February 21, 2024 (Revision 1)

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Project Name: **Geotechnical Investigation – Slope Stability Analysis in Support of Zoning By-Law Amendment, 4380 Trail Road, Ottawa, Ontario**

EXP Project Number: **OTT-21023795-A0**

EXP Services Inc. (EXP) is pleased to present the results of the slope stability analysis to assess the stability of the existing and proposed slopes at the GFL Environmental Inc. (previously Drain-All Ltd.) transferring and processing facility located at 4380 Trail Road, Ottawa, Ontario (Figure 1). The work was completed in accordance with our proposal dated March 30, 2022 and accepted on April 4, 2022.

EXP understands that Drain-All Ltd. has been managing inert fill and clean soil at the 4380 Trail Road Landfill site since 2013. The subject land covers an area of approximately 4.3 hectares and is located east of the closed Nepean Landfill site and directly south of the current operating Trail Road Landfill Site. It is understood that the facility is to be infilled with inert fill in staged phases. For these purposes, EXP has been commissioned by Drain-All Ltd. to prepare a site grading and erosion control plan showing staged infill areas.

The site is low lying compared to the surrounding area. Slopes located at the site boundary vary in height from 7 m to 12 m. The slope inclination varies from approximately 1.8H:1V to 3.0H:1V and the majority of the site is currently approximately at Elevation 99.0 to 101.0 m.

To demonstrate that the site is geotechnically suitable for the proposed use (i.e., current condition, various stages of infill and final site rehabilitation) a slope stability study is required. Field work to include three boreholes/monitoring wells which are coupled with groundwater monitoring program.

1.0 Scope of Work

The geotechnical investigation was undertaken to:

i. Establish the subsurface conditions at three (3) boreholes located at the site;

ii. Assess the stability of the existing slopes; and,

iii. Review the proposed grading plan with respect to stability of the slopes of the regraded site.

2.0 Procedure

The fieldwork for the geotechnical investigation was undertaken on May 12 and 13, 2022, and consisted of drilling three (3) boreholes (Boreholes MW-05, MW-06, and MW-07). The sampling in the boreholes was undertaken from the ground surface and was advanced to termination from 6.7 m to 9.8 m depth

(Elevation 94.1 m to Elevation 93.3 m). The borehole locations are shown in Figure 2. The fieldwork was supervised on a full-time basis by EXP. The elevations of the boreholes refer to the Geodetic datum.

The boreholes were cleared of private and public underground services, prior to the start of drilling operations. The boreholes were drilled using a CME-850 track mounted drill rig equipped with continuous flight hollow stem auger and wash-boring equipment. Standard penetration tests (SPTs) were performed in all the boreholes at 0.75 m depth intervals with soil samples retrieved by the split-barrel sampler. The soil conditions in each borehole were logged based on visual examination of the soil samples. The soil samples were placed in plastic bags and labelled. Standpipes (50 mm diameter) with slotted section were installed in all three boreholes for long-term monitoring of the groundwater levels. The standpipes were installed in accordance with EXP standard practice, and the installation configuration is documented on the respective borehole logs. The boreholes were backfilled upon completion of drilling and the installation of the standpipes.

On completion of the fieldwork, all the samples were transported to the EXP laboratory in the City of Ottawa where they were visually examined by a geotechnical engineer and detailed borehole logs prepared. Geotechnical laboratory testing consisted of performing natural moisture content tests on all the retrieved soil samples as well as grain size analyses on select soil samples.

3.0 Subsurface Conditions and Groundwater Levels

A detailed description of the geotechnical conditions encountered in the boreholes are presented in the attached borehole logs, Figures 3 to 5 inclusive. The borehole logs and related information depict subsurface conditions only at the specific location and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time may also result in changes in the conditions interpreted to exist at the locations where sampling was conducted.

The boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and is not intended to provide evidence of potential environmental conditions.

It should be noted that the soil boundaries indicated on the borehole logs are intended to reflect approximate transition zones for the purpose of geotechnical design and should not be interpreted as exact planes of geological change. The “Notes on Sample Descriptions” preceding the borehole logs form an integral part of this report and should be read in conjunction with this report.

Borehole records from previous investigation were provided to EXP for review. The relevant borehole records are included in this report in Appendix ‘B’.

A review of the borehole logs indicates the following subsurface soil conditions with depth.

3.1 Fill

The surficial soil is fill which extends to 0.3 m to 3.0 m depths (Elevation 100.5 m to Elevation 99.1 m). The fill consists of sandy silt or sand with gravel and various debris and is brown in colour. Based on standard penetration N-values of 6 to 35 for 300 mm of sampler penetration, the fill is in a loose to dense state. Auger grinding was noted in borehole MW-05. This may indicate the presence of debris, cobbles or boulders within the sand deposit. The natural moisture content of the fill ranges from 5 to 22 percent and the unit weight of the fill was determined to range from 21.0 kN/m^3 to 22.0 kN/m^3.

3.2 Sandy Gravel

Underlying the fill in borehole MW-07 is a layer of sandy gravel which extends to 1.4 m depth (Elevation 99.4 m). The sandy gravel is brown in colour. Based on the standard penetration N-values of 42 for 300 mm of sampler penetration, followed by 50 blows for 100 mm of penetration of the sampler, the sandy gravel is considered to be in a dense state. It contains boulders and cobbles. The natural moisture content of the sandy gravel is 3 percent. The results of a grain size analysis performed on this stratum are given on Table 1 (Figure 6).

Table 1: Results of Grain Size Analysis on Sandy Gravel

BH #	Depth (m)	Grain-Size Analysis (%)			USCS
		Fines (Clay and Silt)	Sand	Gravel	Soil Classification (USCS)
MW7-SS2	0.8 - 1.4	8	31	61	Gravel with silt and sand (GW-GM)

This stratum comprises of 8 percent clay and silt, 31 percent sand and 61 percent gravel. (Figure 6). This stratum was not encountered in boreholes MW-05 or MW-06.

3.3 Sand

The fill in boreholes MW-05 and MW-06 and the sandy gravel in borehole MW-07 are underlain by a layer of sand which extends to the entire depth investigated in all three boreholes, i.e., from 6.7 m to 9.8 m depth (Elevation 94.1 m to Elevation 93.3 m). It is brown in colour and becomes grey at 5.3 m to 7.6 m depth (Elevation 96.2 m to Elevation 95.2 m). Based on standard penetration N-values of 4 to 48 for 300 mm of sampler penetration, the sand is considered to be in a loose to dense state. The natural moisture content of the sand is 2 to 26 percent. It comprises of 5 to 16 percent clay and silt, 84 to 92 percent sand and 0 to 3 percent gravel. (Figures 7 to 9). The results of the grain size analyses have been summarized on Table 2.

Table 2: Results of Grain Size Analyses on Sand

BH #	Depth (m)	Grain-Size Analysis (%)			USCS
		Fines (Clay and Silt)	Sand	Gravel	Soil Classification (USCS)
MW5-SS6	3.8 - 4.4	16	84	0	Sand (SM)
MW6-SS12	8.4 - 9.0	15	85	0	Sand (SM)
MW7-SS3	1.5 - 2.1	5	92	3	Sand (SM)

3.4 Bedrock

Auger refusal was not encountered within the termination depth of the boreholes. Bedrock is therefore expected to be deeper than the depth investigated.

3.5 Groundwater Levels

There are seven monitoring wells present at the Site. Two of the wells (P-1 and P-2; shallow and deep) were installed as part of the landfill groundwater monitoring program. Two wells (MW-3 and MW-4) were installed prior to Drain-All purchasing the Site. Three additional wells (MW-5, MW-6, and MW-7) were installed following the recommendations of the hydrogeological assessment (EXP, May 2022) as part of the current groundwater monitoring program.

Groundwater measurements were taken on May 25, 2022, June 8, 2022 and May 5, 2023, in the standpipes installed in all boreholes. Groundwater levels are given in Table 3 below.

Table 3: Summary of Groundwater Level Measurements

BH #	Ground Surface Elevation (m)	Date of Measurement	Groundwater Depth Below Ground Surface (Elevation) (m)	Date of Measurement	Groundwater Depth Below Ground Surface (Elevation) (m)	Date of Measurement	Groundwater Depth Below Ground Surface (Elevation) (m)
MW-1 (P-1)	99.58	May 25, 2022	3.2 (96.4)	June 08, 2022	3.2 (96.4)	May 5, 2023	2.8 (96.8)
MW-2 (P-2)	99.66	May 25, 2022	3.5 (96.2)	June 08, 2022	3.6 (96.1)	May 5, 2023	3.2 (96.5)
MW-3	101.23	May 25, 2022	5.0 (96.2)	June 08, 2022	5.0 (96.2)	May 5, 2023	4.7 (96.5)
MW-4	100.90	May 25, 2022	4.7 (96.3)	June 08, 2022	4.7 (96.3)	May 5, 2023	4.3 (96.6)
MW-5	101.54	May 25, 2022	5.5 (96.1)	June 08, 2022	5.5 (96.1)	May 5, 2023	5.2 (96.4)
MW-6	104.14	May 25, 2022	7.0 (96.1)	June 08, 2022	7.0 (96.1)	May 5, 2023	6.7 (96.4)
MW-7	100.77	May 25, 2022	4.5 (96.3)	June 08, 2022	4.5 (96.3)	May 5, 2023	4.1 (96.6)

The groundwater elevation recorded in the wells ranged from 2.8 m to 7.0 m depth (Elevation 96.8 m to Elevation 96.1 m). Based on the above water levels, groundwater flow direction on the Site is to the north.

The highest annual groundwater elevation was estimated to be 1.5 m above the recorded groundwater levels. This corresponds to groundwater levels ranging from 1.3 m to 5.5 m depth (Elevation 98.3 m to Elevation 97.6 m).

A groundwater contour plan is shown in Figure 10.

The groundwater tabled at the site will be subject to seasonal fluctuations.

4.0 Slope Stability Analysis

4.1 Slope Stability Analysis of Existing Slopes (Initial Assessment)

The stability of the existing slopes at the site under consideration were analysed using Morgenstern-Price Method, GeoStudio/Geo-slope office, Version 10.2.1 computerized system. The purpose of the analysis was to assess the stability of the existing slopes. A total of five cross-sections were analysed. These cross-sections have been shown as Sections A-A to E-E on Figure 2.

The topography was surveyed by Farley, Smith and Denis Surveying Limited, Ontario Land Surveyors, in a survey dated April 27, 2022.

Table 4 presents the results of the natural slope inclinations at the cross-sections analysed based on the results of the topographical survey.

Table 4: Slope Inclination at Cross-Sections Analyzed

Section	Crest of Slope Elevation (m)	Toe of Slope Elevation (m)	Height of Slope (m)	Overall Slope Inclination
A-A	112.0	101.3	10.7	3.0H:1V
B-B	111.1	103.4	7.7	3.0H:1V
C-C	109.5	100.5	9.0	2.6H:1V
D-D	109.8	99.8	10.0	1.8H:1V
E-E	111.2	101.0	10.2	2.2H:1V

The slopes were analyzed for the following conditions:

(1) Effective stress analysis to assess long-term stability of the slopes; and,

(2) Effective stress analysis with seismic loading to assess stability of the slope due to a seismic event.

The analyses of stability of the slopes due to a seismic event were undertaken using pseudo-static analyses. The design ground acceleration for the subject site was determined by site classification and peak ground acceleration. Based on the soil conditions, the site classification of Class D was used for this site. Design ground acceleration for the project site was determined from the Earthquake Hazards Program Website by interpolating 2015 National Building Code of Canada Seismic hazard values, see Appendix B. The earthquake design ground motion was determined with an earthquake having 2 percent probability of exceedance in a 50-year period (0.000404 per annum probability or 2,475 return year). The map indicates a peak ground acceleration (PGA) of approximately 0.267 g[1] at the subject site.

For sustained earthquake loading, horizontal seismic coefficient of 0.178 g (~2/3 PGA) was applied for the analyses. It was assumed that horizontal and vertical acceleration will not occur simultaneously. Therefore, the applied vertical seismic coefficient is equal to 0.

The following assumptions were made:

(1) The crest of the existing slopes varies from Elevation 112.0 m to Elevation 109.5 m whereas the toe of the slopes is at Elevation 103.4 m to Elevation 99.8 m (Table 4).

(2) The soil stratigraphy for the various cross-sections is shown on Figure Nos. 6 to 10 inclusive. The soil Stratigraphy was established from the boreholes drilled at the site during the 2022 EXP investigation as well as from the historical borehole records.

(3) The unit weight and the effective shear strength parameters were selected based on literature research and EXP's experience in the area. Table 5 presents the engineering properties of the various soils used in global slope stability analyses.

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[1] g = the acceleration of gravity, ~9.81 m/sec^2

Table 5: Soil Properties used in Stability Analyses

Soil Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Angle of Internal Friction (degrees)
Fill	19.0	0	27
Compact to dense sand	19.7	0	31
Sand	19.8	0	30
Sand and Gravel	22.0	0	33
Sandy Gravel	22.0	0	33
Silty Sand	19.8	0	30

The results of the slope stability analyses for Sections A-A to E-E have been summarized on Table 6 and are given on Figures 11A to 15B inclusive.

Table 6: Results of Slope Stability Analyses

Section	Loading Condition	Factor of Safety	Figure No.
Section A-A	Effective Stress Analysis	1.76	11A
	Effective Stress Analysis with seismic loading	1.1	11B
Section B-B	Effective Stress Analysis	1.73	12A
	Effective Stress Analysis with seismic loading	1.1	12B
Section C-C	Effective Stress Analysis	1.38	13A
	Effective Stress Analysis with seismic loading	0.93	13B
Section D-D	Effective Stress Analysis	1.11	14A
	Effective Stress Analysis with seismic loading	0.76	14B
Section E-E	Effective Stress Analysis	1.42	15A
	Effective Stress Analysis with seismic loading	0.92	15B

4.2 Discussion

Current practice in the industry and the City of Ottawa requires a factor of safety of 1.5 for static loading conditions (i.e., for effective stress and total stress analyses). The minimum acceptable factor of safety for seismic loading conditions is 1.1 (Mitchell 1983). A review of Table 6 indicates that the slope sections C-C, D-D, and E-E do not meet the City of Ottawa criteria for static loading conditions. Also, Sections C-C, D-D, and E-E do not meet the acceptable factor of safety for seismic loading conditions.

There are two options available to ensure that the stability of the slopes do not present a danger to the workers during the filling operations. These are as follows.

4.3.1 Stabilize all Slopes

Stabilize all the slopes in areas where the work will be undertaken close to the slopes. This may be achieved by cutting the slopes back at an inclination of 3H:1V if space permits. Alternatively, the slopes may be stabilized by placing fill close to the toes of the slopes to achieve a 3H:1V slope. This option has the advantage that the entire site will be available to workers and equipment during filling operations.

4.3.2 Stabilize Slopes in Stages

The second option is to stabilize the slope(s) in stages, i.e., only in the area where filling is to be undertaken. This may be achieved by first placing a fill berm at the toe of the slope(s) where requisite factor of safety is not available. This option will necessitate fencing off area with unstable slopes so that workers and equipment do not have access to areas where the slopes do not meet the required factors of safety.

4.3.3 Filling Operations

The filling operations at the site should be conducted in such a manner that the stability of the existing slopes is not adversely impacted by any of the following measures/actions:

(1) Additional excavation is not undertaken at the site close to the toes of the slopes;

(2) The current height of the slopes is not increased by placing fill close to the crest of the slopes;

(3) All construction equipment is kept at least 3 m back from the crest of the slopes;

(4) The groundwater table at the site is maintained below Elevation 100.0 m during filling operations;

(5) During winter months covering the slopes with tarpaulins would minimize freeze and thaw action and the resultant deterioration of the slopes; and,

(6) The slopes where work is being undertaken should be periodically examined by a geotechnical engineer. The purpose of the inspections would be to locate any potential areas of slope failure so that they can be remediated before the failure occurs. Any localized sloughing or failure of slope(s) due to freeze-thaw action, etc., should be restored immediately to prevent progressive failure of the slope(s).

The above recommendations are subject to change depending on the sequence in which work will be undertaken, scheduling, and the methodology used to undertake the filling operations. Additional slope stability analyses may be required during filling operations to ensure that the proposed work would be undertaken safely.

5.0 Review of Stability of Regraded Slopes

Preparation of the site to receive inert fill for storage will consist of construction of two infiltration trenches to be located in the northwest part of the site with their invert at Elevation 98.8 m and one infiltration trench to be located in the southeast corner of the site (Area A) with its invert at Elevation 98.70 m. In addition, six areas (Areas A, B, C, D, E, and F) have been identified on the site plan C200-3 which will be used for the storage of the inert fill. Subsequent to the placement of the inert fill, the finished grade would vary between Elevation 101 m to 111 m. approximately.

5.1 West Infiltration Trenches and Slope Stability

For construction of the west infiltration trenches, the existing slope located along the west property boundary and partly along the north and south property boundaries will be regraded at an inclination of 20.2 percent to 31.5 percent. This would be achieved by flattening the slopes by cutting close to the top of the slopes and filling close to the toe of the slopes. This would result in stabilizing the previously identified slopes in the vicinity of Sections D-D and E-E (see Figure 2 for locations) which had lower factors of safety. In order to confirm this, Sections D-D and E-E were re-analyzed for the final conditions (refer to Ultimate Site Grading and Erosion Plan, Dwg C200-3, dated April 24, 2022). Section C-C is outside of the proposed infilling area and no further consideration is required so long as no workers will access this area and/or no work will be carried out in this area.

Three additional cross sections in the vicinity of the west infiltration trenches (Sections X-X, Y-Y and Z-Z) were also analyzed and the locations of these cross sections are shown on Figure 2.

The following additional assumptions were made:

(1) As no geotechnical information was available at the locations of Sections X-X and Y-Y, it was assumed that the material properties are similar to those established from the boreholes drilled at the site during the 2022 EXP investigation as well as those given in the historical borehole records provided.

(2) It is understood that random inert fill will be used to re-grade the slopes. The unit weight and strength parameters of the infill that will be used to re-grade the slopes were assumed. These values are presented in Table 7.

Table 7: Additional Soil Properties used in the Analysis of Proposed Slopes

Soil Type	Unit Weight (kN/m3)	Cohesion (kPa)	Angle of Internal Friction (degrees)
Infill Material	18	0	27

The results of the slope stability analyses for Sections D-D, E-E and X-X to Z-Z have been summarized on Table 8 and have been plotted on Figures 16A to 20B inclusive.

Table 8: Results of Slope Stability Analyses of Proposed Slopes

Section	Loading Condition	Factor of Safety	Figure No.
Section D-D	Effective Stress Analysis	3.0	16A
	Effective Stress Analysis with Seismic Loading	1.5	16B
Section E-E	Effective Stress Analysis	2.3	17A
	Effective Stress Analysis with Seismic Loading	1.3	17B
Section X-X	Effective Stress Analysis	1.8	18A
	Effective Stress Analysis with Seismic Loading	1.1	18B
Section Y-Y	Effective Stress Analysis	1.7	19A
	Effective Stress Analysis with Seismic Loading	1.1	19B
Section Z-Z	Effective Stress Analysis	1.7	20A
	Effective Stress Analysis with Seismic Loading	1.1	20B

The results of the analysis indicate the analyzed slopes will meet the required factor of safety of 1.5 for static loading conditions (i.e., for effective) and 1.1 for seismic loading conditions and the slopes are expected to be stable.

5.2 East Infiltration Trench (Area A) and Slope Stability

The east infiltration trench would be located with its invert at Elevation 98.7 m and will be used to drain Area A. Area A will be filled to Elevation 109 m to 110 m close to the western boundary and to Elevation 111 m approximately along the eastern boundary of the area, i.e., close to the top of the existing slope.

The proposed elevations along the southern boundary will vary from Elevation 101 to Elevation 109 m approximately. It is noted that a slope of 2H:1V approximately will be maintained close to the property boundaries above the filled areas.

5.3 Area B

Filling in Area B has been set back from the crest of the slope located along the southern boundary of the site to maintain an approximately 2H:1V slope.

5.4 Area C

Filling in Area C will be undertaken to Elevation 106 m to Elevation 110 m along the north and east boundary. The filling in this area has been set back by 16 m to 20 m approximately from the property boundaries and will not have any impact on the existing slopes located at the property boundaries.

5.5 Areas D, E, and F

These areas are located in the interior of the site and their filling would not have any impact on the slopes located at the property boundaries.

6.0 Conclusions

The stability of the existing slopes located along the property boundary of the site was assessed. It is recommended that in areas where the requisite factor of safety is not available, the slope should be stabilized prior to commencement of work. This may be achieved by constructing a berm at the toe of the slope or by placing fill along the slope close to its toe.

A review of the proposed Site Grading and Erosion Control Plan (Dwg C200-3) indicates that the proposed final slopes at the site will be constructed at inclination of 3H:1V or flatter and therefore are expected to be stable.

The work sequence, scheduling and methodology used to undertake the filling operations is currently not known. EXP will be pleased to provide additional input if requested once these aspects have been finalized.

7.0 General Closure

The comments given in this geotechnical report are based on the geotechnical investigation undertaken by EXP, boreholes drilled by others in the area, and the proposed Ultimate Site Grading and Erosion Control Plan. They are subject to revision if any changes are made to the currently proposed Site Grading and Erosion Control Plan.

The number of boreholes required to determine the localized underground conditions, between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well, as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on the environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

We trust that the information contained in this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Sincerely,

EXP Services Inc.

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LICENSED PROFESSIONAL ENGINEER
February 21, 2024
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Attachments*:*
Figure 1: Site Location Plan
Figure 2: Borehole Location Plan
Figures 3 to 5: Borehole Logs
Figures 6 to 9: Grain Size Analyses
Figure 10: Groundwater Contour Plan
Figures 11A & 11B: Slope Stability Analysis, Section A-A
Figures 12A & 12B: Slope Stability Analysis, Section B-B
Figures 13A & 13B: Slope Stability Analysis, Section C-C
Figures 14A & 14B: Slope Stability Analysis, Section D-D
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Appendices:
Appendix A: Historical Borehole Logs Used in Slope Stability Analyses
Appendix B: 2015 National Building Code Seismic Hazard Calculations

Figures

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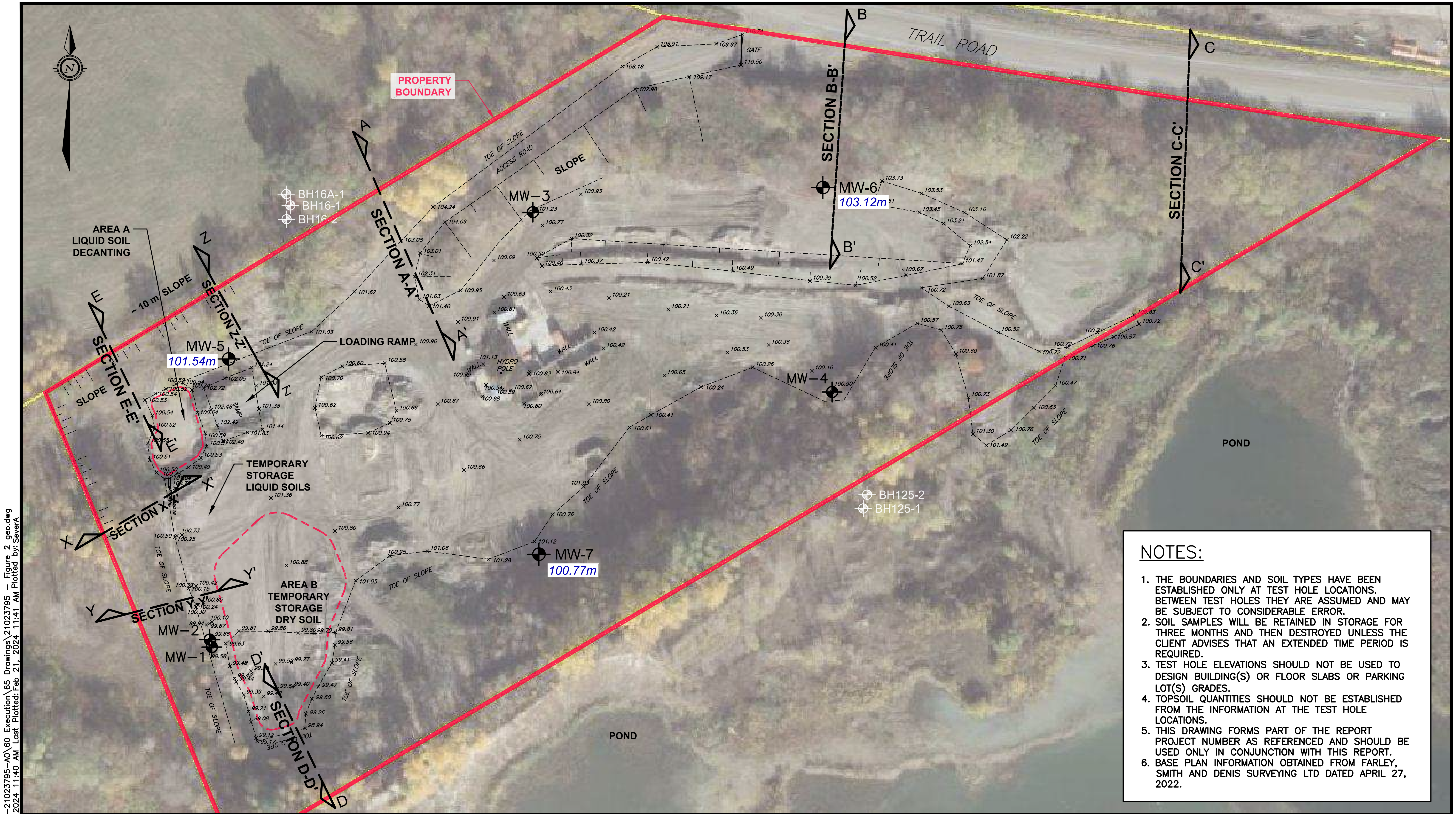
exp Services Inc. 100-2650 Queensview Drive Ottawa, ON K2B 8H6 **www.exp.com**	DESIGN CK / LW	SLOPE STABILITY ANALYSIS 4380 TRAIL ROAD, OTTAWA, ONTARIO		SCALE 1:25,00
	DRAWN AS			
	DATE JULY 2022	SITE LOCATION PLAN		SKETCH NO FIG 1
	FILE NO OTT-21023795			



NOTES:

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT TEST HOLE LOCATIONS. BETWEEN TEST HOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TEST HOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
4. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION AT THE TEST HOLE LOCATIONS.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN INFORMATION OBTAINED FROM FARLEY, SMITH AND DENIS SURVEYING LTD DATED APRIL 27, 2022.

LEGEND

MONITORING WELL LOCATION MW-5
GROUND SURFACE ELEVATION 101.54m
(AT MONITORING WELL) IN METERS
GROUND ELEVATION ×99.58
OFF-SITE MONITORING WELL NO. & LOCATION BH125-1
SECTION MARKS

0 10m 20m 40m
HORIZONTAL 1:1000

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DESIGN	CK / DW
DRAWN	AS
DATE	FEBRUARY 2024
FILE NO	OTT-21023795-A0

GEOTECHNICAL INVESTIGATION
4380 TRAIL ROAD, OTTAWA, ONTARIO

SITE LAYOUT

SCALE 1:1000
SKETCH NO
FIG 2

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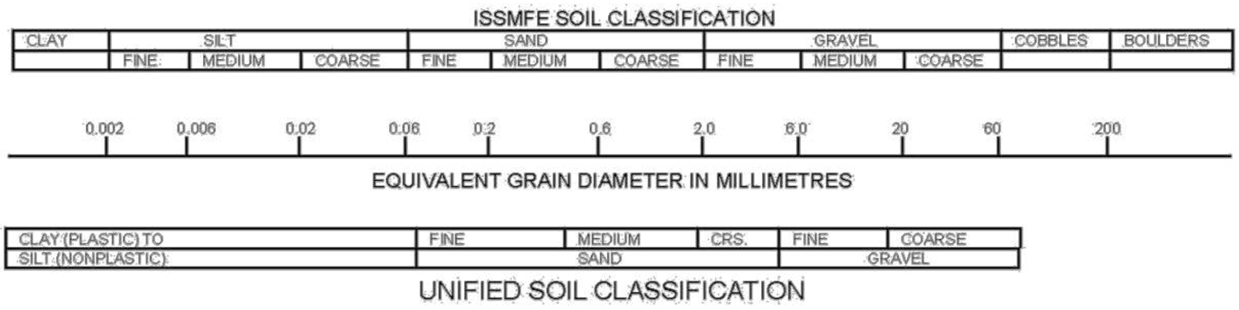
Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Societv for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by **exp** Services Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.



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

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

Log of Borehole MW-05

Project No: OTT-21023795-A0

Project: Slope Stability Analysis

Location: 4380 Trail Road, Ottawa, ON

Figure No. 3

Page. 1 of 1

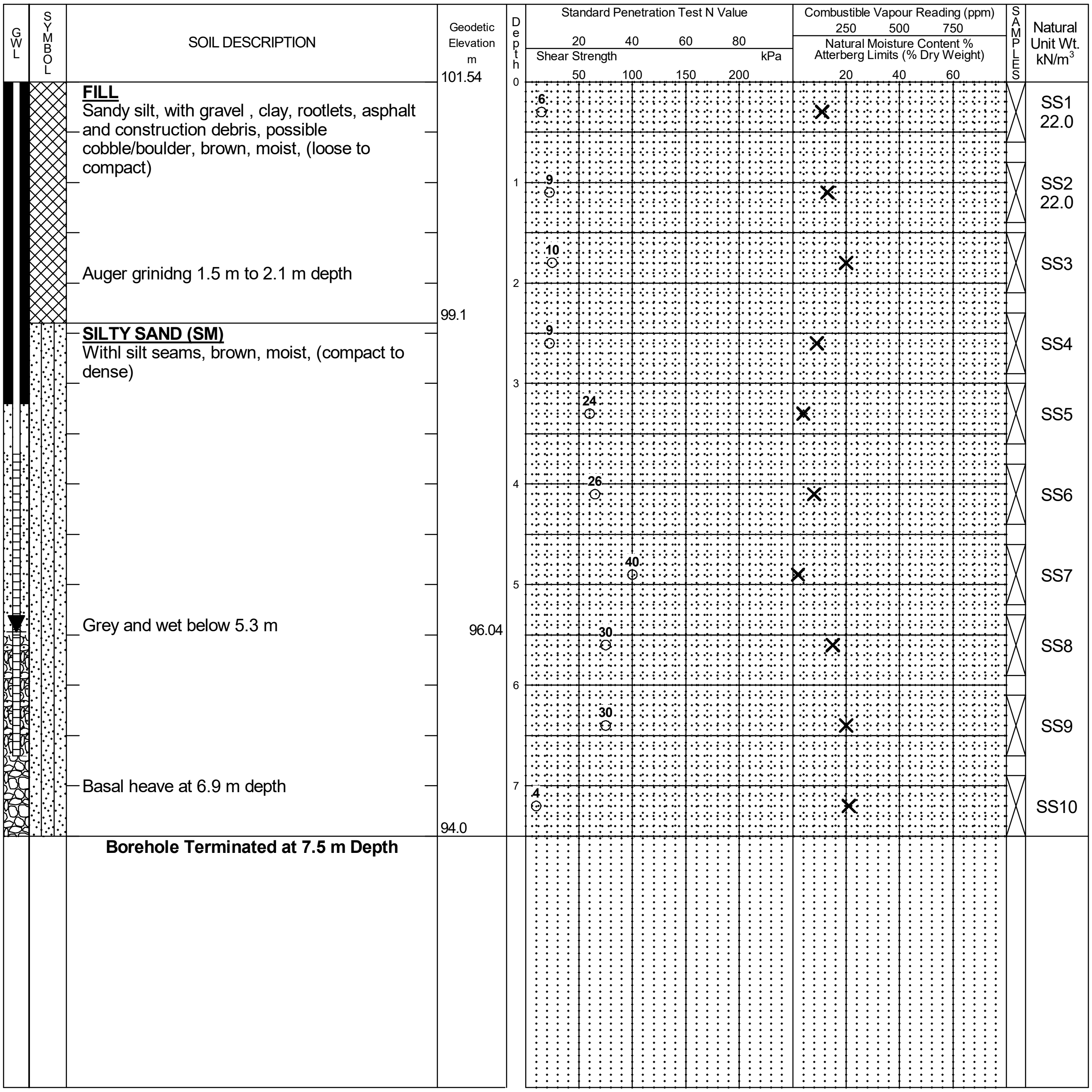
Date Drilled: 'May 13, 2022

Drill Type: CME-850 Track Mounted Drill Rig

Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■		
Shear Strength by Vane Test	+ S	Shear Strength by Penetrometer Test	▲



Geodetic Elevation (m)	Soil Description
101.54	**FILL** Sandy silt, with gravel , clay, rootlets, asphalt and construction debris, possible cobble/boulder, brown, moist, (loose to compact) Auger grinidng 1.5 m to 2.1 m depth
99.1	**SILTY SAND (SM)** Withl silt seams, brown, moist, (compact to dense) Grey and wet below 5.3 m
96.04	
	Basal heave at 6.9 m depth
94.0	**Borehole Terminated at 7.5 m Depth**

Sample	SPT (N) Value	Natural Unit Wt. kN/m³
SS1	6	22.0
SS2	9	22.0
SS3	10	
SS4	9	
SS5	24	
SS6	26	
SS7	40	
SS8	30	
SS9	30	
SS10	4	

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21023795-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	5.5	5.5
May 25, 2022	5.5	
June 8, 2022	5.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW-06

Project No: OTT-21023795-A0

Project: Slope Stability Analysis

Location: 4380 Trail Road, Ottawa, ON

Date Drilled: 'May 12, 2022

Drill Type: CME-850 Track Mounted Drill Rig

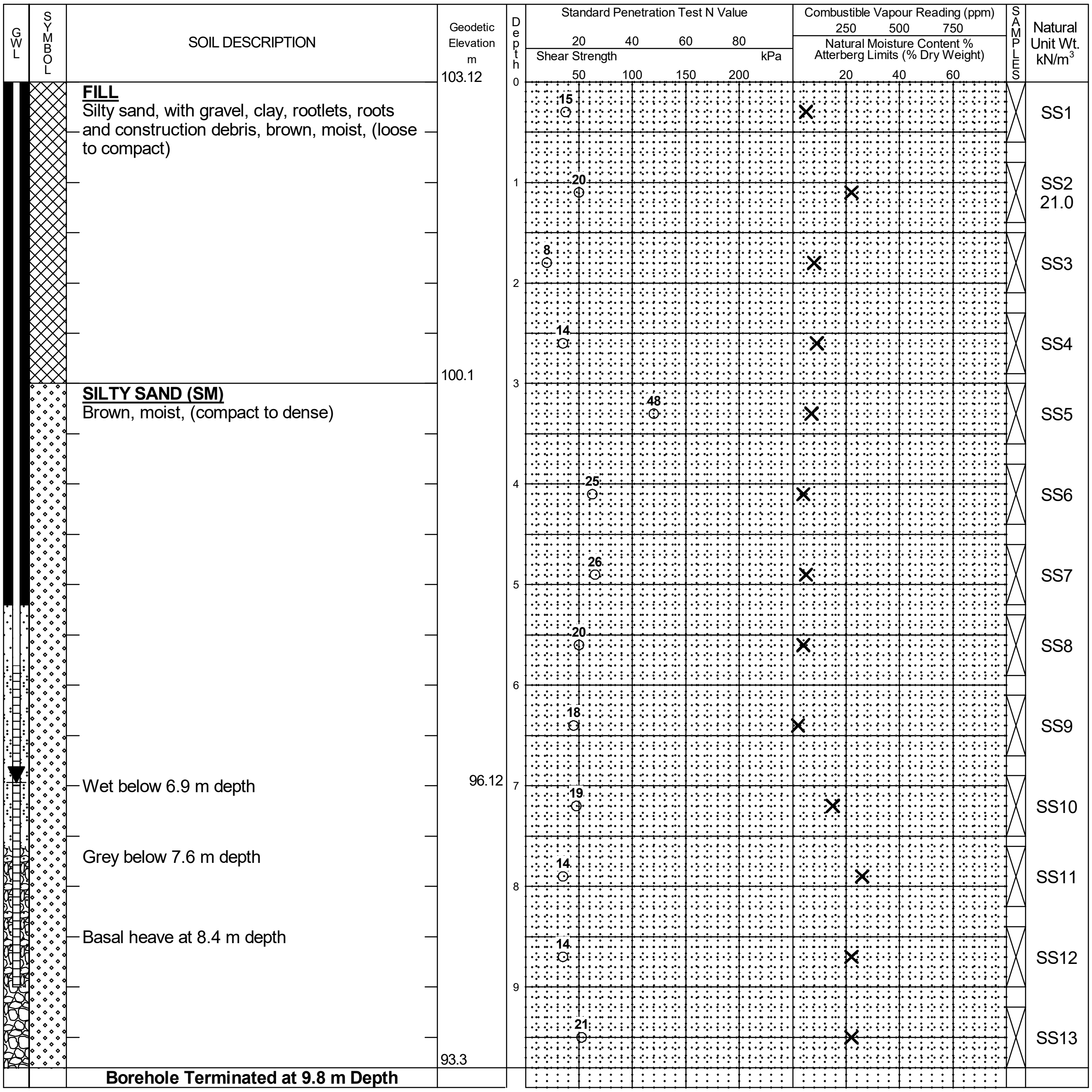
Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 4

Page. 1 of 1

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◫	Natural Moisture Content	✕
SPT (N) Value	○	Atterberg Limits	├─○
Dynamic Cone Test	───	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■		
Shear Strength by Vane Test	+ S	Shear Strength by Penetrometer Test	▲



103.12

FILL
Silty sand, with gravel, clay, rootlets, roots and construction debris, brown, moist, (loose to compact)

100.1

SILTY SAND (SM)
Brown, moist, (compact to dense)

96.12 Wet below 6.9 m depth

Grey below 7.6 m depth

Basal heave at 8.4 m depth

93.3

Borehole Terminated at 9.8 m Depth

SS1	15	
SS2	20	21.0
SS3	8	
SS4	14	
SS5	48	
SS6	25	
SS7	26	
SS8	20	
SS9	18	
SS10	19	
SS11	14	
SS12	14	
SS13	21	

NOTES:

1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21023795-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	8.3	9.0
May 25, 2022	7.0	
June 8, 2022	7.0	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

Log of Borehole MW-07

Project No: OTT-21023795-A0

Project: Slope Stability Analysis

Location: 4380 Trail Road, Ottawa, ON

Date Drilled: 'May 12, 2022

Drill Type: CME-850 Track Mounted Drill Rig

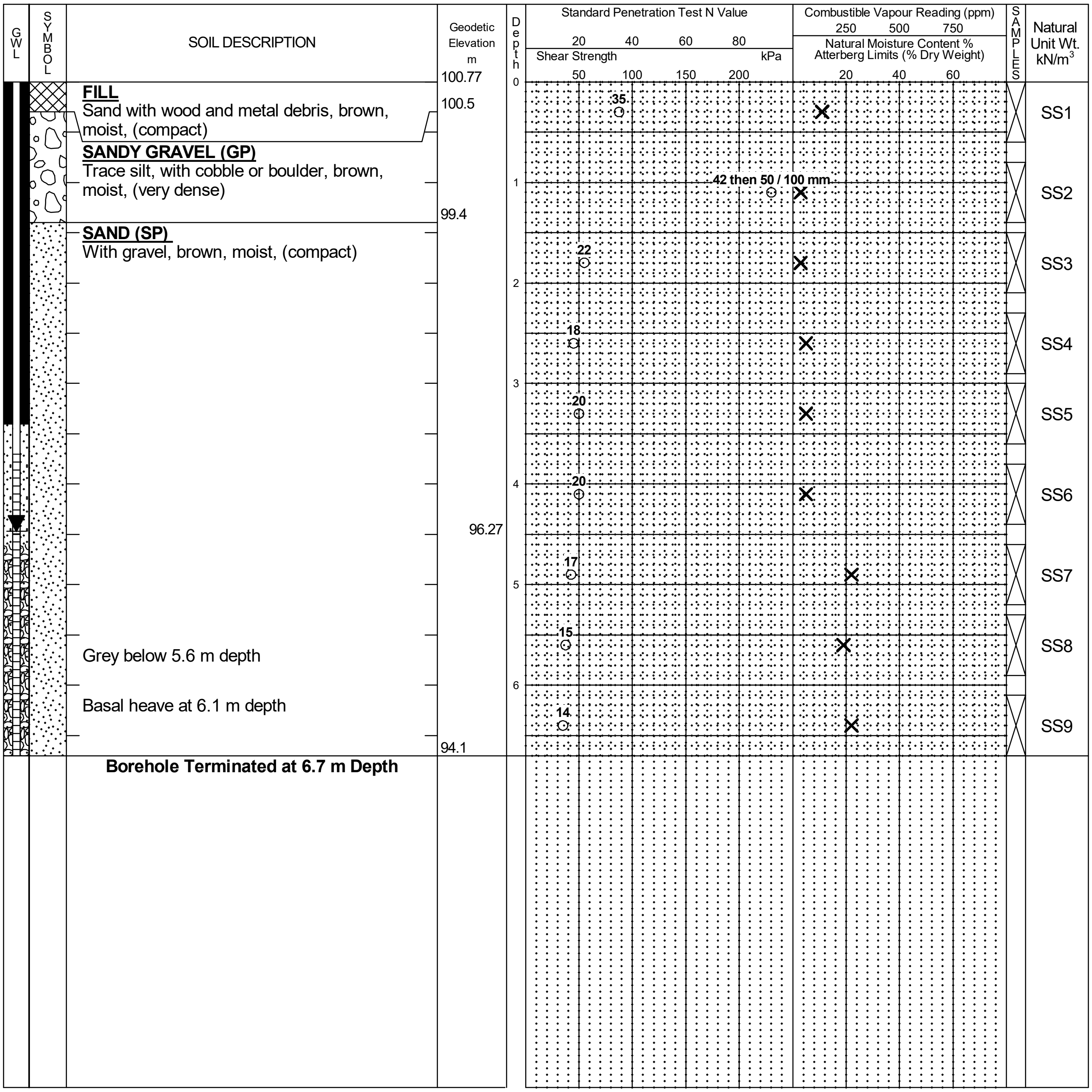
Datum: Geodetic Elevation

Logged by: M.Z. Checked by: I.T.

Figure No. 5

Page. 1 of 1

Split Spoon Sample	☒	Combustible Vapour Reading	☐
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	—	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		



100.77

FILL
Sand with wood and metal debris, brown, moist, (compact)

100.5

SANDY GRAVEL (GP)
Trace silt, with cobble or boulder, brown, moist, (very dense)

99.4

SAND (SP)
With gravel, brown, moist, (compact)

Grey below 5.6 m depth

Basal heave at 6.1 m depth

94.1

Borehole Terminated at 6.7 m Depth

NOTES:
1. Borehole data requires interpretation by EXP before use by others
2. A 50 mm diameter monitoring well was installed as shown.
3. Field work supervised by an EXP representative.
4. See Notes on Sample Descriptions
5. Log to be read with EXP Report OTT-21023795-A0

WATER LEVEL RECORDS

Date	Water Level (m)	Hole Open To (m)
Completion	4.3	5.5
May 25, 2022	4.5	
June 8, 2022	4.5	

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

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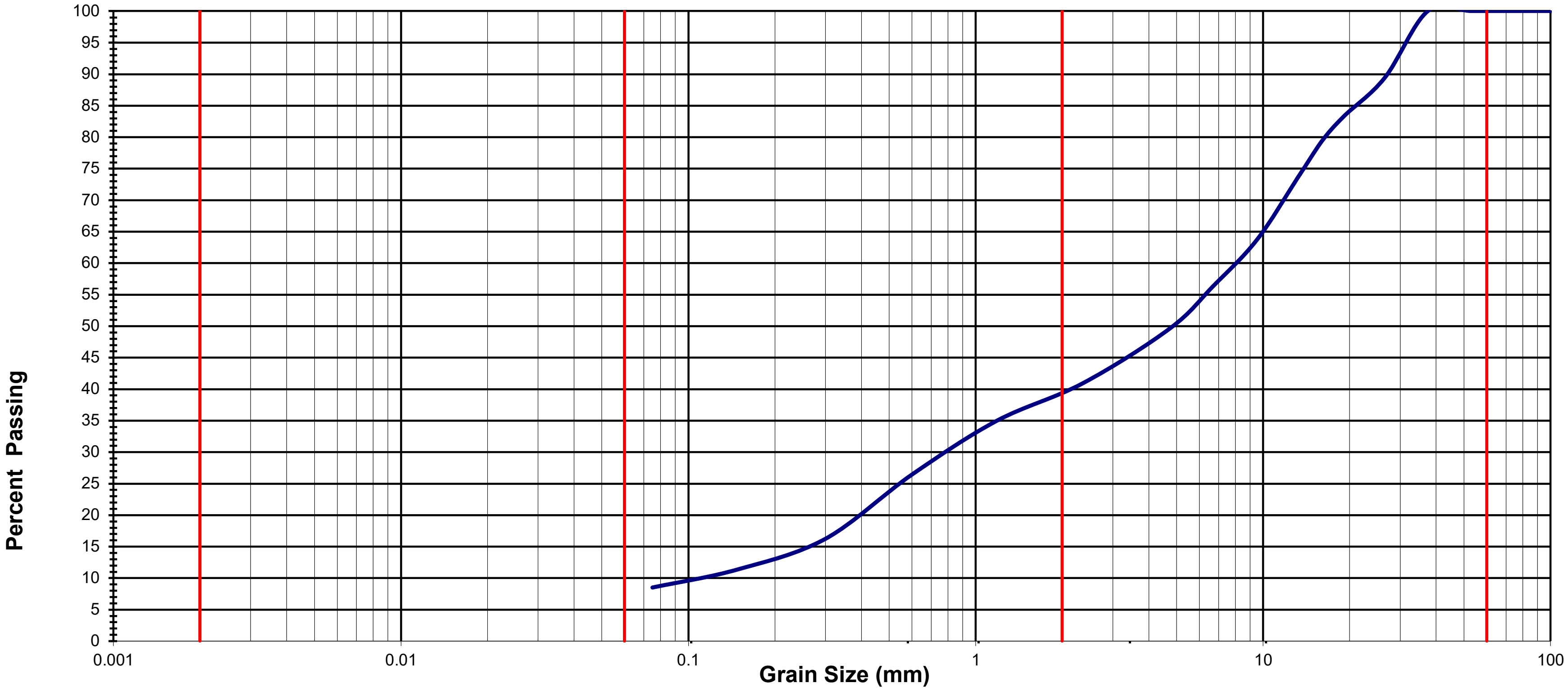
Grain-Size Distribution Curve
Method Test for Sieve Analysis of Aggregate
ASTM C-136

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL			
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	



EXP Project No.:	**OTT-21023795-A0**	**Project Name :**	**Geotechnical Investigation - Slope Stability Trail Road**						
Client :	**Drain-All Ltd.**	**Project Location :**	**4380 Trail Road, Ottawa, Ontario**						
Date Sampled :	**May 12, 2022**	**Borehole No:**	**MW7**	**Sample:**	**SS2**			**Depth (m) :**	**0.8 - 1.4**
Sample Composition :		**Gravel (%)**	**61**	**Sand (%)**	**31**	**Silt & Clay (%)**	**8**	**Figure :**	**6**
Sample Description :	**Poorly Graded Sandy Gravel (SP)**								

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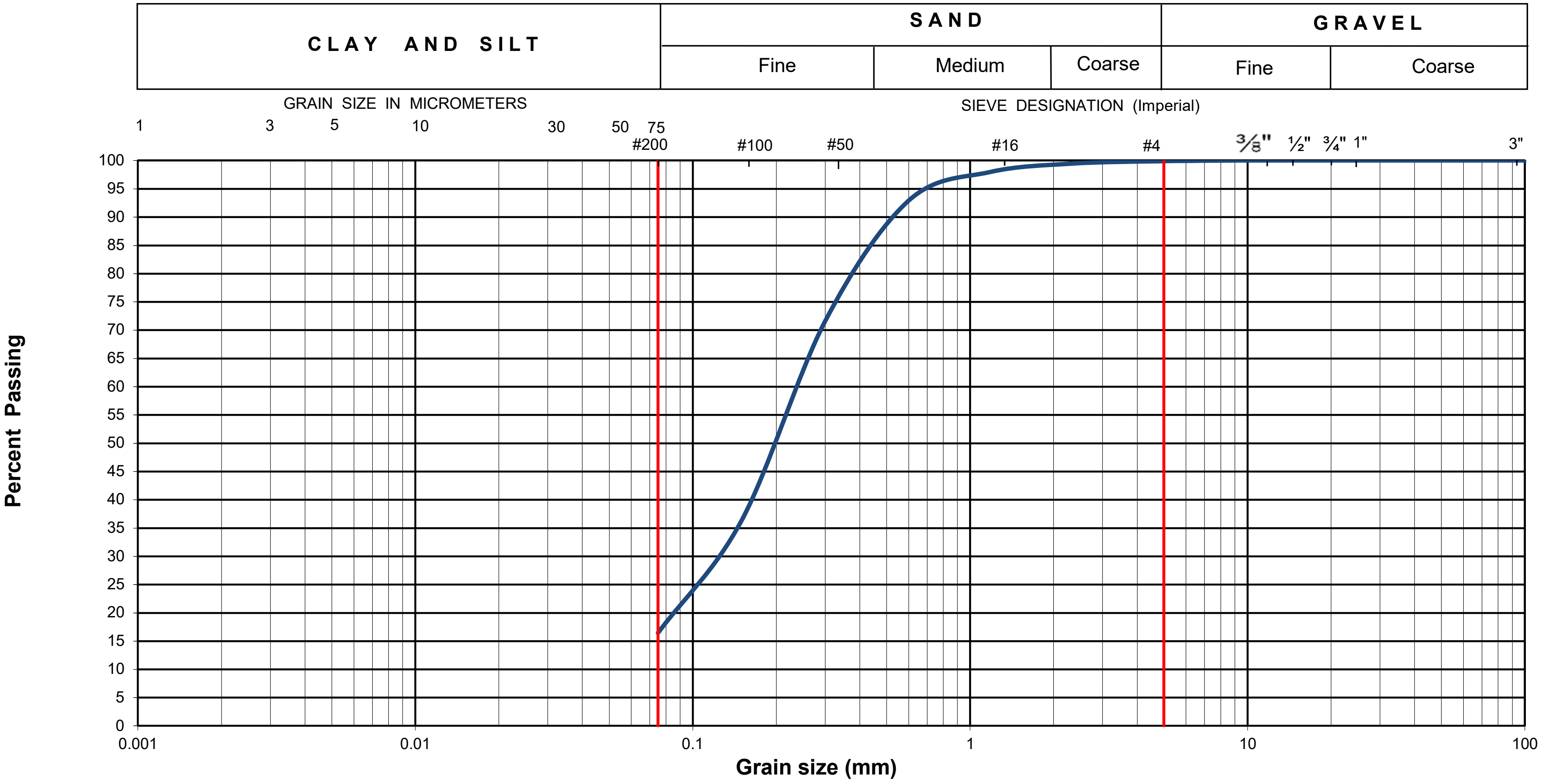
Grain-Size Distribution Curve
Method of Test For Sieve Analysis of Aggregate
ASTM C-136

Unified Soil Classification System



EXP Project No.:	**OTT-21023795-A0**	**Project Name :**	**Geotechnical Investigation - Slope Stability Trail Road**						
Client :	**Drain-All Ltd.**	**Project Location :**	**4380 Trail Road, Ottawa, Ontario**						
Date Sampled :	**May 13, 2022**	**Borehole No:**	**MW5**	**Sample:**	**SS6**			**Depth (m) :**	**3.8 - 4.4**
Sample Composition :		**Gravel (%)**	**0**	**Sand (%)**	**84**	**Silt & Clay (%)**	**16**	**Figure :**	**7**
Sample Description :	**Silty Sand (SM)**								

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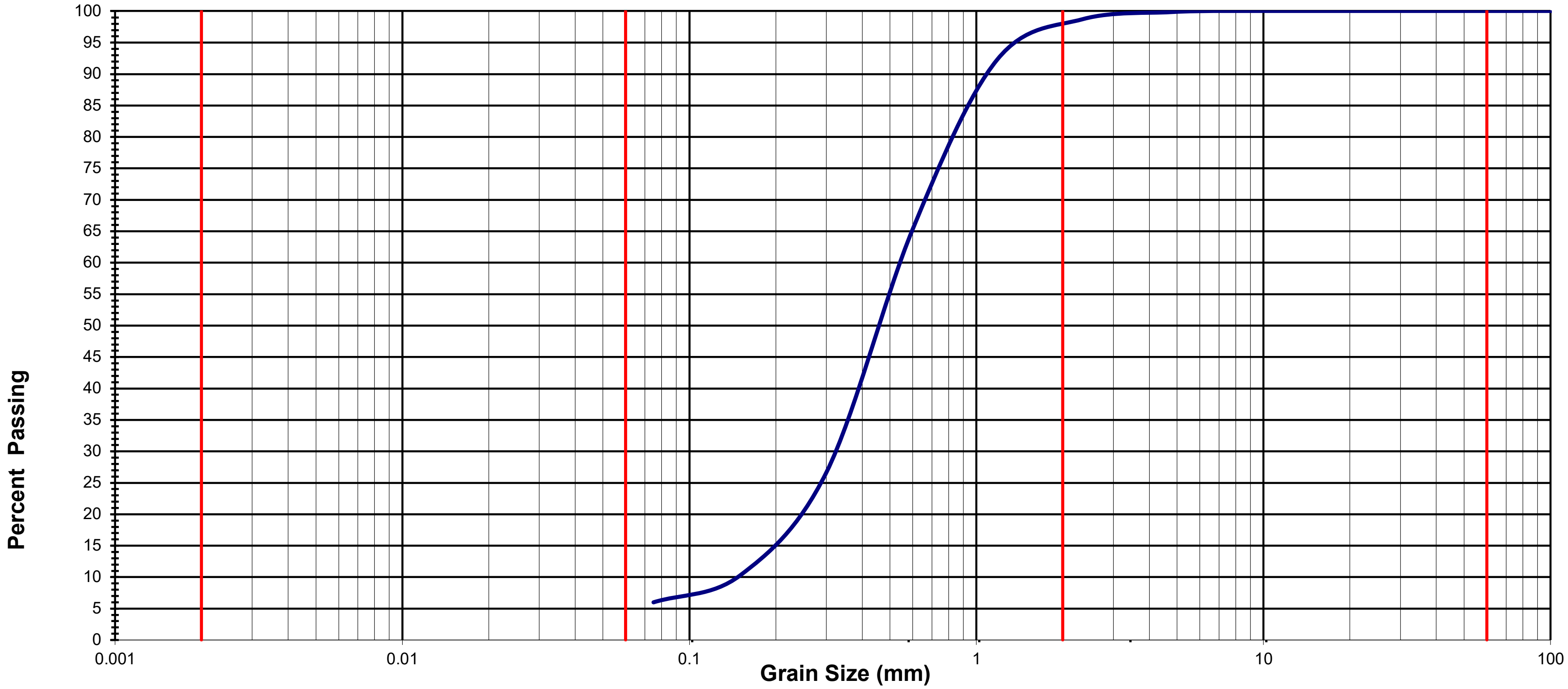
Grain-Size Distribution Curve
Method Test for Sieve Analysis of Aggregate
ASTM C-136

Modified M.I.T. Classification

CLAY	SILT			SAND			GRAVEL			
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	



EXP Project No.:	**OTT-21023795-A0**	**Project Name :**	**Geotechnical Investigation - Slope Stability Trail Road**						
Client :	**Drain-All Ltd.**	**Project Location :**	**4380 Trail Road, Ottawa, Ontario**						
Date Sampled :	**May 12, 2022**	**Borehole No:**	**MW7**	**Sample:**	**SS3**			**Depth (m) :**	**1.5 - 2.1**
Sample Composition :		**Gravel (%)**	**3**	**Sand (%)**	**92**	**Silt & Clay (%)**	**5**	**Figure :**	**8**
Sample Description :	**Poorly Graded Sand (SP)**								

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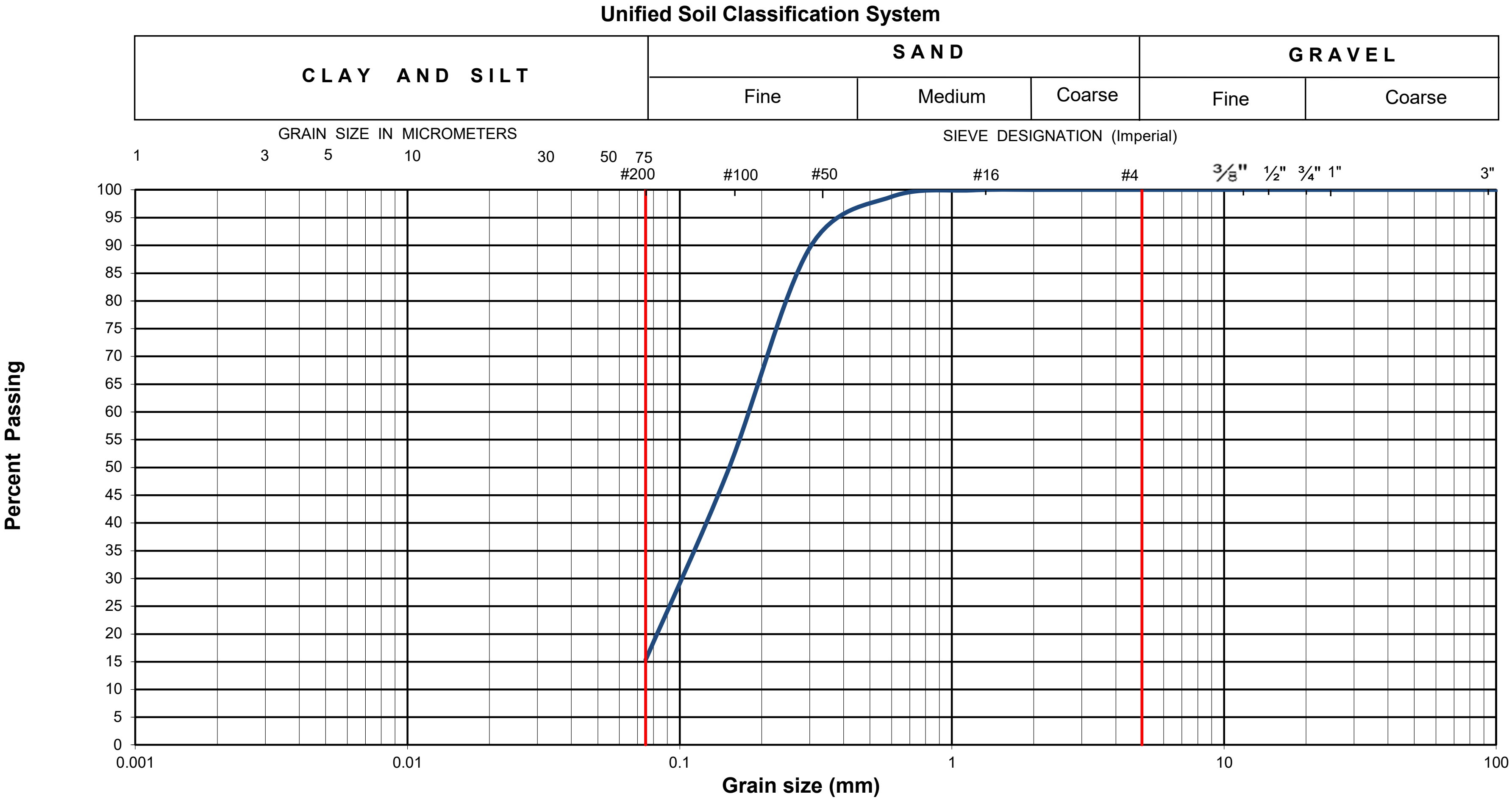
Grain-Size Distribution Curve
Method of Test For Sieve Analysis of Aggregate
ASTM C-136



EXP Project No.:	**OTT-21023795-A0**	**Project Name :**	**Geotechnical Investigation - Slope Stability Trail Road**						
Client :	**Drain-All Ltd.**	**Project Location :**	**4380 Trail Road, Ottawa, Ontario**						
Date Sampled :	**May 12, 2022**	**Borehole No:**	**MW6**	**Sample:**	**SS12**	**Depth (m) :**	**8.4 - 9.0**		
Sample Composition :		**Gravel (%)**	**0**	**Sand (%)**	**85**	**Silt & Clay (%)**	**15**	**Figure :**	**9**
Sample Description :	**Silty Sand (SM)**								

LEGEND

🟥 SITE BOUNDARY

⌖ MONITORING WELL NAME AND LOCATION (GROUNDWATER ELEVATION)

MW-5 GROUNDWATTER SAMPLE LOCATION

➡ GROUNDWATER FLOW DIRECTION

*GROUNDWATER ELEVATIONS FROM MAY 25, 2022

(95.75m) GROUNDWATER CONTOUR ELEVATION

(96.20m) GROUNDWATER ELEVATION

(96.43m)* ELEVATION NOT USED

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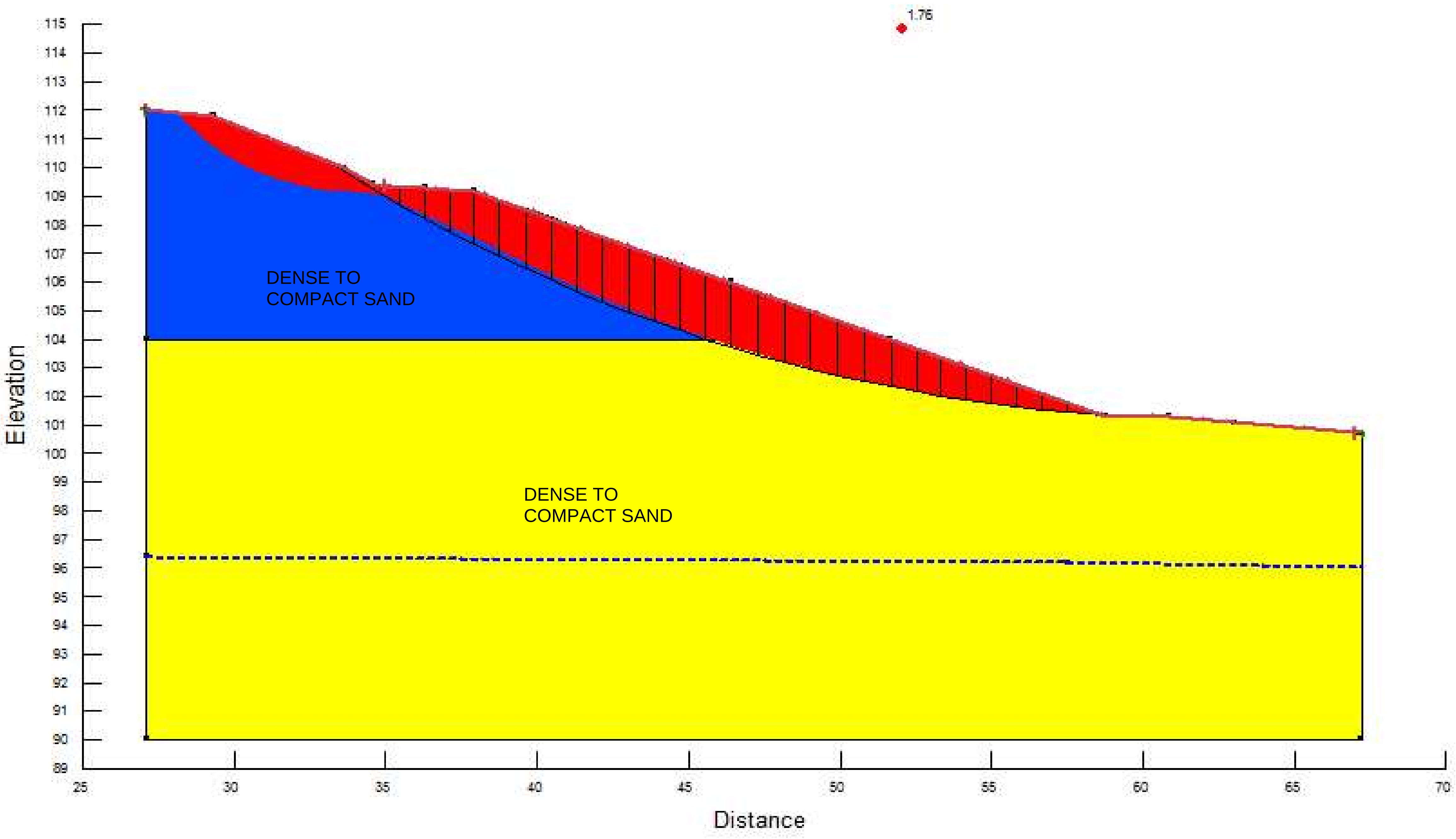
DESIGN	CK / LW
DRAWN	LW / AS
DATE	JULY 2022
PROJECT NO.	OTT-21023795-A0

GROUNDWATER SAMPLING PROGRAM
4380 TRAIL ROAD, OTTAWA, ONTARIO

GROUNDWATER SAMPLING
LOCATIONS & FLOW DIRECTION

SCALE 1:1250

FIG 10



Color	Name	Model	Unit Weight (kN/m^3)	Cohesion' (kPa)	Phi' (°)
🟦	Compact to dense sand	Mohr-Coulomb	19.7	0	31
🟨	Dense to compact sand	Mohr-Coulomb	19.7	0	31

Section A-A'

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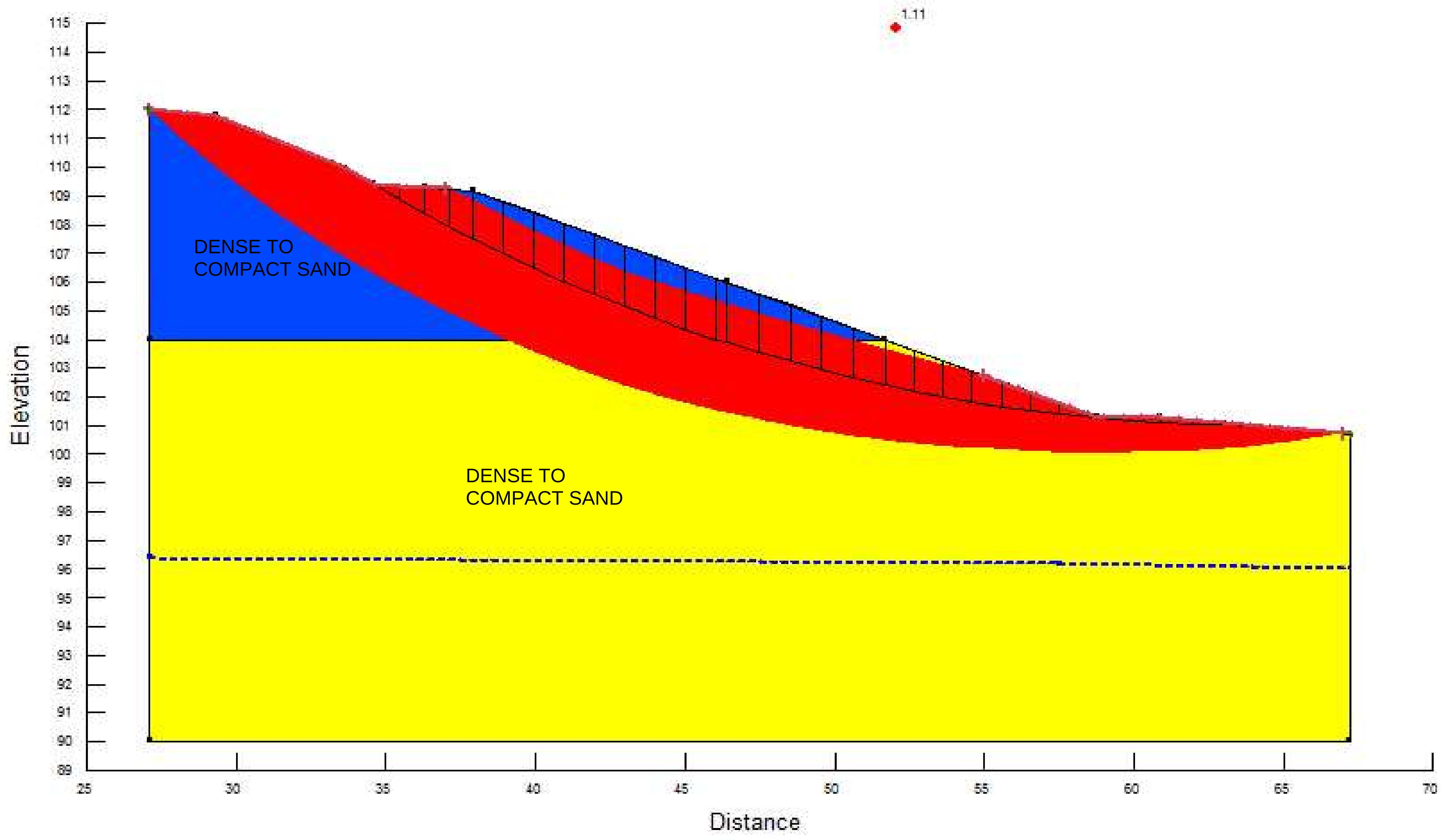
DATE Aug 26, 2022
CLIENT: DRAIN-ALL LTD.
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
DRAWN BY DW
Figure 11A



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟦	Compact to dense sand	Mohr-Coulomb	19.7	0	31
🟨	Dense to compact sand	Mohr-Coulomb	19.7	0	31

Section A-A'

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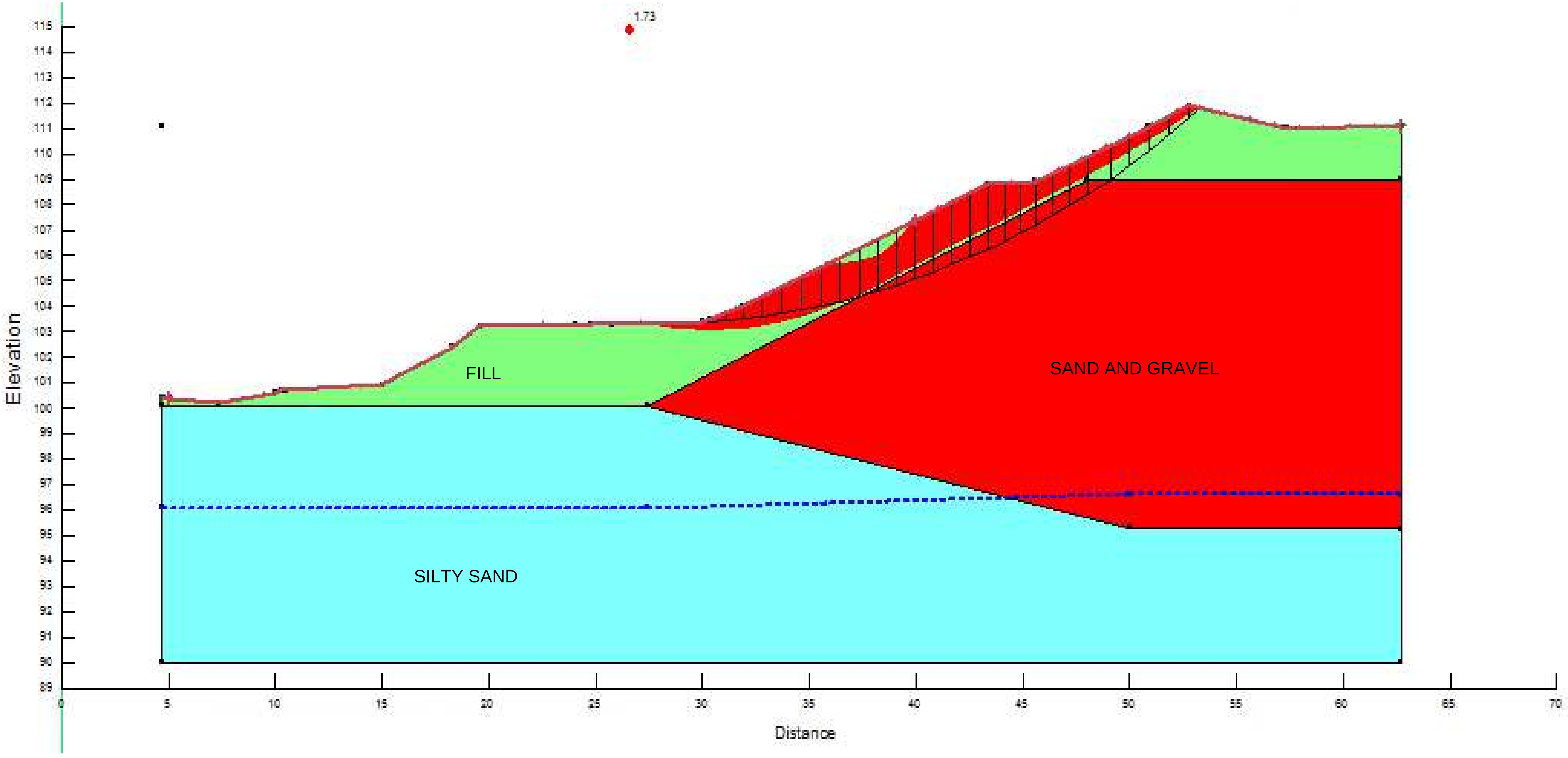
DESIGN DW / CHECKED SA	TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS 4380 Trail Road, Ottawa, Ontario	scale Not to scale
DRAWN BY DW		Figure 11B



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	FILL	Mohr-Coulomb	19	0	27
🟥	Sand and Gravel	Mohr-Coulomb	22	0	33
🟦	Silty Sand	Mohr-Coulomb	19.8	0	30

Section B-B'

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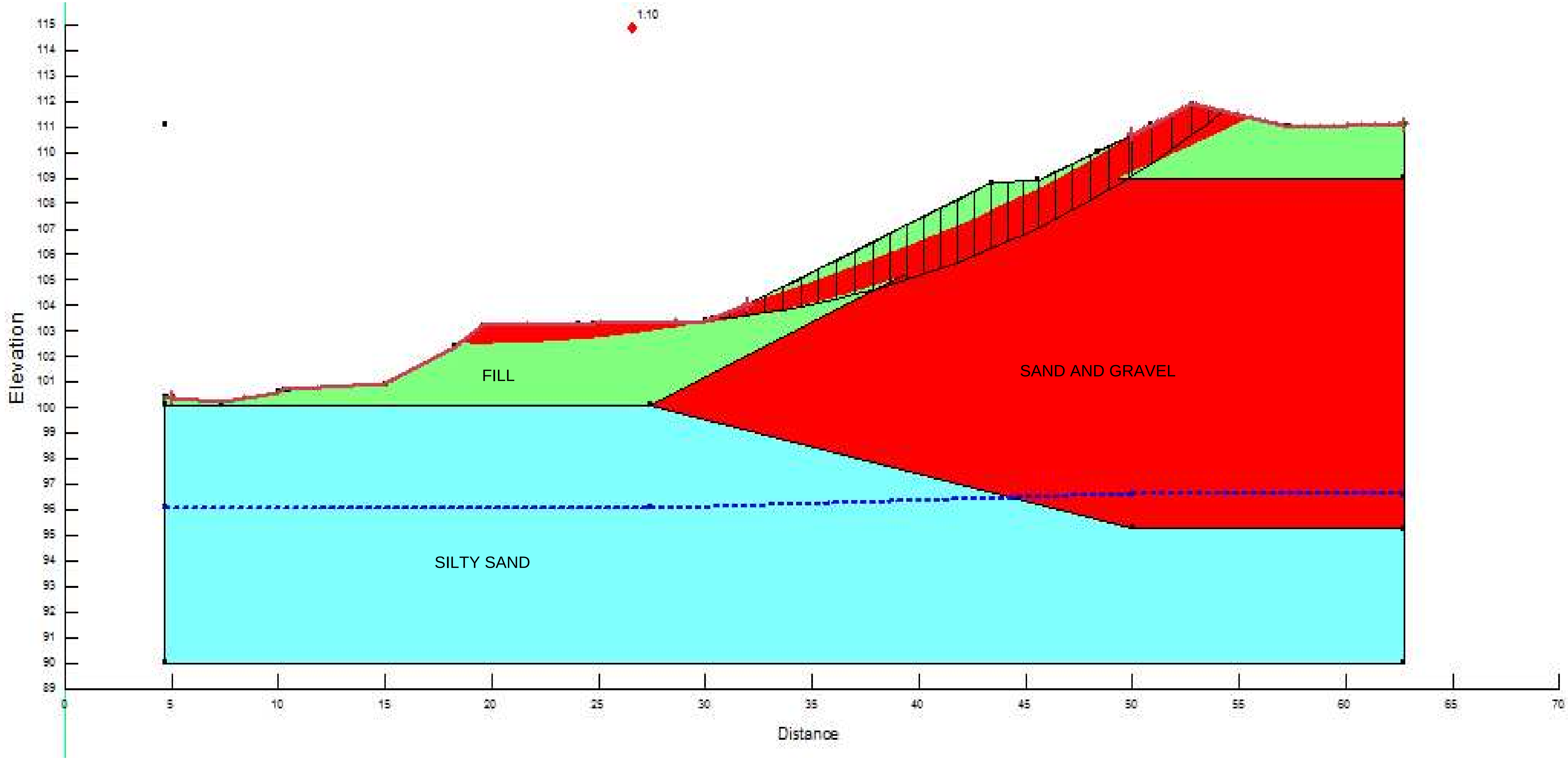
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 12A



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	FILL	Mohr-Coulomb	19	0	27
🟥	Sand and Gravel	Mohr-Coulomb	22	0	33
🟦	Silty Sand	Mohr-Coulomb	19.8	0	30

Section B-B'

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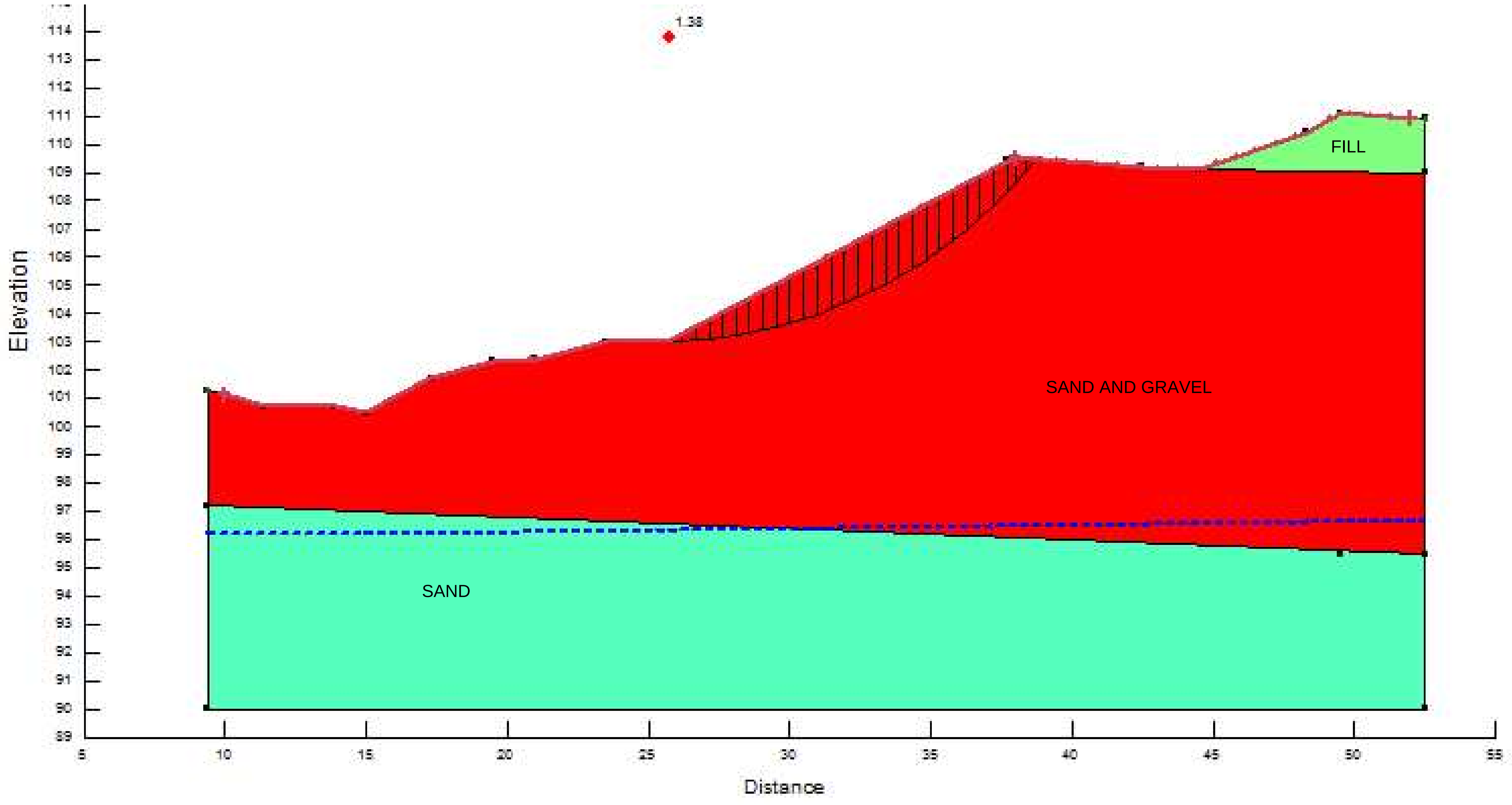
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
project no. OTT-21023795-A0
scale Not to scale
Figure 12B



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	FILL	Mohr-Coulomb	19	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30
🟥	Sand and Gravel	Mohr-Coulomb	22	0	33

Section C-C'

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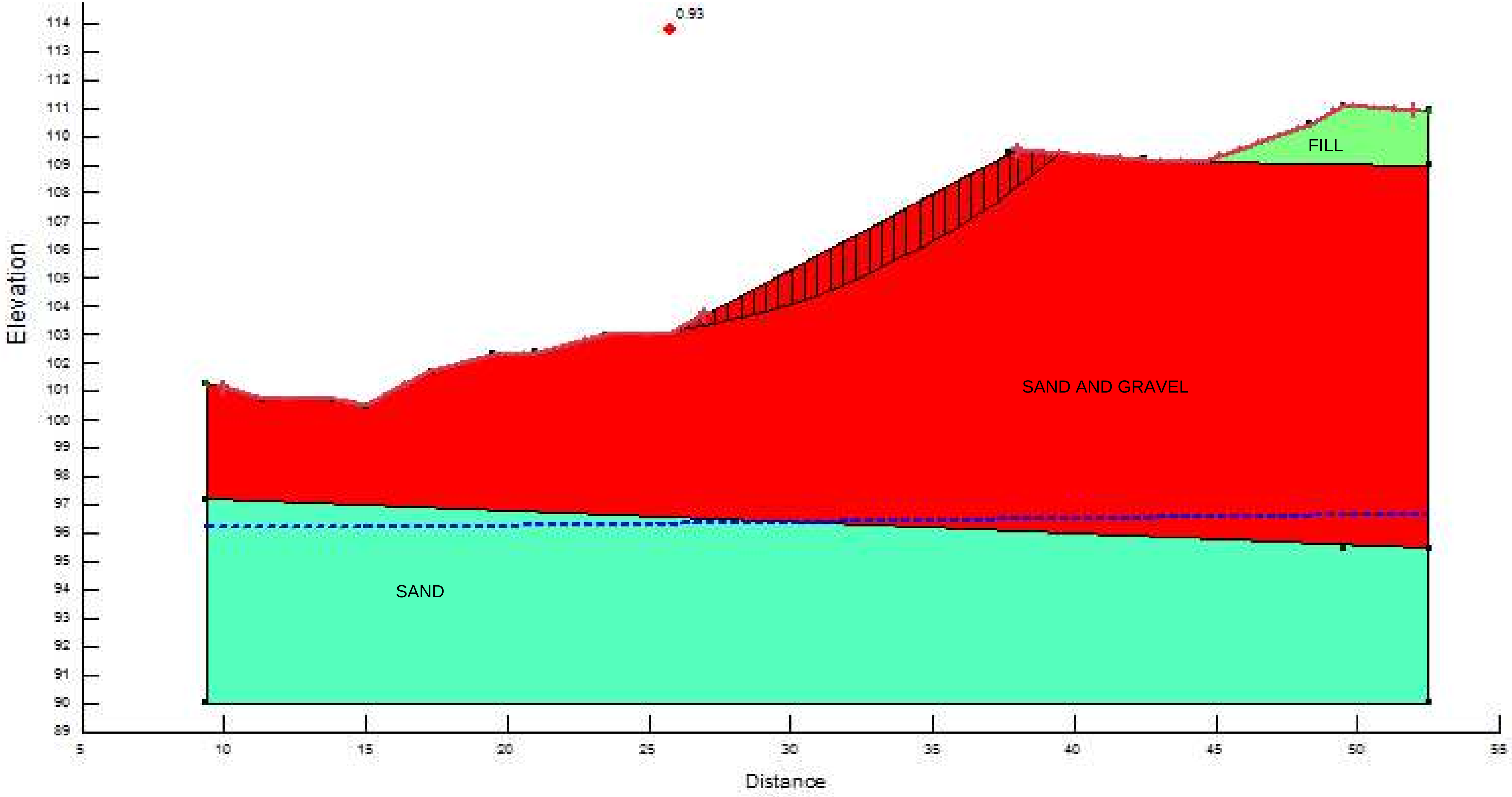
DESIGN DW
CHECKED SA
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
DRAWN BY DW
Figure 13A



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	FILL	Mohr-Coulomb	19	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30
🟥	Sand and Gravel	Mohr-Coulomb	22	0	33

Section C-C'

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DESIGN DW
CHECKED SA
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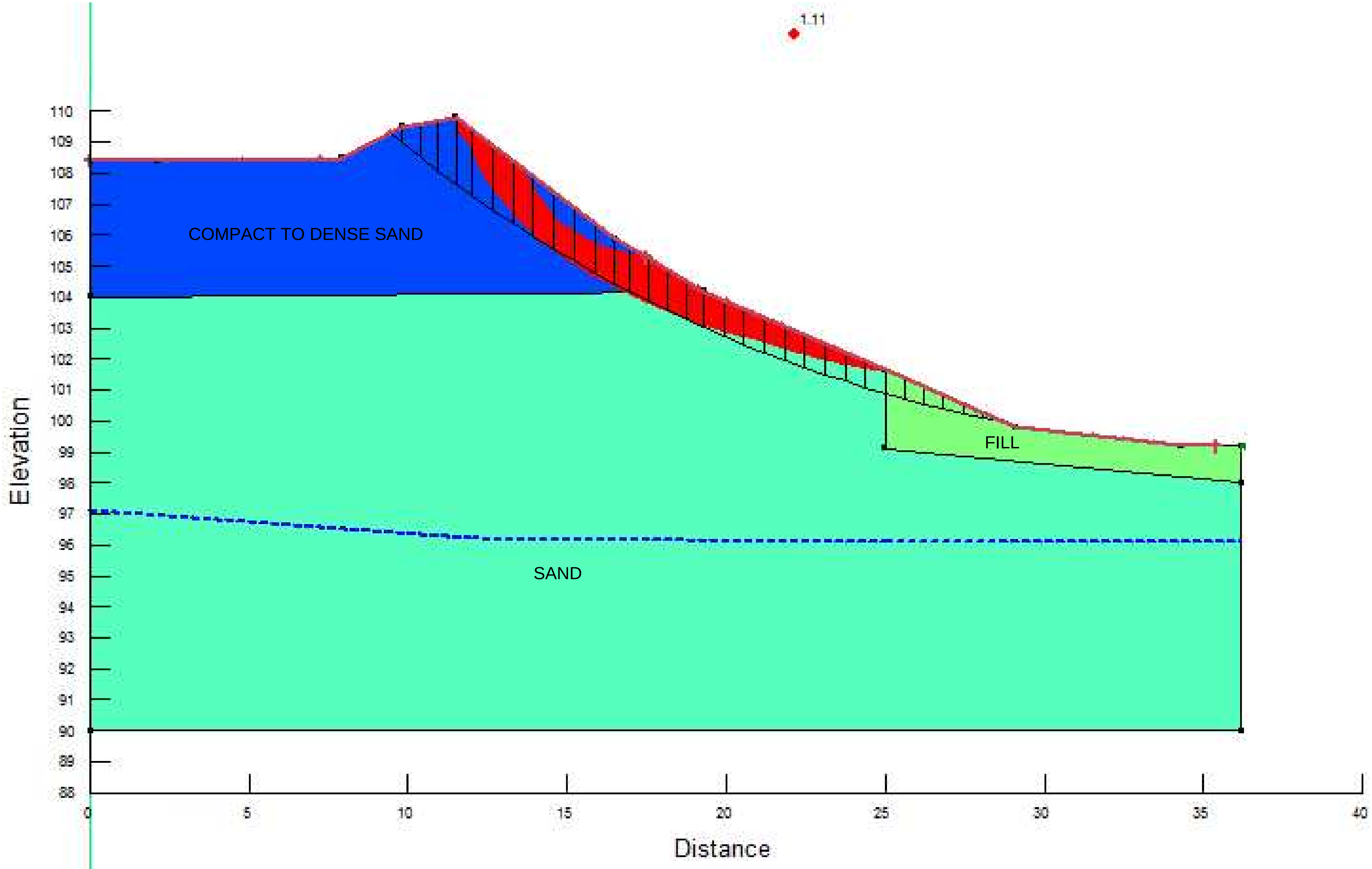
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 13B



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟦	Compact to dense sand	Mohr-Coulomb	19.7	0	31
🟩	FILL	Mohr-Coulomb	19	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section D-D'

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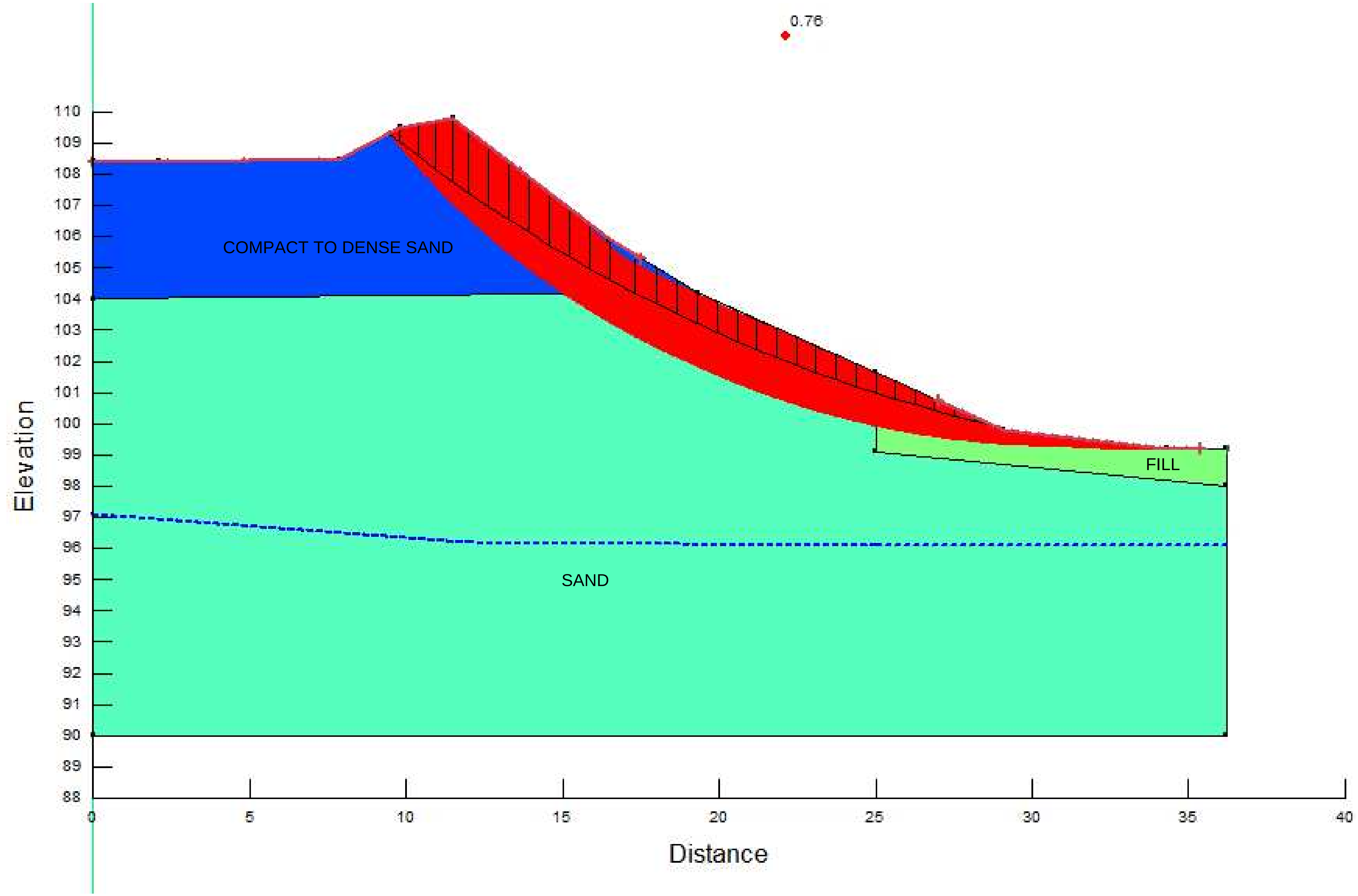
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
DRAWN BY DW
Figure 14A



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟦	Compact to dense sand	Mohr-Coulomb	19.7	0	31
🟩	FILL	Mohr-Coulomb	19	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section D-D'

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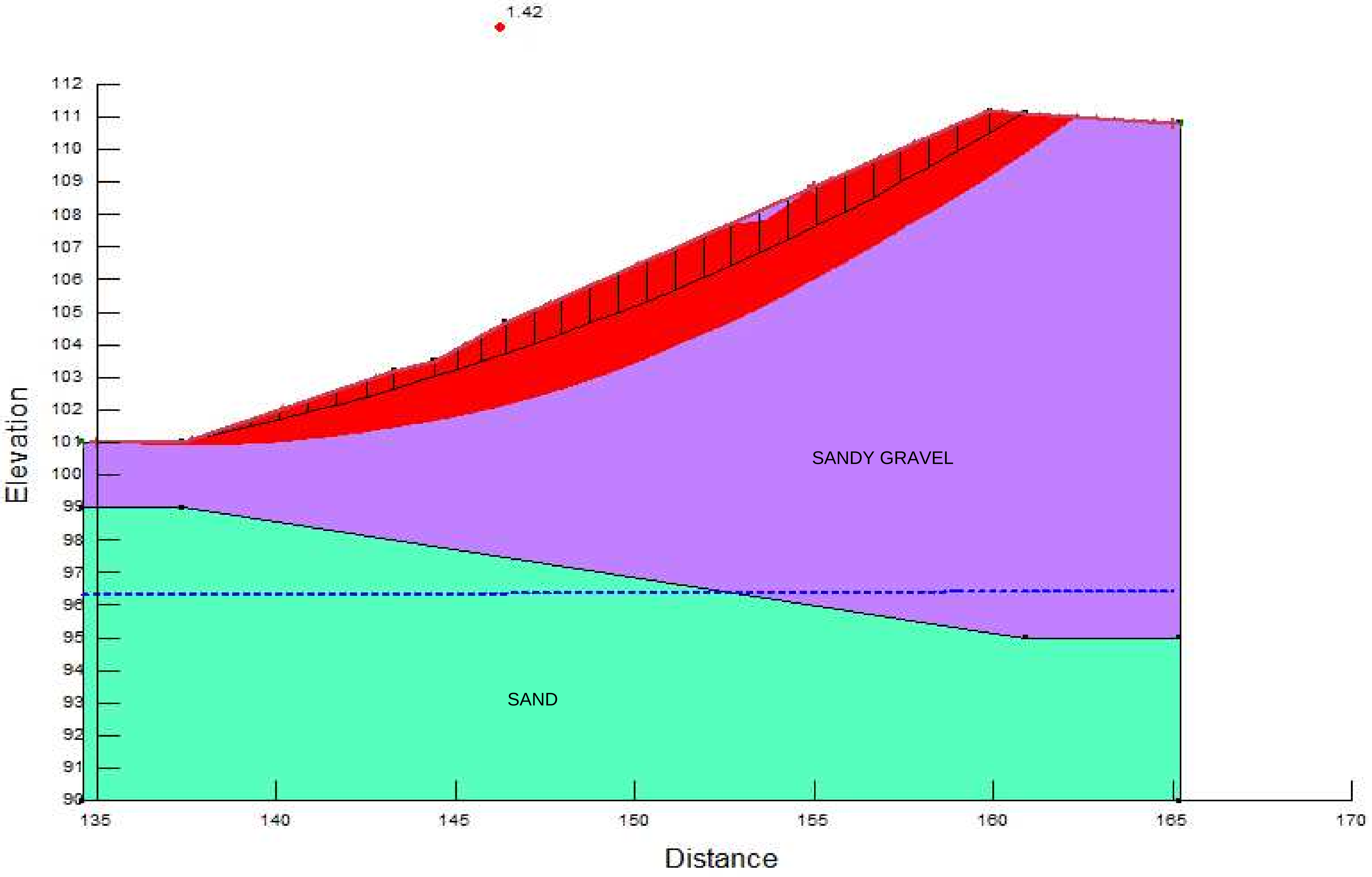
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
DRAWN BY DW
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 14B



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Sand	Mohr-Coulomb	19.8	0	30
🟪	Sandy Gravel	Mohr-Coulomb	22	0	33

Section E-E'

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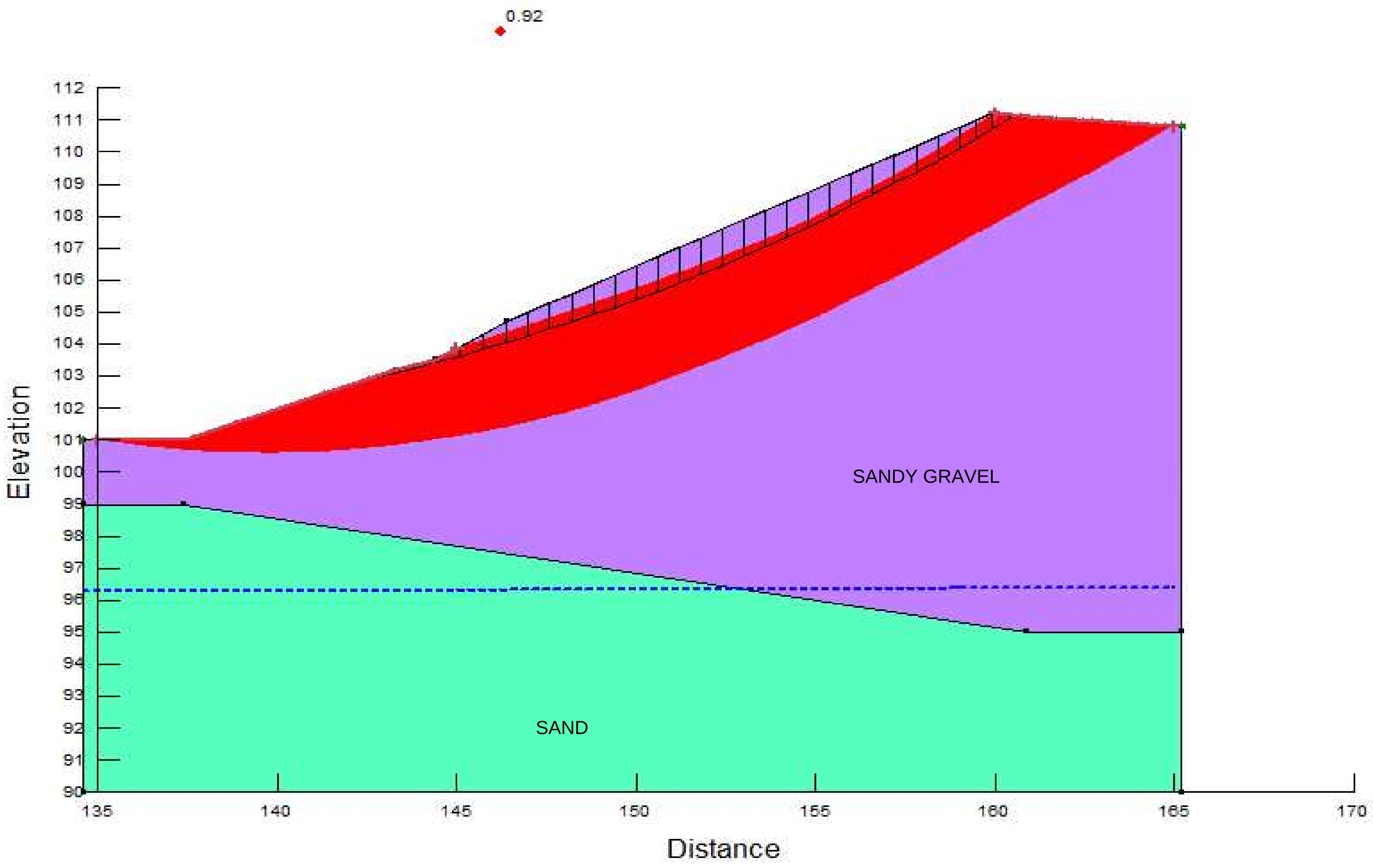
DATE Aug 26, 2022
CLIENT: DRAIN-ALL LTD.
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
DRAWN BY DW
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 15A



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Sand	Mohr-Coulomb	19.8	0	30
🟪	Sandy Gravel	Mohr-Coulomb	22	0	33

Section E-E'

exp.

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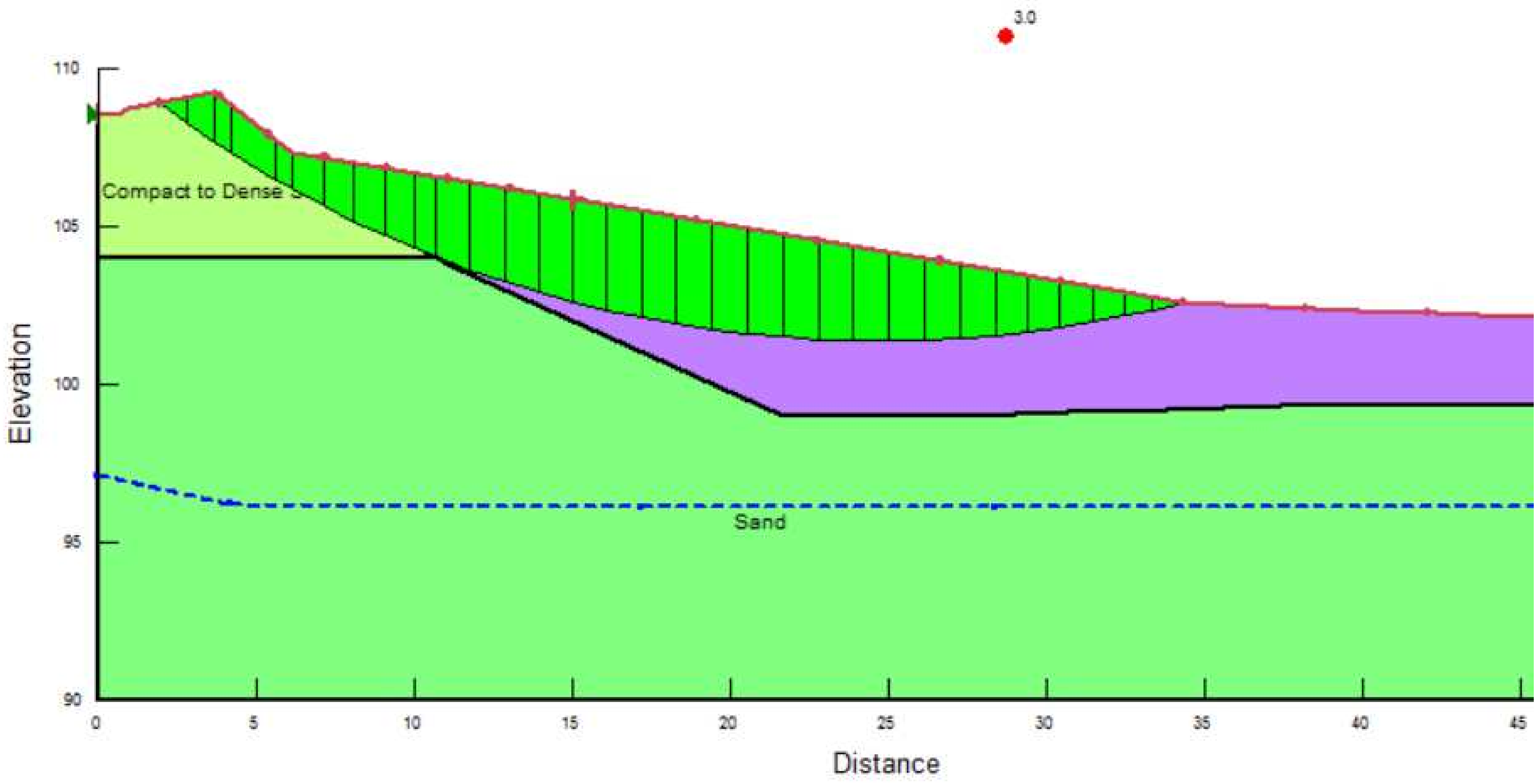
DATE Aug 26, 2022		CLIENT: DRAIN-ALL LTD.	project no. OTT-21023795-A0
DESIGN DW	CHECKED SA	TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS 4380 Trail Road, Ottawa, Ontario	scale Not to scale
DRAWN BY DW			Figure 15B

Re-analysis of Section D-D after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section D-D'

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DESIGN DW
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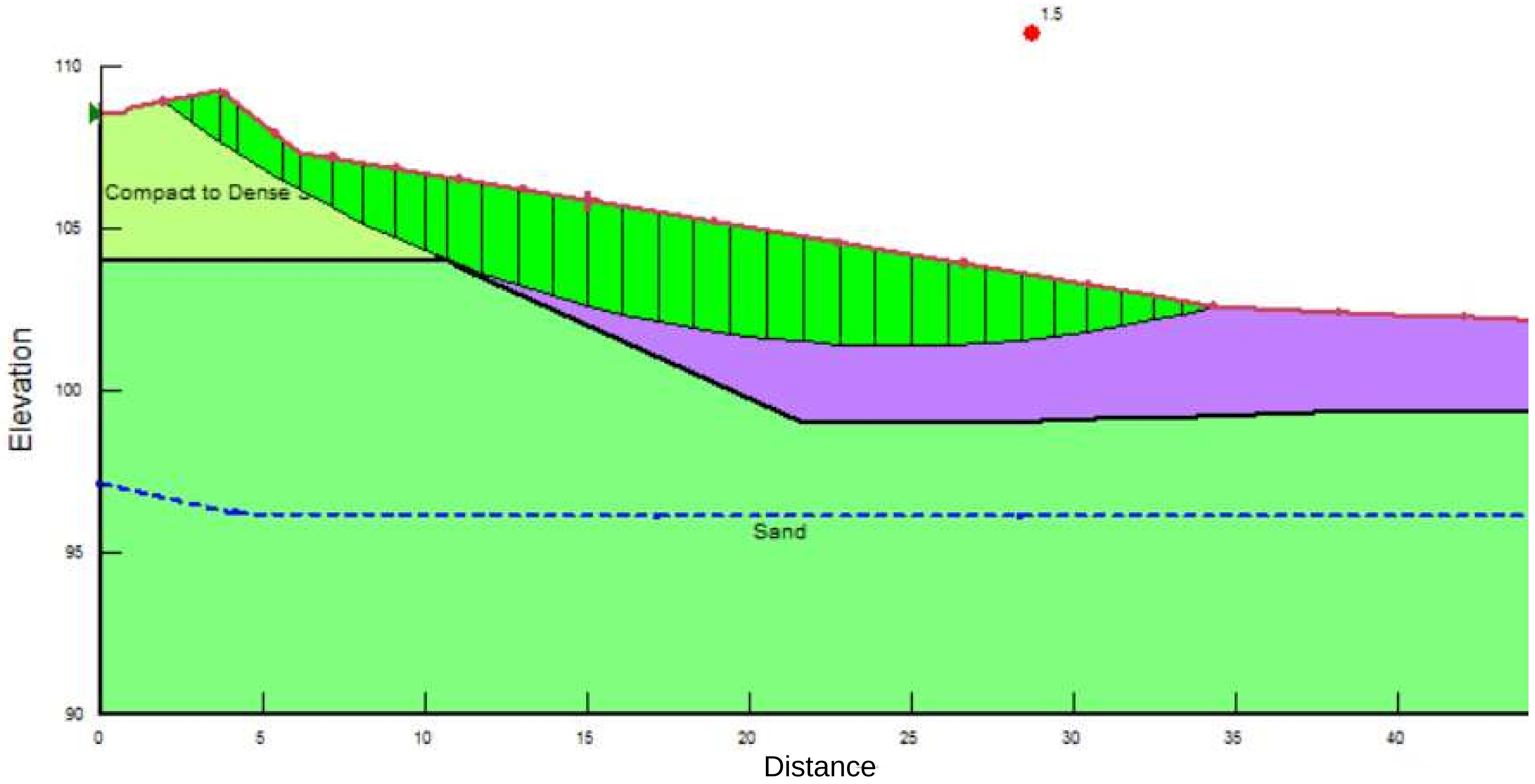
DRAWN BY DW
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 16A

Re-analysis of Section D-D after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section D-D'

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DESIGN DW
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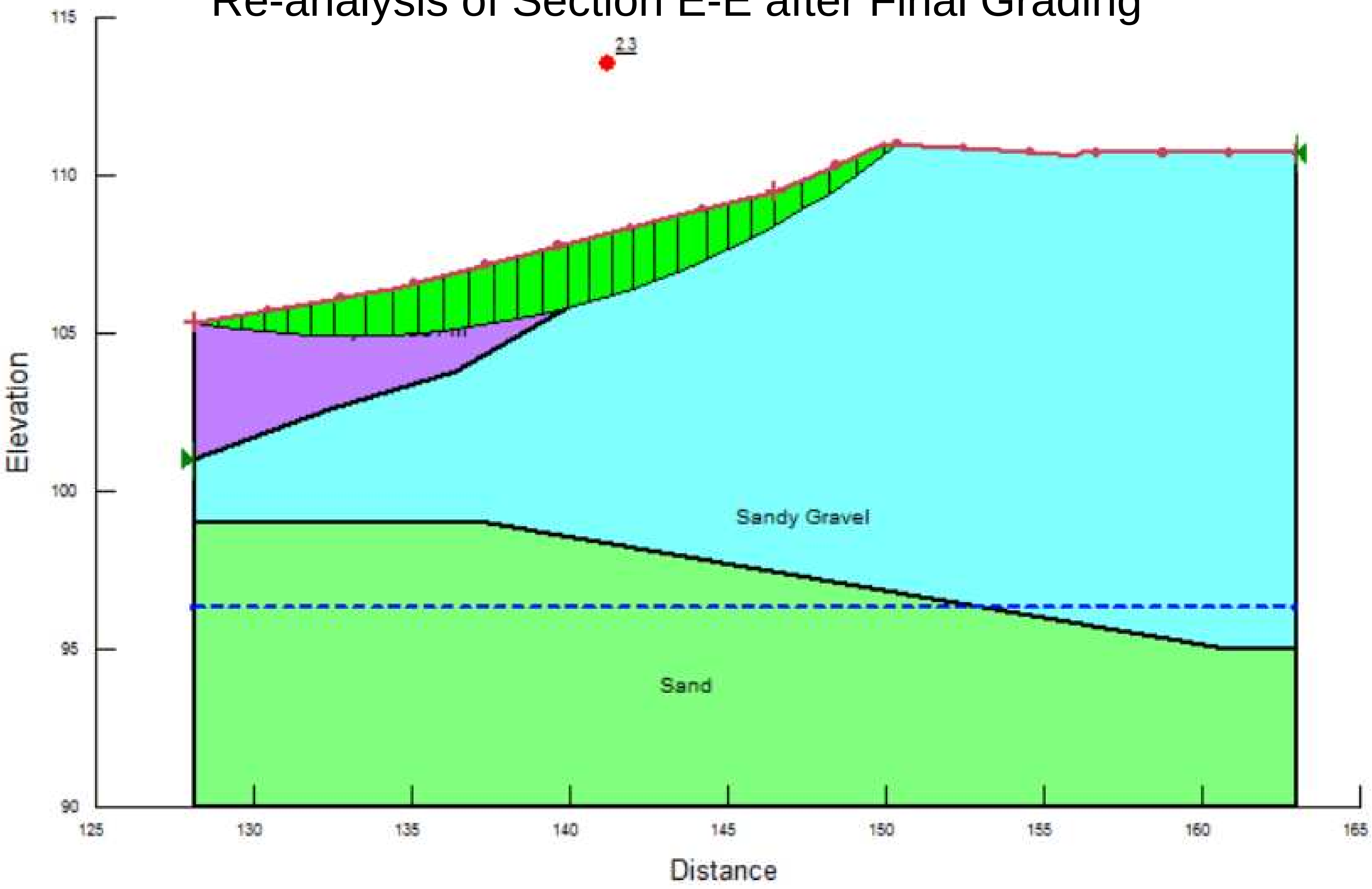
DRAWN BY DW
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 16B

Re-analysis of Section E-E after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section E-E'

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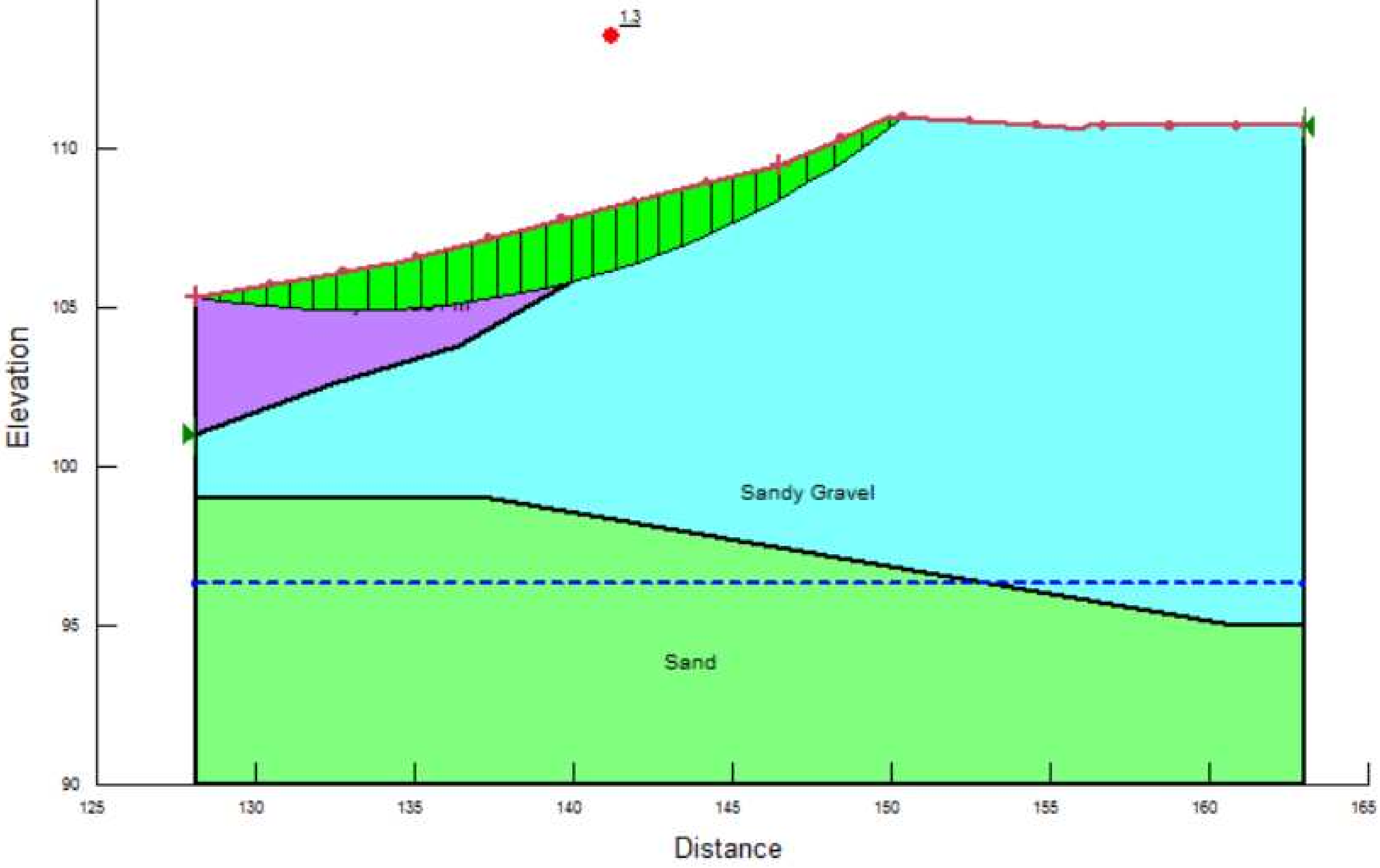
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
DRAWN BY DW
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 17A

Re-analysis of Section E-E after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section E-E'

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DESIGN DW
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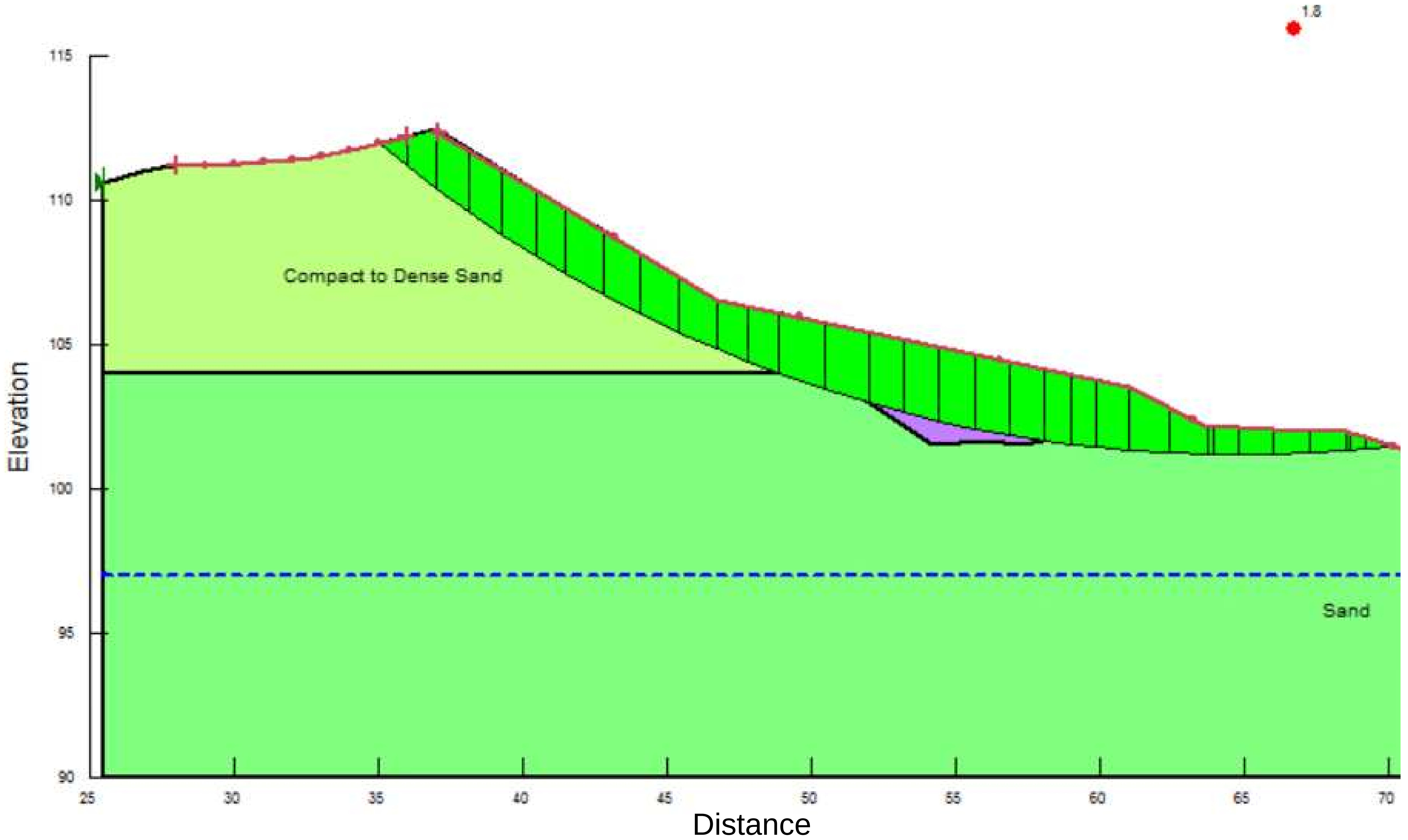
DRAWN BY DW
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 17B

Section X-X' after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section X-X'

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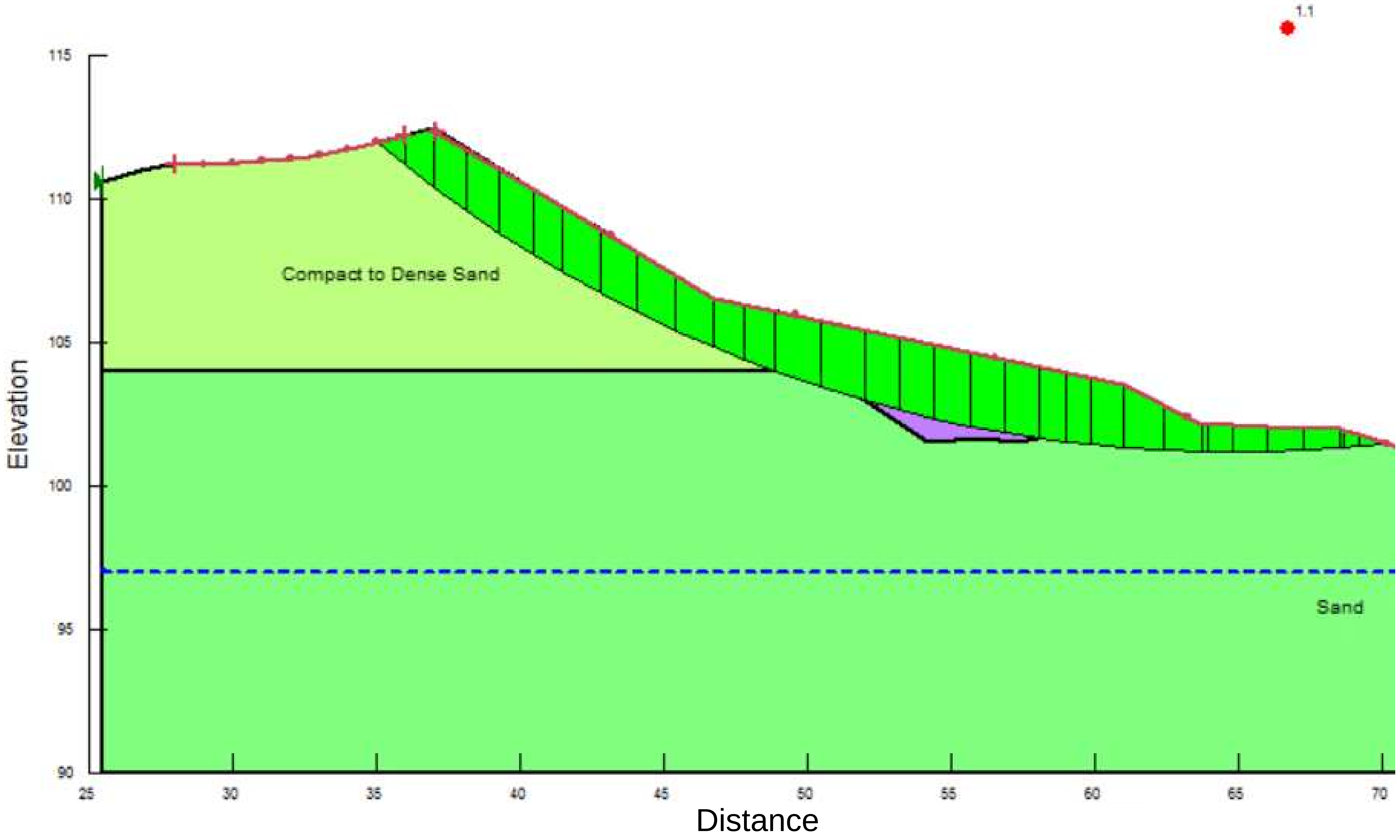
DESIGN DW
CHECKED SA
DRAWN BY DW
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 18A

Section X-X' after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section X-X'

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DESIGN DW
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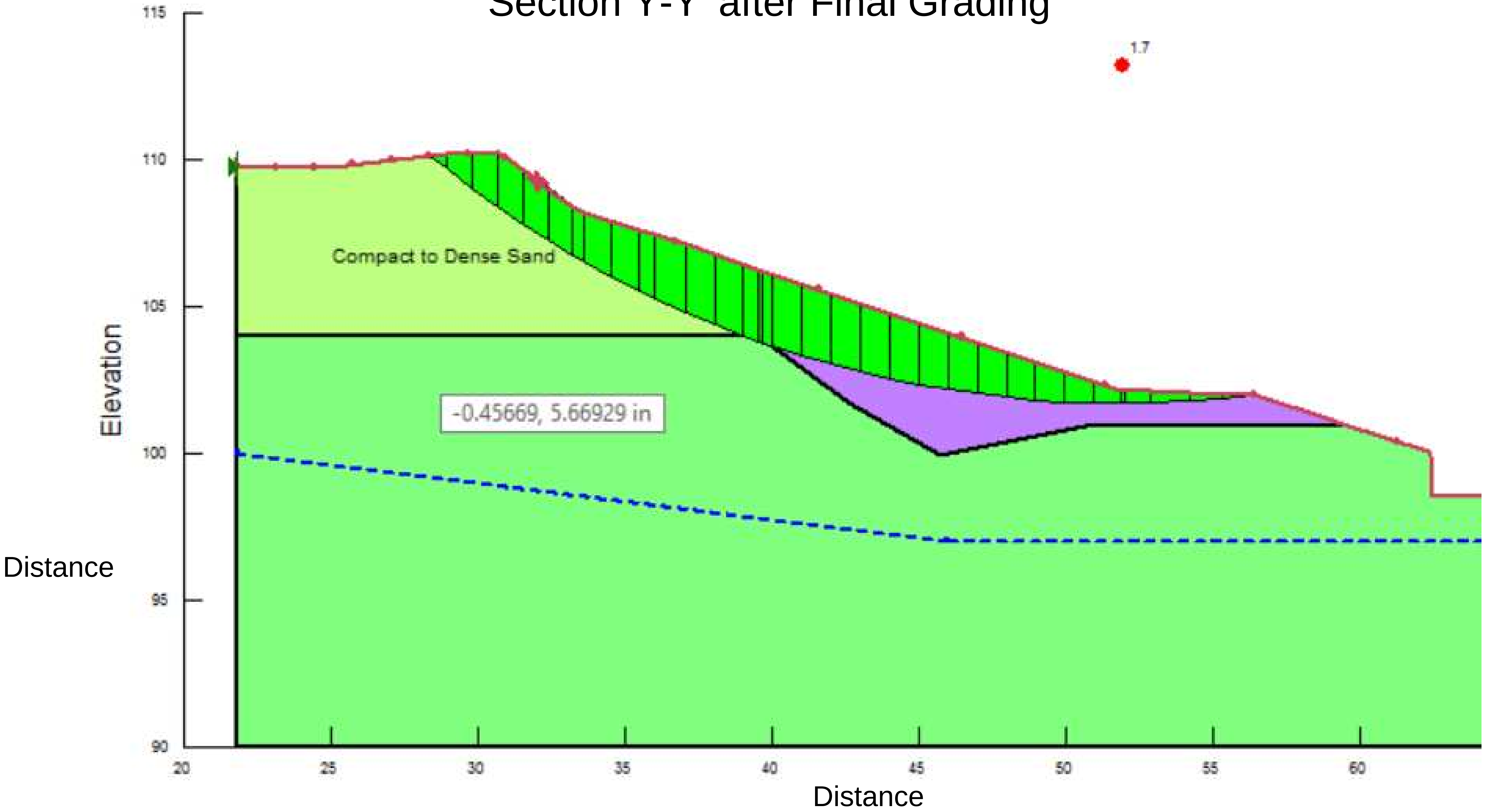
DRAWN BY DW
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 18B

Section Y-Y' after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section Y-Y'

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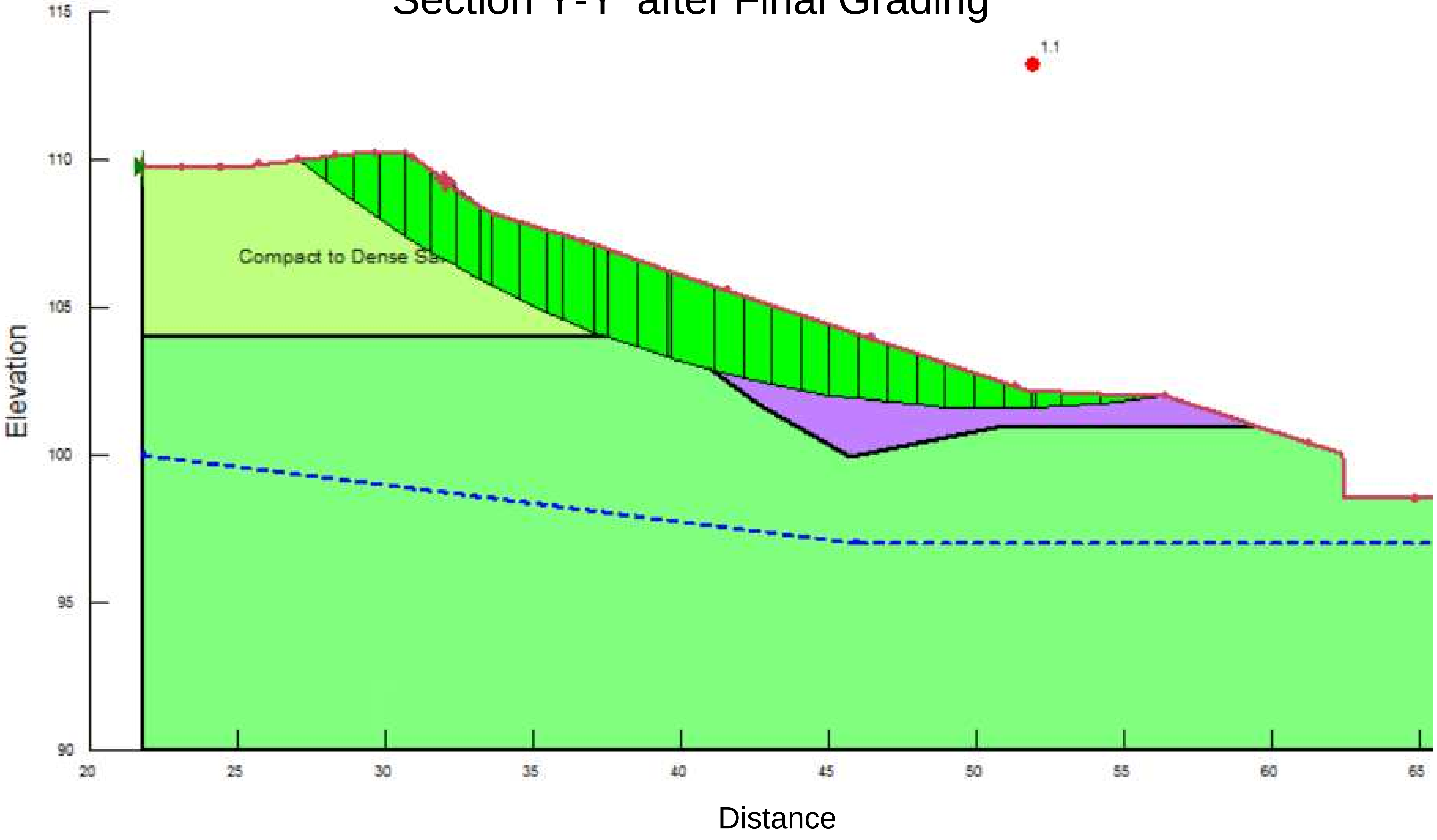
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 19A

Section Y-Y' after Final Grading



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section Y-Y'

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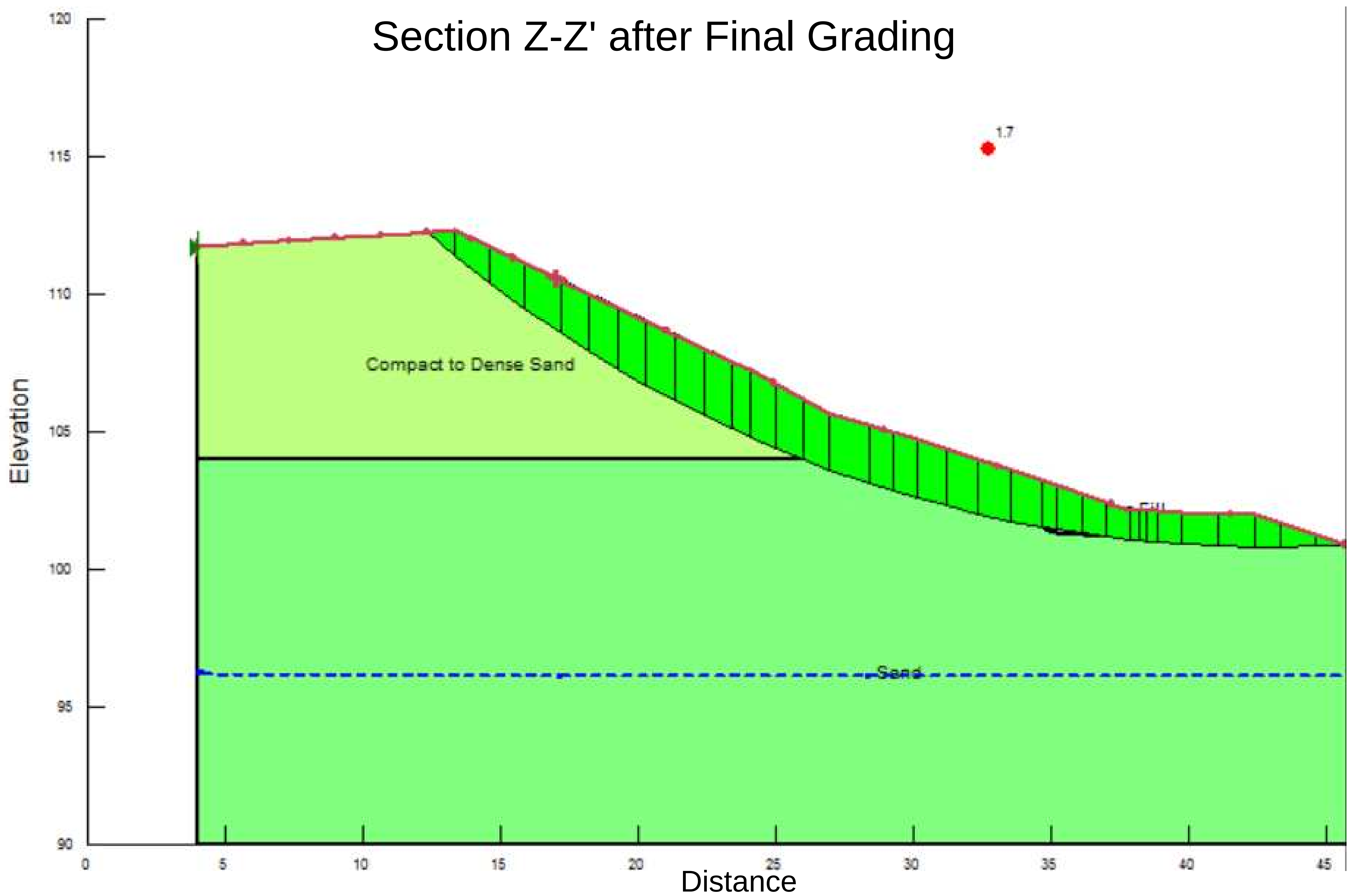
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 19B



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

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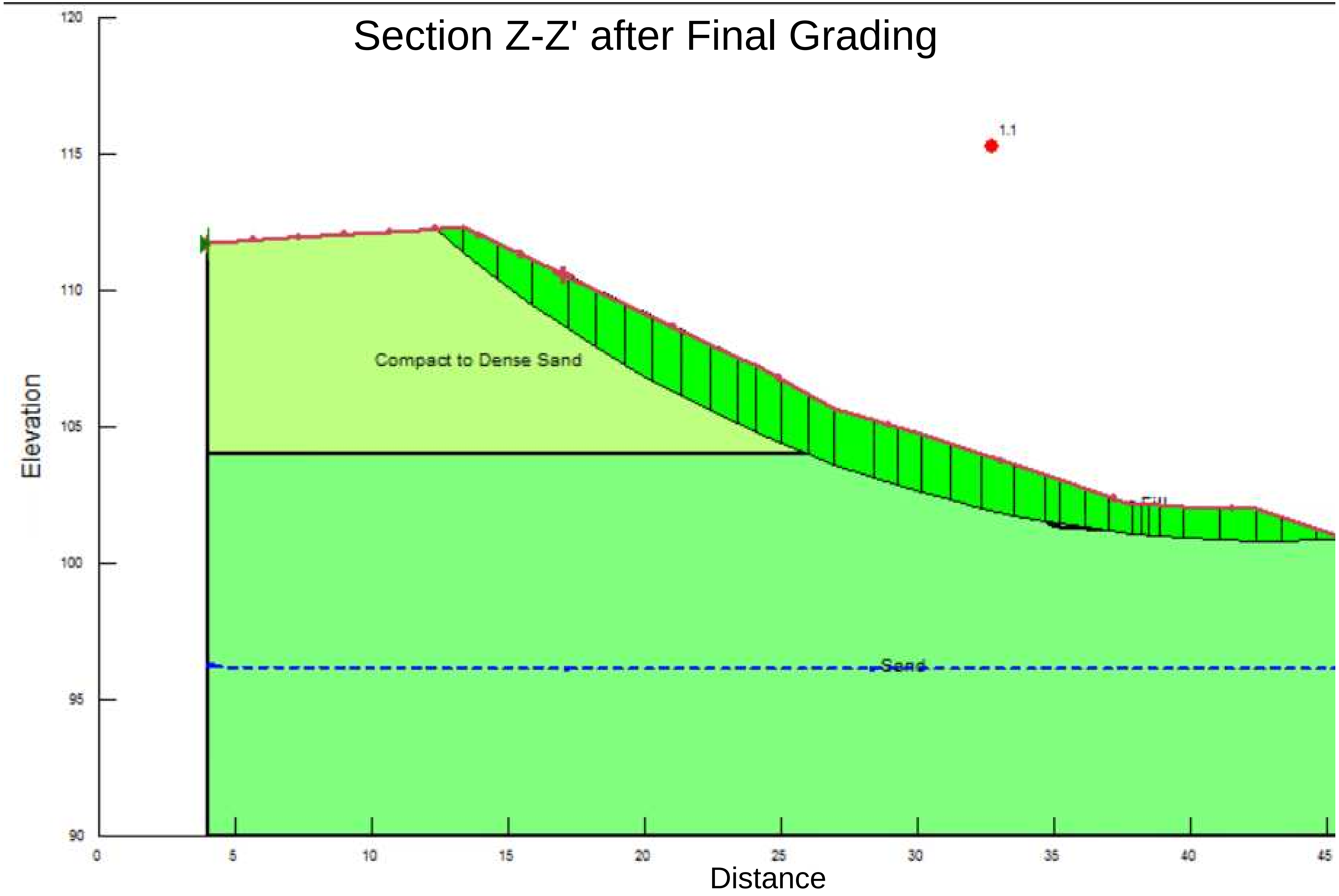
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
DRAWN BY DW
TITLE: STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 20A



Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)
🟩	Compact to Dense Sand	Mohr-Coulomb	19.7	0	31
🟪	HydroVac Fill	Mohr-Coulomb	18	0	27
🟩	Sand	Mohr-Coulomb	19.8	0	30

Section Z-Z'

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DATE Aug 26, 2022
CLIENT: DRAIN-ALL LTD.
project no. OTT-21023795-A0
DESIGN DW
CHECKED SA
DRAWN BY DW
TITLE: PSEUDO-STATIC SLOPE STABILITY ANALYSIS
4380 Trail Road, Ottawa, Ontario
scale Not to scale
Figure 20B

Appendix A: Historical Borehole Logs Used in Slope Stability Analyses

PROJECT: 991-2806

RECORD OF BOREHOLE: BH16A

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: December 14, 1999

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

Gastechtor ppm ⊕ 100 200 300 400; ppm □ 100 200 300 400

HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

BORING METHOD: Power Auger 200mm Diam (Hollow Stem)

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	Ground Surface	113.30 0.00
0	Compact to dense light brown stratified fine SAND, occasional to trace silt,	
9.34	Dense to compact brown to grey fine to medium stratified SAND, occasional coarse sizes, occasional to trace silt	103.96 9.34
35	END OF BOREHOLE	78.25 35.05

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	20
2	50 DO	31
3	50 DO	24
4	50 DO	40
5	50 DO	34
6	50 DO	44
7	50 DO	26
8	50 DO	41
9	50 DO	27
10	CS	-
11	CS	-
12	CS	-

PIEZOMETER OR STANDPIPE INSTALLATION

- Cement Seal
- Native Backfill
- Bentonite Seal
- Native Backfill
- Caved Material
- Bentonite Seal
- Granular Filter
- 38mm PVC #10 Slot Screen #1

Depth scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

DEPTH SCALE
1 : 200

Golder Associates

LOGGED: D.J.S.
CHECKED: AH

BOREHOLE 991-2906.GPJ HYDROGEO.GDT 2/6/01

PROJECT: 011-2929

LOCATION: SEE SITE PLAN

SAMPLER HAMMER, 64kg; DROP, 760mm

RECORD OF BOREHOLE: M107-2

BORING DATE: NOV 12, 2001

SHEET 1 OF 1

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - O: 20 40 60 80

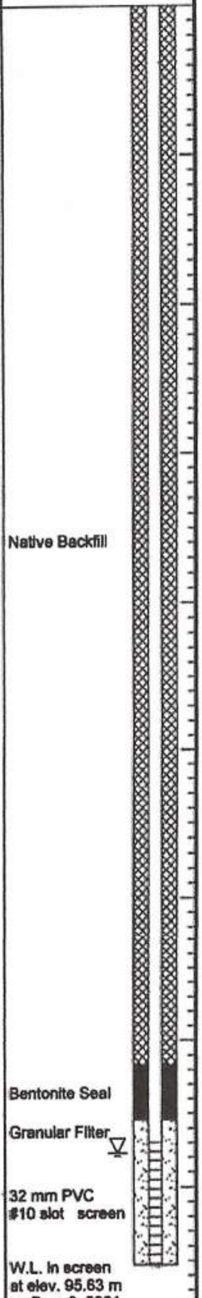
HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl: 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		GROUND SURFACE	111.17			
0	ROTARY DRILLING HW CASING	Brown silty sand, trace gravel (FILL)	0.00	1	50 DO	6
		Brown fine sand, scattered trace gravel (FILL)	0.30 110.26			
		Brown SILTY fine SAND, trace gravel	0.91 109.49			
		Dark brown silty sand TOPSOIL				
2		Compact to dense brown SAND and GRAVEL, occasional cobble and boulder	1.83 108.27			
		Compact brown fine to coarse SAND	2.90 107.36	2	50 DO	5
4 6 8 10 12 14		Brown SAND and GRAVEL, some cobbles, occasional boulder	3.81 95.63			
16		Probably mainly sands, occasional trace of gravel or cobble	15.54 94.11	3	50 DO	37
18 20		END OF BOREHOLE STRATIGRAPHY INFERRED FROM DEEP BOREHOLE	17.08			

PIEZOMETER OR STANDPIPE INSTALLATION



W.L. in screen at elev. 95.63 m on Dec. 3, 2001 (top of pipe at elev. 111.98 m on Nov. 12, 2001)

DEPTH SCALE
1 : 100

Golder Associates

LOGGED: C.A.S.

CHECKED: —

PROJECT: 991-2806

RECORD OF BOREHOLE: M107

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: January 26, 1999

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m
		Ground Surface		111.07			
0	Rotary Drilling HW Casing	Brown silty sand, trace gravel (FILL)					
		Brown fine sand, scattered trace gravel (FILL)		110.16			
		Brown SILTY fine SAND, trace gravel		109.30	1	50 DO	22
		Dark brown silty sand TOPSOIL		1.83			
		Compact to dense brown SAND and GRAVEL, occasional cobble and boulder		108.17 2.90	2	50 DO	19
		Compact brown fine to coarse SAND		107.26 3.81			
5		Brown SAND and GRAVEL, some cobbles, occasional boulder			3	50 DO	85
10							
15		Probably mainly sands, occasional trace of gravel or cobble		95.53 15.54			
20							
25							
30							
35				73.18	4	NQ RC	DD
	Rotary Drilling NQ Core	Slightly weathered grey LIMESTONE BEDROCK, trace calcite and very thin shale interbed END OF BOREHOLE		37.89	5	NQ RC	DD
				71.57 39.50	6	NQ RC	DD
40							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80

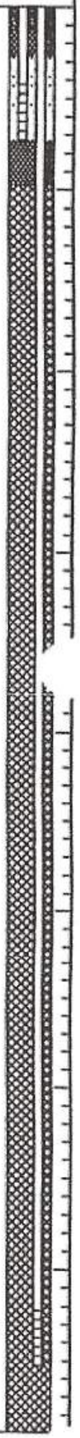
SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DEPTH SCALE
1 : 200

Golder Associates

LOGGED: D.J.S.

CHECKED: AH

BOREHOLE 991-2806.GPJ HYDROGEO.GDT 2 8 01

RECORD OF BOREHOLE: M125-1

SHEET 1 OF 1

PROJECT: 011-2930

LOCATION: See Site Plan

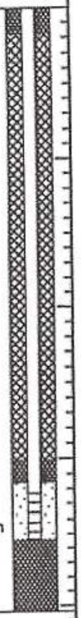
SAMPLER HAMMER, 64kg; DROP, 760mm

BORING DATE: November 20, 2001

DATUM: Geodetic

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		Ground Surface		97.17							
0	POWER AUGER 200 mm Diam. (Hollow Stem)	Loose to dense brown to grey fine SAND, trace silt		0.00	1	50 DO	-				Bentonite Seal ∇
					2	50 DO	8				
5					3	50 DO	4				Native Backfill
					4	50 DO	37				
10					5	50 DO	13				
15					6	50 DO	14				Bentonite Seal Silica Sand 50 mm PVC #10 slot screen A
	ROTARY DRILL NQ Core	Fresh grey LIMESTONE BEDROCK		79.49 17.68	7	NQ RC	DD				Bentonite Seal
					8	NQ RC	DD	T.C.R. (%) 93 S.C.R. (%) 89 R.Q.D. (%) 88			
20		END OF BOREHOLE		76.97 20.20							W.L. in screen at elev. 96.57 m on Dec. 3, 2002 (top of pipe (screen A) at elev. 97.97 m on Jan. 29, 2002)
25											
30											
35											
40											
45											
50											



DEPTH SCALE

1 : 250

Golder Associates

E-324

LOGGED:

CHECKED:

PROJECT: 011-2930

RECORD OF BOREHOLE: M125-2

SHEET 1 OF 1

LOCATION:

BORING DATE: 18 January 2002

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V + Q - ● rem V. ⊕ U - O 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—O^W—⊣ Wl 10 20 30 40	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m				
		Ground Surface		97.16							
0		For stratigraphy refer to record of borehole M125-1		0.00							Bentonite Seal Native Backfill Caved Material 32 mm PVC # 10 slot screen B
5											
		END OF BOREHOLE		89.17 7.99							(top of pipe (screen B) at elev. 98.06 m on Jan. 29, 2002)
10											
15											
20											
25											
30											
35											
40											
45											
50											

BOREHOLE 011-2930.GPJ HYDROGEO.GDT 21/3/02

DEPTH SCALE

1 : 250

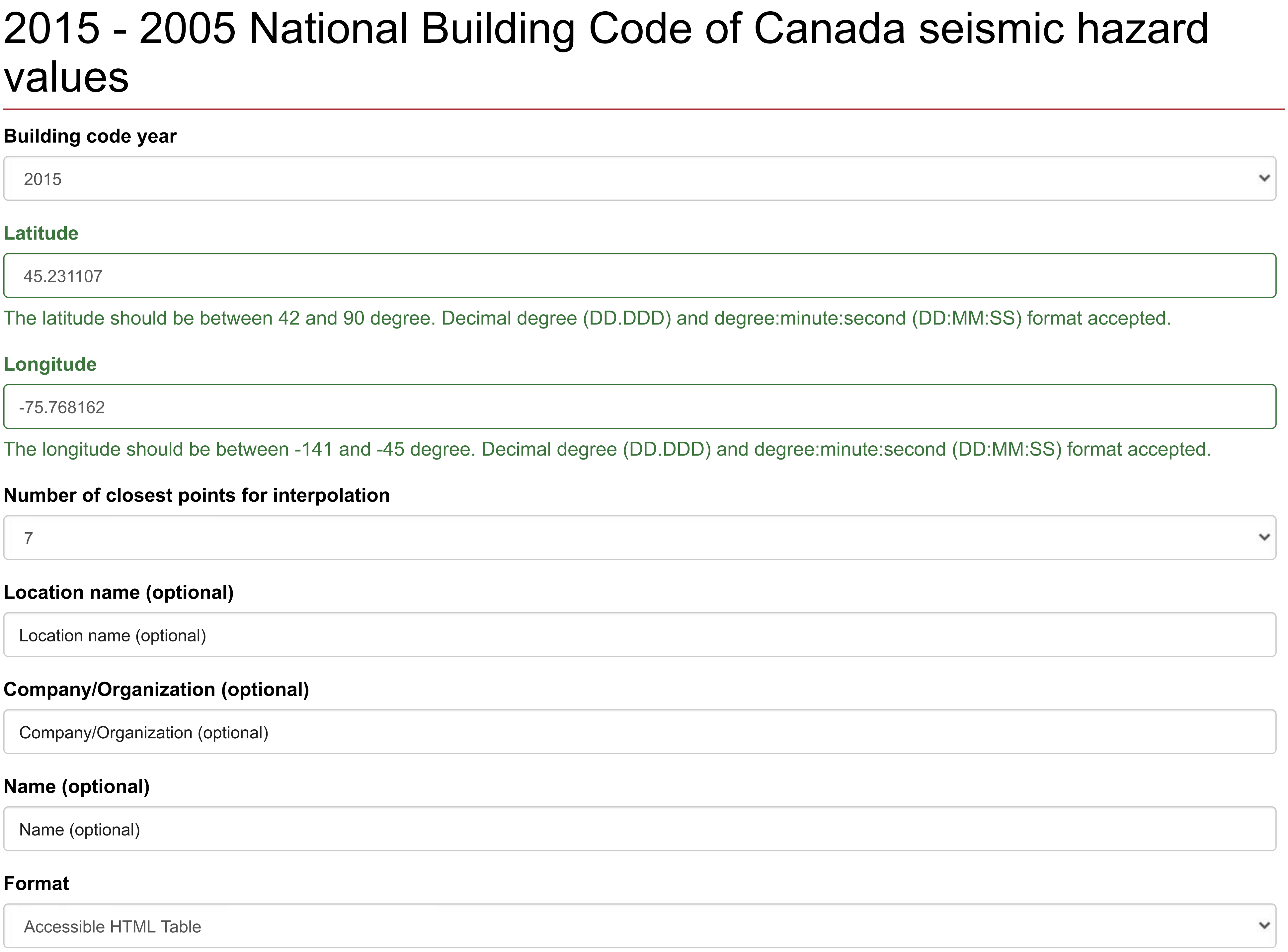
Golder Associates

E-325

LOGGED: D.J.S.

CHECKED:

Appendix B: 2015 National Building Code Seismic Hazard Calculations



2015 - 2005 National Building Code of Canada seismic hazard values

Building code year

2015

Latitude

45.231107

The latitude should be between 42 and 90 degree. Decimal degree (DD.DDD) and degree:minute:second (DD:MM:SS) format accepted.

Longitude

-75.768162

The longitude should be between -141 and -45 degree. Decimal degree (DD.DDD) and degree:minute:second (DD:MM:SS) format accepted.

Number of closest points for interpolation

7

Location name (optional)

Location name (optional)

Company/Organization (optional)

Company/Organization (optional)

Name (optional)

Name (optional)

Format

Accessible HTML Table

Submit

2015 National Building Code interpolated seismic hazard values

Spectral (Sa(T), where T is in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s2). Peak ground velocity is given in m/s. NBCC2015 and S14 values are specified in bold font. Three additional periods are provided – their use is discussed in the NBCC2015 Commentary. These values have been interpolated Using Shepards method from a 10 km spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the calculated values.

Click on the column title to see the map of nearby seismic hazard values and the calculated interpolated value

2%/50 years (0.000404 per annum) probability

Distance	**Latitude**	**Longitude**	**Sa (0.05)**	**Sa (0.1)**	**Sa (0.2)**	**Sa (0.3)**	**Sa (0.5)**	**Sa (1.0)**	**Sa (2.0)**	**Sa (5.0)**	**Sa (10.0)**	**PGA (g)**	**PGV (m/s)**
0.000	45.231	-75.768	0.424	0.497	0.417	0.317	0.225	0.113	0.054	0.014	0.005	0.267	0.187
4.925	45.233	-75.831	0.408	0.480	0.404	0.308	0.219	0.110	0.053	0.014	0.005	0.259	0.182
5.046	45.227	-75.704	0.444	0.519	0.435	0.330	0.234	0.116	0.055	0.015	0.005	0.278	0.194
11.083	45.323	-75.823	0.421	0.495	0.416	0.317	0.225	0.113	0.054	0.014	0.005	0.266	0.187
11.136	45.317	-75.695	0.450	0.526	0.441	0.335	0.237	0.118	0.056	0.015	0.005	0.282	0.196
11.250	45.138	-75.712	0.433	0.506	0.424	0.322	0.228	0.114	0.054	0.014	0.005	0.271	0.189
11.261	45.143	-75.839	0.390	0.461	0.389	0.297	0.212	0.107	0.052	0.014	0.005	0.249	0.177
14.892	45.239	-75.958	0.384	0.454	0.382	0.291	0.209	0.106	0.051	0.014	0.005	0.245	0.174

* The requested site is highlighted in blue