dematheieu bard CONSTRUCTION

SUBMISSION No: 2017-5003-DES-REP-GOL-012B

FROM: Marlen Dinovitzer
CONSTRUCTION DEMATHIEU & BARD (CDB) INC.

TO: Mark McLean
LEA

Contract No	2017-5003
Submission Title	Geotechnical/Foundation Instrumentation Monitoring Report
Date of Submission	September 21st, 2018
Date of Submission Compliance (as per RFP)	10 BD prior to construction
Version	Final
Content Compliance - Reference contract requirements - List Ministry standards, guidelines, directives, policies being used	Geotechnical/Foundation Instrumentation Monitoring Report compliant with the RFP and addendums. (Section 2.4.9.11 and others stipulations)
Executive summary	To adhere to the RFP and addendums requirements, the following report has been written in regards to the Geotechnical/Foundation Instrumentation Monitoring for Calamity Creek Project..

CDB Inc.

Per: _____
Marlen Dinovitzer

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GEOTECHNICAL / FOUNDATION INSTRUMENTATION AND MONITORING REPORT REV.1

Calamity Creek Culvert Replacement
Site No. 47-273/C, Highway 11
Contract Number: DB-2017-5003
Northeastern Region

Submitted to:

Construction Demathieu & Bard (CDB) Inc.
169 Lansdowne St. E, Suite 101
Peterborough ON K9J 7P7

Submitted by:

Golder Associates Ltd.
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1789567-2

September 21, 2018

Distribution List

3 Copies and 1 E-Copy - Ministry of Transportation, Ontario

1 E-Copy - Construction Demathieu & Bard (CDB) Inc.

1 E-Copy - Golder Associates Ltd.

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DRAWINGS

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by Construction Demathieu & Bard Inc. (CDB) to prepare the Geotechnical / Foundation Instrumentation and Monitoring Report for the replacement of the Calamity Creek culvert on Highway 11 (Site No. 47-273/C). The terms of reference for the scope of work are outlined in MTO's Request for Proposal (RFP) titled "Highway 11 – Calamity Creek Culvert Replacement, Northeastern Region Contract Number: DB-2017-5003," issued October 19, 2017, and subsequent addenda, and in Golder's proposal P1789567 dated January 30, 2018.

2.0 SITE DESCRIPTION

The Calamity Creek culvert site is located at Station 17+672 on Highway 11 in the Township of Dymond, north of New Liskeard, Ontario approximately 150 m north of Tobler's Road. The existing culvert is a reinforced concrete box culvert which has a span of about 3.1 m, is 2.5 m high and has a total length of about 270 m. The culvert consists of six sections with lengths between 14 m and 90 m, as shown in plan on Drawing 1. The upstream and downstream invert elevations of the existing culvert are at about Elevation 196.8 m and 194.3 m, respectively. The structure is located below a high fill embankment up to about 15 m high. The highway embankment is up to about 12 m thick with slopes ranging from about 2H:1V to 4H:1V, with some localized areas steeper than 2H:1V.

The topography at the culvert location is located within a valley and is referred to as a "gulch". Calamity Creek flows east to west through the culvert and below the high fill embankment that carries Highway 11 over the "gulch". The surrounding terrain on the valley slopes are covered with vegetation (grass and trees) both upstream and downstream of the culvert inlet and outlet, with natural valley slopes at about 3 Horizontal:1 Vertical (3H:1V) towards the creek. The area outside of the valley, on the tableland, is generally flat and is used for agriculture with a few residential houses in the area. The Highway 11 road surface is at about Elevation 213 m and the bottom of the valley, adjacent to the creek, ranges from about Elevation 199 m at the upstream side and Elevation 193 m at the downstream side.

Golder visited the site on several occasions in the Spring and Summer of 2018 and observed low flow conditions in the creek. The existing highway embankment was observed to be stable; however, local surficial sloughing and erosion was evident along the embankment side-slopes at some areas. Several geotechnical investigations have been performed on site and the borehole location and soil strata drawing (Drawing 1 and 2 respectively) are included in this report for reference.

2.1 General

The geotechnical instrumentation details and recommendations contained in this report are based on interpretation of the factual data obtained from the investigations performed on site, the requirements in the RFP documents (specifically Section 2.4.9.11 of the RFP, DBSP0539, and Special Provision titled "Pipe Installation by Trenchless Method"), and Golder's understanding of the project and proposed construction methods at the time this report was prepared. The proposed monitoring program will provide accurate measurements of ground / structure deflections to assess impacts of the actual pressures, loads, and strains in the ground. As design progresses and throughout construction, the instrumentation details and reading frequencies may change / evolve based on actual measurements, construction operations, and performance of the surrounding ground and facilities / structures. We will notify CDB / MTO of any proposed changes and receive permission prior to making any changes.

As required during construction, copies of test results, observations, and records will be available on site for review by the Contract Administrator and if movements are approaching the allowance limits, the Contract Administrator

will be notified. For ground movements measured to be in excess of anticipated / predicted values, the likely cause(s) will be assessed, along with an evaluation of design assumptions and future performance or mitigation measures, as required.

3.0 TUNNELLING

3.1 Settlement

Settlement above tunnelled or trenchless installations are typically described as exhibiting the shape of an inverted normal probability distribution curve ("bell curve") with the maximum settlement at the centreline of the trenchless installation, tapering to near zero at some distance from the centreline. The ground surface settlement troughs above the proposed new culvert pipes are estimated to extend about 7.6 metres on each side of its alignment for the proposed 2.54 m outer diameter concrete culvert. Based on the proposed tunnelling method, overcut annulus and type of soil and thickness of cover above the trenchless installation, the estimated ground surface/pavement settlement directly above the new culvert(s) is expected to be about 10 millimeters. The estimated settlements assume quality workmanship by the specialist tunnelling contractor. Settlement monitoring of the Highway 11 undercrossing should be carried out prior to, during and after the trenchless installation, to assess any effects of the work on the highway, as discussed below.

3.2 Instrumentation and Monitoring

Consistent with MTO requirements, a monitoring program utilizing a combination of settlement monitors/points consisting of settlement points (SP) and surface settlement markers (SSM) is recommended. All settlement monitoring is to be carried out in general accordance with the requirements in the NSSP titled "*Pipe Installation By Trenchless Method*", included in the Contract documents. The SSM monitoring points are to consist of hexagonal head bolts embedded in the highway pavement and marked with paint and/or flagging tape provided the bolts and flagging do not adversely affect traffic safety and the surveying can be carried out with sufficient precision (±1 mm). The proposed locations of the settlement monitoring points and installation details are shown on Drawing 3.

A total of 13 surface settlement markers (SSMs) and 12 settlement points (SPs) are to be installed to measure settlement. The SSMs are to be positioned on each culvert centreline, at the midpoint between the culvert pipes, and offset 2.0 metres from the centreline away from the twin pipes, and be arranged in two arrays installed along the outside lane markings (i.e. white line) and an array of three along the centre line of the highway, to allow for readings to be taken with limited disruption of traffic. The SPs are to be positioned such that six deep settlement points are to be installed in pairs along the culvert centerlines and six are to be installed in an array of three within the shoulder on each side of the highway, at the approximate locations shown on Drawing 3. The deep settlement monitors should consist of a steel rod anchored at a depth below the depth of frost penetration which for this site is 2.2 m, as interpreted from OPSD 3090.100 (Frost Penetration Depths for Northern Ontario) with the bottom 0.2 metres grouted in place or a base plate provided to be in intimate contact with the founding soils (or approved equivalent). A riser pipe or casing should be provided to separate the rod from the surrounding ground.

The monitoring point installations should be carried out under the direction of qualified geotechnical personnel and the subsequent survey monitoring should be carried out by a licensed surveyor retained by the Project Team with the results being promptly reviewed by a qualified geotechnical engineer on an ongoing basis.

3.3 Establishment of Baseline Conditions

A condition survey to document the existing pavement condition is be carried out prior to the start of construction. The condition survey should include notes and locations about visible flaws such as cracks, distortions, and

deviations, heaves, and depressions. A baseline survey of the monitoring array will be carried out at least three times, prior to construction, with the points referenced to two independent benchmarks. Anomalous readings should be rechecked and/or discarded, as necessary. Acceptance of the baseline survey by all parties should be acknowledged in writing.

3.4 Monitoring Frequency

Monitoring is to be carried out at least once per shift during the construction period, including during temporary work stoppages, non-operational periods and weekends. More frequent readings will be required if anomalous conditions are encountered or alert levels (see below) are being approached or exceeded. Once construction has ceased, monitoring should continue weekly for the first month and monthly thereafter (if required) until such time at which all parties agree that conditions are stable. The monitoring data should be evaluated to see if the magnitude of any movements detected during construction warrant continued monitoring beyond a period of one month following the crossing installations. Anomalous readings should be rechecked and/or discarded, as necessary.

The monitoring frequencies recommended above may be increased if review or alert levels are approaching or exceeded. If a total recorded movement of 10 millimetres (Review Level) relative to the baseline readings is achieved, this should trigger a review of the contractor's methods including tunnelling rate, sequence and ground stabilization methods with a plan to arrest excessive movements. An Alert Level of 15 millimetres relative to the baseline movements should require cessation of tunnelling operations. At this point, implementation of pre-planned settlement mitigation measures is required to assure public safety and maintain traffic flow.

4.0 TEMPORARY EXCAVATION SUPPORT SYSTEMS

4.1 Instrumentation and Monitoring

As part of the construction for the access roads and entry / exit shafts, due to space limitations, temporary protection systems are required at three locations:

- entry shaft sheetpile box structure;
- exit shaft sheetpile box structure; and
- temporary retaining wall located between access road Station 20+130 to 20+180 on east side of highway embankment (Dwg. C-07, Rev. B)

The temporary protection systems / retaining wall are to be designed, constructed and monitored in accordance with DBSP 539 (*Temporary Protection Systems).* The lateral movement of the temporary shoring system will meet Performance Level 1b where the protection system encroaches on the existing highway embankment or Performance Level 2 in other areas, as specified in DBSP 539.

The monitoring will consist of monitoring points (scaled survey targets or pins) installed as follows:

Entry / Exit shafts (up to 8 m deep)

- along the top, at each restraint point (i.e. waler level), at base of excavation, and between walers of the protection system, with targets or pins placed at the extreme ends and distributed at maximum 6 m horizontal intervals along the length of the wall.

Retaining Wall (up to 3 m deep)

- along the top of the protection system and at the base of the wall, with targets or pins placed at the extreme ends and distributed at maximum 6 m horizontal intervals along the length of the wall.

4.2 Monitoring Frequency

The protection systems must be monitored during construction. Readings should be taken during installation of the protection systems at each construction stage during the installation. After installation the readings shall be taken every week.

If movement of the protection system is more rapid than is expected, or, if movement approaches the allowable limit for Performance Level 1b for the entry shaft and retaining wall or Performance Level 2 for the exit shaft, the Contract Administrator shall be notified immediately and suitable measures shall be taken to ensure stability of the protection system and to ensure movement does not exceed the performance level.

5.0 VIBRATION MONITORING

A residential home is located about 100 m from the launching shaft location. A Peak Particle Velocity (PPV) threshold of 50 mm/s is generally considered applicable for vibration impacts on residential buildings. Vibration monitoring is not expected to be required at the existing structure near the launching shaft location as it is considered unlikely that the zone of influence will extend to 100 m, or that the PPV resulting from vibratory installation of sheet piles or driven piles, or TBM operation within the predominantly firm clays will be 50 mm/s or greater. For due diligence purposes, it is recommended that a precondition survey be performed on any structures within a radius of 150 m from the site.

6.0 CLOSURE

This report was prepared by Mr. Matthew Kelly, P.Eng., a geotechnical engineer. Mr. Kevin Bentley, P.Eng., a geotechnical engineer, Associate of Golder and Designated MTO Foundations Contact conducted an independent quality control review of this report.

Signature Page

Golder Associates Ltd.

Matthew Kelly, P.Eng.
Geotechnical Engineer

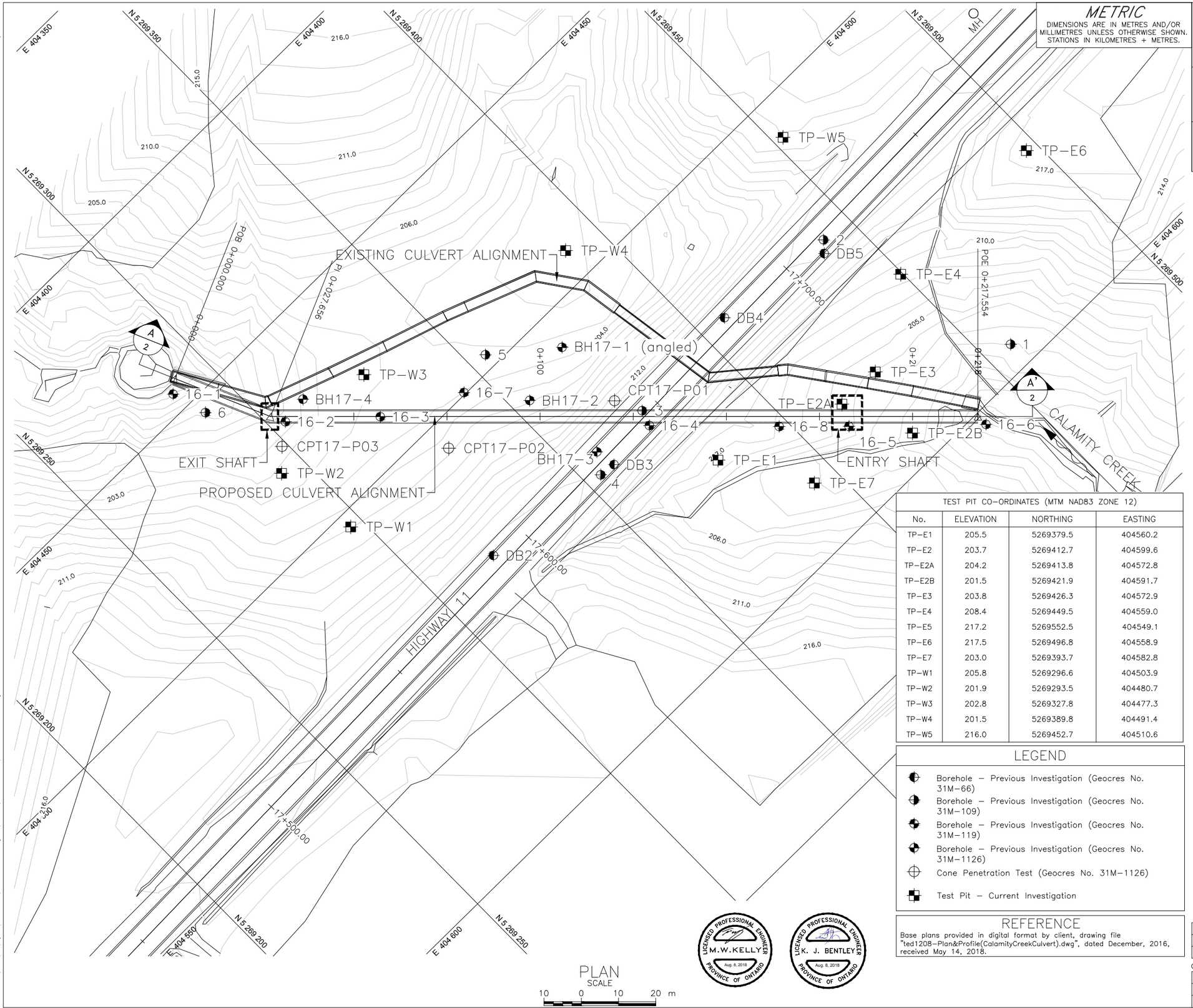
Kevin J. Bentley, P.Eng.
Designated MTO Foundations Contact, Associate

MWK/KJB/rb

https://golderassociates.sharepoint.com/sites/19995g/deliverables/geotechnical foundation working documents/geotech foundation instrumentaion and monitoring/final/rev.1/1789567 - geotechncial monitoring report - calamity creek 2018aug3 2018.docx

Drawings

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN
SCALE
10 0 10 20 m

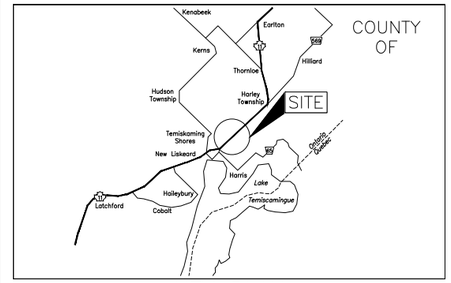
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. DB 2017-5003
WP No.

HIGHWAY 11 CALAMITY CREEK
CULVERT REPLACEMENT
BOREHOLE LOCATIONS

SHEET

GOLDER



KEY PLAN
SCALE
20 0 20 40 m

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 12)			
No.	ELEVATION	NORTHING	EASTING
1	201.8	5269457.4	404593.1
2	214.2	5269441.2	404537.9
3	213.7	5269374.3	404536.5
4	213.9	5269354.3	404541.0
5	203.5	5269354.8	404496.3
6	197.7	5269290.3	404454.7
16-1	194.3	5269287.6	404445.1
16-2	200.5	5269303.9	404471.5
16-3	203.2	5269323.0	404488.4
16-4	213.4	5269372.9	404540.7
16-5	204.0	5269411.0	404578.4
16-6	198.1	5269437.6	404603.8
16-7	204.2	5269343.6	404499.5
16-8	206.9	5269397.6	404565.3
BH17-1 (angled)	205.7	5269370.9	404509.3
BH17-2	207.5	5269354.7	404513.4
BH17-3	213.8	5269357.9	404535.9
BH17-4	201.1	5269311.5	404470.5
CPT17-P01	213.6	5269370.9	404529.4
CPT17-P02	204.9	5269330.2	404507.3
CPT17-P03	202.0	5269298.6	404475.6
DB2	214.3	5269318.6	404536.3
DB3	213.9	5269358.8	404541.6
DB4	213.8	5269407.6	404534.2
DB5	214.1	5269438.8	404540.7

TEST PIT CO-ORDINATES (MTM NAD83 ZONE 12)			
No.	ELEVATION	NORTHING	EASTING
TP-E1	205.5	5269379.5	404560.2
TP-E2	203.7	5269412.7	404599.6
TP-E2A	204.2	5269413.8	404572.8
TP-E2B	201.5	5269421.9	404591.7
TP-E3	203.8	5269426.3	404572.9
TP-E4	208.4	5269449.5	404559.0
TP-E5	217.2	5269552.5	404549.1
TP-E6	217.5	5269496.8	404558.9
TP-E7	203.0	5269393.7	404582.8
TP-W1	205.8	5269296.6	404503.9
TP-W2	201.9	5269293.5	404480.7
TP-W3	202.8	5269327.8	404477.3
TP-W4	201.5	5269389.8	404491.4
TP-W5	216.0	5269452.7	404510.6

LEGEND

- Borehole – Previous Investigation (Geocres No. 31M-66)
- Borehole – Previous Investigation (Geocres No. 31M-109)
- Borehole – Previous Investigation (Geocres No. 31M-119)
- Borehole – Previous Investigation (Geocres No. 31M-1126)
- Cone Penetration Test (Geocres No. 31M-1126)
- Test Pit – Current Investigation

REFERENCE

Base plans provided in digital format by client, drawing file "ted1208-Plan&Profile(CalamityCreekCulvert).dwg", dated December, 2016, received May 14, 2018.

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

LICENSED PROFESSIONAL ENGINEER
M.W.KELLY
Aug. 8, 2018
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
K. J. BENTLEY
Aug. 8, 2018
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. .

HWY. 11	PROJECT NO. 1789567		DIST. .
SUBM'D. MK	CHKD. MK	DATE: 8/8/2018	SITE: 47-273/C
DRAWN: SMD	CHKD. .	APPD. .	DWG. 1

PLOT DATE: August 9, 2018
FILENAME: S:\Clients\MTO\Hwy_11\PR_PROJECTS\1789567_GeotechInvestigation\45_PROD\0001_LocationPlan\1789567-0001-BD-0001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

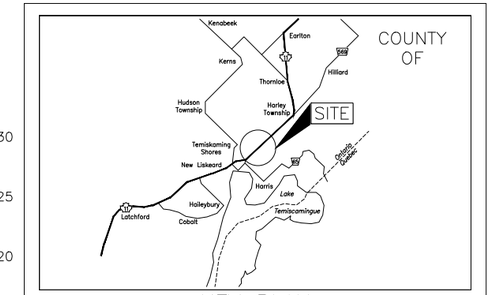
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

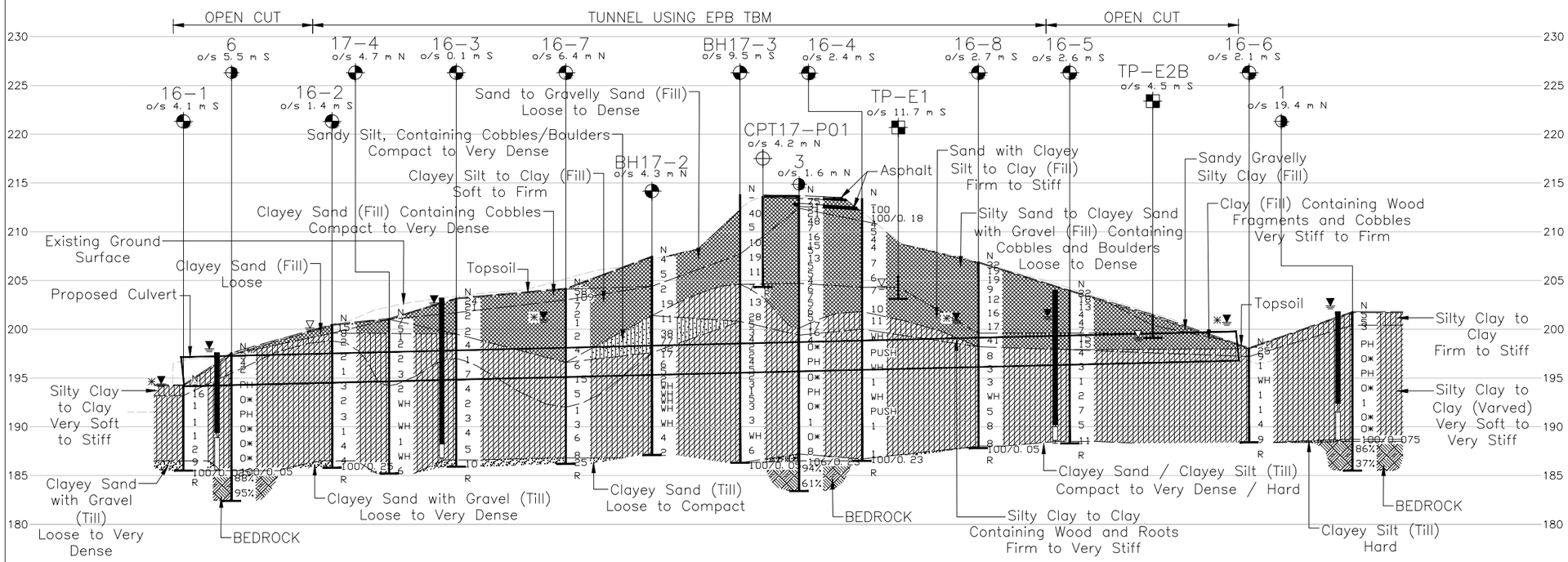
CONT No. DB 2017-5003
WP No.

HIGHWAY 11 CALAMITY CREEK
CULVERT REPLACEMENT
SOIL STRATA

SHEET

GOLDER





A-A' 1 CULVERT SECTION A-A'

HORIZONTAL SCALE
10 0 10 20 m

VERTICAL SCALE
5 0 5 10 m

BOREHOLE CO-ORDINATES (MTM NAD83 ZONE 12)			
No.	ELEVATION	NORTHING	EASTING
1	201.8	5269457.4	404593.1
3	213.7	5269374.3	404536.5
6	197.7	5269290.3	404454.7
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16-5	204.0	5269411.0	404578.4
16-6	198.1	5269437.6	404603.8
16-7	204.2	5269343.6	404499.5
16-8	206.9	5269397.6	404565.3
BH17-2	207.5	5269354.7	404513.4
BH17-3	213.8	5269357.9	404535.9
BH17-4	201.1	5269311.5	404470.5
CPT17-P01	213.6	5269370.9	404529.4
TP-E1	205.5	5269379.5	404560.2
TP-E2B	201.5	5269421.9	404591.7

NOTES

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LEGEND

- Borehole – Previous Investigation (Geocres No. 31M-66)
- Borehole – Previous Investigation (Geocres No. 31M-109)
- Borehole – Previous Investigation (Geocres No. 31M-119)
- Borehole – Previous Investigation (Geocres No. 31M-1126)
- Cone Penetration Test (Geocres No. 31M-1126)
- Test Pit – Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R Refusal
- 100% Rock Quality Designation (RQD)
- WL in piezometer
- WL in Vibrating Wire Piezometer (VWP)
- WL upon completion of drilling

REFERENCE

Base plans provided in digital format by client, drawing file "ted1208-Plan&Profile(CalamityCreekCulvert).dwg", dated December, 2016, received May 14, 2018.

LICENSED PROFESSIONAL ENGINEER M.W.KELLY Aug. 8, 2018 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER K. J. BENTLEY Aug. 8, 2018 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No.

HWY. 11		PROJECT NO. 1789567	DIST.
SUBM'D. MCK	CHKD. MCK	DATE: 8/8/2018	SITE: 47-273/C
DRAWN: SMD	CHKD. MWK	APPD. KJB	DWG. 2

PLOT DATE: August 9, 2018
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MINISTRY OF TRANSPORTATION, ONTARIO

METRIC
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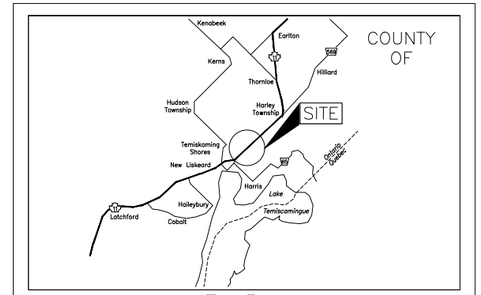
STATIONS IN KILOMETRES + METRES.

CONT No. DB 2017-5003
WP No.

HIGHWAY 11 CALAMITY CREEK
CULVERT REPLACEMENT
SETTLEMENT MONITORING INSTALLATION
LOCATIONS AND DETAILS

SHEET

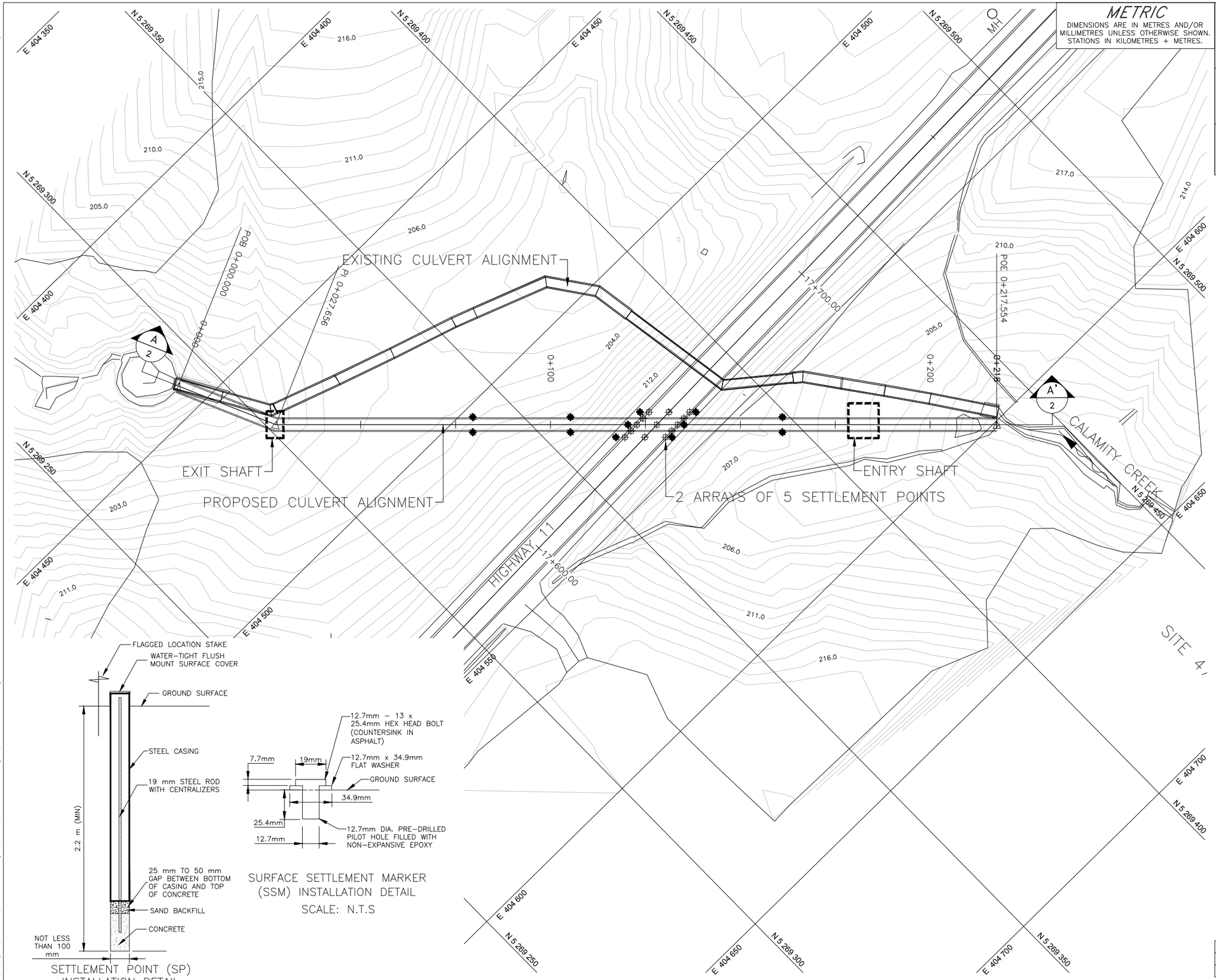
GOLDER



KEY PLAN
SCALE
20 0 20 40 m

LEGEND

- Surface Settlement Marker
- Settlement Point



SETTLEMENT POINT (SP)
INSTALLATION DETAIL
SCALE: N.T.S

SURFACE SETTLEMENT MARKER
(SSM) INSTALLATION DETAIL
SCALE: N.T.S

PLAN
SCALE
10 0 10 20 m

SETTLEMENT MONITORING INSTALLATION DETAILS

REFERENCE

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NOTES

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NO.	DATE	BY	REVISION
1	9/19/18	MK	ADDIITONAL MONITORING POINTS ADDED

Geocres No.

HWY. 11	PROJECT NO. 1789567		DIST.
SUBM'D. MWK	CHKD. MWK	DATE: 9/19/2018	SITE: 47-273/C
DRAWN: SMD	CHKD. KJB	APPD.	DWG. 3

PLOT DATE: September 21, 2018
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