



October 5, 2017

STATIC PILE LOAD TEST REPORT

**South Canal Bridges - North Abutment
Highway 400 Widening from North of King
Road to North of South Canal Road,
Regional Municipality of York
GWP 2025-13-00**

Submitted to:

MTO Central Region
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GEOCRES No. 31D-759

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Distribution:

- 1 Electronic Copy - MTO Foundations Section
- 1 Electronic Copy - Golder Associates Ltd.

REPORT





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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) was retained by the Ministry of Transportation, Ontario (MTO) to oversee and monitor a full-scale static pile load test during construction of the Highway 400-South Canal bridge replacements (see Figure 1 in Appendix A) as part of the widening of Highway 400 from north of King Road to north of South Canal Road in the Regional Municipality of York, Ontario (Contract #2015-2004). The following sections provide a summary of the details associated with the test pile location, installation, testing procedures and results, and a discussion on our interpretation of the results.

The intended purpose of the full-scale pile load test was to compare it with the calculated design geotechnical resistance value and dynamic testing results to verify and optimize correlations between theory, calculated dynamic testing results upon initial driving, and actual measured longer-term geotechnical resistance of the pile in compression. Based on the history of static pile load testing and the soil and groundwater conditions at this site (i.e., presence of artesian pressures), it was anticipated that the full-scale pile load test (if conducted a reasonable time after pile installation) would measure higher pile capacities compared to dynamic testing performed upon initial driving, or on retap within a short period of time following initial driving, at the north abutment. This phenomenon of anticipated strength gain over time is documented in other studies and is attributed to dissipation of pore water pressures over time that increase / peak during initial pile driving. However, the flowing artesian conditions and fine-grained nature of the underlying soils at this site create a unique condition and confirmation of the strength gain over time was considered prudent. Based on the results of the full-scale pile load test, it is intended that consideration be given to using higher geotechnical resistance factors and consequently relatively higher design geotechnical resistances that would allow for optimization of the next stage of pile installation at the north abutment of the South Canal bridges.

In addition, the results of the full-scale pile load test can be used to study the development of geotechnical resistances with time in relatively fine-grained (non-cohesive) soil conditions under artesian pressures, for applicability to other highway bridges in similar conditions.

2.0 BACKGROUND

The Highway 400-South Canal bridges (northbound and southbound) are located approximately 0.5 km north of Highway 9 in the Regional Municipality of York. The existing South Canal bridges span over an approximately 18 m wide excavated canal and the South Canal Bank Road. Both bridges consist of six-span structures constructed in 1948, with the original structures supported on driven timber piles. The bridges were widened toward the outside in 1971, with the widened portion supported on driven steel H-piles.

The detailed design of the new bridge replacements was carried out by AECOM between 2009 and 2015 and driven steel H-piles were selected for support of the new abutments and centre pier for the replacement bridges. Foundation recommendations for design of the proposed new bridges were provided by Golder in the Foundation Investigation and Design Report (FIDR) for the South Canal Bridges, dated July 2015 (GEOCRE No. 31D-556). It is noted that flowing artesian conditions (i.e. high hydrostatic head) were measured within the sand and gravel aquifer located below the lower-permeability soils at the site, and the steel piles were to be driven near the transition between the low permeability layer and this underlying aquifer.



The contract was awarded to The Miller Group (Contractor) and the foundation piling works were subcontracted to Anchor Shoring & Caissons Limited (Anchor). The Contract Administrator (CA) contract was awarded to Highway Construction Inspection (HCI). A copy of the General Arrangement drawing and Borehole Location and Soil Strata drawings for the Contract, as well as pile layout shop drawings for the north abutment foundations are included in Appendix B for reference. Construction to replace the bridges began in 2016, and included a staged approach to limit impacts to traffic on Highway 400. The initial stages of construction included removing and replacing the outside portion of both the northbound and southbound bridges while maintaining traffic on the existing Highway 400 bridges, and piling operations were completed for this stage (Stage 2) in 2016. It is understood that traffic will be diverted to the new widened portion of the bridges and the inner portion of the existing bridges will be removed and replaced with new bridges and foundations as part of Stage 3 construction.

During Stage 2 construction activities for the widened portion of the new bridges, it is understood that challenges and delays were realized due to a number of driven piles at the north abutments not achieving the required design geotechnical resistance during initial stages of pile driving, or on subsequent retapping.

It was decided that a full-scale Pile Load Test was to be performed and compared to the results from PDA testing (and Hiley testing, if available based on hammer type) to allow for optimization in correlations between the PDA test results and actual, longer-term pile capacities in compression.

In collaboration with MTO and the CA, Anchor installed a test pile near the east side of the north abutment of the new widened portion of the South Canal Bridge at the end of Stage 2 operations (see Figure 1) on October 6, 2016. The pile was left in place over the winter and spring, and a Pile Load Test (in general accordance with ASTM 1143) was performed on June 21, 2017, approximately eight months after initial pile installation. The following sections summarize the details of the test pile location and installation, pile load test procedures and results. The last section of the report provides a discussion and our interpretation of the pile load test results.

3.0 SUBSURFACE CONDITIONS AT TEST PILE SITE

3.1 Regional Geology

The South Canal bridge site is located within the Simcoe Lowlands physiographic region according to *The Physiography of Southern Ontario* (Chapman and Putman, 1984), and specifically within the Holland River valley. The Holland River valley is bounded on the south by the South Canal. The floor of the valley consists of peat, soft clays and loose sands. It is understood that during initial construction of Highway 400 through this area, a layer of peat about 2 m to 3 m thick was removed in order to construct the road upon the underlying sand and clay.

3.2 Subsurface Conditions

As part of the foundation investigation for design of the new bridge structures, a total of thirteen boreholes (Boreholes SC-1 to SC-5, SC-7 to SC-11, SC-13, SC-14, and BO-9) were advanced at the South Canal bridges site by Golder, supplemented with three boreholes (F8-2, F8-3 and F8-6) drilled for adjacent high fill embankment areas, and one borehole (OHS7) drilled for a nearby overhead sign. The detailed subsurface soil and groundwater conditions encountered in the boreholes and the results of in situ and laboratory testing are provided in the Foundation Investigation Report (GEOCRES No. 31D-556). A copy of the Borehole Location and Soil Strata drawings provided for the Contract (Sheet Nos. 436 to 439) is included in Appendix B for reference.



The approximate location of the test pile (i.e. Pile Load Test) has been added to Sheet No. 435 for reference in Appendix B. Based on the closest borehole (BO-9), the subsurface conditions generally consist of a surficial layer of topsoil underlain by a layer of firm clayey silt containing organics / peat to a depth of about 2.6 m below ground surface (Elevation 218.4 m). The organic deposit is underlain by a firm to stiff clayey silt to silt deposit containing silty sand interlayers to a depth of about 17.8 m (203.2 m), which is underlain by a compact to very dense sand and silt deposit (classified as a till in adjacent boreholes) to a depth of 23.9 m (Elevation 197.1m). The sand and silt is underlain by interlayers of hard clayey silt and very dense sand to sand and gravel to the termination depth of 26.5 m (Elevation 194.5 m). Flowing artesian groundwater conditions were encountered below a depth of 25.9 m (Elevation 195.1 m) and the water level was measured to be 1.6 m above ground surface (Elevation 222.6 m) within the casing upon completion of drilling operations.

Adjacent boreholes (SC-4 and SC-5) were terminated at depths of 27.9 m (Elevation 192.9 m) and 15.9 m (Elevation 205.3 m) respectively and soil conditions were generally consistent with Borehole BO-9. Unstable “piping” conditions were encountered in the boreholes at depths as shallow as 15.2 m below ground surface (Elevation 205.9 m). Copies of the relevant borehole records are included in Appendix B.

4.0 TEST PILE INSTALLATION

Golder, in collaboration with MTO, prepared and submitted a site-specific scope/work plan to be followed by the Contractor for installation of the test pile and full-scale pile load test procedure. A copy of the scope/work plan titled “Full-Scale Pile Load Test at North Abutment to South Canal Bridges, Highway 400 widening from North of King Road to North of South Canal Road, Regional Municipality of York” is provided in Appendix C and was submitted to MTO and HCI on September 30, 2016, for distribution to the Contractor.

Based on the scope/work plan, the Contractor was instructed to follow the installation procedure below:

“The test pile shall be driven to Elevation 204 m. Given the variable thickness and top elevation of the “100-blow” soil, allowance shall be made for the test pile to be driven up to 2 m deeper, to about Elevation 202 m, upon consultation with MTO Foundations Section and the foundations sub-consultant (Golder Associates Ltd.) to the appropriate pile “set” value prior to the Pile Load Test.”

The test pile location was selected by the Contractor, in collaboration with the CA, and is shown on Figure 1. Golder engineering staff were not present on site during the test pile installation; however, information provided by HCI and the Contractor indicate the test pile (HP310X110 steel H-pile) was driven using a Liebherr H40/4 hydraulic hammer with a rated energy of about 30 kJ. As indicated in the work plan, a hydraulic hammer was used for cost efficiency purposes (as this type of piling rig was already on site in the vicinity of the north abutment), and therefore Hiley testing (conventionally used with diesel hammers) was not carried out. The existing ground surface surrounding the test pile was at about Elevation 220.5 m, and the pile was driven to a final tip elevation of 204 m (i.e., final embedment depth of about 16.5 m below ground surface).

The “set” criteria that was to be established for the test pile to reach the design factored geotechnical resistance value (f-ULS) of 1,275 kN (for production piles in Stage 3) was not achieved, based on comparison to piles driven at the north abutment as part of the previous stage, and based on the information provided by HCI. Pile Driving Analyzer (PDA) testing was carried out on the test pile in increments of 0.5 m between pile tip elevations 205.5 m and 204 m, and the results indicate the estimated initial pile “set” value was not achieved.



Based on the PDA test results, the estimated geotechnical resistance value in compression (ultimate geotechnical resistance of 1,100 kN, and factored ultimate geotechnical resistance (f-ULS) of 550 kN) was significantly lower than design requirements (f-ULS = 1,275 kN), and lower than the results of PDA tests performed on production piles at the North Abutment during Stage 2 piling. Details of the PDA test procedure and results are included in the report titled “*Dynamic Testing and Analyses of Test Pile at Northeast Abutment*” dated November 1, 2016 and included in Appendix D.

5.0 FULL-SCALE STATIC PILE LOAD TEST

5.1 Load Test Set-up

The reaction load system for the PLT was designed, supplied and constructed by the Contractor. Anchor provided pile test arrangement drawings (Drawing Nos. LT1, LT2 and LT3, revision dated June 5, 2017) that show two W920x420 steel beams anchored at each end by two steel W610x155 beams connected to a reaction system consisting of two 760 mm diameter, 7 m deep drilled caissons. A copy of the sealed drawings is provided in Appendix E. A total of four reaction caissons are shown to be designed to resist a total test load of 2,550 kN. The original scope/work plan specified a maximum test load of 3,200 kN was required; however, MTO accepted the lower design reaction based on schedule requirements for the load test, but requested that additional load be applied (if possible) during the test if failure of the test pile had not yet been reached at 2,550 kN.

A hydraulic cylinder jack was used to transfer the load between the top of the pile and the reaction frame. Four dial gauges were set up radially on a reference frame to measure the vertical movements of the top of the pile as the test progressed. The dial gauge readings were used as the primary measurement system for pile axial movements and a series of additional survey points at the top of the pile were measured periodically by a licensed surveyor as a secondary measurement system during the test.

Calibration certificates for the hydraulic cylinder jack and dial gauges were provided by Anchor and copies of the certificates are included in Appendix E. A load cell was requested in the work/scope plan but not incorporated into the loading system by the Contractor; as a result the loads (discussed in the next section) were converted to an equivalent pressure for the hydraulic jack system and the pressure gauge continuously checked and recorded.

A site visit made by Golder representatives on June 20, 2017 (one day before the scheduled test) confirmed the set-up was in general agreement with ASTM 1143.

5.2 Load Test Procedure

The static load test was carried out in general accordance with ASTM D1143-07 using a modified Procedure A – Quick Test method as per the loading and measurement procedure outlined in a letter provided by Golder to the CA titled “*Full-scale Pile Load Test at North Abutment of South Canal Bridges, Highway 400 Widening from North of King Road and North of South Canal Road, Regional Municipality of York*”, dated June 19, 2017 (see copy of letter in Appendix F).

Referring to the June 19th letter, loading was to be carried out in eight increments up to a maximum load of 3,200 kN; however, based on the Contractor’s indication that the reaction system was only capable of sustaining a load of 2,550 kN, it was agreed by all parties (MTO/Golder/CA/Contractor) on the day before the static pile load test that the loading increments be revised as follows:



- six loading increments, at 300, 600, 1200, 1800, 2200 and 2550 kN;
- followed by four unloading increments equal to about 75%, 50%, 25% and 0% of the maximum load achieved.

On behalf of the MTO, Golder requested that consideration be given to increasing the maximum load to beyond 2,550 kN if failure was not achieved; however, the Contractor was reluctant to increase the test load beyond the maximum load the reaction system was designed for, to which Golder/MTO agreed and accepted. The loading increments were to be held for a minimum of 20 minutes, or until the rate of displacement was measured to be less than 0.25 mm per hour (with a maximum of 2 hours).

5.3 Load Test Results

The pile load test was initiated at 8:45 a.m. on June 21, 2017 and all readings were completed by 9:40 a.m. on June 22, 2017. At the time of the test, the weather varied from clear to overcast and there was no rain throughout the duration of the test (see Photographs 1 and 2 in Appendix G). A representative from Anchor applied the load increments by adjusting the hydraulic jack pressures in collaboration with a Golder representative who checked loading increments, calculated and determined hold times, and recorded the pile displacements from the dial gauges (i.e. primary measurement system). A surveyor retained by the Contractor recorded survey measurements of the pile displacements (secondary measurement system) and reaction system (surveyed top of reaction caissons) at each load increment and decrement. Pictures of the pile load test set-up and operation are shown on Photographs 3 to 6 (Appendix G).

It was noted that construction at the South Canal Bridges was ongoing and construction traffic created noticeable “felt” vibrations in the area of the pile load test. Although the vibrations did not appear to affect dial gauge or survey reading accuracy, it is unknown whether vibrations may have impacted the geotechnical resistance / performance of the test pile and/or reaction system caissons.

The results of the pile load test are shown on three corresponding plots on Figure 2 (Appendix A) as follows:

- i) applied load vs. time,
- ii) pile movement vs. time, and
- iii) applied load vs. pile movement.

The pile movement on Figure 2 is based on the average of the four dial gauge readings; the average of the survey point (four total) readings is also shown. The applied load on the test pile was measured from the pressure gauge of the hydraulic jack and was continuously monitored and adjusted in an attempt to sustain constant load, where possible.

It is important to note that, while attempting to increase the test load above 1,800 kN, the caisson reaction system started to heave / fail and the subsequent load increment of 2,200 kN could not be maintained before the hydraulic jack reached the maximum stroke. As a result, the test was interrupted and the pile completely unloaded to allow for the reaction frame / beams to be lowered and re-set, after which time the load was reapplied in an attempt to reach the 2,200 kN load increment. However, the load could not be maintained on this second attempt and ultimate failure of the reaction caissons was reached. Figure 3 (Appendix A) shows the results of the reaction caisson movement (average) and applied load vs. time and indicates the caissons heaved almost 150 mm on average while attempting to reach a load of 2,200 kN.



Photographs (Appendix G) of the top of the caisson located on the north side of the reaction system prior to and after the test are shown on Photographs 4 and 7. Photograph 8 shows the caisson heave / failure on the south side of the reaction system.

6.0 DISCUSSION

6.1 Design Resistance vs. Tested Pile Resistance

Golder's Foundation Design Report recommended that steel H-piles driven a sufficient depth into the "100-blow" soils (with anticipated tip elevations at Elevation 203 m and 204 m at the SBL and NBL portions of the north abutment) will have a design geotechnical resistance factored ultimate limit state value (f-ULS) of 1,275 kN. It is noted that the classification type, depth and thickness of "100-blow" soils in this area is variable (see page 14 in the FIDR).

It is known that many Stage 2 production piles installed along the north abutment did not achieve the design geotechnical resistance, and calculated PDA test results demonstrated ultimate (unfactored) geotechnical resistance values as low as 1,500 kN when tested less than 24 hours after initial driving. The lowest calculated PDA value of 1,100 kN was at the test pile location for the static pile load test, immediately upon completion of initial driving. As per the test pile work plan, the test pile was intended to be driven deeper than Elevation 204.0 m, to attempt to achieve an ultimate geotechnical resistance value closer to the design value and more consistent with the PDA values measured on the production piles driven previously in Stage 2; however, the test pile was not driven deeper. The results of the PDA testing and reported "sets" on the test pile, compared with the results on the previous production piles, suggest that predominant end-bearing resistance on the "100-blow" soil was not effectively achieved. It is possible that the artesian conditions and/or silty soils near the tip of the pile (fitted with a driving shoe as per Contract requirements) may have influenced actual tip resistance during installation and/or the pile simply may not have encountered or penetrated deep enough into the "100-blow" soils to achieve the anticipated design resistance.

Regarding the actual pile load test, taking into consideration the challenges and load fluctuations associated with the progressive failure of the reaction system, the test pile can be interpreted to have experienced a plunging failure at an ultimate load of about 1,700 kN in compression (see Figure 2).

A comparison of the test pile (designated PT1) ultimate and factored geotechnical resistance estimated from the PDA test and full-scale pile load test is provided below. The ultimate geotechnical resistance measured from the pile load test (i.e. 1,700 kN) is greater than the measurement obtained from the PDA test performed on initial driving, but less than the design ultimate resistance provided in the FIDR and Contract Drawings (i.e. 2,550 kN), likely for the reasons discussed above. The geotechnical resistance values estimated from PDA testing on adjacent piles (Pile Nos. 399 and 400) and piles located at the west side of the North Abutment (Pile Nos. 299, 304, and 308) during Stage 2 are also shown below for comparison purposes.



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Pile No.	Pile Tip Elevation (m)	*Reported Eq. Penetration Resistance (Blows/25 mm)	Test / Analysis Method	Set-Up Period (days)	Ultimate Resistance (kN)	Resistance Factor (CHBDC, 2014)	f-ULS Resistance (kN)
PT1 (test pile)	204	8.1	PDA Test	0	1,100	0.5	550
		N/A	Full-Scale Pile Load Test	258	1,700	0.6	1,020
399	204	13.9	PDA Test	Less than 24 hrs.	1,650	0.5	825
400	204	6.1	PDA Test	Less than 24 hrs.	1,500	0.5	750
299	203	5	PDA Test	Less than 24 hrs.	1,400	0.5	700
		8		6 days	1,600	0.5	800
304	203	10	PDA Test	Less than 24 hrs.	1,700	0.5	850
		15		6 days	1,800	0.5	900
308	203	7	PDA Test	Less than 24 hrs.	1,400	0.5	700
		10		6 days	1,400	0.5	700

*Using Liebherr H40/4 Hydraulic Hammer

6.2 Anticipated Strength Gain with Time

For the test pile (PT1), comparing the results of the PDA test performed upon initial driving and the full-scale pile load test performed about 258 days after initial driving, there is a 55% increase in the estimated ultimate geotechnical resistance (1,100 kN vs. 1,700 kN) over this approximately eight-month timeframe. The potential gain in geotechnical resistance over time for design increases more considering the resistance factor for full-scale pile load testing is 0.6 compared to a factor of 0.5 for dynamic PDA testing.

The strength gain over time was also documented during Stage 2 piling (i.e. Piles 299, 304, and 308) where penetration resistance increased and up to a 14% increase in ultimate geotechnical resistance was measured with PDA testing over an approximate five-day set-up period.

Based on the closest borehole (BO-9) information, the test pile likely penetrated through the clayey silt soil and the pile tip terminated on silt / sand and silt soils above the artesian groundwater pressures encountered in the underlying sand and gravel layer at about Elevation 195 m to 198 m at this location.

Based on the test data, it is our opinion that the geotechnical resistance of the driven steel H-pile under compression loading at the test site experienced significant strength gain over time.



Assuming similar soil and groundwater conditions at this site (i.e., presence of artesian pressures below pile tip), it is anticipated that the geotechnical resistance of other piles along the north abutment will increase over time compared to the measured PDA test values upon end of initial driving.

This discussion and interpretation of the pile load test results are intended to provide MTO and the design team with supplementary information for assessment of remaining piling activities on site to make informed decisions whether additional piles or deeper piles are warranted given the geotechnical resistance measured during initial driving is expected to increase with time. The pile load test results and interpretations can also be referenced for future projects with similar piling activities and site conditions. It is noted that the results of this static pile load test are specific to the pile, soil and groundwater conditions at the specific test pile site only and should be used with caution if a practitioner chooses to interpret the results for any other pile location or project. Those using the information contained in this report should make their own interpretation of the factual information and inconsistencies encountered during testing operations as such interpretation may affect/impact design and estimated long-term geotechnical resistance of piles, pile layout and equipment selection, proposed construction methods, scheduling and the like.

6.3 Future Pile Load Tests – General

Based on Golder's experience on this static pile load test, the following suggestions / recommendations are provided for future pile load tests undertaken on similar MTO projects:

- Test Pile Installation: Designer(s) and owner should be on site or notified immediately upon reaching design pile tip elevation and should be provided PDA (or Hiley) results to confirm anticipated and actual test results are acceptable prior to demobilizing the pile driving equipment / crew from site.
- Pile driving records (not just pile "set" values) should be provided for all piles.
- More research / understanding is required to determine whether the conventional Hiley test method (historically MTO's typical/ standard test on production piles) is applicable or can be modified for use with hydraulic hammers (as opposed to conventional diesel hammers, where the Hiley method is well proven). Testing of production piles driven by hydraulic hammers should consider both Hiley and PDA testing to compare these results.
- Considering the reaction system for the current pile load test failed during critical load increments, future tests should specify a tolerable movement of the reaction system components and the designer / CA should be notified if these limits are being approached or exceeded. As per ASTM 1143, the reaction system was designed and drawings sealed by a P.Eng. and the reaction system was surveyed throughout the duration of the test; however, the survey results should be checked with review or alert level limits so that excessive movement / failure can be avoided and the test stopped and remedial measures performed prior to continuing with the test.
- Consideration should be given to stopping adjacent construction activities and/or including vibration limit criteria during pile load test operations.
- Consideration should be given to installing instrumentation to measure pore water pressures prior to, during, and after test pile installation, as applicable. This would improve understanding of initial pore water



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development and dissipation over time and could be correlated to prediction models of potential strength gain over time in different soil and groundwater conditions.



7.0 CLOSURE

This Report was prepared by Mr. Matthew Kelly, P.Eng., and reviewed by Mr. Kevin Bentley, P.Eng., a geotechnical engineer and Associate with Golder, with technical input from Mr. Murty Devata, P.Eng., a specialist foundations consultant with Golder. Ms. Lisa Coyne, P.Eng., a Principal and Designated MTO Foundations Contact for Golder, conducted an independent quality review.

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APPENDIX A

Figures



↑N ○ APPROXIMATE TEST PILE LOCATION (PT1)



Reference: ©2017 Google – Image Digital Globe

CLIENT
AECOM / MTO

CONSULTANT



YYYY-MM-DD	2017-08-24
PREPARED	MK
DESIGN	
REVIEW	KJB
APPROVED	KJB

PROJECT
HIGHWAY 400 – SOUTH CANAL BRIDGE
NEWMARKET, ONTARIO

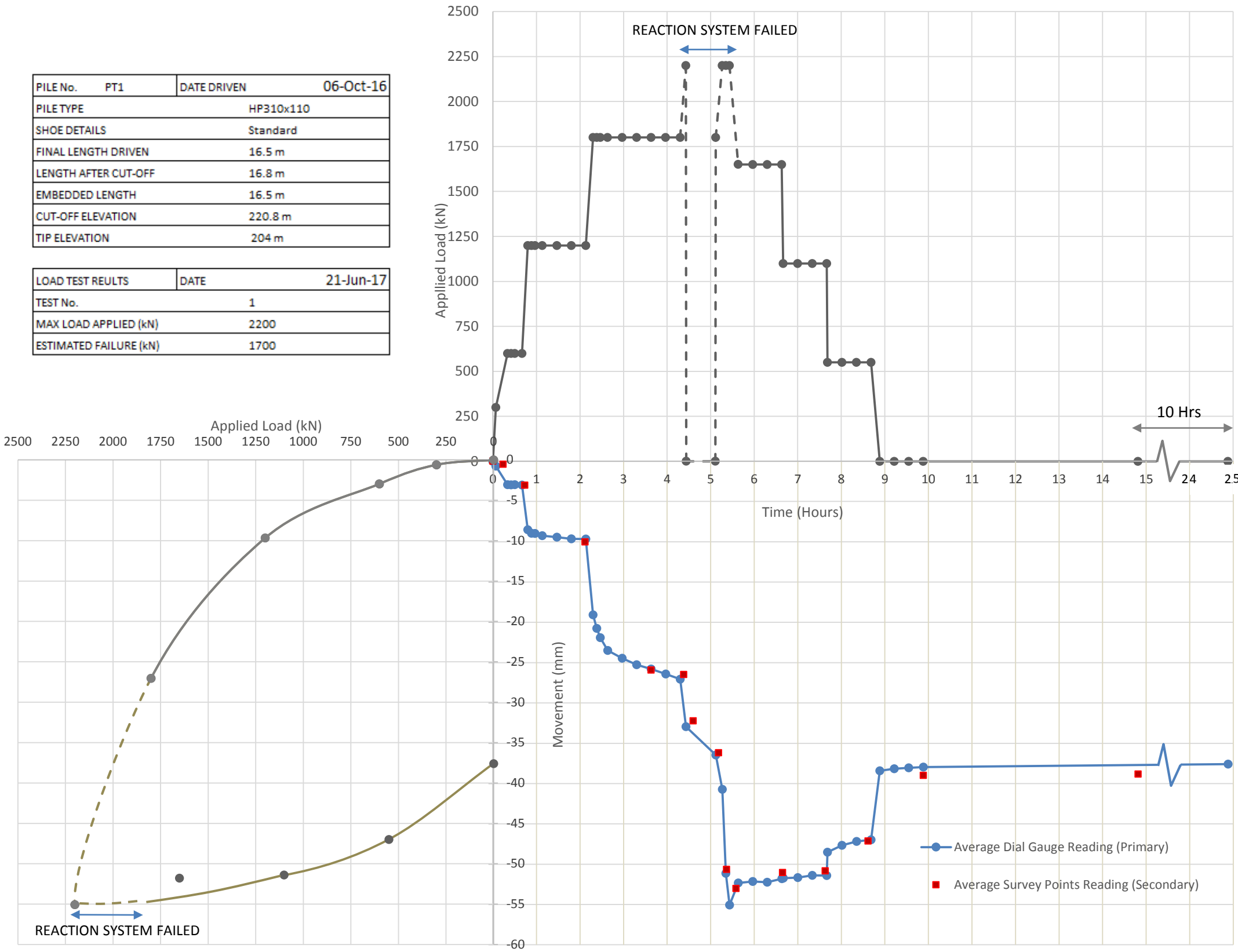
TITLE
PILE LOAD TEST LOCATION PLAN

PROJECT No.
0911110018

FIGURE
1

PILE No.	PT1	DATE DRIVEN	06-Oct-16
PILE TYPE	HP310x110		
SHOE DETAILS	Standard		
FINAL LENGTH DRIVEN	16.5 m		
LENGTH AFTER CUT-OFF	16.8 m		
EMBEDDED LENGTH	16.5 m		
CUT-OFF ELEVATION	220.8 m		
TIP ELEVATION	204 m		

LOAD TEST RESULTS	DATE	21-Jun-17
TEST No.	1	
MAX LOAD APPLIED (kN)	2200	
ESTIMATED FAILURE (kN)	1700	



CLIENT
AECOM / MTO

PROJECT
HIGHWAY 400 – SOUTH CANAL BRIDGE
NEWMARKET, ONTARIO

CONSULTANT

YYYY-MM-DD 2017-08-28

PREPARED DH

DESIGN DH

REVIEW ####

APPROVED ####



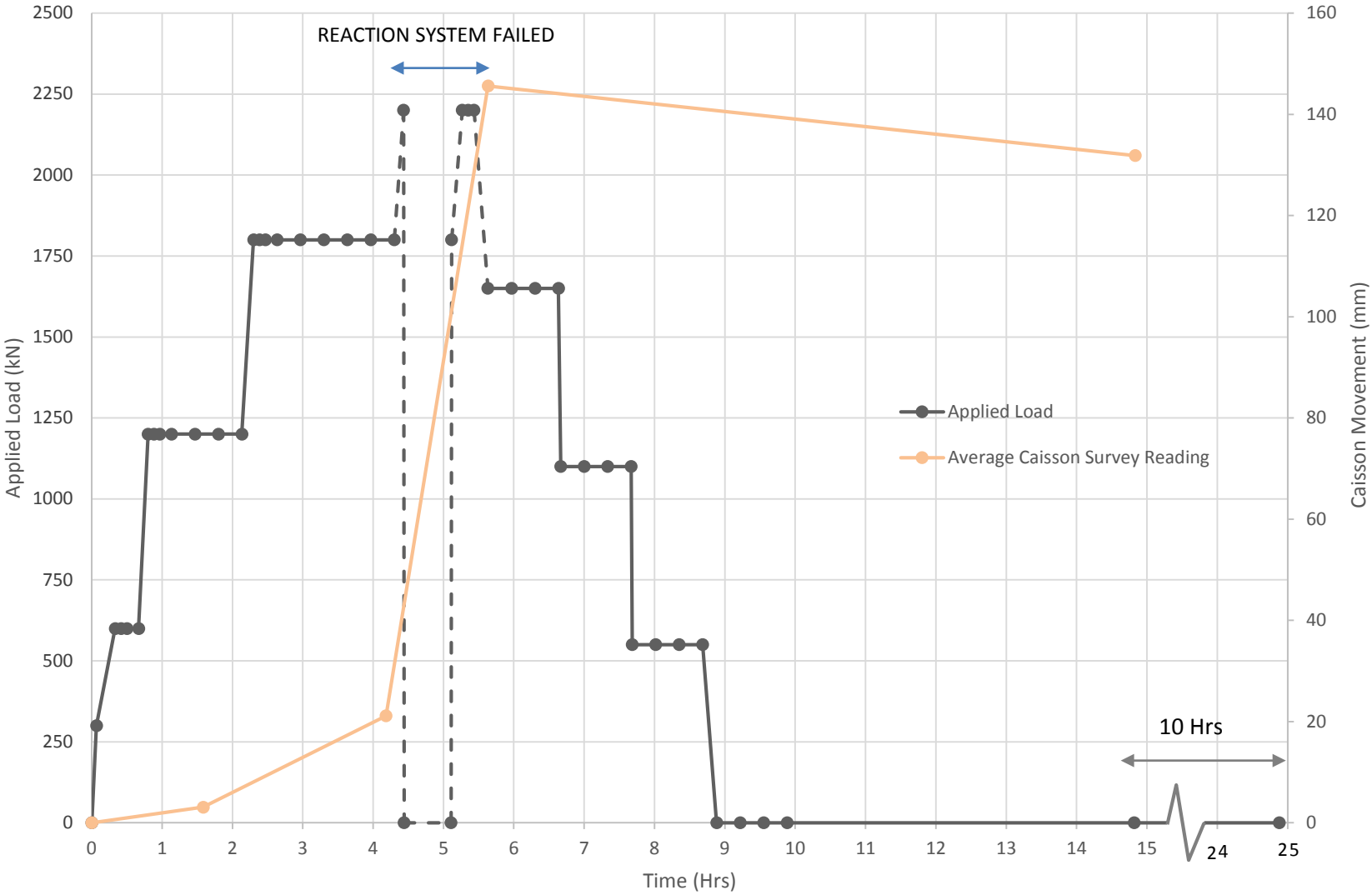
TITLE
STATIC PILE LOAD TEST RESULTS

PROJECT No.
09-1111-0018

FIGURE
2

PILE No.	PT1	DATE DRIVEN	06-Oct-16
PILE TYPE	HP310x110		
SHOE DETAILS	Standard		
FINAL LENGTH DRIVEN	16.5 m		
LENGTH AFTER CUT-OFF	16.8 m		
EMBEDDED LENGTH	16.5 m		
CUT-OFF ELEVATION	220.8 m		
TIP ELEVATION	204 m		

LOAD TEST RESULTS	DATE	21-Jun-17
TEST No.	1	
MAX LOAD APPLIED (kN)	2200	
ESTIMATED FAILURE (kN)	1700	



CLIENT
AECOM / MTO

PROJECT
HIGHWAY 400 – SOUTH CANAL BRIDGE
NEWMARKET, ONTARIO

CONSULTANT

YYYY-MM-DD 2017-08-28



PREPARED DH
DESIGN DH
REVIEW ####
APPROVED ####

TITLE
RESPONSE OF REACTION SYSTEM
(CAISSONS) DURING PILE LOAD TEST

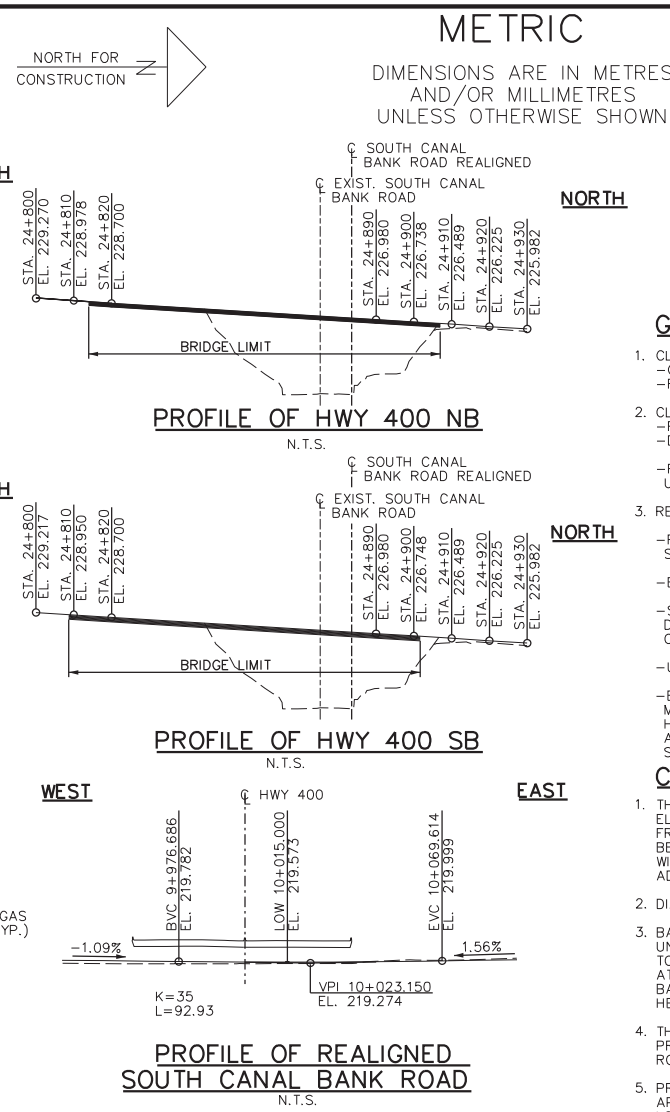
PROJECT No.
09-1111-0018

FIGURE
3



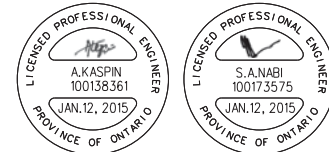
APPENDIX B

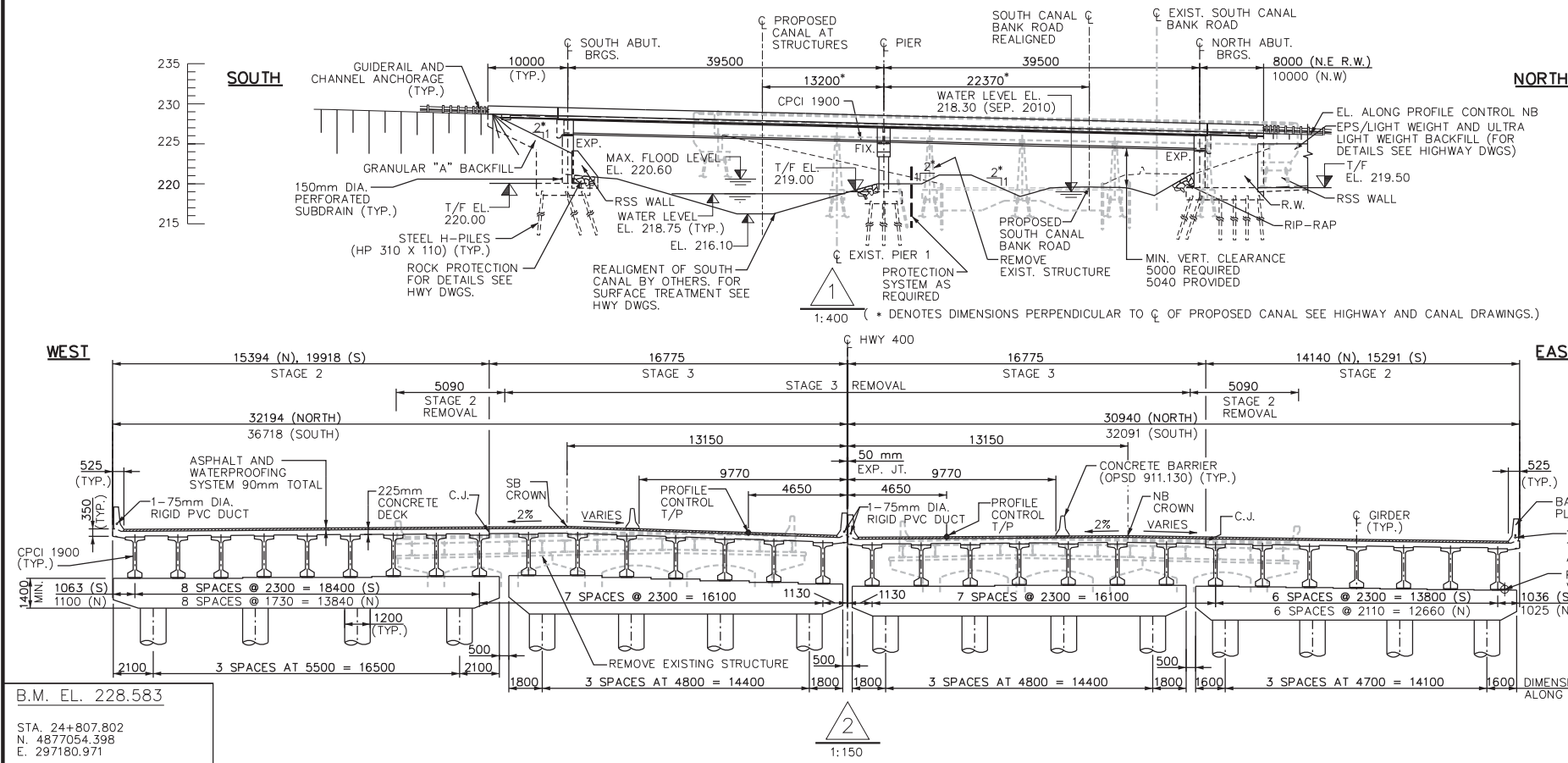
Relevant Contract Documents





	WP	STATION	ELEVATION
SB	WP #1	24+815.690	228.803
	WP #2	24+855.190	227.838
	WP #3	24+894.690	226.871
NB	WP #4	24+820.950	228.679
	WP #5	24+860.450	227.706
	WP #6	24+899.950	226.739

ABUT.	DENOTES	ABUTMENT	
BRGS.	DENOTES	BEARINGS	
C.J.	DENOTES	CONSTRUCTION JOINT	
EL.	DENOTES	ELEVATION	
EPS	DENOTES	RGID EXPANDED POLYSTYRENE	
EXIST.	DENOTES	EXISTING	
EXP. JT	DENOTES	EXPANSION JOINT	
MIN.	DENOTES	MINIMUM	
NB	DENOTES	NORTH BOUND	
N.T.S.	DENOTES	NOT TO SCALE	
R.W.	DENOTES	RETAINING WALL	
SB	DENOTES	SOUTH BOUND	
SHLD	DENOTES	SHOULDER	
SCL	DENOTES	SPEED CHANGE LANE	
STA.	DENOTES	STATION	OP
THK.	DENOTES	THICK	
TPP.	DENOTES	TYPICAL	OP
T/F	DENOTES	TOP OF FOOTING	OP
T/P	DENOTES	TOP OF PAVEMENT	
VERT.	DENOTES	VERTICAL	
WP	DENOTES	WORK POINT	OP





HWY 400	
CONT 2015-2004	
GWP 2025-13-00	
HWY 400 SOUTH CANAL BRIDGE GENERAL ARRANGEMENT	SHEET 435
	

1. CLASS OF CONCRETE:

-GIRDERS.....	50 MPa
-REMAINDER.....	30 MPa

2. CLEAR COVER TO REINFORCING STEEL:

-FOOTINGS.....	100 ± 25
-DECK : TOP.....	70 ± 20
BOTTOM.....	40 ± 10
-REMAINDER.....	70 ± 20

UNLESS OTHERWISE NOTED.

3. REINFORCING STEEL:

-REINFORCING STEEL SHALL BE GRADE 400W UNLESS OTHERWISE SPECIFIED.

-BAR MARKS WITH PREFIX 'S' DENOTE STAINLESS STEEL BARS.

-STAINLESS REINFORCING STEEL BARS SHALL BE TYPE 316LN OR DUPLEX 2205 AND HAVE A MINIMUM YIELD STRENGTH OF 500 MPa, UNLESS OTHERWISE SPECIFIED.

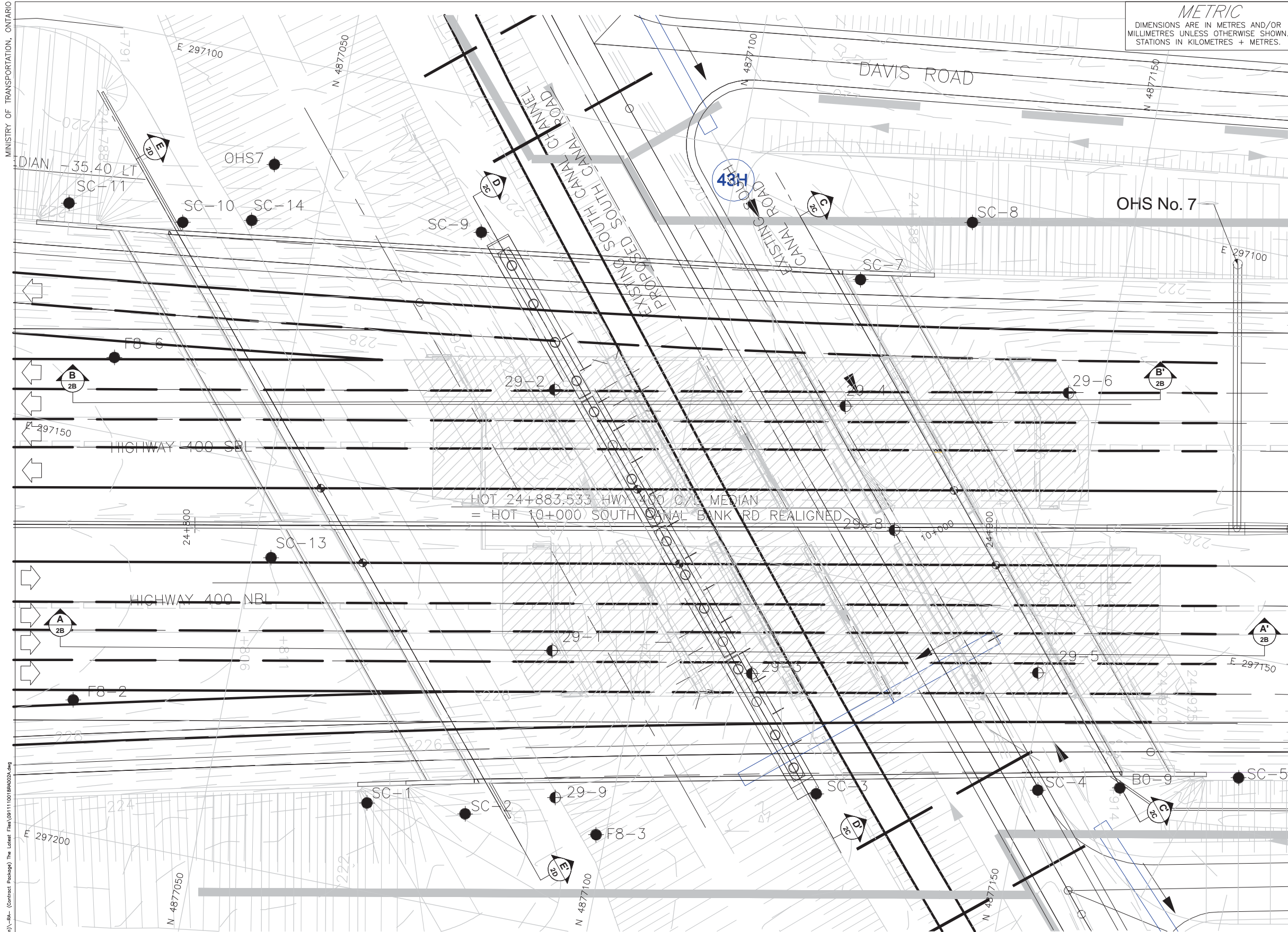
-UNLESS OTHERWISE SHOWN, TENSION LAP SPLICES SHALL CLASS B.

1. THE CONTRACTOR SHALL ESTABLISH THE BEARING SEAT ELEVATIONS BY DEDUCTING THE ACTUAL BEARING THICKNESS FROM THE TOP OF BEARING ELEVATIONS. IF THE ACTUAL BEARING THICKNESSES ARE DIFFERENT FROM THOSE GIVEN WITH THE BEARING DESIGN DATA, THE CONTRACTOR SHALL ADJUST THE REINFORCING STEEL TO SUIT.
2. DIAPHRAGMS SHALL BE CAST INTEGRALLY WITH THE DECK.
3. BACKFILL TO ABUTMENT DIAPHRAGMS SHALL NOT BE PLACED UNTIL THE CONCRETE IN DECK HAS REACHED 25MPa. BACKFILL TO ABUTMENT DIAPHRAGMS SHALL BE PLACED SIMULTANEOUSLY AT BOTH ENDS OF THE STRUCTURE, KEEPING THE HEIGHT OF BACKFILL THE SAME. AT NO TIME SHALL THE DIFFERENCE IN HEIGHT OF BACKFILL BE GREATER THAN 500mm.
4. THE CONTRACTOR IS FULLY RESPONSIBLE FOR ADEQUATE PROTECTION OF ALL UTILITIES, SERVICES, STRUCTURES, ROADWAYS, ETC. DURING CONSTRUCTION OPERATIONS.
5. PROTECTION SYSTEM SHALL BE DESIGNED TO PERFORMANCE LEVEL 2. APPROXIMATE LOCATION OF PROTECTION SYSTEM IS SHOWN, EXACT LOCATION AND LIMITS SHALL BE DETERMINED BY THE CONTRACTOR.
6. THE CONTRACTOR SHALL VERIFY THE LOCATION OF THE EXISTING BRIDGE, DIMENSIONS, PROPOSED REMOVALS AND DETAILS AND REPORT ANY DISCREPANCIES TO THE CONTRACT ADMINISTRATOR BEFORE PROCEEDING WITH THE WORK.

1. GENERAL ARRANGEMENT
2. BOREHOLE LOCATIONS AND SOIL STRATA – 2A, 2B, 2C, 2D
3. CONSTRUCTION STAGING
4. REMOVAL DETAILS
5. FOUNDATION LAYOUT
6. FOUNDATION REINFORCEMENT
7. NORTH ABUTMENT DETAILS
8. SOUTH ABUTMENT DETAILS
9. WINGWALLS AND RETAINING WALL DETAILS
10. RSS WALL #1, 2 AND 3
11. RSS WALL #4
12. PIERS DETAILS
13. PRESTRESSED GIRDERS AND BEARINGS – I
14. PRESTRESSED GIRDERS AND BEARINGS – II
15. PRESTRESSED GIRDERS AND BEARINGS – III
16. DECK LAYOUT AND SCREED ELEVATIONS
17. SBL DECK REINFORCEMENT – I
18. NBL DECK REINFORCEMENT – II
19. DECK REINFORCEMENT – III
20. BARRIER WALL WITHOUT RAILING PL-3
21. MEDIAN BARRIER WALL WITHOUT RAILING PL-3
22. 6000mm APPROACH SLAB
23. EXPANSION JOINT AND SLEEPER SLAB
24. STRIP SEAL EXPANSION JOINT DETAIL
25. PILE DRIVING CONTROL
26. STANDARD DETAILS
27. ELECTRICAL EMBEDDED WORK

OPSD 3101.150	WALLS ABUTMENT, BACKFILL, MINIMUM GRANULAR REQUIREMENT
OPSD 3349.100	DECK, DRAINS, DRAINAGE OF NEW DECK BELOW ASPHALT WEARING SURFACE
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 2mm WIDE AND CONSTRUCTION JOINTS
OPSD 3419.100	GUIDERAIL AND CHANNEL ANCHORAGE
OPSD 3941.200	FIGURES IN CONCRETE, SITE NUMBER AND DATA LAYOUT
OPSD 3950.100	JOINTS--CONCRETE EXPANSION AND CONSTRUCTION ON CONCRETE
OPSD 911.132	GUIDE RAIL SYSTEM CONCRETE BARRIER, CAST IN PLACE, TALL WALL INSTALLATION
OPSD 911.382	GUIDE RAIL SYSTEM, CONCRETE BARRIER DOWEL CONNECTION DETAIL
OPSD 911.130	GUIDE RAIL SYSTEM, CONCRETE BARRIER, CAST-IN-PLACE TYPEA, INSTALLATION

[illegible]



REFERENCE
Base plan and General Arrangement provided in digital format by URS Canada Inc., (Drawing Files "Hwy400_plan.dwg" and "01_GA_July 10 2012.dwg") received November 13, 2013 and September 26, 2012.

NOTES
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METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. 2015-2004
GWP No. 2025-13-00

SOUTH CANAL BRIDGES
HIGHWAY 400 WIDENING
BOREHOLE LOCATIONS

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

SHEET
436

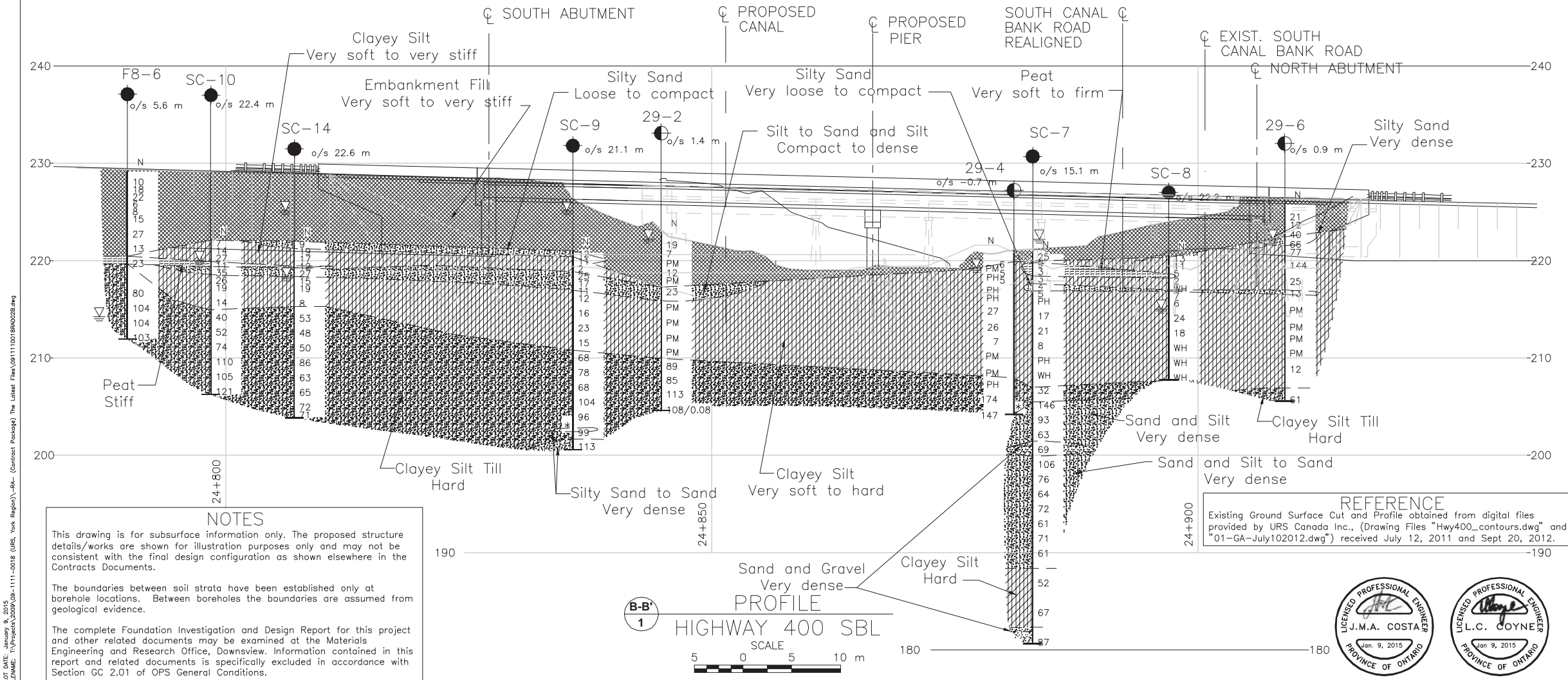
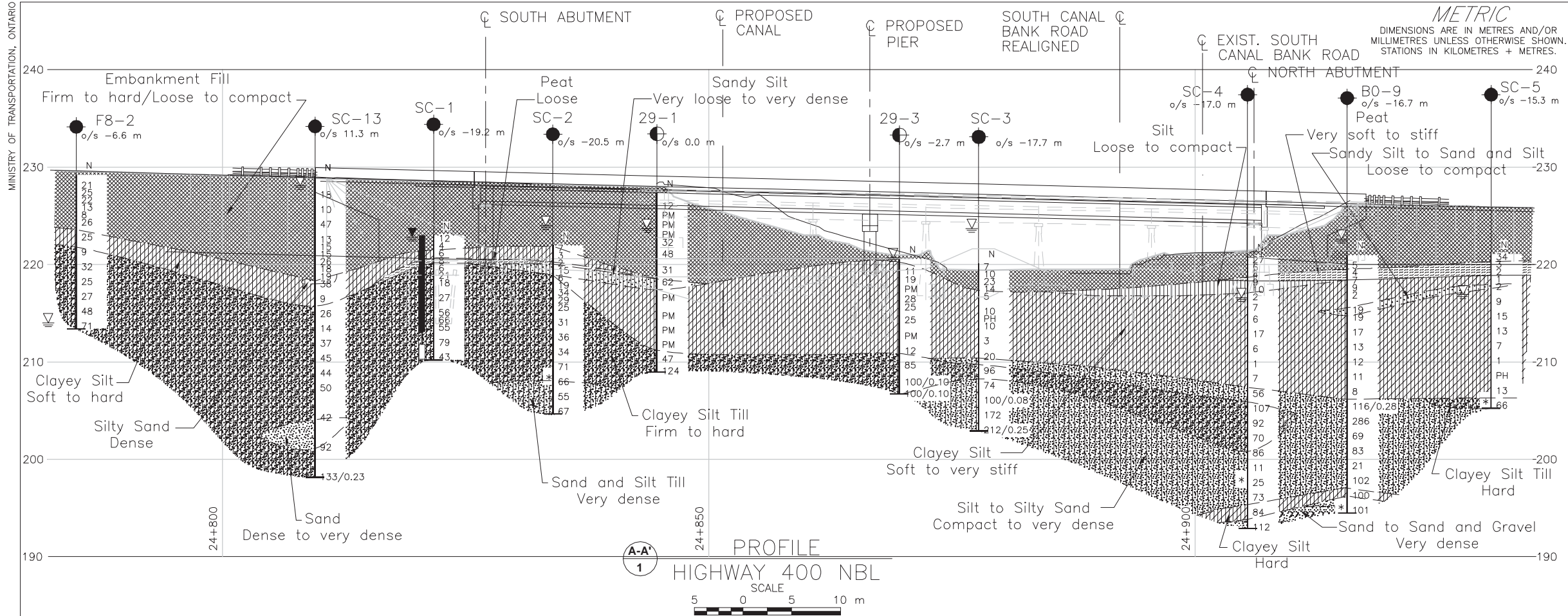


LEGEND

- Borehole - Current Investigation by Golder
- Borehole - Previous Investigation (Geocres No. 31D-029)

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
29-1	227.4	4877089.0	297166.0
29-2	223.9	4877083.0	297134.0
29-3	220.6	4877114.0	297164.0
29-4	221.1	4877119.0	297129.0
29-5	221.1	4877149.0	297157.0
29-6	225.8	4877146.0	297122.0
29-8	221.1	4877128.0	297143.0
29-9	221.1	4877092.9	297183.9
B0-9	221.0	4877161.8	297169.1
F8-2	229.2	4877031.6	297183.6
F8-3	221.0	4877098.8	297187.5
F8-6	229.1	4877028.4	297140.7
OHS7	220.4	4877043.3	297113.2
SC-1	223.0	4877070.0	297189.1
SC-2	222.0	4877082.3	297188.1
SC-3	220.1	4877124.8	297177.2
SC-4	220.8	4877151.8	297171.4
SC-5	221.1	4877176.1	297165.0
SC-7	220.7	4877117.8	297113.1
SC-8	220.5	4877130.1	297103.5
SC-9	221.0	4877070.2	297116.5
SC-10	222.1	4877033.5	297122.5
SC-11	221.8	4877019.1	297122.9
SC-13	229.0	4877052.4	297161.4
SC-14	222.0	4877041.9	297120.6

NO.	DATE	BY	REVISION	
Geocres No.				
HWY. 400		PROJECT NO. 09-1111-0018		DIST.CENTRAL
SUBM'D. NK	CHKD. LCC		DATE: Mar 20, 2013	SITE:
DRAWN: CD/JFC	CHKD. LCC		APPD. JMAC	DWG.2A



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REFERENCE

Existing Ground Surface Cut and Profile obtained from digital files provided by URS Canada Inc., (Drawing Files "Hwy400_contours.dwg" and "01-GA-July102012.dwg") received July 12, 2011 and Sept 20, 2012.



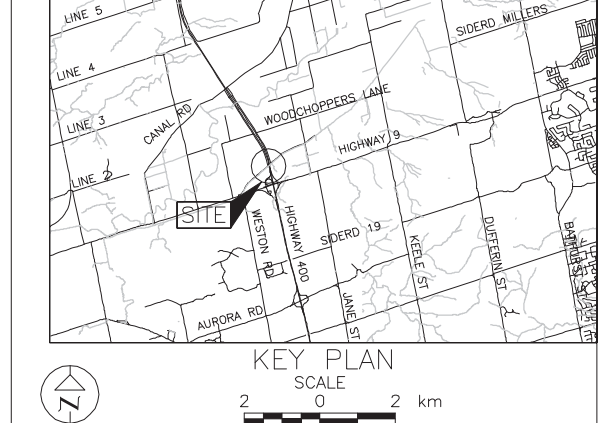
CONT No. 2015-2004
GWP No. 2025-13-00

SOUTH CANAL BRIDGES
HIGHWAY 400 WIDENING
SOIL STRATA

SHEET
437



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation by Golder
- ⊕ Borehole - Previous Investigation (Geocres No. 31D-029)
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL in piezometer, measured on June 12, 2012
- ▽ WL upon completion of drilling
- * Approximate depth at which artesian groundwater pressure encountered

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
29-1	227.4	4877089.0	297166.0
29-2	223.9	4877083.0	297134.0
29-3	220.6	4877114.0	297164.0
29-4	221.1	4877119.0	297129.0
29-6	225.8	4877146.0	297122.0
B0-9	221.0	4877161.8	297169.1
F8-2	229.2	4877031.6	297183.6
F8-6	229.1	4877028.4	297140.7
SC-1	223.0	4877070.0	297189.1
SC-2	222.0	4877082.3	297188.1
SC-3	220.1	4877124.8	297177.2
SC-4	220.8	4877151.8	297171.4
SC-5	221.1	4877176.1	297165.0
SC-7	220.7	4877117.8	297113.1
SC-8	220.5	4877130.1	297103.5
SC-9	221.0	4877070.2	297116.5
SC-10	222.1	4877033.5	297122.5
SC-13	229.0	4877052.4	297161.4
SC-14	222.0	4877041.9	297120.6


NO.	DATE	BY	REVISION
Geocres No.			
HWY. 400		PROJECT NO. 09-1111-0018	DIST.CENTRAL
SUBM'D. NK	CHKD. LCC	DATE: Mar 20, 2013	SITE:
DRAWN: LL/JFC	CHKD. LCC	APPD. JMAC	DWG.2B

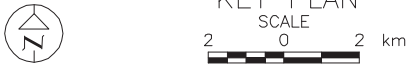
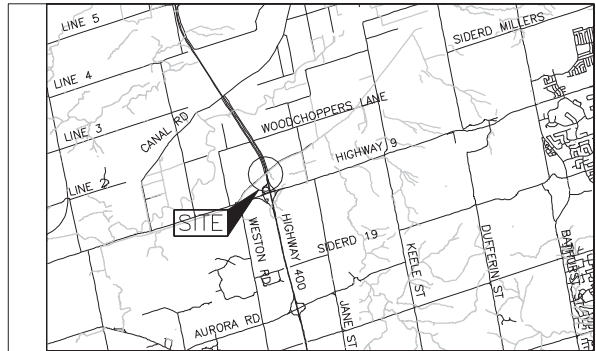
METRIC
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STATIONS IN KILOMETRES + METRES.

CONT No. 2015-2004
GWP No. 2025-13-00

SOUTH CANAL BRIDGES
HIGHWAY 400 WIDENING
SOIL STRATA

SHEET
438

**Golder Associates Ltd.**
MISSISSAUGA, ONTARIO, CANADA



LEGEND

- Borehole - Current Investigation by Golder
- Borehole - Previous Investigation (Geocres No. 31D-029)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling
- * Approximate depth at which artesian groundwater pressure encountered

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
29-2	223.9	4877083.0	297134.0
29-3	220.6	4877114.0	297164.0
29-4	221.1	4877119.0	297129.0
29-5	221.1	4877149.0	297157.0
29-8	221.1	4877128.0	297143.0
B0-9	221.0	4877161.8	297169.1
SC-3	220.1	4877124.8	297177.2
SC-4	220.8	4877151.8	297171.4
SC-7	220.7	4877117.8	297113.1
SC-9	221.0	4877070.2	297116.5

NOTES

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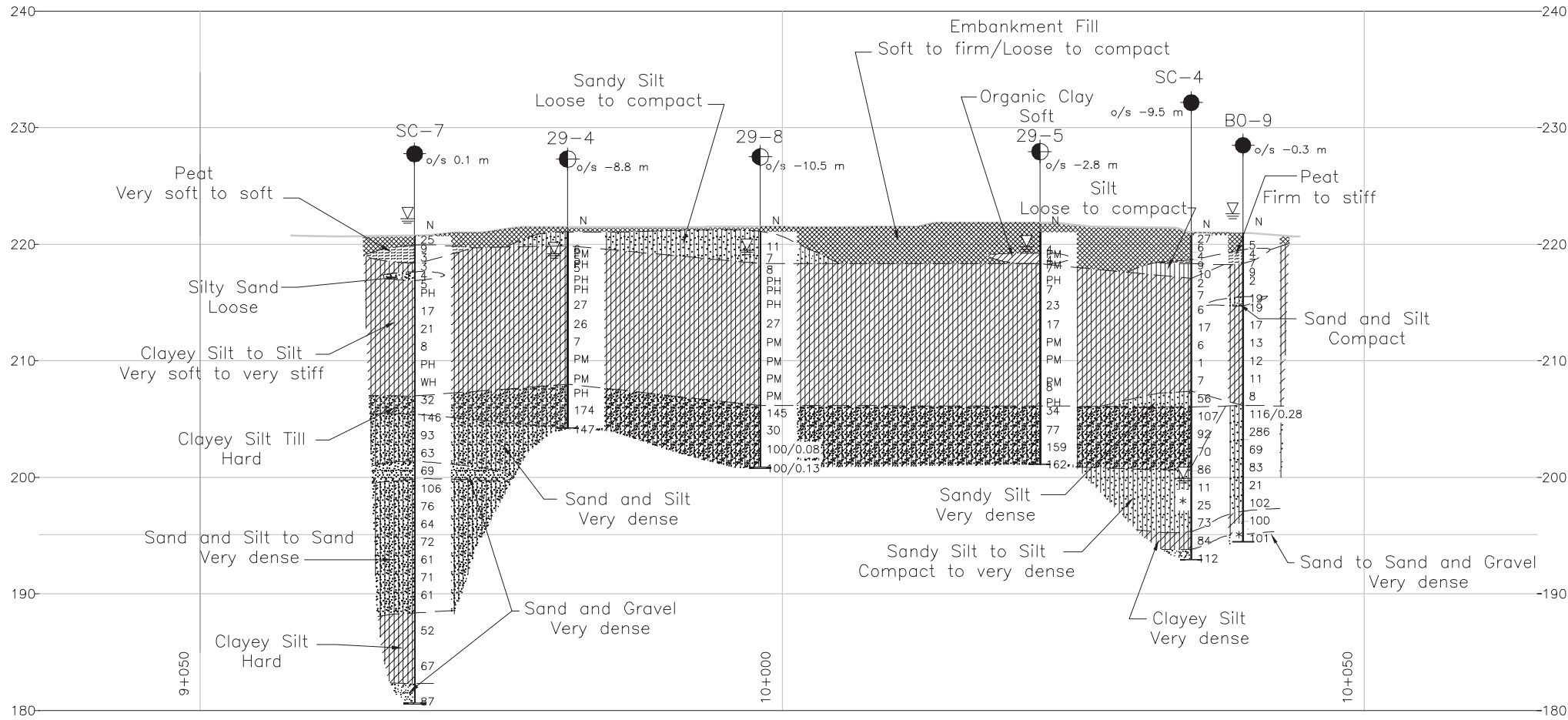
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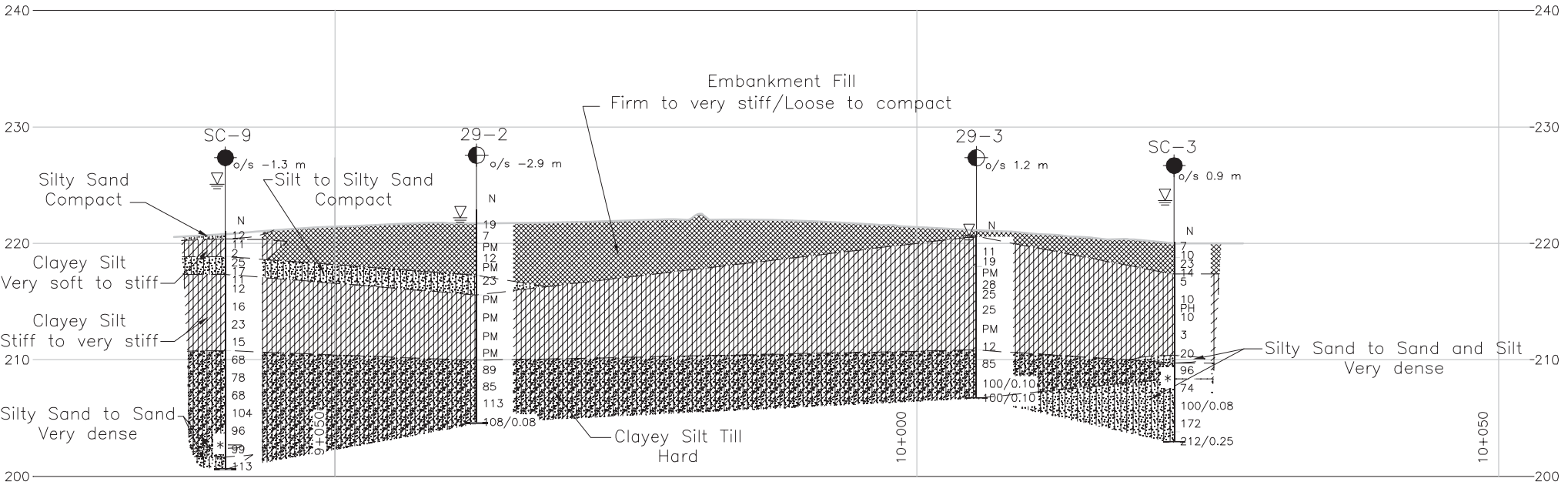
REFERENCE

Existing Ground Surface Cut and Profile obtained from digital files provided by URS Canada Inc., (Drawing Files "Hwy400_contours.dwg" and "01-GA-July102012.dwg") received July 12, 2011 and Sept 20, 2012.

NO.	DATE	BY	REVISION
Geocres No.			
HWY. 400		PROJECT NO. 09-1111-0018	
SUBM'D. NK		CHKD. LCC	DATE: Mar. 20, 2013
DRAWN: LL/JFC		CHKD. LCC	APPD. JMAC
		DIST.CENTRAL	
		SITE:	
		DWG. 2C	



C-C' 1
CROSS-SECTION
NORTH ABUTMENT
SCALE
5 0 5 10 m



D-D' 1
CROSS-SECTION
CENTRE PIER
SCALE
5 0 5 10 m



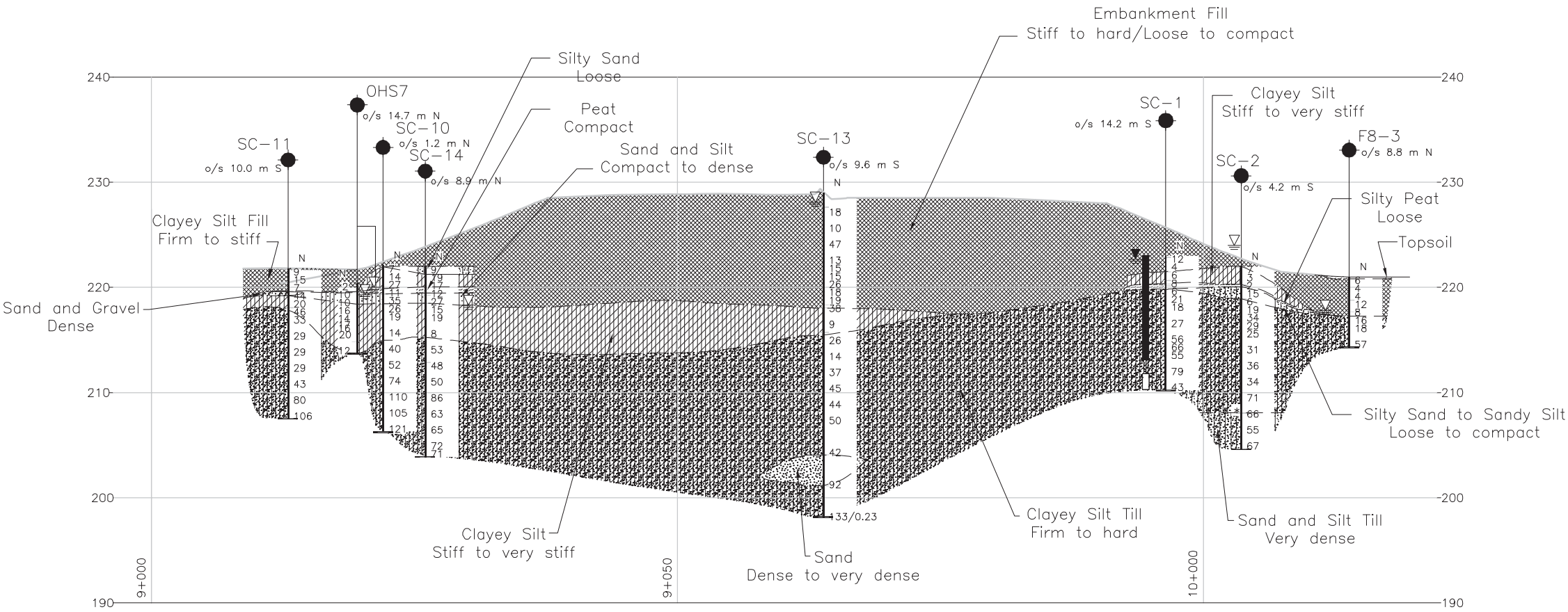
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CONT No. 2015-2004
GWP No. 2025-13-00

SOUTH CANAL BRIDGES
HIGHWAY 400 WIDENING
SOIL STRATA

SHEET
439

**Golder Associates Ltd.**
MISSISSAUGA, ONTARIO, CANADA



E-E'
1
CROSS SECTION
SOUTH ABUTMENT
SCALE
5 0 5 10 m



KEY PLAN
SCALE
2 0 2 km

LEGEND

- Borehole - Current Investigation by Golder
- Borehole - Previous Investigation (Geocres No. 31D-029)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL in piezometer, measured on June 12, 2012
- WL upon completion of drilling
- * Approximate depth at which Artesian Groundwater pressure measured

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
F8-3	221.0	4877098.8	297187.5
OHS-7	220.4	4877043.3	297113.2
SC-1	223.0	4877070.0	297189.1
SC-2	222.0	4877082.3	297188.1
SC-10	222.1	4877033.5	297122.5
SC-11	221.8	4877019.1	297122.9
SC-13	229.0	4877052.4	297161.4
SC-14	222.0	4877041.9	297120.6

NOTES

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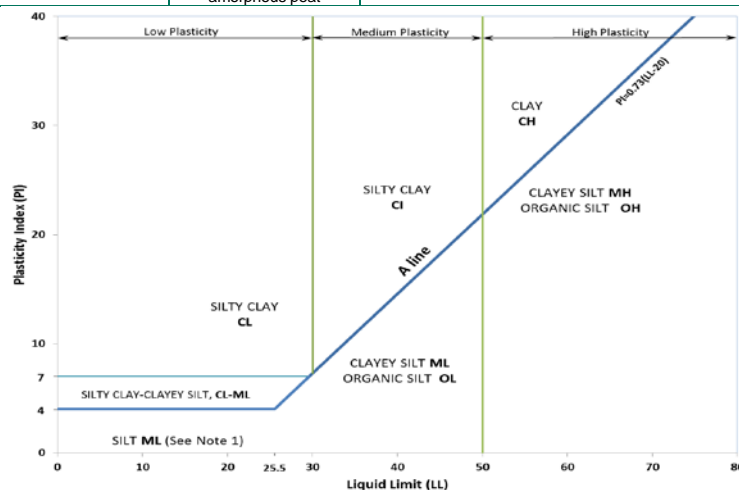
NO.	DATE	BY	REVISION	
Geocres No.				
HWY. 400		PROJECT NO. 09-1111-0018		DIST.CENTRAL
SUBM'D. NK	CHKD. LCC		DATE: Mar. 20, 2013	SITE:
DRAWN: LL/JFC	CHKD. LCC		APPD. JMAC	DWG.2D



METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$		$Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$			Organic Content	USCS Group Symbol	Group Name	
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4		≤1 or ≥3			≤30%	GP	GRAVEL	
				Well Graded	≥4		1 to 3				GW	GRAVEL	
			Gravels with >12% fines (by mass)	Below A Line	n/a						GM	SILTY GRAVEL	
				Above A Line	n/a						GC	CLAYEY GRAVEL	
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6		≤1 or ≥3				SP	SAND	
				Well Graded	≥6		1 to 3				SW	SAND	
			Sands with >12% fines (by mass)	Below A Line	n/a						SM	SILTY SAND	
				Above A Line	n/a						SC	CLAYEY SAND	
Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name		
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)					
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT		
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT		
			Liquid Limit ≥50	Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT		
				Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT		
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30%	CL	SILTY CLAY		
				None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium	(see Note 2)	CI	SILTY CLAY		
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY		
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT		
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT		



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor “trace organics” for soils with between 5% and 30% organic content include the prefix “organic” before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between “clean” and “dirty” sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.



ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (i.e., SAND and GRAVEL, SAND and CLAY)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.).

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
FS	Foil sample
GS	Grab Sample
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size
TP	Thin-walled, piston – note size
WS	Wash sample

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

COHESIVE SOILS

NON-COHESIVE (COHESIONLESS) SOILS

Compactness²

Term	SPT 'N' (blows/0.3m) ¹
Very Loose	0 - 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects.
- Definition of compactness descriptions based on SPT 'N' ranges from Terzaghi and Peck (1967) and correspond to typical average N₆₀ values.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

- SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
- SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index $= (w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index $= (w - w_p) / I_p$
I_C	consistency index $= (w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

PROJECT		RECORD OF BOREHOLE		No B0-9		SHEET 2 OF 2		METRIC																										
G.W.P. 09-1111-0018		LOCATION		N 4877161.8 ; E 297169.1		ORIGINATED BY		TZ																										
DIST Central HWY 400		BOREHOLE TYPE		108 mm Inside Diameter Hollow Stem Augers		COMPILED BY		NK																										
DATUM Geodetic		DATE		November 14-15, 2011		CHECKED BY		LCC																										
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			ELEVATION SCALE			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			SHEAR STRENGTH kPa			WATER CONTENT (%)			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES																													
--- CONTINUED FROM PREVIOUS PAGE ---																																		
	SILT, some clay Very dense Grey Moist		13	SS	16/0.28																													
203.2			14	SS	286																													
17.8	SAND and SILT, trace to some clay Compact to very dense Grey Wet		15	SS	69																													
			16	SS	83																													
			17	SS	21																													
			18	SS	102																													
197.1																																		
23.9	CLAYEY SILT with sand, some gravel Hard Grey Wet		19A	SS	100																													
196.2			19B																															
24.8	SAND, trace gravel, trace silt Very dense Grey Wet																																	
195.5																																		
25.5	SAND and GRAVEL Very dense Grey Wet		20	SS	101																													
194.5																																		
26.5	END OF BOREHOLE																																	
NOTES: 1. Artesian conditions encountered below a depth of 25.9 m (Elev. 195.1 m). 2. Water level measured inside casing at 1.6 m above ground surface (Elev. 222.6 m) on completion of drilling. 3. Borehole abandoned using cement grout with 3 m of bentonite placed above grout immediately below ground surface.																																		

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB

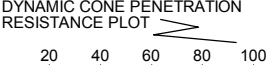

PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-4		SHEET 1 OF 2		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877151.8;E 297171.4</u>		ORIGINATED BY <u>TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>108 mm Inside Diameter Hollow Stem Augers</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>November 17, 18 and 21, 2011</u>		CHECKED BY <u>LCC</u>			

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+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

+3, ×3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT		RECORD OF BOREHOLE		No SC-5		SHEET 2 OF 2		METRIC									
G.W.P. 2835-02-00		LOCATION		N 4877176.1 ; E 297165.0		ORIGINATED BY		TT									
DIST Central HWY 400		BOREHOLE TYPE		108 mm Inside Diameter Hollow Stem Augers		COMPILED BY		NK									
DATUM Geodetic		DATE		November 15, 2011		CHECKED BY		LCC									
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L WATER CONTENT (%)			γ kN/m ³	GR SA SI CL
							20 40 60 80 100	10 20 30									
205.3 15.9	--- CONTINUED FROM PREVIOUS PAGE --- CLAYEY SILT, some sand, trace gravel (TILL) Hard Grey Moist END OF BOREHOLE NOTES: 1. Blowing sands encountered at a depth of 15.2 m (Elev. 205.9 m) 2. Water level in open borehole at a depth of 4.2 m (Elev. 216.9 m) on completion of drilling.		12	SS	66		206										

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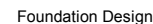
PROJECT <u>09-1111-0018</u>		RECORD OF BOREHOLE No SC-7		SHEET 1 OF 3		METRIC	
G.W.P. <u>2835-02-00</u>		LOCATION <u>N 4877117.8;E 297113.1</u>		ORIGINATED BY <u>SB/TT</u>			
DIST <u>Central</u> HWY <u>400</u>		BOREHOLE TYPE <u>108 mm Inside Diameter Hollow Stem Augers</u>		COMPILED BY <u>NK</u>			
DATUM <u>Geodetic</u>		DATE <u>November 7, 2011</u>		CHECKED BY <u>LCC</u>			

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+ 3, × 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

○ 3% STRAIN AT FAILURE

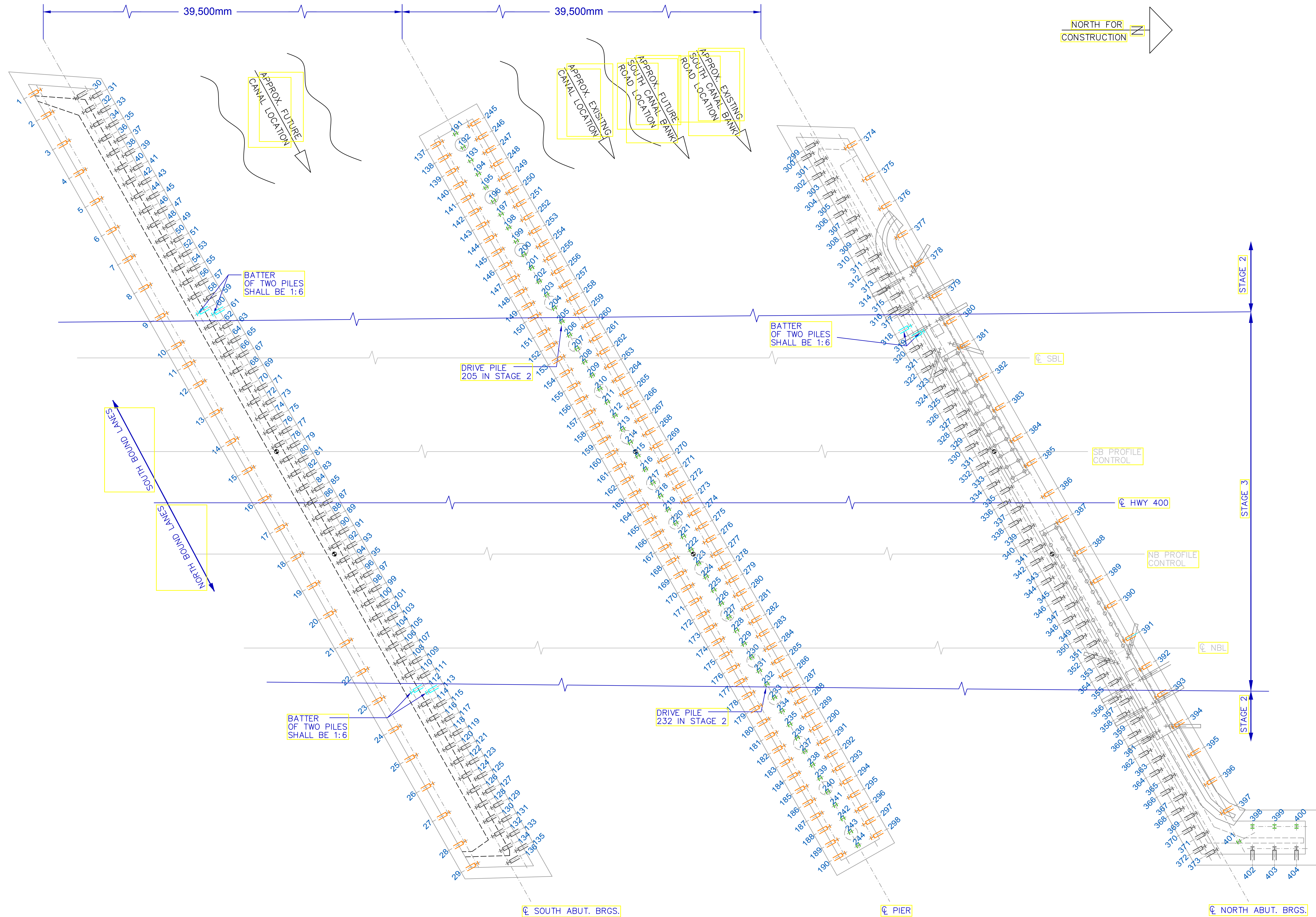


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+3, ×3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 09-1111-0018		RECORD OF BOREHOLE No SC-7		SHEET 3 OF 3		METRIC						
G.W.P. 2835-02-00		LOCATION N 4877117.8; E 297113.1		ORIGINATED BY SB/TT								
DIST Central HWY 400		BOREHOLE TYPE 108 mm Inside Diameter Hollow Stem Augers		COMPILED BY NK								
DATUM Geodetic		DATE November 7, 2011		CHECKED BY LCC								
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES					
	--- CONTINUED FROM PREVIOUS PAGE ---											
188.4	SAND and SILT to SAND, trace to some silt, trace gravel and clay Very dense Grey Wet		24	SS	61							
32.3	CLAYEY SILT, trace sand, trace gravel, containing silt seams Hard Grey Moist		25	SS	52							1 1 65 33
182.3			26	SS	67							
38.4	SAND and GRAVEL, some silt, trace clay Very dense Grey Wet		27	SS	87							47 39 13 1
180.6	END OF BOREHOLE											
40.1	NOTES: 1. Blowing sands and artesian conditions encountered below a depth of 15.7 m (Elev. 205.0m). 2. Tricone and wash boring used below a depth of 15.2 m (Elev. 205.5 m) due to artesian conditions in the sand layer. 3. Artesian pressure up to 1.5 m above ground surface (Elev. 222.2 m) noted during removal of hollow stem augers. 4. Borehole caved at a depth of 36.6 m (Elev. 184.1 m) on completion of drilling. 5. Borehole abandoned using cement grout, with 3 m of bentonite placed above the grout immediately below ground surface.											

GTA-MTO 001 T:\PROJECTS\2009\09-1111-0018 (URS, YORK REGION)\LOG\0911110018.GPJ GAL-GTA.GDT 01/13/15 SIB



GENERAL NOTES:

1. PILE TIP ELEVATIONS DETAILED ON THIS DRAWING ARE APPROXIMATE.
2. VERIFICATION OF THE FOUNDING ELEVATIONS ARE TO BE PERFORMED IN THE THE FIELD BY THE GEOTECHNICAL ENGINEER.
3. PILES ARE TO BE INSTALLED FROM EXISTING GRADE ELEVATION.
4. ELEVATIONS IN PILE SCHEDULE TO TAKE PRECEDENCE OVER PLAN AND DETAILS.
5. ALL PILES ARE TO BE HP310X110.
6. ALL PILES TO BE FITTED WITH TITUS 'H' BEARING PILE POINTS (STANDARD MODEL) OR EQUIVALENT.

GENERAL CONTRACTOR/CLIENT:

1. LOCATE AND EXPOSE/PROTECT (IF REQUIRED) ANY SERVICES ABOVE GROUND OR BELOW GRADE.
2. PROVIDE CERTIFICATION OF LEVEL AND STABLE WORKING PLATFORM FOR ANCHOR'S EQUIPMENT AS WELL AS ACCESS FOR ANCHOR'S EQUIPMENT.
3. PROVIDE ALL LAYOUT & ELEVATIONS AS REQUIRED.

MONITORING & INSPECTION:

1. GEOTECHNICAL ENGINEER TO MONITOR ALL DRIVING OPERATIONS.
2. GEOTECHNICAL ENGINEER TO APPROVE ALL FOUNDING ELEVATIONS.

REFERENCES:

- STRUCTURAL DRAWINGS PREPARED BY URS DATED MARCH 13, 2015
- GEOTECHNICAL INVESTIGATIONS PREPARED BY GOLDER ASSOCIATES

LEGEND:

- SOUTH ABUT. (SBL) SOUTH ABUTMENT - SOUTH BOUND LANE
- SOUTH ABUT. (NBL) SOUTH ABUTMENT - NORTH BOUND LANE
- NORTH ABUT. (SBL) NORTH ABUTMENT - SOUTH BOUND LANE
- NORTH ABUT. (NBL) NORTH ABUTMENT - NORTH BOUND LANE
- PIER (SBL) PIER - SOUTH BOUND LANE
- PIER (NBL) PIER - NORTH BOUND LANE
- NE RET. WALL NORTHEAST RETAINING WALL

00	ISSUED FOR APPROVAL	2016-04-21
Revision	Description	Date



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THE
MILLER
GROUP

Project
MTO 2015-2004 HWY 400

Title
SOUTH CANAL BRIDGE
H-PILE LAYOUT

Drawn by TN	Checked DW	File
Drawing Number S01	Revision 00	Scale 1:100 Date APRIL 21/16

PILE NO.	PART OF STRUCTURE	STAGE	ESTIMATED PILE TIP ELEV. (m)	ESTIMATED PILE CUT-OFF ELEV. (m)	BATTER	PILE LENGTH (m)	PILE LENGTH (Ft.)	FABRICATED LENGTH (Ft.)
1	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
2	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
3	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
4	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
5	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
6	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
7	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
8	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
9	SOUTH ABUT. (SBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
10	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
11	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
12	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
13	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
14	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
15	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
16	SOUTH ABUT. (SBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
17	SOUTH ABUT. (NBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
18	SOUTH ABUT. (NBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
19	SOUTH ABUT. (NBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
20	SOUTH ABUT. (NBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
21	SOUTH ABUT. (NBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
22	SOUTH ABUT. (NBL)	3	200.00	219.40	1:10	19.50	63.96	69.00
23	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
24	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
25	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
26	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
27	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
28	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
29	SOUTH ABUT. (NBL)	2	200.00	219.40	1:10	19.50	63.96	69.00
30	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
31	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
32	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
33	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
34	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
35	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
36	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
37	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
38	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
39	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
40	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
41	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
42	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
43	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
44	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
45	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
46	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
47	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
48	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
49	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
50	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
51	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
52	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
53	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
54	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
55	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
56	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
57	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
58	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
59	SOUTH ABUT. (SBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
60	SOUTH ABUT. (SBL)	2	200.00	219.40	1:6	19.67	64.53	69.00
61	SOUTH ABUT. (SBL)	2	200.00	219.40	1:6	19.67	64.53	69.00
62	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
63	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
64	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
65	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
66	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
67	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
68	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
69	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
70	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
71	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
72	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
73	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
74	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
75	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
76	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
77	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
78	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
79	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
80	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
81	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
82	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
83	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
84	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
85	SOUTH ABUT. (SBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
86	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
87	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
88	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
89	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
90	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
91	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
92	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
93	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
94	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
95	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
96	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
97	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
98	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
99	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
100	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
101	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
102	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
103	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
104	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
105	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
106	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
107	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00

Pile No.	Part of Structure	Stage	Estimated Pile Tip Elev. (m)	Estimated Pile Cut-off Elev. (m)	Batter	Pile Length (m)	Pile Length (ft.)	Fabricated Length (ft.)
108	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
109	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
110	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
111	SOUTH ABUT. (NBL)	3	200.00	219.40	1:4	20.00	65.61	69.00
112	SOUTH ABUT. (NBL)	2	200.00	219.40	1:6	19.67	64.53	69.00
113	SOUTH ABUT. (NBL)	2	200.00	219.40	1:6	19.67	64.53	69.00
114	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
115	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
116	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
117	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
118	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
119	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
120	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
121	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
122	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
123	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
124	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
125	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
126	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
127	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
128	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
129	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
130	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
131	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
132	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
133	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
134	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
135	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
136	SOUTH ABUT. (NBL)	2	200.00	219.40	1:4	20.00	65.61	69.00
137	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
138	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
139	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
140	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
141	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
142	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
143	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
144	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
145	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
146	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
147	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
148	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
149	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
150	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
151	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
152	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
153	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
154	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
155	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
156	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
157	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
158	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
159	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
160	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
161	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
162	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
163	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
164	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
165	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
166	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
167	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
168	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
169	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
170	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
171	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
172	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
173	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
174	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
175	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
176	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
177	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
178	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
179	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
180	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
181	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
182	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
183	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
184	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
185	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
186	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
187	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
188	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
189	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
190	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
191	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
192	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
193	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
194	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
195	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
196	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
197	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
198	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
199	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
200	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
201	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
202	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
203	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
204	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
205	PIER (SBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
206	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
207	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
208	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
209	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
210	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
211	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
212	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
213	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
214	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00

Pile No.	Part of Structure	Stage	Estimated Pile Tip Elev. (m)	Estimated Pile Cut-off Elev. (m)	Batter	Pile Length (m)	Pile Length (ft.)	Fabricated Length (ft.)
215	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
216	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
217	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
218	PIER (SBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
219	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
220	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
221	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
222	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
223	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
224	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
225	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
226	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
227	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
228	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
229	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
230	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
231	PIER (NBL)	3	204.00	217.80	VERT.	13.80	45.28	49.00
232	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
233	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
234	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
235	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
236	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
237	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
238	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
239	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
240	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
241	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
242	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
243	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
244	PIER (NBL)	2	204.00	217.80	VERT.	13.80	45.28	49.00
245	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
246	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
247	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
248	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
249	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
250	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
251	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
252	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
253	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
254	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
255	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
256	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
257	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
258	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
259	PIER (SBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
260	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
261	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
262	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
263	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
264	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
265	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
266	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
267	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
268	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
269	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
270	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
271	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
272	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
273	PIER (SBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
274	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
275	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
276	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
277	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
278	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
279	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
280	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
281	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
282	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
283	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
284	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
285	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
286	PIER (NBL)	3	204.00	217.80	1:10	13.87	45.50	49.00
287	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
288	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
289	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
290	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
291	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
292	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
293	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
294	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
295	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
296	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
297	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
298	PIER (NBL)	2	204.00	217.80	1:10	13.87	45.50	49.00
299	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
300	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
301	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
302	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
303	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
304	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
305	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
306	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
307	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
308	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
309	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
310	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
311	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
312	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
313	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
314	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
315	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
316	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
317	NORTH ABUT. (SBL)	2	203.00	218.90	1:4	16.39	53.77	57.00
318	NORTH ABUT. (SBL)	3	203.00	218.90	1:6	16.12	52.88	57.00
319	NORTH ABUT. (SBL)	3	203.00	218.90	1:6	16.12	52.88	57.00
320	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
321	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00

PILE NO.	PART OF STRUCTURE	STAGE	ESTIMATED PILE TIP ELEV. (m)	ESTIMATED PILE CUT-OFF ELEV. (m)	BATTER	PILE LENGTH (m)	PILE LENGTH (ft.)	FABRICATED LENGTH (ft.)
322	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
323	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
324	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
325	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
326	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
327	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
328	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
329	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
330	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
331	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
332	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
333	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
334	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
335	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
336	NORTH ABUT. (SBL)	3	203.00	218.90	1:4	16.39	53.77	57.00
337	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
338	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
339	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
340	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
341	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
342	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
343	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
344	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
345	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
346	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
347	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
348	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
349	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
350	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
351	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
352	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
353	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
354	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
355	NORTH ABUT. (NBL)	3	204.00	218.90	1:4	15.36	50.39	54.00
356	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
357	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
358	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
359	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
360	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
361	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
362	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
363	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
364	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
365	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
366	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
367	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
368	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
369	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
370	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
371	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
372	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
373	NORTH ABUT. (NBL)	2	204.00	218.90	1:4	15.36	50.39	54.00
374	NORTH ABUT. (SBL)	2	203.00	218.90	1:10	15.98	52.42	54.00
375	NORTH ABUT. (SBL)	2	203.00	218.90	1:10	15.98	52.42	54.00
376	NORTH ABUT. (SBL)	2	203.00	218.90	1:10	15.98	52.42	54.00
377	NORTH ABUT. (SBL)	2	203.00	218.90	1:10	15.98	52.42	54.00
378	NORTH ABUT. (SBL)	2	203.00	218.90	1:10	15.98	52.42	54.00
379	NORTH ABUT. (SBL)	2	203.00	218.90	1:10	15.98	52.42	54.00
380	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
381	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
382	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
383	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
384	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
385	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
386	NORTH ABUT. (SBL)	3	203.00	218.90	1:10	15.98	52.42	54.00
387	NORTH ABUT. (NBL)	3	204.00	218.90	1:10	14.97	49.13	54.00
388	NORTH ABUT. (NBL)	3	204.00	218.90	1:10	14.97	49.13	54.00
389	NORTH ABUT. (NBL)	3	204.00	218.90	1:10	14.97	49.13	54.00
390	NORTH ABUT. (NBL)	3	204.00	218.90	1:10	14.97	49.13	54.00
391	NORTH ABUT. (NBL)	3	204.00	218.90	1:10	14.97	49.13	54.00
392	NORTH ABUT. (NBL)	3	204.00	218.90	1:10	14.97	49.13	54.00
393	NORTH ABUT. (NBL)	2	204.00	218.90	1:10	14.97	49.13	54.00
394	NORTH ABUT. (NBL)	2	204.00	218.90	1:10	14.97	49.13	54.00
395	NORTH ABUT. (NBL)	2	204.00	218.90	1:10	14.97	49.13	54.00
396	NORTH ABUT. (NBL)	2	204.00	218.90	1:10	14.97	49.13	54.00
397	NORTH ABUT. (NBL)	2	204.00	218.90	1:10	14.97	49.13	54.00
398	NE RET. WALL	2	204.00	218.90	VERT.	14.90	48.88	54.00
399	NE RET. WALL	2	204.00	218.90	VERT.	14.90	48.88	54.00
400	NE RET. WALL	2	204.00	218.90	VERT.	14.90	48.88	54.00
401	NE RET. WALL	2	204.00	218.90	VERT.	14.90	48.88	54.00
402	NE RET. WALL	2	204.00	218.90	1:4	15.36	50.39	54.00
403	NE RET. WALL	2	204.00	218.90	1:4	15.36	50.39	54.00
404	NE RET. WALL	2	204.00	218.90	1:4	15.36	50.39	54.00

GENERAL NOTES:

1. PILE TIP ELEVATIONS DETAILED ON THIS DRAWING ARE APPROXIMATE.
2. VERIFICATION OF THE FOUNDING ELEVATIONS ARE TO BE PERFORMED IN THE FIELD BY THE GEOTECHNICAL ENGINEER.
3. PILES ARE TO BE INSTALLED FROM EXISTING GRADE ELEVATION.
4. ELEVATIONS IN PILE SCHEDULE TO TAKE PRECEDENCE OVER PLAN AND DETAIL.
5. ALL PILES ARE TO BE HP310X110.
6. ALL PILES TO BE FITTED WITH TITUS 'H' BEARING PILE POINTS (STANDARD MODEL) OR EQUIVALENT.

GENERAL CONTRACTOR/CLIENT:

1. LOCATE AND EXPOSE/PROTECT (IF REQUIRED) ANY SERVICES ABOVE GROUND OR BELOW GRADE.
2. PROVIDE CERTIFICATION OF LEVEL AND STABLE WORKING PLATFORM FOR ANCHOR'S EQUIPMENT AS WELL AS ACCESS FOR ANCHOR'S EQUIPMENT.
3. PROVIDE ALL LAYOUT & ELEVATIONS AS REQUIRED.

MONITORING & INSPECTION:

1. GEOTECHNICAL ENGINEER TO MONITOR ALL DRIVING OPERATIONS.
2. GEOTECHNICAL ENGINEER TO APPROVE ALL FOUNDING ELEVATIONS.

REFERENCES:

- STRUCTURAL DRAWINGS PREPARED BY URS DATED MARCH 13, 2015
- GEOTECHNICAL INVESTIGATIONS PREPARED BY GOLDER ASSOCIATES

LEGEND:

- | | |
|---------------------|-----------------------------------|
| • SOUTH ABUT. (SBL) | SOUTH ABUTMENT – SOUTH BOUND LANE |
| • SOUTH ABUT. (NBL) | SOUTH ABUTMENT – NORTH BOUND LANE |
| • NORTH ABUT. (SBL) | NORTH ABUTMENT – SOUTH BOUND LANE |
| • NORTH ABUT. (NBL) | NORTH ABUTMENT – NORTH BOUND LANE |
| • PIER (SBL) | PIER – SOUTH BOUND LANE |
| • PIER (NBL) | PIER – NORTH BOUND LANE |
| • NE RET. WALL | NORTHEAST RETAINING WALL |

00	ISSUING FOR APPROVAL	2016-04-21
Revision	Description	Date




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Client



Project

MTO 2015-2004 HWY 400

Title

SOUTH CANAL BRIDGE
H-PILE SCHEDULE

Drawn by TN	Checked DW	File
Drawing Number S02	Revision 00	Scale N.T.S.
		Date APRIL 21/16

NOTE: ALL PILES TO BE FITTED WITH TITUS 'H' BEARING PILE POINTS (STANDARD MODEL) OR EQUIVALENT.



APPENDIX C

Scope/Work Plan for Test Pile Installation and Pile Load Test

Contract No.: 2015-2004

Full-Scale Pile Load Test at North Abutment of South Canal Bridges

Highway 400 Widening from North of King Road to North of South Canal Road, Regional Municipality of York

This document summarizes the scope of work for the Contractor to carry out a full-scale pile load test at or in the vicinity of the north abutment of the Highway 400 bridges (northbound or southbound lanes).

Scope/Work Plan

- The Contractor shall conduct a full-scale Pile Load Test in accordance with ASTM D1143 (Standard test Methods for Deep Foundations Under Static Axial Compressive Load) at the location of the north abutment of the Highway 400-South Canal bridges, using an HP310x110 pile. The static pile load test may be carried out in the vicinity of the north abutment of either the northbound lane or southbound lane structure. The Contractor, in conjunction with the Contract Administrator, shall determine the location of the test site in a manner that minimizes interference with the local traffic, current construction staging and pile driving activities on site.
- It is understood that a hydraulic hammer is currently present at the site in the vicinity of the north abutment, and consideration shall be given to conduct the Pile Load Test using the available hydraulic hammer for cost effectiveness. A provisional line item shall be provided by the Contractor for the Pile Load Test to be carried out using a diesel hammer that allows for Hiley testing – i.e., the provisional line item shall cover the disassembly, mobilization and reassembly of the diesel hammer system that is understood to be in place at the centre pier location, south of the canal.
- The test pile shall be driven to Elevation 204 m. Given the variable thickness and top elevation of the “100-blow” soil, allowance shall be made for the test pile to be driven up to 2 m deeper, to about Elevation 202 m, upon consultation with MTO Foundations Section and the foundations sub-consultant (Golder Associates Ltd.) to the appropriate pile “set” value prior to the Pile Load Test.
- The Contractor shall carry out Pile Driving Analyzer (PDA) testing during the installation of the test pile. It is understood that the Hiley method cannot be employed with a hydraulic hammer. However, if a decision is made by MTO to adopt the provisional item of mobilizing a diesel hammer from the centre pier location, the Hiley method shall be used as well as PDA testing to confirm the ultimate geotechnical resistance, beginning at Elevation 205.5 m and thereafter at 0.5 m intervals of depth.
- The Contractor shall design and install a reaction system for the Pile Load Test that is capable of providing a maximum load of 3,200 kN in compression to the test pile.
- The Contractor shall be responsible for providing all the equipment for the Pile Load Test in accordance with ASTM D1143, including but not limited to the reference beam, loading jack, gauges, etc. The reference beam shall be installed on an independent system at a sufficient distance away from the Pile Load Test setup to prevent any interference from the Pile Load Test.
- The Contractor shall prepare a detailed drawing showing the Pile Load Test setup and the reaction system.
- The full-scale Pile Load Test shall be carried out not earlier than 30 days after the installation of the test pile and reaction piles.
- The Pile Load Test shall be continued to a load equivalent to 3,200 kN or failure load, whichever occurs first.

Justification

The results from the full-scale Pile Load Test will be compared to the results from PDA testing (and Hiley testing, if available based on hammer type) to allow for optimization in correlations between the PDA test results and actual, longer-term pile capacities in compression.

Based on the soil and groundwater conditions at this site (i.e., presence of artesian pressures), it is anticipated that the full-scale Pile Load Test conducted 30 days after pile installation will measure higher pile capacities in the vicinity of the north abutment. In addition, the full-scale pile load test will allow for higher geotechnical resistance factors and consequently higher geotechnical pile capacities. This will allow for optimization of the next stage of pile installation at the north abutment of the South Canal bridges.

In addition, the results of the full-scale Pile Load Test will be used to study the development of geotechnical resistances with time in fine-grained non-cohesive soils under artesian pressures, for applicability to other highway bridges in similar conditions.

n:\active\2009\1111\09-1111-0018 urs - hwy 400 - york\11 - construction support\3 - static pile load test\4 - pile load test report\appendix b\2015-2004 - static pile load test - scope and justification.docx



APPENDIX D

Report: Dynamic Testing and Analyses of Test Pile at Northeast Abutment



November 1, 2016

DYNAMIC TESTING AND ANALYSES OF TEST PILE AT NORTHEAST ABUTMENT

Highway 400 Widening at South Canal Road Newmarket, Ontario



REPORT

Submitted to:

Mr. Dave Winter
Anchor Shoring & Caissons Limited
3445 Kennedy Road
Toronto, Ontario
M1V 4Y3

Report Number: 1666498 (Rev. 1)

Distribution:

1 e-Copy - Anchor Shoring & Caissons Limited
1 e-Copy - Golder Associates Ltd.

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4.0 SUMMARY OF TEST RESULTS.....	2
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ATTACHMENTS

Important Information and Limitations of This Report

APPENDIX A

CAPWAP Results

Pile No. PT1 – Pile Tip Elevation 205.5 m

Pile No. PT1 - Pile Tip Elevation 205 m

Pile No. PT1 - Pile Tip Elevation 204.5 m

Pile No. PT1 - Pile Tip Elevation 204 m



1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Anchor Shoring & Caissons Limited (Anchor) to carry out high strain dynamic testing on a test pile installed at the vicinity of the northeast abutment of the bridge for widening of Highway 400 at South Canal Road located in Newmarket, Ontario.

The primary purpose of Pile Driving Analyzer (PDA) testing was to determine the mobilized geotechnical axial resistance of the tested pile.

The high strain dynamic testing was performed using a PAX model Pile Driving Analyzer manufactured by Pile Dynamics Inc., from Cleveland Ohio, USA. The high strain dynamic testing was carried out in conformance with ASTM D4945-12.

This report presents the results of the PDA testing carried out on one steel H-pile during our site visit on October 6, 2016.

This report should be read in conjunction with the “Important Information and Limitations of This Report” attached to this report. The reader’s attention is specifically drawn to this information, as it is essential for the proper use and interpretation of this report.

2.0 PILES AND DRIVING INFORMATION

Based on the information provided by Anchor, Pile PT1 was PDA tested during our site visit of October 6, 2016. This pile is a HP310X110 steel H pile and was driven with a driving shoe.

A Liebherr H40/4 hydraulic hammer was used for the pile installation and PDA testing. The rated energy of the H40/4 hydraulic hammer is reported to be about 30 kJ.

PDA test was carried out when this pile was driven from a pile tip elevation of about 205.5 m to about 204 m. The driving resistance for this depth interval increased from 29 blows/0.25 m to about 103 blows/0.25 m with the hammer operating between about 47 blows/min and 50 blows/min (BPM).

When the pile tip elevation reached about 204 m (i.e., final embedment depth of about 16.5 m), the pile was subjected to 19 blows with the hammer operating at about 47 to 48 BPM. It was observed that the pile moved about 59 mm.

3.0 PDA TESTING

Table 1 provides a summary of the driving and testing sequence of the PDA tested pile.

Table 1: Summary of Pile Driving and PDA Testing Sequence

Pile No.	Pile Installation Date	Pile Testing Date	PDA Test Condition	Set Up period (days)	Final Embedment Length (m)
PT1	06-Oct-16	06-Oct-16	E OID	0	16.5

E OID: *End of Initial Driving.*

Embedment length referenced in this report is the pile length below the existing ground surface.



4.0 SUMMARY OF TEST RESULTS

A representative hammer blow was selected for Case Pile Wave Analysis Program (CAPWAP) analysis from the respective PDA data sets. The CAPWAP analysis was carried at the pile tip elevation of about 205.5 m and then at every 0.5 m intervals down to about elevation 204 m. Detailed results of the CAPWAP analysis are provided in Appendix A. Table 2 summarizes the results of the PDA and CAPWAP analyses.

During PDA testing with the Liebherr H40/4 hydraulic hammer, the energy transfer ratio was found to be up to 59% during EOID test, when compared to the rated energy of 30 kJ.



**DYNAMIC TESTING AND ANALYSES OF TEST PILE AT NORTHEAST ABUTMENT
HIGHWAY 400 WIDENING AT SOUTH CANAL ROAD, NEWMARKET, ONTARIO**

Table 2: PDA and CAPWAP Results

Pile No.	Blow No.	Hammer Blow Rate (BPM)	Embedment Length (m)	Equivalent PRES (blows/25 mm)	Test Condition	Pile Driving Analyzer Data					CAPWAP Results			Estimated Total Mobilized Resistance (kN)
						EMX (kJ)	RX9	FMX (kN)	CSX (MPa)	CSB (MPa)	Mobilized Static Resistance			
											Total (kN)	Shaft (kN)	Toe (kN)	
PT1	6	47	15	2.9	Eoid	17.6	740	1,919	140	40	749	439	310	750
PT1	138	48	15.5	5.9	Eoid	15.8	1,000	1,852	132	45	942	533	409	940
PT1	250	47	16	6.8	Eoid	15.8	1,112	1,888	132	53	1,064	579	485	1,060
PT1	19	48	16.5	8.1	Eoid	16.1	1,149	1,902	133	71	1,106	606	500	1,100

PRES: Penetration Resistance

Eoid: End of Initial Driving

EMX: Maximum Transferred Energy at Sensors

RX9: Case Capacity based on Jc of 0.9

FMX: Maximum Force

CSX: Maximum Compressive Stress

CSB: Maximum Compressive Stress at Pile Tip



5.0 CONCLUSIONS

The result of the PDA testing completed on the subject pile, starting at about elevation 205.5 m and at every 0.5 m intervals down to about elevation 204 m, are summarized in Table 3.

Table 3: Test Pile Summary

Pile No.	Set Up period (days)	Embedment Length Below the Existing Ground (m)	Pile Tip Elevation (m)	Estimated Mobilized Compression Resistance (kN)	
				EOID	BOR
PT1	0	15	205.5	750	n/a
PT1	0	15.5	205	940	n/a
PT1	0	16	204.5	1,060	n/a
PT1	0	16.5	204	1,100	n/a

No structural damage was observed during PDA testing.

The resistance near the pile tip may be interpreted as either toe resistance or shaft resistance. The CAPWAP model cannot accurately differentiate between the toe resistance and the shaft resistance near the toe; however, the model produced is consistent with the driving conditions and observations.

The test result is representative of site conditions at the time of testing, therefore should not be interpreted as the final resistance of the pile.

6.0 CLOSURE

We trust that this report provides the information that you require at this time. Should you have questions or comments regarding the above, please contact us.



Report Signature Page

GOLDER ASSOCIATES LTD.

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Senior Geotechnical Engineer, Principal

RL/YM/sv

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IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

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Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

Soil, Rock and Ground water Conditions: Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, Golder does not warrant or guarantee the exactness of the descriptions.



IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that Golder interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

Sample Disposal: Golder will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

Follow-Up and Construction Services: All details of the design were not known at the time of submission of Golder's report. Golder should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of Golder's report.

During construction, Golder should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of Golder's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in Golder's report. Adequate field review, observation and testing during construction are necessary for Golder to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, Golder's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

Changed Conditions and Drainage: Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that Golder be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that Golder be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. Golder takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

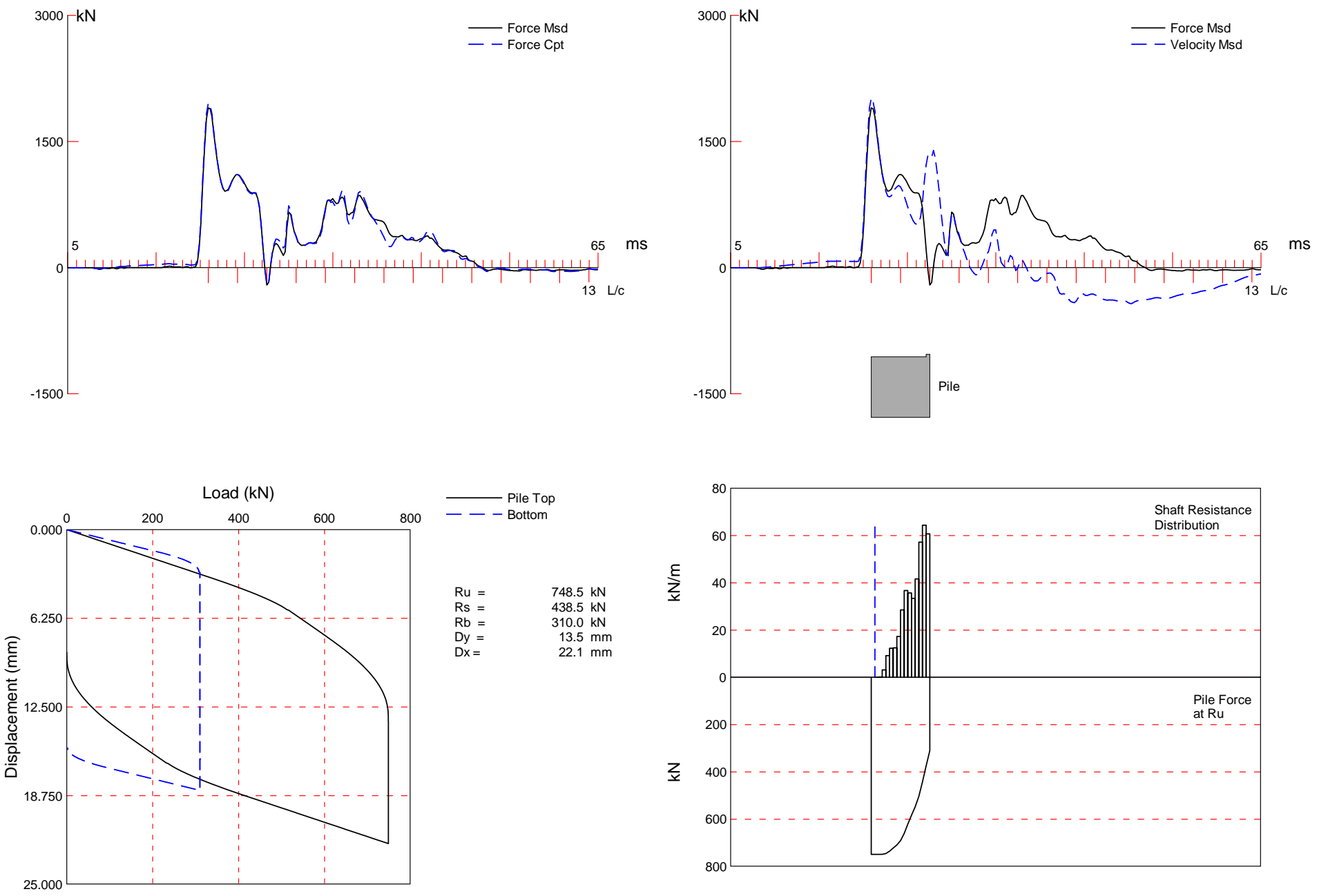


APPENDIX A

CAPWAP Results



Pile No. PT1 – Pile Tip Elevation 205.5 m



1666498; Pile: HWY400 NA PT1 EOID OCT6 1
 HEW400 AND CAN RD; Blow: 6
 Golder Associates Ltd.

Test: 06-Oct-2016 14:06:
 CAPWAP(R) 2006-3
 OP: OS

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 748.5; along Shaft 438.5; at Toe 310.0 kN								
Soil Sgmnt No.	Dist. Below Gages m	Depth Below Grade m	Ru kN	Force in Pile kN	Sum of Ru kN	Unit Resist. (Depth) kN/m	Unit Resist. (Area) kPa	Smith Damping Factor s/m
				748.5				
1	2.1	0.2	0.0	748.5	0.0	0.00	0.00	0.000
2	3.2	1.2	0.2	748.3	0.2	0.19	0.15	0.291
3	4.2	2.3	3.4	744.9	3.6	3.21	2.59	0.291
4	5.3	3.3	9.8	735.1	13.4	9.24	7.48	0.291
5	6.4	4.4	13.1	722.0	26.5	12.35	9.99	0.291
6	7.4	5.5	13.3	708.7	39.8	12.54	10.15	0.291
7	8.5	6.5	18.4	690.3	58.2	17.35	14.04	0.291
8	9.5	7.6	30.3	660.0	88.5	28.57	23.11	0.291
9	10.6	8.6	39.0	621.0	127.5	36.77	29.75	0.291
10	11.7	9.7	37.9	583.1	165.4	35.73	28.91	0.291
11	12.7	10.8	35.5	547.6	200.9	33.47	27.08	0.291
12	13.8	11.8	44.2	503.4	245.1	41.67	33.72	0.291
13	14.8	12.9	60.7	442.7	305.8	57.23	46.30	0.291
14	15.9	13.9	68.3	374.4	374.1	64.40	52.10	0.291
15	17.0	15.0	64.4	310.0	438.5	60.72	49.13	0.291
Avg. Shaft			29.2			29.23	23.65	0.291
Toe			310.0				3246.75	0.098

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(mm)	7.502	2.297
Case Damping Factor		0.224	0.053
Unloading Quake	(% of loading quake)	88	55
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	17	
Resistance Gap (included in Toe Quake) (mm)			0.156
Soil Plug Weight	(kN)		0.12

CAPWAP match quality	=	2.32	(Wave Up Match) ; RSA = 0
Observed: final set	=	8.620 mm;	blow count = 116 b/m
Computed: final set	=	7.659 mm;	blow count = 131 b/m
max. Top Comp. Stress	=	138.8 MPa	(T= 21.3 ms, max= 1.007 x Top)
max. Comp. Stress	=	139.7 MPa	(Z= 5.3 m, T= 22.2 ms)
max. Tens. Stress	=	-10.04 MPa	(Z= 12.7 m, T= 25.5 ms)
max. Energy (EMX)	=	17.44 kJ;	max. Measured Top Displ. (DMX)=20.60 mm

1666498; Pile: HWY400 NA PT1 EOID OCT6 1
 HEW400 AND CAN RD; Blow: 6
 Golder Associates Ltd.

Test: 06-Oct-2016 14:06:
 CAPWAP(R) 2006-3
 OP: OS

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages m	max. Force kN	min. Force kN	max. Comp. Stress MPa	max. Tens. Stress MPa	max. Trnsfd. Energy kJ	max. Veloc. m/s	max. Displ. mm
1	1.1	1956.5	-135.6	138.8	-9.62	17.44	3.4	19.595
2	2.1	1959.1	-62.2	138.9	-4.41	17.34	3.4	19.451
3	3.2	1963.1	-66.8	139.2	-4.74	17.29	3.4	19.282
4	4.2	1967.1	-74.3	139.5	-5.27	17.24	3.4	19.108
5	5.3	1970.1	-82.3	139.7	-5.84	17.11	3.4	18.950
6	6.4	1968.5	-87.0	139.6	-6.17	16.83	3.4	18.797
7	7.4	1968.4	-89.0	139.6	-6.31	16.46	3.3	18.632
8	8.5	1969.1	-91.3	139.7	-6.48	16.07	3.3	18.435
9	9.5	1970.0	-90.8	139.7	-6.44	15.54	3.3	18.217
10	10.6	1952.4	-85.8	138.5	-6.08	14.73	3.2	17.997
11	11.7	1930.6	-89.3	136.9	-6.34	13.73	3.2	17.785
12	12.7	1912.8	-141.6	135.7	-10.04	12.77	3.1	17.578
13	13.8	1876.8	-72.2	133.1	-5.12	11.86	3.6	17.363
14	14.8	1621.9	-62.7	115.0	-4.44	10.76	4.3	17.188
15	15.9	1093.1	-48.4	77.5	-3.43	9.28	4.8	17.068
16	17.0	590.9	-28.7	40.2	-1.95	6.19	4.9	16.950
Absolute	5.3			139.7			(T =	22.2 ms)
	12.7				-10.04		(T =	25.5 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	1190.0	914.8	639.5	364.3	89.1	0.0	0.0	0.0	0.0	0.0
RX	1222.9	956.2	839.6	790.4	760.0	746.3	742.6	740.2	740.2	740.2
RU	1190.0	914.8	639.5	364.3	89.1	0.0	0.0	0.0	0.0	0.0

RAU = 722.7 (kN); RA2 = 638.0 (kN)

Current CAPWAP Ru = 748.5 (kN); Corresponding J(RP)= 0.16; J(RX) = 0.48

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS
m/s	ms	kN	kN	kN	mm	mm	mm	kJ	kN
3.58	21.12	2036.5	1905.8	1919.3	20.598	8.373	8.620	17.6	1202.3

PILE PROFILE AND PILE MODEL

Depth m	Area cm ²	E-Modulus MPa	Spec. Weight kN/m ³	Perim. m
0.00	141.00	206842.7	77.287	1.236
16.95	141.00	206842.7	77.287	1.236
16.95	450.00	206842.7	77.287	1.236
16.97	450.00	206842.7	77.287	1.236

Toe Area 0.095 m²

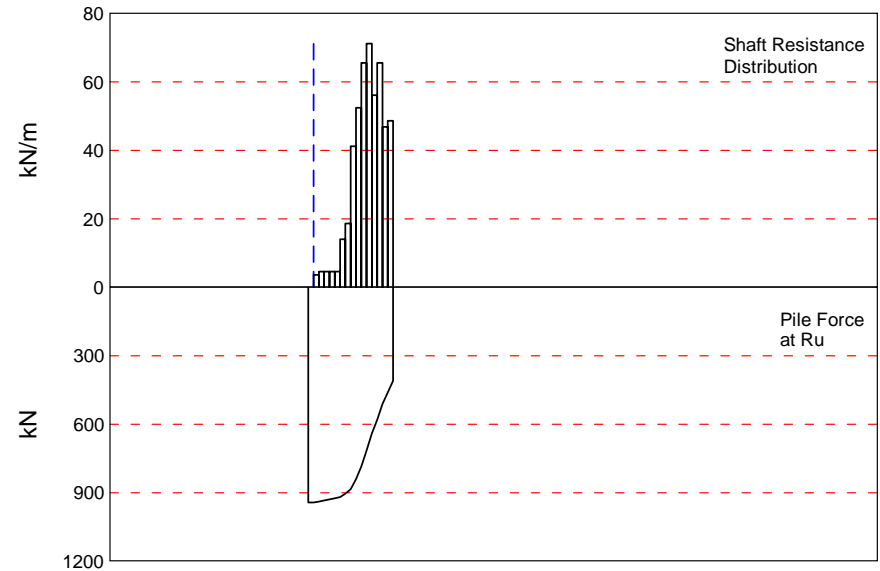
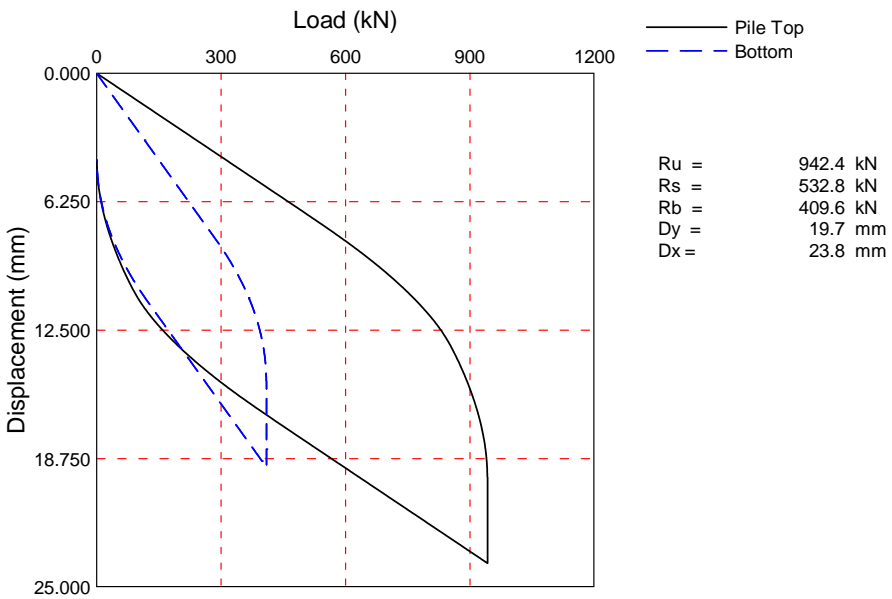
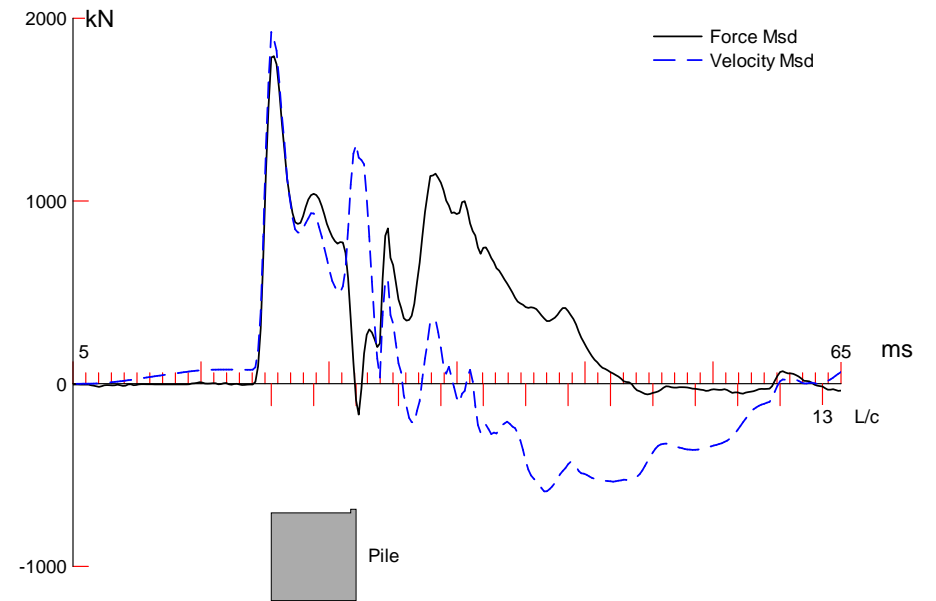
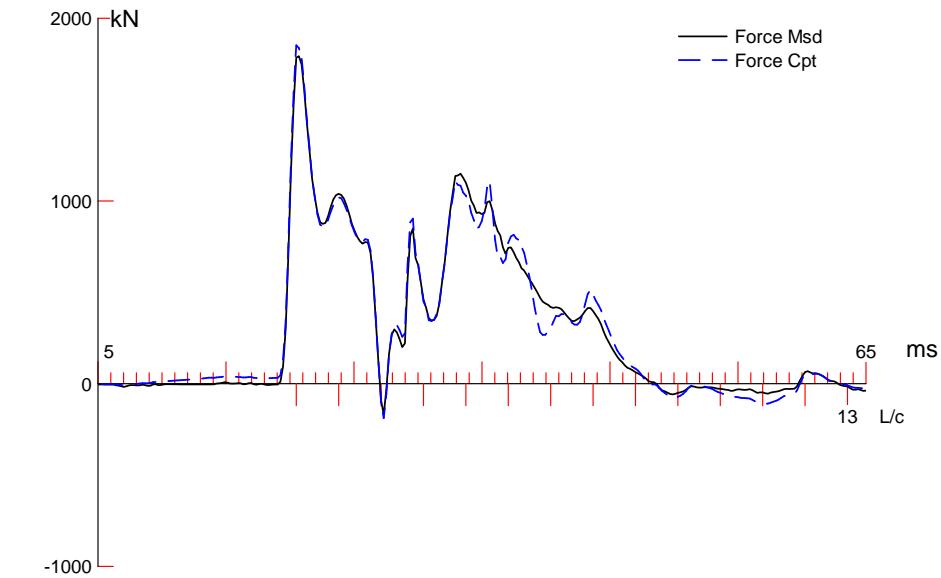
Segmnt Number	Dist. B.G. m	Impedance kN/m/s	Imped. Change %	Slack mm	Tension Eff.	Compression Slack mm	Perim. m
1	1.06	569.29	0.00	0.000	0.000	-0.000	1.236
16	16.97	592.81	0.00	0.000	0.000	-0.000	1.236

Pile Damping 1.0 %, Time Incr 0.207 ms, Wave Speed 5123.0 m/s, 2L/c 6.6 ms



**DYNAMIC TESTING AND ANALYSES OF TEST PILE AT NORTHEAST ABUTMENT
HIGHWAY 400 WIDENING AT SOUTH CANAL ROAD, NEWMARKET, ONTARIO**

Pile No. PT1 - Pile Tip Elevation 205 m



1666498; Pile: HWY400 NA PT1 EOID OCT6 1
 HEW400 AND CAN RD; Blow: 138
 Golder Associates Ltd.

Test: 06-Oct-2016 14:08:
 CAPWAP(R) 2006-3
 OP: OS

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity:		942.4; along Shaft		532.8; at Toe		409.6 kN		
Soil Sgmnt No.	Dist. Below Gages m	Depth Below Grade m	Ru kN	Force in Pile kN	Sum of Ru kN	Unit Resist. (Depth) kN/m	Unit Resist. (Area) kPa	Smith Damping Factor s/m
				942.4				
1	2.1	0.7	3.9	938.5	3.9	5.99	4.85	0.120
2	3.2	1.7	4.9	933.6	8.8	4.62	3.74	0.120
3	4.2	2.8	4.9	928.7	13.7	4.62	3.74	0.120
4	5.3	3.8	4.9	923.8	18.6	4.62	3.74	0.120
5	6.4	4.9	4.9	918.9	23.5	4.62	3.74	0.120
6	7.4	6.0	14.9	904.0	38.4	14.05	11.37	0.120
7	8.5	7.0	19.8	884.2	58.2	18.67	15.10	0.120
8	9.5	8.1	43.7	840.5	101.9	41.20	33.34	0.120
9	10.6	9.1	55.6	784.9	157.5	52.42	42.41	0.120
10	11.7	10.2	69.5	715.4	227.0	65.53	53.02	0.120
11	12.7	11.3	75.5	639.9	302.5	71.18	57.59	0.120
12	13.8	12.3	59.5	580.4	362.0	56.10	45.39	0.120
13	14.8	13.4	69.5	510.9	431.5	65.53	53.02	0.120
14	15.9	14.4	49.7	461.2	481.2	46.86	37.91	0.120
15	17.0	15.5	51.6	409.6	532.8	48.65	39.36	0.120
Avg. Shaft			35.5			34.37	27.81	0.120
Toe			409.6				4289.90	0.309

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(mm)	7.498	11.529
Case Damping Factor		0.112	0.222
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	21	
Resistance Gap (included in Toe Quake)	(mm)		3.168

CAPWAP match quality = 3.41 (Wave Up Match) ; RSA = 0
 Observed: final set = 4.200 mm; blow count = 238 b/m
 Computed: final set = 3.669 mm; blow count = 273 b/m
 max. Top Comp. Stress = 131.4 MPa (T= 20.9 ms, max= 1.001 x Top)
 max. Comp. Stress = 131.5 MPa (Z= 9.5 m, T= 22.8 ms)
 max. Tens. Stress = -12.65 MPa (Z= 8.5 m, T= 56.5 ms)
 max. Energy (EMX) = 15.78 kJ; max. Measured Top Displ. (DMX)=18.26 mm

1666498; Pile: HWY400 NA PT1 EOID OCT6 1
 HEW400 AND CAN RD; Blow: 138
 Golder Associates Ltd.

Test: 06-Oct-2016 14:08:
 CAPWAP(R) 2006-3
 OP: OS

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages m	max. Force kN	min. Force kN	max. Comp. Stress MPa	max. Tens. Stress MPa	max. Trnsfd. Energy kJ	max. Veloc. m/s	max. Displ. mm
1	1.1	1852.8	-127.0	131.4	-9.01	15.78	3.3	17.363
2	2.1	1850.9	-145.3	131.3	-10.31	15.61	3.3	17.040
3	3.2	1847.3	-158.4	131.0	-11.24	15.37	3.3	16.685
4	4.2	1845.8	-165.0	130.9	-11.70	15.14	3.2	16.356
5	5.3	1842.6	-167.0	130.7	-11.84	14.91	3.2	16.039
6	6.4	1842.3	-172.4	130.7	-12.22	14.67	3.2	15.692
7	7.4	1846.0	-173.9	130.9	-12.34	14.40	3.2	15.383
8	8.5	1851.1	-178.3	131.3	-12.65	14.08	3.2	15.207
9	9.5	1853.8	-176.1	131.5	-12.49	13.75	3.1	15.033
10	10.6	1846.0	-165.0	130.9	-11.70	13.05	3.1	14.830
11	11.7	1829.4	-150.9	129.7	-10.70	12.18	3.1	14.599
12	12.7	1804.4	-131.1	128.0	-9.30	11.15	3.0	14.364
13	13.8	1756.2	-110.5	124.5	-7.84	10.05	3.4	14.138
14	14.8	1591.2	-94.4	112.9	-6.70	9.17	4.1	13.917
15	15.9	1086.6	-93.1	77.1	-6.61	8.21	4.6	13.756
16	17.0	666.7	-91.1	45.4	-6.21	7.38	4.7	13.603
Absolute	9.5			131.5			(T =	22.8 ms)
	8.5				-12.65		(T =	56.5 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	1180.4	922.7	665.0	407.3	149.6	0.0	0.0	0.0	0.0	0.0
RX	1201.1	1159.6	1120.1	1080.5	1053.6	1034.7	1017.7	1010.3	1005.0	1001.1
RU	1180.4	922.7	665.0	407.3	149.6	0.0	0.0	0.0	0.0	0.0

RAU = 979.6 (kN); RA2 = 1013.9 (kN)

Current CAPWAP Ru = 942.4 (kN); Corresponding J(RP)= 0.09;

RMX requires higher damping; see PDA-W

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS
m/s	ms	kN	kN	kN	mm	mm	mm	kJ	kN
3.45	20.70	1963.8	1793.6	1852.1	18.262	4.200	4.200	15.8	1408.8

PILE PROFILE AND PILE MODEL

Depth m	Area cm ²	E-Modulus MPa	Spec. Weight kN/m ³	Perim. m
0.00	141.00	206842.7	77.287	1.236
16.95	141.00	206842.7	77.287	1.236
16.95	450.00	206842.7	77.287	1.236
16.97	450.00	206842.7	77.287	1.236

Toe Area 0.095 m²

Segmnt Number	Dist. B.G. m	Impedance kN/m/s	Imped. Change %	Slack mm	Tension Eff.	Compression Slack Eff. mm	Perim. m
1	1.06	569.29	0.00	0.000	0.000	-0.000	1.236

1666498; File: HWY400 NA PT1 EOID OCT6 1
HEW400 AND CAN RD; Blow: 138
Golder Associates Ltd.

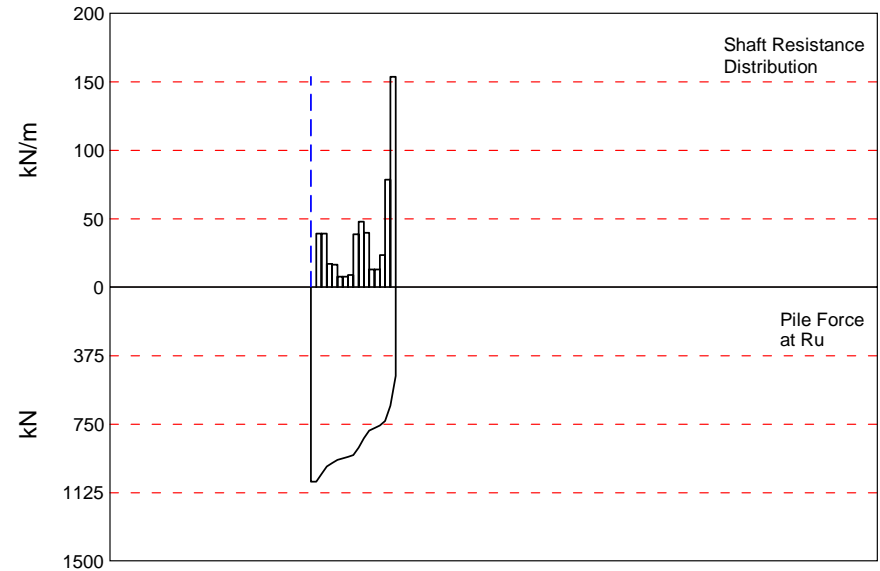
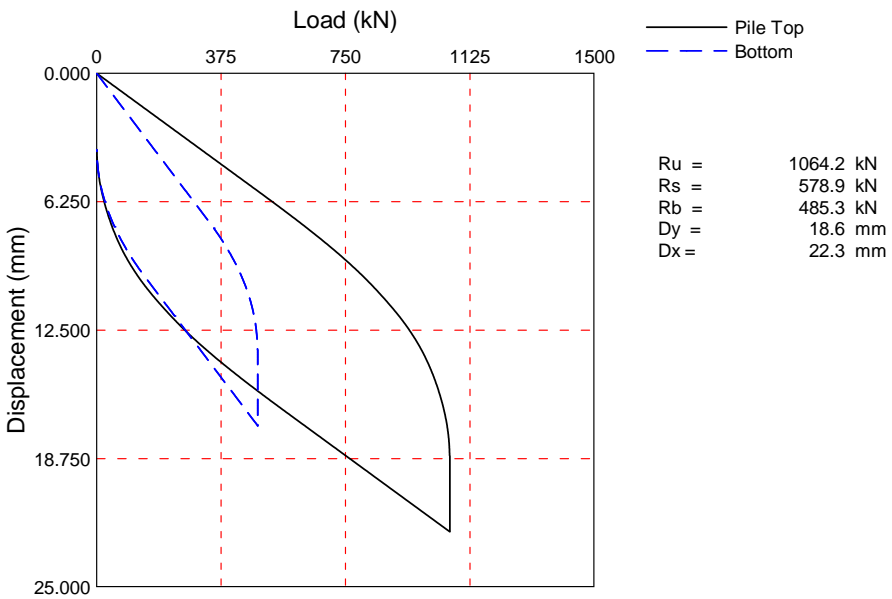
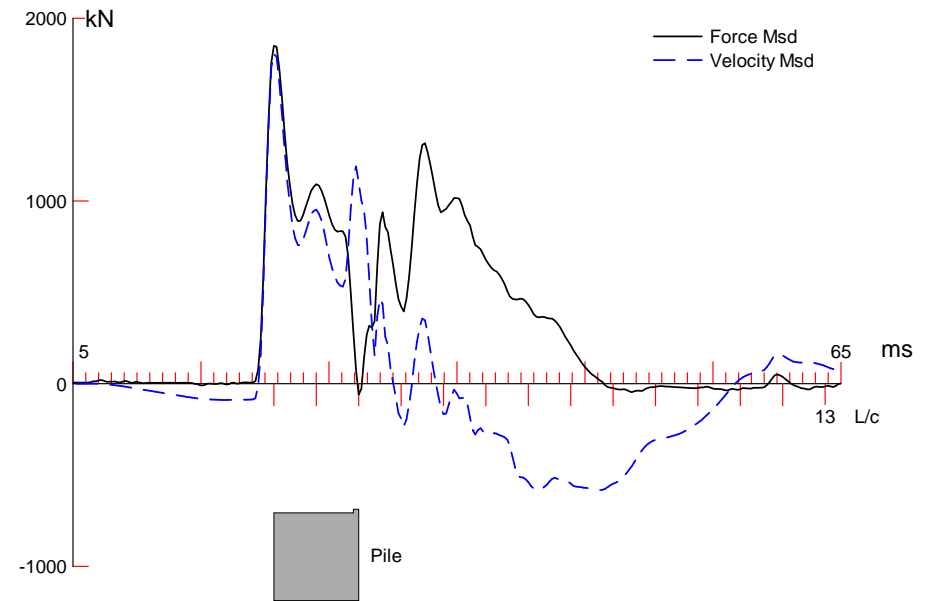
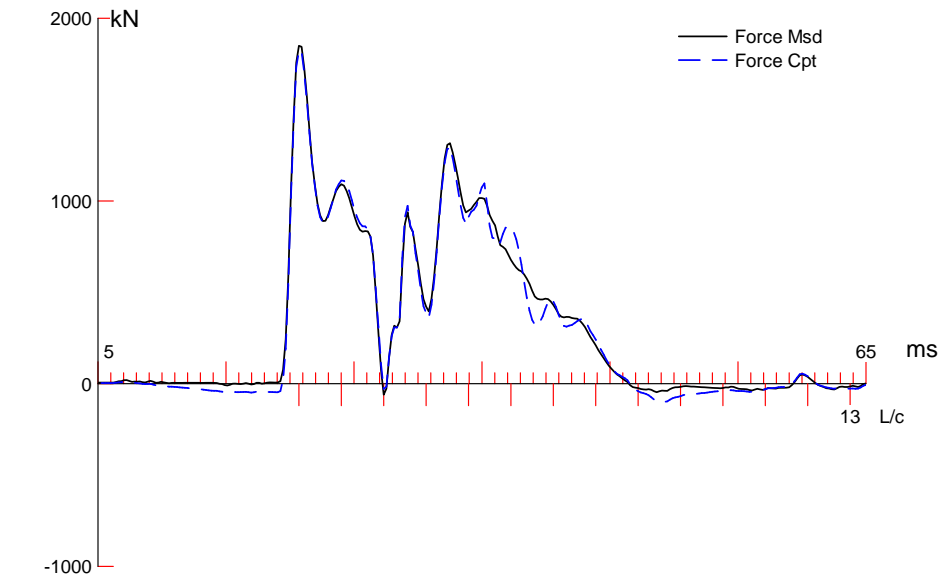
Test: 06-Oct-2016 14:08:
CAPWAP(R) 2006-3
OP: OS

Segmnt Number	Dist. B.G. m	Impedance kN/m/s	Imped. Change %	Slack mm	Tension Eff.	Compression Slack mm	Eff.	Perim. m
16	16.97	592.81	0.00	0.000	0.000	-0.000	0.000	1.236

File Damping 1.0 %, Time Incr 0.207 ms, Wave Speed 5123.0 m/s, 2L/c 6.6 ms



Pile No. PT1 - Pile Tip Elevation 204.5 m



1666498; Pile: HWY400 NA PT1 EOID OCT6 1
 HEW400 AND CAN RD; Blow: 250
 Golder Associates Ltd.

Test: 06-Oct-2016 14:11:
 CAPWAP(R) 2006-3
 OP: OS

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 1064.2; along Shaft 578.9; at Toe 485.3 kN								
Soil Sgmnt No.	Dist. Below Gages m	Depth Below Grade m	Ru kN	Force in Pile kN	Sum of Ru kN	Unit Resist. (Depth) kN/m	Unit Resist. (Area) kPa	Smith Damping Factor s/m
				1064.2				
1	2.1	1.2	41.7	1022.5	41.7	36.22	29.31	0.265
2	3.2	2.2	41.7	980.8	83.4	39.32	31.81	0.265
3	4.2	3.3	18.2	962.6	101.6	17.16	13.88	0.265
4	5.3	4.3	17.6	945.0	119.2	16.59	13.43	0.265
5	6.4	5.4	8.3	936.7	127.5	7.83	6.33	0.265
6	7.4	6.5	8.3	928.4	135.8	7.83	6.33	0.265
7	8.5	7.5	9.6	918.8	145.4	9.05	7.32	0.265
8	9.5	8.6	41.1	877.7	186.5	38.75	31.35	0.265
9	10.6	9.6	50.9	826.8	237.4	47.99	38.83	0.265
10	11.7	10.7	42.3	784.5	279.7	39.88	32.27	0.265
11	12.7	11.8	13.9	770.6	293.6	13.11	10.60	0.265
12	13.8	12.8	13.9	756.7	307.5	13.11	10.60	0.265
13	14.8	13.9	25.0	731.7	332.5	23.57	19.07	0.265
14	15.9	14.9	83.4	648.3	415.9	78.63	63.62	0.265
15	17.0	16.0	163.0	485.3	578.9	153.68	124.34	0.265
Avg. Shaft			38.6			36.18	29.27	0.265
Toe			485.3				5082.74	0.212

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(mm)	7.498	10.351
Case Damping Factor		0.269	0.181
Unloading Quake	(% of loading quake)	52	101
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	33	
Resistance Gap (included in Toe Quake) (mm)			1.127

CAPWAP match quality = 3.05 (Wave Up Match) ; RSA = 0
 Observed: final set = 3.690 mm; blow count = 271 b/m
 Computed: final set = 2.688 mm; blow count = 372 b/m
 max. Top Comp. Stress = 130.4 MPa (T= 21.3 ms, max= 1.011 x Top)
 max. Comp. Stress = 131.8 MPa (Z= 2.1 m, T= 21.5 ms)
 max. Tens. Stress = -10.36 MPa (Z= 2.1 m, T= 49.1 ms)
 max. Energy (EMX) = 15.78 kJ; max. Measured Top Displ. (DMX)=14.28 mm

1666498; Pile: HWY400 NA PT1 EOID OCT6 1
HEW400 AND CAN RD; Blow: 250
Golder Associates Ltd.

Test: 06-Oct-2016 14:11:
CAPWAP(R) 2006-3
OP: OS

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages m	max. Force kN	min. Force kN	max. Comp. Stress MPa	max. Tens. Stress MPa	max. Trnsfd. Energy kJ	max. Veloc. m/s	max. Displ. mm
1	1.1	1838.1	-127.7	130.4	-9.05	15.78	3.2	14.813
2	2.1	1857.8	-146.1	131.8	-10.36	15.57	3.2	14.434
3	3.2	1826.3	-137.5	129.5	-9.75	14.64	3.1	14.064
4	4.2	1788.5	-129.7	126.8	-9.20	13.74	3.1	13.769
5	5.3	1774.5	-130.3	125.8	-9.24	13.20	3.1	13.517
6	6.4	1758.3	-127.0	124.7	-9.01	12.79	3.1	13.232
7	7.4	1758.4	-127.0	124.7	-9.01	12.53	3.1	12.937
8	8.5	1767.3	-125.9	125.3	-8.93	12.23	3.1	12.639
9	9.5	1781.6	-123.0	126.4	-8.72	11.87	3.0	12.361
10	10.6	1754.4	-100.7	124.4	-7.14	11.08	3.0	12.086
11	11.7	1715.5	-82.7	121.7	-5.86	10.22	3.0	11.789
12	12.7	1683.7	-72.0	119.4	-5.11	9.53	2.9	11.519
13	13.8	1662.1	-71.1	117.9	-5.04	9.25	3.2	11.295
14	14.8	1493.4	-69.1	105.9	-4.90	9.00	3.8	11.058
15	15.9	1093.8	-63.7	77.6	-4.52	8.59	4.3	10.803
16	17.0	772.8	-38.5	52.6	-2.62	5.43	4.3	10.592
Absolute	2.1			131.8			(T =	21.5 ms)
	2.1				-10.36		(T =	49.1 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	1267.2	1023.1	778.9	534.8	290.7	46.6	0.0	0.0	0.0	0.0
RX	1353.8	1281.9	1226.3	1204.5	1182.7	1161.0	1139.2	1117.4	1112.7	1112.7
RU	1267.2	1023.1	778.9	534.8	290.7	46.6	0.0	0.0	0.0	0.0

RAU = 1089.3 (kN); RA2 = 1166.2 (kN)

Current CAPWAP Ru = 1064.2 (kN); Corresponding J(RP)= 0.08; matches RX9 within 5%

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS
m/s	ms	kN	kN	kN	mm	mm	mm	kJ	kN
3.23	20.91	1841.3	1867.0	1887.5	14.282	3.693	3.690	15.8	1761.1

PILE PROFILE AND PILE MODEL

Depth m	Area cm ²	E-Modulus MPa	Spec. Weight kN/m ³	Perim. m
0.00	141.00	206842.7	77.287	1.236
16.95	141.00	206842.7	77.287	1.236
16.95	450.00	206842.7	77.287	1.236
16.97	450.00	206842.7	77.287	1.236

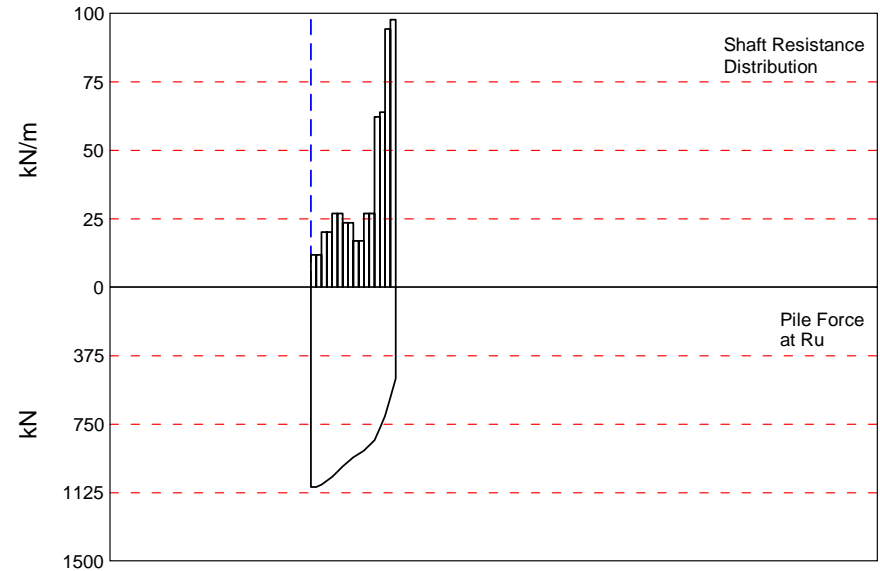
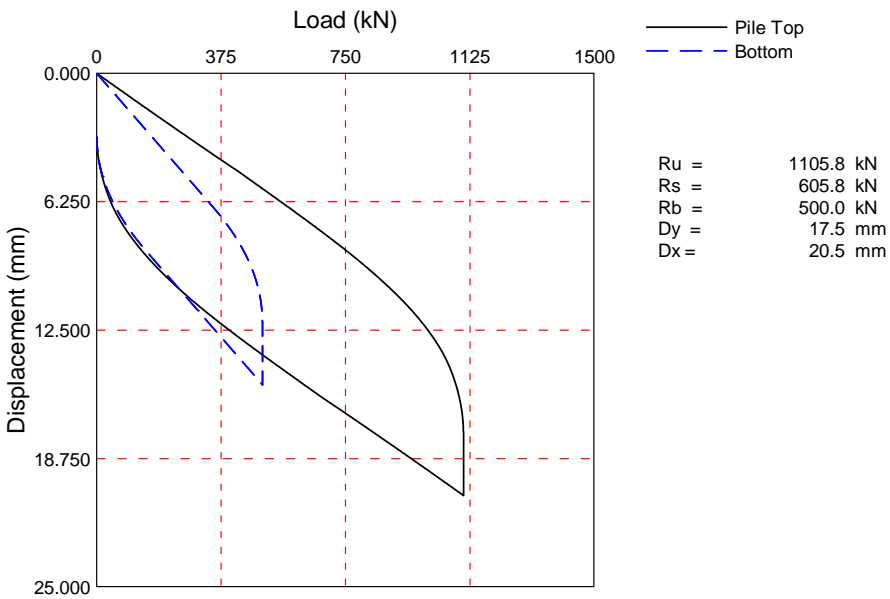
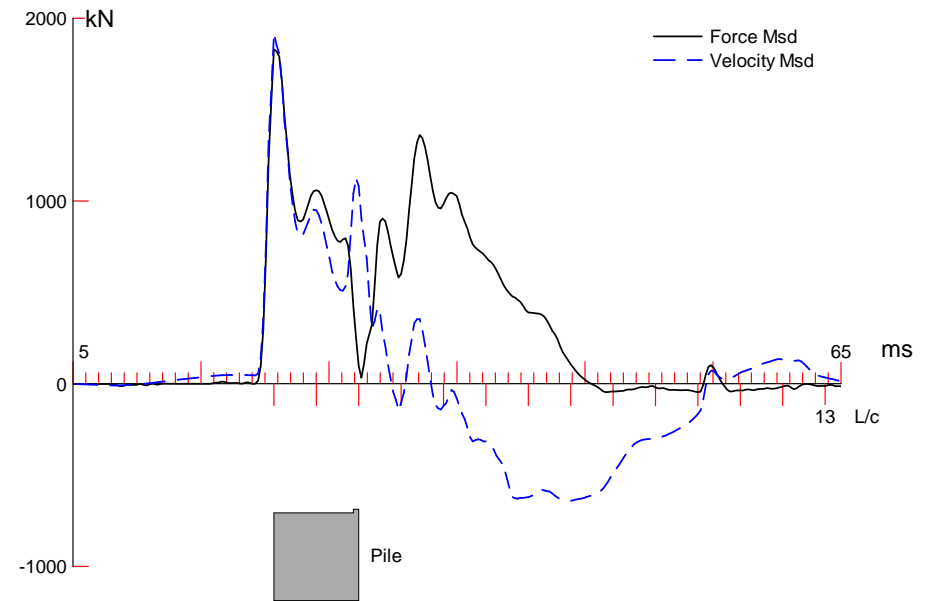
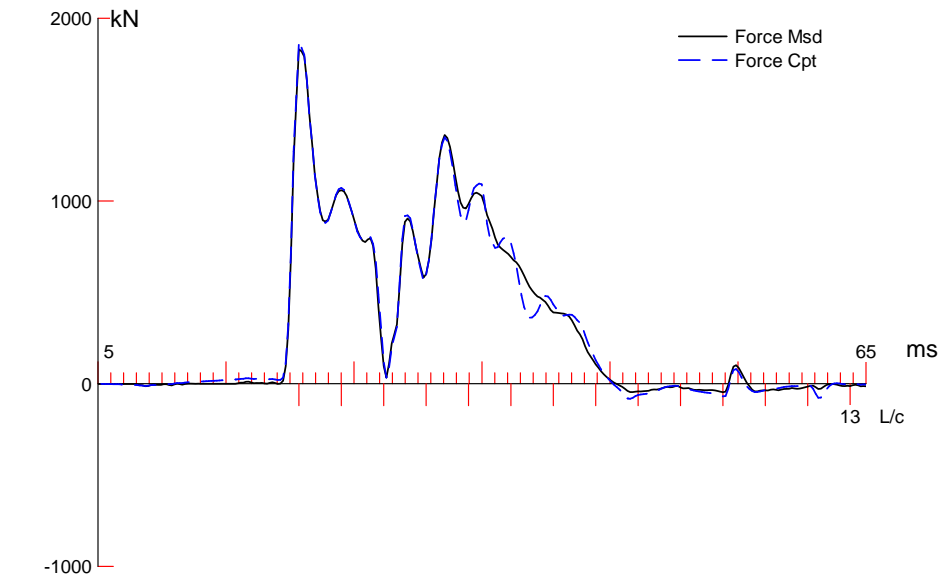
Toe Area 0.095 m²

Segmnt Number	Dist. B.G. m	Impedance kN/m/s	Imped. Change %	Slack mm	Tension Eff.	Compression Slack mm	Perim. m
1	1.06	569.29	0.00	0.000	0.000	-0.000	1.236
16	16.97	592.81	0.00	0.000	0.000	-0.000	1.236

Pile Damping 1.0 %, Time Incr 0.207 ms, Wave Speed 5123.0 m/s, 2L/c 6.6 ms



Pile No. PT1 - Pile Tip Elevation 204 m



1666498; Pile: HWY400 NA PT1 EOID OCT6 2
HEW400 AND CAN RD; Blow: 19
Golder Associates Ltd.

Test: 06-Oct-2016 14:24:
CAPWAP(R) 2006-3
OP: OS

CAPWAP SUMMARY RESULTS

Total CAPWAP Capacity: 1105.8; along Shaft 605.8; at Toe 500.0 kN								
Soil Sgmnt No.	Dist. Below Gages m	Depth Below Grade m	Ru kN	Force in Pile kN	Sum of Ru kN	Unit Resist. (Depth) kN/m	Unit Resist. (Area) kPa	Smith Damping Factor s/m
				1105.8				
1	1.1	0.6	12.6	1093.2	12.6	21.33	17.26	0.080
2	2.1	1.7	12.6	1080.6	25.2	11.88	9.61	0.080
3	3.2	2.7	21.4	1059.2	46.6	20.18	16.32	0.080
4	4.2	3.8	21.4	1037.8	68.0	20.18	16.32	0.080
5	5.3	4.8	28.6	1009.2	96.6	26.97	21.82	0.080
6	6.4	5.9	28.6	980.6	125.2	26.97	21.82	0.080
7	7.4	7.0	25.0	955.6	150.2	23.57	19.07	0.080
8	8.5	8.0	25.0	930.6	175.2	23.57	19.07	0.080
9	9.5	9.1	18.0	912.6	193.2	16.97	13.73	0.080
10	10.6	10.1	18.0	894.6	211.2	16.97	13.73	0.080
11	11.7	11.2	28.6	866.0	239.8	26.97	21.82	0.080
12	12.7	12.3	28.6	837.4	268.4	26.97	21.82	0.080
13	13.8	13.3	66.0	771.4	334.4	62.23	50.35	0.080
14	14.8	14.4	67.8	703.6	402.2	63.92	51.72	0.080
15	15.9	15.4	100.0	603.6	502.2	94.28	76.28	0.080
16	17.0	16.5	103.6	500.0	605.8	97.68	79.03	0.080
Avg. Shaft			37.9			36.72	29.70	0.080
Toe			500.0				5236.70	0.408

Soil Model Parameters/Extensions		Shaft	Toe
Quake	(mm)	7.500	9.282
Case Damping Factor		0.085	0.358
Unloading Quake	(% of loading quake)	100	30
Reloading Level	(% of Ru)	100	100
Unloading Level	(% of Ru)	30	
Resistance Gap (included in Toe Quake) (mm)			1.060

CAPWAP match quality	=	2.37	(Wave Up Match) ; RSA = 0
Observed: final set	=	3.100 mm;	blow count = 323 b/m
Computed: final set	=	2.279 mm;	blow count = 439 b/m
max. Top Comp. Stress	=	133.0 MPa	(T= 21.1 ms, max= 1.000 x Top)
max. Comp. Stress	=	133.0 MPa	(Z= 1.1 m, T= 21.1 ms)
max. Tens. Stress	=	-10.35 MPa	(Z= 17.0 m, T= 48.9 ms)
max. Energy (EMX)	=	15.93 kJ;	max. Measured Top Displ. (DMX)=16.05 mm

1666498; Pile: HWY400 NA PT1 EOID OCT6 2
HEW400 AND CAN RD; Blow: 19
Golder Associates Ltd.

Test: 06-Oct-2016 14:24:
CAPWAP(R) 2006-3
OP: OS

EXTREMA TABLE

Pile Sgmnt No.	Dist. Below Gages m	max. Force kN	min. Force kN	max. Comp. Stress MPa	max. Tens. Stress MPa	max. Trnsfd. Energy kJ	max. Veloc. m/s	max. Displ. mm
1	1.1	1875.6	-93.7	133.0	-6.64	15.93	3.3	15.328
2	2.1	1870.6	-101.1	132.7	-7.17	15.58	3.3	14.973
3	3.2	1866.7	-115.5	132.4	-8.19	15.21	3.3	14.584
4	4.2	1859.5	-127.8	131.9	-9.06	14.71	3.2	14.176
5	5.3	1851.9	-133.0	131.3	-9.43	14.22	3.2	13.759
6	6.4	1841.0	-130.8	130.6	-9.27	13.70	3.2	13.407
7	7.4	1831.3	-127.3	129.9	-9.03	13.25	3.2	13.103
8	8.5	1823.3	-125.0	129.3	-8.87	12.83	3.2	12.771
9	9.5	1813.9	-125.1	128.6	-8.87	12.39	3.2	12.441
10	10.6	1809.4	-126.5	128.3	-8.97	12.09	3.2	12.192
11	11.7	1804.3	-126.9	128.0	-9.00	11.80	3.1	11.921
12	12.7	1800.9	-124.5	127.7	-8.83	11.41	3.1	11.642
13	13.8	1800.0	-132.1	127.7	-9.37	11.08	3.1	11.419
14	14.8	1685.7	-137.6	119.6	-9.76	10.43	3.8	11.229
15	15.9	1277.5	-143.2	90.6	-10.15	9.77	4.2	11.031
16	17.0	1038.1	-152.0	70.7	-10.35	8.90	4.3	10.833
Absolute	1.1			133.0			(T =	21.1 ms)
	17.0				-10.35		(T =	48.9 ms)

CASE METHOD

J =	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
RP	1410.5	1168.9	927.4	685.8	444.3	202.7	0.0	0.0	0.0	0.0
RX	1491.4	1338.9	1301.3	1263.6	1226.0	1204.8	1187.1	1169.6	1159.1	1148.6
RU	1410.5	1168.9	927.4	685.8	444.3	202.7	0.0	0.0	0.0	0.0

RAU = 1067.6 (kN); RA2 = 1192.4 (kN)

Current CAPWAP Ru = 1105.8 (kN); Corresponding J(RP)= 0.13; matches RX9 within 5%

VMX	TVP	VT1*Z	FT1	FMX	DMX	DFN	SET	EMX	QUS
m/s	ms	kN	kN	kN	mm	mm	mm	kJ	kN
3.49	20.91	1984.8	1841.3	1902.3	16.052	2.964	3.100	16.1	1680.0

PILE PROFILE AND PILE MODEL

Depth m	Area cm ²	E-Modulus MPa	Spec. Weight kN/m ³	Perim. m
0.00	141.00	206842.7	77.287	1.236
16.95	141.00	206842.7	77.287	1.236
16.95	450.00	206842.7	77.287	1.236
16.97	450.00	206842.7	77.287	1.236

Toe Area 0.095 m²

Segmnt Number	Dist. B.G. m	Impedance kN/m/s	Imped. Change %	Slack mm	Tension Eff.	Compression Slack mm	Perim. m
1	1.06	569.29	0.00	0.000	0.000	-0.000	1.236
16	16.97	592.81	0.00	0.000	0.000	-0.000	1.236

Pile Damping 1.0 %, Time Incr 0.207 ms, Wave Speed 5123.0 m/s, 2L/c 6.6 ms

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www.golder.com

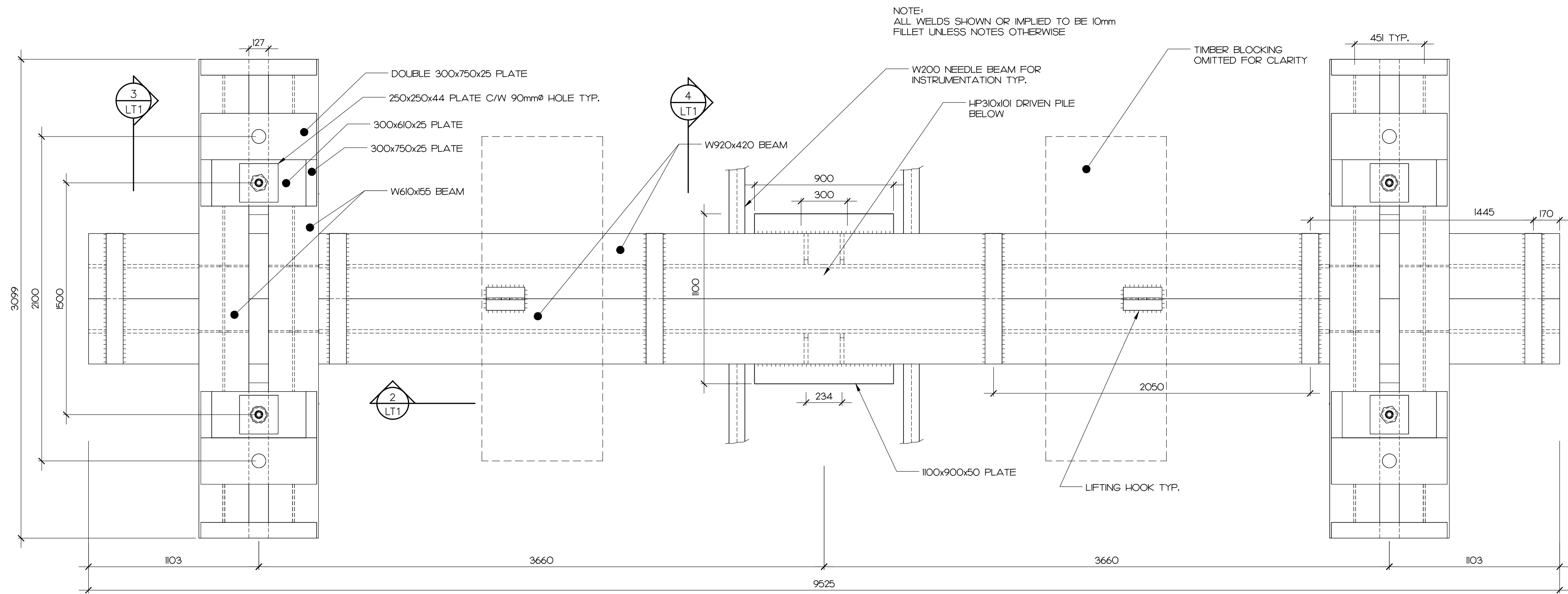
Golder Associates Ltd.
100, Scotia Court
Whitby, Ontario, L1N 8Y6
Canada
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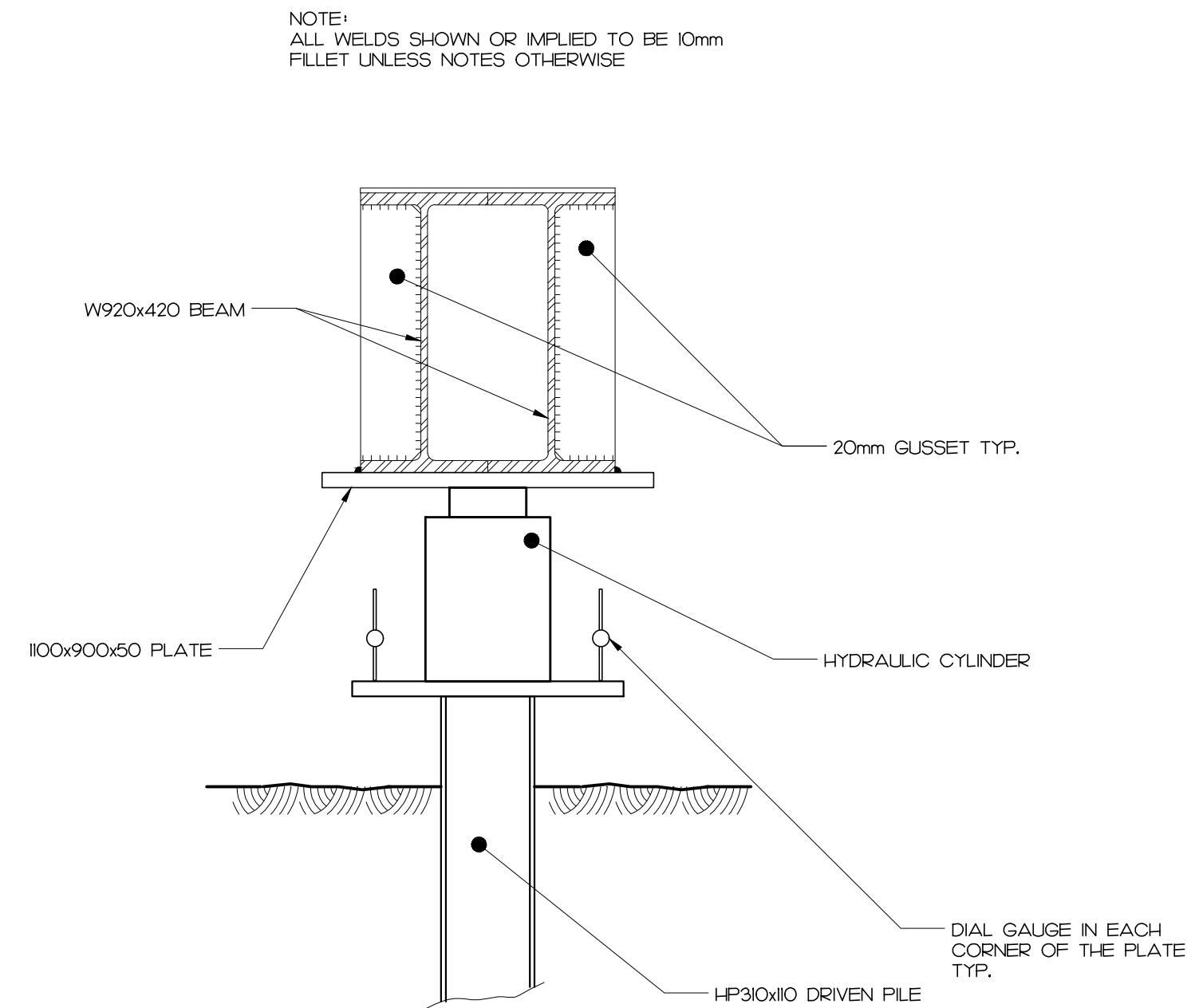


APPENDIX E

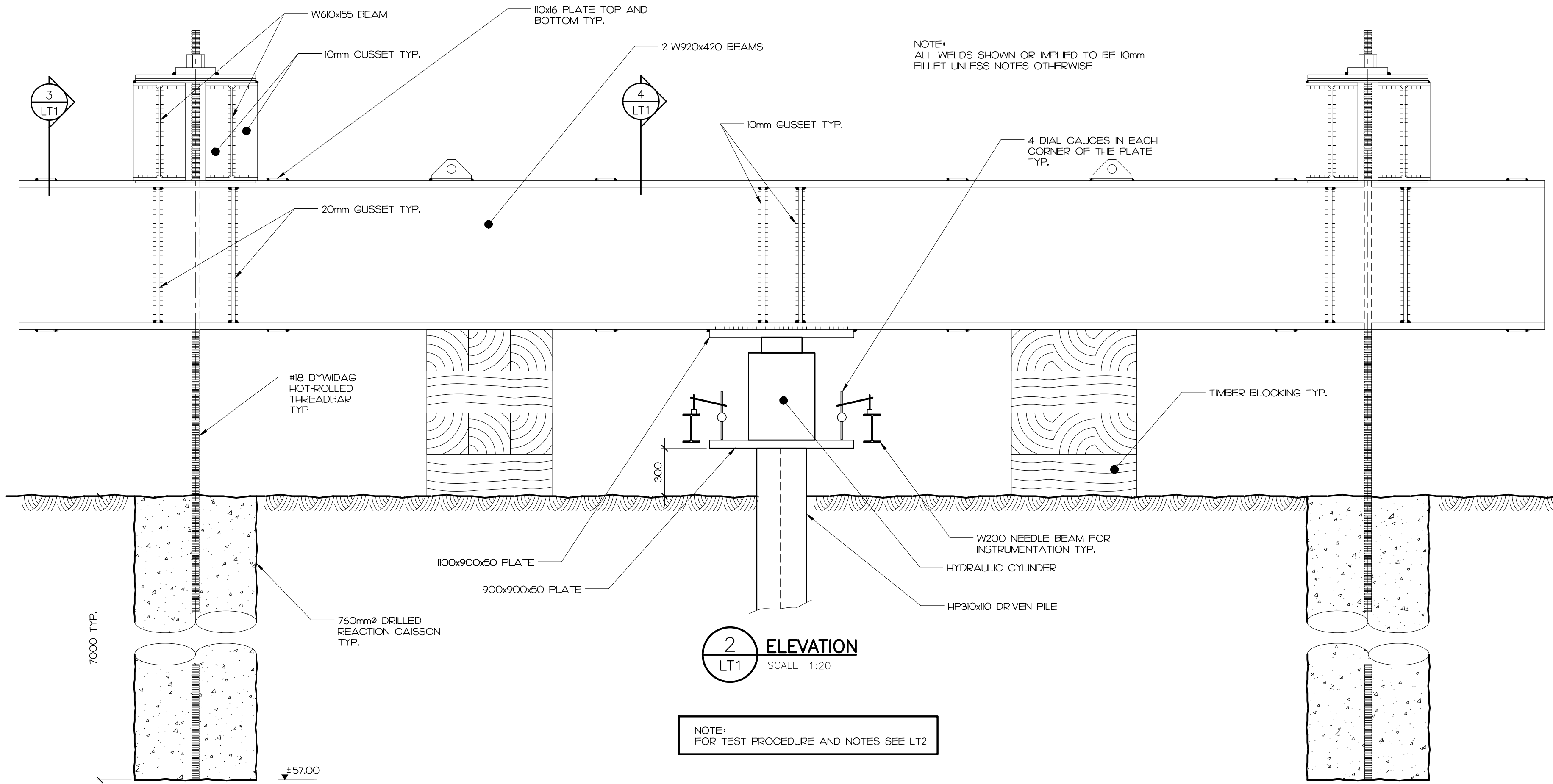
Test Pile Arrangement Drawings, Details and Calibration Certificates



1 PLAN
LT1
SCALE 1:20

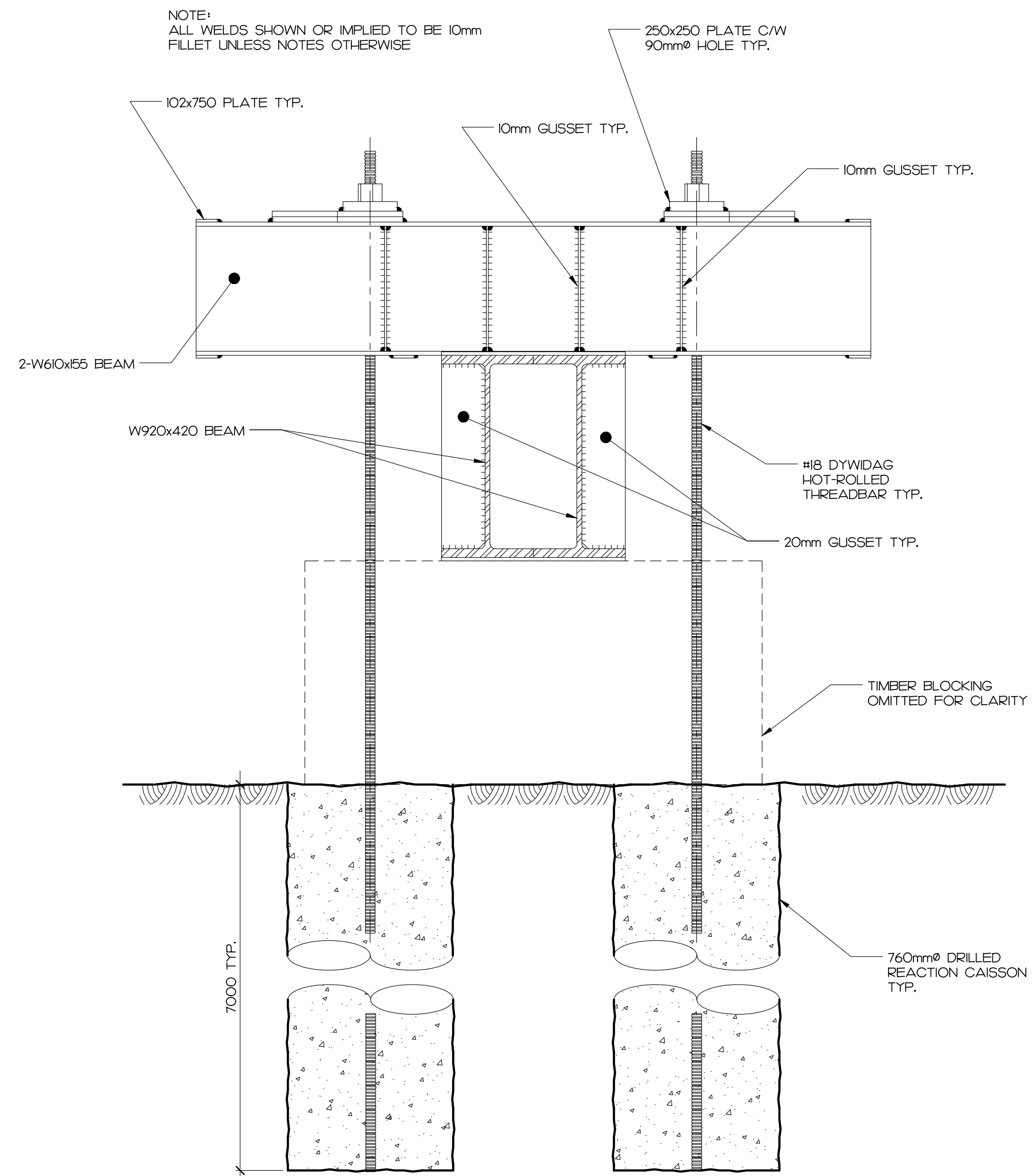


4 SECTION
LT1
SCALE 1:20



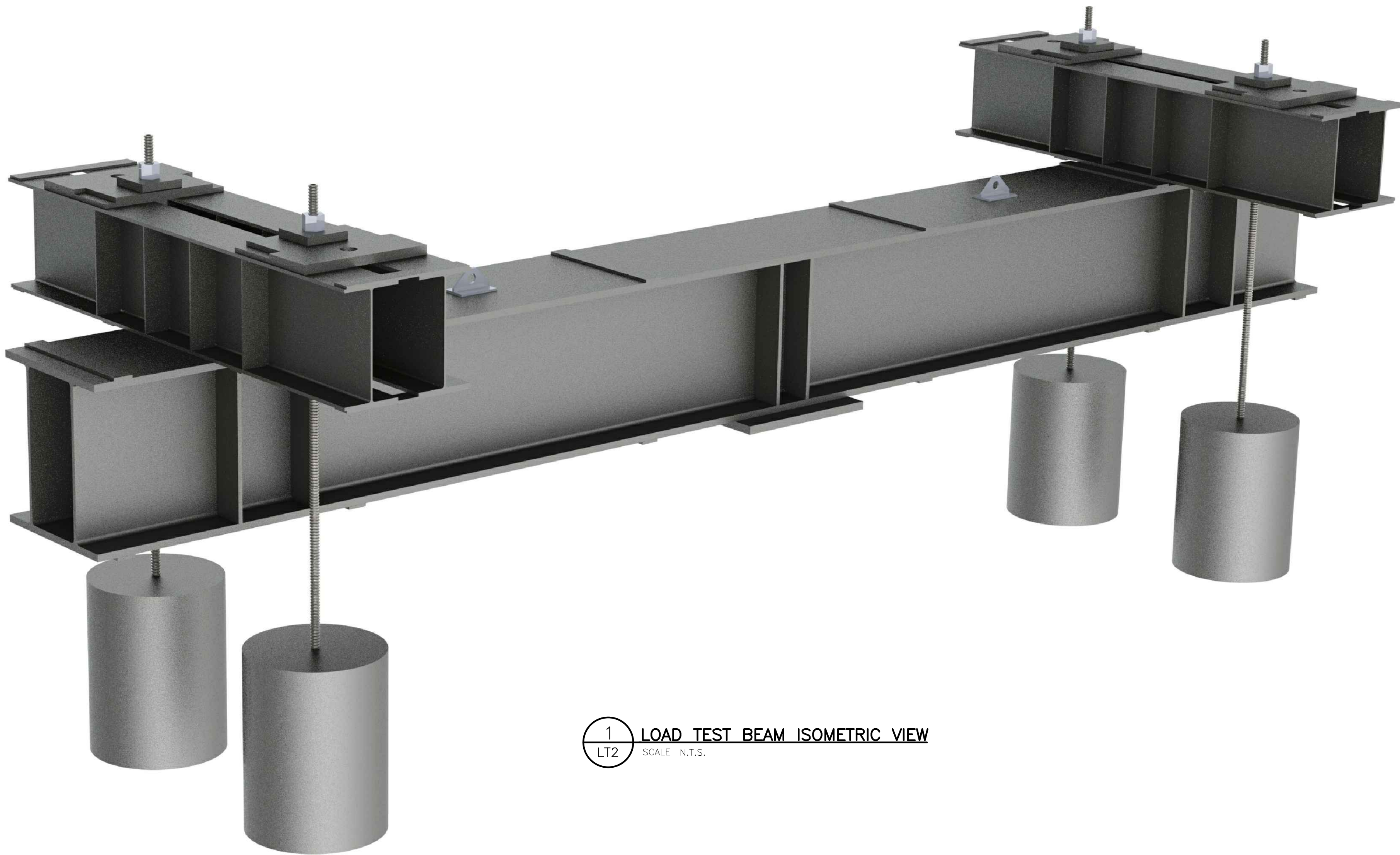
2 ELEVATION
LT1
SCALE 1:20

NOTE: FOR TEST PROCEDURE AND NOTES SEE LT2

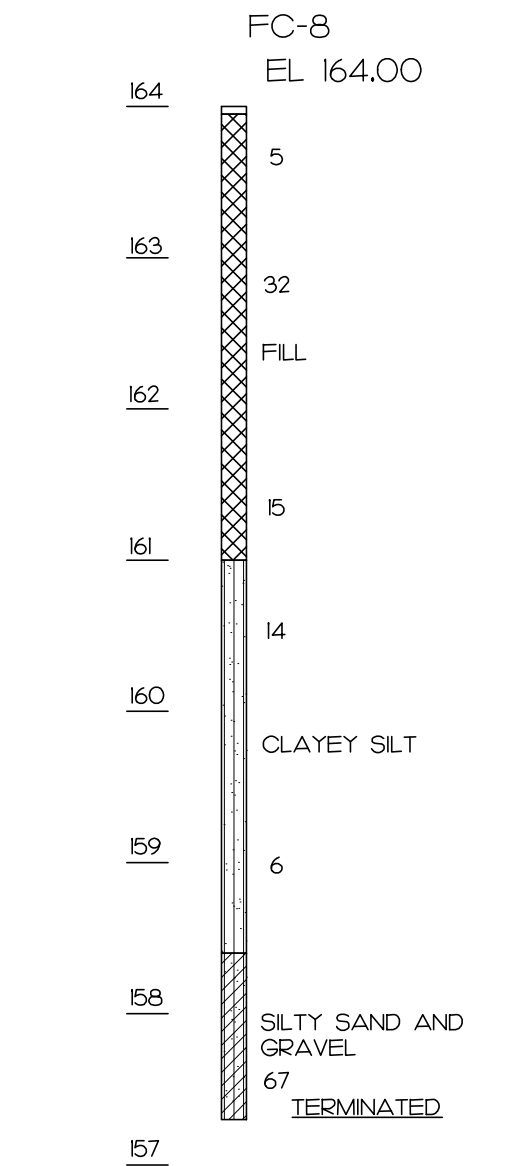


3 SECTION
LT1
SCALE 1:20

1.	GENERAL REVISION	17/06/05
2.	ISSUED FOR REVIEW	17/05/18
No.	DESCRIPTION	Date
NOTES		
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Consultant		
<div> <div> </div> <div> </div> </div>		
P.O. Box 599 Stouffville, ON L4A 7Z7		
Telephone (905)640-8865, Fax (905)640-8855, Cell (416) 937-8999		
Project		
HWY 400		
SOUTH CANAL OVERPASS		
YORK REGION		
ONTARIO		
Drawing Title		
PILE TEST ARRANGEMENT		
Drawn: JC		
Scale: AS NOTED		
Checked: TOR		
Date: MAY., 2017		
Project No.		
1728-10		
Drawing Number		
LT1		



1 LOAD TEST BEAM ISOMETRIC VIEW
LT2 SCALE: N.T.S.



2 BOREHOLE FC-8
LT2 SCALE: 1:50

A. TEST

- All aspects of the test must comply with the O.B.C. and the Occupational Health and Safety Act.
- The test pile is to be tested to a maximum load of 2,550 kN.
- Refer also to the Full-Scale Pile Load Test Specification for this project: Hwy 400 at South Canal Bridge, Contract No.: 2015-2004. Comply with ASTM D1143.

B. REFERENCES

- Design is in accordance with the structural requirements of the Ontario Building Code and The Canadian Highway Bridge Design Code. All work is to be carried out in accordance with the Occupational Health and Safety Act.

C. MATERIALS:

- Structural steel design, connections, fabrication and erection is to conform to requirements of CAN / CSA S16-14 and CAN / CSA S136-16.
- Structural steel to conform to CSA G40.20-13/G40.21-13, grade 350W for wide flanges, channels and hollow structural sections and grade 300W min. for plates and all other shapes. Steel to be fabricated and erected by a shop certified by the Canadian Welding Bureau to the requirements of CSA W47.1-09. Sheet piles are to comply with ASTM A328 or CSA G40.21 with a minimum yield of 345MPa.
- Tie anchors shall be fabricated from the following materials: ASTM A722 830/1035MPa (designated by diameter in mm i.e. 36mm Threadbar) or ASTM A615 517/690MPa (designated by # i.e. #11 Threadbar) or ASTM A615 500MPa (designated by R#) or ASTM A416 Fu=1864 MPa, A=140mm² per strand (designated as Strand). Exact sizes as shown in sections or when not shown to be chosen later for loads shown in the schedule.
- Welding to conform to CSA W59-13. Welders to be qualified to CSA W47.1-09.
- Alternative sections or grades of equivalent strength may be substituted subject to approval by T.H. O'Rourke Structural Consultants.
- Concrete materials, mixing, handling, design, formwork, rebar, placement, cutting and finishing to comply with CSA A23.1,2 & 3, unless modified in writing by the engineer.
- Drill holes to sizes and depths indicated employing liners, mud drilling and/or other methods as required to avoid the ingress of soil or groundwater. Install piles plumb and to line. Fill holes with concrete strength as specified above.

- Concrete strengths to be as follows unless noted:

Reaction caissons 20 MPa,

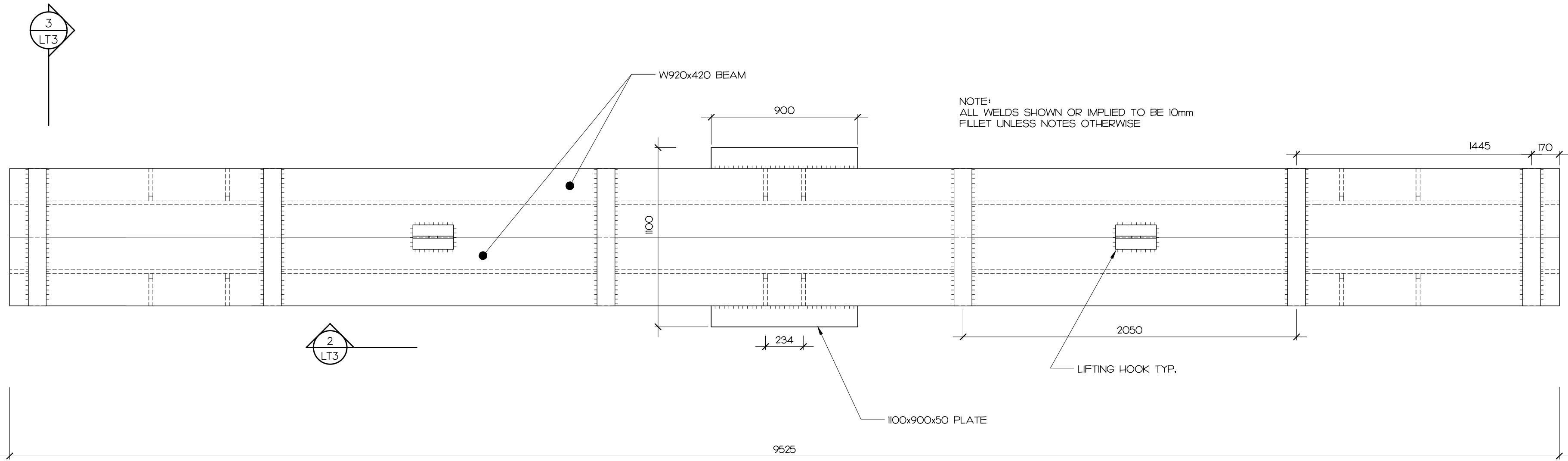
D. PROCEDURE

- Layout proposed location of reaction caissons around pile to be tested and check against the Test Beam Drawing. Check the layout with the actual Test Beam which will be used.
- Drill reaction caissons in the normal fashion using liners if necessary to avoid caving to the depth shown on the Test Beam Drawing. Place reaction tension bars accurately to match Test Beam.
- Place and secure Test Beams as shown on the Test Beam Drawing using wooden blocking to stabilize. Connect all reaction caisson bars and ensure the bars and centerline of pile to be tested are in alignment.
- Build up or cut down test pile to ensure that the reaction point is flat and level. Weld on plate to top of test pile.
- Place the hydraulic jack and all required tubes and wiring. Ensure everything is in proper working order.
- Assemble needle beams and their supports in a solid and secure configuration. Assemble strain gauges placing one on each corner of the Test Pile top plate.
- Check that all parts of the Test Beam assembly are level, plum and in alignment.
- Apply a 10% load increment to ensure that all parts are bedded in properly and everything is functioning properly.
- Survey the tops of the reaction piles before starting the test. Check at 50% load level and after the application of 100% of the test load.
- Conduct the test as per the Engineer's instructions and according to ASTM D1143.
- Ensure the assembly stays in alignment and does not distort or buckle during the test.
- Record the jack hydraulic pressures, the applied load and the strains measured at each load increment during the test. Present the results in a clear, legible and descriptive report.
- Measure strains and reaction caisson elevations when all stresses have been removed.

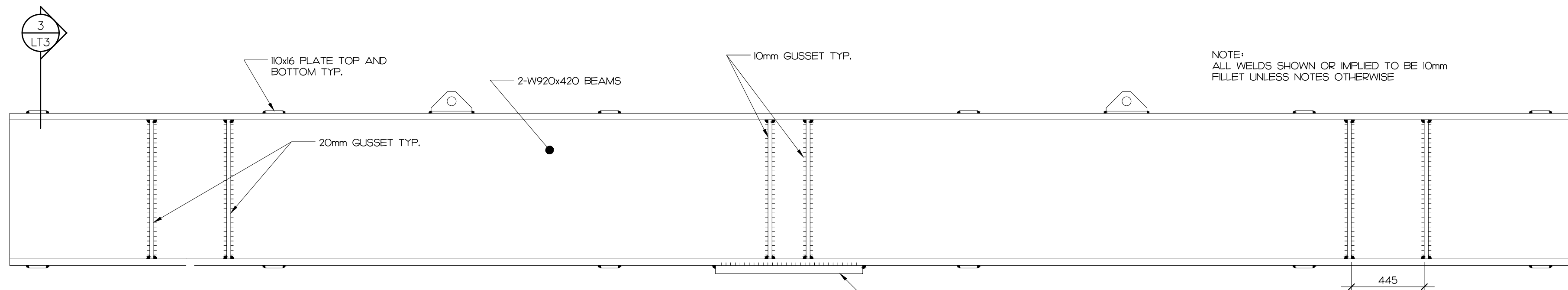
E. CONTRACTOR

- Prepare the test area so that the test pile may be driven and the pile test conducted without encountering obstructions.
- Ensure that test area is always drained with no standing water.
- Ensure that all services in or near the test area are identified. Ensure the pile driver and the pile tester is made aware of such services.

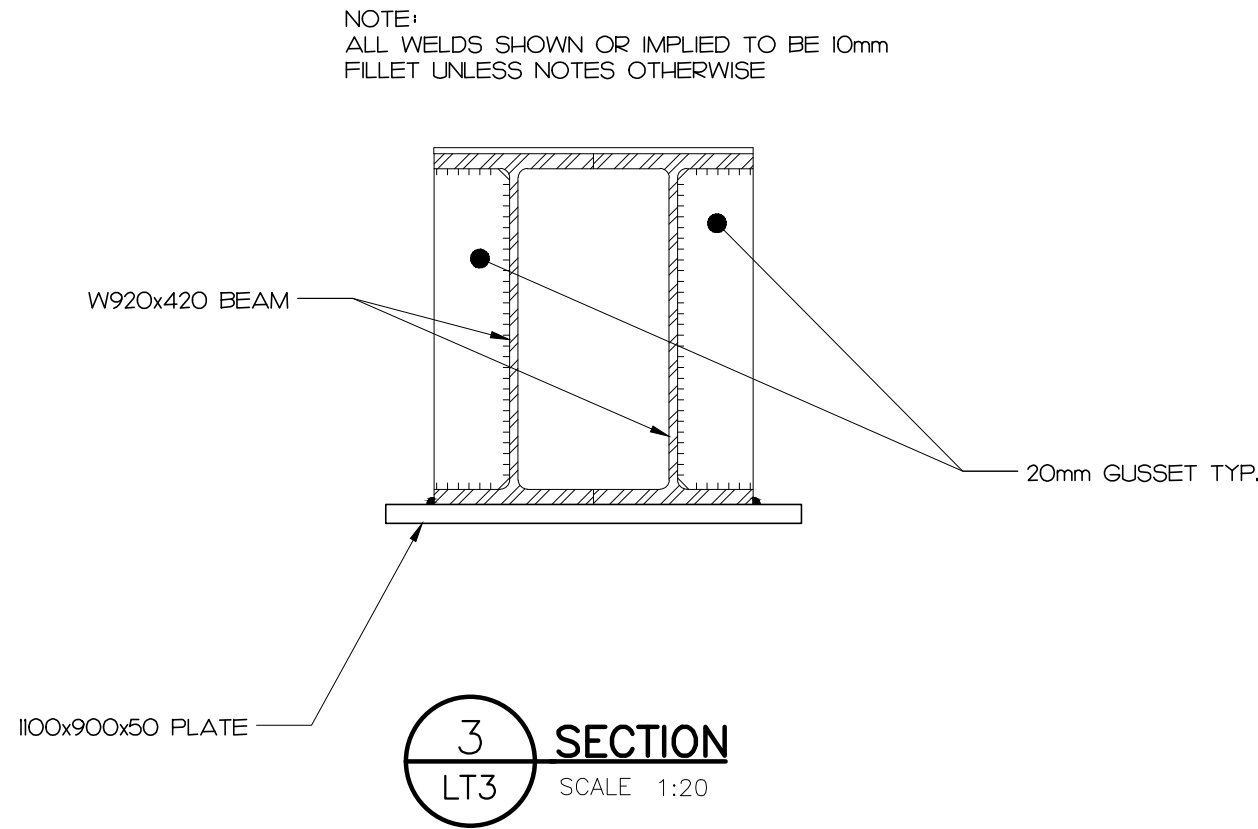
1.	GENERAL REVISION	17/06/05
	ISSUED FOR REVIEW	17/05/18
No.	DESCRIPTION	Date
NOTES		
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Consultant		
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Project		
HWY 400 SOUTH CANAL OVERPASS		
YORK REGION		ONTARIO
Drawing Title		
PILE TEST ARRANGEMENT		
Drawn:	JC	Scale AS NOTED
Checked:	TOR	Date MAY., 2017
Project No.	1728-10	Drawing Number LT2



1 PLAN
LT3 SCALE 1:20



2 ELEVATION
LT3 SCALE 1:20



3 SECTION
LT3 SCALE 1:20

TEST BEAM: TBM01	
MAIN BEAMS	W920x420
TOTAL WIGHT, kg	16502

1.	GENERAL REVISION	17/06/05
	ISSUED FOR REVIEW	17/05/18
No.	DESCRIPTION	Date
NOTES		
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P.O. Box 599 Stouffville, ON L4A 7Z7 Telephone (905)640-8865, Fax (905)640-8855, Cell (416) 937-8999		
Project		
HWY 400 SOUTH CANAL OVERPASS		
YORK REGION ONTARIO		
Drawing Title		
TEST BEAM TBM01 DETAILS		
Drawn: JC		Scale AS NOTED
Checked: TOR		Date MAY., 2017
Project No. 1728-10		Drawing Number LT3

CERTIFIED TEST REPORTS

Reference No.: 039

Date: APRIL 21, 2017

Gauge Type: SOLFRUNT 0 - 10,000 PSI

Machine: Deadweight Tester Mansfield & Green

Traceability To: National Bureau Standards

Dead Weight Pressure

1000 psi
2000 psi
3000 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
9000 psi

Gauge Indicated Pressure

1075 psi
2050 psi
3000 psi
4000 psi
5000 psi
6000 psi
7000 psi
8000 psi
8975 psi

Signature:

Al Hitey

Canadian BBR Inc.
3450 Midland Avenue
Agincourt Ontario

Calibration of Hydraulic Components

600 t DUDGEON

Jack No.2

Ram area (sq.in) = 139

Friction = 1.013

Calibrated with digital pressure gauge
Enerpac Model DGB/ 10,000 psi
And load cell BBR No.2

Gauge pressure (psi)	Load (kips)	Load (kips)	Load (kips)	Average Load (kips)
1000	135.2	135.4	136.1	135.5
2000	271.6	274.4	269.5	271.8
3000	411.0	410.1	409.0	410.0
4000	550.8	547.7	547.6	548.7
5000	685.9	684.1	687.2	685.7
6000	824.6	822.2	825.0	824.0
7000	964.3	958.4	962.4	961.7
8000	1099.4	1093.7	1096.5	1096.5
8500	1167.9	1163.7	1166.2	1165.9



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 Fax. (905) 595-1200
 Calibration@MRM2.ca
 www.MRM2.ca

CALIBRATION CERTIFICATE

CERTIFICATE No. WBH789-2017

INSTRUMENT: Indicator, Dial

CAL. DATE: May 15, 2017

SERIAL_ASSET No. WBH789

CAL. DUE DATE: May 15, 2018

MODEL No. 3428S-19

CUSTOMER: ANCHOR SHORING & CAISSONS LTD

ADDRESS: 3445 Kennedy Road

Toronto

GRADUATION: 0.001 in

ACCURACY: $\pm 0.001''$ (First 2.5 Rev.); $\pm 0.005''$ (Rest of Range)

TEMPERATURE: $20 \pm 2^\circ\text{C}$

HUMIDITY: (30 to 60) %

RANGE: (0 to 4) in

MANUFACTURER: Mitutoyo Corporation

METHOD USED: Comparison

CAL. PROCEDURE: CP-315

UNIT OF MEASUREMENT: Inch (in)

LOCATION: IH-1

PARAMETER	NOMINAL	AS FOUND	AS LEFT	MIN.	MAX.	TOLERANCE (AS LEFT)
Inward	0	0.00000	0.00000	-0.00091	0.00091	IN
	1	1.00050	1.00050	0.99509	1.00491	IN
	2	2.00075	2.00075	1.99509	2.00491	IN
	3	3.00100	3.00100	2.99509	3.00491	IN
	4	4.00125	4.00125	3.99509	4.00491	IN
Outward	2	2.00075	2.00075	1.99509	2.00491	IN
	0	0.00000	0.00000	-0.00091	0.00091	IN

TRACEABLE REFERENCE STANDARD:

INSTRUMENT	
Indicator Calibration System	ASSET No.
	MRM-1060

RECEIVED CONDITION: Operational

Uncertainty of Measurement: ± 0.0003 in

FINAL CONDITION:

Uncertainty of Measurement is recognized in statements of compliance according to Decision Rule 4.2 of ASME B89.7.3.1-2001

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%

Reference Standards are traceable to SI through NIST, NRC or other recognized NMI.

Calibration results are only related to the instrument specified on this certificate.

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Calibration Technician: M100



Rafik Mohamed

Rafik Mohamed, Technical Manager

CALIBRATION CERTIFICATE

CERTIFICATE No. SXZ180-2017

INSTRUMENT: Indicator, Dial

CAL. DATE: May 15, 2017

SERIAL_ASSET No. SXZ180

CAL. DUE DATE: May 15, 2018

MODEL No. 3428S-19

CUSTOMER: ANCHOR SHORING & CAISSONS LTD

ADDRESS: 3445 Kennedy Road
Toronto

GRADUATION: 0.001 in

ACCURACY: $\pm 0.001''$ (First 2.5 Rev.); $\pm 0.005''$ (Rest of Range)

RANGE: (0 to 4) in

TEMPERATURE: $20 \pm 2^\circ\text{C}$

HUMIDITY: (30 to 60) %

MANUFACTURER: Mitutoyo Corporation

METHOD USED: Comparison

CAL. PROCEDURE: CP-315

UNIT OF MEASUREMENT: Inch (in)

LOCATION: IH-1

PARAMETER	NOMINAL	AS FOUND	AS LEFT	MIN.	MAX.	TOLERANCE (AS LEFT)
Inward	0	0.00000	0.00000	-0.00091	0.00091	IN
	1	1.00000	1.00000	0.99509	1.00491	IN
	2	2.00025	2.00025	1.99509	2.00491	IN
	3	3.00050	3.00050	2.99509	3.00491	IN
	4	4.00050	4.00050	3.99509	4.00491	IN
Outward	2	2.00025	2.00025	1.99509	2.00491	IN
	0	0.00000	0.00000	-0.00091	0.00091	IN

TRACEABLE REFERENCE STANDARD:	
INSTRUMENT	ASSET No.
Indicator Calibration System	MRM-1060

RECEIVED CONDITION: Operational

FINAL CONDITION:

Uncertainty of Measurement: ± 0.0003 in

Uncertainty of Measurement is recognized in statements of compliance according to Decision Rule 4.2 of ASME B89.7.3.1-2001
The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%

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Calibration Technician: M100

Rafik Mohamed
Rafik Mohamed, Technical Manager

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 Fax. (905) 595-1200
 Calibration@MRM2.ca
 www.MRM2.ca

CALIBRATION CERTIFICATE

INSTRUMENT: Indicator, Dial

SERIAL_ASSET No. WBH790

MODEL No. 3428S-19

GRADUATION: 0.001 in

ACCURACY: $\pm 0.001''$ (First 2.5 Rev.); $\pm 0.005''$ (Rest of Range)

RANGE: (0 to 4) in

MANUFACTURER: Mitutoyo Corporation

CAL. PROCEDURE: CP-315

CAL. DATE: May 15, 2017

CAL. DUE DATE: May 15, 2018

CUSTOMER: ANCHOR SHORING & CAISSONS LTD

ADDRESS: 3445 Kennedy Road
 Toronto

TEMPERATURE: $20 \pm 2^\circ\text{C}$

METHOD USED: Comparison

HUMIDITY: (50 to 60) %

UNIT OF MEASUREMENT: Inch (in)

LOCATION: IH-1

PARAMETER	NOMINAL	AS FOUND	AS LEFT	MIN.	MAX.	TOLERANCE (AS LEFT)
Inward	0	0.00000	0.00000	-0.00091	0.00091	IN
	1	1.00000	1.00000	0.99509	1.00491	IN
	2	2.00025	2.00025	1.99509	2.00491	IN
	3	3.00025	3.00025	2.99509	3.00491	IN
	4	4.00050	4.00050	3.99509	4.00491	IN
Outward	2	2.00025	2.00025	1.99509	2.00491	IN
	0	0.00000	0.00000	-0.00091	0.00091	IN

TRACEABLE REFERENCE STANDARD:	
INSTRUMENT	ASSET No.
Indicator Calibration System	MRM-1060

RECEIVED CONDITION: Operational

FINAL CONDITION:

Uncertainty of Measurement: ± 0.0003 in

Uncertainty of Measurement is recognized in Statements of compliance according to Decision Rule 4.2 of ASME B89.7.3.1-2001

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%

Reference Standards are traceable to SI through NIST, NRC or other recognized NMI.

Calibration results are only related to the instrument specified on this certificate.

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Calibration Technician: M100

Rafik Mohamed
 Rafik Mohamed, Technical Manager

INSTRUMENT: Indicator, Dial
SERIAL_ASSET No. WBH792
MODEL No. 3428S-19
GRADUATION: 0.001 in
ACCURACY: $\pm 0.001''$ (First 2.5 Rev.); $\pm 0.005''$ (Rest of Range)

CALIBRATION CERTIFICATE

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www.MRM2.ca

CALIBRATION CERTIFICATE

INSTRUMENT: Indicator, Dial
SERIAL_ASSET No. WBH792
MODEL No. 3428S-19

CAL. DATE: May 15, 2017
CAL. DUE DATE: May 15, 2018

CERTIFICATE No. WBH792-2017

GRADUATION: 0.001 in
ACCURACY: $\pm 0.001''$ (First 2.5 Rev.); $\pm 0.005''$ (Rest of Range)
RANGE: (0 to 4) in

CUSTOMER: ANCHOR SHORING & CAISSONS LTD
ADDRESS: 3445 Kennedy Road
Toronto

MANUFACTURER: Mitutoyo Corporation
CAL. PROCEDURE: CP-315

TEMPERATURE: $20 \pm 2^\circ\text{C}$
METHOD USED: Comparison

HUMIDITY: (30 to 60) %

UNIT OF MEASUREMENT: Inch (in)

LOCATION: IH-1

PARAMETER	NOMINAL	AS FOUND	AS LEFT	MIN.	MAX.	TOLERANCE (AS LEFT)
Inward	0	0.00000	0.00000	-0.00091	0.00091	IN
	1	1.00000	1.00000	0.99509	1.00491	IN
	2	2.00050	2.00050	1.99509	2.00491	IN
	3	3.00075	3.00075	2.99509	3.00491	IN
	4	4.00090	4.00090	3.99509	4.00491	IN
Outward	2	2.00050	2.00050	1.99509	2.00491	IN
	0	0.00000	0.00000	-0.00031	0.00031	IN

TRACEABLE REFERENCE STANDARD:	
INSTRUMENT	ASSET No.
Indicator Calibration System	MRM-1060

RECEIVED CONDITION: Operational

FINAL CONDITION:

Uncertainty of Measurement: ± 0.0003 in

Uncertainty of Measurement is recognized in statements of compliance according to Decision Rule 4.2 of ASME B89.7.3.1-2001

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%

Reference Standards are traceable to SI through NIST, NRC or other recognized NMI.

Calibration results are only related to the instrument specified on this certificate.

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Calibration Technician: M100



Rafik Mohamed
Rafik Mohamed, Technical Manager



APPENDIX F

**Letter: Full Scale Pile Load Test at North Abutment of South
Canal Bridges**

June 19, 2017

Project No. 09-1111-0018 (4000)

Mr. Lorne Gibson, C.E.T., rcca
Senior Contract Administrator
Highway Construction Inspection
287 Tiffin Street
Barrie, ON
L4N 7R8

**FULL-SCALE PILE LOAD TEST AT NORTH ABUTMENT OF SOUTH CANAL BRIDGES
HIGHWAY 400 WIDENING FROM NORTH OF KING ROAD AND NORTH OF SOUTH CANAL ROAD
REGIONAL MUNICIPALITY OF YORK**

Dear Sir:

As per your request of June 12, 2017 and further indicated by Tony Sangiuliano, Senior Foundation Engineer, MTO, this letter summarizes the loading increments and durations including unloading that must be followed by the Contractor.

The proposed loading and measurement procedure outlined below is estimated to be less than 1.5 days to complete.

Referring to Section 8.1.2 in ASTM D1143 and after discussions with MTO Foundations, it was agreed that a modified *Procedure A: Quick Test* will be followed for this project. As per the original work plan, unless failure occurs first, the pile will be loaded to a maximum maintained load of 3,200 kN on the single test pile. The load will be applied in increments of about 25% of the design load and each load increment will be maintained for 20 minutes or until the rate of axial movement does not exceed 0.25 mm (0.01 inches) per hour, with a maximum time of 2 hours per load increment. After the maximum load is reached, if failure does not occur, the maximum load will remain on the pile for 12 hours. If failure occurs, maintain the failure load, or maximum load possible, until the total axial movement equals 50 mm (2 inches). After completing the final load increment, remove the load in increments of about 25% of the maximum test load with 1 hour between decrements, as indicated below.



SUMMARY OF LOAD INCREMENTS AND MEASUREMENT READINGS

Load (kN)	Time of Recording Readings after Load is reached	Notes
300	Confirm test setup and equipment / measurement devices are working properly, etc.	As per working drawings, load to about 10% of design load to ensure everything is functioning properly.
600	Immediately, 5, 10, and 20 minutes. (every 20 minutes thereafter up to a maximum of 2 hours, as required)	Adding load: if rate of movement is less than 0.25 mm/hr after 20 minutes, continue to next load increment, otherwise, continue recording measurements every 20 minutes until rate of movement is less than 0.25 mm/hr up to a maximum of 2 hrs.
1200	Same as above	Same as above
1800	Same as above	Same as above
2200	Same as above	Same as above
2600	Same as above	Same as above
2900	Same as above	Same as above
3200	Immediately, 5, 10, 20 minutes, and every 20 minutes thereafter up to 2 hours, then every hour from 2 to 12 hours.	Maximum test load: if pile failure occurs, also take readings immediately before removing the first load increment
2400	Immediately, 20, 40 and 60 minutes	Removing load: record measurements for total of 1 hour (i.e. 60 minutes)
1600	Same as above	Same as above
800	Same as above	Same as above
0	Immediately, 20, 40, 60 minutes and 6 hours after removing all load	Final reading taken 6 hours after removal of all load

We trust this is sufficient for planning and completion of the pile load test. It is noted that the hydraulic jack / load cell and measurement gauges will need to be calibrated and copies of calibration records will need to be provided with the pile load test report.

Yours truly,

GOLDER ASSOCIATES LTD.



Kevin J. Bentley, P.Eng.
Geotechnical Engineer

KJB/MD/lcc/rb



Murty Devata, P.Eng.
Senior Foundation Consultant



APPENDIX G

Photographs



Contract# 2015-2004 Static Pile Load test Site Photographs



Photograph 1: Static load test reaction frame set-up



Photograph 2: Static load test reaction frame set-up



Contract# 2015-2004 Static Pile Load test Site Photographs



Photograph 3: Dial gauge on independent reference beam



Contract# 2015-2004 Static Pile Load test Site Photographs



Photograph 4: Hydraulic jack and dial gauge set-up



Photograph 5: Reaction caisson prior to test (north side)



Contract# 2015-2004 Static Pile Load test Site Photographs



Photograph 6: Static load testing underway, hydraulic pressure gauge in foreground



Contract# 2015-2004 Static Pile Load test Site Photographs



Photograph 7: Reaction Caisson heave / failure during load test (north side)



Photograph 8: Reaction Caisson heave / failure during test (south side)

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South America	+ 55 21 3095 9500

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