NASIRUDDIN
ENGINEERING
LIMITED

Geotechnical Investigation
NEL Report No. NEL-21-MEM-001

Proposed Development
18 & 20 Ferndale Drive North
Barrie, Ontario

Prepared for:

MEM Engineering Inc.
3355 Lehigh Crescent
Mississauga, Ontario
L4T 1W9

By:

Nasiruddin Engineering Limited

February 19, 2021

NASIRUDDIN ENGINEERING LIMITED

EXECUTIVE SUMMARY

This document reports the findings of a Geotechnical Investigation conducted by Nasiruddin Engineering Limited (NEL) in support of a proposed development at 18 and 20 Ferndale Drive North located in Barrie, Ontario.

Five boreholes were advanced through a surface layer of topsoil approximately 200mm thick. Beneath the surface layer, there were layers of sand and silt / silty sand (with trace clay and some or trace gravel). Standard penetration tests carried out within these soil deposits between 1.5m to 3.0m gave 'N' values ranging from 5 blows per 0.3m to about 16 blows per 0.3m, indicating a very loose to compact soil strength with natural water content ranging from 22% to 30% (i.e. wet).

Underground water was encountered in all five boreholes with one representative piezometer stand pipe installed to measure the stabilized water level. Secondary water level measurements were taken approximately three weeks after conclusion of drilling in order to allow water levels to naturally normalize as confining pore pressures dissipate. Water level measurements are summarized in the report. Groundwater will need to be addressed as part of the design and during construction.

Taking into account soil type, 'N' value and the water table, the SLS bearing capacity is estimated to be 75 to 100 kPa.

No chemical testing was carried out for soil or groundwater samples as this was confirmed to not be part of our scope for this study.

Construction-related recommendations are discussed in the report including dewatering, structural footings, settlement, frost protection, excavation and backfilling, shoring and pavement design. Also, soil parameters relevant to the design and construction of these works are discussed.

NASIRUDDIN
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LIMITED

February 19, 2021

MEM Engineering Inc.
3355 Lehigh Crescent
Mississauga, Ontario
L4T 1W9

Attention: Harjinder Singh

Re: Geotechnical Investigation
Report No.: NEL-21-MEM-001
Proposed Development at 18 & 20 Ferndale Drive North, Barrie, Ontario

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Dear Sir,

Please find enclosed herewith our Geotechnical Investigation report for the site location cited above. Borehole drilling at five locations on site was carried out on January 18, 2021 and the retrieved soil samples were brought to our laboratory in Mississauga for further analysis including tactile and visual examination and moisture content testing. Selected representative samples were also tested for grain size distribution analysis to confirm soil descriptions. Groundwater was encountered in all five boreholes with a piezometer installed in one representative location to measure/observe the stabilized water level. No chemical testing was carried out for soil or groundwater samples as this was confirmed to not be part of our scope for this study. The report presents relevant soil characteristics encountered, moisture content observations and concludes with construction recommendations. If you have questions, concerns or require further input to help facilitate design, please do not hesitate to contact the undersigned.

Sincerely,

Nasiruddin Engineering Limited

Michael

Michael Tawdros, P.Eng.
647.980.8513
michael@nasiruddineng.com

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APPENDICES

1.0 INTRODUCTION

Nasiruddin Engineering Limited (NEL) was retained by MEM Engineering Inc. to carry out a geotechnical investigation in support of a proposed development located at a property in Barrie, Ontario which combines the addresses of 18 and 20 Ferndale Drive North.

It is understood that it is proposed to develop the property with an automotive repair establishment and other future developments which would extend close to the property limits.

This geotechnical report is intended to provide sufficient recommendations to establish background design data for the proposed project development.

The investigation was to include advancement of boreholes at the proposed site for performing in-situ testing (Standard Penetration Test), verification of groundwater level if encountered and obtaining soil samples for laboratory testing (soil classification, moisture content and grain-size distribution analysis). Then a report presenting NEL's observations, findings and recommendations was to be prepared and submitted to MEM Engineering Inc.

The following sections contain the interpretation of the collected data and the evaluation of the anticipated behaviour of the soil deposits during various construction works. It should be noted that the opinions expressed in this report should not be considered as recommendations with respect to construction works methodology. Instead, the purpose of the opinions expressed is to provide the designer with information to evaluate construction feasibility and to emphasize items for consideration when preparing the construction specifications.

Contractors planning to submit tenders for construction works should make their own evaluation and interpretation of the factual data presented and summarized in this report and select the most suitable and economical construction methods based on their knowledge and previous experience under similar subsurface conditions. Further limitations are outlined in the concluding section titled Statement of Limitations.

2.0 SITE DESCRIPTION

The site is located in the City of Barrie, Ontario at 18 and 20 Ferndale Drive North in a primarily industrial-commercial use neighbourhood. Activities on surrounding properties include an auto-parts store, truck trailer sales centre, construction machines dealer, a plumbing business and a recycling facility. However, no activities or property uses appear to be within a proximity that would be anticipated to affect or influence geotechnical or geo-environmental characteristics of the subject site. Regarding proximity to major roads, the site is north-west of where Highway 401 and Tiffin Street cross each other.

Currently, the combined property at 18 and 20 Ferndale Drive North appears to be a mostly unused lot with a treeline on its northern boundary. On the 20 Ferndale Drive North portion of the site, there is wild vegetation/grass growth, a partial asphalt driveway and parked (potentially abandoned) cars. However, the site is not completely undeveloped. On the 18 Ferndale Drive North portion of the site, there is an existing, relatively small single-storey structure serviced by gas and hydro. South of this building, an asphalt driveway that turns into a gravel driveway leads to a large parking zone behind the building (west side).

The site appears to be relatively flat with no notable elevation changes or grading undulations. Hence, drainage generally appears to follow gentle slopes towards Ferndale Drive North situated on the east side of the subject property. Storm drainage is likely absorbed through the site's soft surfaces or conveyed as runoff to the road. On Ferndale Drive North, there are catchbasins to intercept and convey storm flows but no other drainage structures were noted during our site visit. Hence, it is not known if there are any ditches or ditch inlets to manage stormwater. The relative flatness of the site, relative flatness of the surrounding adjacent properties and lack of drainage likely means snow and rain are absorbed into the ground with no other apparent path of exit.

ON1Call was contacted and we were informed of utility service members to be contacted for obtaining their clearance/approval for borehole locations before drilling. All required utility locates approvals were obtained from relevant authorities in addition to a private utility locator (Accurate Underground Services) before the start of work and the representative boreholes locations were selected/confirmed accordingly.

Review of Ontario Geological Survey geological maps available through the Ministry of Northern Development and Mines (http://www.mndm.gov.on.ca) including Bedrock Geology, Quaternary Geology, Bedrock Topography and Overburden Thickness, and Surficial Geology reveals that the overburden in the subject area is expected to consist of coarse-textured glaciolacustrine deposits including sand, gravel, minor silt and clay foreshore and basinal deposits. This soil description closely resembles the soil actually encountered in the boreholes advanced on this site as discussed in following sections of this report. The overburden is expected to be underlain by bedrock which may consist of limestone, dolostone, shale, arkose or sandstone of the Shadow Lake Formation which is included as part of the Ottawa Group / Simcoe Group of geological formations.

3.0 FIELD INVESTIGATION AND LABORATORY WORK

Field investigation works were carried out on January 18, 2021. All boreholes were completed the same day.

The boreholes were advanced using Standard Geotechnical Drilling Procedures starting from the existing ground surface. The investigation consisted of two boreholes advanced to 3.05m (10 feet) with the remaining three boreholes advanced to 2.29m (7.5 feet) depth below existing ground/surface level.

Drilling equipment was supplied and operated by Kodiak Drilling. The equipment used was a MARL-M2 drill rig with continuous 4-inch diameter helical flight solid stem auger and 63.5 kg (140 Ib) automatic drop hammer advancing the boreholes.

Borehole drilling was carried out under the supervision of a senior geotechnical engineer from our staff. Soil samples were obtained via split spoon sampling following the Standard Penetration Test (SPT- ASTM D1586) procedures with accompanying 'N' values recorded in blows per 0.3m.

Retrieved soil samples were collected in the field by sealing in moisture free and non-absorbent plastic bags and sent to NEL's laboratory for further examination.

At the NEL laboratory in Mississauga, visual and tactile examination and moisture content testing was carried out on all samples. Grain size distribution analysis tests were carried out on two representative select samples.

One stand up pipe (groundwater monitoring well) was installed at Borehole No. 1 to monitor the groundwater level.

Survey benchmarks were either not available or discoverable at the time of drilling. Hence, temporary benchmark elevations of 100m were assigned to the top of borehole for all boreholes and depths are therefore given relative to existing ground surface at the boreholes location.

All soil samples after laboratory examination and testing will be saved for a period of one month from the date of issue of this report and then discarded unless otherwise requested by the client in writing.

The borehole locations are shown schematically on the Borehole Location Diagram in Appendix B. Cooordinates for the boreholes are summarized in the following table.

Borehole No.	Northing (UTM)	Easting (UTM)
Borehole No. 1	4913801	602315
Borehole No. 2	4913791	602341
Borehole No. 3	4913797	602328
Borehole No. 4	4913802	602314
Borehole No. 5	4913792	602341

Boreholes Coordinates

3.1 Grain Size Distribution Analysis

The sieve and hydrometer test results for two representative samples selected from Borehole No. 1 and 3 shows soil component percentages approximately as follows:

Sample No.	Clay	Silt	Sand	Gravel
BH # 1 Sample # 4	4.6%	47.4%	48.0%	0.0%
BH# 3 Sample # 3	1.1%	37.9%	60.8%	0.2%

Soil Sample Components

These results essentially support the soil descriptions shown on the borehole logs. Lab reports for the above results are attached in Appendix C.

3.2 Laboratory Determination of Water (Moisture) Content

Laboratory testing of soil samples for all boreholes showed moisture content ranging from 20% to 30%. All obtained samples were wet. Samples near the ground surface were likely wet due to the accumulated thick layer of snow and frozen soil. However, it is suspected that subterranean samples were wet likely due to prevailing groundwater conditions (see Section 4.3 below).

4.0 SUBSURFACE CONDITIONS

In general, boreholes were drilled from above the snow-covered surface of the site and initially advanced through the topsoil surface layer. An attempt was made to clear the snow aside before commencement of drilling. Details of existing subsurface soil conditions encountered during the field drilling work and subsequent laboratory examination are given on the attached individual borehole logs. All boreholes were backfilled upon completion in accordance with Ontario Regulation 903 (as amended). General categorical discussions of the overall findings and highlights are discussed below.

4.1 Topsoil (All Boreholes)

The surface layer encountered in all boreholes was a layer of topsoil which had a thickness of approximately 200mm and a moisture content ranging from 23% to 25%.

Sample examinations show that the topsoil is dark grey to black in colour indicating that it contains an appreciable amount of organics with some rootlets and occasionally mixed with sand and rocks.

Topsoil is unstable under loads and highly compressible rendering this material unsuitable for engineering applications. It is weak in shear strength and has a sponge-like texture. The topsoil can only be used/re-used for normal landscaping and landscape contouring purposes if reviewed in the field and accepted by a Geotechnical Engineer from our office.

It should be noted that the thickness of the topsoil surface layer could vary significantly between and beyond the borehole locations. Furthermore, it could also have significant change as a result of grading change of the site, excavation, backfill activities and construction works. Therefore, we recommend that allowance be made for possible variations when making excavation quantity estimates.

4.2 Intermediary Strata

Sand and Silt / Silty Sand (with trace Clay, some or trace Gravel)

Deposits of sand and silt / silty sand (with trace clay and some or trace gravel) were encountered in all boreholes extending from approximately 1.5m depth to 3.05m below the existing ground surface. Standard penetration tests carried out within these soil deposits gave ‘N’ values ranging from 5 blows per 0.3m to about 16 blows per 0.3m, indicating a very loose to compact soil strength with natural water content ranging from 22% to 30%. More details are provided on the borehole logs (Appendix A).

4.3 Groundwater Conditions

Groundwater conditions were noted in all boreholes during and immediately following the drilling operations. Water depths were measured to be at 1.4m to 2.0m below surface elevation. All five boreholes were terminated in wet condition with standing water observed and measured.

One representative piezometer (stand pipe) was installed in Borehole No. 1 to measure the stabilized water level. A secondary water level measurement was taken approximately three weeks after conclusion of drilling in order to allow the water level to naturally normalize as confining pore pressures dissipate. Water level measurements are summarized in the table below:

Piezometer at	Water level on Jan. 18, 2021	Water level on Feb. 10, 2021
Borehole No. 1	1.40m	1.33m

Groundwater Level Readings (Depth from Surface)

However, this is a short-term observation which may not be indicative of the long term groundwater level. It is important to consider the effect of snow thawing, rain fall and surface runoff as capillary forces will cause water seeping down to raise the groundwater table. Over the long term, groundwater conditions may fluctuate as per seasonal variations and precipitation. Groundwater conditions experienced during construction may vary from the conditions encountered during this investigation. Variations in colour from brown to grey noted in upper soil layers of boreholes, as was observed in the boreholes for this site, usually indicates variations in the degree of oxidation in the soil and therefore suggests the likelihood of a fluctuating groundwater level.

Depending on the depth of excavation for foundations, trench excavation for sewers, etc., the contractor carrying out construction works will likely need to contend with groundwater infiltration at the time of construction and project designs will need to address groundwater (e.g. include weeping tiles, protection of foundations, etc.).

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Dewatering

Challenges with groundwater may affect the work on this site (excavations in particular). Any seepage from perched water and/or natural groundwater levels should be handled adequately with properly filtered sump pumps.

The bottom of excavations is anticipated to potentially be below the groundwater table unless the excavation is relatively shallow. However, the recommended depth of building foundations will not be shallow as the ‘N’ values are in the lower range near the surface. Bottom of foundation elevation at deeper depth where greater resistance to settlement can be developed is the most likely construction scenario. Hence, any contractor awarded this work should have the ability to dewater during excavation and have dewatering measures available on standby (see Section 4.3 above regarding possible seasonal variations of groundwater levels).

Relatively high rates of water seepage may be encountered as all soil layers have a prominent amount of sand content. Sandy soil typically has greater hydraulic conductivity allowing groundwater to flow freely and into excavations. Excessive seepage may also occur from surface water flow which should be manageable by gravity drainage and filtered sumps or interim grading and soil berms to re-direct flows. In general, it should be possible to collect any seepage in temporary sumps (protected against erosion where necessary) and removed by pumping.

5.2 Allowable Soil Bearing Capacity

As indicated in the boreholes logs, the ‘N’ values vary in various soil layers. Hence, the soil bearing capacity will also exhibit variation. The ‘N’ values for depths from surface level to about 1.52m (5.0 feet) may not represent the actual soil strength due to the effect of freeze-thaw conditions (freezing depth = depth to which the groundwater in soil is expected to freeze).

The Serviceablity Limit State (SLS) bearing capacity based on wet conditions observed at the time of this investigation and taking into account information from all boreholes is estimated to be **75 to 100 kPa**.

This bearing capacity is rather low and therefore it is not advisable to support building foundations at just below frost depth (as shown on MEM Engineering Inc. Drawing No. A104) unless they are designed to be quite robust or an alternative technology like screw piles is considered.

This information should be verified in the field by our office during construction.

5.3 Structural Footings

Footings for the proposed structures should be founded on adequately prepared subgrade and complying with the following items:

- Exposed subgrade must be stripped of any topsoil, vegetation, loose, wet and/or deleterious material (if present)

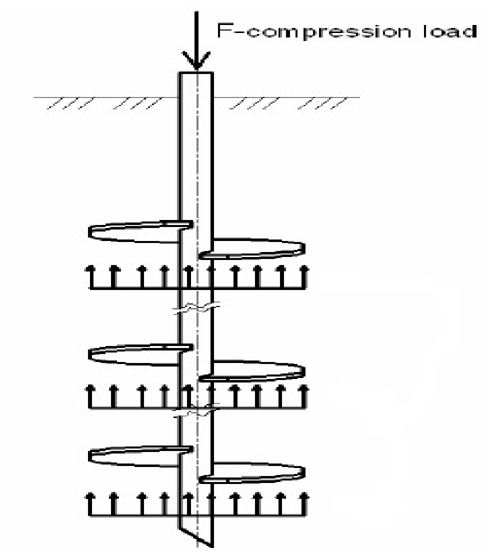
- Weak spots encountered on the exposed subgrade must be excavated and removed

- Exposed surface of the subgrade must be proof rolled (if space allows) or inspected by a Geotechnical Engineer from our office and compacted (if possible) to a minimum of 98% Standard Proctor maximum dry density.

For footing construction, if conventional excavated footings are designed rather than helical piles or caissons, then regardless of designed footing width it is recommended to compact the bottom of the excavated area then backfill using approved Granular 'A' or 19mm Clear Stone to create a level base/pad upon which the bottom of footing(s) will rest.

Backfilling material should be placed in loose lifts of no more than 200 mm each and compacted to 98% Standard Proctor maximum dry density with a moisture content within 2% of its optimum moisture content. If acceptable compaction is demonstrated to be achievable in the field, maximum lift thickness may be increased from 200mm to 300mm upon approval by a Geotechnical Engineer from our office.

Based on the encountered soil conditions at the borehole locations, the foundations of the new structures at the proposed site will likely be supported within the submerged silt/sand stratum below the water table. With this type of soil, difficulties are likely to arise with pouring a slab. The soil can compress under the weight of the concrete causing the slab to shift or sink over time. Pile foundations are often used when there are layers of soft, wet or weak soil which cannot support the weight of the building. Also, although conventional piles are a technically viable solution, they often tend to be a costly option. Hence, it is advisable to consider using the ultimate compression capacity of helical screw piles. According to its theory, the total capacity of a foundation anchor is equal to the sum of the capacities of its individual helices. This provides greater support by engaging more soil surface area within a single location.



Helical Pile

For design elements such as loads and type of foundation, reference should be made to the applicable design codes.

To protect structural foundations/footings from the effects of excessive water content on the site, typically it would be recommended to incorporate weeping tiles/subdrain around the base of building foundations to help intercept and redirect subterranean water away from the structure. However, in our opinion, this will only be effective on this site if an appropriate outlet is identified and designed by a Water Resources/Civil/Municipal Engineer knowledgeable in stormwater management.

5.4 Foundation Settlement

The settlement of the foundations designed with the recommended Serviceability Limit State bearing capacity (SLS) is appropriate for footings founded on the native soil with anticipated differential settlement of 19mm and total settlement of 25mm.

Foundations must meet the requirements specified in the Ontario Building Codes and the structure, if applicable, should be designed to resist an earthquake force as appropriate for Site Classification E (conservatively estimated as per Canadian Foundation Engineering Manual Table 6.1A).

5.5 Frost Protection

Any footings exposed to weathering and in unheated areas should be covered with a minimum of 1.2m of overburden soil or equivalent insulation below the exterior finished grade in order to provide protection from frost.

5.6 Excavation and Backfilling

It is understood that the proposed development buildings will involve slab-on-grade construction. However, it is not known if any underground works requiring trenching will be required to facilitate or further service the site development or if conventional footings will be excavated to deeper depths. If such excavations are carried out, for safety, all excavations should be made to conform to the regulations for construction projects as set out in the Occupational Health and Safety Act. The soil in which an excavation is made is to be classified as the type that the soil most closely resembles. If an excavation contains more than one type of soil, the soil shall be classified as the type with the highest number. Hence, the soil may be considered to be Type 3 in large part based on observed characteristics including the presence of firm or compact to loose soil; however, the higher soil type which governs due to the presence of wet soil is Type 4 as defined by the “Green Book” (Regulations for construction projects under Occupational Health and Safety Act).

Sloping of any excavation should be in accordance with the requirements for Type 4 soil. Accordingly, a bank slope of 3H:1V from the very bottom of excavation is recommended in accordance with the Ontario Health and Safety Regulations due to the site being dominated by silt and sand combination deposits with high moisture content. If the required slope cannot be satisfied due to space or other restrictions, a shoring system such as a trench box designed by a professional engineer should be adopted which meets all applicable standards and governing guidelines to support any excavation.

If water is controlled or observed to be less than assumed at the time of preparing this report, excavations can be modified to conform to the requirements for Type 3 soil. However, this should be confirmed by a Geotechnical Engineer from our office during construction.

Stockpiles of excavated materials should be kept at least 3.0m from the edge of excavations to avoid slope instability, subject to confirmation by the Geotechnical Engineer. Care should also be taken to avoid overloading of any underground services/structures by stockpiles.

Based on the lack of hardness, stiffness or density of the soil encountered on this site, no major excavation difficulties are foreseen but allowance should be made for cobbles/boulders that can occur randomly in the deposits.

If excavating to deeper depth is not practical or is cost prohibitive, consideration may be given to reinforcing the lower strength soils by backfilling with cementitious materials (e.g. unshrinkable fill or low-strength concrete). Alternatively, use of solutions like geogrid, geotextile or geogrid/geotextile combination products may be considered also.

It is recommended that a programme of geotechnical material inspection and testing be carried out during the construction phase of the project to confirm that the conditions exposed in the excavations are consistent with those encountered in the boreholes and the design assumptions, and to confirm that the various project specifications and materials requirements are being met.

Bedding and backfilling for trenches related to underground piping works should be in compliance with City of Barrie site development standards. The material excavated on site will be suitable for re-use as backfill for trenches, underneath concrete slabs and structural backfill provided that at the time of placement it has a moisture content that is within ± 2% of its Standard Proctor

Optimum Moisture Content. Also this material should not be used within the top 1.22m from final grade due to the silt content imparting greater frost susceptibility to the material. If needed, the material can be used shallower than 1.22m in non-critical areas that are not sensitive and can tolerate some heave.

5.7 Shoring

If excavation limits are deep and approach adjacent neighbours' existing structures, a shoring system should be designed to protect adjacent structures, roads and services. The fourth edition of the Canadian Foundation Engineering Manual should be referred to for the design of the shoring system. It should be noted that groundwater and boulders may be encountered during soldier pile construction, and the contractor must be prepared to deal with boulders and water seepage without undue delays. It will be difficult to prevent groundwater from penetrating into the excavation through gaps in timber lagging. For the geotechnical parameters which are considered to be applicable for the design, please refer to the appropriate coefficients tables in the foundation manual. Any surcharge loads must be included in the lateral pressure calculations.

The expected movements of the shoring wall (horizontal and vertical movements) should be monitored during construction to ensure a satisfactory performance of the shoring system. Subsurface conditions may vary beyond the site's confines, so, it is imperative that a stability analysis of the entire support system is undertaken prior to commencement of the shoring construction. The shoring system and surrounding structures must be monitored for horizontal and vertical movements, prior to, during and after the excavation. In addition, a pre-construction survey of adjacent structures/roads may be carried out prior to the shoring/design/construction stage. Any potential adverse effect on adjacent structures should be assessed and suitable preventive/remedial measures implemented.

5.8 Soil Parameters

The following estimated geotechnical parameters may be taken into consideration for design of elements discussed above such as foundations, shoring, trenching, sloping, etc.

Unit weight (γ) sat	14 KN/m3
Friction Angle (φ)	30°
Ko	0.5
Ka	0.33
Kp	3.0

5.9 Pavement

Based on the subgrade characteristics, prevailing moisture conditions and normal anticipated traffic loading, the pavement structures noted below are recommended:

Material	Light Duty	Heavy Duty
HL3 Surface Course Asphalt	40 mm	40 mm
HL8 Binder Course Asphalt	50 mm	100 mm
Granular Base course Granular 'A' compliant with OPSS 1010	200 mm	200 mm
Granular Subbase Granular 'B' Type I compliant with OPSS 1010 Remove any cobbles or boulders protruding out from the prepared surface or which are obstructing and preventing proper compaction	300 mm	450 mm

Recommended Pavement Structures

Note that Heavy Duty pavement would apply to delivery truck and/or Fire Emergency internally designated routes.

The final subgrade should be shaped and crowned to allow drainage to adequately spaced catch basins installed with subdrains leading to a positive outlet. As mentioned in Section 5.6, use of geosynthetics should be considered for mitigation of wet soil conditions.

To prevent saturation of the pavement mantle/base, we emphasize the need for adequate drainage. Catchbasins should contain provisions for drainage infiltration from the granular base course into these drainage structures.

Subdrains should be installed along the driveway areas, curbed perimeters of the development plus be installed to extend between catch basins or at least a run of subdrain installed radially in each direction for each catchbasin.

The asphalt components should be placed and compacted to 93% of the Maximum Relative Marshall Density as measured by Nuclear Densometers.

The surface of finished pavement should be free of depressions and should be sloped to provide effective surface drainage towards the catch basins and not to allow surface water to pond adjacent to the outside edges of the pavement areas. Subdrains shall be installed to intercept excess subsurface moisture and prevent the subgrade from softening especially at the heavy duty pavement areas (if any heavy duty areas are provided).

Due to frost action a differential movement can take place between pavement and manholes or catch basins. So, it is recommended to compact around manholes and catch basins using hand controlled light compaction equipment to avoid damaging them.

6.0 STATEMENT OF LIMITATIONS

The information contained in this report is intended only as guidance for design engineers or architects and are subject to field verification during construction. As more specific subsurface information, with respect to conditions between boreholes, becomes available during excavations on the subject site, this report should be updated if needed. Contractors bidding on or undertaking the work should decide on their own investigations, as well as their own interpretations of the factual borehole results. This concern specifically applies to the classification of the subsurface soil and the potential reuse of these soils on/off site. It is not to be relied upon by constructors nor is this report intended for constructors. However, potential constructors may have copies of the geotechnical information made available to them with the strict understanding that the information supplied is valid only at the borehole locations and that any extrapolation or interpolation of the information is done so at their own risk and liability.

Recommendations and inferences in this report are based on a limited number of boreholes. Subsurface conditions may vary in between and beyond the borehole locations. The borehole locations were selected in consultation with the client representative. Should any footprint locations change from those anticipated at the time of this investigation, NEL should be contacted to review those changes and modify our recommendation accordingly if required.

Report Limitations are an integral part of this report.

Respectfully submitted,

Nasiruddin Engineering Limited

LICENSED PROFESSIONAL ENGINEER
M. Z. TAWDROS
100170411
Feb. 19/2021
PROVINCE OF ONTARIO

Michael Tawdros, P.Eng.
647.980.8513
michael@nasiruddineng.com
www.nasiruddineng.com

APPENDIX A

Borehole Logs

LIST OF ABBREVIATIONS AND LEGEND

NASIRUDDIN ENGINEERING LIMITED

PENETRATION RESISTANCE

Standard Penetration Test (SPT) Resistance N: - The number of blows required to advance a standard split spoon sampler 0.3 m into the subsoil. Driven by a mass of 63.5 kg hammer falling freely a distance of 0.76m.

Dynamic Penetration Resistance: - The number of blows required to advance a 51mm, 60 degree cone, filtered to the end of the drill rods, 0.3 m into the subsoil. The driving energy being 475 J per blow.

DESCRIPTION OF SOIL

The consistency of cohesive soils and the relative density or denseness of cohesionless soils are described in the following terms:

CONSISTENCY	N (blows/0.3 m)	c(kPa)	DENSENESS	N (blows/0.3 m)
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		

TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AU	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample	CT	Chemical Testing Sample

PH Sample Advanced Hydraulically

PM Sample Advanced Manually

ROCK STATE OF WEATHERING

Fresh:	no visible weathering
Faintly Weathered:	weathering at surface of major discontinuities
Slightly Weathered:	penetrative weathering on open discontinuity surfaces
Moderately Weathered:	weathering extends throughout rock mass but rock is not friable
Highly Weathered:	weathering extends throughout rock mass, rock is partly friable
Completely Weathered:	rock wholly decomposed but original structure is preserved

ROCK FRACTURE INDEX

A count of the number of discontinuities in the rock core including both natural fractures, joints, etc. and breaks caused by drilling. Calculated and expressed as a value per foot (0.3 m).

ROCK CORE CONDITION (RECOVERY)

Total Core Recovery: The percentage of solid core recovered regardless of quality or length. Measured relative to the length of the total coring run.

Solid Core Recovery: The percentage of solid core recovered at full diameter regardless of length. Measured relative to the length of the total coring run.

ROCK QUALITY DESIGNATION (RQD)

Indirect measure of the number of fractures and thereby the soundness of the rock mass. It is calculated by the following expression:

$$\text{RQD \%} = \frac{\Sigma \text{ Length of core pieces} > 100\text{mm}}{\text{Total length of core run}} \times 100$$

DIP with respect to (w.r.t.) CORE AXIS

The angle of discontinuity relative to the rock core's length-wise (vertical) axis. In a vertical corehole 90 degrees is horizontal.

ROCK DISCONTINUITY SPACING

DESCRIPTION	SPACING
Very Widely Fractured (VW)	> 2 m
Widely Fractured (WF)	60 cm to 2 m
Medium Fractured (MF)	20 cm to 60 cm
Closely Fractured (CF)	6 cm to 20 cm
Broken	< 6 cm

ROCK STRENGTH

DESCRIPTION	UNIAXIAL COMPRESSIVE STRENGTH (MPa)
Extremely Strong, Grade R6	> 250
Very Strong, Grade R5	100 - 250
Strong, Grade R4	50 - 100
Medium Strong, Grade R3	25 - 50
Weak, Grade R2	5 - 25
Very Weak, Grade R1	1 - 5
Extremely Weak, Grade R0	0.25 - 1

FILL SILT SAND GRAVEL Ground Water Level

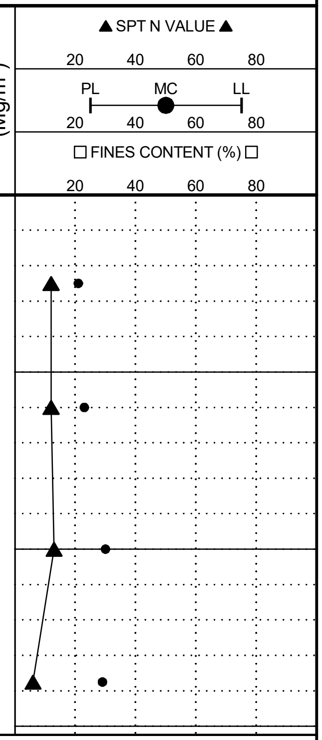
CLAY TILL SHALE ASPHALT PEAT / TOPSOIL

NASIRUDDIN ENGINEERING LIMITED
Nasiruddin Engineering Ltd.
6033 Shawson Drive, Mississauga, L5T 1H8
Ph:905-565-9595 Fax:905-565-9578

BORING NUMBER 1

CLIENT MEM Engineering Inc.
PROJECT NAME Ferndale Drive, Barrie
PROJECT NUMBER NEL - 21 - MEM - 001
PROJECT LOCATION 20 Ferndale Drive North, Barrie
DATE STARTED 21-1-18 **COMPLETED** 21-1-18
GROUND ELEVATION 100 m **HOLE SIZE** 0.11 m
DRILLING CONTRACTOR Kodiak Drilling
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Tawdros **CHECKED BY** A. Qamar
AT END OF DRILLING 1.40 m / Elev 98.60 m
NOTES Marl - M2, Weather cloudy light rain, -3° C
AFTER DRILLING 1.33 m / Elev 98.67 m

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)
		200 mm Top soil, Black, Sand and Rocks					
		Brown, Compact, Sand, some Silt, trace Clay, Wet	SS 1		4-6-6 (12)		
1		Brown, Compact, Silty Sand, trace to some Gravel, Wet	SS 2		5-6-6 (12)		
2		Grey, Compact, coarse Sand and Silt, trace Clay, trace Gravel, Wet	SS 3		5-6-7 (13)		
3		Grey, Loose, Sand and Silt, trace Clay, Wet	SS 4		4-3-3 (6)		



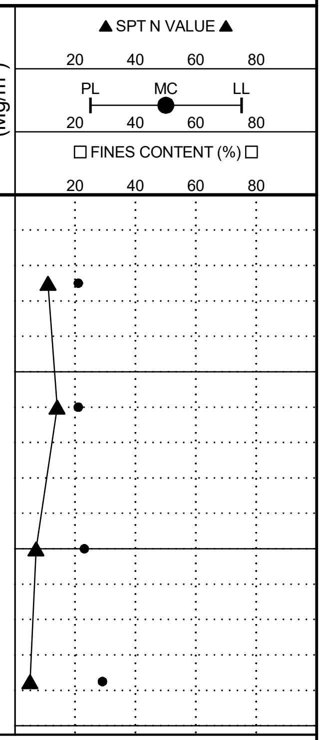
Bottom of hole at 3.05 m.

Nasiruddin Engineering Ltd.
6033 Shawson Drive, Mississauga, L5T 1H8
Ph:905-565-9595 Fax:905-565-9578

BORING NUMBER 2

CLIENT MEM Engineering Inc.
PROJECT NAME Ferndale Drive, Barrie
PROJECT NUMBER NEL - 21 - MEM - 001
PROJECT LOCATION 20 Ferndale Drive North, Barrie
DATE STARTED 21-1-18 **COMPLETED** 21-1-18
GROUND ELEVATION 100 m **HOLE SIZE** 0.11 m
DRILLING CONTRACTOR Kodiak Drilling
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Tawdros **CHECKED BY** A. Qamar
AT END OF DRILLING 2.00 m / Elev 98.00 m
NOTES Marl - M2, Weather cloudy light rain, -3° C
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)
		200 mm Top soil, Black, Sand and Rocks					
		Brown, Compact, Sand, some Silt, trace Clay, Wet	SS 1		3-5-6 (11)		
1		Brown, Compact, Silty Sand, trace to some Gravel, Wet	SS 2		6-7-7 (14)		
2		Grey, Loose, coarse Sand and Silt, trace Clay, trace Gravel, Wet	SS 3		5-3-4 (7)		
3		Grey, Loose, Sand and Silt, trace Clay, Wet	SS 4		3-3-2 (5)		



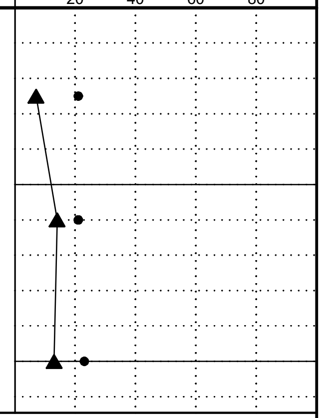
Bottom of hole at 3.05 m.

Nasiruddin Engineering Ltd.
6033 Shawson Drive, Mississauga, L5T 1H8
Ph:905-565-9595 Fax:905-565-9578

BORING NUMBER 3

CLIENT MEM Engineering Inc.
PROJECT NAME Ferndale Drive, Barrie
PROJECT NUMBER NEL - 21 - MEM - 001
PROJECT LOCATION 20 Ferndale Drive North, Barrie
DATE STARTED 21-1-18 **COMPLETED** 21-1-18
GROUND ELEVATION 100 m **HOLE SIZE** 0.11 m
DRILLING CONTRACTOR Kodiak Drilling
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Tawdros **CHECKED BY** A. Qamar
AT END OF DRILLING 2.00 m / Elev 98.00 m
NOTES Marl - M2, Weather cloudy light rain, -3° C
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	▲ SPT N VALUE ▲ 20 40 60 80 / PL MC LL 20 40 60 80 / ☐ FINES CONTENT (%) ☐ 20 40 60 80
		200 mm Top soil, Black, Sand and Rocks						
		Brown, Loose, Sand, some Silt, trace Clay, Wet	SS 1		5-3-4 (7)			
1		Brown, Compact, Silty Sand, trace to some Gravel, Wet	SS 2		6-7-7 (14)			
2		Grey, Compact, coarse Sand and Silt, trace Clay, trace Gravel, Wet	SS 3		7-7-6 (13)			



Bottom of hole at 2.29 m.

Nasiruddin Engineering Ltd.
6033 Shawson Drive, Mississauga, L5T 1H8
Ph:905-565-9595 Fax:905-565-9578

BORING NUMBER 4

CLIENT MEM Engineering Inc.
PROJECT NAME Ferndale Drive, Barrie
PROJECT NUMBER NEL - 21 - MEM - 001
PROJECT LOCATION 20 Ferndale Drive North, Barrie
DATE STARTED 21-1-18 **COMPLETED** 21-1-18
GROUND ELEVATION 100 m **HOLE SIZE** 0.11 m
DRILLING CONTRACTOR Kodiak Drilling
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Tawdros **CHECKED BY** A. Qamar
AT END OF DRILLING 2.00 m / Elev 98.00 m
NOTES Marl - M2, Weather cloudy light rain, -3° C
AFTER DRILLING ---

DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)	▲ SPT N VALUE ▲ (20 40 60 80) / PL MC LL (20 40 60 80) / ☐ FINES CONTENT (%) ☐ (20 40 60 80)
		200 mm Top soil, Black, Sand and Rocks						
		Brown, Compact, Sand, some Silt, trace Clay, Wet	SS 1		3-5-6 (11)			
1		Brown, Compact, Silty Sand, trace to some Gravel, Wet	SS 2		6-9-7 (16)			
2		Grey, Compact, coarse Sand and Silt, trace Clay, trace Gravel, Wet ▼	SS 3		3-8-8 (16)			

Bottom of hole at 2.29 m.

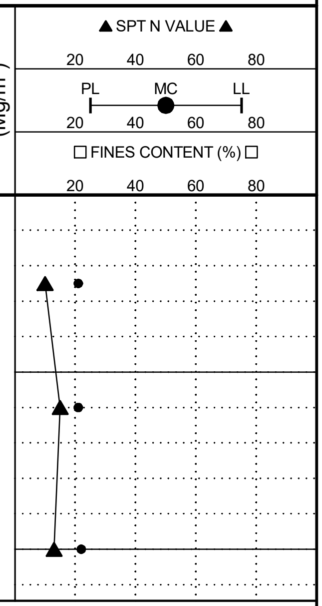
Nasiruddin Engineering Ltd.
6033 Shawson Drive, Mississauga, L5T 1H8
Ph:905-565-9595 Fax:905-565-9578

BORING NUMBER 5

CLIENT MEM Engineering Inc.
PROJECT NAME Ferndale Drive, Barrie
PROJECT NUMBER NEL - 21 - MEM - 001
PROJECT LOCATION 20 Ferndale Drive North, Barrie
DATE STARTED 21-1-18 **COMPLETED** 21-1-18
GROUND ELEVATION 100 m **HOLE SIZE** 0.11 m
DRILLING CONTRACTOR Kodiak Drilling
GROUND WATER LEVELS:
DRILLING METHOD Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY M. Tawdros **CHECKED BY** A. Qamar
AT END OF DRILLING 2.00 m / Elev 98.00 m
NOTES Marl - M2, Weather cloudy light rain, -3° C
AFTER DRILLING ---

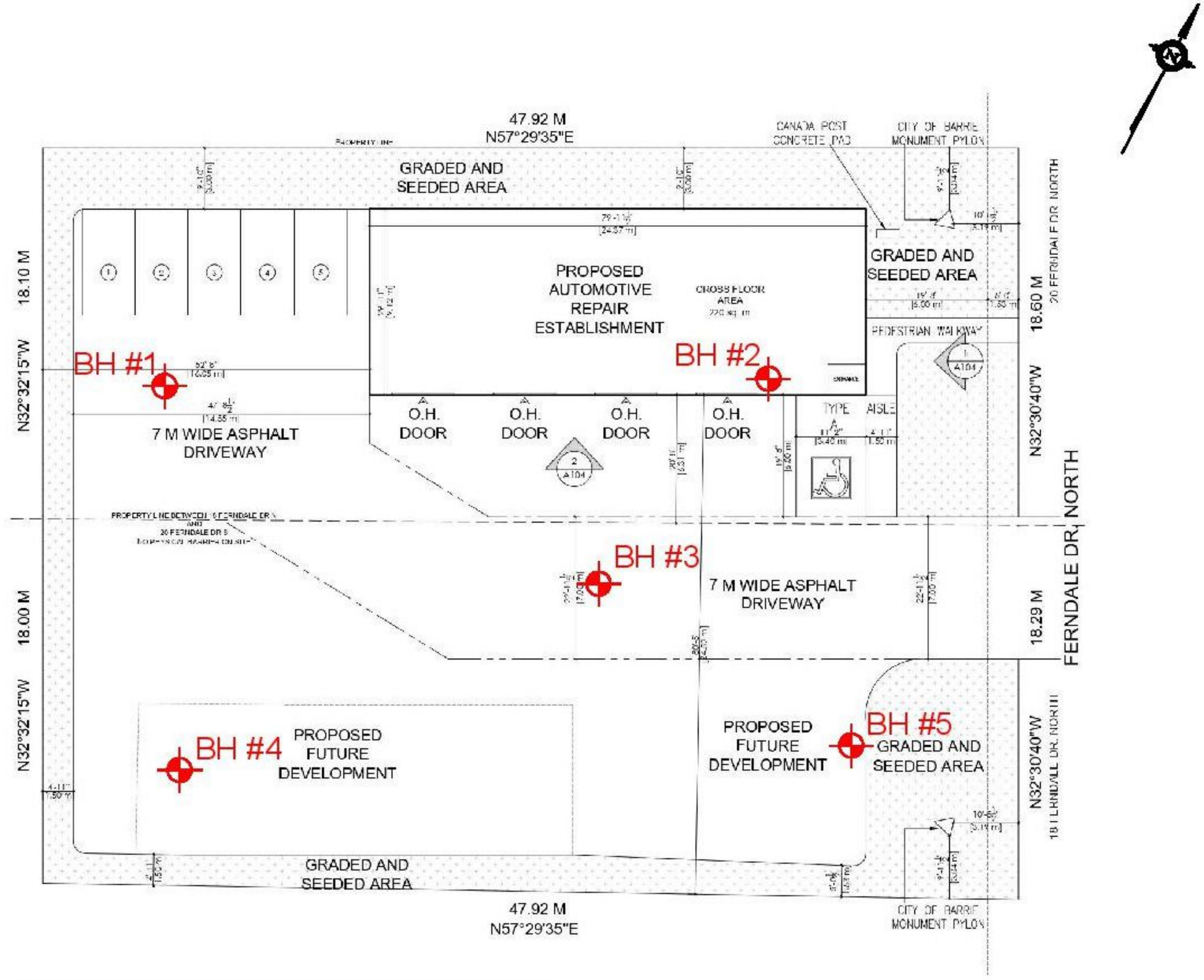
DEPTH (m)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (kPa)	DRY UNIT WT. (Mg/m^3)
		200 mm Top soil, Black, Sand and Rocks					
		Brown, Compact, Sand, some Silt, trace Clay, Wet	SS 1		4-5-5 (10)		
1		Brown, Compact, Silty Sand, trace to some Gravel, Wet	SS 2		6-7-8 (15)		
2		Grey, Compact, coarse Sand and Silt, trace Clay, trace Gravel, Wet	SS 3		7-7-6 (13)		

Bottom of hole at 2.29 m.



APPENDIX B

Borehole Location Diagram



Drawing source: Drawing No. A101 provided by MEM Engineering Inc.

KEY MAP (N.T.S.)
Reference: Google Maps

Note: Locations shown are approximate and are a schematic representation of the borehole locations relative to each other to show how they were numbered. Please refer to body of report for coordinates.

Borehole No. 1 and 2 drilled to 3.05m (10 feet) below existing ground level.

Borehole No. 3, 4 and 5 drilled to 2.29m (7.5 feet) below existing ground level.

NASIRUDDIN ENGINEERING LIMITED
6033 Shawson Drive
Unit 1, 2, 3, 5 and 6
Mississauga, Ontario
L5T 1H8
Canada

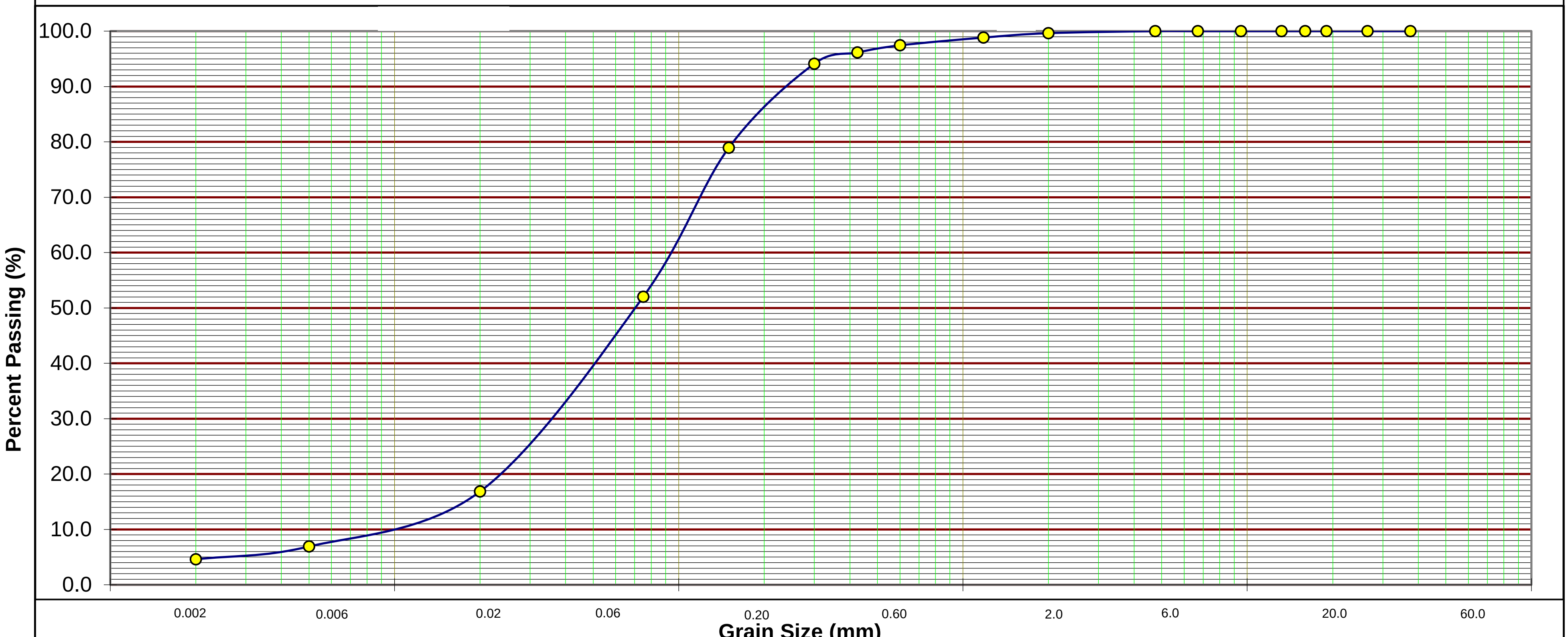
DRAWING: Borehole Location Diagram	
PROJECT: 18 & 20 Ferndale Dr. North, Barrie ON	
SCALE: N.T.S.	DATE: February 19, 2021

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
NEL-21-MEM-001	NEL-01	0

APPENDIX C

Grain Size Distribution Analysis

GRAIN SIZE DISTRIBUTION ANALYSIS



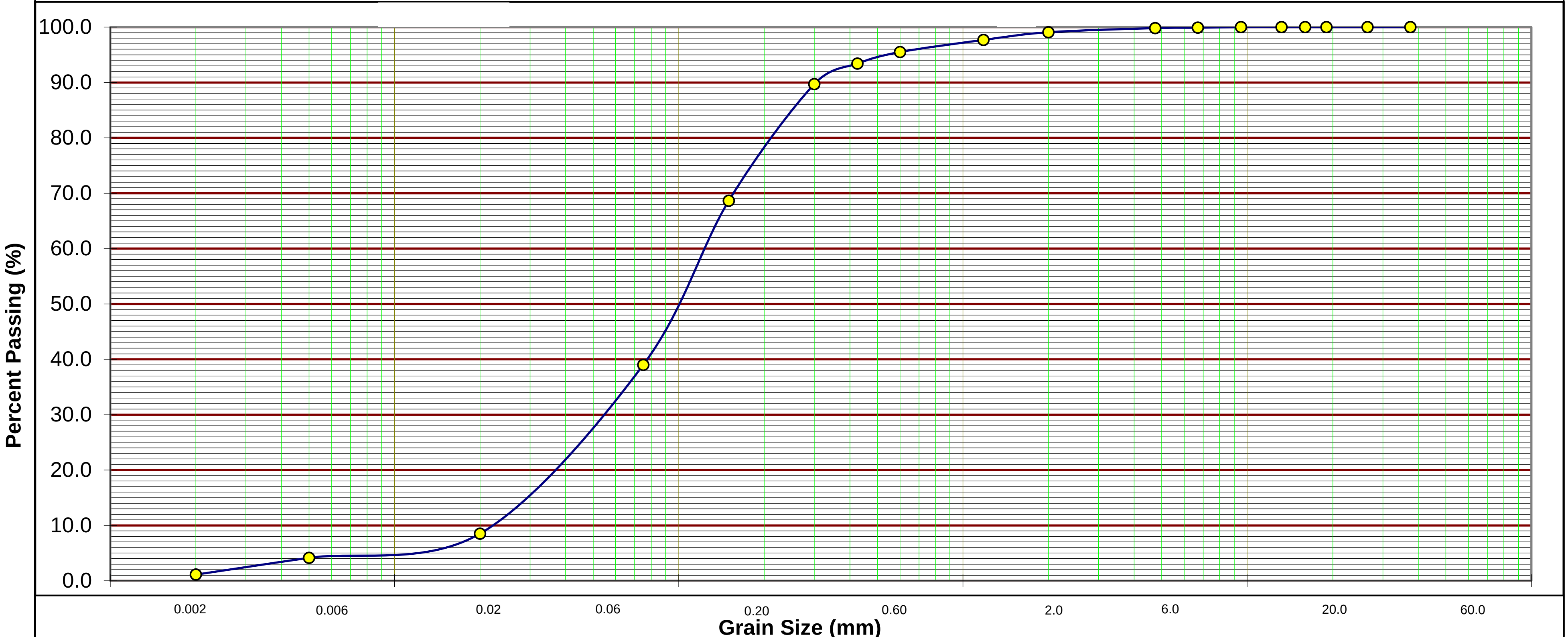
CLAY (4.6 %)	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	COARSE
	SILT (47.4 %)			SAND (48.0 %)			GRAVEL (0.0 %)	

NASIRUDDIN ENGINEERING LIMITED

Client: MEM Engineering Inc.
Project: NEL-21-MEM-001
Location: 20 Ferndale Drive North, Barrie

Date: February 2, 2021
Lab No.: NEL-HYD-21-01
Source: BH # 1, Sample # 4

GRAIN SIZE DISTRIBUTION ANALYSIS



CLAY (1.1 %)	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	COARSE
	SILT (37.9 %)			SAND (60.8 %)			GRAVEL (0.2 %)	

NASIRUDDIN ENGINEERING LIMITED

Client: MEM Engineering Inc.

Project: NEL-21-MEM-001

Location: 20 Ferndale Drive North, Barrie

Date: February 2, 2021

Lab No.: NEL-HYD-21-02

Source: BH # 3, Sample # 3

APPENDIX D

Site Photos

NASIRUDDIN
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LIMITED

General site view

Marl - M2 drilling equipment

NASIRUDDIN
ENGINEERING
LIMITED

Drilling Borehole No. 4

Piezometer stand pipe installed at Borehole No. 1