APPENDIX F

Geotechnical Investigation Report

Dan Currie

From: Ahileas Mitsopoulos [Ahileas.Mitsopoulos@trow.com]
Sent: March 5, 2010 14:28
To: Dan Currie
Cc: Kathy Bemben; Demetri Georgiou
Subject: Red Rock WWTP - Desktop Review of Soils in the Area

Hi Dan,

Our desktop review of the native soil conditions of the five areas for the proposed Red Rock WWTP are described below;

- **Area 1** – Peat organic terrain overlying silt and clay glaciolacustrine plain deposits with mainly low local relief and dry surface conditions. However, the site is near (on the north side of) a rubble Talus pile with mainly high local relief, cliffy volcanic rock signature and dry surface conditions.
- **Area 2** - Peat organic terrain overlying silt and clay glaciolacustrine plain deposits with mainly low local relief and dry surface conditions.
- **Area 3** – The site borders two landforms. The first and to the south is peat organic terrain overlying silt and clay glaciolacustrine plain deposits with mainly low local relief and dry surface conditions. The second and to the north is silt till ground moraine overlying bedrock with mainly moderate relief, sloping and dry surface conditions.
- **Area 4** – The site is located in peat organic terrain overlying silt and clay glaciolacustrine plain deposits with mainly low local relief and dry surface conditions. However, the site is near (on the south side of) silt till ground moraine overlying bedrock with mainly moderate relief, sloping and dry surface conditions.
- **Area 5** – The silt is located in peat organic terrain overlying silt and clay glaciolacustrine plain deposits with mainly low local relief and dry surface conditions. However, the site is borders (on the south side of) sand glaciolacustrine plain deposits with mainly low local relief and dry surface conditions.

Based on google air photo images Areas 1, 2, and 3 are forested and site accessibility is unknown but probably not good. Areas 4 and 5 appear to be cleared and accessibility looks better.

If you have any questions, please do not hesitate to contact us.

Thanks,

Ahileas Mitsopoulos, B.Eng.

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Since 1957

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June 24, 2010

Reference: THB-00009228-AG

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VIA EMAIL: dcurrie@enl-tbay.com

Preliminary Geotechnical Investigation
Proposed Waste Water Treatment Plant Site
West of Red Rock, Ontario

Dear Sirs:

Trow Associates Inc. (Trow) was authorized by Engineering Northwest Limited (ENL) to conduct a preliminary geotechnical investigation for a proposed new Waste Water Treatment Plant (WWTP) location site. The site location, also known as Area 2, is located west of the town of Red Rock, Ontario, see Figure 1.

The purpose of the geotechnical investigation was to obtain subsurface soils and groundwater information to assist with the design of the proposed new WWTP, and selection of the site location. This factual report contains all of our findings.

This letter report only outlines our methodology and factual subsurface findings; no recommendations are provided.

Site Description

The subject property is located west of the town of Red Rock, Ontario (see Figures 1). According to the Ontario Ministry of Natural Resources (MNR), Map 5046, the regional geology in the area (predevelopment) consists of peat organic terrain overlying silt and clay glaciolacustrine plain deposits with mainly low local relief and dry surface conditions.

The site is undeveloped and densely forested with mature trees and shrubs. Between HA2 and HA3, approximately 250 m apart, four ravines were encountered ranging between about 15 m and 35 m wide and between about 5 m and 15 m deep. In the area of HA2 and HA3, the ravine depths were about 1.5 m and 5.0 m, respectively.

Methodology

To assess the subsurface soil conditions at the site of the proposed new WWTP, Trow geotechnical personnel attended the site and conducted the drilling of four test holes, HA2 Top, HA2 Bottom, HA3 Top and HA3 Bottom, as shown on Figure 1.

The test holes were advanced using a hand operated power auger equipped with solid stem continuous flight augers. The drilling was completed on June 15, 2010. The test holes were advanced to depths ranging between about 3.3 m and 3.8 m below ground surface. Refusal to hand power auger was encountered at 3.3 m depth at HA2 Bottom. The test holes were advanced in areas where a ravine was present; therefore, at each of the two locations, one test hole was advanced on top of the ravine and one in the ravine, in an attempt to simulate a deeper test hole.

Soil samples were collected from the augers and the recovered soil samples were examined and logged in the field by Trow geotechnical personnel.

Representative samples of the various soil strata encountered in the test holes were taken to our laboratory in Thunder Bay for testing and for further examination by a geotechnical engineer.

Groundwater level measurements were obtained using an electric tape, prior to backfilling the test holes and UTM coordinates (NAD 83) were taken at the test hole locations using a handheld GPS unit. Due to the densely forested nature of the site, no ground surface elevations at the test holes were surveyed; however, approximate depths were measured between the test holes advanced on top of the ravine and the bottom of the ravine.

Subsurface Conditions

Details of the subsurface conditions encountered at the test holes are provided on the Test Hole Logs included in Appendix A of this report. The subsurface conditions are summarized in the following subsections. Note that the textural descriptions of the soil encountered are based on a visual assessment only, no laboratory testing was performed except for moisture contents.

Organic Silt

All test hole locations were surfaced with organic silt. The organic silt was generally described as soft, dark brown, moist to wet, containing roots and rootlets and extended to about 0.2 m below ground surface.

Silt

Silt was encountered underlying the organic silt. The silt was generally described as loose, brown, moist to wet, containing trace clay and some roots and rootlets. The silt extended to depths ranging between about 0.9 m and 1.8 m below ground surface.

Clayey Silt

Clayey silt was encountered beneath the silt. The clayey silt was generally described as soft, grey and wet, and extended beyond the termination depths of the test holes, ranging between about 3.4 m and 3.8 m below ground surface.

Groundwater

Groundwater was encountered only at the test holes advanced at the bottom of the ravine, HA2 Bottom and HA3 Bottom. Groundwater levels are shown on the Test Hole Logs in Appendix A and are summarized in Table 1, below.

It must be noted that the depth to the groundwater table may fluctuate seasonally, or after periods of extended precipitation or drought, and as such may differ at other times.

Table 1: Groundwater Data

Test Hole	Date Test Hole Completed	Date Measured	Ground Surface Elevation	Depth to Water[3]	Groundwater Seepage Elevation
HA2 Top	June 15/10	June 15/10	--	--	--
HA2 Bottom	June 15/10	June 15/10	--	0.2	--
HA3 Top	June 15/10	June 15/10	--	--	--
HA3 Bottom	June 15/10	June 15/10	--	0.0	--

Notes:
1) All units in meters.
2) Due to the nature of the site, densely forested, no ground surface elevations were surveyed.
3) Depths are relative to ground surface.
4) HA2 Bottom is about 7 m north of HA2 Top and about 1.5 m lower in depth.
5) HA3 Bottom is about 12 m southeast of HA3 Top and about 5.0 m lower in depth.

We trust that this letter report is sufficient for your current requirements. Should you require clarification of some point, please contact this office.

Yours truly,

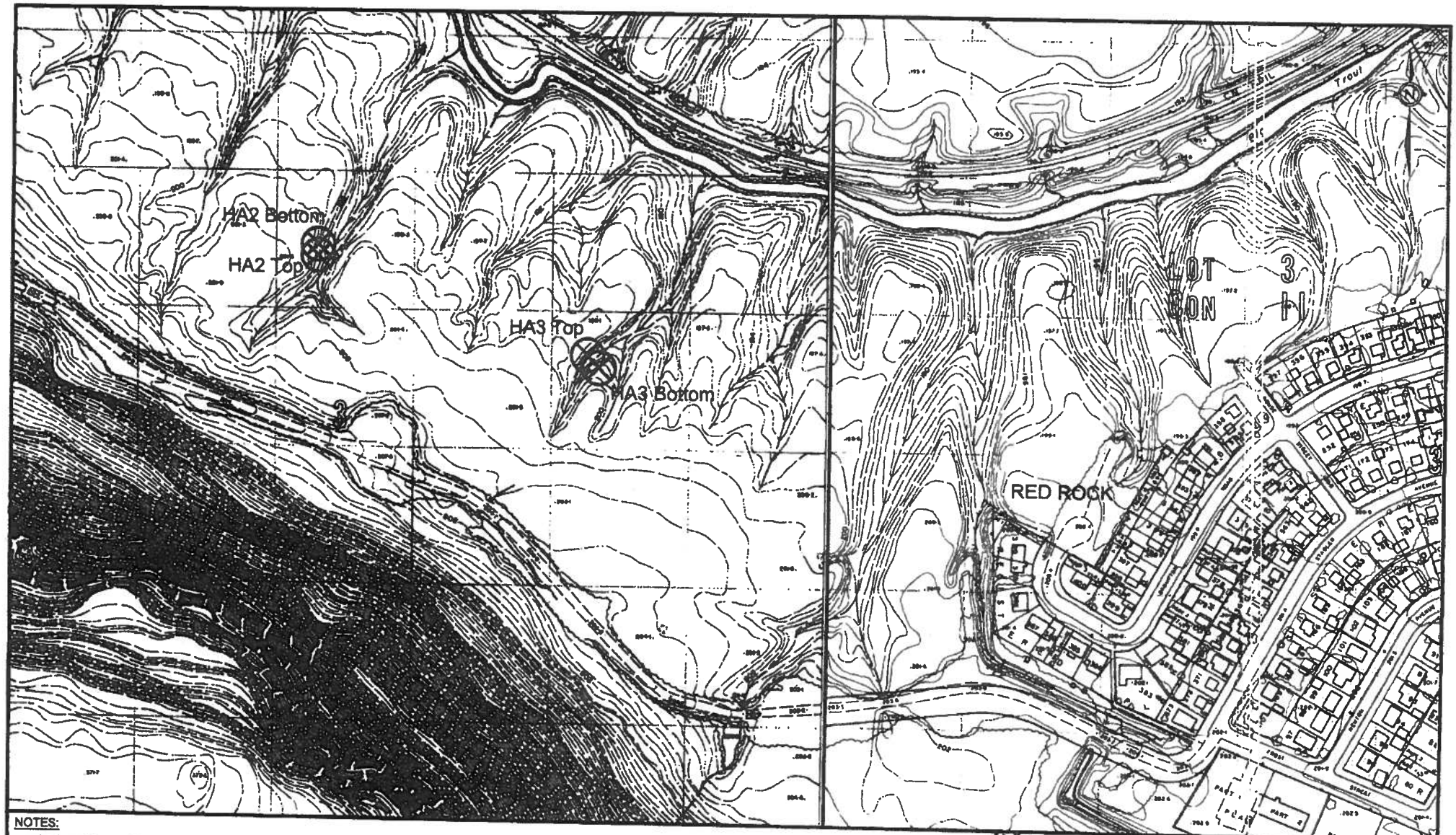
Trow Associates Inc.

Ahileas Mitsopoulos, B.Eng.

Demetri N. Georgiou, MASc., P.Eng
Principal Engineer / Branch Manager

Attachments: Figure 1 – Site & Test Hole Location Plan
Appendix A – Test Hole Logs

FIGURES



NOTES:

1) REFERENCE: 1:2,000 O.B.M. Map Nos. 20 16 4060 54210 and 20 16 4070 54210. North American Datum 1927. Provided by ENL.

LEGEND:

⊗ HA2 Top Hand Auger Test Hole Location

25 0 25 50
IN METERS

Trow Associates Inc.
Thunder Bay, Ontario

FIGURE 1

SITE & TEST HOLE LOCATION PLAN

Preliminary Geotechnical Investigation
Proposed Waste Water Treatment Plant Site - Area 2
West of Red Rock, Ontario
Engineering Northwest Limited

PROJECT NO.:	THB-00009228-AG
SCALE:	1:2,500
DRAWN BY:	AM
CHECKED BY:	DG
DATE:	June 25, 2010

Appendix A

Test Hole Logs

SYMBOLS AND TERMS USED ON THE BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Behavioural properties (i.e. plasticity, permeability) take precedence over particle gradation in describing soils.

Terminology describing soil structure:

Desiccated	-	having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure
Varved	-	composed of regular alternating layers of silt and clay
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or slit and clay
Well Graded	-	having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Uniformly Graded	-	predominantly of one grain size.

Terminology used for describing soil strata based upon the proportion of individual particle sizes present:

Trace, or occasional	less than 10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. silt and sand)	35-50%

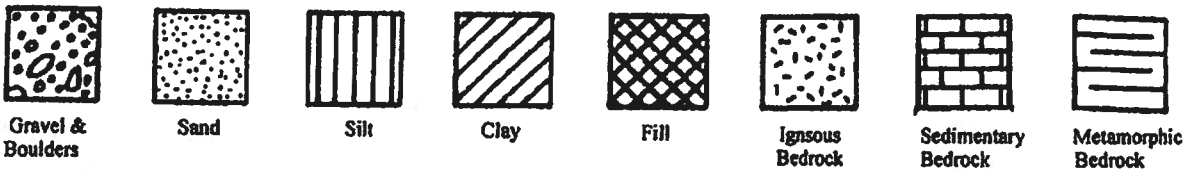
The standard terminology to describe cohesionless soils includes the relative density, as determined by laboratory test or by the Standard Penetration Test 'N' – value: the number of blows of 140 pound (64kg) hammer falling 30 inches (760mm), required to drive a 2 inch (50.8mm) O.D. split spoon sample one foot (305mm) into the soil.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>5	>85

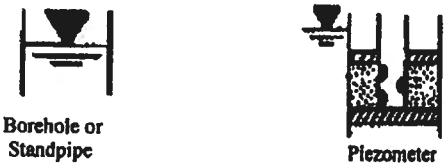
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression tests, or occasionally by standard penetration tests.

Consistency	Undrained Shear Stength		'N' Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

STATA PLOT



WATER LEVEL MEASUREMENT



SAMPLES

SS...	Split spoon sample (obtained by performing the standard penetration test)
ST...	Shelby tube or thin wall tube
PS...	Piston sample
BS...	Bulk sample
WS...	Wash sample
RC...	Rock core AXT, BXL. etc... Rock core samples obtained with the use of standard diamond drilling bits.

OTHER TESTS

G...	Specific gravity
H...	Hydrometer analysis
S...	Sieve analysis
γ	Unit weight
C....	Consolidation
CD...	Consolidated drained triaxial
CU...	Consolidated undrained triaxial with pore pressure measurements
UU...	Unconsolidated undrained triaxial
DS...	Direct shear
P....	Field permeability

ROCK DESCRIPTION

The description of bedrock is based on the rock quality designation (RQD). The classification is based on a modified core recovery percentage in which all pieces of sound core over 100mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, ore weathering in the rock mass and are not counted. In most cases RQD is run on NXL core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from normal insitu fractures.

RQD	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

BOREHOLE LOG

Trow Thunder Bay Branch

HA2 Top

Sheet 1 of 1

PROJECT Proposed Waste Water Treatment Plant, Red Rock, Ontario — PROJECT NO. THB-00009228-AG

CLIENT Engineering Northwest Limited — DATUM N/A

DRILL TYPE/METHOD Diesel Hand Power Auger/SSA — DATES: Boring June 15/10 — Water Level

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)
0						
	0.16	**ORGANIC SILT** - soft, dark brown, wet, roots and rootlets	AS	S1		
		SILT - loose, brown, moist, trace clay, roots and rootlets	AS	S2		
	0.92					
1		**CLAYEY SILT** - soft, brown, wet	AS	S3		
		- becoming grey at about 1.8 m depth				
2			AS	S4		
3			AS	S5		
	3.81					
4		**End of Test Hole**				

OTHER TESTS

SHEAR STRENGTH
S Field Vane Test (#=Sensitivity)
Penetrometer Torvane
40 80 kPa

Atterberg Limits and Moisture
W_P W W_L
SPT N Value Dynamic Cone
20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

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
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

Trow Thunder Bay Branch

HA2 Bottom

Sheet 1 of 1

PROJECT Proposed Waste Water Treatment Plant, Red Rock, Ontario — PROJECT NO. THB-00009228-AG

CLIENT Engineering Northwest Limited — DATUM N/A

DRILL TYPE/METHOD Diesel Hand Power Auger/SSA — DATES: Boring June 15/10 — Water Level June 15/10

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)
0	0.16	ORGANIC SILT - soft, dark brown, wet, roots and rootlets	AS	S1		
		SILT - loose, brown, wet, trace clay, some roots and rootlets	AS	S2		
	0.92					
1		CLAYEY SILT - soft, grey, wet	AS	S3		
2			AS	S4		
		- becoming firm at about 2.6 m depth				
3			AS	S5		
	3.36					
4		End of Test Hole - refusal to auger				

SHEAR STRENGTH
● S Field Vane Test (#=Sensitivity)
▲ Penetrometer ■ Torvane
40 80 kPa

Atterberg Limits and Moisture
W_P W W_L
● SPT N Value × Dynamic Cone
20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

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

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

Trow Thunder Bay Branch

BOREHOLE LOG

HA3 Top

Sheet 1 of 1

PROJECT Proposed Waste Water Treatment Plant, Red Rock, Ontario — PROJECT NO. THB-00009228-AG

CLIENT Engineering Northwest Limited — DATUM N/A

DRILL TYPE/METHOD Diesel Hand Power Auger/SSA — DATES: Boring June 15/10 — Water Level

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WELL LOG	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)	OTHER TESTS
0									
	0.16	**ORGANIC SILT** - soft, dark brown, wet, roots and rootlets			AS	S1			
		SILT - loose, brown, moist, trace clay, some roots and rootlets in upper 0.9 m			AS	S2			
1		- becoming moist to wet, some clay to clayey at about 0.9 m depth			AS	S3			
	1.83								
		CLAYEY SILT - soft, grey, wet							
2					AS	S4			
3					AS	S5			
	3.81								
		End of Test Hole							
4									

SHEAR STRENGTH
- S Field Vane Test (#=Sensitivity)
- ▲ Penetrometer ■ Torvane
- 40 — 80 kPa

Atterberg Limits and Moisture
- W_P W W_L
- ● SPT N Value × Dynamic Cone
- 20 — 40 — 60 — 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

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

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

BOREHOLE LOG

Trow Thunder Bay Branch

HA3 Bottom

Sheet 1 of 1

PROJECT Proposed Waste Water Treatment Plant, Red Rock, Ontario — PROJECT NO. THB-00009228-AG

CLIENT Engineering Northwest Limited — DATUM N/A

DRILL TYPE/METHOD Diesel Hand Power Auger/SSA — DATES: Boring June 15/10 — Water Level June 15/10

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or (%)	SAMPLES N VALUE (blows) or RQD (%)
0	0.16	**ORGANIC SILT** - soft, dark brown, wet, roots and rootlets	AS	S1		
		SILT - loose, brown, wet, trace clay, some roots and rootlets in upper 0.9 m	AS	S2		
1		- some clay at about 0.9 m depth	AS	S3		
	1.83					
2		**CLAYEY SILT** - soft, grey, wet	AS	S4		
3			AS	S5		
	3.66					
4		**End of Test Hole**				

OTHER TESTS

SHEAR STRENGTH
- S Field Vane Test (#=Sensitivity)
- ▲ Penetrometer ■ Torvane
- 40 80 kPa

Atterberg Limits and Moisture
- W_P W W_L
- ● SPT N Value × Dynamic Cone
- 20 40 60 80

NOTES

1) For definition of symbols & terms used on logs, see sheets prior to logs.

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

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