



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE
OTTAWA, ONTARIO**

GWP 4048-11-00

Geocres No.: 31G5-298

Report to:

WSP Canada

Latitude: 45.416477
Longitude: -75.674400

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PART 1. FACTUAL INFORMATION

1 INTRODUCTION

This section of the report presents factual findings obtained from a previous foundation investigation that are pertinent to a proposed camera pole relocation at the location of the proposed new Highway 417 Underpass at Nicholas Street within the City of Ottawa. The investigation was originally carried out by Thurber Engineering Limited (Thurber) for the proposed underpass structure replacement. Thurber carried out this assignment as a sub-consultant to WSP Canada (WSP) under G.W.P. 4048-11-00.

The purpose of this section of the report is to provide a borehole location plan, records of boreholes, laboratory test results and a written description of the subsurface conditions in the vicinity of the camera pole based on the results of the previous investigation. The previous investigation is available in the Geocres library and is identified as follows:

Foundation Investigation Report, Structure Replacement, Highway 417
Nicholas Street Underpass (Site #3-224), Ottawa, Ontario, G.W.P. 4048-11-00,
dated April, 2018. [Geocres 31G5-284]

2 SITE DESCRIPTION

The west side of the existing north approach embankment to the Nicholas Street bridge is presently vegetated with grass with ground surface elevations ranging from about 60 m at the toe of the embankment to about 67 m at Nicholas Street. The embankment has a slope inclination of about 4H:1V.

Nicholas Street currently has two southbound lanes and two northbound lanes divided with a raised median. It is approximately 22 m wide. Highway 417 is a six-lane divided highway. A concrete roadside barrier is present on the north side of the highway in the vicinity of the site. The land adjacent to the site is occupied by apartment buildings, single family dwellings and commercial structures.

3 DESCRIPTION OF SUBSURFACE CONDITIONS

3.1 General

Borehole 17-02 from the previous investigation is located in the vicinity of the proposed camera pole. Please refer to Geocres Report 31G5-284 for a full description of investigation methodology. The location of Borehole 17-02 is shown on the Borehole Location Drawing included in Appendix A. Details of the soil stratigraphy encountered in Borehole 17-02 are presented on the Record of Borehole sheets included in Appendix B. Laboratory test results from the samples collected in Borehole 17-02 are included in Appendix C.

A general description of the stratigraphy based on the conditions encountered in Borehole 17-02 is given in the following sections. However, the factual data presented on the Record of Borehole sheets takes precedence over this general description for interpretation of the site conditions. It must be recognized that the soil and groundwater conditions may vary beyond the borehole location.

In general terms, the subsurface conditions at Borehole 17-02 consist of topsoil and fill that contains waste debris (e.g., brick, coal, organics, wood, ash, and glass) overlying native deposits of silty sand, clay, silt, sandy silt with gravel, and glacial till. The overburden is underlain by shale bedrock.

3.2 Topsoil

A layer of silty sand with organics (topsoil fill) was present at the ground surface of Borehole 17-02. The topsoil was 0.2 m thick with a base elevation of 58.8 m.

3.3 Fill

Fill was present below the topsoil. The fill was composed of sand with silt and gravel and contained waste debris (e.g., brick, coal, organics, wood, ash, and glass). The fill was 4.0 m thick with a base elevation of 55.8 m. The fill was generally brown in colour from 0.2 to 3.0 m depth and was brown-black from 3.0 to 4.2 m depth.

The SPT tests conducted in the fill gave N-values ranging from 1 to 23 blows, indicating a very loose to compact state of packing.

The recorded moisture contents of the fill ranged from 14 to 105%, increasing with depth.

The results of grain size distribution testing conducted on two samples of the fill are summarized below and are illustrated on Figure C1 in Appendix C.

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 24 – 40 |
| Sand | 52 – 64 |
| Silt | 8 – 12 |
| Clay | |

3.4 Silty Sand

A layer of native dark brown silty sand with trace gravel (possibly buried topsoil) was present below the fill. The silty sand was 0.4 m thick with a base elevation of 55.4 m.

The recorded moisture content of the silty sand was 53%.

3.5 Marine Clay

A native deposit of sensitive marine clay was present below the silty sand. The clay was grey in colour and was 3.3 m thick with a base elevation of 52.1 m.

One SPT test conducted in the clay gave an N-value of 2 blows. Field vane tests were performed within the deposit and recorded undrained shear strengths ranging from 47 to 87 kPa, indicating a firm to stiff consistency. Remoulded field vane testing in the clay indicates a sensitive to extra-sensitive soil based on criteria provided in the Canadian Foundation Engineering Manual.

The recorded moisture contents of the clay ranged from 46 to 50%.

The results of grain size distribution testing conducted on one sample of the clay are summarized below and are illustrated on Figure C2 in Appendix C.

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 0 |
| Sand | 4 |
| Silt | 44 |
| Clay | 52 |

Atterberg Limit testing was completed on one sample of the clay. The results are summarized on the Record of Borehole sheets in Appendix B and on Figure C5 in Appendix C. The laboratory results are summarized below and indicate that the clay is of intermediate plasticity (CI).

| Parameter | Value |
|------------------|-------|
| Liquid Limit | 42 |
| Plastic Limit | 22 |
| Plasticity Index | 20 |

3.6 Silt

A native deposit of silt was present below the marine clay. The silt was 0.8 m thick with a base elevation of 51.3 m.

One SPT test conducted in the silt gave an N-value of 9 blows, indicating a loose state of packing.

The recorded moisture content of the silt was 20%.

3.7 Sandy Silt with Gravel

A native deposit of sandy silt with gravel (a transitional layer between the silt and underlying glacial till) was present below the silt. The sandy silt with gravel was 1.1 m thick with a base elevation of 50.2 m.

One SPT test conducted in the sandy silt with gravel gave an N-value of 'weight of hammer', indicating a very loose state of packing.

The recorded moisture content of the sandy silt with gravel was 7%.

The results of grain size distribution testing conducted on one sample of the sandy silt with gravel are summarized below and are illustrated on Figure C3 in Appendix C.

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 26 |
| Sand | 36 |
| Silt | 30 |
| Clay | 8 |

Atterberg Limit testing was completed on the fines portion of one sample of the sandy silt. The results of that testing indicate that the sandy silt is non-plastic.

3.8 Silty Sand with Gravel and Shale Fragments (Glacial Till)

A native deposit of silty sand with gravel and shale fragments (glacial till) was present below the sandy silt with gravel. The glacial till was 5.3 m thick with a base elevation of 44.8 m.

SPT tests conducted in the glacial till generally gave N-values ranging from 2 to 29 blows, indicating a very loose to compact state of packing. One SPT test conducted at the base of the deposit gave an N-value of 100 blows for 203 mm of penetration; however, this high blow count is due to the presence of shale bedrock within the sampled interval rather than the state of packing of the soil matrix.

The recorded moisture contents of the glacial till ranged from 6 to 9%.

The results of grain size distribution testing conducted on one sample of the glacial till are summarized below and are illustrated on Figure C4 in Appendix C.

| Soil Particle | Percentage (%) |
|---------------|----------------|
| Gravel | 27 |
| Sand | 54 |
| Silt | 19 |
| Clay | |

3.9 Shale Bedrock

Shale bedrock was present below the glacial till. The bedrock surface was encountered at a depth of 15.1 m below the existing ground surface (El. 44.8 m). The shale bedrock was cored to a depth of 18.7 m (El. 41.3 m).

The Total Core Recovery (TCR) was consistently 100%, the Solid Core Recovery (SCR) ranged from 98 to 100% and the Rock Quality Designation (RQD) ranged from 78 to 89%. Based on the RQD values, the bedrock is classified as good quality.

3.10 Groundwater

The groundwater level was not monitored within Borehole 17-02 as part of the previous investigation. However, a vibrating wire piezometer was installed in Borehole 17-04 (at the south approach embankment) with its sensor tip at a depth of 16.4 m (elev. 46.2 m) to allow for measurements of the groundwater level. The groundwater level within Borehole 17-04 was measured at approximately 10.4 m depth (elev. 52.2 m) on November 27th, 2017 and on March 22, 2018.

These observations are considered short term and it should be noted that the groundwater level at the time of construction may be higher and seasonal fluctuations of the groundwater level are to be expected. In particular, the groundwater level may be at a higher elevation during the spring and/or after periods of significant and/or prolonged precipitation.

3.11 Analytical Testing

One sample of soil was submitted to Paracel Laboratories in Ottawa, Ontario for analysis of water soluble sulphate and chloride concentrations, pH, and resistivity. The analysis results are included in Appendix C and are summarized in the table below:

| Borehole | Sample | Depth (m) | Sulphate (µg/g) | pH | Resistivity (Ohm-cm) | Chloride (µg/g) |
|----------|--------|-----------|-----------------|------|----------------------|-----------------|
| 17-02 | SS3 | 1.5 – 2.1 | 487 | 7.46 | 1930 | 23 |

4 MISCELLANEOUS

Interpretation of the factual data and the preparation of this report were carried out by Mr. Stephen Dunlop, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



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PART 2. ENGINEERING DISCUSSION AND RECOMMENDATIONS

5 GENERAL

This section of the report presents interpretation of the factual data in Part 1 of this report for the proposed camera pole relocation at the location of the proposed new Highway 417 Underpass at Nicholas Street within the City of Ottawa. A geotechnical assessment and recommendations are provided to assist the project team in designing a suitable foundation for the proposed pole.

This foundation investigation and design report with the interpretation and recommendations contained herein are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction or design-build contractor. The construction or design-build contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

5.1 Proposed Structure

Information on the general location of the proposed camera pole was provided to Thurber by WSP. It is understood that the camera pole will be designed as a direct buried concrete pole with a total length of 24.348 m. The pole will be tapered with a base diameter of 620 mm and a tip diameter of 305 mm. The recommendations provided herein are based on the subsurface conditions encountered in a borehole that was drilled for a previous investigation, which is located in the vicinity of the proposed camera pole. The Record of Borehole is presented in Appendix B.

In relation to the proposed bridge structure, the new camera pole will be located on the west side of the north approach embankment, adjacent to the north abutment. Presently, the proposed camera pole location is at the base of the existing approach embankment and is vegetated with grass. The current ground surface elevation is about 60 m. Once the new approach embankment is constructed, the final ground surface elevation at the proposed camera pole will be about 67 m (i.e., an approximately 7 m high embankment will be present over the existing soils by the time the camera pole is constructed).

The approach fills are to be constructed with OPSS Select Subgrade Material (SSM) or Granular B Type II. The side slope of the approach fill adjacent to the camera pole is understood to be 2.5H:1V.

5.2 Foundation Design

Design of the camera pole should be carried out in accordance with the following document:

- Ministry of Transportation, Ontario (2004) "Guidelines for the Design of High Mast Pole Foundations, Fourth Edition", Engineering Standards Branch, Bridge Office (Reference 1).

Reference should also be made to the following document:

- Canadian Highway Bridge Design Code (2014) CSA S6-14 (Reference 2).

Thurber has assessed the foundation design requirements in relation to the procedures provided in the 'Guidelines for the Design of High Mast Pole Foundations' for homogeneous cohesionless soil. Soil parameters used for this assessment are provided in Table D1 in Appendix D. For a 24.348 m long pole, our analysis indicates a minimum embedment depth of 4.5 m and a minimum caisson diameter of 1.22 m (the outer diameter of the concreted hole, with the 620 mm diameter pole installed in the centre). This assessment neglects passive resistance within the frost penetration depth of 1.8 m. At the request of WSP, the soil-structure interaction was analyzed with the commercially available software, LPILE, to assist with the structural design. This analysis assumes an inclined slope of 2.5H:1V, negligible passive resistance within the upper 1.8 m frost zone, and the following factored loads at the ground surface, as provided by WSP.

| Factored Loads | Serviceability Limit States (SLS) | Ultimate Limit States (ULS) |
|----------------|-----------------------------------|-----------------------------|
| Axial (kN) | 100 | 110 |
| Shear (kN) | 14 | 26 |
| Moment (kN-m) | 184 | 341 |

The LPILE output graphs for shear, moment, deflection, and soil reaction are provided in Appendix D.

It should be noted that some variation should be anticipated in soil conditions between the borehole location and the proposed camera pole foundation.

5.3 Pole Installation

Pole installation should generally be carried out in accordance with OPSS.PROV 615 as amended by Special Provision No. 682S30. The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to the pole installation at this site. Suggested wording for this NSSP is provided in Appendix E.

Excavation/augering equipment must be able to dislodge, handle and remove obstructions/cobbles within the fill.

Since the subsurface conditions are expected to consist of embankment fill above the groundwater level, the drilled hole for the pole installation is expected to remain open during construction even if it is unsupported; however, unexpected soil sloughing or water seepage could occur. As such, temporary liners should be available to support the sidewalls and provide seepage cut-off, as required.

The final grading around the pole should be in accordance with OPSD 2210.010.

5.4 Cement Type and Corrosion Potential

The new pole installation is expected to be entirely within embankment fill constructed with SSM or Granular B Type II. The analytical testing that was carried out for the previous Foundation Investigation Report was completed on samples of the existing soils that will not be in contact with the new camera pole (i.e., the tested soils will be below the new embankment) and are therefore not applicable. However, the following comments are provided regarding cement type and corrosion.

- The imported fill used to construct the embankment is expected to have soluble sulphate concentration less than 1000 µg/g and therefore Type GU Portland Cement should be suitable for use in concrete at this site.
- It is expected that the embankment soils will be subjected to road de-icing salts, which will produce a corrosive sub-surface environment at the location of the camera pole. The potential for corrosion of exposed steel should be considered in the design.

5.5 Construction Risks

The risks for this type of installation are considered low. Concerns during construction mainly involve the handling and removal of obstructions/cobbles, and seepage into the foundation excavation, both of which are unlikely to occur. However, the contractor should be prepared to manage these issues, if required.

If the excavation extends into the existing soil, there is a potential to encounter waste materials within the fill. In that case, the contractor should be prepared to handle and appropriately dispose of the waste off-site.

6 CLOSURE

Engineering analysis and the preparation of this report was completed by Stephen Dunlop, P.Eng. The report was reviewed by Dr. Fred Griffiths, P.Eng., a Designated Principal Contact for MTO Foundation Projects.



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
CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

Appendix A.
Borehole Location Plan



KEYPLAN

LEGEND

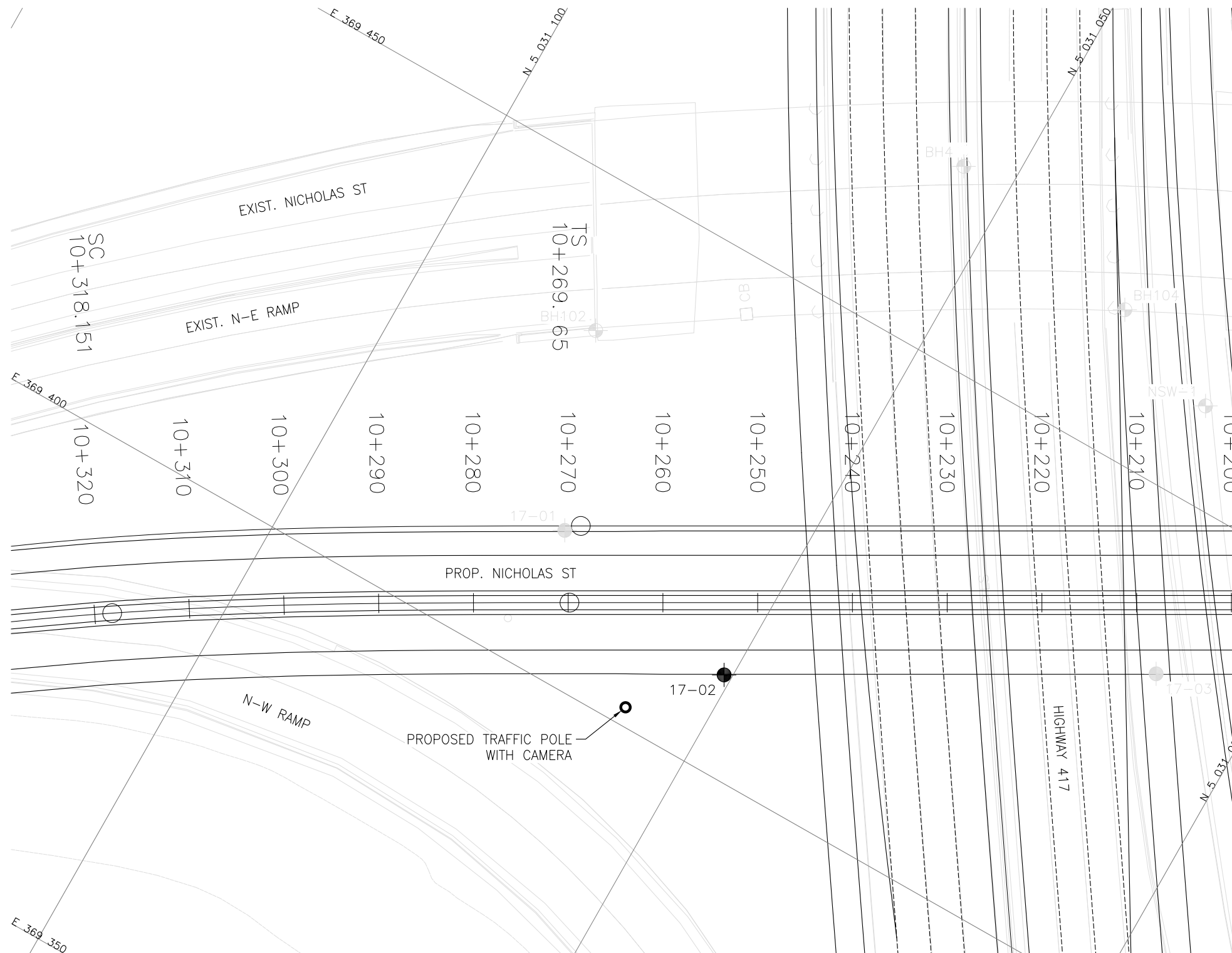
| | |
|---|---------------------------------------|
|  | Borehole (Current Investigation) |
|  | Borehole (Previous Investigation) |
| N | Blows /0.3m (Std Pen Test, 475J/blow) |
| CONE | Blows /0.3m (60° Cone, 475J/blow) |
| PH | Pressure, Hydraulic |
|  | Water Level |
|  | Head Artesian Water |
|  | Piezometer |
| 90% | Rock Quality Designation (RQD) |
| A/R | Auger Refusal |

[illegible]

-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83, Zone 9.

GEOCRES No. 31G5-298



PLAN



| | | | | | | | | | |
|-----------|------|-----|-------------|------|--------|--|------|----------|--|
| REVISIONS | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | DATE | BY | DESCRIPTION | | | | | | |
| DESIGN | SD | CHK | — | CODE | LOAD | | DATE | JAN 2019 | |
| DRAWN | MFA | CHK | SD | SITE | STRUCT | | DWG | 1 | |

CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

Appendix B.
Record of Borehole Sheets



SYMBOLS, ABBREVIATIONS AND TERMS USED ON TEST HOLE RECORDS

TERMINOLOGY DESCRIBING COMMON SOIL GENESIS

| | |
|---------|--|
| Topsoil | mixture of soil and humus capable of supporting vegetative growth |
| Peat | mixture of fragments of decayed organic matter |
| Till | unstratified glacial deposit which may include particles ranging in sizes from clay to boulder |
| Fill | material below the surface identified as placed by humans (excluding buried services) |

TERMINOLOGY DESCRIBING SOIL STRUCTURE:

| | |
|------------|---|
| Desiccated | having visible signs of weathering by oxidization of clay materials, shrinkage cracks, etc. |
| Fissured | having cracks, and hence a blocky structure |
| Varved | composed of alternating layers of silt and clay |
| Stratified | composed of alternating successions of different soil types, e.g. silt and sand |
| Layer | > 75 mm in thickness |
| Seam | 2 mm to 75 mm in thickness |
| Parting | < 2 mm in thickness |

RECOVERY:

For soil samples, the recovery is recorded as the length of the soil sample recovered.

N-VALUE:

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 63.5 kg hammer falling 0.76 m, required to drive a 50 mm O.D. split spoon sampler 0.3 m into undisturbed soil. For samples where insufficient penetration was achieved and N-value cannot be presented, the number of blows are reported over the sampler penetration in millimetres (e.g. 50/75).

DYNAMIC CONE PENETRATION TEST (DCPT):

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to an "A" size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone 0.3 m into the soil. The DCPT is used as a probe to assess soil variability.



STRATA PLOT:

Strata plots symbolize the soil and bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders
Cobbles
Gravel Sand Silt Clay Organics Asphalt Concrete Fill Bedrock

TEXTURING CLASSIFICATION OF SOILS

| Classification | Particle Size |
|----------------|---------------------|
| Boulders | Greater than 200 mm |
| Cobbles | 75 – 200 mm |
| Gravel | 4.75 – 75 mm |
| Sand | 0.075 – 4.75 mm |
| Silt | 0.002 – 0.075 mm |
| Clay | Less than 0.002 mm |

TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

| Descriptive Term | Undrained Shear Strength (kPa) |
|------------------|--------------------------------|
| Very Soft | 12 or less |
| Soft | 12 – 25 |
| Firm | 25 – 50 |
| Stiff | 50 – 100 |
| Very Stiff | 100 – 200 |
| Hard | Greater than 200 |

NOTE: Clay sensitivity is defined as the ratio of the undisturbed strength over the remolded strength.

SAMPLE TYPES

| | |
|-----------------|--|
| SS | Split spoon samples |
| ST | Shelby tube or thin wall tube |
| DP | Direct push sample |
| PS | Piston sample |
| BS | Bulk sample |
| WS | Wash sample |
| HQ, NQ, BQ etc. | Rock core sample obtained with the use of standard size diamond coring equipment |

TERMS DESCRIBING CONSISTENCY (COHESIONLESS SOILS ONLY)

| Descriptive Term | SPT "N" Value |
|------------------|-----------------|
| Very Loose | Less than 4 |
| Loose | 4 – 10 |
| Compact | 10 – 30 |
| Dense | 30 – 50 |
| Very Dense | Greater than 50 |

MODIFIED UNIFIED SOIL CLASSIFICATION

| Major Divisions | | Group Symbol | Typical Description |
|----------------------|--|--------------|--|
| COARSE GRAINED SOIL | GRAVEL AND GRAVELLY SOILS | GW | Well-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GP | Poorly-graded gravels or gravel-sand mixtures, little or no fines. |
| | | GM | Silty gravels, gravel-sand-silt mixtures. |
| | | GC | Clayey gravels, gravel-sand-clay mixtures. |
| | SAND AND SANDY SOILS | SW | Well-graded sands or gravelly sands, little or no fines. |
| | | SP | Poorly-graded sands or gravelly sands, little or no fines. |
| | | SM | Silty sands, sand-silt mixtures. |
| | | SC | Clayey sands, sand-clay mixtures. |
| FINE GRAINED SOILS | SILT AND CLAY SOILS $W_L < 35\%$ | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity. |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | | OL | Organic silts and organic silty-clays of low plasticity. |
| | SILT AND CLAY SOILS $35\% < W_L < 50\%$ | MI | Inorganic compressible fine sandy silt with clay of medium plasticity, clayey silts. |
| | | CI | Inorganic clays of medium plasticity, silty clays. |
| | | OI | Organic silty clays of medium plasticity. |
| | SILT AND CLAY SOILS $W_L > 50\%$ | MH | Inorganic silts, micaceous or diatomaceous fine sandy of silty soils, elastic silts. |
| | | CH | Inorganic clays of high plasticity, fat clays. |
| | | OH | Organic clays of high plasticity, organic silts. |
| HIGHLY ORGANIC SOILS | | Pt | Peat and other organic soils. |

Note - W_L = Liquid Limit



EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION

| | |
|---------------------------|--|
| Fresh (FR) | No visible signs of weathering. |
| Fresh Jointed (FJ) | Weathering limited to surface of major discontinuities. |
| Slightly Weathered (SW) | Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock materials. |
| Moderately Weathered (MW) | Weathering extends throughout the rock mass, but the rock material is not friable. |
| Highly Weathered (HW) | Weathering extends throughout the rock mass and the rock is partly friable. |
| Completely Weathered (CW) | Rock is wholly decomposed and in a friable condition, but the rock texture and structures are preserved. |

TERMS

| | |
|--|--|
| Total Core Recovery: (TCR) | Core recovered as a percentage of total core run length. |
| Solid Core Recovery: (SCR) | Percent ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run. |
| Rock Quality Designation: (RQD) | Total length of sound core recovered in pieces 0.1 m in length or larger, as a percentage of total core length |
| Unconfined Compressive Strength: (UCS) | Axial stress required to break the specimen. |
| Fracture Index: (FI) | Frequency of natural fractures per 0.3 m of core run. |

DISCONTINUITY SPACING

| Bedding | Bedding Plane Spacing |
|---------------------|-----------------------|
| Very thickly bedded | Greater than 2 m |
| Thickly bedded | 0.6 to 2 m |
| Medium bedded | 0.2 to 0.6 m |
| Thinly bedded | 60 mm to 0.2 m |
| Very thinly bedded | 20 to 60 mm |
| Laminated | 6 to 20 mm |
| Thinly laminated | Less than 6 mm |

STRENGTH CLASSIFICATION

| Rock Strength | Approximate Uniaxial Compressive Strength (MPa) |
|------------------|---|
| Extremely Strong | Greater than 250 |
| Very Strong | 100 – 250 |
| Strong | 50 – 100 |
| Medium Strong | 25 – 50 |
| Weak | 5 – 25 |
| Very Weak | 1 – 5 |
| Extremely Weak | 0.25 – 1 |

RECORD OF BOREHOLE No 17-02

1 OF 2

METRIC

GWP# 4048-11-00 LOCATION Nicholas Street Interchange - MTM z10: N 369 410.0 E 5 031 050.8 ORIGINATED BY KE
HWY 417 BOREHOLE TYPE Hollow Stem Augers / NW Casing / NQ Core COMPILED BY KE
DATUM Geodetic DATE 2017.10.19 - 2017.10.23 CHECKED BY FG

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | | UNIT WEIGHT γ kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL | |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|---|--|---------------------------|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa | | | | | | |
| | | | | | | | | WATER CONTENT (%) | | | | | | |
| | | | | | | | | | | | | | | |
| 60.0 | | | | | | | | | | | | | | |
| 0.0 | | | | | | | | | | | | | | |
| 0.2 | <div><div>SILTY SAND with organics Compact Brown FILL</div><div>SAND with silt and gravel with WASTE: brick, coal, organics, wood fragments, ash, glass Very loose to compact Brown FILL</div></div> | | 1 | SS | 23 | | | | | | | | | 40 52 8 (SI+CL) |
| | | | 2 | SS | 7 | | 59 | | | | | | | |
| | | | 3 | SS | 6 | | 58 | | | | | | | |
| | | | 4 | SS | 8 | | 57 | | | | | | | |
| | becoming brown-black at 3.0 m | | 5 | SS | 1 | | 56 | | | | | | | 24 64 12 (SI+CL) |
| 55.8 | | | 6 | SS | 5 | | 55 | | | | | | | |
| 4.2 | SILTY SAND trace gravel | | | | | | 54 | | | | | | | |
| 55.4 | Loose | | | | | | 53 | | | | | | | |
| 4.6 | Dark brown | | | | | | 52 | | | | | | | |
| | CLAY (Cl) Stiff Grey | | 7 | SS | 2 | | 51 | | | | | | | 0 4 44 52 |
| | | | 8 | ST | Push | | 50 | | | | | | | |
| | | | | | | | | | | | | | | |
| 52.1 | | | 9 | SS | 9 | | | | | | | | | |
| 7.9 | SILT Loose Grey | | | | | | | | | | | | | |
| 51.3 | | | | | | | | | | | | | | |
| 8.7 | SANDY SILT with gravel Very loose Grey | | | | | | | | | | | | | |
| | | | 10 | SS | WH | | | | | | | | | 26 36 30 8 non-plastic |
| 50.2 | | | | | | | | | | | | | | |
| 9.8 | SILTY SAND (SM) (Glacial Till) | | | | | | | | | | | | | |

ONTMT4S 17532_NICHOLASSTINTERCHANGE.GPJ 2012TEMPLATE(MTO).GDT 9/4/18

Continued Next Page

+³, ×³: Numbers refer to Sensitivity
20
15
10
(%) STRAIN AT FAILURE

METRIC

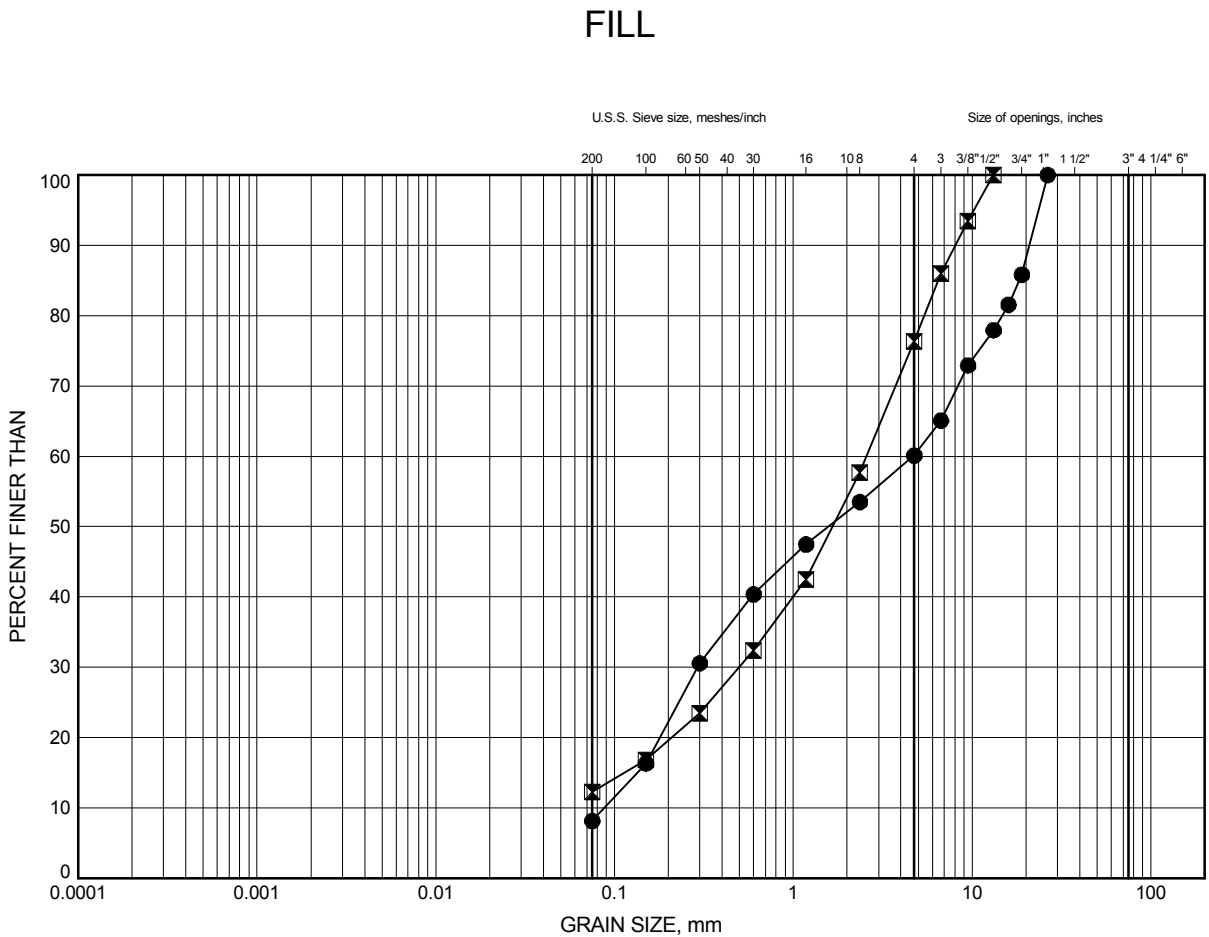
[illegible]

+³, ×³: Numbers refer to Sensitivity

CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

Appendix C.
Laboratory Testing

GRAIN SIZE DISTRIBUTION



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | 17-02 | 0.53 | 59.44 |
| ⊠ | 17-02 | 3.35 | 56.62 |

Date May 2018

GWP# 4048-11-00

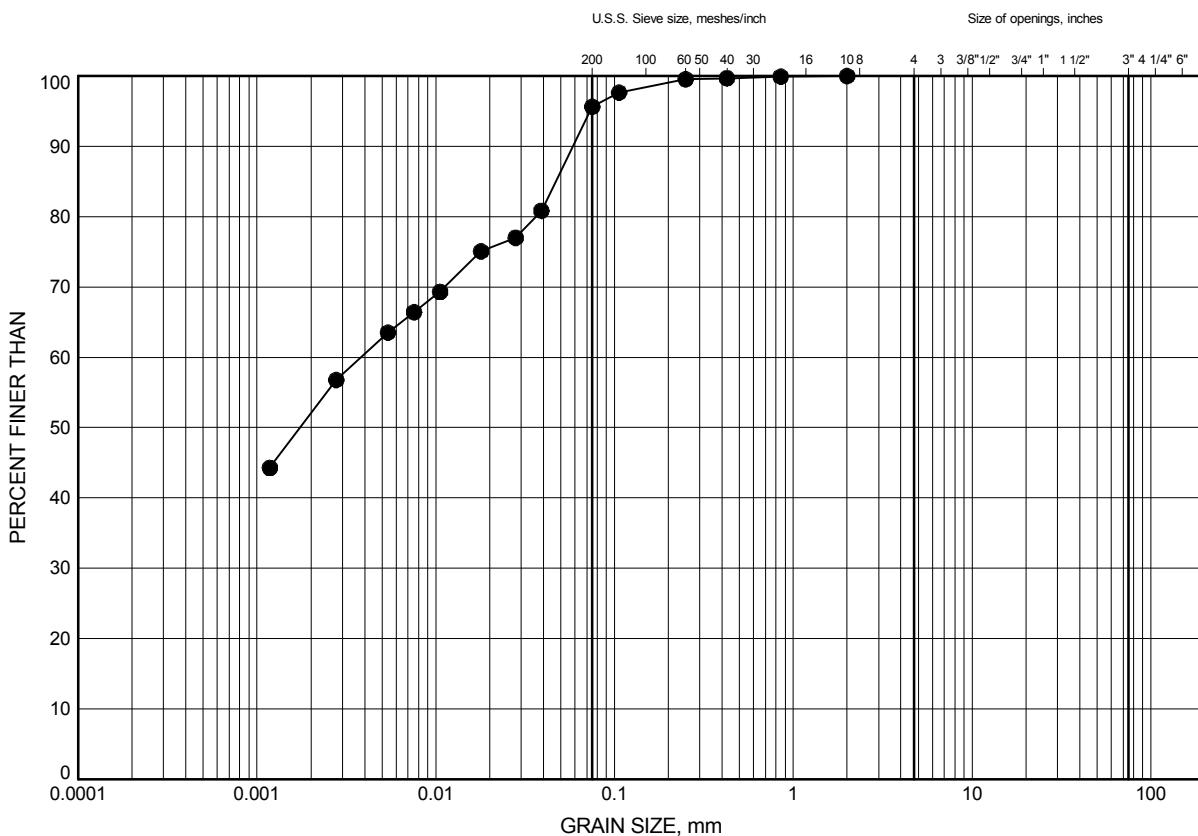


Prep'd KE

Chkd. SD

GRAIN SIZE DISTRIBUTION

CLAY



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | 17-02 | 4.88 | 55.09 |

Date May 2018

GWP# 4048-11-00

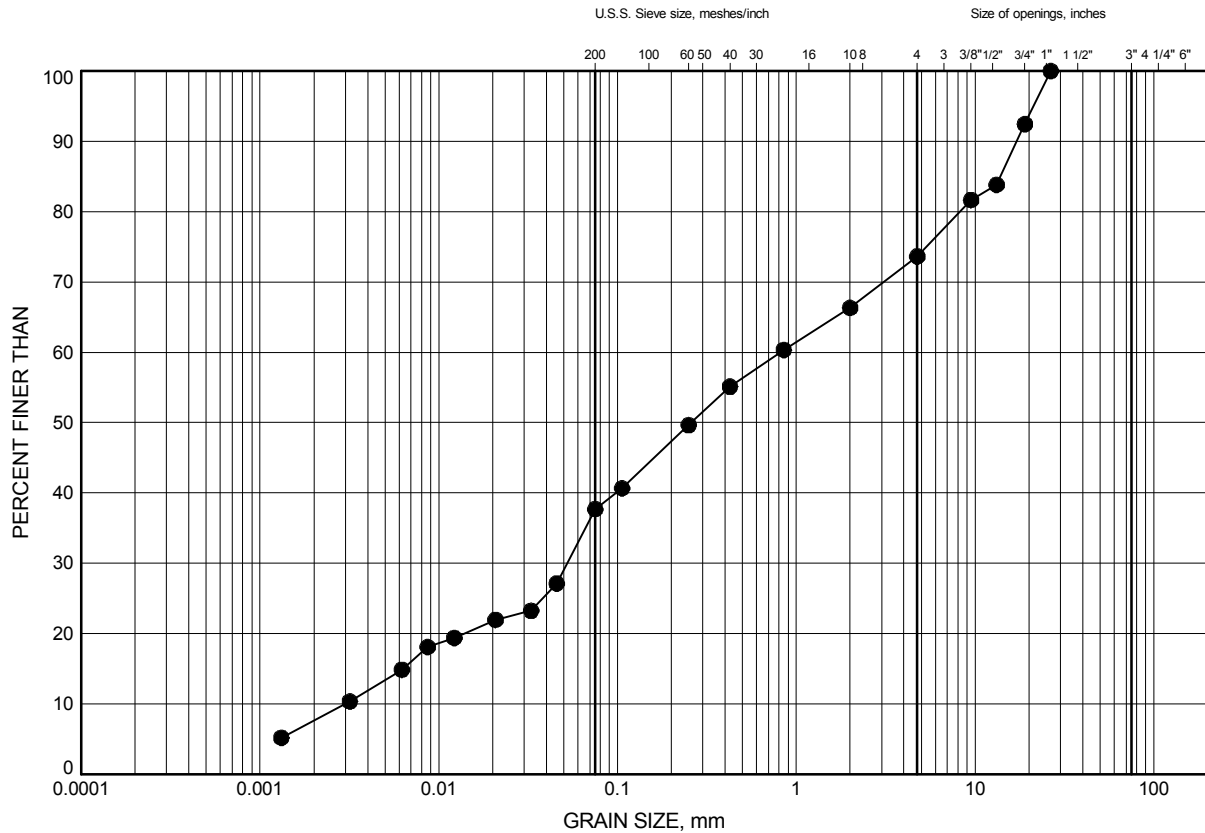


Prep'd KE

Chkd. SD

GRAIN SIZE DISTRIBUTION

SANDY SILT WITH GRAVEL



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | 17-02 | 9.45 | 50.52 |

Date May 2018

GWP# 4048-11-00

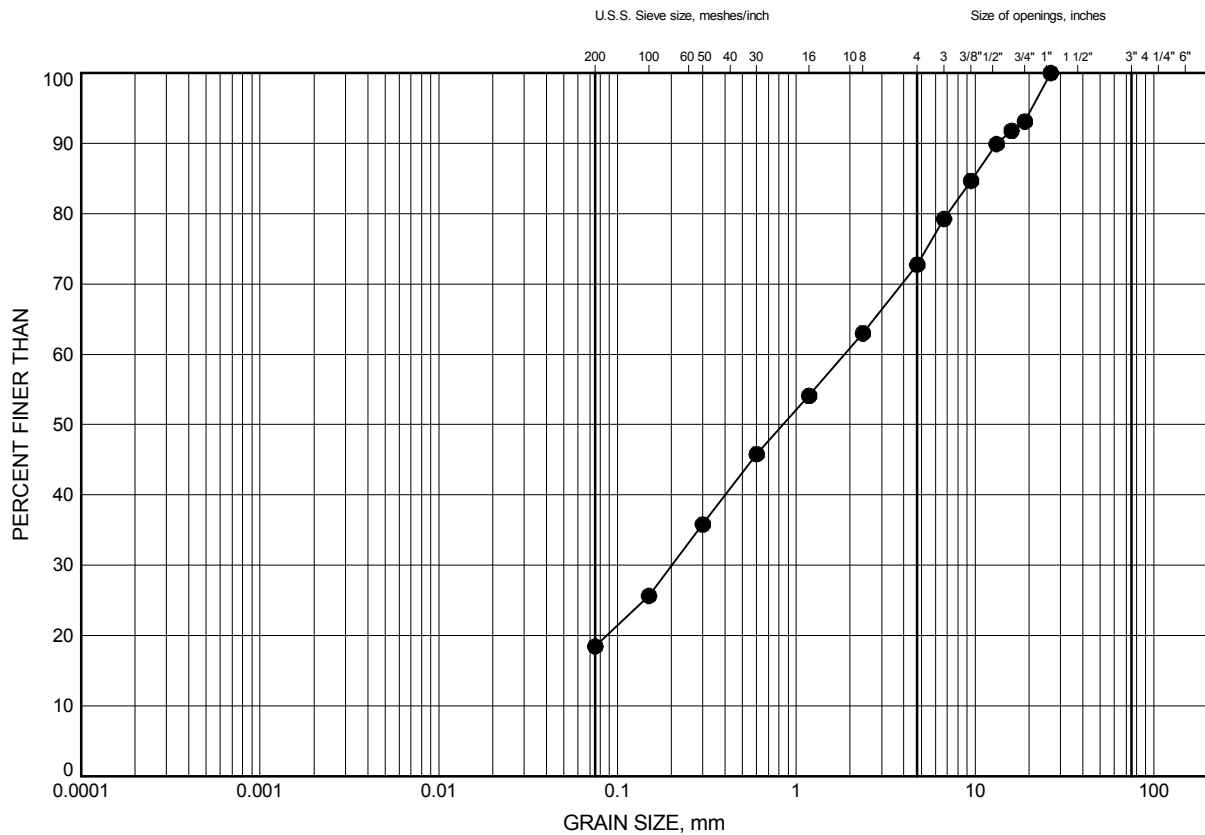


Prep'd KE

Chkd. SD

GRAIN SIZE DISTRIBUTION

GLACIAL TILL



| | | | | | | |
|---------------|------|--------|--------|--------|--------|-------------|
| SILT and CLAY | FINE | MEDIUM | COARSE | FINE | COARSE | COBBLE SIZE |
| FINE GRAINED | SAND | | | GRAVEL | | |

LEGEND

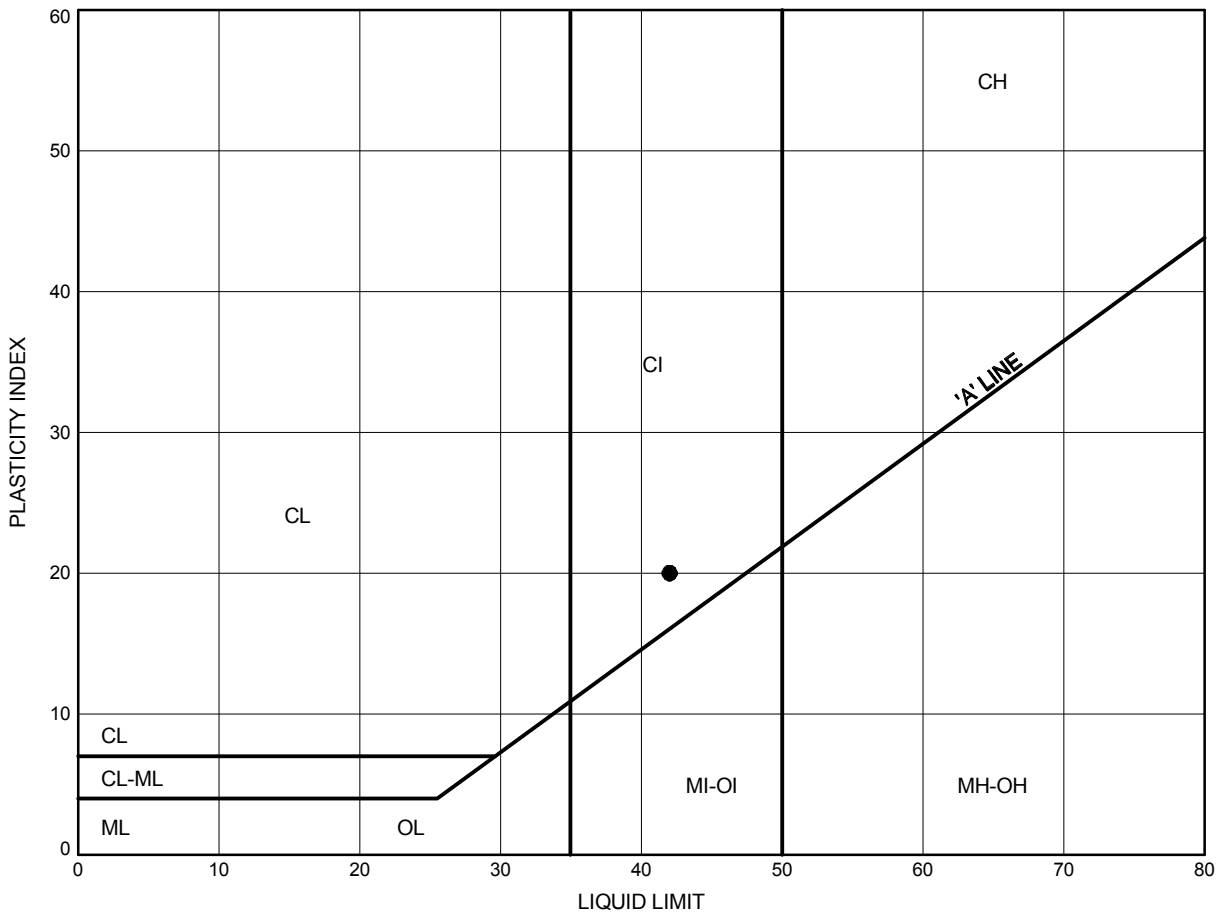
| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | 17-02 | 13.72 | 46.25 |

Date May 2018GWP# 4048-11-00Prep'd KEChkd. SD

Nicholas Street Interchange Camera Replacement
ATTERBERG LIMITS TEST RESULTS

FIGURE C5

CLAY



LEGEND

| SYMBOL | BOREHOLE | DEPTH (m) | ELEV. (m) |
|--------|----------|-----------|-----------|
| ● | 17-02 | 4.88 | 55.09 |

Date May 2018
 GWP# 4048-11-00



Prep'd KE
 Chkd. SD

Appendix D.

Table D1 – Geotechnical Design Parameters

LPile Soil-Structure Interaction Analysis Graphs

CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

TABLE D1
GEOTECHNICAL DESIGN PARAMETERS
CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

| Borehole Details | | Simplified Subsurface Stratigraphy for Design | Depth Below Proposed Grade (m) | Foundation Design Parameters | | | | | Groundwater Depth (m) |
|------------------|-----------|---|--------------------------------|------------------------------|-------------------|----------------------------------|-----------------------------------|-----|-----------------------|
| Borehole | Depth (m) | | | C_u (kPa) | ϕ' (deg.) | γ (kN/m ³) | γ' (kN/m ³) | Kp | |
| 17-02 | 18.7 | * Engineered Embankment Fill | *0.0 - 7.0 | - | 32 | 21 | 11 | 3.3 | 11.6 |
| | | Fill: silty sand | 7.0 - 11.6 | - | 30 | 21 | 11 | 3.0 | |
| | | Clay, stiff | 11.6 - 14.9 | 50 | - | 18 | - | - | |
| | | Silt to sandy silt with gravel, very loose | 14.9 - 16.8 | - | 28 | 18 | 8 | 3.0 | |
| | | Glacial till, very loose to compact | 16.8 - 22.1 | - | 38 | 21 | 11 | 3.3 | |
| | | Shale bedrock | 22.1 - 25.7 | - | - | - | - | - | |

***Note** – Assumes a 7.0 m high embankment is placed over the existing soil and is constructed using cohesionless granular fill compacted in accordance with OPSS.PROV 501. The elevation at the top of the embankment fill is assumed to be 67.0 m.

Definitions:

C_u = Undrained shear strength

ϕ' = Effective friction angle

γ = Total unit weight

γ' = Effective unit weight

Kp = Passive earth pressure coefficient

1. The information provided herein is presented for design purposes only.
2. The frost depth in Ottawa is 1.8 m.
3. Reference: MTO Guidelines for the Design of High Mast Pole Foundations
4. Effective unit weight values should be used below groundwater

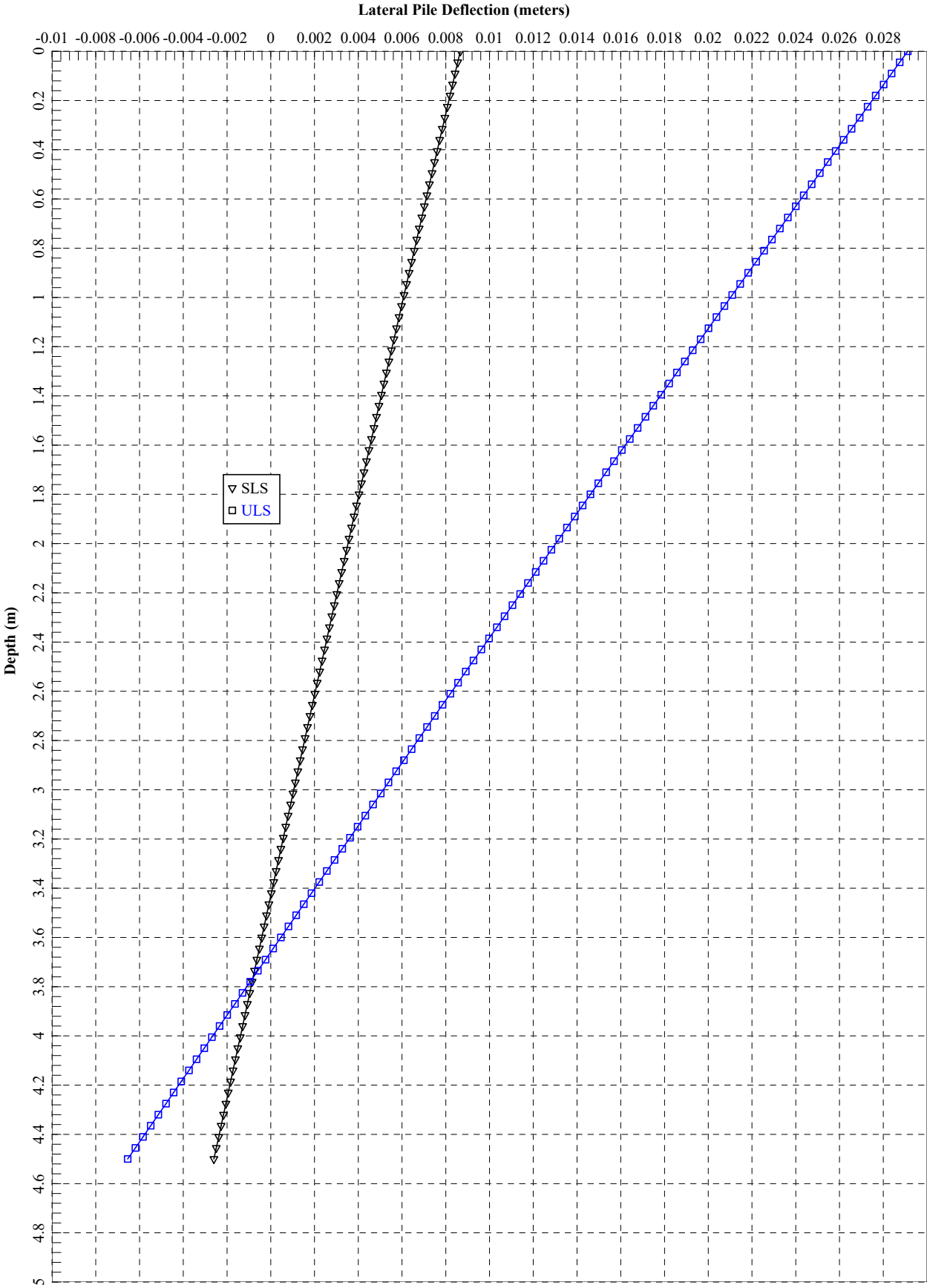


Figure D-1



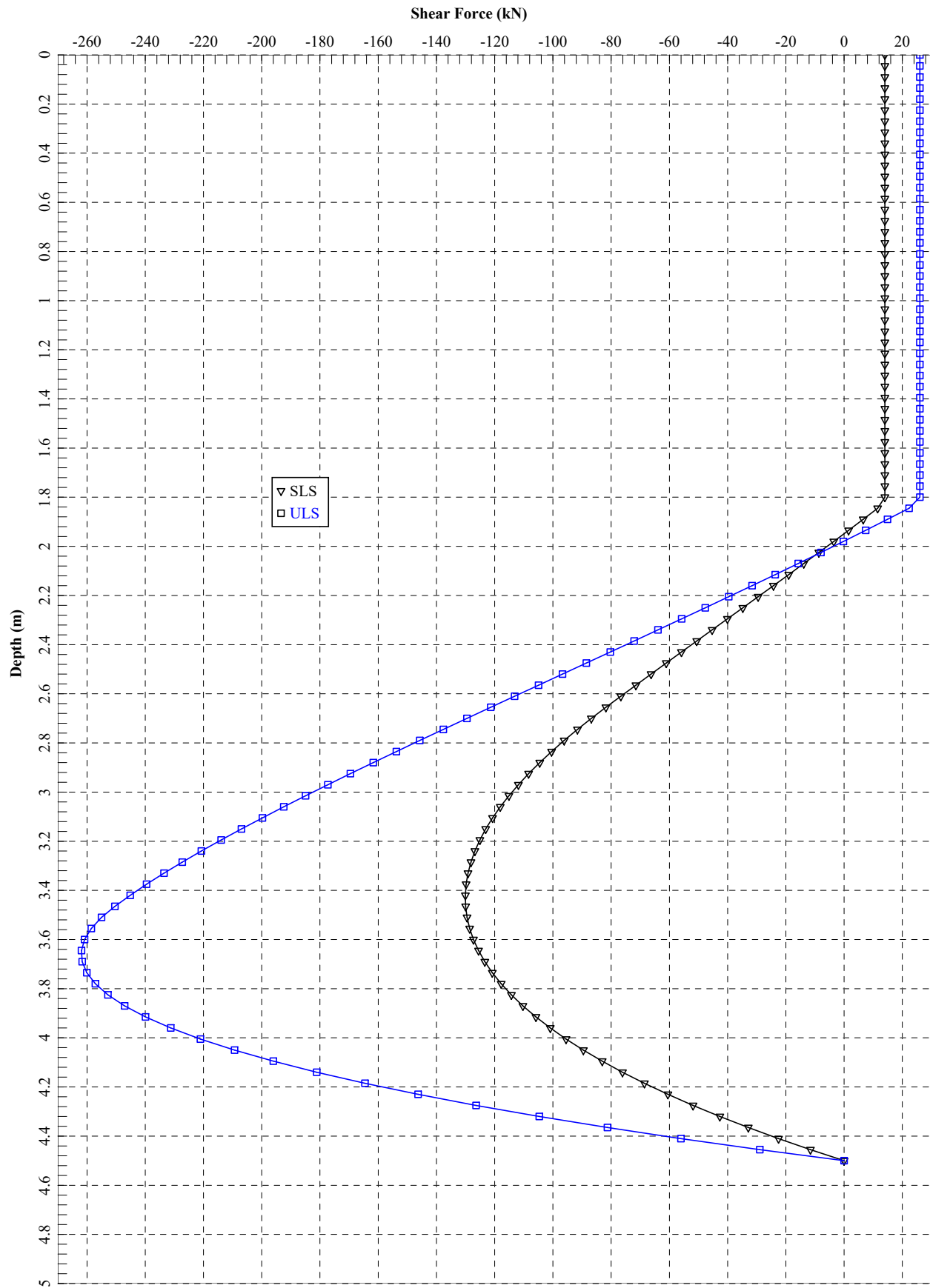


Figure D-2

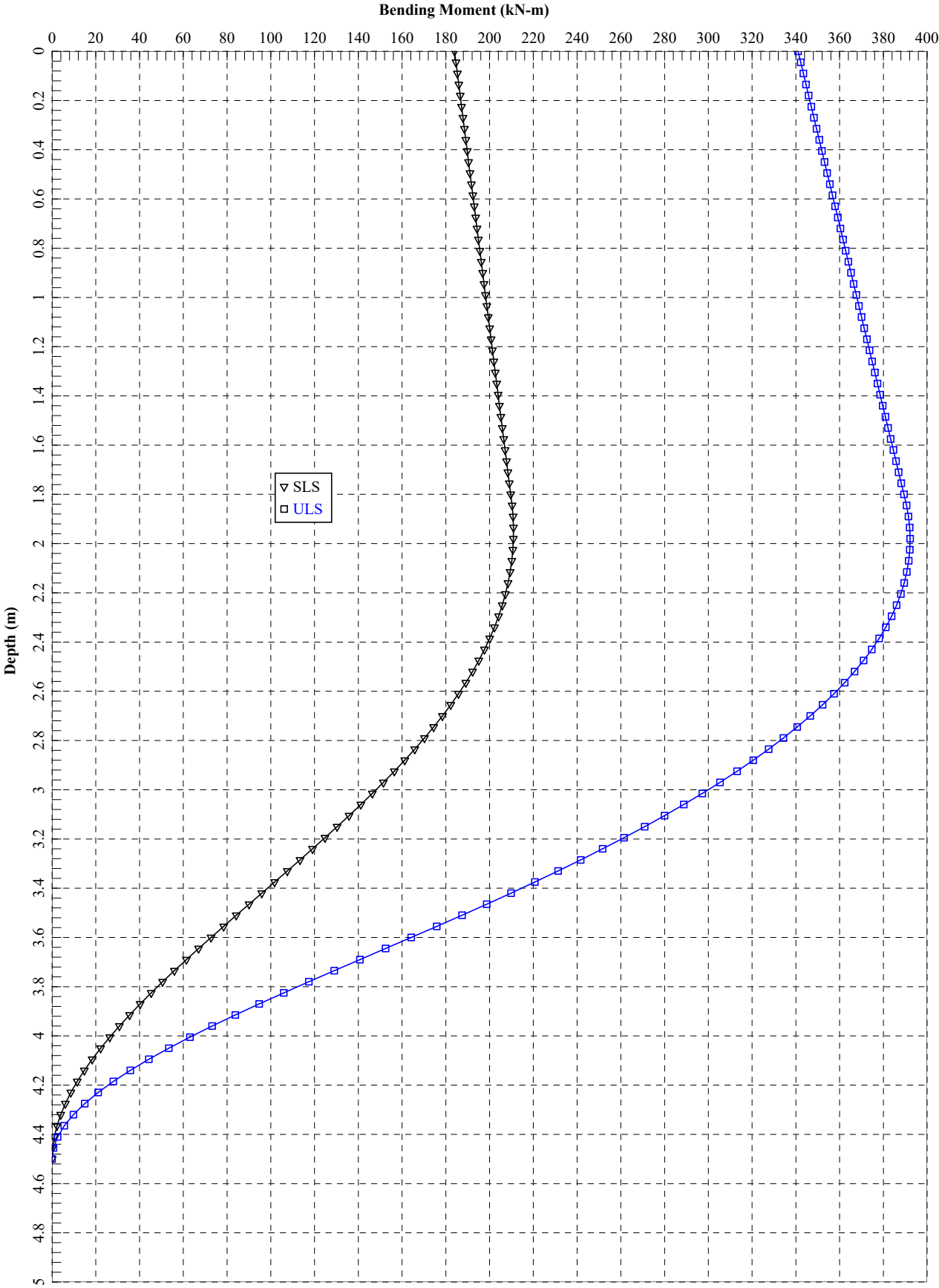


Figure D-3



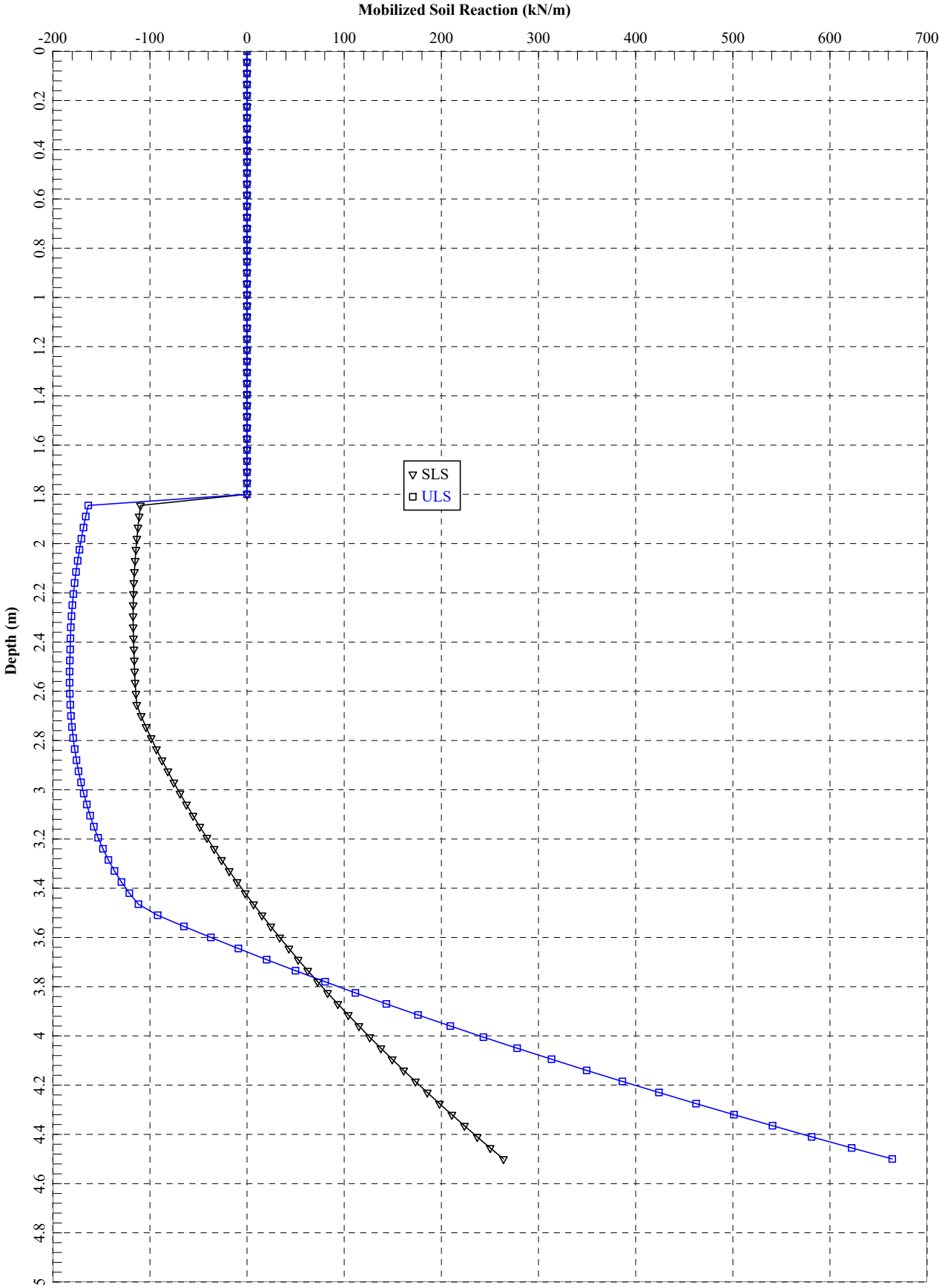


Figure D-4

Appendix E.

List of Special Provisions, Suggested Text for NSSP

CAMERA POLE RELOCATION
HIGHWAY 417 NICHOLAS STREET INTERCHANGE

1. The following Special Provisions and OPSS Documents are referenced in this report:

| | |
|---------------|--|
| OPSS.PROV 501 | Construction Specification for Compacting |
| OPSS.PROV 615 | Construction Specification for Installation of Poles |
| SP 682S30 | Concrete Poles, Direct Buried in Earth with Camera Raising and Lowering System |
| OPSD 2210.010 | Local Grading at Pole Foundations |

2. Suggested text for a NSSP on “Drilled Excavation for Camera Pole Installation”

The Contractor is advised that variable types of subsurface materials may be encountered at the camera pole location.

For bidding purposes, the Contractor shall assume the following:

1. The subsurface conditions at the pole location, prior to embankment construction, are the same as those encountered in Borehole 17-02.
2. There is a possibility that occasional cobbles or other obstructions may be encountered within the fill. Construction equipment must be able to penetrate or remove these obstructions.
3. Water seepage and/or soil sloughing into the drilled hole may occur from the cohesionless fill. Temporary liners must be available on site, or be made available on very short notice, to support the sidewalls and provide seepage cut-off where required.
4. The Contractor is responsible for not disturbing the material at the sides or base of the foundation.
5. The Contractor is responsible for proper disposal of materials generated from the site.