



FINAL REPORT

FOUNDATION INVESTIGATION AND DESIGN REPORT

**Additional Foundation Engineering Retainer Services for Detail Design for
New Eastbound and Westbound Truck Climbing lanes on Highway 17
from Pays Plat River Easterly for 7.2 km, Thunder Bay Area, Ontario**

Agreement No. 6017-E-0066

Assignment No. 5

GWP No. 6120-15-00

MTO GEOCRES No. 42D-58

(Latitude: 48° 52' 43"; Longitude: 87° 32' 19")

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Ontario Ministry of Transportation

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August 29, 2019

Ontario Ministry of Transportation

Northwestern Region Geotechnical Section

Foundation Investigation and Design Report

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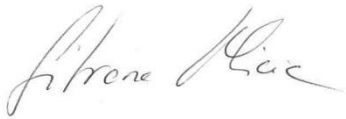
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1 FOUNDATION INVESTIGATION REPORT

1.1 Introduction

This report presents the results of an additional geotechnical investigation completed by **exp** Services Inc. (**exp**) for new eastbound and westbound truck climbing lanes on Hwy 17 from Pays Plat River easterly for 7.2 km (from Station 17+000 to Station 20+325 of the proposed new alignment) including rock surplus management from 17+550 to Station 17+825 of the existing Hwy 17, Rossport, Thunder Bay Area, Ontario. The work was undertaken under Agreement No. 6017-E0066, Assignment No. 5. The terms of reference (TOR) were as presented in Ministry of Transportation Ontario (MTO) email dated May 08, 2019. The investigation program includes the following:

- a) Investigation for a high fill embankment and widening of Hwy 17:
 - From Station 17+000 to 17+050 Lt, 4 to 13 m high (Section A)
 - From Station 18+600 to Station 18+675 Lt, 7 to 13 m high (Section B)
 - From Station 19+325 to Station 19+600 Rt, 4 to 13 m high (Section C)
 - From Station 20+275 to Station 20+325 Lt, up to 5 m high (Section D)
- b) Rock surplus management area:
 - From Station 17+550 to Station 17+825 Lt. (Section E)

The purpose of these investigations was to determine the subsurface conditions by means of a limited number of boreholes (a) along the toe of the embankment of Hwy 17 to permit detailed design and recommendations for the construction of new proposed high fill embankments/roadway widening; and (b) at the proposed rock surplus management area. The site specific geotechnical investigation consisted of a field investigation including visual inspections, drilling of boreholes with hand auger, soil sampling, 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 Descriptions and Geological Setting

1.2.1 Site Descriptions

1.2.1.1 General

The general site conditions were assessed during the site reconnaissance on June 6, 2019. Photographs of the sites are presented in Appendix A. At the subject sites, Hwy 17 travels in a predominantly north-south direction along the north edge of Lake Superior. It is a two lane highway with a speed limit of 90 km/h and paved shoulders.

1.2.1.2 Section A

Section A from Station 17+000 to 17+050 is the area located east of existing Hwy 17. It is investigated for widening the westbound lane (WBL). In this area the highway embankment is approximately 4 m to 13 m high. In some portions the side slope is very steep. The area is heavily vegetated by bushes and trees (Photos 1 to 4). The northern and middle portions of this section are located on the old Hwy 17 rock cut (i.e. blast zone) (Photos 1 and 2), while the southern portion of the embankment base is swampy lowland with a small creek in the middle (Photos 3 and 4). The bedrock outcrop was noticed at the toe level close to Station 17+025 (Photo 2).

1.2.1.3 Section B

Section B from Station 18+600 to 18+675 is the area located east of existing Hwy 17, which is investigated for widening the WBL. In this area the highway embankment is approximately 7 m to 13 m high, with rocky steep slopes (Photo 5). The base of the embankment where the boreholes were located is also covered by rockfill. East of the embankment base the terrain raises into the steep natural rocky slope (Photos 5 and 6). The area is vegetated by bushes and trees (Photos 7 and 8). A small creek was observed in the middle portion of this section as shown on Photo 8. This area also has overhead powerlines, Hydro and Fiber Optics Telephone System (Photo 5).

1.2.1.4 Section C

Section C from Station 19+325 to 19+600 is the area located west of existing Hwy 17, since it was investigated for widening the eastbound lane (EBL). In this area the highway embankment is approximately 4 m to 13 m high, with rocky steep slopes. This area is rugged difficult terrain, heavily vegetated by bushes and dense trees, and barely accessible. Erosion was noticed at the toe level close to Station 19+450 (Photo 10). The bedrock outcrops were noticed at the toe level along the whole section as shown on Photos 10, 11 and 12.

1.2.1.5 Section D

Section D from Station 20+275 to 20+325 is the area located east of existing Hwy 17 which is investigated for widening the WBL. The maximum height of the existing embankment is estimated to be about 5 m, with rocky steep slopes in some portions (Photo 14). In the middle of the section the base of the embankment is swampy and barely accessible (Photo 15). The area is also heavily

vegetated by bushes and trees. The bedrock outcrop was noticed at the toe level close to Station 20+325 (Photo 16).

1.2.1.6 Section E

Section E from Station 17+550 to 17+825 is the approximately 250 m by 150 m area located east of existing Hwy 17 proposed for rock surplus disposal. The proposed area is the rugged hard rocky terrain with rock outcrops and shallow bedrock mostly overlain by thin layer of soil. The area is heavily vegetated by bushes and trees. The photographs of this area are shown in Appendix A (Photos 17 to 25).

1.2.2 Geological Setting

According to the MNR Northern Ontario Engineering Geology Terrain Data Base Map, Ontario Geological Survey Map 2518, dated 1987, the underlying native soil at the site is predominantly glaciofluvial deposits, including shallow water, and sand glaciolacustrine delta deposits. The glaciolacustrine delta of Pays Plat Bay has been known to consist varved clay.

According to Ontario Geological Survey, Bedrock Geology of Ontario Map No. 2518, issued 1991, the bedrock at the site is described as from the Archean Era. The rock is intrusive rock, mainly massive to foliated granodiorite and granite.

1.3 Investigation Procedures

1.3.1 Site Investigation and Field Testing

The field investigation fieldwork was carried out on June 6, 2019 and June 7, 2019 during which time thirty-four (34) boreholes were drilled in Sections A to E with hand augers. The locations of BHs are shown on the Borehole Location Plans, Drawings 1 to 6 in Appendix B.

The field program of this project was as follows:

Section A:

- Drilling of three (3) boreholes (19-MAH-1 to 19-MAH-3A/B) along the proposed embankment toes, off-road drilling

Section B:

- Drilling of three (3) boreholes (19-MAH-4 to 19-MAH-6) along the proposed embankment toes, off-road drilling

Section C:

- Drilling of seven (7) boreholes (19-MAH-7 to 19-MAH-13) along the proposed embankment toes, off-road drilling

Section D:

- Drilling of three (3) boreholes (19-MAH-14 to 19-MAH-16) along the proposed embankment toes, off-road drilling

Section E:

- Drilling of fifteen (15) boreholes (19-RS-1 to 19-RS-15A) strategically located along the proposed area, off-road drilling

All boreholes were strategically located along the proposed widening to provide subsurface information for the design of new high fill embankment and rock surplus management area. The number and location of boreholes were finally determined by MTO and **exp** based on observations during the site reconnaissance on June 6, 2019. These locations were staked in the field by **exp** personnel. The borehole locations (referenced to the MTM NAD83/ Zone 14 coordinate system), ground elevations (referenced to the geodetic datum) and the depths in all sections are summarized in the following Table 1.1.

All of the boreholes in Section A to E (19-MAH-1 to 19-MAH-16 and 19-RS-1 to 19-RS-15A) were advanced to depths of about 0 m to 4.5 m below the ground surface with a hand auger operated by **exp** personnel, since the sites were not accessible with drill rigs or excavators.

The groundwater level was measured upon completion of their drilling and the levels were recorded on borehole log sheets in Appendix C.

The fieldwork was supervised by an **exp** geotechnical representative who directed drilling and sampling operations, logged borehole data in accordance with MTO and/or ASTM Standards for Soils Classification, and retrieved soil samples for subsequent laboratory testing and identification.

All recovered soil samples were placed in labelled moisture-proof bags and returned to **exp**'s Thunder Bay laboratory for additional visual, textual, olfactory examination and selective testing.

Table 1.1. Locations, elevations and depths of BHs

Section	BH #	Location	MTM NAD83 Northing	MTM NAD83 Easting	Ground Elevation (m)	Borehole Depth (m)
A	19-MAH-1	Existing embankment toe	5414599.0	265820.0	262.0	0.3
	19-MAH-2	Existing embankment toe	5414570.9	265829.1	260.9	0.3
	19-MAH-3	Existing embankment toe	5414561.7	265855.9	255.9	2.3
	19-MAH-3A	Existing embankment toe	5414561.7	265855.9	255.9	2.1
	19-MAH-3B	Existing embankment toe	5414561.7	265855.9	255.9	2.1

B	19-MAH-4	Existing embankment toe	5413255.9	266674.3	314.8	0.0*
	19-MAH-5	Existing embankment toe	5413222.0	266668.6	319.8	0.0*
	19-MAH-6	Existing embankment toe	5413190.3	266650.6	324.5	0.0*
C	19-MAH-7	Existing embankment toe	5412558.8	266398.8	300.4	0.0**
	19-MAH-8	Existing embankment toe	5412523.5	266388.3	292.4	0.5
	19-MAH-9	Existing embankment toe	5412473.6	266373.8	282.9	0.7
	19-MAH-10	Existing embankment toe	5412436.1	266378.3	279.0	0.4
	19-MAH-11	Existing embankment toe	5412390.4	266377.7	279.8	1.0
	19-MAH-12	Existing embankment toe	5412352.8	266380.1	282.8	0.3
	19-MAH-13	Existing embankment toe	5412308.1	266385.6	285.2	0.3
D	19-MAH-14	Existing embankment toe	5411670.9	266602.7	240.2	0.6
	19-MAH-15	Existing embankment toe	5411646.9	266615.0	238.8	2.3
	19-MAH-16	Existing embankment toe	5411617.6	266632.7	238.9	0.5
E	19-RS-1	Rock surplus stockpile area	5414229.81	266306.53	311.24	0.2
	19-RS-2	Rock surplus stockpile area	5414166.55	266326.47	310.18	0.4
	19-RS-3	Rock surplus stockpile area	5414108.33	266368.01	309.90	2.0
	19-RS-4	Rock surplus stockpile area	5414051.76	266398.32	310.16	0.2
	19-RS-5	Rock surplus stockpile area	5413986.74	266428.61	309.64	4.5
	19-RS-6	Rock surplus stockpile area	5414189.36	266233.56	313.82	0.7
	19-RS-7	Rock surplus stockpile area	5414114.43	266261.51	313.83	0.0**
	19-RS-8	Rock surplus stockpile area	5414077.56	266299.24	310.99	0.0**

	19-RS-9	Rock surplus stockpile area	5414012.00	266330.46	317.00	0.0**
	19-RS-10	Rock surplus stockpile area	5413956.04	266362.10	314.61	0.6
	19-RS-11	Rock surplus stockpile area	5414164.71	266171.75	309.83	0.4
	19-RS-12	Rock surplus stockpile area	5414106.65	266205.06	308.34	0.1
	19-RS-13	Rock surplus stockpile area	5414049.25	266227.58	307.05	1.2
	19-RS-14	Rock surplus stockpile area	5413975.49	266263.05	313.06	0.0**
	19-RS-15	Rock surplus stockpile area	5413923.87	266298.51	311.24	0.0**
	19-RS-15A	Rock surplus stockpile area	5413923.87	266298.51	311.24	0.5

* - top of rockfill

** - top of outcrop

1.3.2 Available Documents

The available report of the previous investigation in the MTO GEOCRE library is:

Geocres No. 42D-45: "Preliminary Foundation Investigation and Design Report, Proposed Embankment Station 15+800 to 16+275 Township of Lahontan Highway 17" prepared by TBT Engineering Ltd., December 19, 2016

In addition, MTO provided the following documents:

Drainage and Hydrology Report, GWP 612-15-00 "Highway 17 Eastbound and Westbound Truck Climbing Lane, Curve Realignment and Hazard Rock Improvements Pays Plat First Nation Easterly" prepared by Associated Engineering, July 28, 2017

Preliminary Design Report, GWP 6120-15-00 "Highway 17 Pays Plat River Easterly, Truck Climbing Lanes, Curve Realignment, Hazard Rock and Resurfacing Pays Plat First Nation Easterly" prepared by TBT Engineering Ltd., October 9, 2018

Previous Investigation by **exp**:

Foundation Investigation and Design Report, GWP No. 6120-15-00 "Widening of Highway 17 East from Pays Plat River Easterly 7.2 km, Thunder Bay Area, Ontario" prepared by EXP Services Inc., June 13, 2019

1.3.3 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included the determination of natural moisture content on all samples, and particle size distribution and Atterberg Limit tests for approximately 25% of the collected soil samples from all five sections. All of the laboratory tests were carried out according to MTO and/or ASTM Standards as appropriate.

The laboratory test results are provided on the attached borehole log sheets in Appendix C. The results of the grain size analyses tests and Atterberg Limit tests are presented graphically in Appendix D.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigations are presented on the borehole log sheets in Appendix C. Laboratory test results of grain size analyses and Atterberg limit tests are provided in Appendix D. The “Explanation of Terms Used in Report” preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report.

Borehole location plans and stratigraphic sections at the sites are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole logs and stratigraphic sections are inferred from non-continuous sampling and observations of drilling progress. These boundaries typically represent transitions from one soil type to another and should not be regarded as exact planes of geological change. Further, subsurface conditions may vary between and beyond the borehole locations.

A detailed description of the stratigraphy encountered in Sections A through E is discussed in subsequent sections.

1.4.1 Section A (Station 17+000 to Station 17+050)

In general, the subsurface conditions along the proposed east side widening zone of Hwy 17 between Station 17+000 and 17+050 consist of surficial rootmat/peat underlain by gravel with rock blast/silty sand with gravel/ poorly graded sand fill followed by peaty sand. The auger refusal was encountered at the depths of 0.3 m to 2.3 m. Observed outcrops in vicinities of drilled boreholes suggest that refusal was at bedrock. A detailed description of the subsurface conditions within Section A is discussed further in subsequent sections based on the geotechnical investigation conducted by **exp**.

1.4.1.1 Rootmat/Peat

Rootmat/peat was encountered at the surface of all boreholes in Section A, 19-MAH-1 to 19-MAH-3B. The thickness of rootmat/peat is about 0.1 m.

The composition of the layer consists of rootmats and decaying organic matter. The material is brown to black in color and moist to wet.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results indicate that natural moisture content of this material ranges from 21% to 412.6%.

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

1.4.1.2 Gravel with Blast Rock (Fill)

A gravel with blast rock fill layer was encountered below the rootmat/peat in borehole 19-MAH-1, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the fill and the thickness of fill as encountered in boreholes are summarized in Table 1.2 below:

Table 1.2. Summary of gravel with blast rock fill layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-1	261.9	261.7	0.1	0.2

The composition of this layer consists of blast rock and gravel. The material is brown in color and damp.

Laboratory testing performed on one sample consisted of moisture content tests. The test results indicate that natural moisture content of this material is about 3%.

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

1.4.1.3 Silty Sand with Gravel (Fill)

A silty sand with gravel fill layer was encountered below the rootmat/peat in borehole 19-MAH-2, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the fill and the thickness of fill as encountered in boreholes are summarized in Table 1.3 below:

Table 1.3. Summary of silty sand with gravel fill layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-2	260.8	260.6	0.1	0.2

The composition of this layer consists of silt and sand with gravel, some blast rock. The material is brown in color and moist to wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be compact compactness condition.

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

Moisture Content:

- 10%

Grain Size Distribution:

- 41% gravel
- 47% sand
- 13% silt and clay

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 test is also provided on Figure 1 in Appendix D.

1.4.1.4 Sand (Fill)

A poorly graded sand fill layer was encountered below the rootmat/peat in boreholes 19-MAH-3, 19-MAH-3A and 19-MAH-3B. The approximate elevations of the surface and base of the fill and the thickness of fill as encountered in boreholes are summarized in Table 1.4 below:

Table 1.4. Summary of sand fill layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-3	255.8	255.3	0.1	0.5
19-MAH-3A	255.8	255.6	0.1	0.2
19-MAH-3B	255.8	255.4	0.1	0.4

The composition of this layer consists of sand. The material is brown in color and wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be very loose compactness condition.

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

Moisture Content:

- 22% to 36%

Grain Size Distribution:

- 1% to 2% gravel

- 96% to 97% sand
- 2% to 3% silt and clay

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 test is also provided on Figure 2 in Appendix D.

1.4.1.5 Peaty Sand

A native peaty sand layer was encountered below the poorly graded sand fill layer in boreholes 19-MAH-3, 19-MAH-3A and 19-MAH-3B, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the deposit and the thickness of deposit as encountered in boreholes are summarized in Table 1.5 below:

Table 1.5. Summary of peaty sand layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-3	255.3	253.6	0.6	1.7
19-MAH-3A	255.6	253.8	0.3	1.8
19-MAH-3B	255.4	253.8	0.5	1.6

The composition of this layer consists of peat and sand. The material is dark brown in color and wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be very loose compactness condition.

Laboratory testing performed on one sample consisted of moisture content tests. The test results indicate that natural moisture content of this material ranges from 50% to 62%.

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

1.4.2 Section B (Station 18+600 to Station 18+675)

In general, the subsurface conditions along the proposed east side widening of Hwy 17 (i.e. the toe of the existing embankment) between Station 18+600 and 18+675 consist of surficial rockfill. The presence of rockfill on the ground level prevented the drilling by the hand auger. However, the observed outcrops suggest the shallow bedrock. A detailed description of the subsurface conditions encountered along the proposed widening of the Hwy 17 within Section B is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by exp.

1.4.2.1 Rockfill

Rockfill was encountered at the surface of the toe of the existing embankment of boreholes 19-MAH-4, 19-MAH-5, and 19-MAH-6. Due to this surficial rockfill, the hand auger drilling was impossible. In addition, due to overhead powerlines, Hydro and Fiber Optics Telephone System (FOTS) no drilling rig or excavator access is possible. Photographs in Appendix A show the details of the site and borehole locations and this information is also provided on the record of borehole sheets in Appendix C.

1.4.3 Section C (Station 19+325 to Station 19+600)

In general, the subsurface conditions along the proposed west side widening of Hwy 17 (i.e. the toe of the existing embankment) between Station 19+325 and Station 19+600 consist of rootmat/peat underlain by granular fill followed by peaty silt. Auger refusals were encountered at the depths of 0.3 m to 1.0 m. Outcrop was noticed at the ground surface beside the toe of the existing embankment at Station 19+325. A detailed description of the subsurface conditions encountered along the proposed widening of the Hwy 17 within Section C is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by **exp.**

1.4.3.1 Rootmat/Peat

Rootmat/peat was encountered at the surface of boreholes 19-MAH-8 to 19-MAH-13. The thickness of rootmat/peat ranges from 0.1 m to 0.4 m. In addition, peat was found inbetween well graded sand with silt fill and peaty silt for a thickness of 0.2 m in borehole 19-MAH-9. Boreholes 19-MAH-10 and 19-MAH-12 was terminated within this layer due to auger refusal.

The composition of the layer consists of rootmats, trace sand and some gravel. The material is brown/dark brown to black in color, wet and soft.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results indicate that natural moisture content of this material ranges from 122.3% to 281.1%.

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

1.4.3.2 Silty Sand with Gravel/Sand with Silt/Silty Gravel with Sand (Fill)

Silty sand with gravel fill layer was encountered below the rootmat in borehole 19-MAH-8; a well graded and poorly graded sand with silt fill was encountered below the rootmat in borehole 19-MAH-9 and 19-MAH-11, respectively; silty gravel with sand fill was encountered below the rootmat in borehole 19-MAH-13. Boreholes 19-MAH-11 and 19-MAH-13 was terminated within this fill layer due to auger refusal. The approximate elevations of the surface and base of the fill and the thickness of fill as encountered in boreholes are summarized in Table 1.6 below:

Table 1.6. Summary of silty sand with gravel/sand with silt/silty gravel with sand fill layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-8	292.3	292.0	0.1	0.3
19-MAH-9	282.8	282.6	0.1	0.2
19-MAH-11	279.7	278.8	0.1	0.9
19-MAH-13	285.2	285.0	0.1	0.2

The composition of this layer consists of sand, silt, gravel, some organics and occasional cobbles. The material is brown/rusty brown to dark brown in color and moist to wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be loose to compact compactness condition.

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

Moisture Content:

- 29% to 43%

Grain Size Distribution:

- 2% to 45% gravel
- 38% to 88% sand
- 5% to 19% silt and clay

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 test is also provided on Figure 3 in Appendix D.

1.4.3.3 Gravel with Silt and Sand (Fill)

A poorly graded gravel with silt and sand fill layer was encountered below the silty sand with gravel fill in borehole 19-MAH-8, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the fill and the thickness of fill as encountered in boreholes are summarized in Table 1.7 below:

Table 1.7. Summary of gravel with silt and sand fill layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-8	292.1	292.0	0.4	0.1

The composition of this layer consists of gravel, sand, silt, roots and some organics. The material is dark brown in color and moist to wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be compact compactness condition.

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

Moisture Content:

- 19%

Grain Size Distribution:

- 55% gravel
- 34% sand
- 11% silt and clay

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 test is also provided on Figure 4 in Appendix D.

1.4.3.4 Peaty Silt

A native peaty silt layer was encountered below the peat layer in borehole 19-MAH-9, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the deposit and the thickness of deposit as encountered in boreholes are summarized in Table 1.8 below:

Table 1.8. Summary of peaty silt layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-9	282.4	282.2	0.5	0.2

The composition of this layer consists of peat, silt, some sand, some gravel and some cobbles. The material is dark brown in color. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be compact compactness condition.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results indicate that natural moisture content of this material is about 76%.

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

1.4.3.5 Bedrock

Solid outcrop overlain by eroded bits and pieces of rock was encountered at the ground surface beside the toe of the existing embankment at location of borehole 19-MAH-7. Photographs in Appendix A show the details of the site and this information is also provided on the record of borehole sheets in Appendix C.

1.4.4 Section D (Station 20+275 to Station 20+325)

The subsurface conditions along the proposed east side widening of Hwy 17 from Station 20+275 to 20+325 (i.e. the toes of the existing embankment) consist of rootmat/peat underlain by silty sand with gravel fill, sandy peat followed by sandy clayey silt. Auger refusals were encountered at the depths of 0.5 m to 2.3 m. Outcrops were observed in the vicinity of drilling locations. A detailed description of the subsurface conditions encountered along the proposed widening of the Hwy 17 within Section D is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by **exp**.

1.4.4.1 Rootmat/Peat

Rootmat/peat was encountered at the surface of all boreholes 19-MAH-14 to 19-MAH-16. The thickness of rootmat/peat ranges from 0.1 m to 0.7 m. Borehole 19-MAH-16 was terminated within this layer due to auger refusal.

The composition of this layer consists of roots and rootlets and trace to some sand. The material is dark brown to black in color, wet and soft.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results indicate that natural moisture content of this material ranges from 122.5% to 248.1%. The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.4.2 Silty Sand with Gravel (Fill)

A silty sand with gravel fill layer was encountered below the rootmat/peat in borehole 19-MAH-14, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the fill and the thickness of fill as encountered in boreholes are summarized in Table 1.9 below:

Table 1.9. Summary of silty sand with gravel fill layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-14	240.1	239.7	0.1	0.5

The composition of this layer consists of silt, sand and gravel. The material is light brown to brown in color and wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be loose to compact compactness condition.

Laboratory testing performed on one sample consisted of moisture content and grain size distribution tests. The test results are as follow:

Moisture Content:

- 36%

Grain Size Distribution:

- 21% gravel
- 60% sand
- 19% silt and clay

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 test are also provided on Figure 5 in Appendix D.

1.4.4.3 Sandy Peat

A native sandy peat deposit was encountered below the rootmat/peat layer in borehole 19-MAH-15. The approximate elevations of the surface and base of the deposit and the thickness of the deposit as encountered in boreholes are summarized in Table 1.10 below:

Table 1.10. Summary of sandy peat deposit

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-15	238.2	237.4	0.7	0.7

The composition of this layer consists of peat and sand. The material is dark brown in color and wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be soft in consistency.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results indicate that natural moisture content of this material is about 40%. The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.4.4 Sandy Clayey Silt

A native sandy clayey silt deposit was encountered below the sandy peat deposit in 19-MAH-15, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the deposit and the thickness of the deposit as encountered in boreholes are summarized in Table 1.11 below:

Table 1.11. Summary of sandy clayey silt deposit

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-MAH-15	237.4	236.6	1.4	0.9

The composition of this layer consists of sand, silt and clay. The material is light grey in color and wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix suggests firm in consistency.

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

Moisture Content:

- 21%

Grain Size Distribution:

- 2% gravel;
- 27% sand;
- 55% silt; and
- 16% clay;

Atterberg Limits:

- Liquid Limit: 20%;
- Plastic Limit: 12%; and
- Plasticity Index: 8%

The results of the moisture content, grain size distribution and Atterberg Limits tests are provided on the record of borehole sheets in Appendix C. The results of the grain size distribution and Atterberg Limit tests are also provided on Figures 6 and 9, respectively in Appendix D.

1.4.5 Section E (Station 17+550 to Station 17+825)

The subsurface conditions within the footprint (250 m by 150 m) of the proposed rock surplus management area located east of Hwy 17 between Station 17+550 and 17+825 consist of a surficial layer of rootmat/peat underlain by silt, silty gravel with sand followed by silty sand. Auger refusals were encountered at the depths of 0.2 m to 1.2 m in all boreholes except in boreholes located at the south-east boundary of the proposed area. In that area a 2 m thick layer of soft peat was encountered above the underlying refusal in borehole 19-RS-04. In borehole 19-RS-05 a layer of soft compressible peat was encountered to the explored depth of 4.5 m which was the limitation of the hand auger. Outcrops were observed throughout the proposed area. A detailed description of the subsurface conditions encountered for rock surplus management of the Hwy 17 within Section E is discussed further in subsequent sections. It should be noted that the following sections are based on the geotechnical investigation conducted by **exp**.

1.4.5.1 Rootmat/Peat

Rootmat/peat was encountered at the surface of boreholes 19-RS-1 to 19-RS-6, 19-RS-10 to 19-RS-13 and 19-RS-15A. The thickness of rootmat/peat ranges from 0.1 m to 4.5 m. Boreholes 19-RS-1 to 19-RS-5, 19-RS-12, 19-RS-13 and 19-RS-15A was terminated within this layer due to auger refusal.

The composition of this layer consists of roots and rootlets. The material is brown/dark brown to black in color, wet and soft. Peat in borehole 19-RS-13 was fibrous with very strong sulphur odors and charcoal bits were found in upper 0.4 m; peat in borehole 19-RS-6 was also fibrous, but in borehole 19-RS-5, it was spongy and green in colour for upper 0.2 m.

Laboratory testing performed on selected samples consisted of moisture content tests. The test results indicate that natural moisture content of this material ranges from 79% to 389%. The results of the moisture content tests are provided on the record of borehole sheets in Appendix C.

1.4.5.2 Silt

Silt was encountered below the rootmat/peat in borehole 19-RS-10. The approximate elevations of the surface and base of deposit and the thickness of deposit as encountered in boreholes are summarized in Table 1.12 below:

Table 1.12. Summary of silt layer

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-RS-10	314.6	314.5	0.1	0.1

The composition of this layer consists of silt, some sand and trace gravel. The material is grey in color and moist to wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be compact compactness condition.

Laboratory testing performed on one sample of moisture content test. The test result indicate that natural moisture content of this material is about 30%. The results of the moisture content test is provided on the record of borehole sheets in Appendix C.

1.4.5.3 Silty Gravel with Sand

A native silty gravel with sand deposit was encountered below the rootmat layer in borehole 19-RS-11, and was terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the deposit and the thickness of the deposit as encountered in boreholes are summarized in Table 1.13 below:

Table 1.13. Summary of silty gravel with sand deposit

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-RS-11	309.7	309.5	0.2	0.2

The composition of this layer consists of silt, gravel, sand and some cobbles. The material is brown to grey in color and wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be compact compactness condition.

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

Moisture Content:

- 20%

Grain Size Distribution:

- 44% gravel
- 32% sand
- 24% silt and clay

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 7 in Appendix D.

1.4.5.4 Silty Sand

A native silty sand deposit was encountered below the peat deposit in 19-RS-6 and below silt deposit in 19-RS-10, and both the boreholes were terminated within this layer due to auger refusal. The approximate elevations of the surface and base of the deposit and the thickness of the deposit as encountered in boreholes are summarized in Table 1.14 below:

Table 1.14. Summary of silty sand deposit

Borehole	Elevation (m)		Layer Surface Depth (m)	Layer Thickness (m)
	Top	Bottom		
19-RS-6	313.6	313.2	0.3	0.4
19-RS-10	314.5	314.0	0.1	0.5

The composition of this layer consists of sand, silt and occasional cobbles and boulders. The material is light brown/rusty brown to brown in color and moist to wet. From site investigation, during drilling and sampling, relative density for this part of the layer matrix was assessed to be compact compactness condition.

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

Moisture Content:

- 27% to 45%

Grain Size Distribution:

- 4% to 9% gravel
- 58% to 68% sand
- 24% to 36% silt and clay

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 8 in Appendix D.

1.4.5.5 Bedrock

Outcrops were encountered at the ground surface at the locations of boreholes 19-RS-7 to 19-RS-9, 19-RS-14 and 19-RS-15. Photographs in Appendix A show the details of the site and this information is also provided on the record of borehole sheets in Appendix C.

1.5 Groundwater Conditions

Information regarding groundwater levels at the sites was obtained by measuring water levels in the open holes of all boreholes after completion of drilling. The groundwater levels measured in the boreholes are shown on Table 1.15 and on the borehole logs. Water levels measured in open boreholes might not be stabilized due to the relatively short period of observation.

Table 1.15. Groundwater data

Site	Borehole	Date Completed and Measured	Ground Surface Elevation (m)	Groundwater Elevation (m)	Groundwater Depth (m)
Section A	19-MAH-1	6/6/2019	262.0	Dry in open hole	
	19-MAH-2	6/6/2019	260.9	Dry in open hole	
	19-MAH-3	6/6/2019	255.9	255.8	0.1
	19-MAH-3A	6/6/2019	255.9	255.8	0.1
	19-MAH-3B	6/6/2019	255.9	255.8	0.1
Section B	19-MAH-4	6/6/2019	314.8	Not Measured ¹	
	19-MAH-5	6/6/2019	319.8	Not Measured ¹	
	19-MAH-6	6/6/2019	324.5	Not Measured ¹	
Section C	19-MAH-7	6/6/2019	300.4	Not Measured ¹	
	19-MAH-8	6/6/2019	292.4	Dry in open hole	
	19-MAH-9	6/6/2019	282.9	Dry in open hole	
	19-MAH-10	6/6/2019	279.0	Dry in open hole	
	19-MAH-11	6/6/2019	279.8	279.5	0.3
	19-MAH-12	6/6/2019	282.8	Dry in open hole	
	19-MAH-13	6/6/2019	285.2	Dry in open hole	
Section D	19-MAH-14	6/7/2019	240.2	239.95	0.25
	19-MAH-15	6/7/2019	238.8	238.8	0.0
	19-MAH-16	6/7/2019	238.9	239.05	-0.15
Section E	19-RS-1	6/7/2019	311.24	Dry in open hole	
	19-RS-2	6/7/2019	310.18	Dry in open hole	
	19-RS-3	6/7/2019	309.90	309.5	0.4
	19-RS-4	6/7/2019	310.16	Dry in open hole	
	19-RS-5	6/7/2019	309.64	309.64	0.0
	19-RS-6	6/7/2019	313.82	313.37	0.45
	19-RS-7	6/7/2019	313.83	Not Measured ¹	
	19-RS-8	6/7/2019	310.99	Not Measured ¹	
	19-RS-9	6/7/2019	317.00	Not Measured ¹	
	19-RS-10	6/7/2019	314.61	Dry in open hole	
	19-RS-11	6/7/2019	309.83	Dry in open hole	
	19-RS-12	6/7/2019	308.34	Dry in open hole	
	19-RS-13	6/7/2019	307.05	306.9	0.15
	19-RS-14	6/7/2019	313.06	Not Measured ¹	
	19-RS-15	6/7/2019	311.36	Not Measured ¹	
	19-RS-15A	6/7/2019	311.36	311.36	0.0

Notes:

¹Since rockfill/bedrock was found on ground surface, groundwater levels at these holes could not be measured at the time of drilling operations.

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

2 ENGINEERING DISCUSSION & RECOMMENDATIONS FOR GEOTECHNICAL DESIGN

2.1 General

This section of the report provides engineering guidelines on the geotechnical design aspect for the widening of the new eastbound and westbound truck climbing lanes on Hwy 17 from Pays Plat River easterly for 7.2 km (from Station 15+775 to Station 21+225 of the proposed new alignment) and rock surplus management area beside the Hwy 17 from Station 17+550 to Station 17+825, Rossport, Thunder Bay Area, Ontario. The recommendations are based on our interpretation of the factual data obtained from the boreholes advanced during the current additional investigation at the sites performed by **exp** and our understanding of the project requirements. The compiled factual data for each site is presented in **Part I-Foundation Investigation Report** of this report. The interpretation and recommendations provided are intended solely to permit designers, to assess foundation alternatives and design of new embankment widening and rock surplus management area. Comments on construction are only provided to highlight issues that could affect the design. Contractors bidding on the works should make their own assessments of the factual data and how it might affect construction means and methods, scheduling and the like. The report is subject to limitations which follows the text.

Based on information provided by MTO, it is understood that the following design and construction activities were proposed along Hwy 17 between Station 17+000 and Station 20+325:

- Widening of Hwy 17 (i.e. WBL) from Station 17+000 to Station 17+050 with the new high fill (i.e. 4 to 13 m high); it is assumed that the existing Hwy 17 embankment is composed of rockfill – SECTION A
- Widening of Hwy 17 (i.e. WBL) from Station 18+600 to Station 18+675 with the new high fill (i.e. 7 to 13 m high); it is assumed that the existing Hwy 17 embankment is composed of rockfill – SECTION B
- Widening of Hwy 17 (i.e. EBL) from Station 19+325 to Station 19+600 with the new high fill (i.e. 4 to 13 m high); it is assumed that the existing Hwy 17 embankment is composed of rockfill – SECTION C
- Widening of Hwy 17 (i.e. WBL) from Station 20+275 to Station 20+325 with the new high fill (i.e. up to 5 m high); it is assumed that the existing Hwy 17 embankment is composed of rockfill – SECTION D
- Rock surplus management/disposal area east of Hwy 17 from Station 17+550 to Station 17+825 – SECTION E

The preliminary plan, profiles and cross-sections of the proposed new embankment widening and rock surplus management/disposal areas are provided by MTO and shown in drawings attached in Appendix B.

This report addresses the geotechnical design of the foundation for the proposed embankment widening and rock surplus management/disposal area by providing geotechnical design parameters in accordance with the latest edition of the *Canadian Highway Bridge Design Code (CHBDC)* (2014), the *Canadian Foundation Engineering Manual (CFEM)* (2006), and good practice. As requested from MTO, this section provides discussion and recommendations for the design and construction of high fill embankment widening sections of the Hwy 17 roadway platform assessing their stability and settlement. In addition, the recommendations for rock stockpile height, slope geometry, settlement and excavation will be assessed and discussed. Pertinent construction issues from a geotechnical standpoint are examined in general accordance with the instructions from MTO provided in their email dated May 08, 2019.

2.2 Widening of Highway 17 (Sections A, B, C and D)

2.2.1 General

Widening of Hwy 17 was proposed at Sections A, B, C and D as shown on the attached drawings in Appendix B. The widening request identified in the preliminary design drawings at each section as well as the subsurface conditions encountered during this geotechnical investigation are described below. It should be noted that all manually drilled boreholes were located at the toe of existing embankment. There was no borehole drilled from the top of the highway during this current investigation. However, for stability analyses, it is assumed that the existing highway embankment at all investigated sections consists of rockfill (i.e. cobbles and boulders) based on the findings obtained in the previous investigation along Hwy 17 between Station 15+775 and 21+225.

Section A (Station 17+000 to Station 17+050)

Within Section A from Station 17+000 to Station 17+050, the existing Hwy 17 is a two-lane road with 4 m wide paved shoulders. It is proposed that its WBL (i.e. east side) will be widened approximately 4 m and be up to 13 m high in this area. The elevation of the crest of the proposed and existing roadways in this area is approximately 268.8 m. Between Station 17+000 and 17+025 the existing embankment on the east side is about 4 m high having the slope of approximately 1.5H:1V. It is the area of rock cut for the old existing Hwy 17. However, south of Station 17+025 is a creek lowland where the highway embankment height increases to up to 13 m having the slope of approximately 1.5H:1V.

The sub-surface conditions encountered in two boreholes advanced along the east toe of the existing embankment between Station 17+000 to Station 17+025 (19-MAH-1 and 19-MAH-2) consist of surficial rootmat (~0.1 m thick) underlain by gravely fill (~0.3 m thick) followed by auger refusal at the depth of approximately 0.4 m. The presence of outcrops and rock cuts suggests very shallow bedrock at this location. However, the sub-surface conditions at location of boreholes 19-MAH-3, 19-MAH-3A and 19-MAH-3B drilled at the creek lowland consist of surficial rootmat and peat (~0.1 m thick) underlain by very loose gravely/sandy fill (~0.3 m to 0.6 m thick) followed by very loose peaty sand (~1.6 m to 1.8 m thick). The auger refusal was encountered within the 2.1 m and 2.3 m depth below the ground surface. Outcrop was also observed 3 to 4 m west of these tested locations. Groundwater level in the boreholes was encountered approximately 0.1 m below the existing ground surface.

Section B (Station 18+600 to Station 18+675)

From Station 18+600 to Station 18+675 in Section B, it is proposed that the WBL of Hwy 17 (i.e. east side) will be widen approximately 3.5 m to 6.0 m. At Station 18+600 the elevation of the crest of the proposed and existing roadways is 328 m. On the east side the embankment is about 7 to 13 m high having the existing slope of approximately 1.5H:1V.

The east side of the existing highway embankment where the widening is proposed consists of surficial rockfill (i.e. cobble and boulder size) which covers the side and toe of the embankment. Going east from the toe the terrain naturally raises into a steep rocky uphill slope, and the narrow area between the embankment slope and natural slope is covered by rockfill. Therefore, three boreholes which were proposed to be drilled at this area were not be able to be advanced using the hand equipment. On the other side, an access of any machine for drilling or excavation was prevented by steep sides and presence of power lines. Considering the observed surficial conditions at the site it was assessed that the bedrock is shallow at this location. No groundwater observed. Photographs attached in Appendix A show the described conditions.

Section C (Station 19+325 to Station 19+600)

It is proposed that the EBL of Hwy 17 (i.e. west side) will be widen in Section C from Station 19+325 to Station 19+600. The elevation of the crest of the proposed and existing roadways is between 305 m and 288 m at the north (Station 19+325) and south side (Station 19+600) of this section, respectively. On the west side the embankment is between 4 m and 14 m high having the existing slopes along the section vary from 1H:1V to 1.5H:1V.

The sub-surface conditions encountered in seven (7) boreholes advanced along the west toe of the existing embankment between Station 19+325 to Station 19+600 (19-MAH-7 through 19-MAH-13) consist of surficial rootmat (~0.1 m thick) or peat (~0.3 to 0.4 m thick) underlain by granular fill (~0.3 m to 1.0 m thick) followed by auger refusal at the depths of 0.3 m to 1.0 m. The presence of outcrops and rocky/boundary terrain suggests shallow bedrock at this location. The groundwater level in borehole 19-MAH-11 was encountered approximately 0.3 m below the existing ground surface. No ground water observed in other boreholes.

Section D (Section 20+275 to Station 20+325)

It is proposed that the WBL of Hwy 17 (i.e. east side) will be widen approximately 4 m in Section D from Station 20+275 to Station 20+325. The elevation of the crest of the proposed and existing roadways is approximately 243 m. On the east side the embankment is between 3 m and 5 m high having the existing slope of approximately 1.5H:1V.

The sub-surface conditions encountered in two boreholes advanced along the east toe of the existing embankment at Station 20+275 (i.e. 19-MAH-14) and Station 20+325 (i.e. 19-MAH-16) consist of surficial rootmat (~0.1 m thick) underlain by granular fill in borehole 19-MAH-14 or surficial peat in 19-MAH-16 (~0.5 m thick). These soil overburden layers are followed by auger refusal at the depth of approximately 0.5 m. The presence of nearby outcrops suggests very shallow bedrock at these tested locations. However, the sub-surface conditions at location of borehole 19-MAH-15 drilled in

the swampy area at ~Station 20+300 consist of surficial rootmat peat (~0.1 m thick) underlain by soft organic peat (~0.6 m thick) followed by soft sandy peat (~0.7 m thick) and firm sandy clayey silt (~0.9 m thick). The auger refusal was encountered at 2.3 m depth below the ground surface. Groundwater level in the borehole 19-MAH-15 was encountered at the ground surface.

2.2.2 Slope Stability

Limit equilibrium slope stability analyses were carried out for each area at the selected cross-sections using the sub-surface information obtained from the current geotechnical investigation, and proposed embankment configuration provided in the preliminary design drawings. Factors of safety were calculated using the Morgenstern-Price method for critical failure surfaces. The required minimum factor of safety of 1.3 was adopted as the design criteria in both drained and undrained static conditions.

Material parameters adopted in the slope stability analyses are summarized in Table 2.1 below. In analyses, it is assumed that the top peat or other organic material within the footprint of the new fill will be stripped and removed prior to embankment construction. Based on the data from the previous investigation it was assumed that the existing highway was constructed of rockfill at all investigated locations. In the performed analyses it was also assumed that the additional fill will be rockfill.

Table 2.1. Soil strength parameters for slope stability assessment –Sections A, B, C and D

Section/ Station	Layer Name	Bulk Unit Weight, γ (kN/m ³)	Effective Stress Parameters	
			Friction Angle ϕ' (degree)	Cohesion c' (kPa)
All Sections	Granular Pavement	22	35	0
	Existing Embankment (Assumed Rockfill)	18	42	0
	New Embankment (Rockfill)	18	42	0
Section A Station 17+000 to 17+050	Sand (Fill)	19	30	0
	Peaty Sand	15	23	0
Section B Station 18+600 to 18+675	Rockfill	18	42	0
Section C Station 19+325 to 19+600	Sand Fill	19	30	0
Section D Station 20+275 to 20+325	Peat/Sandy Peat	15	23	0
	Silt	18	28	0

*Stability analyses for Section E (i.e. rock surplus management area) will be presented in the following sections

The SLOPE/W graphical printouts, for various analyses performed and discussed below, are included in Appendix E.

Based on the results of stability analyses, new roadway widened embankment in Sections A, B, C and D with slope inclination of rockfill not steeper than 1.5H:1V, and with heights similar to the existing

embankment, are anticipated to be stable. A Factor of Safety against deep seated failure greater than 1.3 is available for widening embankment constructed with rockfill founded on the compact granular soils and/or bedrock prevalent at these sites. If embankment is higher than 10 m then a 2 m wide mid-height berm should be incorporated into the embankment construction.

2.2.3 Settlement

Fill to be placed on native soils for widening of the existing highway embankment will induce some settlement. However, noting no grade raise, the limited width of widening areas and presence of shallow bedrock, the resulting settlement is expecting to occur mainly during construction in the order less than 25 mm, assuming that the top peat/muskeg or other organic material within the footprint of the new fill will be stripped and removed prior to embankment construction. The post construction settlement of the widened embankment in these areas are expected to be minimum (i.e. less than 50 mm which is specified as a maximum limit during pavement design life in Table 1.3 - Post-Construction Settlement Criteria for Embankment Widening from Embankment Settlement Criteria for Design- July 2, 2010, MTO). It is also estimated that the differential settlement rate for the new widened embankment and the differential settlement rate between the existing and the new embankment will be less than 200:1 as per Table 1.3 mentioned above.

2.2.4 Subgrade Preparation and Embankment Construction

Prior to the placement of new fill for the embankment widening, the sites will need to be cleared and grabbed of the existing trees and bushes. All surficial topsoil, organic (i.e. peat/muskeg), loose, soft and/or deleterious materials should be stripped from bellow the proposed embankment widening areas. The exposed subgrade should be inspected and proofrolled, if soil is encountered, under the direction of qualified geotechnical personnel.

Considering the findings in this investigation, the anticipated stripping depths/elevations at the borehole locations are as follows:

Table 2.2. Recommend stripping depths at borehole locations –Sections A, B, C and D

Section	Borehole No.	Existing Ground Elevation at Borehole Location (m)	Recommended Stripping Depth/ Elevation (m)
Section A (Sta. 17+000 to Sta. 050)	19-MAH-1	262	0.3
	19-MAH-2	261.7	0.3
	19-MAH-3/3A/3B	256.8	2.3
Section B (Sta. 18+600 to Sta. 675)	19-MAH-4	314.8	No stripping-rockfill at the ground surface
	19-MAH-5	319.8	
	19-MAH-6	324.5	
Section C (Sta. 19+325 to Sta. 19+600)	19-MAH-7	300.4	Outcrop
	19-MAH-8	292.4	0.5
	19-MAH-9	282.9	0.7

Section	Borehole No.	Existing Ground Elevation at Borehole Location (m)	Recommended Stripping Depth/ Elevation (m)
	19-MAH-10	279.0	0.4
	19-MAH-11	279.8	1.0
	19-MAH-12	282.8	0.3
	19-MAH-13	285.2	0.3
Section D (Sta. 20+275 to 20+325)	19-MAH-14	240.2	0.6
	19-MAH-15	238.8	2.3
	19-MAH-16	238.9	0.5

Grading and embankment construction should be conducted in accordance OPSS.PROV 206. Except for the top 1.0 m, where Granular B Type III should be placed, the embankment fills should consist of an approved rockfill. For rock embankment the layers should not exceed 1.5 m thickness prior to compaction. Material in each layer should be fully compacted prior to the succeeding layer is placed. Each rockfill layer should be compacted with a tractor bulldozer with a minimum number of complete passes of 6 and the maximum passes of 8. A complete pass should be defined as 100% coverage of layer surface.

Embankment fill materials should be properly benched into the existing embankment in accordance with OPSD 2018.010 and compacted. If the benching is impractical at these sites, then the surface of the existing rockfill side slopes to be widened should be scratched to remove any soil/vegetation to provide a good bond between the existing rockfill and the rockfill placed for the widening. Before placing any granular fill including the granular pavement over the rockfill in the widened section, proper chinking should be applied. Alternatively, a suitably robust geotextile can be placed for separation purposes. Upon completion of the filling to the pavement subgrade level, the embankment side slopes should be trimmed to a final inclination. A 2 m wide mid-height berm should be incorporated into the design of 10 m high or higher embankment.

2.3 Rock Surplus Management Area (Section E)

2.3.1 General

Excavated rock that is surplus to embankment construction requirements (i.e. widening, slope flattening, berms, etc.) is proposed to be placed adjacent to the Hwy 17 embankment in the area of Section E shown on Drawing 6 in Appendix B. The designated proposed area is approximately 250 m by 150 m in a footprint, and it is located east of Hwy 17 beyond the MTO right-of-way. Dispose of rock surplus excavated material should be in accordance with OPSS.PROV 206 and OPSS 180.

According to OPSS.PROV 206 the disposal site should be treated as a stockpile. The rock surplus management including stockpiling is an entitlement of the Contractor. All materials removed from rock excavation and not placed in rock embankment should be deemed to be removed as part of the Contractor's rock surplus quantity. All materials removed as part of the rock surplus quantity should be accurately measured by the Contractor. Prior to any rock material placing at the designated area, the

Contractor should complete an accurate survey of the initial ground. Once the stockpile has been completed, the stockpile should then be resurveyed by the Contractor.

The rock surplus stockpiles should be kept stable and rock should be dumped in a manner not to cause nuisance, injury or inconvenience. As specified in OPSS.PROV 206, if compressible soils are present, the proposed stockpile should be re-located or monitoring devices should be installed at the affected location. The subsurface investigation was performed as part of the current investigation to determine if compressible soils are present at the proposed stockpile location. Fifteen (15) locations within the area were explored by manually drilling exploratory holes. The subsurface conditions encountered during this geotechnical investigation are described below. It should be noted that the terrain in that area is rugged and covered by tall trees and dense bushes preventing the access and maneuver of any machine without significant tree clearing. Therefore, drilling of boreholes with a drill rig or excavation of test pits with an excavator was considered as extremely difficult and expensive, and the exploration holes were drilled by a manual auger.

2.3.2 Subsurface Conditions

Photos of the proposed rock surplus management area taken during the current investigation are presented in Appendix A. These photos and the results of current investigation show that the proposed rock surplus management area is the rugged hard rocky terrain with rock outcrops and shallow bedrock mostly overlain by soft peat followed, in some locations, by compacted silty sand. The auger refusal was encountered at the depths between 0.2 m to 1.2 m in all boreholes except in boreholes 19-RS-03 and 19-RS-05 which were located at the south-east boundary of the proposed area. In borehole 19-RS-03, a 2 m thick layer of soft peat was encountered above the underlying refusal. In borehole 19-RS-05 a layer of soft compressible peat was encountered to the explored depth of 4.5 m which was the limitation of the hand auger.

Therefore, the majority of the proposed area is suitable for rock surplus stockpiling, except the zone around boreholes 19-RS-03 and 19-RS-05 (i.e. south-east boundary of the proposed area) where the layer of compressible peat are present on the ground surface. As mentioned before the specified zone with the compressible soil should be avoid or monitoring devices should be installed at that zone. No groundwater was observed in most boreholes. Where it was observed it was at the ground surface or very close.

2.3.3 Slope Stability

To define the stable configuration of the rock stockpile including its height and side slopes, limit equilibrium slope stability analyses were carried out using the sub-surface information obtained from the current geotechnical investigation. Factors of safety were calculated using the Morgenstern-Price method for critical failure surfaces. The required minimum factor of safety of 1.3 was adopted as the design criteria.

2.3.3.1 Majority Rock Stockpile

Considering the subsurface encountered in the majority of the proposed rock surplus management area which consists of shallow bedrock overlain by thin layer of overburden (~90% of the whole area), it is estimated that the rock stockpiles of 10 m height (or even higher) with the slopes of 1.25H:1V will

be safe. However, if the stockpile is 10 m high or higher, a 2 m wide mid-height berm should be incorporated into the stockpile construction.

2.3.3.2 Rock Stockpile at South-East Boundary

As noted in the Section 2.3.2 the layer of compressible soil was encountered in two boreholes drilled along the south-east boundary of the proposed rock surplus management area (see Drawing 6). It was found that the compressible soil is between 2 m and more than 4.5 m thick in that area. Considering that finding, that area could be avoided for deposition of rock surplus. In that case a set-back limit should be approximately 5 m from the marked zones on Drawing 6. However if it is not avoided, it should be specially treated either by excavation of that non-competent material (i.e. soft peat) or by lowering the stockpile height in that area.

To determine the safe height of the rock stockpile founded on the layer of soft peat, the slope stability analyses were performed using the material parameters listed in Table 2.3.

Table 2.3. Soil strength parameters for slope stability assessment for immediate construction conditions—Section E, south-east boundary

Layer Name	Bulk Unit Weight, γ (kN/m ³)	Undrained Shear Strength, Cu (kPa)	Effective Stress Parameters	
			Friction Angle ϕ' (degree)	Cohesion c' (kPa)
Rock Stockpile	18	-	42	0
Peat/Muskeg	16	12	23	1

The results of the slope stability analyses for the deep seated failure in that area, in terms of total stress using undrained shear strengths for the peat, as would apply to rapid construction (short term stability), are shown graphically in Figure E5 in Appendix E. The figure shows the general relationship between stockpile height, side slope and factor of safety against instability for construction of rock stockpile. The figure shows the limiting conditions for stability during stockpile construction in this area. It clearly indicates that adequate factors of safety of 1.3 cannot be achieved for stockpile higher than 3.5 m. It is noted that for the immediate construction conditions the side-slope of the stockpile has only a small influence on temporary stability within the range of side slopes considered.

2.3.4 Settlement

It appears that the rock surplus will be placed on the thin layer of the overburden soils underlain by hard bedrock. Therefore, the negligible settlement is expecting to occur mainly during construction. The post construction settlement of the stockpile will be approximately 1% of its height.

2.3.5 Monitoring

As specified in OPSS.PROV 206, the monitoring should be involved if the rock stockpile will be placed in the area with compressible soils. The monitoring device should consist of a circular 1.0 m diameter 6 mm thick steel plate with a 3.0 m length of 50 mm diameter steel pipe securely welded vertically to the centre of the plate. Whenever the level of rock placement surrounding the monitoring device is vertically within 300 mm of the top of a monitoring device, successive 3.0 m lengths of 50 mm diameter steel pipe should be welded to the top of that device. The length of each new section should be added to the original elevation. The top of each monitoring device should be surveyed prior to rock material placement. After the placement of rock materials is complete the top of each monitoring device should be resurveyed. If the difference in elevation between the two surveys is greater than 300 mm, the initial ground elevations for this location should then be lowered universally by the difference in monitoring device elevation. When more than one monitoring device is placed at a given location, the differences in elevations should be averaged together.

2.4 Engineering Recommendations for Flatter Slopes and Berms to Dispose Surplus Rock (Task 2)

2.4.1 General

All widening areas with high fill along Hwy 17 from Station 16+500 to Station 21+225 which were investigated by **exp** (WO #1 and WO #5) were reviewed, and available information were summarized in Table 2.4. The objective of this review was to provide an assessment if surplus of excavated rock could be disposed at locations of those high fill areas by flattening the slope of the new embankment and/or by building berms.

As can be seen in Table 2.4, seven (7) areas of high fill have been identified and addressed in the following section.

2.4.2 Recommendations and Comments

Based on available information recommendations and comments related for possible deposit of the surplus rock within each area are included in Table 2.4. In addition the drawings attached in Appendix F show the possible slope geometry within the available space between the existing Hwy 17 embankment and MTO's Right of Way (ROW) since the slope geometry and berms have been limited by the ROW. As can be seen on the drawings, it is recommended that the embankment slope be flatten (i.e. flatter than 1.5H:1V) where ever it is possible. The criterion was to lay the toe of the slope at the ROW and built the slope up (flatter than 1.5H:1V) until meet the crest of Hwy 17. In addition, a mid-height berm is recommended to be built if the fill is 10 m or more high. The width of the berm should be minimum 2 m.

In all these area the shallow top rootmat/muskeg/peat layer should be removed prior to placing the rock. The rock should be placed from the bottom of the existing embankment and parallel to it. Dumping of rock from the crest is not acceptable. The deposited rock does not need to be compacted. The existing surface water has to be properly drained.

It is shown in Section 2.2.2 of this report that the widening of Sections A, B, C and D with slope inclination of rockfill not steeper than 1.5H:1V, and with heights similar to the existing embankment, are stable. The same conclusion was made for Sections 2, 3 and 4 in exp's report from June 13, 2019. Therefore, any flatter slope than 1.5H:1V for the embankment widening at investigated areas listed in Table 2.4 is anticipated to be stable.

The following is recommended for each section:

- **Section 2** (from Station 16+500 to Station 16+600) – As shown on Drawing 1-2 in Appendix F the slope at the widening side (east of WBL) can be flattened to 2.5H:1V. The layer of muskeg/peat ~0.2 m to 0.5 m thick has to be removed prior the placing of rock.
- **Section 3** (from Station 18+950 to Station 19+050) – As shown on Drawing 2-2 in Appendix F there is no space to build the slope flatter than 1.5H:1V at the widening side (west of EBL) due to the limitation of the ROW.
- **Section 4** (from Station 20+965 to Station 21+225) - As shown on Drawing 3-2 in Appendix F the slope at the widening side (east of WBL) can be flatten to 2.7H:1V from Station 20+965 to Station 21+075. In that area the layer of muskeg/peat ~0.1 m thick has to be removed prior the placing of rock. From Station 21+075 to Station 21+225 where the bedrock was encountered on the ground surface the slope at the widening side (east of WBL) can be flatten to 7H:1V.
- **Section A** (from Station 17+000 to Station 17+050) - As shown on Drawing 4-2 in Appendix F the slope at the widening side (east of WBL) can be flatten to 2H:1V (or flatter, depending on the available space) from Station 17+000 to Station 17+025. In that area the layer of rootmat ~0.1 m thick has to be removed prior the placing of rock. From Station 17+025 to Station 17+050 where the slope is more than 10 m high a 4 m wide mid-height berm can be built having the lower slope of 1.5H:1V (or flatter) and upper slope of 2.4H:1V, as shown on Figure 4-2. The layer of rootmat/peat ~0.1 m thick has to be removed prior the placing of rock in this area. The proper drainage of the surface water should be provided.
- **Section B** (from Station 18+600 to Station 18+675) - As shown on Drawing 5-2 in Appendix F where the slope is more than 10 m high a 2.5 m wide mid-height berm can be built having the lower and upper slopes of 1.5H:1V. The proper drainage of the surface water should be provided.
- **Section C** (from Station 19+325 to Station 19+600) - As shown on Drawing 6-2 in Appendix F where there is available space and where the slope is more than 10 m high a 2 m wide mid-height berm can be built having the lower slope of 1.5H:1V and upper slopes of 2H:1V. Alternatively, the berm could be 4 m wide so lower and upper slopes are 1.5H:1V. The layer of rootmat/peat ~0.1 m to 0.4 m thick has to be removed prior the placing of rock in this area. The proper drainage of the surface water should be provided.
- **Section D** (from Station 20+275 to Station 20+335) – As shown on Drawing 7-2 in Appendix F the slope at the widening side (east of WBL) can be flattened to 3.3H:1V. The layer of muskeg of ~0.1 m thick and organic peat of ~0.6 m thick have to be removed prior the placing of rock.

Table 2.4 Summary of information of high fill areas and recommendations for disposal of rock surplus

WO	Section	Station		Length (m)	Road Side of Widening	Height of Existing Embankment - up to (m)	Existing Slope at Widening Side	Recommended Slope for Widening (Rockfill)	Soil Layers along Toe of Existing Embankment	Auger Refusal @ (m)	Comments	Recommendations for Disposal of Rock Surplus*
		From	To									
1	Section 2	16+500	16+600	100	East	5	2H:1V	1.5 H:1V	0.2 to 0.5 m muskeg/peat; 0.3 to 2.1 m very loose to very dense silty sand; 1.2 to 1.5 m firm to stiff silty clay; 1.4 m compact to very dense sandy silt	0.6 to 4.9		Flatten the slope (flatter than 1.5H:1V) as shown on Drawing 1-2 in Appendix F
	Section 3	18+950	19+050	100	West	8.5	1.5H:1V	1.5H:1V	0.2 to 0.3 m muskeg/peat; 0.6 m dense silty sand and gravel; underlying bedrock	0.8 to 0.9	Limited space by ROW	There is no space to design the slope flatter than 1.5H:1V, due to limitation by ROW (see Drawing 2-2 in Appendix F)
	Section 4	20+965	21+075	110	East	6	1H:1V to 2H:1V	1.5H:1V	0.1 m muskeg/peat; 2.2 m loose to compact sand; underlying bedrock	2.3		Flatten the slope (flatter than 1.5H:1V) as shown on Drawing 3-2 in Appendix F
		21+075	21+225	150		3			Bedrock	Outcrop		
5	Section A	17+000	17+025	25	East	4	15H:1V	1.5H:1V	0.1 m rootmat; 0.3 m gravelly fill; underlying bedrock	0.4	Area of rock cut for the old existing Hwy 17	Flatten the slope (flatter than 1.5H:1V) as shown on Drawing 4-2 in Appendix F
		17+025	17+050	25		13			0.1 m rootmat/peat; 0.3 to 0.6 m very loose gravelly/sandy fill; 1.6 to 1.8 m very loose peaty sand	2.1 to 2.3	Creek lowland	Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m and more high as shown on Drawing 4-2 in Appendix F; provide proper drainage of the existing creek
	Section B	18+600	18+675	75	East	7 to 13	1.5H:1V	1.5H:1V	Rockfill	0	Narrow area between existing embankment and natural steep rocky uphill slope	Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m or more high as shown on Drawing 5-2 in Appendix F; provide proper drainage of the surface water
	Section C	19+325	19+600	275	West	4 to 14	1H:1V to 1.5H:1V	1.5H:1V	0.1 to 0.4 m rootmat/peat; 0.3 to 1.0 m granular fill; underlying bedrock	0.3 to 1.0		Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill 10 m or more high as shown on Drawing 6-2 in Appendix F
	Section D	20+275	20+335	60	East	3 to 5	1.5H:1V	1.5H:1V	0.1 m rootmat; 0.6 m soft organic peat; 0.7 m soft sandy peat; 0.9 m firm sandy clayey silt	2.3	Swampy area	Flatten the slope (flatter than 1.5H:1V) as shown on Drawing 7-2 in Appendix F; provide proper drainage of the surface water

Notes:

*the widening has to be within the MTO ROW

1. Layers of muskeg/peat/rootmat has to be removed prior the placing the rockfill
2. The deposition of rock surplus does not need to be compacted but it has to be placed from the bottom, not dumped from the crest
3. It has to be built parallel to the highway
4. if the embankment is 10 m or more high, a minimum 2 m wide mid-height berm should be built with maximum 1.5H:1V slope.
5. Proper drainage of the surface water has to be obtained with in the rock surplus deposition.

3 CLOSURE

The recommendations made in this report are in accordance with our present understanding of the project and are provided solely for the team responsible for the design of the works described herein.

We recommend that we be retained to review our recommendations as the design nears completion to ensure that the final design is in agreement with the assumptions on which our recommendations are based and that our recommendations have been interpreted as intended. If not accorded this review, **exp** will assume no responsibility for the interpretation and use of the recommendations in this report.

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 Ms. Sugitha Anandakumar, M.Eng., EIT and Dr. Silvana Micic, P.Eng. It was reviewed by Mr. TaeChul Kim, M.E.Sc., P.Eng. and by Mr. Stan E. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact. The field investigation was supervised by Mr. Elwin Farkas.

exp Services Inc.



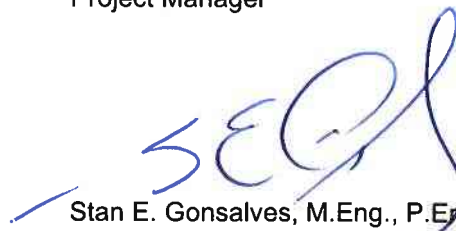
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LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are

August 29, 2019

only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

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The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.

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Where exp has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by exp have utilize specific software and hardware systems. exp makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are exp's instruments of professional service and shall not be altered without the written consent of exp.

Appendix A – Site Photographs

SECTION A – From 17+000 to 17+050



Photo 1. Section A- Old Hwy 17 close to Station 17+000, looking west

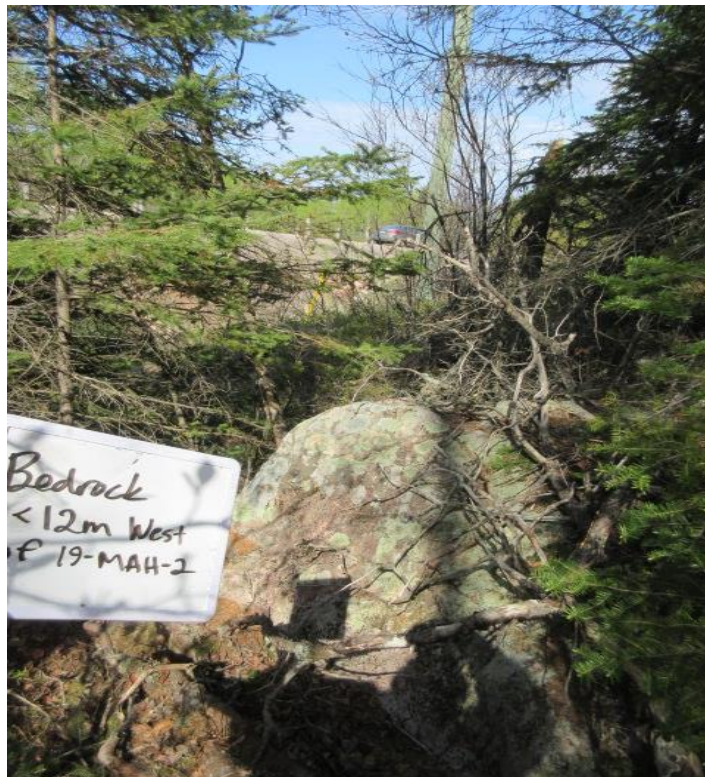


Photo 2. Section A- Bedrock close to 19-MAH-2, west bottom of Hwy 17 existing embankment close to Station 17+025, looking west



Photo 3. Section A- Toe of Hwy 17 existing embankment, creek close to Station 17+050, looking east



Photo 4. Section A- Toe of Hwy 17 existing embankment close to Station 17+000, looking west

SECTION B – From 18+600 to 18+675



Photo 5. Section B - Toe of Hwy 17 existing embankment, rocky steep slopes close to Station 18+675, looking north



Photo 6. Section B – Overhead powerlines at toe of Hwy 17 existing embankment close to Station 18+650, looking south



Photo 7. Section B –Hwy 17 existing embankment close to Station 18+600 (i.e. rocky base), looking east



Photo 8. Section B – Small creek close to Station 18+650, looking east

SECTION C – From 19+325 to 19+600



Photo 9. Section C - Toe of Hwy 17 existing embankment, rocky steep slopes close to Station 19+400, looking east



Photo 10. Section C - Hwy 17, erosion near 19-MAH-9, facing south



Photo 11. Section C - Toe of Hwy 17 existing embankment, possible bedrock near Station 19+325

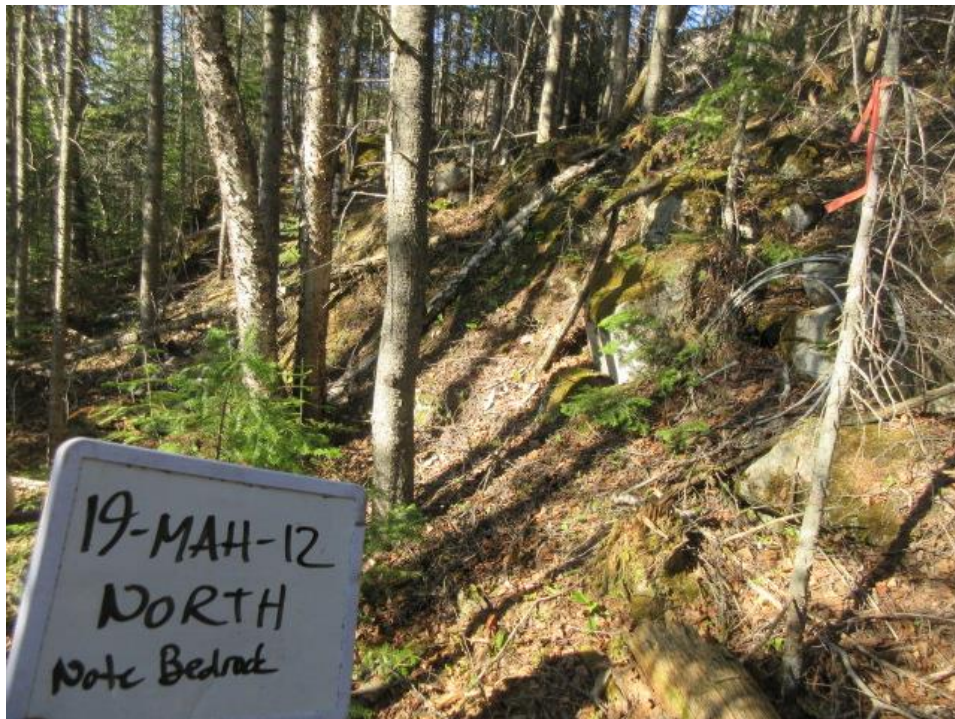


Photo 12. Section C - Toe of Hwy 17 existing embankment, possible bedrock near Station 19+550

SECTION D – From 20+275 to 20+335



Photo 13. Section D - Hwy 17, facing south-east



Photo 14. Section D – West of Hwy 17, rocky steep slope



Photo 15. Section D - Toe of Hwy 17 existing embankment, facing south



Photo 16. Section D – Bedrock outcrop close to 19-MAH-16, near Station 20+335, looking west

SECTION E – From 17+550 to 20+825



Photo 17. Section E – North-east corner of the proposed rock surplus management area, facing south



Photo 18. Section E – East boundary of the proposed rock surplus management area, bedrock ridge



Photo 19. Section E – South boundary of the proposed surplus management area, looking west



Photo 20. Section E – South-west corner of the proposed rock surplus management area, bedrock outcrop



Photo 21. Section E – South boundary of the proposed rock surplus management area, bedrock knob



Photo 22. Section E – East boundary of the proposed rock surplus management area, outcrop



Photo 23. Section E – South-east corner of the proposed rock surplus management area, bedrock near 19-RS-5

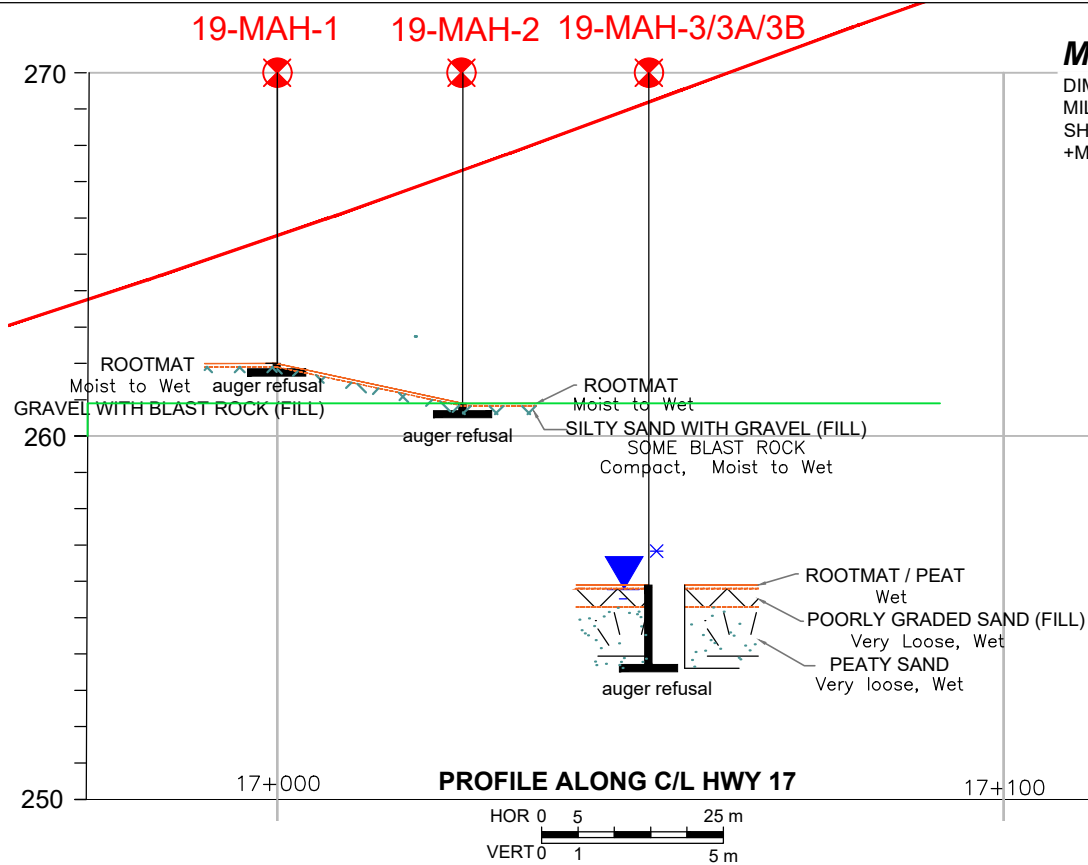
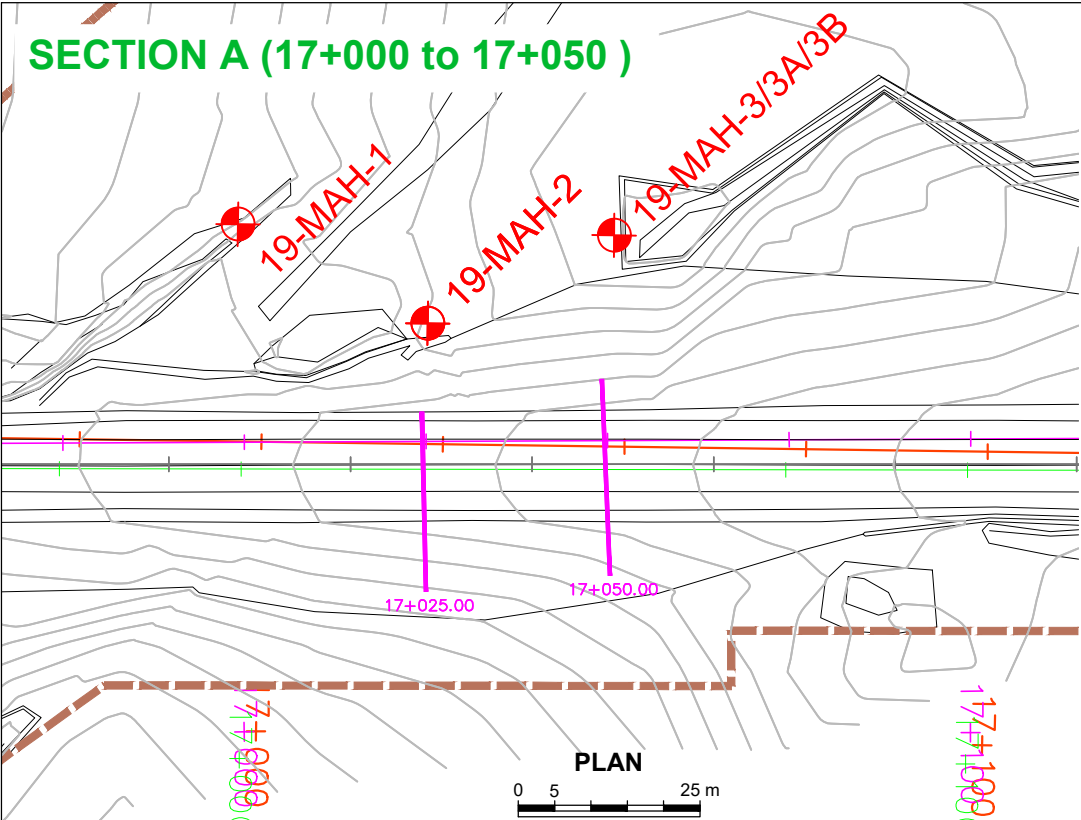


Photo 24. Section E – South boundary of the proposed rock surplus management area, bedrock near 19-RS-10



Photo 25. Section E – In the center of the proposed rock surplus management area, bedrock near 19-RS-7

Appendix B – Drawings



METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

Agreement. No. 6017-E-0066
Assignment No. 5
WO # 2018-11011

Additional Foundation Engineering Retainer Services
for Hwy 17 Widening from Pays Plat River Easterly for
7.2 km. Thunder Bay Area, ON

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION A

EXP Services Inc.

KEY PLAN

LEGEND

- Borehole Location
- Standard Penetration Test (Blows/0.3 m)
- Groundwater level measured in open hole

SOIL STRATA SYMBOLS

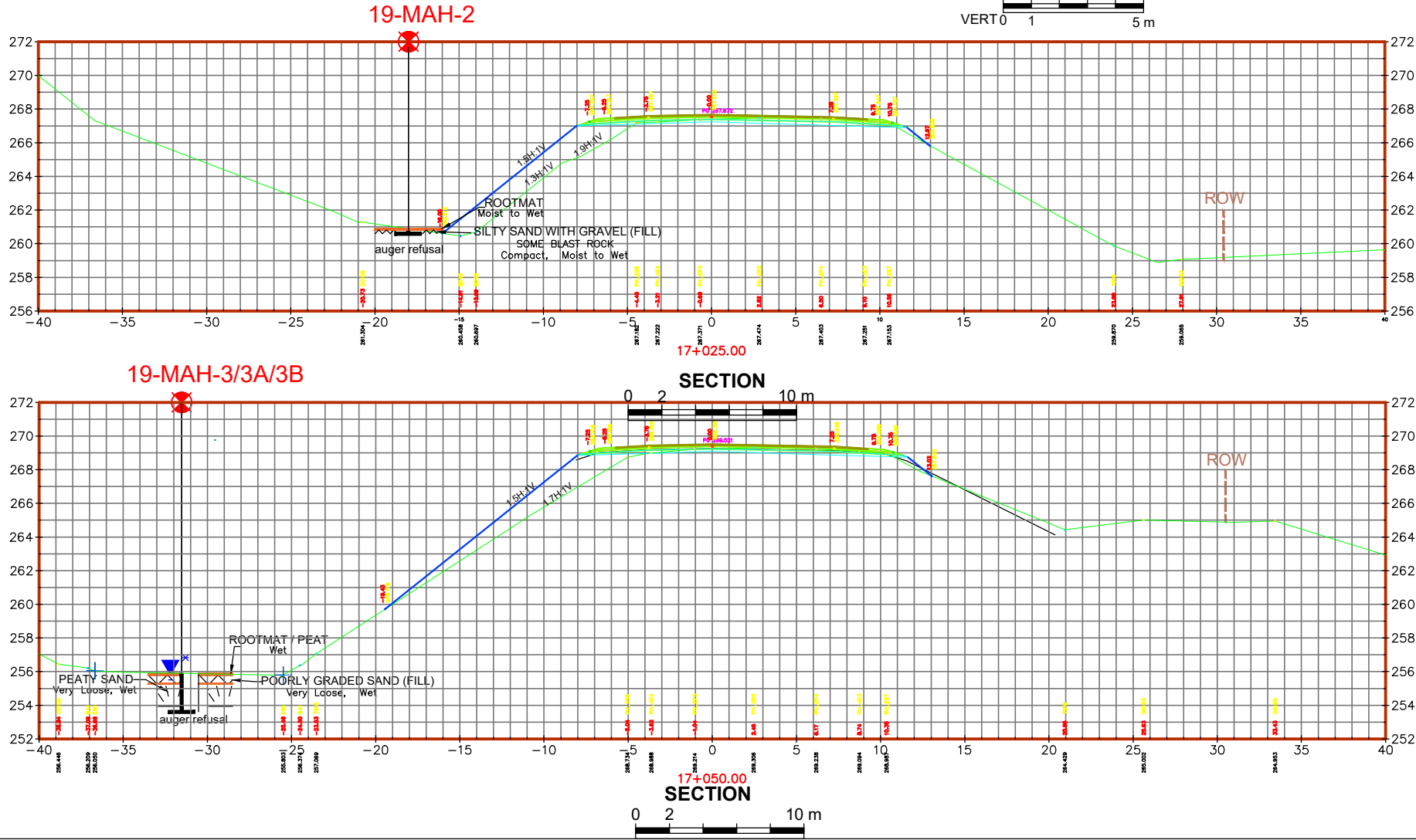
- ROOTMAT/PEAT
- PEATY SAND
- FILL

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-1	262.0	5414599.0	265820.0
19-MAH-2	260.9	5414570.9	265829.1
19-MAH-3/3A	255.9	5414561.7	265855.9

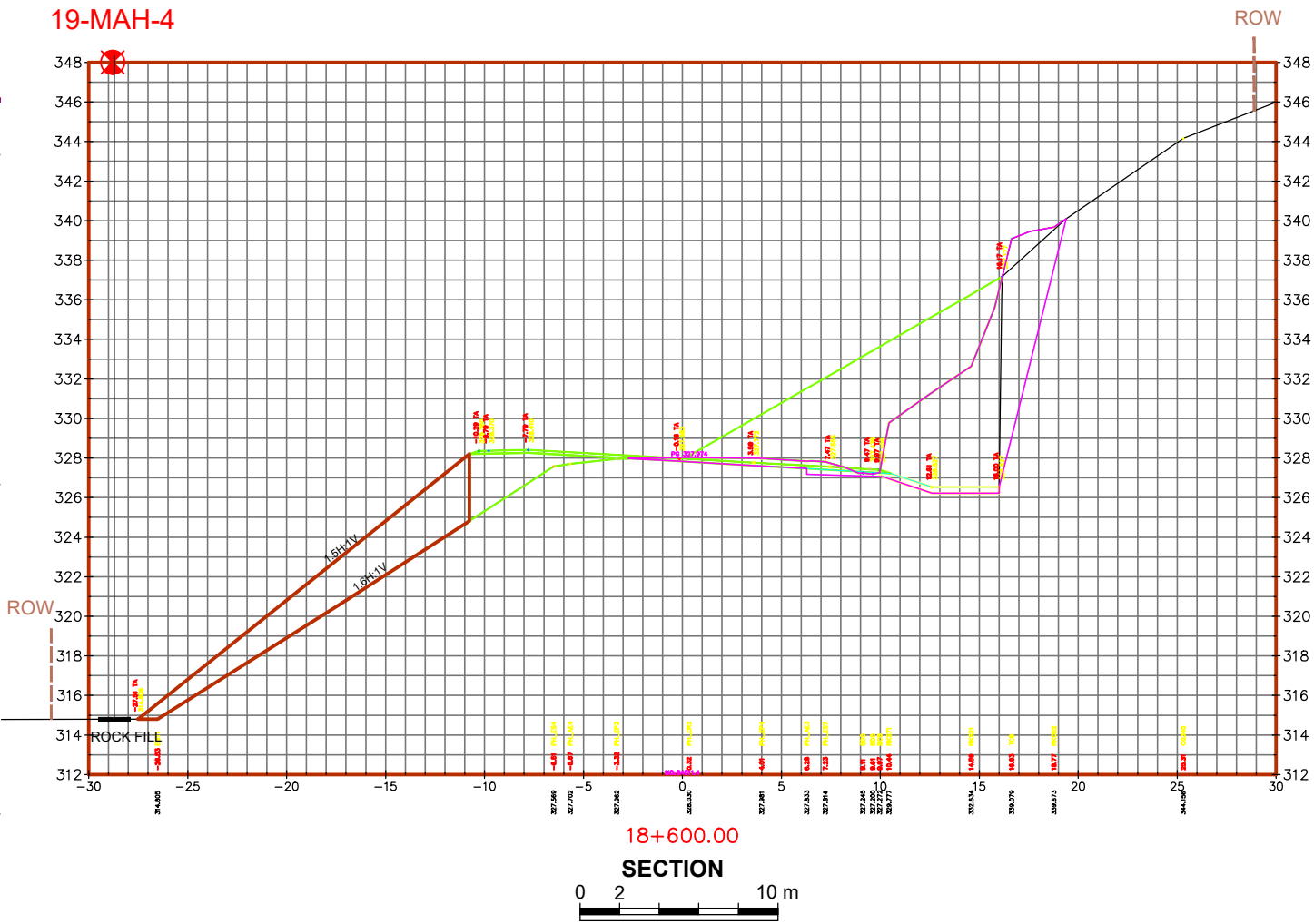
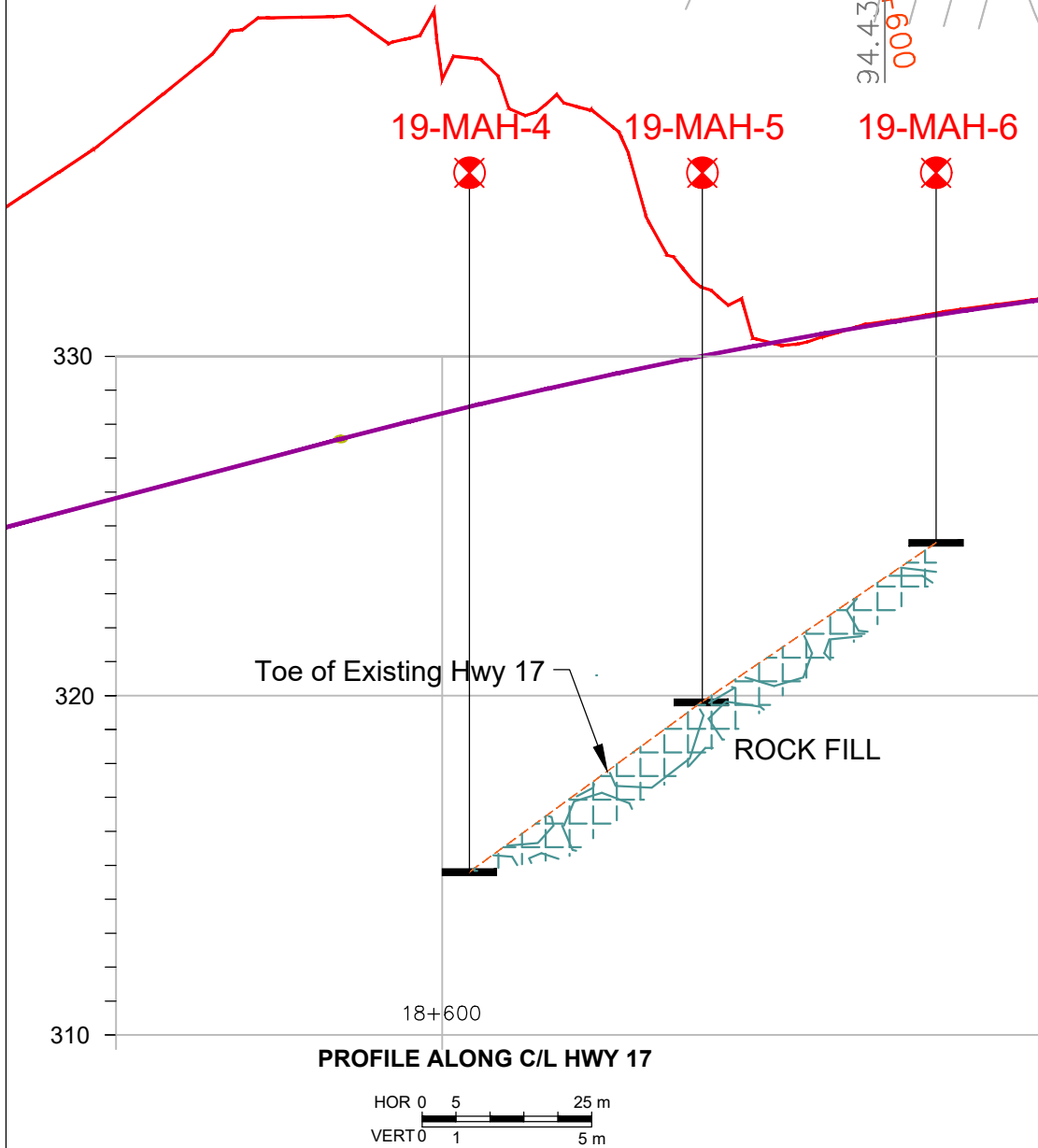
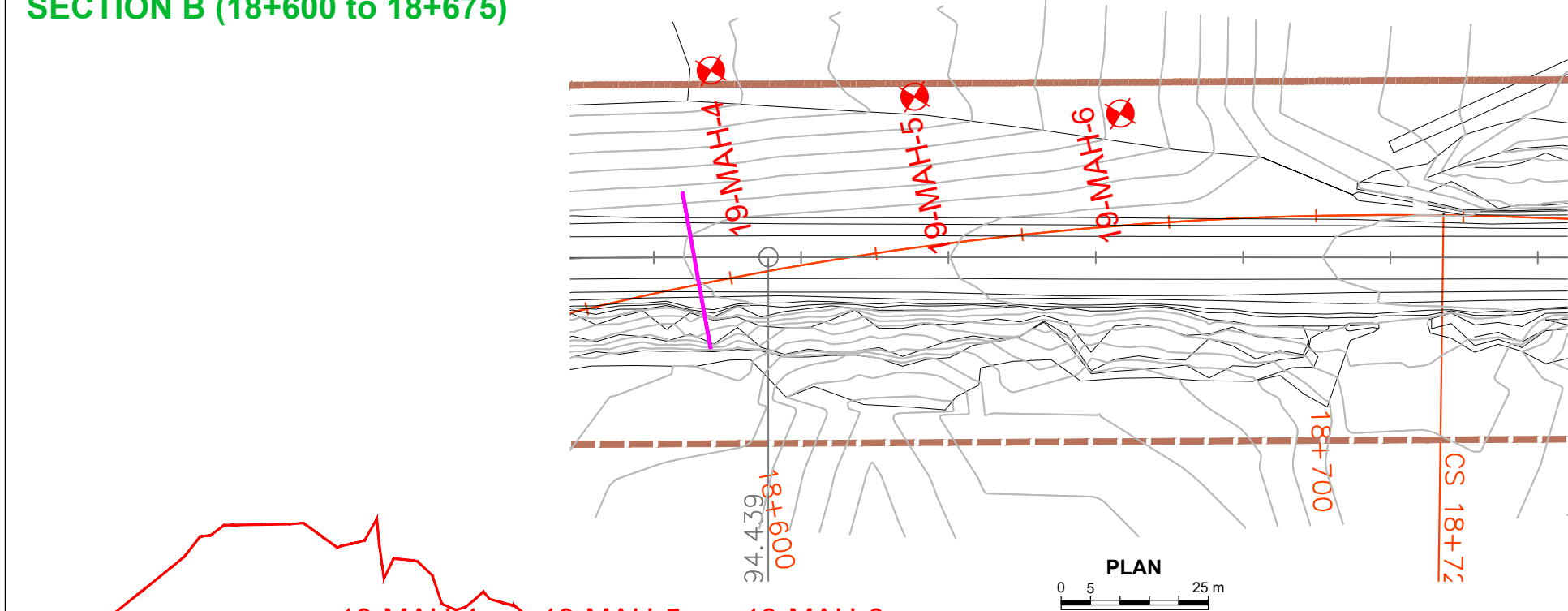
NOTES
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	SM	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
		GEOCRES NO. 42D-58
		PROJECT NO. ADM-00248798-E0
SUBM'D SH	CHECKED SM	DATE Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG DWG. 1



SECTION B (18+600 to 18+675)



METRIC
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MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS



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Assignment No. 5
WO #2018-11011

Additional Foundation Engineering Retainer Services
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7.2 km. Thunder Bay Area, ON

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION B

exp.

EXP Services Inc.

KEY PLAN

LEGEND

Borehole Location

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

SOIL STRATA SYMBOLS

ROCK FILL

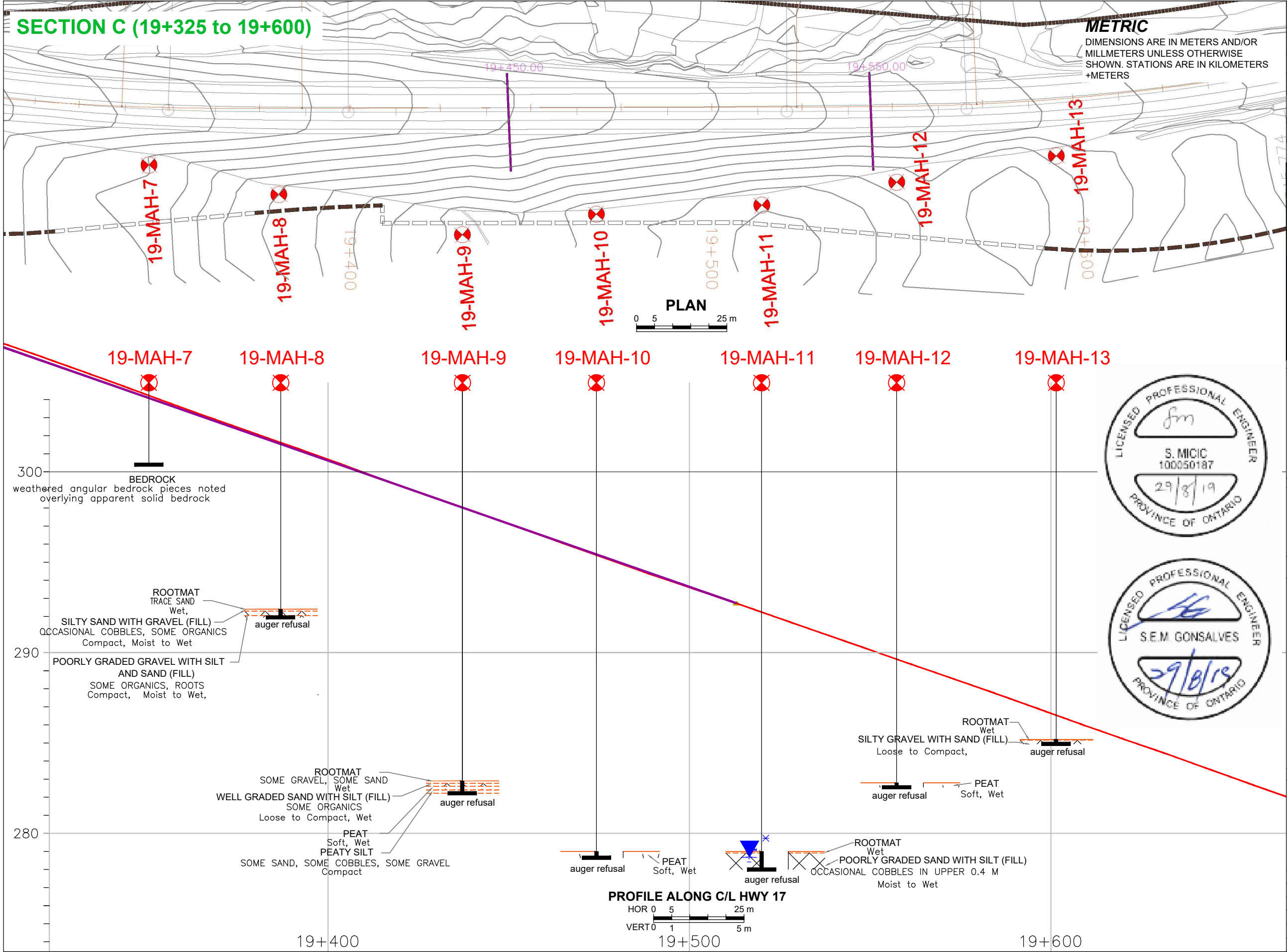
BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-4	314.8	5413255.9	266674.3
19-MAH-5	319.8	5413222.0	266668.6
19-MAH-6	324.5	5413190.3	266650.6

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		DESCRIPTION	
		GEOCRES NO. 42D-58	
		PROJECT NO.	ADM-00248798-E0
SUBM'D SH	CHECKED SM	DATE	Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 2



Agreement No. 6017-E-0066
Assignment No. 5
WO #2018-11011

SHEET
1

Additional Foundation Engineering Retainer Services for Hwy 17 Widening from Pays Plat River Easterly for 7.2 km. Thunder Bay Area, ON

BOREHOLE LOCATION PLAN AND SOIL STRATA SECTION C

EXP Services Inc.

KEY PLAN

LEGEND

- Borehole Location
- Standard Penetration Test (Blows/0.3 m)
- Groundwater level measured in open hole

SOIL STRATA SYMBOLS

- Rootmat/Peat
- FILL
- Peaty SAND

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-7	300.4	5412558.8	266398.8
19-MAH-8	292.4	5412523.5	266388.3
19-MAH-9	282.9	5412473.6	266373.8
19-MAH-10	279.0	5412436.1	266378.3
19-MAH-11	279.8	5412390.4	266377.7
19-MAH-12	282.8	5412352.8	266380.1
19-MAH-13	285.2	5412308.1	266385.6

NOTES

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DATE	BY	DESCRIPTION	
		GEOCRES NO. 42D-58	
		PROJECT NO. ADM-00248798-E0	
SUBM'D SH	CHECKED SM	DATE	Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 3



SECTION C (19+325 to 19+600)

METRIC
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MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

Agreement No. 6017-E-0066
Assignment No. 5
WO #2018-11011

Additional Foundation Engineering Retainer Services
for Hwy 17 Widening from Pays Plat River Easterly for
7.2 km. Thunder Bay Area, ON

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION C

exp

EXP Services Inc.

KEY PLAN

LEGEND

Borehole Location

N

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

SOIL STRATA SYMBOLS

Rootmat/Peat

Peaty SAND

FILL

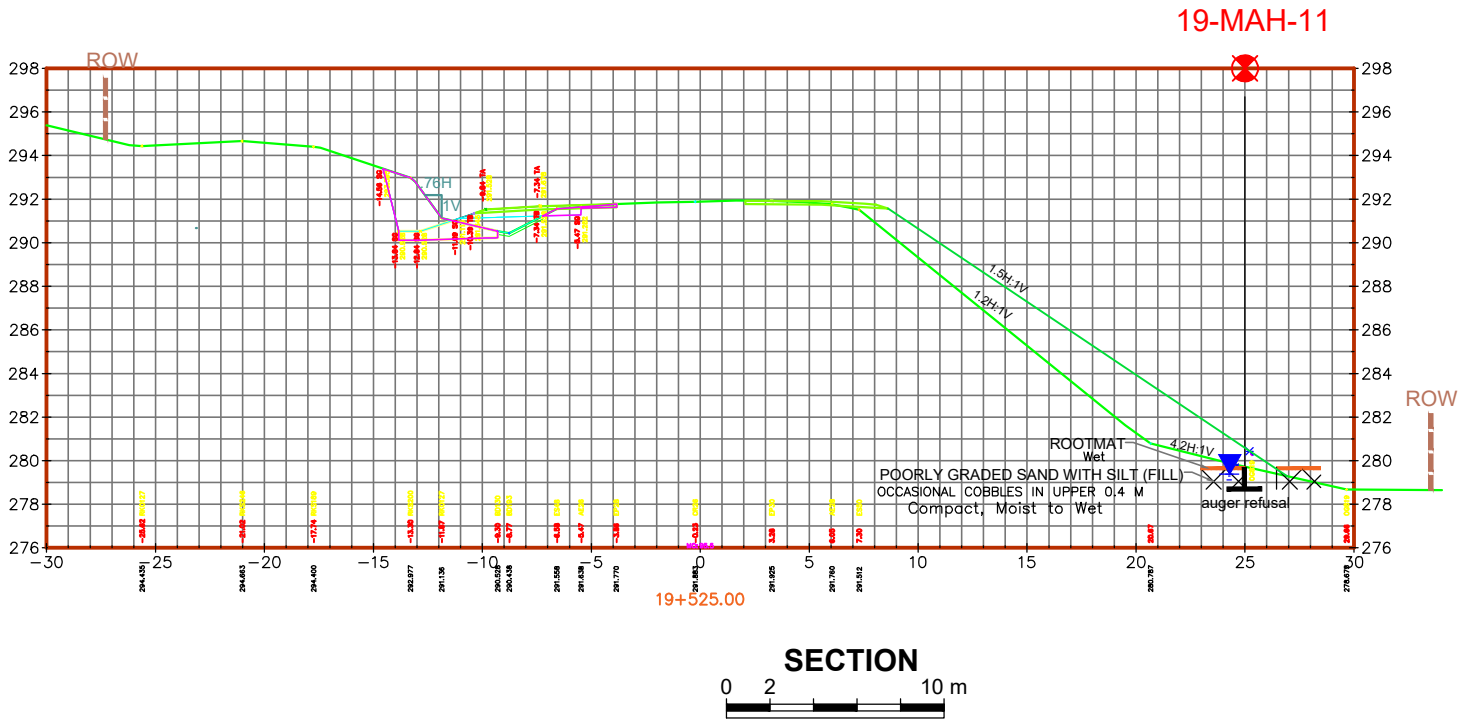
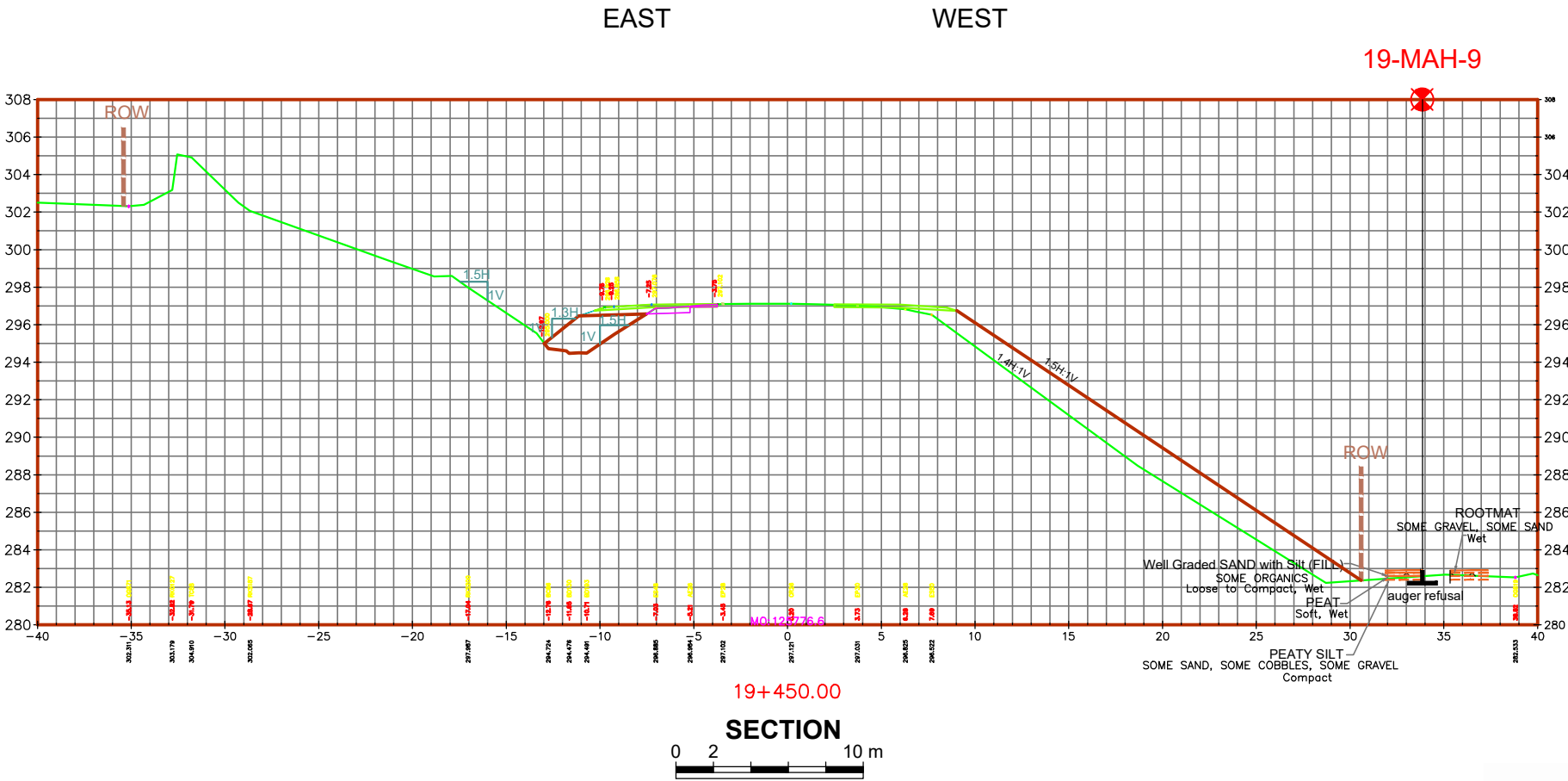
BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-7	300.4	5412558.8	266398.8
19-MAH-8	292.4	5412523.5	266388.3
19-MAH-9	282.9	5412473.6	266373.8
19-MAH-10	279.0	5412436.1	266378.3
19-MAH-11	279.8	5412390.4	266377.7
19-MAH-12	282.8	5412352.8	266380.1
19-MAH-13	285.2	5412308.1	266385.6

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SUBM'D SH	CHECKED SM	DATE Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG DWG. 4



SECTION D (20+275 to 20+335)


METRIC
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MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

Agreement No. 6017-E-0066
Assignment No. 5
WO #2018-11011



SHEET
1

Additional Foundation Engineering Retainer Services
for Hwy 17 Widening from Pays Plat River Easterly for
7.2 km. Thunder Bay Area, ON


BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION D


 **EXP Services Inc.**


KEY PLAN




LEGEND


 Borehole Location


 Standard Penetration Test (Blows/0.3 m)

 Groundwater level measured in open hole

SOIL STRATA SYMBOLS

 Rootmat/Peat

 Peaty SAND

 FILL

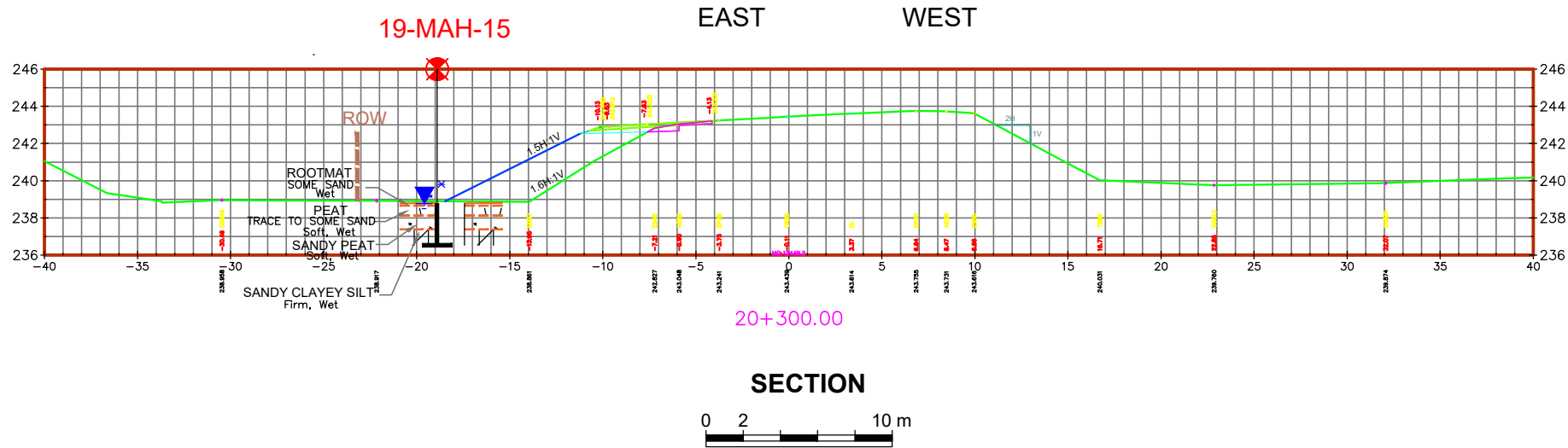
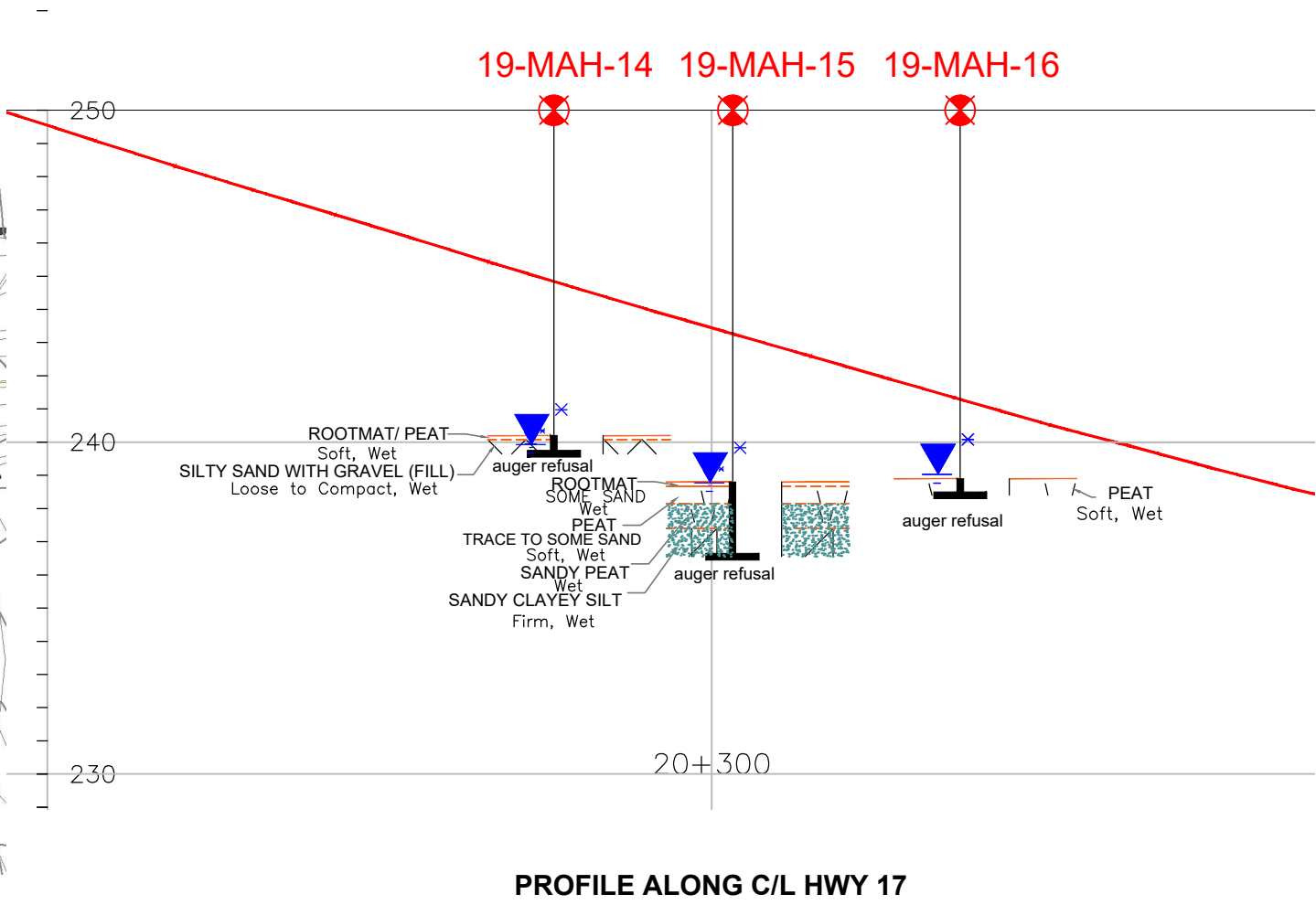
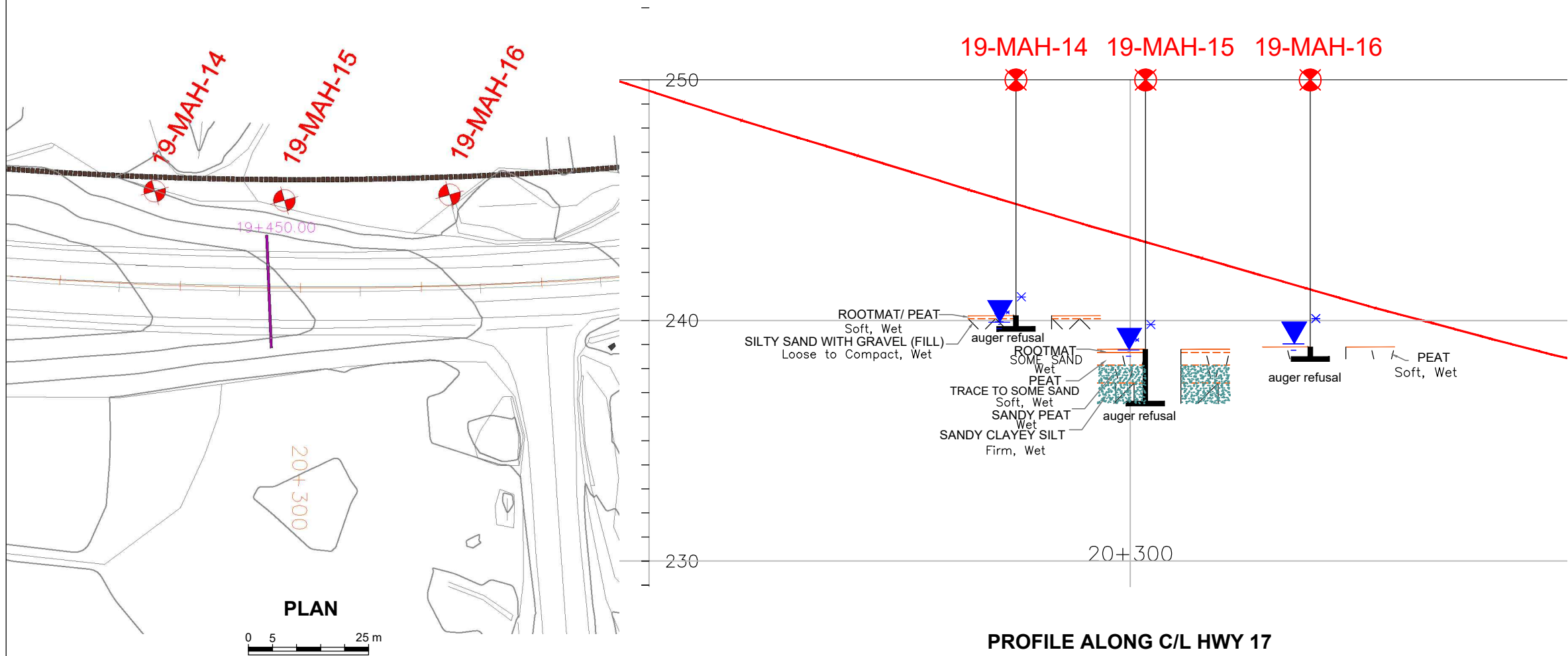
BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-7	300.4	5412558.8	266398.8
19-MAH-8	292.4	5412523.5	266388.3
19-MAH-9	282.9	5412473.6	266373.8
19-MAH-10	279.0	5412436.1	266378.3
19-MAH-11	279.8	5412390.4	266377.7
19-MAH-12	282.8	5412352.8	266380.1
19-MAH-13	285.2	5412308.1	266385.6

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		PROJECT NO. ADM-00248798-E0	
SUBM'D SH	CHECKED SM	DATE	Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 5



SECTION E (17+550 to 17+825)

METRIC
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MILLIMETERS UNLESS OTHERWISE
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+METERS

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Additional Foundation Engineering Retainer Services
for Hwy 17 Widening from Pays Plat River Easterly for
7.2 km. Thunder Bay Area, ON

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION E

exp

EXP Services Inc.

KEY PLAN

HWY 17
Section A
Section B
Section C
Section D
SITE

LEGEND

Borehole Location

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

Area of special treatment

SOIL STRATA SYMBOLS

Rootmat/ Peat

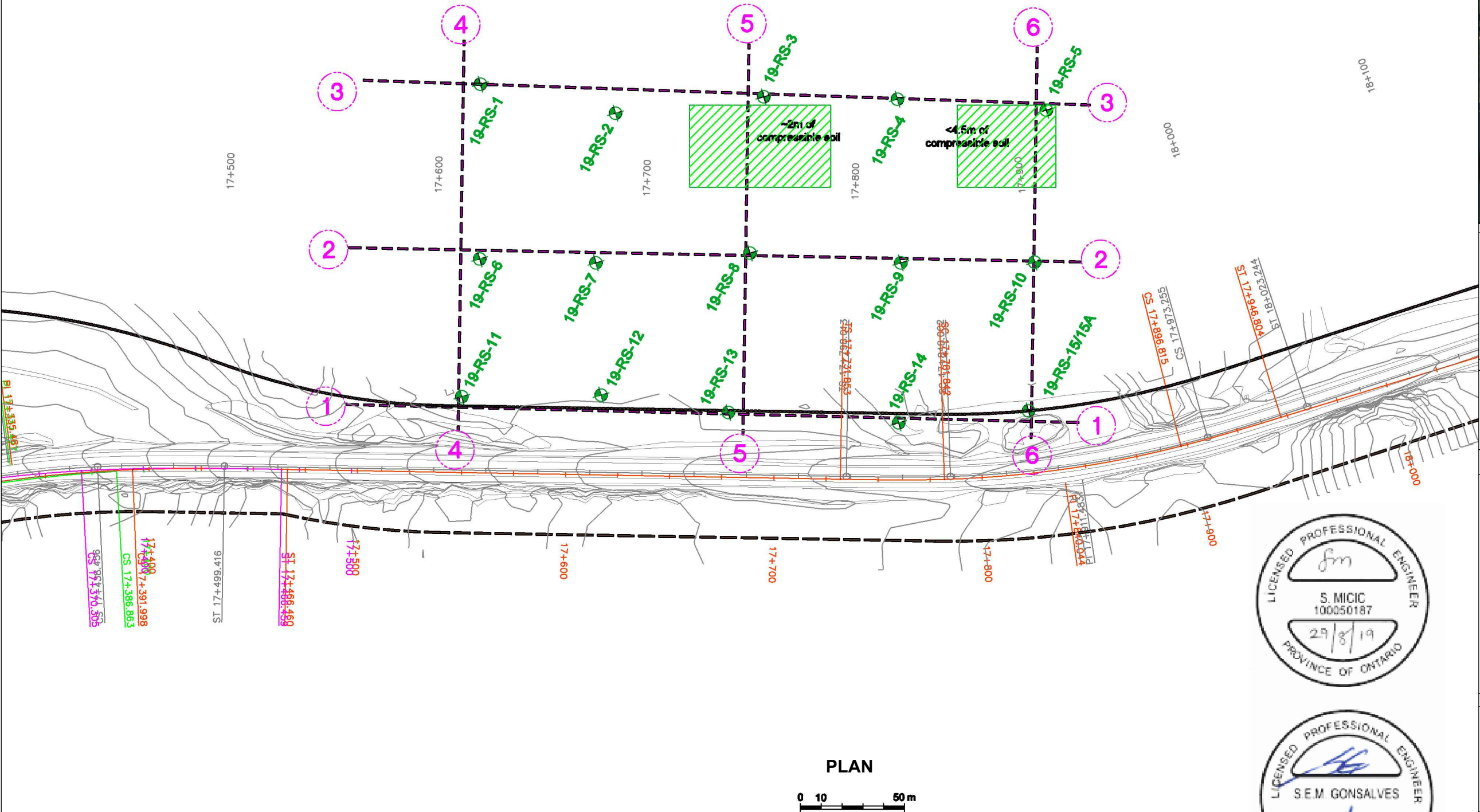
Peaty SAND

FILL

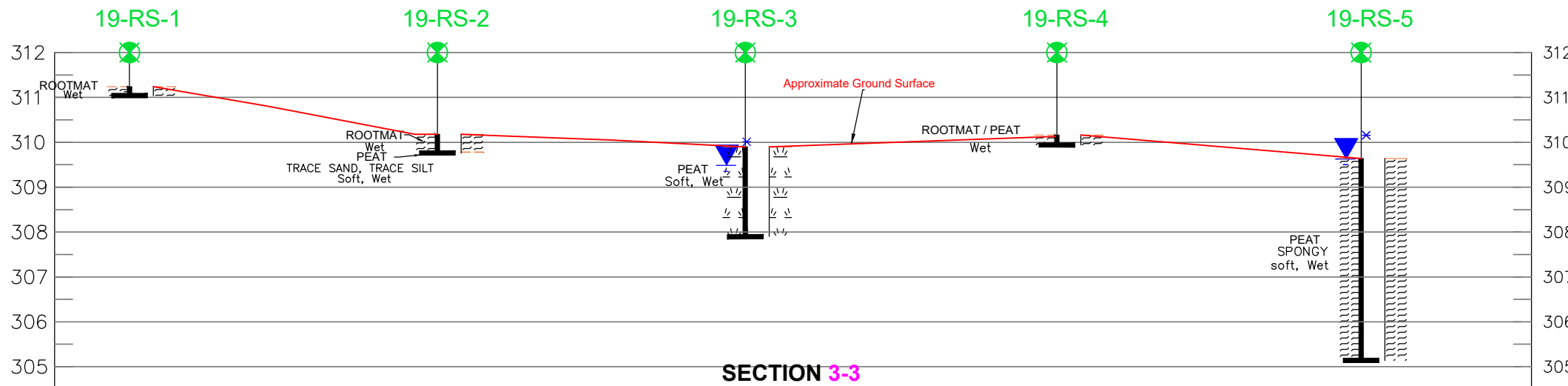
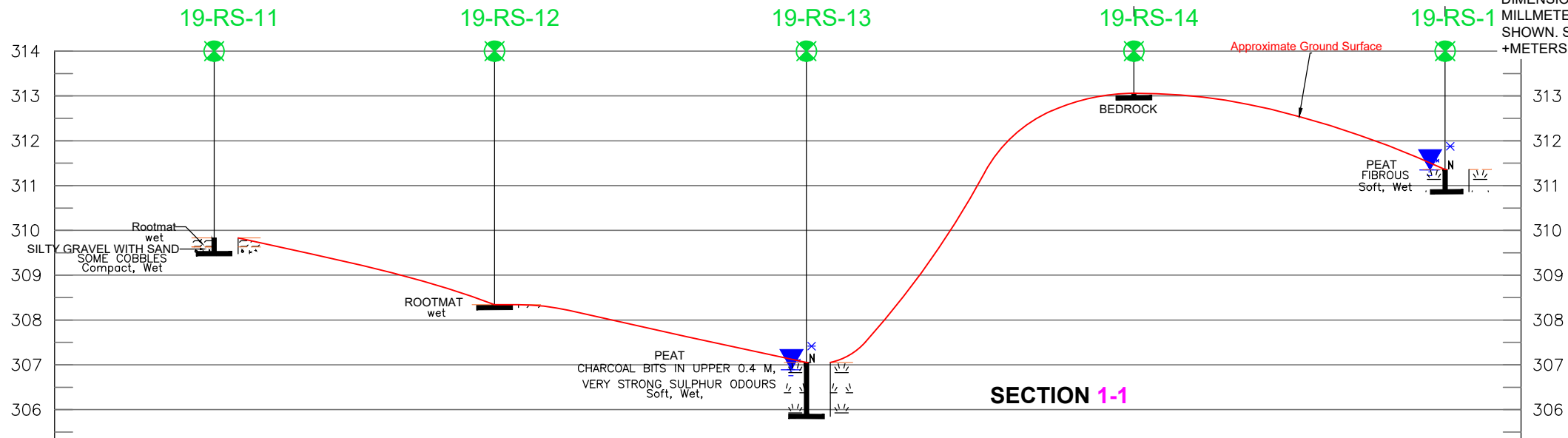
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SECTION E (17+550 to 17+825)



METRIC
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SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA SECTION E

exp

EXP Services Inc.

KEY PLAN

LEGEND

Borehole Location

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

SOIL STRATA SYMBOLS

Rootmat/PeatPeaty SANDFILL

NOTES

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SCALE:

HOR 0 5 30 m

VERT 0 1 3 m



SECTION E (17+550 to 17+825)

METRIC
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SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION E

exp

EXP Services Inc.

KEY PLAN

LEGEND

Borehole Location

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

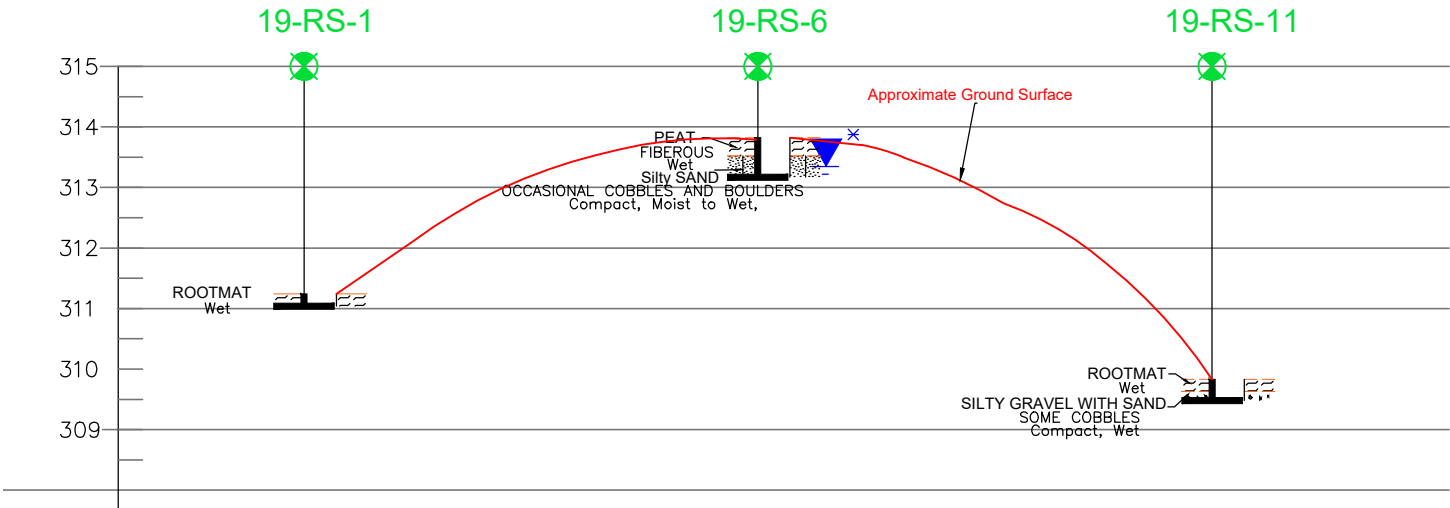
SOIL STRATA SYMBOLS

Rootmat/PeatPeaty SANDFILL

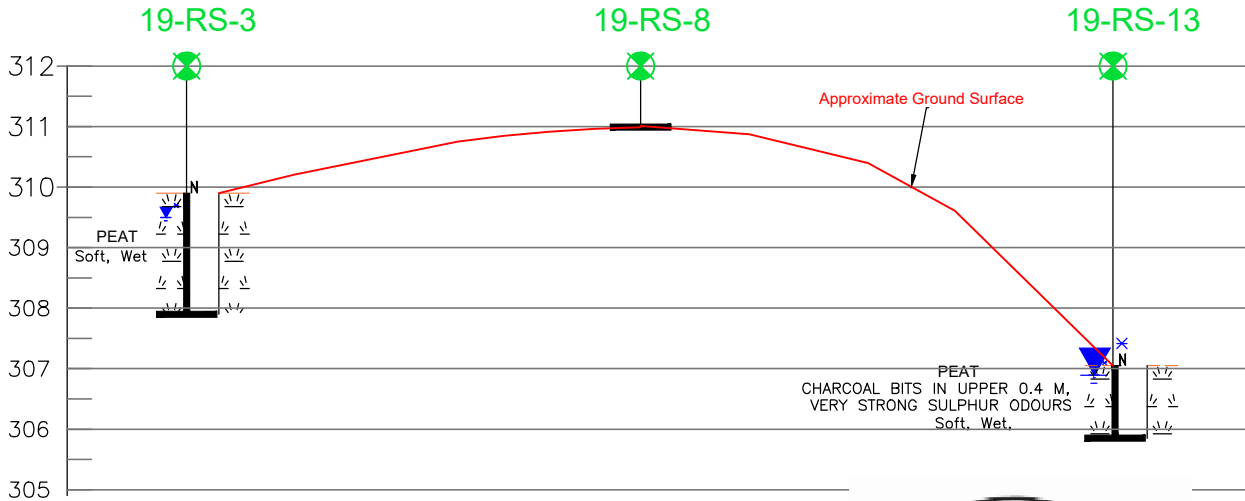
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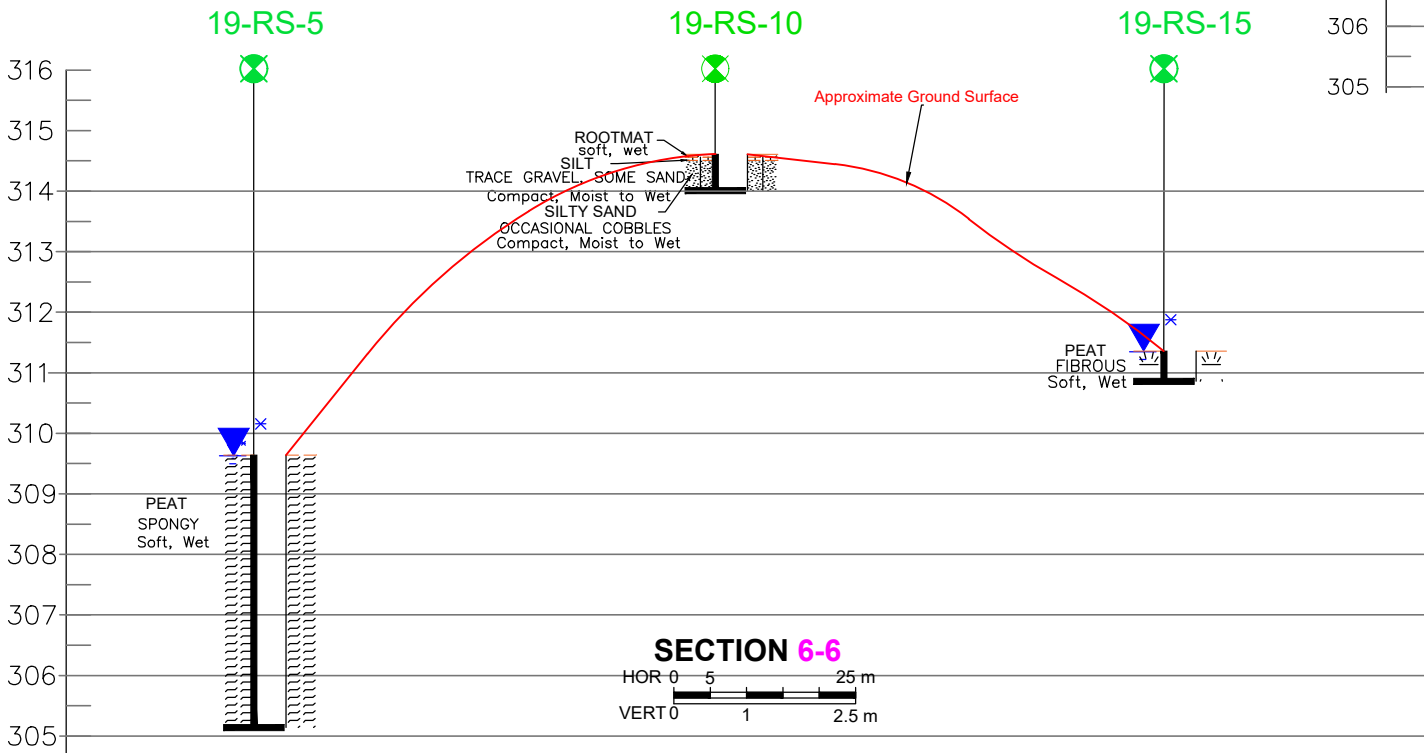
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SECTION 4-4
HOR 0 5 25 m
VERT 0 1 2.5 m



SECTION 5-5
HOR 0 5 25 m
VERT 0 1 2.5 m



SECTION 6-6
HOR 0 5 25 m
VERT 0 1 2.5 m

Appendix C – Borehole Logs

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.

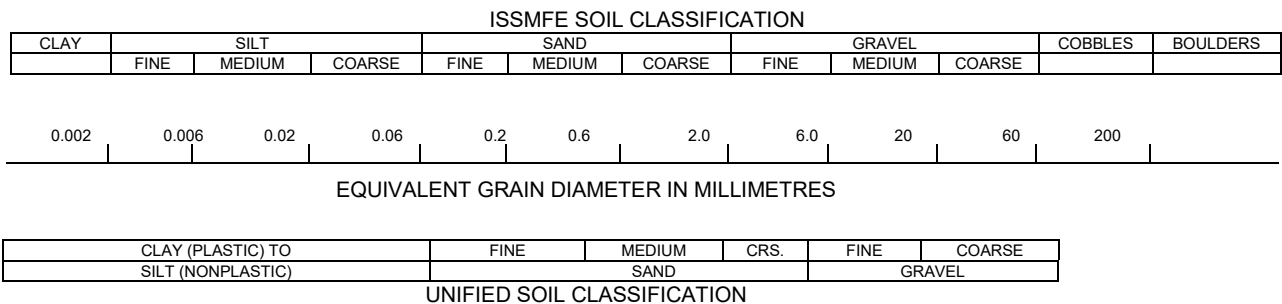
Seam: a thin, confined layer of soil having different particle size, texture, or color from materials above and below.

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.



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 Canadian Foundation Engineering Manual (CFEM):

Table a: Percent or Proportion of Soil

	Criteria
Trace	1% - 10%
Some	10% - 20%
Little	20% - 35%
Some	>35% and main fraction

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≤N<10
Compact	10≤N<30
Dense	30≤N<50
Very Dense	50≤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:

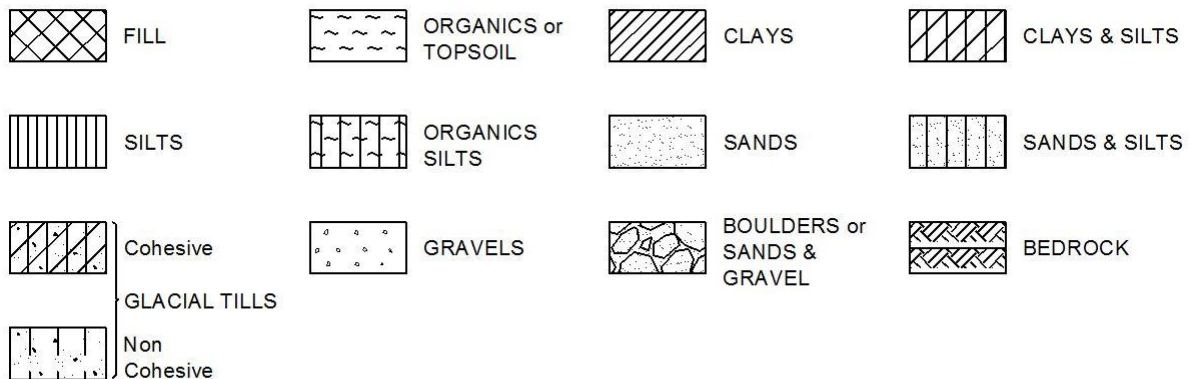
Table c: Consistency of Cohesive Soil

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'	—°	Effective angle of internal friction
c_u	kPa	Apparent cohesion intercept
ϕ_u	—°	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

Brampton, Ontario

RECORD OF BOREHOLE No BH-S1

1 OF 1

METRIC

W.P. GWP No. 6078-18-00 LOCATION Shabaqua Patrol Yard - Proposed Salt/Sand Shed MTM ON-15 312563E 5384446N ORIGINATED BY EF
 DIST 61 HWY 11/17 BOREHOLE TYPE CME 55 Rubber Track / HSA / NQ COMPILED BY NK
 DATUM Geodetic DATE 2019.05.22 - 2019.05.23 LATITUDE 48.59851 LONGITUDE -89.89474 CHECKED BY AM/DG

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		W _P W W _L			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER	WATER CONTENT (%)				
389.5	Asphalt						20 40 60 80 100						GR SA SI CL
389.4 0.1	ASPHALT - about 100 mm Poorly Graded SAND AND GRAVEL (FILL) - trace silt, brown, moist, compact		S1	SS	15		389						39 54 (8)
388.7 0.8	CLAY - trace sand, some silt, reddish brown, wet, very stiff		S2	SS	3		388						
	- becoming silty		S3	SS	3		387						0 4 23 74
			VANE				386						Field Vane = 131 kPa, Sensitivity = 2
			S4	SH			385						Field Vane = 106 kPa, Sensitivity = 3
			S5	SS	2		384						Field Vane = 92 kPa
			VANE				383						
			S6	SS	2		382						40 43 (17)
			VANE				381						
			S7	SS	1		380						
383.9 5.6	SAND AND GRAVEL - some silt, light brown, moist to wet, very dense - sand and gravel encountered during auguring at about 5.6 m depth - refusal to auger and SPT at about 6.1 m depth, NQ core initiated - some cobbles to cobbley at about 6.1 m depth		S8	CORE									
			S9	SS	60								
			S10	CORE									
379.6 9.9	End of Borehole												
	Notes: Groundwater level measured at 0.3 m below ground surface.												

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

ONTARIO MTO F-19115-AG - ADM-00248798-F0 - MTO 6 - SHABAQUA BUILDING - FINAL GPJ ONTARIO MTO.GDT 8/20/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-01

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 265820E 5414599N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8685 LONGITUDE -87.5314 CHECKED BY AM/DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC NATURAL LIMIT MOISTURE CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)													
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER				W _p	W	W _L															
262.0	Rootmat		S1	AUGER																									
0.0	Rootmat - brown, moist to wet																												
261.9																													
0.1	Gravel with Blast Rock (FILL) - brown, damp		S2	AUGER																									
261.8																													
261.8																													
0.3	End of Borehole - refusal																												

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-02

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 265838E 5414580N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8683 LONGITUDE -87.5311 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										WATER CONTENT (%)
260.9	Rootmat																	
260.8	Rootmat - brown, moist to wet		S1	AUGER														
0.1	Silty SAND with Gravel (FILL) - compact, brown, moist to wet, some blast rock		S2	AUGER														
260.6	End of Borehole - refusal																	
0.3	- no groundwater encountered																	

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-03

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 265855E 5414562N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8682 LONGITUDE -87.5309 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									WATER CONTENT (%)			GR
255.9	Rootmat / Peat		S1	AUGER		255														
0.0 255.8 0.1	Rootmat / Peat - dark brown to black, wet Poorly Graded SAND (FILL) - very loose, brown, wet		S2	AUGER																
255.3	Peaty SAND - very loose, dark brown, wet		S3	AUGER	254															
0.6			S4	AUGER																
253.6 2.3	End of Borehole - refusal																			

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19




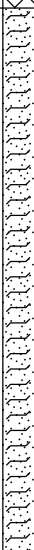
Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-03A

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 265855E 5414562N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8682 LONGITUDE -87.5309 CHECKED BY AM/DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
255.9	Rootmat / Peat		S1	AUGER			255						227.7	1 97 (3)
0.0 255.8 0.1	Rootmat / Peat - dark brown to black, wet Poorly Graded SAND (FILL) - very loose, brown, wet		S2	AUGER										
255.6 0.3	Peaty SAND - very loose, dark brown, wet		S3	AUGER										
253.8 2.1	End of Borehole - refusal													

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-03B

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 265855E 5414562N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8682 LONGITUDE -87.5309 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER					W _p	W	W _L		GR	SA	SI	CL
255.9 0.0	Rootmat / Peat		S1	AUGER		255	20	40	60	80	100									
255.8 0.1	Rootmat / Peat - dark brown to black, wet		S2	AUGER																
	Poorly Graded SAND (FILL) - very loose, brown, wet																			
255.4 0.5	Peaty SAND - very loose, dark brown, wet																			
253.8 2.1	End of Borehole - refusal		S3	AUGER		254														
			S4	AUGER																

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266668E 5413257N	ORIGINATED BY	EF	
DIST	HWY 17	BOREHOLE TYPE	Manual Hand Auger		COMPILED BY	KK	
DATUM	Geodetic	DATE	2019.06.06 - 2019.06.06	LATITUDE	48.8565	LONGITUDE	-87.5197
					CHECKED BY	AMDG	

[illegible]

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-05

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266666E 5413223N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8562 LONGITUDE -87.5197 CHECKED BY AM/DG

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 (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
							20	40	60	80	100	W _p	W	W _L			
319.8 0.0	Fill Rockfill - no augering conducted																

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266651E 5413190N	ORIGINATED BY	EF			
DIST	HWY 17	BOREHOLE TYPE	Manual Hand Auger		COMPILED BY	KK			
DATUM	Geodetic	DATE	2019.06.06 - 2019.06.06	LATITUDE	48.8705	LONGITUDE	-87.5201	CHECKED BY	AM/DG

[illegible]

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


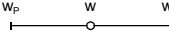
ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266389E 5412568N	ORIGINATED BY	EF	
DIST	HWY 17	BOREHOLE TYPE	Manual Hand Auger		COMPILED BY	KK	
DATUM	Geodetic	DATE	2019.06.06 - 2019.06.06	LATITUDE	48.8649	LONGITUDE	-87.5236
					CHECKED BY	AM/DG	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER	WATER CONTENT (%)
300.4 0.0	Bedrock BEDROCK - weathered angular bedrock pieces noted overlying apparent solid bedrock											GR SA SI CL	

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-08

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266387E 5412524N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8499 LONGITUDE -87.5234 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									
292.4	Rootmat																
0.0 292.3	Rootmat - brown, wet, trace sand		S1	AUGER													
0.1	Silty SAND with Gravel (FILL) - compact, dark brown, moist to wet, occasional cobbles, some organics		S2	AUGER													17 65 (19)
292.1																	
0.4 292.0	Poorly Graded GRAVEL with Silt and Sand (FILL) - compact, dark brown, moist to wet, some organics, roots	S3	AUGER				292										55 34 (11)
0.5	End of Borehole - refusal																
	- no groundwater encountered																

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19






Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-09

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266385E 5412477N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8495 LONGITUDE -87.5235 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									WATER CONTENT (%)			GR
282.9	Rootmat																			
0.0 282.8	Rootmat - brown, wet, some gravel, some sand		S1	AUGER												122.3				
0.1 282.6	Well Graded SAND with Silt (FILL) - loose to compact, wet, brown, some organics		S2	AUGER														2	86 (11)	
0.3 282.4	PEAT - soft, dark brown to black, wet		S3	AUGER												136.2				
0.5 282.2	Peaty SILT - compact, dark brown, some gravel, some sand, some cobbles		S4	AUGER																
0.7	End of Borehole - refusal																			
	- no groundwater encountered																			

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

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-10

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266381E 5412436N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8491 LONGITUDE -87.5235 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									
279.0 0.0	Peat PEAT - soft, dark brown, wet							20	40	60	80	100				143.9 g/cm³	
278.7 0.4	End of Borehole - refusal 																

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-11

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266371E 5412369N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8485 LONGITUDE -87.5236 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										WATER CONTENT (%)	
279.8	Rootmat		S1	AUGER			279												
279.9	Rootmat - dark brown to black, wet		S2	AUGER															
0.1	Poorly Graded SAND with Silt (FILL) - compact, rusty brown, moist to wet, occasional cobbles in upper 0.4 m		S3	AUGER															
278.8																			
1.0	End of Borehole - refusal																		

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-12

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266367E 5412335N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8482 LONGITUDE -87.5237 CHECKED BY AM/DG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			SHEAR STRENGTH kPa					W _p	W	W _L		
282.8	Peat						20	40	60	80	100					
0.0	PEAT - soft, dark brown, wet		S1	AUGER											281.1	
282.6	End of Borehole - refusal															
0.3	- no groundwater encountered															

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19


Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-13

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266361E 5412301N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.06 - 2019.06.06 LATITUDE 48.8479 LONGITUDE -87.5238 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL P. PENETROMETER										WATER CONTENT (%)
285.2	Rootmat		S1	AUGER														
285.0 0.1	Rootmat - dark brown, wet Silty GRAVEL with Sand (FILL) - loose to compact, dark brown, wet, some organics		S2	AUGER														45 38 (18)
285.0 0.3	End of Borehole - refusal																	
	- no groundwater encountered																	

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

METRIC

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





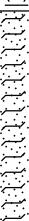
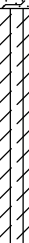
Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-15

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266615E 5411647N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8422 LONGITUDE -87.5204 CHECKED BY AM/DG

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 X P. PENETROMETER															
238.8	Rootmat							20	40	60	80	100											
0.0	Rootmat - dark brown to black, wet, some sand		S1	AUGER													122.5						
238.7																							
0.1	PEAT - soft, dark brown, wet, trace to some sand		S2	AUGER													246.7						
																							
			S3	AUGER													238.3						
238.2																							
0.7	Sandy PEAT - soft, dark brown, wet		S4	AUGER			238								○								
237.4																							
1.4	Sandy Clayey SILT - firm, light grey, wet		S5	AUGER			237								○				2	27	55	16	
236.6																							
2.3	End of Borehole - refusal																						

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-MAH-16

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266633E 5411618N ORIGINATED BY EF
 DIST HWY 17 BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8417 LONGITUDE -87.52 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									
238.9 0.0	Peat PEAT - soft, dark brown to black, wet		S1	AUGER											248.1		
238.4 0.5	End of Borehole - refusal - groundwater / surface water encountered about 0.15 m above ground surface																

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-01

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266299E 5414234N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8652 LONGITUDE -87.5247 CHECKED BY AM/DG

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 (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED + FIELD VANE	○ QUICK TRIAXIAL	× P. PENETROMETER										
311.2 0.0	Rootmat Rootmat - brown, wet		S1	AUGER											250.7					
311.0 0.2	End of Borehole - refusal - no groundwater encountered																			

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

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

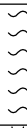
Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-02

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266333E 5414174N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8646 LONGITUDE -87.5244 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIALX P. PENETROMETER							
310.2 0.0	Rootmat Rootmat - brown, wet		S1	AUGER		310								214.9	
309.8 308.8 0.4	PEAT - soft, dark brown to black, wet, trace sand, trace silt End of Borehole - refusal 														

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

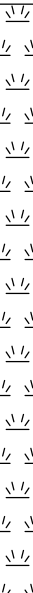










Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-03

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266364E 5414114N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8641 LONGITUDE -87.5239 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER										WATER CONTENT (%)				GR	SA	SI
309.9 0.0	Peat PEAT - soft, dark brown, wet		S1	AUGER			309																	
																								
																								
			S2	AUGER			309																	
																								
																								
			S3	AUGER			308																	
																								
																								
307.9 2.0	End of Borehole - refusal																							

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19



Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-04

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266397E 5414053N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8636 LONGITUDE -87.5234 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
								○ UNCONFINED + FIELD VANE					WATER CONTENT (%)				
								● QUICK TRIAXIAL P. PENETROMETER									
310.2	Rootmat / Peat							20	40	60	80	100					
0.0	Rootmat / Peat - dark brown to black, wet		S1	AUGER			310										
309.9																	
0.2	End of Borehole - refusal																
	- no groundwater encountered																

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266430E 5413993N	ORIGINATED BY	EF			
DIST		HWY		BOREHOLE TYPE	Manual Hand Auger	COMPILED BY	KK		
DATUM	Geodetic	DATE	2019.06.07 - 2019.06.07	LATITUDE	48.863	LONGITUDE	-87.523	CHECKED BY	AMDG

[illegible]

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19




Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-06

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266233E 5414199N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8648 LONGITUDE -87.5257 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									
313.8	Peat							20	40	60	80	100					
0.0	Peat - brown, wet, fibrous		S1	AUGER												173.7	
313.5	Silty SAND - compact, rusty brown, moist to wet, occasional cobbles and boulders		S2	AUGER													6 58 (36)
313.2			S3	AUGER													9 68 (24)
0.7	End of Borehole - refusal																

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266265E 5414138N	ORIGINATED BY	EF			
DIST	_____	HWY	_____	BOREHOLE TYPE	Manual Hand Auger	COMPILED BY	KK		
DATUM	Geodetic	DATE	2019.06.07 - 2019.06.07	LATITUDE	48.8642	LONGITUDE	-87.5253	CHECKED BY	AM/DG

[illegible]

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266298E 5414078N	ORIGINATED BY	EF			
DIST		HWY		BOREHOLE TYPE	Manual Hand Auger	COMPILED BY	KK		
DATUM	Geodetic	DATE	2019.06.07 - 2019.06.07	LATITUDE	48.8638	LONGITUDE	-87.5248	CHECKED BY	AM/DG

[illegible]

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266331E 5414018N	ORIGINATED BY	EF			
DIST	_____	HWY	_____	BOREHOLE TYPE	Manual Hand Auger	COMPILED BY	KK		
DATUM	Geodetic	DATE	2019.06.07 - 2019.06.07	LATITUDE	48.8633	LONGITUDE	-87.5244	CHECKED BY	AM/DG

[illegible]

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

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

Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-10

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266362E 5413956N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8628 LONGITUDE -87.5239 CHECKED BY AM/DG

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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									
314.6	Rootmat																
314.0	Rootmat - soft, brown, wet		S1	AUGER													
314.5	SILT - compact, grey, moist to wet, trace gravel, some sand		S2	AUGER													
0.1	Silty SAND - compact, light brown to brown, moist to wet, occasional cobbles		S3	AUGER													
314.0																	
0.6	End of Borehole - refusal																
	- no groundwater encountered																

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

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

Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-11

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266168E 5414163N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8646 LONGITUDE -87.5265 CHECKED BY AM/DG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			SHEAR STRENGTH kPa					W _p	W	W _L		
309.8	Rootmat						20	40	60	80	100					
0.0	Rootmat - brown, wet		S1	AUGER											145.8	
309.6																
0.2	Silty GRAVEL with Sand - compact, brown to grey, wet, some cobbles		S2	AUGER												
309.5																
0.4	End of Borehole - refusal															
	- bedrock outcrop observed about 4 m northwest of test hole															
	- no groundwater encountered															

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19

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

Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-12

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266196E 5414108N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8641 LONGITUDE -87.5261 CHECKED BY AM/DG

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	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER									
308.3	Rootmat							20	40	60	80	100					
308.0	Rootmat - brown, wet	✓	S1	AUGER													
0.1	End of Borehole - refusal																
	- bedrock outcrop observed about 2.5 m north of test hole																
	- no groundwater encountered																

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO GDT 8/27/19













Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-13

1 OF 1

METRIC

W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266227E 5414046N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8636 LONGITUDE -87.5258 CHECKED BY AM/DG

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
								20	40	60	80	100					20	40	60				
307.1	Peat																						
0.0	PEAT - soft, dark brown to black, wet, charcoal bits in upper 0.4 m, very strong sulphur odours		S1	AUGER		307																	
																							
																							
																							
																							
				S2		AUGER																	
																							
																							
																							
																							
305.9						306																	
1.2	End of Borehole - refusal																						

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266262E 5413981N	ORIGINATED BY	EF
DIST		HWY		BOREHOLE TYPE Manual Hand Auger	COMPILED BY	KK
DATUM	Geodetic	DATE	2019.06.07 - 2019.06.07	LATITUDE 48.8629	LONGITUDE -87.5253	CHECKED BY AM/DG

[illegible]

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

1 OF 1

METRIC

W.P.	GWP No. 6120-15-00	LOCATION	Hwy 17 Between Pays Plat FN and Rossport	MTM ON-14 266294E 5413920N	ORIGINATED BY	EF			
DIST	HWY	BOREHOLE TYPE	Manual Hand Auger		COMPILED BY	KK			
DATUM	Geodetic	DATE	2019.06.07 - 2019.06.07	LATITUDE	48.8625	LONGITUDE	-87.5248	CHECKED BY	AM/DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	20 40 60 80 100	w _p	w			w _L
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER	WATER CONTENT (%)					
311.4 0.0	Bedrock BEDROCK - outcrop							20 40 60 80 100	20	40	60			

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

ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Brampton, Ontario

RECORD OF BOREHOLE No 19-RS-15A

1 OF 1

METRIC

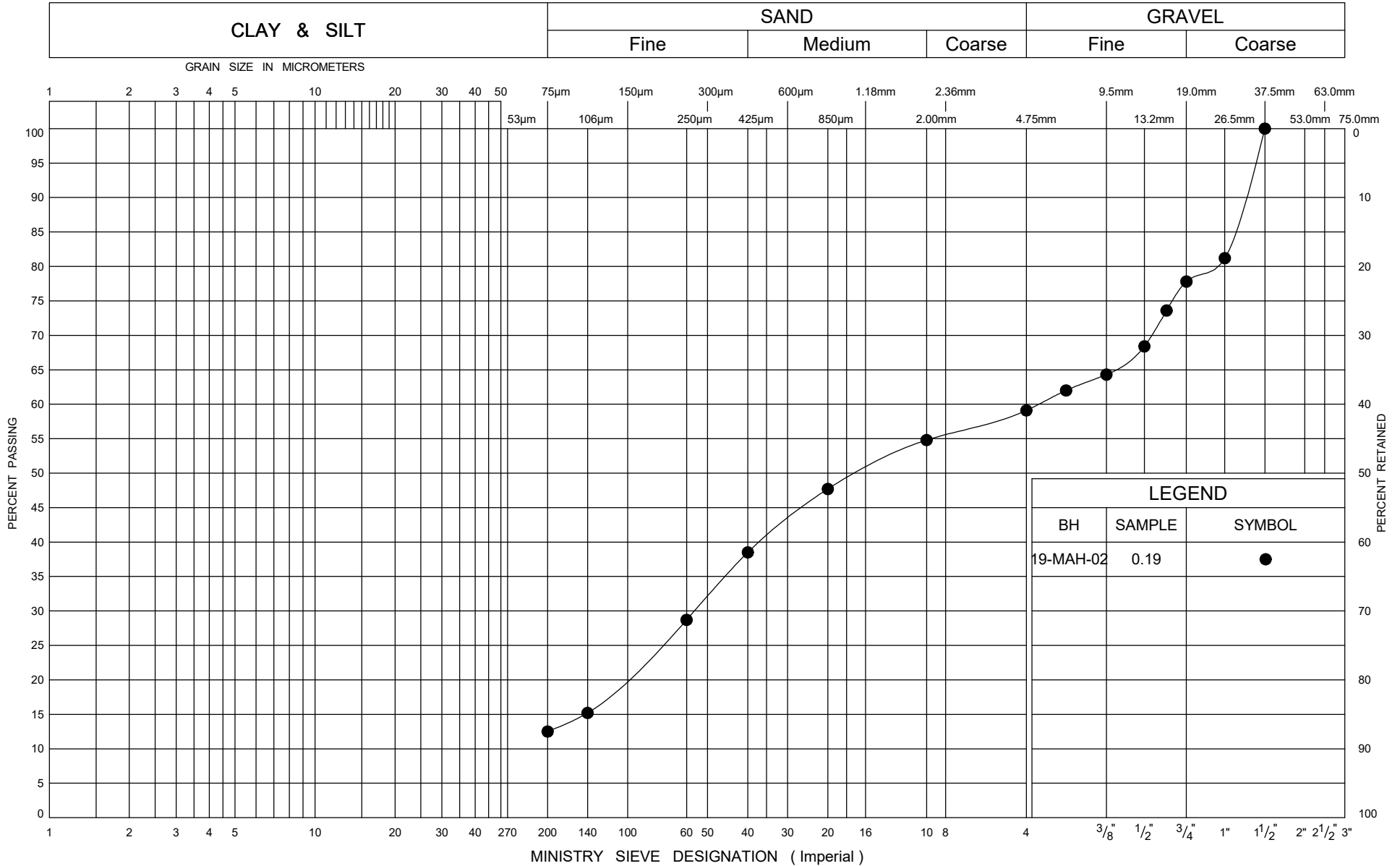
W.P. GWP No. 6120-15-00 LOCATION Hwy 17 Between Pays Plat FN and Rossport MTM ON-14 266298E 5413922N ORIGINATED BY EF
 DIST HWY BOREHOLE TYPE Manual Hand Auger COMPILED BY KK
 DATUM Geodetic DATE 2019.06.07 - 2019.06.07 LATITUDE 48.8625 LONGITUDE -87.5248 CHECKED BY AM/DG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X P. PENETROMETER					W _p W W _L WATER CONTENT (%)				GR	SA	SI	CL
311.4	Peat Moss						311	20	40	60	80	100								
0.0	Peat - soft, dark brown, wet, fibrous																			
310.9																				
0.5	End of Borehole - refusal																			

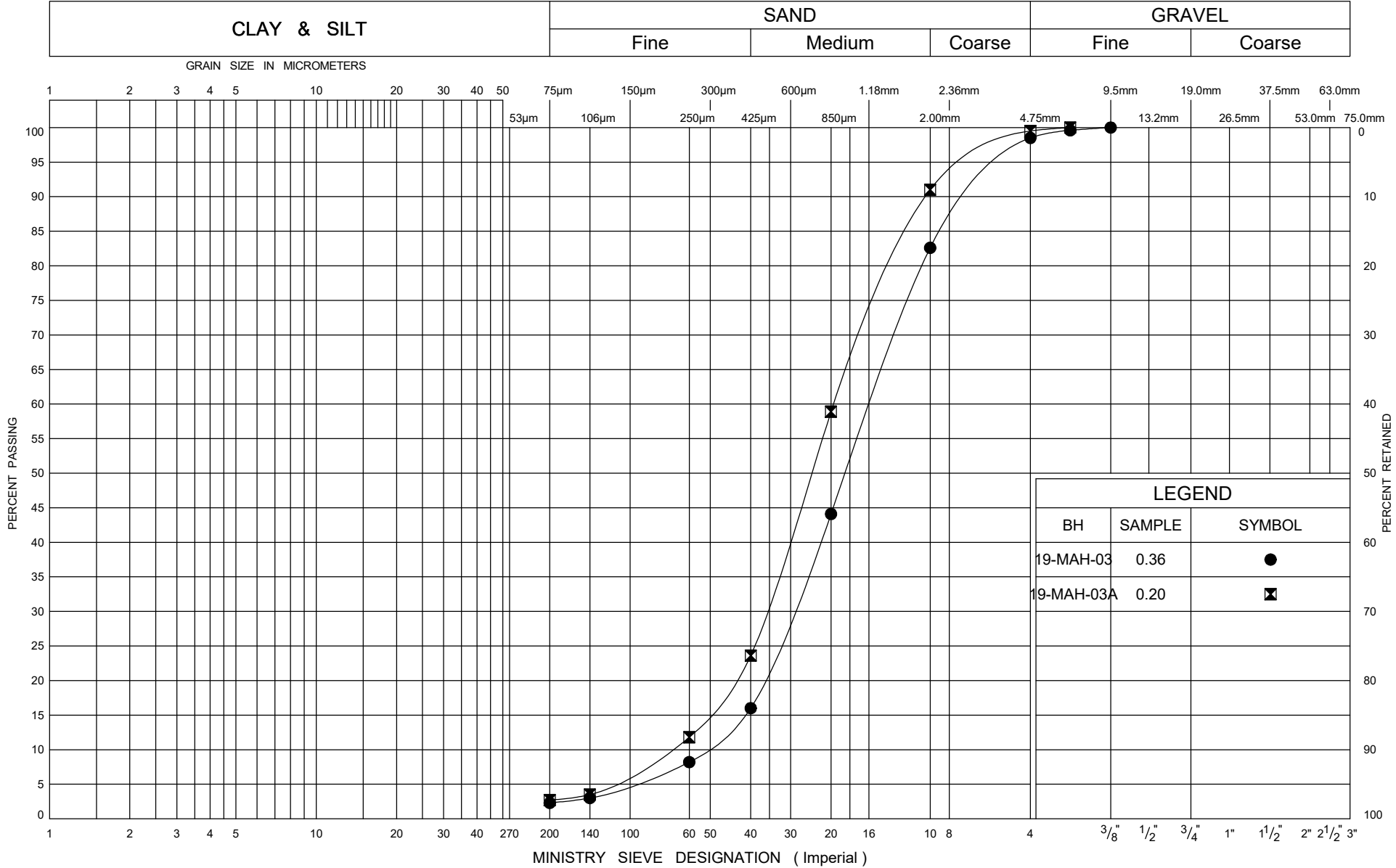
ONTARIO MTO F-18130-BG - ADM-00248798-E0 - MTO 5 - HWY 17 PAYS PLAT TO ROSSPORT.GPJ ONTARIO MTO.GDT 8/27/19

Appendix D – Laboratory Data

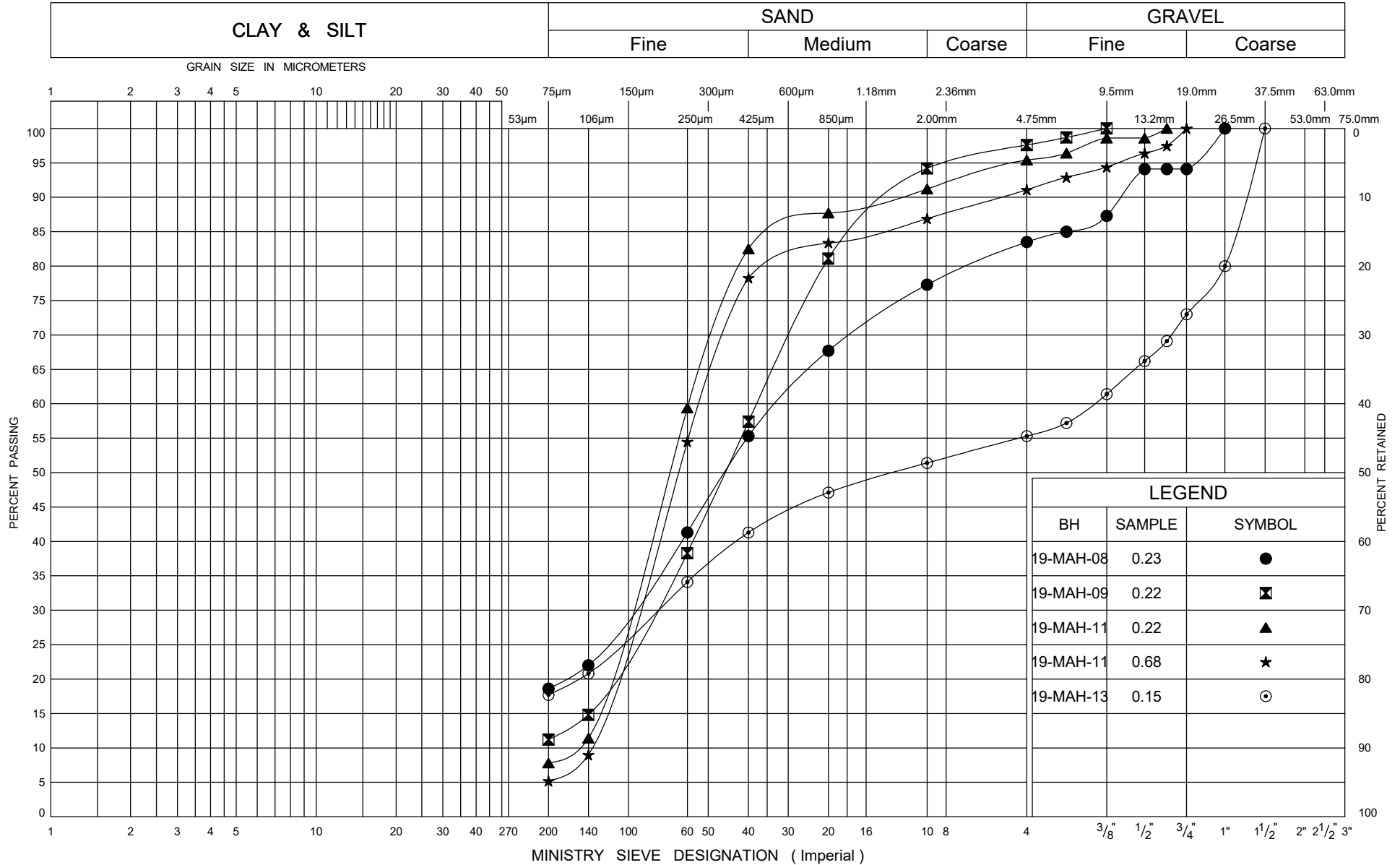
UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

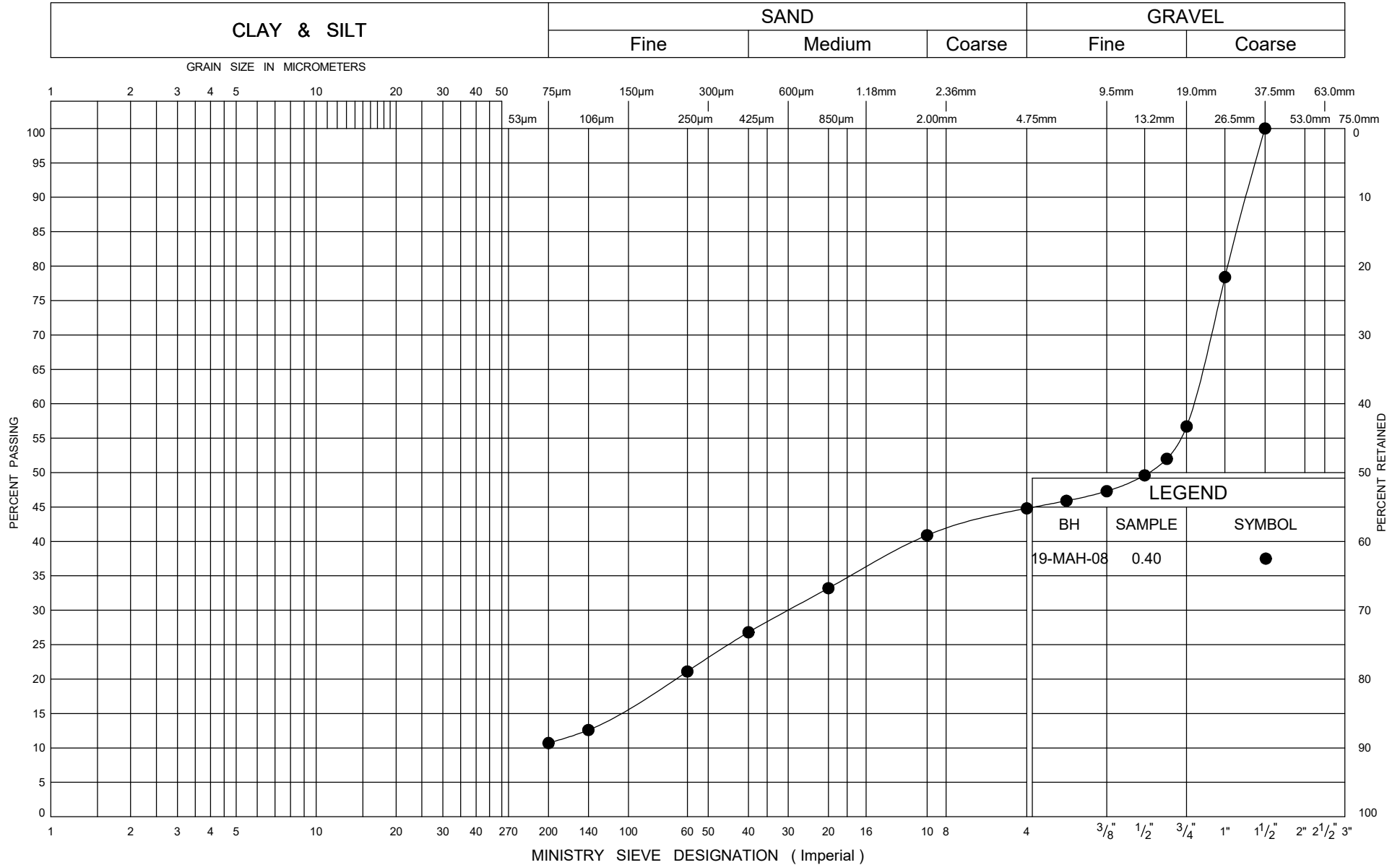
Silty Sand with Gravel/Sand with Silt/Silty Gravel with Sand (Fill)

FIG No 3

W P GWP No. 6120-15-00

6017-E-0066, Assignment 5

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

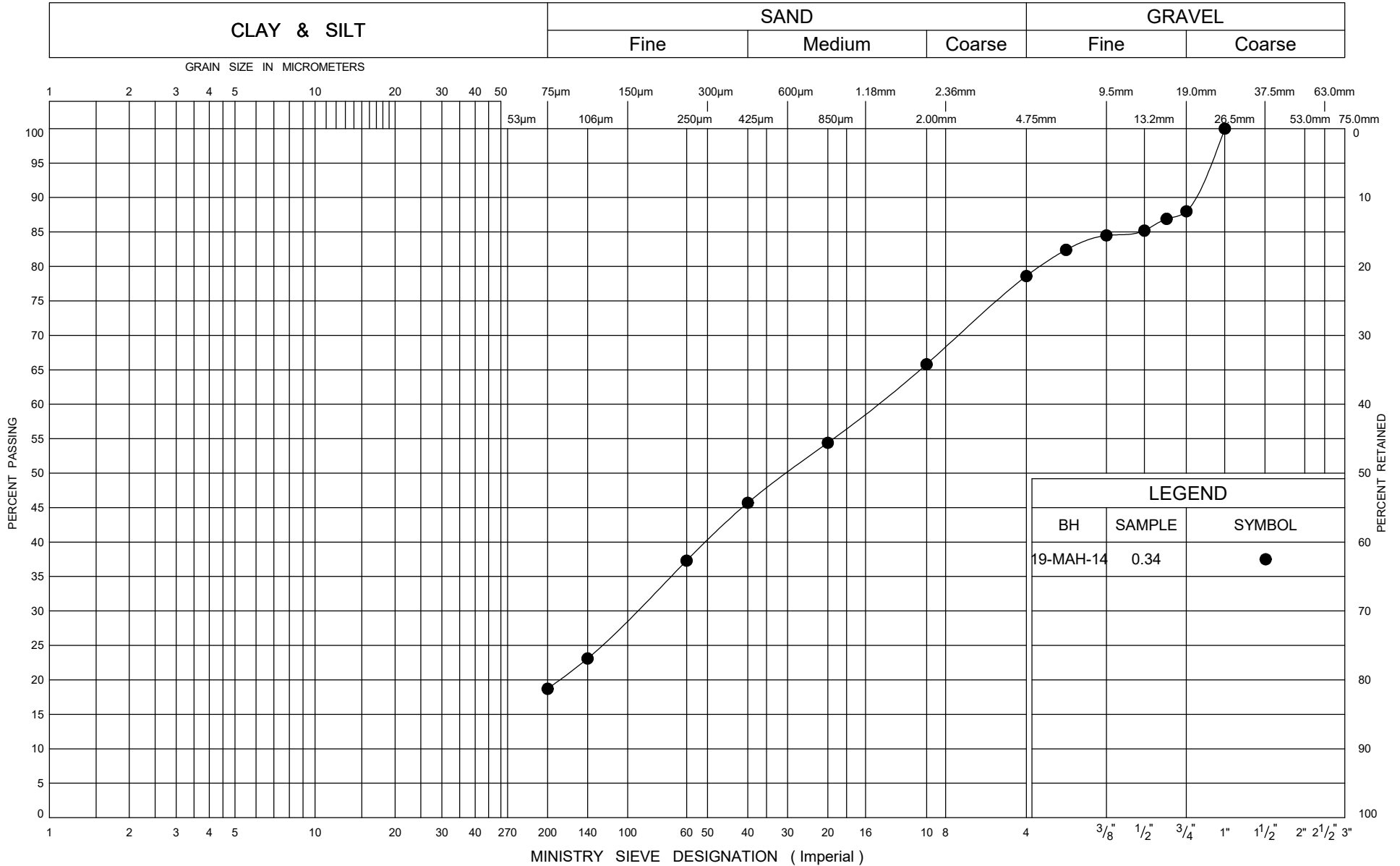
Gravel with Silt and Sand (Fill)

FIG No 4

W P GWP No. 6120-15-00

6017-E-0066, Assignment 5

UNIFIED SOIL CLASSIFICATION SYSTEM



GRAIN SIZE DISTRIBUTION

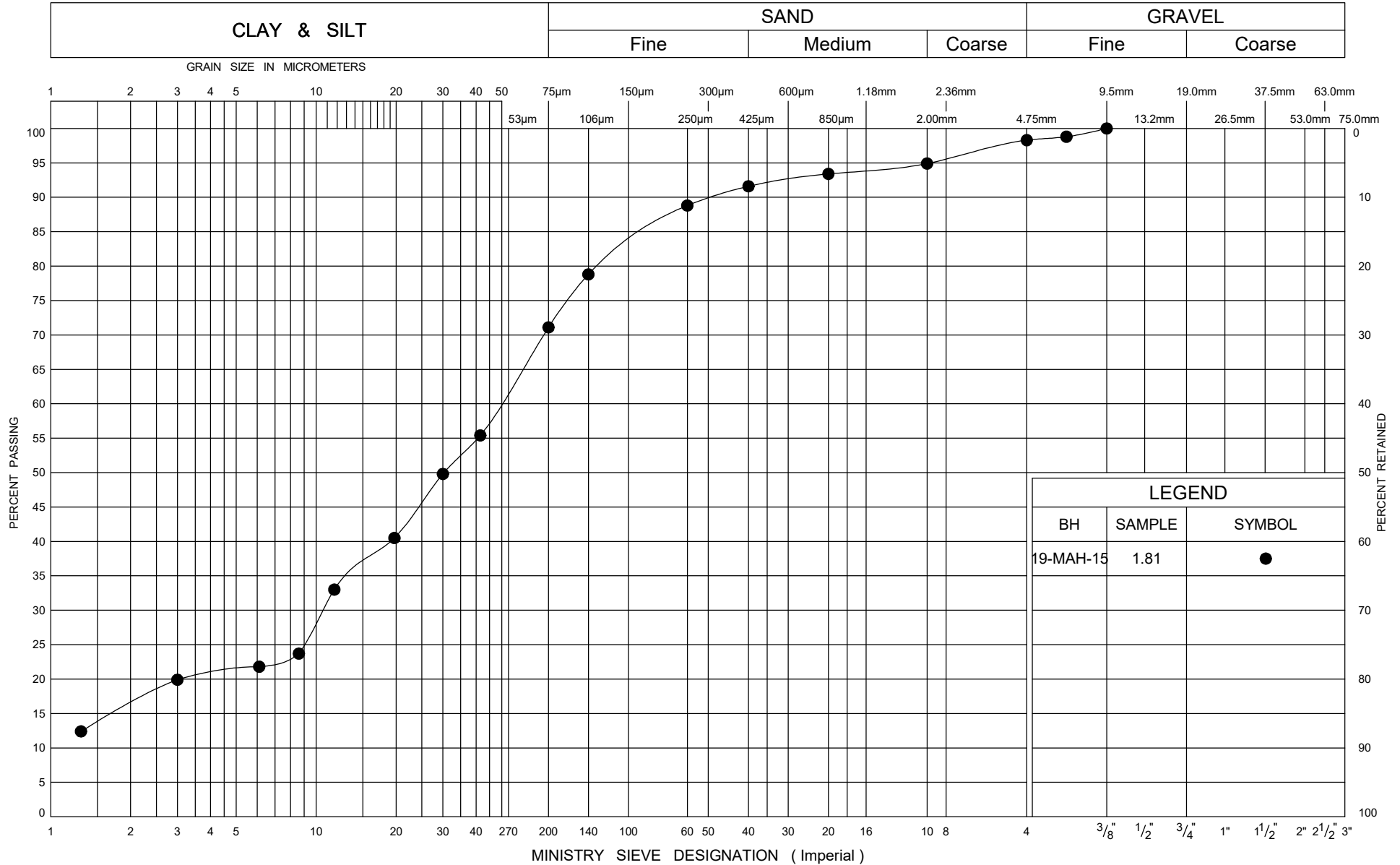
Silty Sand with Gravel (Fill)

FIG No 5

W PGWP No. 6120-15-00

6017-E-0066, Assignment 5

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

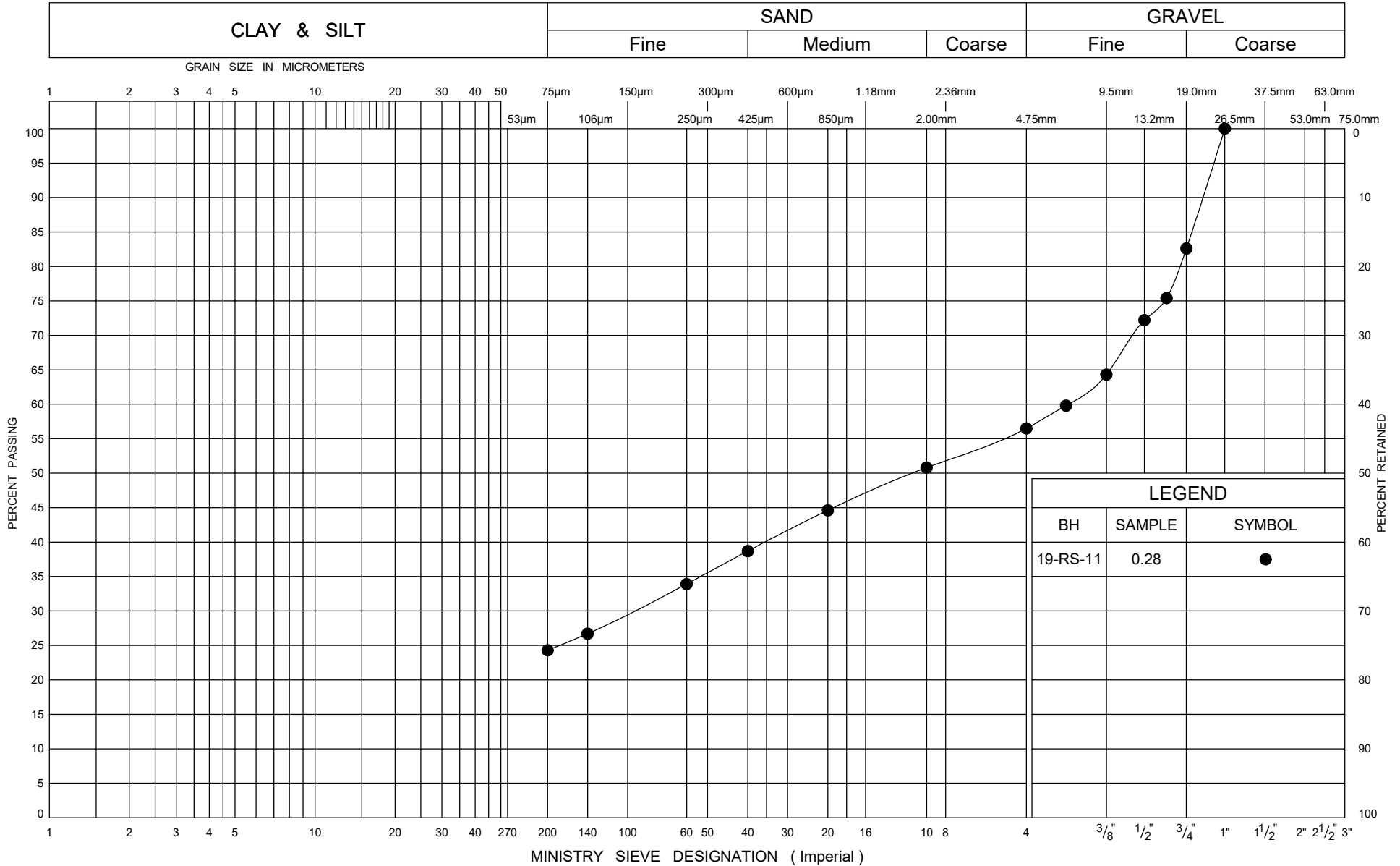
Sandy Clayey Silt

FIG No 6

W P GWP No. 6120-15-00

6017-E-0066, Assignment 5

UNIFIED SOIL CLASSIFICATION SYSTEM



Ministry of
Transportation

GRAIN SIZE DISTRIBUTION

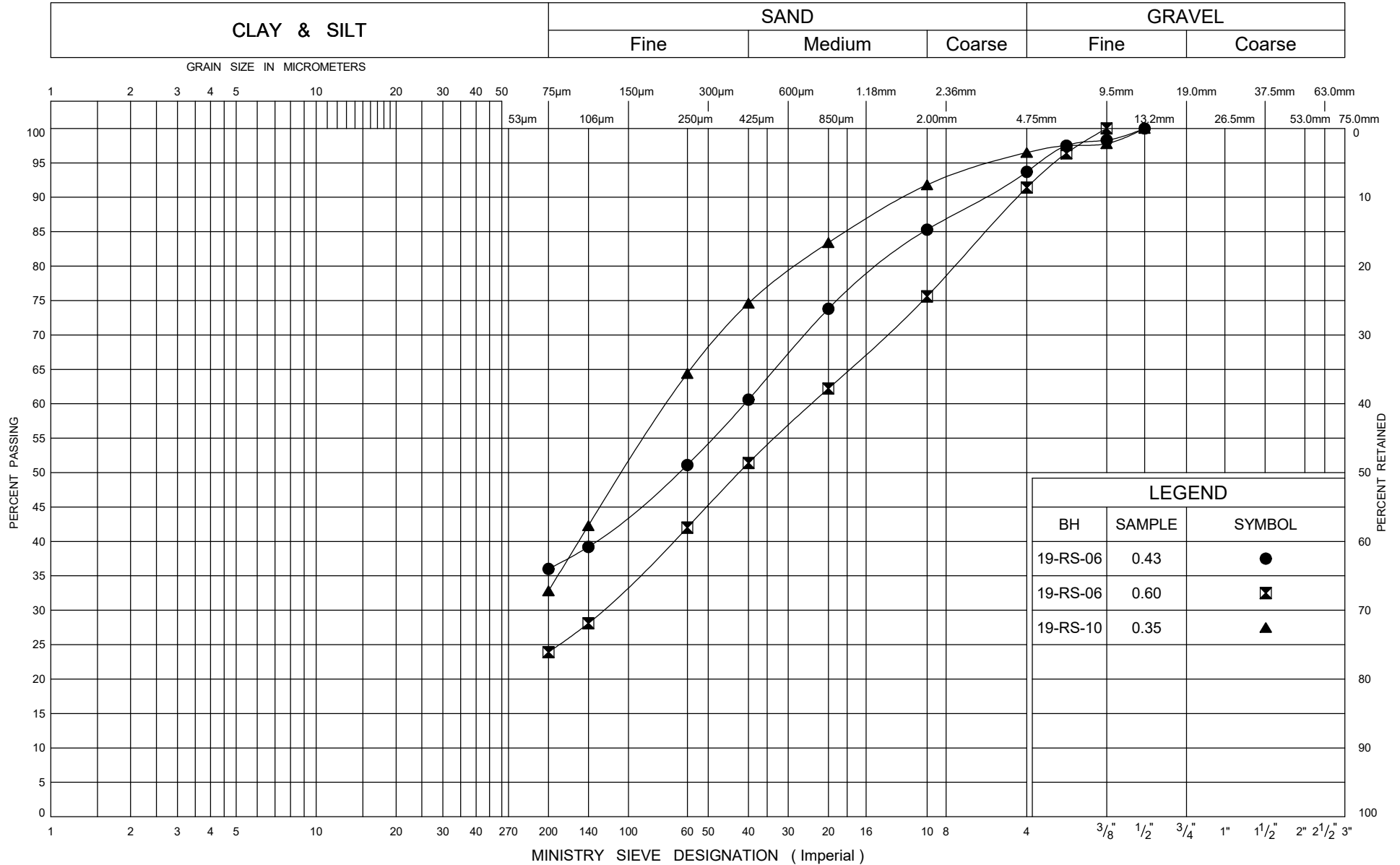
Silty Gravel with Sand

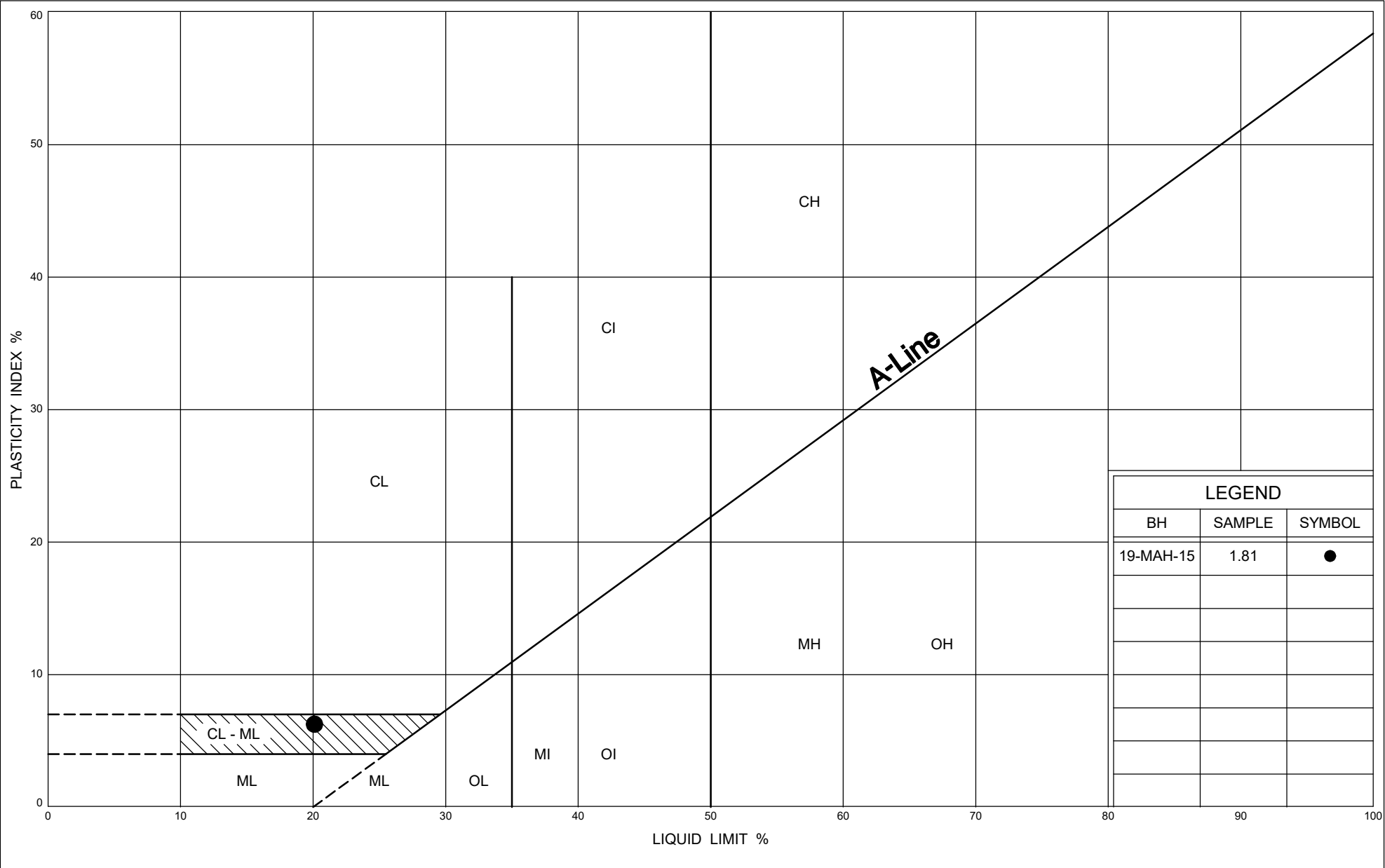
FIG No 7

W P GWP No. 6120-15-00

6017-E-0066, Assignment 5

UNIFIED SOIL CLASSIFICATION SYSTEM





Appendix E – Results of Stability Analyses

SECTIONS A, B, C and D

MTO 6017-E-0066 - Assignment 5
 High Fill Embankment Widening
 Station 17+000 to 17+050 (Section A)
 Drained analysis - Stability

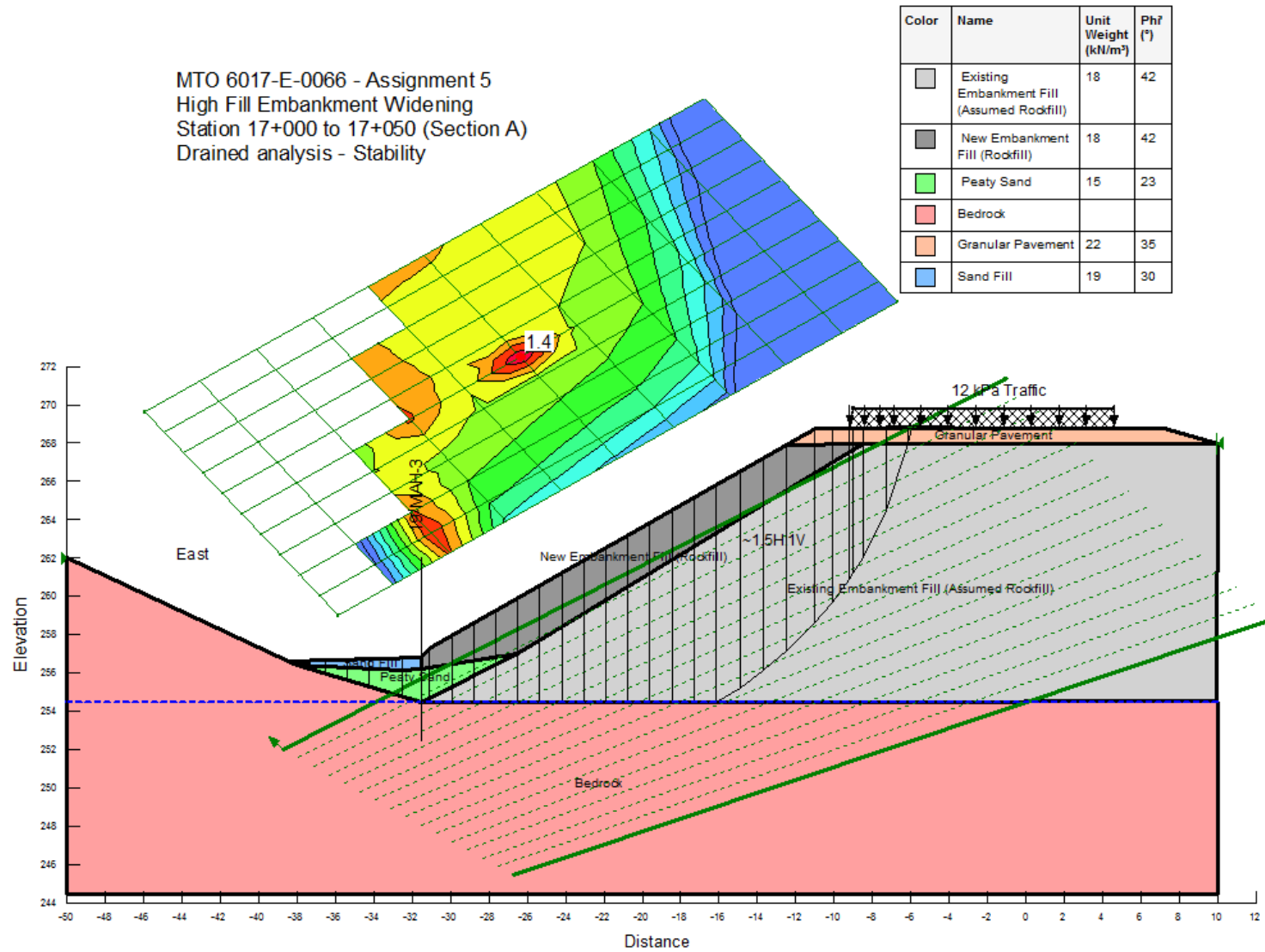


Figure E1. Section A – Results of stability analyses at Sta. 17+050

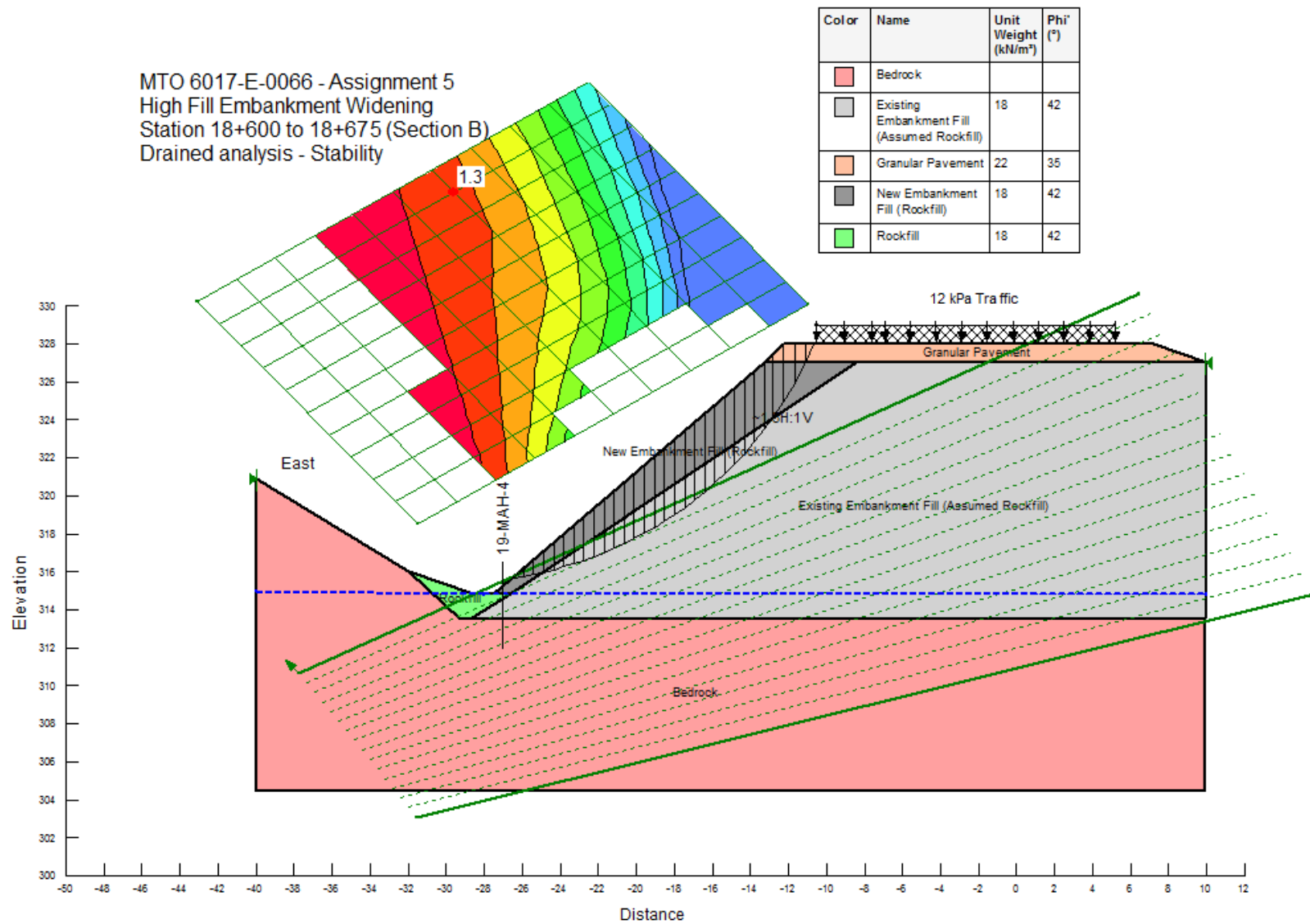


Figure E2. Section B – Results of stability analyses at Sta. 18+600

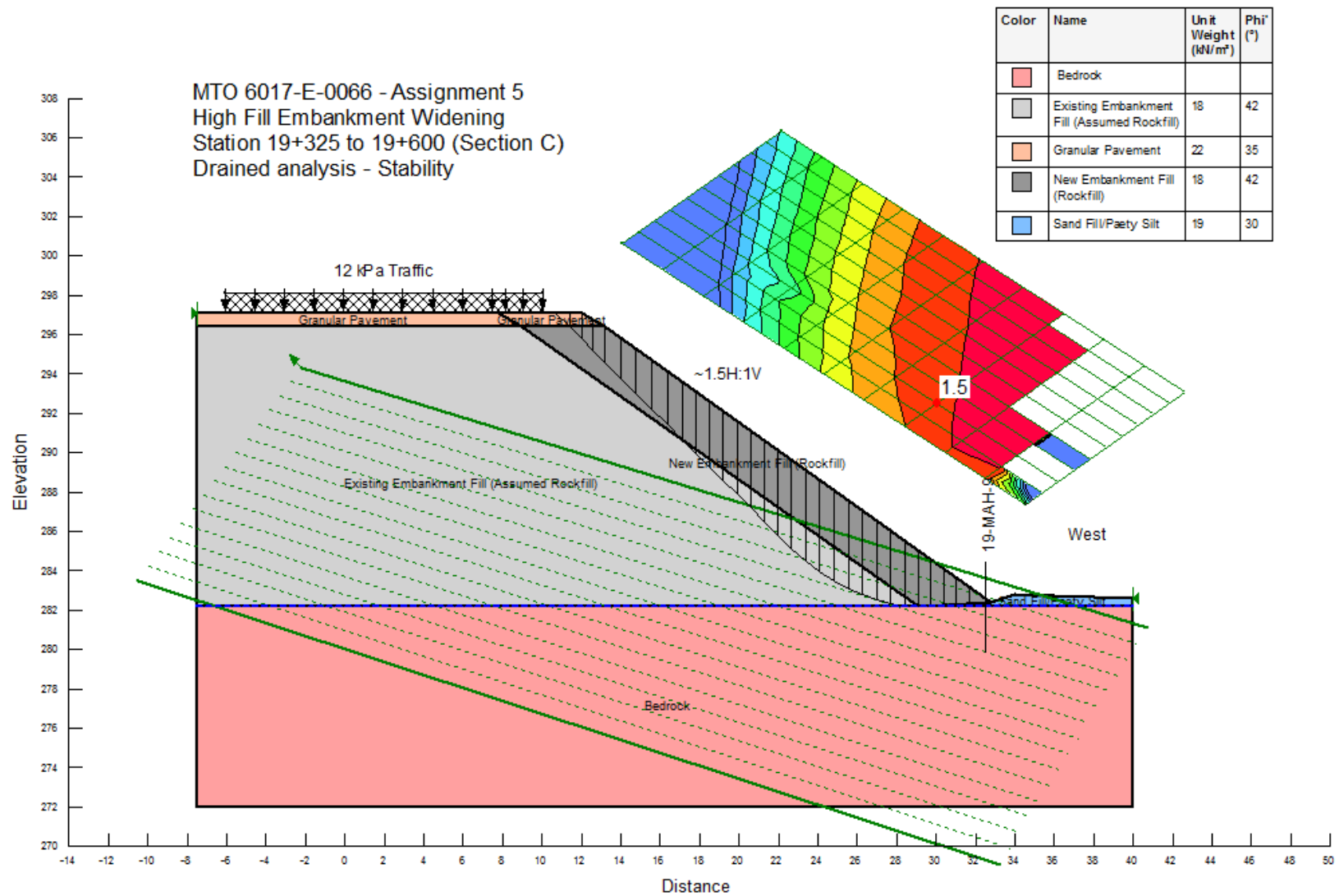








Figure E3. Section C – Results of stability analyses at Sta. 19+450

MTO 6017-E-0066 - Assignment 5
 High Fill Embankment Widening
 Station 20+275 to 20+335 (Section D)
 Drained analysis - Stability

Color	Name	Unit Weight (kN/m ³)	Phi' (°)
	Bedrock		
	Existing Embankment Fill (Assumed Rockfill)	18	42
	Granular Pavement	22	35
	New Embankment Fill (Rockfill)	18	42
	Peat/Sandy Peat	15	23
	Silt	18	28

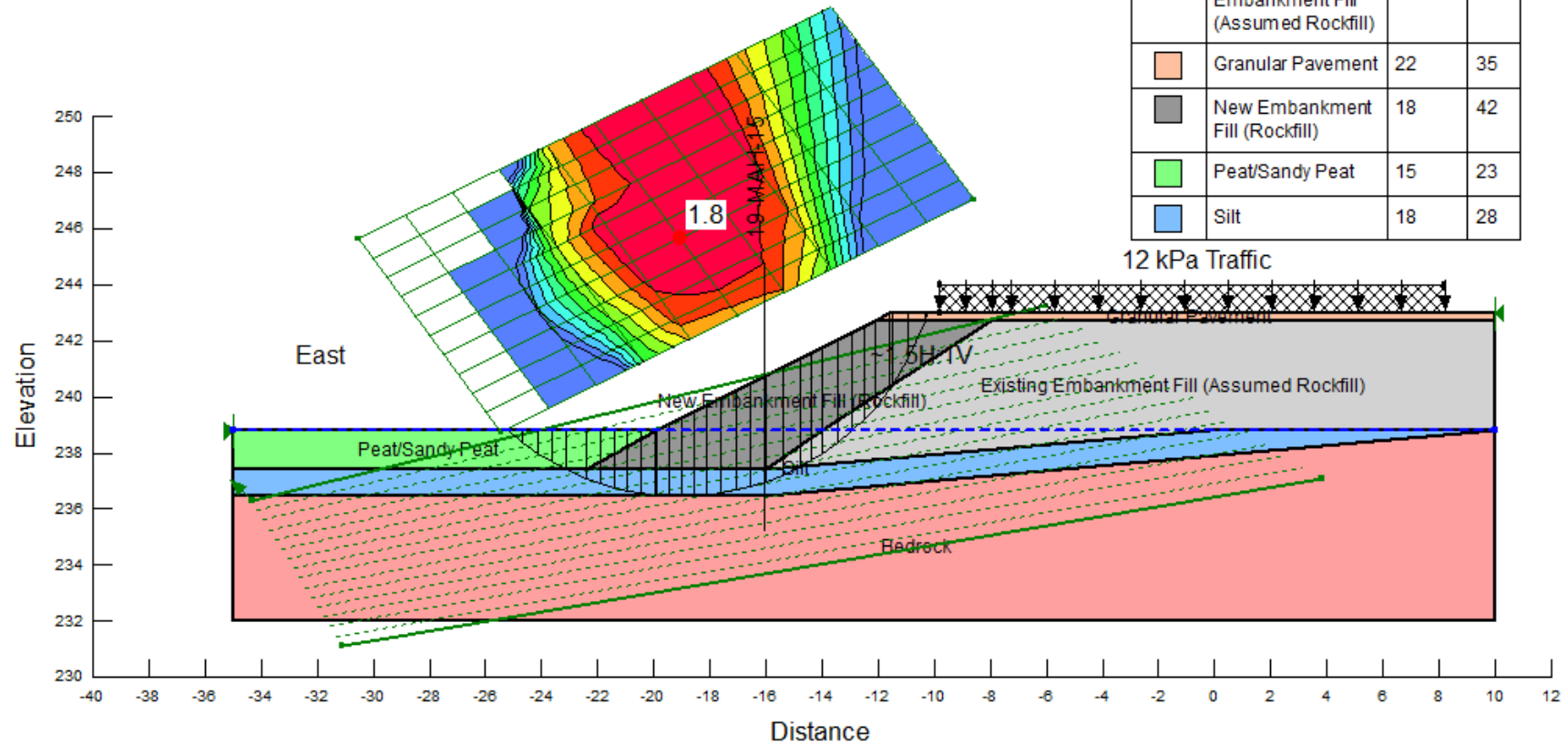


Figure E4. Section D – Results of stability analyses at Sta. 20+300

SECTION E

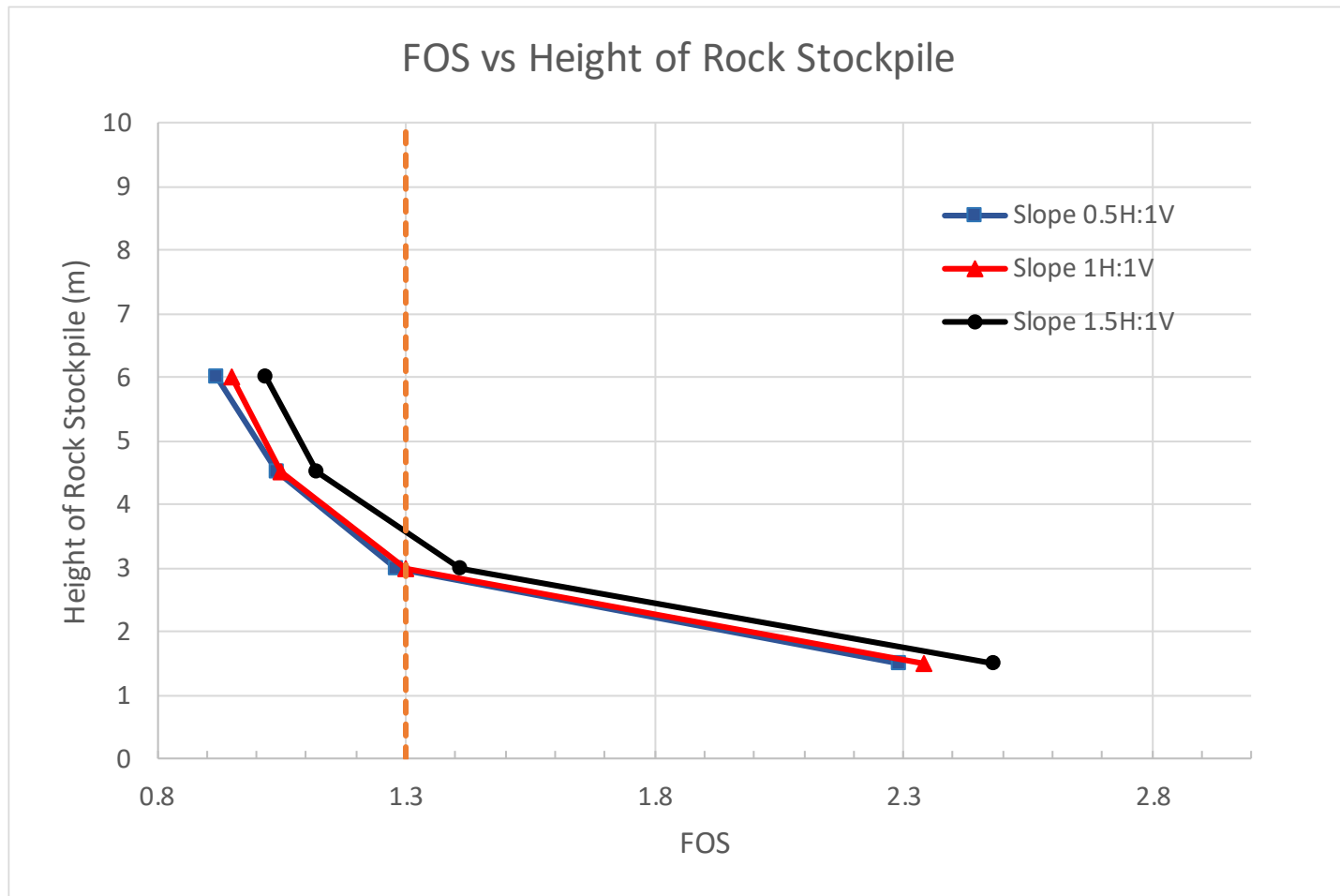


Figure E5. Section E – Factor of Safety versus the height of rock stockpile at the area with soft peat on the ground surface

**Appendix F –
Engineering Recommendations for Flatter Slopes
and Berms to Dispose Surplus Rock (TASK 2)**

SECTION 2- 16+500 to 16+600 (New/ Widened Alignment)

METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

CONT. No. 6017-E-0066
GWP No. 6120-15-00
Assignment No. 5

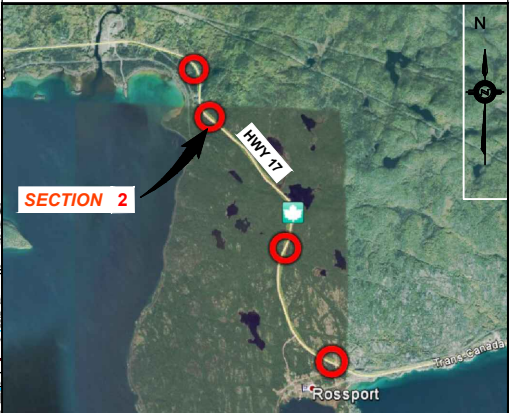
"ENGINEERING RECOMMENDATIONS FOR FLATTER
SLOPES AND BERMS TO DISPOSE SURPLUS ROCK"
(TASK 2)

SHEET
1

exp.

EXP Services Inc.

KEY PLAN



- LEGEND**
- Proposed Borehole Location
 - Proposed Cone Penetration Test CPTu
 - Existing Boreholes
 - Bench Mark Location
 - Standard Penetration Test (Blows/0.3 m)
 - Groundwater level measured in open hole

SOIL STRATA SYMBOLS



BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
BH10	226.93	5414941.14	265460.45
BH11	228.14	5414906.20	265488.82
BH12	233.90	5414892.10	265481.48
BH13	232.97	5414865.64	265528.16

- Notes:**
- * Slope of existing embankment.
 - ** Slope of designed widening.
 - *** Flatten slope to dispose rock surplus.
 - Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m or more high.

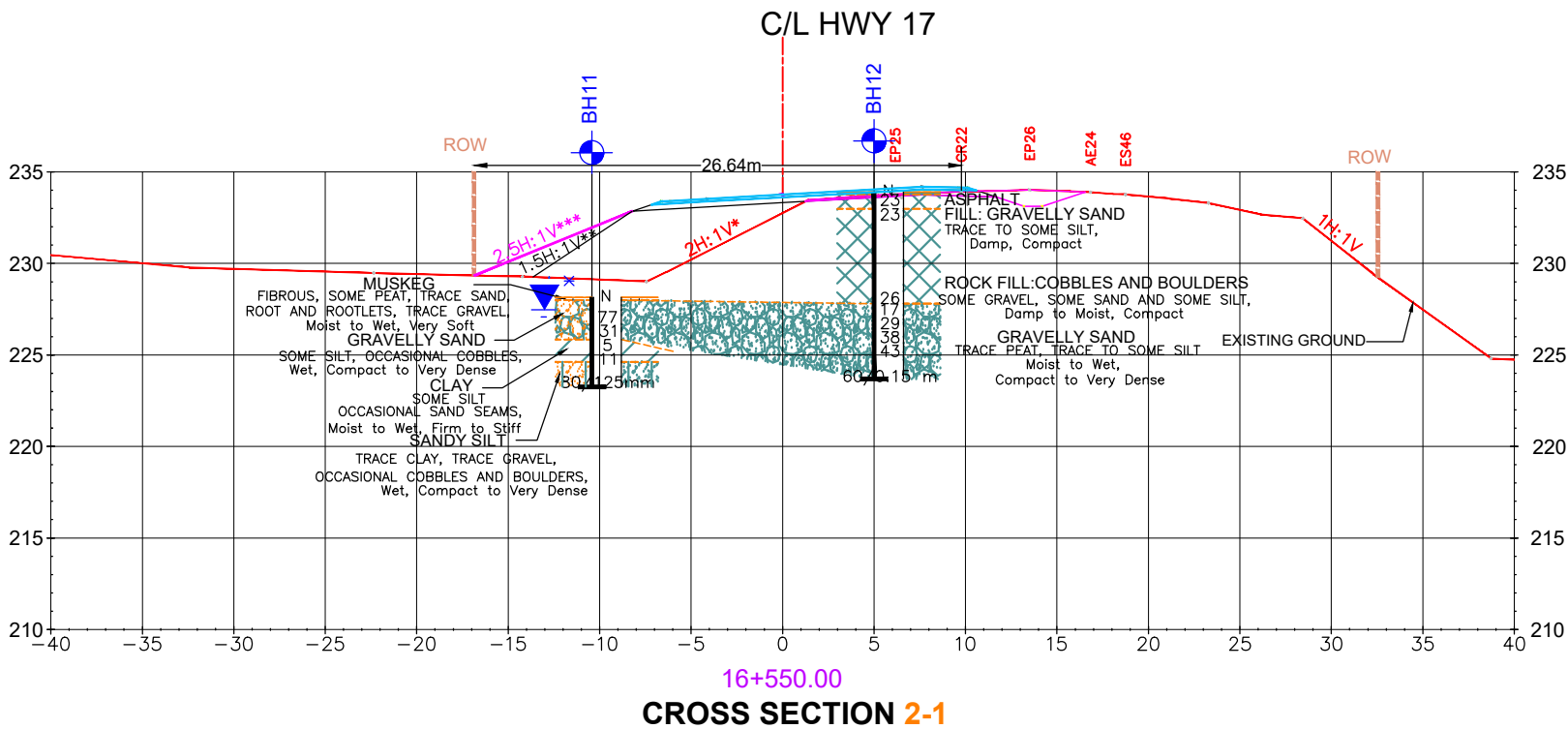
NOTES

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SCALE: HOR 0 10 50 m
VERT 0 5 10

DATE	SM	SUBMISSION FOR MTO REVIEW	
	BY	DESCRIPTION	
		GEOCRES NO. 42D-58	
		PROJECT NO. ADM-00248798-E0	
SUBM'D JH	CHECKED SM	DATE	Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 1-2



SECTION 3- 18+950 to 19+050 (Widening Right for EBTCL)

METRIC

DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE SHOWN.
STATIONS ARE IN KILOMETERS + METERS

CONT. No. 6017-E-0066
GWP No. 6120-15-00
Assignment No. 5

**"ENGINEERING RECOMMENDATIONS FOR FLATTER SLOPES AND BERMS TO DISPOSE SURPLUS ROCK"
(TASK 2)**










EXP Services Inc.














KEY PLAN



LEGEND

-  Proposed Borehole Location
-  Survey Point Location
-  Proposed Cone Penetration Test CPTu
-  Existing Boreholes
-  Bench Mark Location
-  Standard Penetration Test (Blows/0.3 m)
-  Groundwater level measured in open hole

SOIL STRATA SYMBOLS

	ASPHALT		FILL/ ROCK FILL		MUSKEG/ PEAT
	SAND		VARVED CLAY		SILT
	SILTY SAND/ SAND AND SILT/ SANDY SILT		SAND AND GRAVEL		SILTY SAND AND GRAVEL
	SILTY CLAY/ CLAYEY SILT		SILTY SAND (TILL)		
	BEDROCK/ POSSIBLE BEDROCK				

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
BH14	327.42	5412866.44	266529.95
BH15	321.44	5412921.09	266539.71
BH16	323.16	5412839.84	266490.89
BH16A	319.77	5412840.99	266501.76
SP1	320.87	5412881.26	266516.00


Notes:

- * Slope of existing embankment.
- ** Slope of designed widening.
- There is no space for disposal of rock surplus.

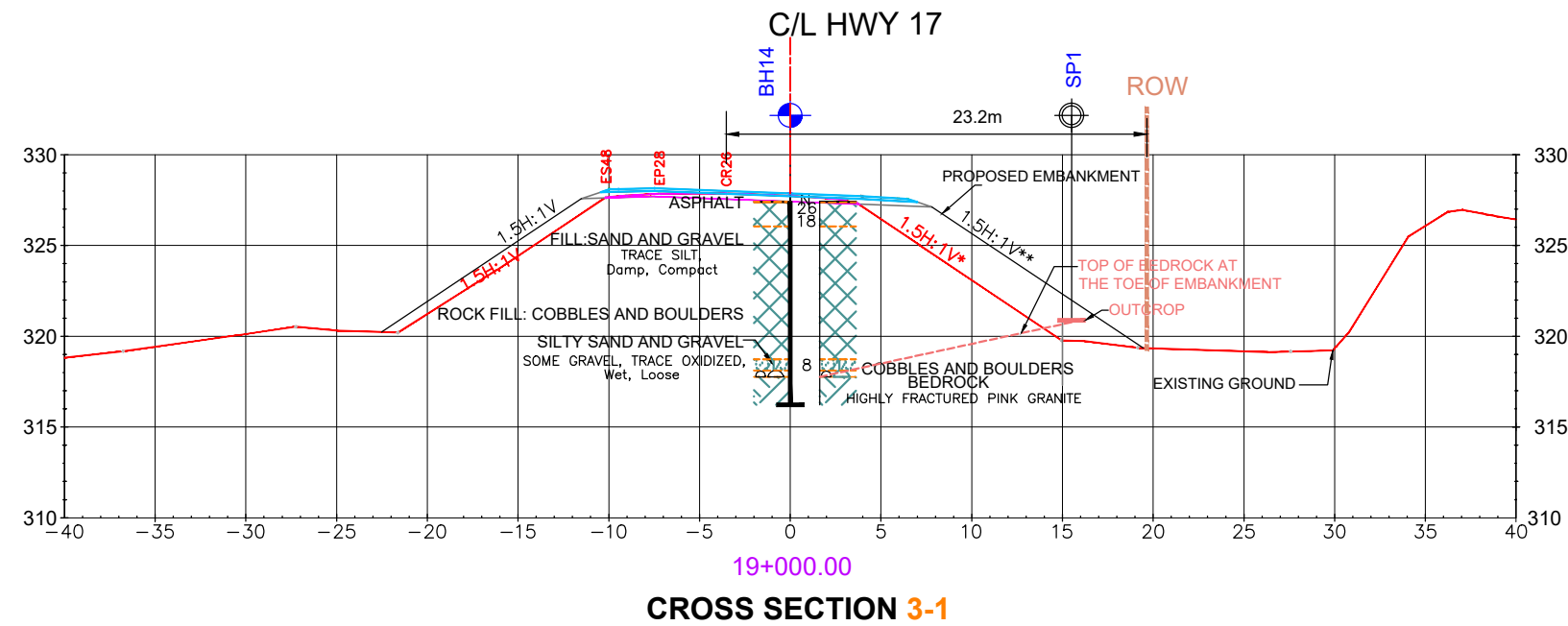
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SCALE: 

	SM	SUBMISSION FOR MTO REVIEW	
DATE	BY	DESCRIPTION	
		GEOCRES NO. 42D-58	
		PROJECT NO. ADM-00248798-E0	
SUBM'D JH	CHECKED SM	DATE	Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 2-2



SECTION 4- 20+965 to 21+225 (Widening Left for WBTCL)

METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

CONT. No. 6017-E-0066
GWP No. 6120-15-00
Assignment No. 5

"ENGINEERING RECOMMENDATIONS FOR FLATTER
SLOPES AND BERMS TO DISPOSE SURPLUS ROCK"
(TASK 2)

SHEET
1



EXP Services Inc.

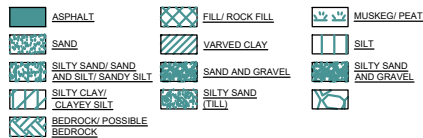
KEY PLAN



LEGEND

- Proposed Borehole Location
- Survey Point Location
- Proposed Cone Penetration Test CPTu
- Existing Boreholes
- Bench Mark Location
- Standard Penetration Test (Blows/0.3 m)
- Groundwater level measured in open hole

SOIL STRATA SYMBOLS



BH No.	ELEV.	MTM CO-ORDINATES	
		NORTHING	EASTING
BH17	207.77	5411256.78	267067.93
BH18	207.57	5411238.57	267101.73
BH19	212.19	5411196.75	267153.48
BH20	205.26	5411210.36	267060.21
BH21	214.79	5411236.36	267070.69
SP2	208.65	5411211.97	267143.51
SP3	207.78	5411185.35	267197.92
SP4	206.13	5411164.24	267244.53
SP5	203.94	5411144.37	267293.22
SP6	209.42	5411207.53	267157.95

Notes:

- * Slope of existing embankment.
- ** Slope of designed widening.
- *** Flatten slope to dispose rock surplus.
- Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m or more high.

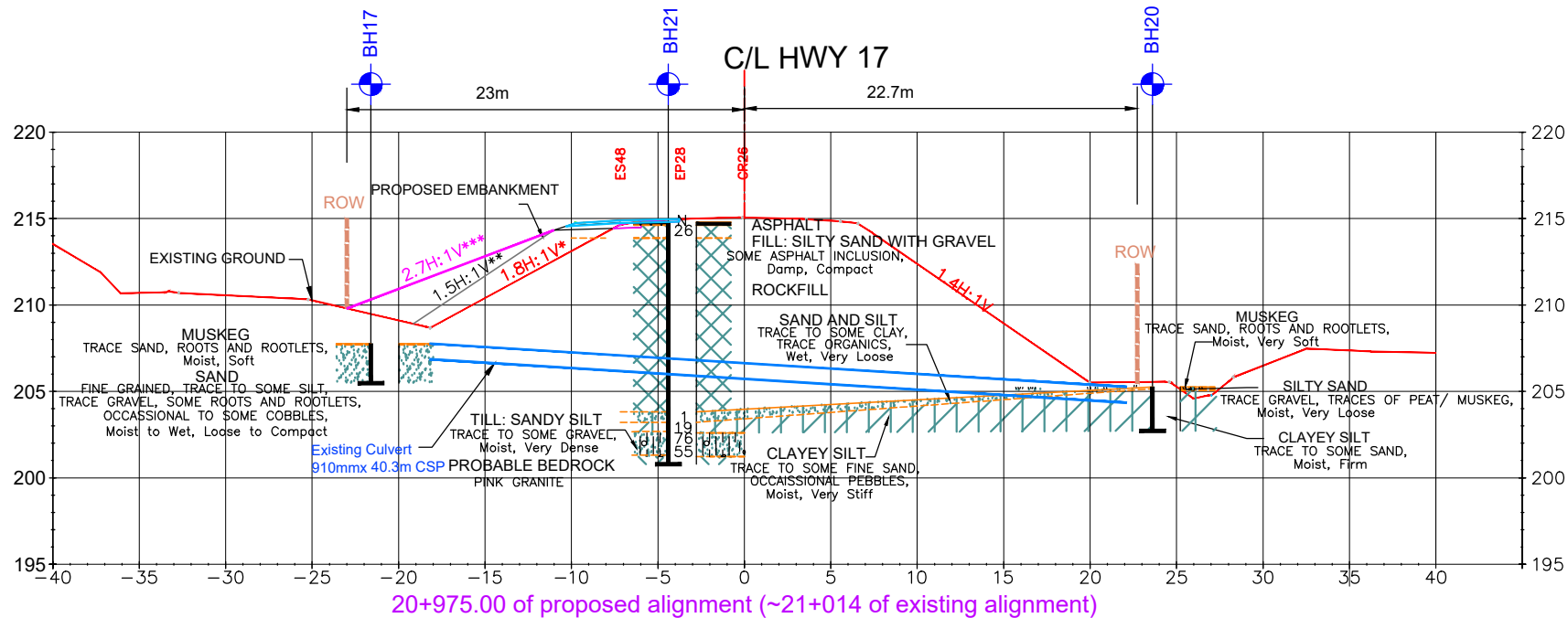
NOTES

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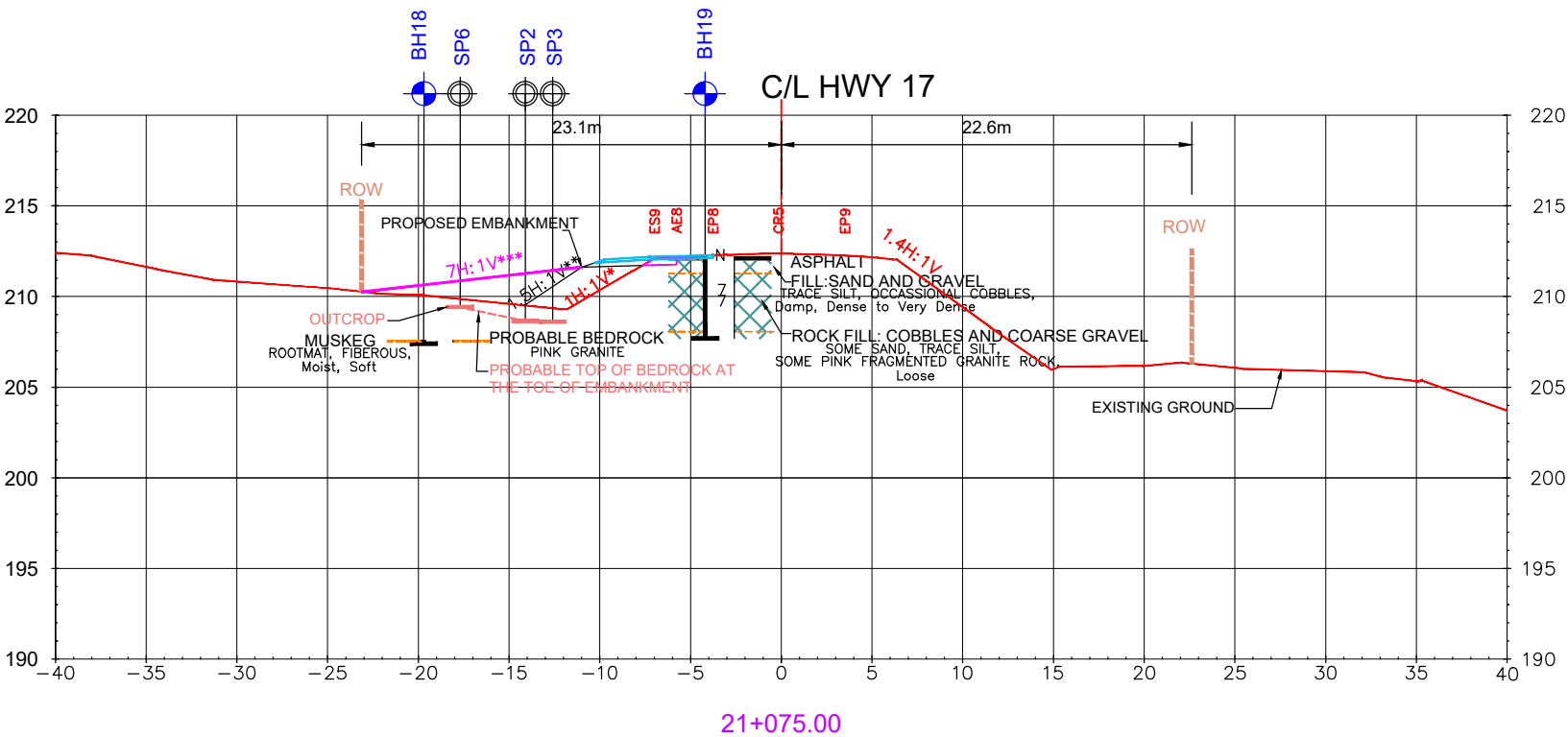
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SCALE: 0 10 m

	SM	SUBMISSION FOR MTO REVIEW	
DATE	BY	DESCRIPTION	
		GEOCRE NO. 42D-58	
		PROJECT NO. ADM-00248798-E0	
SUBM'D SH	CHECKED SM	DATE	Aug. 29, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 3-2

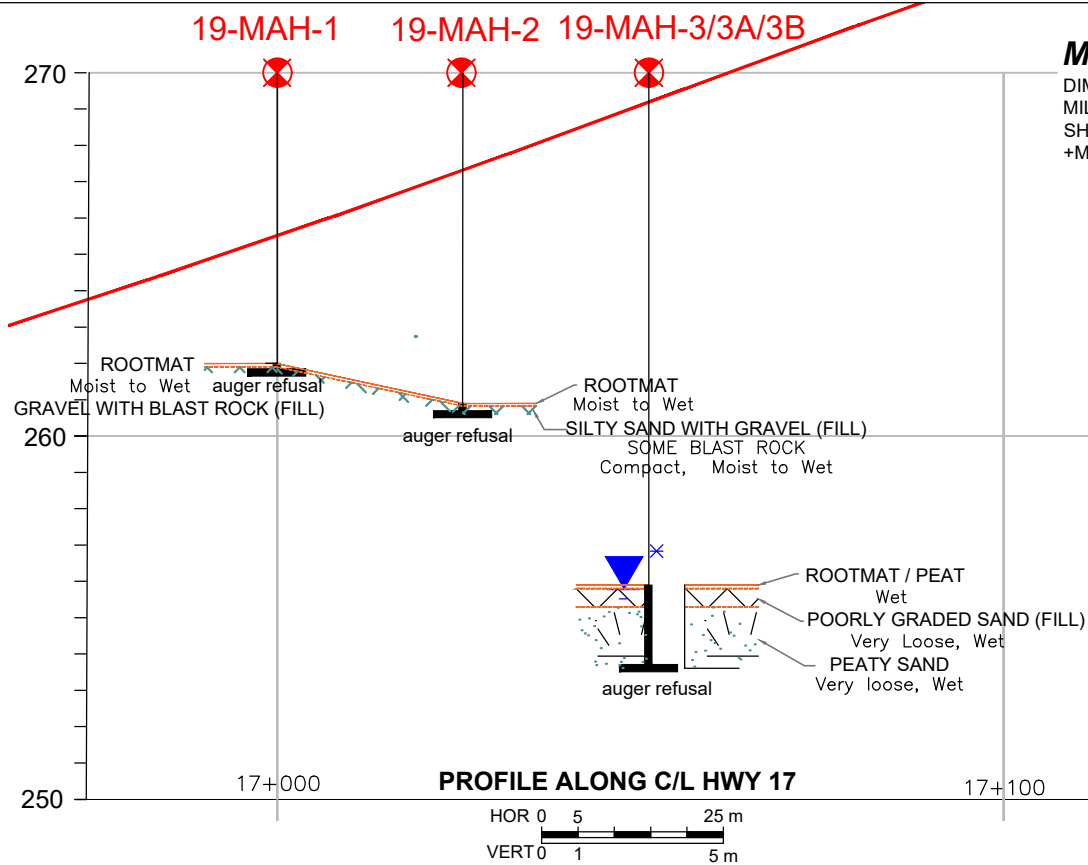
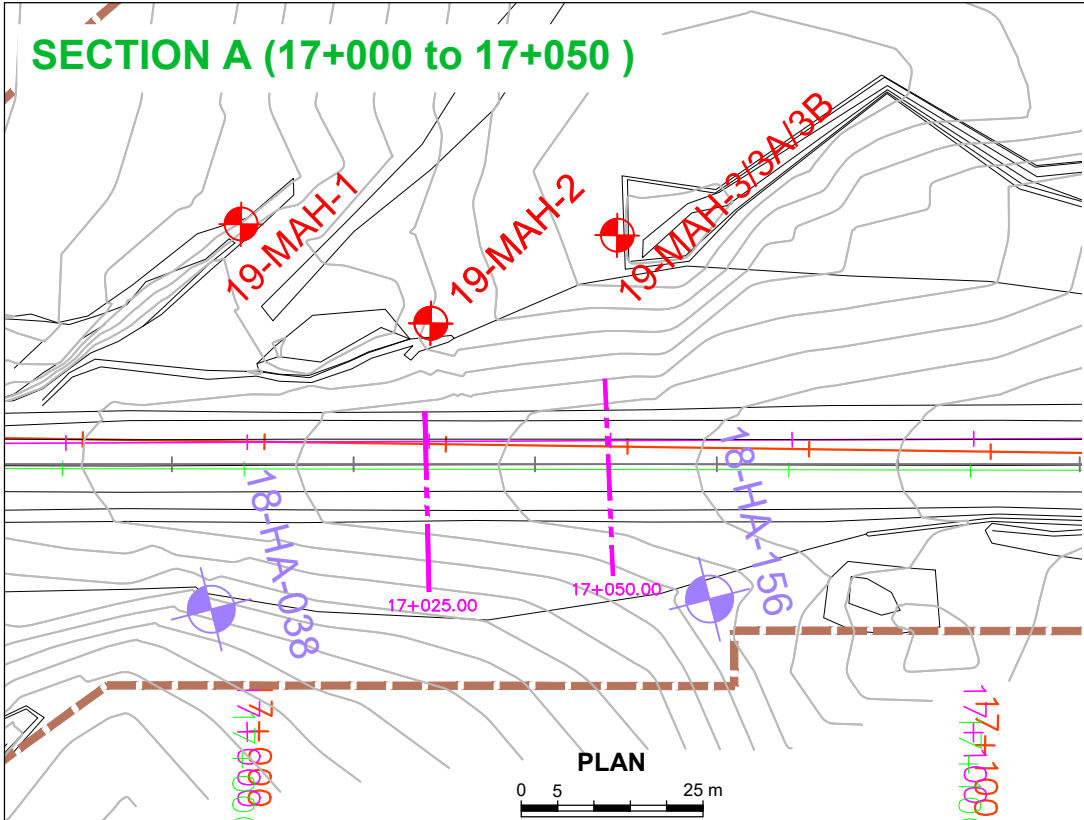


CROSS SECTION 4-1



CROSS SECTION 4-2





METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

Agreement. No. 6017-E-0066
Assignment No. 5
WO # 2018-11011

"ENGINEERING RECOMMENDATIONS FOR FLATTER
SLOPES AND BERMS TO DISPOSE SURPLUS ROCK"
(TASK 2)

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION A

EXP Services Inc.

KEY PLAN

LEGEND

- Borehole Location
- Standard Penetration Test (Blows/0.3 m)
- Groundwater level measured in open hole

SOIL STRATA SYMBOLS

- ROOTMAT/PEAT
- FILL
- PEATY SAND

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-1	262.0	5414599.0	265820.0
19-MAH-2	260.9	5414570.9	265829.1
19-MAH-3/3A	255.9	5414561.7	265855.9

Notes:

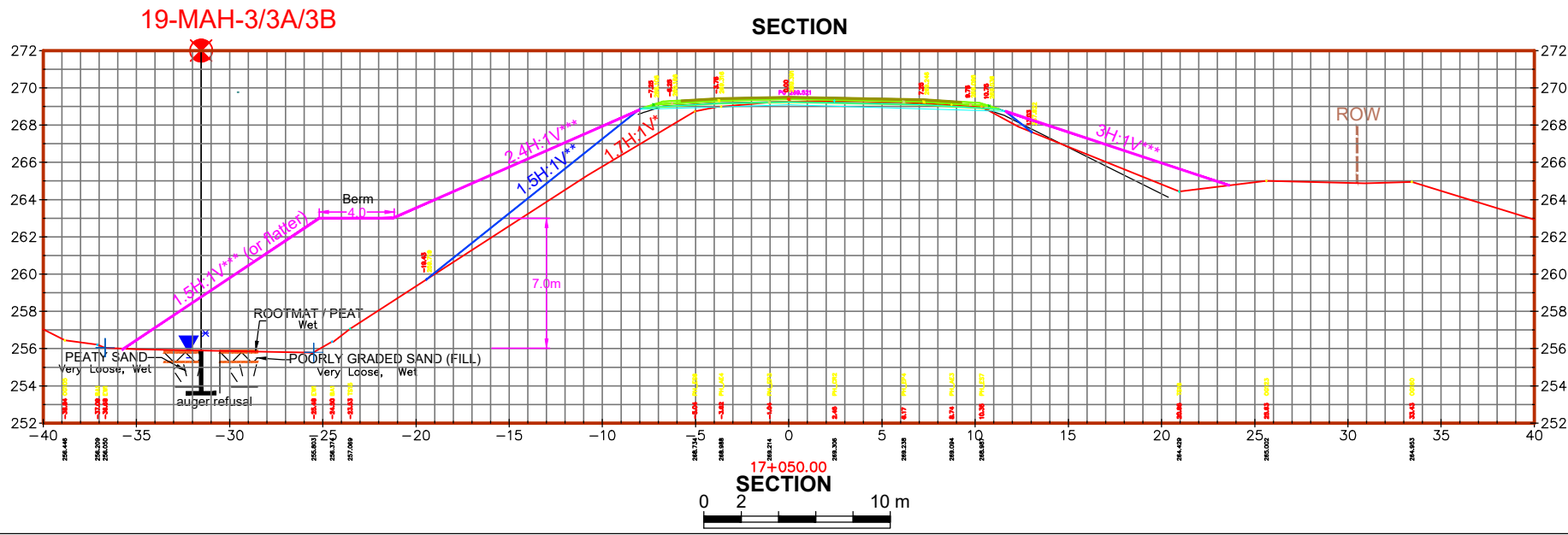
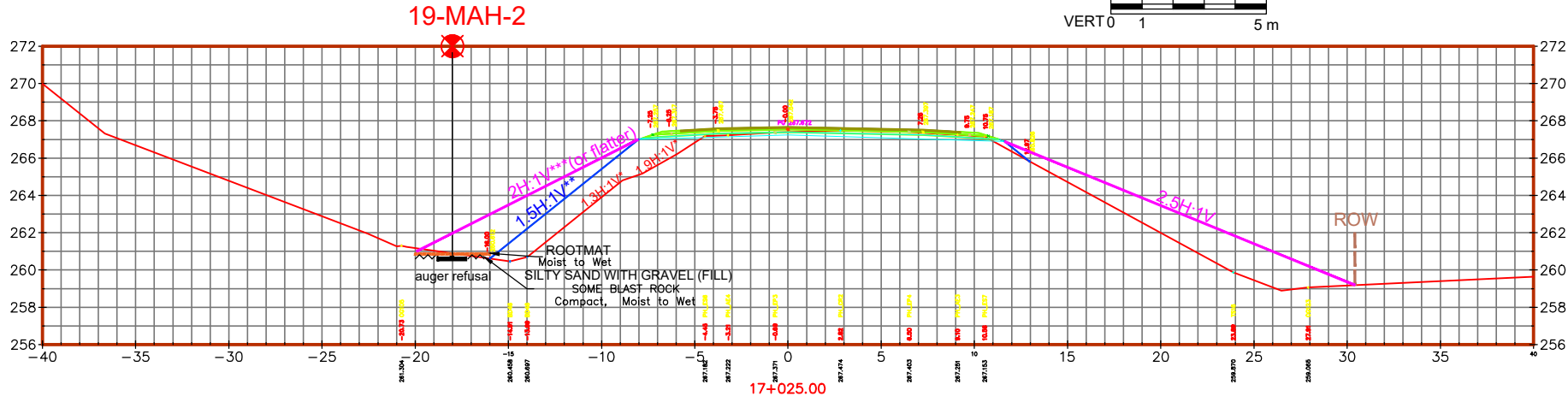
- * Slope of existing embankment.
- ** Slope of designed widening.
- *** Flatten slope to dispose rock surplus.
- Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m or more high.

NOTES

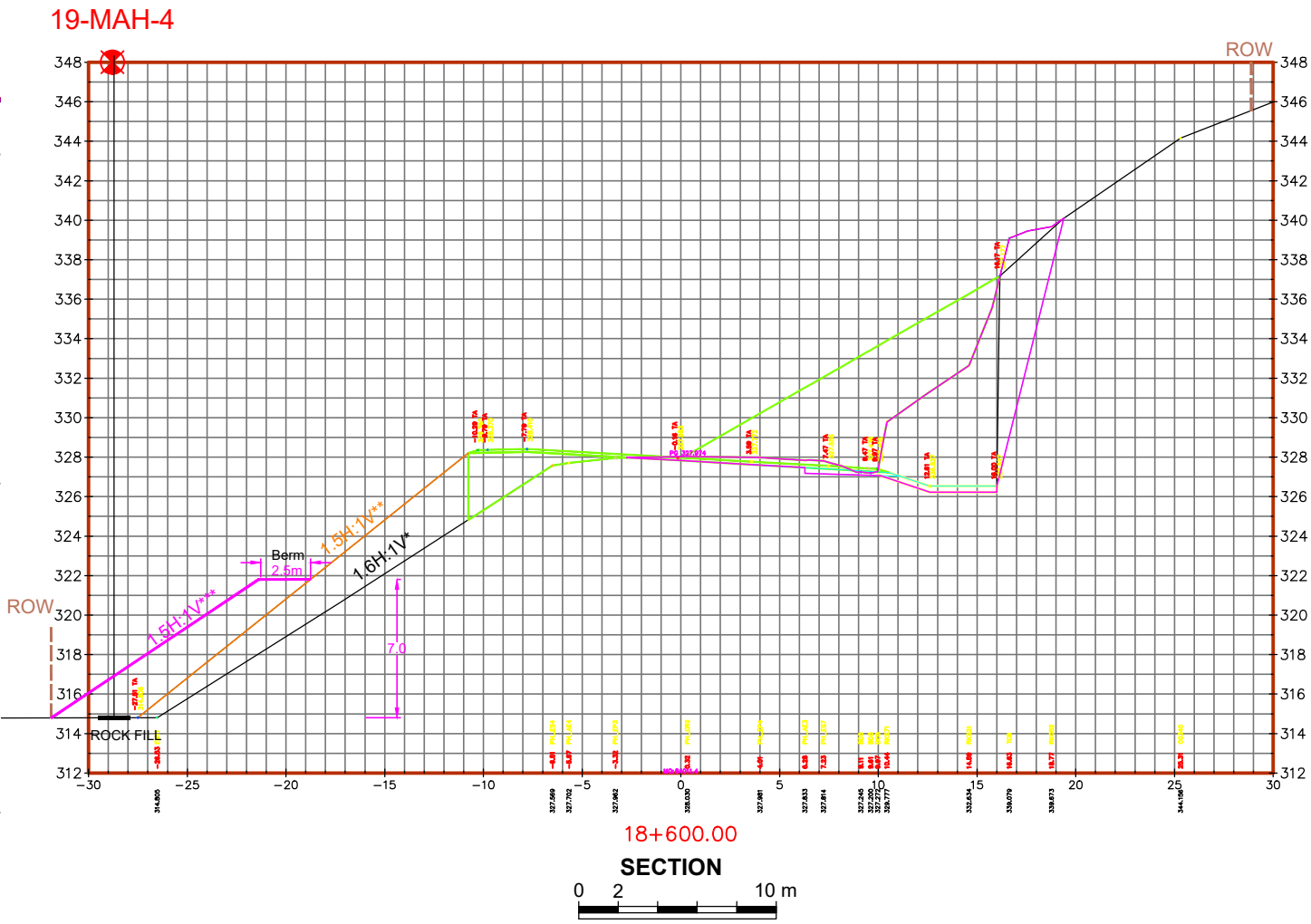
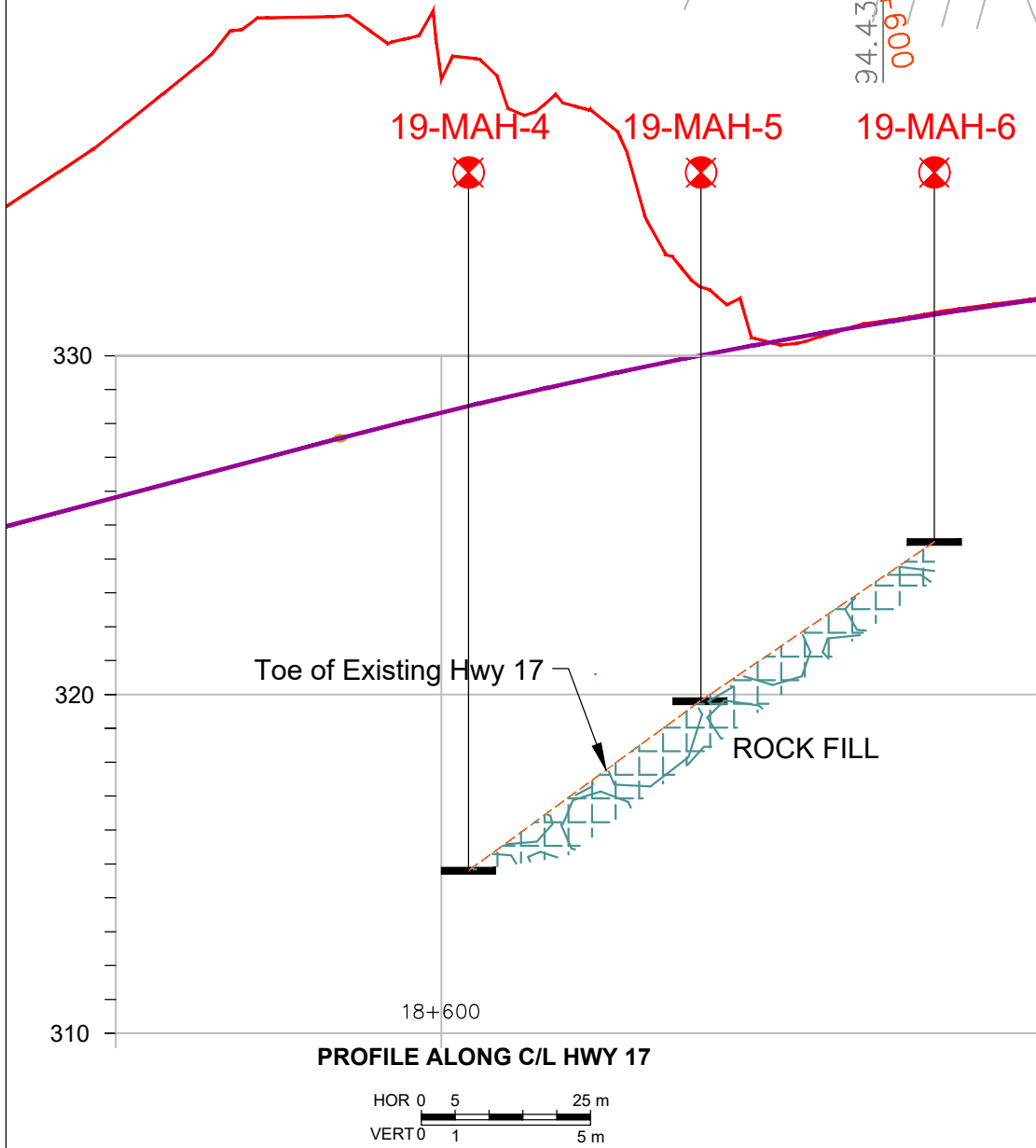
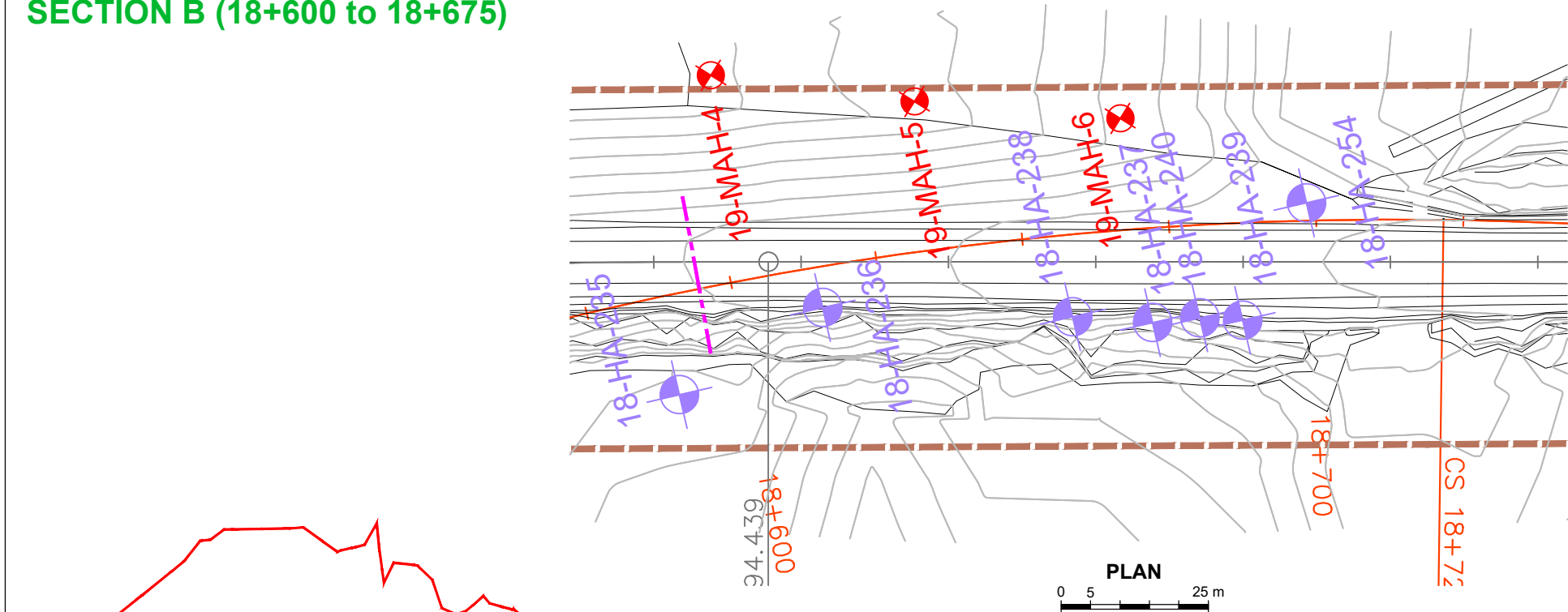
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DATE	SM BY	SUBMISSION FOR MTO REVIEW DESCRIPTION
		GEOCRES NO. 42D-58
		PROJECT NO. ADM-00248798-E0
SUBM'D SH	CHECKED SM	DATE Aug. 30, 19
DRAWN SH	CHECKED SM	APPROVED SG DWG. 4-2



SECTION B (18+600 to 18+675)



METRIC

DIMENSIONS ARE IN METERS AND/OR MILLIMETERS UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETERS +METERS



Agreement No. 6017-E-0066
Assignment No. 5
WO #2018-11011

"ENGINEERING RECOMMENDATIONS FOR FLATTER SLOPES AND BERMS TO DISPOSE SURPLUS ROCK" (TASK 2)

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA SECTION B

EXP Services Inc.

KEY PLAN

LEGEND

Borehole Location

N

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

SOIL STRATA SYMBOLS

ROCK FILL

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-4	314.8	5413255.9	266674.3
19-MAH-5	319.8	5413222.0	266668.6
19-MAH-6	324.5	5413190.3	266650.6

Notes:

* Slope of existing embankment.

** Slope of designed widening.

*** Flatten slope to dispose rock surplus.

- Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m or more high.

NOTES

This drawing is for subsurface information only. The proposed structure details/ works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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DATE	BY	SUBMISSION FOR MTO REVIEW	
		DESCRIPTION	
		GEOCRES NO. 42D-58	
		PROJECT NO. ADM-00248798-E0	
SUBM'D SH	CHECKED SM	DATE	Aug. 30, 19
DRAWN SH	CHECKED SM	APPROVED SG	DWG. 5-2

SECTION C (19+325 to 19+600)

METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS

Agreement No. 6017-E-0066
Assignment No. 5
WO #2018-11011

"ENGINEERING RECOMMENDATIONS FOR FLATTER
SLOPES AND BERMS TO DISPOSE SURPLUS ROCK"
(TASK 2)

SHEET
1

BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION C

exp

EXP Services Inc.

KEY PLAN

LEGEND

Borehole Location

N

Standard Penetration Test (Blows/0.3 m)

Groundwater level measured in open hole

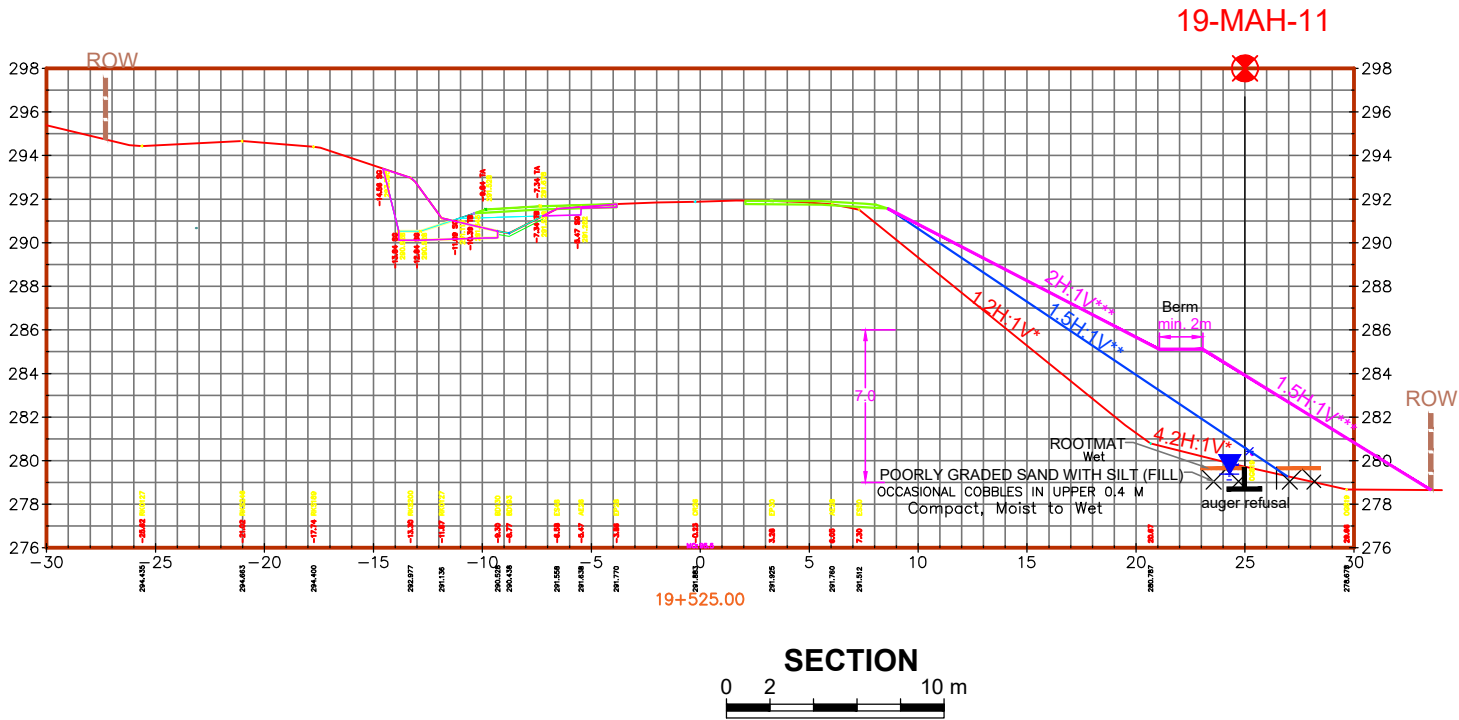
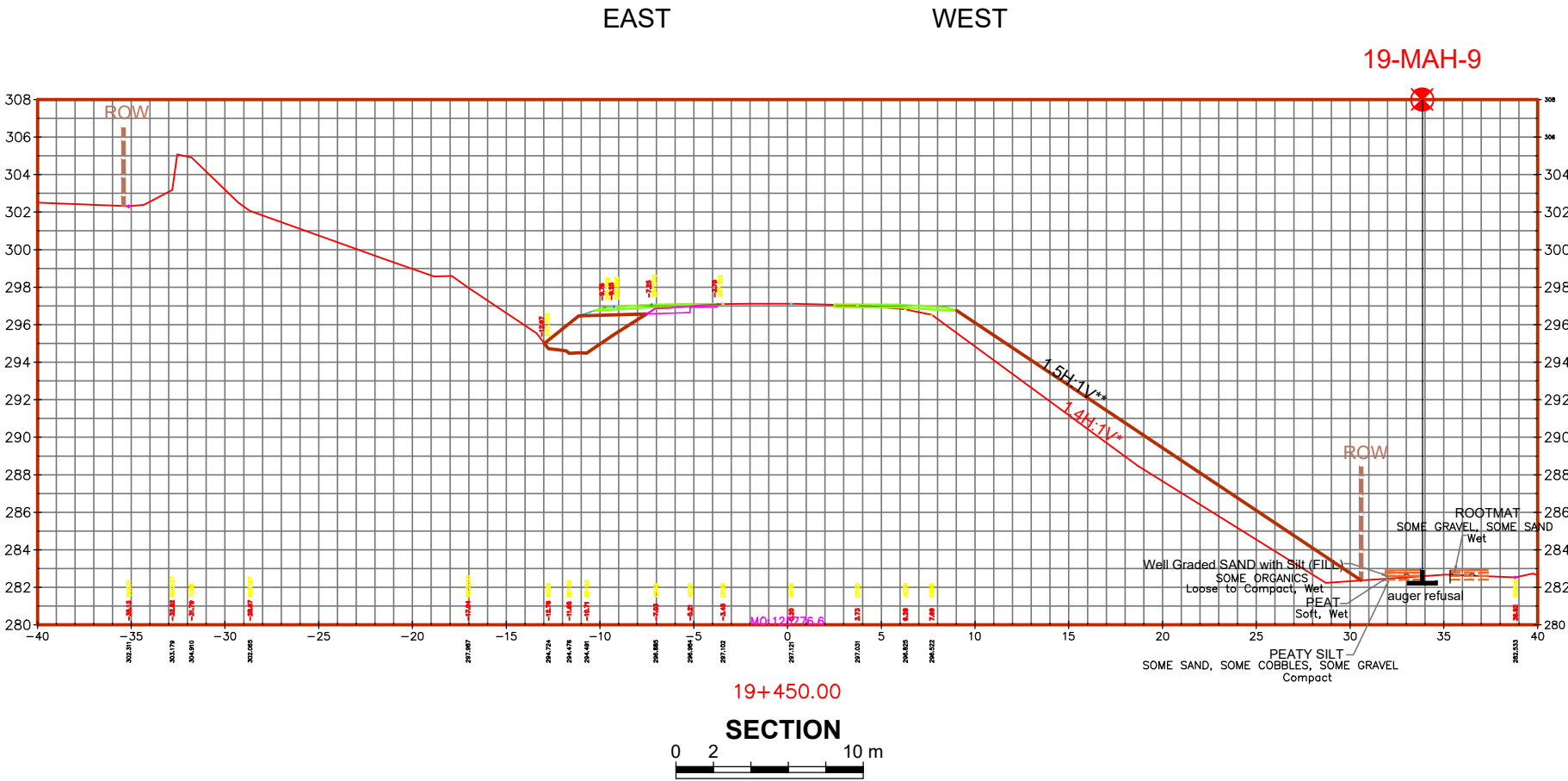
SOIL STRATA SYMBOLS

Rootmat/PeatPeaty SANDFILLNotes:
* Slope of existing embankment.
** Slope of designed widening.
*** Flatten slope to dispose rock surplus.
- Flatten the slope (flatter than 1.5H:1V) and build a min 2 m wide mid-height berm where the fill is 10 m or more high.

NOTES

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The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.




SECTION D (20+275 to 20+335)

METRIC
DIMENSIONS ARE IN METERS AND/OR
MILLIMETERS UNLESS OTHERWISE
SHOWN. STATIONS ARE IN KILOMETERS
+METERS


Agreement No. 6017-E-0066
Assignment No. 5
WO #2018-11011



SHEET
1


BOREHOLE LOCATION PLAN AND SOIL STRATA
SECTION D


 EXP Services Inc.

KEY PLAN



LEGEND


 Borehole Location


 Standard Penetration Test (Blows/0.3 m)

 Groundwater level measured in open hole

SOIL STRATA SYMBOLS

 Rootmat/Peat

 Peaty SAND

 FILL

BH No.	ELEV.	MTM CO-ORDINATES (ZONE ON-14)	
		NORTHING	EASTING
19-MAH-7	300.4	5412558.8	266398.8
19-MAH-8	292.4	5412523.5	266388.3
19-MAH-9	282.9	5412473.6	266373.8
19-MAH-10	279.0	5412436.1	266378.3
19-MAH-11	279.8	5412390.4	266377.7
19-MAH-12	282.8	5412352.8	266380.1
19-MAH-13	285.2	5412308.1	266385.6

Notes:

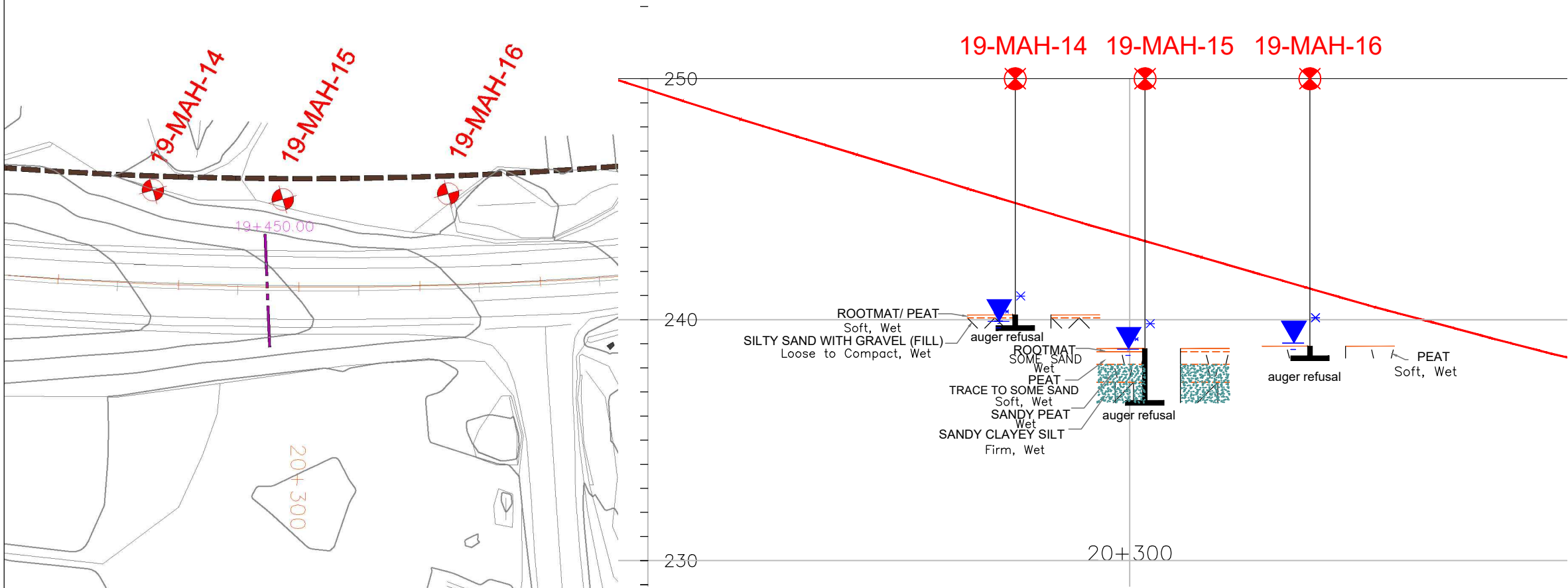
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	SM	SUBMISSION FOR MTO REVIEW
DATE	BY	DESCRIPTION
		GEOCRES NO. 42D-58
		PROJECT NO. ADM-00248798-E0
SUBM'D SH	CHECKED SM	DATE Aug. 30, 19
DRAWN SH	CHECKED SM	APPROVED SG DWG. 7-2



PROFILE ALONG C/L HWY 17

