

April 23, 2021

Project No. 1780055

Mr. John Gawley

Dillon Consulting Ltd.
130 Dufferin Avenue, Suite 1400
London, Ontario
N6A 5R2

**GEOTECHNICAL INVESTIGATION TO ASSESS OBSTRUCTION ENCOUNTERED DURING PILOT TUBE
ADVANCEMENT OF TRENCHLESS CROSSING FOR ELECTRICAL SERVICES
GANANOQUE SOUTH COMMERCIAL VEHICLE INSPECTION FACILITY
HIGHWAY 401, TOWN OF GANANOQUE, LEEDS AND GRENVILLE COUNTY, ONTARIO
MTO G.W.P. 4009-14-00, ASSIGNMENT NO. 4017-E-0003
GEOCRES NO. 31C-307**

Dear Sir:

Golder Associates Ltd. (Golder) has been retained by Dillon Consulting Limited (Dillon) on behalf of the Ministry of Transportation, Ontario (MTO) to provide supplementary foundation engineering services during construction, for the electrical services trenchless crossing (i.e., proposed undercrossing), associated with the Gananoque South Commercial Vehicle Inspection Facility (CVIF) in the Town of Gananoque, Leeds and Grenville County, Ontario.

This letter provides a summary of the supplementary foundation investigation carried out to identify the obstruction(s) encountered during advancement of the pilot tube as part of the guided jack and bore operation and to assess feasible alternatives to complete the trenchless crossing.

BACKGROUND

Trenchless Crossing

The proposed trenchless crossing is to consist of a steel casing (approximately 88 m long) extending from a proposed manhole north of Highway 401, crossing below Highway 401 westbound and eastbound lanes, and terminating at a proposed manhole on the proposed CVIF / existing TIS property south of Highway 401, as shown on Figure 1. The casing will contain several electrical conduits.

The Highway 401 pavement surface is at about Elevation 95.5 m along the trenchless alignment. Highway 401 eastbound and westbound traffic is divided by a grassy median with an approximately 1.5 m deep ditch with the bottom extending to about Elevation 94.3 m at the median centerline.

Referring to the contract documents, the design casing is shown to be 350 mm in diameter, with an invert at Elevation 91.6 m, and top of casing at about Elevation 92.0 m.

The trenchless contractor's work plan indicates a slightly larger casing (508 mm diameter) to be installed at a slightly higher elevation to maintain an invert elevation at about 91.6 m.

Two existing storm sewers with inverts at about Elevation 93.0 m cross perpendicular to the proposed undercrossing near the south limit of the Highway 401 eastbound lanes. The soil cover between the top of the proposed tunnel / casing and sewer invert is about 1 m, as shown on Figure 1.

Existing Foundation Investigation (2019)

Golder carried out a foundation investigation in November 2019 as part of the foundation engineering requirements for the proposed trenchless crossing. The investigation consisted of three sampled boreholes spaced about 30 m apart, designated as Boreholes TC-1, TC-2, and TC-3, advanced at the approximate locations shown on the attached Figure 1. Two additional boreholes, designated as TC-2A and TC-2B, were also advanced in the vicinity (about 1 m and 2 m west) of Borehole TC-2; the boreholes were advanced to auger refusal without sampling to confirm the depth to auger refusal at this location. The encountered subsurface conditions are shown on the attached Figure 1 and summarized in the sections below.

The results of the investigation confirmed bedrock was encountered between Elevations 87.0 m and 89.6 m at the location of the trenchless crossing.

Obstruction(s) Encountered During Trenchless Installation

The Contractor (Coco Paving Inc., [Coco]) retained the services of a specialist trenchless subcontractor (Marathon) for the trenchless installation. The chosen trenchless method (as selected by the Contractor / trenchless subcontractor) is guided auger boring, using advancement of a pilot tube (i.e. small diameter steel rod) before the jack and bore operation, to increase accuracy and control of the jacked casing and auger bore operation.

The north side of the highway was selected by the Contractor as the entry pit which was excavated in late November 2020 and the pilot tube advancement was initiated in early December 2020. The south pit has not been excavated as of the date of this letter.

Three attempts were made to advance the pilot tube on December 4, 8 and 9, all of which encountered refusal due to an obstruction at a distance of about 39 m to 40 m from the entry pit. Based on correspondence received from Dillon on December 7 and 9 and as discussed with the project team on December 7, 9, and 12, a summary of our understanding of the pilot tube installation attempts are summarized below and shown on the attached Sheet 64A provided by Dillon.

- | December 4, 2020: The pilot tube was advanced along the proposed plan alignment to a distance of about 39 m from the entry pit, where it hit an obstruction and could not penetrate further.
- | December 8, 2020: The pilot tube was angled / skewed west of the original alignment and advanced to a distance of about 39 m from the entry pit, where it hit an obstruction, approximately 1.2 m west of the original alignment, and could not penetrate further.
- | December 9, 2020: The pilot tube was angled / skewed east of the original alignment and advanced to a distance of about 40 m from the entry pit, where it hit an obstruction, approximately 2.4 m east of the original alignment.

Marathon has indicated that advancement of the pilot tube from the entry pit to the encountered obstruction was relatively smooth for each attempt with no indication of high resistance until the sudden refusal at the obstruction.

Based on discussions with the project team (Coco, Marathon, MTO, Greer Galloway, Dillon, and Golder) it was decided that a supplementary foundation investigation be completed as an attempt to identify the obstruction(s) and/or gain more insight to the ground conditions surrounding the obstruction(s).

SUPPLEMENTARY INVESTIGATION PROCEDURE

The supplementary investigation was carried out between December 14 and 16, 2020. During this time, ten boreholes were advanced (designated 20-1A/B, 20-2A/B/C, 20-3A/B/C, and 20-4A/B) at the approximate locations shown on the attached Sheet 64A.

The investigation was carried out using a track-mounted CME 45 drill rig supplied and operated by Marathon, with traffic control services and survey provided by Coco. Boreholes 20-1A, 20-1B, 20-2A, 20-2B, 20-2C, 20-3A, 20-3B, 20-3C were advanced using wash boring methods utilizing rotating HW-size casing through the overburden. An HQ core barrel (64 mm inside diameter and 96 mm outside diameter) was used for bedrock coring in Boreholes 20-1B and 20-2A. Boreholes 20-4A and 20-4B were advanced using 110 mm inside diameter continuous flight hollow-stem augers through the overburden.

The boreholes were typically advanced to refusal. For both the wash boring / casing advancement and auger drilling methods, refusal is defined as the depth where a high resistance to further penetration of the casing and/or augers was encountered. At most borehole locations, a soil sample was collected at a 3 m depth (i.e. at the approximate pilot tube and proposed tunnel path) using a 50 mm outer diameter and 35 mm inside diameter split-spoon sampler driven by an automatic hammer in accordance with SPT procedures (ASTM D1586).

Where possible, the groundwater conditions were noted during or immediately following drilling operations; although the majority of boreholes were advanced using wash boring methods so groundwater levels were not considered relevant as the process involves introducing water to the borehole. The boreholes were backfilled upon completion of drilling using bentonite pellets, in general accordance with Ontario Regulation 903 (as amended).

The field work was observed on a full-time basis by a member of Golder's engineering staff, who located the boreholes in the field, observed the drilling, sampling and in situ testing operations, logged the boreholes and examined the soil and rock samples. The soil and bedrock samples were identified in the field, placed in appropriate containers, labelled and transported to Golder's Whitby laboratory where they will be stored for three months and then disposed.

The boreholes were located relative to the original trenchless alignment that had been surveyed and marked on the ground surface at the site. The approximate borehole locations are shown on the attached Sheet 64A. The elevation of the highway was surveyed by Coco and was used as the reference ground surface elevation for the boreholes advanced on the Highway 401 eastbound lanes. The elevation and location of the two boreholes located south of the Highway 401 eastbound lanes and within the active construction area for the CVIF (Boreholes 20-4A and 20-4B) were surveyed by Coco.

INVESTIGATION RESULTS

The first two boreholes (Boreholes 20-1A and 20-1B) were advanced about 39 m to 40 m south of the entry pit and offset about 1.5 m from the original trenchless alignment, at the general location where the obstructions were encountered during the pilot tube advancement. Boreholes 20-1A and 20-1B were advanced to refusal that was

encountered at depths of 4.5 m (El. 91.0 m) and 3.7 m (El. 91.8 m) respectively. Borehole 20-1B was cored and confirmed a layer (0.4 m thick) of gravel to cobble-sized broken rock fragments overlying sound bedrock (granitic gneiss). The bedrock was confirmed by coring about 2.1 m further into the rock. The next borehole (20-2A) was advanced in the fast lane of the Highway 401 EBL (about 1.5 m west of proposed alignment) and encountered refusal at a depth of 3.9 m (El. 91.6 m), after which coring techniques were used to confirm a 0.1 m thick layer of gravel to cobble-sized rock fragments underlain by sound bedrock (granitic gneiss). The bedrock was confirmed by coring about 2.4 m further into the rock.

After bedrock was confirmed at / near the level of the pilot tube profile alignment which is understood to have targeted Elevation 91.8 m, the subsequent boreholes were advanced in a grid-like pattern to assess the top of the potential obstruction (i.e. cobble / boulder layer or bedrock) by advancing each borehole to refusal. A summary of the location, ground surface elevation, soil sample collected within bore path, and depth to refusal at each borehole location is provided below. The relevant information from the boreholes advanced as part of the 2019 investigation is also provided below.

Borehole ID	Offset from Original Alignment	Ground Surface Elevation, m	Soil Sample Classification ²	Auger / Casing Refusal Depth (Elevation) ³ , m	Notes
TC-1	3.0 m west	95.6	-	8.4 (87.2)	Below refusal, coring confirms 0.3 m thick cobble / boulder layer above bedrock
TC-2	3.0 m east	94.3	-	5.2 (89.1)	-
TC-2A	2.0 m east	94.3	-	5.1 (89.2)	-
TC-2B	1.0 m east	94.3	-	5.2 (89.1)	-
TC-3	3.0 m west	95.4	-	5.1 (90.4)	Below refusal, coring suggests 0.7 m thick cobble, boulder layer above bedrock
20-1A	1.8 m west	95.5 ¹	Compact sand	4.5 (91.0)	-
20-1B	1.5 m east	95.5 ¹	Very stiff sandy clayey silt fill	3.7 (91.8)	Below refusal, coring confirms 0.4 m thick gravel / cobble layer above bedrock
20-2A	1.5 m west	95.5 ¹	Compact sand	3.9 (91.6)	Below refusal, coring confirms 0.1 m thick gravel / cobble layer above bedrock
20-2B	3.0 m west	95.5 ¹	Loose sand	4.2 (91.3)	-
20-2C	6.0 m west	95.5 ¹	Loose sand	4.9 (90.6)	-
20-3A	1.5 m west	95.5 ¹	Overburden – no sample collected	4.4 (91.1)	-
20-3B	3.0 m west	95.5 ¹	Compact sand	4.7 (90.8)	-
20-3C	6.0 m west	95.5 ¹	Loose sand	5.1 (90.4)	-
20-4A	3.0 m west	95.0	Compact sand	4.6 (90.4)	Open borehole dry
20-4B	6.0 m west	95.0	Loose sand	4.8 (90.2)	Open borehole dry

Notes:

1. Ground surface elevation is approximate and based on surveyed elevation of highway on north side of eastbound lanes.
2. Visual classification of soil sample collected at a depth of 3 m during 2020 supplementary investigation
3. Refusal indicates the elevation at which increased resistance to borehole advancement was observed. This was typically accompanied by a “grinding” sound heard by our Golder supervisor during rotation of the auger / casing.

DISCUSSION

Based on the results of the supplementary foundation investigation, it is concluded that the obstructions encountered during the three pilot bore attempts are bedrock or a gravel to cobble-sized broken rock / boulder layer directly above the bedrock. In the area of the investigation, the refusal surface (inferred or confirmed bedrock or cobble/boulder layer) is sloping downward to the west, with the highest refusal surface encountered at Elevation 91.8 at Borehole 20-1B. The refusal surface also appears to slope upward from the north (north pit location) to the south, reaching a high point below the Highway 401 eastbound fast lane and then slopes downward to the south towards the proposed south pit location.

Based on the unsuccessful attempts to advance the pilot tube and the preliminary results of the supplementary foundation investigation that indicate the refusal / bedrock surface is sloping down the west, the project team had several conference calls and developed the following alternatives to realign the pilot bore for the trenchless installation. The advantages, disadvantages, risks and relative costs related to the feasible alternatives from a foundation perspective is provided in Table 1.

Option 1 – Maintain North Pit and Skew Alignment Further West: From the existing north entry pit, skew the alignment further west of the original alignment and west of the previous skewed alignments, if possible. As indicated by Marathon during a teleconference, the pilot tube alignment cannot be skewed any further west than the previously skewed pilot bore attempt on December 8, 2020 due to limitations of equipment and the location of the sheet piles / rakers within the pit. As such, this option is not considered feasible and is therefore not discussed further herein.

Option 2 – Widen North Pit and Skew Alignment West: Extend / widen the existing north entry pit to the west to accommodate a more skewed alignment further west of the original alignment and further west of the previously skewed alignment advanced on December 8, 2020.

Option 3 – Widen / New North Pit and Offset Alignment West: Extend / widen the existing north entry pit to the west and offset the new alignment west of (and parallel to) the original alignment. Depending on how far west the offset is located, a new north entry pit may be required.

Option 4 – New Entry Pit on South Side of Highway: Excavate a new entry pit on the south side of Highway 401 and west of the originally proposed exit pit location. The new alignment would target the existing north pit which could be used as the exit pit.

Option 5 – New Entry / Exit Pit in Highway Median - Advance Two Crossings: Excavate a new entry / exit pit in the median ditch to advance two separate trenchless crossings (i.e., a north undercrossing of Highway 401 westbound lanes along the original alignment and a south undercrossing of Highway 401 eastbound lanes on a new profile alignment above bedrock or on a skew west of the original alignment).

In addition to the options above, raising the profile alignment should be considered to reduce the risk of encountering obstructions (i.e., cobbles/boulders/bedrock) during the trenchless installation. However, given the presence of the two storm sewers located near the south limit of Highway 401 eastbound lanes (with inverts approximately 1 m above the proposed tunnel obvert), raising the trenchless profile would result in additional risk associated with ground disturbance to the founding soils surrounding the sewers which could lead to settlement/movement of the existing sewers, especially if a mixed face condition is encountered.

Further, alternative trenchless techniques were briefly discussed by the team, however, the undulating bedrock surface creates mixed face conditions that will present challenges for all of the trenchless techniques originally considered in the 2020 Foundation Report prepared by Golder.

CLOSURE

We trust that the above comments are sufficient for your purposes at this time. Please contact our office should you require further clarification.

Yours Truly,

Golder Associates Ltd.



Anastasia Poliacik, P.Eng.
Geotechnical Engineer

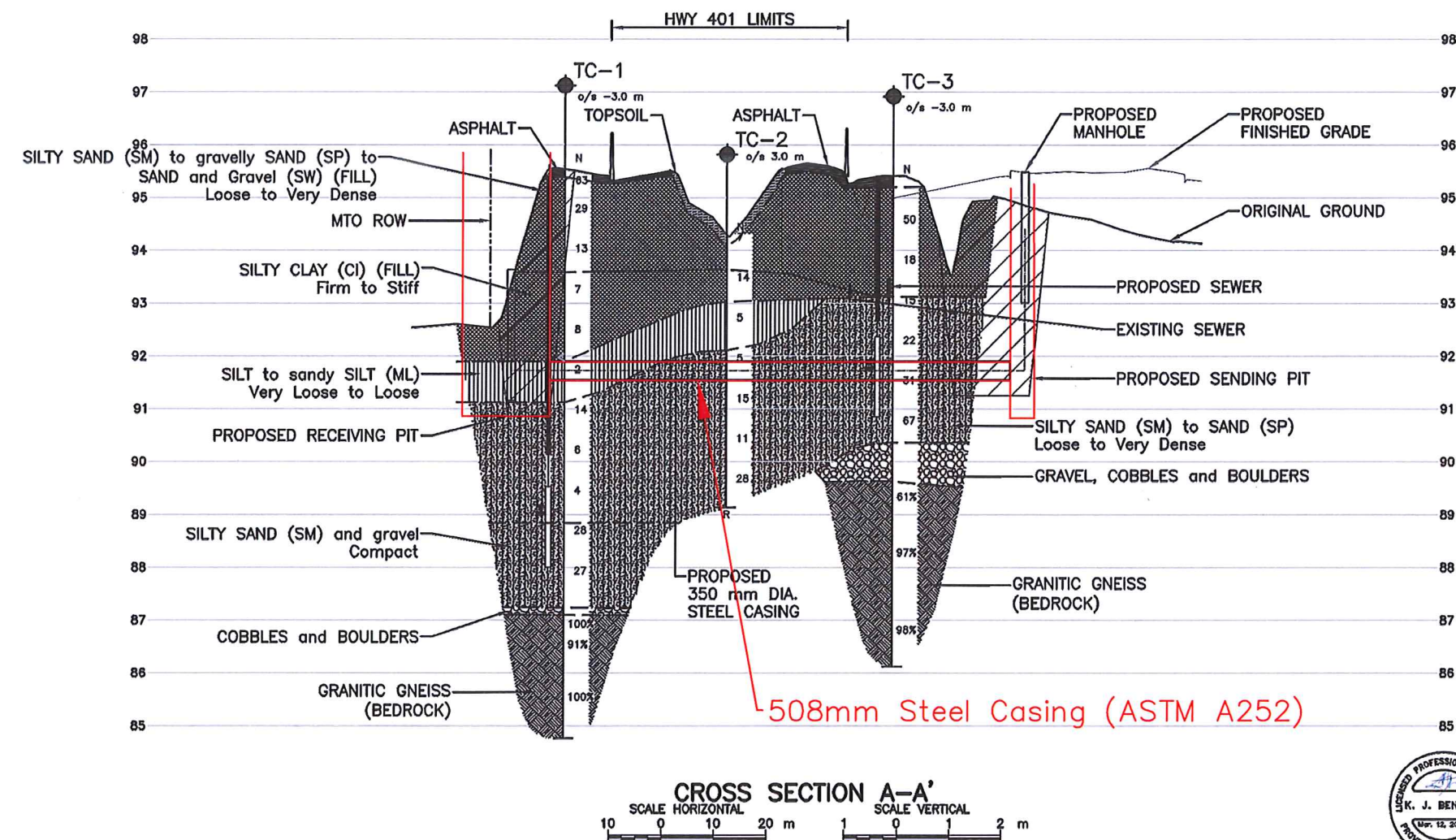
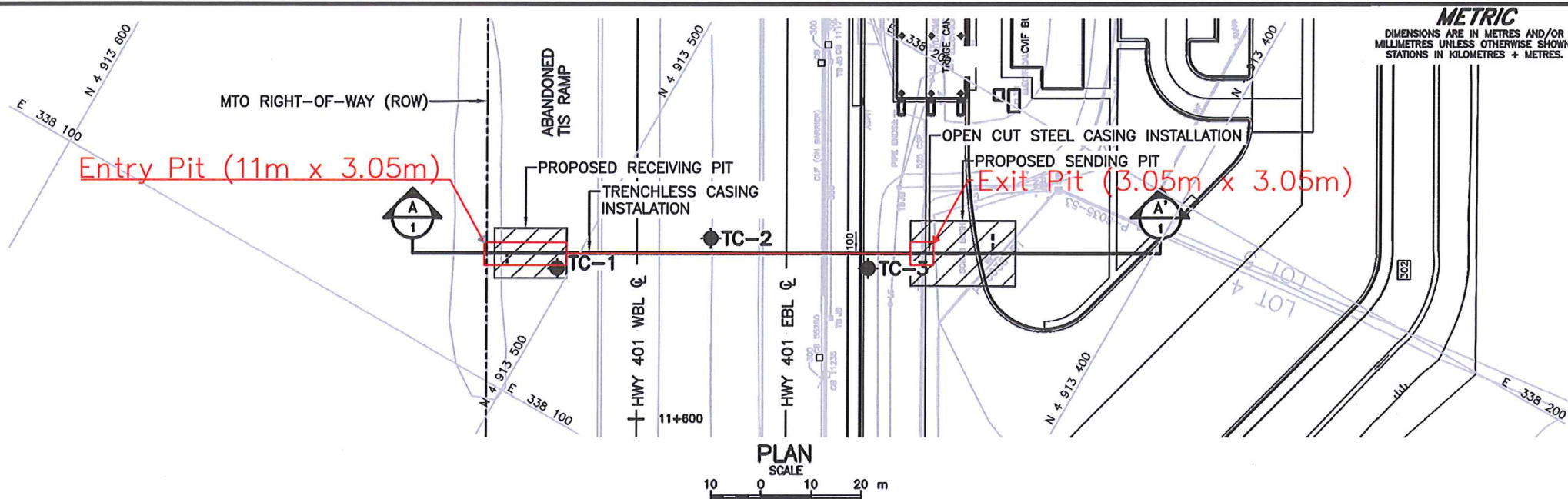


Kevin Bentley, P.Eng.
Associate, MTO Foundations Designated Contact

AMP/KB/;ljv

Attachments: Figure 1 – 2019 Investigation Borehole Plan and Profile, Proposed Alignment
Sheet 64A – Miscellaneous Details, Highway 401, 3 – Phase Undercrossing Details
Table 1 – Evaluation of Trenchless Guided Jack and Bore Pipe Installation Options

[https://golderassociates.sharepoint.com/sites/12573g/wo cvif dd gananoque south/4 foundations/9. construction liason/3. deliverables/3.final letter/1780055 ltr rev0 2021'04'23 - trenchless obstruction investigation.docx](https://golderassociates.sharepoint.com/sites/12573g/wo%20cvif%20dd%20gananoque%20south/4%20foundations/9.%20construction%20liason/3.%20deliverables/3.final%20letter/1780055%20ltr%20rev0%202021'04'23%20-%20trenchless%20obstruction%20investigation.docx)



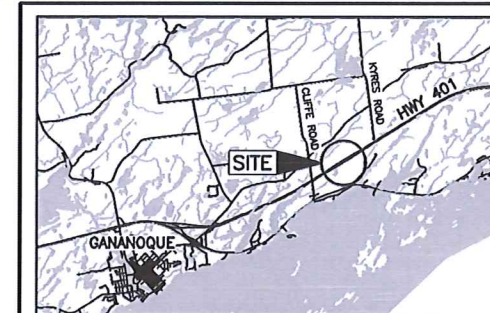
CONT No. 2020-1017
GWP No. 4009-14-00

TRENCHLESS CROSSING
GANANOQUE SOUTH CVIF
BOREHOLE LOCATIONS AND SOIL
STRATA

GOLDER



SHEET
55



KEY PLAN
SCALE 2 0 2 4 km

LEGEND

- Borehole - Current Investigation
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 l/blow)
- R Refusal
- 100% Rock Quality Designation (RQD)
- WL upon completion of drilling
- WL measured in piezometer on December 5, 2019

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
TC-1	95.6	4913502.4	338126.6
TC-2	94.3	4913478.6	338147.1
TC-3	95.4	4913448.2	338157.5

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 Contract Documents.

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

REFERENCE

Base plans provided in digital format by Dillon, drawing file nos. 4009-Base.dwg and Alignments.dwg, received May 10, 2019, 4009-New Construction.dwg, received September 18, 2019 and 3-Phase Undercrossing.dwg, received January 2020.

NO.	DATE	BY	REVISION
1	03/12/2020	KJB	1

Geocres No. 31C-288

HWY. 401	PROJECT NO. 1780055	DIST.
SUBM'D. AP	CHKD. AP	DATE: 03/12/2020
DRAWN: DD	CHKD. KJB	APPD. KJB
		DWG. 1



NOTES



NO.	REVISION	DATE
1		

MARATHON
Marathon Underground Constructors Corporation
6847 Hiram Drive, Greely, ON K4P 1A2
Tel: 613-821-4800
Fax: 613-821-3182
www.marathonunderground.com

PROJECT
Gananoque South CVIF
MTO2020-4017

LOCATION
MacDonald Cartier
Freeway (HWY 401)

JOB NO.
H20315

DESCRIPTION
Work Drawings

SCALE NTS	DATE 02-11-2020
DRAWN BY G.I.	REV. NO. 0
DESIGNED BY ---	DRAWING NO. 001
CHECKED BY CAP	

SUPPLEMENTARY LEGEND

- EXCAVATION
- CONCRETE ENCASED
- STEEL ENCASED
- BOREHOLE, SEE NOTE 4

NOTES:

1. STEEL CASING TO BE INSTALLED BY TRENCHLESS METHOD AS PER SPECIAL PROVISION "PIPE INSTALLATION BY TRENCHLESS METHOD". NOTE THAT 350mm DIAMETER STEEL CASING WAS DETAILED IN ORIGINAL CONTRACT BUT CONTRACTOR HAS PROPOSED USING 508mm DIAMETER STEEL CASING.
2. ELECTRICAL SERVICES/DUCTS TO BE INSTALLED WITHIN CASING AND THE ENDS OF THE CASINGS TO BE SEALED IN ACCORDANCE WITH MTOD 2100.070.
3. ROADWAY PROTECTION SYSTEM, INCLUDING RAKER SUPPORT LOCATION AT RECEIVING PIT, PROVIDED BY CONTRACTOR. PROTECTION SYSTEM ADJUSTMENT MAY BE REQUIRED IN THE FIELD TO ACCOMMODATE CASING EXIT POINT.
4. BOREHOLE LOCATIONS PROVIDED BY GOLDER ASSOCIATES LTD. (DECEMBER 2020).

METRIC

PLATE No
CONT No 2020-4017
WP No 4009-14-00
MISCELLANEOUS DETAILS
HIGHWAY 401
3-PHASE UNDERCROSSING DETAILS

SHEET
64A

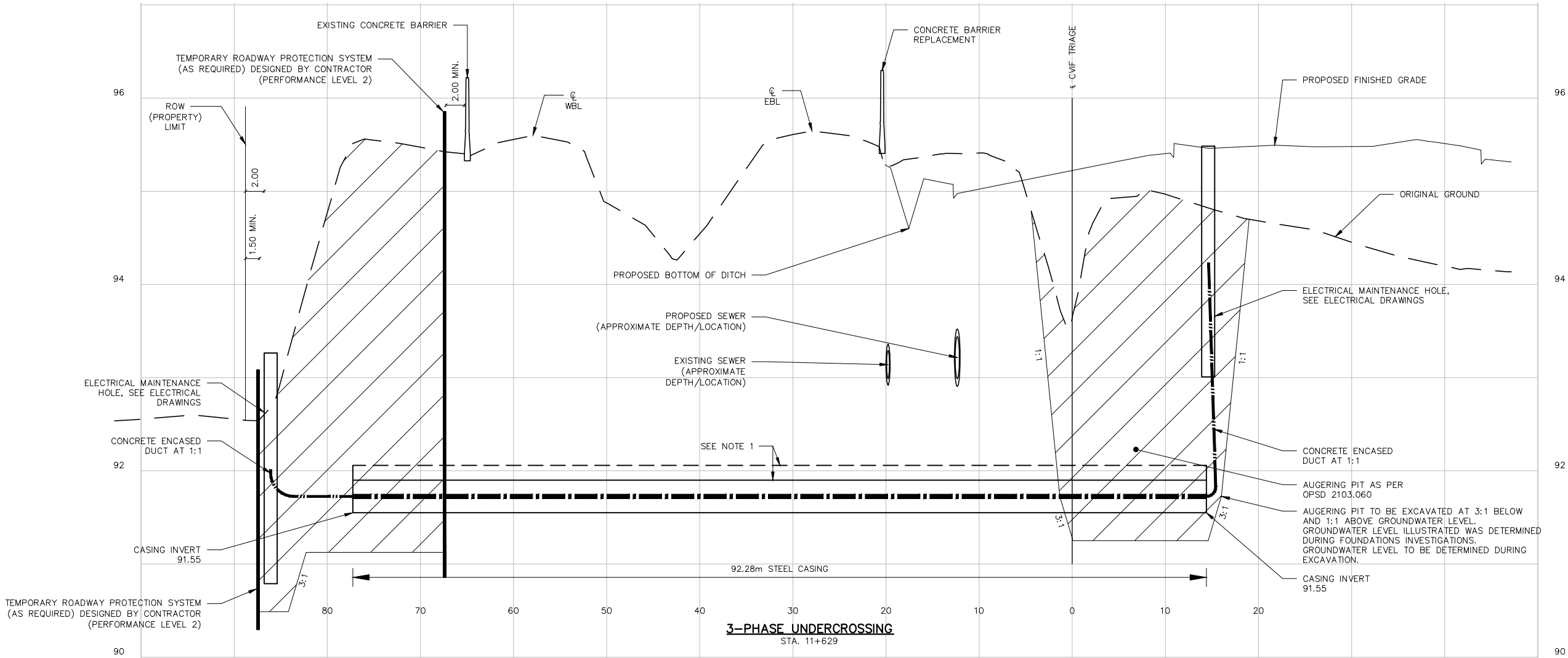
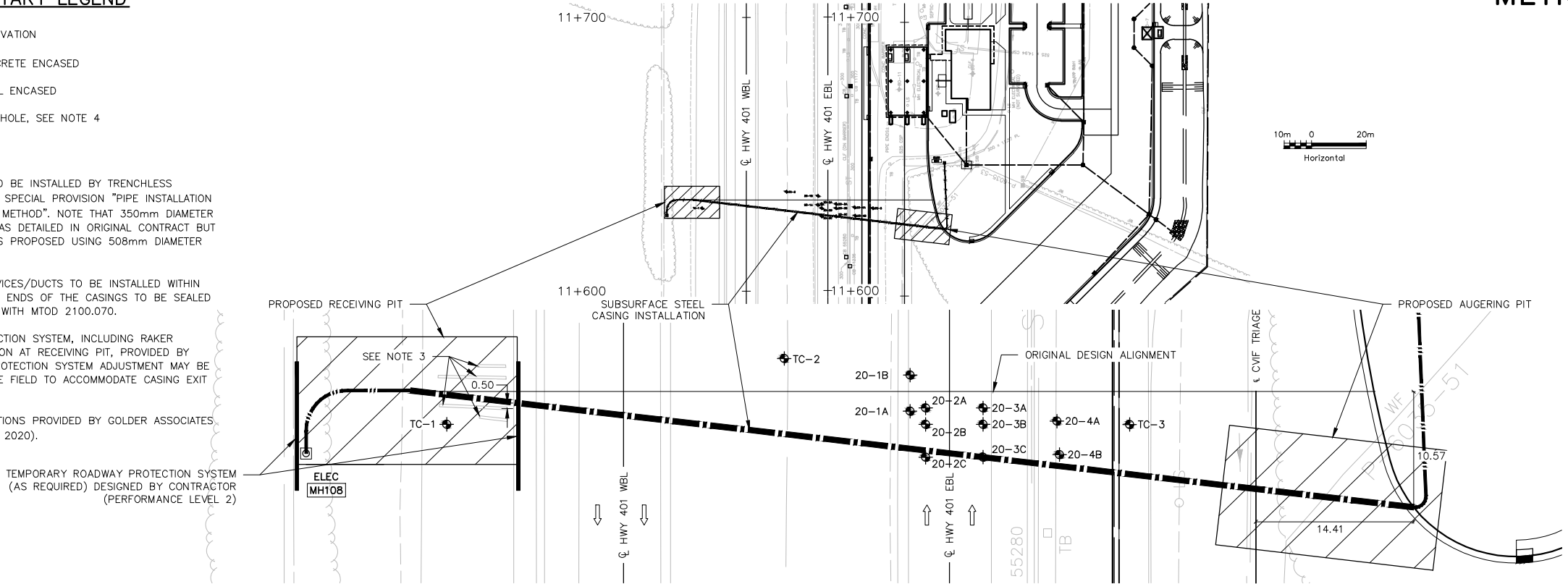


Table 1: Evaluation of Trenchless Guided Jack and Bore Pipe Installation Options

Option	Feasibility of Trenchless Method	Advantages	Disadvantages	Relative Costs	Risk/Consequences
Option 1: Maintain North Pit and Skew Alignment Further West	Not Feasible	<div>N/A</div>	<div>N/A</div>	<div>N/A</div>	<div>N/A</div>
Option 2: Widen North Pit and Skew Alignment West	Feasible	<div><div>Minimal traffic disruption.</div><div>Subsurface conditions along revised alignment have been investigated below Hwy 401 EBL</div><div>Minimal shift at northern section of alignment where successful pilot tube advancement has been proven</div><div>The time required to widen the north shaft would likely have the smallest impact to the construction schedule.</div><div>Possible combination of Option 2 and 3 could be considered to maintain alignment closer to existing borehole information and confirmed successful pilot tube advancement for north half.</div></div>	<div><div>Existing north shaft must be extended to the west, requiring additional design and construction time and efforts.</div><div>Requires relocation of the manholes / electrical connection at north and south end of crossing.</div><div>Depending on skew angle, alignment at south limit may be a significant distance from existing borehole information, and additional foundation investigation may be recommended.</div></div>	<div>Low construction cost to modify north pit.</div>	<div><div>Low risk of encountering cobbles/boulder/bedrock between borehole locations provided skew is at least 4 m west of original alignment near location of encountered obstructions (Hwy 401 EBL)</div><div>Low risk of encountering other bedrock undulations within median and below Hwy 401 WBL given that pilot tube was already advanced at this location; however increased risk at south limit depending on skew angle.</div><div>Risk of unknown conditions at new south limit location could be mitigated if location of exit shaft is flexible (i.e. can south shaft be located further north within CVIF construction area if obstruction is hit near south limit?).</div></div>
Option 3: Widen / New North Pit and Offset Alignment West (parallel to original alignment)	Feasible	<div><div>Minimal traffic disruption.</div><div>Subsurface conditions along revised alignment have been investigated below Hwy 401 EBL.</div><div>The time required to widen the north shaft would have less impact compared to excavating a new shaft.</div><div>Offset instead of skew would maintain existing quantities related to length of crossing, conduits, etc.</div><div>Offset (as opposed to skew) may result in south pit location being closer to original location and existing borehole information</div><div>Possible combination of Option 2 and 3 could be considered to maintain alignment closer to existing borehole information and confirmed successful pilot tube advancement for north half.</div></div>	<div><div>Existing north shaft must be extended to the west, requiring additional design and construction time and efforts. Depending on offset distance, excavation of new shaft may be required.</div><div>Requires relocation of the electrical connection at north and south end of crossing.</div><div>Subsurface conditions along the revised (offset) northern portion of the alignment (i.e. under the Highway 401 WBL) have not been investigated and additional foundation investigation may be recommended, although existing borehole is located west of current shaft location.</div><div>If additional foundation investigation is deemed necessary along the northern portion of the alignment, this would cause additional delays to project schedule.</div></div>	<div>Construction cost similar to Option 2 unless a new pit location is required due to offset distance.</div> <div>Additional costs to investigate the revised northern portion of the crossing – if applicable.</div>	<div><div>Low risk of encountering cobbles/boulder/bedrock between borehole locations provided offset is at least 4 m west of original alignment near location of encountered obstructions (Hwy 401 EBL)</div><div>If an additional foundation investigation is not carried out along the revised northern portion of the alignment, there is a higher risk of changing ground conditions, specifically cobbles/boulder/bedrock surface. The risk increases the further offset the new pit is from existing borehole.</div></div>

Option	Feasibility of Trenchless Method	Advantages	Disadvantages	Relative Costs	Risk/Consequences
Option 4: New Entry Pit on South Side of Highway	Feasible	<ul style="list-style-type: none">Minimal traffic disruption.Subsurface conditions along revised alignment have been investigated below Hwy 401 EBL.Can make use of north pit for exit pit and does not require relocation of the electrical connection at north end of crossing.Need to excavate exit pit on south side anyway; so minor change to work plan / temporary design	<ul style="list-style-type: none">Additional construction efforts required to design and construct entry shaft at south side of Highway 401; albeit relatively minor since exit pit was to be excavated at this location.Potential disruption/conflict with on-going construction operations at CVIF site.Skew angle required to maintain sufficient clearance from obstructions below Highway 401 EBL may result in location of entry pit on south side a significant distance west of existing borehole information. Recommendation for additional foundation investigation may be requested for south limit and south pit location.Requires relocation of the electrical connection at south end of crossing.	<ul style="list-style-type: none">Construction cost may be comparable to Options 2 and 3, but lower than Option 5.	<ul style="list-style-type: none">Depending on the final skew of the alignment and pilot tube advancement, there is risk that the bore may not intercept with the existing north pit and therefore additional excavation at the north pit would be required.Due to significant skew angle to clear obstructions below Hwy 401 EBL (at least 4 m from original alignment), there is risk of changed ground conditions at new south entry pit. Depending on chosen alignment, additional geotechnical investigation may be recommended.
Option 5: New Entry / Exit Pit in Highway Median - Advance Two Separate Crossings	Feasible, not recommended	<ul style="list-style-type: none">Subsurface conditions along revised alignment / profile have been investigated at Hwy 401 EBL.Does not require relocation of the electrical connection at north end of crossing.Successful pilot tube advancement below Hwy 401 WBL confirmed.	<ul style="list-style-type: none">Significant traffic disruption.Significant impacts to construction schedule to construct new shaft in median.Temporary roadway protection systems likely needed for both Highway 401 EBL and WBL requiring significant design and construction effort.Significant delays to overall schedule	<ul style="list-style-type: none">Highest construction cost due to two separate crossing set-ups and significant temporary roadway protection efforts	<ul style="list-style-type: none">For skewed approach in southern half, skew would need to be significant to avoid obstructions and geometry may not be practical (south shaft will be located significantly west)If profile is raised significantly, the soil cover thickness will decrease and the risk of disturbing the ground supporting existing sewers and Highway 401 EBL increases