



FINAL REPORT

FOUNDATION INVESTIGATION REPORT

**Kawawia Creek Culvert Replacement, Highway 502, Site No. 41S-244/C, District
of Kenora**

Agreement No. 6014-E-0017

Assignment No. 6

GWP 6323-14-00

Geocres No. 52F-043

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Ministry of Transportation

Foundation Investigation Report

Agreement No. 6014-E-0017

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GWP 6323-14-00

Geocres No. 52F-043

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Foundation Investigation Report for for Kawawia Creek Culvert Replacement
Highway 502, Site No. 41S-244/C, District of Kenora

Project Number:

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Part I: FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This foundation investigation report presents the results of a geotechnical investigation completed by **exp** Services Inc. for the replacement of Kawawia Creek Culvert, located on Highway 502, about 64.6 km north of the junction of Hwy 11 and Hwy 502, in the District of Kenora, the Ministry of Transportation (MTO) Northwestern Region. The work was undertaken under Agreement # 6014-E-0017, Assignment No. 6 (GWP 6323-14-00). The terms of reference (TOR) were as presented in the MTO letter dated May 27, 2015.

Based on preliminary information provided, it is understood the existing culvert is a corrugated steel pipe (CSP) culvert with a length of about 21 m and diameter of about 3.0 m. It is understood that the existing culvert was constructed/installed in 1977, and is intended to be replaced with a new culvert along the same alignment.

The purpose of the investigation was to evaluate the subsurface conditions along the alignment, to permit detailed design for the culvert replacement. The site specific geotechnical investigation consisted of borings, soil sampling, borehole logging, and field and laboratory testing.

This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing completed for this project.

1.2 Site Description and Geological Setting

1.2.1 Site Description

As shown on Drawing 1 (Appendix B), the Kawawia Creek Culvert is located on Highway 502, about 64.6 km north of the junction of Hwy 11 and Hwy 502, in the District of Kenora, Ontario. At the site, Hwy 502 is a two lane roadway, with a speed limit of 80 km/h and is about 7.0 m wide from edge of pavement to edge of pavement, with narrow sand and gravel shoulders. Based on drawings provided, the roadway embankment is about 4.3 m high with side slopes of about 2V:1H and 1.5V:1H at the culvert inlet and outlet, respectively.

Based on a true north direction, Highway 502 at the Kawawia Creek Culvert location runs generally in a northeast and southwest direction, and Kawawia Creek generally flows northwest to the southeast. However, for simplicity and for the purposes of this report a “project north” has been established and project north is oriented to the centerline of Hwy 502 (i.e. project north is in the same direction as true north’s northeast direction). The orientation of project north is presented on Drawing 1 in Appendix B. Hereinafter, the directions indicated in this report are in referenced to project north.

During the fieldwork on June 23, 24 and 25, 2015, the general site conditions were assessed. Hwy 502 runs in a north and south direction and Kawawia Creek, generally flows from west to east beneath the highway. At the time of this investigation, the approximate creek elevations at the inlet

and outlet were about 396.00 m and 395.99 m, respectively. The elevation of highway pavement centerline at the culvert centerline is about 399.3 m. Guard rails were observed on both sides of the highway and frost heave/settlement of the roadway structure was noted at the culvert location.

At the vicinity of the inlet and outlet of the culvert some minor vegetation was noted at both culvert ends. The surrounding area of the culvert at the west side of Hwy 502 was generally forested and at the east side was generally a low lying area with tall grass. The inlet and outlet appeared to be generally clear of debris and excess vegetation, and as such the flow does not appear to be restricted.

Select photographs are provided in Appendix A.

1.2.2 Geological Setting

According to the MNR Northern Ontario Engineering Geology Terrain Data Base Map, Ontario Geological Survey Map 5061, Scale 1:100,000, dated 1979, the underlying native soil at the site consists of silt till ground moraine overlying bedrock knob, with a subordinate landform consisting of peat organic terrain; mainly low local relief, undulating to rolling, knobby, hummocky, and dry to mixed wet and dry surface conditions.

According the Ministry of Northern Development and Mines (MNDM) Bedrock Geology of Ontario, West-Central Sheet Map No. 2542, Scale 1:1,000,000, dated 1991, the bedrock geology of the site is of the Archean Neo to Mesoproterozoic Era (2.5 to 3.4 Ga), Intrusive rocks, and generally consist of massive to foliated granodiorite to granite.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation was performed on June 23, 24 and 25, 2015. The field program consisted of drilling four (4) sampled boreholes (BH501 to BH504). Two (2) boreholes were located within the highway, BH501, and BH502. BH501 was located about 6.3 m south of the culvert centerline and about 2.2 m west of the highway centerline. BH502 was located about 4.5 m north of the culvert centerline and about 2.7 m east of the highway centerline. An additional two (2) boreholes (BH503 and BH504) were advanced off of the highway. BH503 was located about 7.8 m north of the culvert centerline and about 13.7 m west of the highway centerline (inlet/upstream side). BH504 was located about 16.5 m south of the culvert centerline and about 14.8 m east of the highway centerline (outlet/downstream side). The borehole locations are shown on Drawing 1 in Appendix B.

All the boreholes (BH501 to BH504) were advanced using a CME 850 track mounted drill rig. The drill rig was equipped with hollow stem continuous flight augers and standard soil sampling equipment (includes 51 mm outside diameter split spoon samplers and *in situ* shear vane testing equipment). In addition, the CME 850 drill rig was equipped with rock coring equipment (HQ size). The roadway boreholes BH501 and BH502 were advanced to depths of about 10.6 m, and 9.5 m below ground surface, respectively. The off-road boreholes BH503 and BH504 were advanced to auger and SPT refusal, at depths of about 2.4 m and 3.3 m below ground surface, respectively. The off-road boreholes were terminated at the refusal depths.

At BH501 and BH502, at about 3.0 m and 4.7 m below ground surface, respectively, auger and SPT refusal was encountered and rock coring techniques were conducted to advance the boreholes to determine the nature of refusal (i.e. cobbles and boulders). Rock coring techniques at BH501 and BH502 were continued through additional overburden soils and into the bedrock. Rock core samples were collected at both borehole locations. No rock coring techniques were conducted at the remaining borehole locations.

The borehole locations were referenced to the MTM ON-16 NAD83 coordinate system and their ground surface elevations were surveyed by **exp** personnel. The ground surface elevations, including top of water in the creek, were referenced to a geodetic benchmark (BM) provided (brass plate in rock) south of the site and west of the highway. The BM elevation is 400.038 m. The location of the BM is shown on Drawing 1, in Appendix B.

During the drilling of the boreholes (BH501 to BH504), soil samples were obtained using a 51 mm outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586), and were generally performed at intervals of about 0.75 m. The original field (uncorrected) SPT "N" values were recorded on the borehole logs as recommended in the Canadian Foundation Engineering Manual and used to provide an assessment of *in-situ* compactness (cohesionless) or consistency (cohesive) soils.

Upon completion of the boreholes, groundwater level measurements were carried out in boreholes in accordance with the Ministry of Transportation guidelines. The measured groundwater levels after completion of drilling boreholes were recorded on borehole log sheets in Appendix C. The boreholes were backfilled with a mixture of bentonite and auger cuttings. The borehole decommissioning was in general accordance with the Ministry of the Environment Regulation 903, as amended by Regulation 128/03 (the well regulation under the *Ontario Water Resources Act*).

The fieldwork was supervised by a member of **exp**'s engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples. All of the recovered soil samples were placed in labelled moisture-proof bags which, along with the rock cores, were brought to **exp**'s Thunder Bay laboratory for additional visual, textual and olfactory examination, and for subsequent examination by a geotechnical engineer and laboratory testing.

1.3.2 Laboratory Testing

All samples brought to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content and particle size distribution for approximately 25% of the collected soil samples. Atterberg Limits tests were carried out on select cohesive soil samples. All of the laboratory tests were carried out in accordance with MTO and/or ASTM Standards, as appropriate, at the **exp** laboratory in Thunder Bay, Ontario.

The laboratory test results are provided on the attached borehole log sheets in Appendix C as well as graphically in Appendix D.

In addition, chemical testing of two select soil samples were conducted. The soil samples were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified

and accredited laboratory in Mississauga, Ontario. Details of the chemical testing are discussed below and the lab results are included in Appendix E.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the Borehole Records in Appendix C. Laboratory test results are provided in Appendix D. The “Explanation of Terms Used on Borehole Records” preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report. In addition, photographs of the bedrock core obtained are included in Appendix C.

A borehole location plan and stratigraphic sections are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and stratigraphic sections are inferred from semi-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be interpreted as exact planes of geological change. Furthermore, subsurface conditions may vary between and beyond the borehole locations.

In general, the subsurface conditions along the proposed culvert alignment consist of a layer of gravel fill overlying cobbles and boulders fill, overlying sand, overlying cobbles and boulders, overlying bedrock. A more detailed summary of the subsurface conditions encountered in the boreholes is provided in the following sections.

1.4.1 Poorly Graded Gravel with Silt and Sand to Silty Gravel with Sand Fill

Poorly graded gravel with silt and sand fill becoming silty gravel with sand fill at depth was encountered beneath the asphalt at BH501 and BH502. The asphalt thickness at BH501 and BH502 was about 40 mm and 50 mm, respectively. The gravel fill was generally described as very dense to compact at depth, brown to grey, damp to moist, containing occasional to some cobbles. Trace asphalt pieces were noted in the upper 0.2 m at BH501. The SPT “N” values ranged between 17 and 100 (i.e. SPT refusal) blows per 300 mm penetration, with an average “N” value of about 38. The poorly graded gravel with silt and sand fill to silty gravel with sand fill extended to depths ranging between about 2.3 m (397.0 m elevation) and 3.1 m (396.3 m elevation) below ground surface.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture content:

- 1.2% to 6.0%

Grain size distribution:

- 42% to 58% gravel;
- 33% to 41% sand; and
- 9% to 17% silt and clay size.

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution tests are also provided on Figure 1, in Appendix D.

1.4.2 Cobbles and Boulders Fill

Cobbles and boulders fill was encountered beneath the gravel fill. Two SPT tests were conducted and the “N” values were 24 and 39 blows per 300 mm penetration. It is noted that auger and SPT refusal was encountered at BH501 at about 3.0 m depth. The cobbles and boulders fill extended to depths of about 4.7 m (394.7 m elevation) and 4.3 m (395.1 m elevation) below ground surface at BH501 and BH502, respectively.

Laboratory testing performed on selected samples consisted of moisture content. The test results are as follows:

Moisture content:

- 1.4% to 1.6%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.3 Rootmat

Roomat was encountered surfacing BH503 and BH504. The rootmat was described as soft, brown, and wet. The SPT “N” values ranged between 2 and 8 blows per 300 mm penetration, with an average “N” value of about 6. The rootmat extended to about 0.1 m below ground surface and elevations ranging between about 396.1 m and 396.3 m.

Laboratory testing performed on selected samples consisted of moisture content. The test results are as follows:

Moisture content:

- 74% to 114%

The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.4 Silty Sand with Gravel to Silty Sand

Silty sand with gravel to silty sand was generally encountered beneath the fill and rootmat. The silty sand with gravel to silty sand was generally described as loose to very dense, brown to grey at depth and moist to wet. At BH503 and BH504, occasional cobbles and about 600 mm of sand blow-up was noted. In addition, trace peat was observed at BH504 from about 0.9 m to 1.5 m below ground surface. The SPT “N” values ranged between 4 and 100 (i.e. SPT refusal) blows per 300 mm penetration, with an average “N” value of about 41. The silty sand with gravel to silty sand extended to depths ranging between about 2.4 m and about 7.6 m below ground surface, and elevations ranging between 391.7 m and 394.8 m.

Laboratory testing performed on selected samples consisted of moisture content, and grain size distribution tests. The test results are as follows:

Moisture content:

- 7.3% to 19.3%

Grain size distribution:

- 1% to 42% gravel;
- 40% to 92% sand;
- <5% to 35% silt; and
- <5% to <26% clay size.

Total saturated unit weights have been calculated based on the moisture contents and are estimated to range from about 20.7 to 23.7 kN/m³.

The results of the moisture content, and grain size distribution tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution are also provided on Figures 2 and 3 in Appendix D.

1.4.5 Cobbles and Boulders

Cobbles and boulders were encountered within the sand at BH501 and beneath the sand and BH502. One SPT test was conducted and the “N” value was 100 (i.e. SPT refusal) blows per 300 mm penetration. It is noted that auger and SPT refusal was encountered at BH502 at about 4.7 m depth. The cobbles and boulders extended to about 6.1 m (393.2 m elevation) and 6.5 m (392.8 m elevation) below ground surface.

No laboratory testing was performed on the cobbles and boulders.

1.4.6 Bedrock

Bedrock was encountered underlying the silty sand with gravel, and the cobbles and boulders at BH501 and BH502, at depths of about 7.6 m (391.7 m elevation) and 6.5 m (392.8 m elevation), respectively. The bedrock was generally described as a medium strong (25 MPa to 50 MPa compressive strength), very severely fractured, pink to white, and medium to coarse grained. The boreholes were extended by rock coring about 3.0 m into bedrock, and to depths ranging about 9.5 m and 10.6 m below ground surface. The boreholes were terminated at elevations ranging between about 388.7 m and 389.8 m. Photographs of the bedrock core samples are presented in Appendix C, after the Borehole Logs.

Gross recoveries ranged between about 97% and 100%. The Rock Quality Designation (RQD), which is a modified core recovery, was 0% for all core run samples (very severely fractured).

No laboratory testing was performed on the bedrock.

1.5 Groundwater and Surface Water Conditions

Information on groundwater levels at the site was obtained by measuring the water levels in the open boreholes after completion of drilling. The groundwater levels encountered in the boreholes are shown on the borehole logs and presented below in Table 1.1.

Seasonal variations in the water table should be expected, with higher levels occurring during wetter periods of the year and lower levels during drier periods.

Table 1.1. Groundwater data

Borehole	Date Completed	Date Measured	Ground Surface Elevation ²	Depth to Water ³	Groundwater Elevation
BH501	Jun. 24/15	Jun. 24/15	399.31	3.34	395.97
BH502	Jun. 24/15	Jun. 24/15	399.33	3.40	395.93
BH503	Jun. 25/15	Jun. 25/15	396.41	1.09	395.32
BH504	Jun. 25/15	Jun. 25/15	396.17	0.25	395.92
Kawawia Creek WL Upstream (West) Side	--	Jun. 25/15			396.00 ⁴
Kawawia Creek WL Downstream (East) Side	--	Jun. 25/15	--	--	395.99 ⁴
Notes: 1) All units in metres. 2) Elevations surveyed are referenced to a geodetic benchmark (BM) provided (brass plate in rock) south of the site and west of the highway. The BM elevation is 400.038 m. 3) Depths are relative to ground surface. 4) Indicates top of surface water elevation at Kawawia Creek.					

1.6 Chemical Analyses

Two soil sample were selected for chemical analyses and were sent via courier, in a secure cooler under chain of custody, to Maxxam Analytics Inc., a CALA-certified and accredited laboratory in Mississauga, Ontario. The analytical laboratory results are presented in Appendix E, and are summarized in Table 1.2, below.

Table 1.2. Corrosivity Chemical Analysis

Borehole	pH (unitless)	Chloride (ppm)	Soluble Sulphate (ppm)	Resistivity (ohm-cm)	Conductivity (μ S/cm)
BH503-S4	5.89	89	<20	5,300	190
BH504-S1B	4.90	370	<20	1,500	646

1.7 Closure

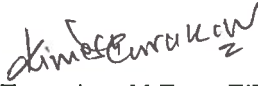
A subsurface investigation is a limited sampling of a site; the subsurface conditions have been established only at the test hole locations. Should conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to assess this additional information and our recommendations, as appropriate. It may then be necessary to perform additional investigation and analysis.

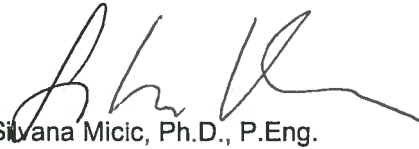
Contractors bidding on or undertaking any proposed work at this site should, relative to the subsurface conditions, decide on their own investigations, if deemed necessary, as well as their own interpretations of the factual results provided herein, so they may draw their own conclusions as to how the subsurface conditions may affect them.

This Foundation Investigation and Design Report has been prepared by Ahileas Mitsopoulos, P.Eng., Nimesh Tamrakar, M.Eng, EIT., Demetri N. Georgiou, MASc. P.Eng., and Silvana Micic, Ph.D., P.Eng. It was reviewed by TaeChul Kim, P.Eng. and by Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Elwin Farkas.

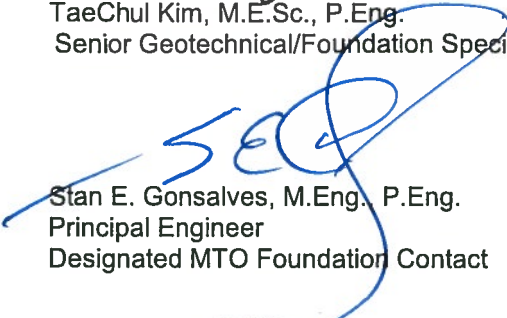
Yours truly,

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Principal Engineer
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Encl.



Appendix A – Site Photographs



Photo 1. Existing culvert inlet on west side of highway



Photo 2. Existing culvert outlet on east side of highway facing south



Photo 3. Facing south on Highway 502 before the existing culvert



Photo 4. Facing north on Highway 502 before the existing culvert

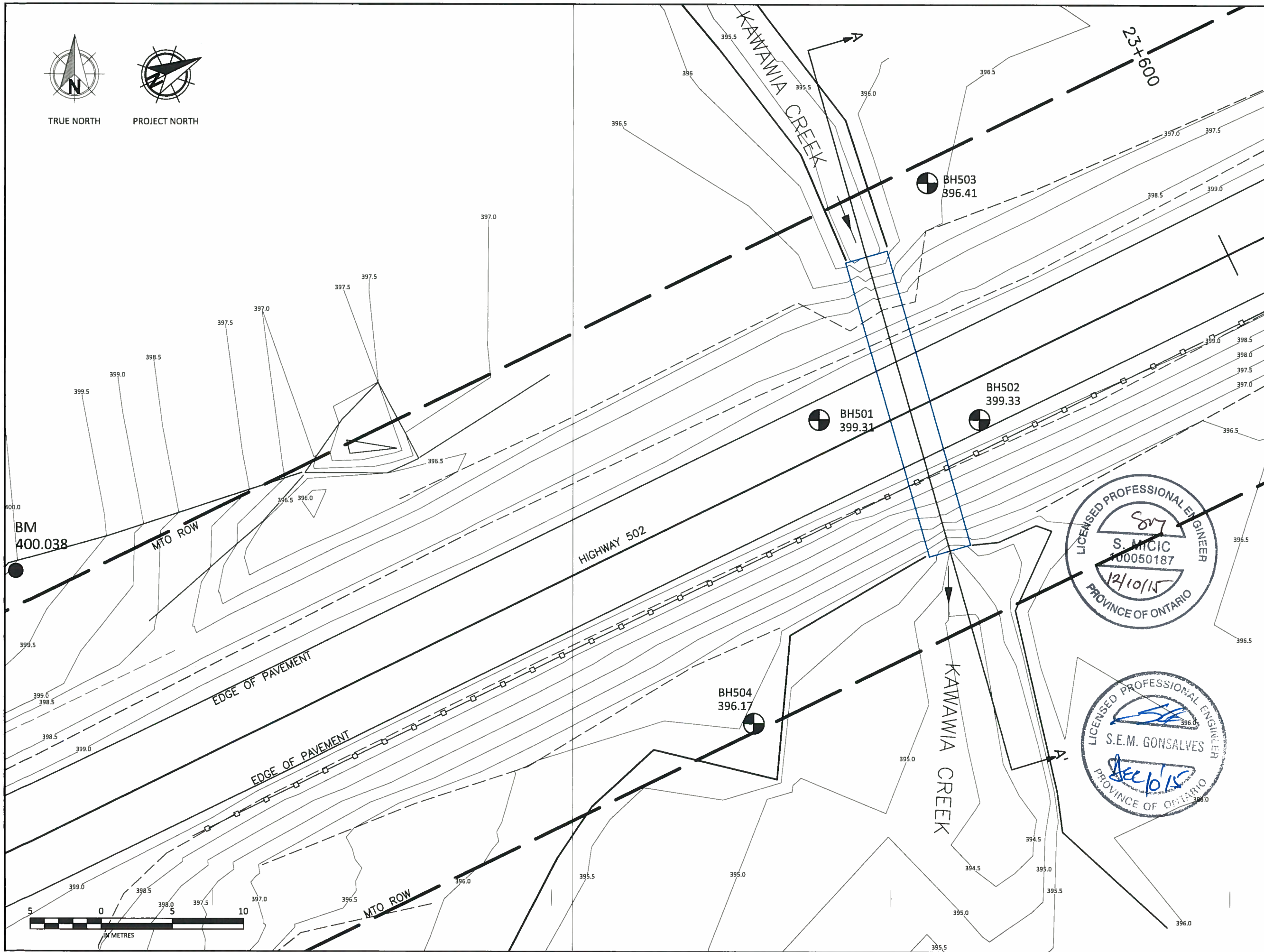
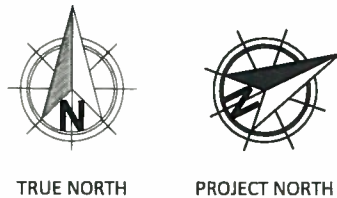


Photo 5. Embankment slope on west side facing south



Photo 6. Embankment slope on east side facing north

Appendix B – Drawings



Agreement No. 6014-E-0017
Assignment No. 6
GWP 6323-14-00

KAWAWIA CREEK CULVERT
(Highway 502, District of Kenora, ON)
PLAN

DWG
1

exp.

exp Services Inc.

KEY PLAN

LEGEND

BH501
399.31

BOREHOLE LOCATION
GROUND SURFACE ELEVATION IN METRES

BM
400.038

BENCHMARK LOCATION
GEODETIC ELEVATION IN METRES

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH501	399.31	5,451,064	315,617
BH502	399.33	5,451,063	315,628
BH503	396.41	5,451,080	315,625
BH504	396.17	5,451,043	315,613

NOTES

1. ALL DIMENSIONS ARE IN METRES.

2. BASE MAP PROVIDED BY CLIENT.

3. MTM COORDINATES BASE ON MTM ZONE ON-16 PROJECTION, AS PER PROVIDED FIGURE.

4. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY.

REVISIONS

DATE	BY	DESCRIPTION

GEOCRES No. 52F-043

Project No. ADM-00223648-E0

Date: December 8, 2015

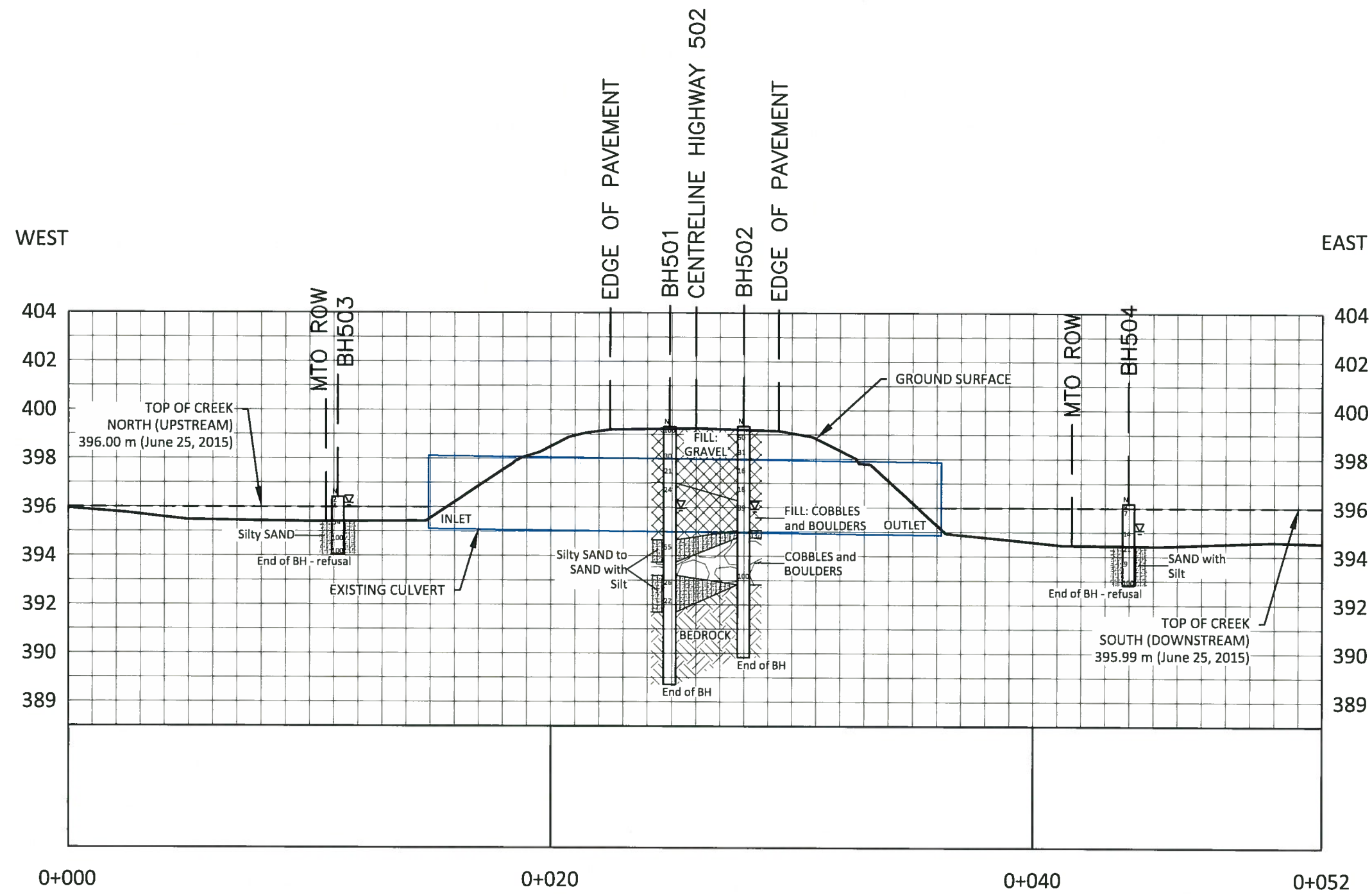
Scale : 1:250

Drawn By: RM

Checked By: AM

Checked By: DG





A - A'
PROFILE OF KAWAWIA CREEK CULVERT



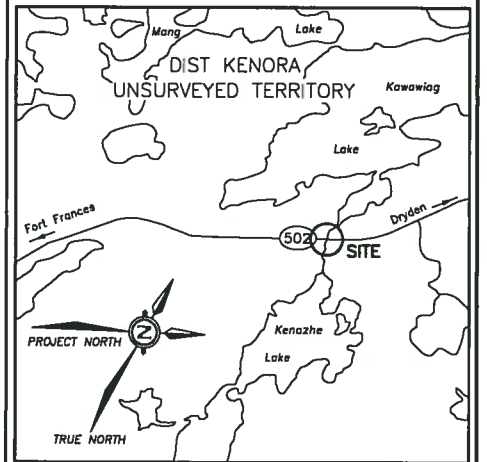
Agreement No. 6014-E-0017
Assignment No. 6
GWP 6323-14-00

KAWAWIA CREEK CULVERT
(Highway 502, District of Kenora, ON)
PLAN

DWG
2

exp. Services Inc.

KEY PLAN



LEGEND

N STANDARD PENETRATION TEST
(BLOWS/0.3 m)
▽ MEASURED WATER LEVEL

BH No.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTH	EAST
BH501	399.31	5,451,064	315,617
BH502	399.33	5,451,063	315,628
BH503	396.41	5,451,080	315,625
BH504	396.17	5,451,043	315,613

NOTES

REVISIONS

DATE	BY	DESCRIPTION
GEOCRE No. 52F-043		Project No. ADM-00223648-E0
Date: December 8, 2015		Horizontal Scale : 1:200
Drawn By: RM		Vertical Scale : 1:200
Checked By: AM		Checked By: DG

Appendix C – Borehole Logs and Bedrock Core Photos

Explanation of Terms Used on Borehole Records

SOIL DESCRIPTION

Terminology describing common soil genesis:

Topsoil: mixture of soil and humus capable of supporting good vegetative growth.

Peat: fibrous fragments of visible and invisible decayed organic matter.

Fill: where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc.; none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

Till: the term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Terminology describing soil structure:

Desiccated: having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.

Stratified: alternating layers of varying material or color with the layers greater than 6 mm thick.

Laminated: alternating layers of varying material or color with the layers less than 6 mm thick.

Fissured: material breaks along plane of fracture.

Varved: composed of regular alternating layers of silt and clay.

Slickensided: fracture planes appear polished or glossy, sometimes striated.

Blocky: cohesive soil that can be broken down into small angular lumps which resist further breakdown.

Lensed: inclusion of small pockets of different soil, such as small lenses of sand scattered through a mass of clay; not thickness.

Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

Homogeneous: same color and appearance throughout.

Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

All soil sample descriptions included in this report follow generally the ASTM D2487-11 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System) with some modification to reflect current MTO practices. The system divides soils into three major categories: (1) coarse grained, (2) fine-grained, and (3) highly organic. The soil is then subdivided based on either gradation or plasticity characteristics. The system provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification. The classification excludes particles larger than 76 mm. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually in accordance with ASTM D2488-09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems. Others may use different classification systems; one such system is the ISSMFE Soil Classification.

ISSMFE SOIL CLASSIFICATION											
CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		
<div><div>0.002</div><div>0.006</div><div>0.02</div><div>0.06</div><div>0.2</div><div>0.6</div><div>2.0</div><div>6.0</div><div>20</div><div>60</div><div>200</div></div>											
EQUIVALENT GRAIN DIAMETER IN MILLIMETRES											
CLAY (PLASTIC) TO				FINE		MEDIUM		CRS.		FINE COARSE	
SILT (NONPLASTIC)				SAND				GRAVEL			
UNIFIED SOIL CLASSIFICATION											

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present and as described below in accordance with Note 16 in ASTM D2488-09a:

Table a: Percent or Proportion of Soil, Pp

	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	$5 \leq Pp \leq 10\%$
Little	$15 \leq Pp \leq 25\%$
Some	$30 \leq Pp \leq 45\%$
Mostly	$50 \leq Pp \leq 100\%$

The standard terminology to describe cohesionless soils includes the compactness as determined by the Standard Penetration Test 'N' value:

Table b: Apparent Density of Cohesionless Soil

	'N' Value (blows/0.3 m)
Very Loose	$N < 5$
Loose	$5 \leq N < 10$
Compact	$10 \leq N < 30$
Dense	$30 \leq N < 50$
Very Dense	$50 \leq N$

The standard terminology to describe cohesive soils includes consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests or similar field and laboratory analysis, Standard Penetration Test 'N' values can also be used to provide an approximate indication of the consistency and shear strength of fine grained, cohesive soils:

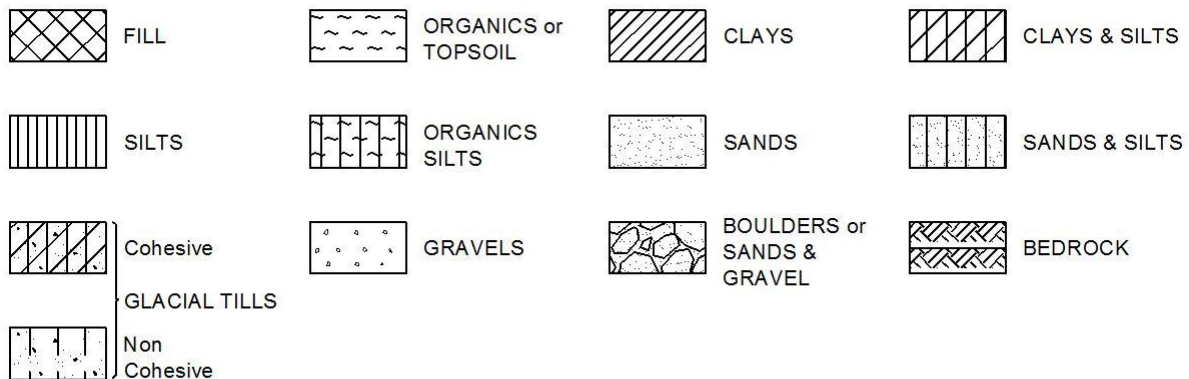
Table c: Consistency of Cohesive Soil

Consistency	Vane Shear Measurement (kPa)	'N' Value
Very Soft	<12.5	<2
Soft	12.5-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

Note: 'N' Value - The Standard Penetration Test records the number of blows of a 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sampler 1 foot (305mm). For split spoon samples where full penetration is not achieved, the number of blows is reported over the sampler penetration in meters (e.g. 50/0.15).

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols:



WATER LEVEL MEASUREMENT



Open Borehole or Test Pit



Monitoring Well, Piezometer or Standpipe

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	Split spoon sample (obtained from the Standard Penetration Test)
WS	Wash sample
BS	Bulk sample
TW	Thin wall sample or Shelby tube
PS	Piston sample
AS	Auger sample
VT	Vane test
GS	Grab sample
HQ, NQ, etc.	Rock core samples obtained with the use of standard size diamond drilling bits

STRESS AND STRAIN

u_w	kPa	Pore water pressure
r_u	1	Pore pressure ratio
σ	kPa	Total normal stress
σ'	kPa	Effective normal stress
τ	kPa	Shear stress
$\sigma_1, \sigma_2, \sigma_3$	kPa	Principal stresses
ε	%	Linear strain
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	Principal strains
E	kPa	Modulus of linear deformation
G	kPa	Modulus of shear deformation
μ	1	Coefficient of friction

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	Coefficient of volume change
c_c	1	Compression index
c_s	1	Swelling index
c_r	1	Recompression index
c_v	m^2/s	Coefficient of consolidation
H	m	Drainage path
T_v	1	Time factor
U	%	Degree of consolidation
σ'_{v0}	kPa	Effective overburden pressure
σ'_p	kPa	Preconsolidation pressure
τ_f	kPa	Shear strength
c'	kPa	Effective cohesion intercept
ϕ'	$-\circ$	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	$-\circ$	Apparent angle of internal friction
τ_R	kPa	Residual shear strength
τ_r	kPa	Remoulded shear strength
S_t	1	Sensitivity = c_u/τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	Density of solid particles
γ_s	kN/m^3	Unit weight of solid particles
ρ_w	kg/m^3	Density of water
γ_w	kN/m^3	Unit weight of water
ρ	kg/m^3	Density of soil
γ	kN/m^3	Unit weight of soil
ρ_d	kg/m^3	Density of dry soil
γ_d	kN/m^3	Unit weight of dry soil
ρ_{sat}	kg/m^3	Density of saturated soil
γ_{sat}	kN/m^3	Unit weight of saturated soil
ρ'	kg/m^3	Density of submerged soil
γ'	kN/m^3	Unit weight of submerged soil
e	1, %	Void ratio
n	1, %	Porosity
w	1, %	Water content
S_r	%	Degree of saturation
W_L	%	Liquid limit
W_P	%	Plastic limit
W_s	%	Shrinkage limit
I_p	%	Plasticity index = $(W_L - W_P)$
I_L	%	Liquidity index = $(W - W_P)/I_p$
I_C	%	Consistency index = $(W_L - W)/I_p$
e_{max}	1, %	Void ratio in loosest state
e_{min}	1, %	Void ratio in densest state
I_D	1	Density index = $(e_{max} - e)/(e_{max} - e_{min})$
D	mm	Grain diameter
D_n	mm	N percent - diameter
C_u	1	Uniformity coefficient
h	m	Hydraulic head or potential
q	m^3/s	Rate of discharge
v	m/s	Discharge velocity
i	1	Hydraulic gradient
k	m/s	Hydraulic conductivity
j	kN/m^3	Seepage force

RECORD OF BOREHOLE No BH501

1 OF 1

METRIC

W.P. GWP No. 6323-14-00 LOCATION Kawawia Creek Culvert (Site No. 41S-244/C) MTM ON-16 5,451,064N 315,617E ORIGINATED BY EF
DIST 61 HWY Hwy 502 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY RM
DATUM Geodetic DATE 6.24.15 - 6.24.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE									
399.3	Asphalt							20	40	60	80	100	20	40	60		GR SA SI CL	
399.0	ASPHALT - about 40 mm		S1	SS	100													
	Poorly Graded GRAVEL with Silt and Sand (FILL) - very dense to dense, brown to grey, damp to moist, some cobbles, trace asphalt pieces in upper 0.2 m		S2	AUGER			399										58 33 (9)	
			S3	SS	30		398											
397.8	Silty GRAVEL with Sand (FILL) - compact, brown to grey, moist																	
1.5			S4	SS	21													
397.0	COBBLES AND BOULDERS (FILL)						397											
2.3			S5	SS	24													
	- refusal to auger and SPT, rock coring techniques initiated at about 3.0 m depth						396											
							395											
394.7	Poorly Graded SAND with Silt - very dense, brown, wet		S6	CORE														
4.7			S7	SS	55		394										1 92 (7)	
393.7	COBBLES AND BOULDERS																	
5.6			S8	CORE														
393.2	Silty SAND with Gravel - compact, grey, wet		S9	SS	26		393										38 50 (12)	
6.1																		
			S10	SS	22		392											
391.7	BEDROCK - medium strong, pink to white, very severely fractured, medium to coarse grained						391										Recovery = 99%, RQD = 0%	
7.6			S11	CORE														
			S12	CORE			390										Recovery=100%, RQD = 0%	
			S13	CORE			389										Recovery=100%, RQD = 0%	
388.7	End of Borehole																	
10.6																		

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH502

1 OF 1

METRIC

W.P. GWP No. 6323-14-00 LOCATION Kawawia Creek Culvert (Site No. 41S-244/C) MTM ON-16 5,451,063N 315,628E ORIGINATED BY EF
 DIST 61 HWY Hwy 502 BOREHOLE TYPE CME 850 Track Carrier / HSA / HQ COMPILED BY RM
 DATUM Geodetic DATE 6.23.15 - 6.24.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE												
								● QUICK TRIAXIAL × LAB VANE												
399.3	Asphalt						20	40	60	80	100	20	40	60		GR SA SI CL				
399.0	ASPHALT - about 50 mm		S1	AUGER																
398.6	Poorly Graded GRAVEL with Silt and Sand (FILL) - dense to very dense, brown to grey, damp, occasional cobbles		S2	SS	50							○								
0.8	Silty GRAVEL with Sand - dense to compact, brown to grey, damp to moist		S3	SS	31							○								
			S4	SS	17							○				No recovery				
	- becoming wet, occasional cobbles at about 2.3 m depth		S5	SS	18							○				42 41 (17)				
396.3	COBBLES AND BOULDERS (FILL)		S6	SS	39							○								
395.1																				
4.3	Silty SAND with Gravel - dense to very dense, brown, wet		S7	AUGER								○				19 40 35 6				
394.8	COBBLES AND BOULDERS - refusal to auger and SPT, rock coring techniques initiated at about 4.7 m depth		S8	CORE																
4.6			S9	SS	100															
392.8			S10	CORE																
6.5	BEDROCK - medium strong, pink to white, very severely fractured, medium to coarse grained		S11	CORE												Recovery = 97%, RQD = 0%				
			S12	CORE												Recovery=100%, RQD = 0%				
			S13	CORE												Recovery = 99%, RQD = 0%				
			S14	CORE												Recovery=100%, RQD = 0%				
389.8	End of Borehole																			
9.5																				



+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No BH503

1 OF 1

METRIC

W.P. GWP No. 6323-14-00 LOCATION Kawawia Creek Culvert (Site No. 41S-244/C) MTM ON-16 5,451,080N 315,625E ORIGINATED BY EF
 DIST 61 HWY Hwy 502 BOREHOLE TYPE CME 850 Track Carrier / HSA COMPILED BY RM
 DATUM Geodetic DATE 6.25.15 - 6.25.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)								
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)				GR	SA	SI	CL	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE																
396.4	Rootmat		S1A	SS	2		396																	
396.0 0.1	ROOTMAT - soft, brown, wet Silty SAND with Gravel - loose, brown, moist to wet		S1B	SS	4																28	49	(23)	
395.6	Silty SAND - dense to very dense, brown to grey, moist to wet																							
0.8			S2	SS	34																	13	61	(26)
			S3	SS	100																			
394.0	- occasional cobbles noted during augering at about 1.9 m depth - about 600 mm of blow up at about 2.1 m depth		S4	SS	100																			
2.4	End of Borehole - refusal to auger and SPT																							

RECORD OF BOREHOLE No BH504

1 OF 1

METRIC

W.P. GWP No. 6323-14-00 LOCATION Kawawia Creek Culvert (Site No. 41S-244/C) MTM ON-16 5,451,043N 315,613E ORIGINATED BY EF
DIST 61 HWY Hwy 502 BOREHOLE TYPE CME 850 Track Carrier / HSA COMPILED BY RM
DATUM Geodetic DATE 6.25.15 - 6.25.15 CHECKED BY DG/AM

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)													
396.2	Rootmat		S1A	SS	8		396		20	40	60	80	100		20	40	60	110	GR	SA	SI	CL		
396.9 0.1	ROOTMAT - soft, brown, wet Poorly Graded SAND with Silt and Gravel - loose to compact, brown to grey, wet, occasional cobbles in upper 0.9 m - trace peat from about 0.9 m to 1.5 m depth		S1B	SS	7																			
			S2	SS	14																			
			S3	SS	21																			
394.0	Poorly Graded SAND with Silt - loose, brown to grey, wet		S4	SS	9		394															9	86	(5)
392.8	- about 600 mm of blow up at about 3.0 m depth		S5	SS	100		393																	
3.3	End of Borehole - refusal to auger and SPT																							



BH501 - Bedrock Core Samples with Depths and Elevations



BH502 - Bedrock Core Samples with Depths and Elevations

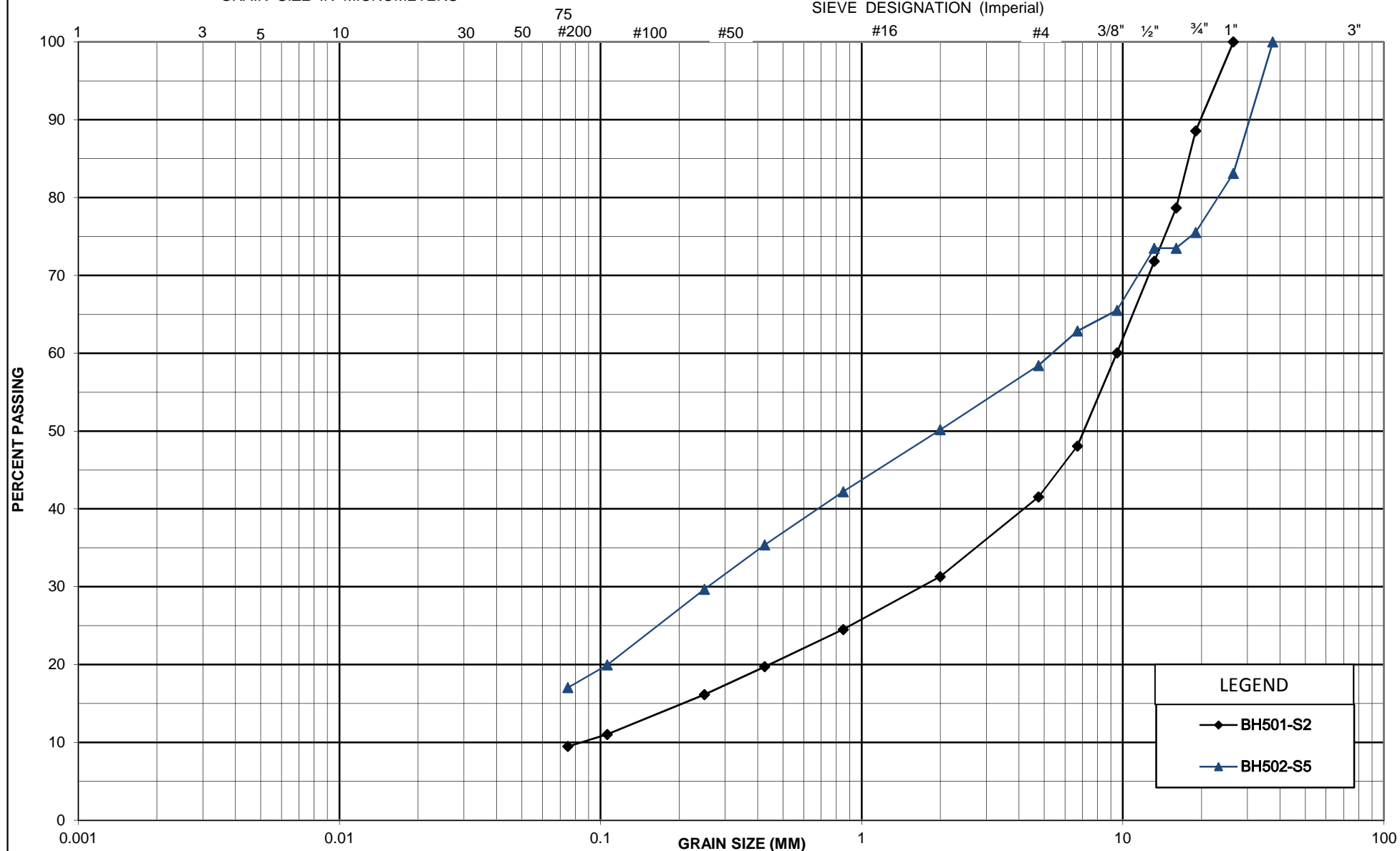
Appendix D – Laboratory Data

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (Imperial)



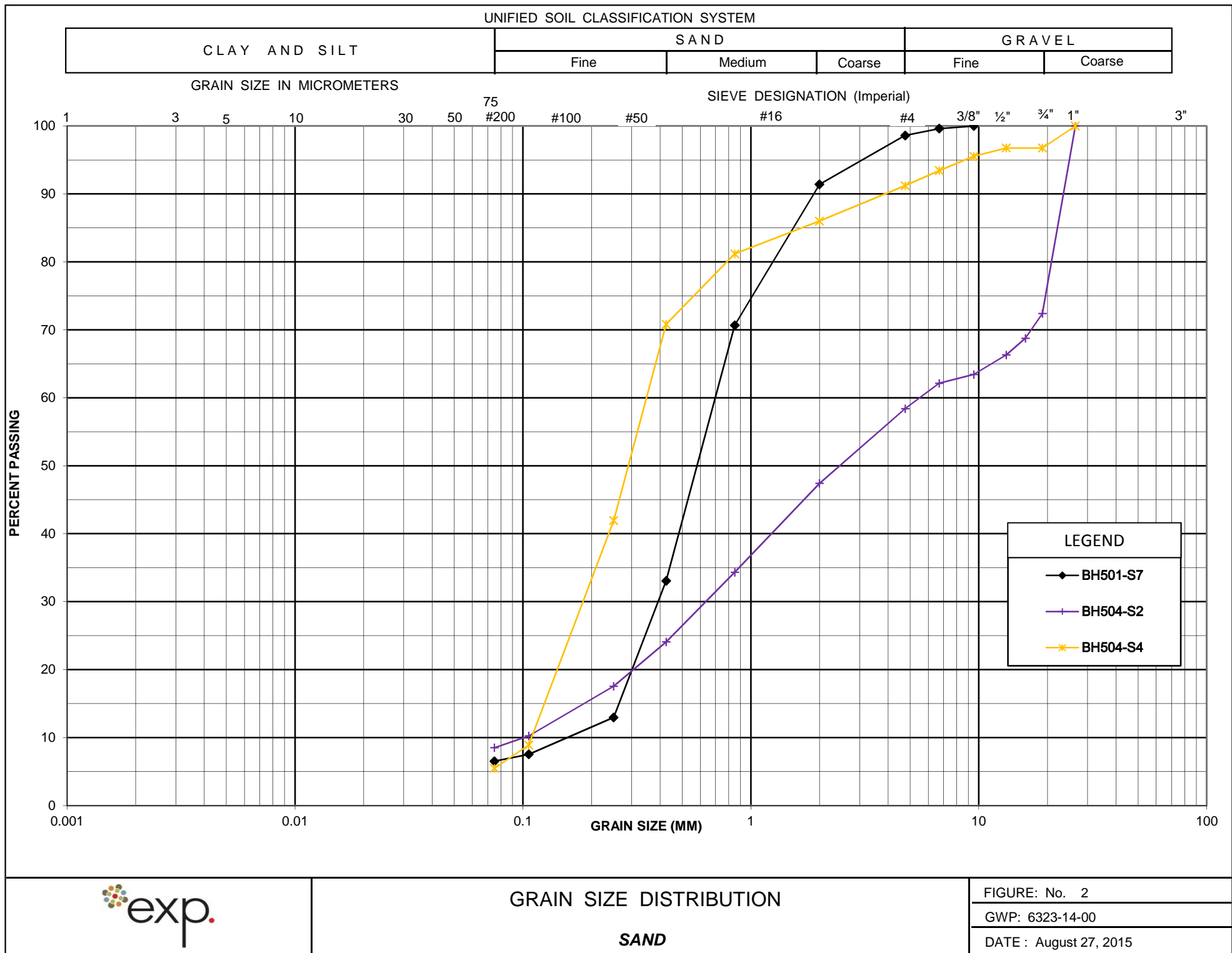
GRAIN SIZE DISTRIBUTION

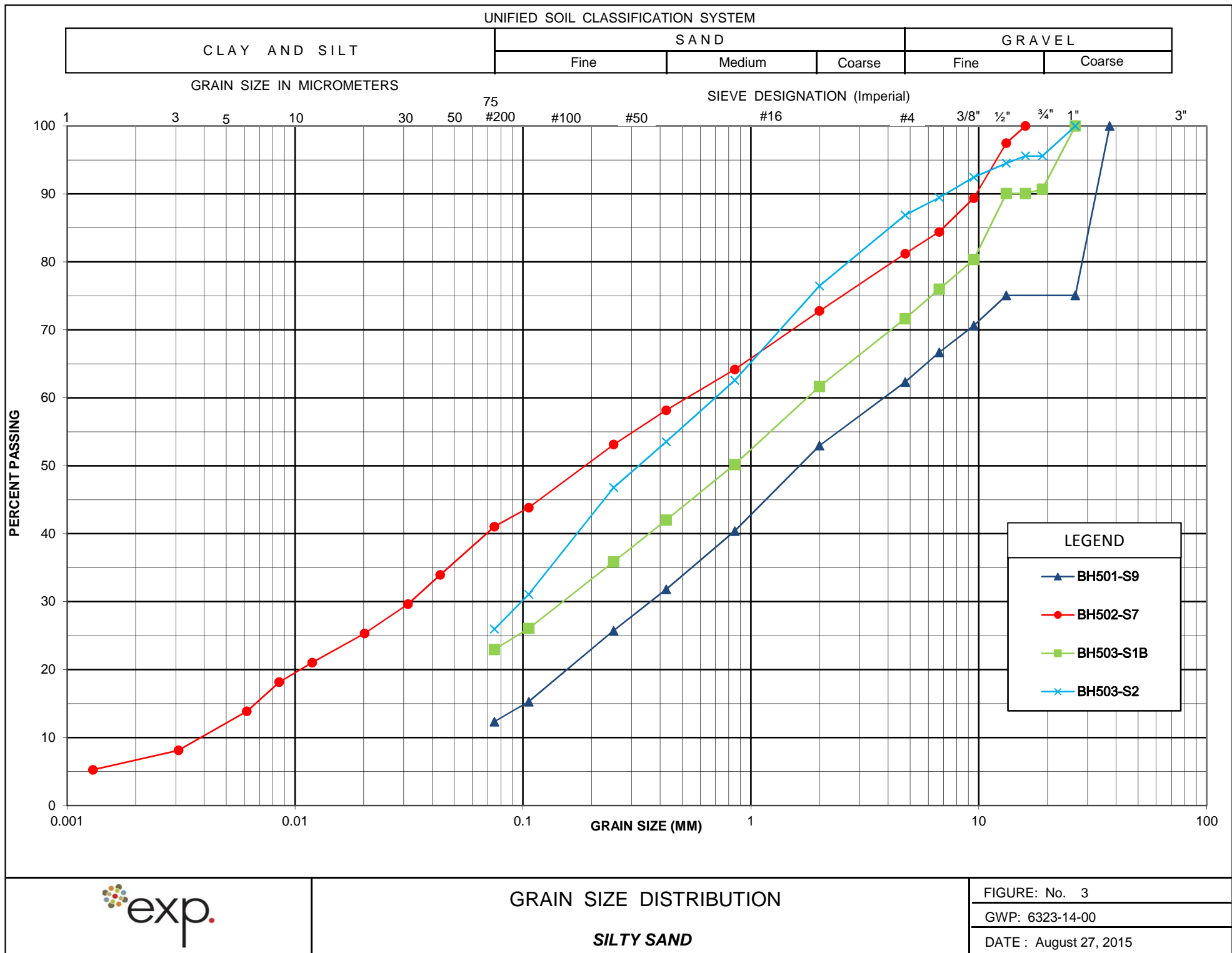
GRAVEL

FIGURE: No. 1

GWP: 6323-14-00

DATE : August 27, 2015





Appendix E – Chemical Analyses

Your Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502
Your C.O.C. #: na

Attention: Ahileas Mitsopoulos/Michael S

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
P7B 5M4

Report Date: 2015/07/09
Report #: R3568313
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C9097

Received: 2015/07/03, 10:55

Sample Matrix: Soil
Samples Received: 10

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Reference
Chloride (20:1 extract)	10	N/A	2015/07/09	CAM SOP-00463	EPA 325.2 m
Conductivity	10	N/A	2015/07/08	CAM SOP-00414	OMOE E3138 v2 m
pH CaCl2 EXTRACT	10	2015/07/08	2015/07/08	CAM SOP-00413	EPA 9045 D m
Resistivity of Soil	5	2015/07/03	2015/07/08	CAM SOP-00414	SM 22 2510 m
Resistivity of Soil	5	2015/07/03	2015/07/09	CAM SOP-00414	SM 22 2510 m
Sulphate (20:1 Extract)	10	N/A	2015/07/09	CAM SOP-00464	EPA 375.4 m

Remarks:

Maxxam Analytics has performed all analytical testing herein in accordance with ISO 17025 and the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act. All methodologies comply with this document and are validated for use in the laboratory. The methods and techniques employed in this analysis conform to the performance criteria (detection limits, accuracy and precision) as outlined in the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act.

The CWS PHC methods employed by Maxxam conform to all prescribed elements of the reference method and performance based elements have been validated. All modifications have been validated and proven equivalent following the 'Alberta Environment Draft Addenda to the CWS-PHC, Appendix 6, Validation of Alternate Methods'. Documentation is available upon request. Maxxam has made the following improvements to the CWS-PHC reference benchmark method: (i) Headspace for F1; and, (ii) Mechanical extraction for F2-F4. Note: F4G cannot be added to the C6 to C50 hydrocarbons. The extraction date for samples field preserved with methanol for F1 and Volatile Organic Compounds is considered to be the date sampled.

Maxxam Analytics is accredited for all specific parameters as required by Ontario Regulation 153/04. Maxxam Analytics is limited in liability to the actual cost of analysis unless otherwise agreed in writing. There is no other warranty expressed or implied. Samples will be retained at Maxxam Analytics for three weeks from receipt of data or as per contract.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

Your Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502
Your C.O.C. #: na

Attention: Ahileas Mitsopoulos/Michael S

exp Services Inc
Thunder Bay Branch
1142 Roland St
Thunder Bay, ON
P7B 5M4

Report Date: 2015/07/09
Report #: R3568313
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B5C9097
Received: 2015/07/03, 10:55

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Hina Siddiqui, Project Manager –Environmental Customer Service
Email: HSiddiqui@maxxam.ca
Phone# (905) 817-5700

=====

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

RESULTS OF ANALYSES OF SOIL

Maxxam ID		AOD715	AOD716	AOD716	AOD717	AOD718		
Sampling Date		2015/06/19 14:10	2015/06/27 12:15	2015/06/27 12:15	2015/06/28 10:20	2015/06/28 17:00		
COC Number		na	na	na	na	na		
	Units	BH101-S7	BH104-S3B/S4/S5	BH104-S3B/S4/S5 Lab-Dup	BH201-S7A	BH203-S3	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	1300	2500		3300	1800		4091370
Inorganics								
Soluble (20:1) Chloride (Cl)	ug/g	790	190	200	170	320	20	4094438
Conductivity	umho/cm	773	395	399	301	557	2	4096183
Available (CaCl2) pH	pH	6.34	6.65		5.49	5.43	N/A	4094481
Soluble (20:1) Sulphate (SO4)	ug/g	270	25	24	<20	<20	20	4094443
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable								

Maxxam ID		AOD719	AOD720	AOD721	AOD722	AOD723	AOD724		
Sampling Date		2015/06/20 07:25	2015/06/26 06:20	2015/06/26 16:15	2015/06/25 15:30	2015/06/25 10:30	2015/06/25 14:10		
COC Number		na	na	na	na	na	na		
	Units	BH301-S9B/S10/S11	BH304-S3	BH403-S3	BH404-S5B	BH503-S4	BH504-S1B	RDL	QC Batch

Calculated Parameters									
Resistivity	ohm-cm	2300	7000	4800	8400	5300	1500		4091370
Inorganics									
Soluble (20:1) Chloride (Cl)	ug/g	220	36	81	<20	89	370	20	4094438
Conductivity	umho/cm	435	143	209	119	190	646	2	4096183
Available (CaCl2) pH	pH	6.54	6.72	6.59	6.72	5.89	4.90	N/A	4094481
Soluble (20:1) Sulphate (SO4)	ug/g	30	<20	<20	27	<20	<20	20	4094443
RDL = Reportable Detection Limit QC Batch = Quality Control Batch N/A = Not Applicable									

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

TEST SUMMARY

Maxxam ID: AOD715
Sample ID: BH101-S7
Matrix: Soil

Collected: 2015/06/19
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD716
Sample ID: BH104-S3B/S4/S5
Matrix: Soil

Collected: 2015/06/27
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD716 Dup
Sample ID: BH104-S3B/S4/S5
Matrix: Soil

Collected: 2015/06/27
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD717
Sample ID: BH201-S7A
Matrix: Soil

Collected: 2015/06/28
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD718
Sample ID: BH203-S3
Matrix: Soil

Collected: 2015/06/28
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

TEST SUMMARY

Maxxam ID: AOD718
Sample ID: BH203-S3
Matrix: Soil

Collected: 2015/06/28
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD719
Sample ID: BH301-S9B/S10/S11
Matrix: Soil

Collected: 2015/06/20
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/08	2015/07/08	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD720
Sample ID: BH304-S3
Matrix: Soil

Collected: 2015/06/26
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD721
Sample ID: BH403-S3
Matrix: Soil

Collected: 2015/06/26
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD722
Sample ID: BH404-S5B
Matrix: Soil

Collected: 2015/06/25
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl2 EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

TEST SUMMARY

Maxxam ID: AOD723
Sample ID: BH503-S4
Matrix: Soil

Collected: 2015/06/25
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl ₂ EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam ID: AOD724
Sample ID: BH504-S1B
Matrix: Soil

Collected: 2015/06/25
Shipped:
Received: 2015/07/03

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	KONE/EC	4094438	N/A	2015/07/09	Deonarine Ramnarine
Conductivity	AT	4096183	N/A	2015/07/08	Lemeneh Addis
pH CaCl ₂ EXTRACT	AT	4094481	2015/07/08	2015/07/08	Surinder Rai
Resistivity of Soil		4091370	2015/07/09	2015/07/09	Automated Statchk
Sulphate (20:1 Extract)	KONE/EC	4094443	N/A	2015/07/09	Deonarine Ramnarine

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.7°C
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Results relate only to the items tested.

Maxxam Job #: B5C9097
Report Date: 2015/07/09

QUALITY ASSURANCE REPORT

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

QC Batch	Parameter	Date	Matrix Spike		Spiked Blank		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
4094438	Soluble (20:1) Chloride (Cl)	2015/07/09	NC	70 - 130	107	70 - 130	<20	ug/g	6.5	35
4094443	Soluble (20:1) Sulphate (SO4)	2015/07/09	NC	70 - 130	109	70 - 130	<20	ug/g	NC	35
4094481	Available (CaCl2) pH	2015/07/08			100	97 - 103			0.51	N/A
4096183	Conductivity	2015/07/08			102	90 - 110	<2	umho/cm	1.0	10

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

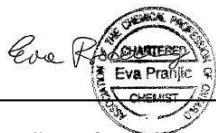
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B5C9097
Report Date: 2015/07/09

exp Services Inc
Client Project #: ADM-00223648-E0
Site Location: MTO ASSIGNMENT #6 - HWYS 11 & 502

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).



Ewa Pranjić, M.Sc., C.Chem, Scientific Specialist

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Analytics International Corporation o/a Maxxam Analytics