• Doug Tarry Limited

c/o Cyril J. Demeyere Limited

Geotechnical Investigation and Slope Assessment

Project Name
Proposed Kemsley Subdivision

Project Location
42537 Southdale Line, St. Thomas

Project Number
LON-00015147-GE

Prepared By:

exp Services Inc.
15701 Robin’s Hill Road, Unit 2
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1. Introduction

Exp Services Inc. (**exp**) has been retained by Cyril J. Demeyere Limited (CJDL) on behalf of Doug Tarry Limited (client) to conduct a Geotechnical Investigation for a proposed development. The subject lands are 29.4±ha total; 24±ha of which are flat agricultural table lands located at 42537 Southdale Line near the intersection of County Rd. #4 in St. Thomas.

This report summarizes the results of the investigation, and provides geotechnical engineering guidelines to assist with the design and construction of the proposed development, site servicing and site pavement. The report also provides information and recommendations pertinent to existing bank slope stability assessment, filling washouts/top end of ravine fingers and Stormwater Management Facilities.

1.1 Terms of Reference

The current investigation was carried out in general accordance with **exp**'s proposal Ref. P16-32 (revised) dated November 2, 2016. Email authorization to proceed with the investigation was received from CJDL on behalf of the Client by email on December 19, 2016.

The purpose of the investigation was to examine the subsoil and groundwater conditions at the site by advancing thirteen (13) sampled boreholes at locations illustrated on the attached Borehole Location Plan and Development Setback - **Drawing 1**.

Based on an interpretation of the factual borehole data, and a review of soil and groundwater information from boreholes advanced at the site, **exp** has provided engineering guidelines for the geotechnical design and construction of the proposed development. More specifically, this report provides comments on excavations, dewatering, site preparation, foundations, seismic design considerations, site servicing, pavement recommendations and floatation of the wet well for the proposed sanitary pumping station.

This report is provided on the basis of the terms of reference presented above, and on the assumption that the design will be in accordance with applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning geotechnical aspects of the codes and standards, this office should be contacted to review the design.

The information in this report in no way reflects on the environmental aspects of the soil. Should specific information in this regard be needed, additional testing may be required.

2. Methodology

The fieldwork was carried out on January 26 through 30, 2017. In general, the geotechnical investigation consisted of the drilling activities of thirteen (13) boreholes at the locations denoted on **Drawing 1** as BH1 through BH13.

The boreholes were advanced by a specialist drilling subcontractor under the full time supervision of **exp** geotechnical staff. The boreholes were advanced utilizing a track-mounted drill rig using 150 mm diameter continuous flight solid/hollow stem augers.

During the investigation program, soil samples were taken at 0.76 m to 1.5 m intervals (as appropriate) utilizing a 50 mm diameter split-barrel sampler, advanced by dropping a 63.5 kg hammer approximately 760 mm, in accordance with the Standard Penetration Test (SPT) method (ASTM 1586). The SPT results are reported as (penetration index) “N” values on the borehole logs. The boreholes were terminated at depths of 5.0 and 18.7 m below ground surface (bgs).

During the drilling activities, the stratigraphy in the boreholes was examined and logged in the field by **exp** geotechnical personnel.

Short-term groundwater level observations within the open boreholes and observations pertaining to groundwater conditions at the borehole locations are recorded in the borehole logs found in **Appendix A**.

Soil samples obtained from the boreholes were inspected and classified in the field immediately upon retrieval for type, texture, colour and moisture. The samples were transferred to **exp**’s London laboratory for tactile examination, detailed descriptions and laboratory testing. The laboratory work program consisted of moisture content determination on all recovered soil samples. One grain size analysis was conducted on a native sample. A few bulk density tests were conducted on all samples from one borehole. The lab test results are plotted on the borehole logs at the respective depths.

Samples remaining after the classification testing will be stored for a period of three months following the date of sampling. After this time, they will be discarded unless prior arrangements have been made for longer storage.

3. Site and Subsurface Conditions

3.1 Site Description

The property is bound to the north by existing residential lots fronting Southdale line, to the east by the Port Stanley Terminal Rail, to the south by a forested ravine backing onto Linda Street and to the west by a forested ravine.

The site is relatively level with some uneven locations. Selected site photos are shown below:

3.2 Soil Stratigraphy

The detailed stratigraphy encountered in the boreholes is detailed in the borehole logs found in **Appendix A**, and summarized in the following paragraphs. It must be noted that the boundaries of the soil indicated in the borehole logs are inferred from non-continuous sampling and observations during excavation. These boundaries are intended to reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

3.2.1 Topsoil

All boreholes were surfaced with topsoil. The thickness of the topsoil ranged between 200 and 300 mm.

It should be noted that topsoil quantities should not be established from the information provided at the borehole locations only. If required, a more detailed analysis (involving shallow test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

3.2.2 Sandy Silt/Silty Sand/Sand

Natural sandy silt/silty sand/sand cohesionless soils were found at BH1, BH3, BH6 through BH9 and BH12 locations below the topsoil extending to depths ranging between and 0.6 and 1.4 m bgs.

The Standard Penetration Test (SPT) ‘N’ values in the cohesionless soils were between 17 to 23 blows per 0.3 m penetration of the split-spoon sampler, indicating a compact relative density.

Based on the moisture contents of the soil samples, the soils were in moist to wet conditions.

3.2.2 Clayey Silt

A natural clayey silt soil was found at all borehole locations except BH9, BH11, BH12 and BH13 below the topsoil or cohesionless soils extending to underlying clayey silt till. The clayey silt soil is mottled brown/grey in color and contains trace to some sand, trace gravel, sand/silty sand and gravel layers/seams, and rootlets.

The Standard Penetration Test (SPT) 'N' values in the native clayey silt were typically between 6 to 17 blows per 0.3 m penetration of the split-spoon sampler, indicating a firm to very stiff consistency. Bulk density test was carried out on clayey silt sample of BH2. The bulk density was 18.8 kN/m^3.

Based on the moisture content results of the clayey silt soil samples, the soil was in a moist condition.

Alternating silty sand and clayey silt layers were encountered at BH11 and BH13 locations below the topsoil and extended to depths of 1.4 m and 2.1 m bgs where clayey silt till was encountered.

3.2.2 Clayey Silt Till

All boreholes encountered clayey silt till. The till was generally brown in colour and became grey at depth. The till contains trace to some sand, trace to some gravel, frequent sand/sandy silt laminations and seams.

A grain size distribution analysis was carried out on one soil sample. Also bulk density tests were carried out on few soil samples. The result of the test is summarized in the following table, and the detailed laboratory test results are provided in **Appendix B**.

Table: Grain Size Distribution

Sample ID	% Gravel	% Sand	% Silt	% Clay
BH2, Sample 4 3.0-3.5 m depth	3	16	43	38

The clayey silt till was typically of a stiff to very stiff consistency based on SPT N Values of 12 to 28 blows for 150 mm penetration of the split spoon sampler to auger refusal. Based on the *in situ* moisture contents, the till was in a moist condition. Bulk density tests were carried out on all clayey silt till samples of BH2. The bulk density results typically ranged from 21.3 to 21.8 kN/m^3.

At the bottom of BH2 (approximate depth of 18.4 m bgs), a sand layer was encountered and extended to the termination depth of the borehole at 18.7 m bgs.

3.3 Groundwater Conditions

Upon completion of drilling, the open borehole excavations were examined for the presence of groundwater and groundwater seepage. Based on short-term observations during drilling and upon completion, no groundwater observations were noted in the deep boreholes. Groundwater was observed in a few of the shallow boreholes which were terminated at depth of 5.0 m bgs. The groundwater was measured at BH5, BH8, BH9, BH11, BH12 and BH13. The groundwater was measured at depths ranging from 0.5 to 3.7 m bgs upon completion of the drilling.

Three water wells were observed at the site. Based on the Ontario Water Well records, it is understood that those wells were installed in 1954 and 1988. Based on the records, the stabilized groundwater tables range from 18.3 m 21.9 m bgs. Therefore, based on the current investigation and well records, it is strongly believed the measured groundwater is a perched groundwater and not a stabilized groundwater.

It is noted that the depth to the groundwater table may vary in response to climatic or seasonal conditions, and as such, may differ at the time of construction, with higher levels in wet seasons.

4. Discussion and Recommendations

4.1 General

At the time of writing this report, there are no design details available. However, it is anticipated that the proposed development will consist primarily of residential units with basements. The residential subdivision is expected to have complete municipal servicing, and will be accessed with paved local roads.

Based on the above, and the results of the current investigation, the following sections of this report provide geotechnical comments and recommendations pertaining to site preparation, excavations, dewatering and groundwater control, foundations, slabs, site servicing, seismic design, slope assessment, filling washouts/top end of ravine fingers and SWM.

4.2 Site Preparation

It is anticipated that, due to the existing grades, slight cut and fill operations may be required. Preparation of the subgrade in the footprints of the proposed houses is a key aspect of construction. Prior to placement of foundations, all deleterious materials, if any, should be stripped from the footprints of the proposed development.

The envelopes of the proposed lots should be cleared of any buried unsuitable materials such as farm drainage / field tiles and any buried utilities or services, which could be encountered during excavation operations across the Site.

Following the removal of the deleterious materials, if any, the exposed subgrade should be thoroughly proof-rolled, and inspected by a geotechnical engineer. Any loose or soft zones noted during the excavation and inspection should be sub-excavated and replaced with approved fill, and re-compacted.

Any excavated soils may be stockpiled onsite and screened for possible re-use. In particular, where the natural clayey silt till/silt deposits are excavated, the excavated material may be considered suitable for reuse as structural fill (foundation wall backfill, service trench backfill, underfloor fill), subject to review and inspection onsite during construction.

The disposal of any excess excavated materials must conform to the MOE Guidelines and requirements. **Exp** can be of assistance if an assessment of the materials is required.

In general, where the exposed subgrade requires reconstruction to achieve the design elevations, structural fill should be used. It is recommended that structural fill be comprised of granular material, such as an OPSS Granular ‘B’, or alternate approved material. The fill should be placed in 300 mm thick lifts (maximum) and compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD). For best compaction results, the *in situ* moisture content of the fill should be within three percent of optimum, as determined by standard Proctor testing. It is also recommended that the structural fill mat should extend laterally a minimum distance beyond the edge of the foundation equal to the thickness of structural fill beneath the footing.

In situ compaction testing should be carried out during the fill placement to ensure that the specified compaction is being achieved.

Care should be taken when placing structural fill to ensure that the fill material does not become saturated or unduly wet prior to suitable levels of compaction being achieved. Additional recommendations pertaining to engineered/structural fill are provided on **Drawing 2**.

If any imported fill material is utilized at the site, verification of the suitability of the fill may be required from an environmental standpoint. Conventional geotechnical testing will not determine the suitability of the material in this regard. Analytical testing and environmental site assessment may be required at the source. This will best be assessed prior to the selection of the material source. A quality assurance program should be implemented to ensure that the fill material will comply with the current Ministry of Environment standards for placement and transportation.

The three (3) water wells noticed at the site should be decommissioned in accordance with O.Reg. 903. Exp can assist with this upon request.

4.2.1 Washout Filling

It is understood that washouts/top end of ravine fingers are proposed be backfilled at few locations which are located at rear property line (specifically to house mostly rear yards) - see Drawing 1. Also, re-establishment of top of bank and shallow ravine at Street 'A' is required. Based on the KCCA Map 2015 SWOOP dated November 11, 2017 provided to us by CJDL, the washout areas are located within the KCCA Regulation Limit. We understand that the client will obtain an approval from KCCA based on the geotechnical recommendations to support the plan of the ravine filling within the washout areas.

During our site walkover, it was observed that there are a few minor existing washout areas at the site that have developed along the top of existing ravine banks, all of which appear to be caused by surface water runoff from the agricultural field. In these locations, the top of bank has retreated into the tablelands of the farm field, causing an irregular top of bank alignment.

Based on the borehole findings and slope gradients at the ravine fingers, from the geotechnical standpoint we support the plan of the ravine filling within the washout areas subject to following the filling construction recommendations provided below.

Upon completion of removing trees and their roots, brush, stripping topsoil, sub-excavating the fill and other deleterious materials down to native soil, engineered fill will be placed to bring up the subgrade to reach the design grade level. Prior to placement of engineered fill, the exposed subgrade should be compacted with heavy equipment. The engineered fill pad must extend at least 2.0 m beyond the footings to be supported, then outwards and downwards at no steeper than 45° to meet the underlying approved native subgrade. In this regard, strict survey control and detailed documentation of the lateral extent of the engineered fill limit should be carried out to ensure that the engineered fill pad fully incorporates the structure to be supported. The surface of the final layer of the backfill should be covered with topsoil. Prior to placement of engineered fill, the exposed subgrade should be compacted with heavy equipment. The engineered fill should be raised at a uniform rate and benched to existing slopes – reference should be made to Benching of Earth Slopes OPSD 208.010.

In determining the most suitable materials for use in backfilling the washout areas with engineered fill, it is important to consider granular "B" which has less tendency for settlement. It is recommended that structural fill be comprised of approved Granular "B".

The granular fill should be placed in maximum 200 mm thick lifts and uniformly compacted to a minimum of 100 percent Standard Proctor Maximum Dry Density (SPMDD). For best compaction results, the in situ moisture content of the fill should be within three percent of optimum, as determined by standard Proctor testing. In situ compaction testing should be carried out during the fill placement to ensure that the specified compaction is being achieved.

For washout fill areas located 2.0 m outside of the proposed building envelope of a home, approved native material can be used. The backfill should be raised at a uniform rate and benched to existing slopes – reference should be made to Benching of Earth Slopes OPSD 208.010. The surface should be left sufficiently even to prevent the ponding of rainwater in ruts and should be rolled smooth to encourage drainage at times of inclement weather. Prior to further fill placing the surface layer should be ripped to key new material into that previously placed.

Care should be taken when placing structural fill to ensure that the fill material does not become saturated or unduly wet prior to suitable levels of compaction being achieved. Fill must never be placed into standing or running water and fill placing should cease when the material is likely to become softened during and after inclement weather.

Engineered fill construction should be carried out under full/part time field review by exp, to approve sub-excavation and subgrade preparation, backfill materials, placement and compaction procedures, and to verify that the specified compaction standards are achieved throughout. During construction, the contractor's representative should monitor field progress and coordinate with exp.

4.3 Excavations

All excavation work must comply with the Occupational Health and Safety Act (OHSA) and Regulations for Construction Projects. OHSA specifies that where workmen must enter a trench or excavation carried deeper than 1.2 m, the trench or excavation must be suitably sloped and/or braced in accordance with the OHSA regulations. Section 226 of the regulations designates four broad classifications of soils to stipulate appropriate measures for excavation safety, and maximum slopes of excavation as follows:

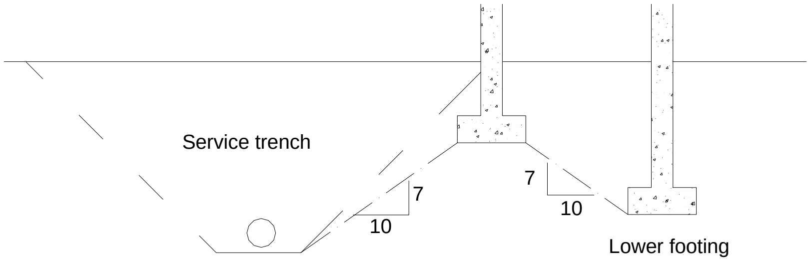
Soil Type	***Base of Slope***	***Maximum Slope Inclination***
1 and 2	Within 1.2 m of bottom of excavation	1 horizontal to 1 vertical
3	From bottom of excavation	1 horizontal to 1 vertical
4	From bottom of excavation	3 horizontal to 1 vertical

The existing native stiff to very stiff clayey silt till soil encountered at the site can be classified as Type 2 soils in their undisturbed and dry state above the groundwater table while the silty sand/silty sand/sand and clayey silt soils are classified as Type 3 soils.

If the construction excavation side slopes recommended above cannot be maintained due to lack of space or close proximity of other structures, an engineered excavation support system must be used. Minimum support system requirements for steeper excavations are stipulated in Sections 234 through 242 of the Act and Regulations. The engineered shoring system, if required, must be in place prior to commencement of the installation operations. The specialist shoring contractor should review the geotechnical information provided in this report and make his own assessment of the shoring design requirements based on its knowledge of the local conditions/geology. The shoring system must be designed to be internally (overturning, and sliding) and externally stable (slope stability/base heave).

4.3.1 Protection of Existing Utilities or Adjacent Structures/Roadways

Generally, if the depth of the excavation extends below an imaginary line extending at a downward gradient of 10 horizontal to 7 vertical (10H:7V) from the outer edge of an existing utility/structure footing or paved roadways (see sketch below), the underpinning of the existing utility/footings must be considered. The location and depth of existing utilities/other structures should be reviewed, and suitable underpinning or protection measures be provided, if required. Underpinning operations should also be performed under the supervision of the geotechnical engineer to provide verification that the base of the underpinning is founded on competent strata.



FOOTINGS NEAR SERVICE TRENCHES OR AT DIFFERENT ELEVATIONS

4.3.2 Design of Temporary Shoring System

The engineered excavation support system for the trench excavations, if required, should be designed to resist lateral earth pressures. Based on the field and laboratory testing carried out by exp during the present geotechnical investigation and our experience with similar soils, the following soil parameters are recommended for the design of the engineered shoring system:

Soil	φ	γ (kN/m^3)	K_a	K_o	K_p
Compact Granular Fill Granular 'B' (OPSS 1010)	32	22.0	0.31	0.47	3.25
On-site Clayey Silt/Sandy Soils	28	18.8	0.36	0.53	2.78
On-site Clayey Silt Till	31	21.5	0.32	0.49	3.10

4.4 Groundwater Control

Based on the perched groundwater observed at few boreholes, minor groundwater infiltration and infiltrated surface water should be anticipated within conventional depths for houses and service trench excavations. It is anticipated that minor groundwater infiltration encountered can likely be accommodated using conventional sump pumping techniques.

Any collected water should be discharged a sufficient distance away from the excavated area to prevent the discharge water from returning to the excavation. Sediment control measures should be provided at the discharge point of the dewatering system. Caution should also be taken to avoid any adverse impacts to the environment.

4.5 Building Foundations

4.5.1 Conventional Shallow Foundations - Native Soils

The proposed development can be constructed on conventional strip and spread footings. Based on the borehole findings, Allowable Soil Pressure (SLS) of 150 kPa and Factored Ultimate Soil Bearing Pressure (ULS) of 230 kPa can be used for the design of the spread footings founded on the natural clayey soil deposits and/or sandy soils founded at depths of 1.2 m and below.

Provided the footing bases are not disturbed due to construction activity, precipitation, freezing or thawing action, etc., and the afore mentioned bearing pressures are not exceeded, the total and differential settlements of footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be within 25 mm and 19 mm respectively.

The footing subgrade must be inspected by a geotechnical engineer, or a geotechnical technician under the supervision of a geotechnical engineer, to ensure that the condition of the subgrade is compatible with the foundation design requirements.

All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m of soil cover or equivalent insulation. Where construction is undertaken during the winter, the footing subgrade should be protected from freezing and the foundation walls should be protected against heave due to cold weather conditions.

It should be noted that the recommended bearing capacities have been calculated by exp from the borehole information for the design stage only. The investigation and comments are necessarily on-going as new information of underground conditions becomes available. For example, more specific information is available with respect to conditions between boreholes, when foundation construction is underway. The interpretation between the boreholes and the recommendations of this report must therefore be checked through field inspections provided by exp to validate the information for use during the construction stage.

4.6 Basements

The basement floors can be constructed using cast slab-on-grade techniques provided the subgrade is stripped of all topsoil and other obviously objectionable material. The subgrade should then be thoroughly proof-rolled. Any soft zones detected during the proof-rolling should be dug out and replaced with clean, compactable material, placed in accordance with the requirements outlined in Section 4.3.

A subgrade prepared in accordance with the recommendations provided in Section 4.2 will provide adequate support to the concrete floors. A modulus of subgrade reaction appropriate for slab design of 30,000 kN/m3 (30 MPa/m) can be used for design of the floor slab supported on natural soils.

A minimum 200 mm (8 inch) thick compacted layer of 19 mm (¾ inch) clear stone should be placed between the prepared subgrade and the floor slab to serve as a moisture barrier. The installation and requirement of vapour barrier under the slab, where applicable, should conform to the flooring manufacturer's and designer's requirements. Relative humidity and/or moisture emission testing may be required to determine the concrete condition prior to flooring installation. Ongoing liaison from this office is available, upon request.

All basement walls should be damp-proofed and must be designed to resist a horizontal earth pressure 'P' at any depth 'h' below the surface as given by the following expression:

$$P = K (\gamma h+q)$$

where, P = lateral earth pressure in kPa acting at depth h;
γ = natural unit weight, a value of 20.4 kN/m^3 may be assumed;
h = depth of point of interest in m;
q = equivalent value of any surcharge on the ground surface in kPa.
K = earth pressure coefficient, assumed to be 0.4

It is recommended that perimeter drains should be installed at the basement footing level. The above expression assumes that the perimeter drainage system prevents the build-up of any hydrostatic pressure behind the wall.

The fill surface around the perimeter of structures should be sloped in such a way that the surface runoff water does not accumulate around the structure.

4.7 Foundation Backfill

In general, the natural soils excavated from the foundation and service trench areas should be suitable for reuse as foundation wall backfill provided the work is carried out during relatively dry weather. Any excavated soils proposed for re-use as backfill should be examined by a geotechnical engineer. The materials to be re-used should be within three percent of optimum moisture for best compaction results. If the weather conditions are very wet during construction, then consideration should be given for the use of imported granular material such as OPSS Granular 'B' as backfill material.

The backfill must be brought up evenly on both sides of walls not designed to resist lateral earth pressures. Drainage and backfill recommendations are given in **Drawing 3**.

The fill surface around the perimeter of structures should be sloped in such a way that the surface runoff water does not accumulate around the structure. It is recommended that an impermeable soil seal such as clay, asphalt or concrete be provided on the surface to minimize water infiltration.

4.8 Earthquake Design Considerations

The recommendations for the geotechnical aspects to determine the earthquake loading for design using the OBC 2006 are presented below.

The subsoil and groundwater information at this Site have been examined in relation to Section 4.1.8.4 of the OBC 2006. Excluding the topsoil, the subsoils expected in the proposed building footprints will generally consist of silty clay soil. It is anticipated that the proposed structures will be founded on these deposits, below any loose or soft zones.

Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2006 indicates that to determine the site classification, the average properties in the top 30 m (below the lowest wet well level) are to be used. The boreholes advanced at this Site were excavated to 18.7 m depth. Therefore, the Site Classification recommendation would be based on the available information as well as our interpretation of conditions below the boreholes based on our knowledge of the soil conditions in the area.

Based on the above assumptions, interpretations in combination with the known local geological conditions, the Site Class for the proposed development is “D” as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2006.

4.9 Site Servicing

Based on the results of the investigation, it is anticipated that services will be set into the natural clayey/sandy soils or engineered fill soils. No bearing problems are anticipated for services set into the natural mineral soils subject to the condition that the perched groundwater, if encountered, be lowered to approximately 0.6 m below the excavation depth.

The bedding aggregate should be placed around the pipe to at least 300 mm (12 inches) above the pipe. The bedding course may be thickened if portions of the subgrade become wet during excavation. The bedding aggregate should be compacted to a minimum 95 percent SPMDD. Sewage lines installed outside of heated areas should be provided with a minimum 1.2 m (4 feet) of soil cover for frost protection.

In general, the natural soils excavated from the service trench areas should be suitable for reuse as trench backfill provided the work is carried out during relatively dry weather. Soils with high *in situ* moisture contents, and that are excavated from below the stabilized groundwater table may be too wet for reuse as backfill unless adequate time is allowed for drying, or if the material is blended with an approved dry fill; otherwise, it may be stockpiled onsite for reuse as landscape fill. As indicated previously, the use of any imported material is subject to review and approval by the contract administrator and geotechnical consultant.

Backfill above the bedding aggregate may consist of the excavated (inorganic) soils, compacted in 300 mm thick lifts (maximum) to a minimum of 95 percent SPMDD. A program of *in situ* density testing should be set up to ensure that satisfactory levels of compaction are achieved.

As noted previously, disposal of excavated materials off-site should conform to current Ministry of Environment guidelines.

4.10 Site Pavements

4.10.1 Subgrade Preparation

Prior to the construction of the driveways and parking lots, the subgrade should be prepared in accordance with the recommendations provided in Section 4.2. The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures should be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as is practically possible.

The most severe loading conditions on pavement areas and the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of subbase fills, restricted construction lanes, and half-loads during paving may be required, especially if construction is carried out during wet weather conditions.

4.10.2 Paved Areas

Provided the preceding recommendations are followed, the pavement thickness design requirements given in the following table are recommended for the anticipated specified street classifications and subgrade conditions.

Recommended Pavement Structure Thickness

Pavement Layer	**Compaction Requirements**	**Local Road**	**Collector Road**
Asphaltic Concrete	92.0 -96.5% BRD or 97.0%Marshall Density	35 mm HL3 over 45 mm HL8	40 mm HL3 over 65 mm HL8
Granular 'A' (Base)	100% SPMDD	150 mm	150 mm
Granular 'B' (Sub-base)	100% SPMDD	300 mm	450 mm
Maximum Allowable Spring Rebound		1.9 mm	1.5 mm
Notes: 1) SPMDD denotes Standard Proctor Maximum Dry Density. 2) The subgrade must be compacted to 98% SPMDD. 3) The above recommendations are minimum requirements.			

Other granular configurations may also be possible provided the granular base equivalency (GBE) thickness is maintained. These recommendations on thickness design are not intended to support heavy and concentrated construction traffic, particularly where only a portion of the pavement section is installed.

The recommended pavement structures provided in the above table are based on the natural subgrade soil properties determined from visual examination and textural classification of the soil samples.

Consequently, the recommended pavement structures should be considered for preliminary design purposes only. A functional design life of about ten years has been used to establish the pavement recommendations. This represents the number of years to the first major rehabilitation, assuming regular maintenance is carried out.

If construction is undertaken under adverse weather conditions (i.e., wet or freezing conditions) subgrade preparation and granular sub-base requirements should be reviewed by the geotechnical engineer. As well, if only a portion of the pavement will be in place during construction, the granular subbase may have to be thickened, and/or the subgrade improved with a geotextile separator or geogrid stabilizing layer. This is best determined in the field during the site servicing stage of construction, prior to road construction.

Where partial pavement structure will be in-place during construction, consideration may be given to using geotextile or geogrid to enhance the stability of the road base, and/or increasing the Granular ‘B’ thicknesses to improve the stability of the road base for construction traffic. In this regard, a minimum of 400 mm of Granular ‘B’ is recommended for local roads, and 600 mm of Granular ‘B’ is recommended for collector roads. Depending on the staging of the subdivision development, and possible areas of concentrated construction access routes, additional granular thicknesses may also be considered.

Samples of both the Granular 'A' and Granular 'B' aggregates should be checked for conformance to OPSS 1010 prior to use on Site, and during construction. The Granular 'B' subbase and the Granular 'A' base courses must be compacted to 100 percent SPMDD.

The asphaltic concrete paving materials should conform to the requirements of OPSS 1150. The asphalt should be placed in accordance with OPSS 310 and compacted to at least 97 percent of the Marshall mix design bulk density.

Good drainage provisions will optimize pavement performance. The finished pavement surface should be free of depressions and should be sloped (preferably at a minimum grade of two percent) to provide effective surface drainage toward catchbasins. Surface water should not be allowed to pond adjacent to the outside edges of pavement areas. In low areas, subdrains should be installed to intercept excess subsurface moisture and prevent subgrade softening, as shown on **Drawing 4**. This is particularly important in heavier traffic areas at the site entrances. The locations and extent of subdrainage required within the paved areas should be reviewed by this office in conjunction with the proposed grading.

A program of in situ density testing must be carried out to verify that satisfactory levels of compaction are being achieved.

To minimize the effects of differential settlements of service trench fill, it is recommended that wherever practical, placement of binder asphalt be delayed for approximately six months after the granular sub-base is put down. The surface course asphalt should be delayed for a further one year. Prior to the surface asphalt being placed, it is recommended that a pavement evaluation be carried out on the base asphalt to identify repair areas or areas requiring remedial works prior to surface asphalt being placed.

4.10.3 Curbs and Sidewalks

The concrete for the curbs and gutters should be proportioned, mixed placed and cured in accordance with the requirements of OPSS 353, OPSS 1350 and local Municipal Requirements.

During cold weather, freshly placed concrete should be covered with insulating blankets to protect against freezing.

The subgrade for the sidewalks should be comprised of undisturbed natural soil or well-compacted fill. A minimum 100 mm thick layer of compacted (minimum 98 percent SPMDD) Granular 'A' should be placed below the sidewalk slabs.

4.11 Stormwater Management Pond Facility

Based on the Drawing titled" Stormwater Management Pond Plan and Profile" prepared by CJDL and dated February 2017, it is understood that a storm water management facility will be constructed onsite to provide quality and quantity control for surface runoff. This facility is proposed to consist of an upper 'wet' cell, to provide required quality control, and a lower 'dry' cell for quantity control.

Based on the discussion in the following sections, the wet and dry cell system within the existing ravine contours is considered acceptable from a geotechnical standpoint.

4.11.1 Wet Pond

The upper, wet cell of the SWM facility will be constructed within the easterly limits of the existing northerly ravine finger at the approximate location of BH3. A large portion of the wet pond was proposed to be constructed in the ravine finger washout area which was proposed to be backfilled. The location of the pond is shown on Drawing 1. The wet pond will consist of a forebay and permanent pond.

It is understood that the existing ravine will require additional excavation and footprint expansion to increase volumetric capacity required to achieve required storage capacity. Based on the SWM drawing, the bases of the forebay and the permanent pond will be at elevations of 224.0 and 223.0, respectively (approximately 4.0 to 5.0 m below existing grades of figure ravine base. The 100-year flood level is 227.14 m. Forebay and permanent pond sidewalls, except the upper portion of the west sidewall of the pond, will be below the base of the ravine. The upper portion of the west sidewall was proposed to be an earth berm. The proposed SWM pond was proposed to be constructed at an inclination of about 4 horizontal: 1 vertical (varies).

BH3 was drilled to a depth of 9.6 m bgs at the approximate location of the proposed ponds. Based on the borehole findings, the site consists of a 2.1 m thick silty sand/clayey silt over clayey silt till, extending to exploration depth of the borehole. The till contained trace to some sand, trace gravel, and silt seams. No groundwater was encountered within the exploration depth of the borehole.

Based on the results of the investigation and anticipated depth of the pond, an earth liner is not required subject to soil inspection and testing at the time of construction. A clay liner if required, should then consist of properly compacted clay (impervious) soils placed on the bottom and sides of the pond. It is recommended that the base and sidewalls of the proposed pond, forebay and/or channel be over-excavated to allow for a 300 mm thick clay liner to be placed. The excavated clayey silt till is generally considered suitable for re-use as the liner material subject to the condition that the clay does not contain gravel larger than 19 mm.

Prior to the installation of the liner, the base and side slopes of the excavations that terminate in the clayey silt till should be scoured and thoroughly proof rolled. This exercise is carried out in an attempt to seal the water producing sand seams naturally occurring in the glacial till stratum, and protect the integrity of the SWM facility.

The clay liner, if required, should be placed in lifts not exceeding 200 mm in thickness and compacted to a Standard Proctor Maximum Dry Density (SPMDD) of 98% within 3% on the wet side of the optimum moisture content. Sheepsfoot rollers should be used to compact the liner to reduce the permeability of the clay liner. Careful subgrade preparation and stringent control of the clay material and the compaction are required. The finished surface of the clay fill liner is normally hand rolled and, to prevent the development of shrinkage cracks it should be kept moist until the pond is filled. The clay liner must also be protected from erosion and/or scouring action of the pond waves.

Sediment build-up will need to be removed from the base of the forebay at regular intervals. It is therefore recommended that a 200 mm Granular 'A' layer be placed over the earth liner, compacted to 100%

SPMDD. Following the granular placement, a turf-stone mat should be placed and cover the entire base of the forebay.

If the soil is subject to erosion or inundation from water, then the slopes should be lined with concrete or rip-rap.

Where required, the rip-rap material should comprise sound limestone, free of inclusions. The limestone should be blasted or crushed, with an average size of 150 to 200 mm. When the source of the rip-rap is known, **exp** should be notified, so that a site visit may be conducted at the quarry, to verify the source and quality of the material.

The slopes of the entire detention facility, after shaping, should be lightly scarified and a 150 mm thick layer of organic topsoil should be placed on the surface to assist in establishing grass-type vegetation which will inhibit erosion. A synthetic erosion blanket can be considered to assist the growth of vegetation. Some routine maintenance of the slope surfaces will likely be required to address minor long term weathering and erosion.

Prior to berm construction, the berm base area should be stripped of topsoil, fill and other deleterious material, the exposed surface should be proof rolled with a heavy static compactor under the supervision of geotechnical personnel from exp. Any soft zones should be subexcavated and replaced with approved on-site or imported material compacted to 98% of the standard Proctor maximum dry density. To prevent seepage from wet to dry ponds through the earth berm which would subsequently induce erosion, the material used to build the berm should be impermeable soils, otherwise a 450 mm thick clay liner is recommended.

During the construction of the SWM Pond, it is recommended that inspection and *in situ* density testing be conducted as well as soil sampling, laboratory testing and monitoring of fill placement. Full-time geotechnical supervision is recommended.

4.11.1.1 Inlet/Outlet Structures

In the vicinity of the proposed inlet/outlet structures, culverts and/or pipes should be carefully backfilled with excavated clay or glacial till soils. No bearing problems are anticipated for flexible or rigid pipes founded on the native deposits or compacted on site soils. The backfill should be in intimate contact with the complete circumference of the pipe. In places where proper compaction may be difficult to achieve, lean concrete backfill should be used.

The support for inlet and outlet structures must be derived from the native soils or engineered fill. An allowable bearing pressure of 150 kPa is available in these soils. Any headwalls should be backfilled using free-draining granular material and may be designed using an active earth pressure coefficient of 0.4 and a unit weight of 21.0 kN/m^3. Any footing must be protected with a minimum of 1.2 m (4 ft) of earth cover or equivalent insulation to provide protection against potential frost damage.

If minor grade changes must be accommodated for the footings of the headwall, the levels can be raised by the placement of lean mix concrete on the natural subgrade soils.

During the construction of the SWM Pond and associated infrastructure, it is recommended that inspection and *in situ* density testing be conducted as well as soil sampling, laboratory testing and monitoring of fill placement. Full-time geotechnical supervision is recommended.

4.11.2 Dry Pond

It is understood that the dry cell will be created immediately west of the proposed wet cell by constructing an earth berm downstream in the existing ravine contours. The earth berm will be sized to detain less-frequent design storms within the ravine limits, for slow release downstream. The location of the dry pond is shown on Drawing 1.

A dry pond is similar to a wet pond except that dry ponds are meant to store a specific volume of stormwater for a short period of time. Stormwater dry ponds are built to temporarily store excess stormwater and allow some pollutants to settle to the bottom of the basin. The water from dry ponds will slowly drain back onto adjacent land features including streams. The purpose of the dry pond is to allow sediment to settle out of the stormwater runoff and to discharge the water gradually, replicating the conditions of naturally vegetated areas.

Based on the drawing provided by CJDL, the base of the pond will be at elevations ranging from 217.5 to 219.0 m and the tops of the berms of the pond will be 222.7 m. The internal faces of the sidewalls have an inclination of 4H:1V and safety benches. The inclination of the sidewall on the west side (external side) will be 3H:1V. The 100-year flood level is 222.33 m.

BH2 was drilled on the table land nearby the proposed dry pond to a depths of 18.7 m bgs (approximate elevation of 208.3). Based on the findings, the soil at the base of the ravine is anticipated to consist of clay soils and would support the dry pond construction. Therefore, the recommendations provided for the wet pond are applicable for the dry pond.

Based on the anticipated groundwater depth which is far below the dry pond base, no concerns regarding groundwater exist, as the base of the pond will not intersect the groundwater table.

4.12 Slope Stability Assessment

4.12.1 Site Reconnaissance

A slope review survey was carried out on February 24, 2017. The survey included detailed observations such as slope vegetation, seepage from slope face, table land drainage and previous landslide activity.

The bank is covered with mature trees to saplings. Wooded areas were observed along the bank of the site. Mature trees are distributed throughout the slope with very few of them tilted. The toe of the slope extends right to the edge of the water and was covered with vegetation. In addition, based on the borehole findings at the site, the site is dominated by a glacial till which has very low erodibility.

Numerous cross sections, designated as Section A-A to S-S were drawn by CJDL along the slopes across the site where the ravines and ravine fingers run along. The Sections are attached for reference. The cross section locations are shown on **Drawing 1.** Three cross sections designated as E-E, K-K and Q-Q are considered the most critical sections in term of slope gradient, slope height and locations across the site.

Based on the rating system indicated in the “Slope Stability Rating Chart” prepared by the Ontario Ministry of Natural Resources, the slope rating at the site was calculated to be 43 at Cross Section E-E, 39 at Cross Section K-K and 35 at Cross Section Q-Q. The slope ratings indicate slight to moderate potential for slope instability. The slope rating charts are attached in Appendix E. Selected photos at approximate locations of sections E-E, K-K and Q-Q are presented below.

Photographs at approximate location of section E-E

Photographs at approximate location of section K-K

Photographs at approximate location of section Q-Q

4.12.2 Slope Assessment

Based on the River and Stream Systems Landform Classifications of Natural Hazards Training Manual (Policy 3.1), the valley corridor at the site is a confined system. Therefore, the erosion hazard limit should be defined based on the combined influence of toe erosion, stable slope allowance and erosion access allowance which are discussed in detail in the following sections.

4.12.2.1 Stable Slope Geometry

The stability of the existing slope was investigated for a number of different Factors of Safety (FOS). The analyses were undertaken by computer methods utilizing the Slope/W computer program for select slope profiles.

The soil parameters used were conservative to build in an added safety factor for the analyses. The following table summarizes the parameters for the predominant soils which were used in **exp**'s evaluation of the stable slope configuration:

Soil Type	Density	Cohesion	Angle of Internal Friction
Clayey Silt	18.8 kN/m^3	5 kPa	26^o
Clayey Silt Till	21.5 kN/m^3	8 kPa	31^o

The design Minimum Factor of Safety from Table 4.3 of the Technical Guide – River and Stream Systems: Erosion Hazard Limit for Active Land Uses (i.e. habitable or occupied structures near slope) should be in the range of 1.3 to 1.5. A minimum factor of safety of 1.4 was used for the analysis as indicated in the report "Geotechnical Principles for Stable Slopes" prepared for the Ministry of Natural Resources.

Slope analyses were only undertaken at Sections E-E and Q-Q by computer methods utilizing the Slope/W computer program for select slope profiles. Several analysis trials of shallow and deep failures were made. Based on all the slope analysis trials, the factor of safety ranged between 1.49 and 1.75. The slope is considered stable. Therefore, <u>NO</u> stable slope allowance is required along the entire slope.

These findings were in general agreement with observations of the local slope (vegetated and treed slope which is beneficial for protection against shallow slides).

4.12.2.2 Toe Erosion Allowance

Determination of toe erosion allowance where toe of slope is located less than 15 m from a watercourse is based on Table 3: Determination of Toe Erosion Allowance in the Technical Guide – River and Stream Systems: Erosion Hazard Limit. Toes of slopes for the entire property except a few locations are located within 15 m of the watercourse.

Based on no evidence of active erosion, less than 5.0 m of bank width and the soil encountered (stiff/hard cohesive till deposit), a toe erosion allowance of 1.0 m is required along the entire slope across the site. Since the required toe erosion allowance of 1.0 m is less than the existing ravine base width, <u>NO</u> toe erosion allowance is required in Erosion Hazard Setback determination.

4.12.2.3 Erosion Access Allowance

The Erosion Access Allowance as specified in Section 3.4 of the MNR Technical Guide is a distance of 6 m from the top of the slope. This allowance is required in order to provide access for repairs to the slope from the top of the slope. **Exp** recommends that a distance of 6.0 m for the erosion access allowance be provided on the table land. No permanent buildings should be constructed within the 6.0 m of the erosion access allowance.

4.12.2.4 Erosion Hazard Limit

The erosion hazard limit (Recommended Development Limit Setback) is defined by the sum of the Stable Safe Slope Line plus the Toe Erosion Component plus the Erosion Access Allowance.

Based on the 3 components, the total distance back from the existing top of bank or proposed top of bank, in the areas of washout filling, to the recommended development limit setback is 6.0 m. The Recommended Development Limit Setback is shown on Drawing 1.

4.12.3 Additional Comments

It is recommended that the site should be graded such that surface water is directed away from the slope. No water from the table land should be out-letted on the face of the slope. However, it is understood that all lots backing onto an existing ravine will be split drainage design: meaning the front yard is directed to the street, and the side and rear yards is directed to the rear yard. The surface water tributary area that will flow over the bank is significantly reduced under post-development conditions from pre-development. Based on the above, if surface water can not be fully directed away from the slope, facilitation of conveyance of surface drainage to the ravine (as occurs under existing conditions) can be made such that outlet surface runoff water down the slope should not be concentrated at one corner but should be spread it out along the entire line of the property.

Spoils from any excavation should be removed from the site. Excavated soils should not be placed over the existing grades near the crest of slope.

During construction, stockpiles of materials, supplies and construction debris should be located away from the slope crest. Additional loading from stockpiled materials should be avoided in proximity to the slope crest.

Debris littering the slope should be removed and vegetation on the slope should be maintained.

Any structural component should be founded on competent soil below a line drawn from the toe of the slope at 3H:1V.

A site specific geotechnical investigation is required to determine the bearing capacity and foundation design option.

4.13 Culvert

It is understood that a culvert might be constructed across the ravine located around Sections AA & BB. No design details are available at the time of writing this report.

Preparation of the subgrade for construction of the culvert should be performed and monitored in accordance with OPSS 902. This should include site review by qualified geotechnical personnel during preparation of the subgrade as well as during.

The topsoil, tree roots and any other deleterious soils revealed at and below the subgrade should be excavated prior to placement of the granular base below the box culvert.

A minimum 300 mm thick layer of compacted granular bedding material should be placed on the subgrade prior to construction of the culvert. The bedding material should comprise Granular A or Granular B Type

II compacted to 100% of the ASTM D-698 (standard Proctor) maximum dry density in conformance to OPSS 501 (Method A).

The invert level of the proposed culvert is expected to be at a depth of about 3-4 m bgs. The subgrade level of the granular bedding is interpreted to be about 0.5 m below the proposed invert level allowing for the thickness of the concrete base of the culvert and for the granular bedding and levelling courses.

The recommended bearing resistance at ultimate and serviceability limit states and the estimated value of the modulus of subgrade reaction provided in previous sections can be used.

Backfill adjacent to the culvert should be placed in accordance with OPSD 803.010, OPSD 3121.150 and OPSS 422. Backfill should be brought up simultaneously on each side of the culvert and operation of heavy equipment within 0.5 times the height of the culvert (each side) restricted to minimise the potential for movement and/or damage of the culvert due to the lateral earth pressure induced by compaction.

The culvert and headwalls must be designed to support the stress imposed by the overlying fill as well as to resist the unbalanced lateral earth pressure and compaction pressure exerted by the backfill adjacent to the culvert walls.

4.14 Inspection and Testing Recommendations

An effective inspection and testing program is an essential part of construction monitoring. The Inspection and Testing Program for site preparation, servicing and foundations typically include the following items:

- Subgrade examination following prior to foundation installation and engineered fill placement;
- Inspection and Materials testing during engineered fill placement (full-time supervision is recommended) and site servicing works, including soil sampling, laboratory testing (moisture contents and Standard Proctor density test on the pipe bedding, trench backfill and engineered fill material), monitoring of fill placement, and *in situ* density testing;
- Footing Base Examinations to confirm suitability to support the design bearing pressures; and, visual examination of concrete reinforcing steel placement in footings set on engineered fill.
- Inspection and testing for underfloor subgrade and granular placement.
- Materials testing for concrete foundations and floor slab construction.

Additional inspection and testing programs are recommended for the construction of the foundations and building envelopes for the proposed building to be constructed onsite.

5. General Limitations

This report is intended solely for **CJDL** and other parties explicitly identified in the report and are prohibited for use by others without **exp**'s prior written consent. This report is considered **exp**'s professional work product and shall remain the sole property of **exp.** Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient's sole risk, without liability to **exp**. Client shall defend, indemnify and hold **exp** harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of geotechnical engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. 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.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, **exp** will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

By issuing this report, **exp** is the geotechnical engineer of record. It is recommended that **exp** be retained during construction of all foundations and during earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the test locations only [Four (4) boreholes BH1 to BH4]. The subsurface conditions confirmed at the borehole locations may vary at other locations. The subsurface conditions can also be significantly modified by the construction activities on site (for example, excavation, dewatering and drainage, blasting, pile driving, etc.). These conditions can also be modified by exposure of soils or bedrock to humidity, dry periods or frost. Soil and groundwater conditions between and beyond the test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction which could not be detected or anticipated at the time of our investigation. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations. If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by **exp** is completed.

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

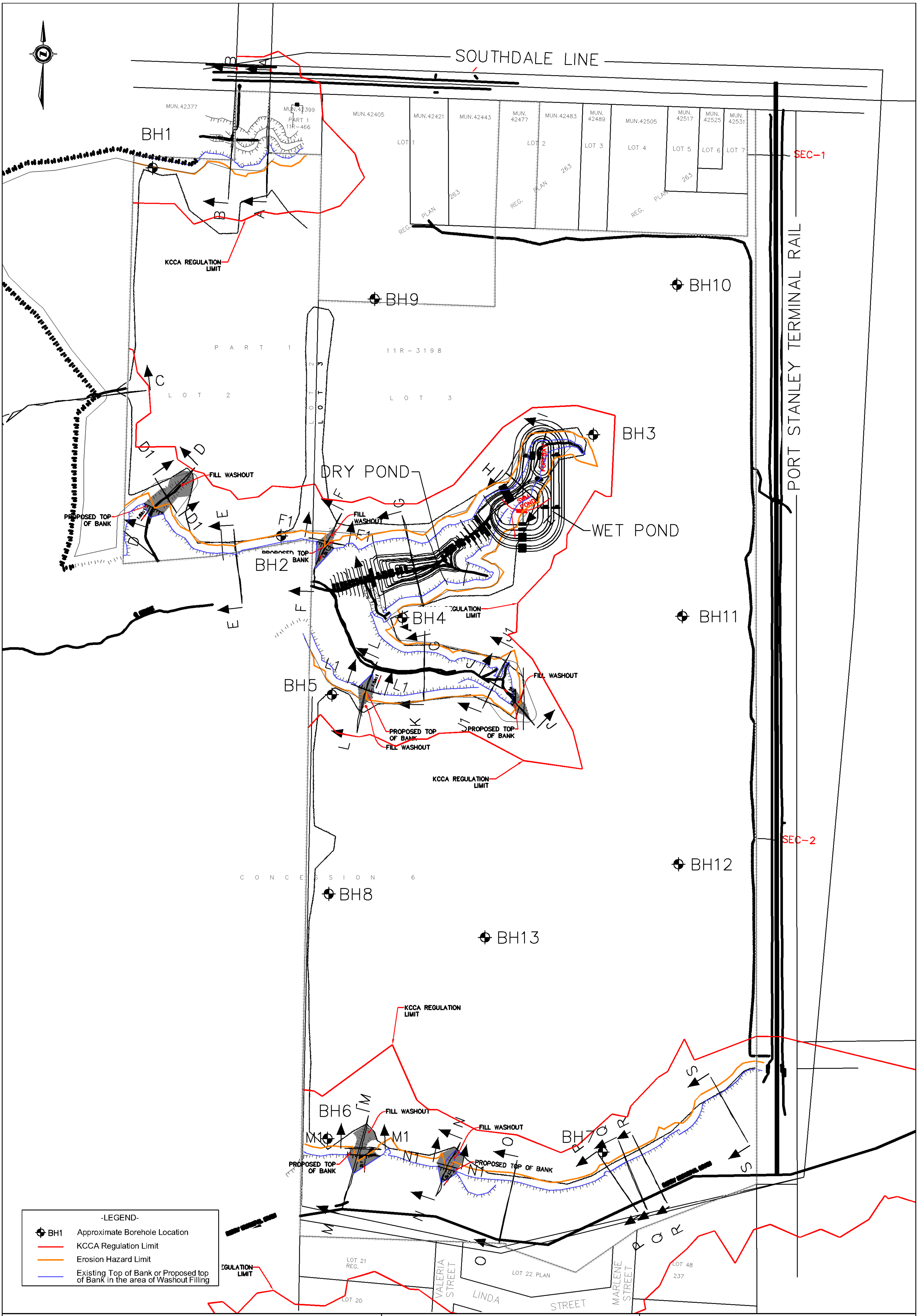
Exp Services Inc. should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not afforded the privilege of making this review, **exp** Services Inc. will assume no responsibility for interpretation of the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

We trust that this report is satisfactory to your present requirements and we look forward to assisting you in the completion of this project. Should you have any questions, please contact the undersigned at your convenience.

All the foregoing and attachments respectfully submitted,

Exp Services Inc.

Drawings



-LEGEND-

⊕ BH1	Approximate Borehole Location
🟥	KCCA Regulation Limit
🟧	Erosion Hazard Limit
🟦	Existing Top of Bank or Proposed top of Bank in the area of Washout Filling

-NOTES-

1. The boundaries and soil types have been established only at borehole locations. Between borehole they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless client advises that an extended time period is required.
3. Topsoil quantities should not be established from the information provided at the test hole locations.
4. The site plan has been reproduced from drawing provided by the client and should be read in conjunction with exp Geotechnical Report LON00015147-GE.

Geotechnical Investigation

Kemsley Farm Subdivision

42537 Southdale Line, St. Thomas, Ontario

CLIENT Doug Tarry Limited / CO DJDL

TITLE Borehole Location Plan & Slope Assessment

DRAWN BY: E.B.

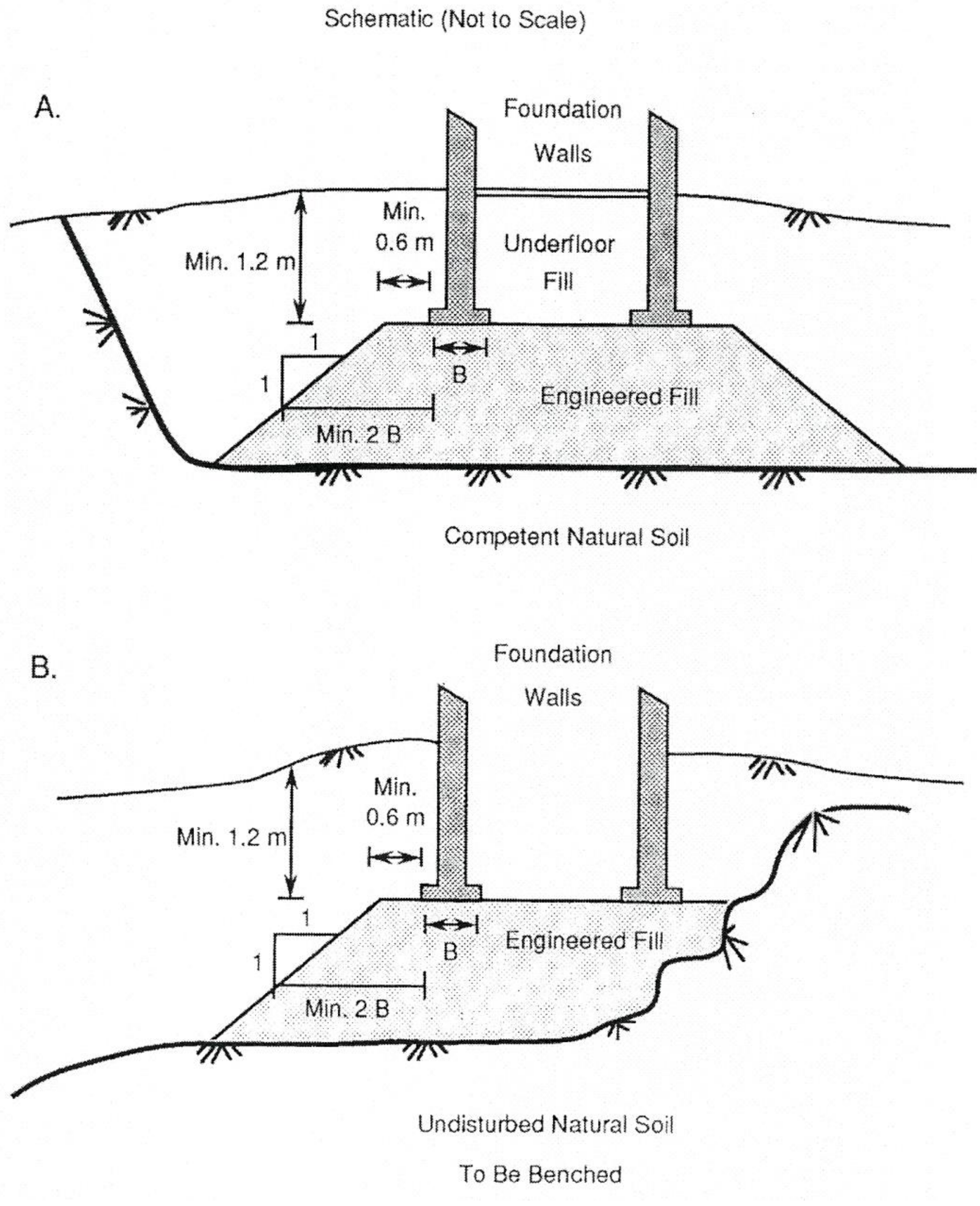
Reviewed BY: I.S.

exp

exp Services Inc.
15701 Robin's Hill Road, London, ON, N5V 0A5

DATE	SCALE	PROJECT NO.	DWG.
MARCH 2017	NTS	LON-00015147-GE	1

DRAWING 2 – GEOMETRIC REQUIREMENTS FOR FOUNDATIONS ON ENGINEERED FILL



SECTION VIEW

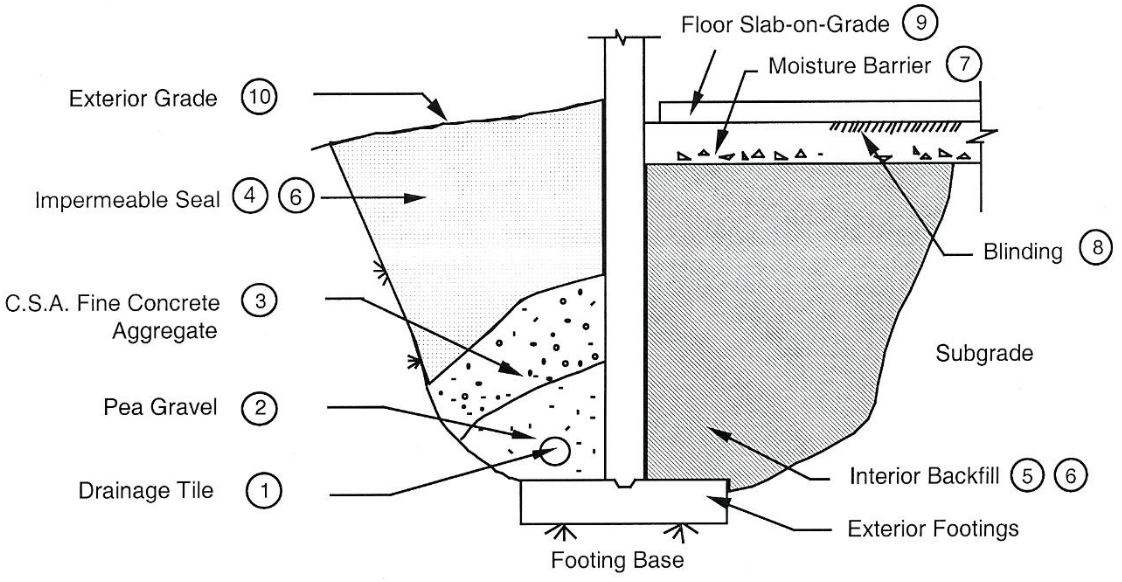
Section A – Typical Section of Slab-on-Grade Building
Section B – Typical Section of Building with Basement

Refer to Detailed Notes on following page.

NOTES FOR ENGINEERED FILL PLACMENT:

1. The area must be stripped of all topsoil contaminated fill material, and other unsuitable soils, and proof rolled. Soft spots must be dug out. The stripped native subgrade must be examined and approved by an **exp** Engineer prior to placement of engineered fill.
2. In areas where engineered fill is placed on a slope, the fill should be benched into the approved subgrade soils. **Exp** would be pleased to provide additional comments and recommendations in this regard, if required.
3. All excavations must be carried out in accordance with the Occupational Health and Safety Regulation of Ontario (Construction Projects - O.Reg. 213.91)
4. Material used for engineered fill must be free of topsoil, organics, frost and frozen material, and otherwise unsuitable or compressible soils, as determined by a Geotechnical Engineer. Any material proposed for use as engineered fill must be examined and approved by **exp**, prior to use onsite. Clean compactable granular fill is preferred. The imported fill should be reviewed to satisfy MOECC Requirements.
5. Approved engineered fill should be placed in maximum 300 mm thick lifts, and uniformly compacted to 100% Standard Proctor dry density throughout. For best compaction results, engineered fill should be within 3 percent of its optimum moisture content, as determined by the Standard Proctor density test.
6. Full time geotechnical monitoring, inspection and *in situ* density (compaction) testing by **exp** is required during placement of the engineered fill.
7. Site grades should be maintained during area grading activities to promote drainage, and to minimize ponding of surface water on the engineered fill mat. Rutting by construction equipment should be kept to a minimum, where possible. Additional work to ensure suitability of engineered fill may be required if fill is placed in extreme (hot/cold) weather.
8. The fill must be placed such that the specified geometry is achieved. Refer to sketches (previous page) for minimum requirements. Proper environmental protection will be required, such as providing frost penetration during construction, and after the completion of the engineered fill mat.
9. An allowable bearing pressure (SLS) of 120 kPa (2,500 psf) may be used for foundations set on engineered fill, provided that all conditions outlined above, and in the Geotechnical Report are adhered to.
10. These guidelines are to be read in conjunction with the attached Geotechnical Report (**exp** Project No. LON-00015070-GE).
11. Footing Base inspections are required to verify the suitability of the subgrade soils, at the time of construction. *In situ* density tests may also be required at the footing base level to confirm material density.

DRAWING 4 – DRAINAGE AND BACKFILL RECOMMENDATIONS (NOT TO SCALE)



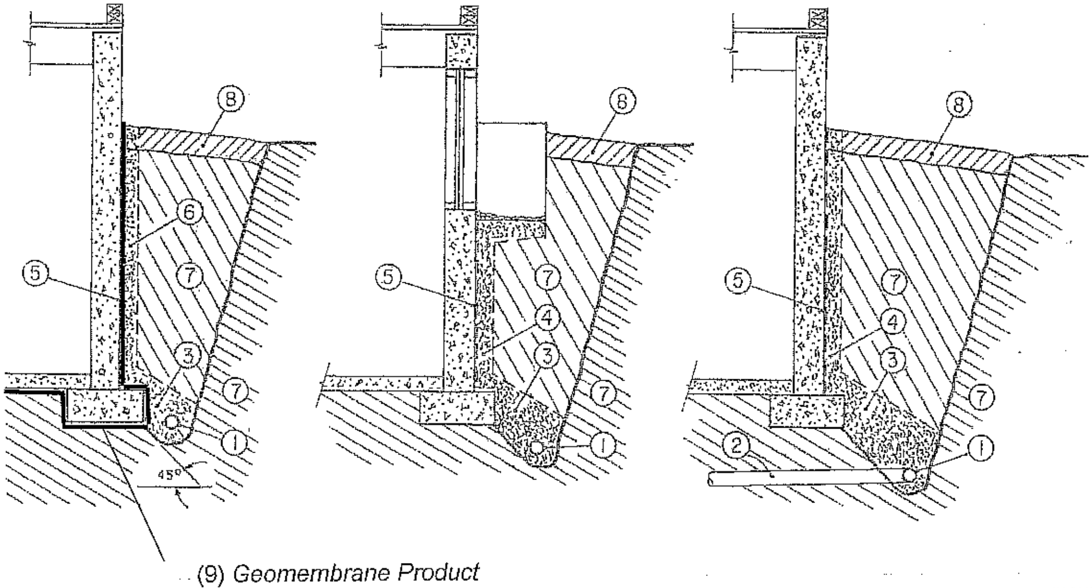
NOTES:

. Drainage tile to consist of 100 mm (4 in.) diameter weeping tile or equivalent perforated pipe leading to a positive sump or outlet. Invert to be minimum of 150 mm (6 in.) below underside of interior floor slab.
2. Pea gravel 150 mm (6 in.) top and sides of drain. If drain is not on footing, place 100 mm (4 in.) of pea gravel below drain. 20 mm (3/4 in.) clear stone may be used provided if it is covered by an approved porous geotextile fabric membrane (Terrafix 270R or equivalent).
3. C.S.A. fine concrete aggregate to act as filter material. Minimum 300 mm (12 in.) top and side of drain. This may be replaced by an approved porous geotextile membrane (Terrafix 270R or equivalent).
4. Impermeable backfill seal of compacted clay, clayey silt or equivalent. If original soil is free-draining, seal may be omitted. Compact backfill to 95 percent Standard Proctor Maximum Dry Density.
5. The interior fill may be any clean, inorganic soil which may be compacted to at least 95 percent Standard Proctor density in this confined space.
6. Do not use heavy compaction equipment within 450 mm (18 in.) of the wall. Do not fill or compact within 1.8 m (6 ft) of wall unless fill is placed on both sides simultaneously.
7. Moisture barrier to be at least 200 mm (8 in.) of compacted 20 mm (3/4 in.) clear, crushed stone or equivalent free-draining material.
8. If the 20 mm (3/4 in.) clear stone requires surface binding, use 60 mm (1/4 in.) clear stone chips.
9. Slab on grade should not be structurally connected to wall or footing.
10. Exterior grade to slope away from building.

This system is not normally required if the floor is at least 300 mm (1 ft.) above exterior grade.

DRW:3a

BACKFILL AND BASEMENT DRAINAGE DRAWING (NOT TO SCALE)

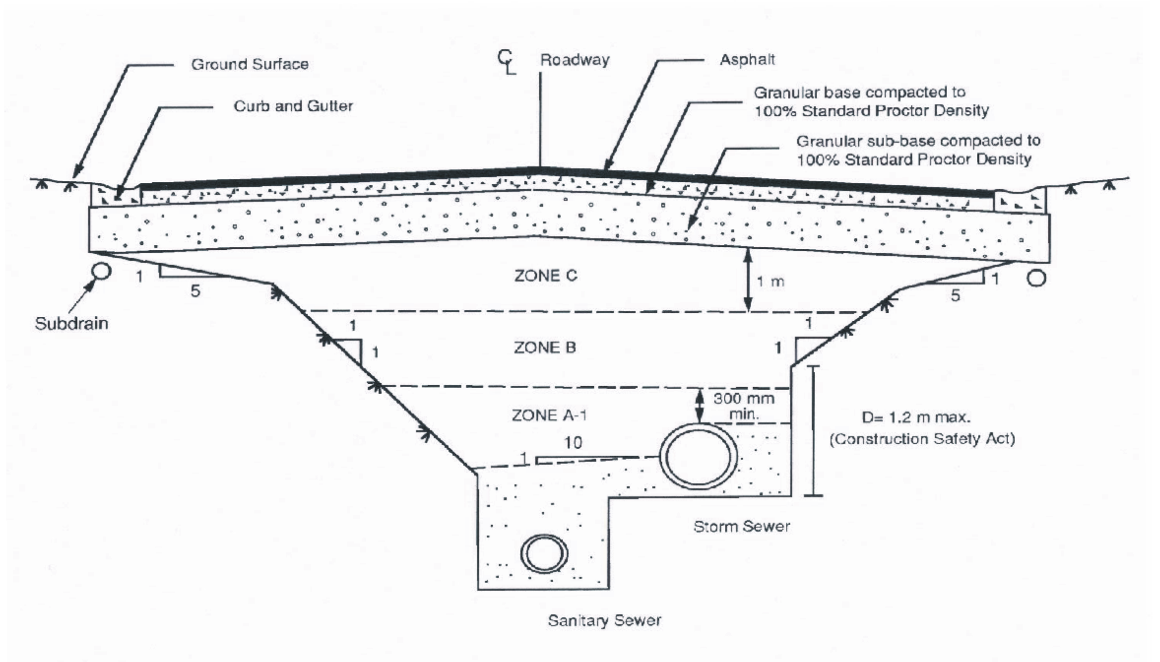


NOTES:

1. Perforated or slotted pipe placed about 300 mm below the upper level of the basement floor slab;
2. Unperforated drain pipe connected to a positive sump; connect to appropriate trap and backwater valve before connecting to sewer, where applicable. Provide appropriate access to the trap for inspection and cleaning;
3. Filter material that is compatible with the grain size characteristics of the foundation and backfill soils, as well as the perforations of the pipe;
4. Filter material continuously or intermittently placed next to the foundation wall to intercept water from window wells and low areas near building (see also 6);
5. Damp-proofing on wall;
6. Optional use of sheet drain or synthetic filter blanket next to foundation wall to replace the soil filter described in 4;
7. Foundation and backfill soils, which may contain fine grain and erodible materials; and,
8. "Topping-off" material, graded away from the building to redirect surface water from the foundations. Low permeability soils, or concrete or asphalt, are preferred.
9. As illustrated in left figure above, provide continuous geomembrane product beneath slab and footings where prevailing groundwater levels may be higher than basement floor slab elevation; extend geomembrane up to existing grade along exterior face of foundation wall.

Reference: Canadian Geotechnical Society 2006, *Canadian Foundation Engineering Manual, 4th Edition, (Figure 12.1, p184).*

DRAWING 5 – TYPICAL BACKFILL DETAIL
STORM AND SANITARY SEWER (COMMON TRENCH)



SECTION VIEW

NOTES:

ZONE A

Granular bedding satisfying current City of Sarnia Standards compacted to 95% Standard Proctor maximum dry density.

ZONE A-I

To be compacted to 95% Standard Proctor maximum dry density.

ZONE B

To be compacted to 95% Standard Proctor maximum dry density.

ZONE C

To be compacted to 98% Standard Proctor maximum dry density.

The excavations shown above are for Type 1 or 2 soils. Where excavations extend through Type 3 soils, the side walls should be sloped back at a maximum inclination of 1 horizontal to 1 vertical from the base (Reference O.Reg 219/31).

DRAWING 6 – TRENCH BACKFILL REQUIREMENTS

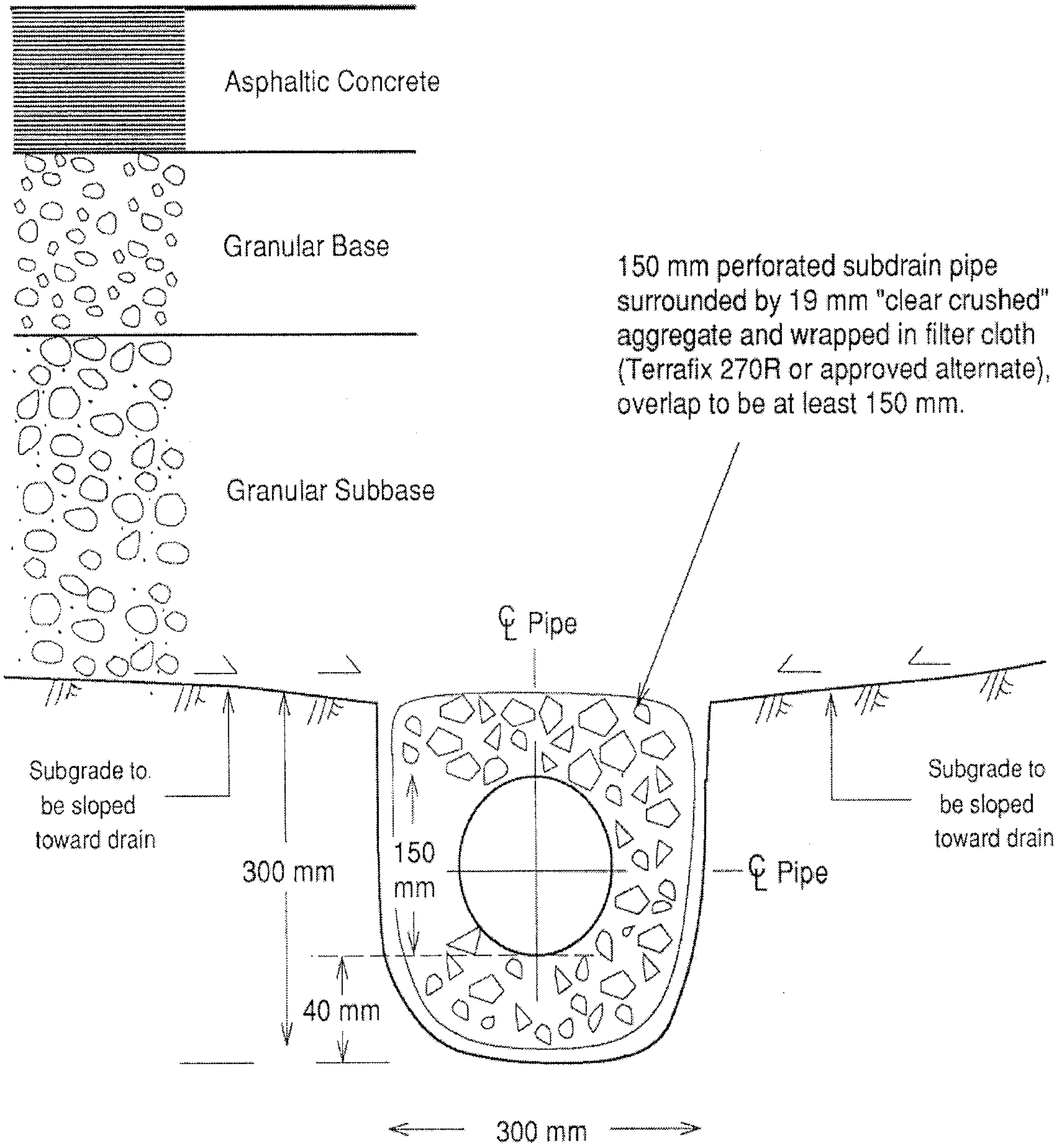
Requirements for backfill in service trenches, etc. should conform to current City of Sarnia and OPS requirements. A summary of the general recommendations for trench backfill is presented on **Drawing 5**.

The bedding materials for the services designated as Zone A on the attached drawings should consist of approved granular material satisfying the current City of Sarnia minimum standards and specifications. (Class B bedding should provide adequate support for the pipes). These materials should be uniformly compacted to 95 percent of standard Proctor dry density. Some problems may be encountered in maintaining alignment when bedding pipes in wet sandy soil. If Granular ‘A’ or other sandy material is used for bedding, they may become ‘spongy’ when saturated. If significant amounts of clear stone are used to stabilize the base, a geotextile should be incorporated to avoid problems with migration of fine grained materials and differential settlement under the pipes as the groundwater rises after backfilling. For minor local use of crushed stone without a geotextile filter, a graded HL3 stone is preferable.

The backfill in Zone B will consist of the native material. This material should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to 95 percent of the standard Proctor maximum dry density. Material wetter than 5 percent above optimum must be allowed to dry sufficiently or should be discarded or used in landscaped areas.

The upper 1 meter of the general backfill (i.e. Zone C) should be placed in loose lifts not exceeding 300 mm (12 inches) and be uniformly compacted to at least 98 percent of the standard Proctor maximum dry density. To achieve satisfactory compaction, the fill material should be within 3 percent of standard Proctor optimum moisture content at placement.

DRAWING 7 – PAVEMENT SUBDRAIN DETAIL



NOTES:

1. All dimensions in millimetres.
2. All subdrains to be set on at least 1% grade draining to a positive outlet.
3. Subgrade soil conditions should be verified onsite, during subgrade preparation works, following site servicing installations.

Scale: NTS

Appendix A - Borehole Logs

exp.

BOREHOLE LOG

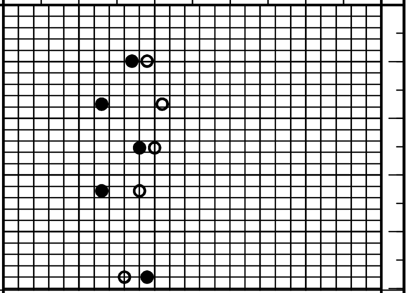
BH1
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 30, 2017** Water Level

DEPTH (m bgs)	ELEVATION (~ m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	228.5								
	228.2	**TOPSOIL** - 300 mm							
	227.9	**SANDY SILT** - brown, loose, moist							
1	227.1	**CLAYEY SILT** - brown/grey, weathered, trace sand, trace gravel, rootlets, very stiff, moist			▨ SS	S1	450	17	19
2		**CLAYEY SILT TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist - 75 mm thick wet sandy silt seam near 1.7 m bgs - 25 mm thick wet sandy silt seam near 3.1 m bgs - becoming grey near 3.2 m bgs			▨ SS	S2	400	13	21
3					▨ SS	S3	450	18	20
4					▨ SS	S4	450	13	18
5	223.5				▨ SS	S5	400	19	16
		End of Borehole at 5.0 m bgs.							

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa
Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE. For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 3.7 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

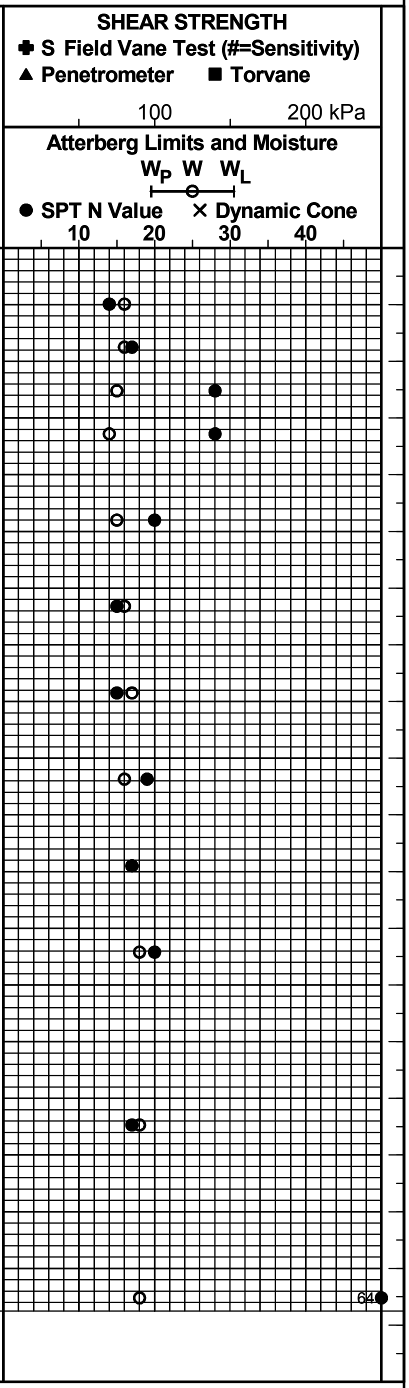
exp.

BOREHOLE LOG

BH2
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 27, 2016**
Water Level

ELEVATION (~m)	STRATA DESCRIPTION	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
227.0						
226.8	**TOPSOIL** - 250 mm					
225.6	**CLAYEY SILT** - brown, trace sand, trace gravel, rootlets, stiff, moist Bulk Density: 18.8 kN/cu.m	▨ SS	S1	350	14	16
	CLAYEY SILT TILL - brown, trace sand, trace gravel, very stiff, moist	▨ SS	S2	450	17	16
	Gr Sa Si Cl 3% 16% 43% 38%	▨ SS	S3	450	28	15
	- becoming grey near 3.4 m bgs	▨ SS	S4	400	28	14
	Bulk Density: 22.2 kN/cu.m	▨ SS	S5	250	20	15
	Bulk Density: 21.8 kN/cu.m	▨ SS	S6	450	15	16
	Bulk Density: 21.7 kN/cu.m	▨ SS	S7	425	15	17
	Bulk Density: 21.7 kN/cu.m	▨ SS	S8	350	19	16
	Bulk Density: 21.5 kN/cu.m	▨ SS	S9	450	17	17
	Bulk Density: 21.2 kN/cu.m	▨ SS	S10	450	20	18
	- wet sand layering encountered near 13.7 m bgs					
	Bulk Density: 21.3 kN/cu.m	▨ SS	S11	450	17	18
208.6	Bulk Density: 20.9 kN/cu.m					
208.3	**SAND** - grey, fine grained, some silt, very dense, wet	▨ SS	S12	450	64	18
	End of Borehole at 18.7 m bgs.					



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 13.4 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

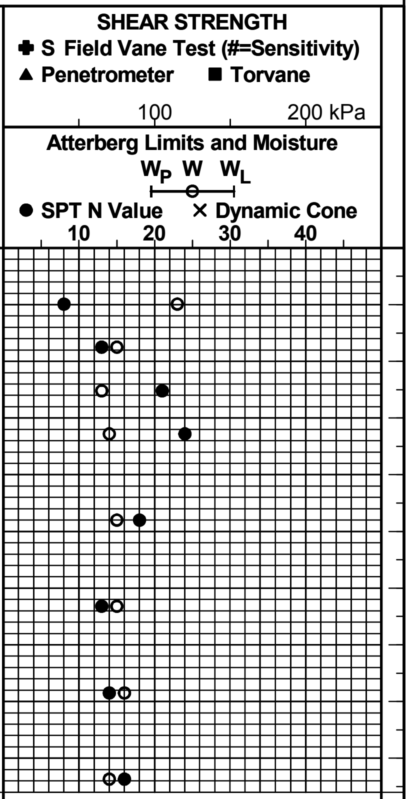
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH3
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 26, 2016**
Water Level

DEPTH (m bgs)	ELEVATION (~m) 229.0	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	228.8	**TOPSOIL** - 250 mm							
	228.4	**SILTY SAND** - brown, loose, moist							
1		**CLAYEY SILT** - brown/grey, weathered, trace to some sand, trace gravel, rootlets in upper 1.4 m bgs, stiff, moist			▨ SS	S1	275	8	23
2	226.9				▨ SS	S2	450	13	15
		CLAYEY SILT TILL - brown, trace sand, trace gravel, stiff to very stiff, moist - becoming grey near 2.5 m bgs			▨ SS	S3	400	21	13
3					▨ SS	S4	450	24	14
4									
5					▨ SS	S5	450	18	15
6					▨ SS	S6	375	13	15
7									
8					▨ SS	S7	450	14	16
9	219.4				▨ SS	S8	350	16	14
10		**End of Borehole at 9.6 m bgs.**							
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 2.7 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

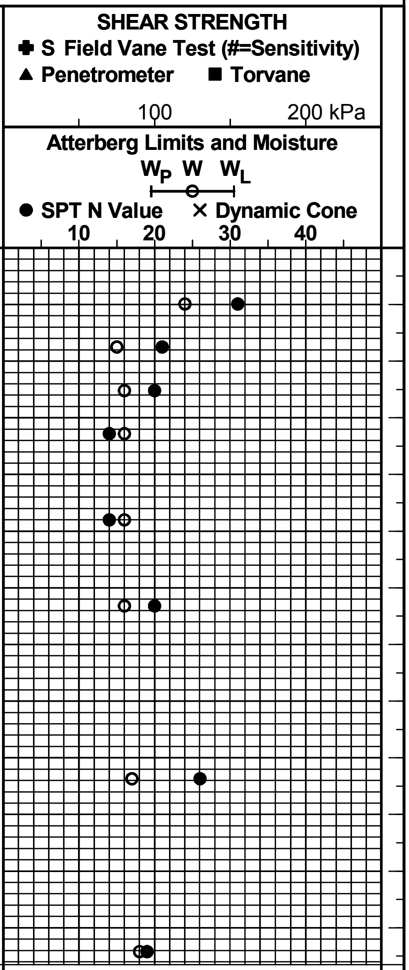
BOREHOLE LOG

BH4
Sheet 1 of 1

CLIENT **Doug Tarry Limited** PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision** DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON** DATES: Boring **January 27, 2016** Water Level

ELEVATION (~m)	STRATA DESCRIPTION
228.5	
228.3	**TOPSOIL** - 250 mm
227.6	**CLAYEY SILT** - brown/grey, weathered, trace sand, trace gravel, stiff, moist
	CLAYEY SILT TILL - brown/grey, trace sand, trace gravel, stiff to very stiff, moist - 50 mm thick moist silt seam near 2.3 m bgs - becoming grey near 2.5 m bgs
215.9	**End of Borehole at 12.7 m bgs.**

SAMPLES				MOISTURE CONTENT
TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	(%)
SS	S1	450	31	24
SS	S2	450	21	15
SS	S3	450	20	16
SS	S4	300	14	16
SS	S5	400	14	16
SS	S6	400	20	16
SS	S8	450	26	17
SS	S10	425	19	18



DEPTH (m bgs) 0–20

NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE. For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 6.7 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

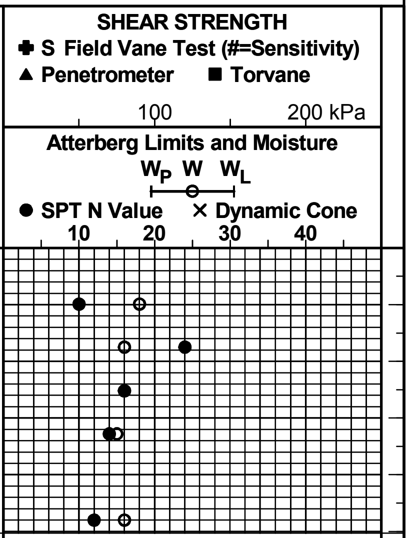
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH5
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 26, 2016**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	228.5							
	228.3	**TOPSOIL** - 250 mm						
	227.1	**CLAYEY SILT** - brown/grey, weathered, some sand, trace gravel, stiff, moist - 75 mm thick silty sand seam encountered near 1.0 m bgs		▨ SS	S1	400	10	18
		CLAYEY SILT TILL - brown, trace sand, trace gravel, stiff to very stiff, moist - becoming grey near 2.5 m bgs		▨ SS	S2	400	24	16
				▨ SS	S3	400	16	16
			∇	▨ SS	S4	450	14	15
5	223.5			▨ SS	S5	450	12	16
		End of Borehole at 5.0 m bgs.						



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 4.6 m bgs and groundwater measured near 3.7 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ▣ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

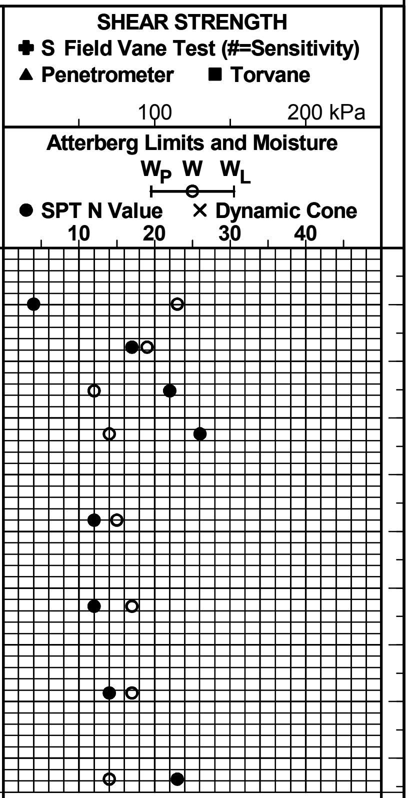
WATER LEVELS
∇ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH6
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 26, 2016**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	**228.5**						
	228.3	**TOPSOIL** - 200 mm					
	227.9	**SANDY SILT** - brown, loose, moist					
1		**CLAYEY SILT** - brown/grey, weathered, trace sand, trace gravel, soft, moist	SS	S1	350	4	23
	226.8	**CLAYEY SILT TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist - occasional wet seam encountered near 1.8 m bgs - becoming grey near 3.5 m bgs					
2			SS	S2	450	17	19
			SS	S3	450	22	12
3			SS	S4	400	26	14
5			SS	S5	450	12	15
6			SS	S6	450	12	17
8			SS	S7	450	14	17
9	218.9		SS	S8	450	23	14
10		**End of Borehole at 9.6 m bgs.**					



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 6.1 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

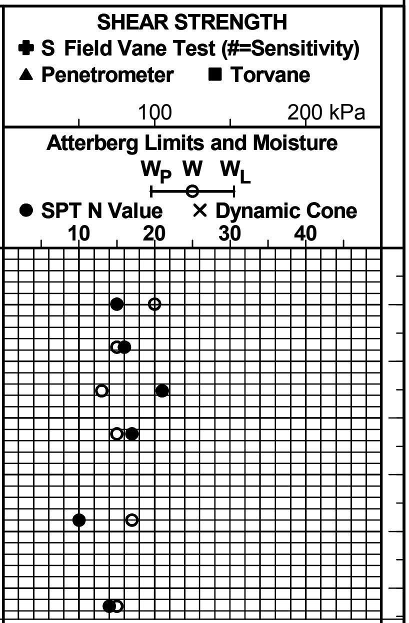
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH7
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 26, 2016** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	229.7						
	229.5	**TOPSOIL** - 250 mm					
	229.1	**SILTY SAND** - brown, loose, moist					
	228.3	**CLAYEY SILT** - brown/grey, weathered, trace to some sand, trace gravel, tree root, stiff, moist - 75 mm thick very moist silty sand and gravel seam encountered near 0.9 m bgs	SS	S1	200	15	20
		CLAYEY SILT TILL - brown, trace sand, trace gravel, stiff to very stiff, moist - becoming grey near 2.1 m bgs	SS	S2	400	16	15
			SS	S3	450	21	13
			SS	S4	400	17	15
			SS	S5	450	10	17
	223.2		SS	S6	450	14	15
		End of Borehole at 6.6 m bgs.					



SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

NOTES

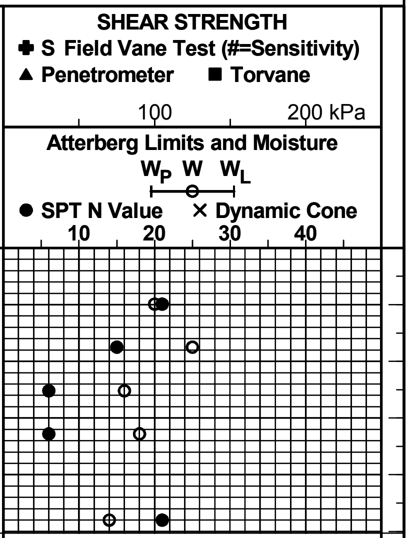
1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 3.0 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

BOREHOLE LOG

BH8
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 26, 2016**
Water Level

Elevation (~m) 230.6	Strata Description	Well Log	Type	Number	Recovery (mm)	N Value (blows)	Moisture Content (%)
230.3	**TOPSOIL** - 280 mm						
229.2	**SAND** - brown, some silt, compact, very moist	▽	SS	S1	250	21	20
227.3	**CLAYEY SILT** - brown, trace sand, trace gravel, some wet sand seams, stiff, moist - becoming grey near 2.1 m bgs - 300 mm thick dilatant silt layer encountered near 2.1 m bgs - 250 mm thick wet sand layer encountered near 3.1 m bgs		SS	S2	350	15	25
			SS	S3	450	6	16
			SS	S4	450	6	18
225.6	**CLAYEY SILT TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist		SS	S5	300	21	14
	End of Borehole at 5.0 m bgs.						



Depth (m bgs): 0–20

NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 1.1 m bgs and groundwater measured near 0.9 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

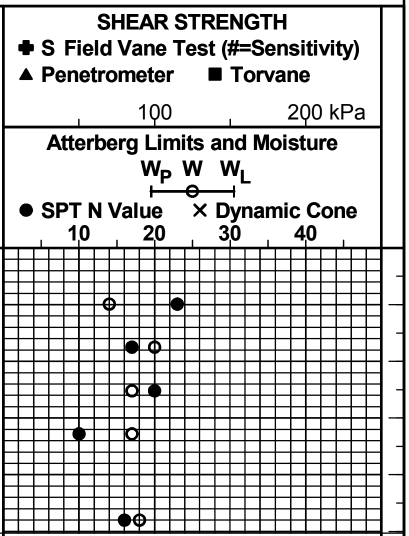
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH9
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 30, 2017** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	228.5							
	228.2	**TOPSOIL** - 280 mm						
1	227.1	**SILTY SAND** - brown, fine to coarse grained, trace gravel, compact, very moist to wet		SS	S1	350	23	14
2		**CLAYEY SILT TILL** - brown, trace sand, trace gravel, stiff to very stiff, moist	⊻	SS	S2	350	17	20
		- becoming grey near 2.4 m bgs		SS	S3	400	20	17
3		- 25 mm thick wet sandy silt seam near 3.1 m bgs		SS	S4	450	10	17
4								
5	223.5			SS	S5	450	16	18
		End of Borehole at 5.0 m bgs.						
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								



SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
⊻ Apparent ▼ Measured ▲ Artesian (see Notes)

NOTES

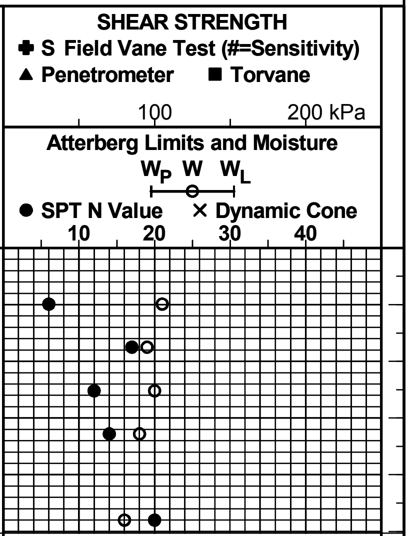
1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 4.0 m bgs and groundwater measured near 2.1 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

BOREHOLE LOG

BH10
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 30, 2017**
Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	230.6								
	230.3	**TOPSOIL** - 280 mm							
1	229.2	**CLAYEY SILT** - brown/grey, weathered, trace sand, trace gravel, rootlets, firm, moist			▨ SS	S1	400	6	21
2		**CLAYEY SILT TILL** - grey, trace sand, trace gravel, stiff to very stiff, moist			▨ SS	S2	300	17	19
					▨ SS	S3	450	12	20
3					▨ SS	S4	400	14	18
4									
5	225.6				▨ SS	S5	50	20	16
		End of Borehole at 5.0 m bgs.							
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 4.0 m bgs and dry upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample
▨ SS Split Spoon
■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.)
◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
▽ Apparent
▼ Measured
▲ Artesian (see Notes)

exp.

BOREHOLE LOG

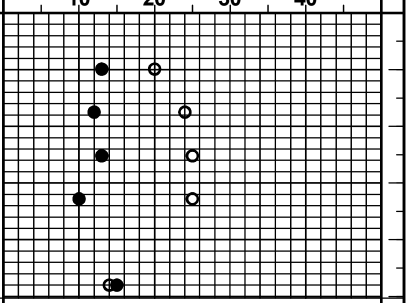
BH11
Sheet 1 of 1

CLIENT **Doug Tarry Limited** PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision** DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON** DATES: Boring **January 30, 2017** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N VALUE (blows)	MOISTURE CONTENT (%)
0	231.2 230.9	**TOPSOIL** - 300 mm	▽					
		ALTERNATING SILTY SAND AND CLAYEY SILT LAYERS - brown/grey, compact, moist to wet						
1				▨ SS	S1	350	13	20
2	229.1			▨ SS	S2	300	12	24
		CLAYEY SILT TILL - grey, trace to some sand, trace gravel, stiff to very stiff, moist - frequent sand laminations and seams in upper 4.0 m bgs		▨ SS	S3	350	13	25
3				▨ SS	S4	400	10	25
4								
5	226.2	- 300 mm thick coarse grained, wet sand layer near 4.6 m bgs		▨ SS	S5	450	15	14
		End of Borehole at 5.0 m bgs.						

SHEAR STRENGTH
✚ S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
100 200 kPa

Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
10 20 30 40



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE. For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 0.6 m bgs and groundwater measured near 0.5 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

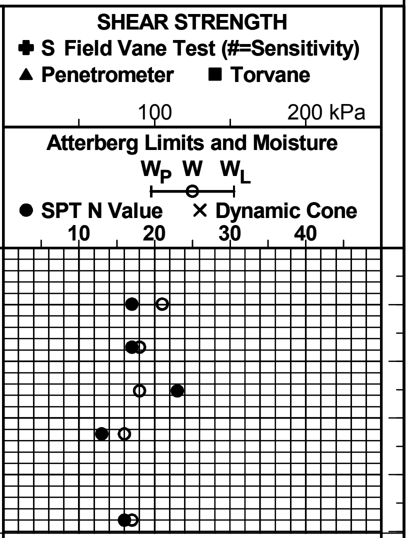
WATER LEVELS
▽ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH12
Sheet 1 of 1

CLIENT **Doug Tarry Limited**
PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision**
DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON**
DATES: Boring **January 30, 2017** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	231.3							
	~~231.0~~	**TOPSOIL** - 280 mm						
		SILTY SAND - brown, fine to medium grained, compact, very moist to wet	⊻					
1	229.9			▨ SS	S1	300	17	21
2		**CLAYEY SILT TILL** - grey, trace sand, trace gravel, stiff to very stiff, moist		▨ SS	S2	350	17	18
		- 50 mm thick silty sand seam near 2.5 m bgs		▨ SS	S3	450	23	18
3				▨ SS	S4	450	13	16
4								
5	226.3			▨ SS	S5	450	16	17
		End of Borehole at 5.0 m bgs.						



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 0.8 m bgs and groundwater measured near 0.8 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ◫ VN Vane Sample

OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

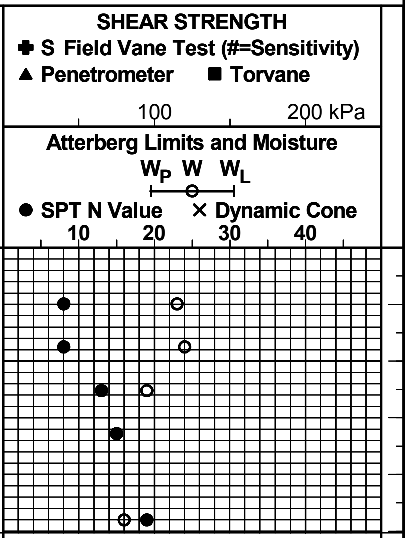
WATER LEVELS
⊻ Apparent ▼ Measured ▲ Artesian (see Notes)

BOREHOLE LOG

BH13
Sheet 1 of 1

CLIENT **Doug Tarry Limited** PROJECT NO. **LON-00015147-GE**
PROJECT **Kemsley Farm Subdivision** DATUM **Geodetic**
LOCATION **42537 Southdale Line, St. Thomas, ON** DATES: Boring **January 30, 2017** Water Level

DEPTH (m bgs)	ELEVATION (~m)	STRATA DESCRIPTION	WELL LOG	TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)	MOISTURE CONTENT (%)
0	230.6							
	230.4	**TOPSOIL** - 250 mm						
		ALTERNATING SILTY SAND AND CLAYEY SILT LAYERS - brown/grey, loose, moist to wet	∇					
1	229.2			SS	S1	350	8	23
		CLAYEY SILT TILL - brown, trace to some sand, trace gravel, stiff to very stiff, moist - frequent sand laminations and sand and silt seams in upper 2.9 m bgs - becoming grey near 2.9 m bgs		SS	S2	400	8	24
2				SS	S3	400	13	19
3				SS	S4	450	15	15
4								
5	225.6			SS	S5	350	19	16
		End of Borehole at 5.0 m bgs.						



NOTES

1) Borehole Log interpretation requires assistance by exp before use by others. Borehole Logs must be read in conjunction with exp Report LON-00015147-GE.
For definitions of terms used on logs, see sheet prior to logs.
2) Borehole open to 0.8 m bgs and groundwater measured near 0.7 m bgs upon completion of drilling.
3) bgs denotes below ground surface.
4) No significant methane gas concentration was detected upon completion of drilling.

SAMPLE LEGEND
☒ AS Auger Sample ▨ SS Split Spoon ■ ST Shelby Tube
◫ Rock Core (eg. BQ, NQ, etc.) ⧈ VN Vane Sample

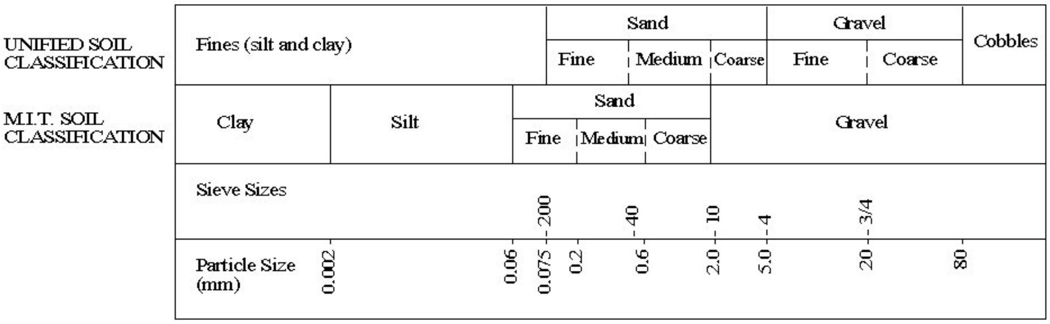
OTHER TESTS

G Specific Gravity	C Consolidation
H Hydrometer	CD Consolidated Drained Triaxial
S Sieve Analysis	CU Consolidated Undrained Triaxial
γ Unit Weight	UU Unconsolidated Undrained Triaxial
P Field Permeability	UC Unconfined Compression
K Lab Permeability	DS Direct Shear

WATER LEVELS
∇ Apparent ▼ Measured ▲ Artesian (see Notes)

NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the 'modified' Massachusetts Institute of Technology (M.I.T.) soil classification system. The laboratory grain-size analysis also follows this classification system. Others may designate the Unified Classification System as their source; a comparison of the two is shown for your information. Please note that, with the exception of those samples where the grain size analysis has been carried out, all samples are classified visually and the accuracy of the visual examination is not sufficient to differentiate between the classification systems or exact grain sizing. The M.I.T. system has been modified and the **exp** classification includes a designation for cobbles above the 75 mm size and boulders above the 200 mm size.

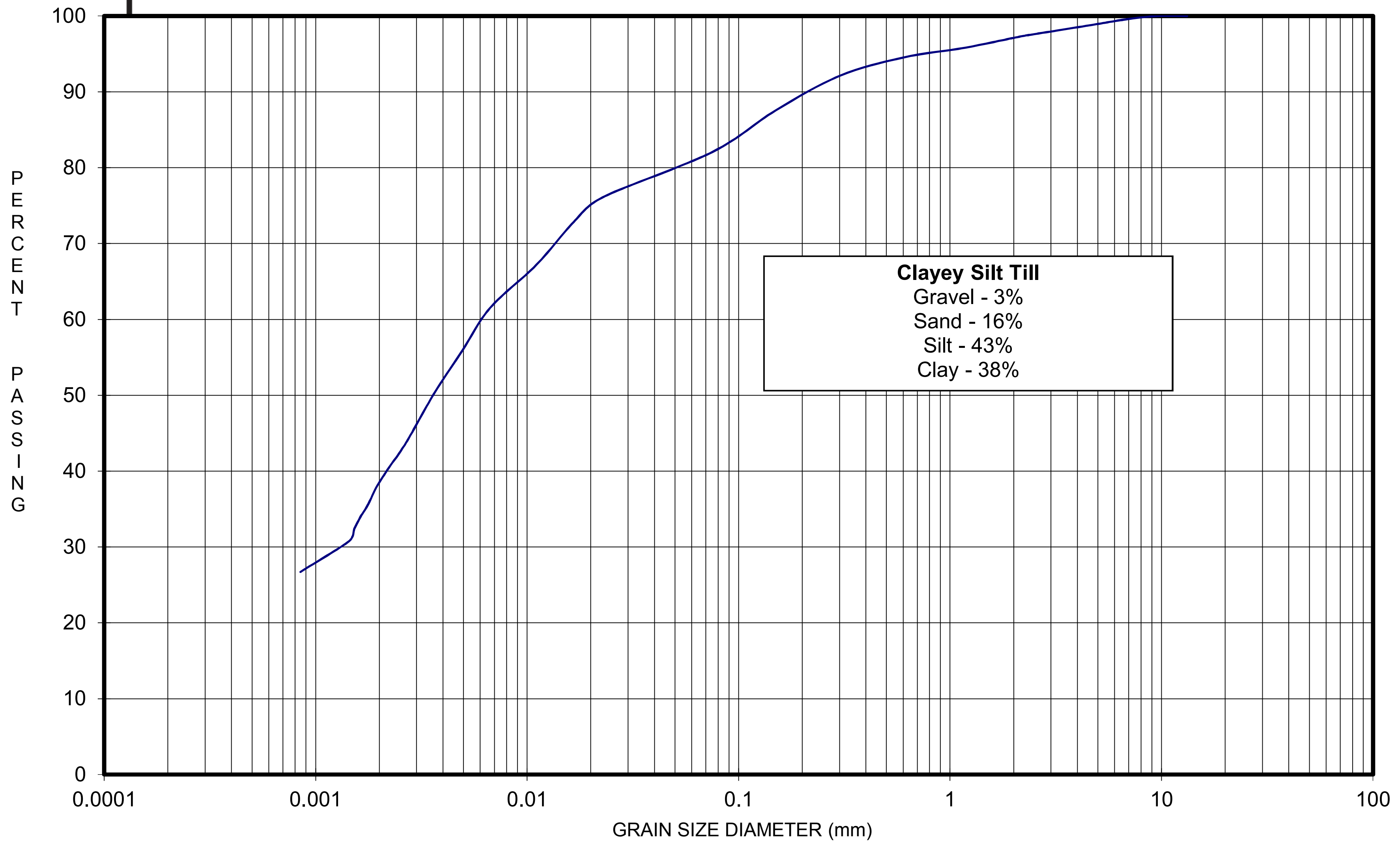


2. **Fill**: Where fill is designated on the borehole log, it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description therefore, may not be applicable as a general description of the site fill material. All fills should be expected to contain obstructions such as large concrete pieces or subsurface basements, floors, tanks, even though none of these obstructions may have been encountered in the borehole. 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 and correct 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. The fill at this site has been monitored for the presence of methane gas and the results are recorded on the borehole logs. The monitoring process neither indicates the volume of gas that can be potentially generated or pinpoints the source of the gas. These readings are to advise of a potential or existing problem (if they exist) and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic waste that renders the material unacceptable for deposition in any but designated land fill sites; unless specifically stated, the fill on the site has not been tested for contaminants that may be considered hazardous. This testing and a potential hazard study can be carried out if you so request. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common, but not detectable using conventional geotechnical procedures.

3. **Glacial 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 (75 to 200 mm in diameter) or boulders (greater than 200 mm diameter) and therefore, contractors may encounter them during excavation, even if they are not indicated on the borehole logs. It should be appreciated that normal sampling equipment can not differentiate the size or type of obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with sensitive excavations or dewatering programs in till material.

Appendix B – Geotechnical Laboratory Test Results

MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		

MODIFIED M.I.T. CLASSIFICATION

Sample Description: Clayey Silt Till (BH2S4, 3.0-3.5 m bgs)

Project: LON00015147GE
Kemsley Farm Subdivision

Figure 1

Appendix C – Inspection and Testing Schedule

INSPECTION & TESTING SCHEDULE

The following program outlines suggested minimum testing requirements during backfilling of service trenches and construction of pavements. In adverse weather conditions (wet/freezing), increased testing will be required. The testing frequencies are general requirements and may be adjusted at the discretion of the engineer based on test results and prevailing construction conditions.

I TRENCH BACKFILL

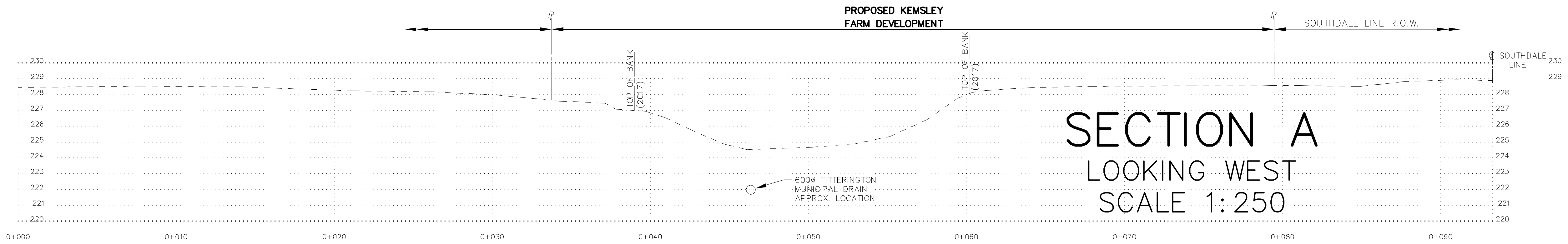
ZONE A	-	one in situ density test per 100 cubic meters or 50 linear metres of trench whichever is less
	-	one laboratory grain size and Proctor density test per 50 density tests or 4000 cubic metres or on change of material (source, visual)
ZONE A1	-	one in situ density test per 75 cubic metres of material or 25 linear metres of each lift of fill
	-	one laboratory grain size and Proctor density test per each 50 density tests or 4000 cubic metres of material placed or as directed by the engineer
ZONES B & C	**-**	one in situ density test per 150 cubic metres of material or 50 linear metres or each lift whichever is less
	-	one laboratory grain size and Proctor density test per 50 density tests or 4000 cubic metres of material placed or as directed by the engineer

II PAVEMENT MATERIALS

GRANULAR SUBBASE	**-**	one in situ density test per 50 linear metres of road
	-	one laboratory grain size and standard Proctor test per 50 density tests or 4000 cubic metres or each change of material (visual, source), as determined by the engineer
GRANULAR BASE	**-**	one in situ density test per 50 linear metres of road
	-	one laboratory grain size and Proctor per 50 density tests or 8000 cubic metres or change in material (visual, source), as determined by the engineer
	-	Benkelman beam testing at 10 metre intervals per lane, after final grading and compaction. Asphaltic concrete should not be placed until rebound criteria have been satisfied.
ASPHALTIC CONCRETE	**-**	one in situ density test per 25 linear metres of roadway
	-	one complete Marshall Compliance test including stability flow, etc. for each mix type to check mix acceptability. One extraction and gradation test per each day of paving to be compared to job mix formula

NOTES: Where testing indicates inadequate compaction, additional fill should not be placed until the area is recompacted and retested at the discretion of the engineer.

Appendix D – Profiles prepared by CJDL



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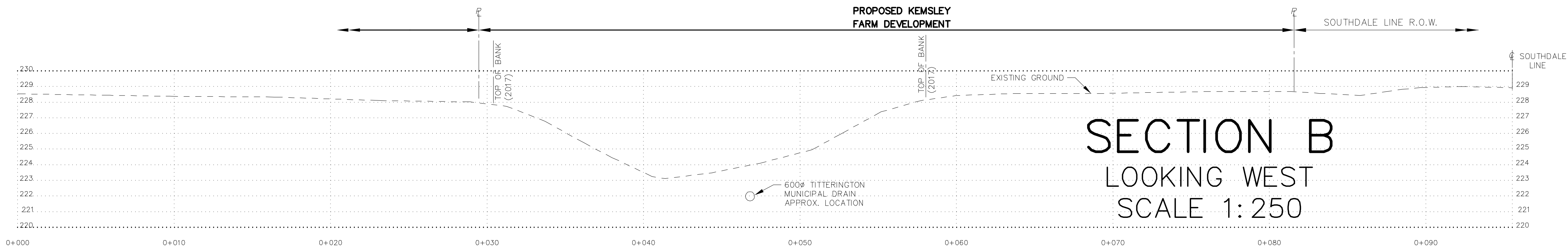

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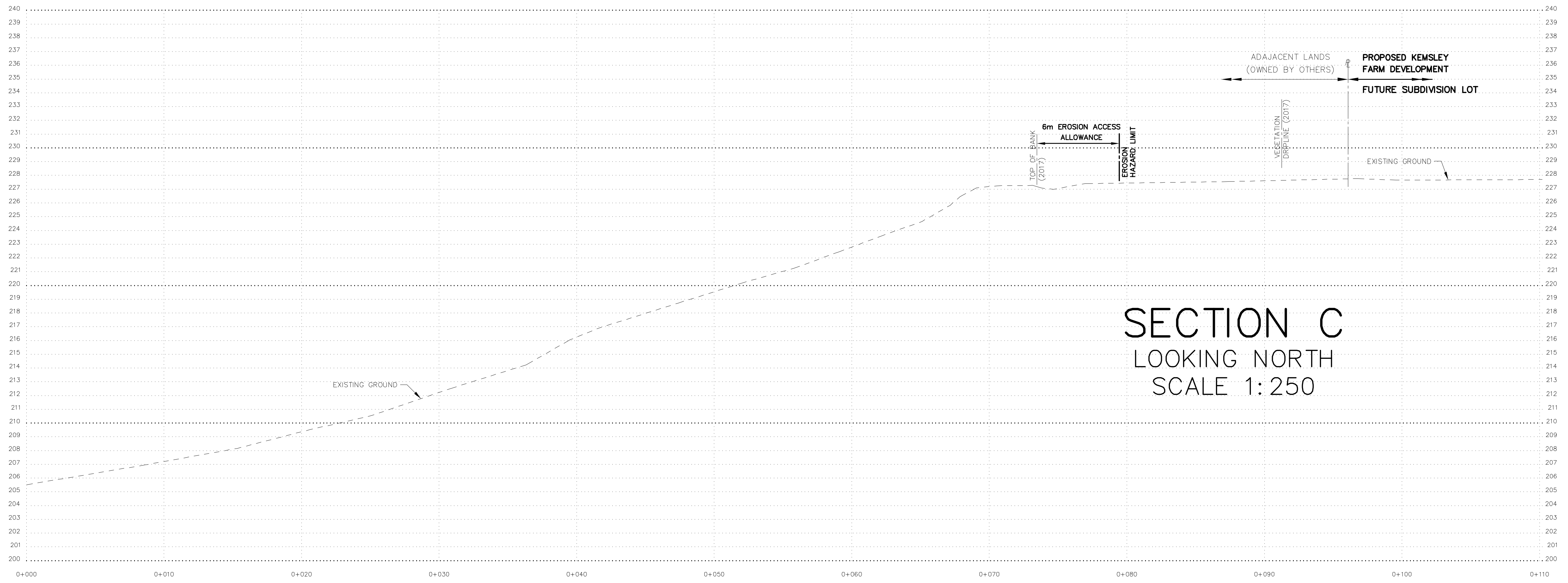

SECTION C
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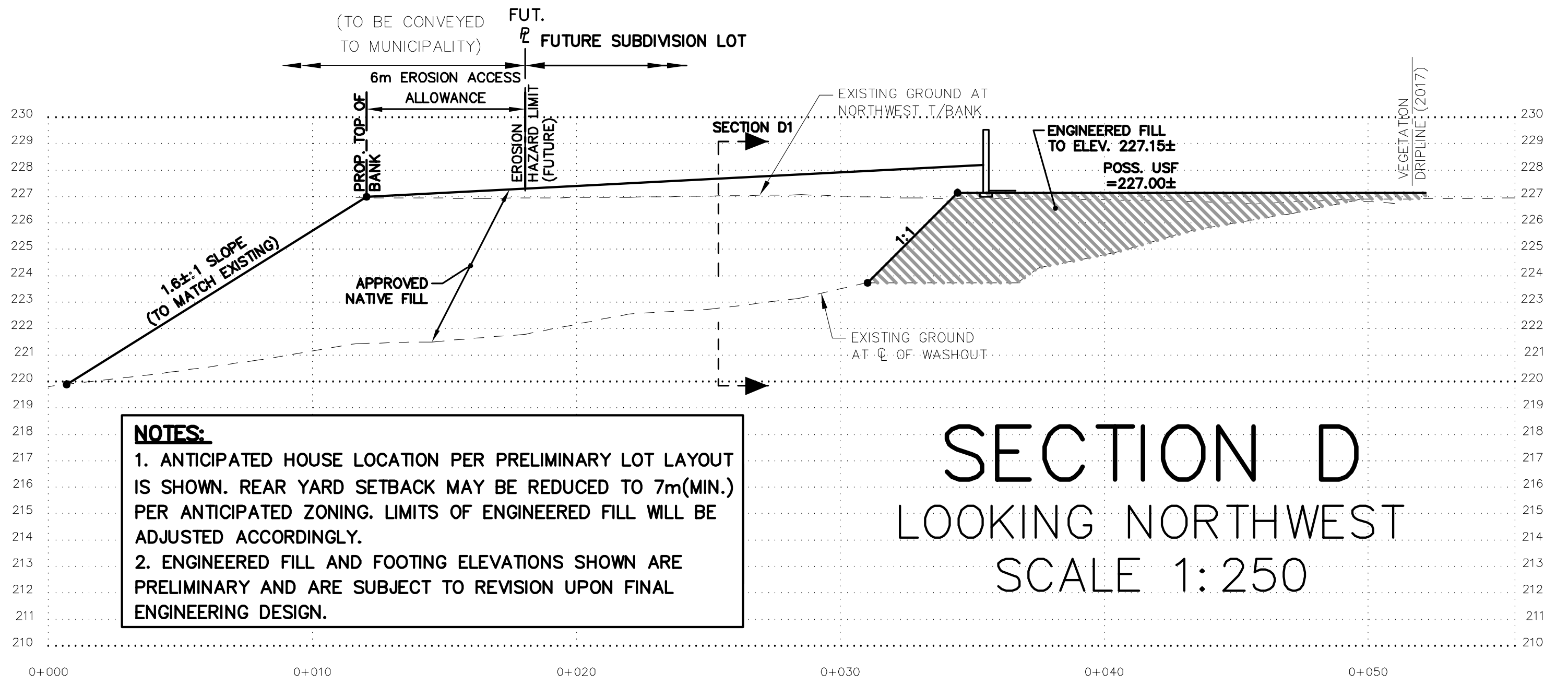
SCALE 1:250



NOTES:
1. ANTICIPATED HOUSE LOCATION PER PRELIMINARY LOT LAYOUT IS SHOWN. REAR YARD SETBACK MAY BE REDUCED TO 7m(MIN.) PER ANTICIPATED ZONING. LIMITS OF ENGINEERED FILL WILL BE ADJUSTED ACCORDINGLY.
2. ENGINEERED FILL AND FOOTING ELEVATIONS SHOWN ARE PRELIMINARY AND ARE SUBJECT TO REVISION UPON FINAL ENGINEERING DESIGN.

SECTION D
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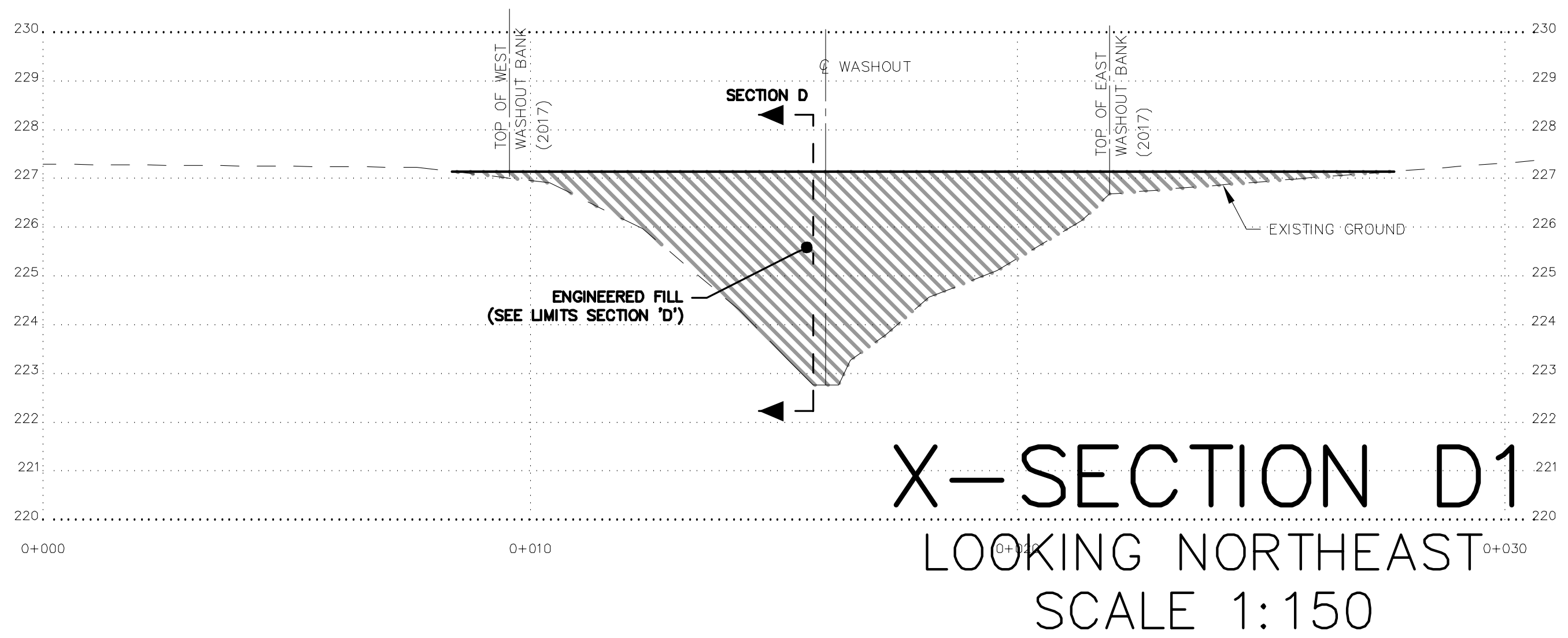

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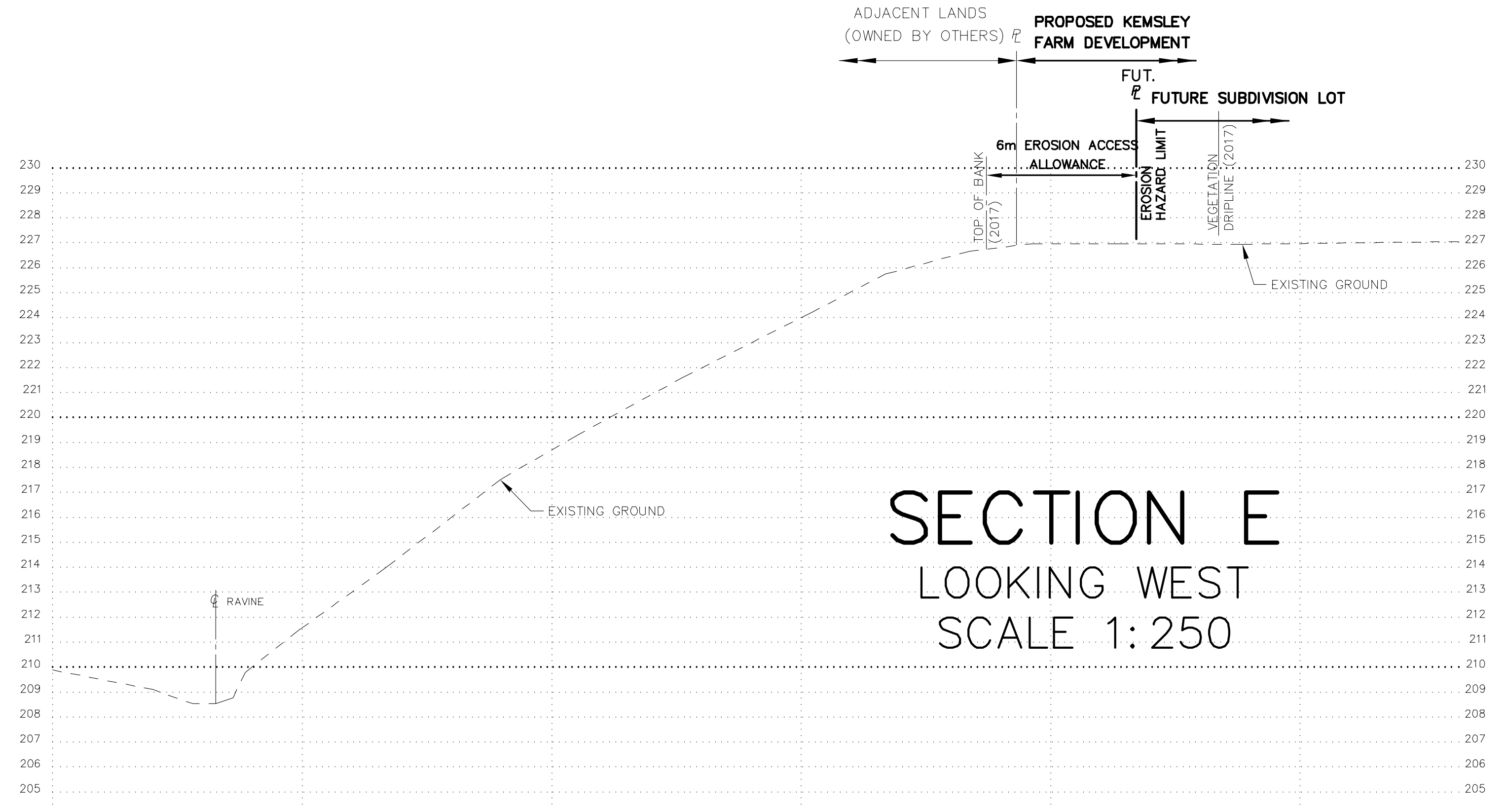

SECTION E
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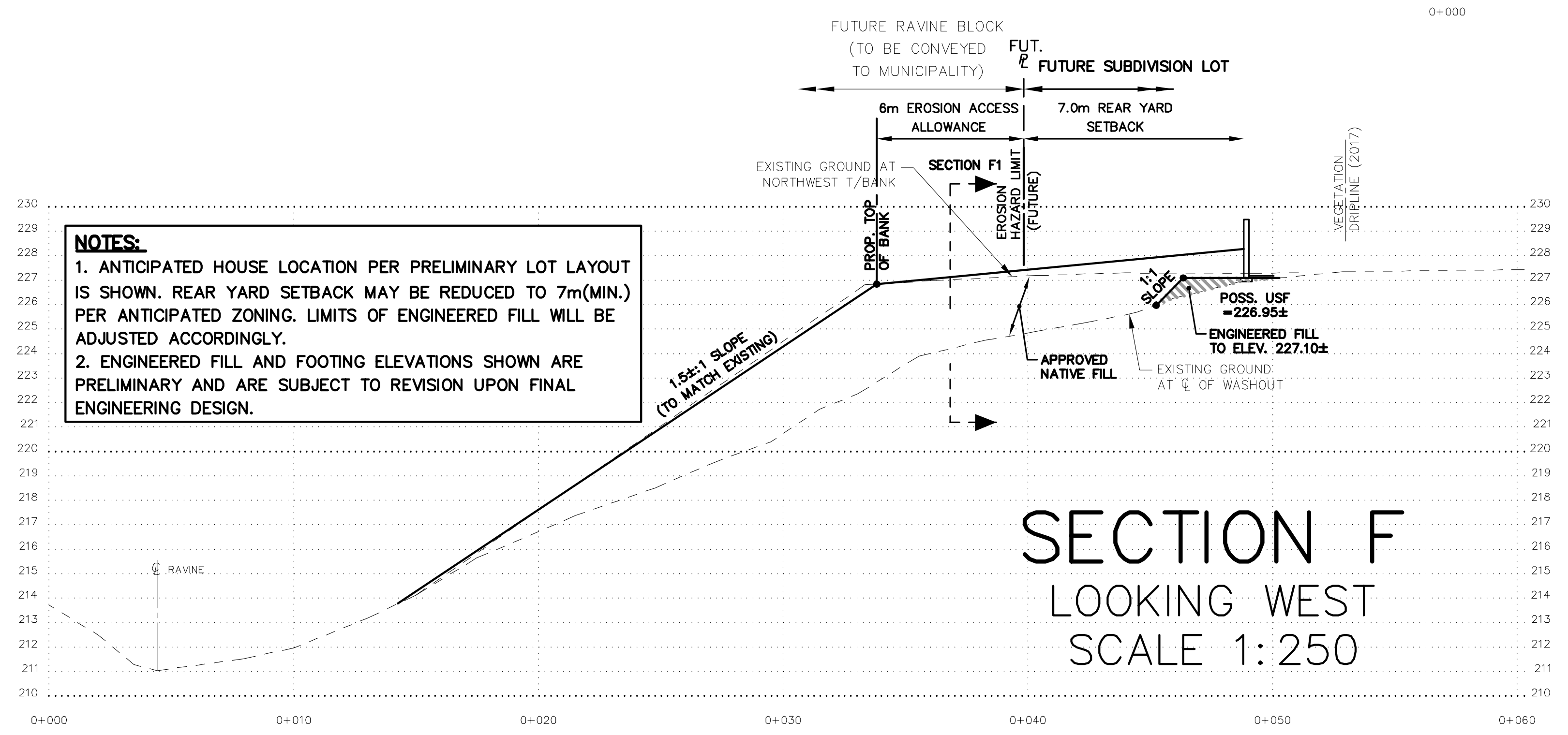

NOTES:
1. ANTICIPATED HOUSE LOCATION PER PRELIMINARY LOT LAYOUT IS SHOWN. REAR YARD SETBACK MAY BE REDUCED TO 7m(MIN.) PER ANTICIPATED ZONING. LIMITS OF ENGINEERED FILL WILL BE ADJUSTED ACCORDINGLY.
2. ENGINEERED FILL AND FOOTING ELEVATIONS SHOWN ARE PRELIMINARY AND ARE SUBJECT TO REVISION UPON FINAL ENGINEERING DESIGN.

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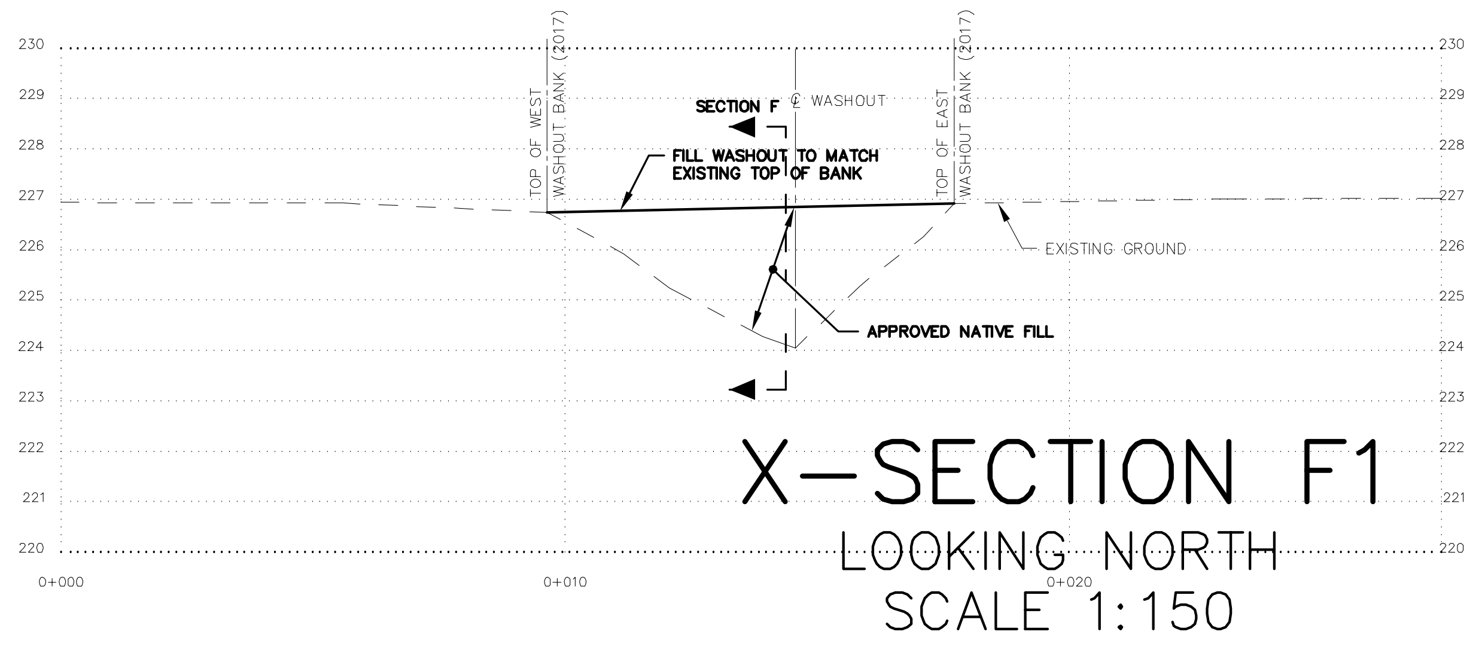

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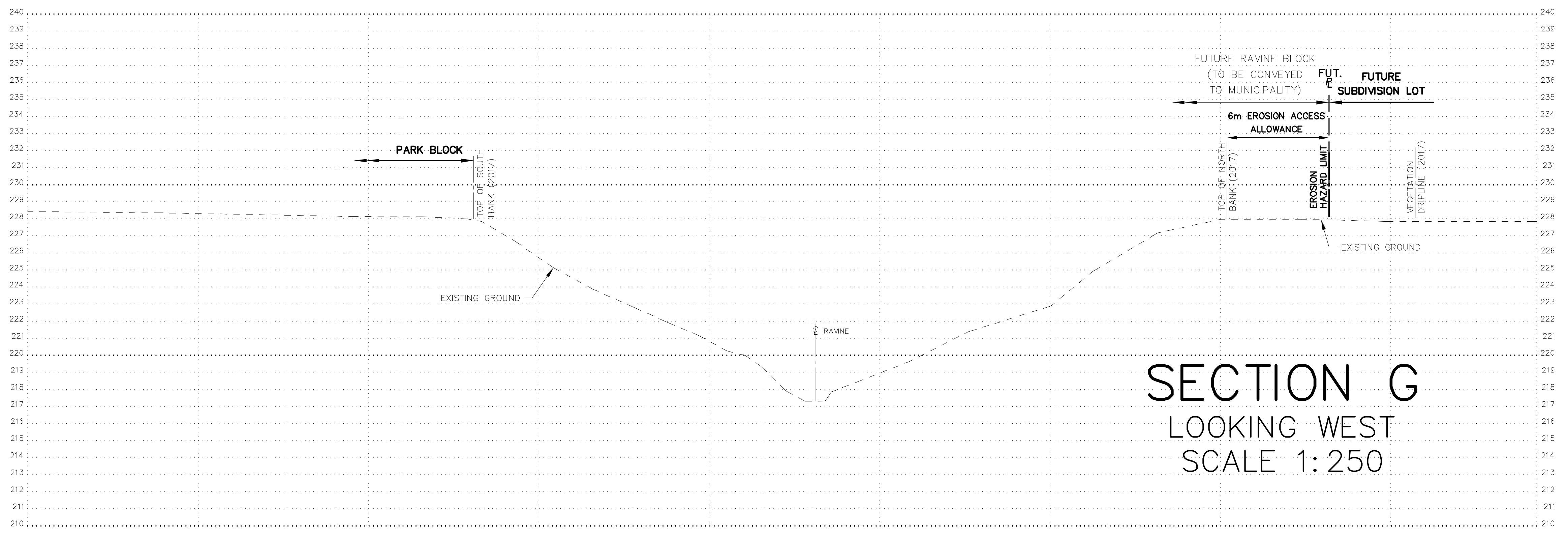

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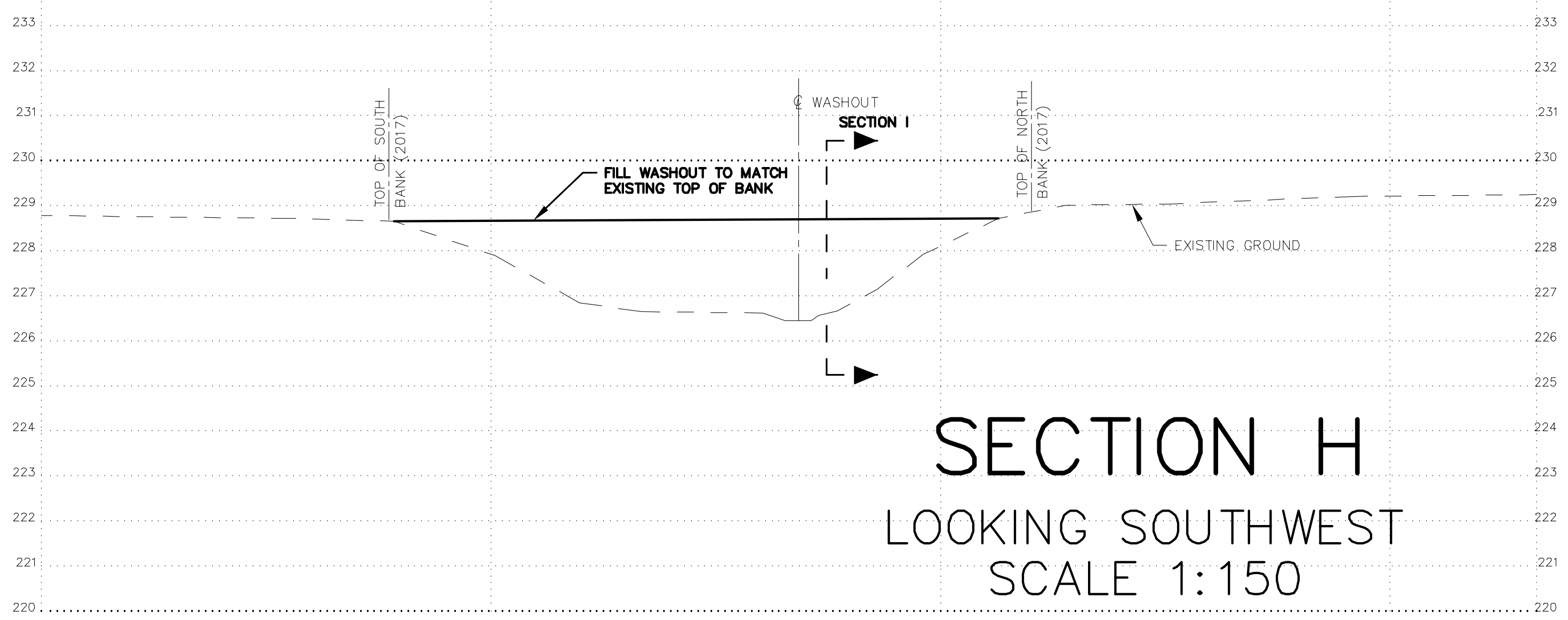

SECTION H
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SCALE 1:150

EXP .,ENCLOSURE No. 2
PROJECT No: LON-00015147-GE

GEOTECHNICAL INVESTIGATION

KEMSLEY FARM SUBDIVISION
DOUG TARRY LIMITED

ALL OF PART 1 11R-3198
AND
PART OF LOT 2 11M-253
GEOGRAPHIC TOWNSHIP OF YARMOUTH
MUNICIPALITY OF CENTRAL ELGIN

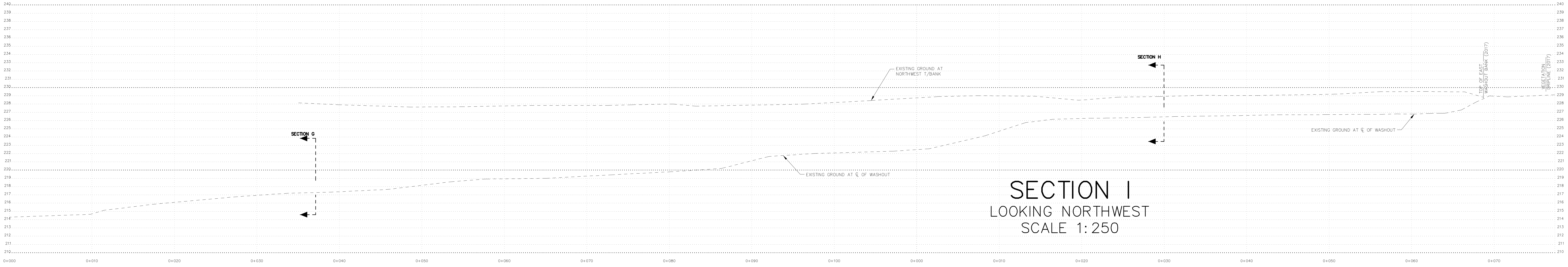
base plan prepared by

CJDL
Consulting Engineers

Cyril J. Demeyere Limited
P.O. Box 460, 261 Broadway
Tillsonburg, Ontario. N4G 4H8
Tel: 519-688-1000
866-302-9886
Fax: 519-842-3235
cjdl@cjdleng.com

1312 27 MARCH 2017

PL 2



SECTION I
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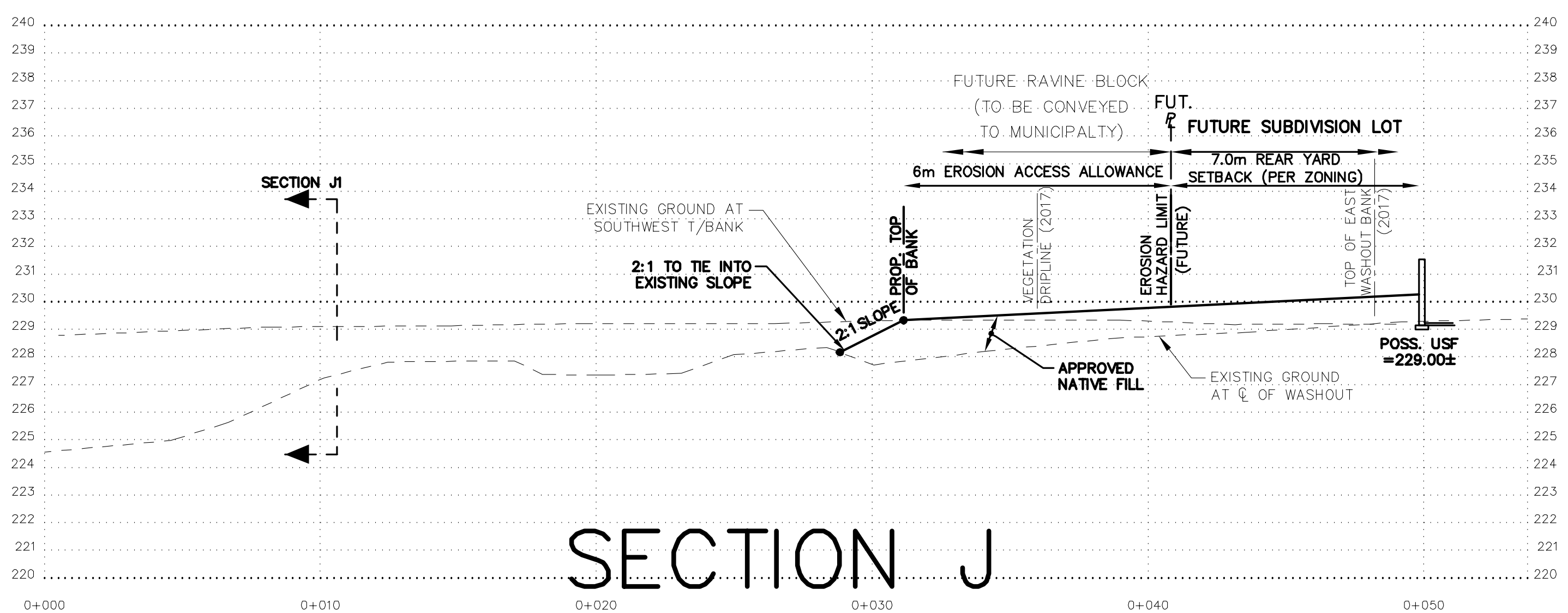

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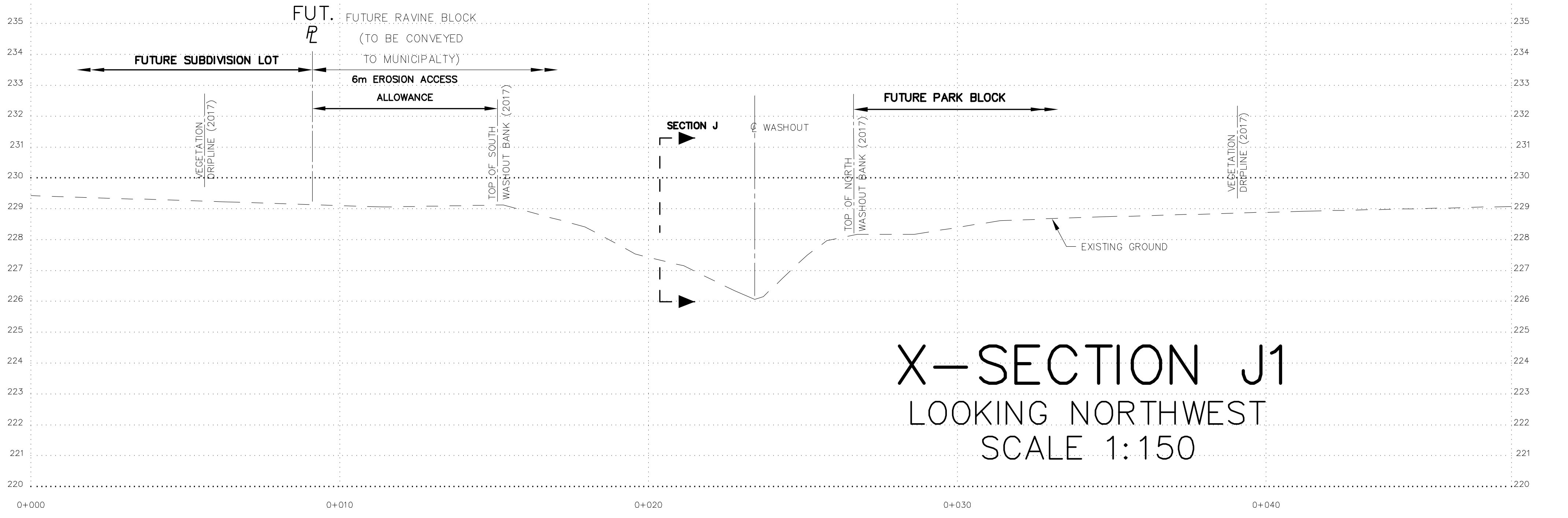

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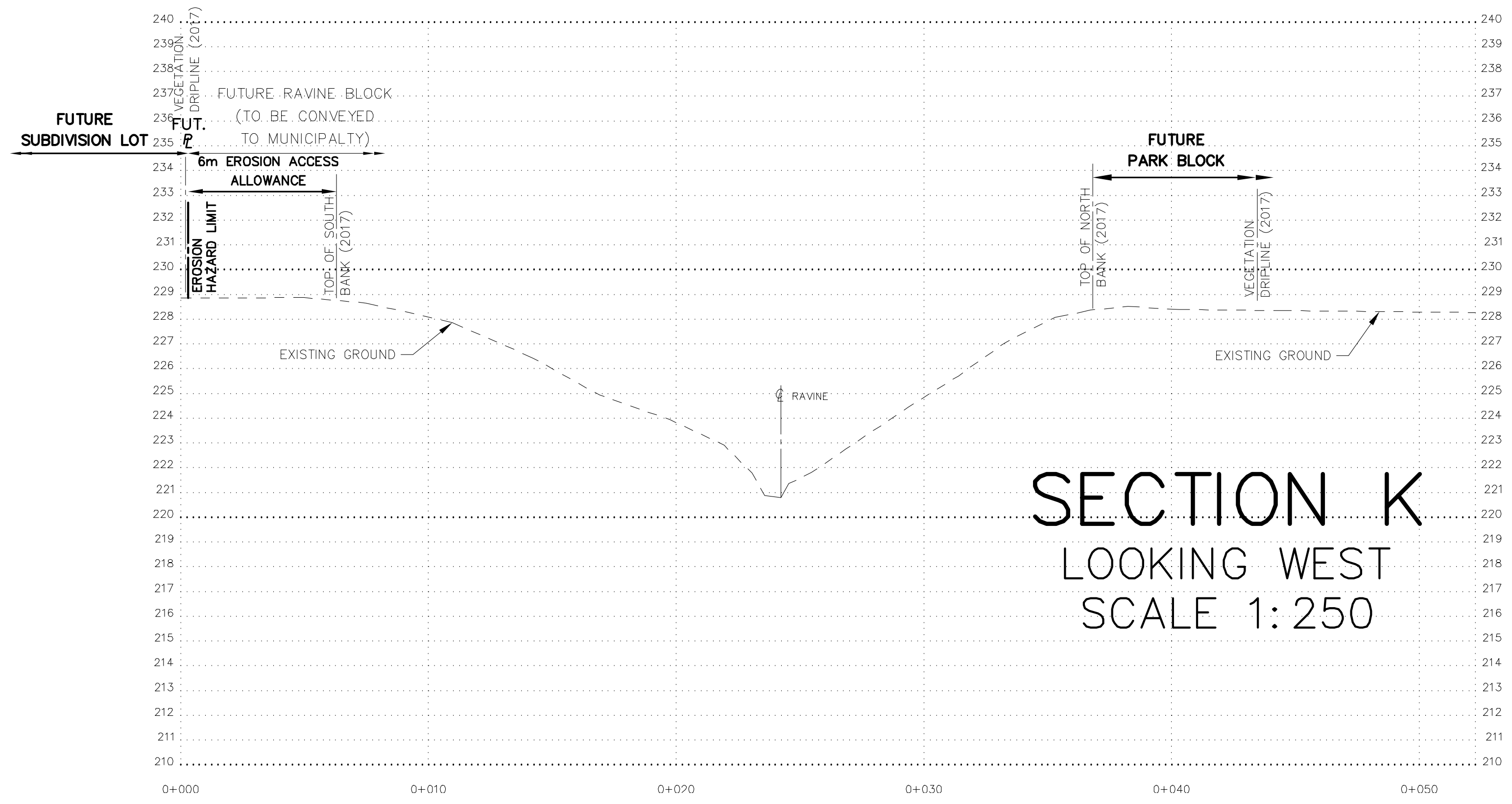

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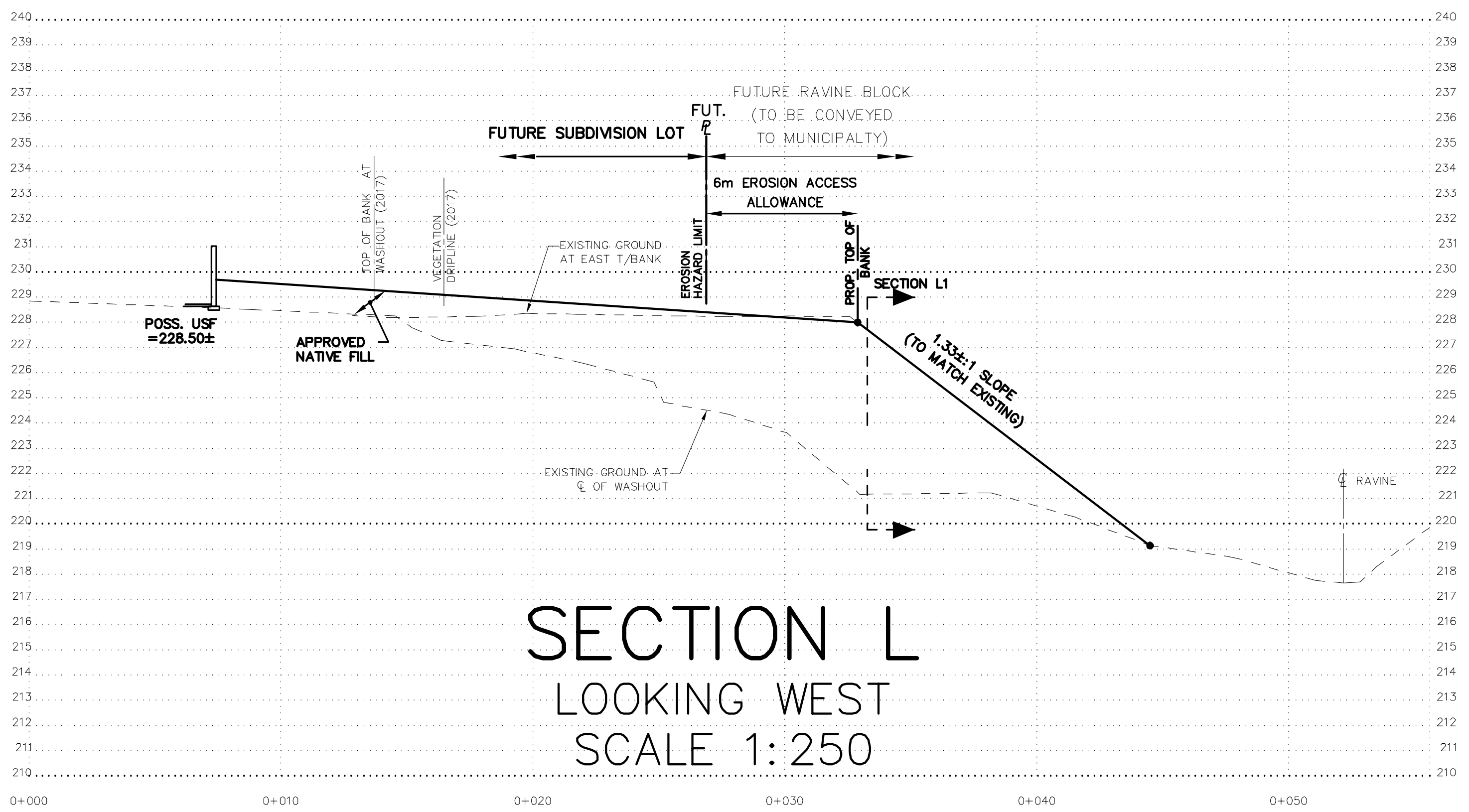

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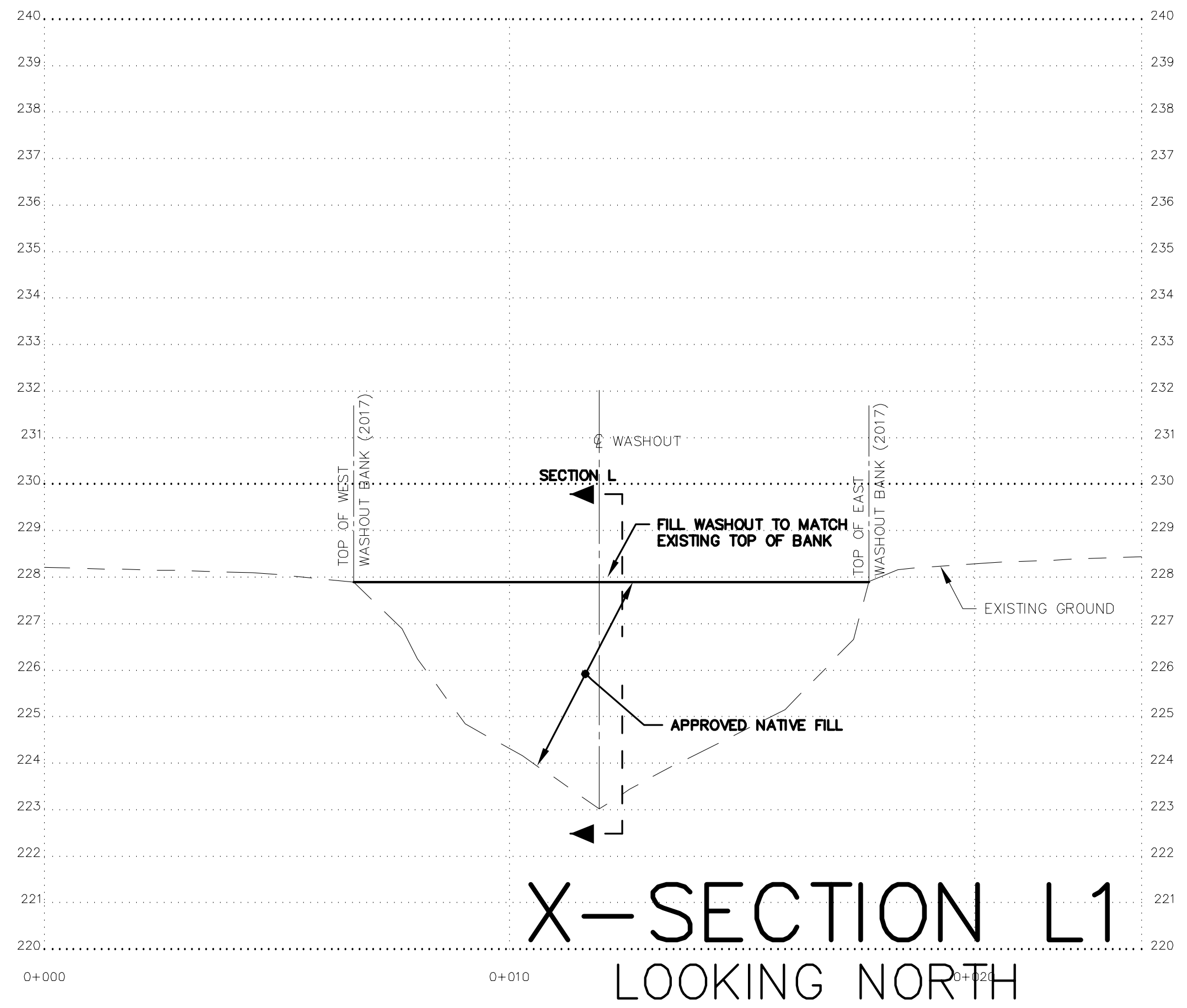
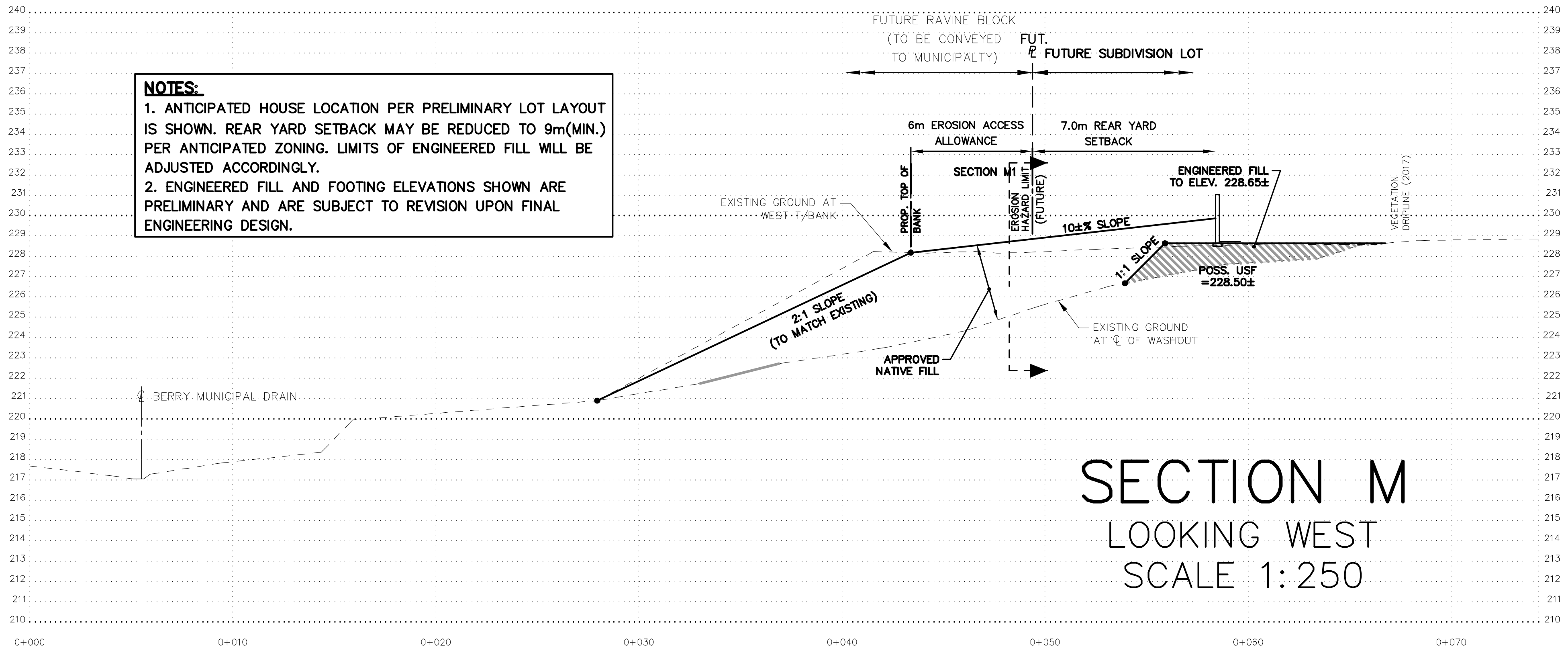


X–SECTION L1
LOOKING NORTH
SCALE 1:150

NOTES:
1. ANTICIPATED HOUSE LOCATION PER PRELIMINARY LOT LAYOUT IS SHOWN. REAR YARD SETBACK MAY BE REDUCED TO 9m(MIN.) PER ANTICIPATED ZONING. LIMITS OF ENGINEERED FILL WILL BE ADJUSTED ACCORDINGLY.
2. ENGINEERED FILL AND FOOTING ELEVATIONS SHOWN ARE PRELIMINARY AND ARE SUBJECT TO REVISION UPON FINAL ENGINEERING DESIGN.



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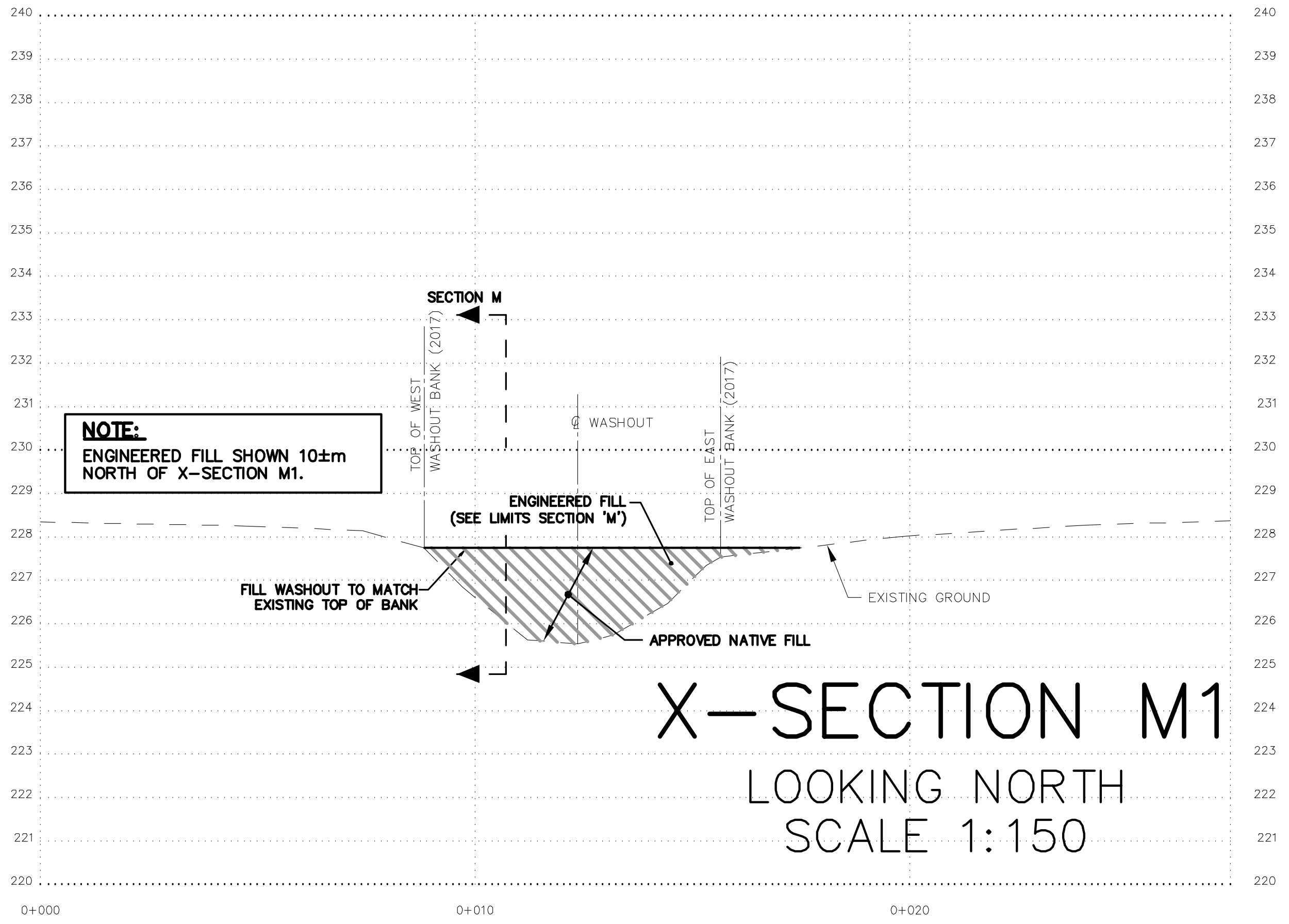
NOTE:
ENGINEERED FILL SHOWN 10±m NORTH OF X–SECTION M1.



X–SECTION M1
LOOKING NORTH
SCALE 1:150

EXP .,ENCLOSURE No. 2
PROJECT No: LON–00015147–GE

GEOTECHNICAL INVESTIGATION

KEMSLEY FARM SUBDIVISION
DOUG TARRY LIMITED

ALL OF PART 1 11R–3198
AND
PART OF LOT 2 11M–253
GEOGRAPHIC TOWNSHIP OF YARMOUTH
MUNICIPALITY OF CENTRAL ELGIN

base plan prepared by

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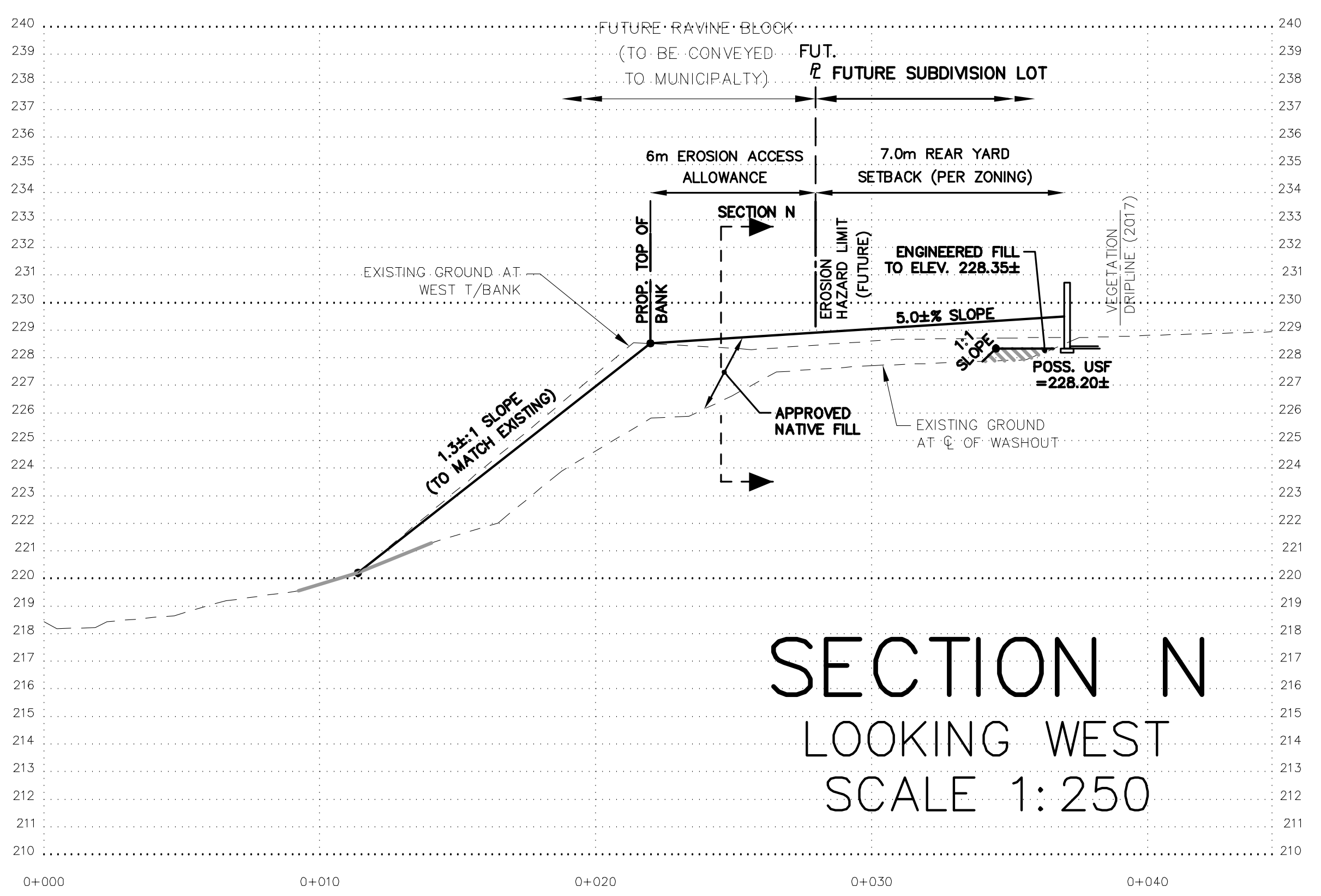

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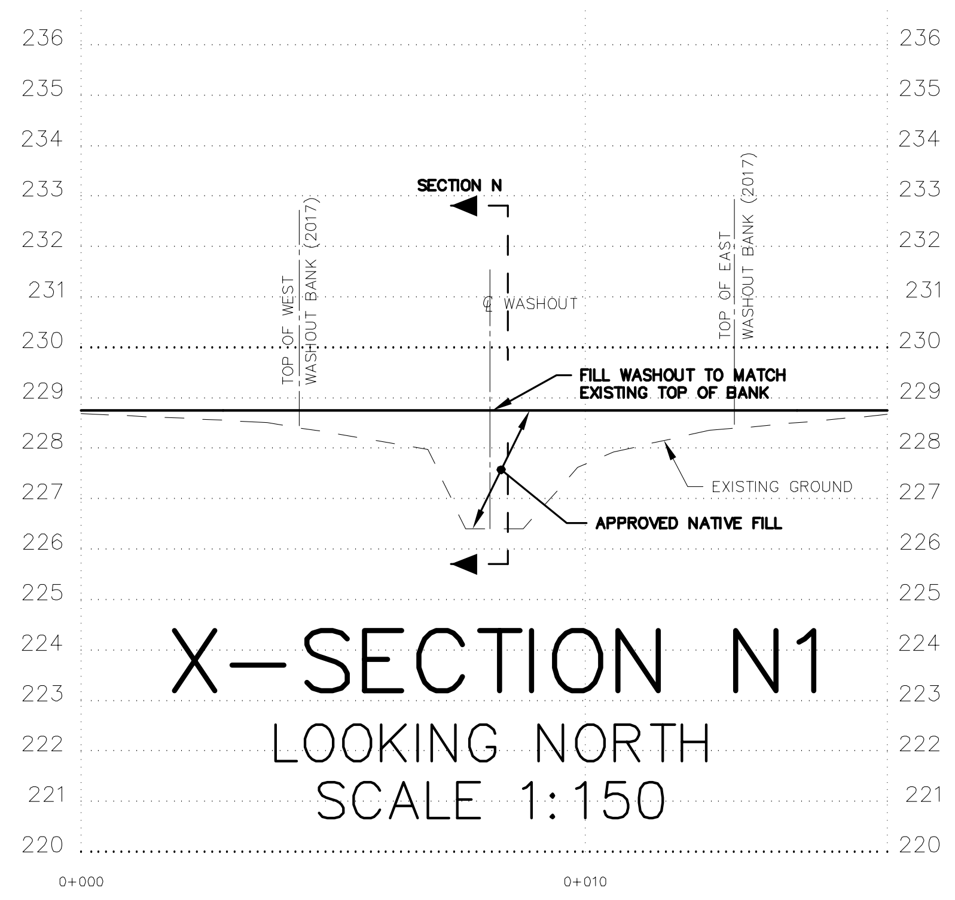

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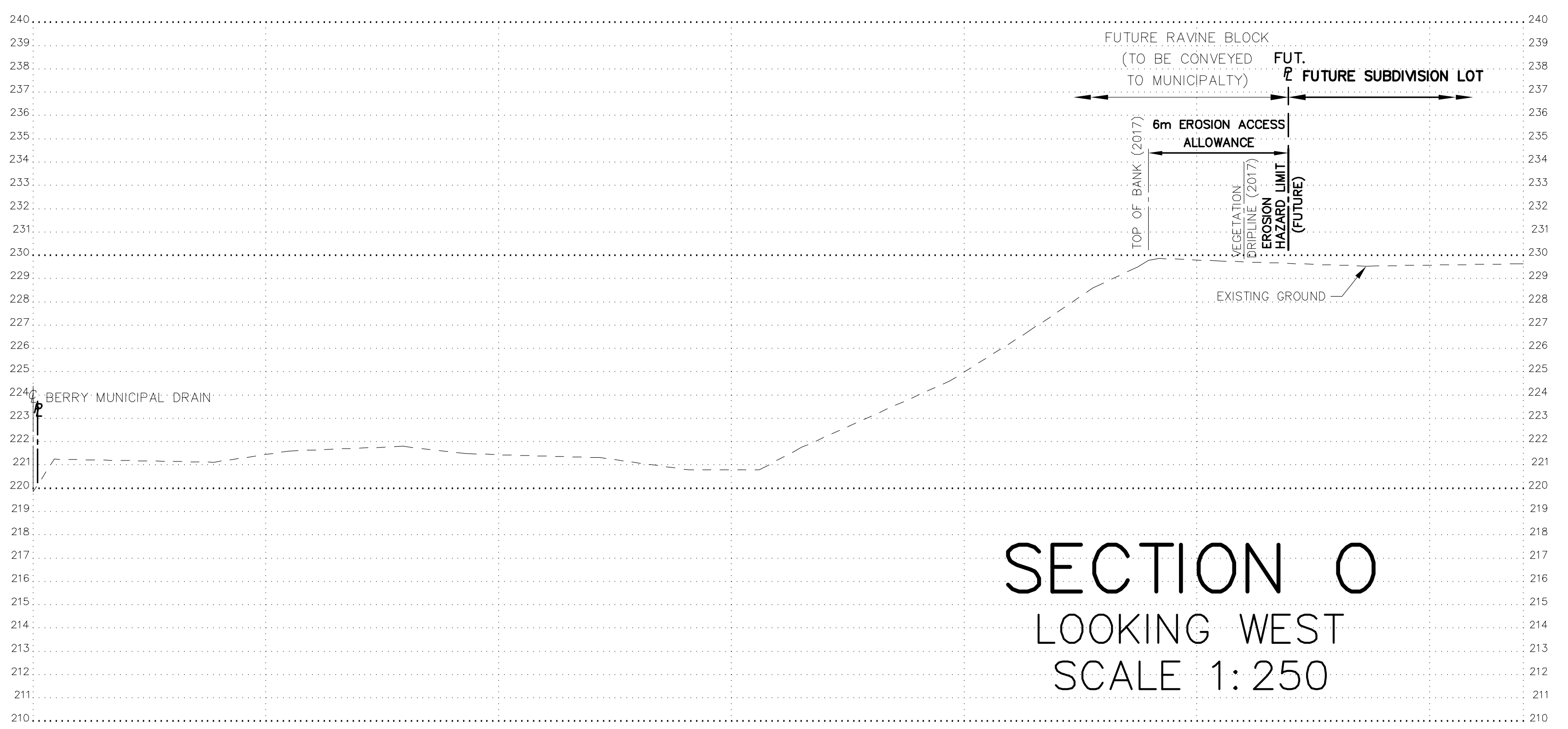
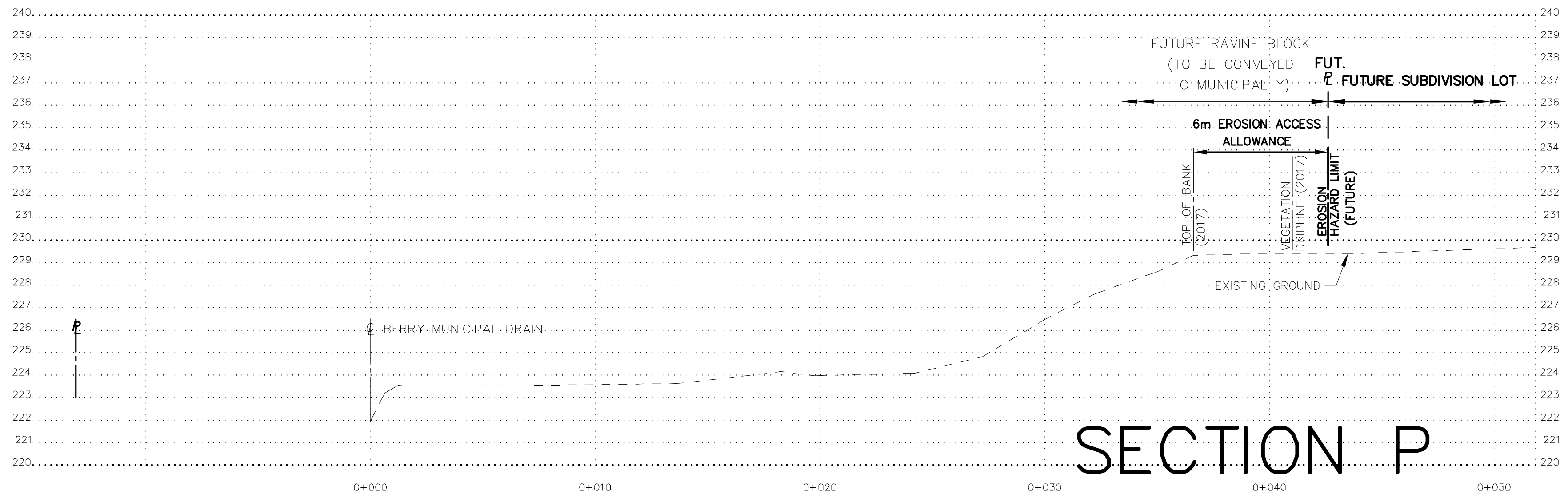
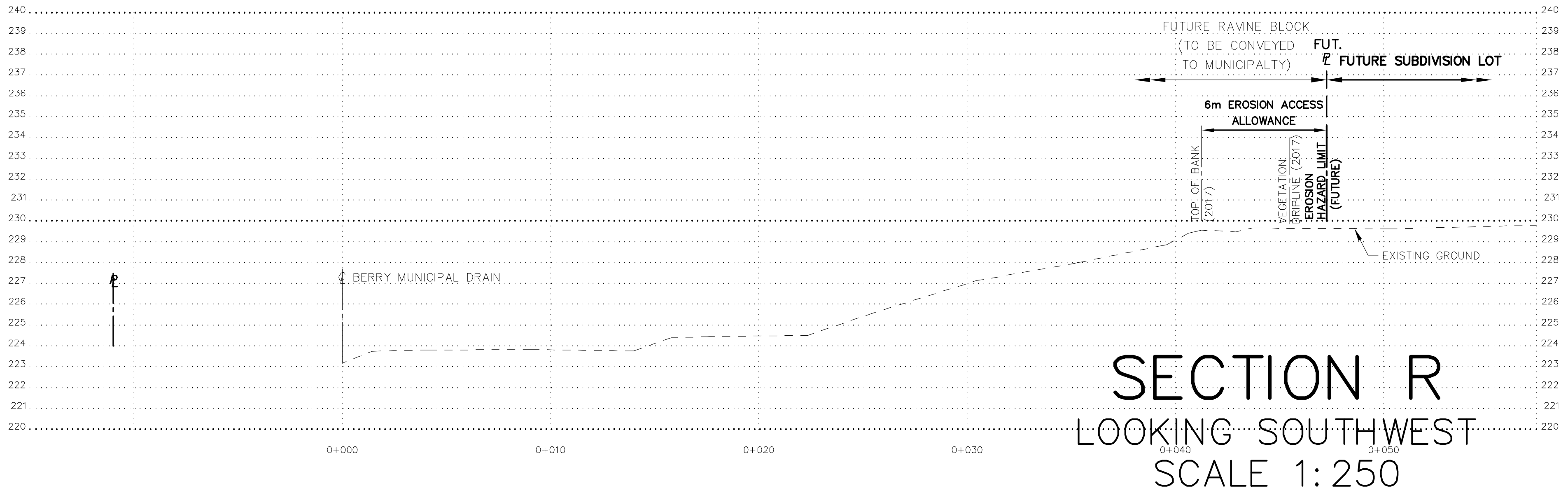


SECTION O
LOOKING WEST
SCALE 1:250



SECTION P
LOOKING SOUTHWEST
SCALE 1:250

SECTION Q
LOOKING SOUTHWEST
SCALE 1:250



SECTION R
LOOKING SOUTHWEST
SCALE 1:250

SECTION S
LOOKING SOUTHWEST
SCALE 1:250

EXP .,ENCLOSURE No. 2
PROJECT No: LON−00015147−GE

GEOTECHNICAL INVESTIGATION
KEMSLEY FARM SUBDIVISION
DOUG TARRY LIMITED

ALL OF PART 1 11R−3198
AND
PART OF LOT 2 11M−253
GEOGRAPHIC TOWNSHIP OF YARMOUTH
MUNICIPALITY OF CENTRAL ELGIN

base plan prepared by

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1312 27 MARCH 2017

Slope Stability Rating Chart at Section E-E

Geotechnical Principles for Stable Slopes,
Ontario Ministry of Natural Resources

Site Location: *42537 Southdale Line*	**Project No.:** LON-000015147
Town/City: *St. Thomas, Ontario*	**Inspection Date:** February 24, 2017
Inspected by: IS	**Weather:** Cloudy

	Rating Value	
Slope Inclination	**Possible**	**Actual**
18 degrees or less (3H:1V or flatter)	0	
18 to 26 degrees (2H:1V to more than 3H:1V)	6	
More than 26 degrees (steeper than 2H:1V)	16	16
Soil Stratigraphy		
shale / limestone / granite (bedrock)	0	
sand, gravel	6	
glacial till	9	9
clay, silt	12	
fill	16	
leda clay	24	
Seepage from Slope Face		
none, or near bottom only	0	0
near mid-slope only	6	
near crest only, or from several levels	12	
Slope Height		
2 m or less	0	
2.1 to 5 m	2	
5.1 to 10 m	4	
more than 10 m	8	8
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	0
light vegetation: mostly grass, weeds, occasional trees, shrubs	4	
no vegetation: bare	8	
Table Land Drainage		
table land flat, no apparent drainage over slope	0	
minor drainage over slope, no active erosion	2	
drainage over slope, active erosion, gullies	4	4
Proximity of Watercourse to Slope Toe		
15 metres or more from slope toe	0	
less than 15 metres from slope toe	6	6
Previous Landslide Activity		
No	0	0
Yes	6	
Slope Instability Rating	**Total:**	**43**

Low Potential	< 24	Site Inspection only, confirmation, report letter
Slight Potential	25-35	Site Inspection and surveying, preliminary study, detailed report
Moderate Potential	> 35	BH Investigation, piezometers, lab tests, surveying, detailed report

Notes: This chart does not apply to rock slopes or Leda Clay slopes.
Choose only one from each category, compare total rating value with above requirements.
Is there a water body (stream, creek, river, pond, bay, lake) at the toe of slope? Yes

If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Slope Stability Rating Chart at Section K-K

Geotechnical Principles for Stable Slopes,
Ontario Ministry of Natural Resources

Site Location: *42537 Southdale Line*
Town/City: *St. Thomas, Ontario*
Inspected by: IS

Project No.: LON-000015147
Inspection Date: February 24, 2017
Weather: Cloudy

Slope Inclination	**Rating Value**	
	Possible	**Actual**
18 degrees or less (3H:1V or flatter)	0	
18 to 26 degrees (2H:1V to more than 3H:1V)	6	
More than 26 degrees (steeper than 2H:1V)	16	16
Soil Stratigraphy		
shale / limestone / granite (bedrock)	0	
sand, gravel	6	
glacial till	9	9
clay, silt	12	
fill	16	
leda clay	24	
Seepage from Slope Face		
none, or near bottom only	0	0
near mid-slope only	6	
near crest only, or from several levels	12	
Slope Height		
2 m or less	0	
2.1 to 5 m	2	
5.1 to 10 m	4	4
more than 10 m	8	
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	0
light vegetation: mostly grass, weeds, occasional trees, shrubs	4	
no vegetation: bare	8	
Table Land Drainage		
table land flat, no apparent drainage over slope	0	
minor drainage over slope, no active erosion	2	
drainage over slope, active erosion, gullies	4	4
Proximity of Watercourse to Slope Toe		
15 metres or more from slope toe	0	
less than 15 metres from slope toe	6	6
Previous Landslide Activity		
No	0	0
Yes	6	
Slope Instability Rating	**Total:**	**39**

Low Potential	< 24	Site Inspection only, confirmation, report letter
Slight Potential	25-35	Site Inspection and surveying, preliminary study, detailed report
Moderate Potential	> 35	BH Investigation, piezometers, lab tests, surveying, detailed report

Notes: This chart does not apply to rock slopes or Leda Clay slopes.
Choose only one from each category, compare total rating value with above requirements.
Is there a water body (stream, creek, river, pond, bay, lake) at the toe of slope? Yes

If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Slope Stability Rating Chart at Section Q-Q

Geotechnical Principles for Stable Slopes,
Ontario Ministry of Natural Resources

Site Location: *42537 Southdale Line*	**Project No.:** LON-000015147
Town/City: *St. Thomas, Ontario*	**Inspection Date:** February 24, 2017
Inspected by: IS	**Weather:** Cloudy

	Rating Value	
	Possible	**Actual**
Slope Inclination		
18 degrees or less (3H:1V or flatter)	0	
18 to 26 degrees (2H:1V to more than 3H:1V)	6	
More than 26 degrees (steeper than 2H:1V)	16	16
Soil Stratigraphy		
shale / limestone / granite (bedrock)	0	
sand, gravel	6	
glacial till	9	9
clay, silt	12	
fill	16	
leda clay	24	
Seepage from Slope Face		
none, or near bottom only	0	0
near mid-slope only	6	
near crest only, or from several levels	12	
Slope Height		
2 m or less	0	
2.1 to 5 m	2	
5.1 to 10 m	4	4
more than 10 m	8	
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	
light vegetation: mostly grass, weeds, occasional trees, shrubs	4	4
no vegetation: bare	8	
Table Land Drainage		
table land flat, no apparent drainage over slope	0	
minor drainage over slope, no active erosion	2	2
drainage over slope, active erosion, gullies	4	
Proximity of Watercourse to Slope Toe		
15 metres or more from slope toe	0	0
less than 15 metres from slope toe	6	
Previous Landslide Activity		
No	0	0
Yes	6	
Slope Instability Rating	**Total:**	**35**

Low Potential	< 24	Site Inspection only, confirmation, report letter
Slight Potential	25-35	Site Inspection and surveying, preliminary study, detailed report
Moderate Potential	> 35	BH Investigation, piezometers, lab tests, surveying, detailed report

Notes: This chart does not apply to rock slopes or Leda Clay slopes.
Choose only one from each category, compare total rating value with above requirements.
Is there a water body (stream, creek, river, pond, bay, lake) at the toe of slope? Yes

If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Appendix E – Slope Rating Charts

Appendix F - Limitations and Use of Report

LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

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

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

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

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

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

RELIANCE ON INFORMATION PROVIDED

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

STANDARD OF CARE

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

COMPLETE REPORT

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