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Severance
Preliminary Hydrogeological Assessment Report
11629 Lakeshore Road
Wainfleet, Ontario
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1.0 INTRODUCTION

1.1 Background

Landtek Engineering Limited (Landtek) was retained by Mr. Mario Rapino to complete a Hydrogeological Assessment for proposed Severance at 11629 Lakeshore Road in Wainfleet, Ontario (the 'Site').

The Site is located in NPCA's Lake Erie Watershed Planning Area (Lake Erie North Shore Watershed Plan, NPCA 2010). The boundary of the Site to the Lake Erie shoreline is approximately 114 m at the southwest corner area and 205 m at the southeast corner area. It is located in a rural settlement, south on 11629 Lakeshore Road, Wainfleet, Ontario. It is bound to the west by undeveloped agricultural lands, to the north by residential developments across Lakeshore Road, and to the east and south by residential developments. The site location map is presented on Figure 1 in Appendix A. The Site surrounding area is serviced by individual sewage systems and groundwater wells.

The topography of the Site slopes gently from north to south. The elevation at the northwest corner is 178 metres above sea level (masl), at the northeast corner is 181 masl, at the southwest corner is 176 masl, and at the southeast corner is 177 masl (Niagara Region topographic map, elevation, terrain).

It is understood that the size of the Site is approximately 17.2 acres, and it is proposed to sever an allowable lot that meets the requirements of the Niagara Region. A lot size of approximately 0.41 hectare (4,056 m^2) with a dilution area of approximately 50m x 30m is proposed for this severance, as shown on Figure 2 in Appendix A.

A Cistern will be used to provide potable water supply to the proposed lot. As a result, this hydrogeological investigation was undertaken only for disposal of wastewater.

1.2 Scope

The scope of this assessment includes collecting and assessing relevant existing information to determine the potential impacts resulting from the use of individual private septic system in and around the Site. These include the following:

- Determining if the bedrock aquifer in the study area is contaminated with human related contaminants including bacteria, ammonia, nitrates, nitrite, phosphate and chloride.
- Determining if individual septic systems are contaminating groundwater.
- Assessment of site-specific conditions including soil type and depth, and depth to groundwater water table.
- Determination if the proposed severances will be permitted.

A review of existing reports, which include mapping information, MOE water well records, available climatic data and land use planning documents, was completed. In addition, a water well survey (desk-top) of dwellings surrounding the project area was conducted in order to determine well construction and use.

2.0 METHODOLOGY

The methodology included the following:

2.1 Land Use Information

Existing relevant reports, publications, topography maps and base maps, land use plans, Ministry of Environment Conservation and Park (MECP) water well records, and aerial photos were reviewed in order to characterize land use and the nature of development within the study area.

2.2 Topography and Climate

The topography of the area was reviewed using 1:50 000 scale topographical maps and 1:10,000 scale OBM mapping. The climate data for the area was obtained from Environment Canada publications and from Environment Canada online database. Average climate data was taken from Welland Station for the period of 1981 to 2010.

2.3 Hydrogeological Setting

The area subsurface conditions were characterized in order to:

- Identify the aquifers and aquitards in the area.
- Ascertain the water supply aquifer susceptibility to contamination.
- Ascertain the groundwater flow direction and potential contaminant receptors.

Assessment of the hydrogeological setting was completed using physical/geological information and water levels.

2.3.1 Local Geology

A review of the following published works covering the study area was completed:

- Surficial (Quaternary) Geological Maps.
- Topographical Maps (1:50 000).
- Ontario Base Mapping (1:10 000).
- The Physiography of Southern Ontario, L.J. Chapman and D.F. Putnam, 1984.
- Ministry of Environment, Conservation and Park (MECP) water wells records
- Technical reports relating to groundwater resources in the Project area.

Assessment of geological information was done using regional mapping of elevation, soils, sediments/overburden and bedrock.

Based on the above information geological cross sections were drawn to understand the geological and hydrogeological setting of the study area.

2.3.2 Regional and Local Hydrogeology

The generated geological cross sections of the project area were used in conjunction with water level data gathered from the MECP water well records and information from the site investigation to classify the geological units as aquifer or aquitard, and to determine the hydrostratigraphy of the area.

2.3.3 Aquifer Vulnerability

An assessment of the aquifer vulnerability was completed using the following:

- Provincial procedure D-5-4 (MECP, 1996)
- Groundwater vulnerability procedures by the Niagara Peninsula Source Protection Authority (NPCA, 2013 and NPCA, 2017); and

2.3.4 Predictive Sewage Impacts Assessment

A predictive assessment of sewage impacts was completed including a nitrate-nitrogen dilution calculation for the proposed septic systems. A sample schematic is presented below of the Section 22.5.8 approach (MECP, 2008) (Figure 3).

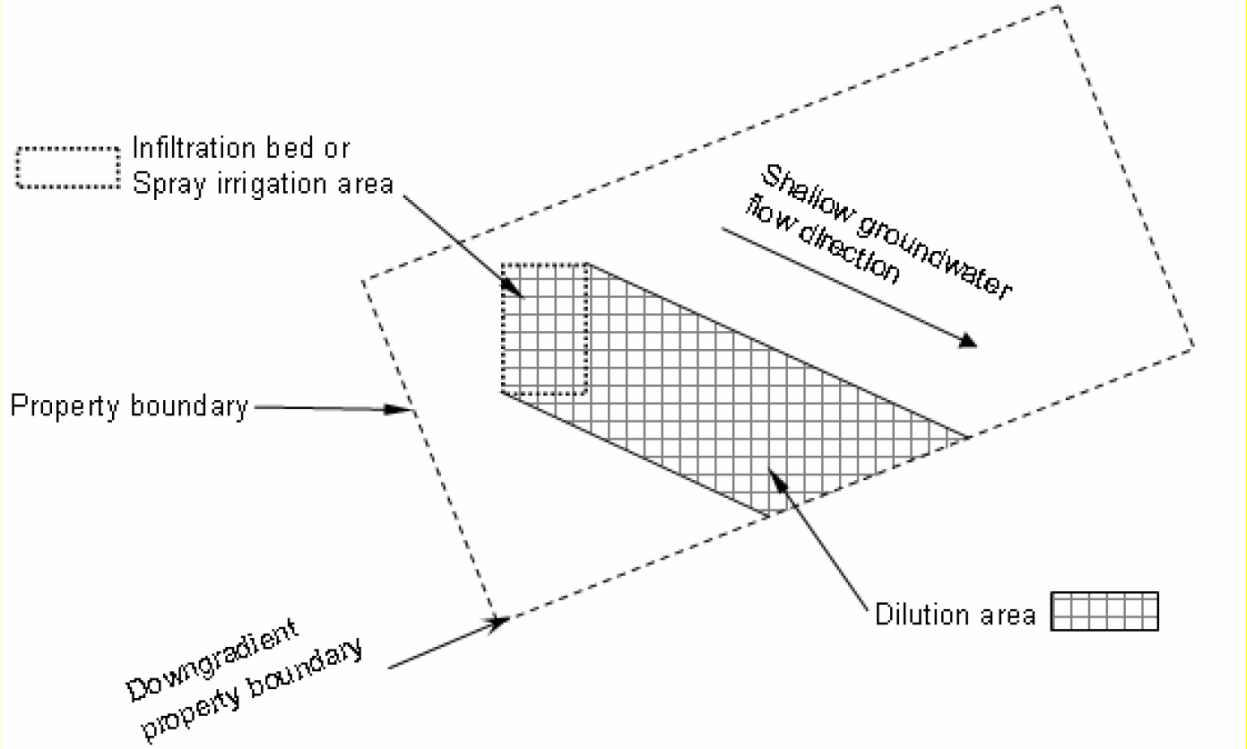


Figure 3: Schematic model for a basic groundwater dilution calculation (MECP, 2008)

2.4 Site Investigation

A field investigation was completed by Landtek on October 31, 2023, and this included the following:

- Completion of four boreholes at the lot proposed for severance to at least 3.0 metres below ground surface (mbgs) or to bedrock refusal, whichever comes first. Representative soil samples were collected for laboratory grain size analysis (including hydrometer testing).
- Observation of groundwater during drilling and after completion if any to determine groundwater level.

Boreholes were completed at the site on October 31, 2023, after One Call and Private Utilities Clearances. It included three (3) boreholes (BH4, BH5, and BH6) using a continuous flight power auger track-mounted drill rig equipped with conventional soil sampling and testing tools. The drilling was conducted by Element Geo of Hamilton Ontario under the supervision of a Landtek staff who logged the borings and examined the samples as they were obtained. A monitoring well was installed in BH6. The results of the drilling are recorded in detail on the on the borehole logs provided in Appendix B.

In total, nine (9) representative soil samples, three from each borehole, were collected for grain size analysis including hydrometer tests. Soil samples were collected from the excavations at depths ranging from 0.0 to 2.0 mbgs.

The monitoring well was constructed with 50 mm inner diameter, Schedule 40 machine slotted PVC screens equipped with a bottom cap, and machine threaded riser pipe. The screen length and slot size was 1.5 m, and 0.10-inch, respectively.

2.4.1 Shallow Groundwater Monitoring

Depths to groundwater in monitoring well MW6 were measured on October 10, 2023.

2.5 Water Well and Septic System Survey

Water Well Survey (Desk-Top)

The MECP Water Well Information System is a publicly available database which contains information such as groundwater well location, well construction details, geologic units encountered with depth, water use, date of construction, and screened interval.

An on-line desk-top search of the well record database was conducted on January 14, 2024. The search was for wells located within approximately 150 m of the Site.

Septic Survey

No dwellings were identified within 100 m of the proposed Lot to be severed. However, two dwellings were identified within 250 m east of the Lot. As these dwellings are cross-gradient to the Site, a septic System survey was not completed.

2.6 Groundwater Quality Impact Assessment

Groundwater impact assessment was conducted to determine the potential extent of contamination of the water supply aquifer beneath the project Site. The assessment was undertaken by analyzing the hydrogeological characteristics of the study area, climatic conditions, land use, and the results of the individual well and septic system survey. The assessment used provincial procedure D-5-4 for Individual On-Site Sewage Systems (MECP, 1996) and the provincial procedure for hydrogeologically sensitive areas (Section 22.5.8, MECP, 2008) as applicable to the Site conditions.

3.0 FINDINGS

3.1 Land Use

The study area is shown on Figure 1, and the land use in the study area is primarily rural residential. The majority of the undeveloped land in the area is designated rural and agricultural.

There are no municipal water or wastewater services in the area. As a result, homes use water wells or cisterns for drinking water, and septic systems for sewage.

3.2 Physiography and Topography

The study area is located in the Haldimand Clay Plain physiographic region, as described by Chapman and Putnam, 1984. Soils in this region tend to be heavy textured and poorly drained. The project area lies south of the Onondaga Escarpment and controls drainage in the area.

Generally, topographic elevation varies from 177 masl to 180 masl within 500 m of the Site varying between 178 masl and 182 masl. However, at Site and it's vicinity the topography ranges from 179 masl to 180 masl.

3.3 Drainage and Surface Water Features

Lake Erie is the major surface water feature in Wainfleet. The shoreline of the Lake is low and appears to be controlled by the bedrock surface, which, together with the morainic hills found in the vicinity, form headlands in the area (Chapman and Putnam, 1984). A few streams flow southward to drain the area.

3.4 Climate

The site is located in the Mixedwood Plains ecozone of Ontario (Natural Resources Canada, 2012). The general climate data presented below in Table 2 was obtained from Environment Canada publications and from the Environment Canada online database. Average climate data was taken from the Welland Station for the period of 1981 to 2010.

Table 1. 1981 to 2010 Climate Normals for Welland Station (as averages)

	Daily Average Temperature (°C)	Average Rainfall (mm)	Average Snowfall (cm)	Average Precipitation (mm)
January	-4.3	38.3	39.9	78.2
February	-3.4	31.1	30.2	61.3
March	0.7	47.2	22.5	69.7
April	7.3	70.7	4.7	75.4
May	13.4	84.7	0.5	85.2
June	18.8	82.9	0.0	82.9
July	21.6	85.9	0.0	85.9
August	20.7	82.4	0.0	82.4
September	16.6	96.8	0.0	96.8
October	10.1	89.0	0.3	89.3
November	4.6	90.6	7.8	98.5
December	-1.1	56.2	35.8	92.0
Year	8.8	855.8	141.6	997.4

3.5 Results of Subsurface Investigation

3.5.1 Boreholes and Monitoring Well

A summary of the boreholes and monitoring wells construction is presented below in Table 2. A site diagram showing the locations of the boreholes and monitoring wells is presented on Figure 2 in Appendix A.

Table 2. Monitoring Wells Construction Details

Well ID	Well Diameter [mm]	Well UTMs*		Depth (mbgs)	Stick Up (m)	Well Screen Depth [mbgs]	
		Easting	Northing			Top	Bottom
MW4	None	63413.1	4747527.3	1.83	None	NA	NA
MW5	None	634105.6	4747539.3	1.83	None	NA	NA
MW6	50	634114.2	4747506.9	2.30	0.70	0.80	2.30

Notes: [*] UTM readings were recorded by Landtek with a GPS with accuracy of -/+ 4m.

3.5.2 Lithologies

Detailed monitoring wells logs are presented in Appendix B, and the lithologies encountered are discussed further in the following sections.

The soil excavation information is generally consistent with the geological data of the area, and the predominant soils comprise of silty clay from ground surface to the end of drilling in bedrock at 1.83 -2.30 mbgs. The soil profile encountered in the excavations are discussed further in the following sections.

Topsoil

Topsoil was encountered in all excavation and test pits at depths ranging from 0.18 to 0.20 mbgs.

Silty Clay/Clayey Silt

Silty Clay/Clayey Silt deposits were encountered in all boreholes at depths ranging from approximately 0.2 mbgs to the end of drilling in bedrock at 1.83 to 2.30 mbgs.

Groundwater

Groundwater was not encountered during drilling and after drilling.

3.5.3 Grain Size Analyses

In total, six (6) soil samples were collected for grain size analysis. Soil samples were collected in BH4, BH5 and BH6 at depths ranging from 0.0 mbgs to 2.0 mbgs. Results of grain size analyses results are provided in Appendix C and are summarized below as follows:

BH4 @ 0.0-0.6 mbgs
Soil classified as Silty Sand with 14.3% gravel, 46.7% sand, 27.2% silt and 11.8% clay.
BH4 @ 0.7-1.2 mbgs

Soil classified as Sandy Silty Clay with 1.2% gravel, 10.3% sand, 37.2% silt and 51.3% clay.

BH5 @ 0.0-0.6 mbgs
Soil classified as Sandy Silty Clay with 0.4% gravel, 15.4% sand, 43.6% silt and 40.6% clay.

BH5 @ 0.7-1.2 mbgs
Soil classified as Silty Clay with 1.8% gravel, 7.4% sand, 34.5% silt and 56.3% clay.

BH6 @ 0.0-1.2 mbgs
Soil classified as Clayey Silt with 19.2% gravel, 24.8% sand, 38.7% silt and 17.3% clay.

BH6 @ 1.5-2.0 mbgs
Soil classified as Silty Clay with 0.2% gravel, 4.8% sand, 30.0% silt and 65.0% clay.

Notes: [1] mbgs = meter below ground surface

3.6 Geology

3.6.1 Surficial Geology

Based on the drilling completed at the Site in October 2023, depth to bedrock varies across the Site, ranging from approximately 0.8 mbgs at the northeast area to 2.9 mbgs at the southwest area.

A search of the MECP water well indicates there are no water wells at the Site. However, depths to bedrock a water well (ID 6602111) located approximately 40 m east of the site, and water well (ID 7102686) located approximately 100 m west of the site were recorded as 1.8 mbgs and 4.6 mbgs, respectively.

As a part of the study, MECP water well records were used to construct stratigraphic cross sections. Locations of the cross sections; and the cross sections A-A' and B-B', are shown in Figures 8, 9A and 9B, respectively. The cross-sections show thicknesses of clayey silt overburden ranging from 1.83 m to 2.3 in the study area over bedrock.

3.6.2 Bedrock Geology

The bedrock in the project area has been mapped as cherty, fossiliferous, locally argillaceous limestone of the Edgecliff Member of the Onondaga Formation, overlying an unnamed member of the Bois Blanc Formation also identified as very cherty, argillaceous, fossiliferous limestone (Armstrong and Dodge, 2007). Where private wells are present in the area these bedrock units are the local aquifer (Section 3.0).

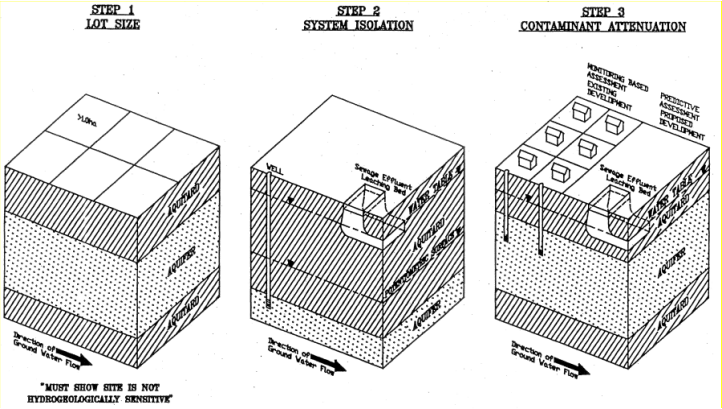
The bedrock topography follows the ground surface topography and at 176 masl to 181 metre above sea level contour has been mapped in the central portion of the Site (NPCA, 2005).

3.6.3 Aquifer Vulnerability

The Site was mapped as a Highly Vulnerable Aquifer (HVA) by the Niagara Peninsula Source Protection Authority (NPSPA, 2013). HVAs are defined as subsurface, geologic formations that are sources of drinking water, which could relatively easily be impacted by the release of pollutants on the ground surface.

Vulnerability may be due to (a) intrinsic susceptibility, a function of the thickness and permeability of overlaying layers, or (b) preferential pathways to the aquifer.

Three Steps have been established to complete contaminant assessment at a Site (Step 3) with HVA (i.e. not isolated from surface contamination) (Step 2) for appropriate lot sizes. These are as shown on Figures 4 below.



Figures 4 – Three Step Water Quality Assessment Process (MECP, 1995)

Due to shallow depths bedrock at the site (Section 5.1), the Site classified as within a Hydrogeologically Sensitive Area (HSA) (NPCA, 2017). MECP (1995,1996) defined HSAs as "*karstic areas, which are areas of fractured bedrock exposed at surface, areas of thin soil cover, or areas of highly permeable soils".* As a result of this classification, the contaminant assessment is required to follow Section 22.5.8 of MECP (2008) to inform site design, effluent treatment and setbacks.

3.6.4 Hydrogeological Setting

The Site is characterized as having local hydrogeologic setting of "shallow soil over fractured bedrock" with the water table in the bedrock aquifer shown on Figure 5 on the following page (MECP, 1995).

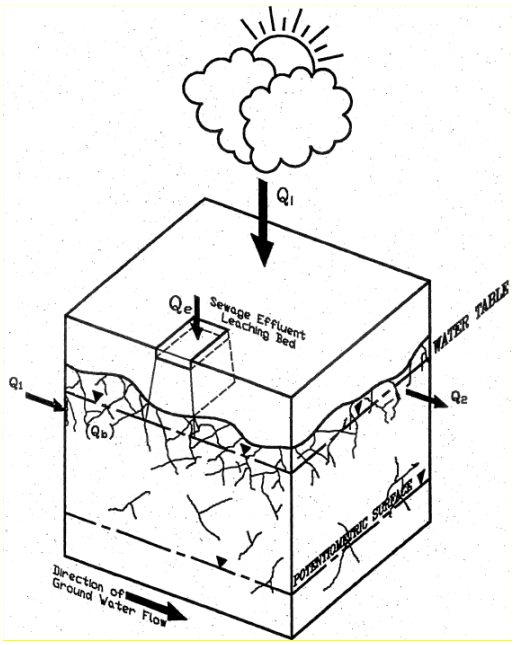


Figure 5 – Shallow soil over fractured bedrock and subsurface sewage system (MECP, 1995)

The MECP water well records were used as source of information on the hydrogeological characteristics of the study area. Geological cross-sections prepared from the MECP water well records show the existence of one prominent aquifer unit, a confined to partially unconfined bedrock aquifer system which serves as the primary water supply source for homes in the area. Static water levels in the reviewed MECP water wells vary between 0.9 and 3.0 meters below ground surface within 500 m radius of the study area, depending on location. All wells were completed in the bedrock aquifer.

3.6.5 Groundwater Flow

The regional water table in the shallow bedrock aquifer has been mapped as being at an elevation of 175.25 to 174.75 masl beneath the Site (NPCA, 2005). Based on land surface topography, groundwater flow was inferred generally north to south.

3.7 Water Well Survey

A search of the MECP water well records MECP water well records within approximately 200 m of the Site was conducted which returned a total of 4 wells comprising of three (3) water wells and one (1) abandoned well, as no wells were identified within 200 m radius of the Site. The records were reviewed to assess the general nature of the groundwater resource in the area and to characterize the local hydrogeologic conditions. The MECP wells location are shown on Figure 5, in Appendix A.

The relatively few returns of water well records are likely due to the relatively great separation distances between the dwellings and prevalent use of Cistern as means of potable water supply.

Two of the well records indicate very thin soils (less than 2 metres, 1.2 to 1.8 m, for protection of the bedrock aquifer: while one record indicates 10.4 m thick soil cover, for protection of the bedrock aquifer.

The records date from 1950 to 1967 and indicate the wells were constructed for domestic supplies in the bedrock aquifer. Following construction, the water well records' general water quality was recorded as fresh. A summary of the data obtained from the review is presented below and a summary of the well records is provided in Appendix D.

Well Construction

- Wells terminated in bedrock 3
- Wells with unknown information 1
- **Total.....4**

Well Uses

- Domestic 3
- Unknown 1
- **Total.....4**

Well Depth

- Less than 15 m 3
- Unknown Depth.....1
- **Total.....4**

4.0 IMPACT ASSESSMENTS

Impact to groundwater in the Study Area can be evaluated by taking into account the survey results, the hydrogeological characteristics of the area and the contaminant load on the bedrock aquifer.

The thickness of the overburden over the bedrock aquifer in the project area is thin ranging from 1.83 mbgs to 2.30 mbgs.

The thickness of the overburden over the bedrock aquifer in the project area including surrounding area is thin ranging 0 m below ground surface north of the Site to 3.0 m south of the Site, and 1.3 m west of the Site to 0.3 m east of the Site. These are shown in cross sections A – A' and B – B', on Figure 9A, and Figure 9B in Appendix A, respectively.

Based on the shallow bedrock at the Site, the hydrogeology of the area is considered to be sensitive with respect to development impacts. As a result, the presence of near surface fractured bedrock constitutes a Highly Sensitive Aquifer which limits the attenuation capacity of the aquifer.

4.1 Impact on Shallow Groundwater System

Topographic, soil and land cover infiltration factors were selected from Table 2 of the MOE Hydrological Technical Information Requirements for Land Development Applications. A soil infiltration factor of 0.25 was adopted for a medium combinations of clay and loam layer overlying the bedrock at the Site.

A mass balance approach was used to determine the worst-case impact to the groundwater system. Dilution is considered as the only means of contaminant attenuation at the Site as the study area is hydrogeologically sensitive. This provides the worst-case scenario. The mass balance approach and dilution assumptions are both in accordance with the MOE "Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment."

Background Nitrate Concentration

Nitrate is the critical contaminant assessed as it is health related as well as a semi-conservative tracer for sewage effluent.

Background nitrate concentration is a very important input in accessing impact of the septic systems at the proposed severances. The three (3) monitoring wells installed at the proposed severance area were completed at depths ranging from 2.0 m to 2.3 m terminating at the silty clay/clayey silt and bedrock contact. There was no groundwater encountered during and after drilling. As a result, groundwater samples could not be obtained for Nitrate analysis. In addition, water wells were not identified at the Site.

No dwellings were identified within 100 m of the proposed Lot to be severed. However, two dwellings were identified within 200 m east of the Lot (Figure 6). As these dwellings are cross-gradient to the Site, a septic System survey was not completed.

Based on "Regional Groundwater Geochemistry on the Niagara Peninsula" a Thesis by Caitlin A Smal, McMaster University, 2016, Nitrate concentration in the bedrock of Onondaga Formation in Port Colborne area was determined to be 0 mg/L. The Nitrate, Nitrite and Ammonia concentrations (mg/L) on the Niagara are shown on Figure 10 in Appendix A.

Wainfleet Township Fire Station is located approximately 67 m east of the larger Site. One other welling is located southeast, cross-gradient to the Site. These do not have the potential to impact the groundwater at the Site.

Based on the foregoing, a background concentration in the bedrock aquifer below the project area of 0 mg/L was adopted for this assessment.

Calculation

A basic groundwater dilution schematic and formulation is provided below in Figure 7.

With reference to Figure 2, estimates of the annual dilution volume (*VA*), the total volume of water (*VT*) and concentration at the property boundary (*CPB*) may be calculated as follows based on mass balance:

$$V_A = A_D \times k$$

$$V_T = V_A + V_S$$

$$C_{PB} = \frac{C_S \times V_S}{V_T}$$

Where:

A_D = dilution area = 50 x 30 = 1,500 (m^2)
K =infiltration rate = 0.25 (m/year)
V_A = annual dilution volume (m^3) = 1,500 m^3 x 0.25 = 375 m^3
V_S = annual sewage volume (m^3/year) = 365 m^3/year
C_S = concentration in sewage (mg/L) = 40
V_T = total volume of water (m^3/year) = 375 m^3/year + 1000 L/day (365 m^3/year) = 740 m^3/year
C_{PB} = concentration at property boundary (mg/L)

The above calculation assumes the following:

1. A 250 mm (10 in) annual dilution precipitation rate (*k*) (MOE Design Guidelines for Sewage Works.)
2. Dilution area of lot of approximately 50 m by 30 m to the southerly property line, assume to be the dilution area.
3. The septic systems will be located in the northern extent of the lot to be severed.

Based on the above parameters,

C_{PB} = 40 mg/L x 365 m^3/year/740 m^3/year = 19.7 mg/L

The calculated nitrate concentration at the property boundary above is below the guideline value of 19.7 mg/L.

Based on the above, a 50% denitrification system will be required in order to achieve a nitrate valued of 9.85 mg/L, which is below the guideline value of 10 mg/L.

5.0 SUMMARY AND CONCLUSIONS

The following summarizes the results of the investigation:

- A 50% denitrification system will be required in order to achieve a nitrate valued of 9.85 mg/L at the site boundary, which is below the guideline value of 10 mg/L.
- Based on the above calculations and considering the given site information, the estimated concentration of nitrate in the receiving groundwater at the site boundary permits the severance of a Lot with a size 0.41 hectare (4,056 m2) from a Lot of 17.2 acre.
- A Cistern should be used as a source of water supply to the proposed lot.

6.0 RECOMMENDATIONS

Based on the completed assessment the following are recommended:

1. The severed lot should be serviced by a private potable water cistern.
2. The septic system should be located in the northern extent of the lot.
3. The existing septic system, if any, should be assessed to determine suitability for the proposed severance. If not, it should be decommissioned.
4. All other Ontario Building Code setbacks and requirements shall be followed with the new septic systems.

7.0 CLOSURE

We trust this report is satisfactory for your purposes. If you have any questions regarding our submission, please do not hesitate to contact Landtek.

Yours truly,

Landtek Limited

Henry Erebor, M.Sc., P.Geo.,

8.0 REFERENCES

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9.0 LIMITATIONS

The conclusions and recommendations given in this report are based on information determined at the borehole locations. Subsurface and ground water conditions between and beyond the boreholes may be different from those encountered at the borehole locations, and conditions may become apparent during construction that could not be detected or anticipated at the time of the geotechnical investigation. It is recommended practice that Landtek be retained during construction to confirm that the subsurface conditions throughout the site are consistent with the conditions encountered in the boreholes.

The comments made in this report on potential construction problems and possible remedial methods are intended only for the guidance of the designer. The number of boreholes may not be sufficient to determine all the factors that may influence construction methods and costs. For example, the thickness and quality of surficial topsoil or fill layers may vary markedly and unpredictably. Contractors bidding on the project or undertaking construction on the site should make their own interpretation of the factual borehole information and establish their own conclusions as to how the subsurface conditions may affect their work.

The survey elevations in the report were obtained by Landtek or others and are strictly for use by Landtek in the preparation of the geotechnical report. The elevations should not be used by any other parties for any other purpose.

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. Landtek accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

This report does not reflect environmental issues or concerns related to the property unless otherwise stated in the report. The design recommendations given in the report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, it is recommended that Landtek be retained during the final design stage to verify that the design is consistent with the report recommendations, and that the assumptions made in the report are still valid.

APPENDIX A

FIGURES

Site Location = Approximately 17.2 acres

LANDTEK LIMITED *CONSULTING ENGINEERS* **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**	
Scale: NTS	Date: January 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario
Title:	Figure 1: Site Location
Project No.	23363

Proposed Lot to be Severed = Approxaltely = 0.41 hectares

LANDTEK LIMITED
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205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

Scale: NTS	Date: January 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario
Title:	Figure 2: Proposedd Lot to be svered
Project No.	23363

Latitude:42.86642, Longitude:-79.35317 (UTM Zone:17, Easting:634522, Northing:4747296)

MOE Water Well Locations

Approximate Location of Lot to be Severed

	LANDTEK LIMITED ***CONSULTING ENGINEERS*** **205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1**
	Scale: See Map — Date: April 2022
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario
Title:	Figure 6: MECP Water Wells in 200 m Radius of Site
Project No.	23363

Latitude:42.86642, Longitude:-79.35317 (UTM Zone:17, Easting:634522, Northing:4747296)

LEGEND

Approximate Sie Boundary

200 m Radius of Site

LANDTEK LIMITED
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205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

	Scale: NTS	Date Januaryl 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario	
Title:	Figure 7: Dwellings Within 200 m Radius of Site	
Project No.	23363	

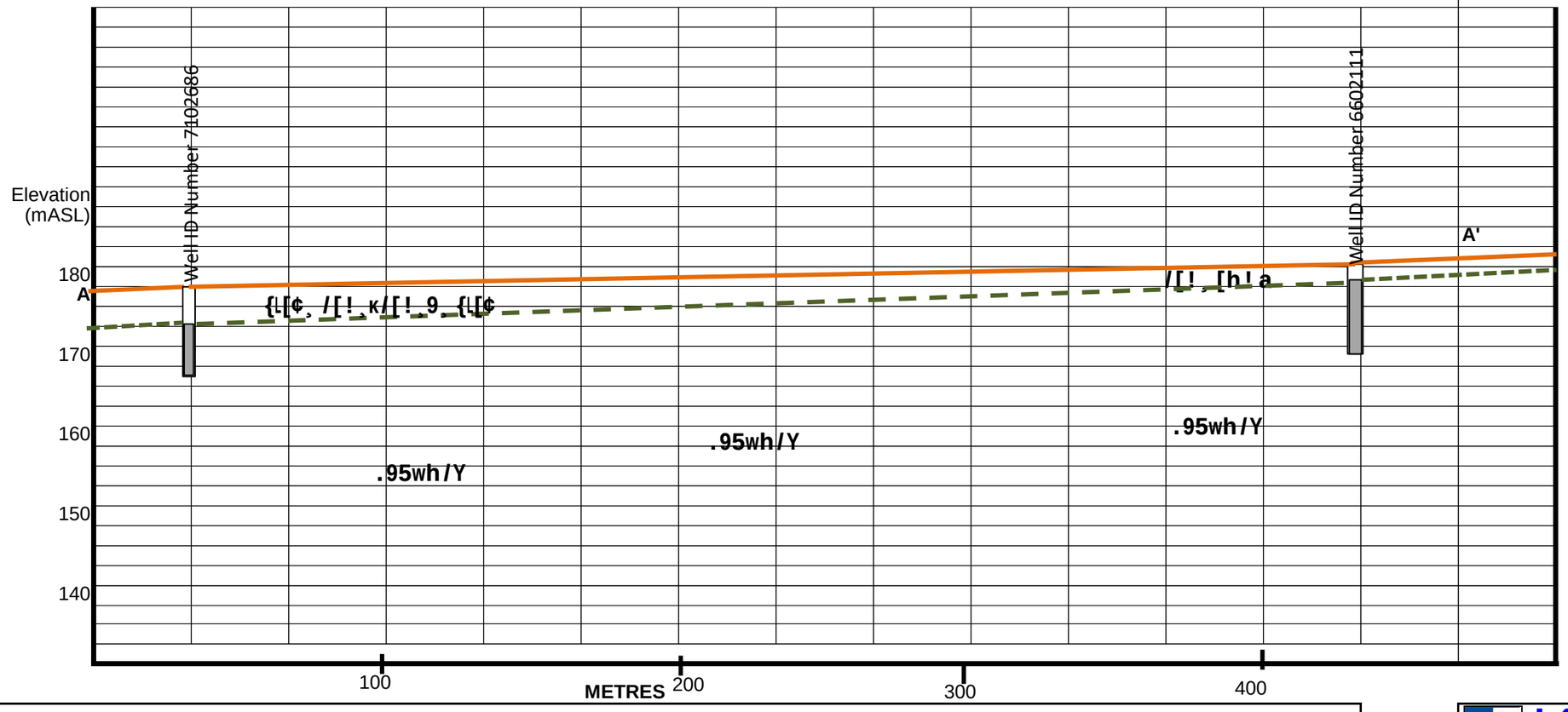
Latitude:42.86715, Longitude:-79.35594 (UTM Zone:17, Easting:634294, Northing:4747373)

LEGEND

- MECP Water Wells
- Approximate Site Boundary
- Cross Section

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

	Scale: NTS	Date: January 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario	
Title:	Figure 8: Cross Sections Locations Plan	
Project No.	23363	



Legend

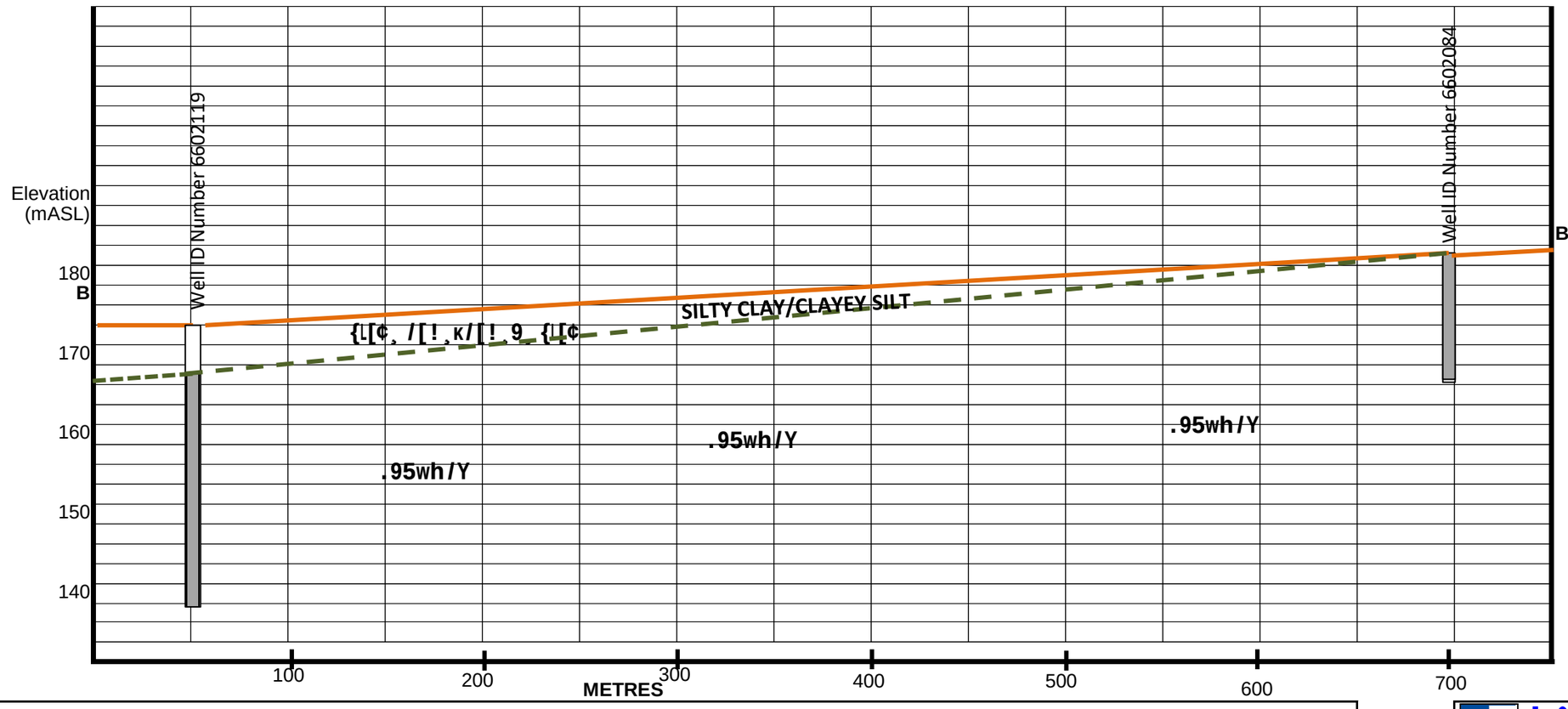
Ground Surface inferred between test locations

Stratigraphy inferred between MOE Well ID Locations based on Well ID 7102686 and Well ID 6602111 Logs

Bedrock

LANDTEK LIMITED

Scale:	As shown	Date: January 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario	
Title:	Figure 9A - Cross-Section A-A'	
Project No.	23363	



Legend

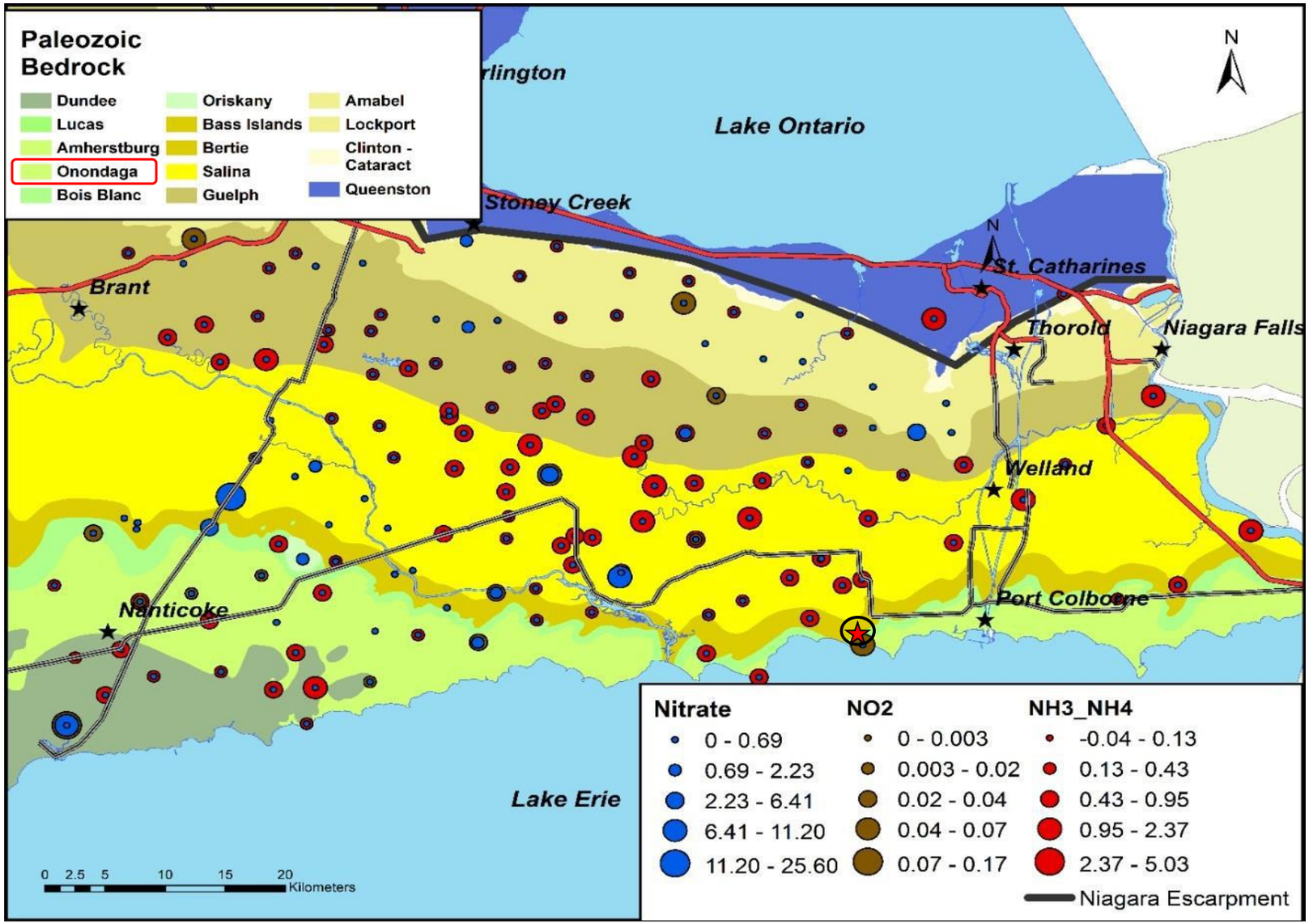
Ground Surface inferred between test locations

Stratigraphy inferred between MOE Well ID Locations based on Well ID 6602119 and Well ID 6602084 Logs

Bedrock

LANDTEK LIMITED

Scale:	As shown	Date: January 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario	
Title:	Figure 9B -Cross-Section B-B'	
Project No.	23363	



Nitrate, Nitrite and Ammonia concentrations (mg/L) on the Niagara Peninsula. Caitlin Smal. 2016

LEGEND

Project Location

LANDTEK LIMITED
CONSULTING ENGINEERS
205 NEBO ROAD, HAMILTON, ONTARIO, L8W 2E1

	Scale: NTS	Date January 2024
Project:	Hydrogeological Investigation 11629 Lakeshore Road Wainfleet, Ontario	
Title:	Figure 10: Nitrate Concentration in Groundwater Niagara	
Project No.	23363	

APPENDIX B

BOREHOLE LOGS

. 2ℕŜK2fŜă [2∃ă

. In	{2ℵf 5ŜăÖℕ⅄LJ y˙
Depth (m)	
0.0 – 0.61	Fill: Sand and Silt, brown, trace stone fragments, moist
0.76-1.20-	Silty Clay, reddish brown, some stone fragments, moist, stiff
1.50-2.00	Silty Clay, reddish brown, some stone fragments, moist, stiff
Bedrock	Bedrock refusal at approximately 2.0 m depth

. Ip	{2ℵf 5ŜăÖℕ⅄LJ y˙
Depth (m)	
0.0 – 0.61	Dark brown organics over Silty clay, reddish brown, trace stone fragments, moist
0.76-1.20-	Silty Clay, reddish brown and grey, trace stone fragments, moist
1.50-2.00	Silty Clay, reddish brown, trace stone fragments, moist, very dense, and hard
Bedrock	Bedrock refusal at approximately 2.0 m depth

. Ic	{2ℵf 5ŜăÖℕ⅄LJ y˙
Depth (m)	
0.0 – 0.61	Dark brown organics over Silty clay, reddish brown, trace stone fragments, fragments, moist
0.76-1.20-	Fill: Silty Clay, reddish brown, trace stone fragments, moist and stiff
1.50-2.30	Silty clay, reddish brown, trace stone fragments, moist and stiff
Bedrock	Bedrock refusal at approximately 2.3 m

APPENDIX C

GRAINSIZE ANALYSIS

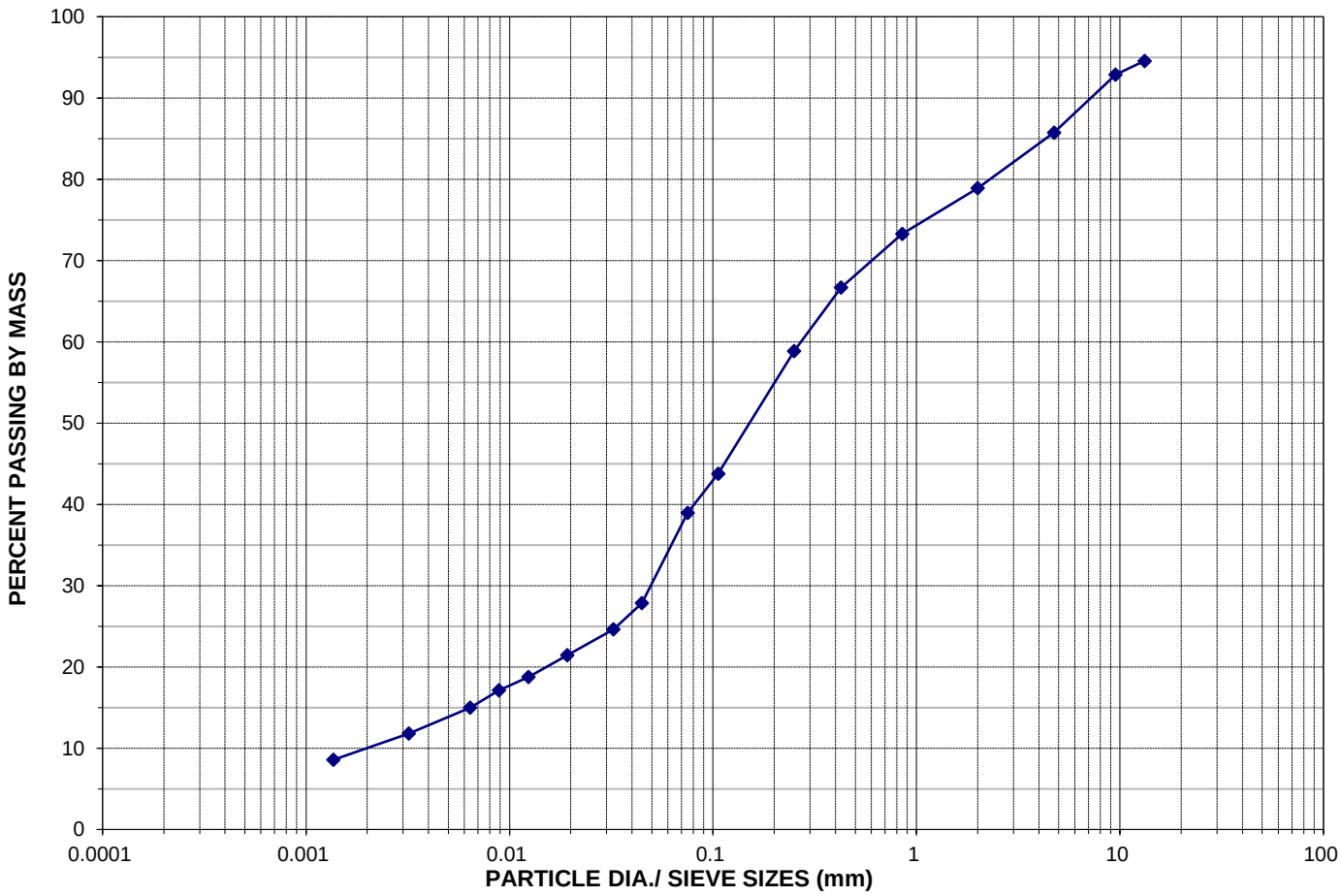
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Proposed Shed/Storage Building
LOCATION: 11629 Lakeshore Road, Wainfleet
CLIENT : Rapino, Mario
SOIL TYPE: Silty Sand
SOURCE: MW 4-1 (0.0-0.6 m)

FILE NO.: 23363
LAB SAMPLE NO.: S255
SAMPLE DATE: October 31, 2023
SAMPLED BY: Geo

PARTICLE SIZE DISTRIBUTION



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

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	94.6	14.3% Gravel 46.7% Sand 27.2% Silt 11.8% Clay
9.5	92.8	
4.75	85.7	
2.0	78.9	
0.850	73.3	
0.425	66.7	
0.250	58.9	
0.106	43.7	
0.075	39.0	
0.0447	27.8	
0.0324	24.6	
0.0192	21.4	
0.0124	18.7	
0.0089	17.1	
0.0064	15.0	
0.0032	11.8	
0.0014	8.6	

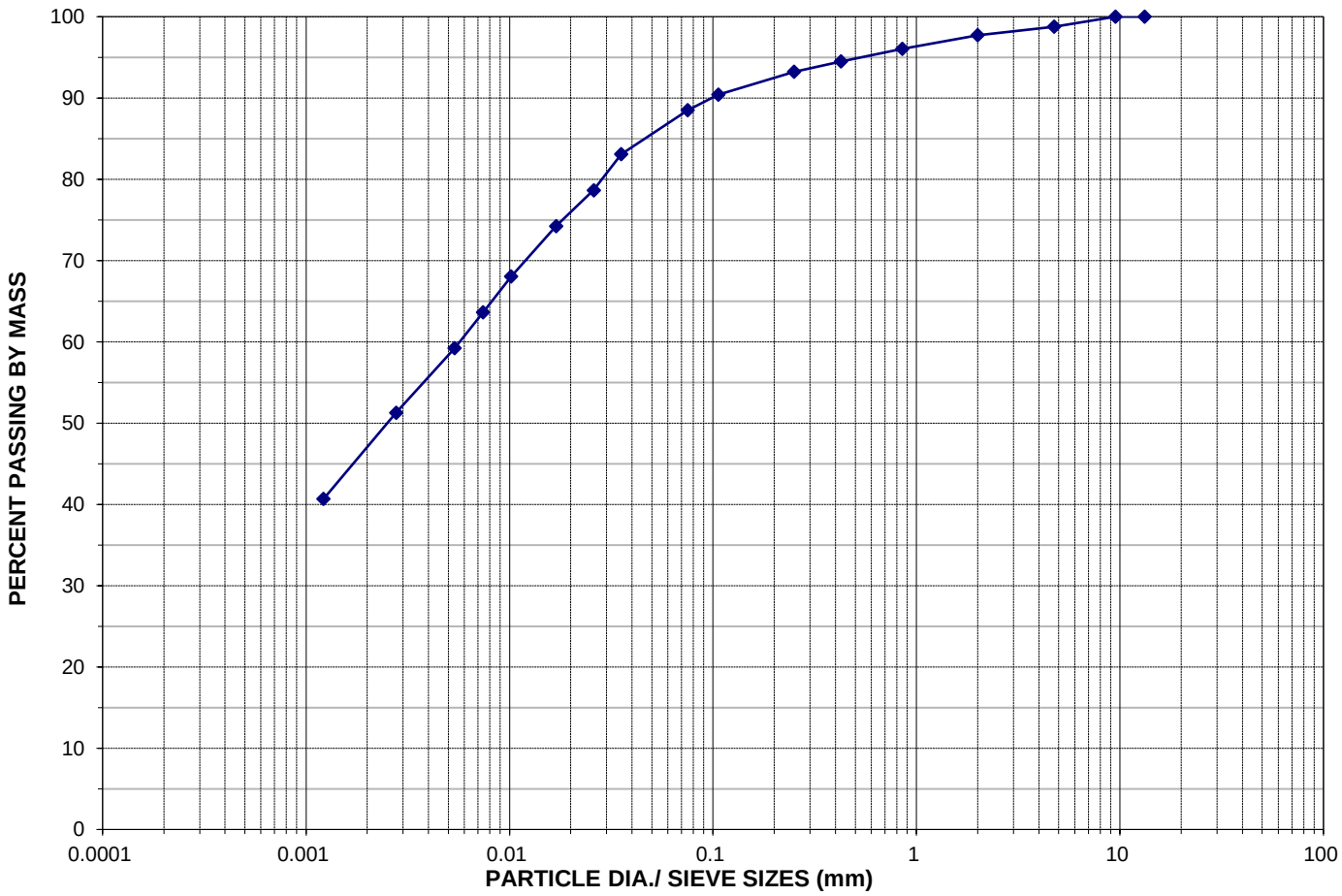
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Proposed Shed/Storage Building
LOCATION: 11629 Lakeshore Road, Wainfleet
CLIENT : Rapino, Mario
SOIL TYPE: Silty Clay
SOURCE: MW 4-2 (0.76-1.20 m)

FILE NO.: 23363
LAB SAMPLE NO.: S256
SAMPLE DATE: October 31, 2023
SAMPLED BY: Geo

PARTICLE SIZE DISTRIBUTION



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

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	100.0	
9.5	100.0	
4.75	98.8	
2.0	97.7	
0.850	96.0	
0.425	94.5	
0.250	93.2	
0.106	90.4	1.2% Gravel 10.3% Sand 37.2 % Silt 51.3% Clay
0.075	88.5	
0.0354	83.1	
0.0259	78.6	
0.0169	74.2	
0.0102	68.0	
0.0074	63.6	
0.0054	59.2	
0.0028	51.3	
0.0012	40.7	

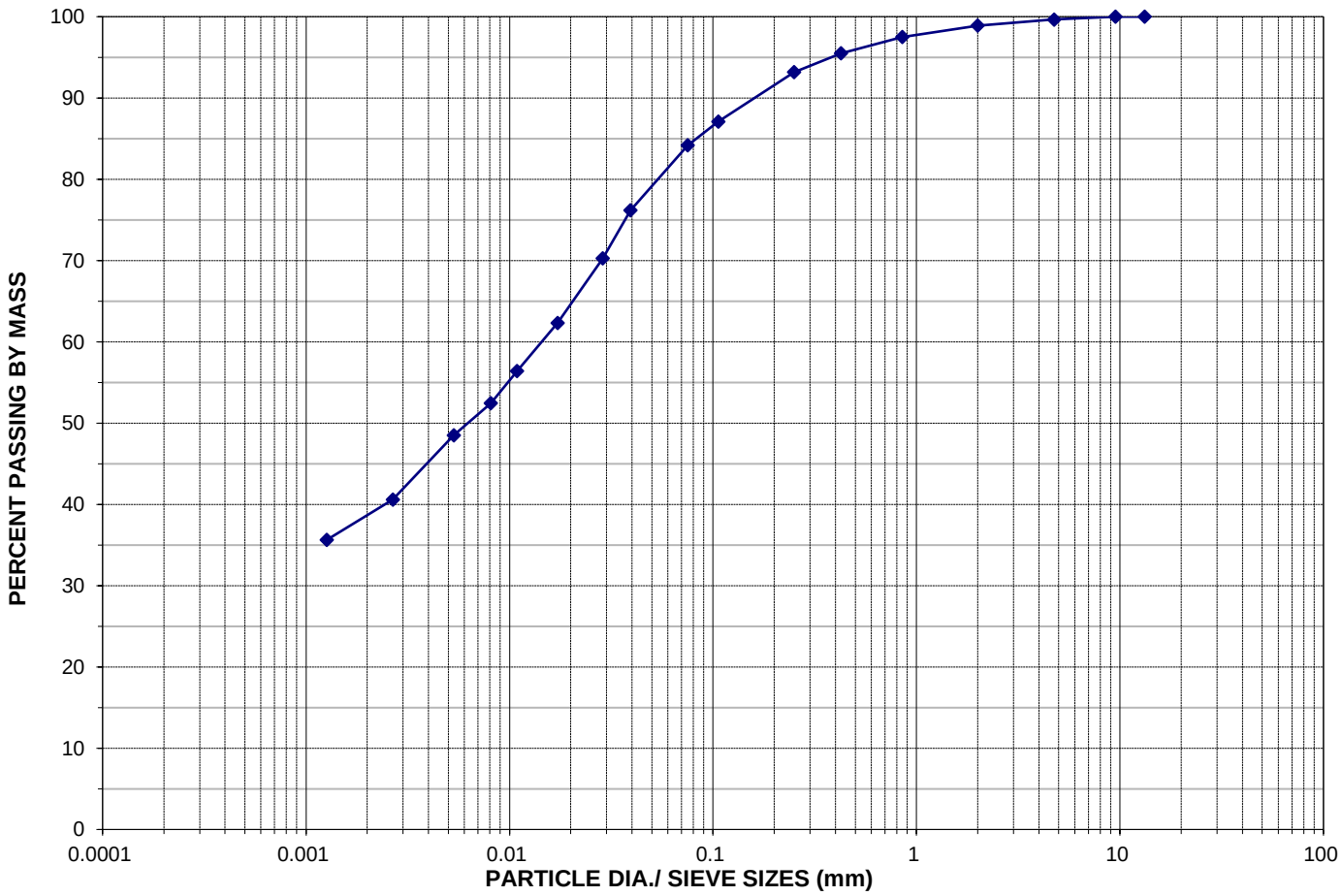
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Proposed Shed/Storage Building
LOCATION: 11629 Lakeshore Road, Wainfleet
CLIENT : Rapino, Mario
SOIL TYPE: Silty Clay
SOURCE: MW 5-1 (0.0-0.6 m)

FILE NO.: 23363
LAB SAMPLE NO.: S257
SAMPLE DATE: October 31, 2023
SAMPLED BY: Geo

PARTICLE SIZE DISTRIBUTION



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

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	100.0	0.4% Gravel 15.4% Sand 43.6% Silt 40.6% Clay
9.5	100.0	
4.75	99.6	
2.0	98.9	
0.850	97.5	
0.425	95.5	
0.250	93.2	
0.106	87.1	
0.075	84.2	
0.0392	76.2	
0.0287	70.2	
0.0173	62.3	
0.0109	56.4	
0.0081	52.4	
0.0053	48.5	
0.0027	40.6	
0.0013	35.6	

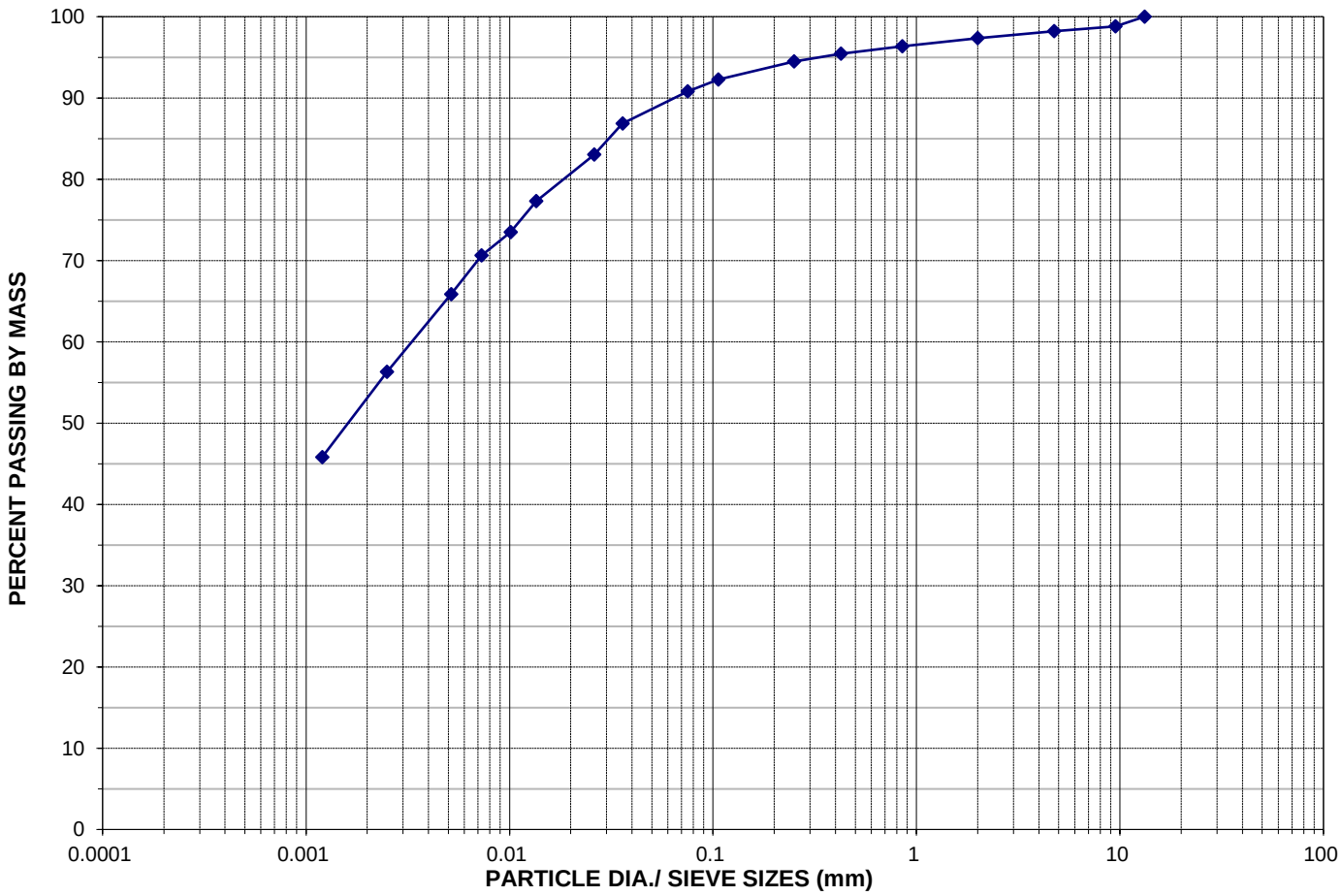
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Proposed Shed/Storage Building
LOCATION: 11629 Lakeshore Road, Wainfleet
CLIENT : Rapino, Mario
SOIL TYPE: Silty Clay
SOURCE: MW 5-2 (0.76-1.20 m)

FILE NO.: 23363
LAB SAMPLE NO.: S258
SAMPLE DATE: October 31, 2023
SAMPLED BY: Geo

PARTICLE SIZE DISTRIBUTION



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

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	100.0	1.8% Gravel 7.4% Sand 34.5% Silt 56.3% Clay
9.5	98.8	
4.75	98.2	
2.0	97.4	
0.850	96.4	
0.425	95.4	
0.250	94.5	
0.106	92.3	
0.075	90.8	
0.0359	86.9	
0.0261	83.1	
0.0135	77.3	
0.0101	73.5	
0.0073	70.6	
0.0052	65.9	
0.0025	56.3	
0.0012	45.8	

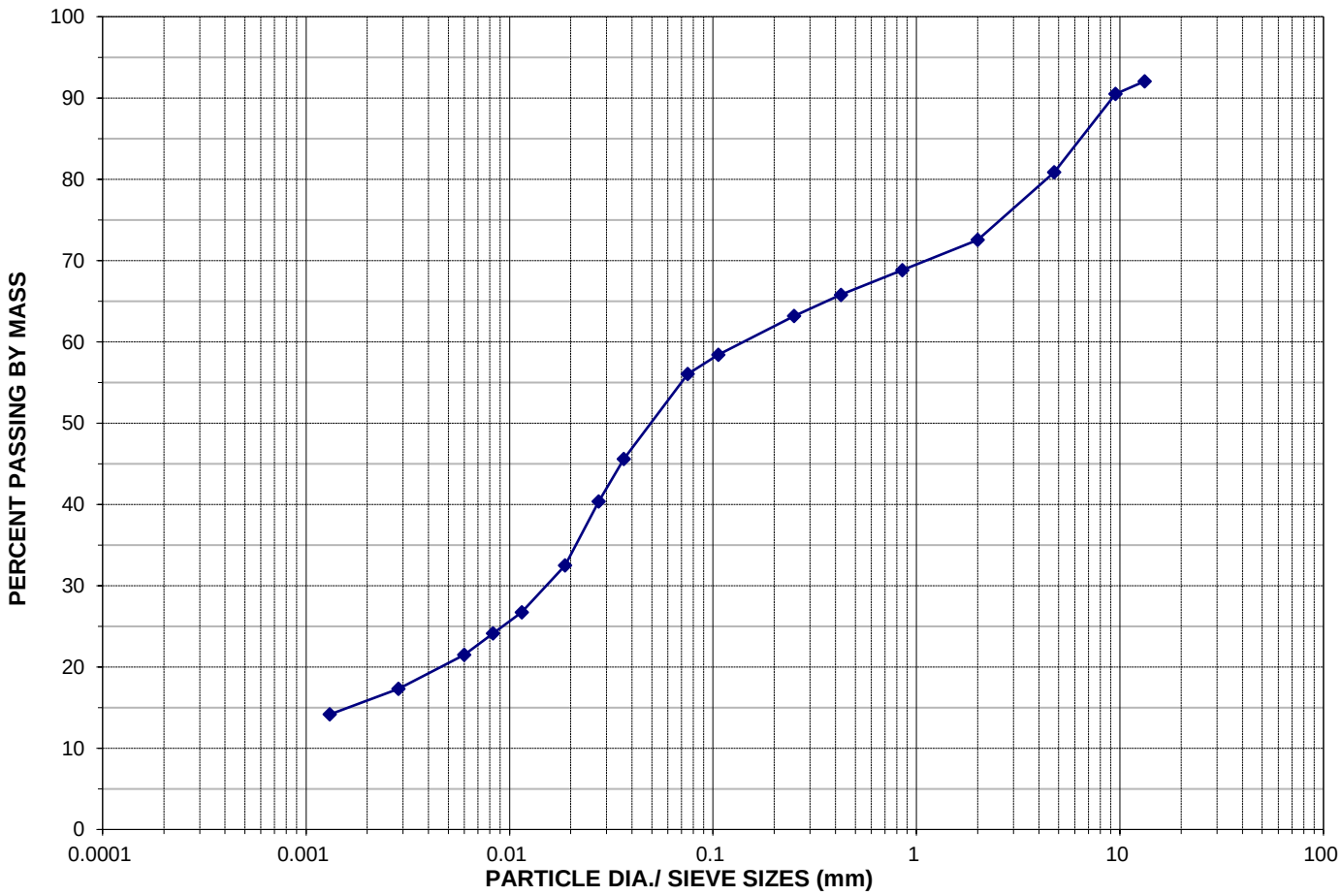
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Proposed Shed/Storage Building
LOCATION: 11629 Lakeshore Road, Wainfleet
CLIENT : Rapino, Mario
SOIL TYPE: Clayey Silt
SOURCE: MW 6-1 (0.0-1.2 m)

FILE NO.: 23363
LAB SAMPLE NO.: S259
SAMPLE DATE: October 31, 2023
SAMPLED BY: Geo

PARTICLE SIZE DISTRIBUTION



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

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	92.0	19.2% Gravel 24.8% Sand 38.7% Silt 17.3% Clay
9.5	90.5	
4.75	80.8	
2.0	72.5	
0.850	68.8	
0.425	65.8	
0.250	63.2	
0.106	58.4	
0.075	56.0	
0.0364	45.6	
0.0274	40.3	
0.0188	32.5	
0.0115	26.7	
0.0083	24.1	
0.0060	21.5	
0.0028	17.3	
0.0013	14.1	

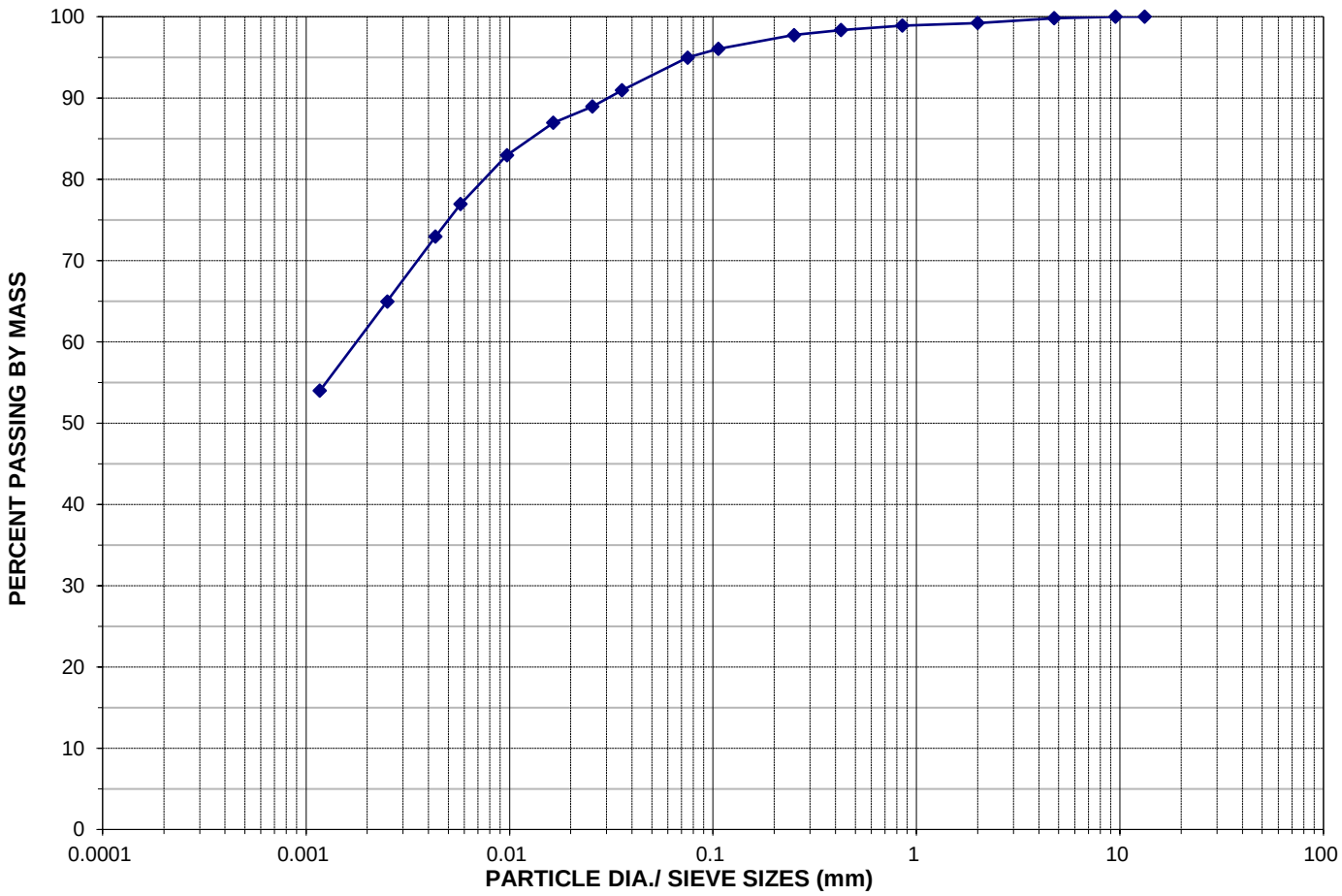
LANDTEK LIMITED
CONSULTING ENGINEERS

PARTICLE SIZE ANALYSIS

PROJECT: Proposed Shed/Storage Building
LOCATION: 11629 Lakeshore Road, Wainfleet
CLIENT : Rapino, Mario
SOIL TYPE: Silty Clay
SOURCE: MW 6-3 (1.5-2.0 m)

FILE NO.: 23363
LAB SAMPLE NO.: S260
SAMPLE DATE: October 31, 2023
SAMPLED BY: Geo

PARTICLE SIZE DISTRIBUTION



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

SIEVE SIZE /PARTICLE DIA. (mm)	PERCENT PASSING SAMPLE	COMMENTS
13.2	100.0	
9.5	100.0	
4.75	99.8	
2.0	99.2	
0.850	98.9	
0.425	98.4	
0.250	97.7	
0.106	96.0	0.2% Gravel 4.8% Sand 30.0 % Silt 65.0% Clay
0.075	95.0	
0.0357	90.9	
0.0256	88.9	
0.0164	87.0	
0.0097	83.0	
0.0057	77.0	
0.0043	73.0	
0.0025	65.0	
0.0012	54.0	

APPENDIX D

MECP WELLS SUMMARY IN 200 M RADIUS OF LOT

Summary of MECP Well Records

Well ID	Date of Completion (MM/DD/YYYY)	Diameter (inches)	UTM NAD83 — Zone 17		Water Found (ft)	SWL	Type	Bedrock Depth (ft)	Well Depth (ft)	Well Depth (m)	Aquifer	Use	Log	Address	Township
			Eastings	Northings											
6602104	08-Jul-50	6	633932.9	4747556	40	3	Fresh	34	40	12.2	Limestone	Domestic Water Supply	Clay/ Limestone	None	Wainfleet
6602111	21-Mar-57	6	634318.9	4747441	23	10	Fresh	6	23	7.0	Limestone	Domestic Water Supply	Sand/ Limestone	None	Wainfleet
6602113	18-Dec-67	5	634323.9	4747455	31	4	Fresh	4	31	9.4	Limestone	Domestic Water Supply	Clay/ Limestone	None	Wainfleet
7203947	07-Jun-13	NA	634314	4747586	NA	NA	NA	NA	NA	NA	NA	Decommissioned	NA	None	Wainfleet