# REPORT ON

Preliminary Geotechnical Investigation
Proposed Residential Development
Neyagawa Boulevard and Burnhamthorpe Road
Oakville, Ontario

## PREPARED FOR:

Argo Neyagawa Corporation

**Project No:** 21-455-100
**Date:** July 14, 2022

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**DRAWINGS**

# 1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Argo Neyagawa Corporation to carry out a preliminary geotechnical investigation for the proposed residential development to be located at Neyagawa Boulevard and Burnhamthorpe Road in Oakville, Ontario.

It is understood that the preliminary proposed residential development will include several buildings (12 to 15-storey residential buildings) along Neyagawa Boulevard and Burnhamthorpe Road, with high density townhouses in the interior of the site. The preliminary proposed development is anticipated to include underground parking/basement. However, the building/house locations and number of underground parking levels are not known at this stage. Design details of the proposed development are not available to us at the time of writing this report.

DS is currently carrying out hydrogeological investigation at the subject site. The hydrogeological report will be documented under a separate cover.

The purpose of this geotechnical investigation was to determine the subsurface conditions at the borehole locations and make preliminary engineering recommendations for the following:

1. Foundations
2. Floor slabs and permanent drainage
3. Earth pressures
4. Excavations and backfill
5. Earthquake considerations
6. Temporary Shoring

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, Canada. The format and contents are guided by client specific needs and economics. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

The foundation recommendations made in this report are based on the subsoil conditions found during the field investigation. The comments made in this report on potential construction problems and possible construction options intended only for guidance of the designer.

This report has been prepared for Argo Neyagawa Corporation and its architects and designers. Third party use of this report without DS Consultants Ltd. consent is prohibited.

## 2. FIELD WORK & LAB TESTING

Eight (8) boreholes (BH22-1B, BH22-2 and BH22-9 to BH22-14, see Drawing 1 for location plan) were drilled at the site during the period of May 17 to 25, 2022 to depths ranging from 12.3 to 17.0m below the existing grade.

**It should be noted that the remaining boreholes (BH22-1A and BH22-3 to BH22-8) were shallow and drilled for environmental purposes. Therefore, these boreholes are not included in this report.**

Boreholes were drilled with solid stem and hollow stem continuous flight auger equipment by a drilling sub-contractor under the direction and supervision of DS Consultants Ltd 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 Consultants Limited laboratory for detailed examination by the project engineer and for laboratory testing.

As well as visual examination in the laboratory, all the soil samples were tested for moisture contents. Selected soil samples were subjected to grain size analyses and gradation curves are presented on Drawings 10 and 11. Atterberg's Limits tests were conducted on selected soil samples and results are presented on the respective borehole logs.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. Monitoring wells were installed at all the borehole locations (MW22-1, MW22-2, BH22-9, MW22-10, MW22-12 and MW22-14) for the longer-term groundwater level monitoring.

The elevation surveying of the borehole locations was undertaken by DS personnel, using the differential GPS unit. 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 approximate. Contractors performing any work referenced to the borehole elevations should confirm the borehole elevations for their work.

# 3. SUBSURFACE CONDITIONS

The borehole location plan is shown on Drawing 1. Notes on samples description are provided on Drawing 1A. The subsurface conditions in the boreholes are presented in the individual borehole log on **Drawings 2 to 9**.

## 3.1 Soil Conditions

**Topsoil/Organic Material:** A surficial topsoil (organic material) layer, varying from 200 to 250 mm in thickness, was present at the surface boreholes BH22-1B, BH22-10 to BH22-12. It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site. Shallow hand-dug test-pits should be carried out to calculate the amount of topsoil at site accurately.

**Fill and Weathered/Disturbed Soils:**

Fill materials (Reworked/weathered/disturbed native material) consisting of clayey silt and sand was detected below the topsoil/organic layer in boreholes BH22-1B, BH22-10 to BH22-12 and at the surface at the remaining boreholes extending to depths ranging from 0.8 to 2.1 m. The fill materials contained some to trace of topsoil, organics and rootlets. The moisture content of the moist to wet cohesionless sandy/silty layers varied from 11 to 28%.

The type/quantity and extent of the existing fill/reworked materials can be explored by further test pit investigation prior to excavations.

**Silty Clay/Silty Clay Till interbeds Sandy Silt to Silty sand Till Deposits:**

Brown to grey deposit consisting of silty clay to silty clay till interbeds sandy silt to silty sand till extended below the fill to the underlying silt till/shale complex and shale bedrock in all the boreholes, to approximate depths ranging from 10.7 to 16.9 m. This deposit contained layers of sandy silt and some to trace of clay, sand, gravel and cobbles. SPT 'N' values measured within the sandy/silty layers varied from 28 to over 100 blows per 300mm of penetration, indicating compact to very dense relative density. SPT 'N' values measured in the clayey layers ranged from 8 to over 50 blows per 300mm of penetration, indicating a stiff to hard consistency. The moisture content of the moist to wet cohesionless sandy/silty layers varied from 7 to 13% and the cohesive clayey material varied from 9 to 17%.

Grain size analyses of seven (7) soil samples from the sandy and silty were conducted, and the results are presented in **Drawings 10 and 11**, with the following fractions:

Clay: 7 to 19%
Silt: 30 to 63%
Sand: 2 to 50%
Gravel: 3 to 22%

Grain size analyses of twelve (12) clayey soil samples were conducted, and the results are presented in **Drawings 10 and 11**, with the following fractions:

Clay: 19 to 25%
Silt: 42 to 69%
Sand: 23 to 33%
Gravel: 1 to 8%

Atterberg limits tests of above noted twelve (12) clayey soil Samples (BH20-1/SS8 and SS13) were conducted. The results are shown on the borehole logs and are summarized as follows:

Liquid limit (WL): 20.1 to 23.6%
Plastic limit (WP): 13.0 to 15.3%
Plasticity index (PI): 7.1 to 9.7

**Clayey/Sandy Silt Till/ Shale Complex:**

Below the silt till in all the borehole locations, except Borehole BH22-14, at approximate depths ranging from 10.7 to 16.9m and extending to approximate depths ranging from 12.2 to 16.9m, a deposit of clayey silt and sandy silt till / shale complex was found overlying shale bedrock. This deposit generally consisted of clayey silt till/sandy silt till mixed with highly weathered shale. This deposit was found to have generally a hard consistency, with measured SPT 'N' value of more than 50 blows per 300 mm of penetration and compact to very dense, with measured SPT 'N' values varying from 29 to more than 100 blows per 300 mm.

Boreholes BH22-9, BH22-10, BH22-12 and BH22-13 were terminated in this deposit at this at depths of 12.3, 17.0, 16.9, 15.3 and 15.3m due to auger refusal, probably due to shale bedrock.

**Shale Bedrock:** Shale bedrock of Queenston Formation was encountered at BH22-1B, BH22-2, BH22-11 and BH22-14 at approximate depths of 15.2, 12.2, 15.3 and 13.5m, respectively, below the existing grade, corresponding to approximate Elevations ranging from 171.7 to 165.7m.

**However, the depth to shale bedrock varies across the site. Therefore, additional boreholes will be required to confirm the bedrock elevations within the entire property, with bedrock coring to confirm the quality of the bedrock, when the development drawings are available.**

Because of the method of drilling and sampling, the surface elevation of bedrock can be different than indicated on the borehole log. Commonly the till overlying the shale contains slabs of

limestone which would give a false indication of the bedrock level. Similarly, the depth of weathering cannot be determined accurately due to the presence of limestone layers.

The shale bedrock generally contains layers of sandstone, limestone and dolostone. Typically, the hard layers comprise about 15 to 20 percent of the unit. However, higher concentrations of hard layers can be present. The hard layers are usually less than 100 to 150 mm in thickness but some layers are much thicker. The thicker layers have been observed to be as much as 750 to 900 mm at other sites. The layers are actually lenses and they can vary significantly in thickness over short distance.

Methane gas is anticipated in the bedrock. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly for caissons. Stress relief features such as folds and faults are common in the shale bedrock. **Appendix A** presents more details and general comments about the shale bedrock.

## 3.2 Groundwater Conditions

Groundwater levels in the monitoring wells installed at all borehole locations were measured on June 8, 2022, at approximate depths ranging from of 0.8 to 8.4 m, i.e. at approximate Elevations varying from 180.9 to 174.1 m.

The groundwater levels (depths and elevations) are summarized in the following Table 3.1.

**Table 3.1: Groundwater Levels Observed in Monitoring Wells**

| Borehole | Surface Elevation (m) | Date of Observation | Water Level Depth (mbgs) | Water Level Elev. (m) |
|---|---|---|---|---|
| BH22-1A (Sallow) | 180.9 | June 8, 2022 | 0.95 | 179.95 |
| BH22-1B (Deep) | 180.9 | June 8, 2022 | 6.8 | 174.1 |
| BH22-2 | 171.7 | June 8, 2022 | 0.8 | 180.9 |
| BH22-9 | 181.5 | June 8, 2022 | 7.4 | 174.2 |
| BH22-10 | 187.9 | June 8, 2022 | 7.4 | 180.5 |
| BH22-12 | 184.7 | June 8, 2022 | 8.4 | 176.3 |
| BH22-14 | 183.3 | June 8, 2022 | 6.1 | 177.2 |

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

Therefore, reference is made to the hydrogeology study report prepared by DS for this project for further details on the extent and the conditions of the groundwater, as well as the recommended groundwater control.

# 4. FOUNDATIONS

It is understood that the preliminary proposed residential development will include several buildings (12 to 15-storey residential buildings) along Neyagawa Boulevard and Burnhamthorpe Road, with high density townhouses in the interior of the site. The preliminary proposed development will also include two levels underground parking/basement. Design details of the proposed development are not available to us at the time of writing this report.

**Therefore, our recommendations should be considered preliminary and will be revised when the proposed Site/Foundation plan becomes available.**

## 4.1 Drilled Caissons

Based on the borehole information, due to the variable soil conditions and the presence of less competent clay and sand layers, the proposed development can be supported by drilled caissons founded on shale bedrock.

Drilled caissons founded in sound shale bedrock at minimum 3.0 m below the shale surface can be designed for a bearing pressure of 7.5 MPa at SLS, and a factored geotechnical resistance of 11.2 MPa at ULS.

Shale bedrock was found at approximate depth varying from approximate depths varying from 12.2 to 15.2m at 4 boreholes below the existing grade, corresponding to approximate Elevations ranging from 171.7 to 165.7m.

**However, the bedrock elevations within the subject property can vary between the boreholes. Additional boreholes with bedrock coring are required to confirm the bedrock quality and elevations across the subject site.**

Hard layers of limestone/siltstone are expected in the bedrock. Coring of hard layers will be required for the installation of caissons.

The presence of groundwater table in the cohesionless (sandy) soils in overburden will make the construction of the caissons difficult. An oversize liner will be required and must be sealed in the underlying silty clay deposit or shale bedrock. Sealing of the liner will be difficult where limestone

layer is present at the surface above the shale and coring of the limestone layer will be required to advance the casing. All caisson bases must be inspected by this office on full time basis.

Where it is necessary to place caissons at different levels on bedrock, the upper caisson must be founded below an imaginary 1 horizontal to 1 vertical line (1H:1V in bedrock) drawn up from the base of the lower caisson. The lower caisson must be installed first to help minimize the risk of undermining the upper caisson.

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

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

It should be noted that the recommended bearing capacities have been calculated by DS Consultants Ltd from the borehole information for the preliminary design stage only. Additional boreholes may be required when the final building plans are available. The investigation and comments are necessarily on-going as new information on 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 Consultants Limited to validate the information for use during the construction stage.

### 4.2 Raft Foundation System:

Alternatively, subject to design loads/grades, the proposed development can be founded on raft foundation.

Due to the variable ground elevations/soil conditions and based on the borehole information, the available soil bearing capacity for the proposed raft foundation at or below a depth of 7 m (and 9 m depth in the area of Borehole BH22-13), in native undisturbed clayey silt till soils, is 200 kPa at SLS (280 kPa at ULS) can be considered.

However, due to the presence of relatively deep clayey deposit, settlement analyses (based on the design loads and depth of excavation) will be required to quantify the total and differential settlements.

In case of that settlement is more than the tolerable limit, then, the raft foundation should be combined with deep foundations such as drilled caissons to support the additional loads. Recommendations of drilled caissons are presented in Section 4.1 above.

## 5. FROST PROTECTION

All grade beams/caps exposed to seasonal freezing conditions must have at least 1.2m of soil cover for frost protection.

There is no official rule governing the required founding depth for footings below unheated basement floors. Certainly, it will not be greater than the 1.2 m required in Southern Ontario for exterior footings. Un-monitored experience indicates that a shallower depth ranging from 0.82 to 0.9 m for interior column footings and 0.4 m for wall footings has been successful where 2 or more basement levels apply. The 0.82 m depth is believed to be close to the minimum structural requirement for interior column footings. Adjacent to air shafts and entrance and exit doors, a footing depth of 1.2 m below floor level is required or, alternatively, insulation protection must be provided.

It is also emphasized that underfloor drainage and/or an adequate free draining gravel base is required to minimize the risk of floor dampness. Floor dampness could lead to temporary icing and the risk of accidents.

## 6. FLOOR SLAB AND PERMANENT DRAINAGE

The lowest floor slab can be supported on grade, provided all disturbed materials are removed. 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.

An underfloor drainage system and a perimeter drainage system around the exterior basement walls will be required. Typical perimeter drainage systems for shoring systems are shown on **Drawings 12 and 13**. Where the exposed subgrade consists of cohesionless soil below the water table, all openings including the subgrade must be covered or wrapped with filter fabric, typically a Class II non-woven textile with a filtration opening size (F.O.S.) of 50 to 100 µm.

If raft foundation alternative is adopted, then tanked basement structures with waterproofing will be required.

## 7. ELEVATOR AND SUMP PITS

If elevator/sump pits are to be installed in cohesionless soils (sandy silt, sand, silt) below the water table, drainage systems at the base level of the pits are not recommended, due to the concern of

loss of fines. In this case, the pits can be designed as water-tight structures, and water pressure on the pit walls and the pit base slab should be considered.

## 8. EARTH PRESSURES

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

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

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

K = Earth pressure coefficient equal to 0.40 for vertical walls and horizontal backfill.

$\gamma$ = 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 buildup of any hydrostatic pressure behind the wall.

When the foundation wall is poured against the caisson wall, the foundation wall as well as the caisson wall should be designed for hydrostatic pressure.

## 9. EXCAVATIONS AND GROUNDWATER CONTROL

Excavations in overburden can be carried out with heavy hydraulic backhoe. Positive dewatering will be required prior to any excavation in cohesionless sandy soils below groundwater table; otherwise it will result in unstable base and flowing sides. The groundwater table should be lowered to a minimum depth of 1 m below the base of the excavation.

DS is carrying out a hydrogeological study at the subject site and more comments regarding the type and extent of groundwater control required will be addressed in the hydrogeology report.

It should be noted that the glacial till soils may contain boulders. Large obstructions in the fill material are anticipated. Provisions must be made in the excavation contract for the removal of boulders in the till and large obstructions in the fill material.

All excavations must be carried out in accordance with the most recent Occupational Health and Safety Act (OHSA). In accordance with OHSA, the fill material can be classified as Type 3 soil above the groundwater table. The very stiff to hard clayey soils can be classified as Type 2 Soil above the

groundwater table and as Type 3 below the groundwater table. The cohesionless soils of silt, sandy silt and silty sand and stiff clayey silt to silty clay (till) can be classified as Type 3 Soil above the groundwater table and Type 4 soil below the groundwater table.

The native soils free from topsoil and organics can be used as general construction backfill, provided its moisture content is within 2 percent of the optimum moisture content. Loose lifts of soil, which are to be compacted, should not exceed 200 mm. Depending on the time of construction and weather, some excavated material may be too wet to compact and will require aeration prior to its use.

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.

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.

## 10. TEMPORARY SHORING

It is understood that the proposed excavations may be supported by a temporary shoring system consisting of timber lagging and soldier piles. A tightly braced caisson wall may be required to support adjacent structures. The requirement for caisson walls is given on **Drawing 14**.

The shoring system must be designed in accordance with the 4th Edition of the Canadian Foundation Engineering Manual. The soil parameters estimated to be applicable for this design are as follows:

1) Earth Pressure Coefficient for shoring:

(a) where movement must be minimal K=0.45

(b) where minor movement (.002H) can be tolerated K=0.30

(c) passive earth pressure for soldier piles (unfactored) Kp=4.0 for sound shale

2) For stability check

$\phi = 30°$

C = 0

$\gamma = 21\ kN/m^3$

surcharge is to be determined by shoring contractor.

3) For rock anchors

An allowable bond stress of 600 kPa (90 psi) can be used in sound bedrock for the design of anchors.

An allowable bond value of 50 kPa is suggested for post-grouted anchors in stiff and compact deposits. An allowable bond value of 100 kPa is suggested for post grouted anchors in hard and dense to very dense soils. An allowable bond value of 600 kPa is suggested for anchors in sound rock; However, this value depends on anchor installation methods and grouting procedures. Gravity poured concrete can result in low bond values while pressure grouted anchors will give higher values and produce a more satisfactory anchor.

The soldier piles should be installed in pre-augered holes taken below the deepest adjacent excavation. The holes should be filled with concrete below the excavation level and half bag mix above the base of the excavation. The concrete strength must be specified by the shoring designer. Temporary liners will be required to help prevent the alluvial deposits or fill from caving during the installation period.

The top anchor must not be placed lower than 3.0 metres below the top of level ground surface. The contractor must decide the anchor capacity and confirm its availability. All anchors must be tested as indicated in the Canadian Foundation Engineering Manual, 4th edition.

Adhesion on the buried caisson shaft or behind the shoring system must be neglected when designing this shoring system.

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

To ensure that movements of the shoring are within an acceptable range, monitoring must be carried out. Vertical and horizontal targets on the soldier piles must be located and surveyed before excavation begins. Weekly readings during excavation should show that the movements will be within those predicted; if not, the monitoring results will enable directions to be given to improve the shoring.

## 11. EARTHQUAKE CONSIDERATIONS

Based on the existing borehole information and according to Table 4.1.8.4.A of OBC 2012, the subject site for the proposed development can be classified as "Class C" for seismic site response, subject to number of levels of underground parking and confirmation by Shear Wave Velocity Test (SWVT). DS can provide further recommendations and comments on the seismic classification when the building locations and design grades/number of basements and basement floor elevations are available.

## 12. GENERAL COMMENTS AND LIMITATIONS OF REPORT

This geotechnical report is preliminary, prepared based on the conceptual design plans. Additional boreholes will be required, once the detailed development plans are available to confirm the findings and recommendations provided in this 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 Consultants Limited at the time of preparation. Unless otherwise agreed in writing by DS Consultants Limited, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the borehole 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 boreholes may differ from those encountered at the borehole 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 borehole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

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

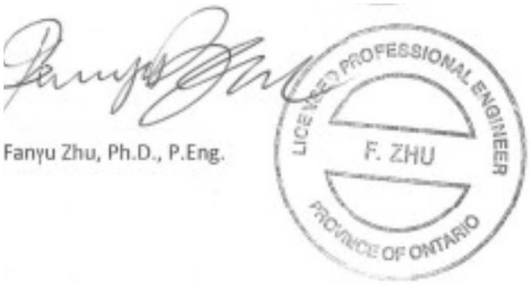
Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS Consultants Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

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

DS CONSULTANTS LTD.


Labib Mousa, P. Eng.

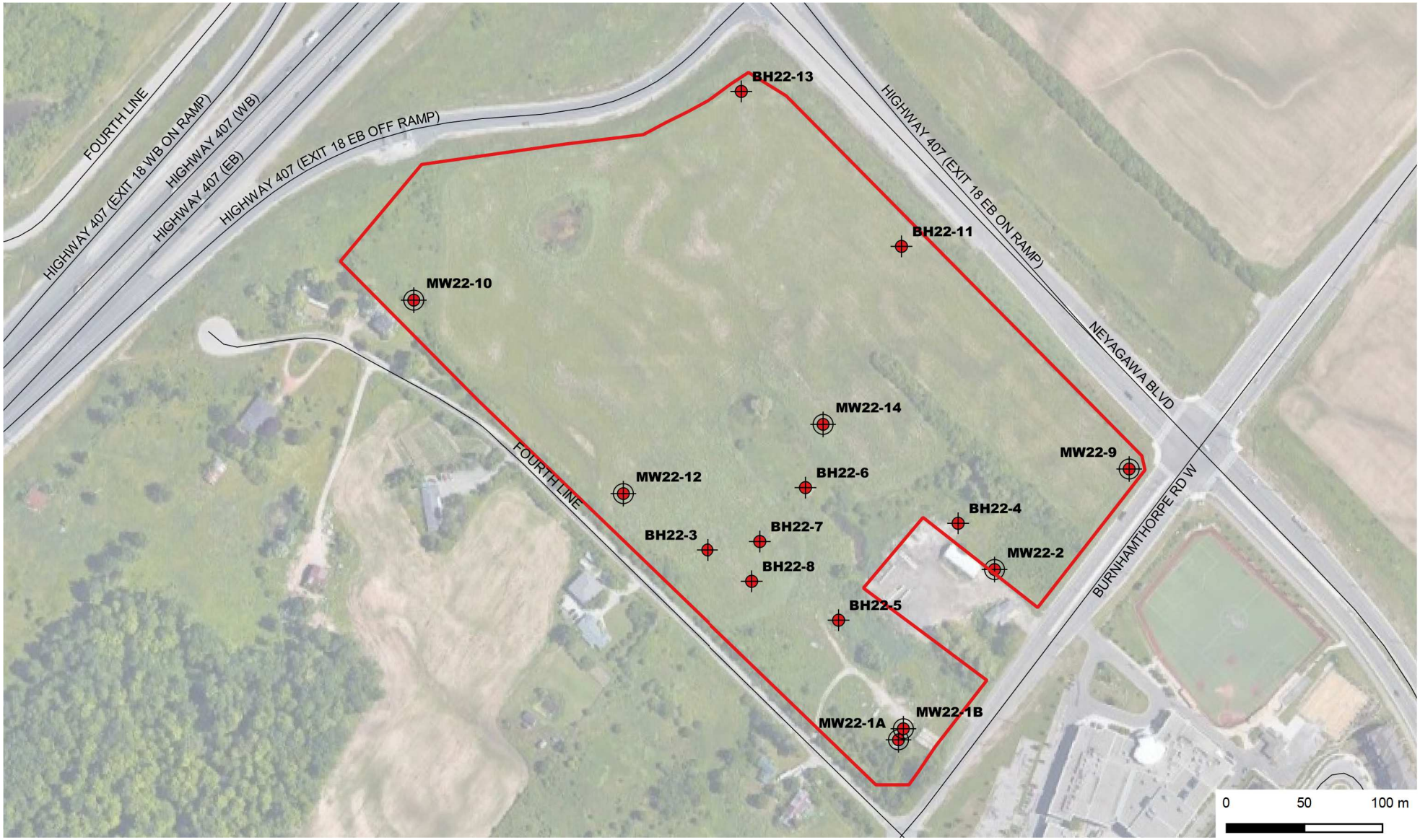



Fanyu Zhu, Ph.D., P.Eng.


Shabbir Dandukwala, M.Eng., P.Eng.

# Drawings

C:\0Sharon\21-455-100 2142 Dorham, Neyagawa Blvd and Burnhamthorpe Rd\1-QGIS\GEO\Drawing 1 – Borehole and Monitoring Well Locations.qgs Aug-05 10:34




Legend

- Approx Property Boundary
- Borehole
- Monitoring Well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Project: GEOTECHNICAL INVESTIGATION
Part of Lot 20, Concession 2, Oakville, ON

Title: **BOREHOLE AND MONITORING WELL LOCATIONS**

N

Client: ARGO NEYAGAWA CORPORATION

| Size: | Approved By: | Drawn By: | Date: |
|---|---|---|---|
| 8.5 x 11 | L.M | S.Y | August 2022 |
| Rev: 0 | Scale: As Shown | Project No.: 21-455-100 | Drawing No.: 1 |

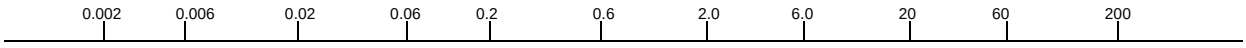
Image/Map Source: *Google Satellite Image*

# Drawing 1A: Notes On 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.

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

# LOG OF BOREHOLE MW22-1A



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4814748.14 E 599997.07

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-17-2022

REF. NO.: 21-455-100
ENCL NO.: 2

| SOIL PROFILE | | | SAMPLES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | "N" BLOWS 0.3 m | GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) 10 20 30 | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| 180.8 | | | | | | | | | | | | |
| 0.0 | Straight Augered to 9.1m immediately adjacent to MW22-1B. | | | | | ▽ | 180 | | | | | |
| | | | | | | | | W. L. 179.9 m Jun 08, 2022 | | | | |
| | | | | | | | 179 | | | | | |
| | | | | | | | 178 | | | | | |
| | | | | | | | 177 | | | | | |
| | | | | | | | 176 | | | | | |
| | | | | | | | 175 | | | | | |
| | | | | | | | 174 | | | | | |
| | | | | | | | 173 | | | | | |
| 171.7 | | | | | | | 172 | | | | | |
| 9.1 | **END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): June 08, 2022 0.95 | | | | | | | | | | | |

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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 MW22-1B



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4814748.99 E 599998.01

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-17-2022

REF. NO.: 21-455-100
ENCL NO.: 3

| ELEV / DEPTH (m) | DESCRIPTION | NUMBER | TYPE | BLOWS "N" 0.3 m |
|---|---|---|---|---|
| 180.9 / 0.0 | **TOPSOIL:** 200mm | 1 | SS | 5 |
| 180.7 / 0.2 | **FILL (REWORKED NATIVE MATERIAL):** clayey silt, trace rootlets, brown, moist, firm to very stiff | 2 | SS | 23 |
| 179.7 / 1.2 | **CLAYEY SILT TILL:** some sand to sandy, trace gravel, occasional cobbles, brown, moist, stiff to very stiff | 3 | SS | 23 |
| | | 4 | SS | 26 |
| | | 5 | SS | 18 |
| | brown to grey below 4.6m | 6 | SS | 17 |
| | | 7 | SS | 12 |
| | | 8 | SS | 11 |
| 171.8 / 9.1 | **SILTY CLAY TILL:** trace sand, trace gravel, occasional cobble, grey, moist, stiff to very stiff | 9 | SS | 13 |
| | | 10 | SS | 20 |
| 168.7 / 12.2 | **SANDY SILT TILL:** some clay, some gravel, reddish brown, moist, very dense | 11 | SS | 50/ 100mm |
| 167.2 / 13.7 | **CLAYEY SILT TILL/SHALE COMPLEX:** some sand, trace gravel, trace shale, reddish brown, moist, hard | 12 | SS | 50/ 75mm |
| 165.7 / 15.2 | **SHALE BEDROCK:** weathered, reddish brown | 13 | SS | 50/ 75mm |
| 15.3 | **END OF BOREHOLE:** | | | |

Notes:
1) 50mm dia. monitoring well installed at 12.2mbgl upon completion.
2) Water Level Readings:

| Date: | Water Level(mbgl): |
|---|---|
| June 8, 2022 | 6.73 |

GROUND WATER CONDITIONS: Bentonite; W. L. 174.1 m Jun 08, 2022; Filter Pack; Slotted Pipe

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

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

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

| REMARKS AND GRAIN SIZE DISTRIBUTION (%) | GR | SA | SI | CL |
|---|---|---|---|---|
| | 6 | 31 | 43 | 20 |
| | 13 | 29 | 42 | 16 |

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 MW22-2



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4814853 E 600057.22

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-25-2022

REF. NO.: 21-455-100
ENCL NO.: 4

| (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | NUMBER | TYPE | BLOWS 0.3 m "N" | GROUND WATER CONDITIONS | ELEVATION |
|---|---|---|---|---|---|---|---|
| 181.7 | | | | | | | |
| 0.0 | **FILL (REWORKED NATIVE MATERIAL):** clayey silt, trace rootlets, reddish brown, moist, firm to stiff | | 1 | SS | 7 | | 181 |
| 180.2 | | | 2 | SS | 11 | W. L. 180.9 m Jun 08, 2022 | |
| 1.5 | **CLAYEY SILT TILL:** sandy, trace gravel, occasional cobble, reddish brown, moist, very stiff to hard | | 3 | SS | 30 | | 180 |
| | | | 4 | SS | 19 | | 179 |
| | | | 5 | SS | 38 | | 178 |
| | grey below 4.6m | | 6 | SS | 22 | | 177 |
| 175.6 | | | | | | | 176 |
| 6.1 | **SILTY CLAY TILL:** sandy, trace gravel, grey, moist, very stiff | | 7 | SS | 18 | | 175 |
| | | | 8 | SS | 15 | | 174 |
| 172.6 | | | | | | | 173 |
| 9.1 | **SANDY SILT TILL/SHALE COMPLEX:** some clay, some gravel, reddish brown, moist, compact to very dense | | 9 | SS | 29 | | 172 |
| | | | 10 | SS | 50/ 130mm | | 171 |
| 169.5 | | | | | | | 170 |
| 169.2 | **SHALE BEDROCK:** weathered, reddish brown | | 11 | SS | 50/ 130mm | | |
| 12.3 | **END OF BOREHOLE:** | | | | | | |

Notes:
1) 50mm dia. monitoring well upon completion.
2) Water Level Readings:

| Date: | Water Level(mbgl): |
|---|---|
| June 8, 2022 | 0.8 |

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)

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

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

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

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# LOG OF BOREHOLE MW22-9



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4814917.46 E 600143.52

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-24-2022

REF. NO.: 21-455-100
ENCL NO.: 5

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | BLOWS 0.3 m "N" | GR | SA | SI | CL |
|---|---|---|---|---|---|---|---|---|
| 181.5 | | | | | | | | |
| 0.0 / 180.1 | **REWORKED NATIVE MATERIAL:** clayey silt, trace organics, brown, moist, stiff ot very stiff (possible fill) | 1 | SS | 8 | | | | |
| | | 2 | SS | 15 | | | | |
| 1.4 / 176.9 | **CLAYEY SILT TILL:** some sand to sandy, trace gravel, occasional cobble, brown, moist, very stiff to hard | 3 | SS | 22 | | | | |
| | | 4 | SS | 30 | | | | |
| | | 5 | SS | 43 | | | | |
| 4.6 / 172.4 | **SILTY CLAY TILL:** sandy, trace gravel, grey, moist, very stiff | 6 | SS | 22 | | | | |
| | | 7 | SS | 21 | | | | |
| | W. L. 174.2 m Jun 08, 2022 | 8 | SS | 20 | 6 | 28 | 43 | 23 |
| 9.1 / 170.8 | **SANDY SILT TILL:** some clay, gravelly, reddish brown, moist, very dense | 9 | SS | 75 | 22 | 27 | 39 | 12 |
| 10.7 / 169.2 | **CLAYEY SILT TILL/SHALE COMPLEX:** trace sand, trace gravel, reddish brown, moist, hard | 10 | SS | 50/ 100mm | | | | |
| 12.3 | **END OF BOREHOLE:** | 11 | SS | 50/ 50mm | | | | |

Notes:
1) Auger refusal at 12.3m due to possible shale bedrock.
2) 50mm dia. monitoring well installed upon completion.
3) Water Level Readings:

| Date: | Water Level(mbgl): |
|---|---|
| June 8, 2022 | 7.39 |

GROUND WATER CONDITIONS
ELEVATION: 181, 180, 179, 178, 177, 176, 175, 173, 172, 171, 170

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

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

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

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

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 MW22-10



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4815025.74 E 599684.38

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-19-2022

REF. NO.: 21-455-100
ENCL NO.: 6

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | BLOWS 0.3 m "N" | ELEVATION |
|---|---|---|---|---|---|
| 187.9 | | | | | |
| 187.6 0.0 | **TOPSOIL:** 250mm | 1 | SS | 3 | |
| 0.3 187.1 | **FILL:** sand, trace silt, trace clay, brown, moist, loose | | | | |
| 1 0.8 | **FILL:** clayey silt, some organics, trace rootlets, brown, moist, stiff to very stiff | 2 | SS | 14 | 187 |
| | | 3 | SS | 23 | |
| 185.8 2 2.1 | **SILTY CLAY TILL:** sandy, trace gravel, brown, moist, stiff to hard | 4 | SS | 34 | 186 |
| 3 | | 5 | SS | 21 | 185 |
| 4 | | | | | 184 |
| 5 | | 6 | SS | 12 | 183 |
| 6 | grey below 6.1m | 7 | SS | 11 | 182 |
| 7 180.3 | | | | | 181 |
| 7.6 8 | **CLAYEY SILT TILL:** sandy, trace gravel, trace shale pieces, reddish brown, moist, stiff to hard | 8 | SS | 13 | W. L. 180.5 m Jun 08, 2022 |
| 9 | | 9 | SS | 16 | 179 |
| 10 | | | | | 178 |
| 11 | | 10 | SS | 11 | 177 |
| 12 | | 11 | SS | 16 | 176 |
| 13 | | | | | 175 |
| 14 | | 12 | SS | 13 | 174 |
| 15 | | | | | 173 |
| | | 13 | SS | 62 | |
| 16 171.1 | | | | | 172 |
| 16.8 | **CLAYEY SILT TILL/SHALE** | 14 | SS | 50/ | 171 |
| 17.0 | **COMPLEX:** sandy, trace gravel, reddish brown, moist, hard | | | 75mm | |
| | **END OF BOREHOLE:** | | | | |
| | Notes: | | | | |
| | 1) 50mm dia. monitoring well installed upon completion. | | | | |
| | 2) Water Level Readings: | | | | |
| | Date: Water Level(mbgl): | | | | |
| | June 8, 2022 7.41 | | | | |

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)

| REMARKS AND GRAIN SIZE DISTRIBUTION (%) | GR | SA | SI | CL |
|---|---|---|---|---|
| | | | | |
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| | 5 | 27 | 43 | 25 |
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| | 6 | 33 | 42 | 19 |
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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 BH22-11



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4815060.23 E 599997.55

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-20-2022

REF. NO.: 21-455-100
ENCL NO.: 7

| ELEV / DEPTH (m) | DESCRIPTION | NUMBER | TYPE | BLOWS "N" 0.3 m | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|
| 186.9 | | | | | | |
| 186.7 0.2 | **TOPSOIL:** 200mm | 1 | SS | 6 | | |
| 186.1 0.8 | **REWORKED NATIVE MATERIAL:** clayey silt, trace topsoil, trace rootlets, brown, moist, firm (possible fill) | 2 | SS | 21 | 186 | |
| | **CLAYEY SILT TILL:** some sand to sandy, trace gravel, occasional cobble, brown, moist, very stiff to hard | 3 | SS | 36 | 185 | |
| | | 4 | SS | 27 | 184 | |
| | grey below 3.1m | 5 | SS | 19 | 183 | |
| | | 6 | SS | 17 | 182 | |
| 180.8 6.1 | **SILTY CLAY TILL:** sandy, trace gravel, grey, moist, very stiff | 7 | SS | 16 | 181 | 4 32 46 18 |
| | | 8 | SS | 18 | 180 | |
| 177.8 9.1 | **SANDY SILT TILL:** some clay, trace gravel, grey, moist, compact to very dense | 9 | SS | 28 | 179 | 8 29 44 19 |
| 176.0 10.9 | **CLAYEY SILT TILL:** some sand, trace gravel, greyish brown, moist, hard | 10 | SS | 86 | 178 | |
| 174.7 12.2 | **SANDY SILT:** trace clay, trace gravel, grey, wet, very dense | 11 | SS | 50/ 75mm | 177 | 1 24 69 6 |
| 173.2 13.7 | **SANDY SILT TILL:** some clay, trace gravel, grey, wet, very dense | 12 | SS | 50/ 25mm | 176 | |
| 171.7 | | | | | 175 | |
| 171.5 15.4 | **CLAYEY SILT TILL/SHALE COMPLEX:** trace sand, trace gravel, reddish brown, moist, hard | 13 | SS | 50/ 50mm | 174 | |
| | **SHALE BEDROCK:** weathered, reddish brown | | | | 173 | |
| | **END OF BOREHOLE:** Notes: 1) Water at depth of 12.2m during drilling. | | | | 172 | |

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)

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 MW22-12



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4814901.67 E 599818.65

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-18-2022

REF. NO.: 21-455-100
ENCL NO.: 8

| SOIL PROFILE (m) ELEV / DEPTH | DESCRIPTION | STRATA PLOT | SAMPLES NUMBER | TYPE | BLOWS "N" 0.3 m | GROUND WATER CONDITIONS | ELEVATION | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100) | PLASTIC LIMIT $w_P$ / NATURAL MOISTURE CONTENT $w$ / LIQUID LIMIT $w_L$ WATER CONTENT (%) (10 20 30) | POCKET PEN. (Cu) (kPa) | NATURAL UNIT WT (kN/m³) | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184.7 | | | | | | | | | | | | |
| 184.5 0.2 | **TOPSOIL:** 200mm | | 1 | SS | 5 | | 184 | | | | | |
| | **REWORKED NATIVE MATERIAL:** clayey silt, trace topsoil, trace rootlets, trace organics, brown, moist, firm to stiff (possible fill) | | 2 | SS | 9 | | | | | | | |
| 183.1 1.6 | **SILTY CLAY TILL:** sandy, trace gravel, brown, moist, very stiff | | 3 | SS | 25 | | 183 | | | | | |
| | | | 4 | SS | 15 | | 182 | | | | | 7 24 48 21 |
| | | | 5 | SS | 20 | | 181 | | | | | |
| 180.1 4.6 | **CLAYEY SILT TILL:** sandy, trace gravel, grey, moist, stiff to very stiff | | 6 | SS | 10 | | 180 | | | | | |
| | | | 7 | SS | 11 | | 179 | | | | | 8 29 43 20 |
| | | | 8 | SS | 16 | | 178 | | | | | |
| | | | | | | W. L. 176.3 m Jun 08, 2022 | 177 | | | | | |
| | | | 9 | SS | 20 | | 176 | | | | | |
| | | | 10 | SS | 18 | | 175 | | | | | |
| | | | 11 | SS | 13 | | 174 | | | | | |
| 171.0 13.7 | **SILTY CLAY TILL:** sandy, trace gravel, grey, moist, hard | | 12 | SS | 37 | | 173 | | | | | 5 25 49 21 |
| 169.4 15.3 | **SILTY SAND TILL:** trace clay, some gravel, brown, wet, very dense | | 13 | SS | 50/ 130mm | | 172 | | | | | 13 50 30 7 |
| 167.9 167.8 16.9 | **CLAYEY SILT TILL/SHALE COMPLEX:** sandy, trace gravel, reddish brown, moist, hard | | 14 | SS | 50/ 100mm | | 171 | | | | | |
| | **END OF BOREHOLE:** | | | | | | 170 | | | | | |
| | Notes: 1) Auger refusal at 16.8m due to possible shale bedrock. 2) 50mm dia.monitoring well installed upon completion. 3) Water Level Readings: | | | | | | 169 | | | | | |
| | Date: Water Level(mbgl): June 8, 2022 8.43 | | | | | | 168 | | | | | |

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 BH22-13



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4815159.61 E 599894.85

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-24-2022

REF. NO.: 21-455-100
ENCL NO.: 9

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | BLOWS 0.3 m "N" | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|
| 189.4 | | | | | | |
| 0.0 | **REWORKED NATIVE MATERIAL:** clayey silt, trace organics, brown, moist, firm to very stiff (possble fill) | 1 | SS | 5 | 189 | |
| 1 | | 2 | SS | 17 | | |
| 188.0 | | | | | 188 | |
| 1.4 | **SILTY CLAY TILL:** sandy, trace gravel, brown, moist, very stiff | 3 | SS | 23 | | |
| 2 | | 4 | SS | 25 | 187 | 8 23 48 21 |
| 3 | | 5 | SS | 23 | 186 | |
| 4 | | | | | | |
| 184.8 | | | | | 185 | |
| 4.6 | **CLAYEY SILT TILL:** sandy, trace gravel, grey, moist, stiff to hard | 6 | SS | 15 | | |
| 5 | | | | | 184 | |
| 6 | | 7 | SS | 17 | 183 | |
| 7 | | | | | | |
| 8 | | 8 | SS | 8 | 182 | 7 32 42 19 |
| 9 | | 9 | SS | 17 | 181 | |
| 10 | | | | | 180 | |
| 11 | | 10 | SS | 50/ 130mm | 179 | |
| 12 | | | | | | |
| 177.2 | | | | | 178 | |
| 12.2 | **SANDY SILT TILL:** some clay, some gravel, grey, wet, very dense | 11 | SS | 50/ 130mm | 177 | 13 31 46 10 |
| 13 | | | | | | |
| 175.7 | | | | | 176 | |
| 13.7 | **CLAYEY SILT TILL/SHALE COMPLEX:** trace sand, trace gravel, grey, moist, hard | 12 | SS | 50/ 100mm | | |
| 14 | | | | | 175 | |
| 15 | | | | | | |
| 174.1 | | | | | | |
| 15.3 | **END OF BOREHOLE:** Notes: 1) Auger refusal at 15.3m due to possible bedrock. | 13 | SS | 50/ 75mm | | |

DYNAMIC CONE PENETRATION RESISTANCE PLOT
SHEAR STRENGTH (kPa)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE
PLASTIC LIMIT $w_P$ NATURAL MOISTURE CONTENT $w$ LIQUID LIMIT $w_L$
WATER CONTENT (%)
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

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 MW22-14



PROJECT: Preliminary Geotechnical Investigation
CLIENT: Argo Neyagawa Corporation
PROJECT LOCATION: Part of Lot 20, Concession 2, Oakville, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4814946.09 E 599947.3

**DRILLING DATA**
Method: Solid Stem Auger
Diameter: 150mm
Date: May-25-2022

REF. NO.: 21-455-100
ENCL NO.: 10

| (m) ELEV / DEPTH | DESCRIPTION | NUMBER | TYPE | BLOWS 0.3 m "N" | GROUND WATER CONDITIONS | ELEVATION | REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|
| 183.3 | | | | | | | |
| 0.0 | **REWORKED NATIVE MATERIAL:** silty clay, trace rootlets, trace organics, brown, moist, firm to very stiff (possible fill) | 1 | SS | 4 | | 183 | |
| 182.3 | | | | | | | |
| 1.0 | **SILTY CLAY TILL:** sandy, trace gravel, brown, moist, very stiff to hard | 2 | SS | 16 | | 182 | |
| | | 3 | SS | 20 | | | |
| | | 4 | SS | 35 | | 181 | |
| | | 5 | SS | 31 | | 180 | |
| | grey below 4.6m | 6 | SS | 17 | | 179 | 6 28 46 20 |
| 177.2 | | | | | | 178 | |
| 6.1 | **CLAYEY SILT TILL:** sandy, trace gravel, grey, moist, stiff | 7 | SS | 12 | W. L. 177.2 m Jun 08, 2022 | | 6 28 46 20 |
| | | 8 | SS | 14 | | 176 | |
| | | 9 | SS | 10 | | 175 | |
| 172.6 | | | | | | 174 | |
| 10.7 | **SANDY SILT TILL:** some clay, trace gravel, grey, wet, very dense | 10 | SS | 84 | | 173 | 3 22 63 12 |
| 171.1 | | | | | | 172 | |
| 12.2 | **CLAYEY SILT TILL:** trace sand, trace gravel, reddish brown, moist, hard | 11 | SS | 50/ 75mm | | 171 | |
| 169.8 | | | | | | | |
| 169.5 | **SHALE BEDROCK:** reddish brown, weathered | 12 | SS | 50/ 130mm | | 170 | |
| 13.8 | **END OF BOREHOLE:** | | | | | | |

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water Level Readings:

| Date: | Water Level(mbgl): |
|---|---|
| June 8, 2022 | 6.13 |

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)

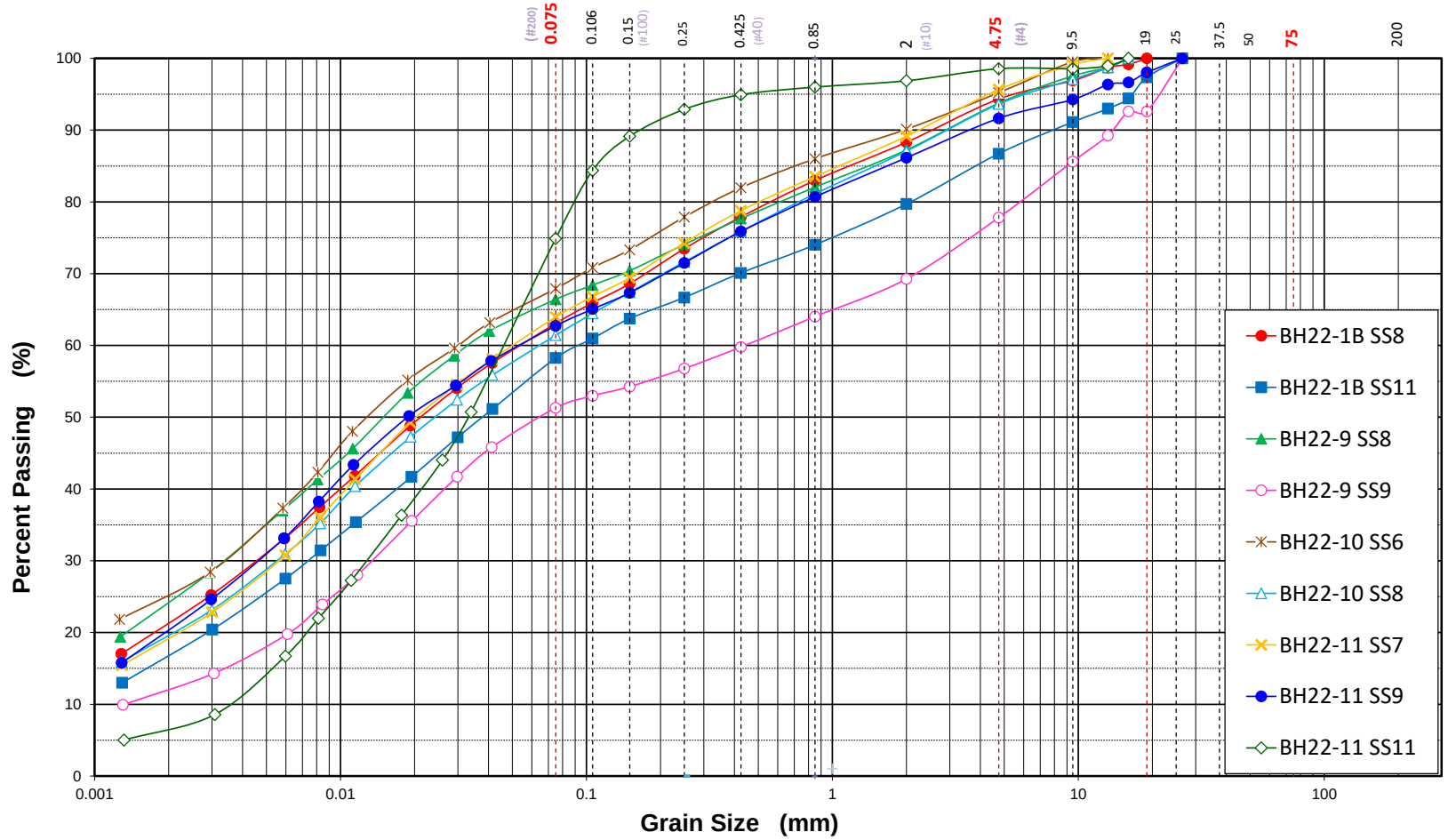
POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

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

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

DS SOIL LOG-2021-FINAL 21-455-100 GEO COPY.GPJ DS.GDT 22-8-5

# Particle Size Distribution (ASTM-D421/D422)

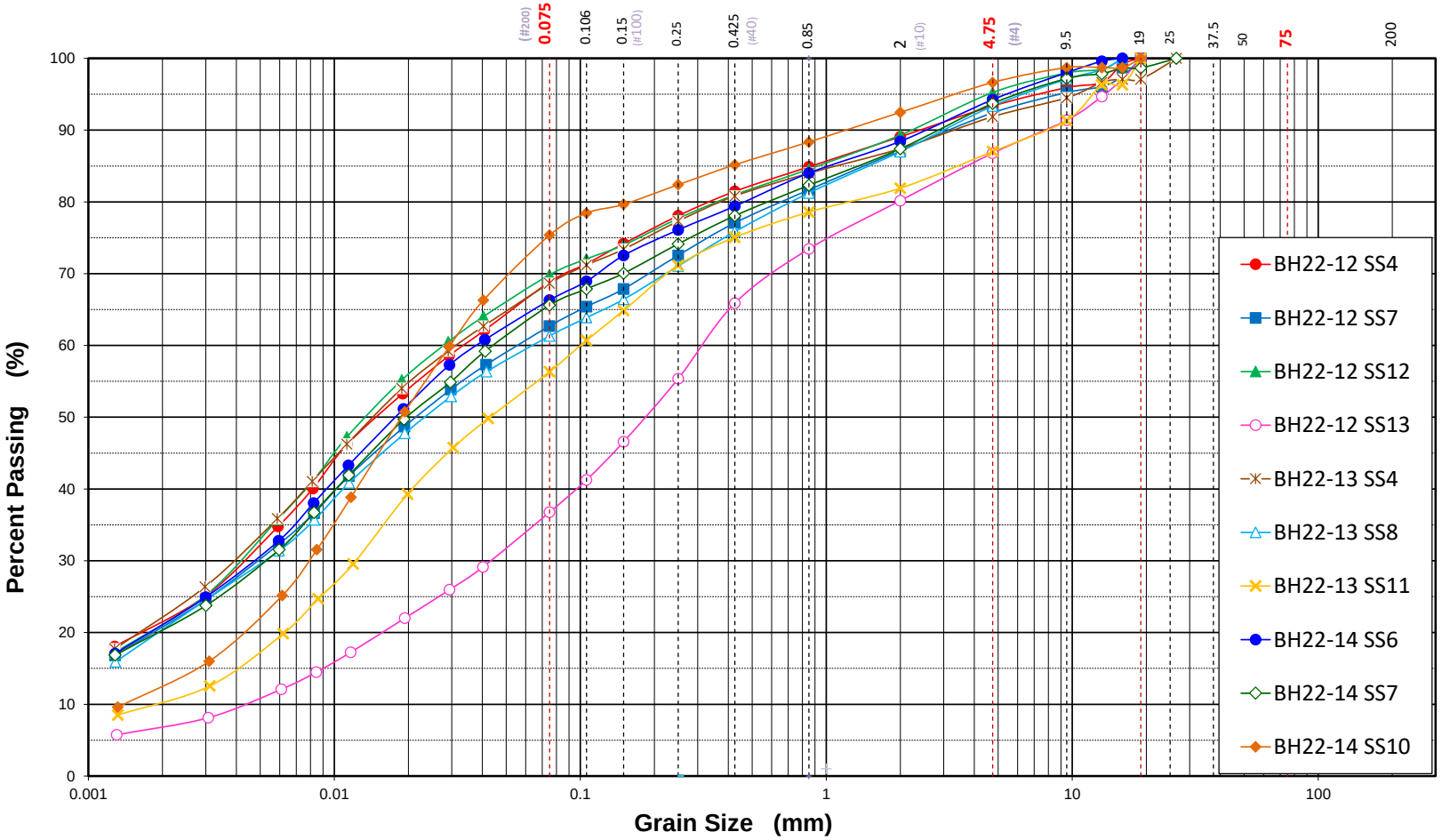



| Silt and Clay | | Sand | | | Gravel | | Cobble + |
|---|---|---|---|---|---|---|---|
| Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | |


**DS CONSULTANTS LTD.**
6221 Highway 7, Unit 16
Vaughan, Ontario, L4H 0K8
Telephone: (905) 264-9393
www.dsconsultants.ca


| | | | |
|---|---|---|---|
| Project | **Preliminary Geotechnical Investigation** | Project No | **21-455-100** |
| Location | **Part of Lot 20, Concession 2, Oakville , ON** | Date | **Jun-01-2022** |
| Client | **Argo Neyagawa Corporation** | Figure No | BH 1-11 |

# Particle Size Distribution (ASTM-D421/D422)




| Silt and Clay | | Sand | | | Gravel | | Cobble + |
|---|---|---|---|---|---|---|---|
| Clay | Silt | Fine | Medium | Coarse | Fine | Coarse | |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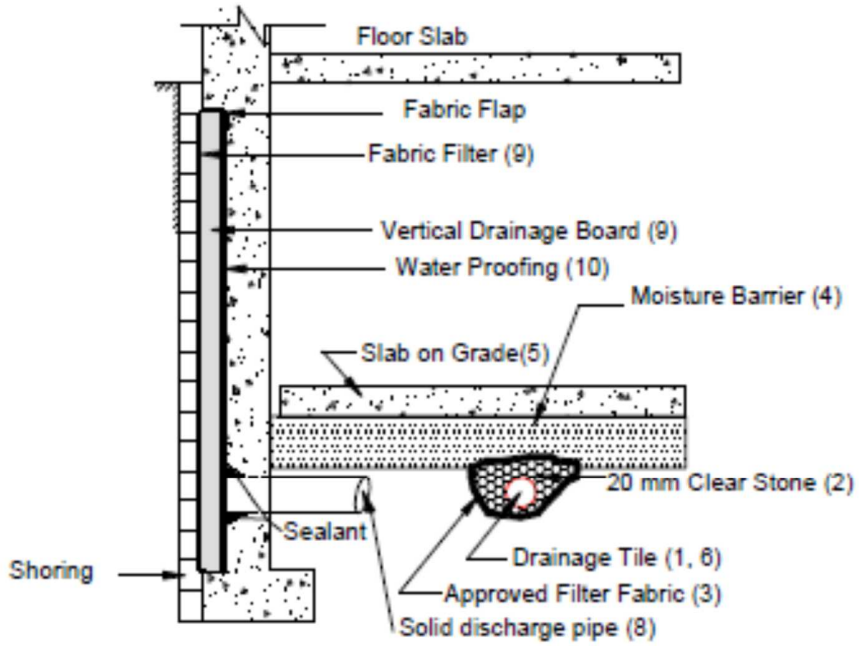
| | | | |
|---|---|---|---|
| Project | **Preliminary Geotechnical Investigation** | Project No | **21-455-100** |
| Location | **Part of Lot 20, Concession 2, Oakville, ON** | Date | **Jun-01-2022** |
| Client | **Argo Neyagawa Corporation** | Figure No | BH 1-11 |

**Project: 21-455-100** **Drawing No. 12**



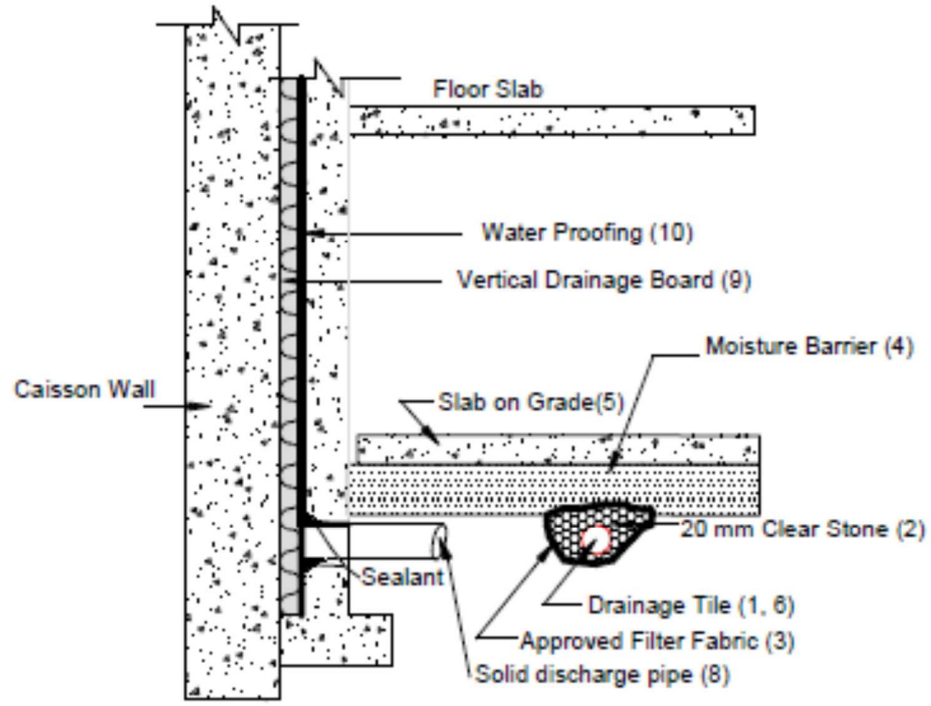

EXTERIOR FOOTING

**Notes**

1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
5. Slab on grade should not be structurally connected to the wall or footing.
6. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the solider piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board with filter cloth should be kept a minium of 1.2 m below exterior finished grade.
10. The basement walls should be water proofed using bentonite or equivalent water-proofing system.
11. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable.

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

**Project: 21-455-100** **Drawing No. 13**




EXTERIOR FOOTING

**Notes**

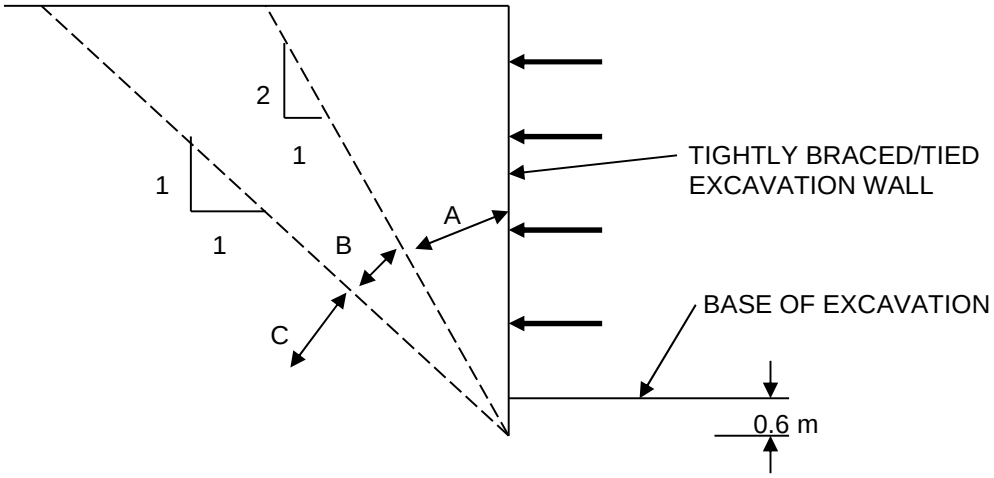
1. Drainage tile to consist of 100 mm (4") diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet, spaced between columns.
2. 20 mm (3/4") clear stone - 150 mm (6") top and side of drain. If drain is not on footing, place100 mm (4 inches) of stone below drain .
3. Wrap the clear stone with an approved filter membrane (Terrafix 270R or equivalent).
4. Moisture barrier to be at least 200 mm (8") of compacted clear 20 mm (3/4") stone or equivalent free draining material. A vapour barrier may be required for specialty floors.
5. Slab on grade should not be structurally connected to the wall or footing.
6. Underfloor drain invert to be at least 300 mm (12") below underside of floor slab. Drainage tile placed in parallel rows 6 to 8 m (20 to 25') centers one way. Place drain on 100 mm (4") clear stone with 150 mm (6") of clear stone on top and sides. Enclose stone with filter fabric as noted in (3).
7. Do not connect the underfloor drains to perimeter drains.
8. Solid discharge pipe located at the middle of each bay between the solider piles, approximate spacing 2.5 m, outletting into a solid pipe leading to a sump.
9. Vertical drainage board mira-drain 6000 or eqivalent with filter cloth should be continous from bottom to 1.2 m below exterior finished grade.
10. The basement walls must be water proofed using bentonite or equivalent water-proofing system.
11. Review the geotechnical report for specific details. Final detail must be approved before system is considered acceptable.

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

**Project: 21-455-100** **Drawing: 14**

## Guidelines for Underpinning in Soil and Excavation Support

Existing foundations located within Zone A normally require underpinning, especially for heavy structures. For some foundations in Zone A, it may be possible to eliminate underpinning and control foundation movement by tightly braced excavation walls, such as caisson walls.




Zone A Foundations located within this zone normally require underpinning. Horizontal and vertical pressures on the excavation wall of non underpinned foundations must be considered

Zone B Foundations located within this zone normally do not require underpinning. Horizontal and vertical pressures on the excavation wall of non underpinned foundations must be considered

Zone C Underpinning to structures is normally founded in this zone. Lateral pressure from underpinning is not normally considered

(Reference: Figure 26.27 from Canadian Foundation Engineering Manual, 4th Edition)

# Appendix A

## General Comments – Bedrock in Greater Toronto Area

The bedrock that makes spread footings or caissons a popular choice for high-rise foundation support is a shale or shale limestone composition. The highest member, the Queenston Formation, is generally found west of Toronto, while the Georgian Bay Formation underlies most of Metro Toronto, with the Collingwood and Whitby Formations east of Toronto. The Queenston is, relatively speaking, the weaker of the four formations that are likely to support caissons or footings.

The Georgian Bay as well as the Queenston and Collingwood/Whitby Formation are of Middle Ordovician Age. It is defined as the rock unit that overlies the bluish grey shales of the Collingwood Formation and is in turn overlain by the red shale of the Queenston Formation. The Georgian Bay Formation consists of bluish and grey shale with interbeds of sandstone, limestone and dolostone. Towards the west where the Georgian Bay formation underlies the Queenston Formation, the limestone content increases significantly and limestone and/or sandstone may comprise as much as 70 to 90 percent of the bedrock. The hard layers are usually less than about 100 to 150 mm thick but some layers are much thicker. The thicker layers have been observed to be as much as 750 to 900 mm at some sites. The layers are actually lenses and they can vary significantly in thickness over short distances.

The upper portion of the bedrock is commonly weathered for a depth of 600 to 1000 mm and within this weathered zone hard limestone layers or lenses are common. These hard limestone layers can result in contractual problems for augers, and can provide misleading bedrock elevations. Where the weathering is more extensive a shale till layer may be found above the bedrock. In the sound bedrock, the limestone, sandstone, dolostone is hard to very hard.

Stress relief features such as folds and faults are common in the bedrock. In these features, the rock is heavily fractured and sheared, and contains layers of shale rubble and clay. Weathering is much deeper than the surrounding rock in these features and often there is a lateral migration of the stress relief features resulting in sound unweathered bedrock overlying fractured and weather bedrock. The stress relief features are usually in the order of 4 to 6 m wide, but the depth can vary from 4 to 5 m to in excess of 10 m. These features occur randomly.

The bedrock contains significant high locked in horizontal stresses. These stresses can impose significant loads on tunnel walls but the slower rate of construction for basements allows for a relaxation of these stresses and they are not normally a problem for basement construction.

Groundwater seepage below the top 1000 mm is generally small, however, at several locations in Toronto and Mississauga large quantities have been encountered.

Bedding joints in the bedrock are very close-to-close, smooth planar in the shale and rough planar in the limestone. Significant vertical jointing is common.

Where the bedrock was cored, a detailed description of the rock core is appended to the borehole log.

Design features related to the bedrock are discussed in other sections of this report, and these general comments must be considered with these comments.

Methane gas exists in the bedrock, normally below the top 1000 mm and more concentrated with depth. Appropriate care and monitoring is essential in all confined bedrock excavations, particularly caissons and tunnels.