



**FOUNDATION INVESTIGATION AND DESIGN REPORT  
TEMPORARY TRANSFER FACILITY FOR  
REHABILITATION OF THE MTO FERRY DOCK AT PELEE ISLAND  
GWP 3029-05-00  
DISTRICT 31, CHATHAM**

**for  
TOTTEN SIMS HUBICKI ASSOCIATES**

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PML Ref.: 06HF051E  
Geocres No.: 40G15-4  
Index ID No. 084FIR and 088 FDR  
June 22, 2007



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**FOUNDATION INVESTIGATION REPORT**  
for  
Temporary Transfer Facility  
for Rehabilitation of the MTO Ferry Dock at Pelee Island  
GWP 3029-05-00  
District 31, Chatham

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**1. INTRODUCTION**

This report summarizes the results of the foundation investigation carried out for the construction of the proposed temporary transfer facility (TTF) on the north side of the existing mainland ferry dock at Pelee Island, Ontario. The TTF will provide ferry dock service during the rehabilitation of the mainland ferry dock, and involves construction of an emergency ramp and a temporary floating dock that will extend approximately 67 m north of the existing dock.

The study was conducted for Totten Sims Hubicki Associates on behalf of the Ministry of Transportation of Ontario.

**2. SITE DESCRIPTION**

The existing mainland ferry dock is located on the west side of Pelee Island. The lands on Pelee Island are developed for residential, agricultural and commercial (seasonal) purposes.

Lake Erie is about 4 to 5 m deep at the location of the TTF. The water level, although subject to seasonal variations, was near elevation 174.3 m at the time of the field investigation.

Selected photographs of the existing ferry dock are provided in Appendix A.

**3. GEOLOGY**

The soil at the site primarily comprises lake bottom sediments of silty sand underlain by silty clay till and sandy silt till.



The underlying bedrock consists of limestone and dolostone of the Dundee formation. Detailed descriptions of the rock core samples retrieved from the boreholes drilled for this study are presented in Table 1.

#### **4. INVESTIGATION PROCEDURES**

The field investigation for this study was carried out during the period of March 29 to April 10, 2007 and comprised three boreholes (Nos. 401 to 403) advanced to depths of 13.8 to 17.2 m. Borehole 401 was drilled to a depth of 17.2 m adjacent to the existing north dock at the location of the TTF, Borehole 402 was drilled to a depth of 13.8 m at the north limit of the proposed TTF, and Borehole 403 was drilled to a depth of 15.1 m approximately 23.0 m north of the proposed north limit of the TTF. Boreholes 401 and 403 were extended 3.0 and 1.3 m into the underlying bedrock, respectively, using NX rock coring equipment. Further details are given in the following table:

| <b>Borehole No.</b> | <b>Depth (m)</b>         |                              |              |
|---------------------|--------------------------|------------------------------|--------------|
|                     | <b>Auger<sup>1</sup></b> | <b>Rock Core<sup>2</sup></b> | <b>Total</b> |
| 401 <sup>3</sup>    | 14.2                     | 3.0                          | 17.2         |
| 402                 | 13.8                     | -                            | 13.8         |
| 403                 | 13.8                     | 1.3                          | 15.1         |

1. Auger drilling; depth relative to lake water level.
2. NX diamond rock coring equipment
3. Refusal to auger penetration was met on a wire mesh wrapped gabion type erosion protection system encountered at a depth of approximately 5 m in Borehole 401. It was necessary to relocate and redrill the hole; the erosion protection was approximately 1 m thick at the second location.

The locations of the boreholes were programmed by Peto MacCallum Ltd. The lake water level at the time of the fieldwork (elevation 174.3), provided by the Great Lakes Information Network, was used as the geodetic vertical reference and used as the datum when describing depths on the borehole logs.

The boreholes were advanced using continuous flight hollow stem augers and NX rock coring equipment, powered by a truck-mounted Diedrich D-50 drillrig, supplied and operated by Soil & Materials Engineering Inc. Borehole 401 was drilled from a platform extended from the existing



north dock. Boreholes 402 and 403 were drilled from a barge. The fieldwork was carried out under full time engineering supervision. The barge was supplied by a specialist marine construction contractor.

Representative samples of the soil were recovered at frequent depth intervals using a conventional split-spoon sampler during drilling. Standard penetration tests were conducted simultaneously with the sampling operation to assess the strength characteristics of the substrata.

All of the recovered samples were returned to our laboratory for detailed visual examination, classification and routine moisture content determinations.

Soils were classified 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 comprised the following tests:

- Natural water content determinations (28)
- Particle Size analyses (9)
- Atterberg Limits tests (7)

## **5. SUMMARIZED SUBSURFACE CONDITIONS**

Reference is made to the appended Record of Borehole sheets for details of the subsurface conditions including soil classifications, inferred stratigraphy, standard penetration test N values, and the laboratory test results. The Grain Size Distribution test results are also provided on Figures GS-1 to GS-4; the Atterberg Limits test results are provided in Figures PC-1 to PC-3.

The borehole locations as well as a stratigraphic profile prepared from the borehole data are shown on Drawings 1 and 2 respectively.



The subsurface stratigraphy revealed in the boreholes generally comprised lake bottom sediments of silty sand underlain by silty clay overlying silty clay till, silty sand till and sandy silt till mantling limestone bedrock. The water depth at the borehole locations ranged from 4.3 m adjacent to the dock and to 4.9 m remote from the dock; the lake bottom elevation was 170.0 and 169.4, respectively. The depth referred to in the following paragraphs is relative to the lake water level.

The subsurface strata encountered are summarized below.

### **5.1 Silty Sand**

The lake bottom sediments comprised loose to dense, brown to grey silty sand with occasional shell fragments and woody organics. This unit was 2.2 m thick adjacent to the dock and penetrated at a depth of 6.5 m, elevation 167.8. Remote from the dock this deposit was 0.6 m thick and penetrated at a depth of 5.5 m, elevation 168.8. The moisture content was 24%.

### **5.2 Silty Clay**

Underlying the lake bottom silty sand was a 3.1 to 3.4 m thick unit of very soft to very stiff, typically soft to stiff generally increasing with depth, grey, silty clay. This unit was penetrated at depths of 8.6 to 9.9 m, elevation 164.4 to 165.7. The moisture content of the silty clay ranged from 12 to 26%, typically 19 to 24%. The liquid limit of the material ranged from 20 to 33, with a plasticity index ranging from 7 to 16.

### **5.3 Silty Clay Till**

A 1.5 to 2.8 m thick unit of very stiff to hard, brownish grey to grey, silty clay till was contacted below the silty clay in all boreholes. This unit was penetrated at depths of 10.9 to 11.4 m, elevation 162.9 to 163.4. The moisture content of the silty clay till ranged from 11 to 14%. The liquid limit of the material also ranged from 20 to 33, with a plasticity index also ranging from 7 to 16.



#### **5.4 Sand/Silty Sand Till**

A very dense, blackish grey to grey, sand/silty sand till was identified below the silty clay till at depths of 10.9 to 11.4 m (elevation 162.9 to 163.4) in all boreholes. This deposit was 0.8 to 1.5 m thick and penetrated at depths of 11.7 to 12.9 m, elevation 161.4 to 162.6. The moisture content of the sand till ranged from 11 to 15%.

#### **5.5 Sandy Silt Till**

Very dense, grey, sandy silt till was identified underlying the sand/silty sand till at depths of 11.7 to 12.9 m. Borehole 402 was terminated in this deposit at a depth of 13.8 m, elevation 160.5. This unit was penetrated upon practical refusal to auger on limestone bedrock at depths of 14.2 and 13.8 m, elevation 160.1 and 160.5, in Boreholes 401 and 403, respectively. The moisture content of the silt till ranged from 10 to 12%. The liquid limit of the material was 18, with a plasticity index of 3, thus indicating that the material is a silt with slightly plastic characteristics.

#### **5.6 Bedrock**

Bedrock was contacted upon practical refusal to auger at depths of 14.2 and 13.8 m (elevation 160.1 and 160.5 m) in Boreholes 401 and 403, respectively.

The bedrock comprised limestone of the Dundee Formation that was judged to be high strength and unweathered to moderately weathered. A detailed description of the rock core samples is presented in Table 1.

The measured core recovery varied from 42 to 100%. The Rock Quality Designation (RQD) determined from the rock core was 70% in Borehole 401 indicating a fair quality rock, and was 0% in the rock core samples retrieved from Borehole 403, indicating a very poor quality rock.





## 5.7 Groundwater

Observation of the groundwater conditions in the boreholes was not possible since the boreholes were advanced over water.

## 6. CLOSURE

The fieldwork was conducted by Soil & Materials Engineering Inc., under the senior direction of Mr. Peter A. Lyall, P.Eng. and Mr. Dennis W. Kerr, MEng., P.Eng.

The laboratory testing is being conducted at the Hamilton office of Peto MacCallum Ltd.

The report was prepared by Mr. Peter A. Lyall, P.Eng. and Mr. Dennis W. Kerr, MEng, P.Eng., Chief Foundation Engineer. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Contact, carried out an independent review of the report.

Sincerely

Peto MacCallum Ltd.

A handwritten signature in blue ink, appearing to read 'D. W. Kerr', is positioned above the printed name.

Dennis W. Kerr, MEng., P.Eng.  
Chief Foundation Engineer



A handwritten signature in blue ink, appearing to read 'B. R. Gray', is positioned above the printed name.

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



PL/DWK:lad



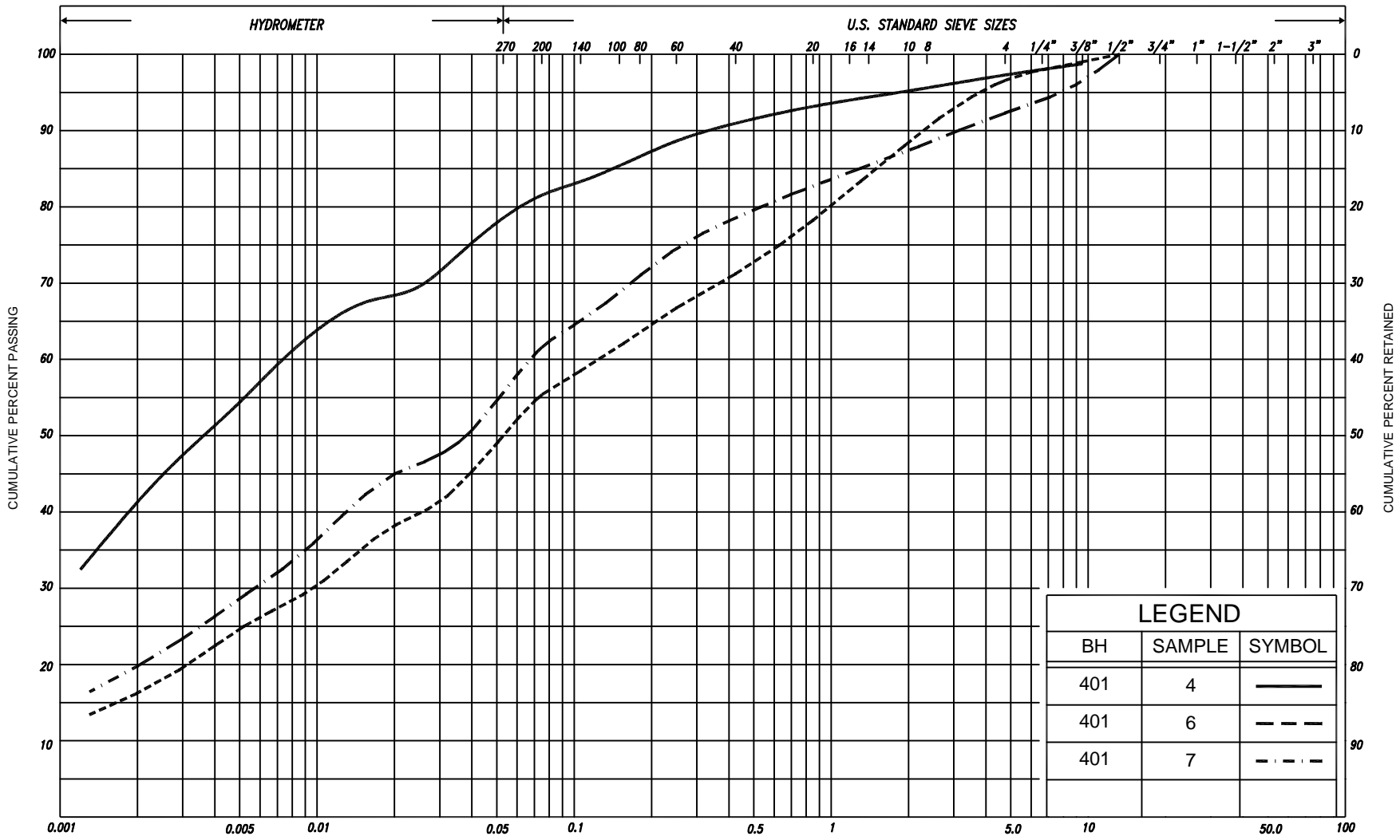
**Table 1**

Rock Core Description

| CORE RECOVERY |            |             |         |         |             | CORE DESCRIPTION   |
|---------------|------------|-------------|---------|---------|-------------|--|
| BH            | Sample No. | DEPTH (m)   | Rec (%) | RQD (%) | DEPTH (m)   | DESCRIPTION  |
| 401           | 11         | 14.2 – 17.2 | 100     | 70      | 14.2 – 17.2 | LIMESTONE: Buff, micritic, banded, with occasional grey layers, few well developed stylolitic partings, heavy pitting/porous layer with minor selenite filling at 16.2 to 16.7 m, high strength, unweathered, close to moderate spaced flat partings, rough to smooth undulating, tight, fair quality.<br><br>Dundee Formation |
| 403           | 13         | 13.8 - 14.4 | 42      | 0       | 13.8 – 15.1 | LIMESTONE: Buff, micritic, banded, high strength, slightly to moderately weathered, mainly shatter, very poor quality.<br><br>Dundee Formation   |
|               | 14         | 14.4 – 15.1 | 83      | 0       |             |  |
|               |            |             |         |         |             |  |

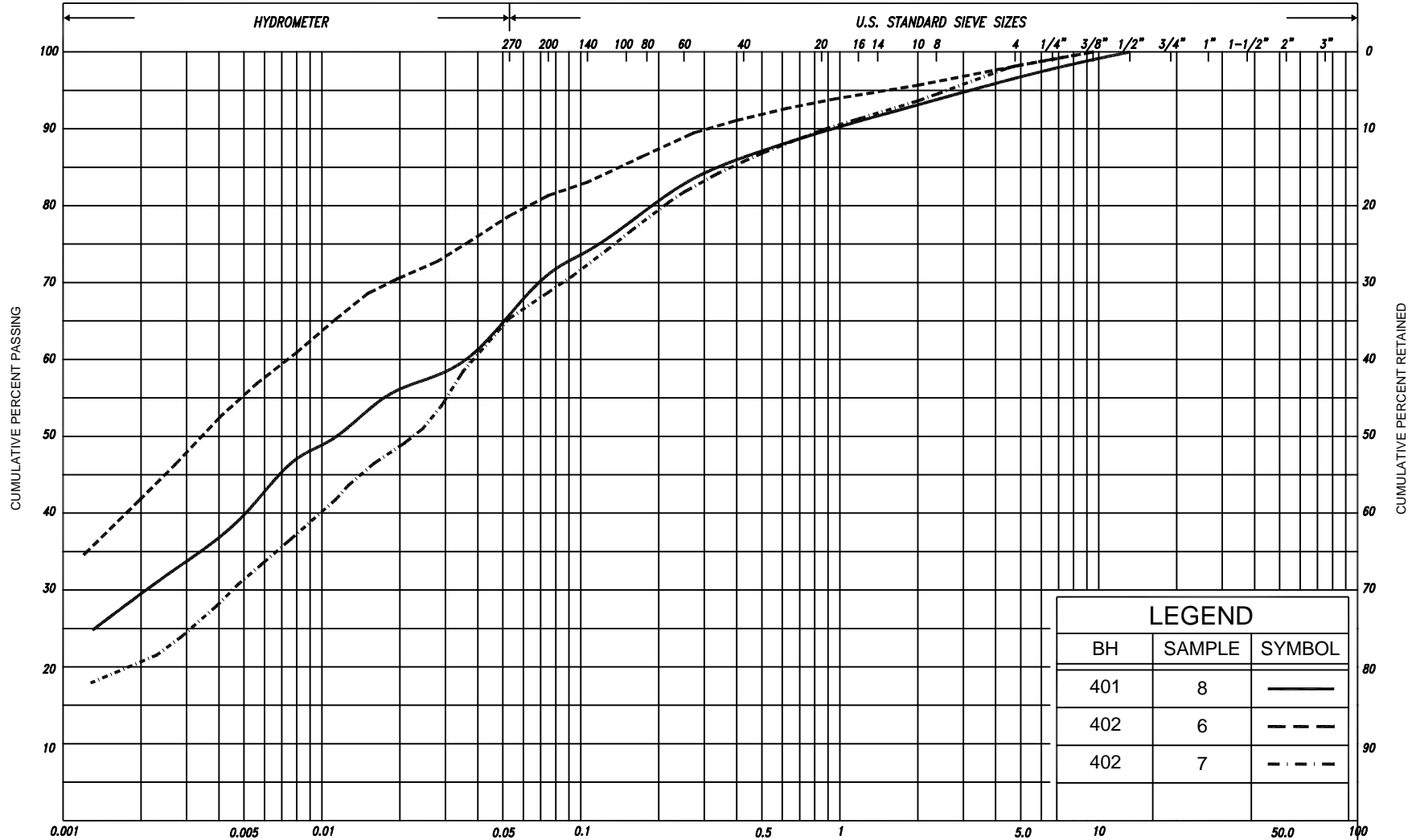
RQD: Rock Quality Designation  
 Drilled: April 9, 2007  
 Logged: April 18, 2007

Originated: Toronto  
 Compiled: J.W.  
 Checked: D.W.K.



| LEGEND |        |             |
|--------|--------|-------------|
| BH     | SAMPLE | SYMBOL      |
| 401    | 4      | ————        |
| 401    | 6      | -----       |
| 401    | 7      | - . - . - . |

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

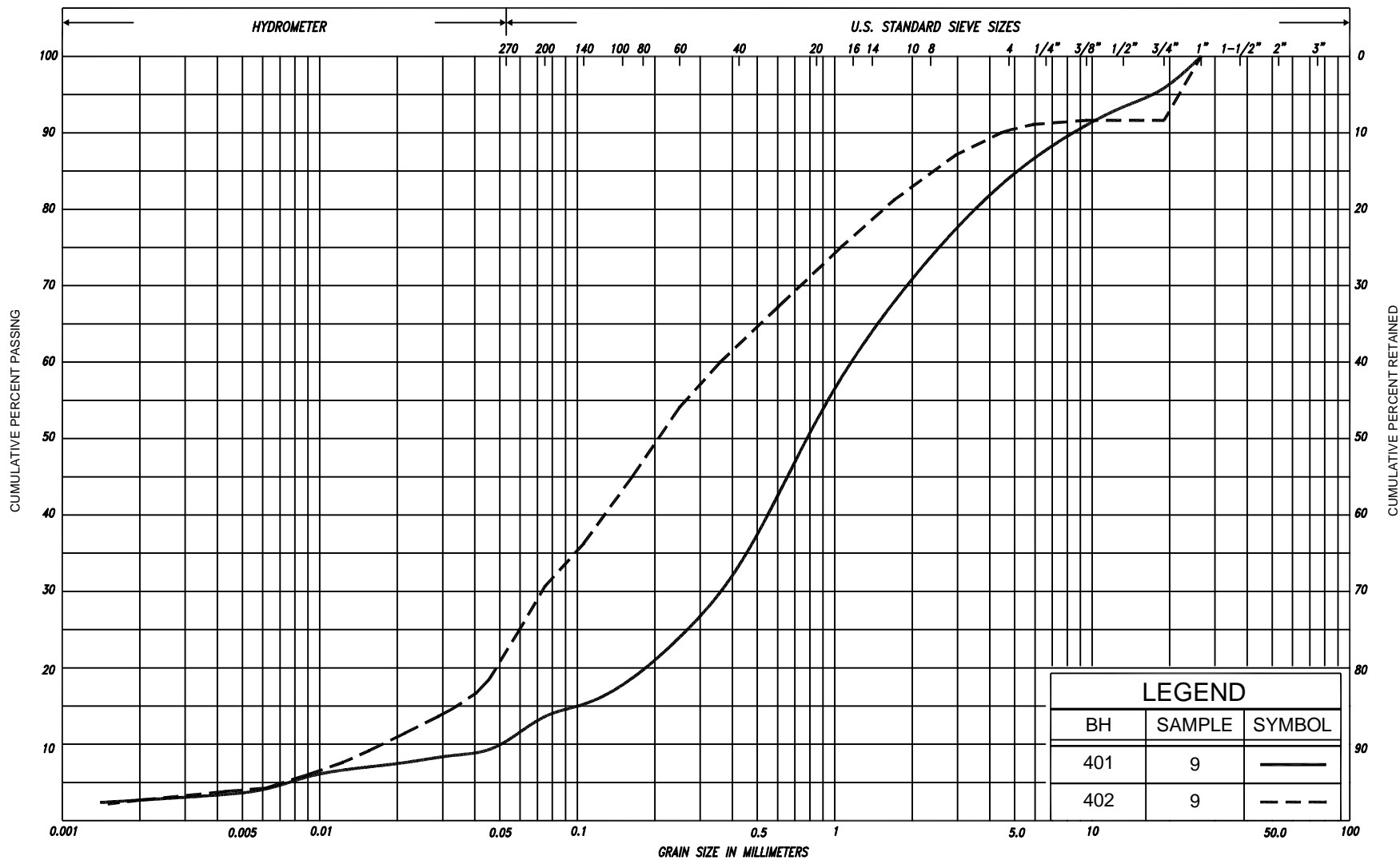


# GRAIN SIZE DISTRIBUTION CLAY (TILL)

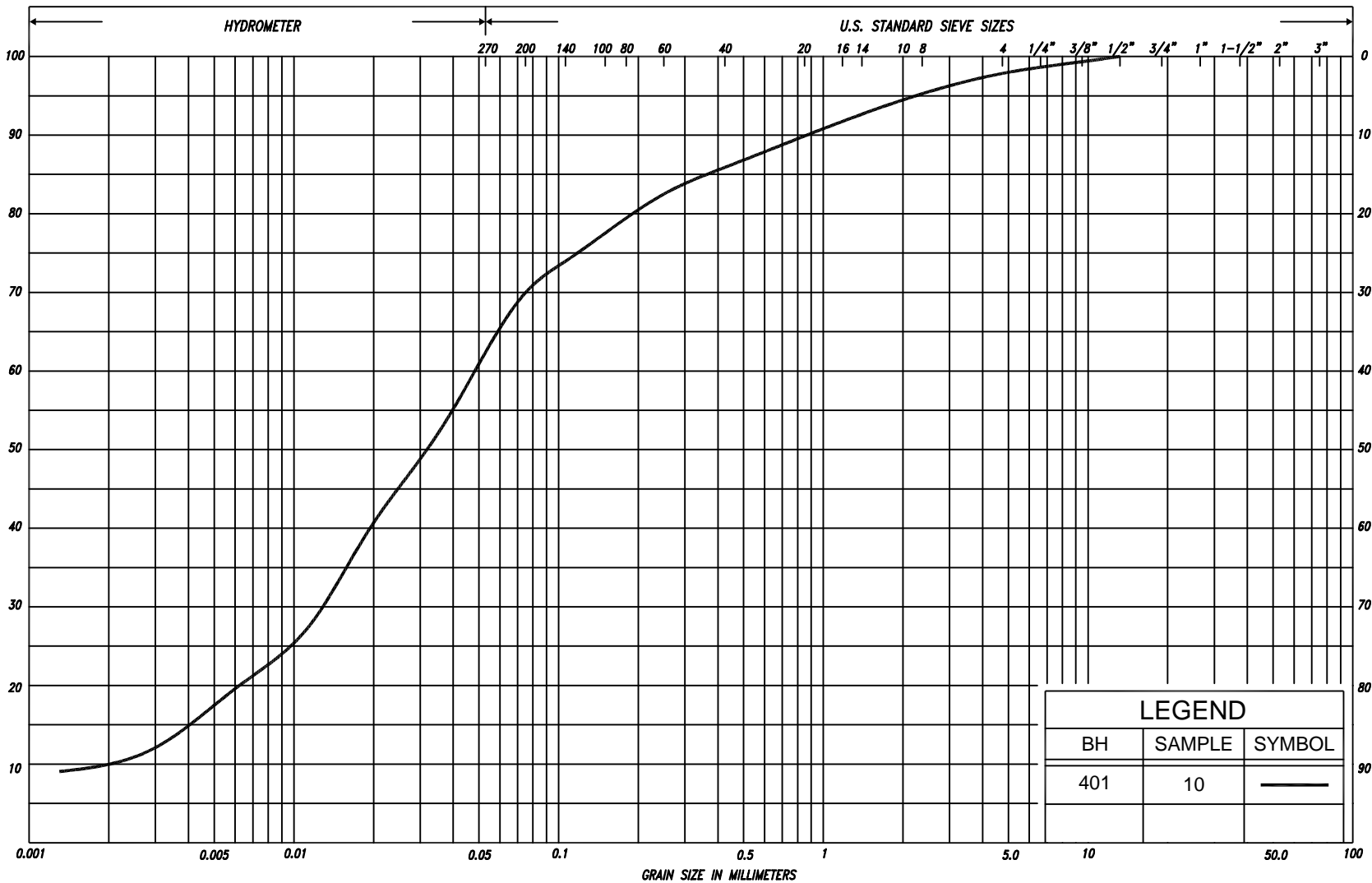
FIG No. GS-2

PELEE ISLAND FERRY DOCK

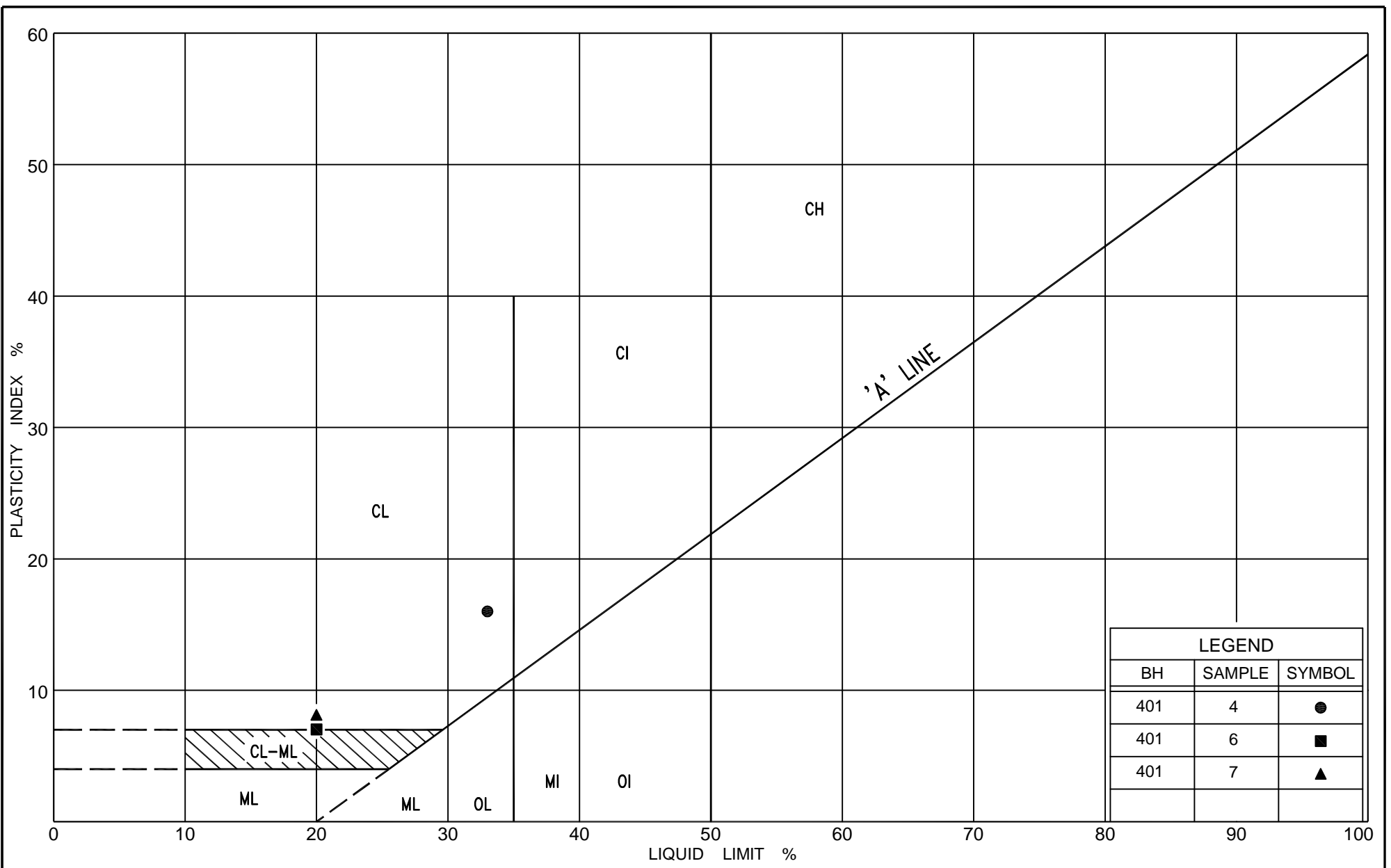
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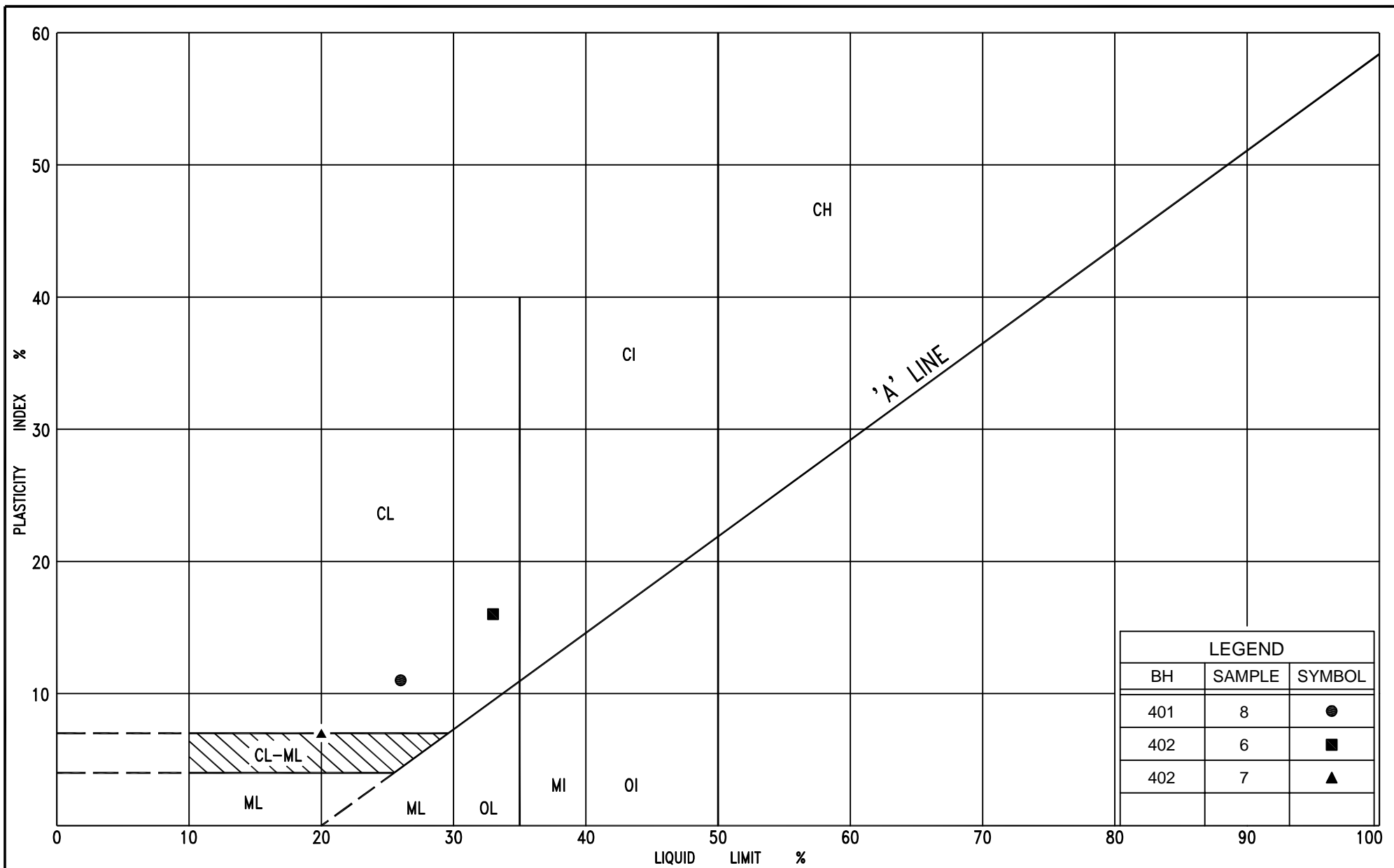


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| SILT & CLAY |  |  |  | FINE |  |  | MEDIUM |  |  | COARSE |  |  | GRAVEL |  |  | COBBLES | UNIFIED |
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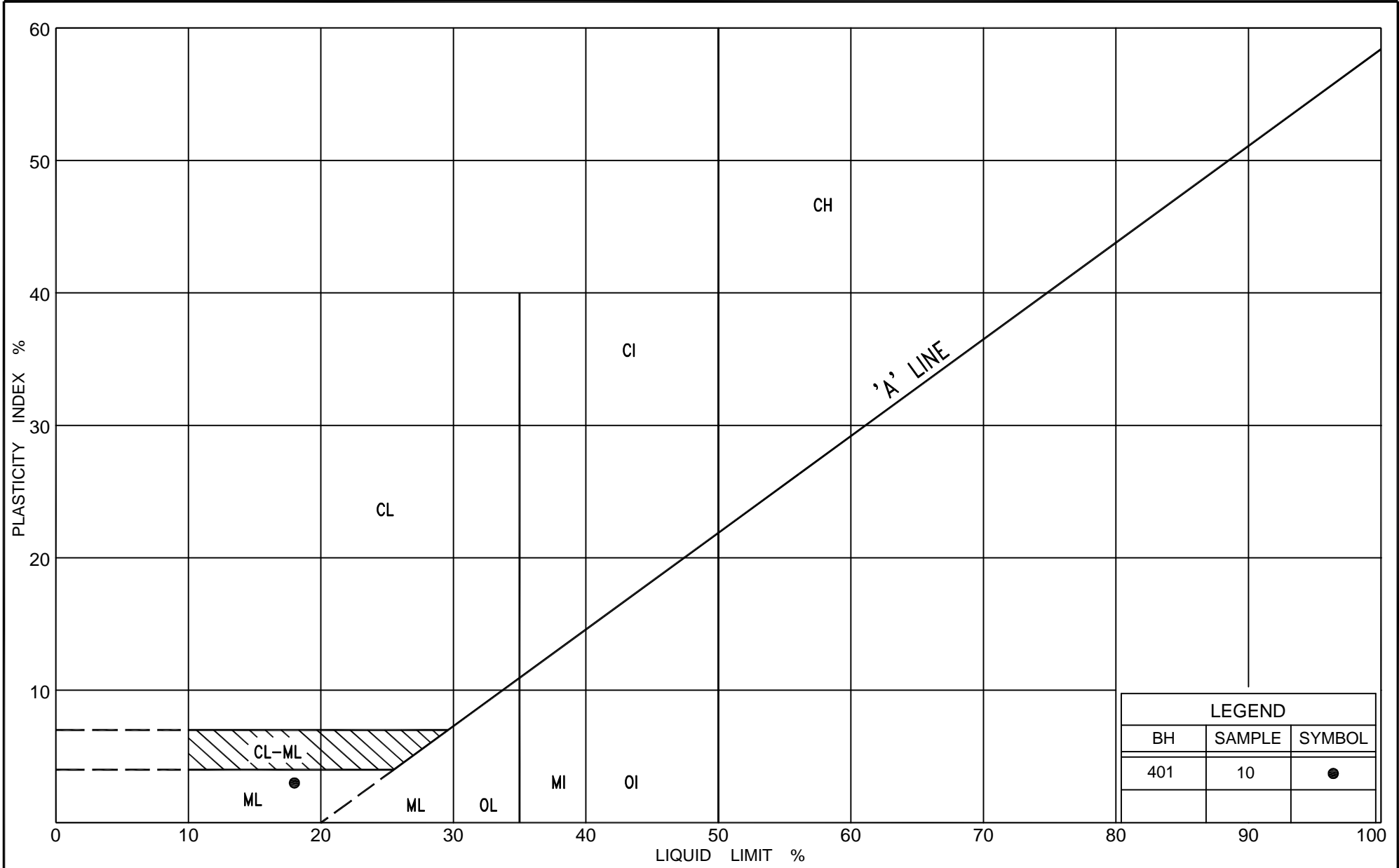


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|-------------|------|--|-------------|------|--------|--|-------------|------|-------------|--------|--------|--|--------|--|--|---------|-------------|
| SILT & CLAY |      |  |             | FINE |        |  | MEDIUM SAND |      |             |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









# TERMS USED IN REPORT



**N Value:** the standard penetration test (SPT) N value is the number of blows required to cause a standard 51 mm O.D. split barrel sampler to penetrate 0.3 m into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kg. Falling freely a distance of 0.76 m. For penetrations of less than 0.3 m N values are indicated as the number of blows for the penetration achieved. Average N value is denoted thus N.

**Dynamic cone penetration test:** continuous penetration of a conical steel point (51 mm 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 0.3 m 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/0.3 m) | 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, 100 mm + 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  | 50 mm      | 50 - 300 mm | 0.3 m - 1 m | 1 m - 3 m | > 3 m      |
|----------|------------|-------------|-------------|-----------|------------|
| Jointing | Very Close | Close       | Mod. Close  | Wide      | Very Wide  |
| Bedding  | Very Thin  | Thin        | Medium      | Thick     | Very Thick |

# ABBREVIATIONS AND SYMBOLS



## FIELD SAMPLING

|    |               |    |                            |
|----|---------------|----|----------------------------|
| SS | Split Spoon   | TP | Thinwall Piston            |
| WS | Wash Sample   | OS | Osterberg Sample           |
| ST | Slotted Tube  | RC | Rock Core                  |
| BS | Block Sample  | PH | T W Advanced Hydraulically |
| CS | Chunk Sample  | PM | T W Advanced Manually      |
| TW | Thinwall Open | FS | Foil Sample                |

## MECHANICAL PROPERTIES OF SOIL

|                |                       |                                      |
|----------------|-----------------------|--------------------------------------|
| $m_v$          | $\text{kPa}^{-1}$     | Coefficient of Volume Change         |
| $C_c$          | 1                     | Compression Index                    |
| $C_s$          | 1                     | Swelling Index                       |
| $C_a$          | 1                     | Rate of Secondary Consolidation      |
| $C_v$          | $\text{m}^2/\text{s}$ | Coefficient of Consolidation         |
| $H$            | m                     | Drainage Path                        |
| $\alpha_v$     | 1                     | Time Factor                          |
| $u$            | %                     | Degree of Consolidation              |
| $\sigma'_{vo}$ | kPa                   | Effective Overburden Pressure        |
| $\sigma'_p$    | kPa                   | Preconsolidation Pressure            |
| $\tau_f$       | kPa                   | Shear Strength                       |
| $c'$           | kPa                   | Effective Cohesion Intercept         |
| $\phi'$        | $^\circ$              | Effective Angle of Internal Friction |
| $c_u$          | kPa                   | Apparent Cohesion Intercept          |
| $\phi_u$       | $^\circ$              | Apparent Angle of Internal Friction  |
| $\tau_R$       | kPa                   | Residual Shear Strength              |
| $\tau_r$       | kPa                   | Remoulded Shear Strength             |
| $s_t$          | 1                     | Sensitivity                          |

## STRESS AND STRAIN

|                                |     |                               |
|--------------------------------|-----|-------------------------------|
| $U_w$                          | kPa | Pore Water Pressure           |
| $\gamma_u$                     | 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            |
| $e$                            | %   | Linear Strain                 |
| $e_1, e_2, e_3$                | %   | Principal Strain              |
| $\varepsilon$                  | kPa | Modulus of Linear Deformation |
| $G$                            | kPa | Modulus of Shear Deformation  |
| $\mu$                          | 1   | Coefficient of Friction       |

## PHYSICAL PROPERTIES OF SOIL

|                       |                        |                                |            |                        |  |
|-----------------------|------------------------|--------------------------------|------------|------------------------|--|
| $\rho_s$              | $\text{kg}/\text{m}^3$ | Density of Solid Particles     | $w_p$      | %                      | Plastic Limit  |
| $\gamma_s$            | $\text{kN}/\text{m}^3$ | Unit Weight of Solid Particles | $w_s$      | %                      | Shrinkage Limit  |
| $\rho_w$              | $\text{kg}/\text{m}^3$ | Density of Water               | $I_p$      | %                      | Plasticity Index = $w_L - w_p$                             |
| $\gamma_w$            | $\text{kN}/\text{m}^3$ | Unit Weight of Water           | $I_L$      | 1                      | Liquidity Index = $\frac{w - w_p}{I_p}$                    |
| $\rho$                | $\text{kg}/\text{m}^3$ | Density of Soil                | $I_C$      | 1                      | Consistency Index = $\frac{w_L - w}{I_p}$                  |
| $\gamma$              | $\text{kN}/\text{m}^3$ | Unit Weight of Soil            | $e_{\max}$ | 1, %                   | Void Ratio in Loosest State                                |
| $\rho_d$              | $\text{kg}/\text{m}^3$ | Density of Dry Soil            | $e_{\min}$ | 1, %                   | Void Ratio in Densest State                                |
| $\gamma_d$            | $\text{kN}/\text{m}^3$ | Unit Weight of Dry Soil        | $I_D$      | 1                      | Density Index = $\frac{e_{\max} - e}{e_{\max} - e_{\min}}$ |
| $\rho_{\text{sat}}$   | $\text{kg}/\text{m}^3$ | Density of Saturated Soil      | $D$        | mm                     | Grain Diameter   |
| $\gamma_{\text{sat}}$ | $\text{kN}/\text{m}^3$ | Unit Weight of Saturated Soil  | $D_n$      | mm                     | n Percent - Diameter                                       |
| $\rho'$               | $\text{kg}/\text{m}^3$ | Density of Submerged Soil      | $C_u$      | 1                      | Uniformity Coefficient                                     |
| $\gamma'$             | $\text{kN}/\text{m}^3$ | Unit Weight of Submerged Soil  | $h$        | m                      | Hydraulic Head or Potential                                |
| $e$                   | 1, %                   | Void Ratio                     | $q$        | m                      | Rate of Discharge  |
| $n$                   | 1, %                   | Porosity                       | $v$        | m/s                    | Discharge Velocity   |
| $w$                   | 1, %                   | Water Content                  | $i$        | 1                      | Hydraulic Gradient   |
| $s_r$                 | %                      | Degree of Saturation           | $k$        | m/s                    | Hydraulic Conductivity                                     |
| $w_L$                 | %                      | Liquid Limit                   | $J$        | $\text{kN}/\text{m}^3$ | Seepage Force  |

# RECORD OF BOREHOLE No 401

1 of 2

METRIC

G.W.P. 3029-05-00 LOCATION Co-ords: 4 624 951 N; 280 882 E ORIGINATED BY T.O.  
DIST 31 HWY -- BOREHOLE TYPE Continuous Flight Hollow Stem Augers and NX Coring COMPILED BY P.L.  
DATUM Geodetic DATE April 10, 2007 CHECKED BY D.W.K.

| SOIL PROFILE  |  |            | SAMPLES |      |                       | GROUND WATER<br>CONCENTRATIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                                    |                                     | UNIT<br>WEIGHT<br>$\gamma$<br>KN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|-----------------------|--------------------------------|-----------------|---|------------------------------------|-------------------------------------|---|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | W <sub>p</sub> VALUES |                                |                 | 20 40 60 80 100                             | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub>               |   |
| 174.3         | Lake Water Level   |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 170.8         | Water  |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 170.8         | Silty sand, trace gravel<br>with shell fragments and<br>woody organics |            | 1       | SS   | 16                    |                                | 170             |   |                                    |                                     |   |   |
|               | Compact Brown Saturated  |            | 2       | SS   | 50/bouncing*          |                                | 169             |   |                                    |                                     |   |   |
| 167.8         |  |            | 3       | SS   | 18                    |                                | 168             |   |                                    |                                     |   |   |
| 167.8         | Silty clay<br>with sand, trace of gravel                               |            |         |      |                       |                                | 167             |   |                                    |                                     |   |   |
| 165.5         | Firm to Grey Wet<br>very stiff   |            | 4       | SS   | 5                     |                                | 167             |   |                                    |                                     |   |   |
|               |  |            | 5       | SS   | 13                    |                                | 166             |   |                                    |                                     |   |   |
|               | Handy, silty, moist  |            | 6       | SS   | 17                    |                                | 165             |   |                                    |                                     |   |   |
|               |  |            | 7       | SS   | 17                    |                                | 164             |   |                                    |                                     |   |   |
| 164.4         |  |            |         |      |                       |                                | 163             |   |                                    |                                     |   |   |
| 164.4         | Silty clay<br>with sand, trace of gravel                               |            |         |      |                       |                                | 162             |   |                                    |                                     |   |   |
|               | Hard Grey Moist  |            | 8       | SS   | 47                    |                                | 161             |   |                                    |                                     |   |   |
|               | (TILL)   |            |         |      |                       |                                | 160             |   |                                    |                                     |   |   |
| 162.9         |  |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 162.9         | Sand, with silt and gravel   |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
|               | Very Blackish Saturated<br>dense grey                                  |            | 9       | SS   | 70                    |                                |                 |   |                                    |                                     |   |   |
|               | (TILL)   |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 161.4         |  |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 161.4         | Sandy silt<br>Trace of gravel  |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 159.9         | Very Grey Moist<br>dense   |            | 10      | SS   | >100                  |                                |                 |   |                                    |                                     |   |   |
|               | (TILL)   |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 160.1         |  |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 160.1         | Limestone bedrock  |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |
| 14.9          | High strength<br>Unweathered<br>Fair quality                           |            |         |      |                       |                                |                 |   |                                    |                                     |   |   |

\* bouncing  
on wire mesh  
wrapped  
cobbles and  
boulders, no  
recovery.  
Moved  
borehole 5m  
west.  
Relocated  
borehole  
encountered  
lm of rock  
fill at this  
depth.

# RECORD OF BOREHOLE No 401

2 of 2

METRIC

G.W.P. 3029-05-00 LOCATION Co-ords: 4 624 951 N; 288 882 E ORIGINATED BY T.O.  
DIST 71 HWY -- BOREHOLE TYPE Continuous flight hollow stem Augers and NX Coring COMPILED BY P.L.  
DATUM Guelph DATE April 10, 2007 CHECKED BY D.W.K.

| SOIL PROFILE  |  |            | SAMPLES |          |            | GROUND WATER<br>*<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  | PLASTIC NATURAL LIQUID<br>LIMIT MOISTURE CONTENT LIMIT |  |  | UNIT<br>WEIGHT<br><br>$\gamma$<br><br>KN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|----------|------------|---------------------------------|-----------------|---|--|--|--|--|---|---|
| FLYV<br>DEPTH | DESCRIPTION                                  | STRAT PLOT | NUMBER  | TYPE     | "N" VALUES |                                 |                 | SHEAR STRENGTH MPa                          |  | W <sub>p</sub> W W <sub>L</sub>                        |  |  |   |   |
| 159.3         |  |            |         |          |            |                                 |                 | 20 40 60 80 100                             |  |  |  |  |   |   |
|               | Refer to Table 1 for<br>detailed description |            | 11      | BC<br>NX |            |                                 | 154             | ○ UNCONFINED + FIELD VANE                   |  |  |  |  |   |   |
|               |  |            |         |          |            |                                 | 158             | ● QUICK TRIAXIAL x LAB VANE                 |  |  |  |  |   |   |
| 157.4         |  |            |         |          |            |                                 |                 | 20 40 60 80 100                             |  | 20 40 60   |  |  |   |   |
| 17.2          | End of borehole                              |            |         |          |            |                                 |                 |   |  |  |  |  |   |   |
|               | Water level observed<br>during drilling      |            |         |          |            |                                 |                 |   |  |  |  |  |   |   |
|               | Water level measured<br>after drilling       |            |         |          |            |                                 |                 |   |  |  |  |  |   |   |



# RECORD OF BOREHOLE No 402

1 of 1

METRIC

G.W.P. 3029-05-00 LOCATION Co-ords: 4 525 016 N; 2RR 904 E ORIGINATED BY T.O.  
DIST 31 HWY -- BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY P.L.  
DATUM Geodetic DATE April 03, 2007 CHECKED BY D.W.K.

| SOIL PROFILE |   |            | SAMPLES |      |          | GROUND WATER<br>CONDITIONS | 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>Y | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |
|--------------|---|------------|---------|------|----------|----------------------------|-----------------|---|--------------|------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|
| FLV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | N-VALUES |                            |                 | SHEAR STRENGTH MPa                          |              |                  |                                    |                                     |                                   |                     |   | WATER CONTENT (%) |
|              |   |            |         |      |          |                            |                 | ○ UNCONFINED                                | + FIELD VANE | ● QUICK TRIAXIAL |                                    |                                     |                                   |                     |   |                   |
| 174.3        | Lake Water Level  |            |         |      |          |                            |                 | 20 40 60 80 100                             |              |                  |                                    |                                     |                                   |                     | GR SA SI CL                                       |                   |
| 0.0          | Water   |            |         |      |          |                            |                 |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 169.4        |   |            |         |      |          |                            | 174             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 4.9          | Silty sand, trace gravel  |            |         |      |          |                            | 173             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 168.8        | Loose Brown Saturated   |            | 1       | SS   | 5        |                            | 172             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 5.5          | Silty clay<br>with sand, trace gravel<br>occasional shell fragments               |            | 2       | SS   | 5        |                            | 171             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
|              | Very soft to stiff Grey Wet   |            | 3       | SS   | 2        |                            | 170             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
|              |   |            | 4       | SS   | 6        |                            | 169             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 165.7        |   |            | 5       | SS   | 10       |                            | 168             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 8.6          | Silty clay<br>with sand, trace of gravel  |            | 6       | SS   | 37       |                            | 167             |   |              |                  |                                    |                                     |                                   |                     | 2 16 39 43  |                   |
|              | Hard Grey Dry<br>(TILL)   |            | 7       | SS   | 30       |                            | 166             |   |              |                  |                                    |                                     |                                   |                     | 2 29 46 21  |                   |
|              |   |            | 8       | SS   | 42       |                            | 165             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 162.9        |   |            |         |      |          |                            | 164             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 11.4         | Silty sand, trace of gravel   |            |         |      |          |                            | 163             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
|              | Very dense Grey Saturated<br>(TILL)   |            | 9       | SS   | 62       |                            | 162             |   |              |                  |                                    |                                     |                                   |                     | 10 59 28 3  |                   |
| 161.4        |   |            |         |      |          |                            | 161             |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 12.9         | Sandy silt<br>trace of gravel   |            | 10      | SS   | >100     |                            |                 |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 160.5        | Very Grey Moist<br>(TILL)   |            |         |      |          |                            |                 |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 159.3        |   |            |         |      |          |                            |                 |   |              |                  |                                    |                                     |                                   |                     |   |                   |
| 158.8        | End of borehole   |            |         |      |          |                            |                 |   |              |                  |                                    |                                     |                                   |                     |   |                   |
|              | Water level observed<br>during drilling<br>Water level measured<br>after drilling |            |         |      |          |                            |                 |   |              |                  |                                    |                                     |                                   |                     |   |                   |

ON\_MOT\_VLR0 0618 051E.GPJ ON\_MOT.GDT 0/18/2007 9:55:22 AM

+7 X5

Numbers refer to  
Sensitivity

20  
10 0 5  
10 (%) STRAIN AT FAILURE

# RECORD OF BOREHOLE No 403

1 of 2

METRIC

G.W.P. 1028-05-00 LOCATION Co-ords: 4 025 037 N; 288 907 E ORIGINATED BY T.C.  
DIST 31 HWY -- BOREHOLE TYPE Continuous Flight Hollow Stem Augers and NX Coring COMPILED BY P.L.  
DATUM Geodetic DATE March 29, 2007 CHECKED BY D.W.K.

| SOIL PROFILE   |   | SAMPLES     |        |          | GROUND WATER<br>CONDITIONS | 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 | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|----------------|---|-------------|--------|----------|----------------------------|-----------------|---|--------------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV.<br>DEPTH | DESCRIPTION   | STRAT. PLOT | NUMBER | TYPE     |                            |                 | N° VALUES                                   | SHEAR STRENGTH MPa |                                    |                                     |                                   |                     |   |
| 174.3          | Lake Water Level  |             |        |          |                            |                 | 20 40 60 80 100                             |                    |                                    |                                     |                                   |                     |   |
| 0.0            | Water   |             |        |          |                            |                 | 20 40 60 80 100                             |                    |                                    |                                     |                                   |                     |   |
| 169.4          |   |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
| 4.9            | Silty sand<br>trace of gravel   |             | 1      | SS       | 35                         |                 |   |                    |                                    |                                     |                                   |                     |   |
| 168.8          | Dense Grey Saturated  |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
| 5.5            | Silty clay<br>with sand, trace of gravel                                  |             | 2      | SS       | 6                          |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | Firm to Grey Wet<br>stiff   |             | 3      | SS       | 6                          |                 |   |                    |                                    |                                     |                                   |                     |   |
|                |   |             | 4      | SS       | 9                          |                 |   |                    |                                    |                                     |                                   |                     |   |
|                |   |             | 5      | SS       | 10                         |                 |   |                    |                                    |                                     |                                   |                     |   |
| 165.7          |   |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
| 8.6            | Silty clay<br>with sand, trace of gravel                                  |             | 6      | SS       | 19                         |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | Very Brownish Moist<br>stiff to grey                                      |             | 7      | SS       | 48                         |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | (TILL)  |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
|                |   |             | 8      | SS       | 91                         |                 |   |                    |                                    |                                     |                                   |                     |   |
| 163.4          |   |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
| 10.9           | Silty sand<br>trace of gravel   |             | 9      | SS       | >100                       |                 |   |                    |                                    |                                     |                                   |                     |   |
| 162.6          | Very dense Grey Moist   |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
| 11.7           | (TILL)  |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | Sandy silt<br>trace of gravel   |             | 10     | SS       | >100                       |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | Very Grey Moist<br>dense  |             | 11     | SS       | >100                       |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | (TILL)  |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
|                |   |             | 12     | SS       | >100                       |                 |   |                    |                                    |                                     |                                   |                     |   |
| 160.5          |   |             |        |          |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
| 13.8           | Limestone bedrock   |             | 13     | RC<br>NX |                            |                 |   |                    |                                    |                                     |                                   |                     |   |
|                | High strength<br>Slightly to moderately<br>weathered<br>Very poor quality |             | 14     | RC<br>NX |                            |                 |   |                    |                                    |                                     |                                   |                     |   |

# RECORD OF BOREHOLE No 403

2 of 2

METRIC

G.W.P. 3020-05-00 LOCATION Co-ords: 4 625 047 N; 288 907 E ORIGINATED BY T.C.  
 DIST 31 HWY -- BOREHOLE TYPE Continuous Flight Hollow Stem Augers and NX Coring COMPILED BY P.L.  
 DATUM Geodetic DATE March 29, 2007 CHECKED BY D.W.K.

| SOIL PROFILE            |   | SAMPLES    |        |      |          | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC NATURAL<br>LIMIT MOISTURE<br>CONTENT |                   | UNIT<br>WEIGHT<br><br>$\gamma$<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|-------------------------|---|------------|--------|------|----------|----------------------------|-----------------|---|-----------------|--|-------------------|---|---|
| ELEV<br>DEPTH           | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE | N-VALUES |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 | W <sub>p</sub> W W <sub>L</sub>              | WATER CONTENT (%) |   |   |
| 159.3<br>159.2<br>159.1 | Refer to Table 1 for<br>detailed description<br>End of borehole |            |        |      |          |                            | 159             |   |                 |  |                   |   | GR SA SI CL                                       |
|                         | Water level observed<br>during drilling                         |            |        |      |          |                            |                 |   |                 |  |                   |   |   |
|                         | Water level measured<br>after drilling                          |            |        |      |          |                            |                 |   |                 |  |                   |   |   |



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

CONT No 2007-3410  
GWP No 3029-05-00  
TEMPORARY TRANSFER FACILITY FOR  
REHABILITATION OF THE  
MTO FERRY DOCK AT PELEE ISLAND  
BOREHOLE LOCATIONS



**PMI Peto MacCallum Ltd.**  
CONSULTING ENGINEERS



| 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)       |  |  |  |
|        | Head                                     |  |  |  |
|        | ARTESIAN WATER<br>Encountered            |  |  |  |
|        | PIEZOMETER                               |  |  |  |

| BH No | ELEVATION | CO-ORDINATES |          |
|-------|-----------|--------------|----------|
|       |           | NORTHINGS    | EASTINGS |
| 401   | 174.3     | 4 624 951    | 288 882  |
| 402   | 174.3     | 4 625 016    | 288 904  |
| 403   | 174.3     | 4 625 037    | 288 907  |

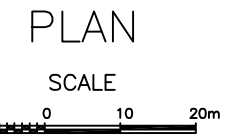
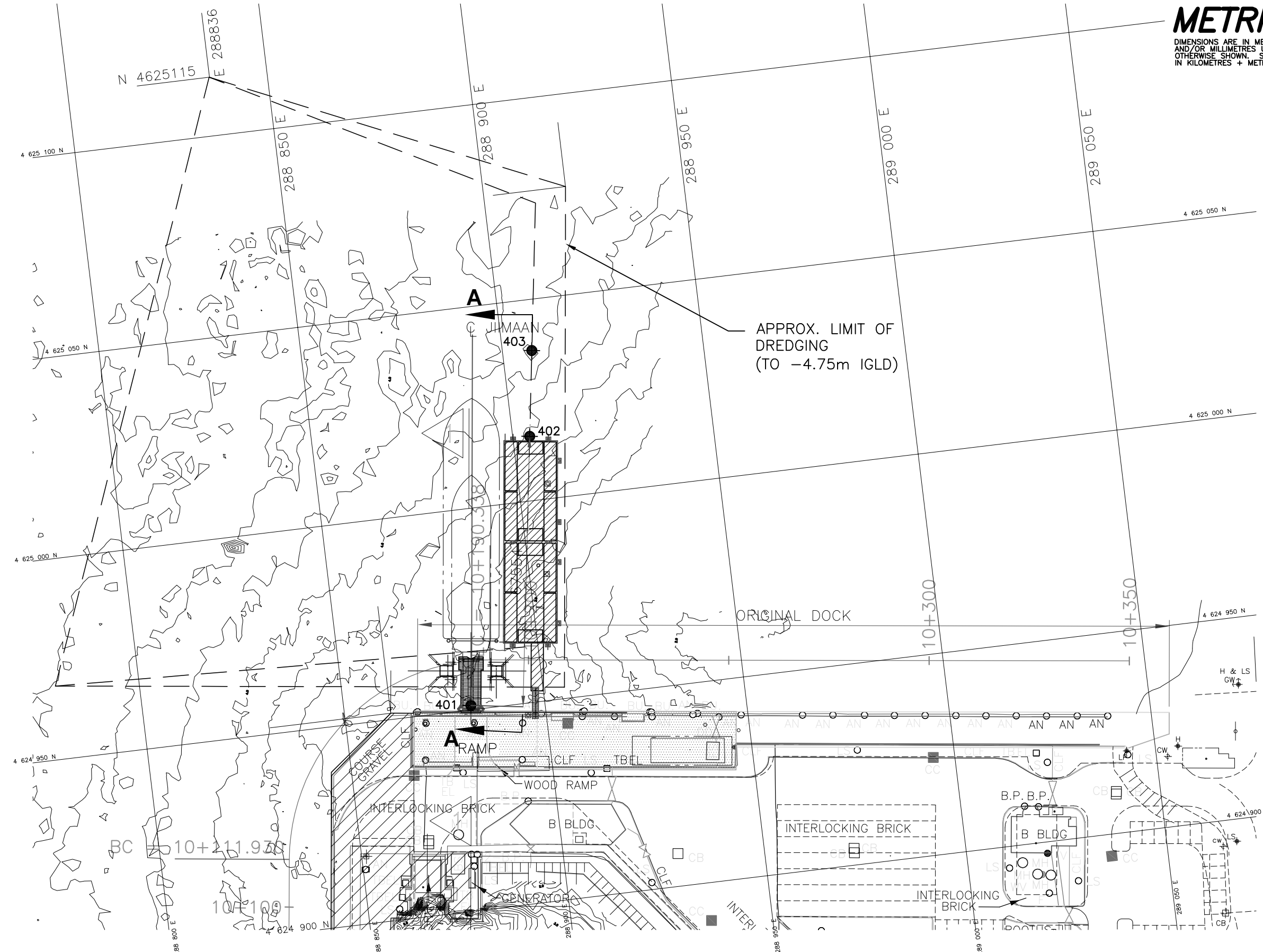


**NOTE**  
The boundaries between soil strata have been established  
only at Borehole locations. Between Boreholes the  
boundaries are assumed from geological evidence.

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

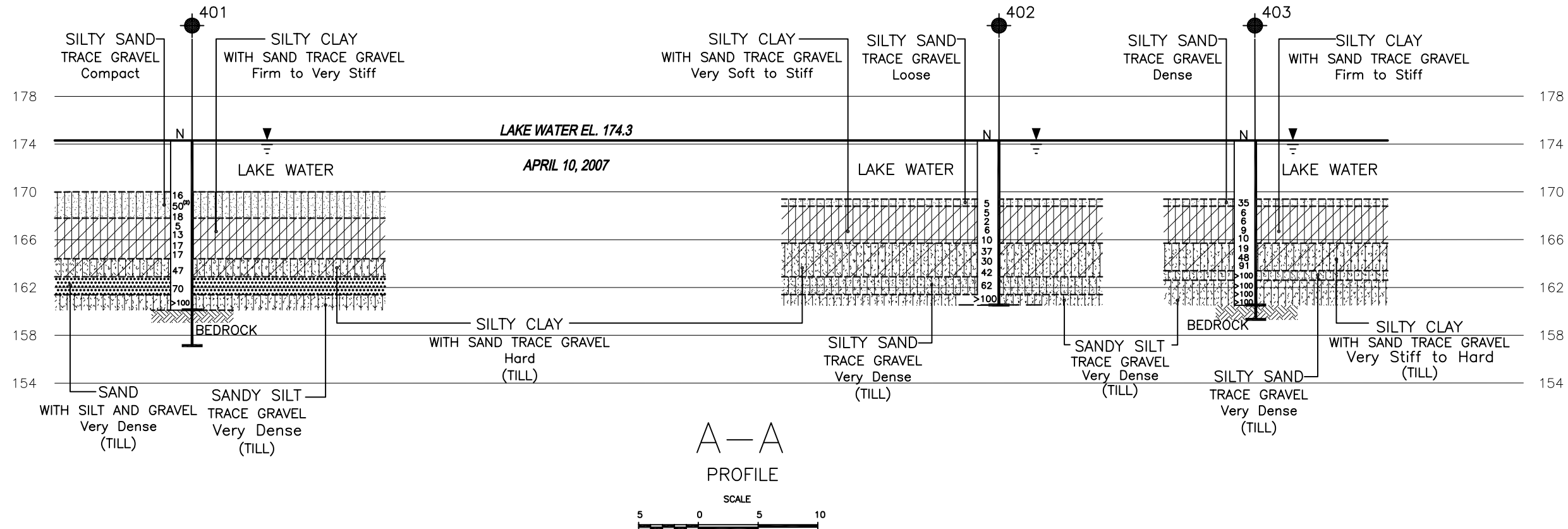
Geocres No. 40G15-4

|        |    |             |                    |      |    |
|--------|----|-------------|--------------------|------|----|
| HWY No |    |             |                    | DIST | 31 |
| SUBM'D | PL | CHECKED PL  | DATE JUNE 18, 2007 | SITE |    |
| DRAWN  | NA | CHECKED DWK | APPROVED DWK       | DWG  | 1  |



- NOTE:
- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
  - REFER TO DRAWING 2 FOR SOIL STRATA.

REF TSH Drawings Nos.;  
42-71058-TF-PETO-SITE.dwg; Base-Pelee.dwg;  
Pelee-Lake-Contours.dwg; received via email  
dated March 29, 2007



| 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)       |              |          |
|                                | Head                                     |              |          |
|                                | ARTESIAN WATER Encountered               |              |          |
|                                | PIEZOMETER                               |              |          |
| BH No                          | ELEVATION                                | CO-ORDINATES |          |
|                                |  | NORTHINGS    | EASTINGS |
| REFER TO DRAWING 1 FOR DETAILS |  |              |          |

NOTE:

- THIS DRAWING IS FOR SUBSURFACE INFORMATION ONLY. SURFACE DETAILS AND FEATURES ARE FOR CONCEPTUAL ILLUSTRATION.
- IN BOREHOLE 401, SAMPLE 2, SPLIT SPOON SAMPLER BOUNCING ON WIRE MESH WRAPPED COBBLES AND BOULDERS, NO RECOVERY. BOREHOLE WAS RELOCATED 5m WEST AND ENCOUNTERED 1m OF ROCKFILL AT THIS DEPTH.
- REFER TO DRAWING 1 FOR BOREHOLE LOCATION PLAN.

REF TSH Drawings Nos.;  
42-71058-TF-PETO-SITE.dwg; Base-Pelee.dwg;  
Pelee-Lake-Contours.dwg; received via email  
dated March 29, 2007



— 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. 40G15-4 |    |             |                         |
| HWY No ---          |    |             | DIST 31                 |
| SUBM'D              | PL | CHECKED PL  | DATE JUNE 18, 2007 SITE |
| DRAWN               | NA | CHECKED DWK | APPROVED DWK DWG 2      |



## **Appendix A**

### Site Photographs



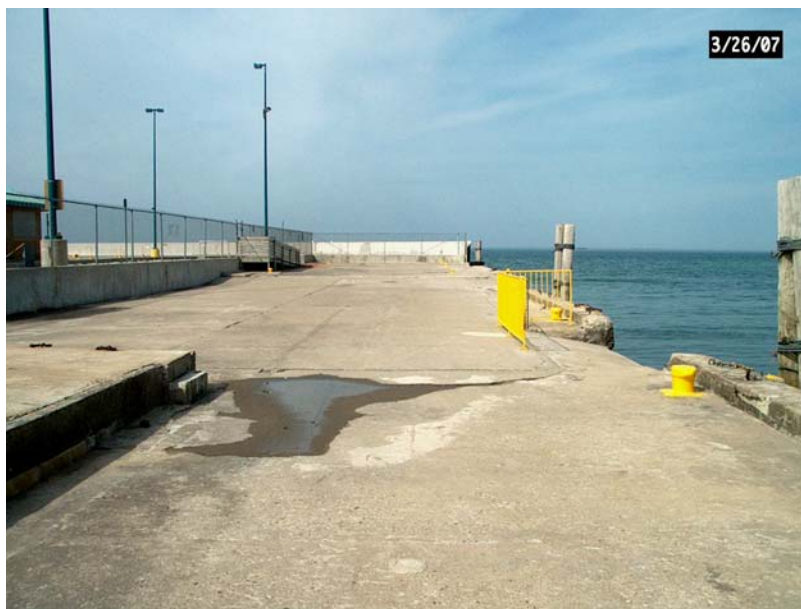
Photograph 1 – View northwest of Pelee Island West Wharf.  
(August 18, 2006)



Photograph 2 – View west of Pelee Island West Wharf.  
(August 18, 2006)



Photograph 3 – Pelee Island North Dock, view east.



Photograph 4 – Pelee Island North Dock, view west.



## **Appendix B**

Rock Core Photograph



Photograph 1 – Borehole 401, 14.2 to 17.2 m



**FOUNDATION DESIGN REPORT  
TEMPORARY TRANSFER FACILITY FOR  
REHABILITATION OF THE MTO FERRY DOCK AT PELEE ISLAND  
GWP 3029-05-00  
DISTRICT 31, CHATHAM**

**for  
TOTTEN SIMS HUBICKI ASSOCIATES**

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- 1 cc: PML Hamilton
- 1 cc: PML Toronto

PML Ref.: 06HF051E  
Geocres No.: 40G15-4  
Index ID No. 088FDR  
June 25, 2007





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Figure 1 – Key Plan

Figure 2 – Typical Section

Appendix A – Suggested NSSP for Field Review During Installation of Piles

**FOUNDATION DESIGN REPORT**  
for  
Temporary Transfer Facility  
for Rehabilitation of the MTO Ferry Dock at Pelee Island  
GWP 3029-05-00  
District 31, Chatham

---

**1. INTRODUCTION**

Construction of a temporary transfer facility (TTF) on the north side of the existing ferry dock at Pelee Island is planned to provide ferry dock service during rehabilitation of the MTO ferry dock at Pelee Island. This report provides foundation engineering comments and recommendations for detailed design and construction of the TTF.

The report was prepared for Totten Sims Hubicki Associates (TSH) on behalf of the Ministry of Transportation of Ontario (MTO).

The comments and recommendations provided in this report are based on subsurface information revealed in boreholes drilled for this study as well as boreholes drilled in 1988 and 1990 prior to construction of the West Dock, and boreholes drilled in 2004 for rehabilitation of the West Dock.

Information concerning design of the TTF was provided on the 90% complete drawings dated March 15, 2007 provided by TSH (Rehabilitation of Ferry Docks, Pelee Island, Temporary Transfer Facility dated March 2007).

It is noted that the new facility will consist of:

- The relocated scudder dock ramp and tower frames that will be supported by driven piles;
- The pile supported pier at the hinged end of the ramp;
- The guide and stop piles for the floating dock.



## 2. SUBSURFACE CONDITIONS

The subsurface stratigraphy revealed in the boreholes generally comprised lake bottom sediments of silty sand underlain by silty clay overlying silty clay till, silty sand till and sandy silt till mantling limestone bedrock. The water depth at the borehole locations ranged from 4.3 m adjacent to the dock to 4.9 m remote from the dock; the lake bottom elevation was 170.0 and 169.4, respectively. The depth referred to in the following paragraphs is relative to the lake water level at the time of the field investigation (March 29 to April 10, 2007).

It is noteworthy that refusal to auger penetration was met on a wire mesh wrapped gabion type erosion protection system encountered at a depth of approximately 5 m in Borehole 401. It was necessary to relocate and redrill the hole; the erosion protection was approximately 1 m thick at the second location.

## 3. SITE DESCRIPTION

The Pelee Island ferry dock is located near the intersection of West Dock Road and West Shore Road on the west side of Pelee Island, Ontario. Refer to Figure 1 for a location plan. The existing ferry dock complex is located on the west wharf and extends approximately 170 m out from shore. The proposed TTF is located on the north side of the original dock as indicated on Drawing 1 and is about 67 m long.

Pertinent details of the subsurface conditions are noted in the following table:

| Borehole No. | Water Depth (m) | Hard Silty Clay Till (m) | Very Dense Sand Till/<br>Silty Sand Till (m) | Bedrock (m)        |
|--------------|-----------------|--------------------------|--|--------------------|
|              | Depth           | Depth <sup>1</sup>       | Depth <sup>1</sup>                           | Depth <sup>1</sup> |
|              | Elevation       | Elevation                | Elevation                                    | Elevation          |
| 401          | 4.3             | 9.9                      | 11.4   | 14.2               |
|              | 170.0           | 164.4                    | 162.9  | 160.1              |
| 402          | 4.9             | 8.6                      | 11.4   | NE                 |
|              | 169.4           | 165.7                    | 162.9  |                    |
| 403          | 4.9             | 8.6                      | 10.9   | 13.8               |
|              | 169.4           | 165.7                    | 163.4  | 160.5              |

1. Depth below lake water level (elevation 174.3 at the time of the field investigation).

NE – Not encountered; Borehole 402 terminated in the very dense sandy silt till at a depth of 13.8 m, elevation 160.5.



## **4. ENGINEERING COMMENTS AND RECOMMENDATIONS**

### **4.1 General**

We understand the design calls for pipe piles driven to refusal in the very dense till to support the axial loads of the scudder dock ramp and tower frames as well as the pier at the hinged end of the ramp. The lateral loads imposed on the floating dock by the Ferry, wind, wave action and lake currents will be resisted by guide piles (open ended steel pipe piles) driven into the dense/hard till. Stop piles will also be driven near the north end of the relocated scudder ramp and tower frame for both the MV Jiimaan and the MV Pelee Islander. The design dredge level at the location of the TTF is 168.75.

It is anticipated that the piles driven for the facility will encounter practical refusal within the very dense sandy silt till near elevation 160.0 to 161.0.

Since the TTF guide piles are intended to resist lateral loads and the axial load is minimal, it is considered that these piles could be driven open ended. It is noted however, that cobbles/boulders were identified in the till units near elevation 163.0 in boreholes drilled for the west dock (Geocres 40G15-3). If hard driving is required to achieve the embedment depth to resist the lateral loads, these piles should be equipped with a driving shoe (OPSD 3001.100 Type I) to minimize the potential for damage during driving.

Due to the potential for cobbles/boulders to be encountered during driving of the stop piles and the piles that will support the scudder dock and ramp and, cognizant of the relatively light pile section to be driven (HSS 273 x 9.5), it is recommended that the bearing piles are equipped with driving shoes.

The pile driving operations should be performed and monitored in accordance with SP 903S01. In addition, a NSSP should be prepared to advise the pile driving contractor of the presence of cobbles/boulders at this site to ensure that more comprehensive engineering supervision is required than is called for in SP 903S01. A suggested wording is provided in Appendix A on the document titled 'Suggested NSSP for Field Review During Installation of Piles'.



The seismic coefficient for the conditions at this site is 1.5 (Type III soil profile as per clause 4.4.6 of the CHBDC, CAN/CSA-S6-00 (2006)). The zonal acceleration ratio is 0.00. The ferry dock is located in Seismic Performance Zone 1.

The liquefaction potential of the clayey soils at the site was evaluated by consideration of the grain size distribution (% of particles < 0.005 mm), liquid limit values and the ratio of the water content to the liquid limit (> 0.9). Based on the research by Marcuson et al (1990), we believe liquefaction of the fine grained soils (more than 35% of the soil particles passing the No. 200 sieve) is unlikely. The liquefaction potential of the silts and sands at the site was assessed using the procedure suggested by Seed and Idriss (1971) and, on this basis, it is considered that liquefaction of the granular soils is unlikely as well (clause 4.6.2 of the CHBDC).

#### **4.2 Temporary Floating Dock Guide Piles**

Resistance to the lateral loads will be provided by the passive earth pressure developed on the piles to a depth of six diameters of the pile below the dredge level as well as the horizontal bearing resistance of the soil below this depth.

It is anticipated that the piles driven to support the scudder dock will encounter practical refusal within the hard sandy silt till near elevation 160.0 to 161.0.

The passive resistance developed by the soil to a depth below the design dredge level equal to six times the diameter of the pile should be computed using the following equation acting on an area equivalent to a width of three pile diameters to a depth of six diameters below the dredge level provided the centre to centre spacing between the piles is greater than five times the diameter of the pile (refer to following table for details). A typical section is provided on Figure 2.



### Passive Pressure

(1)

$$p_p = K_p (\gamma' h_s + q)$$

where  $K_p$  = passive earth pressure coefficient

$h_s$  = depth below design dredge level (m)

$\gamma'$  = buoyant unit weight of soil  
below design dredge level ( $\gamma - \gamma_w$ ) kN/m<sup>3</sup>

$q$  = surcharge load (kN/m<sup>2</sup>)

$\gamma_w$  = unit weight of water  
= 9.8 kN/m<sup>3</sup>

The factored passive resistance at ULS is 0.5 p.

| Elevation       |                                    | Total Unit Weight<br>( $\gamma$ kN/m <sup>3</sup> ) | Effective <sup>2</sup><br>Cohesion<br>( $c'$ )<br>(kPa) | Effective <sup>2</sup><br>Friction Angle<br>( $\phi'$ )<br>(Degrees) | Passive Earth <sup>2</sup><br>Pressure<br>Coefficient<br>( $K_p$ ) |
|-----------------|------------------------------------|---|---|--|--|
| 168.75          | Design Dredge Level <sup>(1)</sup> |   |   |  |  |
| 168.75 to 164.4 | Silty clay                         | 17.0  | 3 <sup>(2)</sup>  | 28 <sup>(2)</sup>  | 2.8  |
| 164.4 to 162.9  | Silty clay till                    | 20.5  | 10  | 32   | 3.2  |
| 162.9 to 161.4  | Sand/silty sand till               | 22.0  | 0   | 40   | 4.6  |
| 161.4 to 160.1  | Sandy silt till                    | 22.0  | 0   | 40   | 4.6  |
| 160.1           | Top of bedrock                     |   |   |  |  |

(1) From TSH drawing referred to in Section 1.

(2) These parameters are based on effective stress design. The silty clay is slightly over consolidated and will be permanently submerged. Hence, use of total stress parameters is considered to be suitable for the silty clay -  $c_u = 45$  kPa;  $\phi' = 0$ .



The factored horizontal bearing resistance at ULS of the strata below the zone of passive pressure development noted above is considered to be:

| Elevation       | Soil Description     | Factored Horizontal Bearing Resistance at ULS (kPa) |
|-----------------|----------------------|---|
| 168.75 to 164.4 | Silty clay           | 50 kPa  |
| 164.4 to 162.9  | Silty clay till      | 200 kPa   |
| 162.9 to 161.4  | Sand/silty sand till | 400 kPa   |
| 161.4 to 160.1  | Sandy silt till      | 500 kPa   |

The following equation should be employed to evaluate the coefficient of horizontal subgrade reaction along the pile; modulus values to model the response of the soil in front of the pile (passive zone) by 'springs' are also provided:

Granular

$$k_s = n_h z/b$$

where  $k_s$  = coefficient of horizontal subgrade reaction  $\text{kN/m}^3$

$n_h$  = coefficient related to soil density  
 Refer to the following table for details

$z$  = depth, m

$b$  = pile width, m



### Cohesive

$$k_s = \frac{67 c_u}{b}$$

where  $k_s$  = coefficient of horizontal subgrade reaction  $\text{kN/m}^3$

$c_u$  = undrained shear strength of the clay  
Refer to the following table for details

$b$  = pile width, m

| Elevation             | Soil Profile         | Soil Density <sup>(1)</sup><br>Coefficient<br>( $n_h$ - $\text{kN/m}^3$ ) | Undrained Shear<br>Strength<br>( $c_u$ - $\text{kPa}$ ) | Soil Modulus <sup>(2)</sup><br>( $k_s$ - $\text{mN/m}^3$ ) |
|-----------------------|----------------------|---|---|--|
| 168.75 <sup>(3)</sup> | Design Dredge Level  |   |   |  |
| 168.75 to<br>164.4    | Silty clay           | N/A   | 45  | 10   |
| 164.4 to<br>162.9     | Silty clay till      | N/A   | 250   | 40   |
| 162.9 to<br>161.4     | Sand/silty sand till | 10,000  | N/A   | 80   |
| 161.4 to<br>160.1     | Sandy silt till      | 15,000  | N/A   | 100  |
| 160.1                 | Top of bedrock       |   |   |  |

(1) Values shown are applicable to 'below water' situations which is the case for the conditions at this site.

(2) Based on a pile width of 273 mm.

(3) From TSH drawing referred to in Section 1.

N/A Not applicable

### **4.3 Scudder Dock Ramp Support Piles**

It is anticipated that the piles driven to support the scudder dock will encounter practical refusal within the very dense sandy silt till near elevation 160.0 to 161.0





The recommended factored axial resistance at ultimate limit states (ULS) for four pipe pile sections is provided:

| <b><u>Factored Axial Resistance at ULS, kN</u></b> |      |
|--|------|
| 273 x 7.1  | 1100 |
| 273 x 9.5  | 1425 |
| 324 x 7.1  | 1300 |
| 324 x 9.5  | 1725 |
| 406 x 11.1   | 2550 |

The very dense sandy silt till is considered to be non yielding. Therefore, the factored resistance at ULS will govern since the load required to cause 25 mm of movement at SLS will be much greater.

Resistance to lateral loads should be computed using the equations provided in section 4.2.

Group action for lateral loading should be considered when the pile spacing in the direction of the loading is less than eight pile diameters/widths. Group action can be evaluated by reducing the coefficient of horizontal subgrade reaction in the direction of loading by a reduction factor, R, as follows:

| <b>Pile Spacing in Direction of Loading<br/>d = Pile Diameter or Width</b> | <b>Subgrade Reaction Reduction Factor, R</b> |
|--|--|
| 8d   | 1.00   |
| 6d   | 0.70   |
| 4d   | 0.40   |
| 3d   | 0.25   |

## 5. CLOSURE

The report was prepared by Mr. Peter A. Lyall, P.Eng. and Mr. Dennis W. Kerr, MEng, P.Eng., Chief Foundation Engineer. Mr. Brian R. Gray, MEng, P.Eng., MTO Designated Contact, carried out an independent review of the report.

Sincerely

Peto MacCallum Ltd.



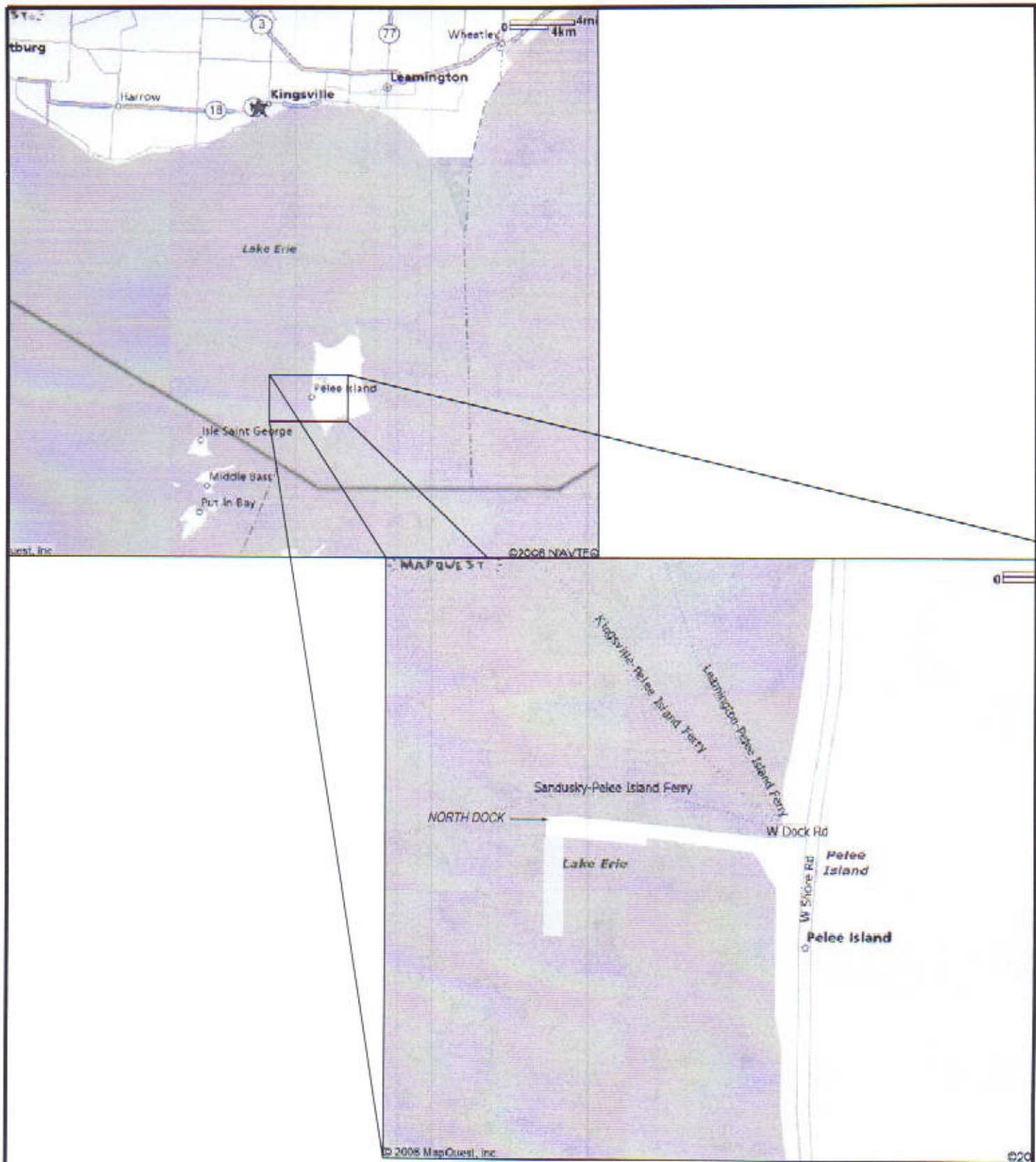
Dennis W. Kerr, MEng, P.Eng.  
Chief Foundation Engineer



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



DWK:lad



**TOTTEN SIMS HUBICKI ASSOCIATES**

**KEY PLAN**

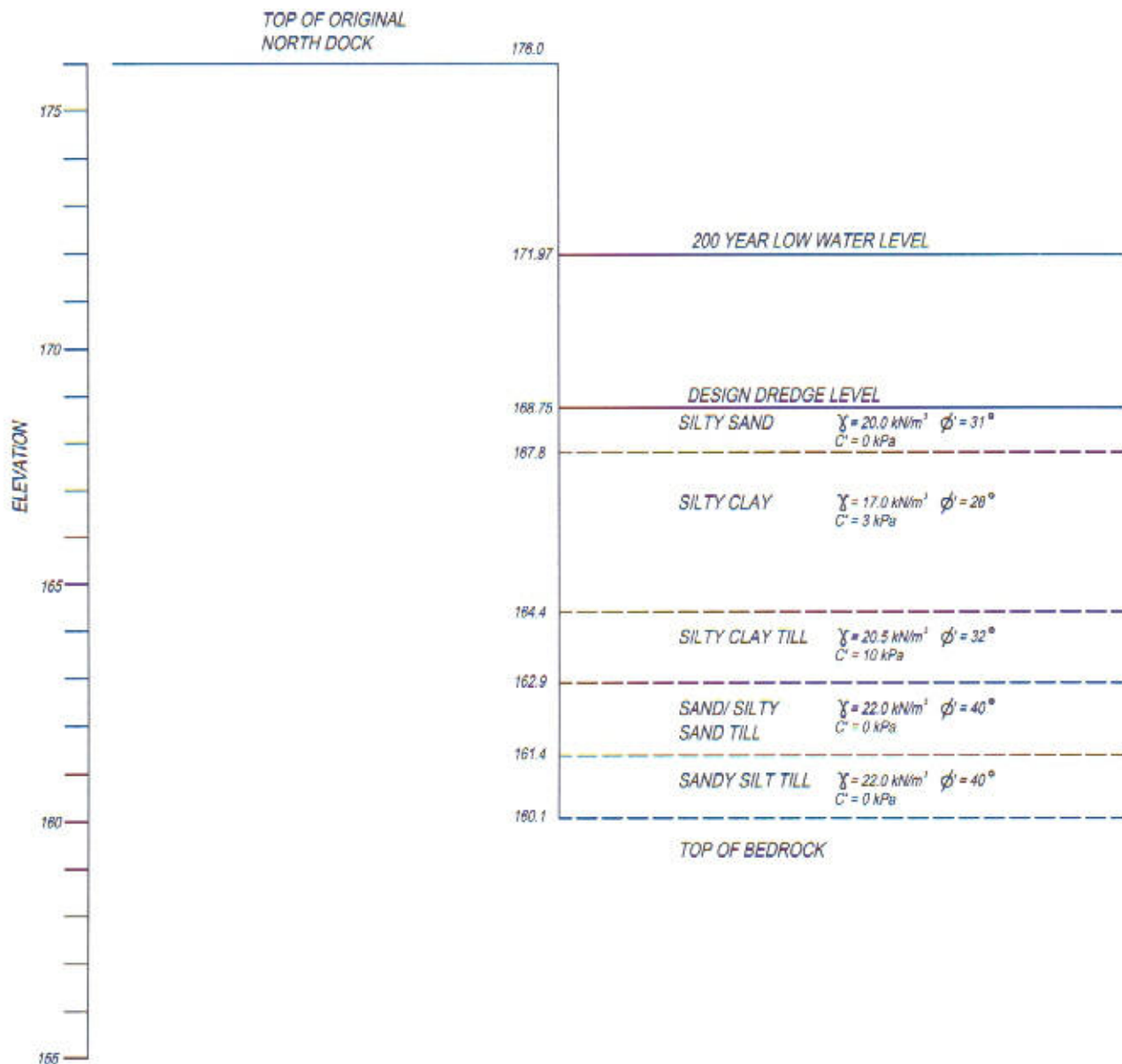
**PELEE ISLAND DOCK  
TEMPORARY TRANSFER FACILITY**



**Peto MacCallum Ltd.**

CONSULTING ENGINEERS

|          |     |            |       |          |            |
|----------|-----|------------|-------|----------|------------|
| DRAWN    | PL  | DATE       | SCALE | PML REF. | FIGURE NO. |
| CHECKED  | DWK | APRIL 2007 | NTS   | 06HF051E | 1          |
| APPROVED | DWK |            |       |          |            |



**TOTTEN SIMS HUBICKI ASSOCIATES**

**TYPICAL SECTION**

**PELEE ISLAND DOCK  
TEMPORARY TRANSFER FACILITY**

**PML Peto MacCallum Ltd.**  
CONSULTING ENGINEERS

|          |     |            |          |          |            |
|----------|-----|------------|----------|----------|------------|
| DRAWN    | PL  | DATE       | SCALE    | JOB NO.  | FIGURE NO. |
| CHECKED  | DWK | APRIL 2007 | AS SHOWN | 06HF051E | 2          |
| APPROVED | DWK |            |          |          |            |



## **Appendix A**

Suggested NSSP for Field Review During Installation of Piles



## **Suggested NSSP for Field Review During Installation of Piles**

### **Control Measures During Driving of Piles**

This special provision describes requirements for site review during driving of piles where cobbles/boulders were identified during the Foundation Investigation at the Pelee Island Temporary Floating Dock.

The contractor is advised that the piles at these structures may be driven through cobbles/boulders which may impede penetration of the piles and/or damage the piles. The contractor is also advised that more comprehensive engineering supervision than is called for in SP903 S01 is required during driving of piles at these locations.

The contractor shall retain a professional engineer with at least five years of continuing work experience providing site review during installation of the driven piles.

The professional engineer shall:

- i) Review the Foundation Investigation Report.
- ii) Monitor the pile penetration over the complete length of the pile.
- iii) Assess the performance of the hammer as the pile is driven.
- iv) Count the number of blows required to advance the pile during each 25 mm of penetration below the depth where the driving resistance exceeds 100 blows for 300 mm of penetration.
- v) Count the number of blows per minute of the hammer during driving of the piles below the depth where the driving resistance exceeds 100 blows for 300 mm of penetration.
- vi) Interpret the data on an ongoing basis as the pile is driven for evidence of unusual conditions that could indicate pile damage, the piles are not overdriven and the need to drive replacement piles if evidence of damage is detected.
- vii) Conduct visual examination of the pile for evidence of damage after the pile is driven.