



REPORT

Foundation Investigation and Design Report

Highway 89 Nottawasaga Bridge Widening (Site No. 30X-0250/B0)

Highway 89, Alliston, Simcoe County

MTO G.W.P. 2022-22-00; W.P. 2121-22-01; Assignment No. 2022-E-046

Submitted to:

Ministry of Transportation, Ontario

159 Sir William Hearst Avenue
Toronto, ON M3M 0B7

Submitted by:

WSP Canada Inc.

6925 Century Ave., Suite 600
Mississauga, ON L5N 7K2

GEOCRES No.: 31D04-011

Latitude: 44.166899°

Longitude: -79.808555°

CA0020332.0247-Fnd-R01-Rev0

March 19, 2025



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PART A

**FOUNDATION INVESTIGATION REPORT
HIGHWAY 89 NOTTAWASAGA RIVER BRIDGE WIDENING
(SITE NO. 30X-0250/B0)
HIGHWAY 89, ALLISTON, SIMCOE COUNTY, ONTARIO
MTO G.W.P. 2022-22-00; W.P. 2121-22-01**

1.0 INTRODUCTION

WSP Canada Inc. (WSP) has been retained by the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of improvements to the Highway 89 / Essa 5th Line intersection, including widening of the Nottawasaga River Bridge on the south side, and rehabilitation / replacement of the Nicolston structural culvert in Alliston, Ontario.

This report presents the results of the foundation investigation carried out for detail design of the Highway 89 over Nottawasaga River Bridge widening (Site No. 30X-0250/B0).

2.0 SITE DESCRIPTION

The Nottawasaga River Bridge is located between Kindlers Road and Essa 5th Line, between the towns of New Tecumseth and Cookstown in Simcoe County Ontario. Highway 89 generally runs east-west at this location, and the Nottawasaga River generally runs north-south under the existing bridge.

The existing bridge structure is a three-span concrete slab on steel girder structure. The original bridge and foundations were constructed as part of a 1960 contract (Contract No. 1960-0171¹). The bridge was subsequently rehabilitated (superstructure replaced) and widened to the north with new foundations as part of the 2009 Contract (2009-2046²). Highway 89 was realigned to the north and the southern portion of the original 1960 substructure was left in place for future widening (see report cover photograph). The existing bridge is primarily supported on the foundations installed as part of the 2009 contract, with approximately a 3.5 m width of the bridge deck supported by the 1960 foundations. The bridge abutments are founded on steel piles, with the 1960 portion consisting of 12BP53 piles (equivalent to 310x79 H-Piles), and the 2009 portion consisting of 310x110 H-Piles. The piers are constructed on shallow spread footings within the Nottawasaga River.

The Highway 89 profile varies between approximately Elevation 211 m and 212 m at the west and east bridge limits and the approach embankment front slope is approximately 8 m and 9 m high relative to the river bottom shown on the drawings, respectively. The front slopes are covered with rock protection / rip-rap and are sloped at about 1.5H:1V to 2H:1V. At the proposed superstructure and highway widening on the south side, the original Highway 89 embankment subgrade still exists behind the exposed concrete abutments and is at about Elevation 210 m and 211 m at the west and east side. The existing west and east approach embankment side-slopes are about 3 m and 5 m high relative to adjacent ground surface and sloped at about 2H:1V. The side-slopes are vegetated primarily with grass and small bushes / trees.

The Nicolston Dam is located downstream of the Nottawasaga River Bridge and the river flows from the south to the north at this location. The water level of the Nottawasaga River was measured at about Elevation 204.3 m during the April 2024 survey carried out by GeoVerra, although the water level is anticipated to fluctuate considerably depending on the season. The river is estimated to range from about 0.6 m to 1.5 m deep near the bridge based on the most recent water level readings.

¹ Department of Highways, Ontario. 1960. *Grading, culverts, granular base, hot mix and structure; Highway 89, District No. 5 Owen Sound; Nottawasaga River Structure; Township of Essa and Tecumseth, County of Simcoe* [1960 Contract Drawings]. MTO Contract No. 60-171; W.P. 218-59.

² Ministry of Transportation, Ontario. 2009. *Grading, drainage, granular base, hot mix paving, illumination and structure; Highway No. 89, District No. Central; From 373 m west to 452 m east of Nottawasaga River Bridge (Site No. 30-250)* [2009 Contract Drawings]. MTO Contract No. 2009-2046; W.P. 2503-04-00.

3.0 INVESTIGATION PROCEDURES

3.1 Previous Borehole Investigation – D.H.O. 1959

Six boreholes (designed 1 to 6) were advanced south of the existing bridge as part of a previous Department of Highways, Ontario (DHO) geotechnical investigation in 1959 (DHO, 1959)³. It is noted that as part of the 1960 construction of the permanent bridge, a temporary Bailey bridge was constructed on the south side near these borehole locations. Boreholes 1, 2, 5, and 6 were advanced south of Highway 89 and at the east and west edges of the Nottawasaga River. Boreholes 3 and 4 were advanced within the river. The boreholes were advanced to depths ranging from 16 m to 28 m below ground or water surface, as applicable. The approximate location of the boreholes, based on the station and offsets presented in the 1959 report, are shown on Drawing 1. A copy of the Record of Boreholes, associated laboratory test results, and original borehole plan and profile drawings are provided in Appendix A.

3.2 Previous Borehole Investigation – Golder 2009

Nine boreholes (designated 07-2 to 07-6, and 08-1 to 08-4) were advanced near the current Nottawasaga River Bridge foundation elements, approach embankments, and associated retaining walls as part of previous geotechnical investigations in 2007 and 2008 by Golder Associates Ltd. (Golder) for the design of the bridge widening to the north (Golder, 2009)⁴. Boreholes 07-2 to 07-4 were advanced along the RSS wall near the northwest abutment; Borehole 07-4 and 07-5 were advanced at the west and east abutments, and Borehole 07-6 advanced at the east approach embankment, respectively. Boreholes 08-1 and 08-3, and Boreholes 08-2 and 08-4 were advanced within the Nottawasaga River at the west and east pier locations, respectively. The boreholes were advanced to depths ranging from 4.7 m to 18.7 m below ground or water surface, as applicable. Details of the Golder 2009 field investigation are included in the associated report (Golder 2009). A copy of the Record of Boreholes and associated laboratory test results are provided in Appendix B and the borehole locations are shown on Drawing 1.

The water levels in the open boreholes were observed throughout the drilling operations, and a piezometer was installed in Boreholes 07-3 and 07-5. The details of the boreholes including location in MTM NAD83 (Zone 10) northing and easting coordinates, geographic (Latitude / Longitude) coordinates, ground surface elevations referenced to Geodetic datum and drilled depths are summarized below.

Table 1: Summary of Boreholes from the Golder 2009 Investigation

Borehole Number	NAD 83 MTM Northing (m) (Latitude, °)	NAD 83 MTM Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
07-2	4,891,914.8 (44.166821)	280,057.6 (-79.809387)	205.4	18.7
07-3	4,891,920.8 (44.166876)	280,085.4 (-79.809040)	206.4	10.9
07-4	4,891,920.5 (44.166873)	280,099.9 (-79.808859)	205.4	7.9

³ Department of Highways, Ontario (DHO). Foundation Investigation. *Rev. Hwy. #89 & Nottawasaga River Crossing, Lot 10, Con. V. Twps. Of Essa & Tecumseth, Approximately 2 ¼ Miles East of Alliston* (MTO GEOCRE 31D00-37) dated December 9, 1959.

⁴ Golder Associates Ltd. Foundation Investigation and Design Report (FIDR). *Highway 89 Nottawasaga River Bridge Rehabilitation/Widening & Retaining Wall and Cut Slope at Intersection of Essa 5th Line and Highway 89, Simcoe County, Ontario. G.W.P. 2503-04-00. Project No. 05-1111-0034-1* (GEOCRE 31D00-454) dated September 2009.

Borehole Number	NAD 83 MTM Northing (m) (Latitude, °)	NAD 83 MTM Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
07-5	4,891,937.5 (44.167028)	280,151.9 (-79.808209)	210.1	14.0
07-6	4,891,943.4 (44.167082)	280,171.3 (-79.807967)	210.5	6.5
08-1	4,891,924.3 (44.166908)	280,108.8 (-79.808748)	204.6 ¹	11.8 ²
08-2	4,891,931.6 (44.166974)	280,133.4 (-79.808440)	204.6 ¹	10.0 ²
08-3	4,891,920.8 (44.166876)	280,113.2 (-79.808692)	204.7 ¹	4.8 ²
08-4	4,891,928.4 (44.166946)	280,137.6 (-79.808388)	204.7 ¹	4.7 ²

Notes:

1. Nottawasaga River water surface elevation.
2. Depth below water surface.

3.3 Current Borehole Investigation

The field work for the current investigation was carried out between April 8 and 10, 2024 during which time two boreholes were advanced (designated BH24-01 and 24-02). The locations of the boreholes advanced during the current investigation are shown on Drawing 1.

Boreholes BH24-01 and BH24-02 were advanced using 210 mm outside diameter (O.D.) hollow stem augers using a CME 75 truck-mounted drill supplied and operated by Atcost Drilling Inc. of Gormley, Ontario.

Soil samples were generally obtained using a 50 mm O.D. split spoon sampler at 0.75 m and 1.5 m intervals of depth. The SPT tests were carried out in general accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586⁵) using an automatic hammer. The split-spoon samplers used in the investigation generally limit the maximum particle size that can be sampled and tested to about 35 mm. Therefore, particles or objects that may exist within the soils that are larger than this dimension would not be sampled or represented in the grain size distributions. Field vane shear tests were conducted in softer cohesive soils for assessment of undrained shear strengths (ASTM D2573⁶).

Standpipe piezometers were installed in both Boreholes BH24-01 and BH24-02 and were screened within a silt and silty sand deposit, respectively. The installed piezometers consist of a 50 mm diameter PVC pipe, with a 1.5 m and 3 m long slotted screen within a filter sand pack. The annulus surrounding the piezometer pipe above the filter sand pack were backfilled to near ground surface with bentonite pellets in general accordance with Ontario Regulation 903 Wells (as amended)⁷. The monitoring wells were capped with flushmount casings at the road surface.

The field work was monitored on a full-time basis by a member of WSP's engineering staff who located the boreholes in the field, directed the sampling and in-situ testing operations, logged the boreholes, and examined

⁵ ASTM D1586 Standard Test Method for Standard Penetration Tests and Split Barrel Sampling of Soils.

⁶ ASTM D2573 Standard Test Method for Field Vane Strength Shear Test

⁷ Ontario Regulation 903 Wells (as amended)

the soil samples. The soil samples were identified in the field, placed in labelled containers, and transported to WSP’s laboratory in Mississauga for further visual review and geotechnical laboratory testing. Index and classification testing consisting of natural moisture content, Atterberg limits, organic content, and grain size distribution were conducted on selected samples. All laboratory tests were carried out in general accordance with MTO and / or ASTM Standards, as applicable.

Seven soil samples obtained from Boreholes BH24-01 and BH24-02, and four water samples (two groundwater samples from Borehole BH24-01 and BH24-02, and two surface water samples from each shore of the Nottawasaga River) were submitted to a specialist analytical laboratory (Bureau Veritas Laboratories of Mississauga, Ontario) under chain of custody procedures for testing of electrical conductivity / resistivity, redox potential, pH, and chemical analysis of sulphate, sulfide, and chloride content, to assess the potential for the soil and water to cause deterioration to concrete and corrosion to steel exposed to the soil and water.

The borehole coordinates were surveyed in the field by WSP personnel using a Trimble Catalyst DA2 Global Positioning System (GPS) unit and the elevation was obtained from the digital terrain model (DTM). The locations given on the borehole records and shown on Drawing 1 are positioned relative to NAD 83 MTM (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum (CGVD28 datum). The borehole locations, including the geographic (Latitude / Longitude) coordinates, the ground surface elevations, and borehole depths are summarized below.

Table 2: Summary of Boreholes from the Current Investigation

Borehole No.	NAD 83 MTM Northing (m) (Latitude, °)	NAD 83 MTM Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
BH24-01	4,891,935.66 (44.167003)	280,164.83 (-79.808044)	210.9	17.4
BH24-02	4891911.74 (44.166785)	280087.14 (-79.809014)	210.0	17.0

3.4 Geophysical (Magnetometer) Survey

A magnetometer survey was carried out at the east and west bridge abutments between August and September, 2024. In order to complete the survey, boreholes were advanced at the east and west abutment locations (designated Borehole 24-01B and 24-02B) and casings installed (consisting of 50 mm diameter PVC pipe) and filled with water between August 20 and 28, 2024. Concrete coring was carried out through the existing 1960 bridge abutments prior to advancing Boreholes 24-01B and 24-02B through the overburden soil. Boreholes 24-01B and 24-02B were advanced using 165 mm outside diameter (O.D.) hollow stem augers followed by wash-rotary techniques (advancement of tricone with water/drilling mud with H Casing) using a Diedrich D25 track-mounted drill supplied and operated by Walker Drilling Inc. of Utopia, Ontario. The boreholes and casing installation was monitored by a member of WSP’s geotechnical engineering staff. During drilling of the boreholes, selected soil samples were collected using conventional SPT procedures with a manual hammer. The wash-rotary technique was used to counter-balance hydrostatic forces and reduce disturbance at the sampling and testing interval. A summary of the borehole log information collected during casing installation at Borehole 24-01B and 24-02B is provided in Appendix A.

The borehole / casing coordinates were surveyed in the field by WSP personnel using a Trimble Catalyst DA2 Global Positioning System (GPS) unit and the elevation was obtained from the digital terrain model (DTM). The

locations given on the magnetometer casing borehole logs and shown on Drawing 1 are positioned relative to NAD 83 MTM (Zone 10) northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum (CGVD28 datum). The casing / borehole locations, including the geographic (Latitude / Longitude) coordinates, the ground surface elevations, and borehole depths are summarized below.

Table 3: Summary of Magnetometer Casing Boreholes from the Current Investigation

Casing / Borehole No.	NAD 83 MTM Northing (m) (Latitude, °)	NAD 83 MTM Easting (m) (Longitude, °)	Ground Surface Elevation (m)	Borehole Depth (m)
24-01B	4,891,929.25 (44.166946)	280,163.70 (-79.808058)	210.7	19.9
24-02B	4891909.96 (44.16677)	280099.25 (-79.808863)	210.0	19.9

The magnetometer survey locations (Boreholes 24-01B and 24-02B) were located within approximately 2 m of the existing steel pile foundations, as estimated based on the 1960 contract drawings¹. The magnetometer survey measures localized anomalies of the normal field (Earth's magnetic field) caused by the induced magnetic field of ferromagnetic material (i.e. steel piles). The results of the magnetometer survey are summarized in Section 5.0, and the details of the survey are provided in the associated technical memorandum in Appendix D.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The site generally lies within the physiographic region known as the Simcoe Lowlands, between two sections of the region known as the Peterborough Drumlin Field, as delineated in *The Physiography of Southern Ontario*⁸.

Most of the Nottawasaga Basin was at one time part of the floor of Lake Algonquin and its surface beds are deltaic and lacustrine origin. Within the Nottawasaga Basin in the Alliston area, where the bridge site is located, near the confluence of the Nottawasaga River and Boyne River are the Essa Flats⁹. The Essa Flats portion of the Basin comprises of a sandy loam soil. The surficial geology in the area adjacent to the Nottawasaga River are described as modern alluvial deposits consisting of clay, silt, sand, and gravel which may contain organics¹⁰.

4.2 Subsurface Conditions

The detailed subsurface soil and groundwater conditions encountered in the boreholes from the current and previous investigations, including piezometer installation details and water level readings, and the results of the in-situ and laboratory tests, are provided on the borehole records in Appendices A to C. The results of the in-situ field tests (i.e., SPT "N"-values and field vane measured undrained shear strengths) as presented on the borehole records and in Section 4 are uncorrected. The detailed results of the geotechnical laboratory testing on soil samples are presented on the laboratory test figures in Appendices A to C. The results of the analytical testing are provided in Appendix C.

⁸ Chapman, L. J. and Putnam, D. F. *The Physiography of Southern Ontario*, Ontario Geological Survey Special Volume 2, Third Edition, 1984. Accompanied by Map P.2715 Scale 1:600,000.

⁹ Ministry of Northern Development and Mines, Ontario. 1988. Aggregate resources inventory of Essa and Tosorontio Townships, Simcoe County, Southern Ontario; Ontario Geological Survey. Aggregate Resources Inventory Paper 113.

¹⁰ Ontario Geological Survey. 2010. Surficial geology of southern Ontario; Ontario Geological Survey, Miscellaneous Release – Data 128 – Revised.

The stratigraphic boundaries shown on the borehole records and on the stratigraphic profile on Drawings 2 to 6 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Variation in the stratigraphic boundaries between and beyond boreholes will exist and is to be expected, particularly adjacent to rivers where sharp stratigraphic changes are likely to occur.

In summary, the soil encountered at this site generally consists of a surficial layer of topsoil or asphalt, underlain by fill or silty sand containing organics, which are in turn underlain by silt and silty sand to sand deposits over a clayey silt-silt to clayey silt deposit. In the river, fill and sand and gravel were typically encountered at the river bed and were underlain by sand and clayey silt deposits. It is noted that the soil conditions encountered in the boreholes advanced during the 1959 investigation are generally consistent with the findings from the 2009 and current investigations, however it describes the underlying clayey silt-silt to silt deposit as a clay silt interbedded with silty clay till.

More detailed descriptions of the major soil layers encountered in the recent boreholes, as well as a summary of laboratory results, are provided in the following sections.

4.2.1 Surficial Layers (Topsoil, Asphalt)

A surficial layer (generally about 0.2 m thick) described as topsoil was encountered at ground surface in Boreholes 07-2 to 07-5 during the previous investigation. In Borehole 07-4 this layer was described as sandy topsoil and had a thickness of 0.6 m. While this surficial layer was encountered in Borehole 07-2 to 07-5, it should be noted that these boreholes were advanced prior to the 2009 widening and embankment construction and topsoil may no longer be present at these locations.

Asphalt, between 355 mm and 430 mm thick, was encountered at ground surface in Boreholes BH24-01 and BH24-02, respectively.

4.2.2 Fill

Where boreholes were advanced at the existing bridge abutment (Boreholes BH24-01 and BH24-02), fill was encountered below the asphalt and was about 3.7 m to 3.8 m thick. During the Golder 2009 investigation prior to the widening, fill was encountered below the topsoil and was about 0.7 m thick on the west side (Borehole 07-3) and about 5.4 m thick on the east side (Borehole 07-5). Fill (about 3.7 m thick) was encountered at ground surface in Borehole 07-6 on the east side near the approach embankment. In 2009, Boreholes 08-3 and 08-4 were advanced in the river at the pier locations and encountered about 0.6 m of fill, before coring through the existing 1960 bridge concrete shallow foundations (measured to be 1.7 m and 1.5 m thick at the west and east pier respectively).

The fill was primarily non-cohesive, consisting of sandy silt, silty sand, and sand. Interlayers of cohesive fill consisting of clayey silt with variable amounts of organics was encountered within or below the non-cohesive fill in Boreholes BH24-01 and BH24-02. Organic pockets and wood fragments were also encountered within the non-cohesive fill in Borehole BH24-02, 08-3 and 08-4. Auger grinding was noted while drilling through the fill deposit in Borehole BH24-02. The silty sand fill was described as sand and silt fill in Borehole 07-5 advanced during the 2009 Golder investigation.

The SPT 'N'-values measured within the non-cohesive fill ranged from 4 blows to 41 blows per 0.3 m of penetration, indicating a loose to dense state of compactness.

The SPT 'N'-values measured within the cohesive fill ranged from 2 to 12 blows per 0.3 m of penetration. An in-situ field vane test carried out on the cohesive fill measured a shear strength of about 29 kPa and a sensitivity of

about 2.9. The results of the SPT 'N'-values and vane testing suggest the cohesive fill has a soft to stiff consistency.

The results of a grain size distribution test carried out on a sample of the non-cohesive fill is shown on Figure B1 in Appendix B.

The water content measured on samples of the non-cohesive and cohesive fills ranged from about 2% to 14% and 12% to 24%, respectively.

4.2.3 Silty Sand containing Organics and Organic Silt

A 2.9 m to 6.4 m thick deposit of silty sand containing organics was encountered on the west side of the river below the topsoil in Borehole 07-2 and below the fill in Boreholes 07-3, 07-4, and BH24-02. The silty sand was described as sand and silt for portions of the deposit in Boreholes 07-2 and 07-4 advanced during the 2009 Golder investigation. In Borehole 24-02, a 2.3 m thick layer of organic silt containing wood pieces was encountered within the silty sand layer.

The SPT 'N'-values measured in the silty sand containing organics deposit range from 1 blow to 8 blows per 0.3 m of penetration, indicating that the majority of the deposit has a very loose to loose state of compactness.

The SPT 'N'-values measured in the organic silt deposit in Borehole BH24-02 were 8 blows and 12 blows per 0.3 m of penetration. An in-situ field vane test carried out within the organic silt layer measured a shear strength of about 86 kPa and a sensitivity of about 2.3. The results of the SPT 'N'-values and the field vane test suggest a stiff consistency.

The results of grain size distribution tests carried out on three samples of the silty sand deposit and one sample of the organic silt deposit are shown in Figures B2, C1 and C2, in Appendices B and C.

The water content measured on samples of the silty sand containing organics deposit ranged from about 13% to 71%, and the water content measured on samples of the organic silt were 40% and 62%.

Atterberg limits tests carried out on two samples of the silty sand containing organics deposit indicate that the fines component of the deposit is non-plastic and are classified as silt. The results of an Atterberg limits test carried out on a sample of the organic silt layer measured a liquid limit of 44% and plastic limit of 37%, corresponding to a plasticity index of 7%. The results of the Atterberg limits test are shown in Figure C3 and indicate that the material is classified as an organic silt.

The organic content measured on six select samples of the silty sand containing organics to organic silt deposit range from 2.6% to 10.1%.

4.2.4 Silt (ML)

A silt deposit was encountered below the fill in Borehole BH24-01 at Elevation 206.8 m and below the silty sand to sand deposit in Borehole 07-2 at Elevation 188.0 m. In Borehole BH24-01 the silt deposit was found to contain clayey silt and sandy silt pockets. The deposit was 7.6 m thick in Borehole 24-01 and the deposit was penetrated for 1.3 m in Borehole 07-2 before the borehole was terminated.

The SPT 'N'-values measured within the silt deposit ranged from 31 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration, indicating a dense to very dense state of compactness.

The results of two grain size distribution tests carried out on samples of the silt deposit are shown in Figure C4 in Appendix C.

The water content measured on samples of the silt deposit range from about 18% to 23%.

Atterberg limits tests carried out on three samples of the silt deposit indicate that the fines component of the deposit is non-plastic and is classified as a silt.

4.2.5 Sand and Gravel (SP/GP)

A sand and gravel deposit was encountered at the riverbed in Boreholes 08-1 and 08-2 at Elevation 203.7 m and 203.1 m, respectively, and below the silty sand containing organics in Borehole 07-2 at Elevation 202.3 m. Inferred cobbles were noted within the deposit in Boreholes 08-1 and 08-2. The deposit was 3.8 m to 4 m thick in the boreholes advanced in the river and was 0.4 m thick in Borehole 07-2.

The SPT 'N'-values measured in the sand and gravel deposit generally range from 14 blows per 0.3 m of penetration to 60 blows per 0.15 m of penetration, with SPT 'N'-Values at the river bottom surface of 4 blows and 8 blows per 0.3 m of penetration. The SPT 'N'-values indicate that the deposit is generally compact to very dense with loose state of compactness near the surface of the riverbed.

The results of grain size distribution tests carried out on two samples of the sand and gravel deposit are shown in Figure B6 in Appendix B.

The water content measured on samples of the sand and gravel deposit ranged from about 7% to 17%.

4.2.6 Silty Sand (SM) to Sand (SP)

A 1.5 m to 13.9 m thick silty sand to sand deposit was encountered under the fill in Borehole 07-5, below the pier concrete foundation in Borehole 08-3, below the silty sand containing organics in Boreholes 07-3, 07-4 and BH24-02, and below the sand and gravel in Boreholes 07-2 and 08-1. Trace organics were encountered within the deposit in Borehole BH24-02 to a depth of 11.3 m below ground surface. The deposit was penetrated for lengths of between 0.6 m and 3.6 m in Boreholes 07-3, 07-4, and 08-3 before the boreholes were terminated within this layer.

The SPT 'N'-values measured in the silty sand to sand deposit range from 25 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration indicating that the deposit has a compact to very dense state of compactness. Heaving sands within the hollow stem augers due to unbalanced water pressure was noted during drilling within the silty sand deposit in Borehole 24-02, which may have led to some sample disturbance.

The results of grain size distribution tests carried out on seven samples of the silty sand to sand deposit are shown in Figures B2, B3, B7 and C1 in Appendices B and C.

The water content measured on samples of the silty sand to sand deposit ranged from about 10% to 24%.

4.2.7 Clayey Silt-Silt (CL-ML) to Clayey Silt (CL)

A clayey silt-silt to clayey silt deposit was encountered below the fill in Borehole 07-6; below the pier concrete in Borehole 08-4; below the silt deposit in Borehole BH24-01; below the sand and gravel deposit in Borehole 08-2; and below the silty sand to sand deposit in Boreholes 07-5, 08-1, and BH24-02. The deposit contained silt pockets in Borehole 24-01 between depths of about 12.2 m and 12.8 m bgs. The deposit was encountered between Elevation 199.1 m and 206.8 m and was penetrated for lengths between 0.7 m and 6.9 m before the boreholes were terminated. The clayey silt-silt was typically described as silt or clayey silt in Boreholes 07-5, 07-6, 08-1, 08-2, and 8-4 advanced during the 2009 Golder investigation.

The SPT 'N'-values measured within the clayey silt-silt to clayey silt deposit range from 43 blows per 0.3 m of penetration to 100 blows per 0.1 m of penetration suggesting a hard consistency.

The results of grain size distribution tests carried out on five samples of the clayey silt-silt to clayey silt deposit are shown in Figures B4, B8, and C5 in Appendices B and C.

The water content measured on samples of the clayey silt-silt to clayey silt deposit ranged from about 18% to 24%.

Atterberg limits tests were carried out on seven samples of the clayey silt-silt to clayey silt deposit and measured liquid limits between 21% and 24%, plastic limits between 16% and 19%, and plasticity indices between 5% and 8%. The results of the Atterberg limits test are shown in Figures B5, B9 and C6 in Appendices B and C, and indicate that the soil is classified as clayey silt-silt to clayey silt of low plasticity.

4.3 Groundwater Conditions

The water levels measured in the open boreholes at the time of the investigation are shown on the borehole records in Appendices A, B and C and are not considered representative of the stabilized hydrostatic water levels at the site.

Standpipe piezometers were installed in Boreholes BH24-01 and BH24-02 to allow monitoring of the stabilized hydrostatic groundwater level at this site. Piezometers were also installed in Boreholes 07-3 and 07-5 as part of the Golder 2009 investigation. The groundwater levels recorded in the piezometers are shown on the borehole records in Appendices B and C and are summarized below.

Table 4: Summary of Piezometer Installations and Water Level Readings

Borehole No. (Piezometer)	Depth (bgs) (Elevation) of Screen Interval / Sand Pack (m)	Depth (bgs) to Water Level (m)	Water Level Elevation (m)	Date of Water Level Reading
24-01	8.2 – 9.7 (202.7 – 201.2)	5.0	205.9	August 26, 2024
		5.1	205.8	November 28, 2024
24-02	12.5 – 15.5 (197.5 – 194.5)	5.1	204.9	August 26, 2024
		5.5	204.5	November 28, 2024
07-3	9.2 – 10.7 (197.2 – 195.7)	1.6	204.8	July 12, 2007
		1.7	204.7	July 31, 2007
		1.6	204.8	August 29, 2007
07-5	10.7 – 13.7 (199.4 – 196.4)	4.8	205.3	July 12, 2007
		4.7	205.4	July 31, 2007
		4.8	205.3	August 29, 2007

The groundwater level observations at this site will be subject to seasonal fluctuations and precipitation events; the water levels should be expected to be higher during the spring season or during and following periods of heavy precipitation and snow melt.

The groundwater levels are also anticipated to fluctuate relative to the Nottawasaga River water level which is described in the next section.

4.3.1 Nottawasaga River (Water) Level / Depth

The water level of the Nottawasaga River was measured at about Elevation 204.3 m during the April 2024 survey carried out by GeoVerra. The river water level is expected to vary and is shown to be at about El. 205 m in January 2006 (Drawing Sheet 51, 2009 Contract) and El. 204.6 m in November 2008 (Golder, 2009).

The 1960 Contract (Contract No. 1960-0171, Drawing TWP#785-250-1-A) indicated the river bottom was at about Elevation 202.9 m near the proposed bridge. During the Golder 2009 investigation, the river bottom was encountered between Elevation 202.8 m and 203.7 m, directly downstream of the existing piers.

The depth of the river ranged between 0.9 m and 1.9 m deep during the previous investigation in Boreholes 08-1 to 08-4, when the water level was measured to be at El. 204.6 m.

4.4 Analytical Testing Results

Seven soil samples were submitted for analysis of parameters used to assess the potential corrosivity of the site soil to steel and concrete. Detailed analytical test results are included in Appendix C and the test results are summarized below:

Table 5: Summary of Analytical Testing Results - Soil

Borehole No., Sample No. Depth (m) / Elevation (m)	pH	Resistivity (ohm-cm)	Electrical Conductivity (μ mho/cm)	Soluble Chlorides (μ g/g)	Soluble Sulphates (μ g/g)	Sulphides (mg/kg)	Redox Potential (mV)
BH24-01, SA-5 3.1 – 3.7 / 207.8 – 207.2	7.76	410	2470	1400	94	3.2	270
BH24-01, SA-9 7.6 – 8.0 / 203.3 – 202.9	7.86	870	1160	550	83	1.5	270
BH24-01, SA-12 12.2 – 12.8 / 198.7 – 198.1	7.85	4100	244	21	79	1.8	270
BH24-02, SA-2+3 0.9 – 2.1 / 209.1 – 207.9	8.05	1200	843	330	40	1.8	270
BH24-02, SA-5 3.1 – 3.7 / 206.9 – 206.3	7.96	2400	420	100	24	0.9	270
BH24-02, SA-10 9.1 – 9.8 / 200.9 – 200.2	7.92	3500	284	80	34	1.6	270
BH24-02, SA-12 12.2 – 12.8 / 197.8 – 197.2	7.90	4100	246	64	31	1.1	270

Four water samples (two groundwater and two surface water) were submitted for analysis of parameters used to assess the potential corrosivity of the water to steel and concrete. Detailed analytical test results are included in Appendix C and the test results are summarized below:

Table 6: Summary of Analytical Testing Results - Water

Borehole No. / Location, Sample Type	pH	Resistivity (ohm-cm)	Electrical Conductivity (μ mho/cm)	Dissolved Chloride (mg/L)	Dissolved Sulphate (mg/L)	Sulphides (mg/L)	Redox Potential (mV)
BH24-01, Groundwater	7.71	130	8000	2500	74	0.052	370
BH24-02, Groundwater	8.00	480	2100	460	21	<0.020 ¹	420
SA-3 East Side of River, Surface Water	8.42	1300	760	63	30	<0.020 ¹	310

Borehole No. / Location, Sample Type	pH	Resistivity (ohm-cm)	Electrical Conductivity (µmho/cm)	Dissolved Chloride (mg/L)	Dissolved Sulphate (mg/L)	Sulphides (mg/L)	Redox Potential (mV)
SA-4 West Side of River, Surface Water	8.43	1500	650	42	27	- ²	350

Note:

1. Less than reportable detection limit.
2. Sulphides not measured due to reagent being lost during sample collection.

5.0 GEOPHYSICAL (MAGNETOMETER) SURVEY RESULTS

Magnetometer tests were carried out inside the casings installed at locations 24-01B and 24-02B (see Drawing 1) to check the as-constructed length of closest surrounding steel piles installed at the east and west bridge abutments. The results of the magnetometer testing detected peak magnetic intensities near the ground surface (adjacent to the steel reinforced concrete abutments) and at about 16.4 m and 13.3 m bgs (i.e. the interpreted pile tip depth) at the east and west abutments respectively. The results of the survey are summarized in the table below and provided in detail in the associated technical memorandum in Appendix D.

Table 7: Summary of Magnetometer Survey Results

Magnetometer Test No. (Abutment Location)	Ground Surface Elevation	Interpreted Pile Tip Depth	Interpreted Pile Tip Elevation
24-01B (East Abutment)	210.7 m	16.4 m bgs	194.3 m
24-02B (West Abutment)	210.0 m	13.3 m bgs	196.7 m

6.0 CLOSURE

This foundation investigation report was prepared by Madison Kennedy, P.Eng., a Geotechnical Engineer with WSP. Kevin Bentley, P.Eng. a Geotechnical Engineer with WSP and MTO Principal Foundations Contact conducted a technical and quality control review of the report.

Madison Kennedy, M.A.Sc. P.Eng.
Geotechnical Engineer

MCK/KJB/al

Kevin Bentley, M.E.Sc., P.Eng.
MTO Principal Foundations Contact

PART B

**FOUNDATION DESIGN REPORT
HIGHWAY 89 NOTTAWASAGA RIVER BRIDGE WIDENING
(SITE NO. 30X-0250/B0)
HIGHWAY 89, ALLISTON, SIMCOE COUNTY, ONTARIO
MTO G.W.P. 2022-22-00; W.P. 2121-22-01**

7.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

7.1 General

This section of the report provides foundation engineering design recommendations for the Highway 89 Nottawasaga River Bridge (Site No. 30X-0250/B0) south widening in Alliston, Ontario. The recommendations herein are based on interpretation of the factual data obtained from the boreholes and geophysical testing completed during the current and previous subsurface explorations. The discussion and recommendations presented are intended to provide the designers with information to assess the feasibility of using the existing substructure foundations to support bridge widening on the south side.

The Foundation Design Report, discussion and recommendations are intended for the use of the MTO and their designers and shall not be used or relied upon for any other purpose or by any other parties, including the construction contractor or design-build proponents. Contractors undertaking the work must make their own interpretation based on the data presented in the Foundation Investigation Report (Part A of this report). Where comments are made on construction, they are provided to highlight those aspects that could affect the design of the project and for which special provisions may be required in the Contract Documents. Those requiring information on aspects of construction must make their own interpretation of the data provided as such interpretation may affect equipment selection, proposed construction methods, scheduling and the like.

7.2 Project Understanding

The existing Nottawasaga River Bridge is a three-span structure (span lengths of about 18 m, 25.6 m and 18 m) and is about 11.6 m wide, consisting of a concrete deck supported on steel girders.

The original bridge and foundations were constructed as part of a 1960 contract (Contract No. 1960-0171). The bridge was subsequently rehabilitated (superstructure replaced) and widened to the north with new foundations as part of the 2009 Contract (2009-2046). Highway 89 was realigned to the north and the southern portion of the original 1960 substructure was left in place (see report cover photograph) for future widening which is now being considered to support the proposed south widening. The existing bridge is primarily supported on the foundations installed as part of the 2009 contract, with approximately a 3.5 m width of the bridge deck supported by the 1960 foundations.

Existing Abutments; The bridge abutments are founded on steel piles, with the 1960 portion consisting of 12BP53 piles (equivalent to 310x79 H-Piles), and the 2009 portion consisting of 310x110 H-Piles. Based on the 1960 contract drawings (Drawing No. D4486-2 / 785-250-2-A), the underside of the pile cap is at El. 206.4 m (677') and 207 m (679.15') at the west and east abutments, respectively. Based on the 2009 contract drawings (Sheet 57) the underside of the pile cap for the north widening is between El. 206.6 m and 207.2 m at the west abutment and at El. 207.9 m for the east abutment. The design pile lengths for the 1960 and 2009 abutment foundations are shown to be about 7.6 m (25') and 9.0 m to 10.1 m long below pile cut-off, respectively.

Although as-built drawings are not provided for either contract, a note on the 1960 contract drawing states that the maximum design load for the steel H-piles is 222 kN (25 tons). Similarly, a note on the 2009 contract drawings (Sheet 57, Note 8) indicates a maximum factored load for pile design at ULS and SLS equal to 807 kN and 587 kN respectively. The 2009 contract drawings (Sheet 57, Note 4) also include a note stating that piles are to be driven in accordance with Standard SS103-11 (i.e. Hiley method) using an ultimate geotechnical resistance of 2,800 kN per pile.

Existing Piers: The piers for both the 1960 and 2009 contracts are shown to be supported on shallow spread footings, enclosed within a sheetpile cofferdam sealed with a tremie contract plug during construction within the Nottawasaga River. Based on the 1960 drawings (Drawing No. D4486-2 / 785-250-2-A), the bottom of the west and east pier footings are at about El. 200.9 m (659') and 201.0 m (659.5'), respectively. The findings in the Golder 2009 report confirmed the underside of the west and east pier footings of the 1960 structure are at about El. 200.5 m and 201.2 m, respectively, which were generally compatible with the 1960 drawings. The 2009 Contract Drawings (Sheet 57) indicate a maximum founding elevation of 200.5 m and 201.2 m at the west and east abutments, respectively, matching the elevations measured in the Golder 2009 report.

Based on the proposed design, the existing bridge structure is to be widened by approximately 3.5 m to the south (consisting of one additional steel girder, widened concrete deck, new barrier wall and new abutment walls / wingwalls) to accommodate one additional turning lane on Highway 89 to access Essa 5th Line. The widened portion of Highway 89 will be maintained at approximately the same existing profile within the limits of the structure and approach embankments, as such no additional fill placement is anticipated. The widening will include rehabilitation of the exposed 1960 substructure elements, with the preferred foundation option being re-use of the existing abutment and pier foundations from the 1960 construction, with supplemental foundation design and support as needed.

7.3 General Foundation Design Context

7.3.1 Consequences and Site Understanding Classification

In accordance with Section 6.5 of the *Canadian Highway Bridge Design Code CAN/CSA S6-19* (CHBDC, 2019) and its *Commentary*, the bridge and its foundation system may be classified as a geotechnical system design for application along a transportation corridor with medium to large traffic volumes and/or with potential impacts on other transportation corridors, resulting in a “typical consequence level” associated with exceeding limit states design.

In addition, given the project-specific foundation investigation carried out at this site (as presented in the Foundation Investigation Report (or Part A of the report)), in comparison to the degree of site understanding in Section 6.5 of CHBDC (2019), the level of confidence for design is considered to be a “typical degree of site and prediction model understanding.” Accordingly, the appropriate corresponding ultimate limit state (ULS) and serviceability limit state (SLS) consequence factor, Ψ , and geotechnical factors ϕ_{gu} and ϕ_{gs} , from Tables 6.1 and 6.2 of the CHBDC (2019) have been used for design.

In addition, reference is made to the MTO Material Engineering Research Office (MERO) Memorandum #2020-01 (dated March 23, 2020) allowing modified geotechnical factors for detail design, as applicable.

7.4 Seismic Design

7.4.1 Seismic Site Classification

The subsurface conditions for seismic site characterization were assessed based on the results of the field investigation and in situ testing. Based on the energy-corrected average penetration resistance, \bar{N}_{60} below the founding level or pile cap, the site may be classified as Site Class C in accordance with Table 4.1 of the CHBDC (2019), in the absence of any geophysical testing.

The CHBDC (2019) states that the seismic hazard values associated with the design earthquakes should be those established for the National Building Code of Canada (NBCC) by the Geological Survey of Canada (GSC).

The current seismic hazard maps (referred to as the 6th generation seismic hazard maps) were developed and made available for public use in 2020.

7.4.2 Spectral Response Values and Seismic Performance Category

In accordance with Section 4.4.3.1 of the 2019 CHBDC, the peak ground acceleration (PGA), peak ground velocity (PGV) and 5% damped spectral response acceleration ($S_a(T)$) values for Site Class C were obtained for the bridge site using the NBCC website (earthquakescanada.nrcan.gc.ca) and are summarized below.

Table 8: Site Class C - Peak Ground Acceleration, Peak Ground Velocity, and Spectral Response

Seismic Hazard Values for Site Class C	10% Exceedance in 50 years (475-year return period)	5% Exceedance in 50 years (975-year return period)	2% Exceedance in 50 years (2,475 year return period)
PGA (g)	0.0364	0.0571	0.0957
PGV (m/s)	0.0328	0.0543	0.0960
$S_a(0.2)$ (g)	0.0811	0.1270	0.2110
$S_a(0.5)$ (g)	0.0580	0.0901	0.1490
$S_a(1.0)$ (g)	0.0316	0.0503	0.0852
$S_a(2.0)$ (g)	0.0143	0.0238	0.0414
$S_a(5.0)$ (g)	0.0034	0.0060	0.0112
$S_a(10.0)$ (g)	0.0012	0.0021	0.0039

In accordance with Table 4.10 of the CHBDC (2019) and input from the structural team on the fundamental period of the bridge, the bridge structure (Importance Category of “Major-Route”) falls within Seismic Performance Category 2 based on the 6th generation seismic model.

Considering the current scope of work is limited to widening of the existing bridge superstructure on the existing foundations, seismic re-assessment of the entire bridge structure (designed in 2009) to meet CHBDC 2019 using 6th generation seismic maps has not been performed. It is noted that if 5th generation seismic maps are used, the bridge structure would be classified as Seismic Performance Category 1 and no seismic design is required. The design requirements associated with meeting Seismic Performance Category 2 should be considered for future work at this bridge site (i.e. rehabilitation, widening, or replacement).

7.5 Corrosion Potential

Soil corrosivity may affect the concrete and/or steel elements (e.g. reinforcing steel or steel piles) of foundations or related structures buried in the soil. The long-term performance and durability of the foundations are directly related to their respective corrosion resistance and the soil corrosivity. Generally, the corrosivity potential of soil can be assessed based on the soil resistivity / electrical conductivity, hydrogen ion concentration (pH), and salts (chloride and sulphate) concentrations. The analytical results for the soil samples submitted for testing are summarized in Section 4.4 and the analytical laboratory test reports are included in Appendix C.

The following sections provide a summary of the corrosion potential of the soil compared with various standards. The designer should take the results of laboratory testing and the associated corrosion potential into consideration in the evaluation of the existing foundations and buried substructure for reuse. Where recommendations are provided, they are for guidance only and the designer should make their own assessment of the corrosion potential and impact based on the laboratory testing results, combined with judgement and experience from other similar sites.

7.5.1 Concrete

The analytical results were compared to CSA A23.1-24 Table 3 (“*Additional requirements for concrete subjected to sulphate attack*”) for potential sulphate attack on concrete. The sulphate concentrations in the tested soil samples range from 24 to 94 µg/g and are below the exposure class of S-3 (Moderate). Similarly, the sulphate concentrations in the tested groundwater and surface water range from 21 to 74 mg/L, which are considered negligible per Table 7.2 of MTO Gravity Pipe Design Guidelines (MTO, 2014). Additionally, based on the Gravity Pipe Design Guidelines (MTO, 2014), the pH measured on soil and water samples is consistently between 7.8 and 8.0 and 7.7 and 8.4, respectively, and is not considered to be detrimental to concrete durability. Therefore, based on the samples tested, there may not be impacts on the structure(s) and sub-structure due to the effects of sulphates. However, given that the structures and foundations are located adjacent to the highway shoulder and have been exposed to de-icing salt, with a higher concentration of chlorides typically measured in the embankment fill soils and groundwater samples, the impacts of chlorides should be considered.

7.5.2 Steel

The corrosion rate of steel piles embedded in soil is influenced by factors including oxygen availability, pH, chlorine content, sulphate content, sulphide ion content and soil moisture content (MTO Structural Manual, 2024). The AASHTO LRFD Bridge Design Specifications (2020, Section 10, 10.7.5, as referenced in CHBDC 2019 Commentary), suggests that corrosion of steel piles be considered, particularly in fill soils, low pH soils, and marine environments. Caltrans discuss that testing for factors impacting the corrosion of steel piles should include soil minimum resistivity, pH, chloride content, sulphate content, sulfide ion content, soil moisture, and oxygen content within soil. Existing fill or disturbed native soils are more prone to corrosion than undisturbed native soils due to the amount of oxygen available (Caltrans, 2021). In addition, pile sections below the groundwater table are generally less susceptible to corrosion, due to the lack of available oxygen.

The MTO Structural Manual (2024) outlines that steel piles above the ground or low water level can not be used without approval from the Structural Section. Approved piles must include additional sacrificial steel based on the chemical properties of the soil or water and be coated over a length at least 1 m above the high water level to 0.6 m below the water level, or 1 m below ground elevation, as applicable. Caltrans (2021) also suggests that the greatest area of concern with regards to corrosion are from the bottom of the pile cap/footing down to about 1 m below the lowest recorded/measured groundwater elevation, due to disturbance and the availability of oxygen.

The corrosion parameters obtained from select samples tested during the current investigation were compared to a number of different standards. The standards are summarized below and a comparison with the associated results are provided in Table 9.

- MTO Gravity Pipe Design Guidelines (MTO, 2014) - Table 3.2 in the guidelines provides a degree of soil corrosiveness from very low to severe, based on resistivity of the soil, and Section 7.1.2 discusses the potential need for protection based on the resistivity of water.
- American Water Works Association (AWWA, 2005) – Provides a point system for soils based on resistivity, pH, redox potential, sulfides and moisture, where results greater than 10 points indicate the soil is corrosive for ductile iron pipes.
- California Department of Transportation (Caltrans, 2021) - Corrosion guidelines (both soil and water) provided and if any of the following apply the soil/water is considered corrosive: a) chloride concentration is 500 ppm or greater; b) sulphate concentration is 1500 ppm or greater; and c) pH 5.5 or less

Table 9: Comparison of Potential Corrosivity against Various Standards (MTO, 2014; AWWA, 2005; Caltrans, 2021)

Sub-Structure	Borehole No., Sample No.	Depth (m) / Elevation (m)	Soil Strata	Water Level (m) / Elevation (m)	MTO Gravity Pipe	AWWA Ductile Iron	Caltrans Corrosion Guidelines
East Abutment	BH24-01, SA-5	3.1 – 3.7 / 207.8 – 207.2	Clayey Silt Fill	5.0 / 205.9	Severe	10+0+0+3.5+1 = 14.5 Corrosive	Corrosive Chlorides
	BH24-01, SA-9	7.6 – 8.0 / 203.3 – 202.9	Silt	5.0 / 205.9	Severe	10+0+0+3.5+2 = 15.5 Corrosive	Corrosive Chlorides
	BH24-01, SA-12	12.2 – 12.8 / 198.7 – 198.1	Clayey Silt-Silt	5.0 / 205.9	Moderate	0+0+0+3.5+2 = 5.5 Not Corrosive	Non-corrosive
	BH24-01 GW Sample	-	Groundwater	5.0 / 205.9	Protection Required	N/A	Corrosive Chlorides
West Abutment	BH24-02, SA-2+3	0.9 – 2.1 / 209.1 – 207.9	Silty Sand to Sandy Silt Fill	5.1 / 204.9	Severe	10+0+0+3.5+1 = 14.5 Corrosive	Non-corrosive
	BH24-02, SA-5	3.1 – 3.7 / 206.9 – 206.3	Silty Sand Fill	5.1 / 204.9	Moderate	2+0+0+3.5+1 = 6.5 Not corrosive	Non-corrosive
	BH24-02, SA-10	9.1 – 9.8 / 200.9 – 200.2	Silty Sand	5.1 / 204.9	Moderate	0+0+0+3.5+2 = 5.5 Not Corrosive	Non-corrosive
	BH24-02, SA-12	12.2 – 12.8 / 197.8 – 197.2	Silty Sand	5.1 / 204.9	Moderate	0+0+0+3.5+2 = 5.5 Not Corrosive	Non-corrosive
	BH24-02 GW Sample	-	Groundwater	5.1 / 204.9	Protection Required	N/A	Non-corrosive
Piers	SA3, East Side of Nottawasaga River SW Sample	-	Surface Water	-	Protection Likely Required	N/A	Non-corrosive
	SA4, West Side of Nottawasaga River SW Sample	-	Surface Water	-	Protection Likely Required	N/A	Non-corrosive

Note: GW = Ground Water; SW = Surface Water

At the east abutment (BH24-01) the results suggest that the fill and underlying silt deposit are corrosive and may be severely corrosive when comparing to the referenced standards. The results from the sample taken from the clayey silt-silt deposit indicate a non-corrosive to moderately corrosive environment. While the corrosion parameters from the silt deposit below the groundwater table and the groundwater sample suggest that the soil corrosivity is severe and the groundwater is considered corrosive (i.e. protection required), it is anticipated that the majority of the corrosion would have occurred above, or within 1 m of the groundwater level. As such, at the east abutment, it is anticipated that there is a higher potential for corrosion of the steel piles to about Elevation 205 m (6 mbgs), and a lower potential for corrosion of the piles below this elevation.

At the west abutment (BH24-02) the results suggest that upper silty sand to sandy silt fill ranges from non-corrosive to severely corrosive when comparing to the referenced standards. Samples of the lower portion of the silty sand fill and the native silty sand indicate a non-corrosive to moderately corrosive environment. While corrosivity samples were not carried out on the organic silt deposit, the presence of soils with high organics and pH between 5.5 and 8.5 could be detrimental to piles (AASHTO LRFD, 2020). The groundwater results similarly range from non-corrosive to requiring corrosion protection due to the low resistivity results. At the west abutment it is anticipated that there is a moderate to severe potential for corrosion of the steel piles to about Elevation 202 m (8 m bgs), and a lower potential for corrosion of the piles below this elevation.

The water samples taken near the banks of the Nottawasaga River are generally considered to be non-corrosive, however, exposed steel or reinforced concrete is recommended to have some level of protection based on the measured low resistivity and elevated pH levels of the surface water.

The steel H-piles installed in 1960 and 2009 likely had different quality and manufacturing standards, and corrosion protection measures may not have been implemented. Based on the corrosion potential of the soils, it is practical to assume some degree of steel section loss has occurred. While the parameters tested provide an indication of the corrosivity potential of the soil, some parameters such as resistivity are also impacted by the soil classification as finer grained soils (i.e. clays and silts) will naturally have a lower resistivity. Thus, the actual corrosion rate of a driven steel pile cannot be accurately estimated by these parameters due to the complex interaction of various factors (Caltrans, 2021).

Estimates of the corrosion rate can be obtained by comparing soil corrosion parameters to similar sites with historical empirical information. Estimated corrosion rates for steel piles in corrosive soils or waters can be used as a first order estimate of corrosion and various jurisdictions (Hannigan et al. 2006, Caltrans 2021) provide corrosion rate estimates ranging from 0.025 mm/year to 0.08 mm/year for each surface exposed to the corrosive soil/water.

The structural engineer will need to evaluate the corrosivity parameters and corrosion rate to evaluate the potential impact to the structural integrity of the 1960 piles and sub-structure elements exposed to the soil and water, as applicable, and check that the intended re-use of the 1960 piles meet the current design criteria. Discussions with the structural engineer indicate design loads on the existing piles are relatively low and the anticipated steel section loss from corrosion is accounted for in the current design. However, it is recommended that the actual steel thickness of selected 1960 steel piles be measured to confirm structural design assumptions to validate the design and proposed re-use of the existing foundation piles, including confirmation of the recommended design geotechnical resistances provided in the next section. Referring to the design drawings, inspection of selected 1960 steel piles will be performed by a structural engineer during construction. Geotechnical related comments and recommendations for the inspection and measurement of the steel thickness for selected 1960 steel piles during construction are discussed further in Section 7.9.4

Following pile inspection, in-situ steel thickness measurements, and confirmation that the piles meet structural design assumptions for the current project, a follow up assessment will need to be made by the structural engineer to determine the actual site specific corrosion rate for the 1960 piles to determine the remaining design life of the rehabilitated structure (specifically the 1960 steel pile foundations). Based on the results of the structural assessment and remaining design life of the piles, future bridge rehabilitation / replacement strategies (including any supplemental foundation design and support) will need to be considered and scheduled accordingly as part of a separate assignment and future contract.

7.6 Existing Foundation Assessment

The existing foundations for the Highway 89-Nottawasaga River Bridge piers and abutments were assessed using the latest CHBDC (2019) requirements.

7.6.1 Spread / Strip Footing

The geotechnical resistance / capacity of the existing spread footings at the piers was assessed based on review of the existing contract drawings (2009 contract drawings, Sheet 57 and 1960 contract drawings, Dwg. D4486-5), and the existing and supplementary geotechnical information.

Based on the contract drawings, the east and west pier footings are about 3 m wide and 25 m long (originally about 15 m long but lengthened by about 10 m as part of the 2009 contract). The founding elevations of the north end of the 1960 pier footings were confirmed to be at about Elevation 200.5 m and 201.2 m at the west and east piers, respectively. The design for the pier footings as part of the 2009 structure widening to the north was to be founded at about the same elevation and tied into the existing pier footings, however, no as-built drawings are available for the 2009 construction.

Based on the boreholes advanced during the Golder 2009 investigation (Boreholes 08-1 to 08-4), as well as Borehole 4 from the 1959 investigation it is anticipated that the foundations are founded on very dense sand and/or hard clayey silt. Given that the contract drawings indicate that the piers were to be constructed using closed sheetpile cofferdam structures with tremie concrete placement, it is reasonable to assume the foundation soils remained relatively undisturbed.

The embedment depth of the pier spread footings was checked based on the elevation of the river bottom as encountered in the boreholes advanced during the Golder 2009 Investigation and the bathymetry shown in the 2009 contract drawings. The river bottom is assumed to be at Elevation 203.1 m for the east pier as measured in Borehole 08-2 (Elev. 203.3 m was measured in Borehole 08-4) and at Elevation 202.8 m for the west pier as measured in Borehole 08-3 (Elev. 203.7 m was measured in Borehole 08-1). Given that the 2009 contract drawings indicate rock protection was installed around the existing and new piers within the river, it is assumed the river bottom surrounding piers has remained at about Elevation 203 m.

Based on the above information, the following geotechnical resistances are estimated for the existing pier foundation elements. Given that the original 1960 and 2009 pier footings were mechanically connected and have similar dimensions and founding elevations, a combined geotechnical resistance is provided for the composite pier foundation elements.

Table 10: Estimate of Geotechnical Resistance of Existing Pier Foundations

Foundation Element	Borehole Reference	Founding Elevation (m)	Founding Stratum	Foundation Dimensions, Width x Length (m)	Factored Ultimate Geotechnical Resistance ¹ (kPa)	Factored Serviceability Geotechnical Resistance ² (kPa)
West Pier (1960 and 2009)	08-1 & 08-3	200.5	Very Dense Sand	3 m x 25 m	500	350
East Pier (1960 and 2009)	08-2 & 08-4	201.2	Hard Clayey Silt	3 m x 25 m	500	350

Note:

1. The river bottom surface used to calculate the depth of embedment was taken as 203.1 m for the east pier and Elevation 202.8 m for the west pier as measured in Boreholes 08-02 and 08-3, respectively.
2. For 25 mm of settlement.

The geotechnical resistances provided above are given under the assumption that loads will be applied concentrically to the centreline/centroid of the footing, as shown on Figure 6.4 of the CHBDC (2019). Where the load is applied eccentrically from the centreline/centroid of the footing, the pressure distribution at ULS and SLS and the eccentricity limit of the footing should be taken into consideration in accordance with Section 6.10.5 of the CHBDC (2019) and its Commentary. Once the structural design is substantially complete, the structural engineer should verify whether the factored ultimate and serviceability resistances provided above require revision based on load inclination.

7.6.1.1 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete footings and subgrade should be calculated in accordance with Section 6.10.4 of the CHBDC (2019). The unfactored friction factor ($\tan \delta$) values between the cast-in-place concrete of the pier footings and the native very dense sand and hard clayey silt soils may be taken as 0.45.

7.6.1.2 Frost Protection

Spread footings should have a minimum of 1.5 m of conventional soil cover for frost protection, in accordance with OPSD 3090.101 (Foundation Frost Penetration Depths for Southern Ontario), measured perpendicular to the nearest ground surface. As the footings are founded below the ice cover of the river this condition may not be applicable for the pier foundations.

7.6.2 Driven Steel H-Piles

7.6.2.1 Axial Geotechnical Resistance

The existing abutments were constructed on steel H-Piles. The 12BP53 piles (equivalent to 310x79 piles) were installed at the abutments of the 1960 portion of the bridge, and 310x110 H-Piles were installed for the 2009 bridge abutments for the north widening.

The axial geotechnical resistance of the existing piles was estimated based on our review of the design drawings, existing and supplementary geotechnical information (including geophysical testing / magnetometer survey to check as-constructed length of piles), and subsequent analysis using the latest CHBDC requirements. It is noted that no quality control or quality verification records or as-build records were available for the foundation piles for both the 1960 and 2009 contracts.

The bottom of the pile caps were taken from the contract drawings. The existing pile lengths used to estimate the geotechnical resistance of the 1960 portion of the bridge abutments near the proposed superstructure widening on the south side were taken from the contract drawings, and modified / lengthened based on the findings from the geophysical testing. The 1960 drawings also indicate a maximum design load of 25 tons was used for the 310x79 H-piles (General Layout Drawing, Note 4), although a design geotechnical resistance value was not shown on the drawings.

Based on the Golder (2009) foundation report, the existing 310x110 H-piles for the north widening were designed using a factored ultimate geotechnical resistance of 1,400 kN and factored serviceability geotechnical resistance of 1,000 kN. The contract drawings also include the following note: "*the piles (are) to be driven in accordance with Standard SS103-11 using an ultimate geotechnical resistance of 2800 kN per pile*" (2009-2046, Sheet 57, Note 4), although the actual driven pile lengths and testing results are not known. The 2009 drawings also

indicate a design maximum factored load at ULS and SLS equal to 807 kN and 587 kN was used for each HP310x110 pile respectively (2009-2046, Sheet 57, Note 8).

Based on the available information, the recommended factored ultimate axial geotechnical resistance and the factored serviceability geotechnical resistance (for 25 mm of settlement) for the existing piles are provided in the table below. These estimated factored geotechnical resistances include potential impacts from corrosion through an estimated reduction in the overall dimension of the piles, although the structural integrity and capacity of the steel pile itself will need to be checked and confirmed by the structural designer.

Table 11: Estimate of Geotechnical Resistance of Existing Piles

Foundation Element	Pile Size	Assumed Pile Length / Tip Elevation ¹	Soil Strata at Pile Tip	Factored Ultimate Geotechnical Resistance (kN) ²	Factored Serviceability Geotechnical Resistance (kN) ²
East Abutment (1960 original)	310x79 ³	12.5 m / 194.5 m	Hard Clayey Silt-Silt (SPT "N"-values > 72)	400	> 400
East Abutment (2009 widening)	310x110	9-10 m / 197 – 198 m	Hard Clayey Silt-Silt (SPT "N"-values > 100)	807 - 1,400	587 - 1,000
West Abutment (1960 original)	310x79 ³	9.5 m / 196.9 m	Very Dense Silty Sand to Hard Clayey Silt-Silt (SPT "N"-values > 53)	350	> 350
West Abutment (2009 widening)	310x110	9-10 m / 197 - 198 m	Very Dense Sand (SPT "N"-values > 100)	807 - 1,400	807 - 1,000

Notes:

1. Pile lengths are based on the results of the geophysical survey for the 1960 piles, and from Contract Drawing 2009-2046, Sheet 57 for the 2009 piles.
2. Analysis includes allowance for reduced dimensions due to section loss of the piles due to corrosion. For 2009 contract piles, the range in factored geotechnical resistance value takes into account the factored design load provided in design drawings and unavailable pile driving and testing records / results.
3. Equivalent to 12BP53 piles noted in Contract Drawing W.P. 218-59, Drawing No. D4486-2 / 785-250-2-A from 1960.

According to the design drawings, a structural engineer is to inspect the condition and measure the corrosion rate / steel thickness of selected 1960 original piles at the East Abutment during construction (see Section 7.9.4). After the pile inspection, if the structural engineer indicates that the structural integrity of the 1960 steel piles are inadequate to support the structural design loads, WSP will need to be given an opportunity to reassess and revise the geotechnical resistances provided in the table above, as applicable.

As the pile spacing is greater than or equal to about 4 pile diameters (centre-to-centre) and the pile cap is resting on soil that was placed more than 50 years ago with no proposed grade raise, a group efficiency for axial resistance of 1 is appropriate and the piles can be assumed to act as single piles with no group interaction effects with regards to axial resistance.

7.6.2.2 Resistance to Lateral Loads

The resistance to lateral loading will be derived from both the pile batter and the soil surrounding the piles. Where ground conditions are generally competent and the lateral loads on the piles are relatively small such that the maximum lateral deflections will be relatively small, the resistance to lateral loading in front of a single pile can be estimated using subgrade reaction theory. However, the response of piles to lateral loading can be highly non-linear, and methods that assume linear behaviour (such as subgrade reaction theory) are only appropriate where the maximum deflections are typically less than 1% of the pile dimension, where the loading is static (i.e., no cycling) and where the pile materials behave linearly (CFEM, 2006). Where these conditions are not met, non-linear lateral behaviour of the soil should be considered by the use of p-y curves.

The factored serviceability geotechnical response of the soil in front of the piles under lateral loading may be estimated using subgrade reaction theory, as described by Terzaghi (1955) and the *Canadian Foundation Engineering Manual* (CFEM 2006). The coefficient of horizontal subgrade reaction, k_h (MPa/m), is based on the equation below for the non-cohesive soils present at this site:

$$k_h = \frac{n_h z}{B} \quad \text{where: } n_h \quad \text{is the constant of horizontal subgrade reaction (MPa/m), as given in Table 12;}$$

z is the depth (m) of the pile below the pile cap; and,

B is the pile diameter/width (m)

The following values of n_h (American Petroleum Institute (API), 2002) may be incorporated into the calculations of horizontal subgrade reaction (k_h) for structural analyses for a single pile.

Table 12: Summary of Unfactored Parameters for Horizontal Subgrade Reaction Modulus (South Side)

Foundation Element	Relevant Borehole(s)	Soil Layer	Elevation Range (m)	n_h (kPa/m)	S_u (kPa)
West Abutment	BH24-02	Very loose to compact silty sand containing organics to sandy silt and stiff organic silt (Above and below the water table)	Above 201.3	1,000	-
		Very dense silty sand (Below the water table)	201.3 to 193.7	15,000	-
East Abutment	BH24-01 / 07-5	Loose to compact silty sand fill with firm to stiff clayey silt interlayers (Above and below the water table)	Above 204.5	1,300	-
		Dense to very dense silt (Below the water table)	204.5 to 199.1	12,000	-
		Hard clayey silt-silt (Below the water table)	199.1 to 193.5	-	200

Group action for lateral loading should also be evaluated by reducing the coefficient of horizontal subgrade reaction either in the direction of loading or perpendicular to the direction of loading by relevant group pile efficiency factors as outlined in Section C6.11.3.4 including Figures C6.22 to C6.24 of the *Commentary to the CHBDC* (2019).

7.6.2.3 Frost Protection

Pile caps should be provided with a minimum of 1.5 m of conventional soil cover for frost protection, in accordance with OPSD 3090.101 (Foundation Frost Penetration Depths for Southern Ontario), measured perpendicular to the face of the abutment slope or surface in front of the abutments to the edge of the underside of the pile cap. If adequate cover cannot be provided for the footing or pile cap, rigid Styrofoam insulation could be installed to compensate for the lack of soil cover and provide protection from frost penetration.

7.7 Lateral Earth Pressures for Design

The lateral earth pressures acting on the abutment walls, wingwalls and any retaining walls will depend on the type and method of placement of the backfill materials, the nature of the soils behind the backfill, the magnitude of

any surcharge loading including construction loadings, the freedom of lateral movement of the structure and the drainage conditions behind the walls.

The following guidelines and recommendations are provided regarding the lateral earth pressures for static (i.e., not seismic) loading conditions. These lateral earth pressure parameters assume the ground level above the wall will be flat (i.e., not sloping). If the inclination of the slope above the wall changes then new lateral earth pressure parameters need to be calculated as per the CHBDC (2019).

The unfactored parameters for the soil encountered during the geotechnical investigation, as well as for any new Granular A and Granular B Type II soil to be used as part of the bridge widening are summarized in the table below.

Table 13: Static Lateral Earth Pressure Parameters for Design

Soil Type	Internal Angle of Friction (ϕ , °)	Unit Weight (γ , kN/m ³)	Coefficient of Lateral Earth Pressure		
			Active, K_a	At-Rest, K_o	Passive, K_p
Earth Embankment Fill	30	19	0.33	0.50	3.0
Granular A	35	22	0.27	0.43	3.7
Granular B Type II	35	21	0.27	0.43	3.7

For walls that are restrained from lateral yielding, at-rest horizontal lateral earth pressures (plus any compaction surcharge) should be used for evaluation. Active pressures should be used for the evaluation of unrestrained walls. The movement to allow active pressures to develop within the backfill, and thereby assume an unrestrained structure for design, should be calculated in accordance with Section C6.12.1 and Table C6.12 of the Commentary to the CHBDC (2019).

7.8 Approach Embankment

7.8.1 Global Stability

Based on the General Arrangement drawing, there is no significant grade change associated with the widening of the Highway 89-Nottawasaga River bridge. The existing approach embankments on the south side, where the previous Highway 89 alignment was located, will be re-used to support a new pavement structure.

A check of the global stability of the existing embankment(s) was carried using the most recent CHBDC (2019) standards and MTO guidance (MERO 2020).

Limit equilibrium slope stability analyses were performed on the east and west approach embankment side slopes using the commercially available program Slide2 (Version 9) by RocScience Inc., employing the Morgenstern Price method of analysis. For all analyses, the Factor of Safety (FoS) of numerous potential failure surfaces were computed for the critical embankment cross section in order to establish the minimum FoS. In general, circular slip surfaces were used in the analyses.

The long-term (effective stress) condition was analyzed given that any short-term (undrained conditions) that may have been present during construction (in 1960 and 2009) would no longer be applicable (i.e. pore water pressures dissipated).

A target factor of safety of 1.54 for long-term stability is normally adopted in the design of permanent slopes under static conditions, per the 2019 CHBDC. Based on MERO (2020), a factor of safety of 1.43 or 1.33 can be considered for permanent conditions for a typical consequence factor (Ψ) and a typical or high degree of

understanding (Φ_{gu}), subject to acceptance by MTO. Given that the existing embankments on the south side have been in place for more than 60 years (constructed in 1960) with no visual signs of inadequate performance, consideration could be given to using a high degree of understanding and adopting a factor of safety equal to 1.33.

For the soils present at the site, the effective stress parameters employed in the analysis were estimated using correlations based on the in-situ Standard Penetration Tests (SPTs) as proposed by U.S. Navy (1986) and were adjusted, as necessary, using engineering judgment based on precedent experience in similar soil conditions.

The simplified stratigraphy and selected soil parameters employed in the analyses are summarized below.

Table 14: Soil Parameters for Stability Analysis

Stratigraphy	Soil Parameters (Long-Term or Effective Stress)		
	Bulk Unit Weight, γ (kN/m ³)	Effective Cohesion, c' (kPa)	Angle of Internal Friction, ϕ (°)
Existing Fill	19	0	30
Very Loose to Loose Silty Sand to Sandy Silt containing Organics	19	0	28
Compact to Very Dense Silty Sand to Sand	20	0	32
Hard Clayey Silt – Silt to Clayey Silt	19	0	31
Dense to Very Dense Silt	19	0	31
Organic Silt	18	0	28

7.8.1.1 West and East Approach Embankments – Stability Results

The soil conditions encountered in boreholes from the current and previous investigations have been used in the creation of the idealized slope stability models (see Figures 3 and 6 for the west and east abutment locations respectively).

For the stability analysis, the groundwater level was assumed to vary between El. 204.7 m and 204.9 m at the west abutment and between El. 204.6 m and 205.9 m at the east abutment, as measured in the boreholes and/or monitoring wells.

Based on the analysis, the Factor of Safety against global instability is greater than 1.33, and generally greater than 1.43 for long-term (effective stress) conditions at the west and east approach embankments (see Figures F1 and F2, respectively, in Appendix F). Pending MTO acceptance, the existing configuration of the existing approach embankments are considered adequate against the risk of global instability.

7.8.2 Settlement

As there is no significant grade raise or embankment widening proposed as part of the project, there will be no substantial loading to the foundation soils and thus any settlements to the foundation soils are anticipated to be less than 25 mm.

7.9 Construction Considerations

7.9.1 Scour/Erosion Protection

The existing foundations for the bridge piers are constructed within the Nottawasaga River, as such, the surrounding riverbed may have experienced scour or erosion adjacent to the pier foundations. The geotechnical

resistances provided in Section 7.6.1 are based on the assumption that the riverbed remains at about El. 203.1 m and 202.8 m at the east and west piers, respectively. Based on the 2009 contract drawings, a layer of rock protection (250 mm to 400 mm gradation) was to be placed around the existing and new piers, although the plan extents of the rock protection are not clear in the drawings provided.

A provision should be made to check and confirm that the erosion/scour protection is present and completely surrounds the piers (especially the south side), such that the elevation of the riverbed surface adjacent to the piers is maintained above El. 203.1 m and 202.8 m at the east and west piers, respectively, and the risk of scour and/or undermining / erosion of the foundations is reduced for the design life of the structure.

Based on the 2009 contract drawings, erosion protection in the form of a 600 mm thick rock protection layer is currently in place at the foreslopes of the abutments.

Confirmation of the performance, extent and design of the existing erosion protection measures at the piers and abutment foreslopes should be checked by the hydraulics engineer to confirm existing conditions are performing adequately and meet the latest design standards. Remediation measures should be included in the current design as required.

7.9.2 Temporary Excavations

All excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Ontario Occupational Health and Safety Act and Regulations for Construction Projects (OHSA), as amended. The existing fill material at this side would be classified as a Type 3 soil above the water table. If perched groundwater is encountered within the depth of excavation, wet fill material would be classified as a Type 4 soil. The native very loose silty sand containing organics would be classified as a Type 4 soil above and below the water table. The dense to very dense silt to silty sand and hard clayey silt to clayey silt-silt was generally encountered below the groundwater table and are considered to be Type 4 soils. Temporary excavations (i.e. those which are open for a relatively short time period) should be made with side slopes no steeper than 1 horizontal to 1 vertical (1H:1V) for Type 3 soils, and no steeper than 3 horizontal to 1 vertical (3H:1V) for Type 4 soils.

Temporary protection systems may be required to facilitate the rehabilitation/ replacement of the abutment wall stems and associated wing walls.

The temporary excavation support systems should be designed and constructed in accordance with OPSS. PROV 539 (*Temporary Protection Systems*) and Special Provision 105S09. The lateral movement of the temporary protection system should meet Performance Level 2 as specified in OPSS.PROV 539, provided that any utilities, if present, can tolerate this magnitude of deformation.

A sheet pile wall and/or soldier pile and timber lagging wall are considered feasible for the temporary protection system at this site. However, the presence of wood pieces encountered in the organic silt deposit may indicate the presence of buried wood obstructions within the organic silt deposit. If obstructions are encountered that limit the depth of penetration such that the passive resistance for a cantilever system is insufficient, lateral support could be provided in the form of rakers or temporary anchors, as required.

While the selection and design of the temporary protection system will be the responsibility of the Contractor, the following geotechnical parameters are provided.

Table 15: Geotechnical Parameters for Temporary Protection System

Soil Type	Unit Weight	Internal Angle of Friction	Undrained Shear Strength	Coefficient of Lateral Earth Pressure ¹		
	(γ , kN/m ³)	(ϕ , degrees)	(s_u , kPa)	Active K_a	At Rest K_o	Passive K_p ²
Existing Non-Cohesive Fill	19	30	-	0.33	0.50	3.0
Existing Cohesive Fill	19	30	30	0.33	0.50	3.0
Very Loose to Loose Silty Sand to Sandy Silt containing Organics	19	28	-	0.36	0.53	2.77
Compact to Very Dense Silty Sand to Sand	20	32	-	0.31	0.47	3.25
Hard Clayey Silt – Silt to Clayey Silt	19	31	200	0.32	0.48	3.12
Dense to Very Dense Silt	19	31	-	0.32	0.48	3.12
Organic Silt	18	28	-	0.36	0.53	2.77

Notes:

1. The earth pressure coefficients noted above are based on a horizontal surface adjacent to the excavation. If sloped surfaces are present, the coefficient of earth pressure should be adjusted accordingly, per CHBDC Clause C6.12.1, Figures C6.28 (active earth pressure) and C6.29 (passive earth pressure), and Clause C6.12.2.2 (at-rest earth pressure).
2. The total passive resistance below the base of the excavation (i.e. adjacent to the temporary protection system) may be calculated based on the values of K_p indicated above but reduced by an appropriate factor that considers the allowable wall movement in accordance with Figure C6.27 of the CHBDC (2019) to account for the fact that a large strain would be required for mobilization of the full passive resistance.

Where temporary protection systems are adopted adjacent to Highway 89, monitoring of the protection system is required as per OPSS.PROV 539 (*Temporary Protection Systems*).

7.9.3 Control of Groundwater and Surface Water

Temporary excavations up to about 3 m deep are anticipated to replace abutment wall stems and wingwalls within the existing embankments. It is anticipated excavations will be above the base of the pile caps (Elevation 206.4 m and 207.0 m for the west and east abutments, respectively). The groundwater level is anticipated to be about 1.1 m to 1.5 m below the base of the pile caps (Elevation 204.9 m and 205.9 m at the west and east abutment, respectively), as such, dewatering is not anticipated to be required. If perched groundwater is encountered in the embankment fill, it is anticipated that groundwater seepage inflow can be controlled through pumping from properly filtered sumps located within the excavation(s). Surface water should be directed away from the excavation(s) at all times.

7.9.4 Corrosion and Section Loss of Existing Piles

The results of the analytical testing indicate that the soil at the abutments (especially the east abutment) at or near the water table have the potential for high corrosivity. As corrosion rates and pile degradation cannot be reliably quantified based on the analytical indicators, it is recommended that the lifespan of the rehabilitated structure reflect the high corrosive potential based on past experience with similar materials in similar environments.

Based on the design drawings and as part of the construction contract for this project, select existing 1960 steel H-piles at the east abutment are to be exposed and inspected by the structural engineer (i.e. flange and web steel thickness measured). It is recommended that the existing piles be inspected as early in the contract as possible such the structural engineer can confirm the 1960 piles meet the structural design criteria (i.e. confirm pile integrity is acceptable) prior to continuing with construction of the bridge widening. Based on conversations with the structural designer, the pile inspection is to target the 1960 pile section between about 0.3 m below the water table and the bottom of the pile cap (between about Elevations 204.7 m and 207 m, respectively). It is our understanding that the 1960 piles have an original design flange and web thickness of 11 mm, and can tolerate up

to 4 mm of section loss from a structural design perspective. It is understood that a minimum 7 mm thick steel H-pile (12BP53 or HP310x79) has sufficient structural capacity to develop the design geotechnical resistances provided in Table 11.

After the minimum steel thickness of the piles is confirmed and accepted by the structural engineer, it is recommended that a subsequent corrosion assessment be performed by the structural engineer to estimate the remaining design life of the original 1960 bridge foundation components. The geotechnical resistance of the piles provided in Section 7.6.2 should also be checked and confirmed by the foundations engineer once the corrosion assessment and design life is provided by the structural engineer. Any supplemental foundation design and recommendations to extend the design life of the structure or replace the widened structure can be provided as part of a future assignment, as applicable.

7.9.5 Decommissioning of Monitoring Wells / Magnetometer Casings

Two groundwater monitoring wells were installed (Boreholes BH24-01 and BH24-02) to permit monitoring of the groundwater levels at the site. In addition, two closed bottom PVC pipes were installed as temporary casing for the magnetometer testing.

Ontario Regulation (O.Reg) 903 amended by O.Reg. 128/03 of the Ontario Resources Act requires that monitoring wells are properly abandoned/decommissioned by qualified personnel.

It is recommended that the decommissioning of the monitoring wells be carried out as part of the construction activities at the site to allow for water level measurements taken prior to and during construction associated with the rehabilitation of the abutments and allow for groundwater sampling, as required. It is also recommended that the magnetometer casings be decommissioned during construction to facilitate additional testing, as required. A sample Non-Standard Special Provision (NSSP) and Notice to Contractor (NTC) for the decommissioning of the groundwater monitoring wells and magnetometer casings has been included in Appendix G.

8.0 CLOSURE

This foundation design report was prepared by Madison Kennedy, P.Eng., a Geotechnical Engineer with WSP. Kevin Bentley, P.Eng. a Geotechnical Engineer with WSP and MTO Principal Foundations Contact conducted a technical and quality control review of the report.

Madison Kennedy, M.A.Sc. P.Eng.
Geotechnical Engineer

Kevin Bentley, M.E.Sc., P.Eng.
MTO Principal Foundations Contact

MCK/KJB/al

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- Ministry of Northern Development and Mines, Ontario. 1988. Aggregate resources inventory of Essa and Tosorontio Townships, Simcoe County, Southern Ontario; Ontario Geological Survey. Aggregate Resources Inventory Paper 113.
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Slide2 (Version 9) by Rocscience Inc.

Ministry of Transportation, Ontario

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Structural Standard SS103-11 Pile Driving Control

Ontario Provisional Standard Drawing:

OPSD 3090.101 Foundation Frost Penetration Depths for Southern Ontario

Ontario Provincial Standard Specifications (OPSS)

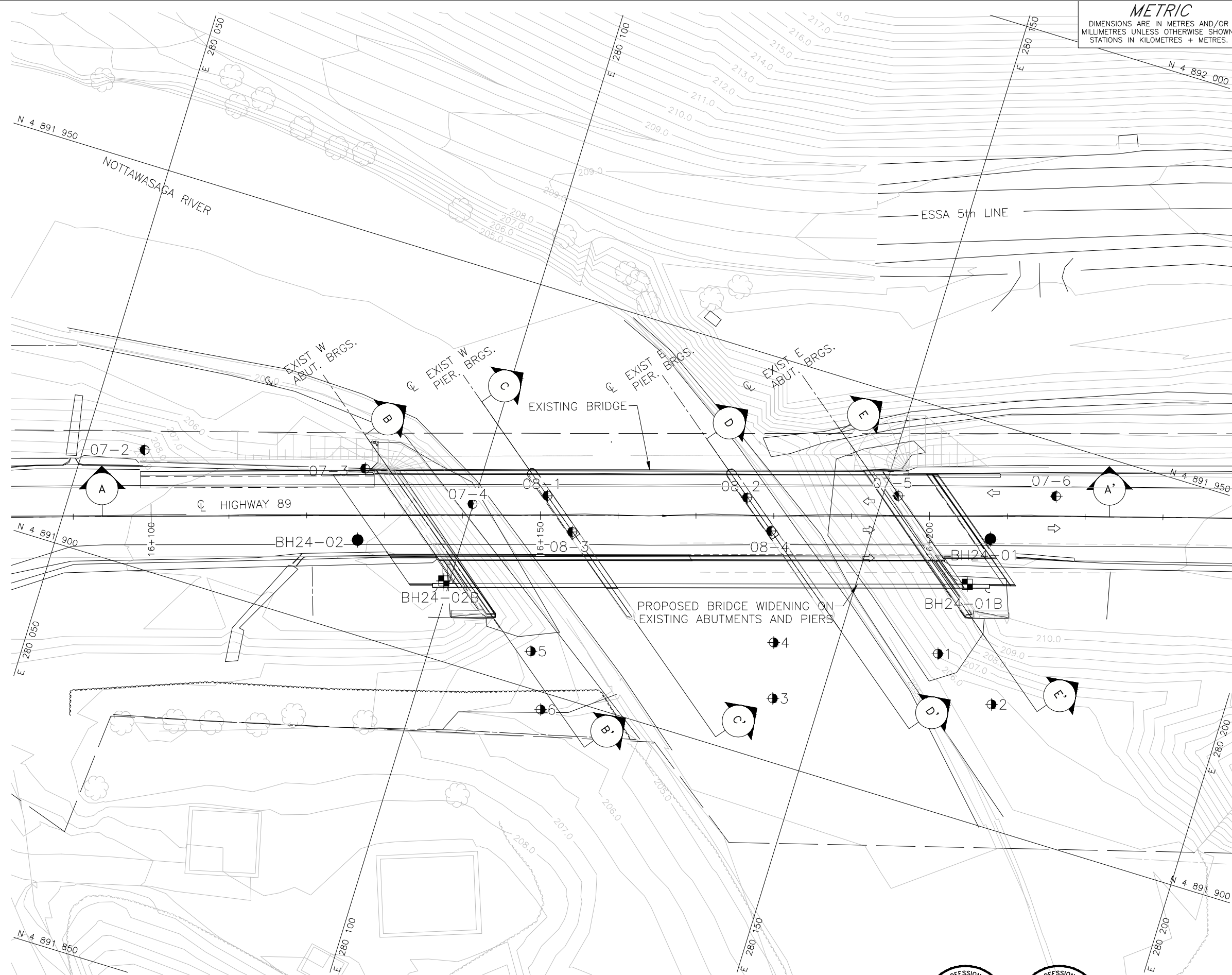
OPSS.PROV 539 Construction Specification for Temporary Protection Systems

Special Provision

Special Provision 105S09 Amendment to OPSS 539, November 2014

Ontario Regulations

Ontario Regulation 213 Construction Projects (as amended)
Ontario Regulation 903 Wells (as amended)



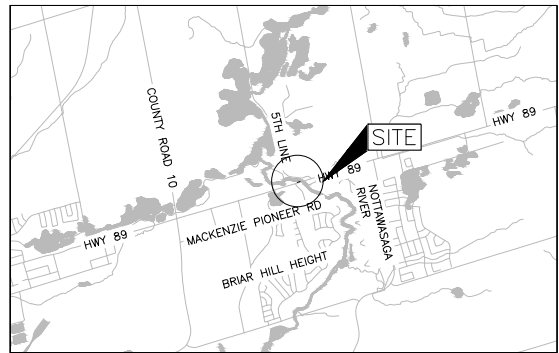
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 2121-22-01

HIGHWAY 89
NOTTAWASAGA RIVER BRIDGE WIDENING
BOREHOLES LOCATIONS PLAN



SHEET



KEY PLAN
SCALE

1 0 1 2 km

LEGEND

- Borehole - Current Investigation
- ⊗ Borehole - Previous Golder 2009 Investigation
- ⦿ Borehole - Previous DHO 1959 Investigation
- Casing Installation - Current Geophysics Investigation

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
07-2	205.4	4891914.8	280057.6
07-3	206.4	4891920.8	280085.4
07-4	205.4	4891920.5	280099.9
07-5	210.1	4891937.5	280151.9
07-6	210.5	4891943.4	280171.3
08-1	204.6	4891924.3	280108.8
08-2	204.6	4891931.6	280133.4
08-3	204.7	4891920.8	280113.2
08-4	204.7	4891928.4	280137.6
BH24-01	210.9	4891935.7	280164.8
BH24-01B	210.7	4891929.2	280163.7
BH24-02	210.0	4891911.7	280087.1
BH24-02B	210.0	4891910.0	280099.2

NOTES

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REFERENCE

Base plans provided in digital format by WSP, drawing file nos. BC-785-89-1.dwg, received September 26, 2024.
GA provided in digital format by WSP, drawing file no. CA0020332.0247 - General Arrangement.dwg, received November 21, 2024.

PLAN
SCALE
5 0 5 10 m



NO.	DATE	BY	REVISION
1			
Geocres No. 31D04-011			
HWY. 89		PROJECT NO. CA0020332.0247	DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 3/18/2025	SITE: 30X-0250/B0
DRAWN: DD/SA	CHKD. .	APPD. .	DWG. 1

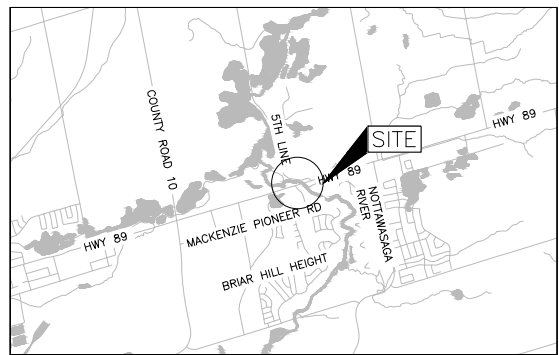
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. _____
WP No. 2121-22-01

HIGHWAY 89
NOTTAWASAGA RIVER BRIDGE WIDENING

SOIL STRATA

SHEET



KEY PLAN
SCALE
1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- ⊕ Borehole – Previous Golder 2009 Investigation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer
- ≡ WL upon completion of drilling

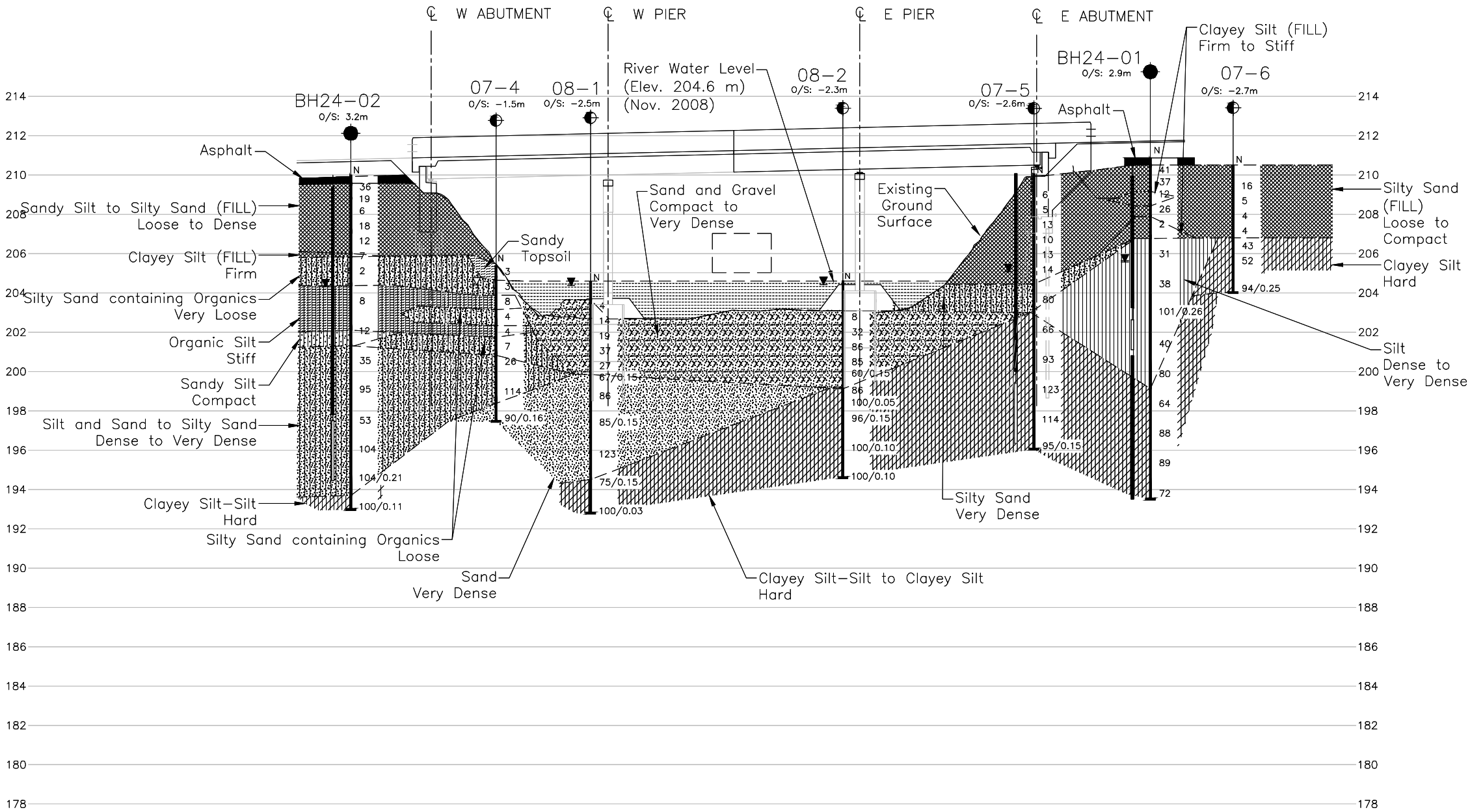
BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
07-2	205.4	4891914.8	280057.6
07-4	205.4	4891920.5	280099.9
07-5	210.1	4891937.5	280151.9
07-6	210.5	4891943.4	280171.3
08-1	204.6	4891924.3	280108.8
08-2	204.6	4891931.6	280133.4
BH24-01	210.9	4891935.7	280164.8
BH24-02	210.0	4891911.7	280087.1

NOTES

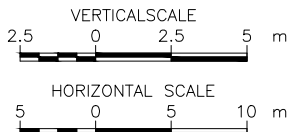
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NO.	DATE	BY	REVISION
Geocres No. 31D04-011			
HWY. 89		PROJECT NO. CA0020332.0247	
SUBM'D. MCK	CHKD. MCK	DATE: 3/19/2025	SITE: 30X-0250/B0
DRAWN: DD/SA	CHKD. MCK	APPD. KJB	DWG. 2



PROFILE A-A'



REFERENCE

GA provided in digital format by WSP, drawing file no. CA0020332.0247 – General Arrangement.dwg, received September 26, 2024.



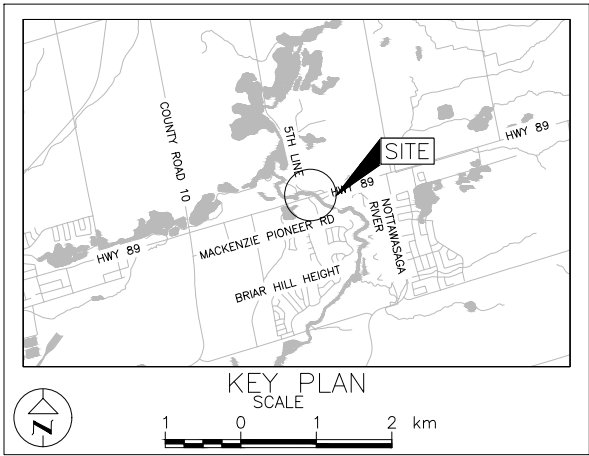
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. _____
WP No. 2121-22-01

HIGHWAY 89
NOTTAWASAGA RIVER BRIDGE WIDENING

SOIL STRATA

SHEET



LEGEND

- Borehole – Current Investigation
- ⊙ Borehole – Previous Golder 2009 Investigation
- ⊖ Borehole – Previous DHO 1959 Investigation
- ⊔ Seal
- ⊔ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
07-3	206.4	4891920.8	280085.4
07-4	205.4	4891920.5	280099.9
BH24-02	210.0	4891911.7	280087.1

NOTES

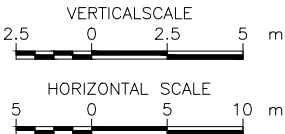
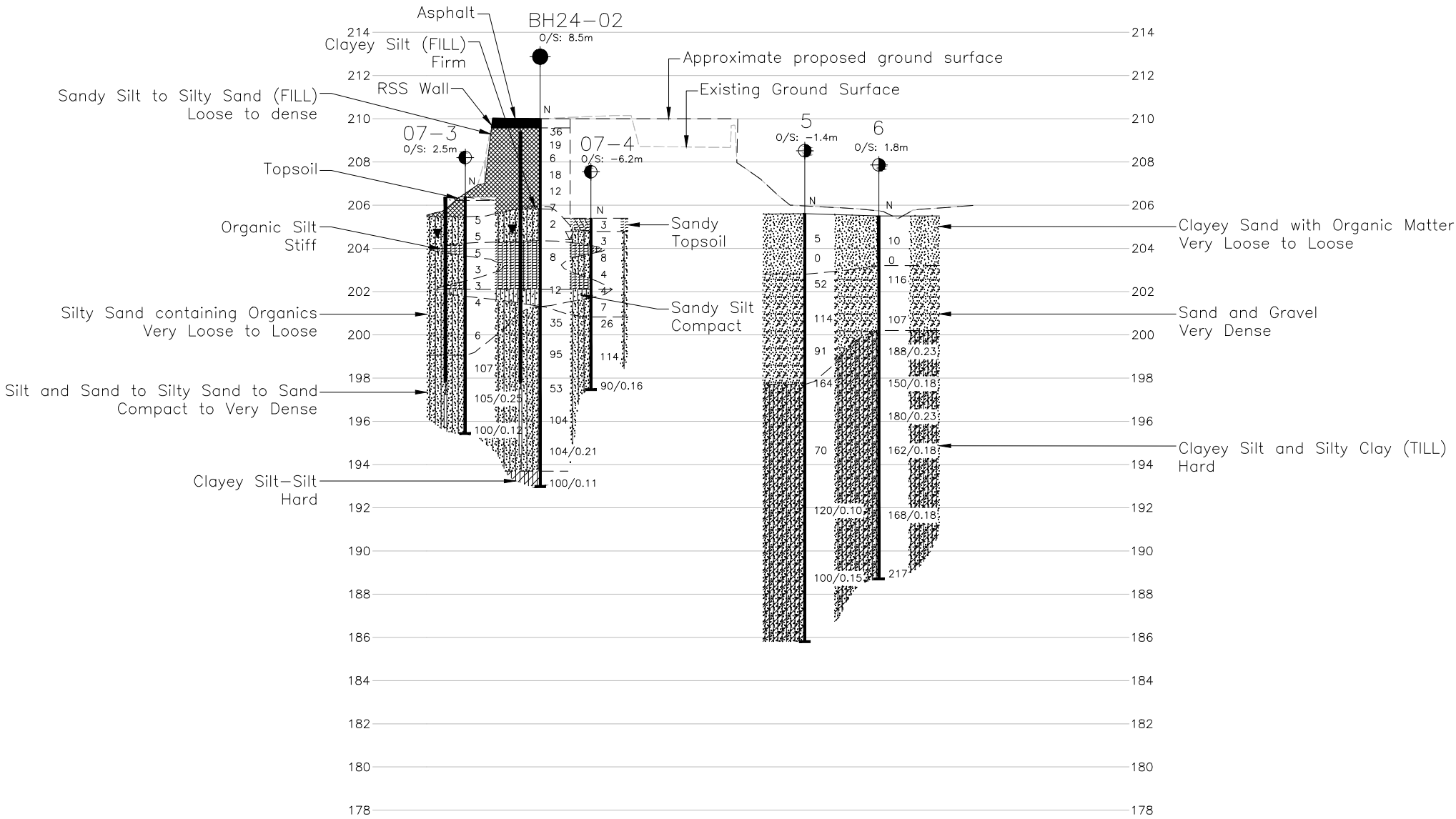
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REFERENCE

GA provided in digital format by WSP, drawing file no. CA0020332.0247 - General Arrangement.dwg, received September 26, 2024.

CROSS SECTION B-B' – WEST ABUTMENT

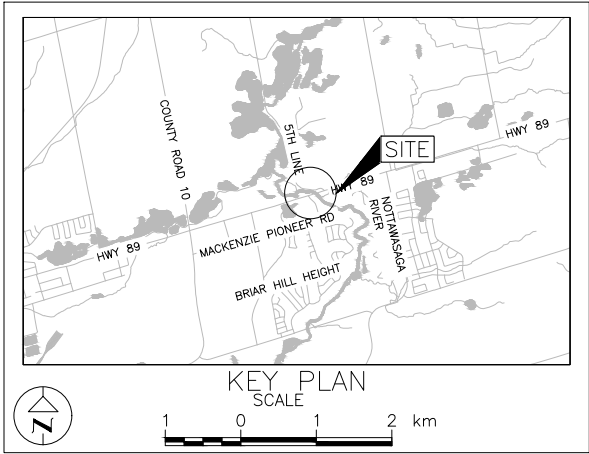


NO.	DATE	BY	REVISION
Geocres No. 31D04-011			
HWY. 89	PROJECT NO. CA0020332.0247		DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 3/19/2025	SITE: 30X-0250/B0
DRAWN: DD/SA	CHKD. MCK	APPD. KJB	DWG. 3

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

CONT No.
WP No. 2121-22-01

HIGHWAY 89
NOTTAWASAGA RIVER BRIDGE WIDENING
SOIL STRATA



LEGEND

Borehole – Previous Golder 2009 Investigation

Borehole – Previous DHO 1959 Investigation

Seal

Piezometer

Standard Penetration Test Value

Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)

WL in piezometer

WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
08-3	204.7	4891920.8	280113.2
08-1	204.6	4891924.3	280108.8

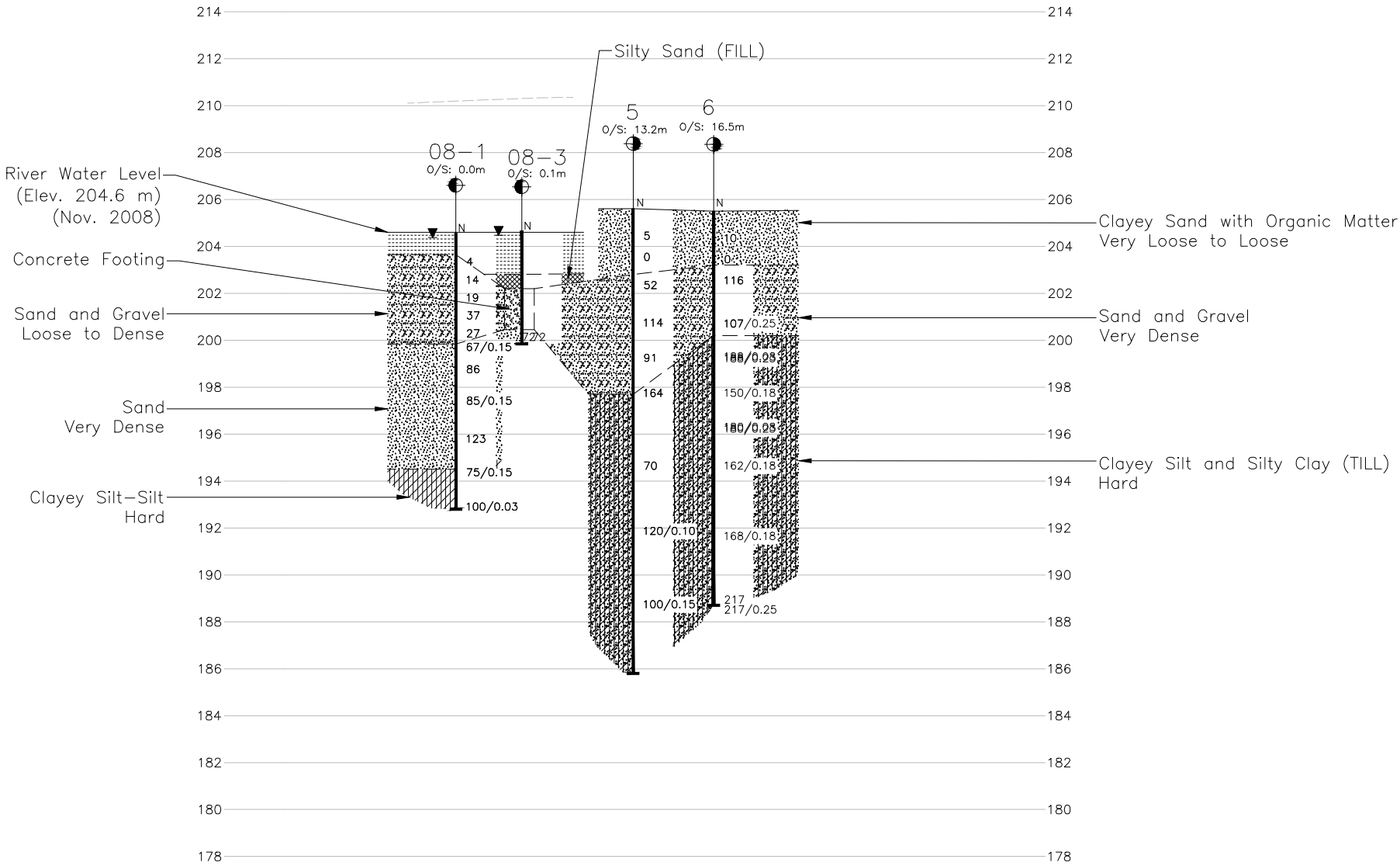
NOTES

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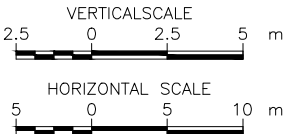
The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

GA provided in digital format by WSP, drawing file no. CA0020332.0247 – General Arrangement.dwg, received September 26, 2024.



CROSS SECTION C-C' – WEST PIER

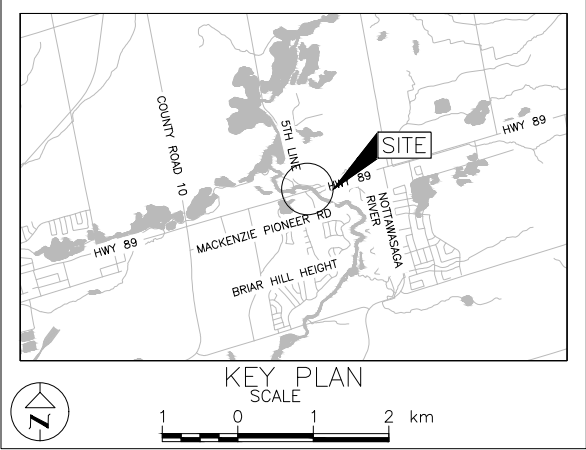
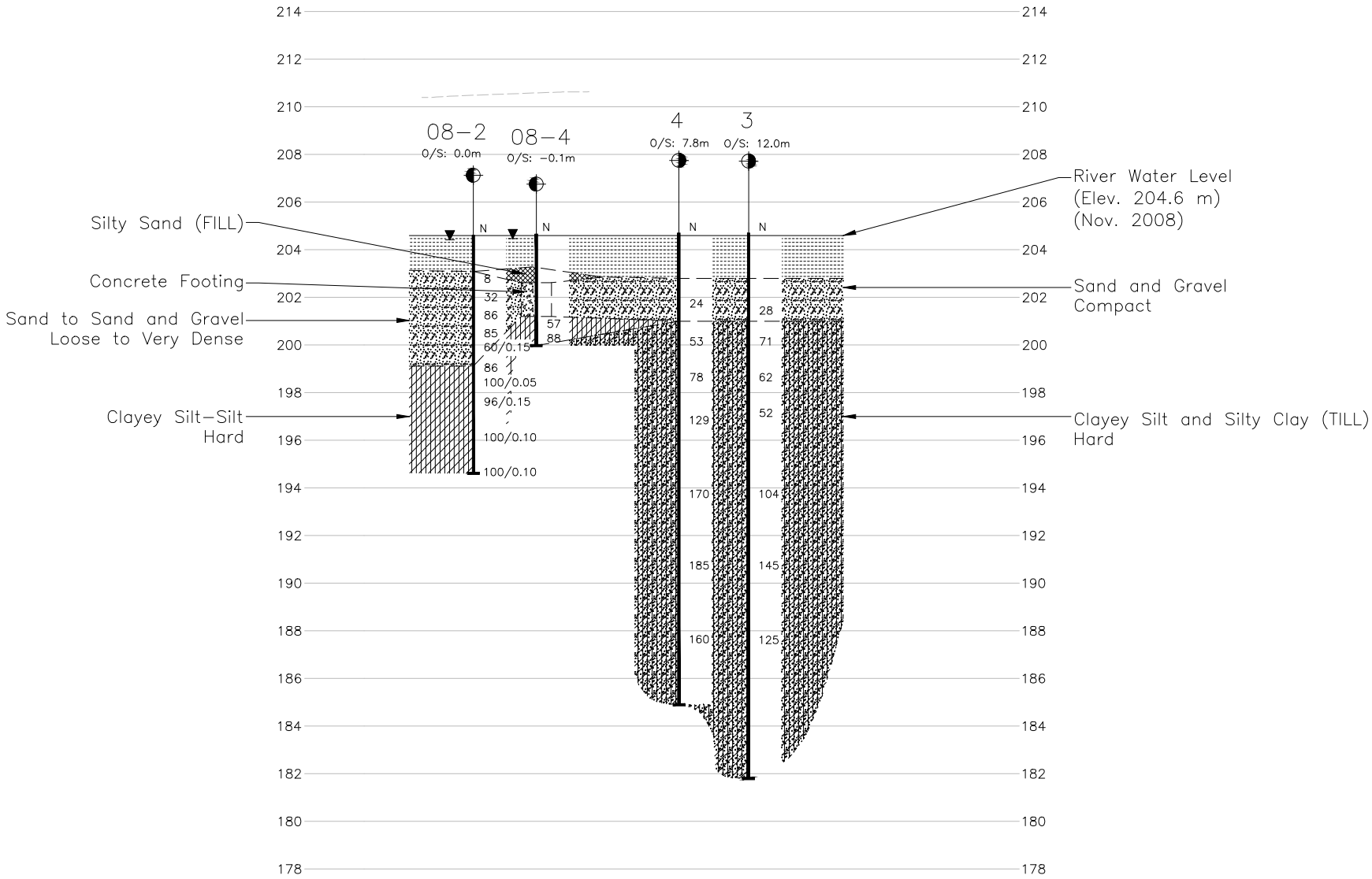


NO.	DATE	BY	REVISION
Geocres No. 31D04-011			
HWY. 89		PROJECT NO. CA0020332.0247	
SUBM'D. MCK	CHKD. MCK	DATE: 3/19/2025	SITE: 30X-0250/B0
DRAWN: DD/SA	CHKD. MCK	APPD. KJB	DWG. 4

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

CONT No.
WP No. 2121-22-01

HIGHWAY 89
NOTTAWASAGA RIVER BRIDGE WIDENING
SOIL STRATA



LEGEND

Borehole – Previous Golder 2009 Investigation

Borehole – Previous DHO 1959 Investigation

Seal

Piezometer

Standard Penetration Test Value

16 Blows/0.3m unless otherwise stated
(Std. Pen. Test, 475 j/blow)

WL in piezometer

WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
08-4	204.7	4891928.4	280137.6
08-2	204.6	4891931.6	280133.4

NOTES

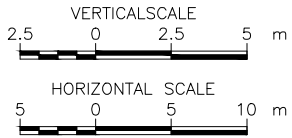
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REFERENCE

GA provided in digital format by WSP, drawing file no. CA0020332.0247 – General Arrangement.dwg, received September 26, 2024.

CROSS SECTION D-D' – EAST PIER



NO.	DATE	BY	REVISION
Geocres No. 31D04-011			
HWY. 89	PROJECT NO. CA0020332.0247		DIST. .
SUBM'D. MCK	CHKD. MCK	DATE: 3/19/2025	SITE: 30X-0250/B0
DRAWN: DD/SA	CHKD. MCK	APPD. KJB	DWG. 5

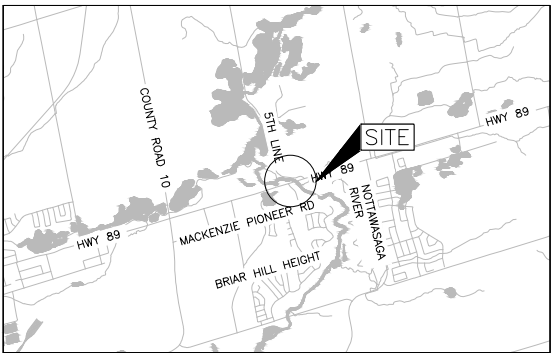
METRIC
DIMENSIONS ARE IN METRES AND/OR
MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No. .
WP No. 2121-22-01

HIGHWAY 89
NOTTAWASAGA RIVER BRIDGE WIDENING

SOIL STRATA

SHEET



KEY PLAN
SCALE

1 0 1 2 km

LEGEND

- Borehole – Current Investigation
- Borehole – Previous Golder 2009 Investigation
- Borehole – Previous DHO 1959 Investigation
- ⊥ Seal
- ⊥ Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL in piezometer
- ≡ WL upon completion of drilling

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
07-5	210.1	4891937.5	280151.9
BH24-01	210.9	4891935.7	280164.8

NOTES

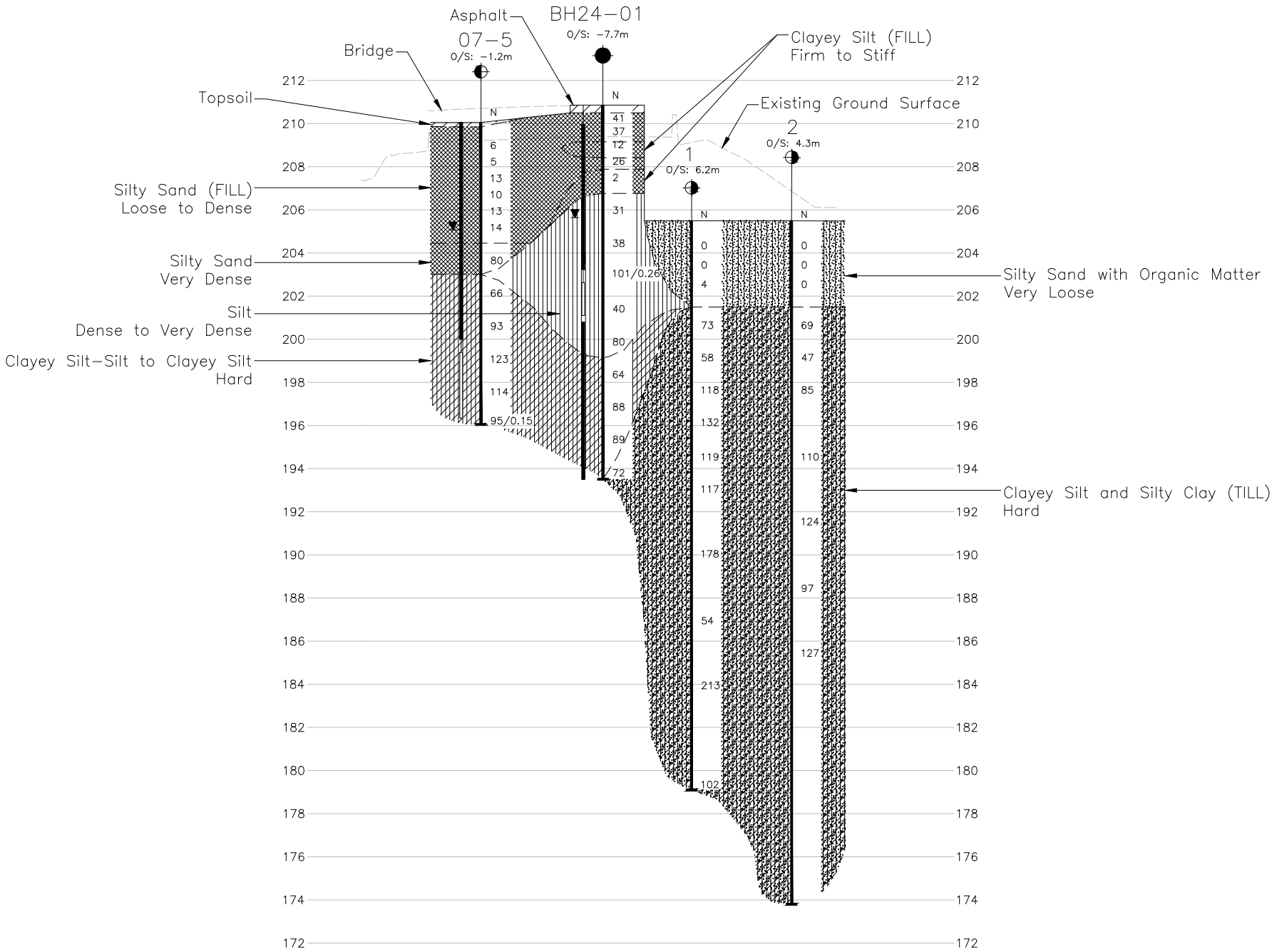
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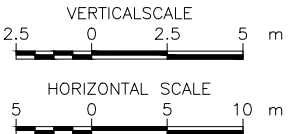
REFERENCE

GA provided in digital format by WSP, drawing file no. CA0020332.0247 - General Arrangement.dwg, received September 26, 2024.

NO.	DATE	BY	REVISION
Geocres No. 31D04-011			
HWY. 89		PROJECT NO. CA0020332.0247	
SUBM'D. MCK	CHKD. MCK	DATE: 3/19/2025	SITE: 30X-0250/B0
DRAWN: DD/SA	CHKD. MCK	APPD. KJB	DWG. 6

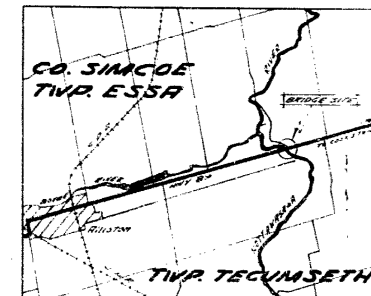
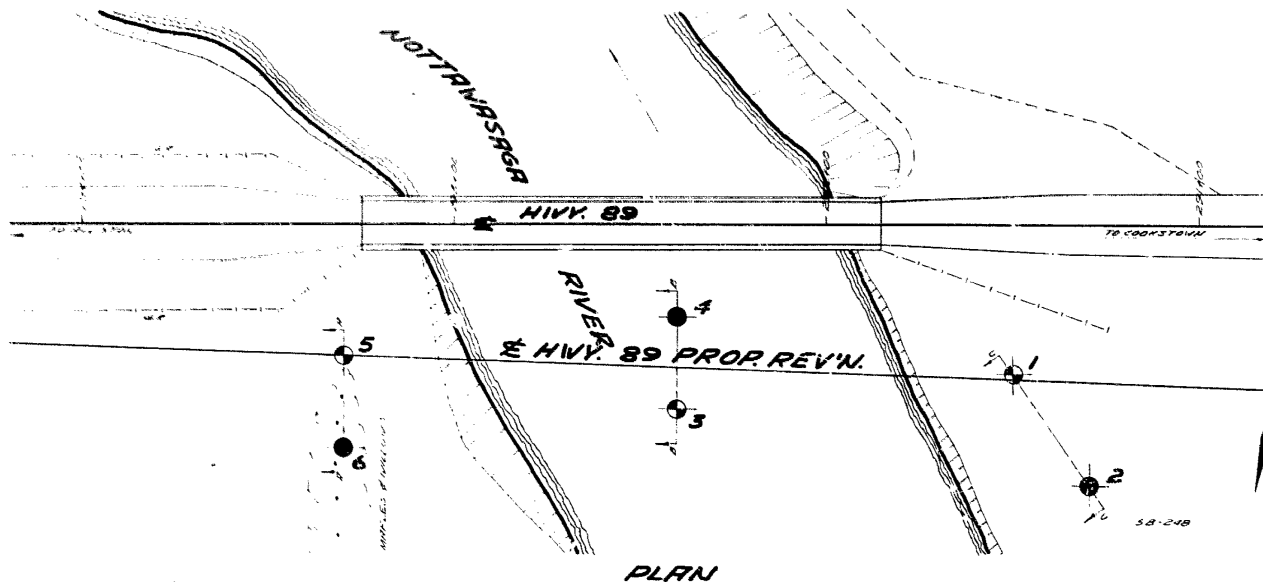


CROSS SECTION E-E' - EAST ABUTMENT

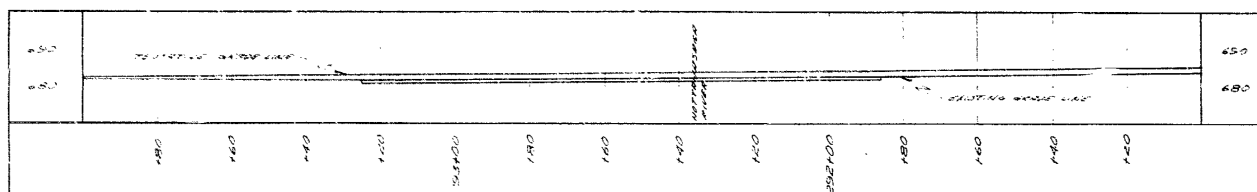


APPENDIX A

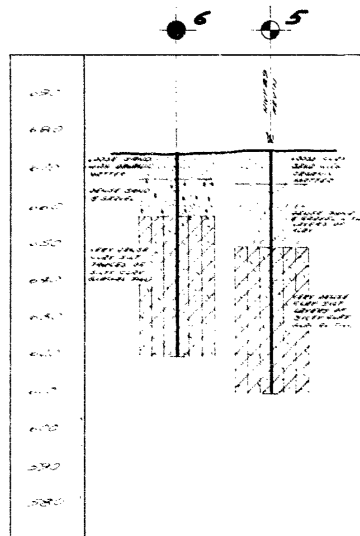
**DHO 1959 Investigation
(GEOCRES 31D00-037)**



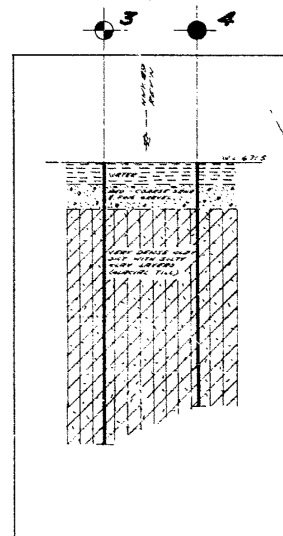
KEY PLAN
SCALE
1 in = 1 mi



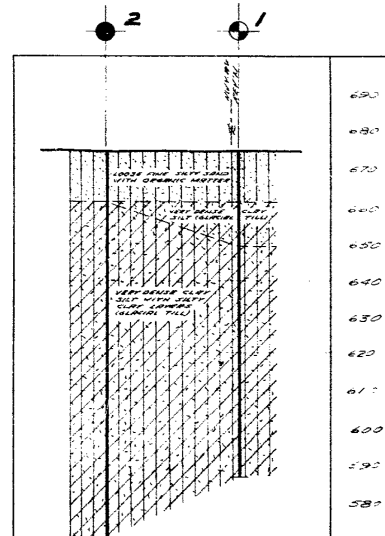
PROFILE



A-A






B-B



C-C

LEGEND

BORE HOLE				
PENETRATION HOLE				
BORE PENETRATION HOLE				
HOLE NO.	ELEVATION	STATION	DISTANCE FROM	
1	674.2	291+50	40' L	
2	674.2	291+30	70' L	
3	671.5	292+40	50' L	
4	671.5	292+50	25' L	
5	674.7	293+30	35' L	
6	674.2	293+30	60' L	

NOTE

THE BOUNDARIES BETWEEN SOIL STRATA HAVE BEEN ESTABLISHED ONLY AT BORE HOLE LOCATIONS. BETWEEN BORE HOLES THE BOUNDARIES ARE ASSUMED FROM GEOLOGICAL EVIDENCE AND MAY BE SUBJECT TO CONSIDERABLE ERROR.

DEPARTMENT OF HIGHWAYS - ONTARIO
MINISTRY OF TRANSPORTATION

**NOTTAWASAGA RIVER
PROPOSED CROSSING**

SHOWING POSITIONS & ELEVATIONS

HWY. 89	DISTRICT 5	SIMCOE
TOWNSHIP 23 S. & 24 S.	TOWNSHIP 23 S. & 24 S.	TOWNSHIP 23 S. & 24 S.
LOCATION 2.5 MI. E. OF DELISTON	CHIEF ENGINEER	DATE 2-8-59
DRAWN BY T. MALLORY	CHECKED BY J. K.	APPROVED BY
DATE 4 NOV 1959	APPROVED BY	DATE 4 NOV 1959
SCALE 1 in = 20 ft		559-98A

DEPARTMENT OF HIGHWAYS - ONTARIO

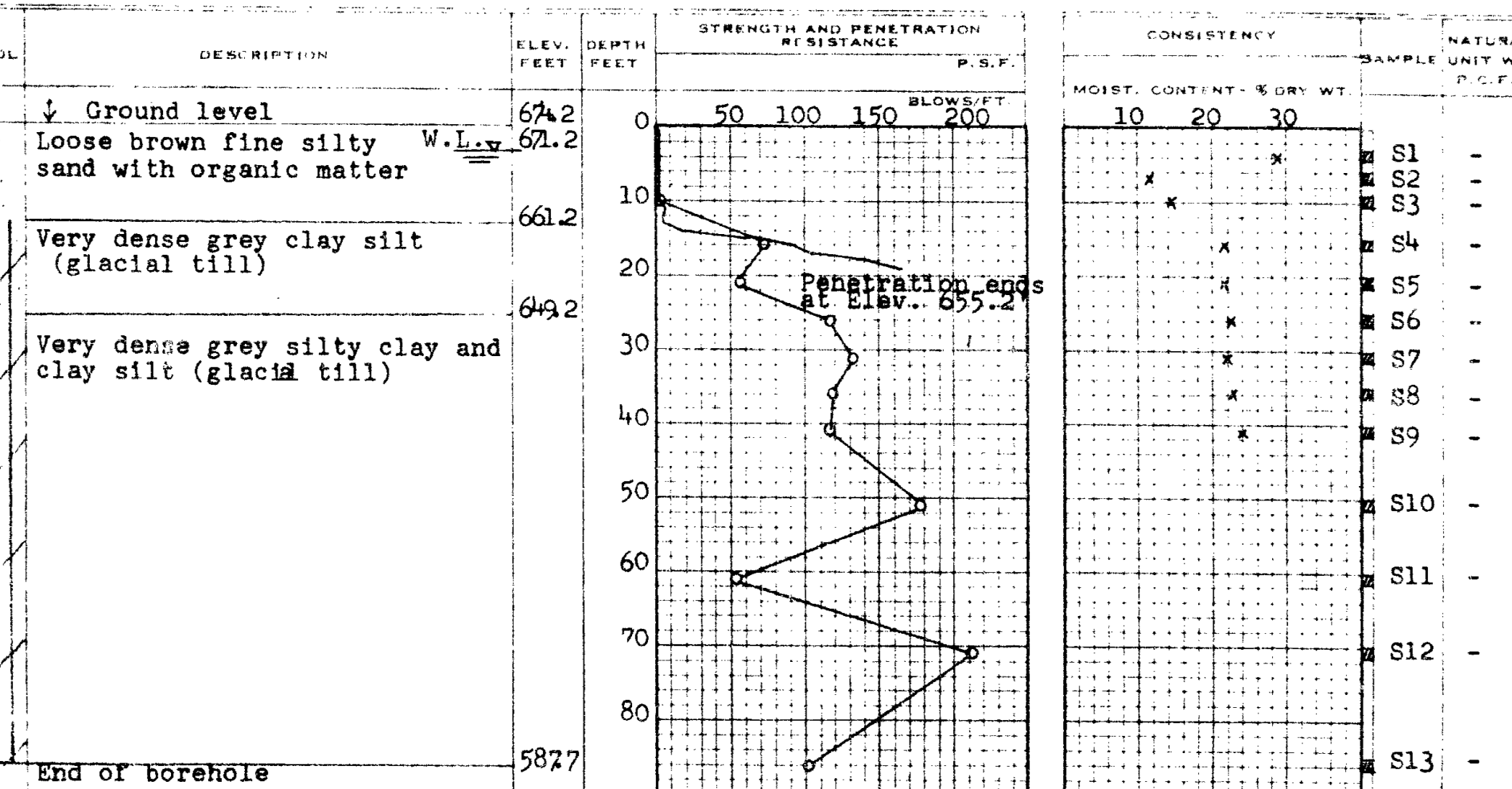
MATERIALS AND RESEARCH SECTION

218-59 BORE HOLE NO. 1
 F59-98 STATION 291+50 (40' Lt)
 M 67^h.2' COMPILED BY B.K.
 NG DATE Oct. 6/58 CHECKED BY A.L.

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 2" SHELBY
 CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) — O
 VANE TEST (G) AND SENSITIVITY (S) — +
 NATURAL MOISTURE AND LIQUIDITY INDEX — LI
 LIQUID LIMIT — X
 PLASTIC LIMIT —



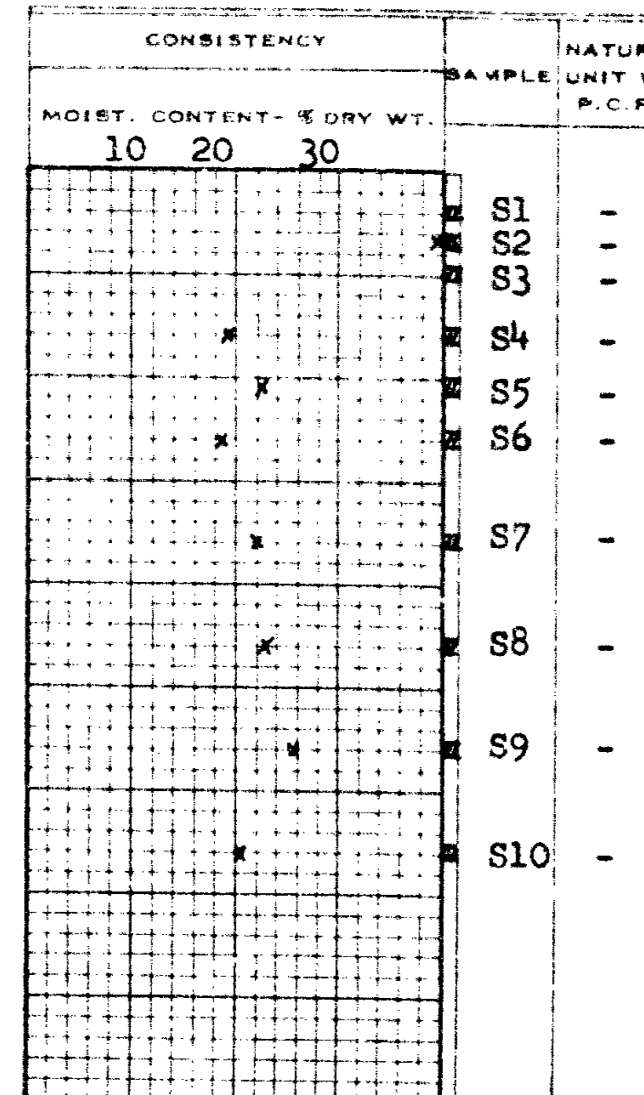
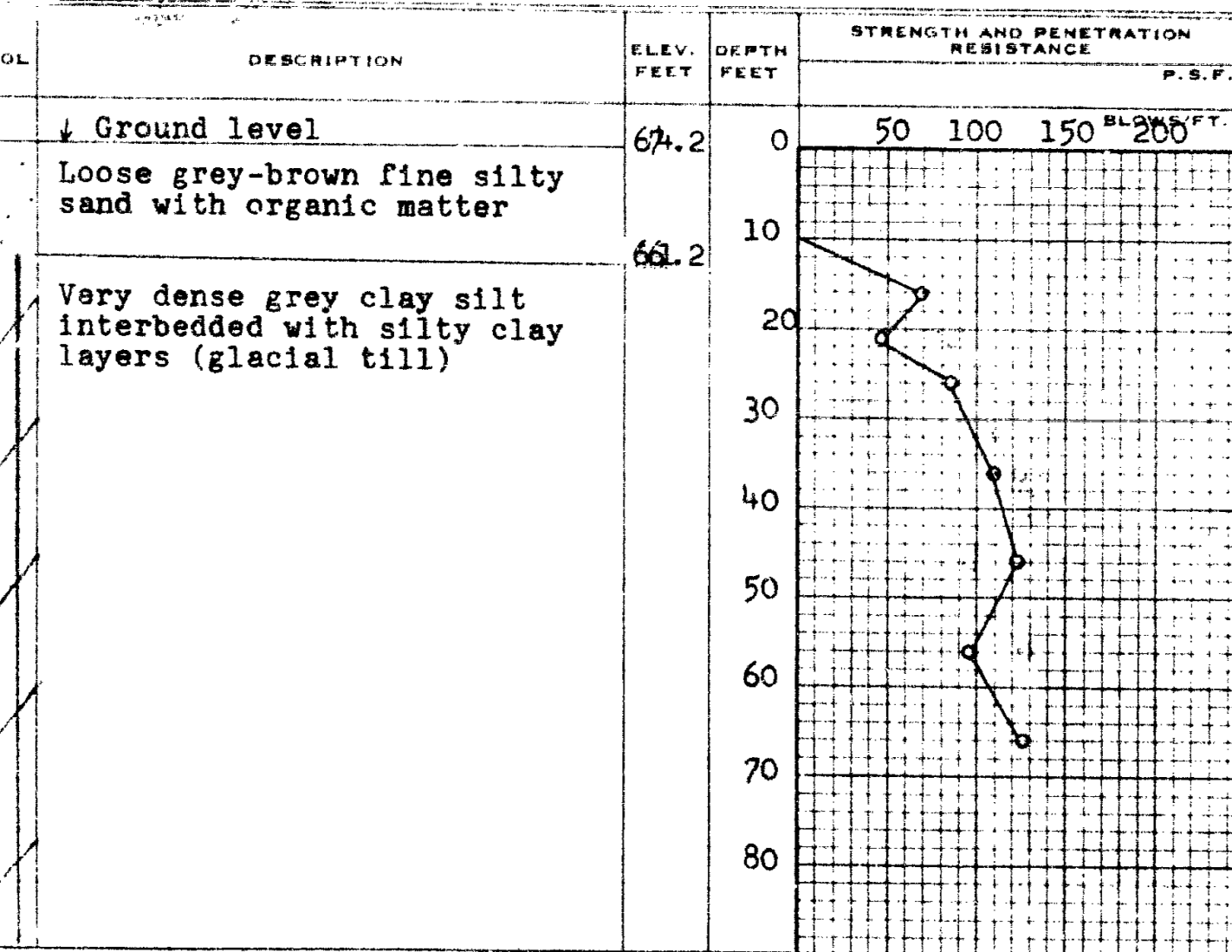
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

218-59 BORE HOLE NO. 2
 F59-98 STATION 291+20 (90' Lt.)
 674.2' COMPILED BY B.K.
 DATE Oct. 9/59 CHECKED BY A.L.

2" DIA. SPLIT TUBE
 2" SHELBY TUBE
 2" SPLIT TUBE
 2" DIA. CONE
 2" SHELBY
 CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



Continued

MATERIALS AND RESEARCH SECTION

G DATE Oct. 9/59 CHECKED BY A.L.

2" DIA. SPLIT TUBE _____
2" SHELBY TUBE _____
2" SPLIT TUBE _____
2" DIA. CONE _____
2" SHELBY _____
CASING _____

LEGEND

1/2 UNCONFINED COMPRESSION (Cu) _____
VANE TEST (C) AND SENSITIVITY (S) _____
NATURAL MOISTURE AND _____
LIQUIDITY INDEX _____
LIQUID LIMIT _____
PLASTIC LIMIT _____

DESCRIPTION	ELEV. FEET	DEPTH FEET	STRENGTH AND PENETRATION RESISTANCE		CONSISTENCY		SAMPLE NO.
			P. S. F.	BLOWS/FT.	MOIST. CONTENT - % DRY WT.		
Borehole Continued	584.2	90					
Same as described above		100					
	570.2	110					
		120					
		130					
		140					
		150					
		160					
		170					

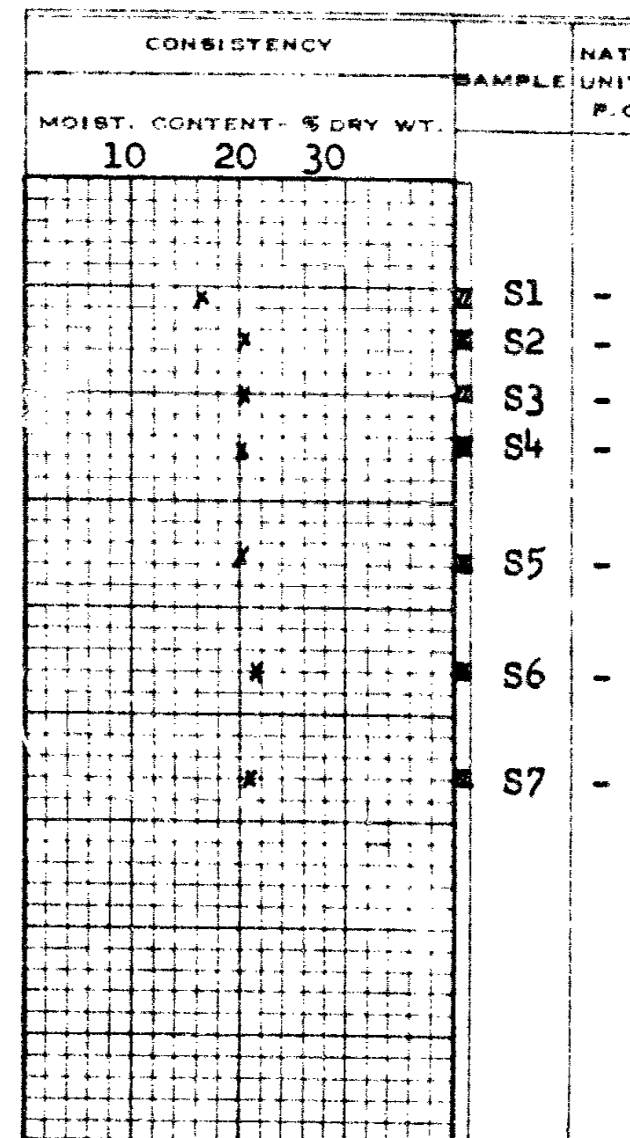
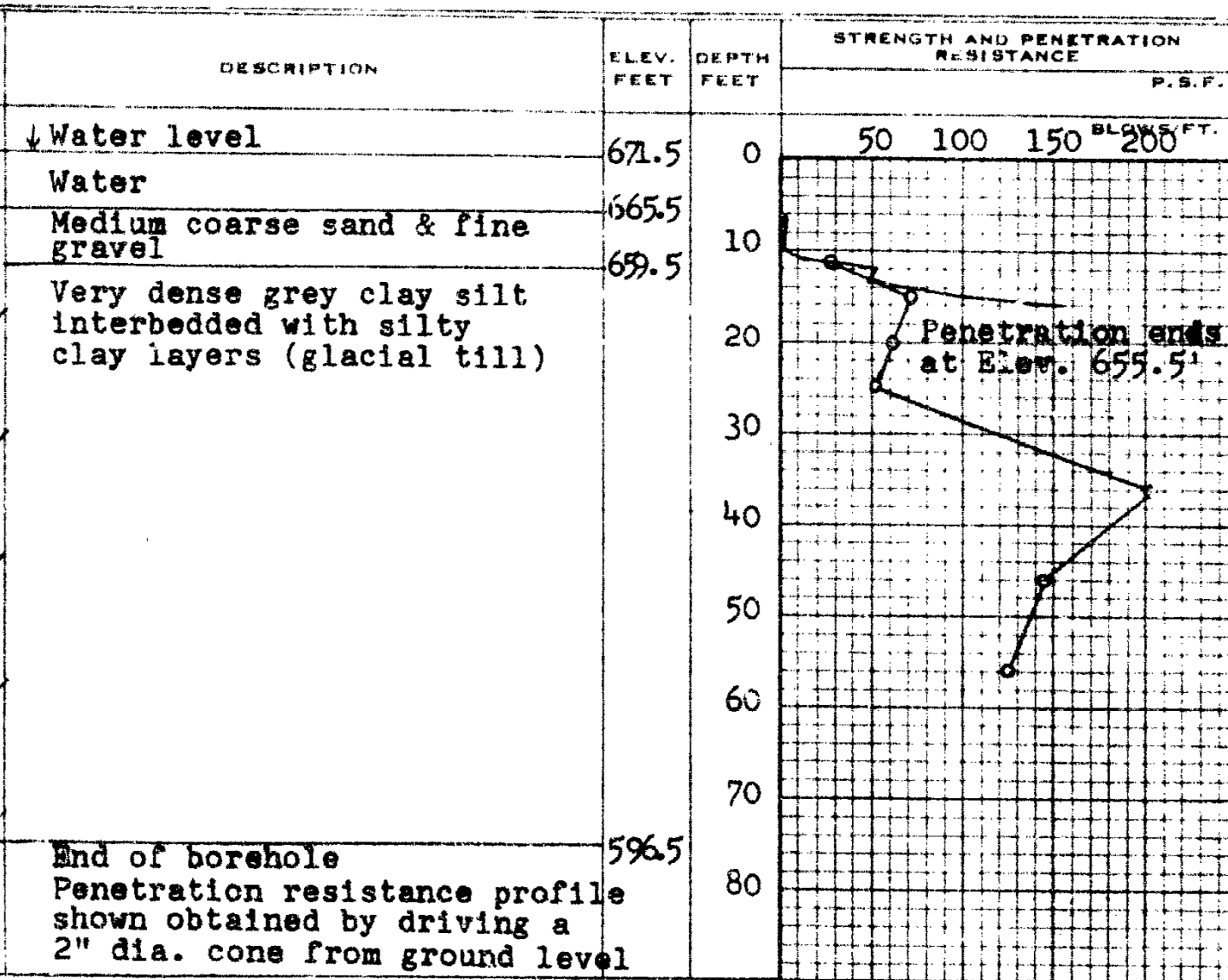
DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

218-59 ----- BORE HOLE NO. 3
 F59-98 ----- STATION 292+40 (50' Lt.)
 671.5' ----- COMPILED BY B.K.
 DATE Oct. 13/59 CHECKED BY A.L.

LEGEND

1/2 UNCONFINED COMPRESSION (Q_u)
 VANE TEST (C) AND SENSITIVITY (S)
 NATURAL MOISTURE AND
 LIQUIDITY INDEX
 LIQUID LIMIT
 PLASTIC LIMIT



to depth noted with an energy of 350 ft. lb. per blow.

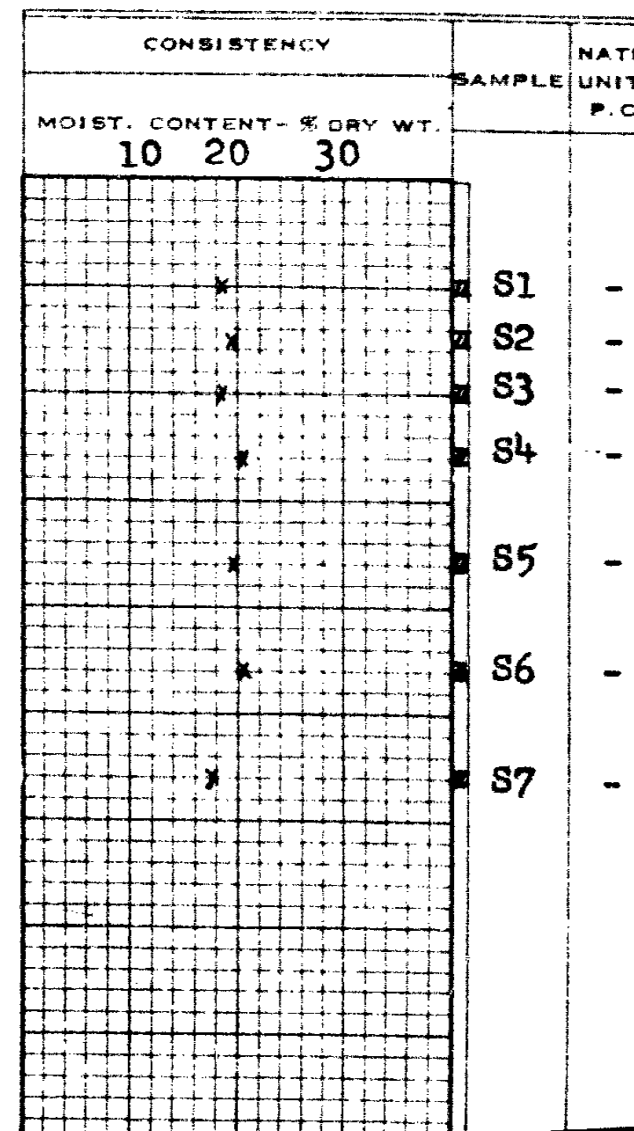
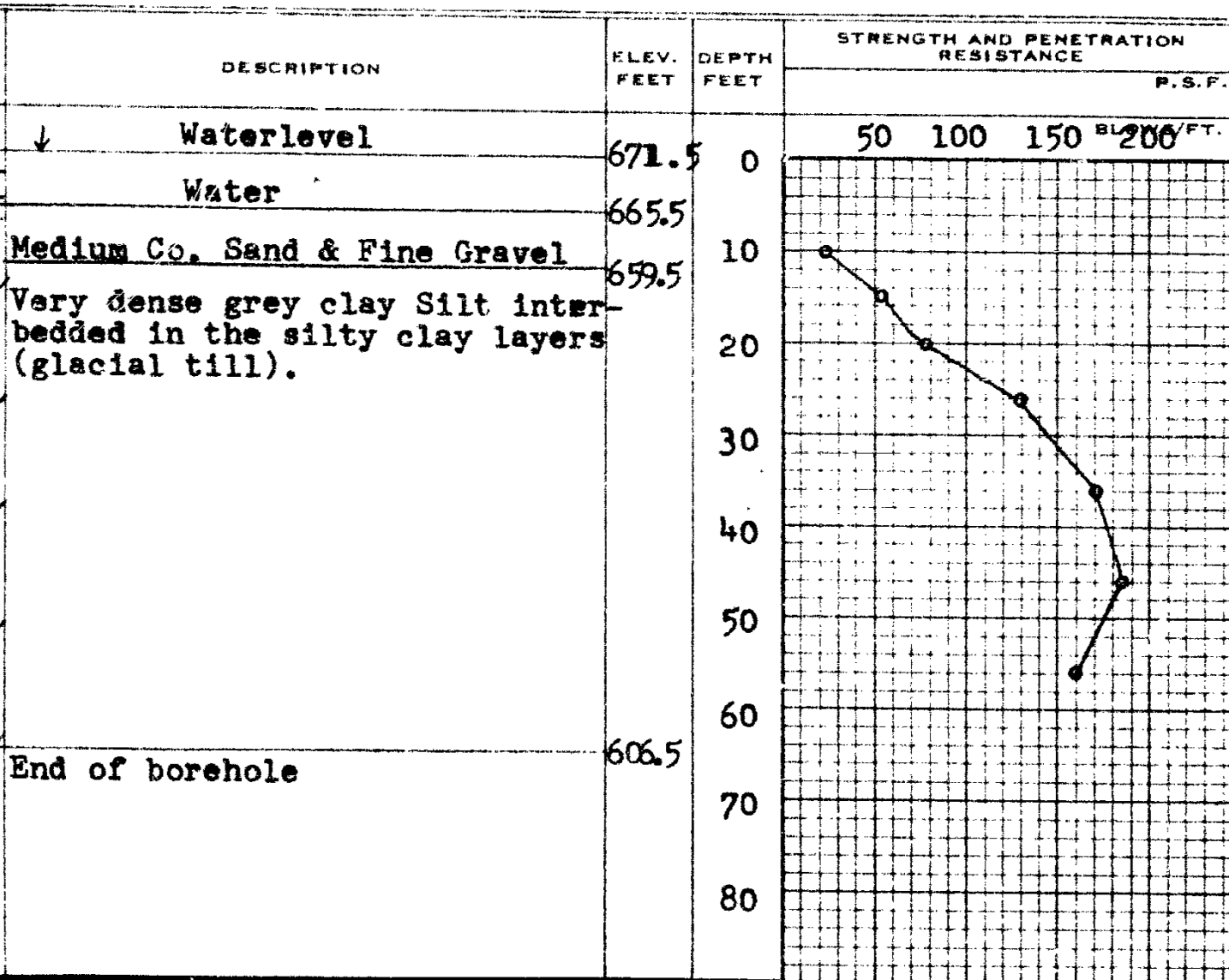
DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS AND RESEARCH SECTION

218-59 BORE HOLE NO. 4
 F 59-98 STATION 292+40 (25' LT)
 671.5' COMPILED BY B.K.
 DATE Oct, 15/59 CHECKED BY A.L.

2" DIA. SPLIT TUBE _____
 2" SHELBY TUBE _____
 2" SPLIT TUBE _____
 2" DIA. CONE _____
 2" SHELBY _____
 CASING _____

LEGEND

1/2 UNCONFINED COMPRESSION (Q_u) _____
 VANE TEST (C) AND SENSITIVITY (S) _____
 NATURAL MOISTURE AND
 LIQUIDITY INDEX _____
 LIQUID LIMIT _____
 PLASTIC LIMIT _____



DEPARTMENT OF HIGHWAYS - ONTARIO

MATERIALS AND RESEARCH SECTION

218-59

BORE HOLE NO. 5

F59-98

STATION 293+30 (35' Lt)

674.7'

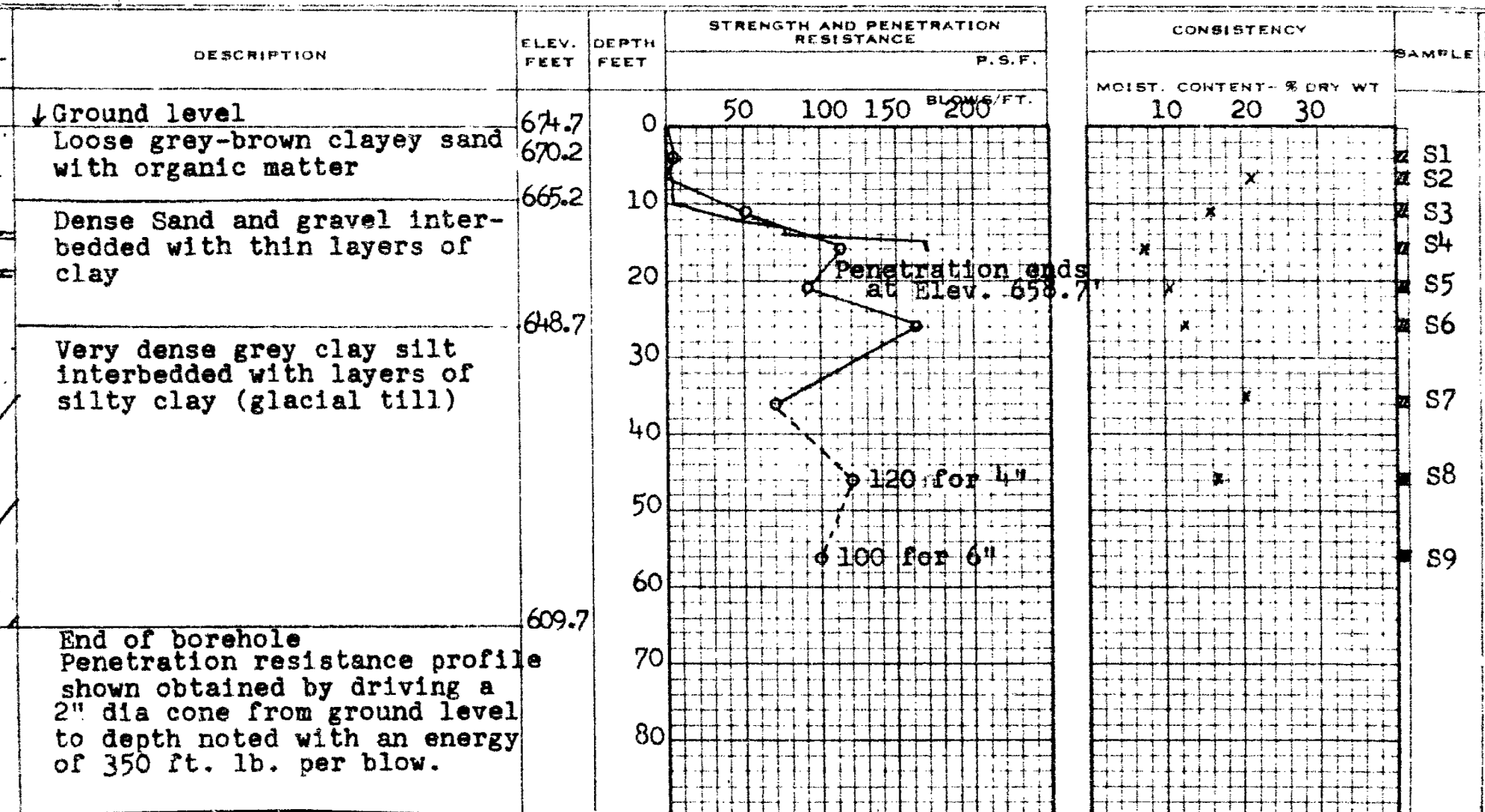
COMPILED BY B.K.

DATE Oct. 14/59 CHECKED BY A.L.

2" DIA. SPLIT TUBE
2" SHELBY TUBE
2" SPLIT TUBE
2" DIA. CONE
2" SHELBY
CASING

LEGEND

1/2 UNCONFINED COMPRESSION (Qu)
VANE TEST (C) AND SENSITIVITY (S)
NATURAL MOISTURE AND
LIQUIDITY INDEX
LIQUID LIMIT
PLASTIC LIMIT



DEPARTMENT OF HIGHWAYS - ONTARIO

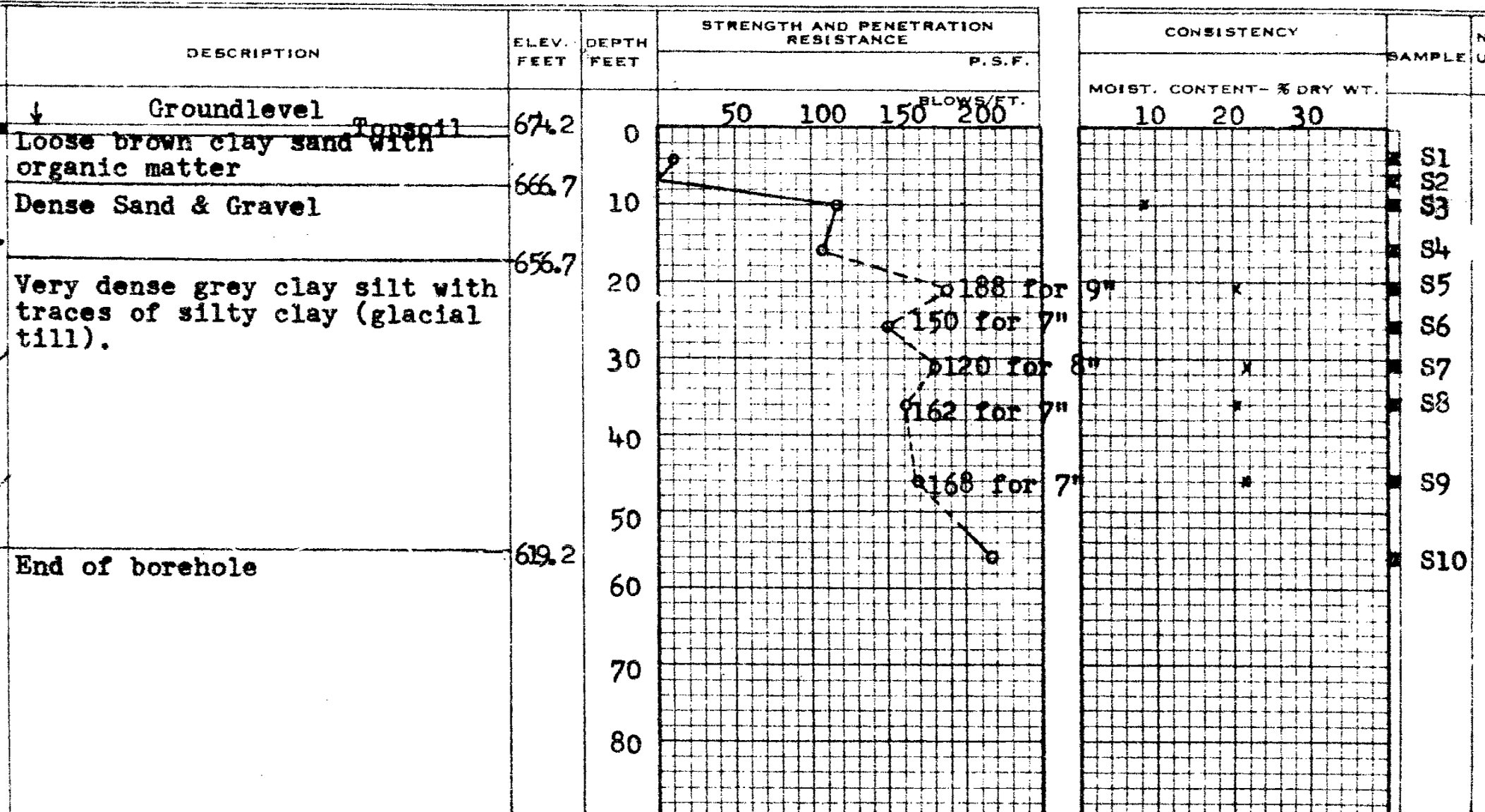
MATERIALS AND RESEARCH SECTION

218-59 ----- BORE HOLE NO. 6 -----
 F 59-98 ----- STATION 293+30 (60' LT). -----
 674.2' ----- COMPILED BY B.K. -----
 DATE Oct. 19/59 CHECKED BY A.L. -----

2" DIA. SPLIT TUBE -----
 2" SHELBY TUBE -----
 2" SPLIT TUBE -----
 2" DIA. CONE -----
 2" SHELBY -----
 CASING -----

LEGEND

1/2 UNCONFINED COMPRESSION (Qu) -----
 VANE TEST (C) AND SENSITIVITY (S) -----
 NATURAL MOISTURE AND LIQUIDITY INDEX -----
 LIQUID LIMIT -----
 PLASTIC LIMIT -----



SUMMARY OF FIELD & LABORATORY TESTS

JOB F 59-98

W.P.218-59

SOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH psi.	UNIT WEIGHT p.c.f.	REMARKS
1	S1	3'-4.5'	Loose brown fine silty sand with organic matter	P	28.9	-	-	-	-	
	S2	6'-7.5'	"	P	11.5	-	-	-	-	
	S3	9'-10.5'	"	4	14.4	-	-	-	-	
	S4	15'-16.5'	Very dense grey clay silt (glacial till)	73	21.8	-	-	-	-	
	S5	20'-21.5'	"	58	21.5	-	-	-	-	
	S6	25'-26.5'	"	118	22.5	-	-	-	-	
	S7	30'-31.5'	Very dense grey silty clay (glacial till)	132	22.0	-	-	-	-	
	S8	35'-36.5'	"	119	22.9	-	-	-	-	
	S9	40'-41.5'	"	117	24.0	-	-	-	-	
	S10	50'-51.5'	"	178	-	-	-	-	-	
	S11	60'-61.5'	Very dense grey clay silt (glacial till)	54	-	-	-	-	-	
	S12	70'-71.5'	Very dense grey clay silt & silty clay (glacial till)	213	-	-	-	-	-	
	S13	85'-86.5'	"	102	-	-	-	-	-	
2	S1	3'-4.5'	Loose grey-brown fine silty sand with organic matter	P	-	-	-	-	-	
	S2	6'-7.5'	"	P	39.8	-	-	-	-	

JOB F50-93

W.P. 218-59

SUMMARY OF FIELD & LABORATORY TESTS

[illegible]

SUMMARY OF FIELD & LABORATORY TESTS

 JOB F59-98

 W.P. 218-59

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS FT	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH psf.	UNIT WEIGHT pcf.	REMARKS
4	S1	9'-10.5'	Medium coarse sand & fine gravel	24	18.4	-	-	-	-	
	S2	14'-15.5'	Very dense grey clay silt interbedded with silty clay layers (glacial till)	53	19.3	-	-	-	-	
	S3	19'-20.5'	"	78	18.6	-	-	-	-	
	S4	25'-26.5'	"	129	20.2	-	-	-	-	
	S5	35'-36.5'	"	170	19.7	-	-	-	-	
	S6	45'-46.5'	"	185	20.4	-	-	-	-	
	S7	55'-56.5'	"	160	17.8	-	-	-	-	
5	S1	3'-4.5'	Loose grey-brown clayey sand with organic matter.	5	-	-	-	-	-	
	S2	6'-7.5'	"	P	21.1	-	-	-	-	
	S3	10'-11.5'	Dense sand and gravel interbedded with thin layers of clay.	52	16.0	-	-	-	-	
	S4	15'-16.5'	"	114	7.3	-	-	-	-	
	S5	20'-21.5'	"	91	10.7	-	-	-	-	
	S6	25'-26.5'	Very dense clay silt interbedded with layers of silty clay (glacial till)	164	12.5	-	-	-	-	
	S7	35'-36.5'	"	70	20.1	-	-	-	-	
	S8	45'-46.5'	"	120-4"	16.6	-	-	-	-	
	S9	55'-56.5'	"	100-6"	-	-	-	-	-	

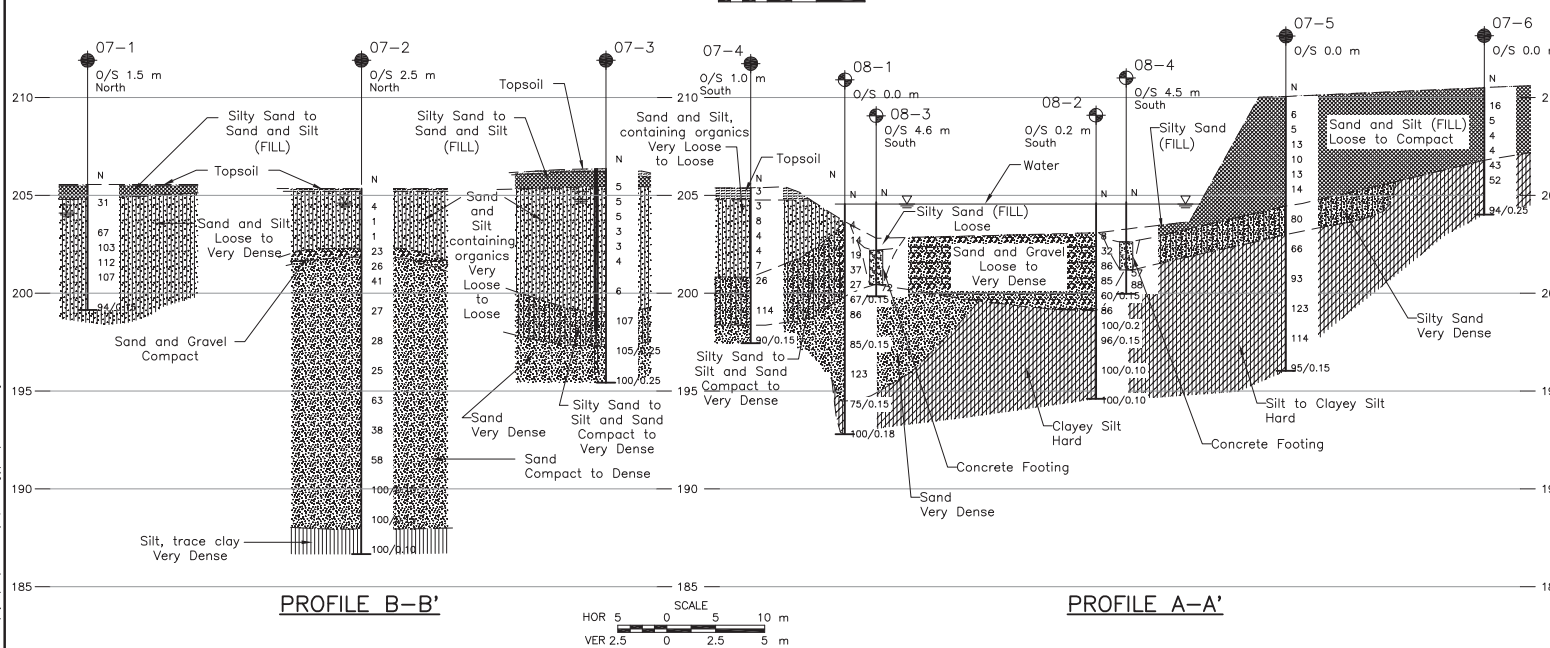
SUMMARY OF FIELD & LABORATORY TESTS

JOB F59-98W.P. 218-59

HOLE NO.	SAMP NO.	SAMPLE DEPTH (FEET)	MATERIAL DESCRIPTION	PENET'N RESIST. BLOWS/FT.	MOIST. CONT. %	PLASTIC LIMIT %	LIQUID LIMIT %	SHEAR STRENGTH p.s.f.	UNIT WEIGHT p.c.f.	REMARKS
6	S1	3'-4.5'	Loose brown clayey sand with organic matter	10	-	-	-	-	-	
	S2	6'-7.5'	"	P	-	-	-	-	-	
	S3	9'-10.5'	Dense sand & gravel	116	8.4	-	-	-	-	
	S4	15'-16.5'	"	107	-	-	-	-	-	
	S5	20'-21.5'	Very dense grey clay silt with traces of silty clay	188-9"	20.3	-	-	-	-	
	S6	25'-26.5'	(glacial till)	150-7"	-	-	-	-	-	
	S7	30'-31.5'	"	180-9"	21.9	-	-	-	-	
	S8	35'-36.5'	"	162-7"	20.1	-	-	-	-	
	S9	45'-46.5'	"	168-7"	21.4	-	-	-	-	
	S10	55'-56.5'	"	217	-	-	-	-	-	
			S denotes Split Spoon Sample							

APPENDIX B

**Golder 2009 Investigation
(GEOCRES 31D00-454)**



NO.		DATE	BY	REVISION
Geocres No.		31D-454		
HWY. 89		PROJECT NO. 05-1111-034		DIST.
SUBM'D. JB	CHKD. HJ	DATE: 16-Sep-09	SITE:	
DRAWN: DD	CHKD. SH	APPD. JMAC	DWG. 1	



NO.	DATE	BY	REVISION		
Geocres No. 31D-454					
HWY. 89		PROJECT NO. 05-1111-034		DIST.	
SUBM'D. JB	CHKD. HJ	DATE: 16-Sep-09	SITE:		
DRAWN: DD	CHKD. SH	APPD. JMAC	DWG. B2		



LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
ST	Slotted tube
TO	Thin-walled, open
TP	Thin-walled, piston
WS	Wash sample

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Cohesionless Soils

Density Index	N
Relative Density	Blows/300 mm or Blows/ft
Very loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	over 50

(b) Cohesive Soils Consistency

	kPa	C_u, S_u	psf
Very soft	0 to 12		0 to 250
Soft	12 to 25		250 to 500
Firm	25 to 50		500 to 1,000
Stiff	50 to 100		1,000 to 2,000
Very stiff	100 to 200		2,000 to 4,000
Hard	over 200		over 4,000

IV. SOIL TESTS

w	water content
w_p	plastic limit
w_l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D_R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

Note: 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.



LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$,	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta \sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - \mu$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
μ	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight*)
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l	liquid limit
w_p	plastic limit
I_p	plasticity index = $(w_l - w_p)$
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_a	coefficient of secondary consolidation
m_v	coefficient of volume change
C_v	coefficient of consolidation
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation pressure
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

T_p, T_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 + \sigma_3)/2$ or $(\sigma'_1 + \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 + \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

Notes: 1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

+³, ×³: Numbers refer to Sensitivity ○³% STRAIN AT FAILURE

MIS-MTO 001 05-1111-034.GPJ GAL-MISS.GDT 9/16/09 DD

PROJECT 05-1111-034			RECORD OF BOREHOLE No 07-2			1 OF 2 METRIC											
W.P. 2503-04-00			LOCATION N 4891914.8 ; E 280057.6			ORIGINATED BY SB											
DIST Central HWY 89			BOREHOLE TYPE Power Auger, 108 mm Hollow Stem Augers			COMPILED BY DD											
DATUM Geodetic			DATE July 5, 2007			CHECKED BY JB/HJ											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L	10 20 30				
205.4	GROUND SURFACE																
0.0	TOPSOIL																
0.2	SAND and SILT, containing organics, trace clay Loose Brown to grey Moist to wet		1	SS	4		205										
	SILTY SAND		2	SS	1		204										
			3	SS	1		203										
202.3																	
3.1	SAND and GRAVEL		4	SS	23		202										
201.9	Compact Grey Wet																
3.5	SAND, trace to some silt, trace to some gravel, trace clay Compact to very dense Grey Moist to wet		5	SS	26		201										
			6	SS	41		200										
			7	SS	27		199										
			8	SS	28		198										
			9	SS	25		196										
			10	SS	63		194										
			11	SS	38		193										
			12	SS	58		191										

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 05-1111-034			RECORD OF BOREHOLE No 07-2			2 OF 2 METRIC										
W.P. 2503-04-00			LOCATION N 4891914.8 ; E 280057.6			ORIGINATED BY SB										
DIST Central HWY 89			BOREHOLE TYPE Power Auger, 108 mm Hollow Stem Augers			COMPILED BY DD										
DATUM Geodetic			DATE July 5, 2007			CHECKED BY JB/HJ										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100					
188.0	SAND, trace to some silt, trace to some gravel, trace clay Compact to very dense Grey Moist to wet		13	SS	100/0.10											
			14	SS	100/0.15											
188.0																
17.4	SILT, trace clay Very dense Grey Moist															
			15	SS	100/0.10											
186.7																
18.7	END OF BOREHOLE															
	NOTE: 1. Water level measured in open borehole upon completion of drilling at 0.8 m below ground surface (Elevation 204.6 m).															

MIS-MTO 001 05-1111-034.GPJ GAL-MISS.GDT 9/16/09 DD

PROJECT 05-1111-034			RECORD OF BOREHOLE No 07-3			1 OF 1 METRIC															
W.P. 2503-04-00			LOCATION N 4891920.8 ; E 280085.4			ORIGINATED BY SB															
DIST Central HWY 89			BOREHOLE TYPE Power Auger, 108 mm Hollow Stem Augers			COMPILED BY DD															
DATUM Geodetic			DATE July 5, 2007			CHECKED BY JB/HJ															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ			GR SA SI CL		
206.4	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30											
0.0	TOPSOIL																				
0.2	Silty sand (FILL) Brown Moist																				
205.5	Silty SAND, trace clay, containing organics Very loose to loose Black and grey Moist		1	SS	5																
0.9			2	SS	5																
			3	SS	5																
			4	SS	3																
			5	SS	3																
			6	SS	4																
	Contains some gravel and slightly organic at 6.1 m depth		7	SS	6																
199.1	Silty SAND, trace clay Very dense Brown to grey Moist		8	SS	107																
7.3																					
197.3	SAND, some silt Very dense Grey Moist		9	SS	105/0.25																
9.1																					
195.4	END OF BOREHOLE		10	SS	100/0.125																
10.9	NOTES: 1. Water level measured in open borehole upon completion of drilling at 1.85 m below ground surface. (Elevation 204.5 m). 2. Water level measured in piezometer on July 12 at 1.6 m below ground surface (Elevation 204.8 m). 3. Water level measured in piezometer on July 31 at 1.7 m below ground surface (Elevation 204.7 m). 4. Water level measured in piezometer on August 29 at 1.6 m below ground surface (Elevation 204.8 m).																				

MIS-MTO 001 05-1111-034.GPJ GAL-MISS.GDT 9/16/09 DD

+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT 05-1111-034			RECORD OF BOREHOLE No 07-4			1 OF 1 METRIC														
W.P. 2503-04-00			LOCATION N 4891920.5 ;E 280099.9			ORIGINATED BY SB														
DIST Central HWY 89			BOREHOLE TYPE Tripod, HQ Wash Boring			COMPILED BY DD														
DATUM Geodetic			DATE July 12, 2007			CHECKED BY JB/HJ														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL			
							20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30								
205.4	GROUND SURFACE																			
0.0	Sandy TOPSOIL, roots Very loose Brown Moist		1	SS	3		205													
204.8																				
0.6	SAND and SILT, trace clay, shells Very loose to loose, containing organics Grey to brown Moist Wet below 1.2 m depth		2	SS	3		204													
			3	SS	8															
			4	SS	4		203													
202.3																				
3.1	Silty SAND, trace clay, containing organics Very loose to loose Grey to black Wet		5	SS	4		202													
			6	SS	7															
200.8							201													
4.6	SILT and SAND, trace gravel and clay Compact to very dense Brown Wet		7	SS	26															
			8	SS	114		199													
198.4																				
7.0	SAND, trace to some silt Very dense Reddish brown to grey Wet						198													
197.5			9	SS	90/0.15															
7.9	END OF BOREHOLE																			
	NOTE: 1. Water level measured in open borehole upon completion of drilling at 0.8 m below ground surface. (Elevation 204.6 m).																			


PROJECT 05-1111-034				RECORD OF BOREHOLE No 07-5				1 OF 2 METRIC						
W.P. 2503-04-00				LOCATION N 4891937.5; E 280151.9				ORIGINATED BY SB						
DIST Central HWY 89				BOREHOLE TYPE Power Auger, 108 mm Hollow Stem Augers				COMPILED BY DD						
DATUM Geodetic				DATE July 3, 2007				CHECKED BY JB/HJ						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
210.1	GROUND SURFACE													
0.0	TOPSOIL													
0.2	Sand and silt , some gravel, trace clay, (FILL) Loose to compact Brown Moist		1	SS	6									
	SILTY SAND		2	SS	5									
			3	SS	13									
			4	SS	10									
			5	SS	13									
			6	SS	14									
204.5														
5.6	Silty SAND, some gravel, trace clay Very dense Brown Moist		7	SS	80									
203.0														
7.1	SILT to CLAYEY SILT Hard Grey Wet		8	SS	66									
	CLAYEY SILT-SILT to CLAYEY SILT		9	SS	93									
			10	SS	123									
			11	SS	114									
			12	SS	95/0.15									
196.0														
14.0														

Continued Next Page

+³, ×³: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

PROJECT <u>05-1111-034</u>		RECORD OF BOREHOLE No 07-5				2 OF 2 METRIC	
W.P. <u>2503-04-00</u>		LOCATION <u>N 4891937.5 ; E 280151.9</u>				ORIGINATED BY <u>SB</u>	
DIST <u>Central</u> HWY <u>89</u>		BOREHOLE TYPE <u>Power Auger, 108 mm Hollow Stem Augers</u>				COMPILED BY <u>DD</u>	
DATUM <u>Geodetic</u>		DATE <u>July 3, 2007</u>				CHECKED BY <u>JB/HJ</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			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					W _p	W			W _L							
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED ○ FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>																	
	END OF BOREHOLE NOTES: 1. Water level measured in open borehole upon completion of drilling at 9.1 m below ground surface. (Elevation 201.0 m). 2. Water level measured in piezometer on July 12 at 4.8 m below ground surface (Elevation 205.3 m). 3. Water level measured in piezometer on July 31 at 4.7 m below ground surface (Elevation 205.4 m). 4. Water level measured in piezometer on August 29 at 4.8 m below ground surface (Elevation 205.3 m).																							

PROJECT <u>05-1111-034</u>		RECORD OF BOREHOLE No 07-6				1 OF 1 METRIC											
W.P. <u>2503-04-00</u>		LOCATION <u>N 4891943.4 ;E 280171.3</u>				ORIGINATED BY <u>SB</u>											
DIST <u>Central</u> HWY <u>89</u>		BOREHOLE TYPE <u>Power Auger, 101 mm Solid Stem Augers</u>				COMPILED BY <u>DD</u>											
DATUM <u>Geodetic</u>		DATE <u>July 3, 2007</u>				CHECKED BY <u>JB/HJ</u>											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
210.5 0.0	GROUND SURFACE Sand and silt, trace to some gravel (FILL) Loose to compact Brown Moist SILTY SAND						210										
			1	SS	16												
			2	SS	5												
			3	SS	4												
			4	SS	4												
206.8 3.7	Clayey Silt, trace gravel Hard Brown to grey Moist		5	SS	43												
			6	SS	52												
204.0 6.5	Becoming grey at 6.3 m END OF BOREHOLE NOTE: 1. Borehole dry upon completion of drilling.		7	SS	94/0.25												

PROJECT		2503-04-00		LOCATION		N 4891924.3 ; E 280108.8		ORIGINATED BY		PKS								
DIST		Central HWY 89		BOREHOLE TYPE		Wash Rotary - NQ Casing		COMPILED BY		SH								
DATUM		Geodetic		DATE		November 12, 2008		CHECKED BY		JMAC								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)
204.6	RIVER SURFACE																	
0.0	Water																	
203.7	SAND and GRAVEL, trace silt and clay, occasional cobble, wood fragments Loose to dense Brown Wet		1	50 DO	4													
0.9																		
			2	50 DO	14													
			3	50 DO	19													
			4	50 DO	37													
199.8	SAND, trace to some silt, trace gravel and clay, occasional cobble Very dense Brown Wet		5	50 DO	27													
4.7																		
			6	50 DO	67/0.15													
			7	50 DO	86													
			8	50 DO	85/0.15													
194.5	CLAYEY SILT, trace to some sand Hard Grey Wet		9	50 DO	123													
10.1																		
			10	50 DO	75/0.15													
192.8	CLAYEY SILT-SILT		11	50 DO	100/0.15													
11.8	END OF BOREHOLE																	

MIS-MTO 001 05-1111-034.GPJ GAL-MISS.GDT 9/16/09 DD

PROJECT		2503-04-00		LOCATION		N 4891931.6 ; E 280133.4		ORIGINATED BY		PKS				
DIST		Central		HWY		89		BOREHOLE TYPE		Wash Rotary - NQ Casing				
DATUM		Geodetic		DATE		November 11, 2008		COMPILED BY		SH				
								CHECKED BY		JMAC				
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
204.6	RIVER SURFACE													
0.0	Water													
203.1														
1.5	SAND and GRAVEL, trace silt and clay, occasional cobble (below 3.05 m) Loose to very dense Brown Wet		1	50 DO	8									
			2	50 DO	32									
			3	50 DO	86									
			4	50 DO	85									
			5	50 DO	60/0.15									
199.1			6	50 DO	86									
5.5	CLAYEY SILT, trace to some sand Hard Grey Wet		7	50 DO	100/0.2									
	CLAYEY SILT-SILT		8	50 DO	96/0.15									
			9	50 DO	100/0.10									
194.6			10	50 DO	100/0.10									
10.0	END OF BOREHOLE													

MIS-MTO 001 05-1111-034.GPJ GAL-MISS.GDT 9/16/09 DD



PROJECT		RECORD OF BOREHOLE No 08-3				1 OF 1 METRIC											
W.P. 05-1111-034		LOCATION N 4891920.8 ; E 280113.2				ORIGINATED BY MWK											
DIST Central HWY 89		BOREHOLE TYPE Wash Rotary - NQ Casing				COMPILED BY SH											
DATUM Geodetic		DATE November 14, 2008				CHECKED BY JMAC											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ kN/m ³	GR SA SI CL
								20 40 60 80 100	○ UNCONFINED + FIELD VANE	● QUICK TRIAXIAL × REMOULDED	W _p	W	W _L				
204.7	WATER SURFACE																
0.0	Water																
202.8																	
1.9	Silty sand, trace gravel, occasional decayed wood (FILL/sediment)																
202.2	Grey																
2.5	Concrete																
200.5																	
4.2	SAND, trace gravel																
	Very dense																
199.8	Brown		1	SS	72												
4.8	Wet																
	END OF BOREHOLE																

MIS-MTO 001 05-1111-034.GPJ GAL-MISS.GDT 9/16/09 DD

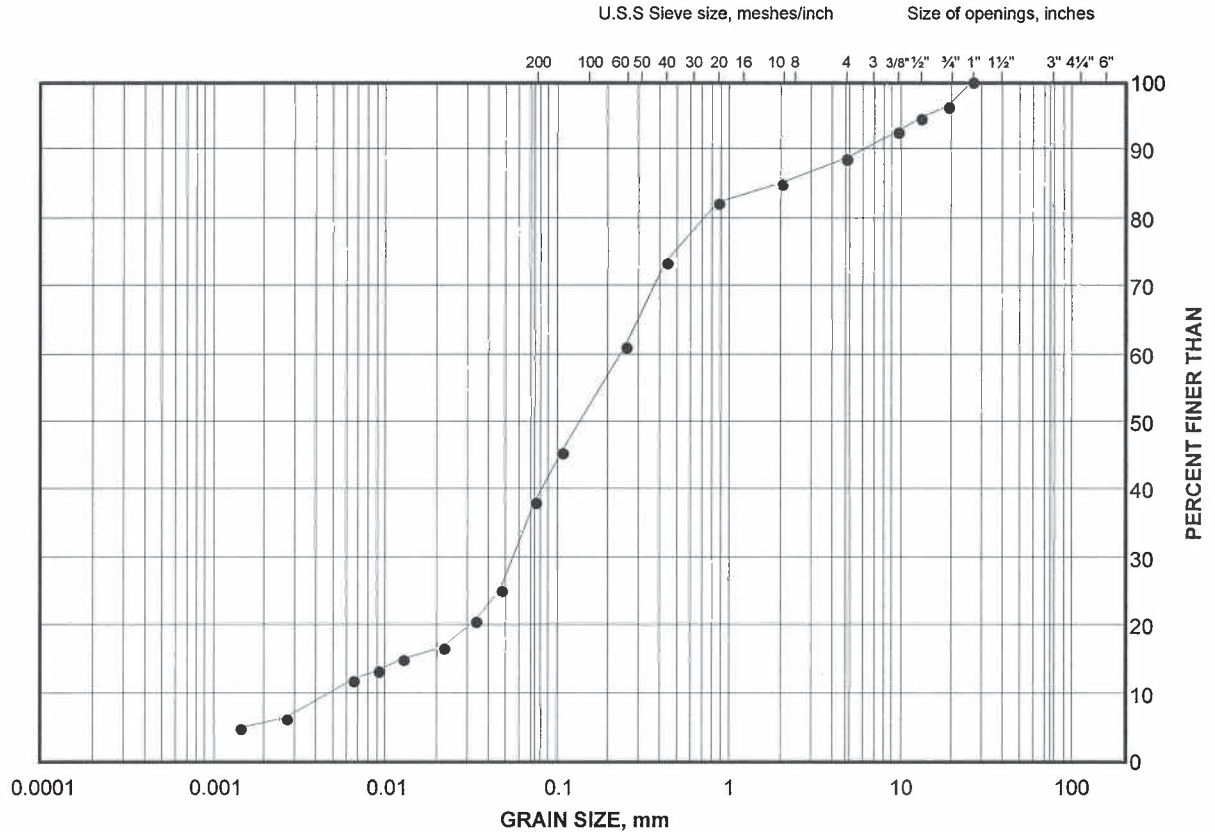
PROJECT 05-1111-034			RECORD OF BOREHOLE No 08-4			1 OF 1 METRIC		
W.P. 2503-04-00			LOCATION N 4891928.4 ;E 280137.6			ORIGINATED BY MWK		
DIST Central HWY 89			BOREHOLE TYPE Wash Rotary - NQ Casing			COMPILED BY SH		
DATUM Geodetic			DATE November 13, 2008			CHECKED BY JMAC		
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100
						PLASTIC LIMIT W _p NATURAL MOISTURE CONTENT W LIQUID LIMIT W _L WATER CONTENT (%)		
						UNIT WEIGHT γ kN/m ³		
						REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
204.7	WATER SURFACE							
0.0	Water							
203.3								
1.4	Silty sand, trace gravel, occasional decayed wood, (FILL/sediment)							
202.6	Grey							
2.0	Concrete							
201.2								
3.5	CLAYEY SILT, trace to some sand Hard Grey Wet		1	SS	57			
200.0	CLAYEY SILT-SILT		2	SS	88			
4.7	END OF BOREHOLE							

GRAIN SIZE DISTRIBUTION

Sand and Silt (Fill)

Silty Sand

FIGURE 1
B1



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	07-5	5	205.9

Project Number: 05-1111-034

Checked By: HJ

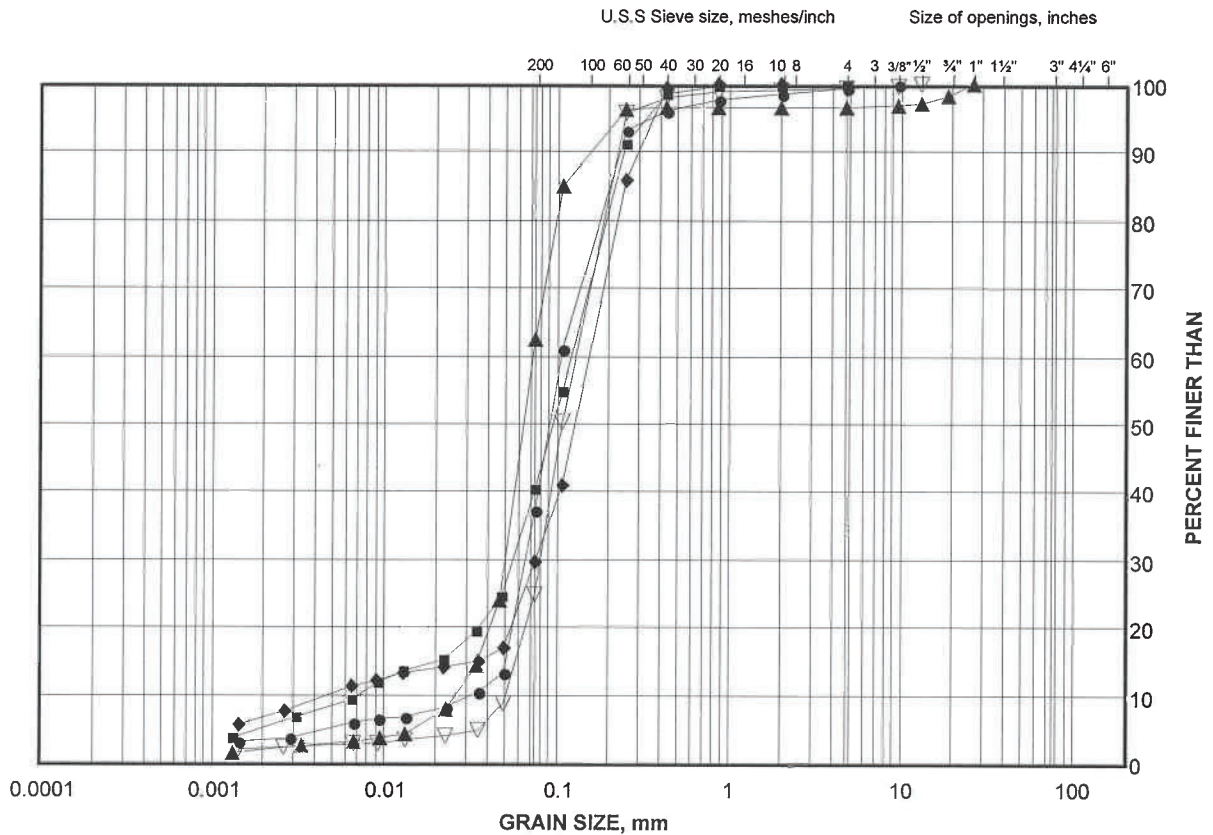
Golder Associates

Date: 25-Sep-07

GRAIN SIZE DISTRIBUTION

~~Sand and Silt to Silty Sand~~
Silt and Sand to Silty Sand

FIGURE 2
B2



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	07-1	3	202.9
■	07-4	4	202.8
◆	07-3	4	203.0
▲	07-4	8	199.0
▽	07-3	8	198.4

Project Number: 05-1111-034

Checked By: HJ

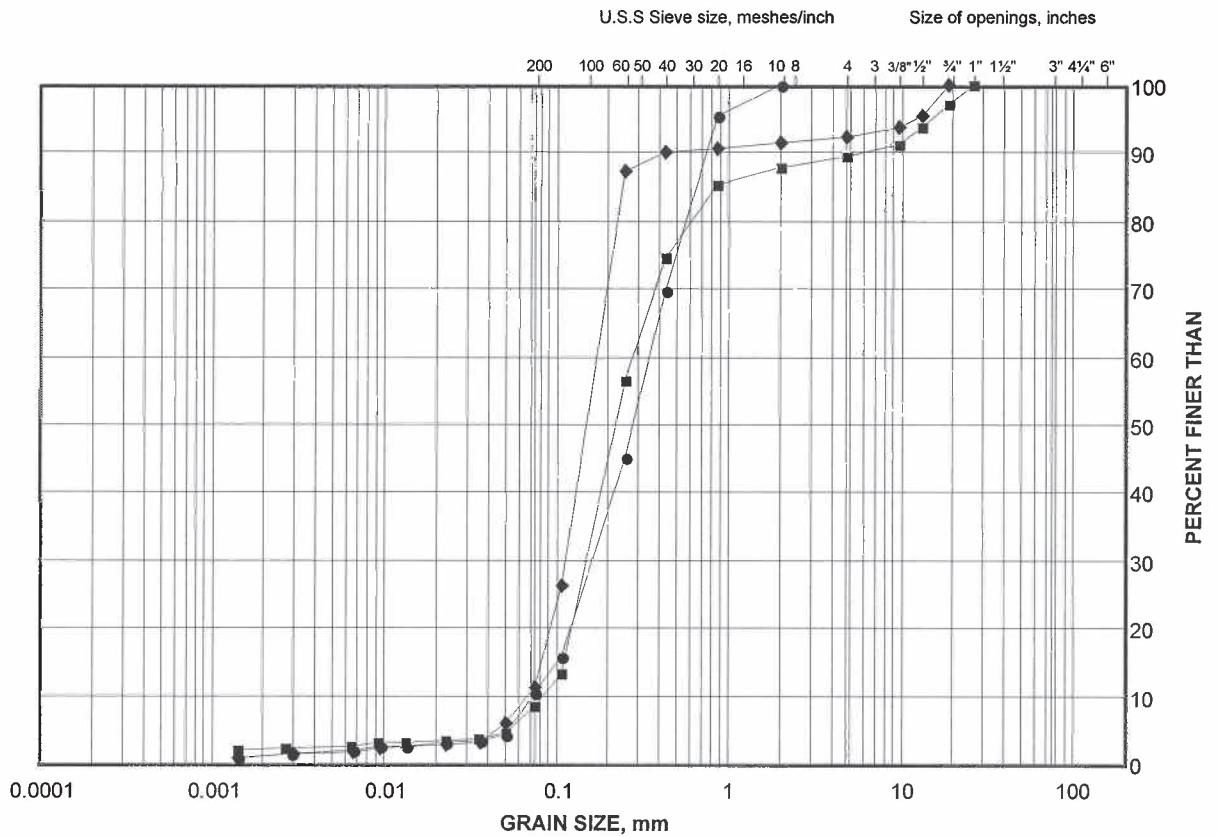
Golder Associates

Date: 25-Sep-07

GRAIN SIZE DISTRIBUTION

Sand

FIGURE 3
B3



SILT AND CLAY SIZES		FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED		SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	07-2	10	194.4
■	07-2	13	190.1
◆	07-2	5	201.2

Project Number: 05-1111-034

Checked By: HJ

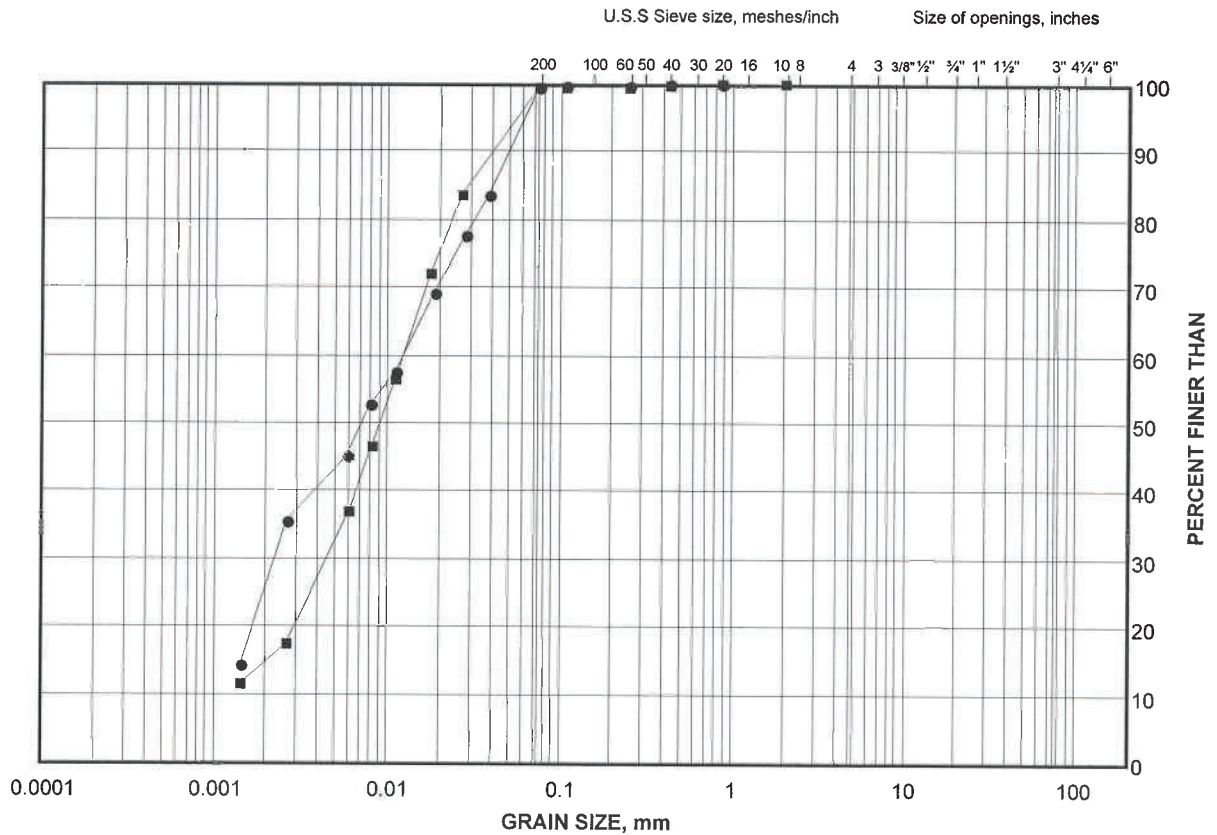
Golder Associates

Date: 25-Sep-07

GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE 4
B4



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

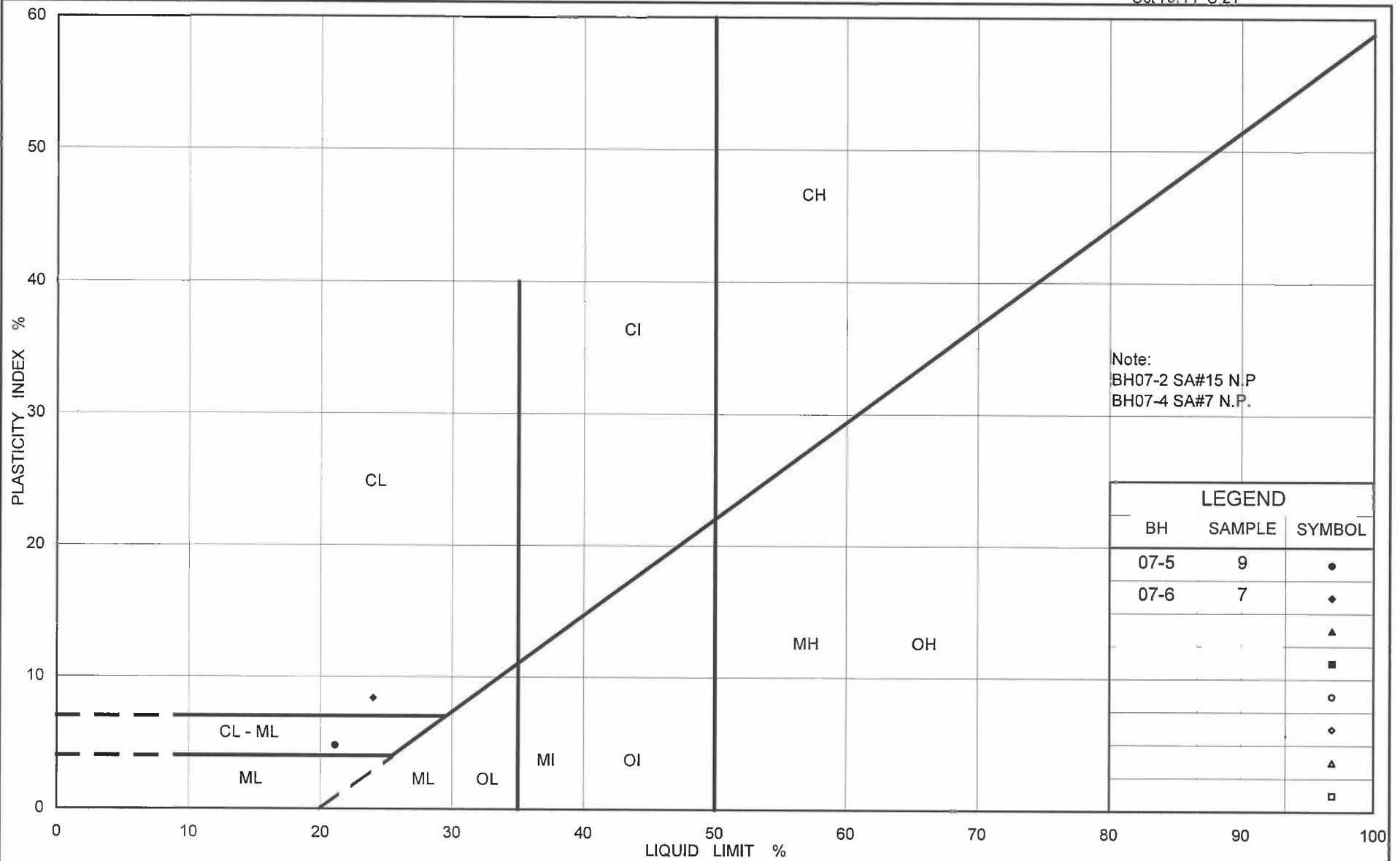
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	07-6	6	205.7
■	07-5	9	200.6

Project Number: 05-1111-034

Checked By: HJ

Golder Associates

Date: 25-Sep-07



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Ontario

PLASTICITY CHART Clayey Silt- Silt to Clayey Silt

Figure No. 5 B5

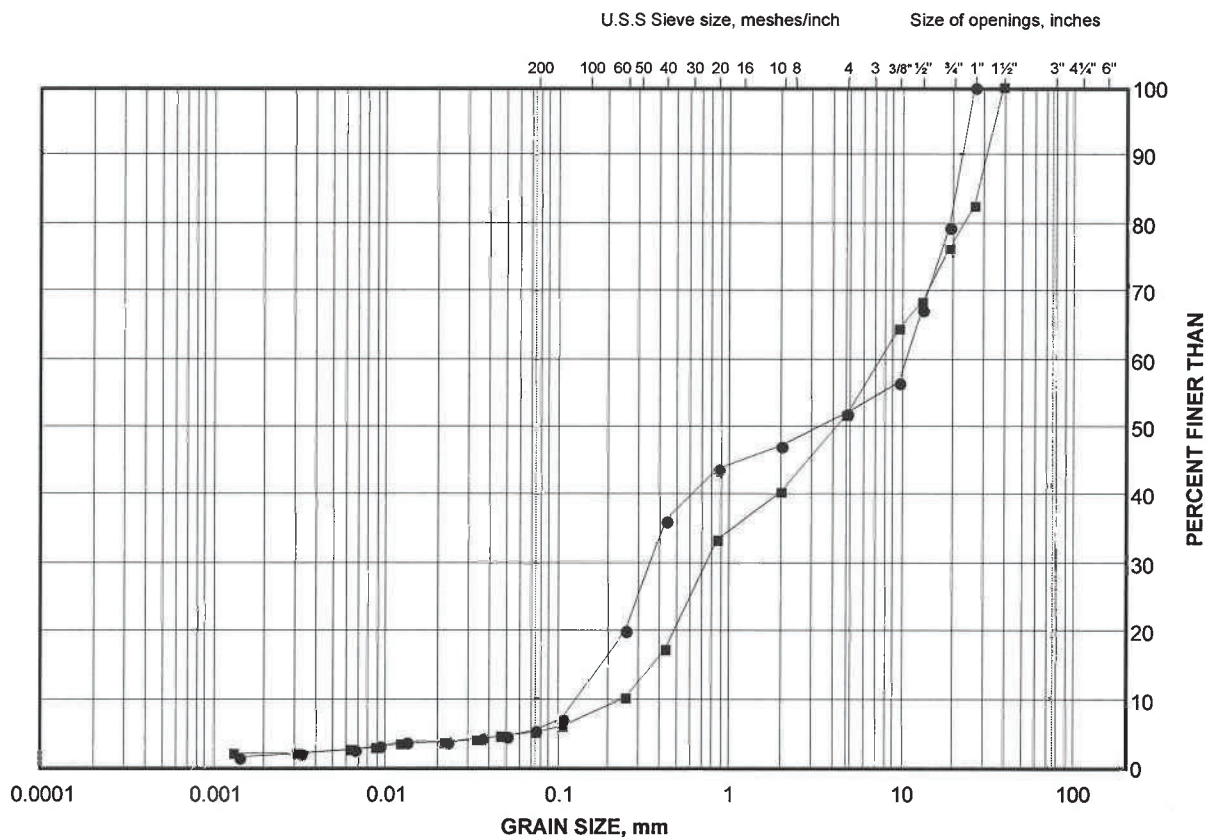
Project No. 05-1111-034

Checked By: HJ

GRAIN SIZE DISTRIBUTION

Sand and Gravel

FIGURE 6
B6



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	08-1	2	202.6
■	08-2	3	201.2

Project Number: 05-1111-034

Checked By: Sen

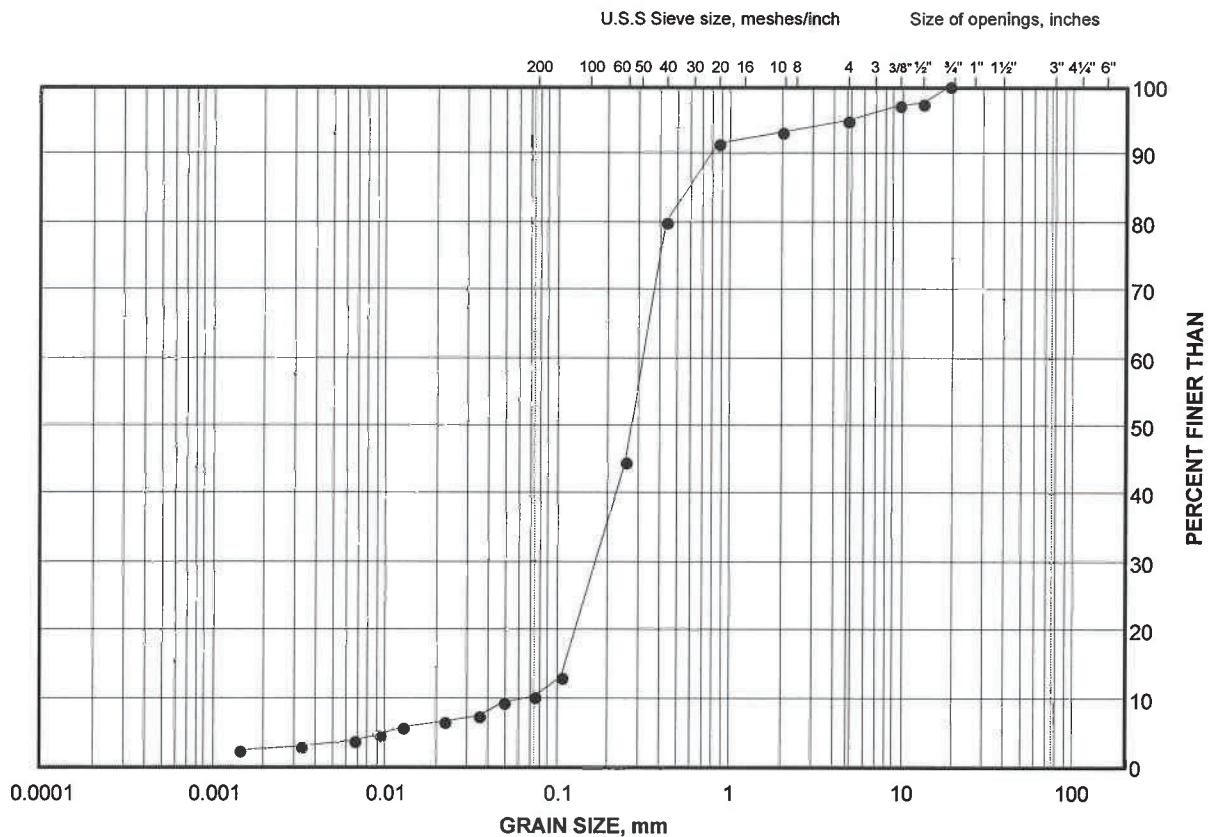
Golder Associates

Date: 09-Sep-09

GRAIN SIZE DISTRIBUTION

Sand

FIGURE 7
B7



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	08-1	8	197.5

Project Number: 05-1111-034

Checked By: Sen

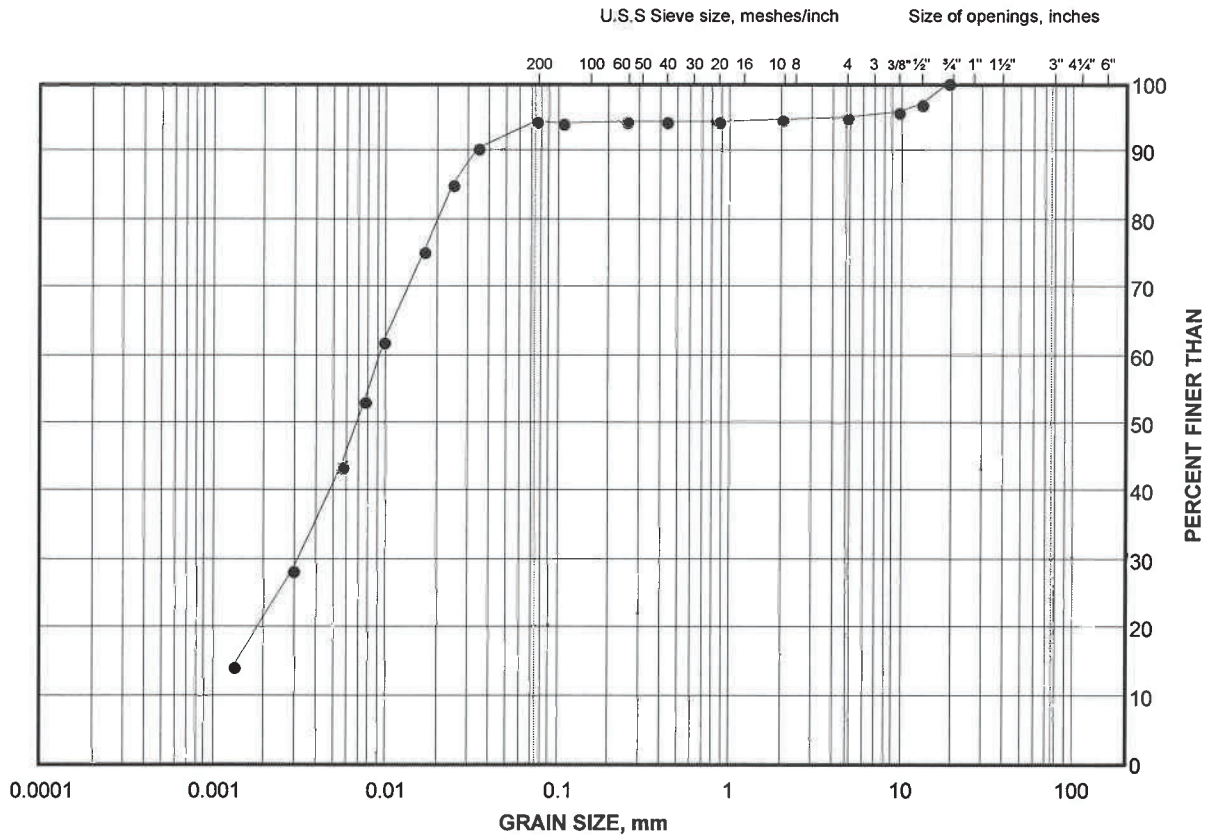
Golder Associates

Date: 09-Sep-09

GRAIN SIZE DISTRIBUTION

Clayey Silt -Silt

FIGURE 8
B8



SILT AND CLAY SIZES	FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE
FINE GRAINED	SAND SIZE			GRAVEL SIZE		SIZE

LEGEND

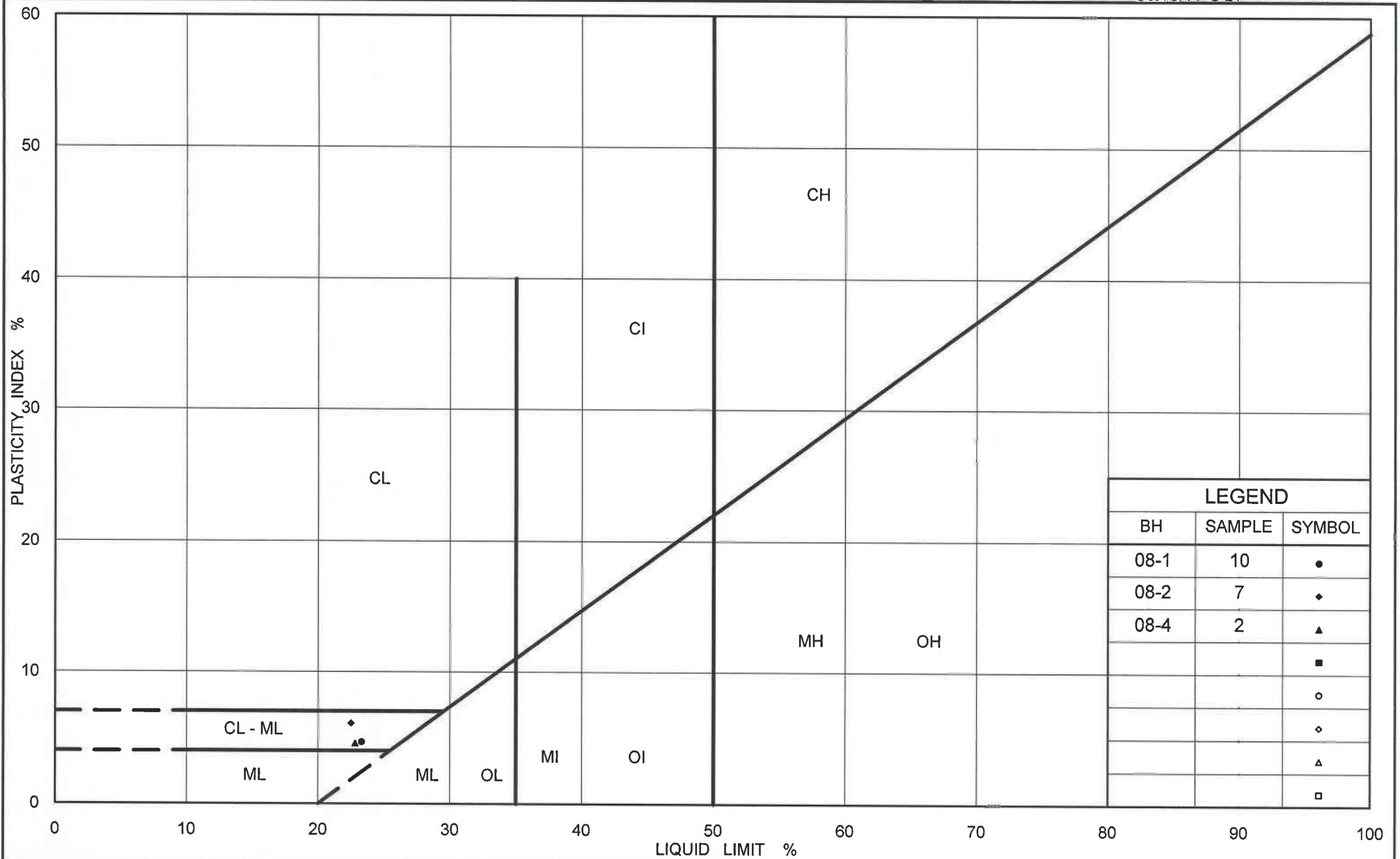
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	08-2	7	198.4

Project Number: 05-1111-034

Checked By: *Sen*

Golder Associates

Date: 09-Sep-09



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt-Silt

Figure No. 9 B9

Project No. 05-1111-034

Checked By: *ben*

APPENDIX C

Current Investigation

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

MINISTRY OF TRANSPORTATION, ONTARIO

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>200	>8
COBBLES	Not Applicable	75 to 200	3 to 8
GRAVEL	Coarse	19 to 75	0.75 to 3
	Fine	4.75 to 19	(4) to 0.75
		2.00 to 4.75	(10) to (4)
SAND	Coarse	0.425 to 2.00	(40) to (10)
	Medium	0.075 to 0.425	(200) to (40)
	Fine		
FINES	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY COMPONENTS^{1,2}

Percentage by Mass	Modifier
> 35	Use 'and' to combine primary and secondary component (i.e., SAND and gravel)
> 20 to 35	Primary soil name prefixed with "gravelly, sandy" as applicable
> 10 to 20	some (i.e., some sand)
≤ 10	trace (i.e., trace fines)

1. Only applicable to components not described by Primary Group Name.

2. Classification of Primary Group Name based on Unified Soil Classification System (ASTM D2487) for coarse-grained soils; fine-grained soils described per current MTO Soil Classification System.

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve friction (f_s) are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC / SC	Rock core / Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample
OD / ID	Outer Diameter / Inner Diameter
HSA / SSA	Hollow-Stem Augers / Solid-Stem Augers

SOIL TESTS

w	water content
PL, w _p	plastic limit
LL, w _L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G _s)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

COARSE-GRAINED SOILS

Compactness¹

Term	SPT 'N' (blows/0.3m) ²
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	> 50

1. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grain size. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

2. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.

FINE-GRAINED SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N' ^{1,2} (blows/0.3m)
Very Soft	< 12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	> 200	> 30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.

2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

LIST OF SYMBOLS

MINISTRY OF TRANSPORTATION, ONTARIO

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
\log_{10}	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
FoS	factor of safety

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
ν	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_L or LL	liquid limit
w_P or PL	plastic limit
I_P or PI	plasticity index $= (w_L - w_P)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index $= (w - w_P) / I_P$
I_C	consistency index $= (w_L - w) / I_P$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index $= (e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
$C_{a(e)}$	secondary compression index
C_a	rate of secondary compression
$C_{a(e)}$	modified secondary compression index
m_v	coefficient of volume change
C_v	coefficient of consolidation (vertical direction)
C_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio $= \sigma'_p / \sigma'_{vo}$

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
c'	effective cohesion
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction $= \tan \delta$
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p'	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q or q'	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

* Density symbol is ρ . Unit weight symbol is γ .
where $\gamma = \rho \cdot g$ (i.e., mass density multiplied by
acceleration due to gravity)

Notes: 1
2

$\tau = c' + \sigma' \tan \phi'$
shear strength = (compressive strength)/2

METRIC

CHECKED BY MCK

+³, x³: Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECTCA0020332.0247

G.W.P.2022-E-0046

DISTCentral

DATUMSurface Elevation:210.9 m

LOCATIONN 4891935.7; E 280164.8 NAD83 / MTM Zone 10 (LAT. 44.167003; LONG. -79.808044)

BOREHOLE TYPE210 mm O.D. Hollow Stem Augers

DATEApr 09, 2024 - Apr 10, 2024

RECORD OF BOREHOLE No. BH24-01

Sheet 2 of 2

METRIC

ORIGINATED BYMTI/KR

COMPILED BYSA/MTI

CHECKED BYMCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT	GR SA SI CL				REMARKS
ELEV. ----- DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L						
								20	40	60	80	100	20	40	60	Y					
	SILT (ML), trace clay, trace sand Dense to very dense Brown to grey Wet						200														
199.1																					
11.7	CLAYEY SILT-SILT (CL-ML), trace sand Hard Grey Wet - 12.2 to 12.8 m: contains Silt pockets						199														
							198														
							197						10				0	0	78	22	
							196														
							195														
							194														
193.5																					
17.4	End of Borehole Notes: 1. Water level measured inside piezometer at a depth of 4.9 m (Elev. 206.0 mASL) upon installation. 2. Water level measured inside piezometer at a depth of 5.0 m (Elev. 205.9 mASL) on 26-Aug-2024. 3. Water level measured inside piezometer at a depth of 5.1 m (Elev. 205.8 mASL) on 28-Nov-2024.						193														
							192														
							191														

+³, x³ : Numbers refer to Sensitivity o³% STRAIN AT FAILURE

PROJECT CA0020332.0247

RECORD OF BOREHOLE No. BH24-02

Sheet 1 of 2

METRIC

G.W.P. 2022-E-0046

LOCATION N 4891911.7; E 280087.1 NAD83 / MTM Zone 10 (LAT. 44.166785; LONG. -79.809014)

ORIGINATED BY MTI

DIST Central HWY 89

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers

COMPILED BY SA

DATUM Surface Elevation:210.0 m

DATE Apr 08, 2024 - Apr 09, 2024

CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT Y kN/m³	GR	SA	SI	CL	REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL	NMC	LL						
								Field Vane	Remoulded	Pocket Pen	Quick Triaxial	Unconfined	W _p	W	W _L						
							20	40	60	80	100	20	40	60	NP Nonplastic						
0.0	ASPHALT (430 mm)																				
209.6			1A																		
0.4	SILTY SAND (SM), some gravel (FILL) Compact to dense Brown Moist - 0.4 to 1.2 m: Auger grinding		1B	SS	36																
208.8			2A	SS	19																
1.2	Sandy SILT (ML), trace clay, trace gravel (FILL) Loose to compact Brown Moist - 1.2 to 3.0 m: Auger grinding		2B																		
			3	SS	6																
	- 2.3 m: contains Clayey Silt pocket between 2.3 m and 2.5 m		4	SS	18																
	- 2.7 m: blackish in colour and contains organics and wood fragments from 2.7 m to 2.8 m																				
207.0																					
3.0	SILTY SAND (SM), trace gravel (FILL) Loose to compact Brown Moist - 3.0 to 4.2 m: Auger grinding		5	SS	12																
206.0			6A																		
4.0	CLAYEY SILT (CL), contains organics (FILL)		6B	SS	7																
205.8			6C																		
4.2	Firm Brown Moist SILTY SAND (SM), trace clay, some gravel, containing organics Very loose to loose Brown Moist to wet - 4.2 to 4.6 m: Auger grinding		7	SS	2										NP		17	49	32	2	
204.4																					
5.6	ORGANIC SILT (OI) and sand, trace clay, trace gravel, contains pieces of wood Stiff Dark brown to black Moist		8	SS	8																

Continued on Next Page

+³, x³ : Numbers refer to Sensitivity o³⁰ STRAIN AT FAILURE

PROJECT CA0020332.0247

RECORD OF BOREHOLE No. BH24-02

Sheet 2 of 2

METRIC

G.W.P. 2022-E-0046

LOCATION N 4891911.7; E 280087.1 NAD83 / MTM Zone 10 (LAT. 44.166785; LONG. -79.809014)

ORIGINATED BY MTI

DIST Central HWY 89

BOREHOLE TYPE 210 mm O.D. Hollow Stem Augers

COMPILED BY SA

DATUM Surface Elevation:210.0 m

DATE Apr 08, 2024 - Apr 09, 2024

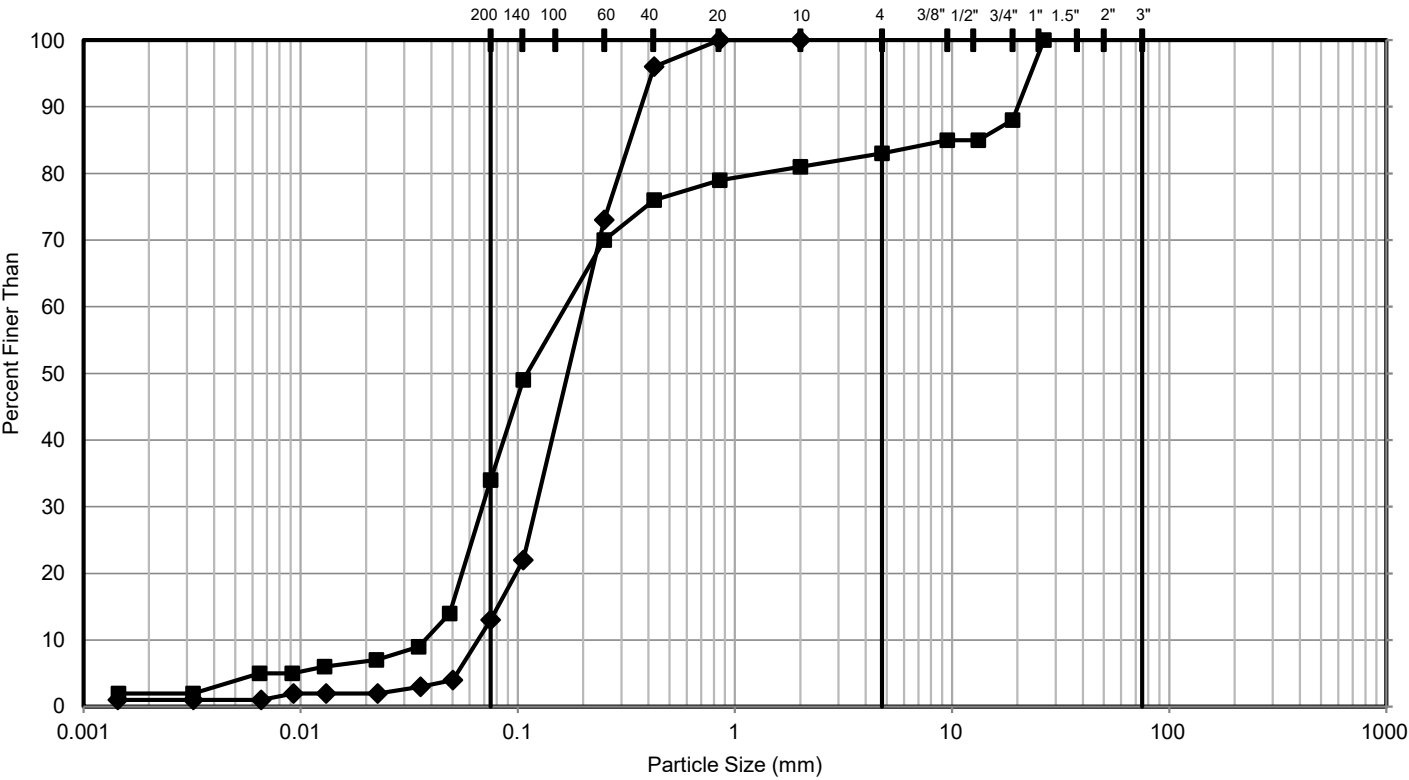
CHECKED BY MCK

SOIL PROFILE			SAMPLES			GROUNDWATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					WATER CONTENT (%)			UNIT WEIGHT					REMARKS
ELEV. DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH (kPa)					PL W _p	NMC W	LL W _L		GR	SA	SI	CL	
								Field Vane Remoulded Pocket Pen Quick Triaxial Unconfined													
								20 40 60 80 100					20 40 60								
	SILTY SAND (SM), trace clay, trace gravel Dense to very dense Grey Wet		11	SS	95		199														
	- 11.3 m: Trace organics from 8.7 m to 11.3 m						198														
	- 12.2 m: heaving sands encountered inside hollow stem augers and possible sample disturbance		12 A 12 B	SS	53		197														
			13	SS	104		196										0	87	12	1	
			14	SS	104/0.21		195														
	- 15.6 m: contains some gravel						194														
193.7																					
16.3	CLAYEY SILT-SILT (CL-ML), trace sand, trace gravel Hard Grey Wet		15	SS	100/0.11		193										1	1	88	10	
193.0																					
17.0	End of Borehole Notes: 1. Water level measured inside augers at a depth of 5.9 m (Elev. 204.1 mALS) at end of drilling. 2. Water level measured inside piezometer at a depth of 5.1 m (Elev. 204.9 mASL) on 26-Aug-2024. 3. Water level measured inside piezometer at a depth of 5.5 m (Elev. 204.5 mASL) on 28-Nov-2024.						192														
							191														

+³, x³ : Numbers refer to Sensitivity o³⁰% STRAIN AT FAILURE


PATH: https://wsponlinecan.sharepoint.com/sites/CA-CA00203320247/Shared Documents/05. Technical/Foundations/5 - Reporting/4 - RPT Bridge/01-Predraft/Appendix C_Current Investigation/Working Files | FILE NAME: Laboratory Particle Size Distribution WTO.xlsm

GRAIN SIZE DISTRIBUTION

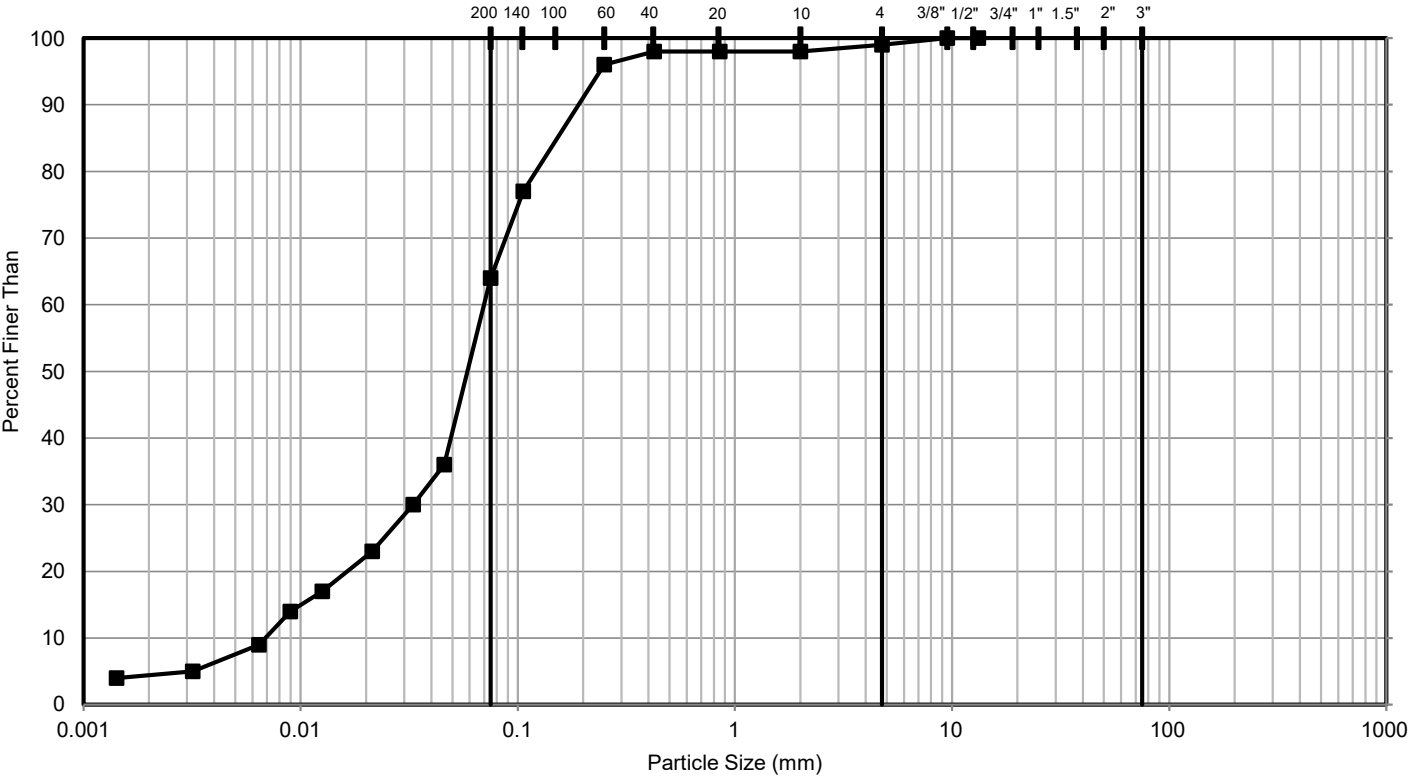


FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-02	7	4.6 - 5.2	205.4 to 204.8
◆	BH24-02	13	13.7 - 14.2	196.3 to 195.8


CLIENT		PROJECT	
Ministry of Transportation, Ontario		Highway 89 Nottawasaga River Bridge Widening (Site No. 30X-0250/B0), G.W.P. 2022-22-00 W.P. 2121-22-01	
<div>CONSULTANT</div> <div></div>	YYYY-MM-DD	2024-11-15	
	DESIGNED	NA	
	PREPARED	MCK	
	REVIEWED	KJB	
	APPROVED	KJB	
TITLE		Silty Sand (SM)	
PROJECT NO.	CONTROL	REV.	FIGURE
CA0020332.0247		0	C1

GRAIN SIZE DISTRIBUTION

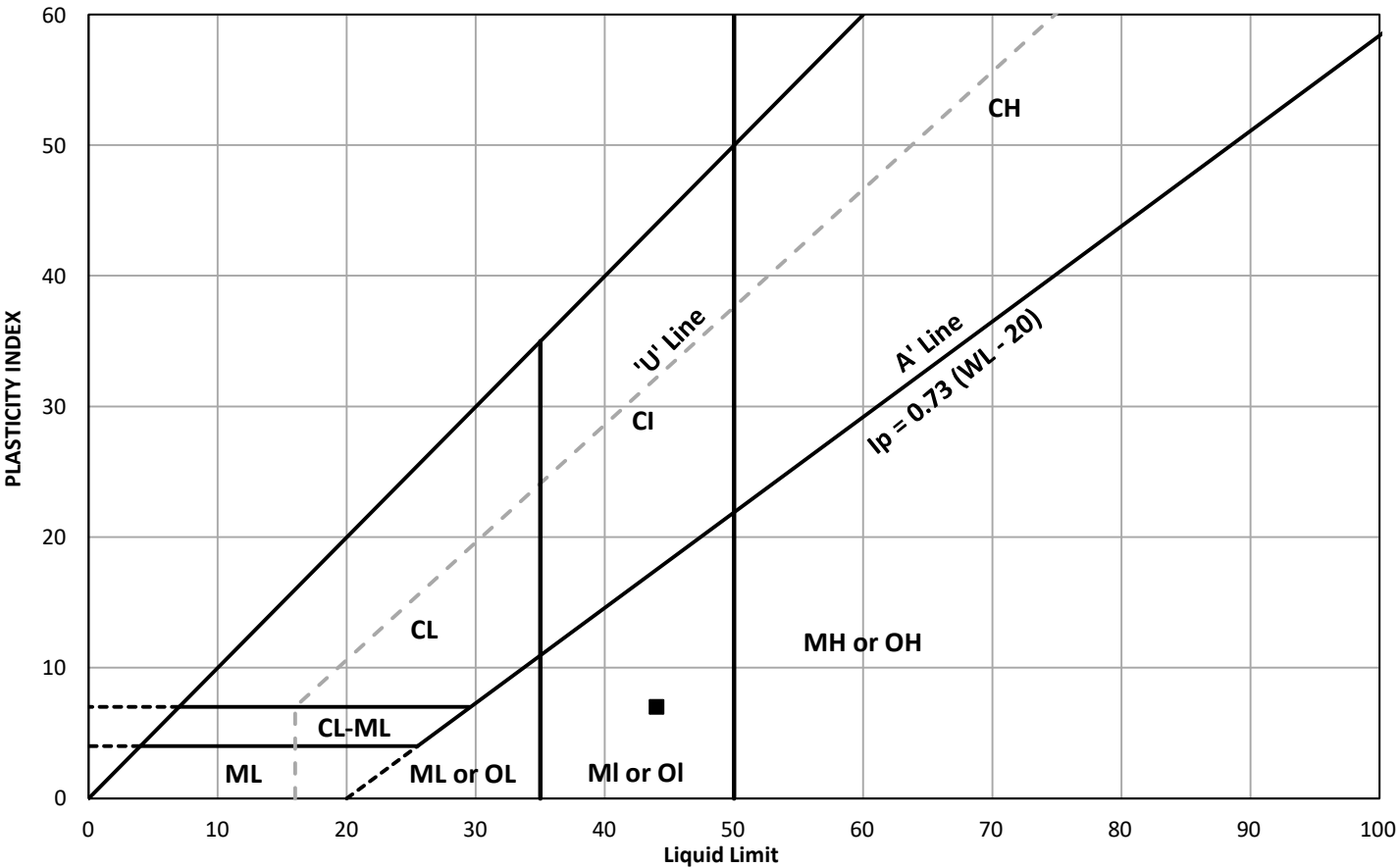


FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-02	8	6.1 - 6.7	203.9 to 203.3

CLIENT		PROJECT	
Ministry of Transportation, Ontario		Highway 89 Nottawasaga River Bridge Widening (Site No. 30X-0250/B0), G.W.P. 2022-22-00 W.P. 2121-22-01	
<div>CONSULTANT</div> <div></div>	YYYY-MM-DD	2024-11-15	
	DESIGNED	NA	
	PREPARED	MCK	
	REVIEWED	KJB	
	APPROVED	KJB	
		TITLE	
		Organic Silt (OI)	
PROJECT NO.	CONTROL	REV.	FIGURE
CA0020332.0247		0	C2

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-02	8	6.1 - 6.7	39.8	44	37	7	0.40

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD

2024-11-15

DESIGNED

NA

PREPARED

MCK

REVIEWED

KJB

APPROVED

KJB

PROJECT

Highway 89 Nottawasaga River Bridge Widening (Site No. 30X-0250/B0)
G.W.P. 2022-22-00 W.P. 2121-22-01

TITLE

Organic Silt (OI)

PROJECT NO.

CA0020332.0247

CONTROL

REV.

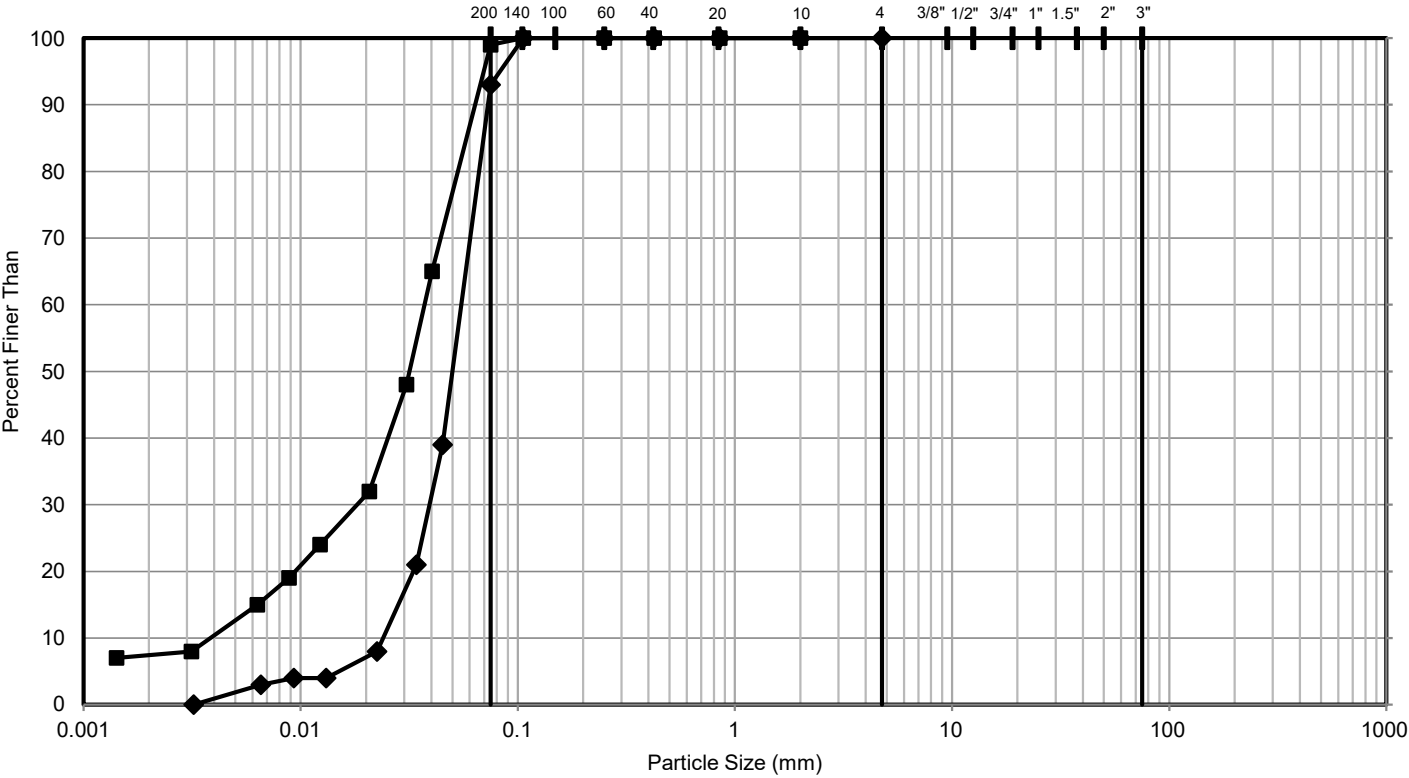
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FIGURE

C3


PATH: https://wsponlinecan.sharepoint.com/sites/CA-CA00203320247/Shared Documents/05. Technical/Foundations/05. Reporting/4 - RPT Bridge/01-Predraft/Appendix C_Current Investigation/Working Files | FILE NAME: Laboratory Particle Size Distribution WTO.xlsm

GRAIN SIZE DISTRIBUTION

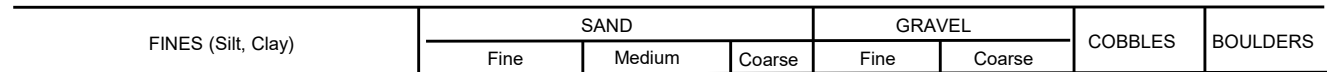


FINES (Silt, Clay)	SAND			GRAVEL		COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Coarse		

Symbol	Sample Location	Sample Number	Depth (m)	Elevation (m)
■	BH24-01	8	6.1 - 6.7	204.8 to 204.2
◆	BH24-01	10	9.1 - 9.8	201.7 to 201.1

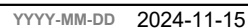
CLIENT		PROJECT	
Ministry of Transportation, Ontario		Highway 89 Nottawasaga River Bridge Widening (Site No. 30X-0250/B0), G.W.P. 2022-22-00 W.P. 2121-22-01	
<div>CONSULTANT</div> <div></div>	YYYY-MM-DD	2024-11-15	
	DESIGNED	NA	
	PREPARED	MCK	
	REVIEWED	KJB	
	APPROVED	KJB	
TITLE		Silt (ML)	
PROJECT NO.	CONTROL	REV.	FIGURE
CA0020332.0247		0	C4

FILE NAME	Laboratory Particle Size Distribution MTO.xls
PATH: https://wspolnecan.sharepoint.com/sites/CA-CA0020323207/Shared Documents/05_Technical/Foundations/5 - Reporting/4 - RPT Bridges/01-Predraft/Appendix C_Current Investigation/Working Files	



CLIENT

CONSULTANT



DESIGNED	NA
----------	----

PREPARED	MCK
----------	-----

REVIEWED KJB

APPROVED KJB

PROJECT

TITLE

Clayey Silt-Silt (CL-ML) to Clayey Silt (CL)

PROJECT NO.

CONTROL

REV.

FIGURE

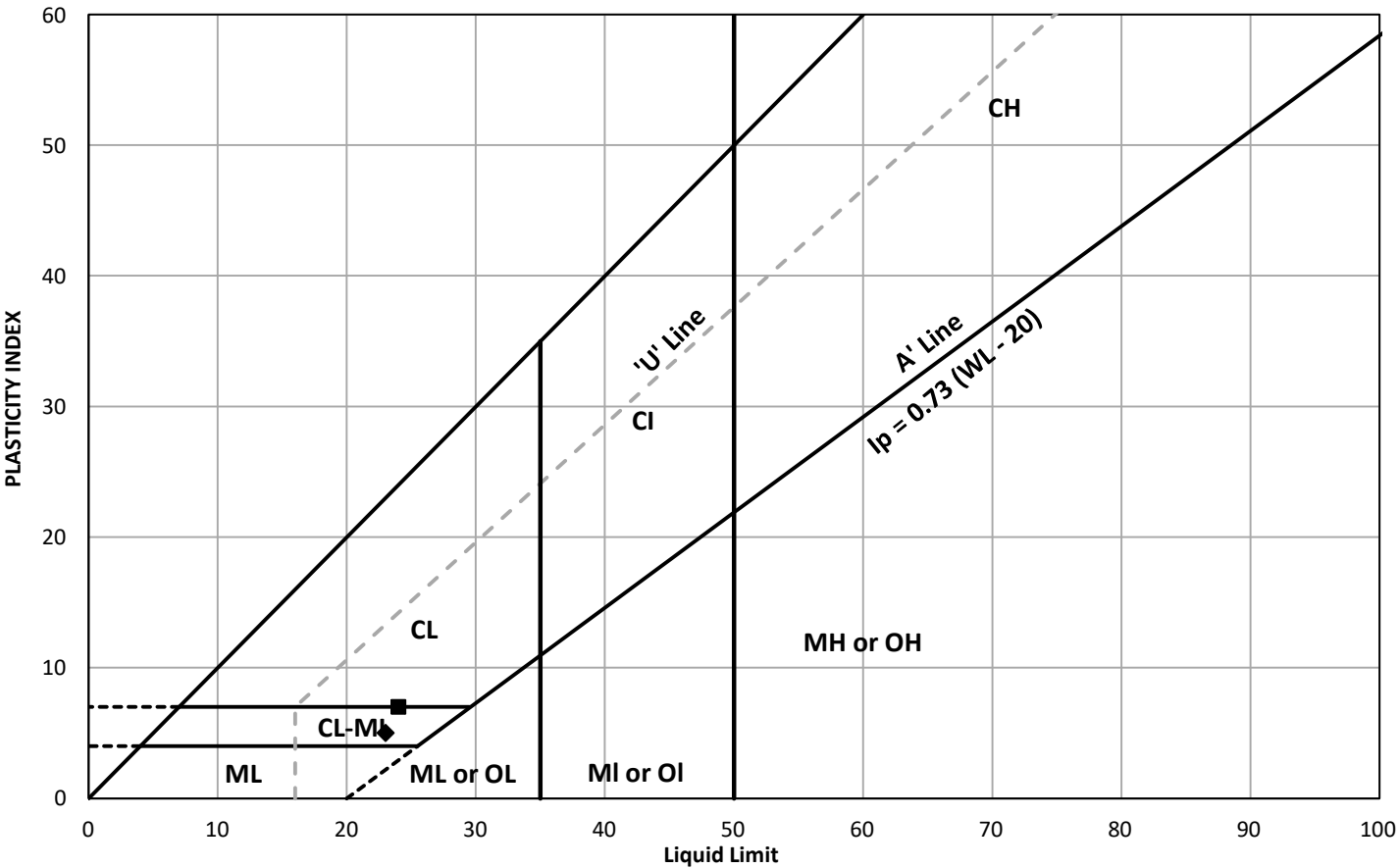
CA0020332.0247

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C5

PATH: https://wsponlinecan.sharepoint.com/sites/CA-CA00203320247/Shared Documents/05. Technical/Foundations/5 - Reporting/4 - RPT Bridges/01-Predraft/Appendix C_Current Investigation/Working Files | FILE NAME: Alterberg Output MTO.xlsm

PLASTICITY CHART




	Sample Location	Sample / Specimen Number	Depth (m)	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
■	BH24-01	13	13.7 - 14.3	20.4	24	17	7	0.49
◆	BH24-02	15	16.8 - 17.0	19.2	23	18	5	0.24

CLIENT

Ministry of Transportation, Ontario

CONSULTANT



YYYY-MM-DD

2024-11-15

DESIGNED

NA

PREPARED

MCK

REVIEWED

KJB

APPROVED

KJB

PROJECT

Highway 89 Nottawasaga River Bridge Widening (Site No. 30X-0250/B0)
G.W.P. 2022-22-00 W.P. 2121-22-01

TITLE

Clayey Silt-Silt (CL-ML) to Clayey Silt (CL)

PROJECT NO.

CA0020332.0247

CONTROL

REV.

0

FIGURE

C6



Your Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Your C.O.C. #: N/A

Attention: Madison Kennedy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2024/05/03
Report #: R8134623
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C4C4317

Received: 2024/04/25, 14:52

Sample Matrix: Soil
Samples Received: 9

Analyses	Quantity	Date	Date	Laboratory Method	Analytical Method
		Extracted	Analyzed		
Chloride (20:1 extract)	9	2024/04/30	2024/05/01	CAM SOP-00463	MOE E3013 m
Conductivity	9	2024/04/30	2024/04/30	CAM SOP-00414	OMOE E3530 v1 m
Moisture (Subcontracted) (1, 2)	9	N/A	2024/05/01	AB SOP-00002	CCME PHC-CWS m
Sulphide in Soil (1)	9	N/A	2024/04/30	AB SOP-00080	EPA9030B/SM4500S2-DF
pH CaCl2 EXTRACT	9	2024/04/29	2024/04/29	CAM SOP-00413	EPA 9045 D m
Redox Potential (3)	9	2024/05/02	2024/05/03	CAM SOP-00421	SM 24 2580 B
Resistivity of Soil	9	2024/04/26	2024/04/30	CAM SOP-00414	SM 24 2510 m
Sulphate (20:1 Extract)	9	2024/04/30	2024/05/01	CAM SOP-00464	MOE E3013 m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, EPA, APHA or the Quebec Ministry of Environment.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) This test was performed by Bureau Veritas Calgary (19th), 4000 19th Street NE, Calgary, AB, T2E 6P8

(2) Offsite analysis requires that subcontracted moisture be reported.



Your Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Your C.O.C. #: N/A

Attention: Madison Kennedy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2024/05/03
Report #: R8134623
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C4C4317

Received: 2024/04/25, 14:52

(3) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode. The test is therefore, not SCC accredited for this matrix.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:

Ankita Bhalla, Project Manager

Email: Ankita.Bhalla@bureauveritas.com

Phone# (905) 817-5700

=====

This report has been generated and distributed using a secure automated process.

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.



**BUREAU
VERITAS**

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		YZU407		YZU408	YZU409			YZU409	
Sampling Date		2024/04/09		2024/04/10	2024/04/10			2024/04/10	
COC Number		N/A		N/A	N/A			N/A	
	UNITS	BH24-01 SA-5	RDL	BH24-01 SA-9	BH24-01 SA-12	RDL	QC Batch	BH24-01 SA-12 Lab-Dup	QC Batch
Calculated Parameters									
Resistivity	ohm-cm	410		870	4100		9358051		
CONVENTIONALS									
Redox Potential	mV	270	N/A	270	270	N/A	9368559	270	9368559
Inorganics									
Soluble (20:1) Chloride (Cl-)	ug/g	1400	40	550	21	20	9364082		
Conductivity	umho/cm	2470	2	1160	244	2	9364027		
Available (CaCl2) pH	pH	7.76		7.86	7.85		9361710		
Soluble (20:1) Sulphate (SO4)	ug/g	94	20	83	79	20	9364092		
Sulphide	mg/kg	3.2 (1)	0.5	1.5 (1)	1.8 (1)	0.5	9365692		
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Extracted past method specified hold time									



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		YZU410	YZU411			YZU411		
Sampling Date		2024/04/08	2024/04/08			2024/04/08		
COC Number		N/A	N/A			N/A		
	UNITS	BH24-02 SA-2+3	BH24-02 SA-05	RDL	QC Batch	BH24-02 SA-05 Lab-Dup	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	1200	2400		9358051			
CONVENTIONALS								
Redox Potential	mV	270	270	N/A	9368559			
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	330	100	20	9364082	110	20	9364082
Conductivity	umho/cm	843	420	2	9364027			
Available (CaCl2) pH	pH	8.05	7.96		9361710			
Soluble (20:1) Sulphate (SO4)	ug/g	40	24	20	9364092	24	20	9364092
Sulphide	mg/kg	1.8 (1)	0.9 (1)	0.5	9365692			
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable (1) Extracted past method specified hold time								

Bureau Veritas ID		YZU412		YZU413		YZU414		
Sampling Date		2024/04/08		2024/04/09		2024/04/15		
COC Number		N/A		N/A		N/A		
	UNITS	BH24-02 SA-10	QC Batch	BH24-02 SA-12	QC Batch	BH24-03 SA-9	RDL	QC Batch

Calculated Parameters								
Resistivity	ohm-cm	3500	9358051	4100	9358051	1800		9358051
CONVENTIONALS								
Redox Potential	mV	270	9368559	270	9368559	270	N/A	9368559
Inorganics								
Soluble (20:1) Chloride (Cl-)	ug/g	80	9364082	64	9364082	200	20	9364082
Conductivity	umho/cm	284	9364027	246	9364027	561	2	9364027
Available (CaCl2) pH	pH	7.92	9361710	7.90	9361722	7.74		9361710
Soluble (20:1) Sulphate (SO4)	ug/g	34	9364092	31	9364092	35	20	9364092
Sulphide	mg/kg	1.6 (1)	9365692	1.1 (1)	9365692	2.4 (1)	0.5	9365692
RDL = Reportable Detection Limit QC Batch = Quality Control Batch N/A = Not Applicable (1) Extracted past method specified hold time								



SOIL CORROSIVITY PACKAGE (SOIL)

Bureau Veritas ID		YZU414			YZU415		
Sampling Date		2024/04/15			2024/04/16		
COC Number		N/A			N/A		
	UNITS	BH24-03 SA-9 Lab-Dup	RDL	QC Batch	BH24-04 SA-8	RDL	QC Batch
Calculated Parameters							
Resistivity	ohm-cm				5200		9358051
CONVENTIONALS							
Redox Potential	mV				270	N/A	9368559
Inorganics							
Soluble (20:1) Chloride (Cl-)	ug/g				<20	20	9364082
Conductivity	umho/cm	564	2	9364027	192	2	9364027
Available (CaCl2) pH	pH				7.56		9361722
Soluble (20:1) Sulphate (SO4)	ug/g				49	20	9364092
Sulphide	mg/kg				3.3	0.5	9365692
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable							



**BUREAU
VERITAS**

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

RESULTS OF ANALYSES OF SOIL

Bureau Veritas ID		YZU407	YZU408	YZU408	YZU409	YZU410	YZU411		
Sampling Date		2024/04/09	2024/04/10	2024/04/10	2024/04/10	2024/04/08	2024/04/08		
COC Number		N/A	N/A	N/A	N/A	N/A	N/A		
	UNITS	BH24-01 SA-5	BH24-01 SA-9	BH24-01 SA-9 Lab-Dup	BH24-01 SA-12	BH24-02 SA-2+3	BH24-02 SA-05	RDL	QC Batch

Physical Testing

Moisture-Subcontracted	%	16	15	16	17	5.4	6.7	0.30	9368179
------------------------	---	----	----	----	----	-----	-----	------	---------

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch

Lab-Dup = Laboratory Initiated Duplicate

Bureau Veritas ID		YZU412	YZU413	YZU414	YZU415		
Sampling Date		2024/04/08	2024/04/09	2024/04/15	2024/04/16		
COC Number		N/A	N/A	N/A	N/A		
	UNITS	BH24-02 SA-10	BH24-02 SA-12	BH24-03 SA-9	BH24-04 SA-8	RDL	QC Batch

Physical Testing

Moisture-Subcontracted	%	17	15	30	21	0.30	9368179
------------------------	---	----	----	----	----	------	---------

RDL = Reportable Detection Limit

QC Batch = Quality Control Batch



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU407
Sample ID: BH24-01 SA-5
Matrix: Soil

Collected: 2024/04/09
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU408
Sample ID: BH24-01 SA-9
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU408 Dup
Sample ID: BH24-01 SA-9
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson

Bureau Veritas ID: YZU409
Sample ID: BH24-01 SA-12
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu



BUREAU
VERITAS

Bureau Veritas Job #: C4C4317
Report Date: 2024/05/03

WSP Canada Inc.
Client Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU409 Dup
Sample ID: BH24-01 SA-12
Matrix: Soil

Collected: 2024/04/10
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR

Bureau Veritas ID: YZU410
Sample ID: BH24-02 SA-2+3
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU411
Sample ID: BH24-02 SA-05
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU411 Dup
Sample ID: BH24-02 SA-05
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU412
Sample ID: BH24-02 SA-10
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR



Bureau Veritas Job #: C4C4317
Report Date: 2024/05/03

WSP Canada Inc.
Client Project #: CA0020332.0247, TASK 900.910
Site Location: ALLISTON, ONTARIO
Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU412
Sample ID: BH24-02 SA-10
Matrix: Soil

Collected: 2024/04/08
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurparteek KAUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU413
Sample ID: BH24-02 SA-12
Matrix: Soil

Collected: 2024/04/09
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurparteek KAUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361722	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurparteek KAUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU414
Sample ID: BH24-03 SA-9
Matrix: Soil

Collected: 2024/04/15
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurparteek KAUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl2 EXTRACT	AT	9361710	2024/04/29	2024/04/29	Taslina Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurparteek KAUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu

Bureau Veritas ID: YZU414 Dup
Sample ID: BH24-03 SA-9
Matrix: Soil

Collected: 2024/04/15
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurparteek KAUR



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VERITAS

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

TEST SUMMARY

Bureau Veritas ID: YZU415
Sample ID: BH24-04 SA-8
Matrix: Soil

Collected: 2024/04/16
Shipped:
Received: 2024/04/25

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride (20:1 extract)	SKAL/EC	9364082	2024/04/30	2024/05/01	Alina Dobreanu
Conductivity	AT	9364027	2024/04/30	2024/04/30	Gurpartee K AUR
Moisture (Subcontracted)	BAL	9368179	N/A	2024/05/01	Ashley Henderson
Sulphide in Soil	SPEC	9365692	N/A	2024/04/30	Irene Donita Villanueva
pH CaCl ₂ EXTRACT	AT	9361722	2024/04/29	2024/04/29	Taslima Aktar
Redox Potential	COND	9368559	2024/05/02	2024/05/03	Gurpartee K AUR
Resistivity of Soil		9358051	2024/04/30	2024/04/30	Automated Statchk
Sulphate (20:1 Extract)	SKAL/EC	9364092	2024/04/30	2024/05/01	Alina Dobreanu



GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	3.3°C
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Results relate only to the items tested.



**BUREAU
VERITAS**

Bureau Veritas Job #: C4C4317

Report Date: 2024/05/03

QUALITY ASSURANCE REPORT

WSP Canada Inc.

Client Project #: CA0020332.0247, TASK 900.910

Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
9361710	Available (CaCl ₂) pH	2024/04/29			100	97 - 103			0.44	N/A
9361722	Available (CaCl ₂) pH	2024/04/29			100	97 - 103			0.11	N/A
9364027	Conductivity	2024/04/30			102	90 - 110	<2	umho/cm	0.55	10
9364082	Soluble (20:1) Chloride (Cl ⁻)	2024/05/01	NC	70 - 130	86	70 - 130	<20	ug/g	6.5	35
9364092	Soluble (20:1) Sulphate (SO ₄)	2024/05/01	91	70 - 130	90	70 - 130	<20	ug/g	0.52	35
9365692	Sulphide	2024/04/30	86	75 - 125	101	75 - 125	<0.5	mg/kg	24	30
9368179	Moisture-Subcontracted	2024/05/01					<0.30	%	3.2	20
9368559	Redox Potential	2024/05/03			103	95 - 105			0.50	35

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)



BUREAU
VERITAS

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Site Location: ALLISTON, ONTARIO

Sampler Initials: MTI

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere, Senior Scientific Specialist

Veronica Falk, B.Sc., P.Chem., QP, Scientific Specialist, Organics

Suwan (Sze Yeung) Fock, B.Sc., Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.



NONT-2024-04-2573

3110 Road, Mississauga, Ontario L5N 2L8
7-5700 Fax: 905-817-5779 Toll Free: 800-563-6266
31/6

WORK ORDER**CHAIN OF CUSTODY RECORD**

Page 1 of 1

Invoice Information		Report Information (if differs from invoice)		Project Information (where applicable)		Turnaround Time (TAT) Required									
Company Name:	WSP Canada Inc	Company Name:	WSP Canada Inc	Quotation #:		<input checked="" type="checkbox"/> Regular TAT (5-7 days) Most analyses									
Contact Name:	Canada Accounts Payable	Contact Name:	Madison Kennedy	P.O. #/ AFE#:	CA0020332.0247, task 900.910	PLEASE PROVIDE ADVANCE NOTICE FOR RUSH PROJECTS									
Address:	6925 Century Ave. Suite 400 600 Mississauga, ON	Address:	6925 Century Ave. Suite 400 600 Mississauga, ON L5N 7K2	Project #:		Rush TAT (Surcharges will be applied)									
Phone:	905-567-4444 Fax: 905-567-6561	Phone:	289-838-4008 778-28-5156 Fax: 905-567-6561	Site Location:	Alliston, Ontario	<input type="checkbox"/> 1 Day <input type="checkbox"/> 2 Days <input type="checkbox"/> 3-4 Days									
Email:	CAPayablesInvoice@wsp.com	Email:	muhammad.irshad@wsp.com; madison.kennedy@wsp.com	Site #:		Date Required:									
MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY				Sampled By:	MTI + KR	Rush Confirmation #:									
Regulation 153		Other Regulations		Analysis Requested				LABORATORY USE ONLY							
<input checked="" type="checkbox"/> Table 1 <input type="checkbox"/> Res/Park <input type="checkbox"/> Med/ Fine <input type="checkbox"/> Table 2 <input type="checkbox"/> Ind/Lomm <input type="checkbox"/> Loarse <input type="checkbox"/> Table 3 <input type="checkbox"/> Agri/ Other <input type="checkbox"/> Table _____ FOR RSC (PLEASE CIRCLE) Y / N		<input type="checkbox"/> CCME <input type="checkbox"/> Sanitary Sewer Bylaw <input type="checkbox"/> MISA <input type="checkbox"/> Storm Sewer Bylaw <input type="checkbox"/> PWQU Region _____ <input type="checkbox"/> Other (Specify) _____ <input type="checkbox"/> REG 558 (MIN. 3 DAY TAT REQUIRED) <input type="checkbox"/> REG 406 Table _____						CUSTODY SEAL Y / N							
Include Criteria on Certificate of Analysis: Y / N								Present Intact							
SAMPLES MUST BE KEPT COOL (< 10 °C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS								COOLING MEDIA PRESENT: 8 / N							
SAMPLE IDENTIFICATION		DATE SAMPLED (YYYY/MM/DD)	TIME SAMPLED (HH:MM)	MATRIX	# OF CONTAINERS SUBMITTED	FIELD FILTERED (CIRCLE) Metals / Hg / CrVI	BTEX/ PHC F1	PHCs F2 - F4	VOCs	REG 153 METALS & INORGANICS	REG 153 ICPMS METALS	REG 153 METALS (Hg, Cr VI, ICPMS Metals, HWS - B)	Corrosivity Package (+ Sulphide)	HOLD- DO NOT ANALYZE	COMMENTS
1	BH24-01 SA-5	2024-04-09	PM	SOIL	2										2 Jars (250 mL and 120 mL)
2	BH24-01 SA-9	2024-04-10	AM	SOIL	2										2 Jars (250 mL and 120 mL)
3	BH24-01 SA-12	2024-04-10	AM	SOIL	2										2 Jars (250 mL and 120 mL)
4	BH24-02 SA-2+3	2024-04-08	AM	SOIL	2										2 Jars (250 mL and 120 mL)
5	BH24-02 SA-05	2024-04-08	AM	SOIL	2										2 Jars (250 mL and 120 mL)
6	BH24-02 SA-10	2024-04-08	PM	SOIL	2										2 Jars (250 mL and 120 mL)
7	BH24-02 SA-12	2024-04-09	AM	SOIL	2										2 Jars (250 mL and 120 mL)
8	BH24-03 SA-9	2024-04-15	PM	SOIL	2										2 Jars (250 mL and 120 mL)
9	BH24-04 SA-8	2024-04-16	PM	SOIL	2										2 Jars (250 mL and 120 mL)
10															
RELINQUISHED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	RECEIVED BY: (Signature/Print)		DATE: (YYYY/MM/DD)	TIME: (HH:MM)	BV JOB #							
M. Talha Irshad		2024-04-25	7:50 PM	[Signature]		2024/04/25	19:52								



Your Project #: CA0020332.0247.TASK 900.910
Site Location: HWY 39 + ESSA LINE 5
Your C.O.C. #: 1024317-01-01

Attention: Madison Kennedy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2024/12/11
Report #: R8441698
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C4AR794

Received: 2024/12/02, 13:50

Sample Matrix: Water
Samples Received: 4

Analyses	Date		Date Analyzed	Laboratory Method	Analytical Method
	Quantity	Extracted			
Chloride by Automated Colourimetry	4	N/A	2024/12/06	CAM SOP-00463	SM 24 4500-Cl E m
Conductivity	4	N/A	2024/12/07	CAM SOP-00414	SM 24 2510 m
Conductivity	4	N/A	2024/12/06	CAM SOP-00414	SM 24 2510 m
pH (1)	4	2024/12/05	2024/12/07	CAM SOP-00413	SM 24th - 4500H+ B
Redox Potential (2)	4	2024/12/05	2024/12/09	CAM SOP-00421	SM 24 2580 B
Resistivity of Water	4	2024/12/04	2024/12/07	CAM SOP-00414	SM 24 2510 m
Sulphate by Automated Turbidimetry	4	N/A	2024/12/06	CAM SOP-00464	SM 24 4500-SO42- E m
Sulphide	3	N/A	2024/12/05	CAM SOP-00455	SM 24 4500-S G m

Remarks:

Bureau Veritas is accredited to ISO/IEC 17025 for specific parameters on scopes of accreditation. Unless otherwise noted, procedures used by Bureau Veritas are based upon recognized Provincial, Federal or US method compendia such as CCME, EPA, APHA or the Quebec Ministry of Environment.

All work recorded herein has been done in accordance with procedures and practices ordinarily exercised by professionals in Bureau Veritas' profession using accepted testing methodologies, quality assurance and quality control procedures (except where otherwise agreed by the client and Bureau Veritas in writing). All data is in statistical control and has met quality control and method performance criteria unless otherwise noted. All method blanks are reported; unless indicated otherwise, associated sample data are not blank corrected. Where applicable, unless otherwise noted, Measurement Uncertainty has not been accounted for when stating conformity to the referenced standard.

Bureau Veritas liability is limited to the actual cost of the requested analyses, unless otherwise agreed in writing. There is no other warranty expressed or implied. Bureau Veritas has been retained to provide analysis of samples provided by the Client using the testing methodology referenced in this report. Interpretation and use of test results are the sole responsibility of the Client and are not within the scope of services provided by Bureau Veritas, unless otherwise agreed in writing. Bureau Veritas is not responsible for the accuracy or any data impacts, that result from the information provided by the customer or their agent.

Solid sample results, except biota, are based on dry weight unless otherwise indicated. Organic analyses are not recovery corrected except for isotope dilution methods.

Results relate to samples tested. When sampling is not conducted by Bureau Veritas, results relate to the supplied samples tested.

This Certificate shall not be reproduced except in full, without the written approval of the laboratory.

Reference Method suffix "m" indicates test methods incorporate validated modifications from specific reference methods to improve performance.

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) "The CCME method and Analytical Protocol (O. Reg 153/04, O. Reg. 406/19) requires pH to be analyzed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the CCME and Analytical Protocol (O. Reg 153/04, O. Reg. 406/19) holding time. Bureau Veritas endeavors



Your Project #: CA0020332.0247.TASK 900.910
Site Location: HWY 39 + ESSA LINE 5
Your C.O.C. #: 1024317-01-01

Attention: Madison Kennedy

WSP Canada Inc.
6925 Century Ave
Suite 100
Mississauga, ON
CANADA L5N 7K2

Report Date: 2024/12/11
Report #: R8441698
Version: 1 - Final

CERTIFICATE OF ANALYSIS

BUREAU VERITAS JOB #: C4AR794

Received: 2024/12/02, 13:50

to analyze samples as soon as possible after receipt."

(2) Oxidation-Reduction Potential (ORP) values are determined using a Ag/AgCl reference electrode. The test is therefore, not SCC accredited for this matrix.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to:

Ashton Gibson, Project Manager
Email: ashton.gibson@bureauveritas.com
Phone# (905)817-5765

=====

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**BUREAU
VERITAS**

Bureau Veritas Job #: C4AR794

Report Date: 2024/12/11

WSP Canada Inc.

Client Project #: CA0020332.0247.TASK 900.910

Site Location: HWY 39 + ESSA LINE 5

Sampler Initials: AM

RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		AKLQ01		AKLQ02			AKLQ02	
Sampling Date		2024/11/28 14:25		2024/11/28 14:10			2024/11/28 14:10	
COC Number		1024317-01-01		1024317-01-01			1024317-01-01	
	UNITS	BH24-01	RDL	BH24-02	RDL	QC Batch	BH24-02 Lab-Dup	QC Batch
Calculated Parameters								
Resistivity	ohm-cm	130		480		9805804		
CONVENTIONALS								
Redox Potential	mV	370	N/A	420	N/A	9810157	390	9810157
Inorganics								
Conductivity	mS/cm	8.78	0.001	2.16	0.001	9810069		
Conductivity	umho/cm	8000	1.0	2100	1.0	9810127		
pH	pH	7.71		8.00		9810128		
Dissolved Sulphate (SO4)	mg/L	74	1.0	21	1.0	9810193		
Sulphide	mg/L	0.052	0.020	<0.020	0.020	9807965		
Dissolved Chloride (Cl-)	mg/L	2500	20	460	5.0	9810183		
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable								



RESULTS OF ANALYSES OF WATER

Bureau Veritas ID		AKLQ03			AKLQ03			AKLQ04		
Sampling Date		2024/11/28 12:30			2024/11/28 12:30			2024/11/28 12:30		
COC Number		1024317-01-01			1024317-01-01			1024317-01-01		
	UNITS	SA-4 WEST RIVER	RDL	QC Batch	SA-4 WEST RIVER Lab-Dup	RDL	QC Batch	SA-3 EAST RIVER	RDL	QC Batch
Calculated Parameters										
Resistivity	ohm-cm	1500		9805804				1300		9805804
CONVENTIONALS										
Redox Potential	mV	350	N/A	9810157				310	N/A	9810157
Inorganics										
Conductivity	mS/cm	0.673	0.001	9810069	0.674	0.001	9810069	0.783	0.001	9810069
Conductivity	umho/cm	650	1.0	9810127				760	1.0	9810127
pH	pH	8.43		9810128				8.42		9810128
Dissolved Sulphate (SO ₄)	mg/L	27	1.0	9810193	26	1.0	9810193	30	1.0	9810193
Sulphide	mg/L							<0.020	0.020	9807965
Dissolved Chloride (Cl ⁻)	mg/L	42	1.0	9810183	42	1.0	9810183	63	1.0	9810183
RDL = Reportable Detection Limit QC Batch = Quality Control Batch Lab-Dup = Laboratory Initiated Duplicate N/A = Not Applicable										



BUREAU
VERITAS

Bureau Veritas Job #: C4AR794

Report Date: 2024/12/11

WSP Canada Inc.

Client Project #: CA0020332.0247.TASK 900.910

Site Location: HWY 39 + ESSA LINE 5

Sampler Initials: AM

TEST SUMMARY

Bureau Veritas ID: AKLQ01
Sample ID: BH24-01
Matrix: Water

Collected: 2024/11/28
Shipped:
Received: 2024/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	SKAL	9810183	N/A	2024/12/06	Massarat Jan
Conductivity	AT	9810127	N/A	2024/12/07	Nachiketa Gohil
Conductivity	AT	9810069	N/A	2024/12/06	Nachiketa Gohil
pH	AT	9810128	2024/12/05	2024/12/07	Nachiketa Gohil
Redox Potential	COND	9810157	2024/12/05	2024/12/09	Gurparteek KAUR
Resistivity of Water		9805804	2024/12/07	2024/12/07	Automated Statchk
Sulphate by Automated Turbidimetry	SKAL	9810193	N/A	2024/12/06	Massarat Jan
Sulphide	ISE/S	9807965	N/A	2024/12/05	Sreena Thekkoot

Bureau Veritas ID: AKLQ02
Sample ID: BH24-02
Matrix: Water

Collected: 2024/11/28
Shipped:
Received: 2024/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	SKAL	9810183	N/A	2024/12/06	Massarat Jan
Conductivity	AT	9810127	N/A	2024/12/07	Nachiketa Gohil
Conductivity	AT	9810069	N/A	2024/12/06	Nachiketa Gohil
pH	AT	9810128	2024/12/05	2024/12/07	Nachiketa Gohil
Redox Potential	COND	9810157	2024/12/05	2024/12/09	Gurparteek KAUR
Resistivity of Water		9805804	2024/12/07	2024/12/07	Automated Statchk
Sulphate by Automated Turbidimetry	SKAL	9810193	N/A	2024/12/06	Massarat Jan
Sulphide	ISE/S	9807965	N/A	2024/12/05	Sreena Thekkoot

Bureau Veritas ID: AKLQ02 Dup
Sample ID: BH24-02
Matrix: Water

Collected: 2024/11/28
Shipped:
Received: 2024/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Redox Potential	COND	9810157	2024/12/05	2024/12/09	Gurparteek KAUR

Bureau Veritas ID: AKLQ03
Sample ID: SA-4 WEST RIVER
Matrix: Water

Collected: 2024/11/28
Shipped:
Received: 2024/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	SKAL	9810183	N/A	2024/12/06	Massarat Jan
Conductivity	AT	9810127	N/A	2024/12/07	Nachiketa Gohil
Conductivity	AT	9810069	N/A	2024/12/06	Nachiketa Gohil
pH	AT	9810128	2024/12/05	2024/12/07	Nachiketa Gohil
Redox Potential	COND	9810157	2024/12/05	2024/12/09	Gurparteek KAUR
Resistivity of Water		9805804	2024/12/07	2024/12/07	Automated Statchk
Sulphate by Automated Turbidimetry	SKAL	9810193	N/A	2024/12/06	Massarat Jan



TEST SUMMARY

Bureau Veritas ID: AKLQ03 Dup
Sample ID: SA-4 WEST RIVER
Matrix: Water

Collected: 2024/11/28
Shipped:
Received: 2024/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	SKAL	9810183	N/A	2024/12/06	Massarat Jan
Conductivity	AT	9810069	N/A	2024/12/06	Nachiketa Gohil
Sulphate by Automated Turbidimetry	SKAL	9810193	N/A	2024/12/06	Massarat Jan

Bureau Veritas ID: AKLQ04
Sample ID: SA-3 EAST RIVER
Matrix: Water

Collected: 2024/11/28
Shipped:
Received: 2024/12/02

Test Description	Instrumentation	Batch	Extracted	Date Analyzed	Analyst
Chloride by Automated Colourimetry	SKAL	9810183	N/A	2024/12/06	Massarat Jan
Conductivity	AT	9810127	N/A	2024/12/07	Nachiketa Gohil
Conductivity	AT	9810069	N/A	2024/12/06	Nachiketa Gohil
pH	AT	9810128	2024/12/05	2024/12/07	Nachiketa Gohil
Redox Potential	COND	9810157	2024/12/05	2024/12/09	Gurparteek KAUR
Resistivity of Water		9805804	2024/12/07	2024/12/07	Automated Statchk
Sulphate by Automated Turbidimetry	SKAL	9810193	N/A	2024/12/06	Massarat Jan
Sulphide	ISE/S	9807965	N/A	2024/12/05	Sreena Thekkoot



GENERAL COMMENTS

Each temperature is the average of up to three cooler temperatures taken at receipt

Package 1	2.3°C
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Results relate only to the items tested.



BUREAU
VERITAS

Bureau Veritas Job #: C4AR794

Report Date: 2024/12/11

QUALITY ASSURANCE REPORT

WSP Canada Inc.

Client Project #: CA0020332.0247.TASK 900.910

Site Location: HWY 39 + ESSA LINE 5

Sampler Initials: AM

QC Batch	Parameter	Date	Matrix Spike		SPIKED BLANK		Method Blank		RPD	
			% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
9807965	Sulphide	2024/12/05	105	80 - 120	98	80 - 120	<0.020	mg/L	NC	20
9810069	Conductivity	2024/12/06			102	85 - 115	<0.001	mS/cm	0.15	10
9810127	Conductivity	2024/12/07			101	85 - 115	<1.0	umho/cm	4.0	10
9810128	pH	2024/12/07			102	98 - 103			0.46	N/A
9810157	Redox Potential	2024/12/09			101	80 - 120			6.4	20
9810183	Dissolved Chloride (Cl-)	2024/12/06	NC	80 - 120	93	80 - 120	<1.0	mg/L	0.55	20
9810193	Dissolved Sulphate (SO4)	2024/12/06	NC	75 - 125	94	80 - 120	<1.0	mg/L	2.8	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spike amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than the native sample concentration)

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (absolute difference <= 2x RDL).



BUREAU
VERITAS

Bureau Veritas Job #: C4AR794

Report Date: 2024/12/11

WSP Canada Inc.

Client Project #: CA0020332.0247.TASK 900.910

Site Location: HWY 39 + ESSA LINE 5

Sampler Initials: AM

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by:

Cristina Carriere, Senior Scientific Specialist

Bureau Veritas has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per ISO/IEC 17025, signing the reports. For Service Group specific validation, please refer to the Validation Signatures page if included, otherwise available by request. For Department specific Analyst/Supervisor validation names, please refer to the Test Summary section if included, otherwise available by request. This report is authorized by Rodney Major, General Manager responsible for Ontario Environmental laboratory operations.

C4AR794
2024/12/02 13:50

Bureau Veritas
6740 Campobello Road, Mississauga, Ontario Canada L5N 2L8 Tel: (905) 817-5700 Toll-free: 800-563-6266 Fax: (905) 817-5777 www.bvna.com



NONT-2024-12-132

Page of

INVOICE TO:		REPORT TO: <i>Same as invoice</i>		PROJECT INFORMATION:	
Company Name: #1326 WSP Canada Inc.		Company Name: <i>MSJ</i>		Quotation #: C41059	
Attention: Accounts Payable		Attention: Madison Kennedy		P.O. #:	
Address: 6925 Century Ave Suite 400 <i>600</i>		Address:		Project: <i>C41059 20332.0247, task 20.910.</i>	
Mississauga ON L5N 7K2				Project Name: <i>Highway 8 & Cassia line 5</i>	
Tel: (905) 567-4444 Fax: (905) 567-6561		Tel:		Site #:	
Email: CAPayablesInvoice@wsp.com		Email: madison.kennedy@wsp.com		Sampled By:	
				Bottle Order #: 1024317	
				COC #: <i>1024317</i>	
				Project Manager: Ashton Gibson	

MOE REGULATED DRINKING WATER OR WATER INTENDED FOR HUMAN CONSUMPTION MUST BE SUBMITTED ON THE BUREAU VERITAS DRINKING WATER CHAIN OF CUSTODY

Regulation 153 (2011)			Other Regulations			Special Instructions		
<input type="checkbox"/> Table 1	<input type="checkbox"/> Res/Park	<input type="checkbox"/> Medium/Fine	<input type="checkbox"/> CCME	<input type="checkbox"/> Sanitary Sewer Bylaw				
<input type="checkbox"/> Table 2	<input type="checkbox"/> Ind/Comm	<input type="checkbox"/> Coarse	<input type="checkbox"/> Reg 558	<input type="checkbox"/> Storm Sewer Bylaw				
<input type="checkbox"/> Table 3	<input type="checkbox"/> Agri/Other	<input type="checkbox"/> For RSC	<input type="checkbox"/> MISA	Municipality				
<input type="checkbox"/> Table			<input type="checkbox"/> PWQO	Reg 406 Table				
<input type="checkbox"/> Other								
Include Criteria on Certificate of Analysis (Y/N)?								
Sample Barcode Label	Sample (Location) Identification	Date Sampled	Time Sampled	Matrix	Field Filtered (please circle): Metals / Hg / Cr VI	Chloride by Automated Colourimetry	Conductivity	pH
1	BH24-01	2024/11/28	14:25	Water		X	X	X
2	BH24-02	2024/11/28	14:10	Water		X	X	X
3	SA-4 West River	2024/11/28	12:30	water		X	X	X
4	SA-3 East River	2024/11/28	12:30	water		X	X	X
5								
6								
7								
8								
9								
10								

* RELINQUISHED BY: (Signature/Print) <i>Amr M... 12/2/24</i>		Date: (YY/MM/DD) <i>2024/12/02</i>	Time <i>13:50</i>	RECEIVED BY: (Signature/Print) <i>Amr M...</i>		Date: (YY/MM/DD) <i>2024/12/02</i>	Time <i>13:50</i>	# jars used and not submitted	Laboratory Use Only				
									Time Sensitive	Temperature (°C) on Receipt <i>13.12</i>	Custody Seal Present	Yes	No

* UNLESS OTHERWISE AGREED TO IN WRITING, WORK SUBMITTED ON THIS CHAIN OF CUSTODY IS SUBJECT TO BUREAU VERITAS'S STANDARD TERMS AND CONDITIONS. SIGNING OF THIS CHAIN OF CUSTODY DOCUMENT IS ACKNOWLEDGMENT AND ACCEPTANCE OF OUR TERMS WHICH ARE AVAILABLE FOR VIEWING AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/COG-TERMS-AND-CONDITIONS.

* IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORD. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

** SAMPLE CONTAINER, PRESERVATION, HOLD TIME AND PACKAGE INFORMATION CAN BE VIEWED AT WWW.BVNA.COM/ENVIRONMENTAL-LABORATORIES/RESOURCES/CHAIN-CUSTODY-FORMS-COCS.

White: Bureau Veritas Yellow: Client

SAMPLES MUST BE KEPT COOL (< 10° C) FROM TIME OF SAMPLING UNTIL DELIVERY TO BUREAU VERITAS

Bureau Veritas Canada (2019) Inc.

APPENDIX D

**Magnetometer Survey Results -
Technical Memorandum**



TECHNICAL MEMORANDUM

DATE October 31, 2024

Project No. CA0020332.0247

TO Madison Kennedy (WSP)

CC Ben Hui (WSP); John Handley (WSP); Kevin Bentley (WSP)

FROM Jon Crawford, Christopher Phillips

EMAIL jonathan.crawford@wsp.com;
christopher.phillips@wsp.com

MAGNETOMETER SURVEY RESULTS – HIGHWAY 89 & ESSA ROAD 5 – MTO (2022-E-0046)

This memorandum presents the results of the Magnetometer tests carried out at the abutments of the Highway 89 bridge over the Nottawasaga River, Ontario (Site No. 30X-0250/B0) originally constructed under MTO Contract 60-171¹. Two separate boreholes were surveyed with the magnetometer borehole logging tool. The boreholes that were surveyed were boreholes 24-01B and 24-02B, which were advanced at the east and west abutments, respectively.

Methodology

Magnetometer survey measures localized anomalies of the normal field (Earth's magnetic field) caused by the induced magnetic field of ferromagnetic material. The induced magnetic field can either increase or decrease the local magnetic field depending on its direction with respect to the normal field. To determine the magnetic field of interest the normal field is subtracted from the total magnetic field which produces data that can be interpreted. The magnitude of induced magnetic field depends on the size of the ferromagnetic material in the pile. The magnitude of the field decays rapidly with increasing distance from the pile.

Figure 1 shows a typical borehole magnetometer survey on site, where a magnetometer is used to detect the magnetic field induced by the steel reinforcement in the concrete pile as it traverses along the borehole and recorded in the recording device. A Fluxgate magnetometer that measures the magnetic field is commonly used. The characteristic of having the peak magnetic value near the ends of the pile makes it possible to interpret the pile toe.

¹ Department of Highways, Ontario. 1960. Grading, culverts, granular base, hot mix and structure; Highway 89, District No. 5 Owen Sound; Nottawasaga River Structure; Township of Essa and Tecumseth, County of Simcoe [1960 Contract Drawings]. MTO Contract No. 60-171; W.P. 218-59.

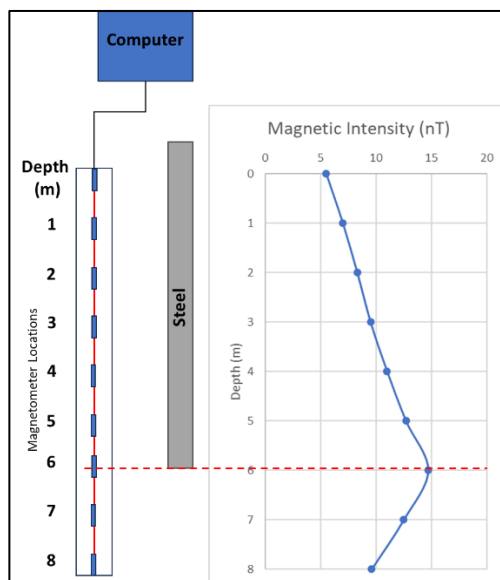


Figure 1: Illustration of the Magnetometer Method

Field Work

The field work was carried out in September 2024, by personnel from the WSP Mississauga office. For each borehole tested the magnetic field was measured using the FGM3D – Compact SENSYS Fluxgate Magnetometer.

The magnetometer was lowered into each borehole from the drill platform and measurements were taken at 0.5 m intervals for the length of each borehole. The data was collected in real time by a field computer and data could be quality controlled on site.

Data Processing

The data is imported to excel and examined for any errors or anomalous values. The results are plotted as depth vs. Magnetic field and compared to the borehole logs and the original drawing of the bridge supports to help interpret the depth of the H-piles of the bridge supports.

Results

The Magnetometer results for the two boreholes are summarized in Figures 2 to 3. The elevation of the top of each borehole were measured to be: 210.67 m (CGVD28) for BH-24-01B and 209.98 m (CGVD28) for BH-24-02B.

Interpreted depths are seen in Table 1 below.

Table 1: Interpreted Pile Depths

Borehole	Borehole Elevation (m – CGVD28)	Interpreted Bottom of Pile
BH-24-01B	210.67	16.4m depth 194.3 m CGVD28
BH-24-02B	209.98	13.3m depth 196.7 m CGVD28

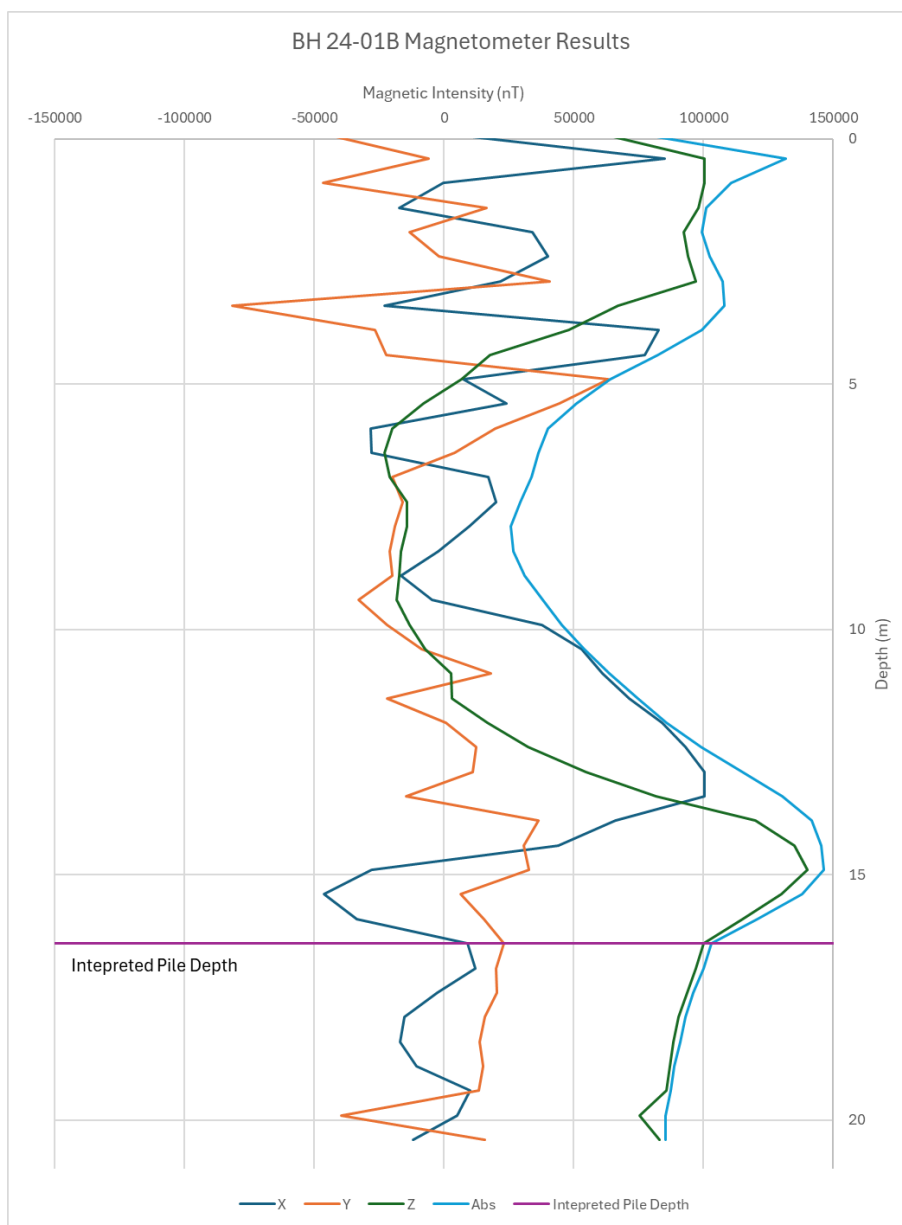


Figure 2: Magnetometer Results of BH 24-01B (East Abutment)

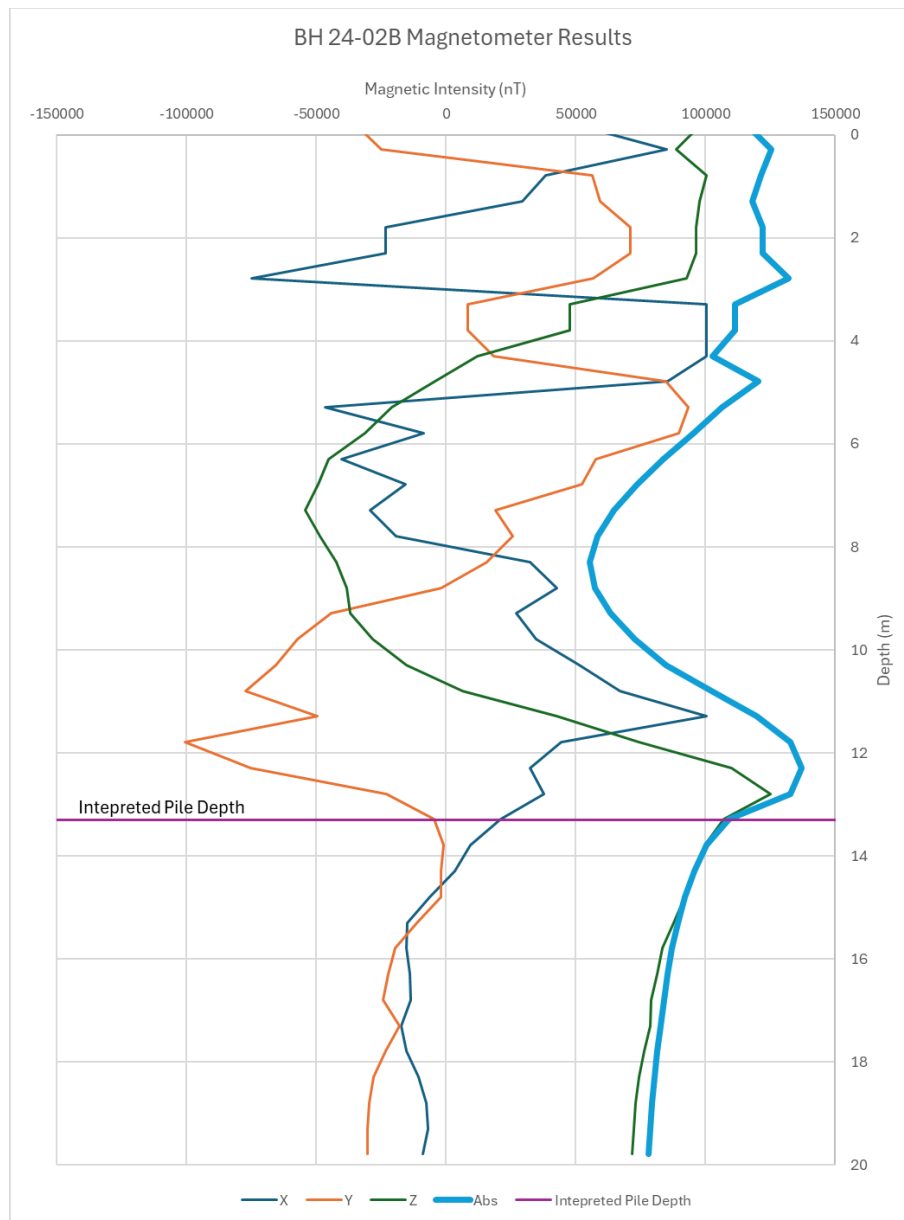


Figure 3: Magnetometer Results of BH 24-02B (West Abutment)

Closure

We trust that this technical memorandum meets your needs at the present time. If you have any questions or require clarification, please contact the undersigned at your convenience.

WSP Canada Inc.



Jon Crawford, MSc
Geophysicist IV

JC/CRP/al



Christopher Phillips, MSc, PGeo
Geophysicist VII, Senior Principal

CASING INSTALATION RECORD BH24-01b

PROJECT No. CA0020332.0247 **NAME** HIGHWAY 89, NOTTAWASAGA RIVER BRIDGE **DATE** Aug 27-28, 2024
LOCATION N: 4891929.25; E: 280163.7 NAD83 / MTM Zone 10 (LAT. 44.166945; LONG. -79.808057) **ELEVATION** 210.7 m
BOREHOLE TYPE 165 mm O.D. Hollow Stem Augers and 102 mm O.D. Mudrotary with H Casing **DATUM** Geodetic

SAMPLE				SOIL DESCRIPTION	REMARKS
No.	Depth (m)		SPT 'N'-Value		
	From	To			
-	0	0.3	-	CONCRETE (330 mm)	
1	2.3	2.9	36	SILTY SAND (SM) trace gravel Dense Moist Brown	
2	3.1	3.7	28	SILTY SAND (SM) , some clay, trace gravel Compact Moist to wet Brown	
3	4.6	5.2	13	Sandy SILT of slight plasticity (ML), some clay, trace gravel, trace organics Compact Moist to wet Grey with black mottling	
4	6.1	6.3	100/0.08 m	Wood pieces, trace gravel	
5	9.1	9.6	122	CLAYEY SILT-SILT (CL-ML), trace gravel, trace organics, containing sandy SILT pockets Hard Moist to wet Grey	
6	12.2	12.5	100/0.10 m	CLAYEY SILT-SILT (CL-ML), trace sand Hard Moist Grey	
7	15.2	15.7	100/0.11 m	CLAYEY SILT-SILT (CL-ML), trace gravel Hard Moist Grey	
8	18.3	18.4	54/0.14 m	CLAYEY SILT-SILT (CL-ML), trace gravel Hard Moist to wet Grey	
9	19.8	19.9	52/0.13 m	CLAYEY SILT-SILT (CL-ML) Hard Moist Grey	
END OF BOREHOLE					
NOTES:				Water condition in Hole:	
1. SPT 'N'-Values obtained using a manual hammer. 2. 50 mm PVC pile installed in borehole to allow for geophysical testing.				Water level not measured due to the addition of drilling fluid.	

Project No.: CA0020332.0247
 Borehole No.: BH24-01b

Originated By MI
 Compiled By MTI
 Checked By MCK

CASING INSTALATION RECORD BH24-02b

PROJECT No. CA0020332.0247 NAME HIGHWAY 89, NOTTAWASAGA RIVER BRIDGE DATE Aug 20-22, 2024
LOCATION N: 4891909.96; E: 280099.25 NAD83 / MTM Zone 10 (LAT. 44.166769; LONG. -79.808862) ELEVATION 210.0 m
BOREHOLE TYPE 165 mm O.D. Hollow Stem Augers and 102 mm O.D. Mudrotary with H Casing DATUM Geodetic

SAMPLE				SOIL DESCRIPTION	REMARKS
No.	Depth (m)		SPT 'N'- Value		
	From	To			
-	0	0.3	-	CONCRETE (305 mm)	
1	3.1	3.7	11	Sandy SILT (ML), trace clay, trace gravel Compact Moist to wet Brown	
2	6.1	6.7	5	ORGANIC SILT (OL), trace clay, trace gravel Loose Moist Grey to black	
3	7.6	8.1	87	SILTY SAND, trace organics Very Dense Moist Brown with oxidation staining	
4	9.1	9.6	46	SILTY SAND (SM), trace gravel, containing wood fragments Dense Wet Brown	
5	12.2	12.7	59	SILTY SAND (SM), trace gravel Very Dense Wet Brown	
6	15.2	15.4	55/0.13 m	CLAYEY SILT-SILT (CL-ML), trace gravel Hard Wet Grey	
7	18.3	18.4	53/0.13 m	CLAYEY SILT-SILT (CL-ML), trace gravel Hard Moist to wet Grey	
8	19.8	19.9	55/0.13 m	CLAYEY SILT-SILT (CL-ML) Hard Moist to wet Grey	
END OF BOREHOLE					
NOTES:				Water condition in Hole:	
1. SPT 'N'-Values obtained using a manual hammer. 2. 50 mm PVC pile installed in borehole to allow for geophysical testing.				Water level not measured due to the addition of drilling fluid.	

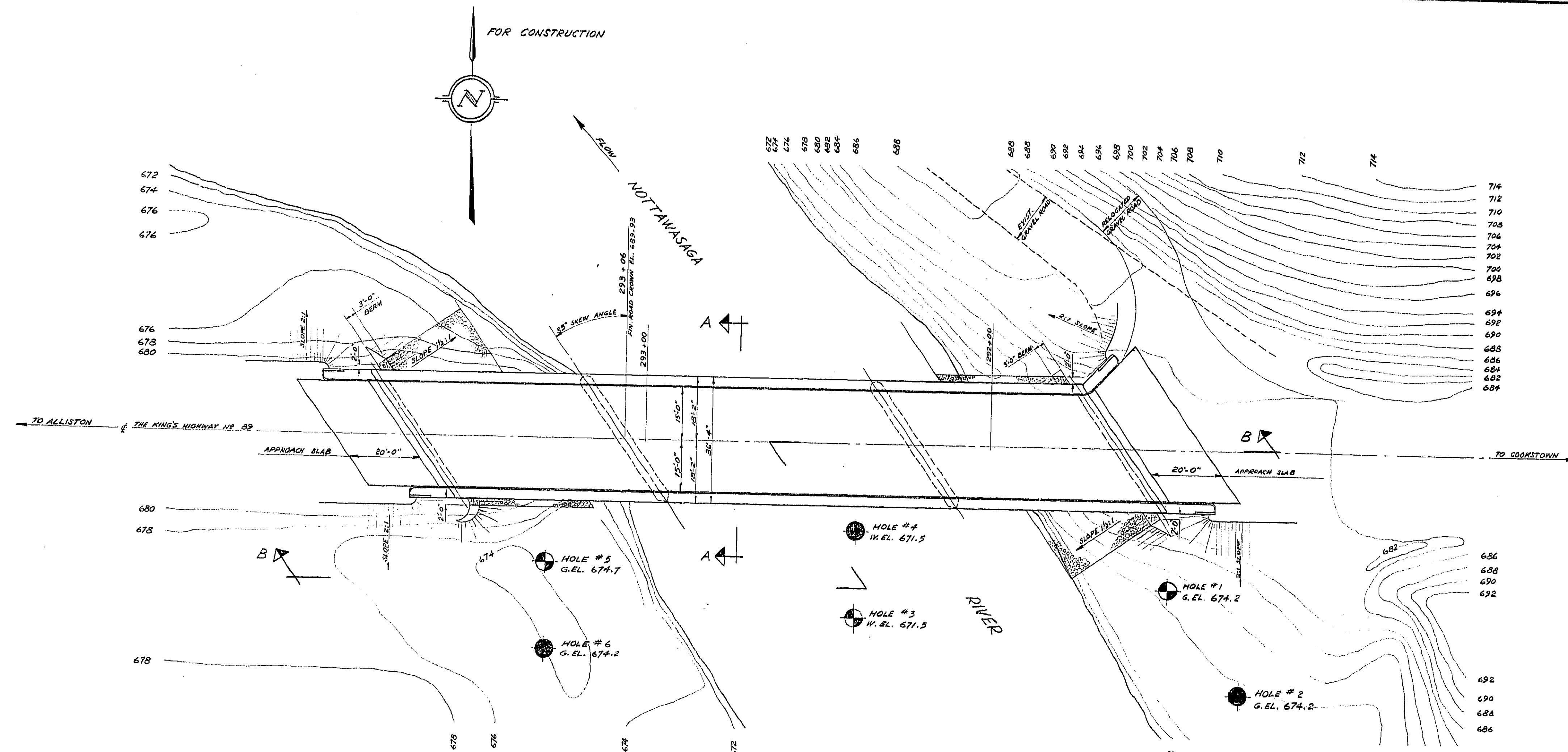
Project No.: CA0020332.0247
Borehole No.: BH24-02b

Originated By MI
Compiled By MTI
Checked By MCK

APPENDIX E

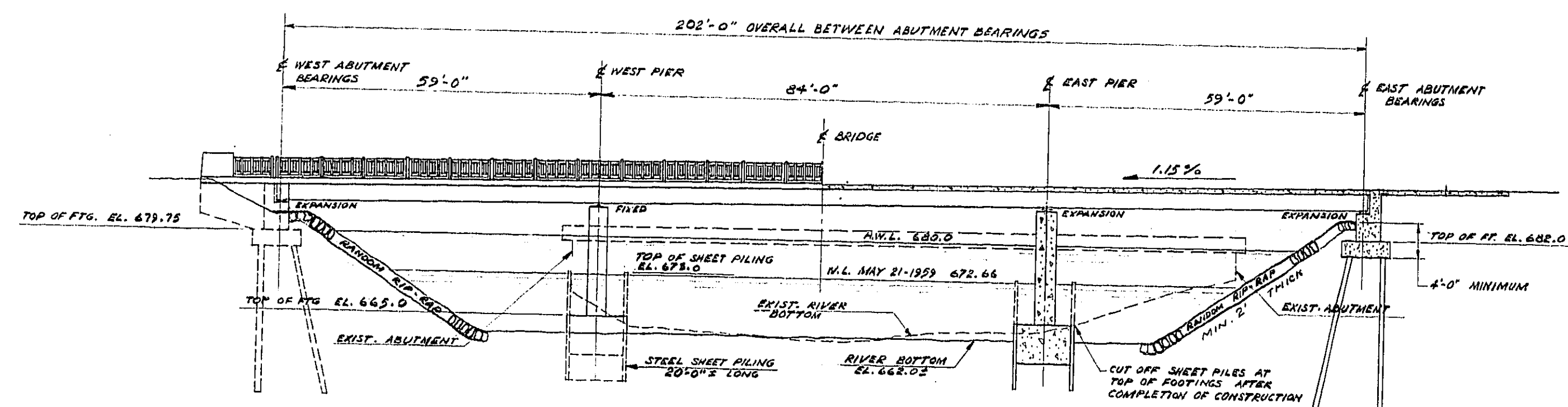
Historic Contract Drawings

1960 As-Constructed Contract Drawings

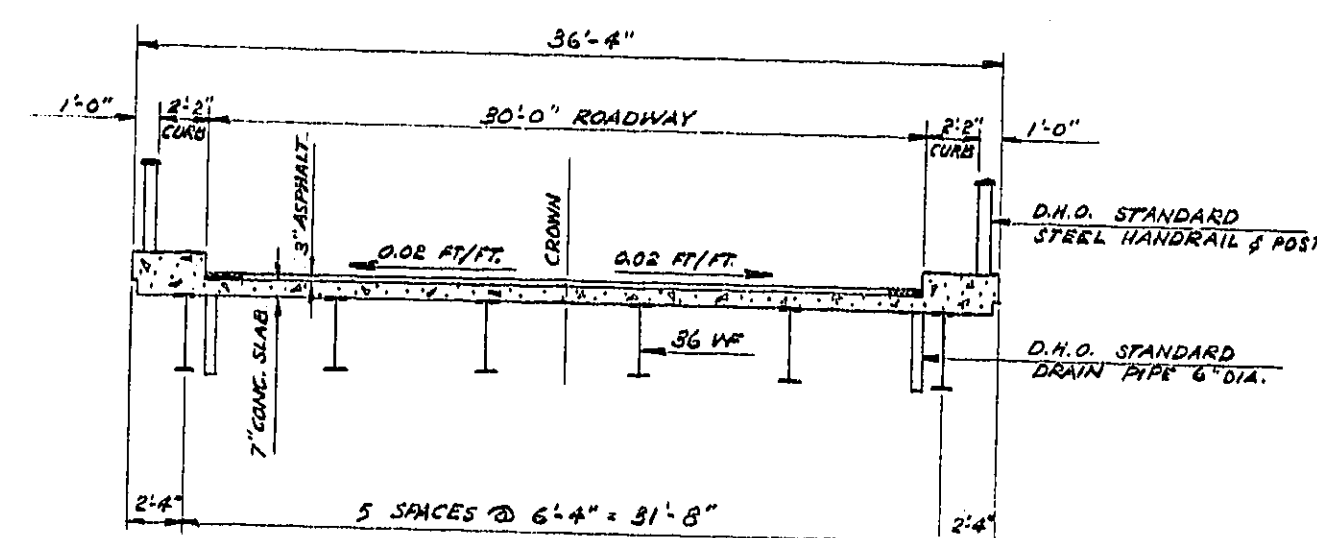


PLAN
SCALE - 1" = 20'

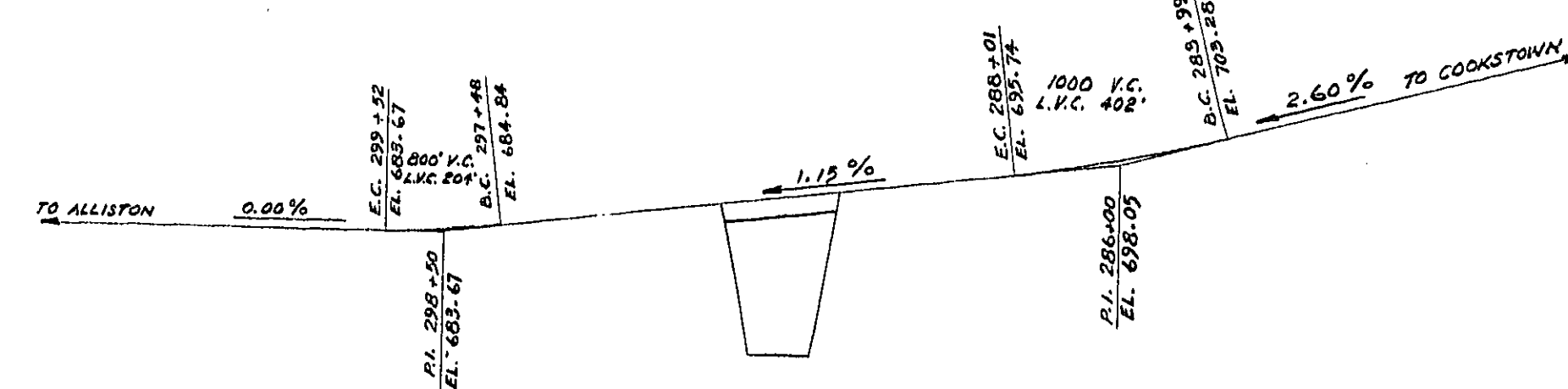
- LEGEND
- BORE & PENETRATION HOLE
 - BORE HOLE



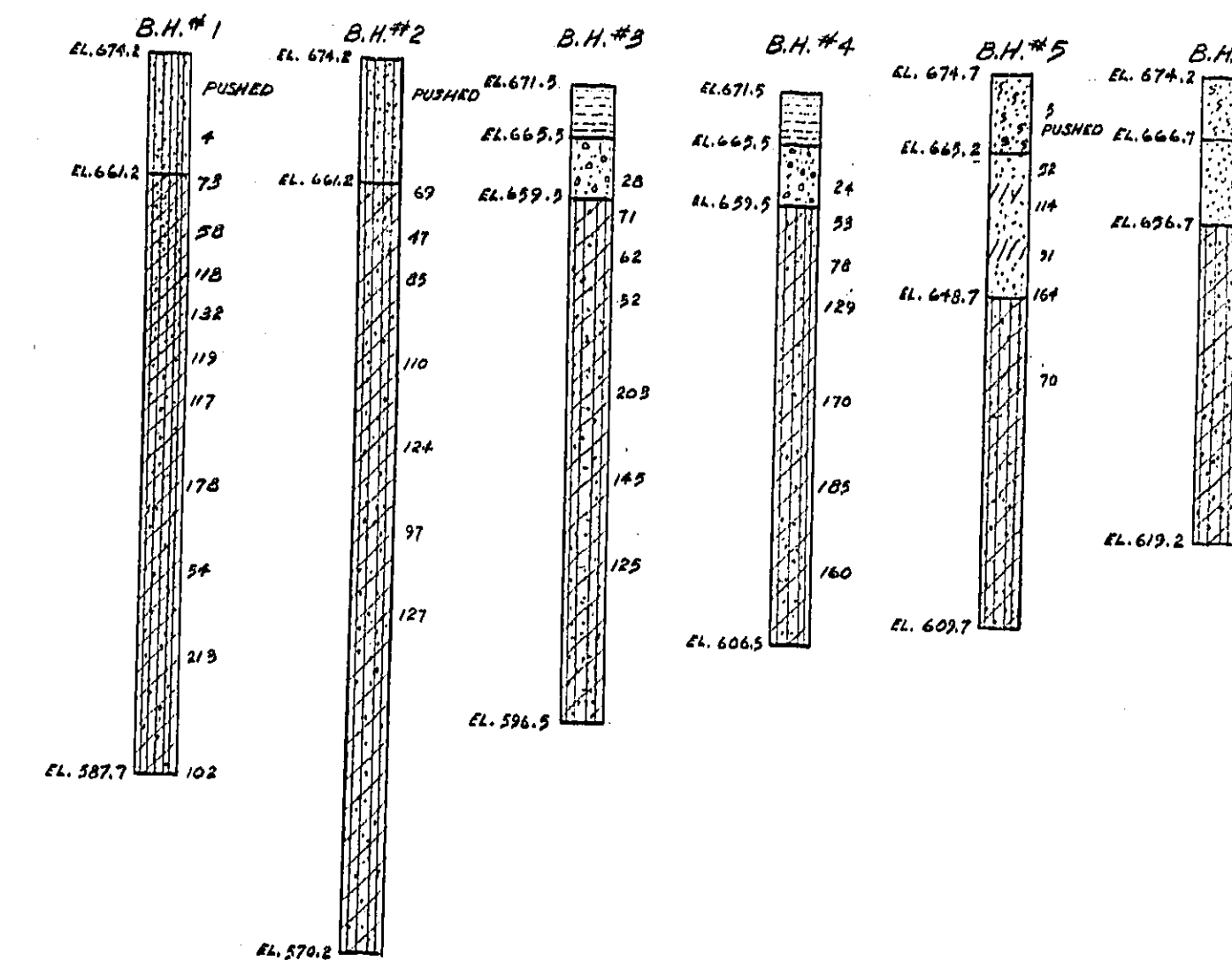
SECTIONAL ELEVATION "B-B"
SCALE - HOR: 1" = 20'
VER: 1" = 20'



SECTION A-A
SCALE - 3/8" = 1'-0"



PROFILE OF CROWN OF FINISHED PAVEMENT
(NOT TO SCALE)

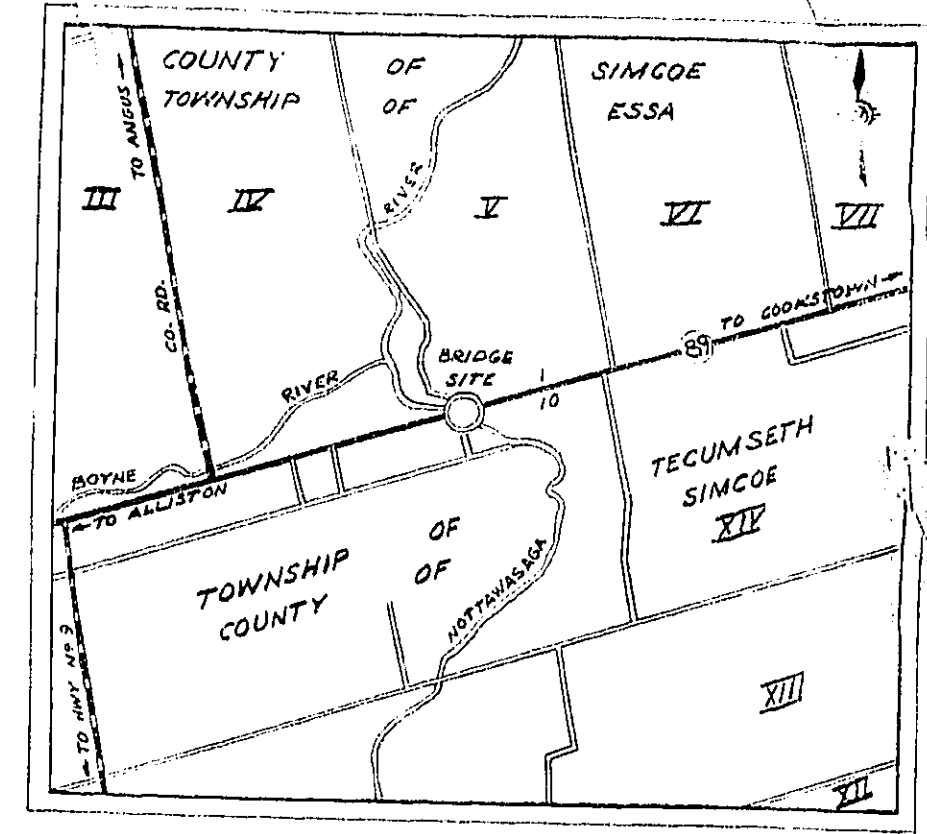


BOREHOLE DATA

NOTE: COMPLETE SOIL INVESTIGATION REPORT NO. BA 974 MAY BE EXAMINED AT THE BRIDGE OFFICE, TORONTO. THE DEPARTMENT DOES NOT GUARANTEE THE ACCURACY OF THE REPORT OR THE ABBRIDGED VERSION SHOWN ON THESE DRAWINGS.

- LOOSE FINE SILTY SAND WITH ORGANIC MATTER
- VERY COARSE GRAY SILT (GLACIAL TILL)
- WATER
- MED. COARSE SAND & FINE GRAVEL
- LOOSE CLAY SAND WITH ORGANIC MATTER
- DENSE SAND & GRAVEL WITH LARGES OF CLAY
- DENSE SAND & GRAVEL

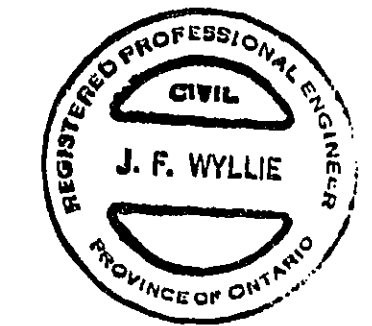
NOTE: FIGURES ON RIGHT HAND SIDE OF BORE HOLES INDICATE STANDARD PENETRATION RESISTANCE IN BLOWS/FT.



KEY PLAN
SCALE - 1" = 0.5 MI.

- NOTES:
1. DISTRICT ENGINEER
 2. STRUCTURAL STEEL CONTRACTOR
 3. GENERAL CONTRACTOR
 4. SPECIAL CONTRACTOR
 5. GENERAL NOTES

NO.	DATE	BY	REVISION
1	1960-10-10	J.F.W.	DESIGN
2	1960-10-10	J.F.W.	CONTRACT
3	1960-10-10	J.F.W.	LOADING
4	1960-10-10	J.F.W.	BRIDGE
5	1960-10-10	J.F.W.	PAVEMENT
6	1960-10-10	J.F.W.	STRUCTURAL
7	1960-10-10	J.F.W.	GENERAL
8	1960-10-10	J.F.W.	SECTIONAL
9	1960-10-10	J.F.W.	PROFILE
10	1960-10-10	J.F.W.	BOREHOLE
11	1960-10-10	J.F.W.	KEY PLAN
12	1960-10-10	J.F.W.	PLAN
13	1960-10-10	J.F.W.	SECTIONAL
14	1960-10-10	J.F.W.	PROFILE
15	1960-10-10	J.F.W.	BOREHOLE
16	1960-10-10	J.F.W.	KEY PLAN
17	1960-10-10	J.F.W.	PLAN
18	1960-10-10	J.F.W.	SECTIONAL
19	1960-10-10	J.F.W.	PROFILE
20	1960-10-10	J.F.W.	BOREHOLE
21	1960-10-10	J.F.W.	KEY PLAN
22	1960-10-10	J.F.W.	PLAN
23	1960-10-10	J.F.W.	SECTIONAL
24	1960-10-10	J.F.W.	PROFILE
25	1960-10-10	J.F.W.	BOREHOLE
26	1960-10-10	J.F.W.	KEY PLAN
27	1960-10-10	J.F.W.	PLAN
28	1960-10-10	J.F.W.	SECTIONAL
29	1960-10-10	J.F.W.	PROFILE
30	1960-10-10	J.F.W.	BOREHOLE
31	1960-10-10	J.F.W.	KEY PLAN
32	1960-10-10	J.F.W.	PLAN
33	1960-10-10	J.F.W.	SECTIONAL
34	1960-10-10	J.F.W.	PROFILE
35	1960-10-10	J.F.W.	BOREHOLE
36	1960-10-10	J.F.W.	KEY PLAN
37	1960-10-10	J.F.W.	PLAN
38	1960-10-10	J.F.W.	SECTIONAL
39	1960-10-10	J.F.W.	PROFILE
40	1960-10-10	J.F.W.	BOREHOLE
41	1960-10-10	J.F.W.	KEY PLAN
42	1960-10-10	J.F.W.	PLAN
43	1960-10-10	J.F.W.	SECTIONAL
44	1960-10-10	J.F.W.	PROFILE
45	1960-10-10	J.F.W.	BOREHOLE
46	1960-10-10	J.F.W.	KEY PLAN
47	1960-10-10	J.F.W.	PLAN
48	1960-10-10	J.F.W.	SECTIONAL
49	1960-10-10	J.F.W.	PROFILE
50	1960-10-10	J.F.W.	BOREHOLE
51	1960-10-10	J.F.W.	KEY PLAN
52	1960-10-10	J.F.W.	PLAN
53	1960-10-10	J.F.W.	SECTIONAL
54	1960-10-10	J.F.W.	PROFILE
55	1960-10-10	J.F.W.	BOREHOLE
56	1960-10-10	J.F.W.	KEY PLAN
57	1960-10-10	J.F.W.	PLAN
58	1960-10-10	J.F.W.	SECTIONAL
59	1960-10-10	J.F.W.	PROFILE
60	1960-10-10	J.F.W.	BOREHOLE
61	1960-10-10	J.F.W.	KEY PLAN
62	1960-10-10	J.F.W.	PLAN
63	1960-10-10	J.F.W.	SECTIONAL
64	1960-10-10	J.F.W.	PROFILE
65	1960-10-10	J.F.W.	BOREHOLE
66	1960-10-10	J.F.W.	KEY PLAN
67	1960-10-10	J.F.W.	PLAN
68	1960-10-10	J.F.W.	SECTIONAL
69	1960-10-10	J.F.W.	PROFILE
70	1960-10-10	J.F.W.	BOREHOLE
71	1960-10-10	J.F.W.	KEY PLAN
72	1960-10-10	J.F.W.	PLAN
73	1960-10-10	J.F.W.	SECTIONAL
74	1960-10-10	J.F.W.	PROFILE
75	1960-10-10	J.F.W.	BOREHOLE
76	1960-10-10	J.F.W.	KEY PLAN
77	1960-10-10	J.F.W.	PLAN
78	1960-10-10	J.F.W.	SECTIONAL
79	1960-10-10	J.F.W.	PROFILE
80	1960-10-10	J.F.W.	BOREHOLE
81	1960-10-10	J.F.W.	KEY PLAN
82	1960-10-10	J.F.W.	PLAN
83	1960-10-10	J.F.W.	SECTIONAL
84	1960-10-10	J.F.W.	PROFILE
85	1960-10-10	J.F.W.	BOREHOLE
86	1960-10-10	J.F.W.	KEY PLAN
87	1960-10-10	J.F.W.	PLAN
88	1960-10-10	J.F.W.	SECTIONAL
89	1960-10-10	J.F.W.	PROFILE
90	1960-10-10	J.F.W.	BOREHOLE
91	1960-10-10	J.F.W.	KEY PLAN
92	1960-10-10	J.F.W.	PLAN
93	1960-10-10	J.F.W.	SECTIONAL
94	1960-10-10	J.F.W.	PROFILE
95	1960-10-10	J.F.W.	BOREHOLE
96	1960-10-10	J.F.W.	KEY PLAN
97	1960-10-10	J.F.W.	PLAN
98	1960-10-10	J.F.W.	SECTIONAL
99	1960-10-10	J.F.W.	PROFILE
100	1960-10-10	J.F.W.	BOREHOLE



W.P. 218-59

LAUGHLIN, WYLLIE & UNFAL
CONSULTING ENGINEERS
TORONTO

DEPARTMENT OF HIGHWAYS-ONTARIO
BRIDGE OFFICE-TORONTO

NOTTAWASAGA RIVER BRIDGE

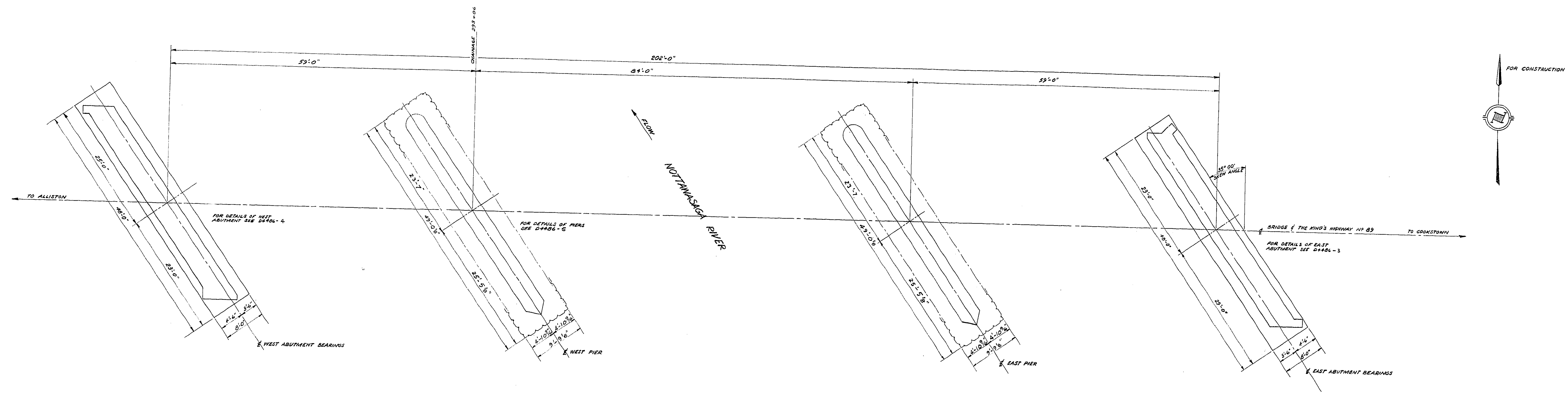
THE KING'S HIGHWAY No. 89
CO. SIMCOE
TWP. ESSA-TECUMSETH LOT 1-10 CON. 1-10

67652 GENERAL LAYOUT

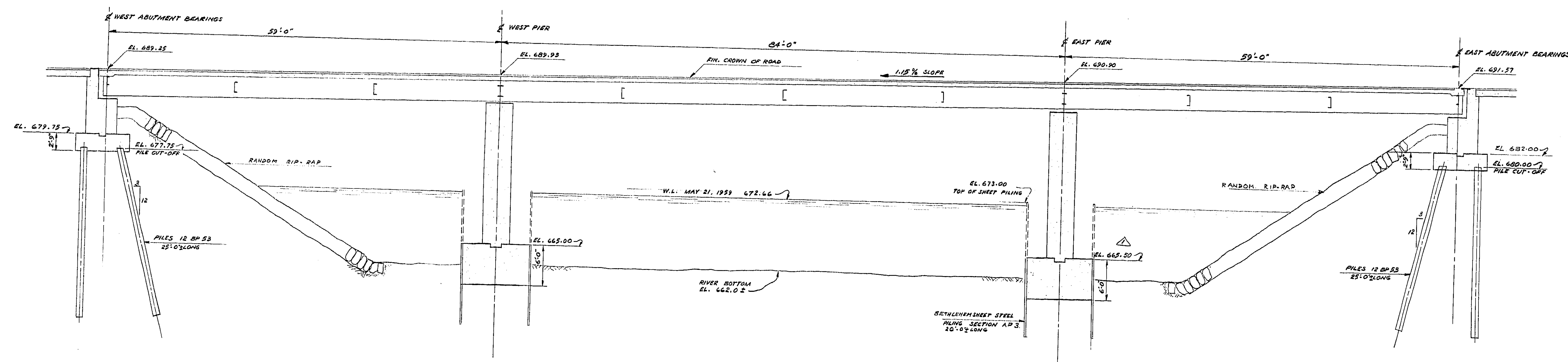
APPROVED
DESIGN ENGINEER
DESIGN
CHECK
CONTRACT
LOADING
BRIDGE
DRAWING

DATE APRIL 1960

W.P. # 765-250-1-A



FOUNDATION PLAN
SCALE: 8" = 1'-0"



SECTION ON 2
SCALE: 8" = 1'-0"

NO.	FOR	DATE
1	DESIGNED	11/9/60
2	CHECKED	11/9/60
3	APPROVED	11/9/60
4	REVISION	
5	REVISION	
6	REVISION	
7	REVISION	
8	REVISION	
9	REVISION	
10	REVISION	



REVISIONS	DATE	BY	DESCRIPTION
1	11/9/60	J.F.W.	DESIGNED
2	11/9/60	J.F.W.	CHECKED
3	11/9/60	J.F.W.	APPROVED
4	11/9/60	J.F.W.	REVISION
5	11/9/60	J.F.W.	REVISION
6	11/9/60	J.F.W.	REVISION
7	11/9/60	J.F.W.	REVISION
8	11/9/60	J.F.W.	REVISION
9	11/9/60	J.F.W.	REVISION
10	11/9/60	J.F.W.	REVISION

W.P. 218-59

LAUGHLIN, WYLLIE & UFNAL
CONSULTING ENGINEERS
TORONTO

DEPARTMENT OF HIGHWAYS-ONTARIO
BRIDGE OFFICE-TORONTO

NOTTAWASAGA RIVER BRIDGE

THE KING'S HIGHWAY No. 89 DIST. No. 5
CO. SIMCOE
TWP. ESSA-TECUMSETH LOT 1-10 CON. IV-XIV

FOUNDATION LAYOUT

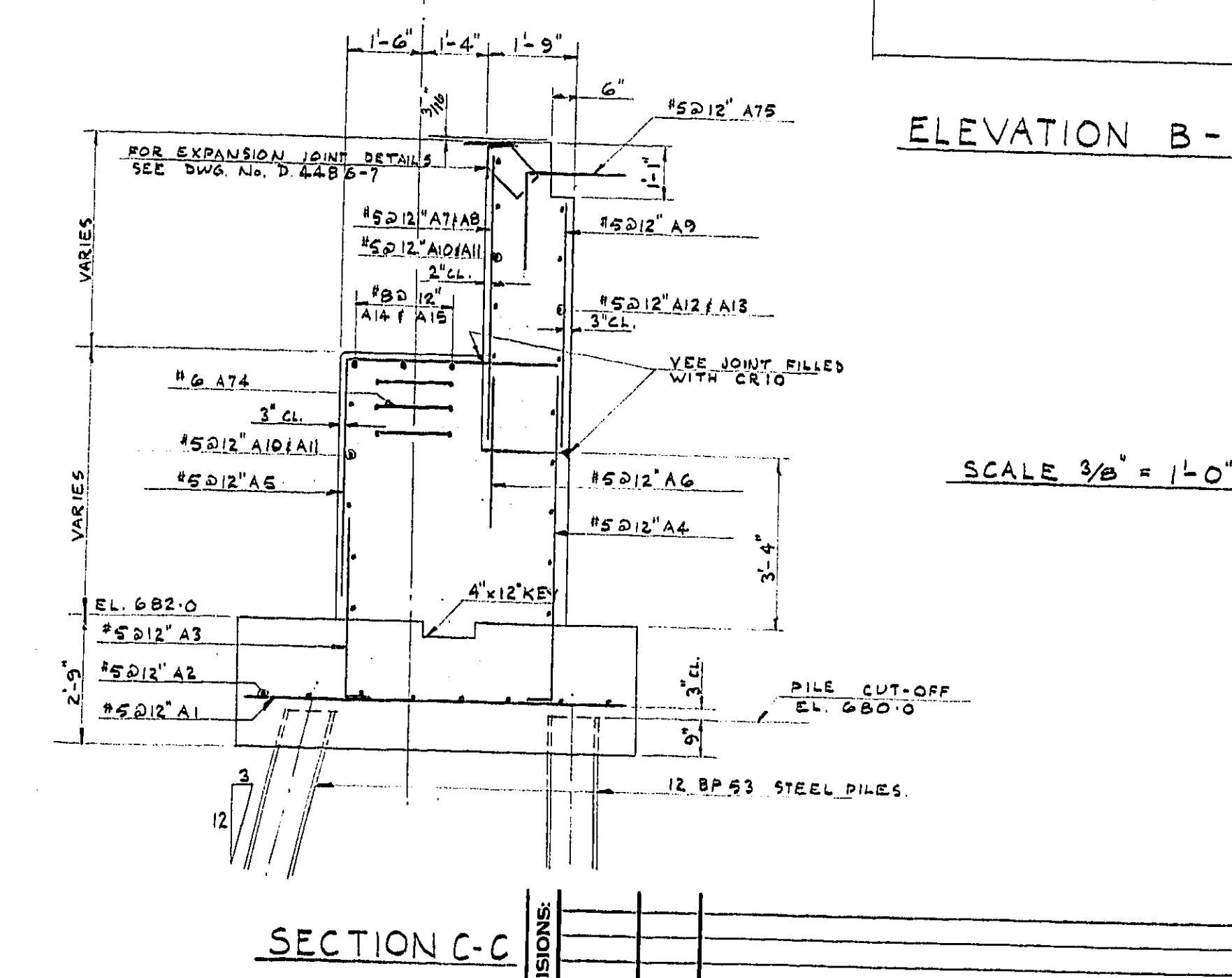
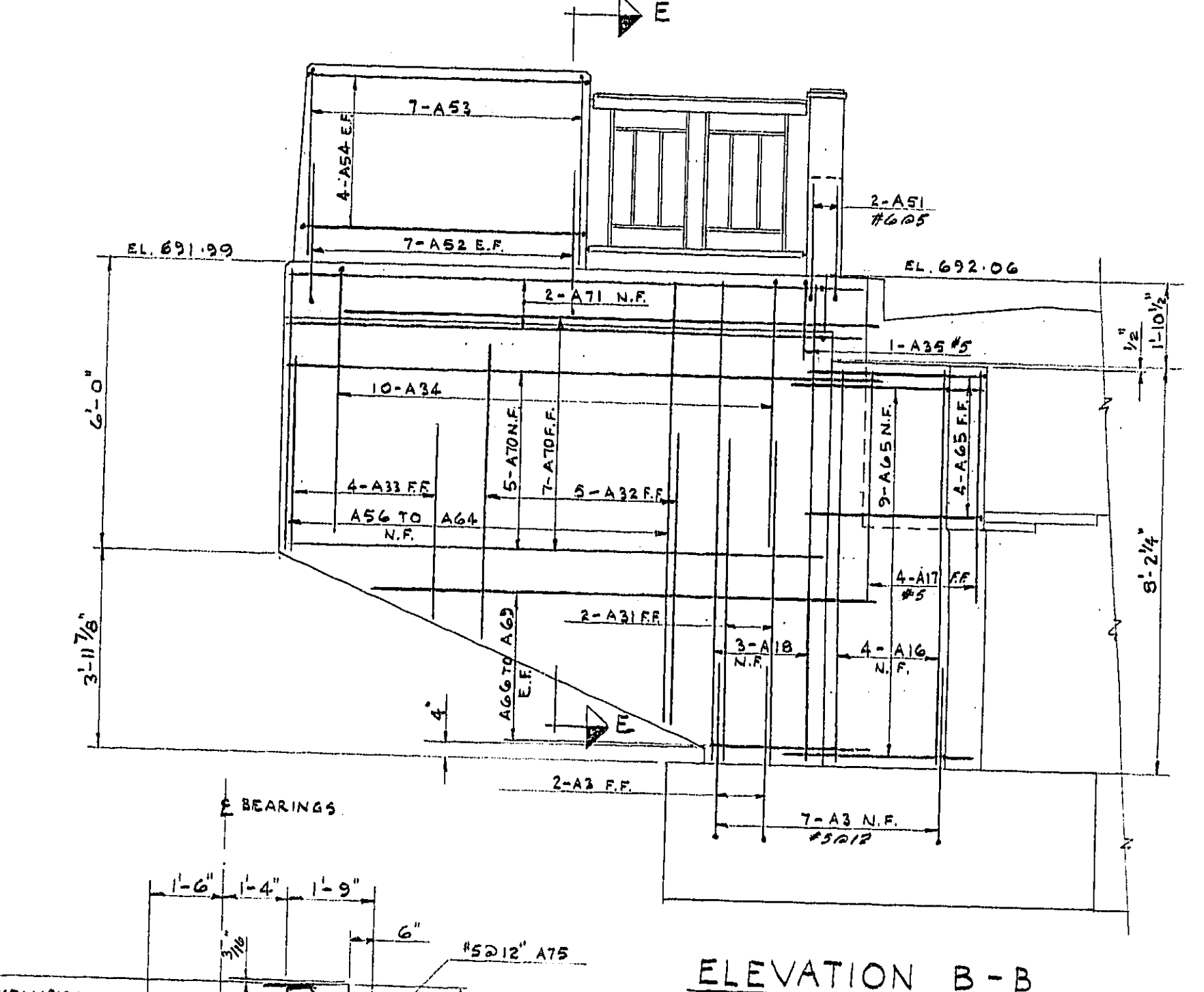
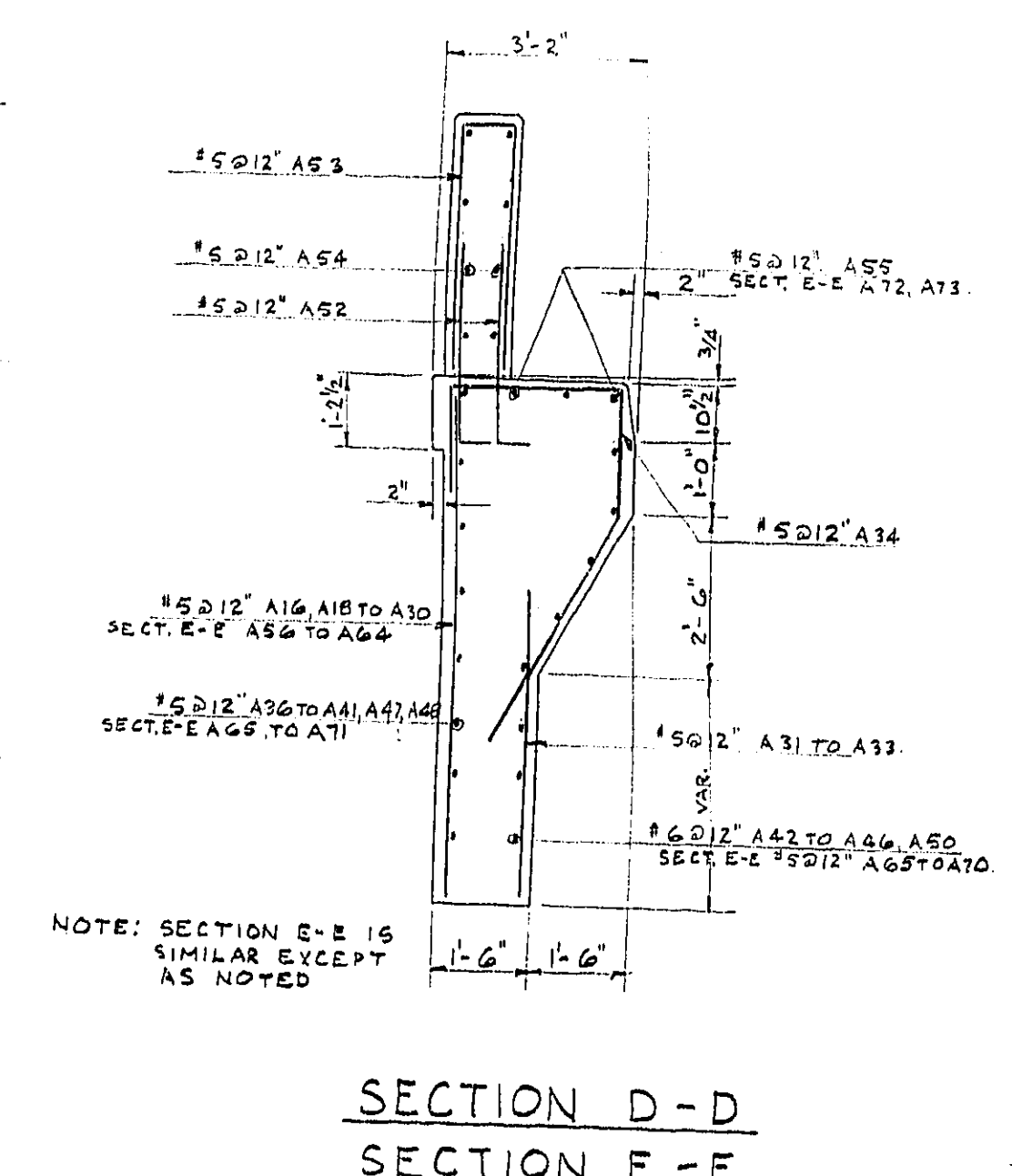
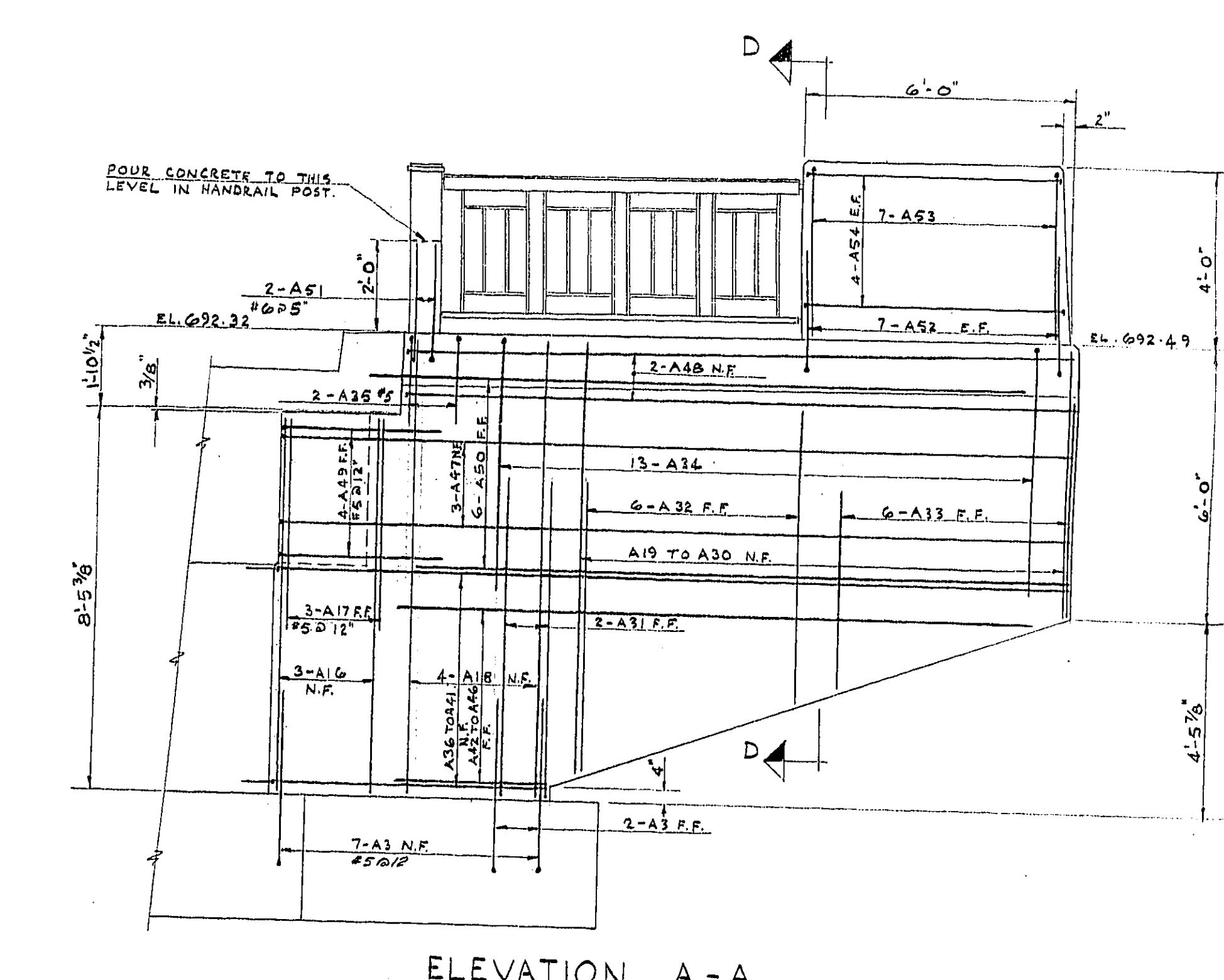
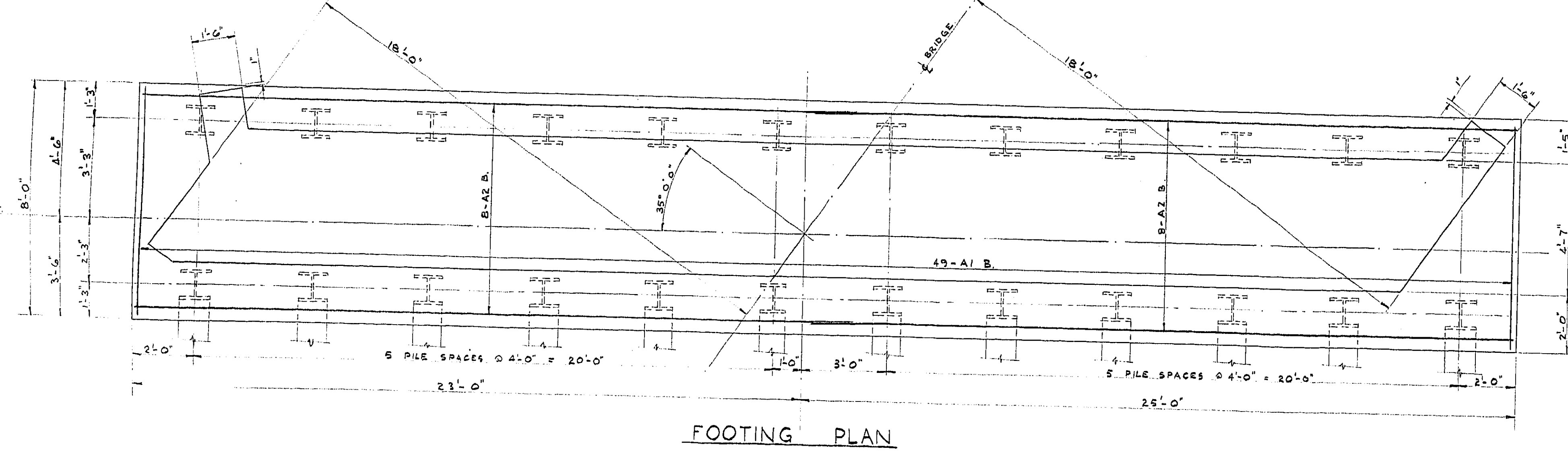
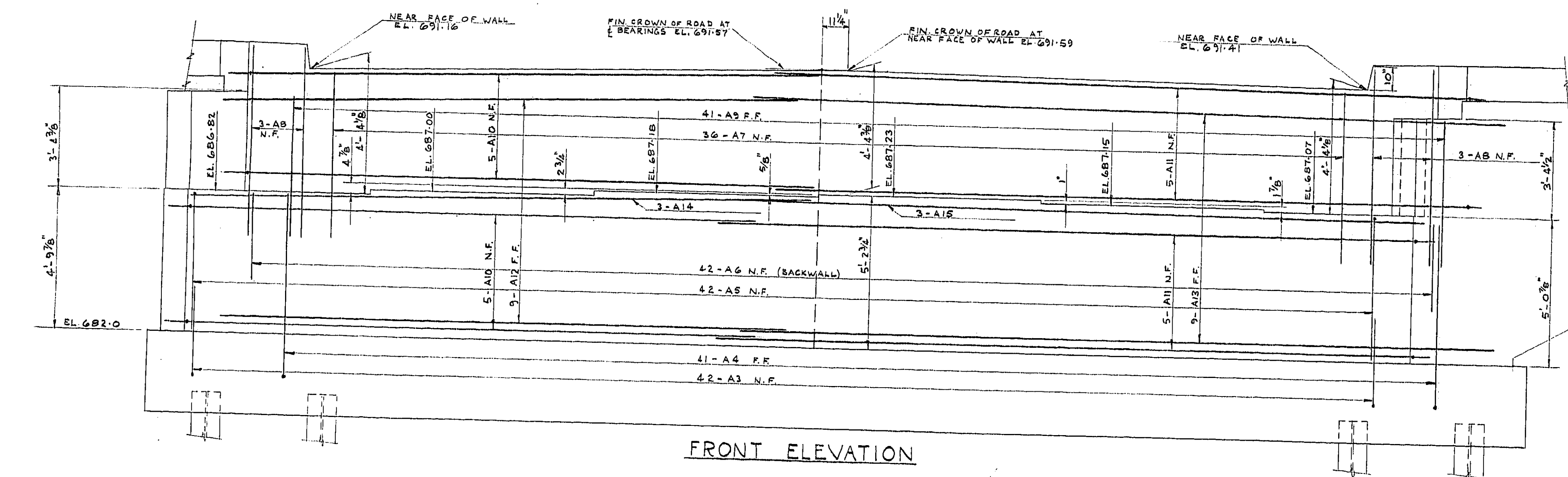
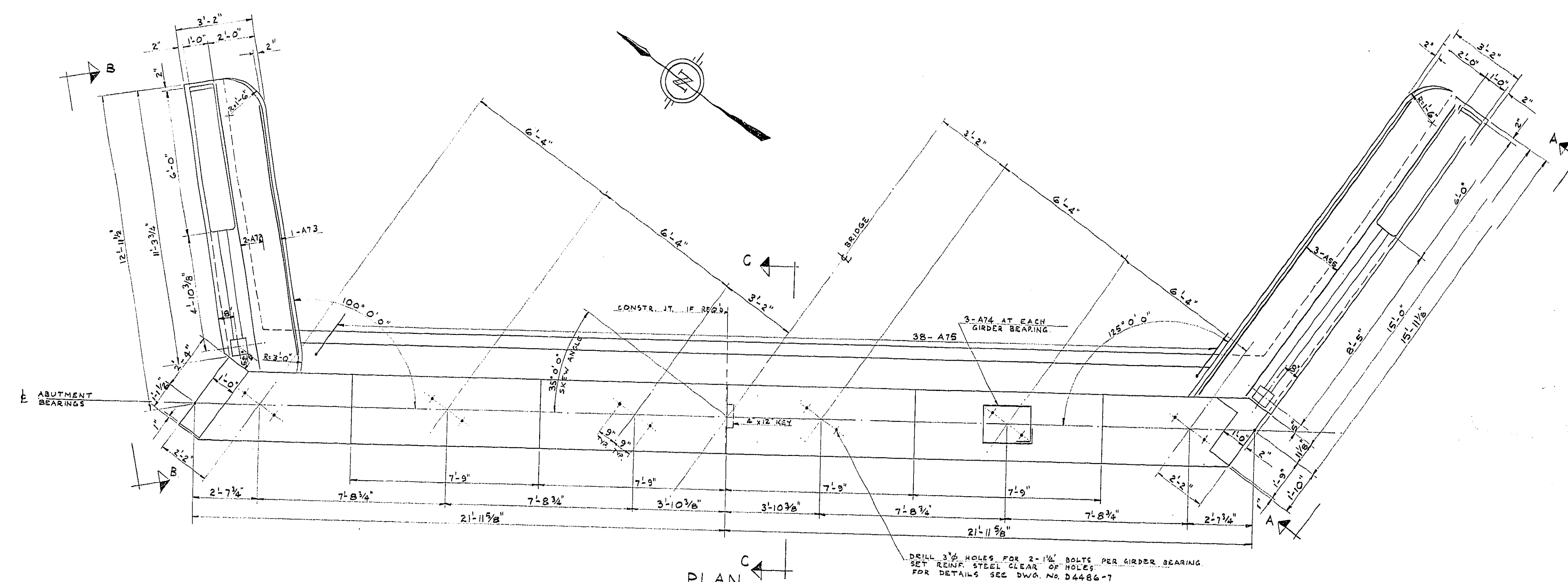
APPROVED: *[Signature]* BRIDGE ENGINEER

DESIGN ENGINEER: *[Signature]*

DESIGN	D. C. B.	CHECK	K. S.	CONTRACT NUMBER	60-156 (60-171)
DRAWING	H. E. X.	CHECK	K. S.	LOADING	H20-S16
TRADING		CHECK		CHARTER NUMBER	D4486-2

DATE: APRIL 1960

Twp# 785-250-2-A



NO.	FOR	DATE
1	FOR	
2	FOR	
3	FOR	
4	FOR	
5	FOR	
6	FOR	
7	FOR	
8	FOR	
9	FOR	
10	FOR	

W.P. 218-59

LAUGHLIN, WYLLIE & UFNAL
CONSULTING ENGINEERS
TORONTO

DEPARTMENT OF HIGHWAYS, ONTARIO
BRIDGE OFFICE, TORONTO

NOTTAWASAGA RIVER BRIDGE

THE KING'S HIGHWAY No. 89 DIST. NO. 5
CO. SIMCOE
TWP. ESSA-TECUMSETH LOT 1-10 CON. X-IV

EAST ABUTMENT

APPROVED
J. F. WYLLIE
PROVINCIAL ENGINEER

BRIDGE ENGINEER
DESIGN ENGINEER

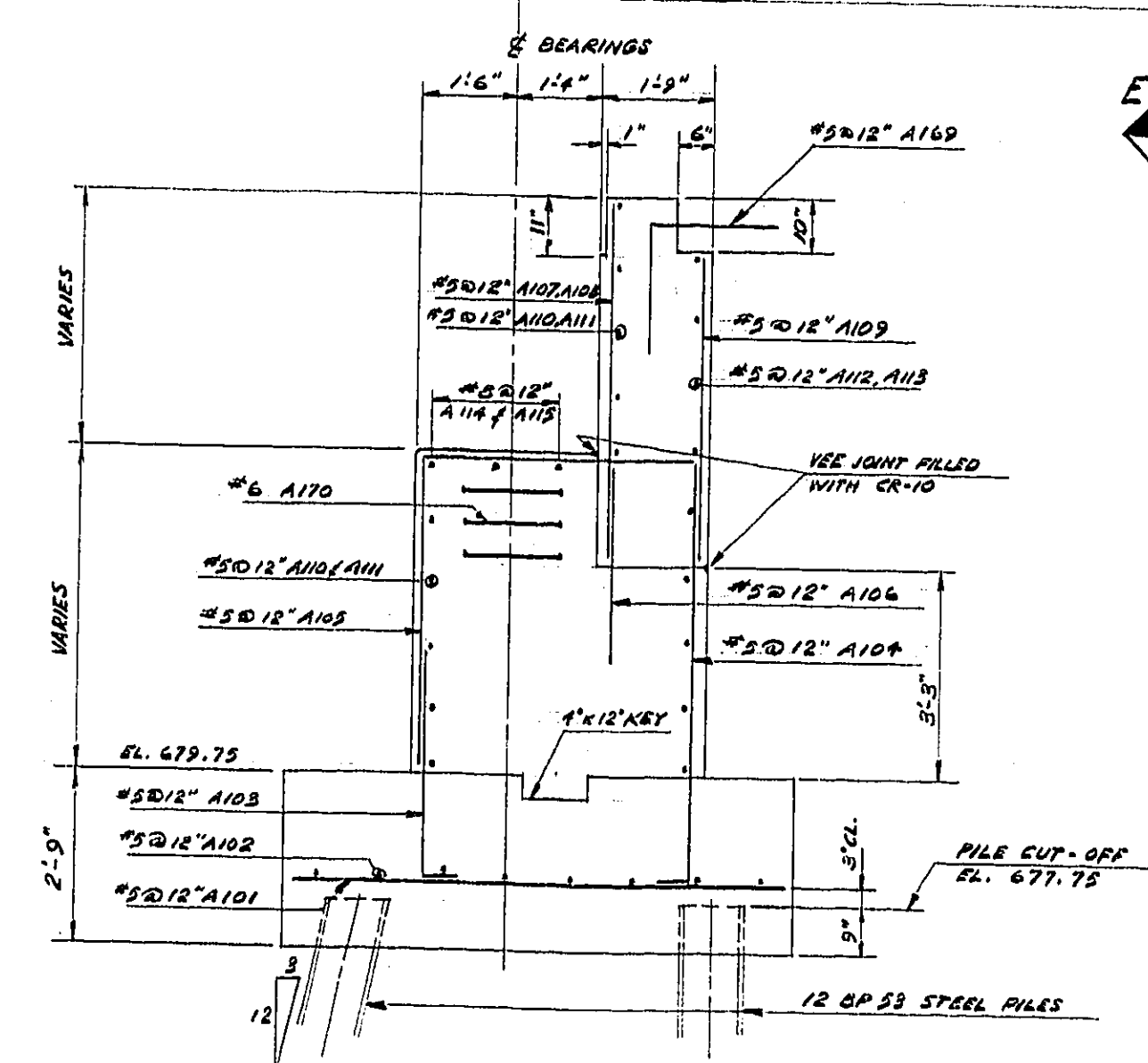
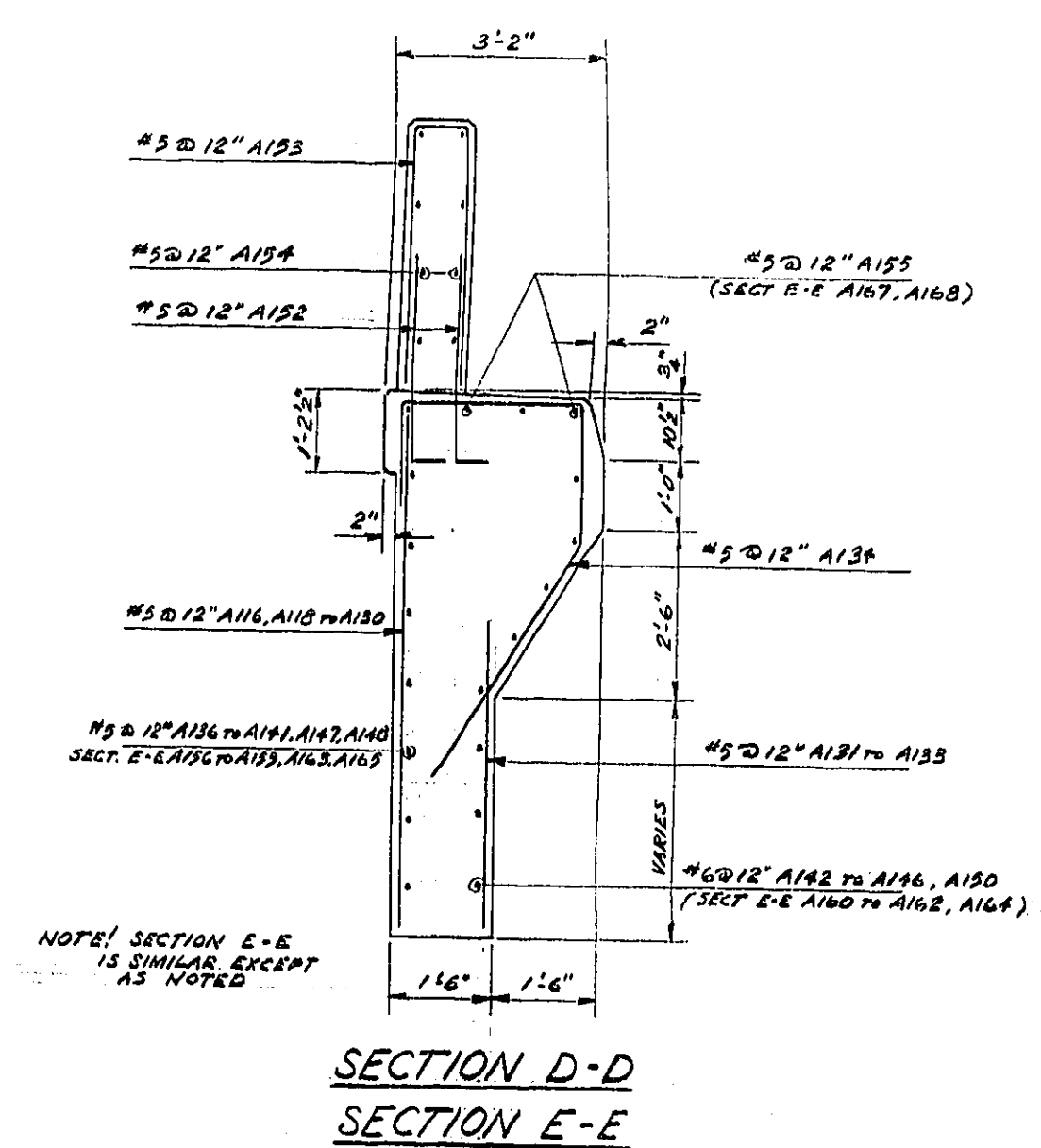
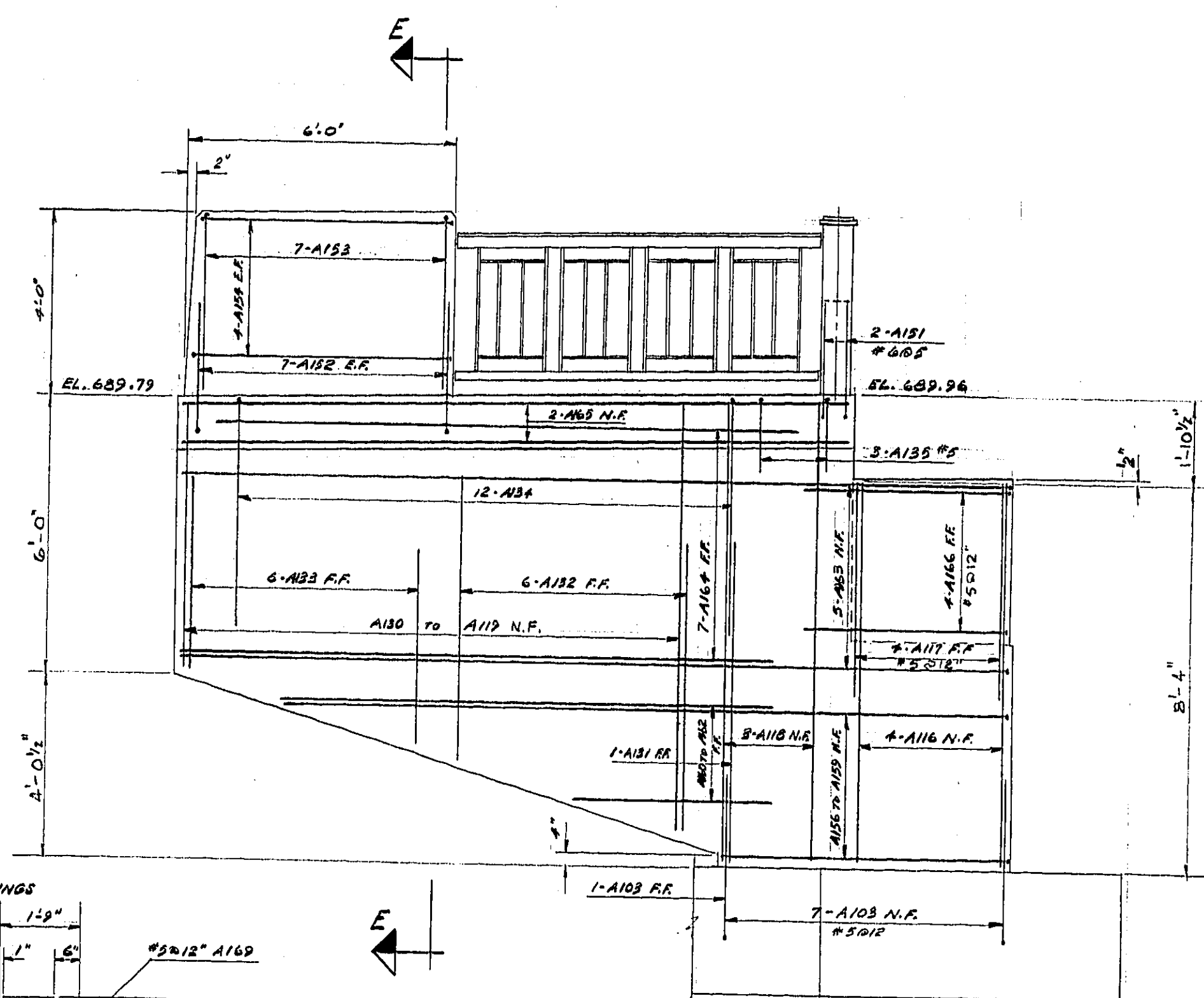
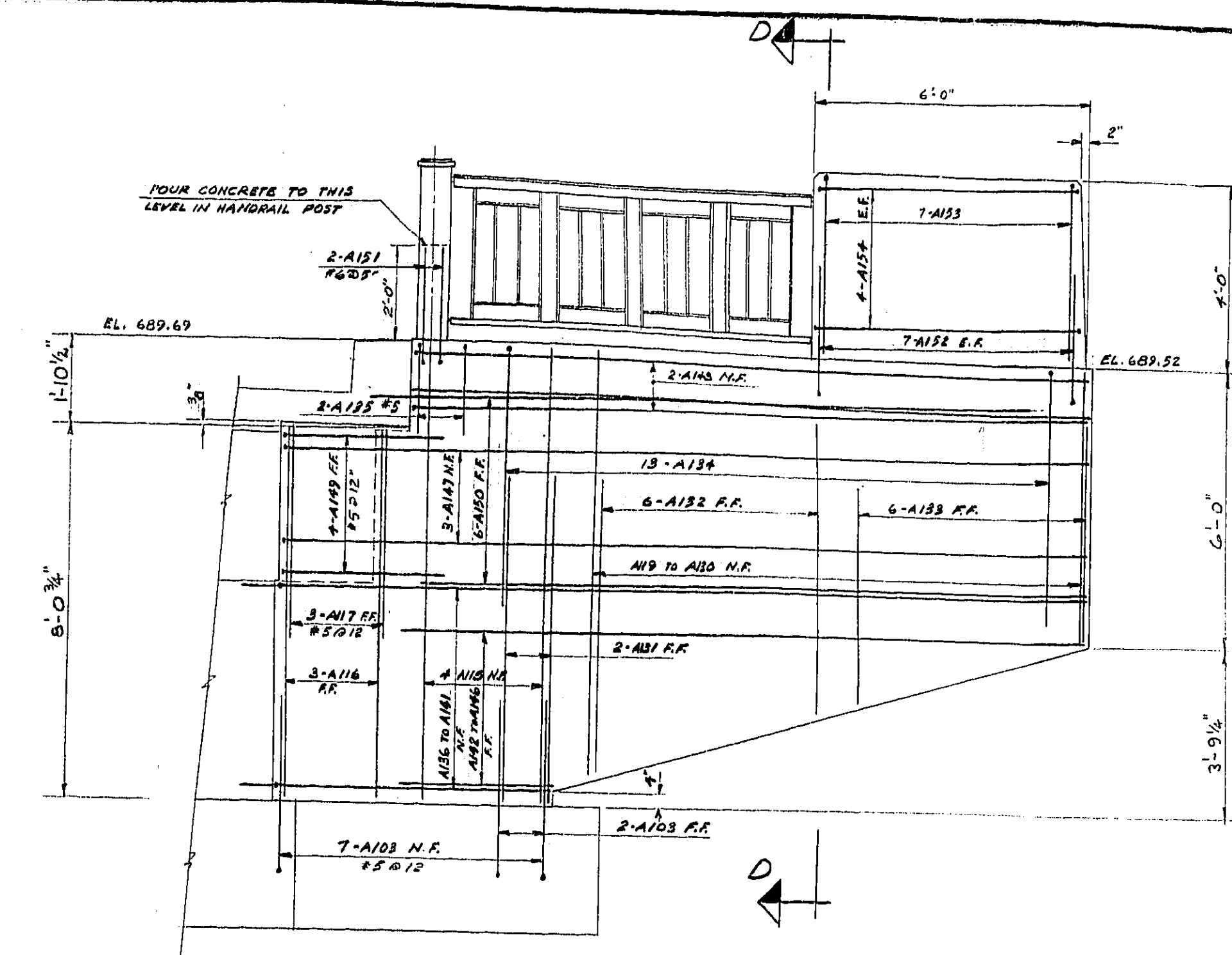
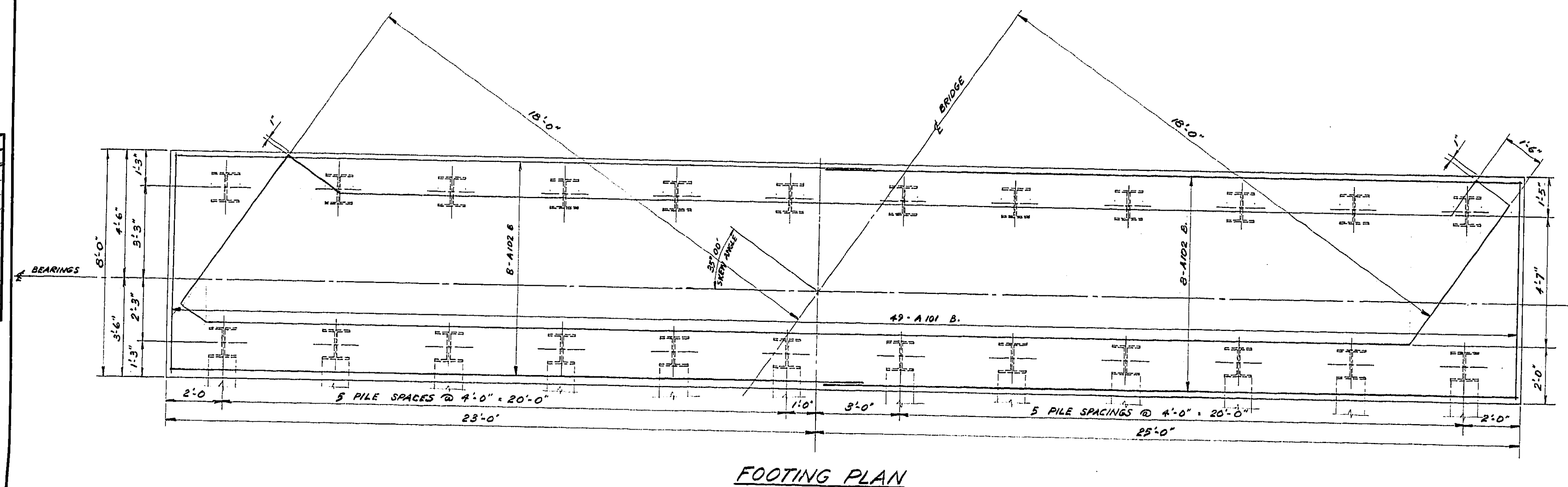
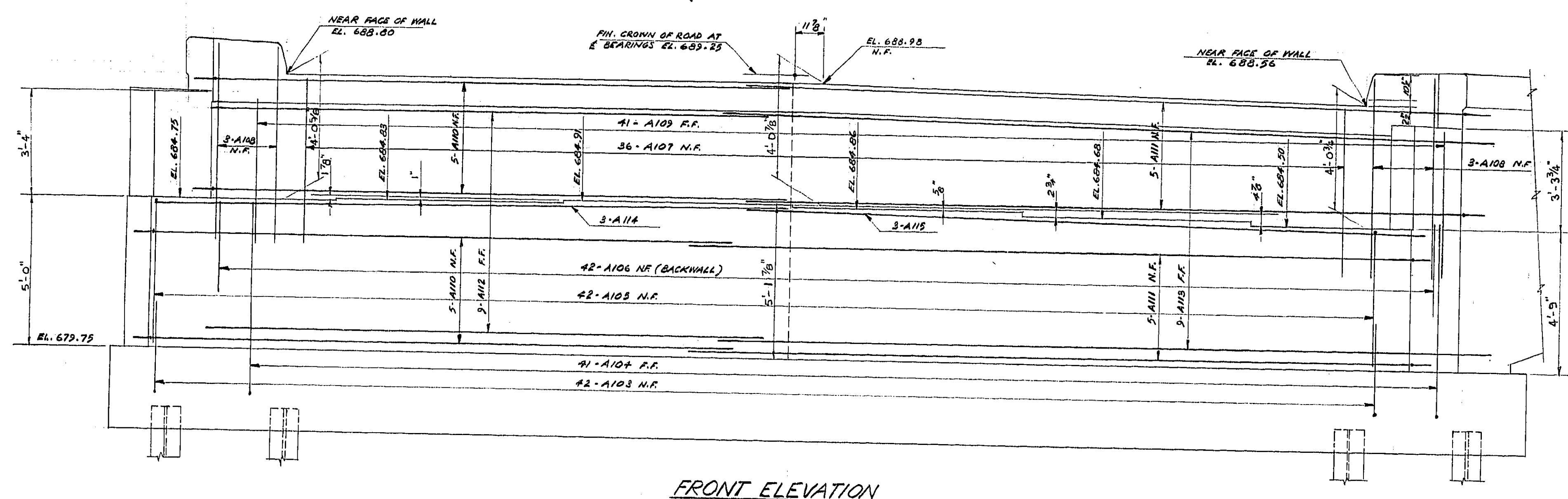
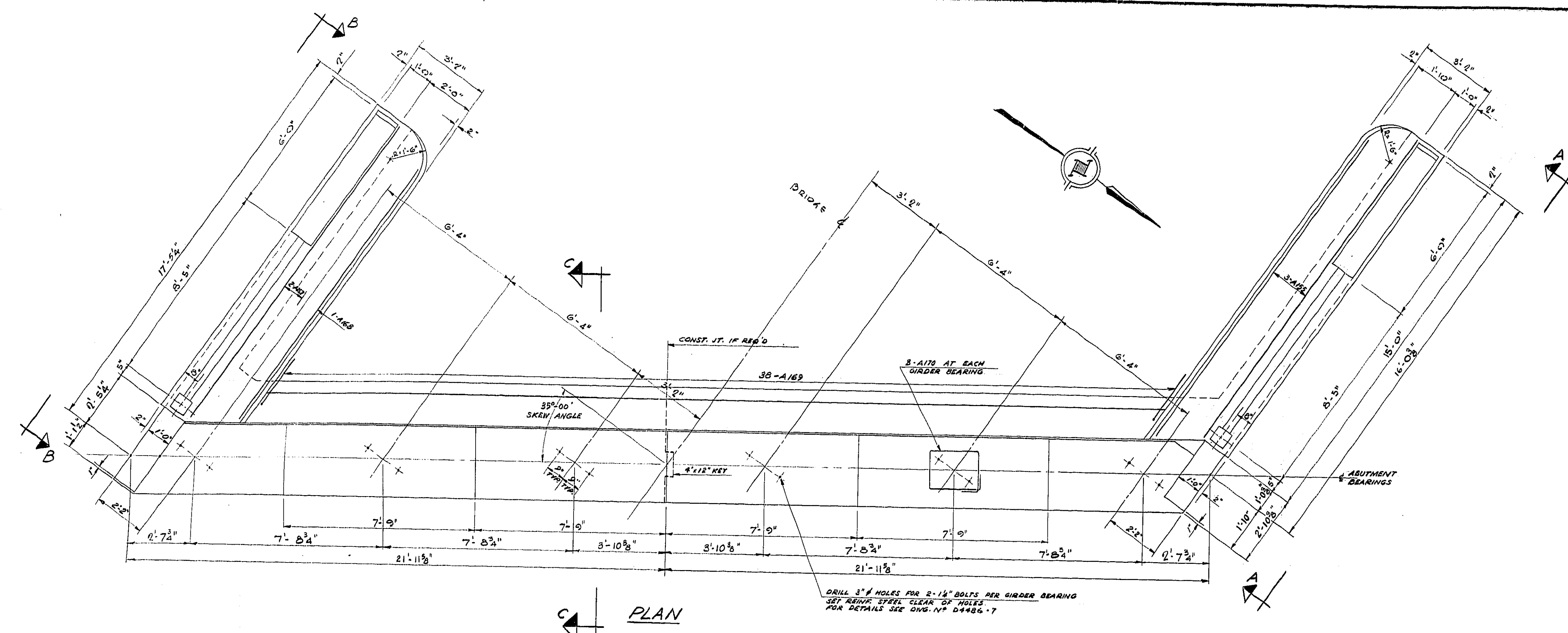
DESIGN D.C.B. CHECK K.S. CONTRACT NO. 67-123 16-171
DRAWING D.C.B. CHECK K.S. 67-123 16-171
TRACING CHECK K.S. 67-123 16-171

DATE APRIL 1960

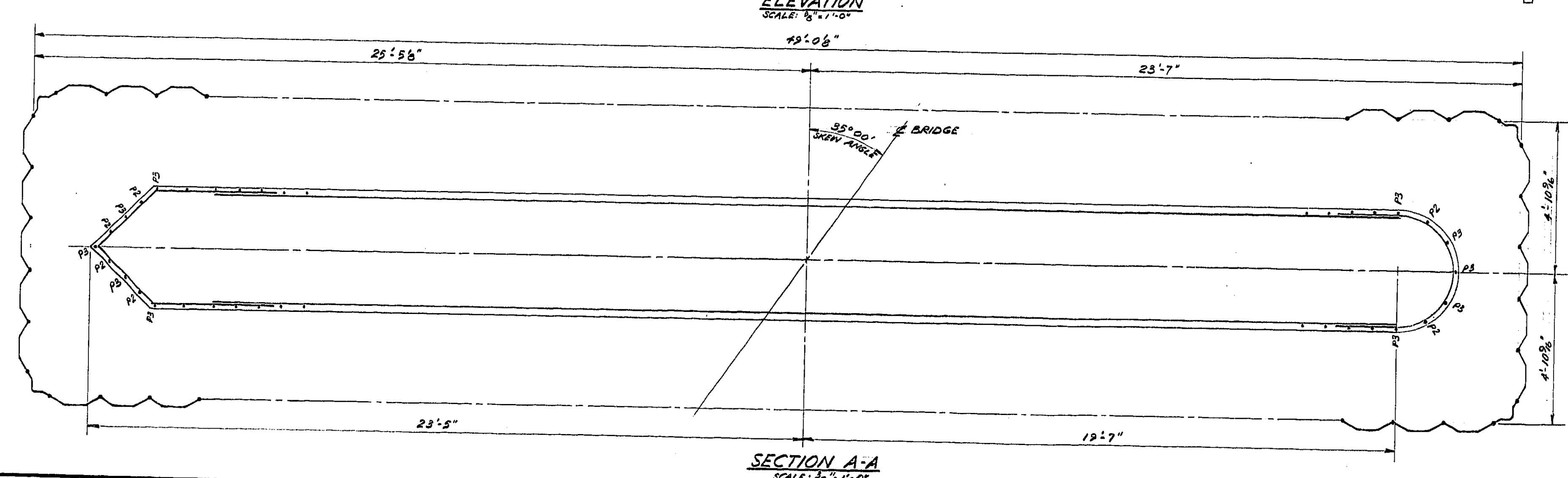
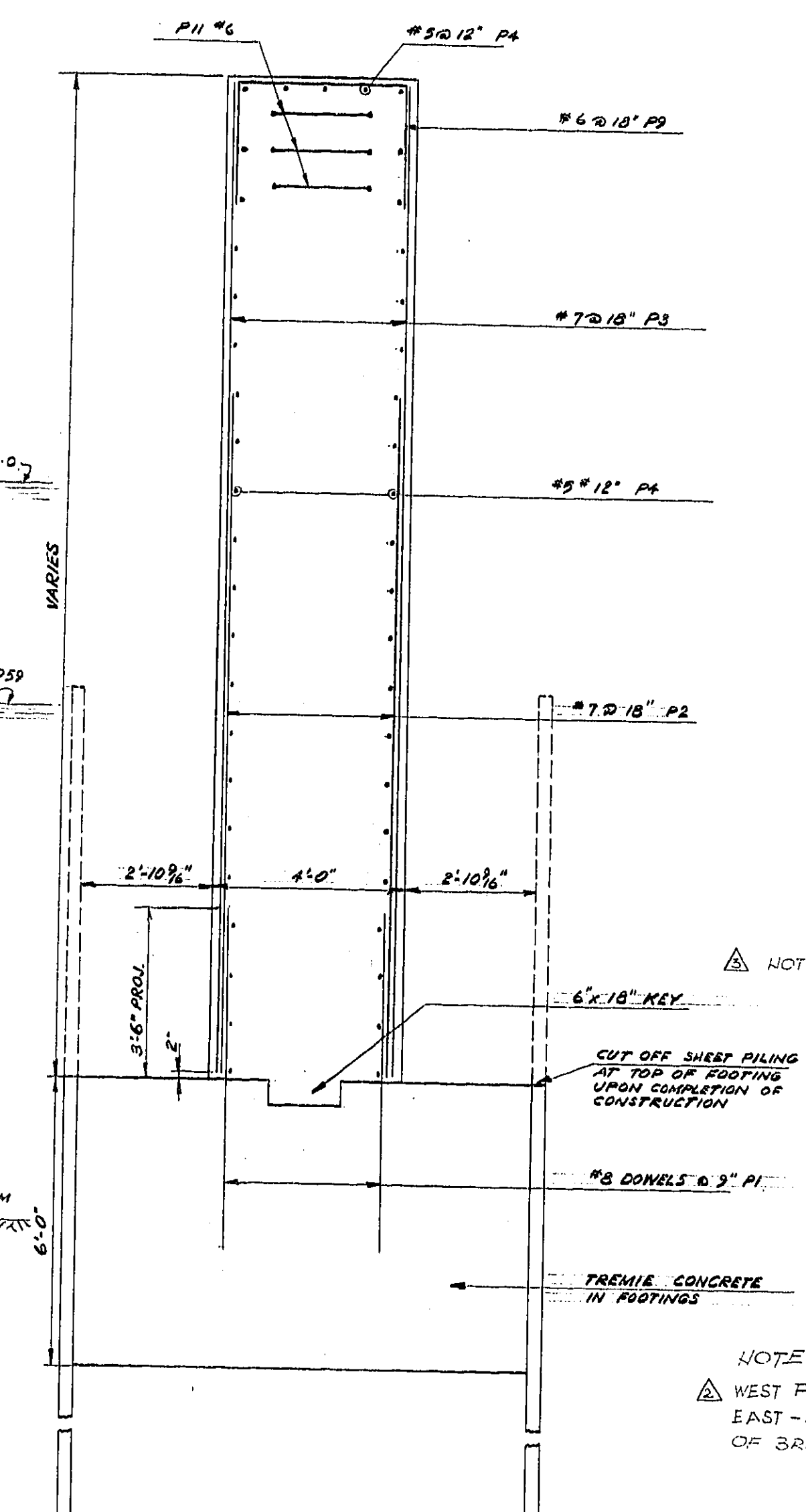
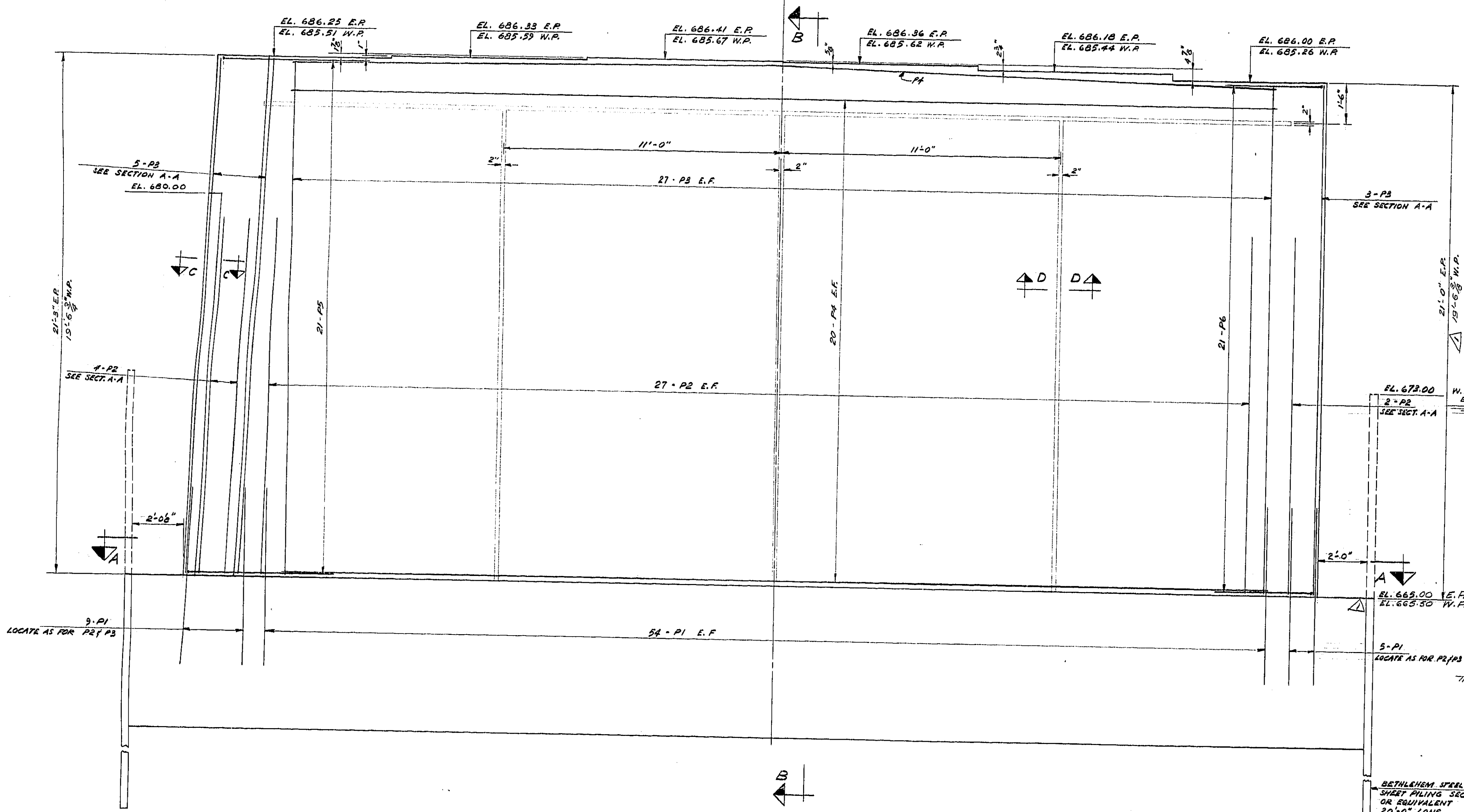
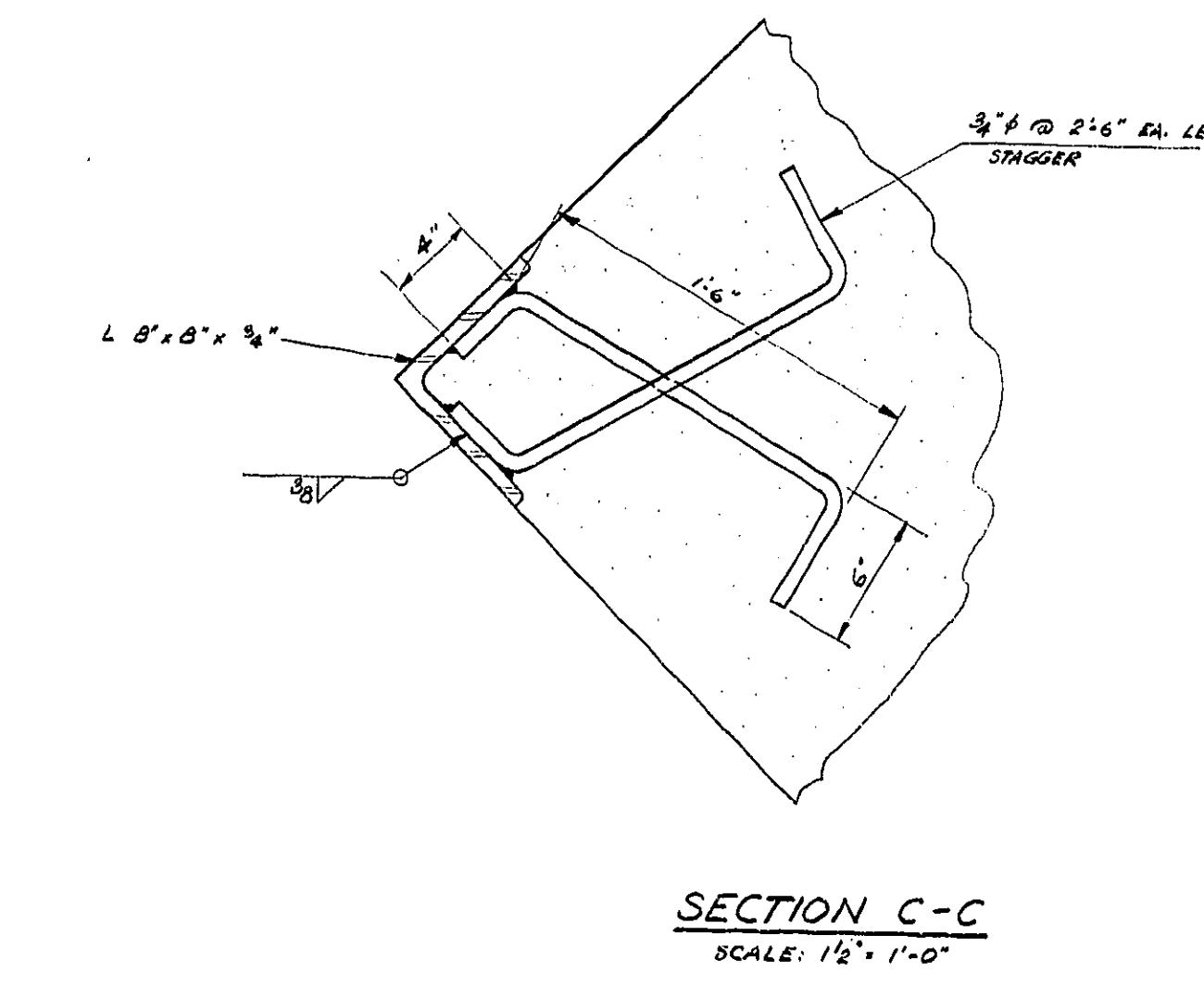
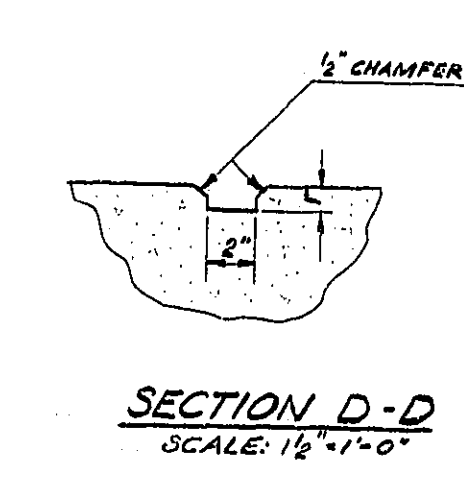
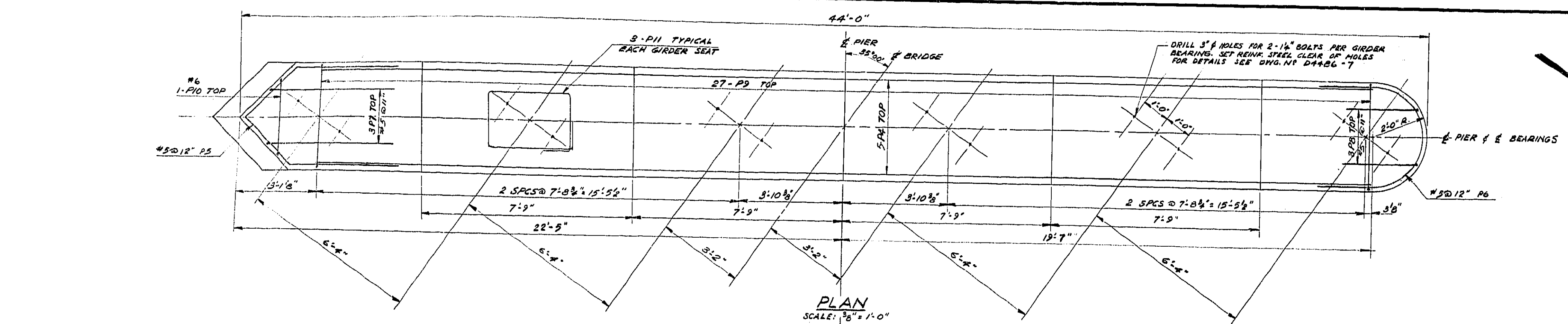
67656

D4486-3

TWP#785-250-3-A

[illegible][illegible]

W. P. 218-59			
<h1 style="margin: 0;">LAUGHLIN, WYLLIE & UFNAL</h1> <p style="margin: 0;">CONSULTING ENGINEERS TORONTO</p>			
<h2 style="margin: 0;">DEPARTMENT OF HIGHWAYS-ONTARIO-</h2> <p style="margin: 0;">BRIDGE OFFICE-TORONTO</p>			
<h1 style="margin: 0;">NOTTAWASAGA RIVER BRIDGE</h1>			
THE KING'S HIGHWAY No. <u>89</u>		DIST. No. <u>5</u>	
CO. <u>SIMCOE</u>			
TWP. <u>ESSA - TECUMSETH</u>		LOT <u>1-10</u> CON. <u>V-XIV</u>	
<h2 style="margin: 0;">WEST ABUTMENT</h2>			
<u>APPROVED</u> 			
_____ DESIGN ENGINEER		_____ DESIGN ENGINEER	
DESIGN	D.C.S. CHECK	K.S.	<u>PROJECTIONS</u> <u>GENERAL</u> <div style="font-size: 2em; margin: 10px 0;">60-135</div> <div style="font-size: 2em; margin: 10px 0;">60-171</div>
DRAWING	M.R.K. CHECK	K.S.	
TRACING			
DATE	APRIL 1960		
		LOADING	
		H20-S16	
		DRAWING NUMBER	



NO.	FOR	DATE
1	FOR	21/9/60
2	FOR	28/9/60
3	FOR	28/9/60
4	FOR	28/9/60
5	FOR	28/9/60
6	FOR	28/9/60
7	FOR	28/9/60
8	FOR	28/9/60
9	FOR	28/9/60
10	FOR	28/9/60
11	FOR	28/9/60
12	FOR	28/9/60

W.P.218-59

LAUGHLIN, WYLLIE & UFNAL
CONSULTING ENGINEERS
TORONTO

DEPARTMENT OF HIGHWAYS-ONTARIO
BRIDGE OFFICE-TORONTO

NOTTAWASAGA RIVER BRIDGE

THE KING'S HIGHWAY No. 89 DIST. No. 5
CO. SIMCOE
TWP. ESSA - TECUMSETH LOT 1-10 CON. X-XIV

EAST & WEST PIERS

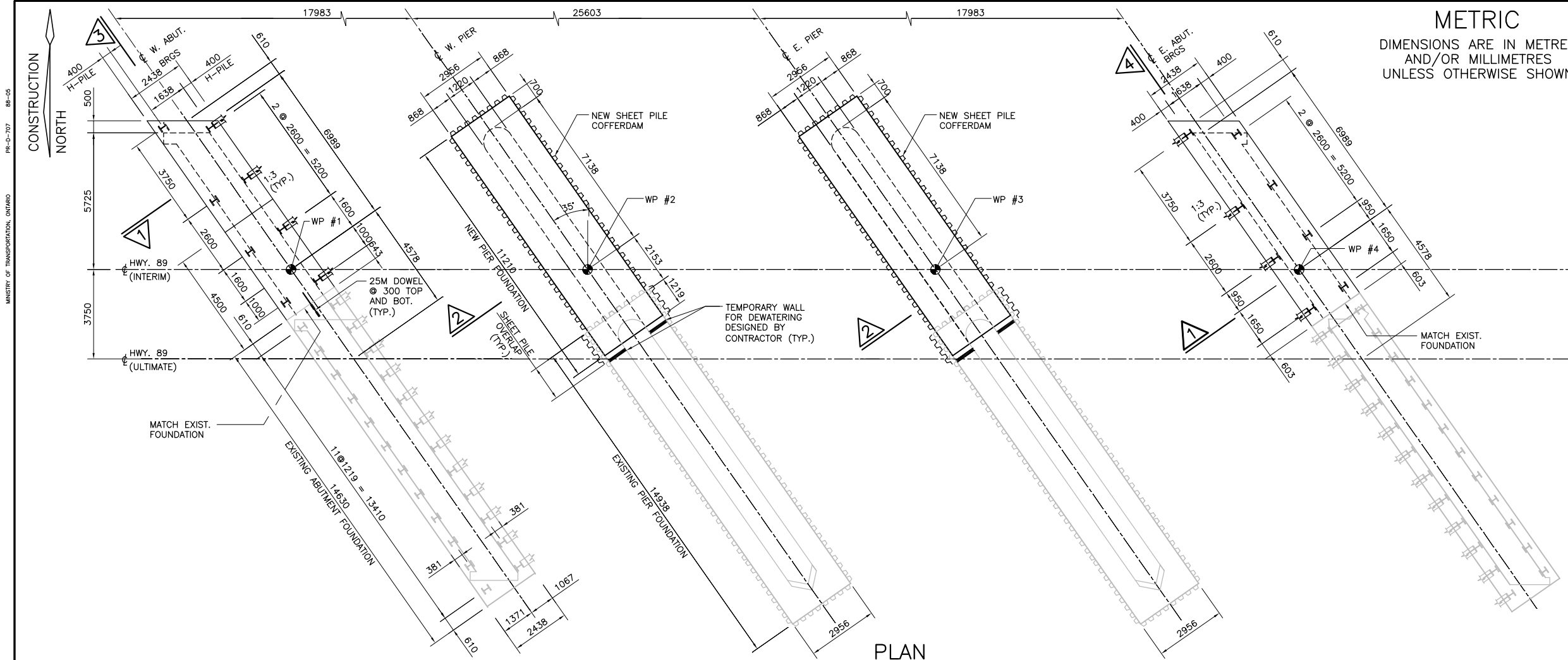
APPROVED
J. F. WYLLIE
BRIDGE ENGINEER

DESIGNER: D.C.B. CHECK: K.S. CONTRACT NUMBER: 60-135 160-171
DRAWING: M.R.K. CHECK: K.S. LOADING: H20-S16
TRACING: J.G.G. CHECK: K.S. DATE: APRIL 1960

REVISIONS:
3/5/60 A.E.S. ADDED NOTE TO KEY, REV. AS CONSTRUCTED
3/5/60 A.E.S. ADDED NOTE, REVISED AS CONSTRUCTED
3/2/60 J.G.G. A FOOTING EL. ADDED & DIM. REV.

TWP# 755-250-5-A

2009 Contract Drawings



METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT
CONT. No. 2009-2046
WP No. 2503-04-00

HIGHWAY 89
NOTTASAWAGA RIVER BRIDGE
BRIDGE REHABILITATION

FOUNDATION I

SHEET

57

MCCORMICK RANKIN CORPORATION
A member of **MMM GROUP**

NOTES:

- PILES TO BE HP310x110 STEEL 'H' PILES.
- PILE SPACINGS ARE MEASURED AT THE UNDERSIDE OF FOOTING.
- PILE LENGTHS SHOWN ARE THEORETICAL LENGTHS BELOW CUT-OFF AND ARE BASED ON ESTIMATED TIP ELEVATIONS. FINAL LENGTHS AND TIP ELEVATIONS SHALL BE DETERMINED ON SITE FROM PILE DRIVING RECORDS.
- THE PILES TO BE DRIVEN IN ACCORDANCE WITH STANDARD SS103-11 USING AN ULTIMATE GEOTECHNICAL RESISTANCE OF 2800kN PER PILE.
- ORIENTATION OF PILES TO BE AS SHOWN ON PLAN.
- WELDING SHALL CONFORM TO CSA STANDARD W59 AND SHALL BE DONE BY WELDER QUALIFIED UNDER CSA STANDARD W47.
- ALL PILES SHALL BE FITTED WITH DRIVING SHOES AS PER OPSD 3000.100.
- PILE DESIGN DATA
MAXIMUM FACTORED LOAD
ULS = 807kN
SLS = 587kN
- VIBRATION MONITORING OF EXISTING BRIDGE SHALL BE COMPLETED DURING PILE DRIVING.
- PILES SHALL BE INSTALLED STARTING AT THE NORTH END AND WORKING SOUTH.

LIST OF ABBREVIATIONS

WP - DENOTES WORKING POINT
T/F - DENOTES TOP OF FOOTING
I.F. - DENOTES INSIDE FACE
O.F. - DENOTES OUTSIDE FACE

PILE DATA

LOCATION	NO. REQUIRED	LENGTH (m)	BATTER
W. ABUTMENT	2	9.6	VERTICAL
	2	9.0	VERTICAL
	2	10.1	1:3
	2	9.5	1:3
E. ABUTMENT	4	9.4	VERTICAL
	4	9.9	1:3

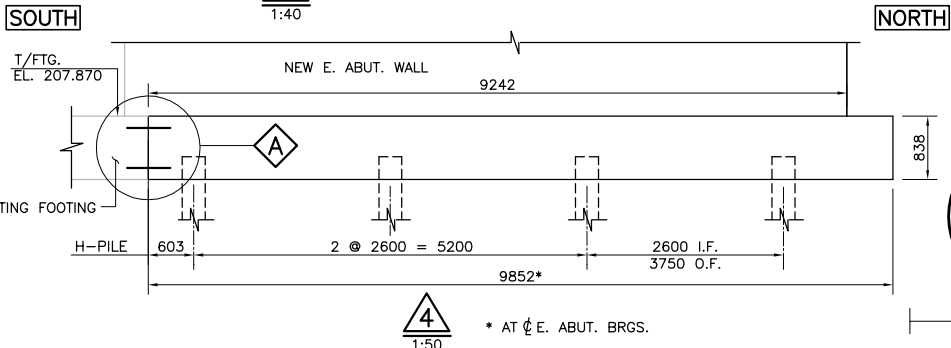
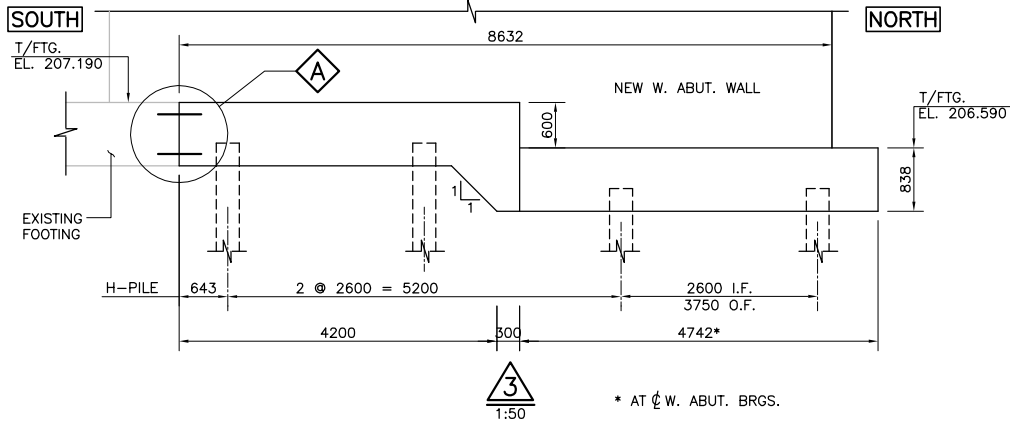
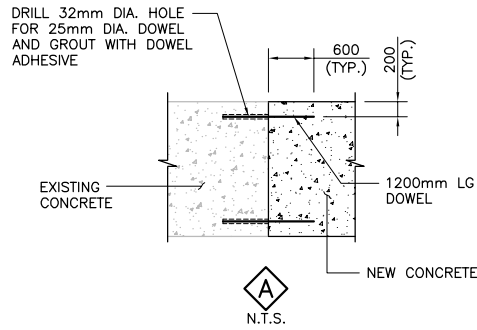
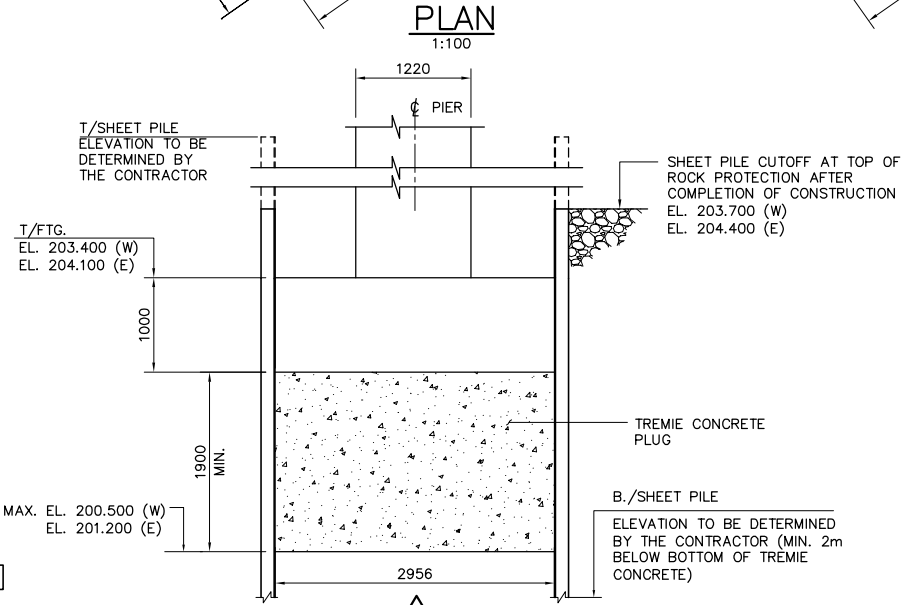
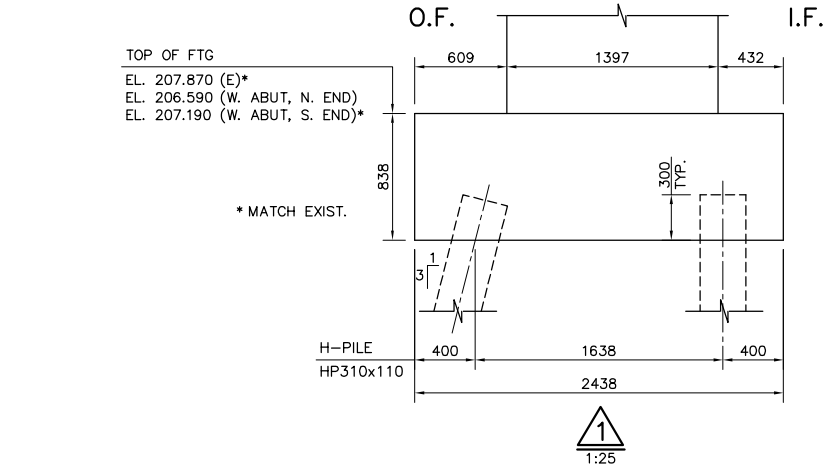
WORK POINT DATA

W.P.	*STATION	CO-ORDINATES	
		NORTHING	EASTING
1	16+134.877	4891917.2019	280094.1911
2	16+152.861	4891922.4459	280111.3925
3	16+178.464	4891929.9119	280135.8827
4	16+196.447	4891935.1559	280153.0841

* STATION CHAINAGES MEASURED ALONG ϕ OF HIGHWAY 89

APPLICABLE STANDARD DRAWINGS:

OPSD 3000.100 FOUNDATION PILES STEEL H-PILES DRIVING SHOE
OPSD 3000.150 FOUNDATION PILES STEEL H-PILES SPLICE



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS	DESCRIPTION
DESIGN KWF	CHK HC
DRAWN RYR	CHK HC
CODE CHBDC	2006
LOAD CL-625-ONT	DATE DEC./09
SITE 30-250	STRUCT
SCHEME	DWG 6

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT
CONT. No. 2009-2046
WP No. 2503-04-00

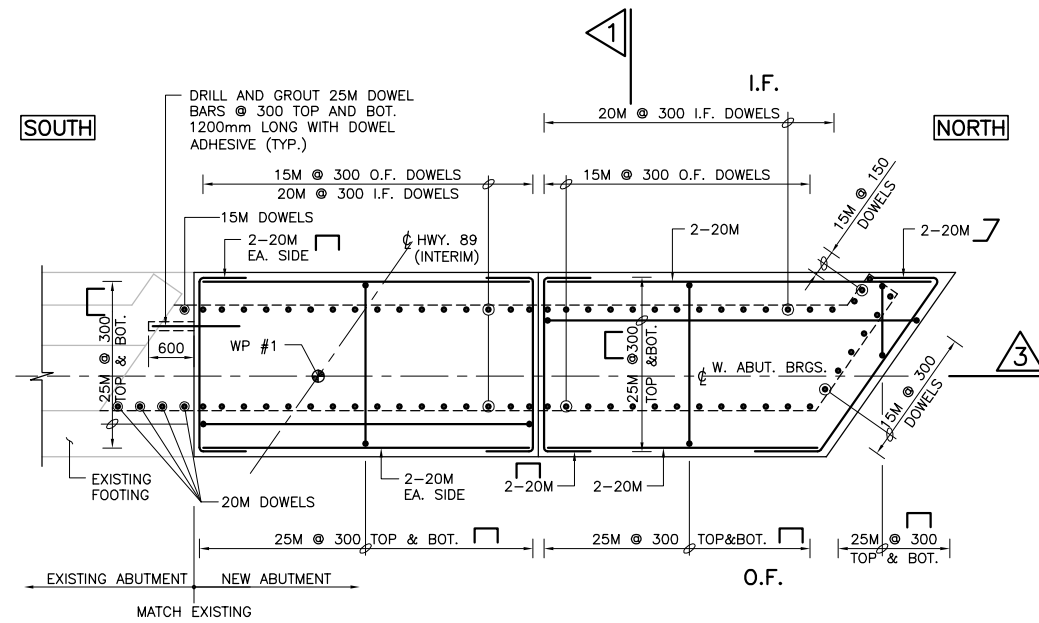
HIGHWAY 89
NOTTASAWAGA RIVER BRIDGE
BRIDGE REHABILITATION

FOUNDATION II

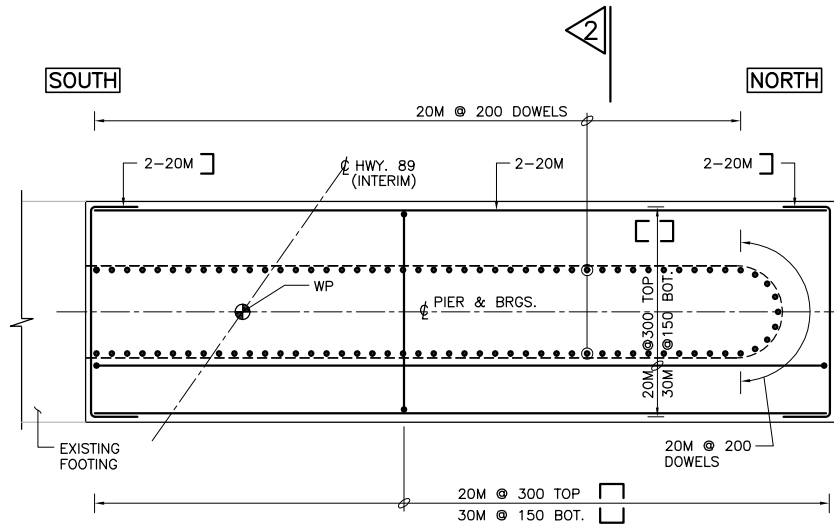
SHEET

58

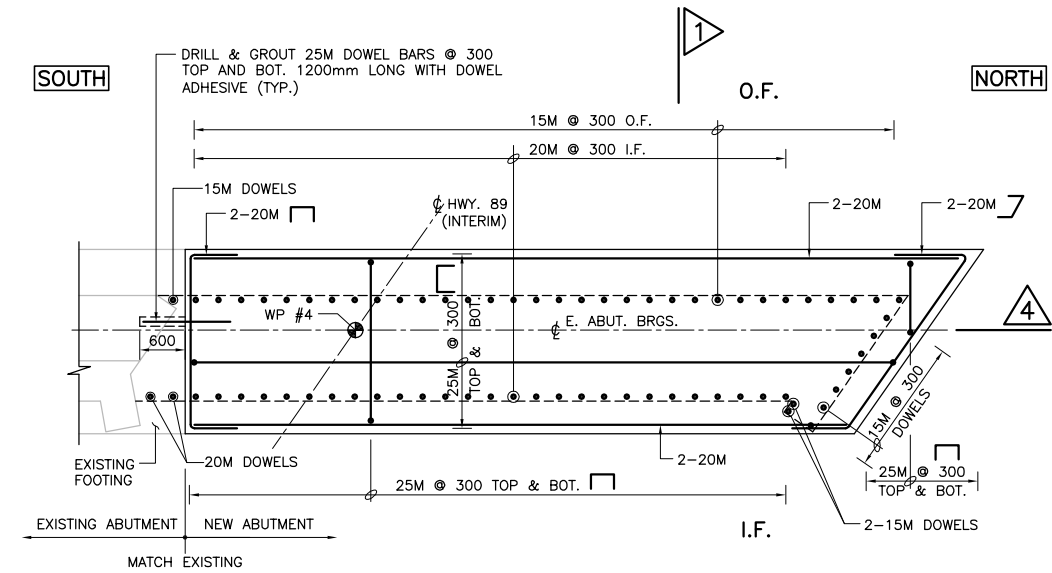
MRC **McCORMICK RANKIN**
CORPORATION
A member of **MMM GROUP**



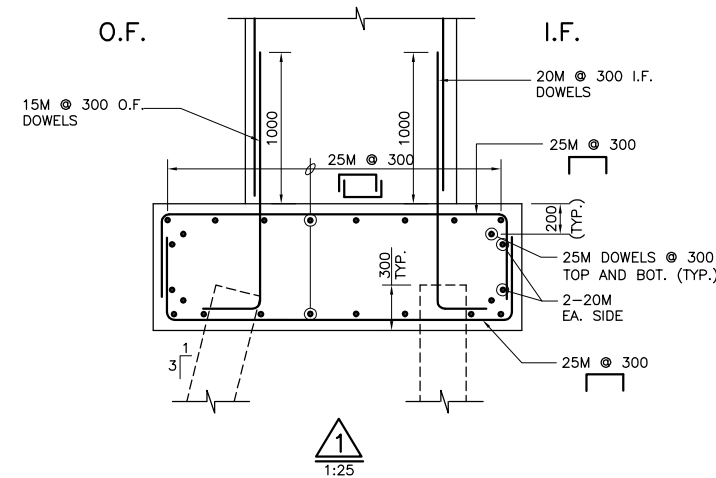
PLAN - WEST ABUTMENT
1:50



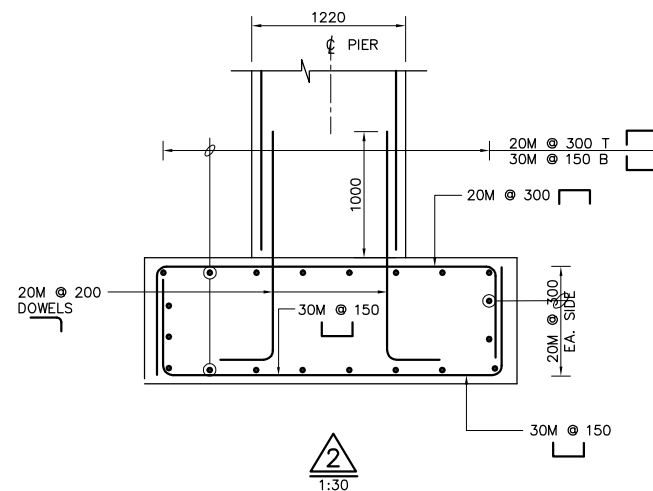
PLAN - PIER
1:50



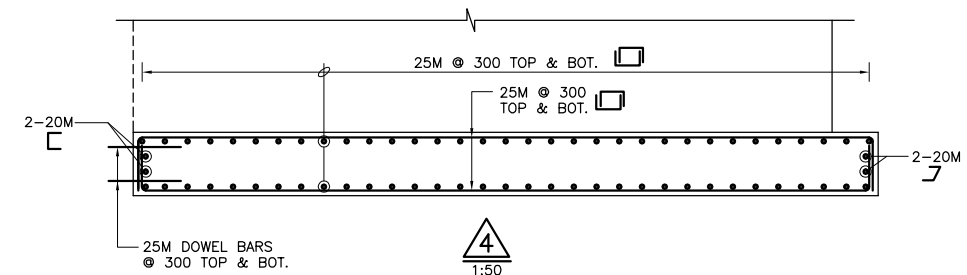
PLAN - EAST ABUTMENT
1:50



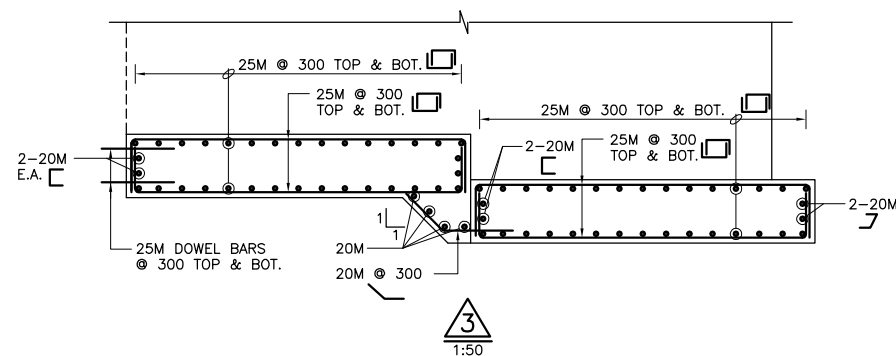
1
1:25



2
1:30



4
1:50

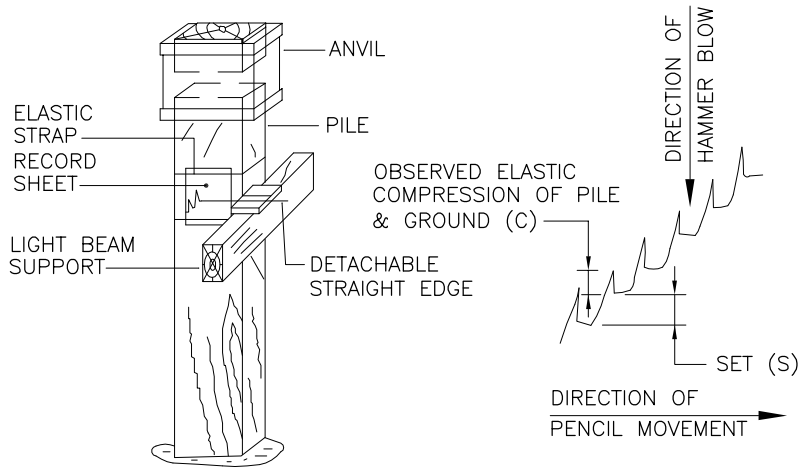


3
1:50



DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

REVISIONS		DESCRIPTION			
DESIGN	KWF	CHK	HC	CODE	CHBDC 2006
DRAWN	RJR	CHK	HC	SITE	30-250
				STRUCT	
				SCHEME	
				DWG	7



FIELD MEASUREMENT TECHNIQUE DURING PILE DRIVING

HAMMERS*		
TYPE	MASS OF RAM W (Kilograms)	RATED ENERGY E (Joules/blow)
9B3	726	12419
10B3	1361	16948
50C	2268	20337
11B3	2268	26005
D12	1250	30506
B225	1360	39300
LB520	2300	40675
B300	1700	46100
D22	2200	53826
B400	2268	62400
D22-02	2200	67000
D22-13	2200	67000
D30-02	3000	91000
D30-13	3000	91000
B500	3129	107100
D36-02	3600	115000
D36-13	3600	115000

NOTE:

Ram may also be referred to as Piston
* See General Notes 5) and 6).

METHOD OF APPLYING THE HILEY FORMULA

The Hiley Formula for:

(a) Double-acting, differential-acting Steam and Diesel Hammers,

$$R = \frac{n e_f E}{S + C/2} \quad \begin{array}{l} e_f = 0.6 \text{ to } 0.8 \text{ for steam hammers} \\ e_f = 1.0 \text{ for diesel hammers} \end{array}$$

(b) Drop Hammers and single-acting Steam Hammers,

$$R = \frac{n e_f WgH}{S + C/2} \quad \begin{array}{l} e_f = 0.75 \text{ for drop hammers} \\ H = \text{height of free fall of mass in metres} \end{array}$$

Where R = Ultimate pile resistance in kilonewtons
 S = Measured penetration of pile per hammer blow in millimetres
 C = Measured rebound of pile per hammer blow in millimetres
 E = Rated Energy of hammer blow in joules
 e_f = efficiency based on manufacturer's gross rated energy (typ. 0.6 to 0.8)
 n = efficiency of blow
 e = coefficient of restitution
 g = 9.80665 m/s²
 $n = \frac{W + Pe^2}{W + P}$
where $e = 0.32$ for steel (or $e = 0.55$. See Note 1 below.)
 $= 0.25$ for timber
 P = Mass of pile + anvil or helmet in kilograms (See Note 2 below)
 W = Mass of ram (piston) in kilograms

NOTE 1:

It is assumed that piles are driven with a pile cushion. Where Steel H-Piles are driven without a cushion, the ultimate pile capacity R should be calculated assuming a coefficient of Restitution $e = 0.55$.

NOTE 2:

Assume mass of anvil = 600 kg unless otherwise noted.

NOTE 3:

The resulting Ultimate Pile Resistance, R , as calculated by Hiley Formula must exceed the Ultimate Geotechnical Resistance given in the Pile Driving Notes on the Contract Drawings.

EXAMPLE FOR DIESEL HAMMERS

Given: Pile HP 310x110, length = 50m
Mass of anvil = 600 kg
Pile driven without a cushion
Hammer is Delmag D22-13
From the Pile Driving Notes on the Contract Drawings,
Ultimate Geotechnical Resistance = 3000 kN

Observations: measured penetration = $S = 5\text{mm}$
measured rebound = $C = 10\text{mm}$

Hiley Formula Calculations

$$P = 50(110) + 600 = 6100 \text{ kg}$$

$$W = 2200 \text{ kg} \quad e = 0.55$$

$$n = \frac{W + Pe^2}{W + P} = \frac{2200 + 6100 (0.55)^2}{2200 + 6100} = 0.49$$

$$E = 67,000 \text{ Joules/blow}$$

$$R = \frac{n e_f E}{S + C/2} = \frac{0.49 (1.0) (67,000)}{5 + (10/2)} = \underline{3283 \text{ kN}} > 3000 \text{ kN} \quad \text{O.K.}$$

METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DISTRICT
CONT. No. 2009-2046
WP No. 2503-04-00

HIGHWAY 89
NOTTASAWAGA RIVER BRIDGE
BRIDGE REHABILITATION

SHEET

PILE DRIVING CONTROL

76



**MCCORMICK RANKIN
CORPORATION**
A member of **MMM GROUP**

NOTES:

- THIS STANDARD DRAWING IS FOR THE CONTROL OF PILE INSTALLATIONS BY VALIDATING DESIGN ASSUMPTIONS.
- THE HILEY FORMULA SHALL BE USED TO CONFIRM PILE RESISTANCE FOR FRICTION-TYPE PILES IN NON-COHESIVE SOILS. FOR USE IN COHESIVE SOILS, THE GEOTECHNICAL ENGINEER WILL HAVE TO BE CONSULTED.
- DURING PILE DRIVING, THE HAMMER HAS TO REBOUND ENOUGH TO MAINTAIN ITS ENERGY PER BLOW. ACCORDINGLY, THE SOIL MUST PROVIDE SUFFICIENT REBOUND FOR THE HILEY FORMULA TO BE EFFECTIVE.
- IF THE ULTIMATE PILE RESISTANCE, AS CALCULATED BY THE HILEY FORMULA, IS NOT REACHED WHEN REFERENCED TO A PRESCRIBED PILE TIP ELEVATION OR RANGE OF ELEVATIONS, THE ADVICE AND RECOMMENDATIONS OF A GEOTECHNICAL ENGINEER SHALL BE SOUGHT.
- THE CONTRACTOR SHALL SUBMIT THE PERTINENT HAMMER PROPERTIES, AS REQUIRED BY OPSS 903.
- THE TABLE OF HAMMERS GIVEN ON THIS STANDARD DRAWING CAN BE USED FOR COMPARING THE SUBMITTED HAMMER PROPERTIES. IT IS APPROXIMATE AND MAY NOT INCLUDE ALL HAMMERS. THE CONTRACTOR SHALL CONTACT THE MANUFACTURER FOR RATED AND ACTUAL HAMMER ENERGIES.
- WHEN APPLYING THE HILEY FORMULA, THE HAMMER SHALL BE OPERATED AT FULL CAPACITY.

EXAMPLE FOR DROP HAMMERS

Given: Timber Pile: length = 15m, density = 641 kg/m³
butt dia. = 0.36m, tip dia. = 0.20m
Mass of Helmet = 300 kg
Mass of Hammer = 2268 kg = W
Fall of Hammer = 1.0 metre = H
 $e = 0.25$
From Pile Driving Notes on Contract Drawings,
Ultimate Geotechnical Resistance = 750 kN

Observations: measured penetration = $S = 5\text{mm}$
measured rebound = $C = 20\text{mm}$

Hiley Formula Calculations

$$P = (15 \times \frac{\pi}{4} \left(\frac{0.36 + 0.20}{2} \right)^2 \times 641) + 300 = 892 \text{ kg}$$

$$e_f = 0.75$$

$$W = 2268 \text{ kg}$$

$$n = \frac{W + Pe^2}{W + P} = \frac{2268 + 892(0.25)^2}{2268 + 892} = 0.74$$

$$R = \frac{n e_f WgH}{S + C/2} = \frac{0.74(0.75)(2268)(9.806)(1.0)}{5 + (20/2)}$$

$$= \underline{823 \text{ kN}} > 750 \text{ kN} \quad \text{O.K.}$$

STANDARD DRAWING
APRIL 2008

SS103-11

PILE DRIVING CONTROL

REVISIONS

NO.	DESCRIPTION
DESIGN	KWF
CHK	HC
CODE	CHBDC 2006
LOAD	CL-625-ONT
DATE	DEC./09
DRAWN	RYY
CHK	HC
SITE	30-250
STRUCT	
SCHEME	
DWG	25

DRAWING NOT TO BE SCALED
100mm ON ORIGINAL DRAWING

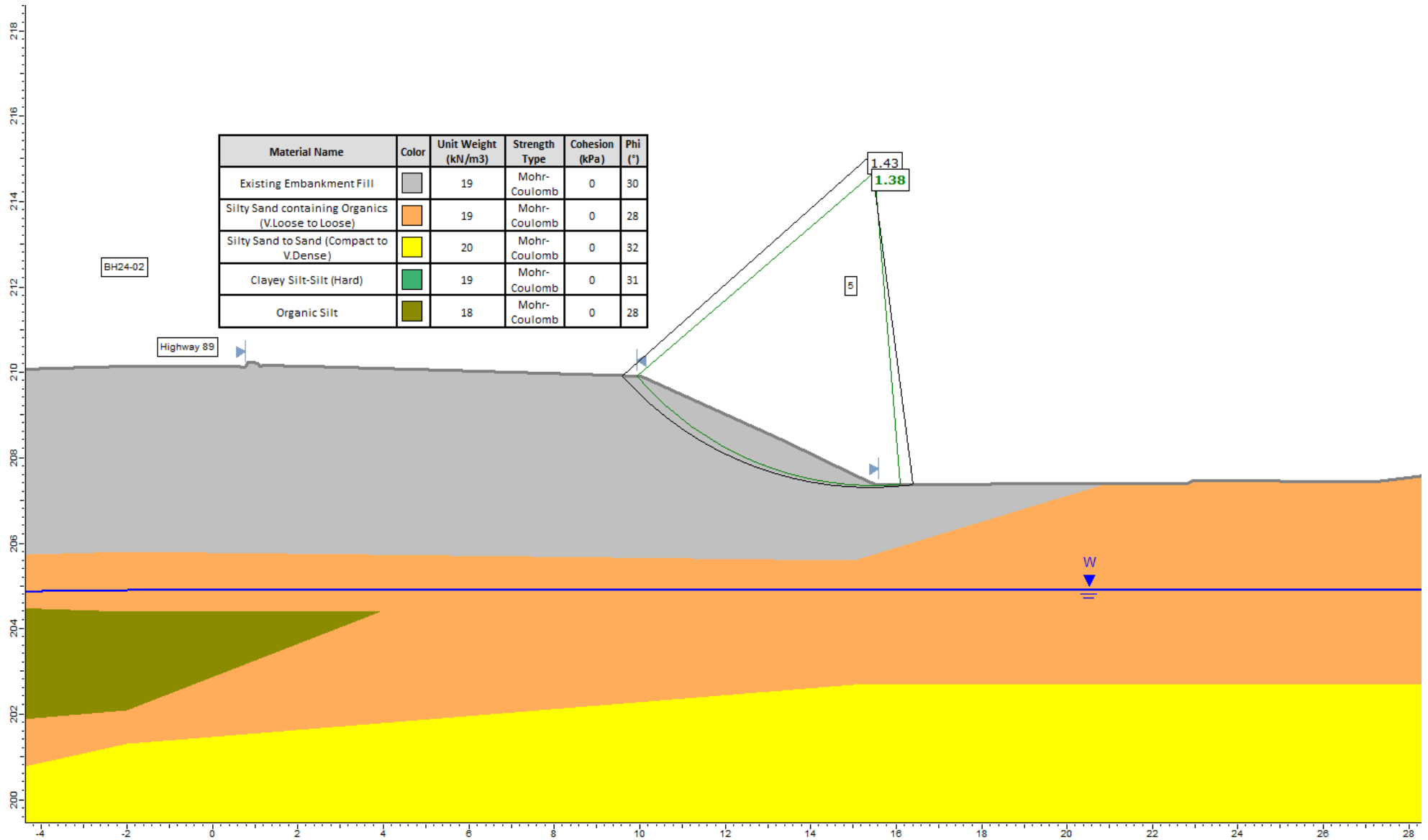
APPENDIX F

Analysis Results



Global Stability Analysis Results (Long Term – Drained Condition)
Highway 89-Nottawasaga River Bridge – West Abutment, South Slope

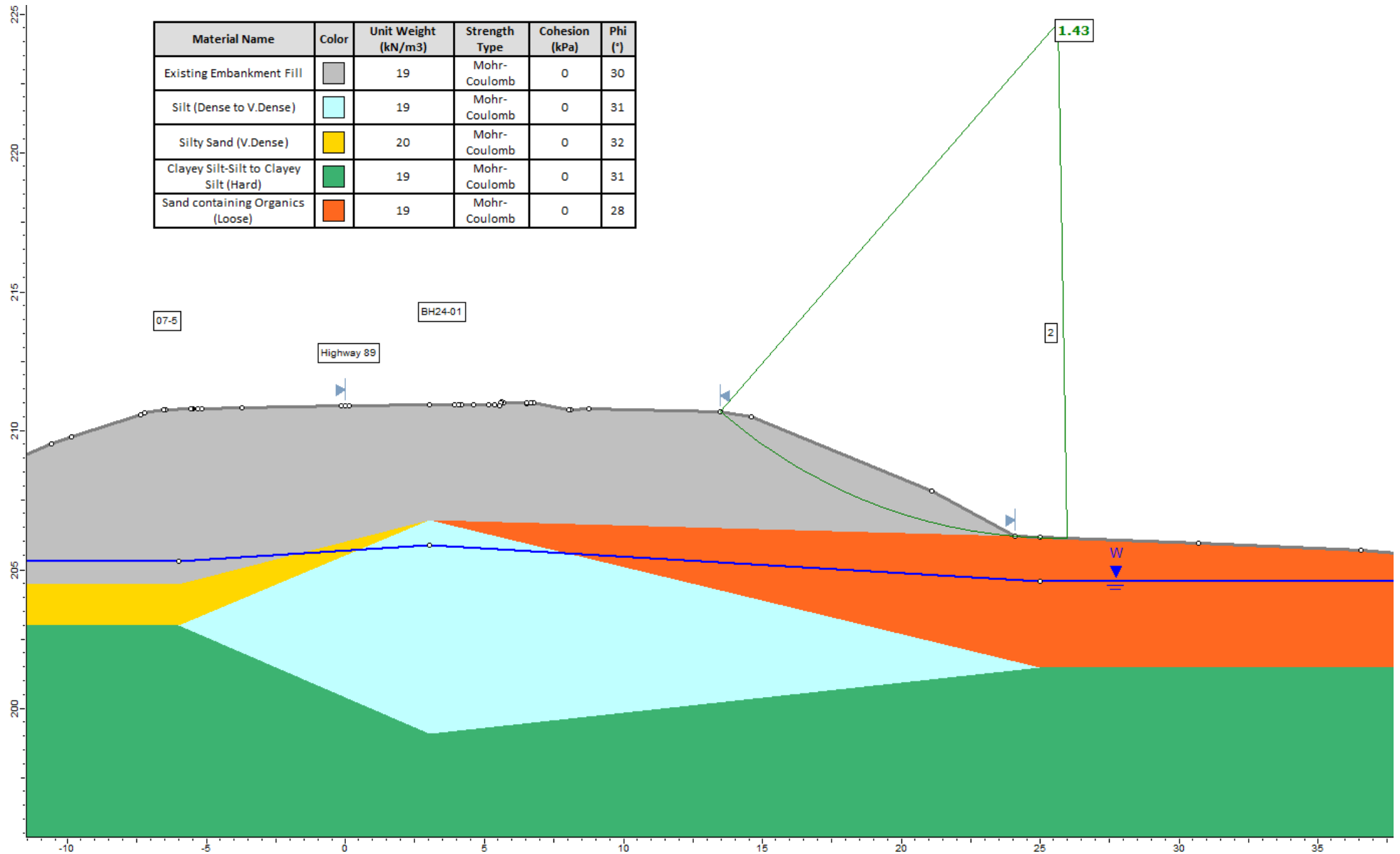
Figure F1





Global Stability Analysis Results (Long Term – Drained Condition)
Highway 89-Nottawasaga River Bridge – East Abutment, South Slope

Figure F2



APPENDIX G

Non-Standard Special Provisions

WELL DECOMMISSIONING - Item No.

Non-Standard Special Provision

Well Decommissioning

Standpipe piezometers were installed in boreholes as part of the Foundation Investigation for the bridge widening. The standpipe piezometers installed as part of the Foundation Investigation are listed below; additional information regarding installation details and location are found within the Foundation Investigation Reports.

Monitoring well information is provided below.

Standpipe Piezometer Identification	Approximate Location		PVC Pipe and Screen Diameter / Borehole Diameter	Depth (below ground surface) to Tip of Well Screen
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
BH24-01	4,891,935.66 (44.167003)	280,164.83 (-79.808044)	50 mm / 210 mm	9.7 m
BH24-02	4891911.74 (44.166785)	280087.14 (-79.809014)	50 mm / 210 mm	15.5 m

The standpipe piezometers are registered as Well Tag Number A372993. The registered owner is the Ministry of Transportation, Ontario.

The standpipe piezometers have been left in place to allow for monitoring of the groundwater levels during construction.

As part of the construction activities a Licensed Well Contractor shall properly decommission the standpipe piezometers after completion of the bridge widening construction and culvert rehabilitation works. The abandonment method for each standpipe piezometer must satisfy the minimum requirements of Ontario Regulation 903 Wells, as amended under the Ontario Water Resources Act. The Contractor must follow the abandonment process and reporting requirements in accordance with O.Reg. 903, as amended. In addition, the Contractor shall provide a written record of the decommissioning procedure to the Contract Administrator. The record shall include plugging material used, depth of plugging material and limit of PVC standpipe/screen removal.

Measure of Payment

For measurement purposes, a count shall be made of the number of standpipe piezometers decommissioned.

Basis of Payment

Payment at the contract price for this tender item shall be full compensation of all labour, equipment and materials for completion of the work.

NOTICE TO CONTRACTOR – GEOPHYSICS PVC PIPES - Item No.

Special Provision

The Contractor is notified that closed bottom PVC tubes filled with water were installed in Boreholes BH-01B and BH-02B, at the west and east abutments of the old Nottawasaga River Bridge, respectively. The approximate locations of the PVC pipes are shown in the table below. The pipes were installed to allow for geophysics testing at the Highway 89-Nottawasaga River Bridge abutments during the foundation investigation. The PVC tubes have been left in place to allow for additional testing and data collection, if required.

General borehole / casing installation information is provided below.

PVC Tube/ Borehole Identification	Approximate Locations		PVC Pipe Diameter / Borehole Diameter	Depth (below ground surface) to Bottom of PVC Tube / Borehole
	Northing (m) (Latitude, °)	Easting (m) (Longitude, °)		
BH24-01b	4,891,929.25 (44.166945)	280,163.7 (-79.808057)	50 mm / 102 mm to 165mm	19.9 m / 19.9 m
BH24-02b	4,891,909.96 (44.166769)	280,099.25 (-79.808862)	50 mm / 102 mm to 165mm	19.9 m / 19.9 m

It is anticipated that the excavation for the rehabilitation of the bridge abutment(s) will remove a portion of the PVC casing pipe in BH24-01B and BH24-02B. As a result, the contractor shall decommission the PVC pipes in BH24-01B and BH24-2B prior to excavation activities. Decommissioning of the PVC pipe could include full removal of the PVC pipe and backfill the hole with a cement-bentonite grout in general accordance with O.Reg. 903, or filling the PVC pipes with a cement-bentonite grout and cutting the pipe a minimum of 0.3 m below the base of the new approach slab.

The contractor shall provide a written record of the decommissioning procedure to the Contract Administrator. The record shall include plugging materials used, depth of plugging materials and limit of the PVC pipe removal.

All costs associated with decommissioning of the PVC pipes are to be completed at no additional cost to the owner.

