GEOTECHNICAL INVESTIGATION

PROPOSED RESIDENTIAL DEVELOPMENT
101 HULL RD, STRATHROY, ONTARIO

LDS PROJECT NO. GE-00286

JUNE 7, 2023

Submitted to:

Gold Leaf Properties Inc.

Distribution (via email):
Joe Van Bree – joevb@mcfltd.ca
Cindy Read – cindyr@mcfltd.ca

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Appendices

1.0 INTRODUCTION

LDS Consultants Inc. (LDS) has been retained by Gold Leaf Properties Inc. to conduct a Geotechnical Assessment for a proposed condominium development with 21 residential units. The subject site is located northeast of the intersection of Victoria Street and Hull Road in Strathroy, municipal number (MN) 101 Hull Road. A Key Plan showing the site location is provided on Figure 1, below.

Figure 1: Key Plan

It is understood that the proposed residential development will be comprised of townhomes and an internal roadway accessed from Hull Road. A preliminary concept plan is provided on Drawing 1, appended.

1.1 Terms of Reference

This document has been prepared for the purposes of providing geotechnical comments and recommendations for the design and construction of a proposed residential condominium development at 101 Hull Road, Strathroy Ontario.

This report provides a summary of the borehole findings (documenting soil and groundwater conditions at the site). The report also includes geotechnical and preliminary hydrogeological comments and recommendations for the proposed townhouse development, including: site preparation (including demolition and restoration of the former building area, and the re-use of excavated materials), excavations and excavation support, groundwater control, foundation design (including soil bearing capacity, subgrade preparation, and allowable settlements), design and construction of building foundations (including basement or slab-on-grade construction, foundation drainage, and backfilling), site servicing (including bedding and trench backfill recommendations), stormwater management considerations, pavement design, and a slope stability analysis.

This report is provided on the basis of the terms noted above, and on the assumption that the design will follow applicable codes and standards. The site investigation and recommendations provided in this report follow generally accepted practice for geotechnical consultants in Ontario.

The format and content of this report has been guided to address specific client needs. LDS has provided engineering guidelines for the geotechnical design and construction at the site. Laboratory testing, where applicable, follows ASTM or CSA Standards. The information in this report in no way reflects on the environmental aspects of the soil.

1.2 Site Description

The subject site sits on approximately 2.7 acres of land at MN 101 Hull Road, located northeast of the intersection at Victoria Street and Hull Road in Strathroy, Ontario. The lands are currently occupied by a residence which fronts on Hull Road. The rear of the lot is thickly wooded with a consistent cover of vegetation and small to medium sized trees, and slopes towards the creek to the north with an overall elevation change of approximately 4.0 m. The front of the lot slopes towards the road grade, with an overall elevation change of approximately 3.5 m. Topography is fairly flat throughout the central portion of the site, with a gradual slope from north to south.

A photographic log was prepared during LDS' site visit on October 25, 2019, and select photographs are included below for reference.

	Photograph 1: Looking north towards the existing residence from Hull Road.

	Photograph 2: Looking west along Hull Road. Note the grade change from the lot to the current road alignment.
	Photograph 3: Looking across the rear yard area, towards the existing slope crest along the north side of the property.
	Photograph 4: Typical view of valley slope along the north side of the property.

1.3 SCRCA Generic Regulation

In May 2006, Ontario Regulation 171/06 came into effect in the St. Clair Region Conservation Authority (SCRCA) watershed, which locally implements the Generic Regulation (Development, Interference with Wetlands and Alterations to Shoreline and Watercourses). This regulation replaces the former Fill, Construction and Alteration to Waterways regulations, and is intended to ensure public safety, prevent property damage and social disruption, due to natural hazards such as flooding and erosion. Ontario Regulation 171/06 is implemented by the local Conservation Authority, by means of permit issuance for works in or near watercourses, valleys, wetlands, or shorelines, when required.

A portion of the site (along the north and west property boundaries) is located within the SCRCA lands, as shown on Drawing 2, appended. There is also a localized watershed drain, located approximately 40.0 m north of the northern site border, that is identified as being within the SCRCA Regulated Area, Property owners must obtain permission from SCRCA before beginning any development, site alteration, construction, or placement of fill within the regulated area. Proposed development within the study area will be subject to the above referenced Regulation. Consultation with the local Conservation Authority for review of site-specific development plans is recommended in this regard.

2.0 INVESTIGATION PROGRAM

2.1 Field Program

LDS carried out a field program consisting of a series of boreholes on September 27, 2019. The boreholes were advanced at the site by a local drilling-contractor, using a track-mounted drill-rig. Three boreholes (denoted as BH1 through BH3) were advanced throughout the site and excavated to a maximum depth of 8.1 m (26.5 ft) below existing grade.

Ground surface elevations at the borehole locations were surveyed by LDS using a Trimble R10 GPS rover. The location of the boreholes are summarized below, and illustrated on Drawing 2, in Appendix A.

Location	Northing, m N	Easting, m E	Ground Surface Elevation (m asl)
BH1	4757116.18	448837.56	230.23
BH2/MW	4757183.28	448812.77	230.12
BH3/MW	4757148.83	448778.30	230.01

Monitoring wells were installed in two of the boreholes (BH2 and BH3) to allow for monitoring the stabilized groundwater level at the site. The wells are comprised of 50 mm diameter CPVC pipes with slotted and filtered screens. Details of monitoring well construction are provided with the attached borehole logs. The monitoring wells have been registered with the Ministry of Environment, Conservation, and Parks (MECP), in accordance with Ontario Regulation (O.Reg.) 903.

The depth to groundwater seepage and short-term water level measurements were obtained prior to backfilling the boreholes. Boreholes were backfilled with a mixture of bentonite chips and cuttings, to restore holes back to level conditions with the ground surface.

Select samples were collected from the boreholes for further review and laboratory testing. Routine moisture content determinations were also carried out on select samples from each borehole. The fieldwork was supervised by members of LDS' technical staff. All samples recovered from the site were returned to LDS for detailed examination and selective testing. Collected samples will be disposed of, following the issuance of the Geotechnical Report, unless prior arrangements have been made for longer term storage.

This Geotechnical Investigation does not include any environmental / chemical testing (i.e. sampling or testing of air, soil, surface water or building materials).

3.0 SUMMARIZED CONDITIONS

3.1 Review of Geological Mapping

Select geological mapping and publications were reviewed for the purposes of reviewing regional characteristics for soil conditions in the town of Strathroy. Findings are summarized below, for reference.

Source Mapping	Summarized Findings
Quaternary Geology mapping for the Strathroy Area (Ontario Geological Survey, Quaternary Geology, Strathroy Area, Scale 1:50,000, Preliminary Map P1972, 1978)	The Quaternary Geological survey mapping indicates that the site is comprised of Eolian deposits of fine to medium sand.
Physiographic mapping for Southwestern Ontario (Chapman, L.J. and Putnam, D.F. 2007. Physiography of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 228).	The Physiographic mapping identifies that the site is located within the central part of the Physiographic Region known as the Cardoc Sand Plains and London Annex. The mapping indicates that the subgrade soils in the area generally consist of sand, silty sand, or sand and gravel soils.
Bedrock Geology of Ontario. Ontario Geological Survey, Miscellaneous Release Data 126, 1:250 000 scale, Revised 2006.	The map reveals that the bedrock in the general area consists of limestone, dolostone and shale from the Hamilton Group. The Hamilton Group (from the middle to lower Devonian period) is characterized by limestones, dolostones, and shale.

3.2 Borehole Findings

A series of three boreholes were advanced at the site to examine soil and shallow groundwater conditions. The borehole locations are shown on Drawing 2, appended.

In general, soils observed in the boreholes consisted of topsoil overlying fine sand. General descriptions of subsurface conditions are summarized in the following sections. Borehole logs are provided in Appendix B, for reference. It should be noted that boundaries of soil indicated in the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

Topsoil

Each borehole surfaced with a layer of topsoil. The topsoil consisted of brown silty loam, with a thickness of 300 mm generally noted across the site. The topsoil was in a damp to moist state at the time of the fieldwork, based on visual and tactile examination.

It should be noted that topsoil quantities noted above are based on information provided at the borehole locations only, and may vary in areas with existing vegetation and tree cover. If required, a more detailed analysis (involving additional shallow test pits) is recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

Sand

Sand was encountered underlying the topsoil in each borehole, and each borehole terminated within this later. The sand was generally described as being brown in color, stratified, with a fine- to medium-grained texture, and containing trace silt. In borehole BH2, a silt seam with an approximate thickness of 300 mm was encountered at a depth of 3.4 m below ground surface. The sand is in a variable loose to compact state, based on Standard Penetration Test (SPT) N-values in the range of 7 to 30 blows per 0.3 m of split-spoon sampler penetration.

Moisture content determinations conducted on recovered samples of the sand generally range between 2 to 18 percent, generally indicative of damp to very moist soil conditions above the stabilized groundwater elevation, and in the order of 20-22 percent below the stabilized groundwater level.

3.3 Shallow Groundwater Conditions

Short term water level observations were recorded from the open boreholes at the time of drilling. Groundwater observations in the open boreholes and a review of soil moisture contents are indicative of the shallow groundwater being contained within the sandy soils near surface. Short term water levels are summarized in the following table.

Borehole	Ground Surface Elevation, m asl	Groundwater Observations	Groundwater Elevation, m asl
BH1	230.23	Dry	- -
BH2/MW	230.12	Water measured at 5.19 m	224.93
BH3/MW	230.01	Water measured at 5.20 m	224.81

Stabilized groundwater levels were measured in the monitoring wells from October 2019 through to February 2021, as shown in the following table.

Date	Depth to Groundwater (m bgs) *Groundwater Elevation (m asl)*	
	BH2	BH3
Ground Surface Elevation	230.119	230.00
02-Oct-2019	6.25 (*223.87)*	6.36 (*223.64)*
25-Oct 2019	6.31 (*223.81)*	6.42 (*223.58)*
29-Nov-2019	5.15 (*224.97)*	5.26 (*224.74)*
07-Jan-2020	5.14 (*224.98)*	5.07 (*224.93)*
05-Feb-2020	6.24 (*223.88)*	6.15 (*223.85)*
06-Mar-2020	5.12 (*225.00)*	5.14 (*224.86)*
02-Apr-2020	5.02 *(225.10)*	5.04 *(224.96)*
13-May-2020	5.09 *(225.03)*	5.10 *(224.90)*
19-Jun-2020	5.16 *(224.96)*	5.18 *(224.82)*
02-Jul-2020	5.29 *(224.83)*	5.29 *(224.71)*
04-Aug-2020	4.87 *(225.25)*	5.28 *(224.72)*
14-Sep-2020	5.26 *(224.86)*	5.30 *(224.70)*
21-Oct-2020	5.30 *(224.82)*	5.30 *(224.70)*

Date	Depth to Groundwater (m bgs) *Groundwater Elevation (m asl)*	
	BH2	BH3
09-Nov-2020	5.25 *(224.87)*	5.24 *(224.76)*
15-Dec-2020	5.20 *(224.92)*	5.18 *(224.82)*
13-Jan-2021	5.23 *(224.89)*	5.21 *(224.79)*
04-Feb-2021	5.25 *(224.87)*	5.27 *(224.73)*

Shallow groundwater varies in response to climatic or seasonal conditions, and, as such, may differ at the time of construction, with higher levels possible in wet seasons. Seasonal fluctuations in the water level were found to range between 4.9 and 6.3 m depth in Borehole BH2, and from 5.0 to 6.4 m depth in Borehole BH3. In addition, the wet soil conditions observed at the time of drilling may be attributed to capillary rise effects in the fine sand, where the water is drawn upwards in to the drier sand soils.

It should be noted that in areas of the site where fill placement is anticipated, that the depth to the shallow groundwater may be altered, in the post-earthworks condition.

3.4 MECP Well Record Review

A review of local well records available through the Ministry of Environment, Conservation, and Parks (MECP) for this area was carried out to review the water levels recorded in the nearby wells. Drawing 3 in Appendix A shows the location of the wells (with corresponding Well Registration No.) which are in close proximity to the site. The water supply wells are summarized in Appendix C, for reference. MECP well records were last updated October 2021.

The majority of the water supply wells noted in the records are set in the shallow to intermediate depth overburden aquifer, contained within the sandy soils. Static water levels in these water supply wells are generally reported at depths ranging from 5 to 8 m. There are a few water supply wells, located west of the site, that are set into a deeper overburden sandy aquifer. Static water levels in these water supply wells are generally reported at depths ranging from 12 to 17 m.

The remaining well records are recorded as observation wells or test holes, as shown in Appendix C. Observation wells and test holes are recorded at variable depths within the well records.

4.0 GEOTECHNICAL COMMENTS AND RECOMMENDATIONS

It is understood that the proposed condominium development will have approximately 20 townhouses, and an internal roadway accessed from Hull Road (refer to Concept Plan shown on Drawing1, appended.)

The boreholes generally revealed a layer of surficial topsoil which is underlain by a layer of fine to medium-grained sand. Stabilized groundwater was encountered below 6.25 m depth (Elevation 223.87 m asl.)

This report provides a summary of the borehole findings (documenting soil and groundwater conditions at the site). The report also includes geotechnical and preliminary hydrogeological comments and recommendations for the proposed townhouse development, including: site preparation (including demolition and restoration of the former building area, and the re-use of excavated materials), excavations and excavation support, groundwater control, foundation design (including soil bearing capacity, subgrade preparation, and allowable settlements), design and construction of building foundations (including basement or slab-on-grade construction, foundation drainage, and backfilling), site servicing (including bedding and trench backfill recommendations), stormwater management considerations, pavement design. In addition, a slope stability analysis has been conducted to confirm the development setback from the existing slope along the north side of the property.

4.1 Site Preparation

4.1.1 Site Grading Activities

Based on existing site conditions, it is expected that some site grading activities will be required, particularly in the front of the property to raise grades onsite and to match the proposed grades along Hull Road. Upwards of 3+ metres of fill is anticipated in this regard.

Vegetation removal and topsoil stripping is anticipated throughout the Site. In general, this is expected to require the removal of about 300 mm of surficial topsoil. Thicker topsoil areas may also be present in proximity to existing wooded areas, and where local depressions are present at the site. Surficial topsoil may be stockpiled on site for possible re-use as landscaping fill. In the event that material is disposed of offsite, testing of the material for transport should conform to MECP Guidelines and requirements.

Prior to placement of engineered fill or new building foundations, existing fill and topsoil, vegetation and otherwise deleterious materials should be removed. Once complete, the exposed subgrade should be thoroughly proof-rolled and inspected by geotechnical field staff from LDS. Any loose or soft zones noted during the inspection should be over excavated and replaced with approved fill.

In areas which engineered fill is to be placed to raise grades, the exposed subgrade soils should be reviewed approved by the geotechnical consultant following topsoil stripping. In accordance with the Ontario Building Code (Section 4.2.4.15), foundations may be set on fill material provided that it can be demonstrated that the fill is capable of safely supporting the building and that detrimental movement of the building will not occur. In this regard, it is recommended that any fill material placed in future building footprints be engineered and verified through an inspection and testing program. Engineered fill should consist of suitable, compactable, inorganic soils, which are free of topsoil, organics and miscellaneous debris. For best compaction results, the fill material should have a moisture content within about 3 percent of optimum, as determined by Standard Proctor testing.

The placement of the engineered fill should be monitored by the geotechnical consultant to verify that suitable materials are used, and to confirm that suitable levels of compaction are achieved. Section 4.1.3 describes the requirements for importing fill soils, as specified in the Excess Soils Regulation, O.Reg. 406/19.

The engineered fill material should be placed in maximum 300 mm (12 inch) thick lifts and uniformly compacted to 100 percent Standard Proctor Maximum Dry Density (SPMDD). Additional notes regarding engineered fill placement are provided in Appendix A.

The existing natural subgrade soils comprised of sand that are not mixed with obviously unsuitable material may be suitable for re-use as engineered fill. The possible re-use of onsite soils should be subject to review and approval by the geotechnical consultants.

Fill material containing building debris and / or topsoil and organic inclusions is generally not expected to be suitable for re-use onsite, except where landscaping (non-structural) fill may be needed. Offsite disposal of these soils will require analytical testing, in accordance with MECP Guidelines and classification requirements for transport and disposal. The testing requirements for disposal will depend on the requirements outlined by the receiver.

4.1.2 Restoration of Former Building Areas

Prior to demolition of the existing residential structure, a Designated Substance Survey (DSS) should be conducted. The need for a DSS is outlined in Section 30 of the Ontario Occupational Health and Safety Act, which specifies that designated substances (regulated under O.Reg. 490/09) and other potentially hazardous building materials must be identified prior to demolition work that may disturb such materials. LDS can assist with developing a scope of work for this work, when tenants and their belongings are no longer occupying the buildings.

Building demolition should include the removal of exiting footings, and septic system (tanks, field tile and tile bedding), if present. Following the demolition of the existing residential building and structures, a site review should be carried out to confirm that building foundations, concrete slabs, building debris and remnant site services are removed from the site. In the event that a water supply well is encountered, it should be decommissioned in accordance with the Regulations outlined in O.Reg. 903. This same regulation applies to the decommissioning of monitoring wells, when they are no longer required.

4.1.3 Excess Soil Management

In December of 2019, the Ministry of Environment, Conservation, and Parks (MECP) released a new regulation under the Environmental Protection Act, titled “On-Site and Excess Soil Management” to support improved management of excess construction soil. Due to Covid-19, the full implementation of this regulation was delayed, with the regulation being paused and phased in over a few years. The implementation delay provided an opportunity for the government to introduce amendments to the Regulation (most recently updated in December 2022), with the regulation being phased in and fully in effect as of January 1, 2023.

Excess soil is defined as material that was generated during construction activities at a Site but will not be needed for grading, fill, or other purposes and therefore needs to be transported off-Site. The regulation requires a project leader to comply with specific requirements before removing excess soil from a project area.

Generally, these requirements include:

- Preparation of an Assessment of Past Uses Report which is similar to a Phase One Environmental Site Assessment for the source site, to evaluate the presence of potentially contaminating activities which may have resulted in the potential for impacted soil or groundwater conditions to be present at the source site;

- Preparation and implementation of a Sampling and Analysis Plan which outlines the suggested sample locations and sampling intervals, analytical sample testing parameters, and sampling frequency;
- Preparation of a Soil Characterization Report, following the soil sampling and analytical testing;
- Preparation of an Excess Soil Destination Assessment Report which identifies where excess soils can be disposed offsite, including a review of Beneficial Reuse Sites, if the developer and/or their contractor have a potential re-use site being considered; and,
- Development and implementation of a tracking system.

The site is within a residential area. No portion of the site is considered to be an “enhanced investigation project area” as defined in O.Reg. 406/19 and O.Reg. 153/04, as amended. The Regulation includes an Exemption (under Section 8), which limits the requirements for the preparation of planning documents for project areas which have most recently been used for agriculture, parkland or residential land-use.

Schedule 2 of the regulation includes a provision for the movement of topsoil which is excavated from the site, and transported directly for reuse as topsoil at a reuse site to be exempt from the regulatory requirements for filing on the Soil Registry and the associated testing requirements, provided that the site is not part of an enhanced investigation area, and where the purpose of the topsoil removal is not for site remediation. As such, if excess soils which are generated within the subdivision limits are limited to topsoil, this Schedule 2 exemption may apply.

For sites which require imported fill (identified as Beneficial Re-Use Sites), a Qualified Person (QP) will need to be retained to prepare an Excess Soil Destination Assessment Report (ESDAR), which outlines the geotechnical requirements for beneficial reuse of imported materials onsite along with the environmental soil quality criteria (including the applicable O.Reg. 153/04 Site Condition Standards) for material which is appropriate to be accepted at the Site. In this case, material meeting the O.Reg. 406/19 Table 2.1 Site Condition Standards, Industrial/Commercial/Community Land Use (or better) would be suitable for acceptance.

4.2 Excavations and Groundwater Control

Excavations for the proposed buildings and site services are generally expected to extend through the topsoil, and will terminate within the natural subgrade soils or engineered fill material. Excavations are expected to remain above the stabilized groundwater level.

All work associated with design and construction relative to excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA). Based on the results of the geotechnical investigation and in accordance with Section 226 of Ontario Regulation 213/91, the sand encountered near ground surface is generally classified as Type 3 soil. Excavations which extend through or terminate in Type 3 soil, temporary excavation side slopes must be cut back at a maximum inclination of 1H:1V from the base of the excavation.

In the event that construction occurs in seasonally wet conditions or when frozen soil conditions are present, care will be required to maintain safe excavation side slopes, and suitable excavation bases. The contractor should use a reasonable effort to direct surface run-off away from open excavations. It should be noted that, if wet seams or zones are encountered, some sloughing may be expected.

4.2.1 Excavation Support

If space restrictions at the site do not allow for conventional open cut without risk of undermining, or where excavation sizes are to be limited, the use of adequate bracing or shoring may be required. In the natural sand

and silt till soils, bracing will not normally be required if the structures are behind a 45-degree line drawn up from the near edge of the excavation.

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 specialist shoring contractor should review the geotechnical information provided in this report. The shoring system must be designed to be internally (overturning, and sliding) and externally stable (slope stability / base heave).

Based on the field and laboratory testing 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	Angle of Internal Friction, φ	Bulk Unit Weight of Soil, γ (kN/m^3)	Active earth pressure coefficient, Ka	At-rest earth pressure coefficient, Ko	Passive east pressure coefficient, Kp
Compact Fine to Medium Sand	33	19.5	0.33	0.47	3.00

In the event that soil conditions near the excavation vary materially from the above soils, the geotechnical consultant should review the soil conditions to confirm the design parameters. A prefabricated trench box may be used for servicing excavations (if required), provided that it is designed (by a professional engineer) to withstand the soil and hydrostatic loading (if applicable).

4.2.2 Groundwater Control

As noted previously, seasonal fluctuations in the water level were found to range between 4.9 and 6.3 m depth in Borehole BH2, and from 5.0 to 6.4 m depth in Borehole BH3. Excavations for site services and building foundations are generally expected to remain above the stabilized groundwater table. Therefore, conventional groundwater control methods are generally expected to be suitable to address surface water infiltration and minor groundwater seepage into open excavations.

Where excavations extend below the stabilized groundwater table, or where groundwater levels are elevated, positive groundwater control methods may need to be utilized for construction dewatering. This information is provided to assist with determining appropriate construction dewatering methods. LDS can provide additional dewatering recommendations if deep excavations are planned at the site.

Groundwater control measures at the site should be sufficient to maintain stable excavated slopes; and provide a dry and stable base for excavations and construction operations. The contractor should use a reasonable effort to direct surface run-off away from open excavations.

4.3 Building Components

4.3.1 Foundation Design

For design of footings on the natural subgrade soils below 1.2 m below existing grades or supported on engineered fill, the following allowable bearing pressures (net stress increase) can be used for design of footings:

- Serviceability Limit States (SLS) 145 kPa (~3000 psf)
- Ultimate Limit States (ULS) 190 kPa (~4000 psf)

All footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.2 m (4 ft.) of soil cover or equivalent insulation.

The natural sandy subgrade may be susceptible to disturbance by construction activities, especially during adverse weather conditions or when water seepage from excavation sidewalls are present. Consequently, after the founding surfaces have been exposed, the soils should be thoroughly recompacted to provide a uniform base, suitable to provide the bearing capacity noted above. Consideration should be given to placing concrete foundations as soon as possible following excavation and subgrade inspection.

Footings at different elevations should be located such that the higher footings are set below a line drawn up at 10 horizontal to 7 vertical from the closest edge of the lower footing. It is important that servicing excavations which encroach on the building foundations are checked to ensure that they do not undermine the building foundations.

Verification of the footing base conditions should be undertaken by the geotechnical engineer at the time of excavation. Provided that the stability of the soils exposed at the founding level is not compromised as a result of construction activity, precipitation, cold weather conditions, etc., and the design bearing pressures are not exceeded, the total and differential settlements of footings are expected to be less than 25 mm and 19 mm, respectively.

It should be noted that the recommended bearing capacities have been calculated by based on the observations of the soil and groundwater conditions within the borehole program at the site. Where variations occur between the borehole locations, and during construction of the new buildings, site verification by the LDS' geotechnical engineer is recommended to confirm soil conditions and verify soil bearing capacity.

4.3.2 Slab-on-Grade Floors

Slab-on-grade floors for the new buildings may be constructed using conventional concrete poured slab techniques, following the review and approval of the subgrade soils.

Around the perimeter of the buildings the ground surface should be sloped on a positive grade away from the structure to promote surface water run-off and reduce groundwater infiltration adjacent to the foundations. Perimeter drains around the foundation may not be required if the floor slab is set at least 300 mm above the exterior grade and the grade is sloped away from the structure.

A moisture barrier, consisting of a minimum 200 mm thick of uniformly compacted 19 mm clear stone should be placed over the approved subgrade. For design purposes, the modulus of subgrade reaction (k) can be taken as 55 MPa/m, for the compacted stone over approved sandy subgrade soils. An alternate configuration of compacted granular material such as OPSS 1010 Granular A may also be considered for the moisture barrier. If alternative materials are proposed for use onsite, the minimum level of compaction and overall design thickness of the moisture barrier layer should be reviewed by the geotechnical consultant.

It is recommended that the water-cement ratio and slump of concrete used for the floor slabs be controlled to minimize shrinkage of the slabs. Adequate joints and / or the use of fibre reinforcement may be considered by the designer to help control cracking. During construction, concrete sampling and testing is recommended to ensure that concrete mix design requirements are satisfied.

4.3.3 Foundation Wall Backfill

In general, the existing natural subgrade soils from the foundation areas are generally expected to be suitable for re-use as foundation wall backfill. The materials to be re-used as foundation wall backfill should be within three percent of optimum moisture content for best compaction results. If the weather conditions are very wet during construction, site review by the geotechnical consultant may be advised to confirm the suitability of onsite soils for reuse.

In the event that excavated materials contain topsoil, organics or otherwise unsuitable material, such materials should be stockpiled separately, and limited to re-use where settlements can be tolerated.

It is recommended that heavy compaction equipment be restricted within 0.5 m of the wall. Backfill should be brought up evenly on both sides of the foundation walls which have not been designed to resist lateral earth pressures.

4.3.4 Seismic Design Considerations

Subsoil and groundwater information at the Site have been examined in relation to Section 4.1.8.4 of the Ontario Building Code (OBC) 2012. The subsoils expected below the proposed pump station will generally consist of compact sand/sand and gravel soils and dense to very dense silt till. Table 4.1.8.4.A. Site Classification for Seismic Site Response in OBC 2012 indicated that to determine the site classification, the average properties in the top 30 m are to be used. The Site Classification recommendation is based on the available information as well as our interpretation of conditions at and below the boreholes, and based on a review of geological mapping and MECP well records, and 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 “C” as per Table 4.1.8.4.A, Site Classification for Seismic Site Response, OBC 2012. In the event that a higher Site Classification is being sought by the structural design engineer, additional deep boreholes and / or multichannel analysis of surface waves (MASW) testing would be required to determine if the soil conditions below the current depth of exploration can support a higher Site Classification.

4.4 LID Considerations

Consideration has been given to identify stormwater management options which allow secondary infiltration or reduced run-off under post-development conditions, to be incorporated into the stormwater management design. LID (Low Impact Development) strategies help to mitigate the impacts of increased runoff and stormwater pollution by managing runoff as close to its source as possible, by incorporating site features which enhance post-development infiltration, evapotranspiration, filtration and detention of stormwater. These practices can help to reduce contaminants in runoff, and can reduce the volume and intensity of stormwater flows.

The infiltration capacity of a soil depends on a number of factors, including particle size distribution, degree of saturation, compactness, adsorbed water (which depends on clay content). The heterogeneous nature of glacial deposits can also contribute to variations in soil permeability where the soil composition may include localized areas with increased fine material or sandy material which can influence soil permeability at different points within the soil strata.

Grain size analyses were not carried out on samples of the sand. Published information available through the Groundwater Information Network (online at www.gin.gw-info.net) provides the following table which summarizes the porosity and hydraulic conductivities for various soil strata encountered within its well record database for Southwestern Ontario.

Lithology	Porosity (%)	Hydraulic Conductivity (m/s)
Sand	26 to 53	2×10^{-7} to 6×10^{-3}

As noted above, a broad range of values are provided for sandy soils. Based on the description and composition of the sandy soils encountered at the site, the hydraulic conductivity values are expected to be in the range of 10^{-5} to 10^{-6} m/s.

Due to the thickness of the sand near surface, shallow lateral infiltration structures such as infiltration galleries or bioretention structures are well suited to the site. Deeper infiltration structures, such as drywells set in the natural sand may also be considered for the site. The use of grassed swales and reduced lot grading can provide benefits in greenspace areas, to extend the amount of time that stormwater is detained on the surface, helping to moderate run-off and provide additional infiltration and evapotranspiration opportunities.

Where site grading activities are planned for the proposed development, onsite review of any materials imported to the site for use is recommended to identify if fill placement can be done to support possible infiltration methods, and to predict the performance of the proposed infiltration structures.

4.5 Site Services

Subgrade soils beneath new services are generally expected to consist of sand. Although no bearing problems are anticipated for flexible or rigid pipes founded on natural deposits, localized base improvement along the trench bottom may be required for excavations which terminate in wet subgrade soils. The extent of base improvement or stabilization is best determined in the field during construction, with consultation from LDS' geotechnical engineer.

4.5.1 Pipe Bedding

For services supported on native deposits, the bedding should conform to Municipal and OPS Standards. Bedding aggregate should be compacted to a minimum 95 percent SPMDD. Water and sewer lines installed outside of heated areas should be provided with a minimum 1.2 m of soil cover for frost protection.

A well graded stone layer may be used in service trenches as bedding below the spring line of the pipe if necessary, to provide stabilization to the excavation base in wet subgrade soils, where encountered. Geotextile may be considered for wrapping the pipe and to limit movement of fines from surrounding soils into the bedding material. Potential locations for use of stone bedding can be identified through site inspection during construction and will vary across the site due to seasonal conditions and variations in perched groundwater conditions.

4.5.2 Trench Backfill

Requirements for backfill in service trenches, etc. should also conform to Municipal and OPS Standards. A program of in situ density testing should be set up to ensure that satisfactory levels of compaction are achieved. Based on the results of this investigation, excavated material for trenches will generally consist of sand. Select portions of this inorganic material may be used for construction backfill provided that reasonable care is exercised in handling the material. In this regard, material should be within 3 percent of the optimum moisture as determined

by the Standard Proctor density test. Stockpiling of material for prolonged periods of time should be avoided. This is particularly important if construction is carried out in wet, adverse weather.

Backfill above bedding aggregate can consist of excavated (inorganic) soils, compacted in maximum 300 mm thick lifts 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.

4.6 Pavement Design

Areas to be paved should be stripped of any obviously unsuitable or unstable material to design subgrade level. The exposed subgrade must then be thoroughly proof-rolled and reviewed by the geotechnical consultant. In the event that loose or soft areas are noted, additional work may be required to sub-excavate and replace unstable soils with suitable compactable material. This work should be completed under the supervision of the geotechnical consultant. In general terms, compacted soils supporting site pavements should be compacted to a minimum level of 98 percent SPMDD.

Provided that the preceding recommendations are followed, pavement thickness design requirements given in the following table are recommended for the anticipated subgrade conditions and traffic loading.

Pavement Component	Minimum Design Thicknesses
Asphaltic Concrete	35 mm HL 3 & 45 mm HL 8
Granular A Base	150 mm
Granular B Subbase	250 mm

The recommended pavement structure provided in this report is based on natural subgrade soil properties determined from visual examination and textural classification of the soil samples. Where new roads intersect with Hull Road, the subgrade beneath new pavement should be tapered to match existing road subgrade to minimize differential frost heaving for the pavement structure. Site review by the geotechnical engineer is recommended to verify this at the time of construction.

It is recommended that samples of both Granular 'A' and Granular 'B' aggregates be checked for conformance to OPSS 1010 prior to use on site, and during construction. Granular 'B' subbase and Granular 'A' base courses should be compacted to a minimum of 100 percent SPMDD.

Asphaltic concrete paving materials should conform to requirements of OPSS 1150. Asphalt should be placed in accordance with OPSS 310 and compacted to a minimum 97 percent of the bulk relative density (BRD). Alternatively, a target compaction level of 92.0 to 96.5 percent of the Marshall Mix design maximum relative density (MRD) may also be an appropriate measure for asphalt compaction

If frequent construction traffic is anticipated while only a portion of site pavements are in place, or if construction is undertaken in poor weather conditions, thickening of the granular subbase may be appropriate and can be reviewed during construction, by the geotechnical consultant.

Good drainage provisions will optimize long term 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.

It is recommended that a program of inspection and materials testing (including laboratory analyses and compaction testing) be carried out during construction to confirm that geotechnical requirements are satisfied.

5.0 Slope Stability Considerations

LDS carried out a geotechnical review of the condition of the slope located at the north end of the site. This slope stability assessment has been conducted to support the proposed residential development located proximal to the top of the slope. A topographic plan, Drawing 5, is provided for reference.

5.1 Site Review

A site review was carried out on October 25, 2019. At the time of the site reconnaissance visit, the slope was observed to be well vegetated with a mixture of young and mature trees. No water seepage or signs of significant overland erosion were observed. Select photos were taken at the site to document slope conditions, and are appended for reference.

During the site reconnaissance, sufficient site details were collected to assess the slope condition using the Ministry of Natural Resources and Forestry (MNRF) Slope Stability Rating Chart. The Rating Chart summarizes site observations and empirically scores various elements which contribute to slope stability, to assess the potential for slope instabilities at the site. A copy of the chart is appended for reference. The Slope Instability Rating is 16, indicating a low potential for instability.

The owner has proposed the construction of a residential development that may extend back towards the slope; and as such, a development limit has been identified based on the site topography and stable slope analyses presented below.

A preliminary topographic survey was carried out at the site to provide confirmation of the topographical mapping for the area. The survey work included the creation of two cross-sections at the locations shown on Drawing 5, appended. Drawing 6 shows the key features and dimensions of each cross section. The overall slope height was surveyed at approximately 4.0 m with the top of slope at an elevation of 229.9 m, and the base of the slope at an average elevation of 225.9 m.

The overall slope inclination is approximately 25 degrees, which corresponds to an overall inclination of 2.1 horizontal to 1 vertical.

5.2 Slope Stability Calculations

The boreholes generally revealed a layer of surficial topsoil which is underlain by a layer of fine to medium-grained sand. Stabilized groundwater was encountered below Elevation 223.87 m, and therefore was not considered in the slope stability analysis. A computational slope stability analysis was conducted using the following soil parameters based on the results of the field program:

Soil	Φ	γ (kN/m^3)	C (kPa)
Fine Sand	33°	19.5	0

Based on review of the above information, the slope is considered to be in a stable condition with a factor of safety in excess of 1.4.

Preliminary calculations indicate the following range of factors of safety:

Cross Section	Shallow Sliding Failure	Medium Depth Failure	Deep Rotational Failure
Slope Profile A	>1.40	> 2.34	> 3.23
Slope Profile B	>1.47	> 3.00	> 4.04

The lowest factor of safety occurs for a shallow sliding failure in the middle to upper part of Section Profiles A and B, which is the most steeply inclined part of the slope in each case. The slip plane intersects the less steep slope at the mid-slope height, and would result in localized slumping. The factors of safety for medium and deep rotational failures are above 2.3, which is indicative of an overall stable slope condition.

In addition to the existing stable slope configuration, it was observed that the flood plain along the toe of the slope is some 20-30 m wide, which easily accommodates any anticipated toe erosion along the creek. As such, an additional toe erosion allowance has not been applied to the slope.

Given the above information, it is recommended that a development setback of 6 m from the top of the existing slope be utilized for this site. The 6 m setback provides an emergency access allowance, in the unlikely event that a significant failure occurs, and provides room to access the slope by construction equipment for remedial works, if needed.

In addition to the above, the proposed grades for the site should be reviewed to ensure that buildings are located outside of the flood hazard for the municipal drain, located approximately 40 m north of the northern site border.

5.3 Geotechnical Comments and Recommendations

The overall slope stability is considered to be in a stable condition, as indicated by the slope stability analyses presented previously. An Emergency Access Allowance of six meters from the top of the slope is shown on Drawings 5 and 6, and represents the Erosion Hazard Limit. From a geotechnical standpoint, development at the top of the slope can be carried out without detrimental impact to the long-term slope stability, provided that some care is taken by the contractors doing the work, and by adhering to the following recommendations.

In the event that construction occurs in seasonally wet conditions or when frozen soil conditions are present, care will be required to maintain safe excavation side slopes, and suitable excavation bases. The contractor should use a reasonable effort to direct surface run-off away from open excavations.

Where possible, uncontrolled surface water flows over the face of the slope should be minimized, to reduce the risk of surface erosion. Erosion control measures may be required during construction, to reduce the risk of concentrated surface water flows from causing surface erosion.

Excavated soils should not be placed over the tableland near the crest of the slope. Any fill placement or changes to existing grades in proximity to the site slope may be subject to review and approval by the SCRCA.

Care must be taken when excavating for building footings and foundations in proximity to the top of the slope, to ensure that excavations are provided with adequate sidewall support. The design of any excavation support system should be prepared by a certified engineer, and should consider the loading associated with the sloped surface.

Final design drawings including final building locations should be reviewed by this office to ensure that the comments and recommendations provided in this report have been properly interpreted.

6.0 CLOSING

The geotechnical recommendations provided in this report are applicable to the project described in the text. LDS would be pleased to provide a review of design drawings and specifications to ensure that the geotechnical comments and recommendations provided in this report have been accurately and appropriately interpreted.

It is important to note that the geotechnical investigation involves a limited sampling of the subsurface conditions at specific borehole locations. The conclusions and recommendations presented in this report reflect site conditions existing at the time of the investigation and a review of available information which has been presented in the report. Should subsurface conditions be encountered which vary materially from those observed in the boreholes, we recommend that LDS be consulted to review the additional information and verify if there are any changes to the geotechnical recommendations.

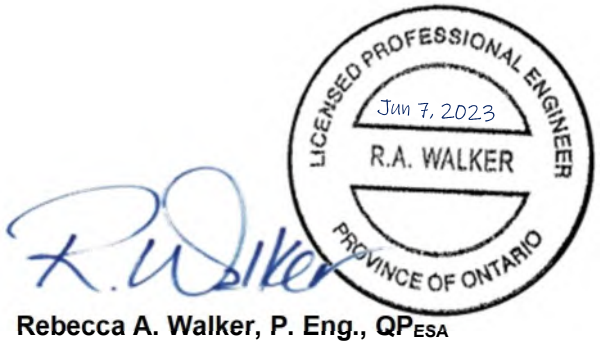
The comments given in this report are intended to provide guidance for design engineers. Contractors making use of this report are responsible for their construction methods and practices, and should seek confirmation or additional information if required, to ensure that they understand how subsurface soil and groundwater conditions may affect their work.

No portion of this report may be used as a separate entity. It is intended to be read in its entirety.

We trust this satisfies your present requirements. If you have any questions or require anything further, please feel free to contact our office.

Respectfully Submitted,

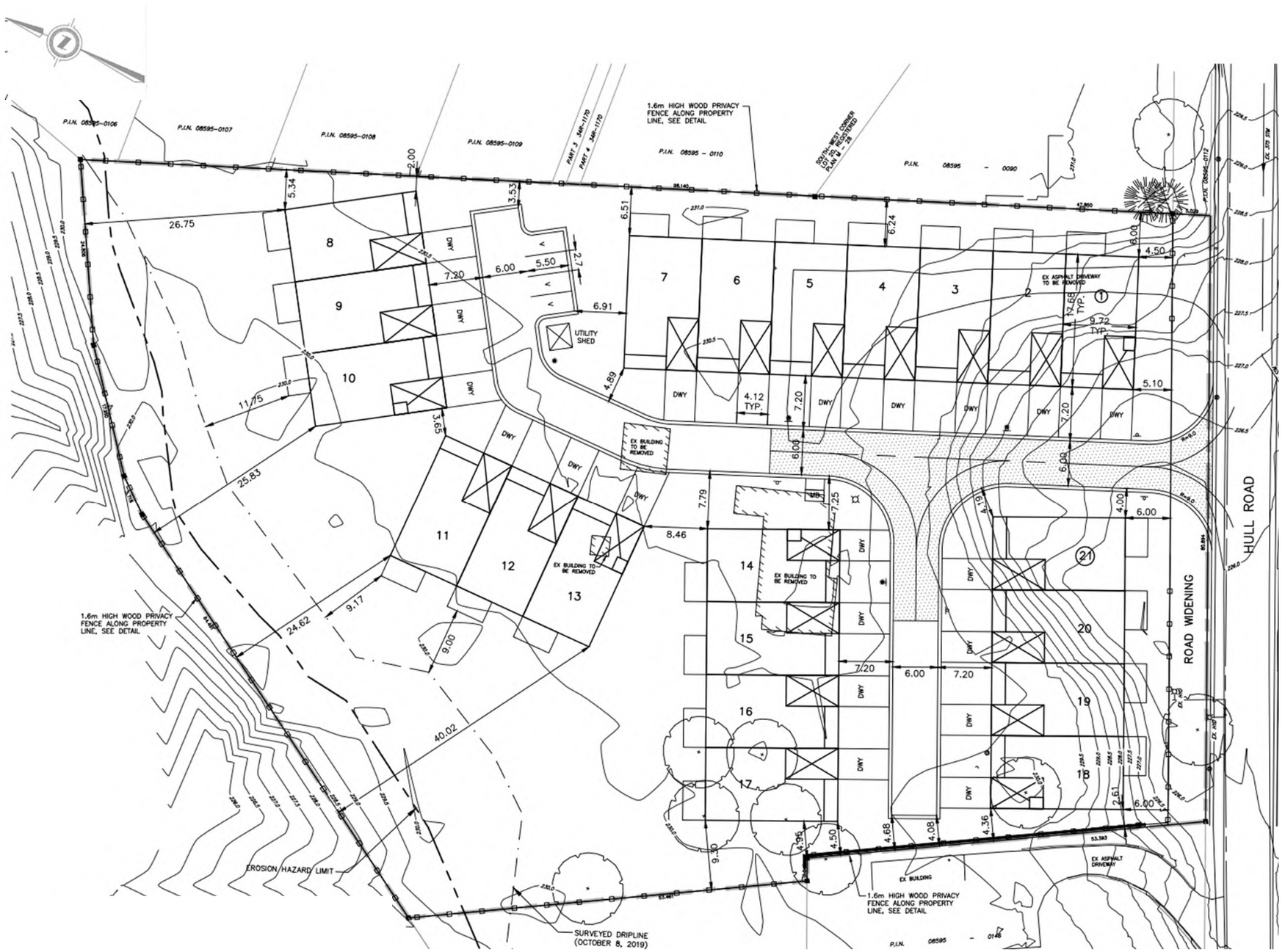
LDS CONSULTANTS INC.



Rebecca A. Walker, P. Eng., QP$_{ESA}$
Principal, Geotechnical Services
Office: 226-289-2952
Cell: 519-200-3742
rebecca.walker@LDSconsultants.ca

APPENDIX A

DRAWINGS AND NOTES



SOURCE:
Produced from Site Plan (Sheet SP1, LD-00209), prepared by LDS Consultants Inc., Aug 31, 2022

LDS

PROJECT NAME

Proposed Resdiential Development

PROJECT LOCATION

101 Hull Rd, Strathroy

DRAWING NAME

Development Concept Plan

SCALE	PROJECT NO.
NTS	GE-00286
DATE	**DRAWING NO.**
June 2023	1

LEGEND

SCRCA Regulated Land

SOURCE

SCRCA Web GIS for Middlesex County, September 2019

LDS

PROJECT NAME

Proposed Condominium Development

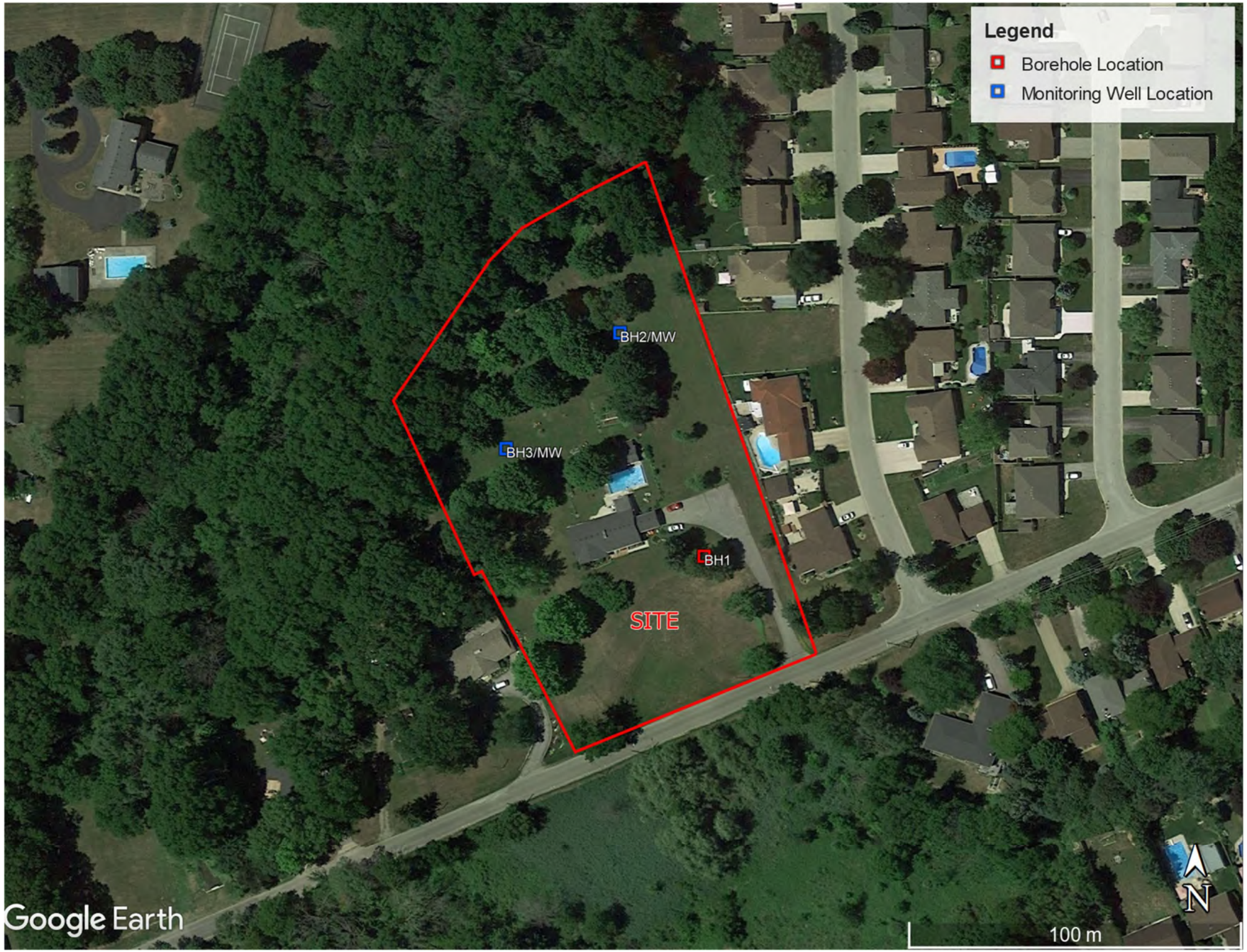
PROJECT LOCATION

101 Hull Rd, Strathroy

DRAWING NAME

SCRCA Regulated Lands

SCALE	PROJECT NO.
As Shown	GE-00286
DATE	**DRAWING NO.**
June 2023	2



Location	Northing, m N	Easting, m E	Ground Surface Elevation (m asl)
BH1	4757116.18	448837.56	230.23
BH2/MW	4757183.28	448812.77	230.12
BH3/MW	4757148.83	448778.30	230.01

SOURCE:
Google Earth Pro, Version 7.3.2.5776,
Coordinates 17T, 448813 m E, 4757141 m N,
Imagery date 7/2/2018

LDS

PROJECT NAME

Proposed Condominium Development

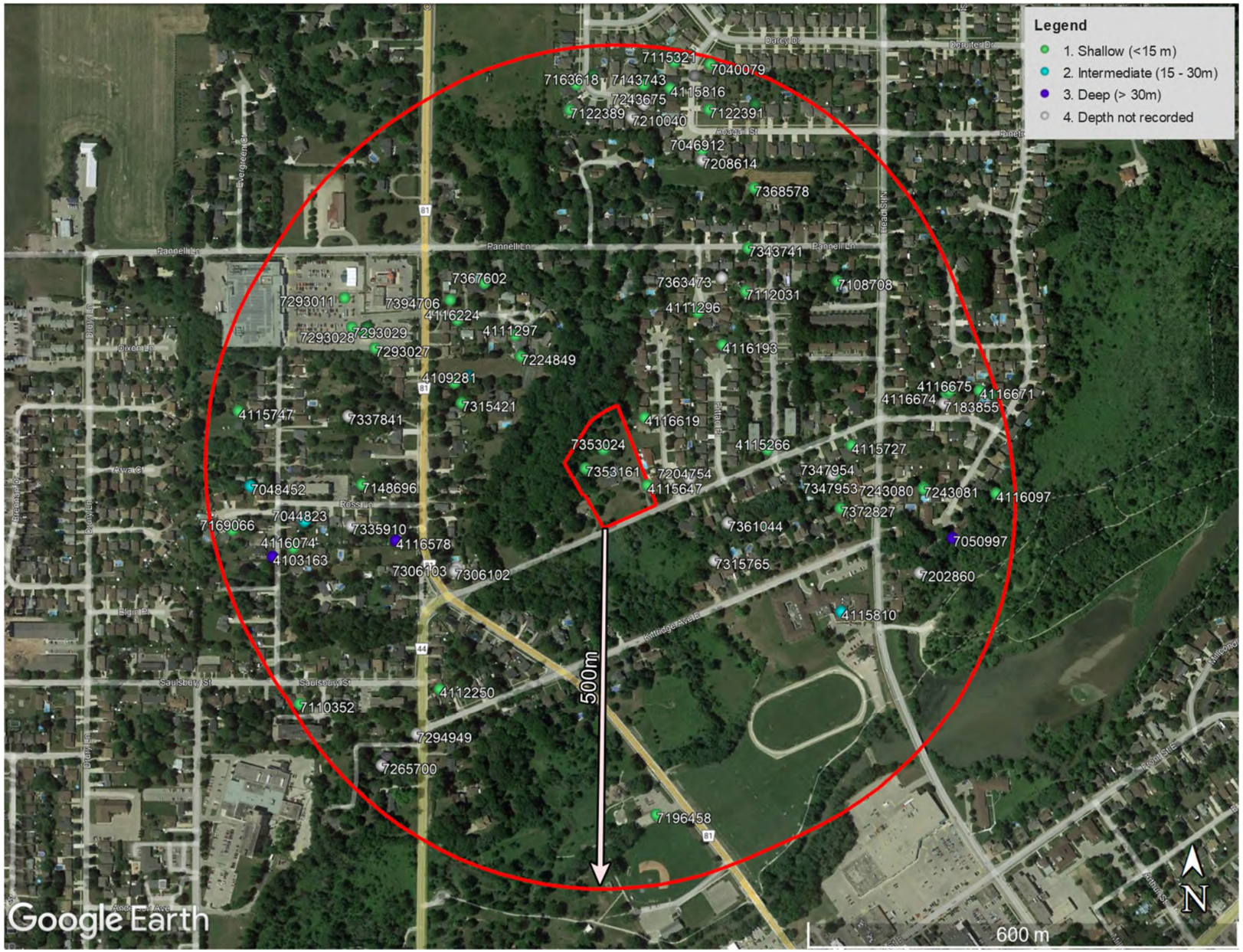
PROJECT LOCATION

101 Hull Rd, Strathroy

DRAWING NAME

Borehole Location Plan

SCALE	PROJECT NO.
As Shown	GE-00286
DATE	**DRAWING NO.**
June 2023	3



SOURCE:
Google Earth Pro, Version 7.3.2.5776, Coordinates 17T, 448813 m E, 4757141 m N, MECP Well Records – updated to October 18, 2021

LDS

PROJECT NAME

Proposed Condominium Development

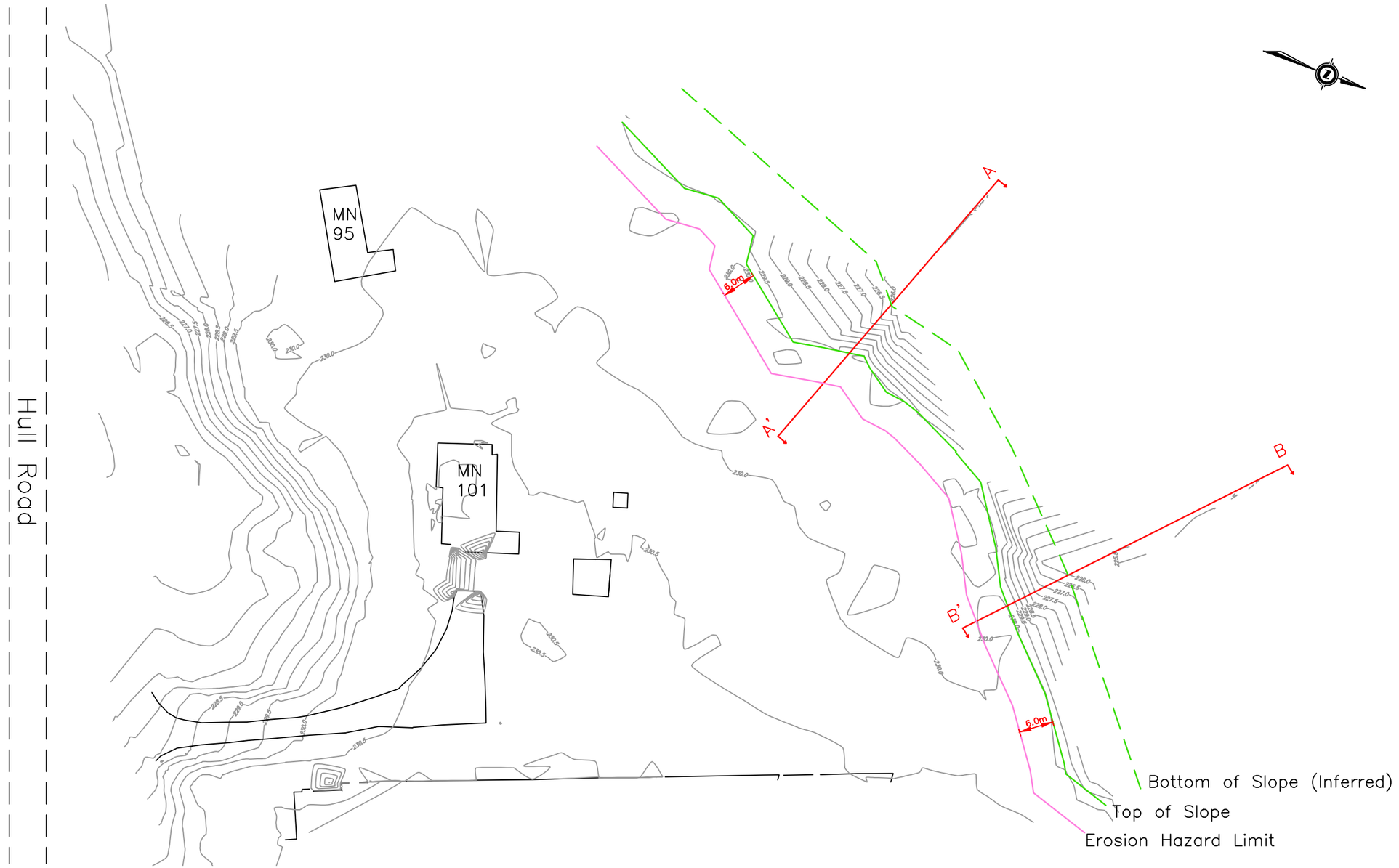
PROJECT LOCATION

101 Hull Rd, Strathroy

DRAWING NAME

MECP Well Locations

SCALE	PROJECT NO.
As Shown	GE-00286
DATE	**DRAWING NO.**
June 2023	4



LICENSED PROFESSIONAL ENGINEER
Jun 7, 2023
R.A. WALKER
PROVINCE OF ONTARIO

LEGEND
- Slope Profile
- Top and Bottom of Slope
- Erosion Hazard Limit

CONSULTANT OR DIVISION
LDS

SOURCES
Drawing Produced from topographic survey conducted by LDS

SCALE
1:750

TITLE
Proposed Condominium Development
Topographic Plan

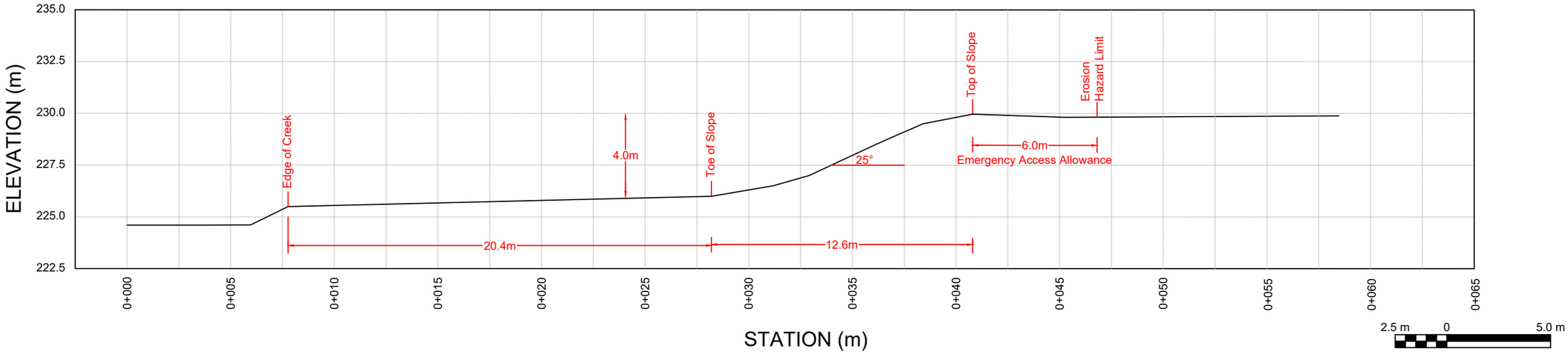
101 Hull Road
Strathroy, ON

PROJECT No.
GE–00286

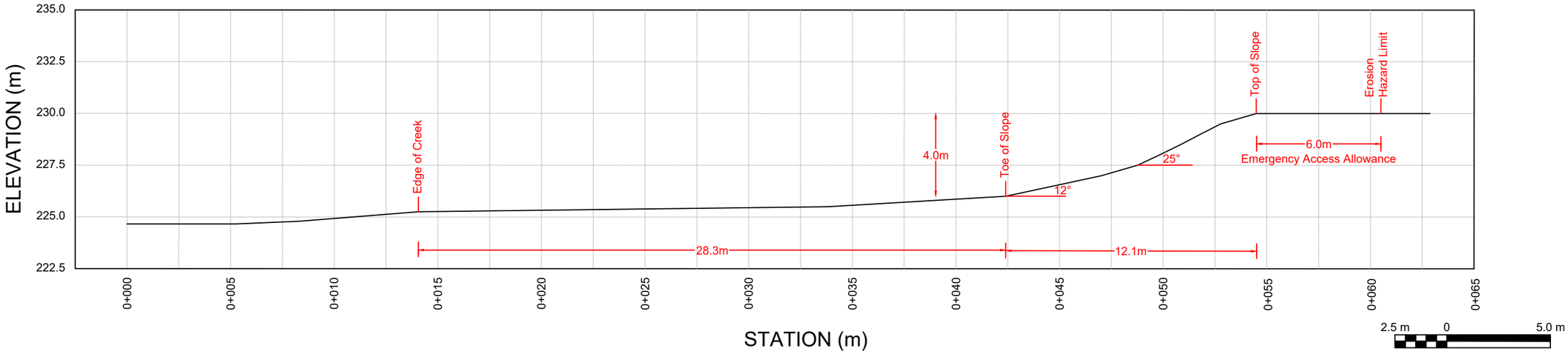
FIGURE No.
5

FIG. Date
JUN 2023

SLOPE PROFILE A-A'



SLOPE PROFILE B-B'

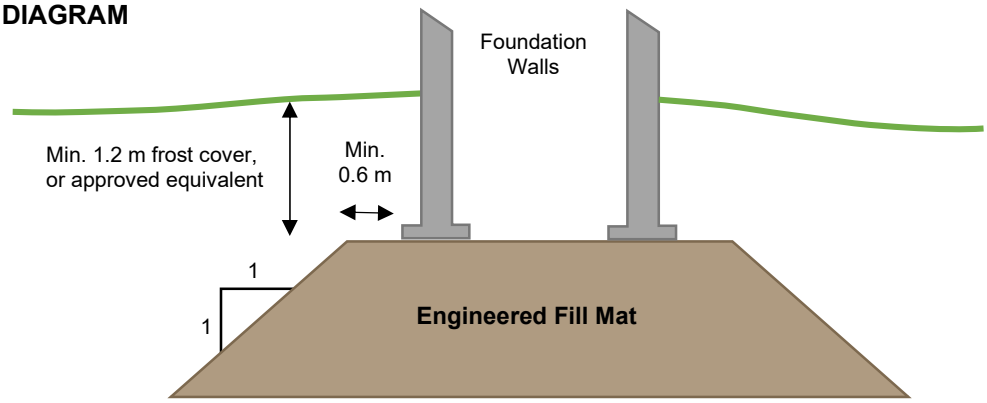


LICENSED PROFESSIONAL ENGINEER
Jun 7, 2023
R.A. WALKER
PROVINCE OF ONTARIO

LEGEND	CONSULTANT OR DIVISION	SOURCES	SCALE	TITLE	PROJECT No.
	LDS	Drawing Produced from field survey conducted by LDS	As Shown	Slope Profiles Profiles A–A' and B–B' 101 Hull Road Strathroy, ON	GE–00286 FIGURE No. 6 FIG. Date JUN 2023

ENGINEERED FILL PLACEMENT

SCHEMATIC DIAGRAM



NOTES:

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 natural subgrade must be examined and approved by the geotechnical consultant**.**
2. In areas where engineered fill is placed on a slope, the fill should be benched into the approved subgrade soils.
3. 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 prior to use onsite.
4. Engineered fill should be placed in maximum 300 mm thick lifts, and uniformly compacted to 100% Standard Proctor dry density. For best compaction results, engineered fill should be within 3 percent of its optimum moisture content, as determined by the Standard Proctor density test.
5. Full time geotechnical monitoring, inspection and in-situ density (compaction) is required during placement of the engineered fill.
6. 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 inclement weather conditions.
7. The fill must be placed such that the specified geometry is achieved. Refer to schematic diagram for minimum requirements. Environmental protection may be required, such as frost protection during construction, and after the completion of the engineered fill mat.
8. An allowable bearing pressure of 145 kPa (3000 psf) may be used provided that all conditions outlined above, and in the Geotechnical Report are adhered to.
9. These guidelines are to be read in conjunction with the attached Geotechnical Report prepared by LDS Consultants Inc.
10. For foundations set on engineered fill, footing enhancement and/or concrete reinforcing steel placement may be recommended. The footing geometry and extent of concrete reinforcing steel will depend on site specific conditions. In general, consideration may be given to having a minimum strip footing width of 500 mm (20 inches), containing nominal steel reinforcement.

LDS	**PROJECT NAME** Proposed Condominium Development	**PROJECT NO.** GE-00286
	PROJECT LOCATION 101 Hull Rd, Strathroy	**DRAWING NO.** **7**

APPENDIX B

BOREHOLE SUMMARY &
LABORATORY TEST RESULTS

NOTES ON SAMPLE DESCRIPTIONS

1. All descriptions included in this report follow the Canadian Foundation Engineering Manual soil classification system, based on visual and tactile examination which are consistent with the field identification procedures. Soil descriptions and classifications are based on the Unified Soil Classification System (USCS), based on visual and tactile observations. Where grain size analyses have been specified, mechanical grain size distribution has been used to confirm the soil classification.

Soil Classification (based on particle diameter)
Clay: < 0.002 mm
Silt: 0.002 – 0.075 mm
Sand: 0.075 – 4.75 mm
Gravel: 4.75 mm – 75 mm
Cobbles: 75 – 200 mm
Boulders: > 200 mm

Terminology & Proportion
Trace: < 10%
Some: 10-20%
Adjective, sandy, gravelly, etc.: 20-35%
And, and gravel, and silt, etc.: > 35%
Noun, Sand, Gravel, Silt, etc.: > 35% and main fraction

2. The compactness condition of cohesionless soils is based on excavator / drilling resistance, and Standard Penetration Test (SPT) N-values where available. The Canadian Foundation Engineering Manual provides the following summary for reference.

Compactness of Cohesionless Soils	SPT N-Value (# blows per 0.3 m penetration of split-spoon sampler)
Very Loose	0 – 4
Loose	4 – 10
Compact	10 – 30
Dense	30 – 50
Very Dense	50+

3. Topsoil Thickness - It should be noted that topsoil quantities should not be established from information provided at the test hole locations only. If required, a more detailed analysis with additional test holes may be recommended to accurately quantify the amount of topsoil to be removed for construction purposes.

4. Fill material is heterogeneous in nature, and may vary significantly in composition, density and overall condition. Where uncontrolled fill is contacted, it is possible that large obstructions or pockets of otherwise unsuitable or unstable soils may be present beyond the test hole locations.

5. Where glacial till is referenced, this is indicative of material which originates from a geological process associated with glaciation. Because of this geological process, 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 or boulders and therefore, contractors may encounter them during excavation, even if they are not indicated on the test hole logs. Where soil samples have been collected using borehole sampling equipment, it should be understood that normal sampling equipment can not differentiate the size or type of obstruction. Because of horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with excavations in till material.

6. Consistency of cohesive soils is based on tactile examination and undrained shear strength where available. The Canadian Foundation Engineering Manual provides the following summary for field identification methods and classification by corresponding undrained shear strength.

Consistency of Cohesive Soils	Field Identification	Undrained Shear Strength (kPa)
Very Soft	Easily penetrated several cm by the fist	0 – 12
Soft	Easily penetrated several cm by the thumb	12 – 25
Firm	Can be penetrated several cm by the thumb with moderate effort	25 – 50
Stiff	Readily indented by the thumb, but penetrated only with great effort	50 – 100
Very Stiff	Readily indented by the thumb nail	100 – 200
Hard	Indented with difficulty by the thumbnail	200+

LDS	Project	**Proposed Condominium Development**	Borehole ID **1**
	Project Location	**101 Hull Rd, Strathroy**	*Sheet 1 of 1*
	Project Number	**GE-00286**	

Date Drilled	**September 27, 2019**	Ground Surface Elevation	**230.23 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	**Dry**
Drilling Method	**Hollow Stem Auger**	Technician	**N Ungerer**
Drilling Contractor	**London Soil Test**	Checked By	**S Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.0						**TOPSOIL** - brown silty loam, moist, 300mm	
0.5							
1.0	SPT	1	70	12		**SAND** - brown, fine grained, damp to moist, compact	*MC - 1.8%*
1.5						- stratification observed below 1.37 m depth	
2.0	SPT	2	70	9			
2.5	SPT	3	60	24		- trace silt observed below 2.13 m depth	*MC - 3.7%*
3.0						- moist to very moist below 2.90 m depth	
3.5	SPT	4	60	15			
4.0							
4.5							
5.0	SPT	5	70	17	*5.03m*		*MC - 6.3%*
						BH Terminated at 5.03 m Open and Dry at completion	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter — No Well Installed
Installation Depth
Screen Length
Depth of Bentonite Seal

Additional Notes

MC - denotes moisture content

LDS	Project	**Proposed Condominium Development**	Borehole ID **2/MW**
	Project Location	**101 Hull Rd, Strathroy**	*Sheet 1 of 1*
	Project Number	**GE-00286**	

Date Drilled	**September 27, 2019**	Ground Surface Elevation	**230.12 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	**5.19 m bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**N Ungerer**
Drilling Contractor	**London Soil Test**	Checked By	**S Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.0						**TOPSOIL** - brown silty loam, moist, 300mm	
0.5							
1.0		1	60	9		**SAND** - brown, fine grained, trace silt, damp, loose	*MC - 16.5%*
1.5		2	50	7			
2.0						- compact below 2.13 m depth	
2.5		3	70	15			*MC - 2.7%*
3.0		4	70	17		- silt seam observed at 3.35 m depth, 300 mm	
3.5							
4.0						- dense below 4.04 m depth	
4.5		5	70	40			*MC - 15.7%*
5.0							
5.5						- saturated and compact below 5.56 m depth	
6.0		6	80	23	02/10/19		
6.5							
7.0							
7.5		7	80	7			*MC - 22.0%*
8.0					*8.08m*	BH Terminated at 8.08 m Water measured at 5.19 m Open at completion	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	-- 51mm
Installation Depth	-- 8.1m
Screen Length	-- 3.0m
Depth of Bentonite Seal	-- 0 - 4.3m

Additional Notes

MC - denotes moisture content

Water Level Measurements

Date	Depth	Elevation
Oct 2 -19	6.25	223.87
Oct 25 -19	6.31	223.81

LDS	Project	**Proposed Condominium Development**	Borehole ID **3/MW**
	Project Location	**101 Hull Rd, Strathroy**	*Sheet 1 of 1*
	Project Number	**GE-00286**	

Date Drilled	**September 27, 2019**	Ground Surface Elevation	**230.00 m asl**
Drill Rig	**D50 Turbo**	Groundwater Level at Completion	**5.20 m bgs**
Drilling Method	**Hollow Stem Auger**	Technician	**N Ungerer**
Drilling Contractor	**London Soil Test**	Checked By	**S Hadden, EIT**

Depth (m)	Sample Type	Sample Number	Recovery (%)	SPT N-value (blows/0.3 m)	Graphic Log	Material Description	Remarks and Other Tests
0.5						**TOPSOIL** - brown silty loam, moist, 300mm	
1.0	Bulk	1	AS			**SAND** - brown, fine grained, trace silt, moist	*MC - 17.5%*
1.5	SPT	2	70	17			
2.0							
2.5	Bulk	3	AS				*MC 2.7%*
3.0	SPT	4	70	18			
3.5							
4.0						- saturated below 4.04 m depth	
4.5	SPT	5	70	22			*MC - 22.1%*
5.0							
5.5						- stratification observed below 5.56 m depth	
6.0	SPT	6	90	26	02/10/19		
6.5							
7.0						- dense below 7.09 m depth	
7.5	SPT	7	80	30			*MC - 20.2%*
8.0					*8.08m*	BH Terminated at 8.08 m Water measured at 5.19 m Open at completion	

Legend

- SPT Sample
- Bulk Sample
- Shelby Tube
- Stabilized Groundwater
- Inferred Groundwater

Well Construction Details

Pipe Diameter	-- 51mm
Installation Depth	-- 8.1m
Screen Length	-- 3.0m
Depth of Bentonite Seal	-- 0 - 4.3m

Additional Notes

MC - denotes moisture content

Water Level Measurements

Date	Depth	Elevation
Oct 2 -19	6.36	223.64
Oct 25 -19	6.42	223.58

APPENDIX C

MECP WELL RECORD SUMMARY

SUMMARY OF MECP WELL RECORD DATA

Well ID	Registration Date	Type	Depth (m)	Water Found (m)	Static Water Level (m)	Pump Rate (LPM)	Well Location / Coordinates		
							Northing, m N	Easting, m E	Distance from Site (m)
Water Supply Wells									
4107550	1976-02-11	Commercial	19.812	13.4112	7.62	113.562	4757273	448613.3	177.2084
4109281	1980-09-04	Domestic	7.62	5.4864	5.4864	22.7124	4757263	448593.3	188.6846
4111296	1988-05-17	Irrigation	7.62	5.4864	5.4864	56.781	4757358	448933.3	171.0262
4111297	1988-06-21	Irrigation	7.62	5.4864	5.4864	30.2832	4757328	448678.3	159.2931
4112250	1990-09-20	Domestic	13.1064	7.9248	7.9248	37.854	4756838	448569.3	318.8327
4115266	2003-05-15	Irrigation	9.144	6.096	6.096	37.854	4757167	449029	172.8563
4115647	2004-05-21	Irrigation	9.144	6.096	6.096	37.854	4757118	448861	On Site
4115727	2004-07-28	Irrigation	10.2108	6.4008	6.4008	37.854	4757172	449146	284.6969
4115747	2004-08-18	Irrigation	6.858	3.6576	3.6576	37.854	4757226	448292	459.4353
4115810	2004-09-21	Irrigation	18.288	12.8016	2.8956		4756941	449130	296.9995
4115816	2004-10-25	Irrigation	7.4676	5.6388	5.6388	26.4978	4757670	448897	446.5608
4116074	2005-05-16	Irrigation	8.6868	5.4864	5.4864	37.854	4757035	448367	395.293
4116097	2005-06-15	Irrigation	5.6388	2.4384	2.4384	26.4978	4757103	449347	473.8996
4116193	2005-07-16	Irrigation	9.6012	6.4008	6.4008	37.854	4757313	448967	169.0172
4116224	2005-08-29	Irrigation	8.6868	5.4864	5.4864	26.4978	4757350	448598	232.8987
4116578	2006-06-14	Irrigation	33.5	10	12	10	4757044	448510	258.0036
4116619	2006-06-29	Irrigation	8.382	6.096	6.096	37.854	4757213	448858	29.64798
4116671	2006-08-16	Irrigation	9.906	6.7056	6.7056	4	4757247	449325	478.1284
4116674	2006-08-24	Irrigation	8.6868	6.096	6.096	3	4757243	449279	433.5046
4116675	2006-08-24	Irrigation	8.6868	6.096	6.096	30.2832	4757246	449283	438.3071
7040079	2006-12-21	Irrigation	8.6868	5.4864	5.4864	10	4757703	448953	491.2547
7040080	2006-12-12	Irrigation	27.5	16	16	10	4757708	448905	485.3738
7044823	2007-06-06	Irrigation	27.5	17	17	10	4757072	448383	370.4823
7046912	2007-06-20	Irrigation	8.6868	5.1816	5.1816	30.2832	4757584	448941	374.0409

Well ID	Registration Date	Type	Depth (m)	Water Found (m)	Static Water Level (m)	Pump Rate (LPM)	Well Location / Coordinates		
							Northing, m N	Easting, m E	Distance from Site (m)
7048452	2007-07-05	Irrigation	24.5	14	14	10	4757121	448308	438.111
7050997	2007-08-28	Cooling And A/C	76.2				4757042	449286	415.5498
7108708	2008-06-11	Irrigation	9.2964	6.096	6.096	10	4757400	449128	352.0077
7110352	2008-07-25	Irrigation	8.6868	5.4864	5.4864	37.854	4756819	448374	488.309
7112031	2008-08-01	Irrigation	9.6012	6.4008	6.4008	37.854	4757387	449000	238.9821
7115321	2008-11-03	Irrigation	8.382	6.096	6.096	37.854	4757706	448903	483.056
7122389	2009-04-09	Irrigation	7.3152	3.9624	3.9624	37.854	4757641	448757	415.5639
7122391	2009-03-30	Irrigation	8.9916	5.7912	5.7912	37.854	4757640	448951	430.3445
7143743	2010-03-31	Irrigation	10.2108	7.0104	7.0104	37.854	4757675	448860	446.638
7146576	2010-05-25	Irrigation	10.2108	7.1628	7.1628	15.1416	4757241	449343	493.3041
7148696	2010-06-11	Irrigation	12.6492	5.4864	5.4864	37.854	4757122	448463	283.5423
7163618	2011-04-25	Irrigation	9.144		6.4008	37.854	4757676	448766	449.0305
7243080	2015-05-20	Irrigation	10.0584		7.3152	13.2489	4757112	449246	373.3598
7243081	2015-05-25	Irrigation	10.3632		7.3152	18.927	4757110	449246	373.249
7315421	2018-04-30	Irrigation	7.4676		5.334	30.2832	4757235	448603	165.517
7343741	2019-08-21	Irrigation	7.62		5.1816	30.2832	4757447	449004	284.5851
7372827	2020-08-18	Irrigation	10.2108	6.4008			4757084	449130	256.8081
7390739	2021-04-14	Irrigation	7.4676	5.0292			4757647	449015	460.3153
7394706	2021-06-21	Irrigation	8.9916	5.4864			4757378	448588	258.5066
Test Holes & Observation Wells									
4103163	1954-12-07		30.48				4757023	448338.3	426.2557
7196458	2012-11-05	Monitoring	7.62	2.1336			4756661	448870	403.8332
7293010	2017-07-11	Test Hole	7.62				4757341	448472	332.8978
7293011	2017-07-11	Test Hole	2.4384				4757382	448441	381.0897
7293027	2017-07-10	Test Hole	7.62				4757312	448483	308.0563
7293028	2017-07-10	Test Hole	7.62				4757333	448469	331.1215
7293029	2017-07-11	Test Hole	7.62				4757341	448451	350.5981
7353024	2019-09-27	Monitoring	7.62	6.096	6.096		4757169	448800	On Site

Well ID	Registration Date	Type	Depth (m)	Water Found (m)	Static Water Level (m)	Pump Rate (LPM)	Well Location / Coordinates		
							Northing, m N	Easting, m E	Distance from Site (m)
7353161	2019-09-27	Monitoring	7.62	6.096	6.096		4757143	448775	On Site
7368578	2020-04-03	Test Hole	7.62	0.3048	0.3048		4757531	449013	357.5868
Well Use Not Recorded									
7169066	2011-08-19		7.9248		4.8768	37.854	4757060	448282	471.8373
7224849	2014-06-18		8.5344		5.4864	28.3905	4757299	448686	132.8923
7174492	2011-12-12		9.144		6.096		4757689	448790	459.7703
7183855	2012-06-27				6.096	26.4978	4757229	449275	424.9912
7202860	2013-05-07				1.524	22.7124	4756994	449240	379.1698
7204754	2013-06-18				6.4008	37.854	4757127	448920	56.76046
7208614	2013-08-08				5.4864	37.854	4757570	448941	360.8266
7210040	2013-10-01				7.3152		4757630	448843	400.4933
7243675	2015-05-27				7.3152	37.854	4757648	448860	419.7555
7265700	2016-05-27						4756732	448488	451.3297
7294949	2017-08-01				5.1816		4756775	448537	386.4382
7306102	2017-12-20					26.4978	4757001	448592	206.5036
7306103	2017-12-20					14.19525	4757006	448595	201.4298
7315765	2018-06-13				6.4008		4757013	448954	111.7887
7335910	2019-05-15				5.7912	37.854	4757065	448448	309.1083
7337841	2019-06-04				3.9624	37.854	4757218	448445	307.7024
7347953	2019-10-21		9.2964		6.096	37.854	4757131	449123	253.0207
7347954	2019-10-21				6.096	37.854	4757131	449119	249.0736
7361044	2020-05-22				6.096	37.854	4757065	448973	102.8957
7363473	2020-06-25				5.4864	75.708	4757406	448967	229.3882
7367602	2020-08-10		8.8392		5.4864	37.854	4757401	448636	242.2784
7373328	2020-11-04						4757687	448931	470.1853

APPENDIX D

SLOPE STABILITY RATING CHARTS

Slope Stability Rating Chart, A – A'

Geotechnical Principles for Stable Slopes
Ontario Ministry of Natural Resources

Site Location: 101 Hull Road	**Project No.: GE-00286**
Town/City: Strathroy, Ontario	**Inspection Date: October 25, 2019**
Inspected by: Rob Walker	**Weather: Overcast 5C**

	Rating Value	Slope Rating
Slope Inclination		
18 degrees or less (3H:1V or flatter)	0	
18 to 28 degrees (2H:1V to 3H:1V)	6	**6**
28 degrees or more (steeper than 2H:1V)	16	
Soil Stratigraphy		
shale / limestone	0	
sand, gravel	6	**6**
till	9	
clay, silt	12	
fill	18	
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	**2**
5.1 to 10 m	4	
more than 10 m	8	
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	**0**
light vegetation: 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	**2**
drainage over slope, active erosion, gullies	4	
Proximity of Watercourse to Slope Toe		
15 m or more from slope toe	0	**0**
Less than 15 m from slope toe	6	
Previous Landslide Activity		
No	0	**0**
Yes	6	
Slope Instability Rating		**16**

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:
Is there is a water body (stream, creek, river, pond, bay, lake) at the toe of slope?
If YES - the potential for toe erosion and undercutting should be evaluated in detail.

Slope Stability Rating Chart, B – B'

Geotechnical Principles for Stable Slopes
Ontario Ministry of Natural Resources

Site Location: 101 Hull Road	**Project No.: GE-00286**
Town/City: Strathroy, Ontario	**Inspection Date: October 25, 2019**
Inspected by: Rob Walker	**Weather: Overcast 5C**

	Rating Value	Slope Rating
Slope Inclination		
18 degrees or less (3H:1V or flatter)	0	
18 to 28 degrees (2H:1V to 3H:1V)	6	**6**
28 degrees or more (steeper than 2H:1V)	16	
Soil Stratigraphy		
shale / limestone	0	
sand, gravel	6	**6**
till	9	
clay, silt	12	
fill	18	
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	**2**
5.1 to 10 m	4	
more than 10 m	8	
Vegetation Cover on Slope Face		
well vegetated: heavy shrubs or forested with mature trees	0	**0**
light vegetation: 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	**2**
drainage over slope, active erosion, gullies	4	
Proximity of Watercourse to Slope Toe		
15 m or more from slope toe	0	**0**
Less than 15 m from slope toe	6	
Previous Landslide Activity		
No	0	**0**
Yes	6	
Slope Instability Rating		**16**

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:
Is there is a water body (stream, creek, river, pond, bay, lake) at the toe of slope?
If YES - the potential for toe erosion and undercutting should be evaluated in detail.

LDS CONSULTANTS INC.

2323 Trafalgar Street
London, Ontario N5V 0E1

www.LDSconsultants.ca