	<b>Project Name</b> <b>407 East Extension Project</b>		<b>Client Name: Her Majesty the Queen</b>	
	<b>Title</b>	<b>Page</b>	<b>Document Number</b>	<b>Rev.</b>
	<b>Structure W-22 Foundation Design Geotechnical Information</b>	1 of 24	610706-33-GEO-RPT-CGP-G005	FA

			<b>407 East Construction General Partnership</b>			<b>HMQ</b>
<b>Rev.</b>	<b>Issue Date</b> (yyyy-mm-dd)	<b>Description</b>	<b>Prepared by</b> Qualitas.	<b>Verified by</b> Quality Manager	<b>Approved by</b> Project Director	<b>Approved by</b>
FA	2013-03-21	Geotechnical information	JA	WG	RH	

# Hwy 407 East Extension Project No. 610706

## Structure W-22 Foundation Design Geotechnical Information

Segment B3

Prepared by:  
Groupe Qualitas Inc.  
401 Hanlan Road, Vaughan, ON, L4L 3T1

Date: 2013-03-21

**FOUNDATION DESIGN  
MEMORANDUM  
FD-W22**

**Reference:** 610706-33-GEO-RPT-CGP-G005\_FA.BRIDGE W22-GEO.pdf  
**Project:** Highway 407 East Extension  
**Title:** Structure W-22  
**Type:** 43 m Single span, integral abutments  
WDL over realigned Lynde Creek Tributary, Twin Bridges

**1 SITE AND GEOTECHNICAL INFORMATIONS**

- 4 boreholes available (W22-1, W22-2, BH-W22-101 and BH-W22-102 (see Appendix 1);
  - Location: see drawings G12166-B3-01B (Appendix 3) and G12166-W22-01 (Appendix 4);
- Stratigraphy: See drawing G12166-W22-01 and attached borehole logs and lab test results (see Appendix 2);
  - Mainly glacial till: dense to very dense silt and sand to silty sand; but with a very loose 1 m layer of sand, trace silt at a depth of 9.0 m;
  - Ground level is generally at an elevation of 118.4 to 120.8 m (except W22-2 which is at 114.8 m);
  - Bedrock was reached in borehole BH-W22-102 at a depth of 20.5 m (Elevation 100.3 m).
- Groundwater level was found to be between Elevations 114.5 to 118.4 m in the 2 boreholes done in 2012, or 2.4 to 3.6 m below grade.
- The HWL in the creek is reported to be close to Elevation 115.42 m.

## **2     DESIGN RECOMMENDATIONS**

### **2.1    FROST PROTECTION**

The foundation must be placed at a minimum depth of 1.2 m below the final grade for adequate frost protection. The equivalent protection could be provided by using polystyrene as suggested by the *Canadian Foundation Engineering Manual* (2006, Section 13.5.2 Page 196). It is usually accepted that 25 mm of polystyrene provide a protection which is equivalent to 600 mm of soil.

### **2.2    FOUNDATION RECOMMENDATIONS**

Two design options could be envisaged at this location:

- 1)    Integral abutment bridge;
- 2)    Semi-integral or box culvert with spread footings.

#### **2.2.1   Integral Abutment Bridge**

- Drawings   610706-33-STR-DRW-005-PA   and   610706-33-STR-DRW-006-PA (Appendix 5) show the general arrangement of the structure;
- According to this drawing, the W-22 structure is an integral abutment structure which uses HP 310 x 110 piles where bottom of CSP will reach Elevation 112.0 m;
- The underside of the abutment walls will be placed near Elevation 115.0 m;
- Piles can be driven to refusal in the very dense glacial till, which could be reached near Elevations 110 to 113, from boreholes BH-W22-101, W22-1 and W22-2. Borehole BH-W22-102 shows that the refusal could be deeper near elevation 104 to 100 m. Thus the piles will develop their geotechnical capacity in end bearing. Pile driving will be difficult and in the final, there is a chance that it will result in very short piles in certain areas, and a very shallow embedment under the CSP.
- Because of these facts, it might be necessary to pre-drill the pile for installation to a depth that would give sufficient embedment. Two solutions should be looked at.

The first solution could be to pre-drill a 300 mm diameter hole to 3 m (or more, if needed for lateral support) below CSP and to backfill it with sand. The pile could be driven through the hole to refusal. Another solution could be to continue the pre-drilled hole (600 mm) under the CSP (to a depth to obtain sufficient lateral support). The pile could be driven to refusal and the pre-drilled hole could be concreted after the pile installation for added lateral resistance. SLS capacity of piles of 1,000 kN and factored ULS capacity of 1,400 kN should be used.

- Lateral capacity of the piles in the glacial till below Elevation 112.0 m can be computed using the following expression for the coefficient of horizontal reaction:

$$k = n_h \frac{z}{d}$$

where  $k$  = coefficient of horizontal subgrade reaction (force per volume) (kN/m<sup>3</sup>)

$z$  = depth (m)

$d$  = diameter or side of the pile (m)

$n_h$  = coefficient of subgrade modulus variation related to soil compactness  
= 6,000 kN/m<sup>3</sup>

## 2.2.2 Semi-integral or box culvert

- Spread footing foundations could also be considered for structure W-22 with a change of the structure (semi-integral or box culvert);
- The proposed footing could be at Elevation 115 or 116 m. It is not recommended to found the footing below elevation 115 because of the influence of the low bearing sand layer (which is very loose). If ground level is lower than Elevation 115, granular “A” pad should be used. Granular “A” fill should be placed in lift of 300 mm thickness and compacted at 100% SP.
- From the result of the boreholes, the soil stratum at Elevation 115 or 116 m is suitable for support of the footings. The alternative footing design shown in the following table can be considered.

FOUNDING ELEVATION (m)	FOUNDING MATERIAL	FACTORED ULS CAPACITY (kPa)	SLS CAPACITY (kPa)
115	Dense to very dense till	400	200
116	Dense to very dense till	400	250

The factored ULS capacity is given for vertical loads. For inclined or eccentric loads, the factored ULS capacity must be revised according to sections 6.7.3 and 6.7.4 of the CHBDC (2006).

## 2.3 LATERAL EARTH PRESSURE

The geotechnical parameters to use in the calculation of the lateral earth pressure are:

PARAMETERS	SYMBOL	BACKFILL	
		Granular "A"	Granular "B" type II
Total unit weight	$\gamma$	22	21
Submerged unit weight	$\gamma'$	12	11
Effective angle of internal friction	$\phi'$	35°	35°
Coefficient of passive earth pressure <sup>(2)</sup>	$K_p$	3.7 <sup>(1)</sup>	3.7 <sup>(1)</sup>
Coefficient of active earth pressure <sup>(2)</sup>	$K_a$	0.27	0.27
Coefficient of earth pressure at rest <sup>(2)</sup>	$K_o$	0.43	0.43
Note 1: The coefficient of passive earth pressure must be reduced to take into account the wall movement required to fully mobilize the passive earth pressure according to Figure 24.5 of the CFEM (2006).			
Note 2: The values of the coefficients in the table are unfactored.			

## **2.4 HORIZONTAL RESISTANCE**

The coefficient of friction ( $\delta$ ) at the base foundation between poured concrete and till (or Granular “A” pad) can be taken as  $35^\circ$  or  $\tan \delta = 0.7$ . This is an unfactored coefficient.

## **2.5 APPROACH FILLS**

- The height of the approach fill will be about 2 to 6 m;
- Settlement of the native soil will most likely take place during construction and is estimated to be less than 10 mm;
- Side slopes should not be steeper than an inclination of 2 H : 1 V and should be protected from erosion.

## **2.6 SEISMIC CONSIDERATION**

- The site is classified as Soil Profile Type I (Table 4.4, CAN/CSA-S6-06).

# **3 CONSTRUCTION RECOMMENDATIONS AND PRECAUTIONS**

## **3.1 INTEGRAL ABUTMENT BRIDGE**

- Bottom of excavations are expected to reach Elevation 112 m if an open excavation is used to put the CSP. Considering that some piles might need pre-drilling, CSP can also be installed in a pre-drilled hole;
- At that elevation, water infiltration may be expected from ground water, with very small flow due to the low permeability of the till, and can be handled by a conventional sump pump arrangement.

### **3.2 SEMI-INTEGRAL OR BOX CULVERT WITH SPREAD FOOTING**

- Bottom of excavation will reach Elevation 115 m for the spread footings;
- Side slopes of the temporary excavation will be stable at 1 H : 1 V;
- Water infiltrations must be handled by a pump of proper capacity;
- Footing should be implemented at a proper depth to be protected from scouring or riprap could be placed in channel for this purpose.

**GROUPE QUALITAS INC.**

Prepared by: Louis D'Amours, P. Eng., M.A.Sc.

Reviewed by: Jean Authier, P. Eng., M.A.Sc.

Date: March 21, 2013

- Appendix 1 - Borehole Logs
- Appendix 2 - Results of Laboratory Tests
- Appendix 3 - Soil Stratigraphy
- Appendix 4 - Borehole Location Plan
- Appendix 5 - Drawings of Structure

# **A P P E N D I X 1**

## **BOREHOLE LOGS**



**CLIENT** : 407 East Construction General Partnership  
**PROJECT** : Highway 407 East Extension  
**LOCATION** : Segment B-3, Whitby, Ontario  
**FILE** : G12166

**BOREHOLE : BH-W22-101**

**DATE** : 2012-09-17

**COORDINATES** : MTM NAD 83

**E**: 345 135.7    **N**: 4 863 766.2

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL 2012-11-08	SAMPLES				IN SITU AND LABORATORY TESTS										
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%) <div><div><div>W<sub>P</sub></div><div>W</div><div>W<sub>L</sub></div></div></div>	OTHER TESTS	▲ C <sub>u</sub> (kPa) ▼ C <sub>us</sub> (kPa) △ C <sub>r</sub> (kPa) ▽ C <sub>rs</sub> (kPa)								
	● N <sub>dc</sub> (blows/300 mm)																	
	10 20 30 40									20 40 60 80								
0.2	118.0	<b>Topsoil.</b> <b>Till</b> : silt and sand, trace gravel and clay. Becoming silty sand, some gravel and clay with depth.  Very dense except between the depths of 1.5 and 2.1 m, where it is dense.		SS-1		63	5											
1				SS-2		100	R											
2				SS-3		100	36											
3				SS-4		100	R											
3.6	114.5			SS-5		100	71											
4				SS-6		100	84											
5				SS-7		100	R											
6				SS-8		100	R											
7				SS-9		100	R											
8				SS-10			R											
9				SS-11			R											
9.3	108.7	<b>End of borehole</b>																

**REMARKS** : R: refusal to the penetration of the split spoon sampler.

**DRILLING METHOD** : Rotation of hollow stem auger to the depth of 7.2 m; simultaneous drilling of a NW casing and NQ core barrel.

**CLIENT** : 407 East Construction General Partnership  
**PROJECT** : Highway 407 East Extension  
**LOCATION** : Segment B-3, Whitby, Ontario  
**FILE** : G12166

**BOREHOLE : BH-W22-102**  
**DATE** : 2012-09-15 to 2012-09-16  
**COORDINATES** : MTM NAD 83  
**E**: 345 104.6    **N**: 4 863 827.7

DEPTH (m)	ELEVATION (m) GEODETIC	DESCRIPTION	WATER LEVEL 2012-11-08	SAMPLES			IN SITU AND LABORATORY TESTS												
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%)				OTHER TESTS	▲ C <sub>u</sub> (kPa) ▼ C <sub>us</sub> (kPa) △ C <sub>r</sub> (kPa) ▽ C <sub>rs</sub> (kPa)						
	<div><div>W<sub>P</sub></div><div>⊕ W</div><div>W<sub>L</sub></div></div>							● N <sub>dc</sub> (blows/300 mm)											
	10							20	30	40	20		40	60	80				
	120.8																		
0.3	120.6	Topsoil.		SS-1	<div><div></div><div></div><div></div></div>	83	7												
		Sand, trace silt and gravel.			<div><div></div><div></div><div></div></div>														
1.0	119.8	Till : silt and sand, trace gravel.		SS-2	<div><div></div><div></div><div></div></div>	100	45												
		Dense.			<div><div></div><div></div><div></div></div>														
2.4	118.4			SS-3	<div><div></div><div></div><div></div></div>	100	33												
				SS-4	<div><div></div><div></div><div></div></div>	100	41							G					
				SS-5	<div><div></div><div></div><div></div></div>	100	50												
3.8	117.0	Till : silty sand, some gravel, trace clay.		SS-6	<div><div></div><div></div><div></div></div>	72	R							G					
		Dense to very dense.			<div><div></div><div></div><div></div></div>														
				SS-7	<div><div></div><div></div><div></div></div>	88	81												
				SS-8	<div><div></div><div></div><div></div></div>	88	81												
				SS-9	<div><div></div><div></div><div></div></div>	47	65												
					<div><div></div><div></div><div></div></div>														
				SS-10	<div><div></div><div></div><div></div></div>	71	42							G S					
					<div><div></div><div></div><div></div></div>														
9.0	111.8	Till : sand, trace silt.		SS-11	<div><div></div><div></div><div></div></div>	50	2												
		Very loose.			<div><div></div><div></div><div></div></div>														

**REMARKS** : R: refusal to the penetration of the split spoon sampler.

**DRILLING METHOD** : Rotation of hollow stem auger to the depth of 13.7 m; simultaneous drilling of a NW casing and NQ core barrel.

**CLIENT** : 407 East Construction General Partnership  
**PROJECT** : Highway 407 East Extension  
**LOCATION** : Segment B-3, Whitby, Ontario  
**FILE** : G12166

**BOREHOLE : BH-W22-102**  
**DATE** : 2012-09-15 to 2012-09-16  
**COORDINATES** : MTM NAD 83  
**E**: 345 104.6    **N**: 4 863 827.7

DEPTH (m)	ELEVATION (m) GEODETTIC	DESCRIPTION	WATER LEVEL 2012-11-08	SAMPLES			IN SITU AND LABORATORY TESTS													
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%)	OTHER TESTS	▲ C <sub>u</sub> (kPa) ▼ C <sub>us</sub> (kPa) △ C <sub>r</sub> (kPa) ▽ C <sub>rs</sub> (kPa)										
	W <sub>P</sub> W <sub>L</sub> W									● N <sub>dc</sub> (blows/300 mm)										
	10   20   30   40							20   40   60   80												
10.0	110.8	Till : silty sand, some gravel.  Compact to very dense.																		
11.0			SS-12		100	52														
12.0			SS-13		75	28														
13.0																				
14.0			SS-14		75	79														
15.0																				
16.0			SS-15		71	78														
17.0			SS-16		83	90														
18.0																				
19.0				SS-17		100	R													
20.0				SS-18		100	R													

**REMARKS** : R: refusal to the penetration of the split spoon sampler.

**DRILLING METHOD** : Rotation of hollow stem auger to the depth of 13.7 m; simultaneous drilling of a NW casing and NQ core barrel.

**CLIENT** : 407 East Construction General Partnership  
**PROJECT** : Highway 407 East Extension  
**LOCATION** : Segment B-3, Whitby, Ontario  
**FILE** : G12166

**BOREHOLE : BH-W22-102**  
**DATE** : 2012-09-15 to 2012-09-16  
**COORDINATES** : MTM NAD 83  
**E**: 345 104.6    **N**: 4 863 827.7

DEPTH (m)	ELEVATION (m) GEODETTIC	DESCRIPTION	WATER LEVEL 2012-11-08	SAMPLES			IN SITU AND LABORATORY TESTS			
				TYPE AND NUMBER	CONDITION	RECOVERY (%)	N or RQD (%)	WATER CONTENT AND ATTERBERG'S LIMITS (%)	OTHER TESTS	
	100.8							$\frac{W_p}{W} \frac{W_L}{W}$ 10 20 30 40	▲ $C_u$ (kPa) ▼ $C_{us}$ (kPa) △ $C_r$ (kPa) ▽ $C_{rs}$ (kPa) ● $N_{dc}$ (blows/300 mm)	20 40 60 80
20.5	100.3	<b>Rock:</b> dark to light grey fissile calcareous shale, horizontal bedding.  Rock of poor to excellent quality.		RC-19		90	49			
22				RC-20		76	47			
23				RC-21		100	97			
24.3	96.5	End of borehole								
25										
26										
27										
28										
29										
30										

**REMARKS** : R: refusal to the penetration of the split spoon sampler.

**DRILLING METHOD** : Rotation of hollow stem auger to the depth of 13.7 m; simultaneous drilling of a NW casing and NQ core barrel.

RECORD OF BOREHOLE No W20-2 2 of 2 METRIC

G.W.P. 07-20015 LOCATION Coords: 4 863 127.7 N; 345 497.7 E ORIGINATED BY Z.I.  
DIST Central HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE December 06, 2010 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20	40
	* 2010 12 08																		
	▽ Water level observed during drilling																		
	▼ Water level measured after drilling																		
	■ Penetrometer test																		

RECORD OF BOREHOLE No W22-1 1 of 1 METRIC

G.W.P. 07-20015 LOCATION Coords: 4 863 780.3 N; 345 129.4 E ORIGINATED BY Z.I.  
DIST Central HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE December 06, 2010 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI C			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED		+ FIELD VANE		● QUICK TRIAXIAL						× LAB VANE		
119.2	Ground Surface						20	40	60	80	100									
0.0	Topsoil																			
119.0	Clayey silt some sand, trace gravel		1	SS	6															
0.2	Firm Brown Moist to hard shale fragments		2	SS	44															
117.5	Sandy silt some clay, trace gravel		3	SS	51															
1.7	Dense to Grey Moist very dense (TILL)		4	SS	38											3 35 43 1				
	clayey silt layers shale fragments		5	SS	52															
115.1	Silty sand some clay, some gravel		6	SS	32															
4.1	Dense to Grey Moist very dense (TILL)		7	SS	42															
	sand layers with gravel		8	SS	100/25cm											27 45 21 7				
			9	SS	100/13cm															
110.1	End of borehole		10	SS	100/3cm															
9.1	Samples 8, 9 and 10: Sampler bouncing																			
	* 2010 12 06																			
	▽ Water level observed during drilling																			
	▼ Water level measured after drilling																			



RECORD OF BOREHOLE No W22-2 1 of 1 METRIC

G.W.P. 07-20015 LOCATION Coords: 4 863 813.5 N; 345 155.5 E ORIGINATED BY Z.T.  
DIST Central HWY 407E BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE December 06, 2010 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ  kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL						
114.8	Ground Surface						20	40	60	80	100					
0.0	Topsoil		1	SS	4											
114.5	Silty sand trace to some clay organic inclusions															
0.3																
114.0	Loose Brown Wet		2	SS	32											
0.8	Silty sand some gravel, trace clay shale fragments															
	Dense to Grey Moist very dense (TILL)		3	SS	75										13 53 30 4	
			4	SS	100/13cm											
			5	SS	100/15cm											
			6	SS	100/5cm											
	trace gravel		7	SS	100/15cm										5 52 36 7	
109.3			8	SS	100/15cm											
5.5	End of borehole															
	Samples 4, 5, 6, 7 and 8: Sampler bouncing															

RECORD OF BOREHOLE No W24-1 1 of 1 METRIC

G.W.P. 07-20015 LOCATION Coords: 4 865 603.9 N; 344 797.5 E ORIGINATED BY A.L.  
DIST Central HWY 407E BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE December 15, 2010 CHECKED BY G.D.

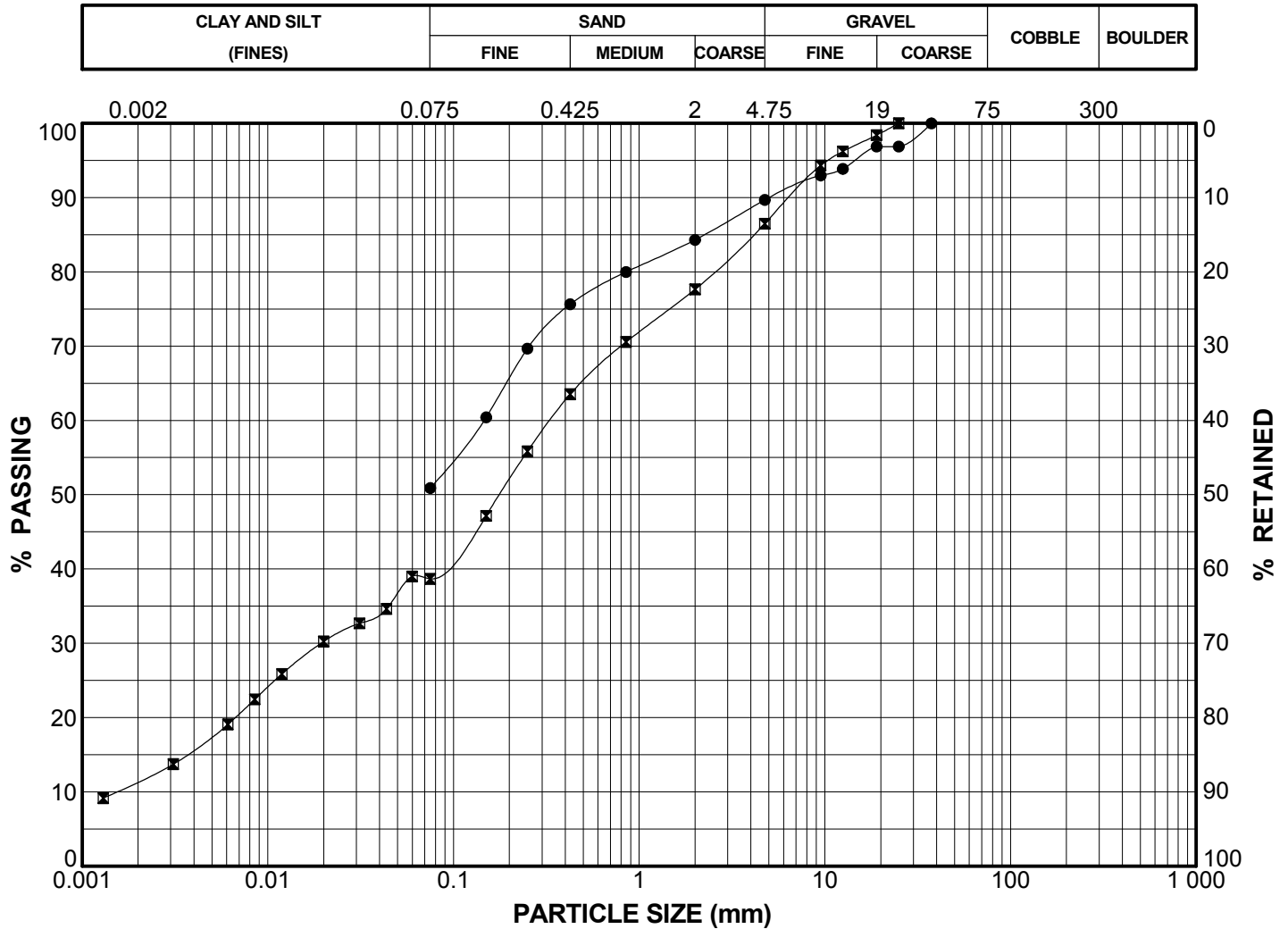
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		SHEAR STRENGTH kPa									
138.1	Ground Surface						20	40	60	80	100					
0.0	Topsoil		1	SS	2											
137.8	Sandy silt, trace clay		2	SS	22	▽*										
0.3	Very loose Brown Wet to compact /grey		3	SS	28											
136.0	Clayey silt trace sand, trace gravel		4	SS	5											
2.1	Firm to Grey Moist soft			FV												
			5	SS	3											
				FV												
			6	SS	3											
132.3	Sand and silt some clay, trace gravel cobbles and boulders		7	SS	28											
5.8	Compact to Grey Moist very dense (TILL)		8	SS	50/5cm											
128.7	End of borehole		9	SS	50/5cm											
9.4	Sample 8 and 9: Sampler bouncing															
	* 2010 12 15															
	▽ Water level observed during drilling															
	▼ Water level measured after drilling															
	■ Penetrometer test															

# **A P P E N D I X 2**

## **RESULTS OF LABORATORY TESTS**

# PARTICLE SIZE DISTRIBUTION

**CLIENT** : 407 East Construction General Partnership  
**PROJECT** : Highway 407 East Extension  
**LOCATION** : Segment B-3, Whitby, Ontario  
**FILE** : G12166



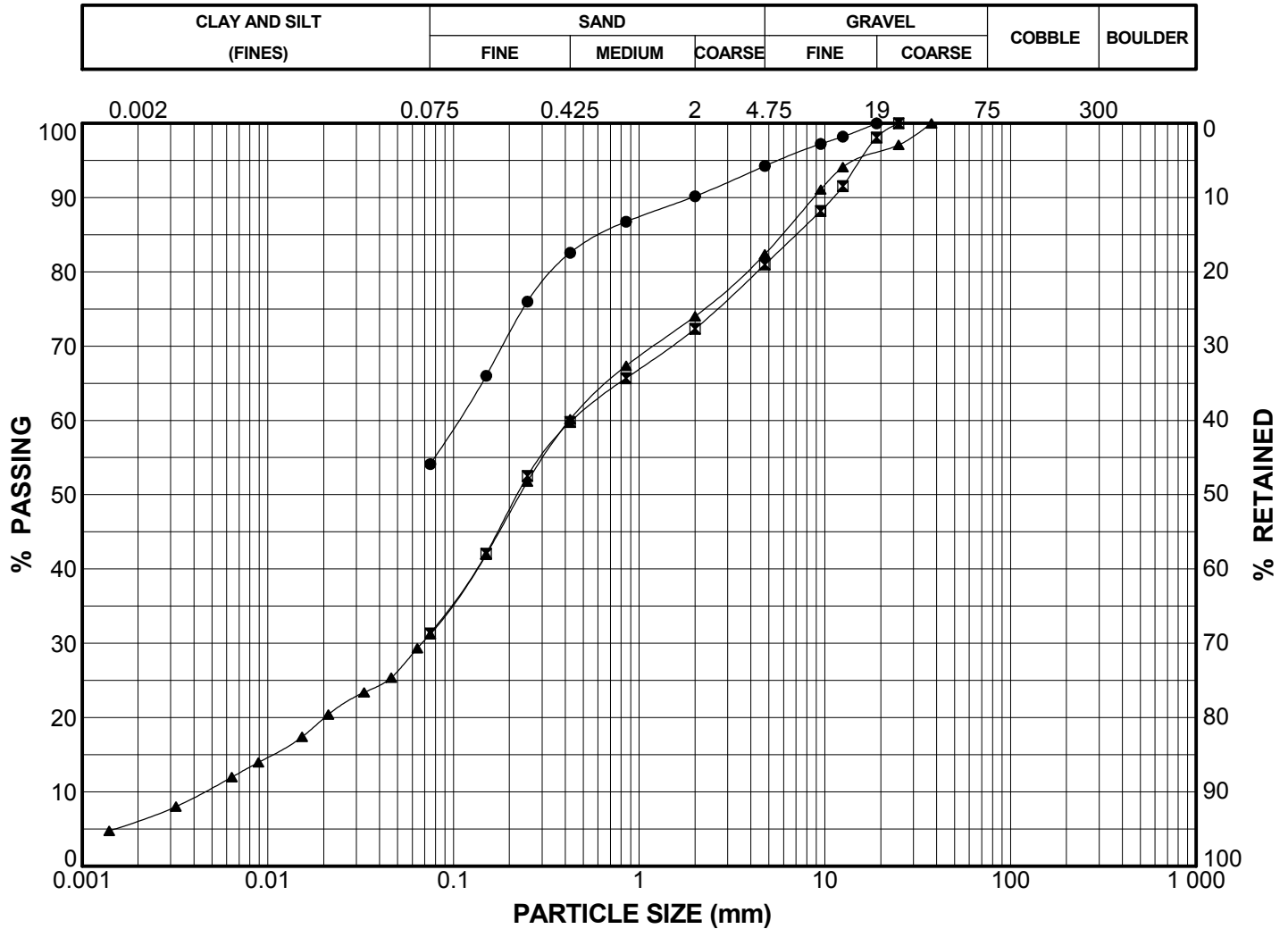
	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-W22-101	SS-3	1.5	2.1	10	39	51		Till : silt and sand, trace gravel.
■	BH-W22-101	SS-6	3.8	4.4	14	48	27	11	Till : silty sand, some gravel and clay.

**REMARKS :**



# PARTICLE SIZE DISTRIBUTION

**CLIENT** : 407 East Construction General Partnership  
**PROJECT** : Highway 407 East Extension  
**LOCATION** : Segment B-3, Whitby, Ontario  
**FILE** : G12166



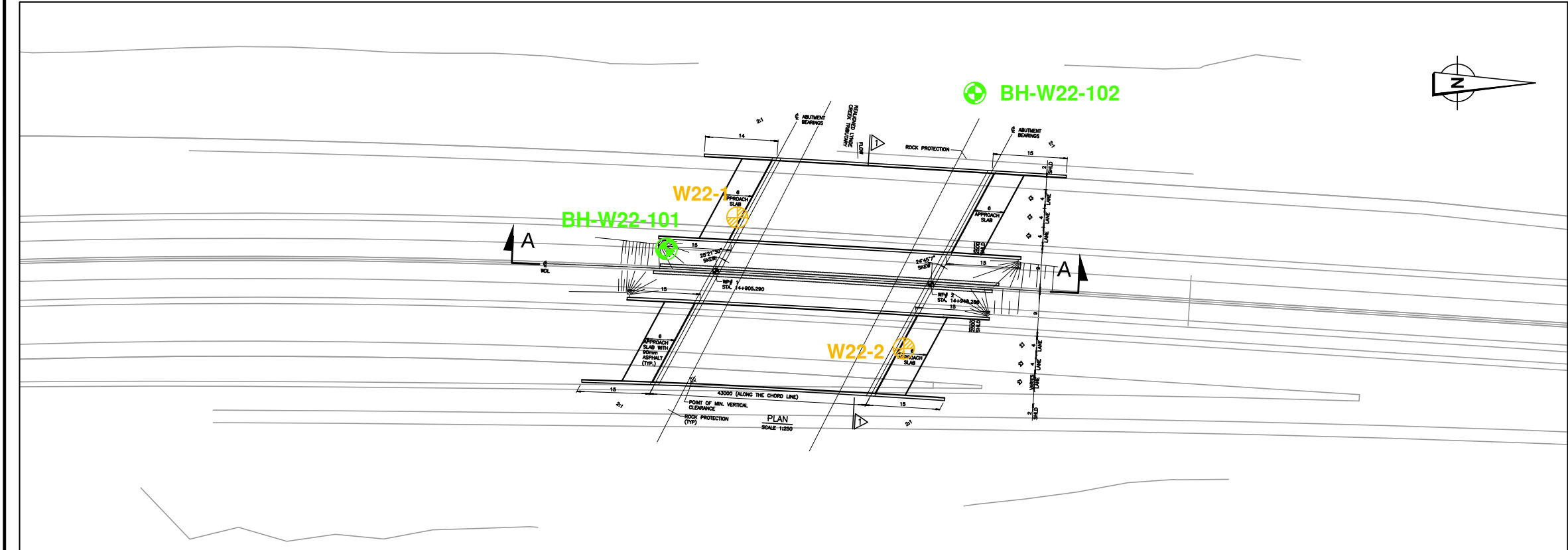
	Sounding	Sample	Depth (m)		Gravel (%)	Sand (%)	Silt and Clay (%)		Description
			from	to					
●	BH-W22-102	SS-4	2.3	2.9	6	40	54		Till : silt and sand, trace gravel.
■	BH-W22-102	SS-6	3.8	4.3	19	50	31		Till : silty sand, some gravel, trace clay.
▲	BH-W22-102	SS-10	7.6	8.2	18	51	25	6	Till : silty sand, some gravel, trace clay.

**REMARKS :**

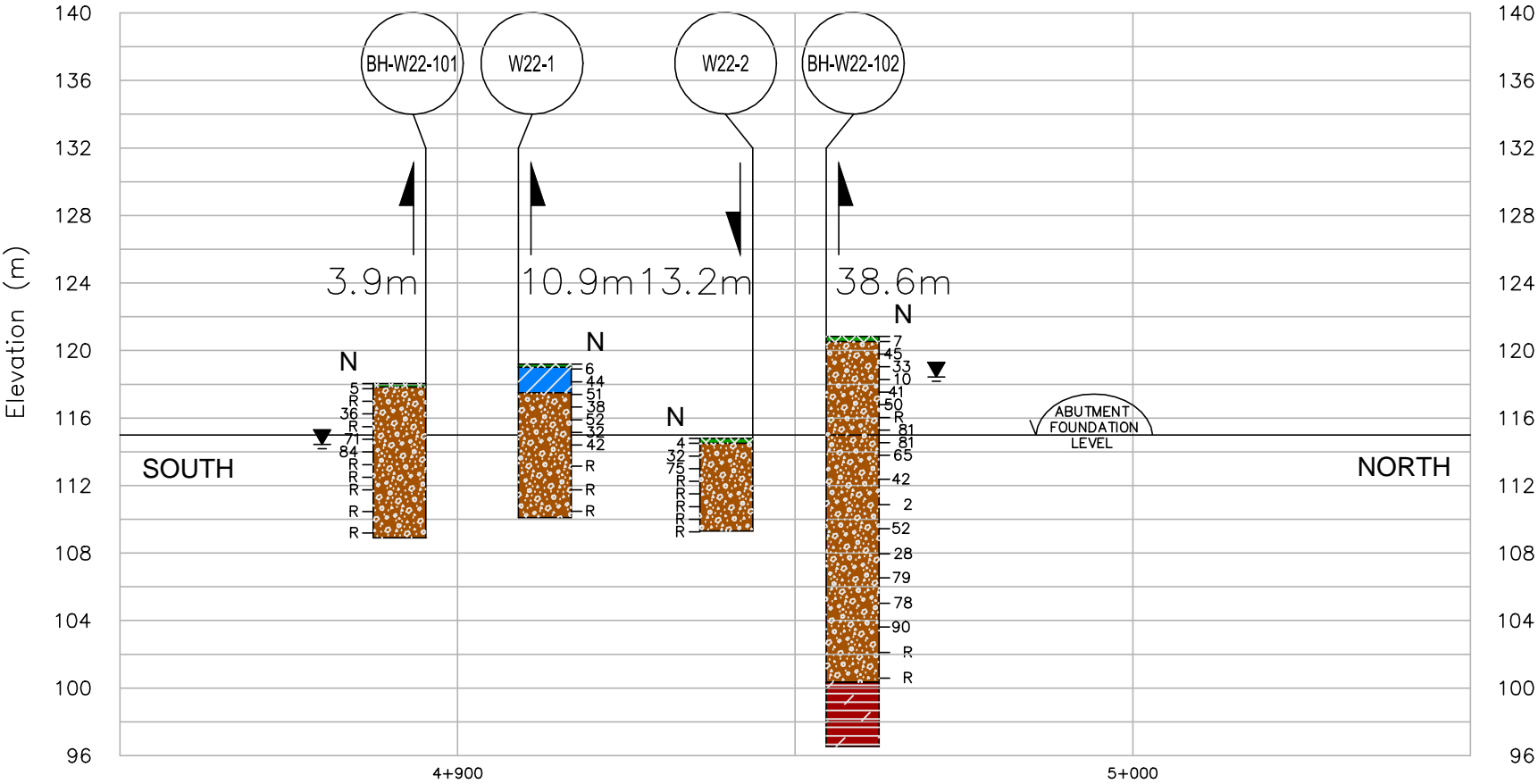
# **A P P E N D I X 3**

## **SOIL STRATIGRAPHY**

T:\PROJ\QUALITAS - ST-LAURENT\Geotech\Projets\Dossiers G12\G12101 à 499\G12166\DAO\ Dessins\G12166-SEG-B3\G12166-SEG-B3-Structure-W22.dwg



STRUCTURE W-22



Scale : 1 : 1000 Hor. / 1 : 400 Vert.  
SECTION A-A

LEGEND

- BH-W22-101** Borehole - Structure
- W22-1** Borehole - Done previously

- Topsoil / Fill / Organic / Asphalt
- Predominantly granular soil  
(sand and silt, sandy silt, silty sand)
- Predominantly clayey soil  
(clay, silty clay, clayey silt)
- Rock



CLIENT:



PROJECT: HIGHWAY 407 EAST EXTENSION  
WEST DURHAM LINK

LOCATION: SEGMENT B-3  
STRUCTURE W-22

TITLE: BOREHOLE LOCATION AND  
STRATIGRAPHIC PROFILE

SCALE: 1 : 1000

DATE:	FILE:	DIV.	DRAWING:
2013-03-20	G12166	W22	01

# **A P P E N D I X 4**

## **BOREHOLE LOCATION PLAN**

T:\PROJ\QUALITAS - ST-LAURENT\Geotech\Projets\Dossiers G12\G12101 à 499\G12166\DAO\Drawings\G12166-SEG-B3 01 to 04 PHOTO.dwg



LEGEND

- TP-B3-14 Test Pit
- BH-W22-101 Borehole - Structure
- W22-1 Borehole - Done previously



CLIENT:



PROJECT: HIGHWAY 407 EAST EXTENSION  
WEST DURHAM LINK

LOCATION: SEGMENT B-3  
STRUCTURES W-22

TITLE: BOREHOLE LOCATION

SCALE: 1 : 2000

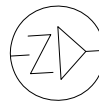
DATE:	FILE:	DIV.	DRAWING:
2013-03-20	G12166	B3	01B

# **A P P E N D I X 5**

## **DRAWINGS OF STRUCTURE**



METRIC  
DIMENSIONS ARE IN METERS  
AND/OR MILLIMETERS  
UNLESS OTHERWISE SHOWN



GENERAL NOTES:

- DESIGN STANDARD AND CODES
1. SCHEDULE 15-1 AND SCHEDULE 15-2: PROJECT AGREEMENT
  2. CAN/CSA-S6-06 CANADIAN HIGHWAY BRIDGE DESIGN CODE
  3. MINISTRY OF TRANSPORTATION OF ONTARIO STRUCTURAL MANUAL
  4. ONTARIO PROVINCIAL STANDARDS SPECIFICATIONS (OPSS)

- DESIGN LOADS
1. LIVE LOAD: CAN/CSA S6-06 & CL-625-ONT INCLUDING DLA
  2. WIND LOAD:  $Q_{f/50} = 0.575 \text{ KPa (WHITBY)}$   
 $Q_{f/100} = 0.64 \text{ KPa (WHITBY)}$
  3. SEISMIC DESIGN CRITERIA
    - ZONAL ACCELERATION RATIO: A = 0.05
    - BRIDGE CLASSIFICATION: EMERGENCY ROUTE
    - IMPORTANCE FACTOR: I = 1.5
    - SITE CLASSIFICATION: S = 1.2 FOR TYPE II

- MATERIAL
1. CONCRETE SHALL HAVE A 28 DAY STRENGTH AS FOLLOWS:
    - PRECAST GIRDER 65 MPa
    - PRECAST DECK PANEL 40 MPa
    - OTHERS 30 MPa
  2. REINFORCING STEEL SHALL CONFORM TO CSA G30.18M GRADE 400R, EXCEPT BARS TO BE WELDED SHALL BE GRADE 400W.
  3. PRESTRESSING STRANDS SHALL CONFORM TO ASTM STANDARD A-416 AND SHALL BE 7 WIRE STRESS-RELIEVED STABILIZED STRAND WITH AN ULTIMATE TENSILE STRENGTH OF 1860 MPa.

ROADWAY CLASSIFICATION: RFD 120

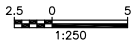
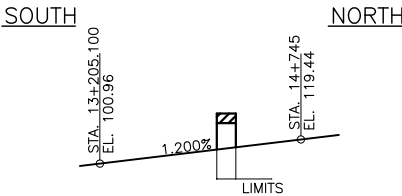
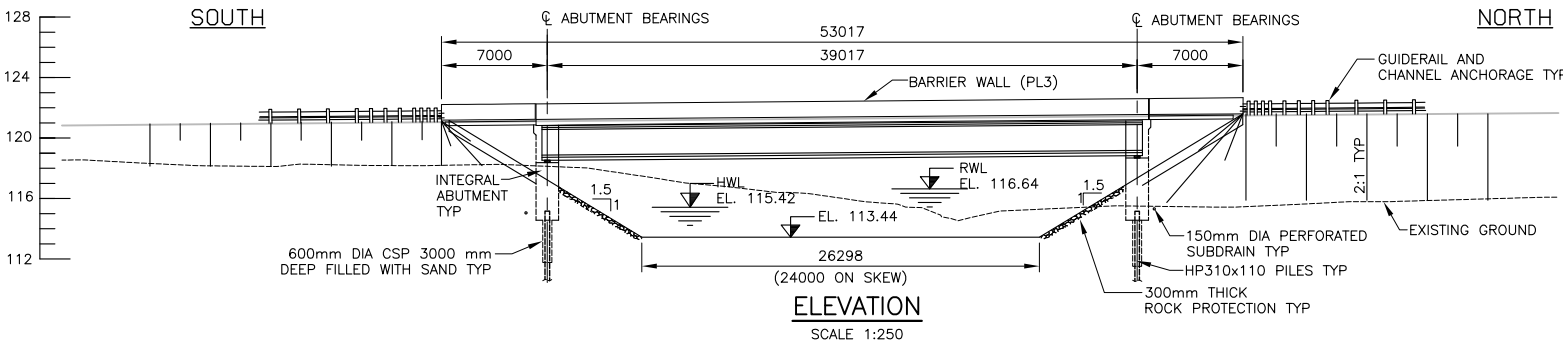
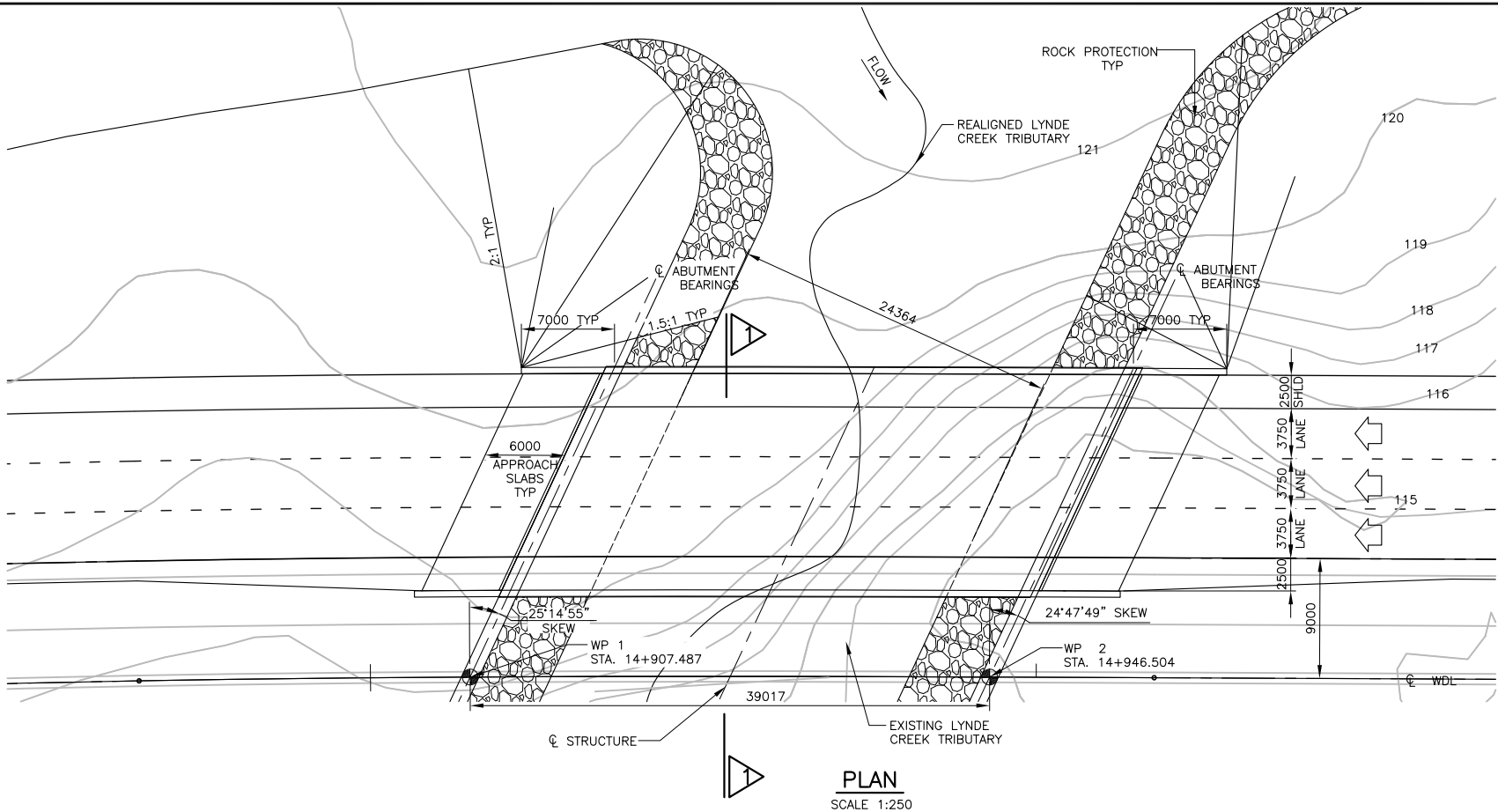
- FOUNDATION NOTES
1. PILE DESIGN AXIAL CAPACITIES: FACTORED GEOTECHNICAL RESISTANCE AT ULS FOR HP310x110 IS 1600 kN

LIST OF ABBREVIATIONS

DIA	DIAMETER
EL.	ELEVATION
HWL	HIGH WATER LEVEL
MIN	MINIMUM
N.T.S.	NOT TO SCALE
RWL	REGIONAL WATER LEVEL
SHLD	SHOULDER
STA.	STATION
T/P	TOP OF PAVEMENT
TYP	TYPICAL
WP	WORK POINT

APPLICABLE STANDARD DRAWINGS



OPSD 3000.100	FOUNDATION, PILES, STEEL H-PILE DRIVING SHOE
OPSD 3000.150	FOUNDATION, PILES, STEEL H-PILE SPLICE
OPSD 3101.150	WALLS, ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD 3370.100	DECK, WATERPROOFING, HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD 3370.101	DECK, WATERPROOFING, HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2 MM WIDE AND CONSTRUCTION JOINTS
OPSD 3390.100	DECK, DRIP CHANNEL
OPSD 3340.100	DECK, DRAINS, WITH DOWNSPOUT
OPSD 3340.150	DECK, DRAINS, WITH TRANSVERSE BAR OPENINGS
OPSD 3419.100	BARRIERS AND RAILINGS, STEEL GUIDE RAIL AND CHANNEL ANCHORAGE
OPSD 3941.200	FIGURES IN CONCRETE, SITE NUMBER AND DATE LAYOUT
OPSD 3950.100	JOINTS, CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE
OPSD 3360.100	DECK, LIGHT POLE BASES, STRUCTURES WITH BARRIER WALLS
OPSD 3102.100	WALLS, ABUTMENT, BACKFILL DRAIN
OPSD 3190.100	WALLS, RETAINING AND ABUTMENT, WALL DRAIN
OPSD 2302.040	EMBEDDED WORK IN STRUCTURE - NEW JERSEY TYPE CONCRETE BARRIER WALL



SCALE  
10m 0 20m

PRE-FINAL SUBMITTAL  
FOR REVIEW ONLY  
2012-12-21

NOT FOR  
CONSTRUCTION

REVISIONS	DATE	DESCRIPTION	DESIGNED BY:	DRAWN BY:	CHECKED BY:	SEAL 1	SEAL 2	CONSULTANT	NAME (PRINT)	INIT.	DATE	ENGINEER 1	<div>JANSEN &amp; SPAANS ENGINEERING INC.</div> <div></div>	TITLE											
	YYYY-MM-DD								DESIGNED					ENGINEER 2	<div>PLANMAC ENGINEERING INC.</div> <div></div>	HIGHWAY 407 EAST EXTENSION GENERAL ARRANGEMENT SHEET 1 STRUCTURE W22 SB WDL OVER REALIGNED LYNDE CREEK TRIBUTARY									
	YYYY-MM-DD								DRAWN					CODE			CHBDC-06	LOAD	CL-625-ONT	SITE	44				
	YYYY-MM-DD								CHECKED					PROJECT NO.			610706	SUBDIVISION	33	DISC. STR	DOC. DRW	DRAWING NUMBER	005	REVISION NUMBER	PA
	YYYY-MM-DD								APPROVED LEAD ENG.																
	YYYY-MM-DD								APPROVED PROJ. MANAGER																
	YYYY-MM-DD																								
	YYYY-MM-DD																								

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AND/OR MILLIMETERS  
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3. SEISMIC DESIGN CRITERIA
- ZONAL ACCELERATION RATIO:  $A = 0.05$
  - BRIDGE CLASSIFICATION: EMERGENCY ROUTE (OVERPASS AND UNDERPASS)
  - IMPORTANCE FACTOR:  $I = 1.5$
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ROADWAY CLASSIFICATION: RFD 120

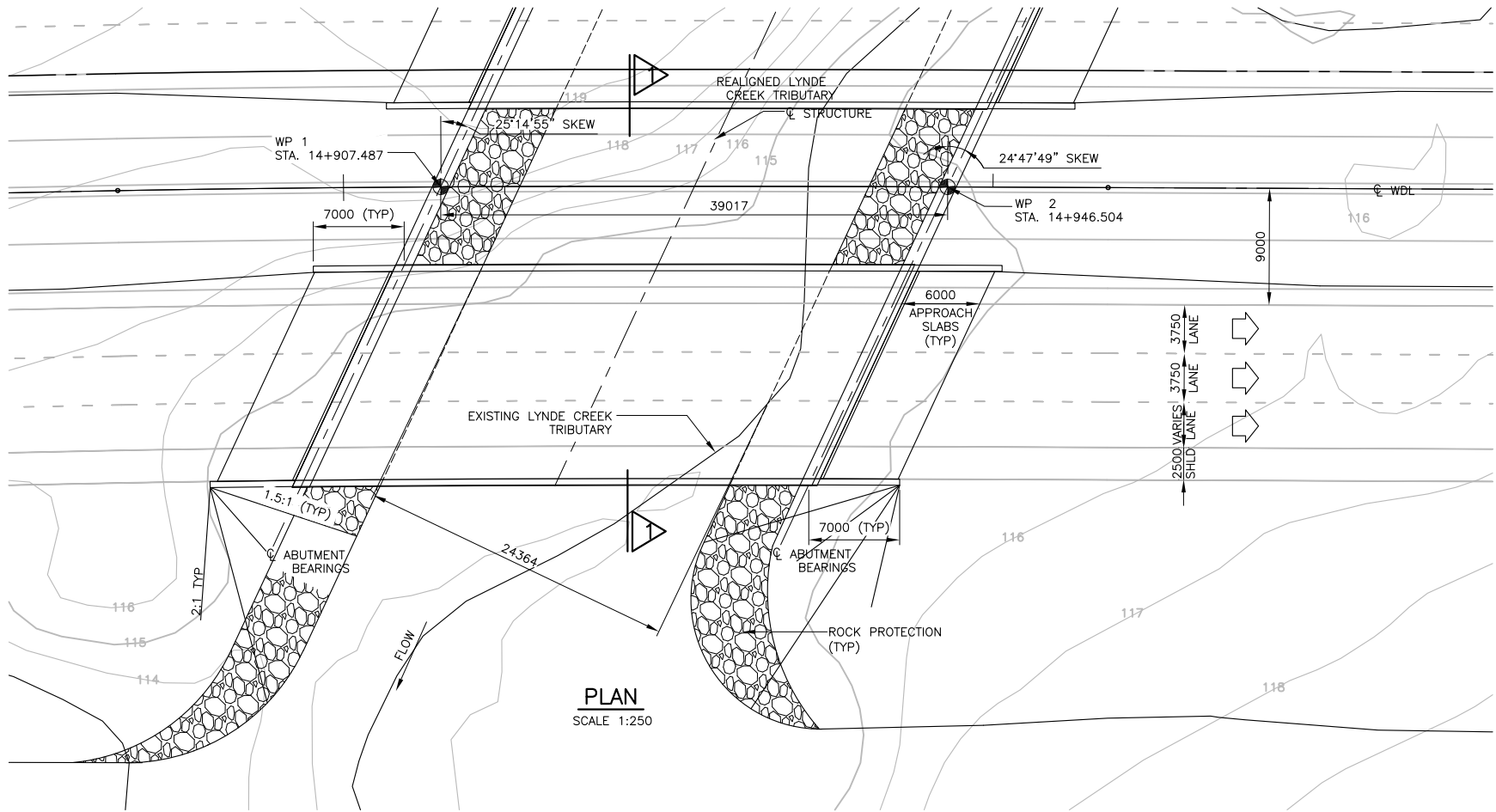
- FOUNDATION NOTES
- PILE DESIGN AXIAL CAPACITIES: FACTORED GEOTECHNICAL RESISTANCE AT ULS FOR HP310x110 IS 1600 kN

LIST OF ABBREVIATIONS

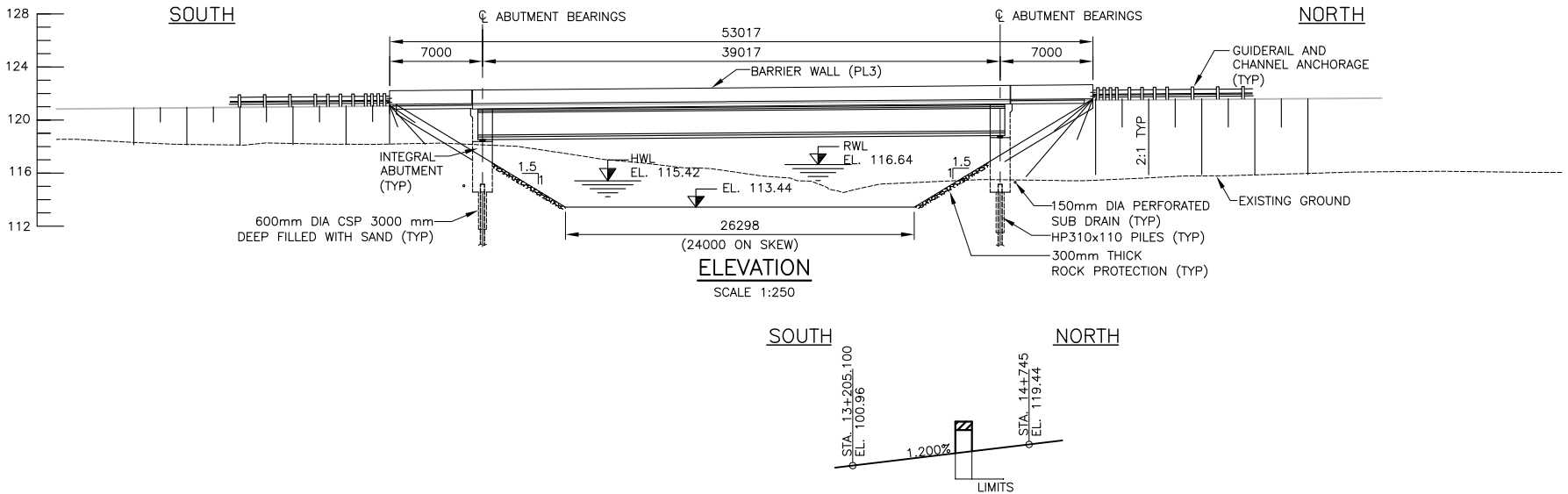
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STA.	STATION
T/P	TOP OF PAVEMENT
TYP	TYPICAL
WP	WORK POINT

APPLICABLE STANDARD DRAWINGS

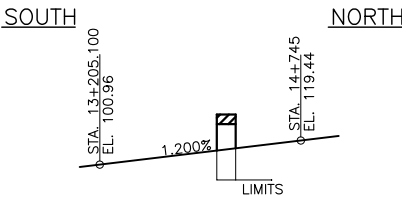
OPSD	3000.100	FOUNDATION, PILES, STEEL H-PILE DRIVING SHOE
OPSD	3000.150	FOUNDATION, PILES, STEEL H-PILE SPLICE
OPSD	3101.150	WALLS, ABUTMENT, BACKFILL MINIMUM GRANULAR REQUIREMENT
OPSD	3370.100	DECK, WATERPROOFING, HOT APPLIED ASPHALT MEMBRANE WITH PROTECTION BOARD
OPSD	3370.101	DECK, WATERPROOFING, HOT APPLIED ASPHALT MEMBRANE AT ACTIVE CRACKS GREATER THAN 2 MM WIDE AND CONSTRUCTION JOINTS
OPSD	3390.100	DECK, DRIP CHANNEL
OPSD	3340.100	DECK, DRAINS, WITH DOWNSPOUT
OPSD	3340.150	DECK, DRAINS, WITH TRANSVERSE BAR OPENINGS
OPSD	3419.100	BARRIERS AND RAILINGS, STEEL GUIDE RAIL AND CHANNEL ANCHORAGE
OPSD	3941.200	FIGURES IN CONCRETE, SITE NUMBER AND DATE LAYOUT
OPSD	3950.100	JOINTS, CONCRETE EXPANSION AND CONSTRUCTION ON STRUCTURE
OPSD	3360.100	DECK, LIGHT POLE BASES, STRUCTURES WITH BARRIER WALLS
OPSD	3102.100	WALLS, ABUTMENT, BACKFILL DRAIN
OPSD	3190.100	WALLS, RETAINING AND ABUTMENT, WALL DRAIN
OPSD	2302.040	EMBEDDED WORK IN STRUCTURE - NEW JERSEY TYPE CONCRETE BARRIER WALL



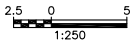
PLAN  
SCALE 1:250



ELEVATION  
SCALE 1:250



PROFILE OF WDL  
N.T.S.



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REVISIONS	DATE	DESCRIPTION	DESIGNED BY:	DRAWN BY:	CHECKED BY:	SEAL 1	SEAL 2	CONSULTANT	NAME (PRINT)	INIT.	DATE
	YYYY-MM-DD							DESIGNED			
	YYYY-MM-DD							DRAWN			
	YYYY-MM-DD							CHECKED			
	YYYY-MM-DD							APPROVED LEAD ENG.			
	YYYY-MM-DD							APPROVED PROJ. MANAGER			
	YYYY-MM-DD										
	YYYY-MM-DD										

CONTRACTOR	407E CGP	OWNER	MTO
ENGINEER 1	JANSSEN & SPAANS ENGINEERING INC.	ENGINEER 2	PLANMAC ENGINEERING INC.
TITLE		HIGHWAY 407 EAST EXTENSION GENERAL ARRANGEMENT SHEET 2 STRUCTURE W22 NB WDL OVER REALIGNED LYNDE CREEK TRIBUTARY	
CODE	CHBDC-06	LOAD	CL-625-ONT
PROJECT NO.	610706	SUBDIVISION	33
DISC. STR.	DOC. DRW	SITE	44
DRAWING NUMBER	006	REVISION NUMBER	PA