



# V. A. WOOD ASSOCIATES LIMITED

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*GEOTECHNICAL INVESTIGATION  
PROPOSED FOUR STOREY BUILDING  
496 TAUNTON ROAD EAST  
OSHAWA, ONTARIO*

*Ref. No. 6817-15-11*

*December 2015*

*Prepared for:*

*D. G. Biddle & Associates Ltd.  
96 King Street East  
Oshawa, Ontario  
L1H 3B6*

*DISTRIBUTION:*

*(4) Copies - D. G. Biddle & Associates Ltd.*

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1.0 **INTRODUCTION**

*V.A. Wood Associates Limited was retained by D. G. Biddle & Associates Ltd. to carry out a geotechnical investigation for the proposed four storey mixed use building at 496 Taunton Road East in Oshawa, Ontario.*

*The 3,600± m<sup>2</sup> property is occupied by a one storey commercial building, which will be removed. The proposed development will include a four storey retail and residential building with a slab on grade and paved parking areas.*

*The purpose of the investigation was to reveal the subsurface conditions and to determine the relevant soil properties for the design and construction of the foundation of the building, the associated site services and the paved areas. The site infiltration of storm water is also to be assessed.*

2.0 **FIELD WORK**

*The field work was carried out on December 10, 2015 and consisted of four boreholes at the locations shown on Enclosure 1. The boreholes were advanced to the sampling depths by means of a power-auger machine equipped for soil sampling. Standard Penetration tests were carried out at frequent intervals of depth and the results are shown on the Borehole Logs as N-values.*

*The field work was supervised by a soils technician and the soil samples were transported to our soils laboratory for further examination, classification and testing. The ground surface at the site is generally flat.*

### 3.0 SUBSURFACE CONDITIONS

*Full details of the soils encountered in each borehole are given on the Borehole Logs, Enclosures 2 to 5 inclusive, and the following notes are intended to summarize this data.*

*The boreholes were augered to a depth of 0.75 m, where no sampling and field testing was carried out.*

*From a depth of 0.75 m, Boreholes 1 and 2 encountered a layer of fill, which extended to a depth of between 1.3± m below grade. The fill is comprised generally of sand with some gravel and brick fragments in places. Standard Penetration tests in the fill gave N-values between 5 and 10 blows/300mm.*

*Based on the test results, the fill is considered to be in a loose to medium compact condition.*

*Below the fill in Boreholes 1 and 2 and from a depth of 0.75 m in Boreholes 3 and 4, the boreholes encountered a native deposit of sand, which extended to a depth of between 1.3 and 2.9 m below grade. This deposit is comprised of fine to medium sand with some fine gravel. Standard Penetration tests in this deposit gave N-values between 31 and 90 blows/300mm. The grain size distribution of the sand from Borehole 4 is shown in Enclosure 7.*

*Based on the test results, the sand is considered to have a dense to very dense relative density.*

*The sand was underlain by a deposit of fine sand which extended to a depth of between 4 and 5.5 m below grade. This deposit contained seams of silty sand or traces of silt. Standard Penetration tests in this deposit gave N-values between 45 and more than 100 blows/300mm. The grain size distribution of a representative sample of the fine sand is shown in Enclosure 6.*

*Based on the test results, the fine sand is considered to have a dense to very dense relative density.*

*The fine sand was underlain by a lower deposit of sand which extended to a depth of more than 6.6 m below grade (maximum depth investigated). This deposit is comprised of fine to medium sand with traces to some gravel. Standard Penetration tests in this deposit gave N-values between 55 and more than 100 blows/300mm.*

*Based on the test results, the lower sand deposit is considered to have a generally very dense relative density.*



4.0 **GROUNDWATER CONDITIONS**

*No free water was encountered in any of the boreholes which were dry and open to the bottom in Boreholes 2, 3 and 4, and caved in at a depth of 6 m in Borehole 1. It is noted that the water level measurement was carried out immediately after completion of drilling, and it is possible that the ground water had not yet stabilized in the boreholes.*

*An examination of the soil samples revealed that they were generally damp to moist and had a brown colour, then started to become wet and/or changed in the colour from brown to greyish brown at a depth of about 5.5 m below grade.*

*Based on the findings, the groundwater table is considered to be located at least 5.5 m below existing grade.*

## 5.0 DISCUSSION AND RECOMMENDATIONS

### 5.1 General

*The boreholes encountered less than 0.7 to 1.3 m of fill, followed by dense to very dense deposits of sand. The groundwater table is considered to be located at least 5.5 m below grade.*

*The proposed structure is a four storey mixed use building with a footprint of  $940 \pm m^2$  and a slab on grade. It is anticipated that the structure will have load bearing reinforced concrete or concrete block walls and internal columns supported on strip and isolated footings.*

*Full details of the proposed structure were not available at the time of this report and, therefore, the following recommendations should be reviewed when these details are available.*

### 5.2 Foundations

*The footings should extend through the fill and onto the dense to very dense sand, which was encountered in the boreholes at a depth of between 0.8 and 1.3 m below grade. This stratum is considered capable of supporting a bearing pressure in SLS of at least 300 kPa (450 kPa ULS).*



*It is estimated that the total and differential settlements of footings designed to the above bearing pressure will be less than 25 and 20 mm respectively. These are normally considered to be acceptable for the proposed structure.*

*All exterior footings or footings in unheated areas should be located at least 1.2 m below finished grade for adequate frost protection. The minimum footing sizes should not be less than those specified in the Ontario Building Code. The slopes between footings should be inclined such that elevation differences between adjacent footings are not more than one half of the horizontal distance between them.*

*All foundation excavations should be inspected by geotechnical personnel from V.A. Wood Associates Limited to ensure that the founding soils are similar to those identified in the Borehole Logs and that they are capable of supporting the design loads.*

*Based on the Ontario Building Code of 2012, the site classification for seismic design should be based on the average soil properties of the top 30 m of the soil profile. The boreholes were only 6.6 m deep and encountered dense to very dense sand deposits.. The very dense deposits are expected to extend to depth and, in this case, a seismic Site Class 'C' classification may be used for this site.*

For the design of members resisting lateral loads the recommended soil parameters are as follows:

<i>Soil Parameters</i>	<i>Loose Fill</i>	<i>Dense to Very Dense Sand and Fine Sand</i>
<i>Unit Weight</i>	<i>19 kN/m<sup>3</sup></i>	<i>21 kN/m<sup>3</sup></i>
<i>Friction Angle</i>	<i>28°</i>	<i>35°</i>
<i>Cohesion</i>	<i>0</i>	<i>0</i>
<i>Coeff. of Earth Pressure At Rest</i>	<i>0.53</i>	<i>0.43</i>
<i>Coeff. of Active Earth Pressure</i>	<i>0.36</i>	<i>0.27</i>
<i>Coeff. of Passive Earth Pressure</i>	<i>2.8</i>	<i>3.7</i>
<i>Coefficient of Friction</i>	<i>--</i>	<i>0.45</i>

### 5.3 Slab On Grade

*It is anticipated that the finished floor of the slab on grade will be located close to the existing grade.*

*All topsoil, organics, loose or wet soil and deleterious materials should be removed from within the building footprint. The exposed subgrade should be inspected, and any loose or wet soils identified should be removed and replaced with compacted approved fill. Any backfill required should be comprised of approved on-site or imported fill, preferably granular soil, placed in not more than 200 mm thick horizontal loose lifts and compacted to at least 98% Standard Proctor maximum dry density (SPMDD).*

*A layer of well-graded free-draining granular material, at least 150 mm thick and compacted to 98% SPMDD, should be placed under the floor slab to provide a uniform bearing surface and to act as a vapour barrier.*

*For the design of the floor slab, a modulus of subgrade reaction,  $K_s$ , of  $40 \text{ MN/m}^3$  ( $150 \text{ lb/in}^3$ ) may be assumed for well compacted granular fill or dense sand.*

#### 5.4 Service Trenches

*It is anticipated that the service trenches will be located within 2.5 m below finished grade. Reference to the Borehole Logs indicates that the subgrade of the pipes will likely be composed of dense to very dense sand/fine sand, which will generally provide adequate support for the pipes and allow the use of normal Class 'B' bedding using Granular 'A' material.*

*Clear crushed stone should not be used as bedding, otherwise the fines from the surrounding subsoil may migrate into the voids of the stone and cause undesirable settlements.*

*If there is local softening of the trench grade, then the bedding thickness may have to be increased. The backfill around manholes should consist of well compacted granular materials.*

5.5 Excavation and Groundwater Control

*No major construction problems, due to water, are expected for the anticipated excavation depths (not exceeding 2.5 m below existing grade). Provision should, however, be made for the control of any surface water run-off and any water seepage by pumping from local sumps, as and where required.*

*Excavations of more than 1.2 m in depth should be cut back to a side slope of 1:1. The sand is liable to slough when dry and to collapse when wet. In this case, the sloped excavation should be covered with plastic sheeting. Alternatively, the excavation may be supported using adequately braced sheeting.*

*It is anticipated that the excavated native sand will be suitable for engineered or structural fill, as long as its moisture content is kept within 3% of its optimum value. Backfill should be placed in horizontal loose layers 150 to 200mm thick and compacted to at least 98% SPMDD.*

*To minimize potential problems, backfilling operations should follow closely after excavation so that only a minimal length of trench slope is exposed. Should construction be carried out in the winter season, particular attention should be given to make sure frozen material is not used as backfill.*



5.6 Pavements

*It is anticipated that the finished grade of the driveways, fire route and parking areas will be close to the existing grade.*

*All topsoil, organics, loose or wet soil, and any deleterious materials should be removed from the areas to be paved. The exposed subgrade should proof-rolled and inspected and any loose/wet areas identified should be replaced with approved compacted fill. Any backfill required should consist of approved on-site or imported material and placed in horizontal lifts not exceeding 200 mm thick and compacted to at least 98% SPMDD.*

*Considering the traffic requirements and subsoil conditions, the following pavement designs are recommended:*

	<i>Car Parking Areas (Light Duty Asphalt)</i>	<i>Fire Route/Driveways (Heavy Duty Asphalt)</i>
	<u>(mm)</u>	<u>(mm)</u>
<i>HL-3 Asphaltic Concrete</i>	50	40
<i>HL-8 Asphaltic Concrete</i>	--	75
<i>Granular 'A' or 20 mm crusher run limestone</i>	150	150
<i>Granular 'B' or 50 mm crusher run limestone</i>	200	300

*The base and sub-base granular materials should be compacted to at least 98% SPMDD and the asphaltic concrete to 96% Marshall density. The thicknesses shown above are compacted thicknesses of the materials. The top course asphalt should not be placed until the base course asphalt has been in place for one winter season.*

*If the City of Oshawa has stricter specifications than shown above, then the City's requirements should be followed.*

*Frequent inspection by geotechnical personnel from V.A. Wood Associates Limited should be carried out during construction to verify the compaction of the subgrade, base courses and asphaltic concrete by in-situ density testing using nuclear gauges.*

### 5.7 Soil Infiltration

*The design of the storm water infiltration is based on the permeability and infiltration properties of the subsoils. These properties may be determined based on the grain size distributon of the soils, their relative density, and the amount of clay and organic content. The sands have a generally dense to very dense relative density and has no clay and organic content. Based on the grain size curves in Enclosures 6 and 7, the estimated permeability and infiltration rates of the subsoils are as follows:*

<i>Sample No.</i>	<i>USCS Classification</i>	<i>Permeability, k</i>	<i>Infiltration Rate</i>
<i>BH4/SS1</i>	<i>Fine to Medium SAND (SW)</i>	<i>10<sup>-4</sup> cm/sec</i>	<i>50 mm/hr</i>
<i>BH3/SS3</i>	<i>Silty Fine SAND (SM)</i>	<i>10<sup>-5</sup> cm/sec</i>	<i>30 mm/hr</i>

*The infiltration rates given above is based on empirical values. Once the type of run-off infiltration is determined we recommend that the infiltration rates for detailed design be determined using in-situ methods, such as the use of a Guelph permeameter.*



6.0 STATEMENT OF LIMITATIONS

*The Statement of Limitations presented on Appendix 'A' is an integral part of this report.*

**V.A. WOOD ASSOCIATES LIMITED**

Prepared by:



Rene Quiambao, P. Eng.



Reviewed by:



V. Wood, M.Eng., P.Eng.,



RQ/VW

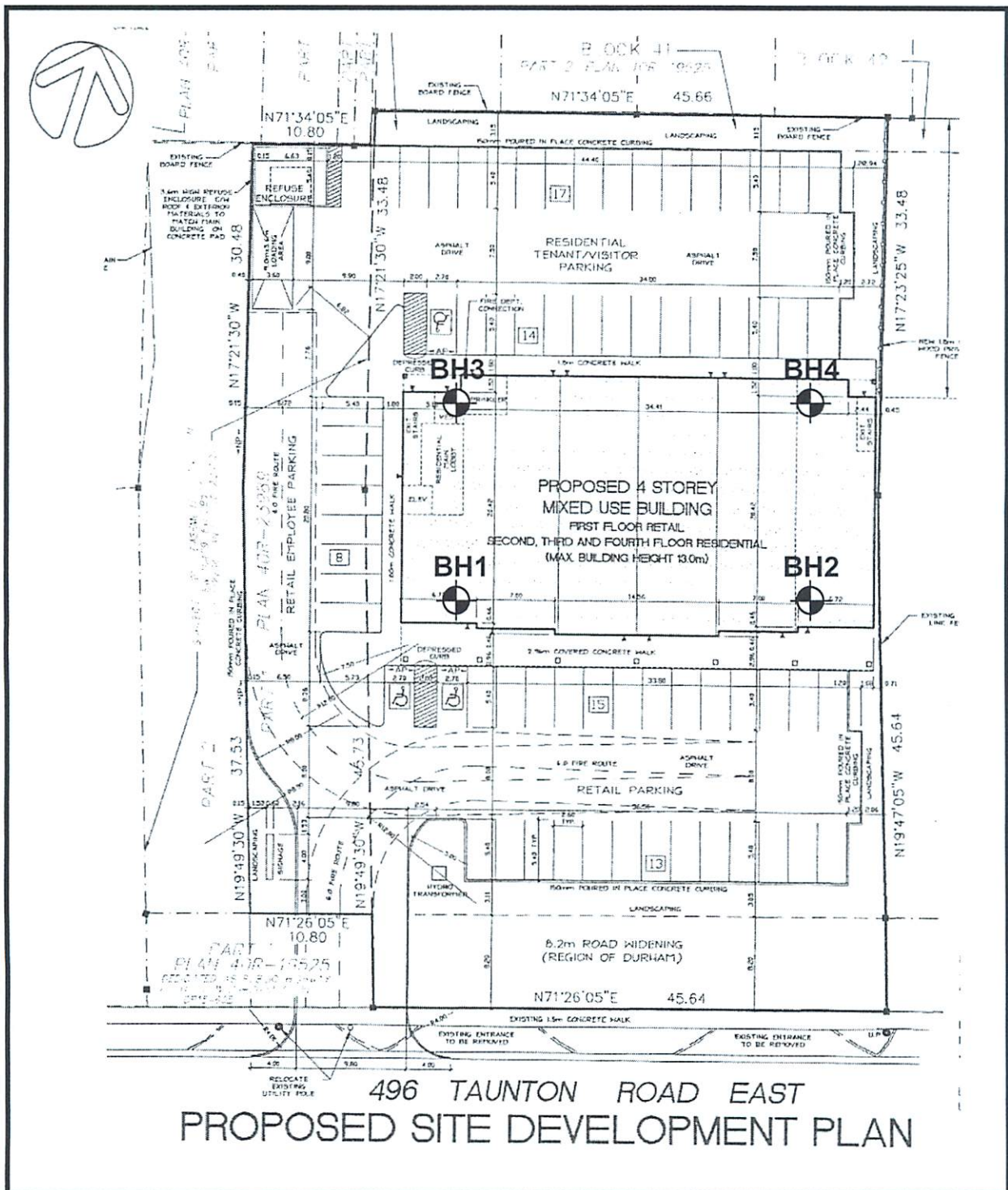
*APPENDIX*

**STATEMENT OF LIMITATIONS**

*The conclusions and recommendations in this report are based on information determined at the borehole locations and on geological data of a general nature which may be available for the area investigated. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations and conditions may become apparent during construction which would not be detected or anticipated at the time of the soil investigation.*

*We recommend that we be retained to ensure that all necessary stripping, subgrade preparation and compaction requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in the boreholes. In cases where this recommendation is not followed, the company's responsibility is limited to interpreting accurately the information encountered at the borehole locations.*

*This report is applicable only to the project described in the introduction, constructed substantially in accordance with details of alignment and elevations quoted in the text.*





Reference No : 6817-15-11

# Borehole No : 1

Enclosure No : 2

Client : D G. Biddle & Associates Ltd.

Project : Proposed Commercial Building

Method : Auger

Location : 496 Taunton Road East, Oshawa, ON

Diameter : 110 mm

Datum Elevation :

Date : December 10, 2015

SUBSURFACE PROFILE					SAMPLE			Standard Penetration Test blows/300mm	Moisture Content, %			Remarks
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value					
									20	40	60	
0	0	Ground Surface										
		Auger to 0.75 m No sampling/Testing										
-0.75		<i>FILL</i>										
-1.3	1	Sand, some gravel and brick fragments, trace topsoil, compact	[Cross-hatch symbol]		1	SS	10	○				
		<i>SAND</i>										
-2.1	2	Very dense, fine to medium sand, some fine gravel, brown, moist	[Stippled symbol]		2	SS	61	○				
		<i>FINE SAND</i>										
	3	Very dense, trace silt, brown, damp	[Dotted symbol]	D R Y	3	SS	94	○				
					4	SS	71	○				
-4	4	<i>SAND</i>										
		Very dense, fine to medium sand, trace fine gravel, brown greyish brown, moist  moist, brown wet, greyish brown	[Dotted symbol]		5	SS	100+	○				
-6.55	6				6	SS	55	○				cave in at 6 m
		End of Borehole										
	7											
	8											

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Disk :

Sheet : 1 of 1

Reference No : 6817-15-11

## Borehole No : 2

Enclosure No : 3

Client : D G. Biddle & Associates Ltd.

Project : Proposed Commercial Building

Method : Auger

Location : 496 Taunton Road East, Oshawa, ON

Diameter : 110 mm

Datum Elevation :

Date : December 10, 2015

SUBSURFACE PROFILE					SAMPLE							Remarks			
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm					Moisture Content, %		
								20	40	60	80		5	15	25
0	0	Ground Surface													
		Auger to 0.75 m No sampling/Testing													
-0.75															
	1	<i>FILL</i> Sand, some gravel, loose			1	SS	5								
-1.3															
	2	<i>SAND</i> Dense to very dense, fine to medium sand, some fine gravel, brown, moist			2	SS	31								
	2				3	SS	51								
-2.9															
	3														
	4	<i>FINE SAND</i> Very dense, trace silt, brown, damp			4	SS	51								
	4														
	5														
	5														
-5.5															
	6	<i>SAND</i> Very dense, fine to medium sand, some gravel, grey, wet			5	SS	63								
	6														
	6														
-6.55															
	6				6	SS	59								
	6														
	7	End of Borehole													
	7														
	8														

cave in at 5.7 m

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Disk :

Sheet : 1 of 1



Reference No : 6817-15-11

# Borehole No : 3

Enclosure No : 4

Client : D G. Biddle & Associates Ltd.

Project : Proposed Commercial Building

Method : Auger

Location : 496 Taunton Road East, Oshawa, ON

Diameter : 110 mm

Datum Elevation :

Date : December 10, 2015

SUBSURFACE PROFILE				SAMPLE							Remarks										
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm				Moisture Content, %									
								20	40	60		80	5	15	25						
0	0	Ground Surface																			
		Auger to 0.75 m No sampling/Testing																Borehole open and dry on completion			
-0.75	1	<b>SAND</b> Very dense, fine to medium sand, some fine to medium gravel, trace silt, brown, moist			1	SS	90														
	2				2	SS	61														
-2.1	3	<b>FINE SAND</b> Very dense, some seams of silty sand, brown, damp to moist			3	SS	94														
	4				4	SS	71														
	5				5	SS	100+														
-5.5	6				6	SS	55														
-6.55	7	End of Borehole																			
	8																				

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Sheet : 1 of 1

Reference No : 6817-15-11

# Borehole No : 4

Enclosure No : 5

Client : D G. Biddle & Associates Ltd.

Project : Proposed Commercial Building

Method : Auger

Location : 496 Taunton Road East, Oshawa, ON

Diameter : 110 mm

Datum Elevation :

Date : December 10, 2015

SUBSURFACE PROFILE					SAMPLE						Remarks								
Elevation m	Depth m	Description	Symbol	Water	Number	Type	N-value	Standard Penetration Test blows/300mm				Moisture Content, %							
								20	40	60		80	5	15	25				
0	0	Ground Surface																	
		Auger to 0.75 m No sampling/Testing																	Borehole open and dry on completion
-0.75																			
	1	<b>SAND</b> Dense, fine to medium sand, trace fine gravel, brown, moist			1	SS	33												
-1.3																			
	2	<b>FINE SAND</b> Dense to very dense, strace silt, brown, damp to moist			2	SS	80												
	3																		
	4																		
	5																		
	6	<b>SAND</b> Very dense, fine to medium sand, some gravel, greyish brown, moist			5	SS	51												
-5.5																			
	6																		
	7	End of Borehole																	
	8																		

**V.A. WOOD ASSOCIATES LIMITED**

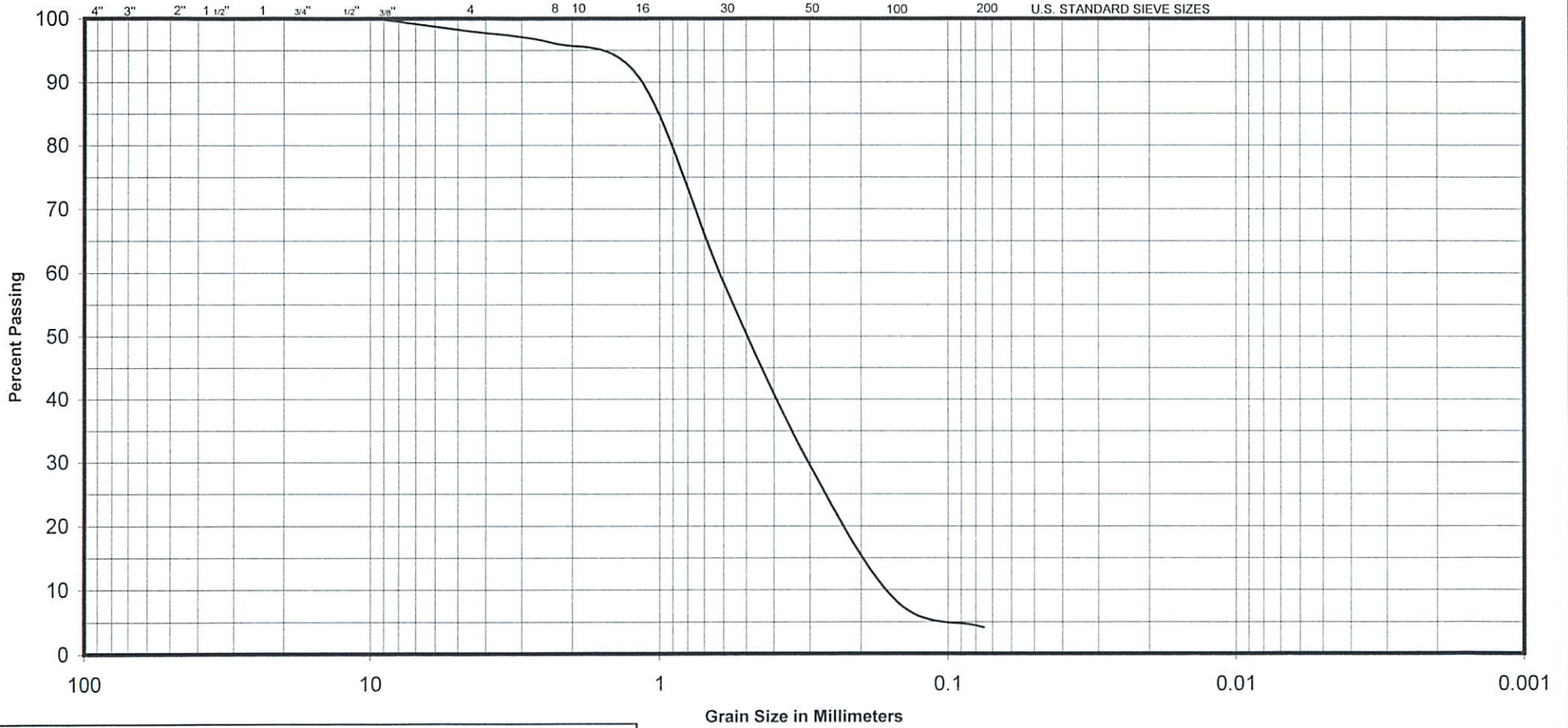
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Sheet : 1 of 1

# GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6817-15-11

GRAVEL				SAND			SILT & CLAY	UNIFIED SOIL CLASSIFICATION SYSTEM
COARSE	FINE		COARSE	MEDIUM	FINE			



PROJECT: D.G. Biddle & Associates Ltd.
LOCATION: 496 Taunton Road East, Oshawa, ON
BOREHOLE NO.: BH4
SAMPLE NO.: SS1
DEPTH : 1 m
DATE: December 2015

Fine to Medium SAND (SW)

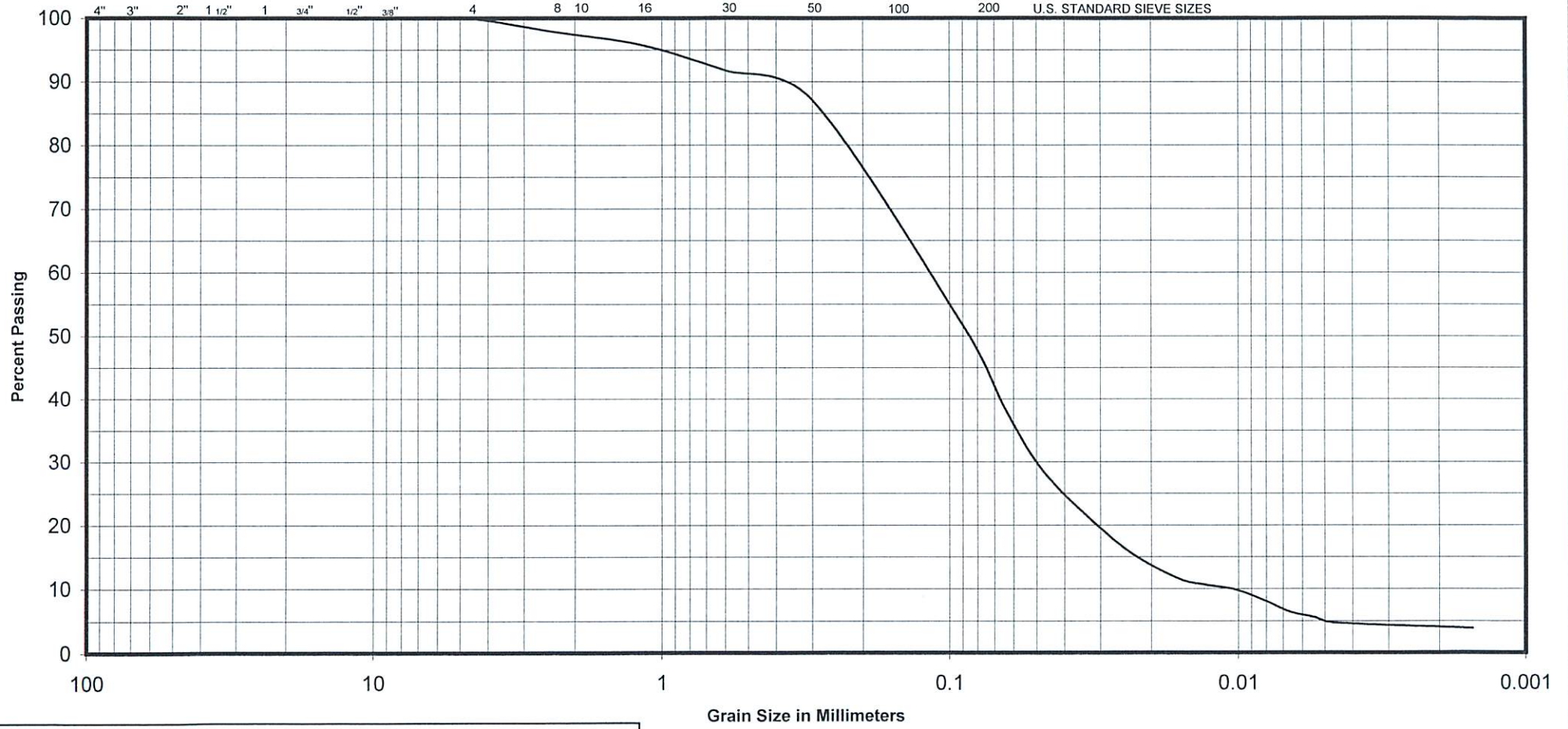
ENCLOSURE No.: 7



# GRAIN SIZE DISTRIBUTION

OUR REFERENCE No.: 6817-15-11

GRAVEL				SAND				SILT & CLAY	
COARSE		FINE		COARSE	MEDIUM		FINE	UNIFIED SOIL CLASSIFICATION SYSTEM	



PROJECT: D.G. Biddle & Associates Ltd.
LOCATION: 496 Taunton Road East, Oshawa, ON
BOREHOLE NO.: BH3
SAMPLE NO.: SS4
DEPTH : 3.3 m
DATE: December 2015

Silty Fine SAND (SM)

ENCLOSURE No.: 6