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Compaction testing - Geotec. Engineering - Soils Inspections

Yuri Mendez
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Ottawa, April 6, 2025

Denis Michaud
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Reference: City of Ottawa comments in the letter dated March 14, 2025 concerning file numbers D02-02-24-0084 & D07-12-24-0177 subject "Feedback Form: Completeness Review (2) Minor Zoning By-law Amendment and Site Plan Control Complex 73, 79 and 83 Ste-Cecile Street".

Subject: response to the referenced comments following the meeting with C of O staff completed on March 20, 2025.

A revised report is issued to respond to the referenced comments. This letter describes the additions to the revised report in response to the comments.

For ease of reference, as a result of the subject meeting, Brett Hughes, B. Eng. sent an email dated March 25 summarizing the outcome of the subject meeting and the resulting modifications to the comments. The number list below reflects the comments and the answers to the comments resulting from the meeting as summarized in Brett's email:

1. Items 11 a, b and c.
   - These items are considered to have been answered and clarified during the subject meeting;
2. Item d has taken the following form as a result of the subject meeting: "As it is not common practice to build on highly compressible materials, the City strongly discourages this approach. It should be noted however that the City's concerns are primarily cosmetic in nature as they pertain to the proposed development and the cracking of the slab on grade. Please be advised that special measures may be required to proceed with this approach."
   - The report R2 attached to this response has a new section "5.1 Residential Basement of Slab Founded on Peat;" having content expressing the fundamental assumptions regarding peat and to keep the slab on peat, the end result of a calculation, and a recommendation for a 12 cm reinforced slab to prevent any cracking.
3. Items e and f ask for foundation dimensions and differentiation of bearing capacity for pad footings and strip footings.
   - The foundation section reflects the same capacity for both strip and pad footings and their dimensions; however, such differentiation is only relevant for foundations on soft clay.

4. Under item f, the following has been added as a requirement via email: “ The Geotechnical Engineer shall indicate their preferred foundation method given the documented risks associated with the other shallow foundation and strip footing alternative. This should be referenced within the discussion of foundation alternatives and also in the executive summary of the report. “
    - The preferred option is the deep foundations option. This is more explicitly expressed in the executive summary and in the foundation sections. The deep foundation has received a more in-depth treat to address issues regarding piles through a significant amount of peat. It is also more explicit that this is due to the fact that lowering the water table will affect neighboring buildings.
5. Item g. Please provide supporting calculations detailing the anticipated total and differential settlements for the conventional shallow footing alternative, and clearly demonstrate the calculated values are within the allowable limits.
    - Item g does not require additional response once item f above has been addressed.
6. item h. This section of the report should include soil parameters used to estimate the load-bearing capacity for different pile diameters and lengths. Please provide the load-bearing capacity for piles and a more detailed discussion on this foundation option.
    - A material properties table has been added to the subsurface materials section. The pile foundation section has been substantially improved to assist other designers and to add other insights for piles driven through peat.
7. i) j) and k)
    - No further action is required once the items above have been addressed.
8. item l. “Although the design of the shoring system is the contractor’s responsibility, the report should still provide mechanical soil properties (unit weight, friction angle, and active/passive earth pressure coefficients) for each soil layer. Additionally, this section should include a more detailed discussion on the site surroundings, setbacks on each side, and anticipated shoring requirements for each boundary.”
    - A material properties table has been added to the subsurface materials section. We added an analysis to this section to assess the need of shoring for 2.5 m maximum excavation depths given the materials and the geometry of cuts along the nearest property line.

Do not hesitate to contact us if you have any questions.

Yuri Mendez, M. Eng, P. Eng

SUBSURFACE INVESTIGATION REPORT

73, 79 AND 83 STE CECILE ST., OTTAWA, ON, K4A 3N6

Abstract

The subsurface conditions at 73, 79 and 83 Ste Cecile St., in the City of Ottawa, ON was investigated via sampling and field testing in 3 boreholes for the sole purpose of development of a 4-Storey Apartment Building by Henry Investments Inc. The boreholes were located along the outside perimeter of the residential dwellings existing at this site as shown in figure 1 in page 8. The site was found to be underlain by peat to a 6.1 to 6.75 m depth in turn underlain by dense silty sand to sampler refusal depths up to 8.84 to 12.95 m. on boulders an/or bedrock.

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LICENSED PROFESSIONAL ENGINEER
March 31, 2025
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Report number: 59-HII-R2[1]
March 31, 2025

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[1] For the account of Henry Investments Inc. (HII) as per email proposal dated October 21 and 24, 2022..

Report 59-HII-R2
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Contents

1 *Executive Summary*

This document reports the findings of subsurface investigation 59-HII-R2 completed at 73, 79 and 83 Ste Cecile St., in the City of Ottawa, ON for the sole purpose of development of a 4-Storey Apartment Building by Henry Investments Inc. having extents and geometry shown in figure 1 in page 8.

The investigation was carried out by advancing 3 boreholess through overburden soils using available exploration techniques for engineering purposes. The information reviewed also includes readily available geologic information from the Geological Survey of Canada (GSC).

Key information about the subsurface conditions across the proposed development area is presented and includes design and construction recommendations and also the physical and mechanical properties of the geotechnical material encountered.

The overburden materials are estimated to be 12 m in thickness above the bedrock. The near-surface materials were found to consist of dark brown peat up to a 6.5 m depth underlain by dense silty sand.

The ground water table is estimated to be at a 2.5 m depth.

The dark brown peat materials and the presence of the water table at 2.5 m depth pose numerous challenges for development. Among those challenges are the inadequacy of peat to support foundations and the potential settlements that will result from lowering the water table.

Because the water table cannot be lowered without affecting neighboring properties, the alternative of removing the peat and founding the building on new engineered fill is too difficult and expensive to implement. Hence, at this time a deep foundation option is preferred. Interior slabs for basement laying at 1.5 m or greater depth from the surface grade can bear on the peat materials at that depth due to consolidation. A conservative estimation of settlements was conducted for the residential basement slab, leading to the recommendation of a reinforced slab.

It is expected that agencies and local government will complete regulatory reviews of this report. It is acknowledged that some of the assessments presented in this report are the end result of years of experience, evaluation, analyses and calculations in the same way that structural plans result from engineering as well. This is the normal implementation of engineering for society as it takes years in university to understand designs and assessments. If an agency expresses concerns of any part of its content, those concerns are welcome by M & Associates Ltd., however, if the concern is such to demand calculations or other assessments, we take that as a technical review. M & Associates Ltd. does not authorize any engineer or agency to conduct technical reviews of our work without our consent; however, if an agency chooses to demand such work, the agency should complete the calculation work themselves to demonstrate that the issue in question is, in fact, of concern. M & A does not exchange calculation work without the agency having anything to show for their concern. We wish to avoid a scenario where an engineer puts checkmarks on our work without them showing their ability to address the issue themselves, showing the concern to their bosses and ourselves. Needless to say, an engineer entering such conduct breaches the ethics codes and respect they ought to their colleagues. In addition, it takes years of experience to assess test results, and it is performed on a case-by-case basis due to the numerous variables that can affect testing, especially in the field.

Geotechnical reports are written before or during the early stages of the design period, and they may contain several alternative treatments to address site conditions as reasonably foreseeable at the time of writing. The reports may also contain recommendations presented for consideration by developers, designers and managers. As such, recommendations presented in the geotechnical reports may or may not be incorporated into the final project design. The reports may also have been prepared prior to revisions to the project size and/or scope, so they may not reflect changes to the project.

Part I

Investigation

2 Sampling and Testing

The field and laboratory program set out in our proposal is guided by the following standards:

- ASTM D 420-98 Standard Guide to Site Characterization for Engineering Design and Construction Purposes,
- ASTM D5434 - 12 Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock,
- ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils,
- ASTM D1586 - 11 based Dynamic Cone Penetration Test (DCPT),
- ASTM D2573 - 08 Standard Test Method for Field Vane Shear Test in Cohesive Soil.

The ASTM D1586 tests were completed using an “auto safety” hammer rated at 60% energy.

In view of the absence of soft to firm clays encountered during the field operations the ASTM D2573 - 08 “Standard Test Method for Field Vane Shear Test in Cohesive Soil” tests were removed from the original field program.

The field program consisted in sampling the subsurface profile using boreholess located as shown in fig. 1 in page 8 along with field review, assessments and classification of samples.

The borehole elevations were estimated based on their location using elevation data in a plan of survey issued for this site. The program included in addition a laboratory review of samples recovered from the field and one sample submitted to a local laboratory to investigate soluble ions concentration, PH and resistivity.

The soil sampling and field testing at each location are shown in the soil profile testing and sampling logs (BH) in the appendices.

Part II

Findings

3 Physical Settings, Strata and Topography

The site consists on three residential lots within a city block. The general topography is flat. It consists on the 73, 79 and 83 Ste Cecile St. parcels in the City of Ottawa, ON. Figure 1 in page 8 shows a plan view of the site displaying the approximate test hole locations and depth.

It can be seen in the testhole logs in appendix A that the site is covered by roughly 6 m of fill including very soft peat underlain by dense silty sand. The materials underlying the dense sand consist of either inferred dense sand and/or dense soils extending to depths of practical refusal to DCPT. DCPT refusals can occur on bedrock and or/boulders.

The geology data base by Belanger J. R. 1998 suggests 3 to 5 m of overburden soils underlain by interbedded limestone and shale bedrock at this site.

4 Surface and Subsurface Materials

The arrangement of strata found in our investigation is shown in the borehole logs in appendix A. Generally, the native geotechnical materials at this site were found to consist of dense silty sand at roughly 6 m overlain by peat and fill. The desnse silty sand is underlain by dense soils to DCPT refusals on either bedrock or boulders.

4.1 *Peat*

The SPT sampler sinks by the weight of the hammer, the drill rods and the sampler in these materials. Note that soft clays of shear strength less than 25 kPa exhibit this insufficient strength to hold the sampler in place for testing. The peat materials are estimated to be normally consolidated to the present overburden pressure. The materials have high water content above the water table and are estimated to be of 10.5 kN/m^3 of bulk density. Thus, the consolidation is estimated to be 15.7 kN/m^2 at 1.5 m depth.

Peat won't generally suit the majority of engineering applications due to its high compressibility, however, road embankments and other similar structures have been built on peat. The compressibility behavior exhibits the features of

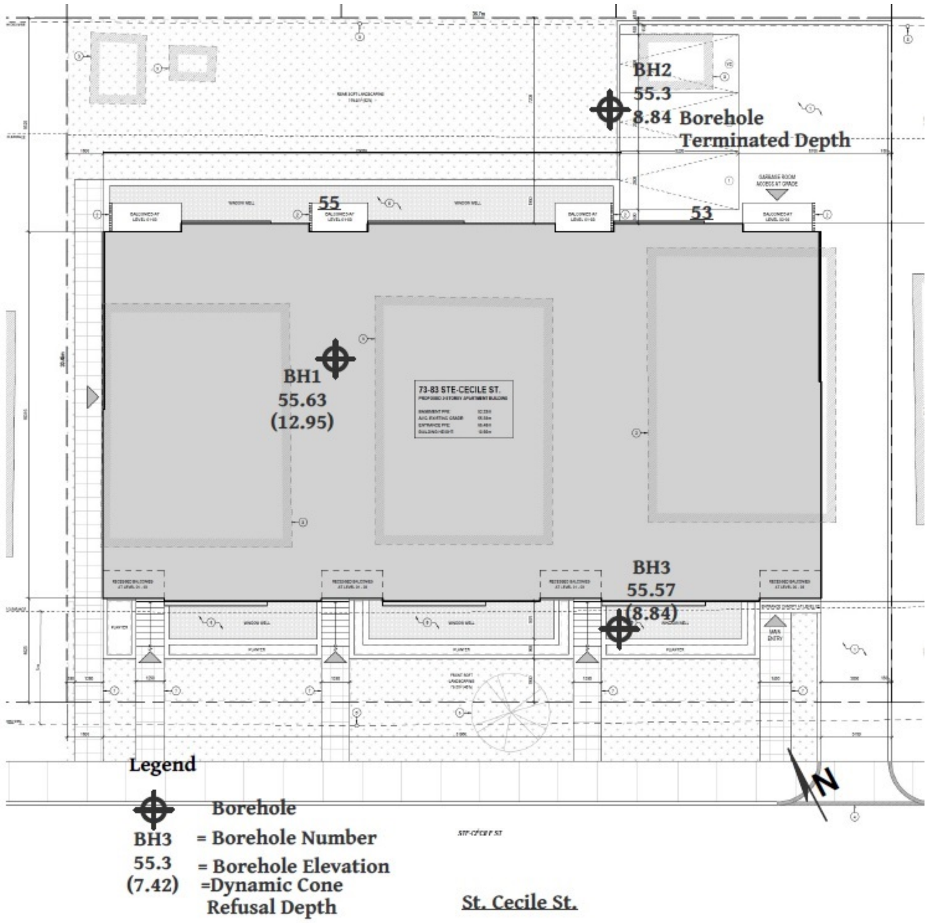

Figure 1: Test hole Locations Plan

compressible geotechnical materials such as clay as depicted by consolidation plots, namely, a recompression portion, a primary consolidation portion, and a creep portion. The mechanical properties depicted in the table in section 4.4 attempt to reflect important remarks made in the literature to, at best, depict the behavior of peats from a mechanical behavior standpoint. Most of the information on this report attempt to reflect 3 key aspects, the peat will be able to at least support its own weight under its current effective stress state; second, the material exhibits a degree of cohesion and third that in a state of stress less than its consolidation, it exhibits a behavior that is predictable along a recompression line, albeit a greater volume change than clays.

In the deep foundation sections, this report examines available research data regarding their behavior of peat.

4.2 Dense Silty Sand

Dense silty sand can provide bearing for relatively light structures. These materials can be subject to caving where excavations exceed the depth of the water table.

4.3 DCPT Tested Strata

The mechanical properties of materials to the 12.95 m depth of the DCPT tests completed in all 3 boreholes can be estimated based on its results shown in the borehole logs in appendix A. The DCPT test results are indicative of dense soils.

4.4 *Material Properties*

The following properties can be considered for the materials found at this site:

Material	Density kg/m^3	Friction Angle	Cohesion kPa	Und. Shear St. kPa/ UCS (mPa)
Peat	1,070	15	5	9
Dense sand	2,000	36	0	N/A
DCPT strata	2,000	36	0	N/A
Bedrock	2,700	30		30

4.5 Groundwater and Moisture

The water level was measured on December 05, 2022 in environmental wells installed in BH1, BH2 and BH3 at 2.77, 2.26 and 2.6 m depth respectively and shown in the boreholes logs. Ground water measurements in stand pipe installations often require numerous assessments in combination with boreholes data.

The water level measurements obtained on December 05, 2022 represent the best available information at this time. The water table is thus approximately at a 52.96 m elevation (± 2.5 m depth). Moisture contents vary above the ground water table.

4.6 Freezing Index, Frost Depth and Frost Susceptibility

The soil materials encountered at this site are frost susceptible and thus will heave upon exposure to freezing temperatures. Heaving destroys the mechanical properties of soils so that any soil which has been frozen is considered disturbed.

Part III

Geotechnical Recommendations

The following set of recommendations result from sampling and testing outlined in section 2 and from geotechnical engineering evaluation and assessments.

Because the water table cannot be lowered without affecting neighboring properties, the alternative of removing the peat and founding the building on new engineered fill is too difficult and expensive to implement. Hence, at this time a deep foundation option is preferred.

The underside of pile caps and/or any USF (Underside of Foundations) at this site will not be deeper than 2.5 m elevation beneath the current grade elevations to avoid dewatering.

Pile installation to driving refusal must be witnessed and accepted by the geotechnical engineer.

Interior slabs for basement laying at 1.5 m or greater depth from the surface grade can bear on the peat materials at that depth due to consolidation.

A conservative estimation of settlements was conducted for the residential basement slab placed on peat, leading to the recommendation of a reinforced slab.

If a solution not requiring de-watering is used, such as caissons, which are used to enclose the perimeter of excavations for construction in bodies of water, engineered fill can be used to buildup the subgrade under the proposed structure. The cost of such systems is generally prohibitive for residential developments.

Because of the prohibitive economic burden of enclosing the excavation with an inpervious barrier, and without dewatering such as caissons, it is expected that the foundation system will consist of a deep foundation solution.

5 Foundations General

Generally speaking, OBC building code-compliant Part 9 and Part 4 residential buildings can be founded on piles.

Interior non-load bearing slabs for basement laying at 1.5 m or greater depth from the surface grade can bear on the peat materials at that depth due to the consolidation estimated to be approximately 15 kPa at that depth.

5.1 *Residential Basement of Slab Founded on Peat*

This report address concerns expressed about the placement of the residential slab on peat. We have examined the following to assess the possibility of cracking:

- In view of estimated unit weights in the order of 10 kN/m^3 of peat materials, at basement elevation 1.5 m below the existing grades, the consolidation is estimated at 15kN/m^2;
- 1.9 kPa (40 psf) residential live load has been examined. 1.9 kPa is envisioned as conservative to account for differential load distribution.
- Because in the context, it is only the differential loads that matter, the weight of the slab can be ignored;
- the movement of the ground can be estimated based on a recompression line because 1.9 plus the slab is less than 15 kPa.

Based on a 0.3 recompression line, a conservative examination of a maximum differential load on a residential non-load-bearing basement slab may reach 1.2 cm. Recompression lines reflect the elastic behavior of the material for loads less than the consolidation pressure.

To prevent cracking, the placement of a 12 cm thick reinforced slab is recommended.

5.2 *Bearing Capacity of Strip and/or Pad Footings*

The following bearing capacity can be used for strip footings up to 1 m wide or pad footings up to 3 m wide placed on undisturbed dense silty sand:

- 200 kPa at service limit (SLS).
- 300 kPa for factored loads (ULS).

The above bearing capacity can also be used for strip footings up to 1 m wide or pad footings up to 3 m wide placed on newly placed granular fill compacted to 100% of its Proctor Standard Density.

Note that in most instances it is for soft clays that the width of foundations need to be restricted.

5.3 *Restrictions for Grading/Terracing/Grade Raises*

The proposed development is not expected to require grade raises. Post development grades are expected to be within 30 cm of the exisitng grade. Grade raises will not affect the foundations of the proposed building, however, a review of grading should be completed once grading plans are available as a level of precaution for nearby houuses.

Grade raises are not problematic for foundations placed on piles, however, the underlying materials can be considereded normally consolidated so that grade raises can only affect neighboring buildings.

5.4 Settlements

For new footings loaded as provided in section 5.2 building settlements for foundations on undisturbed dense silty sand are not to exceed service limit values (SLS) of 25 mm and 20 mm total and differential settlements respectively at this site.

5.5 *Deep Foundation Alternatives*

Due to the restrictions for de-watering, the proposed development could be founded on end bearing piles driven or bored to bedrock at approximately 8 to 13 m depth. Piles are generally driven to refusal and/or drilled and/or socketed into bedrock and proof tested. Steel pipe piles driven to refusal are filled with concrete as general practice in Ottawa. Pile refusals are often decided from pile driving formulae defining the refusal criteria. Once piles are refused and filled with concrete their bearing capacity is accepted to be the value defined by a simple structural formula which can be found in the Canadian foundation engineering manual.

Steel H piles driven to refusal are also used by designers and excavation contractors in Ottawa. Their installation follows a similar process.

Pile installation to driving refusal must be witnessed and accepted by the geotechnical engineer.

Geotechnical resistance for different pile systems socketed and/or end bearing on bedrock can be estimated based on some simplifying assumptions largely based on experience (for materials encountered in Ottawa) and/or field testing available from this investigation. Either specific parameters for design or specific geotechnical resistance for specific pile systems and locations will be provided if requested as part of this report.

Piles other than piles driven to refusals in Ottwa are proof tested. This is a statistical sample within a population of piles. Proof testing can be via electronic analysers that record the behavior of the pile upon impact to determine the capacity, or they can also be loaded.

Proof testing of piles must be witnessed and accepted by the geotechnical engineer.

Generally, excavation, piling and shoring contractors have their own engineers and wide experience installing piles.

5.5.1 Slenderness-Buckling and Lateral Restrain

Slenderness buckling is not often of concern for piles embedded in natural soils, however, concerns have been expressed in the literature for piles installed in very soft soils or peat. Coduto et al. (2016)[2], upon testing, suggest that, "even the softest soils provide enough lateral support to prevent underground buckling in piles subject only to axial loads, especially when a cap is present and provides rotational fixity to the pile top."

It is of note that the above observations have been made for typical pile cross sections, however, no such observations have been found in the literature specifically for micropiles. In view of this, considering the high slenderness ratios applicable to micropiles, *their use for the conditions at this site is not recommended* unless research is found to support their application in these conditions.

With respect to lateral restrain, it is believed that given the geometry of buildings with basements, pile caps linked via grade beams connected to foundation walls provide substantial lateral restraint as the buried height across the length of walls is a substantially high area of lateral bearing. In addition, the floor slab, even when not directly linked to the foundation walls also acts as a diaphragm restraining lateral movement. The above geometry thus indicates that the greater lateral restrain (and thus controlling force) would be derived from geotechnical materials along foundation walls.

5.6 Frost Protection for Foundations

Shallow foundations in section 5.2 on frost susceptible soils are considered to be frost protected when placed at sufficient depth to prevent supporting soils from freezing. Foundations in the perimeter of heated buildings where snow is not cleared are considered frost protected at 1.5 m depth (as having a soil cover of 1.5 m). Foundations away from heated buildings or in areas where snow is cleared, need to be at about 1.8 m depth to be frost protected. On the alternative frost protection can be provided by using foundation insulation for shallower foundations.

5.7 Foundation Insulation

To meet the required frost protection in section 5.6 for foundations for canopies or other structures in the perimeter of the building and in unheated areas in otherwise heated buildings 50 mm of extruded polystyrene insulation (XPS) type V, VI or VII meet foundation insulation requirements for the freezing index in the Ottawa area.

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[2] Coduto, D P., and Kitch, W.A., and Yeung, M.R. (2016). Foundation Design: Principles and Practices, Third Edition. Pearson Education, Upper Saddle River, NJ:, 686 p.

5.8 Foundation Wall Damproofing and Drainage

For foundation elevations above the water table, Appendix C.1 presents page 2 of NRC Construction Evaluation Reports CCMC 12658-R showing damproofing and foundation wall drainage system details satisfying the provisions under OBC 2012 and suitable for the conditions found at this site. Other available similar systems having the components shown in CCMC 12658-R may be used. Foundation drainage must be provided to daylight or a positive outlet, or sump.

Elevator pits below the water table are not recommended if they are to be equiped with foundation drainage.

6 Site Class for Seismic Design

At this site, the geotechnical testing completed are indicative of a Vs(30) exceeding 360 m/s. As such, site class C is assigned under the provisions in section 4.1.8.4 of the Ontario Building Code 2012 (OBC 2012) for seismic design.

7 Roadbed Soils and Pavement Structure

Generally, for low volume roads, the pavement structure to be placed on native soils or engineered roadbed at this site may consist of 400 mm of OPSS granular B, 150 mm of OPSS Granular A and up to 75 mm of asphalt.

For parking lots, pavement structure to be placed on native soils or engineered roadbed at this site may consist of 300 mm of OPSS granular B, 150 mm of OPSS Granular A and 50 mm of asphalt. This thicknesses will vary depending on expected traffic at different locations.

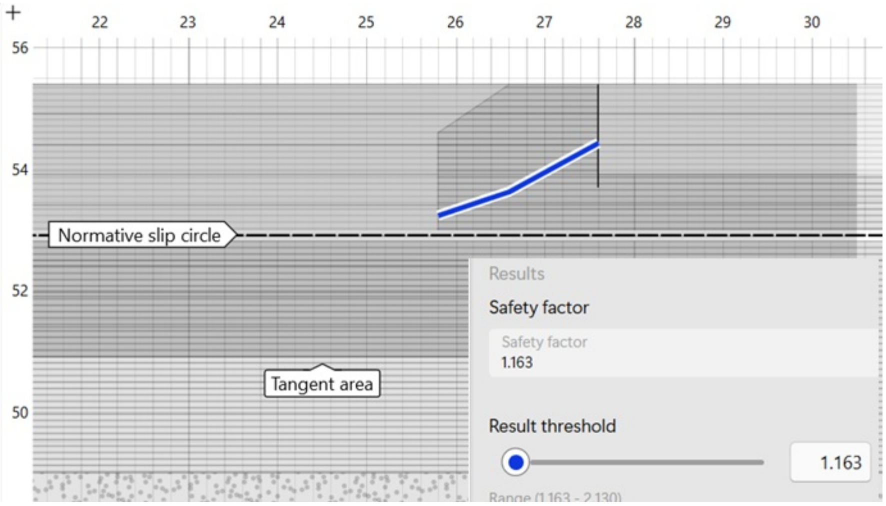
8 *Excavations, Open Cuts, Shoring and Safety*

Typically, the main concern when excavating soils or rock is the stability of the sides of excavations. The stability of the sides is achieved by either cutting the sides to safe slopes or by providing shoring. It is also an issue of safety because of imminent hazards to the safety of workers and to property. As such, excavations are governed by the provisions in the Occupational Health and Safety Act of Ontario (O. Reg. 213/91). The application of O. Reg. 213/91 requires a classification of soils in one or several of four types (type I to type IV).

At this site a preliminary slope stability analysis was completed to examine the need for shoring excavation depths above the water table. The analysis shows that for the geometry shown in fig. 2 in page 15, which applies to the closest property line with 87 Ste. Cecile St., a factor of safety of 1.16 applies to excavations 2.5 m or shallower.

Shoring is required for any excavation deeper than 2.5 m depth.

Information regarding physical and mechanical properties of subsurface materials which will be required for shoring design are provided in this report.



Results

Safety factor

Safety factor
1.163

Result threshold

1.163

Range (1.163 - 2.130)

Figure 2: Factor of safety of proposed open cut

Note also that since excavation and safety are usually in control of the contractor, *shoring design and construction is done by the contractor.*

8.1 Dewatering of Excavations

Dewatering is not recommended as this will damage neighboring properties. Thus, the excavations envisioned under this report do not exceed the depth of the water table. Excavations below the water table are only possible by enclosing the site with caissons, which can isolate the construction perimeter completely without de-watering out side of the excavation perimeter. As discussed above, the cost of such systems can be prohibitive for the majority of residential developments.

9 Underground Corrosion

For the resistivity, PH and soluble ions concentrations found at this site and shown in the Paracel Laboratories certificate of analysis in appendix B.1, the soils are mildly corrosive. Resistivity, PH and soluble ions testing was completed in a representative sample at 6.75 m depth in BH1. After Romanoff (1957)[3], the following corrosion rates can be used:

1. For carbon steel:
    - 16 μm/year for the first 2 years,

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[3] Romanoff's work for the U. S. National Bureau of Standards is authoritative in underground corrosion

   - 12 μm/year, thereafter.

2. For galvanized metal:
   - 4.6 μm/year for the first 2 years,
   - 3.2 μm/year until depletion of zinc,
   - 12 μm/year for carbon steel.

10 Potential of Sulphate Attack to Concrete

For the sulphate content less than 0.1% in soil encountered at this site, there are no restrictions to the cement type which can be used for underground structures. This refers to restrictions associated with sulphate attack only.

11 *Special Issues or Concerns*

This investigation revealed difficult excavation challenges due to the presence of peat materials and high ground water table at this site.

11.1 Impacts to Other Buildings During and After Construction

Water table draw-down will increase the effective stress under neighboring houses and will cause additional settlements due to the very weak founding materials encountered at this site. At this time, it is understood that a deep foundation alternative will be implemented to remove the need for de-watering.

The primary measure to avoid negative impacts to other structures is to establish 2.5 m depth measured from the elevation of the current grades as the maximum depth of pile caps and/or footings to avoid dewatering.

The issues below arise from the conditions encountered:

1. water table draw-down is to be minimized to avoid excessive settlement of neighboring properties. The way to minimize this problem is to avoid any excavation deeper than the water table. If pile caps are considered, the maximum depth to the underside of pile caps should be 2.5 m. clear stone backfill could be considered from the underside of pile caps to the underside of slab;

2. in view of the issue in 1, the shoring system needs to be relatively impervious *and* be of sufficient depth with respect to the bottom of the excavation to sufficiently increase the head loss between the interior of the excavation and its perimeter. Caissons capable of completely sealing the interior of the excavation without de-watering or sheet piles driven into the bedrock are believed to be the best alternative at this time.

3. Grade raises may affect neighboring buildings. Thus, grade raises must be kept minimal and a grading review will be completed.

11.2 Pre-Construction Survey

As noted during the investigation the house at this site and nearby houses exhibit substantial foundation settlements and cracking. A pre-construction survey to map cracks and other defects is recommended to have a level of protection against possible claims for damage due to construction. This pre-construction survey should be supplemented by monitoring during construction, including elevation checks to be reported to construction managers for control measures.

Other measures to protect neighboring houses have been expressed throughout this report, namely, to eliminate the need to draw down the groundwater and to avoid significant grade raises. Thus, basement walls and/or elevator pit walls and/or underside of pile caps below the water table are discouraged.

Disclaimer

Henry Investments Inc. HII and other professionals understand that soils and groundwater information in this report has been collected in boreholess guided by standards and practice guidelines generally accepted for engineering characterization of ground conditions in Ontario and in no case boreholes data and their interpretation warrant understanding of conditions away from the boreholes locations. HII accepts that as development will have spread away from the boreholess other designers will need the best opinion from the geotechnical consultant based on the findings of the investigation so that any statements which could be implicitly or explicitly depart from the conditions at boreholes may be given to fulfill this need in good faith as best available opinion with the information available at the time without any warranties.

12 Limitations

This report was prepared by Yuri Mendez for the account of Henry Investments Inc. (HII), for review by its designated consultants, financial institutions, and government agencies.

The content of the report reflects the judgment of Yuri Mendez P.Eng., in light of the information available to him at the time of preparation.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering.

The reports may also have been prepared prior to revisions to the project size, location or scope, so they may not reflect or be coordinated with post-preparation changes to the project.

Yuri Mendez accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

User Agreement

Acknowledgment of Duties

In this 59-HII-R2 report, Yuri Mendez Engineering (YME) has pursued to fulfill every aspect of the obligations of professional engineers. As a part of those duties, from field work, operations, testing, analyses, application of knowledge and report, YME has ensured that it meats a high standard of Geotechnical engineering practice and care in the province of Ontario. Obligations under R.R.O. 1990, Reg. 941: Professional Engineers Act, R.S.O. 1990, c. P.28, further referred to as Reg. 941 which are of immediate interest to this service are:

"77. 7. A practitioner shall,

i. act towards other practitioners with courtesy and good faith,

ii. not accept an engagement to review the work of another practitioner for the same employer except with the knowledge of the other practitioner or except where the connection of the other practitioner with the work has been terminated,

iii. not maliciously injure the reputation or business of another practitioner,

8. A practitioner shall maintain the honour and integrity of the practitioner's profession and without fear or favour expose before the proper tribunals unprofessional, dishonest or unethical conduct by any other practitioner."

Communications

59-HII-R2 is to be used solely in connection with the development of a 4-Storey Apartment Building by Henry Investments Inc. (HII) and thus subject of communications amongst other professionals (OP), government bodies and authorities, and HII for that purpose. YME demands great care in precluding damage to the integrity of this professional work which may arise from careless communications from engineers of Canada. OP and HII acknowledge understanding that where any such communication occur in connection with this report, they are bound by this agreement as an extension to the standard of care embodied in R.R.O. 1990, Reg. 941 and thus accept that any correspondence from OP or the public seen to add any bad connotations to the breadth, depth, typesetting, typography, formal semantics and scope of this report or otherwise diminish the breadth of services and knowledge delivered in this report which in any way raise concerns or insecurities to the qualities and/or the *reasonable completeness* delivered to HII in this report will be forwarded to YME.

Reasonable Completeness

OP and Henry Investments Inc. acknowledge understanding that said care and said standard has been applied equality to the reasonable completeness of this report relative to the information available from the field program and acknowledge understanding that is neither feasible nor possible to convey geotechnical information in this report that would cover for every possible consideration by OP and/or HII and that upon issuance it will be subject to reviews which may trigger the need to add information which at the discretion of YME will be added when considered within the practice obligations under Reg. 941. The geotechnical information here provided is thus envisioned as to cover for the scope and breadth of design figures and assessments generally foreseeable as needed by other designers at the time of issuance and which could be amended as needed within the context of services provided by other designers. YME agrees to issue revised versions of this 59-HII-R2 report by adding R# to each revision where # is the number of the revision. OP covenant to conduct all communications in connection with these reviews following great care to preclude the suggestion of a breach to the reasonable completeness acknowledged herein. Written communications which may trigger reviews under this agreement will be acknowledged as requests for "review under the 59-HII-R2 report user agreement". This reasonable completeness is also relative to the scope of services generally accepted in geotechnical engineering work in Ontario

Errors

Where errors are found during reviews under the 59-HII-R2 report user agreement, OP covenant great care in communications to preclude the suggestion of a breach to the duties acknowledge herein which could induce damages to YME. Communications triggered by errors or any such communication which would render the person doing the request in a position of technical authority above the author implies an unauthorized review and constitute a serious breach of the code of ethics under Reg. 941 and damages to YME and so subject to disciplinary measures and/or liability for damages to YME. HII is thus acquainted that correction of errors will be made and acknowledged by YME as they may arise in any professional work but in no way OP will purport or render such corrections as omissions departing away from the correction of errors set forth in this agreement. Where communications in connection with the correction of errors process set forth in this agreement raise concerns or insecurities to the qualities and/or the reasonable completeness delivered to HII in this report occur, HII covenants to inform YME. HII is acquainted that such corrections are part of the natural processes associated with the applied sciences nature of this report and so typified explicitly in this agreement to protect YME from inappropriate manipulation of those processes by OP and others.

Disclaimer

HII and OP understand that soils and groundwater information in this report has been collected in boreholess guided by standards and practice guidelines generally accepted for engineering characterization of ground conditions in Ontario and in no case boreholes data and their interpretation warrant understanding of conditions away from the boreholes locations. HII accepts that as development will have spread away from the boreholess other designers will need the best opinion from the geotechnical consultant based on the findings of the investigation so that any statements which could be implicitly or explicitly depart from the conditions at boreholes may be given to fulfill this need in good faith as best available opinion with the information available at the time without any warranties.

Report 59-HII-R2
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Part IV

Appendices

A Borehole Logs

Report 59-HII-R2
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Project: **Proposed Four Storey Apartment Building**		YME Yuri Mendez Engineering.
Location: **73, 79 and 83 Ste. Cecile St.**	Client: **Henry Investments Inc.**	**Test Hole No.: BH1 of 3**
Job No.: **59-HI**	Test Hole Type: **7" OD Auger.**	Date: **November 24, 2022**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

YME Yuri Mendez Engineering

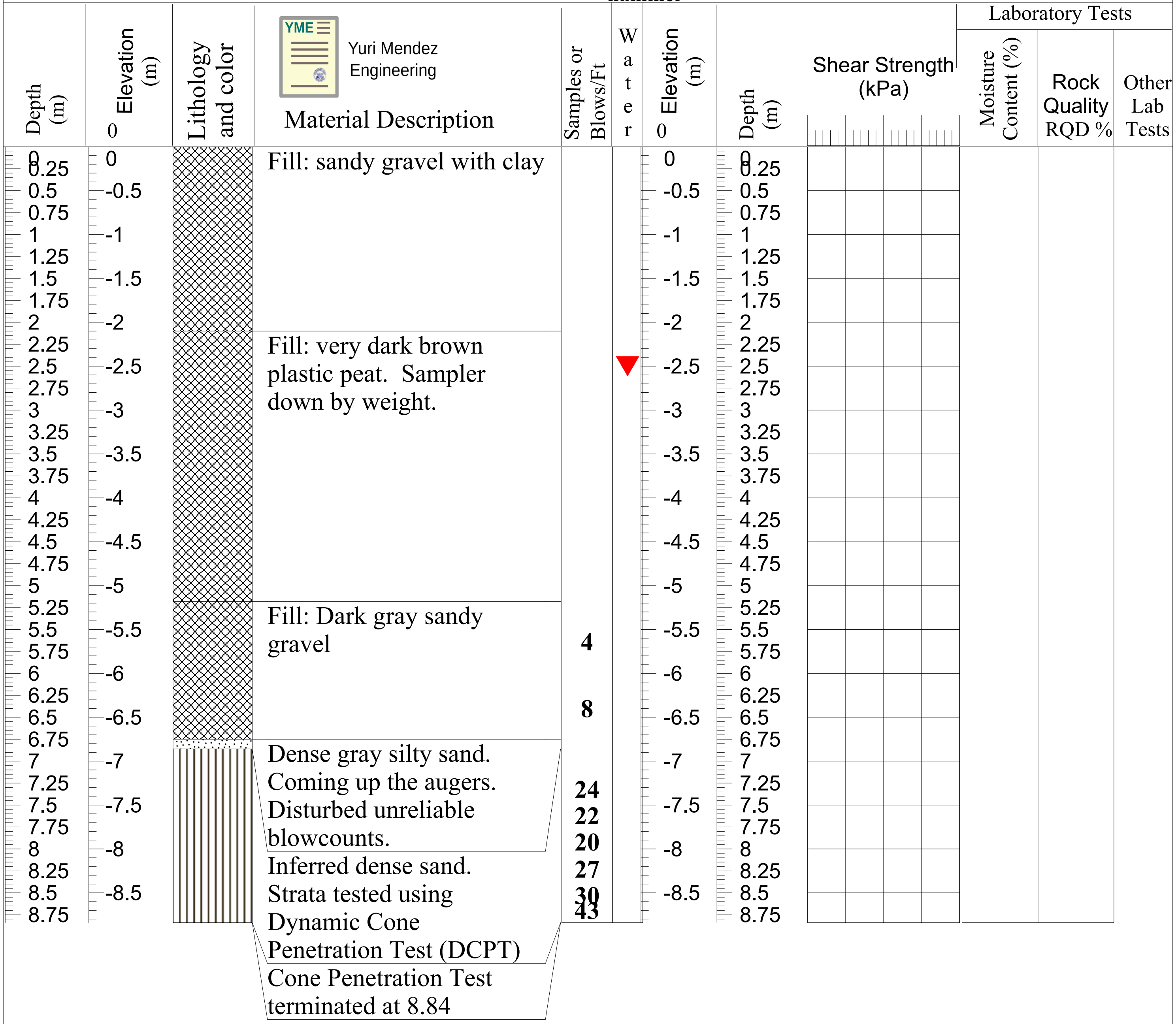
Depth (m)	Elevation (m) 0	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 0	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0 0.25	0	▩	Fill: Granular A			0	0 0.25				
0.5 0.75 1	-0.5 -1	▩	Fill	**11**		-0.5 -1	0.5 0.75 1				
1.25 1.5 1.75 2 2.25 2.5 2.75 3 3.25 3.5 3.75 4 4.25 4.5 4.75 5	-1.5 -2 -2.5 -3 -3.5 -4 -4.5 -5	▩	Fill: very dark brown plastic peat. Sampler down by weight.		▼	-1.5 -2 -2.5 -3 -3.5 -4 -4.5 -5	1.25 1.5 1.75 2 2.25 2.5 2.75 3 3.25 3.5 3.75 4 4.25 4.5 4.75 5				
5.25 5.5 5.75	-5.5	▩	Fill: Dark gray silty sand with gravel	**12**		-5.5	5.25 5.5 5.75				
6 6.25 6.5	-6 -6.5	▩	Fill: Dark gray sandy gravel	**22**		-6 -6.5	6 6.25 6.5				
6.75 7 7.25	-7	⠿	Dense gray silty sand. Coming up the augers. Disturbed unreliable blowcounts.	**4**		-7	6.75 7 7.25				
7.5 7.75 8 8.25 8.5 8.75 9 9.25 9.5 9.75 10 10.25 10.5 10.75 11 11.25 11.5 11.75 12 12.25 12.5 12.75	-7.5 -8 -8.5 -9 -9.5 -10 -10.5 -11 -11.5 -12 -12.5	▥	Inferred dense sand. Strata tested using Dynamic Cone Penetration Test (DCPT)	**2** **8** **29** **31** **18** **21** **21** **27** **20** **18** **16** **19** **23** **24** **32** **21** **>>100**		-7.5 -8 -8.5 -9 -9.5 -10 -10.5 -11 -11.5 -12 -12.5	7.5 7.75 8 8.25 8.5 8.75 9 9.25 9.5 9.75 10 10.25 10.5 10.75 11 11.25 11.5 11.75 12 12.25 12.5 12.75				

Cone Penetration Refusal at 12.95 m depth.

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Four Storey Apartment Building**		YME Yuri Mendez Engineering.
Location: **73, 79 and 83 Ste. Cecile St.**	Client: **Henry Investments Inc.**	**Test Hole No.: BH2 of 3**
Job No.: **59-HI**	Test Hole Type: **7" OD Auger.**	Date: **November 24, 2022**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**



Fill: sandy gravel with clay

Fill: very dark brown plastic peat. Sampler down by weight.

Fill: Dark gray sandy gravel

4
8

Dense gray silty sand. Coming up the augers. Disturbed unreliable blowcounts.

24
22
20

Inferred dense sand. Strata tested using Dynamic Cone Penetration Test (DCPT)

27
30
43

Cone Penetration Test terminated at 8.84

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed Four Storey Apartment Building**

YME Yuri Mendez Engineering.

Location: **73, 79 and 83 Ste. Cecile St.**

Client: **Henry Investments Inc.**

Test Hole No.: BH3 of 3

Job No.: **59-HI**

Test Hole Type: **7" OD Auger.**

Date: **November 24, 2022**

"7" OD Auger."

SPT Hammer Type: **Safety auto hammer**

Logged By: **Yuri Mendez**

Yuri Mendez Engineering

Depth (m)	Elevation (m) 0	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 0	Depth (m)	Shear Strength (kPa)	Laboratory Tests		
									Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0	0	▦	Asphalt			0	0				
0.25		▦					0.25				
0.5	-0.5	▦	Fill: Brown gravely and silty sand			-0.5	0.5				
0.75		▦					0.75				
1	-1	▦	Fill: augered through			-1	1				
1.25		▦					1.25				
1.5	-1.5	▦				-1.5	1.5				
1.75		▦					1.75				
2	-2	▦				-2	2				
2.25		▦					2.25				
2.5	-2.5	▦			▼	-2.5	2.5				
2.75		▦					2.75				
3	-3	▦				-3	3				
3.25		▦					3.25				
3.5	-3.5	▦				-3.5	3.5				
3.75		▦					3.75				
4	-4	▦				-4	4				
4.25		▦					4.25				
4.5	-4.5	▦				-4.5	4.5				
4.75		▦	Fill: gray sand				4.75				
5	-5	▦		**6**		-5	5				
5.25		▦	Fill: Dark gray sandy gravel				5.25				
5.5	-5.5	▦				-5.5	5.5				
5.75		▦					5.75				
6	-6	▦				-6	6				
6.25		░	Dense gray silty sand. Coming up the augers. Disturbed unreliable blowcounts.				6.25				
6.5	-6.5	░				-6.5	6.5				
6.75		▥					6.75				
7	-7	▥				-7	7				
7.25		▥		**8**			7.25				
7.5	-7.5	▥	Inferred dense sand. Strata tested using Dynamic Cone Penetration Test (DCPT)	**11**		-7.5	7.5				
7.75		▥					7.75				
8	-8	▥		**9**		-8	8				
8.25		▥		**10**			8.25				
8.5	-8.5	▥		**32**		-8.5	8.5				
8.75		▥		**>>100**			8.75				

Cone Penetration Refusal at 8.84 m depth.

S = Sample for lab review and moisture content

▼ Interpreted water level

Report 59-HII-R2
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Appendix

B Resistivity, PH and Soluble Salts Test

Certificate of Analysis

Report Date: 08-Dec-2022

Client: **Geoseismic**

Order Date: 29-Nov-2022

Client PO:

Project Description: 79 Ste Cecile

	Client ID:	BH1 SS9	-	-	-		
	Sample Date:	24-Nov-22 09:00	-	-	-	-	-
	Sample ID:	2249155-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	81.5	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.45	-	-	-	-	-
Resistivity	0.1 Ohm.m	51.3	-	-	-	-	-
Anions							
Chloride	5 ug/g	58	-	-	-	-	-
Sulphate	5 ug/g	59	-	-	-	-	-

Appendix

C Foundation Drainage

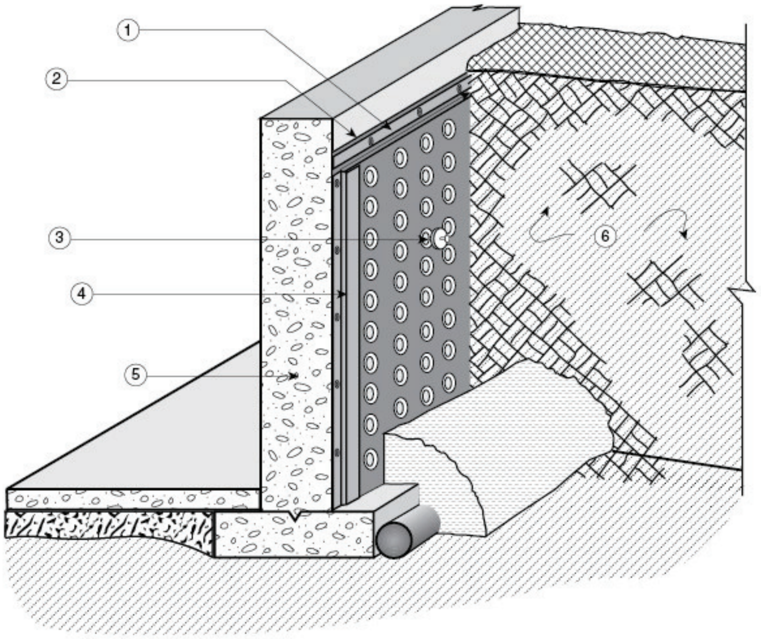

Figure 1. "Cosella-Dörken DELTA®-MS and DELTA®-MS CLEAR Dampproofing Membranes" – face in contact with the soil

1. **termination bar**
2. **caulking (behind membrane)**
3. **fastener**
4. **mould strip**
5. **concrete foundation**
6. **backfill**

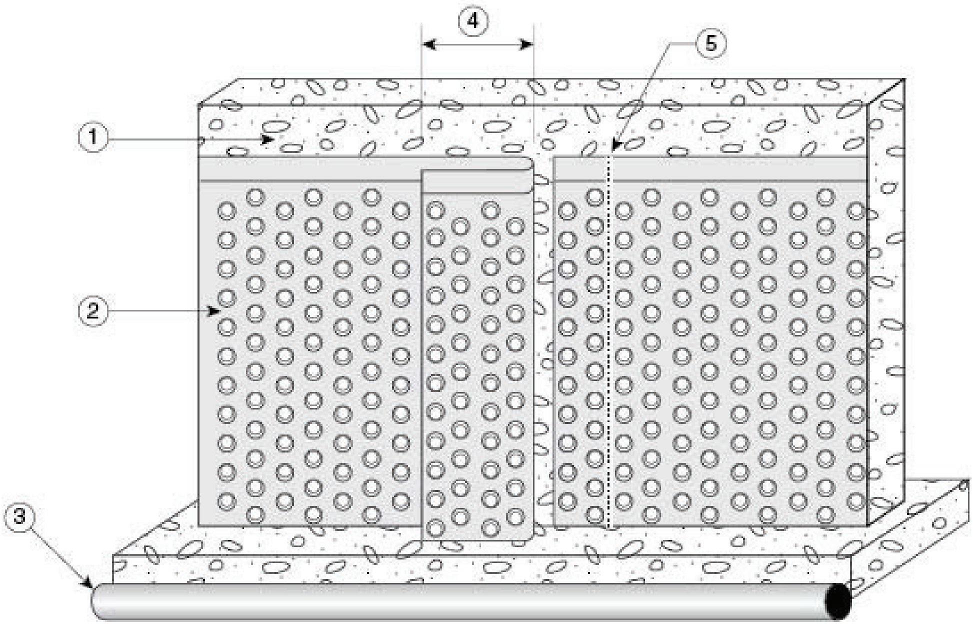

Figure 2. "Cosella-Dörken DELTA®-MS and DELTA®-MS CLEAR Dampproofing Membranes" – face in contact with the wall

1. **concrete foundation**
2. **membrane**
3. **drainage tile**
4. **minimum 6" overlap**
5. **caulking**