



**PRELIMINARY FOUNDATION INVESTIGATION AND DESIGN REPORT  
for**

**JUNCTION CREEK BRIDGE WESTBOUND  
SITE NO. 46-281/2  
HIGHWAY 17 SUDBURY SOUTHWEST BYPASS FOUR-LANING  
CITY OF GREATER SUDBURY  
GWP 5825-05-00  
TOWNSHIP OF WATERS  
DISTRICT 54, SUDBURY, ONTARIO**

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**PART A**  
**PRELIMINARY FOUNDATION INVESTIGATION REPORT**  
for  
Junction Creek Bridge Westbound  
Highway 17 Sudbury Southwest Bypass Four-Laning  
Site No. 46-281/2  
City of Greater Sudbury  
GWP 5825-05-00  
Township of Waters  
District 54, Sudbury, Ontario

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**1. INTRODUCTION**

This report summarizes the results of the preliminary foundation investigation carried out for the proposed Junction Creek Bridge at the future Highway 17 westbound lanes, in the City of Greater Sudbury, Ontario. Peto MacCallum Ltd. (PML) conducted the investigation for Stantec Consulting Ltd. (Stantec) on behalf of the Ministry of Transportation of Ontario (MTO).

The proposed new bridge will carry the future Highway 17 westbound lanes over the Junction Creek. Stantec provided a preliminary layout and ground surface profile for the proposed structure. The existing bridge will carry the eastbound traffic for the future four-laning of the Highway 17.

A previous foundation investigation for the existing Junction Creek Bridge was obtained from the MTO GEOCRES library. This investigation was carried out in January and February 1972 under W.O. No. 72-11011 and W.P. No. 911-71-01. Copies of the previous Record of Borehole logs and the Foundation Drawing No. 72-11011A are enclosed in Appendix A for reference.

This report provides preliminary subsurface information pertaining to the proposed westbound bridge foundations and approach embankments within about 20 m of the abutments.

**2. SITE DESCRIPTION AND GEOLOGY**

The contemplated structure is located about 40 m north of the existing Junction Creek Bridge. The site is about 1,500 m east of the existing interchange of Highway 17 and Sudbury Municipal Road 55 (Middle Junction).





Land use in the vicinity of the site comprises the existing Junction Creek Bridge to the south and a recreational nature trail on the east bank of the Creek where an abandoned sand and gravel pit is also present. The existing Junction Creek Bridge is a three span structure about 55 m long (21 m centre span with two 17 m end spans) and 11 m wide carrying two lanes of Highway 17 traffic. Photographs of the existing bridge and proposed bridge location are enclosed in Appendix B.

Topographically, the structure site is located on undulating terrain with an about 120 m wide valley cut by the Junction Creek. The Junction Creek is about 4.5 m wide (typically 1 to 1.5 m deep) flows north-south from Kelley Lake through the existing Junction Creek Bridge. The ground cover comprises grasses, bush and stands of mature trees. The top of the west bank of the Junction Creek is treed and about 14 m high over the creek bed. The east bank is grass covered and is flatter and lower than the west bank for a distance of about 120 m from the east margin of the creek from where the ground rises easterly to levels above the existing Highway 17 pavement.

The site is located within the Hough Lake Group of the Huronian Supergroup of the Canadian Shield. The typical rock types in the general project area are argillite, siltstone and greywacke of the Pecors Formation. The soil/bedrock interface is typically at variable depths. However, a prominent bedrock outcrop is present in the area of the west pier and west abutment of this structure (Photographs 2 and 3).

### **3. INVESTIGATION PROCEDURES**

The field subsurface investigation was carried out on May 2 and 3, 2007. The investigation included two boreholes, which were identified with the prefix L1. The boreholes were drilled to depths of 3.4 and 11.9 m at the locations shown on Drawing L1-1. Further details are summarized in the following table.

| Junction Creek<br>Bridge | LOCATION      | BOREHOLE<br>NO. | DEPTH (m) |                             |       |
|--------------------------|---------------|-----------------|-----------|-----------------------------|-------|
|                          |               |                 | AUGER     | ROCK<br>CORE <sup>(1)</sup> | TOTAL |
|                          | West Pier     | L1-1            | -         | 3.4                         | 3.4   |
|                          | East abutment | L1-2            | 8.8       | 3.1                         | 11.9  |

(1) NQ diamond rock coring equipment



Del Bosco Surveying Ltd. laid out and surveyed the borehole locations. PML cleared the locations of the boreholes for the presence of underground services and utilities. The elevations in this report are expressed in metres.

The boreholes were advanced using continuous flight hollow stem augers, powered by a track mounted CME-55 drill rig, supplied and operated by a specialist drilling contractor, working under the full-time supervision of a Field Supervisor from the PML engineering staff.

Representative samples of the soils were recovered in the boreholes at frequent depth intervals of 0.75 and 1.5 m for the borehole L1-2. The soil samples were obtained using a split spoon sampler in conjunction with Standard Penetration Tests (SPT). Due to numerous boulders, borehole L1-2 had to be advanced using NQ diamond drilling and wash boring techniques from 7.4 to 8.8 m. The boreholes were extended 3.1 and 3.4 m into the bedrock using NQ diamond rock coring equipment. The PML geologist examined the recovered rock core samples and detailed descriptions are provided in Table A. Photographs of the rock cores recovered in the two boreholes are enclosed in Appendix C.

The groundwater conditions at the borehole locations were assessed during drilling by visual examination of soil, the sampler and drill rods as the samples were retrieved and, when appropriate, by measurement of the water level in the open boreholes. The water level observations are noted on the attached Record of Borehole sheets.

All boreholes were backfilled in accordance with the MTO guidelines and MOE Reg. 903 for borehole abandonment procedures using a bentonite/cement mixture grout.

Soils were identified in the field in accordance with the MTO Soil Classification procedures. Recovered soil samples were returned to our laboratory for detailed visual examination, soil classification and laboratory testing. The laboratory test program included the following tests:

- Natural moisture content determinations (5)
- Grain Size analyses (2)
- Atterberg limits tests (1)



The results of the laboratory natural moisture content determinations, grain size analyses and Atterberg limits are shown on the Record of Borehole sheets. The grain size distribution charts are presented on Figures GS-L1-1 and GS-L1-2. The Atterberg limits are plotted on Figure PC-L1-1.

#### **4. SUMMARIZED SUBSURFACE CONDITIONS**

##### **4.1 General**

Refer to the attached Record of Borehole sheets L1-1 and L1-2 and previous boreholes 1 to 7, 9 and 10 (in Appendix A) for the details of the general subsurface conditions at the site including soil classifications, inferred stratigraphy, soil and rock boundary levels and groundwater observations.

The current and previous borehole locations and the preliminary layout of the proposed Junction Creek Bridge Westbound as well as the longitudinal soil profile are presented on Drawing L1-1.

The soil and bedrock stratigraphy encountered in the current boreholes are generally consistent with the previous boreholes which were drilled about 30 to 40 m to the south. Some differences are outlined on the following paragraphs.

The soil stratigraphy in the borehole drilled at the east abutment (Borehole L1-2) consists of units of surficial fill overlying cohesive clayey silt underlain by cohesionless silts which are in turn underlain by sand locally containing cobbles and boulders extended to argillite bedrock at depth of 8.8 m (elevation 236.7). The previous investigation indicated that the existing east abutment (constructed between Boreholes 9 and 10) encountered a single layer of 10.1 m thick cobbles and boulders extending to bedrock which was encountered at 10.1 m depth (elevation 235.4) in borehole 9. Borehole 10 drilled for the existing east approach embankment was terminated at 1.6 m depth (elevation 244.8) within the layer of cobbles and boulders.

Boreholes were not carried out at the east pier location of the future Junction Creek Bridge Westbound. The east pier site of the existing bridge (Boreholes 6 and 7) was underlain by a layer



of cobbles and boulders mixed with gravel and silty sand extending to bedrock. Bedrock was present at depths of 3.1 and 3.7 m (elevations 240.3 and 239.5).

Bedrock outcrops are/were present at the proposed and existing west pier (Boreholes L1-1, 4 and 5) on the west bank of the Junction Creek as depicted on photographs 2 and 3 included in Appendix B. The bedrock surface levels at the proposed west pier (elevation 246.4) and existing west pier locations (elevations 243.7 and 244.8) vary from 1.6 to 2.7 m.

It is also noted that boreholes were not carried out at the proposed west abutment location. The previous soil cover at the existing west abutment consists of shallow units of topsoil or silty sand or compact to very dense cohesionless sandy silt to silt (Boreholes 2 and 3). Bedrock was encountered at 0.3 m depth (elevations 246.7 and 247.1) in the boreholes 2 and 3. The previous borehole 1 drilled for the existing west approach embankment was terminated at 11.3 m depth (elevation 247.6). It can be seen from photographs 2 and 3 that this bedrock outcrop extends northerly to the west pier and abutment locations.

The soil strata encountered in boreholes L1-1 and L1-2 drilled at the future Junction Creek Bridge Westbound are summarized in the following sections.

#### **4.2 Fill**

A 0.2 m thick surficial fill consisting of sand and gravel with clayey silt and topsoil inclusions likely associated with the construction of the existing nature trail was encountered in borehole L1-2. The fill unit extended to elevation 245.3.

#### **4.3 Clayey Silt**

A deposit of cohesive clayey silt containing scattered thin layers of silt is present below the surficial layer of fill and extends to a depth of 2.4 m, elevation 243.1. The deposit is soft to firm, based on standard penetration N values ranging from 3 to 8.



The grain size distribution chart of one representative sample of the clayey silt is shown on Figure GS-L1-1 and the Atterberg limit on the Plasticity Chart Figure PC-L1-1. The liquid limit of the clayey silt was 26 and the plastic limit 17 giving a plasticity index of 9. Water content determinations in the clayey silt ranged from 22 to 30%.

#### **4.4 Sandy Silt**

Below the cohesive soils, cohesionless deposits of sandy silt with gravel, trace clay containing cobbles locally occurs in borehole L1-2 at a depth of 2.4 m, elevation 243.1. The sandy silt layer extended to an underlying sand deposit at a depth of 3.8 m, elevation 241.7. The sandy silt deposit was in a dense condition, with N values of 37 and 55.

The grain size distribution chart of a representative sample of the sandy silt is shown on Figure GS-L1-2. The water content of one sandy silt sample was 12%.

#### **4.5 Sand**

A 5.0 m thick stratum of sand trace silt trace clay locally containing numerous cobbles and boulders is present below the sandy silt at 3.8 m, elevation 241.7, and extends to the underlying bedrock at 8.8 m, elevation 233.6 in borehole L1-2 drilled at the east abutment. The sand unit typically exhibits a compact/dense relative density, based on N values of 10 and 36 blows. The water content of one sand sample was 14%.

#### **4.6 Bedrock**

Bedrock consisting of argillite was encountered at surface in borehole L1-1 and below the sand deposit in the borehole L1-2. At the structure foundation locations, the bedrock was cored for 3.1 and 3.4 m at following levels:

| LOCATION      | BOREHOLE NO. | DEPTH (m) | BEDROCK ELEVATION | ROCK CORE LENGTH <sup>(1)</sup> |
|---------------|--------------|-----------|-------------------|---------------------------------|
| West Pier     | L1-1         | 0.0       | 246.4             | 3.4                             |
| East abutment | L1-2         | 8.8       | 236.7             | 3.1                             |

(1) NQ diamond rock cores obtained.



Based on visual observation, the west abutment of the new bridge is located over the extensive rock outcrop encountered at the west pier location. The bedrock at the west abutment location is estimated to be at elevation 250.4 based on the available survey data.

The core recovery was 92 to 100% for the core samples. The rock exhibited a high strength and was found to be unweathered. The rock is of fair to excellent quality with Rock Quality Designation (RQD) values typically ranging from 51 to 100%. The detailed rock core descriptions are provided on Table A and representative photographs of the cores are shown in Appendix C.

#### **4.7 Groundwater**

Groundwater was observed during drilling at a depth of 2.4 m, elevation 242.1 in borehole L1-2 (east abutment). It is noted that the water level at the site is influenced by the water level in the Junction Creek. At the time of the investigation, the water level in the creek was estimated to be at about elevation 242.9.

The groundwater levels are subjected to fluctuations due to seasonal and rainfall patterns.

#### **5. MISCELLANEOUS**

The field work was carried out under the supervision of Mr. F. Portela, Senior Field Supervisor, and direction of Mr. C.M.P. Nascimento, P.Eng., Senior Foundation Engineer. Walker Drilling Ltd. supplied the drilling equipment. The laboratory work was carried out in the PML laboratory in Toronto.

This Preliminary Foundation Investigation Report was prepared by Mr. C.M.P. Nascimento, P.Eng., with the assistance of Ms. N.S. Balakumaran, BSc, and was independently reviewed by Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact.

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for

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**6. ENGINEERING RECOMMENDATIONS**

**6.1 General**

Part B of this report provides the preliminary foundation engineering recommendations regarding design and comments for construction of the proposed Junction Creek Bridge Westbound for the future Highway 17 four-laning. The recommendations are preliminary and based on the results of the limited subsurface investigation that was outlined in Part A of this report. Further investigations should be carried out during detailed design.

We understand that the proposed Junction Creek Bridge Westbound will be a three span structure with a total length of 73 m similar to the existing bridge. Based on the top of deck elevations 253.0 and 253.3 at the east and west abutments, it is anticipated that the approach embankments will require up to about 5.0 and 10.0 m of fill at the new west and east abutments, respectively.

It is noted that the bridge span and location were adjusted after the boreholes were drilled. The data was considered to be acceptable for the current preliminary design purposes.

**6.2 Foundations**

**6.2.1 General**

Based on the preliminary data described in previous Part A of the report, founding the proposed bridge piers on spread footings placed on bedrock (west pier) and on native soils (east pier) is



considered feasible. For the pier locations, the driven pile foundation alternatives are not feasible due to the very shallow bedrock.

For the preliminary east abutment location, spread footings or caissons founded on the native soils are not recommended due to the presence of boulders, high groundwater table and marginally compact cohesionless soils. Spread footings on the inferred bedrock are feasible for the west abutment. The alternative schemes of driven pile foundations for the east and west abutments comprising conventional, integral or semi-integral abutment designs are considered feasible, although a rock trench may be required at the west abutment to provide sufficient pile length.

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

The foundation frost depth for structure foundations at this site is 2.0 m, according to OPSD-3090.100. Frost protection is not required for spread footings placed directly on the bedrock.

#### 6.2.2 Spread Footings

For preliminary design purposes, the following are the inferred/anticipated founding depths below existing ground surface and elevations of the bearing surfaces of the pier spread footings founded on bedrock or native soils:

| FOUNDATION ELEMENT | REFERENCE BOREHOLE No. | FOUNDATION SOIL TYPE   | FOUNDING DEPTH (m) | FOUNDING ELEVATION (**) |
|--------------------|------------------------|--|--------------------|-------------------------|
| West Pier          | L1-1                   | Argillite bedrock  | 0.0                | 245.0                   |
| West Abutment      |                        |  | 0.0                | 250.4                   |
| East Pier          | L1-2, 6 & 7            | Compact to dense sandy silt or sand and gravel with boulders and cobbles (*) | 2.0 to 2.4         | 243.4                   |

(\*) Allowance for 2 m frost protection was made.

(\*\*) Assumed bedrock at surface for west pier and west abutment locations.





The recommended preliminary geotechnical resistances for footings bearing on the encountered high strength bedrock and native compact to dense cohesionless soils are as follows:

| FOUNDATION SOIL TYPE   | FACTORED RESISTANCE<br>AT ULS, (kPa) | GEOTECHNICAL RESISTANCE<br>AT SLS, (kPa) |
|--|--------------------------------------|--|
| Argillite Bedrock  | 8000                                 | N/A                                      |
| Compact to dense sandy silt or sand and gravel with cobbles and boulders | 400                                  | 250                                      |

The geotechnical resistance at Serviceability Limit States (SLS) normally allows for 25 mm of total compression of the founding medium. The SLS resistances on soils allow for a total settlement of about 25 mm and differential settlements about half the total amount. Considering the bedrock to be unyielding, the design of footing bearing on bedrock is not governed by settlement criteria since the loading required to produce the above deformation of the bedrock would be larger than the factored geotechnical resistance at Ultimate Limit States (ULS).

The cohesionless silty sand/sand soils are wet and contain cobbles and boulders. This type of footing subgrade is easily disturbed by the excavations to establish the founding levels. Therefore care should be exercised when excavating into these materials. The soil subgrade should be protected with a 75 mm thick layer of concrete upon approval.

The lateral loads imposed on the foundations will be partly resisted by the friction developed between the underside of the concrete footing and the native soils. These forces should be calculated in accordance with the CHBDC. Coefficients of friction of 0.7 and 0.5 may be assumed between concrete footings and the bedrock and compact/dense cohesionless soils respectively, for preliminary purposes.



### 6.2.3 Piles

For the preliminary design of driven pile foundations, steel H-piles driven to refusal on bedrock should be used. The anticipated depths and elevations of the bedrock surfaces are summarized below:

| FOUNDATION ELEMENT | BOREHOLE No.  | FOUNDING DEPTH (m) (*) | FOUNDING ELEVATION |
|--------------------|---------------|------------------------|--------------------|
| West Abutment      | L1-1, 2 and 3 | 5.0                    | 246.4              |
| East Abutment      | L1-2          | 18.8                   | 236.7              |

(\*) Depth below final ground surface. It is assumed that about 5.0 and 10.0 m of fill will be required at the west and east abutments.

For designing integral abutments the west abutment piles will have to be driven into a 4.0 m deep trench excavated into the bedrock to obtain the minimum free pile length of 5.0 m below the abutment stem.

Based on high strength argillite bedrock, the preliminary factored axial resistance at ULS for the pile section noted below is considered to be appropriate:

| FOUNDATION UNIT | FACTORED AXIAL RESISTANCE AT ULS (kN) |
|-----------------|---------------------------------------|
|                 | PILE SECTION 310 X 110                |
| West Abutment   | 2,000                                 |
| East Abutment   | 2,000                                 |

The resistance at SLS normally allows for 25 mm of compression of the pile and founding medium. Considering the bedrock to be a non-yielding material, the design is not expected to be governed by settlement since the required loads causing appreciable deformation of the pile are much larger than the ULS factored capacity.



The piles will have to be driven through the native soils containing cobbles and boulders at the east abutment location. Consequently, there is a risk that the piles may reach refusal on this layer or may be damaged during heavy driving through cobbles above the bedrock surface. If the piles encounter refusal on the layer of boulders or are damaged during driving, additional or replacement piles should be installed.

The piles for the east abutment should be provided with driving shoes to minimize the potential for damage when driving through boulders and those at the west abutment with rock points for setting the piles on the sloping bedrock surface (about 19°). The driving shoes and rock points should conform to OPSD-3000.201 or SP 903S01.

Pile caps should be provided with at least 2.0 m of earth cover or equivalent thermal insulation as protection against frost action. A 25 mm thick layer of polystyrene insulation is thermally equivalent to 600 mm of soil cover.

The lateral loading could be resisted fully or partially by battered piles. For vertical piles such as those used for integral abutments, the resistance to lateral loading will be derived from the soils in front of the piles. For preliminary design purposes, the following values may be used for the computation of lateral resistances:

| <b>Steel H-Pile, 310 x 110</b>         | <b>COMPACT/DENSE<br/>SILT/SAND</b> | <b>GRANULAR<br/>BACKFILL</b> |
|--|------------------------------------|------------------------------|
| Factored Lateral Resistance at ULS, kN | 115                                | 120                          |
| Lateral Resistance at SLS, kN          | 45                                 | 50                           |

### **6.3 Approach Embankments Cut and Fill**

Boreholes were not carried out for the approach embankments to the new Junction Creek Bridge Westbound. It is inferred that the west approach within 20 m of the abutment will require about 2 m of earth cut as indicated by the profile provided by Stantec. However, fill up to 5 m thick will be required at the abutment. The east approach embankment will require about 10 m of fill.



The earth cut of the west approach will likely be on cohesionless soils (as encountered in borehole 1). The fill sections of the west approach fill will be placed on shallow cohesionless soils followed by bedrock. It is inferred from borehole L1-2 that the location of the east approach fill is underlain by an about 2.2 m thick cohesive firm to soft clayey silt unit followed by dense/compact cohesionless soils. Excavation of the firm to soft cohesive soil under the east approach embankment is recommended to improve the stability of the slope and to reduce the total estimated post-construction settlement from about 120 to 60 mm. A preloading and surcharging stage may be required at the east approach embankment to mitigate these settlements. Further subsurface investigation should be carried out in these areas during detailed design to confirm the subsurface conditions.

Based on the inferred condition, construction of the approach embankments at this structure location will be feasible following conventional MTO procedures as outlined in OPSS 501, OPSD-200.010, 201.010, 202.010 and SP 206S03. The settlements of the embankment and native soils will be within tolerable limits and the embankments will be stable at the standard (or flatter than) MTO slope configuration of 2H:1V for earth fill and 1.25H:1V for rock fill.

At the west approach embankment, an erosion control cover, such as by sodding (OPSS 571) or rip-rap (OPSS 511) will be required to minimize the erosion of sandy silt soils exposed by the required earth cut.

## **6.4 Construction Considerations**

### **6.4.1 Excavation**

All excavations at the structure foundation sites should be carried out in accordance with the Occupational Health and Safety Act, local and MTO regulations. For this purpose, the cohesive firm to soft clayey silt and cohesionless compact/dense silty or sandy soils encountered in the boreholes are considered Type 3 soils above the groundwater table. The cohesionless soils are considered Type 4 soils below the groundwater. The bedrock is considered a Type 1 soil.



#### 6.4.2 Groundwater Control

Groundwater was observed during the course of the field work about a depth of 2.4 m (elevation 242.1) at the east abutment and no water was observed at west pier location. The water level in the creek was at about elevation 242.9. It is considered that seepage from native soils and rock fissures or surface water run-off that enters the excavation should be readily handled by conventional sump pumping techniques.

Groundwater conditions should be further assessed during detail design by drilling boreholes to the full depth contemplated for the proposed foundation construction. In particular, for the east pier location, special groundwater control techniques such as cofferdams may be required due to the proximity of the Junction Creek and relatively pervious characteristics of the native soil. This constraint should be investigated further during detailed design.

#### 6.5 Lateral Earth Pressures

The abutment walls should be designed to resist the unbalanced lateral earth pressure imposed by 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.

$$p = K(\gamma h + q) + C_p + C_s$$

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



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

| PARAMETERS                                   | GRANULAR A OR<br>GRANULAR B TYPE II OR TYPE III |
|--|---|
| Internal Friction Angle, $\phi$ (degrees)    | 35  |
| Unit weight, $\gamma$ (kN/m <sup>3</sup> )   | 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 all granular materials in view of their similar physical characteristics.

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

## **7. SCOPE OF ADDITIONAL FOUNDATION INVESTIGATION**

The recommendations in this report are preliminary and based on PML's interpretation of the factual information obtained from a limited number of boreholes and a visual site assessment. Detailed foundation investigation will be required at the structure location during the Detail Design phase of the project. The foregoing interpretation and recommendations are only provided for planning purposes and feasibility studies.



The recommended additional scope of the foundation subsurface investigation for the proposed 15 m wide structure is as follows:

- A minimum of 1 exploration is recommended at each approach embankment. These boreholes shall extend a minimum of 100% of the embankment fill height below the base of the fill, unless bedrock is encountered.
- For deep foundation elements, a minimum of 1 exploration is recommended.
- For shallow foundation elements, a minimum of 2 boreholes are recommended.
- All explorations for the bridge foundation elements should extend a minimum of 3 m below refusal as defined by material for which SPT exceeds 100 blows per 0.3 m.
- Where igneous or metamorphic bedrock is encountered in explorations for foundation elements within the shallow foundation zone, additional boreholes extending to bedrock are recommended at each of the 4 corners of an assumed foundation element footprint. For the additional boreholes, bedrock shall be cored to a minimum depth of 3 m below bedrock surface at one borehole left and one borehole right of the centre of the foundation element.

The east approach embankment is up to about 10 m high and as revealed in borehole L1-2, the site is underlain by about 2.2 m firm to soft clayey silt. The westbound section from Sta. 16+500 (20 m behind the east abutment) to Sta. 16+550 should be investigated during Detail Design as part of the investigation program for High Fills and Embankments over Swamps.

## **8. DISCUSSION OF FOUNDATION ALTERNATIVES**

### **8.1 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 Junction Creek Bridge Westbound at the Highway 17 Sudbury Southwest Bypass.



### **Spread Footings Founded on Bedrock**

#### **Advantages**

- Less costly than deep foundation alternative
- Conventional design and construction of foundations
- Allows semi-integral abutment design

#### **Disadvantages**

- Long-term maintenance costs of expansion joints for conventional abutment and deck design
- Requires rock excavation to achieve a level founding subgrade on bedrock

### **Driven Piles**

#### **Advantages**

- Allows integral abutment design and construction
- Lower long term maintenance cost expansion joints with integral abutment design

#### **Disadvantages**

- More costly than spread footings alternative
- Heavy equipment for pile driving is required
- Requires significant bedrock excavation to achieve minimum required pile length for integral abutment design

## **8.2 Preferred Foundation Option Considerations**

The east abutment foundation should be established on piles in view of the subsoil conditions. From the foundation perspective, both spread footings and driven pile foundations are considered feasible for the west abutment. The spread footing foundations for conventional or semi-integral abutments are considered to be the least costly alternative for construction at this site. The semi-integral or integral abutments will have lower long-term maintenance costs.

The piles should be founded on spread footings established on bedrock (west pier) or native soil (east pier) due to the encountered site conditions. Consequently, this foundation option is recommended for the pier.

Consequently, the most economical alternative in the long term is the semi-integral abutment alternative on spread footings foundations for the west abutment and piers and on piles for the east abutment. This foundation scheme is considered to be the preferred foundation system from





the foundation engineering standpoint, subject to the results of the foundation investigation conducted during the detailed design.

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

## 9. CLOSURE

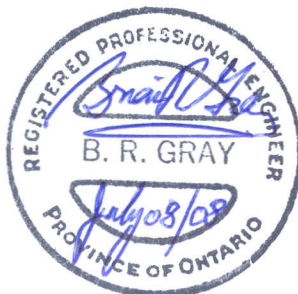
This Preliminary Foundation Design Report was prepared by Mr. C.M.P. Nascimento, P.Eng., with the assistance of Ms. N.S. Balakumaran, BSc. Mr. B. R. Gray, MEng, P.Eng., MTO Designated Principal Contact carried out an independent reviewed of the report.

Yours very truly,

Peto MacCallum Ltd.



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



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

CN/BRG:cn-lnr-mi



**TABLE A**  
**ROCK CORE DESCRIPTIONS**

| CORE RECOVERY |          |             |              |         | CORE DESCRIPTION |   |
|---------------|----------|-------------|--------------|---------|------------------|---|
| BOREHOLE NO.  | CORE NO. | DEPTH (m)   | RECOVERY (%) | RQD (%) | DEPTH (m)        | DESCRIPTION   |
| L1-1          | 1        | 0.0 – 1.4   | 100          | 75      | 0.0 – 3.4        | ARGILLITE: Dark grey, fine crystalline, with dark brown to rust oxidation on partings, high strength, unweathered, very close to moderate spaced flat dipping partings, some vertical partings, smooth to rough planar, tight to oxidized, fair to excellent quality. |
|               | 2        | 1.4 – 3.0   | 100          | 65      |                  |   |
|               | 3        | 3.0 – 3.4   | 100          | 100     |                  |   |
| L1-2          | 8        | 8.8 – 10.1  | 100          | 73      | 8.8 – 11.9       | ARGILLITE: Grey, fine crystalline, with thin white veins, variably pink, green to black coating on partings, high strength, unweathered, close to moderate spaced flat dipping partings, rough planar, tight to oxidized, fair quality.                               |
|               | 9        | 10.1 – 11.9 | 92           | 51      |                  |   |

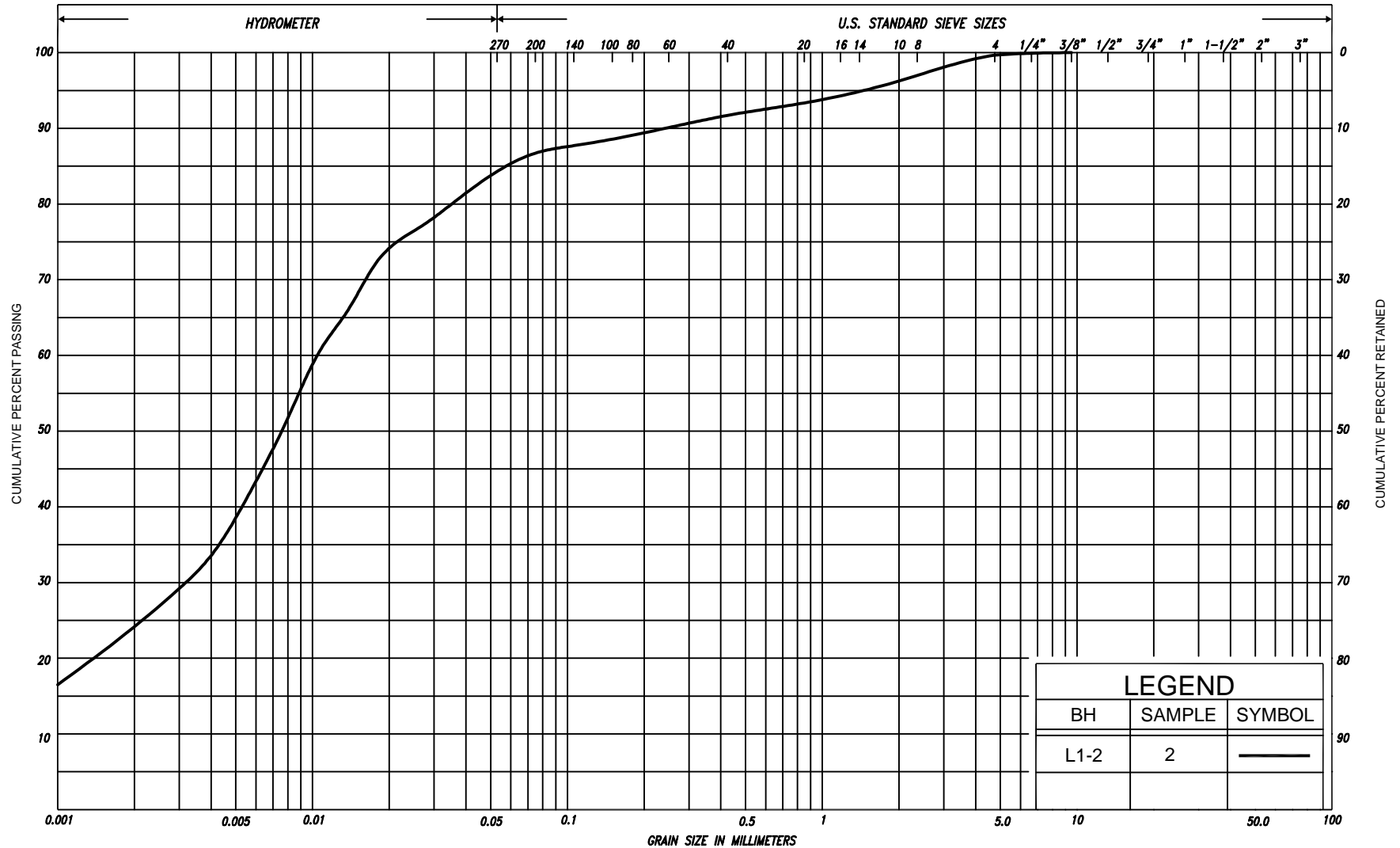
RQD: Rock Quality Designation

Originated: FP  
 Compiled: JFW  
 Checked: NSB/CN



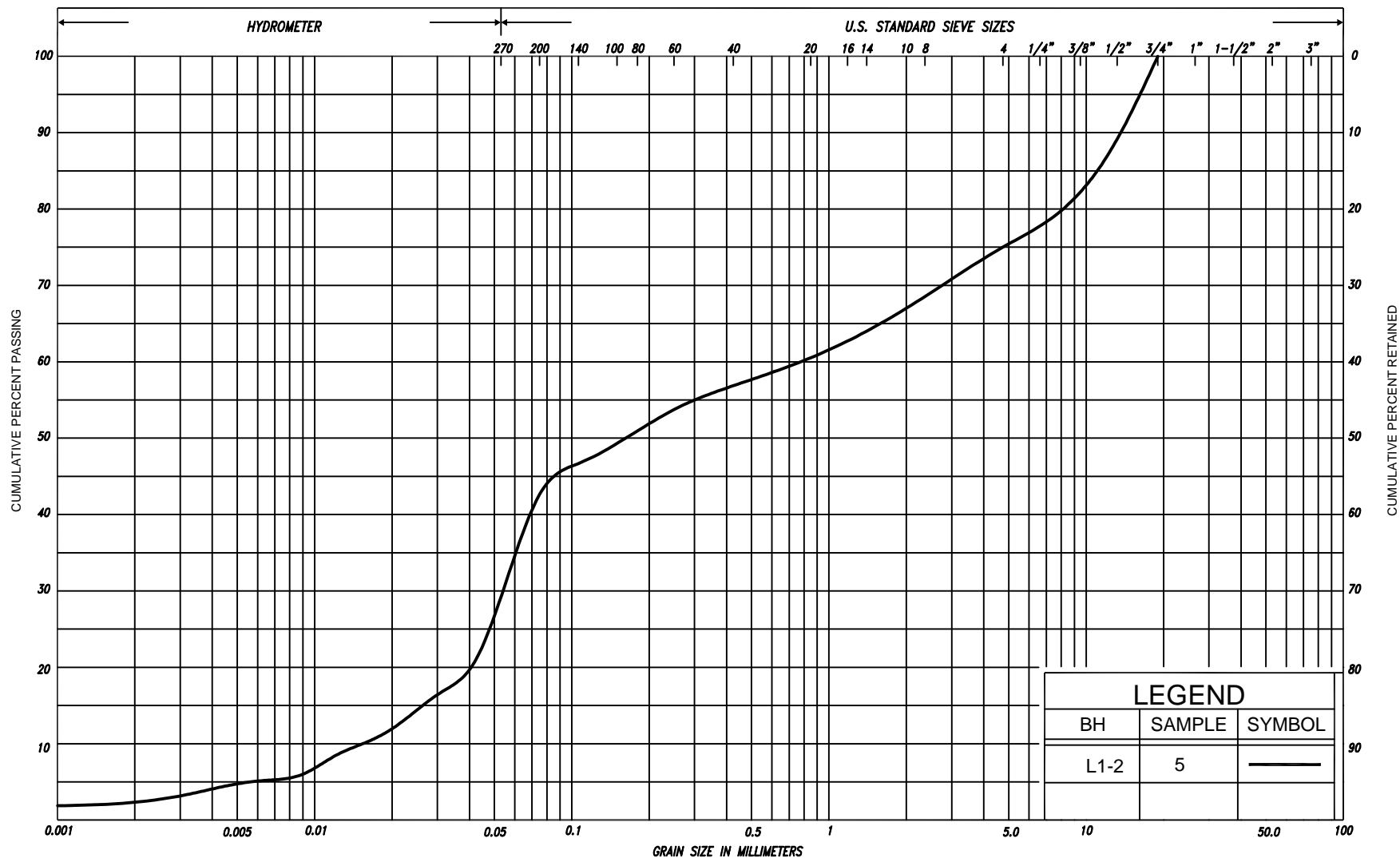
**TABLE 1**  
**LIST OF STANDARD SPECIFICATIONS REFERENCED IN REPORT**

| <b>DOCUMENT</b> | <b>TITLE</b>   |
|-----------------|--|
| OPSS 120        | General Specification for the Use of Explosives                                      |
| OPSS 501        | Construction Specification for Compacting  |
| OPSS 511        | Construction Specification for Rip-Rap, Rock Protection, and Granular Sheeting       |
| OPSS 571        | Construction Specification for Sodding   |
| SP 206S03       | Construction Specification for Grading   |
| SP 405F03       | Construction Specification for Pipe Subdrains  |
| SP 599S22       | Requirements for The Design, Supply and Construction of Retaining Soil Systems (RSS) |
| SP 903S01       | Construction Specification for Piling  |
| OPSD-200.010    | Earth/Shale Grading – Undivided Rural  |
| OPSD-201.010    | Rock Grading-Undivided Rural   |
| OPSD-202.010    | Slope Flattening Using Excess Material on Earth or Rock Embankment                   |
| OPSD-3000.201   | Oslo Points for Foundation, Piles, Steel HP310                                       |
| OPSD-3090.100   | Foundation Frost Depth for Northern Ontario  |
| OPSD-3190.100   | Retaining Wall and Abutment Wall Drain Detail  |

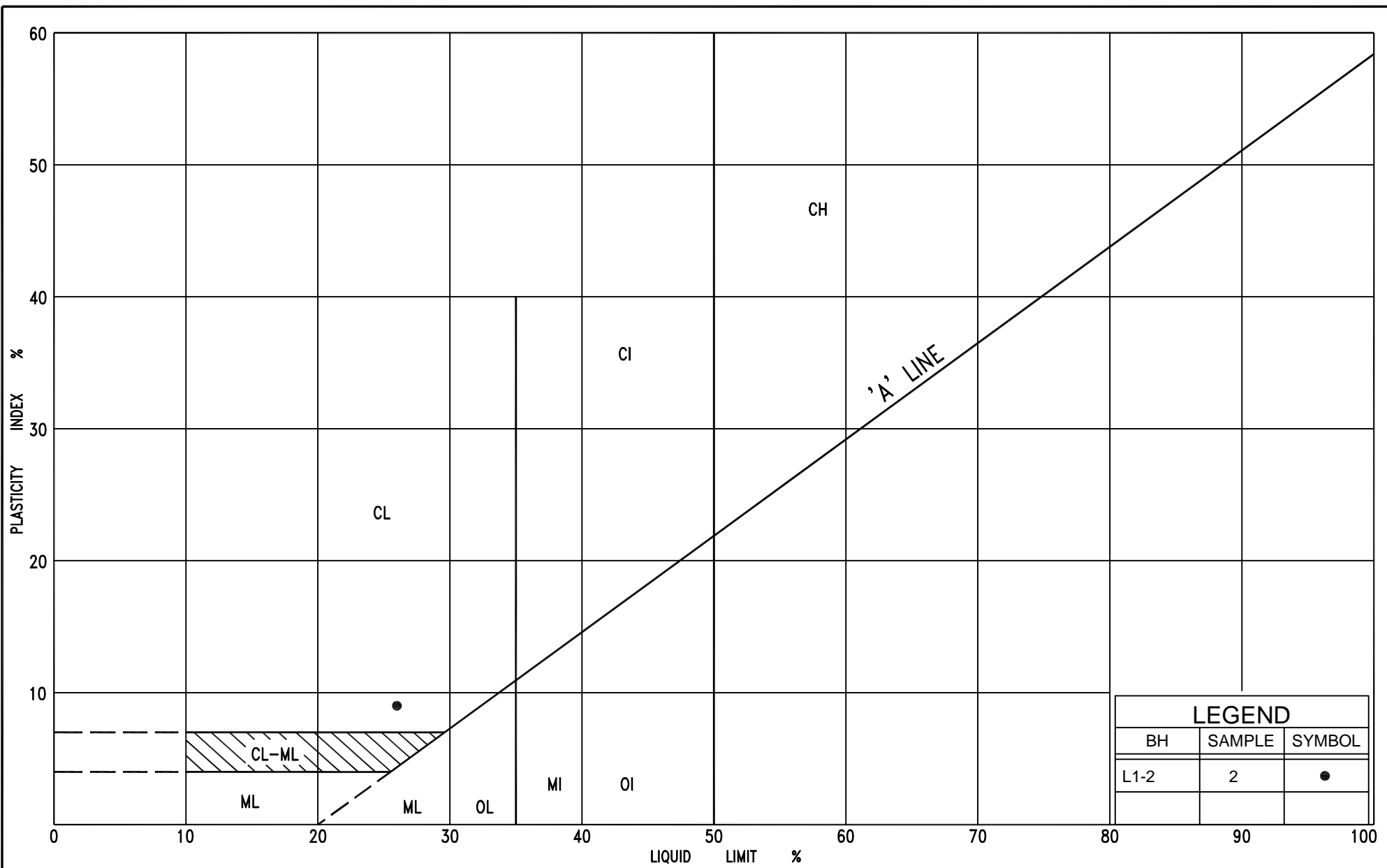


| LEGEND |        |        |
|--------|--------|--------|
| BH     | SAMPLE | SYMBOL |
| L1-2   | 2      | —      |

|             |      |      |        |  |         |      |        |        |        |        |        |  |         |         |         |             |
|-------------|------|------|--------|--|---------|------|--------|--------|--------|--------|--------|--|---------|---------|---------|-------------|
| SILT & CLAY |      |      |        |  | FINE    |      | MEDIUM |        | COARSE | GRAVEL |        |  | COBBLES | UNIFIED |         |             |
|             |      |      |        |  | SAND    |      |        |        |        |        |        |  |         |         |         |             |
| CLAY        | FINE |      | MEDIUM |  | COARSE  |      | FINE   |        | MEDIUM |        | COARSE |  | GRAVEL  |         | COBBLES | M.I.T.      |
|             | SILT |      |        |  |         |      |        |        |        |        |        |  |         |         |         |             |
| CLAY        |      | SILT |        |  | V. FINE | FINE | MED.   | COARSE |        | GRAVEL |        |  |         |         |         | U.S. BUREAU |
|             |      |      |        |  | SAND    |      |        |        |        |        |        |  |         |         |         |             |
|             |      |      |        |  |         |      |        |        |        |        |        |  |         |         |         |             |



|             |      |  |        |  |        |         |        |      |        |  |        |  |        |         |         |         |             |
|-------------|------|--|--------|--|--------|---------|--------|------|--------|--|--------|--|--------|---------|---------|---------|-------------|
| SILT & CLAY |      |  |        |  | FINE   |         | MEDIUM |      | COARSE |  | GRAVEL |  |        | COBBLES | UNIFIED |         |             |
|             |      |  |        |  | SAND   |         |        |      |        |  |        |  |        |         |         |         |             |
| CLAY        | FINE |  | MEDIUM |  | COARSE |         | FINE   |      | MEDIUM |  | COARSE |  | GRAVEL |         |         | COBBLES | M.I.T.      |
|             | SILT |  |        |  |        |         |        |      |        |  |        |  |        |         |         |         |             |
| CLAY        |      |  | SILT   |  |        | V. FINE | FINE   | MED. | COARSE |  | GRAVEL |  |        |         |         |         | U.S. BUREAU |
|             |      |  |        |  | SAND   |         |        |      |        |  |        |  |        |         |         |         |             |



| LEGEND |        |        |
|--------|--------|--------|
| BH     | SAMPLE | SYMBOL |
| L1-2   | 2      | ●      |

## 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 (RQD), 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           |
| $u$                                  | 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

|                |                       |                                      |
|----------------|-----------------------|--------------------------------------|
| $m_v$          | $\text{kPa}^{-1}$     | COEFFICIENT OF VOLUME CHANGE         |
| $C_c$          | 1                     | COMPRESSION INDEX                    |
| $C_s$          | 1                     | SWELLING INDEX                       |
| $C_\alpha$     | 1                     | RATE OF SECONDARY CONSOLIDATION      |
| $C_v$          | $\text{m}^2/\text{s}$ | COEFFICIENT OF CONSOLIDATION         |
| H              | m                     | DRAINAGE PATH                        |
| $T_v$          | 1                     | TIME FACTOR                          |
| U              | %                     | DEGREE OF CONSOLIDATION              |
| $\sigma'_{v0}$ | 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  |
| $T_R$          | kPa                   | RESIDUAL SHEAR STRENGTH              |
| $T_r$          | kPa                   | REMOULDED SHEAR STRENGTH             |
| $S_i$          | 1                     | SENSITIVITY = $\frac{c_u}{T_r}$      |

### PHYSICAL PROPERTIES OF SOIL

|                       |                        |                                |       |      |   |            |                        |  |
|-----------------------|------------------------|--------------------------------|-------|------|---|------------|------------------------|--|
| $\rho_s$              | $\text{kg}/\text{m}^3$ | DENSITY OF SOLID PARTICLES     | n     | 1, % | POROSITY                                  | $e_{\max}$ | 1, %                   | VOID RATIO IN LOOSEST STATE                                |
| $\gamma_s$            | $\text{KN}/\text{m}^3$ | UNIT WEIGHT OF SOLID PARTICLES | w     | 1, % | WATER CONTENT                             | $e_{\min}$ | 1, %                   | VOID RATIO IN DENSEST STATE                                |
| $\rho_w$              | $\text{kg}/\text{m}^3$ | DENSITY OF WATER               | $S_r$ | %    | DEGREE OF SATURATION                      | $I_D$      | 1                      | DENSITY INDEX = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$ |
| $\gamma_w$            | $\text{KN}/\text{m}^3$ | UNIT WEIGHT OF WATER           | $w_L$ | %    | LIQUID LIMIT                              | D          | mm                     | GRAIN DIAMETER   |
| $\rho$                | $\text{kg}/\text{m}^3$ | DENSITY OF SOIL                | $w_p$ | %    | PLASTIC LIMIT                             | $D_n$      | mm                     | n PERCENT - DIAMETER                                       |
| $\gamma$              | $\text{KN}/\text{m}^3$ | UNIT WEIGHT OF SOIL            | $w_s$ | %    | SHRINKAGE LIMIT                           | $C_u$      | 1                      | UNIFORMITY COEFFICIENT                                     |
| $\rho_d$              | $\text{kg}/\text{m}^3$ | DENSITY OF DRY SOIL            | $I_p$ | %    | PLASTICITY INDEX = $w_L - w_p$            | h          | m                      | HYDRAULIC HEAD OR POTENTIAL                                |
| $\gamma_d$            | $\text{KN}/\text{m}^3$ | UNIT WEIGHT OF DRY SOIL        | $I_L$ | 1    | LIQUIDITY INDEX = $\frac{w - w_p}{I_p}$   | q          | $\text{m}^3/\text{s}$  | RATE OF DISCHARGE  |
| $\rho_{\text{sat}}$   | $\text{kg}/\text{m}^3$ | DENSITY OF SATURATED SOIL      | $I_C$ | 1    | CONSISTENCY INDEX = $\frac{w_L - w}{I_p}$ | v          | m/s                    | DISCHARGE VELOCITY   |
| $\gamma_{\text{sat}}$ | $\text{KN}/\text{m}^3$ | UNIT WEIGHT OF SATURATED SOIL  | DTPL  |      | DRIER THAN PLASTIC LIMIT                  | i          | 1                      | HYDRAULIC GRADIENT   |
| $\rho'$               | $\text{kg}/\text{m}^3$ | DENSITY OF SUBMERGED SOIL      | APL   |      | ABOUT PLASTIC LIMIT                       | k          | m/s                    | HYDRAULIC CONDUCTIVITY                                     |
| $\gamma'$             | $\text{KN}/\text{m}^3$ | UNIT WEIGHT OF SUBMERGED SOIL  | WTPL  |      | WETTER THAN PLASTIC LIMIT                 | j          | $\text{KN}/\text{m}^2$ | SEEPAGE FORCE  |
| e                     | 1, %                   | VOID RATIO                     |       |      |   |            |                        |  |

**RECORD OF BOREHOLE No L1-1**

1 of 1

**METRIC**

G.W.P. 5825-05-00 LOCATION Co-ords: 5 142 701 N; 296 662 E ORIGINATED BY F.P.  
 DIST 54 HWY 17 BOREHOLE TYPE Rotary Diamond Drilling COMPILED BY N.S.B  
 DATUM Geodetic DATE May 03, 2007 CHECKED BY NB/CN

| SOIL PROFILE  |   |            | SAMPLES |          |            | GROUND WATER<br>CONDITIONS<br>* | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |            |              |    | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |                   |  |  |
|---------------|---|------------|---------|----------|------------|---------------------------------|-----------------|---|------------------|------------|--------------|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION                               | STRAT PLOT | NUMBER  | TYPE     | "N" VALUES |                                 |                 | SHEAR STRENGTH kPa                          |                  |            |              |    |                                    |                                     |                                   |  |  | WATER CONTENT (%) |  |  |
|               |   |            |         |          |            |                                 |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | ✕ LAB VANE | ✚ FIELD VANE |    |                                    |                                     |                                   |  |  |                   |  |  |
| 246.4         | Ground Surface                            |            |         |          |            |                                 | 20              | 40  | 60               | 80         | 100          | 20 | 40                                 | 60                                  |                                   |  |  |                   |  |  |
| 0.0           | Bedrock                                   |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               | Argillite                                 |            | 1       | RC<br>NQ | REC 100%   |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   | RQD 75%                                  |  |                   |  |  |
|               | Dark grey                                 |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               | High strength                             |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               | Unweathered                               |            | 2       | RC<br>NQ | REC 100%   |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   | RQD 65%                                  |  |                   |  |  |
|               | Fair to excellent quality                 |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
| 243.0         | End of borehole                           |            | 3       | RC<br>NQ | REC 100%   |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   | RQD 100%                                 |  |                   |  |  |
| 3.4           |   |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |
|               | * Borehole charged with<br>drilling water |            |         |          |            |                                 |                 |   |                  |            |              |    |                                    |                                     |                                   |  |  |                   |  |  |



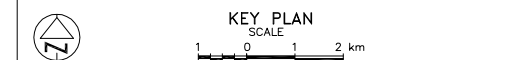
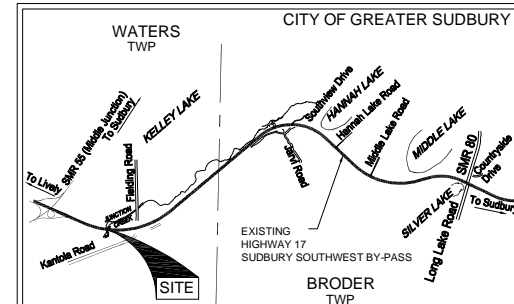
**RECORD OF BOREHOLE No L1-2**

1 of 1

**METRIC**

G.W.P. 5825-05-00 LOCATION Co-ords: 5 142 690 N; 296 706 E ORIGINATED BY F.P.  
DIST 54 HWY 17 BOREHOLE TYPE C.F.H.S.A. + Rotary Diamond Drilling COMPILED BY N.S.B  
DATUM Geodetic DATE May 02, 2007 CHECKED BY NB/CN

| SOIL PROFILE  |   |            | SAMPLES |       |            | GROUND WATER | CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    |              |     |  | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%) |                   |    |    |
|---------------|---|------------|---------|-------|------------|--------------|------------|-----------------|--|----|----|--------------|-----|--|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|---------------------------------------|-------------------|----|----|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE  | "N" VALUES |              |            |                 | SHEAR STRENGTH kPa                       |    |    |              |     |  |                                 |                               |                                |                                       |                                       | WATER CONTENT (%) |    |    |
|               |   |            |         |       |            |              |            |                 | ○ UNCONFINED                             |    |    | + FIELD VANE |     |  |                                 |                               |                                |                                       |                                       | ● QUICK TRIAXIAL  |    |    |
| 245.5         | Ground Surface  |            |         |       |            |              |            |                 | 20                                       | 40 | 60 | 80           | 100 |  |                                 |                               |                                |                                       | GR                                    | SA                | SI | CL |
| 0.0           | Sand and gravel   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 0.2           | clayey silt and topsoil inclusions                      |            | 1       | SS    | 8          |              | 245        |                 |  |    |    |              |     |  | o                               |                               |                                |                                       |                                       |                   |    |    |
|               | Brown (FILL)  |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | clayey silt, some sand layers of silt                   |            | 2       | SS    | 7          |              |            |                 |  |    |    |              |     |  | 100                             |                               |                                |                                       | 0                                     | 14                | 62 | 24 |
|               | Firm      Brown      Moist                              |            |         |       |            |              | 244        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | trace gravel,      cobbles                              |            | 3       | SS    | 3          |              |            |                 |  |    |    |              |     |  | o                               |                               |                                |                                       |                                       |                   |    |    |
|               | Soft      Grey  |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 243.1         |   |            |         |       |            |              | ▽*         |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 2.4           | Sandy silt with gravel, trace clay cobbles              |            | 4       | SS    | 55         |              | 243        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | Dense      Grey      Wet                                |            | 5       | SS    | 37         |              | 242        |                 |  |    |    |              |     |  | o                               |                               |                                |                                       | 25                                    | 32                | 41 | 2  |
| 241.7         |   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 3.8           | Sand trace silt, trace gravel cobbles and boulders      |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | Compact      Grey      Wet to dense                     |            | 6       | SS    | 10         |              | 241        |                 |  |    |    |              |     |  | o                               |                               |                                |                                       |                                       |                   |    |    |
|               |   |            |         |       |            |              | 240        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               |   |            | 7       | SS    | 36         |              | 239        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 238.1         |   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 7.4           | Boulder 0.5m thick                                      |            | 7A      | RC NQ | -          |              | 238        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 237.6         |   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 7.9           |   |            |         |       |            |              | 237        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 236.7         |   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 8.8           | Bedrock   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | Argillite   |            | 8       | RC NQ | REC 100%   |              | 236        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       | RQD                                   | 73%               |    |    |
|               | Grey  |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | High strength   |            |         |       |            |              | 235        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | Unweathered   |            | 9       | RC NQ | REC 92%    |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | Fair quality  |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 233.6         |   |            |         |       |            |              | 234        |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
| 11.9          | End of borehole   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               |   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | *      2007   05   02                                   |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | ▽      Water level observed during drilling             |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |
|               | C.F.H.S.A. denotes Continuous Flight Hollow Stem Augers |            |         |       |            |              |            |                 |  |    |    |              |     |  |                                 |                               |                                |                                       |                                       |                   |    |    |



| LEGEND |  |
|--------|--|
|        | 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 May 2007<br>(Boreholes 1 to 7, 9 & 10 Jan/Feb 1972) |
|        | Head   |
|        | ARTESIAN WATER<br>Encountered  |
|        | PIEZOMETER   |

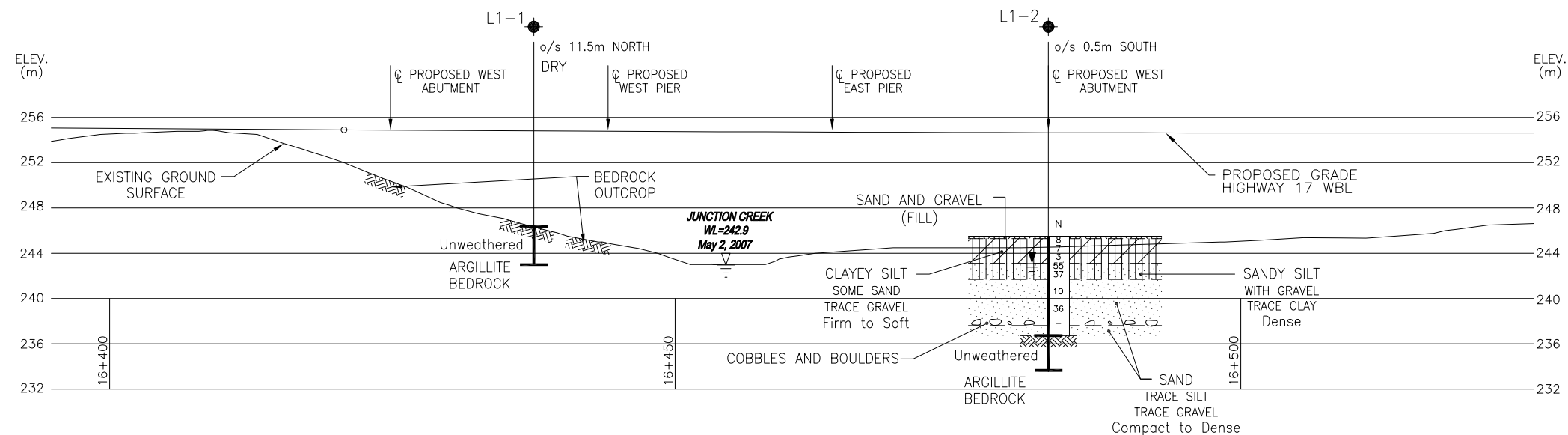
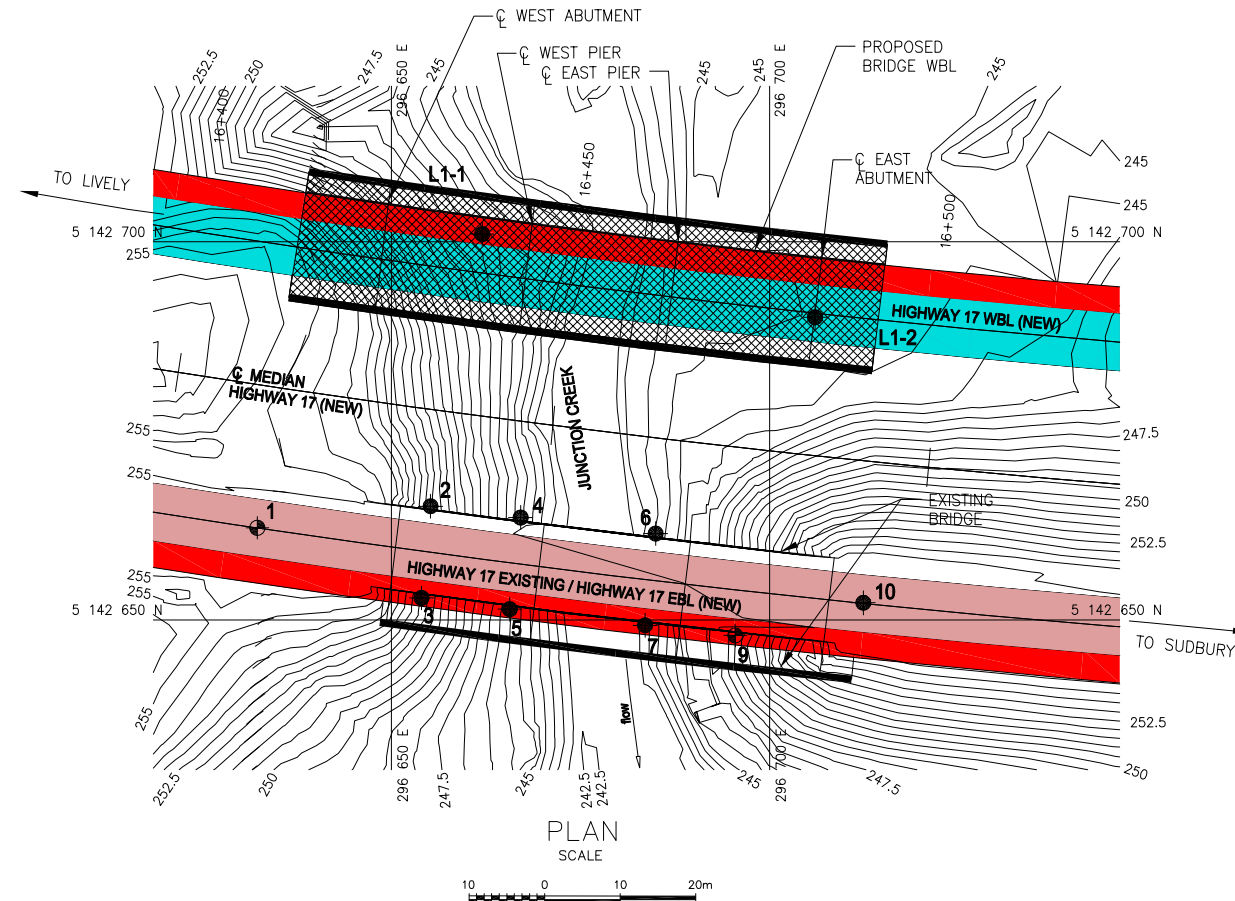
| BH No | ELEVATION | CO-ORDINATES |          |
|-------|-----------|--------------|----------|
|       |           | NORTHINGS    | EASTINGS |
| L1-1  | 246.4     | 5 142 701    | 296 662  |
| L1-2  | 245.5     | 5 142 690    | 296 706  |

REFER DRAWING 72-11011A FOR  
BOREHOLES 1 TO 7, 9 AND 10 DETAILS

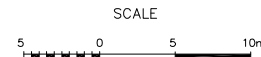
— NOTE —  
The boundaries between soil strata have been established  
only at Borehole locations. Between Boreholes the  
boundaries are assumed from geological evidence.

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

|                     |               |         |          |
|---------------------|---------------|---------|----------|
| Geocres No. 411-223 |               |         |          |
| HWY No              | 17            | DIST    | 54       |
| SUBM'D              | NSB           | CHECKED | CN       |
| DRAWN               | NA            | CHECKED | CN       |
| DATE                | JULY 08, 2008 | SITE    | 46-281/2 |
| APPROVED            | BRG           | DWG     | L1-1     |



PROFILE  
JUNCTION CREEK BRIDGE WESTBOUND



NOTES:

- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- LOCATIONS OF BOREHOLES 1 TO 7, 9 AND 10 ARE ESTIMATED FROM DRAWING 72-11011A
- PRELIMINARY LOCATION OF PROPOSED ABUTMENTS AND PIERS WERE ESTIMATED FOR DISCUSSION PURPOSES IN THIS REPORT ONLY.



REF No. Stantec Drawings; 599\_Alternate 1.dwg; 599\_base.dwg;  
599\_Contours.dwg; Received January 16, 2008



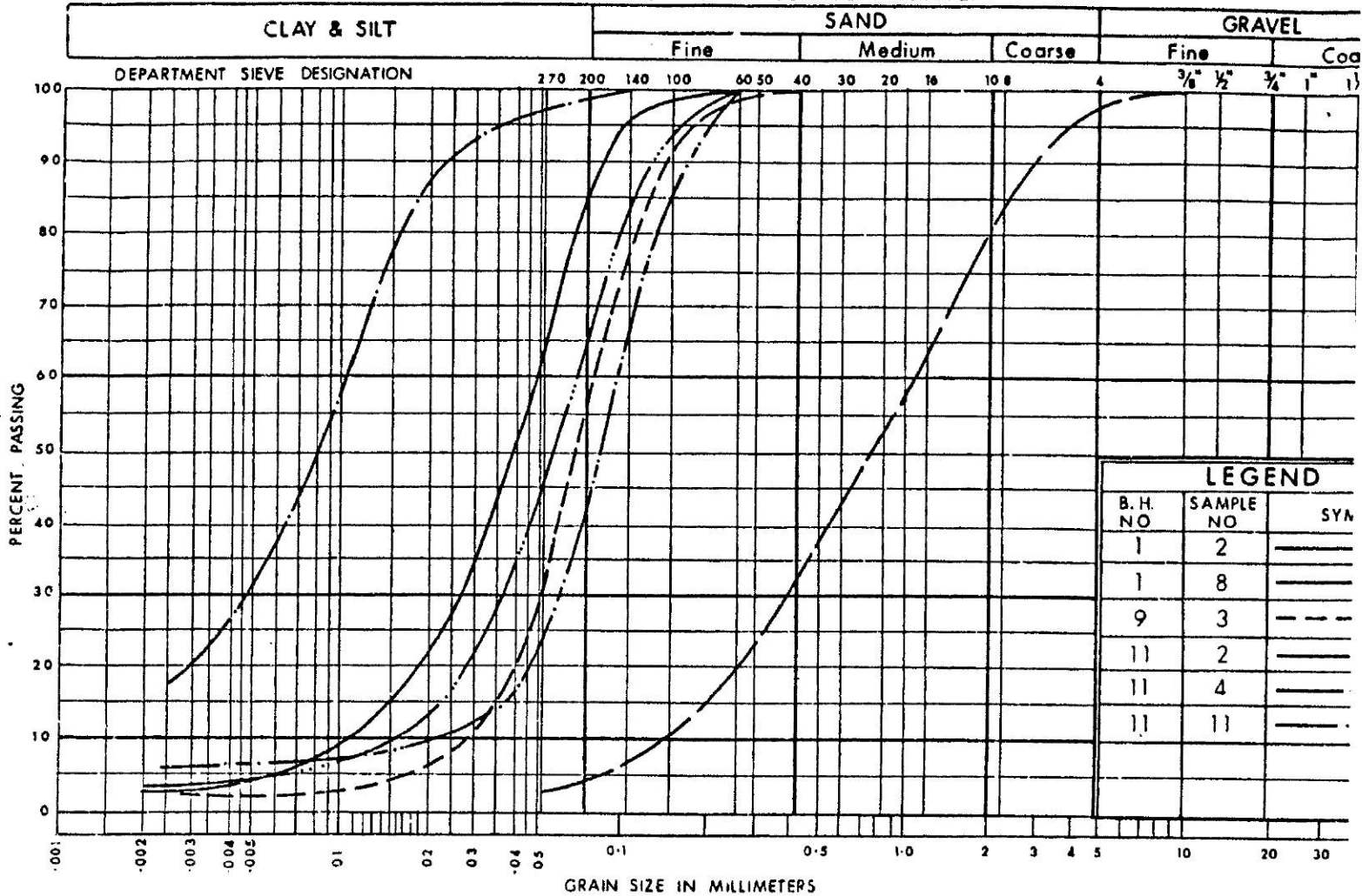
## **APPENDIX A**

### Previous Subsurface Data

(W.O. 72-11011)

(W.P. 911-71-01)

# UNIFIED SOIL CLASSIFICATION SYSTEM



DEPARTMENT  
OF  
TRANSPORTATION AND COMMUNICATIONS



DESIGN SERVICES  
BRANCH

## GRAIN SIZE DISTRIBUTION

SANDY SILT TO SILT

W.P. No. 911-71

JOB No. 72-110

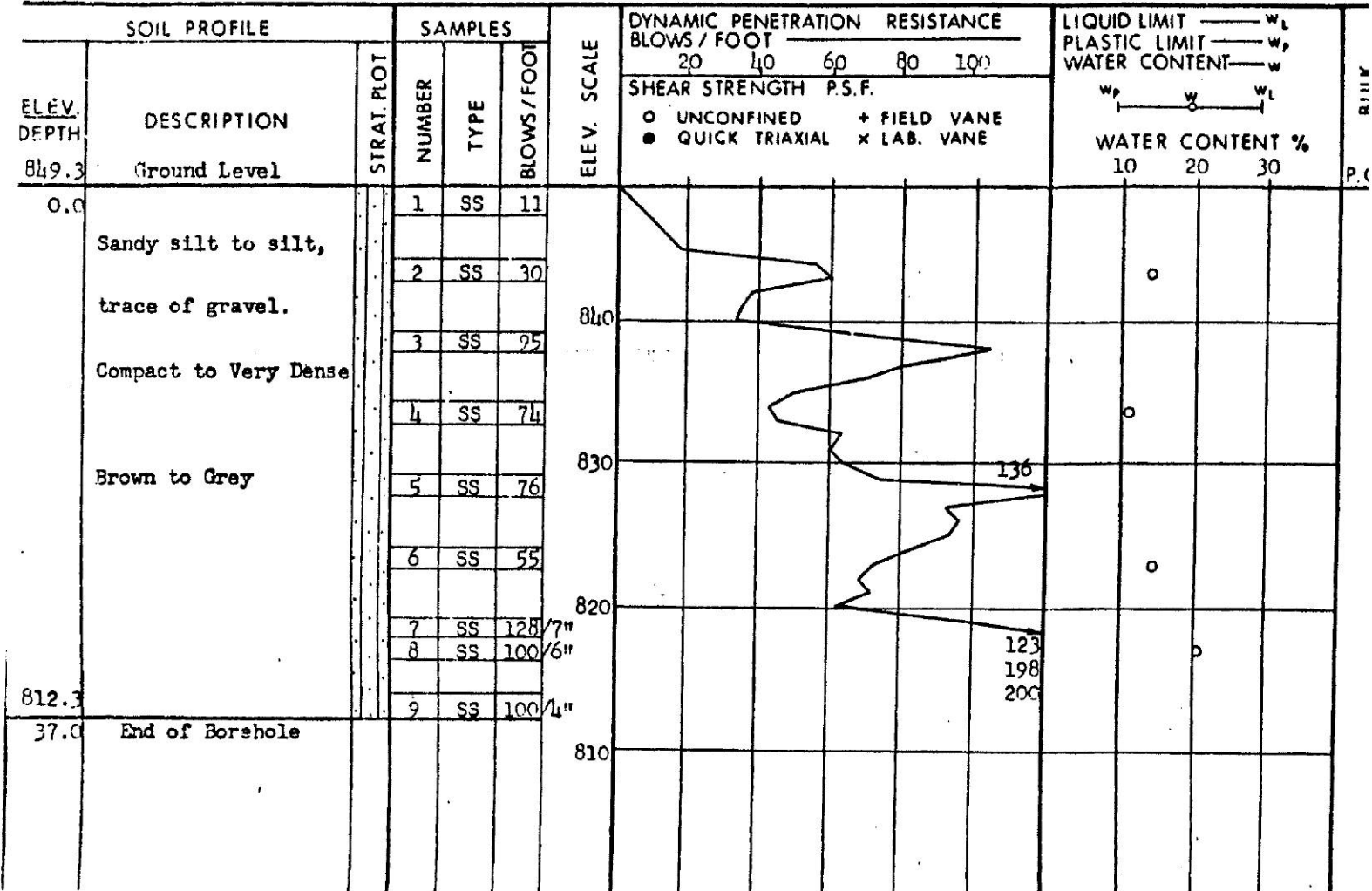
Fig. No. 1

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

RECORD OF BOREHOLE No. 1

FOUR

JOB 72-11011 LOCATION Sta. 339 + 20 Ø ORIGINATED BY \_\_\_\_\_  
W.P. 911-71 BORING DATE Jan. 26 - 28, 1972 COMPILED BY \_\_\_\_\_  
DATUM Geodetic BOREHOLE TYPE BX Casing Washboring Cone Test CHECKED BY S



## RECORD OF BOREHOLE No. 2

FOU

LOCATION Sta. 339 + 90 o/s 20' Lt.

ORIGINATED BY

BORING DATE Jan. 27, 1972

COMPILED BY

BOREHOLE TYPE BX Rock Core

CHECKED BY

[illegible]

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE


## RECORD OF BOREHOLE No. 3

FOUR

JOB 72-11011 LOCATION Sta. 339 + 90 o/s 20' Rt. ORIGINATED BY

W.P. 911-71 BORING DATE Jan. 20 - 24, 1972 COMPILED BY

DATUM Geodetic BOREHOLE TYPE BX Rock Core CHECKED BY

| SOIL PROFILE |                 |   | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE                            |  |  |  |  | LIQUID LIMIT — $w_L$                   |  |  |  |
|--------------|-----------------|---|---------|------|--------------|-------------|---|--|--|--|--|--|--|--|--|
| ELEV. DEPTH  | DESCRIPTION     | STRAT. PLOT   | NUMBER  | TYPE | BLOWS / FOOT |             | BLOWS / FOOT  |  |  |  |  | PLASTIC LIMIT — $w_p$                  |  |  |  |
|              |                 |   |         |      |              |             | SHEAR STRENGTH P.S.F.                                     |  |  |  |  | WATER CONTENT — $w$                    |  |  |  |
|              |                 |   |         |      |              |             | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB. VANE |  |  |  |  | $w_p$ — $w$ — $w_L$<br>WATER CONTENT % |  |  |  |
| 811.6        | Ground Level    |   | 1       | CS   |              |             |   |  |  |  |  |  |  |  |  |
| 1.0          | Sandy Topsoil   |  | 2       | BX   | 100%         | 810         |   |  |  |  |  |  |  |  |  |
|              | 3               |   | BX      | 100% |              |             |   |  |  |  |  |  |  |  |  |
|              | 4               |   | RC      | 100% |              |             |   |  |  |  |  |  |  |  |  |
|              | 5               |   | RC      | 100% |              |             |   |  |  |  |  |  |  |  |  |
|              | 6               |   | BX      | 100% |              |             |   |  |  |  |  |  |  |  |  |
| 800.9        |                 |   |         |      |              | 800         |   |  |  |  |  |  |  |  |  |
| 10.7         | End of Borehole |   |         |      |              |             |   |  |  |  |  |  |  |  |  |
|              |                 |   |         |      |              | 790         |   |  |  |  |  |  |  |  |  |

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 4

JOB 72-11011

LOCATION Sta. 340 + 30 o/s 20' Lt.

W.P. 911-71

BORING DATE Jan. 21, 1972

DATUM Geodetic

BOREHOLE TYPE AXT &amp; BX Rock Core

ORIGINATED BY

COMPILED BY

CHECKED BY

| SOIL PROFILE |                 |             | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE |            | LIQUID LIMIT — $w_L$  |                     |
|--------------|-----------------|-------------|---------|------|--------------|-------------|--------------------------------|------------|-----------------------|---------------------|
| ELEV. DEPTH  | DESCRIPTION     | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT |             | BLOWS / FOOT                   | RESISTANCE | PLASTIC LIMIT — $w_p$ | WATER CONTENT — $w$ |
| 799.6        | Ground Level    |             |         |      |              |             |                                |            |                       |                     |
| 0.0          | Bedrock diorite |             | 1       | AXT  | 05%          |             |                                |            |                       |                     |
|              |                 |             | 2       | RC   | 100%         |             |                                |            |                       |                     |
|              |                 |             | 3       | BX   | 100%         |             |                                |            |                       |                     |
|              |                 |             | 4       | RC   | 100%         |             |                                |            |                       |                     |
|              | Sound           |             | 5       | RC   | 100%         |             |                                |            |                       |                     |
|              |                 |             | 6       | RC   | 100%         |             |                                |            |                       |                     |
| 787.3        | Grey            |             | 7       | BX   | 100%         |             |                                |            |                       |                     |
| 12.3         | End of Borehole |             |         |      |              |             |                                |            |                       |                     |

SHEAR STRENGTH P.S.F.

○ UNCONFINED + FIELD VANE  
 ● QUICK TRIAXIAL x LAB. VANE

LIQUID LIMIT —  $w_L$   
 PLASTIC LIMIT —  $w_p$   
 WATER CONTENT —  $w$

$w_p$  —  $w$  —  $w_L$   
 WATER CONTENT %



DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

## RECORD OF BOREHOLE No. 5

FOU

JOB 72-11011

LOCATION Sta. 340 + 30 o/s 20' Rt.

ORIGINATED BY

W.P. 911-71

BORING DATE Jan. 24, 1972

COMPILED BY

DATUM Geodetic

BOREHOLE TYPE BX Rock Core

CHECKED BY

| SOIL PROFILE |                 |             | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT |              | LIQUID LIMIT — $w_L$<br>PLASTIC LIMIT — $w_p$<br>WATER CONTENT — $w$ |  |  |
|--------------|-----------------|-------------|---------|------|--------------|-------------|--|--------------|--|--|--|
| ELEV. DEPTH  | DESCRIPTION     | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT |             | SHEAR STRENGTH P.S.F.                          |              | WATER CONTENT %  |  |  |
|              |                 |             |         |      |              |             | ○ UNCONFINED                                   | + FIELD VANE |  |  |  |
|              |                 |             |         |      |              |             | ● QUICK TRIAXIAL                               | x LAB. VANE  |  |  |  |
| 805.1        | Ground Level    |             |         |      |              |             |  |              |  |  |  |
| 0.0          | Bedrock diorite |             | 1       | RC   | 100%         | 800         |  |              |  |  |  |
|              | Sound           |             | 2       | RC   | 100%         |             |  |              |  |  |  |
|              |                 |             | 3       | RC   | 100%         |             |  |              |  |  |  |
|              | Grey            |             | 4       | BX   | 100%         |             |  |              |  |  |  |
| 793.1        |                 |             | 5       | BX   | 100%         |             |  |              |  |  |  |
| 12.0         | End of Borehole |             |         |      |              | 790         |  |              |  |  |  |

**FOUN**

ORIGINATED BY T

COMPILED BY

CHECKED BY



[illegible]

## FOU

ORIGINATED BY

COMPILED BY

CHECKED BY


| SOIL PROFILE |   |  | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE<br>BLOWS / FOOT            |  |  |  | LIQUID LIMIT — $w_L$<br>PLASTIC LIMIT — $w_p$<br>WATER CONTENT — $w$ |  |  |  |  |  |
|--------------|---|--|---------|------|--------------|-------------|---|--|--|--|--|--|--|--|--|--|
| ELEV. DEPTH  | DESCRIPTION   | STRAT. PLOT  | NUMBER  | TYPE | BLOWS / FOOT |             | SHEAR STRENGTH P.S.F.                                     |  |  |  | WATER CONTENT %  |  |  |  |  |  |
|              |   |  |         |      |              |             | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB. VANE |  |  |  | $w_p$ — $w$ — $w_L$  |  |  |  |  |  |
| 797.8        | Ground Level  |  |         |      |              |             |   |  |  |  |  |  |  |  |  |  |
| 0.0          | Boulders(up to 18" in size) mixed with gravel & silty sand. |   | 1       | RC   | 70%          | 790         |   |  |  |  |  |  |  |  |  |  |
|              | Very Dense  |  | 2       | RC   | 29%          |             |   |  |  |  |  |  |  |  |  |  |
| 785.8        | Grey  |  |         |      |              |             |   |  |  |  |  |  |  |  |  |  |
| 12.0         | Bedrock diorite   |  | 3       | RC   | 58%          | 780         |   |  |  |  |  |  |  |  |  |  |
|              | Sound   |  | 4       | BX   | 97%          |             |   |  |  |  |  |  |  |  |  |  |
|              | Grey  |  | 5       | BX   | 100%         |             |   |  |  |  |  |  |  |  |  |  |
| 771.8        |   |  | 6       | BX   | 100%         |             |   |  |  |  |  |  |  |  |  |  |
| 26.0         | End of Borehole   |  |         |      |              | 770         |   |  |  |  |  |  |  |  |  |  |

FOUR

ORIGINATED BY

COMPILED BY

CHECKED BY *g*

| SOIL PROFILE |  |  | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE   | LIQUID LIMIT ——— w <sub>L</sub>                         | RISK |
|--------------|--|--|---------|------|--------------|-------------|--|---|------|
| ELEV. DEPTH  | DESCRIPTION  | STRAT. PLOT  | NUMBER  | TYPE | BLOWS / FOOT |             | BLOWS / FOOT<br>20 40 60 80 100  | PLASTIC LIMIT ——— w <sub>p</sub><br>WATER CONTENT ——— w |      |
| 305.8        | Ground Level   |  |         |      |              |             | SHEAR STRENGTH P.S.F.<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB. VANE | WATER CONTENT %<br>10 30 30                             |      |
| 0.0          | Boulders(up to 18" in size) mixed with gravel & silty sand.<br><br>Very Dense<br><br>Brown to Grey |  | 1       | SS   | 75%          | 800         |  |   |      |
|              |  |  | 2       | RC   | 60%          |             |  |   |      |
|              |  |  | 3       | BX   | 55%          |             |  |   |      |
|              |  |  | 4       | BX   | 16%          |             |  |   |      |
|              |  |  | 5       | BX   | 40%          | 790         |  |   |      |
|              |  |  | 6       | BX   | 32%          |             |  |   |      |
|              |  |  | 7       | EC   | 60%          |             |  |   |      |
|              |  |  | 8       | EC   | 100%         |             |  |   |      |
|              |  |  | 9       | BX   | 62%          | 780         |  |   |      |
|              |  |  | 10      | EX   | 0%           |             |  |   |      |
|              |  |  | 11      | AXT  | 69%          |             |  |   |      |
| 772.6        |  |  | 12      | AXT  | 0%           |             |  |   |      |
| 33.0         | Bedrock (diorite)  |  | 13      | AXT  | 100%         | 770         |  |   |      |
|              | Sound Grey   |  | 14      | AXT  | 100%         |             |  |   |      |
| 765.6        |  |  | 15      | AXT  | 100%         |             |  |   |      |
| 10.2         | End of Borehole  |  |         |      |              | 760         |  |   |      |

DEPARTMENT OF HIGHWAYS- ONTARIO  
MATERIALS & TESTING OFFICE

# RECORD OF BOREHOLE No. 10

FOUR

JOB 72-11011

LOCATION Sta. 341 + 80 E

ORIGINATED BY

W.P. 911-71

BORING DATE Jan. 29, 1972

COMPILED BY

DATUM Geodetic

BOREHOLE TYPE BX Casing, Washboring &amp; AXT Rock Core

CHECKED BY S

| SOIL PROFILE |   |             | SAMPLES |      |              | ELEV. SCALE | DYNAMIC PENETRATION RESISTANCE |                       | LIQUID LIMIT — $w_L$  |                     | RISK |
|--------------|---|-------------|---------|------|--------------|-------------|--------------------------------|-----------------------|-----------------------|---------------------|------|
| ELEV. DEPTH  | DESCRIPTION   | STRAT. PLOT | NUMBER  | TYPE | BLOWS / FOOT |             | BLOWS / FOOT                   | SHEAR STRENGTH P.S.F. | PLASTIC LIMIT — $w_p$ | WATER CONTENT — $w$ |      |
| 808.1        | Ground Level  |             |         |      |              |             |                                |                       |                       |                     |      |
| 0.0          | Boulders (up to 9" in size) mixed with gravel & silty sand. |             | 1       | SS   | 12           |             |                                |                       |                       |                     |      |
| 803.1        |   |             | 2       | AXT  | 60%          |             |                                |                       |                       |                     |      |
| 5.3          | End of Borehole   |             |         |      |              | 800         |                                |                       |                       |                     |      |

## ABBREVIATIONS USED IN THIS REPORT

### PENETRATION RESISTANCE

STANDARD PENETRATION RESISTANCE 'N' - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A STANDARD SPLIT SPOON SAMPLER 12 INCHES INTO THE SUBSOIL, DRIVEN BY MEANS OF A 140 POUND HAMMER FALLING FREELY A DISTANCE OF 30 INCHES.

DYNAMIC PENETRATION RESISTANCE - THE NUMBER OF BLOWS REQUIRED TO ADVANCE A 2 INCH, 60 DEGREE CONE, FITTED TO THE END OF DRILL RODS, 12 INCHES INTO THE SUBSOIL. THE DRIVING ENERGY BEING 350 FOOT POUNDS PER BLOW.

### DESCRIPTION OF SOIL

THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE DENSITY OR DENSENESS OF COHESIONLESS SOILS ARE DESCRIBED IN THE FOLLOWING TERMS:-

| <u>CONSISTENCY</u> | <u>'N' BLOWS / FT.</u> | <u>c LB. / SQ. FT.</u> | <u>DENSENESS</u> | <u>'N' BLOWS / FT.</u> |
|--------------------|------------------------|------------------------|------------------|------------------------|
| VERY SOFT          | 0 - 2                  | 0 - 250                | VERY LOOSE       | 0 - 4                  |
| SOFT               | 2 - 4                  | 250 - 500              | LOOSE            | 4 - 10                 |
| FIAM               | 4 - 8                  | 500 - 1000             | COMPACT          | 10 - 30                |
| STIFF              | 8 - 15                 | 1000 - 2000            | DENSE            | 30 - 50                |
| VERY STIFF         | 15 - 30                | 2000 - 4000            | VERY DENSE       | > 50                   |
| HARD               | > 30                   | > 4000                 |                  |                        |

### TYPE OF SAMPLE

|      |                       |      |                               |
|------|-----------------------|------|-------------------------------|
| S.S. | SPLIT SPOON           | T.W. | THINWALL OPEN                 |
| W.S. | WASHED SAMPLE         | T.P. | THINWALL PISTON               |
| S.B. | SCRAPER BUCKET SAMPLE | O.S. | OESTERBERG SAMPLE             |
| A.S. | AUGER SAMPLE          | F.S. | FOIL SAMPLE                   |
| C.S. | CHUNK SAMPLE          | R.C. | ROCK CORE                     |
| S.T. | SLOTTED TUBE SAMPLE   |      |                               |
|      | P.H.                  |      | SAMPLE ADVANCED HYDRAULICALLY |
|      | P.M.                  |      | SAMPLE ADVANCED MANUALLY      |

### SOIL TESTS

|                 |                                 |      |                 |
|-----------------|---------------------------------|------|-----------------|
| Q <sub>u</sub>  | UNCONFINED COMPRESSION          | L.V. | LABORATORY VANE |
| Q               | UNDRAINED TRIAXIAL              | F.V. | FIELD VANE      |
| Q <sub>cu</sub> | CONSOLIDATED UNDRAINED TRIAXIAL | C    | CONSOLIDATION   |
| Q <sub>d</sub>  | DRAINED TRIAXIAL                | S    | SENSITIVITY     |

# ABBREVIATIONS USED IN THIS REPORT

## SOIL PROPERTIES

|            |  |
|------------|--|
| $\gamma$   | UNIT WEIGHT OF SOIL (BULK DENSITY)                                   |
| $\gamma_s$ | UNIT WEIGHT OF SOLID PARTICLES                                       |
| $\gamma_w$ | UNIT WEIGHT OF WATER   |
| $\gamma_d$ | UNIT DRY WEIGHT OF SOIL (DRY DENSITY)                                |
| $\gamma'$  | UNIT WEIGHT OF SUBMERGED SOIL  |
| G          | SPECIFIC GRAVITY OF SOLID PARTICLES $G = \frac{\gamma_s}{\gamma_w}$  |
| e          | VOID RATIO   |
| n          | POROSITY   |
| w          | WATER CONTENT  |
| $S_r$      | DEGREE OF SATURATION   |
| $w_L$      | LIQUID LIMIT   |
| $w_p$      | PLASTIC LIMIT  |
| $I_p$      | PLASTICITY INDEX   |
| s          | SHRINKAGE LIMIT  |
| $I_L$      | LIQUIDITY INDEX $= \frac{w - w_p}{I_p}$                              |
| $I_C$      | CONSISTENCY INDEX $= \frac{w_L - w}{I_p}$                            |
| $e_{max}$  | VOID RATIO IN LOOSEST STATE  |
| $e_{min}$  | VOID RATIO IN DENSEST STATE  |
| $I_D$      | DENSITY INDEX $= \frac{e_{max} - e}{e_{max} - e_{min}}$              |
|            | RELATIVE DENSITY $D_r$ IS ALSO USED                                  |
| h          | HYDRAULIC HEAD OR POTENTIAL  |
| q          | RATE OF DISCHARGE  |
| v          | VELOCITY OF FLOW   |
| i          | HYDRAULIC GRADIENT   |
| k          | COEFFICIENT OF PERMEABILITY  |
| j          | SEEPAGE FORCE PER UNIT VOLUME  |
| $m_v$      | COEFFICIENT OF VOLUME CHANGE $= \frac{-\Delta e}{(1+e)\Delta\sigma}$ |
| $c_v$      | COEFFICIENT OF CONSOLIDATION   |
| $C_c$      | COMPRESSION INDEX $= \frac{\Delta e}{\Delta \log_{10} \sigma}$       |
| $T_v$      | TIME FACTOR $= \frac{c_v t}{d^2}$ (d, DRAINAGE PATH)                 |
| U          | DEGREE OF CONSOLIDATION  |
| $\tau_f$   | SHEAR STRENGTH   |
| $c'$       | EFFECTIVE COHESION INTERCEPT   |
| $\phi'$    | EFFECTIVE ANGLE OF SHEARING RESISTANCE, OR FRICTION                  |
| $c_u$      | APPARENT COHESION  |
| $\phi_u$   | APPARENT ANGLE OF SHEARING RESISTANCE, OR FRICTION                   |
| $\mu$      | COEFFICIENT OF FRICTION  |
| $S_f$      | SENSITIVITY  |

## GENERAL

|                           |                                   |
|---------------------------|-----------------------------------|
| $\pi$                     | $= 3.1416$                        |
| e                         | BASE OF NATURAL LOGARITHMS 2.7183 |
| $\log_e a$ OR $\ln a$     | NATURAL LOGARITHM OF a            |
| $\log_{10} a$ OR $\log a$ | LOGARITHM OF a TO BASE 10         |
| t                         | TIME                              |
| g                         | ACCELERATION DUE TO GRAVITY       |
| V                         | VOLUME                            |
| W                         | WEIGHT                            |
| M                         | MOMENT                            |
| F                         | FACTOR OF SAFETY                  |

## STRESS AND STRAIN

|            |  |
|------------|--|
| u          | PORE PRESSURE  |
| $\sigma$   | NORMAL STRESS  |
| $\sigma'$  | NORMAL EFFECTIVE STRESS ( $\bar{\sigma}$ IS ALSO USED) |
| $\tau$     | SHEAR STRESS   |
| $\epsilon$ | LINEAR STRAIN  |
| $\gamma$   | SHEAR STRAIN   |
| $\nu$      | POISSON'S RATIO ( $\mu$ IS ALSO USED)                  |
| E          | MODULUS OF LINEAR DEFORMATION (YOUNG'S MODULUS)        |
| G          | MODULUS OF SHEAR DEFORMATION                           |
| K          | MODULUS OF COMPRESSIBILITY                             |
| $\eta$     | COEFFICIENT OF VISCOSITY                               |

## EARTH PRESSURE

|          |   |
|----------|---|
| d        | DISTANCE FROM TOP OF WALL TO POINT OF APPLICATION OF PRESSURE   |
| $\delta$ | ANGLE OF WALL FRICTION  |
| K        | DIMENSIONLESS COEFFICIENT TO BE USED WITH VARIOUS SUFFIXES IN EXPRESSIONS REFERRING TO NORMAL STRESS ON WALLS |
| $K_0$    | COEFFICIENT OF EARTH PRESSURE AT REST   |

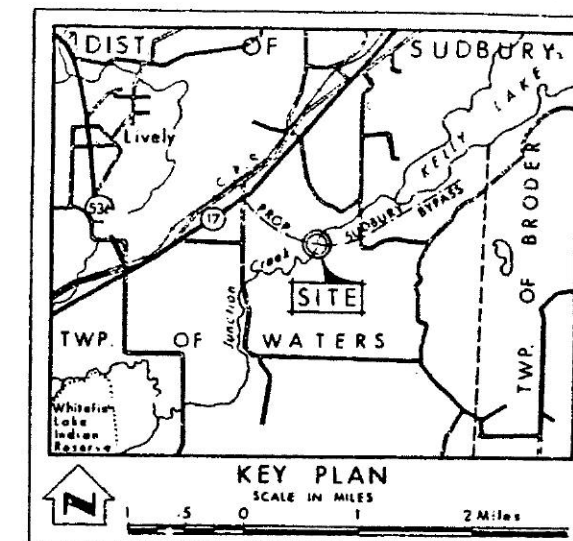
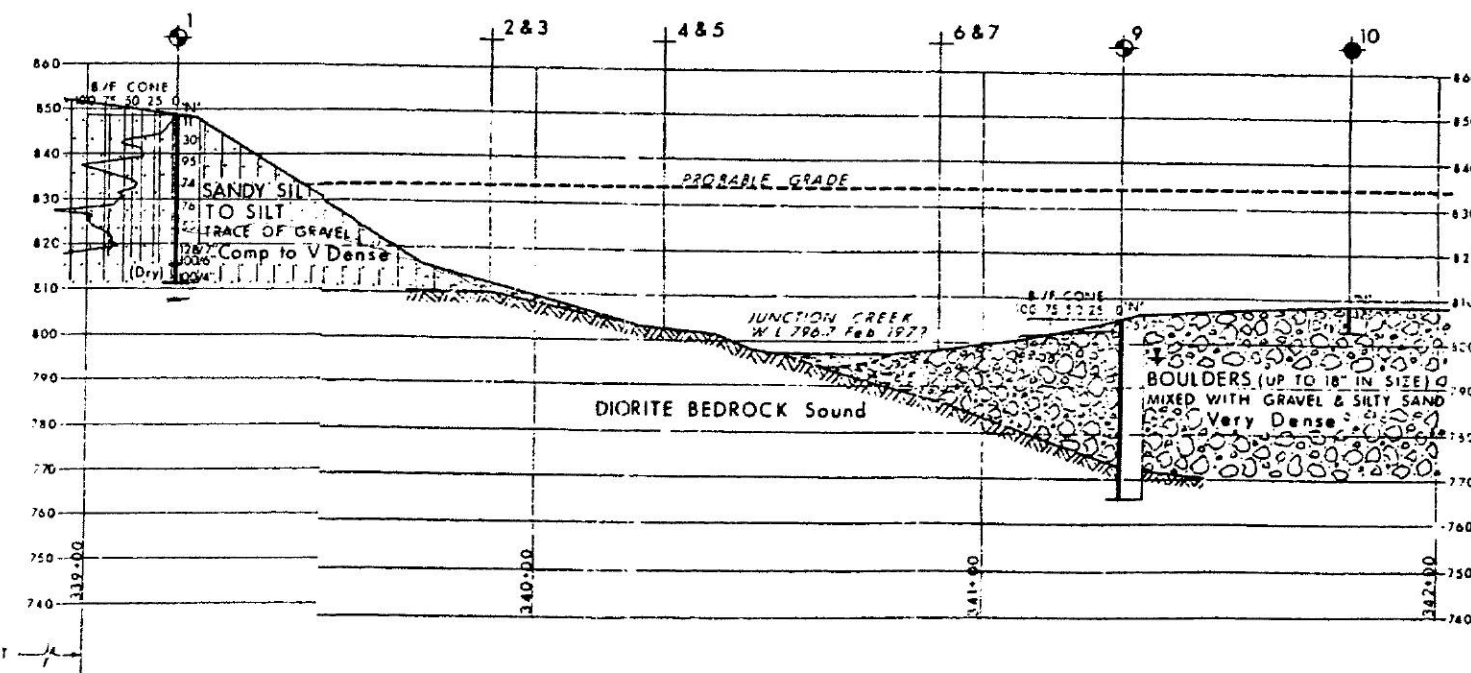
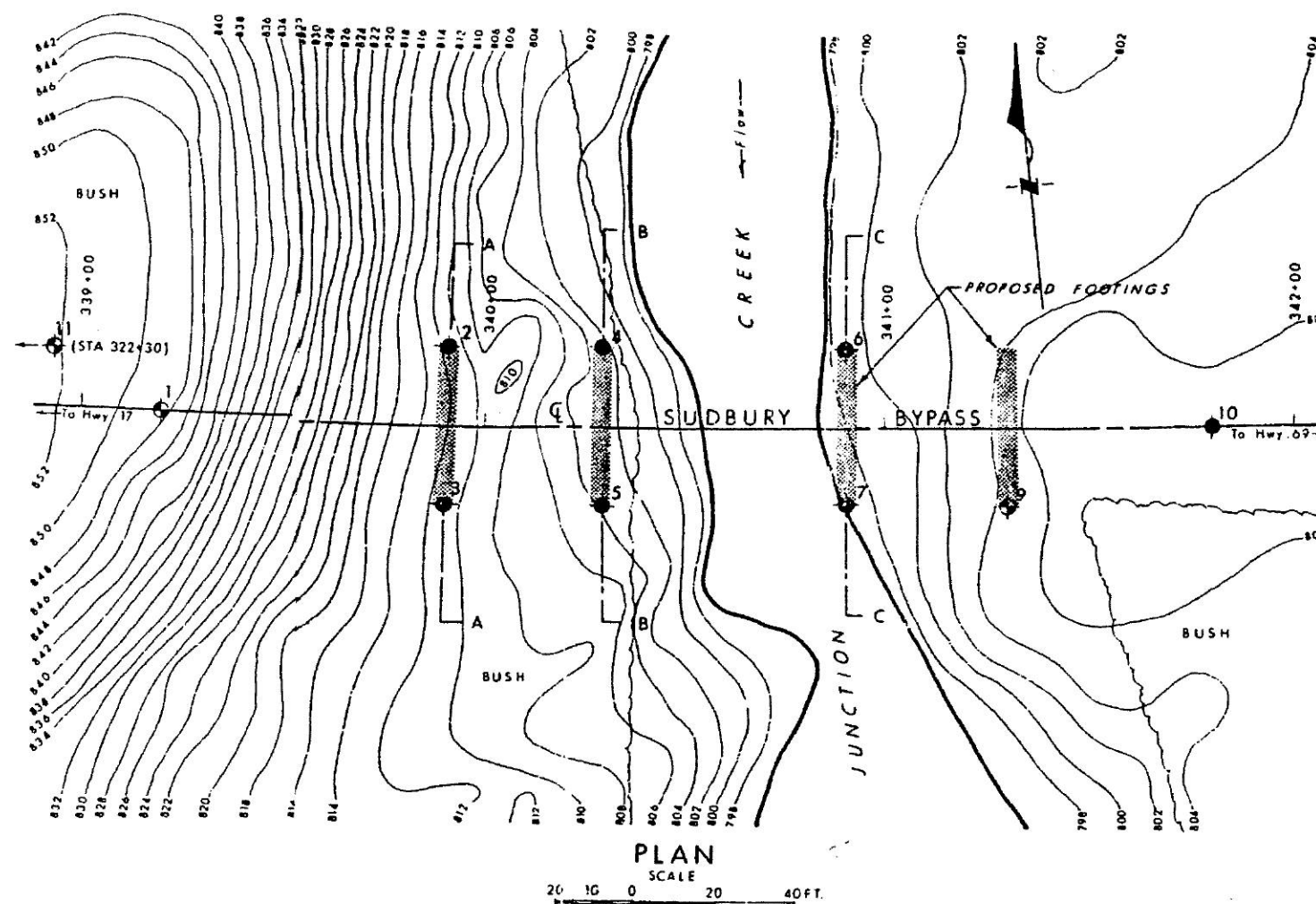
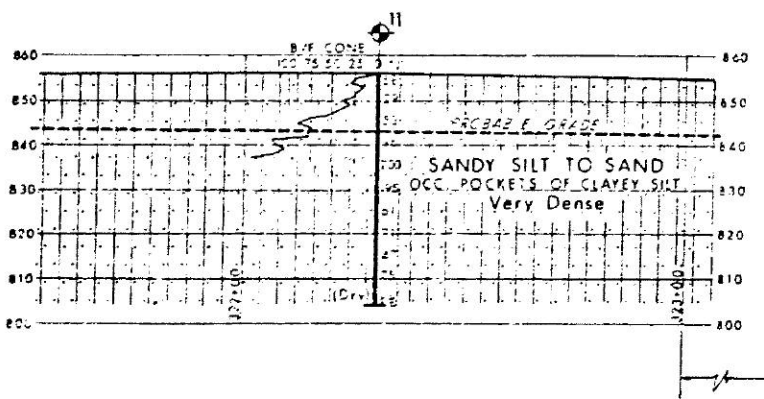
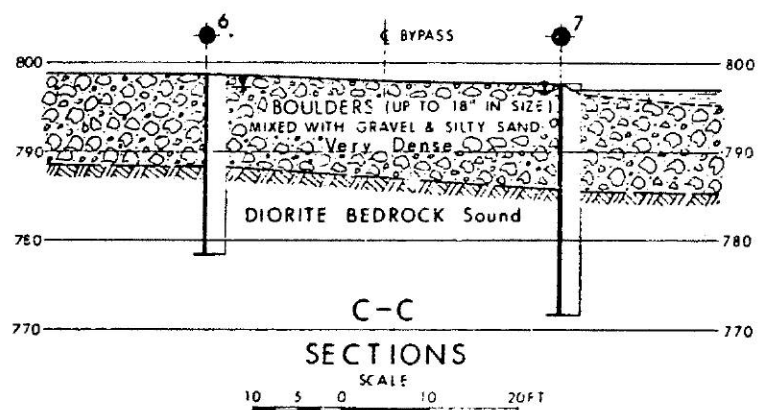
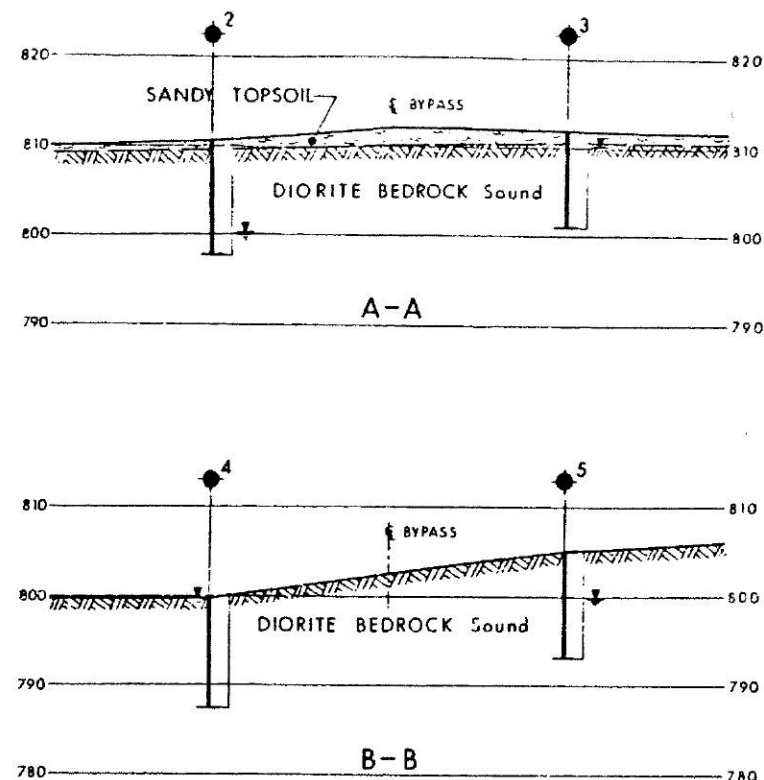
## FOUNDATIONS

|       |   |
|-------|---|
| B     | BREADTH OF FOUNDATION   |
| L     | LENGTH OF FOUNDATION  |
| D     | DEPTH OF FOUNDATION BENEATH GROUND  |
| N     | DIMENSIONLESS COEFFICIENT USED WITH A SUFFIX APPLYING TO SPECIFIC GRAVITY, DEPTH AND COHESION ETC IN THE FORMULA FOR BEARING CAPACITY |
| $k_s$ | MODULUS OF SUBGRADE REACTION  |

## SLOPES

|         |  |
|---------|--|
| H       | VERTICAL HEIGHT OF SLOPE                 |
| D       | DEPTH BELOW TOE OF SLOPE TO HARD STRATUM |
| $\beta$ | ANGLE OF SLOPE TO HORIZONTAL             |





| LEGEND |  |         |         |
|--------|--|---------|---------|
| ◆      | Bore Hole  |         |         |
| ⊕      | Cone Penetration Test  |         |         |
| ⊙      | Bore Hole & Cone Test  |         |         |
| ⬇      | Water Levels established at time of field investigation Jan. & Feb. 1972 |         |         |
| NO.    | ELEVATION  | STATION | OFFSET  |
| 1      | 849.3  | 339+20  | Q       |
| 2      | 810.7  | 339+90  | 20' LT. |
| 3      | 811.6  | 339+90  | 20' RT. |
| 4      | 799.6  | 340+30  | 20' LT. |
| 5      | 803.1  | 340+30  | 20' RT. |
| 6      | 798.7  | 340+90  | 20' LT. |
| 7      | 797.8  | 340+90  | 20' RT. |
| 9      | 805.8  | 341+30  | 20' RT. |
| 10     | 808.4  | 341+80  | Q       |
| 11     | 856.0  | 322+30  | 15' LT. |

**NOTE**

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence and may be subject to considerable error.

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

DEPARTMENT OF TRANSPORTATION & COMMUNICATIONS  
DESIGN SERVICES BRANCH - FOUNDATION OFFICE

**JUNCTION CREEK**

HIGHWAY NO. 17, SUDBURY BYPASS DIST. NO. 17  
Dist. of SUDBURY



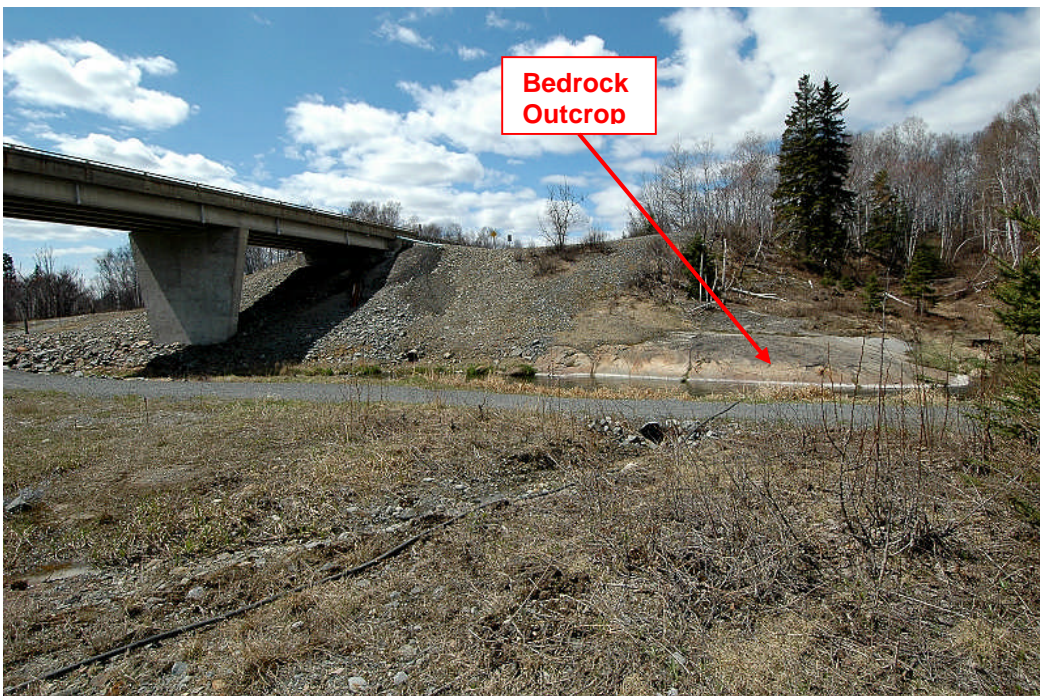


## **APPENDIX B**

### Site Photographs



**Photograph 1:** Looking southwest from east of the structure site. Drill rig at borehole L1-2 (proposed east abutment location). (May 2, 2007)



**Photograph 2:** Looking west from proposed east abutment location. Note bedrock outcrop at west pier location. (May 2, 2007)





**Photograph 3:** Looking south from west pier of structure site. Drill rig is at borehole L1-1. Note bedrock outcrop sloping (about 19°) towards the Junction Creek, from west to east. (May 3, 2007)



## **APPENDIX C**

### Rock Core Photographs



**Photograph 1:** Argillite rock core from borehole L1-1, RC-1. RQD value of 75%.



**Photograph 2:** Argillite rock core from borehole L1-1, RC-2 and RC-3. RQD values of 65 and 100% for RC-2 and RC-3, respectively.





**Photograph 3:** Argillite rock core from borehole L1-2, RC-8 and RC-9. RQD values of 73 and 51% for RC-8 and RC-9, respectively.