



CHUNG & VANDER DOELEN
ENGINEERING LTD.

**GEOTECHNICAL INVESTIGATION
PROPOSED MIXED-USE DEVELOPMENT**

143 Columbia Street West
Waterloo, Ontario

SUBMITTED TO:

PG Design Studio Inc.
388 Phillip Street
Waterloo, Ontario
N2L 6R7

ATTENTION:

Mr. Zeljko Prica



CHUNG & VANDER DOELEN
ENGINEERING LTD.

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September 14, 2018

File No.: G18620

PG Design Studio Inc.
388 Phillip Street
Waterloo, Ontario
N2L 6R7

Attention: Mr. Zeljko Prica

RE: Geotechnical Investigation
Proposed Mixed-Use Development
143 Columbia Street West, Waterloo, Ontario

We take pleasure in enclosing one (1) copy of our Geotechnical Investigation Report carried out at the above-referenced Site. Soil samples will be retained for a period of three (3) months and will thereafter be disposed of unless we are otherwise instructed.

If you have any questions or clarifications are required, please contact the undersigned at your convenience.

We thank you for giving us this opportunity to be of service to you.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.

Eric Y. Chung, M. Eng., P.Eng.
Principal Engineer

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1.0 INTRODUCTION

CHUNG & VANDER DOELEN ENGINEERING LTD. (CVD) has been retained by PG Design Studios Inc. to carry out a geotechnical investigation for the proposed redevelopment of a site located at 143 Columbia Street West, Waterloo, Ontario.

No details or drawings for the proposed redevelopment were available at the time of the preparation of this report. From discussions with the developer, it is understood that several 25-storey apartment buildings with podiums and 1 level underground parking are planned. The finished floor elevations have not been established. It is understood that it is the intention of the developer to eliminate or limit dewatering hence, founding elevations would be mainlined slightly above the water table and finished floor elevations would be adjusted accordingly.

The purpose of this investigation was to determine the subsurface conditions at the site and, based on the findings, to make geotechnical recommendations for:

- Foundation design recommendations;
- Excavation condition;
- Groundwater control during construction;
- Backfilling recommendations;
- Foundation soil classification seismic design per OBC 2012; and
- Foundation walls and shoring design.

2.0 FIELD WORK

In order to investigate the subsurface conditions at the site, nine (9) boreholes were advanced to depths between 15.70 and 22.56 m below ground surface between July 26 and August 8, 2018. The borehole locations are indicated on the Borehole Location Plan, Drawing No. 1.

The field work was carried out under the supervision of a member of our engineering team, who logged the boreholes in the field, effected the subsurface sampling, and monitored the groundwater conditions.

The boreholes were advanced using a track-mounted drilling rig, supplied and operated by specialist contractor. The drill rig was equipped with 107 mm I.D. continuous flight hollow stem augers, mud rotary equipment and standard soil sampling equipment. Standard penetration tests (SPTs) in accordance with ASTM Specification D1586, were carried out at frequent intervals of depth, and the results are shown on the Borehole Logs as Penetration Resistance or “N”-values. The undrained shear strength of the cohesive soil deposit was determined on the slightly disturbed SPT samples using a field pocket penetrometer. The compactness condition or consistency of the soil strata has been inferred from these test results.



The location and ground surface elevation of the boreholes were surveyed by CVD for the purpose of this report. The ground surface elevations were referenced to a temporary benchmark (TBM) which is shown on Drawing No. 1 and described below:

TBM: Top of catch basin located on the west side of the driveway besides Unit B, as shown on Drawing No. 1

Elevation: 339.46 m (geodetic)

3.0 LABORATORY TESTING

Soil samples obtained from the in-situ tests were examined in the field and subsequently brought to our laboratory for visual and tactile examination to confirm field classification. Moisture content determination of all retrieved samples occurred.

In addition, seven (7) grain size distribution analyses were carried out on representative soil samples of the major soil deposits to establish the physical and engineering properties.

4.0 EXISTING SITE CONDITIONS

The site is located at 143 Columbia Street West in Waterloo, Ontario. The site about 34 to 70 m wide and 190 m long. It is occupied by five (5) 2-storey apartment buildings located throughout the site. A paved parking lot is located near the middle of the property with the remainder filled with landscaping. A few large trees are located near the middle of the lot and scattered along the site perimeter.

The ground surface on site is relatively flat laying. The ground surface elevation at the borehole locations ranged between 339.69 and 340.86 m, gently sloping from south to north.



5.0 SUBSURFACE CONDITIONS

5.1 General

In order to investigate the subsurface conditions at the site, nine (9) boreholes were advanced to depths between 15.70 and 22.56 m below ground surface between July 26 and August 8, 2018. The borehole locations are indicated on the Borehole Location Plan, Drawing No. 1.

The stratigraphic boundaries shown on the borehole logs are inferred from non-continuous sampling conducted during advancement of the borehole drilling procedures and, therefore, represent transitions between soil types rather than exact planes of geologic change. The subsurface conditions will vary between and beyond the borehole locations.

In general, the surficial pavement and topsoil were underlain by loose to compact fill materials, followed by compact to very dense fine granular deposits which, in turn, were underlain by stiff to hard clayey sandy silt and compact to very dense sandy silt to silty sand deposit. These deposits were further underlain by very stiff to hard silty clay till.

5.2 Pavement and Topsoil

Asphalt pavement, consisting approximately 75 to 100 mm of asphalt and 300 to 450 mm granular base materials, was penetrated in Boreholes 3, 4, and 5.

Topsoil was encountered at ground surface in Boreholes 1, 2, and 6 to 9 with measured thicknesses between 100 and 250 mm.

5.3 Fill

A layer of fill materials was encountered underlying the pavement and topsoil in Boreholes 1 to 8. The fill layer extended to depths between 1.52 to 2.29 m below ground surface. The composition of the fill materials was highly variable and ranged from silt, some sand to silty sand to sand and gravel and contained topsoil, organics, cobbles and asphalt fragments.

The SPT “N”-values measured within the fill materials ranged from 8 blows per 300 mm of penetration to 50 blows per 125 mm of penetration, indicating a variable loose to very dense compactness condition. The measured water content of the samples collected from this deposit ranged between 11 and 22%, thus indicating a moist to wet moisture condition.



5.4 Fine Granular Deposits

Fine granular deposits were encountered in Boreholes 1 to 9 below the topsoil and fill materials and extended to depths between 5.79 and 17.68 m.

The composition of this fine granular deposits varied throughout the stratum and ranged from sandy silt to silty sand to sand and silt to sand with trace amounts of clay and occasional sand or silt seams. Results of four (4) grain size distribution analyses from Boreholes 2, 3, 6, and 9 are shown graphically on Enclosures 11, 12, 14, and 16.

The SPT “N”-values measured within the fine granular deposit ranged from 9 to 87 blows per 300 mm of penetration, indicating a variable loose to very dense compactness condition. Generally, this deposit was found to have a compact compactness condition. Natural moisture contents were measured between 4 and 28%, indicating a damp to saturated moisture condition.

5.5 Clayey Sandy Silt

A deposit of clayey sandy silt was encountered below fine granular deposits in Boreholes 1, 2, 4, 5, and 7. The clayey sandy silt extended to depths between 11.07 and 19.91 m. The clayey sandy silt contained trace amounts of gravel and occasional silt or clay seams.

The SPT “N”-values measured within this layer ranged from 11 to 66 blows per 300 mm of penetration. The undrained shear strength obtained on the retrieved samples was over 250 kPa. Based on the above test results, the clayey sandy silt is considered to have a stiff to hard consistency. The measured water content of the samples collected from this deposit ranged between 11 and 22%, thus indicating a moist to wet moisture condition.

5.6 Lower Sandy Silt to Silty Sand

A deposit of sandy silt to silty sand was encountered below the fine granular deposits in Boreholes 2, 4, and 5. Where fully penetrated in Boreholes 2 and 4 the deposit extended to depths between 15.54 and 21.34 m.

The composition of this deposit ranged from sandy silt to silty sand and contained trace amounts of clay and occasional clay seams. Result of one (1) grain size distribution analysis from Borehole 4 is shown graphically on Enclosure 13.

The SPT “N”-values measured within this deposit ranged from 14 to 70 blows per 300 mm of penetration, indicating a variable compact to very dense compactness condition. Natural moisture contents were measured between 15 and 21%, indicating a saturated moisture condition.



5.7 Silty Clay Till

A deposit of grey silty clay till was encountered below the fine granular deposits, clayey sandy silt and sandy silt to silty sand in Boreholes 1 to 4 and 6 to 9 which were terminated within the deposit at depths between 17.83 and 22.56 m.

The deposit comprised of silty clay with trace to some sand, trace gravel and occasional sand and silt seams. Results of two (2) grain size distribution analyses from Boreholes 1 and 8 are shown graphically on Enclosures 10 and 15.

The SPT “N”-values measured within this deposit ranged from 21 blows per 300 mm of penetration to 50 blows per 125 mm of penetration. The undrained shear strength obtained on the retrieved samples ranged from 210 kPa to over 250 kPa. Based on the above test results and tactile examination, the silty clay till deposit is considered to have a very stiff to hard consistency. The measured water content of the samples collected from this deposit ranged between 11 and 24%, thus indicating a moist moisture condition.

5.8 Groundwater

Groundwater conditions were monitored during and following completion of borehole sampling.

Monitoring wells were installed in Boreholes 2 and 7. The table below summarizes the water level readings in the monitoring wells:

Borehole No.	Ground Surface Elevation (m)	Date	Water Level Below Existing Ground Surface (m)	Water Level Elevation (m)
2	339.75	August 3, 2018	3.43	336.32
		August 8, 2018	3.41	336.34
7	340.31	August 1, 2018	4.60	335.71
		August 8, 2018	4.60	335.71

The water level measured in the monitoring wells ranged in depths between 3.41 and 4.60 m, corresponding to elevations 335.71 and 336.34 m. The water levels observed during and following the completion of drilling in the remaining boreholes were generally consistent with the water level elevations observed in the monitoring wells.

It is noted that the observed groundwater table will fluctuate seasonally and in response to major weather events.



6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

No details or drawings for the proposed redevelopment were available at the time of the preparation of this report. From discussions with the developer, it is understood that several 25-storey apartment buildings with podiums and 1 level underground parking are planned. The finished floor elevations have not been established. It is understood that it is the intention of the developer to eliminate or limit dewatering hence, founding elevations would be mainlined slightly above the water table and finished floor elevations would be adjusted accordingly.

In general, the surficial pavement and topsoil were underlain by loose to compact fill materials, followed by compact to very dense fine granular deposits which, in turn, were underlain by stiff to hard clayey sandy silt and compact to very dense sandy silt to silty sand deposit. These deposits were further underlain by very stiff to hard silty clay till.

The water level measured in the monitoring wells ranged in depths between 3.41 and 4.60 m, corresponding to elevations 335.71 and 336.34 m. The water levels observed during and following the completion of drilling in the remaining boreholes were generally consistent with the water level elevations observed in the monitoring wells.

6.2 Footing Foundations

Conventional strip and spread footing foundations can be used to support the 25-storey buildings and podiums. Footings cast on competent native compact to very dense fine granular deposits can be designed using a Geotechnical Reaction at SLS of 225 kPa. The SLS value given above is based on a maximum settlement of 25 mm under the footing foundations. The Factored Geotechnical Resistance at ULS is 375 kPa.

The following table summarizes the highest founding level and elevation for the footing at each borehole location:

Borehole No.	Existing Ground Elevation (m)	Highest Founding Depth (m)	Highest Founding Elevation (m)
1	339.69	2.09	337.60
2	339.75	1.75	338.00
3	339.82	2.82	338.00
4	339.91	2.21	337.70
5	339.98	1.98	338.00
6	340.22	1.62	338.60



Borehole No.	Existing Ground Elevation (m)	Highest Founding Depth (m)	Highest Founding Elevation (m)
7	340.31	1.81	338.50
8	340.41	1.61	338.80
9	340.86	0.86	340.00

These soil bearing pressures can be achieved provided that the founding subgrade is undisturbed during construction. The majority of the settlements will take place during construction and the first loading cycle of the building.

It is recommended that a lean concrete mat be placed over approved footing subgrade to prevent further disturbance to the bearing soils resulting from construction activities.

In addition, the footings should be founded below any existing fill materials, on competent native undisturbed soils. Spacing between adjacent footing steps should not be steeper than 10H to 7V. Adjacent to the raft foundation which will be used to support the apartment tower, footings must be founded below any disturbed soil and must be located below a 1H :1V slope projected from the base of the adjacent excavation.

The maximum total and differential settlements of footings designed to the above recommended soil bearing pressure are expected to be less than 25 and 19 mm, respectively, and these are considered tolerable for the structure being contemplated.

Exterior footings and footings in unheated portions of the building should be provided with a soil cover of not less than 1.2 m or equivalent synthetic thermal insulation for adequate frost protection. The founding subgrade soils must be protected from frost penetration during winter construction.

It is recommended that the footing excavations be inspected by the geotechnical engineer to ensure adequate soil bearing and proper subgrade preparation.

6.3 Raft Foundation

It has expected that the 25-storey residential towers and possibly parts of the podiums will be supported on a raft foundation. The finished basement floor level is probably near elevation $337.5 \pm$ m, and the raft foundation would be founded approximately 1.5 to 2.0 m below the basement elevation (between $335.5 \pm$ and $336.0 \pm$ m) on compact to dense fine granular deposits. As no details were available at the time of the preparation of the report it is prudent that the final design is reviewed by a geotechnical engineer to confirm the assumptions made in this report.

Since the anticipated founding level of the raft foundation will be close to the water table (with the



elevator pits possibly located below the water table), it is advisable to locate the basement floor as high as possible to circumvent dewatering requirement. If the raft foundation is located into the groundwater table, dewatering will be required to lower the groundwater to a minimum of 0.6 m below the founding elevation.

Using the soil parameters obtained from SPT values correlations and a soil pressure assumed to be approximately 250 kPa (10 kPa per floor), the total settlements due to live load and dead load were calculated for the apartment tower. The maximum total settlements of a rigid raft supporting the 25-storey building could be up to approximately 25 mm. The settlement response will be “immediate” once the loading is imposed. Assuming the dead load of the apartment will be 80±% of the total loading, settlements due to live load will be in the order of 5 mm.

The following design and construction criteria are recommended:

- Modulus of vertical subgrade reaction of 18 MN/m³ can be used for structural design of the raft foundation.
- Design the structures to accommodate the relative movement between the apartment tower and parking garage.
- Remove any loose or soft soils exposed at the raft founding subgrade and replace such materials with lean concrete.
- Place a 50 to 100 mm thick lean concrete working pad to facilitate placement of reinforcement steel.
- Groundwater must be properly controlled during the raft slab construction.

The designer must take into consideration that the relative settlements between the apartment towers and the garage structure could be up to 5 mm due to the live loads.

It is recommended that the foundation excavations be inspected by the geotechnical engineer to ensure adequate soil bearing and proper subgrade preparation.

6.4 Earthquake Considerations

In accordance with The Ontario Building Code 2012 (OBC), the proposed structure should be designed to resist earthquake load and effects as per OBC Subsection 4.1.8.

Based on the anticipated condition of the underlying soil condition encountered at the boreholes, the site can be classified as a Site Class C as per OBC Table 4.1.8.4.A (Page B4-24).



6.5 Open Cut Excavation and Groundwater Control

Excavations are expected to be in the order of 4 to 5 m deep for basement, foundation and site servicing. The excavations will penetrate loose to compact fill and compact to dense fine granular deposits. These materials are considered to be Type 3 Soils in accordance with the latest Occupational Health and Safety Act.

Above the groundwater table, excavations in the Type 3 Soils are expected to remain stable during the construction period provided that side slopes are cut to 1H : 1V from the bottom of the excavation. Where seepage or perched groundwater is encountered, side slopes should be cut to more stable angles of 3H : 1V. The side slopes should be suitably protected from erosion processes.

Above the groundwater table, rain water or local perched groundwater can be controlled by pumping from filtered sump pits as and where required. It is recommended that excavation for the future development be done during the typically drier summer months when ground water conditions would be expected to lie at lower elevations.

Dewatering will be required for any excavations carried out below the water table, as the fine granular soils will become “quick” and lose its integrity to support loads. The groundwater table must be lowered and controlled to at least 600 mm below the excavation level to facilitate the excavation and construction of raft foundation, footings and walls to be carried out in the dry condition.

In wet to saturated subgrade condition, it will be necessary to excavate below founding level and pour a 75 mm thick mud slab of lean concrete to protect the founding soil from disturbance during the installation of reinforcing steel bars and form work.

6.6 Dewatering

Due to the proposed 1 level of underground parking and the thickness of the raft foundation, the anticipated depths of excavation across the site will be in the order of 4 to 5 m. The excavations could be extended some 0.5 to 1.0 m below the measured groundwater table. The deeper excavations at the elevator pits could extend the excavation some 2.0 m into the groundwater table.

As the amount of groundwater to be pumped is expected to exceed 50,000 Litres/day, this pumping is considered to be a “water taking” by the Ministry of Environment and Climate Change (MOECC) and is subject to the ministry’s “Permit To Take Water (PTTW)” requirements. In March 2016, the Ministry provided an exemption from the permitting requirements for “construction-only” water takings that do not exceed 400,000 L/day. For these modest “construction-only” water takings, the water taking must still be “registered” on the MOECC “Environmental Activity and Sector Registry (EASR)”, but nevertheless a quicker and less formal process is now available to allow pumping to proceed. In addition, the ministry has clarified that surface water from rainfall is not included in the water quantity and there is no time limitation for these regulated water takings, although a qualified person (QP) must still evaluate the water taking for all the same environmental impact issues and then indicate this through the on-line registration procedure. For all other water takings and construction water takings



exceeding 400,000 L/day, a PTTW is still required along with a 90-day review process.

A more detailed assessment by a QP is required to determine if the water taking at this site is likely to exceed 400,000 L/day (278 L/min). Thereafter, the need for either EASR registration or a PTTW can be determined. CVD can provide a hydrogeological study to determine the quantity of groundwater when more details of the proposed redevelopment becomes available.

A dewatering system must be installed to lower the groundwater table to at least 600 mm below the footing/raft founding levels to enable construction to be carried out in a relatively dry condition and that the granular subgrade soils are not disturbed by the hydrostatic pressure.

The objective of a properly installed and operated dewatering system, to be designed by the dewatering contractor, should:

- Lower the water table inside the excavation and intercept seepage which will emerge from the banks and the bottom of the excavation.
- Improve the stability of the bottom of the excavation to prevent disturbance due to hydrostatic pressure.
- Provide a reasonably dry working area in the bottom of the excavation.
- Provide for the collection and removal of surface runoff water and rainfall.

The dewatering system should be monitored to ensure that “silt” is not removed during pumping. It is noted that the selection of the appropriate dewatering system is the responsibility of the contractor. The dewatering system proposed by the contractor should be reviewed by the geotechnical engineer.

The dewatering system should be kept effective until backfilling to the foundations is completed. The dewatering system should be decommissioned gradually.

6.7 Shored Excavation

As excavation is expected to be in the order of 4 to 5 m deep, a shoring system will be required for temporary excavation support during construction where sufficient space is not available for open cut excavation and to support the adjacent structures. Possible shoring supports include soldier pile and timber lagging system, caisson wall or soil nail retaining system with shotcrete facing.

The shoring system is generally designed and built by a specialized shoring contractor. The shoring system should be designed in accordance with the guidelines provided in the Canadian foundation Engineering Manual (CFEM) 4th Edition.

The shoring system will have to withstand the lateral earth pressure, the adjacent roadways, buried services and the traffic loads as well as the adjacent building structures. Frost pressures on the shoring system should be considered if the system is exposed to winter freezing condition. The shoring system



should be monitored to ensure deflection and lateral movements are acceptable, and modifications made to the shoring system if deflection and lateral movements become a problem.

The following soil parameters may be used in the design of shoring. K_o (at rest condition) should be used where the shoring will need to support any existing building/structure.

Soil	Unit Weight (kN/m ³)	Friction Angle (ϕ^e)	Undrained Shear Strength (C_u , kPa)	K_o	K_a	K_p
Fill Materials	19	28	n/a	0.53	0.36	2.77
Compact to Dense Fine Granular Deposits	20	30	n/a	0.50	0.33	3.00

The shoring system can be supported by soil anchor tie-backs and/or raker footings. Soil anchors will provide an unobstructed open space for construction whereas raker supports will obstruct the forming and construction of footings and foundation walls.

If a soldier pile and timber lagging system is adopted, the augering/installation of the soldier piles and timber laggings, especially where they are located adjacent existing structures, should be carried out with caution such that the installation process will not cause future settlements to the adjacent existing structures. The geotechnical engineer should be retained to perform inspection during the installation.

6.8 Floor Slab Construction

The boreholes indicate that native compact to dense fine granular deposits should be exposed at the basement floor slab subgrade.

At the time of floor slab construction, the exposed subgrade should be proof-rolled with a heavy roller in conjunction with an inspection by the geotechnical engineer. Any soft and/or unstable areas detected should be replaced with granular fill which should be compacted to at least 95% SPMDD. On-site inorganic soil may be reused to raise grades where necessary provided its natural moisture content is near to the optimum moisture content. The backfill should be thoroughly compacted in thin lifts to at least 95% SPMDD.

Following the proof-rolling of the subgrade, it is recommended that a minimum 150 mm thick layer of OPSS Granular "A" be placed and compacted to at least 100% SPMDD beneath the concrete floor slabs to provide uniform support. Alternatively, suitably densified 19 mm clear crushed stone can be used. A modulus of subgrade reaction (k_s) of 30 MN/m³ may be used for the design of the floor slabs, considering the floor subgrade will consist of clayey silt and/or sand and silt.



The floor slabs should be separated structurally from the columns and foundation walls. Sawcut control joints should be provided at regular spacing (less than 30 times the concrete slab thickness) and to depths between one-third to one-quarter of the slab thickness.

In order to keep the basement floor level in dry condition, a system of under-floor drains (at typical spacing of 6 m c/c) is recommended to control the groundwater table during seasonally high condition.

6.9 Lateral Earth Pressure

The unbalanced foundation walls and any other soil retaining structures should be designed to resist the lateral earth pressure acting against these walls. The following formula may be used to calculate the unfactored earth pressure distribution. The factored resistance can be calculated by using a factor of 0.8.

$$P = K(\gamma H + q)$$

where:

P =	lateral earth pressure	kPa
K =	earth pressure coefficient, 0.5 for non-yielding foundation wall earth pressure coefficient, 0.3 for yielding retaining wall	
γ =	unit weight of granular backfill, compacted to 95% SPMDD	21 kN/m ³
H =	unbalanced height of wall	m
q =	surcharge load at ground surface	kPa

The backfill for the foundation walls and retaining walls should be free-draining granular materials which should have less than 8% silt particles (OPSS Granular "B" Type 1). The backfill should be placed in thin layers and compacted to 95% SPMDD. Over-compaction should be avoided. Weeping tiles leading to a frost-free outlet or weep holes should be installed to effect drainage behind the retaining wall.

The sliding resistance of the retaining wall footings should be checked. The unfactored horizontal resistance against sliding between cast-in-place concrete and the various soils can be calculated using a friction coefficient as follows:

- Compact to dense fine granular deposits: 0.30

The unit weight of fine granular deposits is 20 kN/m³ and a unit weight of the granular backfill compacted to 95% SPMDD is 21 kN/m³.



7.0 CLOSURE

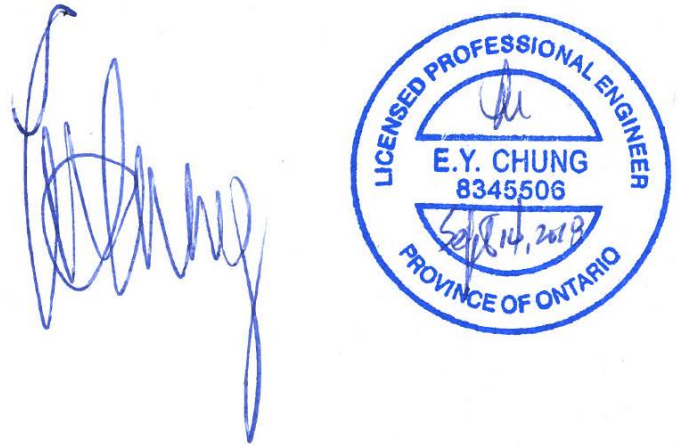
The Limitations of Report, as quoted in Appendix A, is an integral part of this report.

We trust that the information presented in this report is complete within our terms of reference. If there are any further questions concerning this report, please do not hesitate to contact our office.

Yours truly,
CHUNG & VANDER DOELEN ENGINEERING LTD.



Chris Sternik, P.Eng.
Geotechnical Engineer



Eric Y. Chung, M. Eng., P.Eng.
Principal Engineer



APPENDIX A

Limitations of Report



APPENDIX “A”

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Soils Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in the testholes.

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

The benchmark and elevations mentioned in this report were obtained strictly for use in the geotechnical design of the project and by this office only, and should not be used by any other parties for any other purposes.

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. CHUNG & VANDER DOELEN ENGINEERING 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.

This report does not reflect the environmental issues or concerns unless otherwise stated in the report. The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.



ENCLOSURES



FILE No: G18620

BOREHOLE No. 1



Client: **PG Design Studio Inc.**

Project: **Proposed Mixed-Use Development**

Location: **143 Columbia Street West, Waterloo, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**
Method: **HSA / Mud Rotary**
Size: **108 mm I.D. / 82 mm**
Date: **Aug 02 - 18 TO Aug 03 - 18**

SOIL LITHOLOGY			SAMPLE		SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200	PENETRATION RESISTANCE STANDARD ● DYN. CONE ○ 20 40 60 80	W _p	W	W _L			
339.50	Ground Elevation: 339.69 m													
338.50	100 mm TOPSOIL	0.5												
	loose to compact brown FILL, silty sand trace gravel contains topsoil moist to wet	1.0		1	SS	8								
337.94		1.5		2	SS	17								
1.75		2.0		3	SS	19								
	compact brown to grey SAND AND SILT occ. silt seams wet to saturated	2.5		4	SS	23								
		3.0												
		3.5												
		4.0												
		4.5		5	SS	21								
		5.0												
333.90		5.5												
5.79		6.0		6	SS	28								
	stiff to very stiff grey CLAYEY SANDY SILT occ. silt seams moist to wet	6.5												
		7.0												
		7.5												
		8.0		7	SS	27								
		8.5												
		9.0												
		9.5		8	SS	11								
		10.0												
		10.5												
328.62		11.0		9	SS	35								
11.07		11.5												
	very stiff to hard grey SILTY CLAY TILL trace gravel, trace sand moist	12.0												
		12.5		10	SS	42								
		13.0												
		13.5												
		14.0												
		14.5		11	SS	29								

▽ saturated condition observed in Sample No. 5 prior to use of water start of mud rotary

PROJECT MANAGER: **EYC**

**CHUNG & VANDER DOELEN
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FILE No: G18620

BOREHOLE No. 1



Client: **PG Design Studio Inc.**

Project: **Proposed Mixed-Use Development**

Location: **143 Columbia Street West, Waterloo, Ontario**

EQUIPMENT DATA

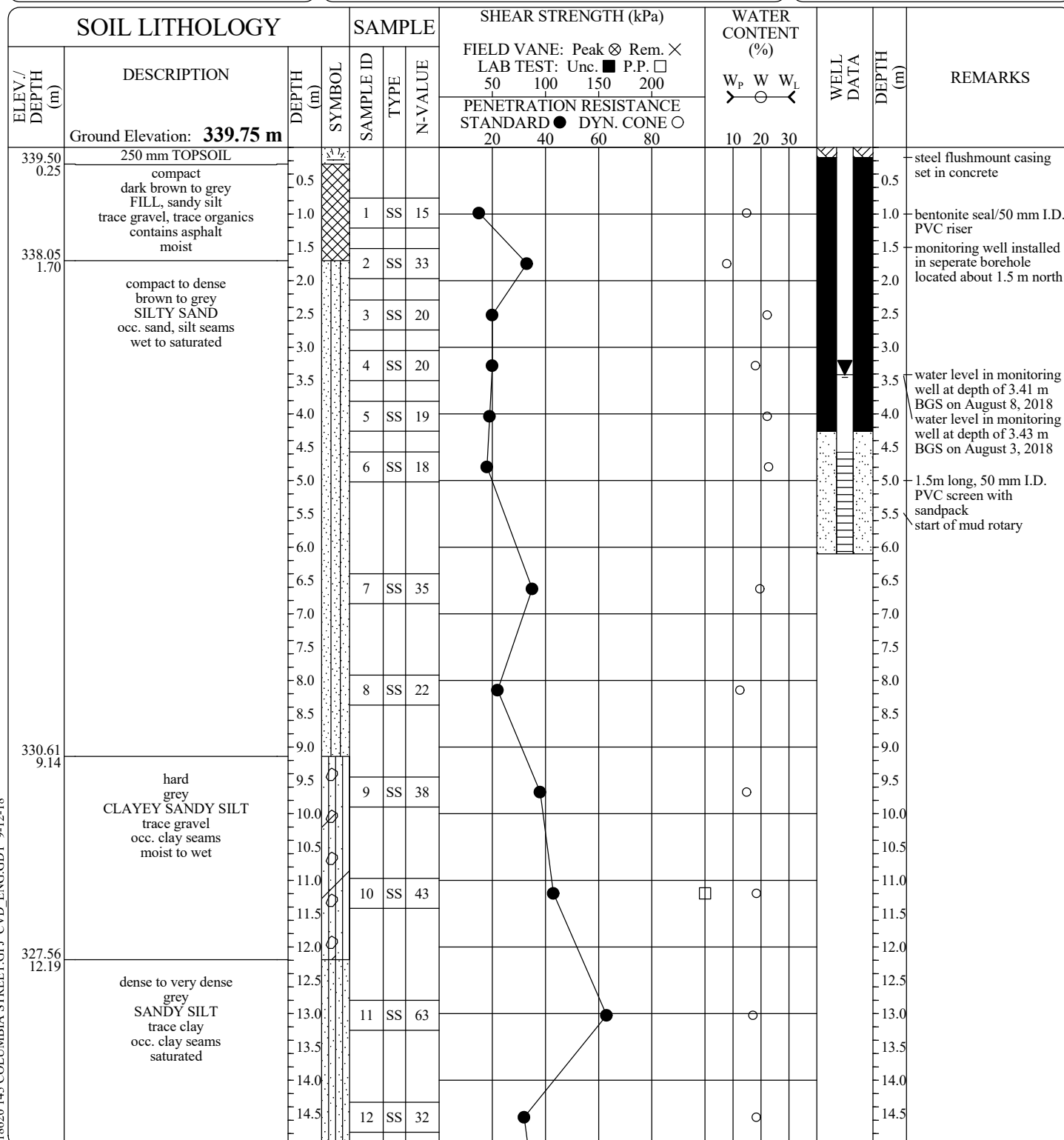
Machine: **Diedrich D50T**
Method: **HSA / Mud Rotary**
Size: **108 mm I.D. / 82 mm**
Date: **Aug 02 - 18 TO Aug 03 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)				WELL DATA	DEPTH (m)	REMARKS		
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				PENETRATION RESISTANCE STANDARD ● DYN. CONE ○			W _p W W _L					
							50	100	150	200	20	40	60	80				10	20
	(continued)																		
321.86 17.83	very stiff to hard grey SILTY CLAY TILL trace gravel, trace sand moist	15.5	⊗													15.5			
		16.0	●	12	SS	37						■		○		16.0			
		16.5	○														16.5		
		17.0	○														17.0		
		17.5	●	13	SS	44							■		○		17.5		
		End of Borehole	18.0														18.0		
			18.5														18.5		
			19.0														19.0		
			19.5														19.5		
			20.0														20.0		
			20.5														20.5		
			21.0														21.0		
			21.5														21.5		
			22.0														22.0		
			22.5														22.5		
			23.0														23.0		
			23.5														23.5		
			24.0														24.0		
			24.5														24.5		
			25.0														25.0		
			25.5														25.5		
			26.0														26.0		
			26.5														26.5		
			27.0														27.0		
			27.5														27.5		
			28.0														28.0		
		28.5														28.5			
		29.0														29.0			
		29.5														29.5			

PROJECT MANAGER: **EYC**

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FILE No: G18620**BOREHOLE No. 2**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **HSA / Mud Rotary**Size: **108 mm I.D. / 82 mm**Date: **Aug 01 - 18 TO Aug 02 - 18**PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**311 Victoria Street North
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ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620

BOREHOLE No. 2



Client: **PG Design Studio Inc.**

Project: **Proposed Mixed-Use Development**

Location: **143 Columbia Street West, Waterloo, Ontario**

EQUIPMENT DATA

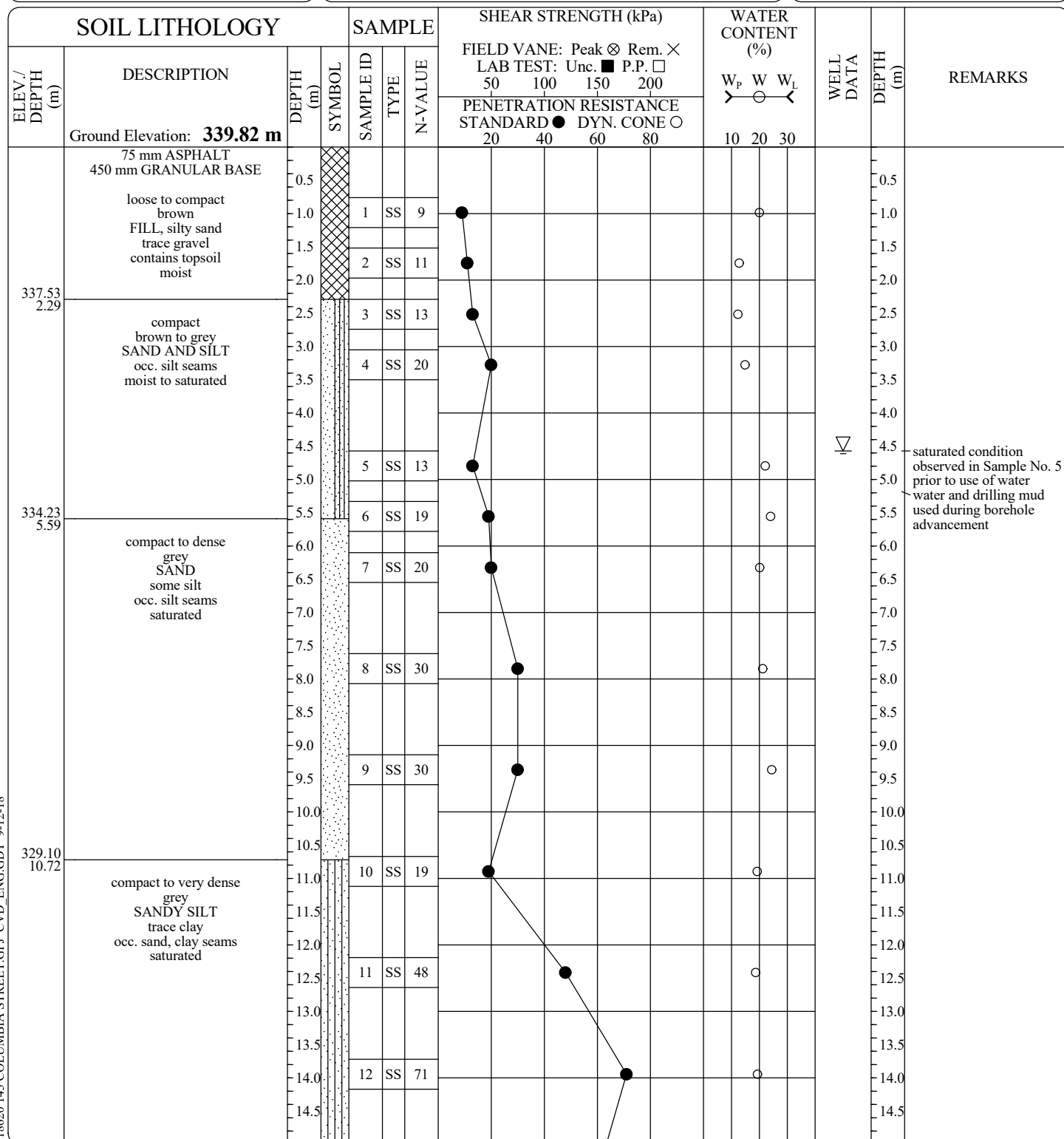
Machine: **Diedrich D50T**
Method: **HSA / Mud Rotary**
Size: **108 mm I.D. / 82 mm**
Date: **Aug 01 - 18 TO Aug 02 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS		
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				PENETRATION RESISTANCE STANDARD ● DYN. CONE ○							
							50	100	150	200	20	40	60				80	10
(continued)																		
322.99 16.76	dense to very dense grey SILTY SAND trace clay saturated	15.5														15.5		
		16.0	13	SS	37											16.0		
		16.5															16.5	
		17.0															17.0	
		17.5	14	SS	44												17.5	
		18.0															18.0	
		18.5															18.5	
		19.0	15	SS	62												19.0	
		19.5															19.5	
		20.0															20.0	
318.41 21.34	hard, grey SILTY CLAY TILL trace gravel, trace sand occ. silt seams moist	20.5	16	SS	70											20.5		
		21.0															21.0	
		21.5															21.5	
		22.0	17	SS	51												22.0	
		22.5															22.5	
		23.0															23.0	
		23.5															23.5	
		24.0															24.0	
		24.5															24.5	
		25.0															25.0	
317.35 22.40	End of Borehole	25.5														25.5		
		26.0															26.0	
		26.5															26.5	
		27.0															27.0	
		27.5															27.5	
		28.0															28.0	
		28.5															28.5	
		29.0															29.0	
		29.5															29.5	

PROJECT MANAGER: **EYC**

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FILE No: G18620**BOREHOLE No. 3**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Aug 07 - 18 TO Aug 07 - 18**PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620

BOREHOLE No. 3



Client: **PG Design Studio Inc.**

Project: **Proposed Mixed-Use Development**

Location: **143 Columbia Street West, Waterloo, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**

Method: **Hollow Stem Auger**

Size: **108 mm I.D.**

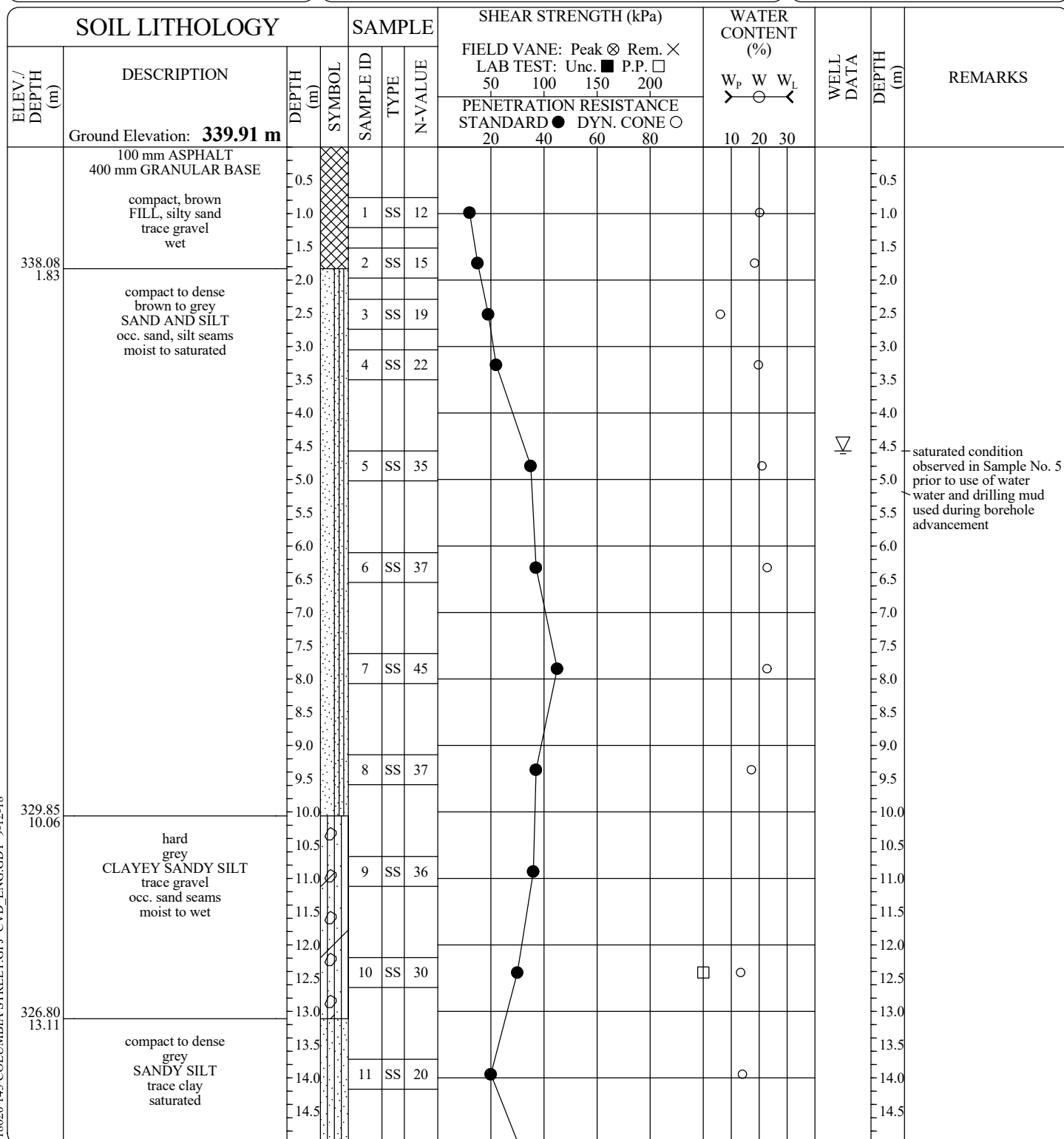
Date: **Aug 07 - 18 TO Aug 07 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS	
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				WATER CONTENT (%)						
							PENETRATION RESISTANCE				W _p W W _L						
							STANDARD ● DYN. CONE ○				↔ ○ ↔						
	(continued)						20	40	60	80	10	20	30				
322.14 17.68	compact to very dense grey SANDY SILT trace clay occ. sand, clay seams saturated	15.5		13	SS	60										15.5	
																16.0	
		16.5														16.5	
		17.0		14	SS	74										17.0	
321.07 18.75	hard, grey SILTY CLAY TILL trace gravel, trace sand moist	17.5													17.5		
															18.0		
		18.5		15	SS	78									18.5		
	End of Borehole	19.0													19.0		
		19.5													19.5		
		20.0													20.0		
		20.5													20.5		
		21.0													21.0		
		21.5													21.5		
		22.0													22.0		
		22.5													22.5		
		23.0													23.0		
		23.5													23.5		
		24.0													24.0		
		24.5													24.5		
		25.0													25.0		
		25.5													25.5		
		26.0													26.0		
		26.5													26.5		
		27.0													27.0		
		27.5													27.5		
		28.0													28.0		
		28.5													28.5		
		29.0													29.0		
		29.5													29.5		

PROJECT MANAGER: **EYC**

**CHUNG & VANDER DOELEN
ENGINEERING LTD.**

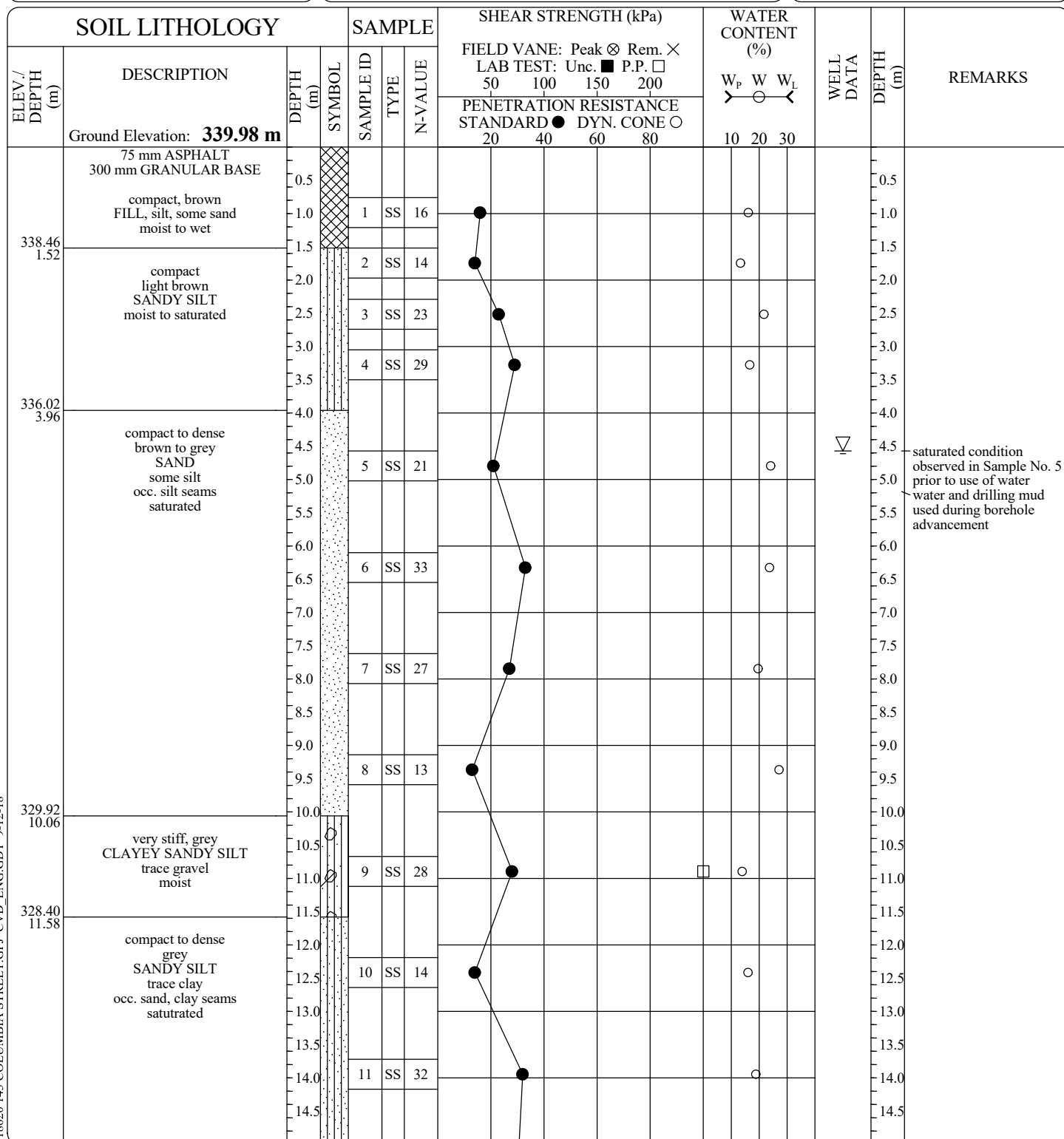
311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620**BOREHOLE No. 4**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Aug 07 - 18 TO Aug 07 - 18**PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620**BOREHOLE No. 4**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo,
Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Aug 07 - 18 TO Aug 07 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS		
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				WATER CONTENT (%)							
							PENETRATION RESISTANCE				W _p	W	W _L					
							STANDARD ● DYN. CONE ○											
	(continued)						20	40	60	80	10	20	30					
324.37 15.54	hard grey SILTY CLAY TILL trace gravel, trace sand occ. sand, silt seams moist	15.5		12	SS	35						□	○		15.5			
		16.0													16.0			
		16.5														16.5		
		17.0		13	SS	32						□	○			17.0		
		17.5															17.5	
321.16 18.75	End of Borehole	18.0														18.0		
		18.5		14	SS	56						□	○			18.5		
		19.0															19.0	
		19.5															19.5	
		20.0															20.0	
		20.5															20.5	
		21.0															21.0	
		21.5															21.5	
		22.0															22.0	
		22.5															22.5	
		23.0															23.0	
		23.5															23.5	
		24.0															24.0	
		24.5															24.5	
		25.0															25.0	
		25.5															25.5	
		26.0															26.0	
		26.5															26.5	
		27.0															27.0	
27.5														27.5				
28.0														28.0				
28.5														28.5				
29.0														29.0				
29.5														29.5				

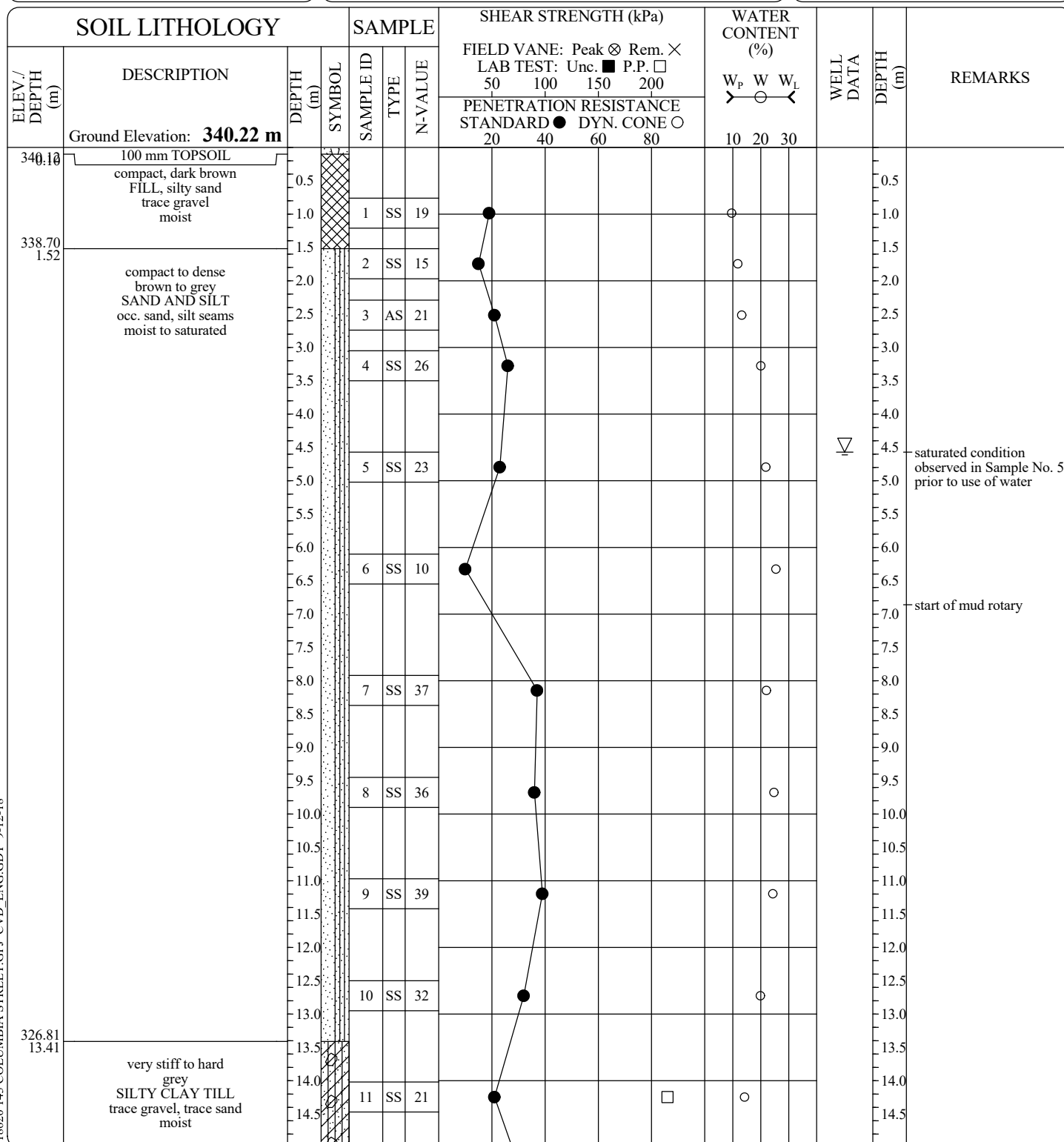
PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620**BOREHOLE No. 5**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Aug 08 - 18 TO Aug 08 - 18**PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620**BOREHOLE No. 5**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo,
Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Aug 08 - 18 TO Aug 08 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS	
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				WATER CONTENT (%)						
											W _p W W _L						
							PENETRATION RESISTANCE STANDARD ● DYN. CONE ○										
	(continued)						20	40	60	80	10	20	30				
324.28 15.70	End of Borehole Start of DCPT	15.5		12	SS	30											
		16.0															
		16.5															
		17.0															
		17.5															
		18.0															
		18.5															
		19.0															
		19.5															
		20.0															
		20.5															
		21.0															
		21.5															
		22.0															
321.08 18.90	End of DCPT	19.0															
		19.5															
		20.0															
		20.5															
		21.0															
		21.5															
		22.0															
		22.5															
		23.0															
		23.5															
		24.0															
		24.5															
		25.0															
		25.5															
26.0																	
26.5																	
27.0																	
27.5																	
28.0																	
28.5																	
29.0																	
29.5																	

PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
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FILE No: G18620**BOREHOLE No. 6**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **HSA / Mud Rotary**Size: **108 mm I.D. / 82 mm**Date: **Jul 31 - 18 TO Aug 01 - 18**PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**
 311 Victoria Street North
 Kitchener, Ontario N2H 5E1
 ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620

BOREHOLE No. 6



Client: **PG Design Studio Inc.**

Project: **Proposed Mixed-Use Development**

Location: **143 Columbia Street West, Waterloo, Ontario**

EQUIPMENT DATA

Machine: **Diedrich D50T**
Method: **HSA / Mud Rotary**
Size: **108 mm I.D. / 82 mm**
Date: **Jul 31 - 18 TO Aug 01 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS		
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				W _p W W _L							
							PENETRATION RESISTANCE STANDARD ● DYN. CONE ○				10 20 30							
	(continued)						20	40	60	80								
320.87 19.35	very stiff to hard grey SILTY CLAY TILL trace gravel, trace sand moist	15.5														15.5		
		16.0	12	SS	37		●					■		○		16.0		
		16.5															16.5	
		17.0															17.0	
		17.5	13	SS	31		●					■		○		17.5		
		18.0															18.0	
		18.5															18.5	
		19.0	14	SS	50		●					■		○		19.0		
	19.5	End of Borehole														19.5		
	20.0															20.0		
	20.5															20.5		
	21.0															21.0		
	21.5															21.5		
	22.0															22.0		
	22.5															22.5		
	23.0															23.0		
	23.5															23.5		
	24.0															24.0		
	24.5															24.5		
	25.0															25.0		
	25.5															25.5		
	26.0															26.0		
	26.5															26.5		
	27.0															27.0		
27.5															27.5			
28.0															28.0			
28.5															28.5			
29.0															29.0			
29.5															29.5			

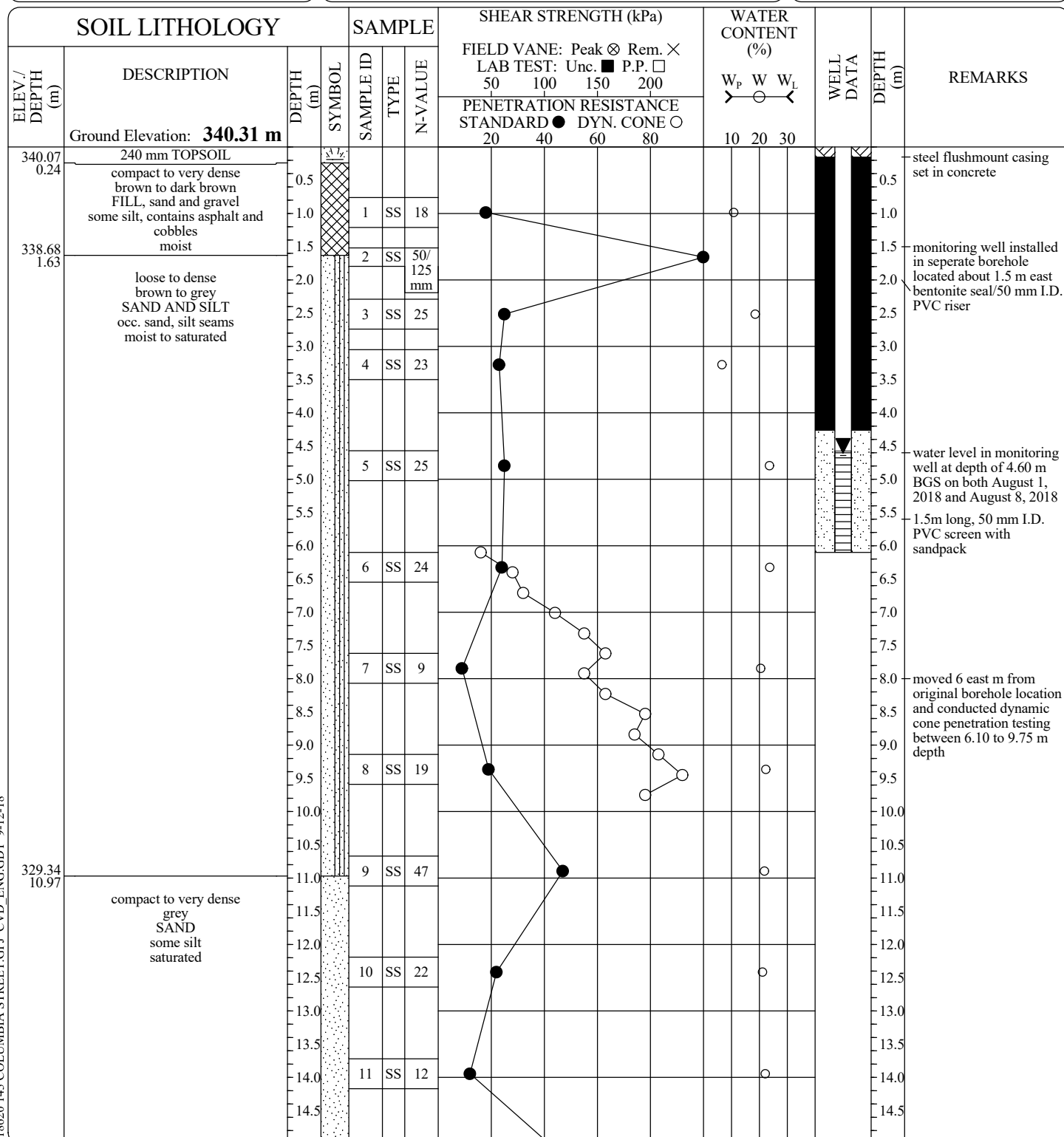
PROJECT MANAGER: **EYC**

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FILE No: G18620**BOREHOLE No. 7**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**

Machine: **Diedrich D50T**
 Method: **Hollow Stem Auger**
 Size: **108 mm I.D.**
 Date: **Jul 27 - 18 TO Jul 27 - 18**

PROJECT MANAGER: **EYC**
**CHUNG & VANDER DOELEN
ENGINEERING LTD.**

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FILE No: G18620

BOREHOLE No. 7



Client: **PG Design Studio Inc.**

Project: **Proposed Mixed-Use Development**

Location: **143 Columbia Street West, Waterloo, Ontario**

EQUIPMENT DATA

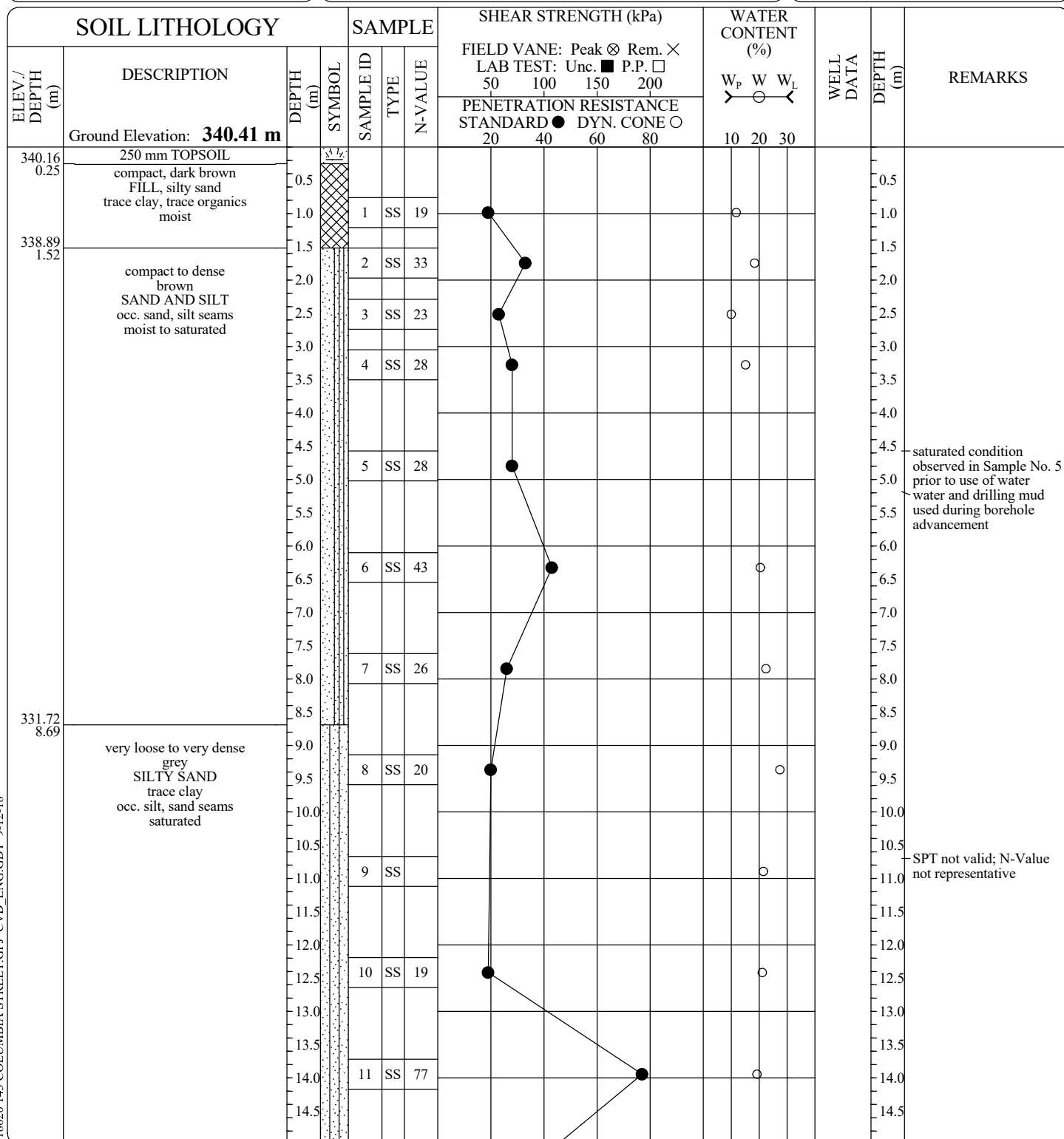
Machine: **Diedrich D50T**
Method: **Hollow Stem Auger**
Size: **108 mm I.D.**
Date: **Jul 27 - 18 TO Jul 27 - 18**

SOIL LITHOLOGY			SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS	
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □ 50 100 150 200				W _p W W _L ↗ — ○ ↖					
(continued)							PENETRATION RESISTANCE STANDARD ● DYN. CONE ○				10 20 30					
324.77 15.54	hard grey CLAYEY SANDY SILT trace gravel occ. sand, silt seams wet	15.5	⊗	12	SS	55										
		16.0	○													
		16.5	⊗													
		17.0	○	13	SS	66										
		17.5	⊗													
320.40 19.91	hard grey SILTY CLAY TILL trace gravel, trace sand moist	18.0	○													
		18.5	⊗	14	SS	33							□	○		
		19.0	○													
		19.5	⊗													
		20.0	○	15	SS	54							□	○		
317.75 22.56	End of Borehole	20.5	⊗													
		21.0	○													
		21.5	⊗	16	SS	63							□	○		
		22.0	○													
		22.5	⊗	17	SS	50							□	○		
		23.0														
		23.5														
		24.0														
		24.5														
		25.0														
		25.5														
		26.0														
		26.5														
		27.0														
		27.5														
		28.0														
		28.5														
		29.0														
		29.5														

PROJECT MANAGER: **EYC**

**CHUNG & VANDER DOELEN
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ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620**BOREHOLE No. 8**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Jul 26 - 18 TO Jul 26 - 18**PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
ENGINEERING LTD.**311 Victoria Street North
Kitchener, Ontario N2H 5E1
ph. (519) 742-8979, fx. (519) 742-7739

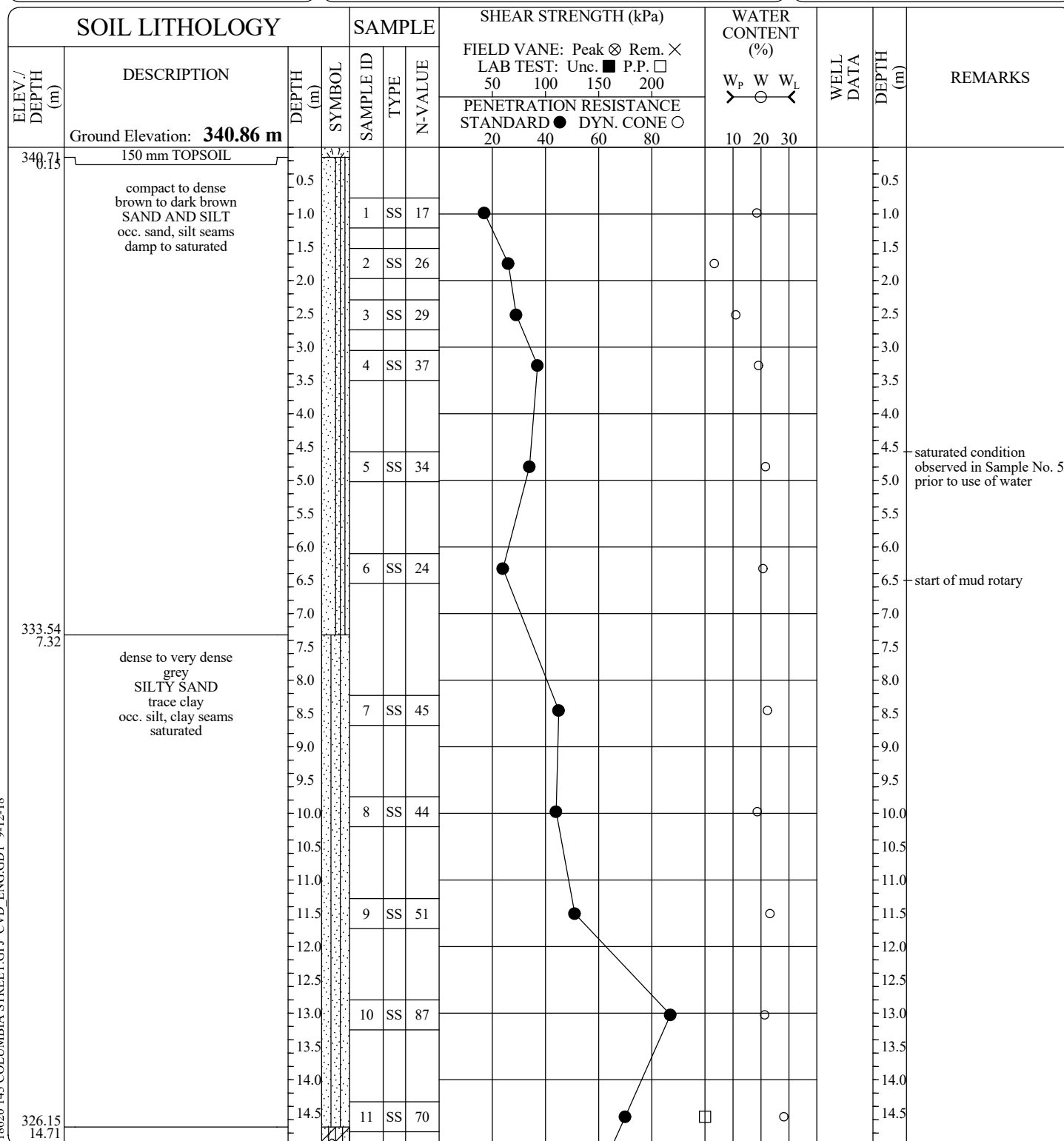
FILE No: G18620**BOREHOLE No. 8**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**Machine: **Diedrich D50T**Method: **Hollow Stem Auger**Size: **108 mm I.D.**Date: **Jul 26 - 18 TO Jul 26 - 18**

SOIL LITHOLOGY			SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)			WELL DATA	DEPTH (m)	REMARKS	
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. × LAB TEST: Unc. ■ P.P. □				WATER CONTENT (%)					
							PENETRATION RESISTANCE STANDARD ● DYN. CONE ○				W _p	W				W _L
							20	40	60	80	10	20	30			
322.73 17.68	compact to dense brown SAND AND SILT occ. sand, silt seams moist to saturated	15.5		12	SS	31	●						○		15.5	
		16.0													16.0	
		16.5													16.5	
		17.0		13	SS	45	●						○		17.0	
		17.5													17.5	
	hard grey SILTY CLAY TILL trace gravel, trace to some sand occ. sand, silt seams moist	18.0													18.0	
		18.5		14	SS	36	●					□	○		18.5	
		19.0													19.0	
		19.5													19.5	
		20.0		15	SS	50	●					□	○		20.0	
315.81 24.60	End of Borehole	20.5													20.5	
		21.0													21.0	
		21.5		16	SS	51	●				□	○		21.5		
		22.0													22.0	
		22.5													22.5	
		23.0		17	SS	46	●					□	○		23.0	
		23.5													23.5	
		24.0													24.0	
24.5		18	SS	50/ 65 mm	■					■	○		24.5			
25.0													25.0			
25.5													25.5			
26.0													26.0			
26.5													26.5			
27.0													27.0			
27.5													27.5			
28.0													28.0			
28.5													28.5			
29.0													29.0			
29.5													29.5			

PROJECT MANAGER: **EYC****CHUNG & VANDER DOELEN
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ph. (519) 742-8979, fx. (519) 742-7739

FILE No: G18620**BOREHOLE No. 9**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**

Machine: **Diedrich D50T**
 Method: **HSA / Mud Rotary**
 Size: **108 mm I.D. / 82 mm**
 Date: **Jul 30 - 18 TO Jul 31 - 18**

PROJECT MANAGER: **EYC**
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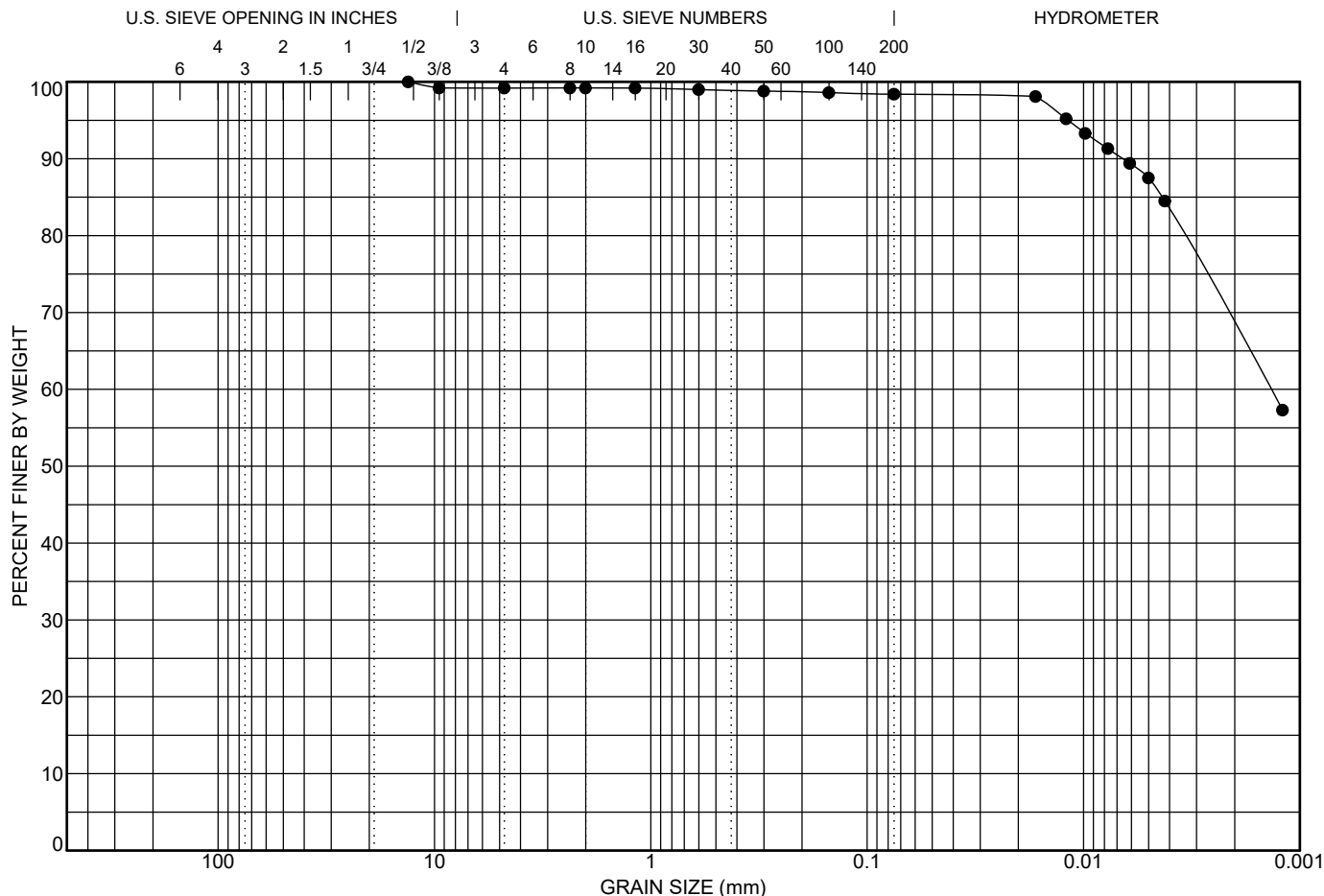
FILE No: G18620**BOREHOLE No. 9**Client: **PG Design Studio Inc.**Project: **Proposed Mixed-Use Development**Location: **143 Columbia Street West, Waterloo, Ontario****EQUIPMENT DATA**

Machine: **Diedrich D50T**
 Method: **HSA / Mud Rotary**
 Size: **108 mm I.D. / 82 mm**
 Date: **Jul 30 - 18 TO Jul 31 - 18**

SOIL LITHOLOGY				SAMPLE			SHEAR STRENGTH (kPa)				WATER CONTENT (%)				WELL DATA	DEPTH (m)	REMARKS			
ELEV./ DEPTH (m)	DESCRIPTION	DEPTH (m)	SYMBOL	SAMPLE ID	TYPE	N-VALUE	FIELD VANE: Peak ⊗ Rem. ×				LAB TEST: Unc. ■ P.P. □							W _p	W	W _L
							PENETRATION RESISTANCE													
							STANDARD ● DYN. CONE ○													
	(continued)						20	40	60	80					10	20	30			
321.51 19.35	hard grey SILTY CLAY TILL trace gravel, trace sand occ. silt, sand seams moist	15.5																		
		16.0	12	SS	53															
		16.5																		
		17.0																		
		17.5	13	SS	57															
		18.0																		
		18.5																		
		19.0	14	SS	69															
		19.5																		
		20.0																		
	20.5																			
	21.0																			
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COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					13.2	0.001			0.8	0.8	98.4	

Date: Sep. 05 - 2018
Client: PG Design Studio Inc.
Contractor:
Source:
Sampled From: BH 1 - SA 12, 15.85 m to 16.30 m depth
Sample No.: 1-12
Date Sampled: Aug. 03 - 2018
Sampled By: NZ
Lab No.: 3573
Date Tested: Sep. 04 - 2018
Type of Material: Silty Clay Till, trace sand

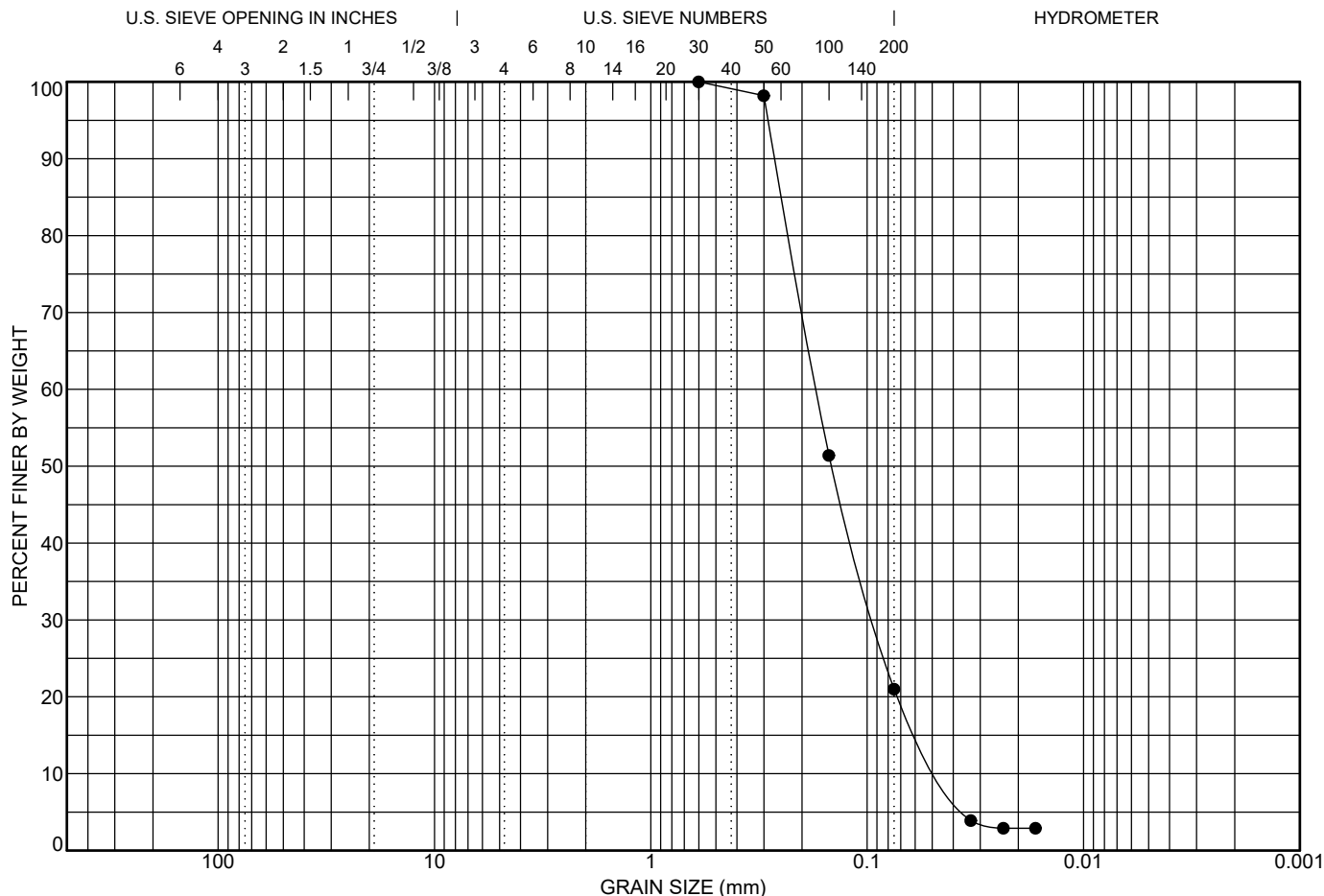
Sieve Size (mm)	Percent Passing	No Specifications



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GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development
Location: 143 Columbia Street West, Waterloo, Ontario
File No.: G18620
Enclosure No.: 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			1.12	3.84	0.6	0.17	0.092	0.044	0.0	79.0	21.0	

Date: Sep. 05 - 2018
Client: PG Design Studio Inc.
Contractor:
Source:
Sampled From: BH 2 - SA 7, 6.40 m to 6.85 m depth
Sample No.: 2-7
Date Sampled: Aug. 02 - 2018
Sampled By: NZ
Lab No.: 3574
Date Tested: Sep. 04 - 2018
Type of Material: Silty Sand

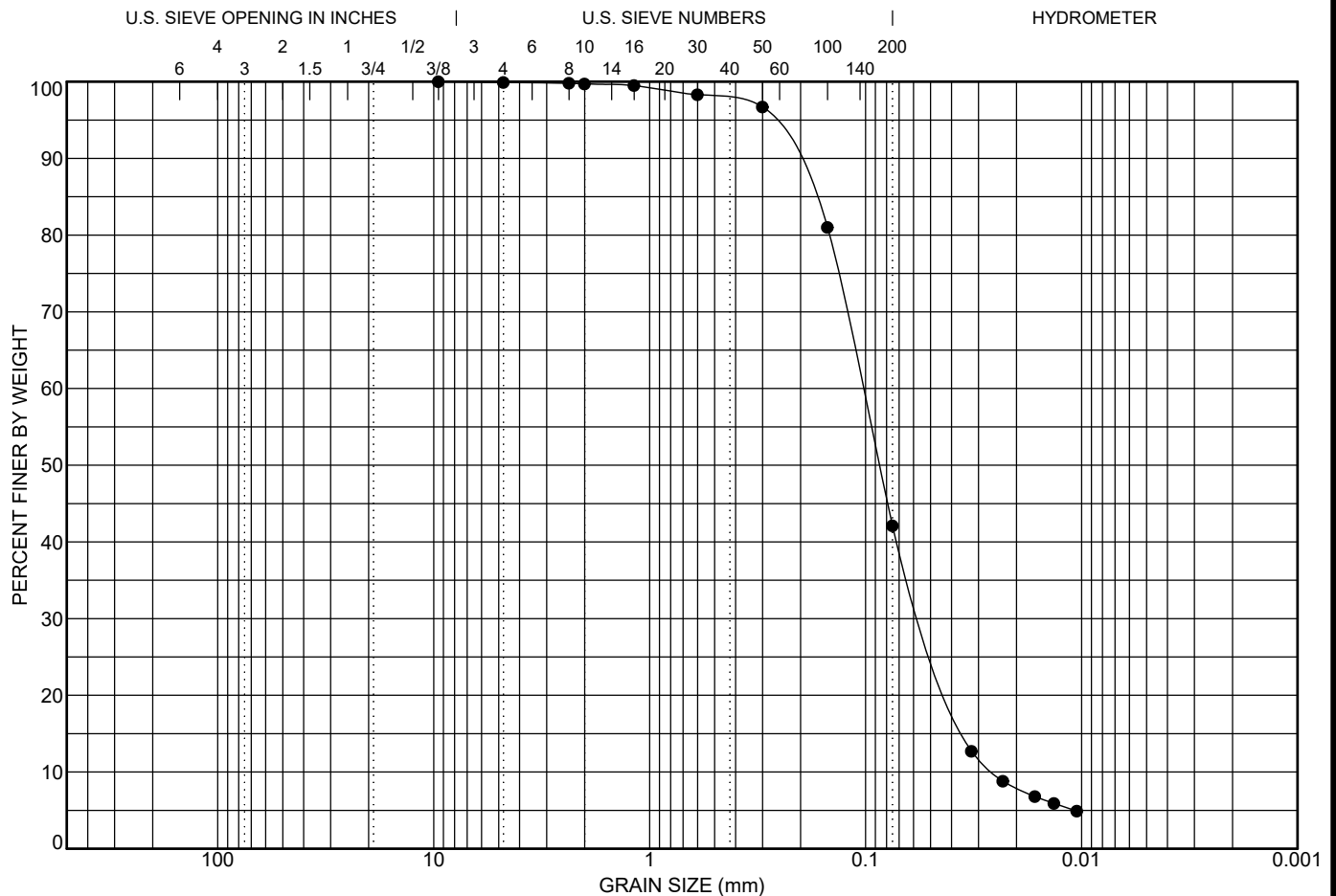
Sieve Size (mm)	Percent Passing	No Specifications



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GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development
Location: 143 Columbia Street West, Waterloo, Ontario
File No.: G18620
Enclosure No.: 11



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			1.06	4.03	9.5	0.103	0.053	0.026	0.1	57.8	42.1	

Date:	Sep. 05 - 2018	Sieve Size (mm)	Percent Passing	No Specifications
Client:	PG Design Studio Inc.			
Contractor:				
Source:				
Sampled From:	BH 3 - SA 5, 4.57 m to 5.02 m depth			
Sample No.:	3-5			
Date Sampled:	Aug. 07 - 2018			
Sampled By:	NZ			
Lab No.:	3575			
Date Tested:	Sep. 04 - 2018			
Type of Material:	Sand and Silt			



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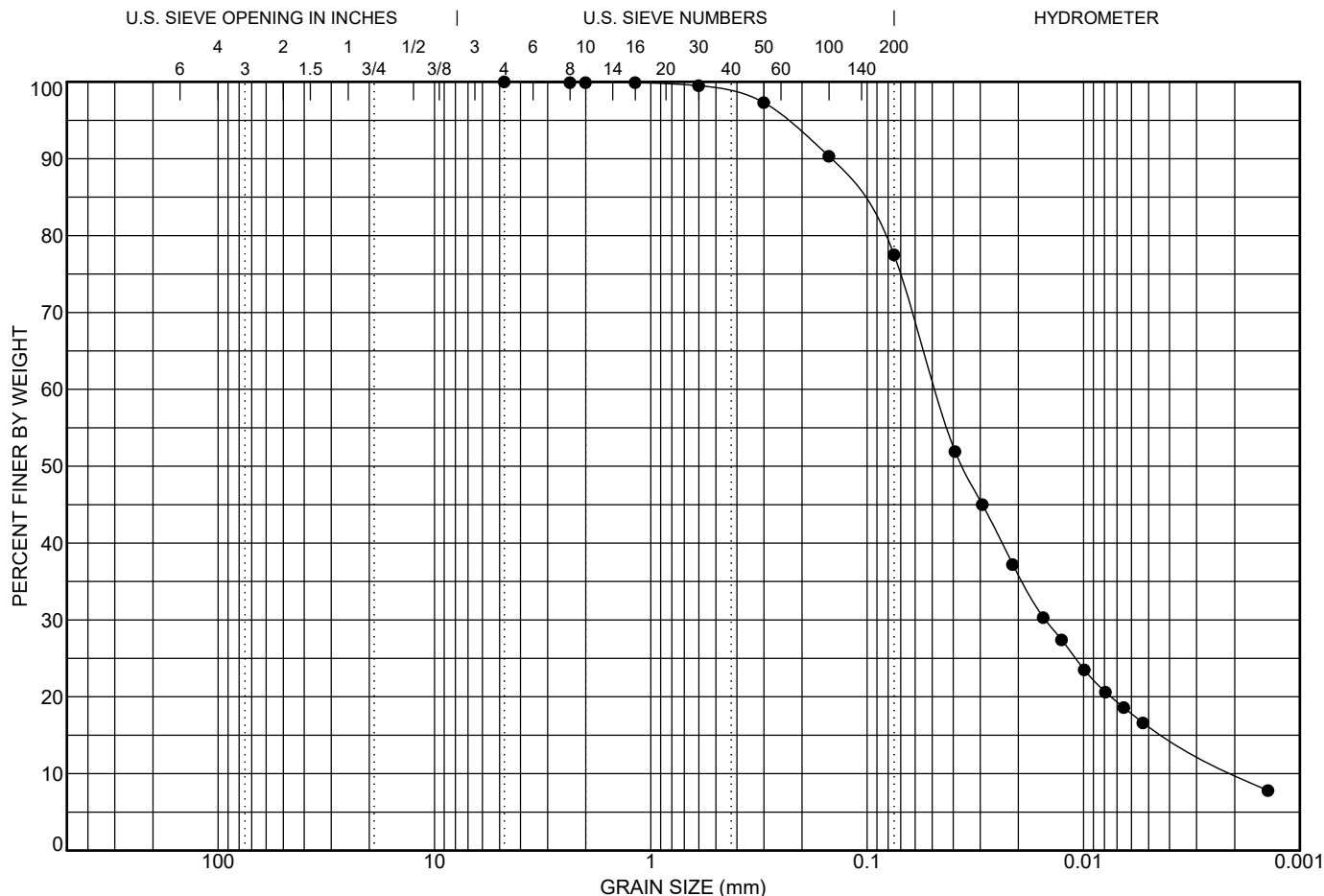
GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development

Location: 143 Columbia Street West, Waterloo, Ontario

File No.: G18620

Enclosure No.: 12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			2.39	24.65	4.75	0.048	0.015	0.002	0.0	22.5	77.5	

Date: Sep. 05 - 2018
Client: PG Design Studio Inc.
Contractor:
Source:
Sampled From: BH 4 - SA 11, 13.72 m to 14.17 m depth
Sample No.: 4-11
Date Sampled: Aug. 07 - 2018
Sampled By: NZ
Lab No.: 3576
Date Tested: Sep. 04 - 2018
Type of Material: Sandy Silt, trace clay

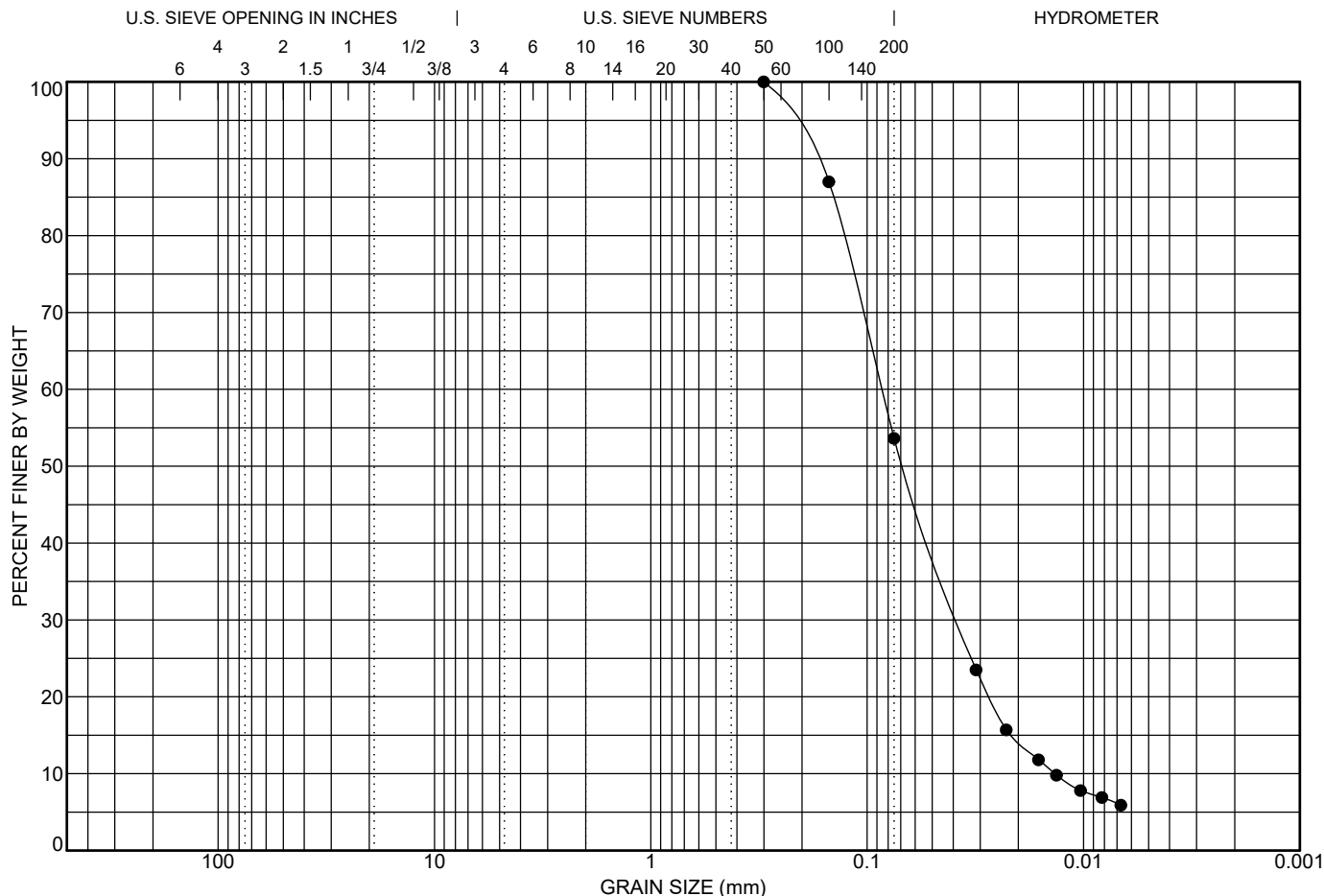
Sieve Size (mm)	Percent Passing	No Specifications



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GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development
Location: 143 Columbia Street West, Waterloo, Ontario
File No.: G18620
Enclosure No.: 13



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			1.23	6.32	0.3	0.086	0.038	0.014	0.0	46.4		53.6

Date: Sep. 05 - 2018
Client: PG Design Studio Inc.
Contractor:
Source:
Sampled From: BH 6 - SA 6, 6.10 m to 6.55 m depth
Sample No.: 6-6
Date Sampled: Aug. 01 - 2018
Sampled By: NZ
Lab No.: 3577
Date Tested: Sep. 04 - 2018
Type of Material: Sand and Silt

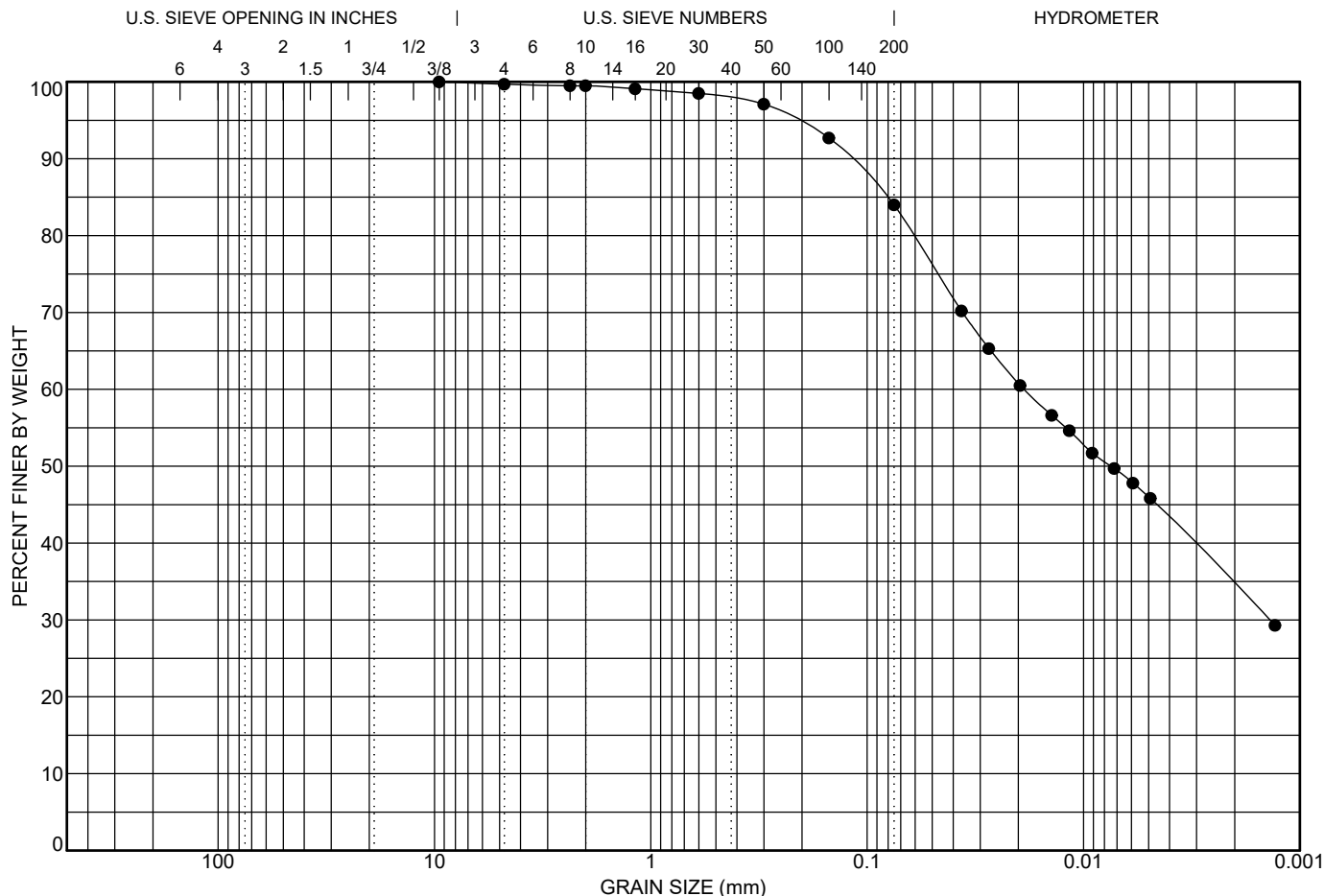
Sieve Size (mm)	Percent Passing	No Specifications



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GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development
Location: 143 Columbia Street West, Waterloo, Ontario
File No.: G18620
Enclosure No.: 14



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
					9.5	0.019	0.001		0.3	15.7	84.0	

Date: Sep. 05 - 2018
Client: PG Design Studio Inc.
Contractor:
Source:
Sampled From: BH 8 - SA 15, 19.81 m to 20.26 m depth
Sample No.: 8-15
Date Sampled: Jul. 26 - 2018
Sampled By: NZ
Lab No.: 3578
Date Tested: Sep. 04 - 2018
Type of Material: Silty Clay Till, some sand

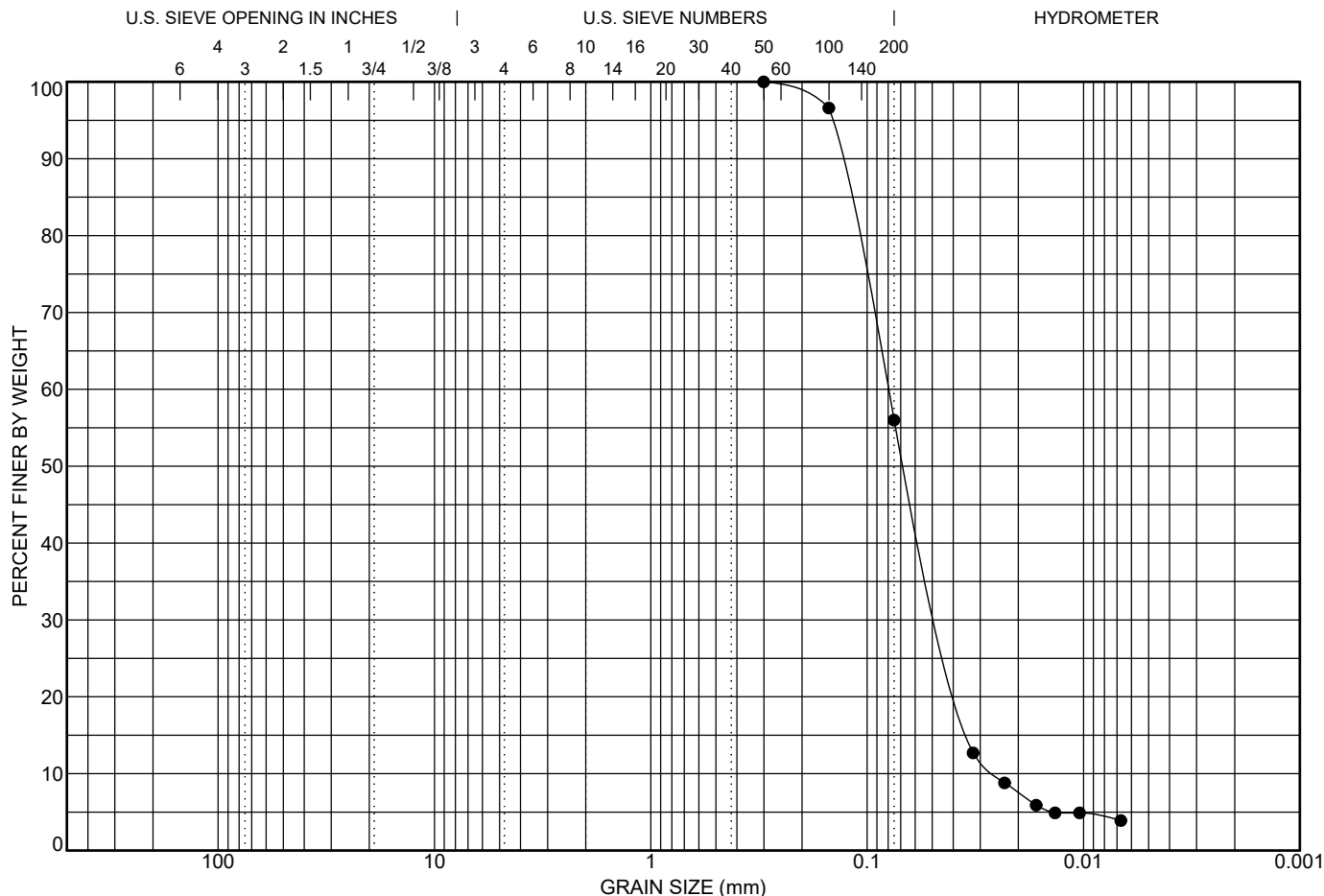
Sieve Size (mm)	Percent Passing	No Specifications



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 e-mail: info@cvdengineering.com

GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development
Location: 143 Columbia Street West, Waterloo, Ontario
File No.: G18620
Enclosure No.: 15



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

LL	PL	PI	Cc	Cu	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
			0.99	3.14	0.3	0.08	0.045	0.026	0.0	44.0	56.0	

Date: Sep. 05 - 2018
Client: PG Design Studio Inc.
Contractor:
Source:
Sampled From: BH 9 - SA 5, 4.57 m to 5.02 m depth
Sample No.: 9-5
Date Sampled: Jul. 31 - 2018
Sampled By: NZ
Lab No.: 3579
Date Tested: Sep. 04 - 2018
Type of Material: Sand and Silt

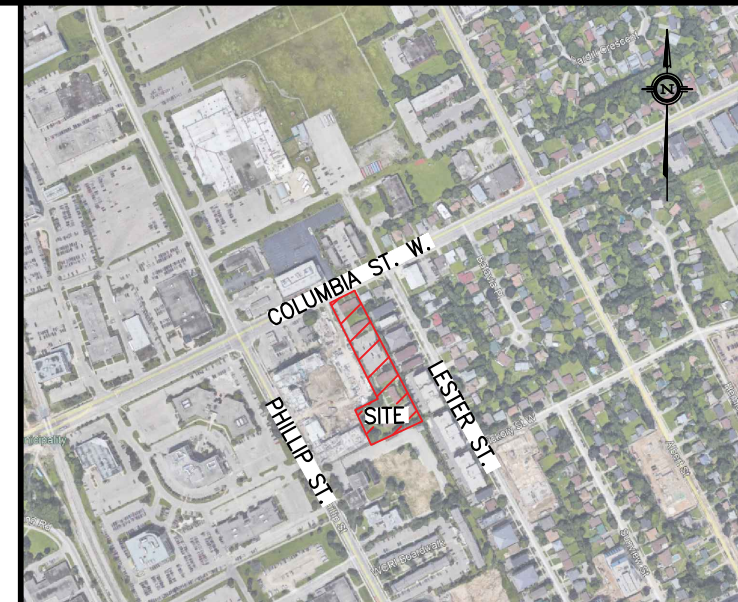
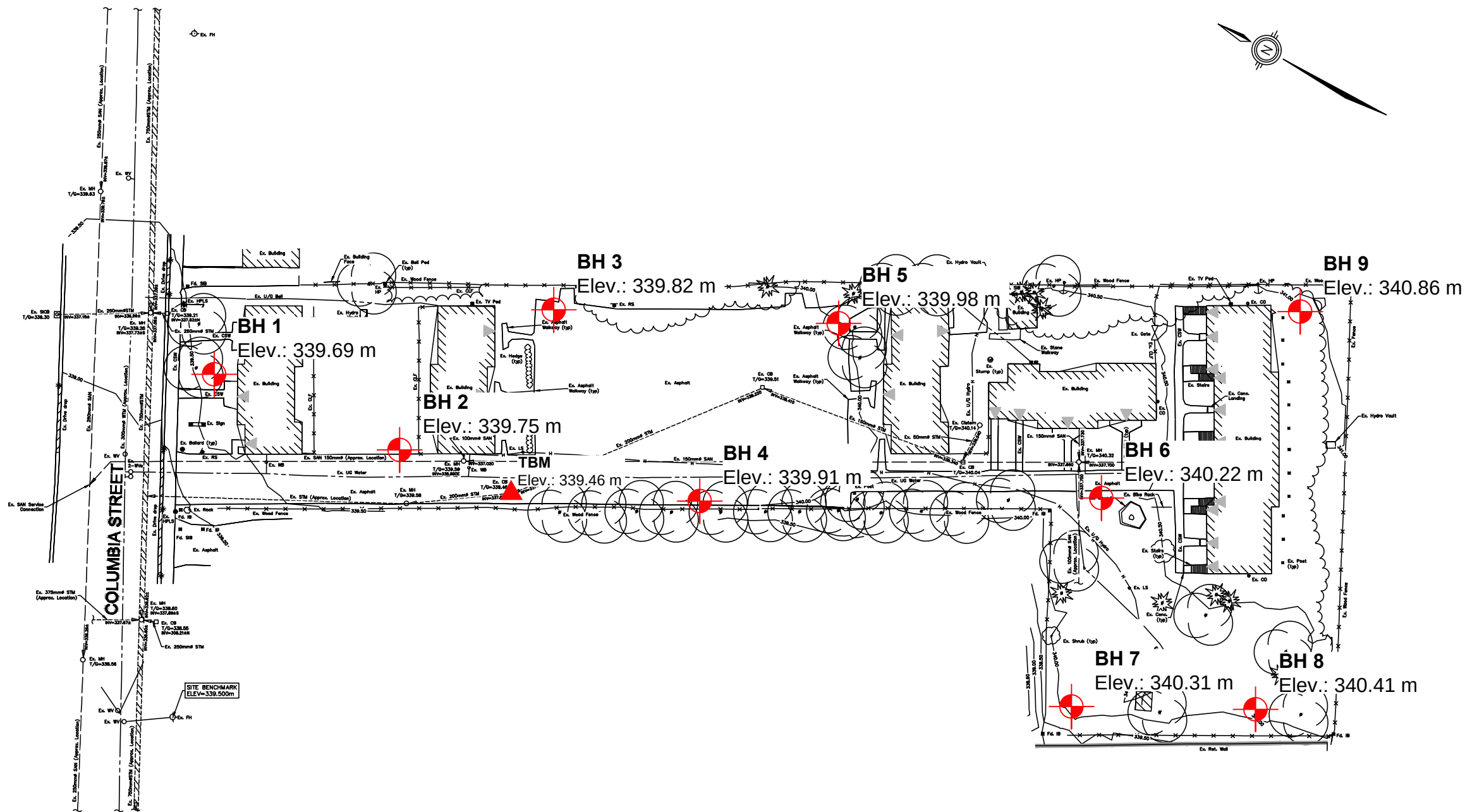
Sieve Size (mm)	Percent Passing	No Specifications



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GRAIN SIZE DISTRIBUTION

Project: Proposed Mixed-Use Development
Location: 143 Columbia Street West, Waterloo, Ontario
File No.: G18620
Enclosure No.: 16



KEY PLAN SOURCE: Google Earth

- LEGEND
- TBM: Top of catch basin located on the west side of driveway besides Unit B Elev.: 339.46 m (Geodetic)
 - Borehole Location

BOREHOLE LOCATION PLAN

Proposed Mixed-Use Development

143 Columbia Street West
Waterloo, Ontario



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Drawn By: NZ	Date: September 2018	File No.: G18620
Checked By: CS	Scale: NTS	Drawing No.: 1