



Foundation Investigation and Design Report

Victoria Street Utilities Relocation

City of Kitchener, Ontario

MTO Project No. (GWP 3103-15-00)

MTO Geocres NO. 40P8-234

**Prepared For:
MMM GROUP LTD**

**SPL Project No.: 10001862
September 28, 2016**

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FOUNDATION INVESTIGATION REPORT
VICTORIA STREET UTILITIES RELOCATION
CITY OF KITCHENER, ON
MTO PROJECT NO. (GWP 3103-15-00)
MTO GEOCRES NO. 40P8-234

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1. INTRODUCTION

SPL Consultants Limited (SPL) was retained by MMM Group Ltd. on behalf of the Ministry of Transportation of Ontario (MTO) to undertake a geotechnical investigation for the Victoria Street Utilities Relocation associated with bridge reconstruction in the City of Kitchener.

The Victoria Street Bridge is located at the interchange of Hwy 85 and Victoria Street North in the City of Kitchener. The bridge will be reconstructed and this reconstruction of the bridge involves widening of the approach east and west embankments as well as proposed new ramps. As a result of this reconstruction the existing utilities present in the area of Victoria Street and Hwy 85 are required to be relocated. A wide range of utilities exist within the project area comprising of watermains, west sanitary sewer, stormwater sewers, watermains, sanitary gravity sewers, forcemains etc. of various sizes ranging from 150mm to over 750mm in diameter and will be relocated. In addition, other utilities such as underground Bell, hydro and Rogers cables are also present in the area which will also be relocated.

A range of watermain sizes and materials (PVC and CPP) will be installed on the east and west of Hwy 85 using open cut. A 600mm dia. CPP watermain from Sta. 0+035 to Sta. 0+160 and from Sta. 0+260 to Sta. 0+340 will be installed using open cut technique, including inside a steel casing primary liner. The watermain at these locations will be 2.2m to 8.3m below ground surface, corresponding to Elev. 314.3 to 321.0m. At Sta. 0+160 to Sta. 0+260 a 600mm watermain will be installed in a 1156mm dia. steel casing primary liner and will cross Hwy 85 and will be installed by means of microtunnelling. The watermain at this location will be 8.6 to 12.5m below ground surface corresponding to Elev. 310m± (**See Watermain Drawings**).

A number of sanitary sewers, storm sewers and forcemains of different diameters will also be relocated due to the reconstruction of the Victoria Street Bridge.

A West sanitary sewer of dia. 300mm to 450mm from Sta. 0+000 to Sta. 0+225 will be installed by means of open cut (**Drawing 3**). From Sta. 0+235 to the entry shaft at Sta. 0+275, a 375mm dia. sanitary sewer in a 600mm dia. RC microtunnel pipe primary liner will be installed by open cut and grouted in place (**Drawing 4**).

A 375mm dia. sanitary sewer in a 600mm RC microtunnel pipe primary liner from about Sta. 0+275 to Sta. 0+387 will be installed by microtunnelling and will be 2.6 to 6.9m below ground surface (**Drawing 4**).

An existing 750mm dia. RCP gravity sanitary sewer from Sta. 0+000 to Sta. 0+160 (**Drawing 5**) which is located on the east side and parallel to Hwy 85, a portion of this gravity sewer will be relocated and will be installed by open cut. A 600 to 1200mm RCP storm sewer on east and west sides of Hwy 85 from Sta. 0+035 to Sta. 0+156 will also be relocated using open cut method (**Drawings 6 and 7**). These RCP sanitary and storm sewers are to be installed using open cut and will be about 2.4 to 8.6m below existing grade.

Other utilities including sanitary CPP, PVC forcemain will also be installed using an open cut technique (**Drawings 8 and 9**). These utilities will be about 3.8 to 5.9m below ground surface, corresponding to Elev. 318.8 to 317.3m. Associated maintenance holes and chambers will also be installed and constructed as part of the new system.

This report deals with the geotechnical issues only. Environmental soil and groundwater issues will be discussed in separate reports.

The main objectives of the investigation were to determine the subsurface conditions at periodic intervals along the proposed utilities alignment by means of ten (10) exploratory boreholes, and to provide associated geotechnical recommendations. In addition, the construction conditions were to be evaluated to assist MMM Group in the preparation of the contract specifications.

The report is presented in two parts. **Part A** of this report presents the factual borehole data, including review of regional geology, the method of investigation, the field and laboratory work, and describes the subsurface conditions encountered during the investigation. **Part B** interprets the ground and groundwater conditions as relevant to the geotechnical design and construction/relocation of the proposed utilities and manholes.

This report is provided on the basis of the terms of reference presented above and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

This report has been prepared for MMM Group Ltd. on behalf of the MTO. Third party use of this report without SPL Consultants Limited consent is prohibited.

PART A – FACTUAL DATA

2. SITE AND REGIONAL GEOLOGY

The project site is located along the interchange of Hwy 85 and Victoria Street North in the City of Kitchener.

The topography of the site slopes down on Hwy 85 from east and west sides of the interchange with elevations ranging from 323.9m± to 318.6m±.

The regional geology of the Victoria Street and Highway 85 area in Kitchener, Ontario originates from the interaction of several glacial lobes. The area is part of the physiographic region known as the Waterloo Sand Hills or Waterloo Moraine (Chapman & Putnam, 1984). The oldest deposit (mapped in the area to the northeast and another to the west of the intersection of Victoria Street and Highway 85) is a sandy silt till to silty sand textured till. This till was reworked and overlain by ice contact stratified sand and gravel, with minor silt, clay and till that were deposited as the ice lobes receded and re-advanced. There are also glaciofluvial major river and delta deposits of sand located to the south of the Victoria Street and Highway 85 intersection, which were laid down as the glacial ice melted and retreated.

3. FIELD AND LABORATORY WORK

3.1 Fieldwork

The field investigation consisted of putting down ten (10) boreholes (BH15-1 to BH15-10) to depths ranging from 6.7 to 17.4m below existing ground surface at the approximate locations shown on the attached **Drawing No. 1**. Boreholes BH15-1 through BH15-3, BH15-5 and BH15-8 through BH15-10 were drilled at the four corners of the interchange of Highway 85 and Victoria Street Bridge for the construction of proposed utilities to be installed by means of an open cut technique. Boreholes BH15-2 through BH15-5 and BH15-7 through BH15-9 were drilled on the private properties namely Kitchener Glass and Factory Shoe which are located on the northeast and northwest corners of the interchange. Boreholes BH15-1 and BH15-10 were moved and drilled at lower elevations as per client's instructions because of the access issues with the private property owners at these locations. Boreholes BH15-4, BH15-6 and BH15-7 were drilled for the trenchless installation of the utilities beneath Hwy 85.

The ground surface geodetic elevations at the location of all boreholes are shown on the borehole logs which were surveyed by SPL using differential GPS, based on Benchmark No. 00819648096 located on south side of Highway 7 (Victoria St. North), 61m east of Edna Street (Elevation: 329.13m).

The field investigation work (borehole drilling) was undertaken between June 11 and August 11, 2015 by At Cost Drilling Inc. under subcontract to SPL. Borehole logging services were provided by the engineering staff of SPL. The boreholes were advanced with power auger drilling machines equipped with solid and hollow stem augers. The soil stratigraphy was recorded by observing the quality and

changes of augered materials which were retrieved from the boreholes, and by sampling the soils at regular intervals of depth using a 50mm O.D. split spoon sampler, in accordance with the Standard Penetration Test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows (SPT 'N'-values) required to drive the sampler 0.3m depth into the undisturbed soil gives an indication of the compactness condition or consistency of the sampled soil material. The SPT 'N' values are indicated on the borehole log sheets (Refer to **Appendix A**). Upon completion all of the boreholes which were not equipped with monitoring wells were sealed with bentonite and asphalt cold patch near the road surface.

At a later stage, upon client's request, all monitoring well installations will be decommissioned under the requirements of Ontario Regulation 903 – Wells. Decommissioning wells will generally be completed by grouting the well from the bottom up with cement-bentonite grout using a tremie pipe and then cutting off the top 1.5 m of the well (below ground surface). All decommissioning will be completed under the supervision of a qualified environmental technologist under the supervision of a Qualified Person.

Soil samples were visually classified in the field and later re-evaluated in our laboratory.

Water level observations were made during drilling and in the open boreholes at the completion of the drilling operations. For the purpose of longer term groundwater monitoring, seven (7) boreholes were equipped with 50 mm diameter monitoring wells including boreholes BH15-1, BH15-2, BH15-4 and BH15-7 through BH15-10. The groundwater levels in the monitoring wells were measured on August 11, 2015 and the data are shown in the borehole logs at the end of each log sheet.

3.2 Geotechnical Laboratory Testing

The soil samples were taken to SPL laboratory where they were re-examined. Representative soil samples were selected for geotechnical index testing. The testing consisted of the measurement of moisture content of all samples, grain size distribution analyses on twenty six (26) selected soil samples and Atterberg Limit test on thirteen (13) selected samples. The results of the particle size distribution tests and Atterberg Limit tests are in **Appendix B** and are also summarized on the associated borehole log sheets in **Appendix A**.

4. SUMMARY OF SUBSURFACE CONDITIONS

4.1 Overview

The boreholes revealed the presence of a variety of soil types ranging in texture from pavement structure, fill material, cohesive silty clay and silty clay till to non-cohesive sand, silt, sandy silt and sand and gravel.

For details of the subsurface conditions encountered at the borehole locations, reference should be made to the individual borehole log sheets presented in **Appendix A**. The properties of the main soil types encountered in the boreholes are described briefly in the following sections.

4.2 Pavement Structure, Topsoil and Fill

All boreholes except (BH15-1) were drilled on the roadway and parking lots of private properties encountered 40 to 250mm of asphalt overlying 200mm to 450mm of granular base and sub-base. BH15-1 was drilled on grass and encountered 150mm of surficial topsoil.

Below the pavement structure and topsoil, fill consisting of silty sand and sand was found. The fill extends to depths ranging from 2.0 to 5.3m below ground surface. The SPT carried out within the fill material recorded 'N' values ranging from 3 to more than 50 blows per 300mm penetration indicating a very loose to very dense state of fill material. High SPT 'N' values infer that boulders/cobbles/buried concrete pieces exist within the fill material. The natural moisture contents ranged from 3% to 21%. Trace to some organics, asphalt pieces and brick fragments were also observed in fill material.

4.3 Sand/Silty Sand/Sand and Gravel

These cohesionless sandy deposits consisting of sand, silty sand and sand and gravel were encountered below the fill material in Boreholes BH15-2 through BH15-5 and B15-7 through BH15-10. SPT 'N' values in these cohesionless deposits were in the range of 5 to 78 blows per 0.3m penetration corresponding to a loose to very dense state. These cohesionless sandy deposits were also found to be saturated in Boreholes BH15-5 through BH15-10. Water contents were measured to range from 3 % to 21%.

Seven (7) grain size analyses revealed the following ranges of particle size distribution:

27% gravel, 57 to 94% sand; 4 to 36% silt and 2 to 6% clay (See Figure 1 in Appendix B).

4.4 Silt/Sandy Silt

These cohesionless silt to sandy silt deposits were locally encountered in BH15-4, BH15-8 and BH15-9. SPT 'N' values in these deposits were in the range of 22 to 39 blows per 0.3m penetration corresponding to a compact to dense state. These deposits were found to be saturated in Boreholes BH15-4 and BH15-9. Water contents were measured to 11 to 18%.

One grain size analysis of a silt sample revealed 15% sand; 75% silt and 10% clay (See Figure 2 in Appendix B).

4.5 Silty Clay Till/Clayey Silt Till and Silty Clay

The silty clay till/clayey silt till deposits were encountered in all boreholes at various depths. Boreholes BH15-4 through BH15-6 and BH15-9 were terminated in this deposit. Wet to saturated interbedded sand

and silt layers were encountered in these deposits at a few borehole locations. Water contents were measured to be from 12 to 15%.

SPT 'N' values of 9 to more than 50 blows per 300mm penetration indicated the cohesive soils to be in a stiff to hard consistency.

Cobbles and boulders should be expected within the silty clay to clayey silt till.

The expected size and percentage of boulders/cobbles within the glacial till are difficult to quantify. Some references regarding excavation and tunnelling within the glacial till in previous projects in the GTA area are presented in **Appendix C**.

Eleven (11) grain size analyses revealed the following range of particles sizes:

1 to 13% gravel; 6 to 33% sand; 38 to 65% silt and 16 to 40% clay (See Figure 3 in Appendix B). Atterberg Limits tests of eleven (11) samples gave Liquid Limits ranging from 17 to 34 (average 25); Plastic Limits of 11 to 15 (average 13); and Plasticity Indices 6 to 19 (average 12). These properties indicate a low plastic silty clay to clayey silt [CL to CL-ML] in the modified Unified Soil Classification System (USCS) (See Figure 5 in Appendix B).

The silty clay was encountered in boreholes BH15-1 through BH15-4 and BH15-6 through BH15-8 below/interbedded the silty clay/clayey silt till deposits. Boreholes BH15-1 through BH15-3, BH15-7 and BH15-8 were terminated in this deposit.

The SPT 'N' values 12 to more than 50 blows per 300mm penetration, indicate a stiff to hard consistency. The water contents ranged from 16% to 25%.

Seven (7) grain size analyses revealed the following range of particle sizes:

1% gravel, 1 to 5% sand; 38 to 61% silt and 39 to 59% clay (See Figure 4). Seven (7) Atterberg limits tests gave Liquid Limits ranges from 33 to 50 (average 41); Plastic Limits of 15 to 19 (average 17); and Plasticity Indices 18 to 31 (average 24). These properties indicate a medium plasticity silty clay [CI] in the modified Unified Soil Classification System (USCS) (See Figure 5).

4.6 Groundwater Conditions

Seven (7) monitoring wells were installed in Boreholes BH15-1, BH15-2, BH15-4, BH15-7 through BH15-10 with screens set at different levels in different soil formation for the longer-term monitoring of groundwater levels.

The groundwater levels measured within the monitoring wells installed ranged from 0.4 to 5.8m below existing grade (Elev. 312.9 to 320.0). Over the long term, seasonal fluctuations in the groundwater level are expected.

Groundwater measurements in the monitoring wells are shown on the attached borehole logs and are also summarized on Table 4.6.

Table 4.6 - Measured Water Levels in Monitoring Wells

BH No.	Ground Surface Elev. (m)	Soil Type at Screen Location (Depth, m)	Depth / Water Level Elevation (m)
			Aug. 11/2015
BH15-1	318.7	Fill/Silty Clay Till/Silty Clay (1.5 – 4.6)	0.4/318.3
BH15-2	323.9	Silty Clay Till (6.1 – 7.6)	5.3/318.6
BH15-4	322.5	Clayey Silt Till/Silt (7.6 – 10.7)	4.7/317.8
BH15-7	322.6	Sand/Sandy Silt/Silty Clay Till (6.1 – 9.1)	3.9/318.7
BH15-8	322.9	Sandy Silt/Sand	4.0/318.9
BH15-9	323.2	Fill/Sandy Silt/Sand and Gravel/Sand (3.1 – 9.1)	3.2/320.0
BH15-10	318.7	Sand/Silty Clay Till (3.1 – 6.1)	5.8/312.9

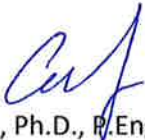
Thank you for the opportunity to be of service to you. Should you have any questions or require further clarification on any aspect of this report, please do not hesitate to contact this office.

Yours very truly,

SPL CONSULTANTS LIMITED



Naeem Ehsan, M.Eng., P.Eng.



Laifa Cao, Ph.D., P.Eng.



Scott Peaker, M.A.Sc., P.Eng.
MTO Designated Tunneling Contact



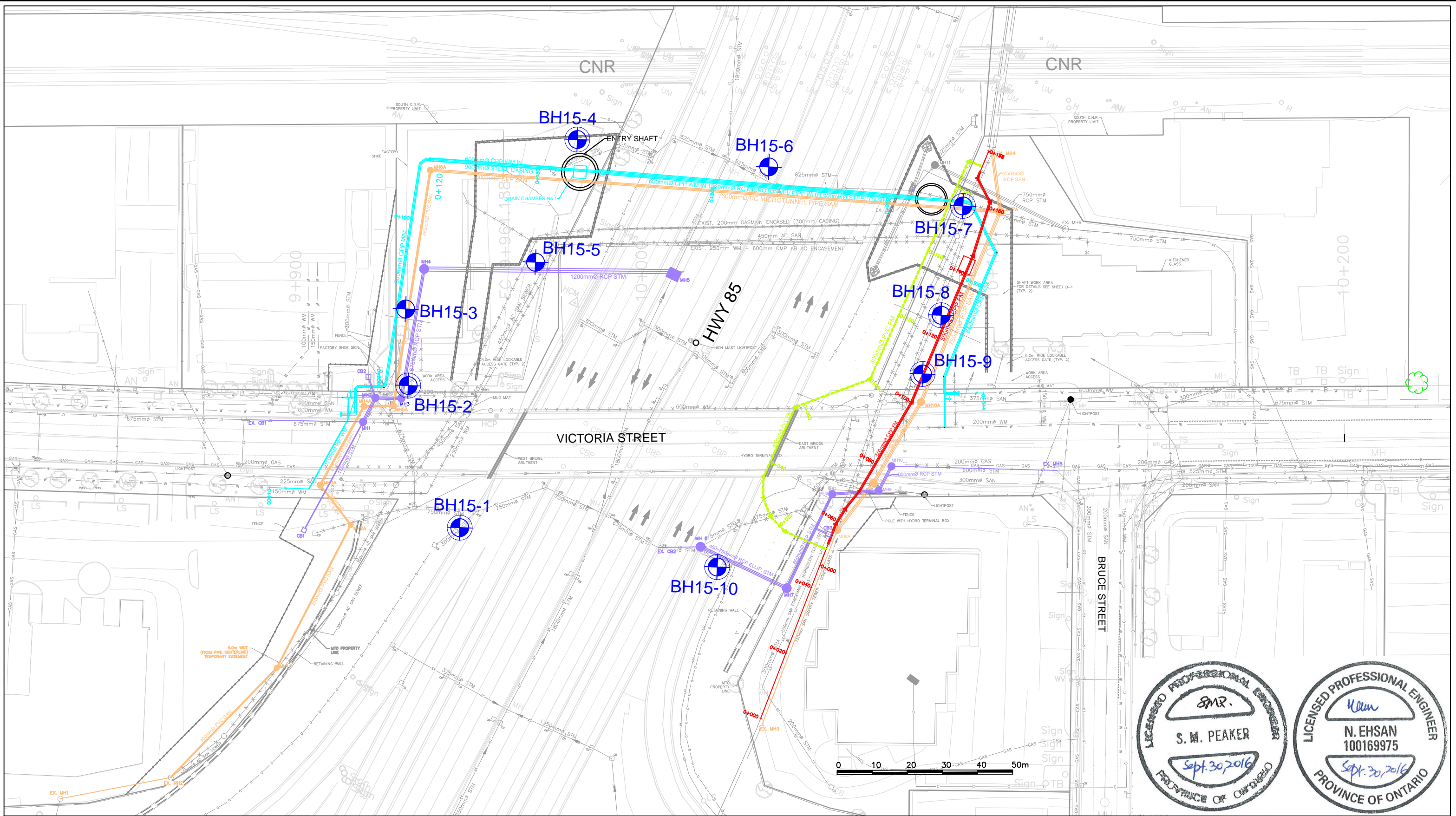
Drawings

Borehole Location Plan (Drawing No. 1)

Geological Sections (Drawing Nos. 2 to 9)


Earth Pressure Distribution on Braced Excavations (Drawing No. 10)

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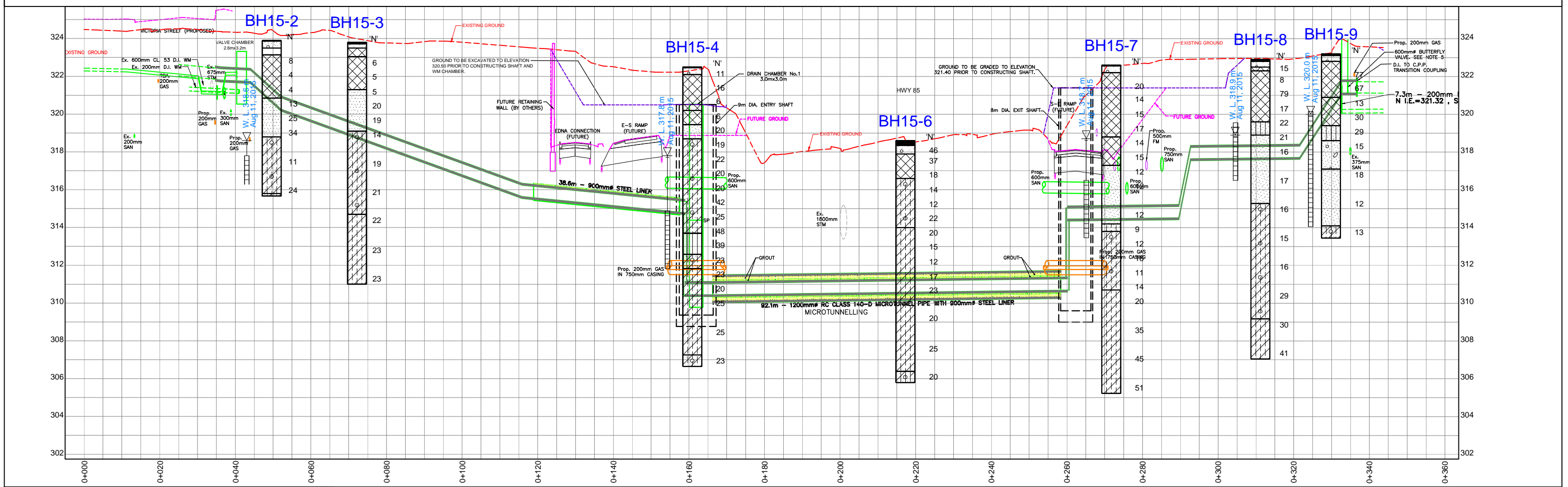
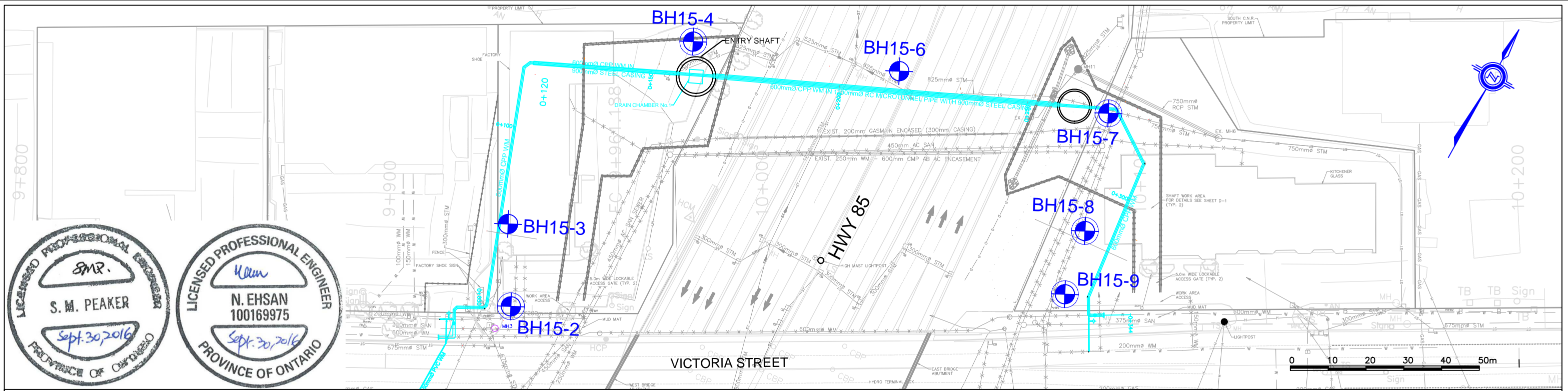


LEGEND


- Borehole Location
- Borehole with Monitoring Well Location

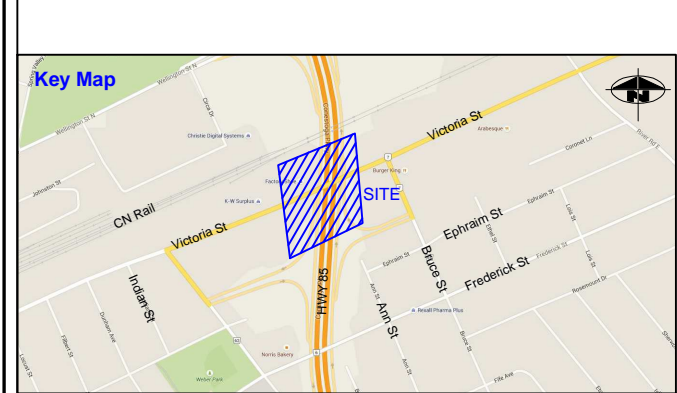
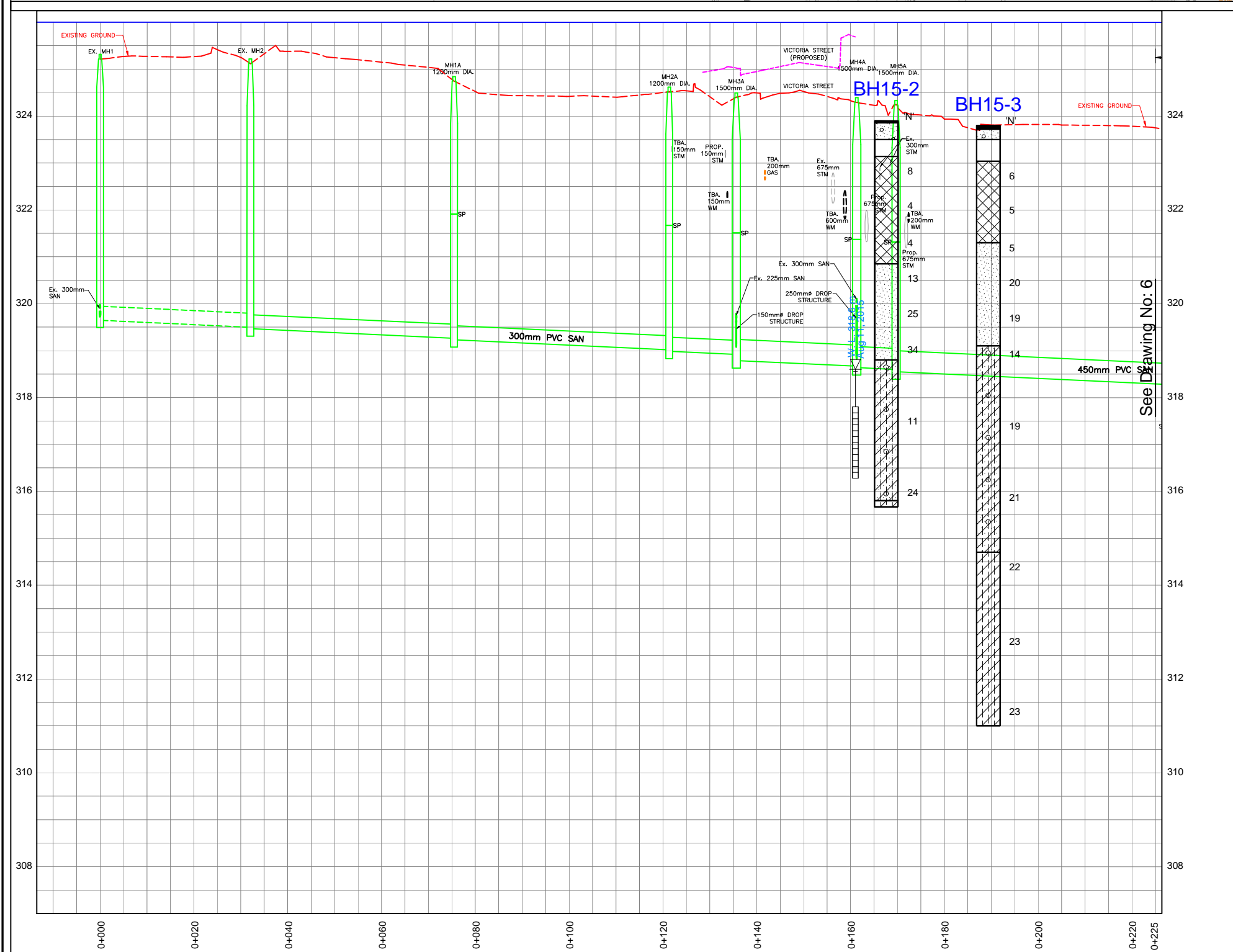
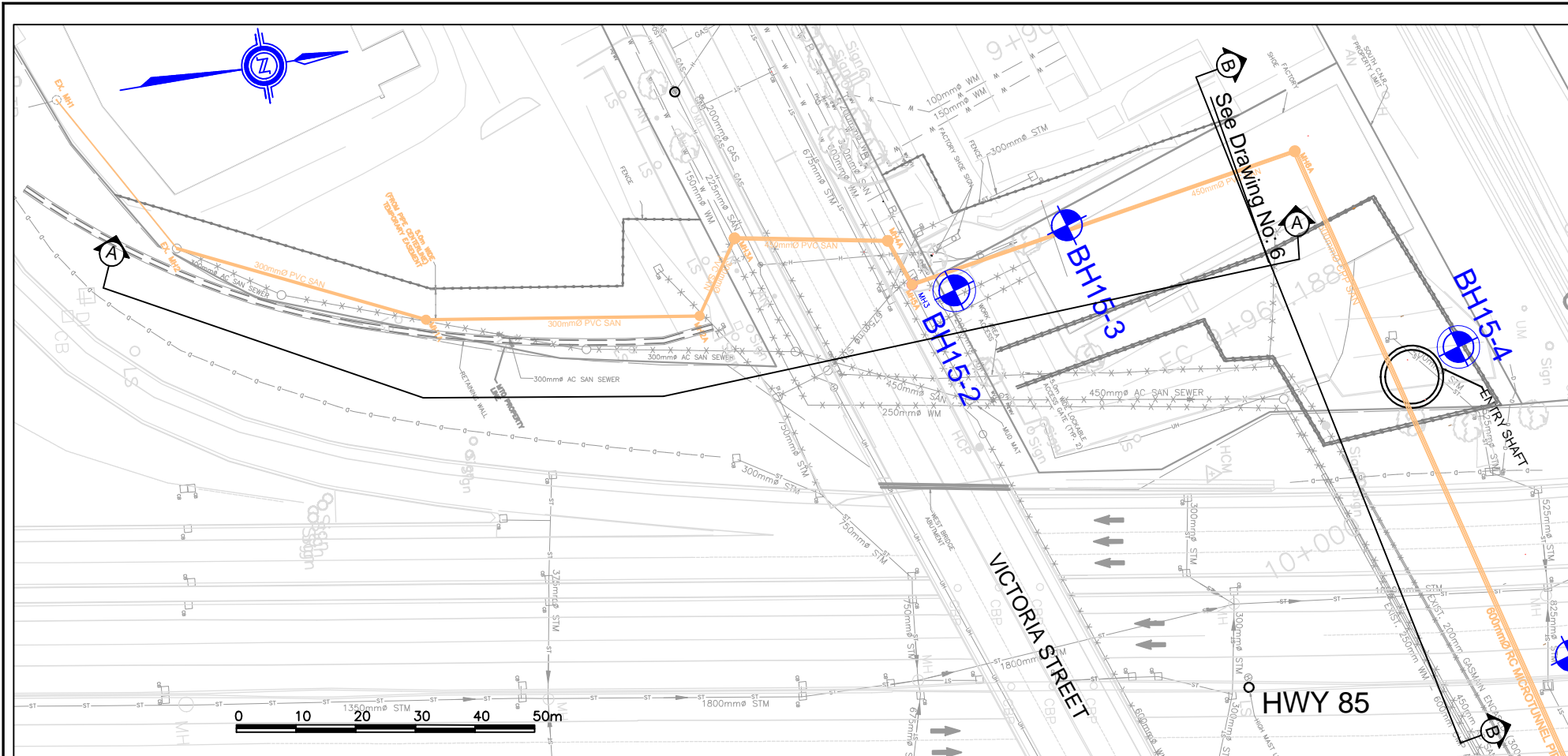
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Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
Original Size: Tabloid	Rev: N/A	 SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology	





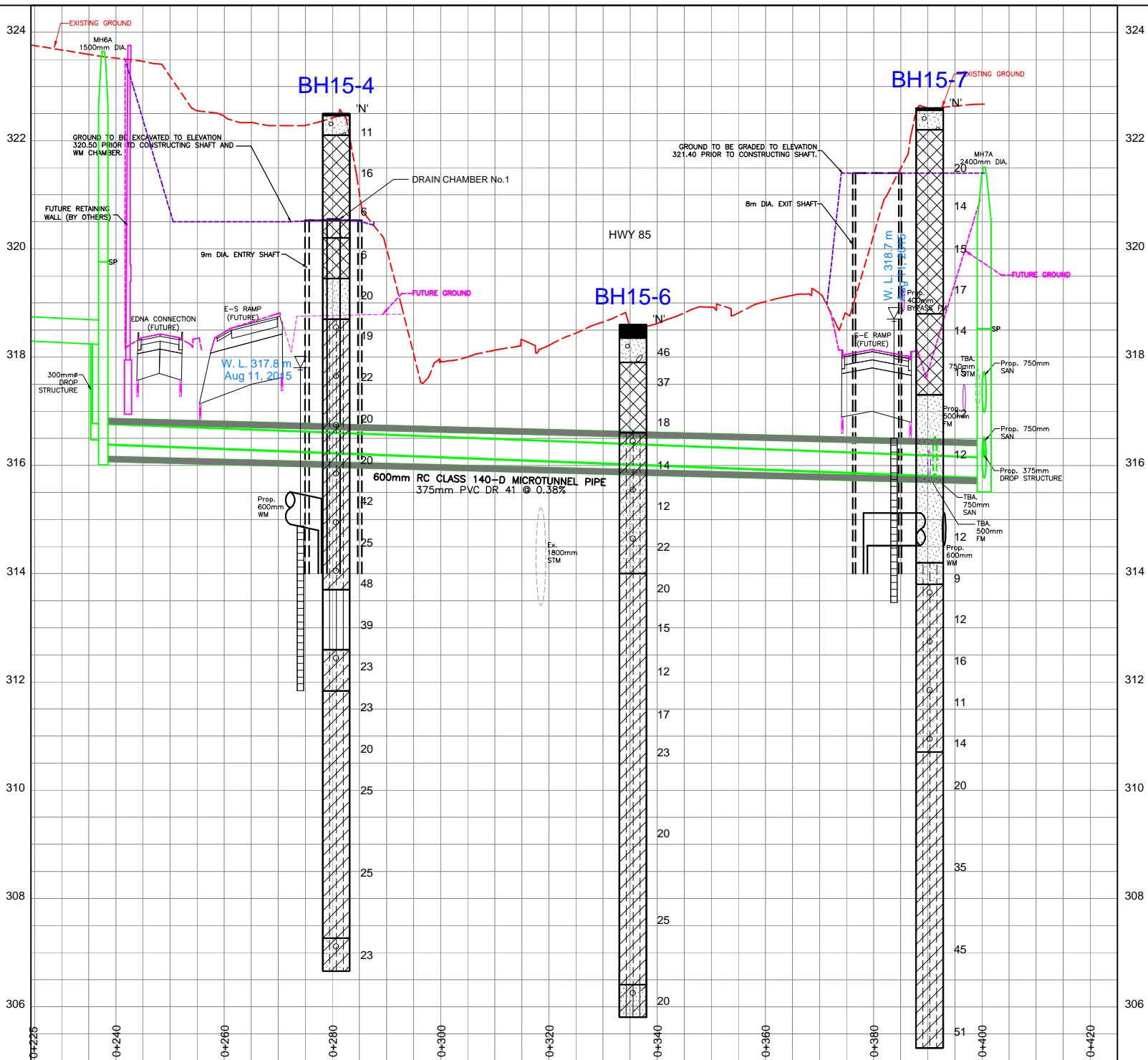
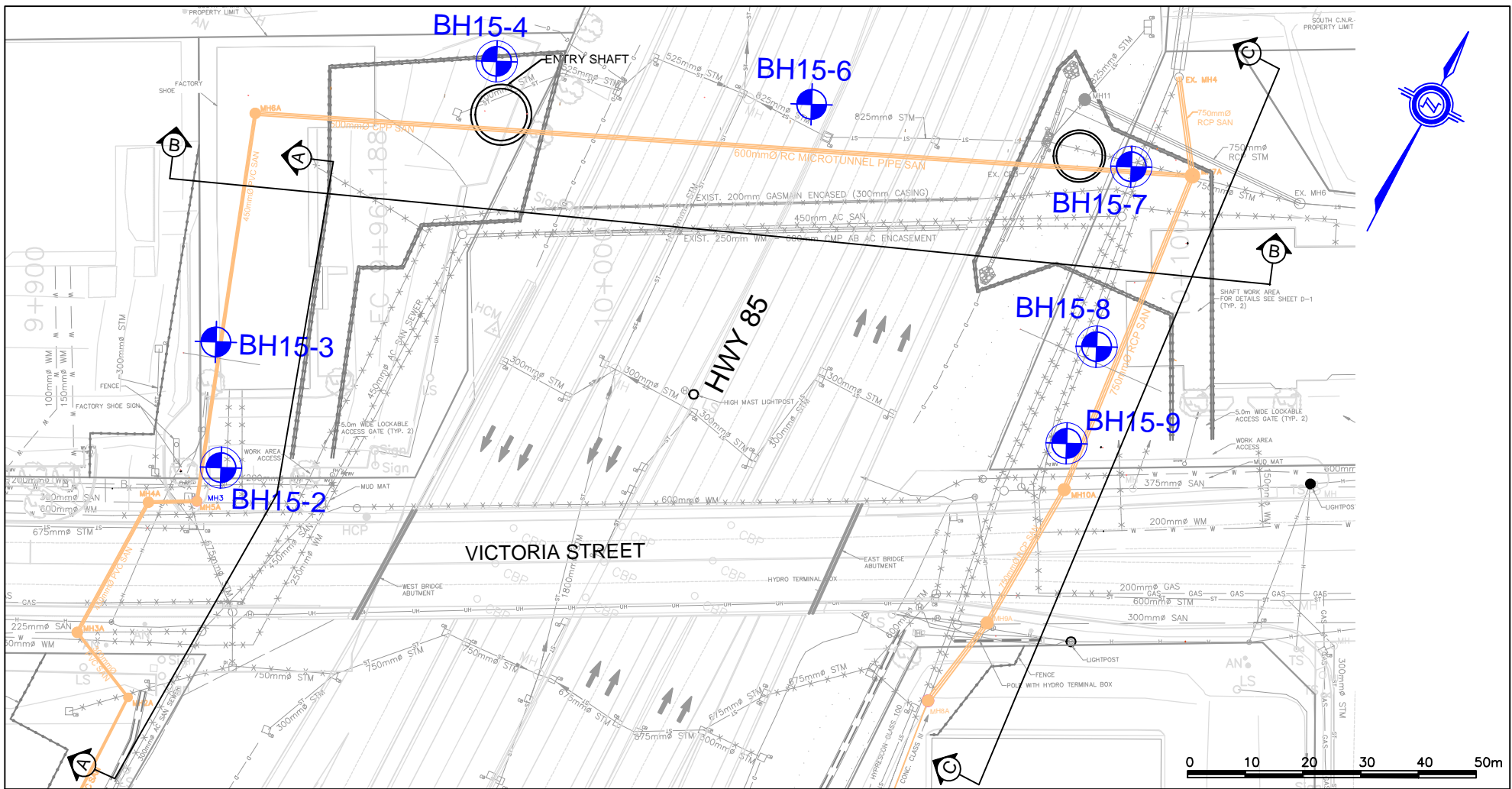
LEGEND		Asphalt	Topsoil	Fill	Silty Sand	Silty Sand Till	Clayey Silt	Silt
Silty Clay	Clayey Silt Till	Silty Clay Till	Sandy Silt	Silt Till	Sand and Silt Till	Sand		
Sandy Silt Till	Sand and Gravel							

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Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
Original Size: Tabloid	Rev: N/A	 SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology	



LEGEND	
	Asphalt
	Topsoil
	Fill
	Silt Till
	Silt
	Silty Sand
	Silty Sand Till
	Clayey Silt
	Sandy Silt
	Sandy Silt Till
	Sand and Gravel
	Sand and Silt Till
	Sand
	Silty Clay
	Silty Clay Till
	Clayey Silt Till

Client: MMM GROUP		Project No.: 10001862	Drawing No.: 3
Drawn: ZMO	Approved: LC	Title: Geological Sections - West Sanitary Sewer	
Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
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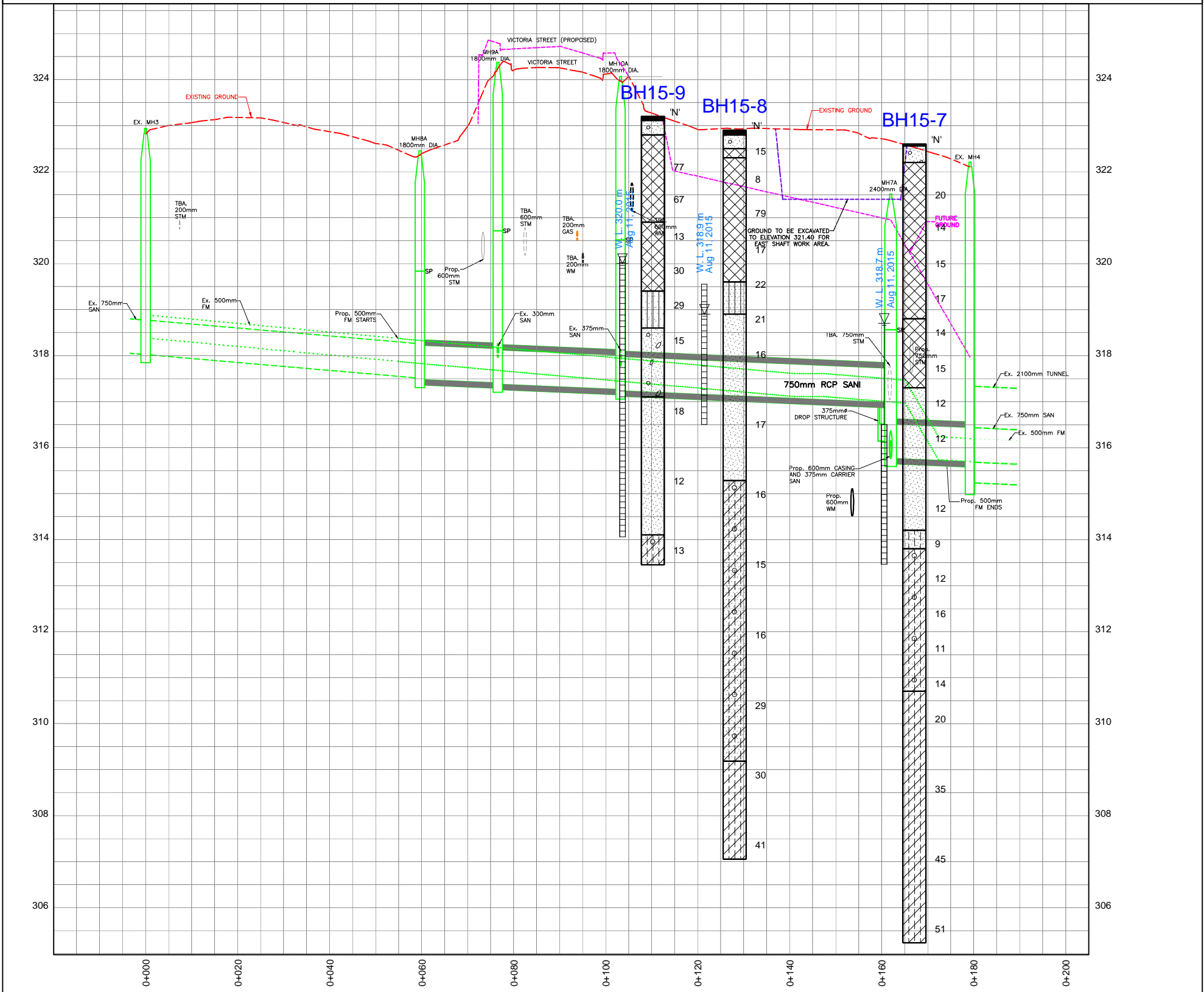
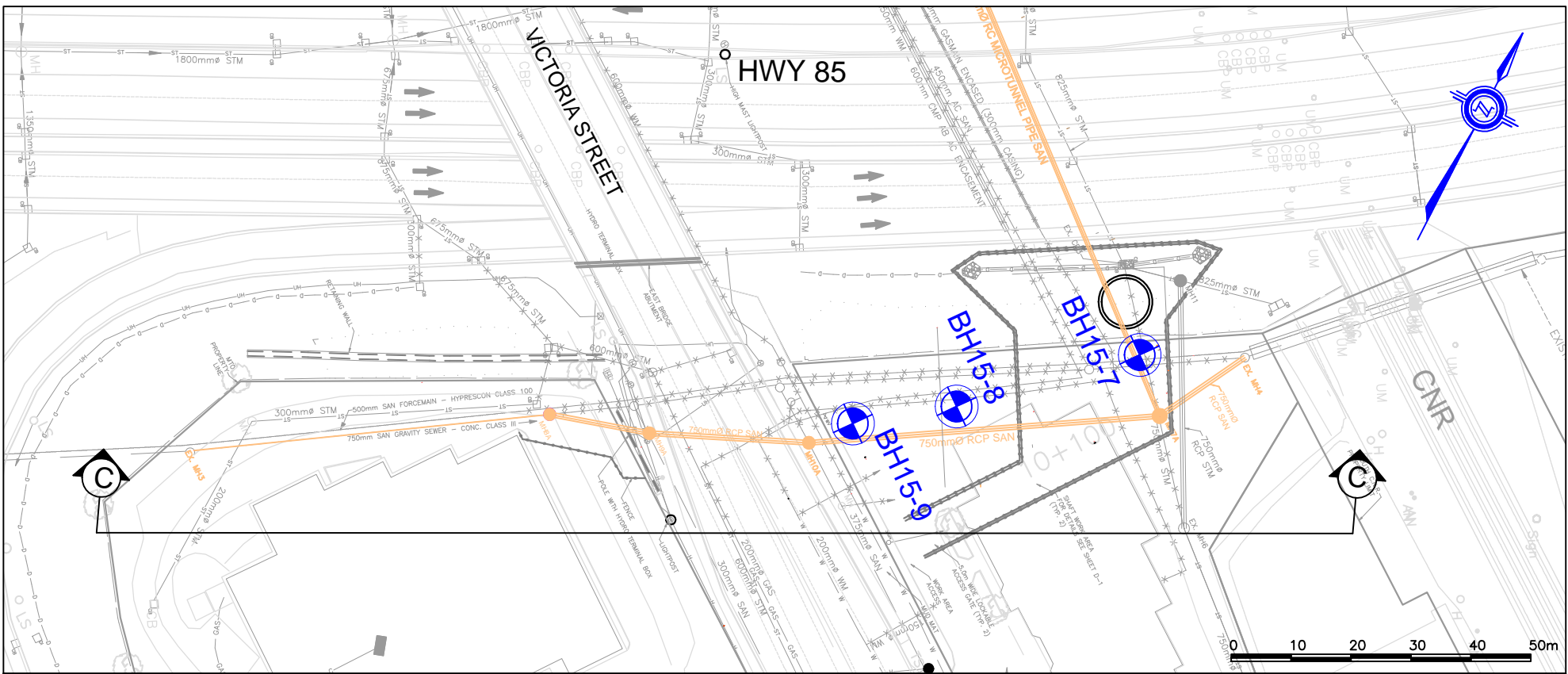


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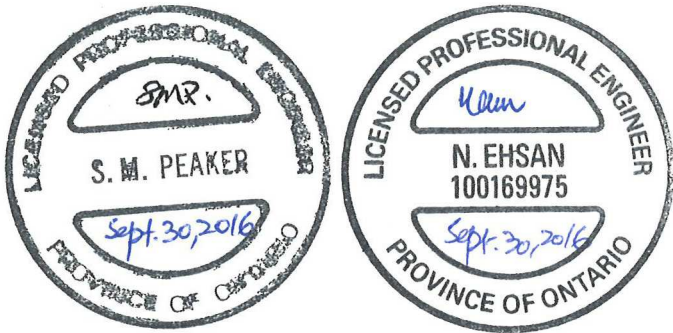
LEGEND	
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	Topsoil
	Fill
	Silty Sand
	Silty Sand Till
	Clayey Silt
	Silt
	Silty Clay
	Clayey Silt Till
	Silty Clay Till
	Sandy Silt
	Silt Till
	Sand and Silt Till
	Sand
	Sandy Silt Till
	Sand and Gravel



Client: MMM GROUP		Project No.: 10001862	Drawing No.: 4
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Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
Original Size: Tabloid	Rev: N/A	SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology	

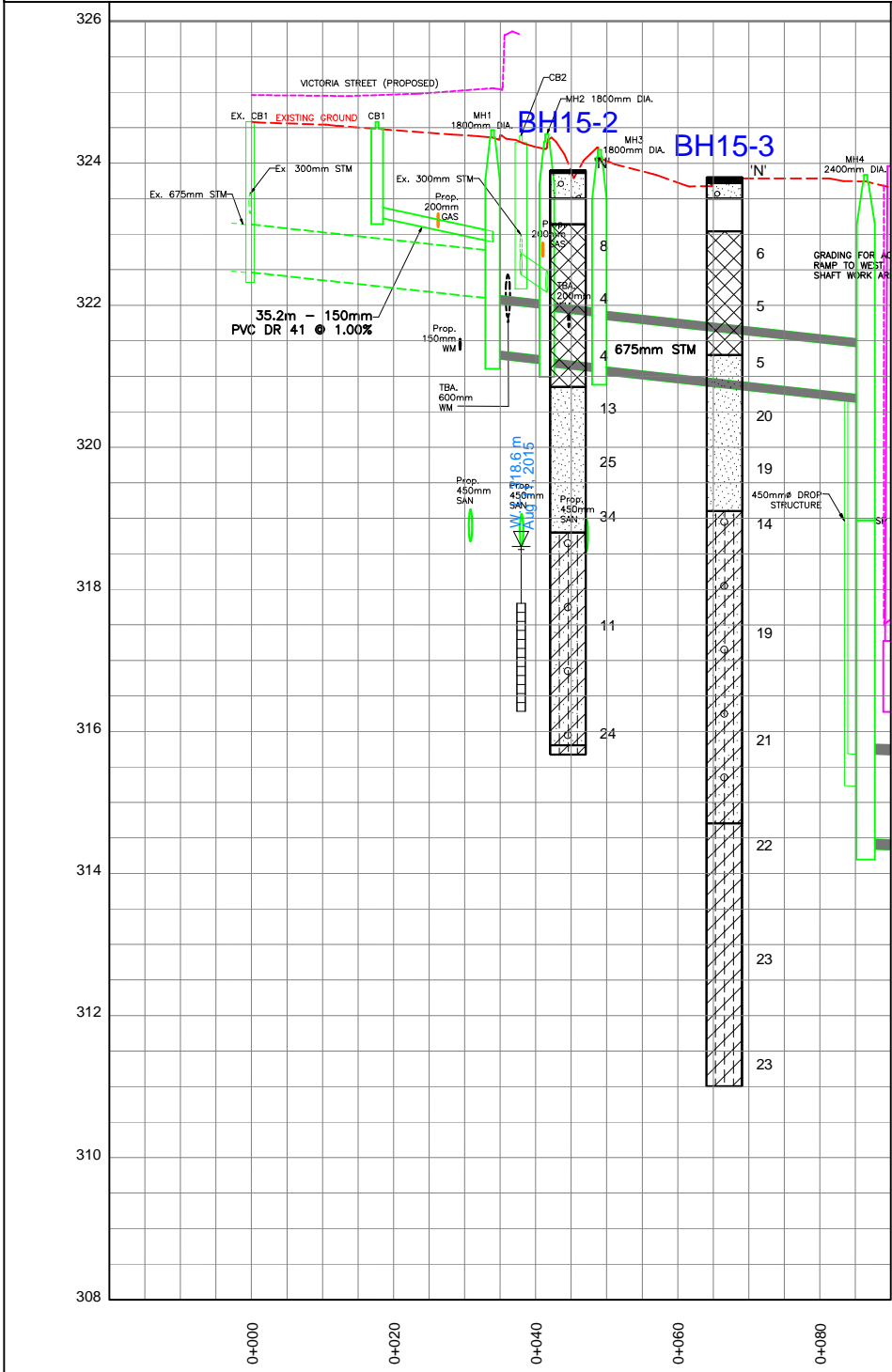
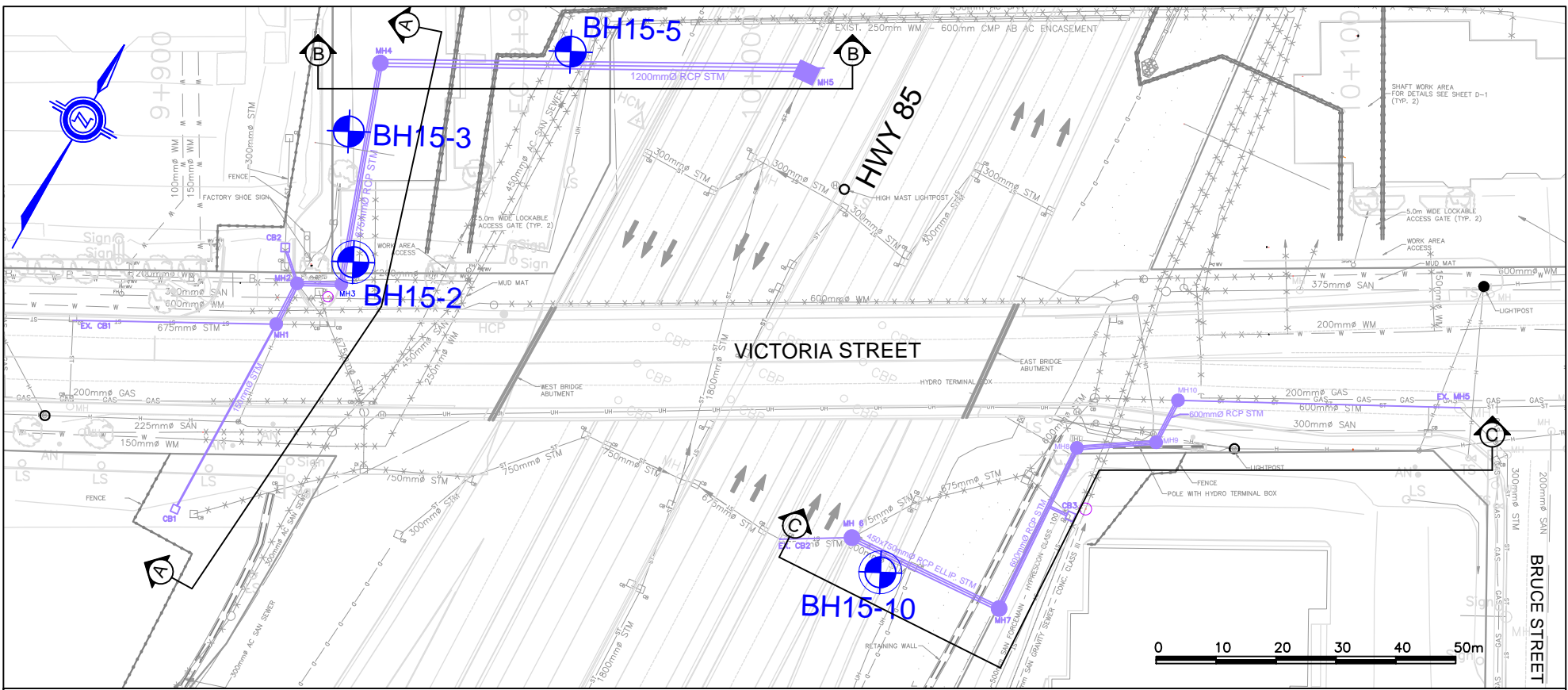


SECTION C-C

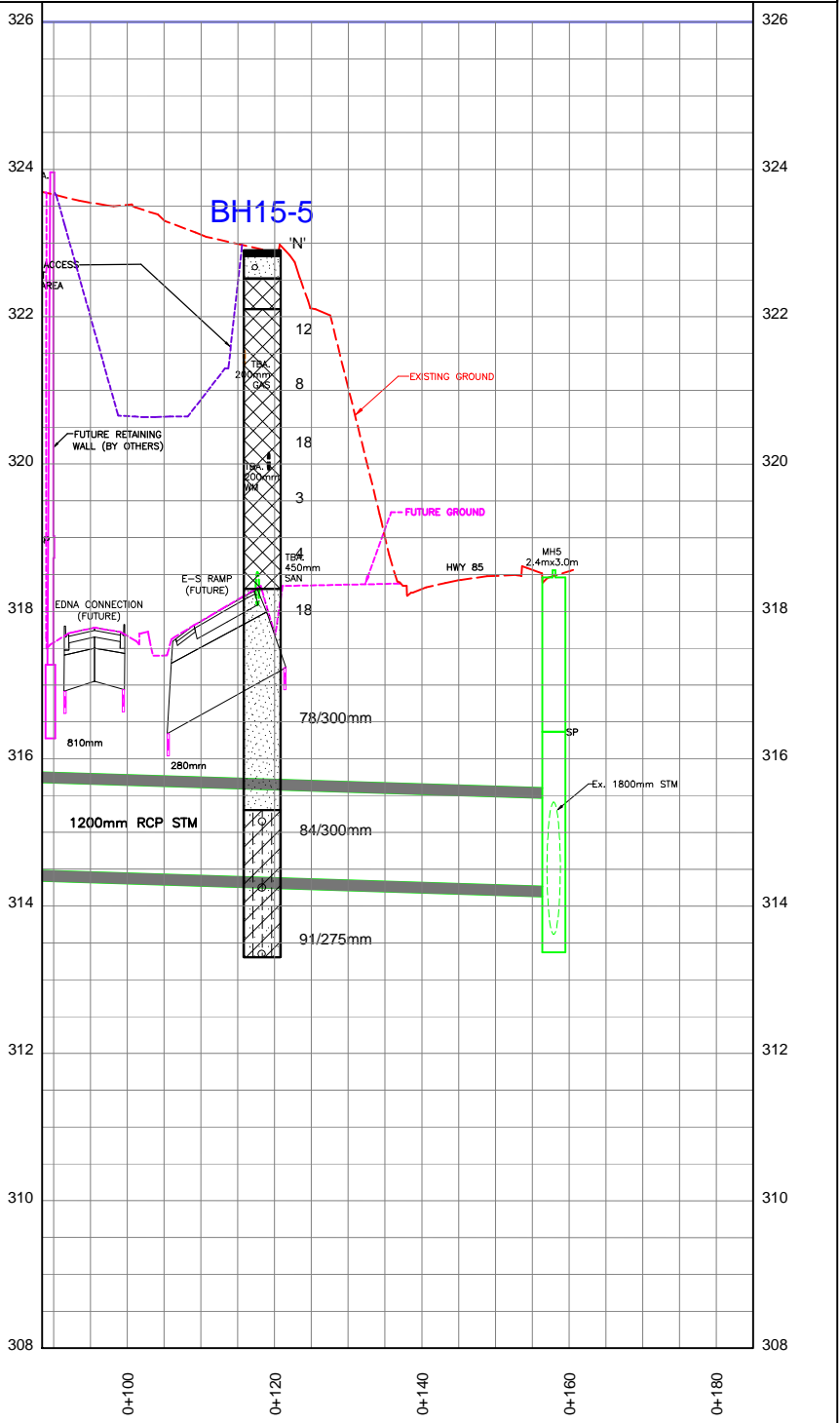


LEGEND	
	Asphalt
	Topsoil
	Fill
	Silt Till
	Silt
	Silty Sand
	Silty Sand Till
	Clayey Silt
	Sandy Silt
	Sandy Silt Till
	Sand and Gravel
	Sand and Silt Till
	Sand
	Silty Clay
	Silty Clay Till
	Clayey Silt Till

Client: MMM GROUP		Project No.: 10001862	Drawing No.: 5
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Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
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SECTION A-A

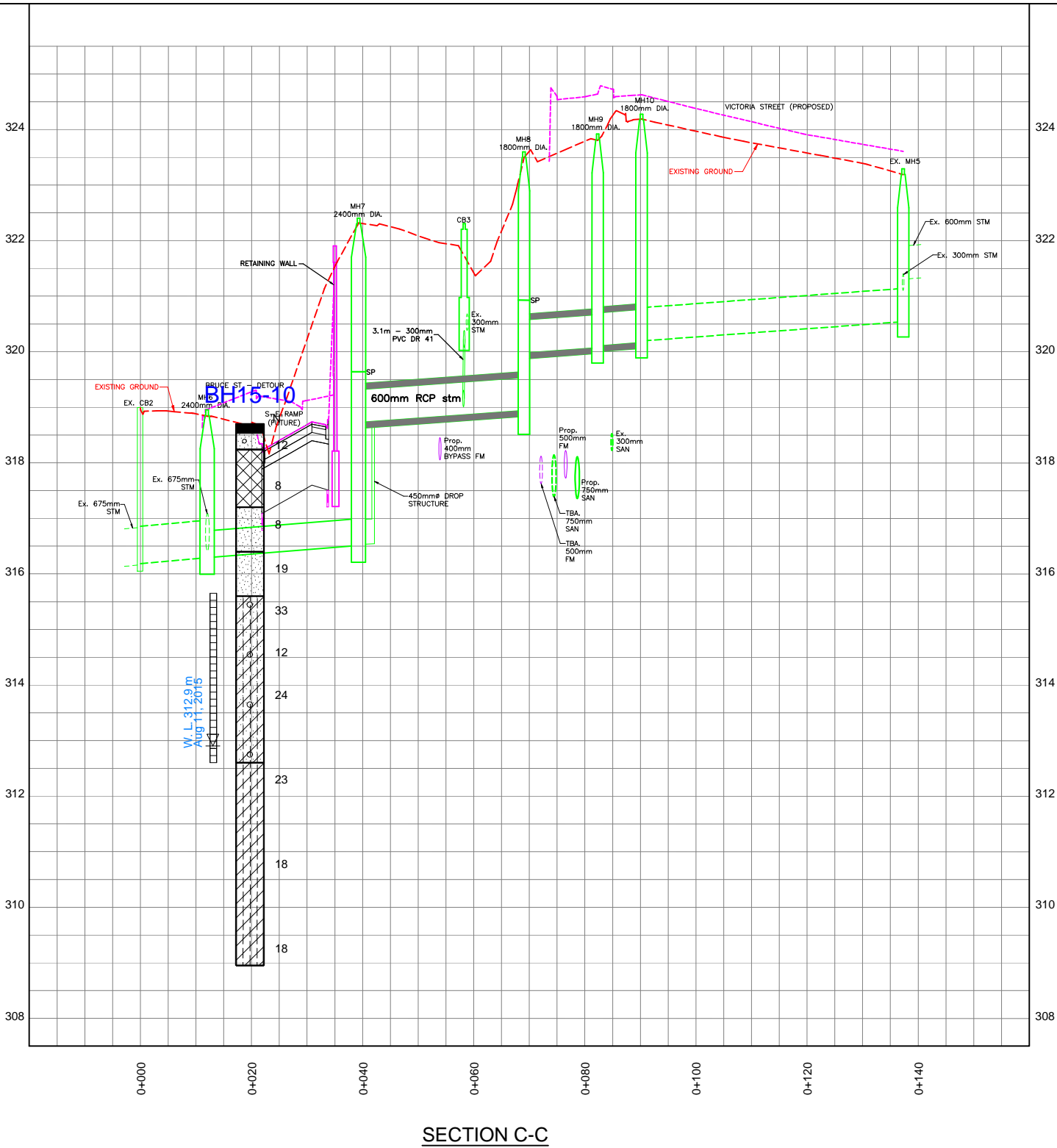
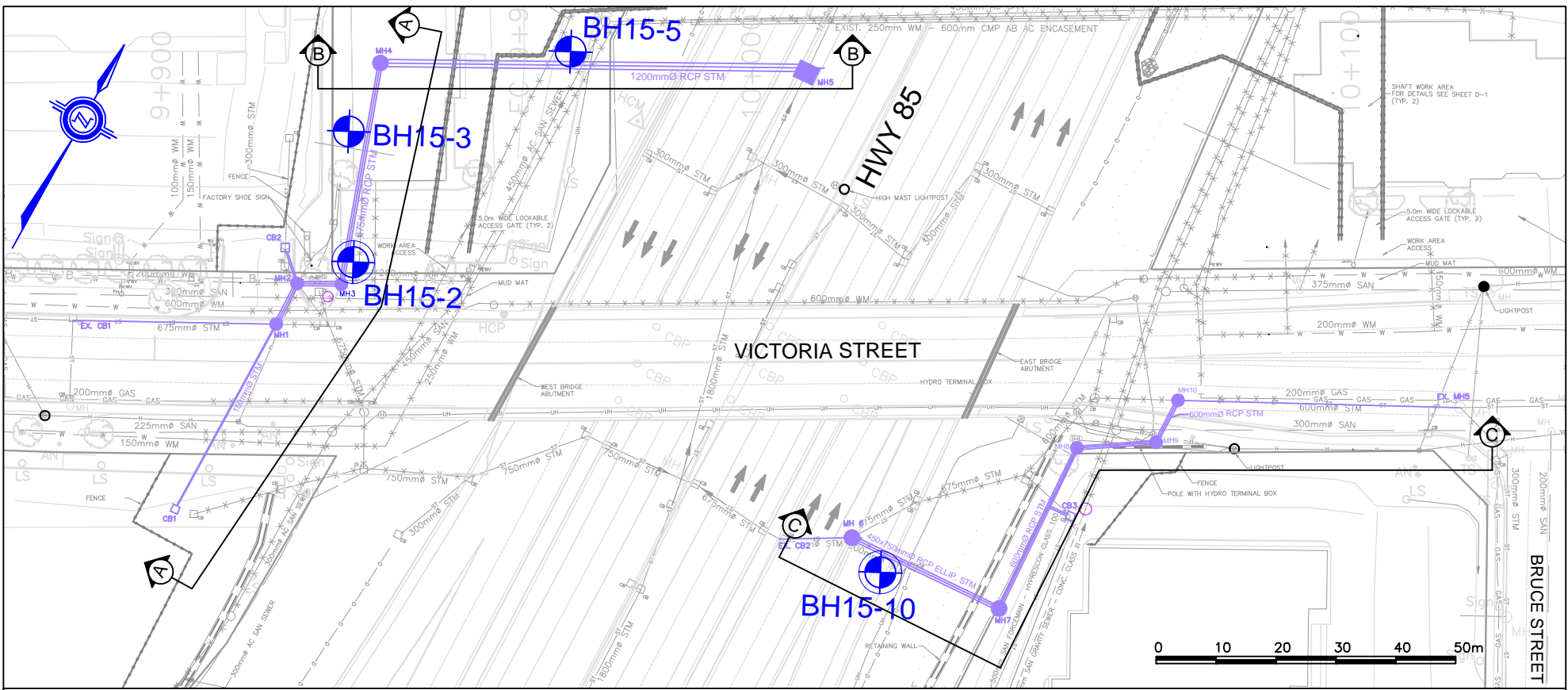


SECTION B-B

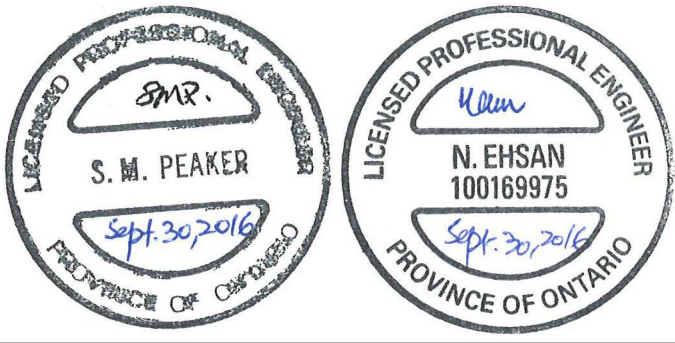


LEGEND	
	Asphalt
	Topsoil
	Fill
	Silt Till
	Silt
	Silty Sand
	Silty Sand Till
	Clayey Silt
	Sandy Silt
	Sandy Silt Till
	Sand and Gravel
	Sand and Silt Till
	Sand
	Silty Clay
	Silty Clay Till
	Clayey Silt Till

Client: MMM GROUP		Project No.: 10001862	Drawing No.: 6
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Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
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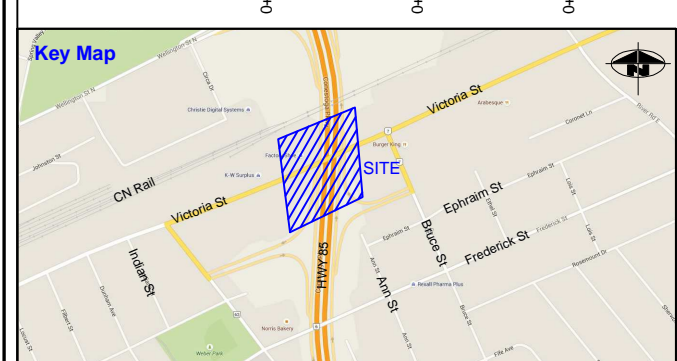
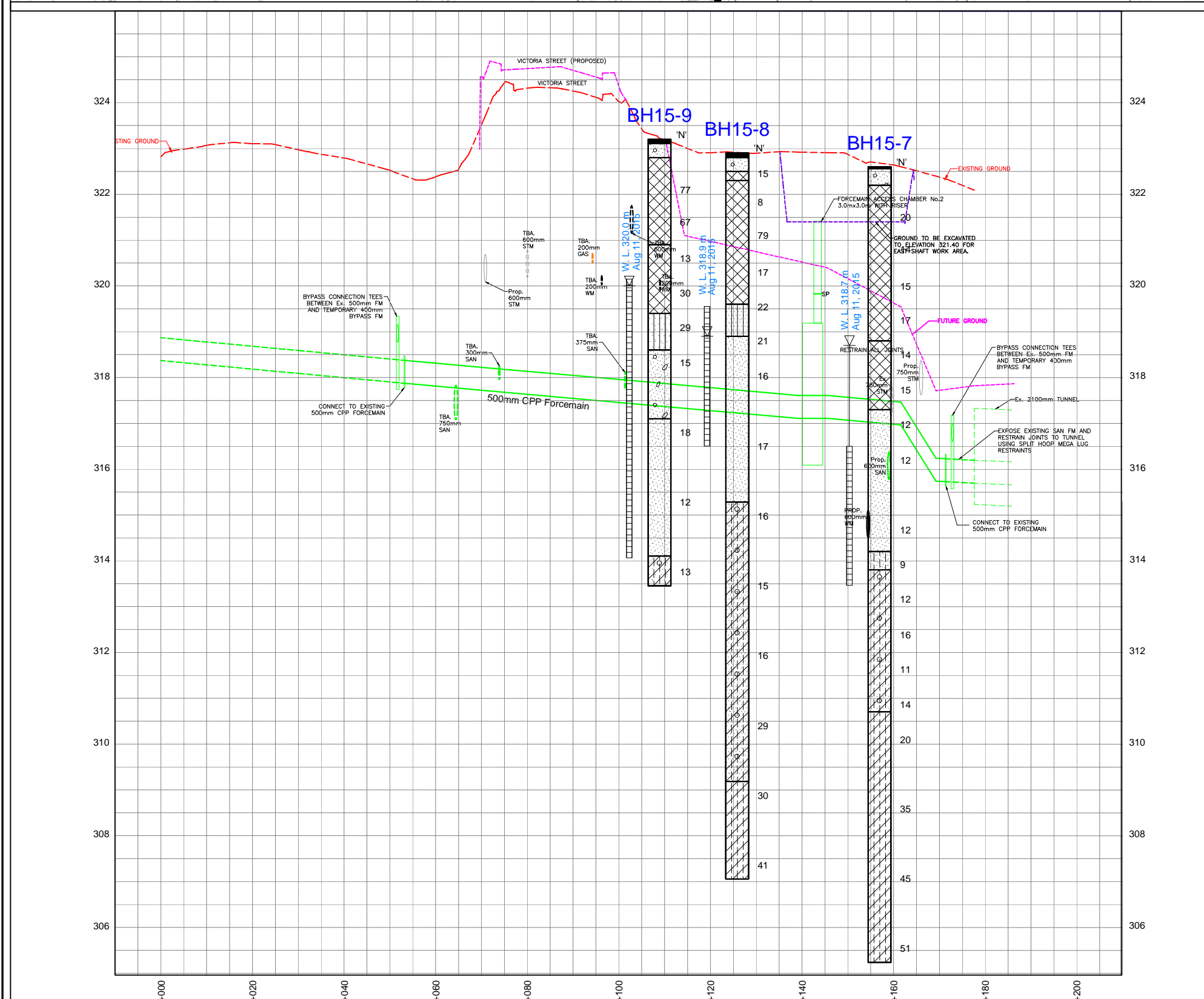
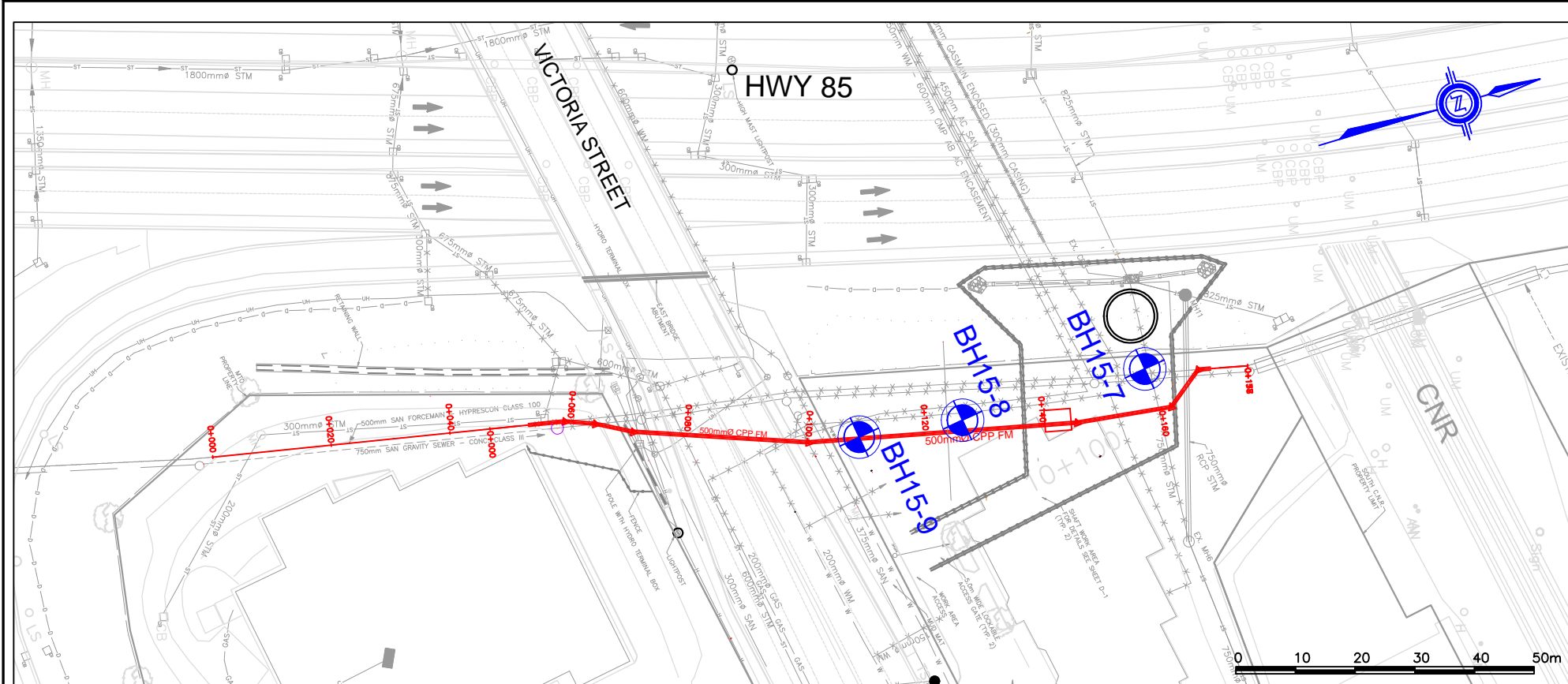


SECTION C-C



LEGEND	
	Asphalt
	Topsoil
	Fill
	Silt Till
	Silt
	Silty Sand
	Silty Sand Till
	Clayey Silt
	Sandy Silt
	Sandy Silt Till
	Sand and Gravel
	Sand and Silt Till
	Sand
	Silty Clay
	Silty Clay Till
	Clayey Silt Till

Client: MMM GROUP		Project No.: 10001862	Drawing No.: 7
Drawn: ZMO	Approved: LC	Title: Geological Sections - RCP Storm Sewer	
Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
Original Size: Tabloid	Rev: N/A	SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology	



LEGEND <div><div><div><div><div></div><div>Asphalt</div></div><div><div></div><div>Silty Sand</div></div><div><div></div><div>Sandy Silt Till</div></div><div><div></div><div>Silty Clay</div></div></div><div><div><div><div></div><div>Topsoil</div></div><div><div></div><div>Silty Sand Till</div></div><div><div></div><div>Sand and Gravel</div></div><div><div></div><div>Silty Clay Till</div></div></div><div><div><div><div></div><div>Fill</div></div><div><div></div><div>Clayey Silt</div></div><div><div></div><div>Sand and Silt Till</div></div><div><div></div><div>Clayey Silt Till</div></div></div><div><div><div><div></div><div>Silt Till</div></div><div><div></div><div>Sandy Silt</div></div><div><div></div><div>Sand</div></div><div><div></div><div>Silt</div></div></div></div></div></div></div></div>	Client: MMM GROUP		Project No.: 10001862	Drawing No.: 8
	Drawn: ZMO	Approved: LC	Title: Geological Sections - Sanitary CPP Forcemain	
	Date: March 23, 2016	Scale: As Shown	Project: Geotechnical Investigation - Victoria Street Utilities Relocations for the Bridge Reconstruction, Town of Kitchener, Ontario	
	Original Size: Tabloid	Rev: N/A	<div><div><div></div><div>SPL Consultants Limited Geotechnical • Environmental • Materials • Hydrogeology</div></div></div>	

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APPENDIX A

Explanation of Terms Used in the Record of Borehole

Borehole Logs (BH15-1 through BH15-10)

Explanation of Terms Used in the Record of Boreholes

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Spoon sample
SH	Shelby tube Sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) required to drive a 50 mm (2 in) drive open sampler for a distance of 300 mm (12 in).

WH – Samples sinks under “weight of hammer”

Dynamic Cone Penetration Resistance, N_d :

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter, 60° cone attached to “A” size drill rods for a distance of 300 mm (12 in).

Textural Classification of Soils

Classification	Particle Size
Boulders	> 200 mm
Cobbles	75 mm - 200 mm
Gravel	4.75 mm - 75 mm
Sand	0.075 mm – 4.75 mm
Silt	0.002 mm-0.075 mm
Clay	<0.002 mm

Coarse Grain Soil Description (50% greater than 0.075 mm)

Terminology	Proportion
Trace	0-10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. sand and gravel)	> 35%

Soil Description

a) Cohesive Soils(*)

Consistency	Undrained Shear Strength (kPa)	SPT “N” Value
Very soft	<12	0-2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very stiff	100-200	15-30
Hard	>200	>30

(*) Hierarchy of Shear Strength prediction

1. Lab triaxial test
2. Field vane shear test
3. Lab. vane shear test
4. SPT “N” value
5. Pocket penetrometer

b) Cohesionless Soils

Density Index (Relative Density)	SPT “N” Value
Very loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Soil Tests

w	Water content
w _p	Plastic limit
w _l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement
D _R	Relative density (specific gravity, G _s)
DS	Direct shear test
ENV	Environmental/ chemical analysis
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified proctor compaction test
SPC	Standard proctor compaction test
OC	Organic content test
U	Unconsolidated Undrained Triaxial Test
V	Field vane (LV-laboratory vane test)
γ	Unit weight

PROJECT: Geotechnical Investigation -Utilities Services Relocation

CLIENT: MMM Group Limited

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON

DATUM: Geodetic

BH LOCATION: N 4812217 E 542745

DRILLING DATA

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Jul/29/2015

REF. NO.: 10001862

ENCL NO.: 2

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p	W	W _L			
318.7								20	40	60	80	100					
318.0	TOPSOIL: 150mm							20	40	60	80	100					
0.2	FILL: silty sand to sand, trace gravel, trace clay, trace organics, brown to grey, moist to saturated, very loose to loose sand and gravel, trace asphalt		1	SS	4												
			2	SS	8												
	trace silty clay pockets		3	SS	3												
316.7																	
2.0	SILTY CLAY TILL: some sand, trace gravel, occasional cobble/boulder, brown, moist, very stiff		4	SS	16												
315.6																	
3.1	SILTY CLAY: trace sand, occasional gravel, contains wet sand seams, grey, moist, very stiff		5	SS	20												
			6	SS	22												
			7	SS	26												
			8	SS	27												
312.0	END OF BOREHOLE																
6.7	Notes: 1) Ground water level was at 3.1m during drilling. 2) 50mm diameter monitoring well installed on completion of drilling. Water level readings: Date August 11, 2015 W.L (bgl)(m) 0.4																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812248 E 542714

DRILLING DATA
 Method: Solid Stem auger
 Diameter: 152 mm
 Date: Jun/23/2015

REF. NO.: 10001862
 ENCL NO.: 3

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p	W	W _L			
323.9								20 40 60 80 100	20 40 60 80 100			10 20 30					GR SA SI CL
323.9	ASPHALT: 40mm																
323.5	GRANULAR BASE/SUBBASE: 350mm (sand and gravel)		1	AS													
323.1	FILL: sand, trace to some silt, some gravel, trace clay, brown, moist		2	SS	8		323										
320.9	FILL: silty sand, trace clay, brown to dark brown, moist to saturated, loose		3	SS	4		322										
			4	SS	4												
320.9	SAND: trace to some silt, trace clay, brown, moist, compact to dense		5	SS	13		holeplug										
			6	SS	25		320										
	layer of gravelly sand, occasional cobble at 4.6m		7	SS	34		319										27 62 8 3
318.8	SILTY CLAY TILL: sandy, trace gravel, occasional cobble/boulder, grey, moist, stiff to hard						W. L. 318.6 m Aug 11, 2015										
	saturated silt/sand seams, grey below 6.1m		8	SS	11		2.3										1 22 52 25
							Screen										
	200mm thick layer of silty sand and silt, saturated at 8.0m		9	SS	24		Holeplug										
315.8	SILTY CLAY: trace to some sand, occasional gravel, contains sand/silt seams, grey, moist, very stiff																
315.7	END OF BOREHOLE																
8.2	Notes: 1) 50mm diameter monitoring well installed on completion of drilling. Water level readings: Date August 11, 2015 W.L (bgl)(m) 5.3																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812257 E 542708

DRILLING DATA
 Method: Solid Stem auger
 Diameter: 152 mm
 Date: Jun/23/2015
 REF. NO.: 10001862
 ENCL NO.: 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		W _p	W	W _L			
323.8								20 40 60 80 100							GR SA SI CL
323.7	ASPHALT: 80mm														
323.5	GRANULAR BASE/SUBBASE: 200mm (silty sand, some gravel)		1	AS											
323.0	FILL: sand, trace silt, trace clay, brown, moist														
323.0	FILL: silty sand, trace clay, trace organics, brown, moist, loose		2	SS	6		323								
322.0			3	SS	5		322								
321.3															
321.3	SAND: trace silt, trace clay, brown, moist, loose to compact		4	SS	5		321								
320.0			5	SS	20		320								0 87 8 5
319.1			6	SS	19		319								
319.1	SILTY CLAY TILL: sandy, contains sand seams, trace gravel, occasional cobble/boulder, grey, moist, stiff to very stiff		7	SS	14		318								
318.0			8	SS	19		317								1 22 53 24
317.0			9	SS	21		316								
316.0	100mm thick layer of sandy silt, trace gravel, saturated at 7.9m						315								
314.7			10	SS	22		314								
314.7	SILTY CLAY: trace to some sand, occasional gravel, some sand/silt seams, grey, moist, very stiff														

SPL SOIL LOG 10001862 GINT FILE AUGUST 12, 2015 GPJ SPL GDT 10/22/15

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation

CLIENT: MMM Group Limited

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchener, ON

DATUM: Geodetic

BH LOCATION: N 4812257 E 542708

DRILLING DATA


Method: Solid Stem auger

Diameter: 152 mm

Date: Jun/23/2015

REF. NO.: 10001862

ENCL NO.: 4

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (C _u) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)										WATER CONTENT (%)	
								20	40	60	80							100	
	SILTY CLAY: trace to some sand, occasional gravel, some sand/silt seams, grey, moist, very stiff(Continued)																		
11			SS	23															
12																			
311.0			12	SS	23														
12.8	END OF BOREHOLE Notes: 1) Borehole was open and dry upon completion of drilling.																		

GROUNDWATER ELEVATIONS

Measurement

1st 2nd 3rd 4th

GRAPH
NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812332 E 542729

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 203 mm
 Date: Jun/17/2015

REF. NO.: 10001862
 ENCL NO.: 5

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L			
322.5															GR SA SI CL
322.0	ASPHALT: 40mm														
322.1	GRANULAR BASE/SUBBASE: 350mm (silty sand, trace gravel)		1	SS	11		322								
0.4	FILL: silty sand, trace clay, trace to some gravel, brown, moist, loose to compact														
			2	SS	16										
	trace to some organics, dark grey to black at 1.5m						321								
			3	SS	6										
320.2															
2.3	FILL: sand, trace silt, trace clay, brown, moist, loose		4	SS	6		320								
319.5															
3.1	SAND: trace silt, brown, moist, compact		5	SS	20										
318.7															
3.8	SILTY CLAY TILL: some sand, trace gravel, occasional cobble/boulder, brown, moist, very stiff to hard		6	SS	19										
	grey below below 4.6m						318								
			7	SS	22										
			8	SS	20		317								11 20 47 22
	contains wet to saturated silt/sand seams below 6.1m														
			9	SS	20		316								7 53 40
	300mm thick layer of wet to saturated silt to sandy silt at 7m		10	SS	42		315								
			11	SS	25		314								
313.7	75mm thick wet sand layer at 8.7m		12	SS	48										
8.8	SILT: some sand, trace clay, occasional gravel, grey, saturated, dense														
			13	SS	39		313								15 75 10
312.6															

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

SPL SOIL LOG 10001862 GINT FILE AUGUST 12, 2015 GPJ SPL GDT 10/22/15

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812332 E 542729

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 203 mm
 Date: Jun/17/2015

REF. NO.: 10001862
 ENCL NO.: 5

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)	
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		W _p W W _L					WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE 							

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation

CLIENT: MMM Group Limited

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchener, ON

DATUM: Geodetic

BH LOCATION: N 4812295 E 542733

DRILLING DATA

Method: Soild Stem Augers

Diameter: 152 mm

Date: Jun/23/2015





REF. NO.: 10001862

ENCL NO.: 6

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)							
								20 40 60 80 100							GR SA SI CL
322.9	ASPHALT: 80mm														
322.5	GRANULAR BASE/SUBBASE: 300mm (sand and gravel)		1	AS											
322.1	FILL: silty sand, trace to some gravel, brown, moist														
322.1	FILL: silty sand, trace gravel, trace clay, trace organics, brown to dark grey, moist, very loose to compact		2	SS	12										
			3	SS	8										
	sand, trace silt, trace clay, trace gravel, brown, moist at 2.3m		4	SS	18										
	trace organic like dark grey clayey silt pockets at 3.1m		5	SS	3										
			6	SS	4										
318.3	SAND: trace silt, trace clay, brownish grey, saturated, compact to very dense		7	SS	18										0 93 4 3
			8	SS	78/ 300mm										
315.3	SILTY CLAY TILL: some sand, trace gravel, contains sand seams, occasional cobble/boulder, grey, moist, hard		9	SS	84/ 300mm										
			10	SS	91/ 275mm										
313.3	END OF BOREHOLE														
9.6	Notes: 1) Ground water level was at 8.2m														

SPL SOIL LOG 10001862 GINT FILE AUGUST 12, 2015.GPJ SPL.GDT 10/22/15

GROUNDWATER ELEVATIONS

	1st	2nd	3rd	4th
Measurement				

GRAPH
NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation

DRILLING DATA

CLIENT: MMM Group Limited

Method: Soild Stem Augers

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchener, ON

Diameter: 152 mm

REF. NO.: 10001862

DATUM: Geodetic

Date: Jun/23/2015

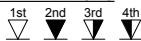
ENCL NO.: 6

BH LOCATION: N 4812295 E 542733

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GROUNDWATER ELEVATIONS

Measurement



GRAPH
NOTES

$+3, \times 3$: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure



LOG OF BOREHOLE BH15-6

1 OF 2

PROJECT: Geotechnical Investigation -Utilities Services Relocation
CLIENT: MMM Group Limited
PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
DATUM: Geodetic
BH LOCATION: N 4812347 E 542782

DRILLING DATA
Method: Solid Stem auger
Diameter: 152 mm
Date: Jul/17/2015

REF. NO.: 10001862
ENCL NO.: 7

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			20 40 60 80 100	20 40 60 80 100	W _p	W	W _L		
318.6	ASPHALT: 250mm													GR SA SI CL
318.4	GRANULAR BASE/SUBBASE: 450mm (sand and gravel)		1	SS	46		318							
317.9	FILL: sand, trace silt, trace gravel, trace clay, brown, moist		2	SS	37									
316.6	saturated below 1.5m		3	SS	18		317							
2.0	SILTY CLAY TILL: some sand, trace gravel, contains wet sand seams/pockets, occasional cobble/boulder, grey, moist, stiff to very stiff		4	SS	14		316							2 21 52 25
			5	SS	12		315							
			6	SS	22									1 11 59 29
314.0	SILTY CLAY: trace sand, trace gravel, contains sand/silt seams/pockets, grey, moist, stiff to very stiff		7	SS	20		314							
4.6			8	SS	15		313							
			9	SS	12		312							
	occasional gravel below 6.9m		10	SS	17		311							2 40 58
			11	SS	23									1 43 56
			12	SS	20		310							
							309							

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

SPL SOIL LOG: 10001862 GINT FILE AUGUST 12, 2015 GPJ SPL GDT 10/22/15

PROJECT: Geotechnical Investigation -Utilities Services Relocation

CLIENT: MMM Group Limited

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchener, ON

DATUM: Geodetic

BH LOCATION: N 4812347 E 542782

DRILLING DATA

Method: Solid Stem auger

Diameter: 152 mm





Date: Jul/17/2015

REF. NO.: 10001862

ENCL NO.: 7

[illegible]

GROUNDWATER ELEVATIONS

	1st	2nd	3rd	4th
Measurement				

GRAPH
NOTES

$+3, \times 3$: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812361 E 542842

DRILLING DATA

Method: Hollow Stem Auger
 Diameter: 203 mm
 Date: Jun/12/2015

REF. NO.: 10001862
 ENCL NO.: 8

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p	W	W _L			
322.6								20	40	60	80	100					GR SA SI CL
322.6	ASPHALT: 40mm																
322.2	GRANULAR BASE/SUBBASE: 350mm (silty sand, some gravel)		1	AS													
0.4	FILL: silty sand to sandy silt, trace to some gravel, trace asphalt pieces, trace brick fragments, dark grey to black, moist to wet, compact		2	SS	20												
			3	SS	14												
	brick pieces at 2m		4	SS	15												
			5	SS	17												
	some gravel, trace brick fragments at 3.1m		6	SS	14												
318.8	FILL: sand, some silt, some gravel, trace rootlets, trace brick fragments, trace asphalt, brown to grey, wet to saturated, compact		7	SS	15												
317.3	SAND: trace silt, trace clay, occasional gravel, brown, saturated, compact		8	SS	12												
			9	SS	12												
	disturbed sample		10	SS													
			11	SS	12												
314.2	SILTY SAND: trace clay, occasional gravel, grey, saturated, loose		12	SS	9												
313.8	SILTY CLAY TILL: some sand, trace gravel, contains wet sand/silt seams, occasional cobble/boulder, grey, moist, stiff to very stiff		13	SS	12												

SPL SOIL LOG 10001862 GINT FILE AUGUST 12, 2015 GPJ SPL GDT 10/22/15

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, × 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation

CLIENT: MMM Group Limited

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchener, ON

DATUM: Geodetic

BH LOCATION: N 4812361 E 542842

DRILLING DATA

Method: Hollow Stem Auger

Diameter: 203 mm

Date: Jun/12/2015

REF. NO.: 10001862

ENCL NO.: 8

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SPL SOIL LOG 10001862 GINT FILE AUGUST 12, 2015.GPJ SPL.GDT 10/22/15

GROUNDWATER ELEVATIONS

Measurement

1st 2nd 3rd 4th

GRAPH
NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812329 E 542844

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 203 mm
 Date: Jun/16/2015

REF. NO.: 10001862
 ENCL NO.: 9

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)				
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)		WATER CONTENT (%)					GR	SA	SI	CL	
												○ UNCONFINED ● QUICK TRIAXIAL							+ FIELD VANE & Sensitivity × LAB VANE
322.9								20	40	60	80	100							
322.9 0.1	ASPHALT: 100mm																		
322.5	GRANULAR BASE/SUBBASE: 300mm (sand and gravel)		1	SS	15														
322.4 0.4	FILL: sandy silt, grey, moist, compact																		
322.3	FILL: sandy silt, trace gravel, trace organics, trace rootlets, trace plastic bag rag, trace peat pockets, dark grey, moist, loose to very dense		2	SS	8														
	sand and gravel, trace cobble layer at 1.5m		3	SS	79														
	75mm thick sand and gravel layer at 2.4m		4	SS	17														
	trace organics at 3.1m																		
319.6			5	SS	22														
318.9			6	SS	21														
4.0	SANDY SILT: trace gravel, brown, moist, compact																		
	SAND: trace silt, trace clay, occasional gravel, brown, saturated, compact		7	SS	16														
			8	SS	17														

Continued Next Page

GROUNDWATER ELEVATIONS

1st 2nd 3rd 4th
 Measurement

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

SPL SOIL LOG 10001862 GINT FILE AUGUST 12, 2015 GPJ SPL GDT 10/22/15

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812329 E 542844

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 203 mm
 Date: Jun/16/2015

REF. NO.: 10001862
 ENCL NO.: 9

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m) ELEV DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p	W	W _L			
								20 40 60 80 100									GR SA SI CL
	SILTY CLAY TILL: some sand, trace gravel, contains wet sand/silt seams, occasional cobble/boulder, grey, moist, very stiff(Continued)																
	70mm thick sand layer at 10.7m																
11			11	SS	16		312										
							holeplug										
12							311										
			12	SS	29												9 17 47 27
13							310										
309.2																	
13.7	SILTY CLAY: trace to some sand, contains silt/sand seams, embedded clayey silt layers, grey, moist, hard		13	SS	30		309										
15							308										
307.1			14	SS	41												
15.9	END OF BOREHOLE Notes: 1) 50mm diameter monitoring well installed on completion of drilling. Water level readings: Date August 11, 2015 W.L. (bgl)(m) 4.0																

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3 , × 3 : Numbers refer to Sensitivity

○ ε=3% Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation

CLIENT: MMM Group Limited

PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON

DATUM: Geodetic

BH LOCATION: N 4812312 E 542846

DRILLING DATA

Method: Hollow Stem Auger/Solid Stem Auger

Diameter: 203mm/152mm

Date: Jun/11/2015

REF. NO.: 10001862

ENCL NO.: 10

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p	W	W _L			
323.2								20	40	60	80	100					
322.9	ASPHALT: 90mm																
322.8	GRANULAR BASE/SUBBASE: 300mm (sand and gravel)		1	AS			323										
0.4	FILL: sandy silt, some gravel, trace asphalt, brown to grey, moist, very dense		2	SS	77		322										
			3	SS	67		321										
	100mm thick sand and gravel layer at 2.0m		4	SS	13		320										
320.9	FILL: sandy silt, trace gravel, trace to some organics, dark grey, moist to saturated, compact to dense		5	SS	30		319										
2.3			6	SS	29		318										
319.4	SANDY SILT: some gravel, trace clay, brown, saturated, compact		7	SS	15		317										
318.6	SAND AND GRAVEL: trace silt, trace clay, brown, saturated, compact		8	SS	18		316										
4.6			9	SS	12		315										
317.1	SAND: trace silt, trace gravel, trace clay, grey, saturated, compact		10	SS	13		314										
6.1							313										
314.1	SILTY CLAY TILL: some sand, trace gravel, contains wet sand/silt seams, occasional cobble/boulder, grey, moist, stiff						312										
9.1							311										
313.5	END OF BOREHOLE						310										
9.8							309										

switched to hollow stem auger at 7.6m
8 80 8 4

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

DRILLING DATA

Method: Hollow Stem Auger/Solid Stem Auger

Diameter: 203mm/152mm

REF. NO.: 10001862

Date: Jun/11/2015

ENCL NO.: 10

BH LOCATION: N 4812312 E 542846

[illegible]

GROUNDWATER ELEVATIONS

	1st	2nd	3rd	4th
Measurement				

GRAPH
NOTES

$+^3, \times^3$: Numbers refer to Sensitivity

○ $\epsilon=3\%$ Strain at Failure

PROJECT: Geotechnical Investigation -Utilities Services Relocation
 CLIENT: MMM Group Limited
 PROJECT LOCATION: 800 Victoria St., (Bridge), Kitchner, ON
 DATUM: Geodetic
 BH LOCATION: N 4812238 E 542816

DRILLING DATA
 Method: Hollow Stem Auger
 Diameter: 203mm
 Date: Aug/10/2015

REF. NO.: 10001862
 ENCL NO.: 10

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIQUID LIMIT			POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kNm ³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%)
(m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" BLOWS 0.3 m			SHEAR STRENGTH (kPa)				W _p	W	W _L			
318.7								20	40	60	80	100					GR SA SI CL
318.0	ASPHALT:160mm																
0.2	GRANULAR BASE/SUBBASE:																
318.3	300mm (sand and gravel)		1	SS	12												
0.5	FILL: clayey silt, trace gravel, brown, moist, stiff																
	400mm thick layer of organic clayey silt, dark grey to black, moist		2	SS	8												
317.2																	
1.5	SAND: some gravel, trace clay, brown to grey, wet, loose		3	SS	8												
316.4																	
2.3	SAND: some silt, trace clay, brown, wet, compact		4	SS	19												
315.6																	
3.1	SILTY CLAY TILL: some sand, trace gravel, occasional cobble/boulder, grey, moist, stiff to hard		5	SS	33												
			6	SS	12												9 16 52 23
	wet sand seams at 4.6m																
			7	SS	24												
312.6																	
6.1	SILTY CLAY: trace sand, occasional gravel, grey, moist, very stiff		8	SS	23												
			9	SS	18												
			10	SS	18												
309.0	END OF BOREHOLE																

Continued Next Page

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES

+ 3, x 3: Numbers refer to Sensitivity

○ ε=3% Strain at Failure

DRILLING DATA

Method: Hollow Stem Auger

Diameter: 203mm

REF. NO.: 10001862

Date: Aug/10/2015

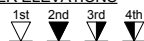
ENCL NO.: 10

BH LOCATION: N 4812238 E 542816

[illegible]

GROUNDWATER ELEVATIONS

Measurement



GRAPH
NOTES

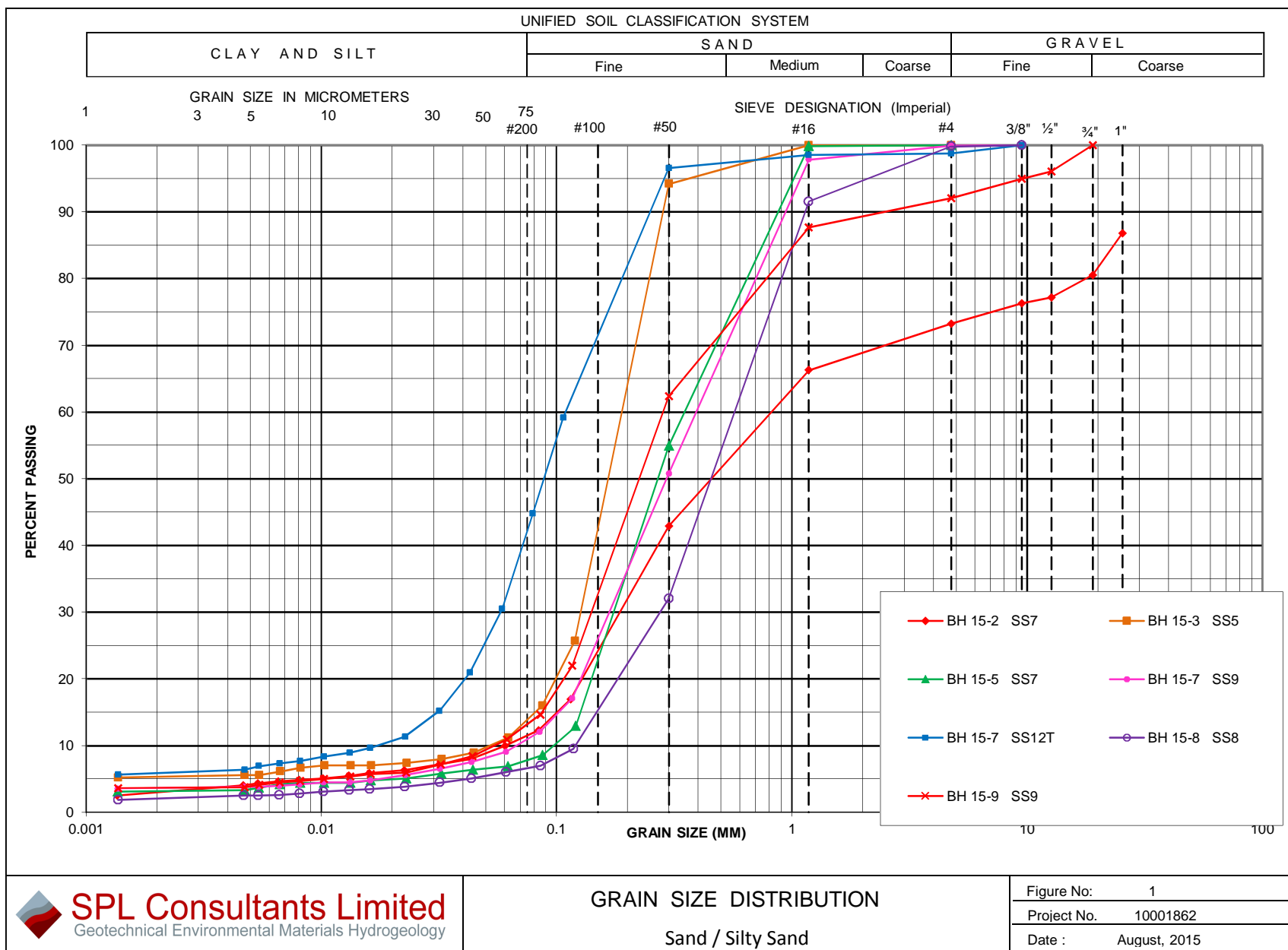
$+3, \times 3$: Numbers refer to Sensitivity

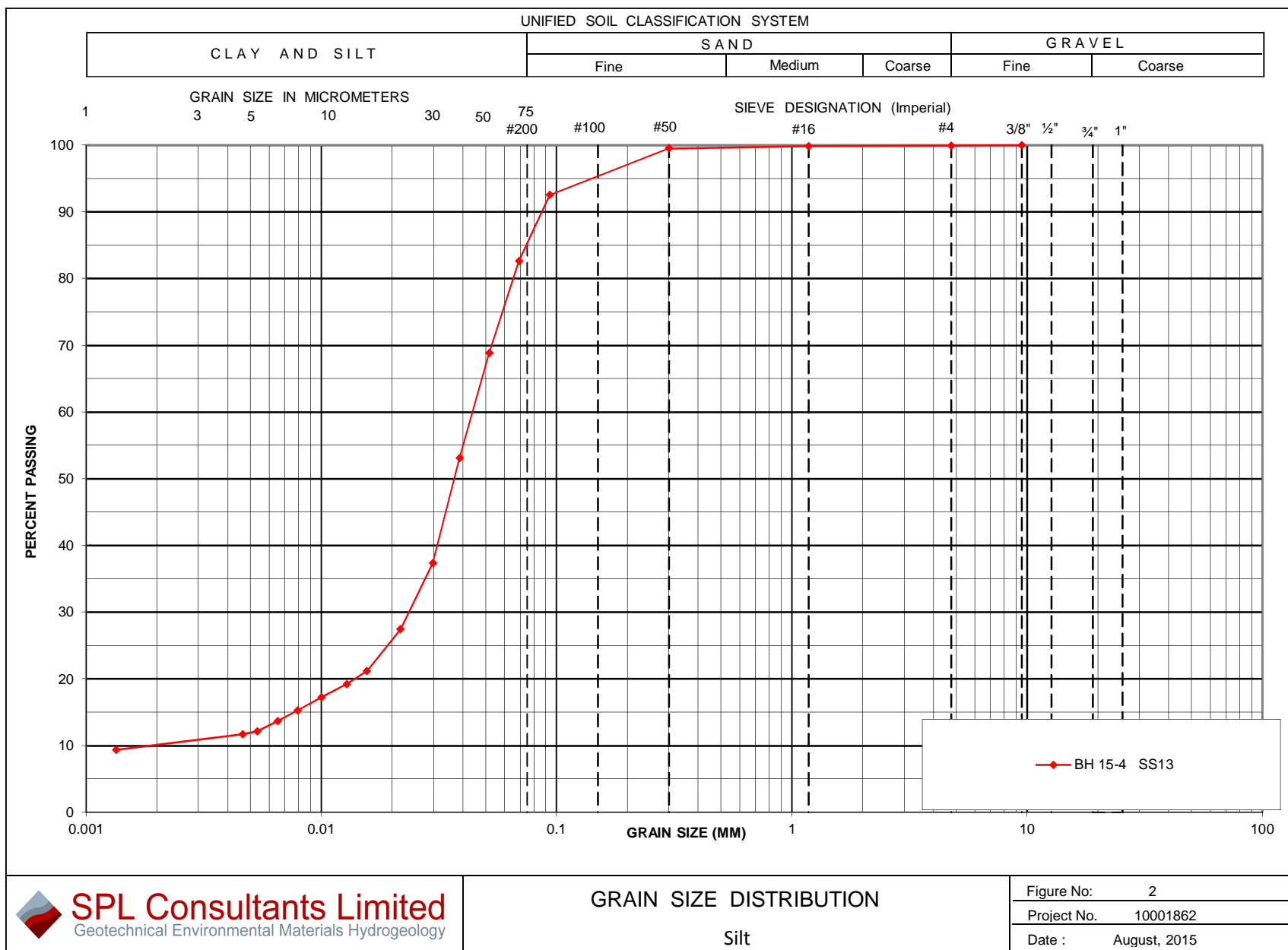
○ $\epsilon=3\%$ Strain at Failure

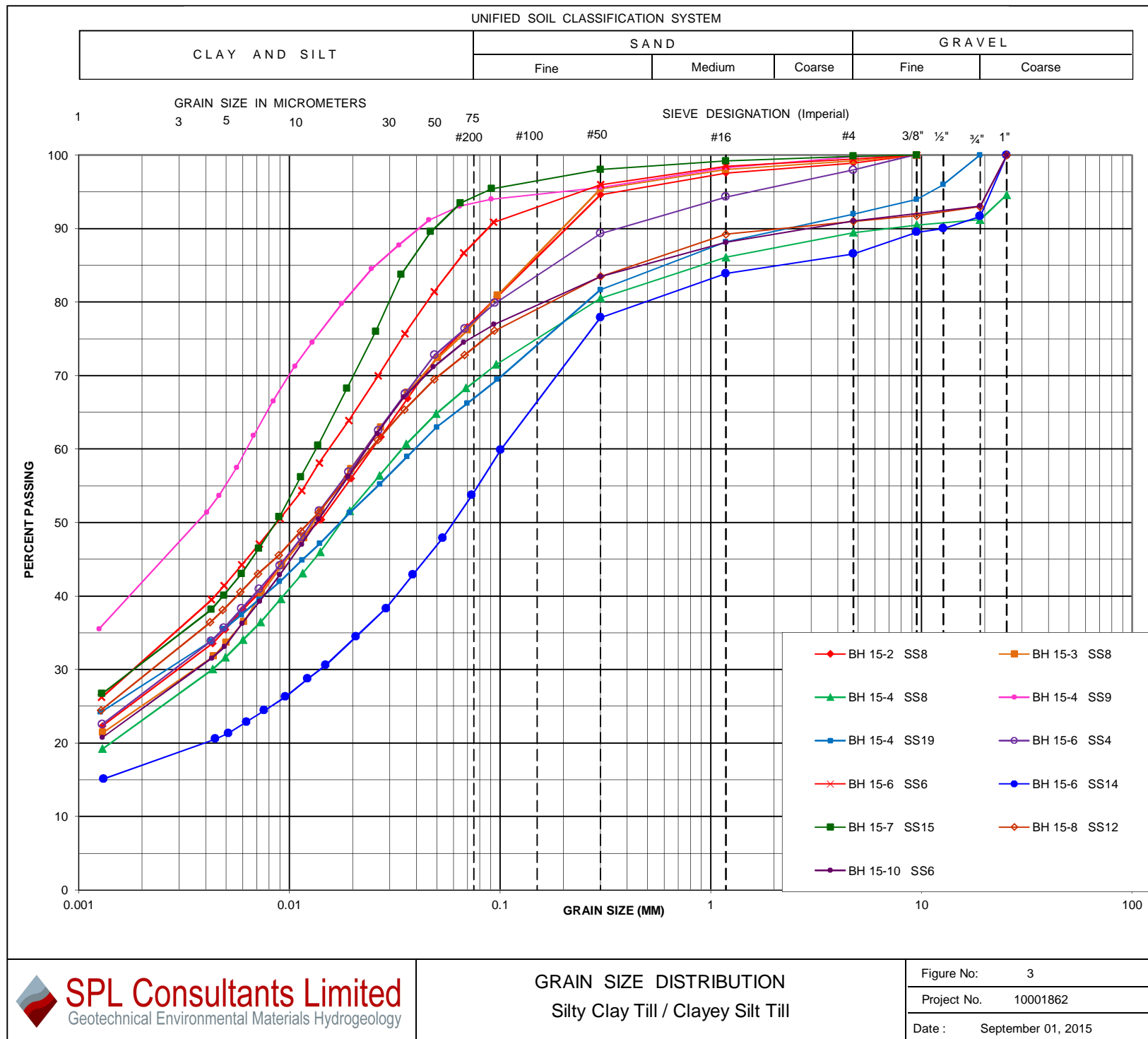
APPENDIX B

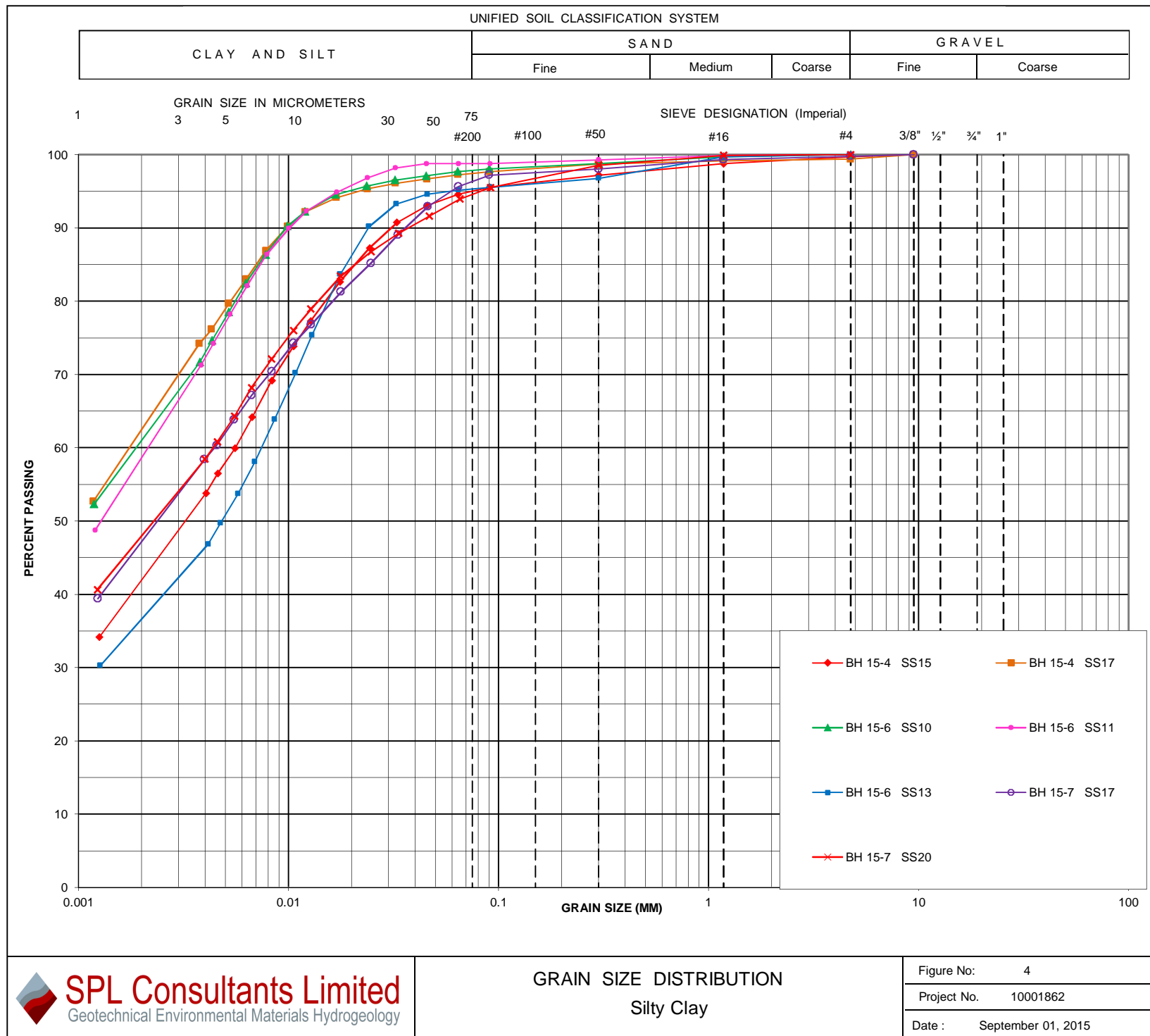
Grain Size Distribution Curves (Figures 1 to 4)

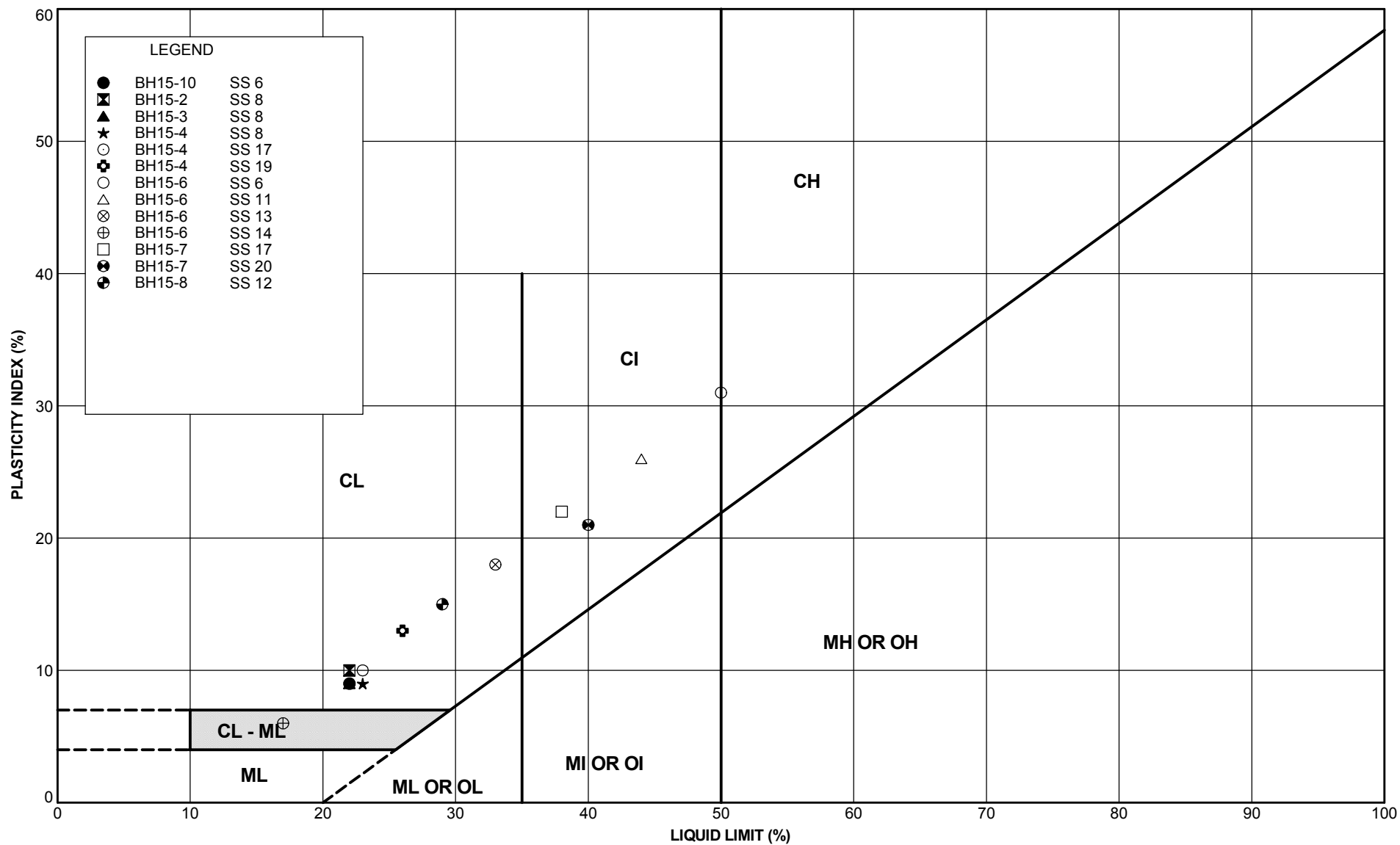
Plasticity Charts (Figure 5)











PLASTICITY CHART

FIGURE NO.	5.
JOB NO.	10001862
DATE	August 14, 2015