April 9, 2026

Please note that the Geocres number for this report has been updated from 42D14-001 to **42D15-002**. Accordingly, the title sheet should reflect Geocres number 42D15-002 instead of 42D14-001.

All other content in the report remains unchanged.

MTO Foundations



THURBER

Detailed Foundation Investigation and Design Report High Fill Embankments, Deep Cuts, and Non-Structural Culverts

Highway 17 Realignment, 9.3 to 13.3 km West of Township of Schreiber Northwestern Region, Ontario

G.W.P. 6333-14-00, GEOCRES No. 42D14-001

Client Name: HATCH
Date: October 22, 2024
File: 37996

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THURBER

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THURBER

DETAILED FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH FILL EMBANKMENTS, DEEP CUTS, AND NON-STRUCTURAL CULVERTS
HIGHWAY 17 REALIGNMENT, 9.3 TO 13.3 KM WEST OF TOWNSHIP OF SCHREIBER
MTO NORTHWESTERN REGION, ONTARIO
G.W.P. 6333-14-00

GEOCRES No. 42D14-001

PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation carried out by Thurber Engineering Ltd. (Thurber) for the Highway 17 curve realignment from 9.3 to 13.3 km west of the Township of Schreiber, Ontario.

The project will include the Highway 17 curve realignment for approximately 4 km, starting 9.3 km west of the Township of Schreiber. The foundation aspects of the project include construction of new high fill embankments, deep cut sections for the new alignment, as well as the installation of new non-structural culverts in two locations. The project also includes construction of a new structural culvert where the realigned highway crosses Hewitson Creek. A separate investigation was completed for the detailed design of the Hewitson Creek Culvert and approach embankments. The Hewitson Creek site is discussed in a separate report entitled:

"Detailed Foundation Investigation and Design Report, Hewitson Creek Culvert Replacement, Highway 17 Realignment, 9.3 to 13.3 km West of Township of Schreiber, MTO Northwestern Region, Ontario, G.W.P. 6333-14-00", File: 37996 (Reference 1).

In addition to the foundation investigations discussed herein and in Reference 1, a detailed level pavement investigation of the proposed highway realignment was previously completed by Thurber in 2023. The pavement investigation is discussed in a separate report entitled:

"*Pavement Design Report, Highway 17 Realignment at Hewitson Creek From 9.3 to 13.3 km West of Schreiber Township, Northwestern Region, Ontario"*, File: 35697, Dated April 21, 2023 (Reference 2).

The purpose of Thurber's investigation was to explore the subsurface conditions along the alignment of the proposed high fill embankments, deep cuts, and culverts, and based on the data obtained, to provide borehole location plans, record of borehole sheets, stratigraphic profiles, laboratory test results and a written description of the subsurface conditions.

Thurber carried out the assignment as a sub-consultant to Hatch Ltd. (Hatch), under the Ministry of Transportation Ontario (MTO) Assignment No. 6023-E-0007.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

2. SITE DESCRIPTION

2.1 Existing and Proposed Highway 17

The existing Highway 17 within the project limits is a two-lane, undivided roadway with at-grade intersections and an eastbound truck-climbing lane. For the purposes of this report, the existing and new highway alignments are considered to operate in an east/west direction. Three at-grade intersections are present within the project limits; at an unnamed access road for Hydro One near the west limit, at the Rainbow Falls Whitesand Lake Campground entrance, and at Ch. Hunter Road near the east limit.

The existing highway corridor is surrounded predominately by heavily wooded areas. The highway crosses a Hydro One high voltage transmission corridor west of Hewitson Creek and east of Rainbow Falls Provincial Park as well as the east project limits. A Canadian Pacific Kansas City (CPKC) rail corridor is located to the south of the highway, and an MTO gravel pit is located south of the highway near the east end of the proposed new alignment. The proposed new alignment is located south of the Hydro One corridor, north of the CPKC rail corridor, and crosses through Rainbow Falls Provincial Park.

Steep hills and creek valleys were noted throughout the existing and proposed alignment, particularly at the Hewitson Creek valley. Bedrock was observed at the ground surface locally near the east and west ends of the proposed alignment near the existing highway. Overall, the ground surface elevation increases by approximately 90 m from the west to east project limits.

Typical photographs of the site are included in Appendix H.

2.2 Regional Geology

Quaternary geological mapping[1] indicates that the proposed highway alignment primarily crosses glaciolacustrine nearshore beach deposits consisting of gravelly sand to sand and gravel. Near the east and west ends of the proposed highway alignment, Precambrian bedrock was mapped[2], indicating the presence of igneous or metamorphic rock at surface or below discontinuous and thin layers of drift. At the east end and near the west end of the proposed alignment, glaciofluvial

[1] Ontario Geological Survey, Ministry of Northern Development and Mines, and Northeast Science and Information Section, Ministry of Natural Resources 2005. Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160.

[2] Ontario Geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release–Data 126 - Revision 1.

outwash deposits are mapped, consisting of gravel and sand.

The bedrock in this area is mapped as massive granodiorite to granite of the Whitesand Lake Batholith. This batholith is typically comprised of medium to coarse grained granite and includes a grey phase ranging in composition from monzodiorite to quartz monzonite[3].

3. SITE INVESTIGATION AND FIELD TESTING

The scope of the detailed foundation investigation consisted of a field drilling program of advancing 21 boreholes along the proposed highway alignment where high fill embankments (fills of 4.5 m height or greater), deep cuts (cuts of 4.5 m deep or deeper) and culverts are planned. The field investigation for these areas was carried out between March 1 and 18, 2024. A subsequent phase of the investigation at the Hewitson Creek site included 11 boreholes that were completed on April 17, 2024 and are described in Reference 1. The boreholes completed for the high fill, deep cut and culvert investigation, along with the locations and assigned nomenclature are summarized in Table 3.1.

Only the areas investigated during this detailed high fill and deep cut investigation are addressed in this report. In addition to the deep cut in earth discussed in this report (Deep Cut 1), the separate pavement investigation from 2023 included a deep cut section in potential bedrock from approximate Sta. 10+390 to 10+800, which is described in Reference 2.

Table 3.1: Summary of Investigation Program

Location and Assigned Nomenclature	Approximate Station	Boreholes	Appendices
High Fill 1 and Non-Structural Culvert (HF1)	10+250 to 10+300	HF1-01 to HF1-04	B1, B2
High Fill 2A (HF2A)	10+940 to 10+990	HF2A-01 to HF2A-02	Refer to Reference 1
Hewitson Creek Structural Culvert (HCC)	10+990 to 11+020	HCC-01 to HCC-06	
High Fill 2B (HF2B)	11+020 to 11+130	HF2B-01 to HF2B-03	
High Fill 3 and Non-Structural Culvert (HF3)	11+600 to 11+650	HF3-01 to HF3-04	C1, C2
High Fill 4 (HF4)	12+050 to 12+300	HF4-01 to HF4-06	D1, D2
Deep Cut 1 (DC1)	12+375 to 12+650	DC1-01 to DC1-07	E1, E2

[3] Carter, M. W. 1988: Geology of Schreiber-Terrace Bay area, District of Thunder Bay; Ontario Geological Survey, Open File Report 5692

The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix A. Details of the subsurface conditions encountered during the foundation investigation are presented in the Record of Borehole sheets in Appendices B1 to E1.

The centreline of the proposed new alignment was surveyed and staked on site by Hatch in advance of the drilling investigation. The borehole locations were established in the field based on measurements (stations and offset distances) from the staked centreline alignments. The horizontal coordinates and ground surface elevations at the borehole locations were established from the topographic data provided by Hatch. The coordinate system MTM NAD83, Zone 14 was used. Utility clearances were obtained prior to the start of drilling.

The boreholes were advanced using a track-mounted drill rig with solid and hollow stem augers, wash boring with NW casing, and NQ coring methods, supplied and operated by Eastern Ontario Diamond Drilling Ltd. of Hawkesbury, Ontario. Standard Penetration Testing (SPT) was carried out in accordance with ASTM D1586 at selected depth intervals.

The field investigation was supervised on a full-time basis by members of Thurber's technical staff who directed the drilling, sampling and in-situ testing operations, logged the boreholes and processed the recovered soil and rock samples for transport to Thurber's laboratory for further examination and testing.

The rock cores were logged, and the Total Core Recovery (TCR), Solid Core Recovery (SCR), Rock Quality Designation (RQD) and the Fracture Indices (FI) were determined.

Groundwater conditions were observed in the open boreholes throughout the drilling operation. Standpipe piezometers were installed in selected boreholes to permit measurement of groundwater levels at the site. All boreholes without a standpipe piezometer were backfilled upon completion of drilling in general accordance with O. Reg. 903. Piezometers were decommissioned as per O. Reg. 903 at the end of the field program.

4. LABORATORY TESTING

The recovered soil samples were subjected to visual identification (VI) and to natural moisture content determination. Selected samples were subjected to grain size distribution analyses (sieve and/or hydrometer), and Atterberg Limits testing. Rock core samples were subjected to Point Load Testing (PLT). The laboratory test results are summarized on the Record of Borehole sheets included in Appendices B1 to E1, and presented on the figures included in Appendices B2 to E2 and F.

Selected soil and surface water samples for the proposed culvert locations were submitted for analytical testing to assess the corrosion potential of soil and water on metal culverts and the potential for sulphate attack on subsurface concrete structures. The analyses were carried out by

SGS Canada Inc. (SGS), an independent Canadian Association for Laboratory Accreditation (CALA) accredited laboratory. The results of the analytical testing are summarized in Section 6 and the laboratory Certificates of Analysis are included in Appendix G.

5. DESCRIPTION OF SUBSURFACE CONDITIONS

Subsurface conditions encountered during the foundation investigation are shown on the Borehole Locations and Soil Strata Drawings in Appendix A. Detailed descriptions of individual soil stratum are presented on the Record of Borehole sheets included in Appendices B1 to E1.

A general description of the soil stratigraphy for each location investigated is given below. However, the factual data presented on the Record of Borehole sheets takes precedence over these general descriptions and must be used for interpretation of the site conditions. It should be recognized and expected that soil conditions may vary between and beyond borehole locations.

In general, the overburden soil across the site consists of topsoil or organic material overlying interbedded sand, silt and gravel deposits, often containing cobbles and boulders. Granite to granodiorite bedrock was encountered below the overburden soils.

5.1 High Fill 1 (HF1) (Sta. 10+250 to 10+300)

Four (4) boreholes (HF1-01 to HF1-04) were advanced along the proposed new alignment between Stations 10+200 and 10+300 near the proposed high fill and non-structural culvert. The boreholes were advanced to depths from 12.0 to 20.1 m (Elev. 214.1 to 206.2 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 2 included in Appendix A. The Record of Borehole Sheets are included in Appendix B1.

The soil conditions encountered generally consist of surficial organic deposits overlying deposits of sand, gravelly sand to sand and gravel, and a thick deposit of sand to silty sand. Underlying the sand deposits, a layer of clayey silt to silty clay was observed overlying the local granite bedrock.

5.1.1 Organics

Organics were encountered at the ground surface in Boreholes HF1-01, HF1-03, and HF1-04. The surficial organics thickness ranged from 150 mm to 300 mm at the borehole locations (base Elev. from 226.6 to 220.2 m). The organic material thickness may vary between and beyond the boreholes.

No SPT testing was completed entirely in the organic material, as all tests extended into the underlying sand. Natural moisture contents of the organic material ranged from 40 to 408%.

5.1.2 Sand

A deposit of sand was observed below the organics in Boreholes HF1-01 and HF1-03, which extended to depths ranging from 0.2 to 0.8 m (Elev. from 225.4 to 225.3 m). The sand deposit was typically described as brown and contained some silt and trace to some gravel. Occasional cobbles were also observed in the sand.

SPT 'N' values recorded in this deposit ranged from 17 to greater than 100 blows per 0.3 m penetration, indicating a compact to very dense relative density. The measured natural moisture contents ranged between 4 and 12%.

The results of grain size analyses conducted on a sample of the sand are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figure B1 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	2
Sand	77
Silt	19
Clay	2

5.1.3 Gravelly Sand to Sand and Gravel

A deposit of gravelly sand to sand and gravel was encountered in all HF1 Boreholes. The layer was encountered at the ground surface in HF1-02, below organics in HF1-04, and below the sand layer in HF1-01 and HF1-03. The deposit ranged in thickness from 0.6 to 4.3 m and extended to depths ranging from 0.8 to 4.6 m (Elev. 225.3 to 215.9 m).

The deposit was typically described as gravelly sand but ranged from gravelly sand to sand and gravel in Borehole HF1-04. The layer contained trace silt, with occasional boulders and cobbles encountered during drilling.

SPT 'N' values recorded in the gravelly sand to sand and gravel ranged from 4 to greater than 100 blows per 0.3 m penetration, indicating a range from very loose to very dense, typically compact to very dense. Natural moisture contents ranged from 1 to 18%.

The results of grain size analyses conducted on samples of the gravelly sand to sand and gravel are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figure B2 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	23 to 52
Sand	42 to 67
Silt and Clay	6 to 10

5.1.4 Sand, Some Silt to Silty Sand

A thick deposit of sand with some silt ranging to silty sand was encountered below gravelly sand to sand and gravel layer in all of the HF1 boreholes. The deposit was described as brown to grey and typically contained trace gravel with occasional cobbles. The thickness of the deposit ranged from 4.1 to 17.5 m and the base was encountered at depths ranging from 7.2 to 17.8 m (Elev. 218.9 m to 208.3 m). A lower sand and silt layer was observed locally in Borehole HF1-03 at a depth of 17.8 m. The borehole was terminated within the sand and silt at a depth of 18.9 m (Elev. 207.2 m).

SPT 'N' values recorded in the sand to silty sand ranged from 4 blows to greater than 100 blows per 0.3 m of penetration, indicating a loose to very dense relative density, typically compact to dense. Natural moisture contents in the deposit ranged from 1 to 29%.

The results of grain size analyses conducted on samples collected in this deposit are provided on the Record of Borehole sheets in Appendix B1 and illustrated in Figures B3 and B4 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)		
	Sand, Some Silt	Silty Sand	Lower Silt and Sand
Gravel	0 to 10	3 to 8	0
Sand	68 to 87	66 to 72	51
Silt	12 to 20	21 to 24	47
Clay	1 to 2	1 to 2	2
Silt and Clay	-	28	-

5.1.5 Silt to Silty Clay

A lower deposit of silt to silty clay was observed below the sand to silty sand deposit in Boreholes HF1-01, HF1-02, and HF1-04. The silt to silty clay was typically described as brown to grey and contained trace to some sand. The silt to silty clay layer was 1.2 to 2.0 m thick and extended to depths from 8.4 m to 16.8 m (Elev. 217.7 to 209.8 m).

SPT 'N' values recorded in the silt to silty clay deposit ranged from 15 to 34 blows per 0.3 m penetration, indicating a stiff to hard relative density, or dense where mainly comprised of silt. Additional SPT 'N' values of greater than 100 blows per 0.3 m of penetration were recorded at the base of the boreholes due to split spoon refusal on bedrock. Natural moisture contents ranged from 18 to 22%.

The results of grain size analyses conducted on samples of the silt to silty clay are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figures B5 and B6 of Appendix B2. The results are summarized as follows:

Soil Particle	Percentage (%)	
	Silt	Silty Clay
Gravel	0	0
Sand	12	4 to 7
Silt	85	54 to 66
Clay	3	27 to 42

The results of the Atterberg Limits tests conducted on samples of the silty clay are provided on the Record of Borehole sheets in Appendix B1 and illustrated on Figure B7 of Appendix B2. The results are summarized as follows:

Index Property	Percentage (%)
Liquid Limit	26 to 36
Plasticity Index	9 to 16

The results of the Atterberg Limits tests indicate that the silty clay layer ranges from low to intermediate plasticity (CL to CI).

5.1.6 Granite Bedrock

Bedrock was encountered underlying the overburden soils at depths from 8.4 to 16.8 m (Elev. 217.7 to 209.8 m) in Boreholes HF1-01, HF1-02 and HF1-04. Bedrock was not encountered in Borehole HF1-03.

The bedrock was described as slightly weathered to fresh and was visually identified as red granite. Where encountered, the bedrock was proven by coring from 3.3 to 3.6 m into the rock.

The Fracture Index (FI), measured as the total number of fractures per 0.3 m of rock core length, was between 0 and 7. Total Core Recovery (TCR) values measured on recovered bedrock samples was 100%. Solid Core Recovery (SCR) values ranged from 57 to 100%. Rock Quality Designation (RQD) values varied from 28 to 100% with most values exceeding 50% indicating fair to excellent quality (average of 69%).

Estimated rock strength values were interpreted from Point Load Tests conducted on the rock cores. The average uniaxial compressive strength (UCS) values per core run from the point load tests ranged from 111 to 242 MPa, indicating that the bedrock is very to extremely strong. The results of the point load tests and photographs of the rock core samples are presented in Appendix F.

5.1.7 Groundwater Conditions

A standpipe piezometer was installed in Borehole HF1-04 to monitor the groundwater table. The description of the piezometer and the measured groundwater levels are summarized in Table 5.1

below.

Table 5.1: HF1-04 Groundwater Measurements

Borehole	Piezometer Details				Date	Water Level (m)	
	Top of Screen (m)	Top of Screen Elevation (m)	Bottom of Screen (m)	Bottom of Screen Elevation (m)		Depth	Elevation
HF1-04	7.65	212.9	10.7	209.8	March 17, 2024	4.2	216.3
					March 18, 2024	4.2	216.3
					April 8, 2024	3.5	217.0
					April 19, 2024	3.5	217.0

The groundwater levels above are short-term readings and seasonal fluctuations of the groundwater levels are to be expected. In particular, the groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

5.2 High Fill 3 (HF3) (Sta. 11+600 to 11+650)

Four (4) boreholes (HF3-01 to HF3-04) were advanced along the proposed new alignment between Stations 11+575 and 11+650 near the proposed high fill and non-structural culvert. The boreholes were advanced to depths from 21.5 to 26.3 m (Elev 231.5 and 225.0 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 3 included in Appendix A. The Record of Borehole Sheets are included in Appendix C1.

The soil conditions encountered generally consist of topsoil overlying deposits of silty sand to sand and silt, sand and gravel, and a lower silty sand to silt. The overburden deposits are underlain by granite bedrock.

5.2.1 Topsoil

Topsoil was encountered at the ground surface in Boreholes HF3-01, HF3-03, and HF3-04. The topsoil thickness ranged from 500 to 800 m at the borehole locations. The topsoil was described as black or brown in colour and contained some sand and gravel in Boreholes HF3-03 and HF3-04.

SPT ‘N’ values recorded in the topsoil ranged from 15 to 61 per 0.3 m penetration, indicating a compact to very dense relative density, which is likely attributed to the presence of some sand and gravel within the organic deposit. Natural moisture contents ranged from 14 to 112%. The topsoil thickness may vary between and beyond the boreholes.

5.2.2 Upper Silty Sand to Sandy Silt

A deposit of silty sand to sandy silt was observed underlying the topsoil in Boreholes HF3-01 and HF3-04. The upper silty sand to sandy silt was also encountered under localized gravelly sand

layers in HF3-02 and HF3-03.

The silty sand to sandy silt deposit was encountered at depths ranging from 0.5 to 1.4 m (Elev. 251.6 to 249.9 m). The layer thickness ranged from 1.0 to 2.5 m in Boreholes HF3-01 and HF3-02 and from 10.2 to 12.3 m in Boreholes HF3-03 and HF3-04. The base of the silty sand to sandy silt deposit ranged from 2.2 m to 13.7 m depth (Elev. 245.8 to 239.3 m), generally dipping towards the southeast.

The silty sand to sandy silt deposit was described as brown or grey and contained trace gravel and occasionally trace clay. Occasional cobbles were also noted during drilling. SPT 'N' values recorded in the deposit ranged from 11 to greater than 100 blows per 0.3 m penetration, indicating a compact to very dense relative density. Natural moisture contents ranged from 9 to 24%.

The results of grain size analyses conducted on samples of the silty sand to sandy silt are provided on the Record of Borehole sheets in Appendix C1 and illustrated on Figures C1 to C3 of Appendix C2. The results are summarized as follows:

Soil Particle	Percentage (%)		
	Sand, Some Silt	Silty Sand	Sandy Silt
Gravel	0	8	0 to 2
Sand	78	60	30 to 39
Silt	20	30	57 to 65
Clay	2	2	3 to 5

5.2.3 Sand and Gravel

Sand and gravel deposits which ranged in composition from sandy gravel to gravelly sand were encountered at the ground surface in Borehole HF3-02, below the topsoil in Borehole HF3-03, and below the silty sand to sandy silt deposit in Boreholes HF3-01 to HF3-04. The deposit was described as brown and containing trace to some silt and occasional cobbles. A boulder was encountered in HF3-04 at a depth of 12.6 m.

A 0.7 to 1.2 m thick localized shallow sand and gravel layer was encountered above the silty sand to sandy silt deposit in Boreholes HF3-02 and HF3-03. The shallow layer extended to depths of 1.2 to 1.4 m (Elev. 251.6 to 246.8 m).

Below the upper silty sand to sandy silt deposit, the top of the sand and gravel was encountered at depths from 2.2 m to 3.0 m (Elev. 247.4 to 245.8 m) in Boreholes HF3-01 and HF3-02, and from 11.0 to 13.7 m (Elev. 240.3 to 239.3 m) in Boreholes HF3-03 and HF3-04, with the top of the deposit typically dipping towards the southeast. Where fully penetrated, the deposit ranged in thickness from 7.4 to 10.3 m and the base extended to depths from 11.5 to 18.4 m (Elev. 237.1 to 232.9 m). Borehole HF3-03 was terminated within the sand and gravel deposit at a depth of 21.5 m (Elev. 231.5 m).

Layers of finer materials were also occasionally encountered within the sand and gravel deposit in Boreholes HF3-01 and HF3-04. A sand layer was encountered from 5.5 to 7.2 m depth (Elev. 244.9 to 243.2 m) in Borehole HF3-01. A sandy silt layer containing trace gravel was encountered from 14.8 to 16.3 m depth (Elev. 235.0 to 236.5 m) in Borehole HF3-04.

SPT 'N' values of 8 to greater than 100 blows per 0.3 m of penetration were recorded in the sand and gravel, typically greater than 18 blows. The relative density of the soil ranged from loose to very dense, typically compact to very dense. SPT refusal of greater than 100 blows per 0.3 m of penetration was frequently reached upon cobbles, boulders, or the underlying bedrock. Rock coring measures were occasionally required to penetrate the deposit. Measured moisture contents in the sand and gravel typically ranged from 4 to 13%. Locally, a moisture content of 51% was measured in the surficial sample from Borehole HF3-02.

The results of grain size analyses conducted on samples of the sand and gravel are provided on the Record of Borehole sheets in Appendix C1 and illustrated on Figure C4 of Appendix C2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	39 to 56
Sand	29 to 48
Silt and Clay	5 to 23

5.2.4 Lower Silty Sand to Silt

A lower layer of silty sand to silt was encountered below the sand and gravel in Boreholes HF3-01, HF3-02, and HF3-04. The top of the silty sand to silt deposit was observed at depths from 11.5 m to 18.4 m (Elev. 237.1 to 232.9 m). The silty sand to silt layer ranged in thickness from 4.5 to 7 m and extended to the bedrock surface, which was encountered between 18.3 and 22.9 m depth (Elev. 232.1 to 228.4 m).

SPT 'N' values recorded in the silty sand to silt ranged from 23 to greater than 100 blows per 0.3 m penetration. The 'N' values indicate that the deposit ranges from compact to very dense. The natural moisture contents of the deposit ranged from 10 to 23%.

The results of grain size analyses conducted on samples of the silty sand to silt are provided on the Record of Borehole sheets in Appendix C1 and illustrated on Figures C2, C3 and C5 of Appendix C2. The results are summarized as follows:

Soil Particle	Percentage (%)		
	Silty Sand	Sandy Silt	Silt
Gravel	7	0	0
Sand	70	30	16
Silt	21	64	79
Clay	2	6	5

5.2.5 Bedrock

Bedrock was encountered underlying the overburden soils from 18.3 m to 22.9 m depth (Elev. 232.1 to 228.4 m) in Boreholes HF3-01, HF3-02, and HF3-04. Bedrock was not encountered in HF1-03.

The bedrock was slightly weathered to fresh and was visually identified as red granite. Where encountered, the bedrock was proven by coring from 3.2 to 3.6 m into the rock.

The Fracture Index (FI), measured as the total number of fractures per 0.3 m of rock core length, was typically between 0 and 4, locally greater than 10 in highly fractured zones found in HF3-01. Total Core Recovery (TCR) values measured on recovered bedrock samples was 100%. Solid Core Recovery (SCR) values ranged from 82 to 100%. Rock Quality Designation (RQD) values varied from 67 to 100% with most values exceeding 70% indicating fair to excellent quality (average of 89%).

Estimated rock strength values were interpreted from Point Load Tests conducted on the rock cores. The average uniaxial compressive strength (UCS) values per core run from the point load tests ranged from 159 to 256 MPa, indicating that the bedrock is very to extremely strong. The results of the point load tests and photographs of the rock core samples are presented in Appendix F.

5.2.6 Groundwater Conditions

A standpipe piezometer was installed in Borehole HF3-04 to monitor the groundwater level. The measured groundwater levels are summarized in Table 5.2 below.

Table 5.2: HF3-04 Groundwater Measurements

Borehole	Piezometer (m)				Date	Water Level (m)	
	Top of Screen Depth	Top of Screen Elevation	Bottom of Screen Depth	Bottom of Screen Elevation		Depth	Elevation
HF3-04	15.2	236.1	18.3	233.0	March 11, 2024	18.3	233.0
					March 19, 2024	Dry	-
					April 8, 2024	Dry	-

Considering that the piezometer was dry on subsequent measurements, it is likely that water added to the borehole for drilling and rock coring purposes had not fully dissipated by the initial measurement on March 11, 2024. Seasonal fluctuations of the groundwater levels are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

5.3 High Fill 4 (HF4) (12+050 to 12+300)

Six (6) high fill boreholes (HF4-01 to HF4-06) were advanced along the proposed alignment between Station 12+050 and 12+300. The boreholes were advanced to depths ranging from 7.7 to 11.3 m (Elev. 271.5 to 250.7 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 4 included in Appendix A. The Record of Borehole Sheets are included in Appendix D1.

The soil conditions typically consist of topsoil overlying sand and gravel to gravelly sand. Occasional sand layers were encountered within the sand and gravel to gravelly sand in some boreholes.

5.3.1 Topsoil

A 225 mm thick topsoil layer was encountered at the ground surface in Borehole HF4-01. Topsoil was not noted in the other HF4 boreholes, where site access and tree clearing work had been done along the proposed highway centreline. However, some organics were noted in the upper part of the surficial soils in Boreholes HF4-02 and HF4-04. The topsoil thickness may vary between and beyond the boreholes.

5.3.2 Sand and Gravel to Gravelly Sand

A thick deposit of sand and gravel ranging to gravelly sand was encountered throughout the site below the topsoil in Borehole HF4-01 at a depth of 0.2 m and at the ground surface in Boreholes HF4-02 to HF4-06. The sand and gravel to gravelly sand was brown and contained trace silt and occasional cobbles. Organics were also occasionally present within the upper 1.5 m of the deposit.

Where fully penetrated, the deposit ranged in thickness and depth from 10.2 m (Elev. 255.6 m) in Borehole HF4-03, which was underlain by sand, and from 7.7 to 8.3 m (Elev. 271.5 to 261.1 m) in Boreholes HF4-04 and HF4-06, which were terminated upon auger refusal at the suspected base of the deposit. Boreholes HF4-01, HF4-02 and HF4-05 were terminated within the sand and gravel to gravelly sand deposit at depths from 10.8 to 11.3 m (Elev. 260.2 to 250.7 m).

SPT ‘N’ values recorded in the sand and gravel to gravelly sand ranged from 11 to greater than 100 blows per 0.3 m penetration, indicating that the deposit ranges from compact to very dense. Natural moisture contents ranged from 1 to 18%.

The results of grain size analyses conducted on samples of the sand and gravel to gravelly sand

are provided on the Record of Borehole sheets in Appendix D1 and illustrated on Figures D1 and D2 of Appendix D2. The results are summarized as follows:

Soil Particle	Percentage (%)	
	Gravelly Sand	Sand and Gravel
Gravel	27 to 37	44 to 58
Sand	56 to 66	33 to 49
Silt and Clay	6 to 7	5 to 9

5.3.3 Sand

Localized layers of sand containing trace silt, trace to some gravel and occasional cobbles were encountered in Boreholes HF4-02, HF4-03, and HF4-04 within or below the sand and gravel gravelly sand deposit. The sand layers were encountered at depths ranging from 1.5 to 10.2 m (Elev. 262.3 to 255.6 m). Where fully penetrated, the measured thickness of the sand ranged from 1.4 to 1.5 m and the base was encountered at depths from 3.0 to 5.6 m (Elev. 263.8 to 260.8 m). Borehole HF4-03 was terminated within a sand layer at a depth of 11.3 m (Elev. 254.5 m).

SPT ‘N’ values recorded in the sand ranged from 10 to 87 blows per 0.3 m penetration, indicating a compact to very dense relative density. Natural moisture contents ranged from 3 to 9%.

5.3.4 Silt and Sand

A localized layer of silt and sand was encountered in Borehole HF4-02 at 3.0 m depth (Elev. 260.8 m) below a sand layer and within the sand and gravel to gravelly sand deposit. The silt and sand was 1.1 m thick and extended to a depth of 4.1 m (Elev. 259.7 m).

One SPT ‘N’ value of 4 blows per 0.3 m penetration was recorded in the silt and sand, indicating a loose relative density. The measured natural moisture content was 25%.

The results of a grain size analyses conducted on a sample of the silt and sand are provided on the Record of Borehole sheets in Appendix D1 and illustrated on Figure D3 of Appendix D2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0
Sand	37
Silt	60
Clay	3

5.3.5 Groundwater Conditions

A standpipe Piezometer was installed Borehole HF4-02 upon completion of drilling. The groundwater levels measured in the piezometer are summarized in Table 5.3 below.

Table 5.3: HF4-02 Groundwater Measurements

Borehole	Piezometer (m)				Date	Water Level (m)	
	Top of Screen Depth	Top of Screen Elevation	Bottom of Screen Depth	Bottom of Screen Elevation		Depth	Elevation
HF4-02	7.6	256.2	10.7	253.1	March 6, 2024	Dry	-
					March 11, 2024	7.3	256.5
					March 18, 2024	Dry	-
					April 8, 2024	Dry	-
					April 19, 2024	Dry	-

Considering that the piezometer was dry on most measurements, it is likely that the measurement recorded on March 11, 2024 does not represent the stabilized groundwater level, which is anticipated to be deeper than the boreholes advanced at the HF4 site. Seasonal fluctuations of the groundwater levels are to be expected. The groundwater level may be at a higher elevation after periods of significant or prolonged precipitation.

5.4 Deep Cut 1 (DC1) (Sta. 12+375 to 12+650)

Seven (7) boreholes (DC1-01 to DC1-07) were advanced along the proposed alignment deep cut section between Stations 12+375 to 12+650. The boreholes were drilled to depths from 9.4 to 17.4 m (Elev. 296.5 to 280.0 m). The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawing 5 included in Appendix A. The Record of Borehole Sheets are included in Appendix E1.

In the boreholes drilled on the existing highway, the soil conditions encountered generally consist of granular fill materials overlying native organics or native sand. The native soils throughout the site typically consisted of deposits of sand, sand and gravel to gravelly sand, and silty sand to sandy silt. Granodiorite to granite bedrock was encountered below the overburden materials in Boreholes DC1-05 and DC1-06.

5.4.1 Asphalt

Boreholes DC1-05 to DC1-07 were drilled on the existing shoulders of Highway 17, where an asphalt layer of 50 to 100 mm thick was encountered at the ground surface.

5.4.2 Embankment Fill

Embankment fill consisting of gravelly sand to sand and gravel with trace silt and occasional cobbles was encountered immediately below asphalt in Boreholes DC1-05 to DC1-07. A layer of silty sand fill with trace organics and clay was also encountered at the ground surface in Borehole DC1-04, which was drilled at an MTO driveway near the existing highway. The silty sand fill extended to a depth of 0.7 m (Elev. 305.3 m) and was underlain by sand and gravel fill.

The gravelly sand to sand and gravel fill was encountered below the asphalt and below the silty

sand fill. The layer ranged in thickness from 2.3 to 4.5 m and was penetrated at depths ranging from 3.0 to 4.6 m (Elev. 304.0 to 303.0 m).

SPT 'N' values recorded in the embankment fill ranged from 15 to greater than 100 blows per 0.3 m penetration, indicating a compact to very dense relative density. Natural moisture contents ranged from 2 to 25% in the gravelly sand to sand and gravel fill and from 22 to 31% in the silty sand fill.

The results of grain size analyses conducted on samples of the gravelly sand to sand and gravel fill are provided on the Record of Borehole sheets in Appendix E1 and illustrated on Figure of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	33 to 48
Sand	49 to 56
Silt and Clay	3 to 11

5.4.3 Organics

A layer of sandy organics with trace silt and wood was observed at the ground surface in Borehole DC1-03, which extended to 0.7 m depth (Elev. 305.8 m). A 0.9 m thick buried organic layer with some sand and trace silt was also observed below the fill materials in Borehole DC1-06 at 3.2 m depth (Elev. 303.8 m), which extended to 4.1 m (Elev. 302.9 m).

SPT 'N' values recorded in the organics to sandy organics ranged from 7 to 77 blows per 0.3 m penetration, indicating a loose to very dense relative density. The N value of 77 in the surficial organics is likely attributed to the presence of wood encountered in the sample. Natural moisture contents of the organics ranged from 23 to 114%.

5.4.4 Sand

Sand was encountered throughout all of the DC1 boreholes except for DC1-01. The native sand was below the overlying fill, organics or surficial sand and gravel noted at Borehole DC1-02. The sand was brown and contained trace to some gravel and trace to some silt. Some organics were observed in the sand in Borehole DC1-07 below the fill materials. Occasional cobbles and boulders were also noted in the sand during drilling.

The top of the sand deposit was encountered at depths from 0.7 to 4.6 m (Elev. 305.8 to 302.9 m). Interstitial layers of sand and gravel to gravelly sand and silty sand to sandy silt were encountered within the deposit. Where fully penetrated, the overall thickness of the sand deposit ranged from 1.5 to 10.1 m and extended to depths between 5.6 m and 13.1 m (Elev. 301.4 to 293.9 m). Boreholes DC1-02 and DC1-04 were terminated within the sand layer at depths of 12.6 to 17.4 m (Elev. 293.4 to 285.6 m).

SPT ‘N’ values from 7 to greater than 100 blows per 0.3 m penetration were recorded in the sand, indicating that the relative density ranges from loose to very dense, typically compact to dense. Natural moisture contents of the sand ranged from 2 to 28%.

The results of grain size analyses conducted on samples of the sand are provided on the Record of Borehole sheets in Appendix E1 and illustrated on Figure E2 of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 14
Sand	81 to 88
Silt	12 to 18
Clay	1 to 2
Silt and Clay	5 to 15

5.4.5 Sand and Gravel to Gravelly Sand

Sand and gravel to gravelly sand was encountered in Boreholes DC1-01, DC1-02, DC1-06, and DC1-07. The deposit was encountered at the ground surface in DC1-01 and DC1-02, below the sand in DC1-06 at a depth of 5.6 m (Elev. 301.4 m), and within the larger sand deposit at depths of 8.7 m and 5.6 m (Elev. 302.2 and 294.3 m), in DC1-02 and DC1-07 respectively.

Where fully penetrated, the sand and gravel to gravelly sand ranged in thickness from 1.6 to 6.1 m, with the base ranging from 7.2 to 14.8 m depth (Elev. 300.6 to 288.2 m), except for a 0.7 m thick surficial layer in Borehole DC1-02. The deposit was thicker at Borehole DC1-01, which was terminated within the sand and gravel at a depth of 9.4 m (Elev. 280.0 m).

SPT ‘N’ values recorded in the sand and gravel to gravelly sand ranged from 7 to greater than 100 blows per 0.3 m of penetration, indicating that the relative density ranges from loose to very dense, typically compact to very dense. Natural moisture contents of the sand and gravel to gravelly sand ranged from 2 to 22%.

The results of grain size analyses conducted on samples of the deposit are provided on the Record of Borehole sheets in Appendix E1, and illustrated on Figure E3 of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	36 to 52
Sand	45 to 54
Silt and Clay	3 to 13

5.4.6 Silty Sand to Sandy Silt

A layer of silty sand to sandy silt, containing trace clay, trace to some gravel, and occasional cobbles was encountered within or below the native sand or underlying the sand and gravel in

Boreholes DC1-03 to DC1-07. The silty sand to sandy silt deposit was encountered at depths ranging from 7.6 m to 10.7 m (Elev. 299.4 to 296.5 m) and extended to depths of 10.2 to 16.0 (Elev 296.8 to 290.5 m). Where fully penetrated, the layer thickness ranged from 1.5 m to 6.0 m. Borehole DC1-07 was terminated within the sand silt at a depth of 11.3 m (Elev. 296.5 m). Borehole DC1-03, was terminated upon auger refusal at the base of the silty sand layer at a depth of 16.0 m (Elev. 290.5 m).

SPT 'N' values recorded in the silty sand to sandy silt ranged from 6 to greater than 100 blows per 0.3 m penetration, indicating a loose to very dense relative density. Natural moisture contents ranged from 9 to 25%.

The results of grain size analyses conducted on samples of the silty sand to sandy silt are provided on the Record of Borehole sheets in Appendix E1, and illustrated on Figure E4 of Appendix E2. The results are summarized as follows:

Soil Particle	Percentage (%)
Gravel	0 to 15
Sand	58 to 83
Silt	15 to 26
Clay	1 to 3

5.4.7 Bedrock

Bedrock was encountered underlying the overburden soils at depths from 10.7 to 13.1 m (Elev. 296.3 to 293.9 m) in Boreholes DC1-05 and DC1-06.

The bedrock was described as slightly weathered to fresh and was visually identified as grey granodiorite in DC1-05, and as red to grey granodiorite to granite in DC1-06. The bedrock was proven by coring 3.5 m into the rock in each borehole.

The Fracture Index (FI), measured as the total number of fractures per 0.3 m of rock core length, was typically between 1 and 6 fractures. Total Core Recovery (TCR) values measured on recovered bedrock samples was 100%. Solid Core Recovery (SCR) values ranged from 29 to 100% (average of 65%). Rock Quality Designation (RQD) values varied from 0 to 76% indicating a range from poor to fair (average of 51%).

Estimated rock strength values were interpreted from Point Load Tests conducted on the rock cores. The average uniaxial compressive strength (UCS) values per core run from the point load tests ranged from 11 to 205 MPa, typically between 96 and 205, indicating that the bedrock is locally weak but typically medium strong to extremely strong. Photographs of the rock core samples and the results of the point load tests are presented in Appendix F.

5.4.8 Groundwater Conditions

A standpipe piezometer was installed in Borehole DC1-04 to monitor the groundwater level. The measured groundwater levels are summarized in Table 5.4 below.

Table 5.4: DC1-04 Groundwater Measurements

Borehole	Piezometer (m)				Date	Water Level (m)	
	Top of Screen Depth	Top of Screen Elevation	Bottom of Screen Depth	Bottom of Screen Elevation		Depth	Elevation
DC1-04	9.5	296.5	12.6	293.4	March 2, 2024	3.4	302.6
					March 3, 2024	10.6	295.4
					March 4, 2024	9.88	296.1
					March 11, 2024	10.25	295.7
					March 14, 2024	10.25	295.7
					March 17, 2024	9.3	296.7
					March 18, 2024	9.78	296.2

Seasonal fluctuations of the groundwater levels are to be expected. The groundwater levels may be at a higher elevation after periods of significant or prolonged precipitation.

6. CORROSIVITY AND SULPHATE TEST RESULTS

Four soil and two surface water samples collected from near the proposed culvert locations at HF1 and HF3 were submitted for analytical testing of corrosivity parameters and sulphate. The results of the analytical tests are summarized in Table 6.1 below and presented in Appendix G.

Table 6.1 Corrosivity Test Results

Parameter	Units (Soil)	Units (Water)	HF1-01 SS3 (5’ – 7’)	HF1-04 SS4 (7.5’ – 9.5’)	HF1	HF3-02 SS5 (10’ – 12’)	HF3-03 SS11 (40’ – 40’9”)	HF3
			Gravelly Sand 1.5 - 2.1 m	Gravelly Sand, 2.3 - 2.9 m	Water	Sand and Gravel, 3.0 - 3.7 m	Sandy Silt, 12.2 - 12.4 m	Water
Chloride	µg/g	mg/L	27	6.1	0.37	10	11	38
Sulfate	µg/g	mg/L	3	2.1	1.6	2.1	1	4.0
Sulfide	%	µg/L	< 0.01	< 0.01	<6	< 0.01	< 0.01	<6

Parameter	Units (Soil)	Units (Water)	HF1-01 SS3 (5' – 7')	HF1-04 SS4 (7.5' – 9.5')	HF1	HF3-02 SS5 (10' – 12')	HF3-03 SS11 (40' – 40'9")	HF3
			Gravelly Sand 1.5 - 2.1 m	Gravelly Sand, 2.3 - 2.9 m	Water	Sand and Gravel, 3.0 - 3.7 m	Sandy Silt, 12.2 - 12.4 m	Water
Electrical Conductivity	µS/cm	µS/cm	88	36	26	50	178	194
pH	-	-	6.05	6.32	6.8	7.13	8.78	7.78
Redox Potential	mV	mV	295	278	226	284	304	192
Resistivity*	ohm.cm	ohm.cm	11400*	27800*	38500*	20000*	5620*	5150*

* Calculated based on conductivity result

7. CLOSURE

The field investigation was supervised on a full-time basis by Mr. Matthew Macaskill, E.I.T. of Thurber. Overall supervision of the field program was provided by Ms. Rachel Bourassa, E.I.T.

Interpretation of the field data and report preparation was carried out by Ms. Rachel Bourassa, E.I.T., and Mr. Mark Farrant, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a designated principal contact for MTO Foundations Projects.

Thurber Engineering Ltd.





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Date: October 22, 2024
File: 37996

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8. GENERAL

This report presents interpretation of the geotechnical data in the factual report and provides foundation recommendations for the detailed design and construction of the proposed Highway 17 realignment from 9.3 to 13.3 km west of the township of Schreiber, Ontario.

This foundation investigation and design report with the interpretations and recommendations is intended for the use of Hatch and the Ministry of Transportation of Ontario and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractors. The contractors must make their own interpretations based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The proposed works are for the detailed design of a 4 km long curve realignment of Highway 17 from 9.3 km west to 13.3 km west of the Township of Schreiber. The foundation aspects of the project include construction of new high fill embankments and deep cut sections for the new alignment, as well as the installation of new non-structural culverts in two high fill locations. The project also includes construction of a new structural culvert where the realigned highway crosses Hewitson Creek. Foundation recommendations for the Hewitson Creek structure and high fill approach embankments are discussed in a separate report (Reference 1).

A separate detailed level pavement investigation of the proposed highway realignment was previously completed by Thurber, which is discussed in a separate report (Reference 2). The pavement investigation included an additional deep cut section in potential bedrock of up to 21 m deep, from approximate Sta. 10+390 to 10+800. No foundation boreholes were advanced in this cut area. The pavement report (Reference 2) should be consulted for factual information and geotechnical recommendations related to the potential rock cut area.

A summary of the high fill embankment (fills of 4.5 m height or greater) and deep cut section (cuts of 4.5 m deep or greater) boreholes advanced, and anticipated foundation soils in each section is provided in Table 8.1 below.

Table 8.1: Summary of Investigation Program

Section	Approximate Station	Length (m)	Maximum Fill Height or Cut Depth (m)	Boreholes	Anticipated Foundation Soils
High Fill 1 and Non-Structural Culvert (HF1)	10+250 to 10+300	50	8	HF1-01 to HF1-04	Organics (up to 300 mm thick), shallow sand to sand & gravel overlying sand to silty sand, silty clay overlying granite bedrock at 8 to 17 m deep
High Fill 3 and Non-Structural Culvert (HF3)	11+600 to 11+650	50	13	HF3-01 to HF3-04	Topsoil (up to 800 mm thick), silty sand to sandy silt, sand and gravel, silty sand to silt overlying granite bedrock at 18 to 23 m deep
High Fill 4 (HF4)	12+050 to 12+300	250	8 (at CL) 12 (at slope)	HF4-01 to HF4-06	Topsoil (up to 225 mm thick), overlying sand and gravel deposits, sand, silt and sand
Deep Cut 1 (DC1)	12+375 to 12+650	275	14	DC1-01 to DC1-07	Asphalt and fill materials overlying native organics, sand, sand and gravel, and silty sand to sandy silt overlying granite to granodiorite bedrock at 10 to 13 m deep.

The locations of the boreholes are shown on the Borehole Locations and Soil Strata Drawings included in Appendix A. Details of the subsurface conditions encountered during the foundation investigation are presented in the Record of Borehole sheets in Appendices B1 to E1.

9. FOUNDATION DESIGN METHODOLOGY

The foundation stability and time dependent settlements, their impacts on the construction schedule and the long-term performance of the proposed embankments have been analyzed for selected critical sections in each high fill and deep cut area included in the current investigation. The embankment fill heights, cut depths and slope geometry used for analysis noted in this report are based on the vertical profile and cross-section drawings provided by Hatch throughout the project, including cross-sections received on July 25 and September 9, 2024. Additional construction considerations are discussed in Section 10.

9.1 General

The subsurface conditions at the high fill and deep cut locations were investigated to assess the stability of the proposed embankment fill and cut slopes, potential settlement issues under the embankments as well as anticipated construction concerns.

Geotechnical factors to be addressed for design of the embankments and deep cuts on this project include:

- The thickness, extent and engineering properties of the foundation soils, with consideration to the extent and thickness of topsoil, organic deposits, compressible and/or excessively soft/loose soils.
- The depth to bedrock or refusal materials.
- Embankment material type (rock fill, granular fill or earth fill).
- Embankment geometry including height, side slope inclination and requirements for stabilizing berms.
- Construction and post-construction settlement of embankments.
- Cut slope geometry including slope angle and requirement for benches.
- Temporary and long-term drainage requirement and erosion control for cut slopes.
- Dewatering for placement of fill in the dry.
- Bedding and backfill requirements for non-structural culverts located in high fill embankment areas.
- Construction procedures.

For the purpose of preparing foundation design recommendations, a number of assumptions have been made that are consistent with MTO's standard highway design practices, including:

- Peat, topsoil, organic deposits, and other deleterious material will be stripped prior to constructing embankments (OPSS.PROV 206).
- Where new fill is placed against an existing earth or granular embankment slope or on a sloping ground surface steeper than 3H:1V, the existing slope will be benched as per OPSD 208.010.
- It is assumed that all high fill embankments on this project (i.e. 4.5 m or greater in height) will be constructed using granular fill or rock fill, except where otherwise noted. It is assumed that excavated bedrock from the deep rock cut area may be used as a source for rock fill and that excavated sand and sand and gravel from Deep Cut area 1 (DC1) may be used as a source for granular fill.

- Embankments will be constructed as outlined in Section 10, with side slopes not steeper than 1.25H:1V for rock fill and 2H:1V for granular fill unless otherwise noted.
- Granular fill embankment slopes at or greater than 8 m high will be provided with a 2 m wide mid-height bench.
- Rock fill embankment slopes at or greater than 10 m high will be provided with a 2 m wide mid-height bench.
- A transition treatment will be provided between adjoining rock fill and granular fill embankment materials (OPSD 205.040).
- All earth cuts will not be steeper than 2H:1V, unless otherwise stated.
- Earth cuts with depths of 6 m or greater will be provided with a 2 m wide mid-height bench.
- A transition will be provided between rock cuts and earth cuts (OPSD 205.050), rock cuts and granular fills (OPSD 205.030) and rock cuts and rock fills (OPSD 205.020).
- Permanent drainage and erosion protection will be provided for all earth cuts and granular embankment slopes. Interceptor ditches will be installed at all earth cut sections (OPSD 200.020).
- Culvert installations will be required in High Fill Areas 1 and 3. It is understood that both culverts are non-structural with spans of less than 3 m.
- All fills shall be placed in the dry.

9.2 Engineering Analyses

Subsurface models were prepared for stability and settlement analyses of the critical embankment sections based on a compilation and analysis of all borehole logs and available field and laboratory testing data. Engineering parameters were selected based on the results of the field and laboratory testing.

9.2.1 Stability Analysis

Slope stability analysis was performed to assess the global stability of the critical sections along the new alignment including at high fills and deep cut areas. The stability analysis was performed using the commercially available software Slope/W, developed by GEO-SLOPE International Ltd.

Static and seismic analyses were performed using the Morgenstern-Price method. As the foundations soils were predominantly cohesionless at the critical sections, long-term / drained conditions were assumed for static effective stress analysis. Analyses were completed using both rock fill and granular fill (locally excavated sand borrow material) for the proposed embankments, with an assumed traffic loading of 16 kPa.

High fill embankments HF1 and HF3 are anticipated to be designed with 1.25H:1V side slopes for rock fill, or 2H:1V side slopes for local granular borrow fill; both with 2 m wide mid-height benches where applicable. Due to the varying terrain including existing slopes offset from the proposed centreline, as well as property limit constraints identified by Hatch, three sections were analyzed within high fill embankment HF4. Near Sta. 12+050, High fill HF4 is anticipated to be designed with a combination of local granular borrow fill overlying rock fill where necessary to address the property constraints. In addition, a widening / slope flattening is proposed near Sta. 12+300 to accommodate a local trail crossing. This widening / slope flattening will be constructed with local granular borrow, which will not contain topsoil or other organic material and will be compacted as per OPSS.PROV 501 (refer to Section 10.1 below). Side slope inclinations at high fill HF4 of 1.25H:1V are anticipated where rock fill is used, and 2H:1V where local granular borrow fill is used; incorporating 2 and 3 m wide mid-height benches where applicable.

The deep cut section (DC1) was assessed with cut slopes inclined at 2H:1V with 2 m wide mid-height benches where applicable. An additional analysis was conducted at Sta. 9+950 of the proposed new Rainbow Falls Provincial Park entrance road, where cut slopes of up to 6 m are anticipated and property constraints limit the use of typical 3H:1V cut slopes. Therefore, based on soil information from Reference 2, an analysis of cut slopes inclined at 2.5H:1V was carried out at this location.

The analyses under seismic loading were performed using a pseudo-static slope stability analysis. All examined sections were analyzed using a horizontal seismic coefficient based on CHBDC 2019 Site Class D (Section 4.4.3.2 of CHBDC 2019). Therefore, a horizontal seismic coefficient, k_h, of 0.032g (one-half of the corresponding site peak ground acceleration in accordance with Section 6.14.9.1 of CHBDC 2019) was used for the seismic stability analysis. The site peak ground acceleration was calculated through the Natural Resource Canada's 2020 National Building Code Seismic Hazard Calculation tool.

The analyses assume that any peat and organic soils below the new embankment footprint have been sub-excavated and backfilled with granular or rock fill prior to placement of new embankment fill, as described in Section 10.1. It is also assumed that all embankment fills will be placed in the dry.

The results of the stability analyses are presented on Figures 1 to 28 in Appendix I and summarized in Table 9.1 below.

Table 9.1: Summary of Stability Analysis

Section	Station	Approx. Fill Height or Cut Depth	Slope Geometry and Fill Type	Loading Condition	Factor of Safety	Figure No.
High Fill 1 (HF1)	10+263	Up to 8 m	1.25H:1V Rock Fill	Static	1.53	1
				Seismic	1.44	2
			2H:1V Mid-Height Bench Local Granular Borrow	Static	1.52	3
				Seismic	1.39	4
High Fill 3 (HF3)	11+610	Up to 13 m	1.25H:1V Mid-Height Bench Rock Fill	Static	1.47	5
				Seismic	1.37	6
			2H:1V 2 Mid-Height Benches Local Granular Borrow	Static	1.48	7
				Seismic	1.36	8
High Fill 4 (HF4)	12+050	11 m along existing slope	1.25H:1V 2 Mid-Height Benches Rock Fill	Static	1.38	9
				Seismic	1.29	10
			2H:1V 2 Mid-Height Benches Local Granular Borrow	Static	1.55	11
				Seismic	1.42	12
			2H:1V Local Granular Borrow over 1.25H:1V Rock Fill 2 Mid-Height Benches **(3 m wide)**	Static	1.49	13
				Seismic	1.38	14
	12+250	Up to 8 m along centreline	1.25H:1V Rock Fill	Static	1.46	15
				Seismic	1.37	16
			2H:1V 2 Mid-Height Benches Local Granular Borrow	Static	1.47	17
				Seismic	1.34	18
	12+300	12 m along existing slope	1.25H:1V 2 Mid-Height Benches Rock Fill	Static	1.56	19
				Seismic	1.45	20
			2H:1V 2 Mid-Height Benches Local Granular Borrow	Static	1.47	21
				Seismic	1.35	22
			2H:1V 2 Mid-Height Benches Local Granular Borrow With Widening / Slope Flattening	Static	1.47	23
				Seismic	1.35	24
Deep Cut 1 (DC1)	12+450	Up to 14 m	2H:1V Mid-Height Bench Earth Cut Slope	Static	1.45	25
				Seismic	1.34	26
Rainbow Falls Provincial Park Entrance Road	9+950	Up to 6 m	2.5H:1V Earth Cut Slope in Silt, some Sand	Static	1.53	27
				Seismic	1.40	28

The computed Factors of Safety (FOS) against slope instability typically meet the minimum FOS required by MTO for typical degree of understanding of approximately 1.5 for static analysis of permanent slopes. The computed FOS for pseudo-static seismic analysis were greater than the minimum FOS required by CHBDC 2019 of 1.1 for typical degree of understanding at all sections assessed.

At High Fill area 4 at Sta. 12+050, Figure 9 indicates that 1.25H:1V rock fill slopes do not achieve an FOS of 1.5. Although 2H:1V granular fill slopes are acceptable from a stability perspective (Figure 11, FOS of 1.55), the toe of the embankment may be too close to the right-of-way limits. Therefore, a combination of local granular borrow fill overlying rock fill (Figure 13, FOS of 1.49) is an acceptable alternative, provided that the 2 mid-height benches are 3 m wide.

At High Fill area 4 at Sta. 12+300, Figures 19 and 21 indicate that rock fill or local granular borrow fill embankment slopes are acceptable. Where the embankment requires widening / slope flattening to accommodate the trail crossing, the widened portion of the fill is also acceptable (Figure 23, FOS of 1.47), provided that it is also constructed of local granular borrow following the configuration of the main embankment. Topsoil or other organic material must not be incorporated within the fill used for widening / slope flattening.

At the Rainbow Falls Provincial Park entrance road, Figure 27 (FOS of 1.53) indicates that earth cut slopes of up to 6 m deep in silt with some sand can be steepened from 3H:1V to 2.5H:1V where necessary to address property constraints.

Based on the results of the slope stability analyses, the proposed high fill and deep cut sections are anticipated to be stable at the slope geometries shown, provided that 2 m wide mid-height benches are included for the applicable fill heights and cut depths as shown (and 3 m wide mid-height benches at Sta. 12+300). Recommendations for construction of high fill embankments and deep cut sections are included in Sections 10.1 and 10.2 respectively.

9.2.2 Settlement Analysis

Settlement analyses were carried out to estimate the magnitude of settlement of the foundation soils occurring during construction and post-construction (long term) under the weight of the embankment fill in the high fill sections and to estimate the magnitude of the embankment fill compression.

In accordance with the MTO document titled “Embankment Settlement Criteria for Design” dated July 2, 2010, one of the criteria adopted for new embankment design is to limit the maximum permissible post-construction settlement within 20 years following paving to 100 mm for compressible soils and 50 mm for non-compressible soils.

As shown in Table 8.1, the foundations soils were generally cohesionless sand, silt, and gravel at all investigated sites. Cohesive foundation soils are present at only one of the sites investigated,

High Fill Area 1, which consists of an approximately 0.6 m to 1.5 m thick silty clay to clayey silt layer. The cohesive layer was encountered below 7.0 to 15.0 m of sand, silty sand, and gravelly sand.

The results of the settlement analyses of the foundation soils at the embankment sections are summarized in Table 9.2. The analyses assume that all topsoil and organic soils below the new embankment footprints have been stripped prior to placement of new embankment fill, as described in Section 10.1.

An assessment of the self-weight compression of the embankment fill materials was also completed. Settlement of the road grade on compacted rock and granular fills is expected to continue at a decreasing rate with time, due to particle re-orientation and degradation of the interparticle contacts. This settlement occurs within 1 year of embankment construction (90% in the first 6 months) over the short-term, and settlement of a further 0.1% of the embankment height occurs after the 1-year period over the long-term life of the embankment.

The estimated settlements due to rock and local granular fill compression at the embankment sections are included in Table 9.2.

The estimated magnitudes and rates of settlement are considered approximate and may vary along and across the highway alignment subject to the thickness of compressible layers at a particular location, variations in the consolidation characteristics of the deposits with depth and location, layer boundary conditions, variations in the relative density of cohesionless soils, the presence of organics or silt/sand/clay partings within the various strata, the depth to bedrock, the height of embankment, and degree of compaction achieved in the fill.

Table 9.2: Estimated Settlements

Section	Station	Approx. Fill Height	Estimated Settlements at Highest Fill Location				
			Foundation Settlement	Rock Fill Compression (mm)		Local Granular Fill Compression (mm)	
			Total (mm)	First 6 Months*	After 6 Months	First 6 Months*	After 6 Months
High Fill 1 (HF1)	10+263	Up to 8 m	90	55	15	40	15
High Fill 3 (HF3)	11+610	Up to 13 m	55	120	30	60	20
High Fill 4 (HF4)	12+250	Up to 8 m	40	55	15	40	15

** Time starts after fill has been placed up to the designed pavement elevation*

The anticipated foundation settlements in the high fill areas range from 40 to 90 mm along the proposed new alignment at the highest fill sections. The settlements will be less as the fill height decreases. The majority of the foundation settlements are expected to occur immediately as embankment construction takes place and be completed by the end of construction.

To mitigate the effects of the settlement due to embankment fill compression, it is recommended

that the new embankments be constructed several months (approximately 3 to 4) in advance of pavement construction to allow the majority of the fill compression to occur.

The embankment and platform width design should be overbuilt and allow for the anticipated foundation and embankment compression settlements provided in Table 9.2, and allow for placement of additional fill to the grade level at the end of the preloading period prior to paving.

10. CONSTRUCTION CONSIDERATIONS

10.1 High Fill Embankments

New high fill embankments are anticipated to be constructed with local granular fill or rock fill excavated from cut sections within the project limits. Embankment construction should be carried out in accordance with OPSS.PROV 206. Rock size should be controlled in accordance with OPSS.PROV 206.

At the sampled locations, based on gradation testing, the existing sand and gravel to gravel fill and the native sand and gravel excavated from Deep Cut area DC1 are considered to be generally acceptable as OPSS.PROV 1010 Granular B Type 1. The native sand excavated from Deep Cut area DC1 is generally acceptable as OPSS.PROV 1010 Select Subgrade Material (SSM). Any organic layers in the excavated sands should not be hauled to the fill sites and should be wasted.

Topsoil and/or organic deposits encountered within the embankment footprints should be stripped and grubbed in accordance with OPSS.PROV 201 and OPSS.PROV 206. Surface drainage and sump pumps are considered appropriate for dewatering where required for stripping of organics.

Rock fill placed above the water table should be constructed in a controlled manner (not end dumped) including blading, dozing and chinking of the rock to minimize voids and bridging. Rock fill must be compacted as per OPSS.PROV 206. Rock fill used to backfill sub-excavated areas below the water table may be placed by end dumping.

At the pavement subgrade level or where granular fill is to be placed over rock fill, the rock fill subgrade must be blinded with spall material and rock fill chinking should be in accordance with OPSS.PROV 206. All granular fill, including where used for widening / slope flattening near Sta. 12+300, must be compacted as per OPSS.PROV 501. All granular embankment fill must be placed in the dry. Appropriate dewatering for embankment fill construction must be carried out in accordance with OPSS.PROV 517 and SP517F01. The design of any dewatering systems is the responsibility of the Contractor. An NSSP to this effect is attached in Appendix J.

Mid-height berms comprising 2 m wide benches should be incorporated along the length of embankments with heights at or exceeding 10 m in rock fill or 8 m in granular fill. Where shown in Table 9.1, 3 m wide benches should be used (near Sta. 12+050). Where new embankment fill is placed against existing embankment slopes or on a sloping ground surface steeper than 3H:1V, the existing earth or granular fill slope must be benched in accordance with OPSD 208.010.

10.2 Cut Sections

The Deep Cut area DC1 investigated is anticipated to involve cuts in typically compact to dense sands, gravels, and silts overlying bedrock. Excavations for cut slope construction should be in accordance with OPSS.PROV 206. All earth cut slopes should be constructed at no steeper than 2H:1V.

Mid-height berms comprising 2 m wide benches should be incorporated along the length of the earth cuts with depths at or exceeding 6 m. The bench should maintain a 2% slope to shed surface run-off.

During construction of earth cuts some areas may reveal a final subgrade to be loose / soft and moisture sensitive. Sub-excavation of the exposed subgrade loose, soft or weak soils may be required in some areas. Sub-excavated areas should be backfilled with well compacted granular fill. Inspection of the subgrade level following earth cut excavation should be carried out by FES staff, including supervision and inspection of sub-excavated areas.

Temporary drainage of the cuts should be provided to maintain a relatively dry, stable excavation. Permanent drainage of the cuts must also be provided. Roadside ditches are expected to provide an adequate level of surface drainage in most areas. Interceptor ditches should be provided at the top of the deep earth cuts in accordance with OPSD 200.020.

Slope protection and drainage measures will be required to ensure the long-term surficial stability of the earth cut slopes. Slope vegetation should be established as soon as possible to protect against surficial erosion in general accordance with OPSS.PROV 804. If vegetation protection is not in place by the winter season, an alternate protection, such as covering the earth cut slopes with temporary erosion control blankets, is recommended to reduce the potential for remedial works required on the side slopes in the spring season prior to topsoil and seeding.

10.3 Non-Structural Culverts

10.3.1 Culvert Excavation, Bedding, Backfill and Groundwater Control

The excavations for culvert installations in High Fill areas HF1 and HF3, which are located at deep watercourse valleys, will extend through existing surficial organics, as well as layered sand, gravelly sand, silty sand, and silt deposits below the water table.

Culvert subgrade preparation, placement and compaction of the bedding layer must be done in the dry. All excavations for culvert construction must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native sand, silt, and gravel with cobbles and boulders that lie above the water table are classified as Type 3 soils. Below the water table (i.e., if the groundwater flow is not controlled), these soils as well as topsoil, peat or other alluvial deposits should be treated as Type 4 soils. As the excavations will likely extend into cohesionless soils below the groundwater table and creek level, surface water control

and effective lowering of the groundwater level will be required to maintain dry excavations for subgrade and bedding preparation.

The equipment used to excavate for culvert construction must be capable of removing/dislodging cobbles and boulders. The selection of the excavation equipment and the means and method of excavation is the responsibility of the Contractor. An NSSP to this effect is attached in Appendix J.

Excavation, bedding, backfilling, and compaction for non-structural culverts must be carried out in accordance with OPSS.PROV 401, OPSS.PROV 421, OPSD 802.010 and OPSD 802.014, as appropriate. Dewatering for grading and non-structural culverts must be carried out in accordance with OPSS.PROV 517 and SP517F01. The design of any dewatering systems is the responsibility of the Contractor.

Any fill, peat, topsoil, organic deposits, loose streambed deposits or deleterious soils at the subgrade level should be sub-excavated to reach competent native subgrade soils and replaced with well compacted granular fill to the design subgrade level.

In order to provide a uniformly competent foundation subgrade condition, the culvert should be placed on a minimum 300 mm thick layer of bedding material meeting OPSS.PROV 1010 Granular A or B Type II requirements, compacted to 98% of Standard Proctor Maximum Dry Density (SPMDD) as per OPSS.PROV 501. Construction equipment should not be allowed to travel on the bedding or the prepared subgrade, which should be protected from disturbance during construction. A separation layer consisting of a non-woven geotextile should be placed between the subgrade soils and the bedding material. The geotextile should meet the specifications for the OPSS Class II (OPSS.PROV 1860) and have a fabric opening size (FOS) not greater than 212 µm.

Culvert backfill should consist of free-draining, non-frost susceptible granular materials such as Granular A or B Type II conforming to the requirements of OPSS.PROV 1010. Rockfill or local granular borrow from the deep cut may be used as embankment fill above the culvert cover and embedment. All fills should be placed in regular lifts and be compacted in accordance with OPSS.PROV 501 or OPSS.PROV 206 as applicable. The backfill should be placed and compacted in simultaneous lifts on both sides of the culvert, and the top of backfill elevation should not differ more than 500 mm on both sides of the culvert at all times. Heavy compaction equipment should not be used adjacent to the walls and on the roof of the culvert.

10.3.2 Settlement

The new culverts in the high fill areas (HF1 and HF3) should be designed to accommodate the foundation settlements expected due to the overlying high fill embankments, described in Section 9.2.2. Accordingly, it is recommended that the culverts are oversized or designed with a camber to accommodate the estimated 55 to 90 mm of foundation settlement.

10.3.3 Scour and Erosion Protection

Erosion protection should be provided at the culvert inlets and outlets. Design of the erosion protection measures should consider hydrologic and hydraulic factors and should be carried out by specialists experienced in this field in accordance with OPSD 810.010, OPSS.PROV 511 and OPSS.PROV 1004.

Typically, rock protection should be provided over all surfaces with which water flow is likely to be in contact. A vegetation cover should be established on all other exposed earth surfaces to protect against surficial erosion in general accordance with OPSS.PROV 804.

10.4 Corrosion and Sulphate Attack Potential

The results of the corrosivity and sulphate analytical tests conducted on the soil samples collected in the boreholes drilled near the proposed culverts indicate the following conditions at the locations tested:

Highway 17 High Fill 1

- The potential for corrosion or sulphate attack on concrete from the surrounding gravelly sand to silty sand is considered to be negligible due to the low concentration of sulphate and chloride in the samples tested.
- The potential for soil corrosion on metal is considered to be very mild.
- Appropriate corrosion protection measures are recommended for metal elements such as CSP or SPCSP culverts. The effect of road de-icing salt should be considered when selecting the corrosion protection measures.

Highway 17 High Fill 3

- The potential for corrosion or sulphate attack on concrete from the surrounding sand and gravel to sandy silt is considered to be negligible due to the low concentration of sulphate and chloride in the samples tested.
- The potential for soil corrosion on metal is considered to be very mild to mild.
- Appropriate corrosion protection measures are recommended for metal elements such as CSP or SPCSP culverts. The effect of road de-icing salt should be considered when selecting the corrosion protection measures.

11. CONSTRUCTION CONCERNS

During construction, qualified Foundations Engineering Specialist (FES) staff should be retained to observe activities related to embankment and cut slope construction and advise the Contract Administrator on construction concerns or issues related to embankment and cut slope stability

or settlement.

Potential construction concerns include, but are not necessarily limited to:

- The thickness and presence of organic deposits were investigated at the borehole locations only. Organic deposits may extend to greater depths or be encountered at other locations between boreholes.
- Geotechnical confirmation is required that all peat, topsoil and organic deposits within the proposed embankment footprints are stripped and replaced with approved backfill.
- In areas with culvert construction, care must be exercised during excavation to avoid disturbing the founding subgrade. When the excavation reaches the required elevation, the subgrade should be inspected and approved by qualified geotechnical personnel.
- Culvert excavations may extend below the groundwater level in cohesionless soils in close proximity to the watercourses. There may be challenges dewatering the excavations and maintaining a dry excavation base. The Contractor must be prepared to employ suitable dewatering techniques to effectively lower the groundwater table below the base of the excavations until the culverts are installed and backfilled.

12. CLOSURE

Engineering analysis and preparation of the foundation design report were carried out by Ms. Rachel Bourassa, E.I.T., Mr. Mark Farrant, P.Eng., and Mr. Stephen Peters, P.Eng. The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.





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Geotechnical Engineering Intern

Mark Farrant, P.Eng.
Associate, Senior Geotechnical Engineer



Date: October 22, 2024
File: 37996

P.K. Chatterji, P.Eng.
Principal, Designated MTO Contact

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

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5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

APPENDIX A

Stratigraphic Plan and Profile Drawings

MINISTRY OF TRANSPORTATION, ONTARIO

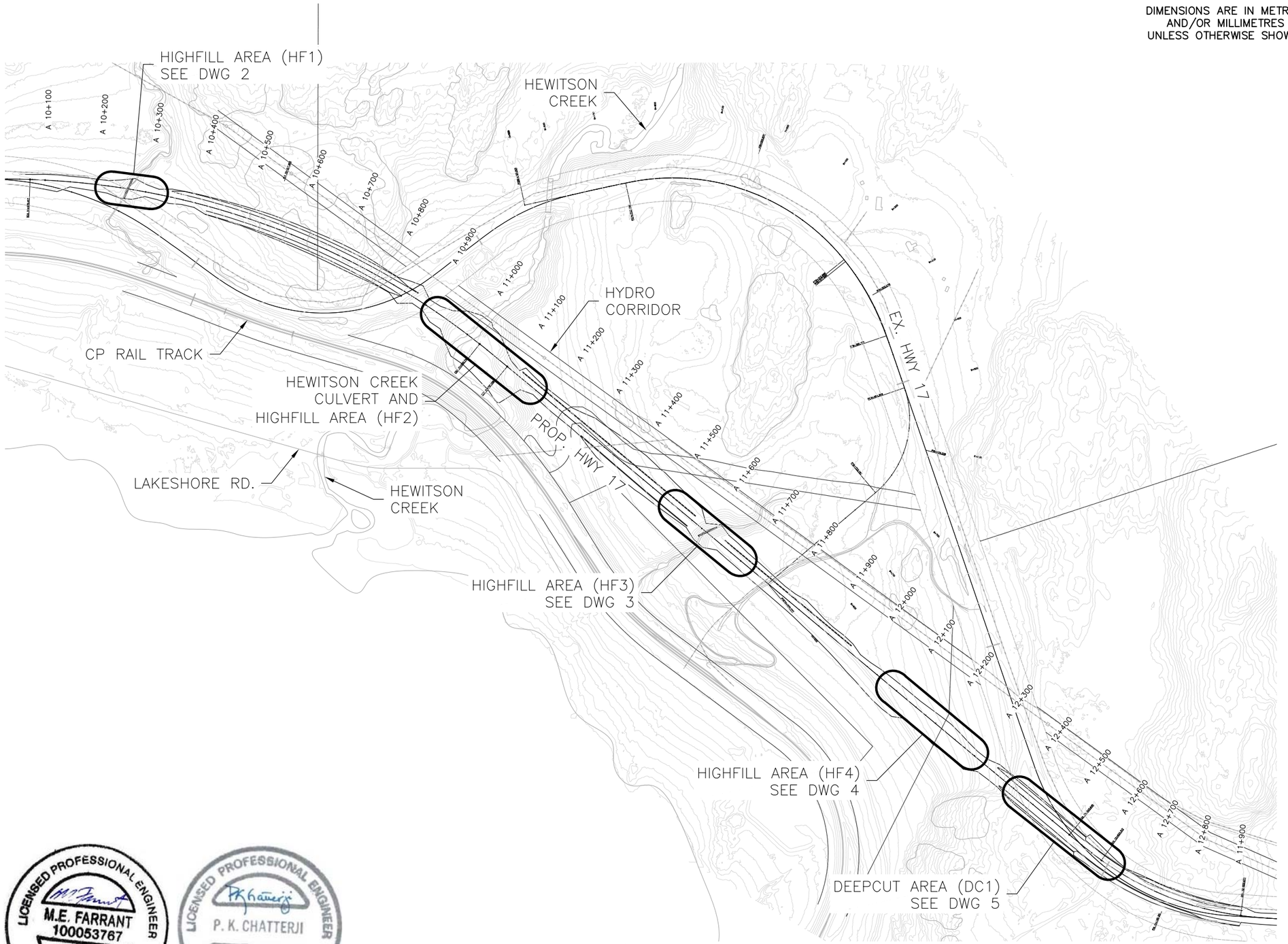
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AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 6333-14-00

HIGHWAY 17
CURVE REALIGNMENT
OVERALL KEYPLAN
SITE PLAN

SHEET



PLAN

160 0 160 320m

SCALE 1:8,000

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 42D14-001

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
October 22, 2024
PROVINCE OF ONTARIO

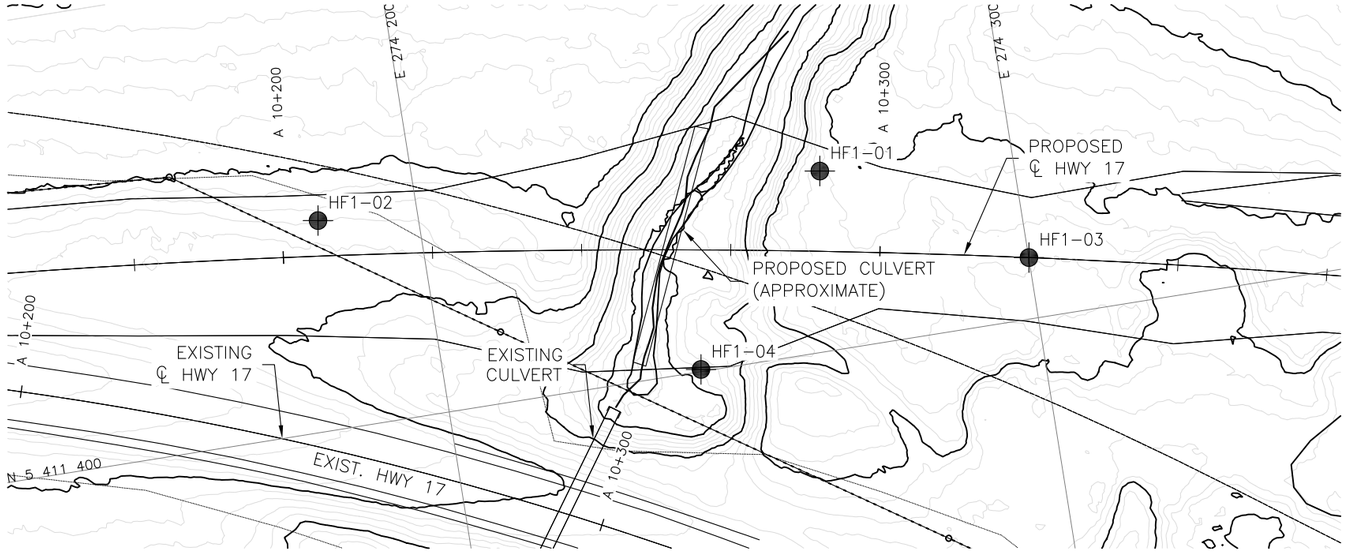
LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
October 22, 2024
PROVINCE OF ONTARIO

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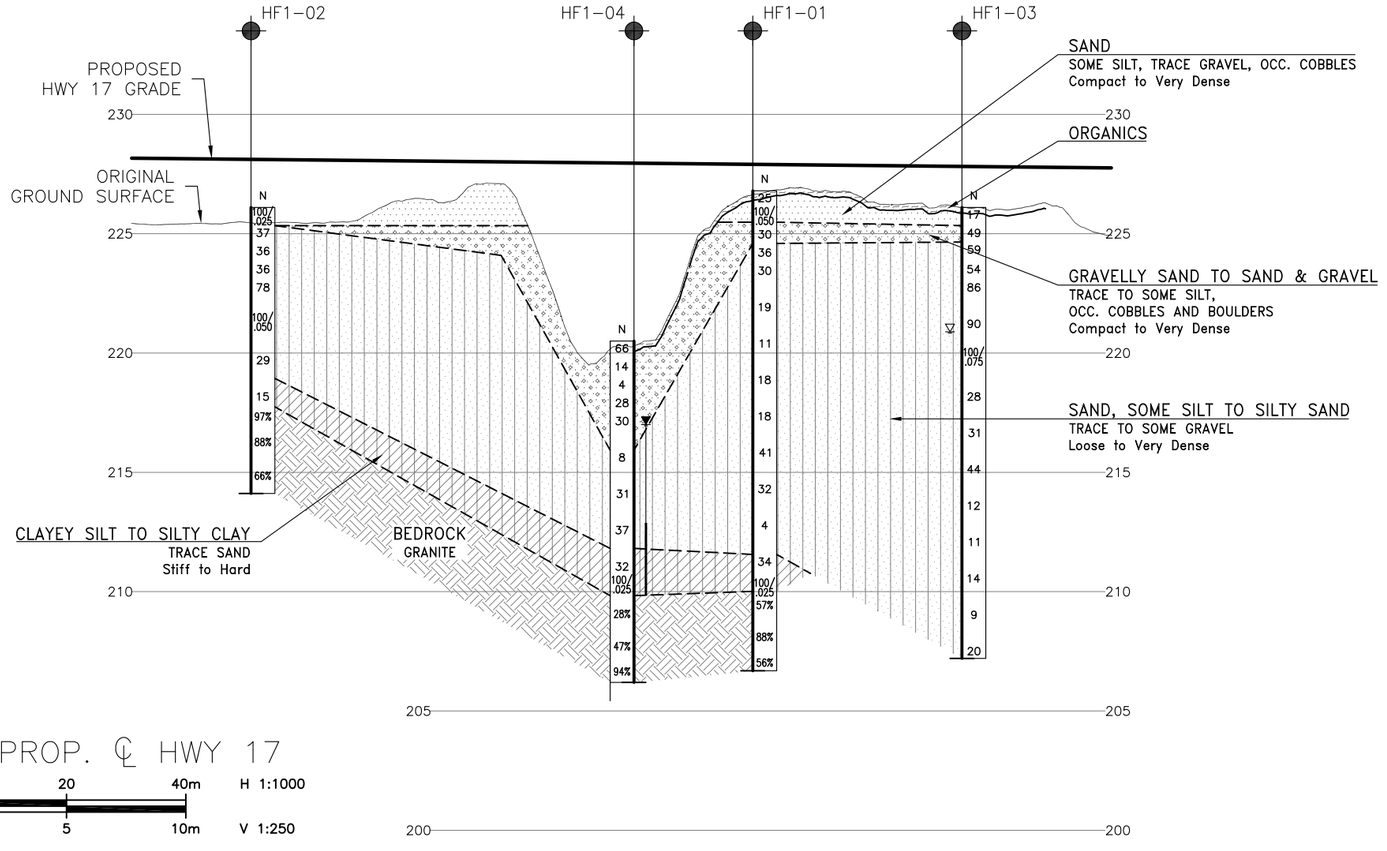
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

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SCALE 1:1000



PROFILE ALONG PROP. ℄ HWY 17

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METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
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October 22, 2024
PROVINCE OF ONTARIO

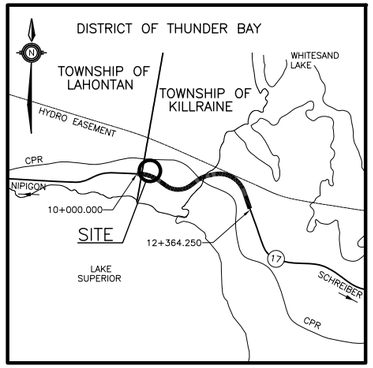
LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
October 22, 2024
PROVINCE OF ONTARIO

CONT No
GWP No 6333-14-00

SHEET

HIGHWAY 17
CURVE REALIGNMENT
HIGH FILL AREA 1
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF1-01	226.8	5 411 430.1	274 267.7
HF1-02	226.1	5 411 435.1	274 183.4
HF1-03	226.1	5 411 410.2	274 300.0
HF1-04	220.5	5 411 400.4	274 242.8

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

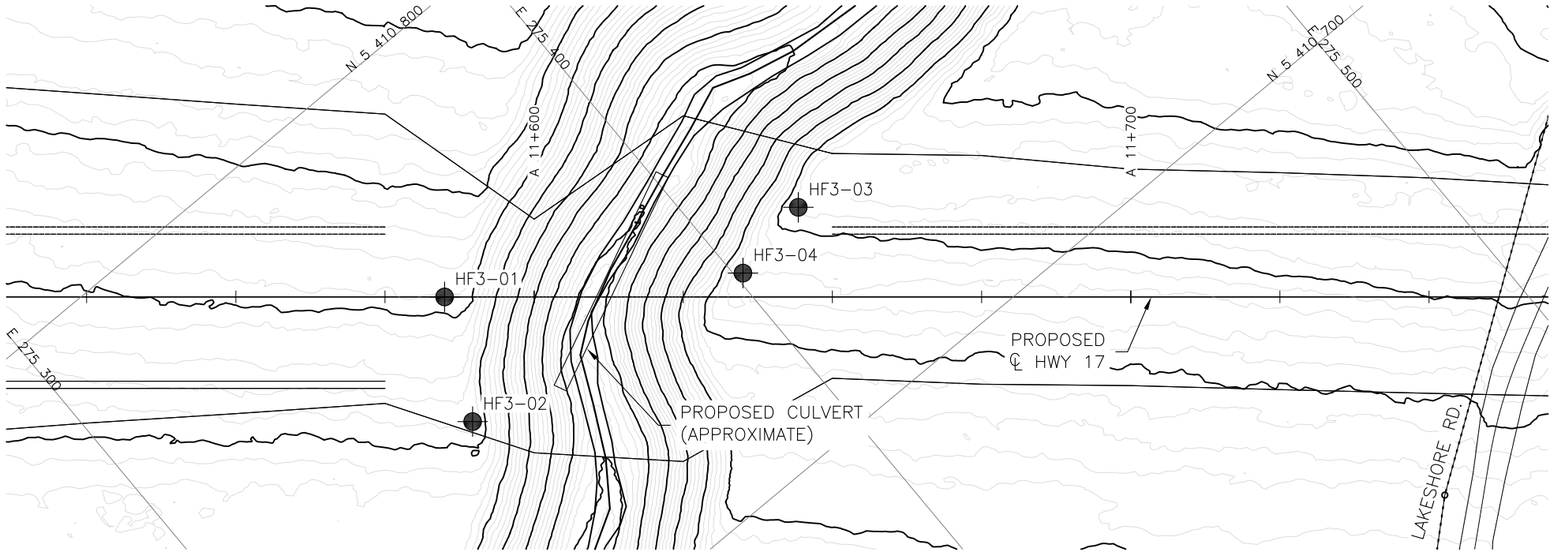
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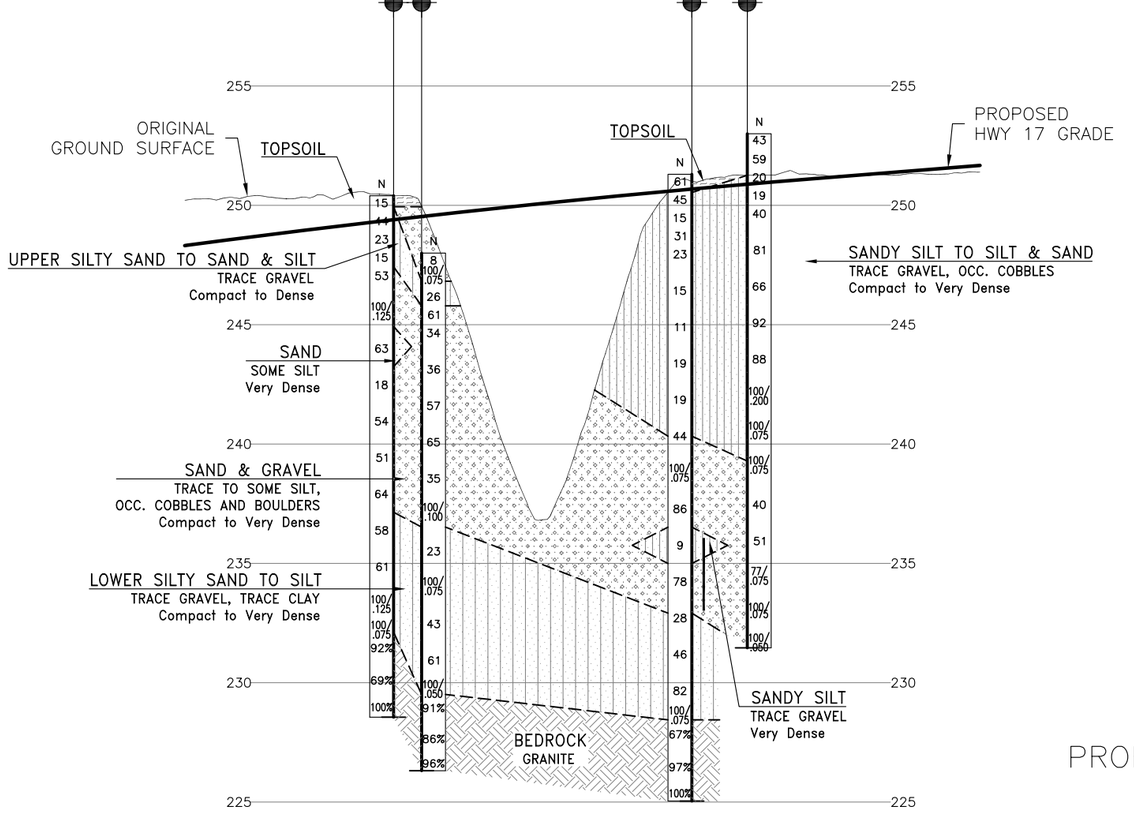
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

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SCALE 1:1000



PROFILE ALONG PROP. ℄ HWY 17

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METRIC

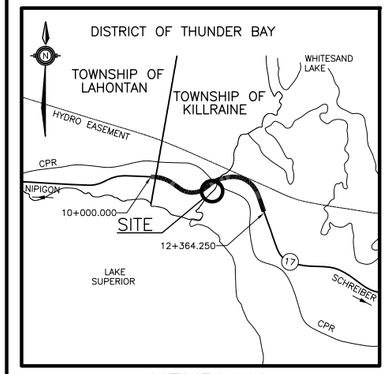
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 6333-14-00

HIGHWAY 17
CURVE REALIGNMENT
HIGHFILL AREA 3
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
▮	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF3-01	250.4	5 410 761.0	275 360.3
HF3-02	248.0	5 410 741.9	275 350.6
HF3-03	253.0	5 410 734.6	275 415.5
HF3-04	251.3	5 410 732.1	275 401.3

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 42D14-001

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
October 22, 2024
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
October 22, 2024
PROVINCE OF ONTARIO

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	RB	CHK	MEF	CODE	LOAD
DRAWN	AN	CHK	RB	SITE	STRUCT

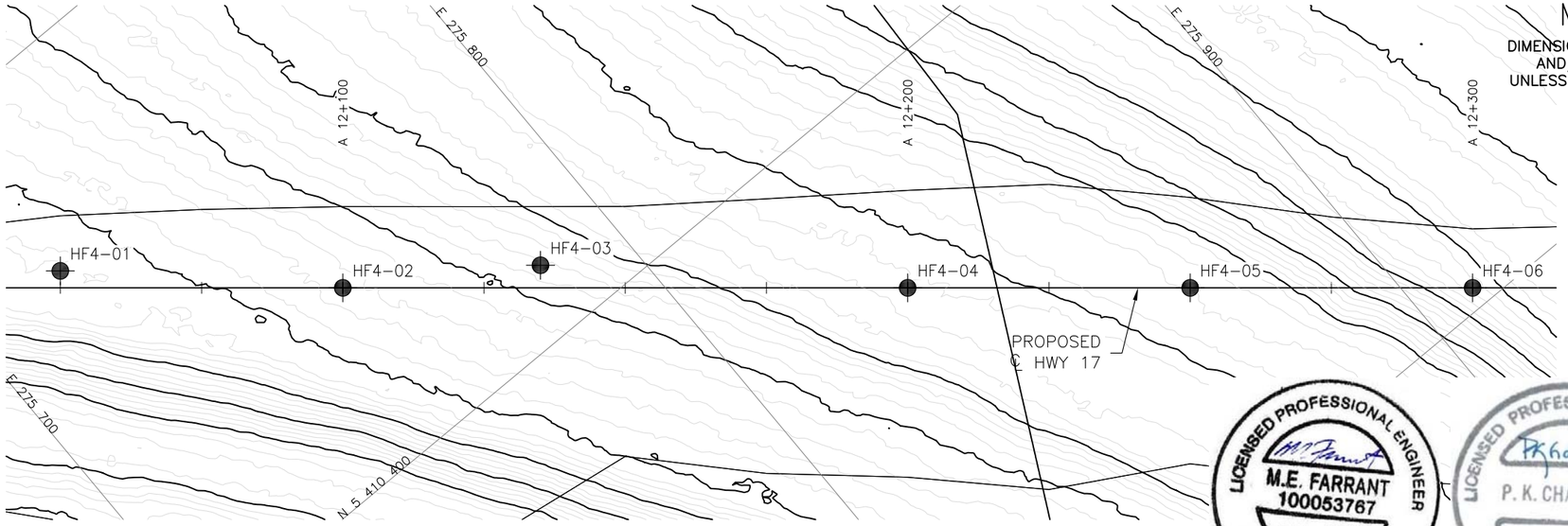
DATE OCT 2024
DWG 3

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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN



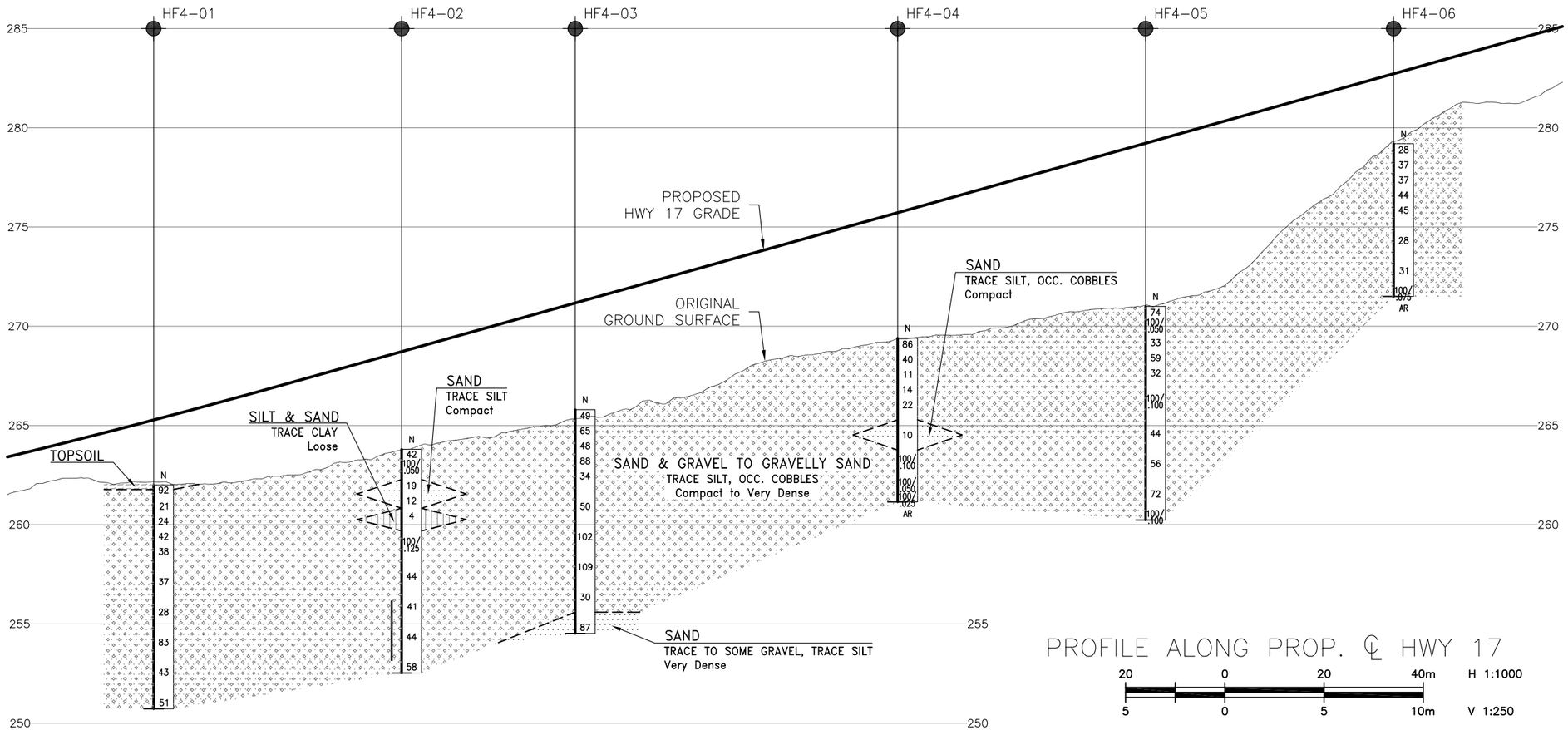
PLAN

20 0 20 40m

SCALE 1:1000

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P. K. CHATTERJI
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PROFILE ALONG PROP. ℄ HWY 17

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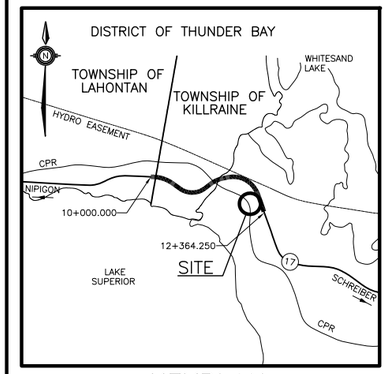
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CONT No
GWP No 6333–14–00

SHEET

HIGHWAY 17
CURVE REALIGNMENT
HIGHFILL AREA 4
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
HF4–01	262.0	5 410 465.8	275 719.6
HF4–02	263.8	5 410 431.5	275 756.1
HF4–03	265.8	5 410 412.2	275 785.6
HF4–04	269.4	5 410 367.5	275 833.0
HF4–05	271.0	5 410 335.5	275 871.4
HF4–06	279.2	5 410 303.5	275 909.8

-NOTES-

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2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

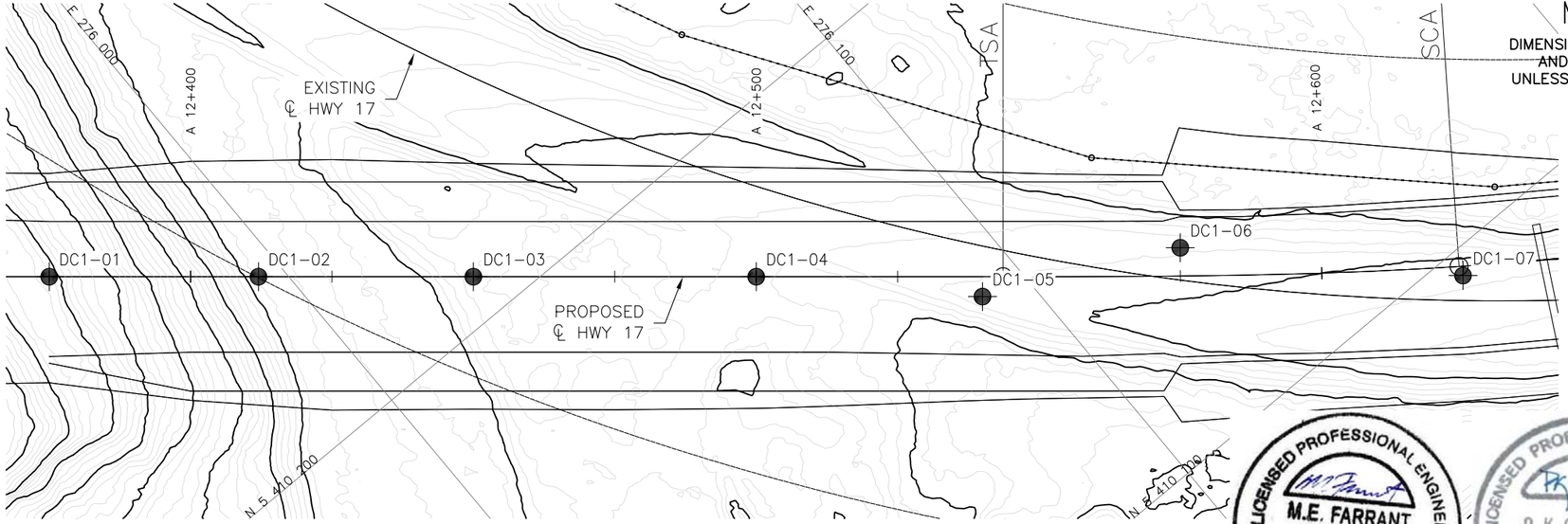
GEOCRES No. 42D14-001

REVISIONS		
DATE	BY	DESCRIPTION

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DATE	OCT 2024	DWG	4				

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MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

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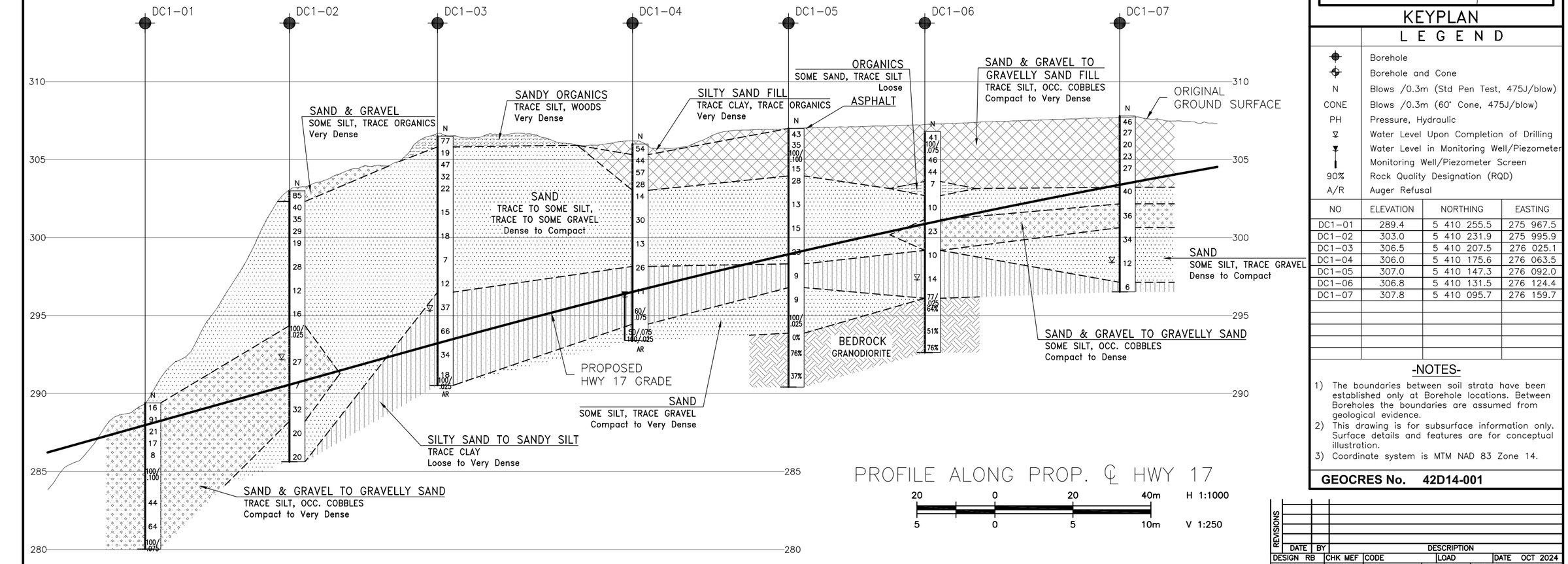
SCALE 1:1000

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
M.E. FARRANT
100053767
October 22, 2024
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
October 22, 2024
PROVINCE OF ONTARIO



PROFILE ALONG PROP. ℄ HWY 17

20 0 20 40m H 1:1000

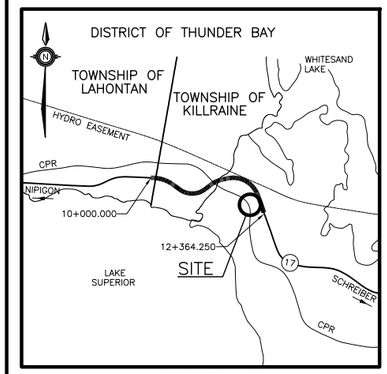
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CONT No
GWP No 6333-14-00

SHEET

HIGHWAY 17
CURVE REALIGNMENT
DEEP CUT AREA 1
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.



KEYPLAN

	LEGEND
⊕	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level Upon Completion of Drilling
▼	Water Level in Monitoring Well/Piezometer
	Monitoring Well/Piezometer Screen
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
DC1-01	289.4	5 410 255.5	275 967.5
DC1-02	303.0	5 410 231.9	275 995.9
DC1-03	306.5	5 410 207.5	276 025.1
DC1-04	306.0	5 410 175.6	276 063.5
DC1-05	307.0	5 410 147.3	276 092.0
DC1-06	306.8	5 410 131.5	276 124.4
DC1-07	307.8	5 410 095.7	276 159.7

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Coordinate system is MTM NAD 83 Zone 14.

GEOCRES No. 42D14-001

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN RB	CHK MEF	CODE	LOAD	DATE	OCT 2024
DRAWN AN	CHK RB	SITE	STRUCT	DWG	5

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APPENDIX B

B1: High Fill 1 Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

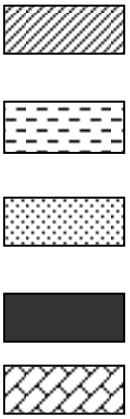
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-01 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 430.1 E 274 267.7 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.16 - 2024.03.17 LATITUDE 48.840561 LONGITUDE -87.416171 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.8	GROUND SURFACE										
0.0	**ORGANICS:** (150mm)										
0.2	**SAND**, some silt, trace gravel, occasional cobbles Compact to Very Dense Brown Moist		1	SS	25		226		○		
			2	SS	100/ 0.050				○		2 77 19 2
225.4							225		○		
1.3	Gravelly **SAND**, trace silt Dense Brown Dry to Moist		3	SS	30						
224.5							224		○		
2.2	Silty **SAND**, trace gravel, occasional cobbles Compact to Dense Brown to Grey Moist		4	SS	36				○		
			5	SS	30		223		○		
			6	SS	19		222		○		8 66 24 2
			7	SS	11		221		○	○	
			8	SS	18		220			○	
			9	SS	18		219				
							218				
							217		○		

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-01 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 430.1 E 274 267.7 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.16 - 2024.03.17 LATITUDE 48.840561 LONGITUDE -87.416171 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND**, trace gravel, occasional cobbles Compact to Dense Brown to Grey Wet										
			10	SS	41		216		○		
							215				
			11	SS	32		214		○		3 69 28 (SI+CL)
							213				
	Very Loose		12	SS	4		212		○		
211.5											
15.2	Clayey **SILT**, trace sand Hard Grey Wet		13	SS	34		211		○		
210.0	No recovery		~~14~~	~~SS~~	~~100/~~		210				FI
16.8	**BEDROCK:** (GRANITE), slightly weathered to fresh, red, very strong				0.025						0
			1	RUN							2 4 1 — RUN #1 TCR=100% SCR=57% RQD=57% UCS=111MPa (Point Load Ave.)
							209				1 1 0 — RUN #2 TCR=100% SCR=91% RQD=88% UCS=174MPa (Point Load Ave.)
			2	RUN			208				0 3
											0 2 — RUN #3 TCR=100% SCR=78% RQD=56% UCS=134MPa (Point Load Ave.)
			3	RUN			207				3

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-01 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 430.1 E 274 267.7 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.16 - 2024.03.17 LATITUDE 48.840561 LONGITUDE -87.416171 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
206.6	Continued From Previous Page										
20.1	END OF BOREHOLE AT 20.1m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-02 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 435.2 E 274 183.4 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.18 - 2024.03.18 LATITUDE 48.840522 LONGITUDE -87.417134 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.1	GROUND SURFACE						226				
0.0	Gravelly **SAND**, trace silt, occasional boulders Very Dense Brown Dry to Moist		1	SS	100/0.025				○		
225.3							225		○		
0.8	**SAND**, some silt, trace gravel, occasional cobbles Dense Brown Moist		2	SS	37						
			3	SS	36		224		○		
			4	SS	36				○		10 68 20 2
223.1							223		○		
3.0	**SAND**, some silt to silty, trace gravel Very Dense to Compact Grey Moist		5	SS	78				○		
			6	SS	100/0.050		222		○		
			7	SS	29		221		○		
218.9							220				
7.2	Silty **CLAY**, trace sand Stiff Grey Moist (Cl)		8	SS	15		219				0 4 54 42
217.7							218				
8.4	**BEDROCK:** (GRANITE), slightly weathered to fresh, red, very strong		1	RUN			217			FI 1 0 1	RUN #1 TCR=100% SCR=100% RQD=97% UCS=228MPa (Point Load Ave.)
			2	RUN						0 0	RUN #2 TCR=100% SCR=88% RQD=88% UCS=242MPa (Point Load Ave.)

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-02 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 435.2 E 274 183.4 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.18 - 2024.03.18 LATITUDE 48.840522 LONGITUDE -87.417134 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						216			1	
										3	
										1	RUN #3 TCR=100% SCR=76% RQD=66% UCS=225MPa (Point Load Ave.)
							215			1	
			3	RUN						3	
214.1										0	
										5	
12.0	END OF BOREHOLE AT 12.0m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

(%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF1-03 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 410.2 E 274 300.0 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.17 - 2024.03.17 LATITUDE 48.840304 LONGITUDE -87.415542 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
226.1	GROUND SURFACE										
0.0 / 225.8	**ORGANICS** Black Wet		1	SS	17		226				
0.3 / 225.3	**SAND**, some silt, trace gravel Compact Brown Moist										
0.8 / 224.7	Gravelly **SAND**, trace silt, occasional cobbles Dense Brown Moist		2	SS	49		225				23 67 10 (SI+CL)
1.4			3	SS	59						
	SAND, trace to some gravel, trace silt Very Dense Brown Moist		4	SS	54		224				
			5	SS	86		223				
			6	SS	90	▽	222				
220.5							221				
5.6	Silty **SAND**, trace gravel, occasional cobbles Compact to Dense Brown Moist to Wet		7	SS	100/ 0.075		220				
			8	SS	28		219				6 72 21 1
							218				
			9	SS	31		217				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-03 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 410.2 E 274 300.0 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.17 - 2024.03.17 LATITUDE 48.840304 LONGITUDE -87.415542 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page						216				
	Silty **SAND**, trace gravel, occasional cobbles Dense Brown Wet		10	SS	44		215		○		
214.4											
11.7	**SAND**, some silt Compact Brown Wet		11	SS*	12		214		○		
			12	SS*	11		213		○		
			13	SS*	14		212		○		0 87 12 1
			14	SS*	9		211		○		
208.3							210				
17.8	**SAND** and **SILT** Compact Grey Wet		15	SS	20		209		○		0 51 47 2
207.2							208				
18.9	END OF BOREHOLE AT 18.9m. WATER LEVEL AT 5.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE. * 3 Inch Spoon used										

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 7/25/24

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Ontario

THURBER

RECORD OF BOREHOLE No HF1-04 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 400.4 E 274 242.8 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.16 - 2024.03.16 LATITUDE 48.840213 LONGITUDE -87.416321 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
220.5	GROUND SURFACE										
0.0 / 220.2	**ORGANICS**, trace gravel, trace silt		1	SS	66		220				
0.3	Brown Moist										
	Gravelly **SAND** to **SAND** and **GRAVEL**, trace silt Very Dense to Compact Brown Moist to Wet		2	SS	14						
			3	SS	4		219				
	Occasional cobbles		4	SS	28		218				
			5	SS	30	▼	217				52 42 6 (SI+CL)
215.9											
4.6	Sandy **SILT** Loose Grey Wet		6	SS	8		216				
			7	SS	31		215				
	Dense						214				
			8	SS	37		213				
211.8							212				
8.7	Silty **CLAY**, trace sand Hard Brown Moist										
211.2 / 9.3	(CL)		9	SS	32		211				0 7 66 27
	SILT, some sand Dense Grey										0 12 85 3

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 7/25/24

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF1-04 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 411 400.4 E 274 242.8 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.16 - 2024.03.16 LATITUDE 48.840213 LONGITUDE -87.416321 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
209.8	**SILT**, some sand Very Dense Grey Wet			SS	100/0.025		210			FI	
10.7	**BEDROCK:** (GRANITE), slightly weathered to fresh, red, very strong		1	RUN			209			4 4 5 1 3	RUN #1 TCR=100% SCR=68% RQD=28% UCS=166MPa (Point Load Ave.)
			2	RUN			208			3 7 5 3	RUN #2 TCR=100% SCR=60% RQD=47% UCS=199MPa (Point Load Ave.)
206.2			3	RUN			207			2 0 0	RUN #3 TCR=100% SCR=94% RQD=94% UCS=195MPa (Point Load Ave.)
14.3	END OF BOREHOLE AT 14.3m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

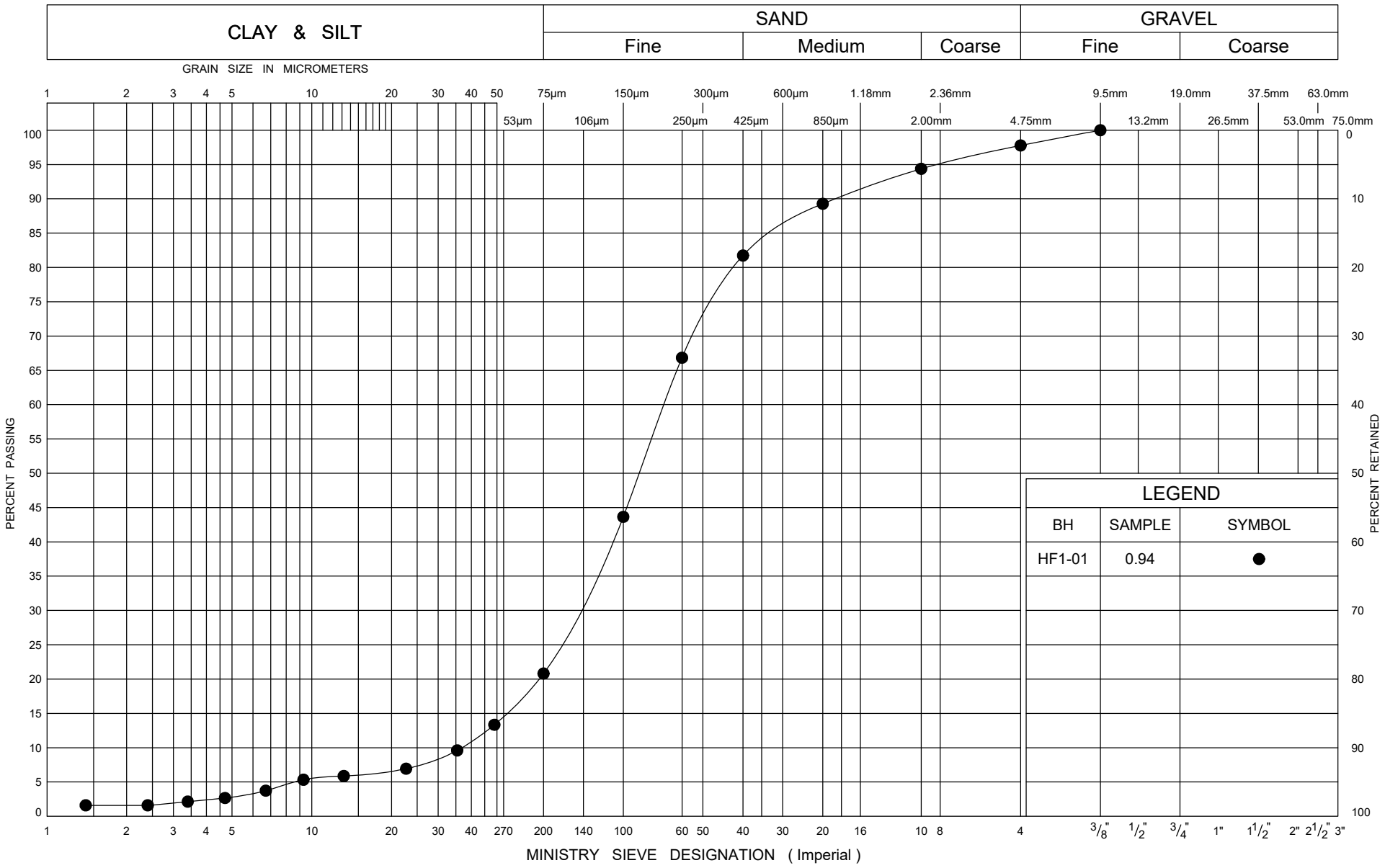
DATE	DEPTH(m)	ELEV.(m)
2024.03.17	4.2	216.3
2024.03.18	4.2	216.3
2024.04.08	3.5	217.0
2024.04.19	3.5	217.0

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

(%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 7/25/24

B2: High Fill 1 Geotechnical Laboratory Testing Results



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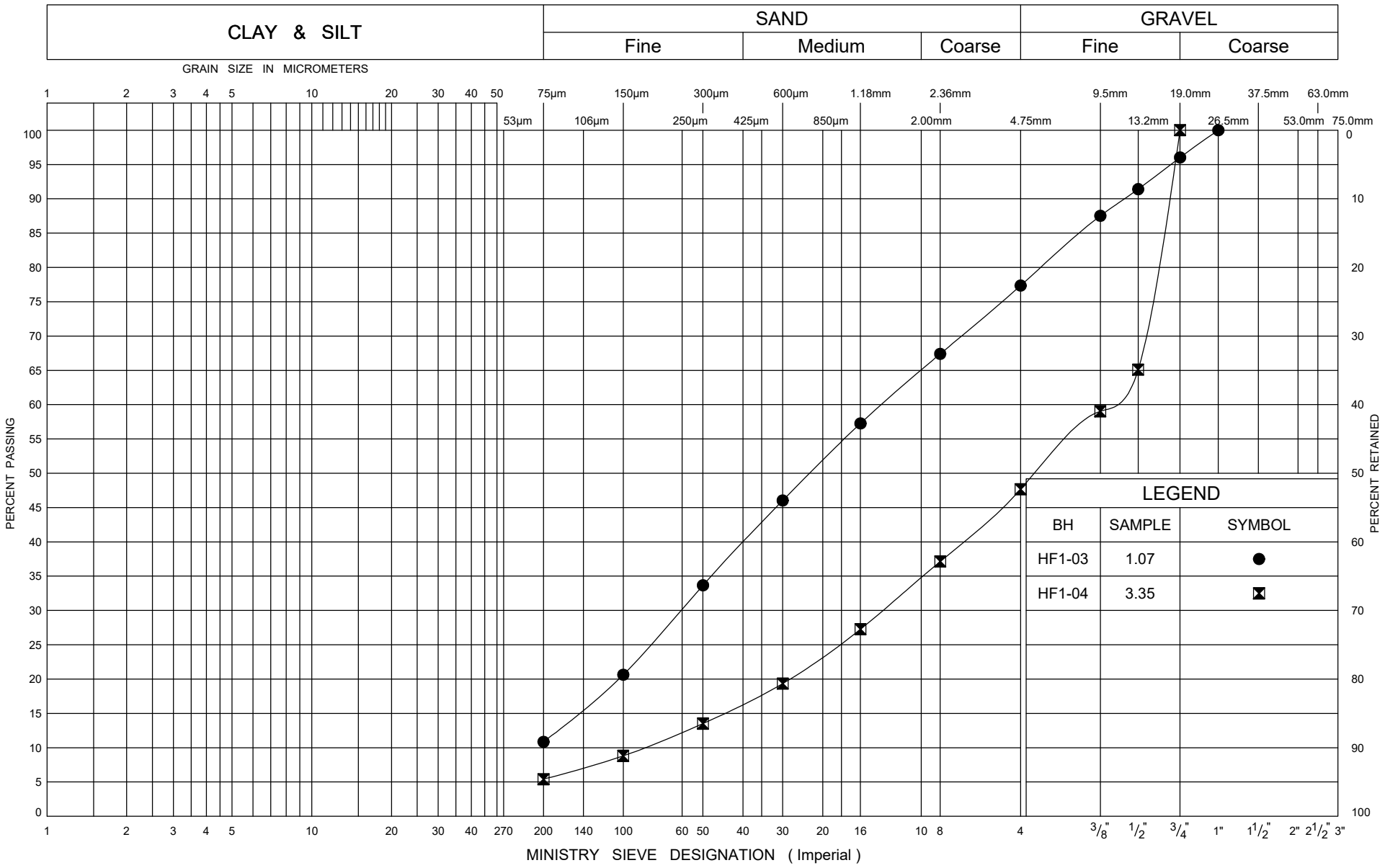
GRAIN SIZE DISTRIBUTION

SAND

FIG No B1

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



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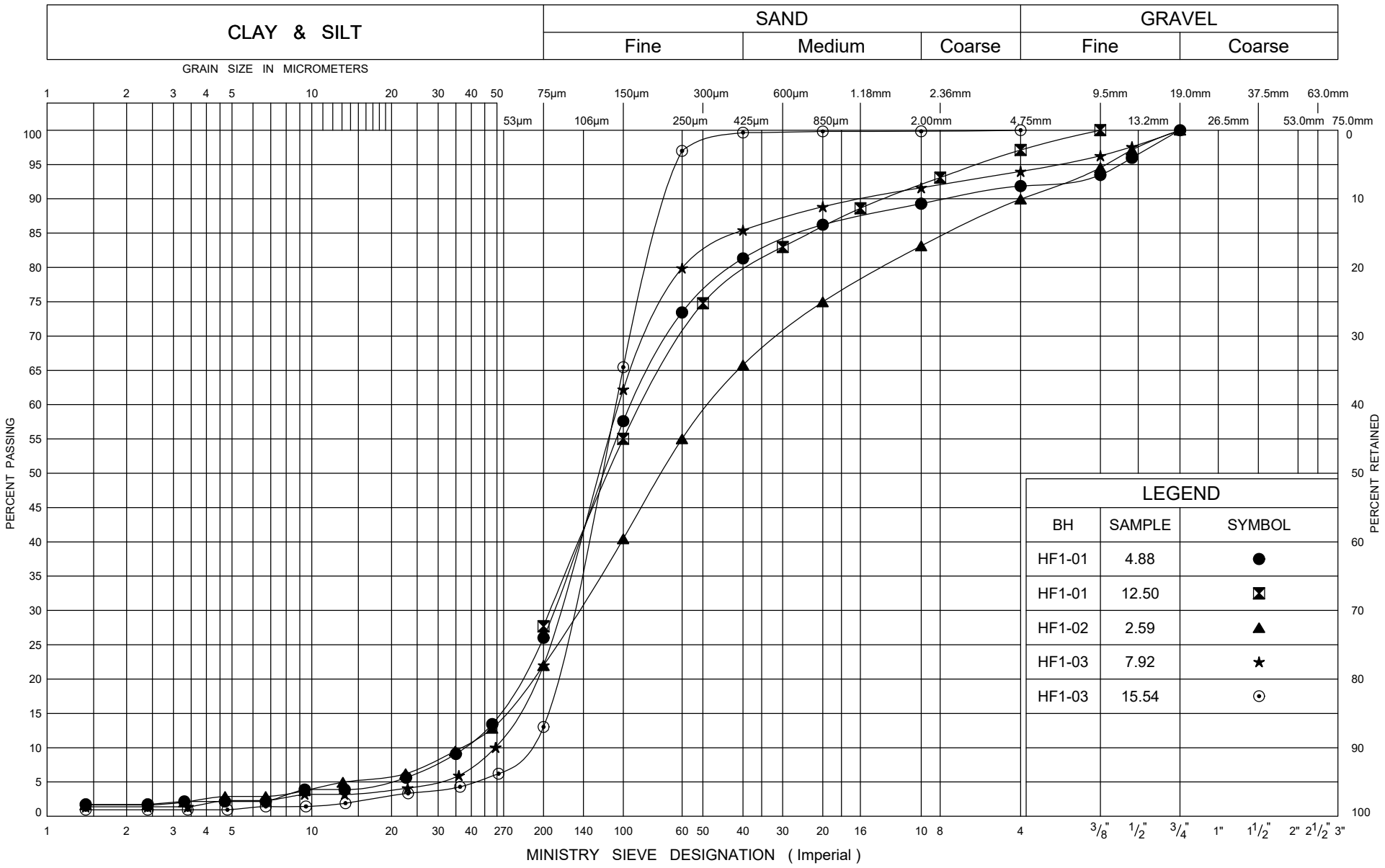
GRAIN SIZE DISTRIBUTION

Gravelly SAND to SAND and GRAVEL

FIG No B2

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24

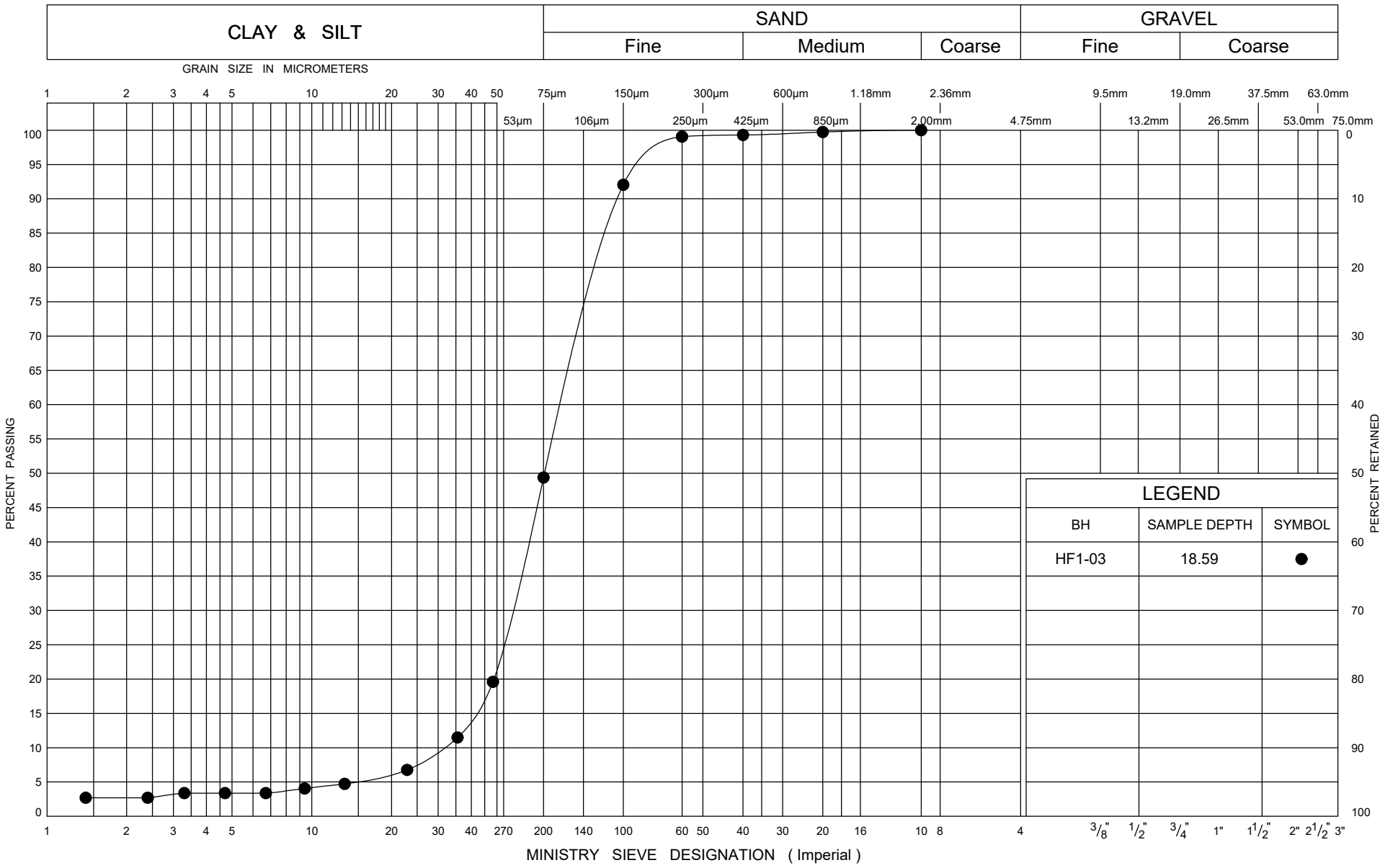
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GRAIN SIZE DISTRIBUTION

SAND, Some Silt to Silty SAND

FIG No B3

GWP# 6333-14-00



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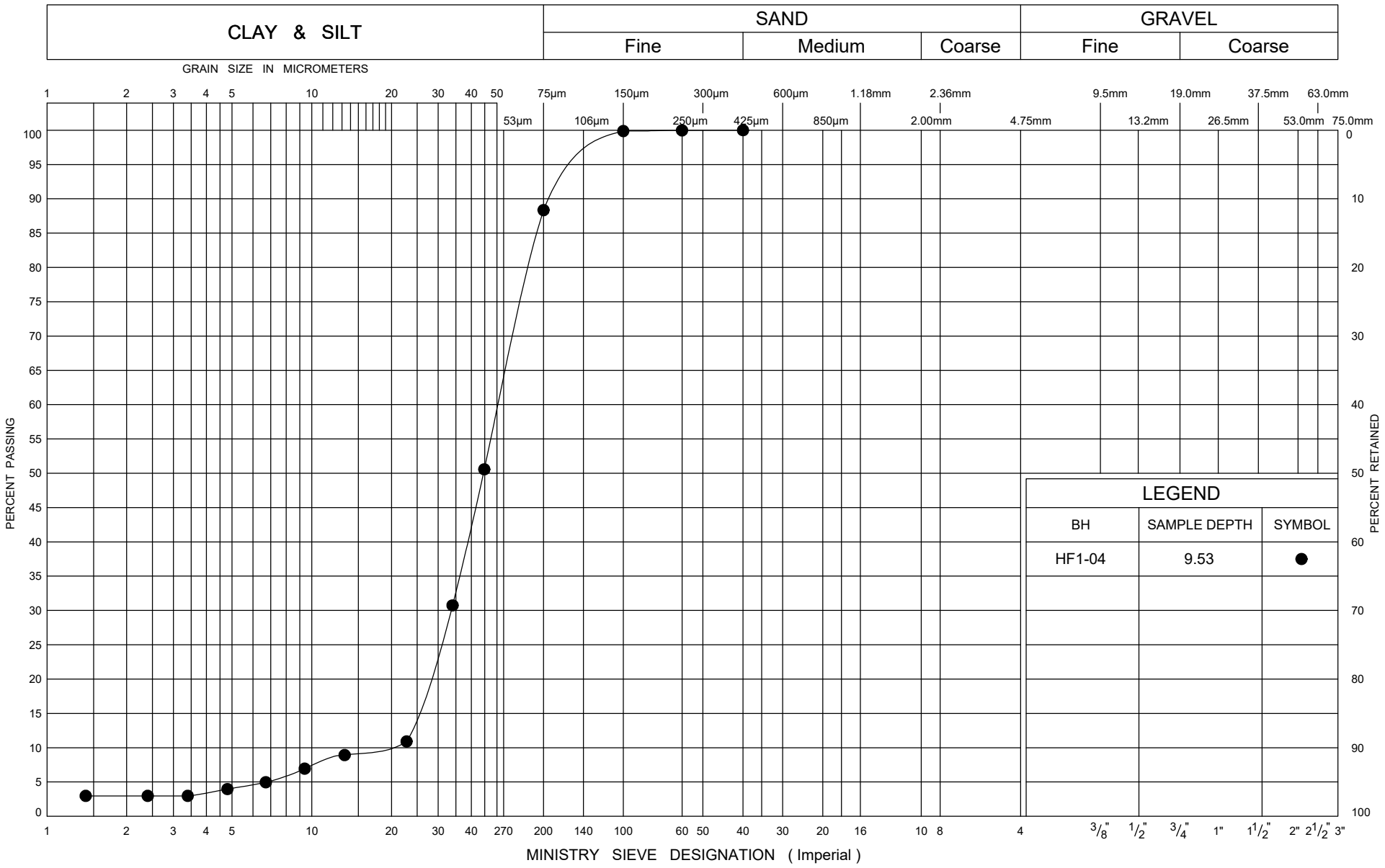
GRAIN SIZE DISTRIBUTION

SAND and SILT

FIG No B4

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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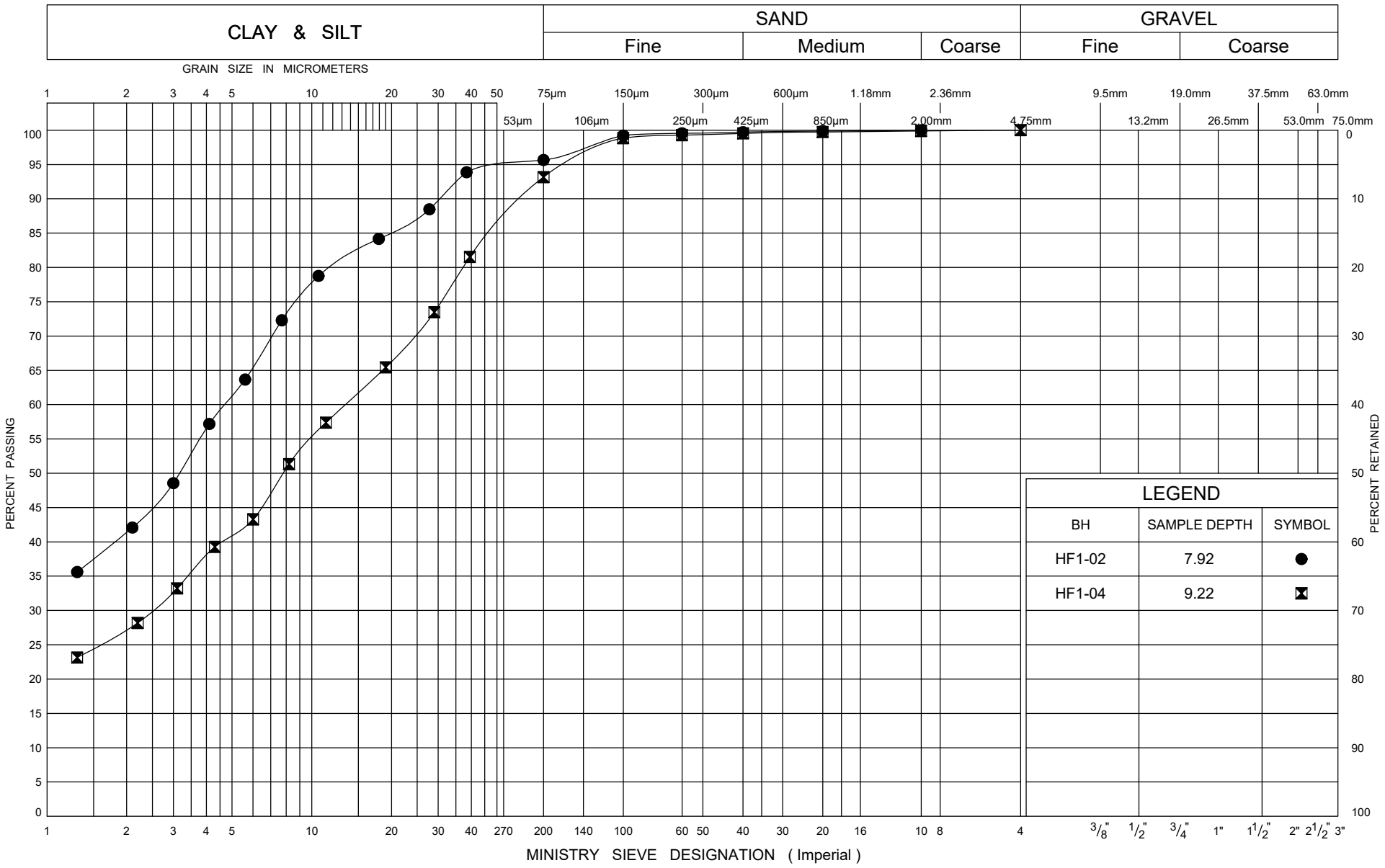
GRAIN SIZE DISTRIBUTION

SILT

FIG No B5

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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GRAIN SIZE DISTRIBUTION

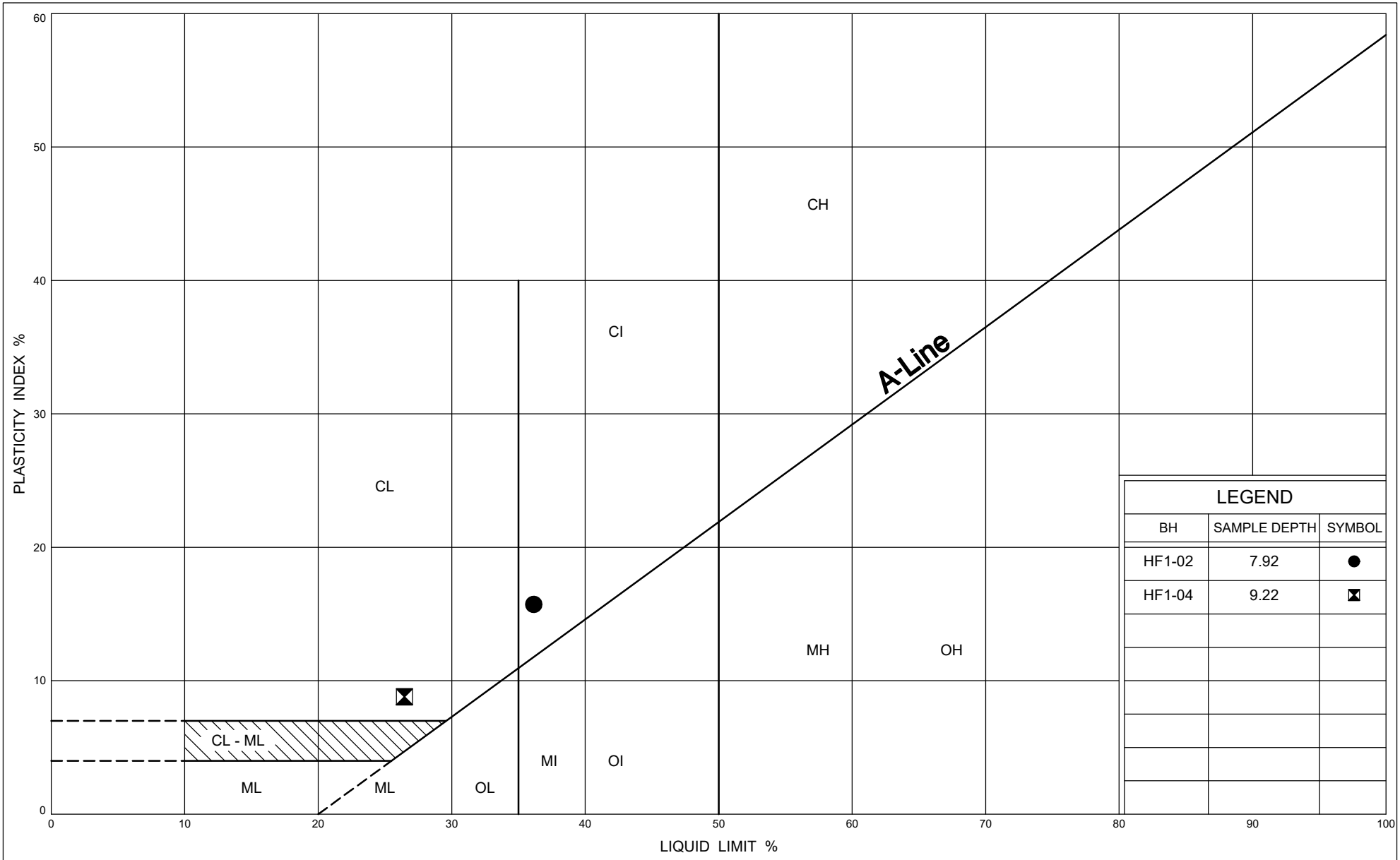
Silty CLAY

FIG No B6

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24

Oct 75, FF - S - 21



ONTARIO MOT PLASTICITY CHART 2 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24

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PLASTICITY CHART

Silty CLAY

FIG No B7

GWP# 6333-14-00

APPENDIX C

C1: High Fill 3 Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

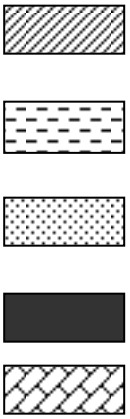
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

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RECORD OF BOREHOLE No HF3-01 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 761.0 E 275 360.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.10 - 2024.03.11 LATITUDE 48.834517 LONGITUDE -87.401050 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
250.4	GROUND SURFACE										
0.0 / 249.9	**TOPSOIL** Compact Black Moist		1	SS	15		250		○		
0.5	Silty **SAND** to **SAND** and **SILT**, trace clay Dense to Compact Brown Moist		2	SS	44				○		0 78 20 2
	Occasional cobbles encountered		3	SS	23		249		○		
247.4			4	SS	15		248		○		
3.0	Sandy **GRAVEL**, some silt Very Dense Brown Wet		5	SS	53		247		○		48 29 23 (SI+CL)
244.9			6	SS	100/ 0.125		246		○		
5.5	**SAND**, some silt Very Dense Brown Wet		7	SS	63		244		○		
243.2							243				
7.2	**GRAVEL** and **SAND**, trace silt Compact to Very Dense Brown Wet		8	SS	18		242		○		
			9	SS	54		241		○		

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF3-01 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 761.0 E 275 360.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.10 - 2024.03.11 LATITUDE 48.834517 LONGITUDE -87.401050 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	GRAVEL and **SAND**, trace silt Very Dense Brown Wet						240				
			10	SS	51				○		
							239				
			11	SS	64		238		○		56 39 5 (SI+CL)
237.1											
13.3	Silty **SAND**, trace gravel, trace clay Very Dense Brown Wet						237				
			12	SS	58				○		
							236				
			13	SS	61		235		○		
							234				
			14	SS	100/ 0.125				○		7 70 21 2
							233				
232.1			15	SS	100/ 0.075				○		
18.3	**BEDROCK:** (GRANITE), red, slightly weathered to fresh, very strong to extremely strong		1	RUN			232			FI 2 1 3 1 1 3	RUN #1 TCR=100% SCR=100% RQD=92% UCS=213MPa (Point Load Ave.) RUN #2 TCR=100% SCR=82% RQD=69% UCS=253MPa (Point Load Ave.)
							231				

Continued Next Page

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

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF3-01 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 761.0 E 275 360.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.10 - 2024.03.11 LATITUDE 48.834517 LONGITUDE -87.401050 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
			2	RUN			230			>10	
										>10	
										1	
			2	RUN			229			1	RUN #2 TCR=100% SCR=100% RQD=100% UCS=254MPa (Point Load Ave.)
228.6										1	
21.8	END OF BOREHOLE AT 21.8m. BOREHOLE BACKFILLED WITH BENTONITE TO GROUND SURFACE.										

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF3-02 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 741.9 E 275 350.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.11 - 2024.03.13 LATITUDE 48.834345 LONGITUDE -87.401182 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.0	GROUND SURFACE										
0.0	Gravelly **SAND**, frequent organics, trace silt Loose to Very Dense Black Wet		1	SS	8				○		
	No recovery		2	SS	100/ 0.075		247				
246.8											
1.2	Silty **SAND**, trace gravel, trace clay Compact Brown Wet		3	SS	26		246		○		8 60 30 2
245.8											
2.2	**SAND** and **GRAVEL**, trace silt Very Dense to Dense Brown Wet		4	SS	61				○		
			5	SS	34		245		○		
			6	SS	36		244		○		45 48 7 (SI+CL)
	Occasional cobbles and boulders		7	SS	57		243		○		
			8	SS	65		242		○		50 40 10 (SI+CL)
			9	SS	35		241		○		
							240				
							239				

Continued Next Page

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF3-02 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 741.9 E 275 350.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.11 - 2024.03.13 LATITUDE 48.834345 LONGITUDE -87.401182 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
236.5	**SAND** and **GRAVEL**, trace silt Very Dense Brown Wet		10	SS	100/ 0.100		237		○		
11.5	Silty **SAND** to Sandy **SILT**, trace clay Compact to Very Dense Brown to Grey Wet		11	SS	23		236		○		
			12	SS	100/ 0.075		235		○		
			13	SS	43		234		○		0 30 64 6
			14	SS	61		233		○		
229.5			15	SS	100/		232		○		
18.5	**BEDROCK:** (GRANITE), red, slightly weathered to fresh, very strong to extremely strong		1	RUN	0.050		231		○	FI 1 0 1 1 0	RUN #1 TCR=100% SCR=100% RQD=91% UCS=222MPa (Point Load Ave.)
							230		○		
							229		○		

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF3-02 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 741.9 E 275 350.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.11 - 2024.03.13 LATITUDE 48.834345 LONGITUDE -87.401182 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
			2	RUN			227			1	RUN #2 TCR=100% SCR=86% RQD=86%
										1	UCS=223MPa (Point Load Ave.)
										2	
			3	RUN						1	RUN #3 TCR=100% SCR=96% RQD=96%
226.3										1	UCS=214MPa
21.7	END OF BOREHOLE AT 21.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										(Point Load Ave.)

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No HF3-03 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 734.6 E 275 415.5 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.09 - 2024.03.09 LATITUDE 48.834282 LONGITUDE -87.400297 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100) o UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
253.0	GROUND SURFACE									
0.0 / 252.3	**TOPSOIL**, some sand, some gravel Dense Brown Dry to Moist		1	SS	43					
0.7 / 251.6	**SAND** and **GRAVEL**, trace silt Very Dense Grey Wet		2	SS	59		252			45 48 7 (SI+CL)
1.4	Sandy **SILT**, trace clay Compact Grey Wet		3	SS	20		251			
			4	SS	19					
	Occasional cobbles Becoming Dense to Very Dense		5	SS	40		250			
							249			
			6	SS	81		248			0 30 65 5
							247			
			7	SS	66		246			
			8	SS	92		245			
							244			
			9	SS	88					1 33 62 4

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF3-03 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 734.6 E 275 415.5 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.09 - 2024.03.09 LATITUDE 48.834282 LONGITUDE -87.400297 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Sandy **SILT**, trace clay Very Dense Grey Wet										
			10	SS	100/ 0.200		242		○		
			11	SS	100/ 0.075		241		○		
							240				
239.3	Occasional cobbles No recovery										
13.7	**SAND** and **GRAVEL**, some silt, trace clay Very Dense Brown Wet		12	SS	100/ 0.075		239				
			13	SS	40		238		○		
							237				
			14	SS*	51		236		○		39 44 17 (SI+CL)
							235				
			15	SS*	77/ 0.075		234		○		
			16	SS	100/				○		

Continued Next Page

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

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF3-03 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 734.6 E 275 415.5 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.09 - 2024.03.09 LATITUDE 48.834282 LONGITUDE -87.400297 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND and **GRAVEL**, some silt, trace clay Very Dense Brown Wet				0.075		232				
231.5			17	SS	100/				○		
21.5	END OF BOREHOLE AT 21.5m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE. * 3 Inch Spoon used				0.050						

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

$\frac{20}{15 \quad 5}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF3-04 1 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 732.1 E 275 401.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.07 - 2024.03.08 LATITUDE 48.834259 LONGITUDE -87.400490 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
251.3	GROUND SURFACE										
0.0	**TOPSOIL**, some sand, some gravel Very Dense Brown Moist		1	SS	61		251				
250.5											
0.8	**SILT** and **SAND**, trace gravel, trace clay, occasional cobbles Compact to Dense Brown Moist		2	SS	45		250				
			3	SS	15						1 39 57 3
			4	SS	31		249				
			5	SS	23		248				
			6	SS	15		247				
			7	SS	11		246				
			8	SS	19		245				2 36 58 4
			9	SS	19		244				
							243				
							242				

Continued Next Page

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

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No HF3-04 2 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 732.1 E 275 401.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.07 - 2024.03.08 LATITUDE 48.834259 LONGITUDE -87.400490 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
240.3	**SILT** and **SAND**, trace gravel, trace clay, occasional cobbles Dense Brown Moist						241				
11.0			10	SS	44		240				
	GRAVEL and **SAND**, some silt Very Dense Brown Moist		11	SS	100/ 0.075		239				48 34 18 (SI+CL)
	Boulder cored from 12.6m						238				
236.5			12	SS	86		237				
14.8	Sandy **SILT**, trace gravel Very Dense Brown Moist		13	SS	9		236				
235.0							235				
16.3	**SAND** and **GRAVEL**, some silt Very Dense Brown Moist		14	SS	78		234				
232.9							233				
18.4	**SILT**, some sand, trace clay Compact Grey Wet		15	SS	28		232				

Continued Next Page

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF3-04 3 OF 3 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 732.1 E 275 401.3 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE NW Casing/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.07 - 2024.03.08 LATITUDE 48.834259 LONGITUDE -87.400490 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SILT, some sand, trace clay Dense to Very Dense Grey Wet		16	SS	46		231		○		0 16 79 5
			17	SS	82		230		○		
							229				
228.4			18	SS	100/ 0.075				○	FI	
22.9	**BEDROCK:** (GRANITE), very strong to extremely strong, red, slightly weathered to fresh		1	RUN			228			3 2 2 4	RUN #1 TCR=100% SCR=83% RQD=67% UCS=256MPa (Point Load Ave.)
			2	RUN			227			0 0 1 0	RUN #2 TCR=100% SCR=97% RQD=97% UCS=159MPa (Point Load Ave.)
							226			1 0 0	
225.0			3	RUN							RUN #3 TCR=100% SCR=100% RQD=100% UCS=190MPa (Point Load Ave.)
26.3	END OF BOREHOLE AT 26.3m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

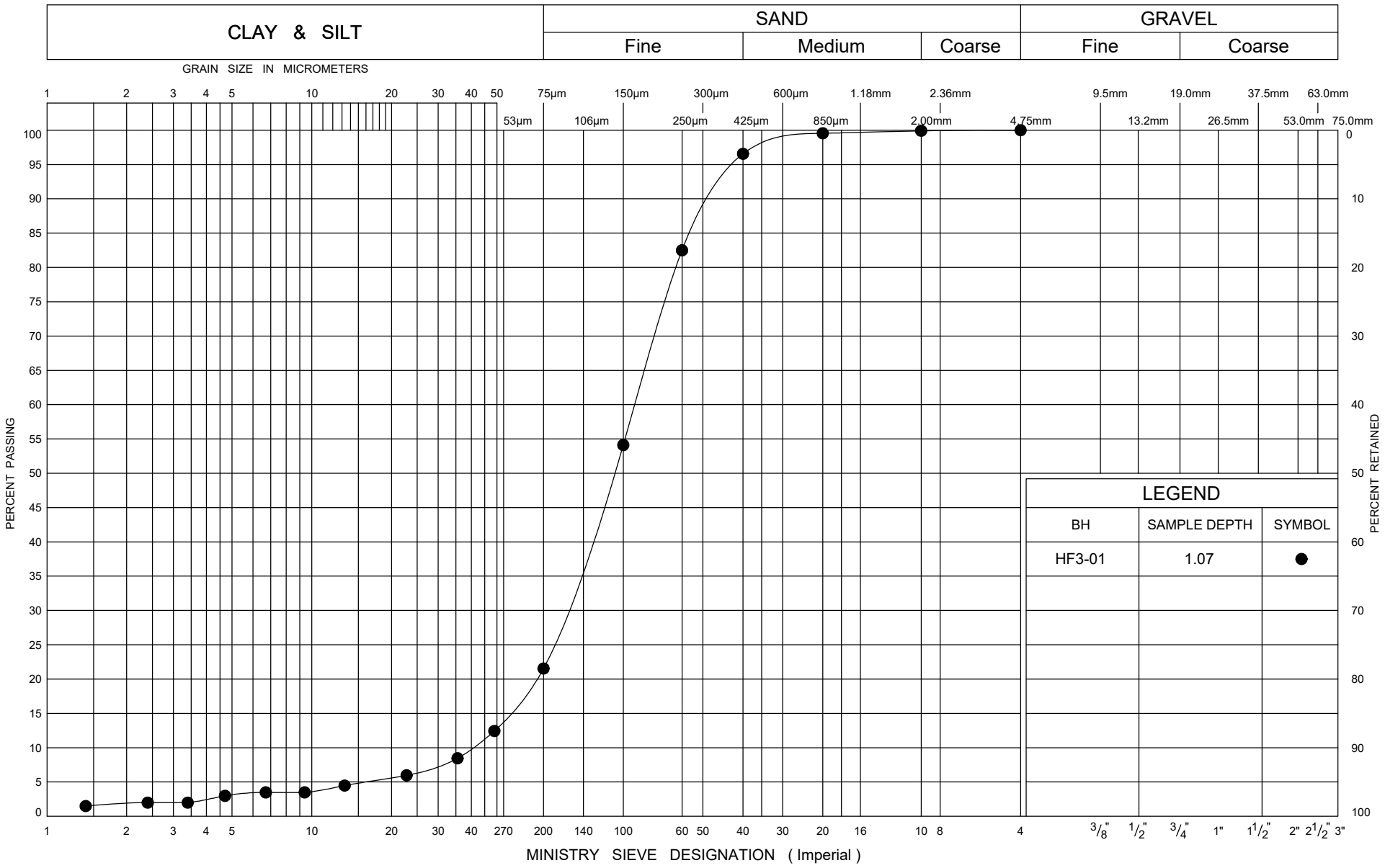
DATE	DEPTH(m)	ELEV.(m)
2024.03.11	18.3	233.0
2024.03.19	Dry	-
2024.04.08	Dry	-

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

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C2: High Fill 3 Geotechnical Laboratory Testing Figures



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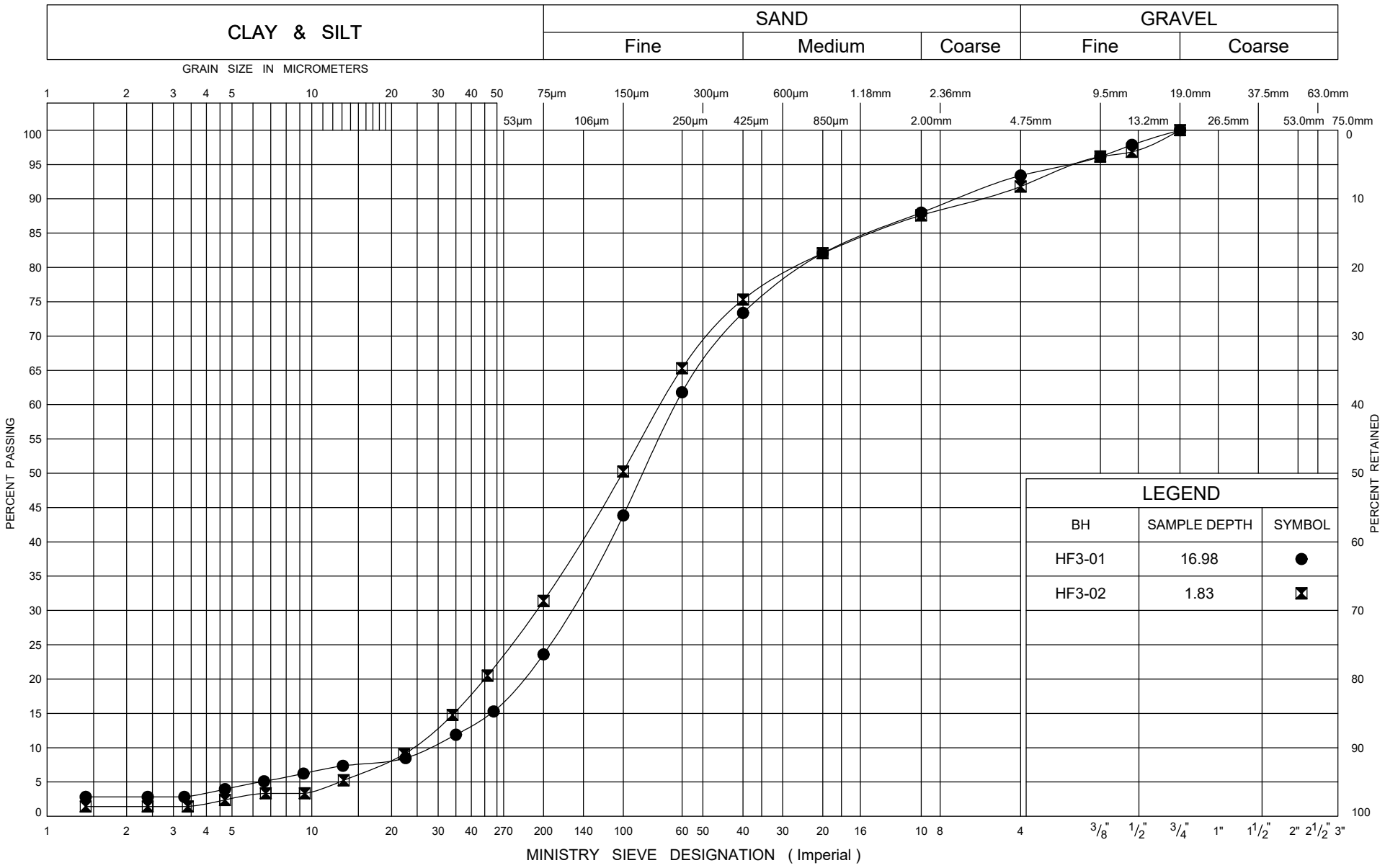
GRAIN SIZE DISTRIBUTION

SAND

FIG No C1

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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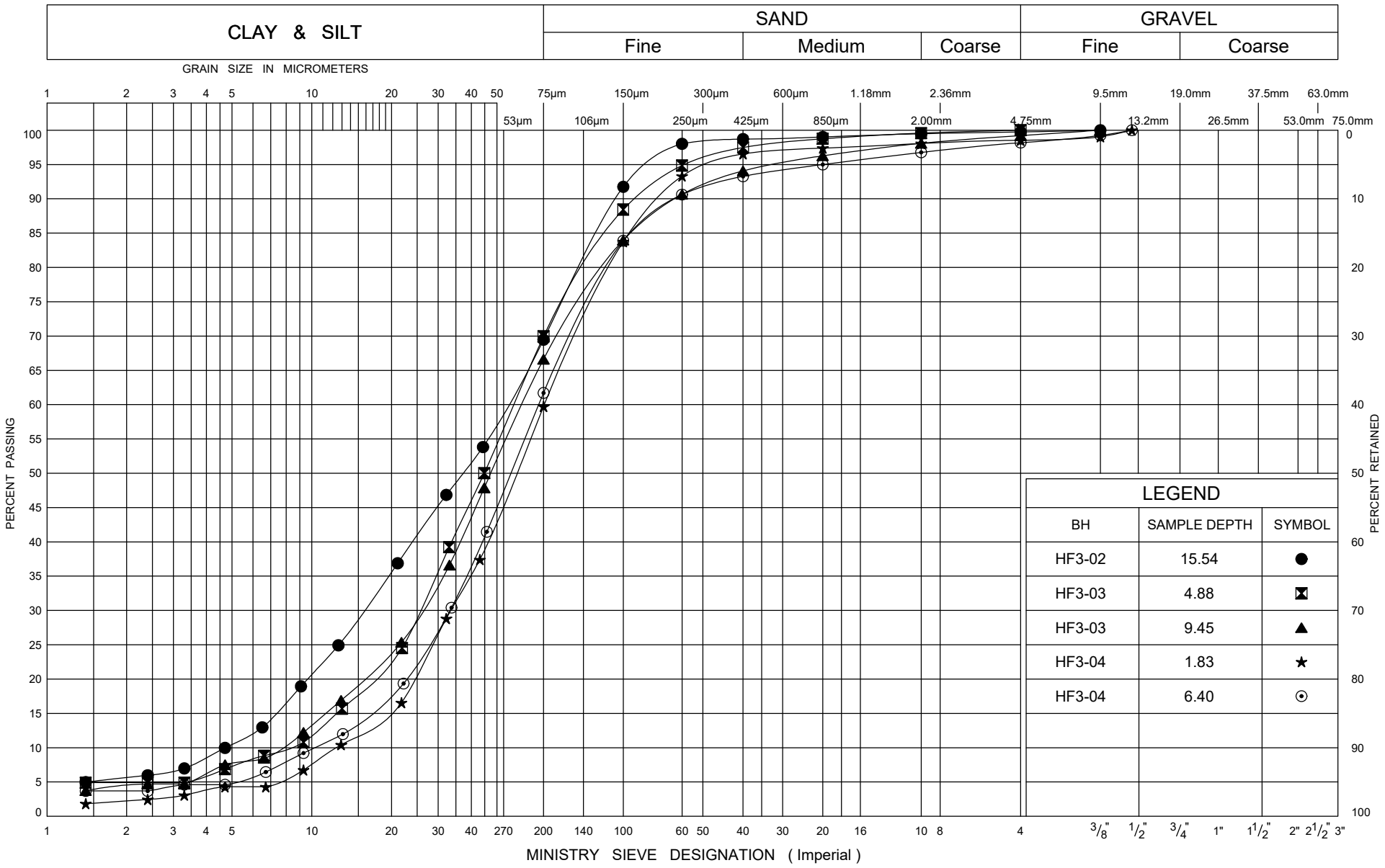
GRAIN SIZE DISTRIBUTION

Silty SAND

FIG No C2

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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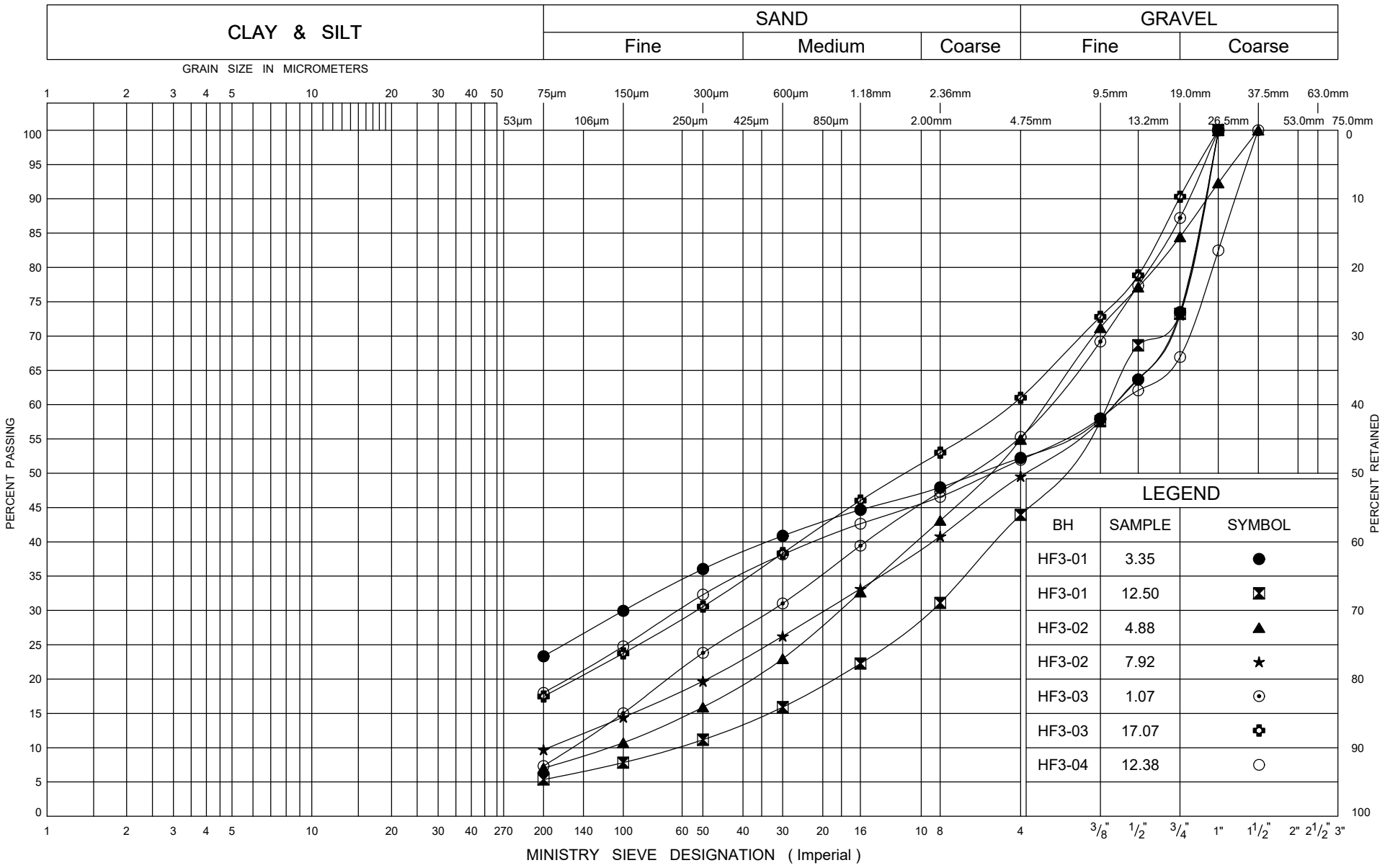
GRAIN SIZE DISTRIBUTION

Sandy SILT

FIG No C3

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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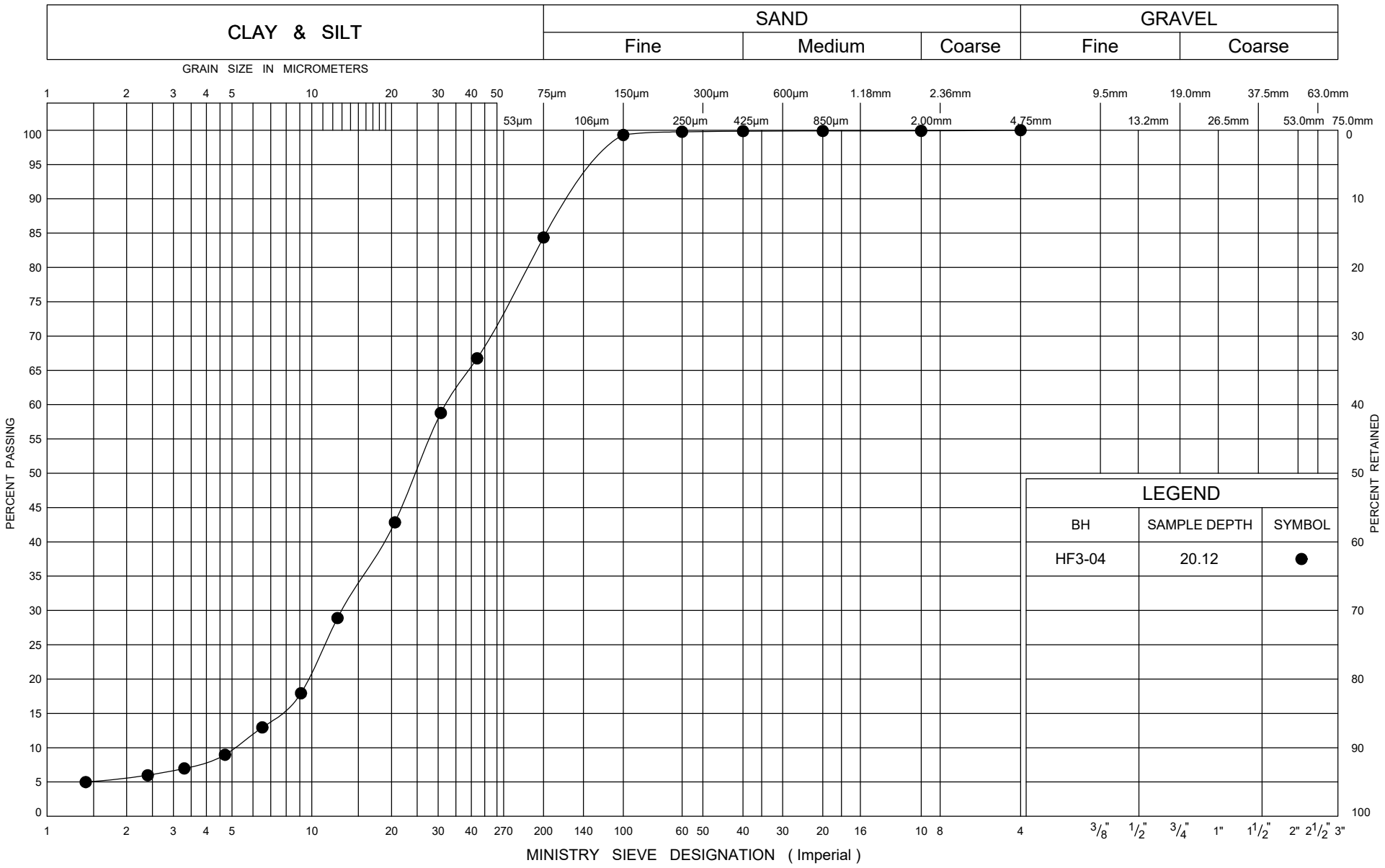
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL

FIG No C4

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



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GRAIN SIZE DISTRIBUTION

SILT

FIG No C5

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24

APPENDIX D

D1: High Fill 4 Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

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RECORD OF BOREHOLE No HF4-01 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 465.8 E 275 719.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831879 LONGITUDE -87.396135 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
262.0	GROUND SURFACE										
0.0	**TOPSOIL:** (225mm)		1	SS	92				○		
0.2	Gravelly **SAND**, trace silt, occasional cobbles Very Dense to Compact Brown Moist										
			2	SS	21		261		○		
			3	SS	24		260		○		28 66 6 (SI+CL)
	Auger grinding aganist cobbles from 2.4m to 3.0m depth		4	SS	42				○		
			5	SS	38		259		○		
	Gravel seam from 4.6m to 5.2m depth		6	SS	37		258		○		58 33 9 (SI+CL)
			7	SS	28		257		○		
	Occasional cobbles		8	SS	83		256		○		
			9	SS	43		255		○		
							254				
							253				
							252				

Continued Next Page

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

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-01 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 465.8 E 275 719.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831879 LONGITUDE -87.396135 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Gravelly **SAND**, trace silt, occasional cobbles Very Dense Brown Moist										
250.7			10	SS	51		251		o		
11.3	END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-02 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 431.5 E 275 756.1 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831572 LONGITUDE -87.395635 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
263.8	GROUND SURFACE										
0.0	Gravelly **SAND**, trace silt, some organics Dense to Very Dense Brown Moist		1	SS	42						
	No recovery		2	SS	100/0.050		263				
262.3											
1.5	**SAND**, trace silt Compact Brown Moist		3	SS	19		262				
			4	SS	12		261				
260.8											
3.0	**SILT** and **SAND**, trace clay Loose Brown Wet		5	SS	4		260				0 37 60 3
259.7											
4.1	Gravelly **SAND**, trace silt Very Dense to Dense Brown Moist		6	SS	100/0.125		259				
			7	SS	44		258				
			8	SS	41		257				
			9	SS	44		256				
							255				
							254				34 60 6 (SI+CL)

Continued Next Page

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF4-02 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 431.5 E 275 756.1 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831572 LONGITUDE -87.395635 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
252.5	Gravelly **SAND**, trace silt Very Dense Brown Moist		10	SS	58		253				
11.3	END OF BOREHOLE AT 11.3m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.03.06	Dry	-
2024.03.11	7.3	256.5
2024.03.18	Dry	-
2024.04.08	Dry	-
2024.04.19	Dry	-

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

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-03 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 412.2 E 275 785.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831400 LONGITUDE -87.395233 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
265.8	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Gravelly **SAND**, trace silt, occasional cobbles Dense to Very Dense Brown Moist		1	SS	49		265		○		37 56 7 (SI+CL)
			2	SS	65				○		
			3	SS	48		264		○		
	Sandy gravel seam		4	SS	88		263		○		57 35 8 (SI+CL)
			5	SS	34		262		○		
			6	SS	50		261		○		
			7	SS	102		260		○		
			8	SS	109		259		○		27 66 7 (SI+CL)
			9	SS	30		258		○		
							257		○		
							256				

Continued Next Page

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

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-03 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 412.2 E 275 785.6 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.06 - 2024.03.06 LATITUDE 48.831400 LONGITUDE -87.395233 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
255.6 / 10.2	Gravelly **SAND**, trace silt Compact Brown Moist										
	SAND, trace to some gravel, trace silt Very Dense Brown		10	SS	87		255		o		
254.5 / 11.3	Moist END OF BOREHOLE AT 11.3m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-04 1 OF 1 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 367.5 E 275 833.0 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.831000 LONGITUDE -87.394584 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
269.4	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt, some organics in upper 50mm Compact to Very Dense Brown Moist		1	SS	86		269		o		
			2	SS	40		268		o		44 48 8 (SI+CL)
			3	SS	11						
			4	SS	14		267		o		
			5	SS	22		266		o		51 44 5 (SI+CL)
265.3											
4.1	**SAND**, trace silt, occasional cobbles Compact Brown Moist		6	SS	10		265		o		
263.8							264				
5.6	Gravelly **SAND**, trace silt, occasional cobbles Very Dense Brown Moist		7	SS	100/ 0.100		263		o		
			8	SS	100/ 0.050		262		o		
261.1	No recovery		9	SS	100/ 0.025						
8.3	END OF BOREHOLE AT 8.3m. UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-05 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 335.5 E 275 871.4 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.830714 LONGITUDE -87.394058 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
271.0	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt, occasional cobbles Very Dense to Dense Brown Moist		1	SS	74				○		
			2	SS	100/0.050		270		○		
			3	SS	33		269		○		55 40 5 (SI+CL)
			4	SS	59		268		○		
			5	SS	32		267		○		
			6	SS	100/0.100		266		○		
			7	SS	44		265		○		44 49 7 (SI+CL)
	No recovery		8	SS	56		264 263		○		
			9	SS	72		262		○		

Continued Next Page

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

$\frac{20}{15}$ 5 $\frac{}{10}$ (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No HF4-05 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 335.5 E 275 871.4 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.830714 LONGITUDE -87.394058 CHECKED BY RB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
260.2			10	SS	100/				o		
10.8	END OF BOREHOLE AT 10.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.100						

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No HF4-06 1 OF 1 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 303.5 E 275 909.8 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.05 - 2024.03.05 LATITUDE 48.830428 LONGITUDE -87.393532 CHECKED BY RB

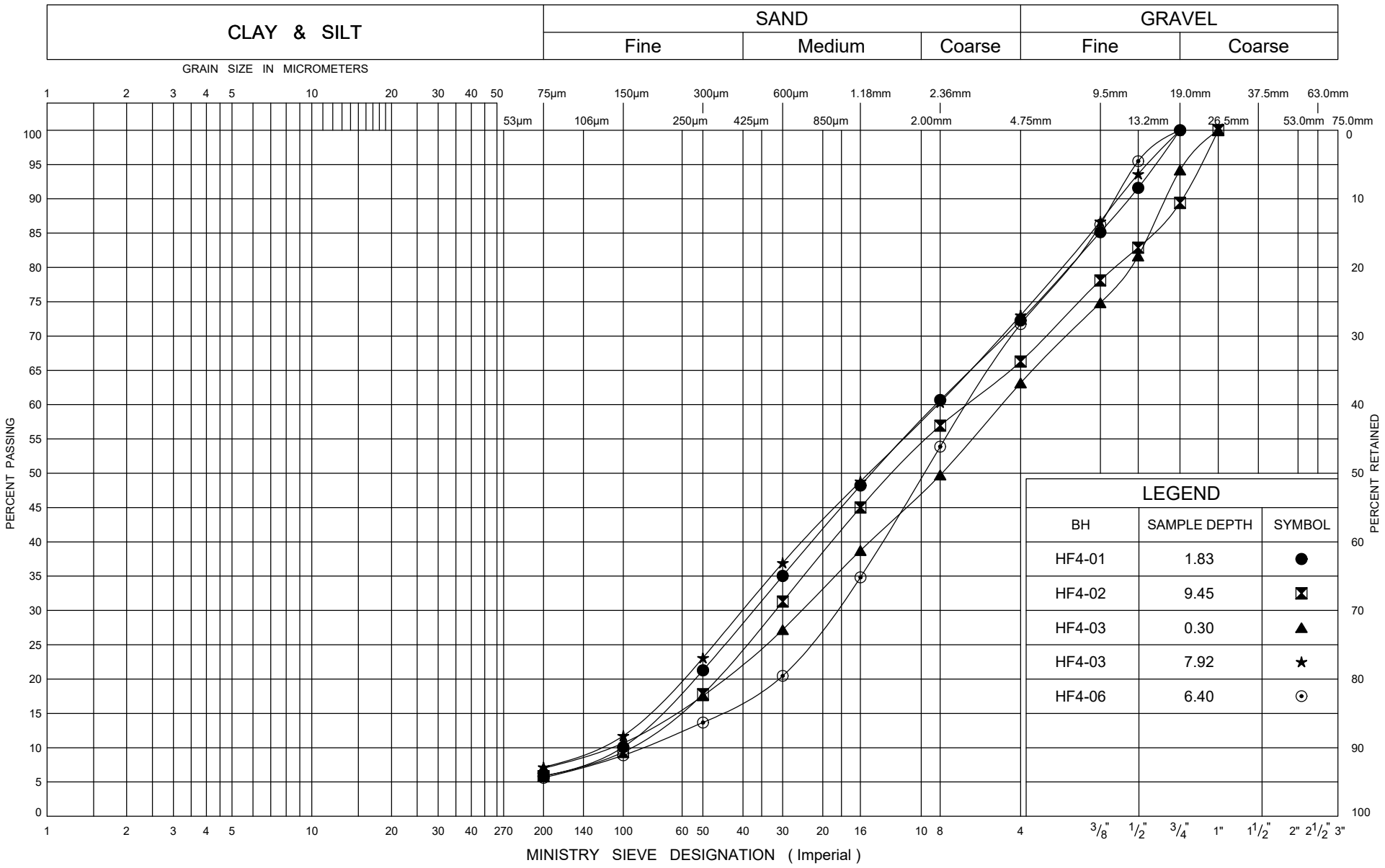
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
279.2	GROUND SURFACE										
0.0	**SAND** and **GRAVEL** to Gravelly **SAND**, trace silt, occasional cobbles Compact to Dense Brown Moist		1	SS	28		279		○		
			2	SS	37		278		○		46 48 6 (SI+CL)
			3	SS	37		277		○		
			4	SS	44				○		
			5	SS	45		276		○		
			6	SS	28		275		○		
			7	SS	31		274		○		28 66 6 (SI+CL)
271.5	No recovery		8	SS	100/ 0.075		273				
7.7	END OF BOREHOLE AT 7.7m UPON AUGER REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.						272				

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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D2: High Fill 4 Geotechnical Laboratory Testing Results



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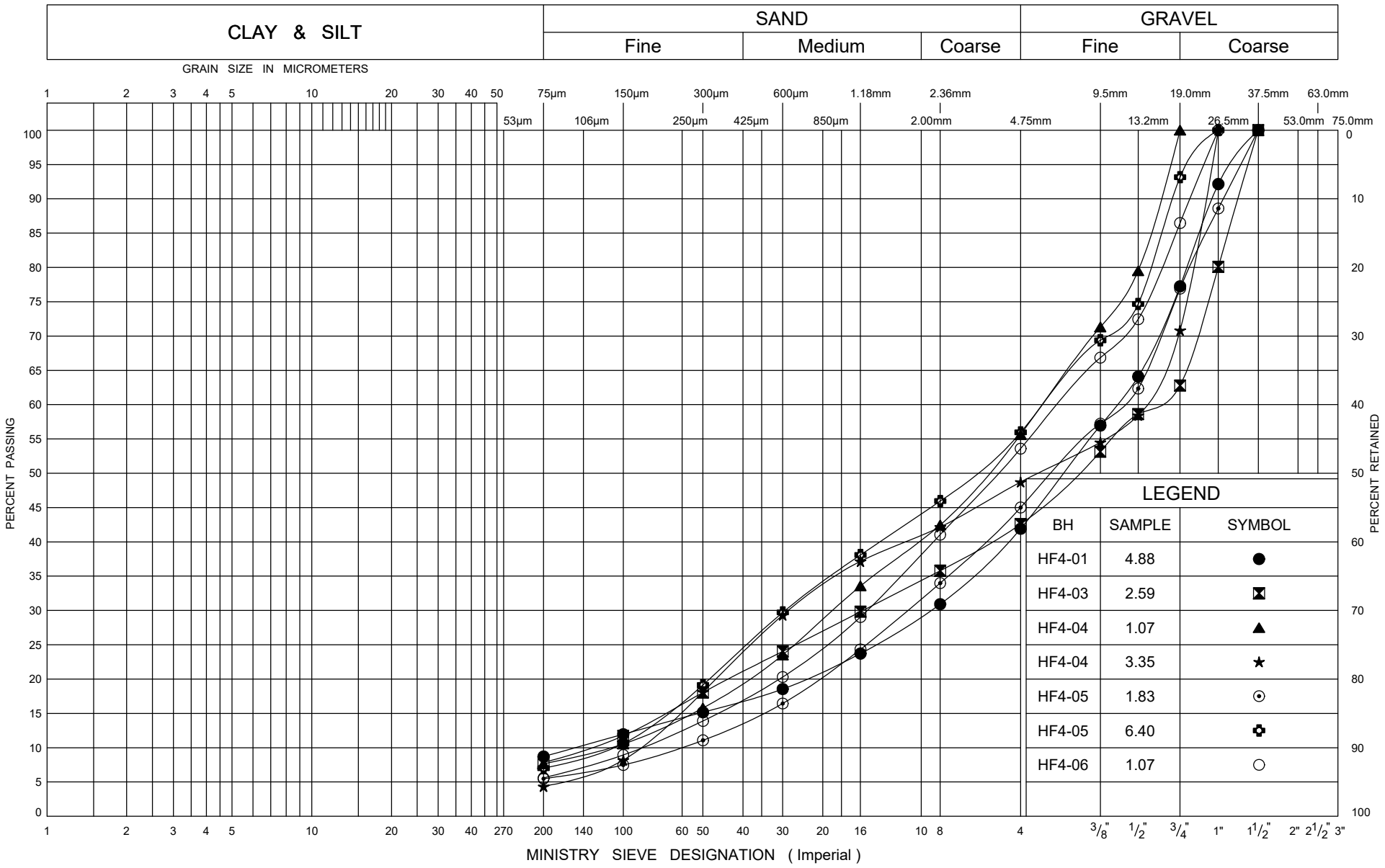
GRAIN SIZE DISTRIBUTION

Gravelly SAND

FIG No D1

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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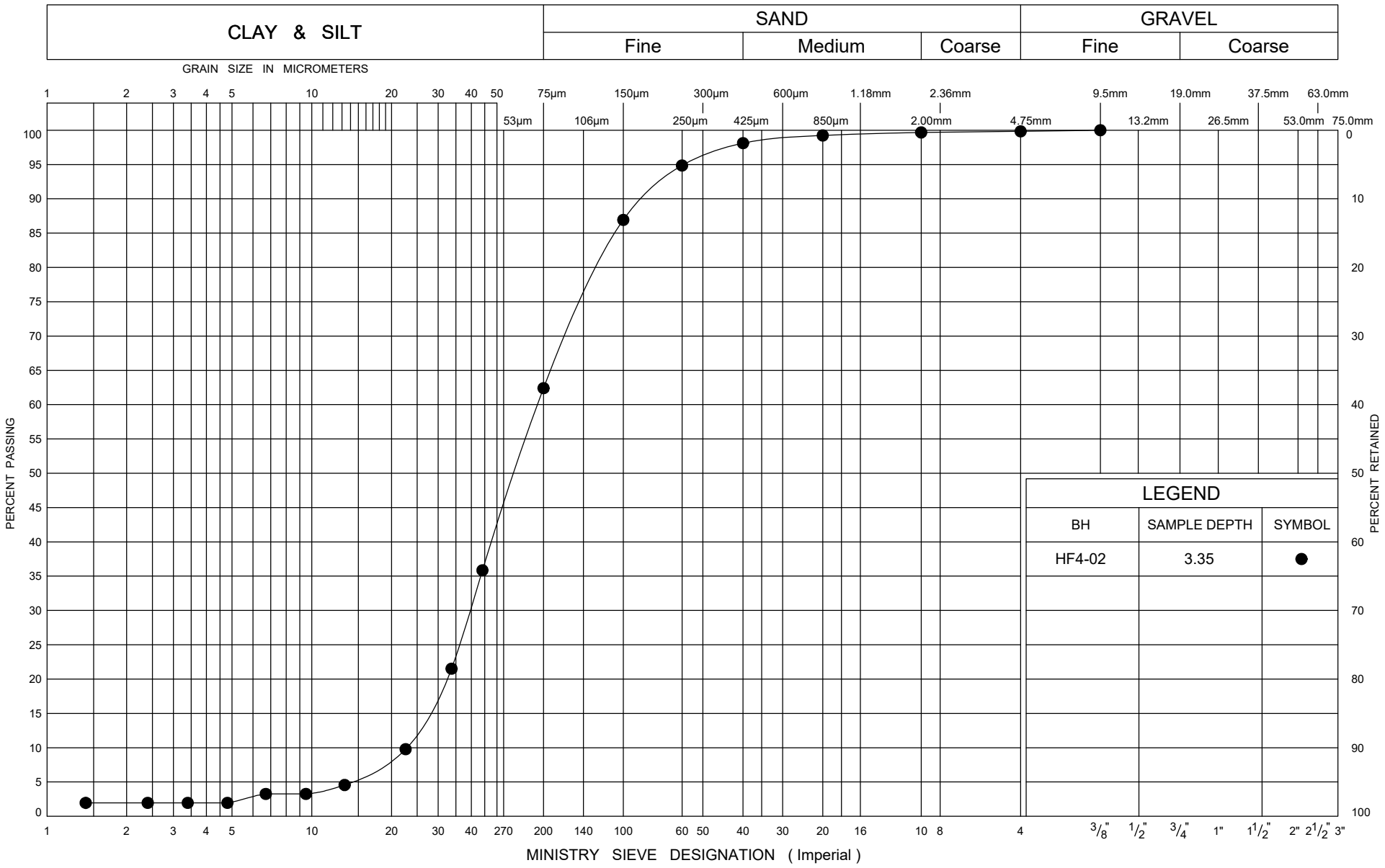
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL

FIG No D2

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



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GRAIN SIZE DISTRIBUTION

SAND and SILT

FIG No D3

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24

APPENDIX E

E1: Deep Cut Section 1 Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT[(1)] 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

1) Laboratory Triaxial Testing
2) Field Insitu Vane Testing
3) Laboratory Vane Testing
4) SPT value
5) Pocket Penetrometer

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT "N" VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample		TP Thin Wall Piston Sample
	PH Sampler Advanced by Hydraulic Pressure		PM Sampler Advanced by Manual Pressure
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

▼ Water Level

C_{pen} Shear Strength Determination by Pocket Penetrometer

(1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.

(2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

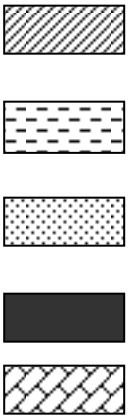
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

Fresh (FR)	No visible signs of weathering.
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	Bedding Plane Spacing
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.

STRENGTH CLASSIFICATION

Rock Strength	Approximate Uniaxial Compressive Strength (MPa)	(psi)	Field Estimation of Hardness*
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

THURBER

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RECORD OF BOREHOLE No DC1-01 1 OF 1 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 255.5 E 275 967.5 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.04 - 2024.03.05 LATITUDE 48.830000 LONGITUDE -87.392744 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
289.4	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, trace silt, occaional cobbles Loose to Very Dense Brown Moist		1	SS	16		289	○			
			2	SS	91			○			36 54 10 (SI+CL)
			3	SS	21		288	○			
			4	SS	17		287	○			
			5	SS	8		286	○			
	Occasional cobbles						285				
	No recovery		6	SS	100/ 0.100		284				
			7	SS	44		283	○			42 52 6 (SI+CL)
			8	SS	64		282	○			
280.0			9	SS	100/		281	○			
9.4	END OF BOREHOLE AT 9.4m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.				0.075						

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC1-02 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 231.9 E 275 995.9 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.03 - 2024.03.04 LATITUDE 48.829788 LONGITUDE -87.392355 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: UNCONFINED, QUICK TRIAXIAL, FIELD VANE, LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
303.0	GROUND SURFACE										
0.0	**SAND** and **GRAVEL**, some silt, trace organics Very Dense Brown		1	SS	85				o		41 46 13 (SI+CL)
302.3											
0.7	**SAND**, trace to some gravel, trace to some silt Dense to Compact Brown Moist		2	SS	40		302		o		
	Possible cobbles No recovery		3	SS	35		301				
			4	SS	29				o		
			5	SS	19		300		o		
	Occasional cobbles		6	SS	28		299		o		
			7	SS	12		298		o		3 82 15 (SI+CL)
			8	SS	16		297		o		
294.3							296				
8.7	Gravelly **SAND**, trace silt Loose to Compact Brown Moist		9	SS	100/ 0.025		295				
	No recovery						294				

Continued Next Page

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC1-02 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 231.9 E 275 995.9 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.03 - 2024.03.04 LATITUDE 48.829788 LONGITUDE -87.392355 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page							20 40 60 80 100	20 40 60		
	Gravelly **SAND**, trace silt Compact Brown Moist					▽			○		
			10	SS	27		292		○		
	175mm thick layer of organics at 11.1m										
							291				
	Trace oxidation Loose		11	SS	7				○		
288.2							290				
			12	SS	32		289		○		
14.8	**SAND**, some gravel, trace silt Compact Grey Wet						288				
			13	SS	20				○		9 86 5 (SI+CL)
							287				
285.6			14	SS	20		286		○		
17.4	END OF BOREHOLE AT 17.4m. WATER LEVEL AT 10.8m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No DC1-03 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 207.5 E 276 025.1 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.02 - 2024.03.02 LATITUDE 48.829571 LONGITUDE -87.391955 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
306.5	GROUND SURFACE										
0.0	Sandy **ORGANICS**, trace silt, wood Very Dense Brown Moist		1	SS	77		306				
305.8											
0.7	**SAND**, trace gravel, trace to some silt, wood fragments Very Dense to Compact Brown Moist		2	SS	19		305				3 85 12 (SI+CL)
	No recovery		3	SS	47						
			4	SS	32		304				
			5	SS	22		303				
			6	SS	15		302				
			7	SS	18		301				
			8	SS	7		300				1 85 12 2
	Some silt						299				
			9	SS	12		298				
296.5							297				

Continued Next Page

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

$\frac{20}{15}$ 5 $\frac{5}{10}$ (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No DC1-03 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 207.5 E 276 025.1 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.02 - 2024.03.02 LATITUDE 48.829571 LONGITUDE -87.391955 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (UNCONFINED, FIELD VANE, QUICK TRIAXIAL, LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
10.0	Silty **SAND**, trace clay Compact to Very Dense Brown Moist						296				
			10	SS	37	▽			o		0 73 26 1
							295				
	Trace gravel Very Dense		11	SS	66		294		o		
							293				
	Dense		12	SS	34				o		
							292				
	Compact		13	SS	18		291		o		
290.5	Very Dense		14	SS	100/ 0.025						
16.0	END OF BOREHOLE AT 16.0m. UPON AUGER REFUSAL. WATER LEVEL AT 11.2m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

20 / 15 5 / 10 (%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No DC1-04 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 175.6 E 276 063.5 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.01 - 2024.03.01 LATITUDE 48.829285 LONGITUDE -87.391430 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
306.0	GROUND SURFACE										
0.0	Silty **SAND**, trace clay, trace organics Very Dense Brown Moist (FILL)		1	SS	54		305				
305.3 / 0.7	**SAND** and **GRAVEL**, trace silt Compact to Very Dense Brown Moist (FILL)		2	SS	44						
			3	SS	57		304				
303.0 / 3.0			4	SS	28						48 49 3 (SI+CL)
	SAND, trace to some gravel, trace silt Compact to Dense Brown Moist		5	SS	14		303				
			6	SS	30		302				
			7	SS	13		301				
298.2	Gravelly sand layer						300				
7.8	Silty **SAND** Compact Brown Wet		8	SS	26		299				
			9	SS	11		298				0 83 15 2
							297				
							296				

Continued Next Page

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

20 / 15 / 10 / 5 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC1-04 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 175.6 E 276 063.5 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.01 - 2024.03.01 LATITUDE 48.829285 LONGITUDE -87.391430 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **SAND** Very Dense Brown Moist Occasional cobbles		10	SS	60/ 0.075		295		○		
294.5											
11.5	**SAND**, some gravel, trace silt Very Dense Brown Moist		11	SS	50/ 0.075		294		○		14 81 5 (SI+CL)
293.4			12	SS	100/ 0.025				○		
12.6	END OF BOREHOLE AT 12.6m. WATER LEVEL AT 11.7m. Well installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.05m slotted screen.										

WATER LEVEL READINGS

DATE	DEPTH(m)	ELEV.(m)
2024.03.02	3.4	302.6
2024.03.03	10.6	295.4
2024.03.04	9.9	296.1
2024.03.11	10.3	295.7
2024.03.14	10.3	295.7
2024.03.17	9.3	296.7
2024.03.18	9.8	296.2

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC1-05 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 147.3 E 276 092.0 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.15 - 2024.03.15 LATITUDE 48.829032 LONGITUDE -87.391040 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.0	GROUND SURFACE										
0.0	**ASPHALT:** (100mm)										
0.1	**SAND** and **GRAVEL**, trace silt, occasional cobbles Dense Brown Moist (FILL)		1	SS	43				○		
			2	SS	35		306		○		41 50 9 (SI+CL)
			3	SS	100/ 0.100		305		○		
	Occasional cobbles Compact		4	SS	15				○		
304.0							304				
3.0	**SAND**, some silt, some organics, occasional cobbles Compact Brown Moist		5	SS	28				○		
			6	SS	13		303				
301.4							302		○		
5.6	**SAND**, trace gravel, trace silt Compact Brown Moist		7	SS	15		301		○		
			8	SS	23		300				
298.3							299		○		
8.7	Sandy **SILT**, occasional cobbles Dense Grey Moist		9	SS	9		298		○		

Continued Next Page

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No DC1-05 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 147.3 E 276 092.0 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.15 - 2024.03.15 LATITUDE 48.829032 LONGITUDE -87.391040 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
296.8	Continued From Previous Page										
10.2	**SAND**, some silt Loose Brown Wet		10	SS	9		296		○		0 81 18 1
	Boulders from 12.2m to 12.4m		11	SS	~~100/~~ 0.025		295				
293.9							294			FI	
13.1	**BEDROCK: (Granodiorite),** grey, slightly weathered to fresh, weak to very strong		1	RUN						6 2 1	RUN #1 TCR=100% SCR=29% RQD=0% UCS=11MPa (Point Load Ave.)
			2	RUN			293			2 1 2	RUN #2 TCR=100% SCR=76% RQD=76% UCS=96MPa (Point Load Ave.)
			3	RUN			292			1 1 2	RUN #3 TCR=100% SCR=46% RQD=37% UCS=204MPa (Point Load Ave.)
290.4							291			3 2 3	
16.6	END OF BOREHOLE AT 16.6m. BOREHOLE BACKFILLED WITH BENTONITE TO 0.3m, THEN ASPHALT TO GROUND SURFACE.										

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

(%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC1-06 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 131.5 E 276 124.4 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828891 LONGITUDE -87.390597 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
307.0	GROUND SURFACE										
0.0	**ASPHALT:** (75mm)										
0.1	Gravelly **SAND**, trace silt, occasional cobbles Dense to Very Dense Brown Moist (FILL)		1	SS	41		306				
			2	SS	100/ 0.075						
			3	SS	46		305				
			4	SS	44		304				
303.8											
3.2	**ORGANICS**, some sand, trace silt Loose Brown Moist		5	SS	7		303				
302.9											
4.1	**SAND**, trace silt Compact Brown Moist		6	SS	10		302				
301.4											
5.6	**SAND** and **GRAVEL**, trace silt, occasional cobbles Dense Brown Wet		7	SS	23		301				52 45 3 (SI+CL)
299.4							300				
7.6	Silty **SAND**, some gravel, trace clay Compact to Loose Brown/Grey Wet		8	SS	10		299				15 58 24 3
			9	SS	14	▽	298				

Continued Next Page

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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Ontario

THURBER

RECORD OF BOREHOLE No DC1-06 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 131.5 E 276 124.4 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers/NQ Coring COMPILED BY AN

DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828891 LONGITUDE -87.390597 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
296.3	Silty **SAND**, some gravel, trace clay Very Dense Grey Wet		~~10~~	~~SS~~	~~77/~~ 0.025					FI	
10.7	**BEDROCK:** (GRANODIORITE to GRANITE, moderately weathered to fresh, red to grey, calcite veins (up to 25mm width) from 10.7m to 13.5m, very strong		1	RUN			296			5 2 1 2 1	RUN #1 TCR=100% SCR=83% RQD=64% UCS=140MPa (Point Load Ave.)
			2	RUN			295			2 1 2 294 4 1	RUN #2 TCR=100% SCR=58% RQD=51% UCS=159MPa (Point Load Ave.)
292.8			3	RUN			293			1 2	RUN #3 TCR=100% SCR=100% RQD=76% UCS=205MPa (Point Load Ave.)
14.2	END OF BOREHOLE AT 14.2m. WATER LEVEL AT 9.7m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

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THURBER

RECORD OF BOREHOLE No DC1-07 1 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 095.7 E 276 159.7 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828572 LONGITUDE -87.390114 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
307.8	GROUND SURFACE					
0.0 / 0.0	**ASPHALT:** (50mm)					
	Gravelly **SAND**, trace silt Dense to Compact Brown Dry to Moist (FILL)		1	SS	46	
			2	SS	27	
			3	SS	20	
			4	SS	23	
	Occasional cobbles		5	SS	27	
303.2						
4.6	**SAND**, some organics, trace gravel, trace silt, occasional cobbles Very Dense Black Moist		6	SS	40	
302.2						
5.6	Gravelly **SAND**, some silt Dense Brown Wet		7	SS	36	
300.6						
7.2	**SAND**, some silt, trace gravel Compact Brown Wet		8	SS	34	
			9	SS	12	▽

ELEVATION SCALE: 307, 306, 305, 304, 303, 302, 301, 300, 299, 298

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

SHEAR STRENGTH kPa (20 40 60 80 100)
○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m^3

REMARKS & GRAIN SIZE DISTRIBUTION (%)	GR	SA	SI	CL
	33	56	11	(SI+CL)
	1	88	11	(SI+CL)

Continued Next Page

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

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No DC1-07 2 OF 2 METRIC

GWP# 6333-14-00 LOCATION MTM NAD83-10: N 5 410 095.7 E 276 159.7 ORIGINATED BY MM

DIST Thunder Bay HWY 17 BOREHOLE TYPE Hollow Stem Augers COMPILED BY AN

DATUM Geodetic DATE 2024.03.14 - 2024.03.14 LATITUDE 48.828572 LONGITUDE -87.390114 CHECKED BY RB

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
297.1	**SAND**, some silt, trace gravel Compact Brown Wet										
10.7 296.5	Sandy **SILT** Loose Brown Wet		10	SS	6		297		o		
11.3	END OF BOREHOLE AT 11.3m. WATER LEVEL AT 9.38m. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO SURFACE.										

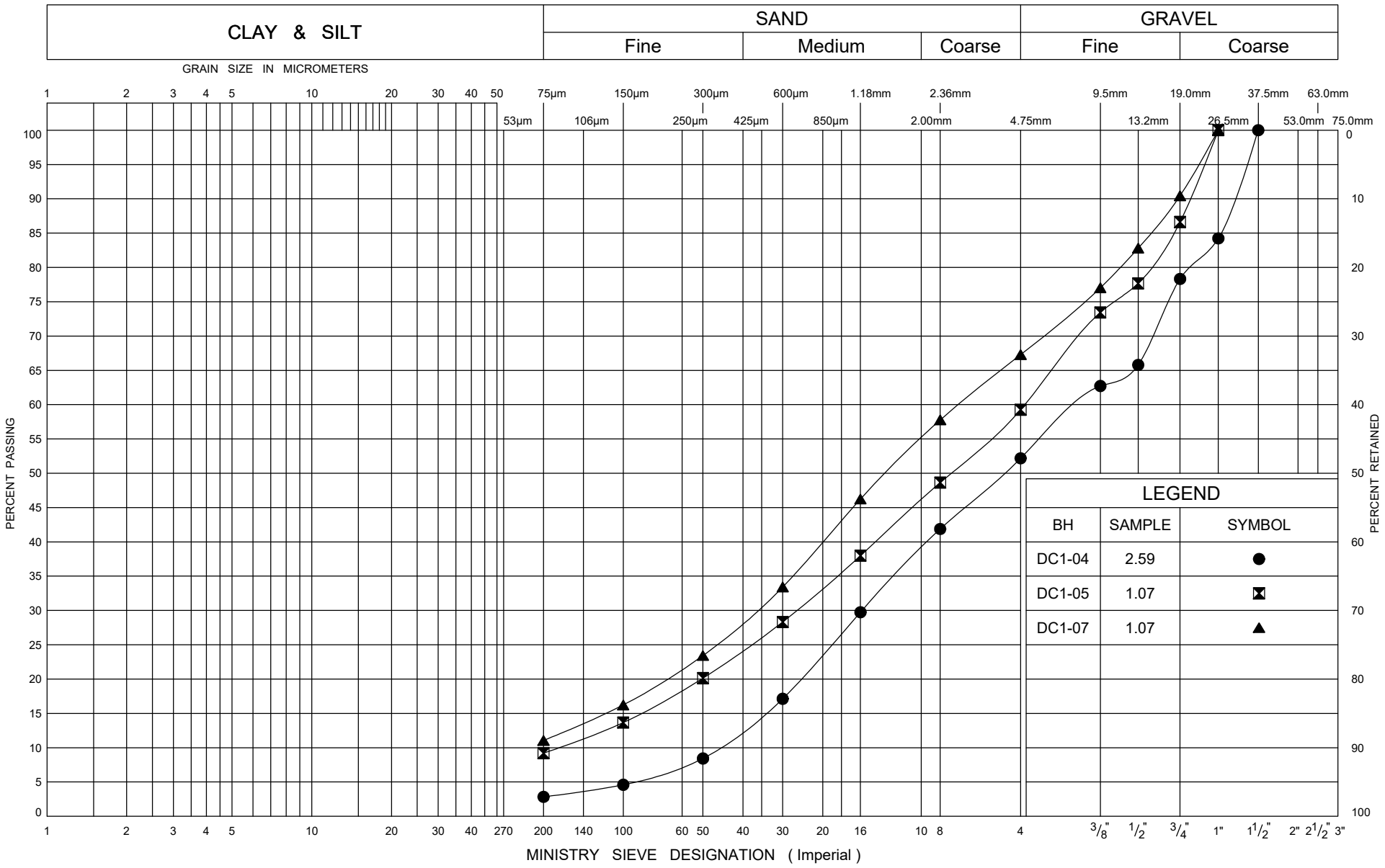
$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4S2 2020LIBRARY(MTO).GLB MTO-37996.GPJ 7/26/24

THURBER

E2: Deep Cut Section 1 Geotechnical Laboratory Testing Results



Ministry of Transportation
Ontario

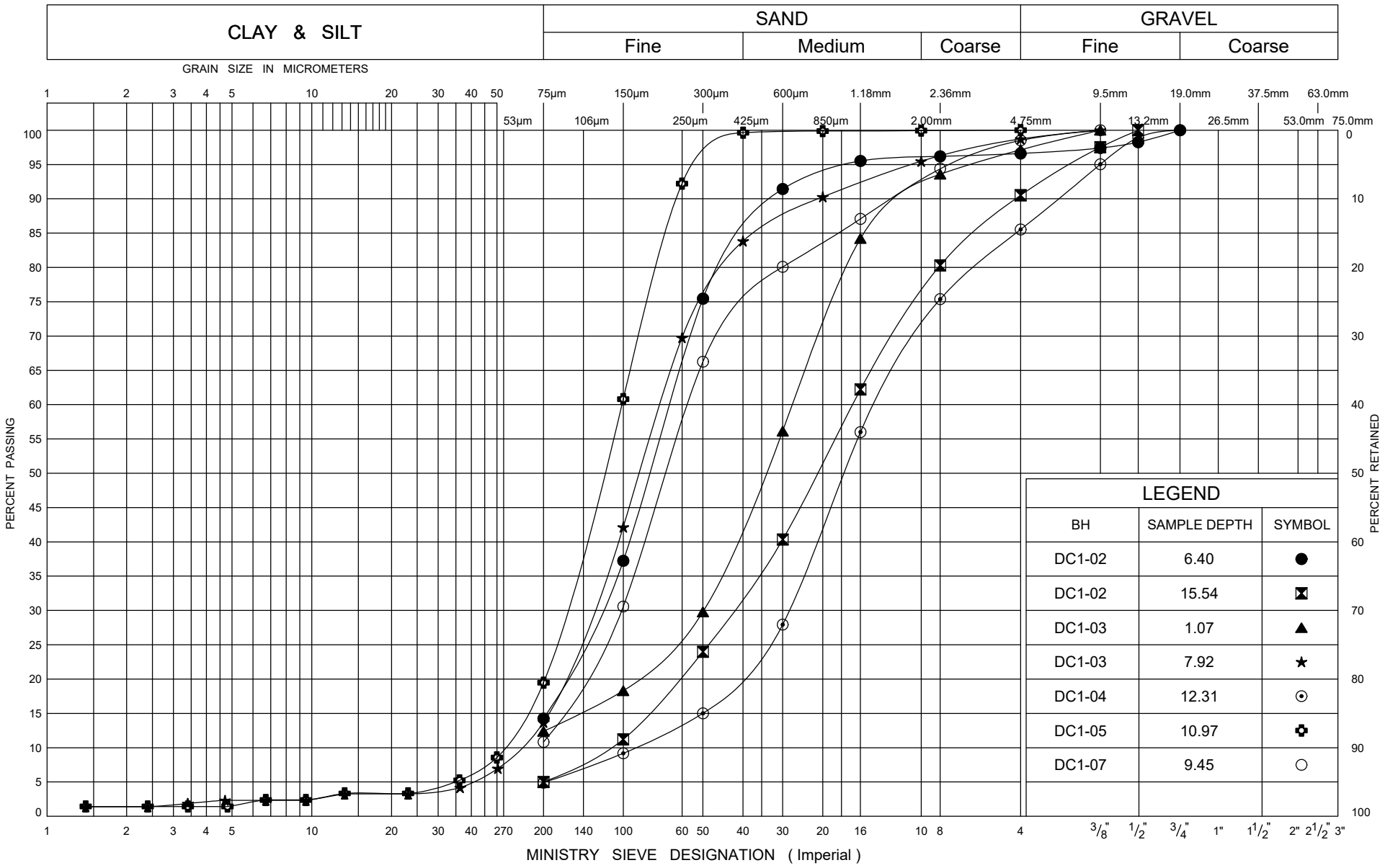
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL to Gravelly SAND FILL

FIG No E1

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



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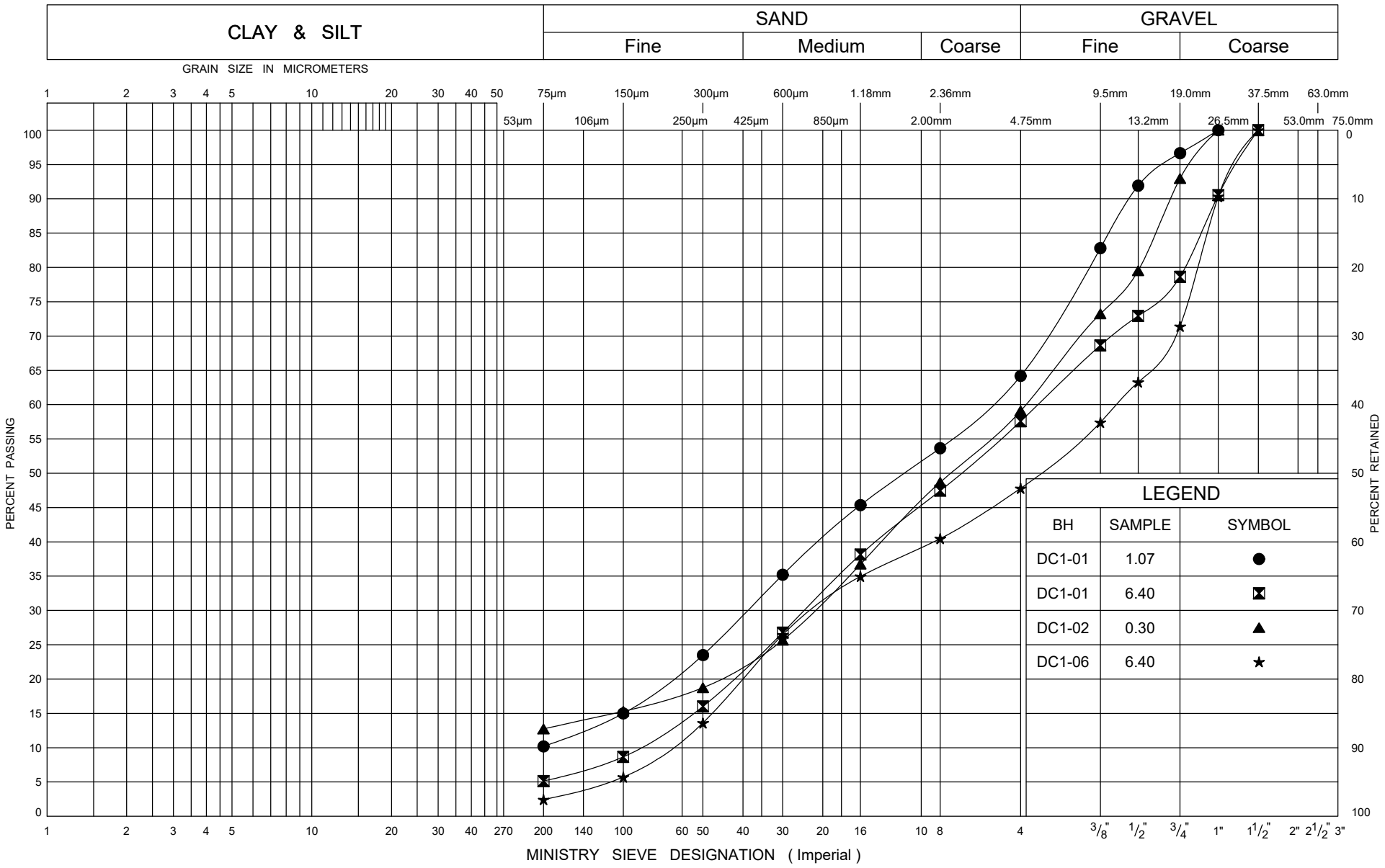
GRAIN SIZE DISTRIBUTION

SAND

FIG No E2

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 3 MTO-37996.GPJ ONTARIO MOT.GDT 5/9/24



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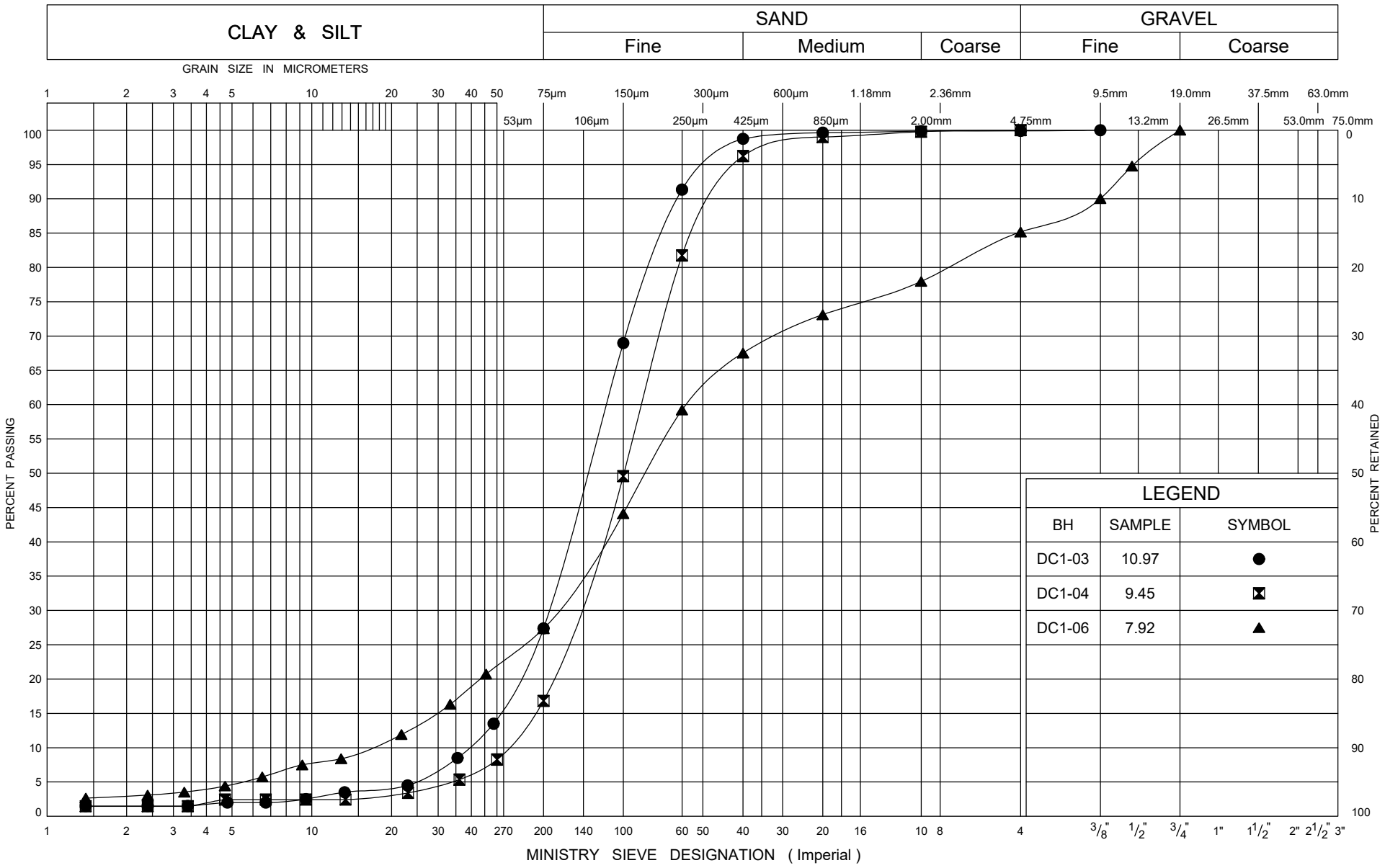
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL

FIG No E3

GWP# 6333-14-00

ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24



ONTARIO MOT GRAIN SIZE 2 MTO-37996.GPJ ONTARIO MOT.GDT 7/30/24

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GRAIN SIZE DISTRIBUTION

Silty SAND to Sandy SILT

FIG No E4

GWP# 6333-14-00

APPENDIX F

Bedrock Laboratory Test Results and Rock Core Photographs

THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	17-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	18-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF1-01	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	16.8	D	3.3	47.2	66.1	1.4	32.8	Granite	Medium Strong
2	1	17.1	D	18.2	47.2	65.5	7.5	181.1	Granite	Very Strong
3	1	17.8	D	12.0	47.1	69.1	5.0	119.8	Granite	Very Strong
4	2	18.2	D	18.5	47.1	71.7	7.7	184.7	Granite	Very Strong
5	2	18.5	D	20.0	47.1	65.8	8.3	199.7	Granite	Very Strong
6	2	18.8	D	12.0	47.1	66.8	5.0	119.8	Granite	Very Strong
7	2	19.2	D	19.3	47.1	68.6	8.0	192.7	Granite	Very Strong
8	3	19.5	D	7.1	47.1	68.9	3.0	70.9	Granite	Strong
9	3	19.8	D	18.3	47.1	67.2	7.6	182.7	Granite	Very Strong
10	3	20.1	D	15.0	47.2	72.5	6.2	149.3	Granite	Very Strong
11										
12										
13					Run 1 Point Load Average:			111.3		Very Strong
14					Run 2 Point Load Average:			174.2		Very Strong
15					Run 3 Point Load Average:			134.3		Very Strong
16										
17										
18										
19										
20										
21										
22										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	18-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	19-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF1-02	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	8.4	D	23.6	47.3	70.0	9.8	234.1	Granite	Very Strong
2	1	8.7	D	23.2	47.1	68.1	9.7	231.6	Granite	Very Strong
3	1	9.0	D	22.0	47.1	71.6	9.2	219.6	Granite	Very Strong
4	2	9.3	D	25.3	47.1	71.7	10.5	252.6	Granite	Extremely Strong
5	2	9.7	D	24.5	47.2	68.4	10.2	243.8	Granite	Very Strong
6	2	10.0	D	24.7	47.1	70.0	10.3	246.6	Granite	Very Strong
7	2	10.3	D	22.5	47.2	68.4	9.3	223.9	Granite	Very Strong
8	3	10.6	D	23.2	47.3	74.0	9.6	230.1	Granite	Very Strong
9	3	10.9	D	25.0	47.3	70.0	10.3	248.0	Granite	Very Strong
10	3	11.3	D	24.5	47.3	71.8	10.1	243.0	Granite	Very Strong
11	3	11.6	D	24.2	47.3	72.3	10.0	240.0	Granite	Very Strong
12	3	11.8	D	16.7	47.3	66.6	6.9	165.6	Granite	Very Strong
13										
14					Run 1 Average			228		Very Strong
15					Run 2 Average			242		Very Strong
16					Run 3 Average			225		Very Strong
17										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	16-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	15-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF1-04	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	10.7	D	18.5	47.1	67.6	7.7	184.7	Granite	Very Strong
2	1	11.1	D	10.4	47.2	68.7	4.3	103.5	Granite	Very Strong
3	1	11.6	D	14.8	47.1	70.1	6.2	147.8	Granite	Very Strong
4	1	11.8	D	23.0	47.3	69.4	9.5	228.1	Granite	Very Strong
5	2	12.3	D	16.4	47.2	78.2	6.8	163.2	Granite	Very Strong
6	2	12.6	D	19.7	47.1	72.4	8.2	196.7	Granite	Very Strong
7	2	12.9	D	23.1	47.2	74.0	9.6	229.9	Granite	Very Strong
8	2	13.4	D	20.7	47.1	70.3	8.6	206.7	Granite	Very Strong
9	3	13.6	D	20.7	47.1	72.8	8.6	206.7	Granite	Very Strong
10	3	13.9	D	21.5	47.1	68.0	8.9	214.7	Granite	Very Strong
11	3	14.3	D	16.5	47.1	74.0	6.9	164.7	Granite	Very Strong
12										
13					Run 1 Average:			166.0		Very Strong
14					Run 2 Average:			199.1		Very Strong
15					Run 3 Average:			195.4		Very Strong
16										
17										
18										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	11-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	19-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF3-01	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	18.3	D	21.5	47.3	67.8	8.9	213.2	Granite	Very Strong
2	1	18.6	D	18.9	47.3	72.2	7.8	187.5	Granite	Very Strong
3	1	19.0	D	24.7	47.4	66.8	10.2	244.2	Granite	Very Strong
4	1	19.3	D	21.3	47.3	77.5	8.8	211.3	Granite	Very Strong
5	1	19.6	D	21.0	47.3	72.5	8.7	208.3	Granite	Very Strong
6	2	19.8	D	24.2	47.3	69.8	10.0	240.0	Granite	Very Strong
7	2	20.4	D	27.1	47.3	75.5	11.2	268.8	Granite	Extremely Strong
8	2	20.7	D	25.3	47.4	71.0	10.4	250.1	Granite	Extremely Strong
9	3	21.1	D	22.9	47.4	68.4	9.4	226.4	Granite	Very Strong
10	3	21.4	D	23.1	47.4	67.6	9.5	228.4	Granite	Very Strong
11	3	21.7	D	31.0	47.4	73.6	12.8	306.5	Granite	Extremely Strong
12										
13					Run 1 Average:			212.9		Very Strong
14					Run 2 Average:			253.0		Extremely Strong
15					Run 3 Average:			253.7		Extremely Strong
16										
17										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	13-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	15-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF3-02	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	18.6	D	13.0	47.2	69.8	5.4	129.4	Granite	Very Strong
2	1	18.9	D	26.7	47.1	67.3	11.1	266.6	Granite	Extremely Strong
3	1	19.2	D	23.2	47.0	70.4	9.7	232.4	Granite	Very Strong
4	1	19.5	D	26.2	47.2	69.3	10.9	260.7	Granite	Extremely Strong
5	2	19.9	D	22.2	47.1	67.1	9.2	221.6	Granite	Very Strong
6	2	20.2	D	24.7	47.2	70.6	10.2	245.8	Granite	Very Strong
7	2	20.5	D	20.8	47.1	74.8	8.7	207.7	Granite	Very Strong
8	2	20.9	D	21.9	47.1	67.9	9.1	218.6	Granite	Very Strong
9	3	21.3	D	20.2	47.1	73.0	8.4	201.7	Granite	Very Strong
10	3	21.6	D	22.8	47.1	70.7	9.5	227.6	Granite	Very Strong
11										
12							Run 1 Average:	222.3		Very Strong
13							Run 2 Average:	223.4		Very Strong
14							Run 3 Average:	214.7		Very Strong
15										
16										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	08-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	16-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** HF3-04	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	22.9	D	20.5	47.3	68.5	8.5	203.3	Granite	Very Strong
2	1	23.3	D	51.6	47.3	63.4	21.3	511.8	Granite	Extremely Strong
3	1	23.6	D	15.0	47.3	70.7	6.2	148.8	Granite	Very Strong
4	1	24.1	D	16.2	47.3	71.1	6.7	160.7	Granite	Very Strong
5	2	24.1	D	11.4	47.3	70.0	4.7	113.1	Granite	Very Strong
6	2	24.5	D	19.6	47.3	68.2	8.1	194.4	Granite	Very Strong
7	2	24.8	D	15.4	47.3	71.4	6.4	152.7	Granite	Very Strong
8	2	25.0	D	11.0	47.3	69.6	4.5	109.1	Granite	Very Strong
9	2	25.3	D	22.9	47.3	73.7	9.5	227.1	Granite	Very Strong
10	3	25.7	D	17.5	47.3	67.5	7.2	173.6	Granite	Very Strong
11	3	26.0	D	19.6	47.3	70.6	8.1	194.4	Granite	Very Strong
12	3	26.2	D	20.5	47.3	73.0	8.5	203.3	Granite	Very Strong
13										
14					Run 1 Average:			256.1		Extremely Strong
15					Run 2 Average:			159.3		Very Strong
16					Run 3 Average:			190.4		Very Strong
17										
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19										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	15-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	19-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** DC1-05	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	13.5	D	1.1	47.1	66.9	0.5	11.0	Granodiorite	Weak
2	2	13.8	D	3.0	47.1	76.4	1.2	30.0	Granodiorite	Medium Strong
3	2	14.2	D	12.1	47.1	68.5	5.0	120.8	Granodiorite	Very Strong
4	2	14.5	D	2.6	47.1	68.7	1.1	26.0	Granodiorite	Medium Strong
5	2	14.8	D	20.9	47.1	75.0	8.7	208.7	Granodiorite	Very Strong
6	3	15.2	D	24.3	47.1	70.0	10.1	242.6	Granodiorite	Very Strong
7	3	15.7	D	19.0	47.1	73.0	7.9	189.7	Granodiorite	Very Strong
8	3	16.2	D	18.1	47.1	72.5	7.5	180.7	Granodiorite	Very Strong
9										
10										
11						Run 1 Average:		11.0		Weak
12						Run 2 Average:		96.3		Strong
13						Run 3 Average:		204.3		Very Strong
14										
15										
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THURBER ENGINEERING LTD.

POINT LOAD TEST SHEET

ASTM D5731-08

Job No:	37996	**Date Drilled:**	14-Mar-24
Project Name:	HWY 17 Hewitson Creek	**Date Tested:**	19-Apr-24
		Tester:	BS
Core Size:	NQ **BH No :** DC1-06	**Client:**	Hatch

Test No.	Run No.	Depth (m)	Axial or Diametral	Gauge (MPa)	Diameter (mm)	Length (mm)	$I_{s(50)}$ (MPa)	UCS (MPa)	Rock Type	Rock Strength (after Hoek & Brown, 1997)
1	1	10.9	D	11.8	47.1	76.5	4.9	117.8	Granodiorite	Very Strong
2	1	11.3	D	16.0	47.1	68.2	6.7	159.7	Granodiorite	Very Strong
3	1	11.6	D	15.2	47.1	73.4	6.3	151.8	Granodiorite	Very Strong
4	1	11.9	D	13.2	47.2	67.6	5.5	131.4	Granodiorite	Very Strong
5	2	12.2	D	3.0	47.1	71.6	1.2	30.0	Granodiorite	Medium Strong
6	2	12.7	D	16.4	47.1	74.5	6.8	163.7	Granodiorite	Very Strong
7	2	13.5	D	28.3	47.1	72.5	11.8	282.5	Granodiorite	Extremely Strong
8	3	13.8	D	20.9	47.1	76.3	8.7	208.7	Granodiorite	Very Strong
9	3	14.1	D	20.1	47.1	78.2	8.4	200.7	Granodiorite	Very Strong
10										
11										
12						Run 1 Average:		140.2		Very Strong
13						Run 2 Average:		158.7		Very Strong
14						Run 3 Average:		204.7		Very Strong
15										
16										
17										
18										
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35										

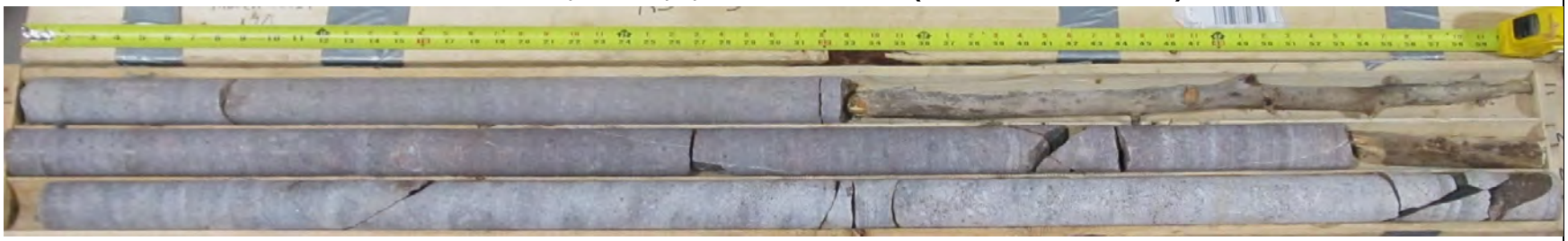
THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole HF1-01, Runs 1, 2, and 3: 16.8 to 20.1 (Elev. 203.8 to 200.5 m)



Borehole HF1-02, Runs 1, 2, and 3: 8.4 to 12.0 (Elev. 217.7 to 214.1 m)



Borehole HF1-04, Runs 1, 2, and 3: 10.7 to 14.3 (Elev. 209.8 to 206.2 m)



THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole HF3-01, Runs 1, 2, and 3: 18.3 to 21.8 (Elev. 232.1 to 228.6 m)



Borehole HF3-02, Runs 1, 2, and 3: 18.5 to 21.7 (Elev. 229.5 to 226.3 m)



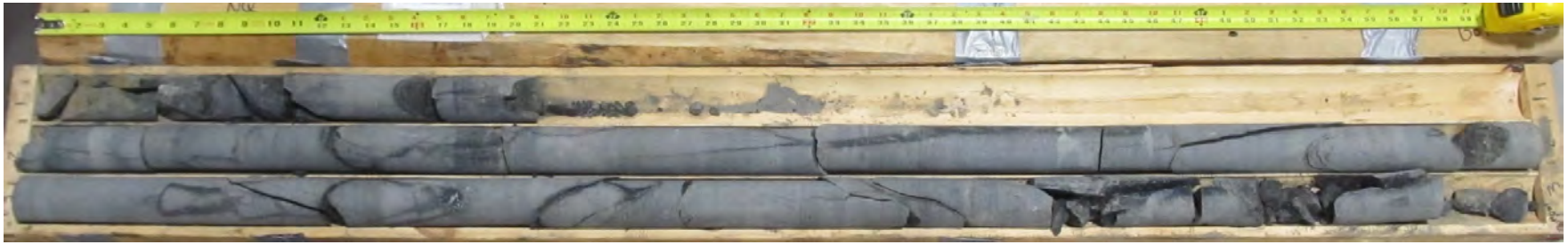
Borehole HF3-04, Runs 1, 2, and 3: 22.9 to 26.3 (Elev. 228.4 to 225.0 m)



THURBER ENGINEERING LTD.

Bedrock Core Photos

Borehole DC1-05, Run 1, 2, 3: 13.1 to 16.6 (Elev. 293.9 to 290.4 m)



Borehole DC1-06, Run 1, 2, 3: 10.7 to 14.2 (Elev. 296.3 to 292.8 m)



APPENDIX G

Analytical Laboratory Test Results





FINAL REPORT

CA15114-APR24 R

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

CA15114-APR24 R

First Page

CLIENT DETAILS		LABORATORY DETAILS	
Client	Thurber Engineering Ltd.	Project Specialist	Jill Campbell, B.Sc.,GISAS
		Laboratory	SGS Canada Inc.
Address	1908 Ironoak Way, Suite 202 Oakville, ON L6H 0N1. Canada	Address	185 Concession St., Lakefield ON, K0L 2H0
Contact	Rachel Bourassa	Telephone	2165
Telephone	905-829-8666 x 263	Facsimile	705-652-6365
Facsimile		Email	jill.campbell@sgs.com
Email	rbourassa@thurber.ca	SGS Reference	CA15114-APR24
Project		Received	04/19/2024
Order Number		Approved	04/25/2024
Samples	Solution (3)	Report Number	CA15114-APR24 R
		Date Reported	04/25/2024

COMMENTS

Temperature of Sample upon Receipt: 1 degrees C
Cooling Agent Present:YES
Custody Seal Present:YES

Chain of Custody: 035940

SIGNATORIES

Jill Campbell, B.Sc.,GISAS



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Client: Thurber Engineering Ltd.
Project:
Project Manager: Rachel Bourassa
Samplers: G.Azzopardi

MATRIX: WATER

Sample Number	6	7	8
Sample Name	HF1	HF3	Hewiston Creek
Sample Matrix	Solution	Solution	Solution
Sample Date	18/04/2024	18/04/2024	18/04/2024

Parameter	Units	RL		Result	Result	Result
General Chemistry						
Conductivity	uS/cm	2		26	194	36
Redox Potential	mV	no		226	192	254
Sulphide	µg/L	6		< 6	< 6	< 6
Metals and Inorganics						
Sulphate	mg/L	0.04		1.6	4.0	2.2
Other (ORP)						
pH	No unit	0.05		6.80	7.78	6.88
Chloride	mg/L	0.04		0.37	38	4.5

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0477-APR24	mg/L	0.04	<0.04	4	20	98	90	110	103	75	125
Sulphate	DIO0477-APR24	mg/L	0.04	<0.04	1	20	98	90	110	101	75	125
Chloride	DIO0537-APR24	mg/L	0.04	<0.04	3	20	99	90	110	86	75	125
Sulphate	DIO0537-APR24	mg/L	0.04	<0.04	0	20	99	90	110	93	75	125

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0529-APR24	uS/cm	2	< 2	0	20	100	90	110	NA		
Conductivity	EWL0530-APR24	uS/cm	2	< 2	0	20	100	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
pH	EWL0529-APR24	No unit	0.05	NA	0		101			NA		
pH	EWL0530-APR24	No unit	0.05	NA	0		101			NA		

Redox Potential

Method: SM 2580 I

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Redox Potential	EWL0490-APR24	mV	no	NA	0	20	104	80	120	NA		

Sulphide by SFA

Method: SM 4500 I Internal ref.: ME-CA-[ENV]SFA-LAK-AN-008

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High	Spike Recovery (%)	Recovery Limits (%) Low	Recovery Limits (%) High
Sulphide	SKA0241-APR24	ug/L	6	<0.006	ND	20	99	80	120	NA	75	125

QC SUMMARY

Method Blank: a blank matrix that is carried through the entire analytical procedure. Used to assess laboratory contamination.
Duplicate: Paired analysis of a separate portion of the same sample that is carried through the entire analytical procedure. Used to evaluate measurement precision.
LCS/Spike Blank: Laboratory control sample or spike blank refer to a blank matrix to which a known amount of analyte has been added. Used to evaluate analyte recovery and laboratory accuracy without sample matrix effects.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate laboratory accuracy with sample matrix effects.
Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.
RL: Reporting limit
RPD: Relative percent difference
AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.
Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.
Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.
"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

SGS provides criteria information (such as regulatory or guideline limits and summary of limit exceedances) as a service. Every attempt is made to ensure the criteria information in this report is accurate and current, however, it is not guaranteed. Comparison to the most current criteria is the responsibility of the client and SGS assumes no responsibility for the accuracy of the criteria levels indicated.

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This report supersedes all previous versions.

-- End of Analytical Report --

Request for Laboratory Services and CHAIN OF CUSTODY

No: 035940

SGS Industries & Environment - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

Page ____ of ____

Laboratory Information Section - Lab use only

Received By: Katelyn Medland
Received By (signature): KM
Received Date: APR 19 2024 (mm/dd/yy)
Received Time: 10 : 00 (hr : min)
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☑ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: ICE
Temperature Upon Receipt (°C) 1.7 . 1
LAB LIMS #: CA15114-APR24 CA14731-APR24

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Eng.	☒ (same as Report Information)
Contact: Rachel Bourassa	Company:
Address: 202-1965 Ironoak Way, Oakville, ON L6H-0M4	Contact:
Phone: 905-829-8666	Address:
Fax:	Phone:
Email: RBourassa@thurber	Email:

Quotation #: P.O. #:
Project #: Site Location/ID:

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends). Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐ 1 Day ☐ 2 Days ☐ 3 Days ☐ 4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

*NOTE: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture:
☐ Table 2 ☐ Ind/Com ☐ Coarse
☐ Table 3 ☐ Agri/Other ☐ Medium/Fine
☐ Table ____ Appx. ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☒ PWQO ☐ MMER
☐ CCME ☐ Other:
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality:

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX	Field Filtered (Y/N)	M & I: Metals & Inorganics (Incl CrVI, CN, Hg pH,(B(HWS),EC,SAR–soil) (Cl, Na-water)	M & I: Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI	M & I: ICP Metals only Sb,As,Ba,Be,B,Cd, Cr,Co,Cu,Pb,Mo,Ni,Se,Ag,Tl,U,V,Zn	SVOC: PAHs only	SVOC: SVOCs all incl PAHs, ABNs, CPs	PCB: PCBs Total ☐ Aroclor ☐	PHC: F1-F4 + BTEX	PHC: F1-F4 only no BTEX	VOC: VOCs all incl BTEX	VOC: BTEX only	Pest: Pesticides Organochlorine or specify other	Other (please specify): Chlorine (Cl) in water, Phenol, Chlorine residual in water, TSS, Free Chlorine residual in water (FRCL), Sewer Use: Specify pkg:, Water Characterization Pkg General ☐ Extended ☐	SPLP: Specify tests ☐ Metals ☐ VOC ☐ 1,4-Dioxane ☐ OCP ☐ ABN	TCLP: Specify tests ☐ M&I ☐ VOC ☐ PCB ☐ B(a)P ☐ ABN ☐ Ignit.	COMMENTS:
1 HF1	18/4/24	8:30	3	Liquid													✓			
2 HF3	18/4/24	9:45	3	Liquid													✓			
3 Hewiston Creek	18/4/24	8:45	3	Liquid													✓			
4 HCC-01	18/4/24	8:55	11	Liquid												✓		✓	✓	
5																				
6																				
7																				
8																				
9																				
10																				
11																				
12																				

Observations/Comments/Special Instructions

Sampled By (NAME): G. AZZOPARDI Signature: Date: 04 / 18 / 24 (mm/dd/yy)
Relinquished by (NAME): G. AZZOPARDI Signature: Date: 04 / 18 / 24 (mm/dd/yy)

Pink Copy - Client
Yellow & White Copy - SGS

Revision #: 1.7
Date of Issue: 07 JUNE 2023

Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. {2} Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). {3} Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.





FINAL REPORT

CA40086-MAY24 R1

37996, Hewitson Creek

Prepared for

Thurber Engineering Ltd.

FINAL REPORT

First Page

CLIENT DETAILS

Client	Thurber Engineering Ltd.
Address	1908 Ironoak Way, Suite 202 Oakville, ON L6H 0N1. Canada
Contact	Rachel Bourassa
Telephone	905-829-8666 x 263
Facsimile	
Email	rbourassa@thurber.ca
Project	37996, Hewitson Creek
Order Number	
Samples	Soil (6)

LABORATORY DETAILS

Project Specialist	Maarit Wolfe, Hon.B.Sc
Laboratory	SGS Canada Inc.
Address	185 Concession St., Lakefield ON, K0L 2H0
Telephone	705-652-2000
Facsimile	705-652-6365
Email	Maarit.Wolfe@sgs.com
SGS Reference	CA40086-MAY24
Received	05/09/2024
Approved	05/21/2024
Report Number	CA40086-MAY24 R1
Date Reported	05/21/2024

COMMENTS

Temperature of Sample upon Receipt: 8 degrees C
Cooling Agent Present: YES
Custody Seal Present: YES

Chain of Custody Number: NA

Corrosivity Index is based on the American Water Works Corrosivity Scale according to AWWA C-105. An index greater than 10 indicates the soil matrix may be corrosive to cast iron alloys.

SIGNATORIES

Maarit Wolfe, Hon.B.Sc

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FINAL REPORT

CA40086-MAY24 R1

Client: Thurber Engineering Ltd.
Project: 37996, Hewitson Creek
Project Manager: Rachel Bourassa
Samplers: Rachel Bourassa

MATRIX: SOIL

Sample Number			5	6	7	8	9	10
Sample Name			HCC-04 SS5 (11'-13')	HCC-03 SS4 (8.5'-10.5')	HF3-03 SS11 (40'-40'9")	HF1-01 SS3 (5'-7')	HF3-02 SS5 (10'-12')	HF1-04 SS4 (7'6"-9'6")
Sample Matrix			Soil	Soil	Soil	Soil	Soil	Soil
Sample Date			03/04/2024	24/03/2024	09/03/2024	16/03/2024	11/03/2024	16/03/2024
Parameter	**Units**	**RL**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Corrosivity Index								
Corrosivity Index	none	1	1	1	4	1	1	1
Soil Redox Potential	mV	no	272	298	304	295	284	278
Sulphide (Na2CO3)	%	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
pH	pH Units	0.05	7.66	7.66	8.78	6.05	7.13	6.32
Resistivity (calculated)	ohms.cm	-9999	19200	12300	5620	11400	20000	27800
General Chemistry								
Conductivity	uS/cm	2	52	81	178	88	50	36
Metals and Inorganics								
Moisture Content	%	0.1	11.6	8.4	12.8	7.3	11.3	8.4
Sulphate	µg/g	0.4	0.6	3.3	1.0	3.0	2.1	2.1
Other (ORP)								
Chloride	µg/g	0.4	1.6	12	11	27	10	6.1

QC SUMMARY

Anions by IC

Method: EPA300/MA300-Ions1.3 | Internal ref.: ME-CA-[ENV]IC-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Chloride	DIO0352-MAY24	µg/g	0.4	<0.4	11	35	105	80	120	103	75	125
Sulphate	DIO0352-MAY24	µg/g	0.4	<0.4	9	35	98	80	120	88	75	125

Carbon/Sulphur

Method: ASTM E1915-07A | Internal ref.: ME-CA-[ENV]ARD-LAK-AN-020

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Sulphide (Na2CO3)	ECS0045-MAY24	%	0.01	< 0.01								

Conductivity

Method: SM 2510 | Internal ref.: ME-CA-[ENV]EWL-LAK-AN-006

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
Conductivity	EWL0387-MAY24	uS/cm	2	< 2	1	20	99	90	110	NA		

QC SUMMARY

pH

Method: SM 4500 I Internal ref.: ME-CA-[ENV]EWL-LAK-AN-001

Parameter	QC batch Reference	Units	RL	Method Blank	Duplicate		LCS/Spike Blank			Matrix Spike / Ref.		
					RPD	AC (%)	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
								Low	High		Low	High
pH	EWL0364-MAY24	pH Units	0.05	NA	0		101			NA		

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Reference Material: a material or substance matrix matched to the samples that contains a known amount of the analyte of interest. A reference material may be used in place of a matrix spike.

RL: Reporting limit

RPD: Relative percent difference

AC: Acceptance criteria

Multielement Scan Qualifier: as the number of analytes in a scan increases, so does the chance of a limit exceedance by random chance as opposed to a real method problem. Thus, in multielement scans, for the LCS and matrix spike, up to 10% of the analytes may exceed the quoted limits by up to 10% absolute and the spike is considered acceptable.

Duplicate Qualifier: for duplicates as the measured result approaches the RL, the uncertainty associated with the value increases dramatically, thus duplicate acceptance limits apply only where the average of the two duplicates is greater than five times the RL.

Matrix Spike Qualifier: for matrix spikes, as the concentration of the native analyte increases, the uncertainty of the matrix spike recovery increases. Thus, the matrix spike acceptance limits apply only when the concentration of the matrix spike is greater than or equal to the concentration of the native analyte.

LEGEND

FOOTNOTES

NSS Insufficient sample for analysis.
RL Reporting Limit.
↑ Reporting limit raised.
↓ Reporting limit lowered.
NA The sample was not analysed for this analyte
ND Non Detect

Results relate only to the sample tested.
Data reported represent the sample as submitted to SGS. Solid samples expressed on a dry weight basis.
"Temperature Upon Receipt" is representative of the whole shipment and may not reflect the temperature of individual samples.
Analysis conducted on samples submitted pursuant to or as part of Reg. 153/04, are in accordance to the "Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act and Excess Soil Quality" published by the Ministry and dated March 9, 2004 as amended.

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This report supersedes all previous versions.

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Request for Laboratory Services and CHAIN OF CUSTODY

SGS Environment, Health & Safety - Lakefield: 185 Concession St., Lakefield, ON K0L 2H0 Phone: 705-652-2000 Fax: 705-652-6365 Web: www.sgs.com/environment
- London: 657 Consortium Court, London, ON, N6E 2S8 Phone: 519-672-4500 Toll Free: 877-848-8060 Fax: 519-672-0361

No:

Page 1 of 1

Laboratory Information Section - Lab use only

Received By: ED
Received Date: 5/9/24 (mm/dd/yy)
Received Time: 12:30 (hr : min)
Received By (signature):
Custody Seal Present: Yes ☑ No ☐
Custody Seal Intact: Yes ☐ No ☐
Cooling Agent Present: Yes ☑ No ☐ Type: ICE
Temperature Upon Receipt (°C) 4x3
LAB LIMS #: CA40086-MAY24

REPORT INFORMATION	INVOICE INFORMATION
Company: Thurber Engineering LTD	☒ (same as Report Information)
Contact: Rachel Bourassa	Company:
Address: 1908 Ironoak Way, Oakville, ON	Contact:
Suite 202, L6H 0N1	Address:
Phone: 416-523-1015	
Fax:	Phone:
Email: RBourassa@Thurber.ca	Email: accountingON@thurber.ca

Quotation #:
P.O. #:
Project #: 37996
Site Location/ID: Hewitson Creek

TURNAROUND TIME (TAT) REQUIRED

☒ Regular TAT (5-7days)

TAT's are quoted in business days (exclude statutory holidays & weekends).
Samples received after 6pm or on weekends: TAT begins next business day

RUSH TAT (Additional Charges May Apply): ☐1 Day ☐2 Days ☐3 Days ☐4 Days

PLEASE CONFIRM RUSH FEASIBILITY WITH SGS REPRESENTATIVE PRIOR TO SUBMISSION

Specify Due Date:

***NOTE**: DRINKING (POTABLE) WATER SAMPLES FOR HUMAN CONSUMPTION MUST BE SUBMITTED WITH SGS DRINKING WATER CHAIN OF CUSTODY

REGULATIONS

☐ O.Reg 153/04 ☐ O.Reg 406/19
☐ Table 1 ☐ Res/Park Soil Texture: ☐ Coarse
☐ Table 2 ☐ Ind/Com ☐ Medium/Fine
☐ Table 3 ☐ Agri/Other
☐ Table ____
Soil Volume ☐ <350m3 ☐ >350m3

Other Regulations:
☐ Reg 347/558 (3 Day min TAT)
☐ PWQO ☐ MMER
☐ CCME ☐ Other: ____
☐ MISA
☐ ODWS Not Reportable *See note

Sewer By-Law:
☐ Sanitary
☐ Storm
Municipality: ____

RECORD OF SITE CONDITION (RSC) ☐ YES ☐ NO

ANALYSIS REQUESTED

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME SAMPLED	# OF BOTTLES	MATRIX
1	HCC-04 SS5(11'-13')	April 3, 2024		1	Soil
2	HCC-03 SS4 (8.5'-10.5')	March 24, 2024		1	Soil
3	HF3-03 SS11 (40' - 40'9")	March 9, 2024		1	Soil
4	HF1-01 SS3 (5' - 7')	March 16, 2024		1	Soil
5	HF3-02 SS5 (10'-12')	March 11, 2024		1	Soil
6	HF1-04 SS4 (7'6" - 9'6")	March 16, 2024		1	Soil
7					
8					
9					
10					
11					
12					

M & I				SVOC		PCB	PHC		VOC		Pest	Other (please specify)								TCLP	COMMENTS:
Field Filtered (Y/N)	Metals & Inorganics (incl CrVI, CN, Hg pH,(B(HWS),EC,SAR--soil) (Cl, Na-water)	Full Metals Suite (ICP metals plus B(HWS-soil only) Hg, CrVI	ICP Metals only Sb,As,Ba,Be,B,Cd,Cr,Co,Cu,Pb,Mo,Ni,	PAHs only	SVOCs all incl PAHs, ABNs, CPs	PCBs ☐ Total ☐ Aroclor	F1-F4 + BTEX	F1-F4 only no BTEX	VOCs all incl BTEX	BTEX only	Pesticides Organochlorine or specify other	Corrosivity				Appendix 2: 406/19 Leachate Screening Levels Table :	Sewer Use: Specify pkg:	Water Characterization Pkg ☐ Extended ☐ General		Specify TCLP tests ☐M&I ☐VOC ☐PCB ☐B(a)P ☐ABN ☐Ignit.	
												✓									
												✓									
												✓									
												✓									
												✓									
												✓									

Observations/Comments/Special Instructions

Sampled By (NAME): Rachel Bourassa	**Signature:** Rachel Bourassa	Date: see above (mm/dd/yy)	Pink Copy - Client
Relinquished by (NAME): Rachel Bourassa	**Signature:** Rachel Bourassa	Date: 05/09/2023 (mm/dd/yy)	Yellow & White Copy - SGS

Revision #: 1.4
Date of Issue: 22 May. 2020

Note: Submission of samples to SGS is acknowledgement that you have been provided direction on sample collection/handling and transportation of samples. {2} Submission of samples to SGS is considered authorization for completion of work. Signatures may appear on this form or be retained on file in the contract, or in an alternative format (e.g. shipping documents). {3} Results may be sent by email to an unlimited number of addresses for no additional cost. Fax is available upon request. This document is issued by the Company under its General Conditions of Service accessible at http://www.sgs.com/terms_and_conditions.htm. (Printed copies are available upon request.) Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

APPENDIX H

Site Photographs

THURBER ENGINEERING LTD.

SITE PHOTOS



Photo 1: Borehole HF1-01 after completion of drilling near Sta 10+275 looking south, photo taken March 18, 2024



Photo 2: Borehole HF1-02 near Sta 10+206 prior to borehole drilling looking west, photo taken March 4, 2024

THURBER ENGINEERING LTD.

SITE PHOTOS



Photo 3: Borehole HF1-04 prior to drilling at Sta. 10+270 (20 m south of proposed CL) looking west, photo taken March 4, 2024



Photo 4: Section HF3 looking southeast along CL near Sta. 11+550, photo taken March 13, 2024

SITE PHOTOS



Photo 5: Borehole HF3-02 near Sta. 11+600 (approximately 20 m south of CL) looking south, taken March 13, 2024



Photo 6: Section HF3 near Sta. 11+610 CL looking along watercourse, photo taken March 7, 2024

SITE PHOTOS



Photo 7: Section HF4 looking west along CL near Sta 12+200, photo taken March 5, 2024



Photo 8: Section HF4 looking west along CL near Sta 12+300, photo taken August 16, 2023

THURBER ENGINEERING LTD.

SITE PHOTOS



Photo 9: Section DC1 looking west along CL from approx. Sta 12+425, photo taken April 10, 2024



Photo 10: Section DC1 looking east along CL from approx. Sta 12+475 towards Highway 17, photo taken August 16, 2023

SITE PHOTOS



Photo 11: Borehole DC1-04 near Sta 12+500 looking east, photo taken March 1, 2024

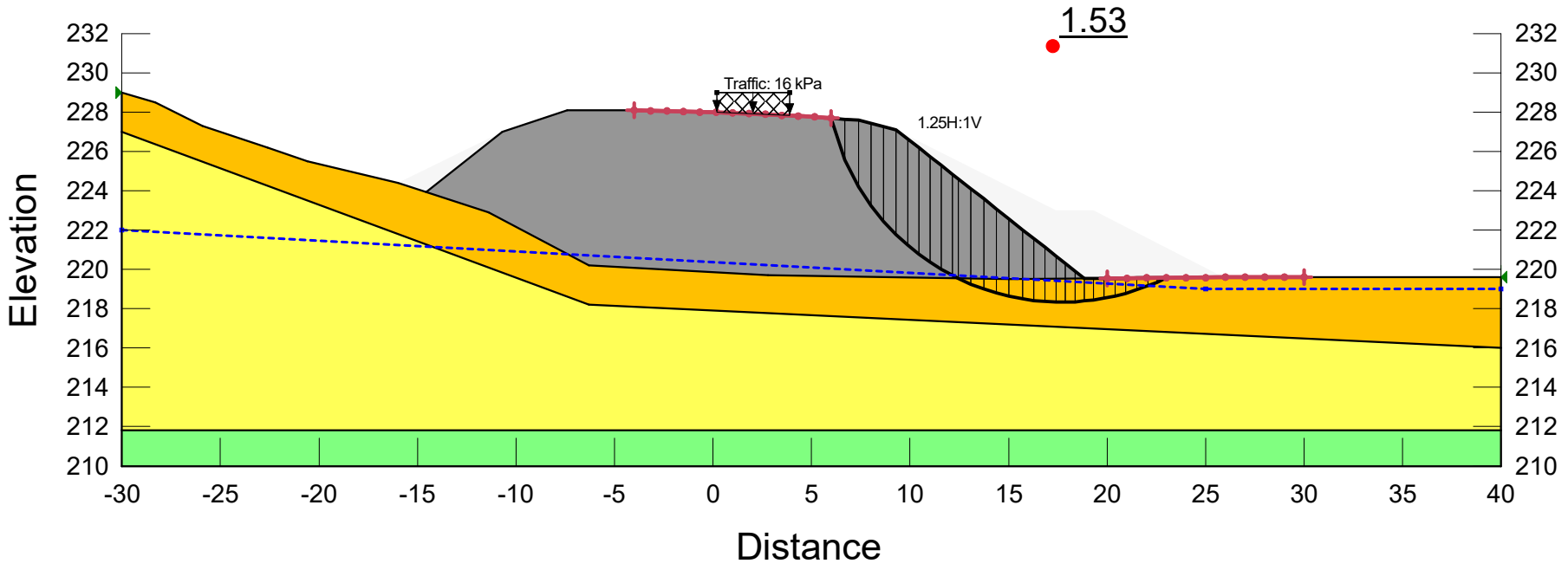


Photo 12: Section DC1 looking west along Highway 17 near Sta 12+660, photo taken August 17, 2023

APPENDIX I

Slope Stability Analysis Figures

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1
	3: Silty CLAY	Mohr-Coulomb	18	0	28	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Rockfill - Static (traffic)

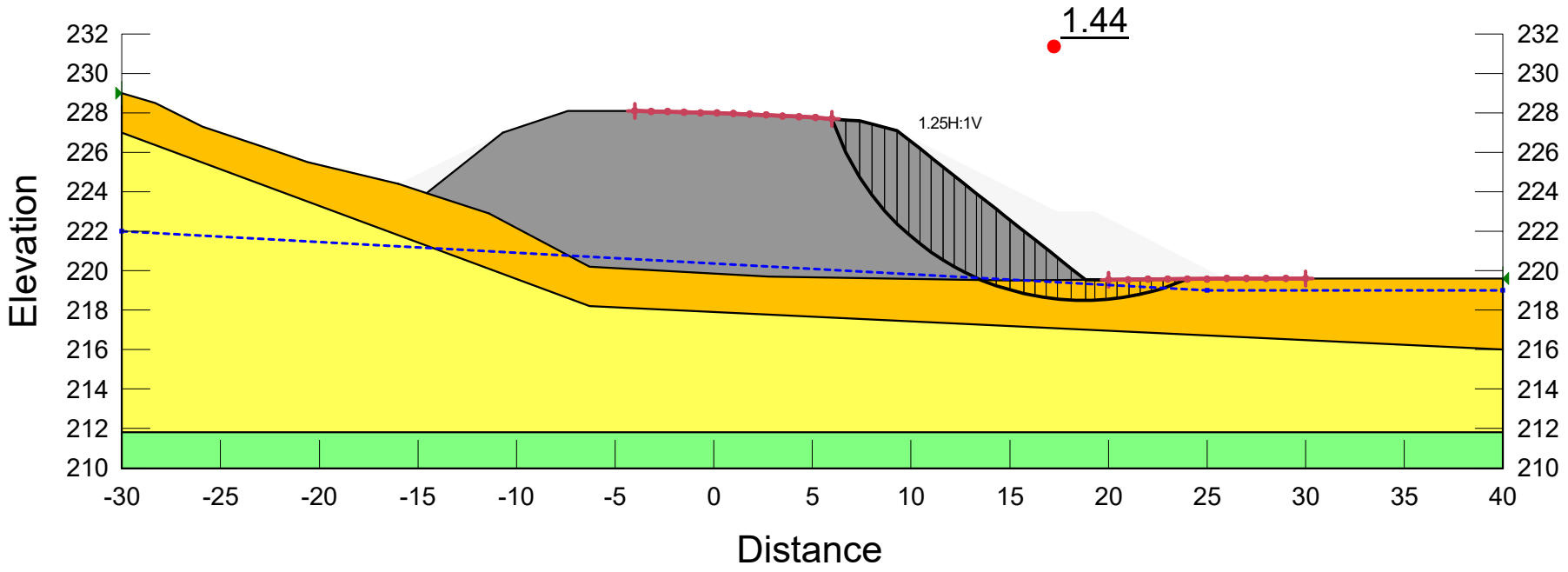
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	07/29/2024, 09:44:33 AM	1:333

Additional Details
Name: High Fill 1 Section 10+263
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (6, 227.7) m, Exit: (22.999948, 219.5734) m
Center: (17.699664, 230.33009) m, Radius: 11.991644 m

Figure 1

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF1 10+200 to 10+350\HF1_001.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1
	3: Silty CLAY	Mohr-Coulomb	18	0	28	1



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Project
Hwy 17, Hewiston

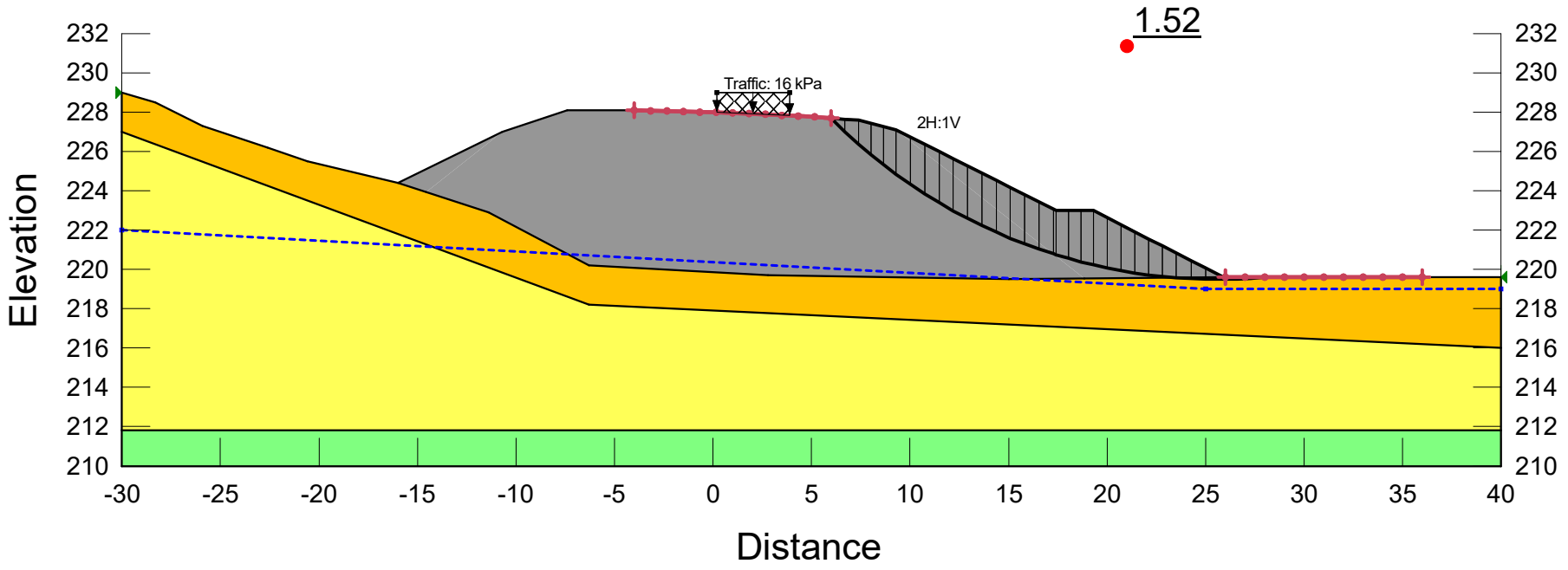
Analysis
Rockfill - Seismic

Seismic Coefficient	Last Run	Scale
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Additional Details
Name: High Fill 1 Section 10+263
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (6, 227.7) m, Exit: (23.999931, 219.58257) m
Center: (18.728127, 231.90826) m, Radius: 13.405771 m

Figure 2

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1
	3: Silty CLAY	Mohr-Coulomb	18	0	28	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Granular - Static (traffic)

Seismic Coefficient
H: 0g, V: 0g

Last Run
07/29/2024, 09:44:32 AM

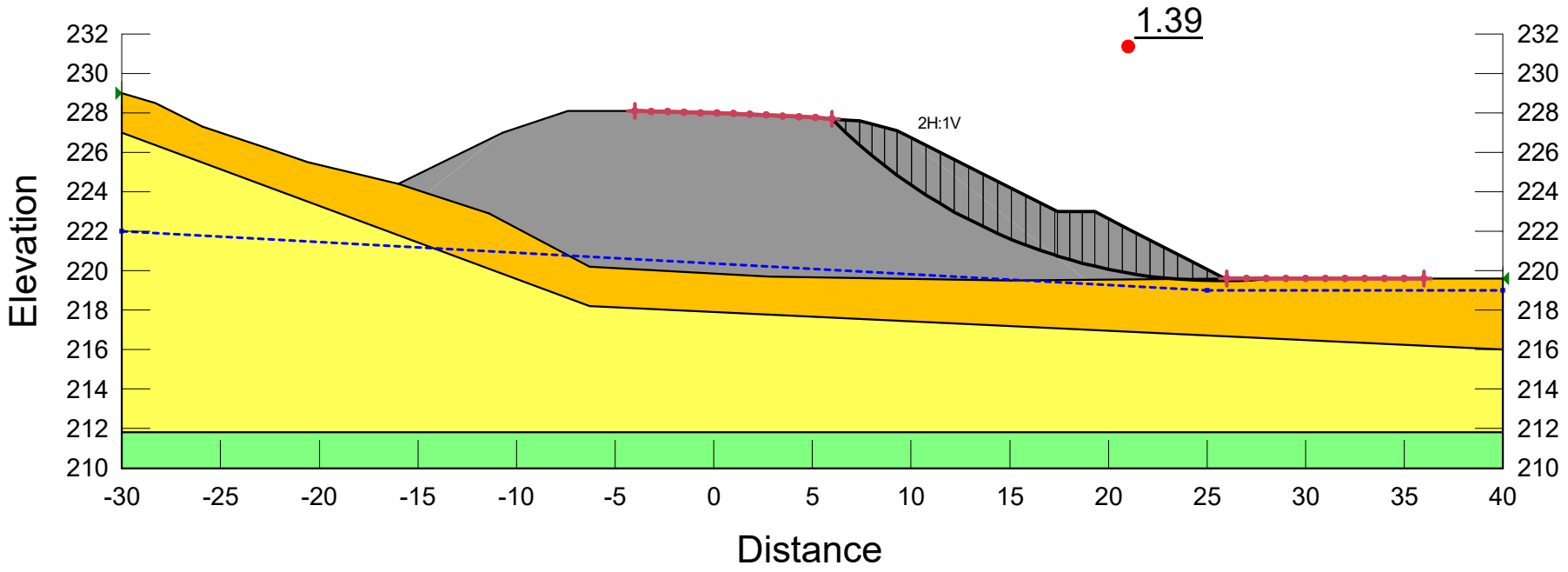
Scale
1:333

Additional Details
Name: High Fill 1 Section 10+263
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (6, 227.7) m, Exit: (28, 219.6) m
Center: (25.621369, 247.06606) m, Radius: 27.568869 m

Figure 3

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF1 10+200 to 10+350\HF1_001.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1
	3: Silty CLAY	Mohr-Coulomb	18	0	28	1



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Project
Hwy 17, Hewiston

Analysis
Granular - Seismic

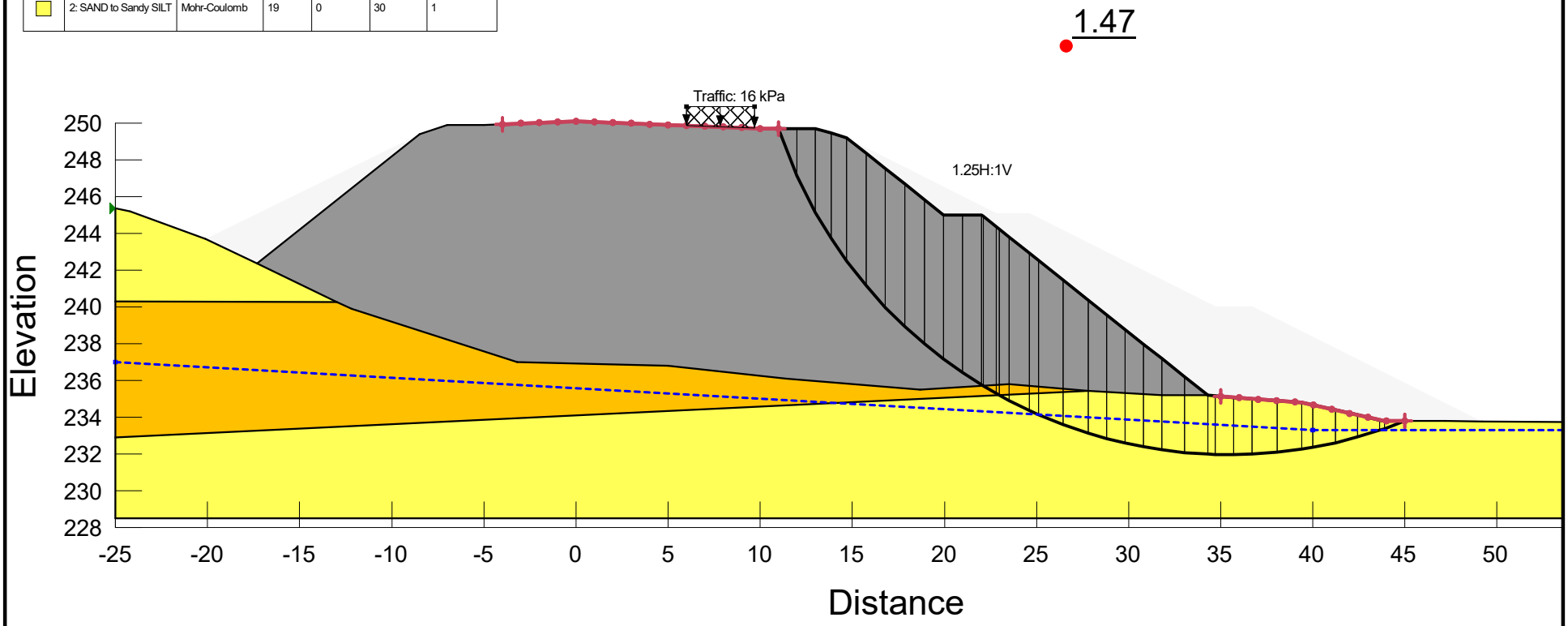
Seismic Coefficient	Last Run	Scale
H: 0.032g, V: 0g	2024-07-31, 11:00:09 AM	1:333

Additional Details
Name: High Fill 1 Section 10+263
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (6, 227.7) m, Exit: (28, 219.6) m
Center: (25.621369, 247.06606) m, Radius: 27.568869 m

Figure 4

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF1 10+200 to 10+350\HF1_002.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1



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Project
Hwy 17, Hewiston

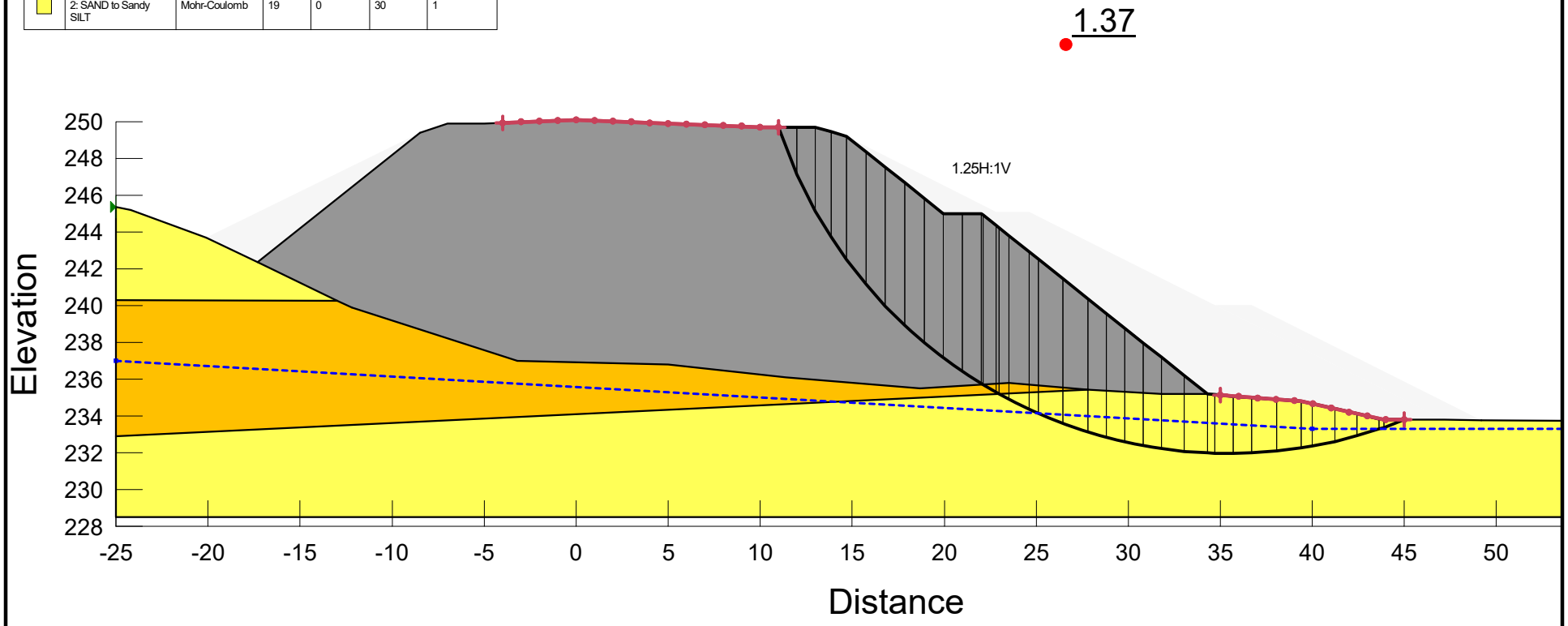
Analysis
Rockfill - Static (Traffic)

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	07/29/2024, 09:41:39 AM	1:333

Additional Details
Name: High Fill 3 Section 11+610
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (11, 249.7) m, Exit: (45, 233.8) m
Center: (35.466966, 257.7171) m, Radius: 25.746966 m

Figure 5

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Rockfill - Seismic

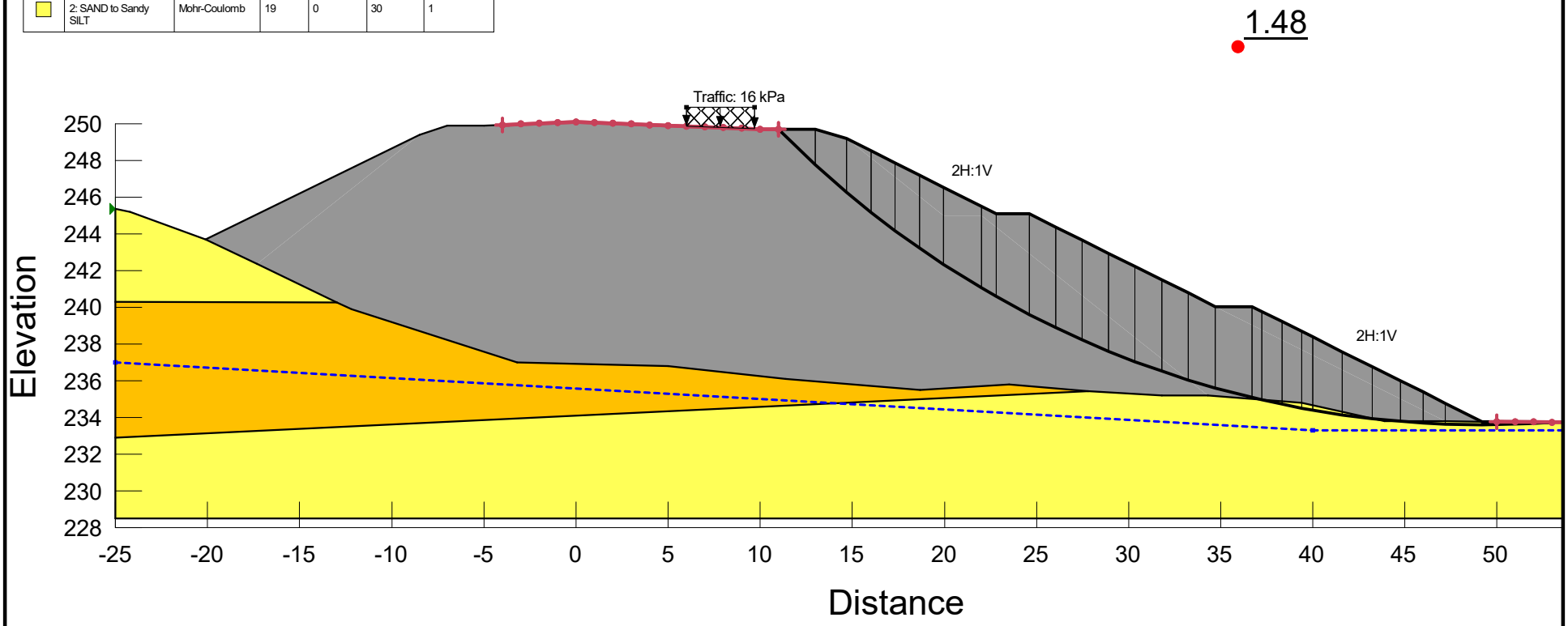
Seismic Coefficient	Last Run	Scale
H: 0.032g, V: 0g	2024-07-31, 11:08:15 AM	1:333

Additional Details
Name: High Fill 3 Section 11+610
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (11, 249.7) m, Exit: (45, 233.8) m
Center: (35.466966, 257.7171) m, Radius: 25.746966 m

Figure 6

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF3 11+550 to 11+650\HF3_002.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1



THURBER

Project
Hwy 17, Hewiston

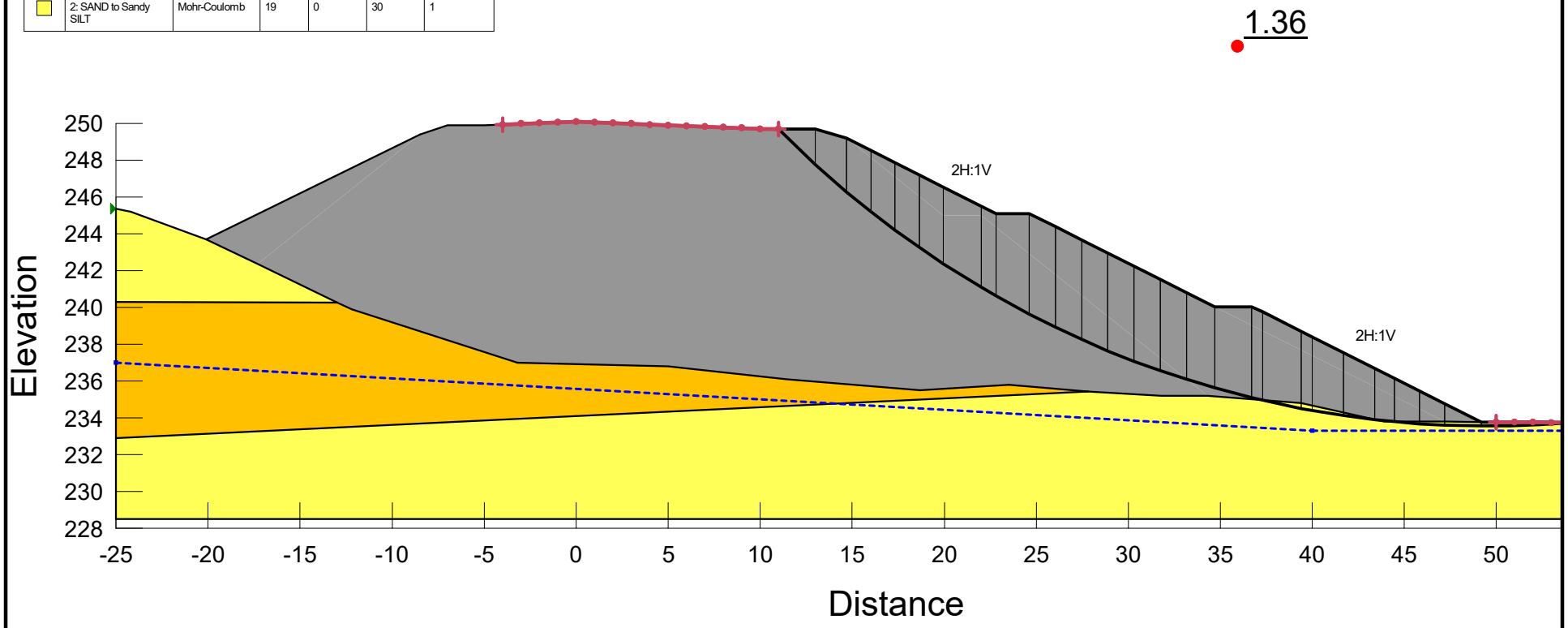
Analysis
Granular - Static (traffic)

Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	07/29/2024, 09:41:39 AM	1:333

Additional Details
Name: High Fill 3 Section 11+610
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 3.04 m
Entry: (11, 249.7) m, Exit: (52.97, 233.75493) m
Center: (49.163512, 286.94407) m, Radius: 53.325175 m

Figure 7

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1
	2: SAND to Sandy SILT	Mohr-Coulomb	19	0	30	1



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Project
Hwy 17, Hewiston

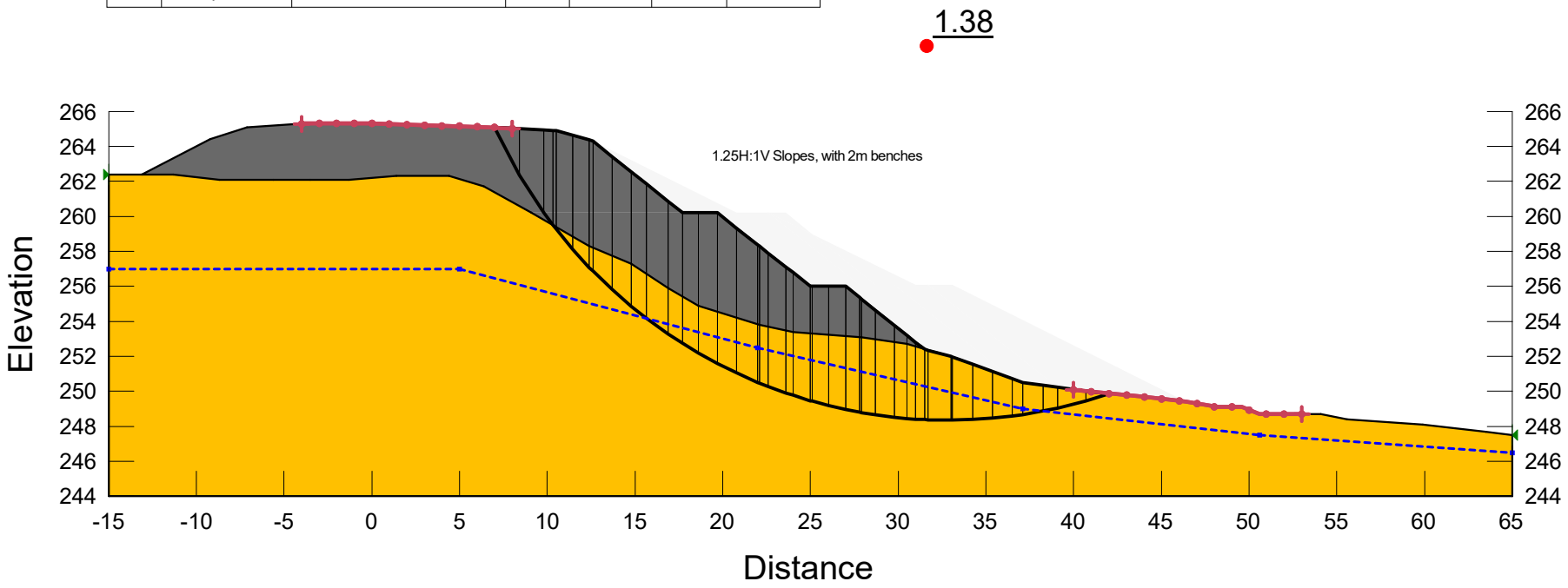
Analysis
Granular - Seismic

Seismic Coefficient	Last Run	Scale
H: 0.032g, V: 0g	2024-07-31, 11:08:14 AM	1:333

Additional Details
Name: High Fill 3 Section 11+610
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (11, 249.7) m, Exit: (53.96, 233.74719) m
Center: (49.515299, 287.59868) m, Radius: 54.034599 m

Figure 8

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



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Project
Hwy 17, Hewitson

Analysis
050 Rockfill - Static

Seismic Coefficient
H: 0g, V: 0g

Last Run
09/25/2024, 10:25:36 AM

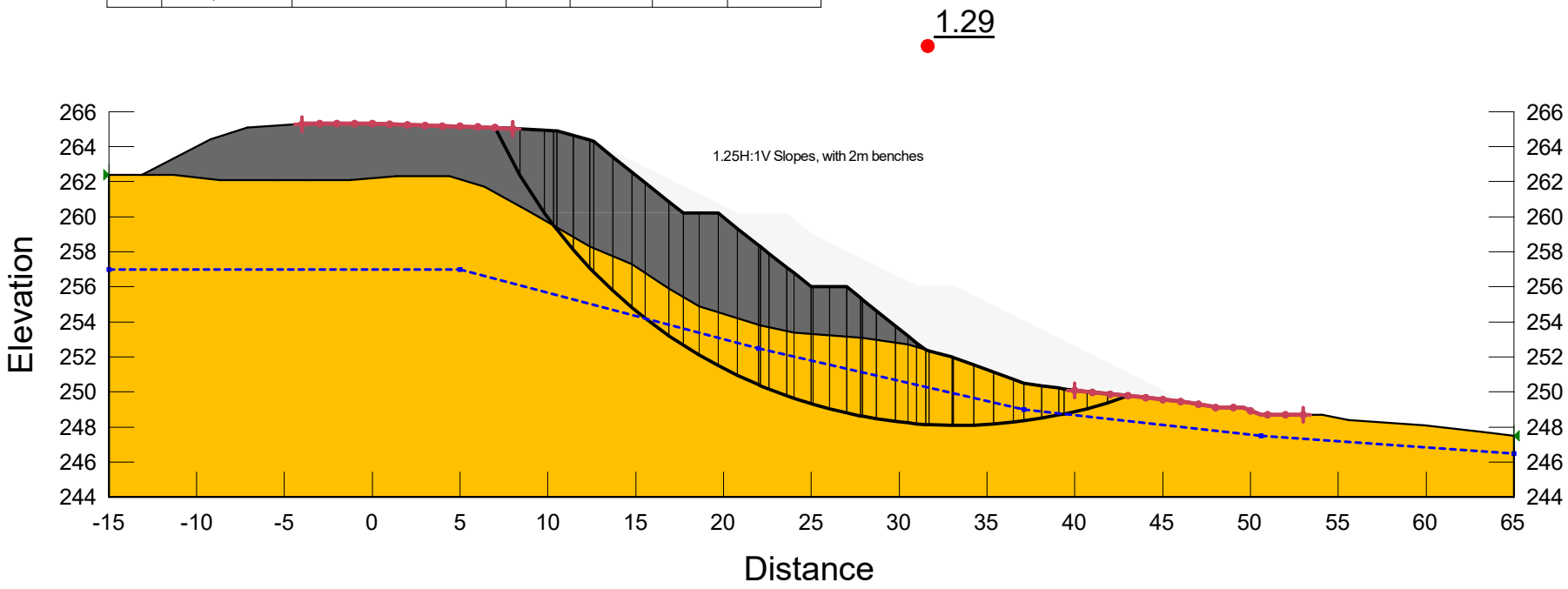
Scale
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Additional Details
Name: Section 12+050, near HF4-01
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.0008801, 265.07944) m, Exit: (42.008746, 249.87169) m
Center: (32.858645, 276.70588) m, Radius: 28.351334 m

Figure 9

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
050 Rockfill - Seismic

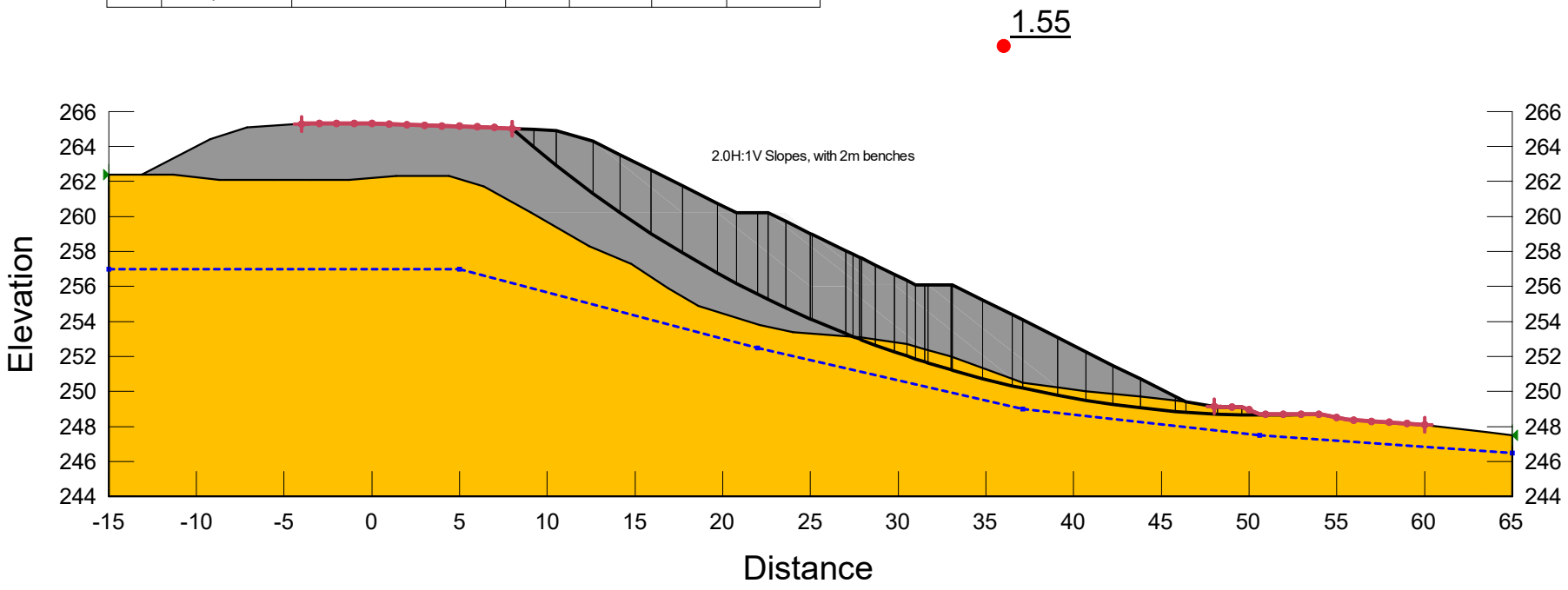
Seismic Coefficient	Last Run	Scale
H: 0.032g, V: 0g	09/25/2024, 10:25:37 AM	1:375

Additional Details
Name: Section 12+050, near HF4-01
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.0008801, 265.07944) m, Exit: (43.014793, 249.77306) m
Center: (33.318005, 276.97899) m, Radius: 28.882353 m

Figure 10

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



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Project
Hwy 17, Hewitson

Analysis
050 SSM - Static

Seismic Coefficient
H: 0g, V: 0g

Last Run
09/25/2024, 10:25:35 AM

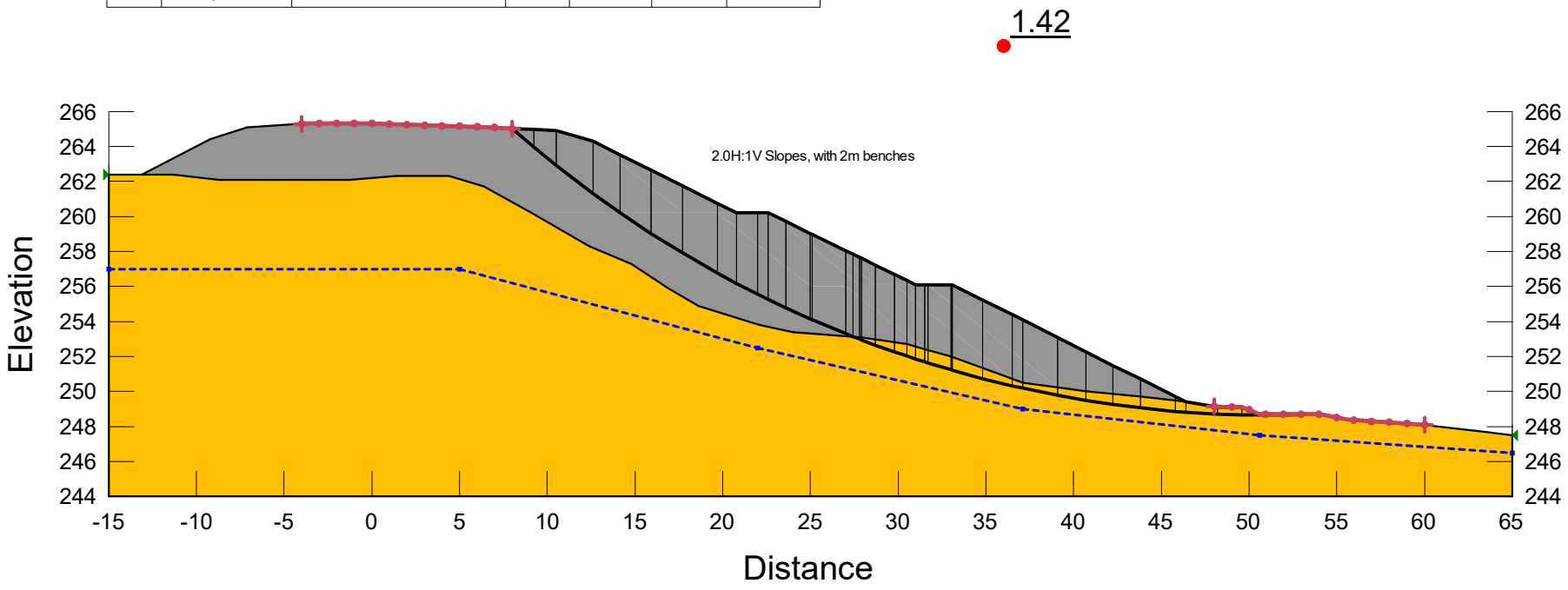
Scale
1:375

Additional Details
Name: Section 12+050, near HF4-01
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.9999998, 265.02821) m, Exit: (53.980492, 248.7) m
Center: (51.220828, 313.83375) m, Radius: 65.192189 m

Figure 11

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
050 SSM - Seismic

Seismic Coefficient
H: 0.032g, V: 0g

Last Run
09/25/2024, 10:25:36 AM

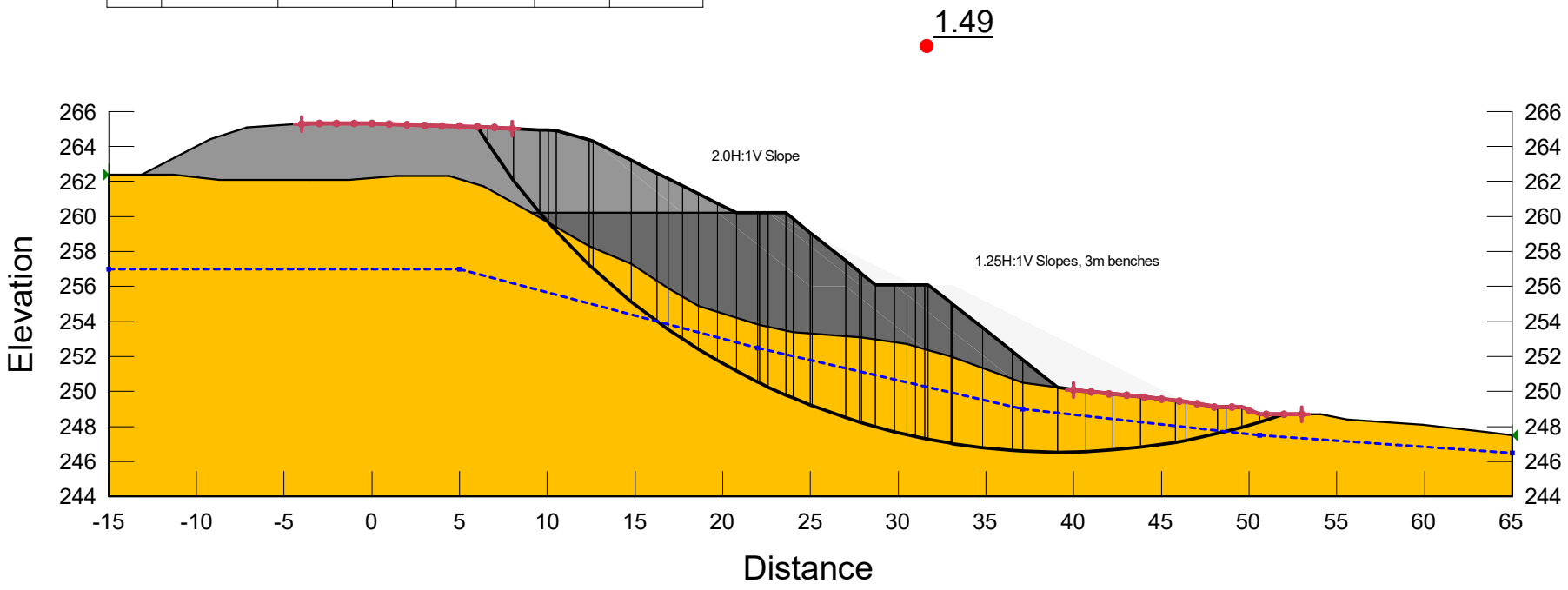
Scale
1:375

Additional Details
Name: Section 12+050, near HF4-01
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.9999998, 265.02821) m, Exit: (53.980492, 248.7) m
Center: (51.220828, 313.83375) m, Radius: 65.192189 m

Figure 12

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



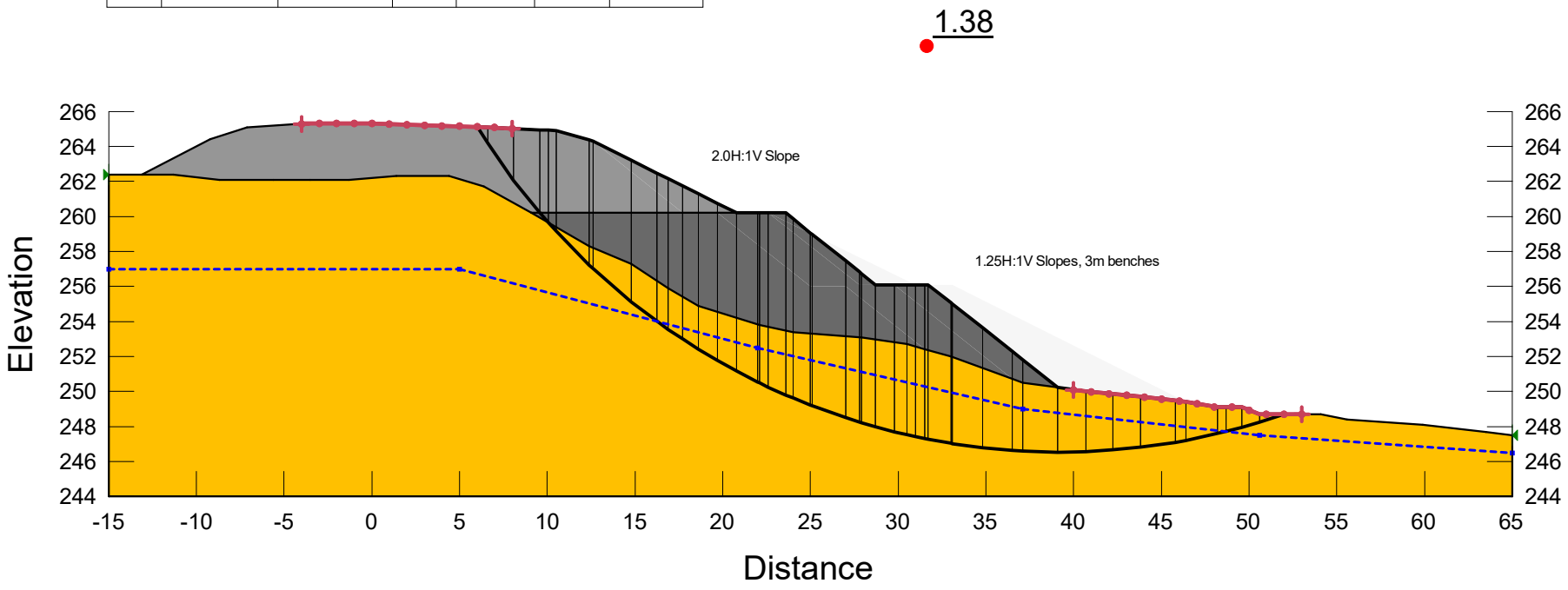
THURBER

Project	
Hwy 17, Hewitson	
Analysis	
050 SSM&Rockfill - Static(3m)	
Seismic Coefficient	Last Run / Scale
H: 0g, V: 0g	09/25/2024, 10:25:35 AM / 1:375

Additional Details
Name: Section 12+050, near HF4-01
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (6.001241, 265.11787) m, Exit: (51.98913, 248.7) m
Center: (39.195749, 285.4816) m, Radius: 38.942995 m

Figure 13

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
050 SSM&Rockfill - Seismic(3m)

Seismic Coefficient
H: 0.032g, V: 0g

Last Run
09/25/2024, 10:25:37 AM

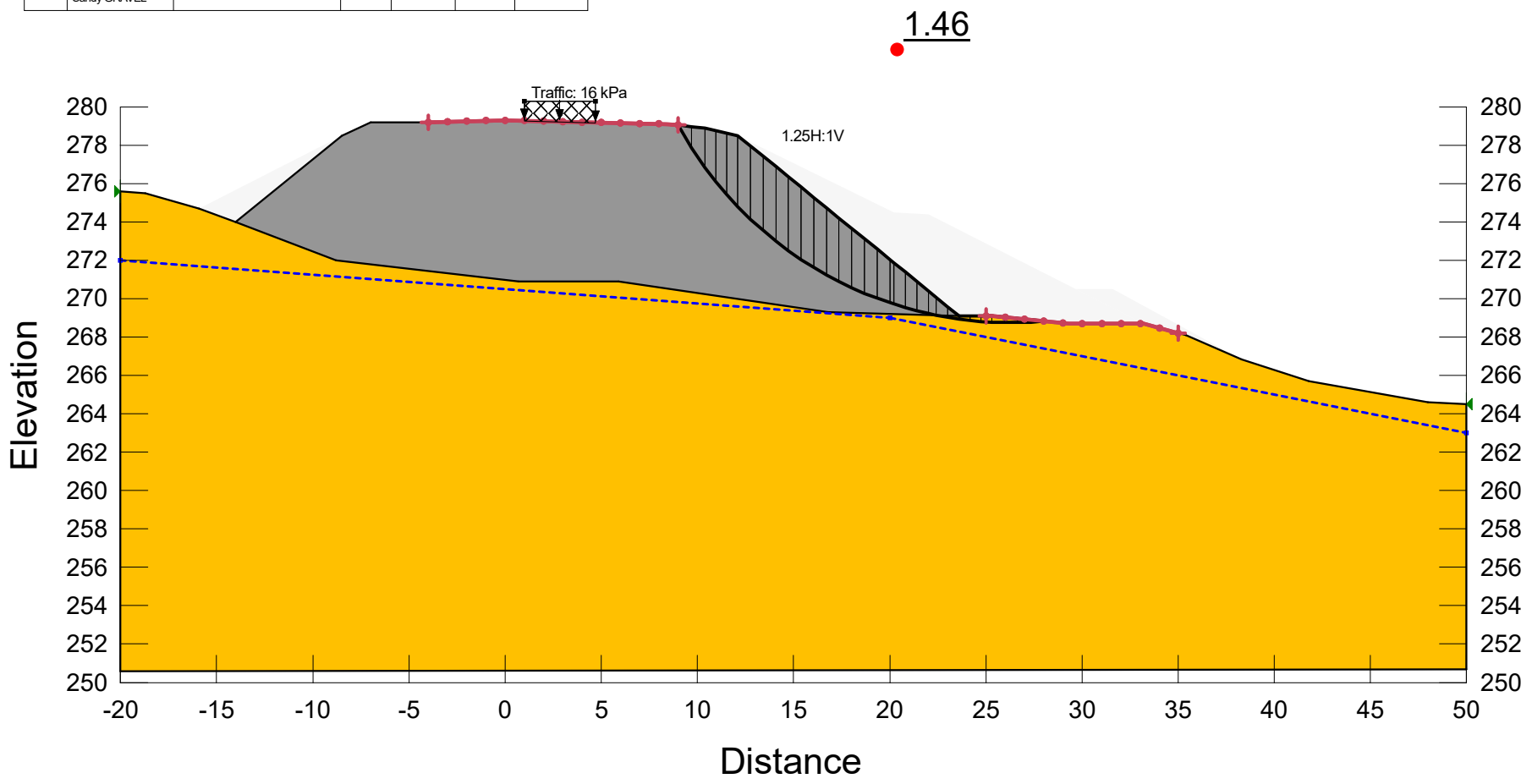
Scale
1:375

Additional Details
Name: Section 12+050, near HF4-01
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (6.001241, 265.11787) m, Exit: (51.98913, 248.7) m
Center: (39.195749, 285.4816) m, Radius: 38.942995 m

Figure 14

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Rockfill - Static (traffic)

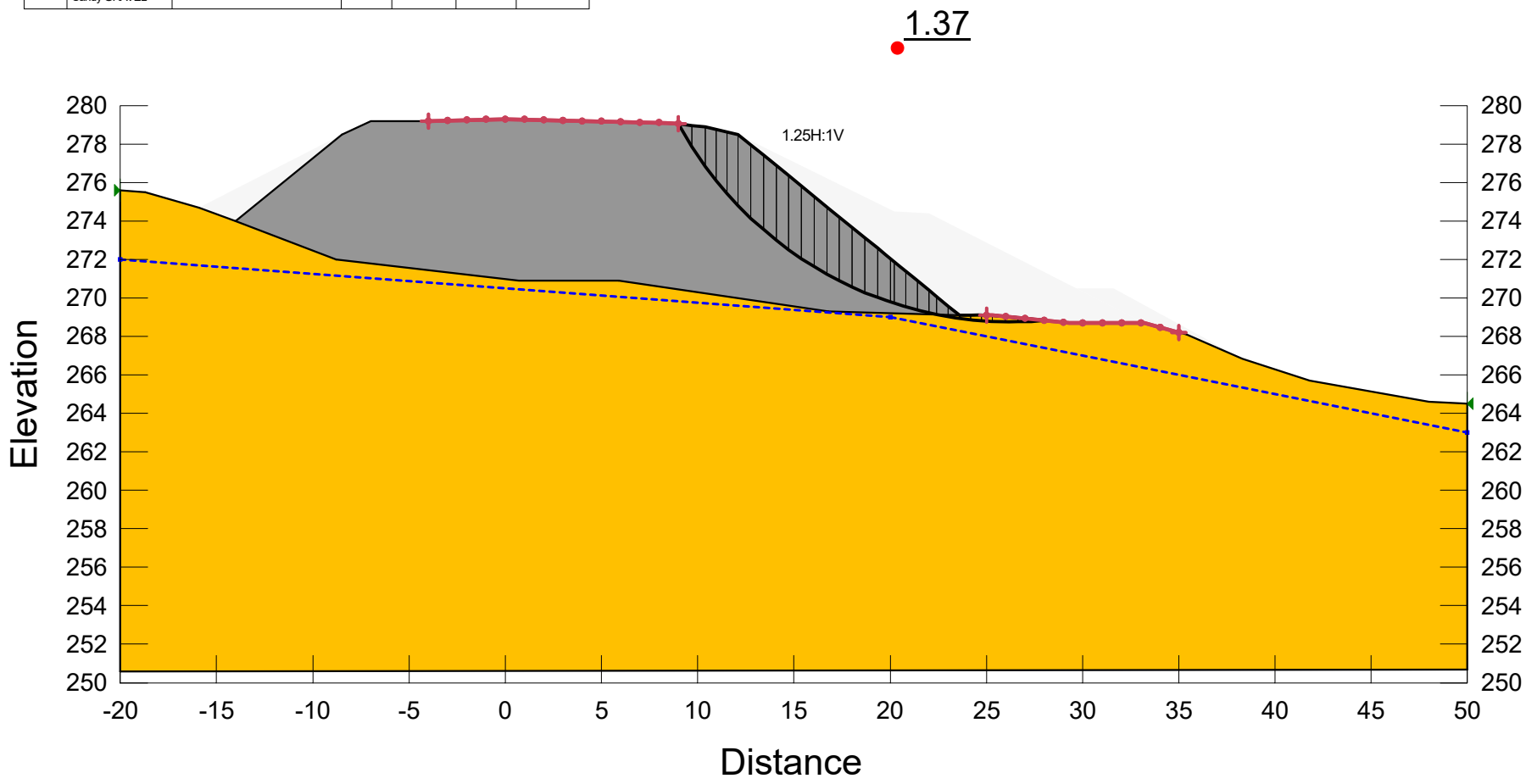
Seismic Coefficient	Last Run	Scale
H: 0g, V: 0g	07/29/2024, 09:53:57 AM	1:333

Additional Details
Name: High Fill 4 Section 12+250
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (9, 279.04) m, Exit: (28.01218, 268.82878) m
Center: (26.280346, 288.40921) m, Radius: 19.656868 m

Figure 15

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_001.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Rockfill - Seismic

Seismic Coefficient
H: 0.032g, V: 0g

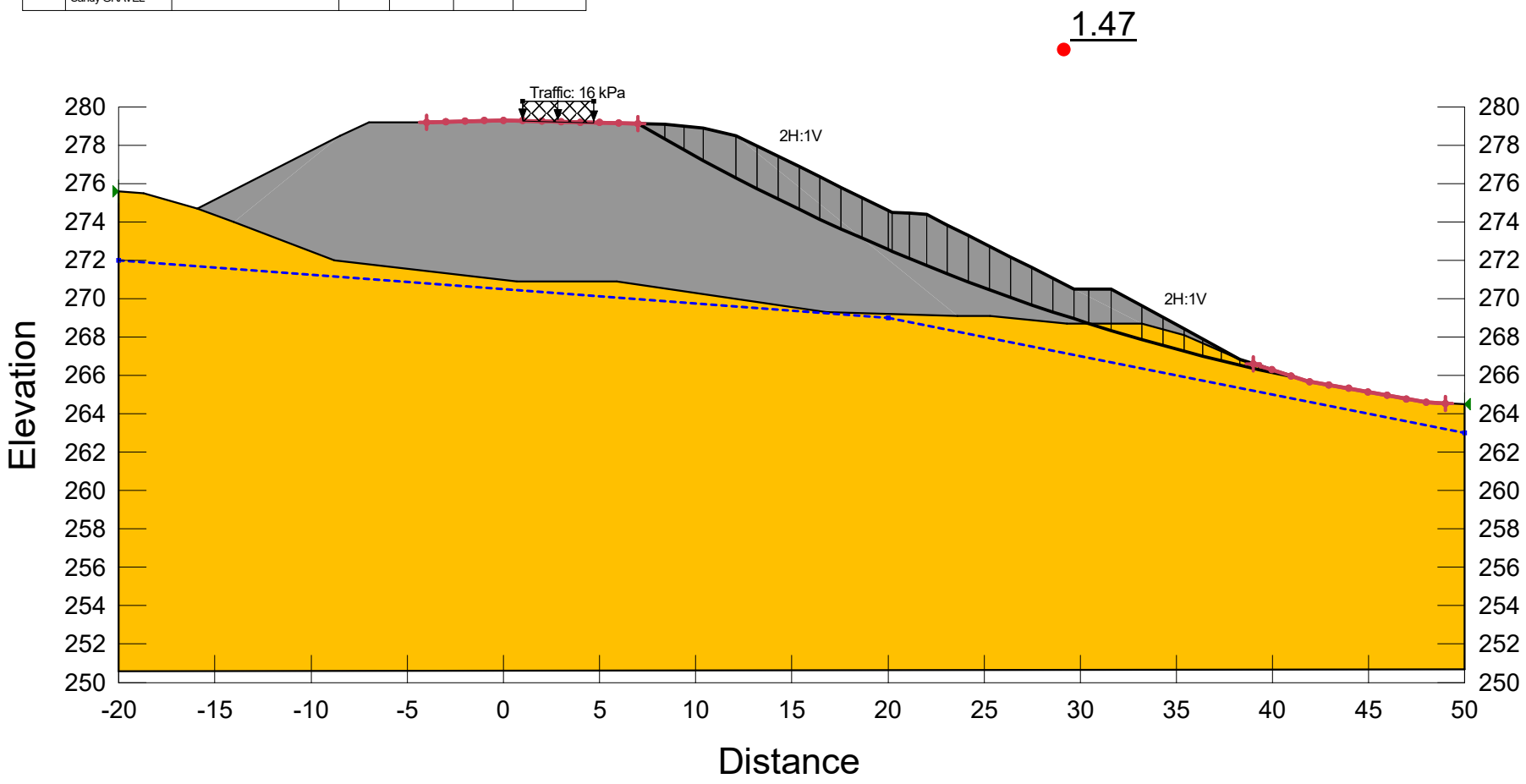
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Scale
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Additional Details
Name: High Fill 4 Section 12+250
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (9, 279.04) m, Exit: (28.01218, 268.82878) m
Center: (26.280346, 288.40921) m, Radius: 19.656868 m

Figure 16

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Granular - Static (traffic)

Seismic Coefficient
H: 0g, V: 0g

Last Run
07/29/2024, 09:53:57 AM

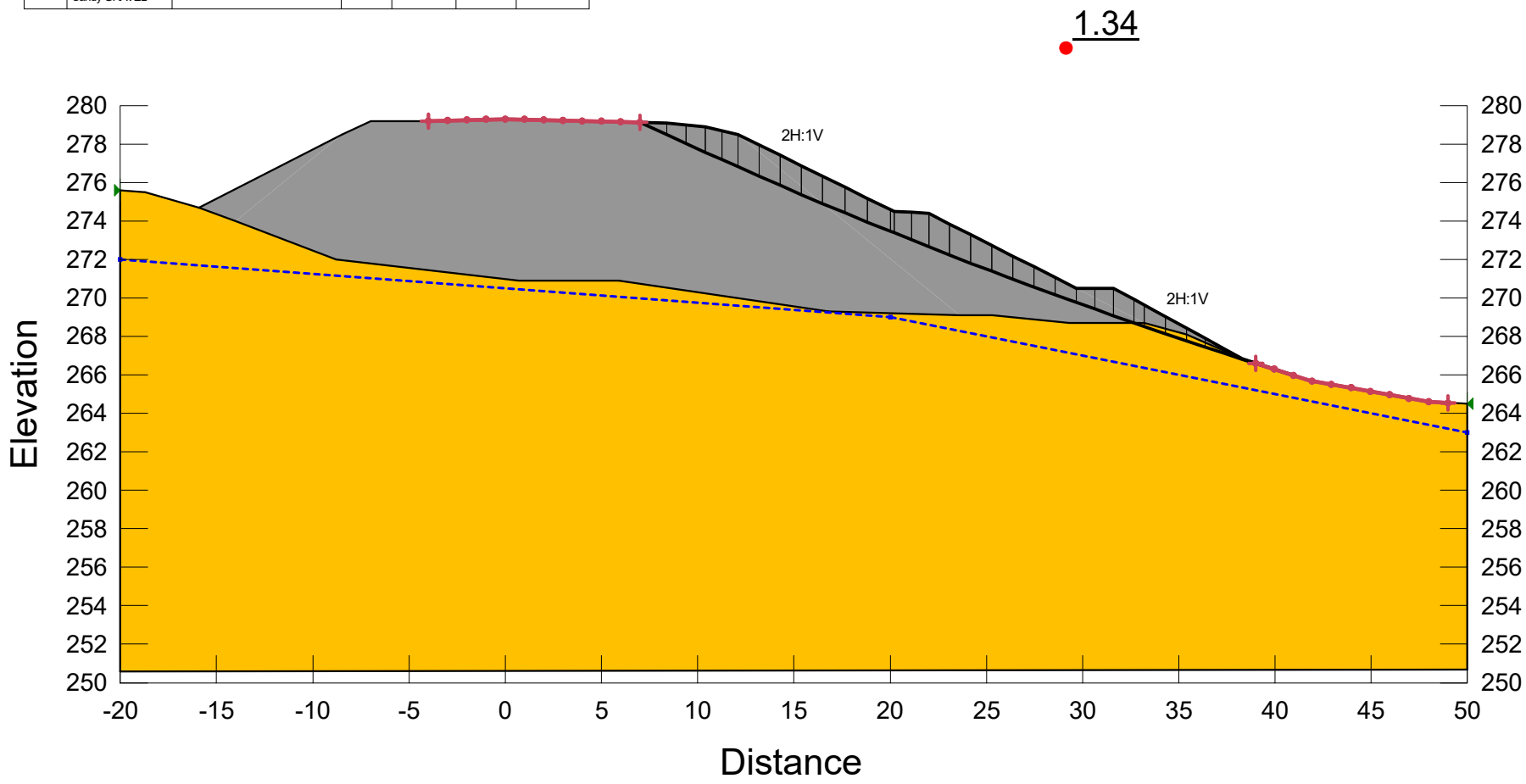
Scale
1:333

Additional Details
Name: High Fill 4 Section 12+250
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 2.28 m
Entry: (7.0000001, 279.13333) m, Exit: (41.205226, 265.89421) m
Center: (64.246002, 376.23015) m, Radius: 112.716 m

Figure 17

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_001.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewiston

Analysis
Granular - Seismic

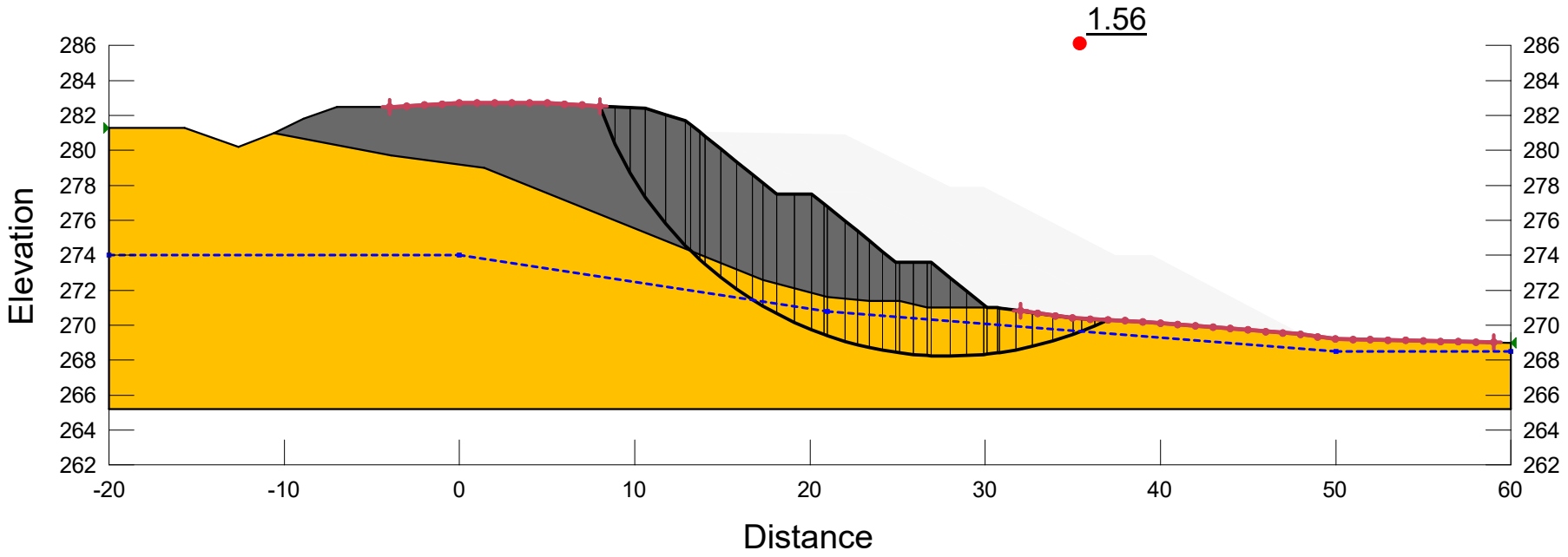
Seismic Coefficient	Last Run	Scale
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Additional Details
Name: High Fill 4 Section 12+250
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.0000001, 279.13333) m, Exit: (40.947516, 265.97836) m
Center: (119.89016, 520.07625) m, Radius: 266.07833 m

Figure 18

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_002.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
300 Rockfill - Static

Seismic Coefficient
H: 0g, V: 0g

Last Run
09/25/2024, 10:25:38 AM

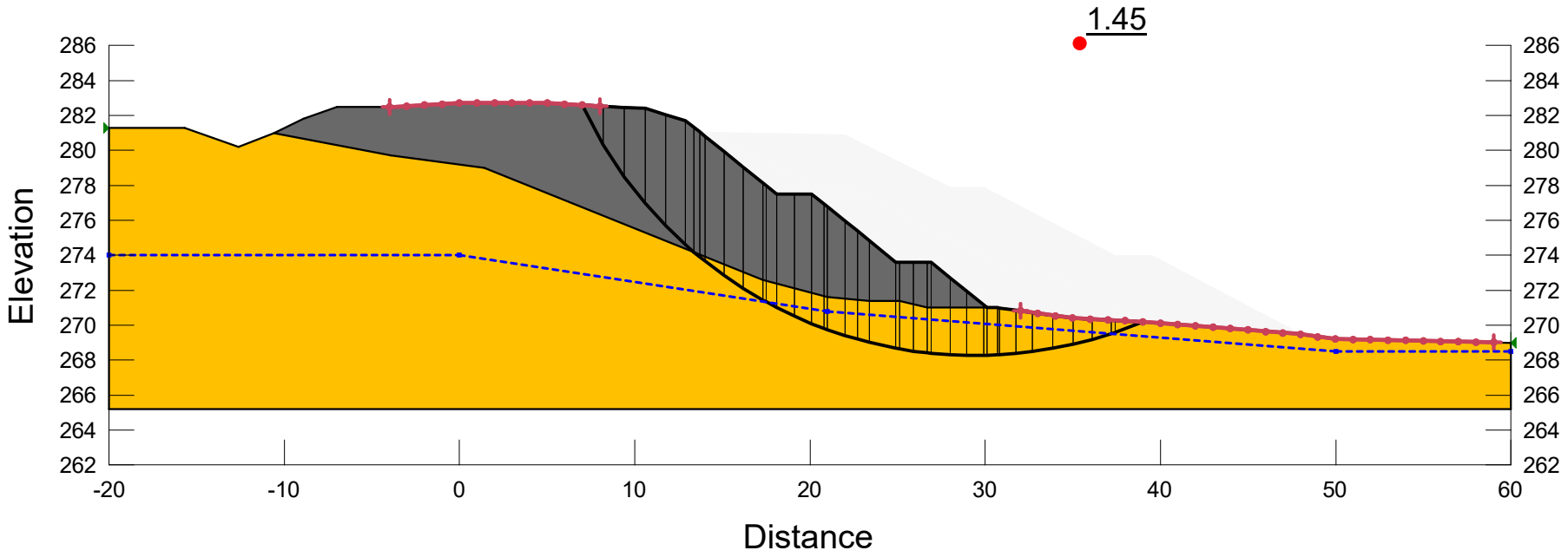
Scale
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Additional Details
Name: Section 12+300, near HF4-06
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.9999998, 282.53929) m, Exit: (36.984023, 270.3008) m
Center: (27.896107, 289.21839) m, Radius: 20.98727 m

Figure 19

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Rockfill	Mohr-Coulomb	19	0	42	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

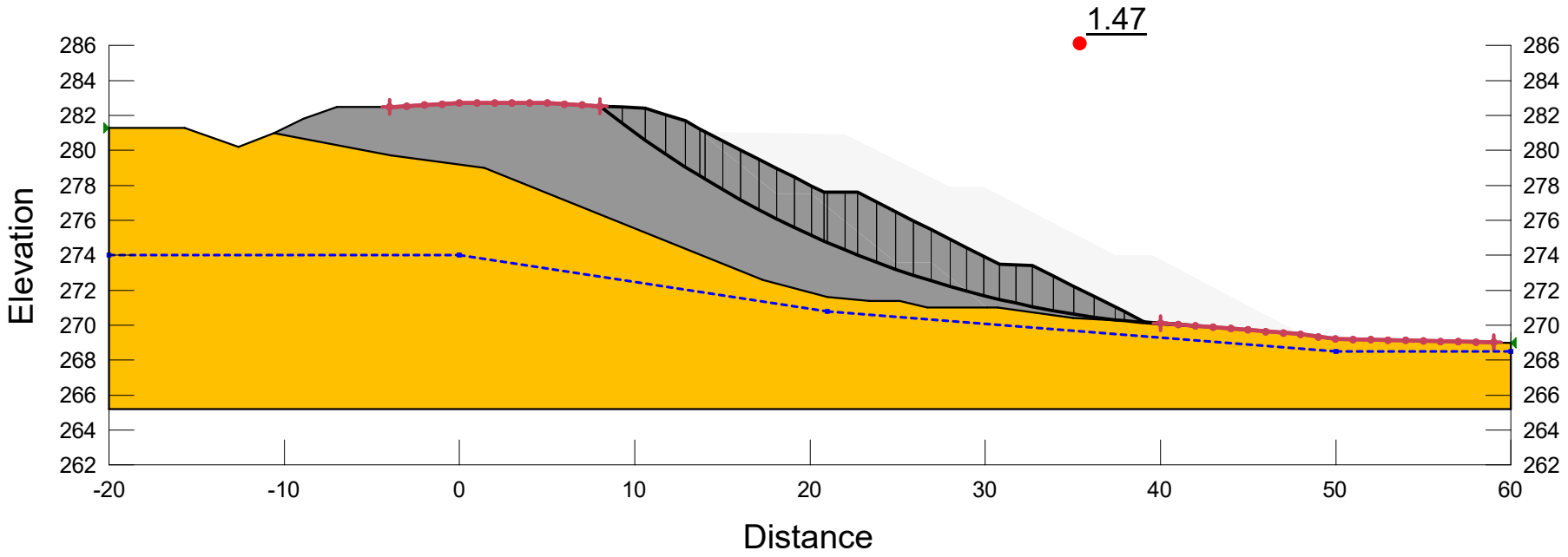
Analysis
300 Rockfill - Seismic

Seismic Coefficient	Last Run	Scale
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Additional Details
Name: Section 12+300, near HF4-06
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.0006242, 282.59282) m, Exit: (38.987743, 270.20061) m
Center: (29.407587, 292.95117) m, Radius: 24.685367 m

Figure 20

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
300 SSM - Static

Seismic Coefficient
H: 0g, V: 0g

Last Run
09/25/2024, 10:25:39 AM

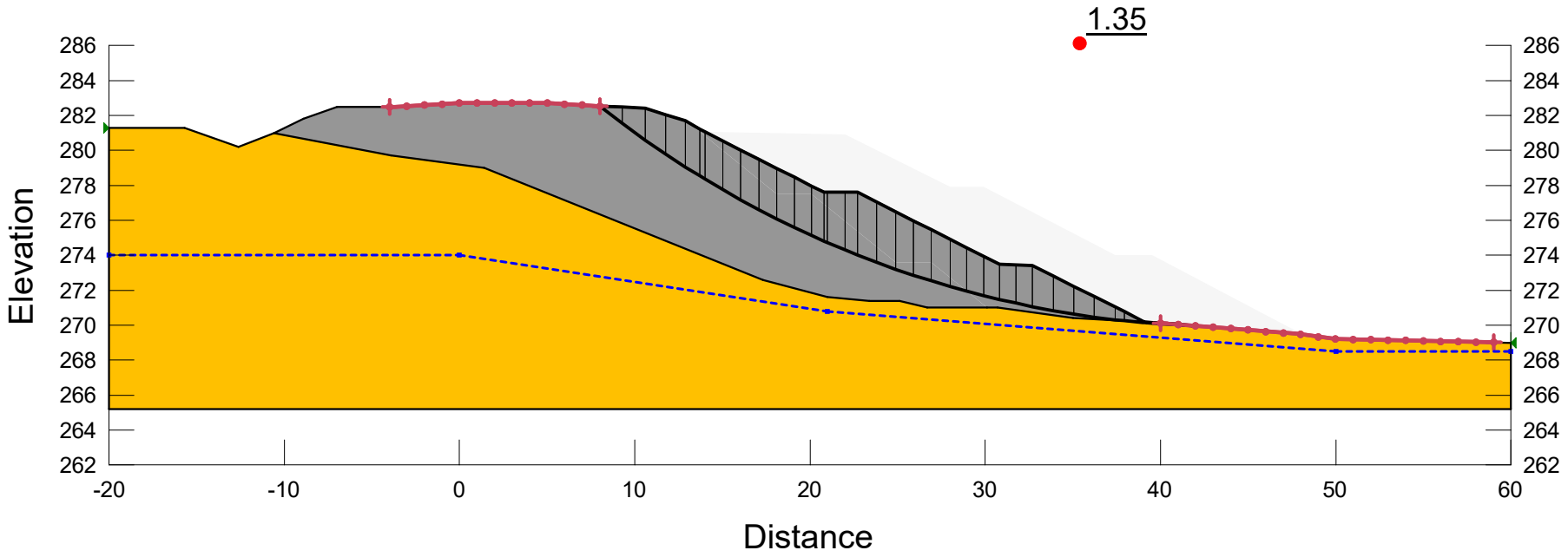
Scale
1:375

Additional Details
Name: Section 12+300, near HF4-06
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.9999998, 282.53929) m, Exit: (41.998537, 269.96012) m
Center: (44.133434, 327.96486) m, Radius: 58.044014 m

Figure 21

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
300 SSM - Seismic

Seismic Coefficient
H: 0.032g, V: 0g

Last Run
09/25/2024, 10:25:45 AM

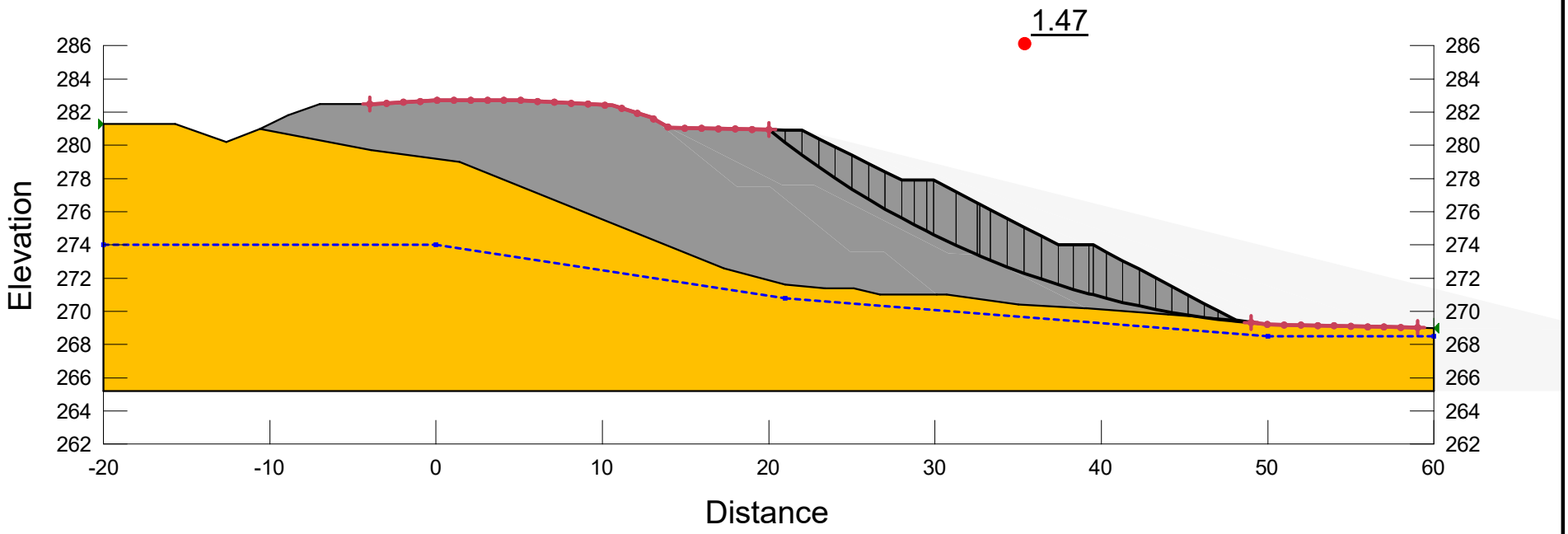
Scale
1:375

Additional Details
Name: Section 12+300, near HF4-06
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (7.9999998, 282.53929) m, Exit: (41.998537, 269.96012) m
Center: (44.133434, 327.96486) m, Radius: 58.044014 m

Figure 22

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
300 SSM - Static, with flattening (2b)

Seismic Coefficient
H: 0g, V: 0g

Last Run
10/16/2024, 02:39:01 PM

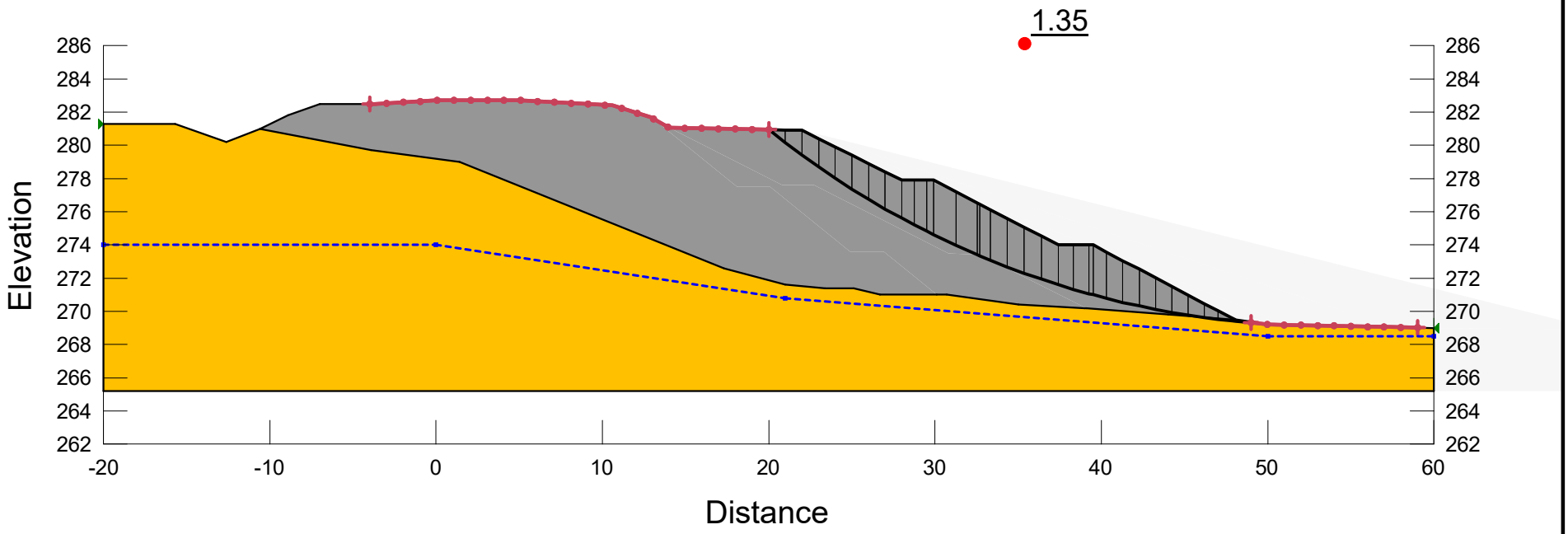
Scale
1:375

Additional Details
Name: Section 12+300, near HF4-06
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (20, 280.93707) m, Exit: (49.430481, 269.27766) m
Center: (53.545396, 322.63812) m, Radius: 53.518881 m

Figure 23

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	0: Local Granular Borrow	Mohr-Coulomb	21	0	30	1
	1: Gravelly SAND to Sandy GRAVEL	Mohr-Coulomb	19	0	32	1



THURBER

Project
Hwy 17, Hewitson

Analysis
300 SSM - Seismic, with flattening (2b)

Seismic Coefficient
H: 0.032g, V: 0g

Last Run
10/16/2024, 02:39:02 PM

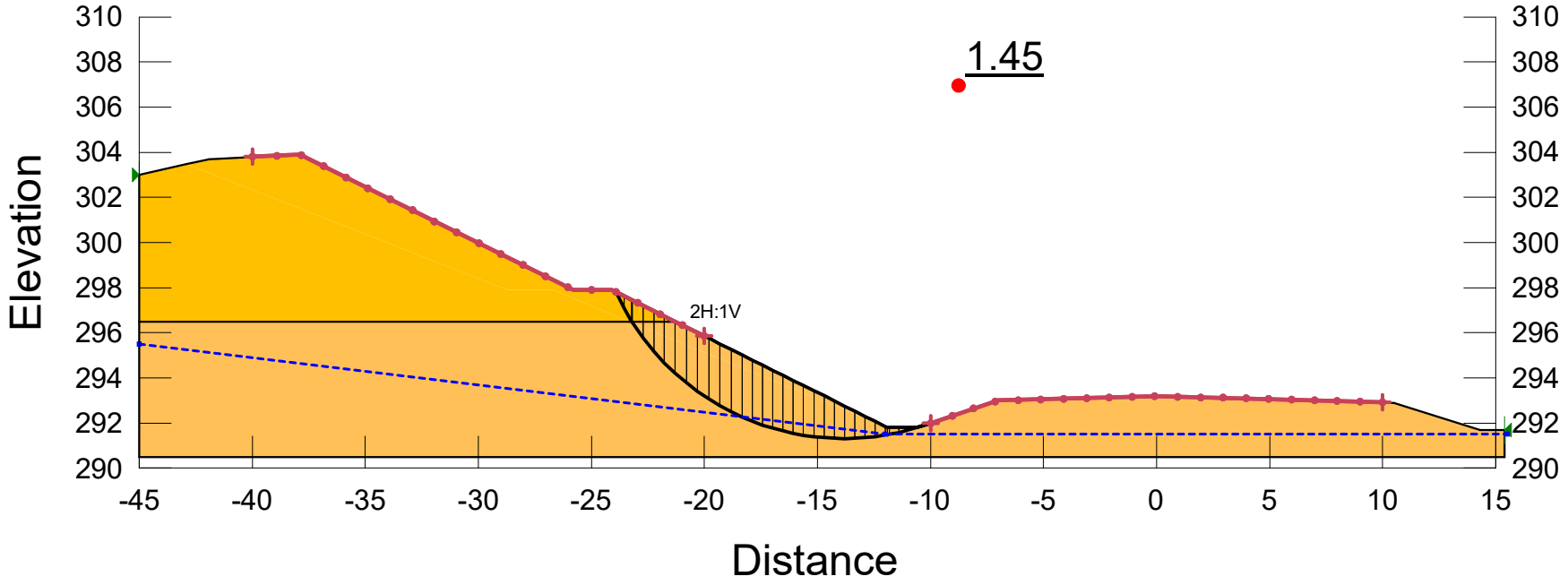
Scale
1:375

Additional Details
Name: Section 12+300, near HF4-06
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (20, 280.93707) m, Exit: (49.430481, 269.27766) m
Center: (53.545396, 322.63812) m, Radius: 53.518881 m

Figure 24

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\HF4 12+050 to 12+350\HF4_003.gsz

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	1: SAND, dense to compact	Mohr-Coulomb	19	0	32	1
	2: Silty SAND, compact to dense	Mohr-Coulomb	19	0	31	1



THURBER

Project
Hwy 17, Hewitson

Analysis
Static 2.0H:1V

Seismic Coefficient
H: 0g, V: 0g

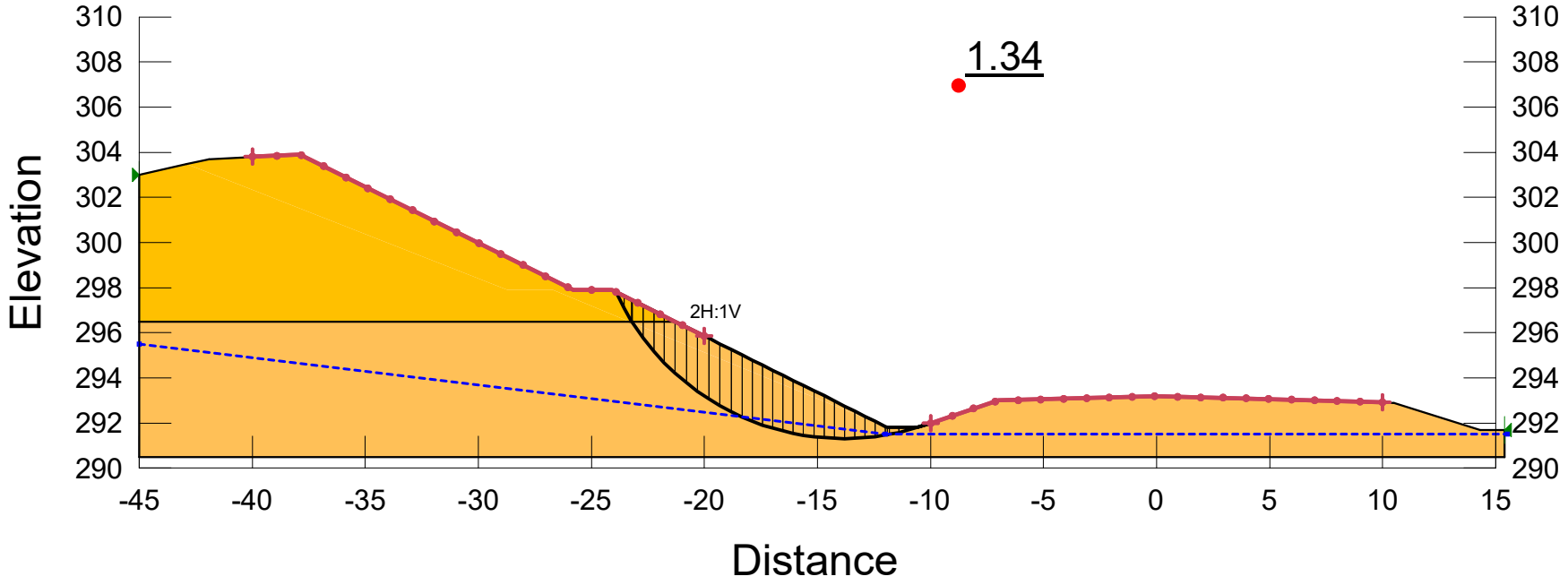
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Scale
1:300

Additional Details
Name: Section 12+450, near DC1-03
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (-23.916247, 297.80812) m, Exit: (-10, 292) m
Center: (-13.834912, 302.38727) m, Radius: 11.072573 m

Figure 25

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	1: SAND, dense to compact	Mohr-Coulomb	19	0	32	1
	2: Silty SAND, compact to dense	Mohr-Coulomb	19	0	31	1



THURBER

Project
Hwy 17, Hewitson

Analysis
Seismic 2.0H:1V

Seismic Coefficient
H: 0.032g, V: 0g

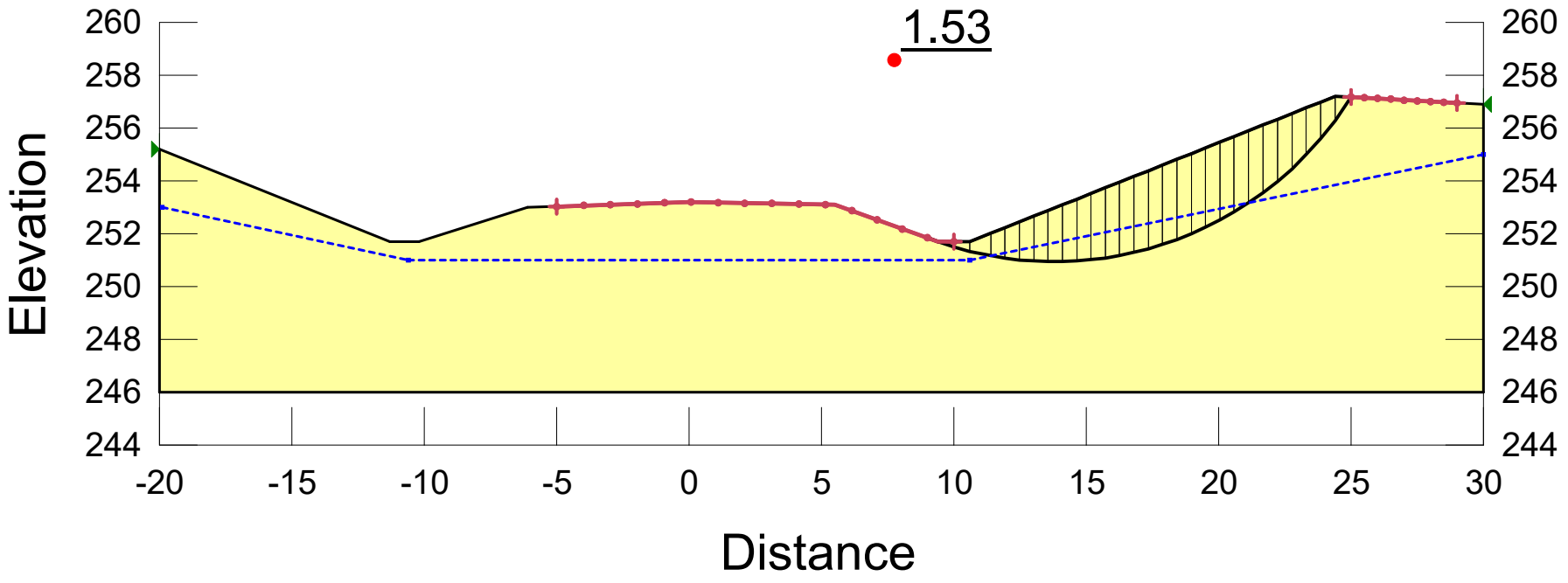
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Scale
1:300

Additional Details
Name: Section 12+450, near DC1-03
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (-23.916247, 297.80812) m, Exit: (-10, 292) m
Center: (-13.834912, 302.38727) m, Radius: 11.072573 m

Figure 26

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	3: Silty for Rainbow Falls Cut	Mohr-Coulomb	19	0	29	1



THURBER

Project
Hwy 17, Hewitson

Analysis
Static 2.5H:1V

Seismic Coefficient
H: 0g, V: 0g

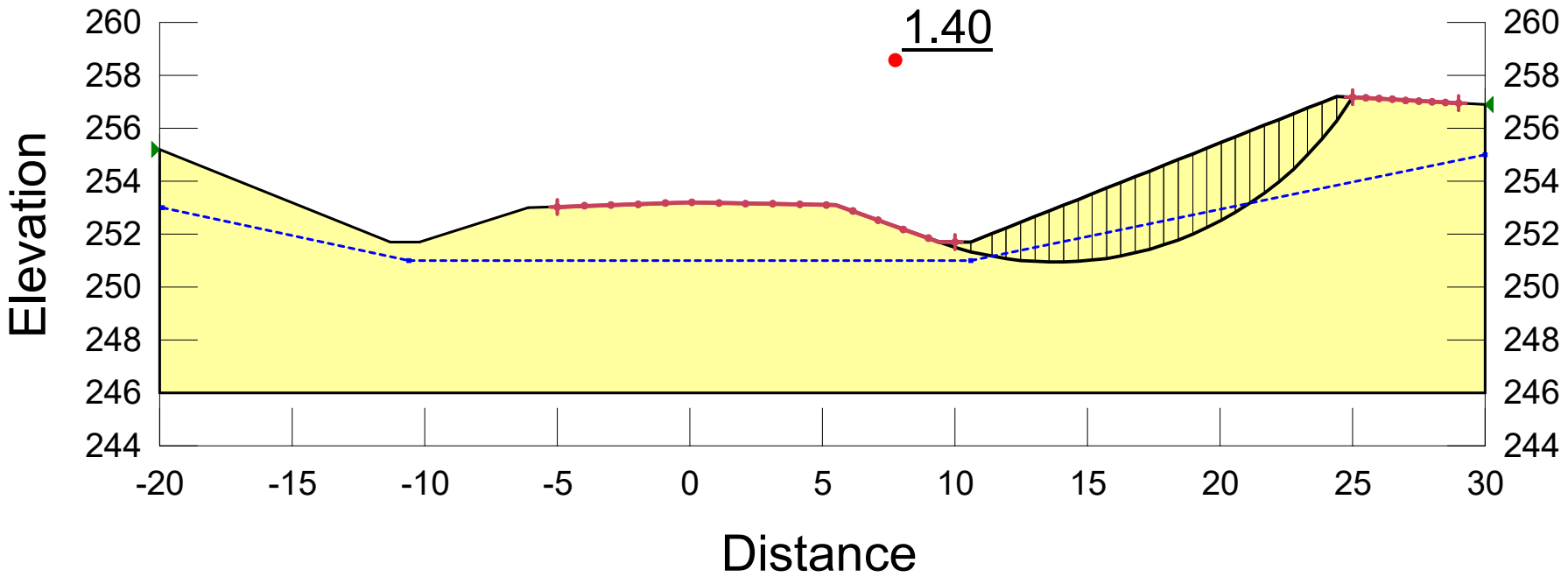
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Scale
1:250

Additional Details
Name: Section 9+950 (Rainbow Falls Entrance Road)
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (9.0080071, 251.84072) m, Exit: (25, 257.16786) m
Center: (13.789317, 264.15472) m, Radius: 13.209682 m

Figure 27

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Piezometric Surface
	3: Silty for Rainbow Falls Cut	Mohr-Coulomb	19	0	29	1



THURBER

Project
Hwy 17, Hewitson

Analysis
Seismic 2.5H:1V

Seismic Coefficient
H: 0.032g, V: 0g

Last Run
10/16/2024, 02:23:57 PM

Scale
1:250

Additional Details
Name: Section 9+950 (Rainbow Falls Entrance Road)
Comments: Slope Stability Assessment
Method: Morgenstern-Price, Half-Sine
Minimum Slip Surface Depth: 1.52 m
Entry: (9.0080071, 251.84072) m, Exit: (25, 257.16786) m
Center: (13.789317, 264.15472) m, Radius: 13.209682 m

Figure 28

H:\30000-39999\37000-37999\37996 Hwy 17 Hewitson Ck Culvert Repl 6023-E-0007\30 Analysis & Reporting\31 Analysis\Rainbow Falls\Rainbow_001.gsz

THURBER

APPENDIX J

List of OPSSs and OPSDs and Suggested Wording for NSSPs

The following OPSS Documents are referenced in this report:

OPSS.PROV 201	Construction Specification for Clearing, Close Cut Clearing, grubbing, and Removal of Surface and Piled Boulders
OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 401	Construction Specification for Trenching, Backfilling, and Compacting
OPSS.PROV 421	Construction Specification for Pipe Culvert Installation in Open Cut
OPSS.PROV 501	Construction Specification for Compacting
OPSS 511	Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting
OPSS.PROV 517	Construction Specification for Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS.PROV 804	Construction Specification for Seed and Cover
OPSS.PROV 1004	Material Specification for Aggregates - Miscellaneous
OPSS.PROV 1010	Material Specification for Aggregates Base, Subbase, Select Subgrade, and Backfill Material
OPSS.PROV 1860	Material Specification for Geotextiles
OPSD 200.020	Earth/Shale Grading, Divided Rural
OPSD 205.020	Transition Treatment Rock Cut to Rock Fill
OPSD 205.030	Transition Treatment Rock Cut to Earth Fill
OPSD 205.040	Transition Treatment Earth Fill to Rock Fill and Earth Fill to Granular Fill
OPSD 205.050	Transition Treatment Rock Cut to Earth Cut
OPSD 208.010	Benching of Earth Slopes
OPSD 802.010	Flexible Pipe Embedment and Backfill Earth Excavation
OPSD 802.014	Flexible Pipe Embedment in Embankment, Original Ground: Earth or Rock
OPSD 810.010	General Rip-Rap Layout for Sewer and Culvert Outlets

- **NSSP for Subgrade Preparation and Dewatering**

  All subgrade preparation, placement of culvert bedding and placement and compaction of all overlying embankment fill must be carried out in the dry. Contractor must temporarily divert any surface water course prior to subgrade preparation and employ appropriate dewatering measures to dewater the subgrade prior to subgrade preparation, placement of culvert bedding and overlying fill. The dewatering method selected by the contractor must be effective to lower the groundwater level to a minimum of 0.5m below the final subgrade level.

  Any buried topsoil, excessively soft soils, large cobbles and boulders, tree trunks/ branches and any soft, very loose organic or other deleterious materials encountered during subgrade preparation must be sub excavated and replaced with compacted granular material to provide a uniformly competent subgrade condition. The contractor shall be responsible for protecting the final subgrade by implementing adequate groundwater control measures and minimizing construction or personnel traffic on the final founding subgrade.

  Immediately following final subgrade preparation, the base must be inspected by the Foundation Engineering Specialist to confirm the prepared subgrade surface conforms to the design requirements.

- **NSSP for Obstructions**

  Excavations of deep cuts and excavations for culvert construction may encounter obstructions such as wood, cobbles, and boulders embedded in the fill and native soils. Such obstructions may impede excavation progress. The contractor shall be prepared to remove, drill through and/or penetrate these obstructions to achieve the design cut/excavation depths.