water level in open borehole:

Date:	Water Level (mbgl):
on completion	2.3

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

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LOG OF BOREHOLE BH21-6

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846610.242 E 573617.42

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 7

(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)	METHANE AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
415.3												
415.0 0.0	**TOPSOIL:** 200mm											
0.2	**SANDY GRAVEL**: some silt, brown, moist, compact to dense		1	SS	17		415					
1			2	SS	48							54 32 (14)
413.8							414					
1.5	**SILTY SAND TILL:** cobble/boulder sizes, brown to grey, moist, compact to very dense		3	SS	19							
2			4	SS	27		413					
3			5	SS	44		412					
4			6	SS	29		411					
5							410					
6			7	SS	71		409					
7							408					
8			8	SS	81							
407.1												
8.2	**END OF BOREHOLE:** Notes: 1) Borehole open and dry upon completion.											

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

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

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LOG OF BOREHOLE BH21-7

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846717.062 E 573766.909

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-15-2021

REF. NO.: 21-129-300
ENCL NO.: 8

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION
412.0							
412.0 / 0.1	**TOPSOIL:** 100mm						
	SAND AND GRAVEL: some silt, brown, moist, loose to very dense		1	SS	4		
			2	SS	65		411
			3	SS	50/ 100mm		
409.7							410
2.3	**SILTY SAND TILL:** cobble/boulder sizes, brown to grey, moist to wet, compact to very dense		4	SS	28		
	wet below 3m depth		5	SS	18		409
			6	SS	50/ 25mm		408
			7	SS	50/ 25mm		407
404.3							406
7.7	**END OF BOREHOLE:**		8	SS	50/ 25mm		405

Notes:

1) Water level in open borehole:

Date:	Water Level (mbgl):
on completion	3.0

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
36	47		(17)

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

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

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH21-8

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846819.483 E 573729.609

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-16-2021

REF. NO.: 21-129-300
ENCL NO.: 9

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS / 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
407.7							
407.6 0.0	**TOPSOIL:** 150mm						
0.2	**GRAVELLY SAND**: some silt, brown, moist, loose to compact		1	SS	3		407
			2	SS	19		
			3	SS	30		406
			4	SS	24		405
403.1			5	SS	23		404
4.6	**SILTY SAND**: some gravel, brown, moist to wet, dense to loose		6	SS	35		403
	wet at 6.1m depth disturbed at 6.1m		7	DIST	(disturbed)		402
400.1							401
7.6	**SILTY SAND TILL:** brown, moist, dense		8	SS	39		400
399.5							
8.2	**END OF BOREHOLE:** Notes: 1) Water level in open borehole: Date: Water Level (mbgl): on completion 6.1						

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

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

34 53 (13)

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH21-9

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846702.204 E 573529.376

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-19-2021

REF. NO.: 21-129-300
ENCL NO.: 10

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m	GROUND WATER CONDITIONS	ELEVATION
408.2							
408.0 0.1	**TOPSOIL:** 100mm						408
	FILL: sand and silt, trace clay, mixed with organics/topsoil, very loose to compact		1	SS	3		
1			2	SS	2		407
2			3	SS	10		
405.9 2.3	**SILTY SAND TILL:** brown, moist to wet, compact to very dense		4	SS	31		406
3	wet at 3m depth		5	SS	13		405
4							404
5	layer of medium to coarse sand		6	SS	33		403
6							
7			7	SS	54		402
8							401
400.0 8.2	**END OF BOREHOLE:**		8	SS	47		400

Notes:

1) Water level in open borehole:

Date: Water Level (mbgl):
on completion 3.0

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

METHANE AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
	41	51	8

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

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LOG OF BOREHOLE MW21-10

PROJECT: Preliminary Geotechnical Investigation - Erin Heights Golf Course
CLIENT: Empire Communities
PROJECT LOCATION: 5525 8 Line, Erin, ON
DATUM: Geodetic
BOREHOLE LOCATION: See Drawing 1 N 4846573.281 E 573806.122

DRILLING DATA
Method: Hollow Stem Auger
Diameter: 200mm
Date: Apr-19-2021

REF. NO.: 21-129-300
ENCL NO.: 11

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION
419.1							419
0.0 / 418.8	**GRANULAR FILL:** 250mm		1	SS	10	Bentonite	
0.3	**FILL**: silty sand, some gravel, trace clay, brown, moist, loose to compact		2	SS	4		418
			3	SS	23	W. L. 417.4 m Apr 28, 2021	417
416.8						Filter Pack	
2.3	**SILTY SAND:** trace gravel, trace clay, brown, wet, loose		4	SS	8	Slotted Pipe	
416.0							416
3.1	**SILTY SAND TILL:** gravelly, brown to grey, moist, dense to very dense		5	SS	44		
			6	SS	58		415
			7	SS	80		414
			8	SS	72		413
410.9							412
8.2	**END OF BOREHOLE:**						411

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water level Reading:

Date:	Water Level (mbgl):
April 28, 2021	1.69

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × 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)

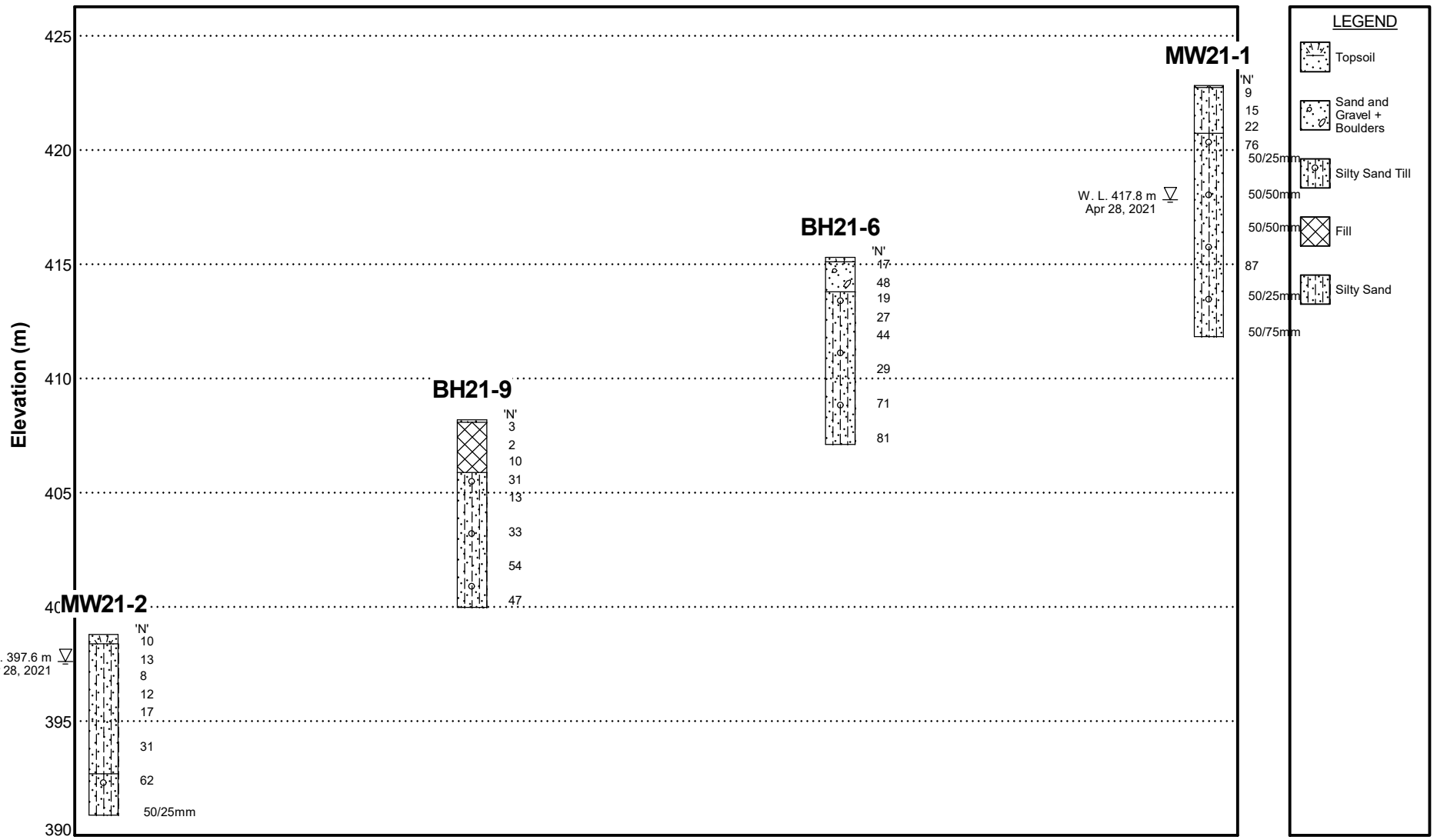
METHANE AND GRAIN SIZE DISTRIBUTION (%)

NUMBER	GR	SA	SI	CL
2	11	54	26	9
4	8	57	26	9

DS SOIL LOG 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 21-5-5

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

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



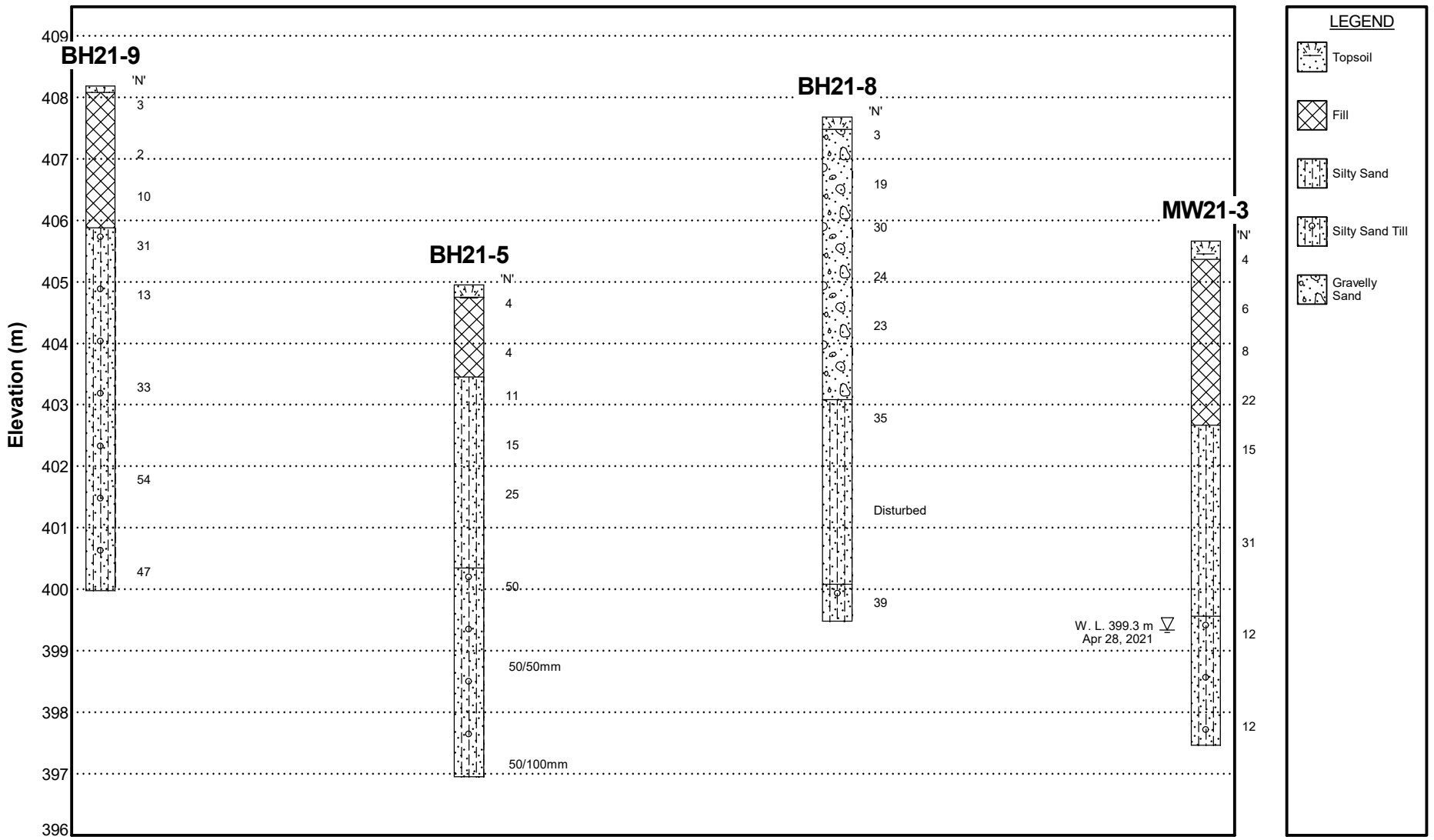
Distance Along Baseline (Not to Scale)

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

Generalized Sub-surface Profile

DRAWING NO.	12
JOB NO.	21-129-300
DATE	Apr 29, 2021

DS FENCE (M) 21-129-300 ERIN HEIGHTS BOREHOLE LOG.GPJ DS.GDT 4/29/21



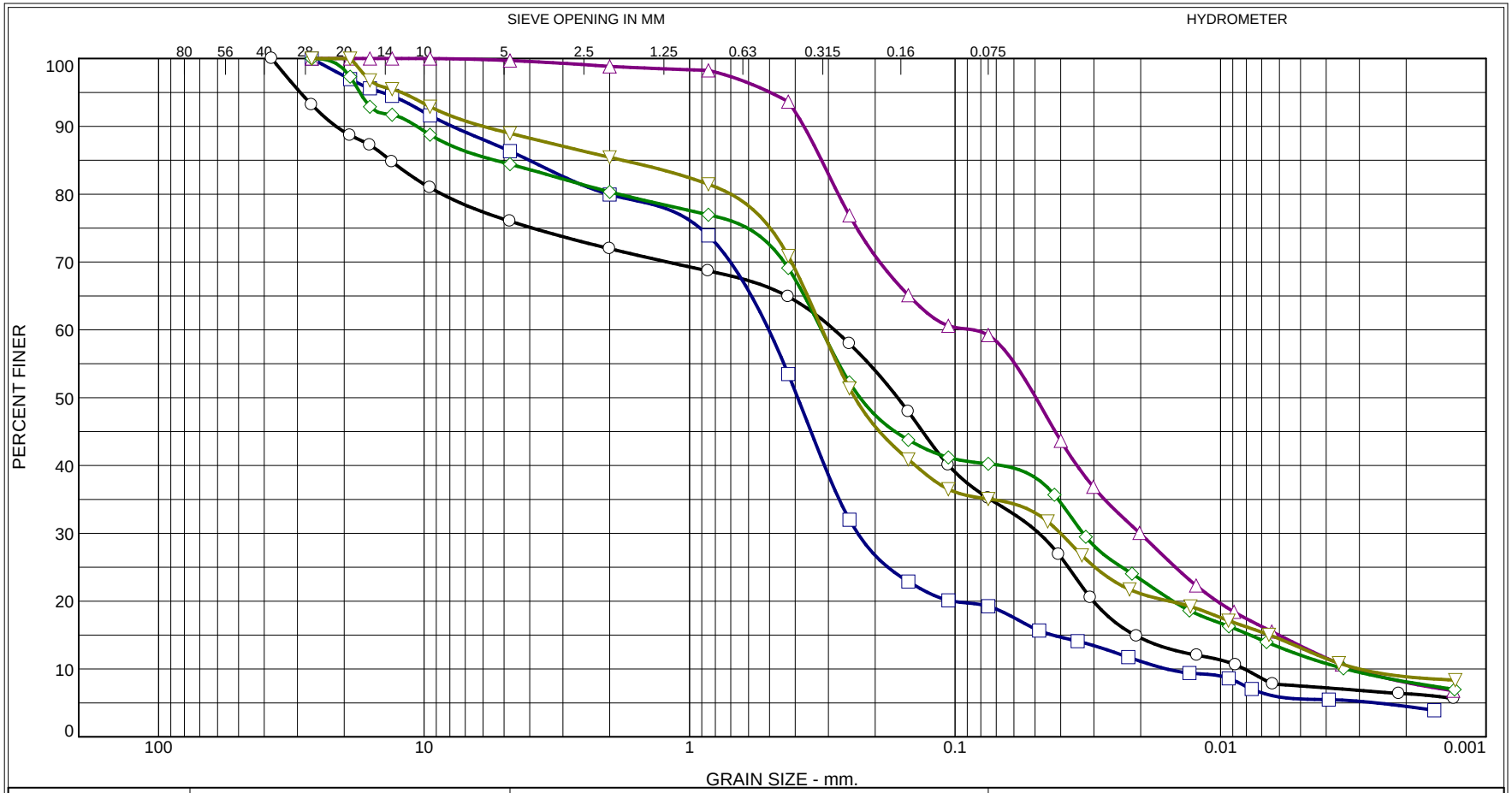
Distance Along Baseline (Not to Scale)

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

Generalized Sub-surface Profile

DRAWING NO.	13
JOB NO.	21-129-300
DATE	Apr 29, 2021

DS FENCE (M) 21-129-300 ERIN HEIGHTS BOREHOLE LOGS.GPJ DS.GDT 4/29/21



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

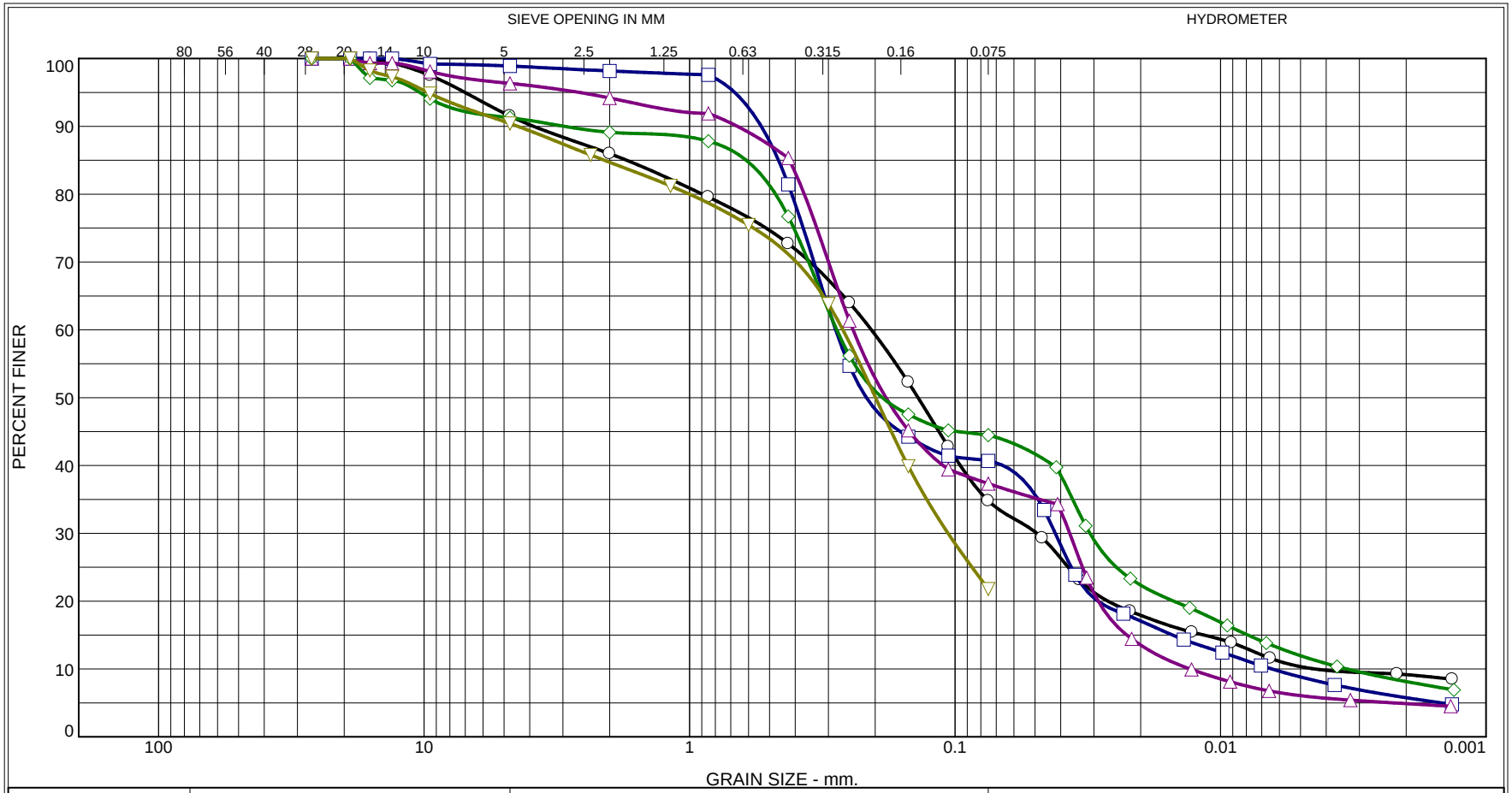
	Location	Source	Sample #	Depth/Elev.	Material Description
○	BH21-5/AS2		CAM-1133		Fill:Gravelly Sand Silty Sand,Sand,Silty Sand
□	MW21-3/SS2		CAM-1117		
△	BH-21-9/SS1		CAM-1123		
◇	BH21-4/SS2		CAM-1118		
▽	MW21-10/SS2		CAM-1126		

Project No. 21-129-300 **Client** Empire Communities **Figure No. :** 14

Particle Size Distribution Report

Erin Heights Golf Course

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

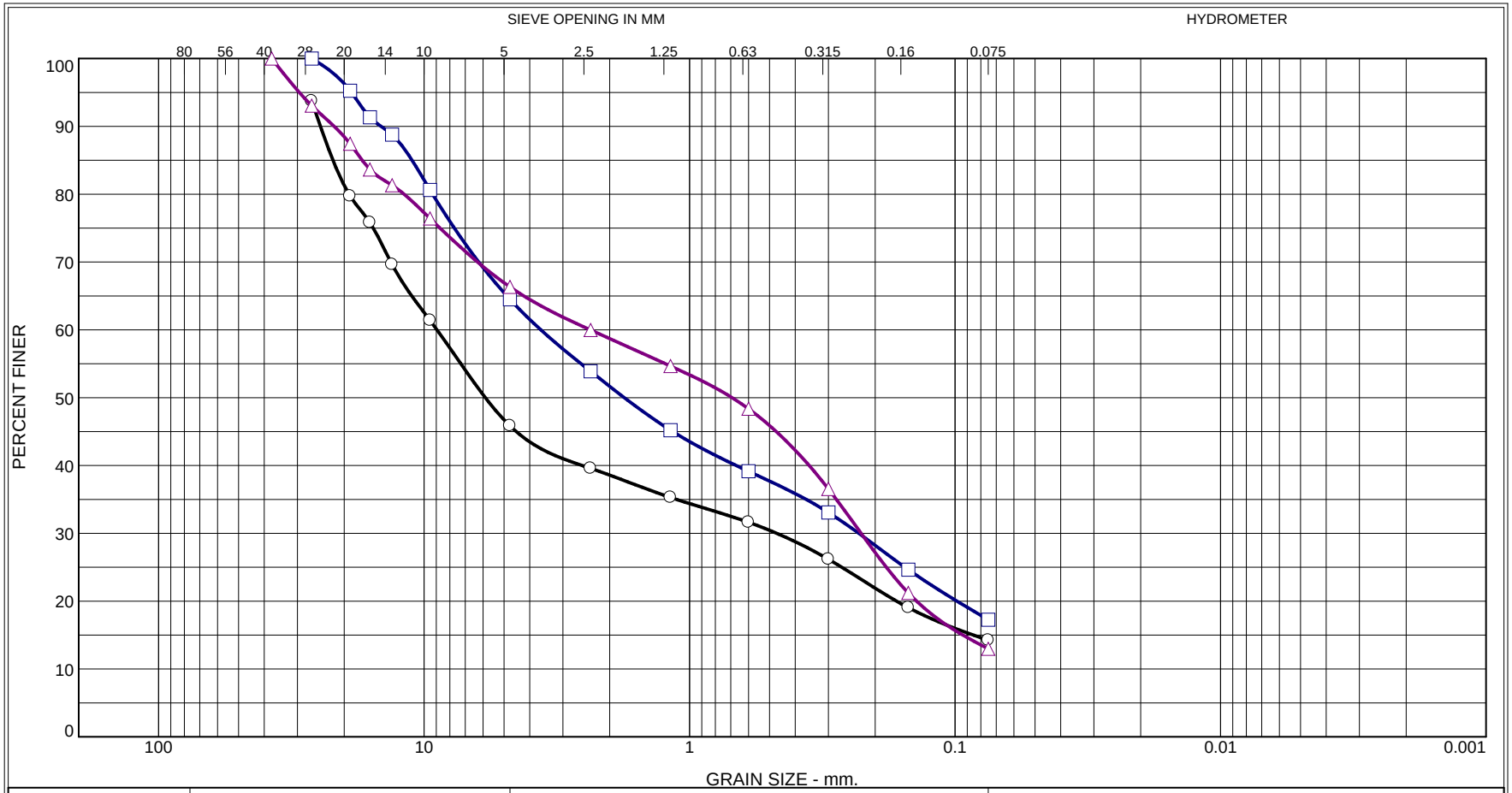
	Location	Source	Sample #	Depth/Elev.	Material Description
○	MW21-10/SS4		CAM-1132		Silty sand,Silt and Sand
□	MW21-2/SS1		CAM-1124		
△	MW21-3/SS6		CAM-1116		
◇	MW21-1/SS1		CAM-1125		
▽	MW-21-2/SS6		CAM-1136		

Project No. 21-129-300 **Client** Empire Communities **Figure No. :** 15

Particle Size Distribution Report

Erin Heights Golf Course

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

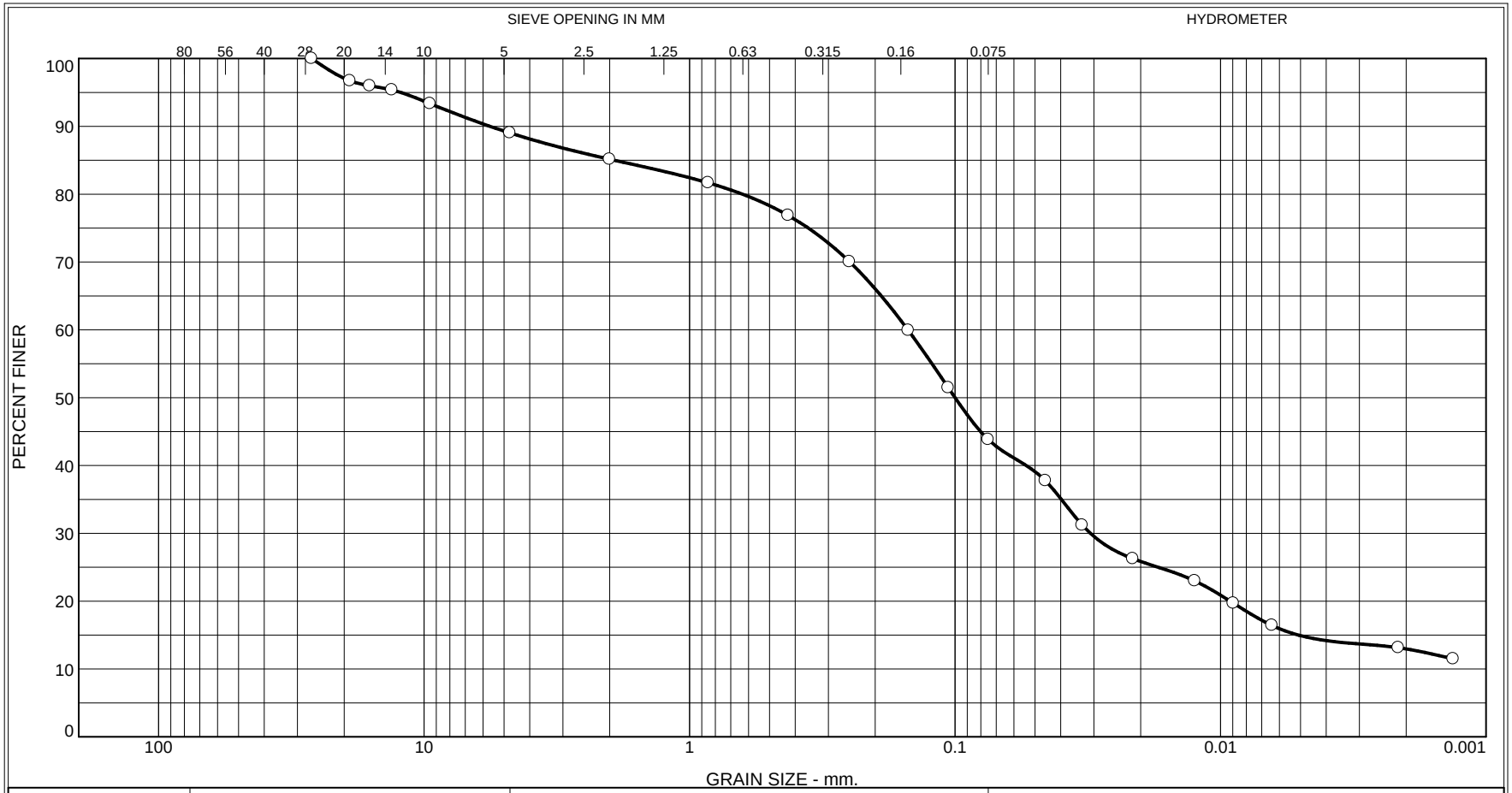
	Location	Source	Sample #	Depth/Elev.	Material Description
○	BH21-6/SS2		CAM-1120		Gravelly sand
□	BH21-7/SS2		CAM-1121		
△	BH21-8/SS2		CAM-1122		

Project No. 21-129-300 **Client** Empire Communities **Figure No. :** 16

Particle Size Distribution Report

Erin Heights Golf Course

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

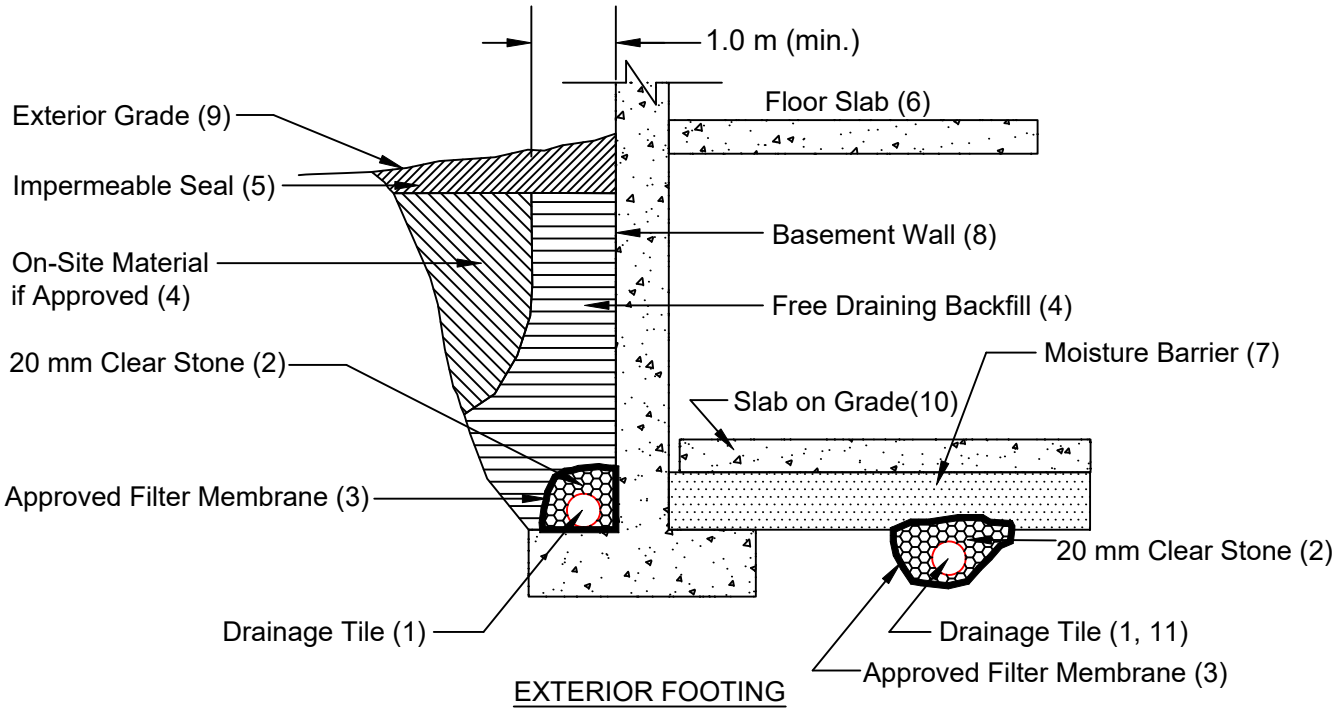
	Location	Source	Sample #	Depth/Elev.	Material Description
○	MW21-1/SS8		CAM-1135		Silty sand,some gravel,some clay

Project No. 21-129-300 **Client** Empire Communities **Figure No. :** 17

Particle Size Distribution Report

Erin Heights Golf Course

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology
CCIL



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.
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)

Appendix A

Engineered Fill Guidelines

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 DS Consultants Ltd (DSCL). Without this confirmation no responsibility for the performance of the structure can be accepted by DSCL. 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 DSCL 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 DSCL during placement of engineered fill is required. Work cannot commence or continue without the presence of the DSCL 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.

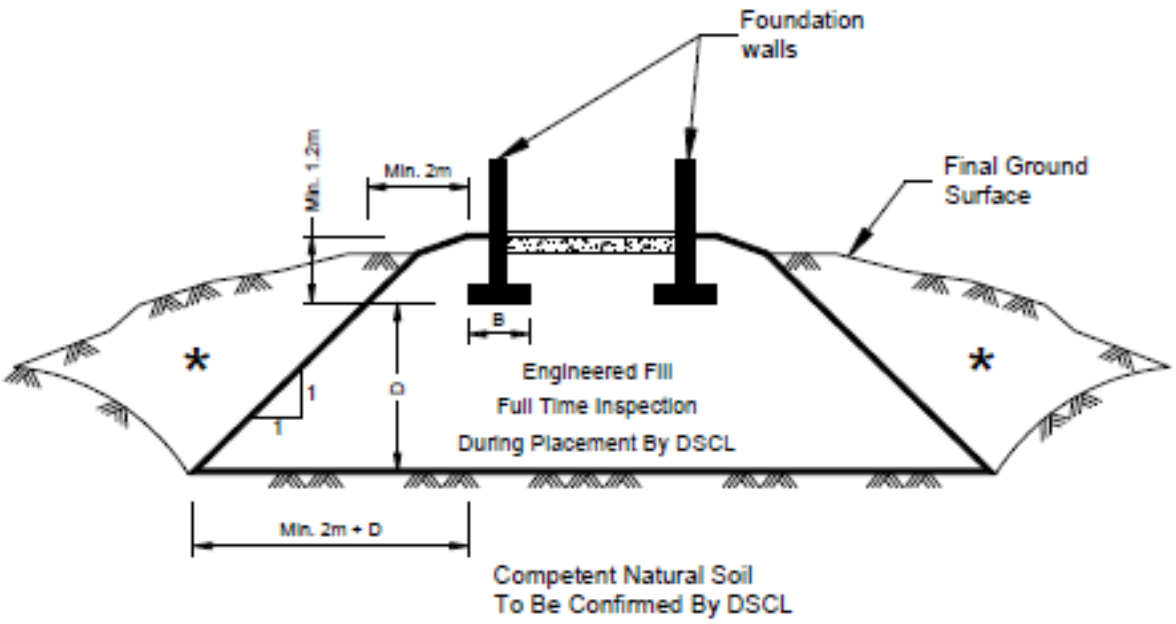
10. After completion of the engineered fill pad a second contractor may be selected to install footings. The prepared footing bases must be evaluated by engineering staff from DSCL prior to footing concrete placements. All excavations must be backfilled under full time supervision by DSCL to the same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

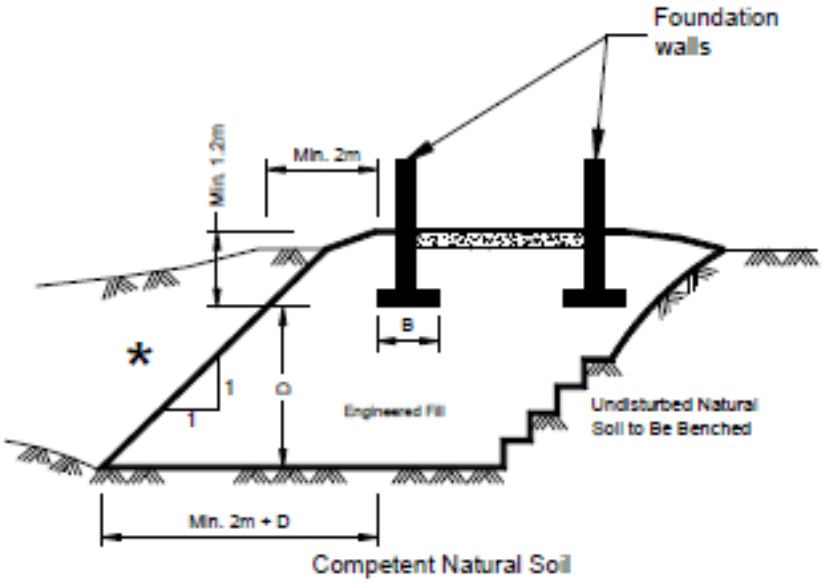
11. After completion of compaction, the surface of the engineered fill pad must be protected from disturbance from traffic, rain and frost. During the course of fill placement, the engineered fill must be smooth-graded, proof-rolled and sloped/crowned at the end of each day, prior to weekends and any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





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