

Foundation Investigation and Design Report

Bradford Bypass – West Contract – 10th Sideroad
Stormwater Management Pond
G.W.P.2026-23-00

Ministry of Transportation Ontario

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PART A – FOUNDATION INVESTIGATION REPORT

Bradford Bypass – West Contract - 10th Sideroad Stormwater Management Pond

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for

Ministry of Transportation Ontario

GEOCRES No: 31D04-028

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1. Introduction

AECOM Canada ULC (AECOM) has been retained by the Ministry of Transportation Ontario (MTO) to undertake a foundation investigation for the proposed Bradford Bypass Project (BBP), West Contract, located in the County of Simcoe and Regional Municipality of York, Ontario. The entire new BBP freeway is a 16.3 km rural controlled access highway connecting Highway 400 to Highway 404. The West Contract is the western section of the project starting at Highway 400 and roughly ending 1.0 km east of County Road 4.

This Part A of the report provides a summary of the findings from the foundation investigation carried out for detailed design of the proposed Stormwater Management Pond (SWMP) located on the 10th Sideroad and new BBP highway interchange and is also designated SWMP 2 for the purpose of this report. The location of the proposed SWMP 2 and the boreholes completed for this report is shown and displayed in **Appendix A**.

2. Site Description

The surrounding land use of the site is generally agricultural and rural, with scattered residential dwellings, utility corridors, and localized commercial and industrial development near major intersections. The site at the location of the proposed SWMP 2 is vegetated and generally sloped towards the south direction with highest elevations being near 284.2 meters above sea level (mASL) and lowest at 280.9 mASL based on reviewed Google Earth images and surveyed borehole data. Site photographs for the proposed SWMP 2 captured during the field investigation are included in **Appendix D** for reference.

As part of the pre-mobilization activities for this subsurface investigation, underground utility locate requests at each proposed borehole location were completed by AECOM. AECOM completed an Ontario 1 Call public utility locate request and retained a private utility locates subcontractor to clear all proposed borehole locations of buried utilities including Hydro One, Enbridge Gas, and other utilities. The only identified underground infrastructure within the project limits is a municipal watermain owned by the Town of Bradford West Gwillimbury. It is our understanding that this watermain will be relocated as part of the BBP.

Overhead hydro and telecommunication lines were observed running parallel to 10th Sideroad and close to a nearby access route. No other buried utilities including gas mains, telecommunication cables, or sanitary sewers, were identified within the proposed borehole areas.

3. Investigation Procedures

The foundation investigation for this proposed SWMP 2 consisted of a desktop study, reviewing available historical data, followed by a field exploration program based on the findings from the desktop study in accordance with the MTO Guideline for Foundation Engineering Services, Version 3.0 (April 2022). The desktop study gathered available geotechnical and geological data from several publicly available databases, such as the Ministry of the Environment, Conservation and Parks (MECP) well records, MTO's GEOCREs database, and other geological databases.

3.1 MTO's GEOCREs Database

A search of the GEOCREs library identified one (1) foundation investigation report, *Preliminary Foundation Investigation and Design Report – 10th Sideroad Underpass, prepared by WSP Golder (September 18, 2023) GEOCREs No. 31D-814*, available near the project site.

In summary, this investigation outlined ground conditions, generally in line with the published information: variable fill underlain by thick cohesive soils (clayey silt, silty clay and clayey silt till), overlaying silty sand till. Groundwater conditions are typically shallow, with perched levels in fills and seasonal fluctuation expected.

3.2 Subsurface Investigation Procedures

The field work for the proposed SWMP 2 was carried out between September 4th and September 9th, 2024, and included the advancement of four (4) total boreholes located at and/or near the proposed pond.

The above noted four (4) boreholes were drilled by utilizing a truck-mounted drill rig outfitted with hollow stem continuous flight augers. All four (4) boreholes were advanced and terminated at a depth of 9.8 meters below the existing ground surface (mBGS).

Soil samples were obtained at regular intervals using a 50 mm split spoon sampler driven with an automatic hammer in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). The split spoon samplers used in the investigation limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions.

In situ testing using Standard Penetration Test (SPT) was carried out at 0.25 m intervals to full depths of the boreholes of 9.8 m. MTO Field Vane testing could not be carried out and Shelby tubes were not obtained because the soils at the site were mostly non-cohesive or exhibited very low plasticity.

The recovered samples from the borehole investigation were identified in the field, placed in labelled containers, and transported to AECOM's Etobicoke laboratory for further Visual Identification (VI) examination and testing. Selected soil samples were subjected to classification tests, including water content determinations, grain size distribution analyses and Atterberg limits determinations. The results of the testing are shown on the Record of Borehole logs provided in **Appendix B**, and on the figures included in Laboratory Test Results, **Appendix C**.

In-situ groundwater levels were measured in the open boreholes prior to backfilling, and subsequently in the monitoring wells installed in three (3) of the four (4) boreholes, namely Boreholes SWMP10-01-MW, SWMP10-02-MW, and SWMP10-03-MW.

The field work was supervised on a full-time basis by a member of AECOM who marked and staked the location of boreholes in the field, supervised the clearance of underground utilities, directed the sampling and testing of all

samples in the field, and logged the boreholes. All laboratory tests were carried out in general accordance with MTO and/or ASTM Standards, as applicable.

All boreholes (excluding ones with monitoring wells installed) were backfilled with a bentonite mixture upon completion of field work in general accordance with Ontario Regulation 903 (as amended) and the ground surface was restored to near original condition as practicable. No monitoring wells have been decommissioned at the time of writing this report, and at least one monitoring well will be retained on site for construction-phase monitoring. Any monitoring wells to be decommissioned, shall be decommissioned in general accordance with Ontario Regulation 903 (as amended).

The borehole locations were surveyed in the field, positioned relative to MTM NAD 83 (Zone 10) northing and easting co-ordinates and ground elevation were referenced by Callon-Dietz Surveyors, an Ontario Land Surveyor to Geodetic datum (CGVD28 datum).

The borehole identifications including their depths, geodetic co-ordinates and elevations are summarized below in **Table 1**. The location of the boreholes is also shown on the Borehole Location Plans, provided in **Appendix A** for reference.

Table 1: Current Foundation Investigation Boreholes

Borehole ID	MTM NAD 83 Zone 10 Co-ordinates		Latitude (°)	Longitude (°)	Ground Surface (mASL)	Depth (mBGS)
	Northing	Easting				
SWMP10-01-MW	4886945	296137	44.122448	-79.608242	280.9	9.8
SWMP10-02-MW	4886993	296136	44.122880	-79.608256	282.6	9.8
SWMP10-03-MW	4886970	296077	44.122672	-79.608992	284.2	9.8
SWMP10-04	4886970	296105	44.122673	-79.608643	283.0	9.8

Notes: mASL – metres above mean sea level
mBGS – meters below existing ground surface

4. Site Geology and Stratigraphy

4.1 Regional Geological Conditions

The site is located within the Simcoe Lowlands physiographic region of southern Ontario, near the transition zone to the Peterborough Drumlin Field and the Schomberg Clay Plains (The Physiography of Southern Ontario, Chapman and Putnam, 3rd Edition, 1984). This region is characterized by streamlined, elongate hills composed of dense glacial till (drumlins), formed beneath a moving ice sheet. These drumlins are often overlain by stratified glaciolacustrine deposits, primarily associated with the post-glacial Lake Algonquin.

In low-lying areas between drumlins, fine-textured lacustrine silts, clays, and fine sands have been deposited, often reaching significant thicknesses. Although these soils typically contain a high proportion of clay-sized particles, the overall behaviour of the soil mass is more like a silt. When saturated, the soil becomes very slippery, while in a drier state it is powdery and friable. Organic deposits such as peat may also be present in depressions or former meltwater channels.

According to the Bedrock Geology of Ontario, Southern Sheet (Map 2544), published by the Ontario Ministry of Northern Development and Mines, the underlying bedrock along the site comprises Ordovician-age units, including the Shadow Lake Formation (sandstone, conglomerate, and shale) and various limestones and dolostones of the Simcoe Group (e.g., Gull River, Bobcaygeon, and Verulam formations). In parts of the corridor, younger shale-dominated units of the Blue Mountain and Collingwood formations may also be present.

Further, the Bedrock Topography of the Alliston Area (Map P.3213) indicates that the bedrock surface depth in the region varies from approximately 130 m to 160 m below the existing ground surface, confirming the presence of a thick overburden layer.

4.2 Summarized Subsurface Conditions

This section provides a general description of the major soil types encountered during AECOM's subsurface investigation carried out at the proposed SWMP 2 site. It should be noted that the boundaries between the strata have been inferred from drilling observations and non-continuous samples. They generally represent a transition from one soil type to another and should not be inferred to represent exact planes of geological change. The subsurface conditions will vary between and beyond the borehole locations.

The subsurface soil and groundwater conditions encountered in the boreholes, and the results of the field and laboratory testing, are shown in **Appendix B**. A list of abbreviations and symbols are provided in **Appendix B**. The geotechnical laboratory test results are included in **Appendix C**.

4.2.1 Topsoil

Topsoil was encountered at the existing ground surface in boreholes SWMP10-02-MW and SWMP10-04. The thickness of the topsoil was 120 mm in both boreholes. It was generally brown in colour and recovered in a moist state. The topsoil thickness may differ beyond the areas where the boreholes were drilled. Some of the variations in topsoil thickness could be attributed to prior agricultural and earthwork activities conducted at the site.

4.2.2 Fill

Surficial fill, consisting of sand with traces of gravel was encountered in borehole SWMP10-01-MW, and extended to a depth of 0.4 mBGS (Elev. 280.6 mASL). The fill layer was described as brown in colour and recovered in a moist state with a moisture content value of approximately 14%.

The SPT N-value for the surficial fill was 3 blows per 305 mm of penetration, indicating a very loose relative density.

4.2.3 Clayey Silt

A cohesive layer of clayey silt, trace sand was encountered in borehole SWMP10-02-MW below the topsoil. This layer was encountered at a depth of 0.1 mBGS (Elev. 282.5 mASL) and extended to 1.5 mBGS (Elev. 281.1 mASL). The clayey silt was brown in colour and recovered in a moist state with a moisture content value of 7%.

The SPT N-values conducted within this layer ranged from 5 to 7 blows per 305 mm of penetration indicating a firm consistency.

4.2.4 Sandy Silt / Silt

A non-cohesive soil deposit, generally described as sandy silt to silt, trace gravel, some clay was encountered in boreholes SWMP10-01-MW, SWMP-10-03-MW, and SWMP10-04. This layer was encountered at depths of 0.1 mBGS (Elev. 283.4 mASL) to 0.8 mBGS (Elev. 280.6 mASL) and extended to depths of 1.5 mBGS (Elev. 281.9 mASL) and 2.3 mBGS (Elev. 279.4 mASL). This layer was brown in colour and recovered in a moist state with moisture content values ranging from 7% to 14%.

The SPT N-values conducted within this layer ranged from 7 to over 100 blows per 305 mm of penetration indicating a loose to very dense relative density.

One grain size distribution test was performed on a select sample, and the tests indicated the following grain size distribution values as shown in **Table 2**.

Table 2: Grain Size Analysis for Sandy Silt

Borehole ID	Sample ID	Sample Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
SWMP10-03-MW	SS-2	0.8 – 1.4	2	34	48	16

The Atterberg limits testing information for the silt is shown **Table 3**.

Table 3: Atterberg Limits Summary for Silt

Borehole ID	Sample ID	Sample Depth (m)	Atterberg Limits			Behaviour
			Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	
SWMP10-04-MW	SS-2	0.8 – 1.4	18	14	4	CL-ML

4.2.5 Sand

A layer of sand with traces of silt was found at the surface in borehole SWMP10-03-MW. This layer was encountered at a depth of 0.0 mBGS (Elev. 284.2 mASL) and extended to 0.8 mBGS (283.4 mASL). This layer was brown in colour and recovered in a moist state.

The SPT N-value conducted within this layer was 11 blows per 305 mm of penetration indicating a compact relative density.

4.2.6 Silty Sand / Sandy Silt / Sand (Till)

A layer of silty sand/sandy silt/sand (till) with trace to some clay, trace gravel, trace cobbles and/or boulders was encountered in all the boreholes. This layer was encountered at depths of 1.5 mBGS (Elev. 281.1 mASL) to 4.6 mBGS (276.4 mASL) and extended to termination depths of 9.8 mBGS (Elev. 271.2 mASL). This layer was brown to grey in colour and recovered in a moist state with moisture content values ranging from 6% to 16%.

The SPT N-values conducted within this layer ranged from 24 to over 100 blows per 305 mm of penetration indicating a compact to very dense relative density, generally very dense.

Eleven (11) grain size distribution tests were performed on select samples and the tests indicated the following grain size distribution values as shown in **Table 4**.

Table 4: Grain Size Analysis for Silty Sand/ Sandy Silt/Sand (Till)

Borehole ID	Sample ID	Sample Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
SWMP10-01-MW	SS-3	1.5 – 2.1	15	62	23	
SWMP10-01-MW	SS-5	3.1 – 3.7	1	68	31	
SWMP10-01-MW	SS-7	4.6 – 5.2	1	75	20	4
SWMP10-01-MW	SS-11	7.6 – 8.2	2	58	31	9
SWMP10-02MW	SS-3	1.5 – 2.1	1	42	42	15
SWMP10-02-MW	SS-7	4.6 – 5.2	1	48	43	8
SWMP10-02-MW	SS-12	8.4 – 9.0	1	57	31	11
SWMP10-03-MW	SS-4	2.3 – 2.9	3	62	35	
SWMP10-03-MW	SS-8	5.4 – 6.0	1	60	29	10
SWMP10-03-MW	SS-12	8.4 – 9.0	3	62	26	9
SWMP10-04-MW	SS-8	5.4 – 6.0	2	70	28	

The Atterberg limits testing information for the sandy silt (till) is shown in **Table 5**.

Table 5: Atterberg Limits Summary for Sandy Silt (Till)

Borehole ID	Sample ID	Sample Depth (m)	Atterberg Limits			Behaviour
			Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	
SWMP10-02-MW	SS-3	1.5 – 2.1	16	12	4	CL-ML

4.3 Groundwater Conditions

Groundwater observations in the open boreholes and the standpipe monitoring well piezometers installed at the site are presented in the table below for reference. A total of six (6) monitoring readings were conducted from November 2024 to June 2025, indicating fluctuating groundwater depths. Localized artesian conditions were observed and recorded in SWMP10-01-MW at a depth of 0.11 m above the ground level (2025/04/04).

Table 6 below summarizes the data obtained from the six (6) monitoring rounds of readings undertaken at the time of this report.

Table 6: Summary of Groundwater Monitoring Readings

Borehole ID	2024/09/06 - 2024/09/09 (mBGS)	2024/11/30 (mBGS)	2025/01/15 (mBGS)	2025/03/27 (mBGS)	2025/04/04 (mBGS)	2025/04/15 (mBGS)	2025/06/06 (mBGS)
SWMP10-01-MW	4.50	1.75	0.98	0.88	-0.11	0.15	0.53
SWMP10-02-MW	-	3.25	2.29	1.13	-	1.00	1.70
SWMP10-03-MW	-	4.90	3.71	1.89	1.37	1.48	2.70
SWMP10-04	3.23	-	-	-	-	-	-

As described above, artesian conditions were recorded in the monitoring well installed borehole SWMP10-01-MW. The hydraulic head above the ground surface was 0.11 m on April 4, 2025, subsiding to 0.15 mBGS on the April 15, 2025, monitoring reading.

The groundwater conditions described in this report refer only to those observed at the place and time of observation noted in the report. These levels and conditions may vary locally due to seasonal fluctuations; groundwater regimes encountered at the site during construction or as a consequence of construction activities at the site or adjacent lands. Further discussion on groundwater conditions may be found in the hydrogeological report prepared for this project, under a separate cover.

5. Foundation Investigation Report Closure

The field work drilling was carried out by Pontil Drilling Ltd. and Landshark Group under the full-time supervision of Mr. A. Ben Mahmoud, EIT, and overall direction of B. Goddard, P.Eng.

This Foundation Investigation Report was prepared by Behnoosh Honarvar Sedighian. Technical and quality reviews were carried out by Senior Geotechnical Engineers, Amer Mohammad, P.Eng., Taesang Ahn, Ph.D., P.Eng. and AECOM's Geotechnical Lead Ontario, and Carlos Nascimento, P.Eng., the Designated MTO Foundations Contact for this project.

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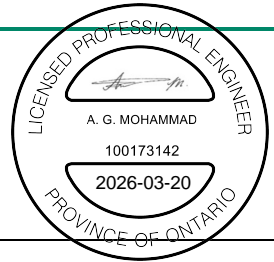


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PART B – FOUNDATION DESIGN REPORT

Bradford Bypass – West Contract - 10th Sideroad Stormwater Management Pond

G.W.P.2026-23-00

For

Ministry of Transportation Ontario

GEOCREs No: 31D04-028

Latitude: 44.122006°

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6. Discussion and Engineering Recommendations

6.1 General

This section of the report provides foundation recommendations in support of the detailed design and construction of the proposed SWMP 2 located southwest of the proposed BBP and 10th Sideroad interchange.

The input provided herein is based on the interpretation of the factual data obtained from the boreholes completed for this current subsurface investigation which have been developed in accordance with the Canadian Highway Bridge Design Code (CHBDC), CSA S6:19 and the MTO Guideline for Foundation Engineering Services (April 2022).

This report has been prepared for the Ministry of Transportation Ontario (MTO) and AECOM's design team. The recommendations and discussions herein are not intended for use by other parties, including contractors. Contractors should undertake their own assessment of the factual data provided in Part A – Foundation Investigation Report (FIR). The discussions and recommendations presented in this report are intended to assist the designers with sufficient information that would enable them to proceed with the detailed design of the proposed SWMP 2 foundations.

Construction comments made herein are based on geotechnical considerations only and should not be relied upon without further independent assessment and qualification in the selection of means and methods for construction. In addition, comments related to construction are provided solely to highlight considerations that may influence design and are not intended to be construed as construction methodology recommendations.

6.2 Project Understanding

Based on the latest design drawing (SWM Ponds Plan Details) provided by the AECOM design team which is included in **Appendix E** and summarized in Table 7, the proposed SWMP 2 is to be constructed at the southwest quadrant of the proposed BBP and the 10th Sideroad interchange. The pond will provide stormwater quantity and quality control for an estimated drainage area of 6.2 hectare (ha).

Based on a review of the drawing, the SWMP 2 will have a bottom of permanent pool level near Elev. 277.3 mASL, which includes an approximate maximum cut depth of 8.7 m from a ground surface elevation near Elev. 286.0 mASL. The top of permanent pool elevation (designated stable water level) is near Elev. 278.3mASL for a pool water depth of 1.0 m.

The side slopes for the SWMP 2 will have a slope of 4H:1V from the pond base to the top of attenuation zone (Elev. 279.0 mASL) for a depth of 1.7 m, therefore, this slope will extend through the top of permanent pool (Elev. 278.3 mASL), top of extended detention (Elev. 278.7 mASL), and top of attenuation (Elev. 279.0 mASL) zones. A side slope transition to a 3H:1V will then occur from the top of attenuation (Elev. 279.0 mASL) zone to the top of freeboard (Elev. 279.3 mASL) for a depth of 0.3 m, matching the final grades.

Table 7: SWMP 2 General Arrangements

SWMP Pond	Bottom of Permanent Pool Elevation (mASL)	Top of Permanent Pool Elevation (mASL)	Top of Extended Detention Elevation (mASL)	Top of Attenuation Zone Elevation (mASL)	Top of Freeboard Elevation (mASL)	Side Slopes	Approximate Maximum Cut Depth (m)
SWMP 2	277.3	278.3	278.7	279.0	279.3	4H:1V to 3H:1V	8.7

6.3 Storm Water Management Pond Design Considerations

6.3.1 Engineering Parameters

A geotechnical model was developed based on the subsurface conditions described in Part A of this report. The selected soil parameters represent average values determined from the interpreted borehole data and laboratory test results.

The model supports the following criteria:

- Assessment of global slope stability for the SWMP 2 cut slopes, seismic and rapid drawdown conditions and pond bases;
- Minimum traffic surcharge load of 16 kPa included in the design where traffic loading or other surface loads may occur near the pond edges or adjacent slopes;
- Estimation of hydraulic conductivities of the native soils at the SWMP 2 site;
- Assessment of the requirement for provision of pond liner and respective installation recommendations; and,
- Basal stability of the pond base.

The selected soil stratigraphy and corresponding engineering parameters are presented on the relevant global stability analyses results in **Appendix F**.

6.3.2 Seismic Design

Seismic hazard values for this site have been derived from the 6th Generation Seismic Hazard Maps, developed by the Geological Survey of Canada (GSC) and referenced in the 2020 edition of the National Building Code of Canada (NBC 2020).

Based on available subsurface data, the deep borehole drilled at the site and in accordance with CHBDC Table 4.1 of CSA S6-19, the site is classified as Site Class 'D', representative of "stiff soil" for the purpose of a slope stability check. Further comments are provided in the following section 6.3.3 of this report.

6.3.3 Consequence Classification and Site Understanding

It is inferred that the proposed SWMP 2 will have "typical consequence levels" associated with exceeding limit states design according with Clause 6.5 and Table 6.1 of the CHBDC. Therefore, a consequence factor, Ψ , of 1.0 should be used in the foundations design.

In view of the level of site investigations completed, the site understanding is classified as “typical degree of site and prediction model understanding”. Therefore, the appropriate ultimate geotechnical resistance factors (Φ) for Table 6.2 of the CHBDC was used to assess the global stability design of the pond.

The table below summarizes the spectral acceleration values for use in stability analysis:

Table 8: Seismic Hazard Values for Site Class D (NBC 2020)

Return Period (Years)	PGA (g)	PGV (m/s)	Sa (0.2s) (g)	Sa (0.5s) (g)	Sa (1.0s) (g)	Sa (2.0s) (g)
475 (10% in 50 yrs)	0.061	0.061	0.108	0.109	0.0622	0.028
975 (5% in 50 yrs)	0.095	0.100	0.168	0.169	0.0933	0.0463
2475 (2% in 50 yrs)	0.154	0.174	0.272	0.274	0.166	0.0798

6.3.4 Estimated Permeability of Overburden Soils

Based on the grain size distribution and Atterberg Limits testing conducted on representative soil samples from the boreholes at the SWMP 2 site, the overburden soils consist predominantly of sandy silt to silty sand till. These soils are characterized by a low plasticity index and a relatively high silt fraction, resulting in low to very low hydraulic conductivity.

Using empirical correlations between grain size characteristics and permeability for fine-grained till materials, the estimated saturated hydraulic conductivity (k) for the overburden soils is within an expected range between 3×10^{-9} and 3×10^{-6} m/s to account for natural variability.

6.3.5 SWMP Liner Design Considerations

The permeability estimates indicate that the native overburden soils have variable hydraulic conductivity and could provide conditions for the construction of a stable SWMP 2, however, seepage could occur from relatively more pervious layers in the banks.

Although the native soils may exhibit relatively low permeability, it is recommended that a compacted clay liner be incorporated to further minimize seepage losses during operation. The liner material should consist of locally available, low-permeability inorganic soils having a permeability of less than 1×10^{-8} m/s. The requirements of material index properties such as Liquid Limit (LL) and Plasticity Index (PI) shall be referred to OPSS.PROV 1205. The liner should be placed over the pond base and side slopes, with a minimum thickness of 0.6 m, and compacted to at least 95% of its Standard Proctor Maximum Dry Density (SPMDD). To ensure a homogenous and crack-free barrier, the material should be placed at 2% to 4% above optimum moisture content and compacted in lifts not exceeding 150 mm.

Alternatively, geosynthetic clay liners may be considered. These liners should be placed in accordance with the manufacturer’s recommendations

All liner placement and compaction activities should be carried out under the supervision of qualified geotechnical staff.

Based on the borehole elevations (surficial elevations between Elev. 282 m ASL and Elev. 284 mASL) and the estimated pond base of Elev. 277.3 mASL, it is likely that the pond excavation will extend below the prevailing groundwater table. Consequently, groundwater inflow might be expected during construction, particularly in the deeper portions of the excavation. The proposed SWMP 2 will be excavated primarily into native sandy silt to silty sand till. The pond will extend below the current groundwater level, and the excavation will require adequate

groundwater control to provide a dry base during construction. Groundwater control is recommended to lower and keep the water levels at least 1.0 m below the base of excavation.

After construction of the liner, the water level in the pond should be raised at a controlled rate and under inspection to preserve the condition of the base and slope materials.

6.3.6 SWMP Base Stability During Operation and Maintenance

Groundwater monitoring completed by AECOM for this current investigation indicated that groundwater levels at the SWMP 2 fluctuate seasonally from approximately ground surface to 4.9 mBGS, corresponding to elevations near Elev. 280.0 mASL to Elev. 281.6 mASL, with localized artesian conditions recorded in piezometer SWMP10-01-MW.

Under temporary maintenance or drawdown conditions, the potential for upward seepage or localized softening of the base should be considered. To maintain adequate stability and limit seepage, the following measures are recommended:

1. Avoid rapid or complete drawdown of the pond; maintain at least 0.5 to 1.0 m of water cover above the base where practical.
2. Where full drawdown is necessary, adopt staged pumping or provide temporary drainage relief (e.g., sump pits, toe drains, or pressure-relief trenches).
3. Place a 200–300 mm granular filter/drainage layer (OPSS.PROV 1004 Granular M or equivalent) over the pond base to intercept minor seepage and protect the subgrade or liner.
4. Monitor groundwater levels during excavation and operation; modify dewatering procedures if seepage or instability is observed.

Based on the observed subsurface conditions and the low permeability till deposit underlying the site, the factor of safety against hydraulic heave or base instability is considered adequate for both short-term (construction) and long-term (operational) conditions, provided the above measures are implemented.

Groundwater conditions described herein reflect those observed at the time of the field investigation and following measurements and are subject to seasonal variation. Additional hydrogeological information is provided in the Hydrogeological Assessment Report prepared separately for this project.

6.3.7 Frost Protection

The design frost penetration depth for the SWMP 2 site is estimated to be 1.5 m, based on the Ontario Provincial Standard Drawing (OPSD) 3090.101 MTO Foundation Frost Penetration Depths for Southern Ontario.

The subsurface conditions within this depth are characterized predominantly by sandy silt/silty sand to clayey silt to silt, as identified in the AECOM boreholes drilled at the site. These soils are generally of low plasticity, moist, and exhibit a variable density. Given their fine-grained composition and moderate capillary moisture retention, these soils are considered frost susceptible.

According to the MTO Frost Classification Criteria, soils containing a high proportion of silt-sized particles typically exhibit moderate to high frost susceptibility, depending on drainage and moisture conditions. As such, the near-surface and the excavation bottom at the SWMP 2 site is classified to be Moderate Frost Susceptibility.

Seasonal frost action may cause minor heaving and softening in exposed areas, particularly where drainage is impeded. Proper drainage should be considered for surface structures, pond liner interfaces, and shallow appurtenances to mitigate potential frost-related movements.

Should construction take place during the winter season, exposed subgrades and underlying soils, specifically for surface or exterior structures, must be protected by the Contractor against freezing for the entire duration of construction, or until adequate frost protection is in place. Backfill should not be placed or compacted in a frozen condition or placed on frozen subgrades.

6.3.8 Global Stability

This section presents the results of the global slope stability assessment completed for the proposed SWMP 2 under static and pseudo-static (seismic) conditions. The purpose of this analysis is to evaluate the adequacy of the proposed 4H:1V to 3H:1V cut slopes, considering the strength and deformation characteristics of the underlying soils and the influence of groundwater conditions.

The analysis was conducted using the limit equilibrium method of slices, implemented through GeoStudio 2024 SLOPE/W, utilizing the Morgenstern-Price method. The assessment accounted for the interpreted subsurface conditions, site-specific groundwater levels, and geotechnical design parameters derived from both laboratory and correlation-based sources.

A minimum surcharge load of 16 kPa has been included in the design where traffic loading or other surface loads may occur near the pond edges or adjacent slopes.

6.3.8.1 Method of Analysis

The slope stability analysis was completed using GeoStudio 2024 SLOPE/W, employing the Morgenstern-Price method, which satisfies both force and moment equilibrium. The intent of the analysis was to determine the critical (minimum) Factor of Safety (FoS) under permanent pool water levels, regional water level, rapid drawdown, and seismic loading conditions for the proposed side slopes.

Based on Tables 6.1 and 6.2 of the CHBDC, minimum FoS were applied for short term (FoS of 1.3) / long term (FoS of 1.5) or saturated / unsaturated static conditions and for a rapid drawdown (FoS of 1.3, temporary condition) respectively.

For pseudo-static (seismic) loading, a minimum FoS of 1.1 was adopted. For the seismic assessment, a pseudo-static horizontal coefficient (k_h) of 0.077 was used. This value was derived conservatively from the NBC 2020 2% in 50-year PGA of 0.154 g for a Seismic Site Class D condition. This coefficient was applied to simulate inertial forces induced during a design earthquake.

6.3.9 Slope Stability Assessments

Slope stability analyses were conducted for representative cross-sections through the proposed SWMP 2 location, including the deepest part of the excavation, where the maximum cut depth is approximately 8.7 mBGS, as previously discussed in Section 6.2.

Detailed outputs of the analyses are provided for reference in **Appendix F** and are summarized in the tables below.

Table 9: Results of Stability Analyses SWMP 2 (N of Pond)*

Analysis Condition	Minimum Factor of Safety	Appendix F Page No.
Permanent Water Level	2.0	1
Regional Storm Event	2.3	2
Rapid Drawdown	2.1	3
Permanent Water Level (Seismic)	1.7	4
Initial Water Level (Seismic)	1.6	5

*Analysis completed for north side of the pond

Table 10: Results of Stability Analyses SWMP 2 (S of Pond)*

Analysis Condition	Minimum Factor of Safety	Appendix F Page No.
Permanent Water Level	3.0	6
Regional Storm Event	4.5	7
Rapid Drawdown	2.9	8
Permanent Water Level (Seismic)	2.3	9
Initial Water Level (Seismic)	2.0	10

*Analysis completed for south side of the pond

The calculated FoS exceed the minimum requirements outlined in CHBDC criteria, indicating that the proposed slope inclinations are geotechnically acceptable under static and pseudo static conditions. Based on the analysis undertaken, the selected gradients are considered stable .

6.3.10 Surficial Stability and Erosion Protection

Surficial stability and erosion protection measures are required to maintain the integrity of the SWMP 2 slopes and inlet/outlet structures under long-term operating conditions and during storm events. The design of erosion protection at the inlet and outlet should be completed by the hydraulic design engineer; however, the following minimum geotechnical recommendations are provided based on site-specific subsurface conditions.

As a minimum, erosion protection for the inlet and outlet structures should be provided in accordance with:

- OPSD 810.010 – Rip-Rap Treatment for Sewer and Culvert Outlets (Type A), and
- OPSD 810.020 – Rip-Rap Treatment for Ditch Inlets.

Rip-rap should extend to at least the obvert of the pipes and should be placed on a properly prepared bedding layer with a non-woven geotextile separator meeting OPSS.PROV 1860 to prevent migration of the underlying silty soils. Rip-rap should extend across the full width of the channel and up the side slopes as required to mitigate erosion during elevated flow velocities or drawdown conditions.

The inlet channel or approach area may be subject to increased turbulence due to changes in local grade. In these locations, a more robust protection system may be required, such as:

- River stone or R-10 rip-rap (per OPSS.PROV 1004),
- Placement over a geotextile separator (OPSS.PROV 1860),
- Extending from the channel bottom to the upper limit of anticipated flow depth.

Above the normal water level, the SWMP 2 side slopes could be vegetated as soon as practicable after earthworks are completed to reduce soil erosion from rainfall events, runoff, and wind. Vegetation should be established using seeding or sodding in accordance with OPSS.PROV 804- Seed and Cover.

The active waterline zone (between permanent pool and high-water level) may require additional protection depending on the long-term ability of vegetation to establish. If vegetative cover is insufficient, a minimum 150 mm

thick R-10 rip-rap may be placed to limit surface erosion; however, this measure may not be necessary where vegetation is successfully established and maintained.

During excavation of the cut slopes, thin water-bearing cohesionless seams may be encountered within the sandy silt till deposits. As these seams may result in localized surficial sloughing or wet-face instability, the placement of 300 mm granular sheeting (in accordance with OPSS.PROV 511 – Rip-Rap, Rock Protection, and Granular Sheeting) may be required in affected areas. The need for granular sheeting should be assessed using an observational approach, with qualified geotechnical staff inspecting exposed cut slopes during excavation to identify seepage zones requiring stabilization.

6.4 Construction Considerations

6.4.1 General

Construction of the SWMP 2 should be carried out under the supervision of qualified geotechnical staff acting as the client representative or Contract Administrator to confirm that the recommendations contained in this report are properly implemented. Additional considerations may arise depending on the contractor’s means and methods. Contractors are advised to seek independent geotechnical advice regarding temporary works, excavation approaches, and dewatering strategies.

6.4.2 Site Preparation / Subgrade Protection

Prior to any earthworks or placement of structural fill, all topsoil, root-bearing or organic materials, and undocumented fill (where present) must be stripped and removed in accordance with OPSS.PROV 206 – Construction Specification for Grading.

Any soft, wet, or unstable materials exposed at the proposed founding levels of the inlet/outlet structures, pond liner interface, or other components should be removed until a competent native subgrade is reached.

Where sub-excavation is required, the excavated area may be backfilled with OPSS.PROV 1010 Granular ‘A’ or Granular ‘B’ Type II, compacted in accordance with OPSS.PROV 501 – Compaction. Subgrade inspection approval, and full-time compaction testing of engineered granular fill material by a client-representative qualified geotechnical staff is required prior to placing any foundation elements.

6.4.3 Open-Cut Excavations / Temporary Protection Systems

All excavations and shoring must comply with the Occupational Health and Safety Act (OHSA) and OPSS.PROV 539 – Temporary Protection Systems.

The following OHSA soil classifications are applicable for open-cut excavations. These classifications reflect both the material type and observed groundwater conditions.

Table 11: Interpreted OHSA Requirements for Open-Cut Excavations

Material / Deposit	Groundwater Conditions**	Recommended OHSA Classification / Excavation Slope*
Surficial Fill (Sand and/or topsoil)	Minor to moderate seepage possible	Type 4; not steeper than 3H:1V
Sandy Silt / Clayey Silt / Silty Sand	Minor to moderate seepage possible	Type 3; not steeper than 1H:1V
Sandy Silt Till / Silty Sand Till	Minor to moderate seepage	Type 3; not steeper than 1H:1V

Notes: *For excavations through multiple soil types, the side slope geometry is governed by the soil with the highest number designation.

**If excavations proceed below the water table, become wet or muddy, or exhibit signs of seepage, they will become a “Type 4 Soil”. A “Type 4 Soil” must be sloped from its bottom with a slope having a minimum gradient of 3H:1V

These recommendations apply to short-term, temporary excavation slopes only. Continuous monitoring for sloughing, seepage, or wet pockets is required—particularly in the sandy silt layers that may soften upon disturbance.

Excavations within the till may generally be completed using standard heavy equipment such as hydraulic excavators. Where conditions require, temporary shoring must be designed by a qualified Professional Engineer and installed in accordance with OPSS.PROV 539.

6.4.4 Groundwater and Surface Water Control

As described earlier in Section 6.3.6, groundwater levels at the site based on the monitoring completed by AECOM varied between approximately ground surface to 4.9 mBGS (corresponding elevations from Elev.280.0 mASL to Elev.281.6 mASL), with occasional artesian response observed. The proposed pond base (El. 277.3 mASL) will be below the groundwater table during construction, and groundwater inflow should be expected during excavation.

Dewatering operations should be carried out and managed in accordance with OPSS.PROV 517, as amended by Special Provision 517F01 (issued February 2024). The design of the dewatering system is the responsibility of the Contractor, and the Contract Documents must alert him to this responsibility. Surface water from runoff and precipitation events should be directed away from the proposed SWMP 2 to mitigate ponding water that could result in disturbance and softening of the subgrade and/or delay construction of the pond liner.

Groundwater inflow will generally be manageable but may still require localized control. Groundwater and surface water should be managed using:

- Filtered sump pumps in low points of the excavation
- Temporary drainage trenches feeding into sumps
- Surface water diversion berms during construction

No deep well dewatering is anticipated. However, if required, dewatering shall be in accordance with OPSS 517 and SP517F01. In addition, rapid drawdown of the pond during maintenance must be avoided, as previously noted, to limit upward seepage pressures.

During heavy rainfall events, runoff must be diverted away from active cuts to prevent erosion and saturation of slope faces.

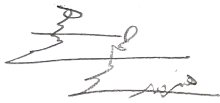
7. Closure

The Foundation Investigation and Design Report was prepared by Behnoosh Honarvar Sedighian and the technical review of the report was completed by A. Mohammad, P.Eng.

An independent quality review of this report was carried out by C. Nascimento, P.Eng., the Designated MTO Foundations Contact and T. Ahn, Ph.D., P. Eng, Quality Control Auditor for this assignment.

AECOM CANADA ULC

Prepared by

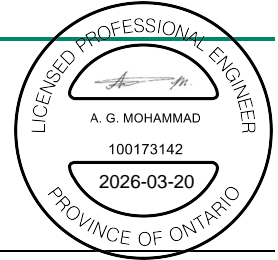


Behnoosh Honarvar Sedighian, M.Sc.
Geotechnical Specialist

Reviewed by



Amer Mohammad, P.Eng.
Senior Geotechnical/Foundation Engineer



Reviewed by



Carlos Nascimento, P.Eng.
Senior Geotechnical/Foundation Engineer
MTO Designated Contact
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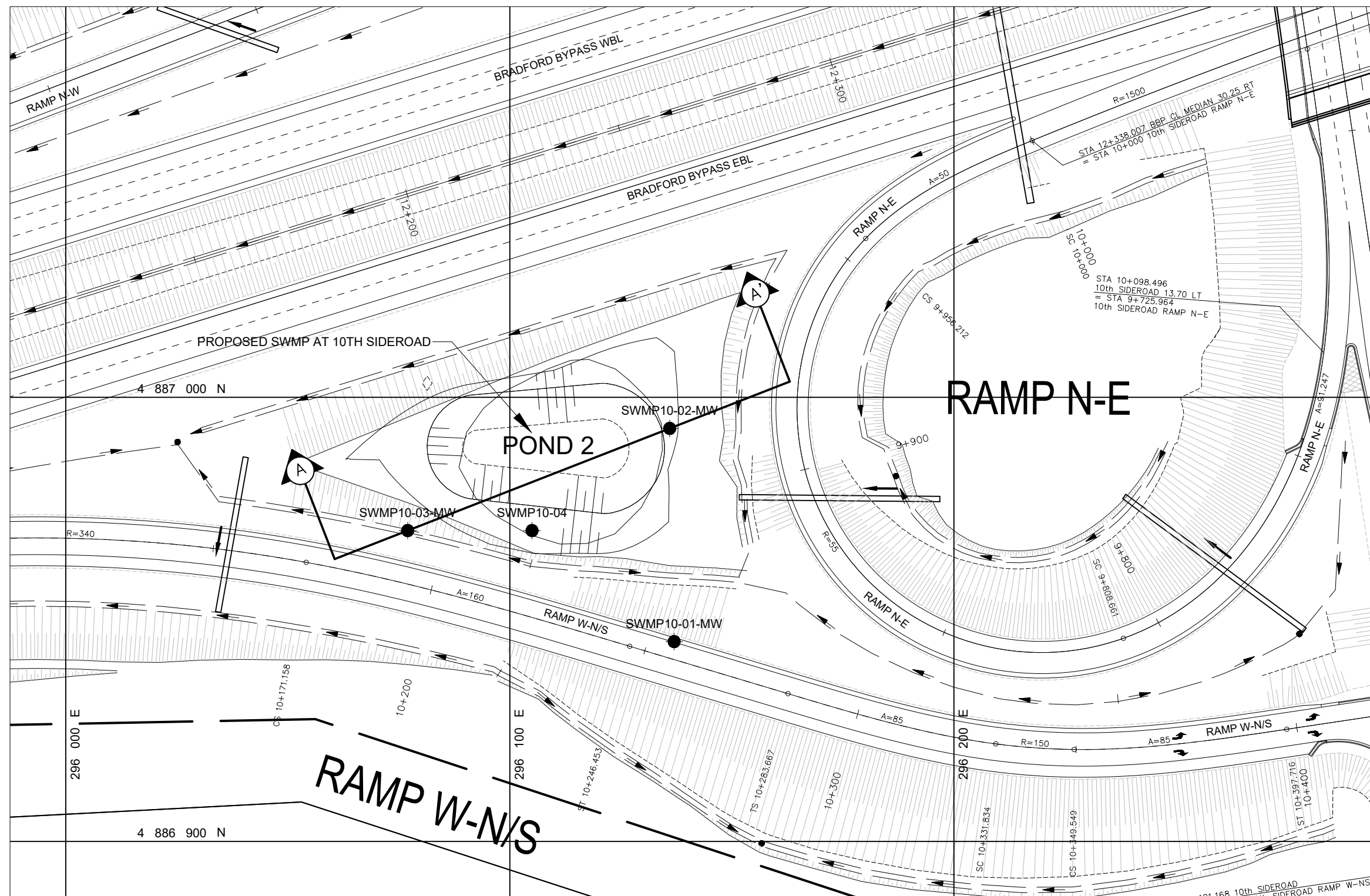
Verified by



Taesang Ahn, Ph.D., P.Eng.
Senior Geotechnical/Foundation Engineer
Geotechnical Lead Ontario
Taesang.Ahn@aecom.com

Appendix **A**

Borehole Location Plan and Soil Stratigraphy Plan

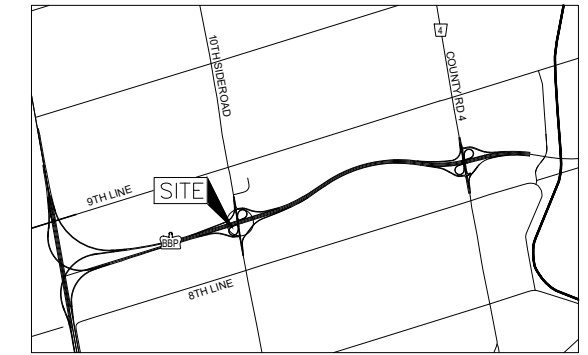


CONT No. 2026-2005
 GWP No. 2026-23-00



BRADFORD BYPASS WEST
 10th SIDEROAD STORM WATER MANAGEMENT PONDS
 BOREHOLE LOCATION PLAN
 STORM WATER MANAGEMENT POND 2

SHEET
 01



KEY PLAN
 SCALE 1:2 km



LEGEND

- BOREHOLE - CURRENT INVESTIGATION
- ⊥ SEAL
- ⊥ PIEZOMETER
- N STANDARD PENETRATION TEST VALUE
- 16 BLOWS/0.3M UNLESS OTHERWISE STATED (STD. PEN. TEST, 475 J/BLOW)
- 100% ROCK QUALITY DESIGNATION (RQD)
- ≡ WL IN PIEZOMETER, MEASURED ON YYYY/MM/DD
- ∇ WL UPON COMPLETION OF DRILLING
- ∇ FLOWING ARTESIAN

BOREHOLE COORDINATES (MTM NAD 83 ZONE 10)

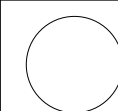
No.	ELEVATION	NORTHING	EASTING
SWMP10-01-MW	280.95	4886945	296137
SWMP10-02-MW	282.62	4886993	296136
SWMP10-03-MW	284.17	4886970	296077
SWMP10-04	283.03	4886970	296105

NOTES:

1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT BE CONSISTENT WITH THE FINAL DESIGN CONFIGURATION AS SHOWN ELSEWHERE IN THE CONTRACTS DOCUMENTS.
3. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.
5. REFERENCE: BASE PLANS PROVIDED IN DIGITAL FORMAT BY AECOM FILES "Bradford Bypass_plan.dwg". RECEIVED OR DATED: MARCH 03, 2025.
6. REFER TO DRAWING No. 02 FOR CROSS SECTION A-A' AND SWMP10-01-MW.



2	JAN 26	CJ	FINAL
1	DEC 25	AV	DRAFT
NO.	DATE	BY	REVISION
Geocres No. 31D04-028			
HWY. BRADFORD BYPASS WEST		PROJECT NO. 60731727	DIST. CENTRAL
SUBM'D. BH	CHKD. GB	DATE: 12/12/2025	SITE:
DRAWN: AV	CHKD. AR	APPD. NC	DWG. 01



NOTES:

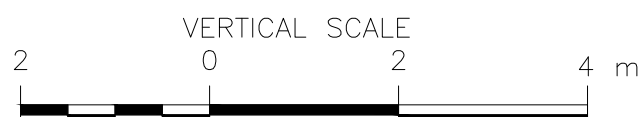
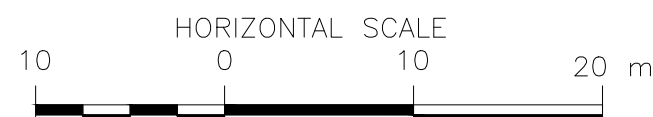
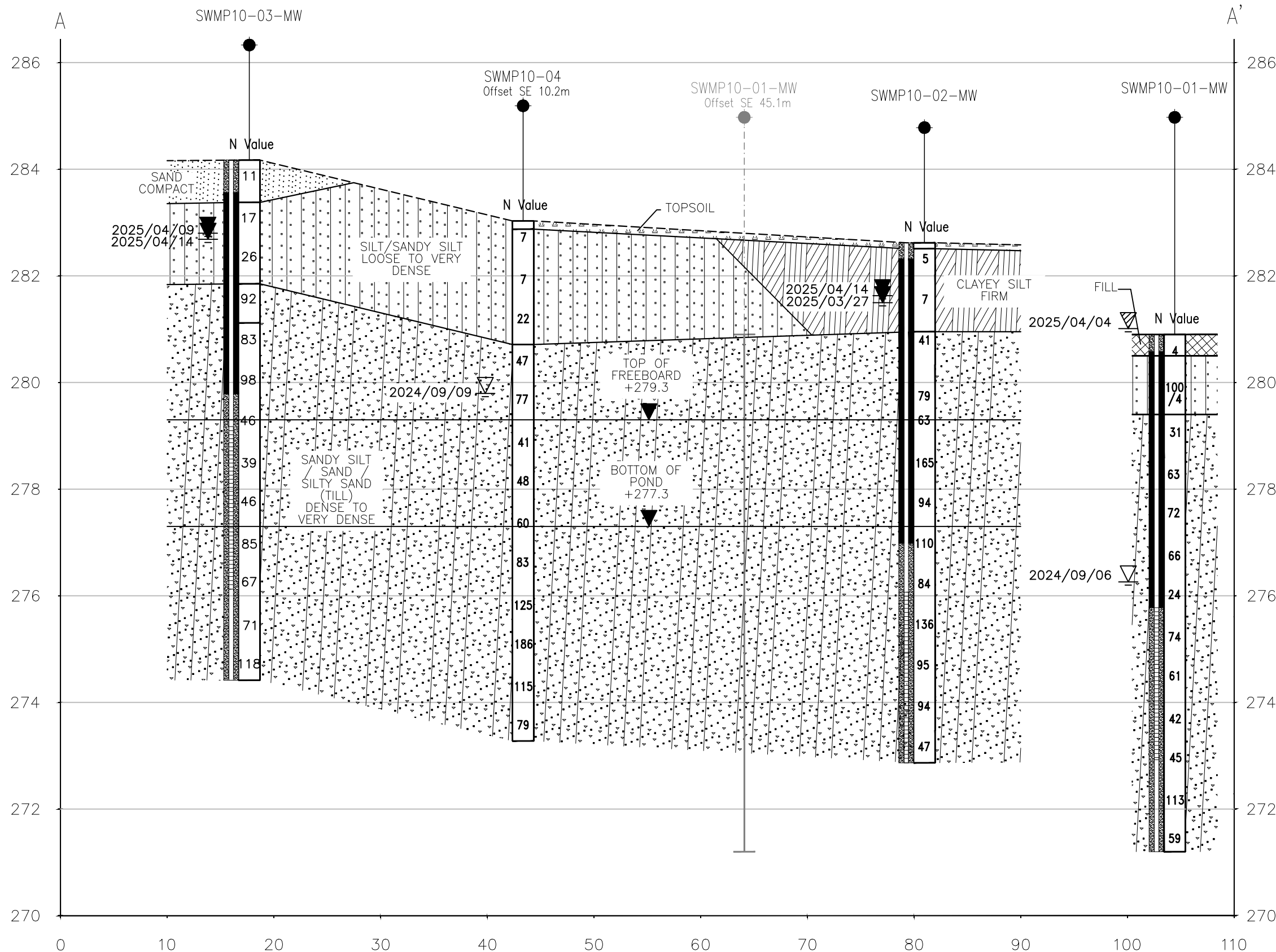
1. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH THE TEXT OF REPORT AND RECORD OF BOREHOLE LOGS.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. THE PROPOSED STRUCTURE DETAILS/WORKS ARE SHOWN FOR ILLUSTRATION PURPOSES ONLY AND MAY NOT BE CONSISTENT WITH THE FINAL DESIGN CONFIGURATION AS SHOWN ELSEWHERE IN THE CONTRACTS DOCUMENTS.
3. THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE.
4. DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETRES AND METRES.
5. REFERENCE: BASE PLANS PROVIDED IN DIGITAL FORMAT BY AECOM FILES "Bradford Bypass_plan.dwg". RECEIVED OR DATED: MARCH 03, 2025.
6. REFER TO DRAWING NO. 01 FOR BOREHOLE LOCATION PLAN.

LEGEND

- BOREHOLE - CURRENT INVESTIGATION
- ▬ SEAL
- ▬ PIEZOMETER
- N STANDARD PENETRATION TEST VALUE
- 16 BLOWS/0.3M UNLESS OTHERWISE STATED (STD. PEN. TEST, 475 J/BLOW)
- 100% ROCK QUALITY DESIGNATION (RQD)
- ▼ WL IN PIEZOMETER, MEASURED ON YYYY/MM/DD
- ▽ WL UPON COMPLETION OF DRILLING
- ▽ FLOWING ARTESIAN

LEGEND - SOIL STRATA:

- TOPSOIL
- FILL
- SAND
- CLAYEY SILT
- SANDY SILT / SAND / SILTY SAND (TILL)
- SILT / SANDY SILT



SECTION A-A'



2	JAN 26	CJ	FINAL
1	DEC 25	VA	DRAFT
NO.	DATE	BY	REVISION
Geocres No. ---			
HWY. BRADFORD BYPASS WEST		PROJECT NO. 60731727	DIST. CENTRAL
SUBM'D. BH	CHKD. GB	DATE: 12/12/2025	SITE:
DRAWN: VA	CHKD. RA	APPD. NC	DWG. 02

Appendix **B**

Records of Boreholes Logs



TERMINOLOGY USED IN BOREHOLE LOGS

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

Peat: A mass of organic matter usually fibrous in texture in various stages of decomposition, generally dark brown to black in colour and of spongy consistency.

Fill: The term fill has been used to describe materials which have been placed by non-natural processes. Fills can often be heterogeneous in nature and those relying on this report should expect them to contain deleterious materials. Such materials can include wood, bricks, slag, porcelain, organics, and obstructions such as scrap metal, storage tanks, and abandoned concrete/steel structures.

Due to the uncertainty of the placement method of the material, the boring samples obtained for this report are not expected to represent other materials at any horizontal or vertical distance from where the sample was obtained.

Fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill site. Unless specifically stated, the fill on this site has not been tested for contaminants that can be considered toxic or hazardous. Testing to determine the toxicity of fill materials can be conducted, if requested.

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

Terminology describing soil structure

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

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

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

Fissured: material breaks along plane of fracture.

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

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

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

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

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

Homogeneous: same color and appearance throughout.

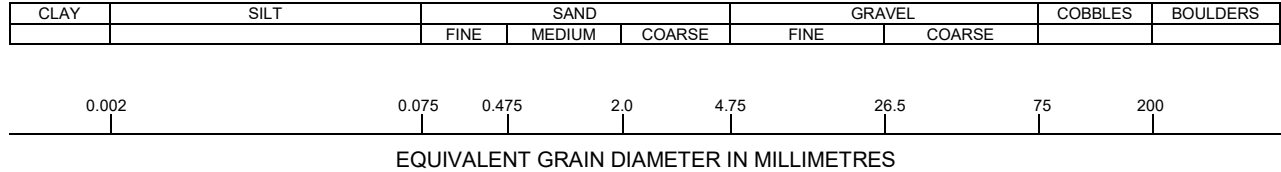
Well Graded: having wide range in grain sized and substantial amounts of all predominantly on grain size.

Uniformly Graded: predominantly on grain size.

Residual: completed weathered sedimentary rock mixed with native soils.

All soil sample descriptions included in this report generally follow the Canadian Foundations Engineering Manual and the Unified Soil Classification System. These systems follow the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by AECOM follow the same system. Note that, with exception of those samples where a grain size distribution analysis has been completed, all samples have been classified by visual inspection. Visual inspection classification is not sufficient to provide exact gain sizing.

ISSMFE / USCS SOIL CLASSIFICATION



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

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

Cohesionless Soils		Cohesive Soils			Composition	
Compactness Condition	SPT N-Index (blows per 0.3 m)	Consistency	Undrained Shear Strength (kPa)	SPT N-Index (blows per 0.3 m)	Term	Criteria
Very loose	0 – 5	Very soft	< 12	< 2	Trace	1% - 10%
Loose	5 – 10	Soft	12 - 25	2 – 5	Some	10% - 20%
Compact	10 – 30	Firm	25 – 50	5 – 8	Adjective	20% - 35%
Dense	30 – 50	Stiff	50 – 100	8 – 15	And	> 35%
Very Dense	> 50	Very Stiff	100 - 200	15 – 30	Noun	> 35% & largest fraction
		Hard	> 200	> 30		

Standard Penetration Test (SPT):

The number of blows required to drive a 50 mm (2 in.) open split spoon sampler from a depth of 150 mm (6 in.) to 450 mm (18 in.) in undisturbed soil. Each blow is driven by a 63.6 kg (140 lb.) hammer free falling a distance of 0.76 m (30 in.).

Sample & Soil Abbreviations		Contaminant Abbreviations		Strata/Graphic Plot					
CORE	Rock core sample	BNAE	base/neutral/acid extractables		Fill		Asphalt		Cobbles
AS	Auger sample	BTEX	benzene, toluene, ethylbenzene, xylenes		Topsoil		Concrete		Sandy Silt Till
FV	Field vane	OCP	organochlorine pesticides		Clay		Silty Clay		Silty Clay Till
PP	Pocket penetrometer	MI	metals & inorganics		Silt		Clayey Silt		Clayey Silt Till
SG	Specific Gravity	PAH	polycyclic aromatic hydrocarbons		Sand		Silty Sand		Silty Gravel
GS	Grab sample	PCB	polychlorinated biphenyls		Gravel		Sand & Gravel		Clayey Gravel
SS	Split spoon sample	PHC	CCME petroleum hydrocarbons (fractions 1 – 4)		Clayey Sand		Shale		Limestone
DCPT	Dynamic cone penetration test	VOC	volatile organic compounds (includes BTEX)						
GR	Gravel	Plasticity Description Liquid Limit (w_l)							
SA	Sand	Low	w _l < 35						
SI	Silt	Medium	35 < w _l < 50						
CL	Clay	High	50 < w _l						

RECORD OF BOREHOLE SWMP10-01-MW 1 OF 1 METRIC

G.W.P. 2026-23-00 LOCATION 10th Sideroad Storm Water Management Pond N 4886945.0; E 296137.0 / MTM Zone 10 ORIGINATED BY CD
 DIST Central HWY BBP BOREHOLE TYPE Truck Mount CME 75 / HSA COMPILED BY PAK
 DATUM Geodetic (CGVD28) DATE 2024.09.05 - 2024.09.06 LATITUDE 44.122448 LONGITUDE -79.608242 CHECKED BY BG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
280.9	GROUND SURFACE																
280.6	FILL, sand, trace gravel, brown, moist, very loose (FILL - 380 mm)	1	SS	4													
0.4	SANDY SILT, trace gravel, trace to some cobbles, brown, moist, loose to very dense	2	SS	100/4													
279.4	SILTY SAND, trace to some gravel, trace clay, grey, moist, dense to very dense (TILL)	3	SS	31											15	62	(23)
1.5		4	SS	63											1	68	(31)
276.4		5	SS	72													
4.6		6	SS	66													
273.3	SAND, trace gravel, trace clay, some silt, grey, moist, cobbles and boulders, compact to very dense (TILL)	7	SS	24											1	75	20 4
7.6		8	SS	74													
271.2		9	SS	61													
273.3	SILTY SAND, trace gravel, trace clay, grey, moist, cobbles and boulders, dense to very dense (TILL)	10	SS	42													
7.6		11	SS	45											2	58	31 9
271.2		12	SS	113													
271.2	END OF BOREHOLE Notes: 1. This log is to be read in conjunction with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. Flowing artesian 0.11 m above ground surface. Well capped on 04/04/2025. 4. The borehole caved in at a depth of 9.1 m. 5. Groundwater level was measured at a depth of 4.5 m upon completion of drilling.	13	SS	59													
9.8																	

AECOM MTO FOUNDATION LOG BBP WEST LOGS 12 23 25.GPJ AECOM OTTAWA DATA TEMPLATE.GDT 26-3-7

Monitoring Well Legend

- Filter Sand
- Bentonite Seal
- Screen
- Bentonite at the bottom of hole



- Open Borehole or Test Pit
- Monitoring Well, Piezometer or Standpipe

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

RECORD OF BOREHOLE SWMP10-02-MW 1 OF 1 METRIC

G.W.P. 2026-23-00 LOCATION 10th Sideroad Storm Water Management Pond N 4886993.0; E 296136.0 / MTM Zone 10 ORIGINATED BY FL
 DIST Central HWY BBP BOREHOLE TYPE Truck Mount CME 75 / HSA COMPILED BY PAK
 DATUM Geodetic (CGVD28) DATE 2024.09.09 - 2024.09.09 LATITUDE 44.122880 LONGITUDE -79.608256 CHECKED BY BG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
282.6	GROUND SURFACE																
282.5	TOPSOIL, brown, moist (120 mm)																
0.1	CLAYEY SILT, trace sand, brown, moist, firm	1	SS	5													
		2	SS	7													
281.1																	
1.5	SANDY SILT, trace to some clay, trace gravel, brown, moist, dense to very dense (TILL)	3	SS	41													1 42 42 15
		4	SS	79													
		5	SS	63													
		6	SS	165													
		7	SS	94													1 48 43 8
		8	SS	110													
		9	SS	84													
		10	SS	136													
		11	SS	95													
274.2																	
8.4	SILTY SAND, some clay, trace gravel, brown, moist, dense to very dense (TILL)	12	SS	94													1 57 31 11
		13	SS	47													
272.9																	
9.8	END OF BOREHOLE																
	Notes: 1. This log is to be read in conjunction with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. Well capped on 11/30/2024. 4. The borehole caved in at a depth of 8.6 m. 5. Groundwater level were measured at 1.00 mBGS on 2025.04.14, 1.13 mBGS on 2025.03.27, 1.70 mBGS on 2025.06.06, 2.29 mBGS on 2025.01.15, 2.36 mBGS on 2025.07.04, 3.25 mBGS on 2024.11.30, and 3.30 mBGS on 2025.08.07.																

AECOM MTO FOUNDATION LOG BBP WEST LOGS 12 23 25.GPJ AECOM OTTAWA DATA TEMPLATE.GDT 26-3-7

Monitoring Well Legend

Filter Sand

 Screen

Bentonite Seal
 Bentonite at the bottom of hole

AECOM

Open Borehole or Test Pit
 Monitoring Well, Piezometer or Standpipe

○ ³% STRAIN AT FAILURE

+ ³, × ³: Numbers refer to Sensitivity

RECORD OF BOREHOLE SWMP10-03-MW 1 OF 1 METRIC

G.W.P. 2026-23-00 LOCATION 10th Sideroad Storm Water Management Pond N 4886970.0; E 296077.0 / MTM Zone 10 ORIGINATED BY CD
 DIST Central HWY BBP BOREHOLE TYPE Truck Mount CME 75 / HSA COMPILED BY PAK
 DATUM Geodetic (CGVD28) DATE 2024.09.04 - 2024.09.04 LATITUDE 44.122672 LONGITUDE -79.608992 CHECKED BY BG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
284.2	GROUND SURFACE																
	SAND , trace silt, brown, moist, compact	1	SS	11													
283.4																	
0.8	SANDY SILT , trace gravel, some clay, brown, moist, compact to very dense	2	SS	17													2 34 48 16
		3	SS	26													
281.9																	
2.3	SILTY SAND , trace to some clay, trace gravel, boulders and cobbles, brown to grey, moist, dense to very dense (TILL)	4	SS	92													3 62 (35)
		5	SS	83													
		6	SS	98													
		7	SS	46													
		8	SS	39													1 60 29 10
		9	SS	46													
		10	SS	85													
		11	SS	67													
		12	SS	71													3 62 26 9
		13	SS	118													
274.4	END OF BOREHOLE																
9.8	Notes: 1. This log is to be read in conjunction with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. Well capped on 11/30/2024. 4. The borehole caved in at a depth of 8.9 m. 5. Groundwater levels were measured at 1.37 mBGS on 2025.04.09, 1.48 mBGS on 2025.04.14, 1.89 mBGS on 2025.03.27, 2.70 mBGS on 2025.06.06, 3.46 mBGS on 2025.07.04, 3.71 mBGS on 2025.01.15, 4.65 mBGS on 2025.08.07, and 4.90 mBGS on 2024.11.30.																

AECOM MTO FOUNDATION LOG BBP WEST LOGS 12 23 25.GPJ AECOM OTTAWA DATA TEMPLATE.GDT 26-3-7

RECORD OF BOREHOLE SWMP10-04

1 OF 1

METRIC

G.W.P. 2026-23-00 LOCATION 10th Sideroad Storm Water Management Pond N 4886970.0; E 296105.0 / MTM Zone 10 ORIGINATED BY FL
 DIST Central HWY BBP BOREHOLE TYPE Truck Mount CME 75 / HSA COMPILED BY PAK
 DATUM Geodetic (CGVD28) DATE 2024.09.09 - 2024.09.09 LATITUDE 44.122673 LONGITUDE -79.608643 CHECKED BY BG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40
283.0	GROUND SURFACE																	
282.0 0.1	TOPSOIL , brown, moist, (120 mm) SILT , trace gravel, brown, moist, loose to compact	1	SS	7	∇													
		2	SS	7		282												
		3	SS	22		281												
280.7 2.3	SANDY SILT , trace gravel, brown to grey, moist, dense to very dense (TILL)	4	SS	47		280												
		5	SS	77		279												
		6	SS	41		278												
		7	SS	48		277												
277.7 5.3	SAND , trace gravel, trace to some clay, trace to some silt, brown to grey, moist, very dense (TILL)	8	SS	60		276												
		9	SS	83		275												
		10	SS	125		274												
		11	SS	186														
		12	SS	115														
		13	SS	79														
273.3 9.8	END OF BOREHOLE Notes: 1. This log is to be read in conjunction with the subject report and project number as presented above. 2. Interpretation assistance by AECOM is required for projects excluding the above mentioned project. 3. The borehole was backfilled with a bentonite hole plug. 4. The borehole caved in at a depth of 9.2 m. 3. Groundwater level measured at a depth of 3.23m upon completion of drilling.																	

AECOM MTO FOUNDATION LOG BBP WEST LOGS 12 23 25.GPJ AECOM OTTAWA DATA TEMPLATE.GDT 26-3-7



○ ³% STRAIN AT FAILURE

+ ³, × ³: Numbers refer to Sensitivity

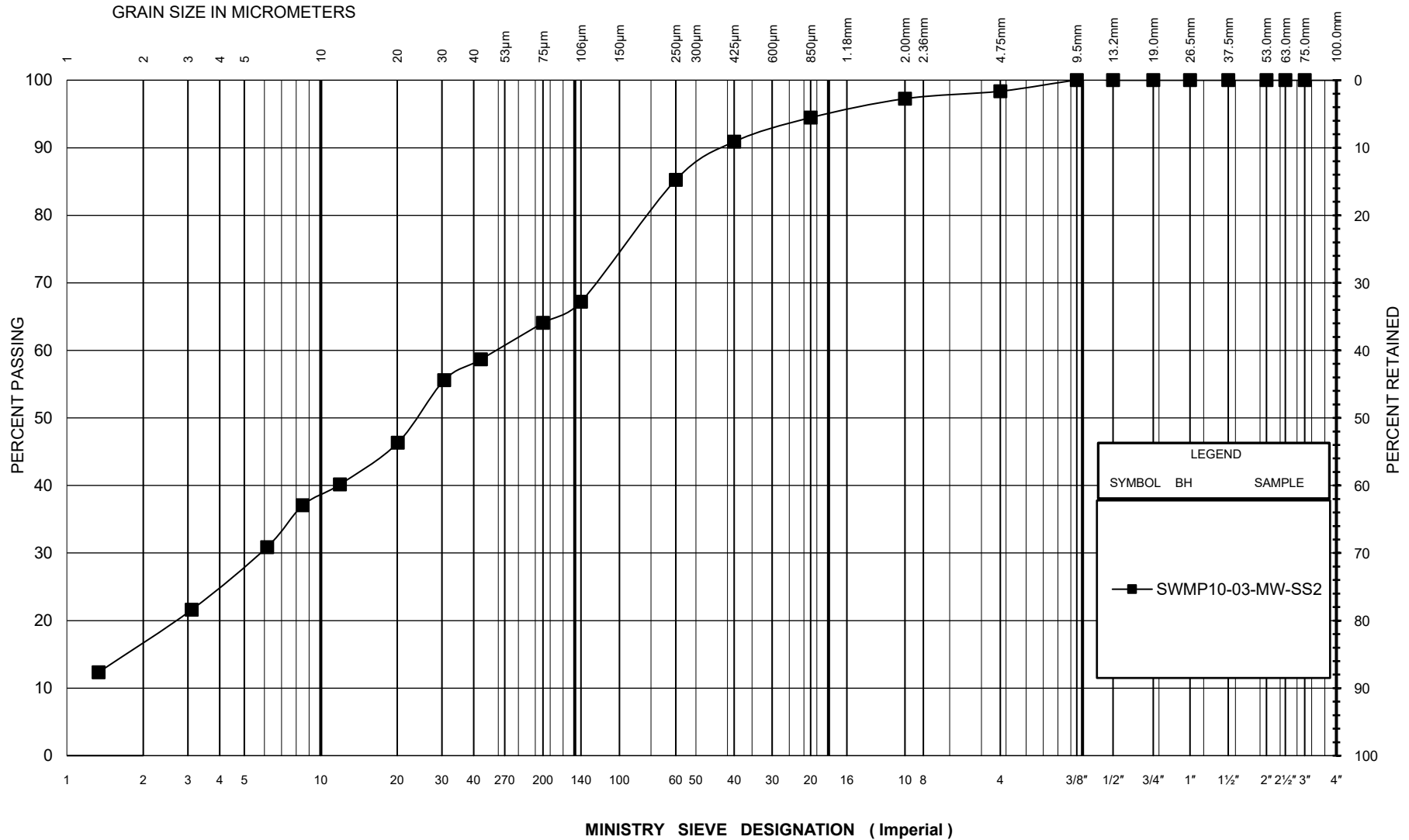
Appendix **C**

Laboratory Test Results



UNIFIED SOIL CLASSIFICATION SYSTEM

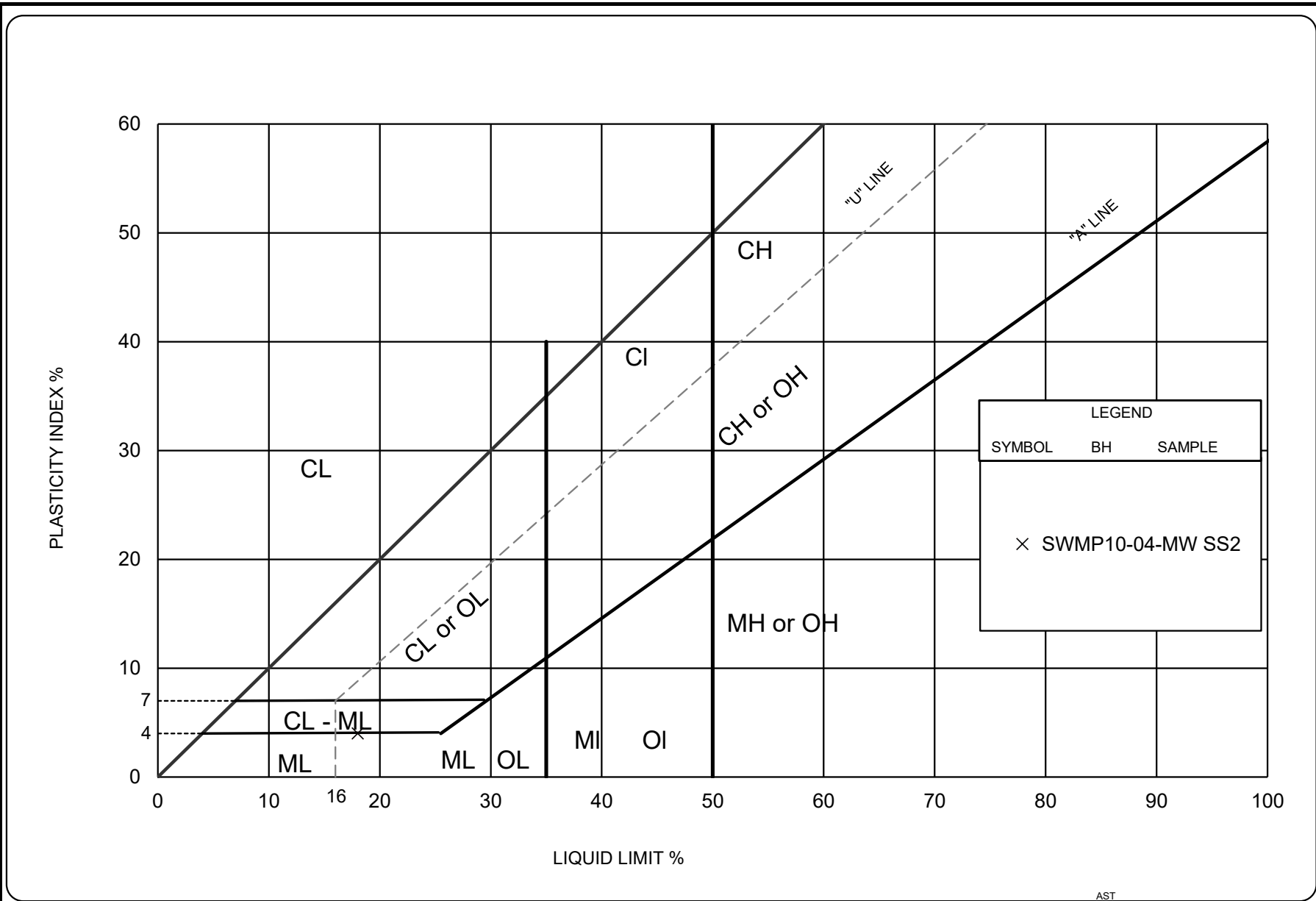
CLAY & SILT					SAND			Gravel		Cobbles
					Fine	Medium	Coarse	Fine	Coarse	



GRAIN SIZE DISTRIBUTION

Sandy SILT, trace gravel, some clay

Figure No.	1
Project No.	60731727
Project Name	Bradford Bypass - 10th Sideroad SWM Pond



Ministry of
Transportation

Ontario

PLASTICITY CHART

SILT

Figure No.

2

Project No.

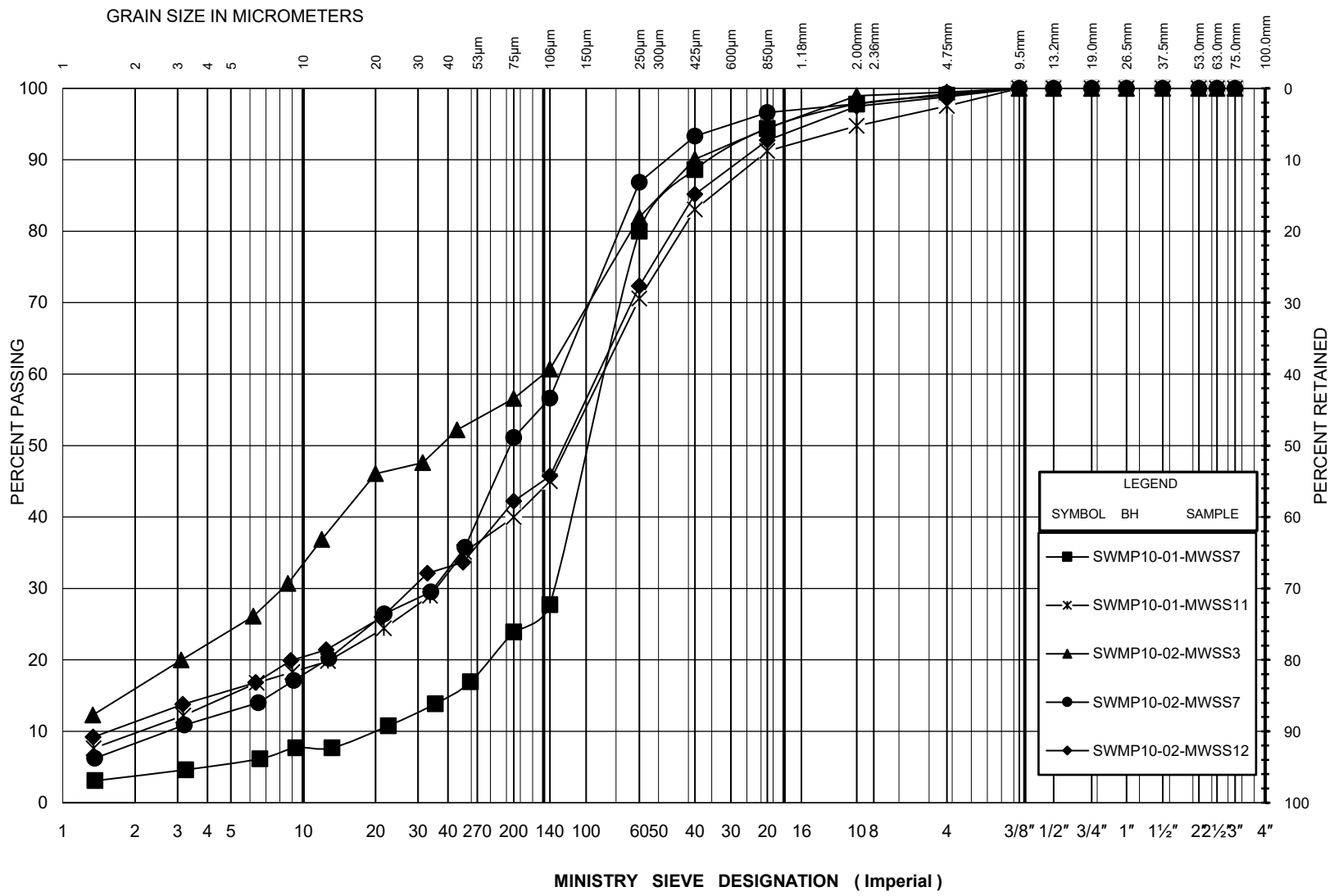
60731727

Project Name

Bradford Bypass -
10th Sideroad SWM Pond

UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY & SILT	SAND			Gravel		Cobbles
	Fine	Medium	Coarse	Fine	Coarse	



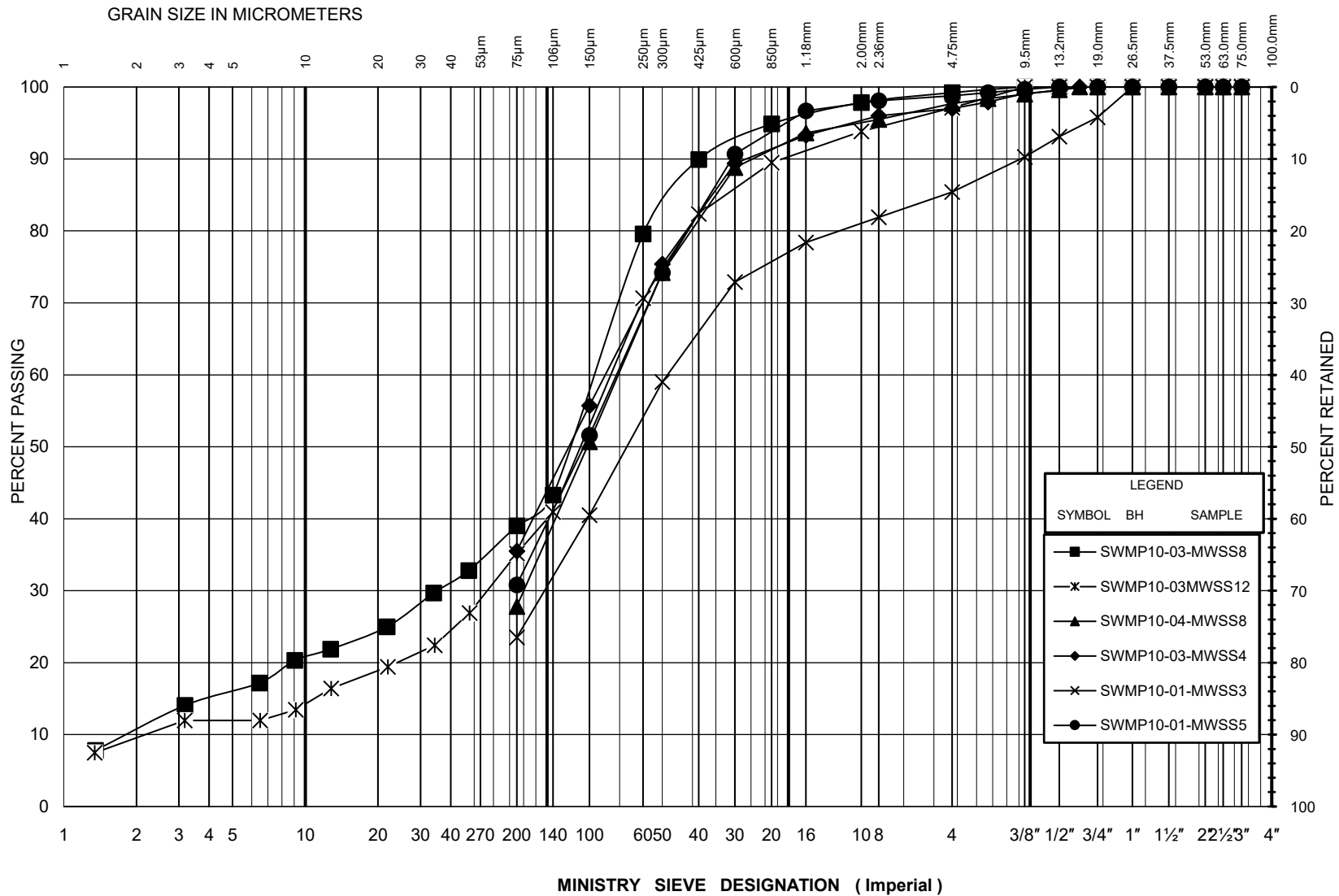
GRAIN SIZE DISTRIBUTION

Sandy SILT / Silty SAND / SAND, trace gravel, trace to some clay TILL

Figure No.	3
Project No.	60731727
Project Name	Bradford Bypass - 10th Sideroad SWM Pond

UNIFIED SOIL CLASSIFICATION SYSTEM

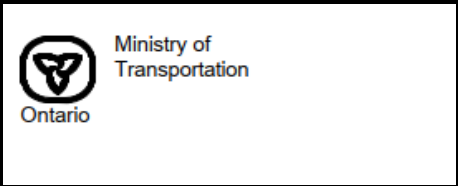
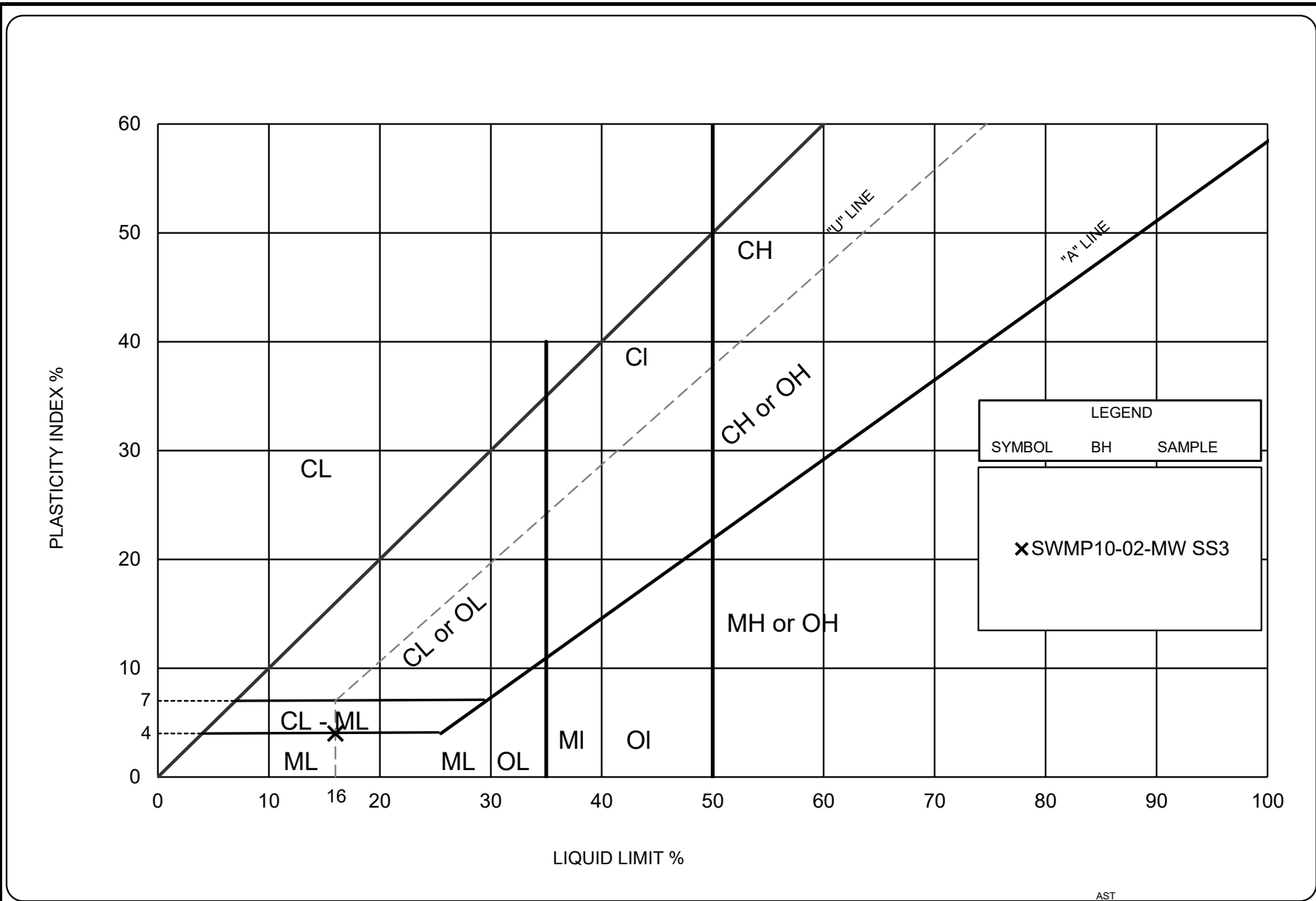
CLAY & SILT					SAND			Gravel		Cobbles
					Fine	Medium	Coarse	Fine	Coarse	



GRAIN SIZE DISTRIBUTION

**Silty SAND / SAND, trace to some gravel,
trace to some clay TILL**

Figure No.	4
Project No.	60731727
Project Name	Bradford Bypass - 10th Sideroad SWM Pond



PLASTICITY CHART

Sandy SILT TILL

Figure No.	5
Project No.	60731727
Project Name	Bradford Bypass - 10th Sideroad SWM Pond

Appendix **D**

Site Photographs



Client Name: MTO	Report Name: Foundation Investigation and Design Report	Street Name: 10 th Sideroad Storm Water Management Pond	Project No.: 60731727
----------------------------	---	--	---------------------------------

Photo No. 1	Date 9/5/2024
Direction Photo Taken South	
Description	
<ul style="list-style-type: none"> ■ General Site conditions ■ Borehole SWMP10-01-MW 	

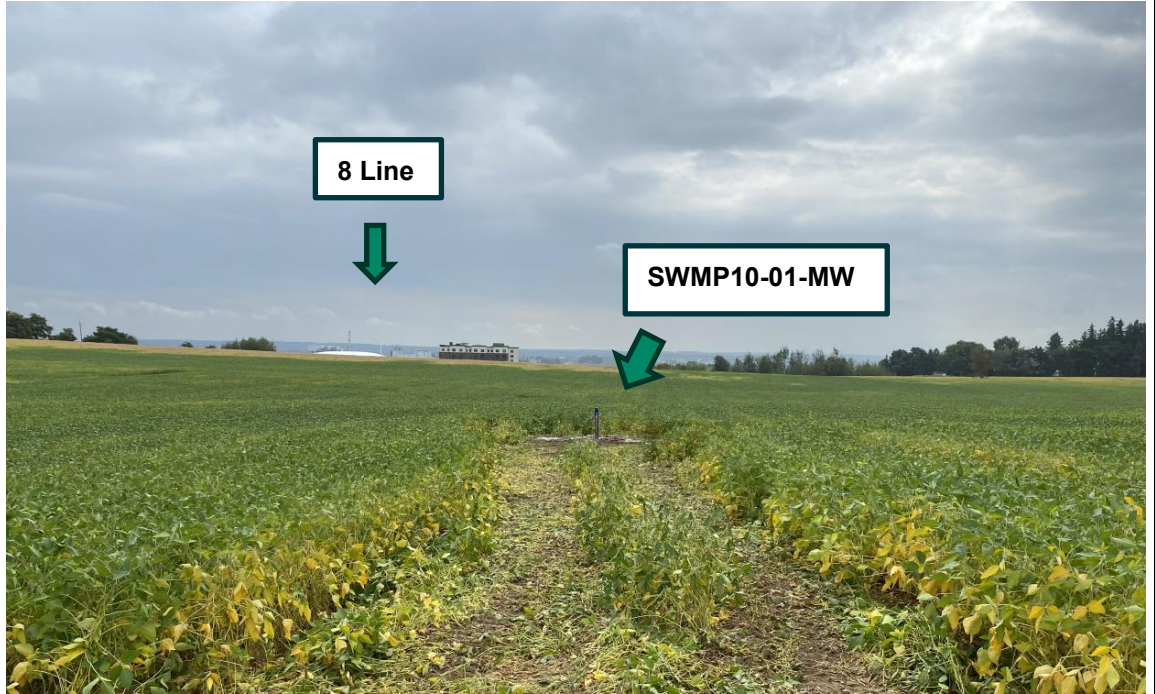


Photo No. 2	Date 9/5/2024
Direction Photo Taken East	
Description	
<ul style="list-style-type: none"> ■ Ground Surface Condition ■ Borehole SWMP10-01-MW 	



Client Name: MTO	Report Name: Foundation Investigation and Design Report	Street Name: 10 th Sideroad Storm Water Management Pond	Project No.: 60731727
----------------------------	---	--	---------------------------------

Photo No. 3	Date 9/9/2024
Direction Photo Taken North	
Description	
<ul style="list-style-type: none"> ■ Well installation completed ■ Borehole SWMP10-02-MW 	

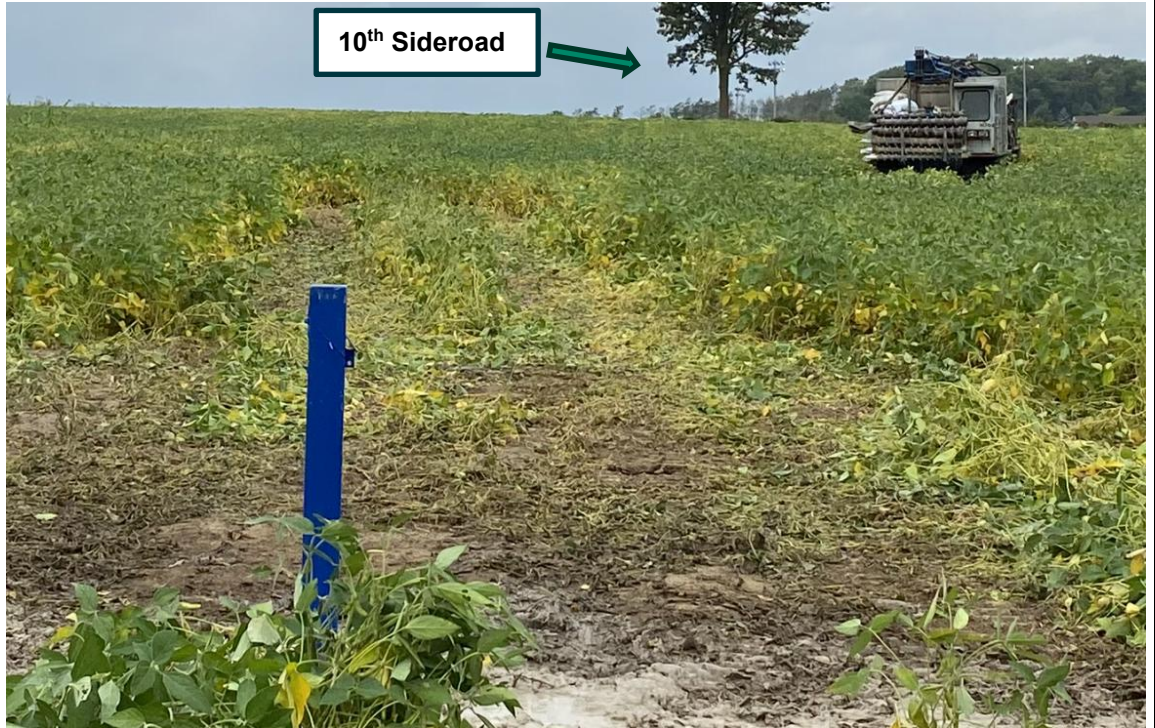


Photo No. 4	Date 9/9/2024
Direction Photo Taken North	
Description	
<ul style="list-style-type: none"> ■ Ground Surface Condition ■ Borehole SWMP10-02-MW 	



Client Name: MTO	Report Name: Foundation Investigation and Design Report	Street Name: 10 th Sideroad Storm Water Management Pond	Project No.: 60731727
----------------------------	---	--	---------------------------------

Photo No. 5	Date 9/4/2024
Direction Photo Taken North	
Description	
<ul style="list-style-type: none"> ■ Well installation completed ■ Borehole SWMP10-03-MW 	

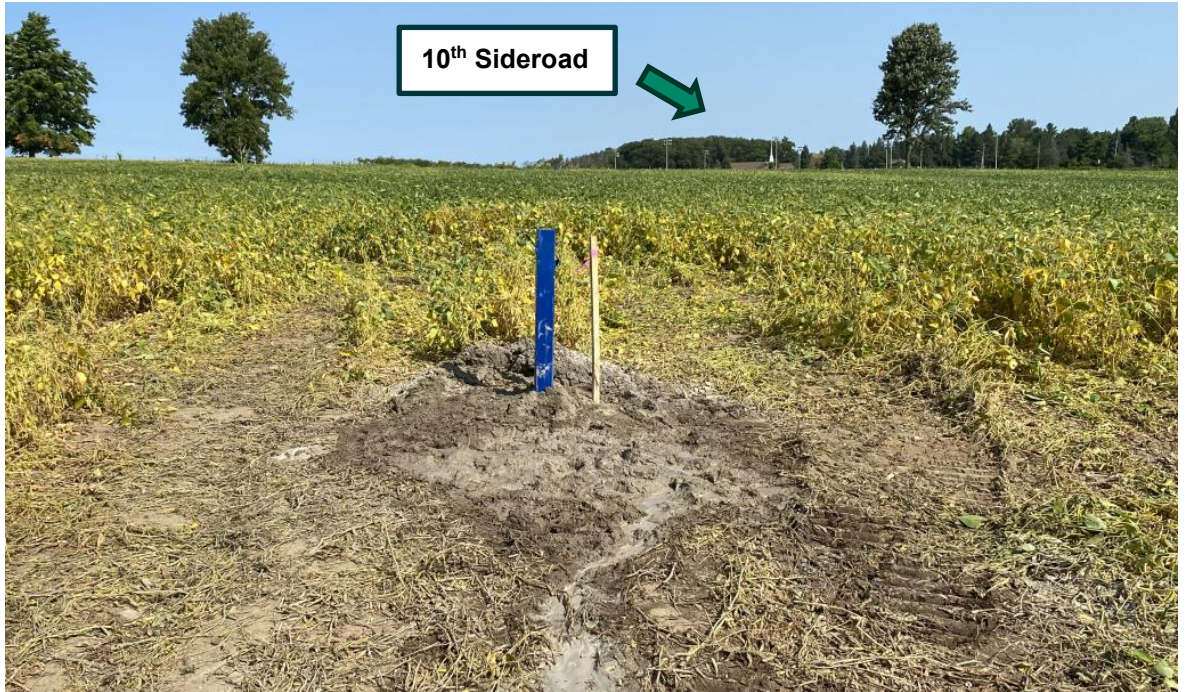


Photo No. 6	Date 4/4/2024
Direction Photo Taken Northeast	
Description	
<ul style="list-style-type: none"> ■ Ground Surface Condition ■ Borehole SWMP10-03-MW 	



Client Name: MTO	Report Name: Foundation Investigation and Design Report	Street Name: 10 th Sideroad Storm Water Management Pond	Project No.: 60731727
----------------------------	---	--	---------------------------------

Photo No. 7	Date 9/9/2024
Direction Photo Taken Southwest	
Description <ul style="list-style-type: none">■ Borehole SWMP10-04■ Start of drilling	



Appendix **E**

SWM Pond Plan Details



2016-10 ANS-D
 MINISTRY OF TRANSPORTATION, ONTARIO
 DRAWING NAME: BBPW-DRN-SWM Pond Plan Details.dwg (DRN02)
 PLOT DATE: 2026/01/31 10:28:29 AM

METRIC
 DIMENSIONS ARE IN METRES AND/OR
 MILLIMETRES UNLESS OTHERWISE SHOWN

HORIZONTAL

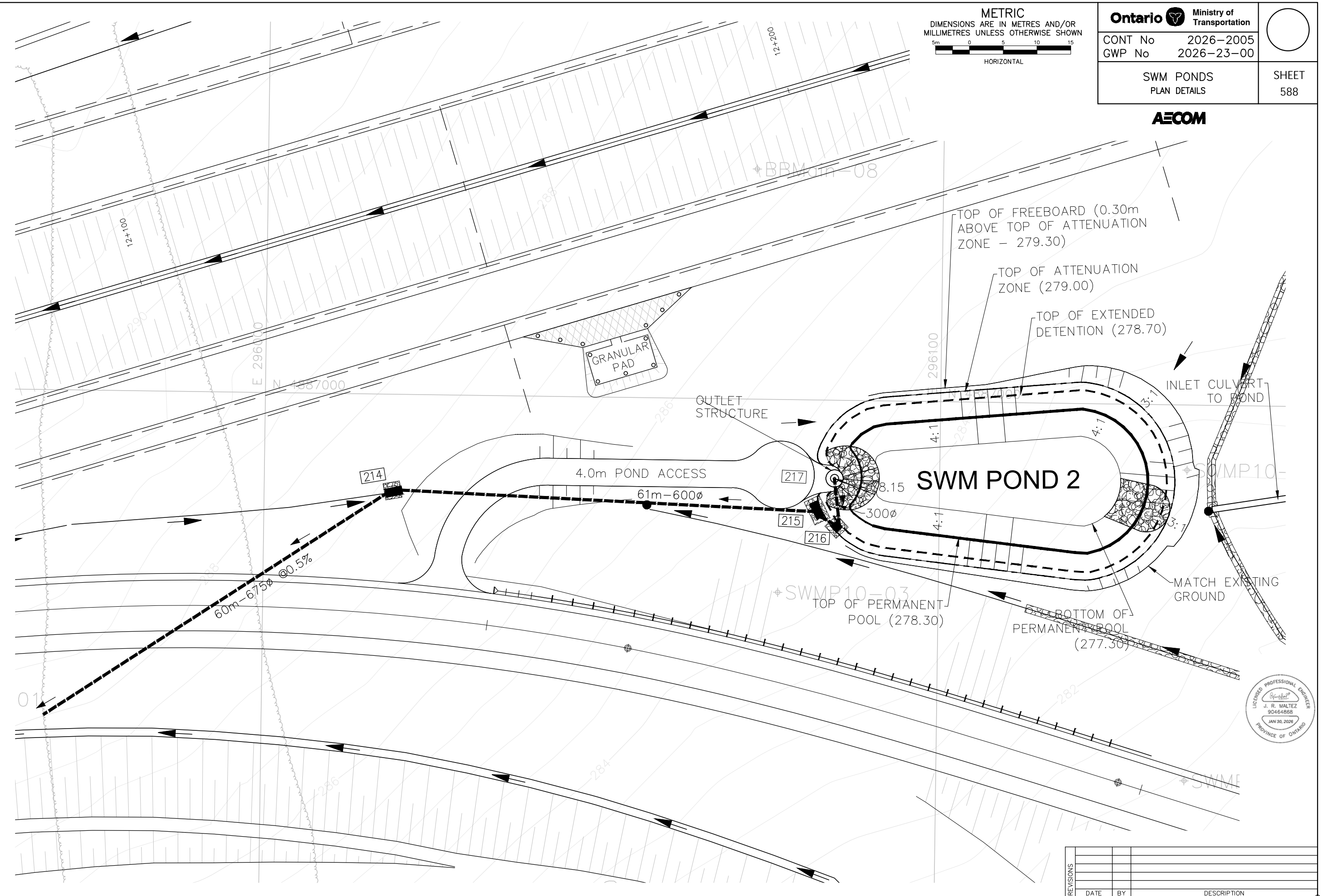
Ontario Ministry of Transportation

CONT No 2026-2005
 GWP No 2026-23-00

SWM PONDS
 PLAN DETAILS

SHEET 588

AECOM



REVISIONS	DATE	BY	DESCRIPTION



Appendix **F**

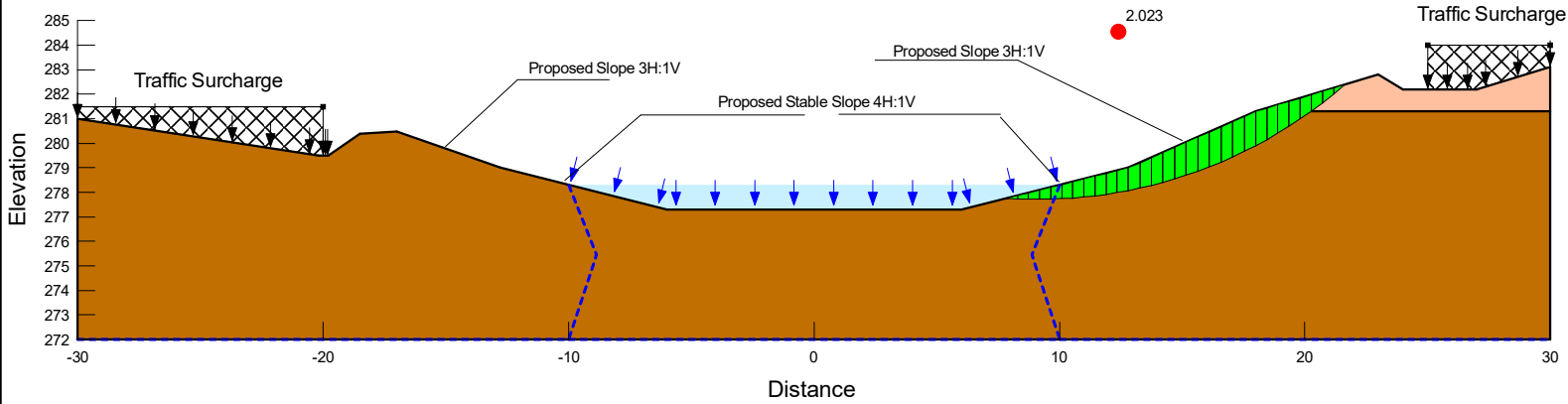
Slope Stability Results



Table: Summary of Slope Stability Assessment

Location	Analysis Type	Target FoS	Calculated FoS	Comment
Northern Side of Pond	Saturated / Unsaturated – Static	1.5	2.023	Permanent Water Level
	Saturated / Unsaturated – Static	1.5	2.309	Regional Storm Event
	Saturated / Unsaturated – Static	1.5	2.056	Rapid Drawdown
	Saturated / Unsaturated – Seismic	1.1	1.671	Permanent Water Level
	Saturated / Unsaturated – Seismic	1.1	1.589	Initial water level
Southern Side of Pond	Saturated / Unsaturated – Static	1.5	3.009	Permanent Water Level
	Saturated / Unsaturated – Static	1.5	4.498	Regional Storm Event
	Saturated / Unsaturated – Static	1.5	2.909	Rapid Drawdown
	Saturated / Unsaturated – Seismic	1.1	2.265	Permanent Water Level
	Saturated / Unsaturated – Seismic	1.1	1.982	Initial water level

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28



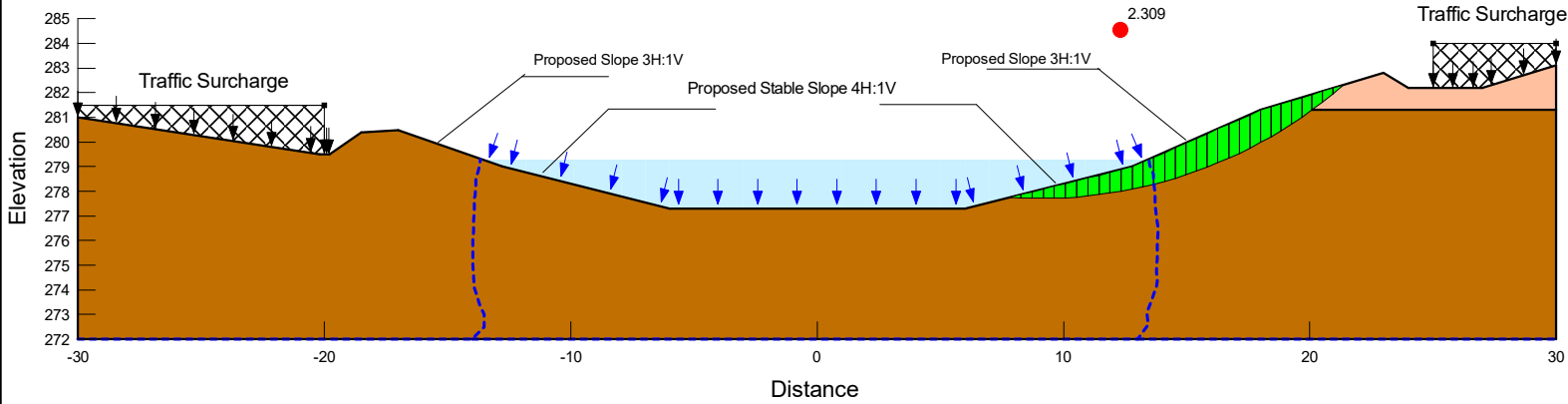
North Side of Pond-Permanent Water Level

SWMP-10th Side Rd.gsz

2026-02-25

1:306

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28



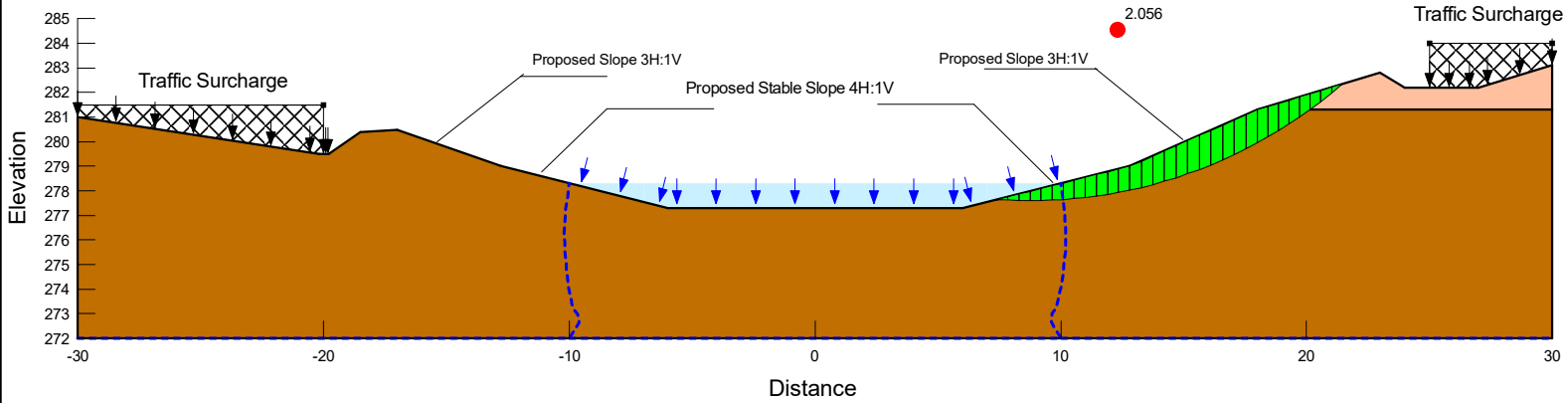
North Side of Pond-Regional Storm Event

SWMP-10th Side Rd.gsz

2026-02-25

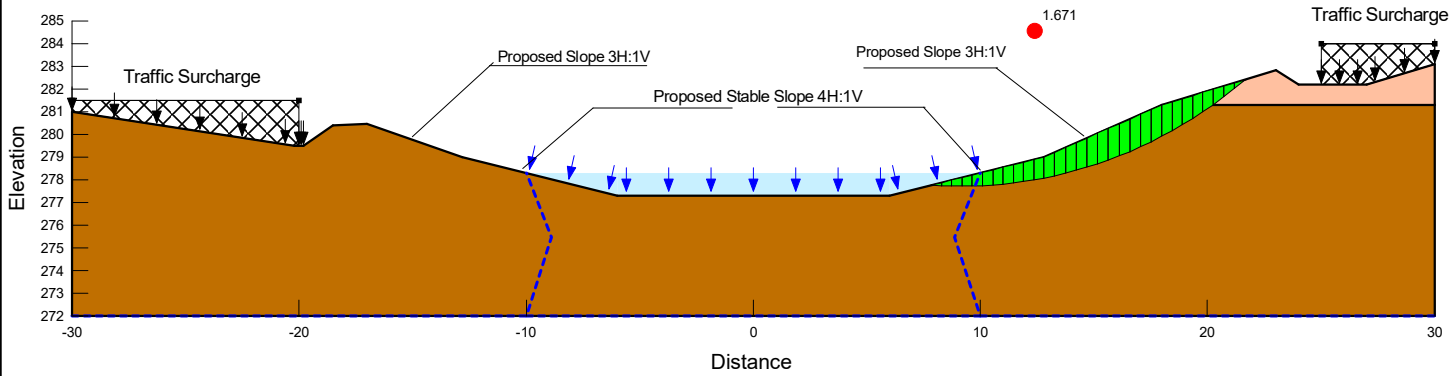
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Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28



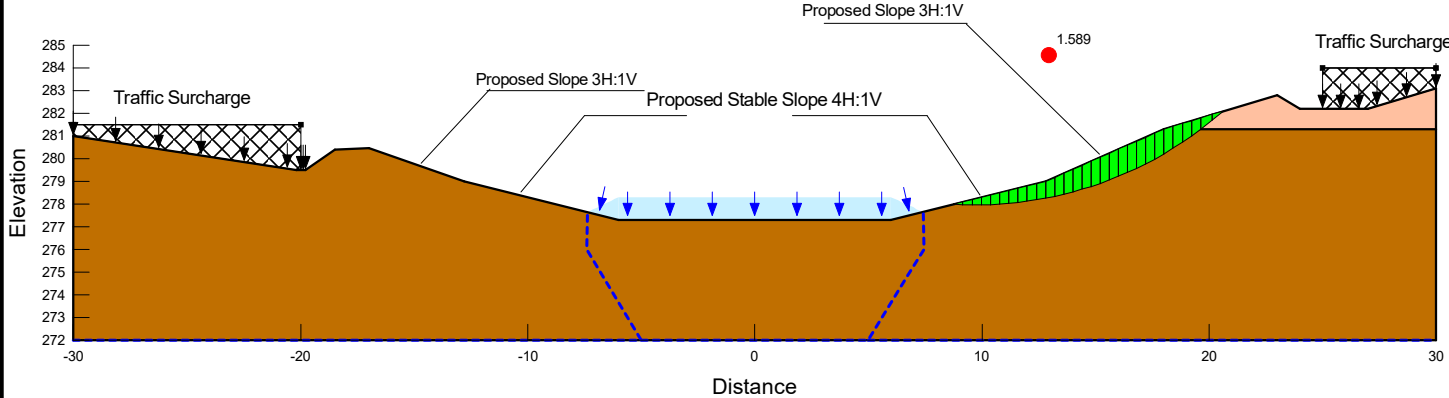
North Side of Pond-Rapid Drawdown
SWMP-10th Side Rd.gsz
2026-02-25
1:306

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34	0	0
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28	0	0



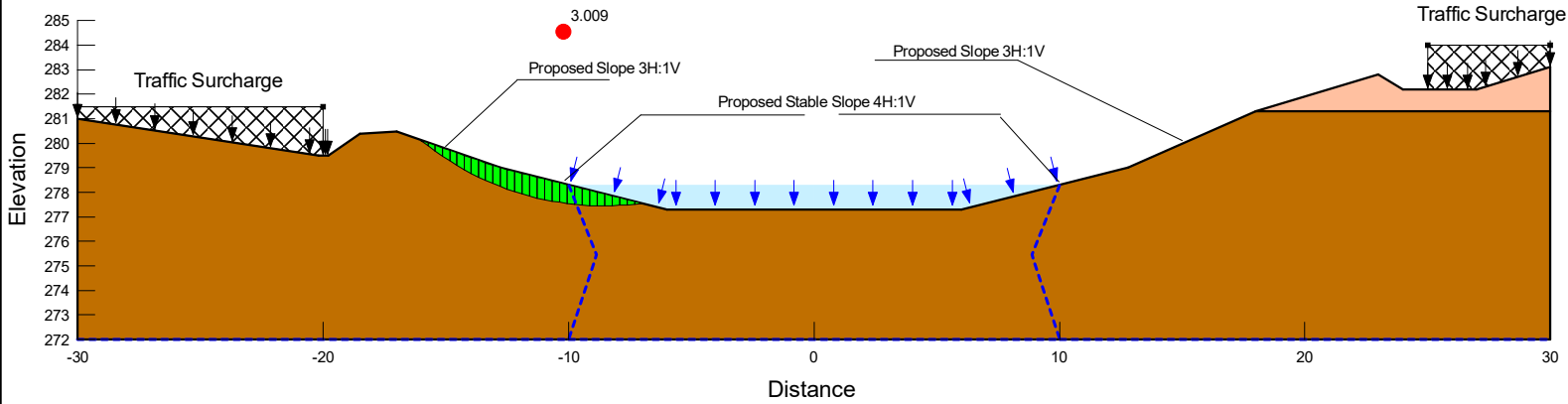
North Side of Pond-Permanent Water Level (Seismic)
SWMP-10th Side Rd.gsz
2026-02-25
1:333

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34	0	0
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28	0	0





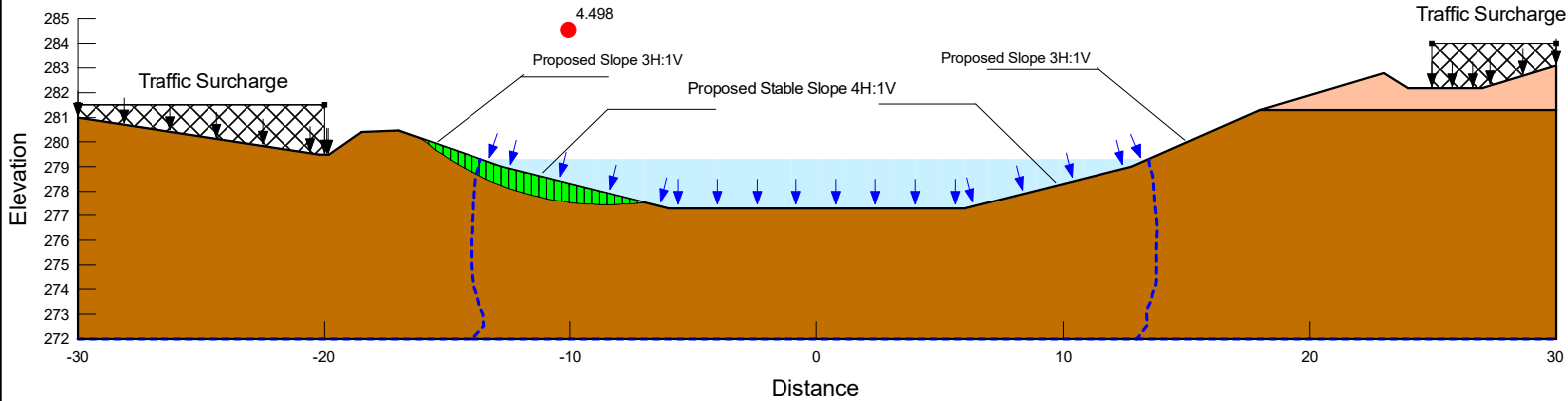
North Side of Pond-Initial Water Level (Seismic)
SWMP-10th Side Rd.gsz
2026-02-25
1:333

Color	Name	Slope Stability Material Model	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28



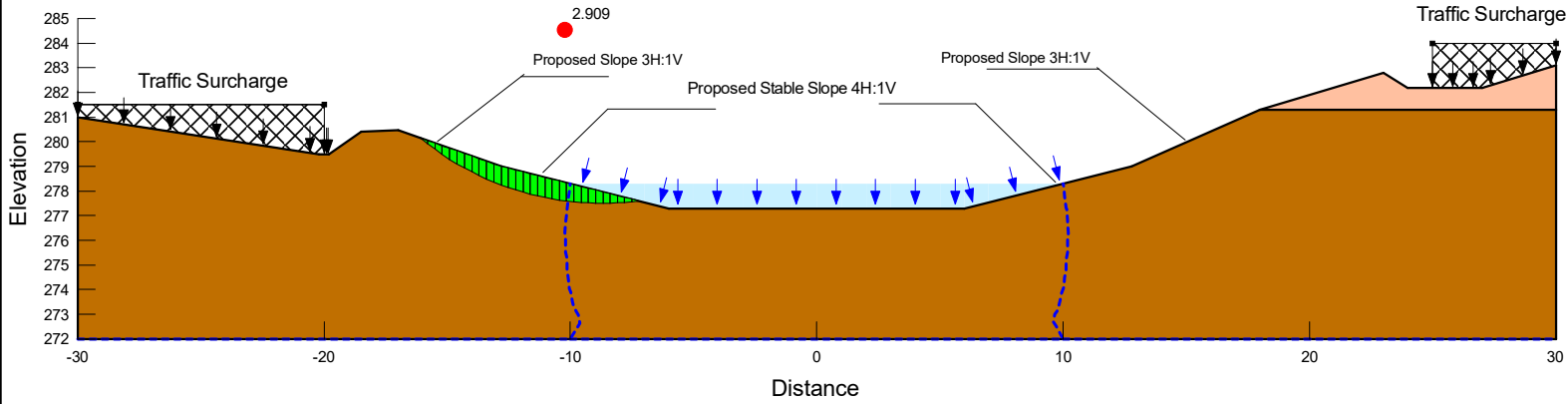
South Side of Pond-Permanent Water Level
SWMP-10th Side Rd.gsz
2026-02-25
1:306

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28





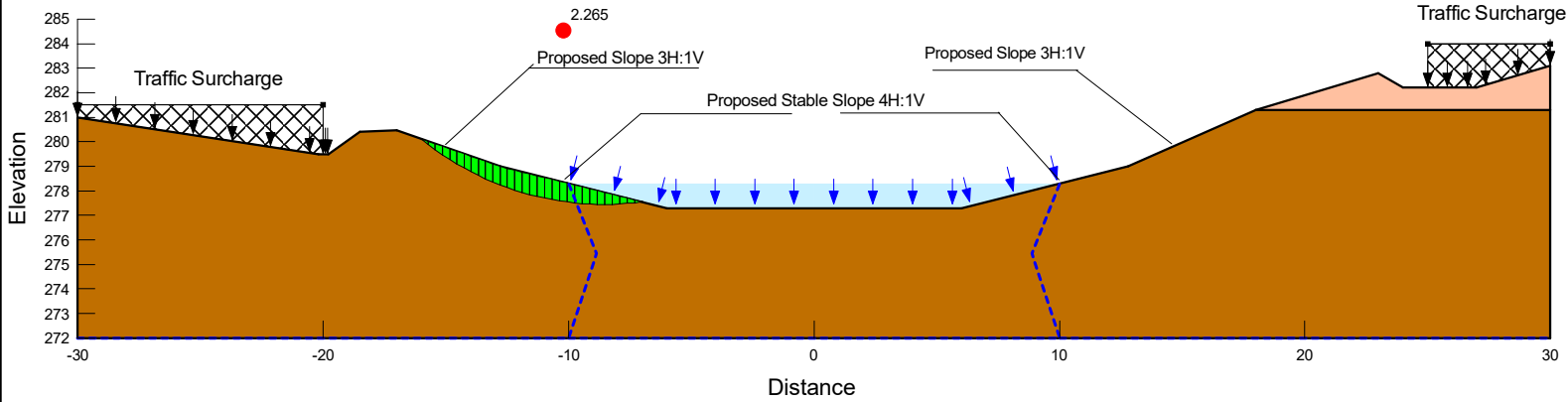
South Side of Pond-Regional Storm Event
SWMP-10th Side Rd.gsz
2026-02-25
1:306

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28



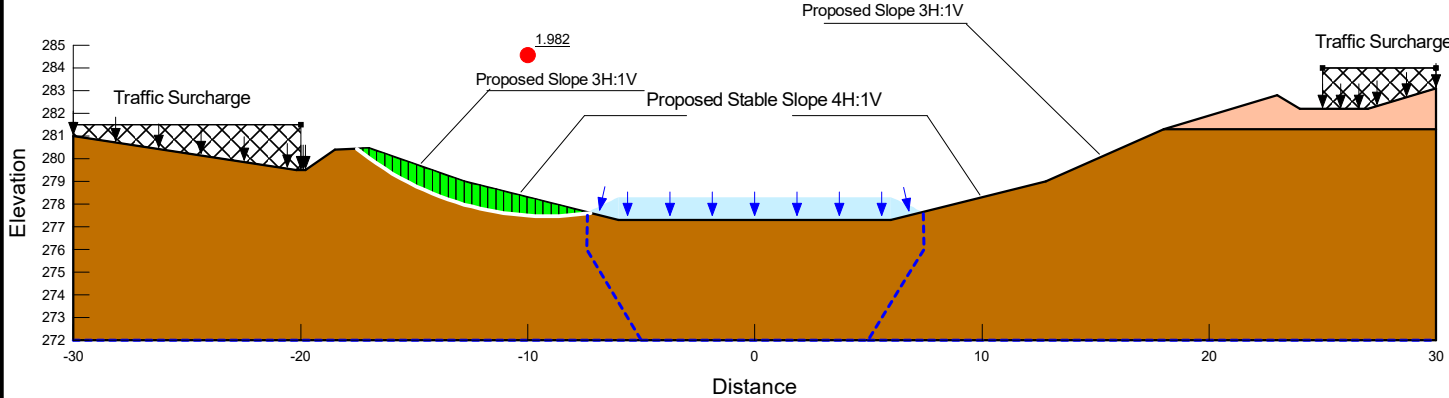
South Side of Pond-Rapid Drawdown
SWMP-10th Side Rd.gsz
2026-02-25
1:306

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34
	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28



South Side of Pond-Permanent Water Level (Seismic)
SWMP-10th Side Rd.gsz
2026-02-25
1:306

Color	Name	Slope Stability Material Model	Unit Weight (kN/m ³)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Cohesion R (kPa)	Phi R (°)
■	Sandy Silt Till to Silty Sand Till, compact to very dense	Mohr-Coulomb	20	0	34	0	0
■	Sandy Silt, loose to very dense	Mohr-Coulomb	18	0	28	0	0



South Side of Pond-Initial Water Level (Seismic)
SWMP-10th Side Rd.gsz
2026-02-25
1:333

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