Appendix A – Integrated Geotechnical and Hydrogeological Assessment Report

PALMER
ENVIRONMENTAL
CONSULTING
GROUP INC.

West Aldershot Creek Erosion EA – Integrated Geotechnical and Hydrogeological Assessment



PECG Project # 1400326

Prepared For
Associated Engineering (Ont.) Ltd

September 30, 2019

Table of Contents

1. Introduction 1
1.1 Background 1
2. Site and Regional Geology 2
3. Field and Laboratory Work 2
4. Subsurface Conditions 3
4.1 Soil Conditions 3
4.2 Hydrogeology 5
5. Slope Stability Analysis 5
5.1 Existing Conditions and Methodology 5
5.2 Long-Term Stable Slope Crest (LTSSC) 6
5.2.1 Stable Slope Inclination 6
5.2.2 Toe Erosion Allowance 7
6. Implications for Erosion Control 8
7. Certification 9
8. References 10

Drawings

Reach 1 – Borehole and Monitoring Well Location Plan 1
Reach 2 and 3 – Location Plan 2

Appendix A

Notes on Sample Descriptions
Explanation of Terms Used in the Borehole Logs
Borehole Logs Encl. No. 1 to 4

Appendix B

Grain Size Distribution Curves Figure No. 1 to 2
Plasticity Chart Figure No. 3

Appendix C

Slope Stability Analysis

Appendix D

Slope Inspection Rating Chart and Form

1. Introduction

Palmer Environmental Consulting Group Inc. (PECG) is pleased to provide Associated Engineering (the Client), on behalf of the City of Burlington (the City), with the results of our integrated geotechnical and hydrogeological assessment along the West Aldershot Creek valley, in Burlington ("the Site"). The baseline geotechnical and hydrogeological information included in this report informs the development and evaluation of alternatives for erosion control in association with completion of a Schedule B Municipal Class Environmental Assessment (EA). A detailed slope stability analysis has been completed along the upper third of the valley (i.e. "Reach 1"), where erosion is most severe and confining banks and valley walls are steepest and highest, based on borehole drilling and measured water levels in groundwater monitoring wells. General comments are provided on slope stability along the middle ("Reach 2") and downstream ("Reach 3") portions of the valley, where valley walls are generally not at risk from fluvial activity.

This report is provided on the basis of the terms presented above. If it can be reasonably foreseen that changes in the proposed plans should require a Geotechnical re-evaluation, or if questions arise concerning Geotechnical aspects of the applicable codes and standards, PECG must be made aware. It may then be necessary to carry out additional boring before the recommendations of this report can be relied upon.

The recommendations made herein follow generally accepted practice for Geotechnical consultants in Ontario. The format and contents of this report are guided by client specific needs and economic factors and may not conform to generalized standards for services.

This report has been prepared solely for the City and Associated Engineering. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties.

1.1 Background

West Aldershot Creek exhibits the effects of an urbanized hydrologic regime, largely without the benefit of stormwater management controls throughout the watershed. Its watershed is covered by a high proportion of impervious surfaces, so it is predisposed to rapid routing of surface runoff and floodwater during even modest rainstorms. The unnaturally rapid, or 'flashy,' hydrologic response has accelerated erosion along the bed and banks of the creek. Anomalous accumulations of sediment at the mouth of West Aldershot Creek, which the City had to dredge to maintain boat access, are a testament to the severity of erosion.

Erosion is most severe along the upstream portion of the study corridor, where the channel is confined along the bottom of a nearly V-shaped ravine with little to no floodplain to attenuate flow energy. Significant bed scour and down-cutting has occurred, which in turn has led to undercutting and collapse of the banks. Several small slope failures have occurred recently along the lower valley walls in response to the fluvial erosion. Trees have fallen into the channel once their root masses are sufficiently undermined, which, in turn, has exacerbated erosion by forcing flows over, under and around the woody debris jams that form. Without intervention, the channel will continue to erode through incremental fluvial scour and mass wastage

until it re-equilibrates with its new hydrologic regime. The downstream portion of the creek, where the valley bottom is wider and a narrow floodplain is more accessible, exhibits fewer, less severe erosion sites.

The City retained AE, which in turn retained PECG, to complete a comprehensive study of observed instability and environmental conditions along the West Aldershot Creek valley as a basis for developing and evaluating erosion control solutions through a Municipal Class EA process. Our team will follow through to complete detailed designs of the preferred alternative selected through the multi-stakeholder evaluation. This report presents the results of a baseline characterization of geotechnical and hydrogeological conditions along the valley in support of the Municipal Class EA process.

2. Site and Regional Geology

The Site is located adjacent to West Aldershot Creek. The study area is situated within the Iroquois Plain physiographic region of Southern Ontario (Chapman and Putnam, 1984). The topography in this region is typically undulating till plains locally overlain by glaciolacustrine deposits. A review of available online surficial geology mapping indicated that the overburden materials of the site generally comprise sand, gravel, and minor silt and clay deposits (Ontario Geological Survey, 2003). Bedrock geology mapping indicated that the site is underlain by materials comprised of shale, limestone, dolostone and siltstone of Queenston Formation (Ontario Geological Survey, 1991). A natural concentration of surface runoff during the Holocene incised the glacial and deglacial deposits through gullying and fluvial erosion, forming the valley through which West Aldershot Creek now flows. Urbanization of the watershed has exacerbated erosion and continues to shape the valley bottom.

3. Field and Laboratory Work

PECG completed a preliminary visual inspection of slopes along the West Aldershot Creek valley using a slope rating system as provided in **Appendix D** (MNR, 2002) and identified four (4) key areas of elevated risk within Reach 1 requiring further site investigation and detailed slope stability analysis (i.e. rating > 35). The level of risk within Reaches 2 and 3 was determined to be minimal and not requiring further site investigation work or detailed slope stability analysis.

The site investigation work for the geotechnical investigation was carried out on August 30 to 31, 2018 by drilling specialists subcontracted to PECG, during which time four (4) boreholes (BH18-1 to BH18-4) were advanced at the locations shown on the Borehole Location Plan, **Drawing 1**. The boreholes were drilled to depths ranging from 9.8 to 14.3m below the existing ground surface.

The boreholes were advanced using continuous flight auger drilling equipment supplied and operated by drilling specialists subcontracted to PECG. The soil stratigraphy was recorded by observing the quality and changes of augered materials that were retrieved from the boreholes, and by sampling the soils at regular intervals of depth using a 50mm O.D. split spoon sampler, in accordance with the Standard Penetration Test (ASTM D 1586) method. This sampling method recovers samples from the soil strata, and the number of blows required to drive the sampler 300mm depth into the undisturbed soil (SPT ‘N’ values) gives an

indication of the compactness condition or consistency of the sampled soil material. The SPT 'N' values are indicated on the borehole logs (Refer to **Appendix A**). The field work for this investigation was supervised by PECG engineering staff, who also logged the boreholes and cared for the recovered samples. PECG staff also examined in situ (undisturbed) sediments exposed in fresh erosion scars along the creek in order to better visualize sedimentological characteristics and stratigraphic contacts (where present) and inform subsequent correlation of units represented in geological cross-sections.

Groundwater condition observations were made in the boreholes during drilling and upon completion of drilling. Monitoring wells were installed in three (3) borehole to allow determination of stabilized groundwater levels. The stabilized groundwater levels were measured on September 18, 2018. The monitoring well installation and groundwater data are summarized in the individual borehole logs and in **Table 1**. The borehole without a monitoring well was backfilled and sealed upon completion of drilling. The distribution of surface indicators of shallow or at-surface groundwater (i.e. seepage), likely perched on an underlying low-permeability unit, were also noted in association with initial site reconnaissance.

All soil samples obtained during this investigation were brought to our laboratory for further examination. These soil samples will be stored for a period of two (2) months after the day of issuing the draft report, after which time they will be discarded unless PECG is advised otherwise in writing. In addition to visual examination in the laboratory, all soil samples from geotechnical boreholes were tested for moisture contents. Grain size analyses of two (2) selected soil samples and Atterberg Limits tests of three (3) soil sample were conducted and the results are presented in **Appendix B**.

The approximate elevations at the as-drilled borehole locations were surveyed using a differential GPS unit by PECG. The elevations at these locations were not provided by a professional surveyor and should be considered approximate. Contractors performing the work should confirm the elevations prior to construction. Borehole locations are plotted on the Borehole Location Plan (**Drawing 1**).

4. Subsurface Conditions

The borehole locations (BH18-1 to BH18-4) are shown on **Drawing 1**. General notes on sample description are presented in **Appendix A**. The subsurface conditions in the boreholes are presented in the individual borehole logs (**Enclosures 1** to **4** inclusive, **Appendix A**). The subsurface conditions in the boreholes are summarized in the following paragraphs.

4.1 Soil Conditions

Topsoil

A 100 to 130mm thick layer of surficial topsoil was encountered in all boreholes. It should be noted that the thickness of the topsoil explored at the borehole locations may not be representative for the site and should not be relied on to calculate the amount of topsoil at the site.

Fill Materials

Fill materials consisting of clayey silt, sandy silt, and sand were encountered below the topsoil in all boreholes, and extended to depths ranging from about 1.0 to 2.6m below the existing ground surface (Elev. 82.5 to 90.7m). For the cohesive clayey silt fill materials, SPT 'N' value of 3 blows per 300mm penetration indicated a soft consistency. For the cohesionless sandy silt and sand fill materials, SPT 'N' values ranging from 5 to 26 blows per 300mm penetration indicated a loose to compact compactness condition. The in-situ moisture contents measured in the fill samples ranged from approximately 2% to 30%.

Silt, Sandy Silt, Silty Sand, and Sand

Silt, sandy silt, silty sand, and sand deposits were encountered below the fill materials in Boreholes BH18-1 to BH18-3, and extended to depths ranging from about 8.0 to 9.5m below the existing ground surface (Elev. 79.4 to 83.7m). SPT 'N' values ranged from 6 to 43 blows per 300mm penetration indicating a loose to dense compactness condition. The natural moisture contents measured in the soil samples ranged from approximately 3% to 23%.

Grain size analysis was conducted on two (2) sandy/silty samples (BH18-1/SS5 and BH18-3/SS8). The result is presented on borehole log and in **Appendix B**, with the following fractions:

Gravel:	0 to 3%
Sand:	5 to 75%
Silt:	13 to 80%
Clay:	9 to 15%

Upper Clayey Silt

An upper clayey silt deposit was encountered between layers of silt, sandy silt, silty sand, and sand deposits in Boreholes BH18-1 and BH18-3. In Borehole BH18-1, this deposit extended from 7.7 to 7.9m below the existing ground surface (Elev. 80.9 to 81.1m). In Borehole BH18-3, this deposit extended from 3.0 to 6.3m below the existing ground surface (Elev. 82.2 to 85.5m). SPT 'N' values ranging from 16 to 43 blows per 300 mm penetration indicated a very stiff to hard consistency. The natural moisture contents measured in the soil samples ranged from approximately 13% to 21%.

Clayey Silt to Silty Clay

Clayey silt to silty clay deposits were encountered below the fill materials or silt, sandy silt, silty sand, and sand deposits in all boreholes, and extended to depths ranging from 9.8 to 14.3m below the existing ground surface (Elev. 74.5 to 78.9m). SPT 'N' values ranging from 7 to 43 blows per 300 mm penetration indicated a firm to hard consistency. All boreholes were terminated in these deposits. The natural moisture contents measured in the soil samples ranged from approximately 18% to 26%.

Consistency (Atterberg) limits test on three (3) samples (BH18-1/SS12, BH18-2/SS10, and BH18-3/SS9) of the fines content of the soil matrix component of the clayey silt to silty clay indicated liquid limits ranging

from 25 to 31, a plastic limits of 16, and plasticity indices ranging from 9 to 15 (see **Appendix B**). According to the modified Unified Soil Classification System, the samples are classified as low plasticity silty clay (CL).

4.2 Hydrogeology

Upon completion of drilling, water was observed in Borehole BH18-4 at a depth of 6.1m below existing ground surface (Elev. 78.8m). Water was encountered during drilling in all boreholes at depths ranging from 1.0 to 3.3m below existing ground surface (Elev. 83.4 to 90.7m). Three (3) 50 mm diameter monitoring wells were installed to monitor stabilized groundwater level. The stabilized groundwater level was measured on September 18, 2018. The monitoring well installation details and the measured groundwater levels are shown in the borehole logs and summarized in **Table 1**.

Table 1: Monitoring Well Details and Water Levels

Monitoring Well ID	Screen Interval (mBGS)	September 18, 2018	
		Water Level Depth (mBGS)	Water Level Elevation (m)
BH18-1	3.0 – 6.1	3.8	85.0
BH18-2	6.1 – 7.6	1.9	89.8
BH18-3	7.6 – 10.7	1.1	87.4

Note: mBGS = meter below ground surface

Measured groundwater levels were supplemented by site reconnaissance data of localized seepage directly adjacent to the creek (i.e. toe of the slope) to estimate the approximate water table and groundwater flow direction. Note that while seepage was observed further up the slope (i.e. mid slope), this is not necessarily representative of the groundwater table and may be a result of a perched water table in the fill material, surface runoff or a combination of the two.

The resultant water table discussed in later sections was fitted based on an interpretation of the aforementioned data, which indicates a groundwater flow direction towards the creek. It should be noted that the groundwater levels can vary and are subject to seasonal fluctuations in response to weather events.

5. Slope Stability Analysis

5.1 Existing Conditions and Methodology

Slope stability analyses were conducted by means of a limit-equilibrium approach using SLIDE® 8.0 (distributed by Rocscience Inc.) software package to determine the Factor of Safety (FoS) of the slope.

Typical FoS acceptance criteria are based on static stability (i.e. no seismic loading) and for this site are considered to be in the range of FoS = 1.3 to 1.5. A number of methods are available to perform the relevant calculations and include Bishop, Spencer and Morgenstern-Price. All were used as a check on one another.

Detailed stability analyses were conducted on four (4) cross-sections across Reach 1 of the creek valley (see **Drawing 1**) in order to evaluate the stability of the existing slopes. Material properties are based on generally accepted local (i.e. Southern Ontario) correlations between the SPT 'N' value and the frictional strength of the in-situ soils as summarized in **Table 2**. Note that stratigraphy of the soils was supplemented by observations of exposed silty clay along the creek bank which have been incorporated into the analyses.

Table 2. Frictional Properties of Relevant Soils

Type	Unit Weight (kN/m^3)	Friction Angle (°)	Cohesion (kPa)
Fill	19.5	26.0	0.0
Sand	21.0	30.0	0.0
Silt / Sand	21.0 – 21.5	30.0 – 33.0	0.0
Clayey Silt	21.0	30.0 – 31.0	5.0 – 8.0
Silty Clay	20.5	28.0	3.0

As previously indicated, the groundwater table has been interpreted based on soil characteristics, site reconnaissance data (i.e. seepage along creek) and one round of water level measurements. Additional water level monitoring would allow further refinement of the groundwater table.

Note that the objective of slope stability modeling is to assess the potential for long-term deep-seated failure. Stability of the slopes in the transient short-term may be subject to atypical conditions (i.e. during construction) which are not considered. This may include loading due to heavy equipment or stockpiling of excavated materials on the crest of the slopes, both of which should be avoided.

Additionally, localized erosion or shallow instabilities that are the result of groundwater seepage or surface runoff are not considered. It is understood that an appropriate vegetation / seeding program would address these issues.

5.2 Long-Term Stable Slope Crest (LTSSC)

5.2.1 Stable Slope Inclination

Reach 1

Results indicate that the slopes within Reach 1 are not subject to deep-seated failure. Detailed slope stability analysis indicates instability is limited to the over-steepened toe region of the slopes, which are expected to continuously slough until attaining a relatively stable 2H:1V slope. This is supported by visual investigation of the mid-crest region of the slope in cross-section, which is at approximately 2H:1V.

Without intervention, the toe will likely naturally flatten out to 2H:1V over time. A summary of slope stability scenarios with their respective factors of safety is provided in **Table 3.** Detailed analysis results are provided in **Appendix C**. The long-term stable slope crest (LTSSC) is delineated on **Drawing 1**.

Table 3. Slope Stability Analysis Results

Section	Scenario (groundwater)	Loading (kPa)	Factor of Safety	Type[1]
1	As measured	0	1.0 – 1.2	Shallow (toe)
2	As measured	50	1.0 – 1.2	Shallow (toe)
3	As measured	25	1.2 – 1.3	Deep-seated
4	As measured	25	1.3 – 1.4	Deep-seated

[1]Note: Shallow (toe) means limited small-scale failure restricted to the toe region of the slope, which has limited impact on stability of the larger slope. Deep-seated means large-scale failure that can impact stability of the larger slope.

Reaches 2 and 3

Several cross-sections as indicated on **Drawing 2** were cut across Reaches 2 and 3 and visually compared to cross-sections from Reach 1 (see **Appendix C**). Generally, the slopes within the downstream reaches (2 and 3) flatten out significantly when compared to Reach 1, indicating comparatively stable conditions. Analysis also indicates the creek channel widens significantly in the downstream reaches when compared to Reach 1, indicating a lower risk of erosive potential and reduced need for mitigative measures.

Given that no boreholes were drilled within Reaches 2 and 3, as per MNRF guidelines (MNR, 2002) in the absence of site-specific geotechnical information, a 3H:1V stable slope inclination has been assumed. The LTSSC is delineated on **Drawing 2**.

5.2.2 Toe Erosion Allowance

The LTSSC is supplemented by a toe erosion allowance as delineated on **Drawings 1** and **2**. The required toe erosion allowance has been determined based on consideration of MNRF guidelines (MNR, 2002), reach-specific rates of bank erosion estimated over the historical record, and an understanding of site-specific fluvial processes.

A toe erosion allowance of 5 m has been applied along Reach 1 based on documentation of a time-averaged erosion rate of approximately 0.05 m/year since 1962, which is consistent with MNR's (2002) toe erosion allowance range of 5 to 8 m for cohesive clay/silt soils. Application of the lower limit of the range is also appropriate because most of the erosive energy along this ravine-like reach is attenuated through down-cutting as opposed to lateral erosion, more typical of the meandering watercourses on which MNR's (2002) empirical ranges are based.

A toe erosion allowance of 8 m has been applied to Reaches 2 and 3, where meanders are better developed and locally separated from the cohesive valley walls by alluvial terraces and sand/silt fill (range of 8 to 15 m, MNR (2002)). Erosion of the toes of actual valley walls is limited. Time-averaged erosion rates approximated through comparative overlay analysis of historical channel positions were deemed unrepresentative due to the short period (1998 to 2017) represented by available aerial photography since readoption of a meander pattern from a historically straightened alignment.

6. Implications for Erosion Control

A number of findings of this integrated geotechnical and hydrogeological assessment of the West Aldershot Creek valley warrant highlighting given their implications for the development and ultimate implementation of erosion control measures:

- West Aldershot School, immediately east of Reach 1, is not currently at risk from fluvial erosion or related slope instability. Erosion control measures should focus on toe-slope protection, thereby minimizing or eliminating the need to consider a toe erosion allowance, and avoid excessive cuts that could compromise upper slope stability.
- The townhouse complex west of Reach 1 is not currently at risk from fluvial erosion or related slope instability. Erosion control measures could not reasonably affect stability of the complex given how far set back it is from the steep western valley wall.
- Both banks (toe slopes) alongside Reach 1 are unstable, as evidenced in the field by over-steepened or undercut and collapsing banks. Without intervention, the banks would likely naturally flatten out to around 2H:1V. As such, erosion control measures that involve bank regrading should also target a 2H:1V slope, unless retaining structures (e.g. armourstone) are incorporated. Opportunities to incorporate benching are also worth considering.
- Groundwater seepage is not the primary factor contributing to instability of the toe along Reach 1. In order to avoid significantly impacting the groundwater table, erosion control measures (e.g. boulder or armourstone revetment) should be free-draining to avoid pooling of water in behind, which could raise the groundwater table and cause stability issues up-slope.
- No specific slope stability concerns were identified along Reaches 2 or 3, apart from local creek bank erosion sites that can be addressed satisfactorily without detailed geotechnical information.
- Disturbed areas not otherwise protected with erosion control treatments should be re-vegetated with native species to inhibit erosion from surface runoff.

Given that no detailed slope stability analyses was performed for Reaches 2 and 3, it is recommended that periodic visual inspection (i.e. every 2 years) of their slopes be carried out using the form provided in **Appendix D**. PECG should be made aware of any potential concerns that arise during these inspections.

7. Certification

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

This report was prepared and reviewed by the undersigned:

Prepared By:

Aldo Katragjini, B.A Sc., EIT
Geotechnical Engineer-in-Training

Prepared By:

Ted Pan, B.A Sc., EIT
Geotechnical Engineer-in-Training

Reviewed By:

Chi Cheng (Dennis) Tseng, M.Sc., P. Eng.
Senior Geotechnical Engineer



Reviewed By:

Robin McKillop, M.Sc., P.Geo.
Principal, Geomorphologist

8. References

ASTM International. 2018. ASTM D1586 / D1586M-18, Standard test method for standard penetration test (SPT) and split-barrel sampling of soils.

Chapman, L.J. and Putnam, D.F. 1984. Physiography of southern Ontario; Ontario Geological Survey

Ontario Geological Survey (OGS). 1991. Bedrock geology of Ontario, southern sheet. Ontario Geological Survey, Map 2544

Ontario Geological Survey (OGS). 2003. Surficial geology of Southern Ontario

Ontario Ministry of Natural Resources. 2002. Technical guide – River & stream systems: Erosion hazard limit

General Comments and Limitations of Report

This geotechnical assessment is preliminary and prepared on the basis of limited number of boreholes. As such additional boreholes are required before the final design is implemented.

PECG should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, PECG will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes and test pits required to determine the localized underground conditions between boreholes and test pits 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 and test pit results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to PECG at the time of preparation. Unless otherwise agreed in writing by PECG, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

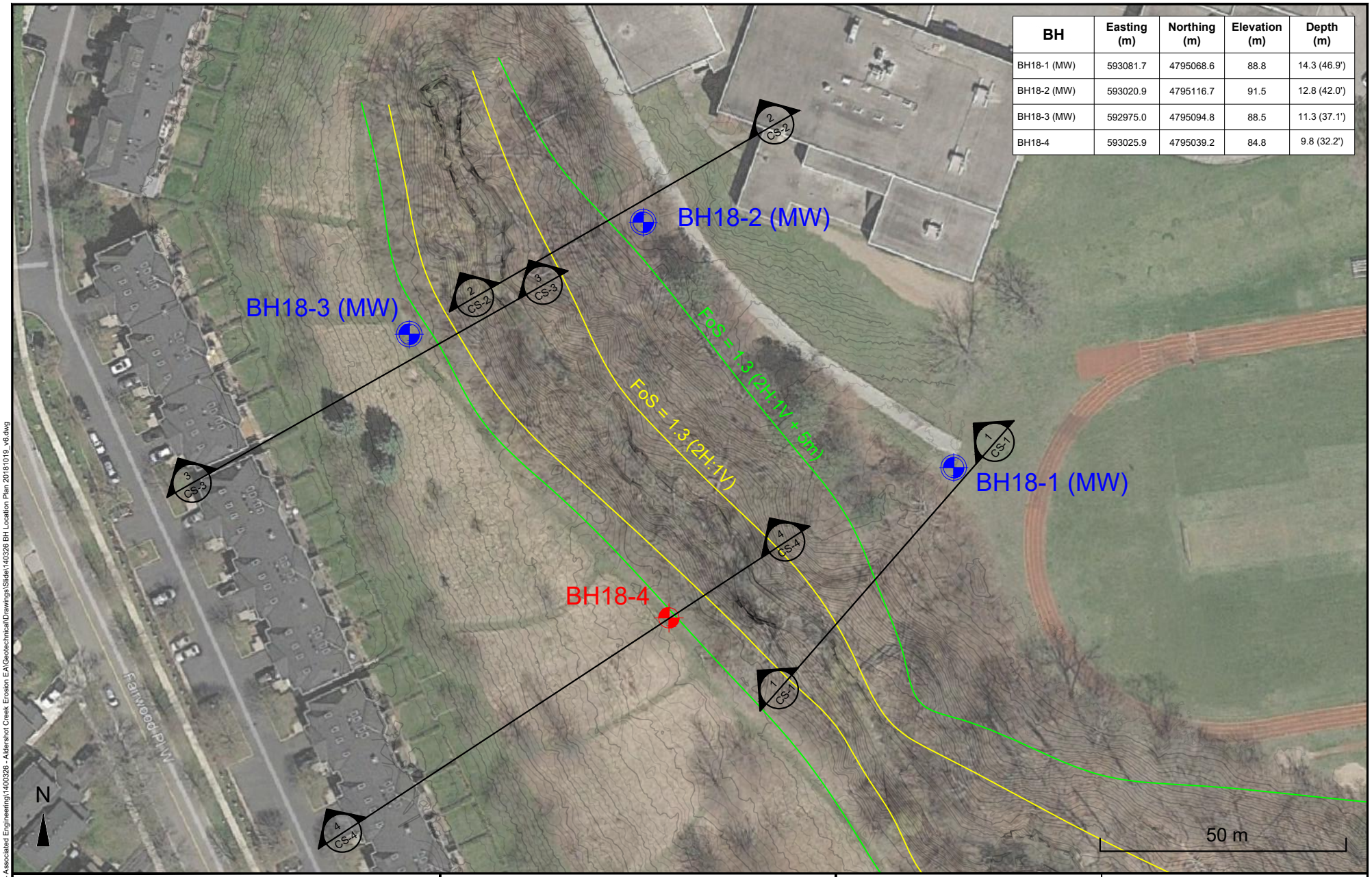
The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with generally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. PECG accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

Drawings



BH	Easting (m)	Northing (m)	Elevation (m)	Depth (m)
BH18-1 (MW)	593081.7	4795068.6	88.8	14.3 (46.9')
BH18-2 (MW)	593020.9	4795116.7	91.5	12.8 (42.0')
BH18-3 (MW)	592975.0	4795094.8	88.5	11.3 (37.1')
BH18-4	593025.9	4795039.2	84.8	9.8 (32.2')

LEGEND

- BH18-1 — Borehole Location
- BH18-1 (MW) — Monitoring Well Location
- Erosion Hazard Limit

Note: Satellite Image from Google Earth (2018)

Client:	Associated Engineering	Project No.:	1400326
Drawn:	AK	Approved:	DT
Date:	Apr. 2019	Scale:	As shown
Original Size:	Letter	Rev:	A-0

Drawing No.: 1

Title: Reach 1 - Borehole and Monitoring Well Location Plan

Project: West Aldershot Creek Erosion EA
Integrated Geotechnical and Hydrogeological Assessment

PALMER ENVIRONMENTAL CONSULTING GROUP INC.
74 Berkeley Street
Toronto, Ontario
M5A 2W7

\\EgnyteDrive\esg\Shared\Projects\Active\14003 - Associated Engineering\1400326 - Aldershot Creek Erosion EA\Geotechnical\Drawings\Slide\140326 BH Location Plan 20181019_v6.dwg



LEGEND

BH18-1	Borehole Location
BH18-1 (MW)	Monitoring Well Location
	Erosion Hazard Limit

Note: Satellite Image from Google Earth (2018)

Client:	Associated Engineering	Project No.: 1400326	Drawing No.: 2
Drawn: AK	Approved: DT	Title:	Reach 2 and 3 - Location Plan
Date: Apr. 2019	Scale: As shown	Project:	West Aldershot Creek Erosion EA Integrated Geotechnical and Hydrogeological Assessment
Original Size: Letter	Rev: A-0	PALMER ENVIRONMENTAL CONSULTING GROUP INC.	74 Berkeley Street Toronto, Ontario M5A 2W7

15

\\EgnyteDrive\pecg\Shared\Projects\Active\14003 - Associated Engineering\1400326 - Aldershot Creek Erosion EA\Geotechnical\Drawings\Slide\Addtl XSEC\Contours_All_v4.dwg

Appendix A

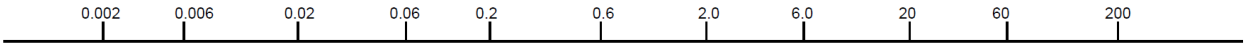
Project: 1400326 **Appendix A**

NOTES ON SAMPLE DESCRIPTIONS

1. All sample descriptions included in this report generally follow the Unified Soil Classification system. Laboratory grain size analyses provided by PECG also follow the same system. Different classification systems may be used by others, such as the system by the International Society for Soil Mechanics and Foundation Engineering (ISSMFE). Please note that with the exception of samples where Gradation and / or Atterberg Limits testing have been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log, it is defined as indicated by the sample recovered during the drilling process. The reader is cautioned that fills are heterogeneous in nature and consequently 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 obstructions 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 indicated 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. The readings are to advise to 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 underground reconstruction, buried oil tanks are common and are generally not detected in a conventional preliminary 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 on the borehole logs. 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.

EXPLANATION OF TERMS USED IN THE BOREHOLE LOGS

Sample Type

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO	Drive open
DS	Dimension type sample
FS	Foil sample
RC	Rock core
SC	Soil core
SS	Spoon sample
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

Penetration Resistance

Standard Penetration Resistance (SPT), 'N':

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter open sampler for a distance of 300 mm (12 in).

Dynamic Cone Penetration Resistance, N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in) to drive uncased a 50 mm (2 in) diameter 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in).

Textural Classification of Soils

Classification	**Particle Size**
Boulders	>300 mm
Cobbles	75 mm – 300 mm
Gravel (Gr)	4.75 mm – 75 mm
Sand (Sa)	0.075 mm – 4.75 mm
Silt (Si)	0.002 mm – 0.075 mm
Clay (Cl)	<0.002 mm
Terminology	**Proportion**
Trace	0 – 10%
Some	10 – 20%
Adjective (e.g. silty or sandy)	20 – 35%
And (e.g. sand and gravel)	> 35 %

Soil Description

a) Cohesive Soils

Consistency	**Undrained Shear Strength (kPa)**	**SPT 'N' Value**
Very Soft	< 12	0 – 2
Soft	12 – 25	2 – 4
Firm	25 – 50	4 – 8
Stiff	50 – 100	8 – 15
Very Stiff	100 – 200	15 – 30
Hard	> 200	> 30

b) Cohesionless Soils

Density Index (Relative Density)	**Undrained Shear Strength (kPa)**	**SPT 'N' Value**
Very Loose	N/A	< 4
Loose	N/A	4 – 10
Compact	N/A	10 – 30
Dense	N/A	30 – 50
Very Dense	N/A	> 50

Soil Tests

w	Water content
w_p	Plastic limit
w_l	Liquid limit
C	Consolidation (oedometer) test
CID	Consolidated isotropically drained triaxial test
CIU	Consolidated isotropically undrained triaxial test with porewater pressure measurement
D_R	Relative density (Specific gravity, Gs)
DS	Direct shear test
ENV	Environmental / chemical analysis
M	Sieve analysis for particle size
MH	Combined sieve and hydrometer (H) analysis
MPC	Modified proctor compaction test
SPC	Standard proctor compaction test
OC	Organic content test
V	Field vane (LV – laboratory vane test)
γ	Unit weight

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

LOG OF BOREHOLE BH18-1

PROJECT: Geotechnical Investigation - Aldershot Creek Erosion

CLIENT: Associated Engineering

PROJECT LOCATION: Burlington, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Solid Stem Augers

Diameter: 150 mm

Date: Aug-30-2018

REF. NO.: 1400326

ENCL NO.: 1

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m
88.8	Ground Surface				
88.7 / 0.1	**TOPSOIL:** 100 mm		1	SS	10
	FILL: sand, trace silt, trace gravel, trace rootlets, trace organics, brown, moist, loose to compact		2	SS	11
87.4 / 1.5	**SAND:** trace to some silt, trace clay, trace gravel, brown, moist to wet, compact to dense		3	SS	18
			4	SS	20
			5	SS	20
			6	SS	19
82.5 / 6.3	**SANDY SILT:** trace clay, brown, wet, dense		7	SS	35
81.7 / 7.2	**SAND:** trace clay, some silt, trace gravel, brown, wet, dense				
81.1 / 7.9	**CLAYEY SILT:** trace sand, brown, wet, hard		8	SS	43
	SAND: trace clay, trace silt, trace gravel, contains pockets of sandy silt, brown, wet, dense				
79.4 / 9.5	**CLAYEY SILT:** trace sand, trace gravel, grey, wet, hard		9	SS	43
78.0 / 10.8	**SILT CLAY:** grey, wet, stiff		10	SS	14
			11	SS	15
74.5 / 14.3	**END OF BOREHOLE**		12	SS	12

1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole.
2. Water Level Readings:

Date	W. L. Depth (mBGS)
Sep 18, 2018	3.76

GROUND WATER CONDITIONS: Concrete; Holeplug; W. L. 85.1 m Sep 18, 2018; Sand Screen; Natural Pack

ELEVATION: 88, 87, 86, 84, 83, 82, 81, 80, 79, 78, 77, 76, 75

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa): 10 (at 11); 10 (at 12); 5 (at 14)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
Spoon Wet	3	75	13	9

GROUNDWATER ELEVATIONS

Measurement 1st 2nd 3rd 4th

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SOIL ROCK AUG 14 2013 - PALMER
PALMER ACAD 2004 - LOG 1400326 - ALDERSHOT CREEK EROSION - 2018 09 19.GPJ - 18-10-19

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

LOG OF BOREHOLE BH18-2

PROJECT: Geotechnical Investigation - Aldershot Creek Erosion

CLIENT: Associated Engineering

PROJECT LOCATION: Burlington, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Solid Stem Augers

Diameter: 150 mm

Date: Aug-30-2018

REF. NO.: 1400326

ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
91.7	Ground Surface											
91.6	**TOPSOIL:** 130 mm						Concrete					
0.1	**FILL:** sand, trace some silt, trace gravel, trace rootlets, brown, moist, compact		1	SS	13				○			
90.7			2	SS	13		91		○			Spoon Wet
1.0	**SAND:** trace to some silt, trace clay, trace gravel, brown, wet, compact		3	SS	16	▽	90		○			
							W. L. 89.9 m Sep 18, 2018					
			4	SS	12		89		○			
							Holeplug					
			5	SS	16		88		○			
86.8			6	SS	26		87		○			
4.9	**SILT:** trace clay, trace sand, contains layers of clayey silt, brown, moist, compact											
86.1							86					
5.6	**SILTY SAND:** trace clay, trace gravel, brown, wet, compact		7	SS	13				○			
85.1							Sand Screen					
6.6	**SAND:** trace to some silt, trace clay, trace gravel, brown, wet to saturated, compact											
83.7			8	SS	20		84		○		45	
8.0	**SILT CLAY:** trace sand, grey, wet, stiff to very stiff						83					
	contains layers of silty sand		9	SS	12		82		○		15	
							Natural Pack					
	trace gravel, contains layers of silty sand		10	SS	22		81		○		10	
							80					
78.9			11	SS	15		79		○		10	
12.8	**END OF BOREHOLE**											

1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole.
2. Water Level Readings:

Date	W. L. Depth (mBGS)
Sep 18, 2018	1.86

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SOIL ROCK AUG 14 2013 - PALGS
PALMER ROCK - 2013 - LOGS - 1400326 - ALDERSHOT CREEK EROSION - 2018 10 19.GPJ - 18-10-19

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

LOG OF BOREHOLE BH18-3

PROJECT: Geotechnical Investigation - Aldershot Creek Erosion

CLIENT: Associated Engineering

PROJECT LOCATION: Burlington, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Solid Stem Augers

Diameter: 150 mm

Date: Aug-31-2018

REF. NO.: 1400326

ENCL NO.: 3

ELEV / DEPTH (m)	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
88.5	Ground Surface											
88.4	**TOPSOIL:** 130 mm						Concrete					
88.1 / 0.1	**FILL:** sandy silt, trace clay, trace gravel, trace rootlets, trace organics, contains pockets of sand, contains cobbles, dark brown, moist, compact to loose		1	SS	21		88					
			2	SS	26	▽	W. L. 87.3 m Sep 18, 2018					
	contains pockets of organics		3	SS	9							
85.9	contains layers of organics, contains organic odour		4	SS	6		86					Spoon Wet
85.6												
85.5 / 3.0	**SILTY SAND:** trace gravel, brown, wet, loose		5	SS	16		85					
	SANDY SILT: trace clay, trace gravel, brown, moist, loose						Holeplug					
	CLAYEY SILT: trace sand, trace gravel, contains layers of silt, brown, wet, very stiff to hard						84					
			6	SS	24							
82.2							83					
6.3	**SILT:** trace to some clay, trace sand, contains pockets of clayey silt, brown, wet, dense to compact		7	SS	35		82					
			8	SS	29		81					0 5 80 15
79.8							80					
8.7	**SILTY CLAY:** trace sand, trace gravel, grey, wet, stiff						Sand Screen					
			9	SS	12		79		5			
							78					
77.2			10	SS	11		Natural Pack		0			
11.3	**END OF BOREHOLE** 1. Upon completion of drilling, a 50mm diameter monitoring well was installed in the borehole. 2. Water Level Readings: Date W. L. Depth (mBGS) Sep 18, 2018 1.14											

GROUNDWATER ELEVATIONS

Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: $+^3$, $\times^3$: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

SOIL ROCK AUG 14 2017 - PALGS
PALMER ACAD 2004 - LOGS 1400326 - ALDERSHOT CREEK EROSION - 2018 0109.GPJ - 18-10-19

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

LOG OF BOREHOLE BH18-4

PROJECT: Geotechnical Investigation - Aldershot Creek Erosion

CLIENT: Associated Engineering

PROJECT LOCATION: Burlington, ON

DATUM: N/A

BH LOCATION: See Borehole Location Plan

Method: Solid Stem Augers

Diameter: 150 mm

Date: Aug-31-2018

REF. NO.: 1400326

ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
84.9	Ground Surface											
84.8	**TOPSOIL:** 130 mm											
0.1	**FILL:** sandy silt, trace clay, trace gravel, trace rootlets, contains cobbles, brown, moist, compact to loose		1	SS	25							
1			2	SS	5		84					
83.4	contains pockets of organics											
1.5	**FILL:** clayey silt, trace sand, trace gravel, some organics, contains layers of silty sand, contains organic odour, dark grey to brown, wet, soft		3	SS	3		83					Spoon Wet
2												
82.5												
2.4	**SILTY CLAY:** trace sand, contains layers of silt, grey, moist to wet, firm to very stiff		4	SS	15		82			>225		
3			5	SS	16					>225		
4							81					
	wet		6	SS	7		80			10		
5												
6							79					
			7	SS	7					10		
7							78					
	trace gravel		8	SS	12		77			5		
8												
9							76					
			9	SS	10					5		
75.1												
9.8	**END OF BOREHOLE** 1. Water was at a depth of 6.1m below ground surface (mBGS) upon completion of drilling. 2. Borehole caved to a depth of 6.1mBGS upon completion of drilling.											

GROUNDWATER ELEVATIONS

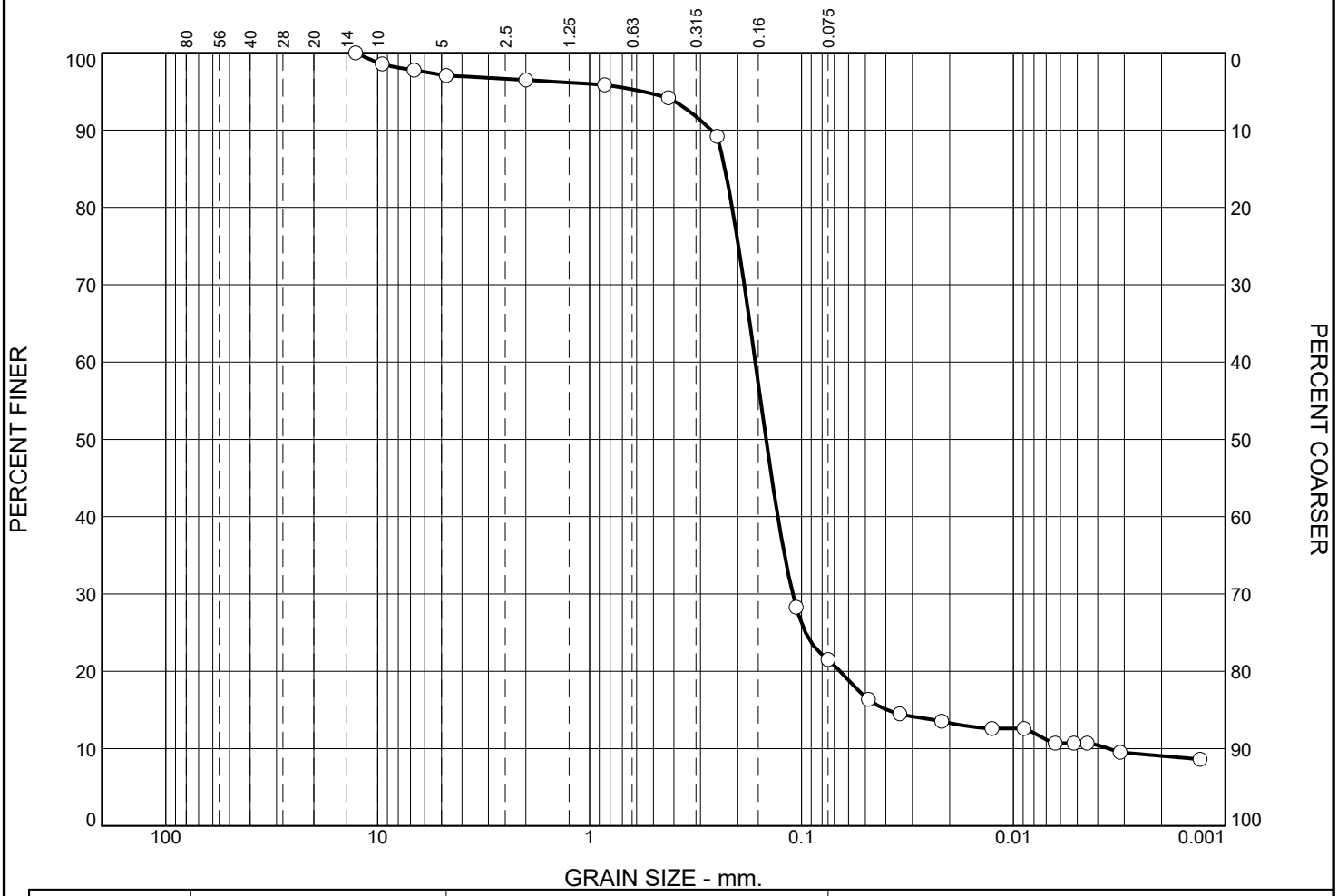
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES + 3, × 3: Numbers refer to Sensitivity ○ ε=3% Strain at Failure

SOIL ROCK AUG 14 2017 - PALGS
PALMER ACAD 2014 - TDS - 1400326 - ALDERSHOT CREEK EROSION - 2018 0919.GPJ - 18-10-19

Appendix B

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	3	1	2	72	13	9

	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.2299	0.1653	0.1469	0.1101	0.0394	0.0036	20.63	46.56

Material Description	USCS	AASHTO
○ FINE SAND, some silt and some clay, trace fine gravel		

Project No. 18-060 **Client:** Palmer Environmental Consulting Group Inc. (PECG)

Project: Laboratory Testing PECG project # 140326

○ **Location:** BH18-1 **Sample Number:** SS5

Date: ○

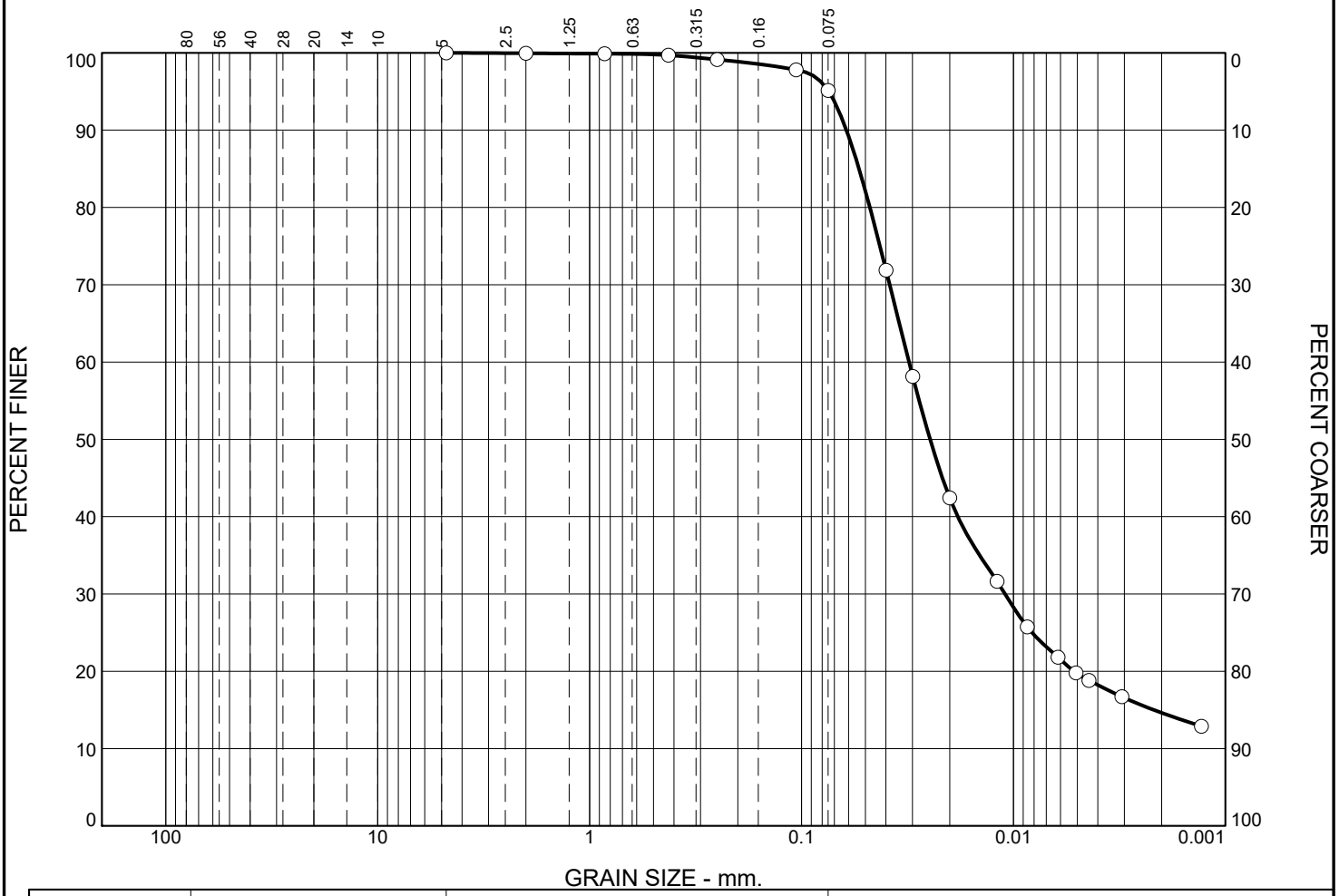
alston associates inc.
consulting engineers

Remarks:

Figure 1

Tested By: AM **Checked By:** DM

Grain Size Distribution Report



	% +3"	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0	0	0	0	0	5	80	15

	Colloids	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○				0.0536	0.0311	0.0247	0.0110	0.0022			

	Material Description	USCS	AASHTO
○	SILT, some clay, trace sand		

Project No. 18-060 **Client:** Palmer Environmental Consulting Group Inc. (PECG)

Project: Laboratory Testing PECG project # 140326

○ **Location:** BH 18-3 **Sample Number:** SS8

Date: ○

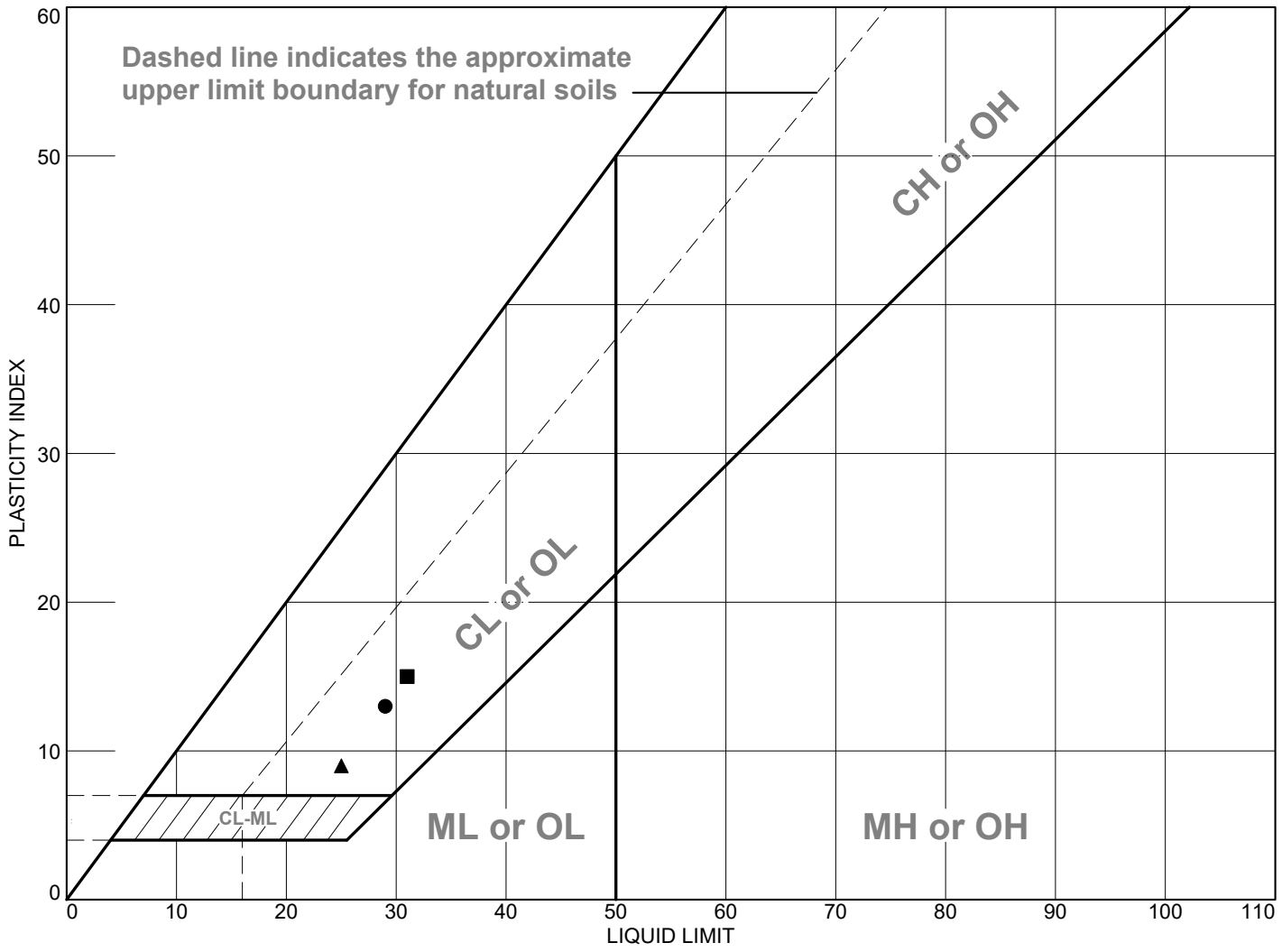
alston associates inc.
consulting engineers

Remarks:

Figure 2

Tested By: NAV/AM **Checked By:** DM

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●		29	16	13			
■		31	16	15			
▲		25	16	9			

Project No. 18-060 **Client:** Palmer Environmental Consulting Group Inc. (PECG)

Project: Laboratory Testing PECG project # 140326

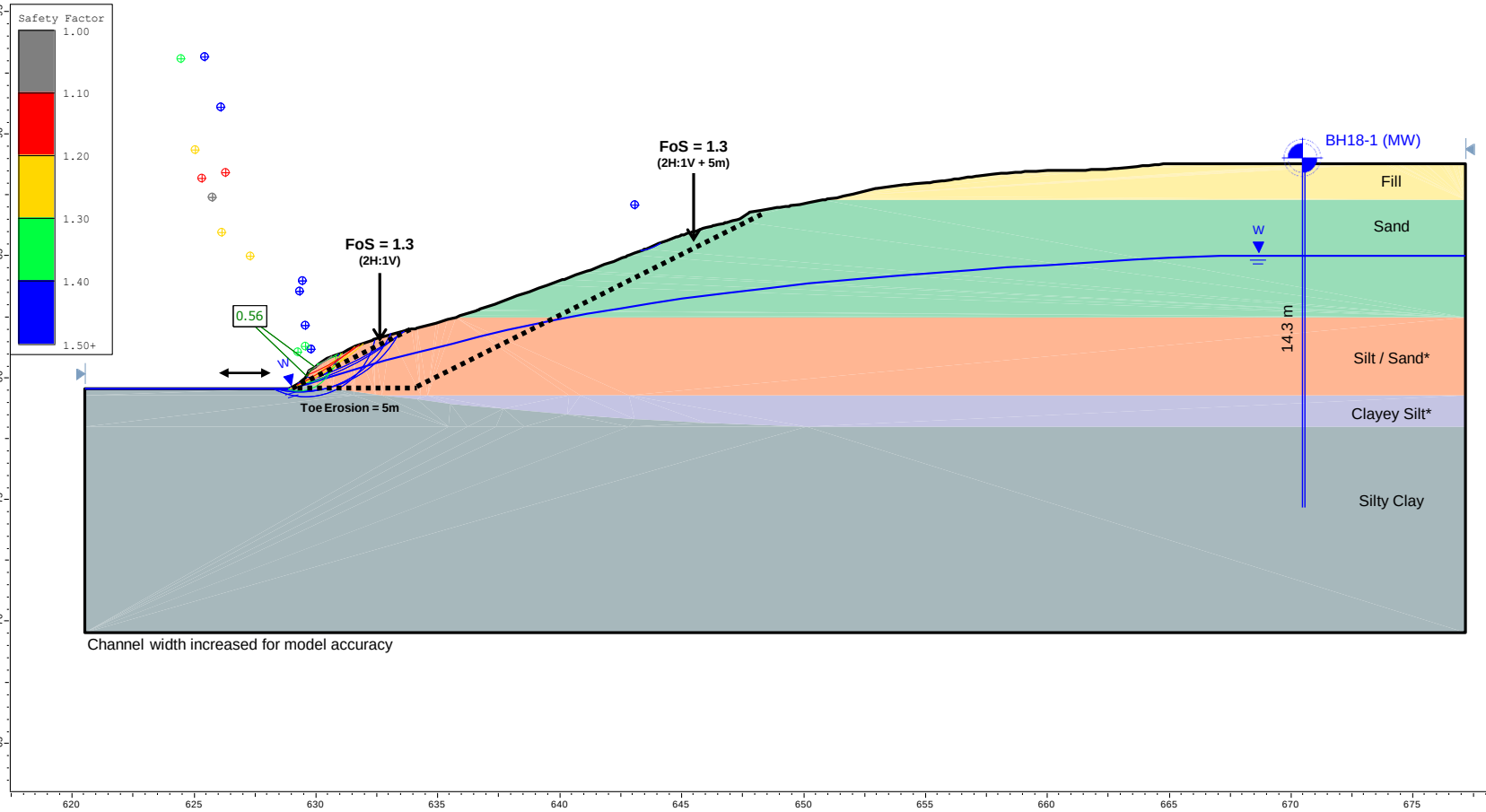
● **Location:** BH18-2 **Sample Number:** SS10
■ **Location:** BH18-1 **Sample Number:** SS12
▲ **Location:** BH18-3 **Sample Number:** SS9

Remarks:

alston associates inc.
consulting engineers

Figure 3

Appendix C

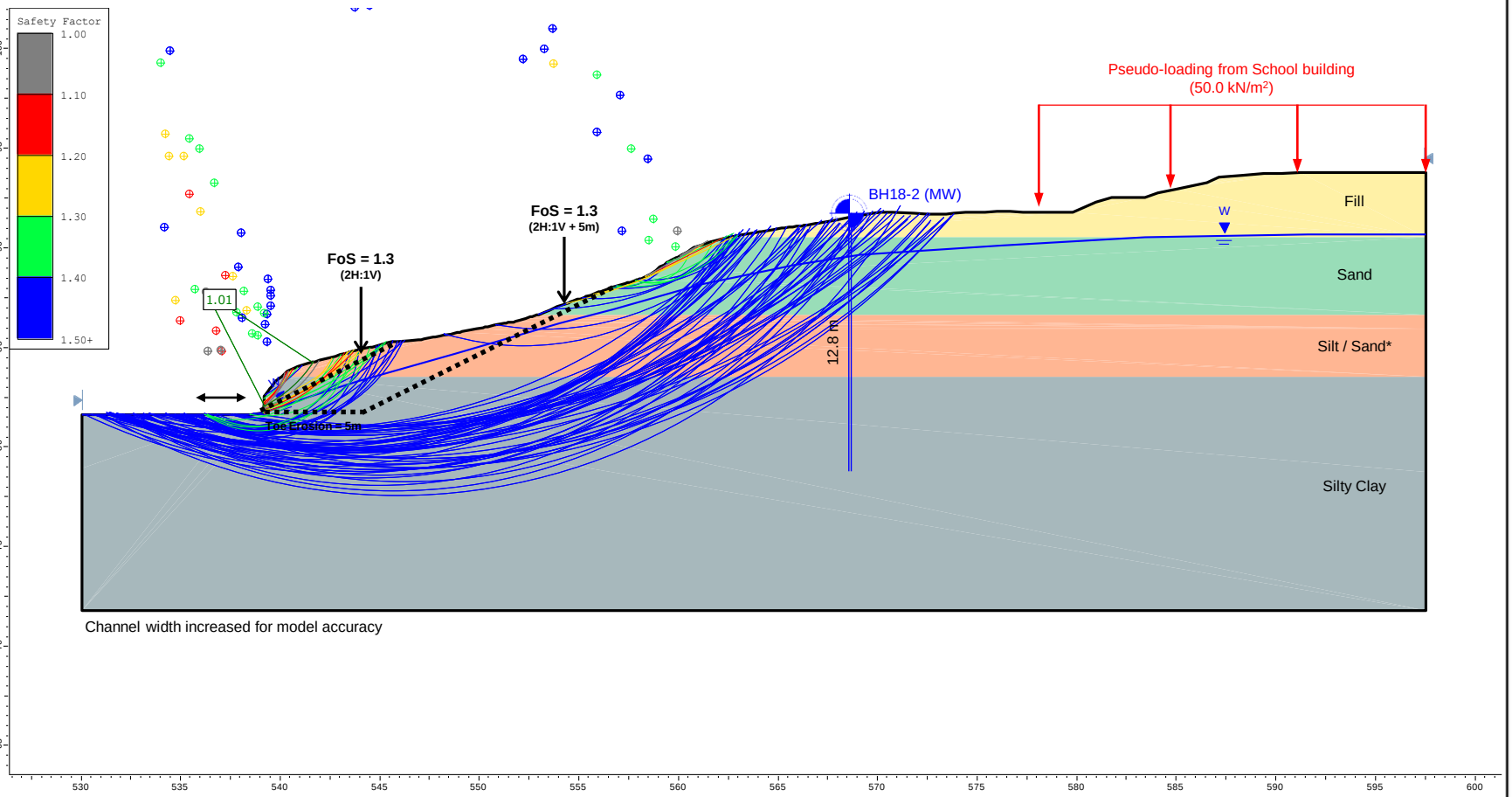


Note: Slope profile based on LIDAR & ground survey data

*Localized variable strength soil unit (i.e. other units are generally consistent strength across the site)

Client:	Associated Engineering			Project No.: 1400326	Drawing No.: 3
Drawn:	AK	Approved:	DT	Title:	Slope Stability - Section 1
Date:	Apr. 2019	Scale:	As shown	Project:	West Aldershot Creek Erosion EA Integrated Geotechnical and Hydrogeological Assessment
Original Size:	Letter	Rev:	A-0	PALMER ENVIRONMENTAL CONSULTING GROUP INC.	74 Berkeley Street Toronto, Ontario M5A 2W7

\\EgnyteDrive\pecg\Shared\Projects\Active\14003 - Associated Engineering\1400326 - Aldershot Creek Erosion EA\Geotechnical\Drawings\Slide\Addl XSEC\Contours_All_v4.dwg

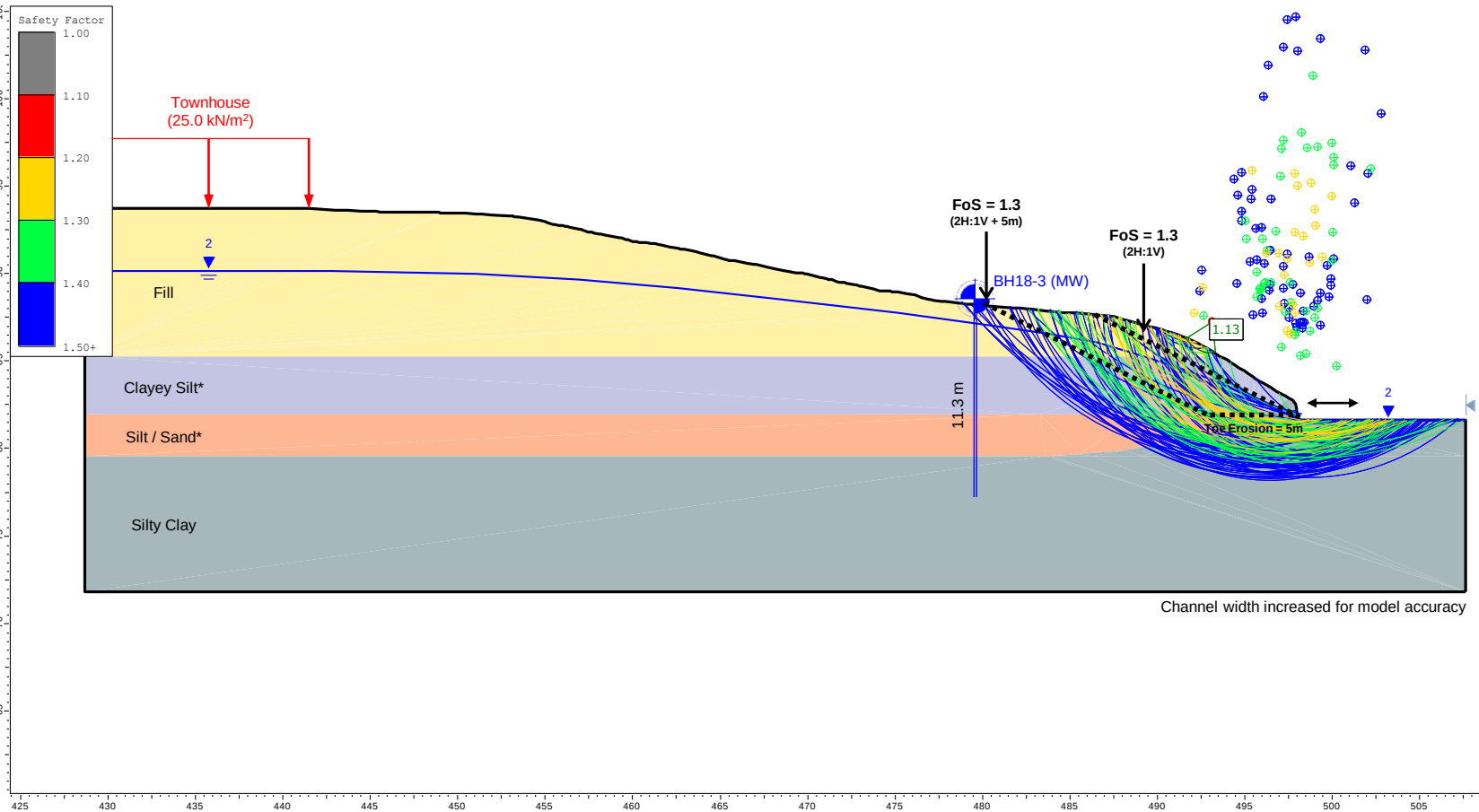


Note: Slope profile based on LIDAR & ground survey data

*Localized variable strength soil unit (i.e. other units are generally consistent strength across the site)

Client:	Associated Engineering			Project No.: 1400326	Drawing No.: 4
Drawn: AK		Approved: DT		Title: Slope Stability - Section 2	
Date: Apr. 2019		Scale: As shown		Project: West Aldershot Creek Erosion EA Integrated Geotechnical and Hydrogeological Assessment	
Original Size: Letter		Rev: A-0		PALMER ENVIRONMENTAL CONSULTING GROUP INC.	74 Berkeley Street Toronto, Ontario M5A 2W7

\\EgnyteDrive\pecg\Shared\Projects\Active\14003 - Associated Engineering\1400326 - Aldershot Creek Erosion EA\Geotechnical\Drawings\SlideModel\ XSEC\Contours_All_v4.dwg

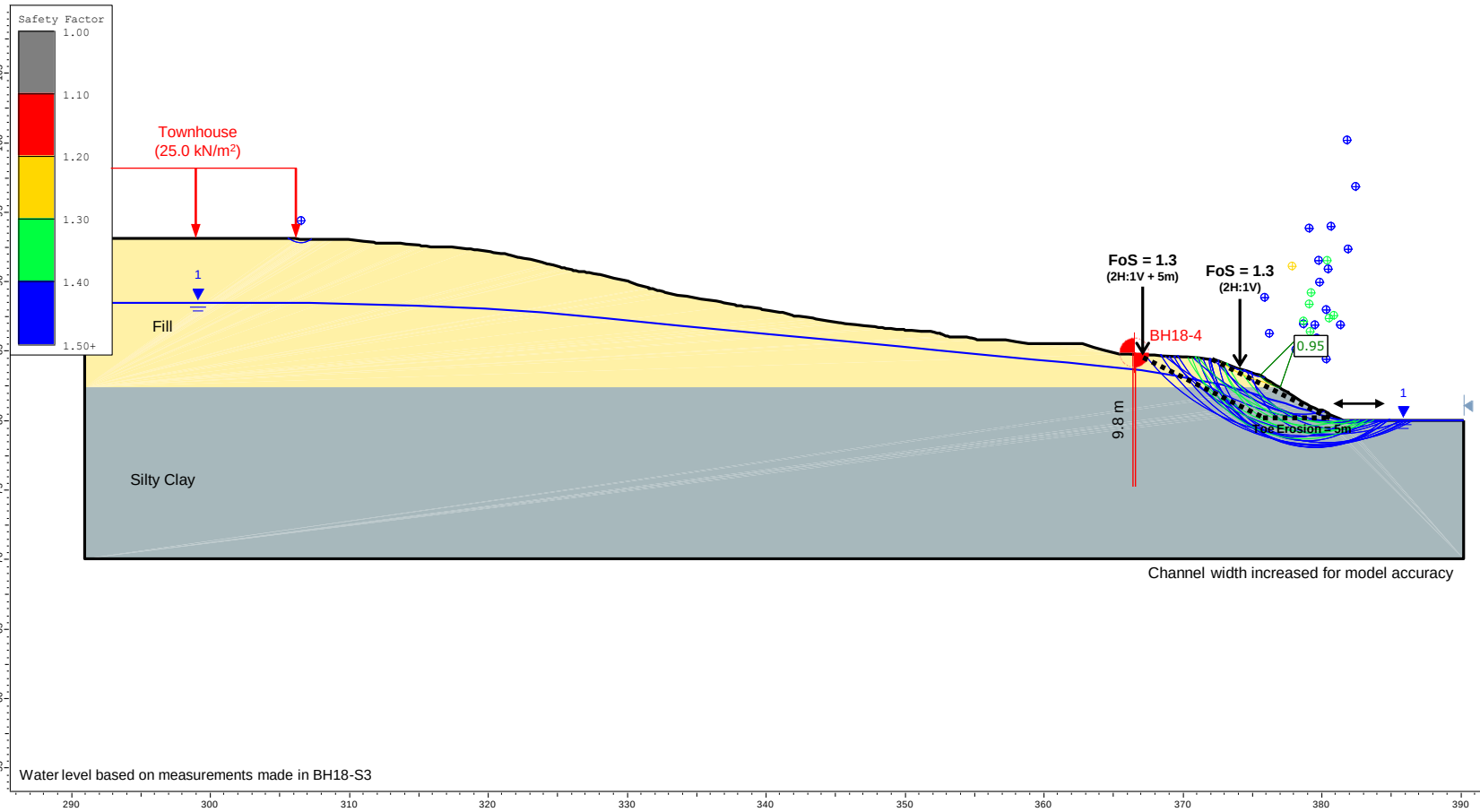


Note: Slope profile based on LIDAR & ground survey data

*Localized variable strength soil unit (i.e. other units are generally consistent strength across the site)

Client:	Associated Engineering			Project No.: 1400326	Drawing No.: 5
Drawn:	AK	Approved:	DT	Title:	Slope Stability - Section 3
Date:	Apr. 2019	Scale:	As shown	Project:	West Aldershot Creek Erosion EA Integrated Geotechnical and Hydrogeological Assessment
Original Size:	Letter	Rev:	A-0	PALMER ENVIRONMENTAL CONSULTING GROUP INC.	74 Berkeley Street Toronto, Ontario M5A 2W7

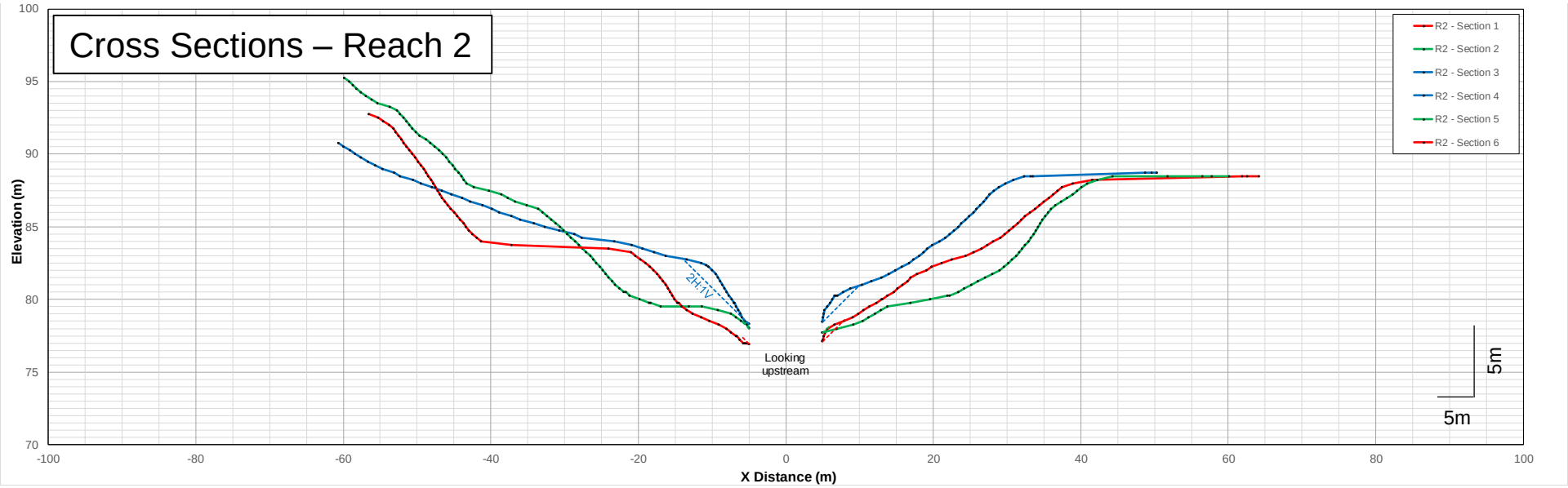
\\EgnyteDrive\pecg\Shared\Projects\Active\14003 - Associated Engineering\1400326 - Aldershot Creek Erosion EA\Geotechnical\Drawings\Slide\Addit XSEC\Contours_All_v4.dwg

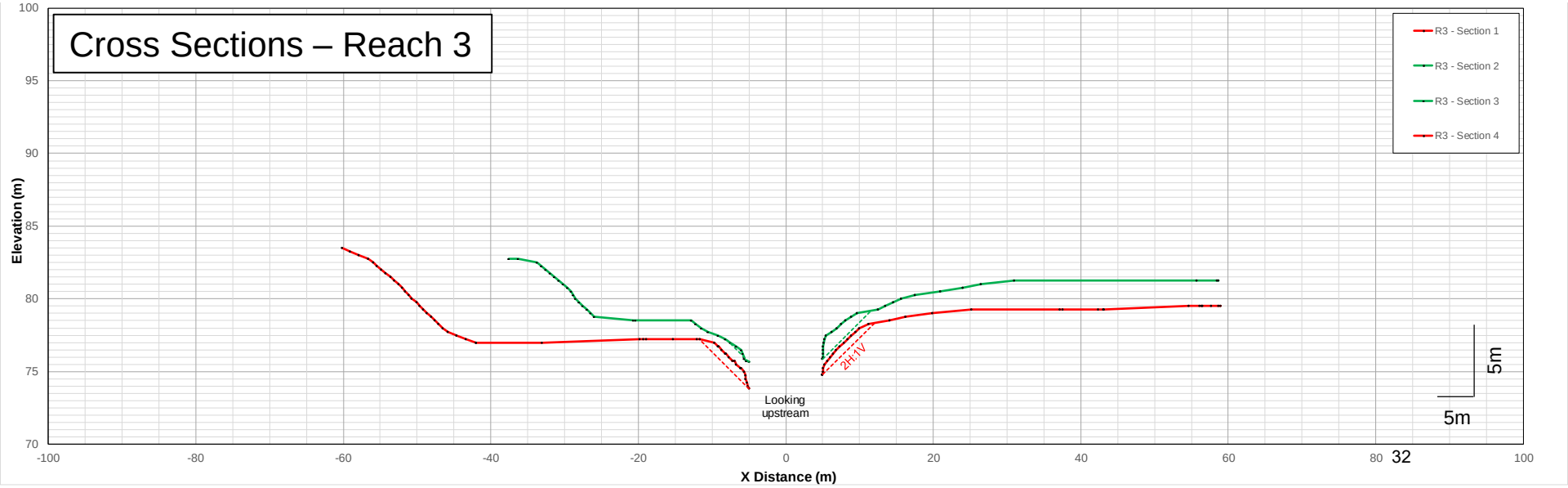


Note: Slope profile based on LIDAR & ground survey data

Client:	Associated Engineering			Project No.: 1400326	Drawing No.: 6
Drawn:	AK	Approved:	DT	Title:	Slope Stability - Section 4
Date:	Apr. 2019	Scale:	As shown	Project:	West Aldershot Creek Erosion EA Integrated Geotechnical and Hydrogeological Assessment
Original Size:	Letter	Rev:	A-0	PALMER ENVIRONMENTAL CONSULTING GROUP INC.	74 Berkeley Street Toronto, Ontario M5A 2W7

\\EgnyteDrive\pecg\Shared\Projects\Active\14003 - Associated Engineering\1400326 - Aldershot Creek Erosion EA\Geotechnical\Drawings\Slide\Addit XSEC\Contours_All_v4.dwg


Cross Sections – Reach 2
R2 - Section 1
R2 - Section 2
R2 - Section 3
R2 - Section 4
R2 - Section 5
R2 - Section 6
Elevation (m)
X Distance (m)
2H:1V
Looking upstream
5m
5m


Cross Sections – Reach 3
R3 - Section 1
R3 - Section 2
R3 - Section 3
R3 - Section 4
Elevation (m)
X Distance (m)
2H:1V
Looking upstream
5m
5m

Appendix D

Project: 1400326

Table 1. Slope Inspection Rating Chart

1. Slope Inclination :		
(degrees)	horizontal:vertical	
a. 18 or less	3:1 or flatter	0
b. 18 – 26	3:1 to 2:1	6
c. 26 or more	2:1 or steeper	16
2. Slope Height:		
a. 2 m or less		0
b. 2 to 5 m		2
c. 5 to 10 m		4
d. 10 m or more		8
3. Soil Stratigraphy:		
a. Shale, Limestone, Granite (Bedrock)		0
b. Sand / Gravel		6
c. Glacial Till		9
d. Clay / Silt		12
e. Fill		16
f. Leda Clay		24
4. Seepage from Slope Face:		
a. None or near toe only		0
b. Near mid slope only		6
c. Near crest only or from several levels		12
5. Proximity of Watercourse to Slope Toe:		
a. 15 m or more from slope toe		0
b. 15 m or less from slope toe		6
6. Table Land Drainage:		
a. Table land flat, no apparent drainage over slope		0
b. Minor drainage over slope, no active erosion		2
c. Drainage over slope, active erosion, gullies		4
7. Vegetation Cover on Slope Face:		
a. Well vegetated: heavy shrubs or forested with mature trees		0
b. Lightly vegetated: mostly grass, weeds, occasional trees, shrubs		4
c. No vegetation: bare		8
8. Previous Landslide Activity:		
a. No		0
b. Yes		6

TOTAL

Low potential **Total < 24**	Slight potential **Total 25 – 35**	Moderate potential **Total > 35**
Site inspection only, memo	Site inspection and survey, preliminary study, report	Drilling with monitoring wells, lab testing, surveying, detailed report

Project: 1400326

Table 2. Detailed Slope Inspection Form

1. Project Name / No.:

a. Inspection Date (DD-MM-YY):

b. Weather conditions (circle)

c. Temperature:

sunny	partly cloudy	cloudy	overcast
calm	breeze	windy	stormy
clear	fog	rain	snow
cold	cool	warm	hot

d. Inspected By:

2. Site (describe roads, features, etc):

a. Sketch:

3. Slope (describe):

a. Sketch:

4. Property Ownership (name, address, phone):

a. Legal Description (lot / conession / township / county):

b. Land use (circle and describe)

- vacant → field / bush / woods / forest / wilderness / tundra
- passive → recreational park / golf course / non-habitable structures / buried utilities / swimming pool
- infrastructure or public use → stadium / hospital / school / bridge / high voltage lines / waste management site

5. Soil Stratigraphy (describe stratigraphy, thickness, type):

a. Crest:

b. Mid:

c. Toe:

6. Slope Seepage (describe):

a. Crest:

b. Mid:

c. Toe :

7. Water Course Features (circle and describe):

a. Swale / Channel:

b. Gully:

c. Stream / Creek / River:

d. Pond / Bay / Lake:

e. Springs:

f. Marshy:

8. Vegetation Cover (grasses, weeds, shrubs, saplings, trees):

a. Crest:

b. Mid:

c. Toe:

9. Structures (buildings, walls, fences, sewers, roads, stairs, decks, towers):

a. Crest:

b. Mid:

c. Toe:

10. Erosive Features (scour, undercutting, bare areas, piping, rills, gully):

a. Crest:

b. Mid:

c. Toe:

11. Slope Slide Features (tension cracks, scarps, slumps, bulges, grabens, ridges, bent trees / fencing):

a. Crest:

b. Mid:

c. Toe: