



REPORT

**HYDROGEOLOGICAL SITE ASSESSMENT FOR
SEAGRAMS AND BISGOULD LANDS AND
STORMWATER MANAGEMENT PONDS
TOWNSHIP OF WOOLWICH, ONTARIO**

for

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Report 2

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Dear Mr. Collie

**Hydrogeological Site Assessment for
Seagrams and Bisgould Lands and
Stormwater Management Ponds
Township of Woolwich, Ontario**

We are pleased to present our Hydrogeological Site Assessment report for the proposed Seagrams and Bisgould Lands residential subdivision development. The work was authorized on August 26, 2010 by Mr. Stephen Collie, P.Eng., Project Manager of AECOM for Thomasfield Homes Limited.

The development will include a sewage pumping station, and two stormwater management ponds, an elementary school, greenways and parks, low and medium density residential dwellings, commercial blocks a future GO Transit station, an existing roadway widening and new roadway construction. The development will have full municipal servicing.

Included in this report are site background review, field work and laboratory results, summarized subsurface conditions, ground water control measures during construction and the assessment of potential impacts on the existing natural and man-made features, together with the illustrative tables, figures, drawings and back-up data in appendices.

Based on the findings presented in this report, Peto MacCallum Ltd. will recommend the completion and submission to the Ministry of the Environment (MOE) of an application for a Category 3 Permit-To-Take-Water (PTTW) in accordance with the MOE's Manual dated April 2005.

We trust you will find this report complete within our terms of reference. Should you have any questions or when we may be of service for in-construction inspection and review services, please do not hesitate to contact this office.

Sincerely

Peto MacCallum Ltd.



Marian S. Molodecki, P.Eng.
Senior Consultant,
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1. INTRODUCTION

Peto MacCallum Ltd. (PML) was retained by AECOM to carry out concurrently with the geotechnical investigation, a Hydrogeological Site Assessment (HSA) for the proposed Seagrams and Bisgould Lands residential subdivision development.

1.1 Site Location and Project Description

The subject site is located in the Township of Woolwich, Ontario and comprised two parcels of land referred to as the Seagrams Lands approximately 66.0 ha in area, which is located south of Victoria Street North, between Hopewell Creek and the existing Greenhouse Road (Township Road No.72); and the Bisgould Lands, east of Greenhouse Road, about 44.0 ha in area. The Seagrams site and is bounded on the south by the CNR on the north by Highway 7 / Victoria Street North, Greenhouse Road (Township Road 72) on the east and Hopewell Creek on the west. The Bisgould parcel extends east from Greenhouse Road a distance of about 840 m and is bounded on the south by Township Road 34. The total area of the development is about 110 ha (272.0 acres)

As shown on the Concept Plan dated May 7, 2010 prepared by GSP Group for the subject site, the proposed development will include residential and commercial blocks including greenways, a sewage pumping station and two stormwater management ponds (SWMPs). The proposed improvements will also include the reconstruction of the existing roadways as well as the construction of new internal roadways with drainage provisions.

It is understood that a future GO Transit station will be constructed immediately north of the existing Canadian National Railway (CNR), and an elementary school is planned on the southwest quadrant of the Victoria Street North and Greenhouse Road intersection.

A sewage pumping station (SPS) will be constructed west of the proposed mixed use dwellings and Street B. It is understood that the ground surface elevation in the vicinity of the proposed SPS is anticipated to be approximately 316.50. The construction of the SPS to the proposed elevation of 306.50 will require excavation to 10.0 m below the existing grades.



The two stormwater management ponds (SWMPs) will be constructed on the Seagrams Lands, north of the existing CN railway. Stormwater will be conveyed through the greenways to the proposed SWMPs. The planned design concept envisions that the bottom of SWMP1 in the southwest corner of the Seagrams Lands will be approximately 8.0 m below the existing grades, and will occupy 2.7 ha (about 6.7 acres) of land. SWMP2 in the southeast corner of the Seagrams Lands will occupy approximately 2.0 ha (about 4.9 acres) of land, and the bottom is expected to be at about 2.0 m below existing grades. Considering the average ground surface elevations of 321.80 and 320.91 in the vicinity of the proposed SWMP in the southwest and southeast corners of the Seagrams Lands, respectively, excavation to elevation 313.80 and 318.91 would be required in the southwest and southeast, respectively for the construction of the SWMPs in accordance with the planned design concept.

Various sanitary sewers will be installed along the planned access and internal streets to typical depths ranging from 4.0 m to 5.0 m (average depth of 4.3 m). Considering an average ground surface elevation of 322.88, trench excavation to an elevation of 318.58 is anticipated within the Seagrams parcel of the subdivision. Localized deep trench excavation will be required for the installation of sanitary sewers to depths between 10.0 m and 12.0 m along the proposed Street A, E and Q. Considering the average ground surface elevations of 323.07 along Street A; 322.39 on Street E and 322.33 on Street Q, installation of the proposed sanitary sewers along the above-mentioned street alignments will require excavations to elevations between 312.07 and 310.39.

A future GO Transit station will be constructed on a land approximately 5.9 ha (about 14.6 acres) in the vicinity of the existing CN tracks in the southeast corner, and an elementary school will be constructed on the northeast corner of the Seagrams Lands on approximately 2.4 ha (about 6.0 acres) of land. It is anticipated that footings of the respective structures will extend to about 1.20 m below the average grades of 322.60 in the southeast corner, and 323.35, at the location of the school.

1.2 Purpose and Scope of Work

A Hydrogeological Site Assessment (HSA) was required for the subject development to determine potential impacts of the construction dewatering on the surrounding natural and man-made features and water wells, and evaluate the ground water level control measures required during excavation and construction of the proposed developments below the groundwater levels. The



HSA focuses in particular on the groundwater control requirements during construction of the proposed structures, including the SPS and the SWMPs

In compliance with the current regulatory criteria, the work objectives were to:

- i) Obtain the appropriate site background information to support the hydrogeological investigation;
- ii) Conduct a site hydrogeological investigation including monitoring well installation, in-situ permeability testing and ground water sampling and testing, and
- iii) Prepare a report of factual data as well as recommendations on the design options for ground water control measures during development of the subject site.

Based on the geotechnical site investigation data concurrently compiled during the present HSA and other environmental assessments in the vicinity of the subject site, as well as the standard practice guidelines, the subject HSA involved the following tasks:

- Task 1: Conduct a site background/historical review of the site information, including geotechnical, hydrogeological and environmental reports and documents compiled to date on the subject site and vicinity.
- Task 2: Review the proposed development drawings to estimate the scope of earthwork operations.
- Task 3: Develop 7 boreholes with monitoring wells to be installed during geotechnical site investigation for ground water sampling and level monitoring, borehole permeability testing and soil sample collection and gradation analyses.
- Task 4: Conduct chemical analyses on representative groundwater samples for parameters/substances in the Regional Municipality of Waterloo storm sewer use by-law criteria and the Provincial Water Quality Objectives (PWQO).
- Task 5: Evaluate the site setting, background information, and field and laboratory data; prepare a hydrogeological site conceptual model and assess the potential impacts on the existing and functional water wells and natural and man-made features in the anticipated dewatering zone of influence, if any.



Task 6: Prepare an HSA report, including factual data, our interpretation of the site conditions and recommendations on the design options for ground water control measures during development of the subject site, potential impacts and the required remedial measures, if any.

1.3 Other Site Investigation Reports and Findings

The present HSA was carried out concurrently with a geotechnical site investigation (Report 1). Relevant Log of Borehole Sheets from the above-mentioned site investigation are attached to this report and were used in the assessment of groundwater control measures. The approximate locations of the boreholes are shown on Drawing 1.

Moreover, no sub-artesian water pressures were observed or purportedly existed in the boreholes or test pits during the geotechnical and hydrogeological site investigations. It is, therefore, anticipated that a near-surface unconfined aquifer underlies the subject site.

1.4 Relevant Regulatory Requirements

In-construction dewatering, like other water takings in Ontario, is governed by the Ontario Water Resources Act (OWRA) and the Water Taking and Transfer Regulation 387/04, a regulation under the OWRA.

The MOE's Permit-To-Take-Water is classified using a risk based approach since all water takings do not pose the same level of risk in terms of causing adverse environmental impact or interference. Separate classification criteria are provided for ground water and surface water takings.

In accordance with the above-noted regulatory requirements and in compliance with the MOE's policy and Permit-To-Take-Water Manual (April 2005), an application should be filed to the MOE for the subject project construction dewatering Permit-To-Take-Water, if the dewatering discharge is greater than 50,000 L/day or about 0.6 l/s.



In general, the applicable environmental quality standards depend on the site location, land use, and source of potable water at the investigation site. For the subject site, we selected the Regional Municipality of Waterloo By-Law 50-92 dated May 29, 1992 (Regulate and Control the Discharge of Waters and Wastes into Bodies of Water within the Regional Area or into the Regional Sanitary Trunk Sewers, Trunk Sewer System, or Sewage Treatment Works) for construction dewatering discharge quality management.

Moreover, for management of the excess soils generated during construction, the off-site disposal operations should be associated with the soils quality condition test results in accordance with the Ontario Regulation 153/04 Site Condition Standards based on a program of representative soil sample chemical analyses to be carried out at the time of construction.

Based on visual examination and particle size distribution analysis of the retrieved soil samples, the soils underlying the subject site are considered to be coarse textured with respect to the regulatory criteria.

Reference is made to the report of a geotechnical site investigation that was carried out concurrently with the present HSA, which addresses the excavated soil disposal options, and is submitted under a separate cover.

1.5 Site Sensitivity

To determine the site sensitivity, Section 41 of the Ontario Regulation 153/04 was evaluated as described in Table 2. Within 30 m of Hopewell Creek and its tributaries flowing from southeast to northwest across Bisgould Land to Seagrams Land, the subject site is located within an environmentally sensitive area under O. Reg. 153/04. Once the individual lots are severed, the properties that are beyond 30 m of the creeks would not be considered environmentally sensitive.

Therefore, for management of the excess soils during construction, the O.Reg153/04 site condition standards applicable to the subject site are Table 1 and Table 2 for sensitive and non-sensitive areas, respectively.



1.6 Rationale for Hydrogeological Site Assessment

In accordance with the subject assessment objectives and the proposed improvement features described above, the present HSA was conducted to assess the site hydrogeological conditions for construction of the proposed structures, and present the scientific study findings for supporting an application to be submitted to the MOE to obtain a PTTW.

In addition to a review of the site physiographic, geological and hydrogeological settings, water well records and previous site investigation reports, a program of monitoring well installation and borehole permeability testing was conducted to further characterize the water-bearing strata that may have to be dewatered during construction. The monitoring wells were concurrently installed during the geotechnical site investigation, and revisited after drilling to record the hydrostatic groundwater level and conduct borehole permeability testing.

Previous site investigations and the geotechnical investigation recently conducted for the subject site have indicated that no sub-artesian water pressures were observed or purportedly existed in the boreholes. It is, therefore, anticipated that a near-surface unconfined aquifer underlies the subject development site.

1.7 Site Physiographic, Geologic and Hydrogeologic Settings

The subject site is located within a general physiographic region known as the Waterloo Hills, which extend into the eastern part of the Regional Municipality of Waterloo. The Township of Woolwich is located in the extensive area of alluvial terraces and low-lying lands of the Grand River spillway system, adjoining the hilly region.

A review of the topographic maps indicated that the existing geodetic ground surface elevations range between approximately 320.0 in the vicinity of the Hopewell Creek, and rising to 332.0 m near an existing cemetery to the east of the site.



The hydrogeology of the subject site and vicinity is primarily controlled by the topography of the area and the water levels in the Hopewell Creek and its adjoining creeks. Shallow (perched) and regional (deep) groundwater bodies with somewhat different hydraulic conditions underlie the subject site. Based on the MOE water well records and the observation of the ground water levels in the monitoring wells, installed during the present geotechnical site investigation, the flow of groundwater within the Seagrams and Bisgould Lands is interpreted to be from southeast to northwest towards the Hopewell Creek, which drains from northeast to southwest into the Grand River.

The overburden soil underlying the subject site comprises localized topsoil / topsoil fill over fill materials underlain by sand and silt layers and, sand, silty or clayey soils deposits. The bedrock, is anticipated to be at about elevations ranging from 297.0 (about 25.0) in the north of Seagrams Lands to approximately 275.0 (about 47 m deep) south of Seagrams Lands. The bedrock, within the Bisgould Lands is anticipated to be at an average elevation of 284.0 (about 40.0 m deep). Within the subject site, the bedrock is composed of grey limestone with green shale interbreeding. No sufficient data on the bedrock groundwater setting was available.

2. FIELD WORK AND LABORATORY ANALYSES

Prior to commencing the field work, the site was cleared for underground utilities by a specialist contractor under the PML's supervision at the location and vicinity of the proposed boreholes BH1 to boreholes BH45. PML staked out the boreholes in the field as approximately shown on Drawing 1.

The borehole drilling, monitoring well installation, and soil sample collection for laboratory analyses were carried out between September 20 and October 04, 2010. In-situ borehole permeability testing and ground water sampling for laboratory analysis were carried out on October 22, 2010.

The above-noted field activities and laboratory analyses are further described in the following sections.



2.1 Borehole Drilling and Monitoring Well Installation

The boreholes were advanced using a track-mounted Diedrich-50 drill rig equipped with continuous flight hollow stem augers, owned and operated by a specialist-drilling contractor.

The field work for subsurface investigation, carried out under the full time supervision of an engineering staff from PML, consisted of drilling 45 geotechnical boreholes designated as Boreholes BH1 to BH45. Seven monitoring wells, consisting of 50 mm diameter, flush threaded, Schedule 40 clean PVC pipes with screen (10 slot), coupled with the PVC riser pipes were installed in Boreholes BH2 (MW2), BH7 (MW7), BH11 (MW11), BH24 (MW24), BH35 (MW35), BH40 (MW40) and borehole BH43 (MW43). The annular space of the borehole around the monitoring well screens was backfilled with clean filter sand (up to 0.6 m above the top of the well screen). Details of the monitoring well installation are shown on the appended Log of Borehole sheets.

The boreholes were advanced to depths ranging from about 6.2 m to 14.6 m below the existing grades. Soil samples were recovered by the standard penetration test (SPT) method and the number of blows required to advance the soil sampler 300 mm was recorded as the SPT N value.

Representative samples of the overburden were recovered at regular depth intervals in the boreholes using conventional split spoon sampler. Samples obtained from the boreholes were immediately placed in glass jars and plastic bags. Observations of visible foreign materials and odours were recorded during the sampling operations. The soil samples collected during this investigation were brought to PML laboratories for detailed visual examination before selecting for testing.

The open boreholes were inspected for free-standing water level upon completion of drilling and sampling.



2.2 Ground Water Sampling and Borehole Permeability Testing

In-situ permeability testing, to estimate the hydraulic conductivity of the overburden deposits, was conducted on October 22, 2010 in Monitoring Wells MW2 located in the area of the proposed sewage pumping station; and in MW7 and MW24 located in the areas of the proposed SWMPs in the southwest and southeast corners of Seagrams Lands, respectively.

Borehole permeability test was conducted by using rising head method, in which periodic water level measurements (using an electronic data recorder or transducer) were recorded as the water level recovered inside the monitoring wells through perforated (screened) part of the well casing.

After purging each monitoring well, the rising head data was recorded at intervals of 10 seconds until the water level returned to the equilibrium condition or until a steady state was attained. After completion of the borehole permeability test, the data was plotted on a semi-logarithmic scale to estimate the basic time lag T_0 that was used to calculate the hydraulic conductivity. The plots of normalized head versus elapsed time and the estimation of the basic time lags are included in Appendix A.

A groundwater sample was also collected from MW2 on October 22, 2010 after well development, which consisted of removing an equivalent of about 10 times the well volume, for chemical analyses and assessment of groundwater quality control measures during in-construction dewatering discharge.

The groundwater sample was delivered to AGAT Laboratories (AGAT). The Canadian Association for Laboratory Accreditation Inc. (CALA) accredits AGAT.

The groundwater sample was analyzed for the parameters listed under the Regional Municipality of Waterloo By-Law 50-92, and for selected parameters listed in the MOE's Provincial Water Quality Objectives (PWQO), Table 2 dated February 1999, for possible construction dewatering water discharge into the existing Hopewell Creek via its tributaries within the subject site and vicinity.

No surface water samples was retrieved and analyzed for baseline water quality of the existing tributaries of Hopewell Creek.



The Chain-of-Custody Record and the laboratory certificates of analysis are included in Appendix B.

2.2.1 Soil Particle Size Distribution Analyses

Representative soil samples obtained from Boreholes 5, 7, 8, 9, 11, 27 and 45 were submitted to PML laboratories for particle size distribution analyses. The particle size distribution curves of the soil samples analyzed are shown as Figures 2 and 8

3. SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Log of Borehole Sheets, tables, figures, drawings and Appendices A, B and C for the field work details and laboratory data compiled. The findings and interpretation of the site subsurface conditions are presented in zones of potential dewatering needs, which include the following major zones of the proposed site improvements:

- **Zone 1:** Sewage pumping station and associated drainage facilities,
- **Zone 2:** Sanitary sewers in the low and medium density apartments and mixed use residential/commercial areas
- **Zone 3:** Stormwater management ponds SWMP1 and SWMP2 and drainage facilities.

3.1 Soil Stratigraphy and Gradation

As described on the Log of Borehole Sheets from the geotechnical site investigation, the soil stratigraphy in the subject site comprised primarily a surficial pavement structure or topsoil, over fill materials underlain by variable till deposits as described below:

Zone 1 - Sewage Pumping Station (SPS)

For construction of the proposed SPS, including the associated drainage utilities to a depth of 6.0 m below the existing grades, Boreholes 3, 10, 11, 19 and 20 were used for characterization of the subsurface. The soil stratigraphy in the vicinity of the proposed SPS comprised topsoil over silt or sand till deposits as described below:



Top Soil

Dark brown sandy silt to clayey silt topsoil layer about 230 to 250 mm thick was encountered in boreholes 10 and 19. The average thickness was about 240 mm.

Fill

The fill material encountered in Borehole 11 comprised grey crushed fine to coarse gravelly sand, trace silt, about 0.3 m thick below the ground surface. The fill material was typically moist with the moisture content of about 18%.

Sandy Silt

A brown fine sandy silt deposit with trace to some gravel, and trace clay seams was encountered underlying the top soil layer in borehole 10 and 20, and extended to depths varying from 1.4 m (elevation: 322.26) in boreholes BH10 to 4.0 m (elevation: 319.30) in boreholes BH20. The sandy silt layer ranged in thickness from 1.20 m in borehole 10 to 3.75 m in borehole 20. The sandy silt deposit was moist (with moisture content varying with depth from 9 to 11%) and compact to very dense with blow counts, N-values per 300 mm, ranging from 11 to 50 per 0.15 m. Borehole 11 was terminated in a basal sandy silt layer, which was encountered at 7.40 m (elevation: 314.99).

Upper Silt and Sand Till

A brown silt and sand till deposit with trace gravel or clay seams was encountered below ground surface in boreholes BH3 or underlying the sandy silt layer in boreholes BH10 or the top soil in boreholes BH19. The till deposit extended to depths of 1.10 m (elevation: 318.30) in Boreholes BH3, 1.70 m (elevation: 321.96) in Boreholes BH 10 and 4.0 m (elevation: 319.35) in Borehole BH19. The till deposit was moist (with moisture content varying with depth from 4 to 9%) and loose to dense with typical blow counts, N-values per 300 mm, ranging from 15 to 44.



Clayey silt till

A brown firm to very stiff, about 2.5 to 4.9 m thick clayey silt till deposit with trace to some sand was encountered at depths ranging from 1.4 m in boreholes BH3 to 2.50 m in Borehole BH11. The till deposit extended to depths of 3.9 m (elevation: 315.24) in Boreholes BH3 to 7.4 m (elevation: 314.99) in Borehole BH11. The till deposit was moist (with moisture content varying with depth from 8 to 14%), and typical blow counts, N-values per 300 mm, ranged from 8 to 91 per 0.25 m. The clayey silt till was, typically, very stiff.

Basal Silt and Sand Till

Boreholes 3 and 10 were terminated in grey silt and sand till layer with trace gravel or clay seams. The till deposit was moist (with moisture content varying with depth from 8 to 10%), and very dense with blow counts, N-values per 300 mm, typically ranging from over 50 to 95 per 0.15 m to 0.3 m.

Groundwater Conditions

The groundwater level first encountered (groundwater strike) in the boreholes or interpreted during drilling from moisture in the soil samples retrieved and borehole cave-ins in Boreholes 3, 10, 11, 19 and 20 varied from 1.5 m (elevation: 317.64) in Borehole BH3 to about 2.7 m (elevation: 320.60) in Borehole BH20 with an average value of 2.0 m (average elevation: 320.37) below grades.

The hydrostatic groundwater level readings on October 22, 2010 in the monitoring wells installed in Borehole BH2 (MW2) and BH11 (MW11) indicated groundwater at depths of 1.20 m (elevation: 313.24) and 4.47 m (elevation: 317.92), respectively below the existing grades. The average hydrostatic ground water level in the area is anticipated to be at about 2.84 m (elevation: 319.53) below the existing grades.



Zone 2: Sanitary Sewers within the Subdivision

For the installation of various sanitary sewers and drainage facilities within the proposed subdivision on the Seagrams lands, Boreholes 3, 4, 10, 11, 12, 13, 19, 20, 21 and 22 were used to assess the stratigraphy. The soil stratigraphy in the area and vicinity of the proposed subdivision comprised top soil or fill over silt or sand deposits as described below:

Top Soil

Dark brown sandy silt to clayey silt topsoil layer about 50 to 300 mm thick was encountered in Boreholes 10, 12, 13, and boreholes 19 to 22. The average thickness was about 210 mm.

Fill

The fill material encountered in boreholes 4 and 11 comprised grey or brown crushed fine to coarse gravelly sand or silt and sand of about 0.3 m thick in Boreholes BH11 and 2.1 m thick below the ground surface in boreholes BH4. The fill material was typically moist with the moisture content of about 8 to 9%.

Silt and Sand Till

A brown sand and silt till or sand till deposit with trace to some gravel and trace clay seams was encountered below the ground surface in boreholes BH3 or underlying the top soil layers in Boreholes 10, 11 and 12. The till deposit was encountered underlying the fill material in Boreholes BH4, and extended to depths varying from 1.4 m in boreholes BH3 to about 7.0 m in Borehole BH12 at an average depth of 3.1 m (elevation: 318.85) below the existing grades.

The deposit was moist to saturated (with moisture contents varying with depth from 9 to 17%) and typically compact to very dense with blow counts, N-values per 300 mm, ranging from 9 to 85. Boreholes 3, 4, 10 and 12 were terminated in basal sand or sand and silt layers, encountered at depths varying between 6.0 m in boreholes BH3 to 11.6 m in Borehole BH12.



Clayey silt till

Brown to grey and firm to hard clayey silt till or clay till deposits with trace to some sand, trace to some gravel were encountered in Boreholes 3, 4, 11, 12, 13 and 21 at depths ranging from 1.4 m in Boreholes BH3 to 11.4 m in Borehole BH13. The thicknesses of the till deposits ranged from about 1.3 m in Borehole BH4 to 4.9 m in Borehole BH11. Borehole 13 was terminated in the clay till deposit. The units were low to medium plastic with moisture content varying with depths from 8 to 21%. Typical blow counts, N-values per 300 mm, ranged from 8 to 80.

Sandy Silt Till

Borehole 11 and Boreholes 20 to 22 were terminated in silt till or sandy soil deposits. These units were contacted at depths ranging from 7.40 m in Boreholes BH11 to 9.5 m in Borehole BH22. The deposits were moist to wet (with moisture contents varying with depths from 8 to 20%) and typically very dense with blow counts, N-values per 300 mm, ranging from about 50 per 0.05 m to 80 per 0.30 m.

Groundwater Conditions

The groundwater level first encountered (groundwater strike) in the boreholes or interpreted during drilling from moisture in the soil samples retrieved and borehole cave-ins in Boreholes 3, 4, 10, 11, 12, 13, 19, 20, 21 and 22 varied from 1.5 m in Borehole BH3 to about 2.9 m in Borehole BH20 with an average value of 2.22 m (average elevation: 320.07).

The hydrostatic groundwater level measured on October 22, 2010 in the monitoring well installed in Borehole BH11 indicated 4.47 m (elevation: 317.92) below the existing grades. The average hydrostatic ground water level in the area is anticipated to be at about 2.84 m (elevation: 319.53) below the existing grades.

Zone 3: Stormwater Management Ponds (SWMPs)

For the construction of the proposed stormwater management ponds, Borehole 7 located in the vicinity of the SWMP in the southwest corner and Borehole 24, located in the southeast corner of



the Seagrams Lands were used to assess the stratigraphy that will be exposed in the respective excavations. The soil stratigraphy in the vicinity of the proposed SWMPs comprised top soil or fill over clayey silt or layered silt deposits underlain by silty or sandy soils as described below:

Topsoil

A 300 mm thick dark brown sandy topsoil layer with relatively high organics content was encountered in Borehole 24. There was no topsoil in Borehole 7.

Fill

The fill material encountered in the Borehole 7 below the existing ground comprised brown, fine to coarse sand and gravel, trace silt, which a thickness of 1.40 m and extended to 2.1 m (elevation: 319.70) below grades. The fill material was moist with the moisture content varying with depth from 5% to 9%.

Silt and Sand

A brown with black organics layered silt and sand unit of about 1.10 m in thickness was encountered underlying the top soil in Borehole BH24 at 0.3 m below grades. The unit was underlain by coarse sand and gravel layer, which extended to 2.1 m (elevation: 318.81) depth. The sand and silt or sand and gravel unit was typical moist with a moisture content of 9%, and loose to compact with blow count values ranging from 4 to 29.

Clayey silt till

A grey, very stiff to hard, about 1.9 m thick in Borehole BH7 and 2.9 m thick in Borehole BH24 was encountered underlying the fill layer in Borehole BH7 or the sand and gravel layer in borehole BH24. The deposit extended to about 4.0 m (elevation: 317.80) in Borehole BH7 and 5.0 m (elevation: 315.91) below the existing grades in Borehole BH24. The clayey till was moist with a typical moisture content of about 10%.

Groundwater Conditions

3.2 Estimated Hydraulic Conductivity

$$K = \frac{r^2}{2LT_0} \ln\left(\frac{L}{R}\right)$$

where

- K = hydraulic conductivity (cm/s)
- L = the length of the screen: 150 cm for BH24 or 300 cm for BH2 and BH7
- R = the radius of the borehole: 7.62 cm
- r = the radius of the well casing: 2.54 cm
- T_0 = the basic time lag in seconds (time at 37% recovery, see Appendix A).



Moreover, the hydraulic conductivity of soil samples taken from Boreholes BH5, BH8, BH9, BH11 and BH27 was estimated using the particle size distribution test results and the Hazen equation for sandy soils (Geotechnical engineering: Principles and practice, D.P. Coduto, Prentice-Hall Inc., 1999).

$$K = C(D_{10}^2) \text{ in cm/s}$$

where D_{10} = Effective grain size in cm (Figures 2 to 8) and

$C = 100$ for sandy soils (a parameter related to grain-size uniformity)

The hydraulic conductivity k-value of the soil samples containing substantial clay particles (in excess of 10%) was estimated using the following expression (Puckett's Method, "Ground Water and Vadose Zone Monitoring", ASTM, STP1053, 1990) in which the percentage of clay was taken from the particle size distribution charts.

$$K = 4.36 \times 10^{-5} \times e^{(-0.1975 \times \% \text{ clay})}$$

where

K = hydraulic conductivity (cm/s)

%clay = percentage of the total soil sample finer than 0.002 mm by weight
(Figures 2 to 8)

The results of borehole permeability tests carried out in three monitoring wells (BH2, BH7 and BH24) and the estimated hydraulic conductivity K-values from particle size distribution test results are listed on Table 4.

The estimated and factored hydraulic conductivity K-values for each major soil type that will be exposed in the excavation trenches at the founding depths of the proposed infrastructures in the above-noted three major development zones are listed below.



CONSTRUCTION ZONES	SOIL TYPE	ESTIMATED AVERAGE K-VALUE (cm/s)	FACTORED AVERAGE K-VALUE (cm/s)
Zone 1 SPS location and vicinity	Sand and silt/sandy soils with clay seams	28.0×10^{-5}	1.0×10^{-3}
Zone 2 Sanitary sewers	Sandy silt/clayey silt	13.0×10^{-5}	4.0×10^{-4}
Zone 3 SWMPs	Sand and silt/silty soils @ SWMP1 location	13.0×10^{-5}	4.0×10^{-4}
	Sand and gravel/sandy soils @ SWMP2 location	225×10^{-5}	7.0×10^{-3}

3.3 Water Sample Chemical Test Results

The laboratory certificates of chemical analyses carried out by AGAT on a groundwater sample from Monitoring Well MW2 in accordance with the chain-of-custody record and the protocol described above (Section 2.2) are included in Appendix B.

Based on the chemical test results, the quality of the groundwater sample complied with the Regional Municipality of Waterloo storm sewer use by-law criteria with the exception of the total suspended solids (TSS).

The measured concentration of total suspended solids (TSS) in MW2 was 37 mg/L which exceeded the Regional Municipality of Waterloo discharges to storm sewers by-law value of 15 mg/L.

Furthermore, the groundwater sample test results were compared with the provincial water quality objectives (PWQO). The concentrations of the total nickel (0.003 mg/L) and total zinc (0.297 mg/L) exceeded the PWQO values of 0.025 mg/L and 0.03 mg/L for total nickel and total zinc, respectively.



4. CONSTRUCTION DEWATERING REQUIREMENTS AND POTENTIAL IMPACTS

The potential construction dewatering requirements and its potential impacts on the surrounding environment depend on the proposed development features to be constructed and the site and surrounding hydrogeological conditions such as existing ground water level and flow regime, drawdown levels required and the groundwater discharge rates needed to achieve the required drawdown levels for maintaining dry working conditions and stable excavation bottom and slopes.

The construction dewatering requirements of the proposed three development zones of the potential impacts are described in the following section.

4.1 Construction Dewatering Requirements

In-construction dewatering like other water takings in Ontario is governed by the Ontario Water Resources Act and the Water Taking and Transfer Regulation 387/04 (a regulation under the Ontario Water Resources Act).

In accordance with the above-noted regulatory requirements and in compliance with the MOE's Permit-To-Take-Water Manual (April 2005), an application should be filed with the MOE for the subject project construction dewatering Permit-To-Take-Water, where the construction dewatering discharge will be greater than 50,000 L/day.

It is understood that the complete design, including plan views, profiles and the proposed utilities/structures invert elevations will be provided in the future for our assessment of the detailed dewatering flow rates analysis. Based on a the evaluation of the available geotechnical site investigation data compiled and a preliminary assessment of required earthwork and utilities placement activities as listed on Table 5, the excess ground water required to be discharged during construction was estimated for the respective zones of the proposed site improvements using typical calculations and taking into consideration the following.



Zone 1: Sewage Pumping Station (SPS)

- i) The SPS is assumed to be approximately 5.0 m x 5.0 m in size with the maximum depth to the excavation bottom at about 10.0 m below the existing grade, which is anticipated to be at elevation 316.50,
- ii) The ground water level is to be lowered about 1.0 m below the excavation bottom to maintain dry working conditions,
- iii) The water-bearing soils underlying at the subject SPS location that will be exposed in the excavated trenches, are primarily compact to dense (typically, compact) brown sand and silt with a factored hydraulic conductivity K-value at about 1.0×10^{-3} cm/s,
- iv) The estimated zone of influence to achieve the required drawdown of 7.84 m during trench excavation is expected to be about 74.0 m on each side of the excavation, and
- v) The ground water discharge rate is estimated to be approximately 14,700 L/day. It is anticipated that dewatering by wellpoints system, installed in the near-surface aquifer, will be required to achieve the required drawdown.

Zone 2: Sanitary Sewers and Associated Drainage Facilities

- vi) The sanitary sewers to be installed throughout the subdivision are to be 400 mm in diameter. The average depth to the excavation trench bottom is to be about 4.3 m throughout the subdivision, excluding construction along Street A, E and Q, which will require relatively deep excavation trench to depths ranging from 11 m to 12 m below existing grades,
- vii) The ground water level is to be lowered about 1.0 m below the lowest trench bottom to maintain dry working conditions,
- viii) The water-bearing soils underlying the various sanitary alignments that will be exposed in the excavated trenches, are primarily loose to compact brown sandy silt with a factored hydraulic conductivity K-value estimated at about 4.0×10^{-3} cm/s,
- ix) The estimated zone of influence to achieve the required drawdowns during trench excavation is expected to be approximately between 12.0 m and 74.0 m, and



- x) The ground water lowering will be in the range of about 1.95 m in average for a dewatering discharge rate of 898,000 L/day during shallow trench excavation throughout the subdivision, excluding sewer installation along the proposed Street A, E and Q.
- xi) Additional ground water lowering in the range of 8.46 m along Street A; 10.14 m along Street E and about 9.67 m along Street Q will be required to maintain dry working conditions in the trenches. The ground water discharge rate is expected to be about 2,15M L/day and can be achieved with a wellpoint system installed in the near-surface aquifer.

Zone 3: Stormwater Management Ponds (SWMP1 and SWMP2)

During construction of the SWMPs, ground water control measures such as pumping to lower the ground water level to maintain dry conditions and stability of the base and side slopes of relatively large excavations will be required. Dewatering methods, including the use of deep wells system with submersible pumps may be required due to the shallow water table (particularly, in the area of SWMP2) and anticipated high rates of dewatering.

The flow rates and the number of wells required may be calculated using the following multiple wells equation in which the flow rate (nq) may be handled by a combination of deep wells and wellpoints as follows:

$$H^2 - h^2 = \frac{nq}{\pi k} \ln \left(\frac{R_0}{r_e} \right)$$

where

- n = the number of wells (deep well and wellpoints)
- q = flow rate per well in m³/sec
- r_e = effective radius of dewatering in m
- H = the total hydrostatic head of the unconfined aquifer in m
- h = the total hydrostatic head of the dewatered unconfined aquifer in m
- R₀ = the radius of influence in m ($= 3000(H - h)\sqrt{k}$)
- K = hydraulic conductivity in m/s



The approximate calculations for determining the dewatering discharge rate are also included in Appendix C.

Based on the MOE's old well data available for the site and vicinity, the bedrock elevation is estimated to be at elevation 275.02 in the area and vicinity of the SWMPs.

For the construction of the proposed SWMPs, the following assumptions were made on the construction dewatering requirements:

- i) The maximum depth of the excavation is to be 8.0 m for SWMP1 and about 2.0 m for SWMP2 below existing grades,
- ii) The groundwater level is to be lowered about 1.0 m below the respective ponds excavation bottom to maintain dry working conditions,
- iii) The water-bearing soils underlying the proposed pond area that will be exposed in the excavation, are primarily dense grey sand and silt for SWMP1 and sand and gravel in the area of SWMP2 with a factored hydraulic conductivity K-value estimated at about 7.0×10^{-3} cm/s,
- iv) The estimated dewatering zone of influence (DZOI) to achieve the required drawdown is estimated to be in the range of about 133.0 m for SWMP1 and about 142.0 m for SWMP2,
- v) The ground lowering will be in the range of about 4.30 m and 2.48 m for SWMP1 and SWMP2, respectively. The dewatering discharge rates are estimated to be 30 to 83 L/sec (exceeding the regulatory 0.6 L/sec) and will require a combination of deep wells and wellpoints system installed in the near-surface aquifer with the estimated maximum daily construction dewatering discharge rates ranging from 2.6×10^6 L/day in the area of SWMP1 to about 7.0×10^6 L/day for SWMP2 where shallow ground water table was encountered.



4.2 Construction Dewatering Potential Impacts

The following potential impacts were postulated as the result of ground water level lowering during excavation/trenching, foundation construction, pipe bedding placement, and backfilling activities for the proposed site improvements:

- i) Ground water level lowering in the existing (functional) water wells,
- ii) Reduction of baseflow in the creeks adjacent to the subject site,
- iii) Trench bottom and slopes instability due to uplift and seepage of ground water in the excavation,
- iv) Induced movement of contaminant plume, if any,
- v) Ground subsidence in the adjacent buildings.

The excavation bottoms and side slopes stability and seepage control during construction can be maintained by groundwater level lowering, box trenching and steel plates when the groundwater levels are lowered about 1.0 m below the utilities lowest invert elevations in the respective dewatering zones.

There are tributaries of Hopewell Creek on the west side of the Seagrams Lands and throughout of the Bisgould Lands, east of the existing Township Road No.72. In-construction dewatering discharges are anticipated to be directed to the adjacent Hopewell Creek or its tributaries within the subject site, with quality and quantity control and pre-discharge groundwater sampling, chemical analyses and treatment measures, if required.

The construction dewatering quality and quantity control measure will primarily consist of decanting the suspended solids by a detention pond and filtration and a monitoring program described in Section 5.2 below.



As the anticipated daily rate of total construction dewatering for the subject improvements is to be significantly high (Table 5), the construction dewatering is to be discharged to the existing Hopewell Creek via its on-site and vicinity tributaries under a Best Management Practice (BMP), which should include sediment and erosion control measures as well as the suspended solids removal by a decanting pond/tank or filtration and a water quantity and quality control monitoring program.

Furthermore, an updated survey of the existing and functional water wells should be carried out in the vicinity of the subject site for water wells that may be impacted during construction dewatering.

As the construction dewatering is expected to be discharged into the creeks, the impact on the creeks baseflow is anticipated to be significant and should be monitored.

5. CONCLUDING REMARKS AND RECOMMENDATIONS

Based on our understanding of the proposed development features and our assumptions pertaining to the dimensions of the sanitary sewers and the SPS, as well as the site settings, subsurface conditions, results of field work, laboratory analyses and the pertinent applicable regulatory requirements, the hydrogeological site assessment salient points and our recommendations in relation to the construction dewatering needs are outlined in the following paragraphs.

5.1 PTTW Application and Supporting HSA Report

Based on the site hydrogeological compiled data and the estimated excess groundwater required to be discharged during construction, an application for Permit-To-Take-Water is to be completed in accordance with the MOE's Permit-To-Take-Water Manual, dated April 2005 and submitted to the MOE together with the payment of application fees. The dewatering (more than 50,000 l/day) at the subject site should not commence the PTTW is obtained.

It is important to note that this draft report is to be completed and finalized based on the design drawings of the proposed improvements to be provided for our review. The completed and finalized HSA report will establish the back-up document for the PTTW application preparation and its processing at the MOE.



Based on the construction dewatering needs of the subject development, the PTTW will fall into Category 3 of the MOE's Manual and source of water taking is the ground water in the near-surface unconfirmed aquifer in the urban setting characterized in this report will be the same for all dewatering wellpoints.

The construction dewatering operations should be associated with sediment and erosion control measures during construction if the pumped groundwater is to be directed to the existing watercourses.

5.2 Ground Water Level and Quality Monitoring Program

The anticipated construction dewatering monitoring program features are outlined below:

- i) The Contractor on behalf of The City (Permit Holder) is to maintain a record of all water takings. This record will include the dates and duration of water takings, and the total measured volume of water pumped per day for each day that water is taken under the Permit. The Contractor is to maintain a separate record for each source and each zone of construction as characterized in this report. The Permit Holder will keep all required records up to date and available at or near the site of the water taking and will produce the records immediately for inspection by a Provincial Officer upon his or her request.
- ii) The total water volume pumped will be measured using a flow measuring device, and the records are to be reported to the MOE through the water taking reporting system (WTRS) in accordance with the Ontario Regulation 450/07.
- iii) The Permit Holder's consultant will monitor bi-weekly the water levels in the existing and functional monitoring wells within the subject street alignment limits during dewatering work to assess the potential impacts of the dewatering activities, if any.
- iv) The Permit Holder's consultant will collect water samples from the wellpoint system discharge pipes or in the decantation tank and from the existing and functional monitoring wells, including BH11 (MW11) and BH24 (MW24), during dewatering within the Seagrams Lands; and BH35 (MW35) within the Bisgould Lands on a monthly basis during dewatering. The water samples are to be analyzed for selected parameters and substances (based on the baseline chemical analyses of water sample collected in the creeks) under the Provincial Water Quality Objectives as the dewatering discharge is likely to be directed to the existing creeks.



- v) Any application submitted to the MOE for renewal or technical amendment of the Permit will be accompanied by all records required by the conditions of the Permit. The records will be interpreted by a qualified person and submitted in the form of a report.

The above-noted monitoring provisions should be finalized based on the conditions of the PTTW to be issued by the MOE for the subject project.

5.3 Construction Dewatering Activities

It is important to note that the design and installation of a construction dewatering system is usually the responsibility of the construction contractor. The contractor should verify the information presented in this report. This may be done by examining the hydrogeologic conditions in a test pit (and a full-range pumping test by the dewatering subcontractor).

Single or double stage wellpoints and/or deep well system may be designed and installed by the contractor along the excavation trench for temporary ground water level lowering during trench bedding, pipe laying and backfilling activities. The contractor should be aware that the purpose of the dewatering system is to maintain stable slopes and dry working conditions. Short step pumping tests are recommended in order to confirm the aquifer conditions and the efficiency of each well.

The extent and details of the dewatering scheme (well size, spacing, pump level, screen size and wick gradation) are left solely to the contractor's discretion to achieve the performance objectives for stable slopes and dry working conditions and will be based on his/her own analysis/interpretation of site conditions, equipment, experience and plant efficiency. The contractor should also appreciate that additional dewatering means and modifications such as additional row of dewatering wells to the initially installed systems may be required as variations in site conditions are encountered.



The construction dewatering plan that should be prepared by the contractor prior to commencement of the construction and the construction dewatering activities as well as abandoning of the wells after the completion of construction should be reviewed and inspected by PML's technical staff to verify appropriate implementation of our recommendations presented in this report and adequate lowering of the ground water during construction in conjunction with our in-construction geotechnical inspection and testing services.

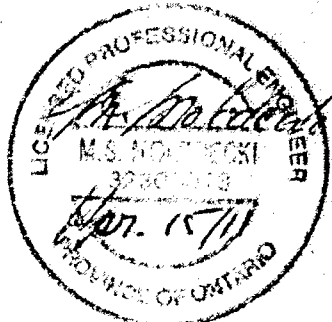
All monitoring wells (MWs) and dewatering wells should be abandoned in accordance with the Ontario Regulation 903, amended to O.Reg.128/03.

Sincerely

Peto MacCallum Ltd.

A handwritten signature in black ink, appearing to read "Dave H. Azo", is positioned above the name.

Dave H. Azo, PhD, E.I.T.
Project Supervisor



Marian S. Molodecki, P.Eng.
Senior Consultant,
Geotechnical and Geoenvironmental Services

DA/MHM:da-mm



TABLE 1
LIST OF REPORTS AND REFERENCES REVIEWED

ITEM	TITLE	SOURCE	DATE
1	The Physiography of Southern Ontario, Third edition	Ontario Ministry of Natural Resources L.J. Chapman and D.F. Putnam	1984
2	Certificate of Approval-Sewage-Number 3-0274-94-956 Seagram Sludge Ponds-Breslau	Ministry of Environment and Energy	January 18, 1995
3	Hydrogeological Technical Information Requirements for Land Development Applications	Ontario Ministry of Environment and Energy	April 1995



TABLE 2
SITE SENSITIVITY ANALYSIS
SITE CONDITION STANDARDS, ENVIRONMENTALLY SENSITIVE AREAS
SECTION 41, ONTARIO REGULATION 153/04

Criteria	Decision for the Subject Site
Section 41. (1) This section applies in relation to a property if,	
(a) the property is within an area of natural significance, or includes or is adjacent to such an area or part of such an area,	No
(b) the soil at the property has a pH values as follows: (i) for surface soil, less than 5 or greater than 9. (ii) for subsurface soil, less than 5 or greater than 11.	No
(c) the property is a shallow soil property.	No
(d) the property includes or is adjacent to a water body or includes land that is within 30 m of a water body; or	yes
(e) a certified person is of the opinion that, given the characteristics of the property and the certifications the qualified person would be required to make in a record of site condition in relation to the property as specified in schedule A, it is appropriate to apply this section to the property.	No

In Section (1) (a) above, "area of natural significance" means any of the following:

1. A provincial park designated by a regulation under the *Provincial Parks Act*.
2. A conservation reserve established under the *Public Lands Act*.
3. An area of natural and scientific interest (life science) identified by the Ministry of Natural Resources as having provincial significance.
4. A wetland identified by the Ministry of Natural Resources as having provincial significance.
5. A area designated by a municipality in its official plan as environmentally significant, however expressed, including designations of areas as environmentally sensitive, as being, as being of environmental concern and as being ecologically significant.
6. An area designated as an escarpment natural area of an escarpment protection area by the Niagara Escarpment Plan under the *Niagara Escarpment Planning and Development Act*.
7. A habitat of endangered or threatened species identified by the Ministry of Natural Resources.
8. Property within an area designated as a natural core area or natural linkage area within the area to which the Oak Ridges Moraine Conservation Plan under the *Oak Ridges Moraine Conservation Act, 2001*.

Therefore: the site is **considered sensitive** under O. Reg. 153/04



TABLE 3
GROUND WATER LEVEL READINGS

MONITORING WELL (MW) No. ⁽¹⁾	GROUND SURFACE ELEVATION ⁽²⁾ (m)	GROUND WATER STRIKE ELEVATION ⁽³⁾ (DEPTH, m)	HYDROSTATIC GROUND WATER LEVEL ELEVATION (DEPTH TO GROUND WATER LEVEL, m)		
			Date: October 15, 2010	Date: October 22, 2010	Date: November 03, 2010
MW2	314.44	313.04 (1.40)	313.00 (1.44)	313.24 (1.20)	313.76 (0.68)
MW7	321.80	320.40 (1.40)	316.80 (5.00)	317.11 (4.69)	-
MW11	322.39	321.59 (0.80)	317.20 (5.19)	317.92 (4.47)	-
MW24	320.91	319.51 (1.40)	320.06 (0.85)	320.39 (0.52)	-

Notes:

- (1) See Drawing 1 for approximate locations and Log of Borehole Sheets for details of monitoring well installation
- (2) Ground surface elevations at the borehole locations were interpreted from the design drawings and are approximate and geodetic.
- (3) Ground Water level encountered during drilling.



TABLE 3
GROUND WATER LEVEL READINGS

MONITORING WELL (MW) No. ⁽¹⁾	GROUND SURFACE ELEVATION ⁽²⁾ (m)	GROUND WATER STRIKE ELEVATION ⁽³⁾ (DEPTH, m)	HYDROSTATIC GROUND WATER LEVEL ELEVATION (DEPTH TO GROUND WATER LEVEL, m)	
			Date: October 15, 2010	Date: October 22, 2010
MW35	321.58	321.13 (0.45)	-	318.24 (3.34)
MW40	329.57	328.27 (1.30)	326.50 (3.07)	326.58 (2.99)
MW43	324.37	322.87 (1.50)	322.16 (2.21)	322.33 (2.04)
AVERAGE		320.97 (1.18)	319.29 (2.96)	319.40 (2.75)

Notes:

- (1) See Drawing 1 for approximate locations and Log of Borehole Sheets for details of monitoring well installation
- (2) Ground surface elevations at the borehole locations were interpreted from the design drawings and are approximate and geodetic.
- (3) Ground Water level encountered during drilling.



TABLE 4
ESTIMATED HYDRAULIC CONDUCTIVITY K-VALUES
BASED ON SOIL SAMPLE GRADATION TEST RESULTS AND
BOREHOLE PERMEABILITY TESTING

OBSERVATION WELL NO.	SOIL TYPE ⁽¹⁾ (SAMPLE NO.)	SAMPLE AVERAGE DEPTH (m)	D ₁₀ ⁽²⁾ (cm) or % Clay	ESTIMATED K-VALUES ⁽³⁾ BASED ON GRAIN SIZE DISTRIBUTION TEST RESULTS (SEE FIGURES 2 THROUGH 8) (cm/s)	MONITORING WELL SCREEN TIP-ELEVATION (DEPTH, m)	ESTIMATED BASIC TIME LAG (s)	ESTIMATED K-VALUES BASED ON BOREHOLE PERMEABILITY TESTING (SEE APPENDIX A) (cm/s)
BH2					304.84 (9.60)	500.0	13.0×10^{-5}
BH5	Sandy silt (SS7)	6.30	0.00045	$2.0 \times 10^{-5(a)}$			
BH7					309.90 (11.90)	140.0	28.0×10^{-5}
BH8	Silt and sand some clay (SS5)	3.30	14% clay	$28.0 \times 10^{-5(b)}$			

Notes:

- (1) See Log of Borehole Sheets for screen soil samples description
- (2) D₁₀: diameter of 10% passing soil particles
- (3) Using: (a) Hazen's Equation or (b) Puckett Equation (see Report Text)



TABLE 4
ESTIMATED HYDRAULIC CONDUCTIVITY K-VALUES
BASED ON SOIL SAMPLE GRADATION TEST RESULTS AND
BOREHOLE PERMEABILITY TESTING

OBSERVATION WELL NO.	SOIL TYPE ⁽¹⁾ (SAMPLE NO.)	SAMPLE AVERAGE DEPTH (m)	D ₁₀ ⁽²⁾ (cm) or % Clay	ESTIMATED K-VALUES ⁽³⁾ BASED ON GRAIN SIZE DISTRIBUTION TEST RESULTS (SEE FIGURES 2 THROUGH 8) (cm/s)	MONITORING WELL SCREEN TIP-ELEVATION (DEPTH, m)	ESTIMATED BASIC TIME LAG (s)	ESTIMATED K-VALUES BASED ON BOREHOLE PERMEABILITY TESTING (SEE APPENDIX A) (cm/s)
BH9	Sand and gravel some silt (SS1)	0.30	0.0030	$90.0 \times 10^{-5(a)}$			
BH11	Sand and gravel some silt (SS2)	0.90	0.0060	$360.0 \times 10^{-5(a)}$			
BH24					314.71 (6.20)	552.0	12.0×10^{-5}
BH27	Silt till some sand some clay (SS7)	7.90	20% clay	$8.4 \times 10^{-5(b)}$			
Estimated Average K-Values (cm/s)				Sand and gravel (some silt): 225.0×10^{-5} (range: 360.0×10^{-5} to 90.0×10^{-5}) Silt till/ silt and sand/sandy silt (some clay): 13.0×10^{-5} (range: 28.0×10^{-5} to 2.0×10^{-5}) Silty clay/clay: 28.0×10^{-5}			

Notes:

- (1) See Log of Borehole Sheets for screen soil samples description
- (2) D₁₀: diameter of 10% passing soil particles
- (3) Using: (a) Hazen's Equation or (b) Puckett Equation (see Report Text)

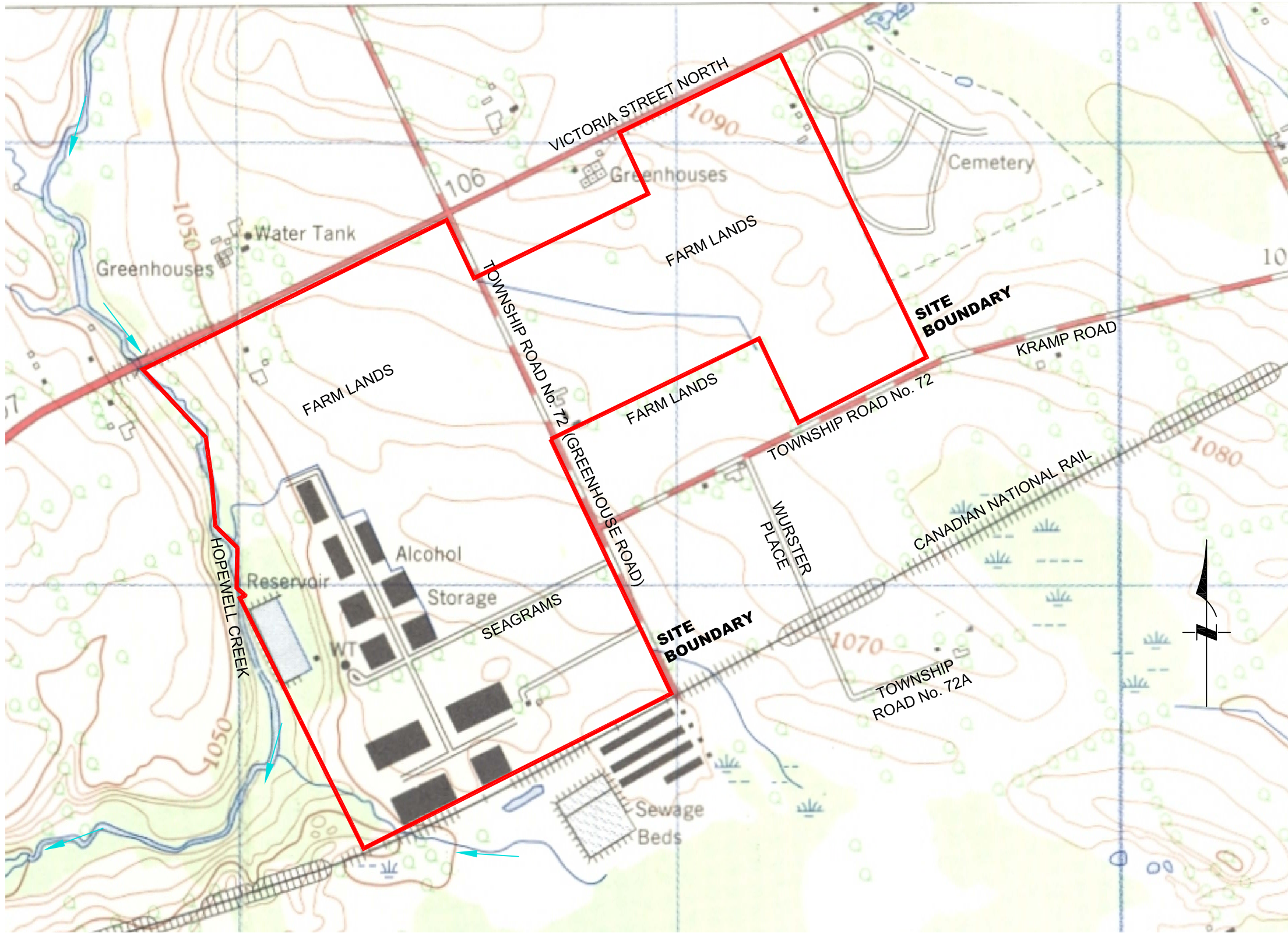


TABLE 5
SUMMARIZED APPROXIMATE TYPICAL CALCULATIONS OF ESTIMATED DEWATERING DISCHARGE RATE AND ZONE OF INFLUENCE

PROPOSED CONSTRUCTION ZONES AND FEATURES		EXISTING GROUND SURFACE ELEVATION (1)	LOWEST PROPOSED STRUCTURE INVERT ELEVATION (DEPTH OF EXCAVATION m) (2)	LOWERED GROUND WATER LEVEL ELEVATION (DEPTH m) (3)	CLOSEST MONITORING WELLS OR BOREHOLES (4)	HYDROSTATIC GROUND WATER LEVEL ELEVATION (DEPTH m) (5)	DRAW-DOWN REQUIRED S_0 (m) (6)	SOIL TYPE (7)	ESTIMATED ZONE OF INFLUENCE R_0 (m) (8)	ESTIMATED DEWATERING DISCHARGE RATE OF THE SEGMENT ($Q = KiA$)				
										Segment Length (m) (9)	K (m/s) (10)	i (%) (11)	A (m ²) (12)	Q (L/day) (13)
Zone 1: Sewage Pumping Station		316.50	306.50 (10.0)	305.50 (11.0)	BH3, BH10 BH11 BH19 & BH20	313.34 (3.16)	7.84	Sand and silt	74.0	5.0	1.0×10^{-5}	10.5	162.0	14,700
Zone 2: Sanitary sewers	Street A	323.07	312.07 (11.0)	311.07 (12.0)	BH2, BH4, BH10, BH11, BH12, BH13, BH19, BH20, BH21 & BH22	319.53 (3.54)	8.46	Sandy silt	51.0	1,065	4.0×10^{-6}	16.7	17,402	1,002,300
	Street E	322.39	310.39 (12.0)	309.39 (13.0)		319.53 (2.86)	10.14		61.0	420	4.0×10^{-6}	16.7	8,292	475,200
	Street Q	322.33	311.33 (11.0)	310.33 (12.0)		320.00 (2.33)	9.67		52.0	555	4.0×10^{-6}	18.6	10,425	674,000
	Subdivision	322.88	318.58 (4.3)	317.58 (5.3)		319.53 (3.35)	1.95		12.0	4,710	4.0×10^{-6}	16.7	15,546	898,000
Zone 3	SMWP1	321.80	313.80 (8.0)	312.80 (9.0)	BH7, MOE well 2 & MOE well 12	317.11 (4.69)	4.31	Sand and silt	133.0	-	1.0×10^{-5}	-	-	2,557,000
	SWMP2	320.91	318.91 (2.00)	317.91 (3.00)	BH24, MOE well 2 & MOE well 12	320.39 (0.52)	2.48	Sand and Gravel	142.0	-	7.0×10^{-5}	-	-	7,210,000
TOTAL DEWATERING DISCHARGE RATE: 12,831,200 L/Day														

Notes:

- (1) The existing ground surface elevations at borehole and monitoring well locations were interpreted by PML and are geodetic; the utilities invert elevations and segments length were not provided at the time of this report.
- (2) Lowered ground water level is assumed to be 1.0 m below the excavation invert.
- (3) See Drawing 1 for approximate locations of boreholes and monitoring wells.
- (4) Ground water hydrostatic level measured after completion of drilling.
- (5) Difference between ground water hydrostatic level and lowered ground water level elevation.
- (6) See Log of Borehole Sheets for soil description.
- (7) Estimated from trench/excavation configuration: $R_0 = 3000S_0 K^{1/2}$, L in m, S_0 in m and K in m/s.
- (8) See Table 4.
- (9) $Q = KiA$, where K : hydraulic conductivity, i : hydraulic gradient (S_0/L) and A : seepage cross-section in the entire excavation trench segment.



NOTE:
THIS DRAWING WAS PREPARED FROM TOPOGRAPHIC MAP 'KITCHENER EAST - No. 10 P/8e EDITION 1, PRODUCED BY THE SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES, FROM INFORMATION AS OF 1964, PRINTED IN 1968.



KEY MAP
SCALE 1 : 50,000

LEGEND:

 SURFACE/CREEK WATER FLOW DIRECTION

No.	REVISIONS	DATE	BY

TOWNSHIP OF WOOLRICH

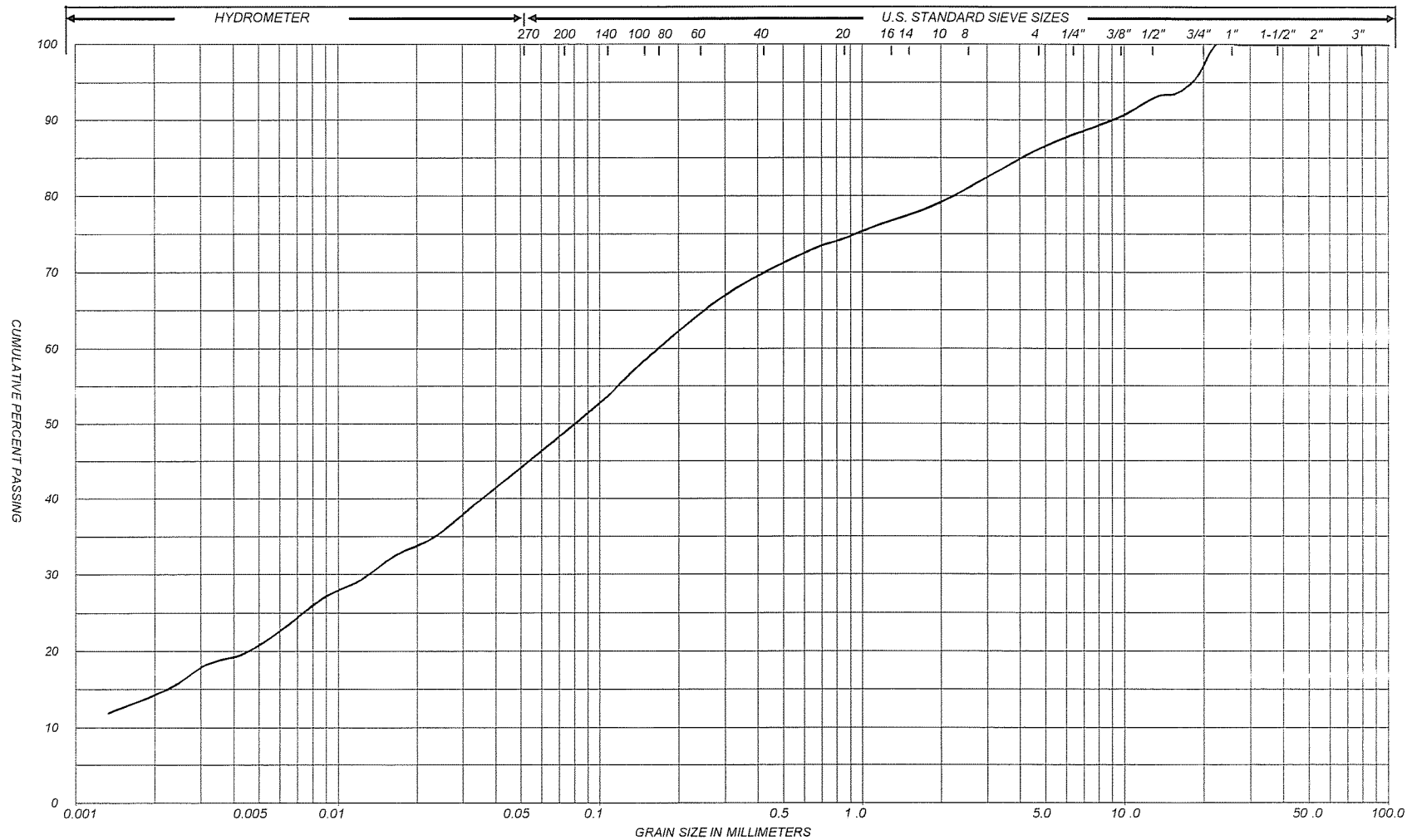
**HYDROGEOLOGICAL SITE ASSESSMENT FOR SEAGRAMS AND BISGOULD LANDS AND STORMWATER MANAGEMENT PONDS
TOWNSHIP OF WOOLRICH, ONTARIO**

**TOPOGRAPHIC MAP AND EXISTING SITE FEATURES
OBSERVED IN OCTOBER 2010**



DRAWN: N.A.	DATE	SCALE	JOB NO.	FIGURE NO.
CHECKED: D.A.	NOV. 2010	1 : 10,000	10KF058	1
APPROVED: M.H.M.				

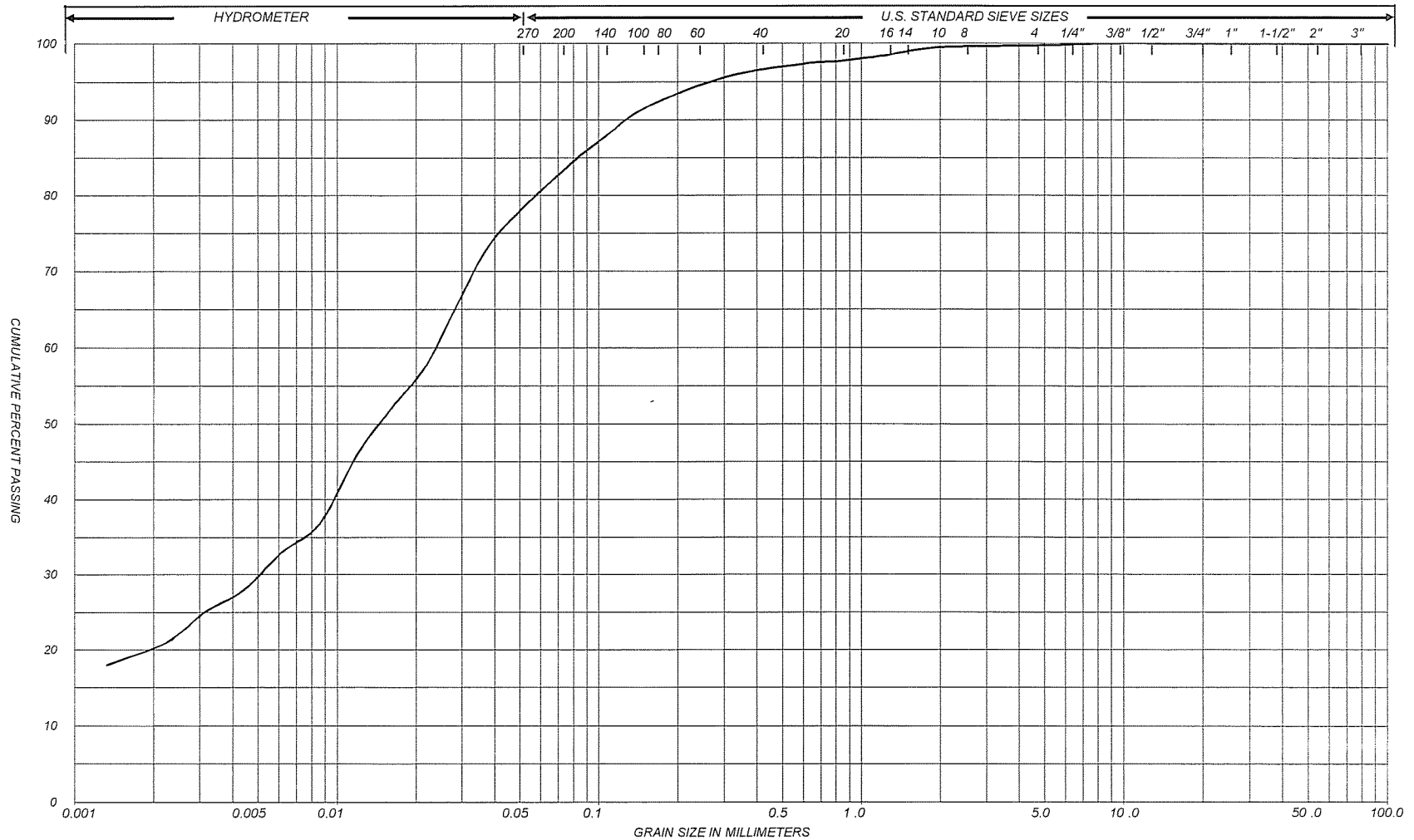
PARTICLE SIZE DISTRIBUTION CHART



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED			
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.	
	SILT					SAND					GRAVEL			COBBLES	M.I.T.		
CLAY		SILT			VERY FINE	FINE	MEDIUM	COARSE	GRAVEL							U.S. BUREAU	
					SAND												

REMARKS Borehole 8, Sample SS5, Depth 3.05 to 3.50 m
SILT AND SAND, SOME GRAVEL

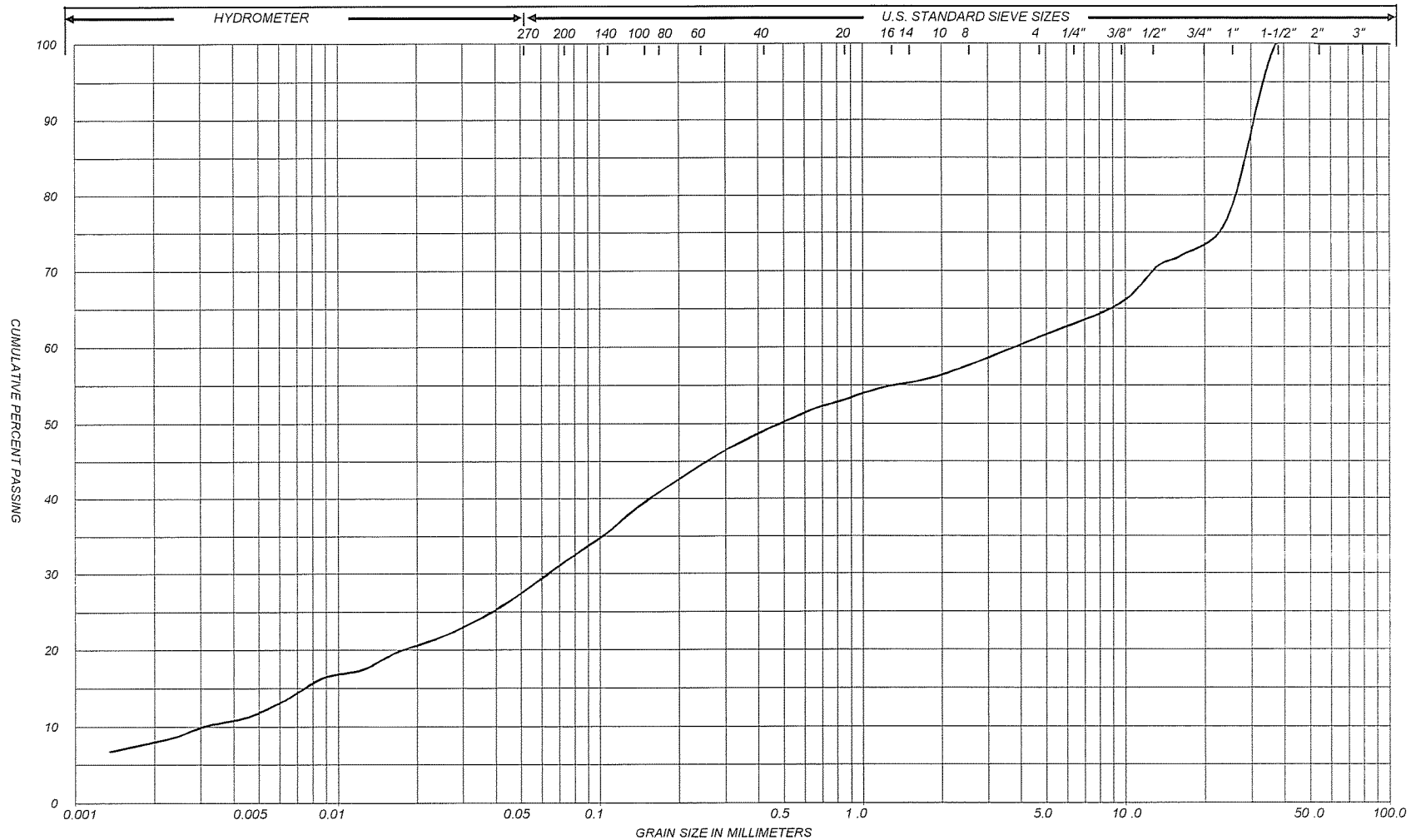
PARTICLE SIZE DISTRIBUTION CHART



SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED
CLAY	FINE		MEDIUM	COARSE	SAND				GRAVEL		COBBLES	M.I.T.
			SILT		FINE	MEDIUM	COARSE					
CLAY		SILT		VERY FINE	FINE	MEDIUM	COARSE	GRAVEL		U.S. BUREAU		
				SAND								

REMARKS Borehole 27, Sample SS7, Depth 7.60 to 8.10 m
SILT TILL, SOME FINE TO MEDIUM SAND, TRACE CLAY

PARTICLE SIZE DISTRIBUTION CHART

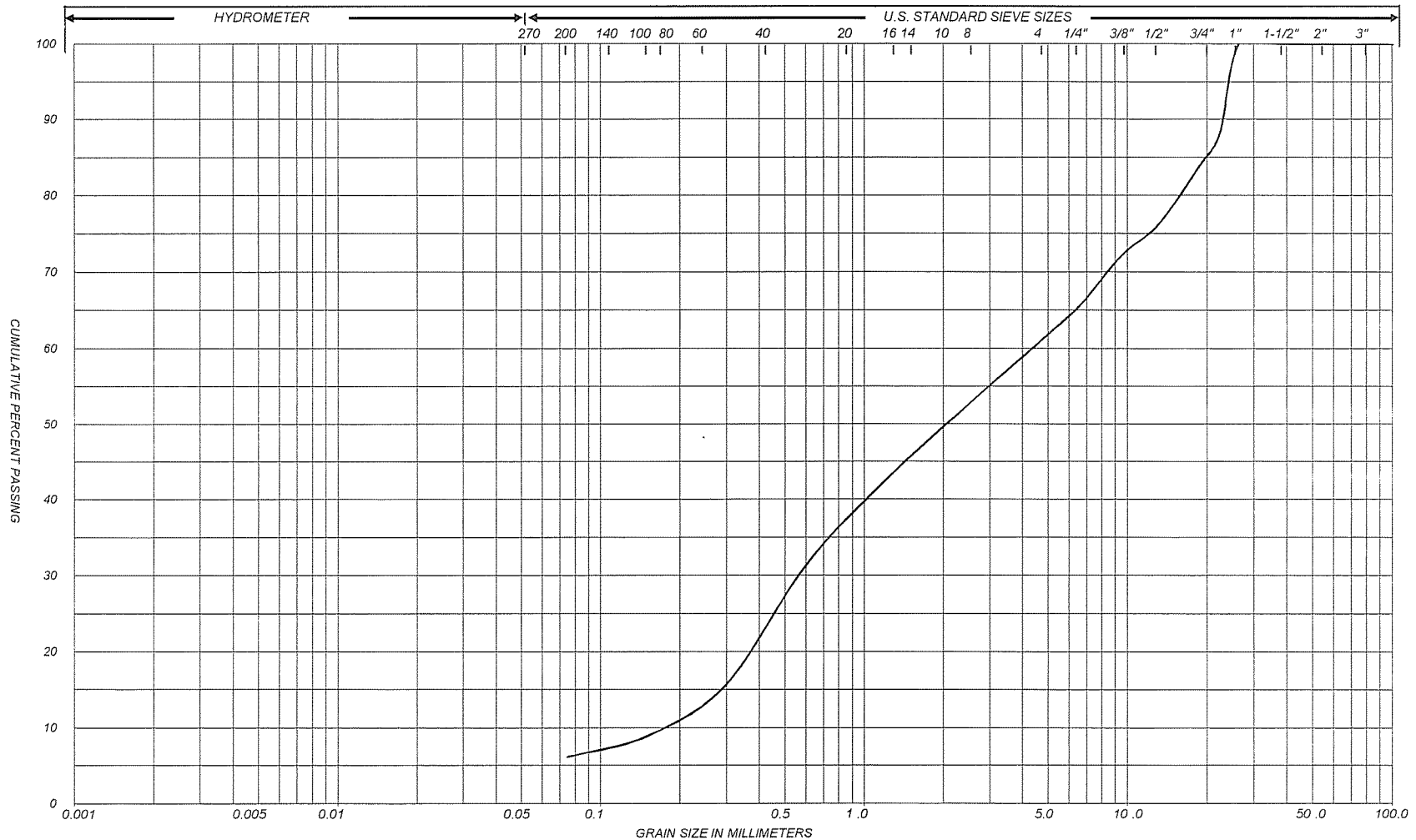


SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL			COBBLES	UNIFIED	
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL		COBBLES	M.I.T.
	SILT					SAND		SAND		SAND		GRAVEL		COBBLES	U.S. BUREAU
CLAY		SILT			VERY FINE	FINE	MEDIUM	COARSE	GRAVEL			COBBLES	U.S. BUREAU		

REMARKS Borehole 45, Sample SS6, Depth 4.55 to 5.05 m

SILT AND SAND TILL, SOME GRAVEL

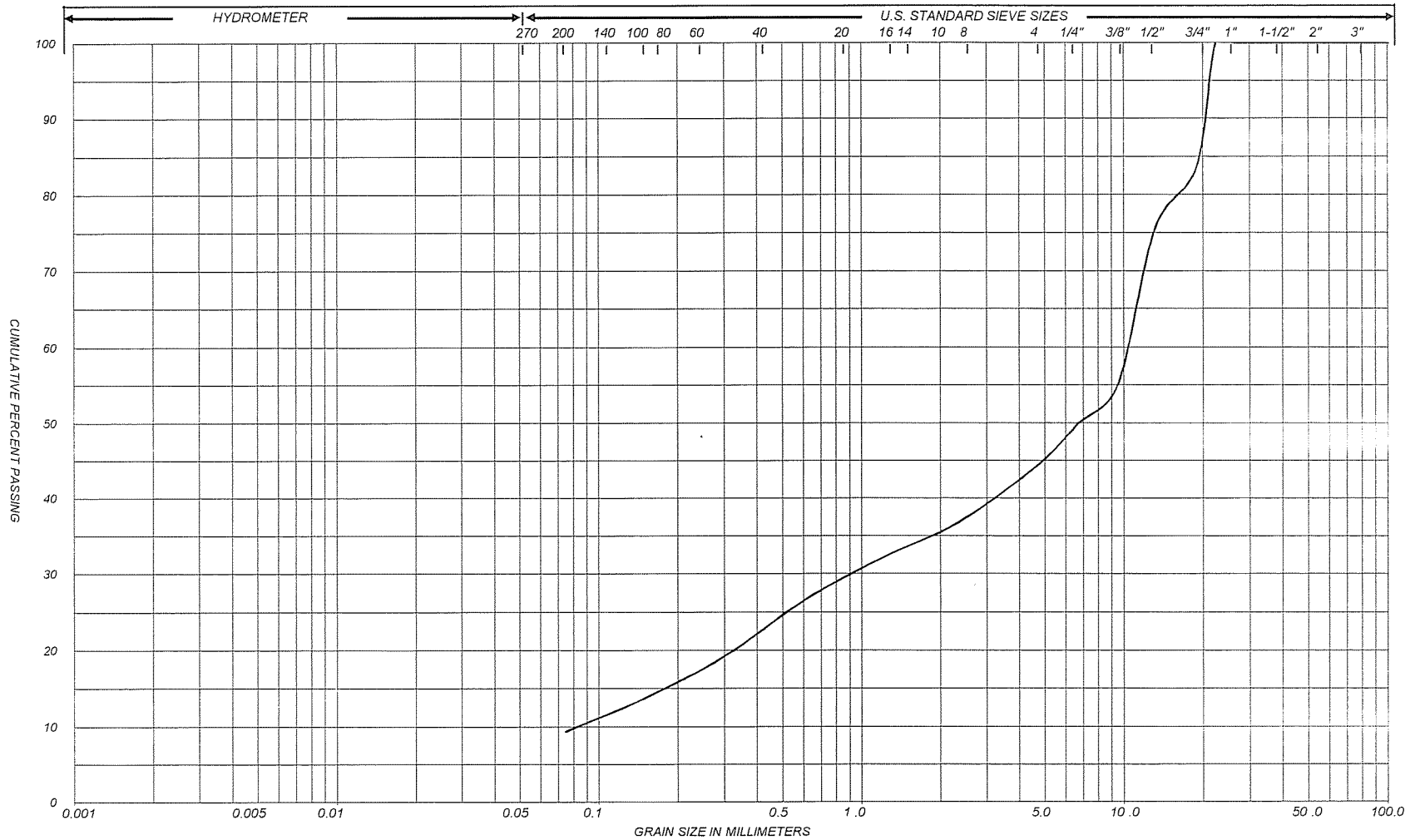
PARTICLE SIZE DISTRIBUTION CHART



SILT & CLAY				FINE		MEDIUM		COARSE	GRAVEL		COBBLES	UNIFIED	
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE	GRAVEL	COBBLES	M.I.T.
	SILT				SAND								
CLAY		SILT			VERY FINE	FINE	MEDIUM	COARSE	GRAVEL				U.S. BUREAU
					SAND								

REMARKS Borehole 5, Sample SS2, Depth 0.75 to 1.20 m
GRAVELLY MEDIUM TO COARSE SAND, TRACE SILT

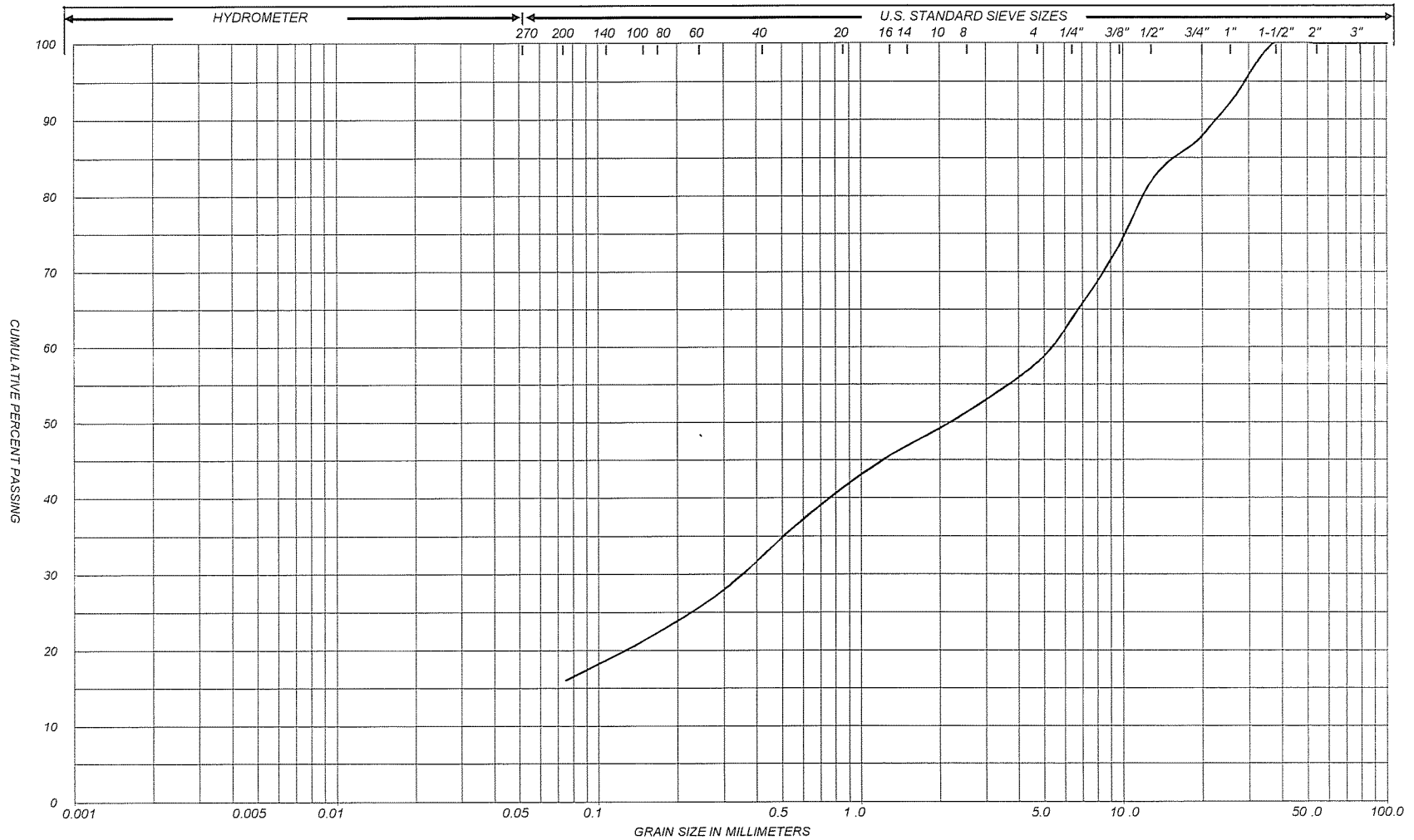
PARTICLE SIZE DISTRIBUTION CHART



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL				COBBLES	UNIFIED		
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL				COBBLES	M.I.T.
	SILT							SAND									
CLAY		SILT				VERY FINE	FINE	MEDIUM	COARSE	GRAVEL					U.S. BUREAU		
						SAND											

REMARKS Borehole 7, Sample SS1, Depth 0 to 0.60 m
FINE TO COARSE SAND AND GRAVEL, TRACE SILT

PARTICLE SIZE DISTRIBUTION CHART

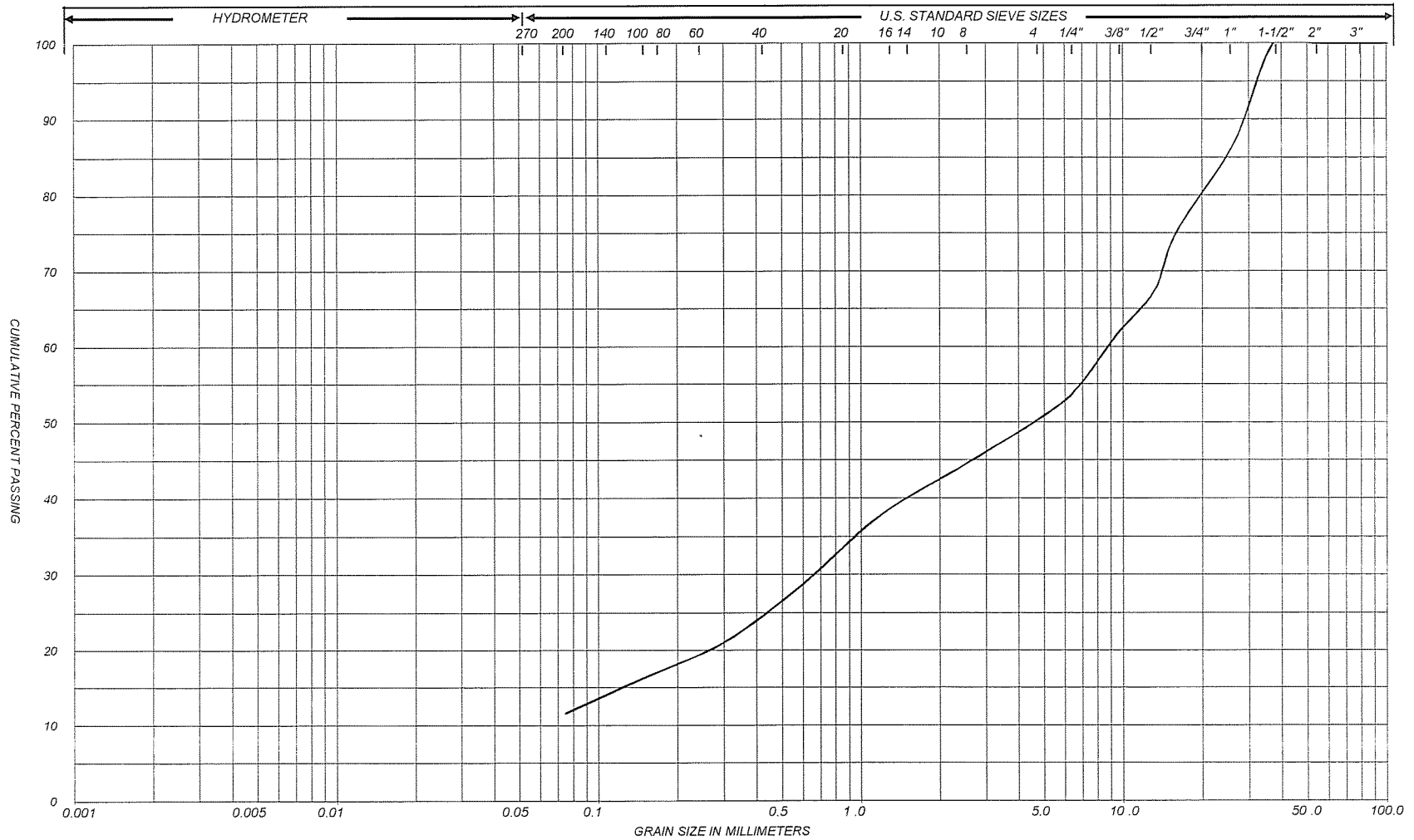


SILT & CLAY				FINE SAND			MEDIUM SAND	COARSE SAND	GRAVEL		COBBLES	UNIFIED
CLAY	FINE SILT		MEDIUM SILT	COARSE SILT	FINE SAND		MEDIUM SAND	COARSE SAND	GRAVEL		COBBLES	M.I.T.
	CLAY		SILT		VERY FINE SAND	FINE SAND	MEDIUM SAND	COARSE SAND	GRAVEL			U.S. BUREAU

REMARKS Borehole 9, Sample SS1, Depth 0 to 0.60 m

SAND AND GRAVEL, SOME SILT

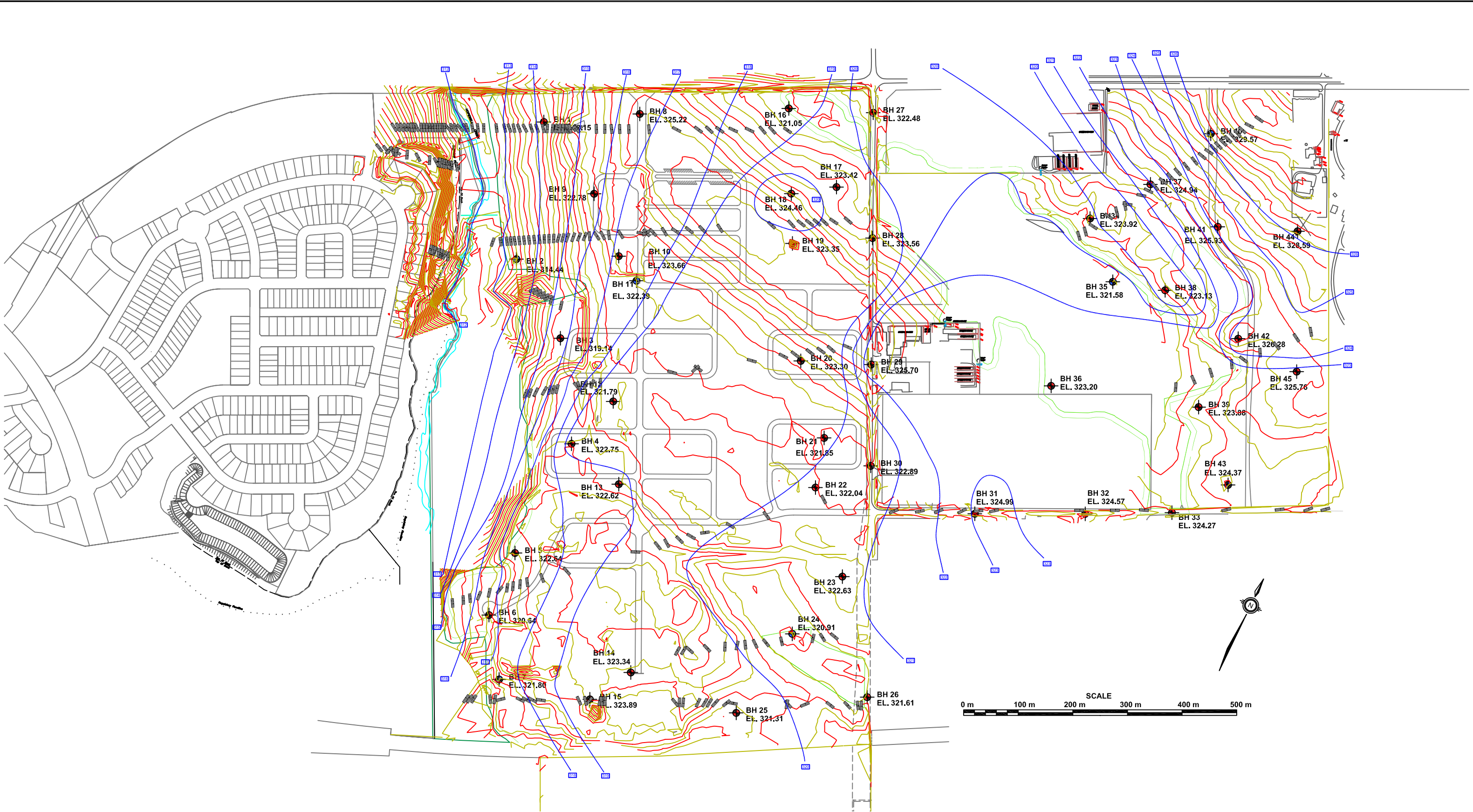
PARTICLE SIZE DISTRIBUTION CHART



SILT & CLAY					FINE		MEDIUM		COARSE	GRAVEL				COBBLES	UNIFIED	
CLAY	FINE		MEDIUM		COARSE	FINE		MEDIUM		COARSE		GRAVEL			COBBLES	M.I.T.
	SILT						SAND									
CLAY		SILT			VERY FINE	FINE	MEDIUM	COARSE	GRAVEL						U.S. BUREAU	
					SAND											

REMARKS Borehole 11, Sample SS2, Depth 0.75 to 1.05 m

SAND AND GRAVEL, SOME SILT



REFERENCE:

BOREHOLE LOCATION PLAN REPRODUCED FROM DRAWING SUPPLIED BY CLIENT.

NOTE:

THE INFERRED STRATIGRAPHY REFERRED TO IN THE REPORT IS BASED ON THE DATA FROM THESE BOREHOLES SUPPLEMENTED BY GEOLOGICAL EVIDENCE. THE ACTUAL STRATIGRAPHY BETWEEN THE BOREHOLES MAY VARY.

CONTOURS BASED ON SEPTEMBER 2010 OBSERVATION OF SHALLOW AQUIFER

LEGEND:

- ◆ BOREHOLE
- ◆ BOREHOLE WITH MONITORING WELL

- WETLAND / SWAMP AREA
- GROUND WATER CONTOUR
- MAJOR TOPOGRAPHIC CONTOUR
- MINOR TOPOGRAPHIC CONTOUR

THOMASFIELD HOMES LIMITED

PROPOSED MIXED USE DEVELOPMENT

SEAGRAMS AND BISGOULD LAND

TOWNSHIP OF WOOLWICH, ONTARIO

GROUND WATER CONTOUR PLAN



DRAWN	K. BENDER	DATE	SCALE	PML REF.	DWG. NO.
CHECKED	M. MOLODECKI	DECEMBER 2010	1:3000	10KF058	REPORT 2 DRAWING 2
APPROVED	M. MOLODECKI				

LIST OF ABBREVIATIONS



PENETRATION RESISTANCE

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

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

DESCRIPTION OF SOIL

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

<u>CONSISTENCY</u>	<u>N (blows/0.3 m)</u>	<u>c (kPa)</u>	<u>DENSENESS</u>	<u>N (blows/0.3 m)</u>
Very Soft	0 - 2	0 - 12	Very Loose	0 - 4
Soft	2 - 4	12 - 25	Loose	4 - 10
Firm	4 - 8	25 - 50	Compact	10 - 30
Stiff	8 - 15	50 - 100	Dense	30 - 50
Very Stiff	15 - 30	100 - 200	Very Dense	> 50
Hard	> 30	> 200		
WTPL	Wetter Than Plastic Limit			
APL	About Plastic Limit			
DTPL	Drier Than Plastic Limit			

TYPE OF SAMPLE

SS	Split Spoon	TW	Thinwall Open
WS	Washed Sample	TP	Thinwall Piston
SB	Scraper Bucket Sample	OS	Oesterberg Sample
AS	Auger Sample	FS	Foil Sample
CS	Chunk Sample	RC	Rock Core
ST	Slotted Tube Sample		
	PH	Sample Advanced Hydraulically	
	PM	Sample Advanced Manually	

SOIL TESTS

Qu	Unconfined Compression	LV	Laboratory Vane
Q	Undrained Triaxial	FV	Field Vane
Qcu	Consolidated Undrained Triaxial	C	Consolidation
Qd	Drained Triaxial		

LOG OF BOREHOLE NO. 1

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 20

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50 100 150 200				PLASTIC LIMIT W_p				
							DYNAMIC CONE PENETRATION $\times$				WATER CONTENT W				
							STANDARD PENETRATION TEST $\bullet$				W_p W W_L				
							BLOWS/0.3M				WATER CONTENT %				
							20	40	60	80	10	20	30		
	GROUND ELEVATION 318.15														
0.25	TOPSOIL: Loose dark brown silt, some sand, some clay, low organic		318	1	SS	3									
0.70	SAND AND SILT: Loose to compact brown sand and silt, trace gravel, damp/ becoming predominantly silt, moist to wet		317	2	SS	12									
1.50			316												
1.80	CLAYEY SILT TILL: Stiff brown clayey silt, some sand, some gravel, slightly plastic, WTPL.		315	5	SS	31									
2.90	becoming hard, sandy, DTPL		314												
3.90			313												
4.50	SILT AND SAND TILL: Very dense grey gravelly silt and sand, trace clay, non-plastic, damp		312												
6.00															
7.00	BOREHOLE TERMINATED AT 7.00 m														
														Upon completion of drilling, borehole open with no free water	

NOTES

CHECKED BY

LOG OF BOREHOLE NO. 2

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

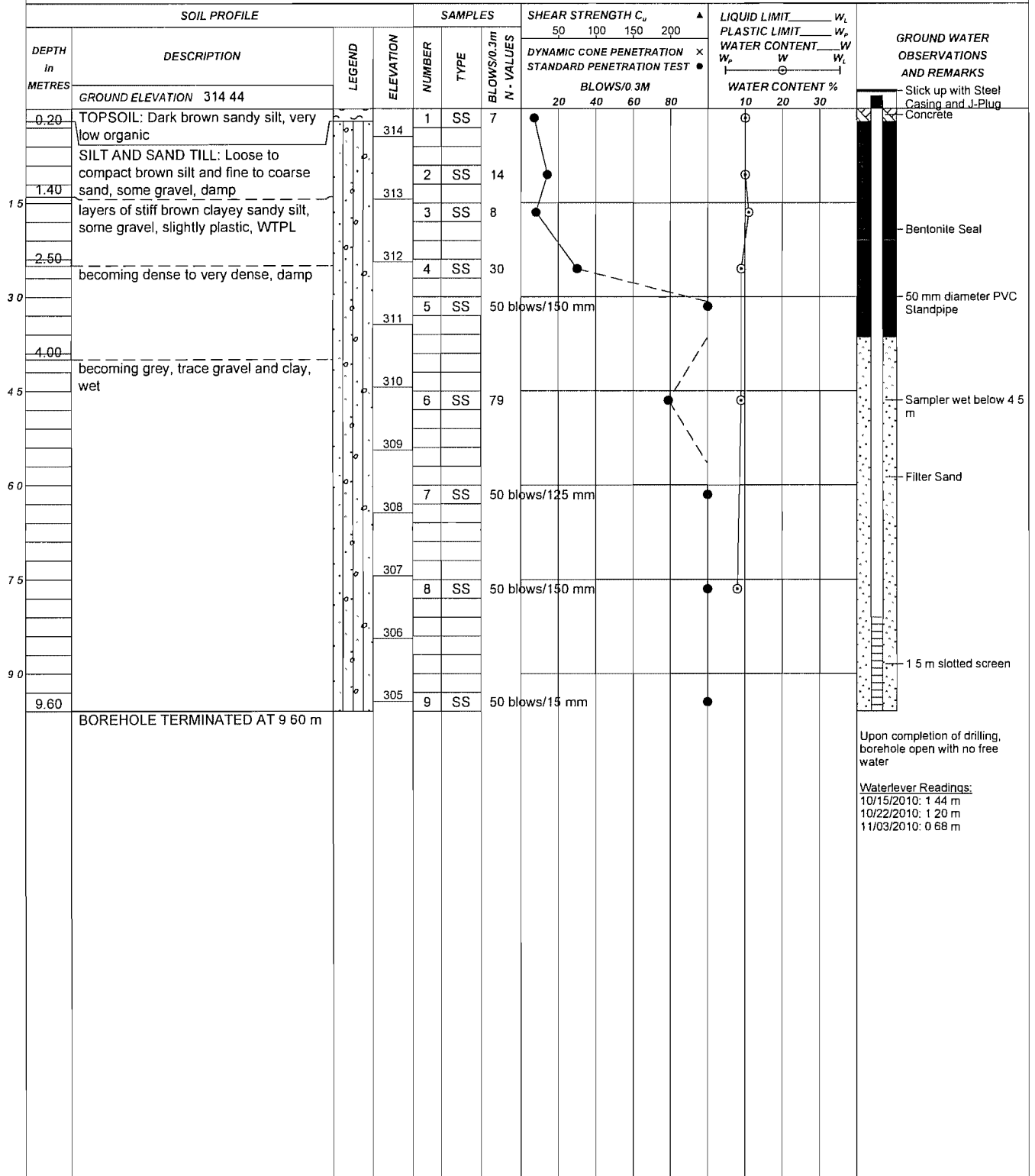
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 21

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey



NOTES

CHECKED BY *[Signature]*

LOG OF BOREHOLE NO. 3

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

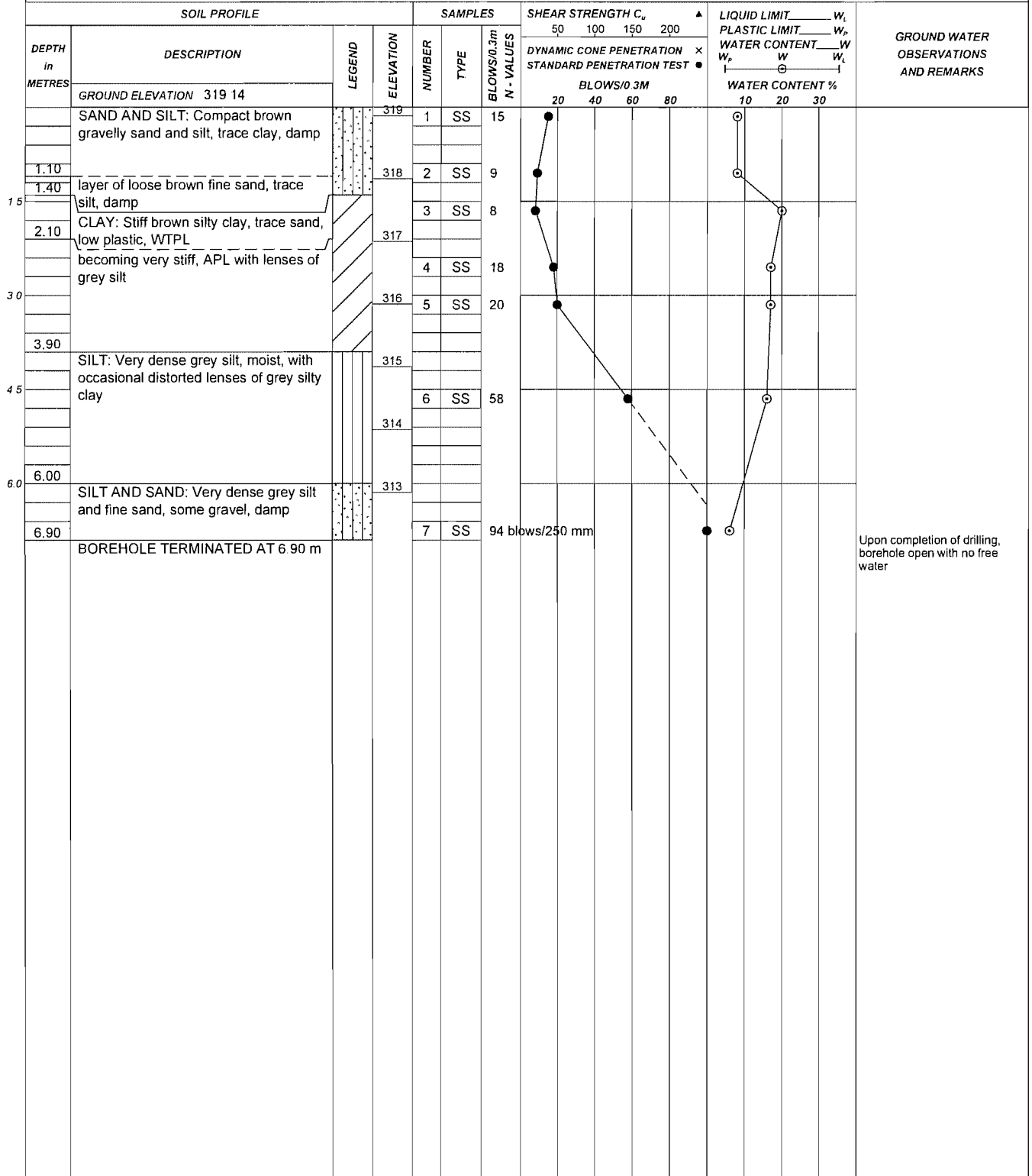
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 20

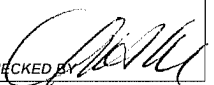
OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey



NOTES

CHECKED BY 

LOG OF BOREHOLE NO. 4

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 20

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS						
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200		PLASTIC LIMIT W_p	WATER CONTENT W				
							DYNAMIC CONE PENETRATION					STANDARD PENETRATION TEST				WATER CONTENT %	
							BLOWS/0.3M										
	GROUND ELEVATION 322.75						20	40	60	80	10	20	30				
	FILL: Compact brown gravelly silt and sand, trace clay, non-plastic, damp		322	1	SS	14											
				2	SS	19											
1.5	becoming grey, damp to moist		321	3	SS	26											
	SILT AND SAND TILL: Very dense brown silt and sand, some gravel, trace clay, non-plastic, damp		320	4	SS	65											
3.0	CLAY TILL: Hard brownish grey silty clay, trace sand and gravel, low plastic, DTPL, occasional thin lenses of silt		319	5	SS	55								Free water encountered below 4.55 m			
	SAND TILL: Very dense brown gravelly fine to coarse sand, some silt, saturated		318	6	SS	54											
4.5																	
	SAND: Very dense grey silty fine sand, wet		317														
6.0				7	SS	79								Upon completion of drilling, borehole caved to 4.3 m with free water at 3.6 m			
	becoming sand and silt		316														
7.5			315	8	SS	69											
	BOREHOLE TERMINATED AT 7.90 m																

NOTES

CHECKED BY 

LOG OF BOREHOLE NO. 5

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

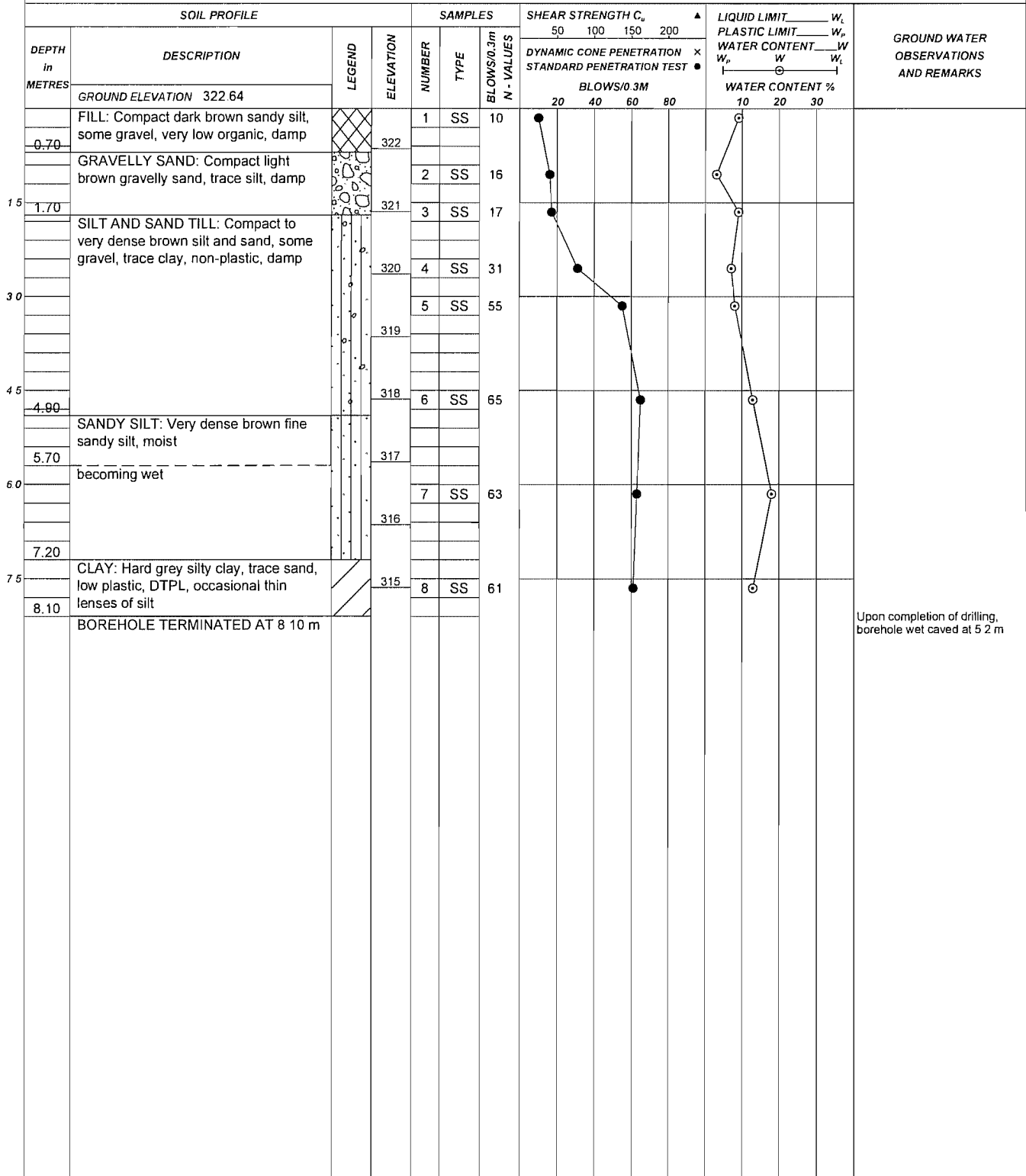
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 20

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey



Upon completion of drilling, borehole wet caved at 5.2 m

NOTES

CHECKED BY

LOG OF BOREHOLE NO. 6

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 20

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS			
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200		PLASTIC LIMIT W_p		
							DYNAMIC CONE PENETRATION $\times$					WATER CONTENT W		
							STANDARD PENETRATION TEST $\bullet$					W_p W W_L		
												WATER CONTENT %		
GROUND ELEVATION 320.64							BLOWS/0.3M		10 20 30					
0.18	TOPSOIL: Dark brown sandy silt, very low organic		320	1	SS	16			Free water encountered below 4.55 m					
0.70	SILT AND SAND. Compact brown silt and sand, damp			2	SS	18								
1.50	SILT AND SAND TILL: Compact brown gravelly silt and sand, trace clay, damp			319	3	SS	19							
1.80	CLAYEY SILT TILL: Stiff brown clayey silt, some sand, some gravel, slightly plastic, APL			318	4	SS	65							
2.10	SILT: Very dense brown silt, damp with distorted lenses of silty clay				5	SS	71							
3.00	SAND: Very dense silty fine sand, moist			317										
3.20														
4.20	becoming dense grey, trace silt, saturated		316	6	SS	38				Upon completion of drilling, borehole wet caved at 3.6 m				
4.50														
5.70			315											
6.00	CLAYEY SILT: Hard brown to grey clayey silt, trace sand, slightly plastic, DTPL		314											
6.90	BOREHOLE TERMINATED AT 6.90 m			7	SS	86								

NOTES

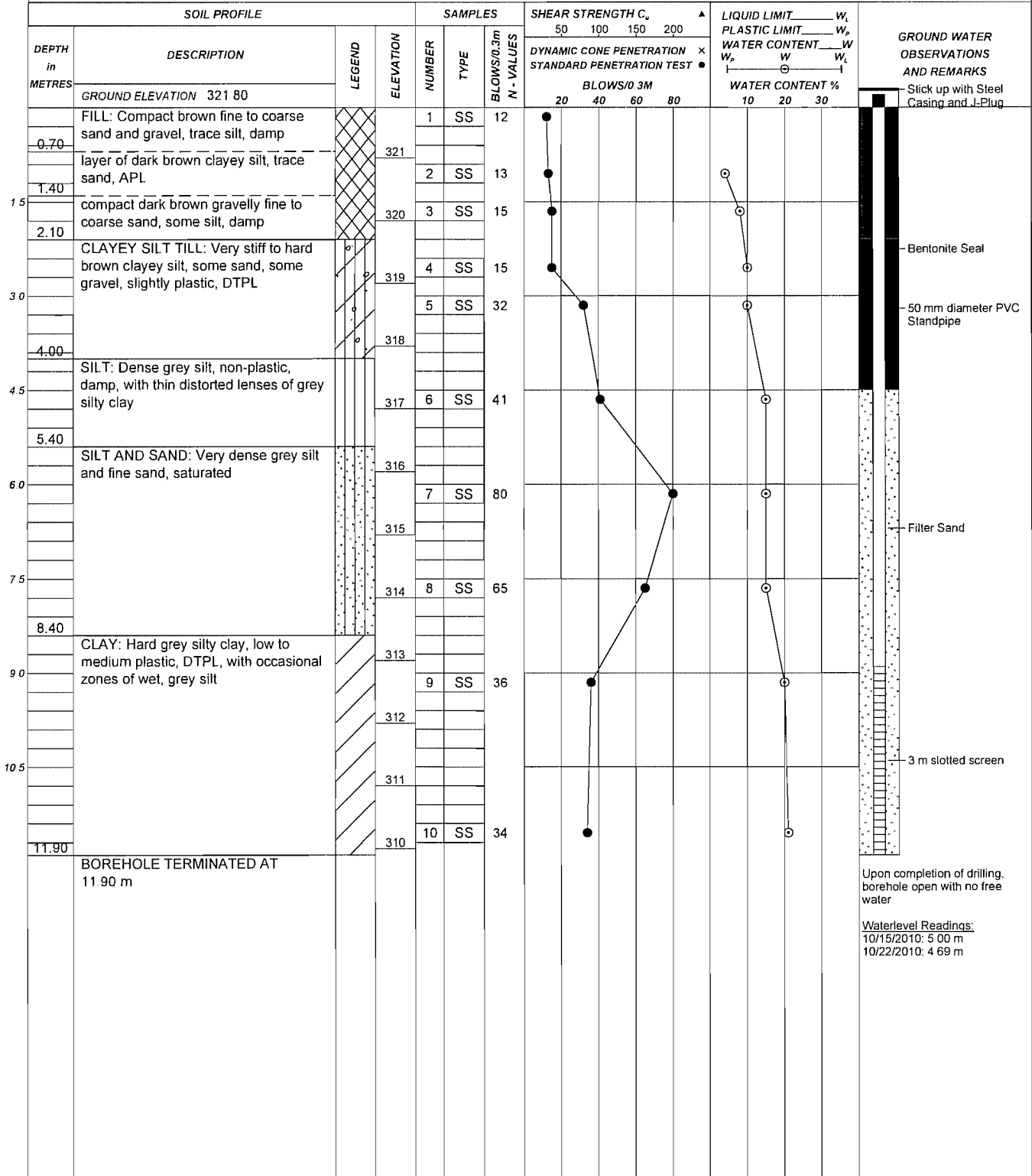
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LOG OF BOREHOLE NO. 7

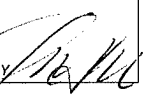
PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 23

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey



NOTES

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LOG OF BOREHOLE NO. 8

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

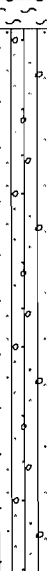
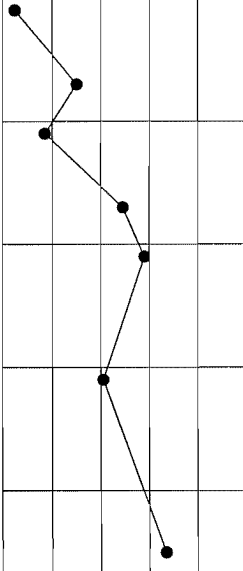
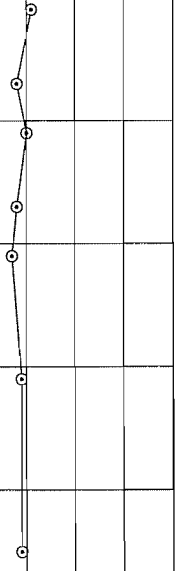
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS				
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200					
							DYNAMIC CONE PENETRATION $\times$					PLASTIC LIMIT W_p			
							STANDARD PENETRATION TEST $\bullet$					WATER CONTENT W			
							BLOWS/0.3M		WATER CONTENT %						
							20	40	60	80	10	20	30		
0.36	TOPSOIL: Dark brown sandy clayey silt, low organic		325	1	SS	5									
	SILT AND SAND TILL: Dense brown silt and sand, some gravel, trace clay, damp		324	2	SS	30									
1.40															
	layer of very stiff brown clayey silt (till), some sand, some gravel, slightly to low plastic, WTPL				3	SS	17								
2.10															
	becoming very dense silt and sand, some gravel, trace clay, damp				4	SS	49								
3.0															
				322	5	SS	58								
4.00															
	layer of grey clayey silt (till), some sand, some gravel, slightly to low plastic, DTPL														
4.5					6	SS	41								
5.00															
	very dense silt and sand, some gravel, trace clay, damp			320											
6.0															
				319											
7.00					7	SS	67								
	BOREHOLE TERMINATED AT 7.00 m											Upon completion of drilling, borehole open with no free water			

NOTES

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LOG OF BOREHOLE NO. 9

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 20

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS	
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200		
							DYNAMIC CONE PENETRATION $\times$ STANDARD PENETRATION TEST $\bullet$					
							BLOWS/0.3M					
							20	40	60	80		
							WATER CONTENT % W_p W W_L					
0.30	FILL: Compact brown fine to coarse sand and gravel, some silt, damp		322	1	SS	14						
0.70	TOPSOIL: Compact brown sandy silt, some gravel, trace clay, very low organic, moist			2	SS	18						
1.5	SILT AND SAND: Compact to dense brown silt and sand, some gravel, trace clay, damp to moist			3	SS	23						
2.60	CLAYEY SILT TILL: Very stiff to hard brown clayey silt, some sand, trace gravel, slightly plastic, APL to DTPL, thin partings of silt			4	SS	32						
3.0				5	SS	47						
4.20												
4.5	becoming grey, sandy			318	6	SS	93					
5.40	SILT AND SAND TILL: Very dense grey silt and sand, some gravel, trace clay, damp			317								
6.0			7	SS	90 blow/250 mm							
7.5												
7.80	BOREHOLE TERMINATED AT 7.80 m		315	8	SS	50 blows/150 mm				Upon completion of drilling, borehole open with no free water		

NOTES

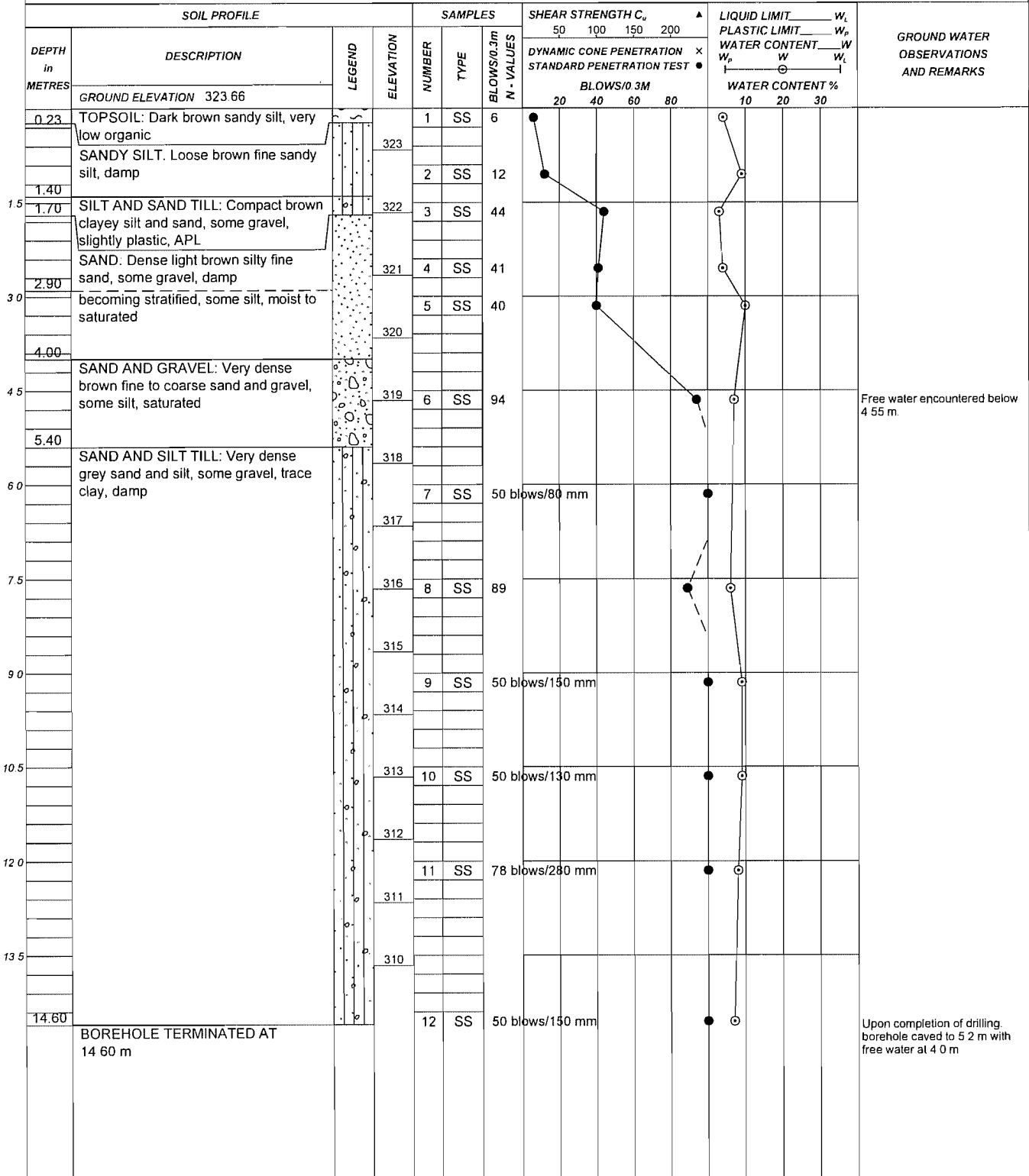
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LOG OF BOREHOLE NO. 10

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 21

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey



NOTES

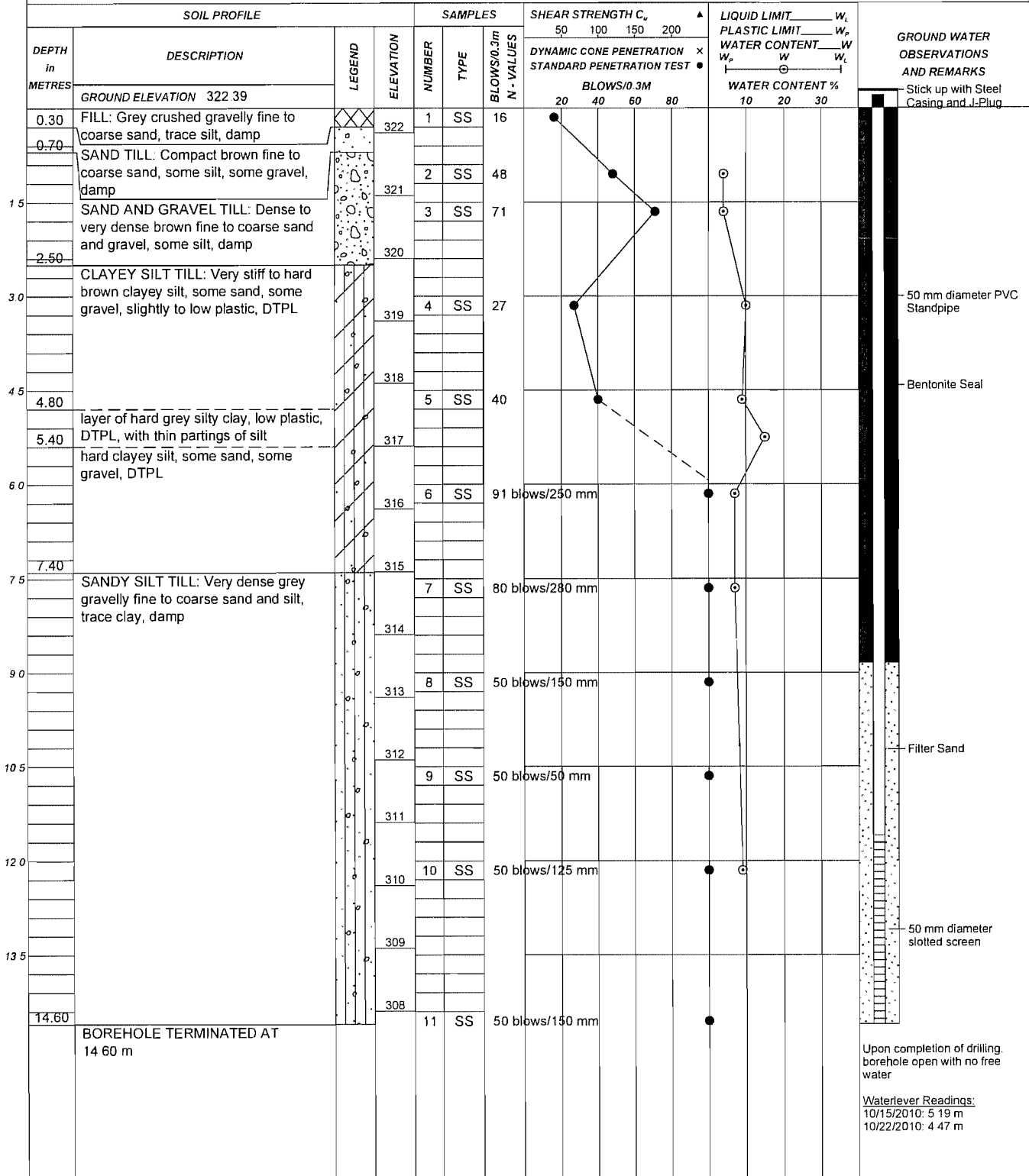
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LOG OF BOREHOLE NO. 11

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 21

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

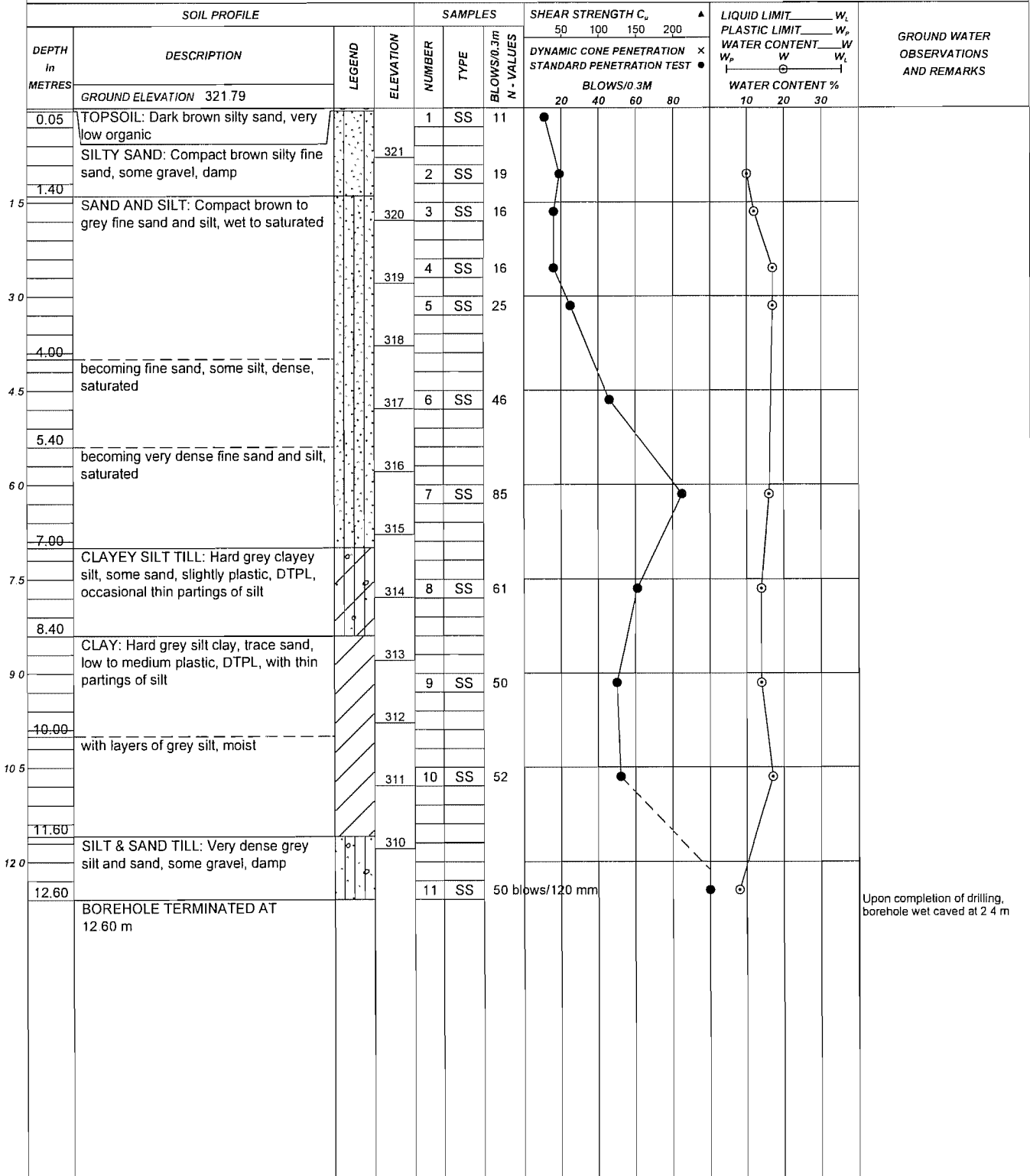
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LOG OF BOREHOLE NO. 12

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 22

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey



Upon completion of drilling, borehole wet caved at 2.4 m

NOTES

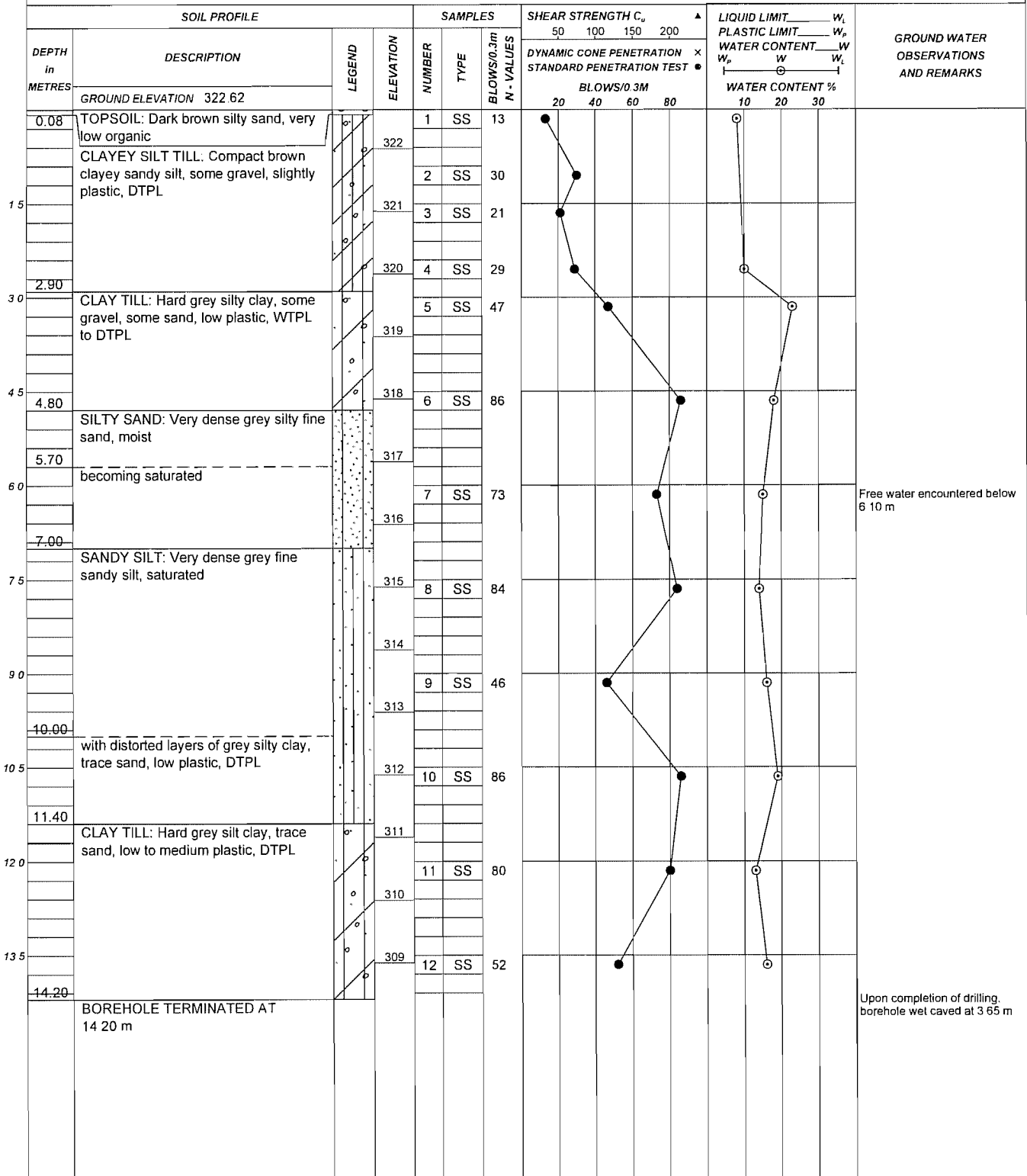
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LOG OF BOREHOLE NO. 13

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 22

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

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LOG OF BOREHOLE NO. 14

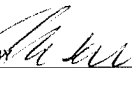
PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 23

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u ▲				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50 100 150 200				PLASTIC LIMIT W_p				
							DYNAMIC CONE PENETRATION ×				WATER CONTENT W				
							STANDARD PENETRATION TEST ●				W_p W W_L				
							BLOWS/0.3M				WATER CONTENT %				
							20 40 60 80				10 20 30				
	GROUND ELEVATION 323.34														
0.60	SANDY SILT: Loose mottled brown and dark brown sandy silt, trace gravel, trace clay, damp		323	1	SS	8									
1.40	SAND AND GRAVEL: Compact brown fine to coarse sand and gravel, trace silt, damp		322	2	SS	18									
1.5				3	SS	19									
	CLAYEY SILT TILL: Very stiff to hard brown clayey silt, some sand, some gravel, slightly plastic, WTPL to DTPL		321												
				4	SS	50									
3.0			320	5	SS	37									
4.5			319												
				6	SS	33									
			318												
5.80															
6.0	CLAY TILL: Hard grey silty clay, trace sand, trace gravel, low to medium plastic, DTPL		317												
7.00				7	SS	42									
	BOREHOLE TERMINATED AT 7.00 m														
													Upon completion of drilling, borehole open with free water at 5.8 m		

NOTES

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LOG OF BOREHOLE NO. 15

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 23

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH In METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p				
							DYNAMIC CONE PENETRATION $\times$				WATER CONTENT W				
							STANDARD PENETRATION TEST $\bullet$				W_p W W_L				
							BLOWS/0.3M				WATER CONTENT %				
0.23	TOPSOIL: Dark brown silt and sand, some gravel, very low organic		323	1	SS	11	20					10	20	30	
1.40	SAND. Compact brown silty fine to medium sand, trace gravel, damp			2	SS	19									
2.10	becoming fine sand, trace silt			3	SS	19									
2.60	SAND AND GRAVEL TILL: Very dense brown sand and gravel, trace silt, damp		321	4	SS	57									
3.00	CLAYEY SILT TILL: Hard brown clayey sandy silt, some gravel, slightly plastic, DTPL, occasional boulders			5	SS	72 blows/200 mm									
4.50			319	6	SS	37									
5.70															
6.00	SILTY SAND: Dense grey silty fine to coarse sand, some gravel, saturated		317	7	SS	31									
7.00	BOREHOLE TERMINATED AT 7.00 m														
															Upon completion of drilling, borehole wet caved at 4.2 m

NOTES

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LOG OF BOREHOLE NO. 16

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT w_L				GROUND WATER OBSERVATIONS AND REMARKS				
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT w_p	WATER CONTENT w	WATER CONTENT w						
							DYNAMIC CONE PENETRATION $\times$				STANDARD PENETRATION TEST $\bullet$								
							BLOWS/0.3M												
							20	40	60	80	10	20	30						
	GROUND ELEVATION 321.05																		
0.36	TOPSOIL: Dark brown sandy clayey silt, low organic		320	1	SS	7													
1.00	SILT: Compact brown silt, trace fine sand, wet mottled grey			2	SS	13													
				3	SS	23													
2.10			319																
2.40	SAND AND GRAVEL: Compact brown sand and gravel, some silt, saturated		318	4	SS	16													
	SILT AND SAND TILL: Compact to very dense grey silt and sand, some gravel, trace clay, moist, with occasional thin layers of wet grey silt, trace sand			5	SS	37													
					317														
					316	6	SS	50 blows/125 mm											
			315																
6.0																			
6.70	BOREHOLE TERMINATED AT 6.70 m			7	SS	50 blows/125 mm													
													Free water encountered below 2.3 m						
													Upon completion of drilling, borehole caved to 5.7 m with free water at 2.4 m						

NOTES

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LOG OF BOREHOLE NO. 17

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50 100 150 200				PLASTIC LIMIT W_p				
							DYNAMIC CONE PENETRATION $\times$				WATER CONTENT W				
							STANDARD PENETRATION TEST $\bullet$				WATER CONTENT %				
							BLOWS/0.3M				10 20 30				
	GROUND ELEVATION 323.42														
0.38	TOPSOIL: Dark brown sandy silt, low organic		323	1	SS	2									
0.70	SAND: Loose brown fine sand, some silt, damp														
	becoming compact light brown fine to coarse sand, trace gravel, trace silt, damp		322	2	SS	12									
1.5															
			322	3	SS	12									
2.10	CLAYEY SILT TILL: Very stiff brown clayey silt, some sand, some gravel, slightly to low plastic, APL to DTPL		321	4	SS	28									
3.0	becoming grey		320	5	SS	25									
4.5	SILT AND SAND TILL: Dense grey silt and sand, some gravel, trace clay, non-plastic, damp, with occasional thin layers of grey wet fine sand		319	6	SS	38							Free water encountered below 4.55 m		
6.0	layers of compact brown saturated fine to coarse sand and gravel, trace silt		317	7	SS	69 blows/250 mm							Upon completion of drilling, borehole wet caved at 4.3 m		
6.80	grey silt and sand														
7.00	BOREHOLE TERMINATED AT 7.00 m														

NOTES

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LOG OF BOREHOLE NO. 18

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p	WATER CONTENT W	WATER CONTENT %		
							DYNAMIC CONE PENETRATION $\times$ STANDARD PENETRATION TEST $\bullet$								
							BLOWS/0.3M								
	GROUND ELEVATION 324.46						20	40	60	80	10	20	30		
0.25	TOPSOIL: Dark brown sandy clayey silt, low organic		324	1	SS	5								Free water encountered below 4.55 m	
	SANDY SILT TILL. Compact brown sandy silt, some gravel, trace clay, non to slightly plastic, moist			2	SS	11									
1.40	CLAYEY SILT TILL: Very stiff brown clayey silt, some sand, some gravel, slightly to low plastic, APL to DTPL		323	3	SS	16									
			322	4	SS	27									
2.90	with occasional thin partings of fine sand			5	SS	20									
			321												
4.00	SAND: Dense brown fine sand, some gravel, some silt, saturated		320	6	SS	59									
4.80	SILT: Very dense brown silt, some fine sand, some gravel, wet		319												
5.70	CLAY TILL: Hard grey silty clay, trace sand, trace gravel, low plastic, DTPL		318												
7.00	BOREHOLE TERMINATED AT 7.00 m			7	SS	36								Upon completion of drilling, borehole wet caved at 4.2 m	

NOTES

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LOG OF BOREHOLE NO. 19

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

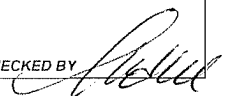
OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p	WATER CONTENT W	WATER CONTENT W		
							DYNAMIC CONE PENETRATION $\times$				STANDARD PENETRATION TEST $\bullet$				
							BLOWS/0.3M				WATER CONTENT %				
							20	40	60	80	10	20	30		
							GROUND ELEVATION 323.35								
0.25	TOPSOIL: Dark brown clayey sandy silt, low organic		323	1	SS	6									
	SILT AND SAND TILL: Compact brown silt and sand, some gravel, trace clay, non-plastic, damp		322	2	SS	26									
1.40	becoming dense			3	SS	35									
2.90	becoming very dense		321	4	SS	41									
				5	SS	95									
														Free water encountered below 4.55 m	
4.00			319												
4.5	SILT: Dense brown silt, some very fine sand, saturated, with layers of brown silty fine sand, saturated			6	SS	39									
5.60			318												
6.0	CLAY TILL: Hard grey silty clay, some sand, trace gravel, low plastic, DTPL		317	7	SS	41									
7.5			316												
8.00				8	SS	37									
	BOREHOLE TERMINATED AT 8.00 m													Upon completion of drilling, borehole wet caved at 4.2 m	

NOTES



LOG OF BOREHOLE NO. 20

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

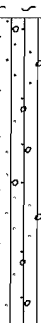
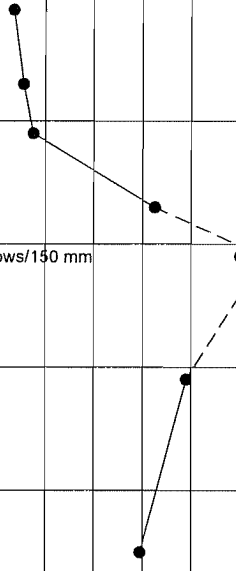
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS				
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200					
							DYNAMIC CONE PENETRATION $\times$ STANDARD PENETRATION TEST $\bullet$					WATER CONTENT W			
							BLOWS/0.3M					WATER CONTENT %			
	GROUND ELEVATION 323.30						20	40	60	80	10	20	30		
0.25	TOPSOIL: Dark brown sandy clayey silt, low organic		323	1	SS	7									
	SANDY SILT TILL: Loose to compact brown sandy silt, some gravel, trace clay, non to slightly plastic, damp														
			322	2	SS	11									
1.5				3	SS	15									
2.10	becoming very dense		321												
				4	SS	65									
3.0			320	5	SS	50 blows/150 mm									
4.00	SILT: Hard grey clayey silt, trace sand, slightly to low plastic, DTPL, with distorted layers of silt		319												
4.5			6	SS	78										
		318													
6.0			317												
7.00	BOREHOLE TERMINATED AT 7.00 m			7	SS	59									
							Upon completion of drilling, borehole open with no free water								

Upon completion of drilling, borehole open with no free water

NOTES

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LOG OF BOREHOLE NO. 21

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS					
DEPTH In METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200						
							DYNAMIC CONE PENETRATION $\times$ STANDARD PENETRATION TEST $\bullet$					PLASTIC LIMIT W_p				
							BLOWS/0.3M					WATER CONTENT W				
							WATER CONTENT %									
	GROUND ELEVATION 321.85						20	40	60	80	10	20	30			
0.30	TOPSOIL: Dark brown clayey sandy silt, low organic			1	SS	6										
	CLAYEY SILT TILL: Stiff to very stiff brown clayey silt, some sand, some gravel, slightly plastic, DTPL			2	SS	15										
1.40	SANDY SILT TILL: Compact brown fine sandy silt, some gravel, trace clay, non to slightly plastic, moist			3	SS	27										
				4	SS	27										
3.0				5	SS	42										
3.20	SILT: Dense brown to grey silt, some fine sand, moist to wet															
4.20																
4.5	CLAY: Hard grey silty clay, low plastic, DTPL, with zones of silt and clayey silt			6	SS	60										
6.0																
6.70																
6.90	SILT: Very dense grey silt, trace very fine sand, moist BOREHOLE TERMINATED AT 6.90 m			7	SS	70										
												Upon completion of drilling, borehole wet caved at 3.6 m				

NOTES

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LOG OF BOREHOLE NO. 22

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

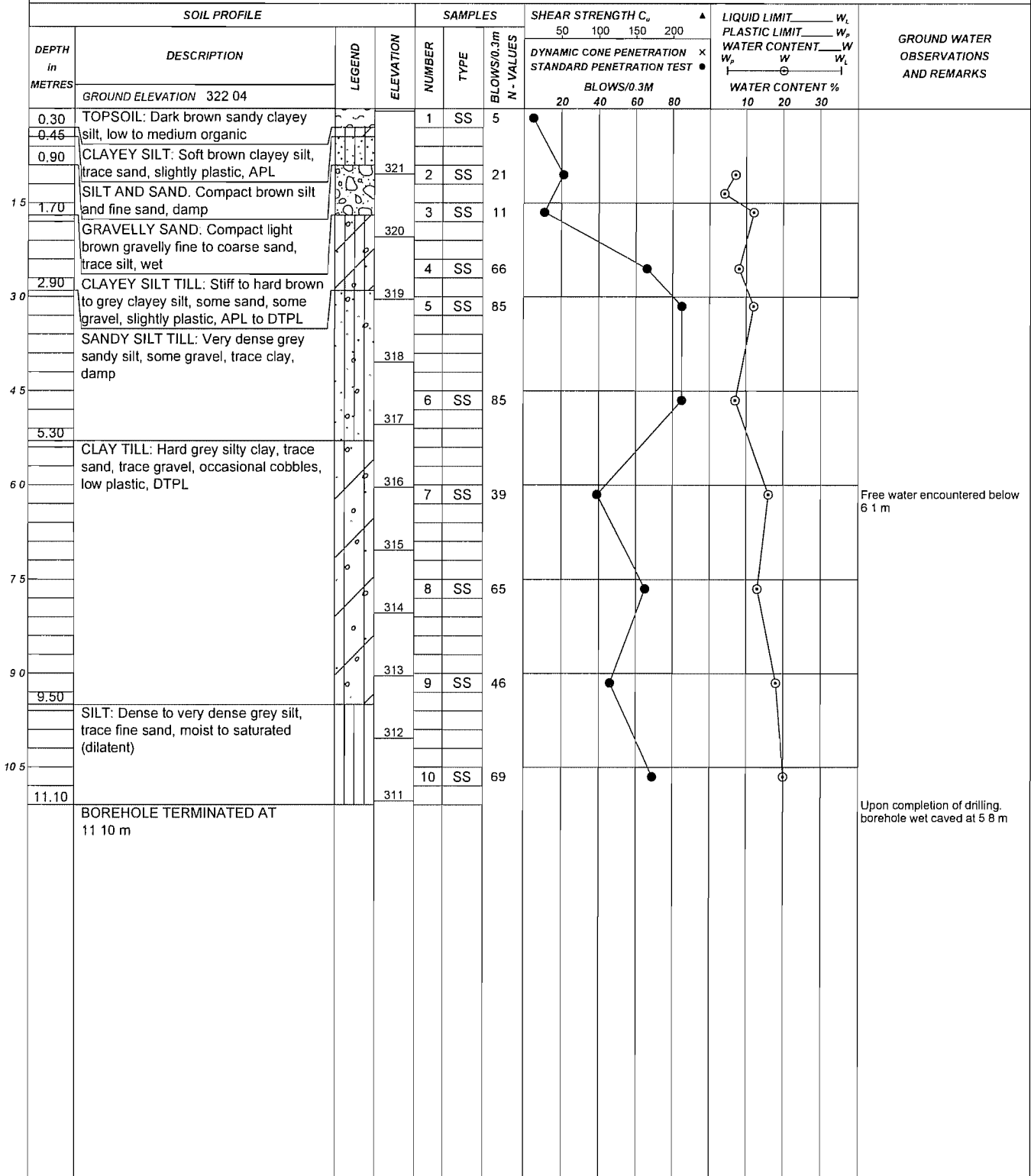
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 29

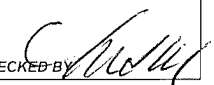
OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey



NOTES

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LOG OF BOREHOLE NO. 23

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 30

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS				
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p	WATER CONTENT W	WATER CONTENT W						
							DYNAMIC CONE PENETRATION $\times$				STANDARD PENETRATION TEST $\bullet$					WATER CONTENT %			
							BLOWS/0.3M				10 20 30								
0.20	TOPSOIL: Dark brown sandy silt, low organic		322	1	SS	13								Free water encountered below 2.3 m					
	SAND AND GRAVEL TILL: Compact to very dense brown fine to coarse sand and gravel, some silt, damp			2	SS	70													
1.5		321	3	SS	82														
2.10	SAND: Compact brown fine to coarse sand, some gravel, trace silt, saturated	320	4	SS	24														
2.90	CLAYEY SILT TILL: Hard brown to grey clayey silt, some sand, some gravel, slightly to low plastic, DTPL	319	5	SS	76														
3.0		318	6	SS	76														
4.5		317																	
5.40		316																	
6.0	SILT AND SAND TILL: Very dense grey silt and sand, some gravel, trace clay, non to slightly plastic, damp	315	7	SS	50 blows/150 mm														
7.5																			
7.70	BOREHOLE TERMINATED AT 7.70 m			8	SS	50 blows/100 mm								Upon completion of drilling, borehole caved to 5.0 m with water seepage from 1.8 m					

NOTES

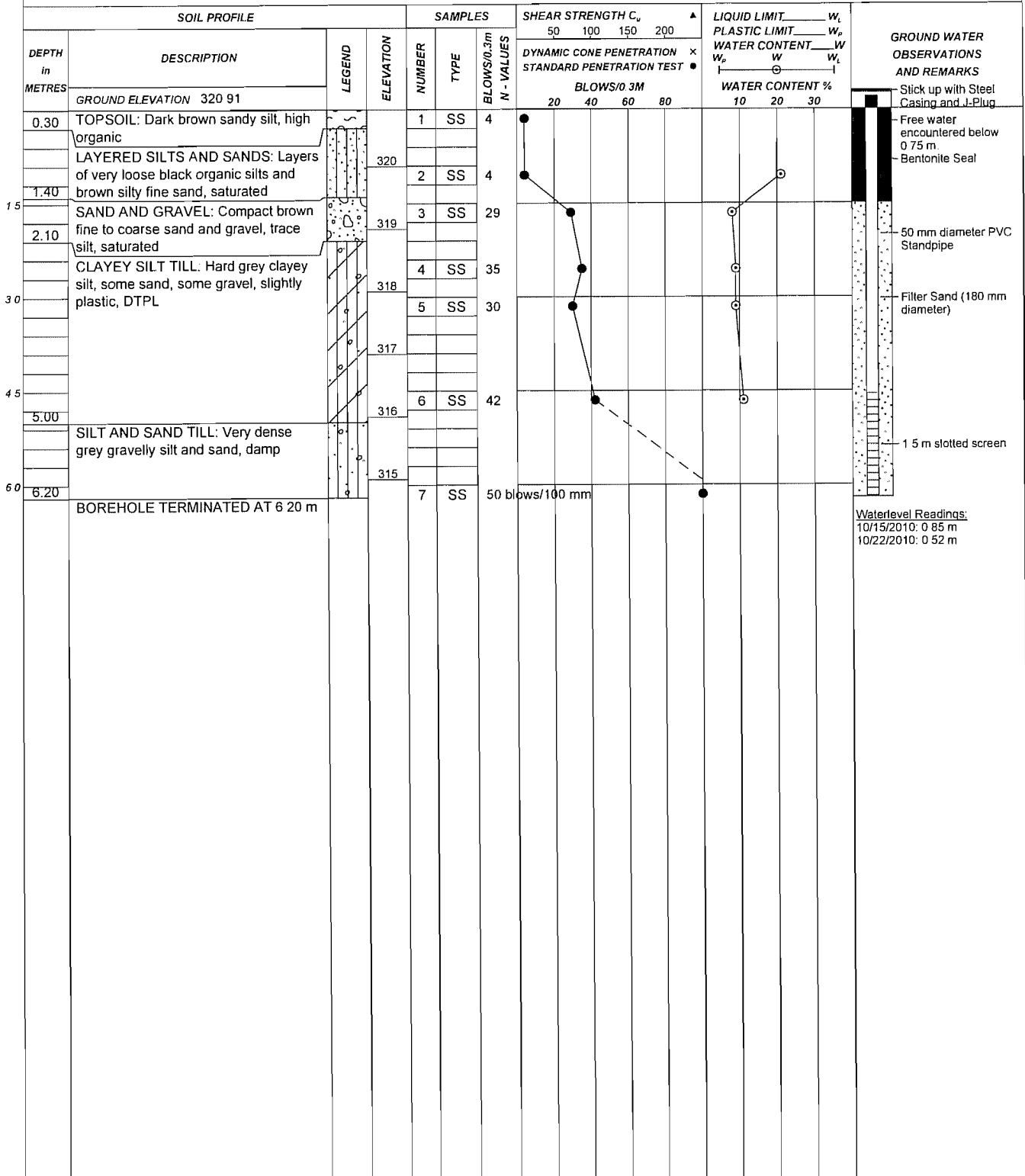
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LOG OF BOREHOLE NO. 24

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 23

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

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LOG OF BOREHOLE NO. 25

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 23

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey

SOIL PROFILE						SAMPLES		SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS		
DEPTH In METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p			
							DYNAMIC CONE PENETRATION		WATER CONTENT W					
							STANDARD PENETRATION TEST							
								BLOWS/0.3M		WATER CONTENT %				
								20	40	60	80	10	20	30

0.20	TOPSOIL: Dark brown sandy silt, low organic		321	1	SS	11			Free water encountered below 1.5 m
	SAND: Compact brown gravelly fine to coarse sand, trace silt, damp		320	2	SS	19			
1.40	SAND AND SILT TILL: Very dense brown gravelly sand and silt, saturated		319	3	SS	50			
2.40	CLAYEY SILT TILL: Very stiff brown sandy clayey silt, trace gravel, slightly plastic, DTPL		318	4	SS	24			
			317						
4.40	layer of dense silt, trace clay, trace fine sand			6	SS	58			
5.10	becoming hard sandy clayey silt, trace gravel, slightly plastic, DTPL		316						
			315						
7.00	BOREHOLE TERMINATED AT 7.00 m			7	SS	61			Upon completion of drilling, borehole wet caved at 2.2 m

Free water encountered below 1.5 m

Upon completion of drilling, borehole wet caved at 2.2 m

NOTES

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LOG OF BOREHOLE NO. 26

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 24

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES		SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS					
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150		200				
							DYNAMIC CONE PENETRATION $\times$				WATER CONTENT W				
							STANDARD PENETRATION TEST $\bullet$				WATER CONTENT %				
							BLOWS/0.3M				WATER CONTENT %				
	GROUND ELEVATION 321.61							20	40	60	80	10	20	30	
0.05	TOPSOIL: Dark brown sandy silt			1	SS	23									
	SAND AND GRAVEL: Compact brown fine to coarse sand and gravel, some silt, dry to damp, with layers of compact brown sandy silt, trace of gravel, trace clay, moist		321	2	SS	22									
1.5			320	3	SS	9									
	CLAYEY SILT TILL: Stiff to very stiff grey clayey silt, some sand, some gravel, slightly plastic, WTPL to APL		319	4	SS	9									
3.0			318	5	SS	18									
4.00															
4.5	SANDY SILT TILL: Dense to very dense grey sandy gravelly silt, trace clay, non-plastic, damp		317	6	SS	44									
			316												
6.0			315												
6.90	BOREHOLE TERMINATED AT 6.90 m			7	SS	85									
															Upon completion of drilling, borehole remained open with no free water

Upon completion of drilling, borehole remained open with no free water

NOTES

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LOG OF BOREHOLE NO. 27

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 27

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS	
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p	WATER CONTENT W	WATER CONTENT W_L			
							DYNAMIC CONE PENETRATION				STANDARD PENETRATION TEST					
							BLOWS/0.3M				WATER CONTENT %					
							20	40	60	80	10	20	30			
	GROUND ELEVATION 322.48															
0.30	PAVEMENT STRUCTURE: 25 mm tar and chip, over 275 mm brown sand and gravel, some silt, damp		322	1	SS									Free water encountered below 6.55 m Upon completion of drilling, borehole wet caved at 5.8 m		
0.50				2	SS	9										
0.70	FILL: Black silty sand, some gravel (old pavement)		321													
1.40	TOPSOIL: Black sandy silt, medium organic			3	SS	8										
1.80	SILT ALLUVIUM: Stiff olive brown clayey silt, some sand		320	4	SS	17										
	SILT AND SAND: Loose brown silt and sand, some gravel, wet			5	SS	50										
	CLAYEY SILT TILL: Stiff to hard brown clayey silt, some sand, some gravel, slightly plastic, WTPL to DTPL		319													
4.20	SANDY SILT TILL: Very dense grey sandy silt, some gravel, trace clay, non to slightly plastic, damp		318	6	SS	70										
4.5			317													
5.80	with zones of grey saturated silt, trace fine sand		316													
6.0																
7.00	BOREHOLE TERMINATED AT 7.00 m			7	SS	82 blows/250 mm										

NOTES

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LOG OF BOREHOLE NO. 28

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 27

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey

SOIL PROFILE						SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS		
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p	WATER CONTENT W			
							DYNAMIC CONE PENETRATION $\times$				STANDARD PENETRATION TEST $\bullet$				
							BLOWS/0.3M				WATER CONTENT %				
							20	40	60	80	10	20		30	
	GROUND ELEVATION 323.56														
0.90	PAVEMENT STRUCTURE: Tar and chip over 875 mm of light brown gravelly fine to coarse sand, some silt, damp		323										Upon completion of drilling, borehole caved to 5.7 m with free water at 4.0 m		
1.5	SANDY SILT TILL: Compact brown fine sandy silt, some gravel, trace clay, non to slightly plastic, moist		322	1	SS	9									
2.10	CLAY TILL: Very stiff brown silty clay, trace sand, trace gravel, low plastic, DTPL, occasional thin partings of silt			2	SS	14									
3.0			321	3	SS	24									
4.00			320	4	SS	22									
4.5	CLAYEY SILT TILL: Hard grey clayey silt, some sand, some gravel, slightly plastic, DTPL		319	5	SS	52									
5.80			318												
6.0	SAND AND GRAVEL: Very dense brown fine to coarse sand and gravel, some silt, saturated		317												
7.00				6	SS	85									
	BOREHOLE TERMINATED AT 7.00 m														

NOTES

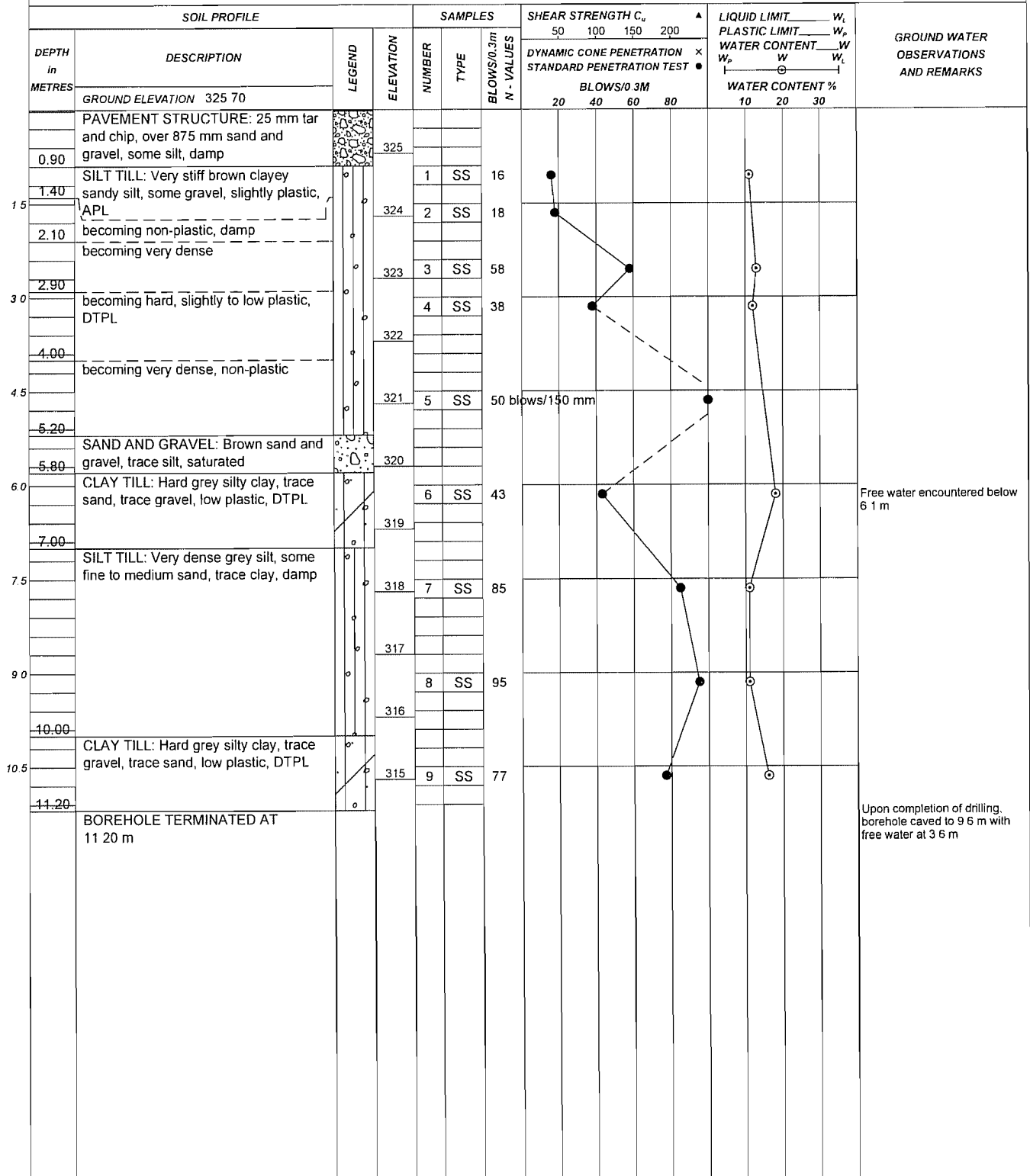
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LOG OF BOREHOLE NO. 29

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 27

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

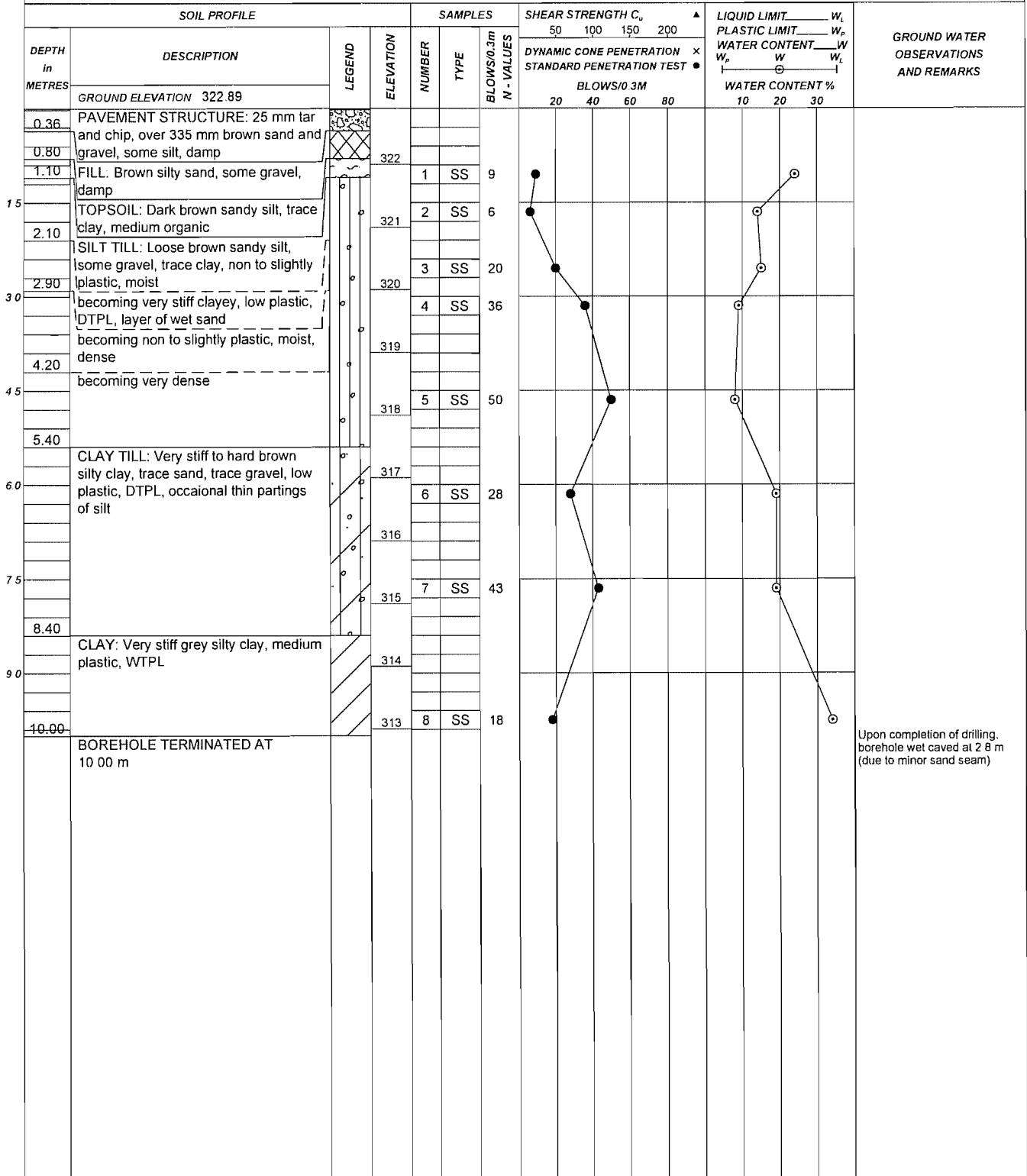
CHECKED BY 

LOG OF BOREHOLE NO. 30

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 27

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

CHECKED BY

LOG OF BOREHOLE NO. 31

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

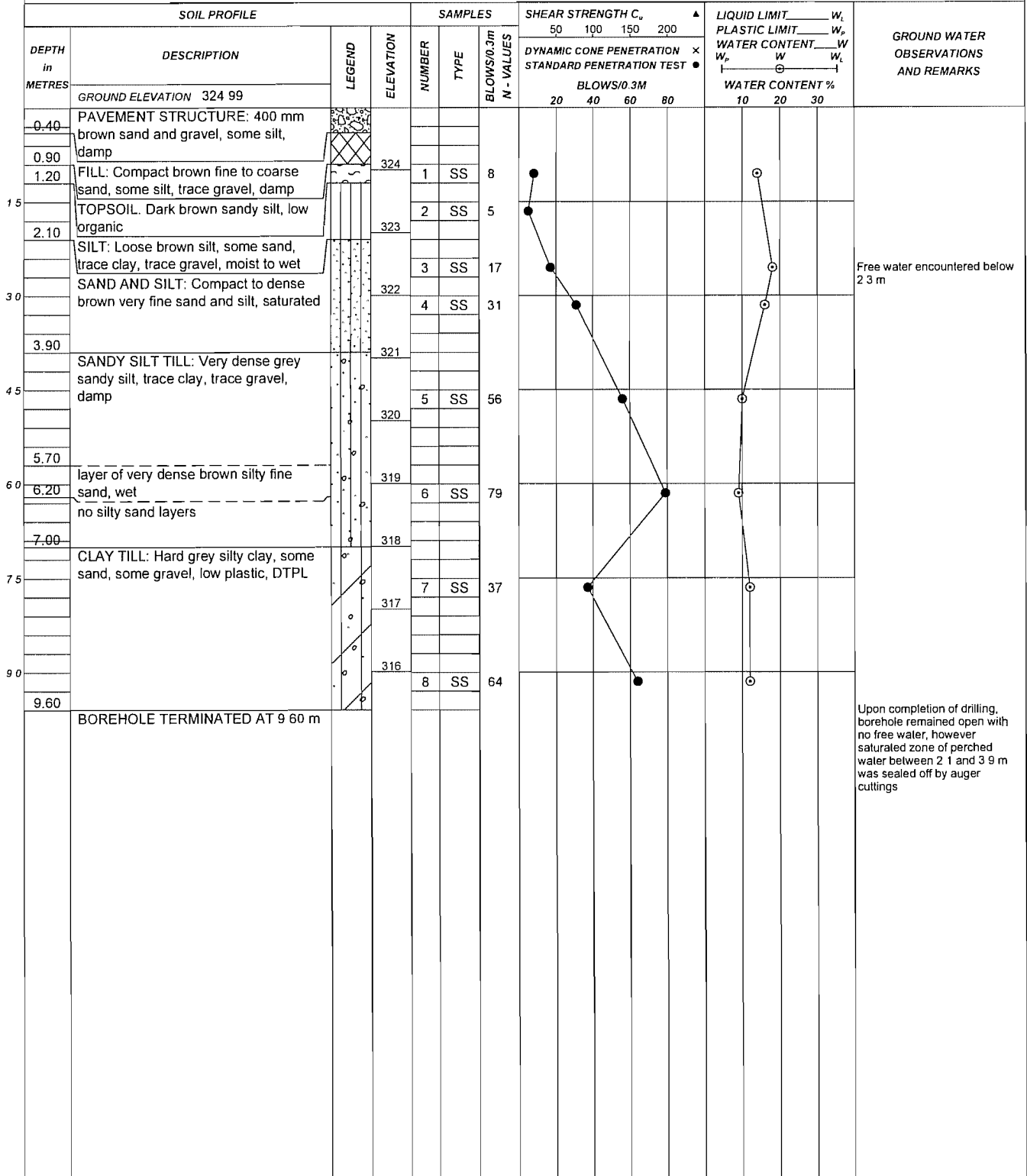
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 24

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey



NOTES

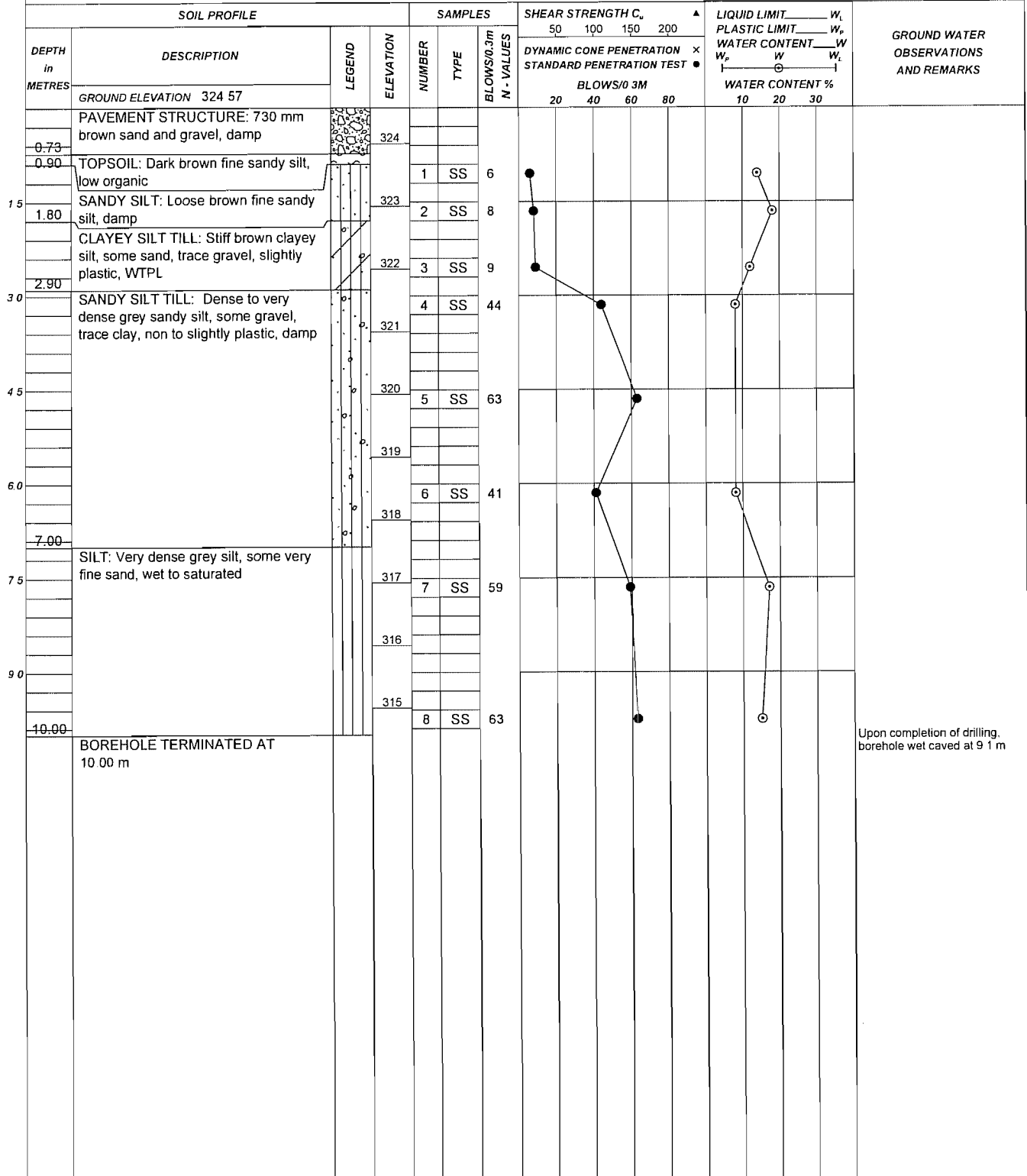
CHECKED BY

LOG OF BOREHOLE NO. 32

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 09 24

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

CHECKED BY

LOG OF BOREHOLE NO. 33

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

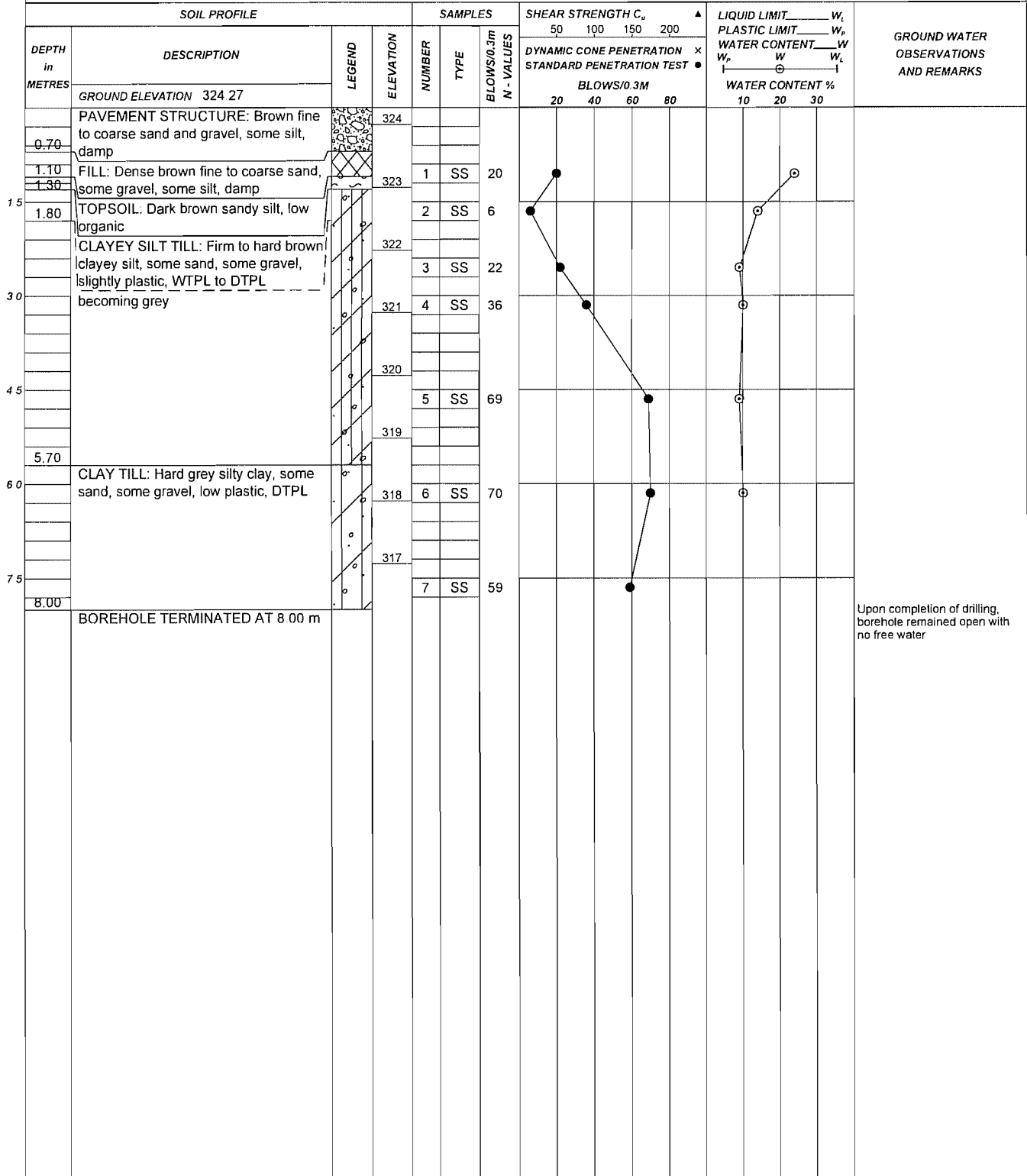
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 27

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey



Upon completion of drilling, borehole remained open with no free water

NOTES

CHECKED BY

LOG OF BOREHOLE NO. 34

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 10 01

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey

SOIL PROFILE			SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L		GROUND WATER OBSERVATIONS AND REMARKS						
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150		200					
							DYNAMIC CONE PENETRATION $\times$				PLASTIC LIMIT W_p					
							STANDARD PENETRATION TEST $\bullet$				WATER CONTENT W					
											WATER CONTENT %					
							20	40	60	80	10	20	30			
0.20	TOPSOIL: Dark brown sandy silt, low organic		323	1	SS	11	●						○			
	SILT AND SAND TILL. Compact to dense brown silt and sand, some gravel, trace clay, damp			2	SS	46	●						○			
1.5				3	SS	36	●						○			
				4	SS	40	●						○			
2.90			becoming very dense		5	SS	66	●						○		
4.00	becoming grey													○		
4.5				319	6	SS	50 blows/125 mm							○		
5.50	CLAYEY SILT TILL: Hard grey clayey silt, some sand, some gravel, slightly plastic, DTPL														○	
6.0				318	7	SS	79	●							○	
6.50	BOREHOLE TERMINATED AT 6.50 m															
															Upon completion of drilling, borehole remained open with no free water	

Upon completion of drilling, borehole remained open with no free water

NOTES

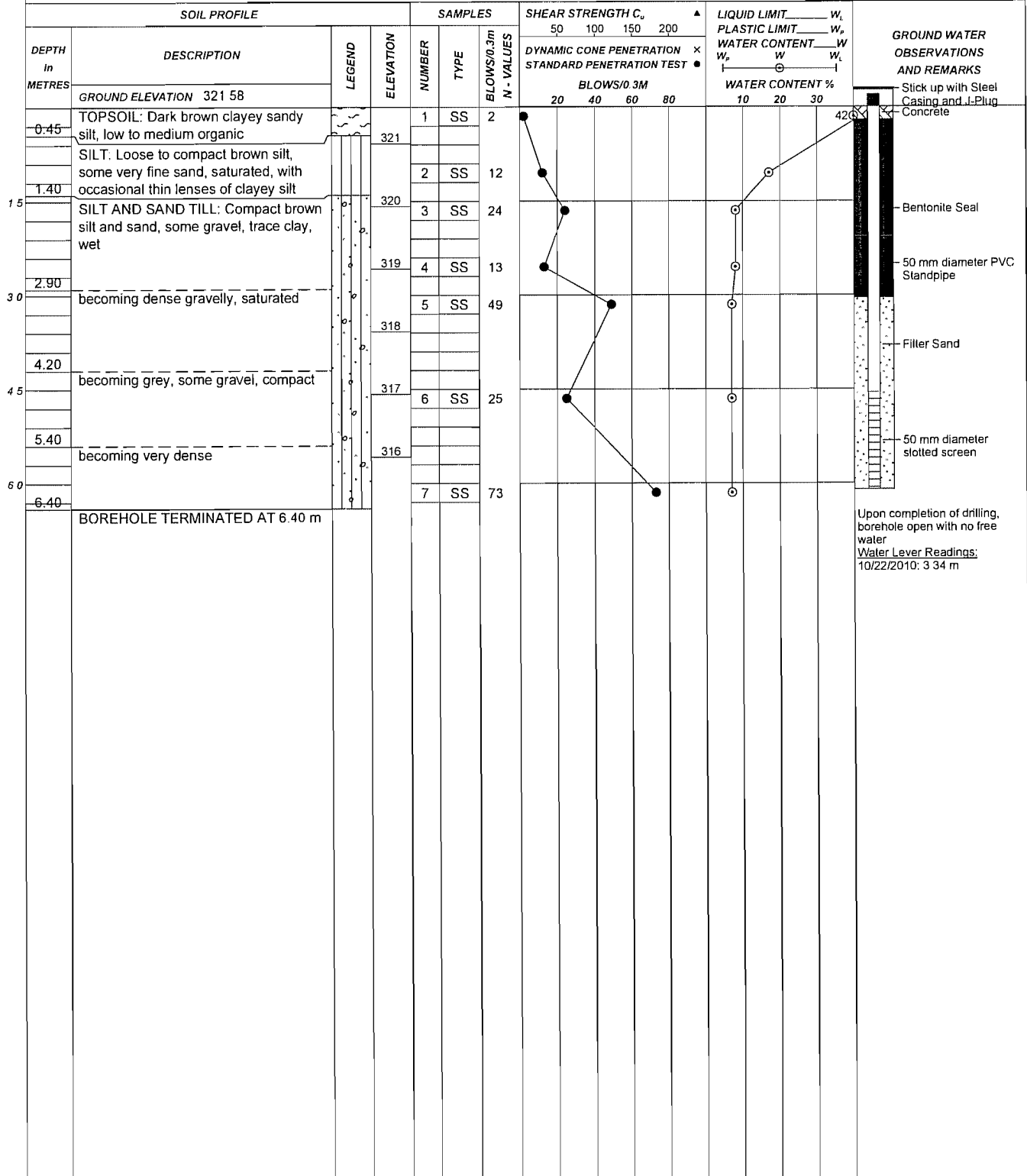
CHECKED BY

LOG OF BOREHOLE NO. 35

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 10 04

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey



NOTES

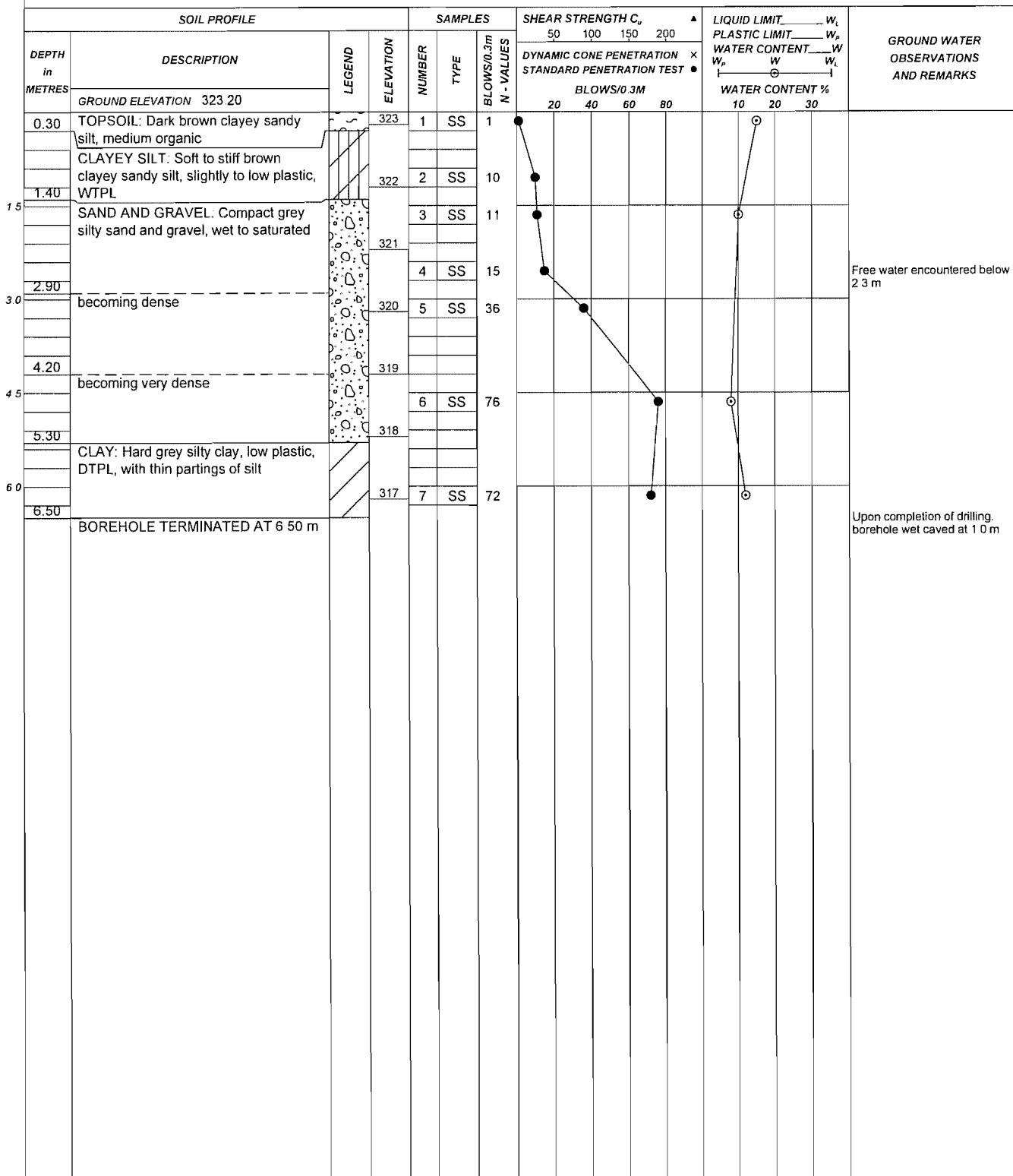
CHECKED BY

LOG OF BOREHOLE NO. 36

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 10 04

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey



NOTES

CHECKED BY

LOG OF BOREHOLE NO. 37

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

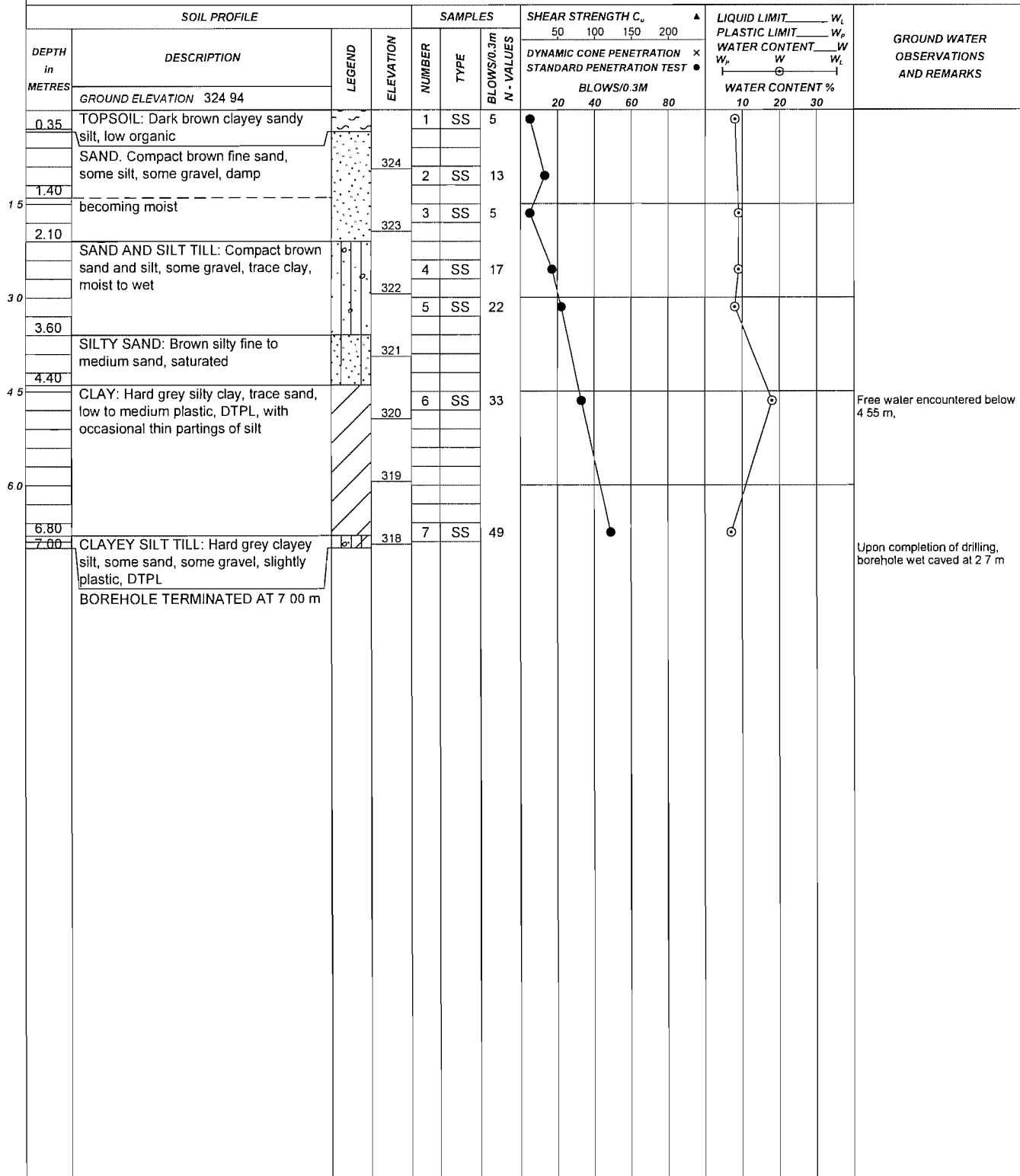
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 10 01

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey



Free water encountered below 4.55 m,

Upon completion of drilling, borehole wet caved at 2.7 m

NOTES

CHECKED BY

LOG OF BOREHOLE NO. 38

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

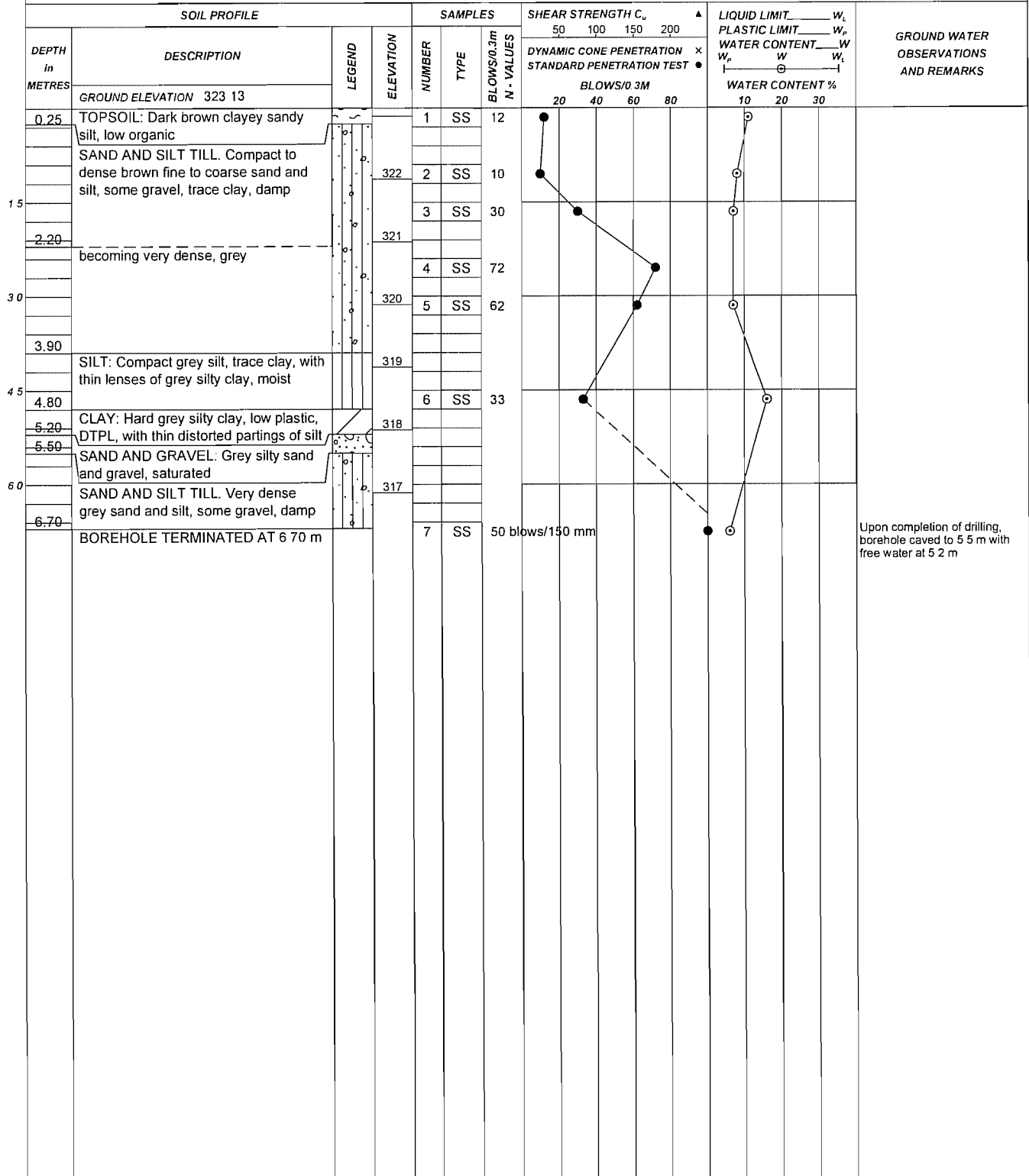
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 10 04

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey



NOTES

CHECKED BY

LOG OF BOREHOLE NO. 39

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 10 04

OUR PROJECT NO. 10KF058

ENGINEER M Molodecki

TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES				SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH In METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50 100 150 200				PLASTIC LIMIT W_p					
							DYNAMIC CONE PENETRATION $\times$				WATER CONTENT W					
							STANDARD PENETRATION TEST $\bullet$				W_p W W_L					
							BLOWS/0.3M				WATER CONTENT %					
	GROUND ELEVATION 323.88						20 40 60 80					10 20 30				
0.35	TOPSOIL: Dark brown silty sand, very low organic			1	SS	3										
	SAND: Loose brown fine to coarse sand, some silt, damp to saturated		323	2	SS	6										
1.40																
1.5	SAND AND SILT TILL: Compact to very dense brown sand and silt, some gravel, trace clay, wet to damp		322	3	SS	18								Free water encountered at 1.5 m		
			321	4	SS	68										
2.90	becoming grey, gravelly			5	SS	67										
3.0			320													
4.5			319	6	SS	58										
			318													
6.0																
6.90	BOREHOLE TERMINATED AT 6.90 m		317	7	SS	76								Upon completion of drilling, borehole remained open with no free water		

NOTES

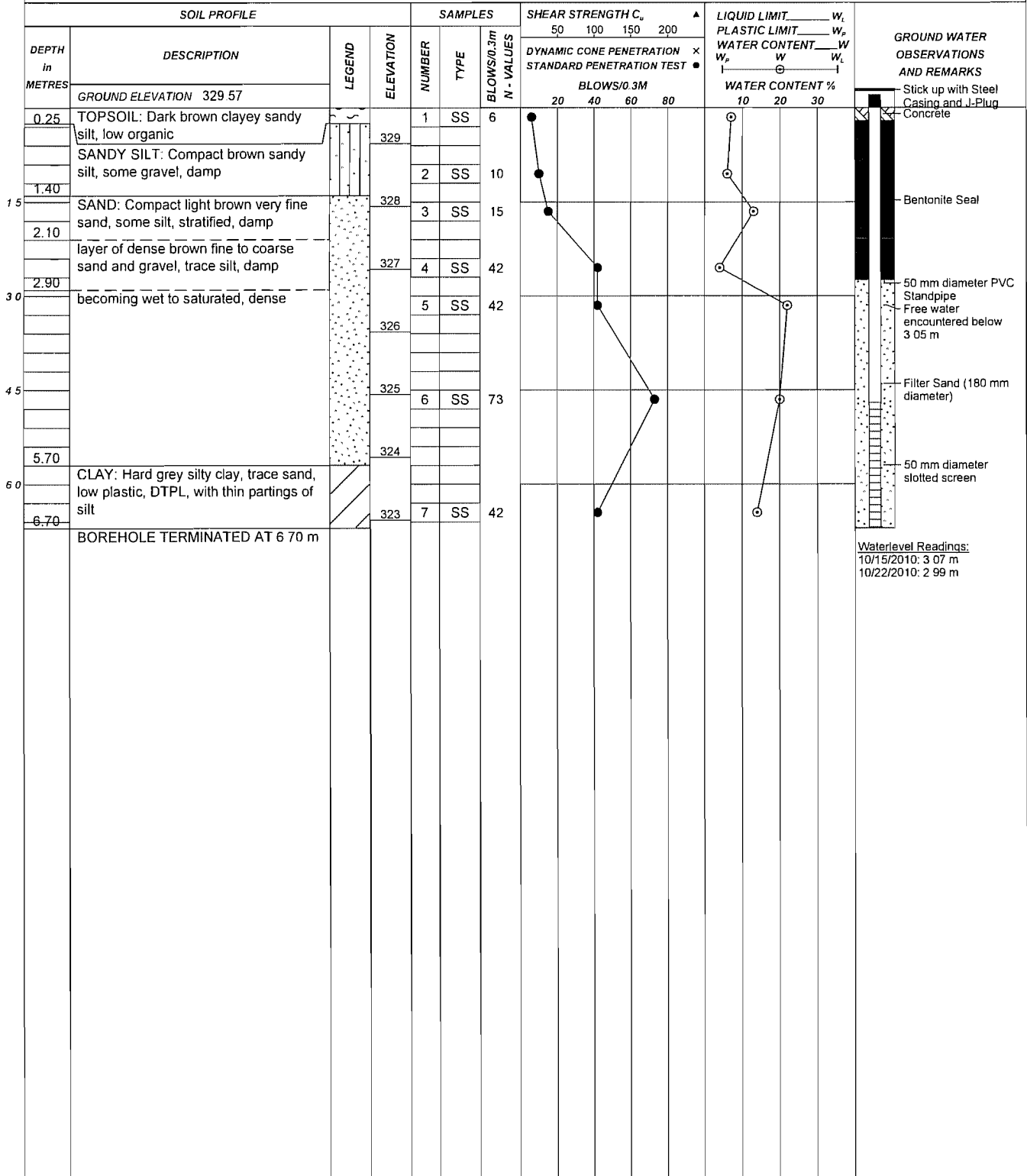
CHECKED BY 

LOG OF BOREHOLE NO. 40

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Hollow Stem Augers

BORING DATE 2010 10 01

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey



NOTES * Sampler overfilled

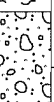
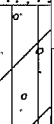
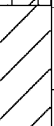
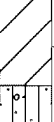
CHECKED BY *[Signature]*

LOG OF BOREHOLE NO. 41

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

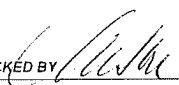
BORING DATE 2010 09 30

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u		LIQUID LIMIT W_L			GROUND WATER OBSERVATIONS AND REMARKS			
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p				
							DYNAMIC CONE PENETRATION						WATER CONTENT W		
							STANDARD PENETRATION TEST						W_p	W	W_L
													WATER CONTENT %		
							BLOWS/0.3M								
0.25	TOPSOIL: Dark brown sandy clayey silt, low organic		325	1	SS	12	20					10			
	SAND AND GRAVEL: Compact brown sand and gravel, some silt, damp				2	SS	24	40					20		
1.40	LAYERED SILTS AND CLAYS: Layers of brown silt, wet, clayey silt, slightly to low plastic, APL and grey silty clay, low to medium plastic, DTPL		324	3	SS	15	20					10			
				4	SS	32	40					20			
				323	5	SS	21	20					10		
2.90	CLAY: Very stiff to hard grey silty clay, trace sand, low to medium plastic, DTPL, with thin lenses and partings of silt		322												
				321	6	SS	37	40					20		
5.40	SAND AND SILT TILL: Very dense grey gravelly sand and silt, trace clay, damp		320												
				7	SS	85	80						10		
7.00	BOREHOLE TERMINATED AT 7.00 m		319												
														Upon completion of drilling, borehole remained open and dry. Overnight, borehole wet caved at 1.4 m	

Upon completion of drilling, borehole remained open and dry. Overnight, borehole wet caved at 1.4 m

NOTES

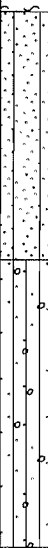
CHECKED BY 

LOG OF BOREHOLE NO. 42

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 30

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u ▲				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50 100 150 200				PLASTIC LIMIT W_p				
							DYNAMIC CONE PENETRATION ×				WATER CONTENT W				
							STANDARD PENETRATION TEST ●				W_p W W_L				
							BLOWS/0.3M				WATER CONTENT %				
	GROUND ELEVATION 326 28						20	40	60	80	10	20	30		
0.18	TOPSOIL Dark brown sandy silt, some gravel, low organic		326	1	SS	5	●					○			
	SILTY SAND: Loose to compact brown silty fine sand, trace gravel, damp						●					○			
							●					○			
1.5								●					○		
				325	2	SS	10								
				3	SS	19									
2.10	becoming wet to saturated		324				●								
				4	SS	19									
3.0															
3.20	SILT AND SAND TILL: Very dense brown gravelly silt and sand, trace clay, damp		323	5	SS	69						○			
4.20	becoming grey		322												
4.5				6	SS	85						○			
			321												
6.0															
			320												
6.70	BOREHOLE TERMINATED AT 6.70 m			7	SS	50 blows/110 mm						●			
														Upon completion of drilling, borehole remained open with no free water	

NOTES

CHECKED BY

LOG OF BOREHOLE NO. 43

PROJECT PROPOSED MIXED USE DEVELOPMENT

LOCATION Township of Woolwich (Breslau), Ontario

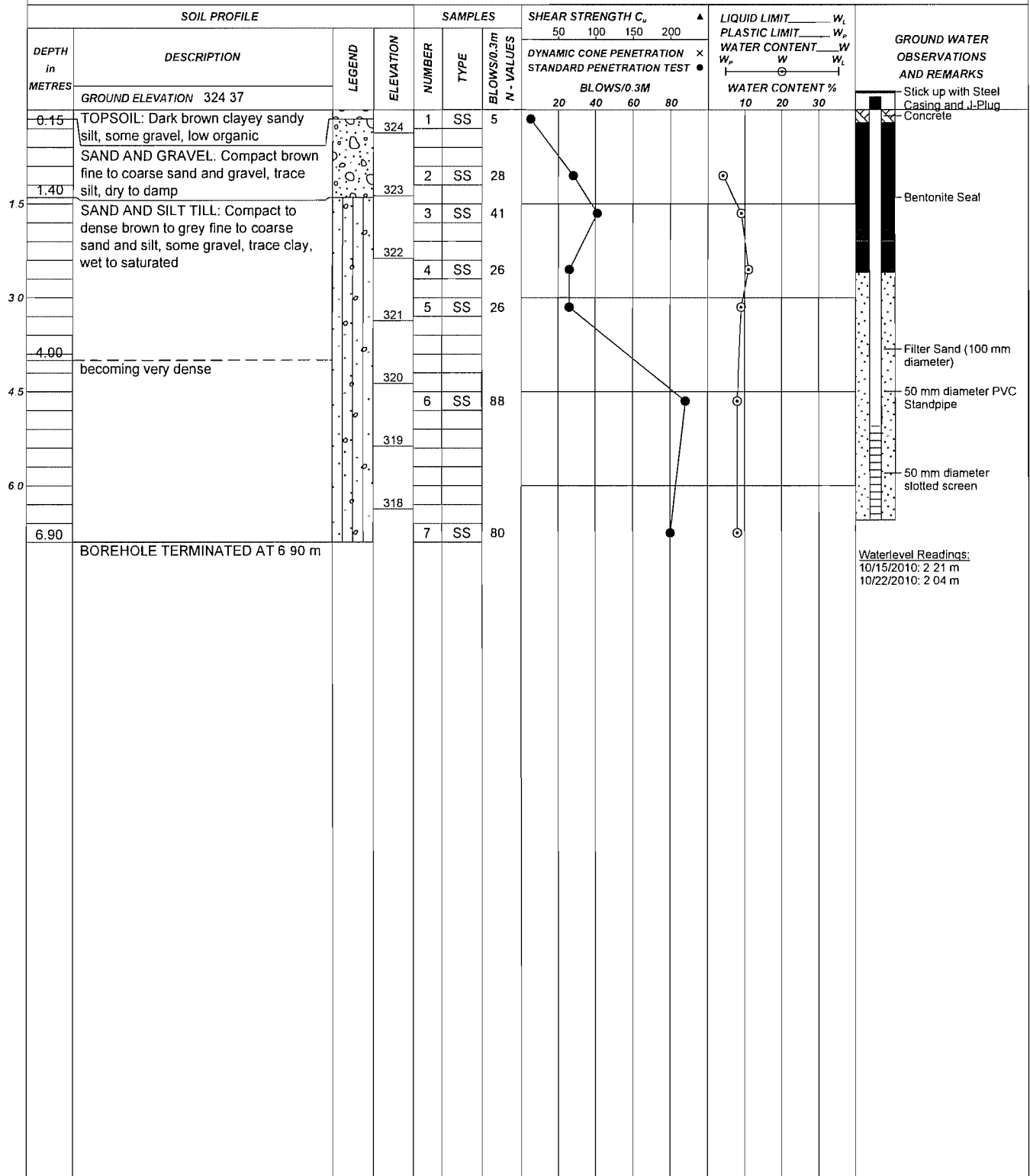
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 30

OUR PROJECT NO. 10KF058

ENGINEER M. Molodecki

TECHNICIAN M. Rapsey



Waterlevel Readings:
10/15/2010: 2.21 m
10/22/2010: 2.04 m

NOTES

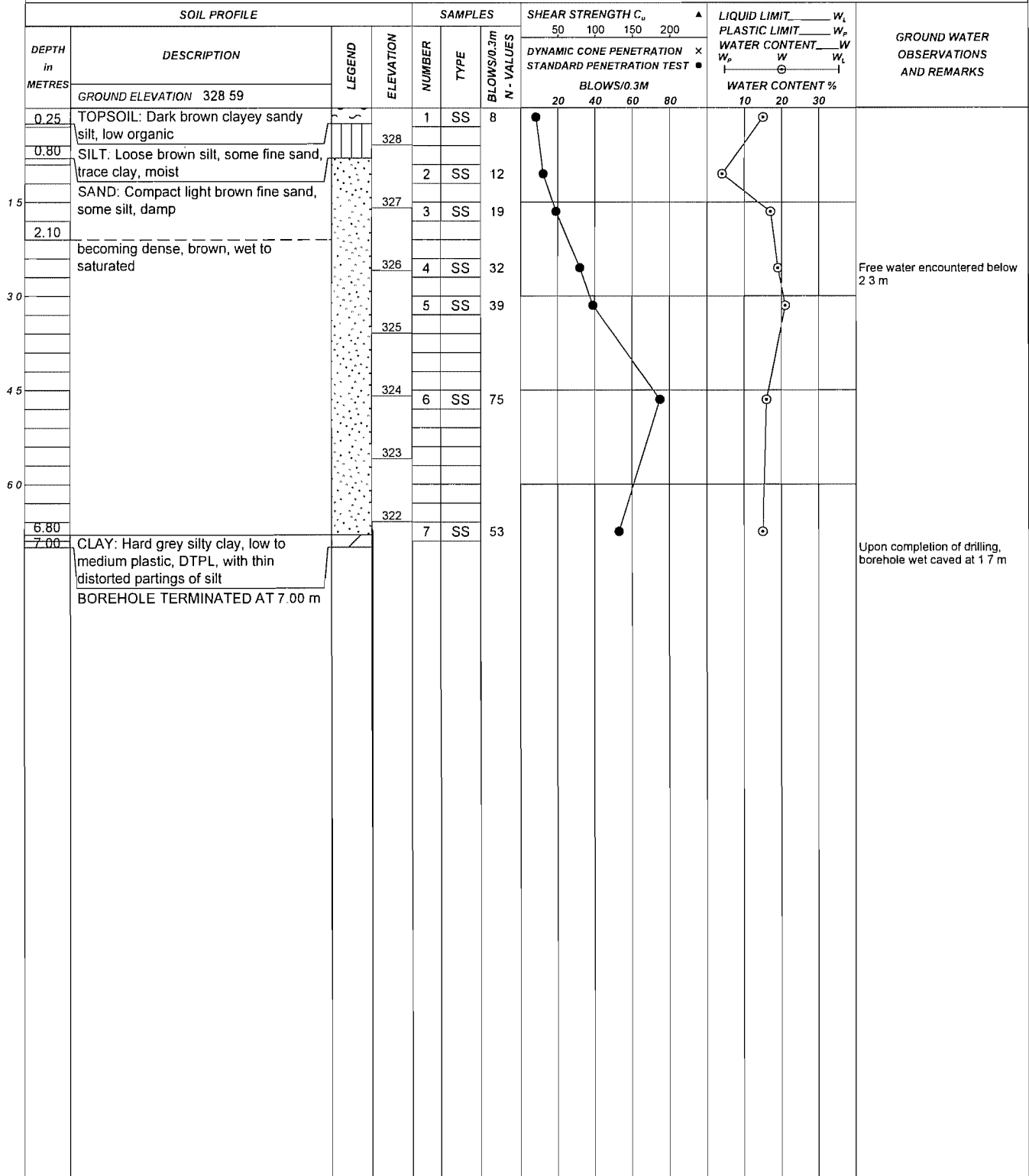
CHECKED BY

LOG OF BOREHOLE NO. 44

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 10 01

OUR PROJECT NO. 10KF058
ENGINEER M Molodecki
TECHNICIAN M Rapsey



NOTES * Sampler overfilled

CHECKED BY

LOG OF BOREHOLE NO. 45

PROJECT PROPOSED MIXED USE DEVELOPMENT
LOCATION Township of Woolwich (Breslau), Ontario
BORING METHOD Continuous Flight Solid Stem Augers

BORING DATE 2010 09 30

OUR PROJECT NO. 10KF058
ENGINEER M. Molodecki
TECHNICIAN M. Rapsey

SOIL PROFILE				SAMPLES			SHEAR STRENGTH C_u				LIQUID LIMIT W_L				GROUND WATER OBSERVATIONS AND REMARKS
DEPTH in METRES	DESCRIPTION	LEGEND	ELEVATION	NUMBER	TYPE	BLOWS/0.3m N - VALUES	50	100	150	200	PLASTIC LIMIT W_p	WATER CONTENT W	WATER CONTENT %		
							DYNAMIC CONE PENETRATION $\times$				WATER CONTENT W				
							STANDARD PENETRATION TEST $\bullet$				WATER CONTENT W				
							BLOWS/0.3M				WATER CONTENT %				
0.25	TOPSOIL: Dark brown sandy clayey silt, low organic			1	SS	8									
	SAND AND SILT. Compact brown sand and silt, some gravel, damp		325	2	SS	18									
1.40	SILT AND SAND TILL: Compact brown silt and sand, some gravel, trace clay, moist		324	3	SS	18									
2.10	becoming very dense, gravelly			4	SS	71									
2.90	becoming grey		323	5	SS	88									
			322												
4.5			321	6	SS	85									
			320												
6.0															
6.70	BOREHOLE TERMINATED AT 6.70 m			7	SS	50 blows/150 mm									
</															

NOTES

CHECKED BY 



APPENDIX A

Borehole Permeability Testing Plots

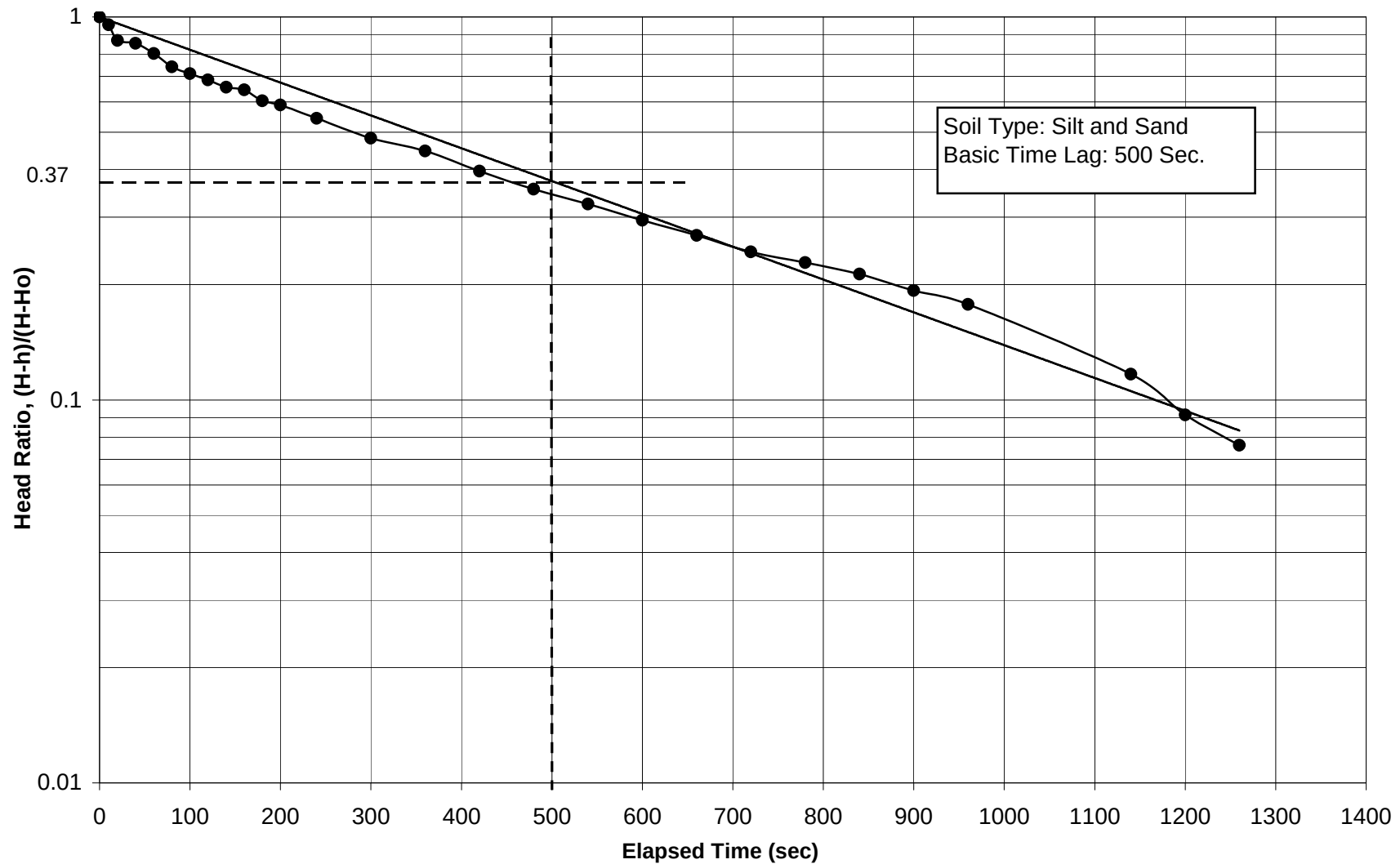
Date:	22-Oct-10	H = Static Water Level	mbgs
Conducted by:	AL	Ho = Head at time = 0	mbgs
		h = Water Level at time t	mbgs
Well Number:	MW2	To =	500 sec
Well Screen Bottom:	9.60 mbgs		
Top of Pipe:	1.1 mags	L =	150 cm
Well Casing Diameter:	2.0" ID	2R =	15.24 cm
Well Elevation:	314.44 masl	2r =	5.08 cm
Static Water Level:	2.23 mbgs		
Ground Elevation:	314.44 masl		

$$K = \frac{r^2}{2LT_0} \ln\left(\frac{L}{R}\right) = \boxed{1.3E-04} \text{ cm/s}$$

Time t (sec)	Water Level (mbgs)	Water Level Elevation (masl)
0	4.20	310.24
10	4.11	310.33
20	3.94	310.50
40	3.91	310.53
60	3.81	310.63
80	3.69	310.75
100	3.63	310.81
120	3.58	310.86
140	3.52	310.92
160	3.50	310.94
180	3.42	311.02
200	3.39	311.05
240	3.30	311.14
300	3.18	311.26
360	3.11	311.33
420	3.01	311.43
480	2.93	311.51
540	2.87	311.57

Time t (sec)	H-h	H-Ho	(H-h)/(H-Ho)
0	1.970	1.970	1.000
10	1.880	1.970	0.954
20	1.710	1.970	0.868
40	1.680	1.970	0.853
60	1.580	1.970	0.802
80	1.460	1.970	0.741
100	1.400	1.970	0.711
120	1.350	1.970	0.685
140	1.290	1.970	0.655
160	1.270	1.970	0.645
180	1.190	1.970	0.604
200	1.160	1.970	0.589
240	1.070	1.970	0.543
300	0.950	1.970	0.482
360	0.880	1.970	0.447
420	0.780	1.970	0.396
480	0.700	1.970	0.355
540	0.640	1.970	0.325

Plot of Normalized Head Versus Elapsed Time - Borehole 2 (MW2) Slug Test



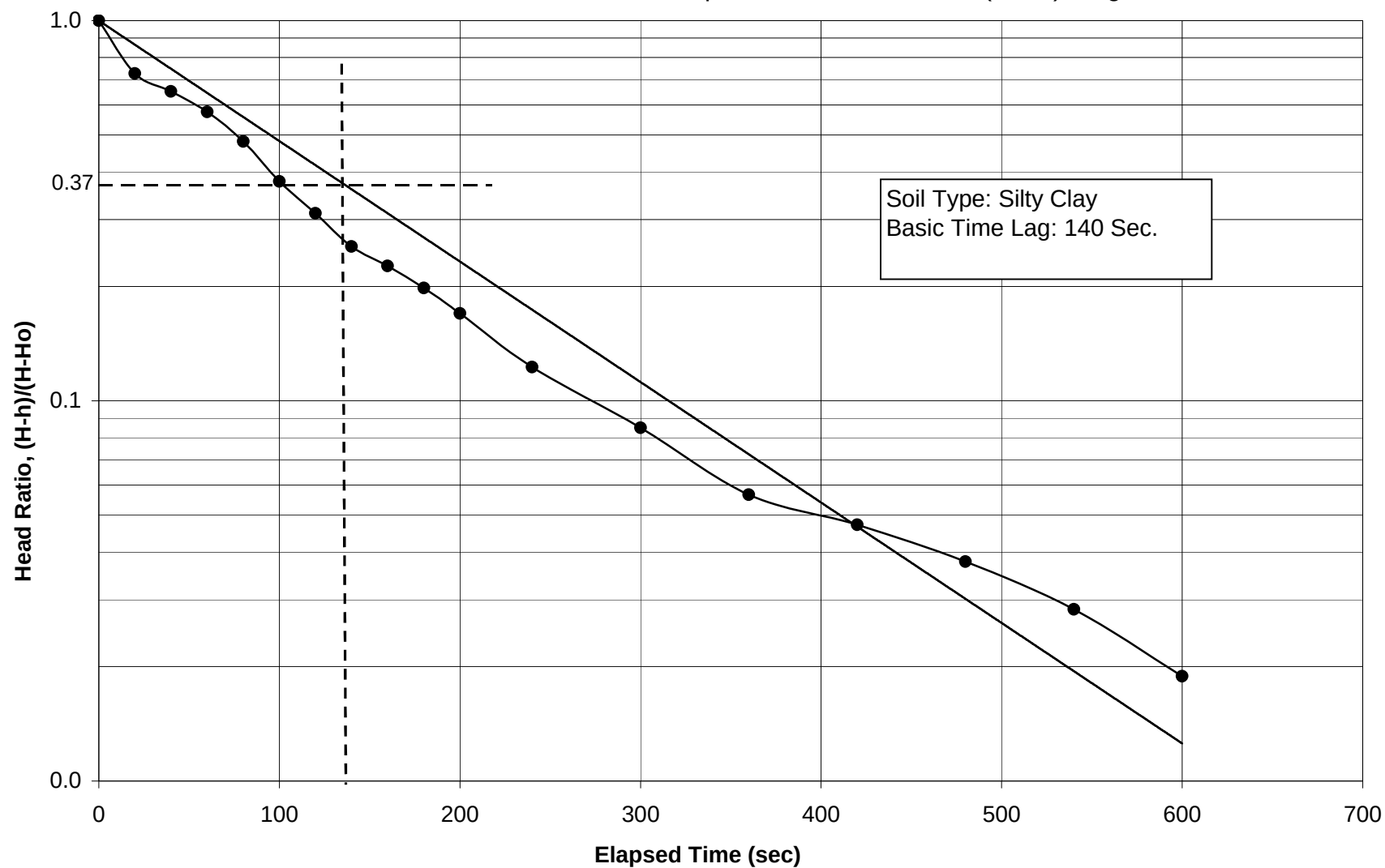
Date:	22-Oct-10	H = Static Water Level	mbgs
Conducted by:	AL	Ho = Head at time = 0	mbgs
		h = Water Level at time t	mbgs
Well Number:	MW7	To =	140 sec
Well Screen Bottom:	11.90 mbgs		
Top of Pipe:	0.66 mags	L =	300 cm
Well Casing Diameter:	2.0" ID	2R =	15.24 cm
Well Elevation:	321.8 masl	2r =	5.08 cm
Static Water Level:	5.35 mbgs		
Ground Elevation:	321.8 masl		

$$K = \frac{r^2}{2LT_0} \ln\left(\frac{L}{R}\right) = \boxed{2.8E-04} \text{ cm/s}$$

Time t (sec)	Water Level (mbgs)	Water Level Elevation (masl)
0	6.41	315.39
20	6.12	315.68
40	6.04	315.76
60	5.96	315.84
80	5.86	315.94
100	5.75	316.05
120	5.68	316.12
140	5.62	316.18
160	5.59	316.21
180	5.56	316.24
200	5.53	316.27
240	5.48	316.32
300	5.44	316.36
360	5.41	316.39
420	5.40	316.40
480	5.39	316.41
540	5.38	316.42
600	5.37	316.43
660	5.36	316.44

Time t (sec)	H-h	H-Ho	(H-h)/(H-Ho)
0	1.060	1.060	1.000
20	0.770	1.060	0.726
40	0.690	1.060	0.651
60	0.610	1.060	0.575
80	0.510	1.060	0.481
100	0.400	1.060	0.377
120	0.330	1.060	0.311
140	0.270	1.060	0.255
160	0.240	1.060	0.226
180	0.210	1.060	0.198
200	0.180	1.060	0.170
240	0.130	1.060	0.123
300	0.090	1.060	0.085
360	0.060	1.060	0.057
420	0.050	1.060	0.047
480	0.040	1.060	0.038
540	0.030	1.060	0.028
600	0.020	1.060	0.019
660	0.010	1.060	0.009

Plot of Normalized Head Versus Elapsed Time - Borehole 7 (MW7) Slug Test



Date:	22-Oct-10	H =	Static Water Level	mbgs
Conducted by:	AL	Ho =	Head at time = 0	mbgs
		h =	Water Level at time t	mbgs
Well Number:	MW24	T ₀ =	552	sec
Well Screen Bottom:	6.2			mbgs
Top of Pipe:	1.03			mags
Well Casing Diameter:	2.0" ID	L =	150	cm
Well Elevation:	320.91	2R =	15.24	cm
Static Water Level:	3.1	2r =	5.08	cm
Ground Elevation:	320.91			masl

$$K = \frac{r^2}{2LT_0} \ln\left(\frac{L}{R}\right) = \mathbf{1.2E-04} \text{ cm/s}$$

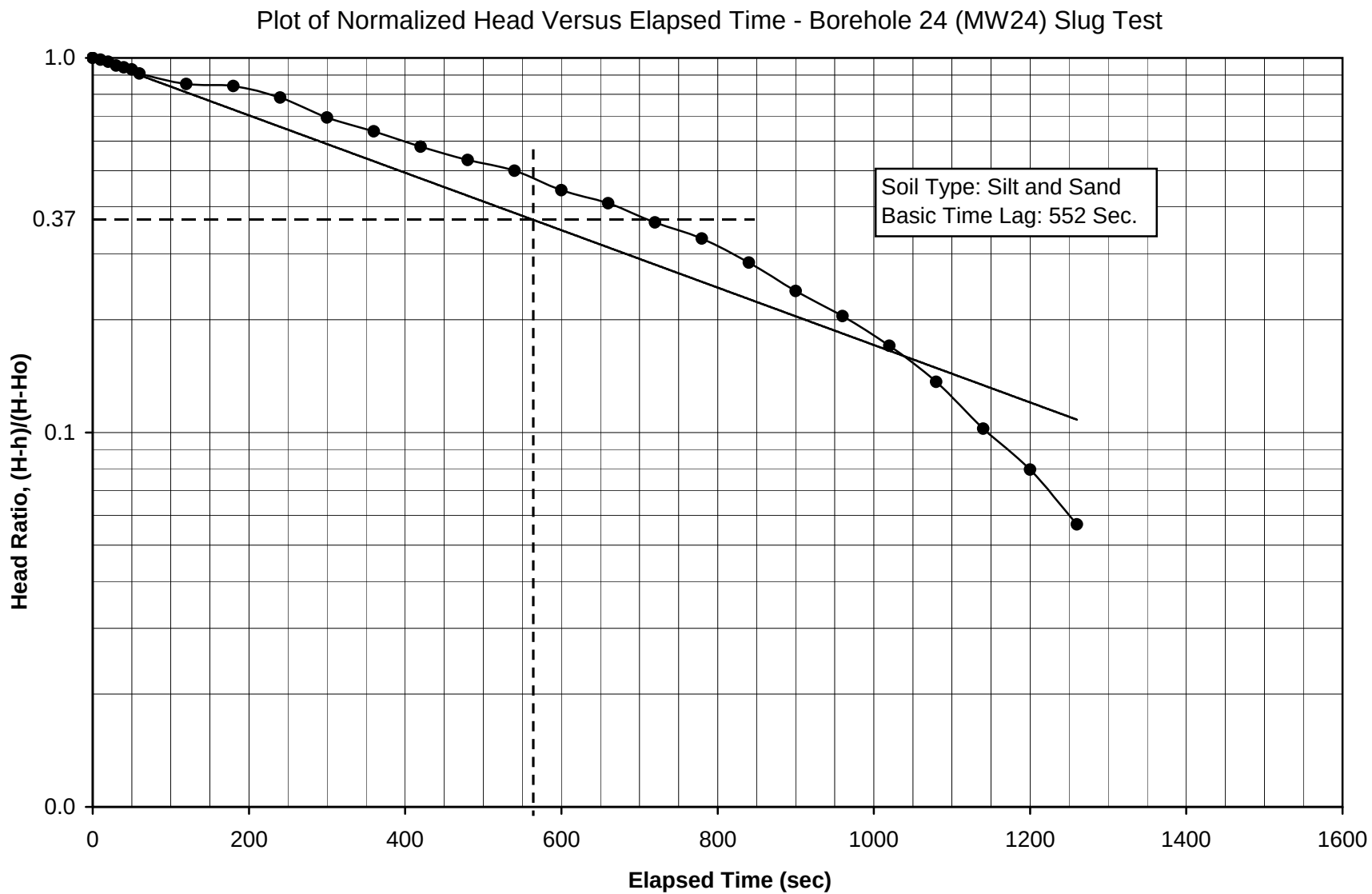
Time t (sec)	Water Level (mbgs)	Water Level Elevation (masl)
0	3.98	316.93
10	3.97	316.94
20	3.96	316.95
30	3.94	316.97
40	3.93	316.98
50	3.92	316.99
60	3.90	317.01
120	3.85	317.06
180	3.84	317.07
240	3.79	317.12
300	3.71	317.20
360	3.66	317.25
420	3.61	317.30
480	3.57	317.34
540	3.54	317.37
600	3.49	317.42
660	3.46	317.45
720	3.42	317.49
780	3.39	317.52
840	3.35	317.56
900	3.31	317.60

Time t (sec)	H-h	H-Ho	(H-h)/(H-Ho)
0	0.880	0.880	1.000
10	0.870	0.880	0.989
20	0.860	0.880	0.977
30	0.840	0.880	0.955
40	0.830	0.880	0.943
50	0.820	0.880	0.932
60	0.800	0.880	0.909
120	0.750	0.880	0.852
180	0.740	0.880	0.841
240	0.690	0.880	0.784
300	0.610	0.880	0.693
360	0.560	0.880	0.636
420	0.510	0.880	0.580
480	0.470	0.880	0.534
540	0.440	0.880	0.500
600	0.390	0.880	0.443
660	0.36	0.880	0.409
720	0.32	0.880	0.364
780	0.29	0.880	0.330
840	0.25	0.880	0.284
900	0.21	0.880	0.239



Time t (sec)	Water Level (mbgs)	Water Level Elevation (masl)
960	3.28	317.63
1020	3.25	317.66
1080	3.22	317.69
1140	3.19	317.72
1200	3.17	317.74
1260	3.15	317.76
1320	3.13	317.78

Time t (sec)	H-h	H-Ho	(H-h)/(H-Ho)
960	0.18	0.880	0.205
1020	0.15	0.880	0.170
1080	0.12	0.880	0.136
1140	0.09	0.880	0.102
1200	0.07	0.880	0.080
1260	0.05	0.880	0.057
	0.03		





APPENDIX B

Ground Water Sample Laboratory Certificates of Analyses



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T445919

PROJECT NO: 10KF058

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Dave Azo

Microbiological Analysis (water)

DATE SAMPLED: Oct 22, 2010

DATE RECEIVED: Oct 22, 2010

DATE REPORTED: Oct 29, 2010

SAMPLE TYPE: Water

Parameter	Unit	G / S	RDL	MW2 2080901
Fecal Coliform	CFU/100mL	200	1	<1

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Waterloo Storm Sewer

Certified By:

Elizabeth Potokowska



AGAT Laboratories

Certificate of Analysis

AGAT WORK ORDER: 10T445919

PROJECT NO: 10KF058

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Dave Azo

Waterloo Storm Sewer Use By-law - Inorganics

DATE SAMPLED: Oct 22, 2010

DATE RECEIVED: Oct 22, 2010

DATE REPORTED: Oct 29, 2010

SAMPLE TYPE: Water

Parameter	Unit	G / S	RDL	MW2 2080901
pH	NA		NA	8.00
Total Suspended Solids	mg/L	15	12	37
Total Cadmium	mg/L	0.05	0.001	<0.001
Total Chromium	mg/L	0.2	0.002	0.003
Total Copper	mg/L	1.0	0.005	<0.005
Total Lead	mg/L	0.05	0.010	<0.010
Total Nickel	mg/L	0.5	0.003	0.003
Total Zinc	mg/L	0.5	0.001	0.297
Total Mercury	mg/L		0.0001	<0.0001

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard: Refers to Waterloo Storm Sewer

Certified By:

Elizabeth Potokowska



AGAT Laboratories

Guideline Violation

AGAT WORK ORDER: 10T445919

PROJECT NO: 10KF058

5835 COOPERS AVENUE
MISSISSAUGA, ONTARIO
CANADA L4Z 1Y2
TEL (905)712-5100
FAX (905)712-5122
<http://www.agatlabs.com>

CLIENT NAME: PETO MACCALLUM LIMITED

ATTENTION TO: Dave Azo

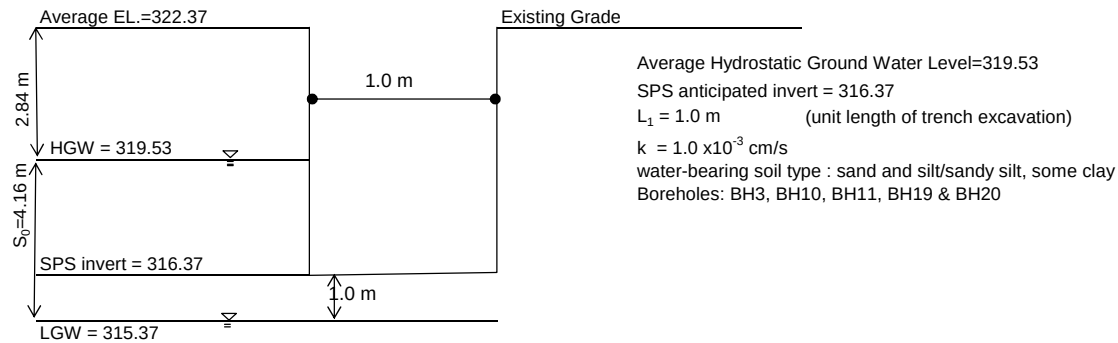
SAMPLEID	SAMPLE TITLE	GUIDELINE	ANALYSIS PACKAGE	PARAMETER	GUIDEVALUE	RESULT
2080901	MW2	Waterloo Storm Sewer	Waterloo Storm Sewer Use By-law - Inorganics	Total Suspended Solids	15	37



APPENDIX C

Approximate Calculations for Estimation of Construction Dewatering Rates

1) Zone 1: Proposed Sewage Pumping Station (SPS) to 6.0 m Below Grades
Assumptions: SPS to be 1.0 m wide and Trench Excavation to be 1.0 m long



Calculations

$$\text{SEEPAGE AREA} = 2 \times 3.16 \times (1.0 + 1.0) + (1.0 + 1.0) \text{ m}^2$$

$$= 13.64 \text{ m}^2 \text{ per unit width and unit length of excavation}$$

R_0 = Dewatering Zone of influence

$$R_0(\text{m}) = 3000 S_0 k^{1/2} \text{ with } S_0 \text{ in m and } k \text{ in m/s}$$

$$R_0 = 3000 \times (319.53 - 315.37) \times (4.0 \times 10^{-6})^{1/2} = \underline{25.0 \text{ m}}$$

Flow gradient

$$i = S_0 / R_0$$

$$i = 4.16 / 39 = 11.0\%$$

Discharge

$$Q = kiA = 4.0 \times 10^{-5} \times 0.011 \times 13.64$$

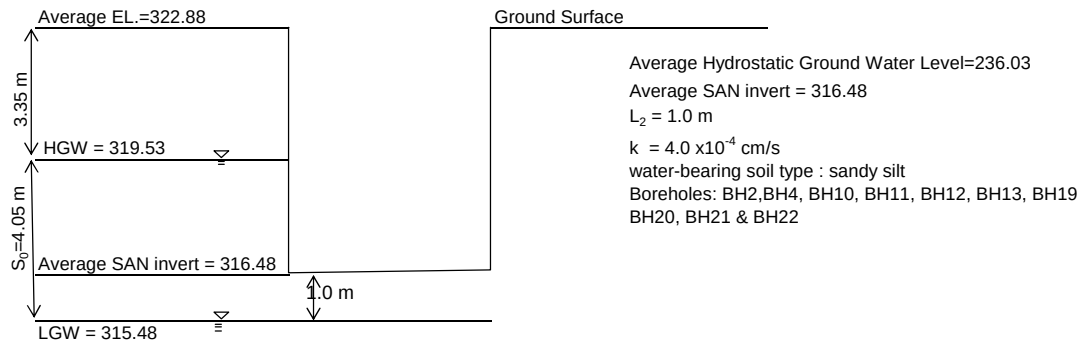
$$Q = 0.000015 \text{ m}^3/\text{s} = 0.015 \text{ L/sec}$$

$$\underline{Q_1 = 1,300 \text{ L/Day per unit width and unit length of excavation}}$$

2) Zone 2: Sanitary Sewers and Associated Drainage Manholes Installation within the Proposed Subdivision

Assumptions: sanitary sewer trench is to be 1.0 m wide and Trench Excavation to be 1.0 m long.

Average sanitary sewer depth = 6.40 m below grades. (average value from approximate SAN depths provided)



Calculations

$$\text{SEEPAGE AREA} = 2 \times 3.05 \times (1.0 + 1.0) + (1.0 + 1.0) \text{ m}^2$$

$$= 14.20 \text{ m}^2$$

R_0 = Dewatering Zone of influence

$$R_0(\text{m}) = 3000 S_0 k^{1/2} \text{ with } S_0 \text{ in m and } k \text{ in m/s}$$

$$R_0 = 3000 \times (236.03 - 231.503) \times (7.0 \times 10^{-5})^{1/2} = \underline{\underline{114.0 \text{ m}}}$$

Flow gradient

$$i = S_0 / R_0$$

$$i = (319.53 - 315.48) / 18.0 = 22.0\%$$

Discharge

$$Q = k i A = 4.0 \times 10^{-6} \times 0.22 \times 14.2$$

$$Q = 0.000013 \text{ m}^3/\text{s} = 0.013 \text{ L/sec}$$

$$\underline{\underline{Q_2 = 1,090 \text{ L/Day per unit width and unit length of excavation}}}$$

SWMP1 AREA (SOUTHWEST CORNER)	
BH/MWs: BH7 & MOE WELLS NO.2 & 12	
Ground Surface EL (m)	321.800
Hydrostatic Ground Water EL (m)	317.110
Lowered Ground Water EL	312.800
Bedrock EL.	275.020
k (m/s) =	1.00E-05
H (m) =	42.090
h (m) =	37.780
S ₀ (m) =	4.310
R ₀ (m) =	40.888
a (m) =	96.400
b (>a, m) =	280.000
r _e (m) =	92.692
R ₀ (m) =	133.580
nq (m ³ /s) =	0.0296
n =	30
q (m ³ /s) =	0.0010

SWMP Area Dewatering Data	
Q _{total} (L/s) = nq	30
Q _{total} (L/min) = nq	1,776
Q _{total} (gal/min) = nq	469
For Nb wells (n) =	30
q per well =	16 gal/min

SWMP2 AREA (SOUTHEAST CORNER)	
BH/MWs: BH24 & MOE WELLS NO.2 & 12	
Ground Surface EL (m)	320.910
Hydrostatic Ground Water EL (m)	320.390
Lowered Ground Water EL	317.910
Bedrock EL.	275.020
$k \text{ (m/s)} =$	7.00E-05
$H \text{ (m)} =$	45.370
$h \text{ (m)} =$	42.890
$S_0 \text{ (m)} =$	2.480
$R_0 \text{ (m)} =$	62.248
$a \text{ (m)} =$	98.000
$b (>a, \text{m}) =$	204.000
$r_e \text{ (m)} =$	79.772
$R_0 \text{ (m)} =$	142.020
$nq \text{ (m}^3/\text{s)} =$	0.0834
$n =$	40
$q \text{ (m}^3/\text{s)} =$	0.0021

SWMP Area Dewatering Data	
$Q_{\text{total}} \text{ (L/s)} = nq$	83
$Q_{\text{total}} \text{ (L/min)} = nq$	5,007
$Q_{\text{total}} \text{ (gal/min)} = nq$	1,323
For Nb wells (n) =	40
q per well =	33 gal/min