**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT FOR**
**NEW AMABLE-DU-FOND RIVER BRIDGE – HIGHWAY 630**
**CALVIN TOWNSHIP, NORTH BAY AREA – SITE NO. 43-085**
**AGREEMENT NUMBER 5005-E-0001**
**GWP NO. 177-98-00**


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**PART A**
**PRELIMINARY FOUNDATION INVESTIGATION REPORT**
for
New Amable-du-Fond River Bridge – Highway 630
Calvin Township, North Bay Area – Site No. 43-085
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## 1. INTRODUCTION

This report presents the results of the preliminary foundation investigation carried out at the site of the preferred alignment of a new bridge carrying Highway 630 over the Amable-du-Fond River in the Township of Calvin, North Bay Area and including the approach embankments for the realigned Highway 630. The preliminary foundation study was carried out for Stantec Consulting Limited (Stantec) on behalf of the Ministry of Transportation of Ontario (MTO).

MTO plans to replace the two existing single-lane bridges located at the Highway 630 crossing of Amable-du-Fond River about 1.4 km south of Highway 17. A new structure will replace the northern bridge, Site No. 43-085. The preliminary investigation for the southern structure was reported separately.

Stantec and MTO considered four alternative alignments of the Highway 630 across the Amable-du-Fond River. A description of the alignments is provided below:

- Alternative 1: Existing Highway 630 alignment.
- Alternative 2: New alignment to the west side.
- Alternative 3: New alignment to the east side.
- Alternative 4: New alignment to the east side with a 250 m radius.

It is understood that Stantec and MTO presently identified Alternative 3 as the preferred alignment for the River crossing and Highway 630 realignment. However, the selected alternative could be different from the currently preferred alignment.

Part A of this report summarizes the results of the preliminary foundation investigation carried out at the site of the preferred alternative No. 3 new Amable-du-Fond River Bridge foundations and associated approach embankments.

## 2. SITE DESCRIPTION

Site photographs are included in Appendix A for illustration. The existing Highway 630 through the investigated section is presently a two-lane rural highway leading from Highway 17 to the Town of Kiosk. The two bridges are separated by a bedrock outcrop island which separates the Amable-du-Fond River into a north branch and a south branch. The Key Map provided on Drawing ADF - A1 shows approximately the four alternative alignments and preferred bridge sites.

The approximate alternative alignments are shown on Photographs 1 to 7. The new bridge will span the north branch of the Amable-du-Fond River about 7 m east of the existing structure. The ground surface along the preferred alignment is undulating and covered with cobbles and boulders and exposed rock outcrops (Photographs 2 to 7). The Highway 630 grades typically rise up from the bridges towards the north and south.

The land along the section of the Highway is forested and used locally for a few residences and community facilities. A set of railway tracks operated by the Ottawa Valley Raillink (OVR) exists about 200 m north of the bridge site.

The investigated bridge and embankment sites are located in a geological area comprising bedrock outcrops and shallow soil cover. Undulating bedrock outcrops along the river bed have produced shallow rapids and relatively fast water flow (Photographs 2 to 5 and 7). The bedrock underlying the bridge site comprises plutonic rocks (gneissic monzonitic rock with minor gneissic granitic rocks) of the Canadian Shield.

The depth of frost penetration depth for the area of the Amable-du-Fond River Bridge is 2.0 m according to the OPSD 3090.100.

## 3. INVESTIGATION PROCEDURES

The subsurface investigation was carried out during the periods from October 31 and December 14, 2006. Peto MacCallum Ltd. (PML) surveyed the exposed bedrock and investigated the soil cover over the bedrock by means of test pits. A total of 14 survey points and test pits were obtained and reported in record of borehole logs in accordance with MTO format. These boreholes were numbered from A1 to A14.

The test pits were advanced through the soil cover with a track-mounted excavator, supplied and operated by a local contractor, working under the full-time supervision of a member of our engineering staff. The test pits were extended to depths ranging from the 0.4 to 1.5 m where they terminated typically by refusal on bedrock or on very dense cobbles and boulders. The relative density of the encountered soils were assessed by probing the test pit wall to a safe depth (1.2 m), by observation of the test pits wall and by noting the relative ease of excavation.

The survey points and test pits were laid out in general accordance with the requirements noted in the Request for Proposal and as modified for the actual site conditions (outcrops) after discussions with MTO. The locations of the survey points and test pits (boreholes) are shown on the Foundation Drawing ADF-A2. PML determined the ground surface elevations at the outcrop and test pit locations in relation to a benchmark provided by DelBosco Surveying Limited. All elevations in this report are expressed in meters.

Soils were identified in accordance with the MTO Soil Classification Manual procedures. The groundwater conditions in the test pits were assessed during the digging of the test pits by visual examination of the soil and, where encountered, by measuring the groundwater level in the open boreholes. PML backfilled all of the test pits in accordance with the MTO and MOE (Reg. 903) guideline for test pit abandonment.

The recovered soil samples were returned to our laboratory for detailed visual examination and classification. The laboratory testing program consisted of two natural moisture content determinations and two grain size distribution analyses of selected soil samples. The laboratory grain size determinations are reported on Figures A-1. All of the test results are summarized on the Record of Borehole sheets.

## 4. SUMMARIZED SUBSURFACE CONDITIONS

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred soil stratigraphy, natural moisture content determinations, grain size analyses and groundwater observations.

The general stratigraphy revealed in the test pits comprised discontinuous topsoil overlying native cohesionless gravelly sand and sand and gravel overlying bedrock and boulders or extensive bedrock outcrops. All test pits terminated in the gravel and sand deposits which were considered competent soil to support the proposed embankment and bridge foundations for preliminary discussion purposes. The boundaries between soil strata were established at the borehole location only. Between and beyond the boreholes, the boundaries are assumed and may vary.

### 4.1.1 Fill

Fill was not encountered in the test pits however fill soils should be expected at the site as part of the approach embankments to the existing bridge.

### 4.1.2 Topsoil

Boreholes A-1, A-2 and A-4 encountered discontinuous layers of topsoil 200 and 300 mm thick.

### 4.1.3 Sand/Gravel/Boulders

Discontinuous cohesionless dense to very dense mixtures of sand, gravel and cobbles/boulders in varying proportions were encountered below the topsoil or at the ground surface. These soils extended to the 0.4 to 1.5 m termination depths of the test pits, elevations 171.7 to 179.8.

The grain size distribution charts of two samples of the soil cover are included as Figure A-1. The moisture content determinations on the soil samples were about from 6% to 8%.

#### 4.1.4 Bedrock

Bedrock was encountered at the surface of ten survey locations designated A-5 to A-14 approximately surveyed on the "rock island" between the bridge locations at levels ranging from elevations 175.5 to 178.2. Inferred bedrock was also found in two of the test pits (A-3 and A-4) dug on the north bank of the River at 0.4 to 0.6 m depths, elevations 171.7 and 171.9.

#### 4.1.5 Groundwater

Groundwater was not encountered during the excavation of the test pits. The groundwater at the site is expected to be governed by the level of water in the Amable–du-Fond River which was at about elevation 172.3 at the time of the investigation (December 14, 2006) near the proposed new bridge crossing.

Seasonal fluctuations and variations due to rainfall patterns affect the groundwater levels at this site.

## 5. MISCELLANEOUS

Mr. R. Mount, P. Eng and Mr. M. Rapsey supervised the subsurface investigation under the direction of Mr. C.M.P. Nascimento, P. Eng., Senior Project Engineer. T.B. Concrete and Aggregates Ltd. supplied the backhoe used for the test pits. This report was prepared by Mr. C.M.P. Nascimento, P. Eng. and reviewed by Mr. Brian R. Gray, MEng, P. Eng, MTO Designated Principal Contact.

**PART B**
**PRELIMINARY FOUNDATION DESIGN REPORT**
for
New Amable-du-Fond River Bridge – Highway 630
Calvin Township, North Bay Area – Site No. 43-085
Agreement Number 5005-E-0001
GWP No. 177-98-00

## 6. GENERAL

### 6.1 General

There are currently two existing single-lane bridges at the Highway 630 crossing of the Amable-du-Fond River about 1.4 km south of Highway 17. A new structure will replace the northernmost structure, Site No. 43-085 on a new alignment to the east of the existing bridge. This is the currently preferred alternative alignment (Alternative 3) as indicated by Stantec.

This Part B of the report provides preliminary foundation engineering recommendations regarding design and comments for construction of the northernmost new Amable–du-Fond River Bridge on Highway 630, as part of the bridge Preliminary Design. The recommendations are preliminary and based on the results of the current limited subsurface investigation, as outlined in Part A of this report. The recommendations are for planning purposes and for providing information necessary for the feasibility study. The comments on the construction aspects are to highlight those aspects that could affect the planning of the project.

The following sections of this report discuss the key issues (foundation alternatives, embankment settlement, stability and geometry, construction concerns such as groundwater control) for the proposed bridge and the proposed scope of work for the foundation investigation to be completed during Detail Design.

Table 1 contains a list of the standard specifications referenced in this report. All elevations in this report are in metres.

## 6.2 Bridge Foundation Alternatives

We understand that the preferred alternative will cross the north branch of Amable-du-Fond River about 7 m to the east of the existing bridge and anticipate that the new bridge will be a single-span structure.

For the purpose of the discussions in this report, we assumed that the top of the new bridge deck would be maintained at about the existing elevation 176.7.

The soil stratigraphy revealed in the boreholes generally indicated that the new north and south abutments will be located over bedrock outcrops overlain locally by shallow topsoil. The water level in the Amable-du-Fond River, which was at about elevation 172.3 (December 2006) likely fluctuates seasonally and determines the groundwater table at the bridge foundation site.

Founding the new north and south bridge abutments on spread footings placed on the bedrock encountered at the site is feasible. The founding level for the north abutment is near the level of the water in the Amable-du-Fond River, therefore construction of this spread footing will require the local installation of temporary cofferdams schemes to keep the founding subgrade in the dry. Alternatively, a pad of tremie concrete may be cast over the prepared rock surface to facilitate footing construction in the dry.

During detail design, the rock should be inspected by a rock specialist (geologist or rock mechanics engineer) to evaluate the depth of removal of weathered zones and the potential for damage due to joint freezing and scour.

A scheme with pile foundations at the north and south abutments for an integral abutment design alternative is also possible. However, this alternative is not recommended given the proximity of the river with potential scour concerns of the approach fill at the abutment and the required extent of rock excavation to provide the required free pile length.

We consider that drilled caissons to support the foundations are not practical for this site due to the presence of shallow bedrock.

The seismic site coefficient for the stratigraphy conditions at this site is 1.0 [soil profile Type I, Canadian Highway Bridge Design Code (CHBDC) 2006 Edition, clause 4.4.6].

### 6.3 Spread Footings

For the preliminary design of the structure abutment footings, we assumed the following preliminary reference elevations:

| Foundation Element | Subgrade Reference Elevation |
|---|---|
| North Abutment | 171.2 |
| South Abutment | 175.0 |

Notes: Allowance for a foundation frost depth is not required for footing on the bedrock. Scaling of about 0.5 m of the weathered rock allowed below the encountered rock surface.

The recommended preliminary bearing resistances for minimum 1.0 m wide footings for the abutments constructed on the unweathered bedrock are as follows:

| | |
|---|---|
| Factored Geotechnical Resistance at ULS | 10,000 kPa |
| Geotechnical Resistance at SLS | N/A |

The groundwater level will not influence the computation of the ULS resistance. The geotechnical resistance at SLS normally allows for 25 mm of total compression of the founding medium. Considering the bedrock to be unyielding, settlement criteria will not govern the design.

The recommended values apply to vertical and concentric loads only. The designer should consider the effects of inclined loads and eccentricity, as applicable.

The rock quality should be evaluated for Detail Design and, if of poor quality should be evaluated by a rock mechanic specialist to determine the requirements for rock bolting and/or protection against scour by river action.

The footings founded directly on the unweathered bedrock will not require frost protection.

The friction developed between the underside of the concrete footing and the bedrock will partly resist the lateral loads imposed on the foundations by the approach embankment fills. Rock dowels may be used for providing the additional required resistance. Calculation of these forces should be in accordance with the CHBDC. A coefficient of friction equal to 0.7 may be assumed between concrete footings and the bedrock.

## 7. NEW APPROACH EMBANKMENTS

The alignment of the south approach embankment is located on a bedrock outcrop with exposed bedrock and bedrock covered with shallow topsoil, and the north approach embankment is over very dense sand and gravel deposits containing cobbles and boulders overlying bedrock near the bridge site.

We anticipate that construction of earth or rock fill embankment for the bridge approaches and the new Highway 630 platform will be straightforward in view of the encountered subgrade conditions.

Earth or rock fill approach embankments and new embankments should be designed and constructed in accordance with OPSD 200.010, 201.010, 202.010, 202.020, 3101.150, 3101.200 and SP 206S03, as applicable. The side slopes of the approach embankments will be stable where they are inclined no steeper than 2H:1V for earth fill and 1.25H:1V for rock fill.

Since the subgrade for the new embankments comprise of unyielding bedrock or very dense sand and gravel containing boulders, settlements of the foundation subgrade will be negligible. Completion of the settlements of the cohesionless native soils will occur during construction.

Most of the settlements of the embankments constructed with granular materials will occur during construction with some 10 mm estimated adjacent to the new bridge abutments.

The earth fill slopes, if employed, should be protected against surface erosion by sodding (OPSS 571) and suitable vegetation. The new approach embankments should be protected against scour caused by the river waters (OPSS 511).

## 8. EARTH PRESSURES

The abutment walls should resist the unbalanced lateral earth pressure imposed by the backfill adjacent to the wall. The lateral earth pressure, p (kPa) may be computed using the equivalent fluid pressure diagrams presented in Section 6.9 of the CHBDC or employing the following equation.

$$p = K(\gamma h + q) + Cp + Cs$$

where K = coefficient of lateral earth pressure (dimensionless)
$\gamma$ = unit weight of free-draining granular material, $kN/m^3$
h = depth below final grade, m
q = surcharge load, kPa, if present.
Cp = compaction pressure, kPa (refer to clause 6.9.3 of CHBDC)
Cs = earth pressure induced by seismic events, kPa (refer to clause 4.6.4 of CHBDC)
where Ø = angle of internal friction of retained soil ($35^o$ for Granular A or Granular B Type II)
$\delta$ = angle of friction between the soil and wall ($23.5^o$ for Granular A or Granular B Type II)

The seismic site coefficient for the conditions at this site was provided previously (Section 6.2).

Free-draining granular material should be used as backfill behind the wall. The following parameters are recommended for design:

| PARAMETERS | GRANULAR A OR GRANULAR B TYPE II |
|---|---|
| Internal Friction Angle, Ø (degrees) | 35 |
| Unit weight, $\gamma$ ($kN/m^3$) | 22.8 |
| Coefficient of Active Earth Pressure, $K_a$ | 0.27 |
| Coefficient of Earth Pressure At Rest, $K_o$ | 0.43 |
| Coefficient of Passive Earth Pressure, $K_p$ | 3.69 |

The assigned geotechnical parameter values are the same for both granular materials in view of their similar physical characteristics.

The coefficient of earth pressure at-rest should be used for design of rigid and unyielding walls, the active earth pressure coefficient for unrestrained structures. The earth pressure coefficients should be reviewed if the slope of the backfill exceeds $10^{o}$ to the horizontal. Alternatively, the material above the top of the wall could be treated as a surcharge load (q in the preceding equation).

The magnitude of the passive resistance is dependent on the actual lateral movement of the structure toward the retained soil. We refer to Figure C6.16 of the CHBDC for this computation. The subsoil/backfill should be considered as medium dense sand for the project.

A subdrain system (SP 405F03) and/or weep holes (OPSD 3190.100) should be installed to minimize the build-up of hydrostatic pressure behind the wall. The subdrain pipes should be surrounded by a properly designed granular filter or geotextile to prevent migration of fines into the system. The drainage pipe should be installed on a positive grade and lead to a frost-free outlet.

Backfilling adjacent to retaining structures should be carried out in conformance with Ontario Provincial Standard specifications for granular backfill at abutments (OPSD 3101.150).

Operation of compaction equipment adjacent to retaining structures should be restricted to limit the compaction pressure noted in clause 6.9.3 of the CHBDC. Refer to SP 105S10 for additional information in this regard.

# 9. CONSTRUCTION CONSIDERATIONS

## 9.1 Excavation

Excavation for construction of the abutment foundations on spread footings will extend through the shallow native very dense soils containing boulders. The contract should allow for the removal/excavation of boulders.

The bedrock is classified as Type 1 soil and the very dense sand and gravel soil is classed as Type 2 soil according to Occupational Health and Safety Act (Ontario Regulation 213/91) criteria. Compact sands and the existing embankment fills should be classified as Type 3 soil. The excavations should be carried out in accordance with the soils in the slopes having the highest number. The need to excavate flatter side slopes if excessively soft/wet materials or concentrated seepage zones are encountered locally should be considered.

The cohesionless soils below the groundwater are considered as Type 4 soil if groundwater is not adequately controlled. For this condition, side slopes should be cut at 3H:1V slopes.

## 9.2 Road Protection Considerations

Should construction and traffic staging require traffic adjacent to the future excavations, it is anticipated that a suitable roadway protection scheme following SP 105S19 will be required to support the walls of the excavation and adjacent traffic lanes during construction.

Several protection scheme alternatives such as sheet piling, sheeting supported by rakers or bracing, cantilever or anchored soldier piles and lagging may be considered. It is noted however that soldier pile and lagging schemes are not considered adequate where the excavation will be carried out through embankment sand and gravel fills or cohesionless native materials in particular under the groundwater table. For preliminary design purposes, the road protection schemes should be designed for performance level 1b to prevent movement of the existing embankment. The contractor is responsible for the selection, detailed design and performance of a road protection scheme.

### 9.3 Groundwater Control Considerations

The water levels observed are close to those of the proposed founding subgrade for the north bridge abutment and may fluctuate seasonally and with precipitation patterns. In view of the proximity of the river, the use of conventional sump pumping will not be adequate to control the groundwater in the excavations and temporary cofferdams may be required. Alternatively, the founding subgrade may be covered with a layer of concrete placed following tremie methods to allow construction of the footing in the dry.

The contract documents should clearly state that groundwater control in the excavations is the contractor's responsibility.

## 10. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION

Based on the results of the site review and assuming that the new bridge will be located at the alignment investigated, the recommended additional scope of the foundation investigation is as follows:

- Boreholes should be carried out for the north and south abutment foundations for the new alignment, in accordance with the MTO standard borehole configuration for shallow foundations on bedrock.
- Boreholes should be carried out 20 m from the abutment sites for approach embankment design.
- Additional approach embankment boreholes should be provided along the preferred alignment to investigate the extent and condition of the native cohesionless soils encountered in the current investigation.

# 11. DISCUSSION OF FOUNDATION ALTERNATIVES

## 11.1 Advantages and Disadvantages of Foundation Alternatives

The following table summarizes the advantages and disadvantages and inferred risks/consequences of each of the foundation alternatives for the proposed Highway 630 northernmost bridge at Amable-du-Fond River. The pile foundation alternative is not recommended.

**ADVANTAGES AND DISADVANTAGES**

| SPREAD FOOTINGS ON NATIVE SOIL/BEDROCK | | DRIVEN PILES | |
|---|---|---|---|
| ADVANTAGES | DISADVANTAGES | ADVANTAGES | DISADVANTAGES |
| Less costly than deep foundation alternative<br><br>Conventional design and construction of foundations<br><br>Allows semi-integral abutment design | Requires ground water control to establish founding subgrade in the dry at the abutment or a tremie concrete pad | Allows integral abutment design and construction | More costly than shallow foundation alternative<br><br>Requires pre-drilling to allow pile installation through rock<br><br>Potential scour problems from river flow |

Notes: 1. Spread footings on engineered fill is not applicable at this site.
2. Driven piles include integral abutment designs. Caisson foundations were not considered practical at this site.

## 11.2 Preferred Foundation Option Considerations

From the foundation perspective the spread footings are considered feasible. The driven pile foundations are possible but impractical because of potential scour from the river flow and due to extensive rock excavation to install the piles. Spread footing foundations are considered the least costly alternative and therefore the preferred option.

The selected foundation alternative also depends on other considerations, such as structural design and road grades, which are being evaluated separately by Stantec.

## 12. CLOSURE

This preliminary design report was prepared by Mr. C. M. P. Nascimento, P.Eng., Senior Project Engineer and reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

Yours very truly,

Peto MacCallum Ltd.

C. M. P. Nascimento, P.Eng.,
Senior Project Engineer

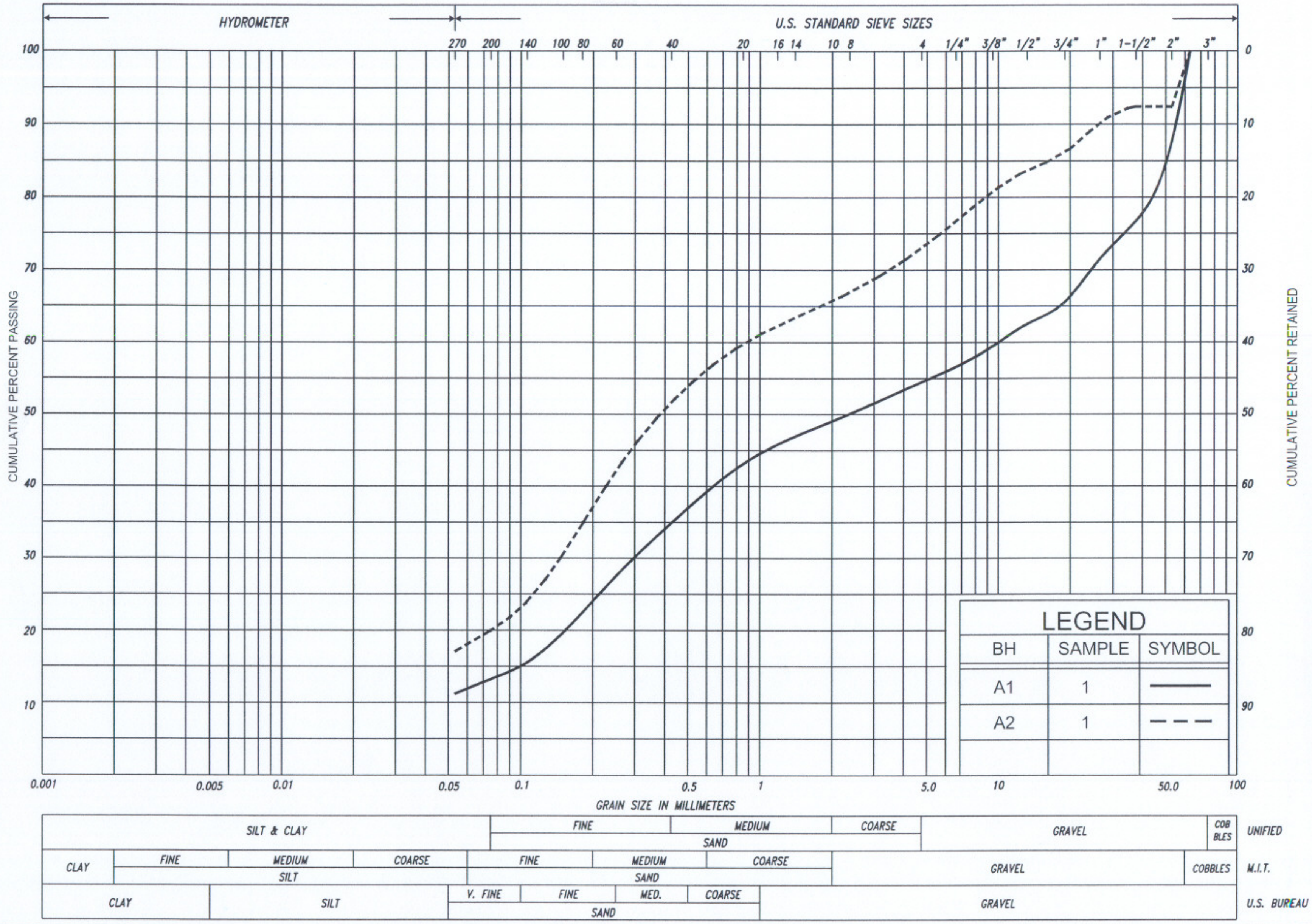
Brian R. Gray, MEng, P.Eng.
MTO Designated Principal Contact

CN/BRG:cn-mi

# TABLE 1

## LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT

| DOCUMENT | TITLE | DATE |
|---|---|---|
| OPSS 511 | Construction Specification for Rip-Rap, Rock Protection and Granular Sheeting | November 2004 |
| OPSS 571 | Construction Specification for Sodding | November 2001 |
| SP 105S10 | Construction Specification for Compaction | November 2004 |
| SP 105S19 | Construction Specification for Protection Systems | November 2006 |
| SP 206S03 | Construction Specification for Grading | November 2006 |
| SP 405F03 | Construction Specification for Pipe Subdrains | November 2006 |
| OPSD 200.010 | Earth/Shale Grading – Undivided Rural | November 2005 |
| OPSD 201.010 | Rock Grading-Undivided Rural | November 2005 |
| OPSD 202.010 | Slope Flattening Using Excess Material on Earth or Rock Embankment | November 2005 |
| OPSD 202.020 | Drainage Gap for Slope Flattening on Rock or Granular Embankment | November 2005 |
| OPSD 3090.100 | Foundation Frost Depth for Northern Ontario | November 2005 |
| OPSD 3101.150 | Minimum Granular Backfill Requirements - Abutments | November 2005 |
| OPSD 3101.200 | Rock Backfill Requirements - Abutments | November 2005 |
| OPSD 3190.100 | Retaining Wall and Abutment Wall Drain Detail | November 2005 |




Ministry of Transportation Ontario

# GRAIN SIZE DISTRIBUTION

SAND and GRAVEL to SAND with gravel
some silt, trace clay

| | |
|---|---|
| FIG No. | A-1 |
| HWY | 630 |
| G.W.P. No. | 177-98-00 |

# EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS $\bar{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475 J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH ($c_u$) AS FOLLOWS:

| $c_u$ (kPa) | 0 - 12 | 12 - 25 | 25 - 50 | 50 - 100 | 100 - 200 | >200 |
|---|---|---|---|---|---|---|
| | *VERY SOFT* | *SOFT* | *FIRM* | *STIFF* | *VERY STIFF* | *HARD* |

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

| N (BLOWS/0.3m) | 0 - 5 | 5 - 10 | 10 - 30 | 30 - 50 | >50 |
|---|---|---|---|---|---|
| | *VERY LOOSE* | *LOOSE* | *COMPACT* | *DENSE* | *VERY DENSE* |

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND / OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (R Q D), FOR MODIFIED RECOVERY, IS:

| RQD (%) | 0 - 25 | 25 - 50 | 50 - 75 | 75 - 90 | 90 - 100 |
|---|---|---|---|---|---|
| | *VERY POOR* | *POOR* | *FAIR* | *GOOD* | *EXCELLENT* |

JOINTING AND BEDDING:

| SPACING | 50mm | 50 - 300mm | 0.3m - 1m | 1m - 3m | >3m |
|---|---|---|---|---|---|
| JOINTING | *VERY CLOSE* | *CLOSE* | *MOD. CLOSE* | *WIDE* | *VERY WIDE* |
| BEDDING | *VERY THIN* | *THIN* | *MEDIUM* | *THICK* | *VERY THICK* |

## ABBREVIATIONS AND SYMBOLS

### FIELD SAMPLING

| | | | |
|---|---|---|---|
| S S | SPLIT SPOON | T P | THINWALL PISTON |
| W S | WASH SAMPLE | O S | OSTERBERG SAMPLE |
| S T | SLOTTED TUBE SAMPLE | R C | ROCK CORE |
| B S | BLOCK SAMPLE | P H | T W ADVANCED HYDRAULICALLY |
| C S | CHUNK SAMPLE | P M | T W ADVANCED MANUALLY |
| T W | THINWALL OPEN | F S | FOIL SAMPLE |
| F V | FIELD VANE | | |

### STRESS AND STRAIN

| | | |
|---|---|---|
| $u_w$ | kPa | PORE WATER PRESSURE |
| $r_u$ | 1 | PORE PRESSURE RATIO |
| $\sigma$ | kPa | TOTAL NORMAL STRESS |
| $\sigma'$ | kPa | EFFECTIVE NORMAL STRESS |
| $\tau$ | kPa | SHEAR STRESS |
| $\sigma_1, \sigma_2, \sigma_3$ | kPa | PRINCIPAL STRESSES |
| $\epsilon$ | % | LINEAR STRAIN |
| $\epsilon_1, \epsilon_2, \epsilon_3$ | % | PRINCIPAL STRAINS |
| E | kPa | MODULUS OF LINEAR DEFORMATION |
| G | kPa | MODULUS OF SHEAR DEFORMATION |
| $\mu$ | 1 | COEFFICIENT OF FRICTION |

### MECHANICAL PROPERTIES OF SOIL

| | | |
|---|---|---|
| $m_v$ | $kPa^{-1}$ | COEFFICIENT OF VOLUME CHANGE |
| $C_c$ | 1 | COMPRESSION INDEX |
| $C_s$ | 1 | SWELLING INDEX |
| $C_\alpha$ | 1 | RATE OF SECONDARY CONSOLIDATION |
| $c_v$ | $m^2/s$ | COEFFICIENT OF CONSOLIDATION |
| H | m | DRAINAGE PATH |
| $T_v$ | 1 | TIME FACTOR |
| U | % | DEGREE OF CONSOLIDATION |
| $\sigma'_{vo}$ | kPa | EFFECTIVE OVERBURDEN PRESSURE |
| $\sigma'_p$ | kPa | PRECONSOLIDATION PRESSURE |
| $\tau_f$ | kPa | SHEAR STRENGTH |
| $c'$ | kPa | EFFECTIVE COHESION INTERCEPT |
| $\phi'$ | -° | EFFECTIVE ANGLE OF INTERNAL FRICTION |
| $c_u$ | kPa | APPARENT COHESION INTERCEPT |
| $\phi_u$ | -° | APPARENT ANGLE OF INTERNAL FRICTION |
| $\tau_R$ | kPa | RESIDUAL SHEAR STRENGTH |
| $\tau_r$ | kPa | REMOULDED SHEAR STRENGTH |
| $S_t$ | 1 | SENSITIVITY $= \frac{c_u}{\tau_r}$ |

### PHYSICAL PROPERTIES OF SOIL

| | | |
|---|---|---|
| $\rho_s$ | $kg/m^3$ | DENSITY OF SOLID PARTICLES |
| $\gamma_s$ | $kN/m^3$ | UNIT WEIGHT OF SOLID PARTICLES |
| $\rho_w$ | $kg/m^3$ | DENSITY OF WATER |
| $\gamma_w$ | $kN/m^3$ | UNIT WEIGHT OF WATER |
| $\rho$ | $kg/m^3$ | DENSITY OF SOIL |
| $\gamma$ | $kN/m^3$ | UNIT WEIGHT OF SOIL |
| $\rho_d$ | $kg/m^3$ | DENSITY OF DRY SOIL |
| $\gamma_d$ | $kN/m^3$ | UNIT WEIGHT OF DRY SOIL |
| $\rho_{sat}$ | $kg/m^3$ | DENSITY OF SATURATED SOIL |
| $\gamma_{sat}$ | $kN/m^3$ | UNIT WEIGHT OF SATURATED SOIL |
| $\rho'$ | $kg/m^3$ | DENSITY OF SUBMERGED SOIL |
| $\gamma'$ | $kN/m^3$ | UNIT WEIGHT OF SUBMERGED SOIL |
| e | 1,% | VOID RATIO |

| | | |
|---|---|---|
| n | 1,% | POROSITY |
| w | 1,% | WATER CONTENT |
| $S_r$ | % | DEGREE OF SATURATION |
| $w_L$ | % | LIQUID LIMIT |
| $w_P$ | % | PLASTIC LIMIT |
| $w_S$ | % | SHRINKAGE LIMIT |
| $I_P$ | % | PLASTICITY INDEX $= w_L - w_P$ |
| $I_L$ | 1 | LIQUIDITY INDEX $= \frac{w - w_P}{I_P}$ |
| $I_C$ | 1 | CONSISTENCY INDEX $= \frac{w_L - w}{I_P}$ |
| DTPL | | DRIER THAN PLASTIC LIMIT |
| APL | | ABOUT PLASTIC LIMIT |
| WTPL | | WETTER THAN PLASTIC LIMIT |

| | | |
|---|---|---|
| $e_{max}$ | 1,% | VOID RATIO IN LOOSEST STATE |
| $e_{min}$ | 1,% | VOID RATIO IN DENSEST STATE |
| $I_D$ | 1 | DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$ |
| D | mm | GRAIN DIAMETER |
| $D_n$ | mm | n PERCENT - DIAMETER |
| $C_u$ | 1 | UNIFORMITY COEFFICIENT |
| h | m | HYDRAULIC HEAD OR POTENTIAL |
| q | $m^3/s$ | RATE OF DISCHARGE |
| v | m/s | DISCHARGE VELOCITY |
| i | 1 | HYDRAULIC GRADIENT |
| k | m/s | HYDRAULIC CONDUCTIVITY |
| j | $kN/m^3$ | SEEPAGE FORCE |

# RECORD OF BOREHOLE No A-1



**METRIC**

| | | | |
|---|---|---|---|
| G.W.P. 177-98-00 | LOCATION Highway 630 (New) Sta. 10+149 CL | | ORIGINATED BY M.R |
| DIST 54 HWY 630 | BOREHOLE TYPE Excavator | | COMPILED BY M.R |
| DATUM Geodetic | DATE December 14, 2006 | | CHECKED BY C.N |

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100) | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 181.3 | Ground surface | | | | | * | | | | | |
| 0.0 | Topsoil | | | | | | | | | | |
| 0.2 | Sand and gravel some silt, trace clay boulders | | 1 | CS | - | | 181 | | o | | 46 41 (13) |
| | Dense — Rusty brown to grey — Moist | | | | | | | | | | |
| 179.8 / 1.5 | Very dense — grey | | | | | | 180 | | | | |
| | End of borehole | | | | | | | | | | |
| | Practical refusal to excavate due to extremely dense soils | | | | | | | | | | |
| | NOTE: The relative density of the deposit was assessed by probing and visual methods. | | | | | | | | | | |

* Borehole dry

Upon completion of excavation moderate caving of sidewalls



+7, ×5: Numbers refer to Sensitivity — 20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

**Peto MacCallum Ltd.**
Foundation Design

# RECORD OF BOREHOLE No A-2

 **METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+123.5 CL ORIGINATED BY M.R

DIST 54 HWY 630 BOREHOLE TYPE Excavator COMPILED BY M.R

DATUM Geodetic DATE December 14, 2006 CHECKED BY C.N

| ELEV DEPTH | DESCRIPTION | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | NATURAL MOISTURE CONTENT w (%) | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|
| 179.8 | Ground surface | | | | * | | | |
| 0.0 | Topsoil | | | | | | | |
| 0.3 | Sand and gravel trace silt | | | | | | | |
| 178.9 | Dense, Rusty brown, Moist | | | | | 179 | | |
| 0.9 | Sand with gravel some silt, trace clay boulders | 1 | GS | | | | o | 27 53 (20) |
| 178.3 / 1.5 | Very dense, Grey, Moist | | | | | | | |

End of Borehole

Practical refusal to excavate due to extremely dense soils.

NOTE:
The relative density of the deposit was assessed by probing and visual methods.

* Borehole dry

Upon completion of excavation moderate caving of sidewalls

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT $W_P$, NATURAL MOISTURE CONTENT W, LIQUID LIMIT $W_L$; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³



+7, ×5: Numbers refer to Sensitivity    20 / 15–○–5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

Peto MacCallum Ltd.
Foundation Design

# RECORD OF BOREHOLE No A-3



METRIC

| | | | |
|---|---|---|---|
| G.W.P. 177-98-00 | LOCATION Highway 630 (New) Sta.10+059.5 CL | | ORIGINATED BY M.R |
| DIST 54 | HWY 630 | BOREHOLE TYPE Excavator | COMPILED BY M.R |
| DATUM Geodetic | | DATE December 14, 2006 | CHECKED BY C.N |

| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE) 20 40 60 80 100 | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.3 | Ground surface | | | | | | | | | | |
| 0.0<br>171.9<br>0.4 | Cobbles and boulders some sand, trace silt<br>Dense Brown Wet | | | | | | 172 | | | | |
| | End of borehole<br><br>Refusal to excavate on bedrock or large boulders<br><br>NOTE:<br>The relative density of the deposit was assessed by probing and visual methods.<br><br>* Borehole dry | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 7/24/2007 1:19:00 PM

+[7], ×[5]: Numbers refer to Sensitivity

20 / 15 —o— 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

**Peto MacCallum Ltd.**
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# RECORD OF BOREHOLE No A-4



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+045.5 CL ORIGINATED BY M.R

DIST 54 HWY 630 BOREHOLE TYPE Excavator COMPILED BY M.R

DATUM Geodetic DATE December 14, 2006 CHECKED BY C.N

| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.3 | Ground surface | | | | | | | | | | |
| 0.0 | Topsoil | | | | | | 172 | | | | |
| 0.3 | | | | | | | | | | | |
| 171.7 / 0.6 | Sand and gravel with boulders, trace silt<br>Very dense Brown Moist | | | | | | | | | | |
| | End of borehole<br>Refusal to excavate on bedrock or large boulders<br>NOTE: The relative density of the deposit was assessed by probing and visual methods.<br>* Borehole dry | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 7/24/2007 1:19:01 PM

$+^7, \times^5$: Numbers refer to Sensitivity

20 / 15 –○– 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

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Foundation Design

# RECORD OF BOREHOLE No A-5



METRIC

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+027, o/s 3.0m Rt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $W_P$ NATURAL MOISTURE CONTENT W LIQUID LIMIT $W_L$ / WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| 175.5 | Ground surface | | | | | * | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |



$+^7$, $\times^5$ : Numbers refer to Sensitivity

20 / 15 —○— 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No A-6



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+019, o/s 3.0m Rt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100) | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | | | | | |
| 176.5 | Ground surface | | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 4/24/2007 4:22:59 PM

+7, ×5: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No A-7



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+015.5, o/s 6.0m Rt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100) | PLASTIC LIMIT $W_P$ — NATURAL MOISTURE CONTENT W — LIQUID LIMIT $W_L$ / WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | | | | | |
| 176.2 | Ground surface | | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | | |



$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No A-8

 **METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+015.5, o/s 3.0m Rt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | SAMPLES | | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $W_P$ NATURAL MOISTURE CONTENT W LIQUID LIMIT $W_L$ / WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | | | | |
| 176.7 | Ground surface | | | | | | | | | | |
| 0.0 | Bedrock at Surface | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 4/24/2007 4:23:01 PM

$+^7, \times^5$: Numbers refer to Sensitivity     20 / 15 —○— 5 / 10 (%) STRAIN AT FAILURE

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# RECORD OF BOREHOLE No A-9



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+012, CL ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100 | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | | | | | |
| 177.2 | Ground surface | | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | | |
| | Borehole dry | | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 4/24/2007 4:23:02 PM

$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

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# RECORD OF BOREHOLE No A-10



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+004, o/s 8.0m Rt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | SAMPLES | | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE (20 40 60 80 100) | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV / DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | | | | |
| 178.2 | Ground surface | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |



$+^7$, $\times^5$: Numbers refer to Sensitivity

20 / 15—○—5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

Peto MacCallum Ltd.
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# RECORD OF BOREHOLE No A-11



**METRIC**

G.W.P. 177-98-00 | LOCATION Highway 630 (New) Sta. 10+004 CL | ORIGINATED BY R.M.

DIST 54 HWY 630 | BOREHOLE TYPE Manual | COMPILED BY N.S.B.

DATUM Geodetic | DATE October 31, 2006 | CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 20 40 60 80 100 | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | |
| 177.6 | Ground surface | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 4/24/2007 4:22:50 PM

$+^{7}$, $\times^{5}$: Numbers refer to Sensitivity

20 / 15 – 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

**Peto MacCallum Ltd.** Foundation Design

# RECORD OF BOREHOLE No A-12



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+001, o/s 5.0m Lt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) (20 40 60 80 100) | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT W / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS * | ELEVATION SCALE | | | | |
| 177.2 | Ground surface | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | |
| | * Borehole dry | | | | | | | | | | |

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 4/24/2007 4:22:51 PM

$+^7, \times^5$: Numbers refer to Sensitivity

20 / 15 — 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

**Peto MacCallum Ltd.**
Foundation Design

# RECORD OF BOREHOLE No A-13



**METRIC**

G.W.P. 177-98-00 LOCATION Highway 630 (New) Sta. 10+000, o/s 8.0m Rt. ORIGINATED BY R.M.

DIST 54 HWY 630 BOREHOLE TYPE Manual COMPILED BY N.S.B.

DATUM Geodetic DATE October 31, 2006 CHECKED BY C.N

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE (20 40 60 80 100) | PLASTIC LIMIT $W_P$ / NATURAL MOISTURE CONTENT $W$ / LIQUID LIMIT $W_L$ — WATER CONTENT (%) (20 40 60) | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * | | | | | |
| 176.7 | Ground surface | | | | | | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | |

* Borehole dry

ON_MOT VER3 06TF056-2.GPJ ON_MOT.GDT 4/24/2007 4:22:52 PM

+7, X5: Numbers refer to Sensitivity

20 / 15 –O– 5 / 10 (%) STRAIN AT FAILURE

Ministry of Transportation Ontario

Peto MacCallum Ltd.
Foundation Design

# RECORD OF BOREHOLE No A-14



**METRIC**

| | | | | | |
|---|---|---|---|---|---|
| G.W.P. | 177-98-00 | LOCATION | Highway 630 (New) Sta. 10+000, o/s 4.0m Lt. | ORIGINATED BY | R.M. |
| DIST 54 | HWY 630 | BOREHOLE TYPE | Manual | COMPILED BY | N.S.B. |
| DATUM | Geodetic | DATE | October 31, 2006 | CHECKED BY | C.N |

| ELEV / DEPTH | SOIL PROFILE: DESCRIPTION | STRAT PLOT | SAMPLES: NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE) 20 40 60 80 100 | PLASTIC LIMIT $W_P$, NATURAL MOISTURE CONTENT W, LIQUID LIMIT $W_L$; WATER CONTENT (%) 20 40 60 | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 177.3 | Ground surface | | | | | * | | | | | |
| 0.0 | Bedrock at surface | | | | | | | | | | |

* Borehole dry



$+^7, \times^5$: Numbers refer to Sensitivity

20 / 15 —○— 5 / 10 (%) STRAIN AT FAILURE

# METRIC

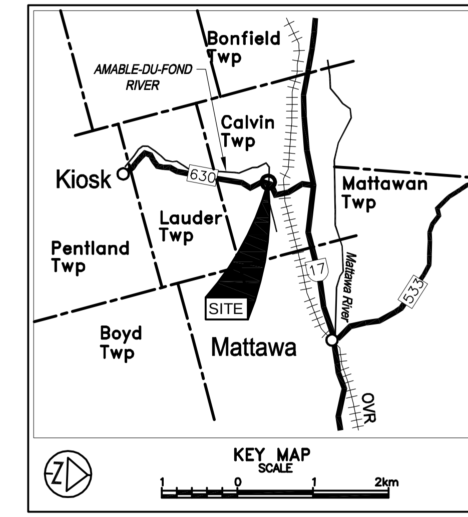
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES

CONT No
GWP No 177-98-00

AMABLE-DU-FOND RIVER BRIDGE
HIGHWAY 630
KEY PLAN

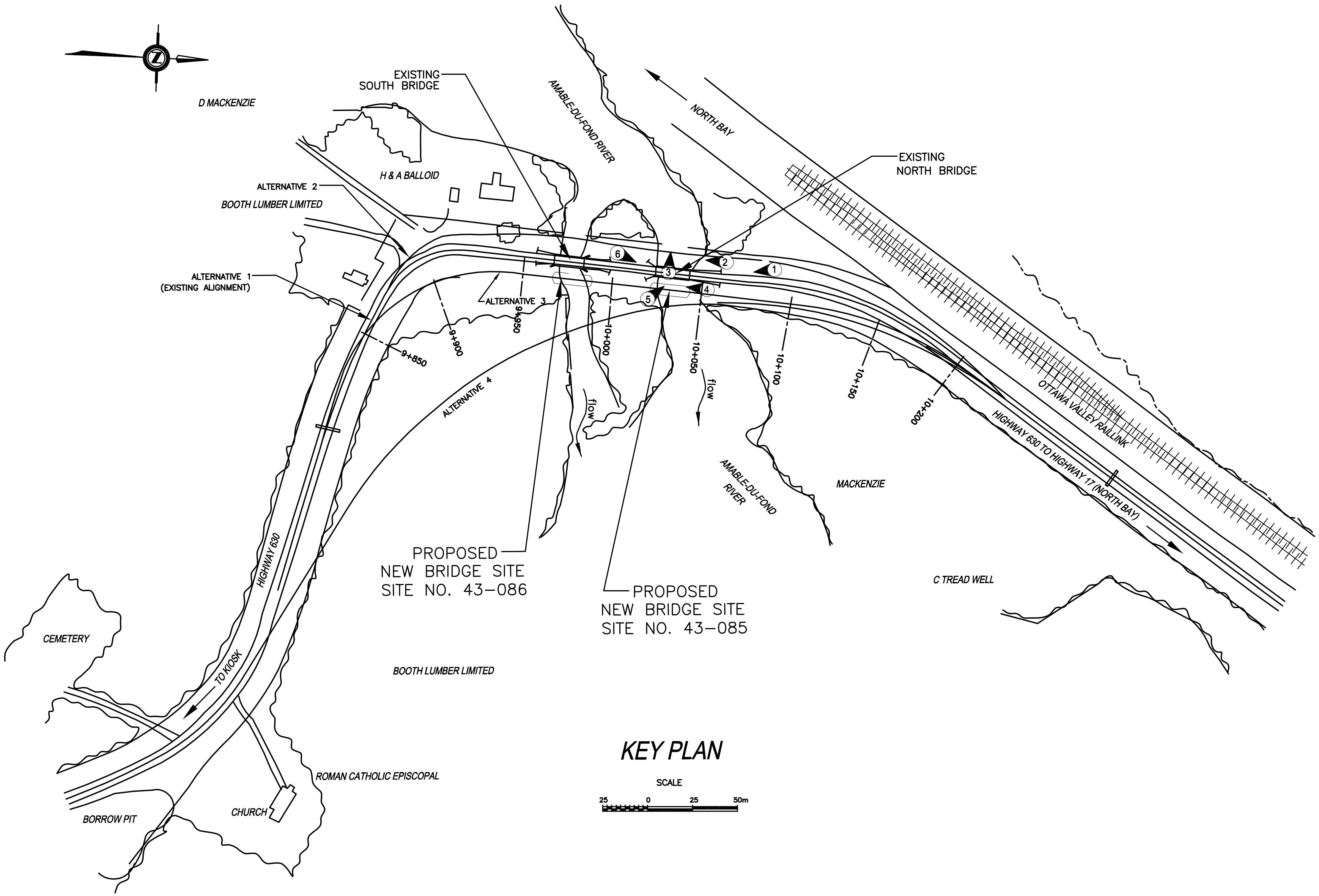
SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS




LEGEND

Photograph location and view direction




## KEY PLAN

SCALE
25 0 25 50m

NOTES:

1. REFER TO DRAWING ADF-A-2 FOR BOREHOLE LOCATIONS PLAN.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF. No.: 612_base_137_88_00-Amable Plan received in pdf format from Stantec Consulting Ltd. dated October 27, 2006

| REVISIONS | DATE | BY | DESCRIPTION |
|---|---|---|---|

Geocres No. 31L-109

| | | | | | |
|---|---|---|---|---|---|
| HWY No 630 | | | | DIST | SUDBURY |
| SUBM'D GD | CHECKED CN | DATE JULY 16, 2007 | | SITE | 43-085 |
| DRAWN NA | CHECKED CN | APPROVED BRG | | DWG | ADF-A-1 |

# METRIC

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

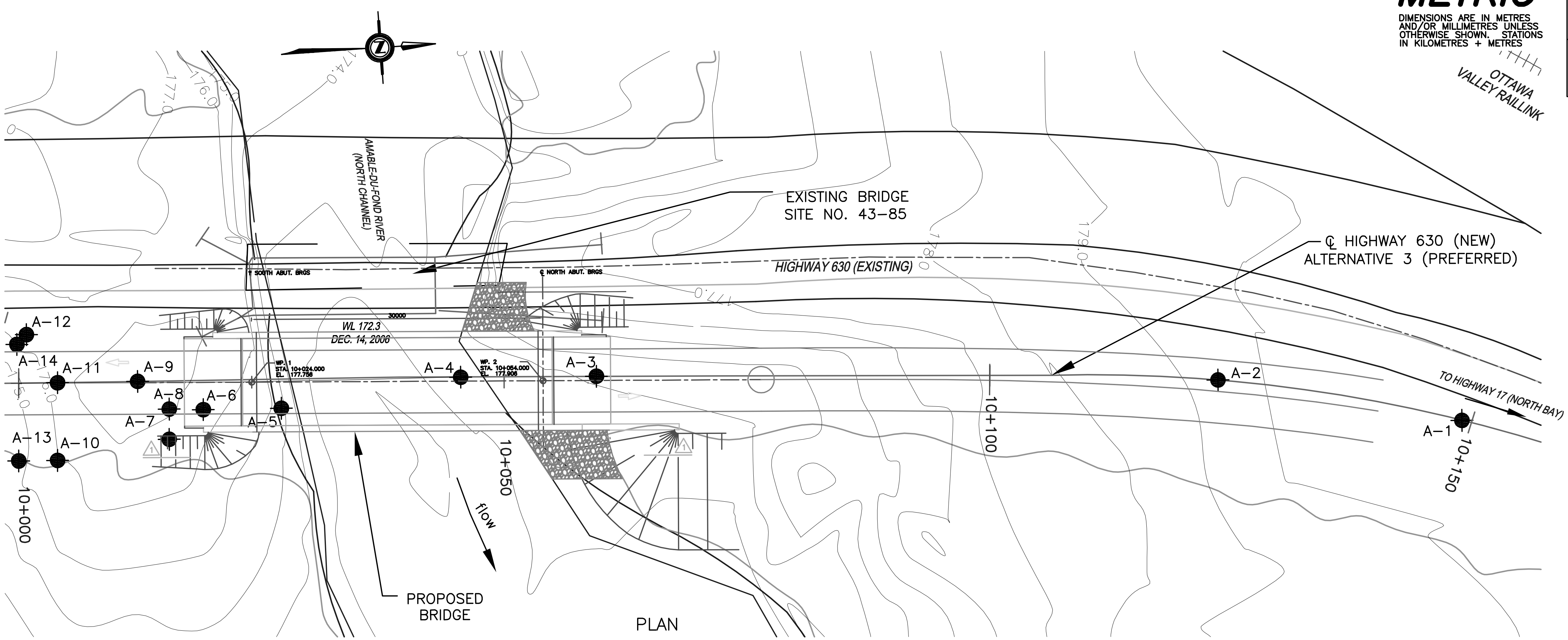
CONT No

GWP No 177-98-00

AMABLE-DU-FOND RIVER BRIDGE
HIGHWAY 630
BOREHOLE LOCATIONS

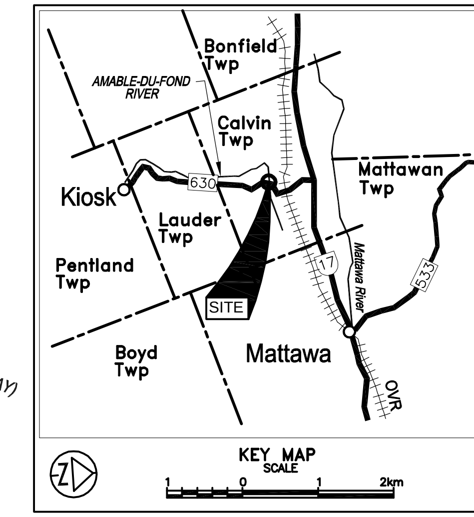
SHEET

Peto MacCallum Ltd.
CONSULTING ENGINEERS




PLAN

SCALE 5 0 5 10m



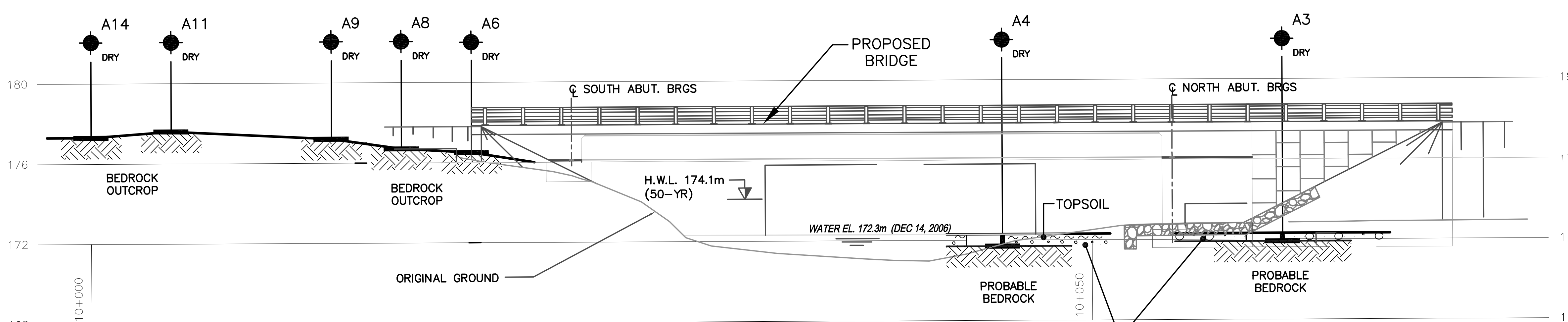

KEY MAP

SCALE 1 0 1 2km

**LEGEND**

| Symbol | Description |
|---|---|
| | Borehole |
| | Dynamic Cone Penetration Test (Cone) |
| | Borehole & Cone |
| N | Blows/0.3m (Std. Pen Test, 475 J / blow) |
| CONE | Blows/0.3m (60° Cone, 475 J / blow) |
| | W L at time of investigation DEC 2006 |

| BH No | ELEVATION | STA. | o/s CL |
|---|---|---|---|
| A-1 | 181.3 | 10+149 | CL |
| A-2 | 179.8 | 10+123.5 | CL |
| A-3 | 172.8 | 10+059.5 | CL |
| A-4 | 172.3 | 10+045.5 | CL |
| A-5 | 175.5 | 10+027 | 3.0m Rt. |
| A-6 | 176.5 | 10+019 | 3.0m Rt. |
| A-7 | 176.2 | 10+015.5 | 6.0m Rt. |
| A-8 | 176.7 | 10+015.5 | 3.0m Lt. |
| A-9 | 177.2 | 10+012 | CL |
| A-10 | 178.2 | 10+004 | 8.0m Rt. |
| A-11 | 177.6 | 10+004 | CL |
| A-12 | 177.2 | 10+001 | 5.0m Lt. |
| A-13 | 176.7 | 10+000 | 8.0m Rt. |
| A-14 | 177.3 | 10+000 | 4.0m Lt. |




(EAST SIDE VIEW 1-1 SHOWN)

℄ PROFILE HWY 630 (NEW)

SCALE 2.5 0 2.5 5m


**– NOTE –**
The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

| REVISIONS | | |
|---|---|---|
| AUG.13/07 | CN | PROFILE ADDED |
| DATE | BY | DESCRIPTION |

NOTES:

1. REFER TO DRAWING ADF-A-1 FOR KEY PLAN.
2. THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.

REF. No.: 612_base_137_88_00-Amable Plan received in pdf format from Stantec Consulting Ltd. dated October 27, 2006

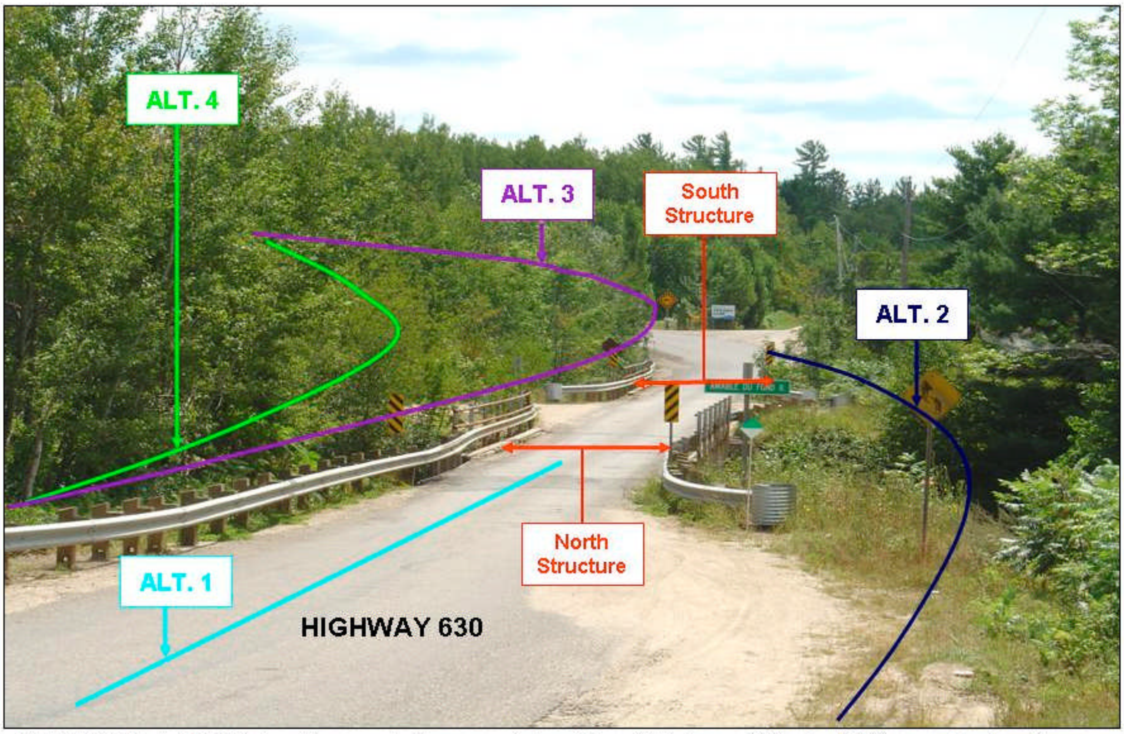
Geocres No. 31L-109

| | | | | | |
|---|---|---|---|---|---|
| HWY No | 630 | | | DIST | SUDBURY |
| SUBM'D | GD | CHECKED CN | DATE JULY 16, 2007 | SITE | 43-085 |
| DRAWN | NA | CHECKED CN | APPROVED BRG | DWG | ADF-A-2 |

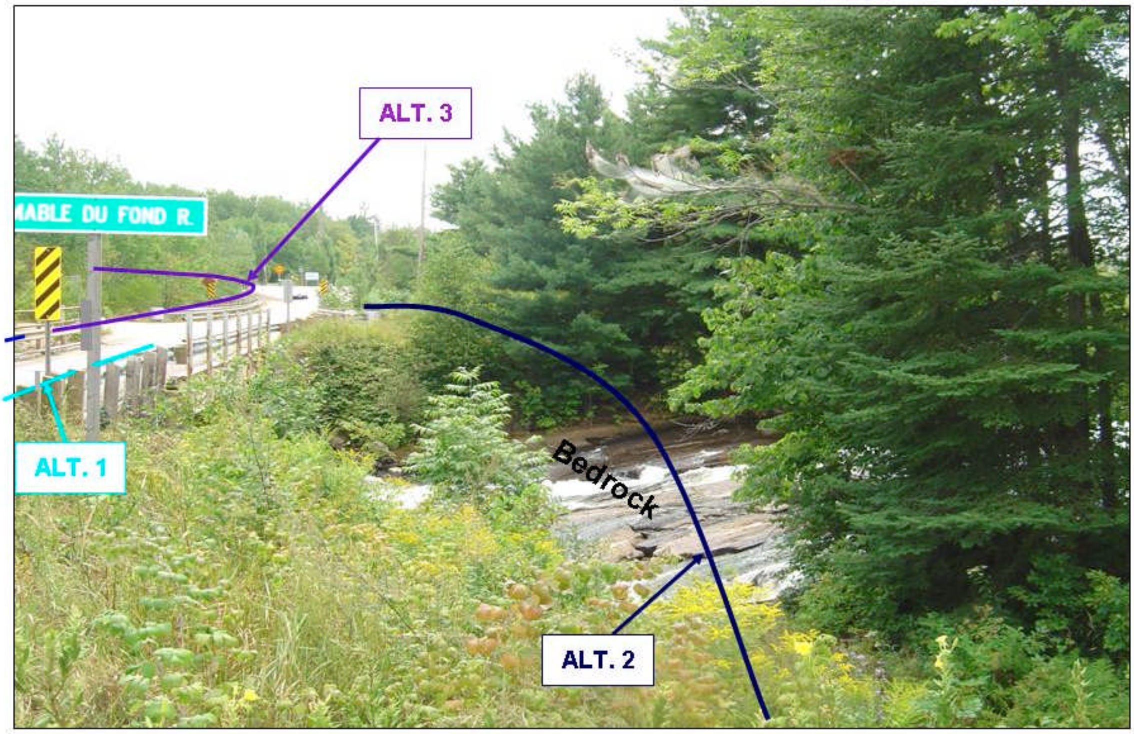
# APPENDIX A

Site Photographs

# AMABLE-DU-FOND RIVER BRIDGE (NORTH)



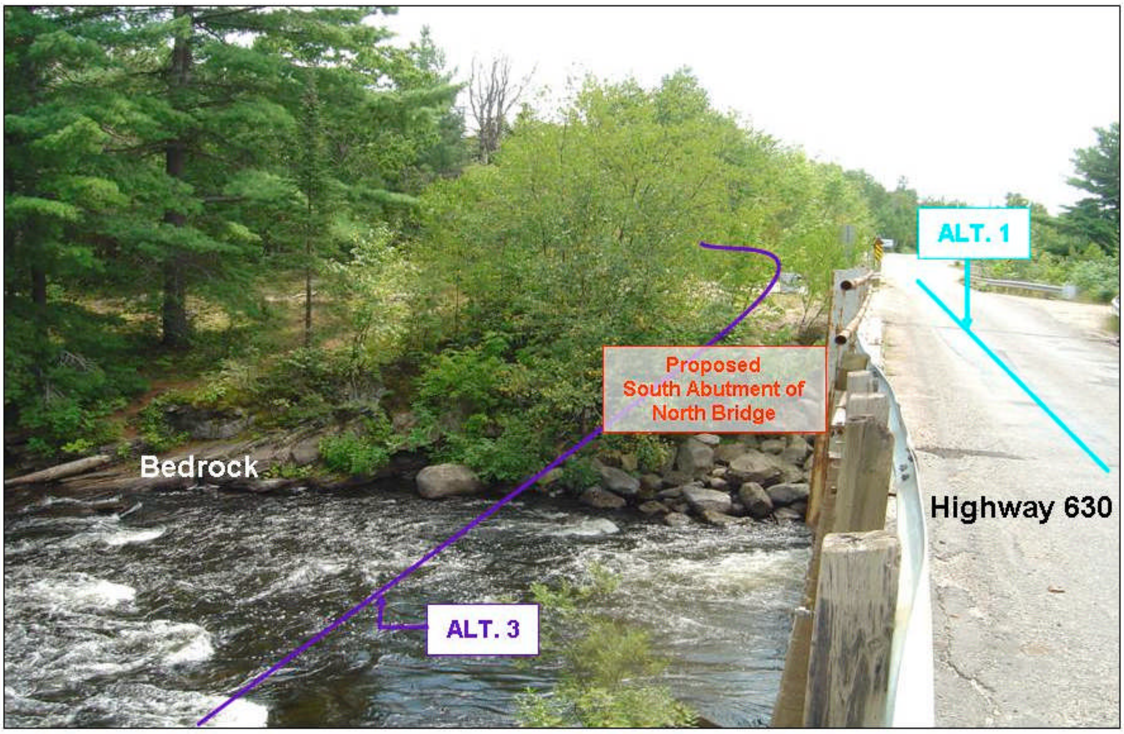

**Photograph 1** VIEW: Looking south from west shoulder of Highway 630 about 30 m north of northern single lane Amable-du-Fond River Bridges. Alignment alternatives 1 (existing alignment), 2 (west side) and 3 and 4 (both east side) are shown. Alternative 3 is the preferred alignment. (August 17, 2006)




**Photograph 2** VIEW: Looking south from west side of north Amable-du-Fond River Bridge about 10 m west of Highway 630. Bedrock identified in river bed. (August 17, 2006)

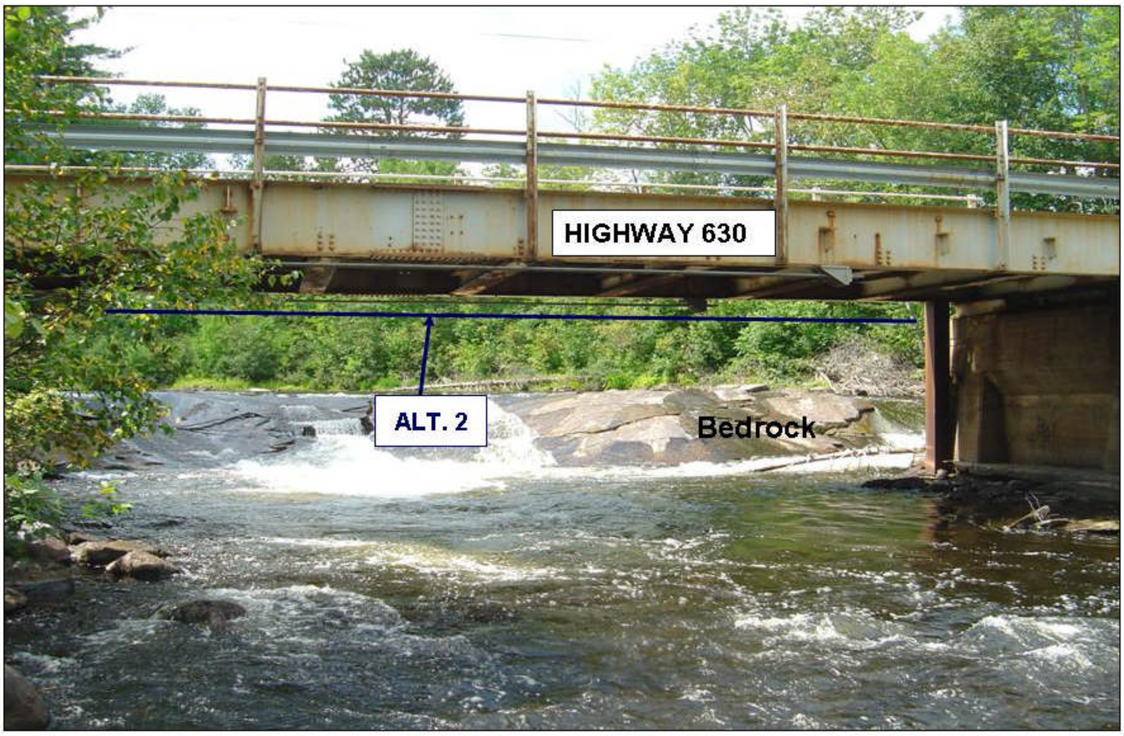
# AMABLE-DU-FOND RIVER BRIDGE (NORTH)


**Photograph 3** VIEW: Looking west from west side of deck of Highway 630 north bridge over Amable-du-Fond River. (August 17, 2006)

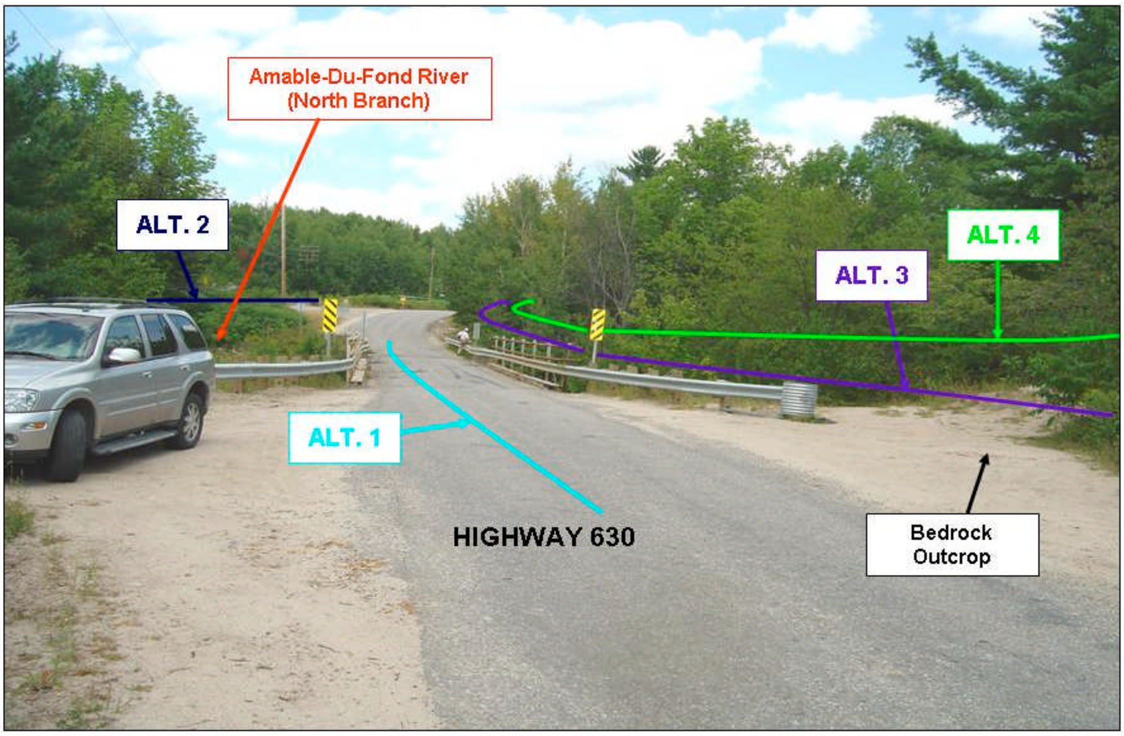



**Photograph 4** VIEW: Looking south from east side of north abutment of north Amable-du-Fond River Bridge. Alternative 3 is the preferred alignment. (August 17, 2006)

# AMABLE-DU-FOND RIVER BRIDGE (NORTH)

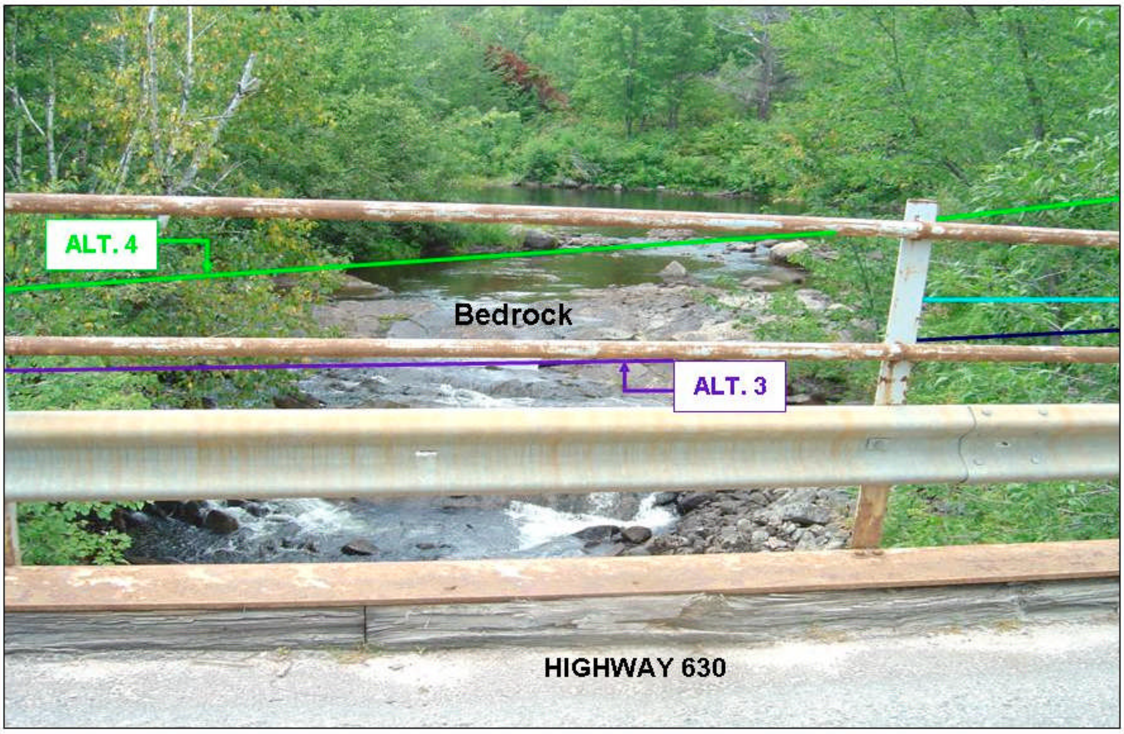



**Photograph 5** VIEW: Looking west from south bank of Amable-du-Fond River about 10 m downstream from north bridge structure. (August 17, 2006)




**Photograph 6** VIEW: Looking north from west shoulder of Highway 630 at island between the bridge structures spanning the Amable-du-Fond River. (August 17, 2006)

## AMABLE-DU-FOND RIVER BRIDGE (NORTH)




**Photograph 7** VIEW: Looking east (downstream) from east side of middle of northern Amable-du-Fond River Bridge. (August 17, 2006)