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**PRELIMINARY FOUNDATION
INVESTIGATION AND DESIGN REPORT
CULVERTS
STRUCTURE SITES 30-399, 571, 572, 573 & 415
HIGHWAY 400 WIDENING FROM 1 KM SOUTH
OF HIGHWAY 89 TO HIGHWAY 11
G.W.P. 30-95-00, AGREEMENT NO. 3005-A-000074**

Submitted to:

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December 2001

001-1143F-18

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PART A

PRELIMINARY FOUNDATION INVESTIGATION REPORT

CULVERTS

STRUCTURE SITES 30-399, 571, 572, 573 & 415

HIGHWAY 400 WIDENING FROM 1 KM SOUTH

OF HIGHWAY 89 TO HIGHWAY 11

G.W.P. 30-95-00, AGREEMENT NO. 3005-A-000074

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1.0 INTRODUCTION

Golder Associates Ltd. has been retained by URS Cole, Sherman (Cole, Sherman) on behalf of the Ministry of Transportation, Ontario (MTO) to provide preliminary foundation engineering services for the ultimate widening of Highway 400 from 1 km south of Highway 89, northerly 30 km to Highway 11, in Simcoe County, Ontario. Foundation engineering services are required for the widening and / or replacement of eighteen existing overpass and underpass structures, as well as five structural culverts.

This report addresses the five structural culverts. A foundation investigation has been carried out, in which two boreholes were advanced at each culvert location and in-situ and laboratory testing was conducted, to determine the subsurface conditions at the sites for this preliminary design study.

The terms of reference for the scope of work are outlined in Golder Associates' Proposal No. P01-1192, dated June 2000.

2.0 INVESTIGATION PROCEDURES

A subsurface investigation at the five culvert sites was carried out between October 26, 2000 and March 15, 2001, at which time ten boreholes were drilled. Boreholes C-1 and C-2 were advanced at the east and west side, respectively, of the existing culvert at Station 10+780. Boreholes C-3 and C-4 were advanced at the east and west side, respectively, of the existing culvert at Station 11+675. Boreholes C-5 and C-6 were advanced at the east and west side, respectively, of the existing culvert at Station 12+900. Boreholes C-7 and C-8 were advanced at the east and west side, respectively, of the existing culvert at Station 13+100. Boreholes C-9 and C-10 were advanced at the east and west side of the existing culvert at Station 16+730, respectively. The boreholes were advanced to between 8.1 m and 21.5 m depth below ground surface.

The investigation was carried out using a bombardier-mounted B-57 drill rig supplied and operated by Master Soil Investigations Ltd. of Weston, Ontario. The boreholes were advanced using 108 mm diameter solid stem augers. Samples of the overburden were obtained at 0.75 m to 1.5 m intervals of depth using 50 mm outside diameter split-spoon samplers in accordance with the Standard Penetration Test (SPT) procedure. The water levels in the open boreholes were observed throughout the drilling operations, and piezometers were installed in Boreholes C-1, C-4, C-5 and C-10, to permit monitoring of the groundwater levels at the site.

The field work was supervised on a full-time basis by members of our staff who located the boreholes in the field, directed the drilling, sampling, and in-situ testing operations, and logged the boreholes. The soil samples were identified in the field, placed in labelled containers and transported to Golder Associates' laboratory in Mississauga for further examination. Index and classification tests consisting of water content determinations, Atterberg Limits tests and grain size distribution analyses were carried out on selected soil samples.

The borehole locations and elevations were surveyed by Callon Dietz, Ontario Land Surveyors. The borehole elevations are referenced to geodetic datum, and the northing and easting co-ordinates are referenced to the MTM NAD83 survey system. The approximate borehole locations, together with elevations and northing and easting co-ordinates, are shown on the attached Drawings 1 to 5.

3.0 SITE GEOLOGY AND STRATIGRAPHY

3.1 Regional Geological Conditions

This 30 km section of Highway 400 traverses, from south to north, the following physiographic regions as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, Third Edition, 1984): the Simcoe Lowlands; the Peterborough Drumlin Field; a second lobe of the Simcoe Lowlands; and the Simcoe Uplands. Along Highway 400, the Simcoe Lowlands are present from the southern limit of the project to just south of Innisfil Creek (about 1 km north of Highway 89) and again from Highway 27 (Essa Road) to about 1 km north of Highway 90 (Dunlop Street). The Peterborough Drumlin Field occupies the belt between these lobes of the Simcoe Lowlands, extending from just south of Innisfil Creek to Highway 27 (Essa Road). The Simcoe Uplands extend from about 1 km north of Highway 90 (Dunlop Street) to beyond the northern limit of the project at Highway 11.

The two sections where Highway 400 crosses the Simcoe Lowlands consist of two lobes of a sand plain which include the shores of Kempenfelt Bay, the Nottawasaga River and Innisfil Creek. The surficial soils of these sections of the Simcoe Lowlands consist primarily of sand, although silt, clay or peat may be found in low-lying areas.

The surficial soils in the Peterborough Drumlin Field consist primarily of gravelly sand till or sand and gravel deposits. Drumlins (glacially-shaped hills) are more frequent in the southern portion of the section of the Peterborough Drumlin Field traversed by Highway 400. Deposits of silt, clay or peat may be found in the low-lying areas between drumlins.

The surficial soils in the Simcoe Uplands physiographic region are primarily sandy silt till deposits, known to contain occasional boulders. Low-lying areas may be infilled with shallow sand and gravel deposits, which are shoreline deposits of a former glacial lake that once flooded the area.

3.2 Site Stratigraphy

The detailed subsurface soil and groundwater conditions encountered in the boreholes, together with the results of the laboratory testing carried out on selected soil samples, are given on the Record of Borehole Sheets and Figures 1 to 4. The approximate locations and ground surface elevations for the borings are shown on the attached Drawings 1 to 5. The stratigraphic boundaries shown on the borehole records are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsoil conditions will vary between and beyond the borehole locations.

In summary, the subsoils at the sites consist of topsoil and fill overlying a deposit of hard clayey silt till. At some locations, a deposit of sand overlies the clayey silt till and at other locations, a deposit of silty sand till is present below the fill or clayey silt till. A detailed description of the subsurface conditions encountered in the boreholes at each of the culvert locations is provided in the following sections.

3.3 Culvert at Station 10+780, Structure Site 30-399

Boreholes C-1 and C-2 were drilled on the east and west sides of the existing culvert which extends under Highway 400 at Station 10+780. The ground surface at the borehole locations is at Elevations 226.5 m and 227.2 m in Boreholes C-1 and C-2, respectively. The approximate grade of Highway 400 at this location is about Elevation 228.5 m.

3.3.1 Topsoil and Fill

Between 300 mm and 600 mm of topsoil was encountered in the boreholes. In both boreholes, about 1.7 m of fill soil was encountered below the topsoil. The fill generally consists of clayey silt containing trace to some sand, trace gravel and trace to some organics. Standard Penetration Test (SPT) 'N' values of 8 and 11 blows per 0.3 m of penetration were measured in the fill, indicating that the clayey silt fill has a stiff consistency. The natural moisture content measured on one sample of the fill was about 16 percent.

3.3.2 Peat

A 1.1 m layer of fibrous peat was encountered below the fill in Borehole C-1 at about Elevation 224.2 m. The SPT 'N' value measured within the peat was 4 blows per 0.3 m of penetration indicating that the peat has a firm consistency. The natural moisture content measured on one sample of the peat was about 61 percent.

3.3.3 Sand

A 3.9 m thick deposit of sand containing some silt and trace gravel was encountered below the peat in Borehole C-1 at about Elevation 223.1 m. The SPT 'N' values measured within the sand

were between 44 and 80 blows per 0.3 m of penetration indicating that the sand has a dense to very dense relative density. The grain size distribution test result for a representative sample of this deposit is shown on Figure 1. The natural moisture content measured on samples of the sand range from 16 and 21 percent.

3.3.4 Clayey Silt Till

A deposit of clayey silt till underlies the sand in Borehole C-1 and the topsoil in Borehole C-2 at about Elevations 219.2 m and 225.1 m in the two boreholes, respectively. The till deposit extends to the maximum depth investigated (about Elevation 217 m).

The clayey silt till contains trace to some sand and gravel; the grain size distribution test result for a representative sample of this till is shown on Figure 2. The deposit also contains occasional sand seams / partings. The measured SPT 'N' values ranged from 31 blows to greater than 100 blows per 0.3 m of penetration indicating that this till deposit has a hard consistency.

The natural moisture contents measured on samples of the clayey silt till ranged from 14 to 25 percent. Atterberg Limits testing measured a plastic limit of 14 percent, a liquid limit of 32 percent, and a plasticity index of about 18 percent. The results of the Atterberg Limits testing indicate that the till is inorganic and of low plasticity.

3.4 Culvert at Station 11+675, Structure Site 30-571

Boreholes C-3 and C-4 were drilled on the east and west sides of the existing culvert which extends under Highway 400 at Station 11+675. The ground surface at the borehole locations is at Elevations 230.5 m and 230.8 m in Boreholes C-3 and C-4, respectively. The approximate grade of Highway 400 at this location is about Elevation 232.5 m.

3.4.1 Topsoil and Fill

Approximately 300 mm of topsoil was encountered below the ground surface in Borehole C-4. In Borehole C-3, 1.5 m of fill material was encountered below the ground surface. The fill consists of silty sand containing some gravel and trace organics. One SPT 'N' value measured within the fill was 3 blows per 0.3 m of penetration indicating a very loose relative density.

3.4.2 Clayey Silt

Beneath the topsoil in Borehole C-4, a 1.2 m thick layer of clayey silt with sand and trace organics was encountered. One SPT 'N' value measured within the clayey silt was 6 blows per 0.3 m of penetration indicating a firm consistency.

3.4.3 Silty Sand to Sand and Gravel

A 3.5 m thick deposit of silty sand was encountered below the clayey silt in Borehole C-4 at about Elevation 229.3 m. The silty sand contains trace clay, trace gravel and occasional clayey silt layers. The SPT 'N' values measured within the silty sand were between 10 and 77 blows per 0.3 m of penetration indicating that the silty sand has a compact to very dense relative density. The natural moisture content measured on representative samples of the deposit range from 14 to 25 percent.

The lower 0.7 m of the deposit consists of sand and gravel containing some silt and trace clay. One SPT 'N' value measured within the sand and gravel was 16 blows per 0.3 m of penetration indicating that the sand and gravel has a compact relative density.

3.4.4 Clayey Silt Till

A deposit of clayey silt till underlies the fill in Borehole C-3 and sand and gravel in Borehole C-4 at about Elevations 229.0 m and 225.8 m in the boreholes, respectively. The till deposit extends to the maximum depth investigated (between Elevations 221 m and 223 m).

The clayey silt till contains trace to some sand and gravel and occasional sand partings. The upper 4 m of the deposit in Borehole C-3 had measured SPT 'N' values ranged from 2 to 24 blows per 0.3 m of penetration indicating that this upper portion of the till deposit has a soft to very stiff consistency. Within the lower 4 m of the deposit in Borehole C-3 (below Elevation 225 m) and for the full stratum depth in Borehole C-4, the measured SPT 'N' values range from 32 blows to greater than 100 blows per 0.3 m of penetration indicating that this portion of the till has a hard consistency.

The natural moisture contents measured on samples of the clayey silt till ranged from 12 to 23 percent. Atterberg Limits testing measured plastic limits of 12 and 16 percent, liquid limits of 26 and 32 percent, and plasticity indices of 14 and 18 percent. The results of the Atterberg Limits testing indicate that the till is inorganic and of low plasticity.

In Borehole C-4, a 0.3 m thick layer of wet sand and gravel containing trace silt was present within the till deposit at about Elevation 223.5 m.

3.5 Culvert at Station 12+900, Structure Site 30-572

Boreholes C-5 and C-6 were drilled on the east and west sides of the existing culvert which extends under Highway 400 and the Service Road at Station 12+900. The ground surface at the borehole locations is at Elevation 249.9 m. The approximate grade of Highway 400 at this location is about Elevation 255.5 m.

3.5.1 Topsoil and Fill

Approximately 300 mm of topsoil was encountered below the ground surface in Borehole C-6. In both boreholes, 2.4 m to 6.9 m of fill material was encountered below the ground surface or topsoil. The fill in Borehole C-5 drilled through the Service Road consists of 0.8 m of sand and gravel underlain by 4.1 m of silty sand containing trace gravel and clay underlain by 2.0 m of sand and gravel containing trace silt and clay. In Borehole C-6, the 2.4 m of fill consisted of silty sand containing some gravel, trace clay and trace organics. The SPT 'N' values measured within the fill were between 8 and 68 blows per 0.3 m of penetration indicating a very loose to very dense relative density.

3.5.2 Clayey Silt Till

A deposit of clayey silt till underlies the fill in both boreholes at about Elevations 243.0 m and 247.2 m in Boreholes C-5 and C-6, respectively. The till deposit extends to the maximum depth investigated (Elevation 235.6 m).

The clayey silt till contains trace of sand and trace to some gravel. The SPT 'N' values measured in the till ranged from 9 blows to greater than 100 blows per 0.3 m of penetration indicating that the till has a stiff to hard consistency. In general, the SPT 'N' values are greater than 40 blows per 0.3 m of penetration indicating a hard consistency.

The natural moisture contents measured on samples of the clayey silt till ranged from 7 to 13 percent. Atterberg Limits testing measured plastic limits of 9 and 11 percent, liquid limits

of 15 and 16 percent, and plasticity indices of about 5 and 7 percent. The results of the Atterberg Limits testing indicate that the clayey silt till is inorganic and of low plasticity.

3.6 Culvert at Station 13+100, Structure Site 30-573

Boreholes C-7 and C-8 were drilled on the east and west sides of the existing culvert which extends under Highway 400 at Station 13+100. The ground surface at the borehole locations is at Elevations 255.5 m and 260.6 m in Boreholes C-7 and C-8, respectively. The approximate grade of Highway 400 at this location is about Elevation 261.5 m.

3.6.1 Fill

About 10.7 m of fill material was encountered below the ground surface in Borehole C-8 which was drilled from the Highway 400 grade. The upper 4.6 m of fill consisted of clayey silt containing some sand and trace gravel. The SPT 'N' value measured in this fill was 39 blows per 0.3 m of penetration indicating a hard consistency. The lower 6.1 m of the fill consisted of silty sand containing trace to some gravel. The SPT 'N' values measured in of this fill were about 45 blows per 0.3 m of penetration indicating a dense relative density.

3.6.2 Clayey Silt Till

A 4.6 m thick deposit of clayey silt with sand till containing trace gravel was encountered below the ground surface in Borehole C-7. The SPT 'N' values measured in the till ranged from 20 to 26 blows per 0.3 m of penetration indicating that the till has a very stiff consistency.

The natural moisture contents measured on one sample of the clayey silt till was 12 percent. Atterberg Limits testing measured a plastic limit of 10 percent, a liquid limit of 16 percent, and a plasticity index of about 6 percent. The results of the Atterberg Limits testing indicate that the clayey silt till is inorganic and of low plasticity.

3.6.3 Silty Sand Till

A deposit of silty sand till underlies the fill or clayey silt till in the boreholes at about Elevations 250.9 m and 249.9 m in Boreholes C-7 and C-8, respectively. The till deposit extends to the maximum depth investigated (between Elevations 243.1 m and 239.1 m).

The silty sand till contains trace to some clay and trace to some gravel. Grain size distribution test results for representative samples of this till are shown on Figure 3. The natural moisture contents measured on samples of the silty sand till ranged from 5 to 11 percent. The SPT 'N' values measured in the silty sand till ranged from 19 blows to greater than 100 blows per 0.3 m of penetration indicating that the till has a compact to very dense relative density. In general the deposit becomes more dense with depth.

3.7 Culvert at Station 16+730, Structure Site 30-415

Boreholes C-9 and C-10 were drilled on the east and west sides of the existing culvert which extends under Highway 400 at Station 16+730. The ground surface at the borehole locations is at Elevations 288.0 m and 291.8 m in Boreholes C-9 and C-10, respectively. The approximate grade of Highway 400 at this location is about Elevation 296.0 m.

3.7.1 Topsoil

A layer of topsoil, between 600 mm and 700 mm thick was encountered below the ground surface in both boreholes. The SPT 'N' values measured within the topsoil were 8 and 10 blows per 0.3 m of penetration.

3.7.2 Clayey Silt Till

A deposit of clayey silt till underlies the topsoil in the boreholes. The till deposit extends to the maximum depth investigated (about Elevation 279.5 m).

The clayey silt till contains some to with sand and some gravel; the grain size distribution test result for a representative sample of this till is shown on Figure 4. The measured SPT 'N' values ranged from 14 blows to greater than 100 blows per 0.3 m of penetration, but typically greater than 40 bows per 0.3 m of penetration indicating that the till has a hard consistency.

The natural moisture contents measured on samples of the clayey silt till range from 6 to 8 percent. Atterberg Limits testing measured plastic limits of 9 and 10 percent, liquid limits of 15 and 17 percent, and plasticity indices of 5 and 7 percent. The results of the Atterberg Limits testing indicate that the clayey silt till is inorganic and of low plasticity.

3.8 Groundwater Conditions

The water levels in the boreholes were observed during and upon completion of drilling. Piezometers were installed in Boreholes C-1, C-5 and C-10 and sealed into the clayey silt till. A piezometer was installed in Borehole C-4 and was sealed into the silty sand to sand and gravel deposit. The details of the piezometer installations are shown on the Record of Borehole Sheets and the results of the water level readings are given in the table below.

| Culvert Location | Borehole Number | Water Level On Completion of Drilling | | Water Level in Piezometer | | | | | |
|------------------|-----------------|---------------------------------------|---------------|---------------------------|---------------|----------------|---------------|---------------|---------------|
| | | | | After Installation | | March 19, 2001 | | June 19, 2001 | |
| | | Depth (m) | Elevation (m) | Depth (m) | Elevation (m) | Depth (m) | Elevation (m) | Depth (m) | Elevation (m) |
| 10+780 | C-1 | 6.6 | 221.9 | --- | --- | 3.6 | 224.9 | --- | --- |
| | C-2 | Dry | --- | N/A | N/A | N/A | N/A | N/A | N/A |
| 11+675 | C-3 | 4.6 | 225.9 | N/A | N/A | N/A | N/A | N/A | N/A |
| | C-4 | 2.3 | 228.5 | 4.1 | 226.7 | 1.4 | 229.4 | --- | 229.4 |
| 12+900 | C-5 | --- | --- | 6.9 | 243.0 | 5.3 | 244.6 | --- | 244.6 |
| | C-6 | 4.1 | 245.8 | N/A | N/A | N/A | N/A | N/A | N/A |
| 13+100 | C-7 | 4.6 | 250.9 | N/A | N/A | N/A | N/A | N/A | N/A |
| | C-8 | --- | --- | N/A | N/A | N/A | N/A | N/A | N/A |
| 16+730 | C-9 | 5.2 | 282.8 | N/A | N/A | N/A | N/A | N/A | N/A |
| | C-10 | 3.3 | 288.5 | 11.4 | 280.4 | --- | --- | 2.6 | 289.2 |

It should be noted that groundwater levels are expected to fluctuate seasonally and are expected to be higher during wet periods of the year.

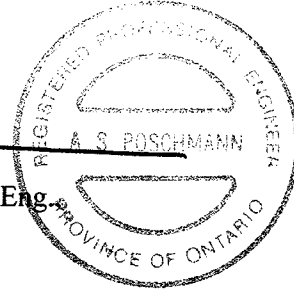
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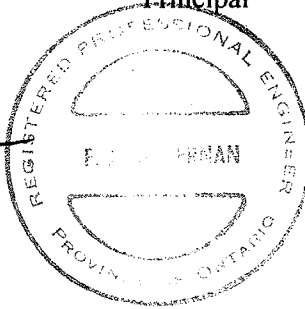
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PART B

**PRELIMINARY FOUNDATION DESIGN REPORT
CULVERTS**

**STRUCTURE SITES 30-399, 571, 572, 573 & 415
HIGHWAY 400 WIDENING FROM 1 KM SOUTH
OF HIGHWAY 89 TO HIGHWAY 11
G.W.P. 30-95-00, AGREEMENT NO. 3005-A-000074**

4.0 ENGINEERING RECOMMENDATIONS

4.1 General

This section of the report provides preliminary foundation design recommendations for the widening and / or replacement of five structural culverts, associated with the widening of Highway 400. The recommendations are preliminary only and are based on interpretation of the factual data obtained from a limited number of boreholes advanced during the subsurface investigation at this site. The interpretation and recommendations provided are intended for planning purposes only, to provide the information necessary at this stage of the study. As such, where comments are made on construction they are provided only in order to highlight those aspects which could affect the planning of the project. Further foundation investigation will be required at these culvert sites as part of the detailed design stage of the project.

It is understood that Highway 400 will be widened from its existing six-lane configuration to an interim configuration of eight-lanes, and an ultimate configuration of ten-lanes, and that an alternative for a twelve-lane express / collector system is under consideration between Molson Park Drive and Duckworth Street in Barrie. Throughout the project length, it is expected that the existing highway platform will be widened by between 13 m and 30 m. Widening and / or replacement of five structural culverts in the area will be necessary.

The Highway 400 grade at the sites varies from Elevation 228.5 m at the southernmost site to about Elevation 296.0 m at the northernmost culvert site.

4.2 Foundation Options, Culvert at Station 10+780

The soils at the east side of the site consist of topsoil and fill overlying a peat deposit which is underlain by a dense to very dense sand deposit in turn underlain by hard clayey silt till. On the west side of the existing structure, the topsoil and fill is underlain by hard clayey silt till. Based on these subsurface conditions, it is recommended that the widening or replacement structure be supported on the hard clayey silt till or the dense to very dense sand.

The use of deep foundations is not recommended at this site due to the presence of suitable material at or just below the founding elevation of the existing culverts.

The invert of the existing twin corrugated steel pipe arch (CSPA) culverts varies between Elevation 224.4 m on the east side of Highway 400 to Elevation 224.1 m on the west side. Just north of the twin culverts exists a corrugated steel pipe (CSP) culvert with an invert at about Elevation 223.5 m. For preliminary design of the culvert, it is recommended that the peat deposit

as encountered on the east side of the highway extending to about Elevation 223.1 m, be sub-excavated and replaced as required. At the west side, with the base of the culvert at or below Elevation 224.4 m, the culvert will be founded on the hard clayey silt.

4.2.1 Axial Geotechnical Resistance

For the culvert founded on the properly prepared clayey silt till or on compacted granular placed on the underlying very dense sand deposit, a factored geotechnical resistance at Ultimate Limit States (ULS) of 600 kPa may be assumed. The geotechnical resistance at Serviceability Limit States (SLS) may be taken as 400 kPa. The geotechnical resistance at SLS will have to be reviewed following the detailed design stage of subsurface investigation once the culvert size, configuration and loadings are known.

4.3 Foundation Options, Culvert at Station 11+675

The soils on the east side of the existing structure consist of fill which is underlain by clayey silt till which has a firm to hard consistency below Elevation 228 m but is soft above this elevation. The soils at the west side of the site consist of topsoil overlying a deposit of compact to very dense silty sand to sand and gravel which is underlain by hard clayey silt till. Based on these subsurface conditions, it is recommended that the widening or replacement structure be founded on the compact silty sand or the firm clayey silt till. There is potential for differential settlement along the culvert due to the presence of the firm upper portion of the till on the east side. In this regard, consideration could be given to sub-excavating the firm clayey silt till to Elevation 226 m and replacing with compacted granular.

The use of deep foundations is not recommended at this site due to the presence of suitable material at or just below the founding elevation of the existing culvert.

The invert of the existing corrugated steel pipe arch (CSPA) culvert varies between 228.7 m on the east side of Highway 400 to 228.0 m on the west side. The soft clayey silt till must be sub-excavated to at least Elevation 228 m on the east side of the highway. The founding soils will therefore vary from firm to very stiff clayey silt till on the east side of the highway to compact silty sand on the west side.

4.3.1 Axial Geotechnical Resistance

For the culvert founded on the properly prepared compact silty sand or firm to very stiff clayey silt till deposits at or below Elevation 228.0 m a factored geotechnical resistance at Ultimate Limit States (ULS) of 450 kPa may be assumed. For preliminary design purposes, the geotechnical resistance at Serviceability Limit States (SLS) may be taken as 300 kPa. The geotechnical resistance at SLS will have to be reviewed following the detailed design stage of subsurface investigation, once the culvert size, configuration and loadings are known.

For the option of sub-excavating and replacing the firm clayey silt till (to Elevation 226 m) on the east side of the highway, a factored geotechnical resistance at ULS of 600 kPa and a corresponding SLS value of 450 kPa may be assumed.

4.4 Foundation Options, Culvert at Station 12+900

The soils at the site of the existing culvert structure consist of topsoil and fill underlain by generally hard clayey silt till.

The invert of the existing concrete box culvert varies between Elevation 245.2 m on the east side of the Service Road to Elevation 245.4 m on the west side of Highway 400. These invert levels are within the hard clayey silt till on the west side of the highway; however, sand and gravel fill was found extending from the culvert invert level to Elevation 243 m on the east side. This fill may be related to the existing culvert or the Service Road construction. For preliminary design, it should be assumed that sub-excavation to Elevation 243 m and replacement will be required on the east side of the highway.

The use of deep foundations is not recommended at this site due to the presence of suitable material at or just below the founding elevation of the existing culvert.

4.4.1 Axial Geotechnical Resistance

For the box culvert on the properly prepared hard clayey silt till deposit or on compacted granular fill placed on the underlying till, a factored geotechnical resistance at Ultimate Limit States (ULS) of 600 kPa may be assumed. For preliminary design purposes, the geotechnical resistance at Serviceability Limit States (SLS) may be taken as 400 kPa. The geotechnical resistance at SLS will have to be reviewed following the detailed design stage of subsurface investigation, once the culvert size, configuration and loadings are known.

4.5 Foundation Options, Culvert at Station 13+100

At the west end of the existing culvert, compact to very dense silty sand till is expected at and below about Elevation 250 m. At the east end of the culvert, a layer of very stiff clayey silt till is present below the ground surface and overlies the silty sand till encountered at Elevation 251 m. The invert of the existing concrete box culvert varies between Elevation 252.2 m on the east side of Highway 400 to Elevation 250.0 m on the west side. Based on the subsurface conditions encountered the widening or replacement structure will be founded within the compact to very dense silty sand till and / or very stiff clayey silt till.

The use of deep foundations is not recommended at this site due to the presence of suitable material at or just below the founding elevation of the existing culvert.

4.5.1 Axial Geotechnical Resistance

For the box culvert placed at or below Elevation 252 m on the east side and 250 m on the west side, a factored geotechnical resistance at Ultimate Limit States (ULS) of 450 kPa may be used. For preliminary design purposes, the geotechnical resistance at Serviceability Limit States (SLS) may be taken as 300 kPa. The road embankment is up to about 10 m in height in the vicinity of the culvert, and the embankment loading itself will have an impact on the settlement. The geotechnical resistance at SLS will have to be reviewed following the detailed design stage of subsurface investigation, once the footing size, configuration and loadings are known.

4.6 Foundation Options, Culvert at Station 16+730

The soils at the site of the existing culvert structure consist of topsoil underlain by generally hard clayey silt till. Based on these subsurface conditions, it is recommended that the widening or replacement structure be founded on spread footings placed on the hard clayey silt till. The invert of the existing concrete arch culvert varies between Elevation 285.5 m on the east side of Highway 400 to Elevation 286.0 m on the west side. A design founding level at or below these invert levels will be within the hard clayey silt till. Preliminary recommendations for spread footings are provided in the following sections.

The use of deep foundations is not recommended at this site due to the presence of suitable material at or just below the founding elevation of the existing culvert.

4.6.1 Axial Geotechnical Resistance

Spread footings placed on the properly prepared hard clayey silt till deposit at the design elevations given above may be designed using a factored geotechnical resistance at Ultimate Limit States (ULS) of 650 kPa. This value assumes a footing width of 2 m and founding depth of 1.5 m. The settlement of footings founded on the clayey silt till will be dependent on the footing size and configuration, and on the applied loads. For preliminary design purposes, the geotechnical resistance at Serviceability Limit States (SLS) may be taken as 450 kPa. The geotechnical resistance at SLS will have to be reviewed following the detailed design stage of subsurface investigation, once the footing size, configuration and loadings are known.

The geotechnical resistances provided herein are given under the assumption that the loads will be applied perpendicular to the surface of the footings; where the load is not applied perpendicular to the surface of the footing, inclination of the load should be taken into account in accordance with the Ontario Highway Bridge Design Code (OHBD).

4.6.2 Resistance to Lateral Loads

Resistance to lateral forces / sliding resistance between the concrete footing and the subsoils should be calculated in accordance with Section 6-8.4.3 of the OHBD. The angle of friction between the concrete footings and the undisturbed hard clayey silt till founding soil should be taken as 25 degrees; the corresponding coefficient of friction, $\tan \delta$, would be 0.47.

4.6.3 Frost Protection

The footings should be provided with a minimum of 1.5 m of soil cover for frost protection.

4.7 Frost Protection

The design frost depth for the five culvert sites is 1.5 m.

4.8 Pipe Culverts, Bedding and Backfill

Circular pipe and pipe arch culverts should be designed for the full overburden pressure and live load assuming a soil unit weight of 21 kN/m³.

The culverts should be provided with at least 400 mm of OPSS Granular 'A' bedding shaped to the underside of the pipe culverts. In accordance with OHBDC Clause 7-8.4, a 200 mm layer of that portion of the bedding which is in direct contact with the pipe arch should be left uncompacted to allow proper embedment of the pipe profile. The remaining portion of the bedding should be compacted to at least 95 percent of the Standard Proctor maximum dry density using suitable vibratory compaction equipment. Specifications provided by the pipe manufacturer with respect to bedding requirements should be adhered to if different from the above general requirements. The minimum depth of bedding will depend on the size of the pipe and should adhere to the manufacturer's specifications.

The backfill to the culvert should be free-draining granular fill meeting the specifications of OPSS Granular 'A' or Granular 'B', Type II but with less than 5 percent passing the 200 sieve. Adequate and careful compaction of the backfill under the haunches is essential for the performance of the culvert. The backfill should be placed in lifts not exceeding 200 mm loose thickness and compacted to 95 percent Standard Proctor dry density. The fill depth during placement should be maintained equal on both sides of the culvert with one side not exceeding the other by more than 400 mm.

Backfill to the culverts should be in accordance with OPSD 803.010 and 803.02. For general backfilling within the future roadway limits, granular fill meeting the specifications for OPSS Granular B Type 2 should be used. Representative samples of the materials proposed for use should be submitted to a qualified laboratory for suitable testing and determination of laboratory Proctor values prior to placement and compaction. Inspection and testing should be carried out by qualified geotechnical personnel during fill placement and compaction.

Since the performance of the arch culvert is highly dependant on the compaction of the haunches, equipment restrictions exist. The suppliers' specifications should be followed with respect to compaction equipment tolerances in close proximity to the culvert. As a guide, small air operated tampers or vibrating pads are typically required for the compaction of the fill within 300 mm of the culvert sides while hand rollers or packers are typically specified for distances of up to 1.5 m from the culvert sides. Heavier compactors may generally be used for compaction of the remaining areas. Inspection and field density testing should be carried out by qualified geotechnical personnel during all earthfill placement operations to ensure that appropriate materials are used and adequate levels of compaction have been achieved.

4.9 Lateral Earth Pressures

The lateral pressures acting on the concrete arch culvert extensions for the culvert at Station 16+730 will depend on the type and method of placement of the backfill materials, on the nature of the soils behind the backfill and on the subsequent lateral movement of the structure. The following recommendations are made concerning the design of the abutments, in accordance with the OHBDC:

- Select free-draining granular fill meeting the specifications of OPSS Granular 'A' or Granular 'B' but with less than 5 percent passing the 200 sieve should be used as backfill behind the walls. This fill should be compacted in loose lifts not greater than 200 mm in thickness to 95 percent of the material's Standard Proctor maximum dry density in accordance with OPSS501. Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill. Other aspects of the culvert granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD 803.010 and 803.02.
- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the culvert, in accordance with OHBDC Figure 6-7.4.3. Compaction equipment should be used in accordance with OPSS 501.06.
- The granular fill may be placed either in a zone with width equal to at least 1.5 m behind the back of the stem (Case I from OHBDS Figure 6-7.4.1) or within the wedge-shaped zone defined by a line drawn at 1.5 horizontal to 1 vertical (1.5H:1V) extending up and back from the footing (Case II from OHBDS Figure 6-7.4.3).
- For Case I, the pressures are based on the existing and proposed embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight: 20 kN/m³

Coefficients of lateral earth pressure:

| | |
|----------------|------|
| Active, K_a | 0.35 |
| At rest, K_o | 0.50 |

- For Case II, the pressures are based on the granular fill as placed and the following parameters (unfactored) may be assumed:

| | Granular 'A' | Granular 'B' Type II |
|---|----------------------|---------------------------------|
| Soil unit weight: | 22 kN/m ³ | 21 kN/m ³ |
| Coefficients of lateral earth pressure: | | |
| Active, K_a | 0.27 | 0.31 |
| At rest, K_o | 0.43 | 0.47 |

- If the wall support allows lateral yielding of the stem, active earth pressures may be used in the geotechnical design of the structure. If the culvert support does not allow lateral yielding, at-rest earth pressures should be assumed for geotechnical design.

It should be noted that the above design recommendations and parameters assume level backfill and ground surface behind the culvert walls. Where there is sloping ground behind the walls (i.e. sloping upwards away from the culvert), the coefficient of lateral earth pressure must be increased to account for the slope.

4.10 Erosion Protection

Erosion protection to the culvert should be provided as appropriate. Consideration could be given to use of suitable non-woven geotextiles and rip-rap as required to provide erosion protection based on hydraulic requirements. An upstream clay seal and / or a cut-off wall should be provided to control seepage through the bedding below the culvert. The material specification for a clay seal should be as per OPSS 1205. In addition, sediment control such as silt fences, erosion control blanket may be required during construction and diversion of the creek to mitigate migration of fine soil particles in to the creek.

4.11 Construction Considerations

4.11.1 Subgrade Protection

For protection of the founding stratum a working mat of lean concrete should be placed as soon as practical after reaching the base of the excavation and following completion of inspection. This mat could be 150 mm thick and could serve as the bedding for the culvert provided drainage

under the culvert is not required and provided that an adequate level surface can be achieved with the lean concrete. Where drainage is required or where additional levelling is required, granular bedding should be provided.

4.11.2 Dewatering

Groundwater seepage into the excavations for culvert construction should be expected particularly at the sites where water-bearing deposits are present or interlayers of granular soil are present within the till deposits. In general, pumping from properly-filtered sumps or a filtered drain placed at the base of the excavation should provide sufficient groundwater control during foundation works. The creek / ditch waters will have to be diverted in order to permit construction in the dry. Surface water run-off, which is expected to be more significant than groundwater seepage, should be directed away from the footing excavations.

On the east side of the culvert at Station 10+780, sub-excavation of the peat to the surface of the sand will be extended some 2 m below the measured groundwater level. Dewatering will be required at this site to allow proper compaction on the granular backfill material.

Depending on the time of year for construction, the groundwater level at the culvert at Station 11+675 may be up to 1.5 m above the proposed founding level. In this case, groundwater control/dewatering would be required to maintain the integrity of the founding stratum. Groundwater control could consist of closed steel sheeting driven into the underlying clayey silt till.

The clayey silt till soils in which the some of the footing excavations will be formed are susceptible to disturbance from ponded water and construction traffic. Provision should be made in the Contract Documents for the placement of a lean concrete mat to protect the soils from such disturbance.

4.11.3 Excavation

Culvert at Station 10+780

Based on the results of the investigation, the excavations may extend to a depth of up to 5.5 m below existing grade, through clayey silt fill, peat, and clayey silt till. Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act for Construction Activities. The fill and peat would be classified as Type 3

soil and the hard clayey silt till soils would be classified as Type 1 soil. Temporary open-cut slopes should therefore be maintained no steeper than 2 horizontal to 1 vertical (2H:1V) through the sand and fills and 1H:1V through the till. Where space restrictions dictate, excavations could also be carried out within a braced excavation or trench box.

Culvert at Station 11+675

Based on the results of the investigation, the excavations may extend to a depth of up to 5.5 m below existing grade. The excavation would extend through silty sand fill, clayey silt, silty sand and clayey silt till. Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act for Construction Activities. The fill would be classified as Type 3 soils. The clayey silt and silty sand would be classified as Type 4 soil. Temporary open-cut slopes should therefore be maintained no steeper than 3 horizontal to 1 vertical (3H:1V) through the clayey silt and sand deposits and 2H:1V through the fill. Where space restrictions dictate, excavations could also be carried out within a braced excavation or trench box.

Culvert at Station 12+900

Based on the results of the investigation, the excavations may extend to a depth of up to 12.5 m below existing grade depending on the proximity to the existing embankment. The excavation would extend through silty sand to sand and gravel fill and stiff to hard clayey silt till. Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act for Construction Activities. The stiff to hard clayey silt till soils would be classified as Type 1 soil. The fill deposits would be classified as Type 3 soil. Temporary open-cut slopes should therefore be maintained no steeper than 2 horizontal to 1 vertical (2H:1V) through fill and 1H:1V through the till. Where space restrictions dictate, excavations could also be carried out within a braced excavation or trench box.

Culvert at Station 13+100

Based on the results of the investigation, the excavations will extend to a depth of up to 11.5 m below existing grade depending on the proximity to the existing embankment. The excavation would extend through clayey silt to silty sand fill, very stiff clayey silt till and compact to very

dense silty sand till. Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act for Construction Activities. The very stiff clayey silt till and compact to very dense silty sand till soils would be classified as Type 1 soil. The fill would be classified as Type 3 soil. Temporary open-cut slopes should therefore be maintained no steeper than 2 horizontal to 1 vertical (2H:1V) through fill and 1H:1V through the tills. Where space restrictions dictate, excavations could also be carried out within a braced excavation or trench box.

Culvert at Station 16+730

Based on the results of the investigation, excavations for culvert footing construction will extend to a depth of up to 2.5 m below existing grade. The excavations would generally extend through stiff to hard clayey silt till. Excavations should be carried out in accordance with the guidelines outlined in the latest edition of the Occupational Health and Safety Act for Construction Activities. The clayey silt till soils would be classified as Type 1 soil. Temporary open-cut slopes should therefore be maintained no steeper than 1 horizontal to 1 vertical (1H:1V) through the tills. Where space restrictions dictate, footing excavations could also be carried out within a braced excavation or trench box.

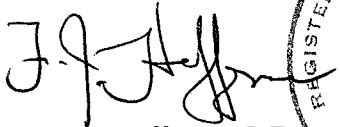
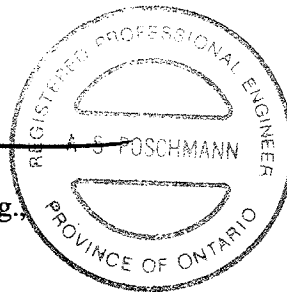
GOLDER ASSOCIATES LTD.



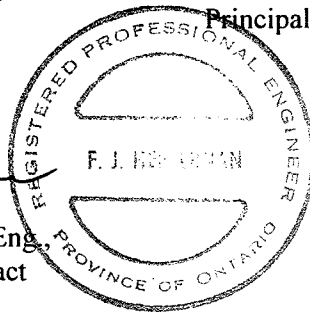
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SEMP/ASP/FJH/clg

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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 |

III. SOIL DESCRIPTION

(a) Cohesionless Soils

| Density Index (Relative Density) | N 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 |

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.)

(b) Cohesive Soils

| Consistency | c_u, s_u kPa | 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 |

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.

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 ($\sigma' = \sigma - u$) |
| σ'_{vo} | initial effective overburden stress |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stresses (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 |
| * | Density symbol is ρ . Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density x acceleration due to gravity) |

(a) Index Properties (con't.)

| | |
|-----------|--|
| 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) |

(c) 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 |

(d) Consolidation (one-dimensional)

| | |
|-------------|--|
| C_c | compression index (normally consolidated range) |
| C_r | recompression index (overconsolidated range) |
| C_s | swelling index |
| C_α | 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 | Overconsolidation ratio $= \sigma'_p / \sigma'_{vo}$ |

(e) Shear Strength

| | |
|------------------|--|
| τ_p, τ_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 |

Notes: 1. $\tau = c' + \sigma' \tan \phi'$

2. Shear strength = (Compressive strength)/2

| PROJECT 001-1143F | | | RECORD OF BOREHOLE No C-1 | | | 1 OF 1 | | | METRIC | | |
|----------------------|---|------------|---|------|------------|--|-----------------|---|---|------------------|-------------|
| W.P. 30-95-00 | | | LOCATION N 4896326.9; E 292177.2 | | | ORIGINATED BY PKS | | | | | |
| DIST Central HWY 400 | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | COMPILED BY LCC | | | | | |
| DATUM Geodetic | | | DATE Oct.26/2000 | | | CHECKED BY ASP | | | | | |
| SOIL PROFILE | | | SAMPLES | | | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | | PLASTIC NATURAL LIQUID UNIT REMARKS & GRAIN SIZE DISTRIBUTION (%) | | |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | GROUND WATER CONDITIONS | ELEVATION SCALE | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED | WATER CONTENT (%) W _p W W _L | UNIT WEIGHT γ | GR SA SI CL |
| 226.5 | GROUND SURFACE | | | | | | | | | | |
| 0.0 | Topsoil | | 1 | AS | | | 226 | | | | |
| 225.9 | Clayey Silt, trace to some sand, trace gravel, trace to some organics (Fill) Stiff Brown Moist | | 2 | SS | 11 | | 225 | | | | |
| 0.6 | | | 3 | SS | 8 | | | | | | |
| | | | | | | | | | | | |
| 224.2 | Fibrous Peat Firm Black Moist | | 4 | SS | 4 | | 224 | | | | |
| 2.3 | | | 5 | SS | 66 | | 223 | | | | |
| 223.1 | Sand, some silt, trace gravel Dense to very dense Grey Wet | | 6 | SS | 80 | | 222 | | | | |
| 3.4 | | | 7 | SS | 65 | | 221 | | | | |
| | | | 8 | SS | 44 | | 220 | | | | |
| | | | 9 | SS | 57 | | 219 | | | | |
| 219.2 | Clayey Silt, trace sand and gravel, occasional sand seams/partings (Till) Hard Grey Moist | | 10 | SS | 111 | | 217 | | | | |
| 7.3 | | | | | | | | | | | |
| 216.9 | END OF BOREHOLE | | | | | | | | | | |
| 9.6 | | | | | | | | | | | |

ON_MOT 0011143F.GPJ ON_MOT.GDT 25/9/01

| PROJECT 001-1143F | | | | RECORD OF BOREHOLE No C-2 | | | | 1 OF 1 | | METRIC | | | | | |
|----------------------|--|------------|---------|---|------------|----------------------------|-----------------|---|--|--------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| W.P. 30-95-00 | | | | LOCATION N 4896322.8; E 292130.0 | | | | ORIGINATED BY AZ | | | | | | | |
| DIST Central HWY 400 | | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | | COMPILED BY LCC | | | | | | | |
| DATUM Geodetic | | | | DATE Nov. 1/2000 | | | | CHECKED BY ASP | | | | | | | |
| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED | | | | | | | |
| 227.2 | GROUND SURFACE | | | | | | | | | | | | | | |
| 0.0 | Topsoil | | 1 | SS | 7 | | 227 | | | | | | | | |
| 0.3 | Clayey Silt, some sand (Fill) | | | | | | 226 | | | | | | | | |
| 225.1 | | | | | | | 225 | | | | | | | | |
| 2.1 | Clayey Silt, some sand, trace gravel (Till) Hard Grey Moist | | 2 | SS | 37 | | 224 | | | | | | | | |
| | | | 3 | SS | 54 | | 223 | | | | | | | | 2 11 55 32 |
| | | | 4 | SS | 55 | | 222 | | | | | | | | |
| | | | 5 | SS | 46 | | 221 | | | | | | | | |
| | | | 6 | SS | 37 | | 220 | | | | | | | | |
| | | | 7 | SS | 31 | | 219 | | | | | | | | |
| | | | 8 | SS | 33 | | 218 | | | | | | | | |
| 217.4 | END OF BOREHOLE | | | | | | | | | | | | | | |
| 9.8 | Note: 1. Open borehole dry upon completion of drilling. | | | | | | | | | | | | | | |

ON_MOT_0011143F.GPJ ON_MOT_GDI 25/9/01

| PROJECT 001-1143F | | | | RECORD OF BOREHOLE No C-3 | | | | 1 OF 1 | | METRIC | | | | |
|---|--|------------|---------|---|------------|----------------------------|--------------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| W.P. 30-95-00 | | | | LOCATION N 4897209.0; E 291968.1 | | | | ORIGINATED BY AZ | | | | | | |
| DIST Central HWY 400 | | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | | COMPILED BY LCC | | | | | | |
| DATUM Geodetic | | | | DATE Oct.26/2000 | | | | CHECKED BY ASP | | | | | | |
| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | *N* VALUES | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED | | | | | | |
| 230.5 | GROUND SURFACE | | | | | | | | | | | | | |
| 0.0 | Silty Sand, some gravel, trace organics (Fill) Very loose Brown Moist | | 1 | | | | 230 | | | | | | | |
| | | | 2 | SS | 3 | | 229 | | | | | | | |
| 229.0 | | | | | | | | | | | | | | |
| 1.5 | Clayey Silt, trace to some sand, trace gravel (Till) Soft to very stiff Grey Moist | | 3 | SS | 2 | | 228 | | | | | | | |
| | | | 4 | SS | 15 | | | | | | | | | |
| | | | 5 | SS | 8 | | 227 | | | | | | | |
| | | | 6 | SS | 7 | | | | | | | | | |
| | | | 7 | SS | 24 | | 226 | | | | | | | |
| 225.0 | | | | | | | | | | | | | | |
| 5.5 | Clayey Silt, trace sand and gravel, occasional sand partings (Till) Hard Grey Moist | | 8 | SS | 104 | | 224 | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 9 | SS | 68 | | 223 | | | | | | | |
| | | | | | | | 222 | | | | | | | |
| 220.9 | | | 10 | SS | 96 | | 221 | | | | | | | |
| 9.6 | END OF BOREHOLE | | | | | | | | | | | | | |
| Note: 1. Water level in open borehole at 4.6m depth (Elev.225.9m) upon completion of drilling. | | | | | | | | | | | | | | |

ON_MOT_0011143F.GPJ ON_MOT.GDT 25/9/01

| PROJECT 001-1143F | | | | RECORD OF BOREHOLE No C-4 | | | | 1 OF 1 | | METRIC | | | | |
|----------------------|---|------------|---------|---|------------|----------------------------|-----------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| W.P. 30-95-00 | | | | LOCATION N 4897193.6; E 291920.1 | | | | ORIGINATED BY AZ | | | | | | |
| DIST Central HWY 400 | | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | | COMPILED BY LCC | | | | | | |
| DATUM Geodetic | | | | DATE Oct.31/2000 | | | | CHECKED BY ASP | | | | | | |
| 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 | | | | | | |
| 230.8 | GROUND SURFACE | | | | | | | | | | | | | |
| 0.0 | Topsoil | | | | | | | | | | | | | |
| 230.5 | | | | | | | | | | | | | | |
| 0.3 | Clayey Silt with sand, trace organics Firm Brown Moist | | 1 | SS | 6 | | 230 | | | | | | | |
| 229.3 | | | | | | | | | | | | | | |
| 1.5 | Silty Sand, trace clay, trace gravel, occ. clayey silt layers Compact to very dense Brown to grey Moist to wet | | 2 | SS | 12 | | 229 | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 3 | SS | 10 | | 228 | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 4 | SS | 20 | | 227 | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 5 | SS | 77 | | 226 | | | | | | | |
| 226.5 | | | | | | | | | | | | | | |
| 4.3 | Sand and Gravel, some silt, trace clay Compact Grey | | 6 | SS | 16 | | 225 | | | | | | | |
| 225.8 | | | | | | | | | | | | | | |
| 5.0 | Wet Clayey Silt, trace to some sand, trace gravel (Till) Very stiff to hard Grey Moist | | | | | | | | | | | | | |
| | | | 7 | SS | 32 | | 224 | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 8 | SS | 38 | | 223 | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 9 | SS | 60 | | | | | | | | | |
| 222.6 | | | | | | | | | | | | | | |
| 8.2 | END OF BOREHOLE | | | | | | | | | | | | | |
| | Notes: 1. Water level in open borehole at 2.3m depth (Elev.228.5m) upon completion of drilling. 2. Water level in piezometer after installation at 4.1m depth (Elev.226.7m). 3. Water level in piezometer at 1.4m depth (Elev.229.4m) on March 19, 2001. | | | | | | | | | | | | | |

ON_MOT 0011143F.GPJ ON_MOT.GDT 25/9/01

ON_MOT 0011143F.GPJ ON_MOT.GDT 25/9/01

+3, X3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

ON_MOT 0011143F.GPJ ON_MOT.GDT 25/9/01

+³, X³: Numbers refer to Sensitivity ○^{3%} STRAIN AT FAILURE

| | | | | | |
|----------------------|---|----------------------------------|--|--------|---------------|
| PROJECT 001-1143F | | RECORD OF BOREHOLE No C-6 | | 1 OF 2 | METRIC |
| W.P. 30-95-00 | LOCATION N 4898408.7; E 291680.3 | ORIGINATED BY AZ | | | |
| DIST Central HWY 400 | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | COMPILED BY LCC | | | |
| DATUM Geodetic | DATE Oct.31/2000 | CHECKED BY ASP | | | |

| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
|---------------|---|------------|---------|------|-----------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | *N VALUES | | | SHEAR STRENGTH kPa | WATER CONTENT (%) | | | | | |
| 249.9 | GROUND SURFACE | | | | | | | | | | | | | |
| 249.8 | Topsoil | | 1 | SS | 10 | | | | | | | | | |
| 0.3 | Silty Sand, some gravel, trace clay, trace organics (Possible Fill) Compact Brown Moist | | | | | | | | | | | | | |
| 247.2 | | | | | | | | | | | | | | |
| 2.7 | Clayey Silt, with to some sand, trace to some gravel (Till) Stiff to hard Brown becoming grey at 5.3m depth Moist | | 2 | SS | 9 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 3 | SS | 40 | | | | | | | | | |
| | | | 4 | SS | 53 | | | | | | | | | |
| | | | 5 | SS | 70 | | | | | | | | | |
| | | | 6 | SS | 53 | | | | | | | | | |
| | | | 7 | SS | 103 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 8 | SS | 61 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 9 | SS | 130 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 10 | SS | 98 | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | 11 | SS | 110 | | | | | | | | | |
| 235.6 | | | | | | | | | | | | | | |
| 14.3 | | | | | | | | | | | | | | |

ON_MOT 0011143F.GPJ ON_MOT.GDT 25/9/01

Continued Next Page

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

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

ON MOT 0011143F.GPJ ON MOT.GDT 25/9/01

| | | | | | |
|----------------------|---|----------------------------------|--|--------|---------------|
| PROJECT 001-1143F | | RECORD OF BOREHOLE No C-7 | | 1 OF 1 | METRIC |
| W.P. 30-95-00 | LOCATION N 4898636.1; E 291670.5 | ORIGINATED BY PKS | | | |
| DIST Central HWY 400 | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | COMPILED BY LCC | | | |
| DATUM Geodetic | DATE Oct.30/2000 | CHECKED BY ASP | | | |

| SOIL PROFILE | | | SAMPLES | | | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT | | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT | | | UNIT WEIGHT γ kN/m³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|---------------|--|------------|---------|-------|-----------|----------------------------|-----------------|---|-----------------------------|---|---|----------------|-----------------------------------|---|
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | *N VALUES | | | SHEAR STRENGTH kPa | | WATER CONTENT (%) | | | | |
| | | | | | | | | ○ UNCONFINED ● QUICK TRIAXIAL | + FIELD VANE x REMOULDED | w _p | w | w _L | | |
| 255.5 | GROUND SURFACE | | | | | | 20 40 60 80 100 | | | | | | | GR SA SI CL |
| 0.0 | Clayey Silt with sand, trace gravel (Till) Very Stiff Grey-brown Moist | | | | | ▽ | 255 | | | | | | | 4 59 34 3 |
| | | | 1 | SS | 20 | | 254 | | | | | | | |
| | | | | | | | 253 | | | | | | | |
| | | | 2 | SS | 25 | | 252 | | | | | | | |
| | | | 3 | SS | 26 | | 251 | | | | | | | |
| 250.9 | | | | | | | 250 | | | | | | | |
| 4.6 | Silty Sand, trace to some clay, trace to some gravel (Till) Compact to very dense Grey brown becoming grey below 6.9m depth Moist | | 4 | SS | 24 | | 249 | | | | | | | |
| | | | 5 | SS | 42 | | 248 | | | | | | | |
| | | | 6 | SS | 50 | | 247 | | | | | | | |
| | | | 7 | SS | 125 | | 246 | | | | | | | |
| | | | 8 | SS | 74 | | 245 | | | | | | | |
| | | | | | 244 | | | | | | | | | |
| | | 9 | SS | 65/15 | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | 10 | SS | 50/08 | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| 243.1 | | | | | | | | | | | | | | |
| 12.4 | END OF BOREHOLE | | | | | | | | | | | | | |
| | Note: 1. Water level in open borehole at 4.6m depth (Elev.250.9m) upon completion of drilling. | | | | | | | | | | | | | |

ON_MOT_0011143F.GPJ_ON_MOT_GDT_25/9/01

| PROJECT 001-1143F | | | RECORD OF BOREHOLE No C-8 | | | 1 OF 2 | | | METRIC | | | | | | | | |
|----------------------|---|------------|---|------|-----------|--|-----------------|---|---|--|--|-------------|--|---|---------------------------------------|--|--|
| W.P. 30-95-00 | | | LOCATION N 4898571.1; E 291670.5 | | | ORIGINATED BY GD | | | | | | | | | | | |
| DIST Central HWY 400 | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | COMPILED BY LCC | | | | | | | | | | | |
| DATUM Geodetic | | | DATE Mar.14-15/2001 | | | CHECKED BY ASP | | | | | | | | | | | |
| 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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x REMOULDED | | | WATER CONTENT (%) w _p — w — w _L | | | γ | GR SA SI CL | | |
| 260.6 | GROUND SURFACE | | | | | | | 20 40 60 80 100 | | | | | | | | | |
| 0.0 | Silty Clay, some sand, trace gravel (Fill) Hard Brown Moist | | | | | | 260 | | | | | | | | | | |
| | | | | | | | 259 | | | | | | | | | | |
| | | | | | | | 258 | | | | | | | | | | |
| | | | 1 | SS | 39 | | 257 | | | | | | | | | | |
| 256.0 | | | | | | | 256 | | | | | | | | | | |
| 4.6 | Silty Sand, trace to some gravel (Fill) Dense Brown Moist | | | | | | 255 | | | | | | | | | | |
| | | | 2 | SS | 45 | | 254 | | | | | | | | | | |
| | | | | | | | 253 | | | | | | | | | | |
| | | | | | | | 252 | | | | | | | | | | |
| | | | 3 | SS | 44 | | 251 | | | | | | | | | | |
| 249.9 | | | | | | | 250 | | | | | | | | | | |
| 10.7 | Silty Sand, trace to some gravel, trace clay (Till) Compact to very dense Grey Moist | | 4 | SS | 21 | | 249 | | | | | | | | | | |
| | | | | | | | 248 | | | | | | | | | | |
| | | | 5 | SS | 19 | | 247 | | | | | | | | | | |
| | | | | | | | 246 | | | | | | | | | | |
| | | | 6 | SS | 36 | | | | | | | | | | | | |

ON_MOT_0011143F.GPJ ON_MOT.GDT 25/9/01

Continued Next Page

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

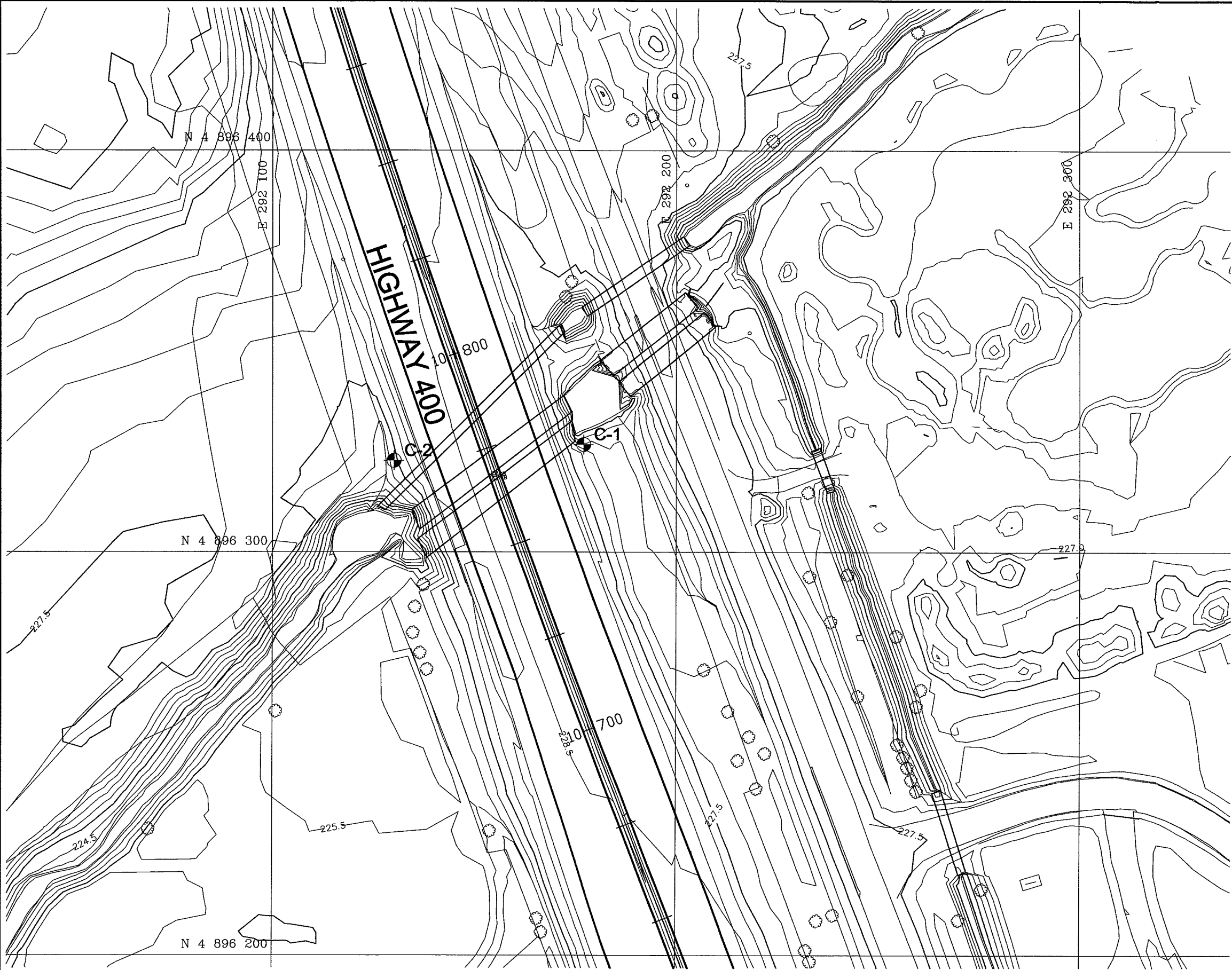
| PROJECT 001-1143F | | | | RECORD OF BOREHOLE No C-8 | | | | 2 OF 2 | | METRIC | | | | | |
|--------------------------------------|--|------------|---------|---|------------|----------------------------|-----------------|---|--|--------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| W.P. 30-95-00 | | | | LOCATION N 4898571.1; E 291670.5 | | | | ORIGINATED BY GD | | | | | | | |
| DIST Central HWY 400 | | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | | COMPILED BY LCC | | | | | | | |
| DATUM Geodetic | | | | DATE Mar.14-15/2001 | | | | CHECKED BY ASP | | | | | | | |
| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | "N" VALUES | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED | | | | | | | |
| --- CONTINUED FROM PREVIOUS PAGE --- | | | | | | | | | | | | | | | |
| | Silty Sand, trace to some gravel, trace clay (Till) Compact to very dense Grey Moist | | 7 | SS | 53 | | 245 | | | | | | | | |
| | | | | | | | 244 | | | | | | | | |
| | | | 8 | SS | 57 | | 243 | | | | | | | | |
| | | | | | | | 242 | | | | | | | | |
| | | | 9 | SS | 48 | | 241 | | | | | | | | |
| 239.1 | | | | | | | 240 | | | | | | | | |
| 21.5 | END OF BOREHOLE | | 10 | SS | 98/15 | | | | | | | | | | |

| PROJECT 001-1143F | | | | RECORD OF BOREHOLE No C-9 | | | | 1 OF 1 | | METRIC | | | | | |
|----------------------|--|-----------------|---------|---|-----------|----------------------------|-----------------|---|--|--------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| W.P. 30-95-00 | | | | LOCATION N 4902176.0; E 291036.9 | | | | ORIGINATED BY AZ | | | | | | | |
| DIST Central HWY 400 | | | | BOREHOLE TYPE 108mm ID SOLID STEM AUGERS AND CASING | | | | COMPILED BY LCC | | | | | | | |
| DATUM Geodetic | | | | DATE Oct.30/2000 | | | | CHECKED BY ASP | | | | | | | |
| 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 kN/m ³ | REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL |
| ELEV DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE | *N VALUES | | | SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL X REMOULDED | | | | | | | |
| 288.0 | GROUND SURFACE | | | | | | | | | | | | | | |
| 0.0 | Topsoil | | 1 | SS | 8 | | | | | | | | | | |
| 287.4 | Clayey Silt, some to with sand, some gravel (Till) Stiff to hard Brown becoming grey below 3.7m depth Moist Cobbles below 5.5m depth inferred from grinding/resistance to augering | | 2 | SS | 14 | | | | | | | | | | |
| 0.6 | | | 3 | SS | 50 | | | | | | | | | | |
| | | | 4 | SS | 56 | | | | | | | | | | |
| | | | 5 | SS | 78 | | | | | | | | | | |
| | | | 6 | SS | 123 | | | | | | | | | | |
| | | | 7 | SS | 140 | | | | | | | | | | |
| | | | 8 | SS | 105 | | | | | | | | | | |
| 279.9 | | END OF BOREHOLE | | | | | | | | | | | | | |
| 8.1 | Note: 1. Water level in open borehole at 5.2m depth (Elev.282.8m) upon completion of drilling. | | | | | | | | | | | | | | |

ON_MOT_0011143F.GPJ ON_MOT.GDT 25/9/01

ON_MOT 0011143F.GPJ ON_MOT.GDT 25/9/01

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



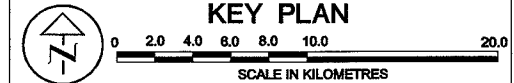
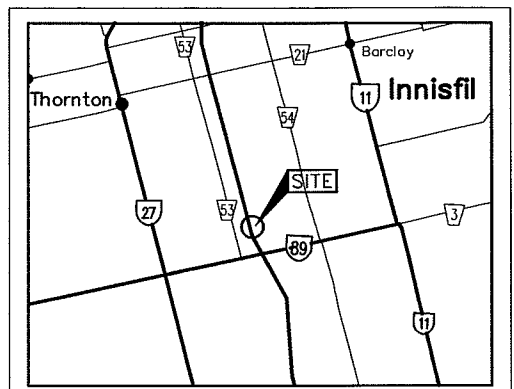
DIST HWY 400
CONT. No.
GWP No. 30-95-00
CULVERT AT STATION 10+780
HWY 400
BOREHOLE LOCATION PLAN



SHEET



Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



LEGEND

- Borehole, previous investigation
- ⊙ Borehole, present investigation

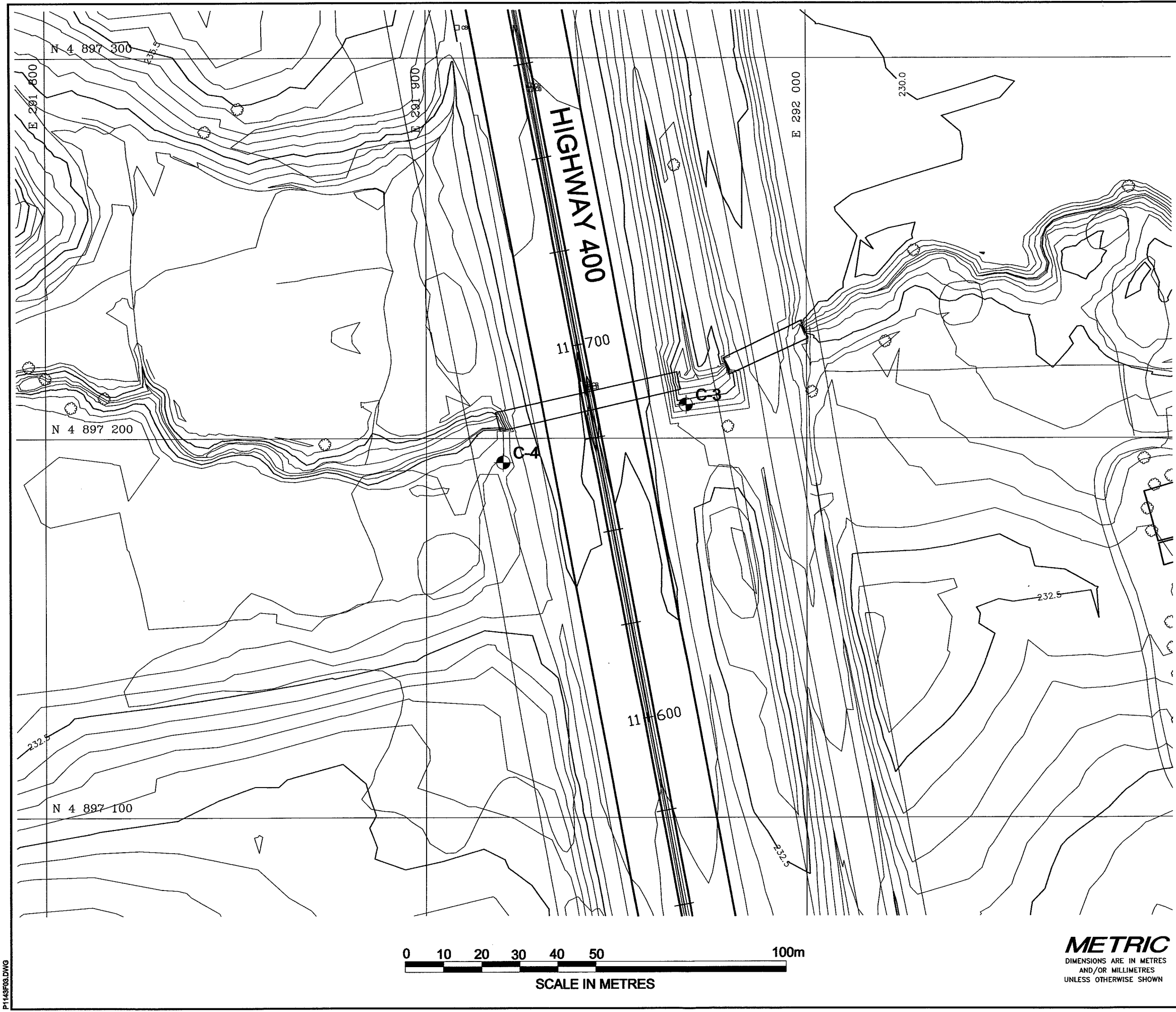
| No. | ELEVATION | LOCATION | |
|-----|-----------|-------------|-----------|
| | | NORTHING | EASTING |
| C-1 | 226.5 | 4,896,326.9 | 292,177.2 |
| C-2 | 227.2 | 4,896,322.8 | 292,130.0 |

REFERENCE

This drawing was created from digital file "33811.dwg"
provided by URS Cole Sherman

| | | | |
|--------------|-----------|------------------------|-------------|
| Geocres No. | | | |
| HWY. No. 400 | | PROJECT NO.: 001-1143F | |
| SUBM'D. LCC | CHKD. ASP | DATE: JANUARY 2001 | SITE 30-399 |
| DRAWN: MHW | CHKD. LCC | APPD. ASP | DWG. 1 |

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



DIST HWY 400

CONT. No.

GWP No. 30-95-00

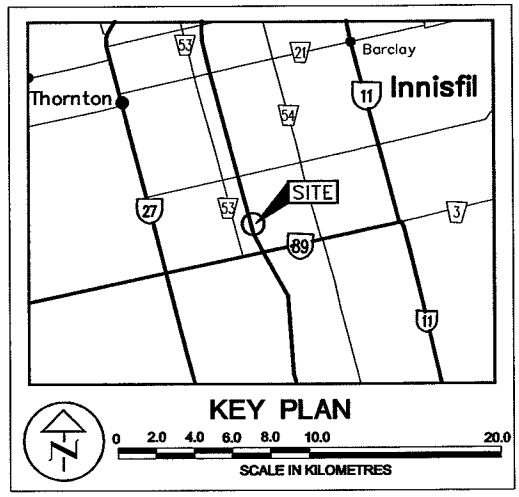
CULVERT AT STATION 11+675

HWY 400

BOREHOLE LOCATION PLAN

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



LEGEND

Borehole, previous investigation

Borehole, present investigation

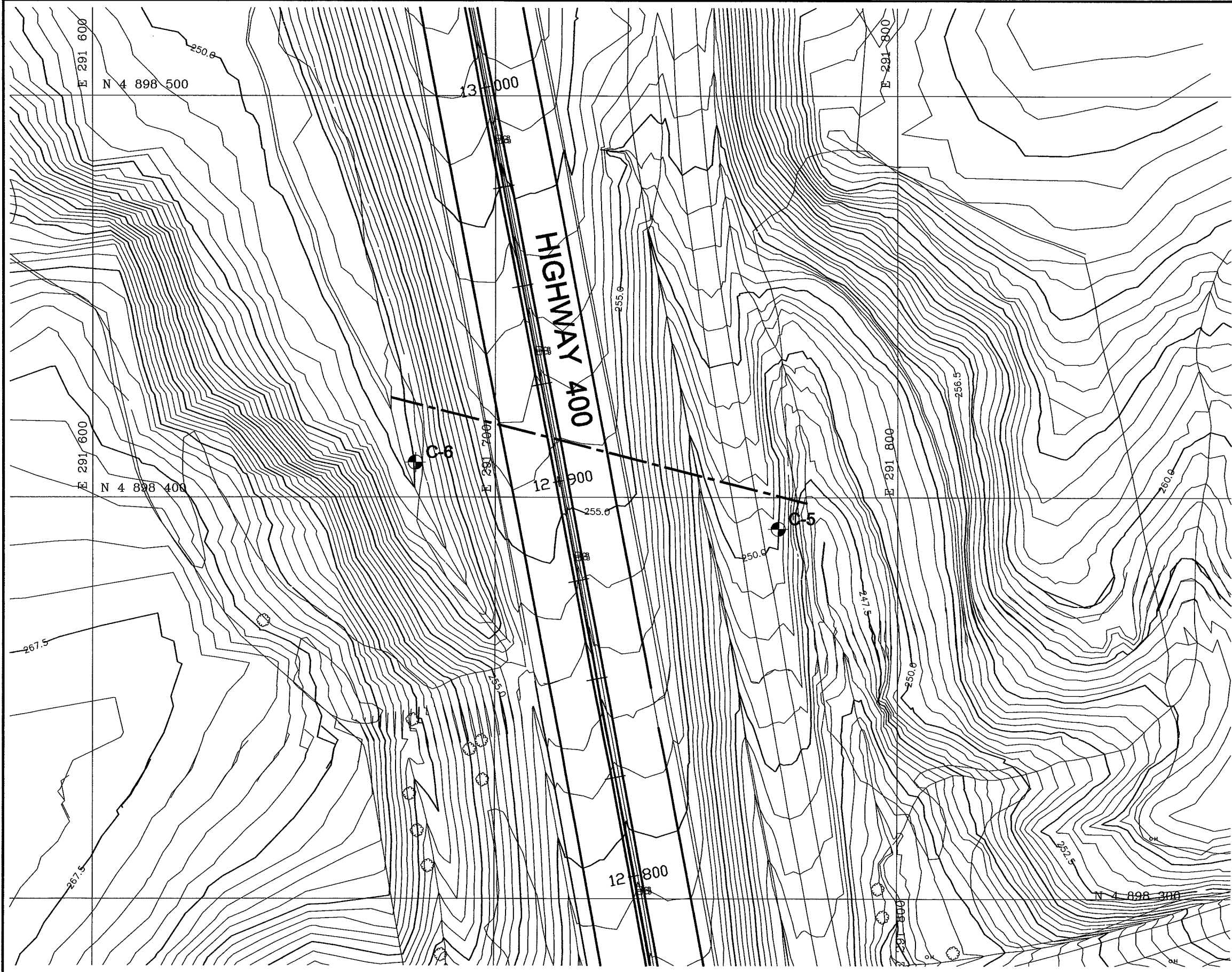
REFERENCE

This drawing was created from digital file "33810.dwg" provided by URS Cole Sherman

| | | | |
|--------------|-----------|------------------------|-------------|
| NO. | DATE | BY | REVISION |
| Geocres No. | | | |
| HWY. No. 400 | | PROJECT NO.: 001-1143F | |
| SUBM'D. LCC | CHKD: ASP | DATE: JANUARY 2001 | SITE 30-571 |
| DRAWN: MHW | CHKD. LCC | APPD. ASP | DWG. 2 |

P1143F03.DWG

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



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

DIST HWY 400

CONT. No.

GWP No. 30-95-00

CULVERT AT STATION 12+900

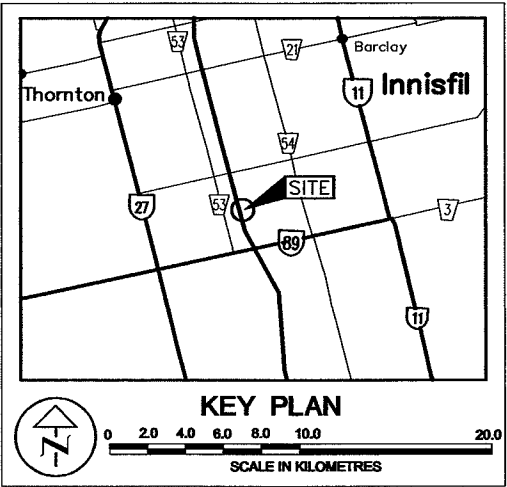
HWY 400

BOREHOLE LOCATION PLAN

SHEET

Golder Associates

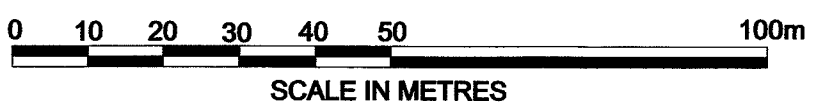
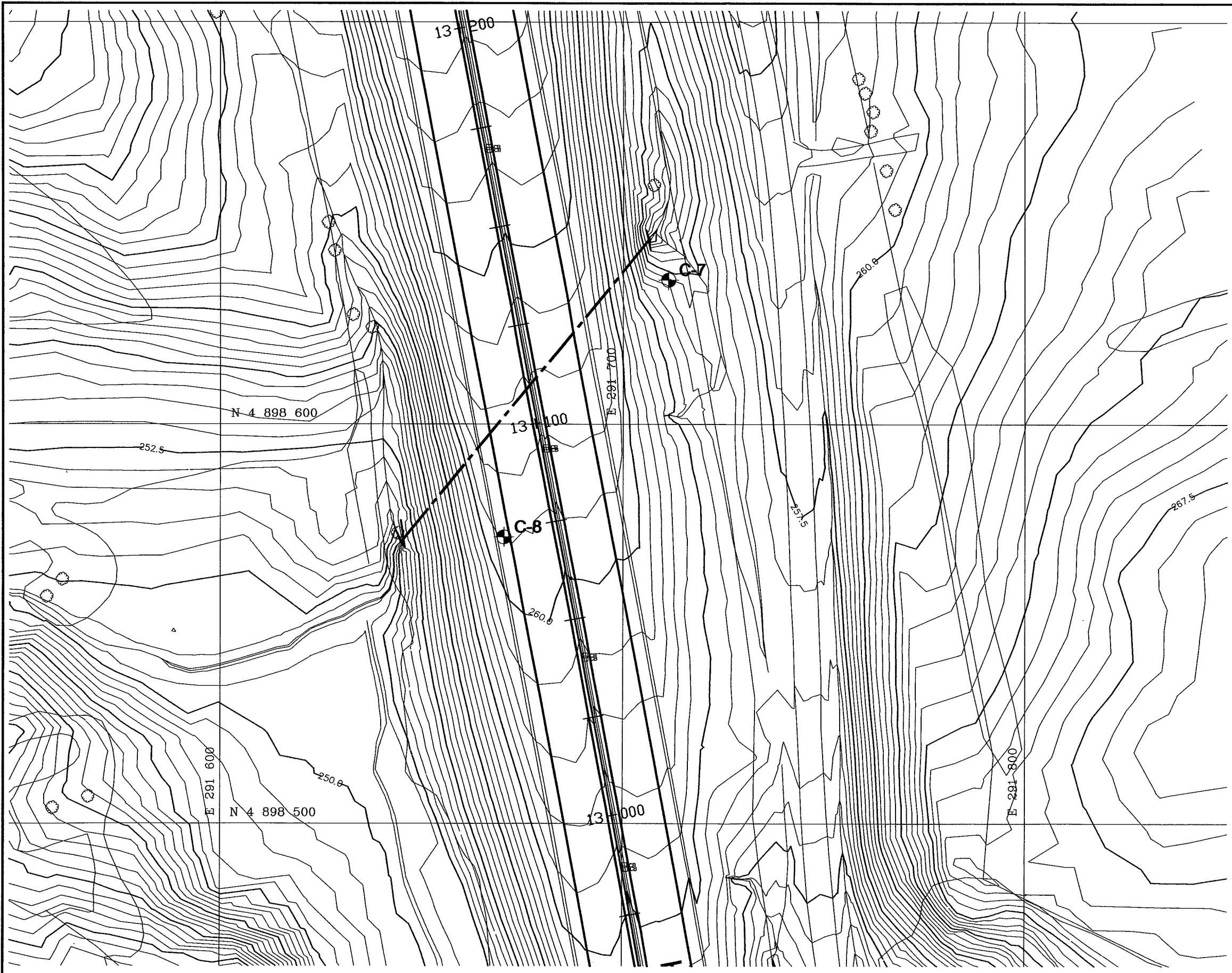
Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



| LEGEND | | | |
|--------|----------------------------------|-------------|-----------|
| | Borehole, previous investigation | | |
| | Borehole, present investigation | | |
| No. | ELEVATION | LOCATION | |
| | | NORTHING | EASTING |
| C-5 | 249.9 | 4,898,392.1 | 291,770.3 |
| C-6 | 249.9 | 4,898,408.7 | 291,680.3 |

REFERENCE
This drawing was created from digital file "33810.dwg"
provided by URS Cole Sherman

| | | | |
|--------------|-----------|------------------------|-------------|
| | | | |
| NO. | DATE | BY | REVISION |
| Geocres No. | | | |
| HWY. No. 400 | | PROJECT NO.: 001-1143F | |
| SUBM'D. LCC | CHKD: ASP | DATE: JANUARY 2001 | SITE 30-572 |
| DRAWN: MHW | CHKD. LCC | APPD. ASP | DWG. 3 |



SCALE IN METRES

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

DIST HWY 400


CONT. No.

GWP No. 30-95-00

CULVERT AT STATION 13+100

HWY 400

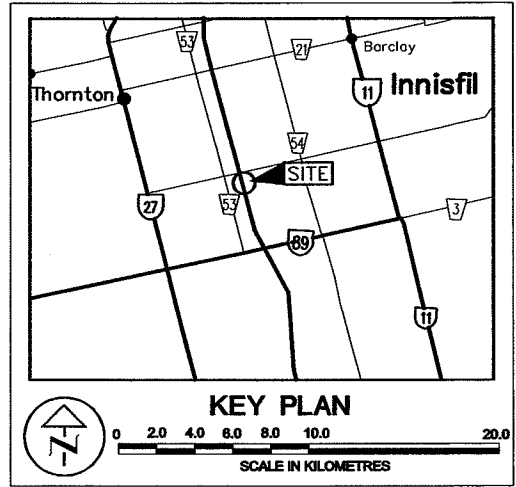
BOREHOLE LOCATION PLAN



Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



SHEET



| LEGEND | | | |
|---|----------------------------------|-------------|-----------|
|  | Borehole, previous investigation | | |
|  | Borehole, present investigation | | |
| No. | ELEVATION | LOCATION | |
| | | NORTHING | EASTING |
| C-7 | 255.5 | 4,898,636.1 | 291,711.3 |
| C-8 | 260.6 | 4,898,571.1 | 291,670.5 |

REFERENCE
This drawing was created from digital file "33809.dwg"
provided by URS Cole Sherman

| | | | |
|--------------|-----------|------------------------|-------------|
| NO. | DATE | BY | REVISION |
| Geocres No. | | | |
| HWY. No. 400 | | PROJECT NO.: 001-1143F | |
| SUBM'D. LCC | CHKD: ASP | DATE: JANUARY 2001 | SITE 30-573 |
| DRAWN: MHW | CHKD. LCC | APPD. ASP | DWG. 4 |



DIST HWY 400

CONT. No.

GWP No. 30-95-00

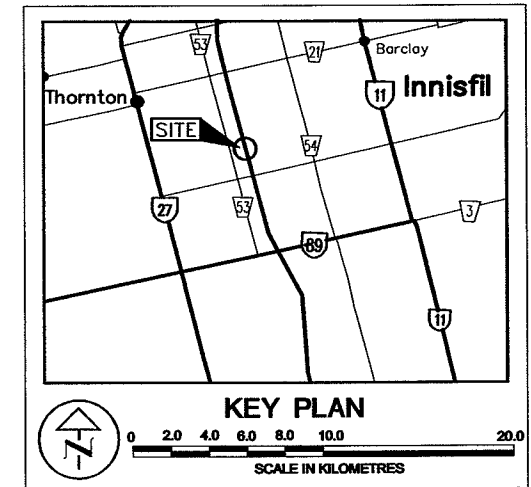
CULVERT AT STATION 16+730

HWY 400

BOREHOLE LOCATION PLAN

SHEET

 **Golder Associates Ltd.**
MISSISSAUGA, ONTARIO, CANADA



| LEGEND | | | |
|--------|----------------------------------|-------------|-----------|
| | Borehole, previous investigation | | |
| | Borehole, present investigation | | |
| No. | ELEVATION | LOCATION | |
| | | NORTHING | EASTING |
| C-9 | 288.0 | 4,902,176.0 | 291,036.9 |
| C-10 | 291.8 | 4,902,139.0 | 290,980.2 |

REFERENCE
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provided by URS Cole Sherman

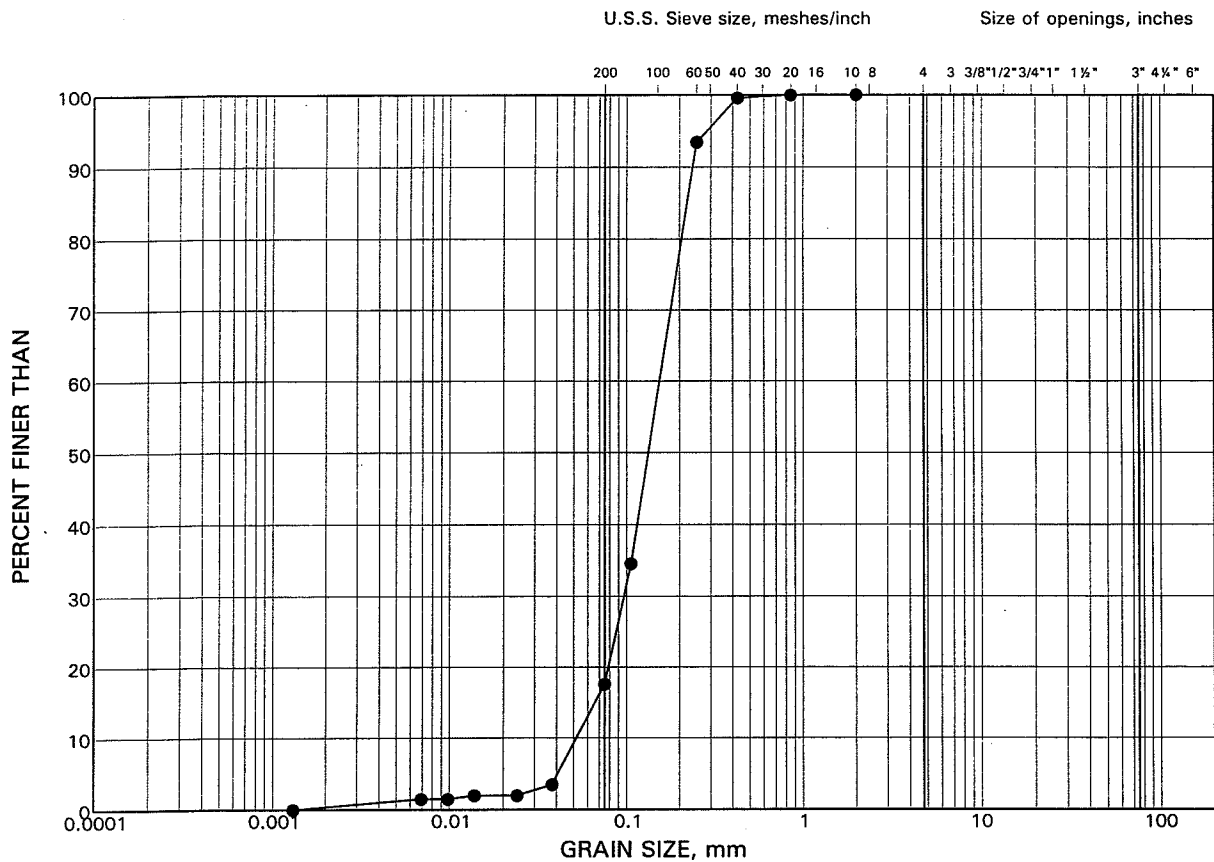
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|--------------|-----------|------------------------|-------------|
| | | | |
| | | | |
| NO. | DATE | BY | REVISION |
| Geocres No. | | | |
| HWY. No. 400 | | PROJECT NO.: 001-1143F | |
| SUBM'D. LCC | CHKD: ASP | DATE: JANUARY 2001 | SITE 30-415 |
| DRAWN: MHW | CHKD. LCC | APPD. ASP | DWG. 5 |

P1143F07.DWG

GRAIN SIZE DISTRIBUTION

Sand

FIGURE 1



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

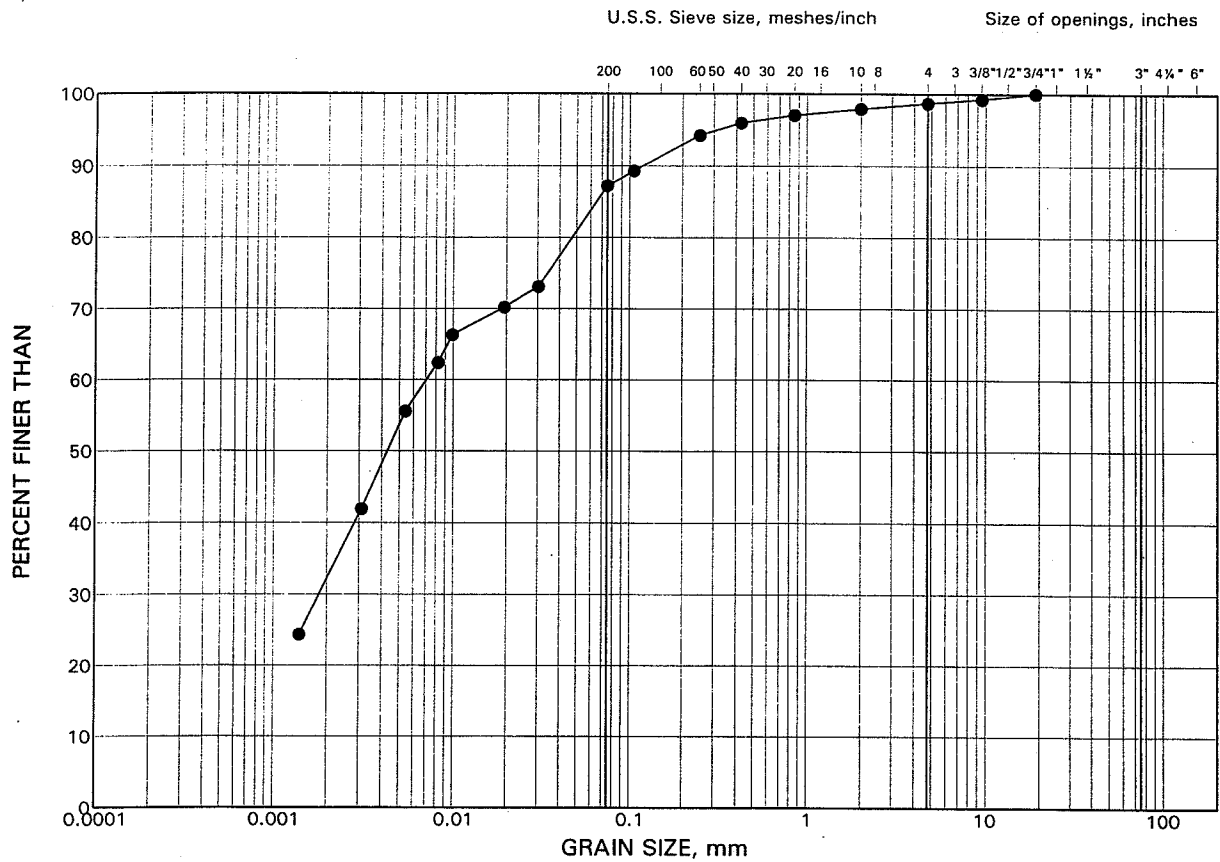
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| • | C-1 | 6 | 222.2 |

GRAIN SIZE DISTRIBUTION

Clayey Silt (Till)

FIGURE 2



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

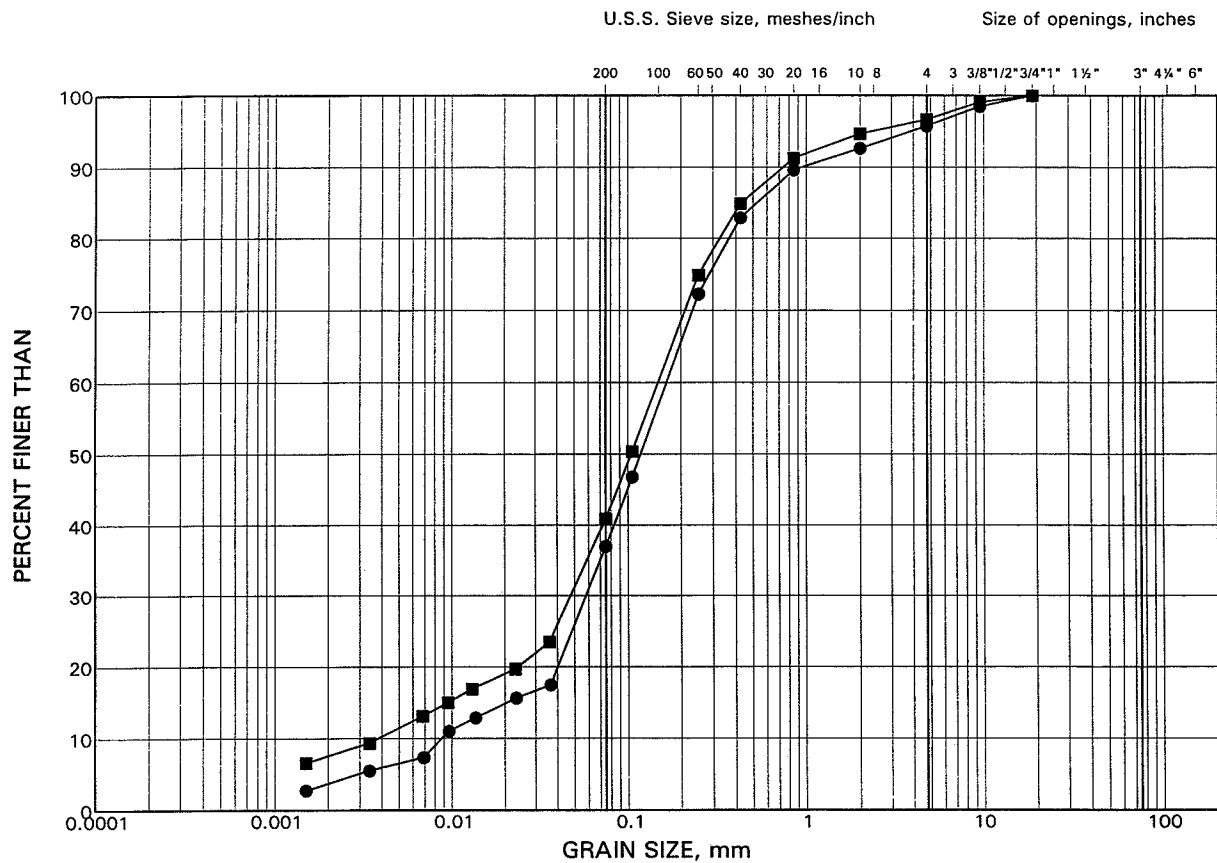
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| • | C-2 | 3 | 222.8 |

GRAIN SIZE DISTRIBUTION

Silty Sand (Till)

FIGURE 3



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

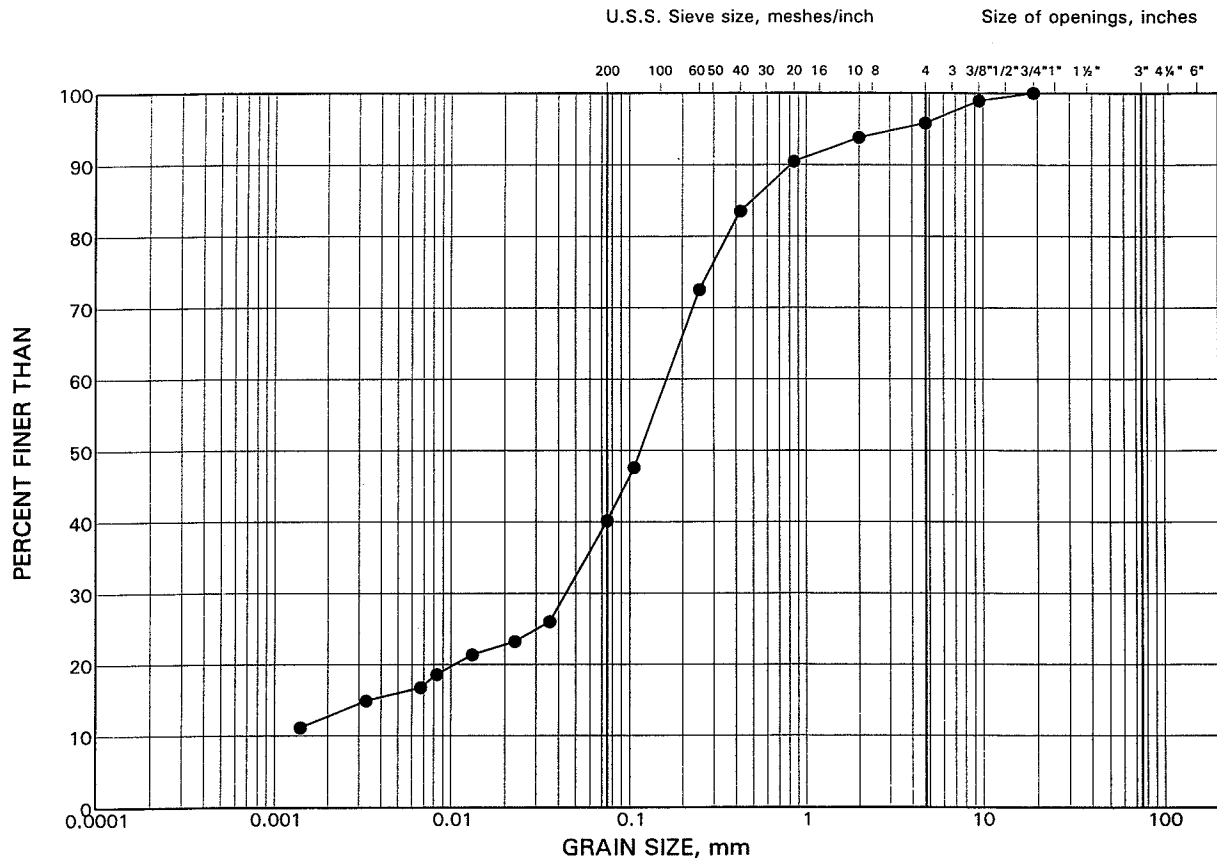
LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| ● | C-7 | 5 | 249.6 |
| ■ | C-8 | 5 | 247.8 |

GRAIN SIZE DISTRIBUTION

Clayey Silt (Till)

FIGURE 4



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

LEGEND

| SYMBOL | BOREHOLE | SAMPLE | ELEVATION (m) |
|--------|----------|--------|---------------|
| • | C-9 | 5 | 283.6 |