



## **The Municipality of Middlesex Centre**

### **Geotechnical Investigation**

**Project Name**

Olalondo Gravel Pit – Underwater Extraction  
London, Ontario

**Project Number**

LON-00015778-GE

**Prepared By:**

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

**Date Submitted**

March 8, 2018

# The Municipality of Middlesex Centre

## Geotechnical Investigation

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Date Submitted:  
March 8, 2018

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## 1. Introduction

**Exp Services Inc. (exp)** was retained by the Municipality of Middlesex Centre (Municipality) to conduct a Geotechnical Investigation to assess the gravel quantity and quality at the existing pit located west of Olalondo Road, in the City of London, Ontario. Authorization for **exp** to proceed with the work was given by the Municipality. In preparing this report, the information provided by the client has been utilized.

### 1.1 Project Description

The gravel pit is located at 21515 Olalondo Road in Middlesex Centre (Concession 6 North Part Lot 1 former London Township, Registered Plan 33R392 Parts 1 and 3).

To support the application for a Category 1: Class “A” license for a pit operation which intends to extract aggregate material from below the established groundwater level, a Gravel Quantity / Quality Assessment, Hydrogeological Level 2 and Natural Environment Level 1 assessment needs to be completed. The pit is currently operating and extracting materials from above the groundwater table.

### 1.2 Terms of Reference

The purpose of the investigation was to examine the subsoil and groundwater conditions at the site by advancing nine (9) boreholes and eleven (11) test pits at the locations illustrated on the attached Location Plan, **Drawing 1**.

The investigation was carried out in general accordance with our proposal P17-351, dated October 4, 2017. Authorization to proceed was given by the Municipality of Middlesex Centre.

The objective of the Geotechnical Report is to summarize the results of the investigation, and provide information pertaining to the general quantity and quality of the aggregate materials encountered at the site.

Reference is made to **Appendix C** of this report, which contains further information necessary for the proper interpretation and use of this report.

## 2. Methodology

The fieldwork was conducted on November 9, 27, 28 and December 4, 2017 and consisted of advancing nine (9) boreholes and eleven (11) test pits at the approximate locations shown on **Drawing 1**. The boreholes are designated as BH 1 through BH 9 and the test pits as TP 1 through TP 11.

The boreholes were advanced using a locally subcontracted, track mounted drilling unit equipped with continuous flight hollow stem augers, soil sampling and soil testing equipment. The boreholes were terminated at depths of between about 3.1 and 11.3 m below the ground surface. Monitoring wells were installed in BH 1, BH 2, BH 6, BH 7 and BH 9.

The test pits were advanced using a locally subcontracted backhoe excavator. The test pits were terminated at depths of between about 1.1 and 3.8 m below the ground surface.

Within the boreholes, Standard Penetration Tests (SPTs) were performed to assess the compactness or consistency of the underlying soils and to obtain representative samples. During the field program, the soil samples obtained were examined and logged in the field by **exp** geotechnical personnel.

Soil stratigraphy and observations pertaining to groundwater seepage into the test holes are recorded in the logs found in **Appendix A**. Two subsurface profiles (sections) across the site are shown on **Drawings 2 and 3**.

Following the drilling, the boreholes were backfilled with the excavated materials and bentonite, to satisfy the requirements of Ontario Regulation 903. The test pits were backfilled with the excavated materials and nominally compacted with the excavator bucket.

Representative samples of the various soil strata encountered at the test hole locations were taken to our laboratory in London for further examination by a geotechnical engineer. Laboratory testing for this investigation included routine moisture content determinations and grain size distribution analyses. The results of the laboratory testing carried out are presented on the test hole logs found in **Appendix A** and the gradation figures in **Appendix B**.

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

The test holes were surveyed in the field by a member of our geotechnical engineering staff. The benchmark used is described as “the northeast abutment of the weigh scale”. The benchmark was assigned an elevation of 100 m referenced to local datum.

---

## 3. Site and Subsurface Conditions

### 3.1 Site Description

The subject site is located just west of Olalondo Road and south of Medway Road in the City of London. For the purpose of this report, the site can generally be divided into two regions as follows:

West Portion: This area includes the area of current pit operation and the farming area immediately to the west. There is about a 7.0 to 7.5 m difference in elevation along the bank that separates the farm land and the mining operation. The test holes included in the west portion of the site are boreholes BH 1, BH 2 and BH 4, and test pits TP 1, TP 2 and TP 3.

East Portion: The area east of the current pit operation which has been rehabilitated (capped) with fill soils. The topography of this area is variable, with a 2 m difference in elevation between lowest and highest elevations, with the site generally rising towards the northeast area. The test holes included in the east portion of the site are boreholes BH 3, BH 5 to BH 9, and test pits TP 4 to TP 11.

### 3.2 Soil Stratigraphy

The detailed stratigraphy encountered in each borehole and the results of routine laboratory tests carried out on representative samples of the subsoils are presented on the test hole logs found in **Appendix A**. It must be noted that boundaries of soil indicated on the logs are inferred from non-continuous sampling and observations during excavating. These boundaries are intended to reflect transition zones for the purposes of geotechnical design and should not be interpreted as exact planes of geological change.

The subsurface soil conditions encountered in the test holes are summarized as follows.

#### 3.2.1 West Portion

##### 3.2.1.1 Topsoil and Silt

Boreholes BH 1 and BH 2 were advanced in the farm area west of the pit operations. From the ground surface, these boreholes encountered 280 and 350 mm of topsoil material, respectively.

Beneath the topsoil in BH 1 and BH 2, brown silt was encountered. The thickness of the silt varied from about 0.4 to 1.0 m at the borehole locations. The brown silt material was firm as indicated from SPT values of 5 and 6 blows per 0.3 m of penetration. The moisture content of a sample of the brown silt obtained was about 17 percent.

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### **3.2.1.2 Sand and Gravel**

Underlying the clayey silt in BH 1 and BH 2, and from the pit floor in BH 4, TP 1, TP 2 and TP 3, coarse grained materials ranging in gradation from sand and gravel, to sandy gravel, to sand, were encountered. The thickness of the unmined material in BH 1 and BH 2 was extensive, ranging from about 5.2 to 7.5 m. The thickness of the sand and gravel materials in TP 1, TP 2, TP 3 and BH 4 advanced in the current pit ranged between about 0.5 and 3.5 m. Measured 'N' values in the sand and gravel materials ranged from 17 to 61 blows per 0.3 m, with two values in excess of 50 blows per 0.15 m of penetration. These values indicate that the material is compact to very dense. The moisture content of the samples obtained varied from about 1 to 13 percent.

### **3.2.1.3 Silty Clay Till**

Beneath the sand and gravel, grey silty clay till was encountered to the termination depth of the test holes. Measured 'N' values were typically in excess of 30 blows per 0.3 m, indicating a hard consistency. The moisture content of the samples of silty clay till obtained varied from about 8 to 15 percent.

### **3.2.1.4 Groundwater**

Groundwater levels were noted in BH 4, TP 1 and TP 2 upon completion of drilling/excavation, at depths of between about 1.2 and 1.8 m below grade. Test pit TP 3 was dry upon completion.

Monitoring wells were installed in BH 1 and BH 2. **Exp** attended the site to measure water levels in the wells on December 6 and 15, 2017 and January 16, 2018. On each date, no water level was observed in the monitoring wells.

## **3.2.2 East Portion**

### **3.2.2.1 Fill Materials and Clayey Silt**

The remaining boreholes and test pits were advanced in the east portion of the site that had been rehabilitated with surficial fill materials. With the exception of TP 4, fill materials comprised of silty clay, clayey silt, sandy silt and sand and gravel were encountered. The fill materials ranged in thickness from about 0.7 to 1.8 m at the test hole locations. Measured 'N' values obtained in the fill materials ranged from 6 to 20 blows per 0.3 m. The moisture content of the samples of fill materials obtained varied from about 13 to 29 percent.

Underlying the fill materials in TP 6 and TP 9, brown clayey silt was encountered. The thickness of the clayey silt was about 0.8 and 1.0 m at the test pit locations, respectively.

### **3.2.2.2 Sand and Gravel**

Beneath the fill materials in BH 5, BH 6, BH 9, TP 5, TP 7, TP 8, TP 10 and TP 11, and the clayey silt in TP 6, coarse grained materials, predominantly made up of sand and sandy gravel were encountered. These materials ranged in thickness from about 0.6 to 1.6 m at the test hole locations. SPT 'N' values in these materials ranged from 25 to 56 blows per 0.3 m, indicating that the material is compact to very dense. The moisture content of the samples obtained varied from about 3 to 14 percent. It is noted that sand and gravel materials were not encountered in BH 3, BH 7, BH 8, TP 4 and TP 9.

### **3.2.2.3 Silty Clay Till**

The boreholes and test pits were terminated in very stiff to hard, grey silty clay till. The moisture content of the samples of grey silty clay till obtained varied from about 5 to 14 percent.

### **3.2.2.4 Groundwater**

Groundwater levels were noted in TP 6, TP 7, TP 8, TP 10 and TP 11 upon completion of excavation, at depths of between about 1.6 and 2.2 m below grade. A groundwater level was also noted in BH 8 at about 4.3 m below grade upon completion. The remaining test holes were dry upon completion.

Monitoring wells were installed in BH 6, BH 7 and BH 9. **Exp** attended the site to measure water levels in the wells on December 6 and 15, 2017 and January 16, 2018. The table below provides the water levels below ground surface recorded on each day.

	<b>BH 6</b>	<b>BH 7</b>	<b>BH 9</b>
December 6, 2017	1.5 m	3.6 m	1.2 m
December 15, 2017	1.4 m	3.1 m	1.2 m
January 16, 2018	1.0 m	3.8 m	0.8 m

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

## 4. Discussion and Recommendations

### 4.1 General

As indicated previously, the gravel pit is located at 21515 Olalondo Road in Middlesex Centre.

To support the application for a Category 1: Class “A” license for a pit operation which intends to extract aggregate material from below the established groundwater level, a Gravel Quantity / Quality Assessment, Hydrogeological Level 2 and Natural Environment Level 1 assessment needs to be completed. The pit is currently operating and extracting materials from above the groundwater table.

### 4.2 Quantity and Quality of Material

The portion of the site east of the current production area was previously mined and has been rehabilitated to some extent by placing the unusable soils that had been extracted during mining over the sandy soils and native silty clay till.

Based on the results of this investigation, this portion of the site will likely not yield any worthwhile extraction value since the granular materials are comprised in a relatively thin layer, typically ranging from only about 1.0 to 1.5 m in thickness. Further, the overlying fill material would have to be excavated (peeled off) to reach the granular materials below. Also, some of these granular materials encountered during the field program would be classified as fine sand and silty sand, and would likely not meet the gradation requirements of OPSS Granular ‘B’, Type I material. In addition, many of the granular materials extend below the groundwater level.

The west portion of the site which includes the current production area and the farm land (unmined area) immediately to the west has good potential for gravel extraction. Assuming a groundwater elevation of 96.5 m, it is understood that license limit is 1.5 m above this level (98.0 m). In the current production area, the floor of the pit is generally at this level and further extraction would be below the license limit. The farm land has extractable quantity above and below the current license limit.

The table below presents the available quantities (above and below the current license limit) by section of land. Reference can be made to **Drawing 4** which shows the different sections of land.

**Table 1 – Gravel Quantities**

Section	1a	1b	2a	2b	TP1	TP2	TP3	BH4	Total Quantity (tonnes)
Quantity*	220,000	10,000	110,000	4,500	9,000	-	-	-	353,500
Quantity**	30,000	-	-	-	80,000	30,000	7,500	28,000	175,500

\*above current license limit    \*\*below current license limit

The above quantities assume a 15 m offset from the property line and that a 1 to 1 slope of the bank wall is maintained. It is also assumed that the gravel would only be extracted to a depth of 0.3 m above the elevation of natural silty clay till.

Grain size distribution analyses were carried out on select samples of the granular materials obtained from the test pits. As indicated on Figures 1 through 5, the materials are generally within or just marginally outside the gradation envelop of a Granular 'B', Type I material. Based on the gradations, the material can be classified as a Sandy Gravel.

A laboratory Standard Proctor test was carried out on a sample of the Sandy Gravel obtained from TP 11. The maximum dry density of the sample was 2050 kg/m<sup>3</sup> at an optimum moisture content of 7.3 percent.

## 5. General Limitations

The information presented in this report is based on a limited investigation designed to provide information to support an assessment of the current geotechnical conditions within the subject property. The conclusions and recommendations presented in this report reflect site conditions existing at the time of the investigation. Consequently, during the future development of the property, conditions not observed during this investigation may become apparent. Should this occur, **exp** Services Inc. should be contacted to assess the situation, and the need for additional testing and reporting. **Exp** has qualified personnel to provide assistance in regards to any future geotechnical and environmental issues related to this property.

Our undertaking at **exp**, therefore, is to perform our work within limits prescribed by our clients, with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended in this report.

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

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

This report was prepared for the exclusive use of **The Municipality of Middlesex Centre** and may not be reproduced in whole or in part, without the prior written consent of **exp**, or used or relied upon in whole or in part by other parties for any purposes whatsoever. Any use which a third party makes of this report, or any part thereof, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **Exp** Services Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

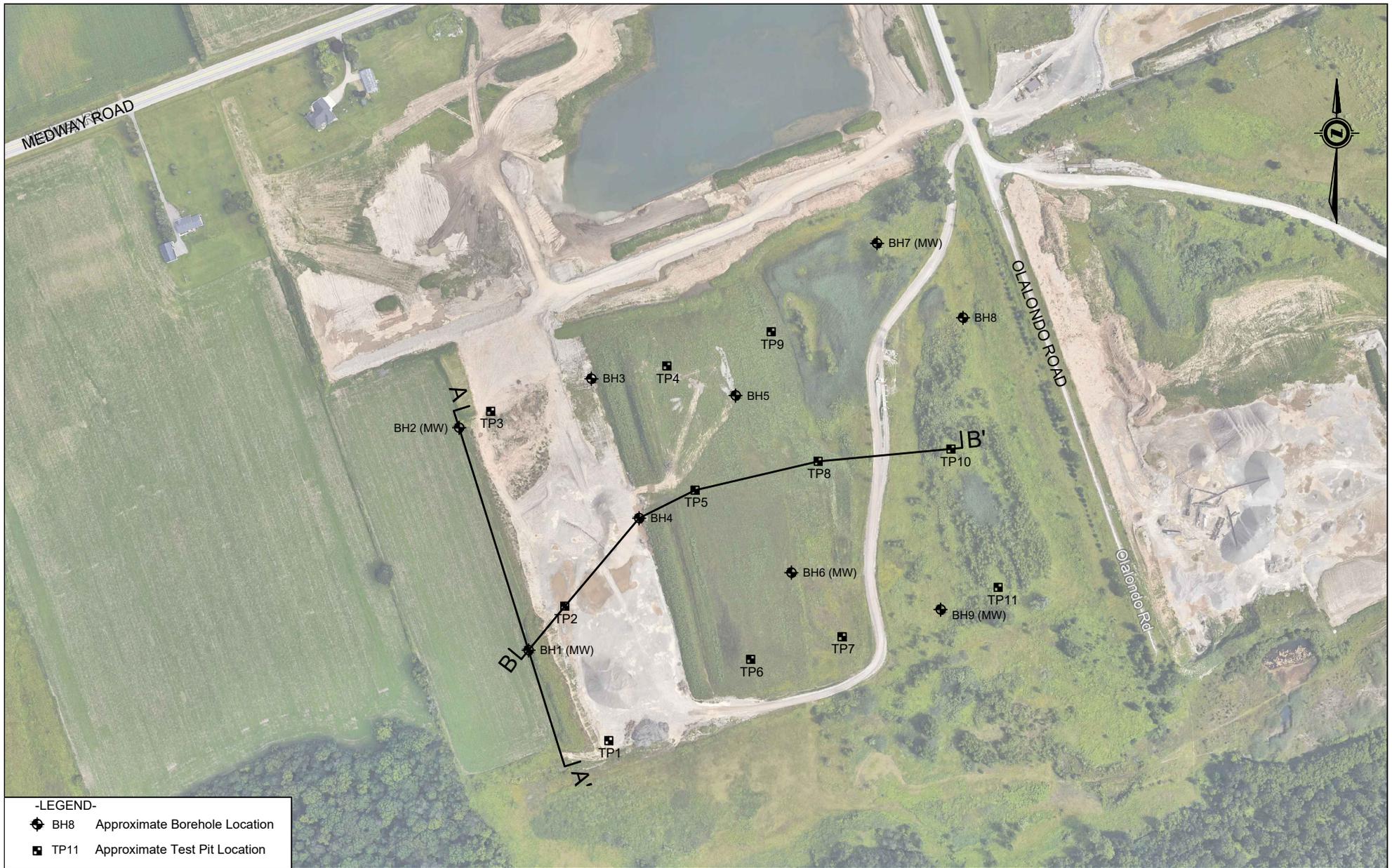
We trust this report is satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

**Client:** Municipality of Middlesex Centre  
**Project Name:** Olalondo Gravel Pit – Underwater Extraction, London, Ontario  
**Project Number:** LON-00015778-GE  
**Date:** March 8, 2018

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## Drawings



**-LEGEND-**

- ◆ BH8 Approximate Borehole Location
- TP11 Approximate Test Pit Location

**-NOTES-**

1. The boundaries and soil types have been established only at test hole locations. Between test holes they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless client advises that an extended time period is required.
3. Topsoil quantities should not be established from the information provided at the test hole locations.
4. The site plan was reproduced from Google Maps and should be read in conjunction with EXP Geotechnical Report LON-00015778-GE.

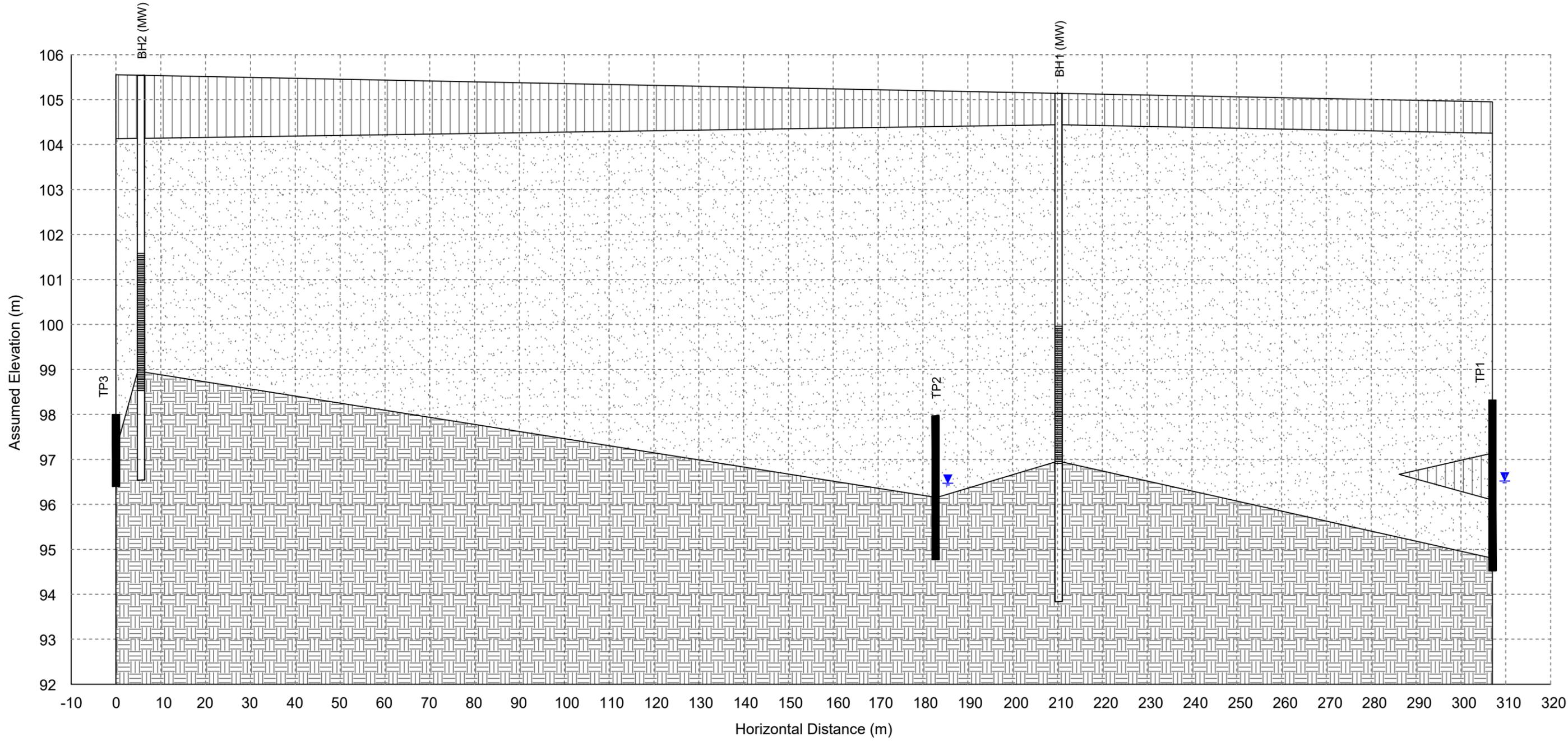
**Geotechnical Investigation**  
**Olalondo Pit Underwater Extraction**  
**21515 Olalondo Road**  
**Middlesex Centre, Ontario**

<b>CLIENT</b> The Municipality of Middlesex Centre	
<b>TITLE</b> Borehole Location Plan	
Prepared By: E.B.	Reviewed By: B.G.
<b>EXP Services Inc.</b> 15701 Robin's Hill Road, London, ON, N5V 0A5	
<b>DATE</b> February 2018	<b>SCALE</b> NTS
<b>PROJECT NO.</b> LON-00015778-GE	<b>DWG.</b> 1

# Cross Section A - A'

N

S



-LEGEND-

	Groundwater Measurement
	Silt
	Sand/Sandy Gravel/Sand and Gravel
	Silty Sand
	Silty Clay Till

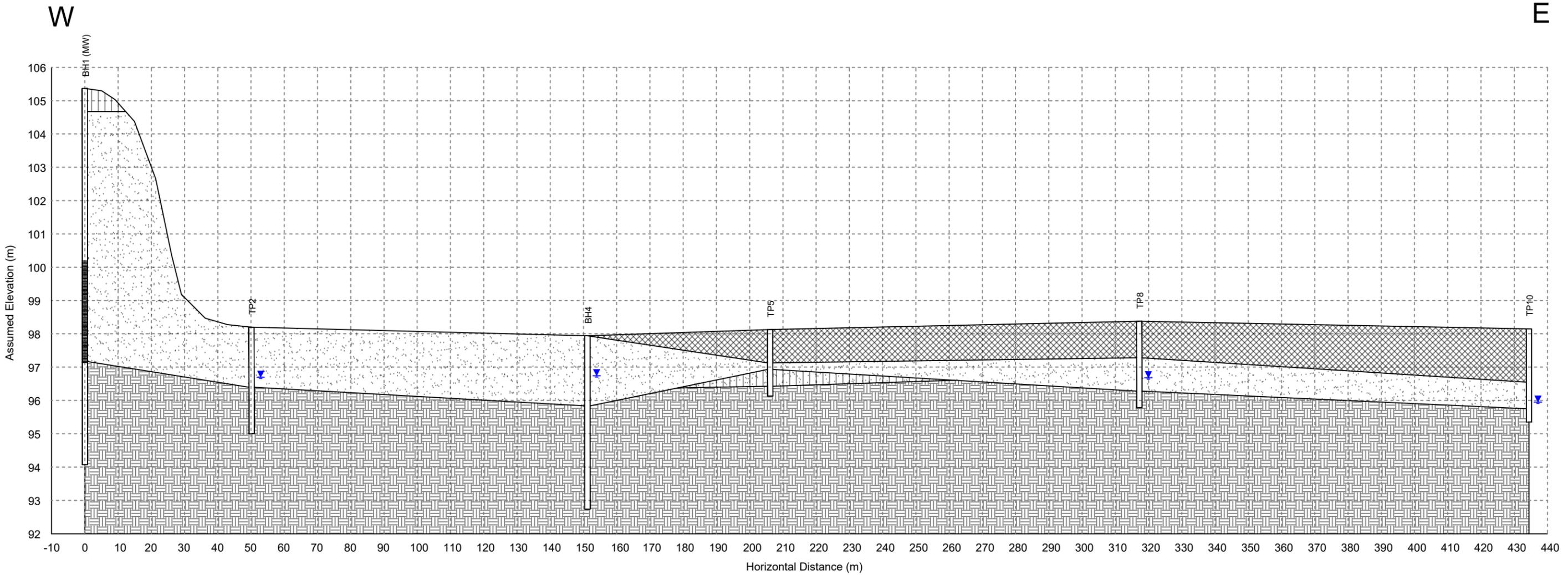
-NOTES-

1. The cross section should be read in conjunction with EXP Report LON-00015778-GE.

Geotechnical Investigation  
**Olalondo Pit Underwater Extraction**  
 21515 Olalondo Road  
 Middlesex Centre, Ontario

CLIENT The Municipality of Middlesex Centre		
TITLE Cross Section A - A'		
DRAWN BY: E.B.	REVIEWED BY: B.G.	DATE February 2018
		EXP Services Inc. 15701 Robin's Hill Road London, ON, N5V 0A5
SCALE H=1:900, V=1:90 (11x17)	PROJECT NO. LON-00015778-GE	DWG. 2

# Cross Section B - B'



-LEGEND-

	Groundwater Measurement
	Possible Fill
	Silt
	Sand/Sandy Gravel/Sand and Gravel
	Silty Sand
	Silty Clay Till

-NOTES-

1. The cross section should be read in conjunction with EXP Report LON-00015778-GE.

Geotechnical Investigation  
**Olalondo Pit Underwater Extraction**  
 21515 Olalondo Road  
 Middlesex Centre, Ontario

CLIENT The Municipality of Middlesex Centre		
TITLE Cross Section B - B'		
DRAWN BY: E.B.	REVIEWED BY: B.G.	DATE February 2018
		EXP Services Inc. 15701 Robin's Hill Road London, ON, N5V 0A5
SCALE H=1:1200, V=1:120 (11x17)	PROJECT NO. LON-00015778-GE	DWG. 3



**-NOTES-**

1. The boundaries and soil types have been established only at test hole locations. Between test holes they are assumed and may be subject to considerable error.
2. Soil samples will be retained in storage for 3 months and then destroyed unless client advises that an extended time period is required.
3. The site plan has been reproduced from MNR Topographic Mapping and should be read in conjunction with EXP Geotechnical Report LON00015778-GE.

Geotechnical Investigation

**Olalondo Pit Underwater Extraction**

21515 Olalondo Road

Middlesex Centre, Ontario

**-LEGEND-**



Approximate Borehole Location



Approximate Test Pit Location

**CLIENT** The Municipality of Middlesex Centre

**TITLE** Gravel Quantities

**DRAWN BY:**  
EB

**REVIEWED BY:**  
BG

**SCALE**  
As Shown



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

**DATE**  
FEBRUARY 2018

**PROJECT NO.**  
LON-00015778-GE

**DWG.**  
4

## **Appendix A – Borehole and Test Pit Logs**



# BOREHOLE LOG

**BH1 (MW)**

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring December 4, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	● S Field Vane Test (#=Sensitivity)
0	105.14									
	104.86	TOPSOIL - 280 mm			SS	S1	500	5	22	
	104.45	SILT - brown, some clay, trace sand, trace organics, loose, moist			SS	S2	300	20	2	
-1		SAND AND GRAVEL - brown, trace to some silt, occasional cobbles, compact to very dense, moist			SS	S3	550	54	1	
-2					SS	S4	450	32	2	
-3					SS	S5	375	20	8	
-4		- occasional clayey silt/silt pockets encountered near 3.35 m bgs			SS	S6	450	20	3	
-5	100.64	SAND - brown, medium grained, trace silt, compact to dense, moist			SS	S7	500	34	3	
-6	99.58	SANDY GRAVEL - brown, trace to some silt, dense to very dense, moist			SS	S8	275	50*	2	
-7					SS	S9	500	46	3	
-8	96.92	SILTY CLAY TILL - brown, some sand, trace gravel, very stiff to hard, moist			SS	S10	600	25	15	
-9					SS	S11	250	50*	8	
-10		- becoming grey near 9.75 m bgs								
-11	93.86	End of Borehole at 11.27 m bgs.								
-12										
-13										

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.
- Water Level Readings:  
 December 6, 2017 - dry  
 December 15, 2017 - dry  
 January 16, 2018 - dry

**SAMPLE LEGEND**

- AS Auger Sample
- Rock Core (eg. BQ, NQ, etc.)
- SS Split Spoon
- ST Shelby Tube
- VN Vane Sample

**OTHER TESTS**

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

**WATER LEVELS**

- ▽ Apparent
- ▼ Measured
- ▲ Artesian (see Notes)



# BOREHOLE LOG

**BH2 (MW)**

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring December 4, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH		
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	● S Field Vane Test (#=Sensitivity)	▲ Penetrometer ■ Torvane
0	105.54	TOPSOIL - 350 mm			SS	S1	500	5	28	●	
1	104.17	SILT - brown, some clay, trace sand, trace organics, loose, moist			SS	S2	300	6	17	●	
2		SAND AND GRAVEL - brown, trace silt, occasional cobbles, compact to very dense, moist			SS	S3	550	19	2	●	
3					SS	S4	450	42	2	●	
4					SS	S5	375	50*	2	●	
5					SS	S6	450	31	4	●	
6					SS	S7	500	61	13	●	61
7	98.99	SILTY CLAY TILL - grey, some sand, trace gravel, hard, moist			SS	S8	275	64	8	●	64
8					SS	S9	500	58	10	●	58
9	96.55				End of Borehole at 8.99 m bgs.						

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.
- Water Level Readings:  
 December 6, 2017 - dry  
 December 15, 2017 - dry  
 January 16, 2018 - dry

**SAMPLE LEGEND**

	AS Auger Sample		SS Split Spoon		ST Shelby Tube
	Rock Core (eg. BQ, NQ, etc.)		VN Vane Sample		

**OTHER TESTS**

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

**WATER LEVELS**

	Apparent		Measured		Artesian (see Notes)
--	----------	--	----------	--	----------------------



# BOREHOLE LOG

BH3

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 28, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH		
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	S Field Vane Test (#=Sensitivity)	Penetrometer
0	100.30	FILL - sand, brown, some gravel, coarse grained, occasional silt pockets, compact, moist	[Cross-hatch pattern]		SS	S1	450	20	13	○ ●	
1	99.54	SILTY CLAY TILL - brown to grey, some sand, trace gravel, occasional cobbles, hard, moist	[Diagonal lines pattern]		SS	S2	375	31	10	○ ●	
2					SS	S3	25	46	5	○ ●	○ ●
3					SS	S4	600	35	9	○ ●	○ ●
4					SS	S5	600	27	12	○ ●	○ ●
4	96.64				End of Borehole at 3.66 m bgs.						
5											
6											
7											
8											
9											
10											
11											
12											
13											

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.
- Borehole open and dry upon completion of drilling.

**SAMPLE LEGEND**

AS Auger Sample     SS Split Spoon     ST Shelby Tube  
 Rock Core (eg. BQ, NQ, etc.)     VN Vane Sample

**OTHER TESTS**

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

**WATER LEVELS**

Apparent     Measured     Artesian (see Notes)



# BOREHOLE LOG

BH4

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 28, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		● S Field Vane Test (#=Sensitivity)	▲ Penetrometer ■ Torvane
0	97.94	SAND AND GRAVEL - brown, occasional cobbles, compact to dense, moist - becoming wet near 0.61 m bgs		▽	SS	S1	475	49	7	○	●
-1					SS	S2	400	50	7	○	●
-2	95.81	SILTY CLAY TILL - grey, some sand, trace gravel, occasional cobbles, hard, moist			SS	S3	450	17	13	○	●
-3					SS	S4	400	44	11	○	●
-4					SS	S5	550	46	11	○	●
-5	92.76				SS	S6	500	42	14	○	●
-6		End of Borehole at 5.18 m bgs.									
-7											
-8											
-9											
-10											
-11											
-12											
-13											

**NOTES**  
 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.  
 2) bgs denotes below ground surface.  
 3) \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.  
 4) Borehole open to 1.68 m bgs and ground water measured near 1.22 m bgs upon completion of drilling.

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

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

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



# BOREHOLE LOG

BH5

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 28, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH			
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	S Field Vane Test (#=Sensitivity)	Penetrometer	Torvane
0	99.04											
0	98.69	FILL - silt, brown, trace to some clay, trace sand, compact, moist	[Pattern]		SS	S1	600	28	17			
1		SAND AND GRAVEL - possible fill, brown, trace silt, occasional cobbles, compact to very dense, moist			SS	S2	500	52	3			52
2	97.52	SILTY CLAY TILL - brown, some sand, trace gravel, hard, moist			SS	S3	300	30	13			
3		- becoming grey near 2.59 m bgs			SS	S4	250	50*	11			
5	93.86				SS	S5	400	39	10			
6		End of Borehole at 5.18 m bgs.										
7												
8												
9												
10												
11												
12												
13												

**NOTES**  
 1) Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.  
 2) bgs denotes below ground surface.  
 3) \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.  
 4) Borehole open and dry upon completion of drilling.

**SAMPLE LEGEND**  
 [Pattern] AS Auger Sample [Pattern] SS Split Spoon [Symbol] ST Shelby Tube  
 [Pattern] Rock Core (eg. BQ, NQ, etc.) [Symbol] VN Vane Sample

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

**WATER LEVELS**  
 [Symbol] Apparent [Symbol] Measured [Symbol] Artesian (see Notes)



# BOREHOLE LOG

**BH6 (MW)**

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring December 4, 2017 Water Level Jan 16/18

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	● S Field Vane Test (#=Sensitivity)
0	98.10	FILL - silt, brown, trace to some clay, some sand, trace gravel, trace topsoil, compact, moist			SS	S1	550	16	18	
1					SS	S2	300	18	14	
2	96.27				SS	S3	425	37	14	
	95.66	SAND AND GRAVEL - brown, trace silt, occasional cobbles, dense, wet			SS	S4	550	20	12	
3					SS	S5	400	36	11	
4		SILTY CLAY TILL - brown, some sand, trace gravel, very stiff to hard, moist - becoming grey near 3.05 m bgs			SS	S6	500	50*	12	
5	92.92	End of Borehole at 5.18 m bgs.								
6										
7										
8										
9										
10										
11										
12										
13										

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.
- Water Level Readings:  
 December 6, 2017 - 1.49 m bgs, Elevation 96.61 m  
 December 15, 2017 - 1.41 m bgs, Elevation 96.69 m  
 January 16, 2018 - 1.04 m bgs, Elevation 97.06 m

**SAMPLE LEGEND**

AS Auger Sample     SS Split Spoon     ST Shelby Tube  
 Rock Core (eg. BQ, NQ, etc.)     VN Vane Sample

**OTHER TESTS**

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

**WATER LEVELS**

Apparent     Measured     Artesian (see Notes)



# BOREHOLE LOG

**BH7 (MW)**

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 27, 2017 Water Level Jan 16/18

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	● S Field Vane Test (#=Sensitivity)
0	99.53	SAND - possible fill, brown, some gravel, some clay, compact, moist			SS	S1	450	20		
-1		- trace organics and wood encountered near 1.27 m bgs			SS	S2	370	17		
-2	97.70	SILTY CLAY TILL - brown, some sand, trace gravel, occasional cobbles, very stiff to hard, moist			SS	S3	75	47		
-3		- becoming grey near 3.05 m bgs			SS	S4	450	39		
-4					SS	S5	50	55		
-5					SS	S6	450	34		
-6					SS	S7	100	69		
-7					SS	S8	500	48		
-8					SS	S9	400	17		
-9					SS	S10	550	27		
-10					SS	S11	400	30		
-11										
-12										
-13	86.73	End of Borehole at 12.80 m bgs.								

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- \* denotes: 50 blows recorded before 150 mm spoon sampler penetration.
- Water Level Readings:  
 December 6, 2017 - 3.62 m bgs, Elevation 95.92 m  
 December 15, 2017 - 3.11 m bgs, Elevation 96.43 m  
 January 16, 2018 - 3.81 m bgs, Elevation 95.73 m

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

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

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



# BOREHOLE LOG

**BH8**  
Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 27, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	● S Field Vane Test (#=Sensitivity)
0	98.89	SAND AND GRAVEL - possible fill, brown, trace clay, occasional silt pockets, compact, moist to wet			SS	S1	550	6		
-1					SS	S2	400	20		
-2	97.06	SILTY CLAY TILL - grey, some sand, trace gravel, occasional cobbles, hard, moist			SS	S3	300	46		
-3					SS	S4	400	46		
-4					SS	S5	300	39		
-5					SS	S6	75	79		
-5	93.71									
-6		End of Borehole at 5.18 m bgs.								
-7										
-8										
-9										
-10										
-11										
-12										
-13										

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- Borehole open to 4.57 m bgs and ground water measured near 4.27 m bgs upon completion of drilling.

**SAMPLE LEGEND**

AS Auger Sample     SS Split Spoon     ST Shelby Tube  
 Rock Core (eg. BQ, NQ, etc.)     VN Vane Sample

**OTHER TESTS**

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

**WATER LEVELS**

Apparent     Measured     Artesian (see Notes)



# BOREHOLE LOG

**BH9 (MW)**

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 28, 2017 Water Level Jan 16/18

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.29	CLAYEY SILT - possible fill, brown, some sand, some gravel, trace organics, moist			SS	S1	250	29		
1	97.29	SANDY GRAVEL - brown, some silt to silty, occasional cobbles, compact to very dense, moist - becoming wet near 1.52 m bgs			SS	S2	400	9	○	●
2	95.85				SS	S3	350	9	○	●
3	93.11	SILTY CLAY TILL - grey, some sand, trace gravel, occasional cobbles, very stiff to hard, moist			SS	S4	550	14	○	●
4					SS	S5	350	10	○	●
5					SS	S6	400	81	○	●
6		End of Borehole at 5.18 m bgs.								
7										
8										
9										
10										
11										
12										
13										

**NOTES**

- Borehole Log interpretation requires assistance by EXP before use by others. Borehole Logs must be read in conjunction with EXP Report LON-00015778-GE.
- bgs denotes below ground surface.
- Water Level Readings:  
 December 6, 2017 - 1.18 m bgs, Elevation 97.11 m  
 December 15, 2017 - 1.24 m bgs, Elevation 97.05 m  
 January 16, 2018 - 0.75 m bgs, Elevation 97.54 m

**SAMPLE LEGEND**

AS Auger Sample     SS Split Spoon     ST Shelby Tube  
 Rock Core (eg. BQ, NQ, etc.)     VN Vane Sample

**OTHER TESTS**

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

**WATER LEVELS**

Apparent     Measured     Artesian (see Notes)



# TEST PIT LOG

TP1

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.32	SANDY GRAVEL - brown, fine to coarse grained		▽					100	200 kPa
1	97.12	SILTY SAND - brown							Atterberg Limits and Moisture	
2	96.12	SAND AND GRAVEL - dense, wet							W <sub>p</sub> W W <sub>L</sub>	● SPT N Value × Dynamic Cone
3	94.82	SILTY CLAY TILL - grey, some sand, trace gravel							10 20 30 40	
4	94.52	End of Test Pit at 3.8 m bgs.								
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 1.8 m bgs after 3 hours.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP2

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	97.97	<b>SANDY GRAVEL</b> - brown, fine to coarse grained  Grain Size Analysis Gravel Sand Silt 74% 24% 2%		▽					100	200 kPa
1										
2	96.17	<b>SILTY CLAY TILL</b> - brown, some sand, trace gravel  - becoming grey near 2.4 m bgs								
3	94.77	<b>End of Test Pit at 3.2 m bgs.</b>								
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 1.5 m bgs.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP3

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES				MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)	N VALUE (blows)		◆ S Field Vane Test (#=Sensitivity)	▲ Penetrometer
0	98.00	<b>SANDY GRAVEL</b> - brown, fine to coarse grained, occasional cobbles							100	200 kPa	
	97.50	<b>Grain Size Analysis</b> Gravel Sand Silt 66% 26% 8% <b>SILTY CLAY TILL</b> - grey, some sand, trace gravel								<b>Atterberg Limits and Moisture</b> $W_p$ $W$ $W_L$ ● SPT N Value × Dynamic Cone 10 20 30 40	
1	96.40	<b>End of Test Pit at 1.6 m bgs.</b>									
2											
3											
4											
5											
6											
7											

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Test pit dry at completion.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP4

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity) ▲ Penetrometer    ■ Torvane 100                      200 kPa
0	99.41	SILTY CLAY TILL - brown, some sand, trace gravel - becoming grey and hard near 0.3 m bgs								
1	98.31	End of Test Pit at 1.1 m bgs.								
2										
3										
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Test pit dry at completion.  
 3) bgs denotes below ground surface.

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

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

**WATER LEVELS**  
 Apparent     Measured     Artesian (see Notes)



# TEST PIT LOG

TP5

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.13	SILTY CLAY - possible fill, brown, with sand and gravel							100	200 kPa
1	97.13	SAND AND GRAVEL - brown								
	96.93	SANDY SILT - brown								
	96.43	SANDY SILT - brown								
2	96.13	SILTY CLAY TILL - grey, some sand, trace gravel								
		End of Test Pit at 2.0 m bgs.								
3										
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Test pit dry at completion.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP6

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	97.85	CLAYEY SILT - possible fill, brown, with sand and gravel						100	200 kPa	
1	96.85	CLAYEY SILT - brown, some sand, trace gravel								
2	96.05	SAND - brown, fine to medium grained, trace gravel, wet - some water seepage near 1.8 m bgs		▽						
3	94.85	SILTY CLAY TILL - grey, some sand, trace gravel								
	94.45	End of Test Pit at 3.4 m bgs.								
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 2.0 m bgs.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP7

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH					
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)	▲ Penetrometer	■ Torvane	○	
0	97.60	SAND AND GRAVEL - possible fill, brown, with clay and silt							100	200	Atterberg Limits and Moisture			
1	96.70	SILTY SAND - brown to grey  - becoming wet near 1.6 m bgs		▽							W <sub>p</sub>	W	W <sub>L</sub>	
2	95.20	SILTY CLAY TILL - grey, some sand, trace gravel									● SPT N Value	× Dynamic Cone		
3	94.60	End of Test Pit at 3.0 m bgs.									10	20	30	40
4														
5														
6														
7														

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 1.6 m bgs.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP8

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.38	SILTY SAND - possible fill, brown, with clay and gravel						100	200 kPa	
1	97.28	SANDY GRAVEL - brown, fine to coarse grained		▽						
2	96.28	Grain Size Analysis Gravel Sand Silt 76% 18% 6%								
	95.78	SILTY CLAY TILL - grey, some sand, trace gravel								
3		End of Test Pit at 2.6 m bgs.								
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 1.7 m bgs.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP9

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.85	Silty SAND AND GRAVEL - possible fill, brown, some clay						100	200 kPa	
0.5	98.15	CLAYEY SILT - brown, some sand, trace gravel								
1.5	97.15	SILTY CLAY TILL - grey, some sand, trace gravel								
2.3	96.55	End of Test Pit at 2.3 m bgs.								
3										
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Test pit dry at completion.  
 3) bgs denotes below ground surface.

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

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

**WATER LEVELS**  
 Apparent     Measured     Artesian (see Notes)



# TEST PIT LOG

TP10

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.15	SANDY SILT - possible fill, brown, with clay and gravel	[Cross-hatch pattern]					100	200 kPa	
1	96.55	SANDY GRAVEL - brown, fine to coarse grained, wet	[Gravel pattern]							
2	95.75	Grain Size Analysis Gravel 69% Sand 27% Silt 4% - caving near 2.3 m bgs	[Gravel pattern]	▽						
3	95.35	SILTY CLAY TILL - grey, some sand, trace gravel	[Clay pattern]							
3		End of Test Pit at 2.8 m bgs.								
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 2.2 m bgs.  
 3) bgs denotes below ground surface.

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

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

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



# TEST PIT LOG

TP11

Sheet 1 of 1

CLIENT The Municipality of Middlesex Centre PROJECT NO. LON-00015778-GE  
 PROJECT Olalondo Pit Underwater Extraction DATUM Assumed  
 LOCATION 21515 Olalondo Road, Middlesex Centre, ON DATES: Boring November 9, 2017 Water Level \_\_\_\_\_

DEPTH (m bgs)	ELEVATION (-m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES			MOISTURE CONTENT (%)	SHEAR STRENGTH	
					TYPE	NUMBER	RECOVERY (mm)		N VALUE (blows)	◆ S Field Vane Test (#=Sensitivity)
0	98.23	SANDY SILT - possible fill, brown, with clay and gravel						100	200 kPa	
1	96.83	SANDY GRAVEL - brown, fine to coarse grained		▽						
2		Grain Size Analysis Gravel Sand Silt 73% 24% 3% - caving near 2.2 m bgs								
3	95.23	SILTY CLAY TO CLAYEY SILT - grey, some sand, trace gravel								
	94.73	End of Test Pit at 3.5 m bgs.								
4										
5										
6										
7										

**NOTES**  
 1) Test Pit Log interpretation requires assistance by EXP before use by others. Test Pit Log must be read in conjunction with EXP Report LON-00015778-GE.  
 2) Groundwater measured near 1.9 m bgs.  
 3) bgs denotes below ground surface.

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

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

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

## NOTES ON SAMPLE DESCRIPTIONS

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

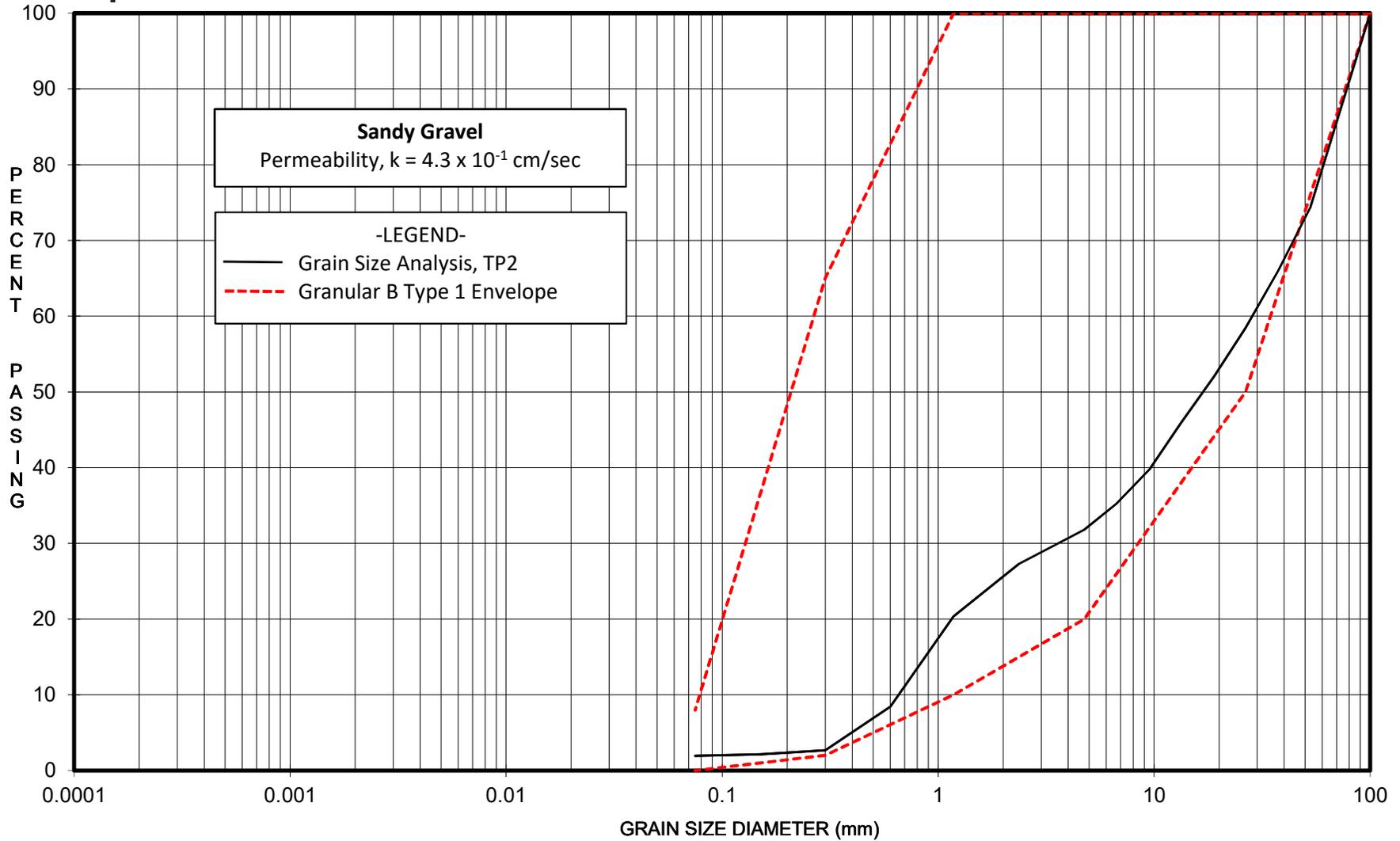
UNIFIED SOIL CLASSIFICATION	Fines (silt and clay)		Sand			Gravel		Cobbles		
			Fine	Medium	Coarse	Fine	Coarse			
M.I.T. SOIL CLASSIFICATION	Clay	Silt	Sand			Gravel				
			Fine	Medium	Coarse					
Sieve Sizes										
Particle Size (mm)										
	0.002		0.06	0.075 – 200	0.2	0.6 – 40	2.0 – 10	5.0 – 4	20 – 3/4	80

- Fill:** Where fill is designated on the testhole log, it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The testhole description therefore, may not be applicable as a general description of the site fill material. All fills should be expected to contain obstructions such as large concrete pieces or subsurface basements, floors, tanks, even though none of these obstructions may have been encountered in the testhole. Since testholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact and correct composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. The fill at this site has **not** been monitored for the presence of methane gas. Some fill material may be contaminated by toxic waste that renders the material unacceptable for deposition in any but designated land fill sites; unless specifically stated, the fill on the site has not been tested for contaminants that may be considered hazardous. This testing and a potential hazard study can be carried out if you so request. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common, but not detectable using conventional geotechnical procedures.
- Glacial Till:** The term till on the testhole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process, the till must be considered heterogeneous in composition and as such, may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (75 to 200 mm in diameter) or boulders (greater than 200 mm diameter) and therefore, contractors may encounter them during excavation, even if they are not indicated on the testhole logs. It should be appreciated that normal sampling equipment can not differentiate the size or type of obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited area; therefore, caution is essential when dealing with sensitive excavations or dewatering programs in till material.

## **Appendix B – Laboratory Test Results**



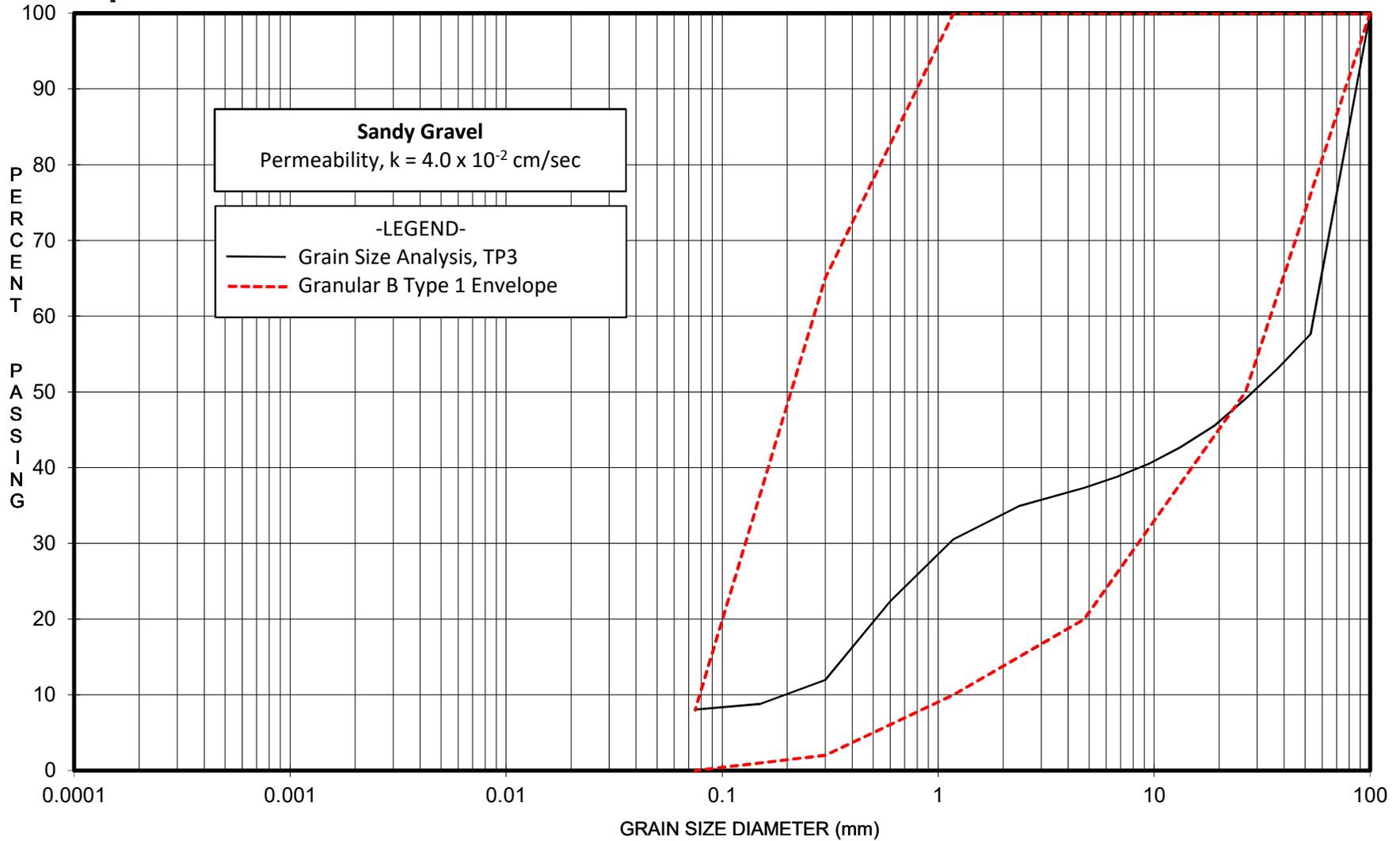
# MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
	SILT			SAND			GRAVEL			
MODIFIED M.I.T. CLASSIFICATION	Sample Description: Test Pit 2						Olalondo Pit Extraction Project: LON00015778GE			Figure 1



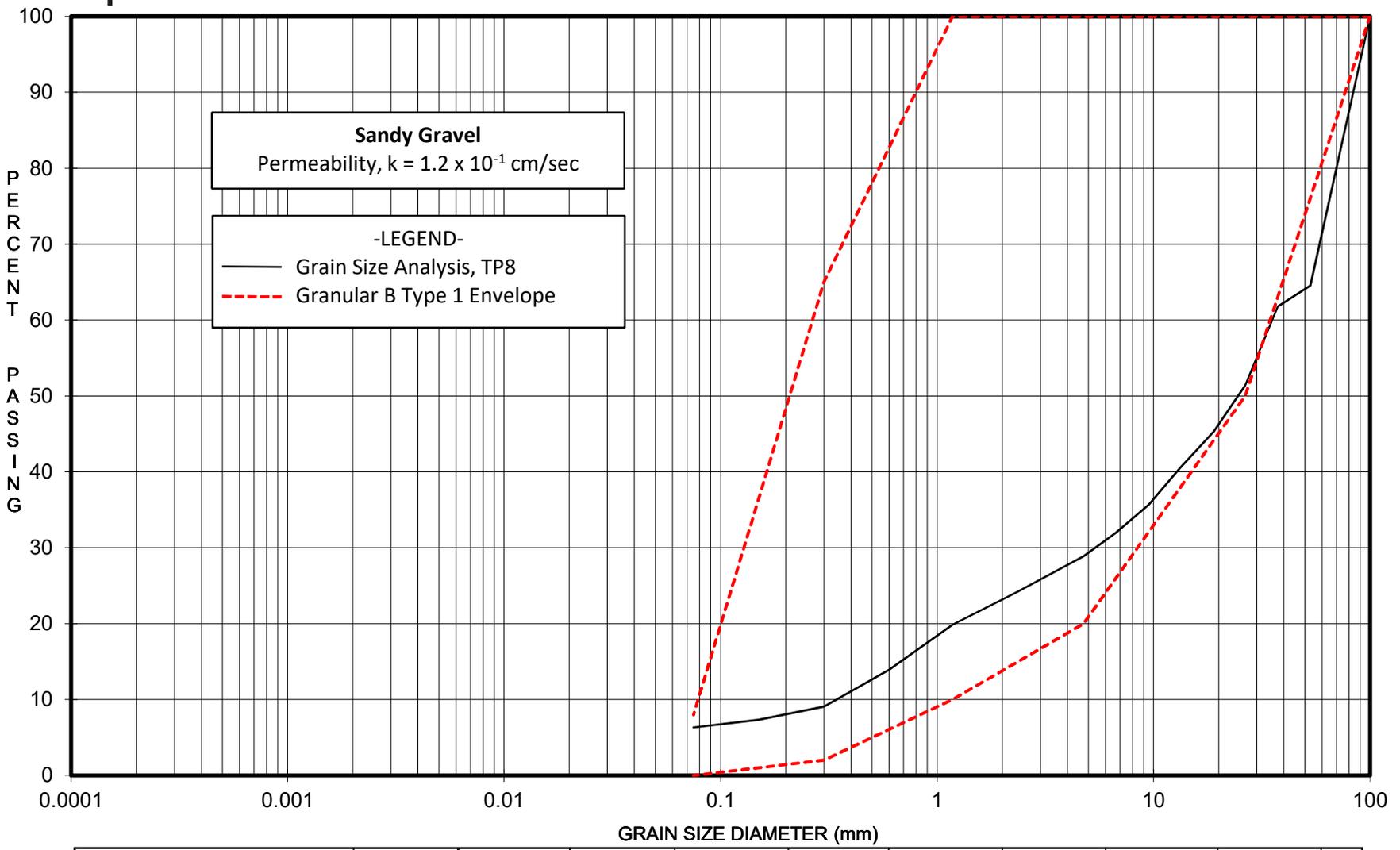
# MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
	SILT			SAND			GRAVEL			
MODIFIED M.I.T. CLASSIFICATION	<b>Sample Description: Test Pit 3</b>						<b>Olalondo Pit Extraction Project: LON00015778GE</b>			<b>Figure 2</b>



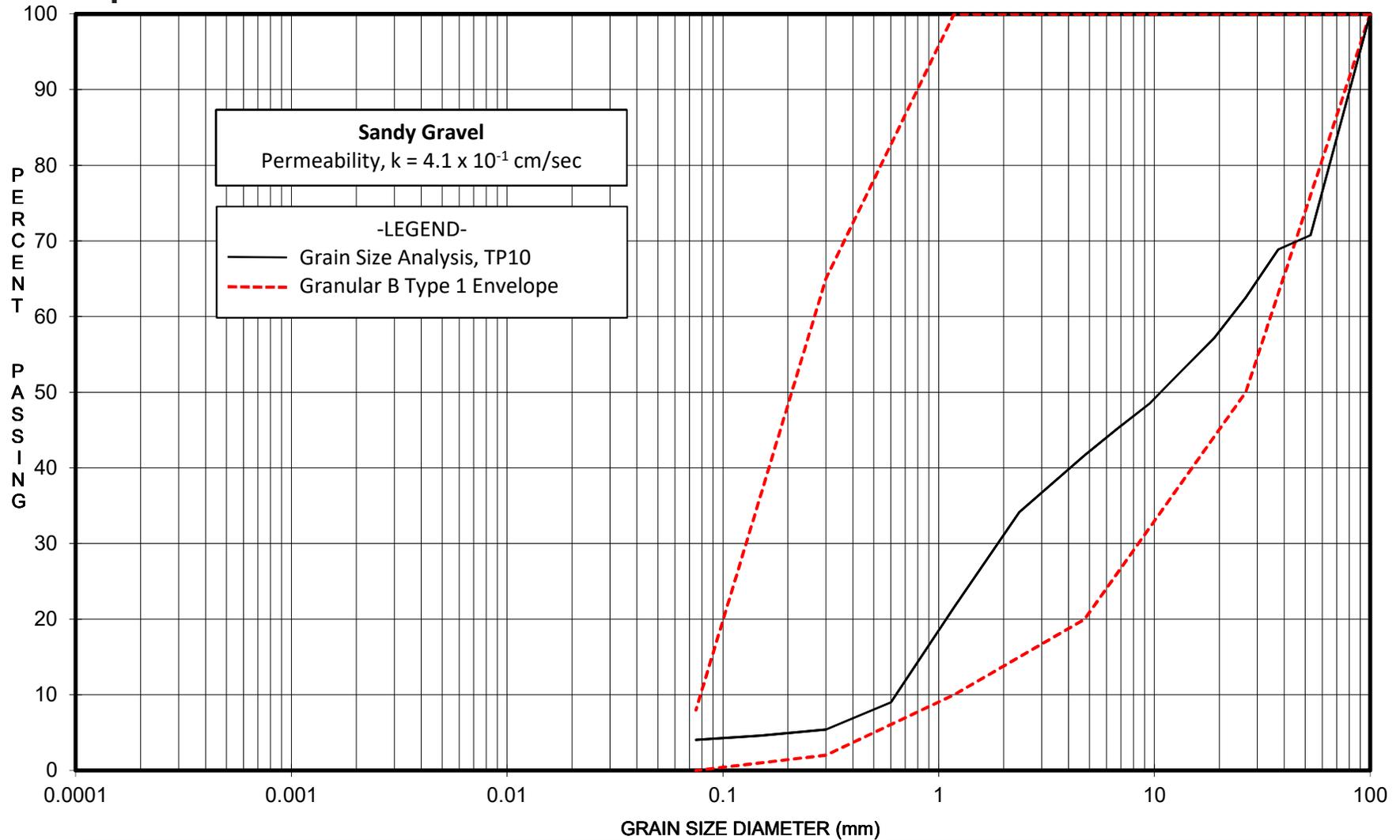
# MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	
	SILT			SAND			GRAVEL			
MODIFIED M.I.T. CLASSIFICATION	Sample Description: Test Pit 8						Olalondo Pit Extraction Project: LON00015778GE			Figure 3



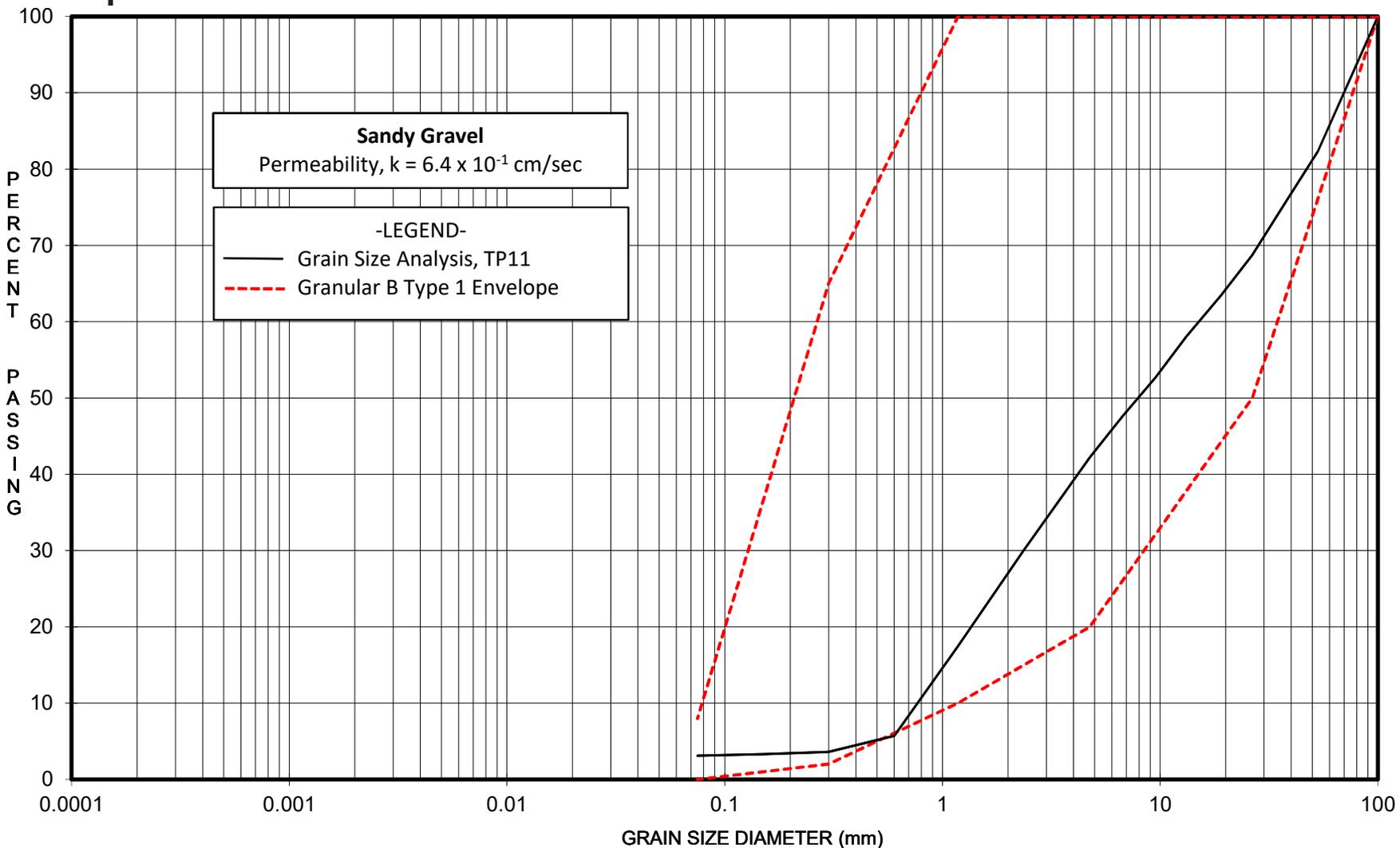
# MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION	Sample Description: Test Pit 10					Olalondo Pit Extraction Project: LON00015778GE			Figure 4



# MECHANICAL GRAIN SIZE ANALYSIS



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
MODIFIED M.I.T. CLASSIFICATION	Sample Description: Test Pit 11					Olalondo Pit Extraction Project: LON00015778GE			Figure 5

## **Appendix C – Limitations and Use of Report**

## **LIMITATIONS AND USE OF REPORT**

### **BASIS OF REPORT**

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

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

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

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

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

### **RELIANCE ON INFORMATION PROVIDED**

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

### **STANDARD OF CARE**

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

### **COMPLETE REPORT**

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