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OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:

GEOCRES No
30M4-86

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Golder Associates

REPORT ON

FOUNDATION INVESTIGATION AND DESIGN
EMBANKMENTS
QUEEN ELIZABETH WAY /
RED HILL CREEK EXPRESSWAY AND
BURLINGTON STREET INTERCHANGES
AGREEMENT NO. 9820-7411-2805
HAMILTON, ONTARIO

Submitted to:

Ministry of Transportation Ontario
Head, Geotechnical Engineering Section
Atrium Tower, 5th Floor
1201 Wilson Avenue
Downsview, Ontario
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TABLE OF CONTENTS

SECTION PAGE

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Golder Associates

November 30, 1998

981-8033

Ministry of Transportation, Ontario
Geotechnical Section
Atrium Tower, 5th Floor
1201 Wilson Avenue
Downsview, Ontario M3M 1J8

ATTENTION: Mr. Dennis Billings, P.Eng.
Head

**RE: FOUNDATION INVESTIGATION AND DESIGN
EMBANKMENTS
QUEEN ELIZABETH WAY / RED HILL CREEK EXPRESSWAY AND
BURLINGTON STREET INTERCHANGES
HAMILTON, ONTARIO**

Dear Sirs:

Please find enclosed our preliminary report which provides recommendations for the geotechnical aspects of design of the proposed fill embankments at the Queen Elizabeth Way / Red Hill Creek Expressway and Burlington Street Interchanges.

We trust that the contents of this report is satisfactory for your present requirements. Should you have any questions regarding the information provided herein, or require further information, please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Sydney Pang

Sydney Pang, P.Eng.
Project Engineer

Fin J. Heffernan, P. Eng.
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WORD S/FINALDAT/OTHPRJT/981-8033/88033KP1

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by the Ministry of Transportation (MTO) to carry out a foundation investigation at the locations of the proposed embankments at the Queen Elizabeth Way (QEW) / Red Hill Creek Expressway (RHCE) and Burlington Street (BS) Interchanges in Hamilton, Ontario. We understand that this project involves the construction of new ramps and realignment of existing ramps. This report focuses on the design aspects of embankments. Embankments associated with the ramps will be up to 11 m in height.

The purpose of the foundation investigation is to determine the subsurface and groundwater conditions at locations along the proposed embankment alignments by means of a number of boreholes which are typically spaced at 50 m intervals. In situ tests were carried out at regular intervals of depths, and laboratory tests were carried out on selected soil samples. Based on our interpretation of the factual data obtained, recommendations are provided on the geotechnical aspects of embankment design. Comments are also provided on anticipated construction aspects, where they may affect the design of the proposed works.

The subsurface information obtained during previous investigations has been referenced in the preparation of this report. The references are listed as follows:

- MTO report titled "Foundation Investigation Report for Proposed Underpass Structure at the Crossing of the Reconstructed QEW at Hwy. #20, Stoney Creek Traffic Circle, Co. of Wentworth, Dist. No. 4 (Hamilton), Cont. No. 74-110, W.P. 10-57-02, W.O. 72-11033, Site 36-1336-62 (Geocres No. 30M4-19).
- MTO report titled "Foundation Investigation Report for Red Hill Creek Crossing Widening", Dist. No. 4 (Hamilton), Hwy. QEW, W.P. 83-74-19, Site 36-1336-62 (Geocres No. 30M5-143).
- MTO report titled "Foundation Investigation Report for QEW N/S Transportation Corridor Interchange", Dist. No. 4 (Hamilton), W.P. 54-88-00A (Geocres No. 30M4-67).
- Golder Associates Report No. 981-1108, titled "Preliminary Foundation Investigation, Queen Elizabeth Way / Red Hill Creek Expressway Interchange, Stoney Creek, Ontario", dated April 1988.
- Golder Associates Report No. 981-1108, titled "Preliminary Foundation Investigation, Queen Elizabeth Way / Burlington Street Interchange, Hamilton, Ontario", dated July 1998.

- Golder Associates Report No. 951-1326, titled "Laboratory Testing Program and Engineering Application Assessment of Lightweight Blast Furnace Slag", dated August 1996.

The terms of reference for this project are in general accordance with those outlined in the Schedule "A" of the Consultant Assignment Agreement No. 9820-7411-2805 titled "Terms of Reference for QEW and Red Hill Creek Expressway Project Including Burlington St. I/C".

Reference is also made to the following publication:

- Bjerrum, L. 1972. Embankments on Soft Ground. *ASCE Specialty Conference on Earth Structures*, Purdue University, Lafayette, IN, Vol. 2, pp. 1 – 54.

2.0 SITE DESCRIPTION

The sites are located adjacent to the southwest shoreline of Lake Ontario; one in the vicinity of the existing interchange between the Queen Elizabeth Way (QEW) and Centennial Parkway (Highway 20) [also referred to as Red Hill Creek Expressway (RHCE) Interchange hereafter] and the other at the existing interchange between QEW and Burlington Street (also referred to as Burlington Street (BS) Interchange hereafter] in Hamilton, Ontario.

Red Hill Creek Expressway (RHCE) Interchange

The southwest shore of the lake is less than 1 km north of this site (see Drawing RHCE 1). The terrain in this area is generally flat-lying with the ground surface varying between about Elevations 78 m and 83 m along the alignment of the proposed works. Minor undulations across the site mainly involve embankments at the existing interchange, the right-of-way of the QEW, as well as regrading and landscaping of adjacent lands.

Burlington Street (BS) Interchange

Van Wagner Beach, which is situated at the southwest shore of Lake Ontario, is less than 200 m to the north and east of the site. The Red Hill Creek flows in a northerly and westerly direction across the southern portion of the project area. The ground surface at the level of the floodplain varies between about Elevations 75 m and 77 m. Undulations across the site area are mainly associated with fill embankments and landscaping of the existing interchange, and the right-of-way of the QEW.

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between September 08 and October 17, 1998. The investigation was carried out concurrently with a field program for geotechnical investigation consisting of embankments less than 4 m in height, speed change lanes, existing and proposed pavement structures, as well as all associated roadway construction and reconstruction.

During the period mentioned above, a total of 53 boreholes were put down along alignments of embankments 4 m or higher. These boreholes were typically spaced at about 50 m along ramp centrelines, and some of them were offset from the respective centrelines (see Drawings RHCE 1 and BS1). Another 137 boreholes were put down for geotechnical / pavement requirements along ramp alignments, where embankments are less than 4 m in height. The investigation was carried out using track-mounted CME 55 drill rigs supplied and operated by a specialist drilling contractor from Toronto.

The boreholes were advanced to depths ranging from 4 m to 11 m below existing ground surface. One borehole in the Burlington Street Interchange area was taken down to bedrock at about 15 m depth. In each borehole, soil samples were obtained at 0.75 m to 1.5 m intervals of depth as part of the Standard Penetration Test (SPT) using conventional 50 mm diameter split-spoon samplers. Field vane shear tests using a standard MTO NX size vane were carried out within the cohesive deposits where possible. Relatively undisturbed cohesive soil samples were retrieved at selected depths, using 75 mm diameter thin-walled Shelby tube samples, in all boreholes where softer zones within the cohesive deposits were encountered. Groundwater conditions in the boreholes were observed during the drilling operations. One 19 mm diameter piezometer was installed in each of eleven selected boreholes to permit monitoring of the groundwater levels.

The field work for this investigation was supervised by members of our technical staff who cleared the locations of buried utilities and logged the boreholes. The soil samples obtained were placed in labelled plastic containers and transported to our Mississauga laboratory for further examination and laboratory testing. Representative soil samples were tested to determine Atterberg limits, grain size distribution and natural water content. Three specimens of the softer silty clay, prepared from Shelby tube samples, were subjected to laboratory oedometer tests to determine consolidation characteristics. Two sets of specimens were subjected to isotropically consolidated, undrained triaxial (CIU) tests with pore water pressure measurements to determine strength characteristics.

Co-ordinates and ground surface elevations at the as-drilled borehole locations were provided by Bennett Young surveyors. The northing and easting co-ordinates, as well as ground surface elevations, of the boreholes are shown on the Record of Borehole sheets, and are listed in Drawings RHCE 1 and BS1. It is understood that the elevations are referred to the Geodetic datum.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

The QEW in this area follows the shoreline of Lake Ontario and lies mainly in the Iroquois Plain physiographic region. The Iroquois Plain is generally composed of shallow sandy materials deposited on the bed of the glacial Lake Iroquois. The area is also referred to as the Niagara Fruit Belt (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The bedrock at this site is shale of the Queenston Formation. The shallow sands, which can only be found at the north and east limits of the Burlington Street interchange area, are underlain by silty clay glacial tills. Typical depths to bedrock at this site lie within the range of 13 m to 15 m depth below ground surface.

4.2 Description of Subsurface Conditions

The detailed subsurface soil, bedrock and groundwater conditions encountered in the high embankment boreholes, together with the results of the laboratory tests carried out on selected soil samples, are presented on the attached Record of Borehole sheets. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

The subsurface conditions encountered in the geotechnical / pavement boreholes are very similar to those conditions encountered in the high embankment boreholes. Detailed records of the geotechnical / pavement boreholes are contained in Appendices I and II.

In the vicinity of the Red Hill Creek Expressway (RHCE) interchange, high embankments are associated with four proposed ramps, designated as E-S RHCE Ramp (Boreholes RESR's), S-W RHCE Ramp (RSWR's), S-E RHCE Ramp (RSER's) and W – RHCE Ramp (WRHR's). Simplified stratigraphic profiles (Profiles A-A, B-B, C-C and D-D) and sections (Sections 1-1, 2-2, 3-3 and 4-4) along these ramps are shown on Drawing RHCE 1.

In the vicinity of the Burlington Street (BS) interchange, high fills are associated with five ramps, designated as S-W (Burlington Street) Ramp (Boreholes BSWR's), E-S (Burlington Street) Ramp

(Boreholes BESR's), W-S (Burlington Street) Ramp (BWSR's), S-E (Burlington Street) Ramp (Boreholes BSER's) and W – Woodward Avenue Ramp (WWAR's). Simplified stratigraphic profiles along selected alignments are shown on Drawing BS 1.

4.2.1 Red Hill Creek Expressway (RHCE) Interchange

In summary, the subsoils in this vicinity consist of surficial topsoil / fill overlying typically soft to very stiff silty clay deposits. A soft to firm zone of silty clay (to be referred to as "softer" clay hereafter) was generally encountered underneath a silty clay crust. The site is underlain by silty clay glacial till which in turn overlies shale bedrock. The bedrock surface, which appeared to step downward towards Lake Ontario, was at between 6 m and 18 m depths below existing ground surface, where encountered.

A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1.1 Topsoil and Fill Materials

Topsoil of thickness ranging typically between 0.05 m and 0.15 m was encountered in a majority of the boreholes.

Fill materials, where encountered, lie immediately below the topsoil. The fill generally consists of silty sand and / or clayey silt to silty clay; interlayering between the granular and cohesive materials occurred at some locations. The fill generally extends to between 1.2 m and 2.1 m depths below existing ground surface, except at the location of Boreholes RESR-10 and RSWR-5 where the fill is up to about 3 m thick. Apart from trace amount of organics and rootlets, the fill appeared to be free of debris and other foreign materials; although some asphalt fragments were found in the fill samples obtained from Boreholes RESR-8 and RSWR-7 and some shale fragments were found in the fill samples obtained in Boreholes RSER-4, RSER-5 and RSER-6.

The granular fill is typically compact to dense in relative density with SPT 'N' values typically ranging between 23 blows and 39 blows per 0.3 m penetration. The cohesive fill is firm to hard in consistency with 'N' values typically ranging between 9 blows and 42 blows per 0.3 m penetration. The higher 'N' values are likely attributed to the presence of shale or asphalt fragments. Measured water contents of fill samples ranged from 10 per cent to 17 per cent.

4.2.1.2 Silty Sand, Sand and Sandy Silt

Surficial silty sand, sand and sandy silt deposits were encountered in most boreholes drilled in the RHCE interchange area. These deposits underlie the fill or topsoil, and overlie or interlayer with clayey silt materials. These granular soils typically extend to between 2 m and 4 m depths below existing ground surface, except at the locations of Boreholes RSER-2 and RSWR-16 where they were encountered at up to about 6 m depth. Figures 1 to 3 show grain size distributions of representative samples of the silty sand, sand and sandy silt. The relative density of the silty sand deposit is compact to very dense, as indicated by SPT 'N' values ranging from 13 blows to greater than 60 blows per 0.3 m penetration; the 'N' values were generally increasing with depth. The measured natural water contents of selected samples of these deposits ranged from 11 per cent to 23 per cent.

4.2.1.3 Silty Clay

An extensive silty clay deposit, with some clayey silt zones, was encountered in all boreholes put down in the RHCE interchange area. This deposit underlies the topsoil / fill, and / or the sandy soils, and extends to the top surface of the glacial till. The silty clay was fully penetrated in Boreholes RESR-23, RSER-2 to RSER-6 during the present investigation, and in Boreholes 1 to 9 from a previous investigation. The top surface of this deposit was encountered at between approximately Elevations 78 m and 82 m, except in Borehole RESR-10 where it was encountered at Elevation 75 m. In most boreholes, a zone of "softer" clay is present underneath the weathered crust of this silty clay deposit; this "softer" zone is discussed in the following section. Clayey silt zones were encountered in Boreholes RESR-4, RESR-24, RESR-25, RSER-1 to RSER-4 and RSER-6. The overall thickness of this silty clay deposit (including the "softer" zone) is generally greater than 5 m, but is as thin as 1.5 m in Borehole 2 and as thick as 12 m in Borehole 5.

The silty clay is generally mottled brown and grey (within the crust) changing to grey colour with depth. The measured SPT 'N' values within the deposit (excluding the "softer" zone) vary from 11 blows to 48 blows per 0.3 m penetration, indicating a generally stiff to hard consistency, with occasionally values greater than 60 blows. Field vane shear strength ranged from 50 kPa to greater than 100 kPa. Grain size distribution curves for representative samples of this deposit are shown on Figures 4 to 6. Atterberg limits tests carried out on representative samples of this soil gave liquid limits ranging from 20 per cent to 35 per cent, and plastic limits ranging from 8 per cent to 18 per cent indicating a soil of low plasticity. Measured water contents on selected silty clay samples ranged between 8 per cent and 28 per cent.

4.2.1.4 "Softer" Clay

A "softer" zone was encountered within the silty clay deposit, as described above, in all but Boreholes RESR-10, RESR-25 to RSER–26, RSER-2 to RSER–5, RSWR-16 and RSWR-17 from the present investigation, and Boreholes 1, 2 and 7 from the previous investigation. This "softer" zone was encountered at between Elevations 77 m and 73 m in all borehole locations (except Borehole 7) east of the QEW. This zone was not present in some boreholes west of the QEW; where encountered, it extends from Elevations 77 m to 74 m. The thickness of this layer generally varies between about 3 m to 4 m at the boreholes put down during this investigation. This zone is up to about 5 m thick in Boreholes 3, 5 and 6 put down during a previous investigation.

Grain size distribution curves for samples of the "softer" clay are shown on Figures 7 and 8. Atterberg limits tests carried out on representative samples of this soil gave liquid limits ranging from 25 per cent to 43 per cent, and plastic limits ranging from 12 per cent to 24 per cent indicating low to medium plasticity. Measured water contents on selected samples ranged between 18 per cent and 37 per cent, although a majority of the values lied between 20 per cent and 30 per cent.

This "softer" clay zone is grey in colour throughout. Field vane shear tests were carried out at regular intervals of depth within this deposit. For the purpose of discussion and based on subsurface stratigraphy, the vane strengths are grouped according to Profiles A-A, B-B, C-C and D-D on Drawing RHCE 1. Figures 20 to 23 show the variation of field vane strengths with elevation as measured in boreholes located within each of the sections. In Section A-A, the vane strengths vary between 15 kPa and 40 kPa, indicating a soft to firm consistency. In Section B-B, the vane strengths vary between 20 kPa and about 50 kPa, also indicating a soft to firm consistency. In Profiles C-C and D-D, this "softer" zone was only encountered at some borehole locations. Vane strengths measured within Profile C-C ranged between 12 kPa and 35 kPa indicating very soft to firm consistency; the two low values of 12 kPa and 13 kPa (very soft to soft consistency) were measured in Borehole RSER-3. Only three measurements were taken in Profile D-D, with values lying between 20 kPa and 25 kPa (soft consistency). Based on the measured undisturbed and remoulded strengths, this deposit has a sensitivity of 2 to 4.

Three oedometer tests were carried out on relatively “undisturbed” Shelby tube samples of the “softer” clay recovered from Boreholes RESR-7, RESR-1 and RSER-6. These samples were located at about mid-depth of the “softer” clay, and are considered representative of this deposit. Results of the tests indicate that the samples have a preconsolidation pressures, σ'_p, ranging from 100 kPa to 120 kPa, with overconsolidation ratios (OCR) of 1.1 to 1.5 relative to the existing effective overburden stresses. The compression indices, C_c, range between 0.14 and 0.27, and the recompression indices C_r, angle between 0.025 and 0.045. Figures 15 to 17 show detailed results of the three oedometer tests.

Two sets of isotropically consolidated undrained triaxial (CIU) tests were carried out on selected samples of the “softer” clay obtained from Boreholes RESR-7 and RSWR-1. Within the anticipated range of normal stress increase (initial stress indicating over-consolidation to final stress indicating normal consolidation) under embankment loadings, the test results as shown on Figures 18 and 19 indicate that the combination of strength parameters range from $\phi' = 27°$, $c' = 0$, to $\phi' = 15°$, $c' = 20$ kPa.

4.2.1.5 Silty Clay Glacial Till

Silty clay glacial till was encountered underlying the silty clay in Boreholes RESR-10, RESR-23, RSER-2 to RSER-7 put down during this investigation, and in all but Borehole 4 put down during the previous investigation. The thickness of this till, where penetrated, varies from 1 m in Borehole 1 to up to 8 m in Borehole 6.

The glacial till is generally grey in colour changing to a reddish grey colour with depth. It typically contains some sand and trace to some gravel, with occasional shale fragments. Measured SPT ‘N’ values typically range from about 30 blows to greater than 100 blows per

0.3 m penetration, indicating a hard consistency. Some very stiff zones, as indicated by SPT ‘N’ values of 16 blows to 25 blows per 0.3 m penetration, were present within the upper zones of the deposit. Measured water contents on selected till samples ranged between 10 per cent and 16 per cent.

4.2.1.6 Bedrock

Bedrock of the Queenston Formation consisting of shale with occasional interlayers of limestone and siltstone was encountered in Borehole RESR-26 drilled during this investigation. The bedrock surface was at about Elevation 76.4 m, or 5.8 m below existing ground surface. Bedrock was encountered in all boreholes except Borehole 4 drilled during the previous investigation. Bedrock coring was not carried out in any of the boreholes. Split-spoon samples of shale were retrieved in the boreholes extended by augering or tri-coning into the bedrock. Refusal to split-spoon sampler advance was encountered at the depths where shale bedrock was encountered.

4.2.1.7 Groundwater Conditions

Piezometers were sealed in eight selected boreholes during this investigation. A piezometer was also installed in the previous Borehole 4. Details of the piezometer installations and the water level measurements are shown on the attached Record of Borehole sheets and on Drawing RHCE 1. Groundwater conditions in the open hole upon completion and / or during drilling for the remaining boreholes are shown on the Record of Borehole sheets.

The water level measurements indicate that the groundwater level within the "softer" clay is generally between Elevations 76 m and 78 m, or about 2 m to 3.5 m below existing ground surface. It should be noted that the water levels are subject to seasonal fluctuations.

4.3.1 Burlington Street (BS) Interchange

In summary, the subsoils in this vicinity consist of surficial topsoil and / or fill overlying a deposit of very stiff to hard silty clay to clayey silt glacial till, except at locations closer to Lake Ontario where extensive sand to sand and gravel deposits were encountered. Shale bedrock underlies the till at borehole locations where the till was fully penetrated.

Detailed descriptions of the subsurface conditions encountered in the boreholes are provided in the following sections.

4.3.1.1 Fill

Fill was encountered in all boreholes (put down at "high fill" locations), except Borehole BESR-8 located within the interchange area. The fill typically extends to between Elevations 73 m and 75 m, or approximately 1 m to 4 m depths below existing ground surface. The fill generally consists of a wide variety of soils ranging from silty clay to silty sand. Organics are present in many fill samples obtained, either mixed with the soil matrix or interlayered with the soil in the form of peat and / or topsoil, such as in Boreholes BWSR-5, BWSR-6, BESR-5 and BESR-6. Debris such as decayed rubber, brick and wood fragments, as well as shale pieces, are present within the fill at Boreholes WWAR-4, BWSR-1 to BWSR-5, BSWR-6, BESR-5 and BESR-9 from the current investigation, and Boreholes 1 and 2 from a previous investigation.

The consistency / relative density of the fill is variable. The cohesive fill is firm to hard, as indicated by SPT 'N' values ranging from 4 blows to 37 blows for 0.3 m of penetration. The sandy silt to silty sand fill is in a generally compact to dense state as indicated by 'N' values of 13 blows to about 50 blows per 0.3 m penetration, except at Boreholes BSWR-8 and BESR-9 where 'N' values are less than 10 blows indicating a loose state. Figure 9 shows the grain size distribution of a silty clay fill sample. The measured natural water contents of selected samples of the fill typically ranged from about 10 per cent to 20 per cent.

4.3.1.2 Peat

Peat was encountered in several borehole locations (BWSR-3 to BWSR-5, WWAR-3 to WWAR-4, BESR-7 to BESR-10). The peat layers have a firm to stiff consistency as indicated by 'N' values of 8 blows to 13 blows per 0.3 m penetration. Peat layers are up to about 1 m thick at Boreholes WWAR-3, BWSR-3 and BWSR-4 and less than 1 m in the remaining boreholes where the peat was encountered. The peat was typically at or within 4.5 m of ground surface. In Borehole WWAR-3, the peat sample has a water content of 78 per cent and an organic content of 36 per cent. Figure 10 shows a grain size distribution of a peat sample with a clayey silt and sand soil matrix. In Borehole BESR-8, the peat sample has a water content of 48 per cent and an organic content of 10 per cent. Atterberg limit tests carried out on this sample gave a liquid limit of 54 per cent and a plasticity index of 25 per cent, which plotted below the 'A' line on the plasticity chart, indicating that it is an organic clayey silt of high plasticity (symbol OH).

4.3.1.3 Silty Clay Glacial Till

An extensive silty clay glacial till deposit was encountered at and below the fill and / or organic materials in Boreholes BWSR-3 to BWSR-8, BSER-4 and BSER-5, BESR-6 from the current investigation and in Boreholes 1 and 2 from a previous investigation. Where penetrated, the thickness of this till is up to 12 m. This till generally consists of a silty clay matrix with trace to some sand and some gravel. This soil is typically very stiff to hard as indicated by SPT 'N' values ranging from 16 blows to more than 50 blows per 0.3 m penetration.

The silty clay till is generally mottled brown and grey in colour (within the weathered crust) changing to grey colour with depth. Grain size distribution curves for representative samples of the weathered crust and the underlying till are shown on Figures 11 and 12, respectively. Atterberg limits tests carried out on the same samples gave liquid limits of 28 per cent and 37 per cent, and plasticity indices of about 14 per cent to 20 per cent, indicating a silty clay of low to medium plasticity. Measured water contents on selected silty clay till samples ranged between about 14 per cent and 20 per cent. The water content of the lower portion of the till is above its plastic limit; the water content of the upper weathered crust is below its plastic limit which indicates that this material is more desiccated than the lower till material.

4.3.1.4 Sand to Sand and Gravel

Water-bearing sand and / or sand and gravel were encountered in Boreholes WWAR-3 to WWAR-5, BWSR-5, BSWR-6 to BSWR-9, and BESR-6 to BESR-10. These deposits underlie the fill and organic materials and, where encountered, is typically greater than 5 m thick. Figure 13 shows the grain size distribution of two representative samples of this sand. The sand is in a compact to very dense state as indicated by SPT 'N' values of 11 blows to greater 39 blows per 0.3 m penetration. Grain size distribution of a sand and gravel sample is shown on Figure 14. The sand and gravel has typical 'N' values ranging between 13 blows and 70 blows per 0.3 m penetration indicating a compact to very dense state; although some loose zones with 'N' values less than 10 blows are present at some locations.

4.3.1.5 Bedrock

Bedrock of the Queenston Formation consisting of shale with occasional interlayers of siltstone was encountered in Boreholes BSER-4, BSER-1 and BSER-2. Bedrock coring was not carried out in any of these boreholes. These boreholes were advanced into the weathered zone of the bedrock by augering, and split-spoon samples of the shale were retrieved. Practical refusal to split-spoon sampler advance and / or distinctively higher resistance to augering was encountered at the depths where shale bedrock was encountered.

4.3.1.6 Groundwater Conditions

Piezometers were installed in Boreholes BWSR-5, BSWR-6, BSER-4, BSER-1 and BSER-2 put down during this and previous investigation. Details of the piezometer installations and the water level measurements are shown on the attached Record of Borehole sheets and on Drawing BS 1. Groundwater conditions in the open hole upon completion and / or during drilling for the remaining boreholes are shown on the Record of Borehole sheets.

The measurements indicate that the groundwater level lies between Elevations 72 m and 75 m or about 2 m to 3.5 m below existing ground surface. It should be noted that the water levels are subject to seasonal fluctuations.

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of foundation design of the proposed embankments at the QEW / RHCE and QEW / BS interchanges based on our interpretation of the factual information obtained during this and previous investigations. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

The project information utilized for the preparation of this report was obtained from the MTO. We understand that the plans and profiles, as well as digital base plans, were prepared by McCormick Rankin Corporation (MRC). For the purpose of discussion, the embankment alignments are divided into several portions along the longitudinal profiles, based on stratigraphy and soil properties, as shown on Drawings RHCE 1 and BS 1.

5.2 Embankment Design - Red Hill Creek Expressway Interchange

The existing terrain in this vicinity is relatively flat-lying with ground surface elevations generally ranging between Elevations 80 m and 82 m. The subsoils encountered in the boreholes put down in this vicinity generally consist of a thin veneer of topsoil overlying surficial silty sand to sandy silt, which in turn overlies an 8 m to 12 m thick silty clay deposit. Within this deposit and underneath a 1 m to 3 m thick stiffer crust is a "softer" zone of about 3 m to 4 m in thickness. The silty clay then becomes stiffer with depth and grades into a glacial till. The site is underlain by shale bedrock. Measured groundwater levels lie between 2 m and 3.5 m depths below existing ground surface.

Factors governing the design of these embankments include (i) the depth, thickness, undrained strength and consolidation characteristics of the “softer” silty clay deposit, (ii) the height and density of the embankment fill, (iii) the different combinations of thickness and stiffness / density of the silty clay crust / surficial sands and silts, (iv) the drainage and compressibility characteristics of the clay layer, (v) space restrictions and other considerations in some areas (such as approach embankment locations) prohibiting the use of berms or flatter slopes. Further, consideration was given to the cost effectiveness of different types of embankment materials, their respective settlement characteristics as well as their environmental impacts.

For discussion purposes in this report, two types of granular fill, namely normal earth fill and lightweight fill, are considered. Normal acceptable earth fill is defined as conventional clean earth fill (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010). Well compacted earth fill is assumed to have a unit weight, γ, of 21 kN/m^3 and an effective friction angle, ϕ', of 32 degrees. Lightweight fill refers to granular blast furnace slag materials. Extensive geotechnical and environmental laboratory tests were carried out on two types (Type 1 and Type 2) of blast furnace slag materials (refer to Golder Associates report 971-1326 for details). In this report, a well compacted Type 1 slag, with a unit weight of 14 kN/m^3 and an effective friction angle of 35 degrees, is considered. Alternative materials such as polystyrene has relatively high cost. Due to the local availability of the lightweight slag, the use of polystyrene is not considered advantageous at this site.

For the purpose of embankment stability assessment and reporting, the alignment is divided into profiles designated as A-A, B-B, C-C and D-D as shown on Drawing RHCE 1. These divisions are largely based on subsurface stratigraphy and soil properties. Due to some relatively low undrained strengths of the "softer" clay, it is considered that short-term or undrained loading conditions would be critical to embankment stability. Slope stability analyses in terms of total stresses were carried out for each of the profiles using the Morgenstern and Price method. Analysis in terms of effective stress (long-term or drained conditions) were also carried out. Based on the borehole information, each section was analysed using representative soil parameters and subsurface stratigraphy (see Figures 24 to 27).

Measured field vane shear strength of the "softer" clay was as low as 12 kPa, and measured plasticity index was up to about 25 per cent. Profiles of field vane strength versus elevations are as shown on Figures 20 to 23. According to Bjerrum (1972) and considering the plasticity indices, corrected C_u values of the "softer" clay would have been only 95 per cent of the measured field values shown on the figures. Owing to its presumably glacio-lacustrine origin, there is potential for the "softer" clay to exhibit undrained strength anisotropy where the shear strength on a horizontal plane is less than that on a vertical plane. As such, the vane measurement of strength on a vertical plane could be higher than the average strength that can be mobilized on a typical, presumably horizontal, potential failure plane through the "softer" clay deposit. Based on consideration of the risks involved and past experience of embankment on soft clay, a Factor of Safety (F.S.) of 1.3, in conjunction with uncorrected, lower bound, shear strength values (see Figures 20 to 23), is considered appropriate for use in analysis and design of embankments at this site.

Stability analyses based on stress increases and consolidation parameters of the underlying clayey soils were conducted. Based on the results of oedometer tests carried out on samples retrieved from Boreholes RESR-1, RESR-7 and RSER-6, it is estimated that the pre-consolidation pressure, σ'_p, ranged between 100 kPa and 120 kPa. The soil at mid-level of the "softer" clay stratum is considered to have been pre-consolidated by about 30 kPa to 40 kPa in excess of the existing effective overburden stresses (OCR of 1.1 to 1.5). As a result of stress increase due to embankment loading, it is anticipated that σ'_p of the "softer" clay will be exceeded. As such, significant settlement will be induced within this deposit.

Consideration was given to a variety of measures to enhance embankment stability. These measures include the use of lightweight blast furnace slag, and polystyrene (discussed previously), earth berms, slope flattening, wick drains and geosynthetics. Wick drains increase the rate of pore water pressure dissipation and enhance the gain in shear strength of the soil. Its effectiveness can only be verified by extensive instrumentation during and after construction. In view of the scope of work at this site, wick drains are not considered to be cost effective. Geosynthetics provide physical reinforcement to weak founding soil. The effectiveness of using geosynthetics at this site is doubtful since the "softer" clay underlies existing fill, clay crust and / or surficial sands. Slope flattening would be effective in enhancing embankment stability, but this is generally less efficient in terms of material quantities than provision of berms. Based on the above considerations, it is considered that the use of lightweight fill or conventional earth fill with berms will be appropriate to enhance stability, where required, at this site.

5.2.1 Profile A-A (E-S RHCE Ramp) Stations 29+850 to 30+100

5.2.1.1 Undrained (Total Stress) Slope Stability

Fill heights between 5.5 m and 10 m are to be constructed within this section. The following discussion is divided into two portions due to the apparent absence of the "softer" clay between Stations 30+050 and 30+100. The stability analysis is focussed on the portion between Stations 29+850 and 29+900 (fill height up to 7 m) where the “softer” clay is thicker and is present at shallower depths. A proposed bridge (Bridge B) will span between approximately Stations 29+900 and 30+050.

Between about Stations 30+050 to 30+100 (Boreholes RESR-9, RESR-10, and RESR-7), only a thin layer of firm clay (vane strength of 45 kPa) was encountered at 8 m depth in Borehole RESR 9; the remaining soils within these boreholes are relatively competent. It is considered, therefore, that a conventional embankment using normal fill with a slope inclination of 2 horizontal to 1 vertical (2H:1V) would be stable.

Figure 20 shows a plot of field vane shear strengths, C_u , versus elevation for Profile A-A from Stations 29+850 to 30+050. From this data, a design profile is delineated for the purpose of stability assessment. A design C_u value of 15 kPa is associated with Elevations 74 m to 76 m. Figure 24 summarizes the stratigraphy, geotechnical parameters and results of the stability analyses. The locations of the critical slip circles for cases with or without berms, under the highest proposed fill for this portion, are shown. Results of the analysis indicate that a normal fill embankment of up to 5 m in height, with a slope inclination of 2 horizontal to 1 vertical, would be stable against a deep-seated, rotational type failure. To ensure stability for fills higher than 5 m, the use of toe berms or lightweight fill will be required.

Parametric studies were carried out using berms of different heights. Based on these studies and past experience, it is considered that berms of one-third the height of fill would be adequate at this site.

Figure 28 plots the required berm widths against fill heights for the normal earth fill. For fills of between 5 m and 7 m, one-third height berms will be required to achieve a F.S. of 1.3. For the highest proposed fill of 7 m between Stations 29+850 and 29+900, a berm width of 10 m will be required. In the case of lightweight fill, berms will not be required for an embankment of up to 7 m in height.

5.2.1.2 Settlement

Results of settlement analysis, assuming an embankment height of 7 m, indicate that the post-construction settlement induced as a consequence of embankment loading using normal earth fill would be up to the order of 175 mm to 225 mm. For a normal fill height of 5 m, the corresponding post-construction settlement is estimated to be of the order of 125 mm to 175 mm. These ranges of settlement take into account the effects of stabilizing berms. However, if lightweight fill is used (no berms), the resulting settlement for 7 m high fill would be reduced to the order of 100 mm to 150 mm. After the completion of the normal earth fill placement, it is estimated that up to 60 per cent of the anticipated settlement would have taken place after about three months. If lightweight fill is placed and left for the same period, it is estimated that up to 50 per cent of the anticipated settlement would have taken place.

If scheduling permits, consideration should therefore be given to pre-loading of the embankment, i.e. build up to profile grade and wait for, say, up to three months prior to carrying out paving and other works to allow a large portion of the settlement to take place. Flexible pavement should be considered at this site. The above measures, where properly implemented, would avoid the occurrence of abrupt settlement along the ramp alignment.

5.2.2 Profile B-B (E-S RHCE and S-W RHCE Ramps) Stations 29+600 to 29+850

5.2.2.1 Undrained (Total Stress) Slope Stability

Fill heights between 4 m and 8 m in height are to be constructed in this section. Figure 21 shows a plot of field vane shear strengths, C_u , versus elevation for Profile B-B. From this data, a design profile is delineated for the purpose of stability assessment. A design C_u value of 22 kPa is associated with Elevations 74.5 m to 77 m. Figure 25 summarizes details and results of the analysis. Results of the analysis indicate that a normal fill embankment of up to 6.5 m in height, with a slope inclination of 2 horizontal to 1 vertical, would be stable. To ensure stability for fills higher than 6.5 m, the use of berms or lightweight fill will be required.

Parametric studies were carried out using berms of different heights. Based on these studies and past experience, it is considered that berms of one-third the height of fill would be adequate at this site.

Figure 28 plots the required berm widths against fill heights for the normal earth fill. For fills higher than 6.5 m, one-third height berms will be required to achieve a F.S. of 1.3. For the highest proposed fill of 8 m, a berm width of 7 m will be required. In the case of lightweight fill, berms will not be required for embankments of up to 8 m in height.

5.2.2.2 Settlement

Results of settlement analysis, assuming an embankment height of 8 m, indicate that the post-construction settlement induced as a consequence of embankment loading using normal fill would be up to the order of 200 mm to 250 mm. For a normal fill height of 6.5 m, the corresponding post-construction settlement is estimated to be of the order of 125 mm to 175 mm. However, if lightweight fill is used (no berms), the resulting settlement for 8 m high fill would be reduced to the order of 125 mm to 175 mm. After the completion of normal earth fill placement, it is estimated that up to 60 per cent of the anticipated settlement would have taken place after about three months. If lightweight fill is placed and left for the same period, it is estimated that up to 50 per cent of the anticipated settlement would have taken place.

If scheduling permits, consideration should be given to pre-loading of the embankment, prior to carrying out paving and other works to allow a large portion of the settlement to take place. A preloading period of, say, up to three months should be allowed. Flexible pavement should be considered at this site. The above measures, where properly implemented, would avoid the occurrence of abrupt settlement along the ramp alignment.

5.2.3 Profile C-C (E-S RHCE and S-W RHCE Ramps) Stations 29+200 to 29+450

5.2.3.1 Undrained (Total Stress) Slope Stability

Fill heights between 5 m and 9 m are to be constructed in this section. Figure 22 shows a plot of field vane shear strengths, C_u, versus elevation for Profile C-C. From this data, a design profile is delineated for the purpose of stability assessment. A design C_u value of 15 kPa is associated with

Elevations 74 m to 76 m. Figure 26 summarizes details and results of the analysis. Results of the analysis indicate that a conventional normal fill embankment of up to 6 m in height with a slope inclination of 2 horizontal to 1 vertical would be stable. To ensure stability for fills higher than 6 m, the use of berms or lightweight fill will be required.

Parametric studies were carried out using berms of different heights. Based on these studies and past experience, it is considered that berms of one-third the height of fill would be adequate at this site.

Figure 29 plots the required berm widths against fill heights for the normal earth fill. For fills greater than 6 m high, one-third height berms will be required to achieve a F.S. of 1.3. A berm width of 8 m will be required for a highest proposed fill height of 9 m. In the case of lightweight fill, berms will not be required for embankments of up to 9 m in height.

5.2.3.2 Settlement

Results of settlement analysis, assuming an embankment height of 9 m, indicate that the post-construction settlement induced as a consequence of embankment loading using normal fill would be up to the order of 125 mm to 150 mm. For a normal fill height of 6 m, the corresponding post-construction settlement is estimated to be of the order of 75 mm to 100 m. However, if lightweight fill is used (no berms), the resulting settlement for 9 m high fill would be reduced to the order of 75 mm to 100 mm. After the completion of normal earth fill placement, it is estimated that up to 60 per cent of the anticipated settlement would have taken place after about three months. If lightweight fill is placed and left for the same period, it is estimated that up to 50 per cent of the anticipated settlement would have taken place.

If scheduling permits, consideration should be given to pre-loading of the embankment, prior to carrying out paving and other works to allow a large portion of the settlement to take place. A preloading period of up to three months should be allowed. Flexible pavement should be considered at this site. The above measures, where properly implemented, would avoid the occurrence of abrupt settlement along the ramp alignment.

5.2.4 Profile D-D (S-E RHCE Ramp) Stations 10+194 to 10+584

5.2.4.1 Undrained (Total Stress) Slope Stability

Fill heights between 8 m and 11 m are to be constructed within this section. Figure 23 shows a plot of field vane shear strengths, C_u, versus elevation for Profile D-D. From this data, a design profile is delineated for the purpose of stability assessment. A C_u value of 22 kPa is associated with about Elevations 74 m to 77 m. Figure 27 summarizes details and results of the analysis. Results of the analysis indicate that a conventional normal fill embankment of up to 8 m in height, with a slope inclination of 2 horizontal to 1 vertical, would be stable. To ensure stability for fills higher than 8 m, the use of berms or lightweight fill will be required.

Parametric studies were carried out using berms of different heights. Based on these studies and past experience, it is considered that berms of one-third the height of fill would be adequate at this site.

Figure 29 plots the required berm widths against fill heights for the normal earth fill. For fills greater than 8 m, one-third height berms will be required to achieve a F.S. of 1.3. A berm width of 10 m will be required for a highest proposed fill height of 11 m. In the case of lightweight fill, berms will not be required for embankments of up to 11 m in height.

5.2.4.2 Settlement

Results of settlement analysis, assuming an embankment height of 11 m, indicate that the post-construction settlement induced as a consequence of embankment loading using normal fill would be up to the order of 275 mm to 350 mm. For a normal fill height of 8 m, the corresponding post-construction settlement is estimated to be of the order of 200 mm to 250 mm. However, if lightweight fill is used (no berms), the resulting settlement for 11 m high fill would be reduced to the order of 125 mm to 200 mm. After the completion of normal earth fill placement, it is estimated that up to 60 per cent of the anticipated settlement would have taken place after about three months. If lightweight fill is placed and left for the same period, it is anticipated that up to 50 per cent of the anticipated settlement would have taken place.

If scheduling permits, consideration should be given to pre-loading of the embankment, prior to carrying out paving and other works to allow a large portion of the settlement to take place. A preloading period of up to three months should be allowed. Flexible pavement should be considered at this site. The above measures, where properly implemented, would avoid the occurrence of abrupt settlement along the ramp alignment.

5.2.5 Drained (Effective Stress) Slope Stability

To confirm that the embankment slopes would remain stable in the long-term, stability analyses have also been carried out for all critical locations using drained (effective stress) parameters. For the "softer" clay stratum, two combinations of strength parameters ($c' = 0$, $\phi' = 27°$, and $c' = 15$ kPa, $\phi' = 15°$) obtained from the CIU tests were used. Results of the analysis indicate that embankments (normal or lightweight fill) of up to the proposed heights will be stable for the requirements discussed in the total stress analysis.

5.2.6 Approach Embankments

Several bridges are to be constructed at locations shown on Drawing RHCE 1. In Profiles A-A, B-B and C-C, where the "softer" clay is present at shallow depths, it is recommended that one-third height berms or lightweight fill (slag) be used to ensure embankment stability (as discussed above). These measures are required both in the transverse and the longitudinal directions. Due to space restrictions at the approach embankment / abutment locations, and in order to reduce the overall length of the bridge structures, it is beneficial to use lightweight slag in the immediate vicinity of the approaches to abutments where the presence of "softer" clay affects embankment stability. Figure 30 shows how the slag may be used at a typical approach embankment / abutment location. A transition zone with an inclination of 3H:1V is suggested to minimize abrupt settlement.

5.2.7 Low Embankments (less than 4 m in height)

Based on the field and laboratory data presented in Appendix I, it is considered that subexcavation is not required along the low embankment alignments, provided that topsoil stripping is carried out as per the requirements of OPSS 206. In areas where there is a requirement for grade raise over existing pavement, the existing asphalt may be left in place.

Low embankments with conventional 2H:1V slopes will be stable. Estimated settlements for fills of up to 4 m in height would be in the order of 50 mm. However, the majority of the settlement is expected to occur during and immediately after embankment construction.

5.3 Embankment Design – Burlington Street Interchange

The existing terrain across the Red Hill Creek floodplain is flat-lying. Undulations across the site area are mainly associated with fill embankments and landscaping of the existing interchange and the QEW right-of-way. The ground surface at the level of the floodplain varies between about Elevations 76 m and 78 m. The subsoils encountered in the boreholes put down during the present and previous investigations generally consist of existing fill overlying very stiff to hard silty clay glacial till. Some layers of peat / organics are present within and / or underneath the fill. The glacial till is underlain by shale bedrock. Measured and observed groundwater levels are at about Elevation 75 m, or typically within 2 m depth below existing ground surface.

The design of embankments in this vicinity depends primarily on (i) the thickness and nature of the existing fill and of the peat / organics where present, (ii) the height and density of the embankment material. The underlying glacial till is competent throughout and is a good founding material.

5.3.1 Profile A-A [E-S (BS) Ramp Stations 10+370 to 10+950 and S-W (BS) Ramp 10+570 to 10+120]

5.3.1.1 Slope Stability

Fills up to 9 m in height are to be constructed within this section. The locations of high embankment of between 6 m and 9 m coincide with locations immediately adjacent to the east and west side of the QEW (Boreholes BESR-5 and BESR-6) where the existing fill is between 3 m and 4 m in thickness. The existing cohesive and granular fills are generally stiff and compact, respectively. At both borehole locations, however, there is a black coloured cohesive zone at the bottom of the fill of about 0.5 m thick where a large amount of organics is mixed with the soil matrix. This zone has a typically firm to stiff consistency. Embankments composed of normal fill of up to 9 m in height, with a slope inclination of 2 horizontal to 1 vertical, will be stable.

5.3.1.2 Settlement

For the section to the east of the QEW, compression of the existing fill with organics and the underlying sand to sand and gravel will occur during or immediately after construction. Peat existing at or near ground surface should be sub-excavated to avoid excessive settlement. Such sub-excavation may extend up to 2.5 m depth in the vicinity of Borehole BSWR-6.

In the area between Bridges 2 and 4, if the peat which interlayers with or underlies the fill is left in place, it is estimated that consolidation settlement under a maximum fill height of about 8 m would be in the order of 150 mm to 200 mm, and would take place during construction. Assuming the rate of secondary compression, C_α, is 0.03 for the peat / organics, it is estimated that further settlement due to secondary compression would be in the order of 100 mm.

To avoid excessive settlement, it is recommended that the existing fill along with the peat / organics be sub-excavated and replaced with approved materials. Such sub-excavation may extend up to 3.5 m below existing ground surface in the vicinity of Boreholes BSWR-5 and BESR-5. In this case, the stability of the 8 m high embankment would also be ensured with normal earth fill.

5.3.2 Profile B-B [S-E (BS) Ramp Stations 10+300 to 10+400]

5.3.2.1 Slope Stability

Fills up to 4.5 m in height are to be constructed within this section. At the locations of Boreholes BSER-4 and BSER-5, existing sandy silt fill extends to between 1 m and 2.5 m below ground surface. The fill is generally in a compact state. Embankments composed of normal earth fill, with a slope inclination of 2 horizontal to 1 vertical, will be stable.

5.3.2.2 Settlement

Immediate or elastic settlement of embankments constructed on the existing fill is expected to occur during or immediately after construction and, therefore, post-construction measures are not required.

5.3.3 Profile C-C [W-S (BS) Ramp Stations 10+700 to 11+050]

5.3.3.1 Slope Stability

Embankments of up to 6 m in height are to be constructed within this section. Cohesive fill of between 1 m to 3 m were encountered in Boreholes BWSR-1 to BWSR-8, WWAR-1, WWAR-3 to WWAR-5. The fill has a typically stiff to very stiff, and occasionally, firm consistency. Peat layers, and layers of soils mixed with large amount of organics, were found underlying or interlayering with the fill. Occasional layers of loose sands and silts are also present in some boreholes. Embankments composed of normal earth fill, with a slope inclination of 2 horizontal to 1 vertical, will be stable.

5.3.3.2 Settlement

Immediate or elastic settlement of embankments constructed on the existing fill is expected to occur during or immediately after construction and, therefore, post-construction measures are not required.

5.3.4 Low Embankments (less than 4 m in height)

Based on the field and laboratory data presented in Appendix II, it is considered that subexcavation is not required along the low embankment alignments, provided that topsoil stripping is carried out as per the requirements of OPSS 206. In areas where there is a requirement for grade raise over existing pavement, the existing asphalt may be left in place. Where peat / organics is encountered at or near ground surface, such as along one section of the W-RHCE ramp, from approximately Stations 11+125 to 11+575, it is recommended that the peat be excavated to firm base, and replaced with normal acceptable earth fill.

Low embankments with conventional 2H:1V slopes will be stable. Along Profile A-A, estimated settlements for fills up to 4 m in height would be in the order of 50 mm where the peat / organics (interlayering with or underneath existing fill) is left in place. The majority of the settlement is expected to occur during and immediately after the construction of the embankments. Settlement will be negligible if the peat / organics is sub-excavated and replaced with normal acceptable earth fill.

5.4 Construction

In general, topsoil and organic deposits should be stripped from the subgrade areas within the plan limits of the embankments. All subgrade soils should be proof-rolled prior to fill placement.

5.4.1 Normal Earth Fill

Construction of embankments above the prepared subgrade may be carried out using clean earth material (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010), depending on material available. All fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 per cent of the material's Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 per cent of the Standard Proctor maximum dry density.

5.4.2 Lightweight (Slag) Fill

The use of light vibratory equipment is recommended for compaction of the slag material. In general, the slag material should be placed and compacted in accordance with OPSS 206.07. The following amendments are, however, noted.

For embankments, the slag material should be placed in loose lifts of 300 mm and compacted by four passes of a single-drum vibratory compactor such as Bomag 142 or equivalent. For backfill of structures, the slag material should be placed in loose lifts of 300 mm and compacted by eight passes of a manually guided tamper such as a Bomag BPR 30 / 38 D or equivalent.

Some water should be added to the slag material during placement and compaction to provide a lubricating effect between particles. The amount of water added or needed is influenced by field conditions, and is best determined on a site specific basis.

Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved. Vegetation cover should be established on all slopes to protect the embankment fill against surficial erosion as per current Ministry of Transportation standards.

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RECORDS OF BOREHOLES
RED HILL CREEK AND
BURLINGTON STREET INTERCHANGES
(CURRENT INVESTIGATION)

Golder Associates

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
DO	Drive open
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 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):
An electronic cone penetrometer with a 60° conical tip and a projected end area of 10 cm^2 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 (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

(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

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 test (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

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789773.574; E 284053.236

RECORD OF BOREHOLE RESR-8

BORING DATE: SEPT.16/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa: nat V - + Q - ● rem V - ⊕ U - O (20, 40, 60, 80)

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT: Wp —O W— Wl (10, 20, 30, 40)

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	85.72				
		Topsoil	0.09				
		Clayey Silt, some sand, trace gravel, some asphalt fragments Very stiff to hard Brown Moist (Fill)		1	50 DO	19	
1				2	50 DO	40	
			84.20 1.52	3	50 DO	60	
		END OF BOREHOLE					Open hole dry upon completion of drilling.
2							
3							
4							
5							
6							
7							
8							
9							
10							

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RESR9.BHS

RECORD OF BOREHOLE RESR-9

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789760.049; E 284076.977

BORING DATE: SEPT.16/98

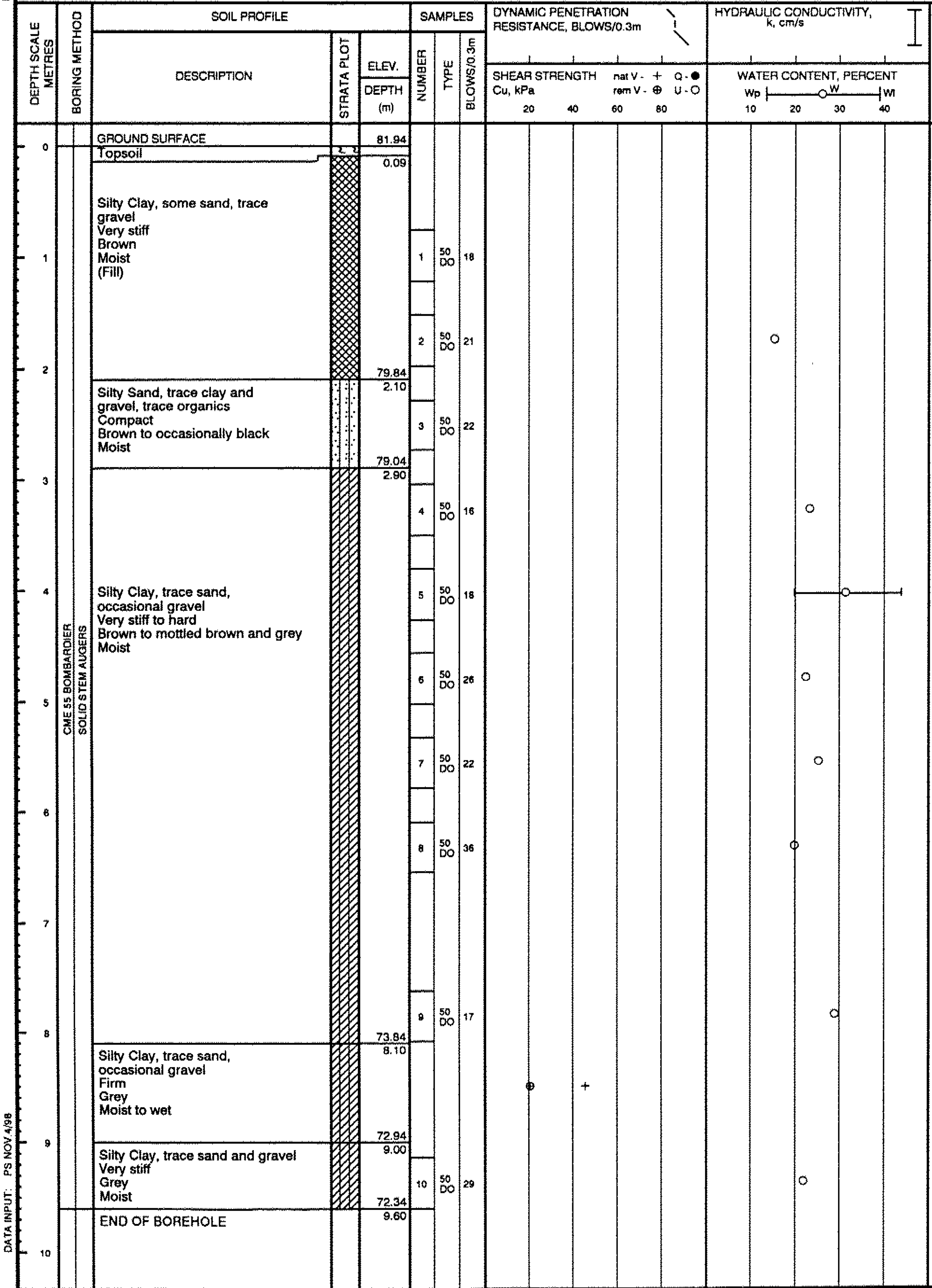
SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

SOIL PROFILE (BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS)

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	81.94
Topsoil	0.09
Silty Clay, some sand, trace gravel Very stiff Brown Moist (Fill)	79.84 2.10
Silty Sand, trace clay and gravel, trace organics Compact Brown to occasionally black Moist	79.04 2.90
Silty Clay, trace sand, occasional gravel Very stiff to hard Brown to mottled brown and grey Moist	73.84 8.10
Silty Clay, trace sand, occasional gravel Firm Grey Moist to wet	72.94 9.00
Silty Clay, trace sand and gravel Very stiff Grey Moist	72.34 9.60
END OF BOREHOLE	

SAMPLES

NUMBER	TYPE	BLOWS/0.3m
1	50 DO	18
2	50 DO	21
3	50 DO	22
4	50 DO	16
5	50 DO	18
6	50 DO	26
7	50 DO	22
8	50 DO	36
9	50 DO	17
10	50 DO	29



ADDITIONAL LAB. TESTING: MH (Sample 5)

PIEZOMETER OR STANDPIPE INSTALLATION: Open hole dry upon completion of drilling.

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

DATA INPUT: PS NOV 4/98

SOILM6

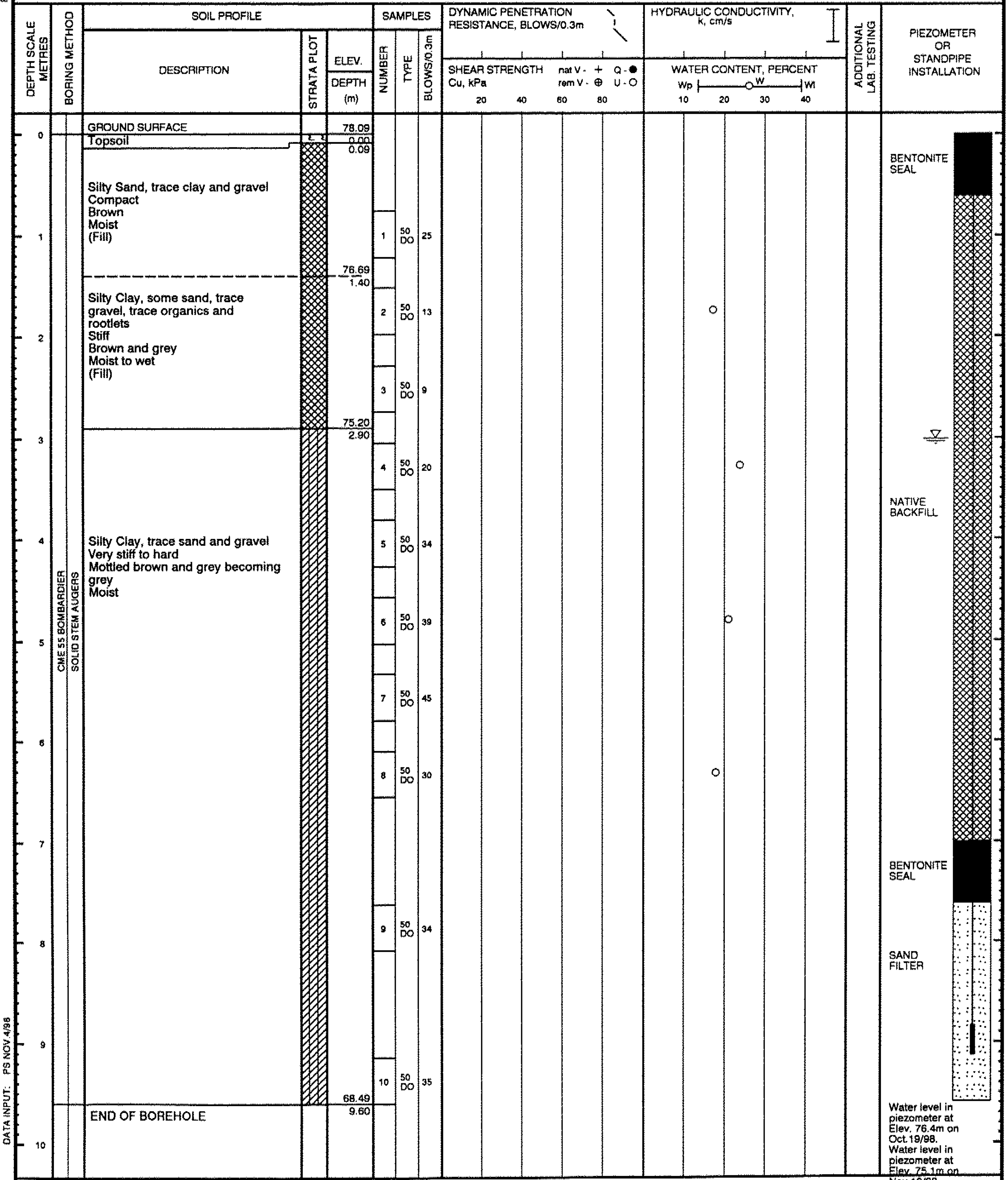
RESR10.BHS

W.P.: 441-97-00
DIST.: 4, HWY: QEW
LOCATION: N 4789717.289; E 284088.854

RECORD OF BOREHOLE RESR-10

BORING DATE: SEPT.16/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033



DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	78.09
Topsoil	0.00
Silty Sand, trace clay and gravel Compact Brown Moist (Fill)	0.09
Silty Clay, some sand, trace gravel, trace organics and rootlets Stiff Brown and grey Moist to wet (Fill)	76.69 1.40
Silty Clay, trace sand and gravel Very stiff to hard Mottled brown and grey becoming grey Moist	75.20 2.90
END OF BOREHOLE	68.49 9.60

NUMBER	TYPE	BLOWS/0.3m
1	50 DO	25
2	50 DO	13
3	50 DO	9
4	50 DO	20
5	50 DO	34
6	50 DO	39
7	50 DO	45
8	50 DO	30
9	50 DO	34
10	50 DO	35

Water level in piezometer at Elev. 76.4m on Oct.19/98.
Water level in piezometer at Elev. 75.1m on Nov.10/98.

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RESR22.BHS

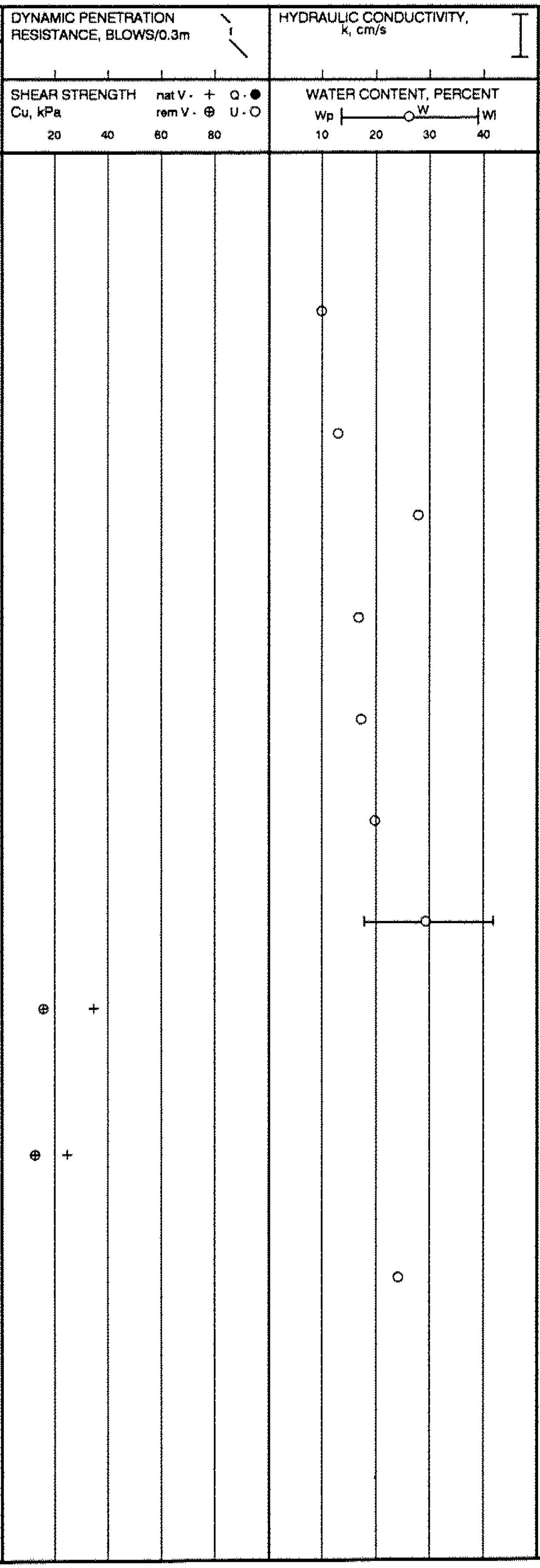
W.P. 441-97-00			SHEET 1 OF 1
DIST. 4, HWY: QEW		BORING DATE: SEPT.21/98	DATUM: GEODETIC
LOCATION: N 4789869.805; E 283491.991			PROJECT: 981-8033

RECORD OF BOREHOLE RESR-22

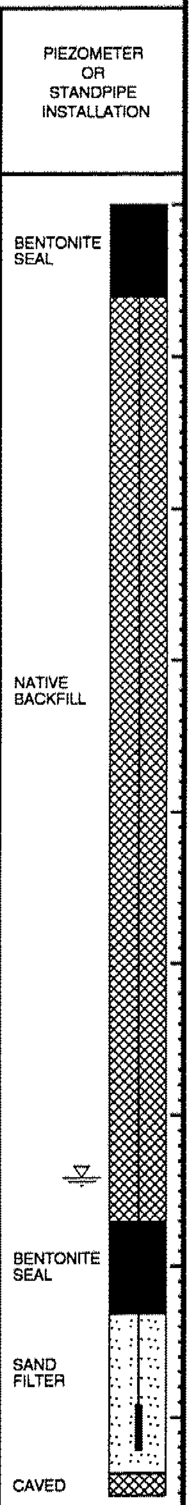
BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	GROUND SURFACE	82.49
	Topsoil	0.00
	Clayey Silt, some sand and gravel Very stiff Brown Dry (FILL)	0.12
1	Silty Sand, trace gravel and clay, trace organics Compact Brown Moist	81.09 1.40
2	Silty Clay, trace sand and gravel Stiff to very stiff Mottled brown and grey Moist	80.39 2.10
3	Sand and Silty Sand interlayered Very dense Brown Wet	79.29 3.20
4	Silty Clay, trace sand and gravel Hard Mottled brown and grey Moist	78.64 3.85
5	Silty Clay, trace sand, occasional gravel Soft to firm Grey Moist to wet	77.29 5.20
8	Silty Clay, trace sand and gravel Very stiff Grey Moist	74.59 7.90
	END OF BOREHOLE	73.96 8.53
9		
10		

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	28
2	50 DO	16
3	50 DO	15
4	50 DO	55
5	50 DO	32
6	50 DO	32
7	50 DO	6
8	75 TO	PH
9	75 TO	PH
10	50 DO	17



ADDITIONAL LAB. TESTING



Water level in piezometer at Elev. 76.1m on Oct.19/98 and Nov.10/98.

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789847.214; E 283449.726

RECORD OF BOREHOLE RESR-23

BORING DATE: SEPT.18/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	GROUND SURFACE	81.37
	Topsoil	0.00
	Silty Clay, trace to some sand, trace gravel, trace rootlets above 1.5m depth Hard becoming very stiff Mottled brown and grey Moist	0.12
3.65	Silty Clay, trace sand and gravel Stiff to very stiff Grey Moist	77.72 3.65
7	Silty Clay, trace sand and gravel Hard Grey Moist (Glacial Till)	74.38 7.00
8	END OF BOREHOLE	73.30 8.08

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	75
2	50 DO	78
3	50 DO	24
4	50 DO	18
5	50 DO	11
6	50 DO	10
7	50 DO	16
8	50 DO	42

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
20 40 60 80

SHEAR STRENGTH Cu, kPa
nat V - + Q - ●
rem V - ⊕ U - ○

⊕ (approx. 4.6 m depth)
\+ >101 (approx. 4.6 m depth)

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT
Wp ├──○W──┤ Wl
10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open hole dry upon completion of drilling.

DATA INPUT: PS OCT.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RESR24.BHS

RECORD OF BOREHOLE RESR-24

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789832.766; E 283391.004

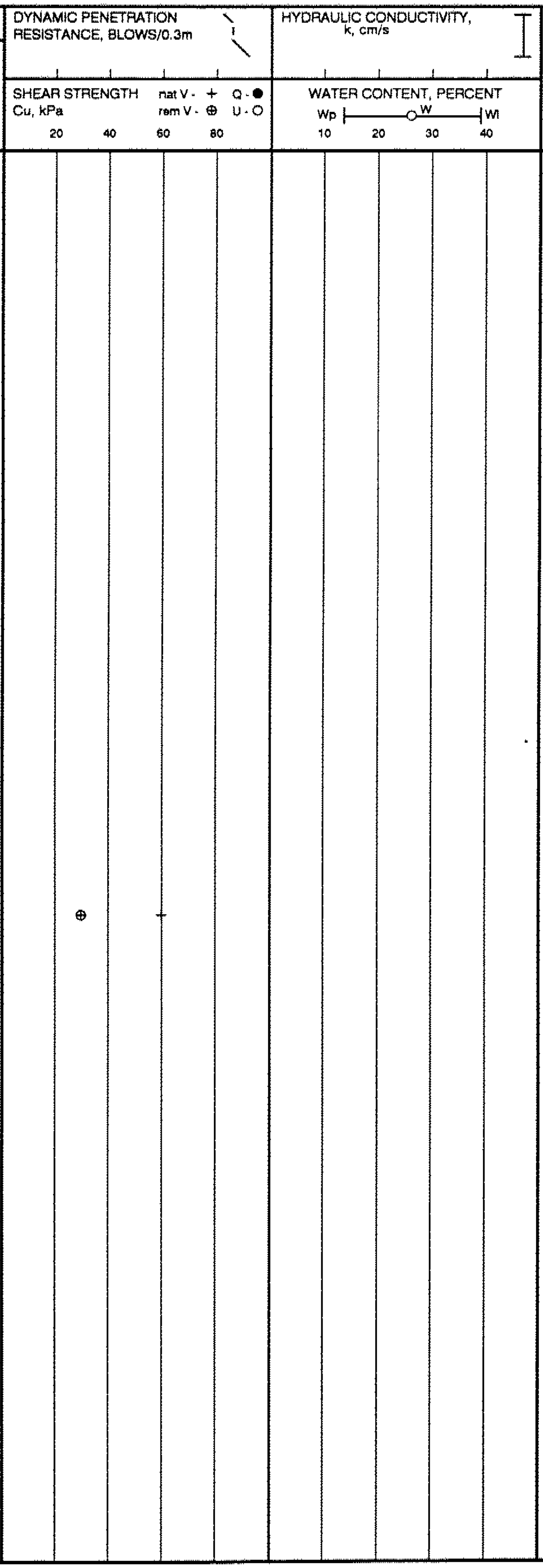
BORING DATE: SEPT.18/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	81.71
Topsoil	0.00
Clayey Silt, trace to some sand, trace gravel Hard Brown to mottled brown and grey Dry	0.12
Silty Clay, trace to some sand, trace gravel Hard becoming very stiff	79.61 2.10
Silty Clay, trace sand and gravel Stiff to hard Grey Moist	77.31 4.40
END OF BOREHOLE	73.63 8.08

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	65
2	50 DO	100
3	50 DO	69
4	50 DO	39
5	50 DO	26
6	50 DO	15
7	50 DO	27
8	50 DO	49



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open hole dry upon completion of drilling.

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RESR25 BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789809.089; E 283350.457

RECORD OF BOREHOLE RESR-25

BORING DATE: SEPT.17/98

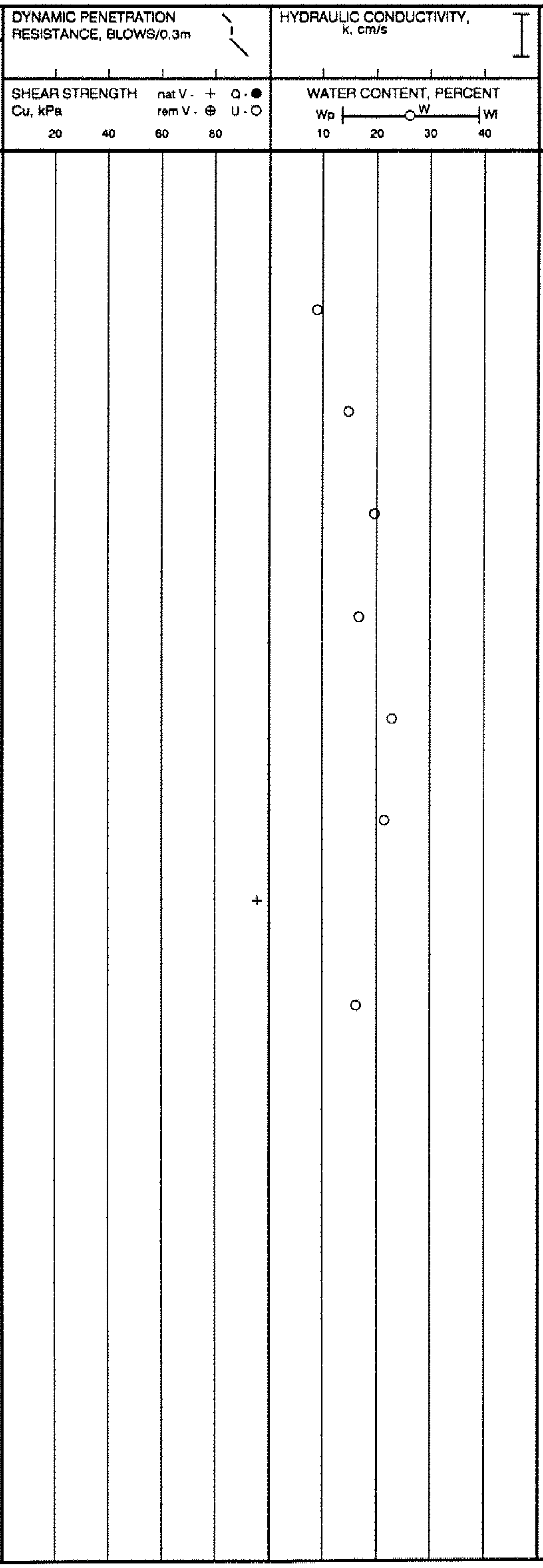
SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE	81.67				
	Topsoil	0.09				
1	Clayey Silt, trace to some sand, trace gravel Hard Mottled brown and grey Dry to moist		1	50 DO	70	
			2	50 DO	50	
2		79.57 2.10				
	Silty Clay, trace sand and gravel Very stiff Mottled brown and grey Moist		3	50 DO	29	
3			4	50 DO	25	
		78.02 3.65				
4	Silty Clay, trace sand and gravel Stiff Grey Moist		5	50 DO	10	
			6	50 DO	14	
5		76.47 5.20				
	Silty Clay, trace sand and gravel Stiff to very stiff Grey Moist					
6		75.40 6.27	7	50 DO	45/.18	
	END OF BOREHOLE Refusal to split spoon sampler advance					Open hole dry upon completion of drilling.
7						
8						
9						
10						



ADDITIONAL LAB. TESTING

DATA INPUT: PS NOV.4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RESE26.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789794.775; E 283300.262

RECORD OF BOREHOLE RESR-26

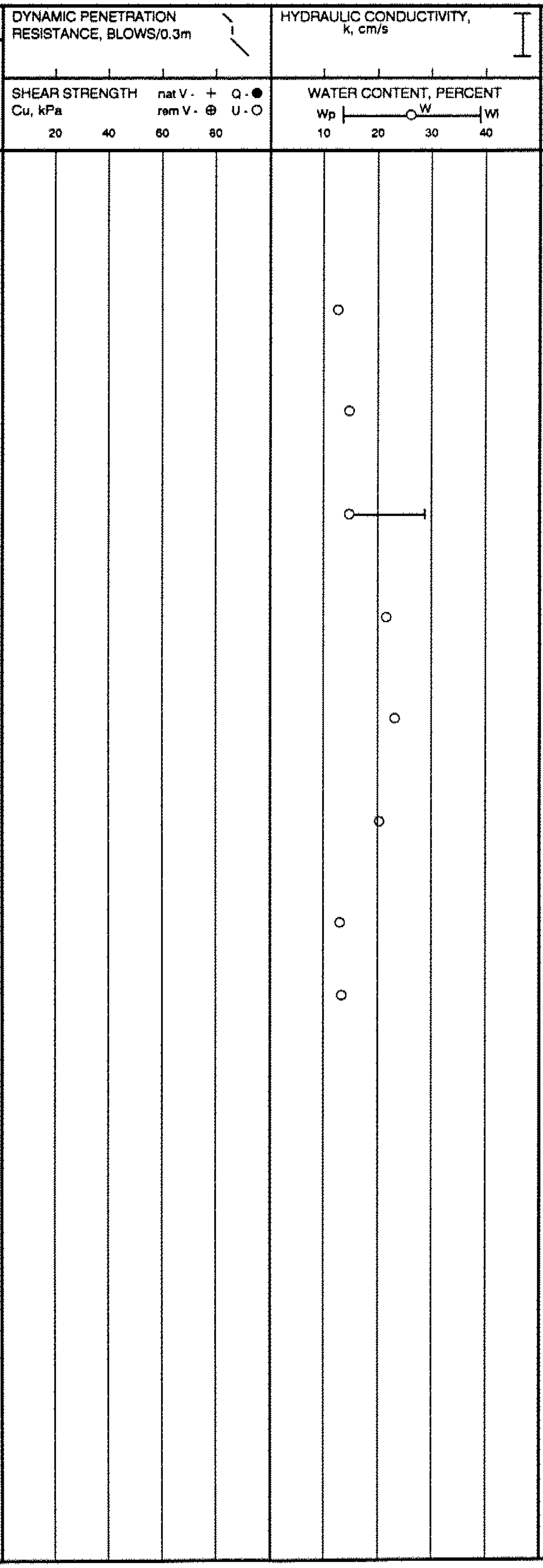
BORING DATE: SEPT.21/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	82.12
Topsoil	0.00
Silty Clay, trace sand and gravel, some rubble (Fill)	0.09
	81.52 0.60
Silty Clay, some sand, trace gravel Hard becoming very stiff Mottled brown and grey Moist	
	77.22 4.90
Silty Clay, trace sand and gravel Hard Grey Moist	
Shale Highly weathered Reddish brown (Bedrock)	76.37 5.75
END OF BOREHOLE Refusal to split spoon sampler advance	76.00 6.12

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	46	
2	50 DO	55	
3	50 DO	54	MH
4	50 DO	31	
5	50 DO	24	
6	50 DO	20	
7	50 DO	60	
8	50 DO	30/.03	



PIEZOMETER OR STANDPIPE INSTALLATION: Open hole dry upon completion of drilling.

DEPTH SCALE 1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

DATA INPUT: PS NOV.4/98

SOILM6

RSWR1.BHS

W.P. 441-97-00

RECORD OF BOREHOLE RSWR-1

SHEET 1 OF 1

DIST. 4, HWY: QEW

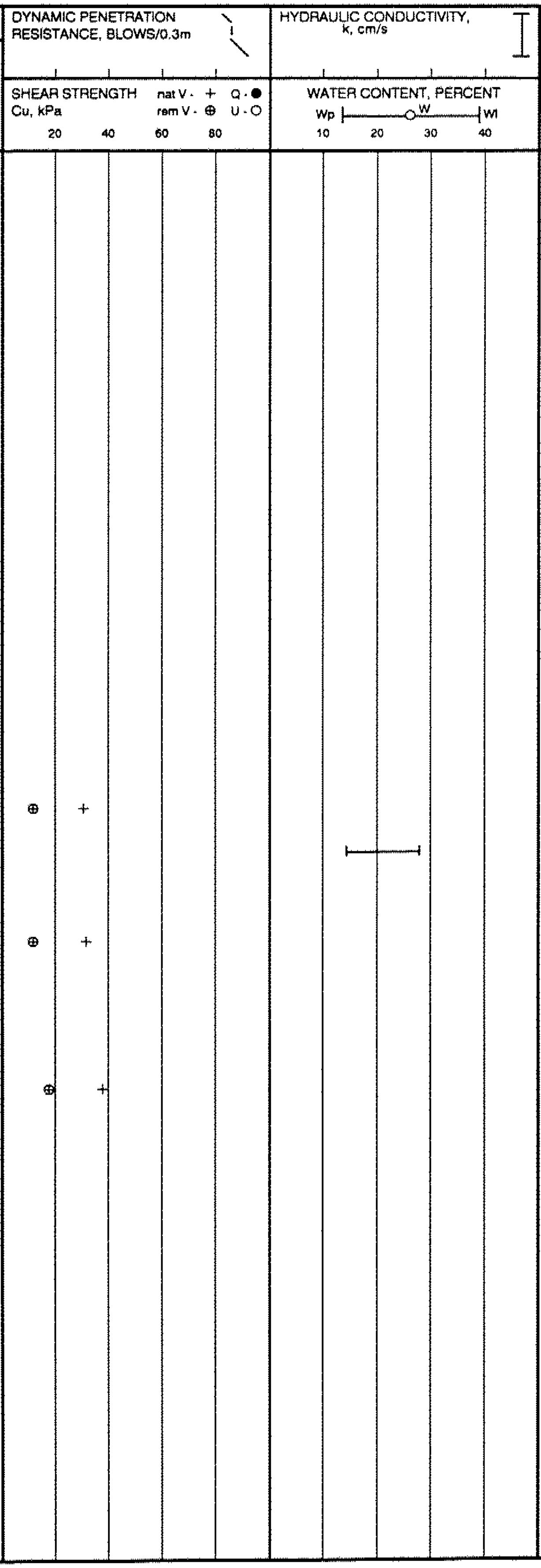
BORING DATE: SEPT.15/98

DATUM: GEODETIC

LOCATION: N 4789897.650; E 283676.951

PROJECT: 981-8033

BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	80.91					
	Topsoil	0.00					
	Silty Sand, trace to some clay, trace gravel Dense to very dense Brown Moist	0.12					
			1	50 DO	32		
			2	50 DO	49		
			3	50 DO	55		
			4	50 DO	15		
	Silty Clay, trace sand Stiff Grey Moist	77.56 3.35					
	Silty Clay, trace sand, occasional gravel, occasional silt seams Soft to firm Grey Moist to wet	77.21 3.70					
			5	50 DO	4		
			6	75 TO	PH	MH	
			7	75 TO	PH		
	Silty Clay, trace sand and gravel Hard Grey Moist	74.06 6.85					
			8	50 DO	34		
	END OF BOREHOLE	73.44 7.47					Open hole dry upon completion of drilling.



DEPTH SCALE

1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

DATA INPUT: PS NOV.4/98

SOILM6

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789896.779; E 283725.695

RECORD OF BOREHOLE RSWR-2

BORING DATE: SEPT.14/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

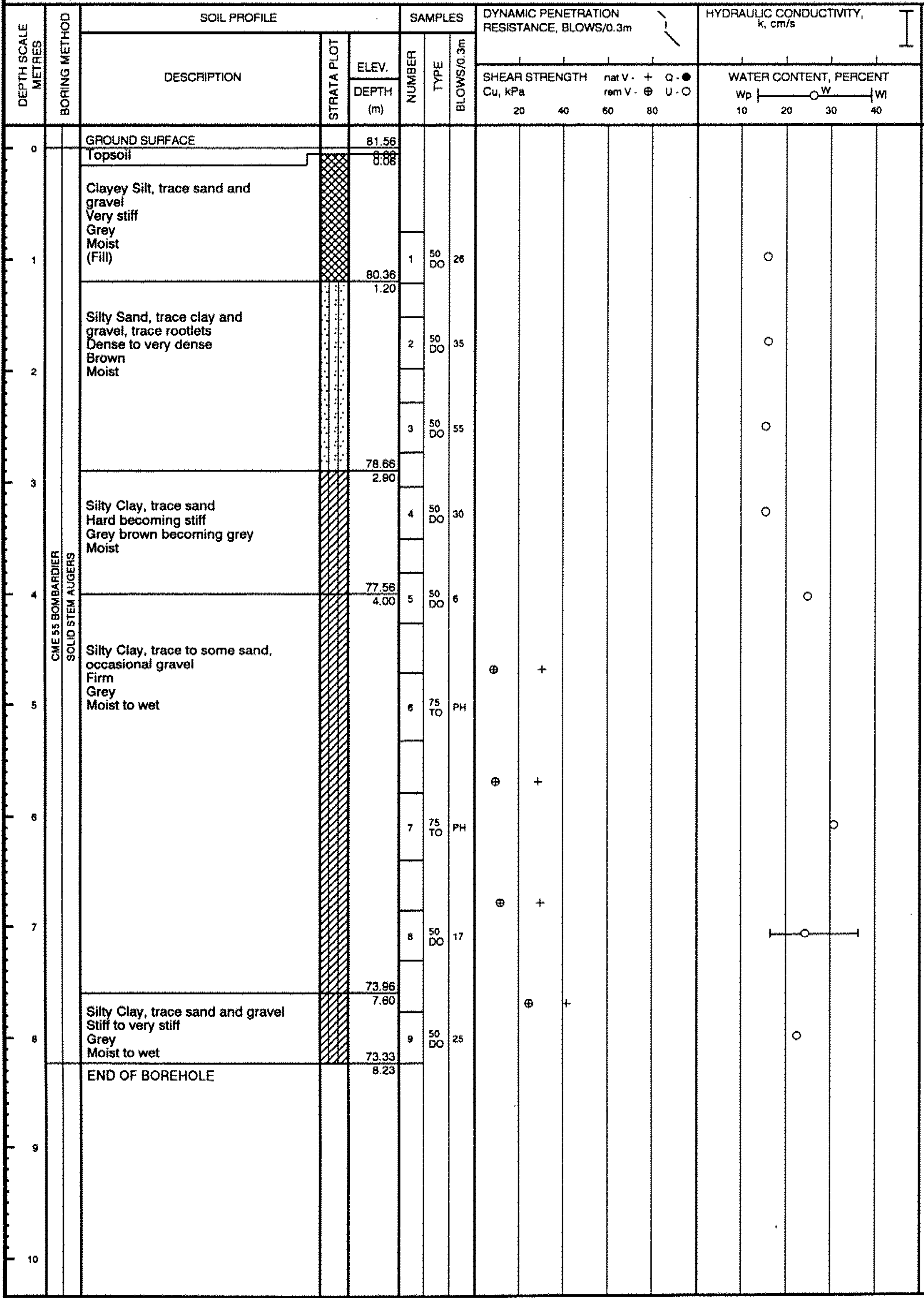
BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	81.56
Topsoil	81.50 0.06
Clayey Silt, trace sand and gravel Very stiff Grey Moist (Fill)	80.36 1.20
Silty Sand, trace clay and gravel, trace rootlets Dense to very dense Brown Moist	78.66 2.90
Silty Clay, trace sand Hard becoming stiff Grey brown becoming grey Moist	77.56 4.00
Silty Clay, trace to some sand, occasional gravel Firm Grey Moist to wet	73.96 7.60
Silty Clay, trace sand and gravel Stiff to very stiff Grey Moist to wet	73.33 8.23
END OF BOREHOLE	

SAMPLES

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	26	
2	50 DO	35	
3	50 DO	55	
4	50 DO	30	
5	50 DO	6	
6	75 TO	PH	
7	75 TO	PH	
8	50 DO	17	MH
9	50 DO	25	



PIEZOMETER OR STANDPIPE INSTALLATION

Water encountered at base of hole upon completion of drilling.

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSWR3.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4798893.879; E 283782.342

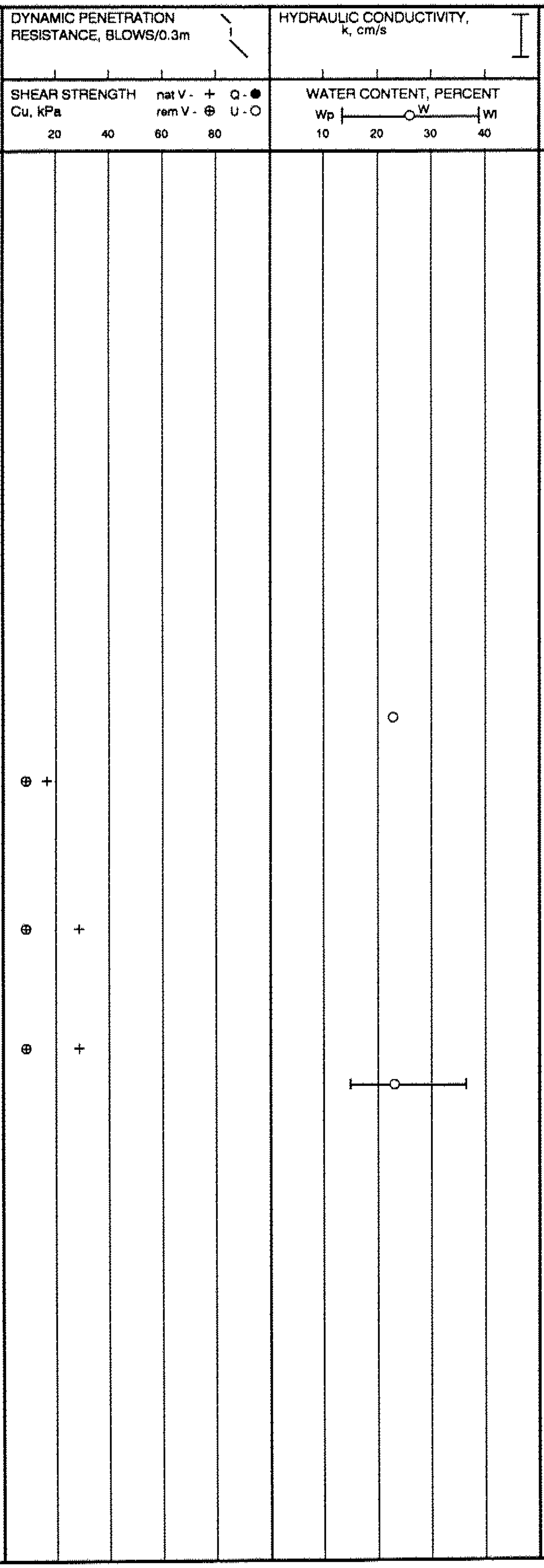
RECORD OF BOREHOLE RSWR-3

BORING DATE: SEPT.9/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	81.07				
0	Topsoil	0.00 0.06				
1	Silty Sand, trace clay, trace oxidized stains Compact Brown Moist (FILL)		1	50 DO	28	
		79.17 1.90	2	50 DO	24	
2	Silty Clay, trace sand and gravel Hard Mottled brown Moist		3	50 DO	30	
3		77.37 3.70	4	50 DO	35	▽
4	Silty Clay, trace sand, occasional gravel Soft to firm Grey Moist to wet		5	50 DO	8	
5			6	75 TO	PH	
6			7	75 TO	PH	
7		73.77 7.30	8	50 DO	8	
8	Silty Clay, trace to some sand and gravel Stiff to hard Grey Moist to wet		9	50 DO	14	
9		71.47 9.60	10	50 DO	30	
10	END OF BOREHOLE					Water level in open hole at 3.7m depth upon completion of drilling.



DATA INPUT: PS nov.4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSWR4.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789893.645; E 283830.623

RECORD OF BOREHOLE RSWR-4

BORING DATE: SEPT.9/98

SHEET 1 OF 1

DATUM: GEODETIC

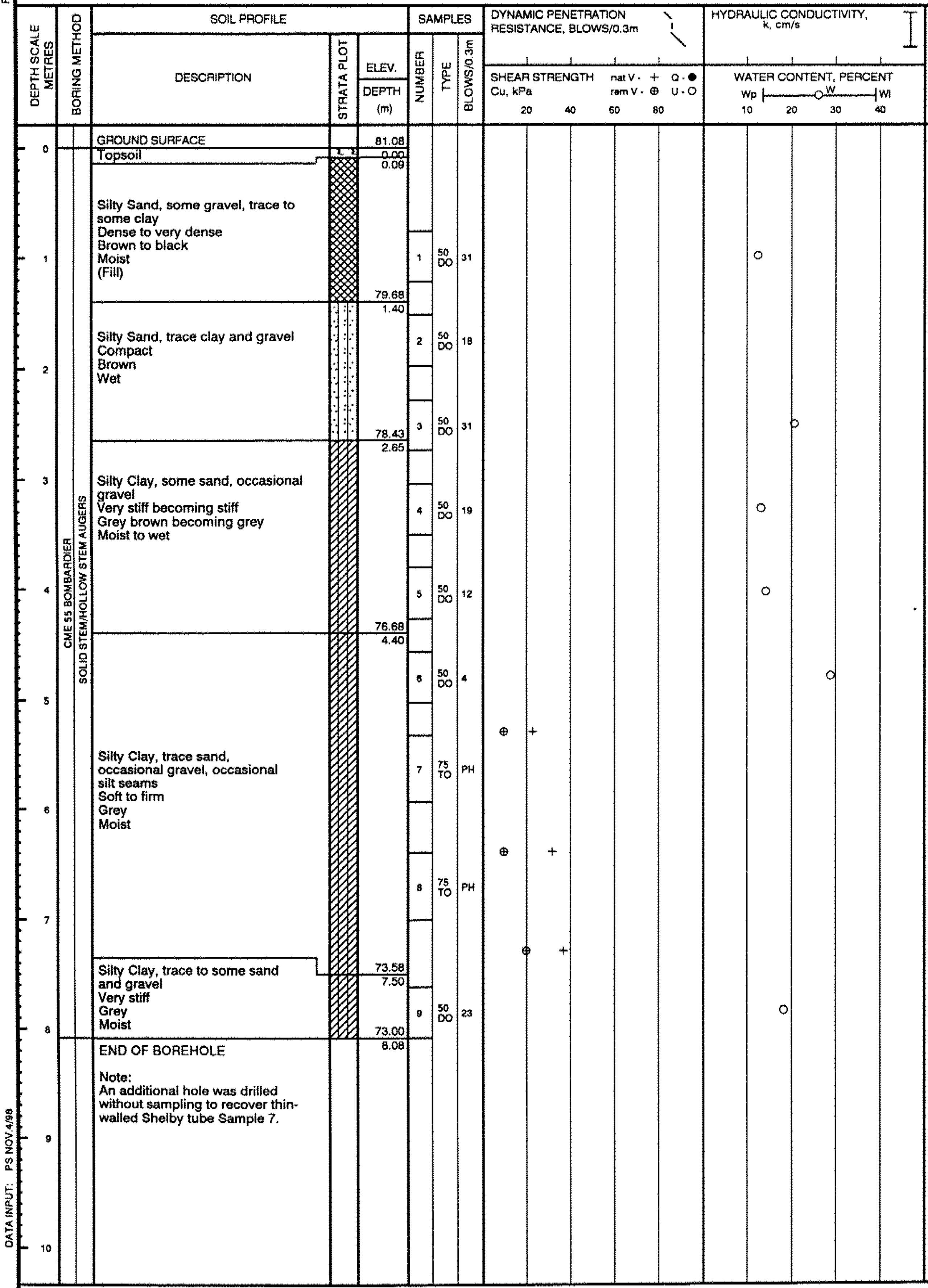
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER
SOLID STEM/HOLLOW STEM AUGERS

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	81.08
Topsoil	0.00 0.09
Silty Sand, some gravel, trace to some clay Dense to very dense Brown to black Moist (Fill)	79.68 1.40
Silty Sand, trace clay and gravel Compact Brown Wet	78.43 2.65
Silty Clay, some sand, occasional gravel Very stiff becoming stiff Grey brown becoming grey Moist to wet	76.68 4.40
Silty Clay, trace sand, occasional gravel, occasional silt seams Soft to firm Grey Moist	73.58 7.50
Silty Clay, trace to some sand and gravel Very stiff Grey Moist	73.00 8.08
END OF BOREHOLE	

Note:
An additional hole was drilled without sampling to recover thin-walled Shelby tube Sample 7.

NUMBER	TYPE	BLOWS/0.3m
1	50 DO	31
2	50 DO	18
3	50 DO	31
4	50 DO	19
5	50 DO	12
6	50 DO	4
7	75 TO	PH
8	75 TO	PH
9	50 DO	23



PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 3.0m depth upon completion of drilling.

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RSWR5.BHS

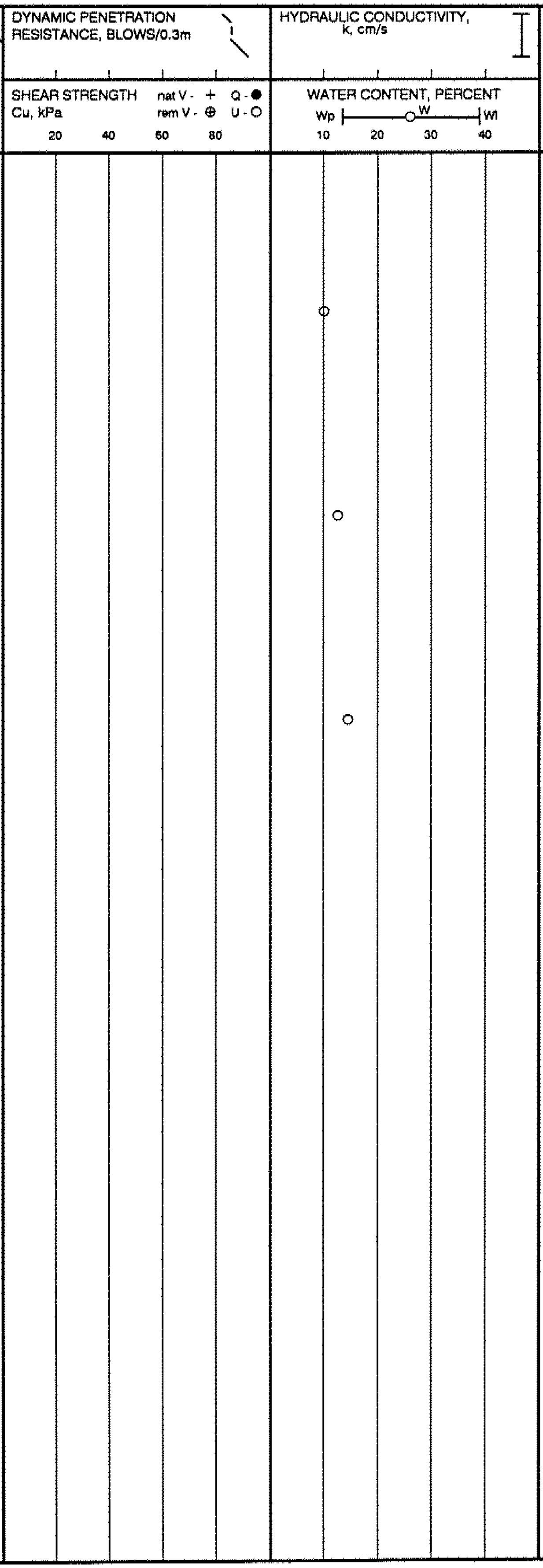
W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789873.234; E 283876.838

RECORD OF BOREHOLE RSWR-5

BORING DATE: SEPT.10/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	82.12					
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil	0.00					
1		Silty Sand, some gravel, trace clay, trace rootlets Dense Mottled brown Moist (Fill)	0.09	1	50 DO	47		
2		Clayey Silt, trace to some sand and gravel, occasional sand lenses Hard Mottled brown and grey Moist (Fill)	80.72 1.40	2	50 DO	42		
				3	50 DO	38		
3		Topsoil	79.28 2.90					
		Silty Clay, trace sand and gravel Very stiff Mottled brown and grey Moist		4	50 DO	24		
4		Silty Sand, trace sand and gravel Very dense Brown Moist	78.32 3.80	5	50 DO	62		
		END OF BOREHOLE	77.85 4.27					Water encountered at base of hole upon completion of drilling.



DATA INPUT: PS nov.4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSWR6.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789839.774; E 283914.421

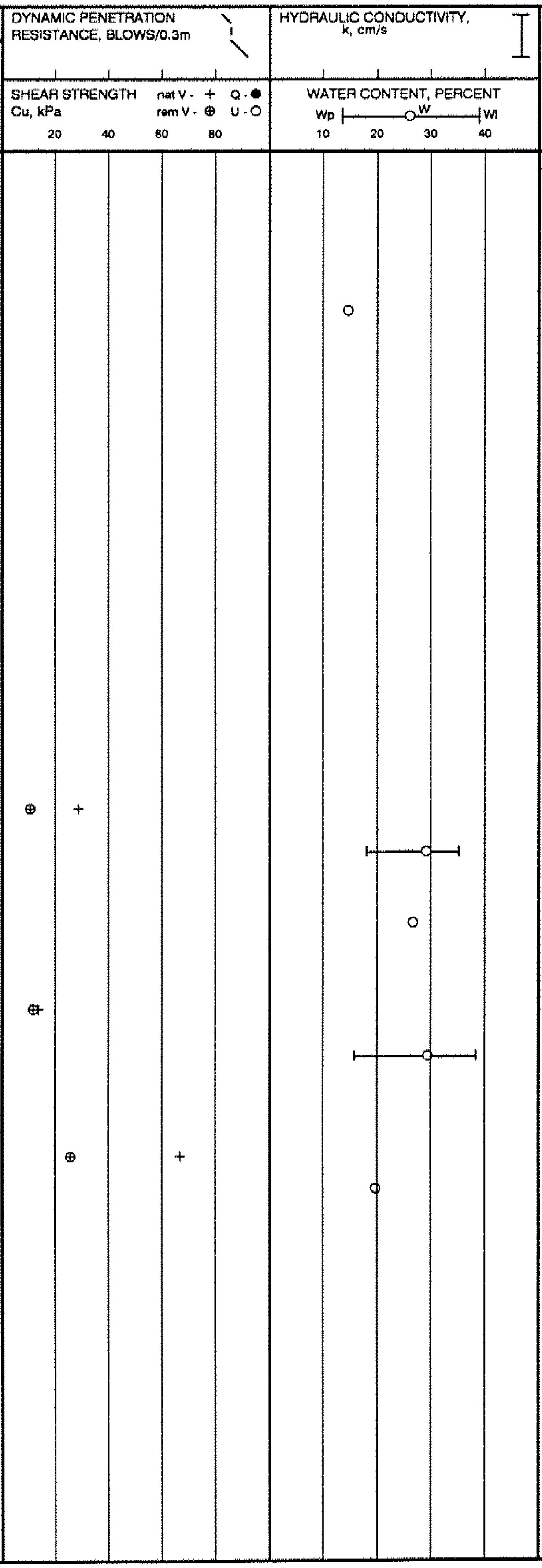
RECORD OF BOREHOLE RSWR-6

BORING DATE: SEPT.10/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	80.93					
Topsoil	0.00					
Clayey Silt, some sand and gravel, trace rootlets and organics Very stiff Brown Moist (Fill)	0.09	1	50 DO	24		
Silty Sand, trace clay and gravel Dense Brown and grey Moist to wet	79.53 1.40	2	50 DO	34		
Silty Clay, trace to some sand, trace gravel Very stiff Grey Moist	78.58 2.35	3	50 DO	16		
		4	50 DO	21		
		5	50 DO	10		
Silty Clay, trace sand, occasional gravel, occasional silt seams Soft to firm Grey Moist to wet	76.93 4.00	6	75 TO	PH		
		7	50 DO	6		
		8	75 TO	PH	SG= 2.69 MH	
Silty Clay, trace sand and gravel Stiff to very stiff Grey Moist	73.93 7.00	9	50 DO	25		
END OF BOREHOLE	73.16 7.77					Water encountered at bottom of hole upon completion of drilling.



DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

DATA INPUT: ps nov.4/98

SOILM6

RSWR7.BHS

W.P. 441-97-00

RECORD OF BOREHOLE RSWR-7

SHEET 1 OF 1

DIST. 4, HWY: QEW

BORING DATE: SEPT.15/98

DATUM: GEODETIC

LOCATION: N 4789796.386; E 283931.606

PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ├─○W─┤ Wl 10 20 30 40	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		81.52 0.00							
		Topsoil		0.09							
1		Silty Sand, some clay, trace gravel, trace organics, rootlets, asphalt fragments Compact to dense Brown Moist (Fill)	▩	79.69 1.83	1 2	50 DO 50 DO	30 33				
2		Silty Sand, trace clay and gravel Very dense Brown Wet		78.78 2.74	3	50 DO	65				
3		END OF BOREHOLE									Split spoon wet at and below 2m depth.
4											
5											
6											
7											
8											
9											
10											

DATA INPUT: PS NOV.4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSWR16.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789851.160; E 283491.327

RECORD OF BOREHOLE RSWR-16

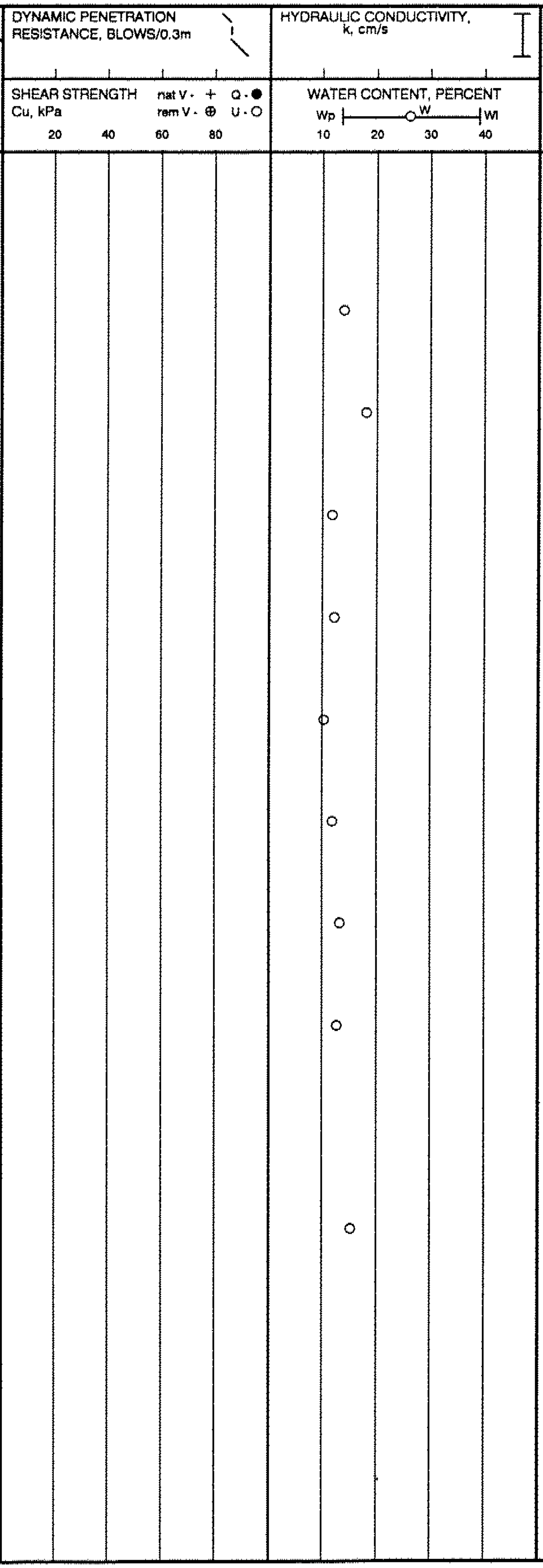
BORING DATE: SEPT.22/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES: 0 to 10
BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	81.00
Topsoil	0.00 0.09
Silty Clay, trace to some sand, trace gravel, trace oxidized stains Hard Brown and grey Moist	77.60 3.40
Silty Sand, trace clay and gravel Very dense Brown Moist	77.35 3.65
Silty Clay, trace to some sand, trace gravel Very stiff Grey Moist	76.60 4.40
Silty Sand, trace to some clay, trace gravel Very dense Grey Moist	75.05 5.95
Silty Clay, trace sand and gravel, some clay inclusions Hard Grey Moist	72.92 8.08
END OF BOREHOLE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	40
2	50 DO	42
3	50 DO	75
4	50 DO	90
5	50 DO	27
6	50 DO	97
7	50 DO	57
8	50 DO	32
9	50 DO	42



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open hole dry upon completion of drilling.

DATA INPUT: PS nov.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RSWR17.BHS

RECORD OF BOREHOLE RSWR-17

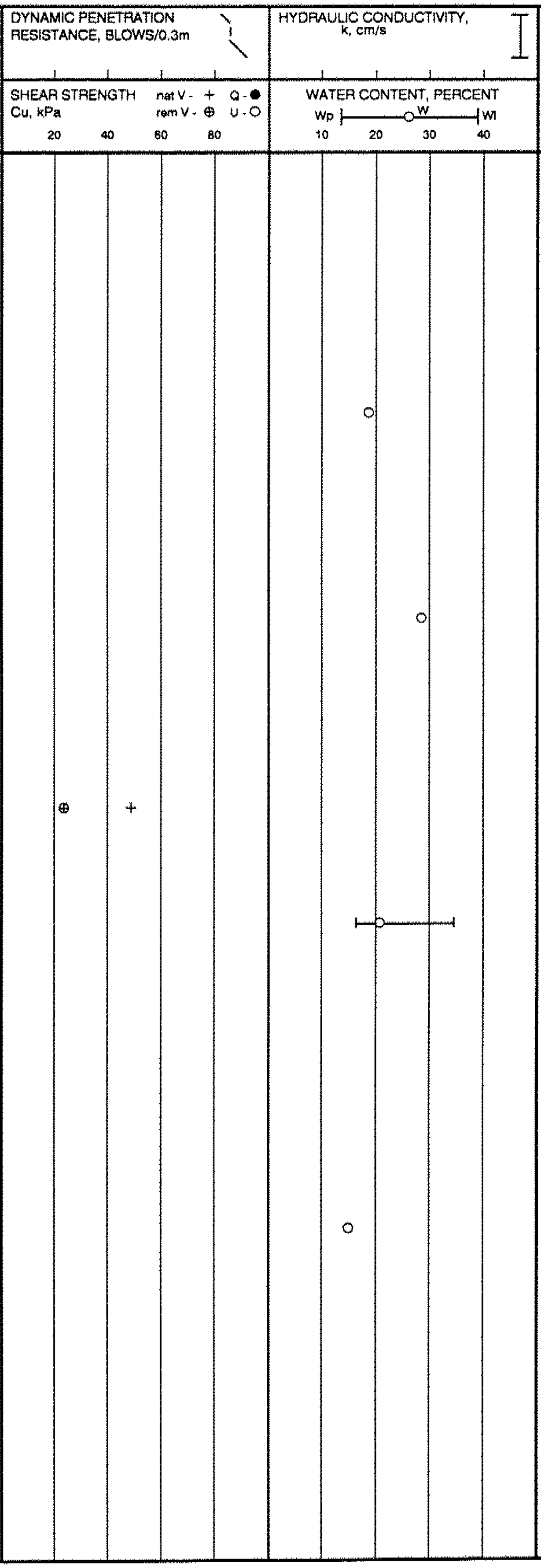
W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789831.050; E 283441.682
BORING DATE: SEPT.18/98
SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES: 0 – 10

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
GROUND SURFACE		81.17 0.00
Topsoil		0.12
Silty Clay, trace to some sand, trace gravel Hard becoming very stiff Mottled brown and grey Moist	▨	76.87 4.30
Silty Clay, trace sand, occasional gravel Stiff to very stiff Grey Moist	▨	75.22 5.95
Silty Clay, trace sand and gravel Very stiff Grey Moist	▨	73.09 8.08
END OF BOREHOLE		

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	37
2	50 DO	23
3	50 DO	26
4	50 DO	19
5	50 DO	20
6	50 DO	15
7	50 DO	29
8	50 DO	29



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Open hole dry upon completion of drilling.

DATA INPUT: PS nov.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RSWR18.BHS

W.P. 441-97-00

RECORD OF BOREHOLE RSWR-18

SHEET 1 OF 1

DIST. 4, HWY: QEW

BORING DATE: SEPT.17/98

DATUM: GEODETIC

LOCATION: N 4789803.517; E 283395.162

PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● — rem V - ⊕ U - ○ — 20 40 60 80

WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 10 20 30 40

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa	WATER CONTENT, PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE		81.61							
0	Topsoil		0.00							
	Silty Clay, trace to some sand, trace gravel Hard becoming very stiff Mottled brown and grey Moist		0.15							
1				1	50 DO	39				
				2	50 DO	52				
2										
				3	50 DO	20				
3										
				4	50 DO	25				
			77.96 3.65							
4	Silty Clay, trace sand and gravel Stiff to hard Grey Moist			5	50 DO	13				
							96			
5										
				6	50 DO	18				
6										
				7	50 DO	32				
7										
				8	50 DO	39				
8			73.53							
	END OF BOREHOLE		8.08							Open hole dry upon completion of drilling.
9										
10										

DATA INPUT: PS NOV 4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RSER1.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789801.626; E 283419.093

RECORD OF BOREHOLE RSER-1

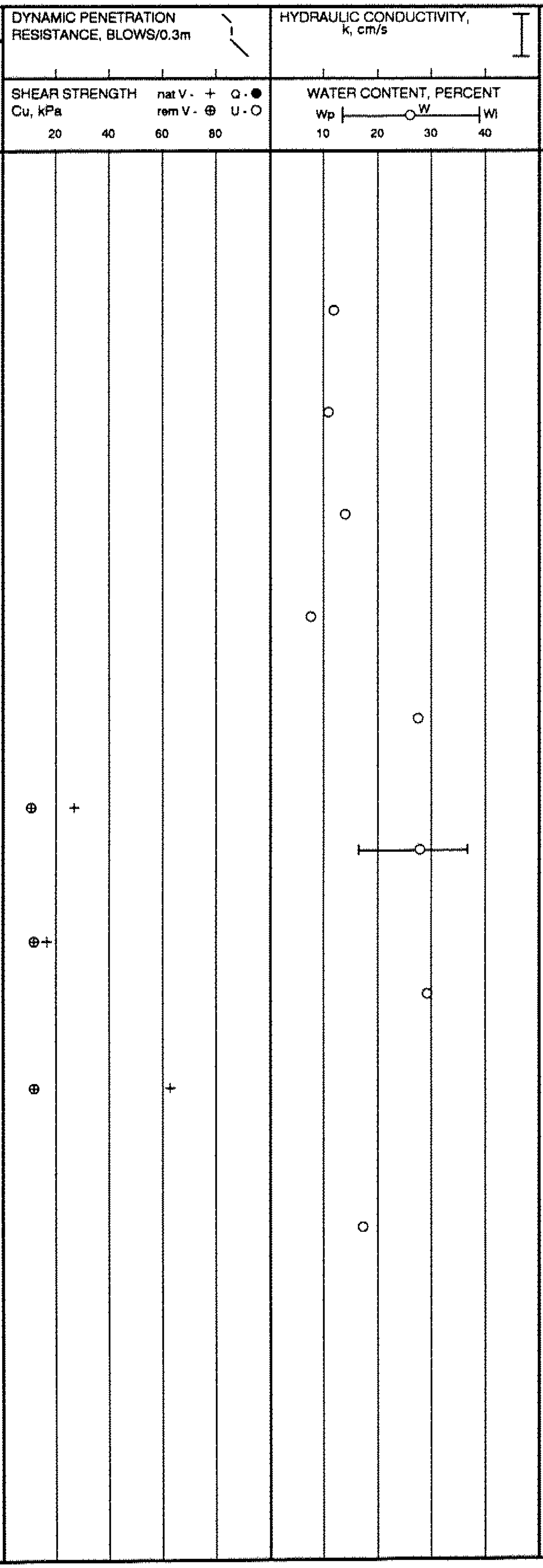
BORING DATE: SEPT.21/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

DESCRIPTION	ELEV.	DEPTH (m)
GROUND SURFACE	81.70	0.00
Topsoil		0.09
Silty Sand, trace to some clay, trace gravel, occasional clayey silt interlayers, trace oxidized stains Dense to very dense Brown Moist	79.60	2.10
Clayey Silt and Sand, some gravel Dense Brown to grey Wet	77.70	4.00
Silty Clay, trace to some sand, trace gravel, occasional silt seams Soft to firm Grey Moist to wet	75.30	6.40
Silty Clay, trace sand and gravel Stiff becoming hard Grey Moist	73.62	8.08
END OF BOREHOLE		

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	34	
2	50 DO	50	MH
3	50 DO	47	
4	50 DO	40	MH
5	50 DO	6	
6	50 DO	5	MH
7	75 TO	PH	
8	50 DO	50	



PIEZOMETER OR STANDPIPE INSTALLATION

Open hole dry upon completion of drilling.

DEPTH SCALE 1 to 50

DATA INPUT: PS NOV 4/98

SOILM6

Golder Associates

LOGGED: PKS
CHECKED: SP

RECORD OF BOREHOLE RSER-2

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789827.539; E 283460.834

BORING DATE: SEPT.21/98

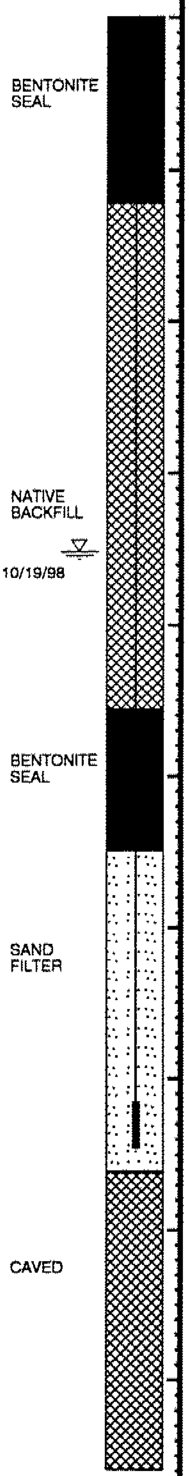
SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	81.44			
Topsoil	0.00			
Silty Sand, trace clay and gravel Compact Brown Dry	0.09	1	50 DO	15
Clayey Silt, trace to some clay, trace gravel Hard Brown Moist	80.04 1.40	2 3	50 DO 50 DO	35 41
Silty Sand, fine grained, trace clay and gravel Very dense Brown Wet	78.54 2.90	4	50 DO	60
Sand, medium to coarse grained, some gravel, trace clay Very dense Brown Wet	77.74 3.70	5 6	50 DO 50 DO	77 70
Silty Clay, trace to some sand, trace gravel Very stiff to hard Grey Moist	75.89 5.55	7 8 9	50 DO 50 DO 50 DO	15 27 56
Silty Clay, trace sand and gravel, occasional shale fragments Hard Grey and occasional reddish grey Moist (Glacial Till)	72.94 8.50	10	50 DO	80
END OF BOREHOLE	71.84 9.60			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
HYDRAULIC CONDUCTIVITY, k, cm/s
SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80
WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 10 20 30 40
ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Water level in piezometer at Elev. 77.9m on Oct.19/98 and Nov.10/98.

DATA INPUT: PS NOV 4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSER3.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789815.135; E 283492.021

RECORD OF BOREHOLE RSER-3

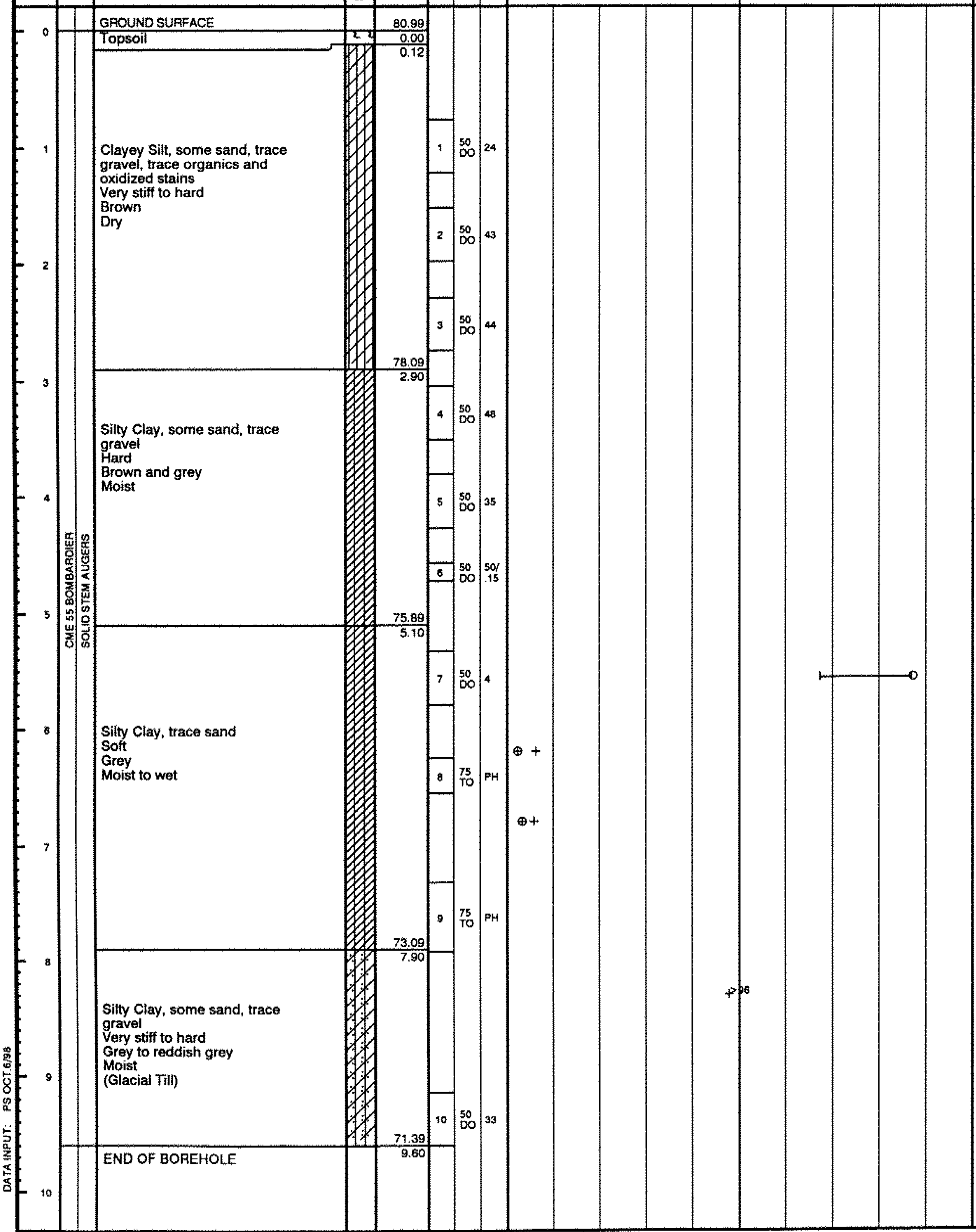
BORING DATE: SEPT.23/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	80.99			
Topsoil	0.00			
Clayey Silt, some sand, trace gravel, trace organics and oxidized stains Very stiff to hard Brown Dry	0.12	1	50 DO	24
		2	50 DO	43
		3	50 DO	44
Silty Clay, some sand, trace gravel Hard Brown and grey Moist	78.09 2.90	4	50 DO	46
		5	50 DO	35
		6	50 DO	50/.15
Silty Clay, trace sand Soft Grey Moist to wet	75.89 5.10	7	50 DO	4
		8	75 TO	PH
		9	75 TO	PH
Silty Clay, some sand, trace gravel Very stiff to hard Grey to reddish grey Moist (Glacial Till)	73.09 7.90	10	50 DO	33
END OF BOREHOLE	71.39 9.60			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○
HYDRAULIC CONDUCTIVITY, k, cm/s
WATER CONTENT, PERCENT — Wp, W, Wl
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION



Water level in open hole at 5.2m depth upon completion of drilling.

DATA INPUT: FS OCT.6/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

W.P. 441-97-00

RECORD OF BOREHOLE RSER-4

SHEET 1 OF 2

DIST. 4, HWY: QEW

BORING DATE: SEPT.22/98

DATUM: GEODETIC

LOCATION: N 4789806.060; E 283536.669

PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	80.92			
Topsoil	0.00 0.09			
Clayey Silt, some sand, trace gravel Hard Brown to mottled brown Dry to moist		1	50 DO	32
		2	50 DO	30
Silty Clay, trace sand and gravel Very stiff Mottled brown and grey Moist	78.82 2.10	3	50 DO	29
		4	50 DO	28
		5	50 DO	27
Silty Clay, trace sand and gravel Very stiff Grey Moist	76.52 4.40	6	50 DO	20
		7	50 DO	14
		8	50 DO	26
Silty Clay, trace to some sand, trace gravel, trace shale fragments Hard Grey to occasional reddish grey Moist (Glacial Till)	73.92 7.00	9	50 DO	32
		10	50 DO	43

CONTINUED ON NEXT PAGE

DATA INPUT: PS NOV 4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

W.P. 441-97-00

RECORD OF BOREHOLE RSER-4

SHEET 2 OF 2

DIST. 4, HWY: QEW

BORING DATE: SEPT.22/98

DATUM: GEODETIC

LOCATION: N 4789806.060; E 283536.669

PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m				
		CONTINUED FROM PREVIOUS PAGE									
10	CME 55 BOMBARDIER SOLID STEM AUGERS	Silty Clay, trace to some sand, trace gravel, trace shale fragments Hard Grey with occasional reddish grey Moist (Glacial Till)	▨	69.79 11.13	11	50 DO	51				
11		END OF BOREHOLE									Open hole dry upon completion of drilling.
12											
13											
14											
15											
16											
17											
18											
19											
20											

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSER5.BHS

W.P. 441-97-00

RECORD OF BOREHOLE RSER-5

SHEET 1 OF 2

DIST. 4, HWY: QEW

BORING DATE: SEPT.22/98

DATUM: GEODETIC

LOCATION: N 4789776.448; E 283576.096

PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m ╲ (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s I; WATER CONTENT, PERCENT Wp ├──○W──┤ Wl (10 20 30 40)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		81.20							
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil		0.00 0.06							
1		Silty Sand, some gravel, trace sand Dense Brown Moist (Fill)	▩	79.80 1.40	1	50 DO	32				
2			▨		2	50 DO	22				
			▨		3	50 DO	30				
3		Silty Clay, trace to some sand, trace gravel Very stiff Mottled grey and brown Moist	▨		4	50 DO	24				
4			▨		5	50 DO	29				
5			▨	76.20 5.00	6	50 DO	20				
			▨		7	50 DO	11				
6		Silty Clay, trace sand and gravel Stiff to hard Grey Moist	▨					⊕ +>124			
			▨		8	50 DO	25				
7			▨								
8			▨		9	50 DO	42				
			▨	72.70 8.50							
9		Silty Clay, trace sand and gravel, occasional shale fragments Hard Grey and occasional reddish grey Moist (Glacial Till)	▨		10	50 DO	35				
10		CONTINUED ON NEXT PAGE									

DATA INPUT: PS nov 4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RESR1.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789912.492; E 283688.868

RECORD OF BOREHOLE RESR-1

BORING DATE: SEPT.15/98

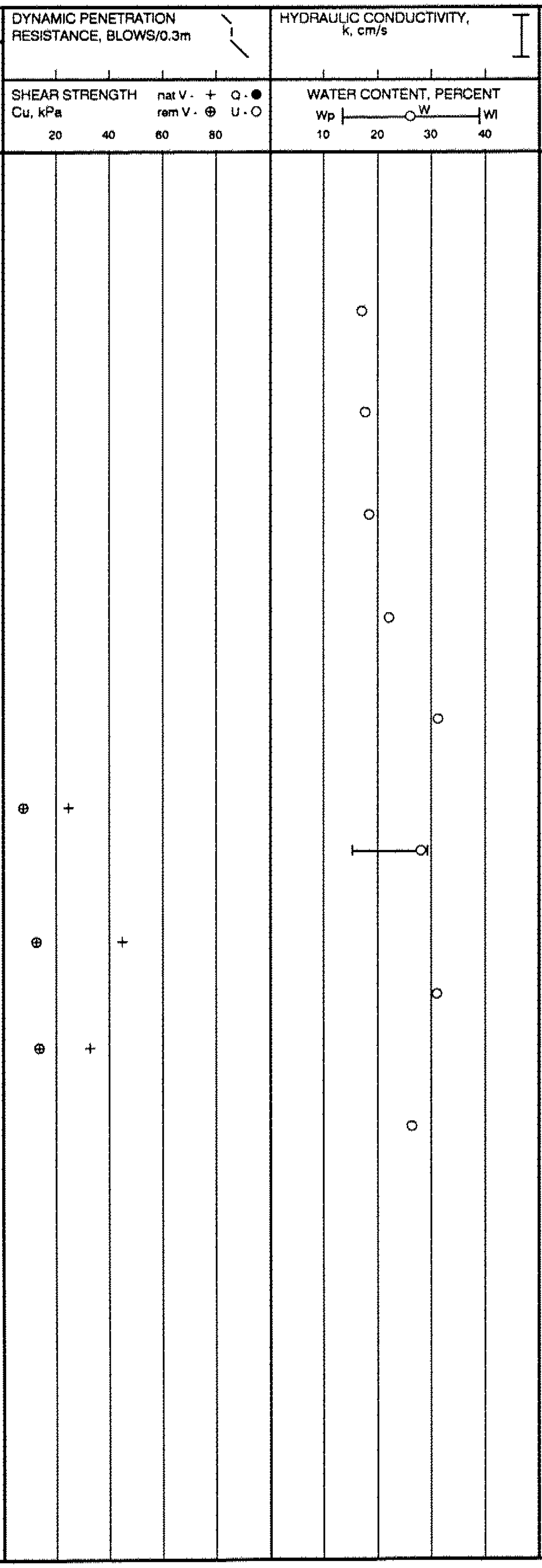
SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	GROUND SURFACE	80.78					
	Topsoil	0.00					
	Silty Sand, trace to some clay, trace gravel, trace rootlets Dense to very dense Brown Moist	0.12					
1			1	50 DO	31		
			2	50 DO	67		
2	Silty Clay, trace sand Very stiff becoming stiff Grey Moist	78.68 2.10					
			3	50 DO	17		
3			4	50 DO	14		
	Silty Clay, trace sand, occasional gravel Soft to firm Grey Moist to wet	77.08 3.70					
4			5	50 DO	5		
5			6	75 TO	PH	C MH S.G.= 2.70	
6			7	75 TO	PH		
	Silty Clay, trace sand and gravel Very stiff Grey Moist to wet	73.98 6.80					
7			8	50 DO	18		
	END OF BOREHOLE	73.46 7.32					
8							
9							
10							



DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RESR2.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789920.027; E 283724.308

RECORD OF BOREHOLE RESR-2

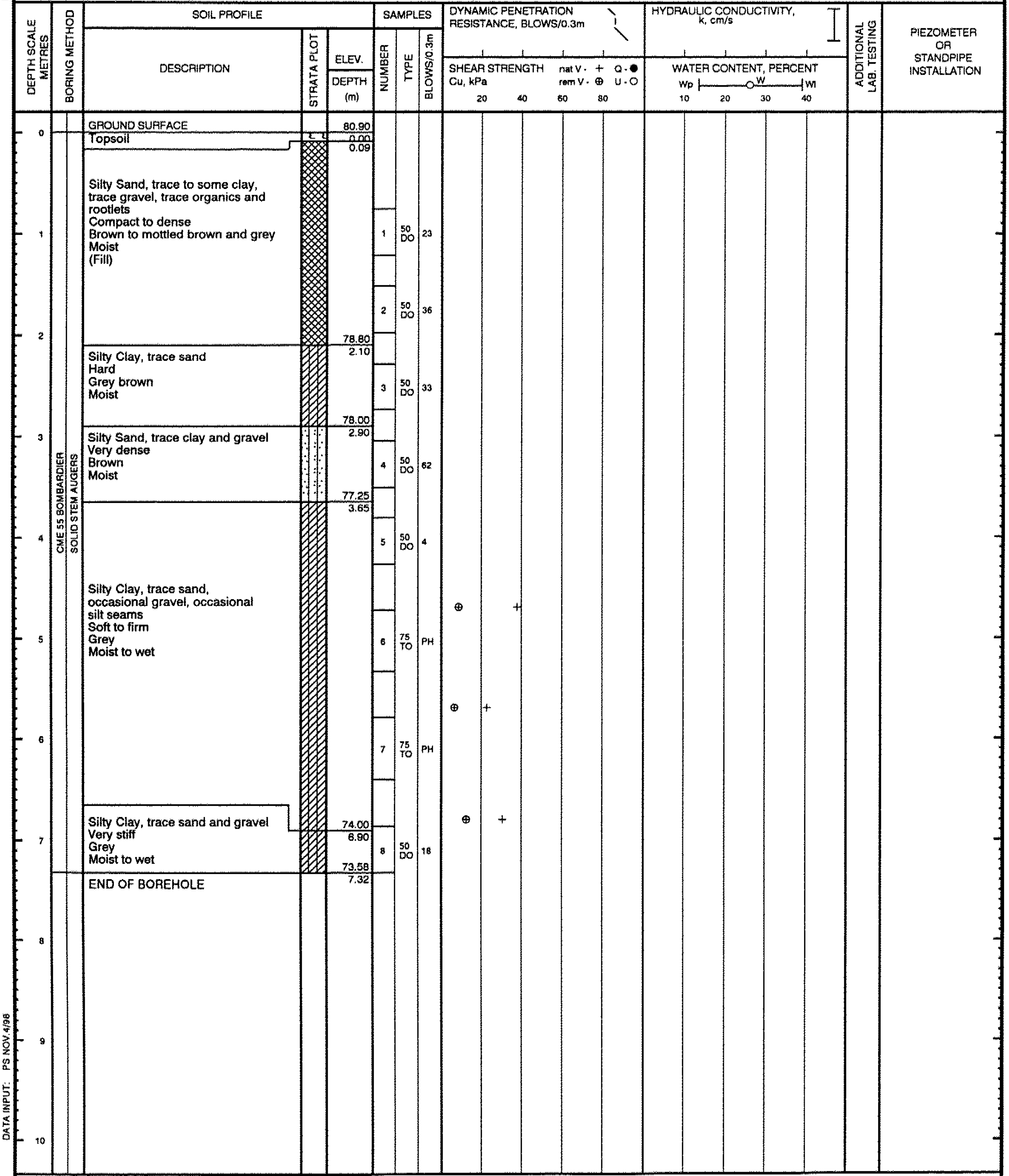
BORING DATE: SEPT.15/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	80.90
Topsoil	0.00
Silty Sand, trace to some clay, trace gravel, trace organics and rootlets Compact to dense Brown to mottled brown and grey Moist (Fill)	0.09
Silty Clay, trace sand Hard Grey brown Moist	78.80 2.10
Silty Sand, trace clay and gravel Very dense Brown Moist	78.00 2.90
Silty Clay, trace sand, occasional gravel, occasional silt seams Soft to firm Grey Moist to wet	77.25 3.65
Silty Clay, trace sand and gravel Very stiff Grey Moist to wet	74.00 6.90
END OF BOREHOLE	73.58 7.32

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	23
2	50 DO	36
3	50 DO	33
4	50 DO	62
5	50 DO	4
6	75 TO	PH
7	75 TO	PH
8	50 DO	18



DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

DATA INPUT: PS NOV.4/98

SOILM6

RESR3.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789910.123; E 283783.704

RECORD OF BOREHOLE RESR-3

BORING DATE: SEPT.14/98

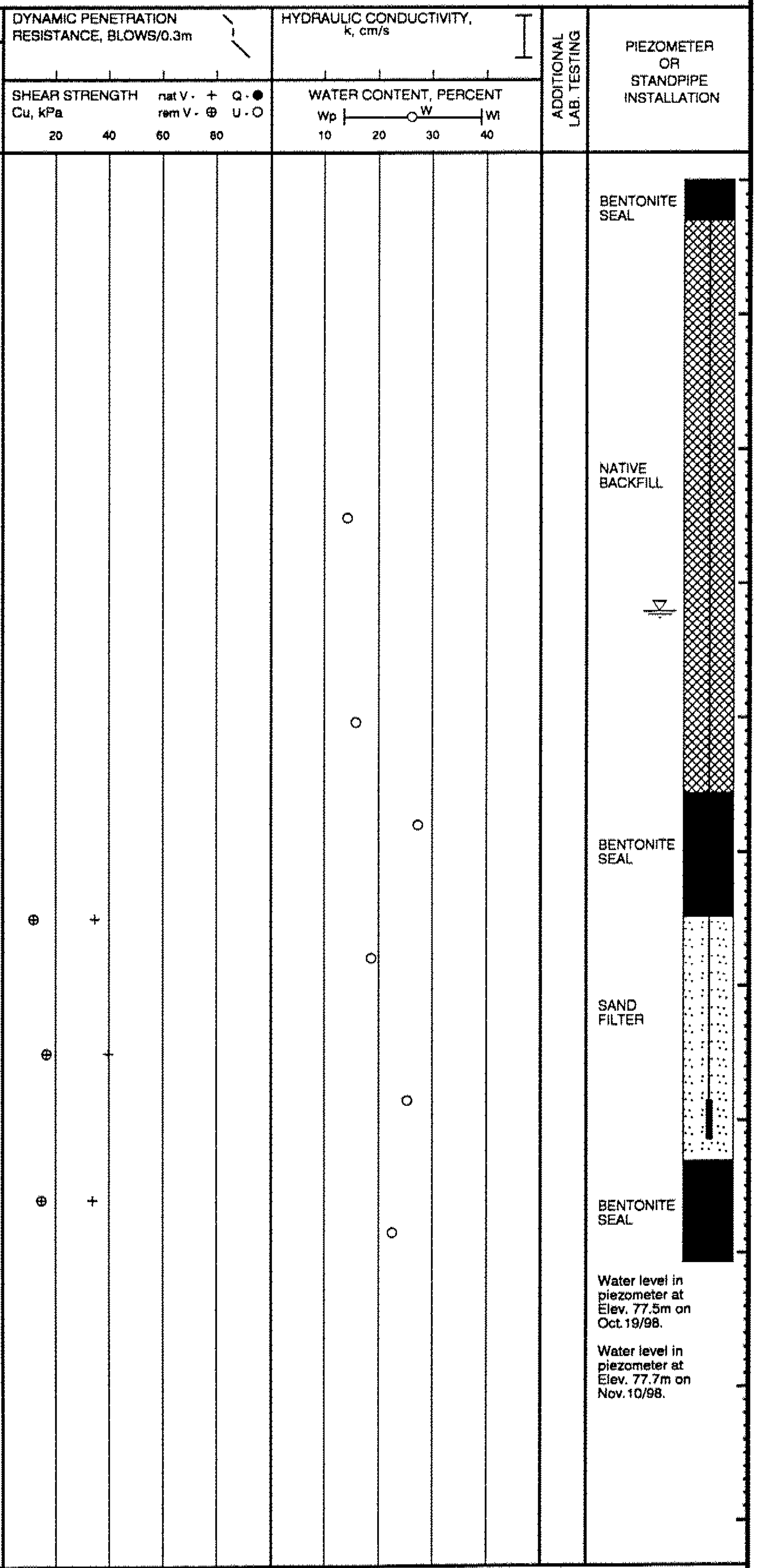
SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	80.87			
Topsoil	0.06			
Silty Sand, trace clay and gravel, trace oxidized stains Compact Brown to mottled grey and brown Moist (Fill)		1	50 DO	24
		2	50 DO	28
	78.77 2.10			
Silty Clay, trace sand and gravel Hard Mottled grey and brown Moist		3	50 DO	45
		4	50 DO	48
	77.17 3.70			
Silty Sand, trace clay and gravel Very dense Brown Moist to wet		5	50 DO	60
	76.47 4.40			
Silty Clay, trace sand, occasional gravel, occasional silt seams Stiff becoming firm Grey Moist to wet		6	50 DO	13
		7	75 TO	PH
		8	75 TO	PH
	73.37 7.50			
Silty Clay, trace sand and gravel Very stiff Grey Moist to wet		9	50 DO	23
	72.79 8.08			
END OF BOREHOLE				



Water level in piezometer at Elev. 77.5m on Oct.19/98.

Water level in piezometer at Elev. 77.7m on Nov.10/98.

DATA INPUT: PS NOV 4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RESR4.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789899.827; E 283831.334

RECORD OF BOREHOLE RESR-4

BORING DATE: SEPT.11/98

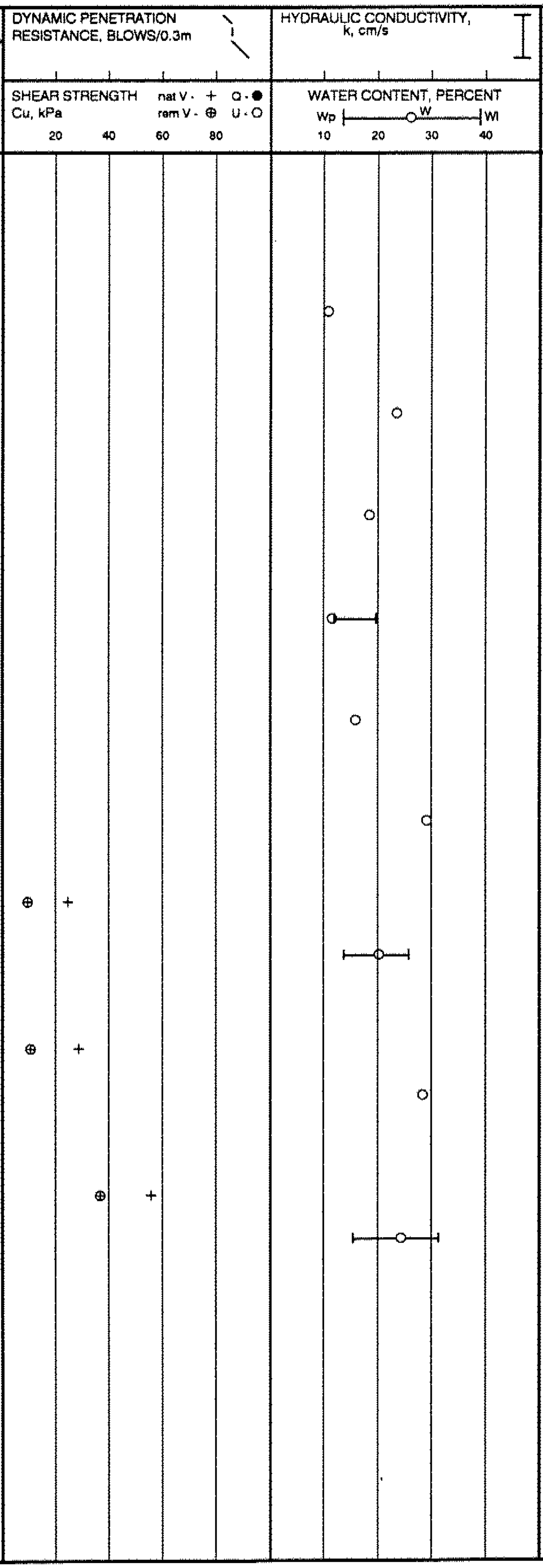
SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM/HOLLOW STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	80.84				
Topsoil	0.06				
Silty Sand, some clay and gravel, trace organics Compact Brown Moist (Fill)	79.44 1.40	1	50 DO	25	
Sand, some silt, trace clay and gravel Compact to dense Brown Wet	78.14 2.70	2	50 DO	13	
		3	50 DO	50	MH
Clayey Silt and sand, trace to some gravel Hard becoming stiff Brown to grey Moist to wet	76.44 4.40	4	50 DO	69	MH S.G.= 2.68
		5	50 DO	12	
Silty Clay, some sand, occasional gravel, occasional silt seams Firm grey Moist to wet	73.34 7.50	6	50 DO	4	
		7	75 TO	PH	MH S.G.= 2.71
		8	75 TO	PH	
Silty Clay, some sand, trace gravel Very stiff Grey Moist to wet	72.61 8.23	9	50 DO	26	MH S.G.= 2.73
END OF BOREHOLE					



PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open borehole at 3.7m depth below ground surface.

DEPTH SCALE METRES 0–10

DATA INPUT: PS NOV.4/98

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

SOILM6

RECORD OF BOREHOLE RESR-5

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789890.228; E 283881.828

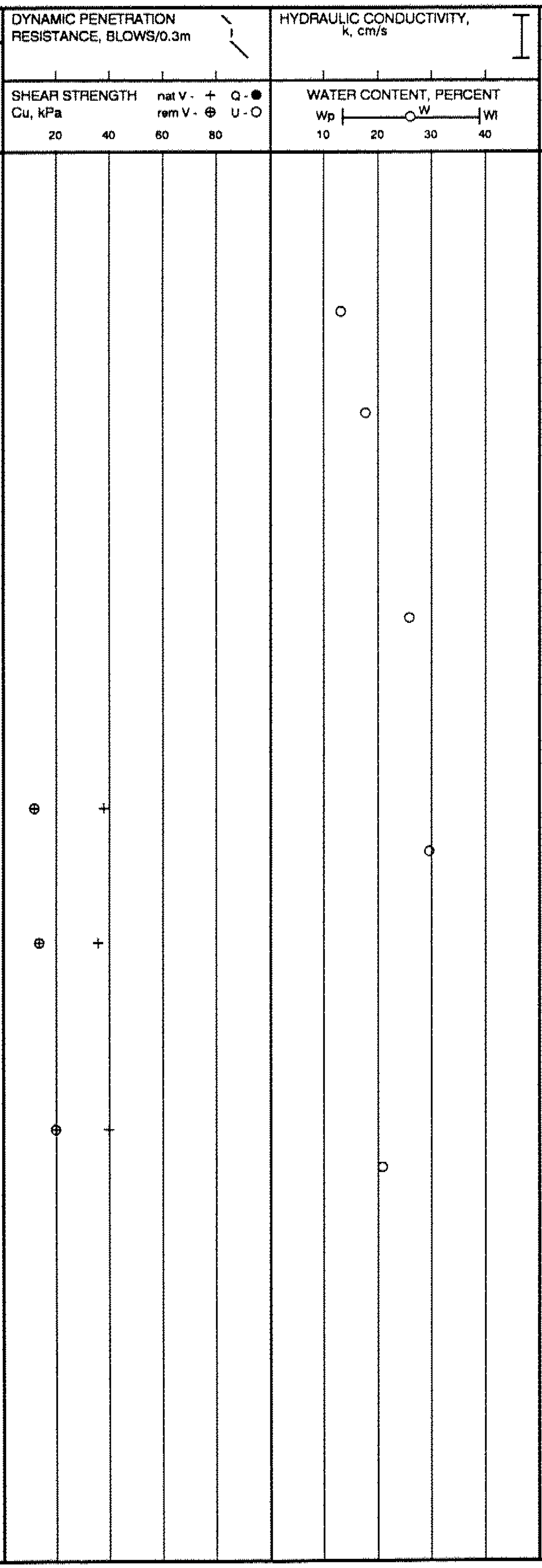
BORING DATE: SEPT.11/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	80.91
Topsoil	0.00
Silty Sand, trace to some clay and gravel, trace rootlets Dense Brown Moist (FILL)	0.09
Silty Clay, trace sand and gravel, trace rootlets and organics above 2m depth Very stiff Brown to mottled grey and brown Moist	79.50 1.40
Silty Clay, trace sand, occasional gravel, occasional silt seams Firm Grey Moist to wet	77.21 3.70
Silty Clay, trace sand and gravel Very stiff Grey Moist to wet	73.71 7.20
END OF BOREHOLE	73.29 7.62

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	39
2	50 DO	19
3	50 DO	26
4	50 DO	24
5	50 DO	17
6	75 TO	PH
7	75 TO	PH
8	75 TO	PH
9	50 DO	26



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 4.0m depth upon completion of drilling.

DEPTH SCALE 1 to 50

DATA INPUT: PS NOV.4/98

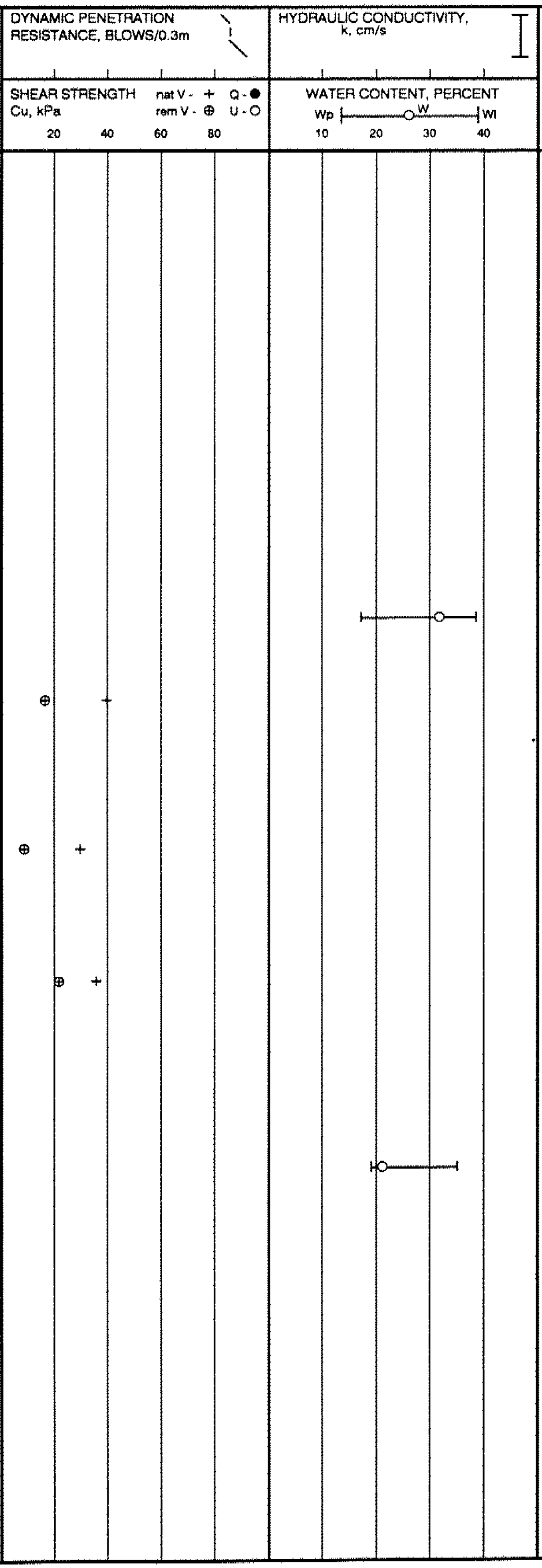
LOGGED: PKS
CHECKED: SP

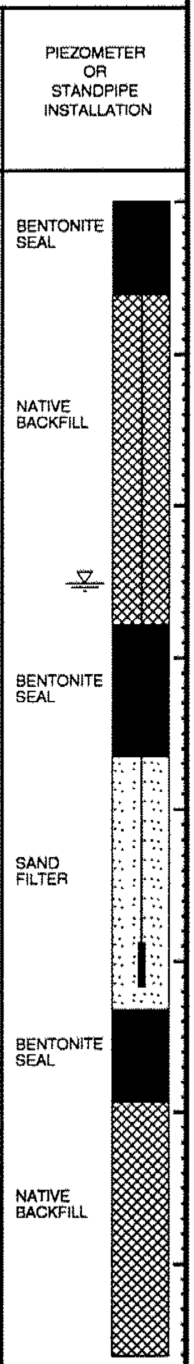
RESR6.BHS

RECORD OF BOREHOLE RESR-6

W.P.	441-97-00			SHEET 1 OF 1	
DIST.	4, HWY: QEW	BORING DATE:	SEPT.11/98	DATUM:	GEODETIC
LOCATION:	N 4789874.637; E 283931.999			PROJECT:	981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	80.77				
		Topsoil	0.09				
		Silty Sand, trace clay Compact Brown Moist					
1				1	50 DO	16	
			78.92 1.85	2	50 DO	34	
2		Silty Clay, some sand, trace gravel Hard Grey Moist		3	50 DO	37	
3			77.62 3.15	4	50 DO	11	MH
4		Silty Clay, trace sand, occasional gravel, occasional silt seams Firm Grey Moist to wet		5	75 TO	PH	
5				6	75 TO	PH	
6				7	75 TO	PH	
7				8	50 DO	12	
		Silty Clay, some sand, trace gravel Very stiff Grey Moist to wet	73.61 7.16	9	50 DO	27	MH
		END OF BOREHOLE	73.15 7.62				
8							
9							
10							





Water encountered at bottom of hole upon completion of drilling.

Water level in piezometer at Elev. 78.2m on Oct.19/98.

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RESR7.BHS

W.P. 441-97-00

RECORD OF BOREHOLE RESR-7

SHEET 1 OF 1

DIST. 4, HWY: QEW

BORING DATE: SEPT.10/98

DATUM: GEODETIC

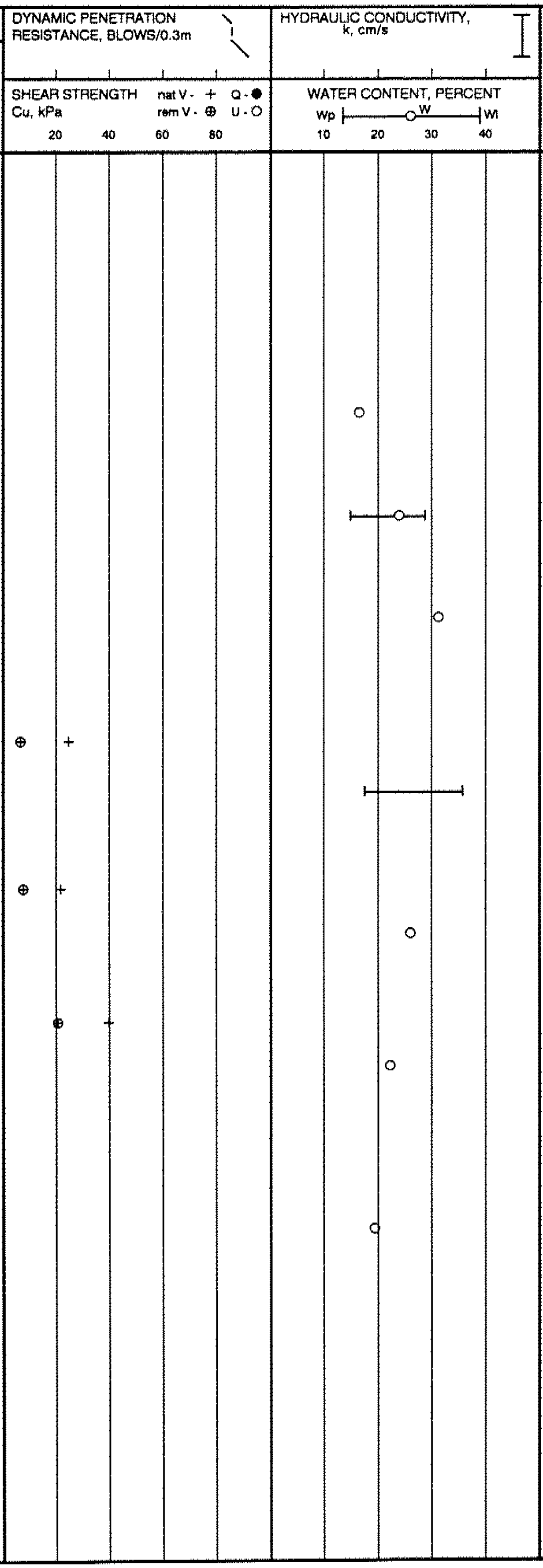
LOCATION: N 4789846.915; E 283971.199

PROJECT:

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	80.47
Topsoil	0.00
Sandy Silt to Silt, trace to some clay, trace gravel Compact to dense Brown Moist	0.09
Silty Clay, trace sand Stiff Grey Moist to wet	78.37 2.10
Silty Clay, tarce sand, occasional gravel, occasional sil seams Soft to firm Grey Moist to wet	77.57 2.90
Silty Clay, trace sand and gravel Very stiff to hard Grey Moist	74.07 6.40
END OF BOREHOLE	72.39 8.08

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	29	
2	50 DO	38	MH
3	50 DO	11	MH
4	50 DO	4	
5	75 TO	PH	CIU C MH S.G.= 2.69
6	75 TO	PH	
7	50 DO	16	
8	50 DO	42	



PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 6.7m depth upon completion of drilling.

DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DATA INPUT: PS NOV 4/98

DEPTH SCALE 1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

SOILM6

RSER5.BHS

W.P.: 441-97-00
DIST: 4, HWY: QEW
LOCATION: N 4789776.448; E 283576.096

RECORD OF BOREHOLE RSER-5

BORING DATE: SEPT.22/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		CONTINUED FROM PREVIOUS PAGE									
10	CME 55 BOMBARDIER SOLID STEM AUGERS	Silty Clay, trace sand and gravel, occasional shale fragments Hard Grey and occasional reddish grey Moist (Glacial Till)	▨								
11				70.07 11.13	11	50 DO	40				
		END OF BOREHOLE									
12											
13											
14											
15											
16											
17											
18											
19											
20											

DATA INPUT: PS nov.4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

RSER6.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4789746.708; E 283610.970

RECORD OF BOREHOLE RSER-6

BORING DATE: SEPT.23/98

SHEET 1 OF 2

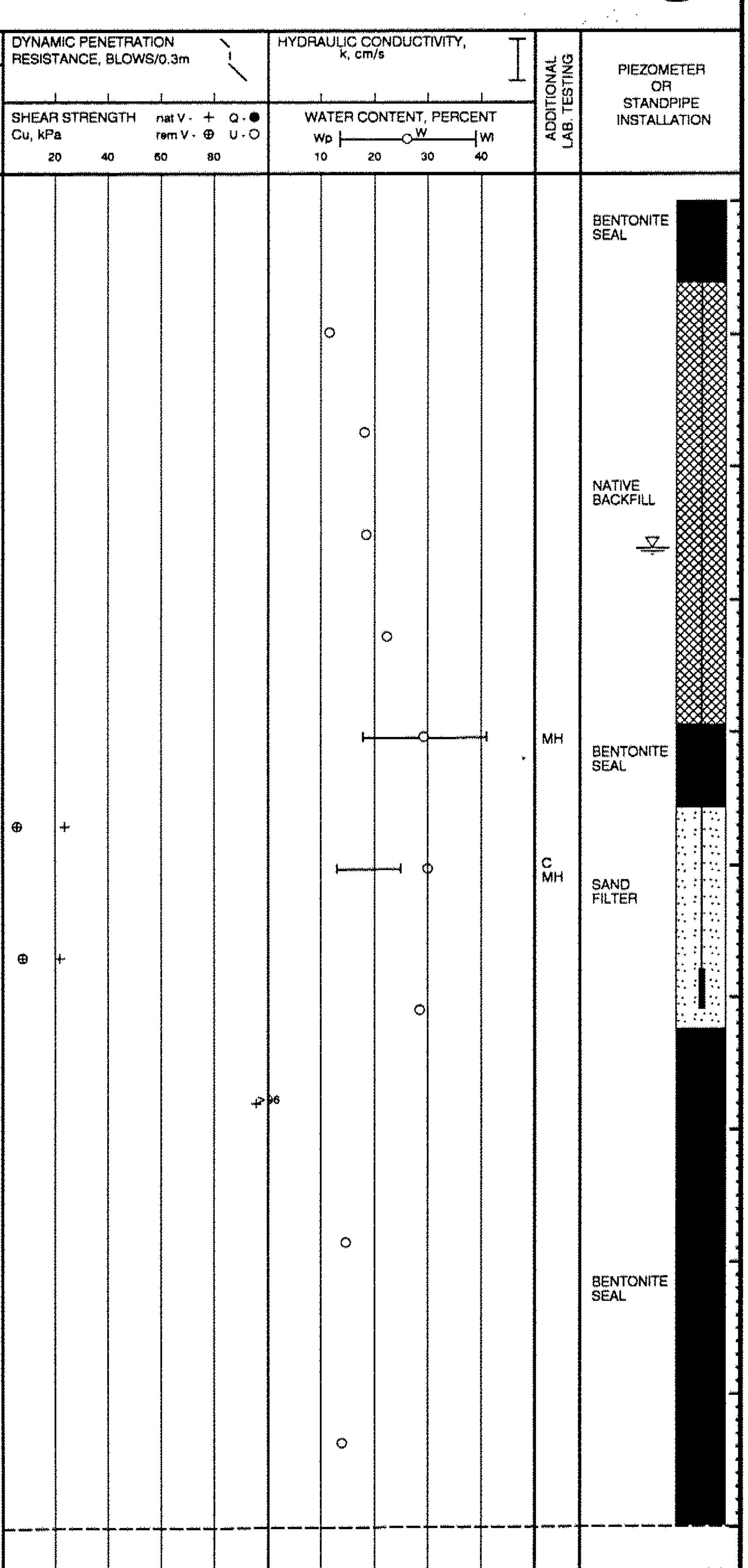
DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	GROUND SURFACE	81.25
0	Topsoil	0.00
0.09	Clayey Silt, some sand, trace gravel, some organics and oxidized stains Hard becoming stiff Brown to reddish brown Dry to moist	0.09
2.10	Silty Clay, trace to some sand, trace gravel, occasional silt seams Very stiff Brown and grey Dry to moist	79.15 2.10
3.65	Silty Clay, trace to some sand, occasional gravel, occasional silt seams Soft to firm Grey Moist to wet	77.60 3.65
6.70	Silty Clay, some sand, trace gravel Very stiff Grey Moist	74.55 6.70
8.50	Silty Clay, some sand, trace gravel, occasional shale fragments Hard Grey to occasional reddish grey Moist (Glacial Till)	72.75 8.50
10	CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	32	
2	50 DO	11	
3	50 DO	26	
4	50 DO	23	
5	50 DO	6	MH
6	75 TO	PH	C MH
7	75 TO	PH	
8	50 DO	28	
9	50 DO	38	



DEPTH SCALE 1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

DATA INPUT: PS NOV 4/98

SOILM6

RSER6.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789746.708; E 283610.970

RECORD OF BOREHOLE RSER-6

BORING DATE: SEPT.23/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER SOLID STEM AUGERS	CONTINUED FROM PREVIOUS PAGE									
11		Silty Clay, some sand, trace gravel, occasional shale fragments Hard Grey to occasional reddish grey Moist (Glacial Till)		70.12 11.13	10	50 DO	39		○		
		END OF BOREHOLE									Water level in open hole at 4.6m depth upon completion of drilling. Water level in piezometer at Elev. 78.1m on Oct.19/98. Water level in piezometer at Elev. 78.7m on Nov.10/98.
12											
13											
14											
15											
16											
17											
18											
19											
20											

DATA INPUT: PS NOV.4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RSER7.BHS

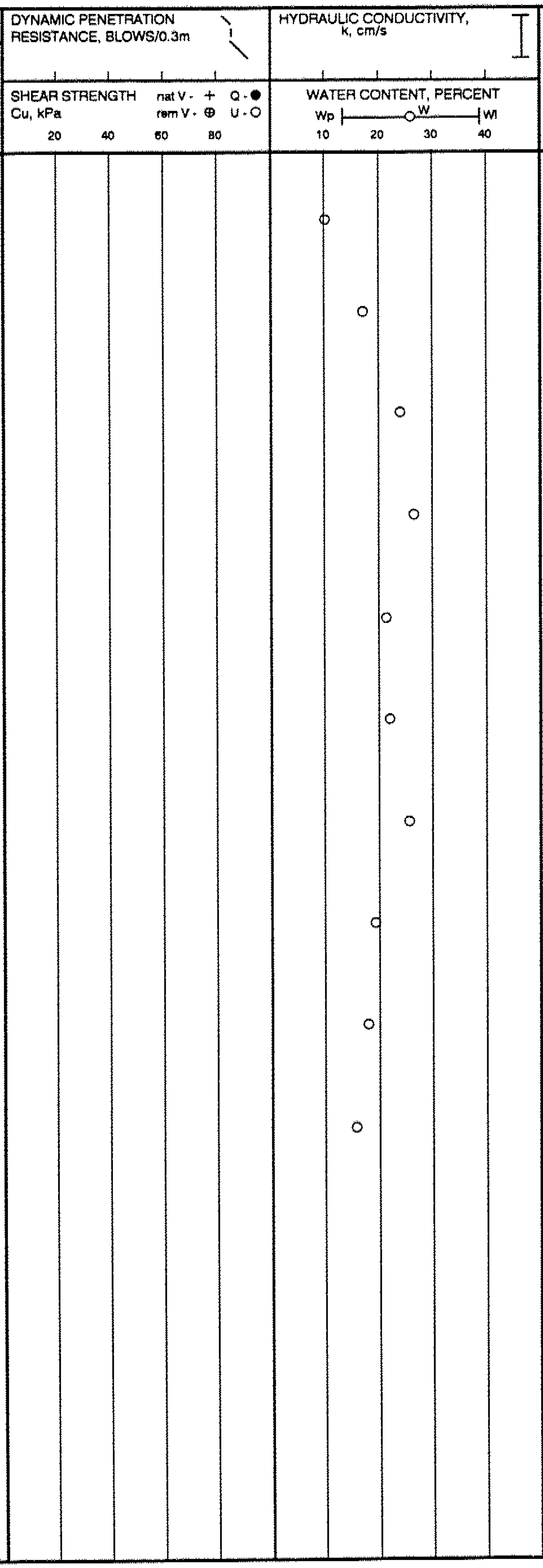
W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789659.941; E 283737.247

RECORD OF BOREHOLE RSER-7

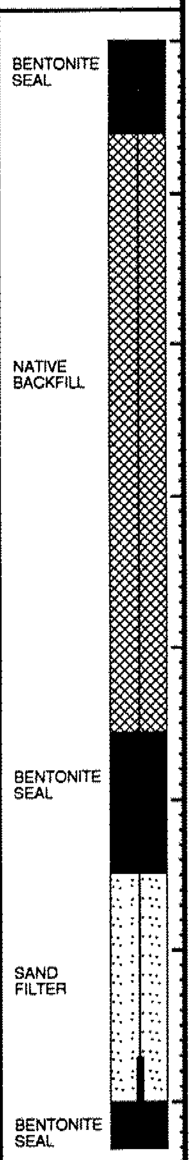
BORING DATE: SEPT.20/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	80.67			
		Topsoil	0.00			
		Sandy Silt, some clay, trace to some gravel, some sand seams with oxidized stains Dense becoming compact Brown Dry to moist (Fill)	0.15	1	50 DO	33
1				2	50 DO	14
		Silty Clay, some sand, trace gravel, trace organics and oxidized stains Firm to stiff Mottled grey and brown Moist	79.27 1.40	3	50 DO	13
2				4	50 DO	7
3				5	50 DO	8
		Silty Clay, some sand, occasional gravel Firm to very stiff Grey Moist	77.02 3.65			
4				6	50 DO	7
5				7	50 DO	7
				8	50 DO	11
6				9	50 DO	16
		Silty Clay, some sand, trace gravel, occasional shale fragments Very stiff Grey to occasional reddish grey Moist (Glacial Till)	73.97 6.70			
7				10	50 DO	29
		END OF BOREHOLE	73.35 7.32			
8						
9						
10						



ADDITIONAL LAB. TESTING



Open hole dry upon completion of drilling.

Piezometer dry on Oct.19/98 and Nov.10/98.

DATA INPUT: PS NOV.4/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

WRHR1.BHS

W.P.	441-97-00		
DIST.	4, HWY: QEW	BORING DATE:	OCT.5/98
LOCATION:	N 4789802.365; E 283292.963		

RECORD OF BOREHOLE WRHR-1

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

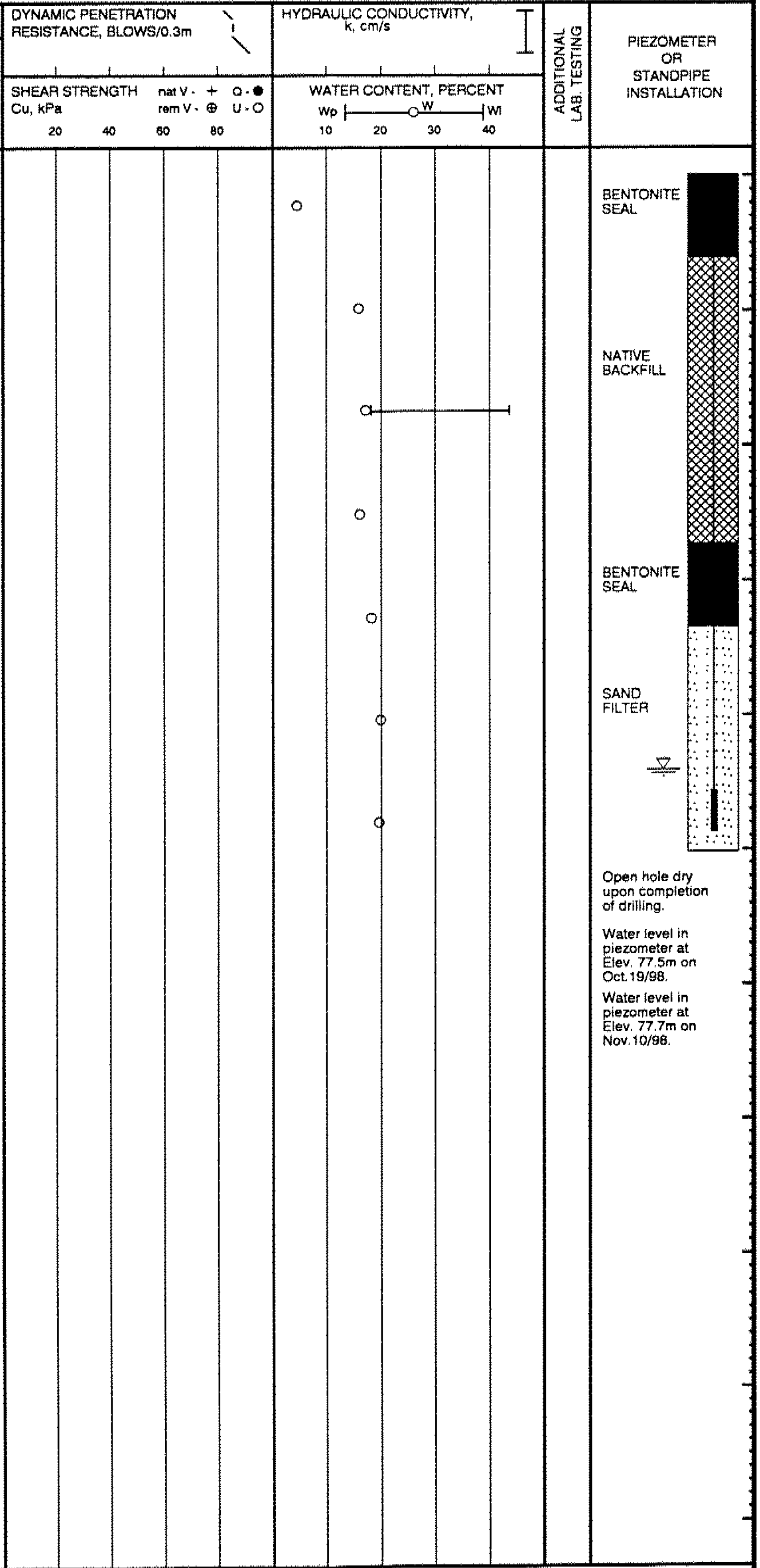
BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE

DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	82.10 0.00
Topsoil	0.03
Silty Sand, some clay, occasional limestone fragment up to 60mm dimension Loose Brown Dry (Fill)	81.50 0.60
Silty Clay, some sand, tarce gravel, trace silt seams and oxidized stains Stiff to hard Mottled brown and grey Dry to moist	77.70 4.40
Silty Clay, some sand, trace gravel Very stiff Grey Moist	77.07 5.03
END OF BOREHOLE	

SAMPLES

NUMBER	TYPE	BLOWS/0.3m
1	AS	-
2	50 DO	31
3	50 DO	49
4	50 DO	21
5	50 DO	10
6	50 DO	30
7	50 DO	23



DEPTH SCALE METRES: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

Open hole dry upon completion of drilling.

Water level in piezometer at Elev. 77.5m on Oct.19/98.

Water level in piezometer at Elev. 77.7m on Nov.10/98.

DATA INPUT: PS nov.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

WRHR2.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4789814.781; E 283323.466

RECORD OF BOREHOLE WRHR-2

BORING DATE: OCT.5/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		81.71							
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil		0.00							
		Silty Clay, some sand, trace gravel, some rootlets Very stiff Brown and grey Dry (Fill)	▩	0.15	1	50 DO	19				
				81.11 0.60							
1		Silty Clay, some sand, tarce gravel, trace silt seams and oxidized stains Hard Mottled brown and grey Dry to moist	▨		2	50 DO	45				
2					3	50 DO	36				
					4	50 DO	36				
3					5	50 DO	30				
				78.06 3.65							
4		Silty Clay, some sand, trace gravel Very stiff Grey Moist	▨		6	50 DO	17				
				77.44 4.27							
		END OF BOREHOLE									Open hole dry upon completion of drilling.
5											
6											
7											
8											
9											
10											

DATA INPUT: PS nov.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

WRHR3.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION:

RECORD OF BOREHOLE WRHR-3

BORING DATE: OCT.5/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V - + Q - ● rem V - ⊕ U - O) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ├─○W─┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil		0.00							
		Silty Clay, some sand, trace gravel, some rootlets and oxidized stains, occasional silt seams Very stiff to hard Mottled brown and grey Dry to moist		0.15	1	50 DO	14				
1					2	50 DO	44				
					3	50 DO	41				
2					4	50 DO	32				
3		Silty Clay, some sand, trace gravel, occasional silt pockets Very stiff Grey Moist		2.90	5	50 DO	20				Open hole dry upon completion of drilling.
		END OF BOREHOLE		3.51							
4											
5											
6											
7											
8											
9											
10											

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

WRHR4.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION:

RECORD OF BOREHOLE WRHR-4

BORING DATE: OCT.5/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE									
		Topsoil		0.00							
		Silty Clay, some sand, trace gravel, occasional silt seams, some organics and oxidized stains Very stiff to hard Brown to mottled brown Dry to moist	▨	0.12	1	50 DO	15				
1			▨		2	50 DO	44				
2			▨		3	50 DO	38				
			▨		4	50 DO	38				
3		Silty Clay, some sand and gravel Very stiff Grey Moist	▨	2.74	5	50 DO	23				
		END OF BOREHOLE		3.51							Open hole dry upon completion of drilling.
4											
5											
6											
7											
8											
9											
10											

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BSWR5.BHS

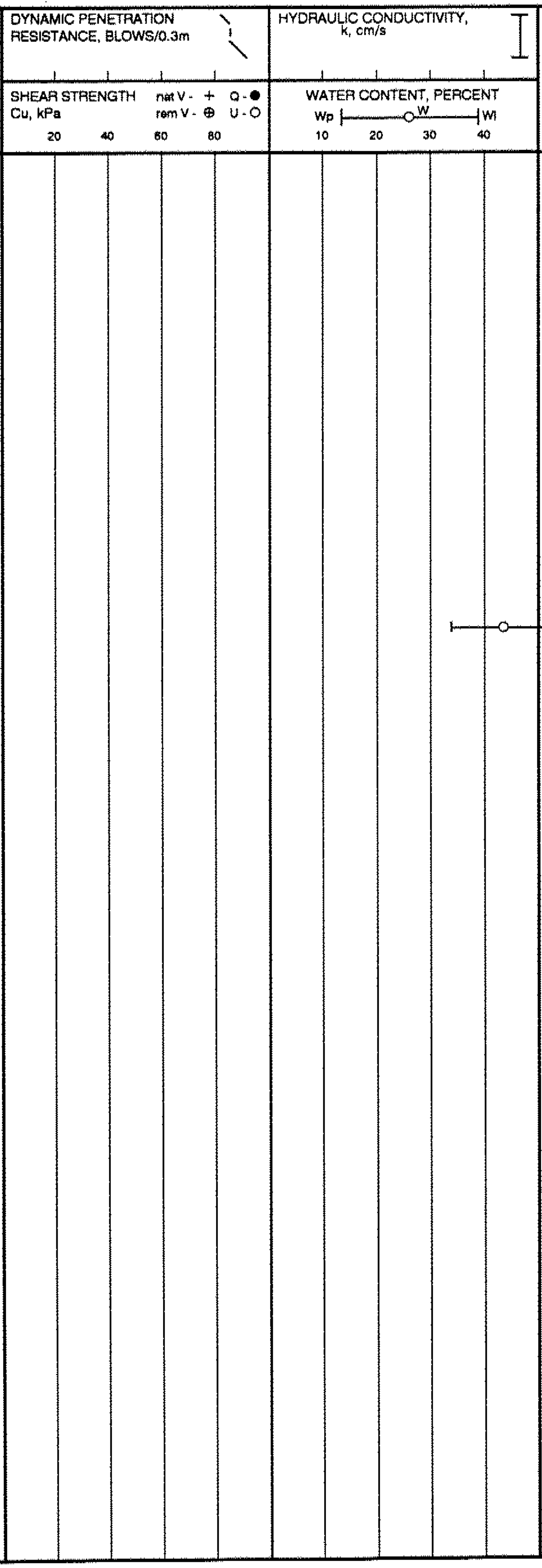
RECORD OF BOREHOLE BSWR-5

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791040.110; E 282899.899

BORING DATE: SEPT.28/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	77.91					
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil	0.00					
		Sandy Silt, some clay, tarce gravel, some organics and oxidized stains Dense Brown Dry (Fill)	77.61 0.30	1	50 DO	31		
1				2	50 DO	34		
		Topsoil	76.41 1.50	3	50 DO	22		
2		Clayey Silt, some sand, trace gravel, some organics and brick fragments Hard Brown to occasionally black Dry to moist (Fill)	1.70	4	50 DO	36		
				5	50 DO	47		
3		Silty Clay, trace sand with organics Firm Black Wet (Fill)	74.91 3.00	6	50 DO	7	MH	
4		Silty Clay, some sand, trace gravel Very stiff to hard Mottled brown and grey Moist	74.26 3.65	7	50 DO	24		
				8	50 DO	50		
5		END OF BOREHOLE	73.03 4.88					Open hole dry upon completion of drilling.
6								
7								
8								
9								
10								



DATA INPUT: PS NOV 5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BSWR6.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4791034.717; E 283096.960

RECORD OF BOREHOLE BSWR-6

BORING DATE: SEPT.24/98

SHEET 1 OF 1

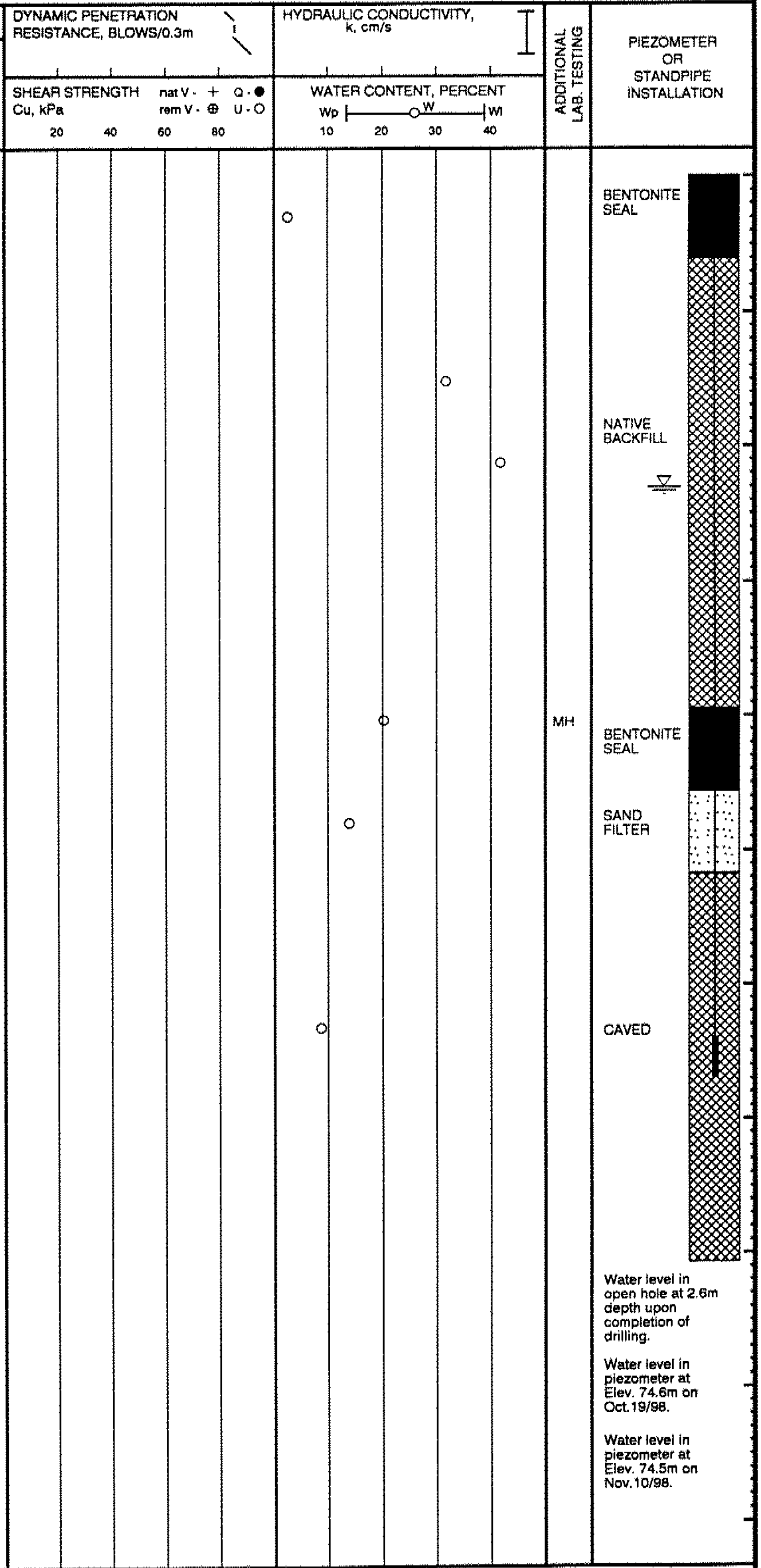
DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	76.76
Topsoil	0.00 76.55
Silty Sand, some sand and gravel, trace organics and rootlets Dense Brown Dry (Fill)	0.21 76.15 0.60
Clayey Silt, trace clay and gravel, some organics Hard becoming stiff Brown Dry to moist (Fill)	74.95 1.80
Clayey Silt, trace sand and gravel, some organics, rootlets and decayed wood pieces Firm to stiff Dark brown to black Moist (Fill)	74.31 2.45
Sand, fine to medium grained, trace to some gravel, trace silt Compact to dense Brown Wet	71.56 5.20
Sand and gravel, trace silt and clay Dense to very dense Grey brown Wet	68.68 8.08
END OF BOREHOLE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	51	
2	50 DO	33	
3	50 DO	9	
4	50 DO	6	
5	50 DO	11	
6	50 DO	21	MH
7	50 DO	39	
8	50 DO	38	
9	50 DO	70	
10	50 DO	22	



Water level in open hole at 2.6m depth upon completion of drilling.

Water level in piezometer at Elev. 74.6m on Oct.19/98.

Water level in piezometer at Elev. 74.5m on Nov.10/98.

DATA INPUT: PS nov.5/98

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

SOILM6

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791031.064; E 283152.040

RECORD OF BOREHOLE BSWR-7

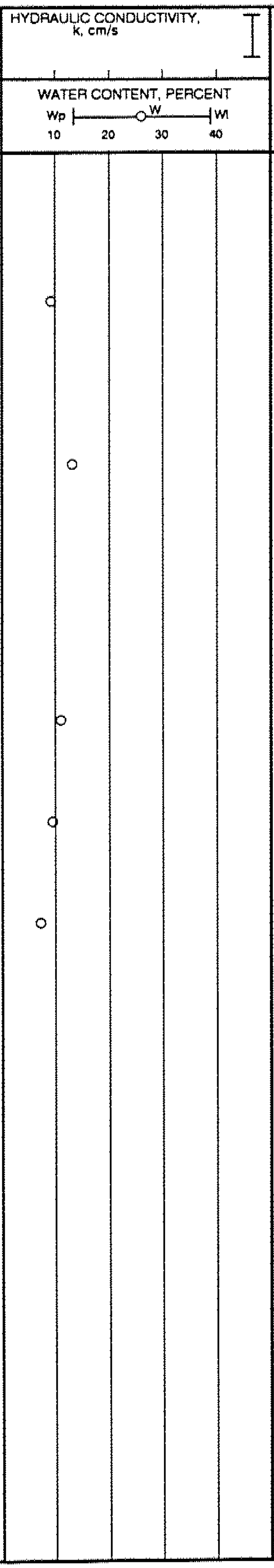
BORING DATE: SEPT.24/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	76.09					
Topsoil	0.00					
Clayey Silt, some sand, trace gravel, some organics Very stiff Reddish brown Dry (Fill)	75.85 0.24	1	50 DO	29		
		2	50 DO	25		
Sand, fine to medium grained, some gravel, trace to some silt Compact Grey and brown Wet	74.87 1.22	3	50 DO	18		▽
		4	50 DO	19		
Sand and gravel, trace silt Loose becoming very dense Grey Wet	73.34 2.75	5	50 DO	13		
		6	50 DO	7		
		7	50 DO	28	MH	
		8	50 DO	69		
		9	50 DO	50		
END OF BOREHOLE	69.54 6.55					Water level in open hole at 1.8m depth upon completion of drilling.

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH Cu, kPa: nat V - + Q - ● rem V - ⊕ U - ○ (20, 40, 60, 80)
HYDRAULIC CONDUCTIVITY, k, cm/s



DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

DATA INPUT: PS nov.5/98

BSWR8.BHS

RECORD OF BOREHOLE BSWR-8

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4790999.787; E 283196.158

BORING DATE: SEPT.25/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m | HYDRAULIC CONDUCTIVITY, k, cm/s | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

SHEAR STRENGTH Cu, kPa: nat V - + Q - ● rem V - ⊕ U - ○ (20, 40, 60, 80)

WATER CONTENT, PERCENT: Wp ├──○W──┤ Wl (10, 20, 30, 40)

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	76.50
Silty Sand, trace clay, some organics Loose Brown to black Dry (Fill)	0.00
Sandy Silt, some sand, trace gravel, some organics Loose Brown Dry to moist (Fill)	75.90 0.60
Sand and Gravel, trace silt Compact to very dense Grey Wet	75.30 1.20
Loose	73.75 2.75
	72.85 3.65
END OF BOREHOLE NOTE: Coordinates and elevations estimated from existing plans and profiles.	71.47 5.03

NUMBER	TYPE	BLOWS/0.3m
1	50 DO	9
2	50 DO	5
3	50 DO	26
4	50 DO	22
5	50 DO	4
6	50 DO	27
7	50 DO	71

Water level in open hole at 1.2m depth upon completion of drilling.

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BSWR9.BHS

W.P. 441-97-00	**RECORD OF BOREHOLE BSWR-9**	SHEET 1 OF 1	
DIST. 4, HWY: QEW	BORING DATE: SEPT.25/98	DATUM: GEODETIC	
LOCATION: N 4790952.52; E 283198.829		PROJECT: 981-8033	

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp —O W— Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		76.50							
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil		0.00							
		Clayey Silt, some sand, trace gravel, some organics Very stiff becoming firm Reddish brown Dry to moist (Fill)		0.18	1	50 DO	27				
1					2	50 DO	18				
					3	50 DO	6				
2		Sand, some gravel, trace silt Compact Grey Wet		74.50 2.00	4	50 DO	25				
3					5	50 DO	21				
		END OF BOREHOLE NOTE: Coordinates and elevations estimated from existing plans and profiles.		72.99 3.51							Water level in open hole at 1.8m depth upon completion of drilling.
4											
5											
6											
7											
8											
9											
10											

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BESR5.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4791051.574; E 282912.756

RECORD OF BOREHOLE BESR-5

BORING DATE: SEPT.28/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE	78.13					
0	Topsoil	0.00					
	Sandy Silt, some clay, trace gravel, trace organics and oxidized stains Compact Brown to grey brown Dry (Fill)	77.83 0.30	1 2 3	50 DO 50 DO 50 DO	21 24 13		
2	Silty Clay, some sand, trace gravel, trace organics Stiff to very stiff Brown Dry to moist (Fill)	76.30 1.83	4 5	50 DO 50 DO	18 13		
3	Silty Clay, some sand, some organics, trace brick fragments Soft to firm Black Moist to wet (Fill)	75.13 3.00	6	50 DO	8	MH	
4	Silty Clay, some sand, trace gravel Hard Mottled brown and grey Moist (Glacial Till)	74.63 3.50	7 8 9 10	50 DO 50 DO 50 DO 50 DO	32 63 26 44		
	END OF BOREHOLE	71.58 6.55					Open hole dry upon completion of drilling.

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

Depth scale: 0 1 2 3 4 5 6 7 8 9 10

DATA INPUT: PS NOV.5/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

BESR6.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791048.274; E 283084.233

RECORD OF BOREHOLE BESR-6

BORING DATE: SEPT.24/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - O — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp ├──O W──┤ Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE	76.87				
0		Topsoil	0.00 76.66				
		Silty Sand, some gravel Dense Brown Dry (Fill)	0.21	1	50 DO	63	
		Clayey Silt, some sand, trace gravel, some organics and oxidized stains Hard becoming black Brown to occasionally black Dry to moist (Fill)	76.27 0.60				
1				2	50 DO	35	
				3	50 DO	16	
2				4	50 DO	11	
		Sand, medium to coarse grained, trace to some gravel, trace silt Compact to very dense Brown Wet	73.96 2.90				▽
3				5	50 DO	14	
4				6	50 DO	21	
				7	50 DO	54	
5		Sand and gravel, trace silt Compact to very dense Grey and brown Wet	71.67 5.20	8	50 DO	19	
6				9	50 DO	67	
7							
8				10	50 DO	63	
		Silty Clay, trace sand and gravel Hard Grey Moist (Glacial Till)	68.17 8.70				
9				11	50 DO	33	
		END OF BOREHOLE	67.27 9.60				Water level in open hole at 2.9m upon completion of drilling.
10							

DATA INPUT: PS nov.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BESR7.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4791047.571; E 283133.398

RECORD OF BOREHOLE BESR-7

BORING DATE: SEPT.24/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - O — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	76.27				
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil	0.00				
		Sandy Silt, some clay, trace gravel, some organics Compact to dense Reddish brown Dry (Fill)	0.18	1	50 DO	24	
1				2	50 DO	36	
		Sand, medium to coarse grained, trace to some gravel, trace silt Compact Brown Wet	74.90 1.37	3	50 DO	22	▽
2				4	50 DO	18	
3		Sand and gravel, trace silt Compact to very dense Brown to grey brown Wet	73.57 2.70	5	50 DO	32	
4				6	50 DO	14	
5				7	50 DO	64	
				8	50 DO	30	
6				9	50 DO	55	
7				10	50 DO	59	
8		END OF BOREHOLE	68.19 8.08				Water level in open hole at 1.8m depth upon completion of drilling.
9							
10							

DATA INPUT: PS nov.5/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

BESR8.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791032.901; E 283180.799

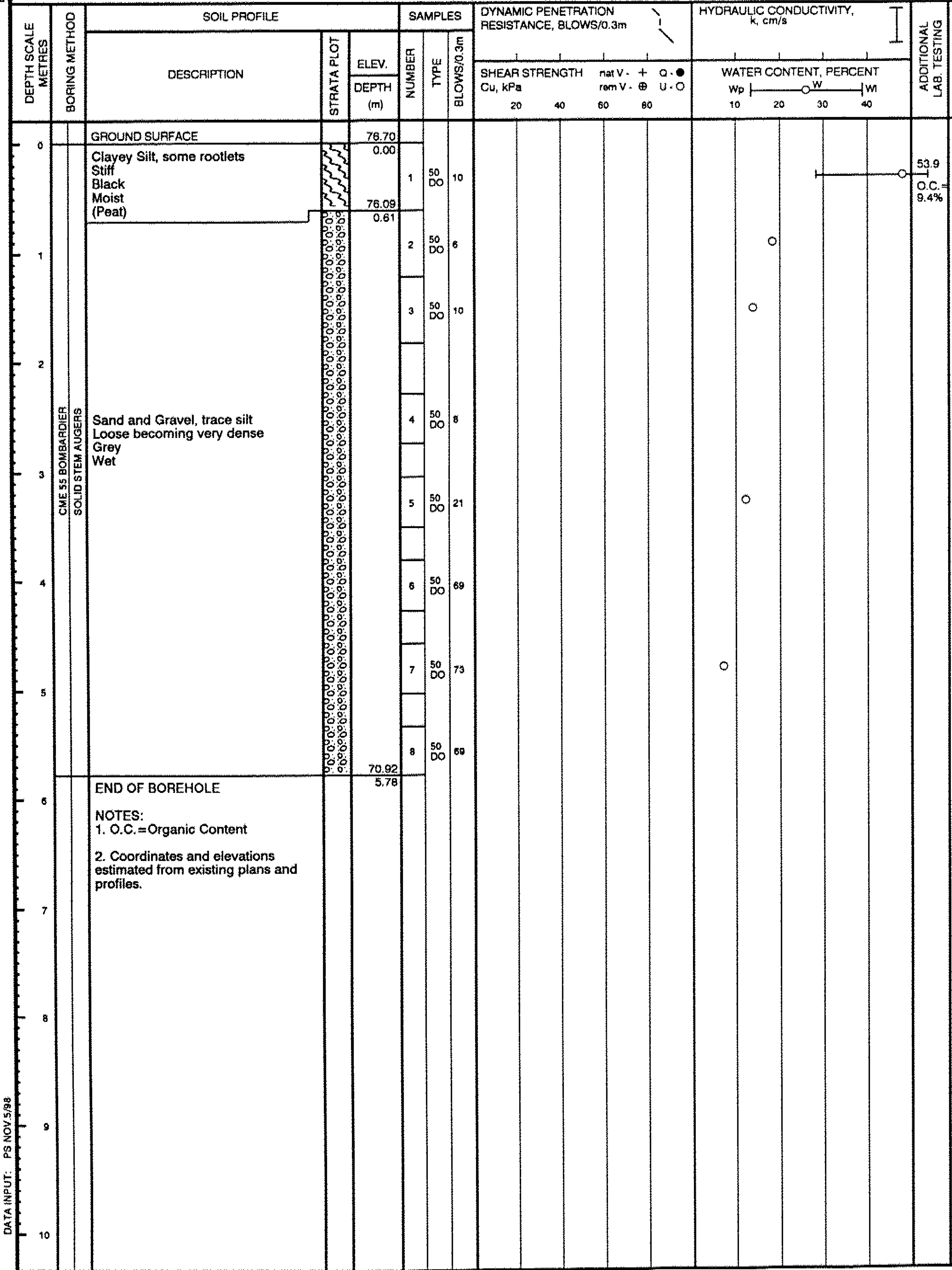
RECORD OF BOREHOLE BESR-8

BORING DATE: SEPT.25/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

DESCRIPTION	ELEV. / DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	76.70 0.00					
Clayey Silt, some rootlets Stiff Black Moist (Peat)	76.09 0.61	1	50 DO	10	O.C.= 9.4%	
Sand and Gravel, trace silt Loose becoming very dense Grey Wet		2	50 DO	6		
		3	50 DO	10		
		4	50 DO	8		
		5	50 DO	21		
		6	50 DO	69		
		7	50 DO	73		
	70.92 5.78	8	50 DO	69		
END OF BOREHOLE						Water level in open hole at 1.2m depth upon completion of drilling.



NOTES:
1. O.C.=Organic Content

2. Coordinates and elevations estimated from existing plans and profiles.

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BESR9.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791032.901; E 283228.878

RECORD OF BOREHOLE BESR-9

BORING DATE: SEPT.25/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s
WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 10 20 30 40
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		76.00				
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Peat	≈	0.00 75.40	1	50 DO	3	
1		Silty Sand, trace clay and gravel, some organics and decayed wood fragments Very loose to loose Grey Moist to wet (Fill)	▩	0.60 74.20	2 3	50 DO 50 DO	5 4	
2 3 4		Sand and Gravel, trace silt Loose to compact Grey Wet	°	1.80 71.73	4 5 6	50 DO 50 DO 50 DO	7 17 17	
5 6 7 8 9 10		END OF BOREHOLE NOTE: Coordinates and elevations estimated from existing plans and profiles.		4.27				Water level in open hole at 1.2m depth upon completion of drilling.

DATA INPUT: PS NOV.5/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION:

RECORD OF BOREHOLE BESR-10

BORING DATE: SEPT.25/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		75.30							
0		Topsoil		0.00 75.00 0.30	1	50 DO	15				
1		Clayey Silt, some sand, trace gravel, some organics and oxidized stains Very stiff Brown to mottled brown Dry to moist (Fill)		73.80 1.50	2	50 DO	27				
		Organic Silt Compact Black Moist to wet		73.50 1.80	3	50 DO	21				▽
2		Silty Sand, some gravel, trace clay, some organics Compact Grey Wet		72.55 2.75	4	50 DO	13				
3		Sand and Gravel, trace silt Dense Grey Wet		71.79 3.51	5	50 DO	31				
		END OF BOREHOLE									
4											Water level in open hole at 1.7m depth upon completion of drilling.
5											
6											
7											
8											
9											
10											

DATA INPUT. PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

BWSR1.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION:

RECORD OF BOREHOLE BWSR-1

BORING DATE: SEPT.29/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil		0.00							
		Clayey Silt, some sand, trace gravel, some organics and rootlets, trace oxidized stains and shale fragments Very stiff Brown Dry to moist (Fill)		0.15	1	50 DO	37				
1					2	50 DO	24				
					3	50 DO	18				
2		END OF BOREHOLE		1.83							Open hole dry upon completion of drilling.
3											
4											
5											
6											
7											
8											
9											
10											

DATA INPUT: PS NOV 5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BWSR2 BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION:

RECORD OF BOREHOLE BWSR-2

BORING DATE: SEPT.15/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - O
20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp ⊢—O W—⊣ Wl
10 20 30 40

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE							
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil		0.00					
		Clayey Silt, some sand, trace gravel, some organics, occasional shale fragments Hard becoming very stiff Brown to mottled grey and brown Dry to moist (Fill)	▨	0.21	1	50 DO	30		
1			▨		2	50 DO	37		
			▨		3	50 DO	15		
2			▨		4	50 DO	17		
		END OF BOREHOLE		2.44					Open hole dry upon completion of drilling.
3									
4									
5									
6									
7									
8									
9									
10									

DATA INPUT: PS NOV 4/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BWSR3.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791120.039; E 282875.839

RECORD OF BOREHOLE BWSR-3

BORING DATE: SEPT.29/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
	CME 55 BOMBARDIER SOLID STEM AUGERS	GROUND SURFACE		76.25							
0		Topsoil	≈	0.00							
		Clayey Silt, some sand, trace gravel, trace organics and rubber fragments Very stiff Brown Dry (Fill)	▩	0.20 75.05	1	50 DO	21				
1					2	50 DO	24				
		Peat, decayed wood Stiff Black Moist	≈	1.20 74.25	3	50 DO	13				
2		Silty Clay, some sand, trace gravel, trace oxidized stains Hard Mottled grey and brown becoming brown Moist (Glacial Till)	▨	2.00 70.46	4	50 DO	23				
					5	50 DO	36				
3					6	50 DO	63				
4					7	50 DO	31				
5					8	50 DO	34				
					9	50 DO	32				
6		END OF BOREHOLE		5.79							Open hole dry upon completion of drilling.
7											
8											
9											
10											

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BWSR4.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION: N 4791167.659; E 282876.274

RECORD OF BOREHOLE BWSR-4

BORING DATE: SEPT.29/98

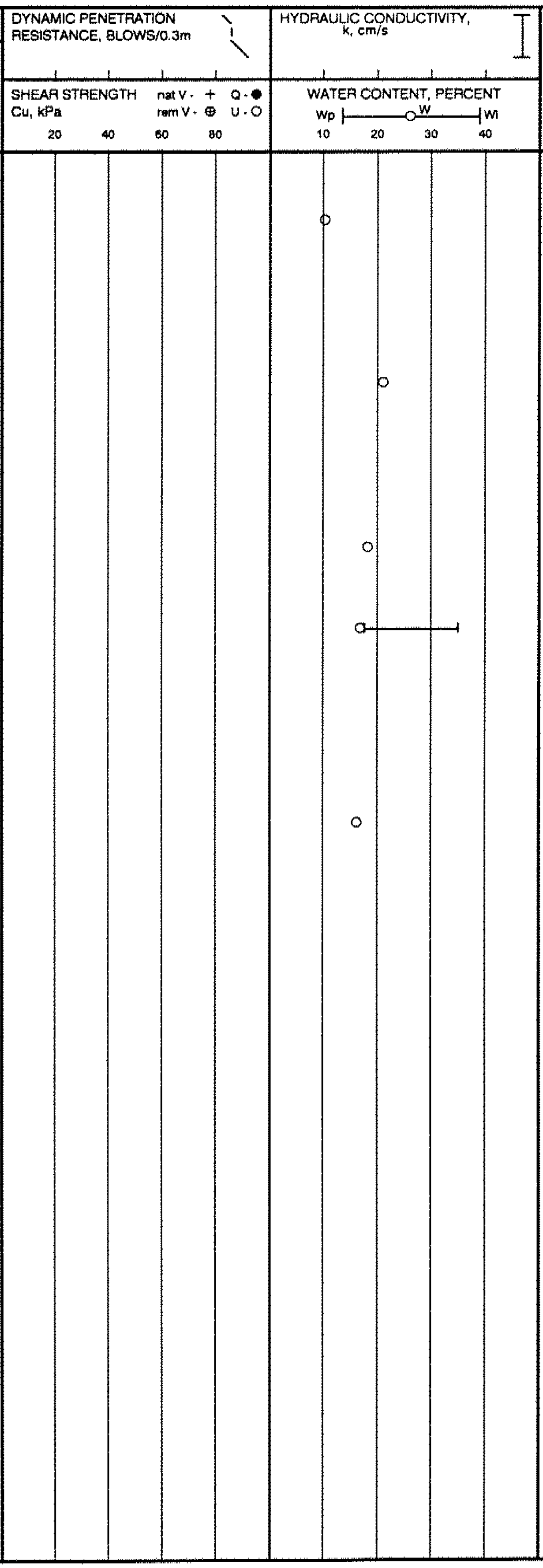
SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	76.49					
Topsoil	0.00					
Clayey Silt, some sand, trace gravel, some organics Very stiff Brown Dry (Fill)	0.15	1	50 DO	21		
	75.59 0.90	2	50 DO	21		
Peat, decayed rubber fragments Firm to stiff Black Moist (Fill)		3	50 DO	10	O.C.= 9.1%	
	74.34 2.15	4	50 DO	9		
Silty Clay, trace to some sand, trace gravel, trace organics and oxidized stains Hard Mottled brown and grey becoming brown Moist (Glacial Till)		5	50 DO	46		
		6	50 DO	45	MH	
		7	50 DO	53		
		8	50 DO	43		
	70.70	9	50 DO	37		
END OF BOREHOLE NOTE: O.C.=Organic Content	5.79					Open hole dry upon completion of drilling.



DEPTH SCALE METRES: 0 1 2 3 4 5 6 7 8 9 10

DATA INPUT: PS NOV.5/98

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: PKS

CHECKED: SP

BWSR5 BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791215.411; E 282858.717

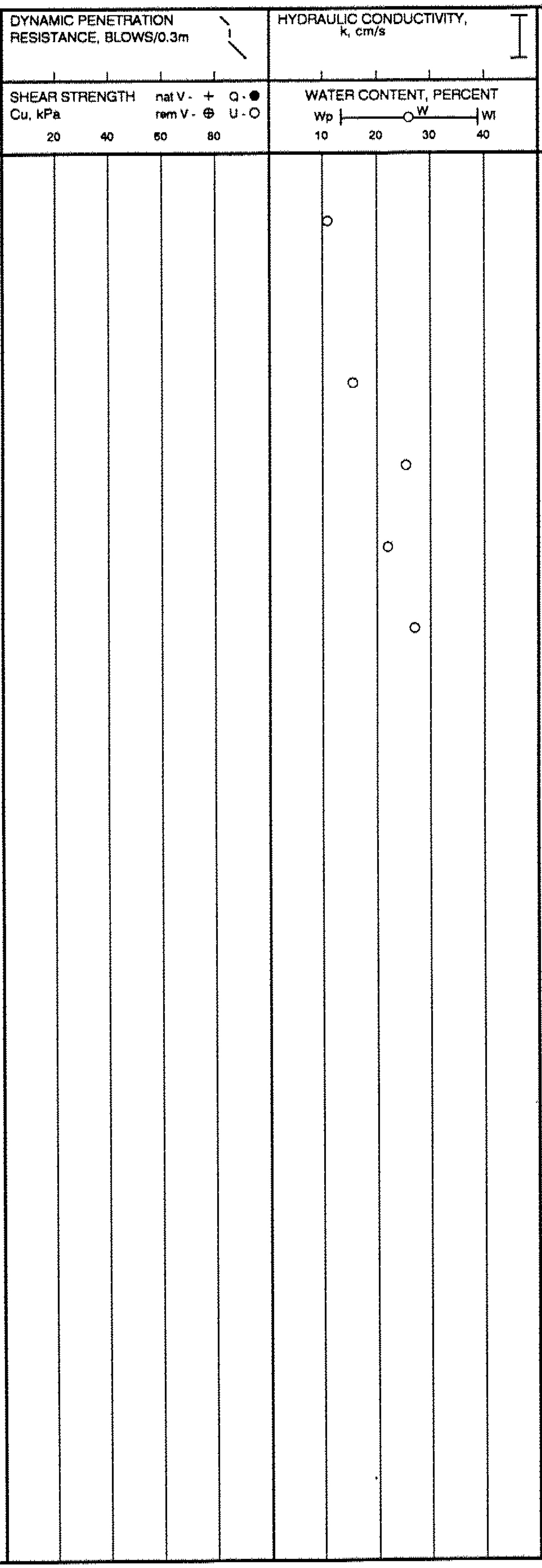
RECORD OF BOREHOLE BWSR-5

BORING DATE: SEPT.29/98

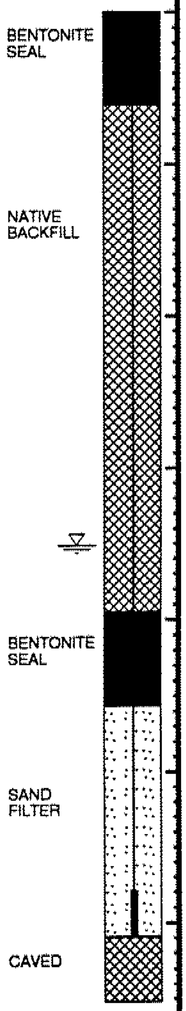
SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
GROUND SURFACE	75.73				
Topsoil	0.00				
Clayey Silt, some sand, trace gravel, some organics Hard becoming firm Brown Dry to moist (Fill)	0.15	1	50 DO	33	
		2	50 DO	24	
	73.90	3	50 DO	5	
Peat	1.83				
Sand, some silt, trace clay Loose Dark grey to black Wet		4	50 DO	3	MH
	73.14				
Peat	2.59	5	50 DO	6	
Silty Clay Soft Grey Wet	2.74 72.68				
Sand, trace to some silt Compact to loose Dark grey Wet	3.05	6	50 DO	11	
	71.69				
Silty Clay, some sand, trace gravel Firm becoming hard below 4.4m depth Brown and grey Moist to wet (Glacial Till)	4.04	7	50 DO	5	
		8	50 DO	63	
		9	50 DO	56	
	69.20	10	50 DO	61	
END OF BOREHOLE	6.53				



PIEZOMETER OR STANDPIPE INSTALLATION



Water level in open hole at 1.8m depth upon completion of drilling.

Water level in piezometer at Elev. 71.5m on Oct.19/98.

Water level in piezometer at Elev. 72.2m on Nov.10/98.

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BWSR6.BHS

RECORD OF BOREHOLE BWSR-6

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791261.196; E 282837.638

BORING DATE: SEPT.28/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	76.03
Topsoil	0.00
Clayey Silt, some sand, trace gravel, some organics Hard becoming stiff Brown Dry to moist (Fill)	0.15
Silty Clay, some sand, trace gravel Firm Brown Moist (Fill)	74.23 1.80
Silty Clay, some sand, some organics Soft to firm Dark grey to black Moist to wet (Fill)	73.28 2.75
Silty Clay, some sand, trace gravel Stiff Grey Wet	72.28 3.75
Silty Clay, some sand, trace gravel Very stiff to hard Mottled brown and grey Moist to wet (Glacial Till)	71.63 4.40
END OF BOREHOLE	69.48 6.55

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	31
2	50 DO	30
3	50 DO	8
4	50 DO	7
5	50 DO	5
6	50 DO	4
7	50 DO	12
8	50 DO	18
9	50 DO	31
10	50 DO	55

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 3.2m depth upon completion of drilling.

DEPTH SCALE (METRES): 0 1 2 3 4 5 6 7 8 9 10

DATA INPUT: PS nov 5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

BWSR7.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791306.281; E 282814.985

RECORD OF BOREHOLE BWSR-7

BORING DATE: SEPT.28/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES | BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE		76.31			
Topsoil		0.00			
Clayey Silt, some sand, trace gravel, some organics and rootlets Very stiff to hard Brown Dry to moist (Fill)	▨	0.15	1	50 DO	24
	▨		2	50 DO	33
Silty Clay, some sand, trace gravel, some organics Hard becoming firm Brown and grey Moist (Fill)	▨	75.11 1.20	3	50 DO	50/.15
	▨		4	50 DO	11
	▨		5	50 DO	4
Silty Clay, some sand, trace gravel Hard Mottled brown and grey becoming brown Moist (Glacial Till)	▧	73.26 3.05	6	50 DO	44
	▧		7	50 DO	56
	▧		8	50 DO	45
	▧		9	50 DO	56
END OF BOREHOLE		70.52 5.79			

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 3.1m depth upon completion of drilling.

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOIL.M6

BWSR8.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791350.940; E 282792.120

RECORD OF BOREHOLE BWSR-8

BORING DATE: SEPT.28/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DEPTH SCALE METRES

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

Depth scale (m)	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
	GROUND SURFACE		76.53				
0	Topsoil		0.00				
	Clayey Silt, some sand, trace gravel, some organics Very stiff to hard Brown Dry (Fill)		0.15	1	50 DO	29	
1			75.33	2	50 DO	31	
	Silty Clay, some sand, trace gravel, some organics Stiff Brown Moist (Fill)		1.20	3	50 DO	11	
2	Silty Clay, some sand, trace gravel Stiff Mottled brown and grey Moist (Glacial Till)		74.73 1.80	4	50 DO	11	
				5	50 DO	14	
3				6	50 DO	14	
	Sand Grey to black		72.93 3.60				
4	Silty Clay, some sand, trace gravel Hard Grey and brown Moist to wet (Glacial Till)		3.80	7	50 DO	55	
				8	50 DO	45	
5	END OF BOREHOLE		71.50 5.03				Open hole dry upon completion of drilling.
6							
7							
8							
9							
10							

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - O — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

DATA INPUT: PS NOV 5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

RECORD OF BOREHOLE BSER-4

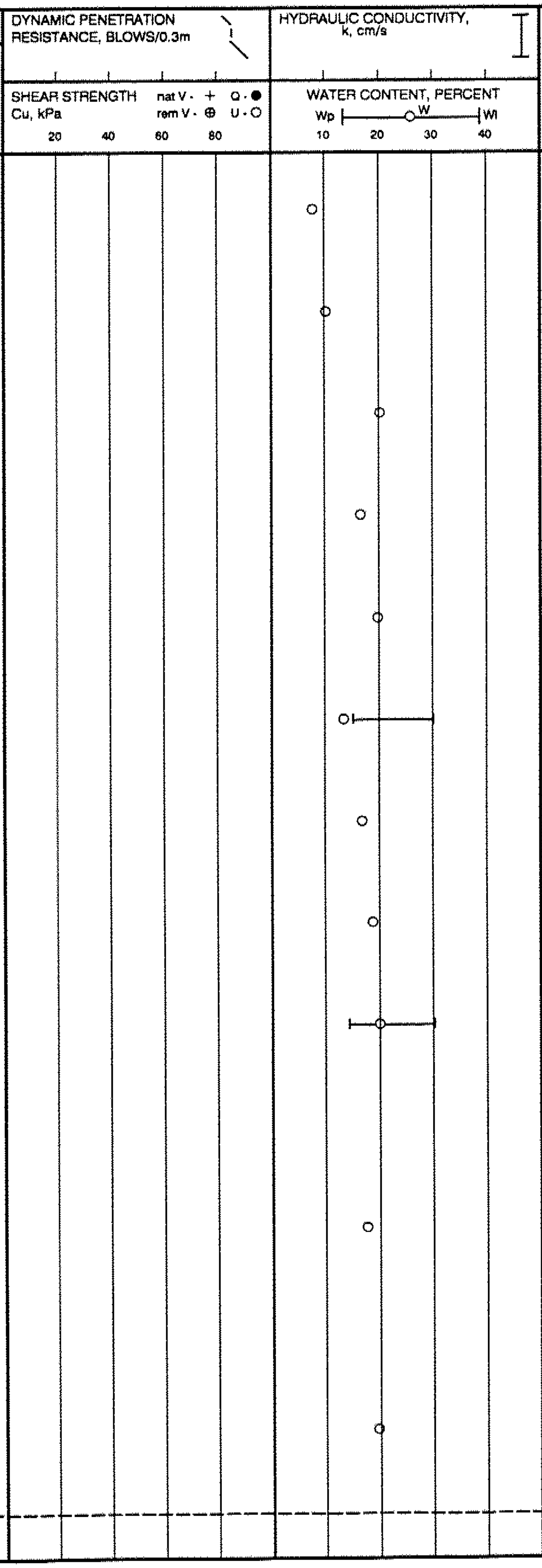
W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4790958.551; E 283000.917
BORING DATE: OCT.1/98
SHEET 1 OF 2
DATUM: GEODETIC
PROJECT:

BSER4.BHS

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	77.11
0	Topsoil	0.00
	Sandy Silt, some clay, trace gravel, some organics Compact to loose Brown becoming reddish brown Dry to moist (Fill)	0.15
	Silty Clay, some sand, trace gravel, some fine sand and silt seams Hard Mottled brown and grey Moist to wet (Glacial Till-weathered crust)	74.66 2.45
	Silty Clay, some sand, trace to some gravel, trace shale fragments below 10m depth Very stiff becoming hard below 9m depth Grey becoming reddish grey Moist (Glacial Till)	71.91 5.20
10	CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	23	
2	50 DO	23	
3	50 DO	8	
4	50 DO	23	
5	50 DO	41	
6	50 DO	37	MH
7	50 DO	39	
8	50 DO	18	
9	50 DO	16	MH
10	50 DO	27	
11	50 DO	32	



PIEZOMETER OR STANDPIPE INSTALLATION
BENTONITE SEAL
NATIVE BACKFILL

DATA INPUT: PS NOV.5/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

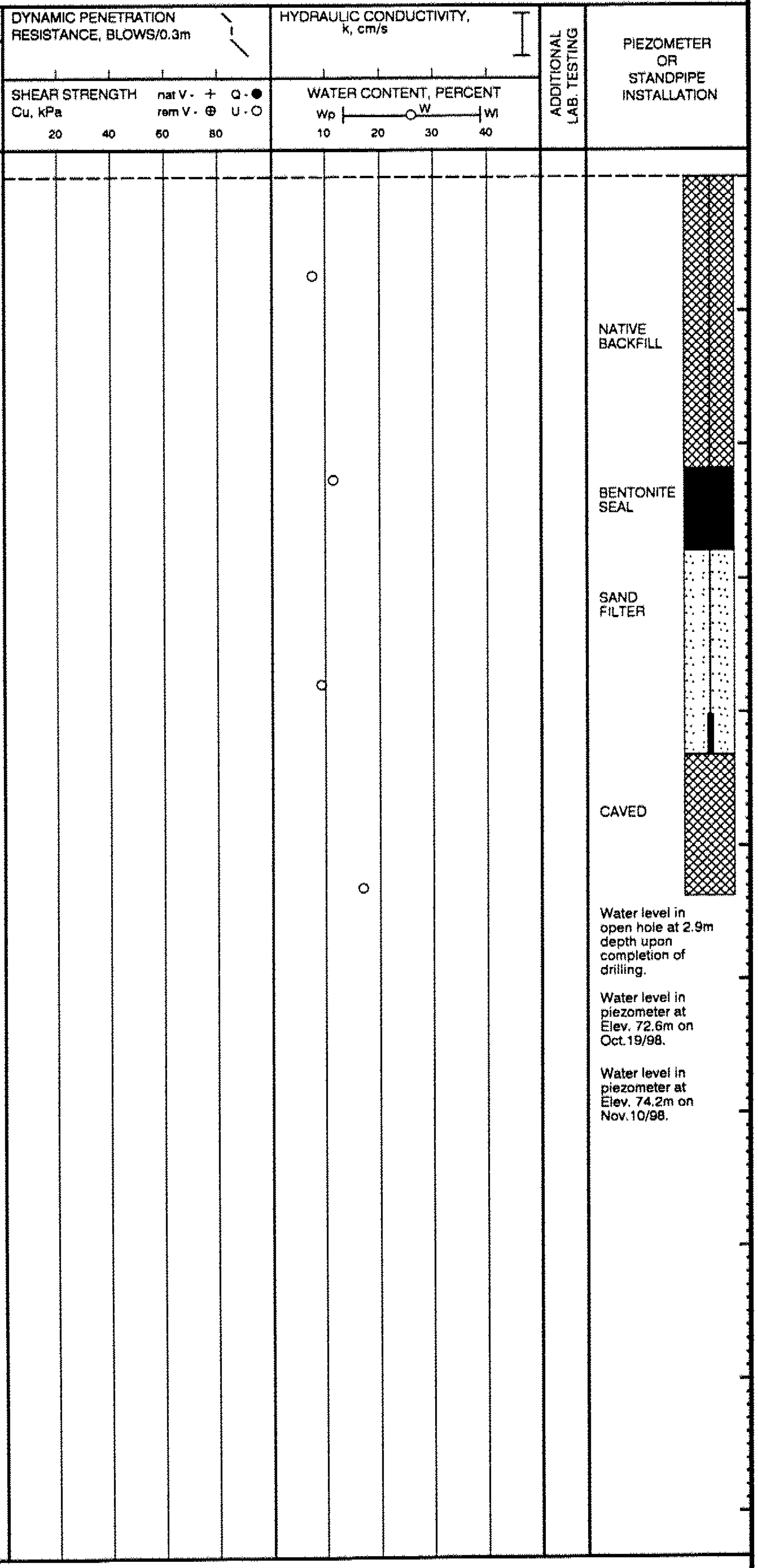
RECORD OF BOREHOLE BSER-4

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4790958.551; E 283000.917

BORING DATE: OCT.1/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT:

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
		CONTINUED FROM PREVIOUS PAGE					
10	CME 55 BOMBARDIER SOLID STEM AUGERS	Silty Clay, some sand, trace to some gravel, trace shale fragments below 10m depth Very stiff becoming hard below 9m depth Grey becoming reddish grey Moist (Glacial Till)			12	50 DO	50/ .15
12					13	50 DO	50/ .15
13					14	50 DO	50/ .15
14				62.81 14.30			
15		Shale Highly weathered Reddish brown Dry (Bedrock)		61.72 15.39	15	50 DO	50/ .15
		END OF BOREHOLE					
16							
17							
18							
19							
20							



Water level in open hole at 2.9m depth upon completion of drilling.

Water level in piezometer at Elev. 72.6m on Oct.19/98.

Water level in piezometer at Elev. 74.2m on Nov.10/98.

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

BSER5.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4790936.369; E 283021.374

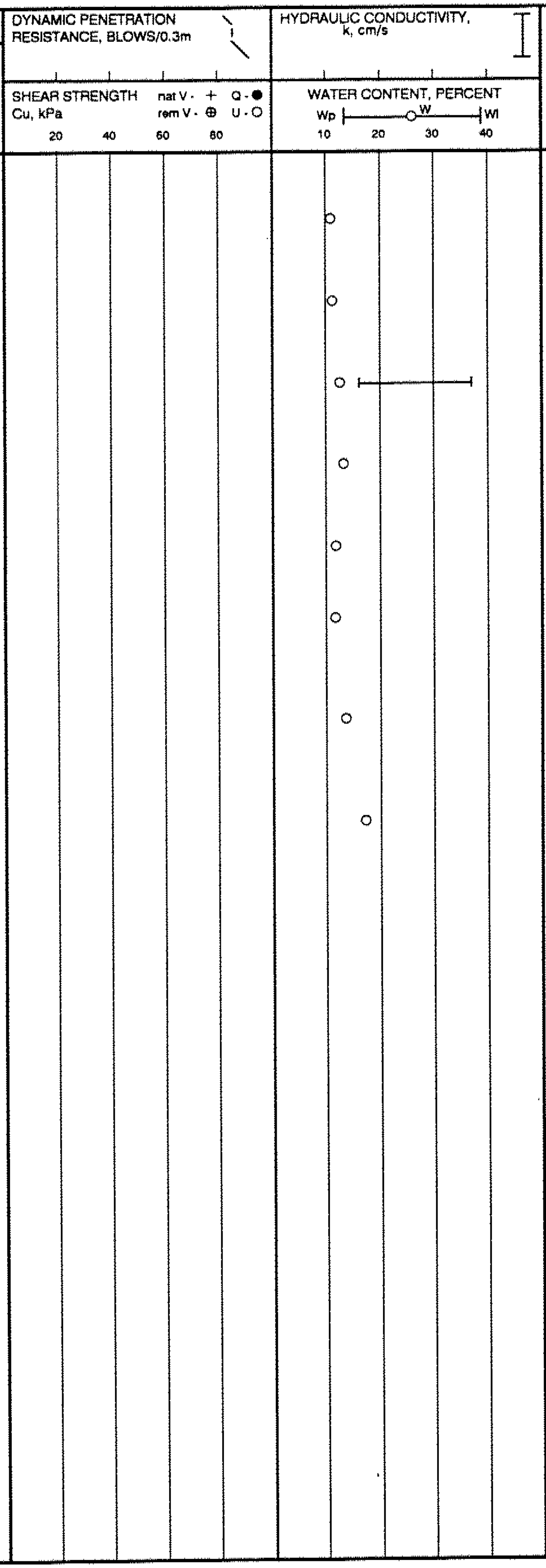
RECORD OF BOREHOLE BSER-5

BORING DATE: OCT.1/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DESCRIPTION	ELEV. DEPTH (m)	SAMPLE NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
GROUND SURFACE	77.05					
Topsoil	0.00					
Sandy Silt, some clay, trace gravel, some organics, trace rootlets Very stiff to hard Brown Dry (Fill)	0.15	1	50 DO	23		
		2	50 DO	31		
	75.85 1.20					
Silty Clay, trace to some sand, trace gravel, some fine sand and silt seams Very stiff to hard Brown to mottled brown and grey Dry to moist (Glacial Till-weathered crust)		3	50 DO	23	MH	
		4	50 DO	46		
		5	50 DO	56		
		6	50 DO	65		
		7	50 DO	42		
		8	50 DO	18		
END OF BOREHOLE	72.02 5.03					Open hole dry upon completion of drilling.



DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

WWAR1.BHS

W.P. 441-97-00

DIST. 4, HWY: QEW

LOCATION:

RECORD OF BOREHOLE WWAR-1

BORING DATE: OCT.2/98

SHEET 1 OF 1

DATUM: GEODETIC

PROJECT: 981-8033

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m SHEAR STRENGTH Cu, kPa (nat V - + Q - ● rem V - ⊕ U - ○) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s WATER CONTENT, PERCENT (Wp ⊢—○W—⊣ Wl) 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE									
		Topsoil		0.00 0.09							
	CME 55 BOMBARDIER SOLID STEM AUGERS		▨		1	50 DO	49				
1		Silty Sand, some gravel, trace clay, trace organics Compact to very dense Brown Moist (Fill)	▨		2	50 DO	42				
			▨		3	50 DO	18				
2			▨		4	50 DO	62				
		END OF BOREHOLE		2.44							Open hole dry upon completion of drilling.
3											
4											
5											
6											
7											
8											
9											
10											

DATA INPUT: PS NOV.5/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

WWAR3 BHS

RECORD OF BOREHOLE WWAR-3

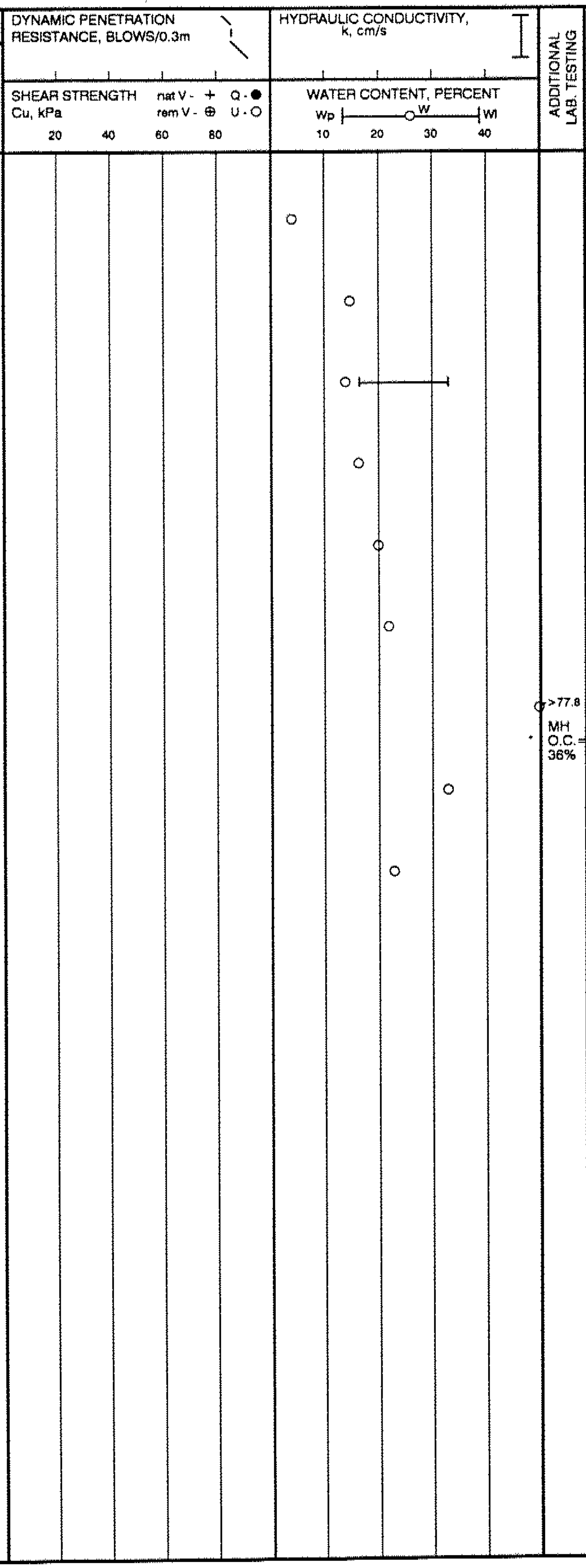
W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791483.505; E 282710.853

BORING DATE: OCT.2/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE		76.95			
Topsoil		0.00			
Sandy Silt, some sand, trace gravel, some rootlets and trace organics Very dense Brown Dry (Fill)		0.09 76.35 0.60	1 2	50 DO 50 DO	54 17
Clayey Silt, some sand, trace gravel, trace organics Very stiff to hard Brown Dry to moist (Fill)		74.50	3 4	50 DO 50 DO	33 22
Silty Clay, some sand, trace gravel, trace organics Stiff Brown Moist (Fill)		2.45 73.45	5 6	50 DO 50 DO	11 11
Clayey Silt and Sand with organics Firm to stiff Black Moist (Peat)		3.50 72.40	7	50 DO	8
Sand, trace silt Very loose to compact Grey Wet		4.55 71.46	8 9	50 DO 50 DO	4 12
END OF BOREHOLE NOTE: O.C.= Organic Content		5.49			



PIEZOMETER OR STANDPIPE INSTALLATION

Water first encountered in open hole at 4.3m depth during drilling.

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

DATA INPUT PS NOV.5/98

SOILM6

WWAR4.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791455.705; E 282729.400

RECORD OF BOREHOLE WWAR-4

BORING DATE: OCT.2/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80
SHEAR STRENGTH Cu, kPa: nat V - + Q - ● rem V - ⊕ U - ○
HYDRAULIC CONDUCTIVITY, k, cm/s
WATER CONTENT, PERCENT: Wp ├──○W──┤ Wl: 10 20 30 40
ADDITIONAL LAB. TESTING
PIEZOMETER OR STANDPIPE INSTALLATION

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)
	GROUND SURFACE	76.91
0	Topsoil	0.00
	Clayey Silt, some sand, trace gravel, some organics, trace cinders and brick fragments Very stiff becoming stiff Brown Dry to moist (Fill)	0.09
	Clayey Silt, some sand, trace gravel Firm to stiff Brown and grey Moist (Fill)	74.46 2.45
	Sand, coarse grained, some silt Loose Grey Wet	73.11 3.80
4	Peat	72.81 4.10
	Sand, coarse grained, trace silt Loose to compact Grey Wet	72.51 4.40
5	END OF BOREHOLE	72.03 4.88

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	34
2	50 DO	28
3	50 DO	25
4	50 DO	14
5	50 DO	8
6	50 DO	14
7	50 DO	6
8	50 DO	14

▽

Water level in open hole at 3.6m depth upon completion of drilling.

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

WWAR5.BHS

W.P. 441-97-00
DIST. 4, HWY: QEW
LOCATION: N 4791426.243; E 282747.929

RECORD OF BOREHOLE WWAR-5

BORING DATE: OCT.2/98

SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-8033

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - O — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp ⊢—O W—⊣ Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	76.79				
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Topsoil	0.00				
		Sandy Silt, some clay, trace gravel, some organics Dense Brown Dry (Fill)	0.09	1	50 DO	40	
1		Clayey Silt, some sand, trace gravel, trace organics Very stiff becoming stiff Brown to brown and grey Dry to moist (Fill)	76.19 0.60	2 3 4	50 DO 50 DO 50 DO	21 15 9	
2 3		Silty Clay, some sand, trace gravel, some organics Stiff Brown and grey Moist (Fill)	74.34 2.45	5 6	50 DO 50 DO	10 9	
4		Sandy Silt with organics Loose Black Moist	73.29 3.50	7	50 DO	5	▽
		Sand, some silt with organics Compact Grey to black Wet	72.54 4.25	8	50 DO	14	
5		END OF BOREHOLE	71.91 4.88				Water level in open hole at 4.2m depth upon completion of drilling.
6							
7							
8							
9							
10							

DATA INPUT: PS NOV.5/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: PKS
CHECKED: SP

SOILM6

January 1999

981-8033

RECORDS OF BOREHOLES
RED HILL CREEK INTERCHANGE
(PREVIOUS INVESTIGATION)

Golder Associates

N1108001.BHS

RECORD OF BOREHOLE 1

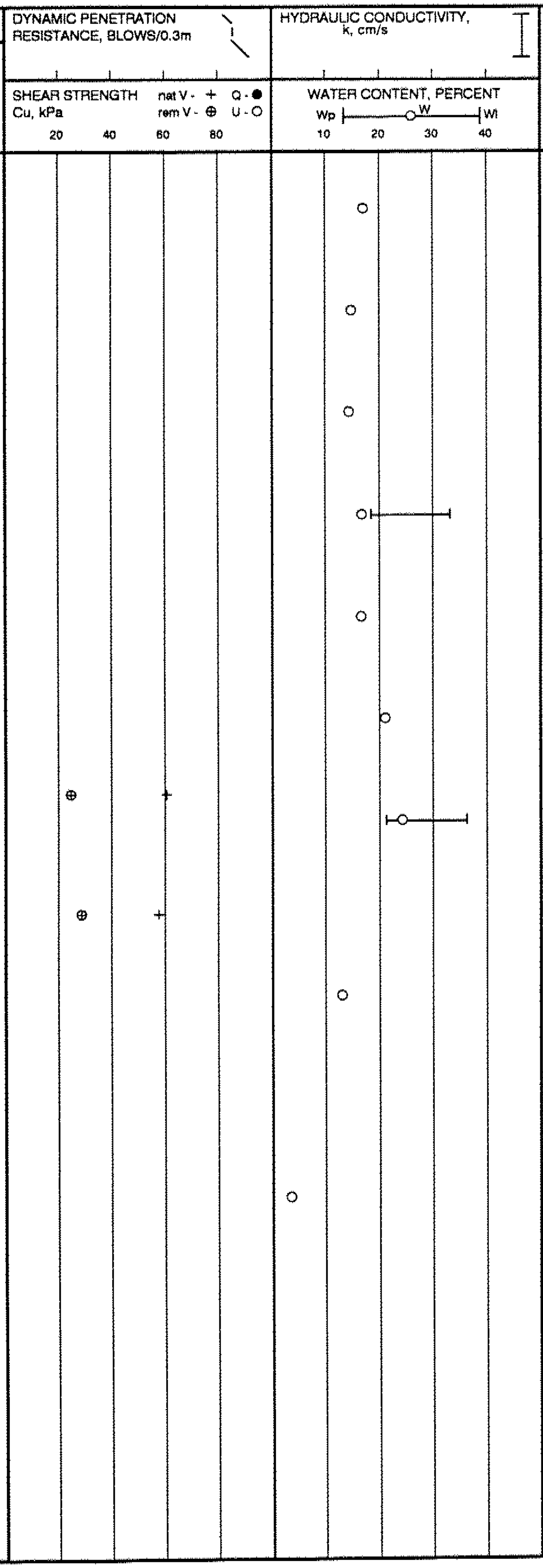
W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789789; E 283322

BORING DATE: FEB.12/98

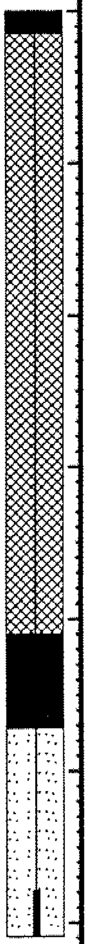
SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
	GROUND SURFACE		81.90				
0	Topsoil		0.00				
	Sandy Silt to Sand, some clay and gravel Compact Brown Moist (Fill)	▩	0.10	1	50 DO	12	
1				2	50 DO	40	
	Silty Clay, trace sand Hard Mottled grey and brown Moist	▨	80.80 1.10	3	50 DO	73	
2				4	50 DO	38	MH
3				5	50 DO	32	
4	Silty Clay, trace sand, occasional gravel Stiff Grey Moist	▨	78.20 3.70	6	50 DO	12	
5				7	50 DO	14	MH
6	Silty Clay, some sand, trace gravel, some shale fragments Hard Reddish grey Dry (Glacial Till)		76.10 5.80		50 DO	60/ .03	
7	Shale Highly weathered Reddish brown (Bedrock)		75.00 6.90				
8	END OF BOREHOLE Refusal to split spoon sampler advance		74.28 7.62		50 DO	60/ .03	
9							
10							



PIEZOMETER OR STANDPIPE INSTALLATION



Open hole dry on completion of drilling.
Water level in piezometer at Elev. 78.7m on March 25/98.
Piezometer found to be destroyed in Oct/98.

DATA INPUT: PS JAN 25/99

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

N1108002 BHS

RECORD OF BOREHOLE 2

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789876; E 283553

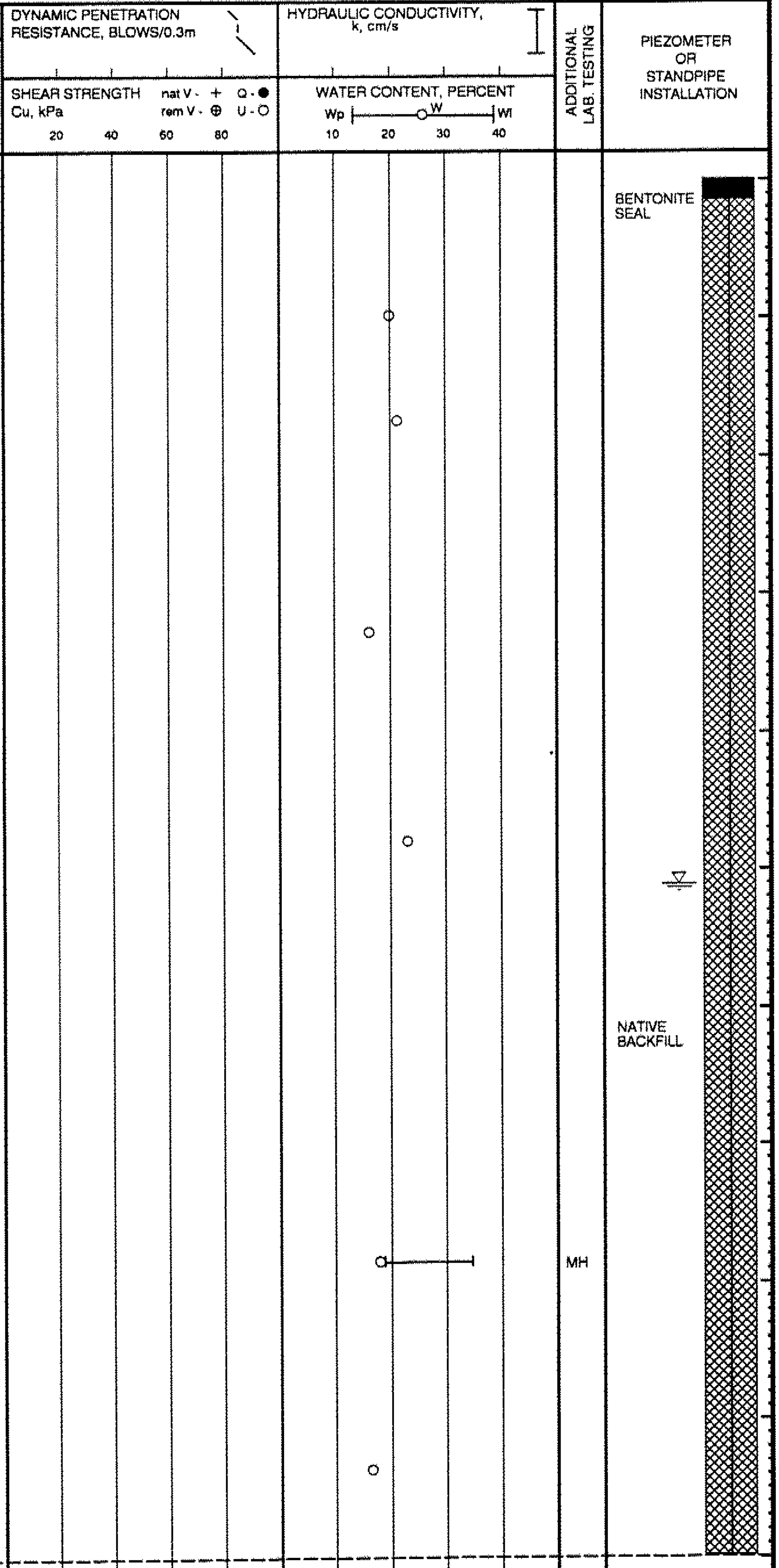
BORING DATE: FEB.12/98

SHEET 1 OF 3
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER; HOLLOW STEM AUGERS / TRI-CONE

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	80.50 0.00
Sandy Silt to Silty Sand, some rootlets and organics Loose to compact Dark brown to brown Wet to moist (Fill)	79.13 1.37
Silty Clay, some sand, trace gravel, trace oxidized stains, occ. sand seams Very stiff to hard Mottled grey and brown Moist	77.60 2.90
Silty fine Sand Very dense to dense Brown Dry to moist	76.08 4.42
Silty Clay, some sand, trace to some gravel Very stiff to hard Grey becoming reddish grey Moist (Glacial Till) Occasional cobbles inferred and shale fragments below 7.5m depth.	
CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	4
2	50 DO	12
3	50 DO	29
4	50 DO	67
5	50 DO	95
6	50 DO	47
7	50 DO	19
8	50 DO	16
9	50 DO	30
10	50 DO	33



DEPTH SCALE 1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

DATA INPUT: PS jan 25/99

SOILM6

N1108002.BHS

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789876; E 283553

RECORD OF BOREHOLE 2

BORING DATE: FEB.12/98

SHEET 2 OF 3
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER
HOLLOW STEM AUGERS / TRI-CONE

CONTINUED FROM PREVIOUS PAGE

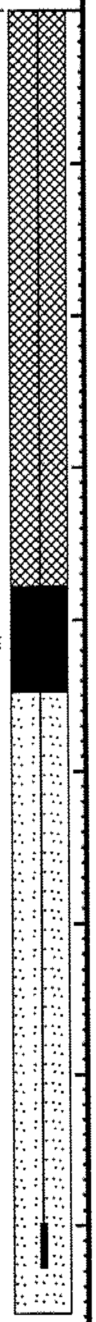
DEPTH SCALE METRES	DESCRIPTION	ELEV. DEPTH (m)
10	Silty Clay, some sand and gravel Very stiff to hard Grey becoming reddish grey Moist (Glacial Till)	69.50 11.00
11–20	Shale, some green grey siltstone interbeds Highly to slightly weathered Reddish brown (Bedrock)	
15	Limestone interbed inferred at about 15.2m depth.	

CONTINUED ON NEXT PAGE

SAMPLES NUMBER	TYPE	BLOWS/0.3m
11	50 DO	70
12	50 DO	50/.08
13	50 DO	50/.08
14	50 DO	50/.08
15	50 DO	50/.08
16	50 DO	95/.13
17	50 DO	100/.1

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s
WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 10 20 30 40
ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Water level in piezometer at Elev. 78.7m immediately after installation (likely influence by water used during drilling).

DATA INPUT: PS Jan.25/99

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108002.BHS

RECORD OF BOREHOLE 2

W.P.	N/A
DIST.	4; HWY: QEW
LOCATION:	N 4789876; E 283553
BORING DATE:	FEB.12/98
SHEET 3 OF 3	
DATUM:	GEODETIC
PROJECT:	981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m	HYDRAULIC CONDUCTIVITY, k, cm/s	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m	SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80	WATER CONTENT, PERCENT Wp ├──○W──┤ Wl 10 20 30 40		
		CONTINUED FROM PREVIOUS PAGE									
20	CME 55 BOMBARDIER HOLLOW STEM AUGERS / TRI-CONE	Shale Highly to slightly weathered Reddish brown (Bedrock)									Water level in piezometer at Elev. 75.4m on March 25/98 and Nov.10/98.
21				59.11 21.39	18	50 DO	100 /05				
		END OF BOREHOLE									
22											
23											
24											
25											
26											
27											
28											
29											
30											

DATA INPUT: PS Jan.25/99

DEPTH SCALE	LOGGED: GD
1 to 50	CHECKED: SP

Golder Associates

SOILM6

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789899; E 283640

RECORD OF BOREHOLE 3

BORING DATE: FEB.24/98

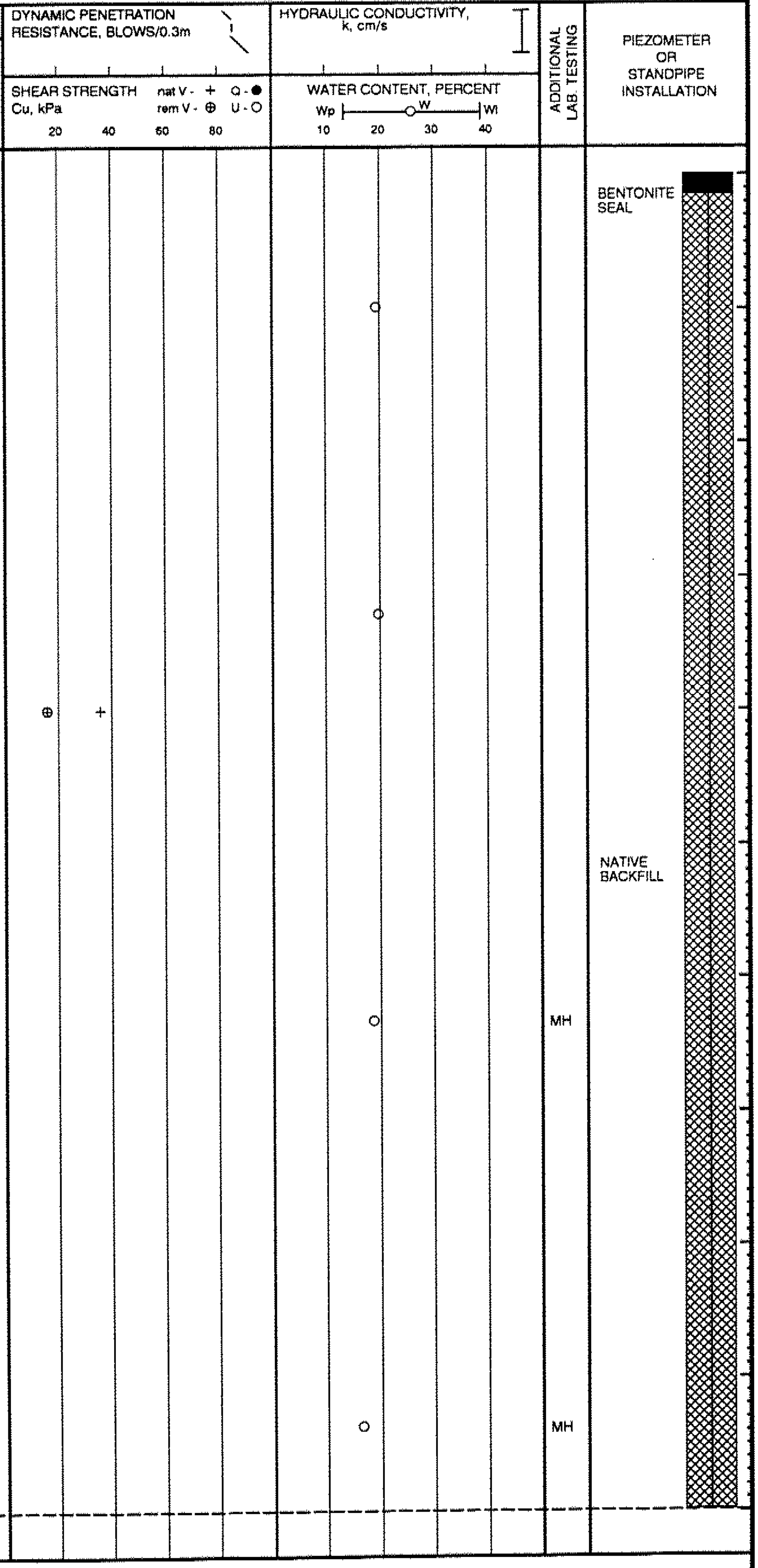
SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

N1108003.BHS

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	CME 55 BOMBARDIER HOLLOW STEM AUGERS	GROUND SURFACE	78.70					
		Topsoil	0.00	1	50 DO	14		BENTONITE SEAL
		Silty Clay, trace sand Stiff Mottled brown Moist	78.40 0.30	2	50 DO	13		
1		Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Firm Grey Moist	77.60 1.10	3	50 DO	7		
2				4	75 TO	PH		
3				5	50 DO	8		
5				6	75 TO	PH		NATIVE BACKFILL
6		Silty Clay, some sand, trace to some gravel Very stiff to hard Grey to reddish grey Moist (Glacial Till)	73.00 5.70	7	50 DO	18	MH	
8				8	50 DO	36		
9				9	50 DO	34	MH	
10		CONTINUED ON NEXT PAGE						



DATA INPUT: PS MAR 30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108003.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789899; E 283640

RECORD OF BOREHOLE 3

BORING DATE: FEB.24/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE					
10–11.90		Silty Clay, some sand, trace to some gravel Very stiff to hard Grey to reddish grey Moist (Glacial Till)	66.80 11.90	10	50 DO	24	
11.90–13.84		Shale Highly weathered Reddish brown (Bedrock)	64.86 13.84	11	50 DO	102 /13	
				12	50 DO	100 /.1	
14		END OF BOREHOLE Refusal to split spoon sampler advance					Borehole dry on completion of drilling. Piezometer dry on March 25/98.

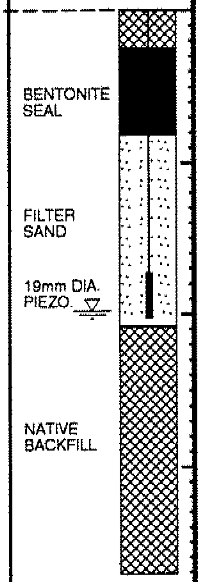
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp ⊢—O W—⊣ Wl — 10 20 30 40

ADDITIONAL LAB. TESTING



Depth scale: 10 11 12 13 14 15 16 17 18 19 20

DATA INPUT: PS MAR.30/98

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: GD

CHECKED: SP

SOILM6

RECORD OF BOREHOLE 4

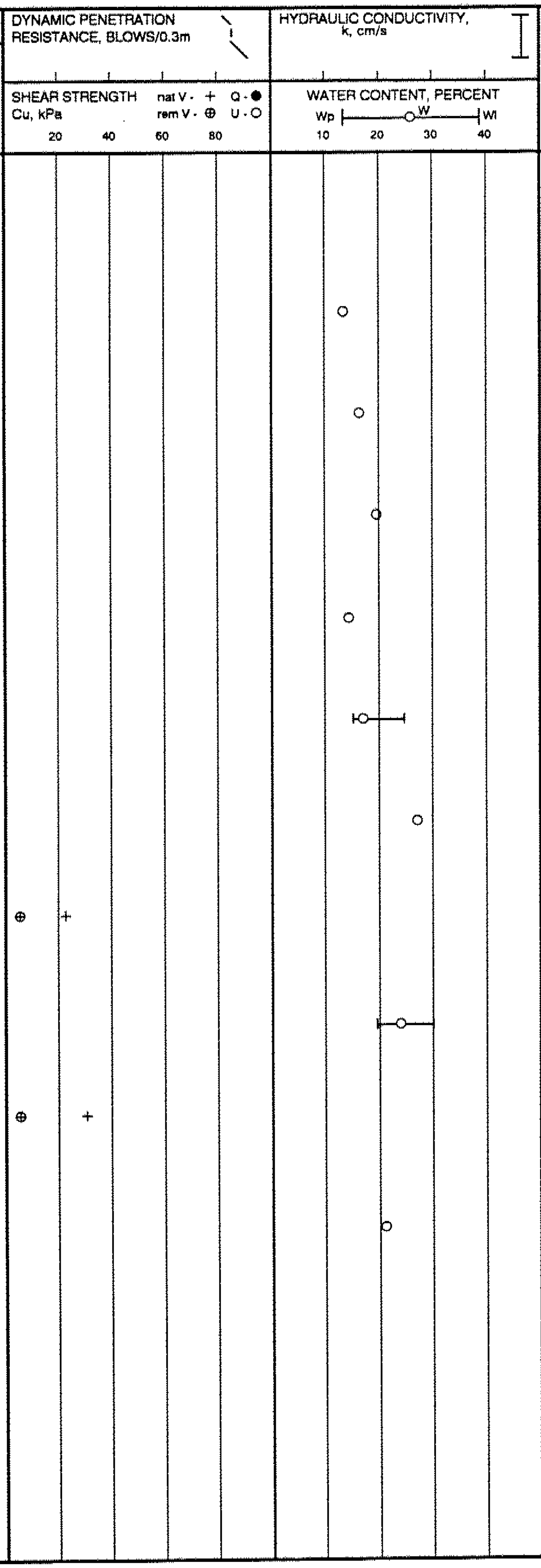
W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789865; E 283912

BORING DATE: FEB.11/98

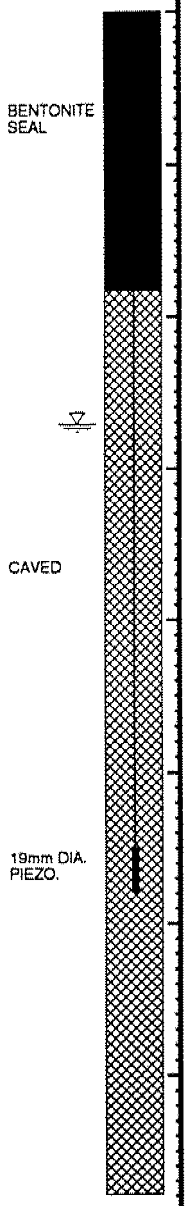
SHEET 1 OF 1
DATUM: GEODETIC
PROJECT: 981-1108

N1108004.BHS

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
		GROUND SURFACE	81.30				
0	CME 55 BOMBARDIER SOLID STEM AUGERS	Silty Sand, trace clay Very loose Brown Moist (Fill)	0.00	1	50 DO	3	
		Clayey Silt, trace gravel, trace rootlets and organics Very stiff Dark brown (Fill)	80.70 0.60	2	50 DO	24	
1		Silty Sand, some clay, trace gravel Compact Brown Wet	79.93 1.37	3	50 DO	15	
2		Silty Clay, trace sand Very stiff Brown becoming grey Moist	78.86 2.44	4	50 DO	27	
3				5	50 DO	29	
4				6	50 DO	17	MH
		Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Soft to firm Grey Moist to wet	76.88 4.42	7	50 DO	7	
5							
6				8	50 DO	8	MH
7		Silty Clay, trace sand and gravel Very stiff Grey Moist	74.00 7.30	9	50 DO	17	
8		END OF BOREHOLE	8.08				
9							
10							



PIEZOMETER OR STANDPIPE INSTALLATION



Water level in open borehole at Elev. 77.8m depth during drilling. Water level in piezometer at Elev. 78.6m on Oct.19/98.

DATA INPUT: PS JAN.25/99

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

N1108005.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789835; E 284004

RECORD OF BOREHOLE 5

BORING DATE: FEB.17&18/98

SHEET 1 OF 2

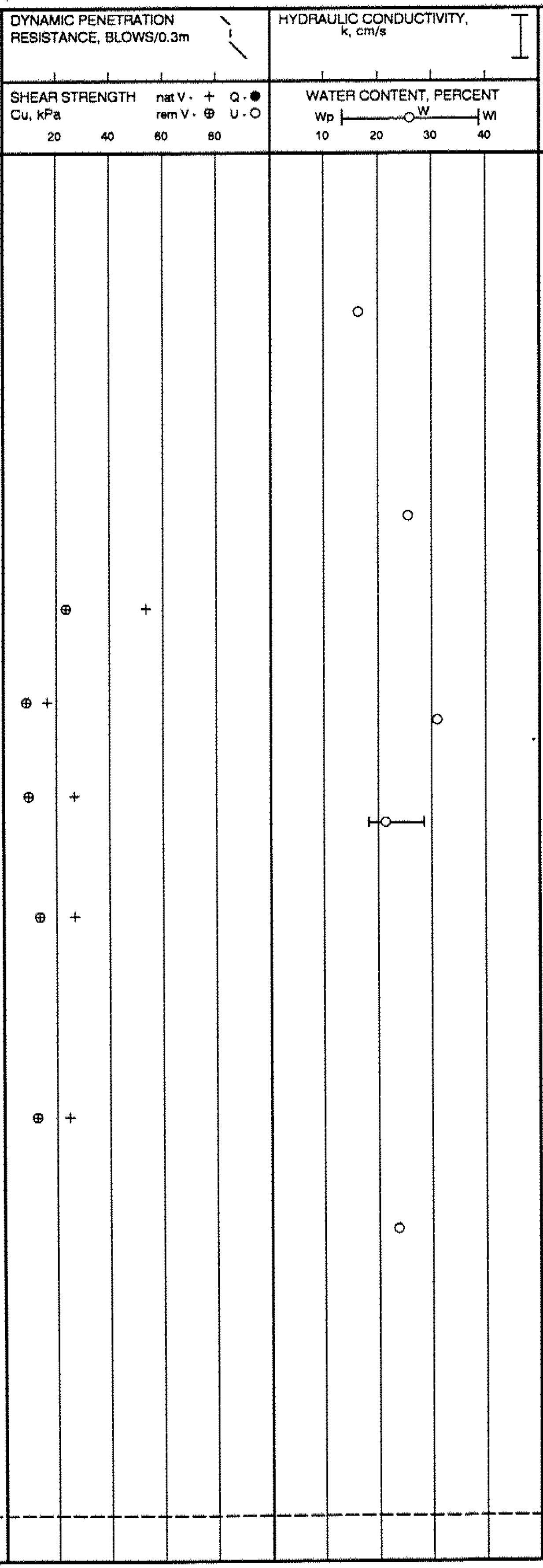
DATUM: GEODETIC

PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV.	DEPTH (m)
0	GROUND SURFACE	79.80	
0	Topsoil		0.00
	Sand, trace silt and gravel Compact Brown Moist (Fill)	79.50	0.30
1	Silty Clay, trace sand, occasional rootlets Hard Mottled brown Moist	78.65	1.15
2	Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Stiff becoming soft to firm below 3.5m depth Grey Moist	77.67	2.13
7	Silty Clay, trace sand and gravel Very stiff Grey Moist	72.70	7.10
10	CONTINUED ON NEXT PAGE		

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	23	
2	50 DO	23	
3	50 DO	36	
4	50 DO	10	
5	50 DO	5	
6	50 DO	4	
7	50 DO	0	MH
8	50 DO	0	
9	50 DO	16	
10	50 DO	21	



PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 3.7m depth on completion of drilling.

DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: GD

CHECKED: SP

N1108005.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789835; E 284004

RECORD OF BOREHOLE 5

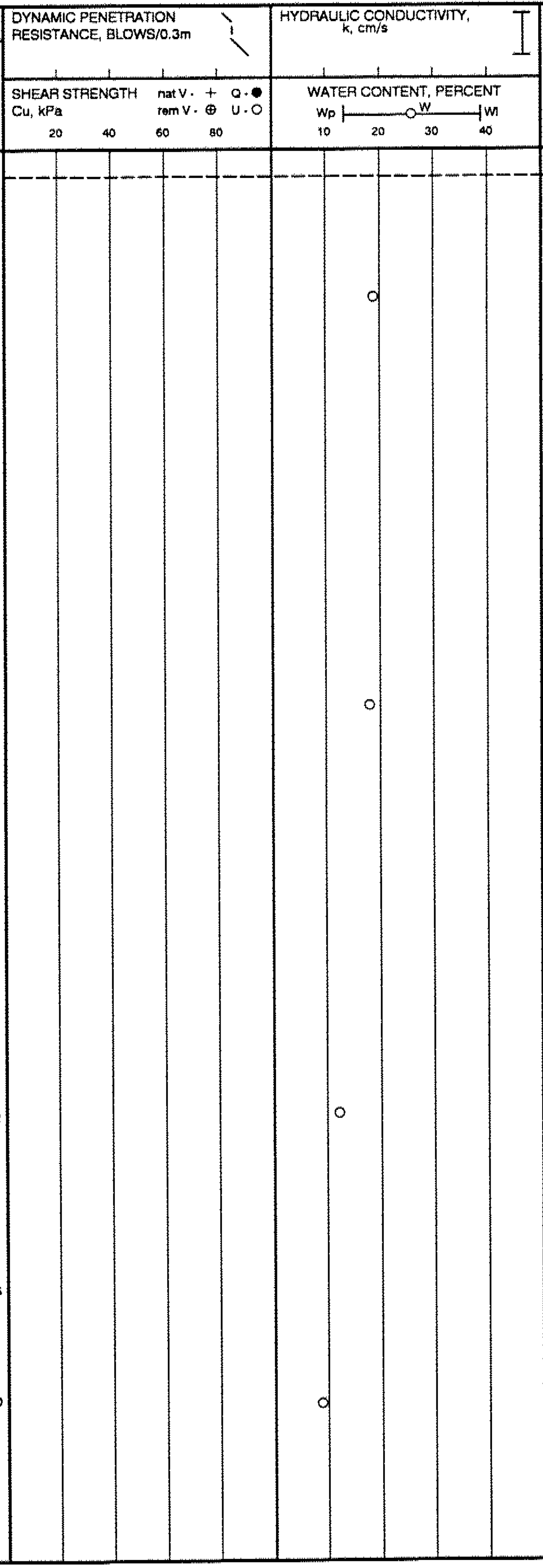
BORING DATE: FEB.17&18/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE						
11		Silty Clay, trace sand and gravel Very stiff Grey Moist		11	50 DO	23		
12				12	50 DO	28		
13			66.60 13.20					
14		Silty Clay, some sand, trace gravel Hard Grey becoming reddish grey Moist (Glacial Till)		13	50 DO	30	MH	
15				14	50 DO	59		
17				15	50 DO	102		
18			61.80 18.00					
18		Shale Highly weathered, occ. limestone interbeds Reddish brown Dry (Bedrock)		16	50 DO	125 /.1		
19			60.52 19.28	17	50 DO	100 /08		
20		END OF BOREHOLE Refusal to split spoon sampler advance						



DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: GD

CHECKED: SP

RECORD OF BOREHOLE 6

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789811; E 284032

BORING DATE: FEB.18&19/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
GROUND SURFACE	80.30			
Topsoil	0.00			
Silty Sand, trace clay Dense to compact Brown Moist to wet	0.15	1	50 DO	2
		2	50 DO	50
		3	50 DO	28
Silty Clay, trace sand Hard Grey Moist	78.17 2.13	4	50 DO	44
Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Soft to firm Grey Moist	77.40 2.90	5	75 TO	PH
		6	75 TO	PH
		7	50 DO	5
		8	75 TO	PH
Silty Clay, trace sand and gravel Stiff Grey Moist	71.70 8.60	9	50 DO	10

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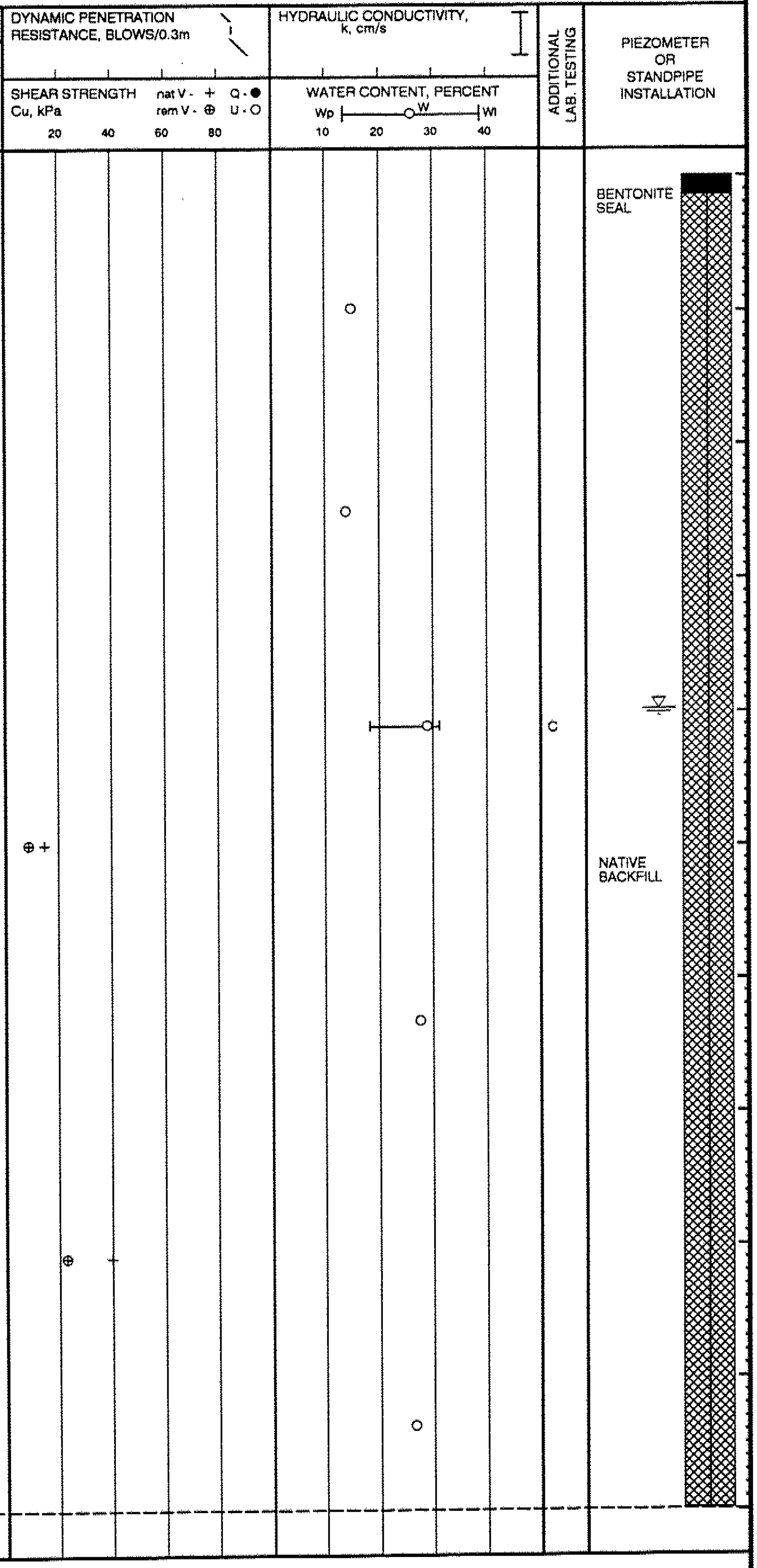


DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

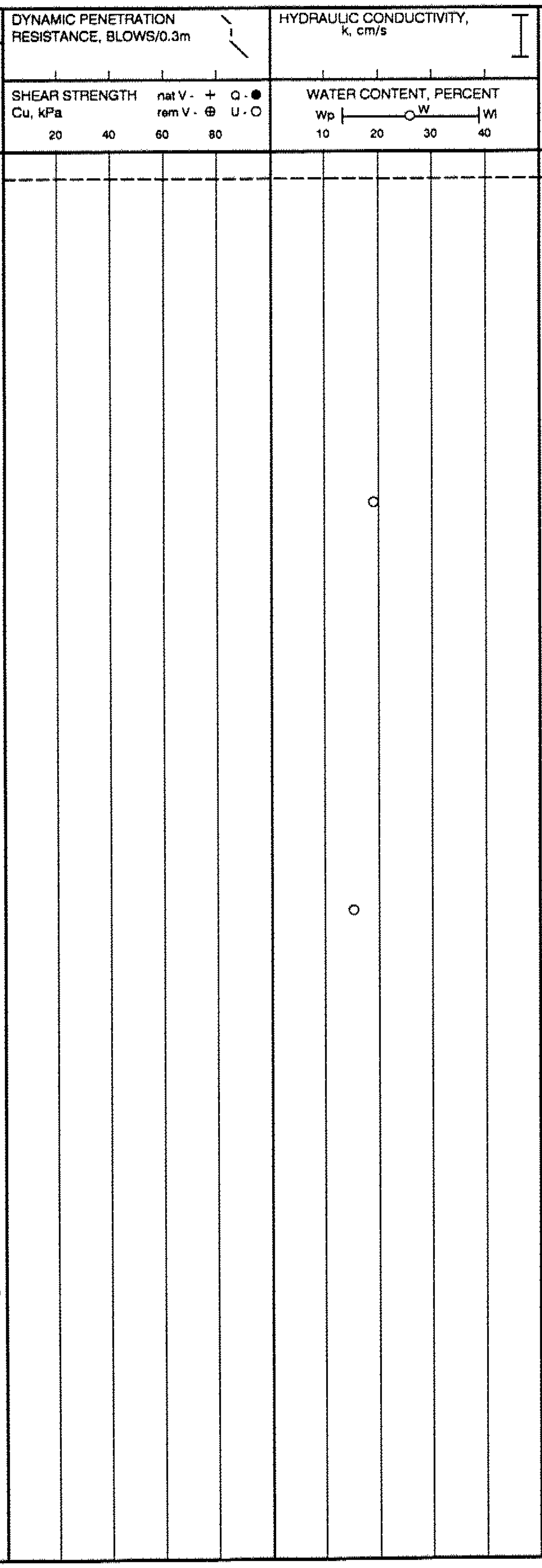
W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789811; E 284032

RECORD OF BOREHOLE 6

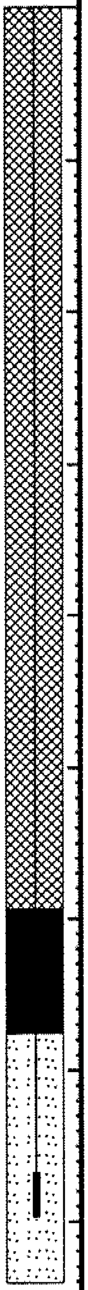
BORING DATE: FEB.18&19/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE					
		Silty Clay, trace sand and gravel, occasional shale fragments Hard Grey becoming reddish grey below 16m depth Moist (Glacial Till)	70.20 10.10				
11				10	50 DO	35	
12				11	50 DO	33	NATIVE BACKFILL
14				12	50 DO	34	
15				13	50 DO	74	
16							BENTONITE SEAL
17				14	50 DO	65	FILTER SAND
18		Shale Highly weathered Reddish brown Dry (Bedrock)	62.30 18.00				19mm DIA. PIEZO.
			61.88	15	50 DO	129 /.1	
		END OF BOREHOLE Refusal to split spoon sampler advance	18.42				Borehole dry on completion of drilling. Water level in piezometer at Elev. 76.3m on March 25/98.



ADDITIONAL LAB. TESTING



DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

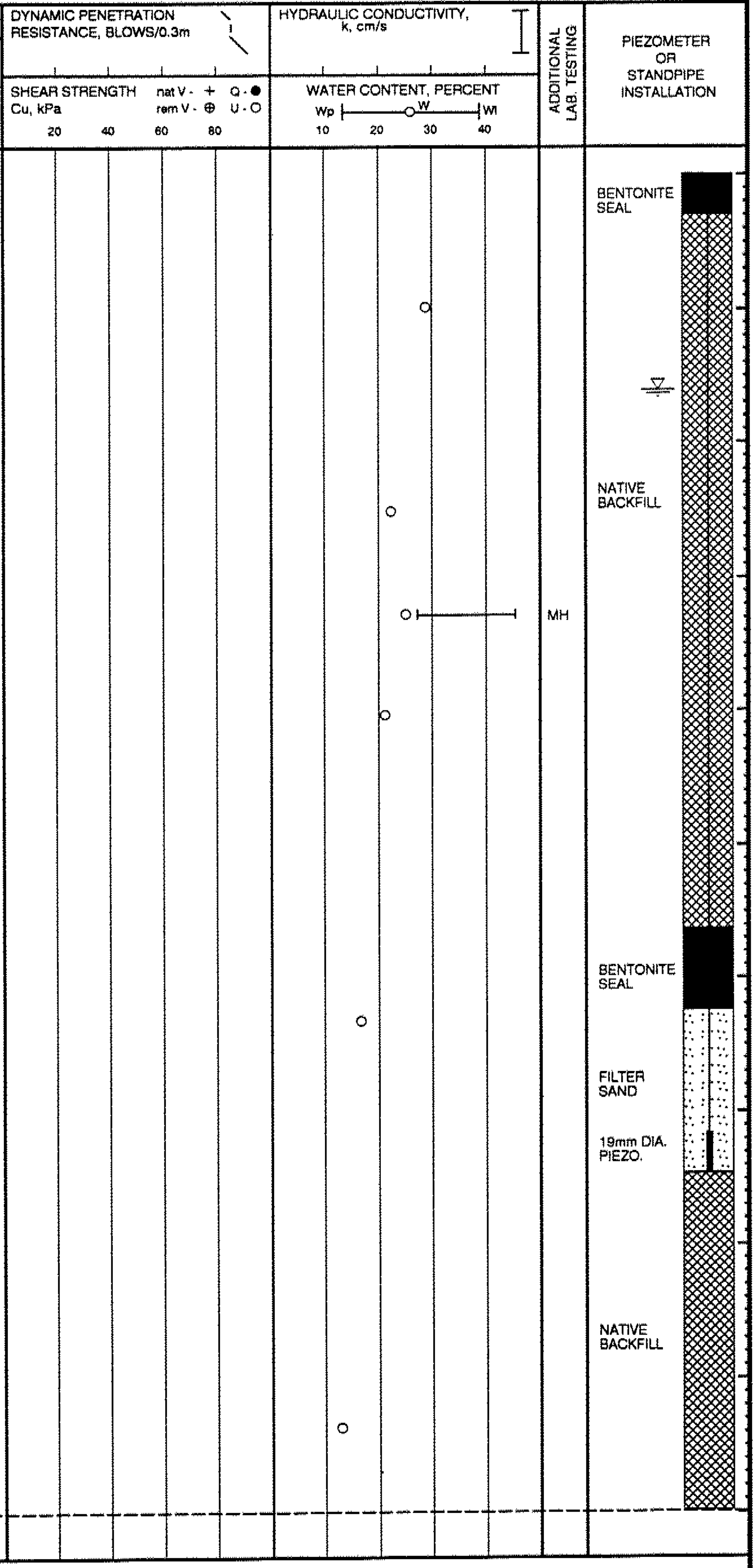
RECORD OF BOREHOLE 7

W.P. N/A		SHEET 1 OF 2
DIST. 4; HWY: QEW	BORING DATE: FEB.20/98	DATUM: GEODETIC
LOCATION: N 4789713; E 284126		PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	78.00
Topsoil	0.00
Clayey Silt, trace sand, some gravel Firm to stiff Brown Moist (Fill)	77.70 0.30
Silty Clay, trace sand and gravel Very stiff to hard Mottled grey and brown to brown Moist	76.63 1.37
Silty Clay, some sand, trace gravel; occasional shale fragments below 10m depth. Very stiff Grey Moist (Glacial Till)	72.40 5.60

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	8
2	50 DO	8
3	50 DO	17
4	50 DO	31
5	50 DO	22
6	50 DO	30
7	50 DO	36
8	50 DO	28
9	50 DO	26
10	50 DO	24



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DEPTH SCALE 1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

DATA INPUT: PS JAN.25/99

RECORD OF BOREHOLE 7

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789713; E 284126

BORING DATE: FEB.20/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		CONTINUED FROM PREVIOUS PAGE					
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey becoming reddish grey Moist (Glacial Till)					NATIVE BACKFILL
10.7				11	50 DO	65/ .23	
12.4				12	50 DO	93	
13.9		Weathered Shale at 13.9m depth.	64.05 13.95	12	50 DO	50/ .08	
14		END OF BOREHOLE Refusal to split spoon sampler advance					Borehole dry on completion of drilling. Water level in piezometer at Elev. 74.4m on March 25/98 and at Elev. 76.4m on Nov.10/98.

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, kPa: nat V - + Q - ● rem V - ⊕ U - ○ (20, 40, 60, 80)

WATER CONTENT, PERCENT: Wp ├──○W──┤ Wl (10, 20, 30, 40); sample 12 at 12.4 m: ○ at about 11

ADDITIONAL LAB. TESTING

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

DATA INPUT: PS JAN.25/99

N1108008.BHS

RECORD OF BOREHOLE 8

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789682; E 284160

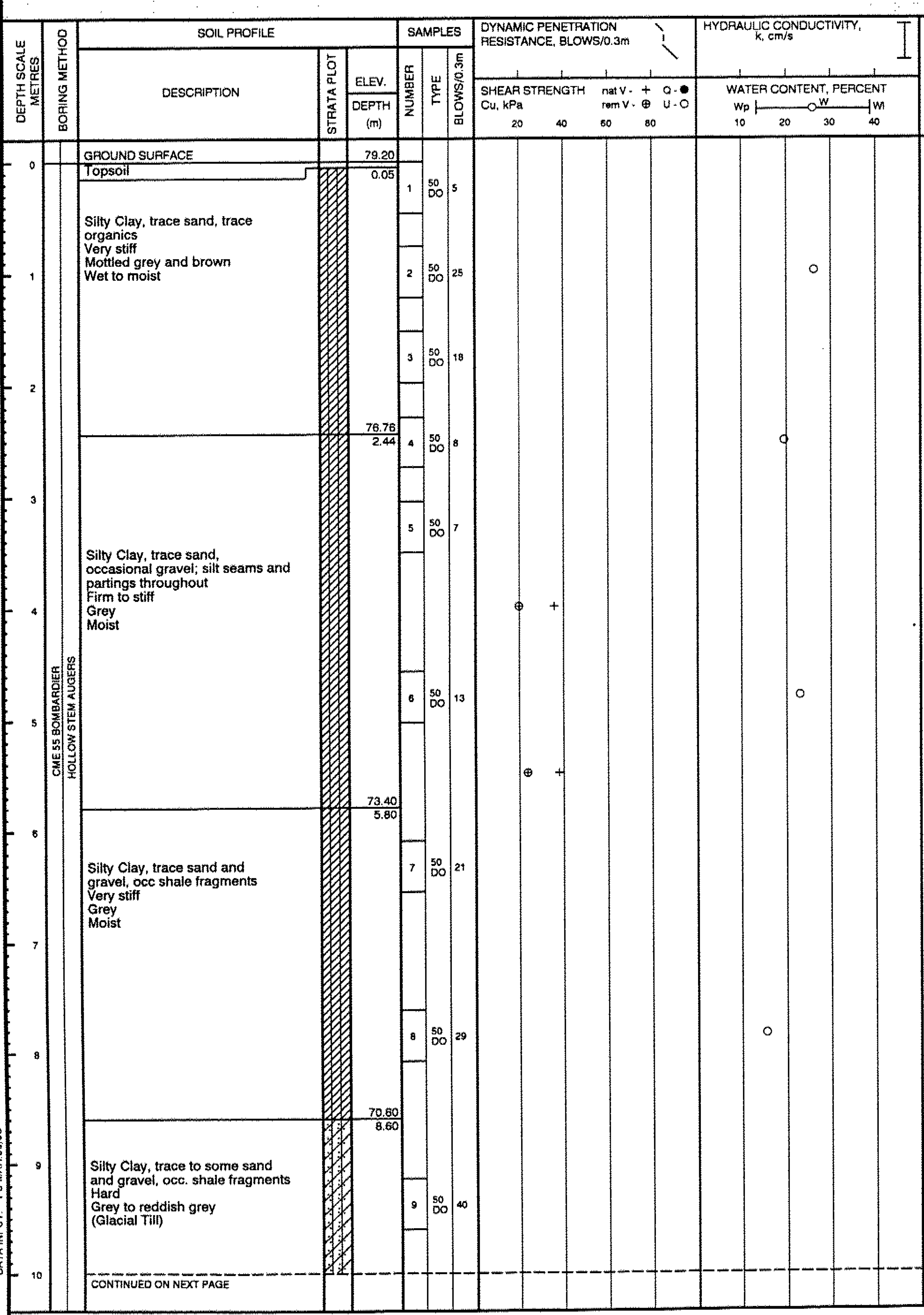
BORING DATE: FEB.23/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
GROUND SURFACE	79.20
Topsoil	0.05
Silty Clay, trace sand, trace organics Very stiff Mottled grey and brown Wet to moist	76.76 2.44
Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Firm to stiff Grey Moist	73.40 5.80
Silty Clay, trace sand and gravel, occ shale fragments Very stiff Grey Moist	70.60 8.60
Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)	
CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	5
2	50 DO	25
3	50 DO	18
4	50 DO	8
5	50 DO	7
6	50 DO	13
7	50 DO	21
8	50 DO	29
9	50 DO	40



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DATA INPUT: PS MAR.30/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

N1108008.BHS

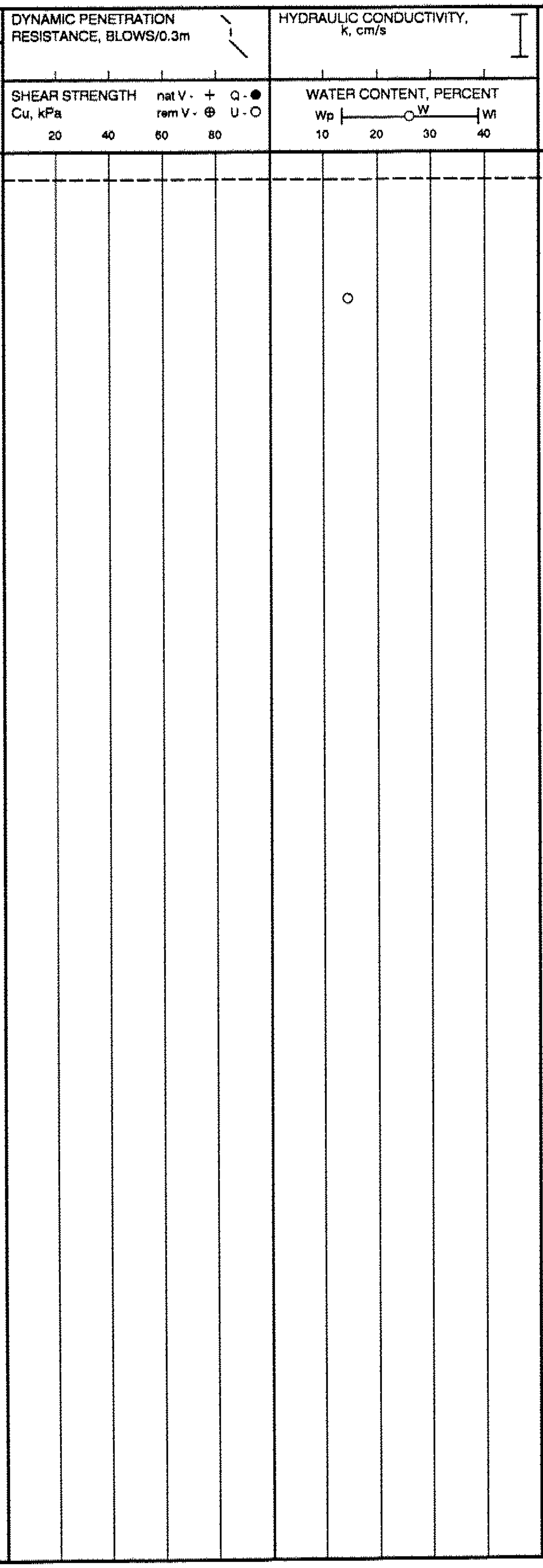
W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789682; E 284160

RECORD OF BOREHOLE 8

BORING DATE: FEB.23/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE						
11		Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)		10	50 DO	61		
12				11	50 DO	100 /08		
13			66.20 13.00					
14		Shale Highly weathered, occ. limestone interbeds Reddish brown Dry (Bedrock)		12	50 DO	127 /15		
15			63.96 15.24					Borehole dry on completion of drilling.
		END OF BOREHOLE Refusal to auger advance						
16								
17								
18								
19								
20								



DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1105009.BHS

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789696; E 283711

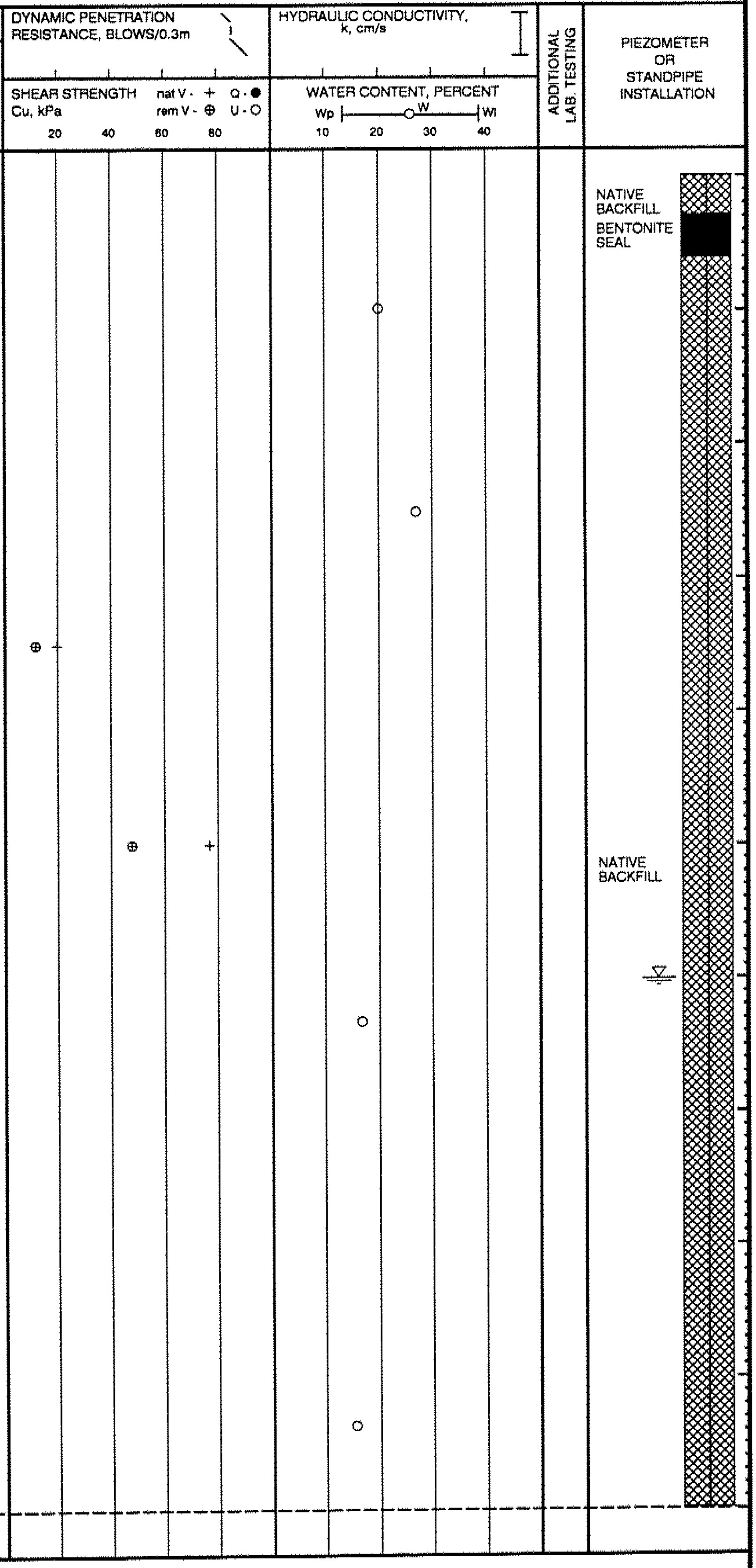
RECORD OF BOREHOLE 9

BORING DATE: FEB.25/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER, HOLLOW STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m
	GROUND SURFACE	79.60			
0	Silty sand becoming clayey silt Compact becoming stiff Brown (FILL)	0.00	1	50 DO	15
		79.00 0.60			
1	Silty Clay, trace sand and gravel, some oxidized staining Very stiff to stiff Grey brown to grey Moist		2	50 DO	26
			3	50 DO	14
2		77.50 2.10			
	Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Firm to stiff Grey Moist		4	50 DO	5
3					
4			5	50 DO	10
5		74.00 5.60			
6	Silty Clay, trace sand and gravel Hard Grey Moist		6	50 DO	32
7		72.60 7.00			
8	Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)		7	50 DO	32
9			8	50 DO	31
10	CONTINUED ON NEXT PAGE				



DATA INPUT: PS JAN 25/99

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108009.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789696; E 283711

RECORD OF BOREHOLE 9

BORING DATE: FEB.25/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

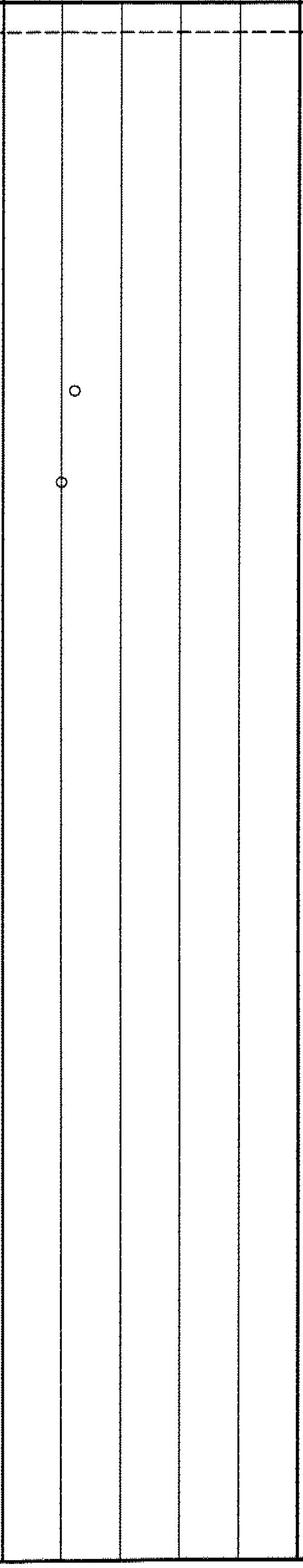
DEPTH SCALE METRES	BORING METHOD	DESCRIPTION	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.3m
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE				
11		Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)		9	50 DO	36
12				10	50 DO	45
13				11	50 DO	62
14		Shale Highly weathered Reddish brown (Bedrock)	65.40 14.20	12	50 DO	128
		END OF BOREHOLE	14.33			
15						
16						
17						
18						
19						
20						

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○ 20 40 60 80

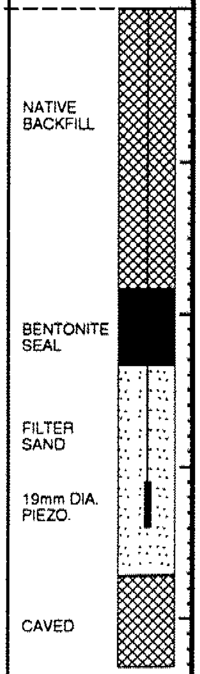
HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT Wp W Wl 10 20 30 40



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



Borehole dry on completion of drilling.
Water level in piezometer at Elev. 67.8m on March 25/98 and at Elev. 73.6m on Nov.10/98.

DATA INPUT: PS JAN 25/99

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

January 1999

981-8033

RECORDS OF BOREHOLES
BURLINGTON STREET INTERCHANGE
(PREVIOUS INVESTIGATION)

Golder Associates

N1108BH1.BHS

W.P.

DIST. 4; HWY. QEW

LOCATION: N 4791122.69; E 282867.57

RECORD OF BOREHOLE 1

BORING DATE: JUNE 25/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

SOIL PROFILE

DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	76.10 0.00
Clayey Silt, some sand, trace gravel, trace organics, rubber fragments Stiff Brown and black Moist (FILL)	74.73 1.37
Silty Clay, trace sand, trace to some gravel, some silt seams and partings Very stiff to hard Mottled grey and brown becoming brown Moist (Glacial Till - weathered crust)	70.90 5.20
Silty Clay, trace to some sand and gravel, trace shale fragments below 12m depth Very stiff becoming hard below 10m depth Grey becoming reddish grey Moist (Glacial Till)	
CONTINUED ON NEXT PAGE	

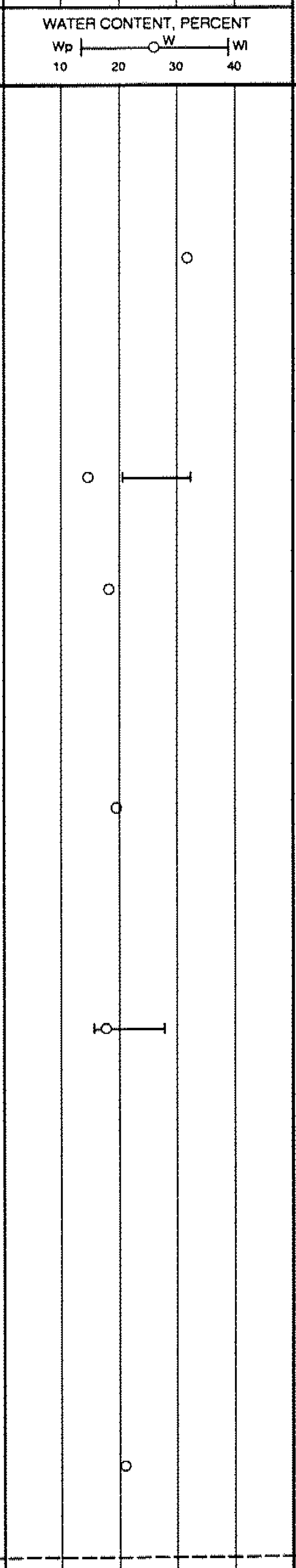
SAMPLES

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 OD	12	
2	50 OD	15	
3	50 OD	69	MH
4	50 OD	55	
5	50 OD	44	
6	50 OD	48	
7	50 OD	23	
8	50 OD	24	MH
9	50 OD	24	
10	50 OD	25	

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa nat V - + Q - ● rem V - ⊕ U - ○

HYDRAULIC CONDUCTIVITY, k, cm/s



PIEZOMETER OR STANDPIPE INSTALLATION

NATIVE BACKFILL

DATA INPUT: PS JAN 25/99

SOILM6

DEPTH SCALE 1 to 50

Golder Associates

LOGGED: DB

CHECKED: SP

N1108BH1.BHS

RECORD OF BOREHOLE 1

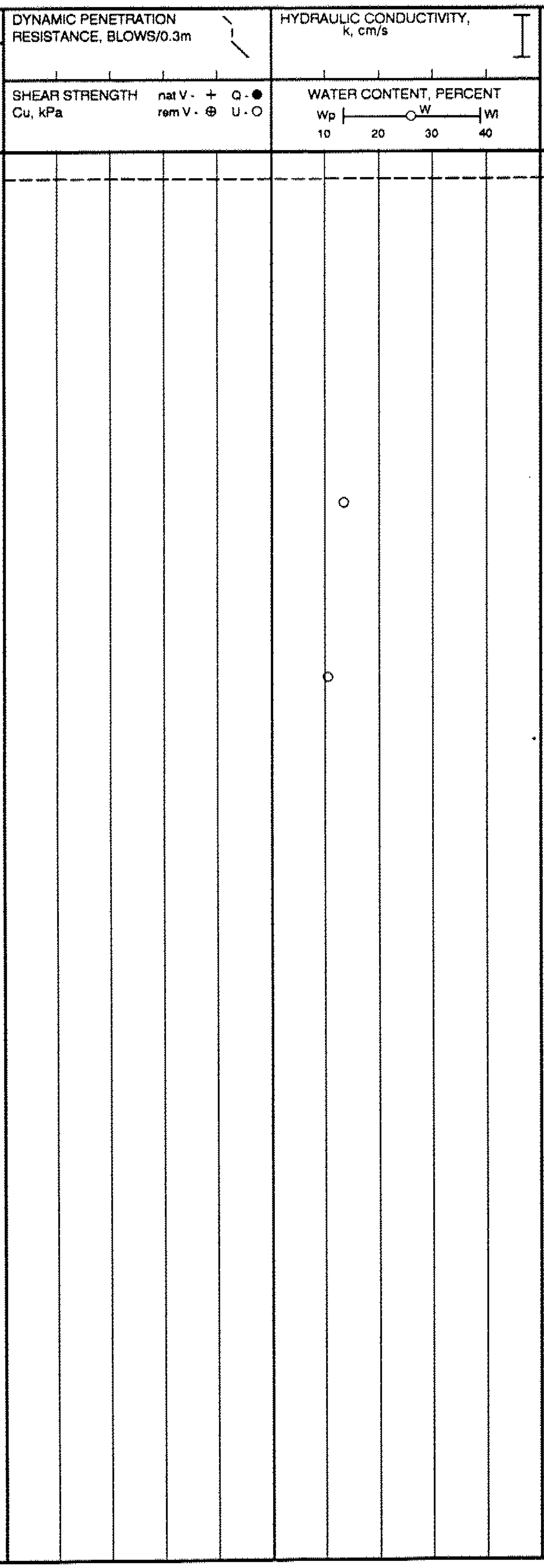
W.P.
DIST. 4; HWY. QEW
LOCATION: N 4791122.69; E 282867.57

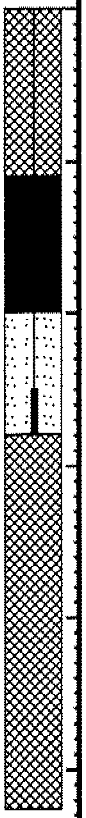
BORING DATE: JUNE 25/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CONTINUED FROM PREVIOUS PAGE						
	Silty Clay, trace to some sand and gravel, trace shale fragments below 12m depth Very stiff becoming hard below 10m depth Grey becoming reddish grey Moist (Glacial Till)		11	50 OD	30		NATIVE BACKFILL
11							BENTONITE SEAL
12			12	50 OD	112		SAND FILTER
13		62.69 13.41					
	Sandy Silt, some gravel, trace clay, trace shale fragments Very dense Reddish brown Moist (Glacial Till)	62.26 13.84	13	50 OD	182	MH	NATIVE BACKFILL
14	Shale, occ. siltstone interbeds Highly weathered Reddish brown Dry (Bedrock)						
15		60.83 15.27		50 OD	145 /28		
	END OF BOREHOLE						
16							
17							
18							
19							
20							





Water level in piezometer at Elev. 72.6m on July 15/98 and at Elev. 74.8m on Nov.10/98.

DATA INPUT: PS JAN.25/99

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: DB
CHECKED: SP

SOILM6

RECORD OF BOREHOLE 2

W.P.
DIST. 4; HWY. QEW
LOCATION: N 4791062.07; E 283044.75

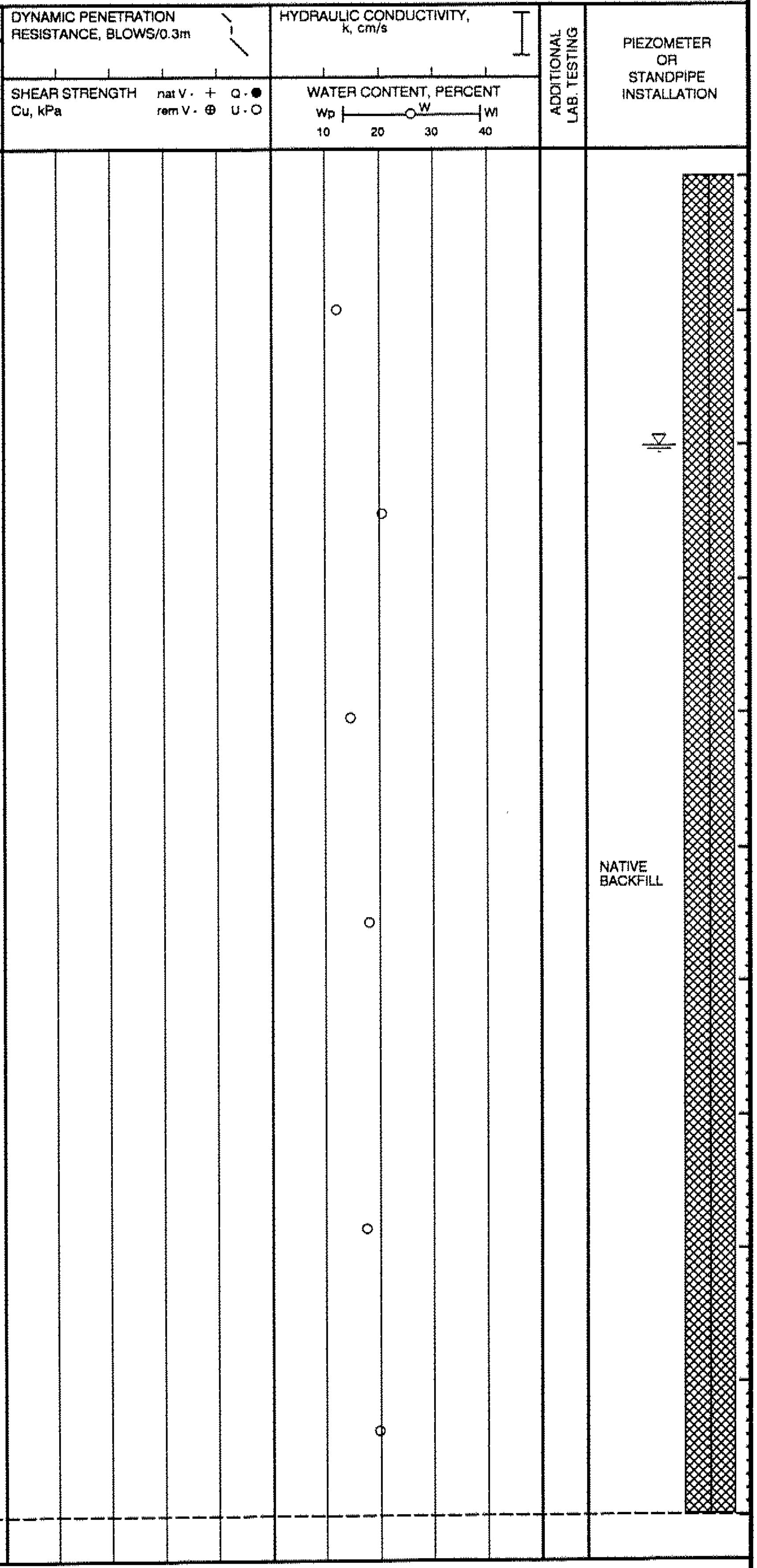
BORING DATE: JUNE 26/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER SOLID STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)
0	GROUND SURFACE	76.30 0.00
0–2.13	Clayey Silt, trace to some sand and gravel, trace shale fragments Very stiff to stiff Brown and grey Dry (Fill)	74.17 2.13
2.13–2.90	Silty Clay, trace to some sand and gravel Stiff Brown and grey Moist (Fill)	73.40 2.90
2.90–6.00	Silty Clay, trace sand and gravel, some silt seams and partings Hard Mottled grey and brown becoming brown Moist (Glacial Till - weathered crust)	70.30 6.00
6.00–10	Silty Clay, trace to some sand and gravel Very stiff becoming hard below 10m depth Grey becoming reddish grey Moist (Glacial Till)	
10	CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 OD	22
2	50 OD	9
3	50 OD	9
4	50 OD	69
5	50 OD	50
6	50 OD	43
7	50 OD	32
8	50 OD	29
9	50 OD	24
10	TO	PH
11	50 OD	22



DATA INPUT: PS JAN.25/99

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: DB
CHECKED: SP

N1108BH2.BHS

W.P.

DIST. 4; HWY. QEW

LOCATION: N 4791062.07; E 283044.75

RECORD OF BOREHOLE 2

BORING DATE: JUNE 26/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

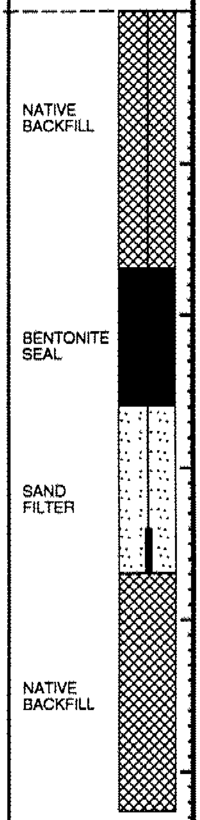
DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	WATER CONTENT, PERCENT (Wp ○W Wl; 10 20 30 40)	ADDITIONAL LAB. TESTING
10	CME 55 BOMBARDIER SOLID STEM AUGERS	CONTINUED FROM PREVIOUS PAGE						
11		Silty Clay, trace to some sand and gravel Very stiff becoming hard below 10m depth Grey becoming reddish grey Moist (Glacial Till)		12	50 OD	42		
12–14		Sandy Silt, trace clay, trace gravel, trace shale fragments Very dense Reddish brown Moist (Glacial Till)	64.57 11.73	13	50 OD	150 /15	○	
				14	50 OD	150 /08		
15		Shale Highly weathered Reddish brown Dry (Bedrock)	61.82 14.48	15	50 OD	110 /03		
		END OF BOREHOLE	61.03 15.27					

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

HYDRAULIC CONDUCTIVITY, k, cm/s

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○

PIEZOMETER OR STANDPIPE INSTALLATION



Water level in piezometer at Elev. 74.9m on July 15/98 and at Elev. 74.3m on Nov.10/98.

16

17

18

19

20

DATA INPUT: PS JAN 25/99

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

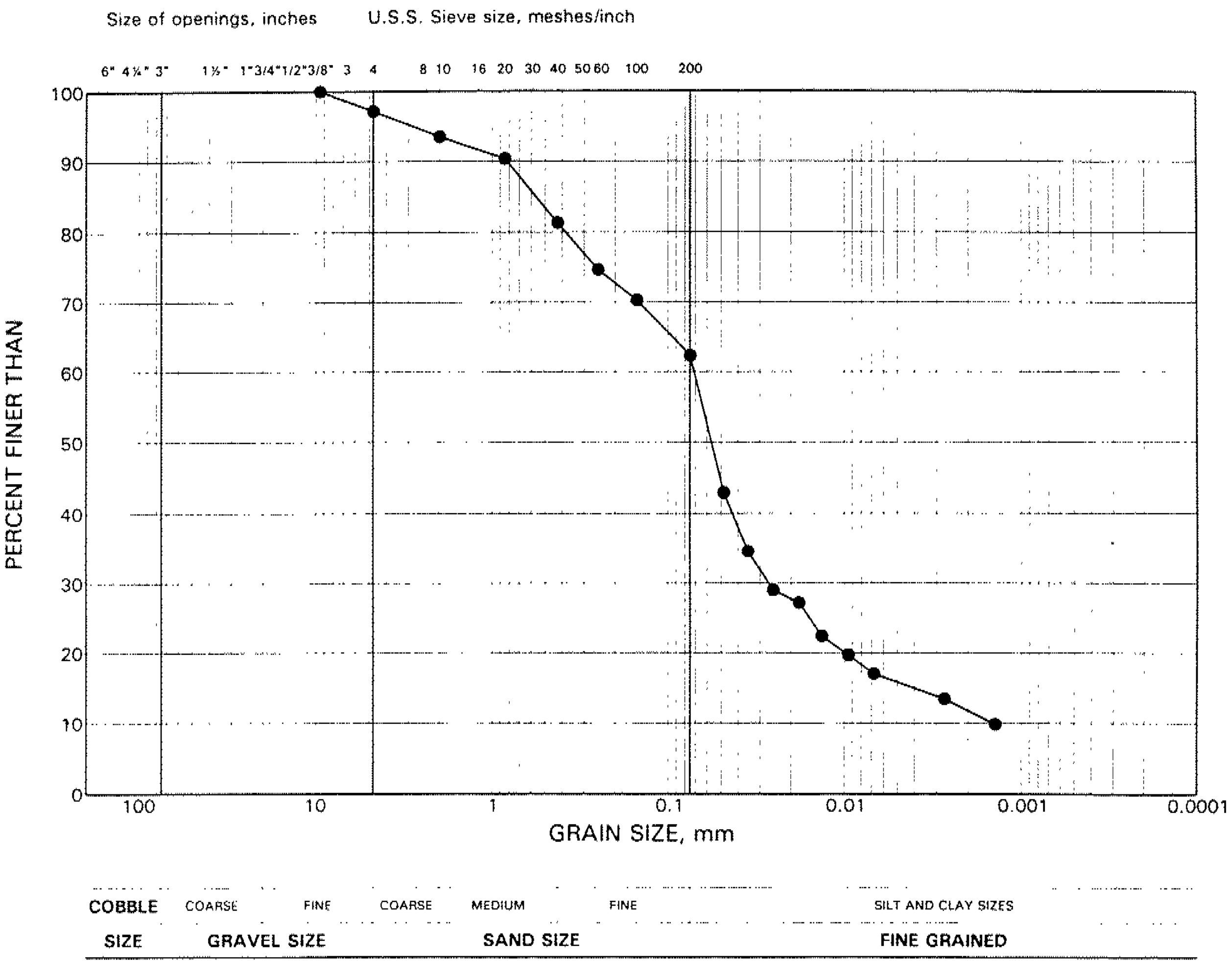
LOGGED: DB

CHECKED: SP

OVERSIZE DRAWING(S)

GRAIN SIZE DISTRIBUTION
SILTY SAND with CLAYEY SILT interlayers

FIGURE 1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RSER-1	2	81.5

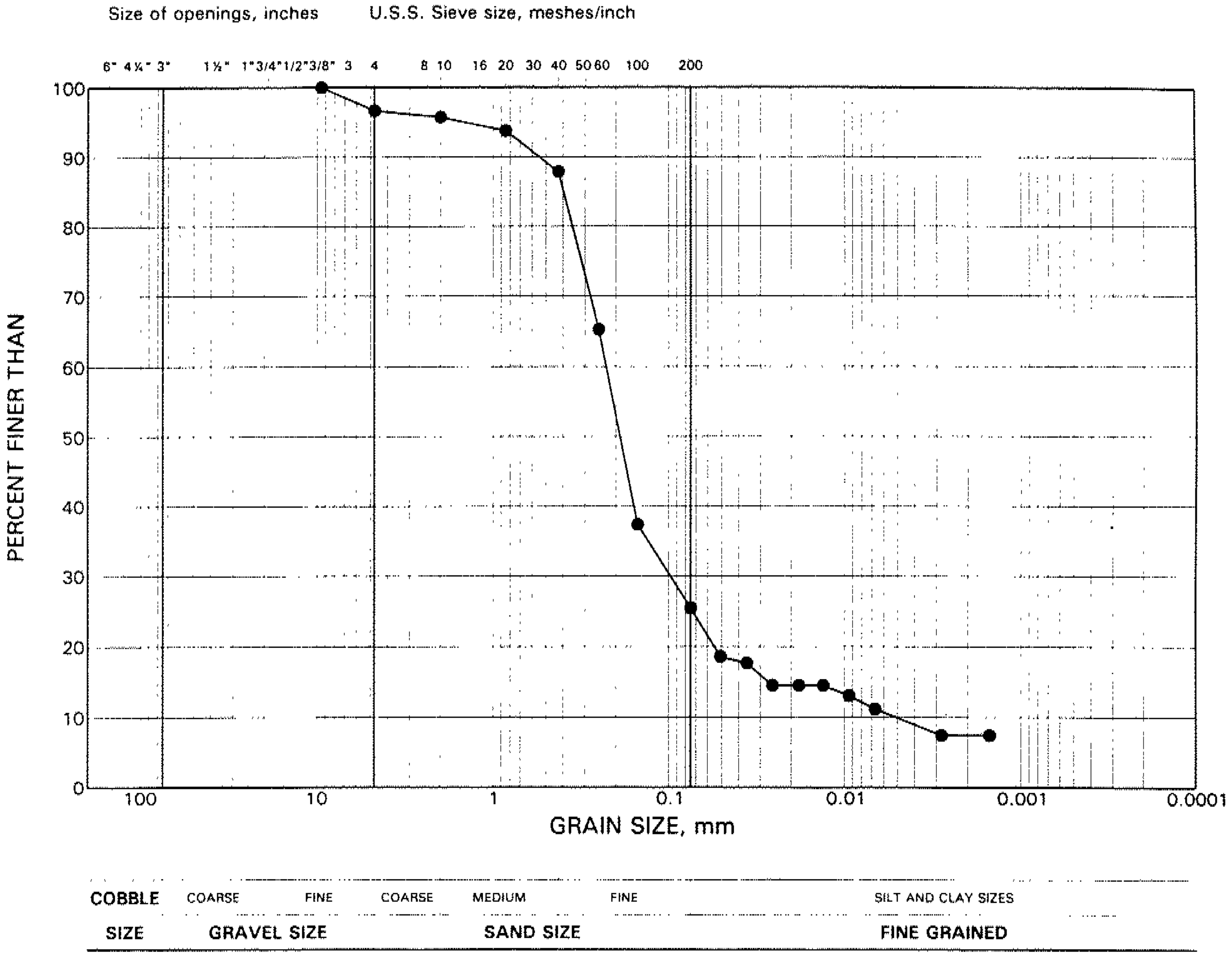
Project 981-8033

Golder Associates

GRAIN SIZE DISTRIBUTION

SAND, some silt, trace clay

FIGURE 2



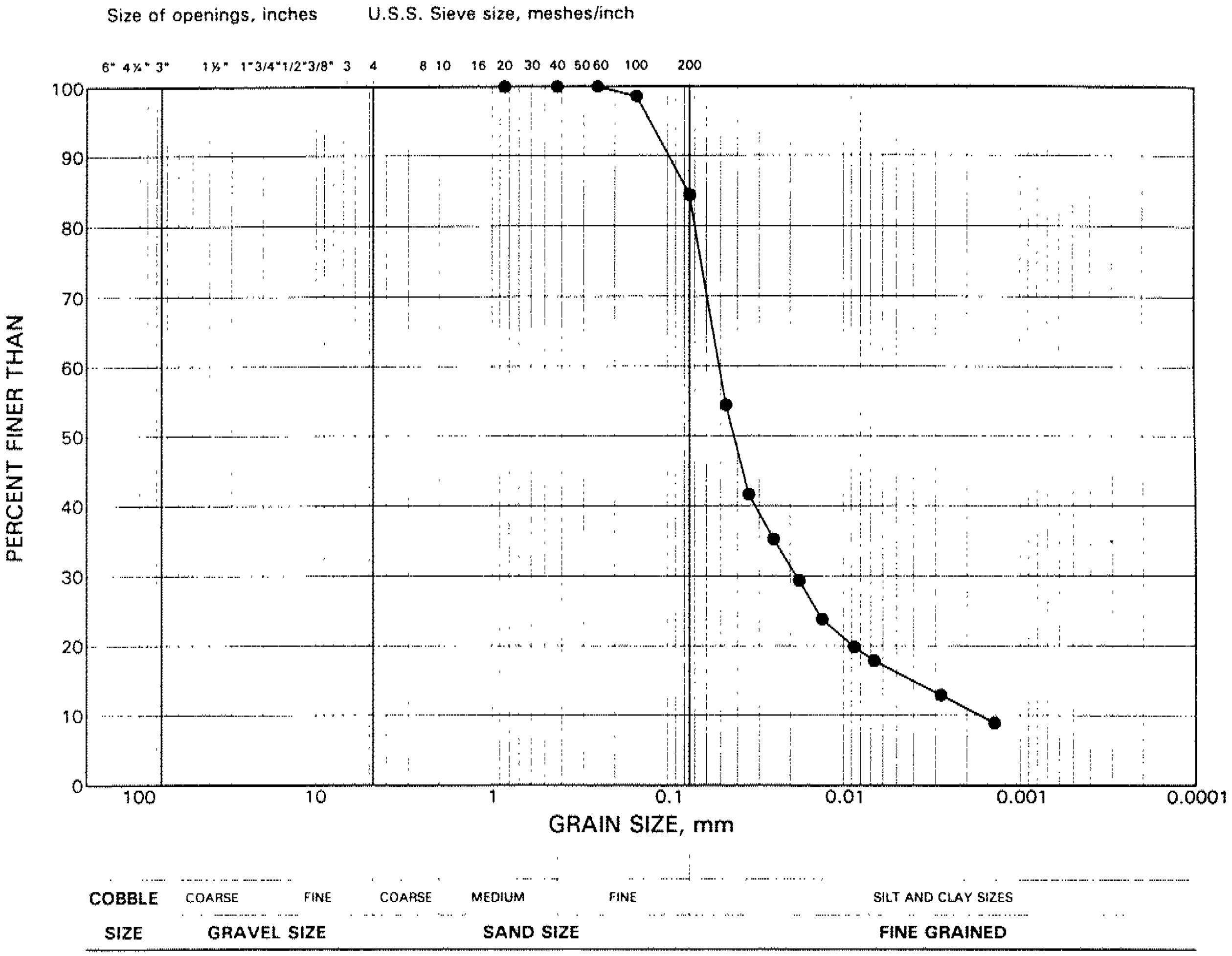
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RESR-4	3	78.1

GRAIN SIZE DISTRIBUTION

SILT, some sand and clay

FIGURE 3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RESR-7	2	78.5

Project 981-8033

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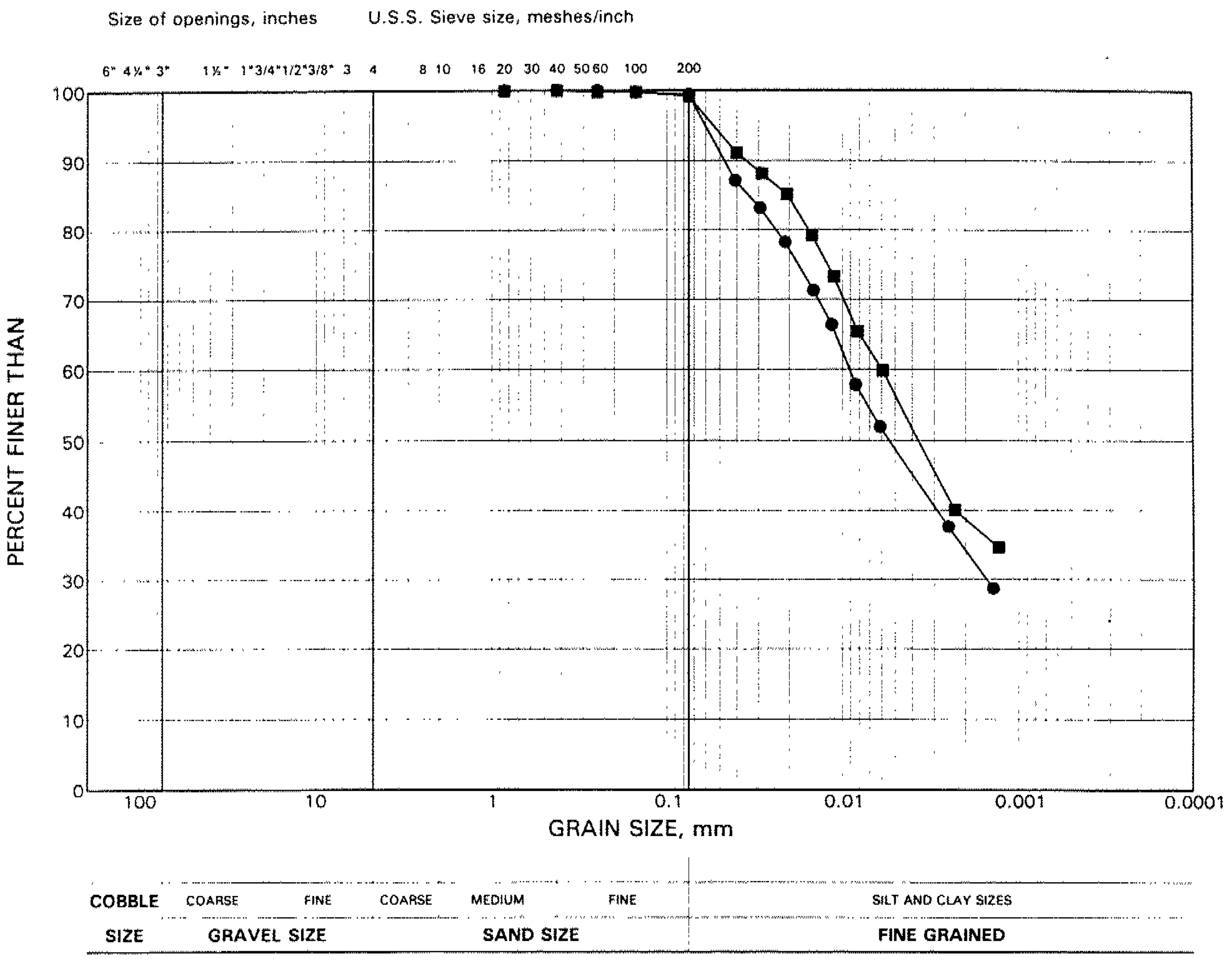
GRAIN SIZE DISTRIBUTION
SILTY CLAY, trace sand (Crust)

FIGURE 4

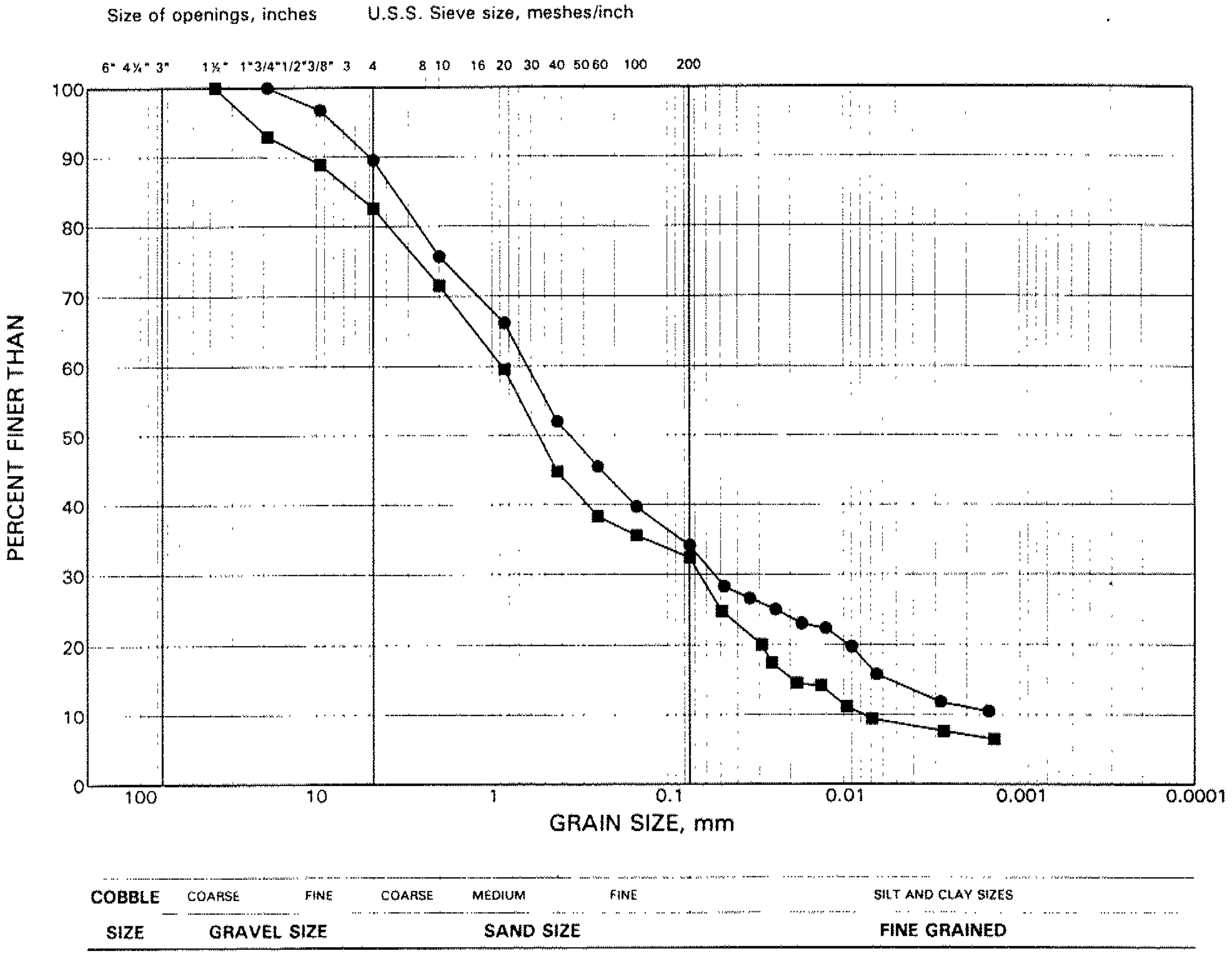


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RESR-7	3	77.8
■	RESR-9	5	77.6

GRAIN SIZE DISTRIBUTION
CLAYEY SILT and SAND, trace to some gravel

FIGURE 5

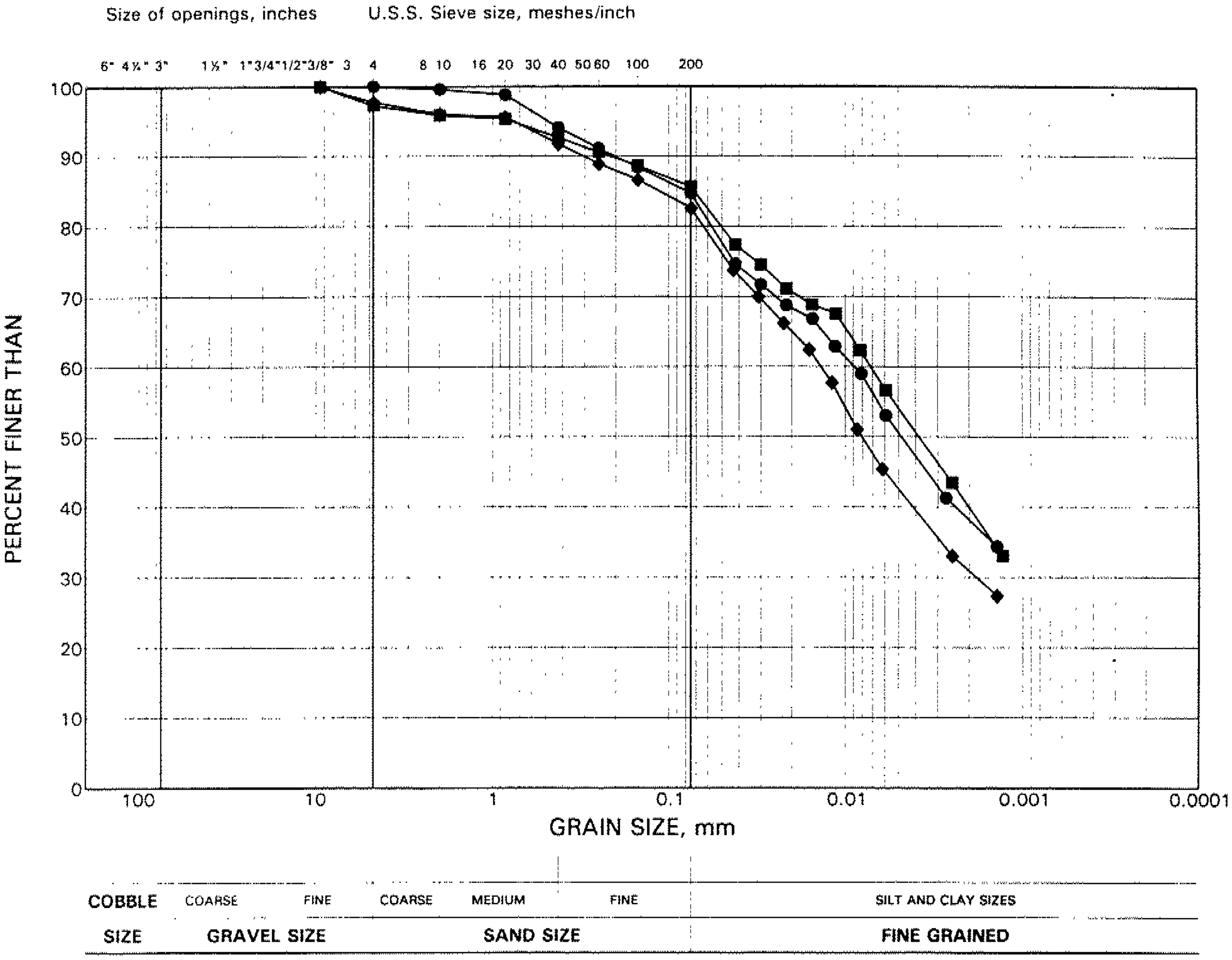


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RESR-4	4	77.3
■	RSER-1	4	78.2

GRAIN SIZE DISTRIBUTION
SILTY CLAY, some sand, trace gravel

FIGURE 6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RESR-4	9	72.6
■	RESR-6	9	73.2
◆	RESR-26	3	79.4

Project 981-8033

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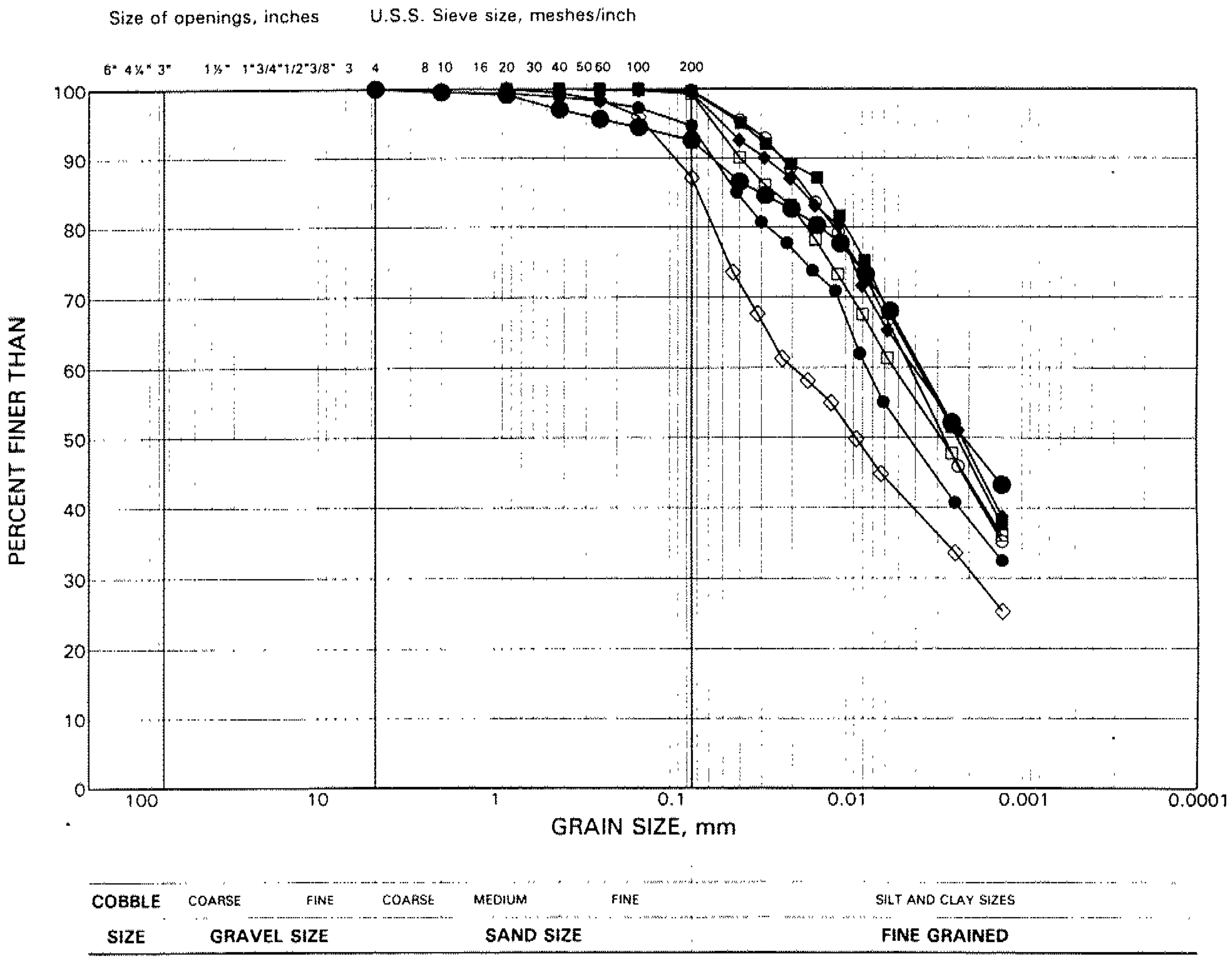
GRAIN SIZE DISTRIBUTION
SILTY CLAY, trace sand ("softer" clay)

FIGURE 7

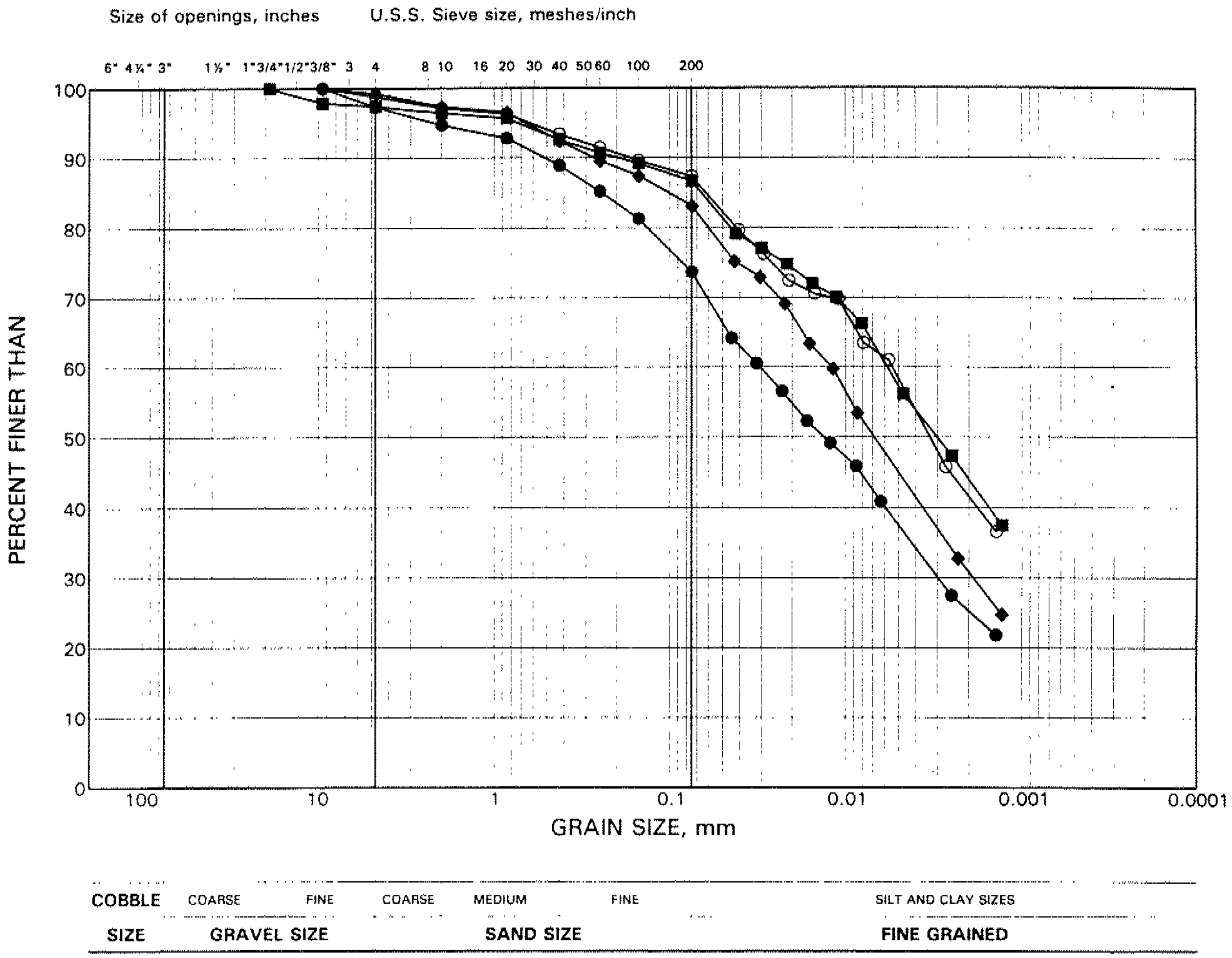


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	RESR-1	6	75.5
■	RESR-6	4	77.3
◆	RESR-7	5	75.6
○	RESR-7	5	76.0
□	RSER-6	5	77.0
◇	RSWR-1	6	75.9
●	RSWR-6	8	74.0

GRAIN SIZE DISTRIBUTION
SILTY CLAY some sand, trace gravel ("softer" clay)

FIGURE 8



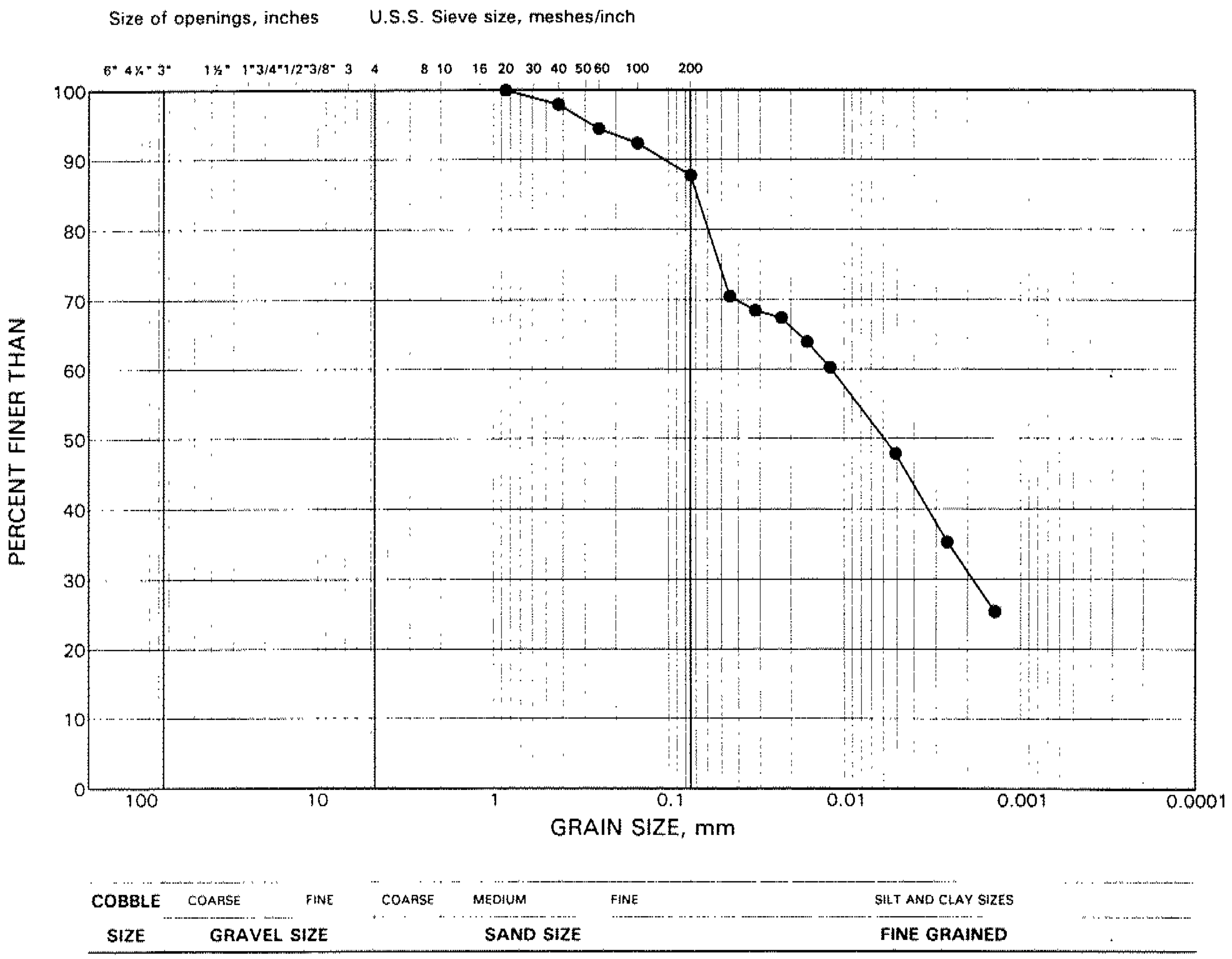
LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	RESR-4	7	74.8
■	RSER-1	6	76.7
◆	RSER-6	6	76.0
○	RSWR-2	8	74.3

GRAIN SIZE DISTRIBUTION

SILTY CLAY, trace sand (Fill)

FIGURE 9

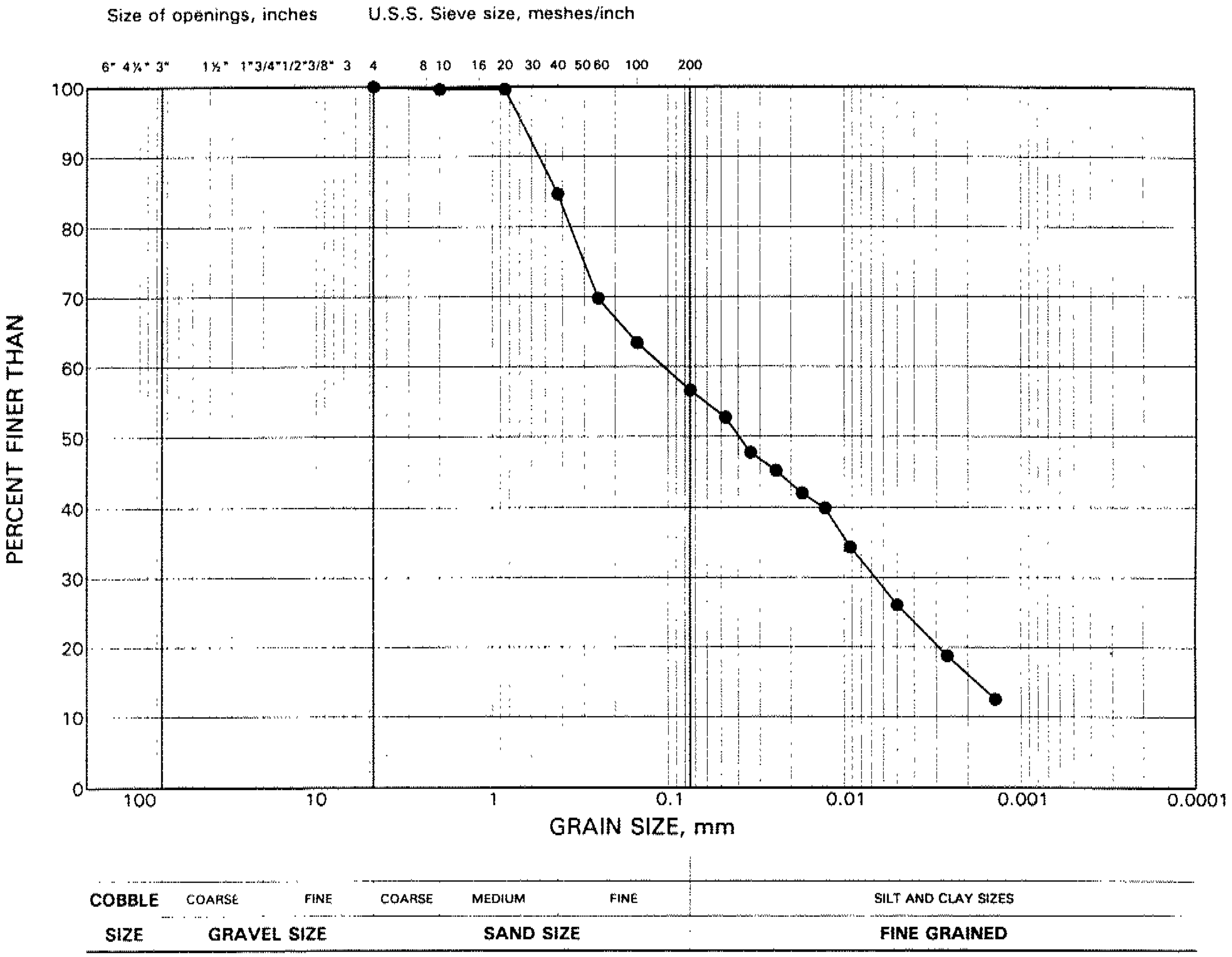


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BSWR-5	6	74.2

GRAIN SIZE DISTRIBUTION
CLAYEY SILT and SAND (Peat)

FIGURE 10



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	WWAR-3	7	72.7

Project 981-8033

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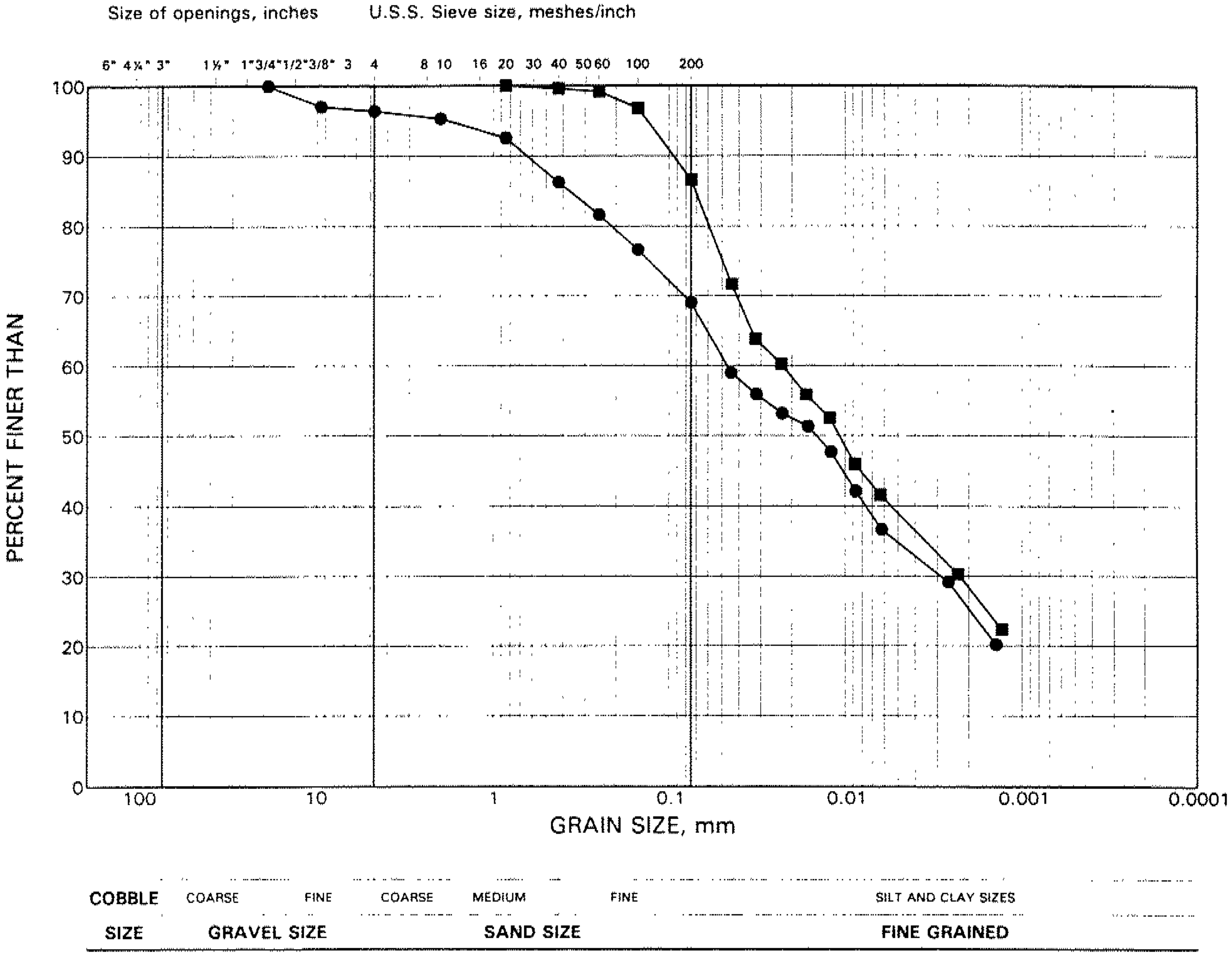
GRAIN SIZE DISTRIBUTION
SILTY CLAY some sand trace gravel (Glacial Till - Weathered Crust)

FIGURE 11

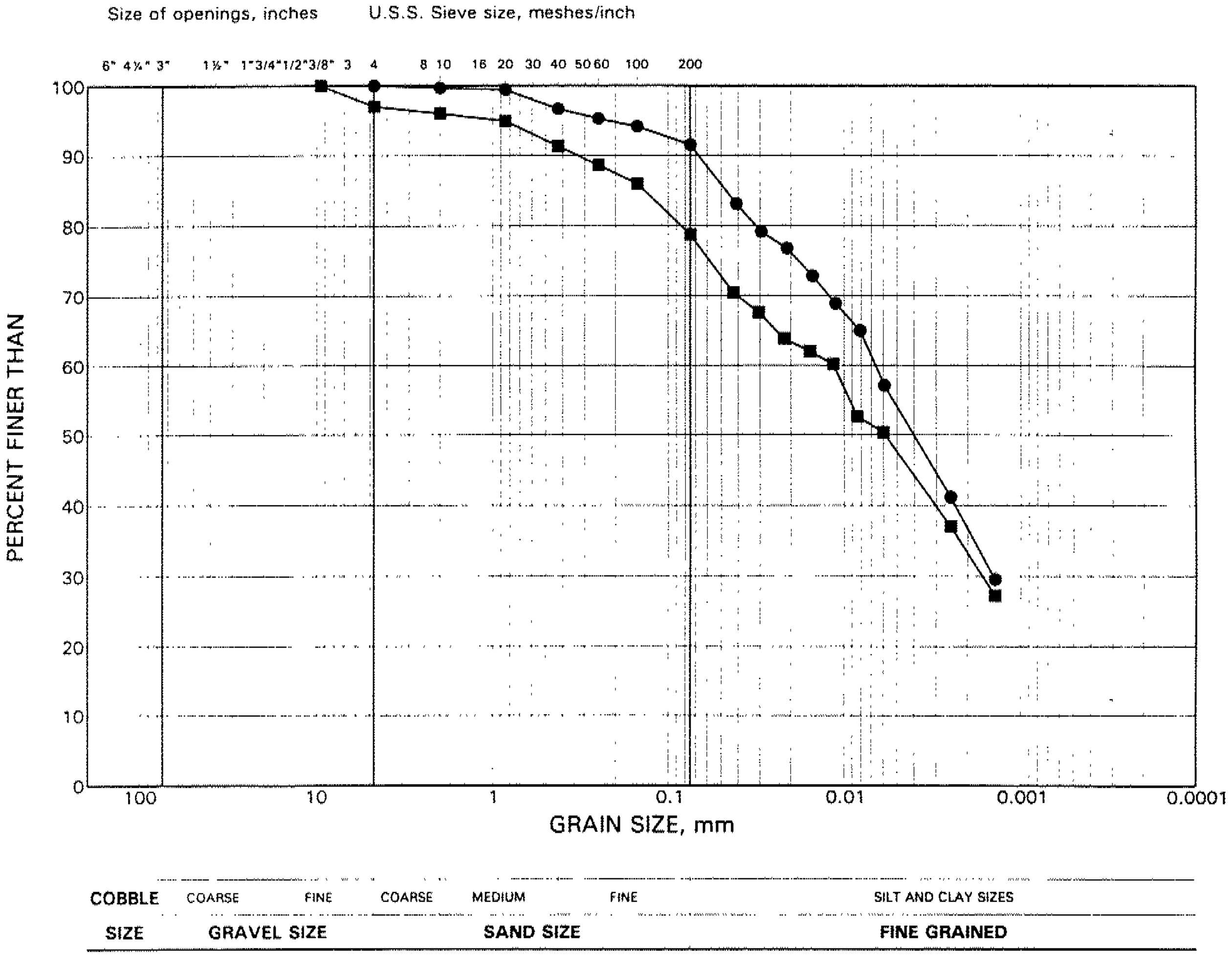


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BSER-4	6	72.8
■	BSER-5	3	75.3

GRAIN SIZE DISTRIBUTION
SILTY CLAY, some sand, trace gravel (Glacial Till)

FIGURE 12

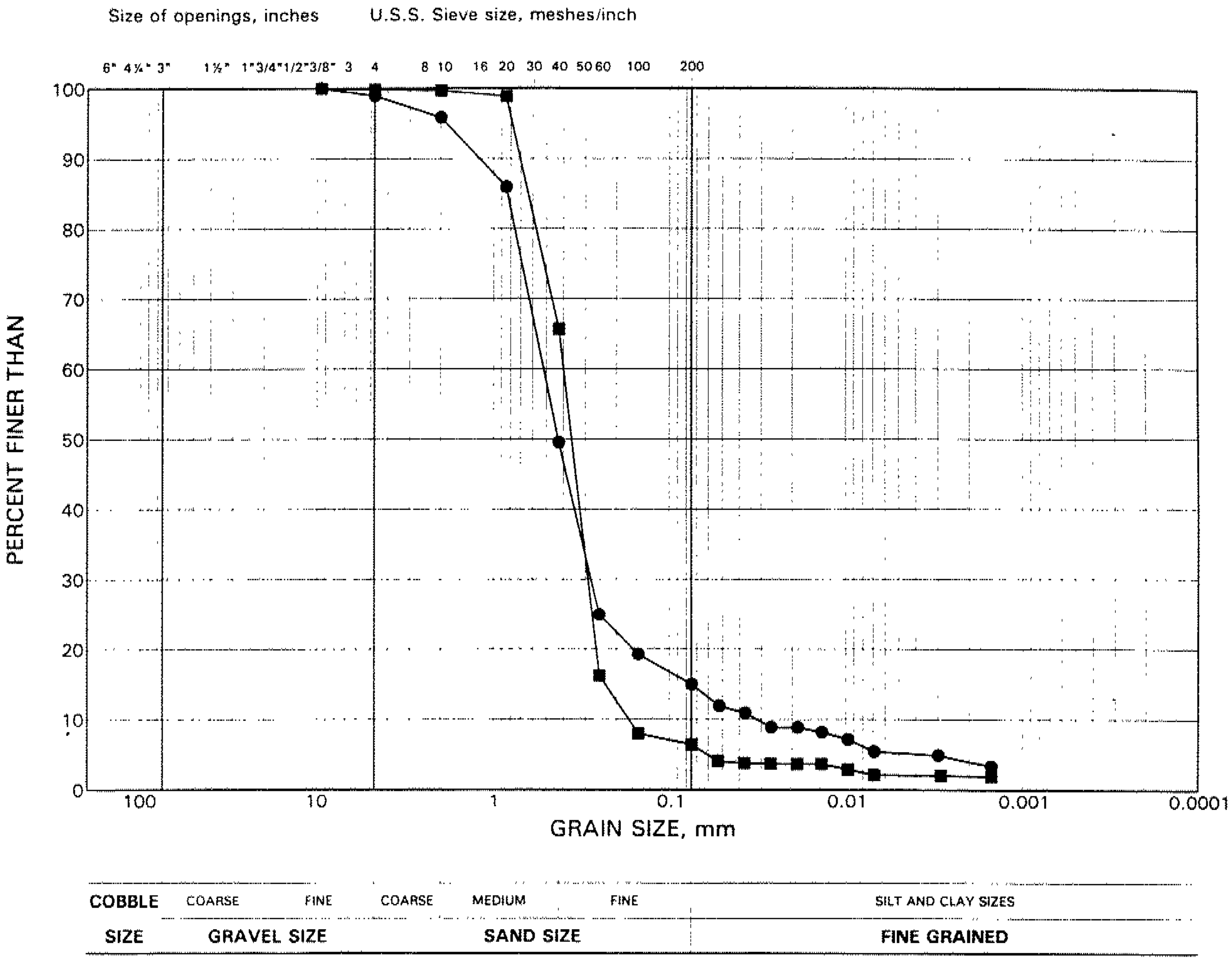


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BWSR-4	6	72.8
■	BSER-4	9	70.5

GRAIN SIZE DISTRIBUTION
SAND some silt trace clay

FIGURE 13

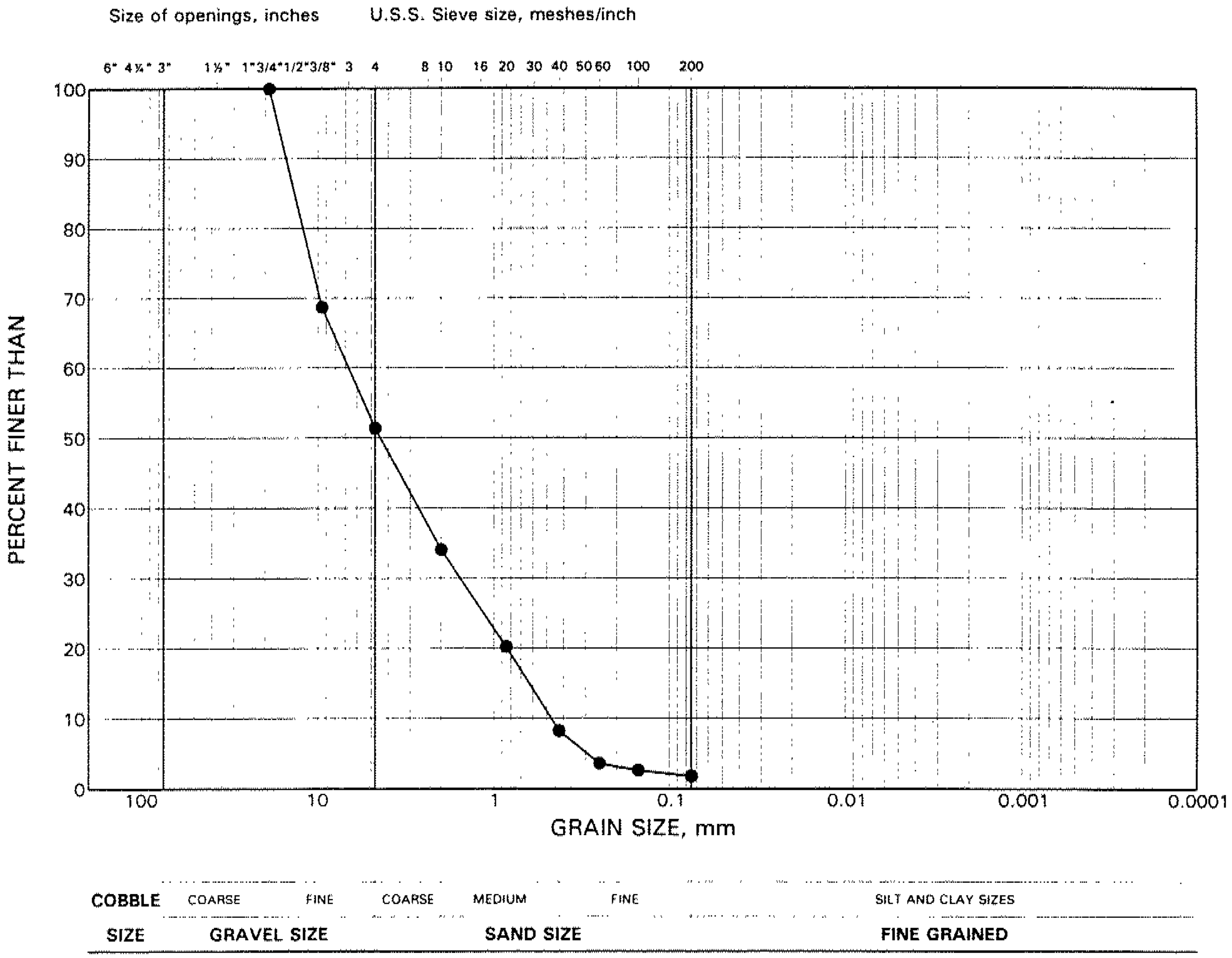


LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BWSR-5	4	73.3
■	BSWR-6	6	72.5

GRAIN SIZE DISTRIBUTION
SAND and GRAVEL trace silt

FIGURE 14



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	BSWR-7	7	71.1

Project 981-8033

Golder Associates

CONSOLIDATION TEST DATA SUMMARY
BOREHOLE RESR-1 SAMPLE 6
SHEET 1 OF 3

FIGURE 15

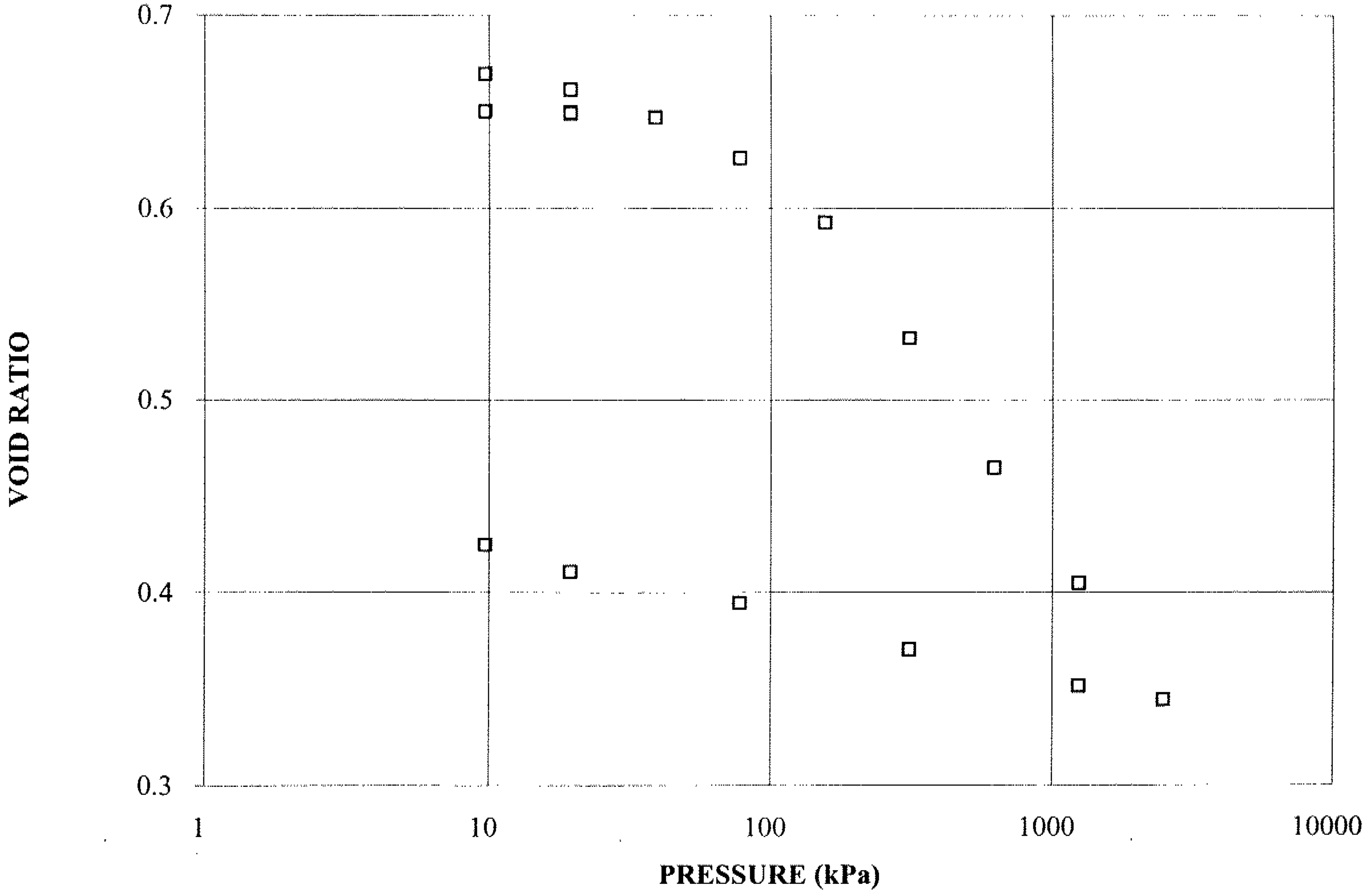
PROJECT	981-8033	SPECIFIC GRAVITY	2.70 measured	DATE STARTED	98-10-01
BOREHOLE	RESR-1	AREA(mm^2)	3149.99	DATE COMPLETED	98-10-11
SAMPLE	6	SOLIDS HT.2HS	11.334		
DEPTH, m	4.7-5.3	DRY WEIGHT, g	96.506		

Load kPa	Corr. Height mm	Void Ratio	Average Height mm	t90 sec	t50 sec	cv. t90 cm2/s	k cm/S	mv m2/kN
0.00	19.040	0.680	19.040					
9.71	18.927	0.670	18.984	10		7.64E-02	4.58E-06	6.11E-04
19.42	18.834	0.662	18.881	30		2.52E-02	1.24E-06	5.03E-04
38.83	18.668	0.647	18.751	10		7.45E-02	3.28E-06	4.49E-04
19.42	18.693	0.649	18.681					6.76E-05
9.71	18.704	0.650	18.699					5.95E-05
19.42	18.699	0.650	18.702	6		1.24E-01	3.28E-07	2.71E-05
38.83	18.670	0.647	18.685	27		2.74E-02	2.11E-07	7.84E-05
77.67	18.430	0.626	18.550	21		3.47E-02	1.11E-06	3.25E-04
155.53	18.055	0.593	18.243	60		1.18E-02	2.91E-07	2.53E-04
310.66	17.371	0.533	17.713	55		1.21E-02	2.74E-07	2.32E-04
621.32	16.606	0.465	16.989	142		4.31E-03	5.46E-08	1.29E-04
1242.64	15.923	0.405	16.265	110		5.10E-03	2.88E-08	5.77E-05
2485.28	15.234	0.344	15.579	58		8.87E-03	2.53E-08	2.91E-05
1242.64	15.316	0.351	15.275					
310.66	15.530	0.370	15.423					
77.67	15.807	0.395	15.669					
19.42	15.993	0.411	15.900					
9.71	16.154	0.425	16.074					

Notes:
k calculated using Cv based on t90 values.

Water Content %, initial	26.0		
Water Content %, final	18.5		
Original Volume, cc	59.98		
Volume of Solids, cc	35.70		
Volume of Voids, cc	24.27	Unit Weight, kN/m^3	19.89
Degree of Saturation, %	103.4	Dry Unit Weight, kN/m^3	15.79

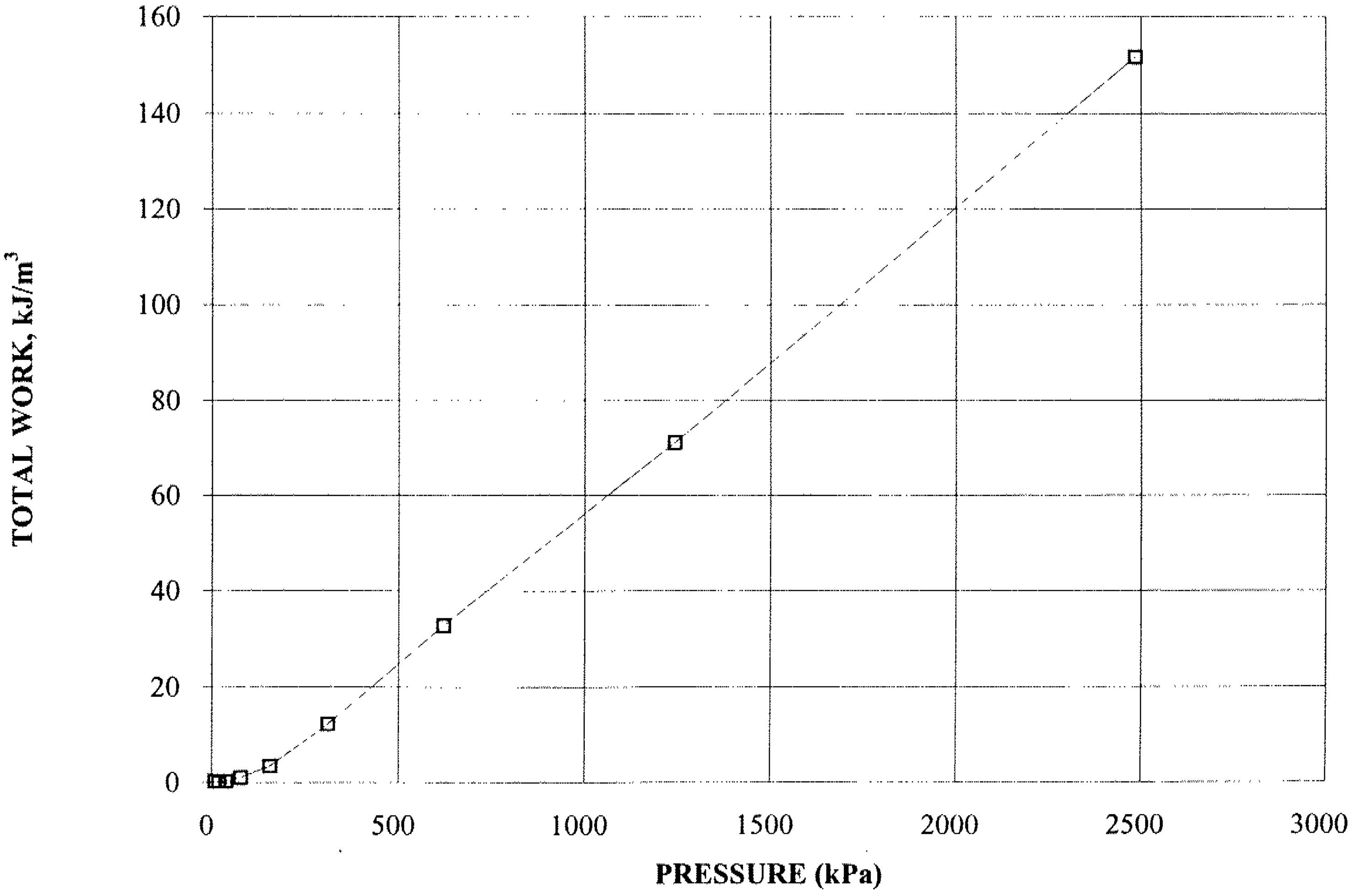
CONSOLIDATION TEST
VOID RATIO vs LOG. PRESSURE



CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE
BOREHOLE RESR-1 SAMPLE 6
SHEET 2 OF 3

FIGURE 15

CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE



CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE
BOREHOLE RESR-1 SAMPLE 6
SHEET 3 OF 3

FIGURE 15

Golder Associates

CONSOLIDATION TEST DATA SUMMARY
BOREHOLE RESR-7 SAMPLE 5
SHEET 1 OF 3

FIGURE 16

PROJECT	981-8033	SPECIFIC GRAVITY	2.70 measured	DATE STARTED	98-10-16
BOREHOLE	RESR-7	AREA(mm^2)	3154.96	DATE COMPLETED	98-10-31
SAMPLE	5	SOLIDS HT.2HS	10.002		
DEPTH, m		DRY WEIGHT, g	85.04		

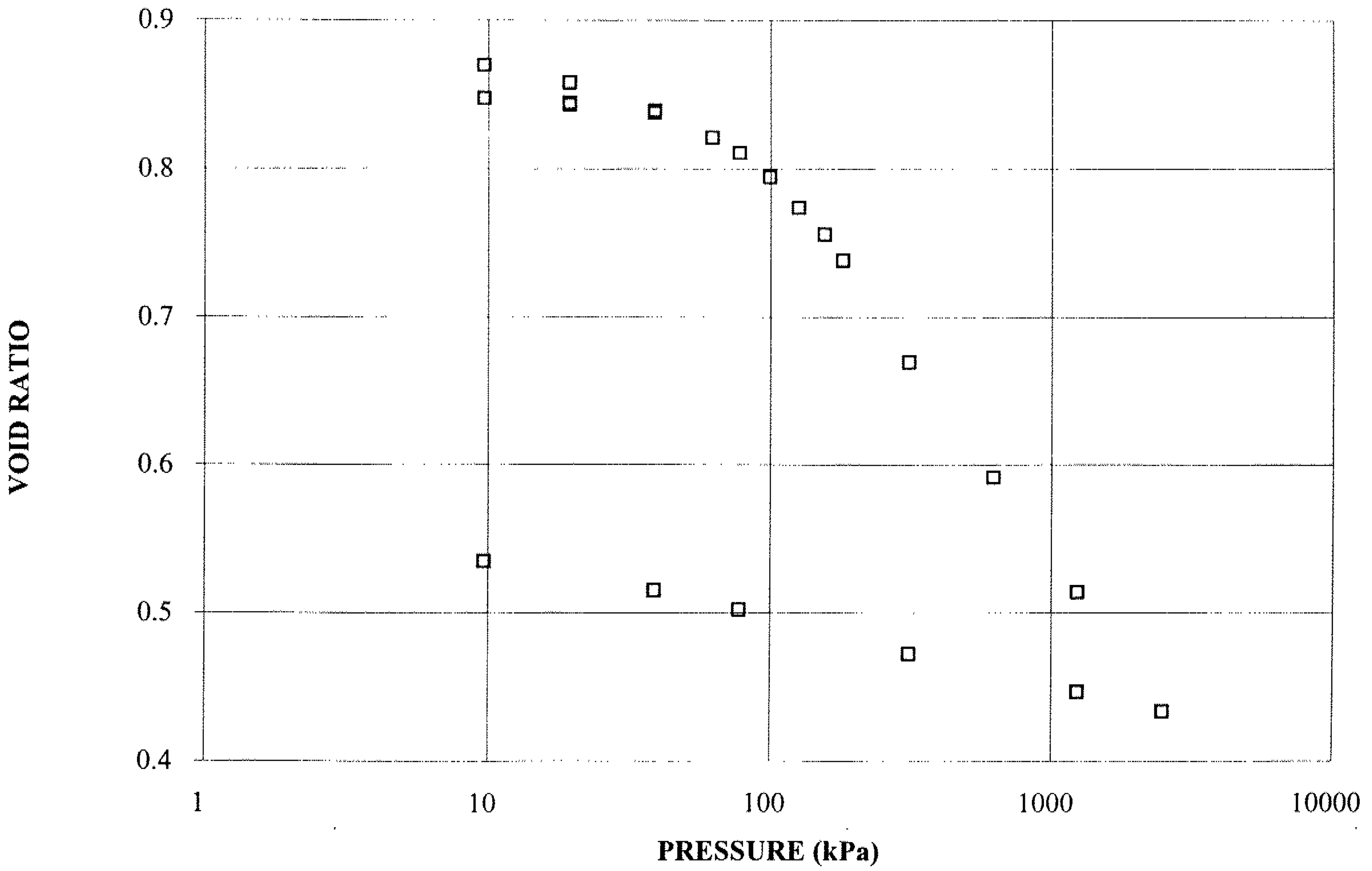
Load kPa	Corr. Height mm	Void Ratio	Average Height mm	t_{90} sec	t_{50} sec	cv. t_{90} cm^2/s	k cm/s	mv m^2/kN
0.00	19.050	0.905	19.050					
9.67	18.707	0.870	18.879	27		2.80E-02	5.11E-06	1.86E-03
19.39	18.588	0.858	18.648	8		9.21E-02	5.81E-06	6.43E-04
38.77	18.399	0.840	18.494	18		4.03E-02	2.02E-06	5.12E-04
19.39	18.438	0.844	18.419					1.06E-04
9.69	18.484	0.848	18.461					2.49E-04
19.39	18.452	0.845	18.468	45		1.61E-02	2.73E-07	1.73E-04
38.77	18.385	0.838	18.419	15		4.79E-02	8.52E-07	1.81E-04
62.03	18.215	0.821	18.300	8		8.87E-02	3.34E-06	3.84E-04
77.54	18.113	0.811	18.164	51		1.37E-02	4.64E-07	3.45E-04
99.25	17.948	0.795	18.031	29		2.38E-02	9.29E-07	3.99E-04
125.62	17.742	0.774	17.845	26		2.60E-02	1.04E-06	4.10E-04
155.09	17.560	0.756	17.651	55		1.20E-02	3.82E-07	3.24E-04
179.90	17.385	0.738	17.473	11		5.88E-02	2.13E-06	3.70E-04
310.17	16.700	0.670	17.043	585		1.05E-03	2.85E-08	2.76E-04
620.34	15.918	0.592	16.309	315		1.79E-03	2.32E-08	1.32E-04
1240.68	15.145	0.514	15.532	165		3.10E-03	1.99E-08	6.54E-05
2481.36	14.338	0.434	14.742	52		8.86E-03	2.96E-08	3.41E-05
1240.68	14.471	0.447	14.405					
310.17	14.729	0.473	14.600					
77.54	15.026	0.502	14.878					
38.77	15.156	0.515	15.091					
9.69	15.352	0.535	15.254					

Notes:
k calculated using Cv based on t90 values.

Water Content %, initial	35.4
Water Content %, final	23.5
Original Volume, cc	60.10
Volume of Solids, cc	31.55
Volume of Voids, cc	28.55
Degree of Saturation, %	105.5

Unit Weight, kN/m^3	18.79
Dry Unit Weight, kN/m^3	13.88

CONSOLIDATION TEST
VOID RATIO vs LOG. PRESSURE

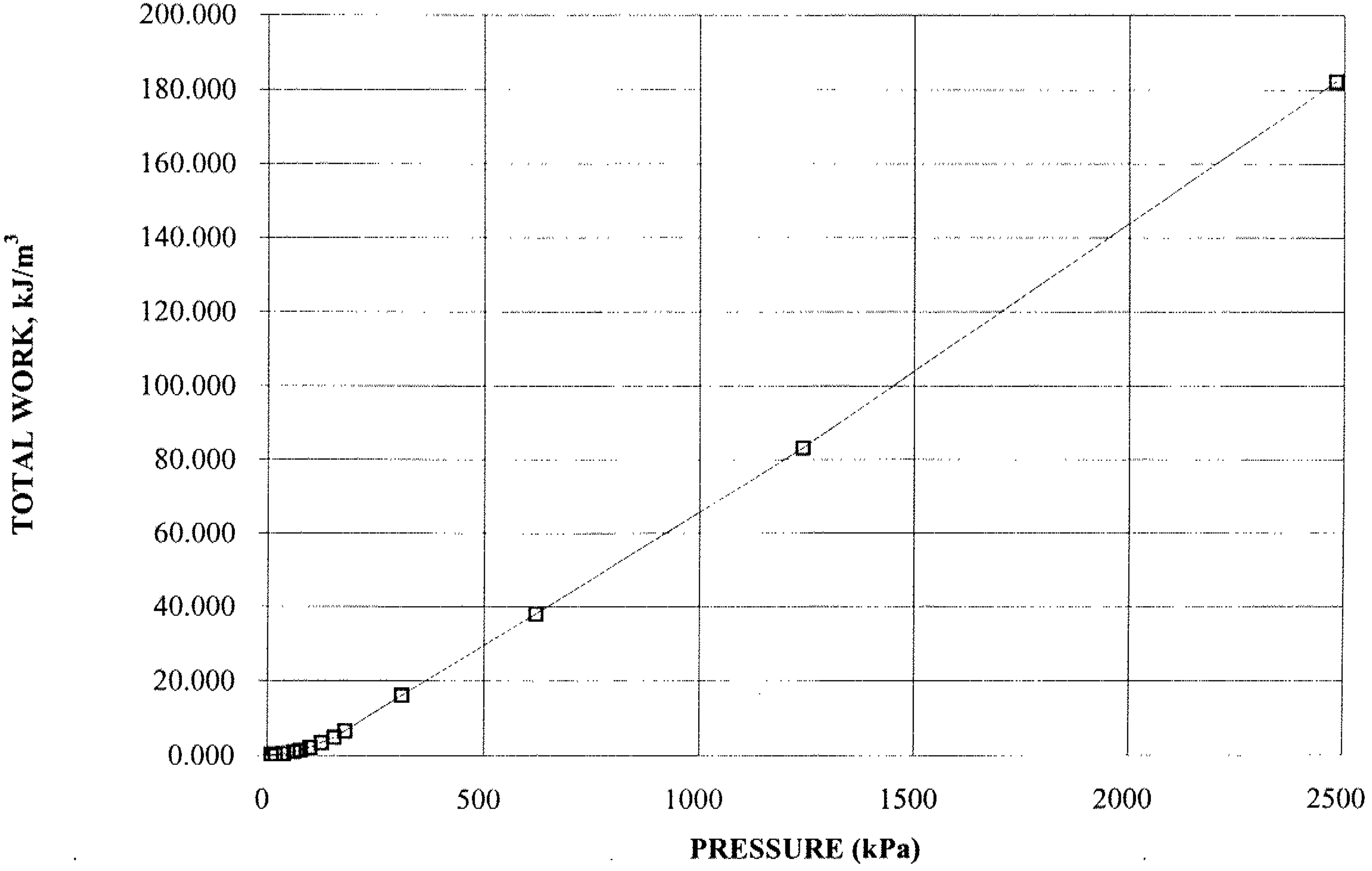


CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE
BOREHOLE RESR-7 SAMPLE 5
SHEET 2 OF 3

FIGURE 16

Golder Associates

CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE



CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE
BOREHOLE RESR-7 SAMPLE 5
SHEET 3 OF 3

FIGURE 16

Golder Associates

CONSOLIDATION TEST DATA SUMMARY
BOREHOLE RSER-6 SAMPLE 6
SHEET 1 OF 3

FIGURE 17

PROJECT	981-8033	SPECIFIC GRAVITY	2.70 assumed	DATE STARTED	98-10-16
BOREHOLE	RSER-6	AREA(mm^2)	3161.94	DATE COMPLETED	98-10-31
SAMPLE	6	SOLIDS HT.2HS	11.620		
DEPTH, m		DRY WEIGHT, g	99.02		

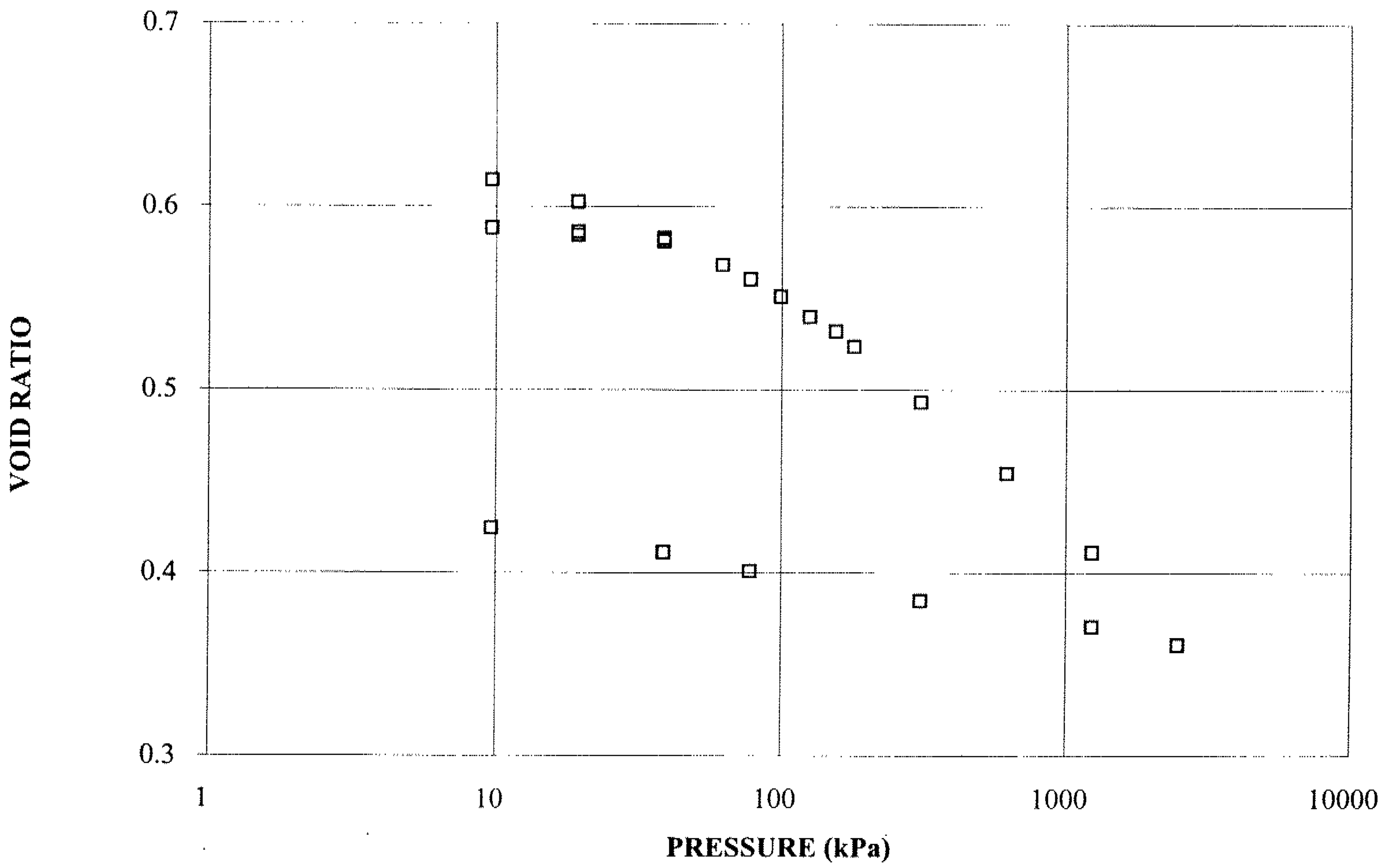
Load kPa	Corr. Height mm	Void Ratio	Average Height mm	t_{90} sec	t_{50} sec	cv. t_{90} cm^2/s	k cm/s	mv m^2/kN
0.00	19.050	0.639	19.050					
9.67	18.762	0.615	18.906	18		4.21E-02	6.45E-06	1.56E-03
19.34	18.622	0.603	18.692	9		8.23E-02	6.13E-06	7.60E-04
38.69	18.395	0.583	18.509	10		7.26E-02	4.38E-06	6.16E-04
19.34	18.414	0.585	18.405					5.16E-05
9.67	18.460	0.589	18.437					2.50E-04
19.34	18.436	0.587	18.448	16		4.51E-02	5.76E-07	1.30E-04
38.69	18.375	0.581	18.406	23		3.12E-02	5.07E-07	1.66E-04
61.90	18.227	0.569	18.301	5		1.42E-01	4.66E-06	3.35E-04
77.37	18.137	0.561	18.182	30		2.34E-02	6.99E-07	3.05E-04
99.04	18.027	0.551	18.082	34		2.04E-02	5.32E-07	2.67E-04
125.34	17.899	0.540	17.963	41		1.67E-02	4.18E-07	2.55E-04
154.74	17.808	0.533	17.854	25		2.70E-02	4.30E-07	1.62E-04
179.50	17.709	0.524	17.759	51		1.31E-02	2.70E-07	2.10E-04
309.49	17.353	0.493	17.531	13		5.01E-02	7.06E-07	1.44E-04
618.97	16.898	0.454	17.126	128		4.86E-03	3.67E-08	7.72E-05
1237.94	16.399	0.411	16.649	70		8.39E-03	3.48E-08	4.23E-05
2475.89	15.815	0.361	16.107	82		6.71E-03	1.63E-08	2.48E-05
1237.94	15.930	0.371	15.873					
309.49	16.092	0.385	16.011					
77.37	16.281	0.401	16.187					
38.69	16.399	0.411	16.340					
9.67	16.553	0.425	16.476					

Notes:
k calculated using Cv based on t90 values.

Water Content %, initial	24.0
Water Content %, final	17.6
Original Volume, cc	60.23
Volume of Solids, cc	36.74
Volume of Voids, cc	23.49
Degree of Saturation, %	101.2

Unit Weight, kN/m^3	20.00
Dry Unit Weight, kN/m^3	16.13

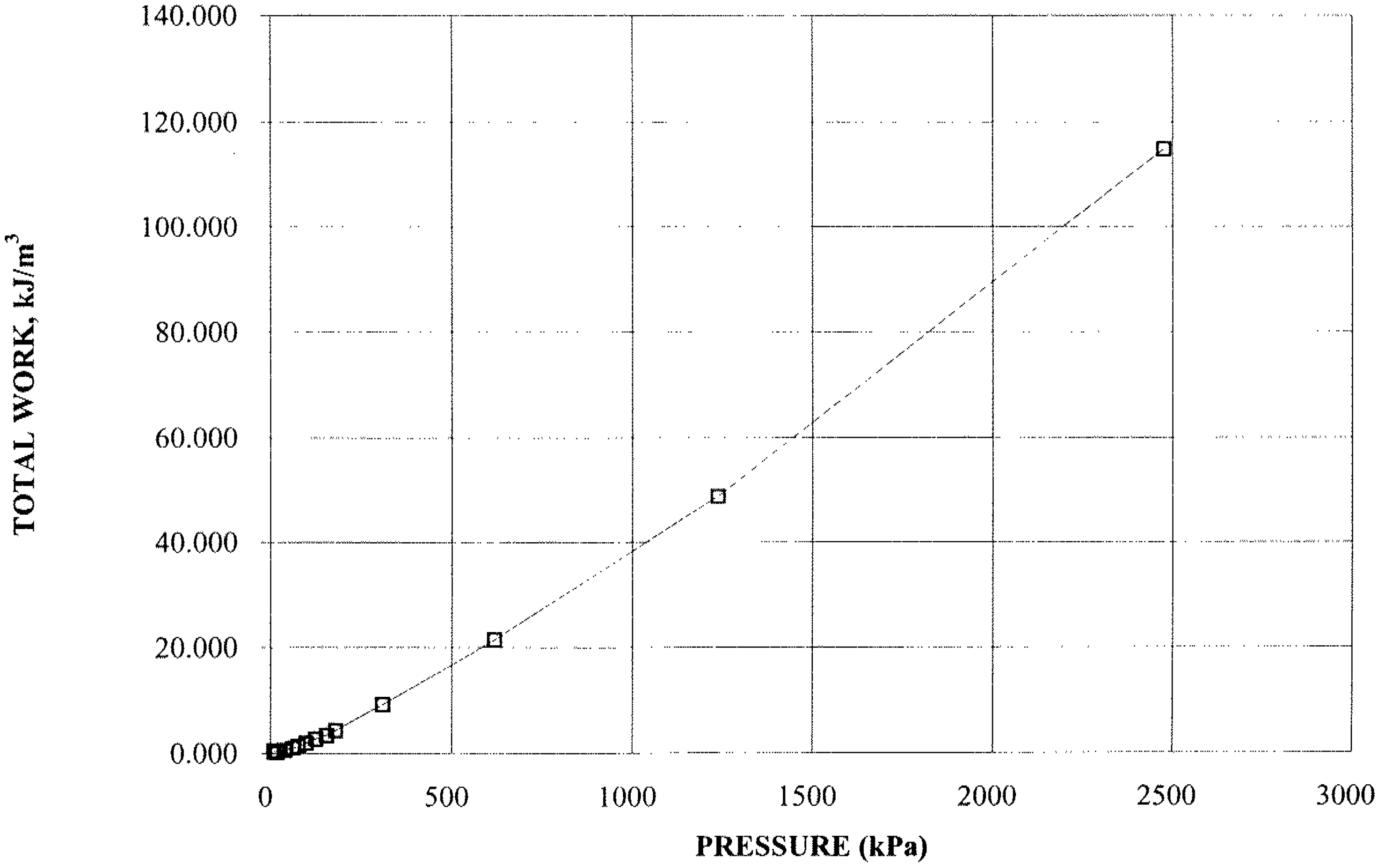
CONSOLIDATION TEST
VOID RATIO vs LOG. PRESSURE



CONSOLIDATION TEST
VOID RATIO VS. LOG PRESSURE
BOREHOLE RSER-6 SAMPLE 6
SHEET 2 OF 3

FIGURE 17

CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE



CONSOLIDATION TEST
TOTAL WORK, kJ/m^3 vs PRESSURE
BOREHOLE RSER-6 SAMPLE 6
SHEET 3 OF 3

FIGURE 17

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

SHEET 1 OF 3

FIGURE 18

TEST STAGE	A	B
BOREHOLE NUMBER	RESR-7	RESR-7
SAMPLE NUMBER	5	5
SPECIMEN DIAMETER, cm	4.96	4.95
SPECIMEN HEIGHT, cm	10.09	10.06
WATER CONTENT BEFORE CONSOLIDATION, %	36.5	37.8
CELL PRESSURE, δ_3, kPa	255.0	355.0
BACK PRESSURE, kPa	205.0	205.0
PORE PRESSURE PARAMETER "B"	0.99	0.99
CONSOLIDATION PRESSURE, δc, kPa	50.0	150.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	2.9	6.0
WATER CONTENT AFTER CONSOLIDATION, %	34.4	33.5
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5
TIME TO FAILURE, DAYS	2	2
WATER CONTENT AFTER TEST, %	33.9	32.9
MAX. DEVIATOR STRESS, $(\delta_1-\delta_3)$, kPa	72.1	105.8
AXIAL STRAIN AT $(\delta_1-\delta_3)$ MAXIMUM, %	2.7	5.2
MAX EFFECTIVE PRINCIPAL STRESS RATIO, (δ_1/δ_3) MAXIMUM	3.5	2.6
DEVIATOR STRESS AT (δ_1/δ_3) MAXIMUM, kPa	72.1	94.5
AXIAL STRAIN AT (δ_1/δ_3) MAXIMUM, %	2.7	8.1
PORE PRESSURE PARAMETER, Af, AT $(\delta_1-\delta_3)$ MAXIMUM	0.29	0.69
PORE PRESSURE PARAMETER, Af, AT (δ_1/δ_3) MAXIMUM	0.29	0.96
NATURAL WATER CONTENT, w, %	33.9	33.5
DRY DENSITY, mg/m^3	1.39	1.37
FILTER DRAINS USED, y/n	y	y
TEST NOTES:		
CHANGED RATE OF STRAIN, %/hr		
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %		
FAILURE PLANE NUMBER	2	1
ANGLE OF FAILURE, DEGREES	50	65

DATE: September, 1998

PROJECT NUMBER: 981-8033

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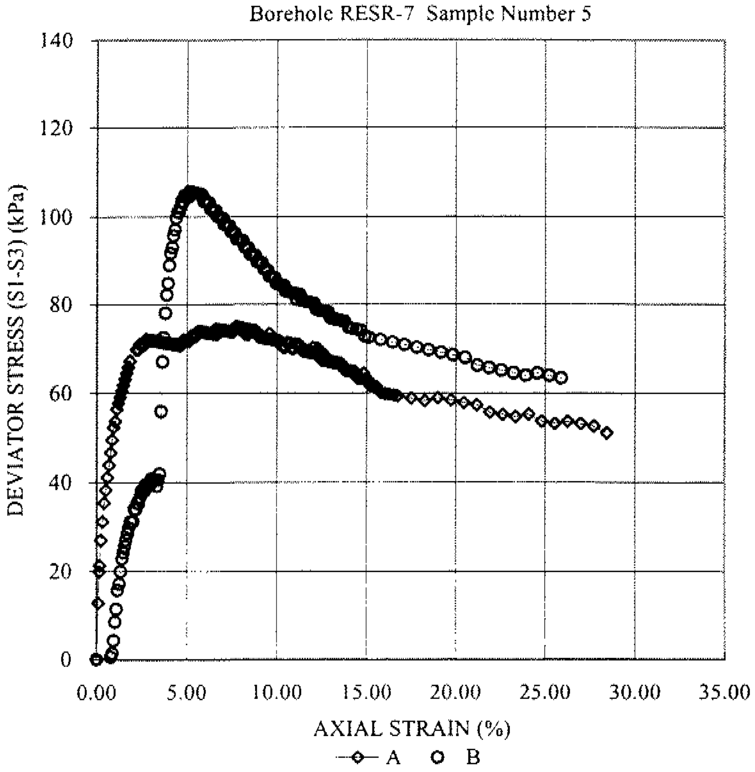
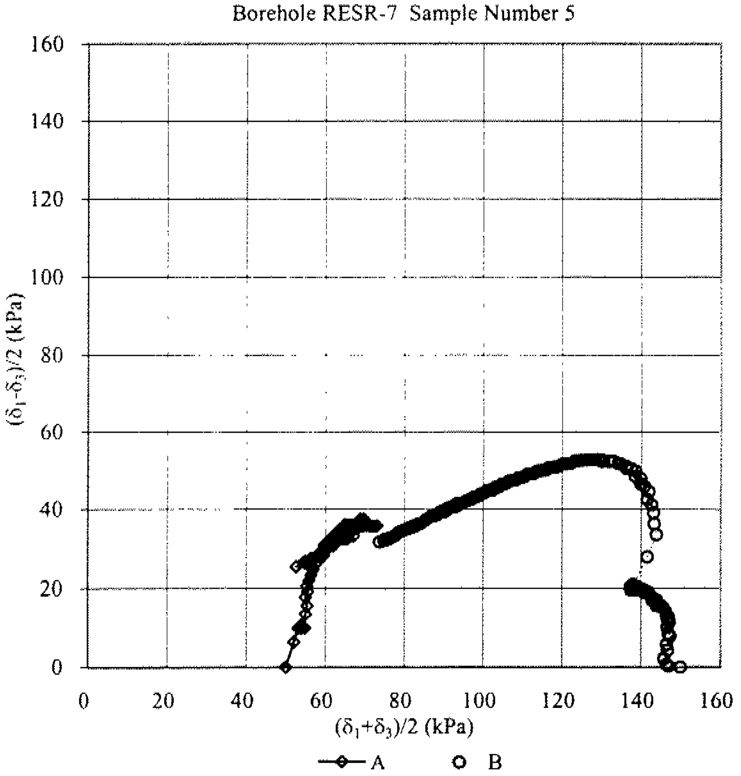
CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS SHEET 2 OF 3

FIGURE 18





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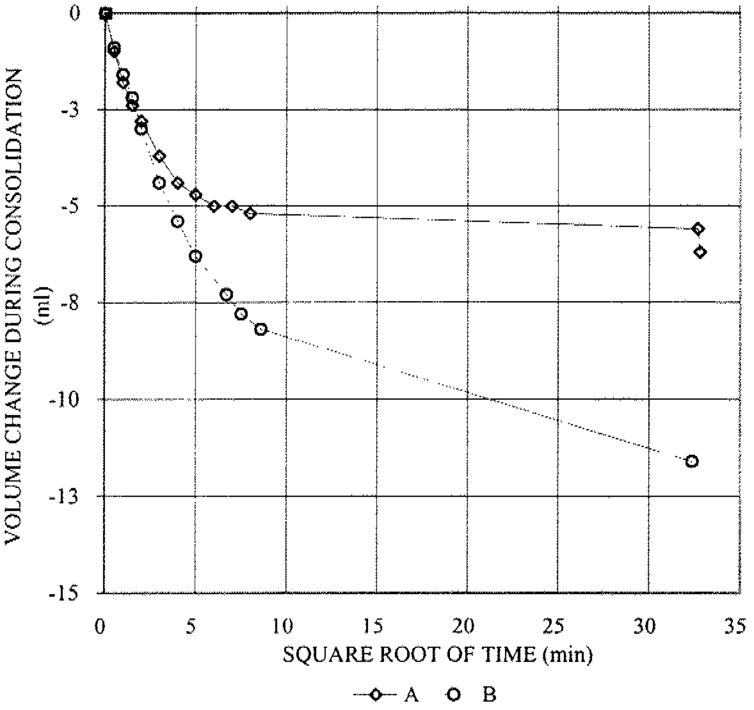
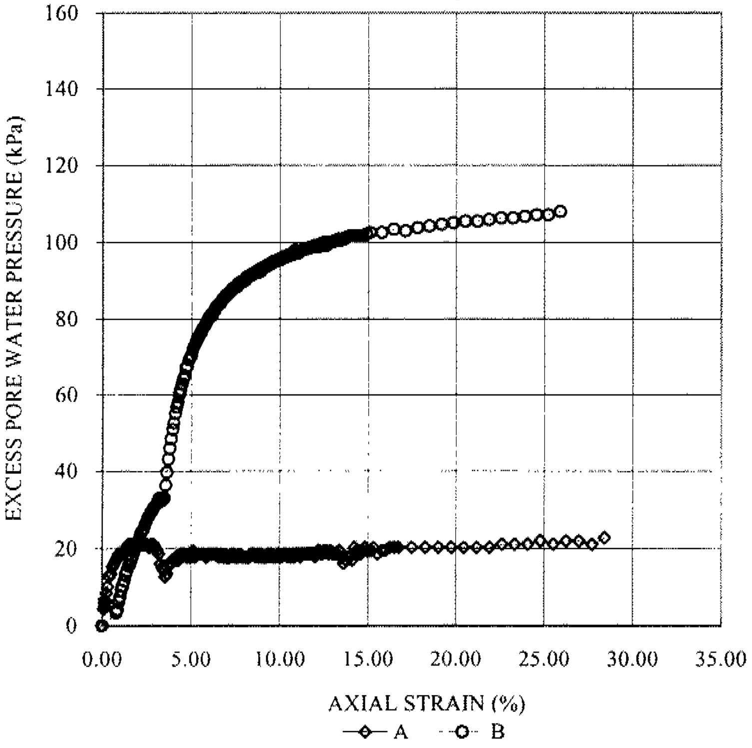
CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS
SHEET 3 OF 3

FIGURE 18

Borehole RESR-7 Sample Number 5



Borehole RESR-7 Sample Number 5



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CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 1 OF 3

FIGURE 19

TEST STAGE	A	B	C
BOREHOLE NUMBER	RSWR-1	RSWR-1	RSWR-1
SAMPLE NUMBER	6	6	6
SPECIMEN DIAMETER, cm	4.99	4.99	5.03
SPECIMEN HEIGHT, cm	10.15	10.12	10.17
WATER CONTENT BEFORE CONSOLIDATION, %	22.9	27.3	27.4
CELL PRESSURE, δ_3, kPa	255.0	305.0	405.0
BACK PRESSURE, kPa	205.0	205.0	205.0
PORE PRESSURE PARAMETER "B"	0.96	0.96	0.96
CONSOLIDATION PRESSURE, δc, kPa	50.0	100.0	200.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	1.9	1.6	4.5
WATER CONTENT AFTER CONSOLIDATION, %	21.8	26.4	24.6
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	21.5	24.5	24.2
MAX. DEVIATOR STRESS, $(\delta_1\text{-}\delta_3)$, kPa	69.8	102.9	154.0
AXIAL STRAIN AT $(\delta_1\text{-}\delta_3)$ MAXIMUM, %	6.8	4.4	4.4
MAX EFFECTIVE PRINCIPAL STRESS RATIO, (δ_1/δ_3) MAXIMUM	3.5	3.1	3.0
DEVIATOR STRESS AT (δ_1/δ_3) MAXIMUM, kPa	66.2	102.9	145.2
AXIAL STRAIN AT (δ_1/δ_3) MAXIMUM, %	2.2	5.6	12.1
PORE PRESSURE PARAMETER, Af, AT $(\delta_1\text{-}\delta_3)$ MAXIMUM	0.31	0.48	0.67
PORE PRESSURE PARAMETER, Af, AT (δ_1/δ_3) MAXIMUM	0.36	0.50	0.88
NATURAL WATER CONTENT, w, %	20.5	23.7	24.2
DRY DENSITY, mg/m^3	1.72	1.63	1.61
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr			
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %			
FAILURE PLANE NUMBER	n/a	n/a	n/a
ANGLE OF FAILURE, DEGREES	n/a	n/a	n/a

DATE: October, 1998

PROJECT NUMBER: 981-8033

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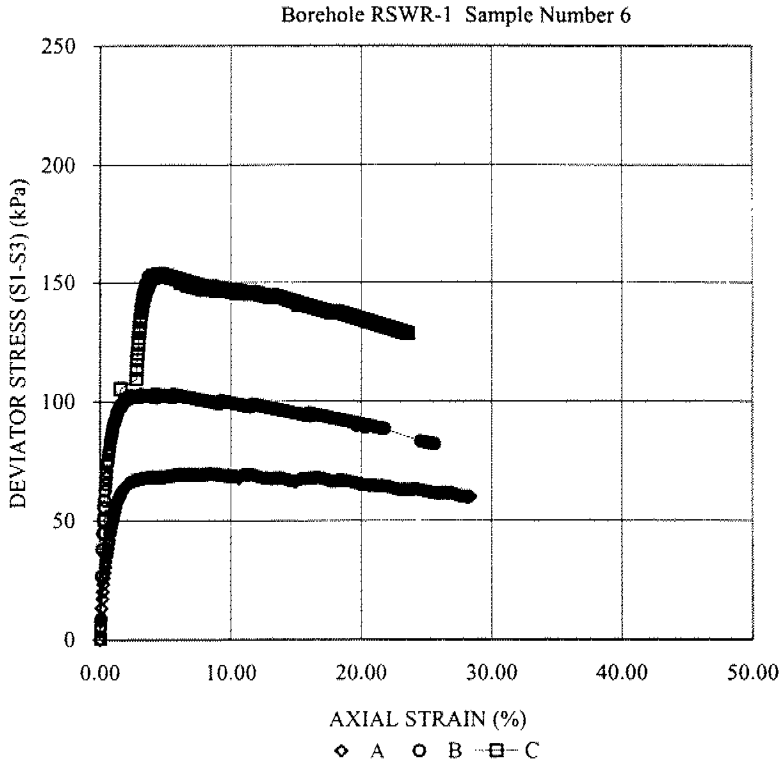
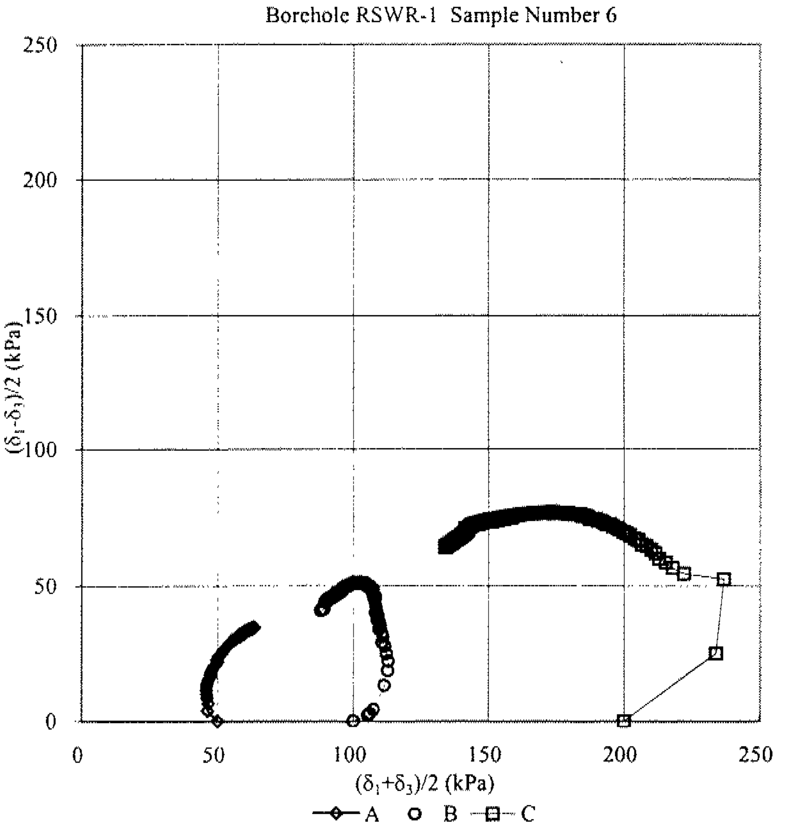
CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS SHEET 2 OF 3	FIGURE 19





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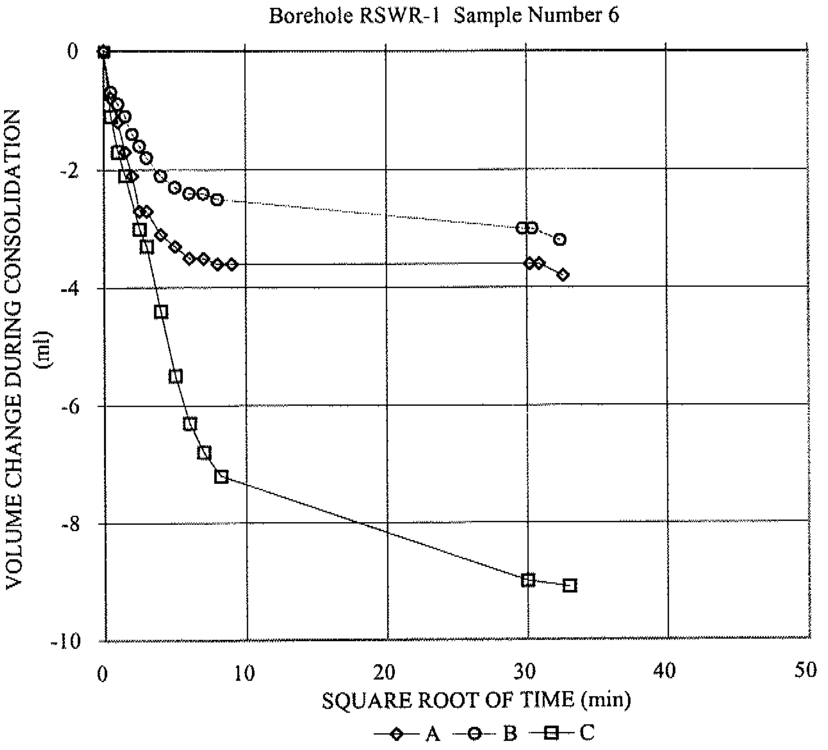

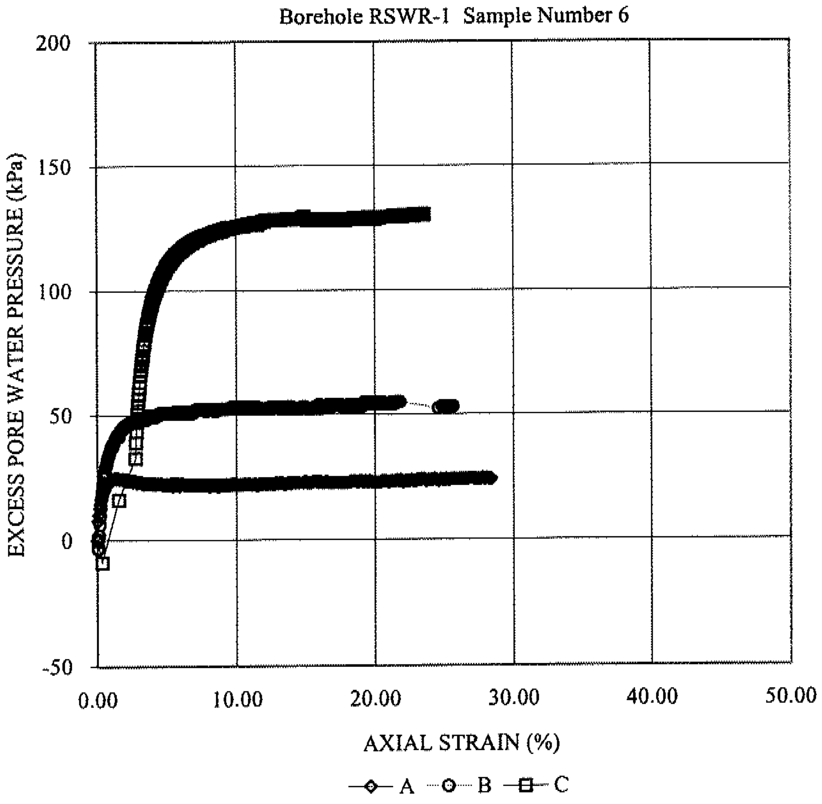

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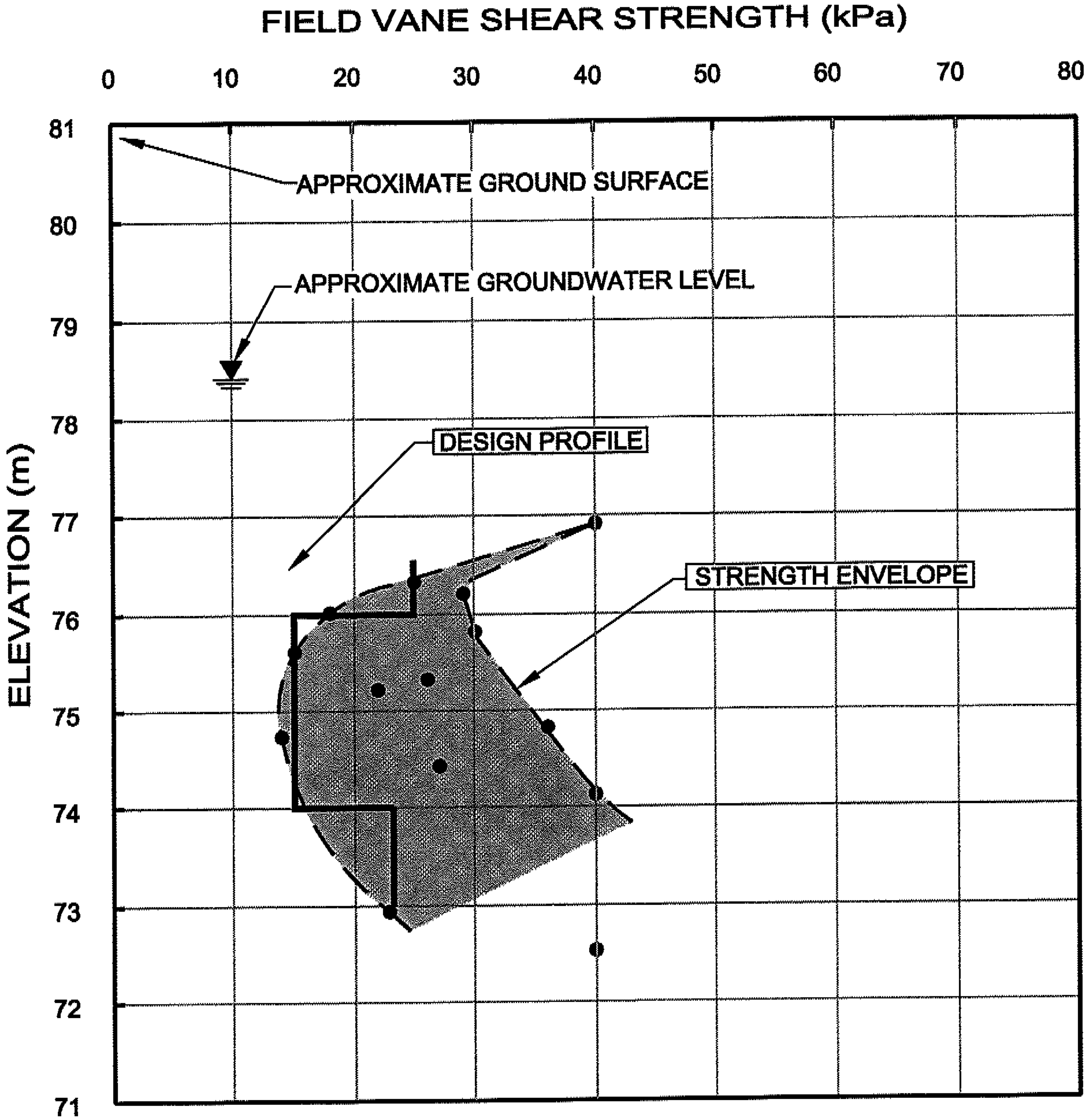
PROFILE OF FIELD VANE SHEAR STRENGTH VS. ELEVATION PROFILE A-A (E-S RHCE RAMP, STA. 29+850 TO 30+100)

FIGURE 20



LEGEND

● MEASURED FIELD VANE SHEAR STRENGTH (REFER TO RECORD OF BOREHOLES)

NOTE

FOR LOCATION OF PROFILE A-A, SEE DRAWING RHCE 1

Date NOVEMBER 1998

Project 981-8033

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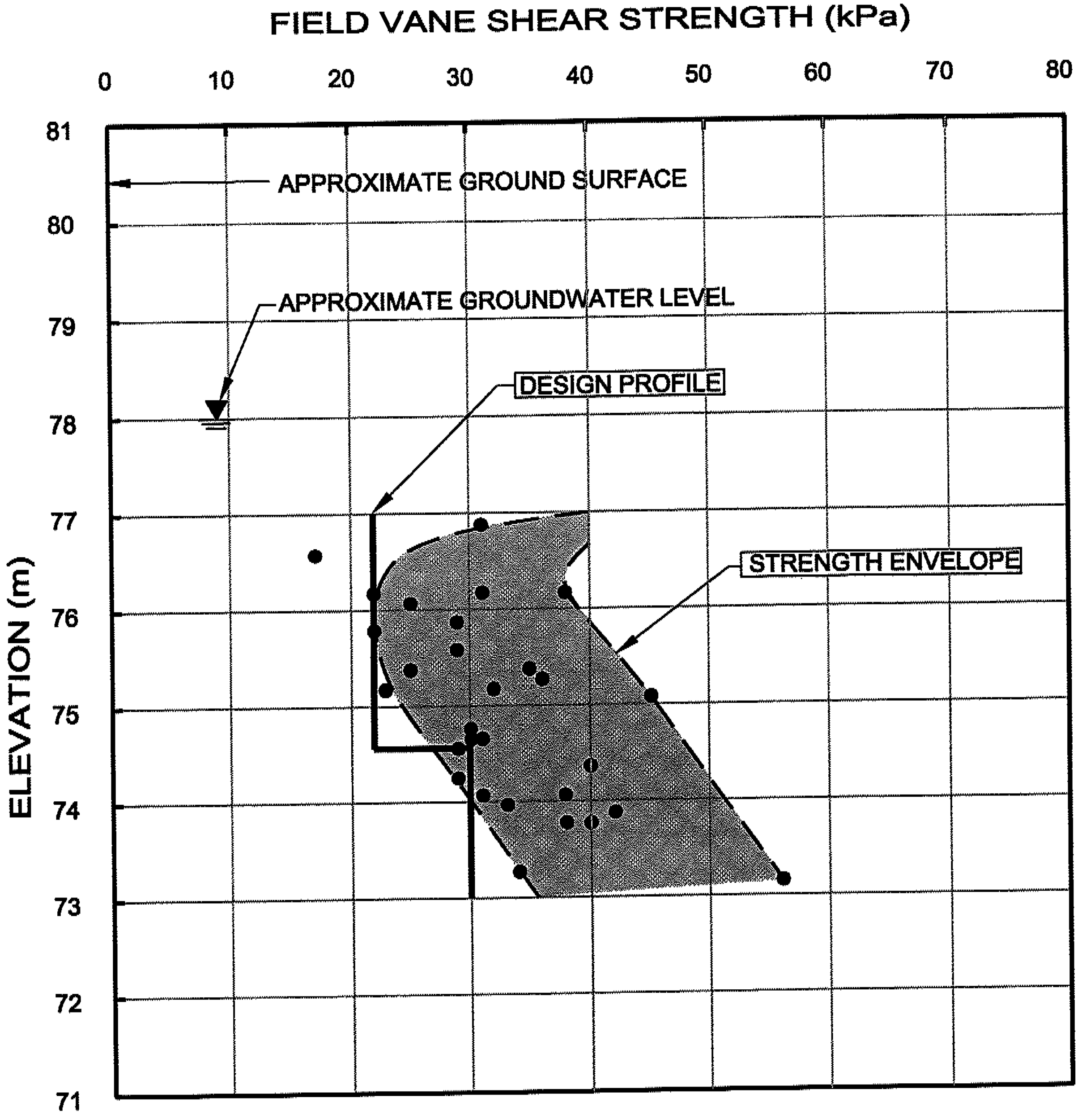
Drawn PS/MMZ

Chkd SP

N8033020.DWG

PROFILE OF FIELD
VANE SHEAR STRENGTH VS. ELEVATION
PROFILE B-B (E-S RHCE RAMP, STA. 29+600 TO 29+850)

FIGURE 21



LEGEND

● MEASURED FIELD VANE SHEAR STRENGTH (REFER TO RECORD OF BOREHOLES)

NOTE

FOR LOCATION OF PROFILE B-B, SEE DRAWING RHCE 1

Date NOVEMBER 1998

Project 981-8033

Golder Associates

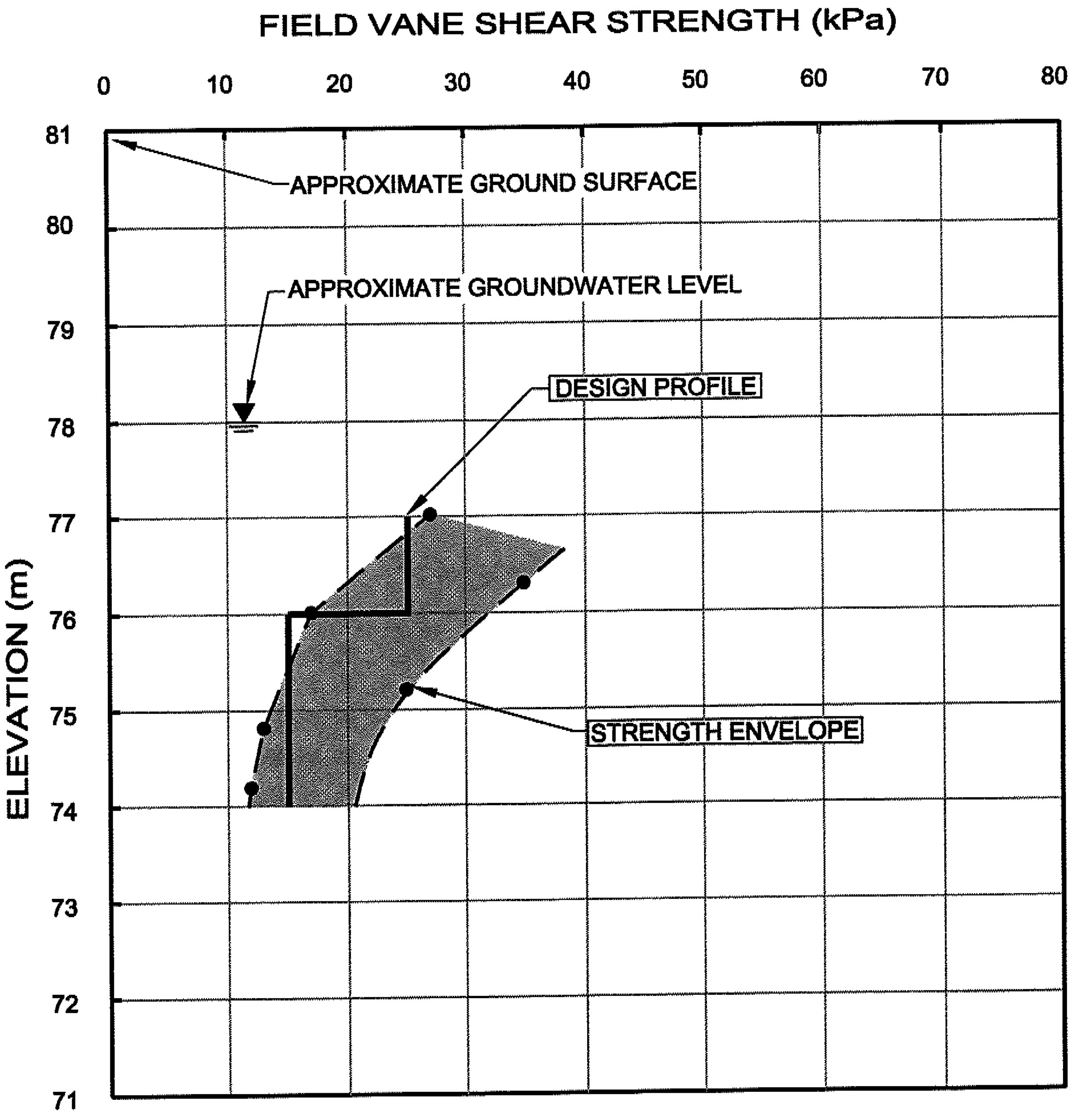
Drawn PS/MMZ

Chkd SP

N8033021.DWG

PROFILE OF FIELD
VANE SHEAR STRENGTH VS. ELEVATION
PROFILE C-C (E-S RHCE RAMP, STA. 29+200 TO 29+450)

FIGURE 22



LEGEND

● MEASURED FIELD VANE SHEAR STRENGTH (REFER TO RECORD OF BOREHOLES)

NOTE

FOR LOCATION OF PROFILE C-C, SEE DRAWING RHCE 1

Date NOVEMBER 1998

Project 981-8033

Golder Associates

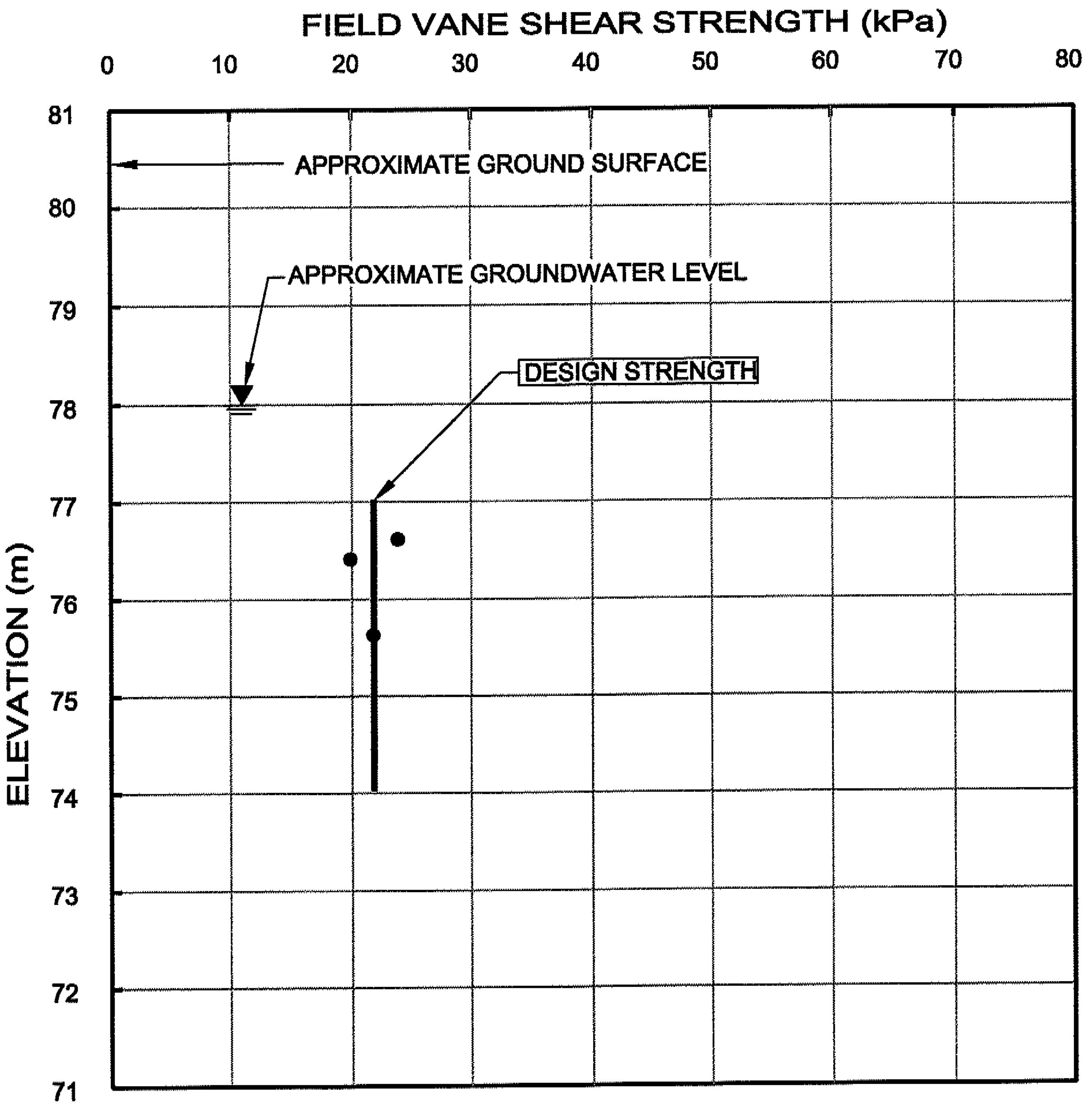
Drawn PS/MMZ

Chkd SP

N8033022.DWG

PROFILE OF FIELD VANE SHEAR STRENGTH VS. ELEVATION PROFILE D-D (S-E RHCE RAMP, STA.10+194 TO 10+584)

FIGURE 23



LEGEND

● MEASURED FIELD VANE SHEAR STRENGTH (REFER TO RECORD OF BOREHOLES)

NOTE

FOR LOCATION OF PROFILE D-D, SEE DRAWING RHCE 1

Date NOVEMBER 1998

Project 981-8033

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Drawn PS/MMZ

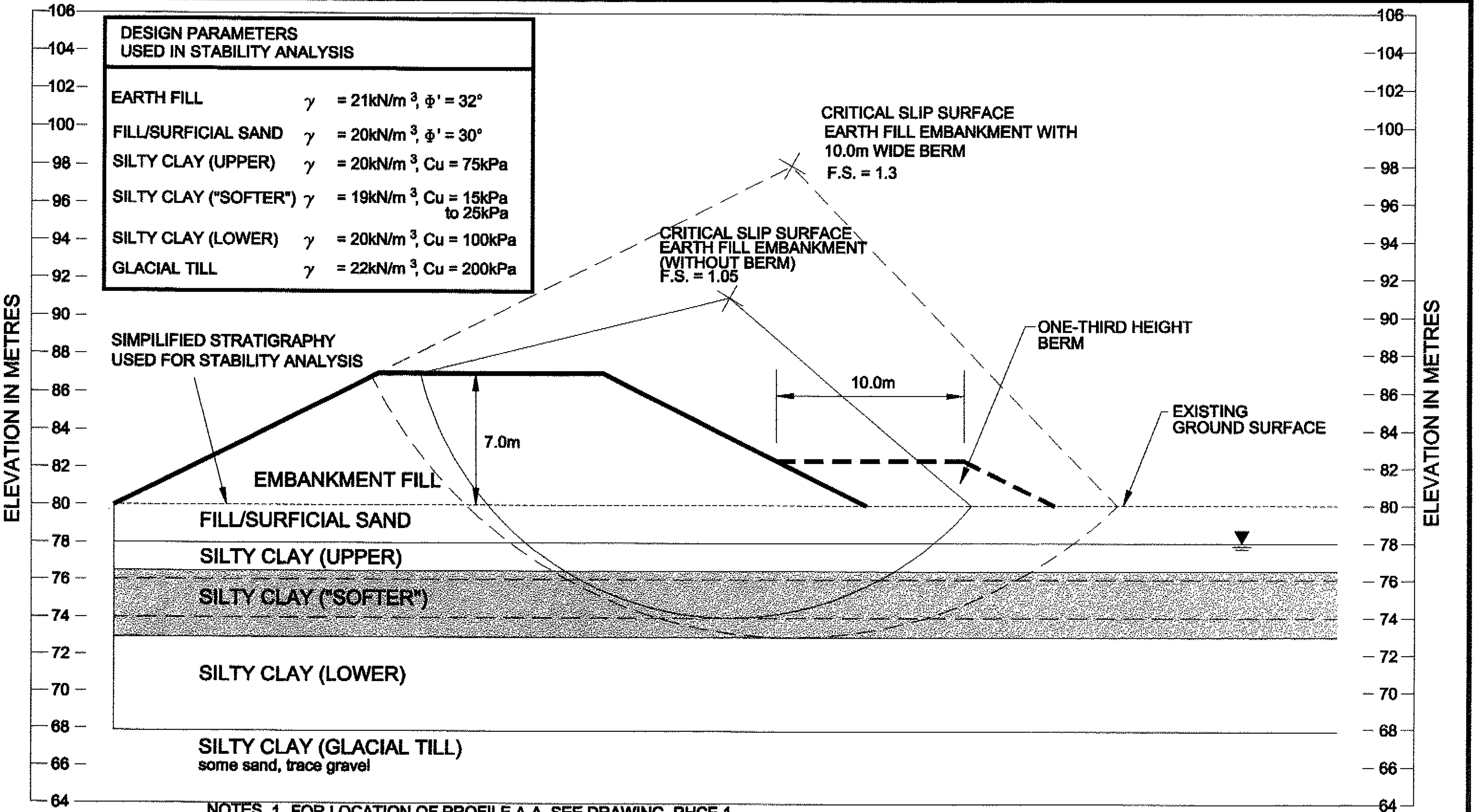
Chkd SP

N8033023.DWG

N8033F24.DWG

TYPICAL STRATIGRAPHY AND STABILITY ANALYSIS SUMMARY PROFILE A-A (E-S RHCE RAMP, STA. 29+850 to 30+100)

FIGURE 24



NOTES
1. FOR LOCATION OF PROFILE A-A, SEE DRAWING RHCE 1.
2. FOR DETAILED STRATIGRAPHIC INFORMATION, REFER TO RECORD OF BOREHOLES RSWR-6, RESR-6, RESR-7, 5 AND 6 .
3. FOR DESIGN STRENGTH PROFILE OF "SOFTER" CLAY LAYER, SEE FIGURE 20.

Date JANUARY, 1999

Project 981-8033

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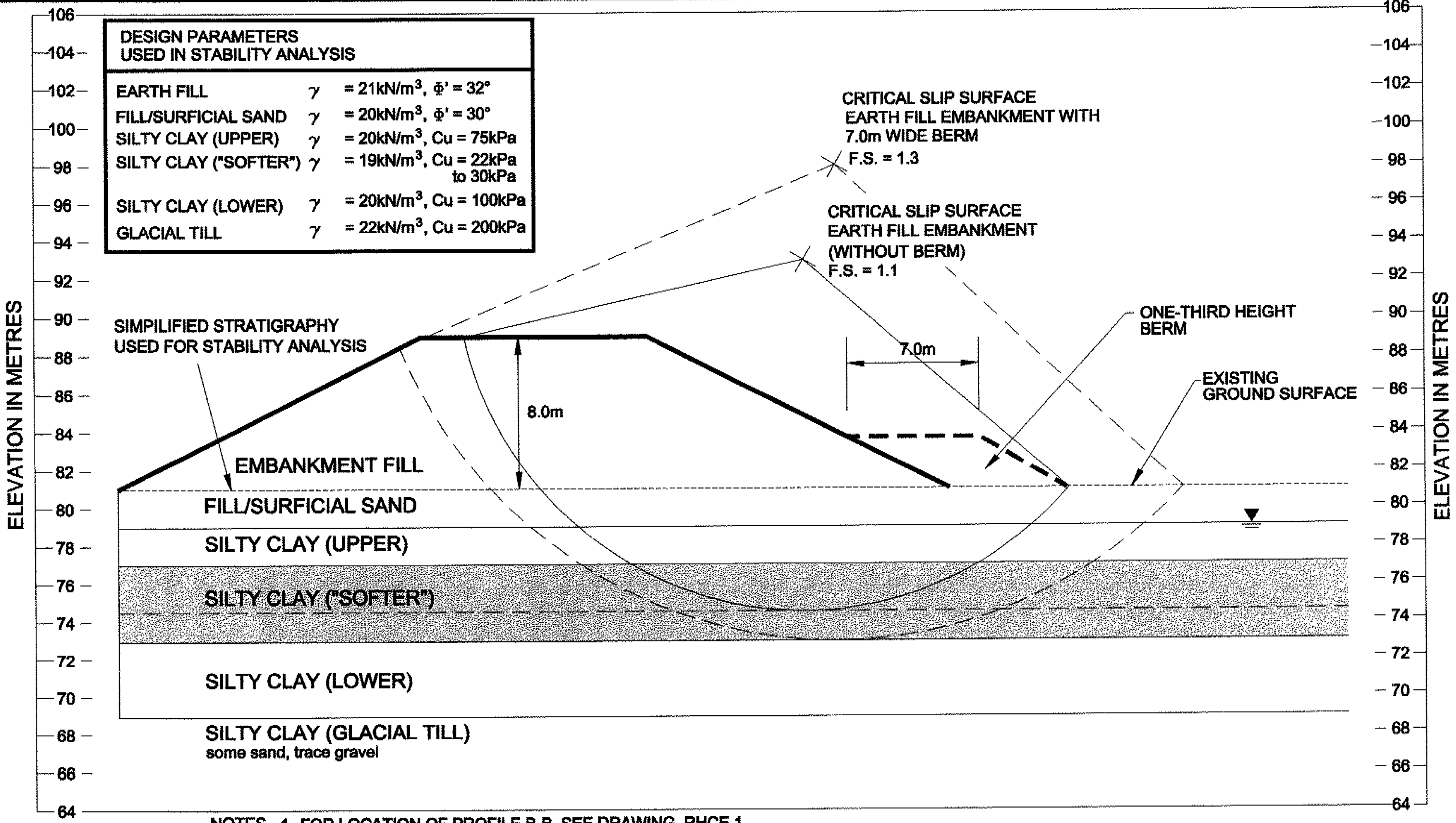
Drawn JFC

Chkd SP

N8033f25.DWG

TYPICAL STRATIGRAPHY AND STABILITY ANALYSIS SUMMARY PROFILE B-B (E-S RHCE AND S-W RHCE RAMPS, STA. 29+600 to 29+850)

FIGURE 25



DESIGN PARAMETERS USED IN STABILITY ANALYSIS

EARTH FILL	γ	$= 21 kN/m^3$, $\Phi' = 32°$
FILL/SURFICIAL SAND	γ	$= 20 kN/m^3$, $\Phi' = 30°$
SILTY CLAY (UPPER)	γ	$= 20 kN/m^3$, Cu = 75kPa
SILTY CLAY ("SOFTER")	γ	$= 19 kN/m^3$, Cu = 22kPa to 30kPa
SILTY CLAY (LOWER)	γ	$= 20 kN/m^3$, Cu = 100kPa
GLACIAL TILL	γ	$= 22 kN/m^3$, Cu = 200kPa

NOTES
1. FOR LOCATION OF PROFILE B-B, SEE DRAWING RHCE 1.
2. FOR DETAILED STRATIGRAPHIC INFORMATION, REFER TO RECORD OF BOREHOLES RESR-4, RSWR-4, RESR-5, RSWR-5, RESR-1, RSWR-1, RESR-2, RSWR-2 AND RESR-3.
3. FOR DESIGN STRENGTH PROFILE OF "SOFTER" CLAY LAYER, SEE FIGURE 21.

Date JANUARY 1999
Project 981-8033

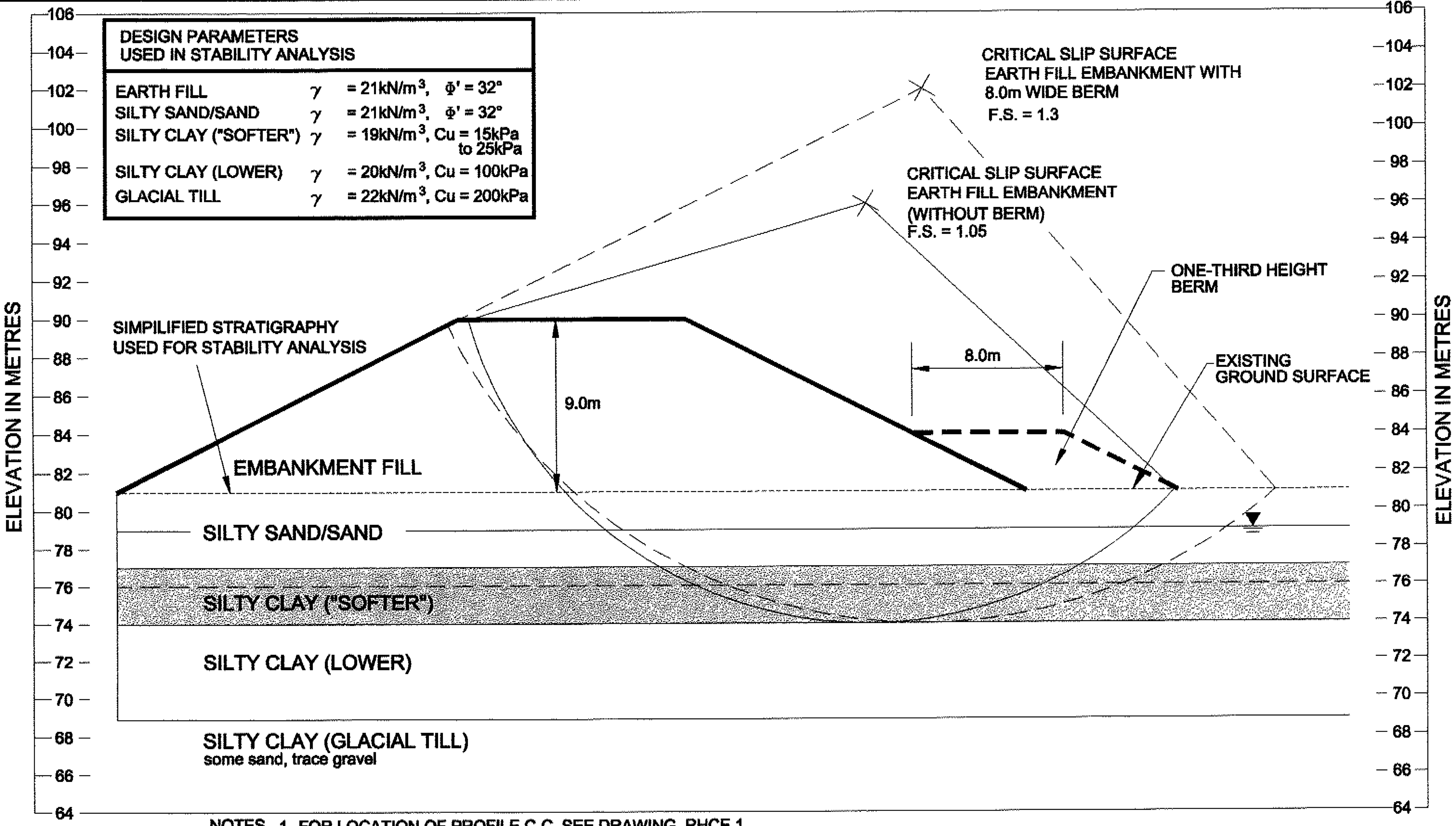
Golder Associates

Drawn JFC
Chkd SP

N8033F26.DWG

TYPICAL STRATIGRAPHY AND STABILITY ANALYSIS SUMMARY PROFILE C-C (E-S RHCE AND S-W RHCE RAMPS, STA. 29+200 to 29+450)

FIGURE 26



DESIGN PARAMETERS
USED IN STABILITY ANALYSIS

EARTH FILL	γ	= 21kN/m^3, Φ' = 32°
SILTY SAND/SAND	γ	= 21kN/m^3, Φ' = 32°
SILTY CLAY ("SOFTER")	γ	= 19kN/m^3, Cu = 15kPa to 25kPa
SILTY CLAY (LOWER)	γ	= 20kN/m^3, Cu = 100kPa
GLACIAL TILL	γ	= 22kN/m^3, Cu = 200kPa

NOTES
1. FOR LOCATION OF PROFILE C-C, SEE DRAWING RHCE 1.
2. FOR DETAILED STRATIGRAPHY, SEE RECORD OF BOREHOLES RSER-1 (THE "SOFTER" CLAY LAYER IS NOT PRESENT IN MOST BOREHOLES WITHIN PROFILE C-C).
3. FOR DESIGN STRENGTH PROFILE OF "SOFTER" CLAY LAYER, SEE FIGURE 22.

Date JANUARY 1999
Project 981-8033

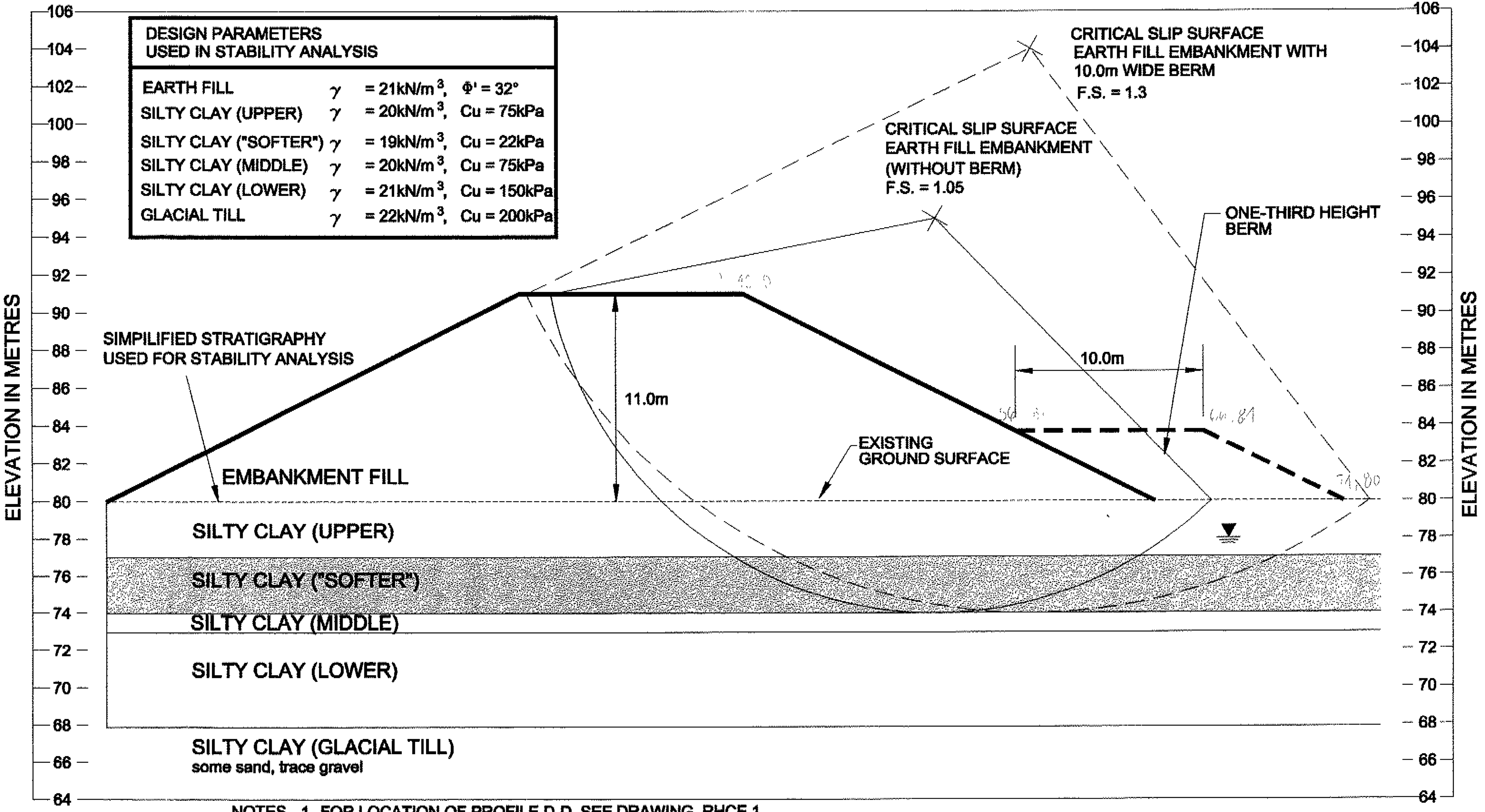
Golder Associates

Drawn JFC
Chkd SP

N8033F27.DWG

TYPICAL STRATIGRAPHY AND STABILITY ANALYSIS SUMMARY
PROFILE D-D (S-E RHCE RAMP, STA. 10+194 TO 10+584)

FIGURE 27



DESIGN PARAMETERS USED IN STABILITY ANALYSIS

EARTH FILL	γ	$= 21 kN/m^3$,	$\Phi' = 32°$
SILTY CLAY (UPPER)	γ	$= 20 kN/m^3$,	Cu = 75kPa
SILTY CLAY ("SOFTER")	γ	$= 19 kN/m^3$,	Cu = 22kPa
SILTY CLAY (MIDDLE)	γ	$= 20 kN/m^3$,	Cu = 75kPa
SILTY CLAY (LOWER)	γ	$= 21 kN/m^3$,	Cu = 150kPa
GLACIAL TILL	γ	$= 22 kN/m^3$,	Cu = 200kPa

NOTES
1. FOR LOCATION OF PROFILE D-D, SEE DRAWING RHCE 1.
2. FOR DETAILED STRATIGRAPHY, SEE RECORD OF BOREHOLES RSER-6, RSER-7 AND 9.
3. FOR DESIGN STRENGTH PROFILE OF "SOFTER" CLAY LAYER, SEE FIGURE 23.

Date JANUARY 1999
Project 981-8033

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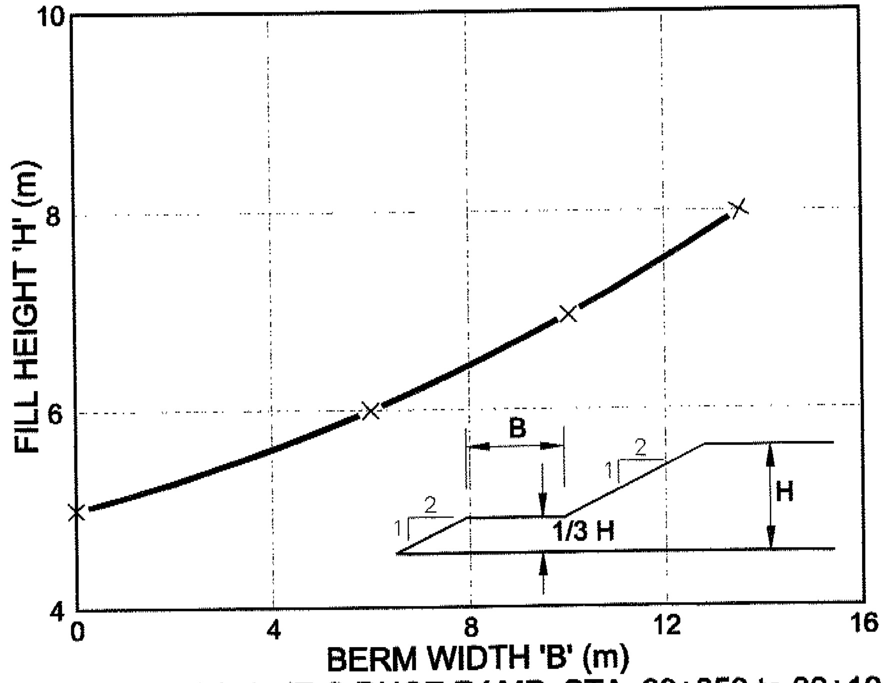
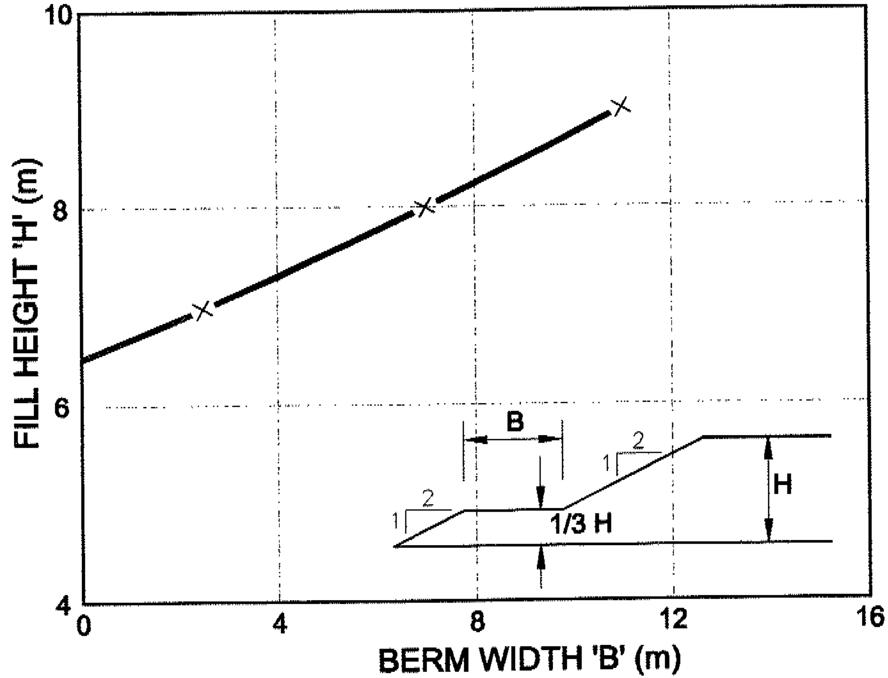
Chkd SP

FILL HEIGHT vs BERM WIDTH
(PROFILES A-A AND B-B)

FIGURE 28



PROFILE A-A (E-S RHCE RAMP, STA. 29+850 to 30+100)



PROFILE B-B (E-S RHCE AND S-W RHCE RAMPS, STA. 28+600 to 29+850)

LEGEND

×▬× F.S. = 1.3 EARTH FILL (γ = 21 kN/m^3)

Date JANUARY 1999

Project 981-8033

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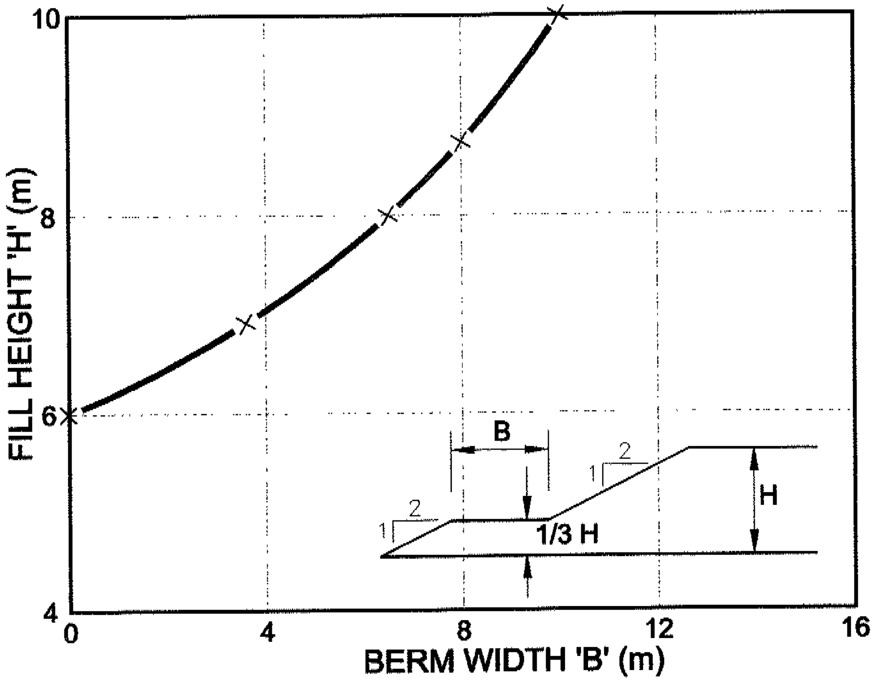
Drawn JFC

Chkd SP

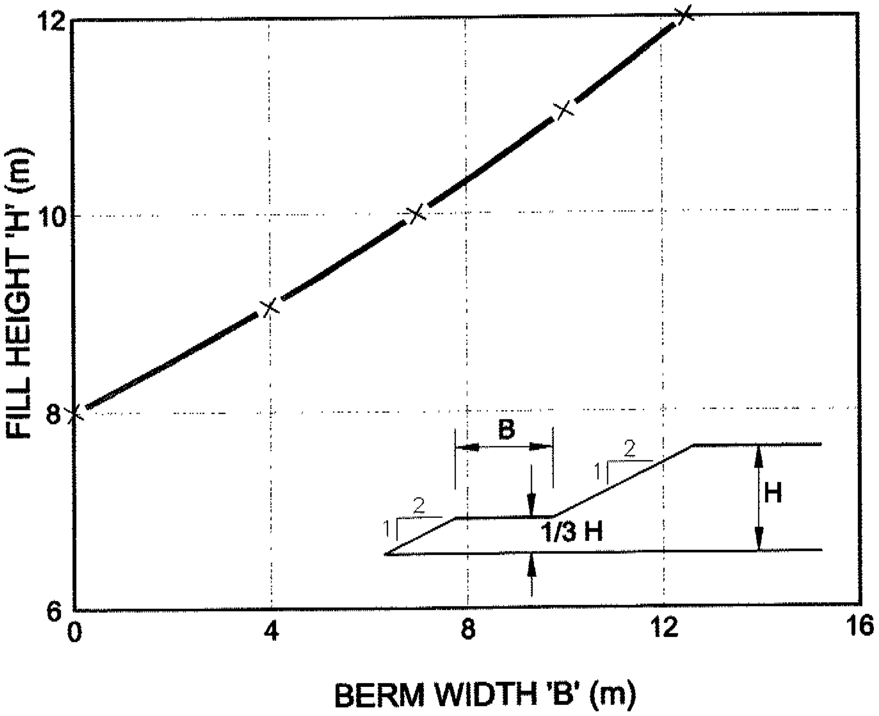
N8033F28.DWG

FILL HEIGHT vs BERM WIDTH (PROFILES C- C AND D-D)

FIGURE 29



PROFILE C-C (E-S RHCE AND S-W RHCE RAMPS, STA. 29+200 to 29+450)



PROFILE D-D (S-E RHCE RAMP, STA. 10+194 to 10+584)

LEGEND

×▬▬× F.S. = 1.3 EARTH FILL ($\gamma = 21\ kN/m^3$)

Date JANUARY 1999

Project 981-8033

Golder Associates

Drawn JFC

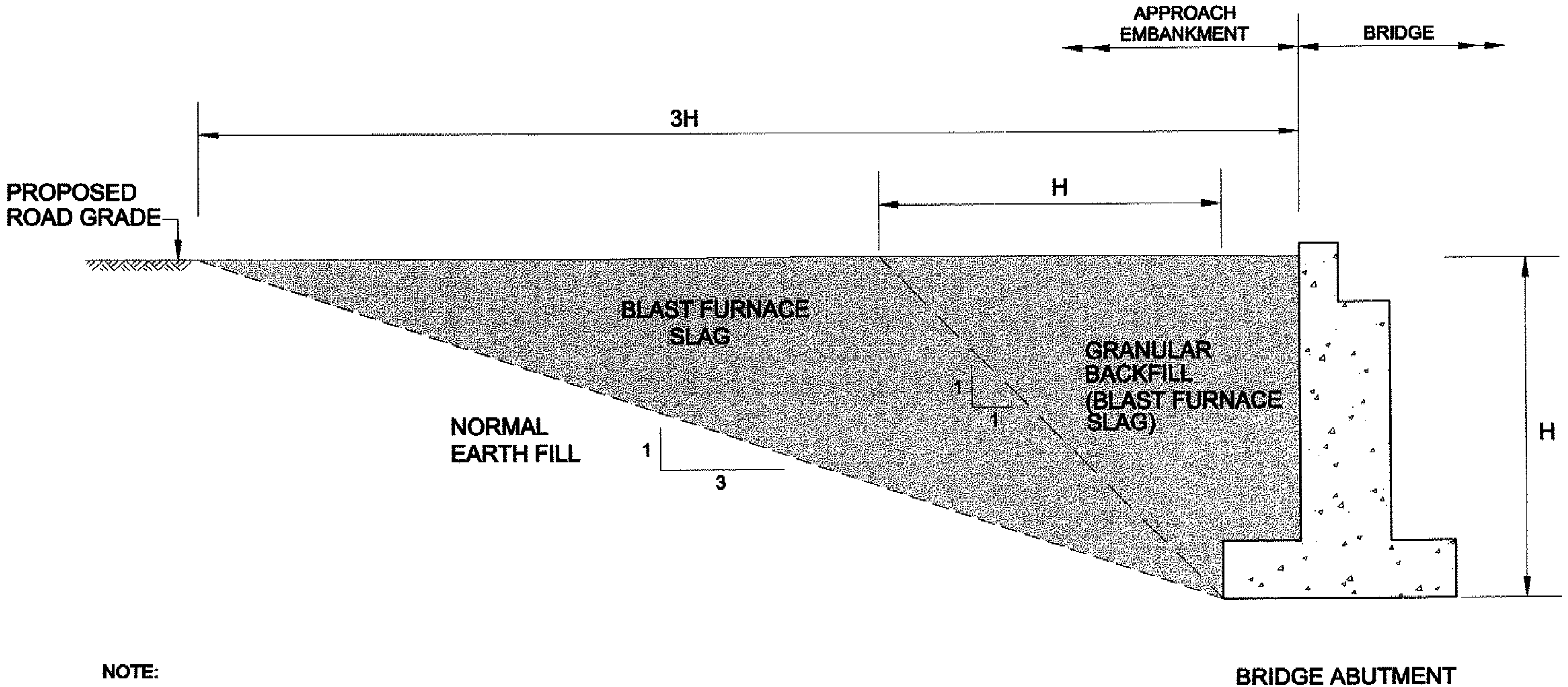
Chkd SP

N8033F29.DWG

N8033F30.DWG

SCHEMATIC SECTION OF BRIDGE ABUTMENT WALL BACKFILLED WITH BLAST FURNACE SLAG

FIGURE 30



NOTE:

THIS DIAGRAM IS ONLY INTENDED TO SHOW SCHEMATICALLY WHERE THE BLAST FURNACE SLAG IS TO BE PLACED BEHIND AN ABUTMENT WALL.

Date NOVEMBER, 1998

Project 981-8033

Golder Associates

Drawn JFC

Chkd SP

APPENDIX I

RECORDS FOR LOW EMBANKMENT BOREHOLES RED HILL CREEK EXPRESSWAY INTERCHANGE

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

E-NORTH SERVICE ROAD RAMP

21+310 at C/L D+0.0

0 - 060 Tps
060 - 750 Br Si Sa
750 - 1.5 Br Sa Si W Cl

21+350 at C/L D+0.0

0 - 060 Tps
060 - 1.5 Br Si Sa

21+400 at C/L D+0.0

0 - 300 Br Sa W Gr, Moist
300 - 1.5 Br Si Cl Tr Sa Tr Gr, Moist

21+450 at C/L D+0.0

0 - 1.5 Cr Gr

21+500 at C/L D+0.0

0 - 750 F Sa Tr Gr, Moist
750 - 1.5 Si Cl Tr Sa Tr Gr, Moist

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

E-NORTH SERVICE ROAD RAMP

21+550 at C/L D+0.0

0 - 600 Br Si Sa W Cl Tr Gr, Moist .... **Sample No. ENSR 7/1**

Sieve	% Passing
2.36 mm	99.9 %
75 μm	56.2 %
5-75 μm	39 %
w	5.0 %
Frost Susc.	LSFH
K	0.32

600 - 1.8 Br Si Cl W Sa Tr Gr, Moist, Hard

21+600 - 2.00 Rt C/L D+0.0

0 - 060 Tps
060 - 900 Si Sa W Gr .... **Sample No. ENSR 8/2**

Sieve	% Passing
9.5 mm	100.0 %
4.75 mm	83.6 %
1.18 mm	61.1 %
75 μm	23.1 %
w	4.0 %
Classification	SM

900 - 1.8 Br Sa Si W Cl Tr Gr, Compact - Dense

21+650 - 5.00 Rt C/L D+0.0

0 - 060 Tps
060 - 900 Sa W Gr Tr Si
900 - 1.5 Br Sa Si Tr Blk Org, Moist

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

E-NORTH SERVICE ROAD RAMP

21+700 at C/L D+0.0

0 - 300 Asph
300 - 750 Cr Gr
750 - 1.5 Br Cl Si W Sa Tr Gr, Moist

21+750 at C/L D+0.0

0 - 300 Asph
300 - 750 Cr Gr
750 - 1.5 Br Sa Si W Cl Tr Org, Moist

21+800 at C/L D+0.0

0 - 380 Asph
380 - 600 Cr Gr
600 - 1.5 Sa Si W Cl Tr Gr Tr Org, Moist

21+850 at C/L D+0.0

0 - 380 Asph
380 - 900 Cr Gr
900 - 1.5 Br Cl Si W Sa Tr Org, Moist

21+900 at C/L D+0.0

0 - 300 Asph
300 - 900 Cr Gr
900 - 1.5 Br Sa W Si Tr Org, Moist

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

E-NORTH SERVICE ROAD RAMP

21+950 at C/L D+0.0

0 - 300 Asph
300 - 900 Cr Gr
900 - 1.8 Br Sa W Si Tr Cl Tr Org, Moist, Dense ....**Sample No. ENSR 15/2**

Sieve	% Passing
2.36 mm	97.6 %
75 μm	51.6 %
5-75 μm	45 %
w	16.6%
Frost Susc.	MSFH
K	0.26

22+000 at C/L D+0.0

0 - 300 Asph
300 - 900 Cr Gr
900 - 1.5 Br Sa Si W Cl Tr Gr Tr Org, Moist

22+050 at C/L D+0.0

0 - 300 Asph
300 - 900 Cr Gr
900 - 1.5 Br Si Sa Tr Cl Tr Org, Moist

22+100 at C/L D+0.0

0 - 300 Asph
300 - 900 Cr Gr
900 - 1.5 Br Sa Si W Cl, Moist

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

E-NORTH SERVICE ROAD RAMP

22+150 at C/L D+0.0

0 - 380 Asph
380 - 960 Cr Gr
960 - 1.5 Gry Si Cl W Sa Tr Gr, Moist

22+200 at C/L D+0.0

0 - 360 Asph
360 - 600 Cr Gr
600 - 1.2 Br Br Sa W Si Tr Org, Compact....................**Sample No. ENSR 20/2**

Sieve	% Passing
2.36 mm	100.0 %
75 μm	99.0 %
5-75 μm	40 %
w	24.9%
Frost Susc.	LSFH
K	0.33

1.2 - 1.8 Br/Gry Si Cl W Sa Tr Gr, Moist, Stiff

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

E-S RHCE RAMP

30+200 at C/L D+0.0

0 - 1.8 Br Sa Si W Cl Tr Gr, Moist, Compact - Dense ....**Sample No. RESR 11/1**

Sieve	% Passing
2.36 mm	100.0%
75 μm	65.5 %
5-75 μm	40 %
w	6.4 %
Frost Susc.	LSFH
K	0.37

30+250 at C/L D+0.0

0 - 3.5 Br/Gry Si Cl Tr Sa Tr Gr, Moist, Very Stiff

30+300 at C/L D+0.0

0 - 600 BrCl Si W Sa W Gr, Hard, Dense ....**Sample No. RESR 13/1**

Sieve	% Passing
2.36 mm	78.1 %
75 μm	61.9 %
5-75 μm	38 %
w	7.9 %
W_l	23.1 %
W_p	13.8 %
I_p	9.3 %
Frost Susc.	LSFH
Classification	CL
K	0.20

600 - 1.8 Br Si Cl Tr Sa Tr Gr, Moist, Very Stiff

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

S-W RHCE RAMP

29+950 at C/L D+0.0

0 - 090 Tps
090 - 1.8 Br Sa Si W Cl Tr Gr Tr Org, Dense ....**Sample No. RSWR 8/1**

Sieve	% Passing
2.36 mm	97.6 %
75 µm	68.3 %
5-75 µm	45 %
w	5.4 %
Frost Susc.	MSFH
K	0.32

30+000 at C/L D+0.0

0 - 090 Tps
090 - 450 Si Sa W Gr
450 - 1.5 Br Sa Si W Cl Tr Gr

30+050 at C/L D+0.0

0 - 060 Tps
060 - 1.5 Si Sa W Gr

30+100 - 2.00 Rt C/L D+0.0

0 - 090 Tps
090 - 300 Gry Si Sa W Gr
300 - 900 Br Sa W Si
900 - 1.1 Blk Org Tps
1.1 - 1.5 Gry Si Cl

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

30+150 at C/L D+0.0

0 - 240 Blk Tps
240 - 1.5 Gry Si Cl W Sa, Moist

S-E RHCE RAMP

10+614 at C/L D+0.0

0 - 090 Tps
090 - 2.4 Br Sa Si W Cl Tr Gr, Compact - Dense ....**Sample No. RSER 8/1**

Sieve	% Passing
2.36 mm	95.7 %
75 µm	69.4 %
5-75 µm	39 %
w	7.6 %
Frost Susc.	LSFH
K	0.28

2.4 - 3.0 Gry Sa Si W Cl Tr Gr Tr Org, Moist, Compact

10+664 at C/L D+0.0

0 - 390 Cr Gr
390 - 1.2 Br Sa Si W Cl Tr Gr Tr Org, Dense
1.2 - 1.8 Br/Gry Cl Si W Sa Tr Org, Moist, Stiff - Very Stiff

10+714 at C/L D+0.0

0 - 210 Cr Gr
210 - 1.5 Br Cl Si W Sa, Moist

10+744 at C/L D+0.0

0 - 450 Cr Gr
450 - 1.5 Br Cl Si W Sa, Moist

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

10+814 at C/L D+0.0

0 - 450 Cr Gr
450 - 1.5 Br/Gry Cl Si W Sa Tr Gr Tr Org

S-E RHCE RAMP

10+864 - 2.00 Lt C/L D+0.0

0 - 090 Tps
090 - 180 Si Sa W Gr ....**Sample No. RSER 13/1**

Sieve	% Passing
2.36 mm	95.9 %
75 μm	70.6 %
5-75 μm	40 %
w	10.8 %
Frost Susc.	LSFH
K	0.23
Classification	ML

180 - 1.8 Br Sa Si W Cl Tr Gr, Compact - Dense

10+914 - 3.00 Lt C/L D+0.0

0 - 030 Tps
030 - 300 Si Sa W Gr
300 - 1.5 Br Sa Si W Cl Tr Gr, Moist

10+964 - 3.00 Lt C/L D+0.0

0 - 060 Tps
060 - 510 Si Sa W Gr
510 - 1.5 Br Sa Si W Cl Tr Gr

11+014 - 5.00 Lt C/L D+0.0

0 - 030 Tps

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

030 - 600 Si Sa W Gr
600 - 1.5 Br Sa Si W Cl Tr Gr, Moist

S-E RHCE RAMP

11+074 at C/L D+0.0

0 - 210 Asph
210 - 600 Cr Gr
600 - 1.5 Br Cl Si W Sa, Moist

11+114 at C/L D+0.0

0 - 210 Asph
210 - 750 Cr Gr
750 - 1.5 Br Cl Si W Sa Tr Gr, Moist

11+164 at C/L D+0.0

0 - 210 Asph
210 - 750 Cr Gr
750 - 1.5 Br Cl Si W Sa, Moist

11+214 at C/L D+0.0

0 - 180 Asph
180 - 750 Cr Gr ....**Sample No. RSER 20/1**

Sieve	% Passing
26.5 mm	98.0 %
19.0 mm	97.5 %
9.5 mm	67.8 %
4.75 mm	45.0 %
1.18 mm	23.3 %
75 μm	6.6 %

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

w 4.8 %
Classification GP-GM

750 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Stiff - Very Stiff
1.5 - 1.8 Gry Si Cl Tr Sa, Moist, Stiff

S-E RHCE RAMP

11+264 at C/L D+0.0

0 - 210 Asph
210 - 750 Cr Gr
750 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

11+314 at C/L D+0.0

0 - 210 Asph
210 - 750 Cr Gr
750 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

11+364 at C/L D+0.0

0 - 150 Asph
150 - 900 Cr Gr
900 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

11+414 at C/L D+0.0

0 - 210 Asph
210 - 600 Cr Gr
600 - 1.6 Br Sa Tr Si Tr Org, Dry - Moist, Dense
1.6 - 1.8 Gry Si Cl W Sa, Moist, Hard

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

S-E RHCE RAMP

11+464 at C/L D+0.0

0 - 210 Asph
210 - 600 Cr Gr
600 - 1.5 Br Si Sa Tr Cl Tr Org, Moist

11+514 at C/L D+0.0

0 - 210 Asph
210 - 900 Cr Gr
900 - 1.5 Br Si Sa Tr Org, Moist - Wet

11+564 at C/L D+0.0

0 - 210 Asph
210 - 690 Cr Gr
690 - 1.5 Br Si Sa Tr Org, Moist

11+614 at C/L D+0.0

0 - 300 Asph
300 - 900 Cr Gr ....**Sample No. RSER 28/1**

Sieve	% Passing
19.0 mm	100.0 %
9.5 mm	83.3 %
4.75 mm	65.0 %
1.18 mm	34.3 %
75 μm	12.8 %

RED HILL CREEK EXPRESSWAY INTERCHANGE RAMPS

w 2.5 %
Classification SM

900 - 1.2 Blk/Br Cl Si W Sa Tr Gr Tr Org, Very Stiff
1.2 - 1.8 Br Si Sa Tr Cl Tr Org, Moist, Compact

S-E RHCE RAMP

11+664 at C/L D+0.0

0 - 330 Asph
330 - 870 Cr Gr
870 - 1.5 Gry Si Cl W Sa, Moist

11+714 at C/L D+0.0

0 - 450 Asph
450 - 900 Cr Gr
900 - 1.5 Gry Si Cl W Sa Tr Gr, Moist

11+764 at C/L D+0.0

0 - 450 Asph
450 - 900 Cr Gr
900 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

HIGHWAY 20 INTERCHANGE RAMPS

W-N/S RAMP

10+150 at C/L D+0.0

0 - 150 Tps
150 - 1.8 Br Cl Si Tr Sa Tr Gr, Stiff -Very Stiff............**Sample No. HWNR 1/1**

Sieve	% Passing
2.36 mm	100.0 %
75 μm	91.1 %
5-75 μm	46 %
w	24.8 %
Frost Susc.	MSFH
K	0.43

10+200 at C/L D+0.0

0 - 150 Tps
150 - 1.5 Br Cl Si Tr Sa

10+250 at C/L D+0.0

0 - 210 Tps
210 - 1.1 Br Sa Si W Cl Tr Gr
1.1 - 1.5 Gry Si Cl W Sa Tr Gr, Moist

10+300 at C/L D+0.0

0 - 180 Tps
180 - 900 Br Sa Si W Cl Tr Gr
900 - 1.5 Gry Cl Si W Sa

HIGHWAY 20 INTERCHANGE RAMPS

W-N/S RAMP

10+340 - 1.00 Lt C/L D+0.0

0 - 090 Tps
090 - 1.8 Br Cl Si Tr Sa, Dry - Moist, - Very Stiff - Hard..... **Sample No. HWNR 5/1**

Sieve	% Passing
2.36 mm	100.0 %
75 µm	95.6 %
5-75 µm	61 %
w	9.5 %
Frost Susc.	HSFH
K	0.45

10+400 - 10.00 Lt C/L D+0.0

0 - 030 Tps
030 - 1.1 Sa W Gr Tr Si
1.1 - 1.5 Br Sa Si W Cl Tr Gr, Moist

HIGHWAY 20 INTERCHANGE RAMPS

N-E RAMP

9+750 - 1.50 Rt C/L D+0.0

0 - 090 Tps
090 - 500 Si Sa W Gr
500 - 1.5 Br Cl Si W Sa Tr Gr Tr Org

9+800 - 2.00 Rt C/L D+0.0

0 - 900 Cr Gr
900 - 1.5 Br Cl Si W Sa Tr Gr Tr Org

9+850 at C/L D+0.0

0 - 150 Asph
150 - 1.1 Cr Gr ....**Sample No.HNER 3/1**

Sieve	% Passing
19.0 mm	100.0 %
9.5 mm	93.9 %
4.75 mm	75.8 %
1.18 mm	50.2 %
75 µm	14.3 %
w	8.3 %
Classification	SM

1.1 - 1.8 Br/Gry Si Cl W Sa, Moist, Stiff - Hard

9+920 - 2.00 Rt C/L D+0.0

0 - 030 Tps
030 - 680 Si Sa W Gr
680 - 1.5 Br/Gry Cl Si W Sa, Moist

HIGHWAY 20 INTERCHANGE RAMPS

N-E RAMP

9+950 - 2.00 Rt C/L D+0.0

0 - 030 Tps
030 - 1.1 Si Sa W Gr
1.1 - 1.5 Br/Gry Cl Si W Sa Tr Gr, Moist

10+000 - 3.00 Rt C/L D+0.0

0 - 030 Tps
030 - 1.1 Si Sa W Gr
1.1 - 1.5 Br/Gry Cl Si W Sa Tr Gr, Moist

VAN WAGNER BEACH ROAD REALIGNMENT

10+000 at C/L D+0.0

0 - 210 Asph
210 - 750 Cr Gr
750 - 1.5 Br Sa W Si, Moist

10+060 at C/L D+0.0

0 - 300 Cr Gr
300 - 1.5 Br Sa W Gr Tr Si

10+100 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Sa W Gr Tr Si

10+150 at C/L D+0.0

0 - 060 Tps
060 - 1.8 Br Si Sa Tr Gr, Compact - Dense ....**Sample No. VWBR 4/1**

Sieve	% Passing
2.36 mm	87.0 %
75 μm	34.5 %
5-75 μm	24 %
w	3.3 %
Frost Susc.	LSFH
K	0.16

10+200 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Si Sa W Gr

10+250 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Si Sa W Gr

VAN WAGNER BEACH ROAD REALIGNMENT

10+300 at C/L D+0.0

0 - 060 Tps
060 - 1.8 Br Si Sa W Gr, Dense

10+360 at C/L D+0.0

0 - 240 Cr Gr
240 - 1.5 Br Si Sa W Gr

10+400 at C/L D+0.0

0 - 150 Asph
150 - 300 Conc
300 - 900 Sa W Gr W Si
900 - 1.5 Br Sa W Si Tr Org, Moist

CONFEDERATION DRIVE REALIGNMENT

10+000 at C/L D+0.0

0 - 210 Asph
210 - 600 Cr Gr
600 - 1.2 Br Sa Si W Cl Tr Gr, Moist, Dense
1.2 - 1.8 Br Si Sa W Cl, Moist, Dense

10+100 - 2.00 Rt C/L D+0.0

0 - 750 Cr Gr
750 - 950 Blk Org Tps
950 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

10+150 at C/L D+0.0

0 - 030 Tps
030 - 750 Si Sa W Gr
750 - 1.5 Br Sa Si, Moist - Wet

10+200 - 2.00 Rt C/L D+0.0

0 - 750 Cr Gr
750 - 900 Blk Org Tps
900 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

10+300 - 4.00 Lt C/L D+0.0

0 - 300 Asph
300 - 750 Cr Gr ....**Sample No. CDR 6/1**

Sieve	% Passing
19.0 mm	100.0 %
9.5 mm	89.8 %
4.75 mm	71.6 %
1.18 mm	52.6 %
75 μm	13.3 %
w	7.5 %
Classification	SM

CONFEDERATION DRIVE REALIGNMENT

750 - 1.2 Br Si Sa Tr Org, Moist, Compact
1.2 - 1.8 Br Si W Sa, Moist, Dense

10+330 - 4.00 Lt C/L D+0.0

0 - 300 Asph
300 - 750 Cr Gr
750 - 1.5 Br Sa Si W Cl Tr Org, Moist

10+420 - 4.00 Lt C/L D+0.0

0 - 300 Asph
300 - 600 Cr Gr
600 - 1.5 Br Cl Si W Sa Tr Gr Tr Org

2

APPENDIX II

RECORDS FOR LOW EMBANKMENT BOREHOLES
BURLINGTON STREET INTERCHANGE

BURLINGTON STREET INTERCHANGE RAMPS

S-W (BS) RAMP

10+657 at C/L D+0.0

0 - 090 Tps
090 - 900 Br Cl Si W Sa Tr Gr, Stiff - Very Stiff
900 - 1.0 Tps
1.0 - 1.8 Gry Si Cl W Sa Tr Gr Tr Org, Moist, Very Stiff

10+710 at C/L D+0.0

0 - 090 Tps
090 - 750 Br Si Cl W Sa Tr Gr Tr Org
750 - 1.5 Br Cl Si W Sa Tr Gr, Moist

Note: Stations and offsets are approximate as the alignment of the ramp was modified after the initial field work had been completed.

BURLINGTON STREET INTERCHANGE RAMPS

W-S (BS) RAMP

10+038 - 2.00 Lt C/L D+0.0

0	- 150 Asph
150	- 530 Cr Gr
550	- 1.5 Si Tr F Sa & Gr, Moist

10+088 - 2.00 Lt C/L D+0.0

0	- 150 Asph
150	- 470 Cr Gr
470	- 810 Si W Gr Tr F Sa, Moist
810	- 1.5 Si Tr Gr & Org, Moist

10+139 - 4.00 Lt C/L D+0.0

0	- 150 Asph
150	- 640 Cr Gr
640	- 1.5 Si Occ Pkts Cl, Moist

BURLINGTON STREET INTERCHANGE RAMPS

W-S (BS) RAMP

10+189 - 6.00 Lt C/L D+0.0

0 - 130 Asph
130 - 520 Cr Gr
520 - 930 Si W Gr
930 - 1.5 Si Tr F Sa & Cl, Wet @ 1.4

10+240 - 7.50 Lt C/L D+0.0

0 - 150 Asph
150 - 650 Cr Gr
650 - 1.0 Si W Gr Tr F Sa, Moist
1.0 - 1.5 Si Tr F Sa, Moist

10+695 - 8.00 Lt C/L D+0.0

0 - 100 Tps
100 - 1.5 Sa Si Tr Cl Tr Gr

10+745 - 9.00 Lt C/L D+0.0

0 - 150 Tps
150 - 1.5 Si W Cl, Moist, Firm

10+850 - 9.00 Lt C/L D+0.0

0 - 150 Tps
150 - 1.5 Br Cl Si W Sa Tr Gr

10+850 at C/L D+0.0

0 - 150 Tps
150 - 1.2 Br Cl Si W Sa Tr Gr W Org, Dry - Moist, Very Stiff - Hard

BURLINGTON STREET INTERCHANGE RAMPS

1.2 - 3.1 Br/Gry Si Cl W Sa Tr Gr W Org, Moist, Hard - Firm

W-S (BS) RAMP

10+950 at C/L D+0.0

0 - 150 Tps
150 - 1.8 Br Cl Si W Sa Tr Gr W Org, Dry - Moist, Hard - Firm
1.8 - 1.9 Peat
1.9 - 2.6 Gry/Blk Sa W Si Tr Cl, Wet, Loose

11+050 at C/L D+0.0

0 - 200 Tps
200 - 1.2 Br Cl Si W Sa Tr Gr Tr Org, Very Stiff
1.2 - 2.0 Blk Peat, Moist, Stiff

11+200 - 5.00 Rt C/L D+0.0

0 - 150 Tps
150 - 1.8 Br Cl Si W Sa Tr Gr W Org, Dry - Moist, Very Stiff

11+150 at C/L D+0.0

0 - 210 Tps
210 - 2.4 Br/Gry Cl Si W Sa Tr Gr W Org, Dry - Moist, Hard - Very Stiff

BURLINGTON STREET INTERCHANGE RAMPS

E-S (BS) RAMP

10+260 at C/L D+0.0

0 - 150 Asph
150 - 900 Cr Gr
900 - 1.5 Br Cl Si W Sa Tr Gr, Moist

10+300 at C/L D+0.0

0 - 180 Asph
180 - 600 Cr Gr
600 - 1.8 Br Cl Si W Sa Tr Gr Tr Org, Dry - Moist, Very Stiff - Hard

10+360 - 7.00 Lt C/L D+0.0

0 - 150 Tps
150 - 1.8 Br Sa Si W Cl Tr Gr Tr Org, Compact

10+400 at C/L D+0.0

0 - 210 Tps
210 - 1.8 Br/Blk Cl Si W Sa Tr Gr, Stiff - Very Stiff

10+930 at C/L D+0.0

0 - 300 Asph
300 - 450 Cr Gr
450 - 900 Br Si Sa
900 - 1.5 Br Cl Si W Sa Tr Gr, Moist

10+980 at C/L D+0.0

BURLINGTON STREET INTERCHANGE RAMPS

0 - 300 Asph
300 - 690 Cr Gr
690 - 1.5 Br Sa Si W Cl Tr Gr

E-S (BS) RAMP

11+020 at C/L D+0.0

0 - 390 Asph
390 - 900 Cr Gr
900 - 1.5 Br Cl Si W Sa Tr Gr

11+060 at C/L D+0.0

0 - 210 Asph
210 - 900 Cr Gr
900 - 1.8 Br Cl Si W Sa Tr Gr, Moist, Very Stiff - Hard

BURLINGTON STREET INTERCHANGE RAMPS

S-E (BS) RAMP

10+200 - 2.00 Lt C/L D+0.0

0 - 090 Tps
090 - 600 Br Sa Si W Cl
600 - 1.5 Br Cl Si W Sa Tr Gr

10+260 at C/L D+0.0

0 - 180 Tps
180 - 750 Br Sa Si W Cl
750 - 1.5 Br Cl Si W Sa Tr Gr

10+310 at C/L D+0.0

0 - 180 Tps
180 - 3.0 Br Sa Si W Cl Tr Gr Tr Org, Compact - Dense ...**Sample No. BSER 6/1**

Sieve	% Passing
2.36 mm	99.7 %
75 μm	57.3 %
5-75 μm	38 %
w	6.6 %
Frost Susc.	LSFH
Classification	CL
K	0.20

10+470 at C/L D+0.0

0 - 300 Asph
300 - 750 Cr Gr

BURLINGTON STREET INTERCHANGE RAMPS

750 - 2.7 Br Cl Si W Sa Tr Gr, Moist, Stiff - Hard
2.7 - 2.9 Asph
2.9 - 3.0 Br Si Sa, Moist, Dense

S-E (BS) RAMP

10+500 at C/L D+0.0

0 - 360 Asph
360 - 600 Cr Gr
600 - 3.0 Br/Blk Sa Si W Cl Tr Gr Tr Org, Moist, Compact ..**Sample No. BSER 2/2**

Sieve	% Passing
2.36 mm	99.1 %
75 μm	57.5 %
5-75 μm	33 %
w	15.6 %
W_l	33.3 %
W_p	17.2 %
I_p	16.1 %
Frost Susc.	LSFH
Classification	CL
K	0.22

10+616 at C/L D+0.0

0 - 180 Asph
180 - 540 Cr Gr
540 - 1.5 Br/Blk Cl Si W Sa Tr Gr Tr Org

BURLINGTON STREET INTERCHANGE RAMPS

S-E RHCE RAMP

9+773 - 4.00 Rt C/L D+0.0

0 - 180 Asph
180 - 510 Cr Gr
510 - 1.5 Br cl Si W Sa Tr Gr, Moist

9+823 at C/L D+0.0

0 - 210 Asph
210 - 450 Cr Gr
450 - 1.5 Br/Blk Cl Si W Sa Tr Gr Tr Org

9+873 at C/L D+0.0

0 - 210 Asph
210 - 450 Cr Gr
450 - 1.5 Br/Blk Cl Si W Sa Tr Gr Tr Org

9+923 at C/L D+0.0

0 - 180 Asph
180 - 450 Cr Gr
450 - 1.5 Br/Blk Cl Si W Sa Tr Gr Tr Org, Moist

9+983 - 3.00 Lt C/L D+0.0

BURLINGTON STREET INTERCHANGE RAMPS

0 - 450 Gry Si Sa W Gr
450 - 1.5 Br Cl Si W Sa Tr Gr Tr Blk Org, Moist

10+027 - 2.00 Lt C/L D+0.0

0 - 300 Cr Gr
300 - 900 Br/Blk Cl Si W Sa Tr Gr, Stiff - Very Stiff
900 - 1.2 Blk Cl Si Tps, Moist
1.2 - 1.8 Br Cl Si W Sa Tr Gr, Moist, Stiff

S-E RHCE RAMP

10+073 at C/L D+0.0

0 - 150 Tps
150 - 1.1 Br Si Sa W Gr
1.1 - 1.5 Gry/Br Cl Si W Sa Tr Gr, Moist

10+123 at C/L D+0.0

0 - 180 Tps
180 - 1.2 Br Cl Si W Sa W Gr Tr Org, Very Stiff - Hard.....**Sample No. BSRH 5/1**

Sieve	% Passing
2.36 mm	82.4 %
75 μm	67.8 %
5-75 μm	34 %
w	10.4 %
W_l	32.0 %
W_p	17.5 %
I_p	14.5 %
Frost Susc.	LSFH
Classification	CL
K	0.16

1.2 - 1.4 Brick Debris
1.4 - 3.5 Br Cl Si W Sa Tr Gr, Stiff - Hard

BURLINGTON STREET INTERCHANGE RAMPS

10+223 at C/L D+0.0

0 - 150 Tps
150 - 240 Si Sa W Gr
240 - 600 Br/Gry Sa Si W Cl Tr Gr Tr Org, Compact - Dense
600 - 1.8 Br/Gry Cl Si W Sa Tr Gr Tr Org, Very Stiff
1.8 - 3.0 Br Si Cl W Sa Tr Gr, Moist, Very Stiff

S-E RHCE RAMP

10+273 at C/L D+0.0

0 - 090 Tps
090 - 150 Si Sa W Gr
150 - 1.2 Br Sa Si W Cl Tr Gr Tr Org, Compact - Dense
1.2 - 1.5 Blk Si Cl Tps
1.5 - 1.8 Gry Si Cl W Sa Tr Gr, Very Stiff

10+323 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Sa Si W Cl Tr Gr

10+373 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Sa Si W Cl Tr Gr

BURLINGTON STREET INTERCHANGE RAMPS

W - WOODWARD AVE RAMP

10+015 - 8.00 Rt C/L D+0.0

0 - 090 Tps
090 - 2.4 Br Si Sa W Gr Tr Cl Tr Org, Moist, Compact - Very Dense

10+110 - 1.00 Lt C/L D+0.0

0 - 090 Tps
090 - 2.5 Br Cl Si W Sa Tr Gr Tr Org, Dry - Moist, Very Stiff - Hard

10+145 - 2.00 Lt C/L D+0.0

0 - 090 Tps
090 - 2.5 Br Cl Si W Sa Tr Gr W Org Tr Brick Debris, Dry - Moist, Very Stiff - Stiff

10+180 - 2.00 Lt C/L D+0.0

0 - 090 Tps
090 - 600 Br Sa Si W Cl Tr Gr W Org, Dense
090 - 2.5 Br/Gry Cl Si W Sa Tr Gr Tr Org, Dry - Moist, Very Stiff - Stiff

BURLINGTON STREET INTERCHANGE RAMPS

WOODWARD W-S BURLINGTON STREET RAMP

10+000 at C/L D+0.0

0 - 210 Asph
210 - 600 Cr Gr
600 - 1.5 Br Si Cl W Sa Tr Gr Tr Org

10+050 - 1.50 Lt C/L D+0.0

0 - 210 Asph
210 - 690 Cr Gr
690 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

10+100 - 1.00 Lt C/L D+0.0

0 - 180 Asph
180 - 1.2 Cr Gr
- 1.2 NFP Blds

10+150 at C/L D+0.0

0 - 150 Asph
150 - 600 Cr Gr
600 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

BURLINGTON STREET INTERCHANGE RAMPS

10+200 at C/L D+0.0

0 - 060 Tps
060 - 300 Si Sa W Gr
300 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

10+250 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

WOODWARD W-S BURLINGTON STREET RAMP

10+300 at C/L D+0.0

0 - 090 Tps
090 - 1.8 Br Cl Si W Sa Tr Gr Tr Org, Dry - Moist, Stiff - Very Stiff

10+350 at C/L D+0.0

0 - 060 Tps
060 - 600 Br Cl Si W Sa Tr Gr Tr Org, Moist
600 - 1.5 Blk Si Cl Tps

10+410 at C/L D+0.0

0 - 060 Tps
060 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Dry - Moist

10+470 at C/L D+0.0

0 - 240 Asph
240 - 600 Cr Gr
600 - 1.5 Si Sa W Gr, Moist
1.5 - 1.8 Br Cl Si W Sa Tr Gr, Moist, Stiff

BURLINGTON STREET INTERCHANGE RAMPS

WOODWARD E-S BURLINGTON STREET RAMP

10+000 at C/L D+0.0

0 - 150 Asph
150 - 600 Cr Gr
600 - 1.2 Br Cl Si W Sa Tr Gr, Hard
1.2 - 1.8 Br/Gry Si Sa W Gr, Moist, Compact

10+050 - 2.00 Rt C/L D+0.0

0 - 150 Asph
150 - 510 Cr Gr
510 - 1.5 Br/Gry Cl Si W Sa Tr Gr Tr Org

10+090 at C/L D+0.0

0 - 170 Asph
170 - 600 Cr Gr
600 - 1.5 Br Cl Si W Sa Tr Gr Tr Org, Moist

10+120 at C/L D+0.0

BURLINGTON STREET INTERCHANGE RAMPS

0 - 060 Tps
060 - 1.2 Br Cl Si W Sa Tr Gr Tr Org, Hard
1.2 - 3.0 Br/Gry Si Cl W Sa Tr Gr Tr Org, Moist - Wet, Stiff - Very Stiff

W-RHCE RAMP

10+200 - 7.00 Rt C/L D+0.0

0 - 150 Tps
150 - 1.8 Br Cl Si W Sa Tr Gr Tr Org, Dry - Moist, Very Stiff

10+250 at C/L D+0.0

0 - 150 Tps
150 - 600 Br Sa Si W Cl Tr Gr Tr Org, Compact
600 - 1.8 Br Cl Si W Sa Tr Gr Tr Org, Stiff - Very Stiff

10+300 at C/L D+0.0

0 - 150 Tps
150 - 1.2 Br Sa Si W Cl Tr Gr Tr Org, Loose - Compact
1.2 - 2.6 Blk/Br Sa Tr Si Tr Cl, Moist - Wet, Loose
2.6 - 4.2 Gry Sa W Si, Wet, Stiff

10+400 at C/L D+0.0

BURLINGTON STREET INTERCHANGE RAMPS

0 - 180 Tps
180 - 600 Br Sa Si W Cl Tr Gr Tr Org, Compact
600 - 2.3 Br/Blk Cl Si W Sa Tr Gr Tr Org, Moist, Firm - Stiff
2.3 - 3.6 Blk Tps W Peat Tr Sa, Moist
3.6 - 4.2 Blk/Gry Sa W Si Tr Org, Wet, Loose
4.2 - 4.4 Br Cl Si W Sa Tr Gr, Wet, Stiff

10+450 at C/L D+0.0

0 - 210 Tps
210 - 1.2 Br Sa Si W Cl Tr Gr Tr Org, Compact
1.2 - 1.8 Br Sa Si W Cl Tr Gr Tr Org Tr Brick Debris, Moist, Compact

W-RHCE RAMP

10+515 at C/L D+0.0

0 - 300 Tps
300 - 1.5 Br Sa Si W Cl Tr Gr Tr Org

10+550 at C/L D+0.0

0 - 300 Tps
300 - 1.8 Br Sa Si W Cl Tr Gr Tr Org, Compact - Dense

10+750 at C/L D+0.0

0 - 180 Tps
180 - 600 Br Si Sa W Cl Tr Gr Tr Org, Compact ....**Sample No. WRHR 27/1**

Sieve	% Passing
2.36 mm	99.4 %
75 μm	55.1 %
5-75 μm	38 %
w	6.1 %

BURLINGTON STREET INTERCHANGE RAMPS

Frost Susc.	LSFH
K	0.23

600 - 1.8 Br Cl Si W Sa Tr Gr, Hard

10+800 at C/L D+0.0

0 - 090 Tps
090 - 1.2 Br Sa Si W Cl Tr Org
1.2 - 1.5 Blk Org Tps

W-RHCE RAMP

10+850 at C/L D+0.0

0 - 150 Tps
150 - 1.5 Br Sa Si W Cl Tr Blk Org Tps

10+900 at C/L D+0.0

0 - 180 Tps
180 - 900 Br Sa Si W Cl
900 - 1.5 Br Cl Si W Sa Tr Gr

10+950 at C/L D+0.0

0 - 150 Tps
150 - 600 Br Si Sa W Gr
600 - 1.2 Br Sa Si W Cl Tr Gr Tr Org, Compact
1.2 - 1.8 Br Cl Si W Sa Tr Gr, Hard

BURLINGTON STREET INTERCHANGE RAMPS

11+050 - 1.00 Rt C/L D+0.0

0 - 1.1 Br/GryCl Si W Sa Tr Gr Tr Org
1.1 - 1.5 Gry/Br Si Cl W Sa Tr Gr, Moist

11+100 - 2.00 Rt C/L D+0.0

0 - 1.5 Br/Gry Cl Si W Sa Tr Gr, Pieces of Metals, Dry - Moist

W-RHCE RAMP

11+150 - 1.00 Lt C/L D+0.0

0 - 150 Peat
150 - 750 Br Sa Si Tr Gr, Moist - Wet
750 - 1.5 Gry/Br Si Cl W Sa Tr Gr, Moist - Wet

11+250 - 3.00 Rt C/L D+0.0

0 - 300 Peat
300 - 1.1 Gry/Br Cl Si W Sa Tr Gr, Moist - Wet
1.1 - 1.5 Br/Gry Si Cl W Sa Tr Gr Tr Org, Moist - Wet

11+300 - 2.00 Rt C/L D+0.0

0 - 300 Blk/Br Peat

BURLINGTON STREET INTERCHANGE RAMPS

300 - 750 Gry/Br Cl Si W Sa Tr Gr, Moist - Wet
750 - 1.1 Br/Gry Si Cl W Sa Tr Gr Tr Org, Moist - Wet

11+400 - 12.00 Rt C/L D+0.0

0 - 300 Blk/Br Peat
300 - 1.1 Gry/Br Cl Si W Sa Tr Gr Tr Org, Moist - Wet
1.1 - 1.5 Gry/Br Si Cl W Sa Tr Gr Tr Org, Moist - Wet

11+450 - 4.00 Rt C/L D+0.0

0 - 300 Peat, Moist - Wet
300 - 1.2 Br/Gry Cl Si W Sa Tr Gr, Moist - Wet
1.2 - 1.5 Br/Gry Si Cl W Sa Tr Gr Tr Org, Moist - Wet

W-RHCE RAMP

11+500 - 3.00 Rt C/L D+0.0

0 - 300 Blk Peat
300 - 750 Br/Gry Cl Si W Sa Tr Gr, Moist - Wet
750 - 1.4 Gry/Br Si Cl W Sa Tr Gr, Moist - Wet

11+550 - 8.00 Rt C/L D+0.0

0 - 300 Blk/Br Peat
300 - 900 Br/Gry Cl Si W Sa Tr Gr, Moist - Wet

11+600 - 3.00 Rt C/L D+0.0

0 - 120 Tps
120 - 720 Br Si Sa

BURLINGTON STREET INTERCHANGE RAMPS

720 - 1.5 Br Cl Si W Sa Tr Gr

11+650 at C/L D+0.0

0 - 150 Tps
150 - 680 Cl Si W Sa Tr Gr Tr Org, Stiff
680 - 2.0 Sa Si W Cl Tr Gr, Compact - Dense

11+700 at C/L D+0.0

0 - 060 Tps
060 - 1.5 Br Cl Si W Sa Tr Gr

W-RHCE RAMP

11+750 at C/L D+0.0

0 - 060 Tps
060 - 750 Br Cl Si W Sa Tr Gr
750 - 1.5 Br Cl Si W Sa

11+800 at C/L D+0.0

0 - 090 Tps
090 - 1.5 Br Cl Si W Sa Tr Gr, Stiff - Hard

11+850 at C/L D+0.0

BURLINGTON STREET INTERCHANGE RAMPS

0 - 090 Tps
090 - 2.0 Br Si Sa Tr Cl Tr Gr, Compact - Dense ....**Sample No. WRHR 5/1**

Sieve	% Passing
2.36 mm	100.0 %
75 μm	54.2 %
5-75 μm	39 %
w	4.8 %
W_l	23.3 %
W_p	16.7 %
I_p	6.6 %
Frost Susc.	LSFH
Classification	CL-ML
K	0.32

This report was prepared
for Hamilton-Wentworth
but should be kept in
our files under a
separate GEOCres No.

GEOCRES No
30M4-85

Golder Associates Ltd.

2180 Meadowvale Boulevard
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Golder Associates

PRELIMINARY REPORT

PRELIMINARY FOUNDATION INVESTIGATION QUEEN ELIZABETH WAY / RED HILL CREEK EXPRESSWAY INTERCHANGE STONEY CREEK, ONTARIO

Submitted to:

McCormick Rankin Corporation
2655 North Sheridan Way
Mississauga, Ontario, L5K 2P8

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April 1998

981-1108

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Fax (905) 567-6561

Golder Associates

April 09, 1998

981-1108

McCormick Rankin Corporation
2655 North Sheridan Way
Mississauga, Ontario
L5K 2P8

ATTENTION: Mr. Michael Chiu, P.Eng.

RE: PRELIMINARY FOUNDATION INVESTIGATION
QUEEN ELIZABETH WAY /
RED HILL CREEK EXPRESSWAY INTERCHANGE
STONEY CREEK, ONTARIO

Dear Sirs:

Please find enclosed our preliminary report which provides recommendations for the geotechnical aspects of preliminary design of the works for the proposed Queen Elizabeth Way / Red Hill Creek Expressway Interchange, Stoney Creek, Ontario.

We trust that the contents of this report is satisfactory for your present requirements. Should you have any questions regarding the information provided herein, or require further information, please contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

Anne S. Poschmann, P.Eng.
Principal

SP/ASP/sp/clg
WORD S/FINALDAT/1100/981-1108/81108DR1

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION

Golder Associates Ltd. has been retained by McCormick Rankin Corporation (MRC) on behalf of the Regional Municipality of Hamilton Wentworth to carry out a foundation investigation at the site of the proposed Queen Elizabeth Way and Red Hill Creek Expressway Interchange in Stoney Creek, Ontario. We understand that this project involves the construction of four new bridges, including one crossing the QEW, and several new ramps incorporating parts of the alignment of the existing North Service Road. Fill embankments associated with the ramps and bridge abutments will be up to 10 m in height. Consideration is being given to the use of reinforced earth walls at two of the bridge abutment locations.

The purpose of the foundation investigation is to determine the subsurface conditions at the locations of the proposed bridge structures and at selected embankment locations, by means of a limited number of boreholes. In-situ tests were carried out at regular intervals of depths, and laboratory tests were carried out on selected soil samples. Based on our interpretation of the factual data obtained, recommendations are provided on the geotechnical aspects of preliminary foundation design. Comments are also provided on anticipated construction aspects, where they may affect the design of the proposed works.

The subsurface information obtained during a previous investigation, titled "Foundation Investigation Report for Proposed Underpass Structure at the Crossing of the Reconstructed QEW at Hwy. #20, Stoney Creek Traffic Circle, Co. of Wentworth, Dist. No.4 (Hamilton), Cont. No. 74-110, W.P. 10-57-02, W.O. 72-11033, Site 36-144, has been referenced in the preparation of this report.

The terms of reference for this project are in general accordance with those outlined in the Work Package, Design Preliminaries No. 1 Task No. 1.3, and Miscellaneous Preliminary Design No.4 Task No. 4.1, dated January 21, 1998.

2.0 SITE DESCRIPTION

The site is located in the vicinity of the existing interchange between the Queen Elizabeth Way (QEW) and Centennial Parkway (Highway 20). The south shore of Lake Ontario is less than 1 km north of the site (see key plan). The terrain in this area is generally flat-lying. The ground surface at the site generally varies between about Elevations 78 m and 83 m, along the alignment of the proposed works. Minor undulations across the site mainly involve fill embankments at the existing interchange, the right-of-way of the QEW, as well as regrading and landscape on adjacent lands

3.0 INVESTIGATION PROCEDURES

The field work for this investigation was carried out between February 11 and February 25, 1998. During this period, seven boreholes were drilled at the proposed bridge abutment locations, and two boreholes were drilled at selected locations along the proposed embankments. The investigation was carried out using a track-mounted CME 55 drill rig supplied and operated by a specialist drilling contractor from Toronto.

The boreholes were advanced to depths ranging from 7.6 m to 21.4 m below existing ground surface. In each borehole, soil samples were obtained at 0.75 m to 1.5 m intervals of depth as part of the Standard Penetration Test (SPT) using conventional 50 mm diameter split spoon samplers. Field vane shear tests using a standard MTO NX size vane were carried out within the softer cohesive zones. Relatively undisturbed cohesive soil samples were retrieved at selected depths, using 75 mm diameter thin-walled Shelby tube samples, in Boreholes 3 and 6. Groundwater conditions in the boreholes were observed during the drilling operations. One 19 mm diameter piezometer was installed in each of seven selected boreholes to permit monitoring of the groundwater levels.

The field work for this investigation was supervised by members of our technical staff who cleared the locations of buried utilities and logged the boreholes. The soil and rock samples obtained were placed in labeled plastic containers and transported to our Mississauga laboratory for further examination and laboratory testing. Representative soil samples were tested to determine Atterberg limits, grain size distribution and natural water content. A specimen of the softer cohesive soil, prepared from a Shelby tube sample, was subjected to a laboratory oedometer test to determine its consolidation characteristics.

Approximate coordinates and ground surface elevations at the as-drilled borehole locations, as reported in this draft report, were provided by MRC based on borehole location sketches prepared by Golder Associates field staff. Precise survey of these boreholes will be carried out once a survey crew can be arranged by MRC. The approximate northing and easting co-ordinates, as well as ground surface elevations, of the boreholes are shown on the Record of Borehole sheets. It is understood that the elevations are referred to the Geodetic datum.

4.0 GENERAL SITE GEOLOGY AND STRATIGRAPHY

4.1 Site Geology

The QEW in this area follows the shoreline of Lake Ontario and lies mainly in the Iroquois Plain physiographic region. The Iroquois Plain is generally composed of shallow sandy materials deposited on the bed of the glacial Lake Iroquois. The area is also referred to as the Niagara Fruit Belt (Chapman and Putnam, "The Physiography of Southern Ontario", 3rd Edition, 1984). The bedrock at this site is shale of the Queenston Formation. The depth to bedrock at this site is in the range of 10 m or deeper below ground surface.

4.2 Description of Subsurface Conditions

The detailed subsurface soil, bedrock and groundwater conditions encountered in the boreholes, together with the results of the laboratory tests carried out on selected soil samples, are presented on the attached Record of Borehole sheets. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and, therefore, represent transitions between soil types rather than exact planes of geological change. Subsurface conditions will vary between and beyond the borehole locations.

Borehole 1 was located some 250 m south of the proposed bridge over the QEW, along the alignment of the proposed approach embankment. Boreholes 2 and 3 were drilled at the abutment locations of the proposed bridge over the QEW (to be referred to as Bridge A hereafter). Borehole 4 was located some 70 m west of the proposed bridge over Highway 20 (Bridge B). Boreholes 5 and 6 were put down at the abutment locations of Bridge B. Boreholes 7 and 8 were located at the abutment locations of the proposed bridge over the NSR-W and E-NSR ramps (Bridge C). Borehole 9 was drilled at the east abutment location of the proposed bridge over the Highway 20 W-N/S ramp (Bridge D).

In summary, the subsoils at the site consist of surficial topsoil/fill overlying typically soft to very stiff silty clay deposits. A soft to firm zone of silty clay (to be referred to as "softer" clay hereafter) was generally encountered underneath a desiccated silty clay crust . The site is underlain by silty clay glacial till which in turn overlies shale bedrock. The bedrock surface, which appears to step downward towards Lake Ontario, was at between 7 m and 18 m depths below existing ground surface, where encountered.

A detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

4.2.1 Topsoil and Fill Materials

Topsoil of thickness ranging between 0.05 m and 0.3 m was encountered in Boreholes 1, 3, 5, 6, 7 and 8.

Fill materials were encountered, either immediately below the topsoil or at ground surface, in all but Boreholes 3, 6 and 8. In Boreholes 1, 2 and 5, the fill consists of sandy silt, silty sand to sand extending to between 1.1 m and 1.4 m depths below ground surface. In Boreholes 4 and 9, the upper portion of the fill is comprised of silty sand and the fill grades to clayey silt with depth. The thickness of the fill at these two locations was 1.4 m and 0.6 m, respectively. The fill at Borehole 7 extends to 1.4 m depth and consists of clayey silt materials. Apart from trace amount of organics and rootlets, the fill appears to be free of debris and other foreign materials.

The granular fill is typically loose to compact in relative density and the cohesive fill is typically firm to stiff in consistency.

4.2.2 Silty Sand

Silty sand deposits were encountered in Boreholes 4 and 6 underlying the fill or topsoil, and extending to between 2.1 m and 2.5 m depths, respectively. In Borehole 2 , the silty sand underlies the silty clay crust and extends from 2.9 m to 4.4 m depths. The relative density of the silty sand deposit is compact to very dense, as indicated by the SPT 'N' values which ranged from 16 blows to 95 blows for 0.3 m of penetration. The measured natural water contents of selected samples of this deposit range from 15 per cent to 21 per cent.

4.2.3 Silty Clay

An extensive silty clay deposit was encountered in all boreholes put down in the present investigation. This deposit typically underlies the topsoil/fill and/or silty sand and extends to the top surface of the glacial till, except in Borehole 2 where it is interlayered with silty sand. The top surface of this deposit was encountered at between Elevations 80.8 m and 76.6 m. Except in Boreholes 1, 2 and 7, a zone of “softer” clay is present underneath the desiccated crust of this silty clay deposit; the "softer" clay zone is discussed in the following section. The overall thickness of this silty clay deposit (including the ”softer” zone) varies significantly between locations, from only 0.8 m in Borehole 2 to as much as 12 m in Borehole 5.

The silty clay is generally mottled brown and grey in colour (within the desiccated crust) changing to grey colour with depth. Measured SPT ‘N’ values within the deposit (excluding the “softer” zone) vary from 16 blows to over 70 blows per 0.3 m penetration, indicating a generally very stiff to hard consistency. In Borehole 1, however, this silty clay has a stiff consistency as indicated by field vane shear strengths of about 60 kPa. Grain size distribution curves for samples of this deposit are shown on Figure 1. Atterberg limits tests carried out on representative samples of this soil gave liquid limits ranging from 25 per cent to 45 per cent, and plastic limits ranging from 10 per cent to 18 per cent indicating a soil of low to medium plasticity. Measured water contents on selected silty clay samples range between 14 per cent and 27 per cent.

4.2.4 “Softer” Clay

A “softer” zone of silty clay was encountered within the silty clay deposit, as described above, in all but Boreholes 1, 2 and 7. The thickness of this layer varies from about 3 m to about 6 m at the borehole locations. This zone is up to 6 m in thickness in Boreholes 5 and 6; and is about 5 m in thickness in Borehole 3.

This “softer” clay zone is grey in colour throughout. Field vane shear strengths vary between 18 kPa and 40 kPa, indicating a soft to firm consistency. Between about Elevations 76 m and 72.5 m in Borehole 5, the vane shear strength values are consistently at or less than 25 kPa, indicating a soft consistency. These vane strengths are largely consistent with the SPT ‘N’ values of between 0 and 8 blows for 0.3 m penetration. This deposit contains silt seams and partings throughout. Grain size distribution curves for samples of the "softer" clay are shown on Figure 2. Atterberg limits tests carried out on representative samples of this soil gave liquid limits ranging from 29 per cent to 36 per cent, and plastic limits ranging from 10 per cent to 15 per cent indicating a soil of low to medium plasticity. Measured water contents on selected "softer" clay samples range between 20 per cent and 31 per cent.

A laboratory oedometer test was carried out on a relatively "undisturbed" Shelby tube sample of the "soft" clay recovered from about 4 m depth in Borehole 6. Results of the test indicate that the sample has a preconsolidation pressure of about 160 kPa.

4.2.5 Silty Clay Glacial Till

Silty clay glacial till was encountered underlying the silty clay at all borehole locations, except at Borehole 4 where the borehole was terminated within the silty clay. The thickness of this till, where encountered, varies from 1 m in Borehole 1 to up to 8 m in Borehole 6.

The glacial till is generally grey in colour changing to a reddish grey colour with depth. It typically contains some sand and trace to some gravel, with occasional to some shale fragments. Measured SPT 'N' values typically range from about 30 blows to greater than 100 blows per 0.3 m penetration, indicating a hard consistency. Some very stiff zones, as indicated by SPT 'N' values of 16 blows to 25 blows per 0.3 m penetration, were present within the upper zones of the deposit. Grain size distribution curves of samples of the glacial till are shown on Figure 3. Atterberg limits tests carried out on the cohesive matrix of two representative samples of this soil gave liquid limits of 35 per cent and 31 per cent, and plastic limits of 16 per cent and 13 per cent, respectively. Measured water contents on selected till samples range between 10 per cent and 22 per cent

4.2.6 Bedrock

Bedrock of the Queenston Formation consisting of shale with occasional interlayers of limestone and siltstone was encountered in all of the boreholes except Borehole 4. Bedrock coring was not carried out in any of the boreholes. Split spoon samples of shale were retrieved in the boreholes extended by augering or tri-coning (Borehole 2) into the bedrock. Refusal to split spoon sampler advance was encountered at the depths where shale bedrock was encountered.

The bedrock surface depths and elevations at the borehole locations put down during the present investigation are summarized below:

Borehole Number	*Location*	*Bedrock Surface Depth (m)*	*Bedrock Surface Elevation (m)*
1	Approach Embankment to Bridge A	6.9	75.0
2	South Abutment Bridge A	11.0	69.5
3	North Abutment Bridge A	11.9	66.8
4	Approach Embankment to Bridge B	-	-
5	West Abutment Bridge B	18.0	61.8
6	East Abutment Bridge B	18.0	62.3
7	West Abutment Bridge C	13.9	65.3
8	East Abutment Bridge C	13.0	68.2
9	East Abutment Bridge D	14.2	65.4

4.2.7 Groundwater Conditions

Piezometers were installed in all but Boreholes 5 and 8. Details of the piezometer installations and the water level measurements are shown on the attached Record of Borehole sheets. The water levels in the piezometers as measured on March 25, 1998, and groundwater conditions encountered during and/or immediately upon completion of drilling are summarized in the table below.

The water level measurements indicate that the groundwater level within the "soft" clay (at Elevations 78.7 m and 19.4) is higher than the level within the underlying glacial till and shale (at Elevations 74.4 m to 76.3 m) indicating a downward hydraulic gradient within the silty clay deposit. It should be noted that the water levels are subject to seasonal fluctuations.

Borehole Number	*Stratum in Which Piezometer Tip is Sealed*	*Water Level Measurements in Piezometers/Open Boreholes*			
		Depth (m)		*Elevation (m)*	
		February 1998 (open borehole)	*March 25, 1998 (Piezometer)*	*February 1998 (open borehole)*	*March 25, 1998 (piezometer)*
1(Approach Bridge A)	"Soft" Clay/Till	Dry	3.2	Dry	78.7
2 (Bridge A)	Shale	1.8	5.1	78.7	75.4
3 (Bridge A)	Till/Shale	Dry	Dry	Dry	Dry
4(Approach Bridge B)	Silty Clay/"Soft" Clay	3.5	1.9	77.8	79.4
5 (Bridge B)	-	3.7	-	76.1	-
6 (Bridge B)	Till/Shale	Dry	4.0	Dry	76.3
7 (Bridge C)	Till	Dry	3.6	Dry	74.4
8 (Bridge C)	-	Dry	-	Dry	-
9 (Bridge D)	Till	Dry	11.8*	Dry	67.8*

NOTE: * Water level may not have stabilized

5.0 ENGINEERING RECOMMENDATIONS

5.1 General

This section of the report provides our recommendations on the geotechnical aspects of preliminary foundation design of the proposed QEW/RHCE Interchange based on our interpretation of the factual information obtained during this investigation. It should be noted that the interpretation and recommendations are intended for use only by the design engineer. Where comments are made on construction, they are provided only to highlight those aspects which could affect the design of the project. Those requiring information on aspects of construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

This report addresses aspects of preliminary foundation design of the proposed works associated with the QEW/RHCE Interchange which include four bridge structures and approach embankments. The four bridges, designated as Bridges A to D for discussion purposes in this report, are shown on the Borehole Location Plan.

The project information utilized for the preparation of this report was obtained from the following drawings provided by MRC : (i) Drawing numbered Plan 4 of 4 and titled "Queen Elizabeth Way / Red Hill Creek Expressway, Preliminary Design", and (ii) drawing numbered Plates 2, 6, ,7, 8, 9 and titled "Queen Elizabeth Way / Red Hill Creek Expressway, Preliminary Design, Q.E.W./R.H.C.E. Interchange – Plan and Red Hill Creek Expressway Interchange Profiles".

5.2 Bridge Foundations

The subsoils encountered in the boreholes put down during the present investigation typically consist of fill and surficial sands and silts overlying stiff to very stiff silty clay, which consists of a zone of "soft" clay at most locations. The silty clay deposits are underlain by silty clay glacial till overlying shale bedrock. The bedrock surface appears to step downward towards Lake Ontario. The water level in the piezometers sealed within the "soft" clay varies between about Elevations 78.7 m and 79.4 m (2 m to 3 m depth below existing ground surface), whereas the water level in the piezometers sealed within the till and shale varies between about Elevations 74.4 m and 76.3 m.

The proposed bridges may be supported by steel H-piles driven to refusal on shale bedrock. Based on the approximate borehole elevations currently available, the following pile tip elevations and depths for piles driven to the bedrock surface may be assumed for preliminary design:

Bridge Structure	***Preliminary Design Pile Tip Information***	
	Elevation (m)	***Depth Below Existing Ground Surface (m)***
Bridge A	69.0 to 69.5	11 to 12
Bridge B	61.5 to 62.5	18
Bridge C	64.0 to 66.0	13 to 14
Bridge D	65.5	14

Given the thickness and very dense nature of the glacial till immediately overlying the bedrock at Bridges B and C, there is a possibility that practical refusal to penetration may be reached for some of the piles before reaching the bedrock surface. It is estimated that practical refusal may be met at 1 m above the bedrock surface at the west abutment of Bridge B, at 3 m above the bedrock surface at the west abutment of Bridge C and at 1 m above the bedrock surface at the east abutment of Bridge C.

The base of the pile caps should be provided with a minimum of 1.2 m of earth cover for frost protection purposes.

5.2.1 Axial Geotechnical Resistance

For piles driven to refusal on / within the shale bedrock, the following axial capacities may be assumed for HP310x110 piles

- factored axial capacity at Ultimate Limit State (ULS) of 2,800 kN based on the structural capacity,
- geotechnical resistance at Serviceability Limit States (SLS) of 1,800 kN for 25 mm of settlement.

For the case where the piles are driven to practical refusal within the glacial till (possible at Bridges B and C as indicated above), a factored axial capacity at ULS of 1,100 kN and geotechnical resistance at SLS of 900 kN may be assumed for HP310x110 piles.

The design capacity of the piles at this site will depend on the magnitude of negative skin friction (downdrag) imposed by the consolidation of the "soft" clay layer, where present, induced by fill placement for embankment construction. Based on existing borehole information, the following values (unfactored) of downdrag load may be assumed for HP310x110 piles:

Bridge Structure	*Unfactored Downdrag Load per Pile (kN)*
Bridge A South abutment	0
Bridge A North abutment	300
Bridge B	300
Bridge C	300
Bridge D	300

A final set of no less than 10 blows per 12 mm of penetration should be obtained at the maximum hammer energy. Provision should be made to re-tap all piles to confirm the set after adjacent piles have been driven. The above set criteria should be reviewed at the time of construction in light of the constructor's proposed equipment, so that over-driving and possible damage to the piles is avoided.

The H-piles should be driven to an initial set equal to or greater than 10 blows per 12 mm of penetration (unless abrupt peaking occurs) using a hammer with rated energy of about 50 kilojoules but not exceeding 60 kilojoules. On reaching the required set, the hammer energy should be reduced by about 75 per cent and the pile should then be re-driven by increasing the hammer energy slowly up to the maximum rated energy of over about 40 blows. This procedure is intended to improve the process of seating of the pile on the bedrock surface.

Glacial till inherently contains boulders although they were not encountered nor inferred during the present investigation. The pile tips should be reinforced to minimize damage to the pile during driving (such as by welding a 12 mm plate to the bottom 300 mm of each flange as per OPSD 3301.00).

Further subsurface investigation including coring of the bedrock will be required as part of the final design phase to confirm the bedrock surface elevation at all foundation locations and to assess the nature and strength of the bedrock to confirm the load carrying capacity of the piles.

5.3 Lateral Earth Pressures

The lateral pressures acting on the bridge abutments 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 walls:

- Select free-draining granular fill meeting the specifications of OPSS Granular A or B but with less than 5 per cent passing the 200 sieve should be used as backfill behind the walls. All granular fill should be compacted in lifts of loose thickness not greater than 200 mm to 95 per cent of the material's Standard Proctor maximum dry density.
- Longitudinal drains and weep holes should be installed to provide positive drainage of the granular backfill.
- The granular fill may be placed either in a zone with width equal to at least 1.2 m behind the back of the stem (Case I) or within the wedge-shaped zone defined by a 60 degree line extending up and back from the bottom of the rear face of the footing (Case II).
- If the wall support allows lateral yielding of the stem (unrestrained structure), active earth pressures may be used in the geotechnical design of the structure. If the abutment support does not allow lateral yielding (restrained structure), at-rest pressures should be assumed for geotechnical design.
- A compaction surcharge equal to 16 kPa should be included in the lateral earth pressures for the structural design of the abutment wall in accordance with OHBDC Figure 6-7.4.3.
- For Case I, the pressures are based on the in-situ soils/embankment fill materials and the following parameters (unfactored) may be assumed:

Soil unit weight		20 kN/m^3
	(assuming the in-situ soils and/or clean earth fill)	
Coefficients of lateral earth pressure:		
	'active'	0.33
	'at rest'	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***
Soil Unit Weight	22 kN/m^3	21 kN/m^3
Coefficient of Lateral Earth Pressure		
'active'	0.27	0.31
'at rest'	0.43	0.47

It should be noted that the above design parameters assume level backfill and ground surface behind the wall. Other aspects of the abutment granular backfill requirements with respect to sub-drains and frost taper should be in accordance with OPSD-3501-00.

5.4 Approach Embankments

In general, topsoil and organic deposits should be stripped from the subgrade areas of the fill embankment, and all subgrade soils should be proof-rolled prior to fill placement. The subgrade soils will consist of fill materials, surficial sands and silts and / or the underlying silty clay.

5.4.1 Slope Stability

Based on profiles provided by MRC, approach embankments up to 10 m in height are to be constructed at this site. At the location of Bridge B (Boreholes 5 and 6), up to 6 m of "soft" clay are present at about 2 m to 3 m depths and the maximum proposed embankment height is 7 m. Results of preliminary stability analysis carried out for this situation, using assumed representative geotechnical parameters for the soils, indicate that a conventional embankment slope inclination of 2 horizontal to 1 vertical would be unstable against a deep-seated, rotational type failure. To ensure stability, toe berms or slope flattening will be required. Further subsurface investigation and analysis will be required as part of the final design phase to assess critical combinations of "soft" clay thickness and embankment height.

5.4.2 Settlement

Based on the currently proposed embankment heights and the laboratory oedometer test results, the preconsolidation pressure of the "soft" clay will be exceeded under the proposed embankment loading in some areas. Preliminary settlement analysis, using assumed representative geotechnical parameters, indicate that the consolidation settlement induced as a consequence of embankment construction will be in the order of 200 mm to 300 mm. Consideration could be given to pre-loading of the embankment prior to bridge construction to allow some settlement to take place.

5.4.3 Construction

Construction of embankments above the prepared subgrade may be carried out using clean earth fill (in accordance with OPSS 212) or Select Subgrade Material (in accordance with OPSS 1010), depending on material available. All embankment fill should be placed in regular lifts with loose thickness not exceeding 300 mm, and be compacted to at least 95 per cent of the material's Standard Proctor maximum dry density. The final lift prior to placement of the granular subbase or base course should be compacted to 100 per cent of the Standard Proctor maximum dry density. Inspection and field density testing should be carried out by qualified geotechnical personnel during all fill placement operations to ensure that appropriate materials are used and that adequate levels of compaction have been achieved. Vegetation cover should be established on all slopes to protect the embankment fill against surficial erosion.

5.5 Reinforced Earth Walls

We understand that consideration is being given to the use of reinforced earth for the construction of the wingwalls at Bridges B and D. The "soft" clay zone at the location of Bridge B was found to be 6 m thick and was encountered at about 2 m depth; and 2 m thick and at about 2 m depth at the location of Bridge D. The measured field vane shear strength of the clay at these locations are as low as 15 kPa and 20 kPa, respectively. At Bridge B, it is considered that significant settlement could occur due to the reinforced soil mass loading and that global stability is also a concern. As such, reinforced earth construction may not be feasible at Bridge B. At Bridge D, the higher shear strength and smaller thickness of the "soft" clay layer present more favourable conditions for reinforced earth wall construction. The wall footings should be designed to accommodate fairly low bearing capacities.

GOLDER ASSOCIATES LTD.

Sydney Pang, P.Eng.
Project Engineer

Anne S. Poschmann, P.Eng.
Principal

SP/ASP/sp/clg
WORD S/FINALDAT/1100/981-1108/981108DR1

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
DO	Drive open
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 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):

An electronic cone penetrometer with a 60° conical tip and a projected end area of 10 cm^2 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 (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

(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

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 test (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

N1106001.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789789; E 283322

RECORD OF BOREHOLE 1

BORING DATE: FEB.12/98

SHEET 1 OF 1

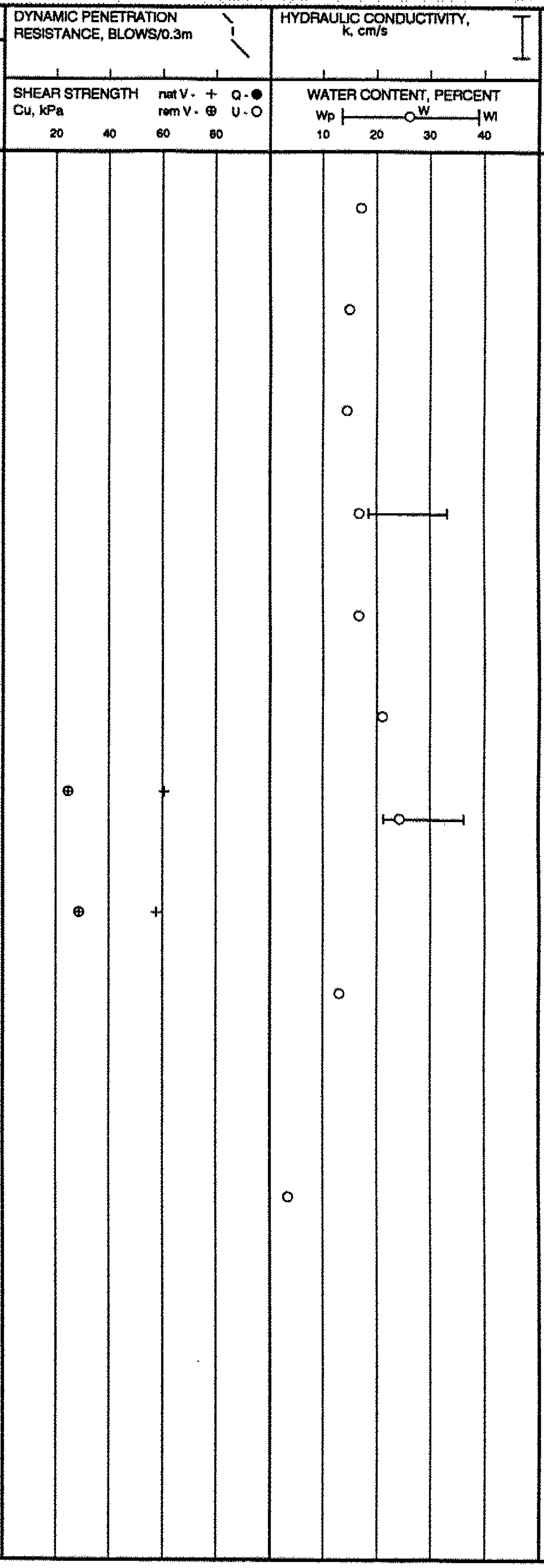
DATUM: GEODETIC

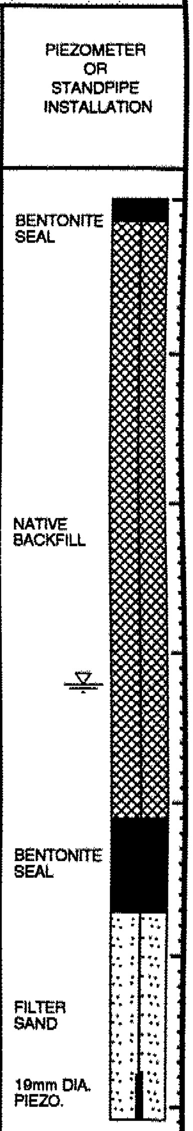
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

ELEV. DEPTH (m)	DESCRIPTION
81.90	GROUND SURFACE
0.00	Topsoil
0.10	Sandy Silt to Sand, some clay and gravel Compact Brown Moist (Fill)
80.80 1.10	Silty Clay, trace sand Hard Mottled grey and brown Moist
78.20 3.70	Silty Clay, trace sand, occasional gravel Stiff Grey Moist
76.10 5.80	Silty Clay, some sand, trace gravel, some shale fragments Hard Reddish grey Dry (Glacial Till)
75.00 6.90	Shale Highly weathered Reddish brown (Bedrock)
74.28 7.62	END OF BOREHOLE Refusal to split spoon sampler advance

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	12	
2	50 DO	40	
3	50 DO	73	
4	50 DO	38	MH
5	50 DO	32	
6	50 DO	12	
7	50 DO	14	MH
	50 DO	60/ .03	
	50 DO	60/ .03	





Open hole dry on completion of drilling.
Water level in piezometer at Elev. 78.7m on March 25/98.

DATA INPUT: PS MAR 30/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

N1108002.BHS

W.P. N/A

RECORD OF BOREHOLE 2

SHEET 1 OF 3

DIST. 4; HWY: QEW

BORING DATE: FEB.12/98

DATUM: GEODETIC

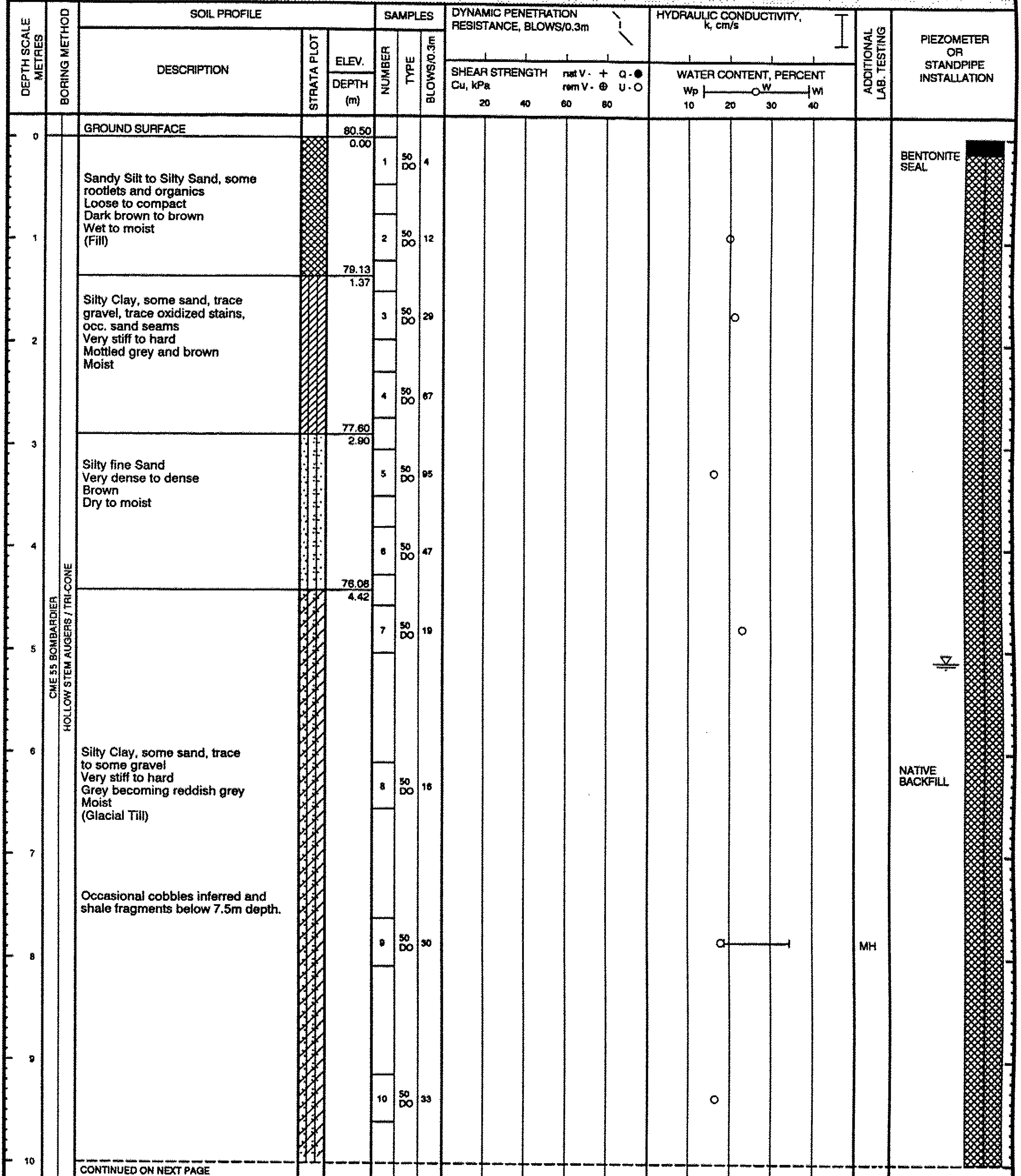
LOCATION: N 4789876; E 283553

PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER; HOLLOW STEM AUGERS / TRI-CONE

SOIL PROFILE – DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
GROUND SURFACE		80.50
Sandy Silt to Silty Sand, some rootlets and organics Loose to compact Dark brown to brown Wet to moist (Fill)	▩	0.00
Silty Clay, some sand, trace gravel, trace oxidized stains, occ. sand seams Very stiff to hard Mottled grey and brown Moist	▨	79.13 1.37
Silty fine Sand Very dense to dense Brown Dry to moist	⁝	77.60 2.90
Silty Clay, some sand, trace to some gravel Very stiff to hard Grey becoming reddish grey Moist (Glacial Till) Occasional cobbles inferred and shale fragments below 7.5m depth.	▨	76.08 4.42
CONTINUED ON NEXT PAGE		

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	4	
2	50 DO	12	
3	50 DO	29	
4	50 DO	67	
5	50 DO	95	
6	50 DO	47	
7	50 DO	19	
8	50 DO	16	
9	50 DO	30	MH
10	50 DO	33	



DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

W.P.	N/A
DIST.	4; HWY: QEW
LOCATION:	N 4789876; E 283553

RECORD OF BOREHOLE 2

BORING DATE: FEB.12/98

SHEET 2 OF 3
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER / HOLLOW STEM AUGERS / TRI-CONE

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m
SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80
HYDRAULIC CONDUCTIVITY, k, cm/s
WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl — 10 20 30 40
ADDITIONAL LAB. TESTING

CONTINUED FROM PREVIOUS PAGE

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	Silty Clay, some sand and gravel Very stiff to hard Grey becoming reddish grey Moist (Glacial Till)				
			11	50 DO	70
11		69.50 11.00			
12	Shale, some green grey siltstone interbeds Highly to slightly weathered Reddish brown (Bedrock)		12	50 DO	50/ .08
13			13	50 DO	50/ .08
14					
15	Limestone interbed inferred at about 15.2m depth.		14	50 DO	50/ .08
16					
17			15	50 DO	50/ .08
18			16	50 DO	95/ .13
19					
20			17	50 DO	100 /.1

CONTINUED ON NEXT PAGE

PIEZOMETER OR STANDPIPE INSTALLATION

Water level in piezometer at Elev. 78.7m immediately after installation (likely influence by water used during drilling). Water level in piezometer at Elev. 75.4m on March 25/98.

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108002.BHS

W.P.	N/A
DIST.	4; HWY: QEW
LOCATION:	N 4789876; E 283553

RECORD OF BOREHOLE 2

BORING DATE: FEB.12/98

SHEET 3 OF 3

DATUM: GEODETIC

PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat V - + Q - ● rem V - ⊕ U - ○) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		CONTINUED FROM PREVIOUS PAGE									
20	CME 55 BOMBARDIER HOLLOW STEM AUGERS / TRI-CONE	Shale Highly to slightly weathered Reddish brown (Bedrock)									
21				59.11 21.39	19	50 DO	100 /05				
		END OF BOREHOLE									
22											
23											
24											
25											
26											
27											
28											
29											
30											

DATA INPUT: PS MAR 30/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

N1108003.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789899; E 283640

RECORD OF BOREHOLE 3

BORING DATE: FEB.24/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

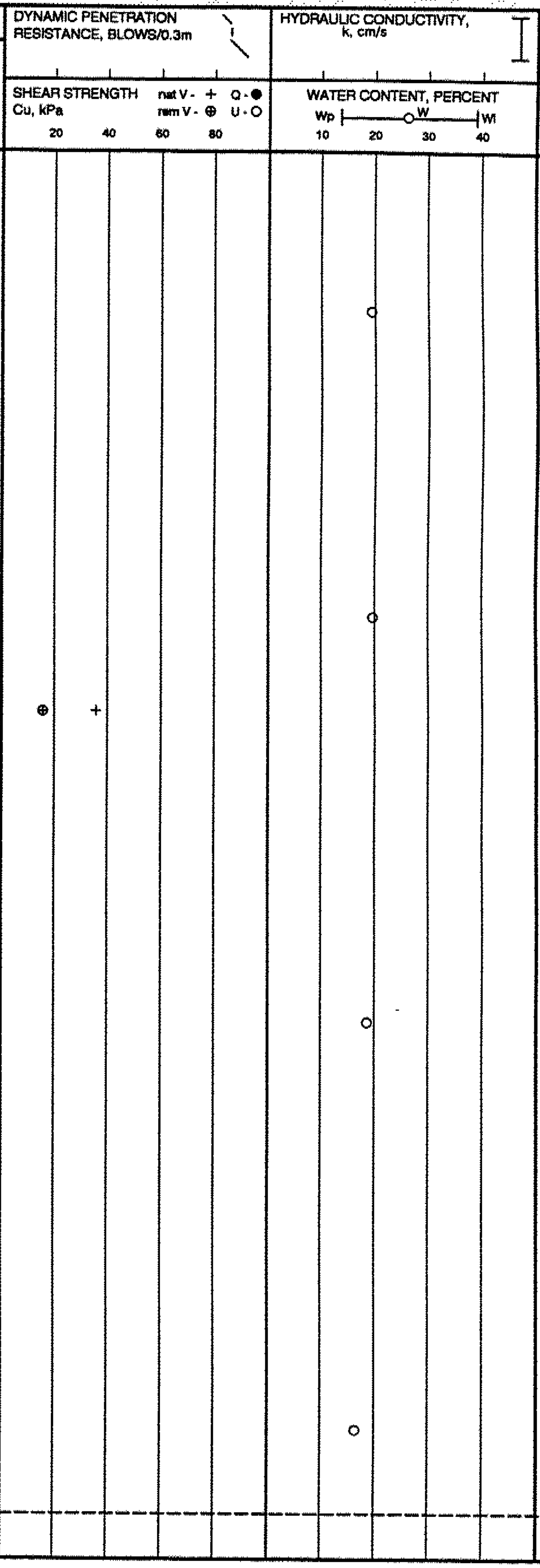
DEPTH SCALE METRES: 0 – 10

SOIL PROFILE

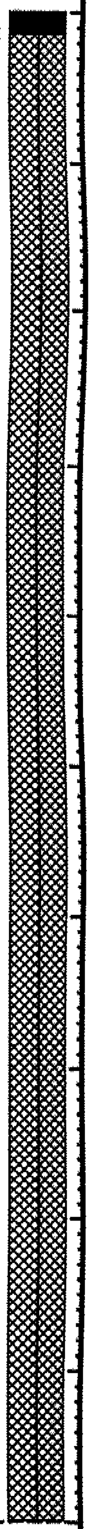
DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)
GROUND SURFACE		78.70
Topsoil		0.00
Silty Clay, trace sand Stiff Mottled brown Moist		78.40 0.30
Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Firm Grey Moist		77.60 1.10
Silty Clay, some sand, trace to some gravel Very stiff to hard Grey to reddish grey Moist (Glacial Till)		73.00 5.70
CONTINUED ON NEXT PAGE		

SAMPLES

NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	14	
2	50 DO	13	
3	50 DO	7	
4	75 TO	PH	
5	50 DO	8	
6	75 TO	PH	
7	50 DO	18	MH
8	50 DO	36	
9	50 DO	34	MH



PIEZOMETER OR STANDPIPE INSTALLATION



DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE

1 to 50

Golder Associates

LOGGED: GD

CHECKED: SP

N1108003.BHS

W.P. N/A

DIST. 4; HWY. QEW

LOCATION: N 4789899; E 283640

RECORD OF BOREHOLE 3

BORING DATE: FEB.24/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m

SHEAR STRENGTH Cu, kPa — nat V - + Q - ● rem V - ⊕ U - ○ — 20 40 60 80

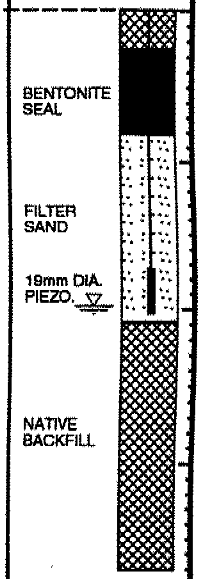
HYDRAULIC CONDUCTIVITY, k, cm/s

WATER CONTENT, PERCENT — Wp ├──○W──┤ Wl — 10 20 30 40

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE				
		Silty Clay, some sand, trace to some gravel Very stiff to hard Grey to reddish grey Moist (Glacial Till)		10	50 DO	24
12		Shale Highly weathered Reddish brown (Bedrock)	66.80 11.90	11	50 DO	102 /13
				12	50 DO	100 /.1
14		END OF BOREHOLE Refusal to split spoon sampler advance	64.86 13.84			

PIEZOMETER OR STANDPIPE INSTALLATION



Borehole dry on completion of drilling. Piezometer dry on March 25/98.

DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108004.BHS

W.P.: N/A

DIST.: 4; HWY: QEW

LOCATION: N 4789865; E 283912

RECORD OF BOREHOLE 4

BORING DATE: FEB.11/98

SHEET 1 OF 1

DATUM: GEODETIC

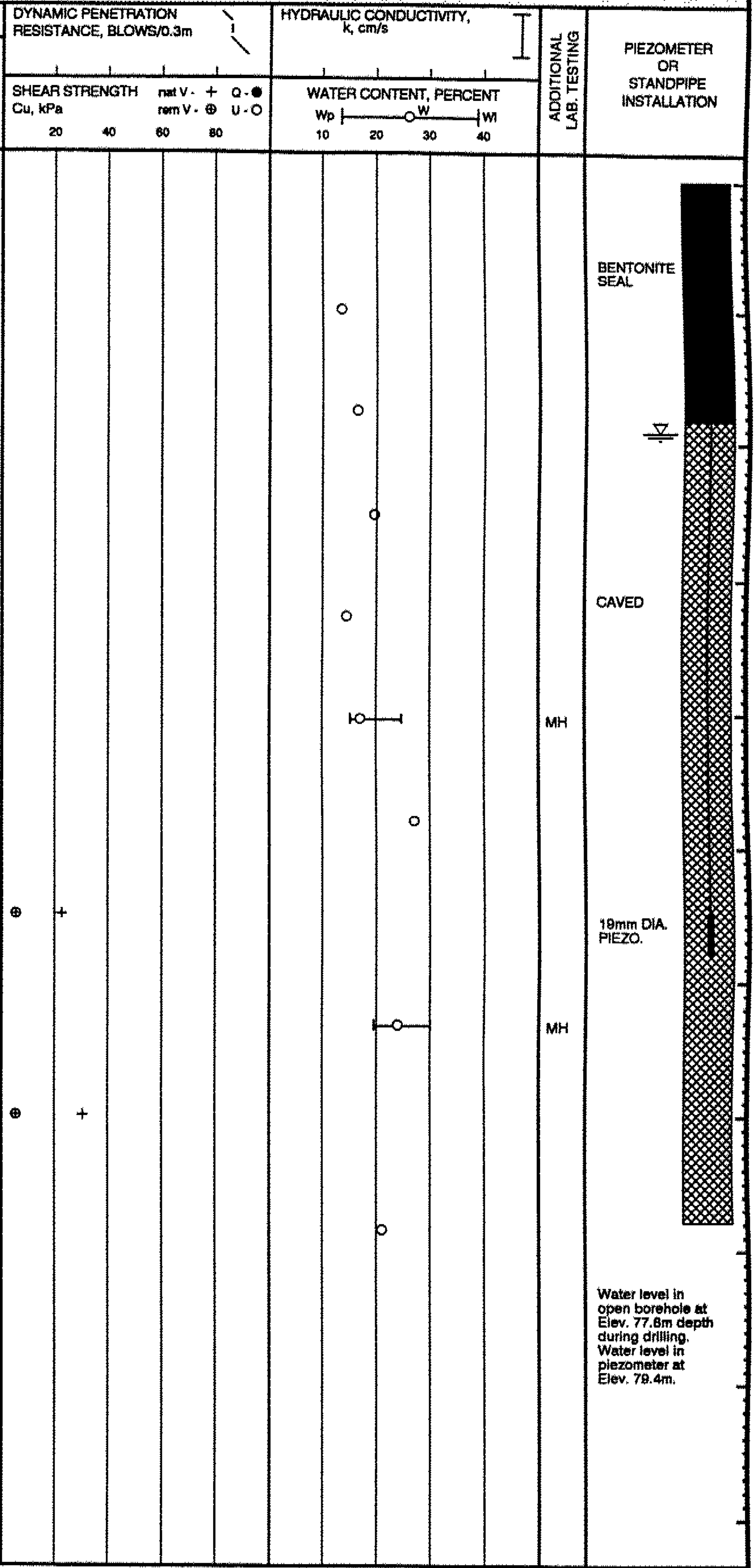
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER, SOLID STEM AUGERS

DEPTH SCALE METRES: 0 – 10

SOIL PROFILE DESCRIPTION	ELEV.	DEPTH (m)
GROUND SURFACE	81.30	
Silty Sand, trace clay Very loose Brown Moist (Fill)		0.00
Clayey Silt, trace gravel, trace rootlets and organics Very stiff Dark brown (Fill)	80.70	0.60
Silty Sand, some clay, trace gravel Compact Brown Wet	79.93	1.37
Silty Clay, trace sand Very stiff Brown becoming grey Moist	78.86	2.44
Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Soft to firm Grey Moist to wet	76.88	4.42
Silty Clay, trace sand and gravel Very stiff Grey Moist	74.00	7.30
END OF BOREHOLE		8.08

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	3	
2	50 DO	24	
3	50 DO	16	
4	50 DO	27	
5	50 DO	29	
6	50 DO	17	MH
7	50 DO	7	
8	50 DO	6	MH
9	50 DO	17	



Water level in open borehole at Elev. 77.6m depth during drilling. Water level in piezometer at Elev. 79.4m.

DATA INPUT: PS MAR.30/98

DEPTH SCALE 1 to 50

Golder Associates

LOGGED: GD

CHECKED: SP

SOILM6

N1108005.BHS

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789835; E 284004

RECORD OF BOREHOLE 5

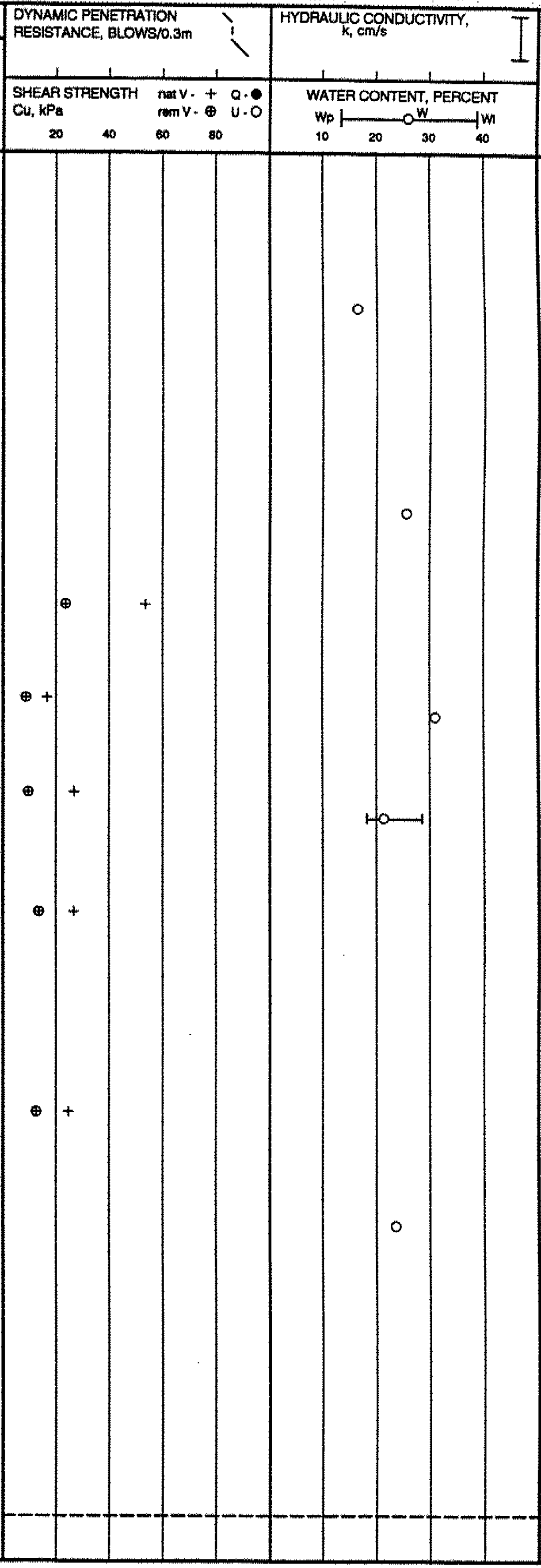
BORING DATE: FEB.17&18/98

SHEET 1 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
0	GROUND SURFACE	79.80
	Topsoil	0.00
	Sand, trace silt and gravel Compact Brown Moist (Fill)	79.50 0.30
1	Silty Clay, trace sand, occasional rootlets Hard Mottled brown Moist	78.65 1.15
2	Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Stiff becoming soft to firm below 3.5m depth Grey Moist	77.67 2.13
7	Silty Clay, trace sand and gravel Very stiff Grey Moist	72.70 7.10
10	CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING
1	50 DO	23	
2	50 DO	23	
3	50 DO	36	
4	50 DO	10	
5	50 DO	5	
6	50 DO	4	
7	50 DO	0	MH
8	50 DO	0	
9	50 DO	16	
10	50 DO	21	



PIEZOMETER OR STANDPIPE INSTALLATION

Water level in open hole at 3.7m depth on completion of drilling.

DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108005.BHS

W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789835; E 284004

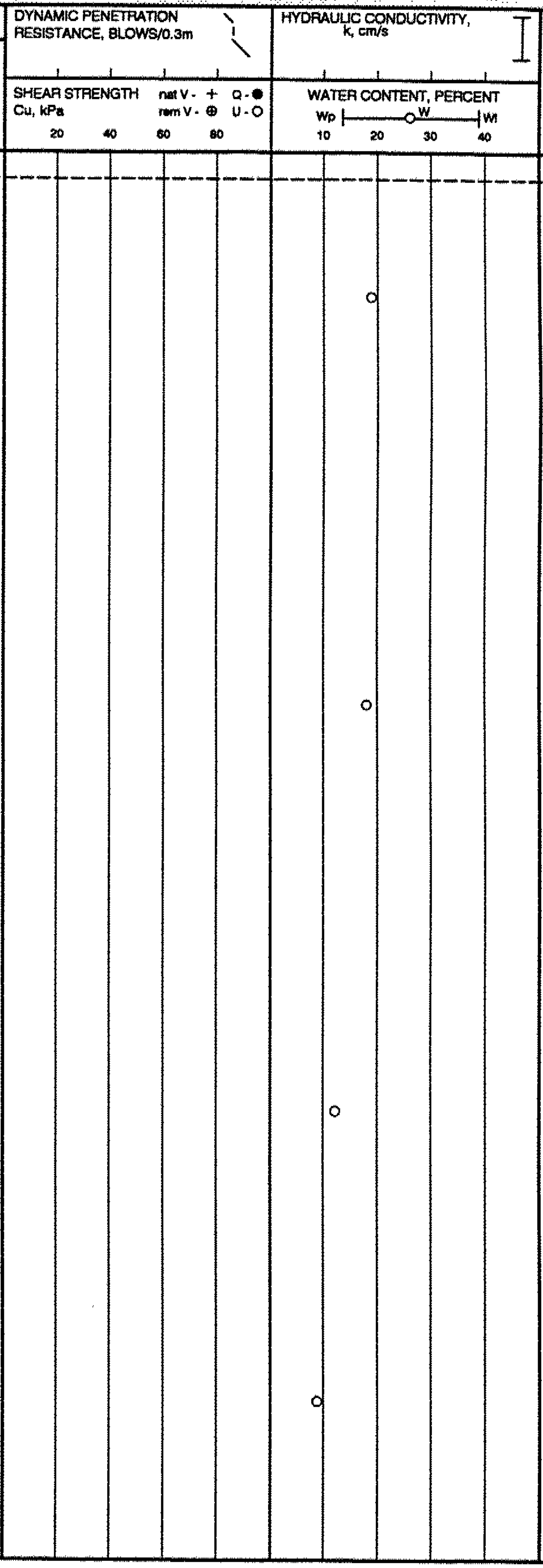
RECORD OF BOREHOLE 5

BORING DATE: FEB.17&18/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CONTINUED FROM PREVIOUS PAGE						
11	Silty Clay, trace sand and gravel Very stiff Grey Moist		11	50 DO	23		
12			12	50 DO	28		
13		66.60 13.20					
14	Silty Clay, some sand, trace gravel Hard Grey becoming reddish grey Moist (Glacial Till)		13	50 DO	30	MH	
15			14	50 DO	59		
16							
17			15	50 DO	102		
18		61.80 18.00					
	Shale Highly weathered, occ. limestone interbeds Reddish brown Dry (Bedrock)		16	50 DO	125 /.1		
19		60.52 19.28	17	50 DO	100 /08		
	END OF BOREHOLE Refusal to split spoon sampler advance						
20							



DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

DATA INPUT: PS MAR.30/98

SOILM6

N1106006.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789811; E 284032

RECORD OF BOREHOLE 6

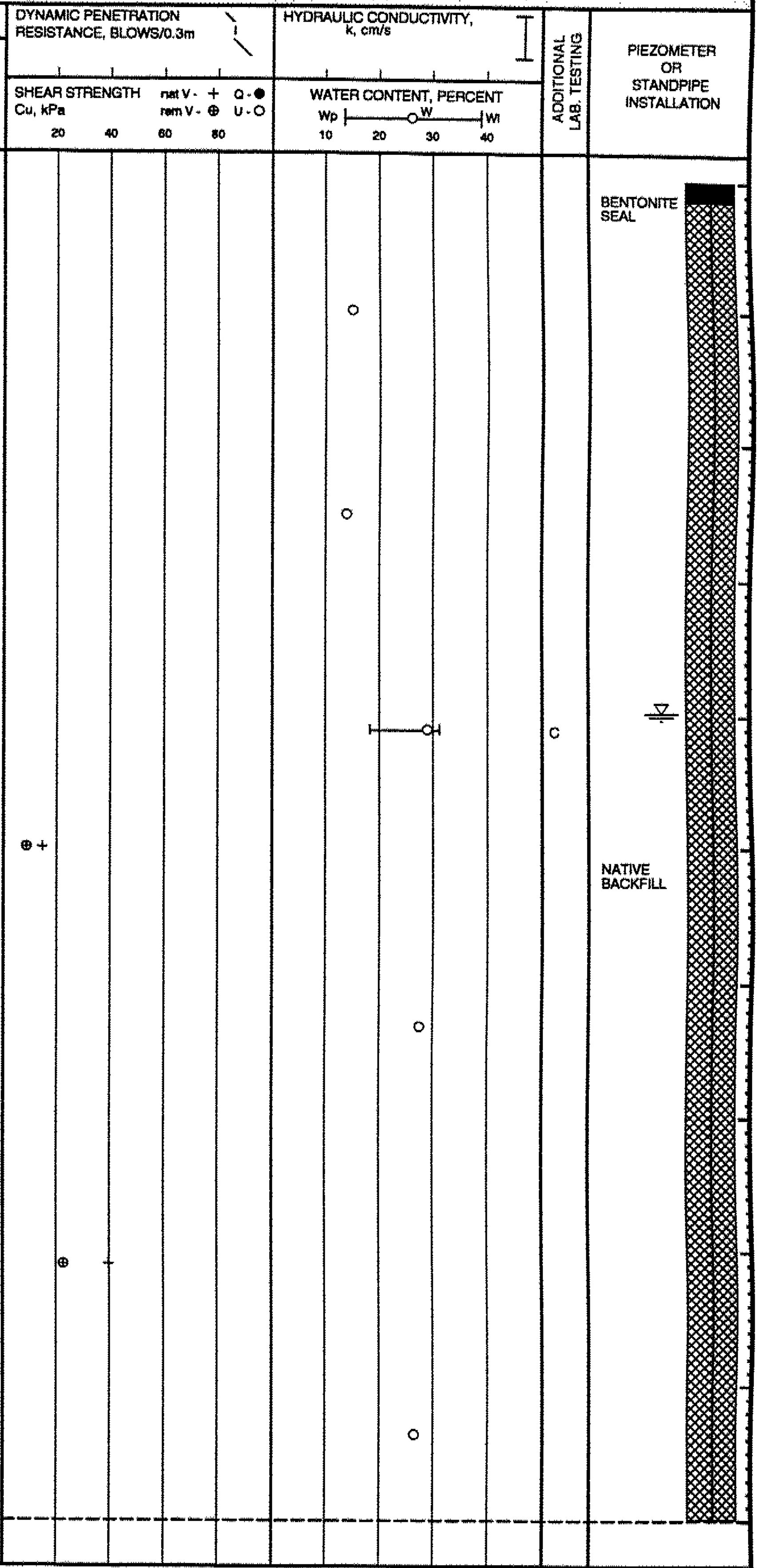
BORING DATE: FEB.18&19/98

SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
0	CME 55 BOMBARDIER HOLLOW STEM AUGERS	GROUND SURFACE	80.30			
		Topsoil	0.00			
		Silty Sand, trace clay Dense to compact Brown Moist to wet	0.15	1	50 DO	2
1				2	50 DO	50
				3	50 DO	28
2		Silty Clay, trace sand Hard Grey Moist	78.17 2.13	4	50 DO	44
3		Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Soft to firm Grey Moist	77.40 2.90	5	75 TO	PH
4				6	75 TO	PH
6				7	50 DO	5
7				8	75 TO	PH
9		Silty Clay, trace sand and gravel Stiff Grey Moist	71.70 8.60	9	50 DO	10
10		CONTINUED ON NEXT PAGE				



DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1106006.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789811; E 284032

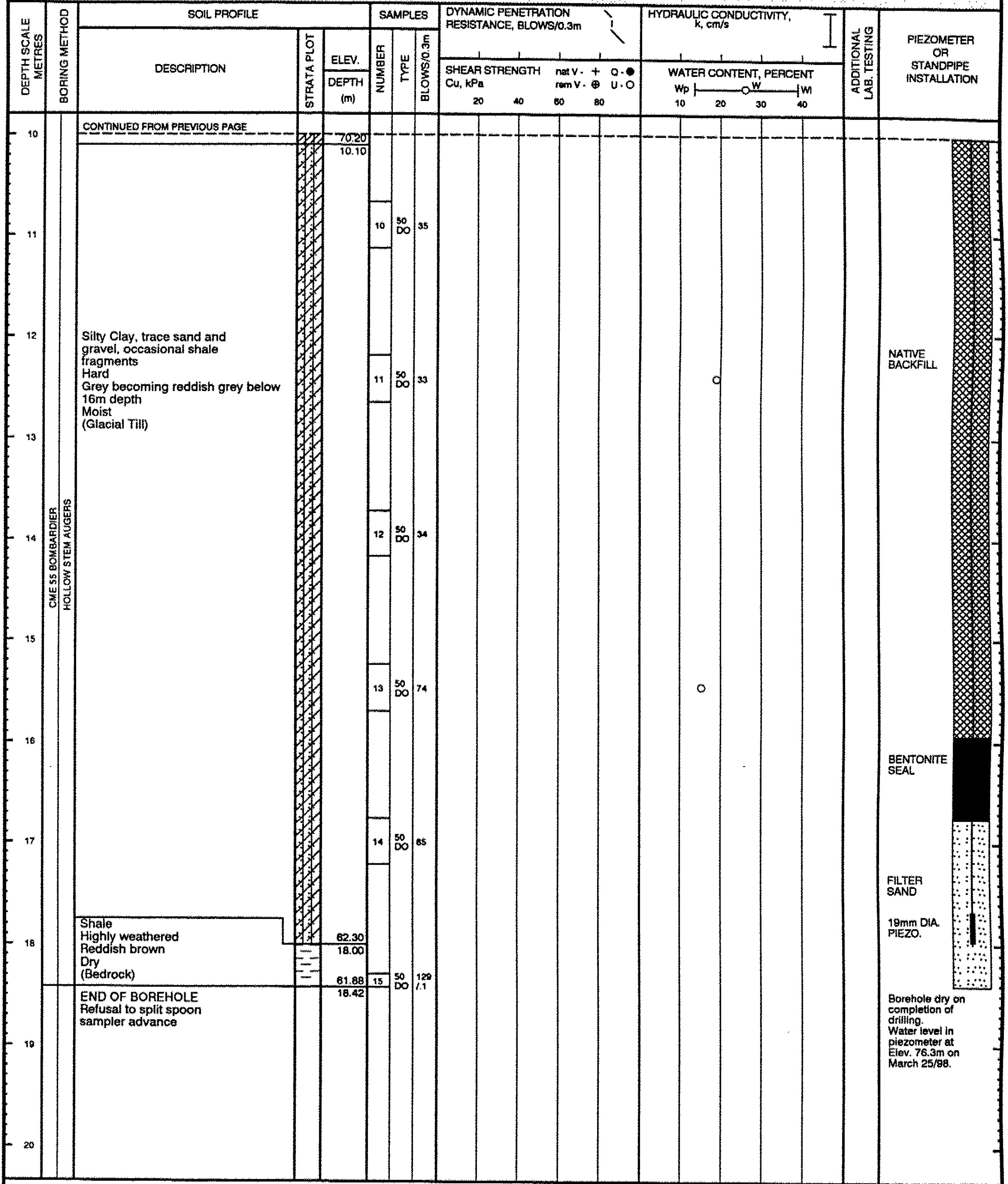
RECORD OF BOREHOLE 6

BORING DATE: FEB.18&19/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108



DESCRIPTION	ELEV. / DEPTH (m)
CONTINUED FROM PREVIOUS PAGE	
Silty Clay, trace sand and gravel, occasional shale fragments Hard Grey becoming reddish grey below 16m depth Moist (Glacial Till)	70.20 10.10
Shale Highly weathered Reddish brown Dry (Bedrock)	62.30 18.00
END OF BOREHOLE Refusal to split spoon sampler advance	61.88 18.42

SAMPLES NUMBER	TYPE	BLOWS/0.3m
10	50 DO	35
11	50 DO	33
12	50 DO	34
13	50 DO	74
14	50 DO	65
15	50 DO	129 /.1

NATIVE BACKFILL

BENTONITE SEAL

FILTER SAND

19mm DIA. PIEZO.

Borehole dry on completion of drilling.
Water level in piezometer at Elev. 76.3m on March 25/98.

DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108007.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789713; E 284126

RECORD OF BOREHOLE 7

BORING DATE: FEB.20/98

SHEET 1 OF 2

DATUM: GEODETIC

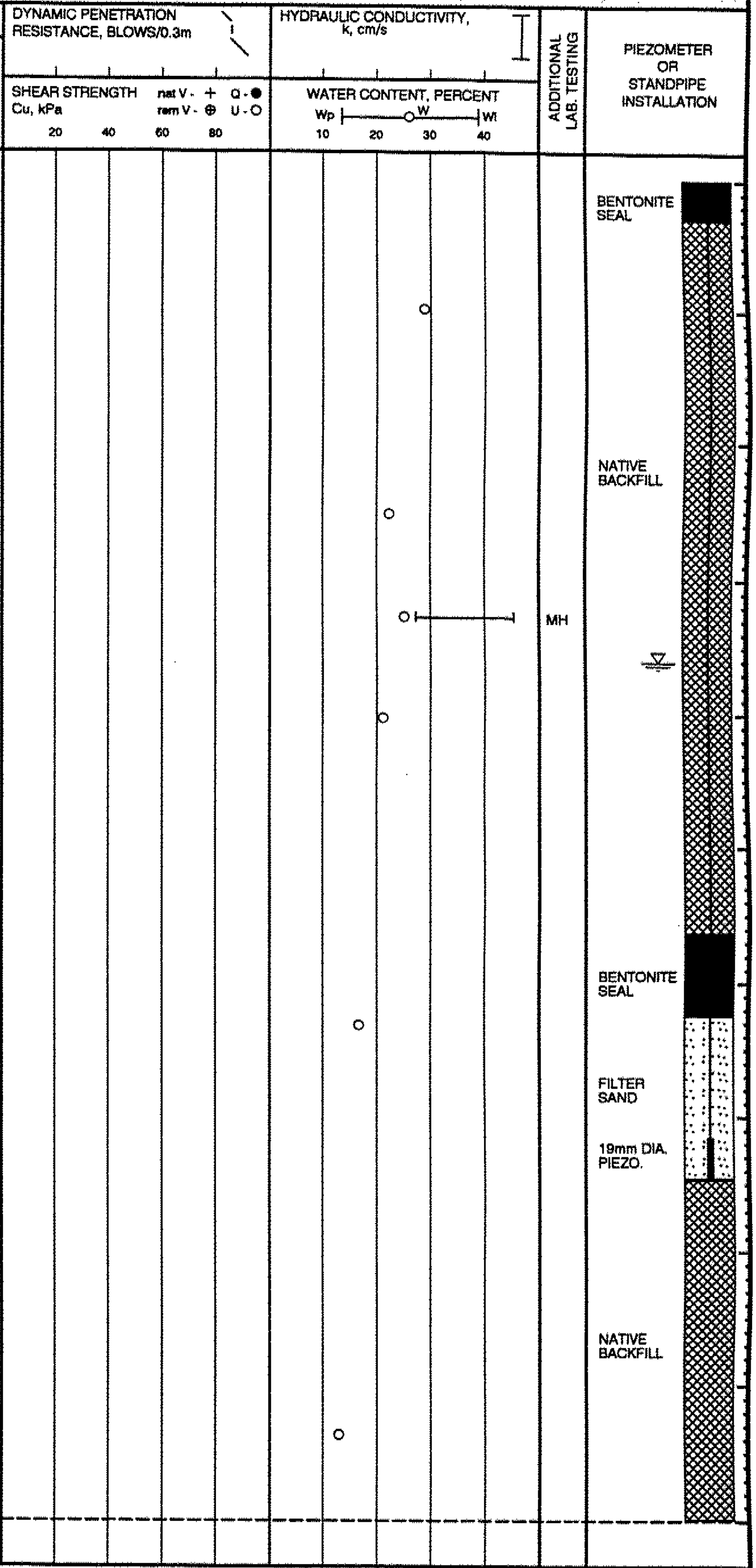
PROJECT: 981-1108

DEPTH SCALE METRES: 0 – 10

BORING METHOD: CME 55 BOMBARDIER
HOLLOW STEM AUGERS

SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
GROUND SURFACE	78.00
Topsoil	0.00
Clayey Silt, trace sand, some gravel Firm to stiff Brown Moist (Fill)	77.70 0.30
Silty Clay, trace sand and gravel Very stiff to hard Mottled grey and brown to brown Moist	76.63 1.37
Silty Clay, some sand, trace gravel; occasional shale fragments below 10m depth. Very stiff Grey Moist (Glacial Till)	72.40 5.60
CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	8
2	50 DO	8
3	50 DO	17
4	50 DO	31
5	50 DO	22
6	50 DO	30
7	50 DO	36
8	50 DO	28
9	50 DO	26
10	50 DO	24



DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD

CHECKED: SP

N1106007.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789713; E 284126

RECORD OF BOREHOLE 7

BORING DATE: FEB.20/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat V - + Q - ● rem V - ⊕ U - ○) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		CONTINUED FROM PREVIOUS PAGE									
11	CME 55 BOMBARDIER HOLLOW STEM AUGERS	Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey becoming reddish grey Moist (Glacial Till)			11	50 DO	65/ .23				
12					12	50 DO	93		○		NATIVE BACKFILL
13		Weathered Shale at 13.9m depth.		64.05	12	50 DO	50/ .08				
14		END OF BOREHOLE Refusal to split spoon sampler advance		13.95							Borehole dry on completion of drilling. Water level in piezometer at Elev. 74.4m on March 25/98.
15											
16											
17											
18											
19											
20											

DATA INPUT: PS MAR 30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108008.BHS

W.P. N/A

DIST. 4; HWY. QEW

LOCATION: N 4789682; E 284160

RECORD OF BOREHOLE 8

BORING DATE: FEB.23/98

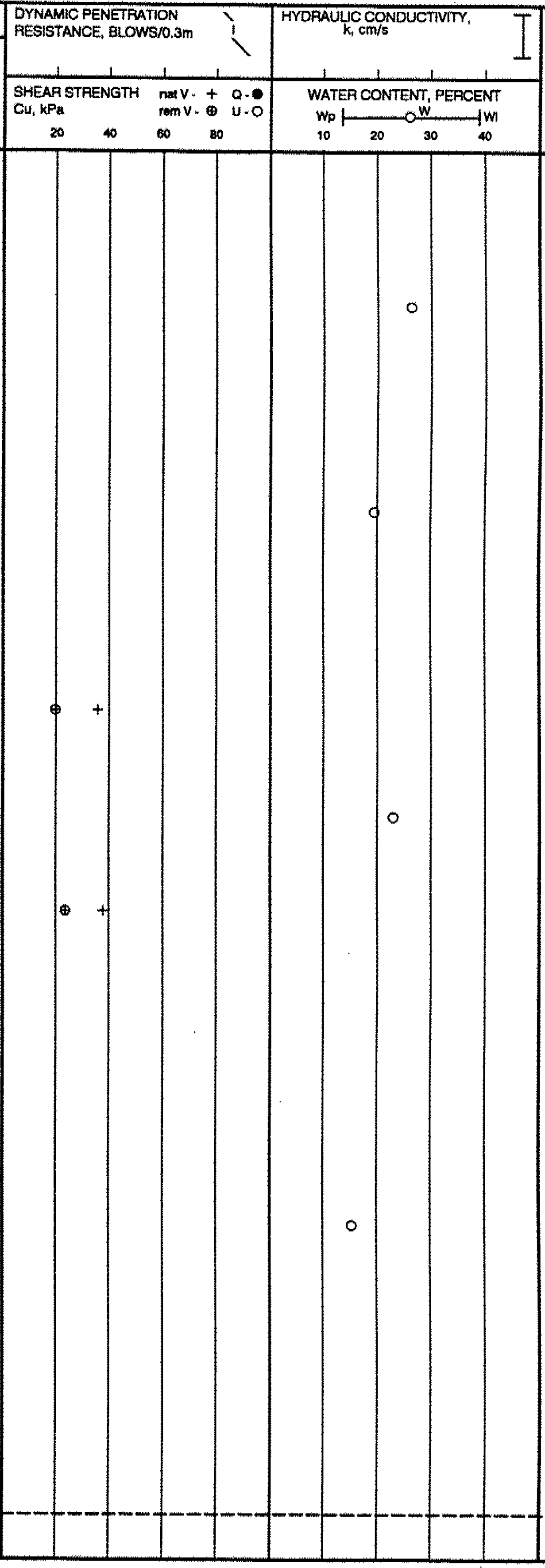
SHEET 1 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m
0	GROUND SURFACE	79.20			
	Topsoil	0.05			
	Silty Clay, trace sand, trace organics Very stiff Mottled grey and brown Wet to moist		1	50 DO	5
1			2	50 DO	25
			3	50 DO	18
2	Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Firm to stiff Grey Moist	76.76 2.44	4	50 DO	8
3			5	50 DO	7
4–5			6	50 DO	13
6	Silty Clay, trace sand and gravel, occ shale fragments Very stiff Grey Moist	73.40 5.80	7	50 DO	21
7–8			8	50 DO	29
9	Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)	70.60 8.60	9	50 DO	40
10	CONTINUED ON NEXT PAGE				



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108008.BHS

W.P. N/A

DIST. 4; HWY: QEW

LOCATION: N 4789682; E 284160

RECORD OF BOREHOLE 8

BORING DATE: FEB.23/98

SHEET 2 OF 2

DATUM: GEODETIC

PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m / SHEAR STRENGTH Cu, kPa (nat V - + Q - ● rem V - ⊕ U - O) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s / WATER CONTENT, PERCENT Wp ├──O W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE									
11		Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)			10	50 DO	61		○		
12					11	50 DO	100 /08				
13				66.20 13.00							
14		Shale Highly weathered, occ. limestone interbeds Reddish brown Dry (Bedrock)			12	50 DO	127 /15				
15				63.96 15.24							Borehole dry on completion of drilling.
		END OF BOREHOLE Refusal to auger advance									
16											
17											
18											
19											
20											

DATA INPUT: PS MAR.30/98

SOILM6

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

N1108009.BHS

W.P. N/A

RECORD OF BOREHOLE 9

SHEET 1 OF 2

DIST. 4; HWY: QEW

BORING DATE: FEB.25/98

DATUM: GEODETIC

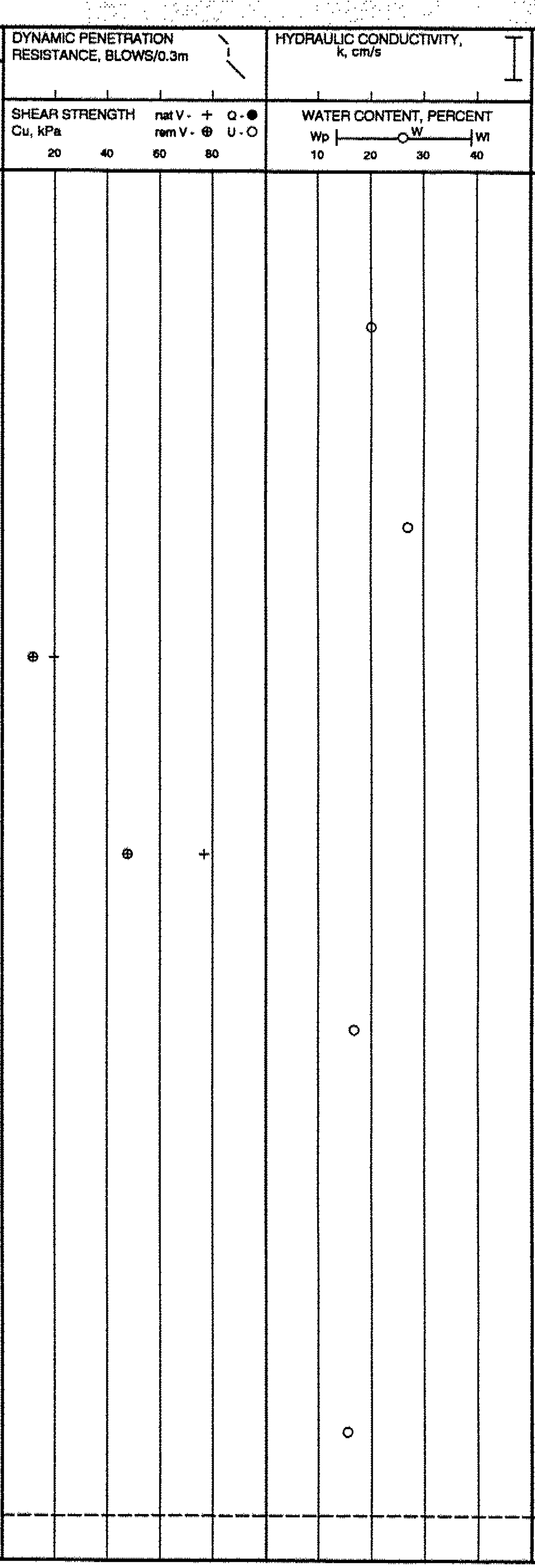
LOCATION: N 4789696; E 283711

PROJECT: 981-1108

BORING METHOD: CME 55 BOMBARDIER HOLLOW STEM AUGERS

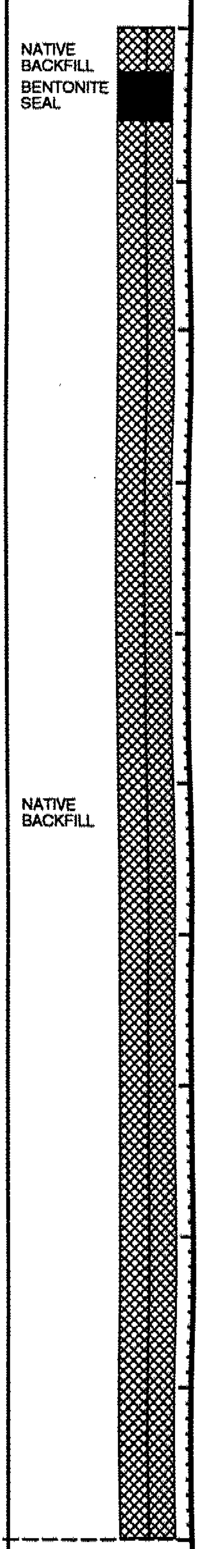
DEPTH SCALE METRES	SOIL PROFILE DESCRIPTION	ELEV. / DEPTH (m)
0	GROUND SURFACE	79.60
	Silty sand becoming clayey silt Compact becoming stiff Brown (FILL)	0.00
		79.00 0.60
1	Silty Clay, trace sand and gravel, some oxidized staining Very stiff to stiff Grey brown to grey Moist	
2		77.50 2.10
3	Silty Clay, trace sand, occasional gravel; silt seams and partings throughout Firm to stiff Grey Moist	
5		74.00 5.60
6	Silty Clay, trace sand and gravel Hard Grey Moist	
7		72.60 7.00
8	Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)	
10	CONTINUED ON NEXT PAGE	

SAMPLES NUMBER	TYPE	BLOWS/0.3m
1	50 DO	15
2	50 DO	26
3	50 DO	14
4	50 DO	5
5	50 DO	10
6	50 DO	32
7	50 DO	32
8	50 DO	31



ADDITIONAL LAB. TESTING

PIEZOMETER OR STANDPIPE INSTALLATION



DATA INPUT: PS MAR.30/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

N1108009.BHS

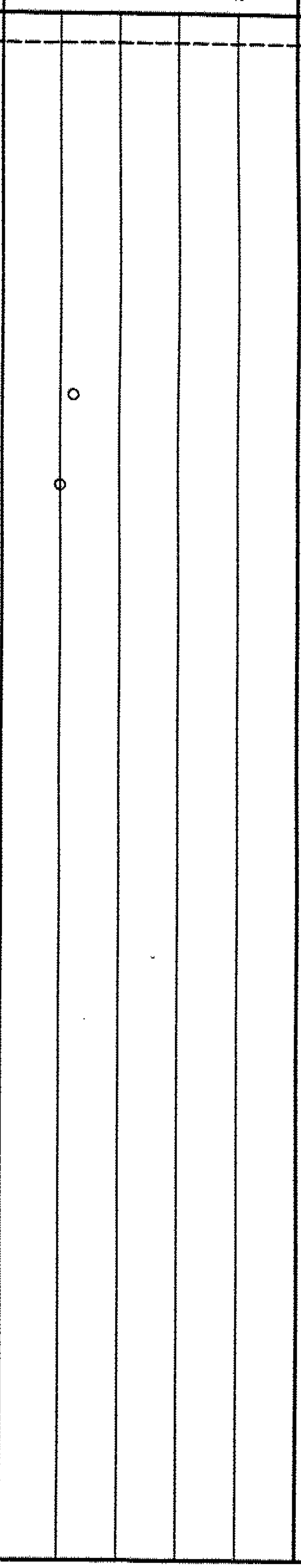
W.P. N/A
DIST. 4; HWY: QEW
LOCATION: N 4789696; E 283711

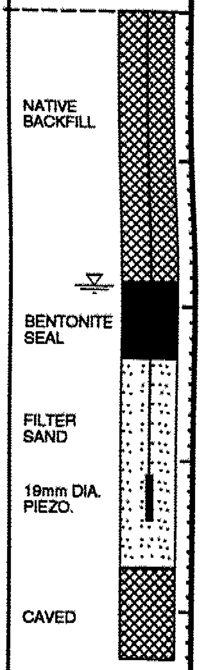
RECORD OF BOREHOLE 9

BORING DATE: FEB.25/98

SHEET 2 OF 2
DATUM: GEODETIC
PROJECT: 981-1108

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m; SHEAR STRENGTH Cu, kPa (nat V - + Q - ● rem V - ⊕ U - O) 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s; WATER CONTENT, PERCENT Wp ├──O W──┤ Wl 10 20 30 40	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	CME 55 BOMBARDIER HOLLOW STEM AUGERS	CONTINUED FROM PREVIOUS PAGE									
11		Silty Clay, trace to some sand and gravel, occ. shale fragments Hard Grey to reddish grey (Glacial Till)			9	50 DO	36				NATIVE BACKFILL
12					10	50 DO	45				BENTONITE SEAL
13					11	50 DO	62				FILTER SAND 19mm DIA. PIEZO.
14		Shale Highly weathered Reddish brown (Bedrock)		65.40 14.20	12	50 DO	128				CAVED
		END OF BOREHOLE		14.33							
15											
16											
17											
18											
19											
20											





Borehole dry on completion of drilling.
Water level in piezometer at Elev. 67.8m on March 25/98.

DATA INPUT: PS MAR 30/98

DEPTH SCALE
1 to 50

Golder Associates

LOGGED: GD
CHECKED: SP

SOILM6

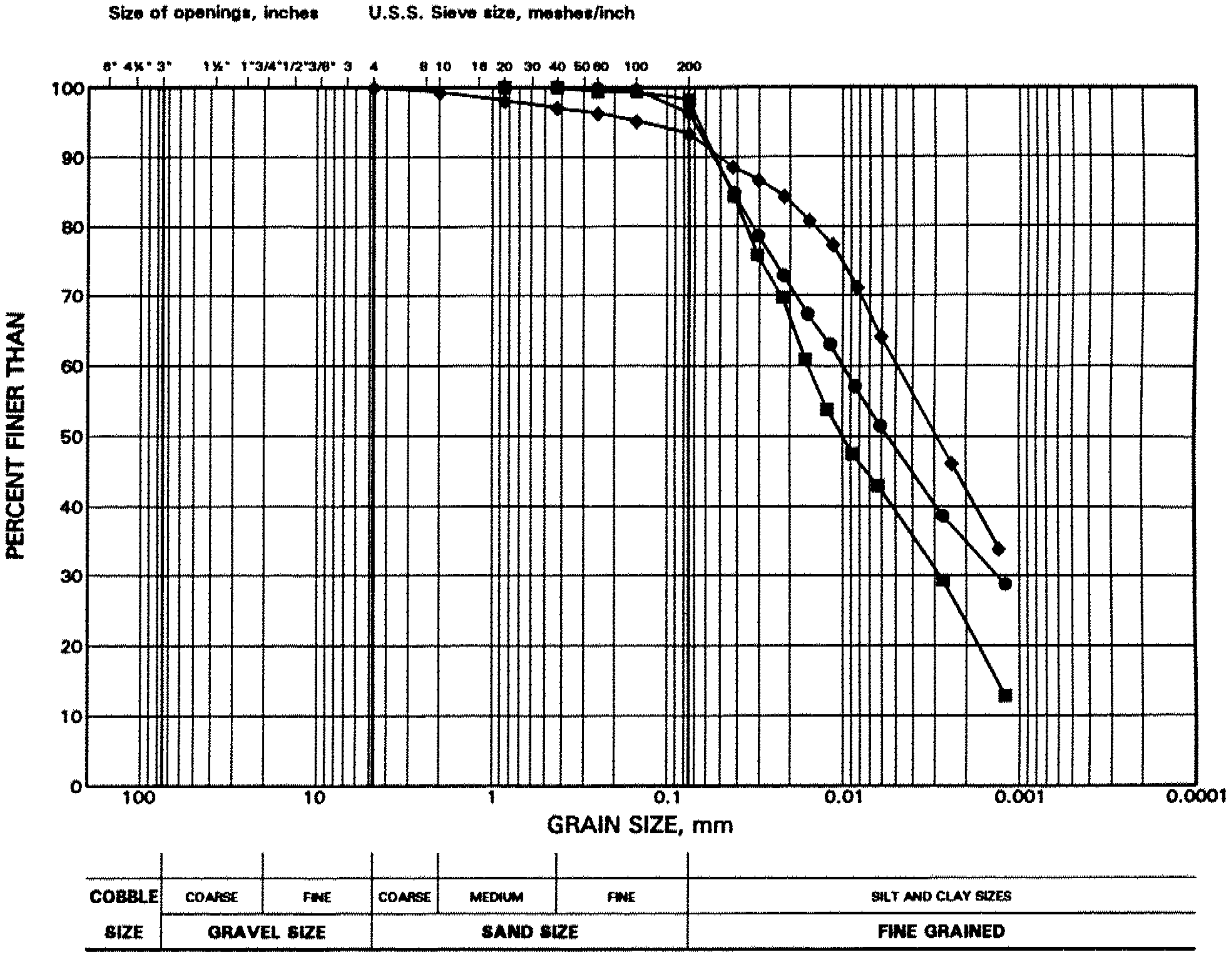
APPENIDX A

RECORD OF BOREHOLE SHEETS
MINISTRY OF TRANSPORTATION
CONTRACT 75-07
W.P. 44-71-02 & 71-03

GRAIN SIZE DISTRIBUTION

Silty Clay, trace sand

FIGURE 1

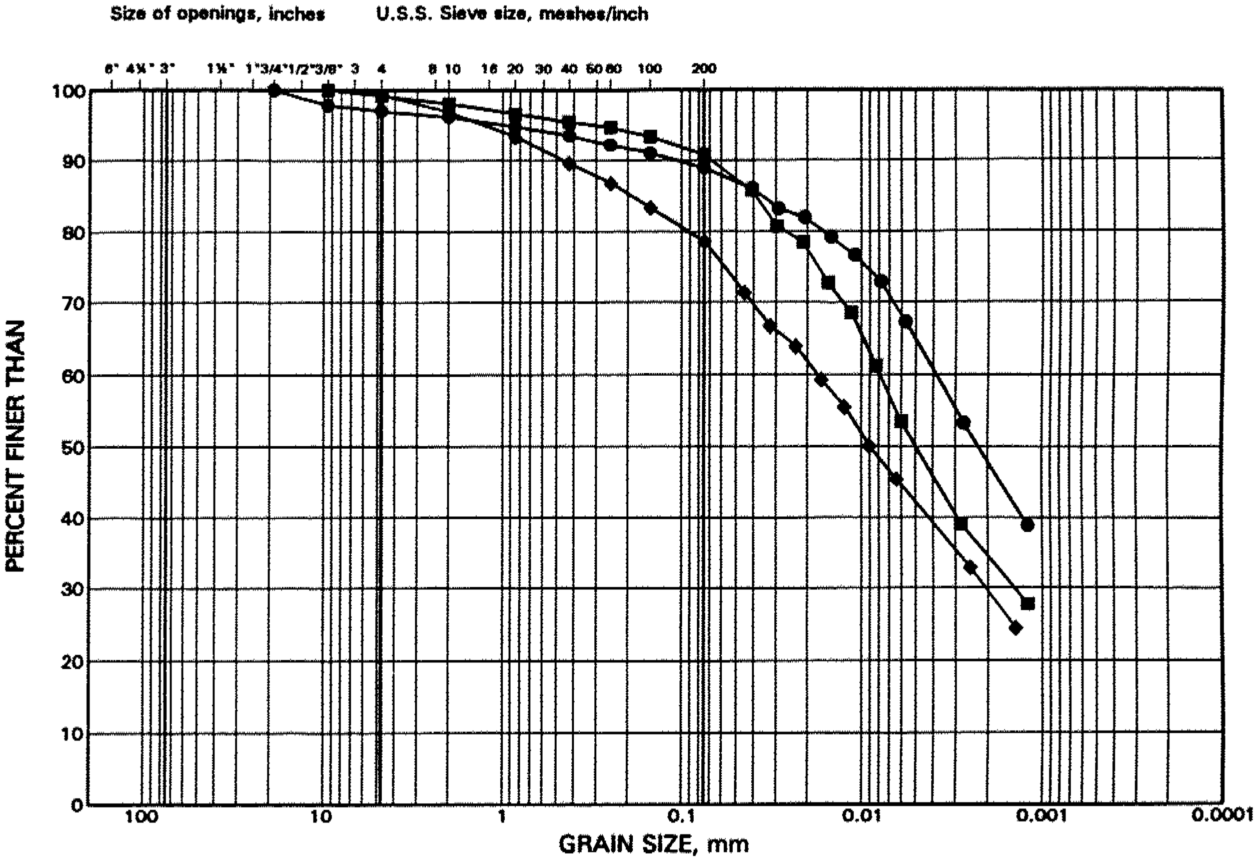


LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	1	4	2.7
■	4	6	4.3
◆	7	5	3.5

GRAIN SIZE DISTRIBUTION
Silty Clay, trace to some sand occasional gravel ("soft" clay)

FIGURE 2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	1	7	5.0
■	4	8	6.6
◆	5	7	5.0

Project 981-1108

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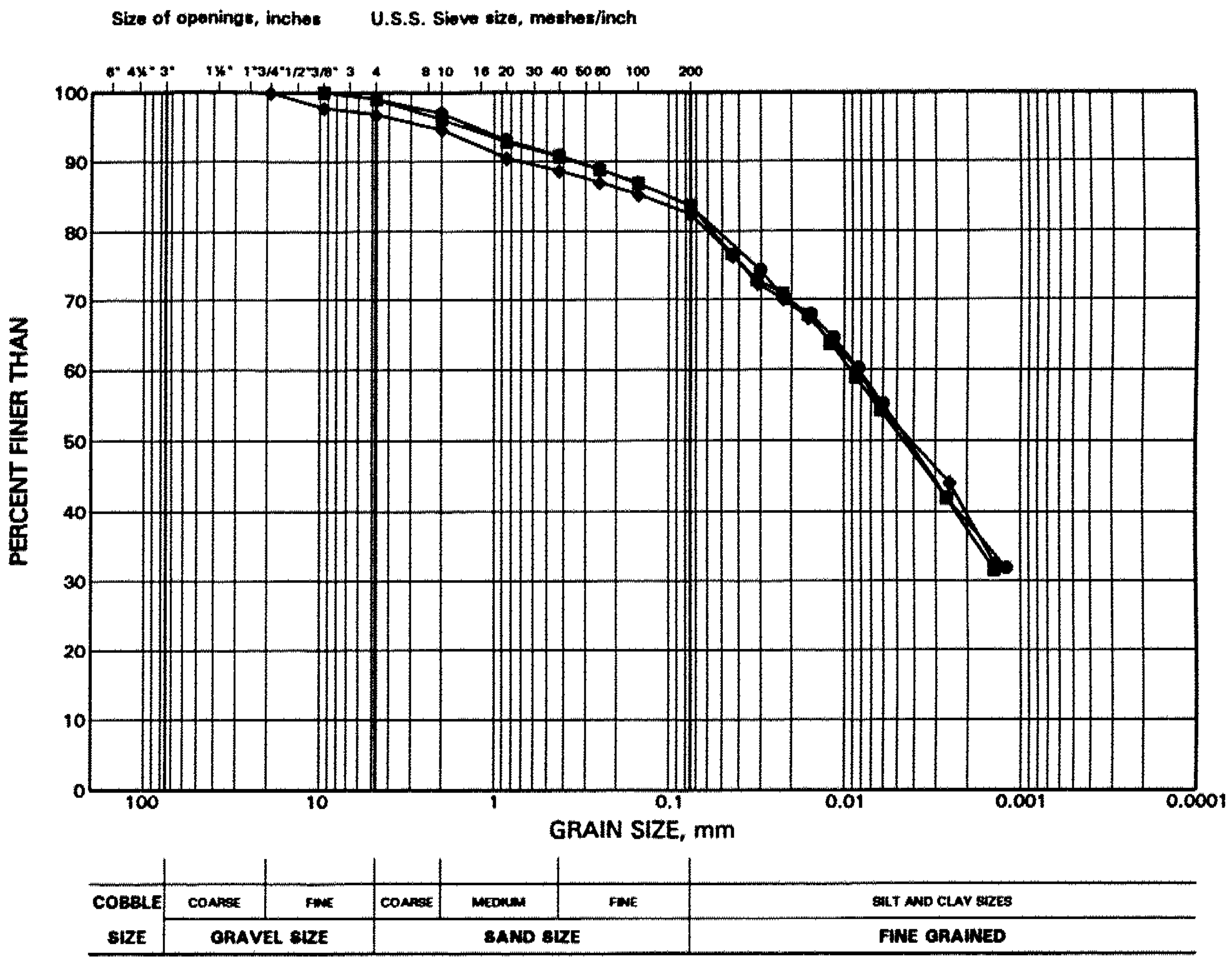
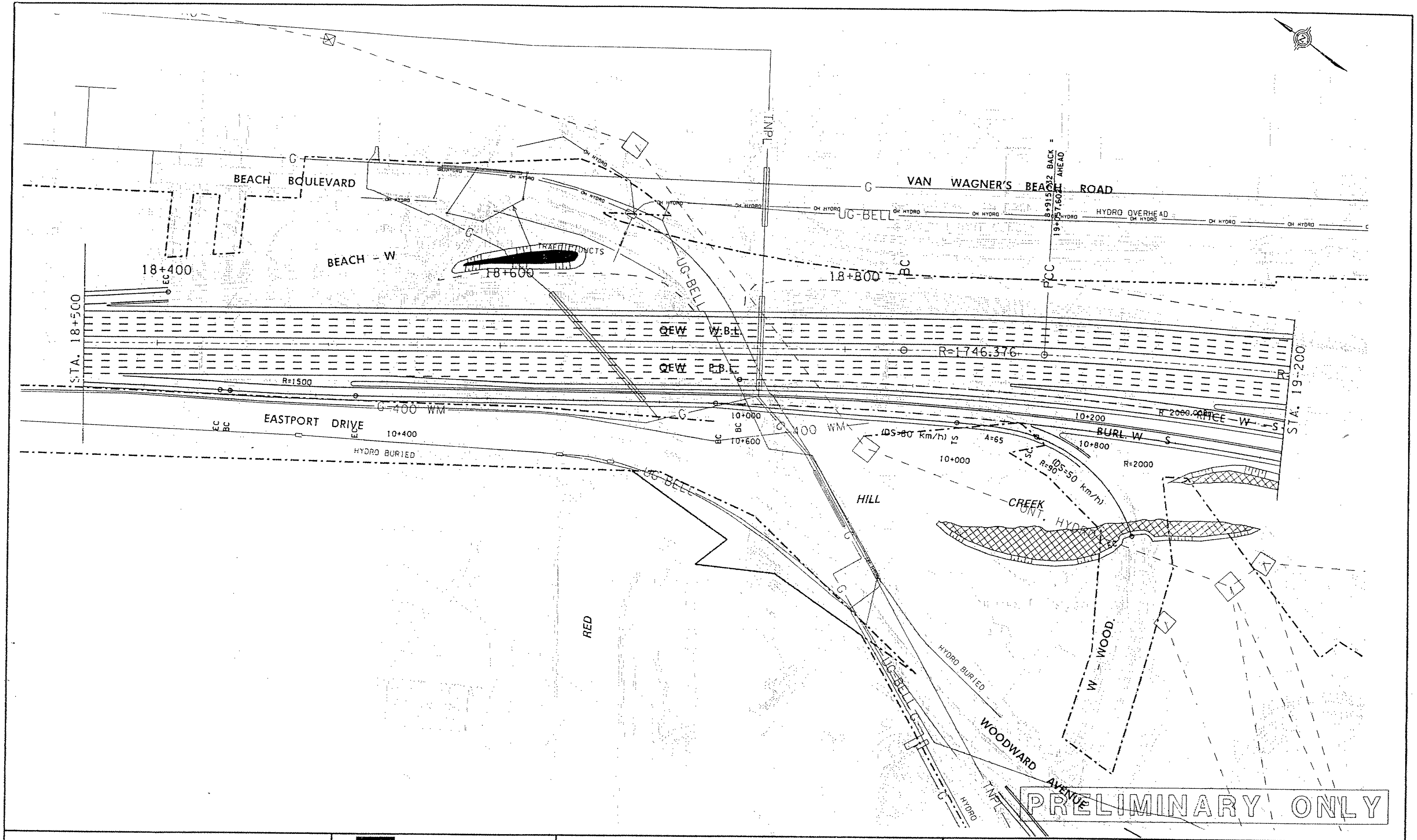
GRAIN SIZE DISTRIBUTION
Silty Clay some sand trace gravel (Glacial Till)

FIGURE 3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	2	9	8.1
■	3	7	6.6
◆	5	13	14.2



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

MRC McCORMICK RANKIN CORPORATION

Scale
0 40 80m

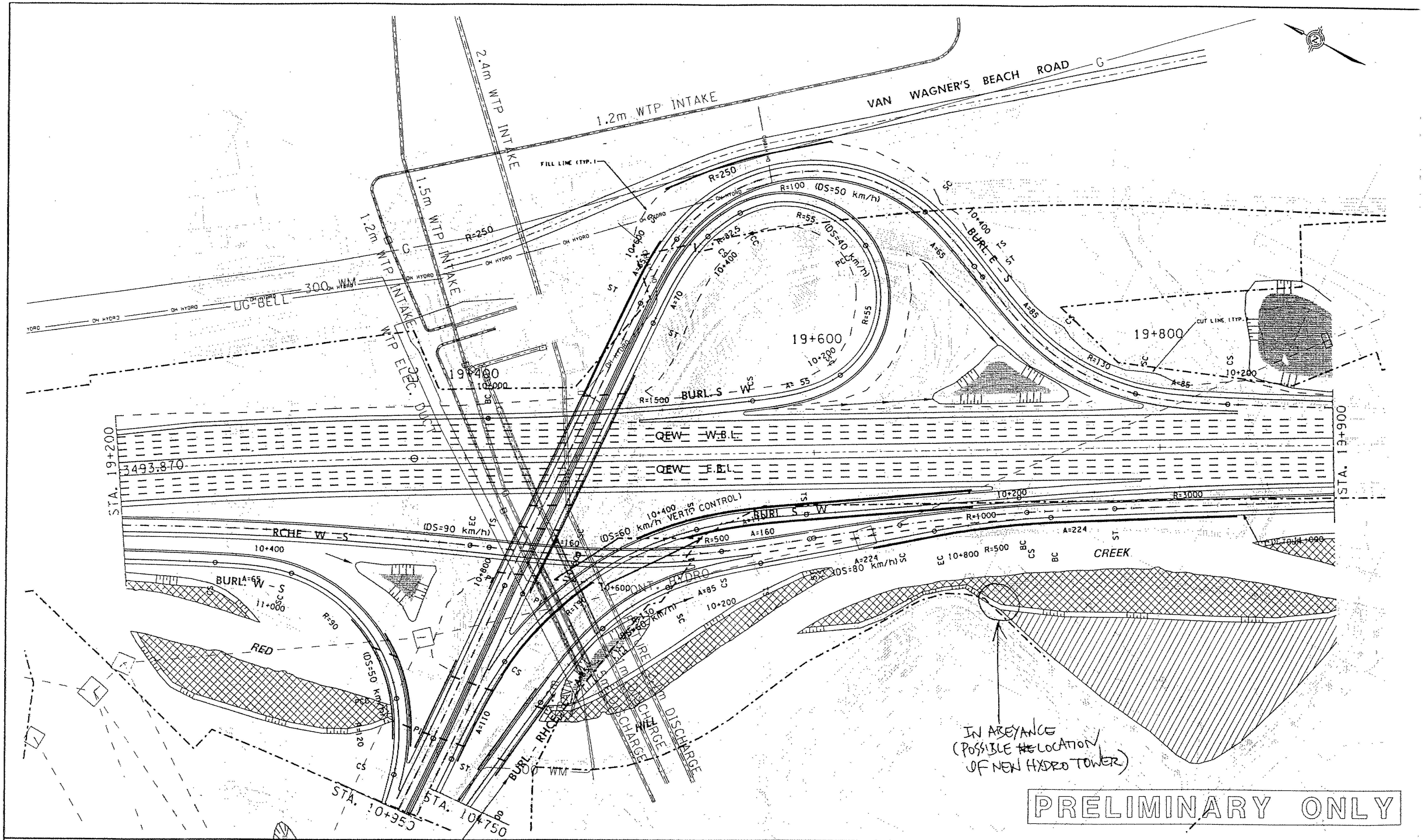
Legend

▩ PRIMARY AREAS CONSIDERED FOR FLOODPLAIN EXCAVATION

▨ SUPPLEMENTAL AREAS FOR FLOODPLAIN EXCAVATION

QEW
STA. 18+500 TO STA. 19+200

EXHIBIT



IN ABEYANCE
(POSSIBLE ~~HE~~ LOCATION
OF NEW HYDRO TOWER)

PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

MRC McCORMICK RANKIN CORPORATION

Scale 0 40 80m

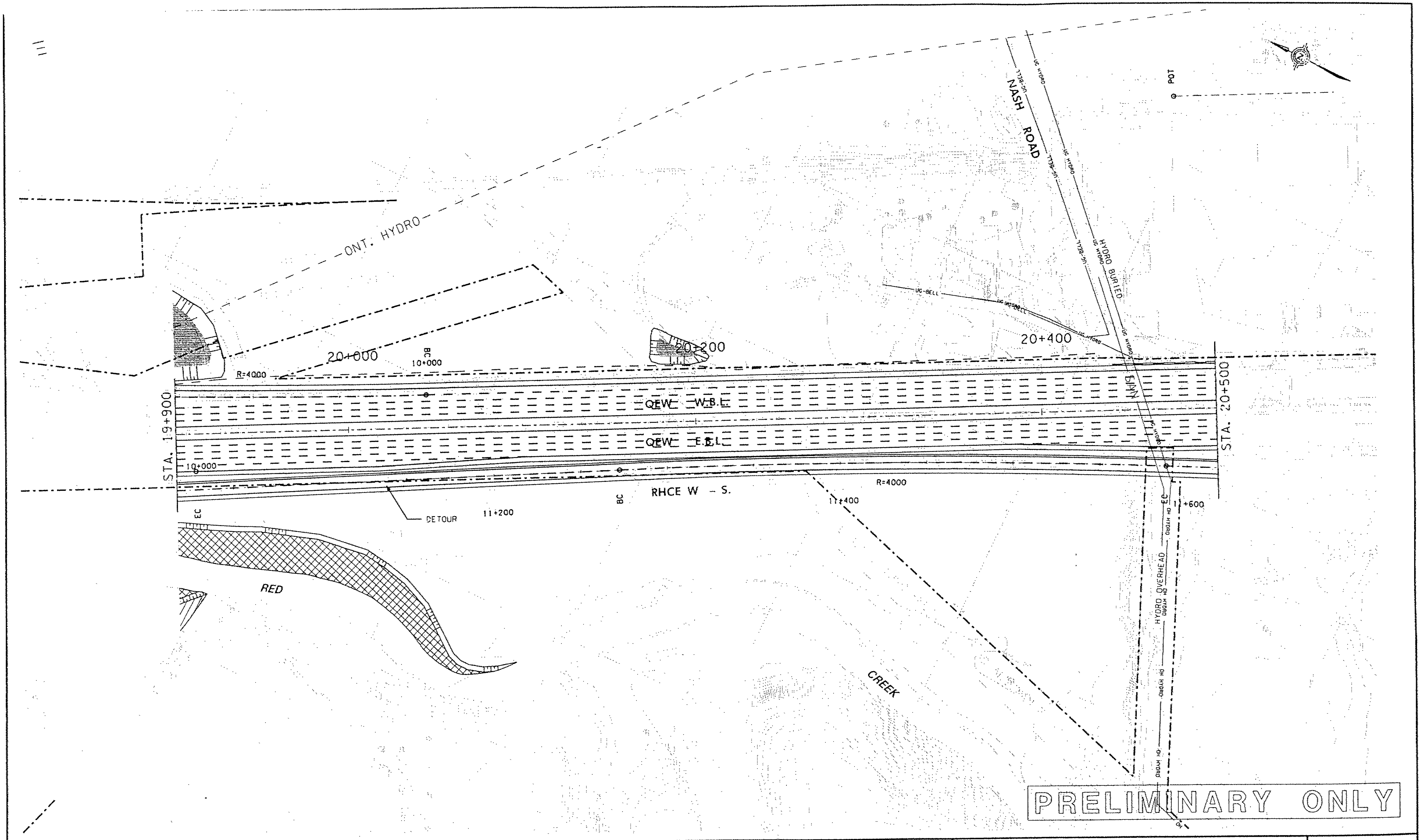
Legend

▩ PRIMARY AREAS CONSIDERED FOR FLOODPLAIN EXCAVATION

▨ SUPPLEMENTAL AREAS FOR FLOODPLAIN EXCAVATION

QEW
STA. 19+200 TO STA. 19+900

EXHIBIT



PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

MRC
McCORMICK RANKIN
CORPORATION

Scale
0 40 80m

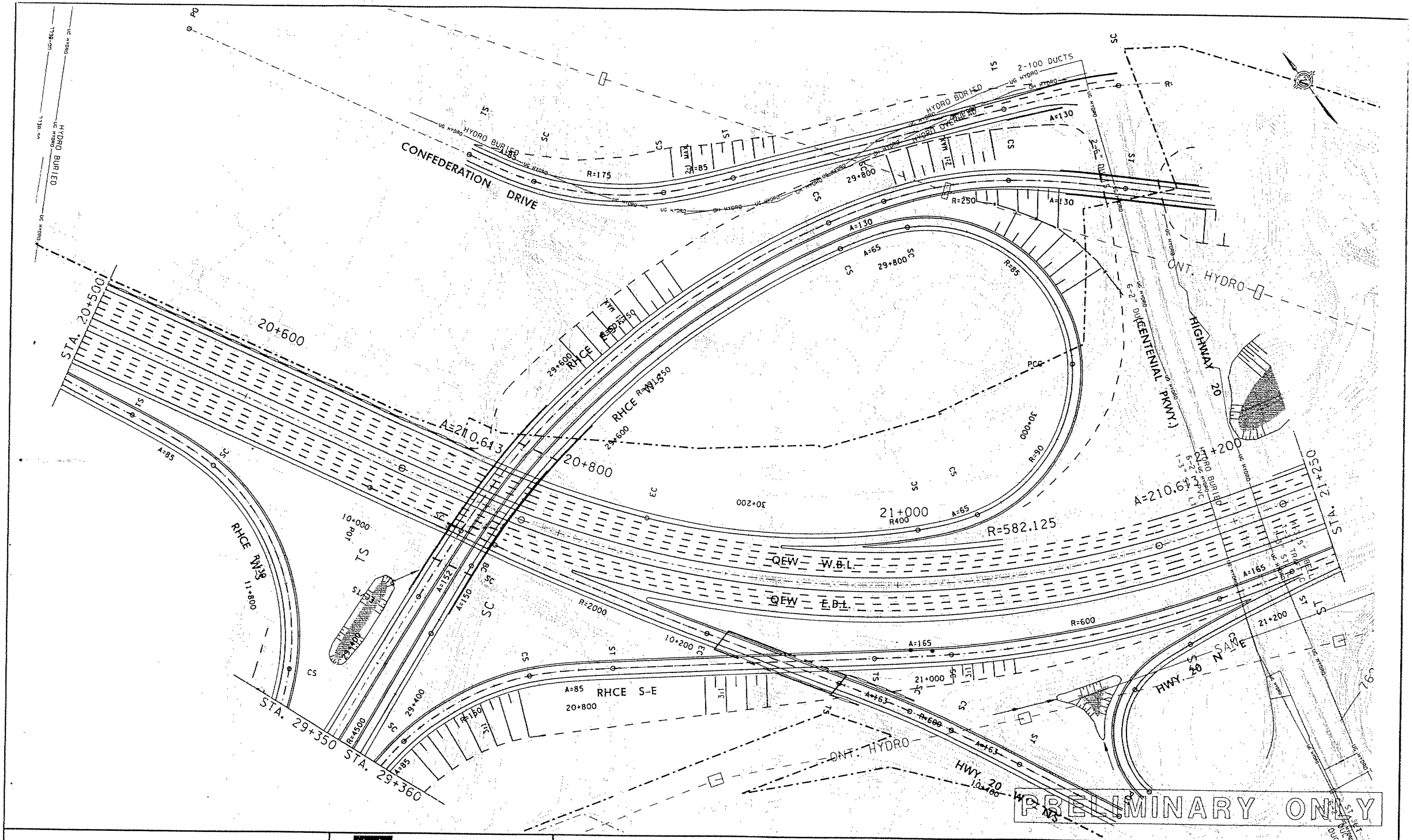
Legend

▩ PRIMARY AREAS CONSIDERED FOR FLOODPLAIN EXCAVATION

▨ SUPPLEMENTAL AREAS FOR FLOODPLAIN EXCAVATION

QEW
STA. 19+900 TO STA. 20+500

EXHIBIT



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

MRC McCORMICK RANKIN CORPORATION

Scale
0 40 80m

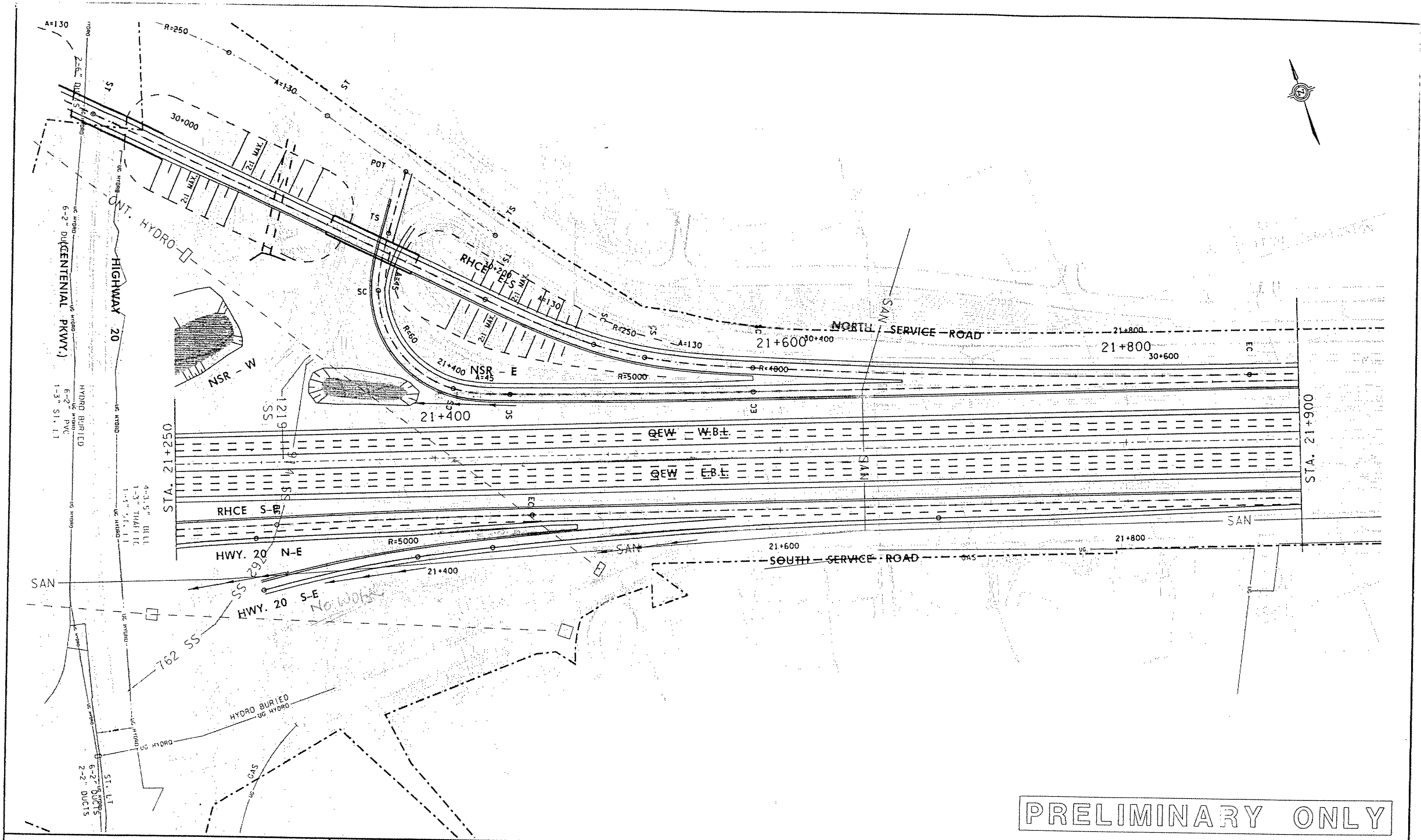
Legend

▩ PRIMARY AREAS CONSIDERED FOR FLOODPLAIN EXCAVATION

▨ SUPPLEMENTAL AREAS FOR FLOODPLAIN EXCAVATION

QEW
STA. 20+500 TO STA. 21+250

EXHIBIT



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

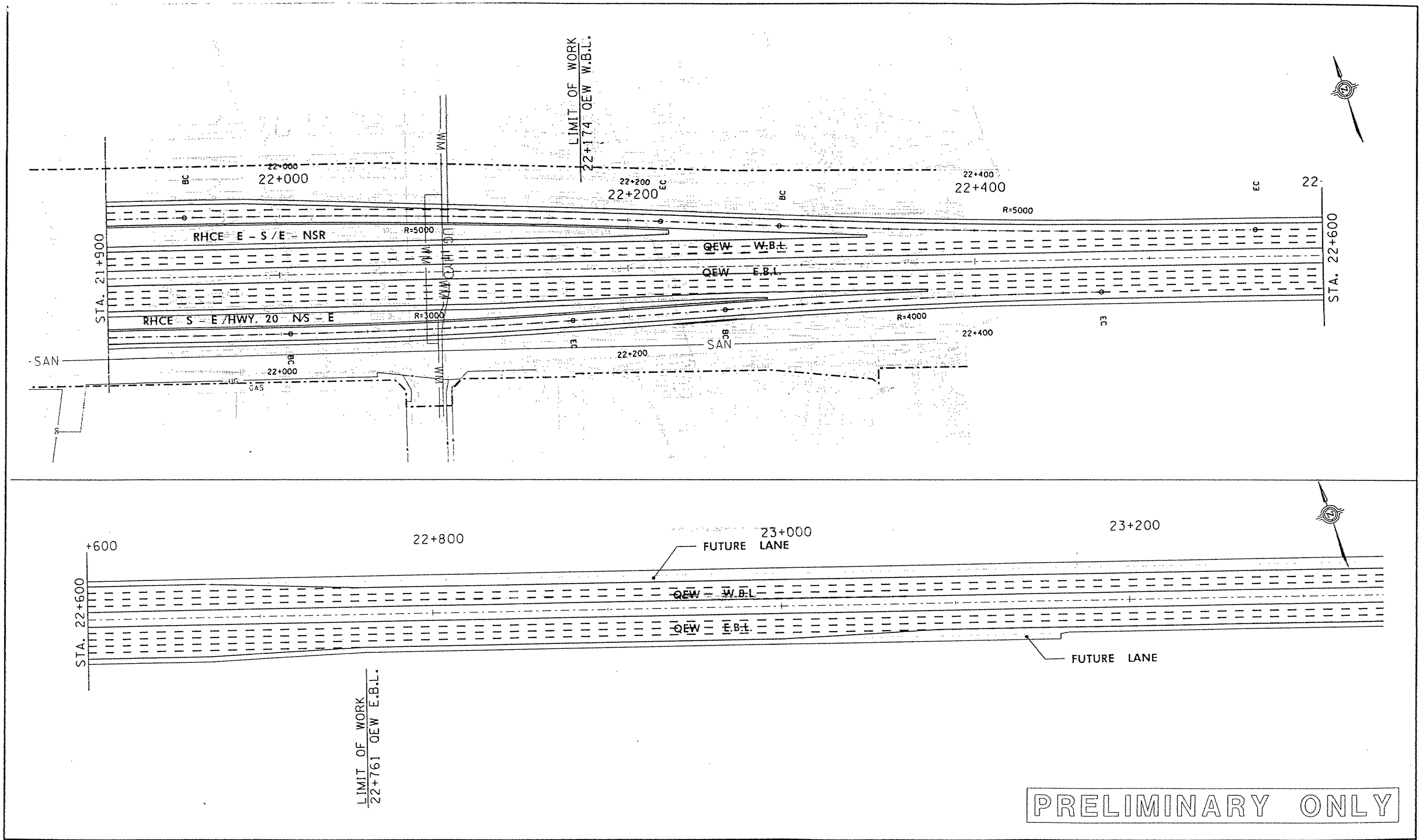
MRC McCORMICK RANKIN CORPORATION

Scale
0 40 80m

Legend

QEW
STA. 21+250 TO STA. 21+900

EXHIBIT



PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

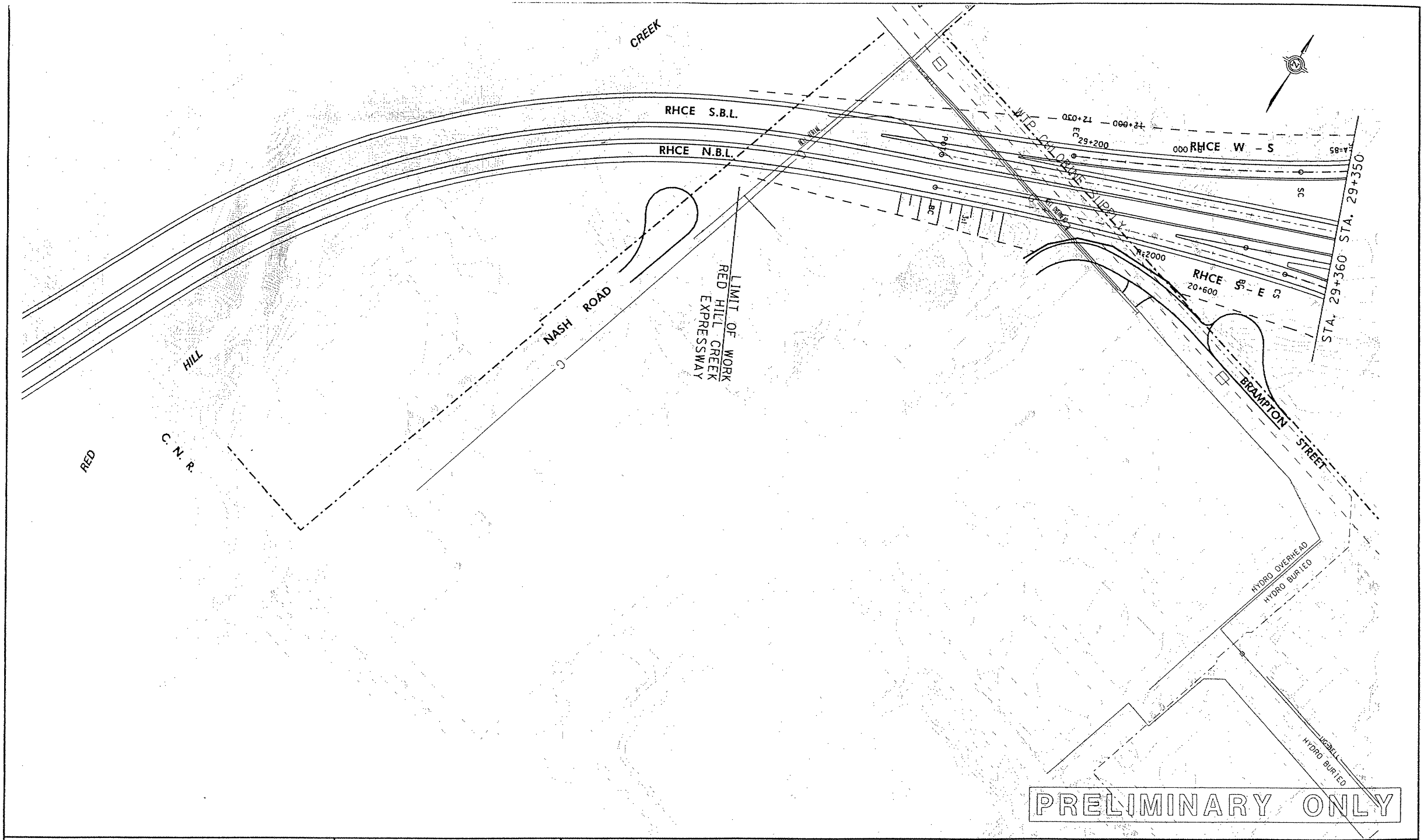
MRC
McCORMICK RANKIN
CORPORATION

Scale
0 40 80m

Legend

QEW
STA. 21+900 TO STA. 23+200

EXHIBIT



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

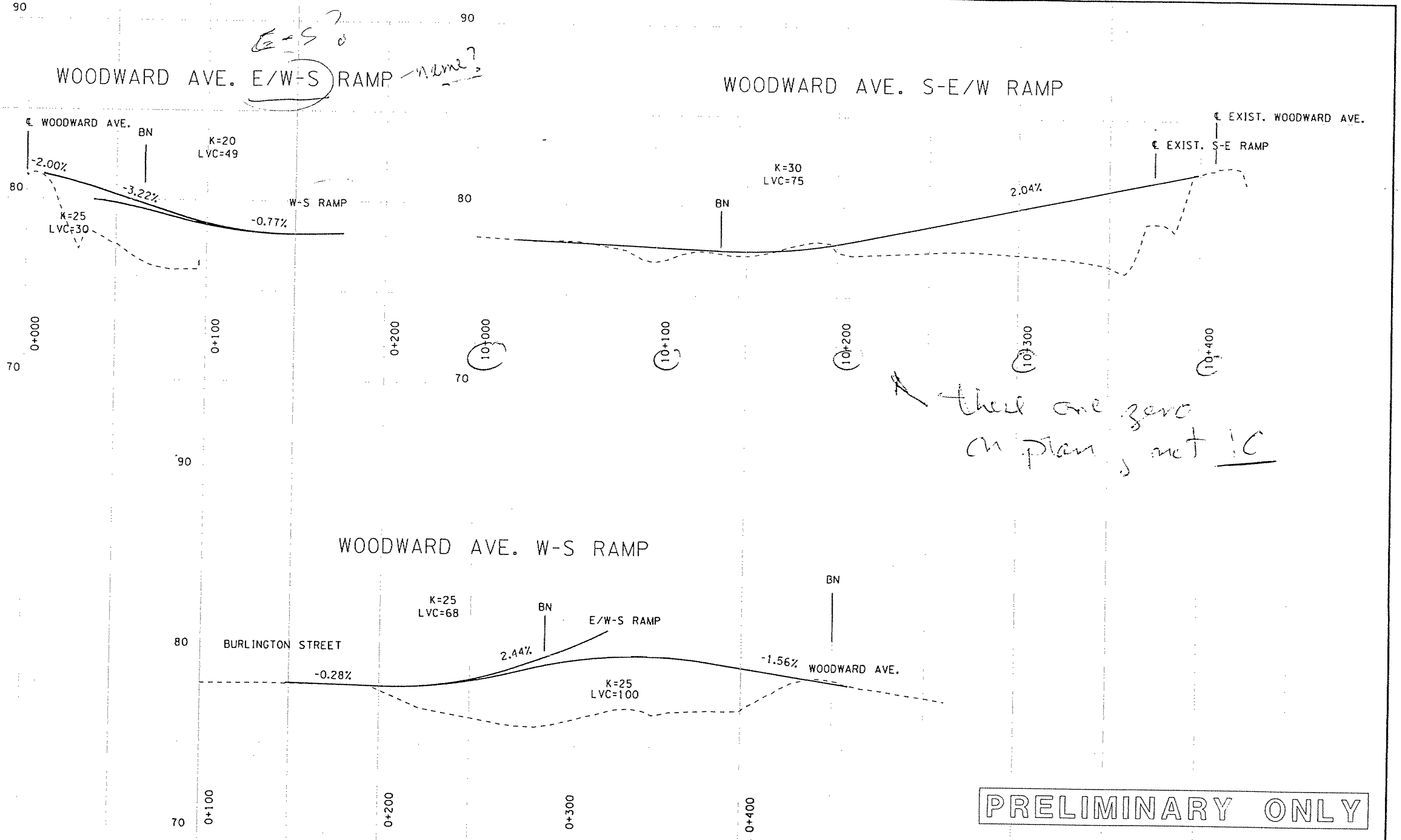
MRC McCORMICK RANKIN CORPORATION

Scale 0 40 80m

Legend

REDHILL CREEK
EXPRESSWAY

EXHIBIT



E-S ?

name?

these are zero on plan, not 10

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

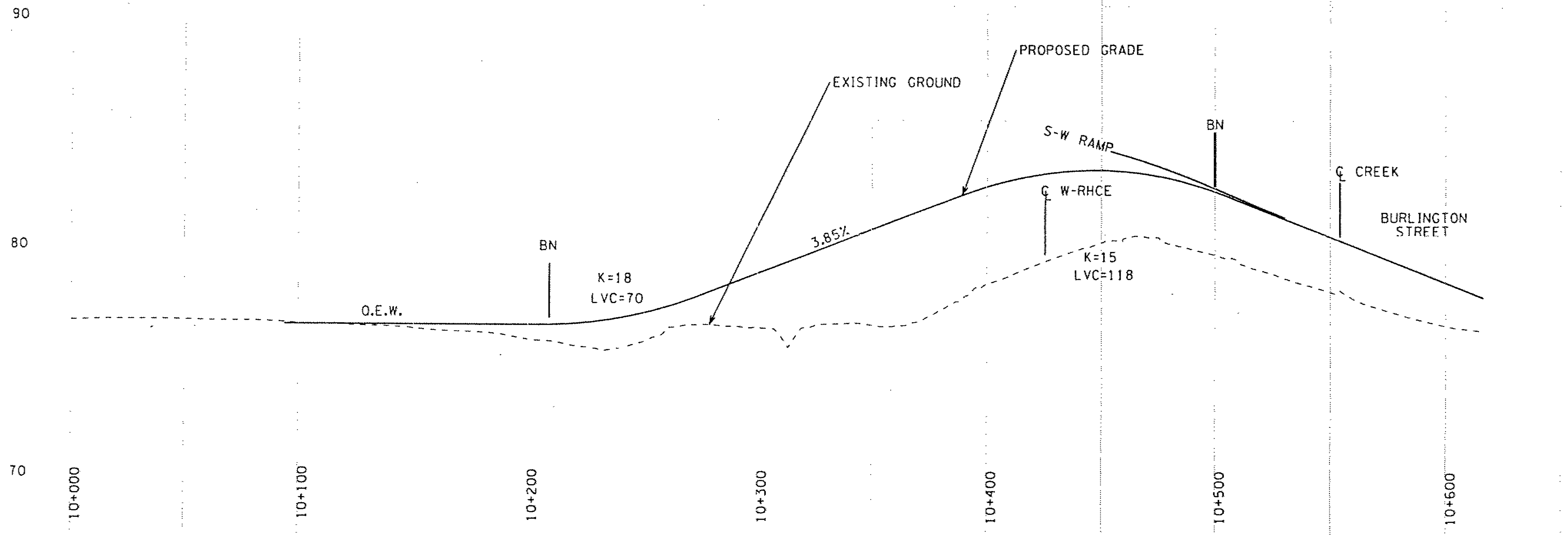
MRC McCORMICK RANKIN CORPORATION

Scale 0 40 80m

Legend

PROFILE
WOODWARD AVENUE RAMPS

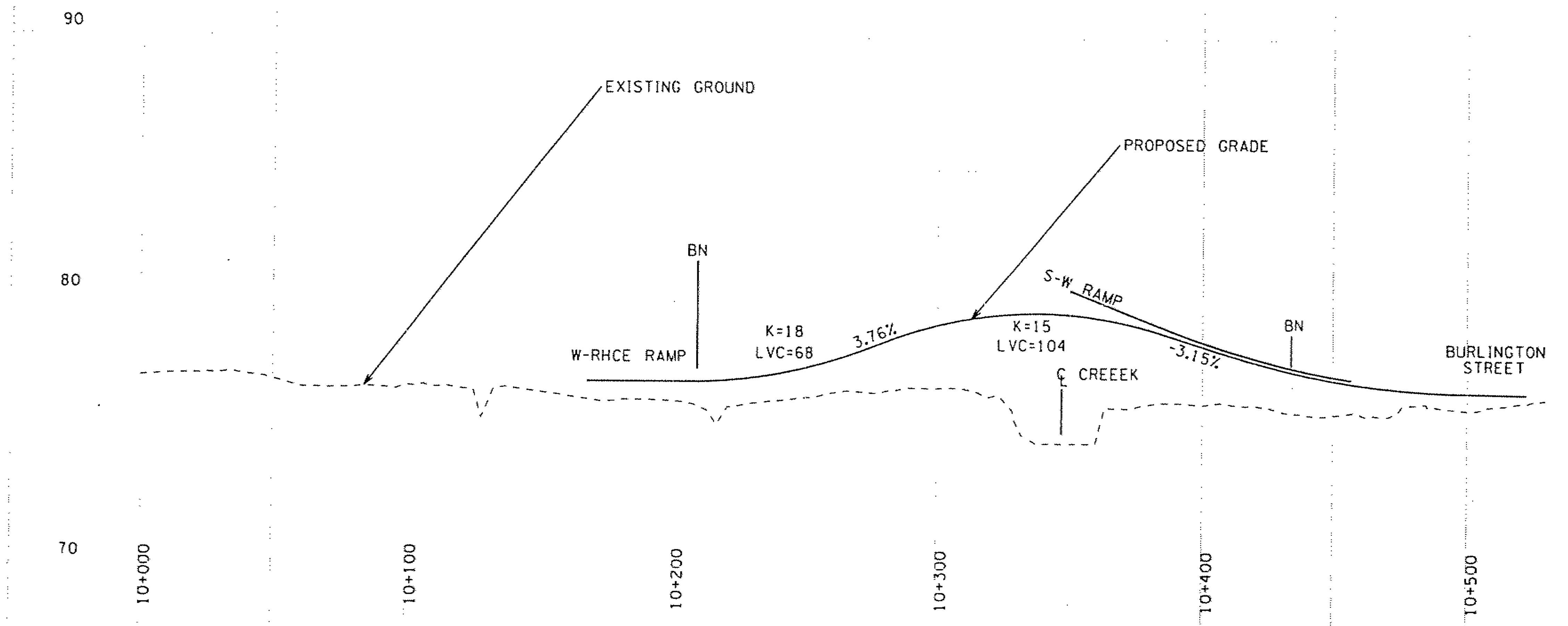
EXHIBIT



S-E RAMP (BURLINGTON ST.)

PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY Preliminary Design Report GWP 441-97-00	MRC McCORMICK RANKIN CORPORATION Scale 0 40 80m	Legend	PROFILE BURLINGTON INTERCHANGE S-E RAMP	EXHIBIT



S-RHCE RAMP (BURLINGTON ST.)

PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

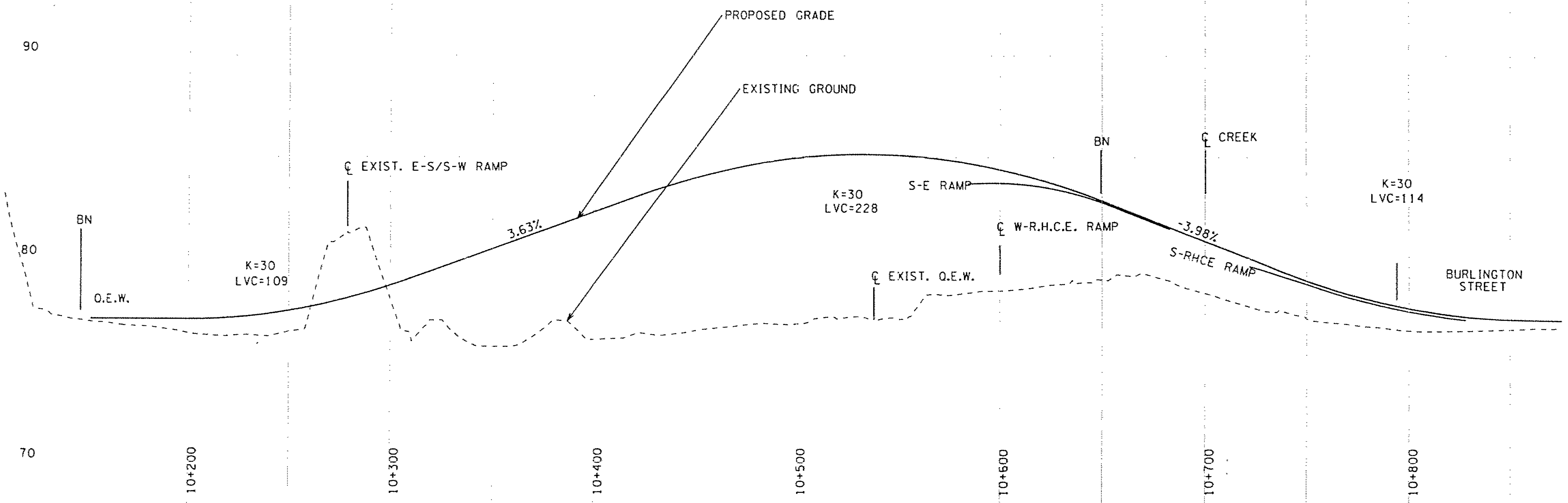
MRC McCORMICK RANKIN CORPORATION

Scale 0 40 80m

Legend

PROFILE
BURLINGTON INTERCHANGE
S-RHCE RAMP

EXHIBIT



S-W RAMP (BURLINGTON ST.)

PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

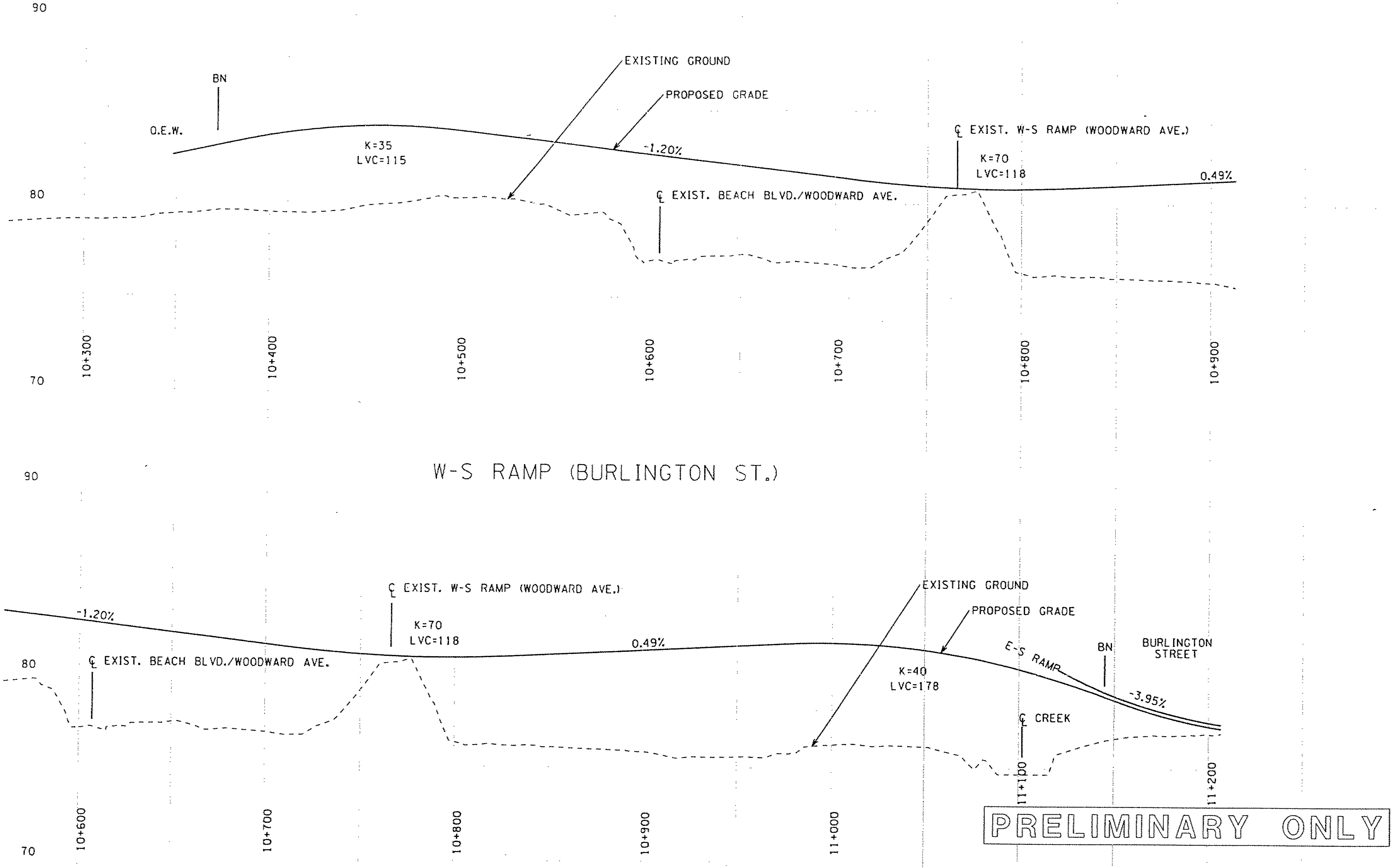
MRC McCORMICK RANKIN CORPORATION

Scale 0 40 80m

Legend

PROFILE
BURLINGTON INTERCHANGE
S-W RAMP

EXHIBIT



PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

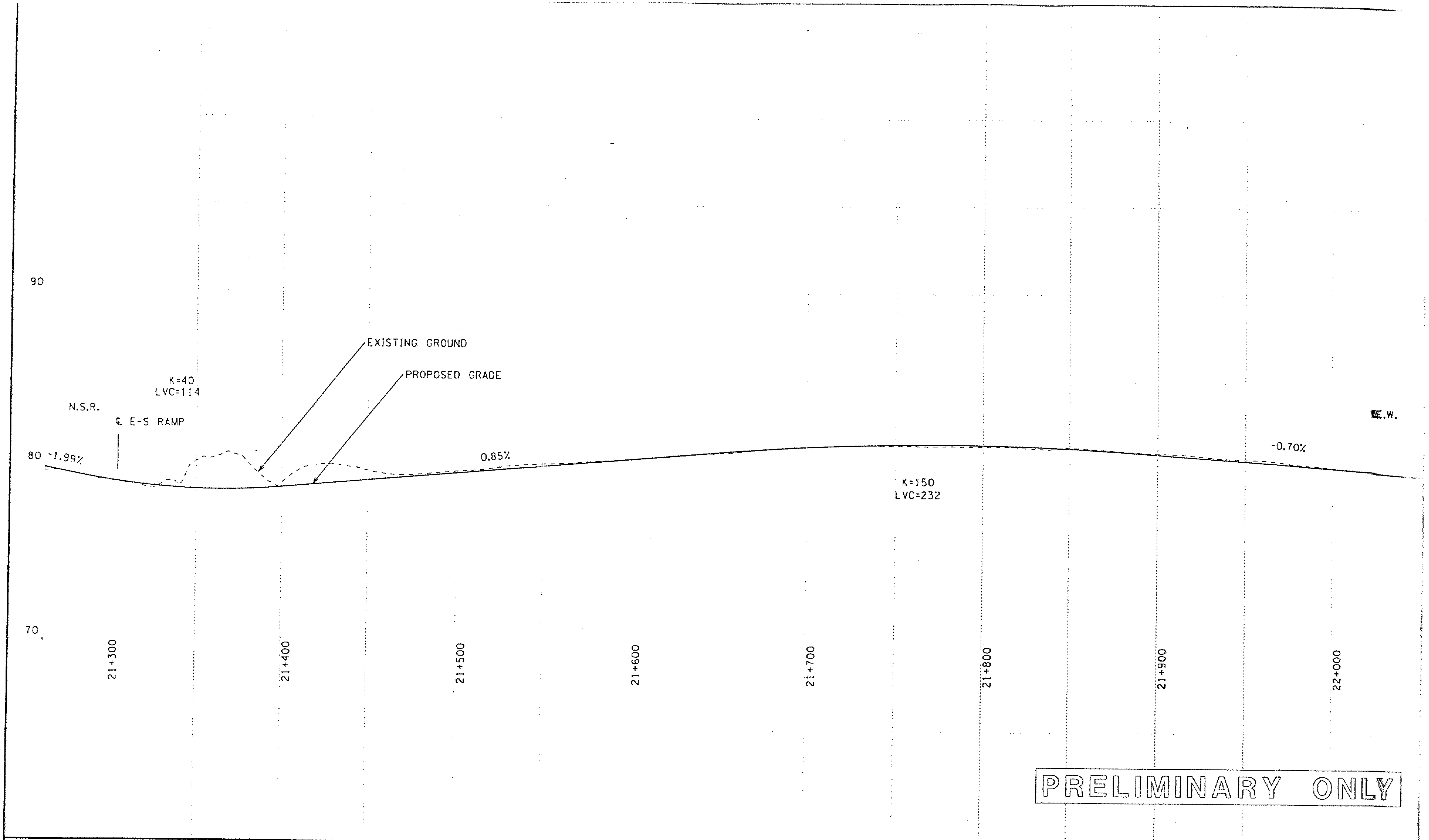
MRC McCORMICK RANKIN CORPORATION

Scale
0 40 80m

Legend

PROFILE
BURLINGTON INTERCHANGE
W-S RAMP

EXHIBIT



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

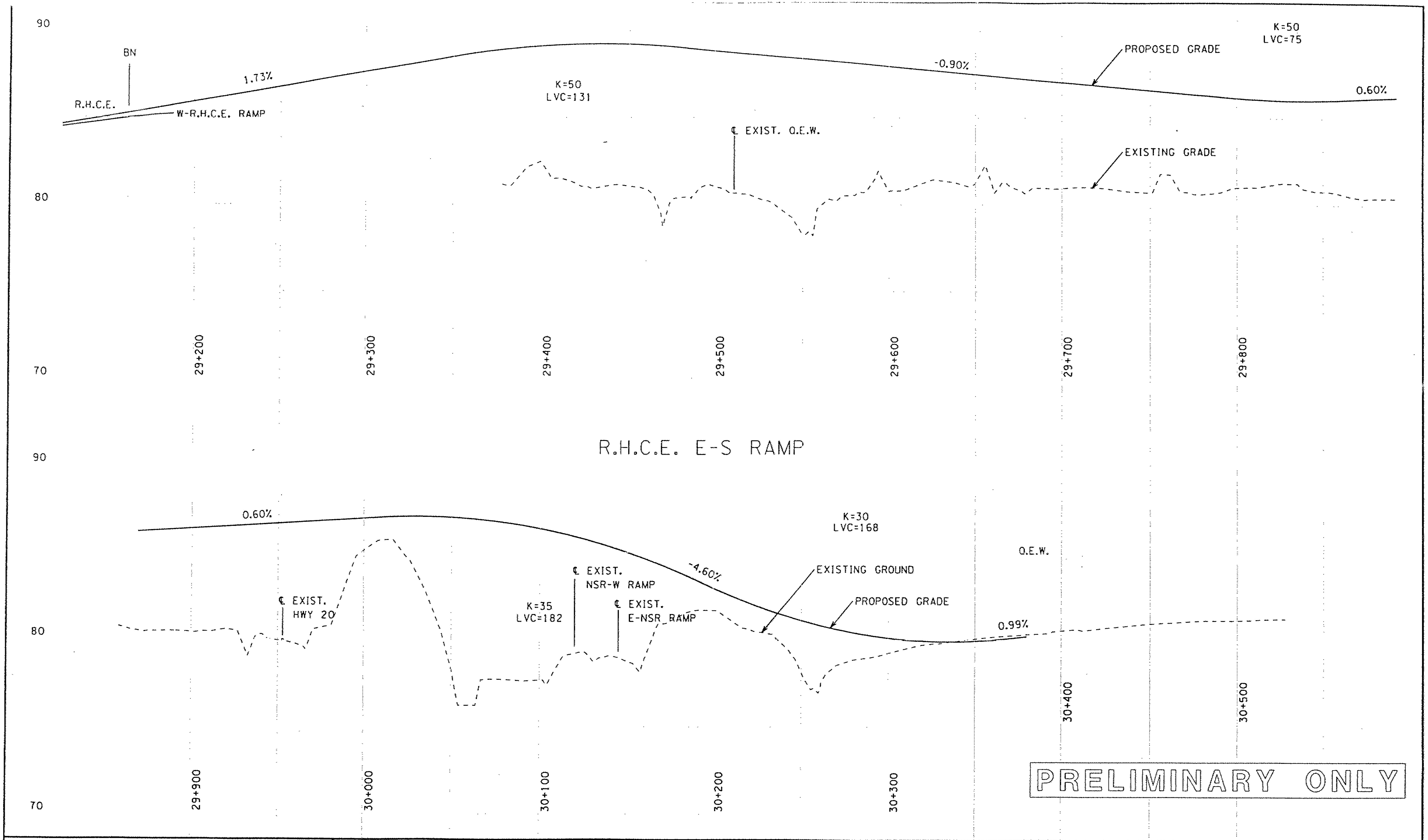
MRC McCORMICK RANKIN CORPORATION

Scale

Legend

PROFILE
REDHILL CREEK EXPRESSWAY
E-NORTH SERVICE ROAD

EXH[illegible]T



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

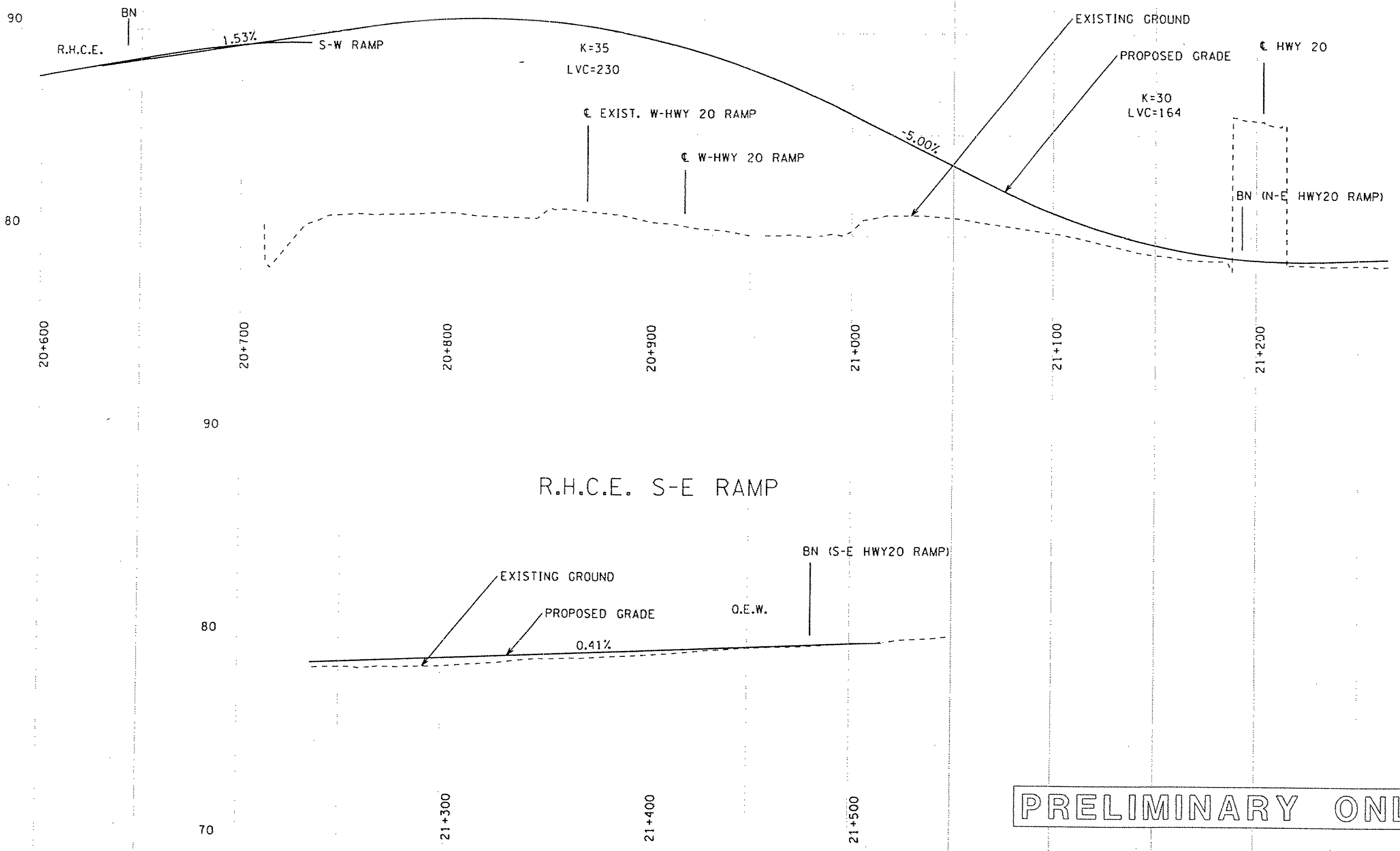
MRC McCORMICK RANKIN CORPORATION

Scale
0 40 80m

Legend

PROFILE
REDHILL CREEK EXPRESSWAY
E-S RAMP

EXHIBIT



PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

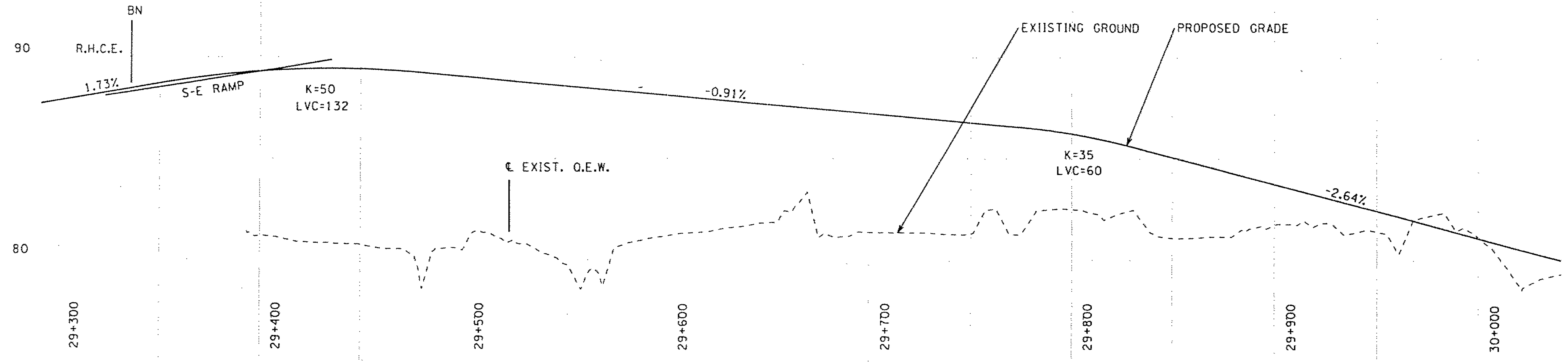
MRC McCORMICK RANKIN CORPORATION

Scale 0 40 80m

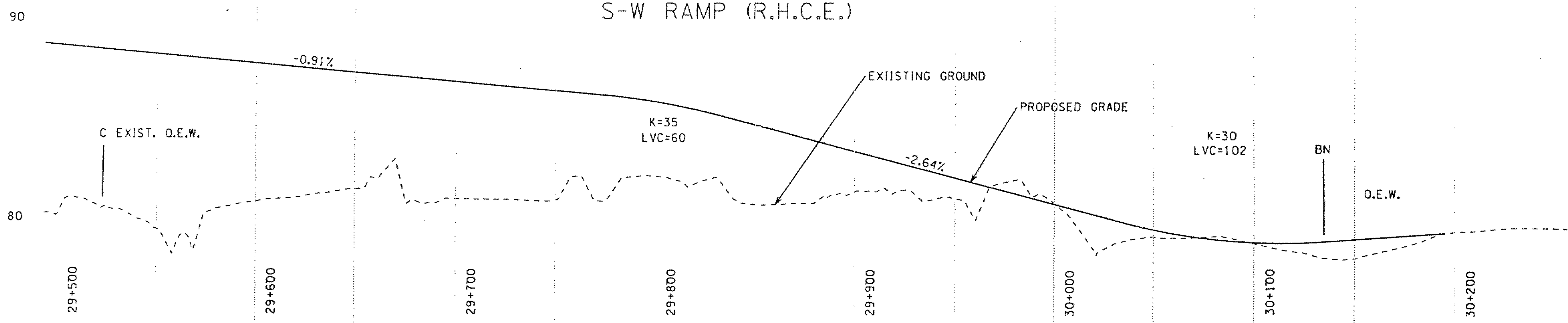
Legend

PROFILE
REDHILL CREEK EXPRESSWAY
S-E RAMP

EXHIBIT



S-W RAMP (R.H.C.E.)



PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

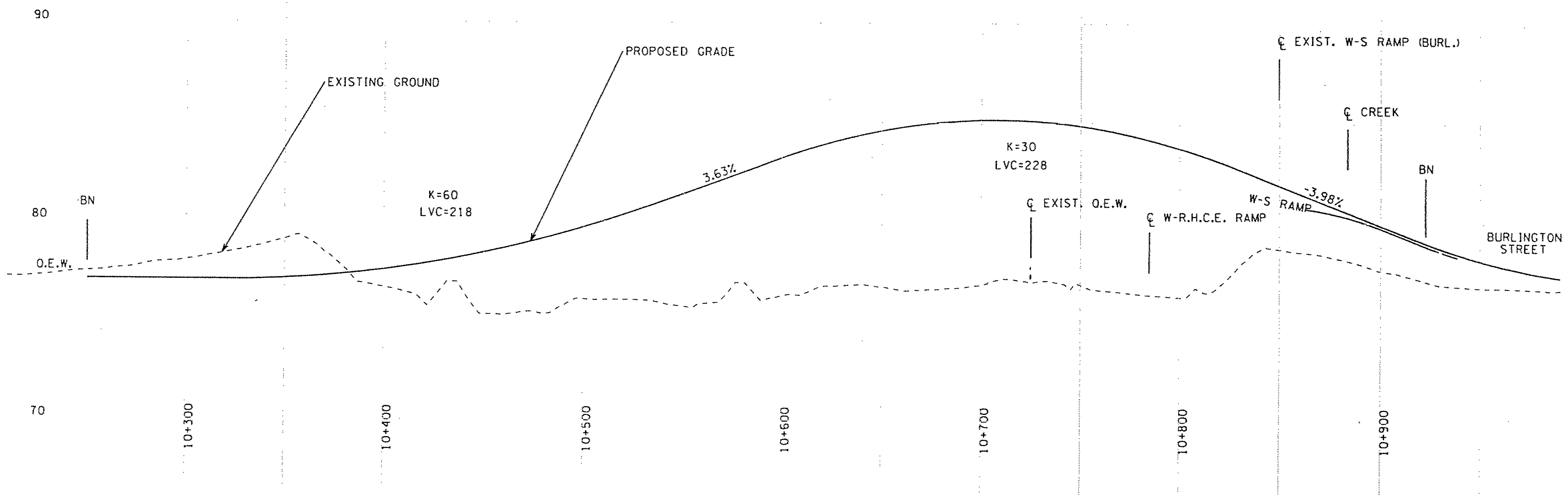
MRC
McCORMICK RANKIN
CORPORATION

Scale
0 40 80m

Legend

PROFILE
REDHILL CREEK EXPRESSWAY
S-W RAMP

EXHIBIT



E-S RAMP (BURLINGTON ST.)

PRELIMINARY ONLY

QEW/RED HILL CREEK EXPRESSWAY Preliminary Design Report GWP 441-97-00	MRC McCORMICK RANKIN CORPORATION Scale 0 40 80m	Legend	PROFILE BURLINGTON INTERHCANGE E-S RAMP	EXHIBIT

memorandum

To: Felix Tam - ATMS
John Lam – Structural Section
Bob Bendell – Electrical Section
Pat Reynolds - Environmental Section
Betty Bennett - Foundation Office
Fouad Tannous - Geotechnical Section

Date: May 31, 1999

From: Highway Engineering Section
Peel, Halton and Hamilton
4th Floor, Atrium Tower
Central Region

Re: **QEW and the Red Hill Creek Expressway**
City of Hamilton, G.W.P. 441-97-00
Consultant's Fee Estimates

As a result of the Federal Government Penal Hearing of the RHCE, the Regional Municipality of Hamilton-Wentworth and the ministry have formulate a contingency plan to staged the detail design in order to minimize the need to redesign should the results of the Hearing impact the Expressway. Therefore, McCormick Rankin has divided the scope of work and fee estimate into three packages.

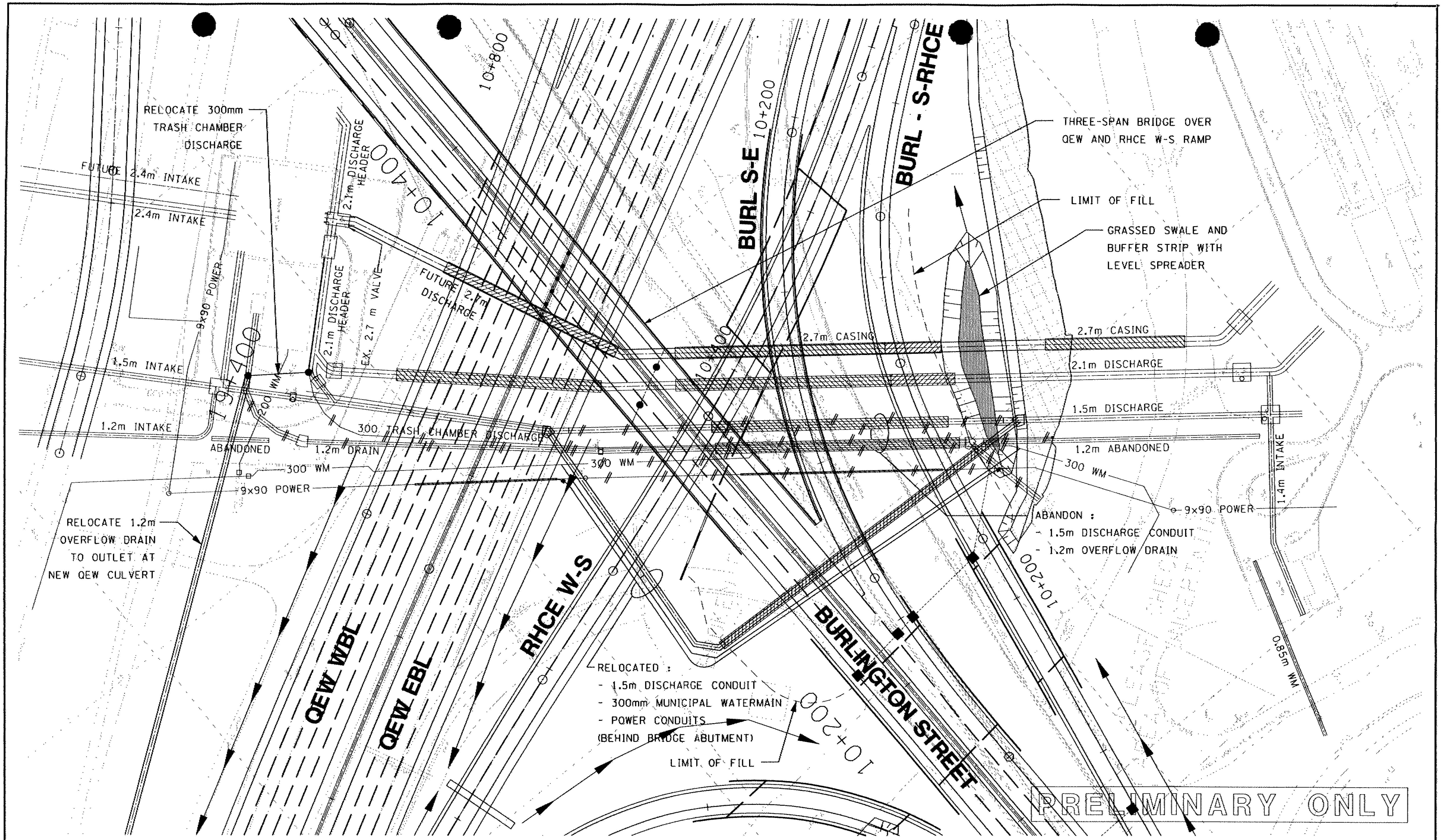
1. Water Treatment Plant discharge conduit relocation
2. QEW widening and Burlington Interchange
3. RHCE Interchange

Please review the enclosed packages and advice on the acceptability of the proposed scope of work and design fee estimates. A written response by Friday, June 4, 1999 is required. Should you have any questions, please call me at Ext. 5534.

Thanks,

Joseph Lai
Senior Project Engineer

c.c. P. Shaver (memo only)
F. Leech (memo only)



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

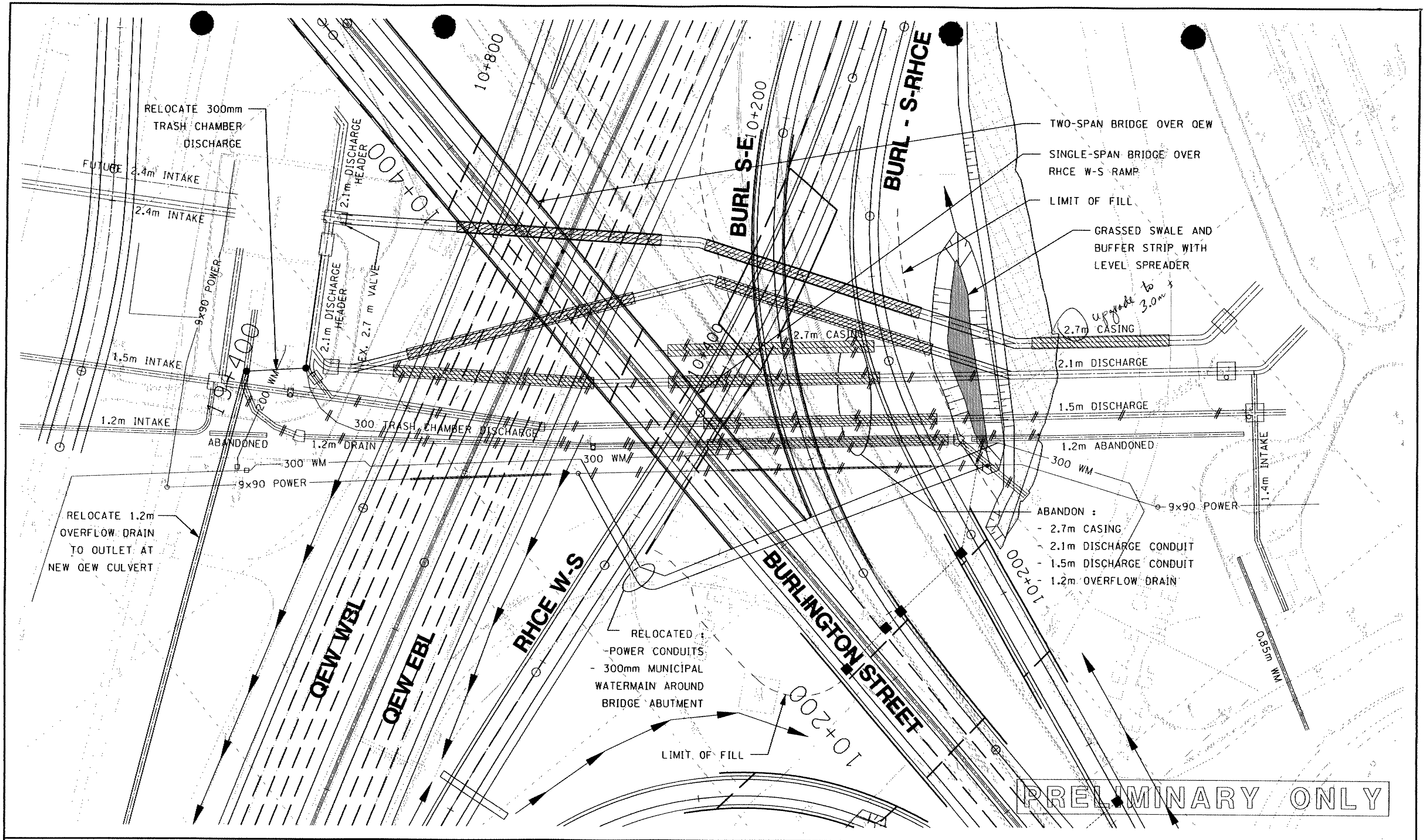
Scale
0 20 40

Legend

WATER TREATMENT PLANT
ALTERNATIVE TWO
RELOCATION OF 1.5m DIA. DISCHARGE CONDUIT

EXHIBIT

OPTION (2A): BUILD 2.7m+ Ø pipe, use existing 2.1; Abandon 1.5m



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

Scale
0 20 40

Legend

WATER TREATMENT PLANT

ALTERNATIVE THREE

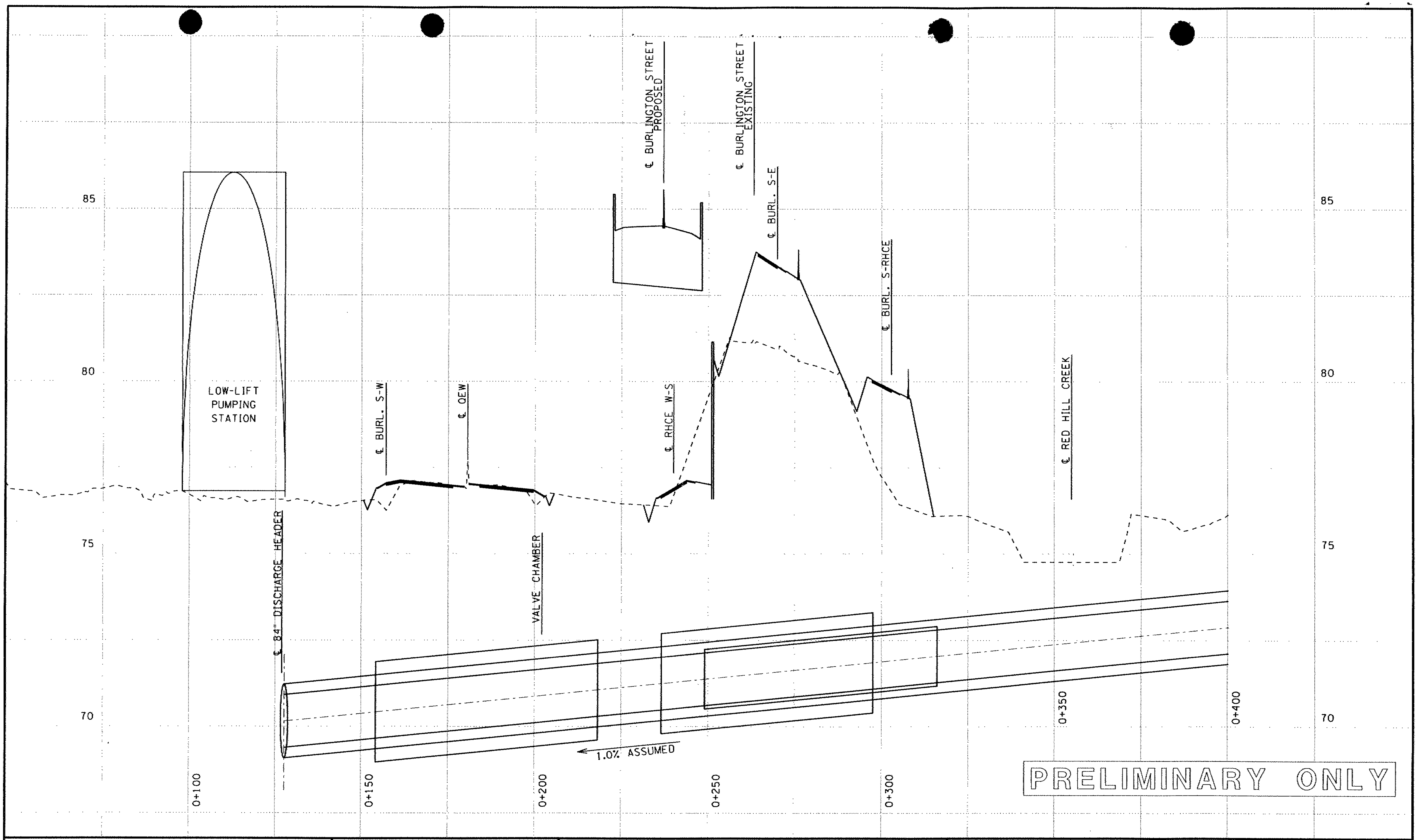
RELOCATION OF 2.1m DIA. DISCHARGE CONDUIT AND
ABANDON 1.5m DIA. DISCHARGE CONDUIT

EXHIBIT

QEW/RED HILL CREEK EXPRESSWAY
PRELIMINARY DESIGN

REGION OF HAMILTON-WENTWORTH
WATER TREATMENT PLANT AND LOW-LIFT PUMPING STATION CONDUIT RELOCATION/PROTECTION ALTERNATIVES

	ALTERNATIVE ONE **No Discharge Conduit Relocation**	**ALTERNATIVE TWO** **Relocate 1.5m Dia. Discharge Conduit**	**ALTERNATIVE THREE** **Relocate 2.1m Dia. Discharge Conduit and Abandon 1.5m Dia. Discharge Conduit**
Assumptions	• bridge over the QEW and RHCE W-S ramp can be constructed to avoid 1.5m and 2.1m discharge conduits by overbuilding span, and by constructing two column pier. • neither discharge conduit can carry any additional embankment loading. • cost premium associated with longer bridge will offset the cost of relocation of the discharge conduits.	• bridge over the QEW and RHCE W-S ramp cannot be constructed with sufficient clearance between the foundation elements and the 1.5m discharge conduit. • neither discharge conduit can carry any additional embankment loading. • cost premium associated with longer bridge will offset the cost of relocation of the 2.1m discharge conduit.	• neither discharge conduit can be protected from construction of the QEW bridge. • neither discharge conduit can carry any additional embankment loading. • two bridges constructed (over QEW and over RHCE W-S ramp) using conventional foundation elements
Description	• three-span bridge over QEW and RHCE W-S ramp. • existing 1.5m discharge conduit remains in place. • existing 2.1m discharge conduit remains in place. • the future 2.7m conduit can be installed on the intended route without any interference. • existing protective casings for the existing 2.1m conduit and the future 2.7m conduit extended to south beyond constructed retaining wall which protects conduits from weight of roadway embankment. • 1.5m overflow drain relocated to outlet at new QEW culvert. • 300mm trash chamber discharge connected to 1.5m overflow drain. • 300mm municipal watermain and pump house power supply conduits (9x90mm) relocated around front face of south bridge abutment.	• three-span bridge over QEW and RHCE W-S ramp. • 1.5m discharge conduit relocated west of Burlington Street, passing beneath roadway embankment on south side of QEW and RHCE W-S ramp. • 2.1m discharge conduit remains in place. • the future 2.7m conduit can be installed on the intended route without any interference. • existing protective casings for the existing 2.1m conduit and future 2.7m conduit extended beyond toe of roadway embankment. • 1.5m overflow drain relocated to outlet at new QEW culvert. • 300mm trash chamber discharge connected to 1.5m overflow drain. • 300mm municipal watermain and pump house power supply conduits (9x90mm) relocated behind the south bridge abutment parallel to the relocated 1.5m conduit.	• two-span bridge over QEW, and single-span bridge over RHCE W-S ramp. • 1.5m discharge conduit abandoned and replaced by future 2.7m. • 2.1m discharge conduit relocated to the east passing through south span of QEW underpass. • 2.7m discharge conduit would need to be constructed to replace the existing 1.5m conduit and would pass through the north span of the QEW underpass. • existing protective casings for the 2.1m and future 2.7m conduits would be abandoned and replaced with new casings which extend beyond the toe of the roadway embankment. • 1.5m overflow drain relocated to outlet at new QEW culvert. • 300mm trash chamber discharge connected to 1.5m overflow drain. • 300mm municipal watermain and pump house power supply conduits (9x90mm) relocated behind the south bridge abutment.
Risks	• 1.5m discharge conduit is damaged during construction.	• 1.5m discharge conduit is too fragile to connect relocated pipe.	• none.
Order of Magnitude Cost of relocation/protection	• $250,000 premium for bridge construction. • $100,000 for other utilities (ie. overflow drain, watermain, power conduit).	• $250,000 premium for bridge construction. • $600,000 for relocation of 1.5m discharge conduit. • $100,000 for other utilities (ie. overflow drain, watermain, power conduit).	• no cost premium for bridge construction. • $3,500,000 for relocation of 2.1m discharge conduit and construction of 2.7m discharge conduit. • $100,000 for other utilities (ie. overflow drain, watermain, power conduit).
Staging Implications	• extension of protective sleeves (for 2.1m and future 2.7m discharge conduits) can be carried out in advance of stage I roadway construction. • relocation of other utilities (ie. watermain, power conduit) needs to be coordinated with staged ramp construction.	• relocation of 1.5m discharge conduit and other utilities (ie. watermain, power conduit) can be carried out in advance of stage I roadway construction, however, relocated utilities need to be installed through existing Burlington Street embankment while under traffic (tunnelling likely required).	• construction of new protective sleeves under QEW needs to be carried out in advance of stage I roadway construction (ie. tunnelling likely required) since relocation of discharge conduits needs to be complete prior to constructing QEW structure.



QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441 97 00

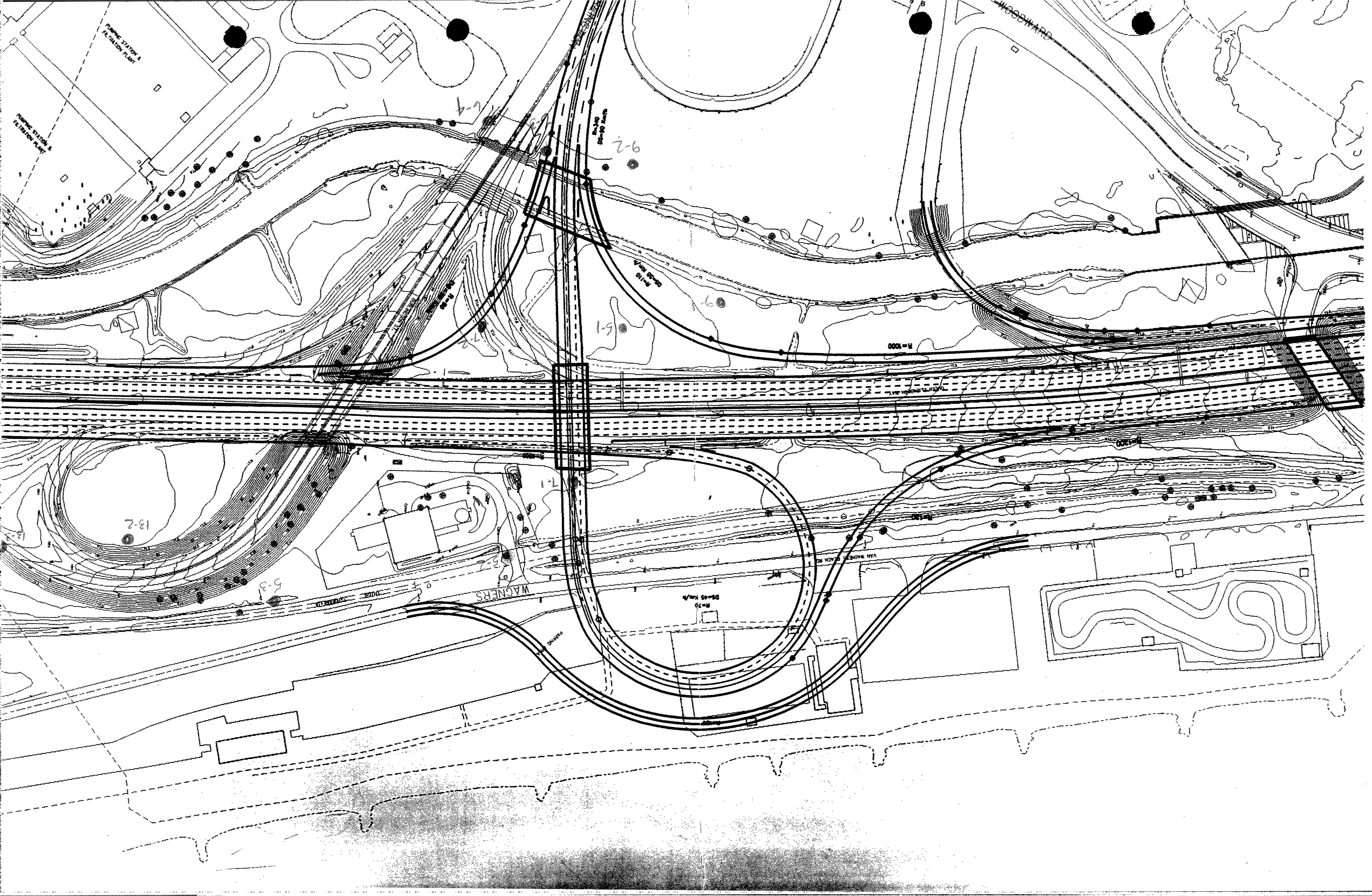
MRC McCORMICK RANKIN CORPORATION

Scale 0 20 HOR. 2 VER. 40 HOR. 4 VER.

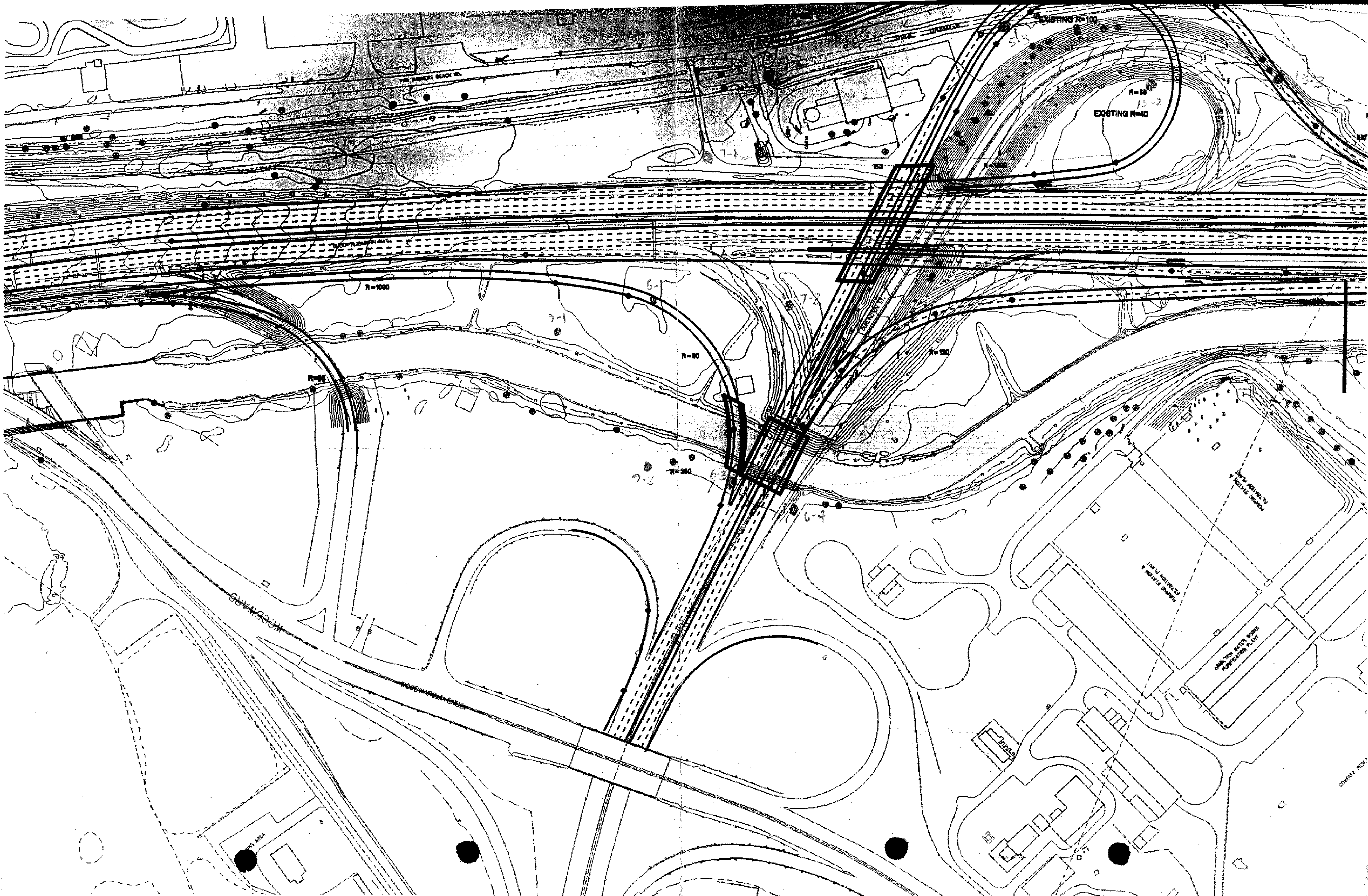
Legend

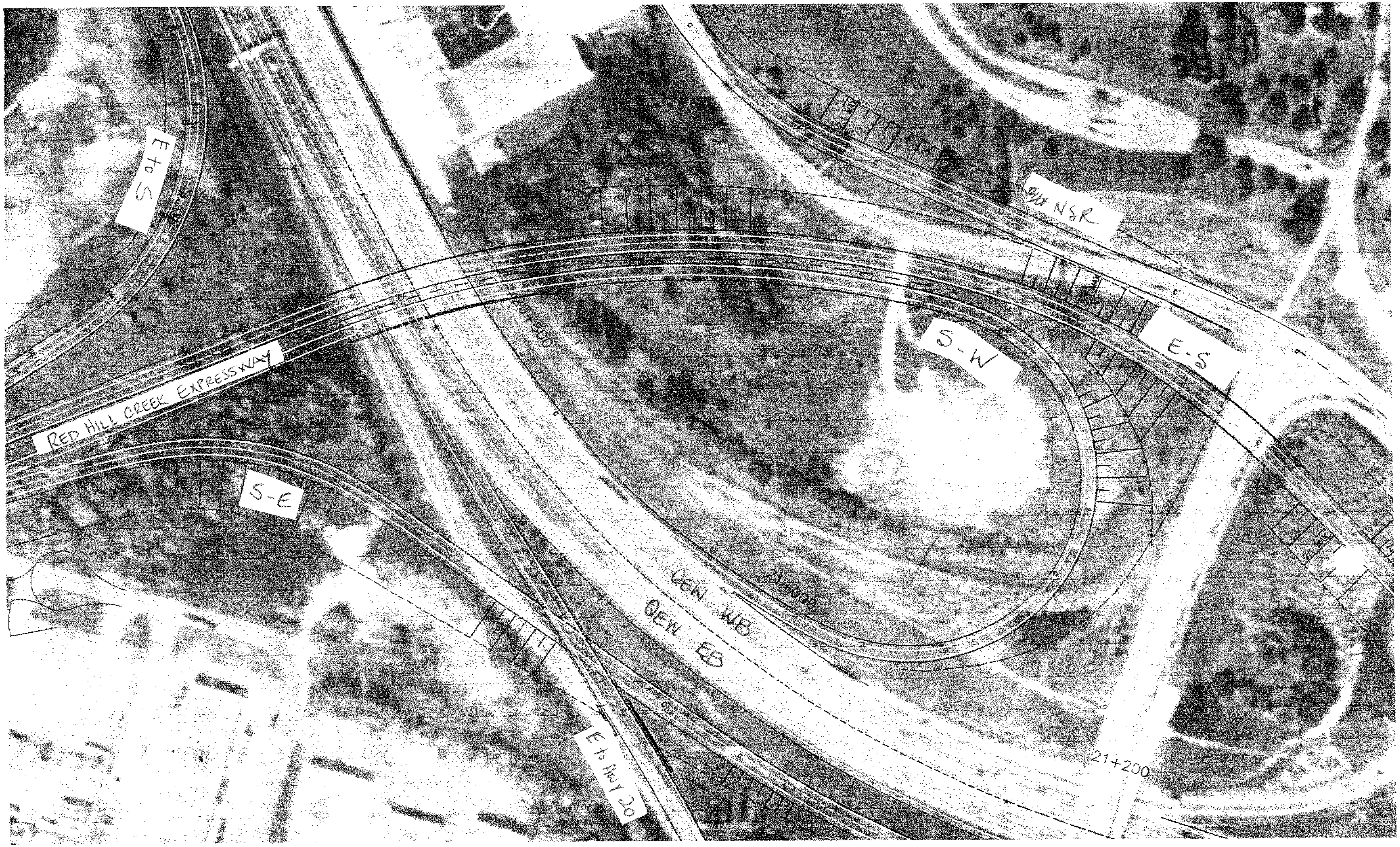
WATER TREATMENT PLANT
PROFILE
TAKEN ALONG 1.5m DIA. DISCHARGE CONDUIT

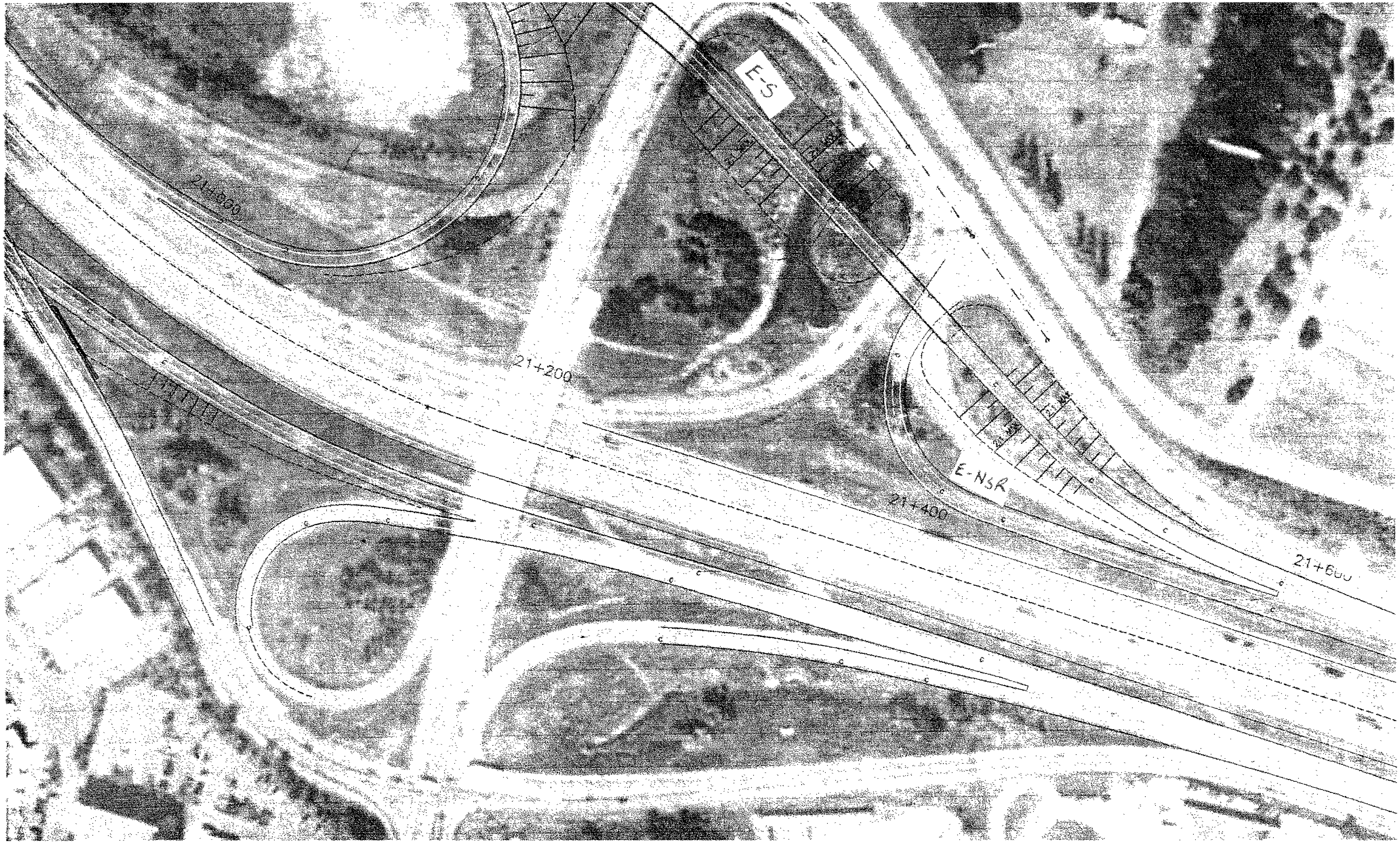
EXHIBIT

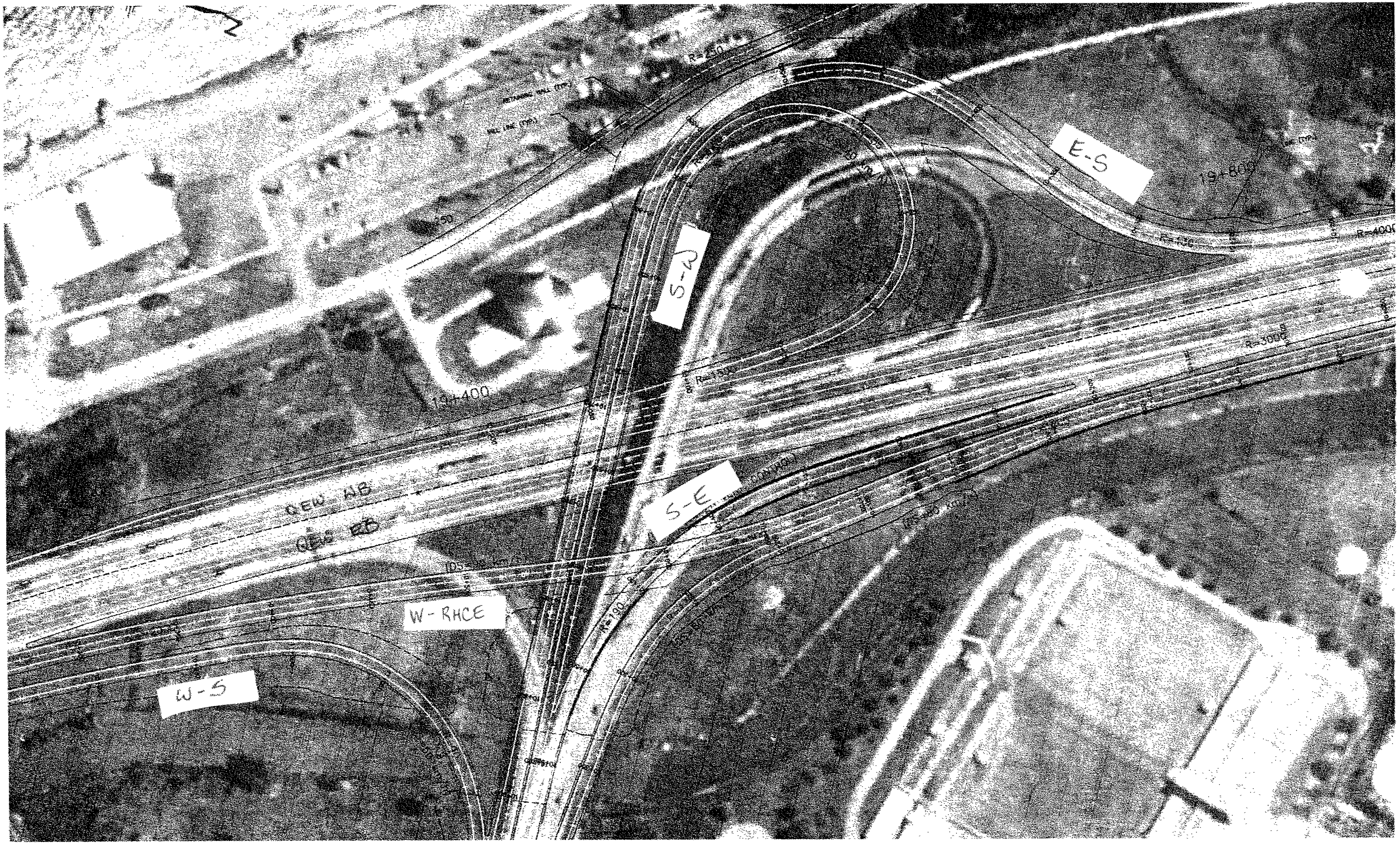

PUMPING STATION & FILTRATION PLANT
PUMPING STATION & FILTRATION PLANT
WOODWARD
WAGNERS
VAN WAGNERS BEACH RD
R=340 DS=30 Km/h
R=110 DS=50 Km/h
R=70 DS=45 Km/h
R=1000
R=1200
6-4
9-2
9-1
15-1
7-2
7-1
13-2
5-3
15-2


R = 85,00
R=350,00
R=400,00
R=130


EXISTING R=100
5-3
8-2
13-2
R=55
13-2
EXISTING R=40
VAN WAGNERS BEACH RD.
WAGNERS
7-1
R=1000
R=1000
5-1
7-2
9-1
R=80
R=130
R=55
9-2
R=360
6-3
6-4
WOODWARD
WOODWARD AVENUE
PUMPING STATION & FILTRATION PLANT
PUMPING STATION & FILTRATION PLANT
HAMILTON WATER WORKS PURIFICATION PLANT
COVERED RESE
PARKING AREA


E to S
NSR
RED HILL CREEK EXPRESSWAY
20+800
S-W
E-S
S-E
QEW WB
QEW EB
21+000
21+200
E to Hwy 20


E-S
21+000
21+200
E-NSR
21+400
21+600

E-S
19+800
R=4000
R=250
RETAINING WALL (TYP)
WALL LINE (TYP)
250
S-W
R=3000
R=1500
19+400
QEW WB
QEW EB
S-E
R=190
W-RHCE
W-S

MINUTES OF MEETING

PROJECT:	QEW/RHCE Preliminary Design	**MEETING NO.:**	2
		FILE NO.:	**3620-300**
DATE:	July 15, 1998	**TIME:**	1:30pm

PLACE: Region of Hamilton-Wentworth
Regional Environment Department
35 King Street East, Hamilton

PRESENT:				
	B. Matthews-Malone	RHW	G. Moore	RHW
	P. Marko	RHW	I. Routledge	PUMC
	G. Boychuk	RHW	B. Stofko	MRC
	M. Robinson	RHW	K. Rodger	MRC

PURPOSE: To review the proposed Burlington Street/QEW Interchange and discuss the impacts to the existing Regional Water Treatment Plant infrastructure.

	PROCEEDINGS	**ACTION BY**
2.1	The proposed interchange was presented in plan which highlighted the existing WTP infrastructure relative to the proposed structural elements of the interchange.	
2.2	None of the existing intake conduits will be impacted significantly by the proposed interchange.	
2.3	The 1.2m overflow drain, the 300mm cast iron watermain and the pump house power supply will all be impacted by the proposed interchange. These can be relocated relatively easily, and MRC will review possible relocation schemes.	MRC
2.4	The 1.5m and 2.1m discharge conduits will be impacted by the proposed interchange and will likely need to be protected in place since relocation would be difficult and costly.	
2.5	The routing of the future discharge conduit will need to be reviewed since the existing route is in conflict with the interchange. MRC will develop alternate routes.	MRC

**McCORMICK
RANKIN** *CONSULTANTS IN TRANSPORTATION*
2655 North Sheridan Way, Mississauga, Ontario, Canada L5K 2P8
Tel: (905) 823-8500 Fax: (905) 823-8503 E-mail: mrc@mrc.ca

	PROCEEDINGS	ACTION BY
2.6	Some of the available documentation show the future discharge conduit identify the diameter as either 84" or 108". Discussion took place regarding the requirements of this future conduit. M. Robinson speculated that addition of a 108" discharge conduit would increase the existing conveyance to 300mgd to match the capacity of the treatment plant. M. Robinson also noted that the future conduit will not be required to address any capacity constraints in the foreseeable future unless the demand for Regional water increases dramatically (ie. if the Region begins to supply water to other surrounding municipalities.)	
2.7	Discussion took place regarding the implications of precluding access to the outside of the discharge conduits by constructing structural foundation elements above them. It was established that this would never be required since the conduits can be accessed (for the purpose of relining them) from their ends. The conduits would likely be totally replaced and the existing ones abandoned in the event of a structural problem.	
2.8	Construction of the interchange in such close proximity to the discharge conduits is a concern which needs to be addressed. B. Matthews-Malone stated that the Region will undertake pre- and post-construction condition surveys of the conduits. The condition surveys will need to be carried out during periods of low water demand (ie. fall or winter).	B. Matthews-Malone
2.9	The location of the discharge conduits will eventually need to be established (plan and elevation) accurately. M. Robinson and I. Routledge will provide any additional as-constructed information indicating the locations of the discharge conduits. K. Rodger and M. Robinson will coordinate any additional field survey that may be required.	M. Robinson/ I. Routledge K. Rodger
2.10	For the purpose of the preliminary structural design, the intent will be to maximize the clearance from the conduits. Where this is not feasible, construction methods and foundation elements which minimize disruption to the conduits will need to be reviewed (ie. drilled caissons versus driven piles). Protection alternatives will be prepared by MRC and forwarded to the Region for their review.	MRC

PROCEEDINGS

ACTION BY

Minutes prepared by
McCormick Rankin Corporation

Kevin Rodger, P. Eng.

cc: All Attending
S. Jacobs, MTO

Ontario

Ministry of Transportation | Ministère des Transports

Phone: (416) 235-5509
Fax: (416) 325-8070
e-mail: lam@mto.gov.on.ca

Central Region - Structural Engineering
1201 Wilson Avenue
Atrium Tower, 4th floor
Downsview, Ontario
M3M 1J8

memorandum

May 12, 1998

TO: Betty Bennett, P. Eng.
Pavement and Foundation Section

c.c.: Steve Jacobs, Highway Engineering

RE: **Foundation Investigation and Recommendations**
Red Hill Creek Expressway and QEW
G.W.P. 441-97-00
RHCE/QEW, Central Region

RECEIVED
MAY 13 1998
FOUNDATION DESIGN SECTION

Attached please find one copy of the preliminary foundation investigation report by Golder Associates for your review and comment.

Kindly take appropriate action. If you required any further assistance, kindly contact the undersigned.

John K. Lam, P. Eng.
Senior Structural Engineer
for:
Volker Boehnke, P. Eng.
Head, Structural Engineering

C:\design\441-97-00\foundation.doc

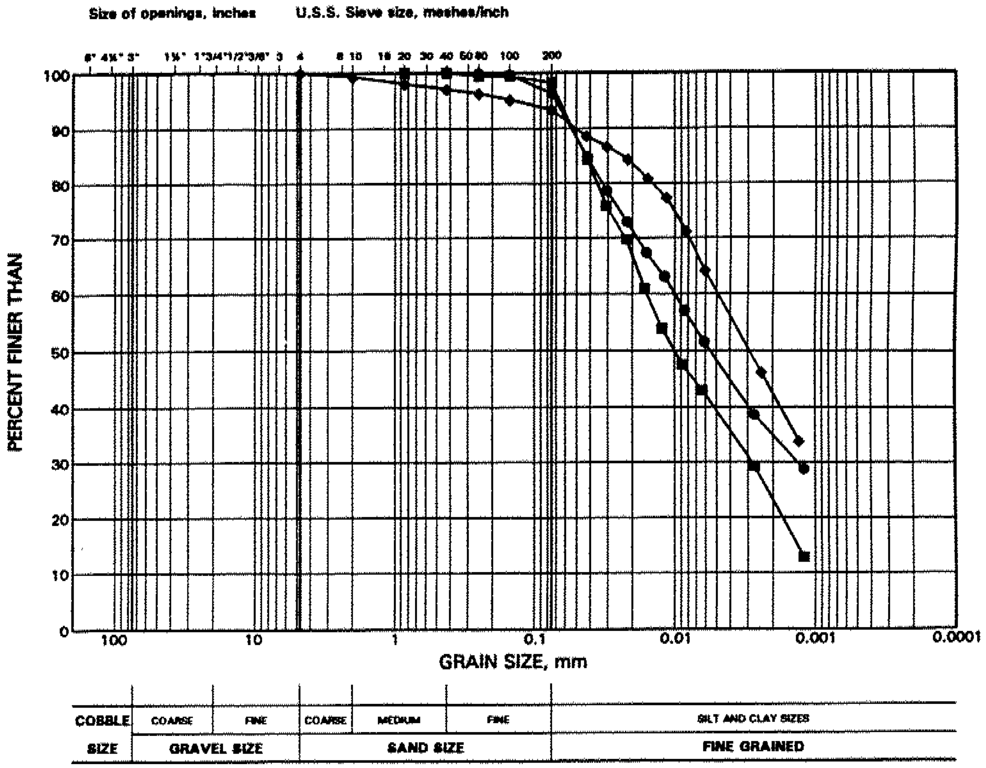
– Pile loading : Max ULS : 2000 kPa

APPENIDX A

RECORD OF BOREHOLE SHEETS
MINISTRY OF TRANSPORTATION
CONTRACT 75-07
W.P. 44-71-02 & 71-03

GRAIN SIZE DISTRIBUTION
Silty Clay, trace sa[illegible]

FIGURE 1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	1	4	2.7
■	4	6	4.3
◆	7	5	3.5

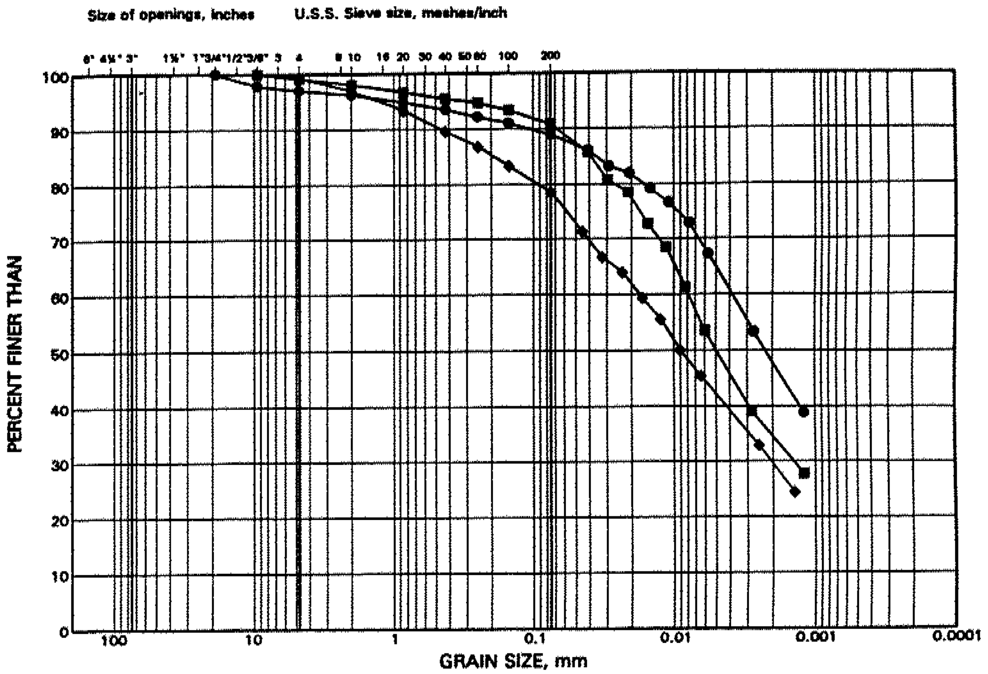
Project 981-1108

Golder Associates

GRAIN SIZE DISTRIBUTION

Silty Clay, trace to som[illegible]nd
occasional gravel ("soft" [illegible]lay)

FIGURE 2



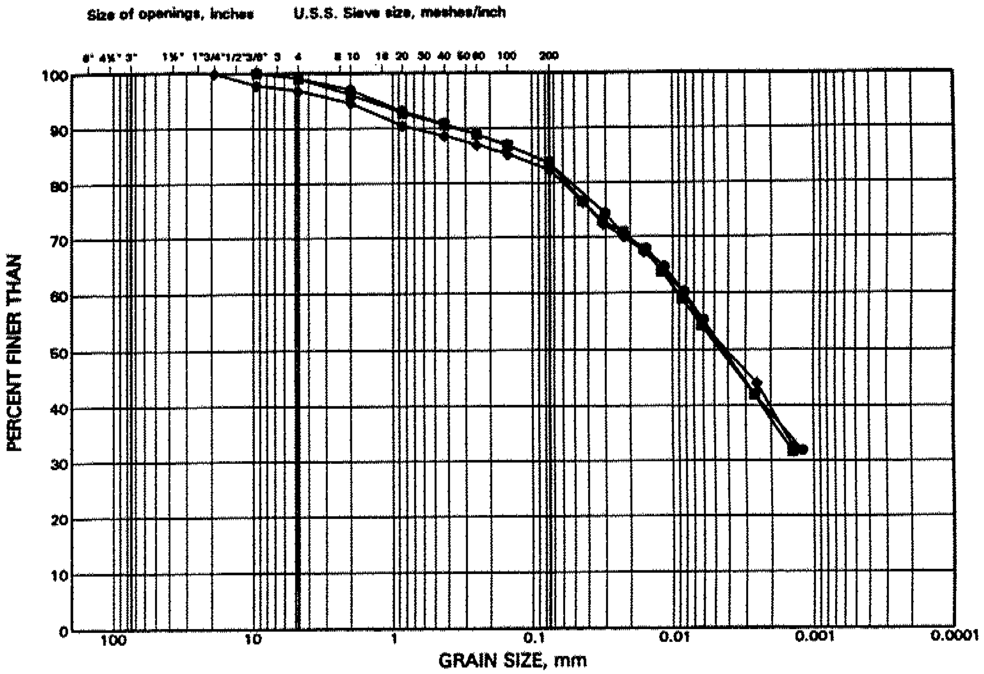
COBBLE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND CLAY SIZES
SIZE	GRAVEL SIZE		SAND SIZE			FINE GRAINED

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	1	7	5.0
■	4	8	6.6
◆	5	7	5.0

GRAIN SIZE DISTRIBUTION
Silty Clay some sand trac[illegible]ave[illegible]
(Glacial Till)

FIGURE 3



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
●	2	9	8.1
■	3	7	6.6
◆	5	13	14.2

From: Fouad Tannous
To: MTOHO1.TORHO2.Bennett
Date: 1998/06/01 12:50 pm
Subject: WP 440-97-00 QEW and RHEW Project

Betty,

Please be advised that the Geotechnical Office is in the process of preparing terms of reference for an advanced geotechnical investigation/pavement design for the Redhill Expwy. project. This work is being conducted as a separate consultant assignment and will not be included as a component of the TPM. Your office will be required to prepare parts of the terms of reference pertaining to cuts and fills exceeding 4.5 m in height. I will provide you with profiles detailing the existing and proposed work as soon as they become available form the project manager.

Thanks

Fouad 5433

CC: Kohlberg

From: Betty Bennett
To: MTOCR.DOWNSVCR.Tannous, MTOCR.DOWNSVCR.Kohlberg
Subject: Red Hill Creek Expwy - Embankments

Fouad, Rob

As discussed, the Foundations portion of this consultant assignment will cover all the ramps associated with the proposed Burlington Street interchange and the Red Hill Creek Expressway interchange.

The subsurface investigation should satisfy the requirements of both the pavement and foundations terms for fieldwork, i.e. boreholes every 50 m where embankment heights are less than 5 m and boreholes every 25 m where embankment heights are greater than 5 m.

The foundations report will contain the subsurface data and the analysis and recommendations for cut and fill embankments. It will cover the foundations requirements but will not include pavement design.

The estimated cost for the foundations component is $ 65 000.

Subsurface investigation:	$ 25 000
Engineering, drafting, etc.	$ 40 000

(As stated above, the cost does not include pavement design).

If there are any questions, please advise.

Betty

QEW & REDHILL CK. EXPRESSWAY.

Foundations investigation criteria to be used for ramps.

BURLINGTON STREET

S-W Ramp.	Sta	10+000	to	10+880.
E-S Ramp	Sta	10+000	to	11+060
W-S Ramp	Sta	10+000	to	11+200
S-E Ramp	Sta	10+000	to	10+616
W-RHCE Ramp	Sta	10+000	to	12+030

REDHILL CREEK EXPRESSWAY.

E - NSR Ramp	Sta	21+264	to	22+400
E - S RHCE Ramp	Sta	29+120	to	30+650
S - W RHCE Ramp	Sta	29+300	to	30+250
S - E RHCE Ramp	Sta	20+630	to	22+350

Hwy 20

QEW E to Hwy 20

Change to HSR

Burlington Street

S-W Ramp 880 m

- Fill embankments to height of 8m

400m/25 = 16 bhs × 5m = 80m ; 480/50 = 10 bhs × 3m = 30 m (3 d)

E-S Ramp

- Fill embankments to height of 8.5 m 1100 m (5 d)

500 m/25 = 20 bhs × 5m = 100m ; 600 m/50 = 12 bhs × 3m = 36 m (450')

W-S Ramp

- Fill embankments to height of 5 m 1200 m

1 bh / 50m, depth of 3m (24 bh × 3m = 72 m] (2½ day)

S-E Ramp.

- Fill embankments to height of 5m 600 m

1 bh / 50m , depth of 3m → 12 bhs × 3m = 36m (120') (1 day)

W-RHCE 2000 m

- Fills - ~ 2-3m [1 bh / 50m = 40 bhs]

= depth of 2m × 40 bhs = 80 m (260') (2½ days)

~~E2-NSR2~~

14 d

(3 wks)

26
32
24
36
40
158 bhs

RHCE Ramps.

E - NSR : No substantial cut or fill $\frac{1100}{50} = 22$ bhs 1100 m (1½ d)
$22 \times 2m = 44m$ (144')

E - S RHCE : Fills to height of 10 m 1500 m
$500m/25 = 20$ bhs $\times 5m = 100m$; $\frac{1000}{50} = 20$ bhs $\times 2m = 40m$ (460') (5 d)

S-W RHCE : Fills to height of 9 m 950 m
$400/25 = 16$ bhs $\times 5m = 80m$; $\frac{450}{50} = 9$ bhs $\times 2m = 18m$ (320') (3½ d)

S-E RHCE : Fills to height of 9.5m 280 m
$150/25 = 6$ bhs $\times 5m = 30m$; $\frac{130}{50} = 3$ bhs $\times 2 = 6m$ (118') (1 d)

11 d

TOTAL DURATION of INVESTIGATION : 25 d × $1000/d = $25 000

COST ESTIMATE :		
	Investigation	25 000
	Analysis, Drafting	40 000
		65 000

22
40
25
9
96

FOUNDATION INVESTIGATION FOR EMBANKMENTS

Bh's spacing

50 m spacing where height < 5m
25 m spacing where height > 5m

TOTAL # of bh's 158 + 96 = 254

From: Steve Jacobs
To: MTOHO1.TORHO2(Bennett)
Date: 1997/12/17 9:10am
Subject: Red Hill Creek Workplan -Reply

>>> Betty Bennett 12/08/97 02:20pm >>>
Steve

J.Lam forwarded an updated work plan from Golder Associates dated Nov. 27, 1997.

The original work plan did not identify any foundation investigation and report at the RHCE. This new work plan has introduced $ 25 000 + of foundation investigation and design at the proposed Red Hill Creek interchange at QEW.

Have Golder's terms changed since the original work plan was reviewed?

Betty

MRC added the foundation work at RHCE/QEW for the November study design. My understanding is that it should have been in the first draft but was not added until the second (Nov.) draft.

Currently, the Region of Hamilton Wentworth is paying for the preliminary design work at the RHCE/QEW interchange, and we are paying for the rest.

Steve

Hamilton Wentworth hiring McCormick Rankin
to carry out preliminary design for
Red Hill Ck. interchange at QEW
$18 - 25 million

Copy of report to John Lam

Comments re: proposal by McCormick Rankin
- review the package & comment
- what details req'd for preliminary
- Mon. Nov. 17.

Consider upgrading level of preliminary fdn inv.

Steve Jacobs: issue W.O.
request.

John Lam: to check whether culverts & number

From: Steve Jacobs
To: Lam, MTOHO1.TORHO2.Dundas
Date: 1997/11/14 11:08am
Subject: Study Design Comments -RHCE/QEW

Please comment on the proposed study design from MRC for the above project. (Dave- new copy of " Work Tasks" is now on your desk)

Are the listed work activities for structural/foundations appropriate for a Preliminary Design Study?

Are the associated costs reasonable?

Please identify additional work tasks if their list is deficient. If their list is recommending tasks that are normally done in detail design, please identify these as well.

The consultant would like to finalize the study design by next Tuesday, Nov. 18.

I am attempting to provide a new W.O number for this project. W.P. numbers are being assigned by RMB.

Additional large scale plans of the three alternatives are being prepared for your use.

If you are interested, I will arrange an internal study team meeting to present the final Study Design for this study. This would provide you with an opportunity to talk directly to the consultant/sub- consultant to ensure they understand our requirements.

Steve

7540-1021

SEND TO John Lam
Structural Section

HAND DELIVER TO - DEC 1/97
BETTY BENNETT
FDN DESIGN SECTION

FROM Steve Jacobs DEPT. Engineering, PH-H-W DATE DEC 2

SUBJECT
FOUNDATION WORK PLAN - RED HILL CREEK EXPRESSWAY

Attached is the revised workplan, following comments from foundations section.
Any additional comments -? Please advise ASAP.

Steve Jacobs

REPLY

REPLY FROM

REPLY DATE

TO WRITE: HANDWRITE OR TYPE. REMOVE AND RETAIN SECOND COPY. **TO REPLY:** WRITE REPLY IN BOTTOM AREA.

Ontario

MRC

FACSIMILE TRANSMISSION

TO: MTO

ATTENTION: Steve Jacobs, Planning

No of sheets transmitted: 6 including this sheet. MAIL: YES NO X

FROM: Michael Chiu DATE: 97.11.27

W.O. NO. 3620 PROJECT: RHCE/QEW

MESSAGE:

Steve,

Attached is revised work plan for Geotechnical from Golder based on reduced boreholes at Burlington I/C.

If possible, I would like to get MTO's approval on this and send Golder out there as early as possible.

FAX NO:

McCORMICK
RANKIN
CORPORATION

CONSULTANTS IN TRANSPORTATION

2655 North Sheridan Way, Mississauga, Ontario, Canada L5K 2P8
Tel: (905) 823-8500 Fax: (905) 823-8503 E-mail: mrc@mrc.ca

PRELIMINARY DESIGN
QEW/RED HILL CREEK EXPRESSWAY

Task: Field Work – Preliminary Geotechnical Field Investigation – Bridge Foundation Investigation

Purpose:

To carry out geotechnical investigation to obtain sufficient subsurface information to permit preliminary design recommendations with respect to the structure design. Investigation to consist of:

4 boreholes at Burlington Street interchange (5 bridges) (reduced from 10)

Is ~~[illegible]~~ RHCE part of this assignment?

7 boreholes at Red Hill Creek Expressway interchange (4 bridges)
boreholes extended with sampling to the bedrock surface - anticipate at 20 m depth

2 boreholes at the RHCE interchange to permit assessment of embankment stability at selected locations
boreholes extended with sampling to 8 m depth

Input/Data from Others:

Preliminary plan and profile for the proposed bridges and interchange ramps (from MRC);

GEOCRES file data for adjacent bridges (GAL to obtain from MTO);

Confirmation of bridge structure locations in the field prior to obtaining service clearance (from MRC);

Permission to enter properties (from MRC);

Underground service clearance (by GAL); and

Surveyed locations and ground surface elevations at completed boreholes after drilling (from MRC).

Documentation/Output:

Completed field borehole logs for use in preparation of report

Work Items:

- compile and review available subsurface information for Burlington Street and Centennial Parkway bridges over QEW as well as other subsurface information in the immediate vicinity of the proposed bridges;
- identify appropriate borehole locations for preliminary design;
- identify access and traffic control requirements (assume that boreholes can be located such that lane closure is not required);
- clear underground services at borehole locations;
- make arrangements with MTO as required for access (assume that other property access permissions as required will be provided to us);
- complete drilling program; and
- measure water levels in piezometer installations.

Staff:

A. Poschmann - Project Manager
S. Pang - Project Engineer
B. Bordignon - Field Engineer

NOTES: 11 boreholes put down by MTO (WP 54-88-00) in 1988 in the area of the proposed Burlington Street I.C. The proposed number of boreholes for the current program has therefore been reduced to 4 from 10.

Confirm steve
with ~~Shaw~~
that RHCE
is Hamilton
responsibilit

November 20, 1997

P71-1491

PRELIMINARY DESIGN
ESTIMATED PERSON HOURS/FEES

Field Program

RHCE I/C	9 boreholes	176 m overburden
Burlington Street I/C	4 boreholes	80 m overburden

Previous Cost	*1.3 Geotechnical*	*RHCE Interchange*					*Burlington Street Interchange and QEW*				
		Principal *(110)*	*Senior Engineer* *(90)*	*Technician/ Junior Engineer* *(60)*	*CAD/ Drafting* *($55)*	*Fees/ Disbursements*	*Principal* *(110)*	*Senior Engineer* *(90)*	*Technician/ Junior Engineer* *(60)*	*CAD/ Drafting* *(55)*	*Fees/ Disbursements*
	Field Investigation – Foundation Design										
Same hrs	1.1 Project Set-up and Administration	5	20			2,400	7	20			2,640
Same hrs	1.2 Service Clearance/Site Arrangements		10	25		2,400		4	20		1,560
85 hr	1.3 Drilling Supervision			70		4,200			40		2,400
Same	1.4 Water Levels/Site Inspection			15		900			10		600
	Total Hours/Fees	5	30	110		9,900	7	24	70		7,200
17 000	1.5 Drilling Contractor – Foundation Investigation					15,000					8,000
	1.6 Travel and Other Disbursement					700					700
26 830	TOTAL TASK 1.3					25,600					15,900

Reduced by 40%

PRELIMINARY DESIGN
QEW/RED HILL CREEK EXPRESSWAY

Task: Office Engineering – Preliminary Foundation Report Preparation –
Bridge Foundation Investigation

Purpose:

To compile data obtained during current and previous geotechnical investigations, to complete laboratory testing, to analyze the data and to produce a report providing geotechnical design recommendations for the preliminary design of the proposed structures.

Input/Data from Others:

Preliminary plan and profile for the proposed bridges and interchange ramps

Documentation/Output:

Completed geotechnical report including:

- borehole location plan
- detailed record of borehole logs and description of subsoil conditions
- geotechnical design parameters including foundation alternatives, preliminary load bearing/carrying capacities for feasible foundations, lateral earth pressures, comments on aspects of construction with potential impact on design

Work Items:

- inspect soil samples and compile final borehole logs
- carry out laboratory testing on selected soil samples
- summarize subsoil conditions and analyze bridge foundation alternatives
- prepare plans and sections as required
- write report
- submit in draft form for comments
- finalize report (to be signed by Principal Engineer and Designated MTO Contract)

Staff

A. Poschmann	- Project Manager
S. Pang	- Project Engineer
B. Bordignon	- Junior Engineer

November 20, 1997

P71-1491

PRELIMINARY DESIGN
ESTIMATED PERSON HOURS/FEES

4.7 Final Foundation Report	*RHCE Interchange*					*Burlington Street Interchange and QEW*				
	Principal *(110)*	*Senior Engineer* *(98)*	*Technician/ Junior Engineer* *(60)*	*CAD/ Drafting* *(55)*	*Fees/ Disbursements*	*Principal* *(110)*	*Senior Engineer* *(90)*	*Technician/ Junior Engineer* *(60)*	*CAD/ Drafting* *(55)*	*Fees/ Disbursements*
Review Subsurface Information and Prepare Geotechnical Report										
1.1 Project Administration	5	10			1,450	5	10			1,[illegible]
1.2 Data Compilation		5	30		2,250		10	40		3,300
1.3 Draft Report Preparation	10	40	25	35	8,125	10	40	15	45	8,075
1.4 Liaison with Design Team	5	5			1,000	5	5			1,000
1.5 Review with MTO and Finalize Report	10	20	5	10	3,750	10	20	5	10	3,750
Total Hours/Fees	30	80	60	45	16,575	30	85	60	55	17,575
1.6 Laboratory Testing -Foundation Investigation					2,000					2,000
1.7 Direct Disbursements					800					800
TOTAL TASK 4.7					19,375					20,375

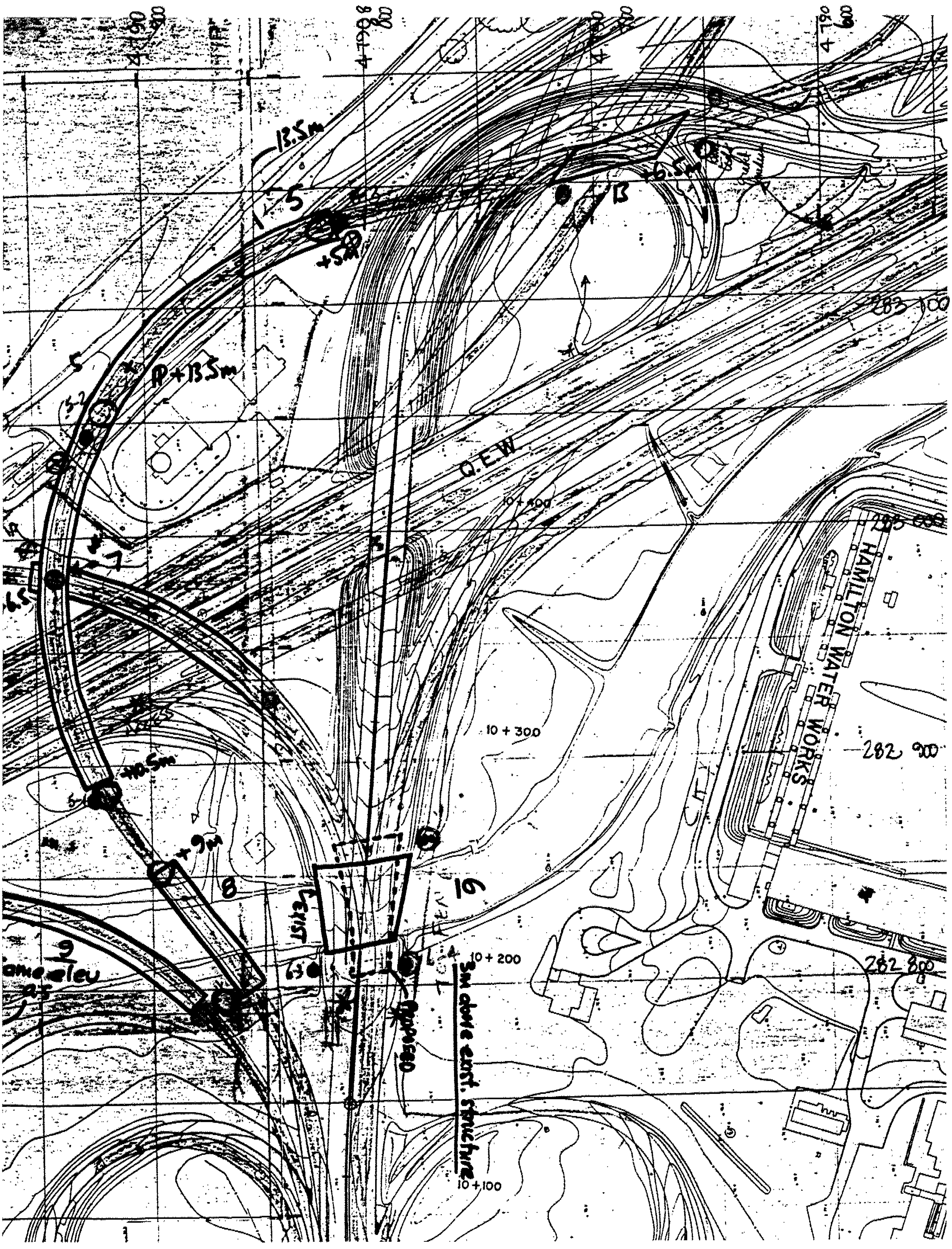
Assumptions: • Environmental testing of soils not included [if necessary, allow $8,000 for laboratory testing and data compilation; additional to above costs]

Previous Cost
18 775

2000

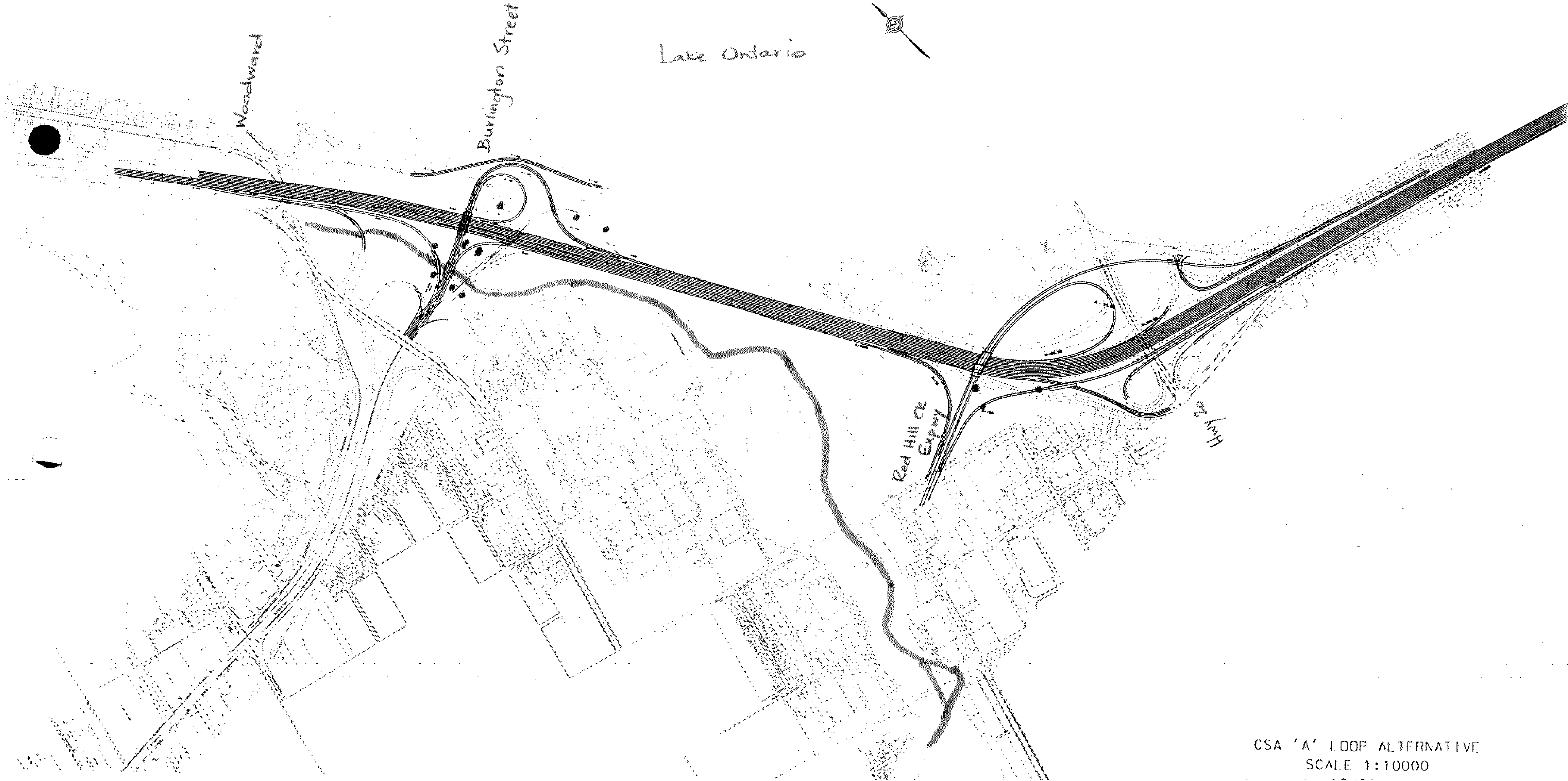
23275
4500
18775

17575
800
18375


4+900
4+800
4+700
283 100
283 000
282 900
282 800
10+400
10+300
10+200
10+100
Q.E.W.
HAMILTON WATER WORKS
13.5m
5
+5m
13
6.5m
10+13.5m
6.5
+10.5m
+9m
8
9
same elev as
16
EXIST
6.4
3m above exist. structure


R = 100
R = 60
R = 180
R = 130
VAN WAGNERS BEACH RD
PARKING AREA
WAGNERS
5-2
5-3
13-2
R = 2000
R = 2000
R = 1000
ACH
12-5
11-
R=65
5-1
9-1
7-2
R=60 DS=60 km/h
R=140 DS=60 km/h
BURLINGTON ST
9-2
R=340 DS=60 km/h
6-4
BURLINGTON
WOODWARD
WOODWARD AVENUE
PUMPING STATION & FILTRATION PLANT
5m
1:2000
282 450
4791 150
N


COLD STORAGE
R=130
R=400,00
R = 85,00
R=350,00
R=150



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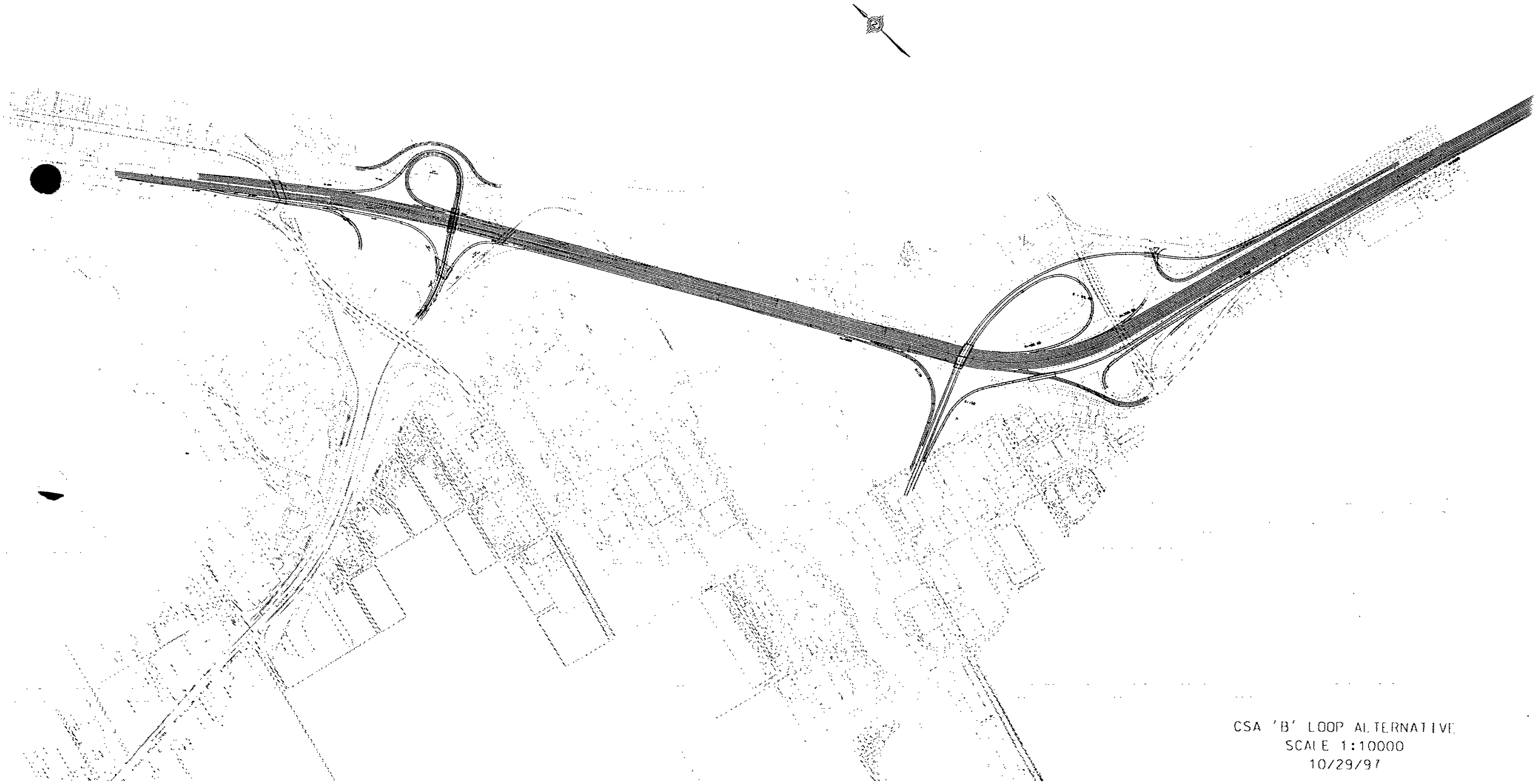

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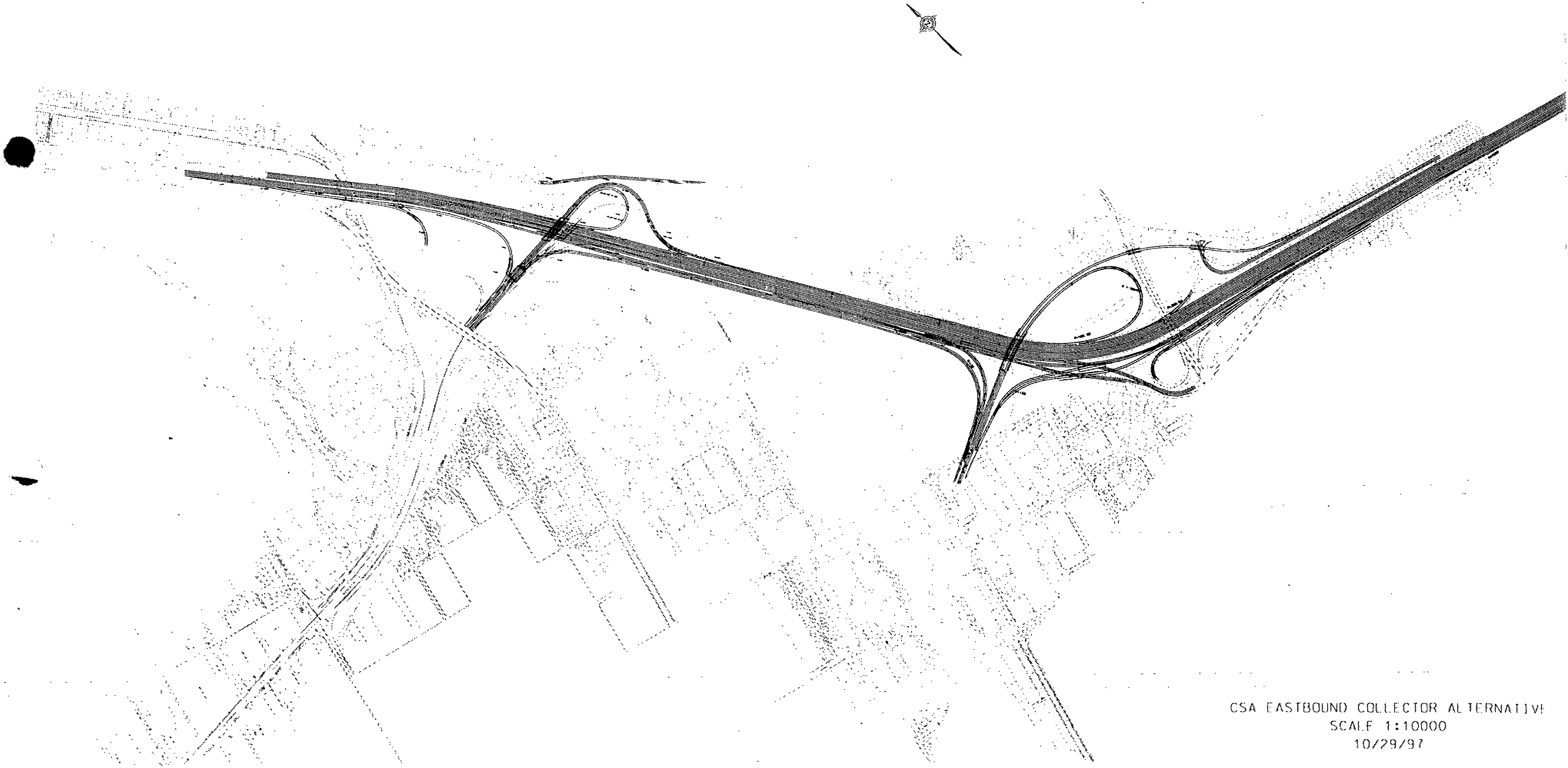

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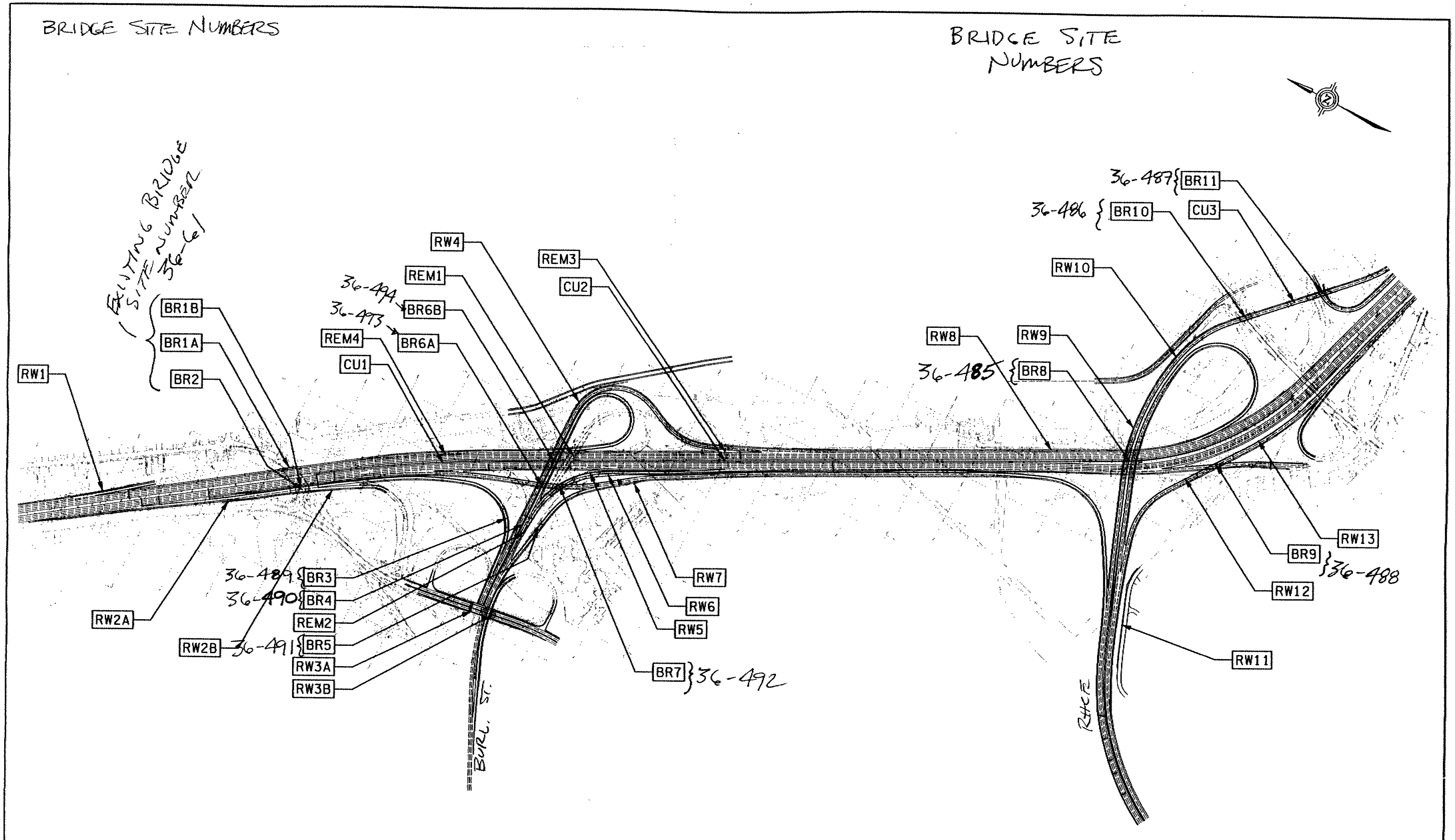


QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

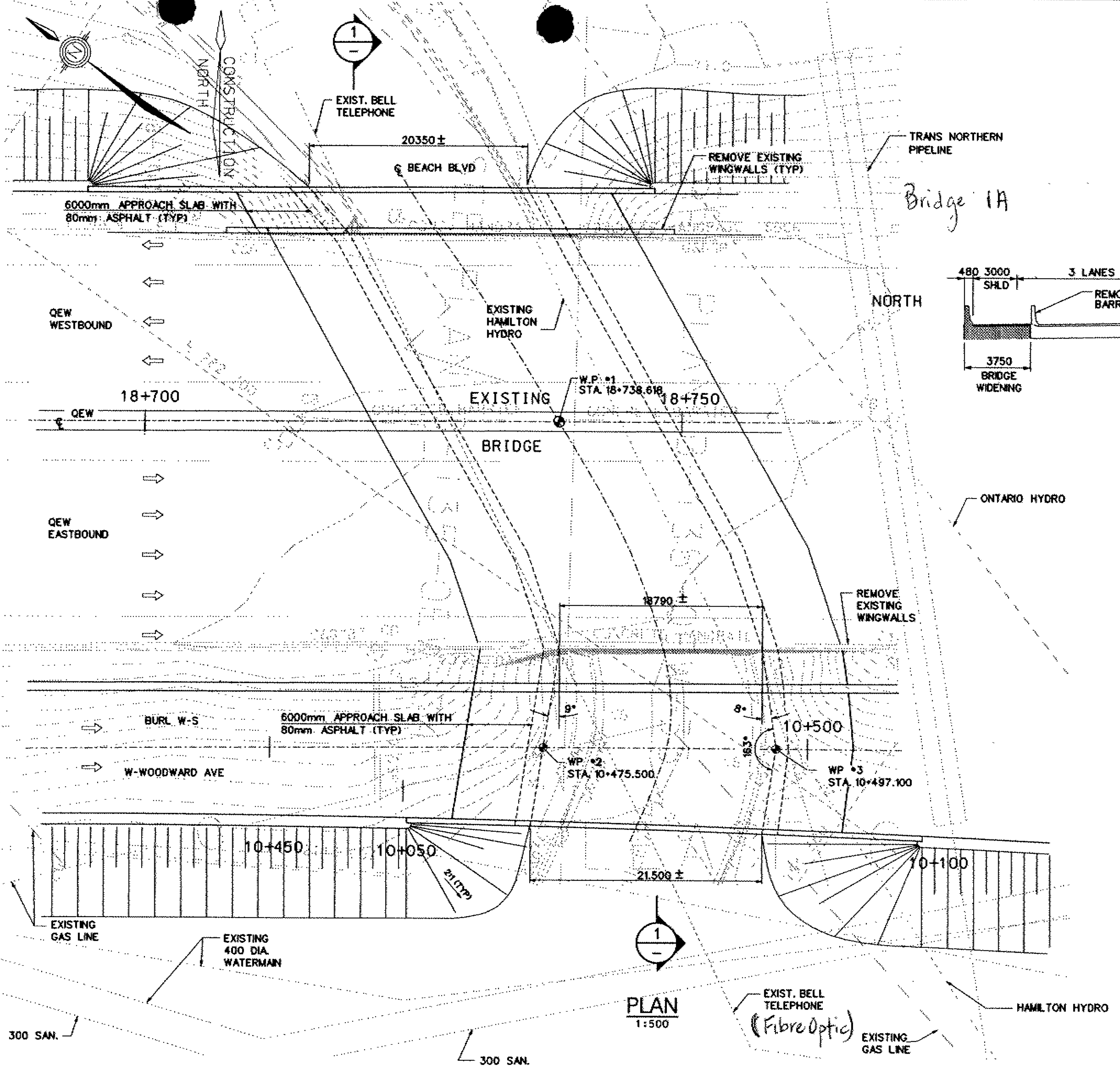
MRC
McCORMICK RANKIN CORPORATION

Scale
N.T.S

Legend
REM Structure to be Removed
BR Proposed Bridge
RW Proposed Retaining Wall
CU Proposed Culvert

STRUCTURAL KEY PLAN

EXHIBIT
6-2



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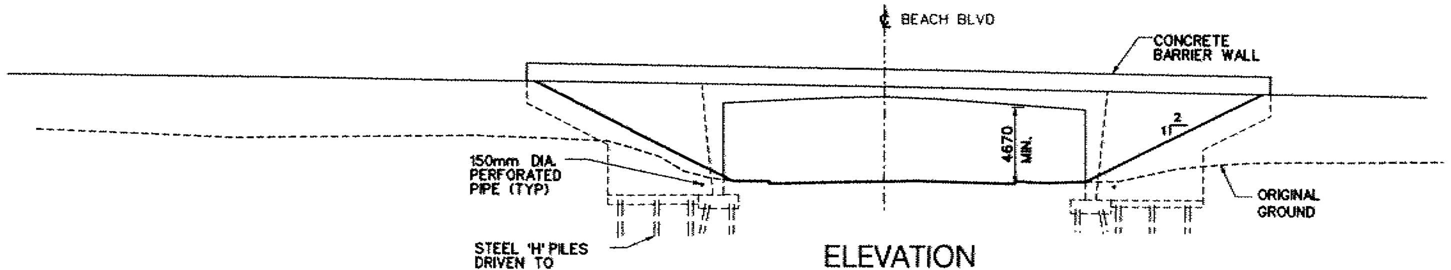

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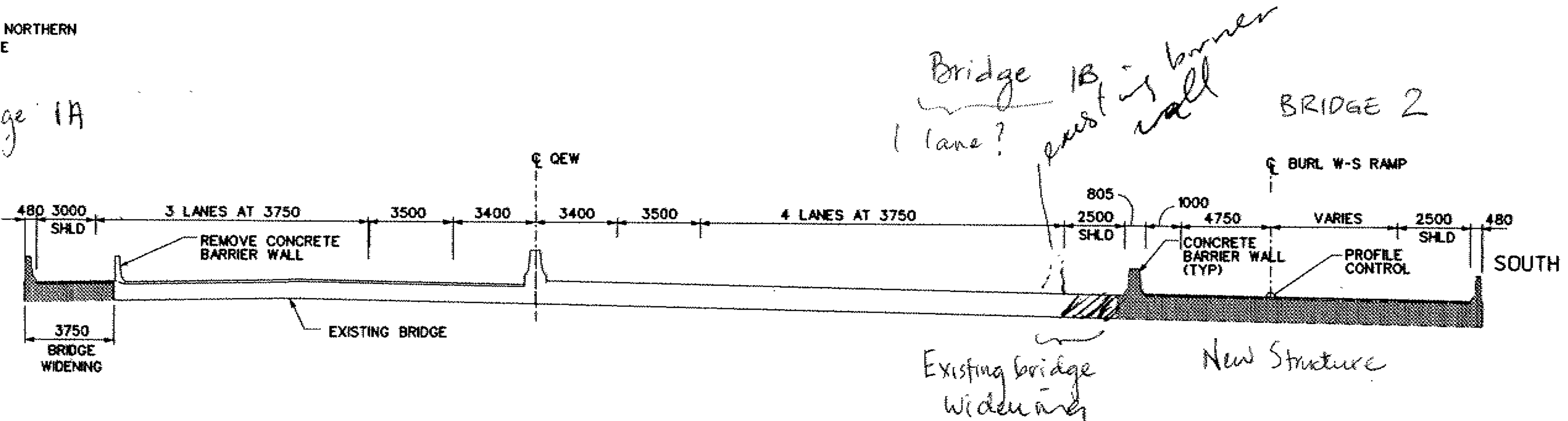

SECTION 1
1:150

· Several utilities in vicinity of ftg

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REVISION DATE DEC 23-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

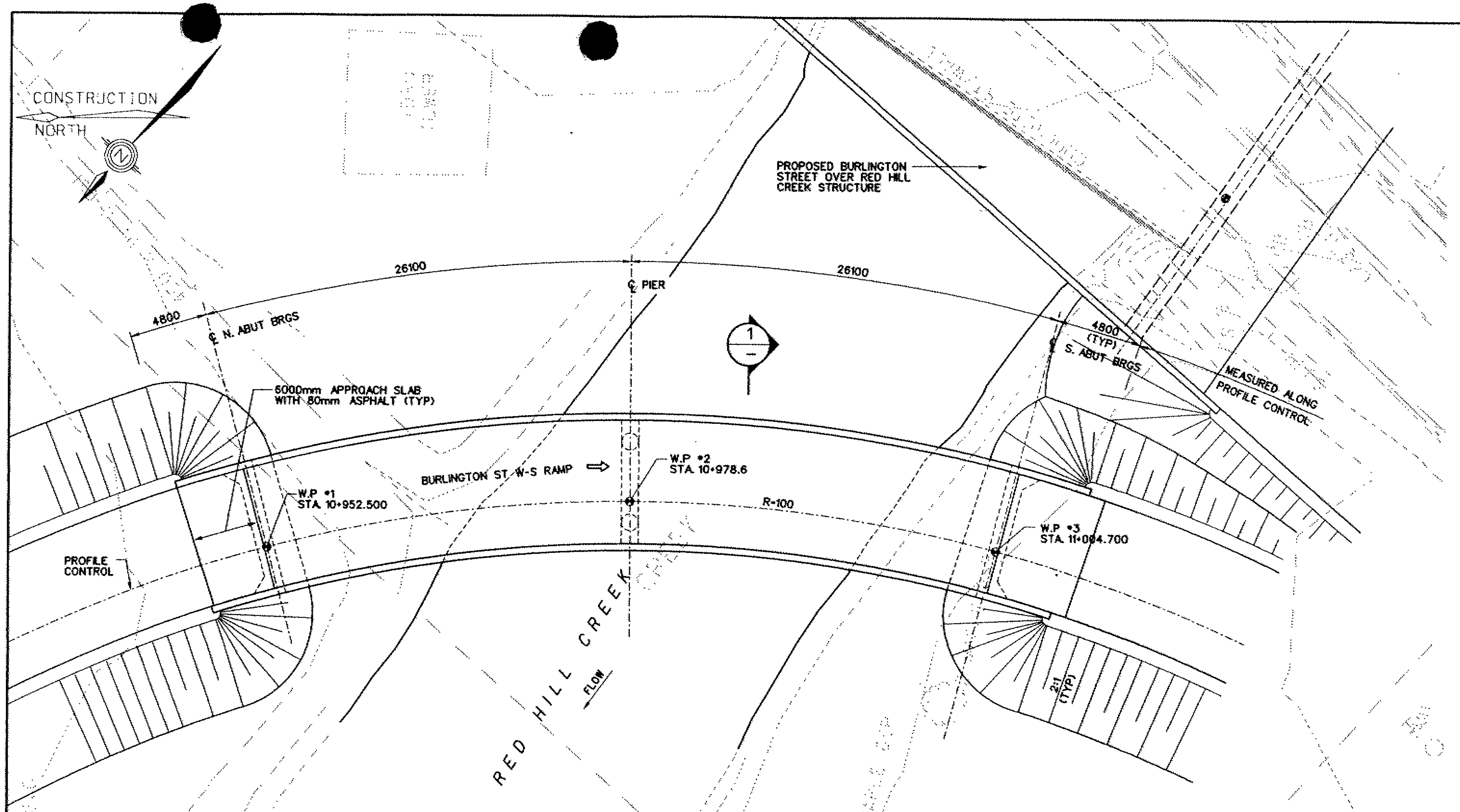
MRC McCORMICK RANKIN CORPORATION

Scale
AS SHOWN

QEW /RED HILL CREEK EXPWY
QEW OVER BEACH BOULEVARD

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR1&2
24



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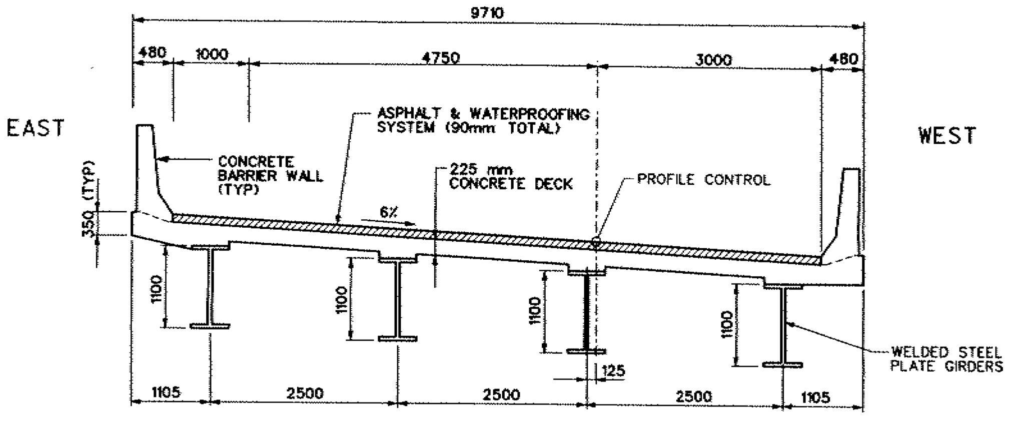
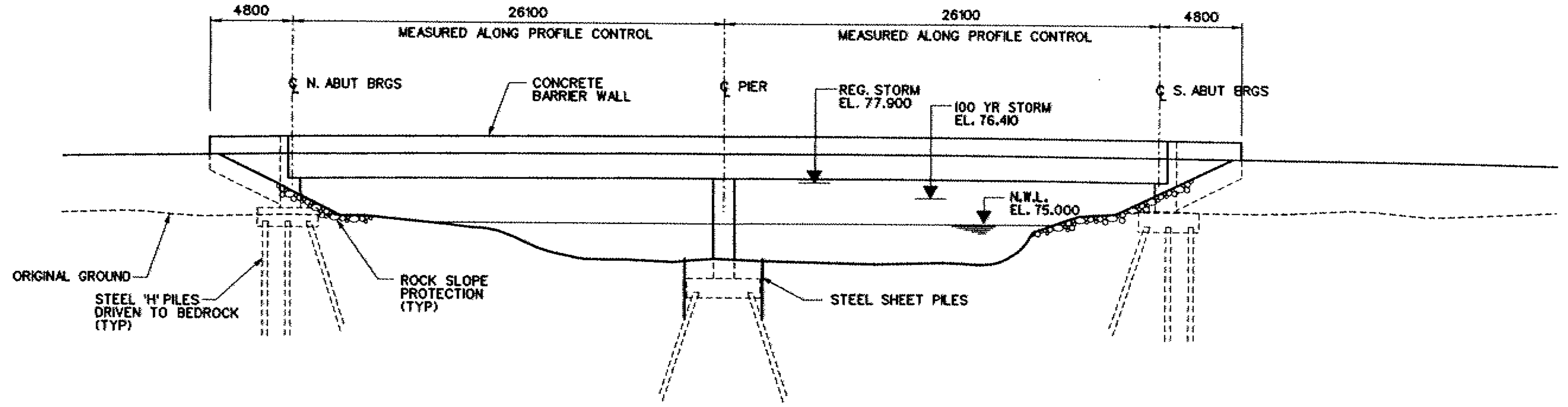


SECTION ①
1:50

Centre pier skew likely to obstruct creek flow
Will consider 3-span or single span



ELEVATION
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REVISION DATE DEC 22-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

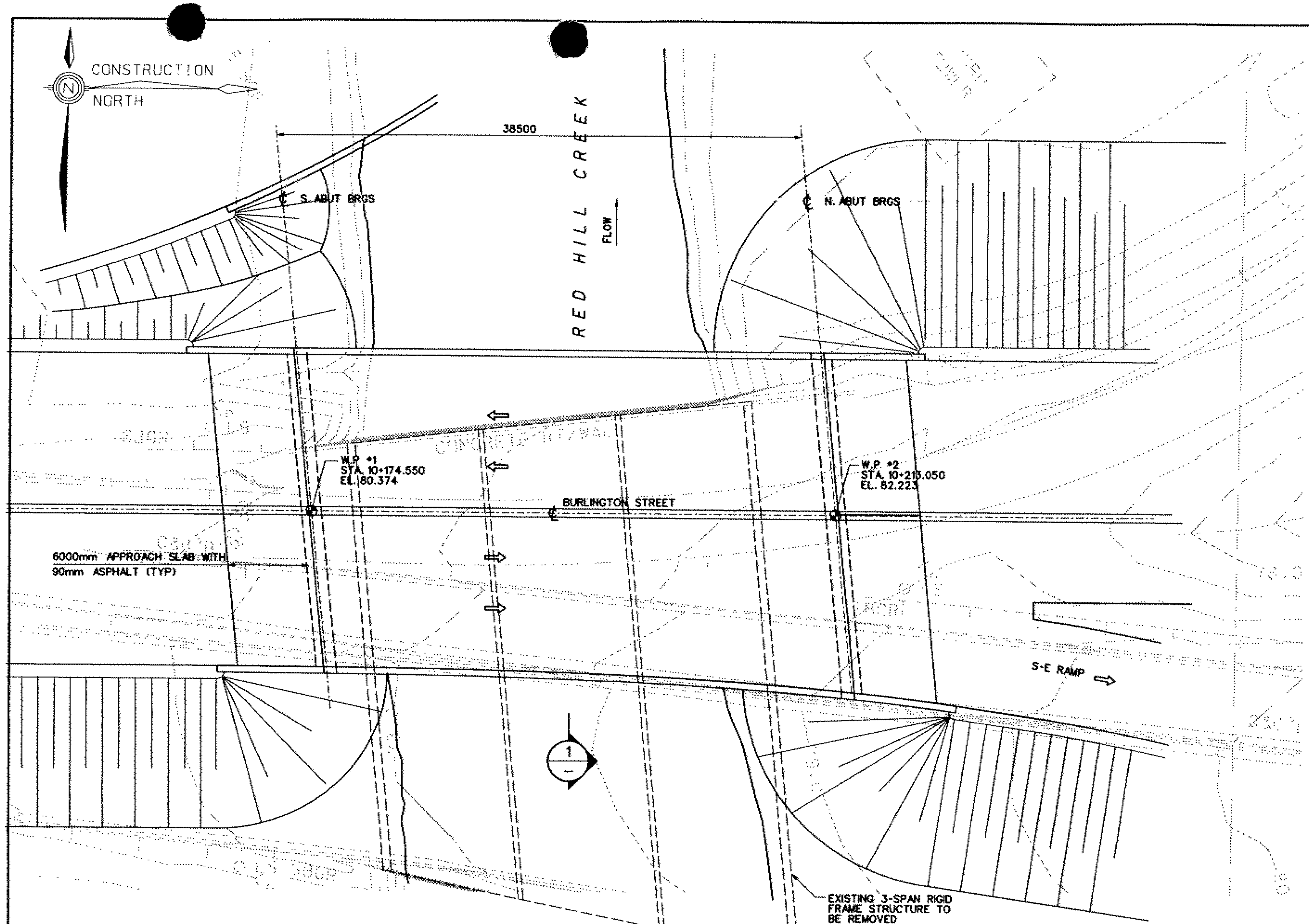
MRC McCORMICK RANKIN CORPORATION

Scale
AS SHOWN

QEW /BURLINGTON STREET INTERCHANGE
BURLINGTON ST W-S RAMP OVER
RED HILL CREEK

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR3
5



PLAN
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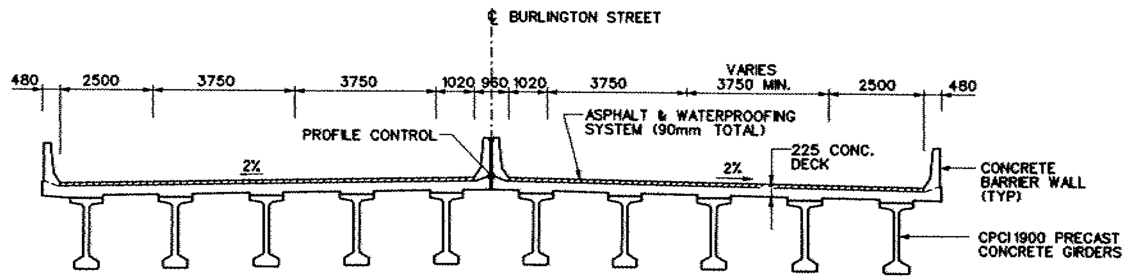
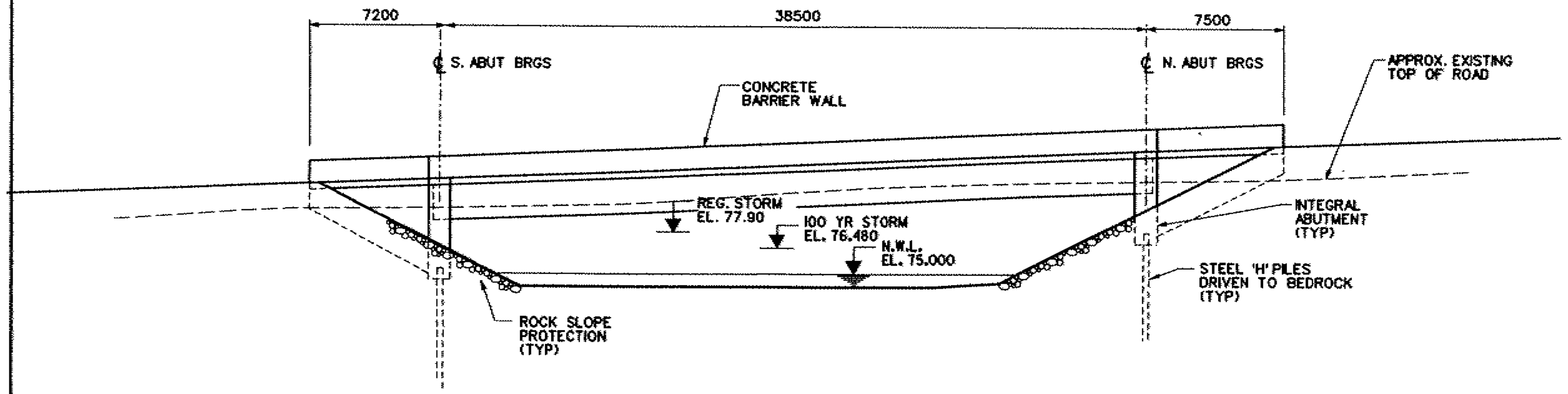


SECTION 1
1:200

Old Bridge removal in 3 phases



~ 2m grade increase

ELEVATION
1:400

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QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

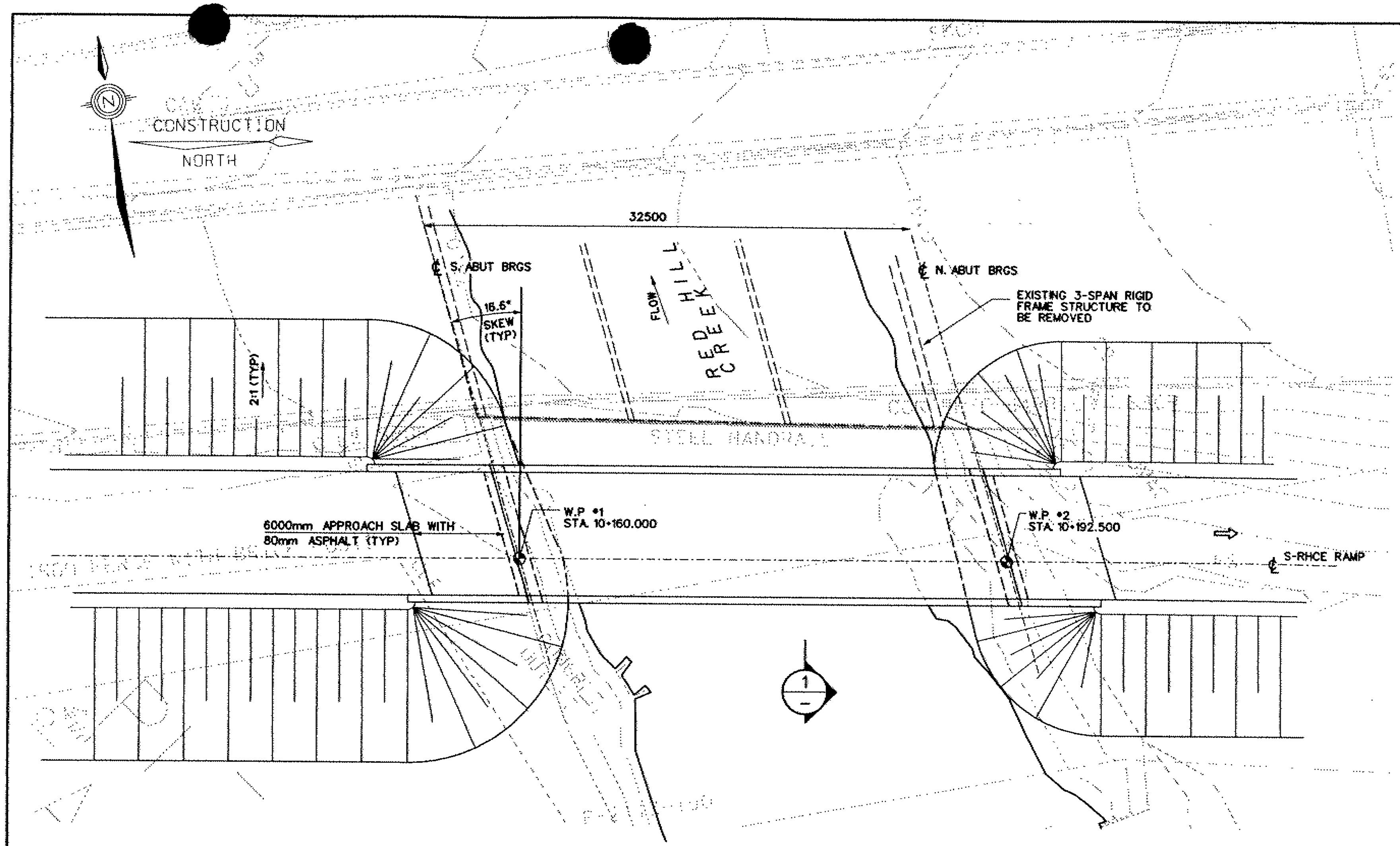
MRC
McCORMICK RANKIN
CORPORATION

Scale
AS SHOWN

QEW /BURLINGTON STREET INTERCHANGE
BURLINGTON STREET OVER RED HILL CREEK

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR4
6



PLAN
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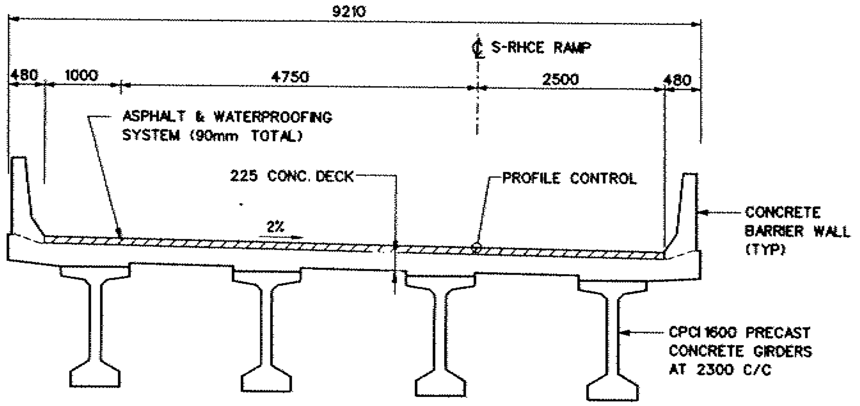

SECTION 1
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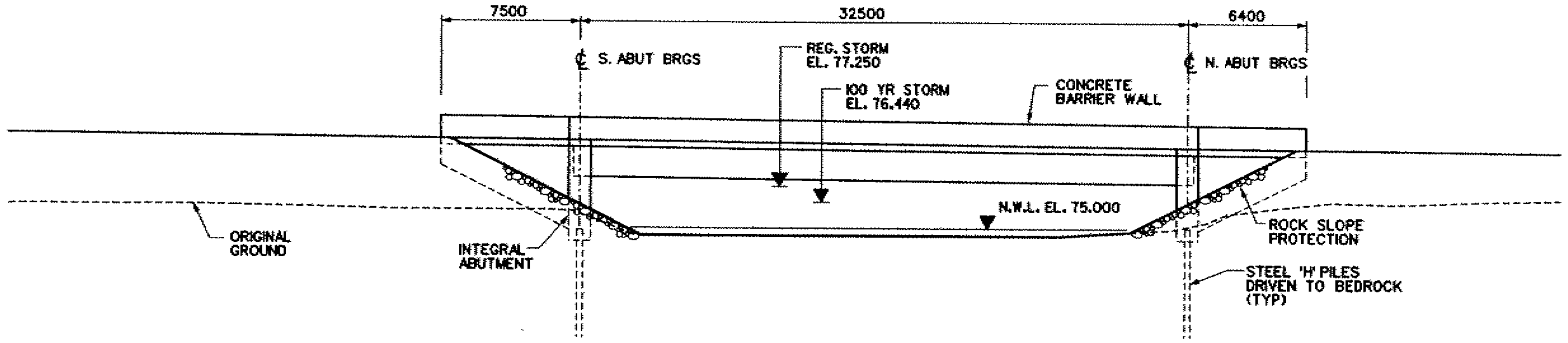

ELEVATION
1:400

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DEC 22-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

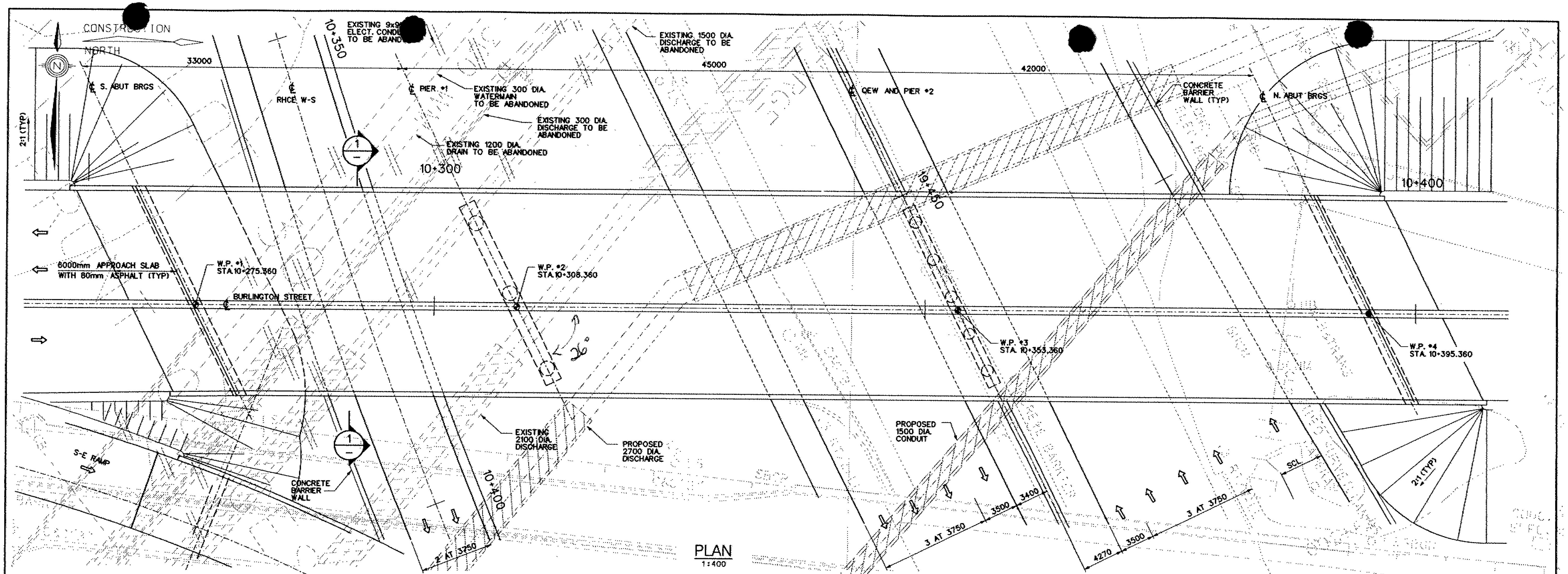
MRC
McCORMICK RANKIN CORPORATION

Scale
AS SHOWN

QEW /BURLINGTON STREET INTERCHANGE
S-RHCE RAMP OVER REDHILL CREEK

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR5
7



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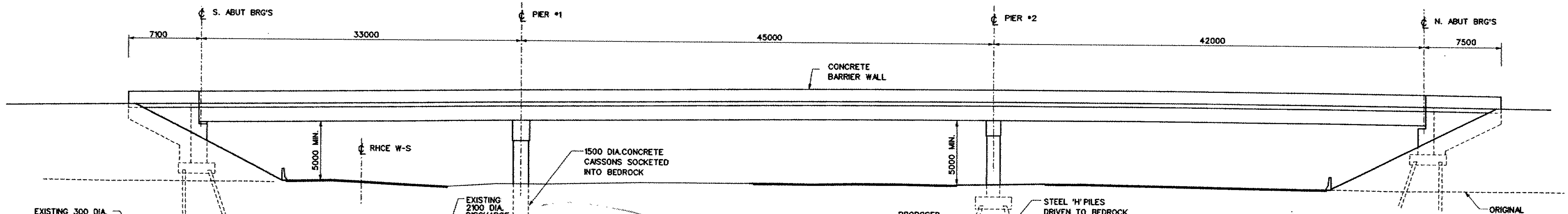
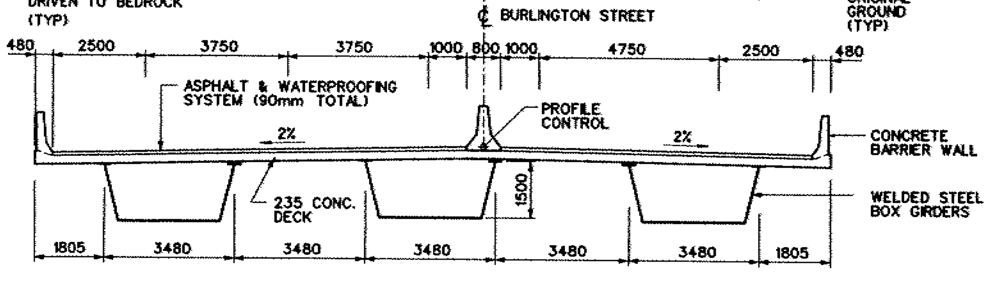


May consider spread footing.

ELEVATION
1:400



SECTION $\frac{1}{1}$
1:200

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REVISION DATE DEC 08-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

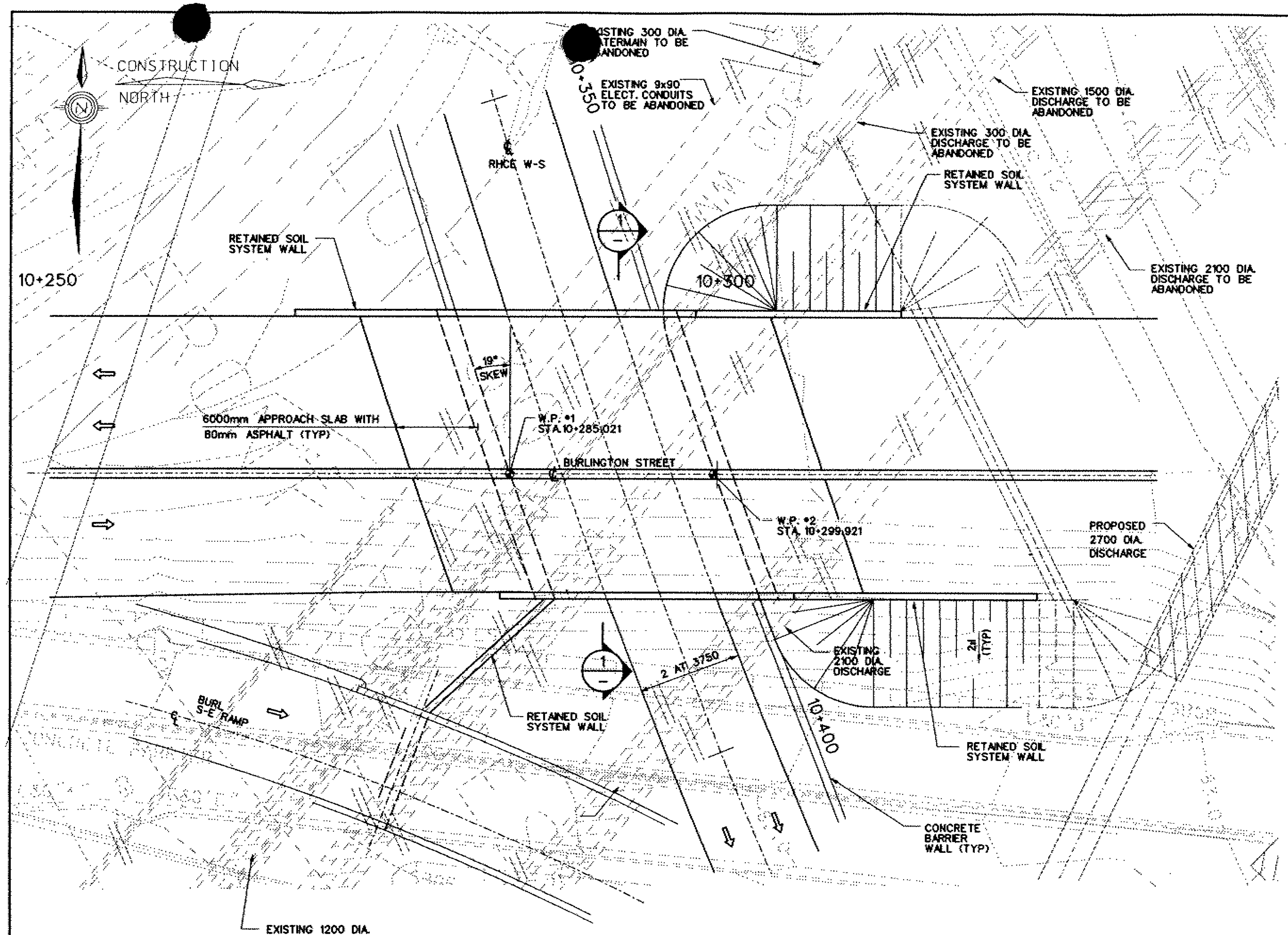
MRC
McCORMICK RANKIN CORPORATION

Scale
AS SHOWN

QEW BURLINGTON STREET INTERCHANGE
BURLINGTON STREET S-W AND E-S RAMPS OVER
QUEEN ELIZABETH WAY AND RHCE W-S RAMP

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR-6
10A



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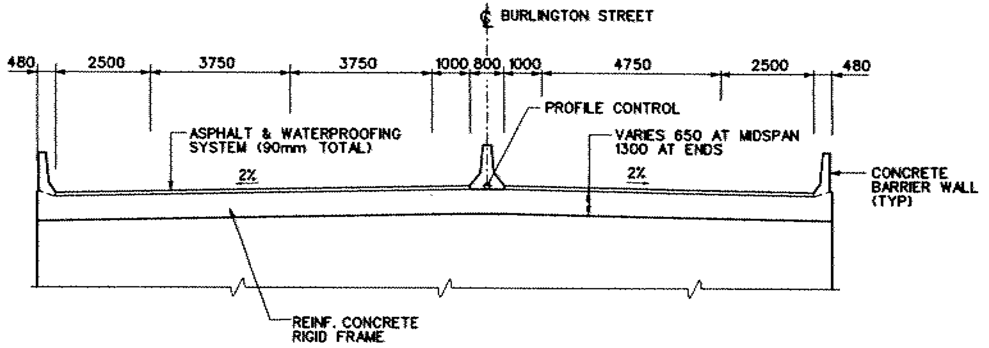

SECTION 1
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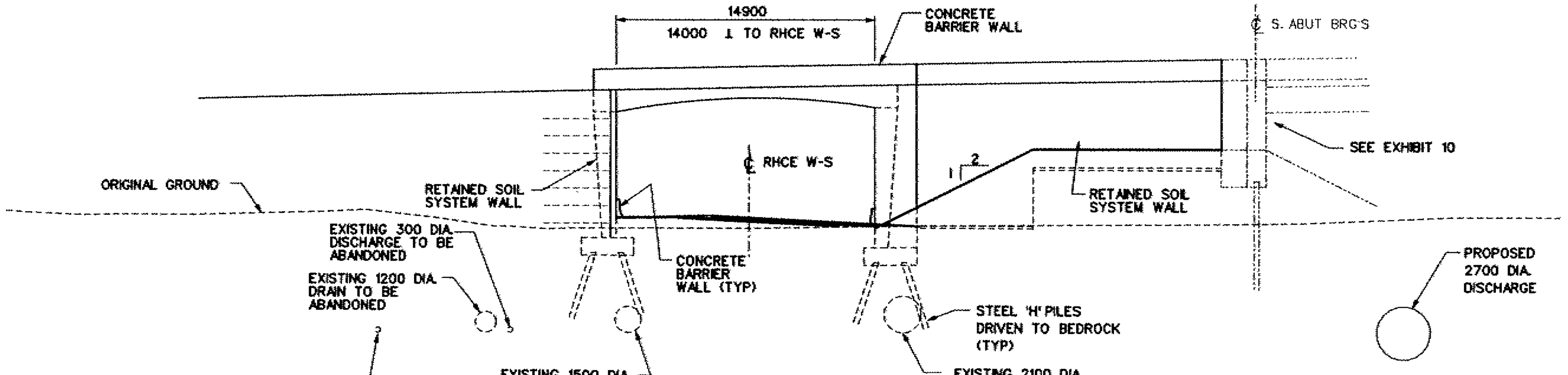

ELEVATION
1:400

} Deficient sight distance.

The 2 structure proposal assumes the two discharge pipes will be abandoned

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

MRC McCORMICK RANKIN CORPORATION

Scale AS SHOWN

BURLINGTON STREET S-W RAMP OVER
RED HILL CREEK EXPRESSWAY W-S

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR6A
9

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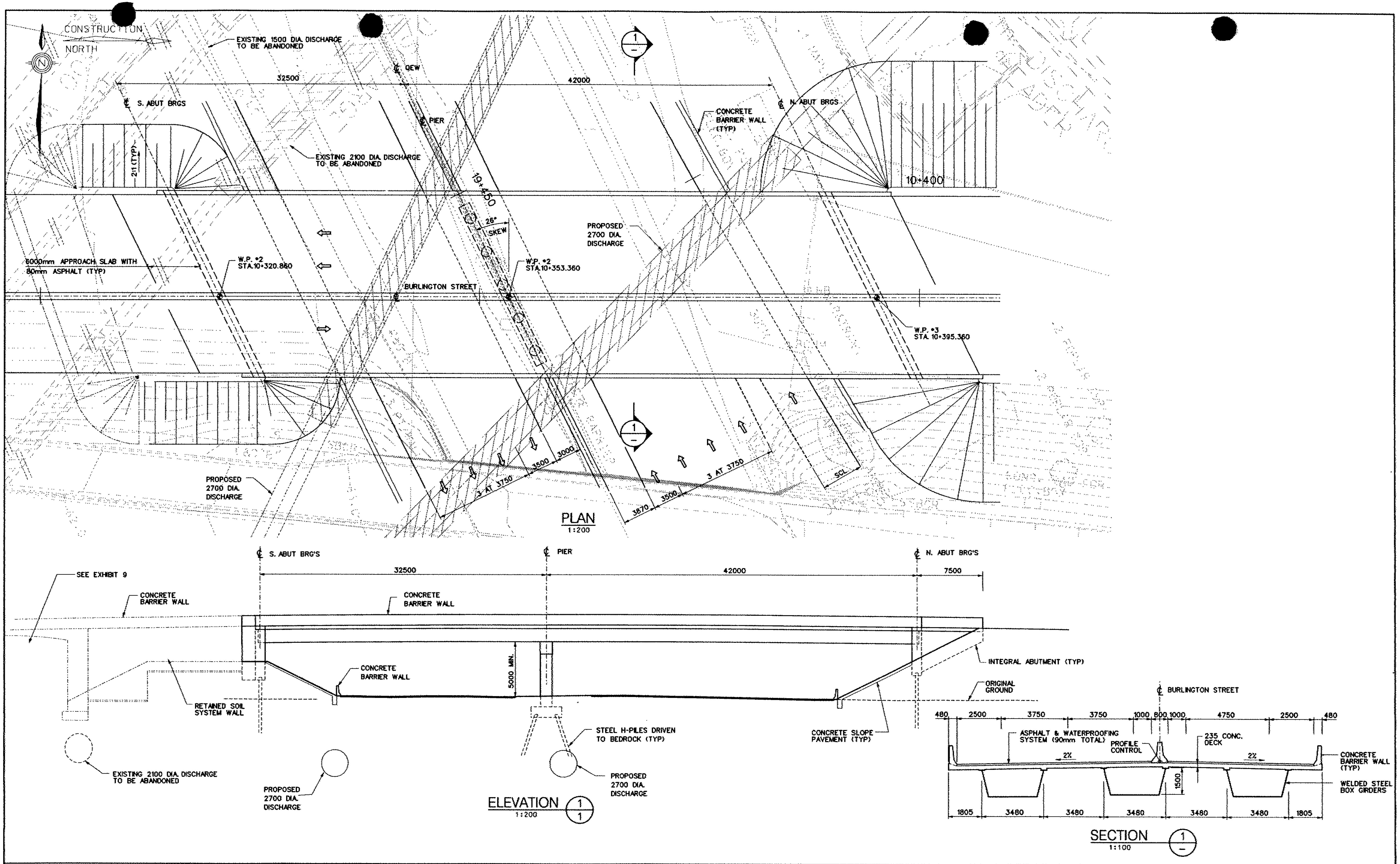
REVISION DATE DEC 23-98



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REVISION DATE DEC 17-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

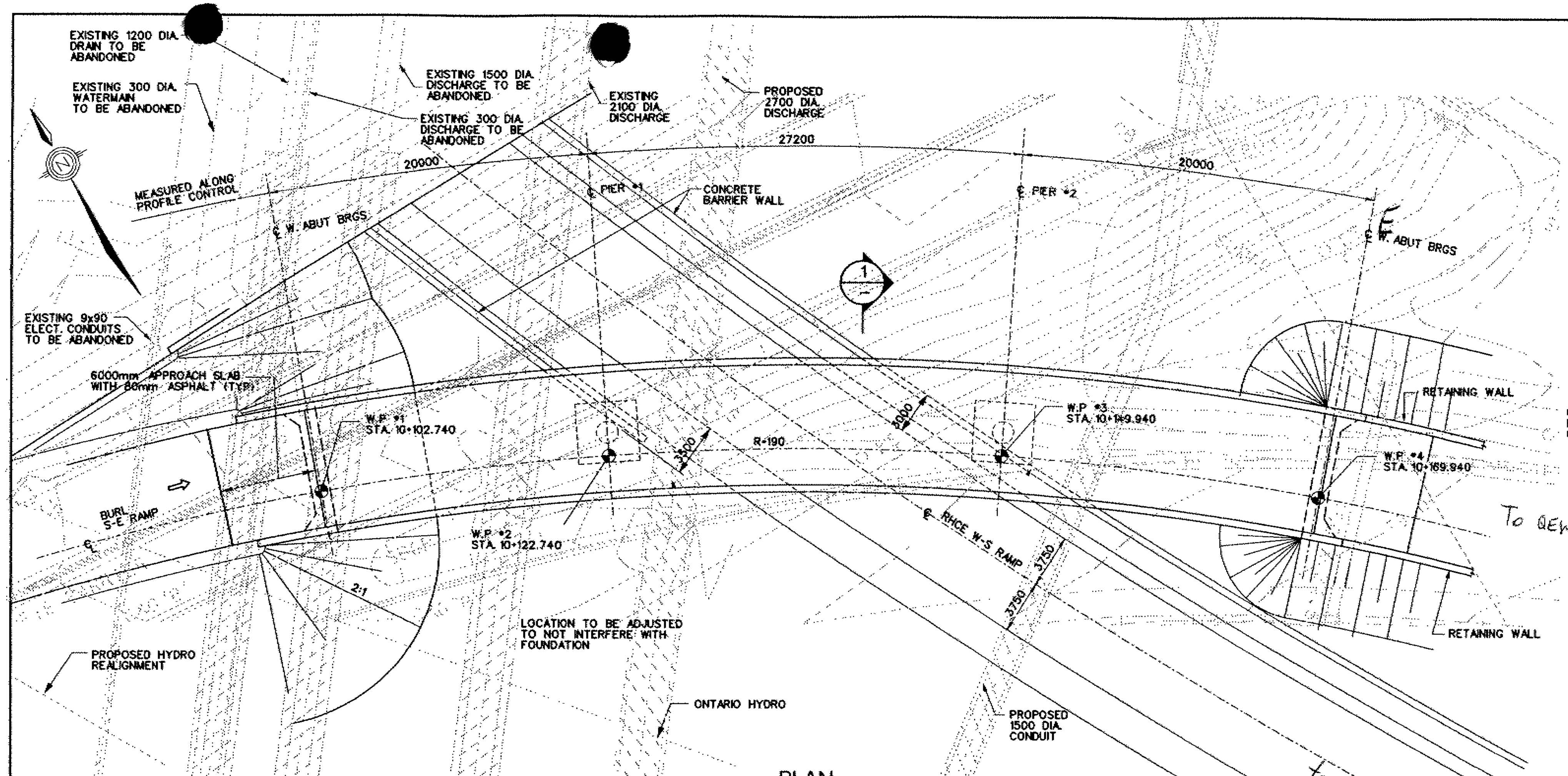
MRC
McCORMICK RANKIN
CORPORATION

Scale
AS SHOWN

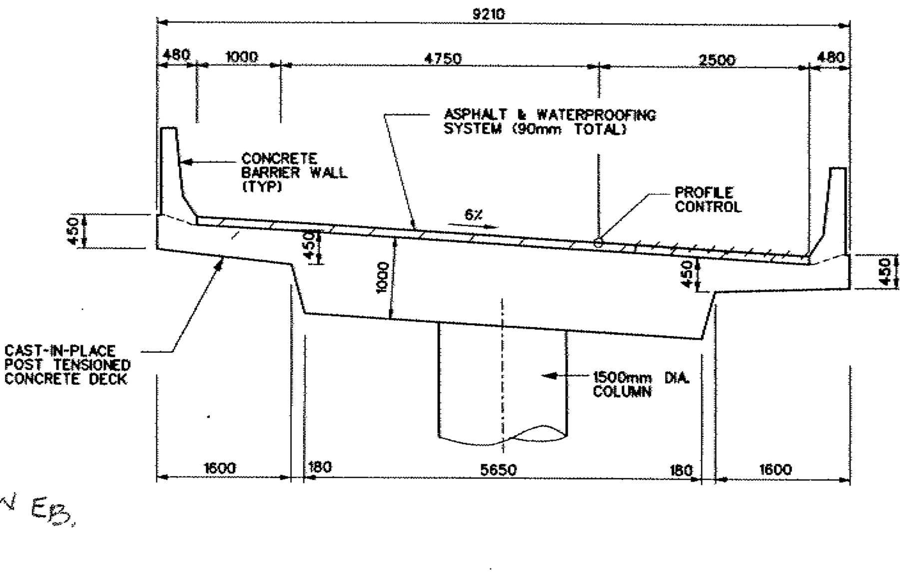
QEW /BURLINGTON STREET S-W AND E-S RAMPS
OVER QUEEN ELIZABETH WAY

PRELIMINARY GENERAL ARRANGEMENT

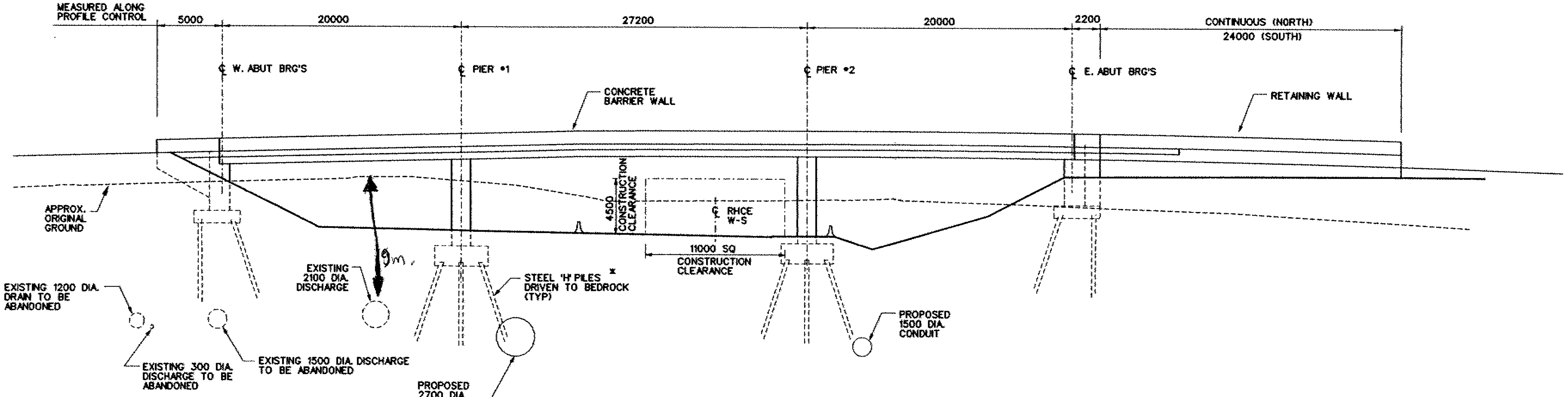
EXHIBIT
BR6B
10



PLAN
1:400



SECTION 1
1:50



ELEVATION
1:400

* CONSIDER CAISSONS IF 2100 DIA. DISCHARGE IS NOT ABANDONED

Structure configuration dependent on the loc'n of the 2100 ø discharge pipe

C:\04DATA\3620-400-8.DGN
REVISION DATE DEC 22-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

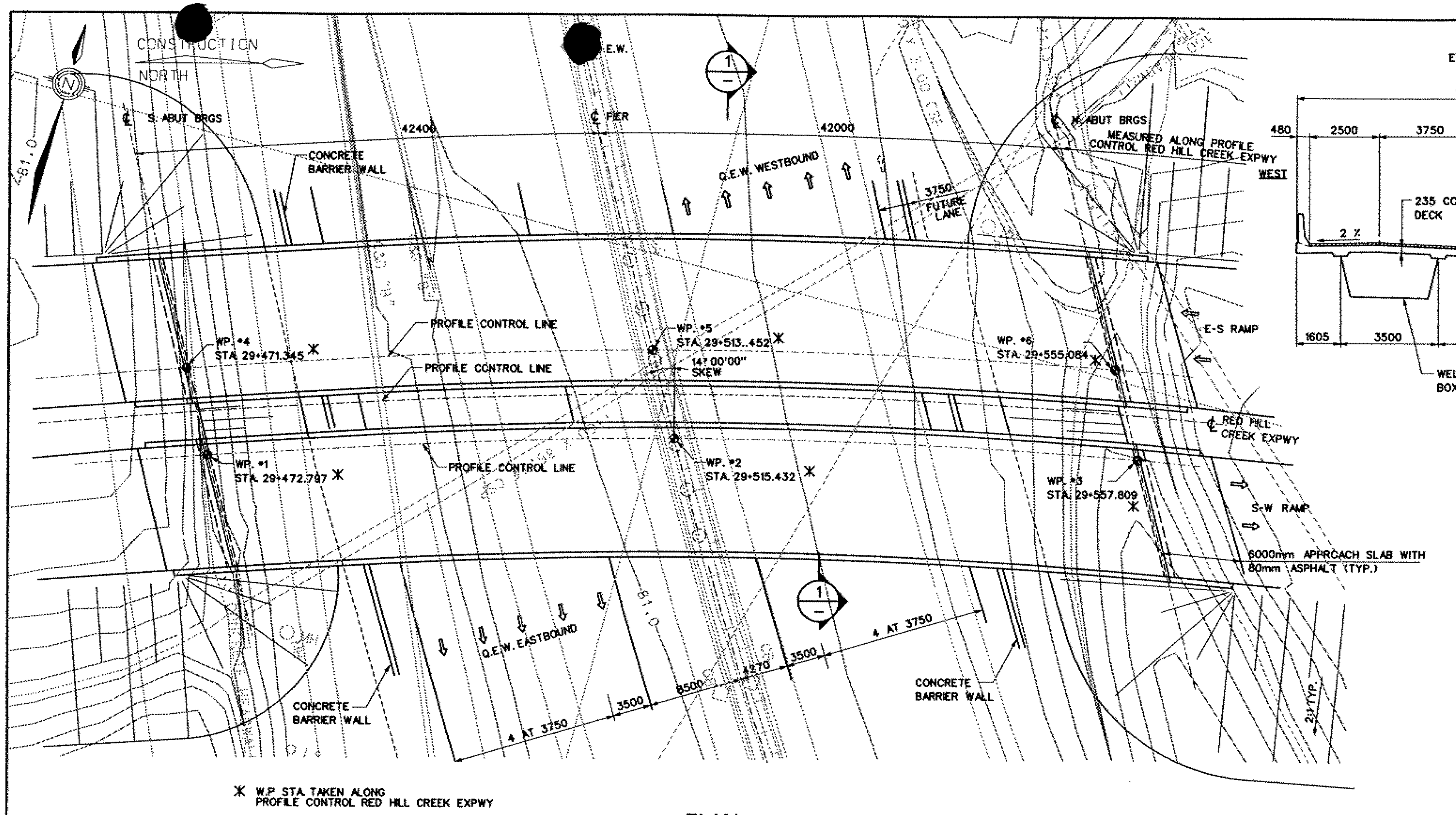
MRC McCORMICK RANKIN CORPORATION

Scale
AS SHOWN

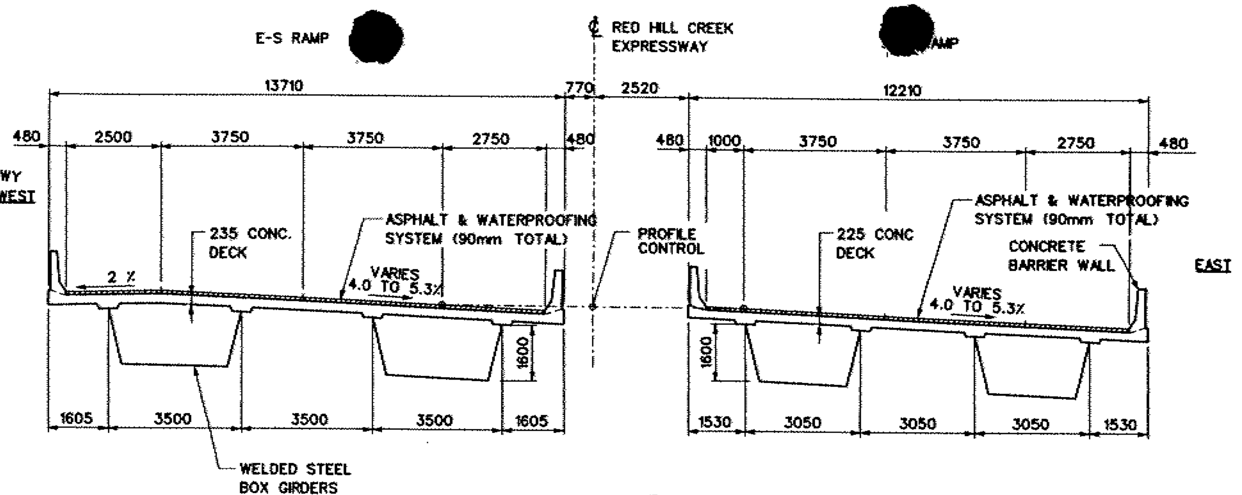
QEW /BURLINGTON STREET INTERCHANGE
BURLINGTON ST S-E RAMP OVER RHCE W-S

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR 7
8



PLAN
1:500



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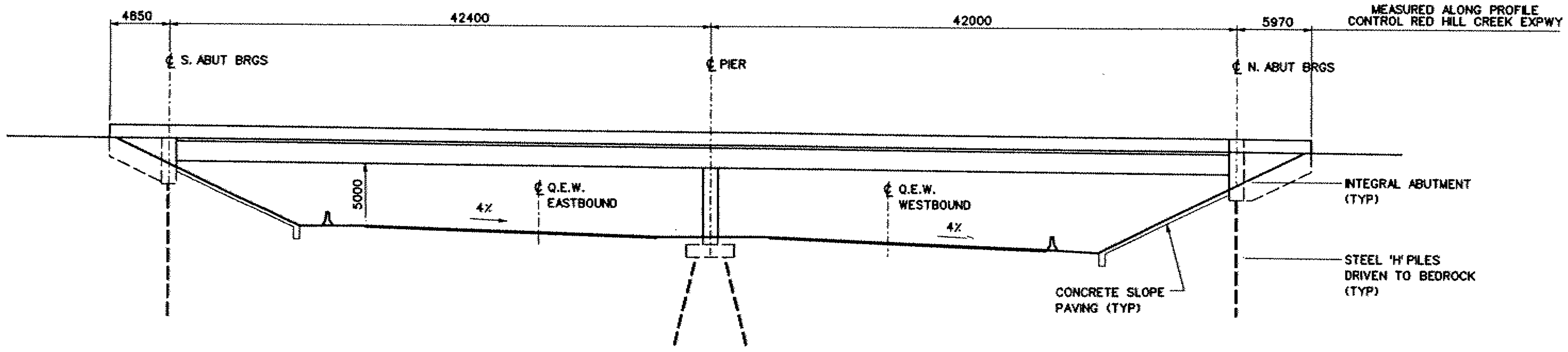


ELEVATION
1:500

1C:DATA\STRUC\3620-400-1.DGN
REVISION DATE DEC 21-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

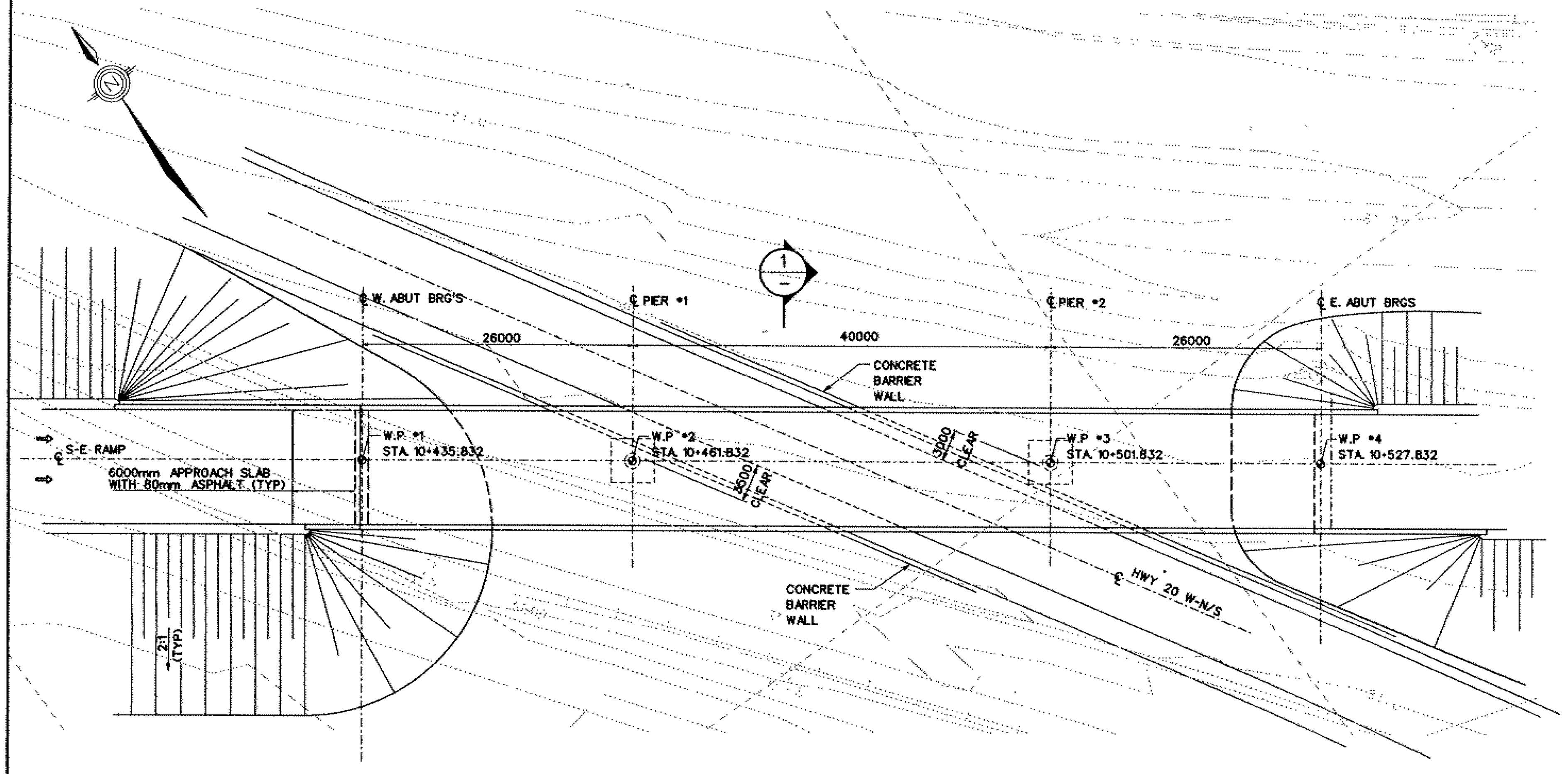
MRC McCORMICK RANKIN CORPORATION

Scale AS SHOWN

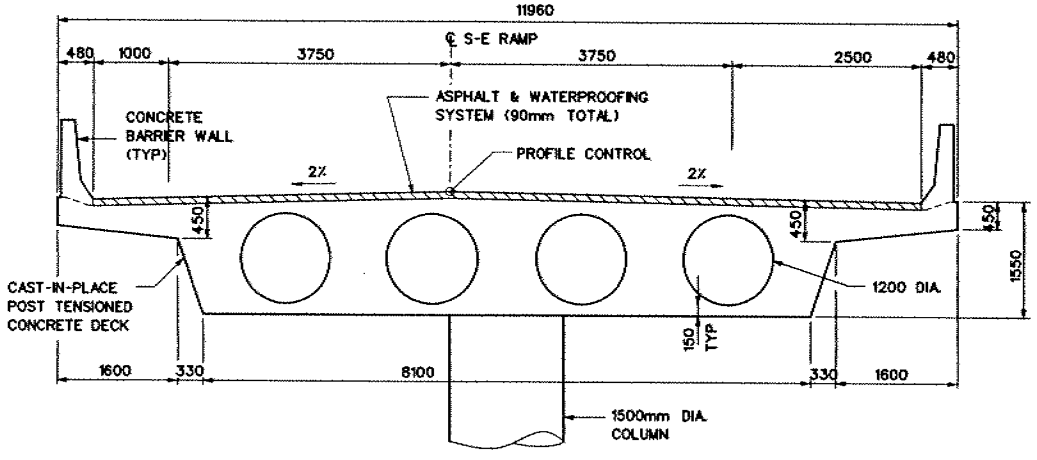
QEW /RED HILL CREEK EXPWY INTERCHANGE
RHCE E-S RAMP AND S-W RAMPS OVER QEW

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR8
1



PLAN
1:600



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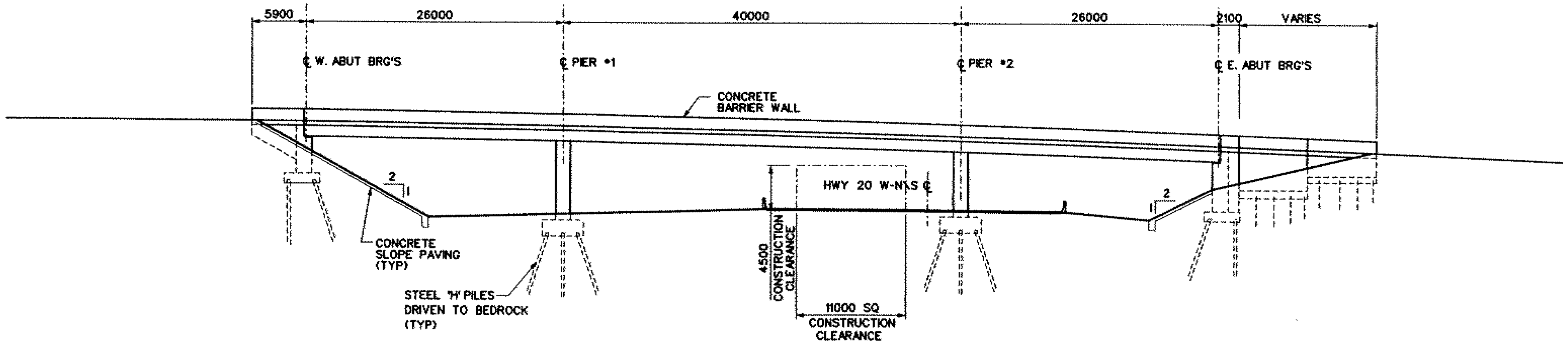
Skew is a problem



ELEVATION
1:600

C:\04DATA\3620-400-4.DGN
REVISION DATE DEC 17 98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

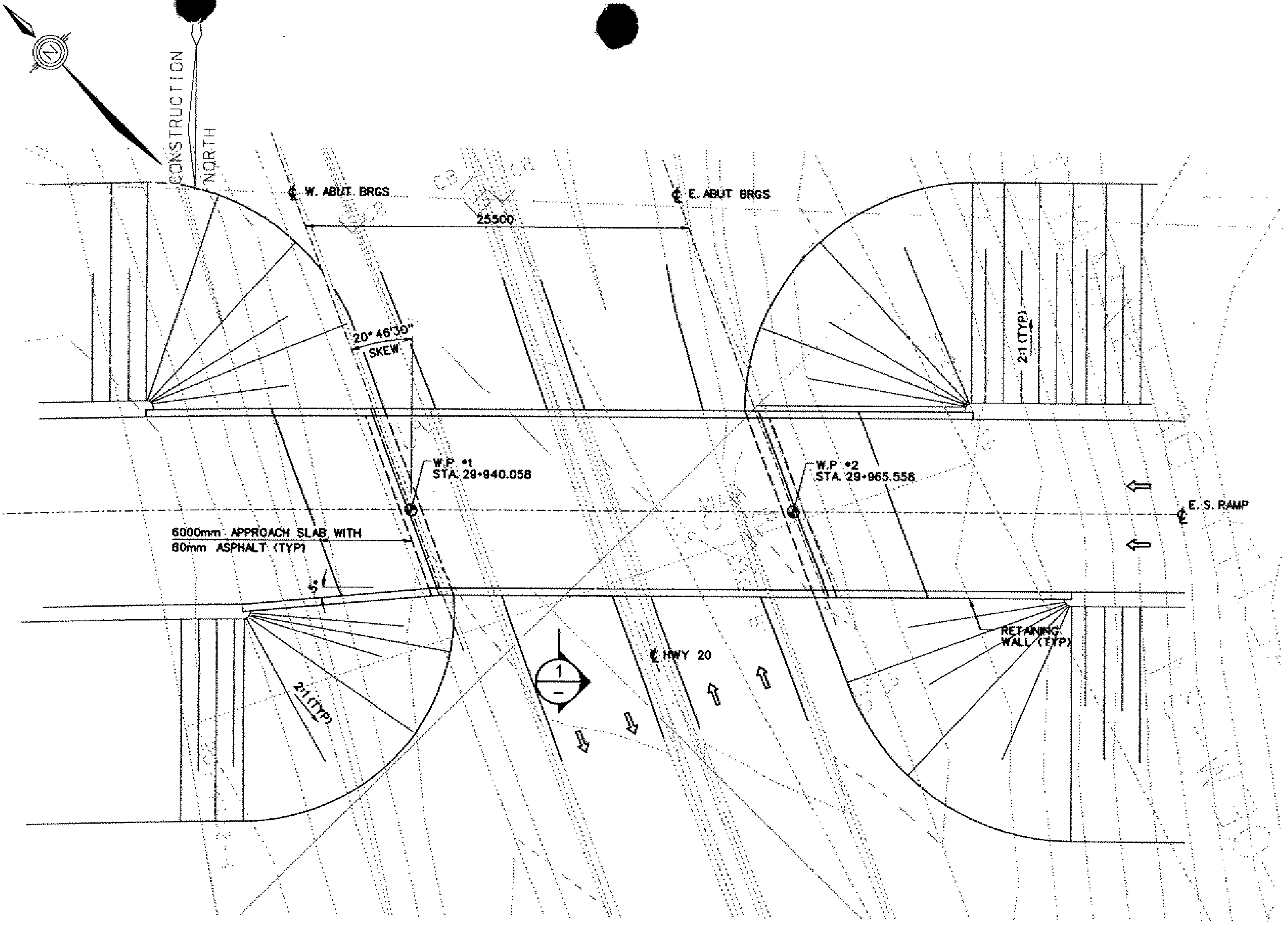
MRC
McCORMICK RANKIN
CORPORATION

Scale
AS SHOWN

QEW /REDHILL CREEK EXPWY INTERCHANGE
S-E RAMP OVER HWY 20 W-N/S

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR9
4



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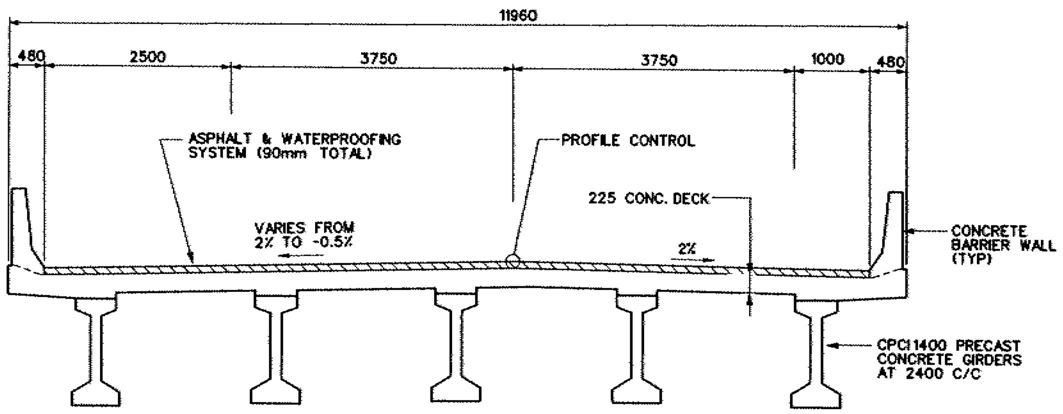
1:400



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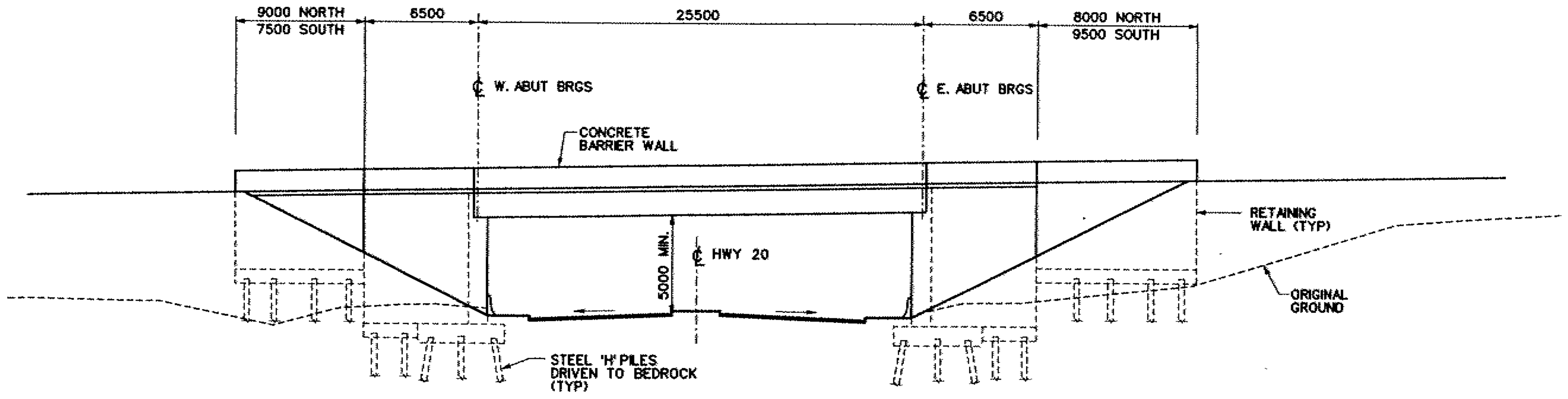

ELEVATION
1:400

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REVISION DATE DEC 09-98

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

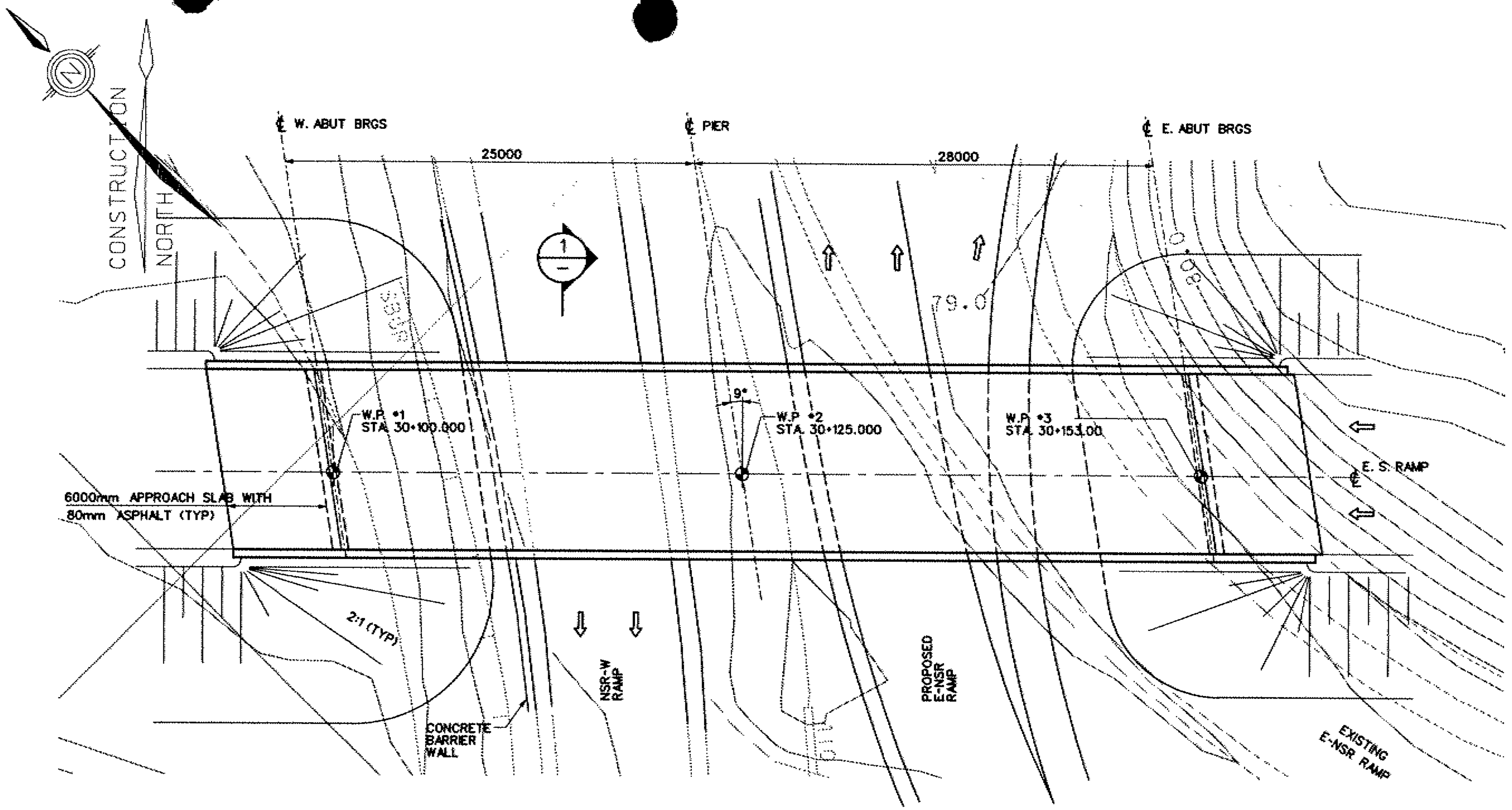
MRC
McCORMICK RANKIN CORPORATION

Scale
AS SHOWN

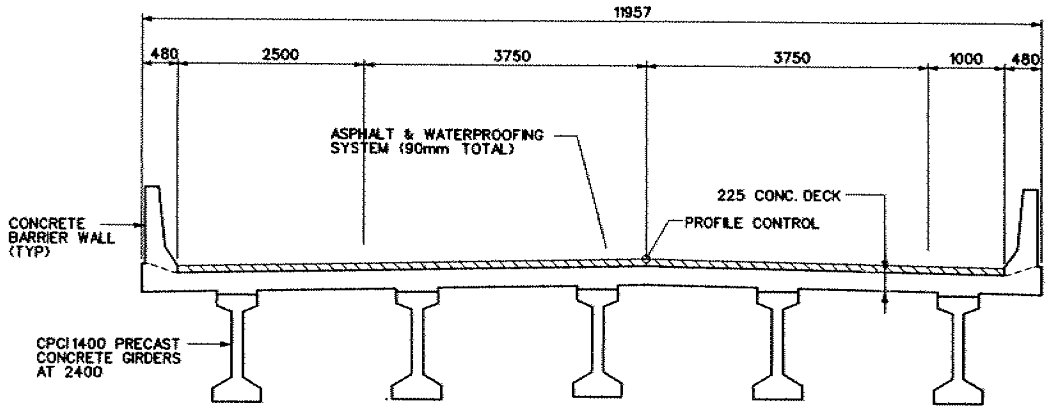
QEW /REDHILL CREEK EXPWY INTERCHANGE
E-S RAMP OVER HWY 20

PRELIMINARY GENERAL ARRANGEMENT

EXHIBIT
BR 10
2



PLAN
1:400



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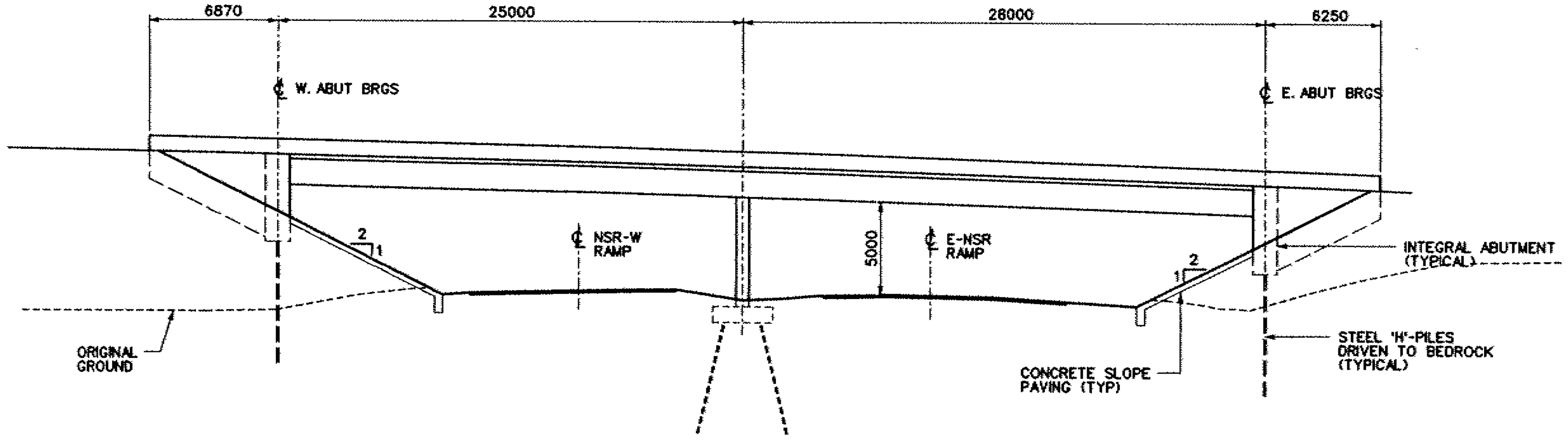
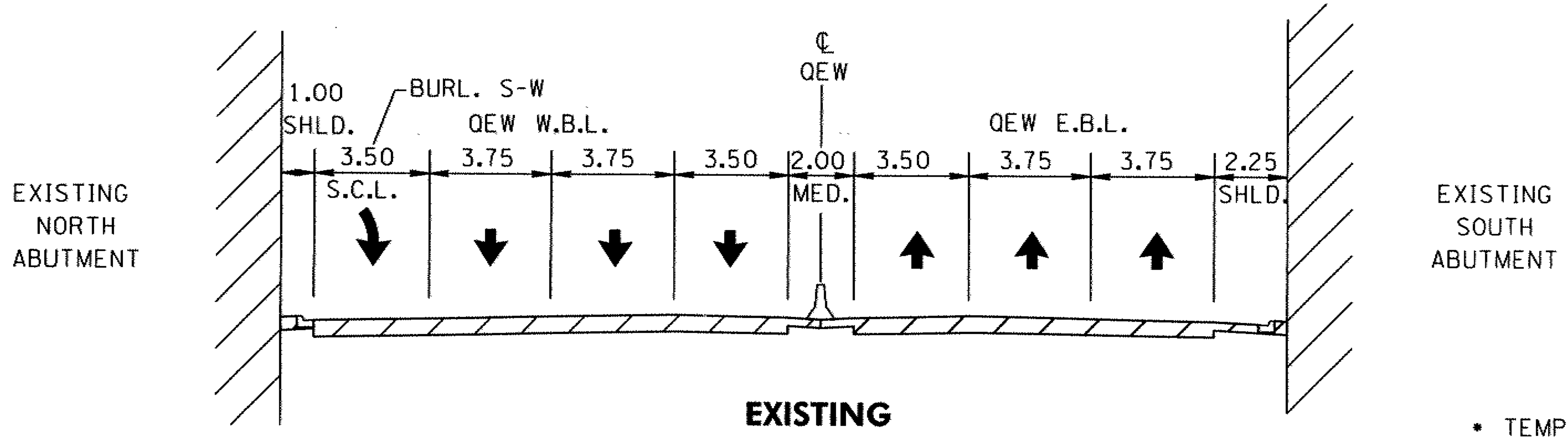


ELEVATION
1:400

C:\hDATA\3620-400-3.DGN
REVISION DATE DEC 21-98

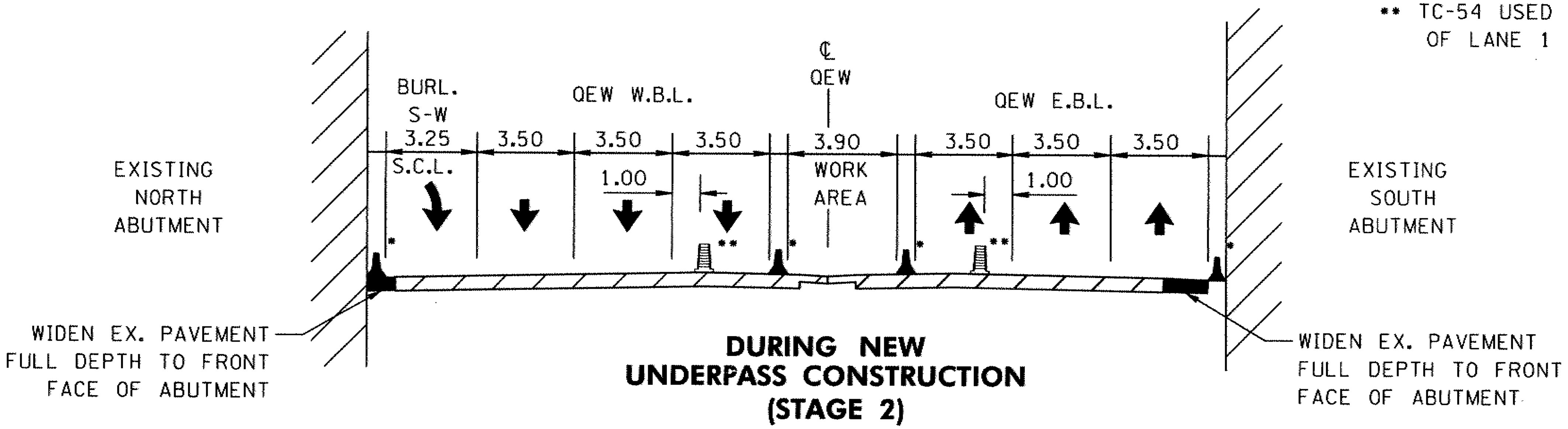
QEW/RED HILL CREEK EXPRESSWAY Preliminary Design Report GWP 441-97-00	MRC McCORMICK RANKIN CORPORATION Scale AS SHOWN	QEW /RED HILL CREEK EXPWY INTERCHANGE E-S RAMP OVER NSR-W AND E-NSR RAMPS PRELIMINARY GENERAL ARRANGEMENT	EXHIBIT BR 11 3



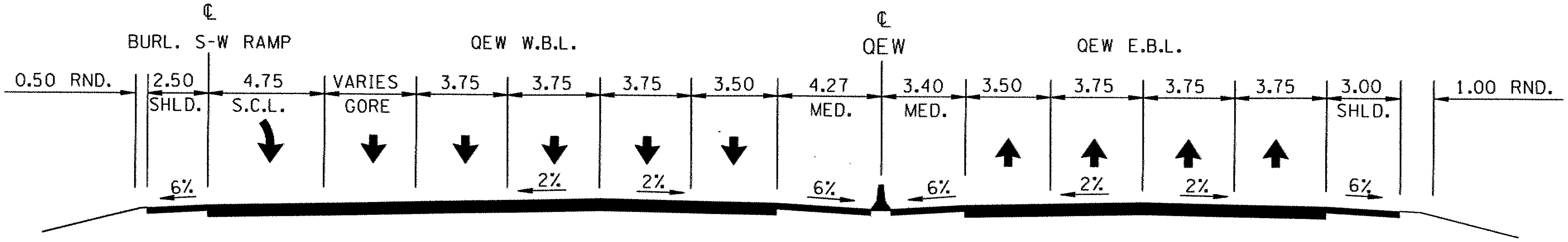
EXISTING

* TEMPORARY CONCRETE BARRIERS

** TC-54 USED FOR OFF PEAK CLOSURES OF LANE 1



DURING NEW UNDERPASS CONSTRUCTION (STAGE 2)



PROPOSED

APPROXIMATE STA. 19+500

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

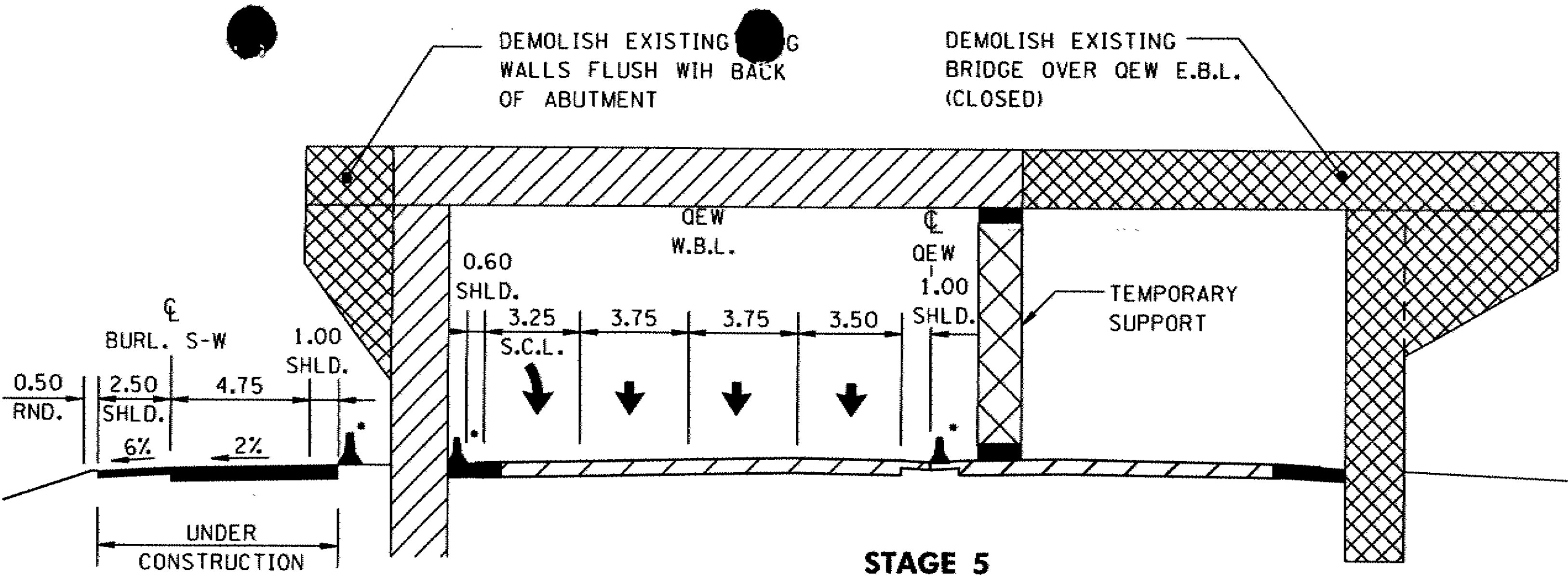
MRC McCORMICK RANKIN CORPORATION

Scale
Not To Scale

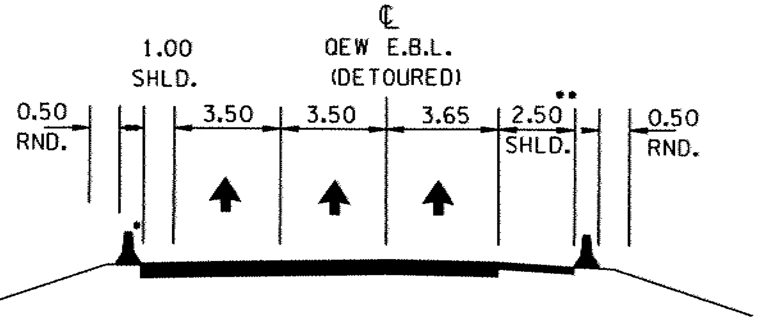
Legend
▨ EXISTING
■ PROPOSED

TYPICAL SECTIONS
QEW - 3
AT EXISTING BURLINGTON STREET UNDERPASS

PLATE



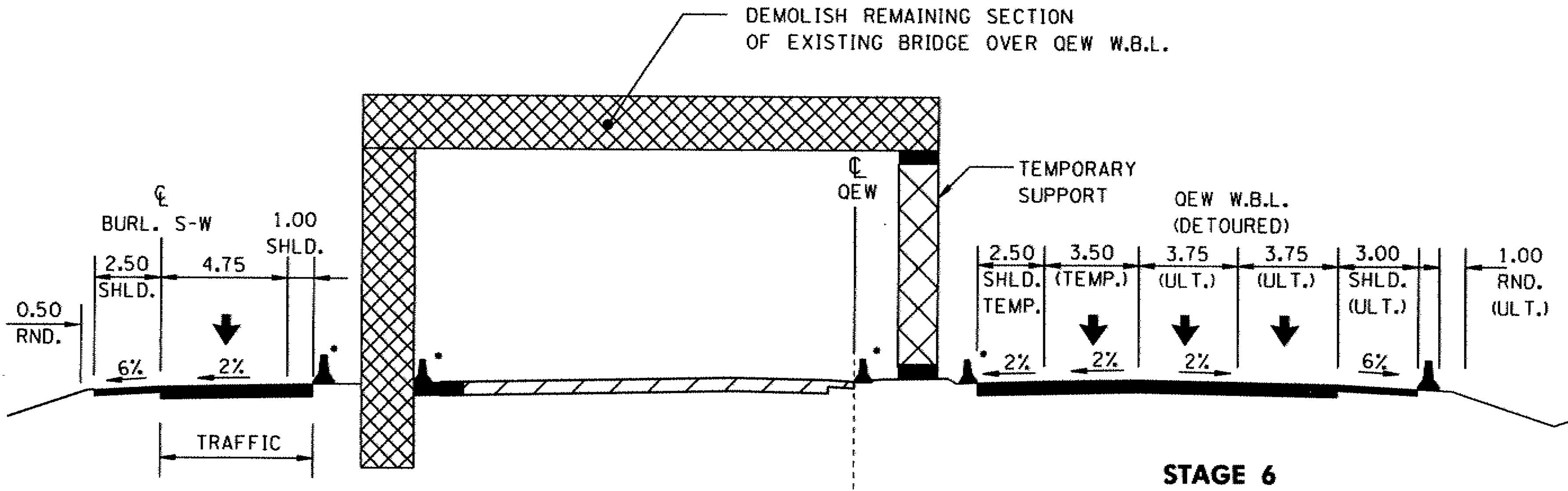
STAGE 5
EXISTING BURLINGTON STREET UNDERPASS DEMOLITION



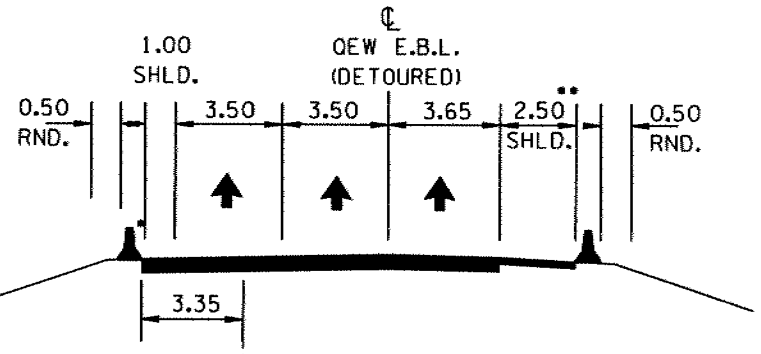
QEW E.B.L. DETOUR (STAGES 5 AND 6)

• TEMPORARY CONCRETE BARRIER

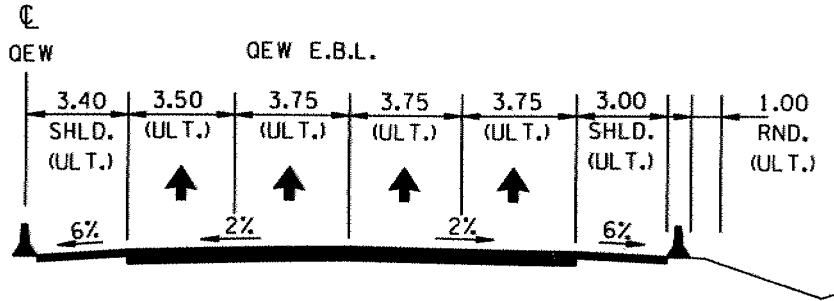
•• MIN. SHOULDER WIDTH WITH BARRIER DURING WINTER



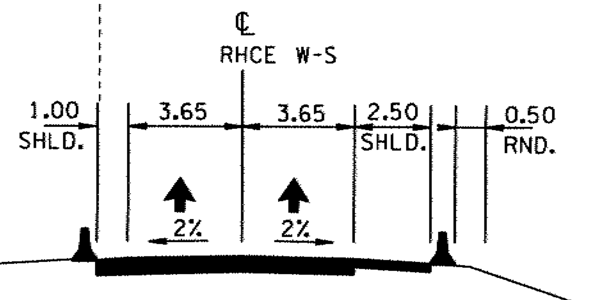
STAGE 6
EXISTING BURLINGTON STREET UNDERPASS DEMOLITION



QEW E.B.L. DETOUR (STAGES 5 AND 6)



ULTIMATE QEW E.B.L.



RHCE W–S RAMP ULTIMATE

QEW/RED HILL CREEK EXPRESSWAY

Preliminary Design Report
GWP 441-97-00

MRC McCORMICK RANKIN CORPORATION

Scale Not To Scale

Legend
▨ EXISTING
▩ DEMOLITION
■ PROPOSED

TYPICAL SECTIONS
QEW – 4
EXISTING BURLINGTON STREET UNDERPASS DEMOLITION

PLATE

memorandum

Ontario

To: V. Boehnke
Structural Engineering
Central Region

November 17, 1997

Attn: J. Lam
Sr. Structural Engineer

From: Pavements and Foundations Section
Room 315 Central Building

Phone: 235-4333

Re: Redhill Creek Expressway
Preliminary Design - Foundations

A study design for the Redhill Creek Expressway (RHCE) was submitted by McCormick Rankin for review by MTO. The project limits extend from approximately 1 km east of Highway 20 to 1 km west of burlington Street. The terms of this assignment covers the preliminary design of QEW widening between the Burlington Street interchange and the RHCE interchange.

For the foundations component, it is understood from reading the study design draft that preliminary recommendations are required for the proposed Burlington Street interchange alternatives only. A foundation investigation and preliminary recommendations for the interchange at RHCE and QEW falls under a different work plan. Clarification of this is requested in order to ensure that preliminary foundation design is also being carried out at this location. It would also be of assistance to know the number of structures, existing and proposed, that are included in this assignment.

At the Burlington Street interchange, the foundations consultant, Golder Associates Ltd., proposes a foundation investigation that includes advancing ten boreholes within the interchange.

For preliminary foundation recommendations, it is generally sufficient to carry out one to two borings per structure in order to comment on the most feasible foundations. Generally, the consultant carries out a historical search for existing borehole information. We have no record that the foundations consultant carried out a search of existing borehole information.

The information obtained form the field should also be sufficient to alert the designer to any potential geotechnical problems associated with the site, e.g. settlement or slope stability concerns. In the situation where a number of alternatives are presented, the foundations consultant would provide preliminary recommendations for each. The assignment requires a Preliminary Foundation Investigation and Design Report for the proposed crossings. The signature and stamp of the principal engineer and designated MTO contact would be required for this assignment.

The Pavements & Foundations Section carried out a preliminary foundation investigation in 1989 under 54-88-00 for the proposed reconstruction of QEW between Kirk Avenue and Hwy 20. This study included preliminary designs for the Burlington Street interchange and the "Hamilton N-S Transportation Corridor" interchange.

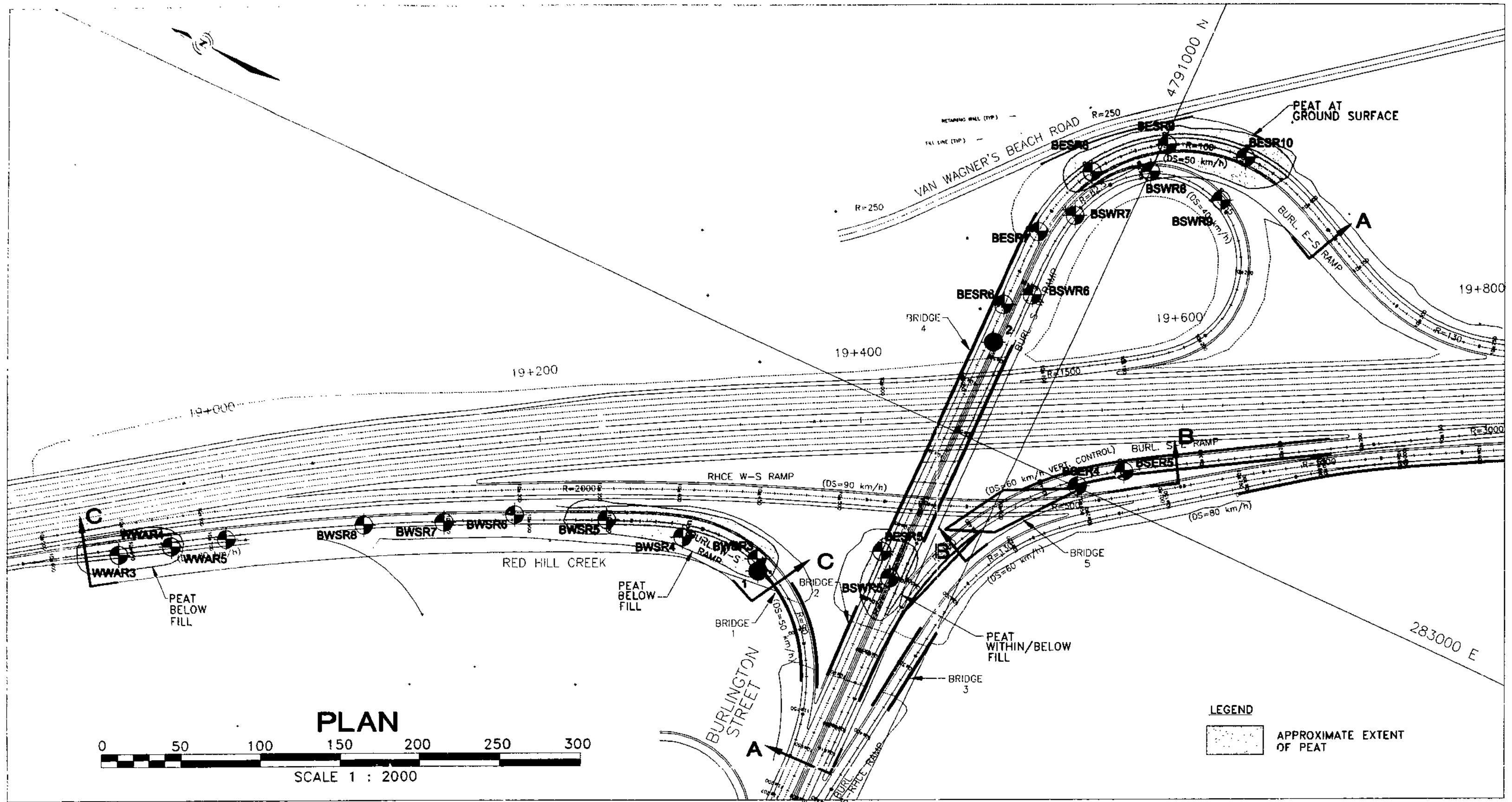
At the Burlington Street I.C., eleven borings were carried out as part of the preliminary foundation investigation. All borings were advanced to the shale bedrock.

As existing information is available at this site, it is our opinion that the number of borings proposed by Golder Associates for the foundations can be substantially reduced, i.e. by 50% to 60%. Accordingly, the number of engineering hours will require reassessment. A resubmission of the foundations proposal is in order and falls under the prime Consultant's responsibility.

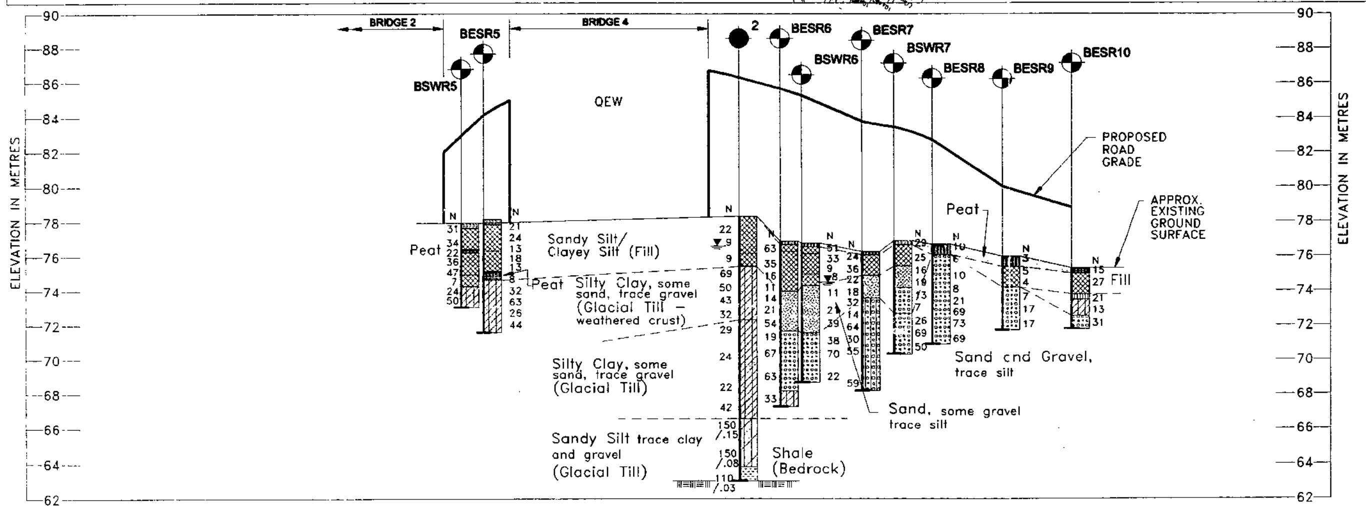
In light of our comments, the number of probeholes suggested for the geotechnical component should also be examined.

If there are any questions or comments, please advise.

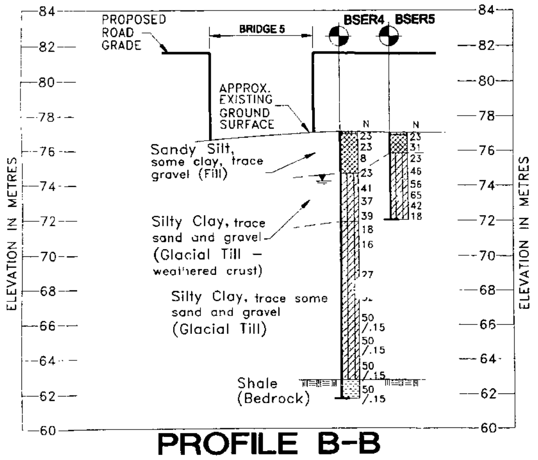
Betty Bennett, P.Eng.
Foundation Engineer



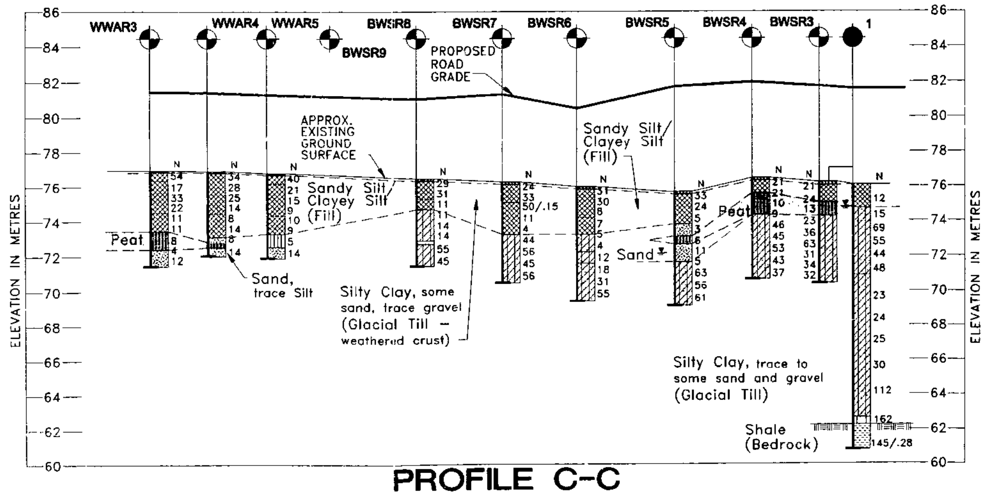
PLAN



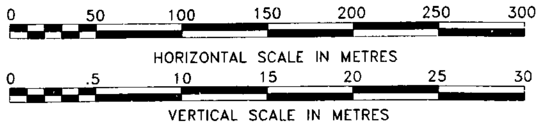
PROFILE A-A



PROFILE B-B



PROFILE C-C



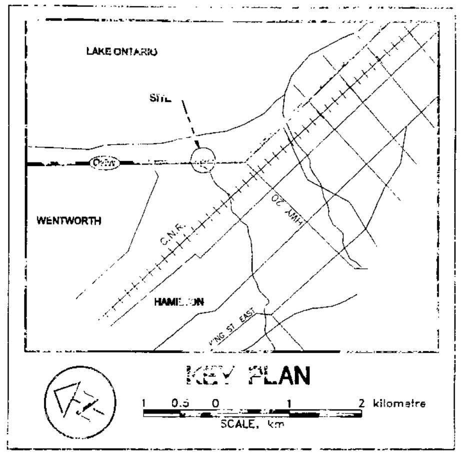
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

DIST. 4 HWY. QEW
WP No. 441-97-00
AG. No. 9820-7411-2805

QEW BURLINGTON STREET
INTERCHANGE
BOREHOLE LOCATIONS & SOIL STRATA

Golder Associates
Golder Associates Ltd.
MISSISSAUGA, ONTARIO CANADA

Retaining Walls
Proposed in MRC's PDR



KEY PLAN

LEGEND

◈	Borehole (Current Investigations)
●	Borehole (Golder Associates Report no. 981-1108, dated July, 1998)
N	Blows/0.3m (Std. Pen. Test, 475 j/blow)
20kPa	Field Vane Shear Strength 'MTO 'N' Vane)
▼	WATER LEVEL in Soil on Nov. 10/98

No.	ELEVATION	LOCATION	
		NORTHING	EASTING
BESR5	78.13	4791051.574	282912.756
BESR6	76.87	4791048.274	283084.233
BESR7	76.27	4791047.571	283133.398
BESR8 *	76.69	4791032.901	283180.799
BESR9 *	76.00	4790997.366	283215.405
BESR10	75.30	4790949.585	283228.378
BSER4	77.11	4790958.551	283000.917
BSER5	77.05	4790936.369	283021.374
BWSR3	76.25	4791120.039	282875.839
BWSR4	76.49	4791167.659	282876.274
BWSR5	75.73	4791215.411	282858.717
BWSR6	76.03	4791261.196	282837.638
BWSR7	76.31	4791306.281	282814.985
BWSR8	76.53	4791350.940	282792.120
BSWR5	77.91	4791040.110	282899.899
BSWR6	76.76	4791034.717	283096.960
BSWR7	76.09	4791031.064	283152.040
BSWR8 *	76.50	4790999.787	283196.158
BSWR9 *	76.50	4790952.520	283198.829
WWAR3	76.95	4791483.505	282710.853
WWAR4	76.91	4791455.705	282729.400
WWAR5	76.79	4791426.243	282747.929
1	76.22	4791116.271	282869.265
2	76.67	4791044.158	283060.701

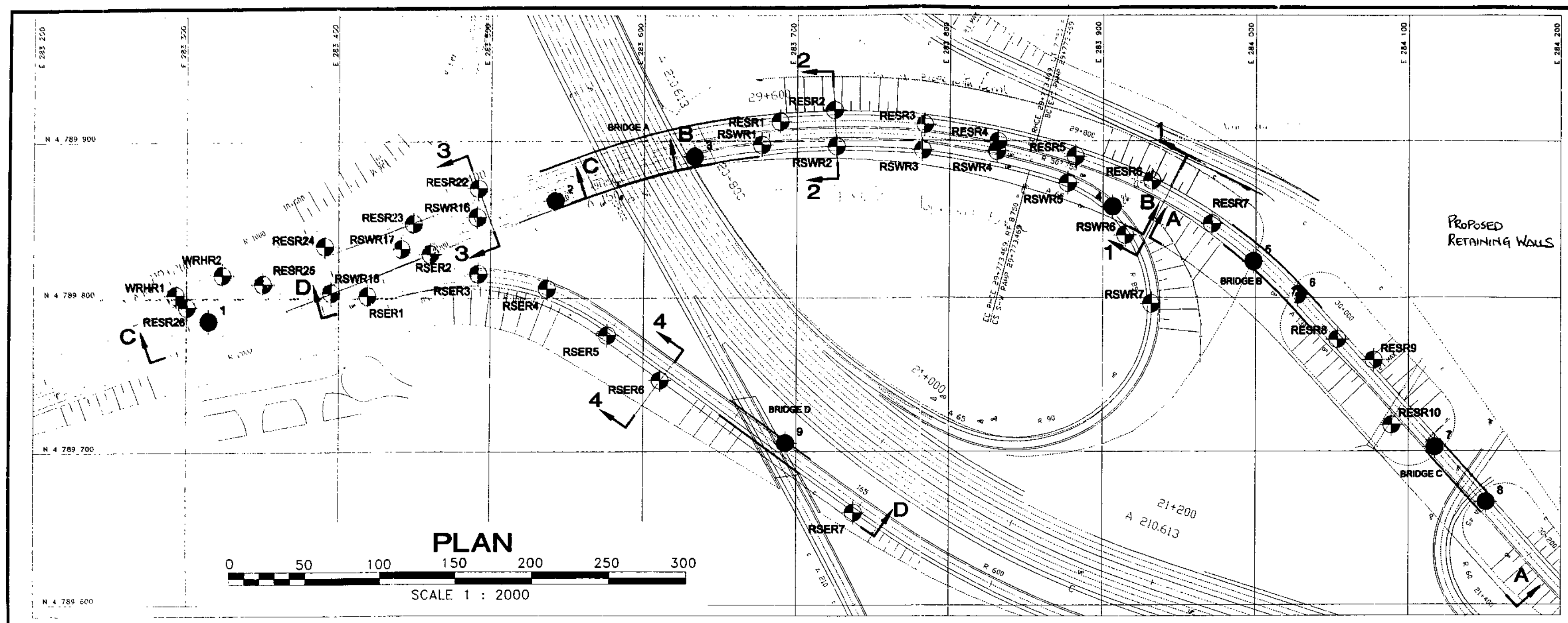
* THE NORTHING, EASTING AND ELEVATION OF THESE HOLES ARE APPROXIMATE, THEY ARE NOT SURVEYED IN.

NOTES

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NO.	DATE	BY	REVISION
2	JAN./99	SP	FINAL
1	NOV/.98	SP	ISSUED FOR REVIEW

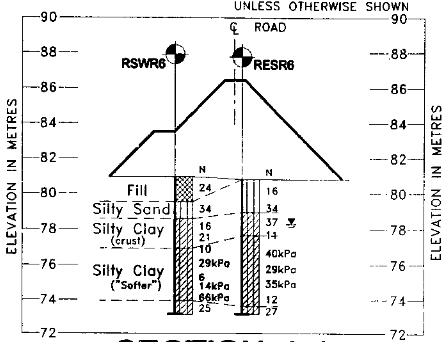
HWY. QEW		PROJECT NO.: 981-8033	DIST. 4
SUBM'D. SP	CHKD: SP	DATE: 1998 11 27	SITE
DRAWN: PS/JFC	CHKD. SP	APPD.	DWG. BS 1



PLAN

METRIC

DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN



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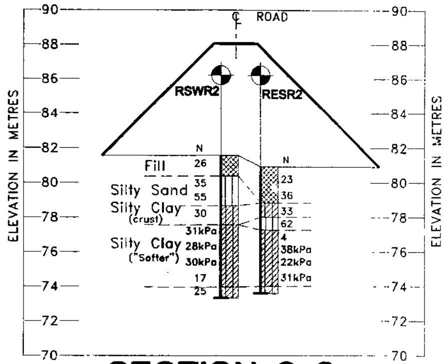

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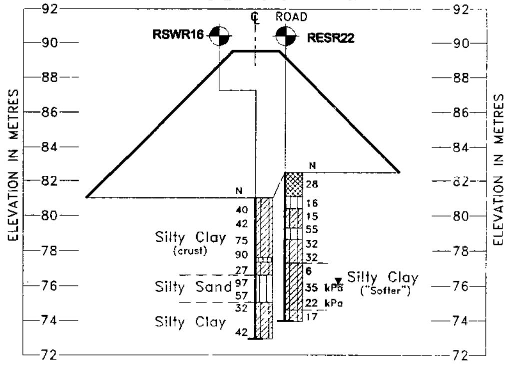

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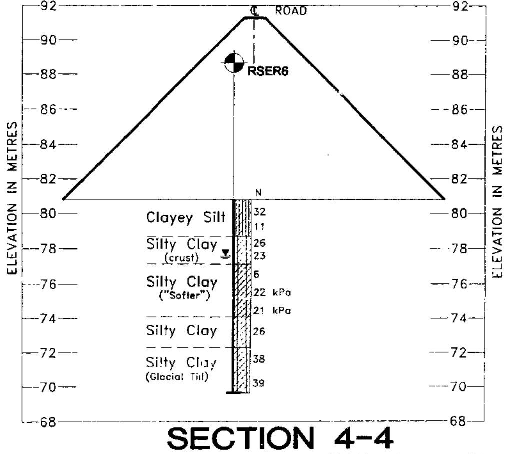


SECTION 4-4

NOTES

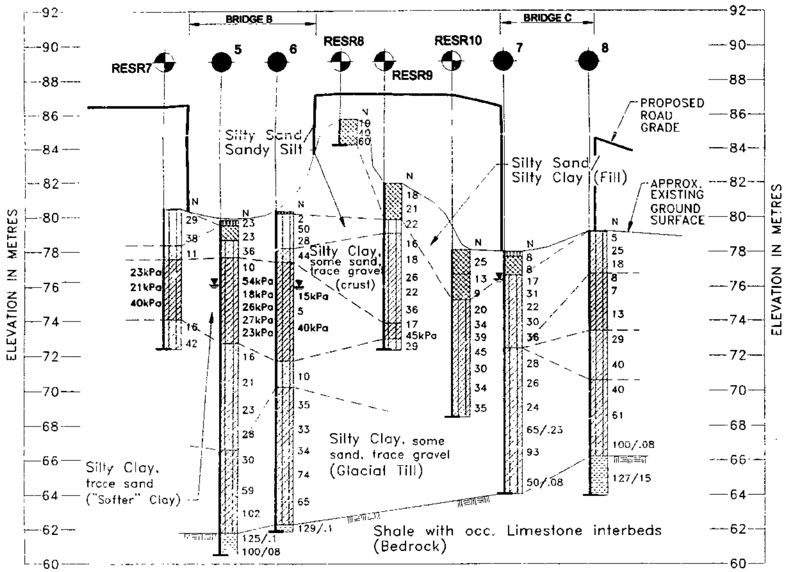
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

0 50 100 150 200 250 300

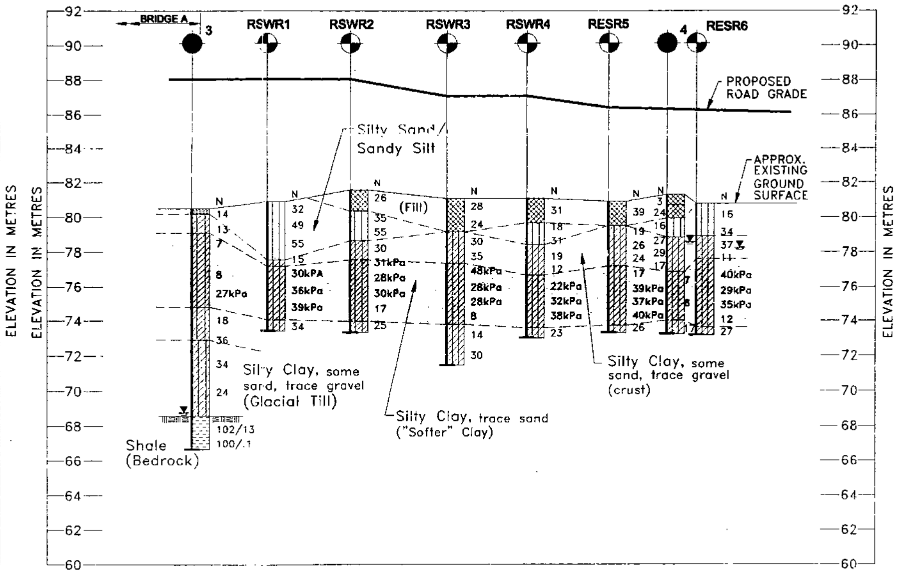
HORIZONTAL SCALE IN METRES

0 5 10 15 20 25 30

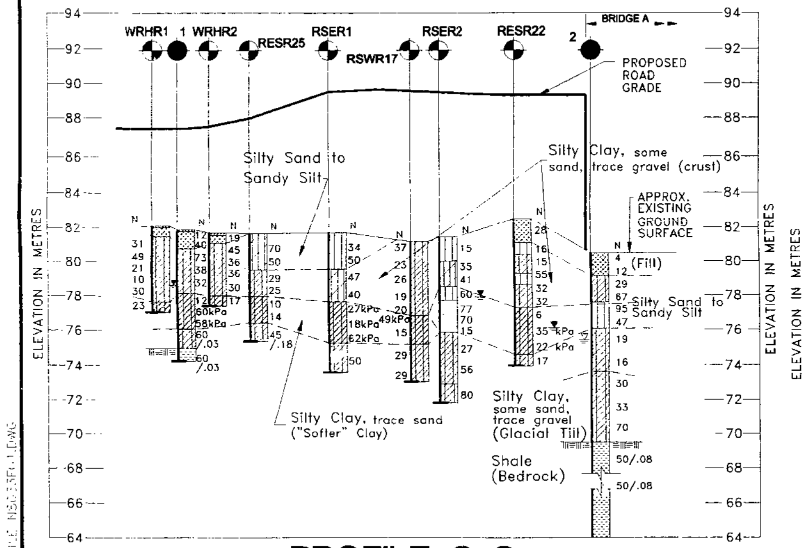
VERTICAL SCALE IN METRES



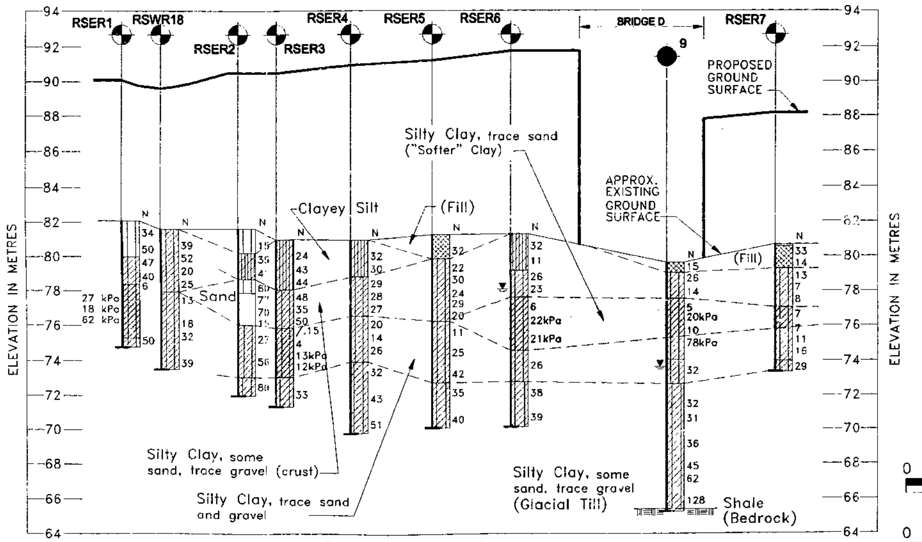
PROFILE A-A



PROFILE B-B



PROFILE C-C



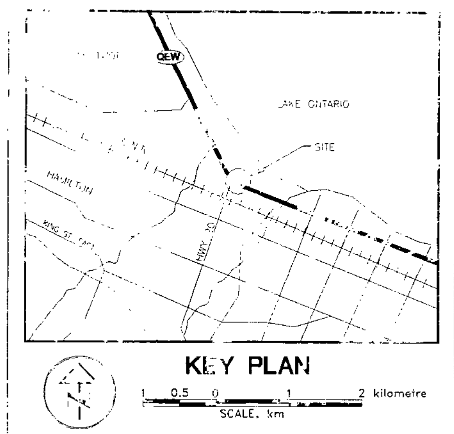
PROFILE D-D

DIST. 4 HWY. QEW
WP No. 441-97-00
AG. No 9820-7411-2805

QEW / RHCE
INTERCHANGE
BOREHOLE LOCATIONS & SOIL STRATA

SHEET

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

◐	Borehole (Current investigation)
●	Borehole (Golder Associates Report No. 981-1108, Dated April, 1998)
N	Blows/0.3m (Std. Pen. Test, 475 j/blow)
20kPa	Field Vane Shear Strength (MTO 'N' Vane)
▼	Water Level in Soil on Nov. 10/98
▽	Water Level in Rock on Nov. 10/98

No.	ELEVATION	LOCATION NORTHING	EASTING
RESR1	80.78	4789912.492	283688.868
RESR2	80.90	4789920.027	283724.308
RESR3	80.87	4789910.123	283783.704
RESR4	80.84	4789899.827	283831.334
RESR5	80.91	4789890.228	283881.826
RESR6	80.77	4789874.637	283931.999
RESR7	80.47	4789846.915	283971.199
RESR8	85.72	4789773.574	284053.236
RESR9	81.94	4789760.049	284076.977
RESR10	78.10	4789717.289	284088.854
RESR22	82.49	4789869.805	283491.991
RESR23	81.38	4789847.214	283449.726
RESR24	81.71	4789832.766	283391.004
RESR25	81.67	4789809.089	283350.457
RESR26	82.12	4789794.775	283300.262
RSWR1	80.91	4789897.650	283576.951
RSWR2	81.56	4789896.779	283725.695
RSWR3	81.07	4789895.879	283782.342
RSWR4	81.08	4789893.645	283830.623
RSWR5	82.12	4789873.234	283876.838
RSWR6	80.93	4789839.774	283914.421
RSWR7	81.52	4789796.386	283931.606
RSWR16	81.00	4789851.160	283491.327
RSWR17	81.17	4789831.050	283441.682
RSWR18	81.61	4789803.517	283395.162
RSER1	81.70	4789801.626	283419.093
RSER2	81.44	4789827.539	283460.834
RSER3	80.99	4789815.135	283492.021
RSER4	80.92	4789806.060	283536.669
RSER5	81.20	4789776.448	283576.096
RSER6	81.25	4789746.708	283610.970
RSER7	80.57	4789659.941	283737.247
WRHR1	82.10	4789802.365	283292.963
WRHR2	81.71	4789814.781	283323.466
1	81.89	4789785.829	283314.567
2	80.64	4789861.911	283541.888
3	79.05	4789889.953	283632.856
4	81.74	4789857.975	283906.259
5	79.90	4789822.847	283998.321
6	80.55	4789801.992	284027.472
7	77.76	4789702.577	284117.178
8	78.01	4789666.654	284150.768
9	79.89	4789705.676	283692.956

NO.	DATE	BY	REVISION
2	JAN./99	SP	FINAL
1	NOV./98	SP	ISSUED FOR REVIEW

HWY. QEW		PROJECT NO.: 981-8033	DIST. 4
SUBM'D. SP	CHKD: SP	DATE: 1998 11 27	SITE
DRAWN: PS/JFC	CHKD. SP	APPD.	DWG. RHCE 1

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

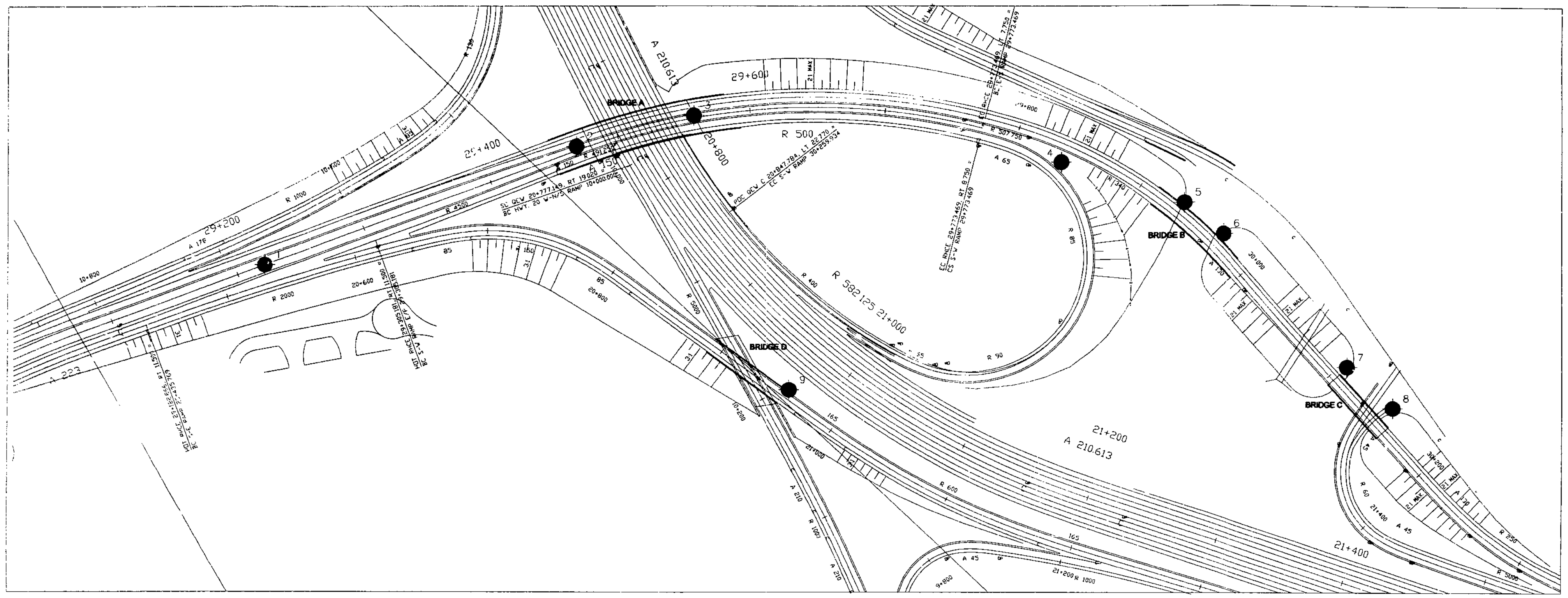
CONT. No.
WP No.

QEW / RHCE INTERCHANGE
BORE HOLE LOCATIONS

SHEET

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

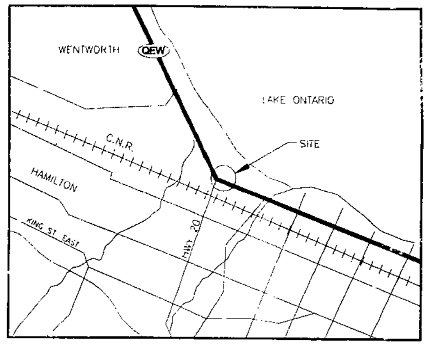


PLAN

0 40 80 120 160 240 320
SCALE 1 : 2000

PROFILE

0 5 10 15 20 30 40m
SCALE IN METRES



KEY PLAN

1 0.5 0 1 2 kilometre
SCALE, km

LEGEND	
●	Bore Hole
⊕	Dynamic Cone Penetration Test (Cone)
◐	Bore Hole & Cone
N	Blows/0.3m (Std. Pen. Test, 475 j/blow)
Cone	Blows/0.3m (60° Cone, 475 j/blow)
▼	WL at time of investigation 1998 03

No.	ELEVATION	LOCATION	
		STATION	OFFSET
1			
2			
3			
4			
5			
6			
7			
8			
9			

NOTES

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE : The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Offices, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

NO.	DATE	BY	REVISION

Geocres No.

HWY. QEW		PROJECT NO.: 981-1108	DIST. 4
SUBM'D. SP	CHKD: SP	DATE: 1998 03 30	SITE
DRAWN: PS	CHKD. SP	APPD.	DWG.

ACAD FILE FIG1.DWG

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

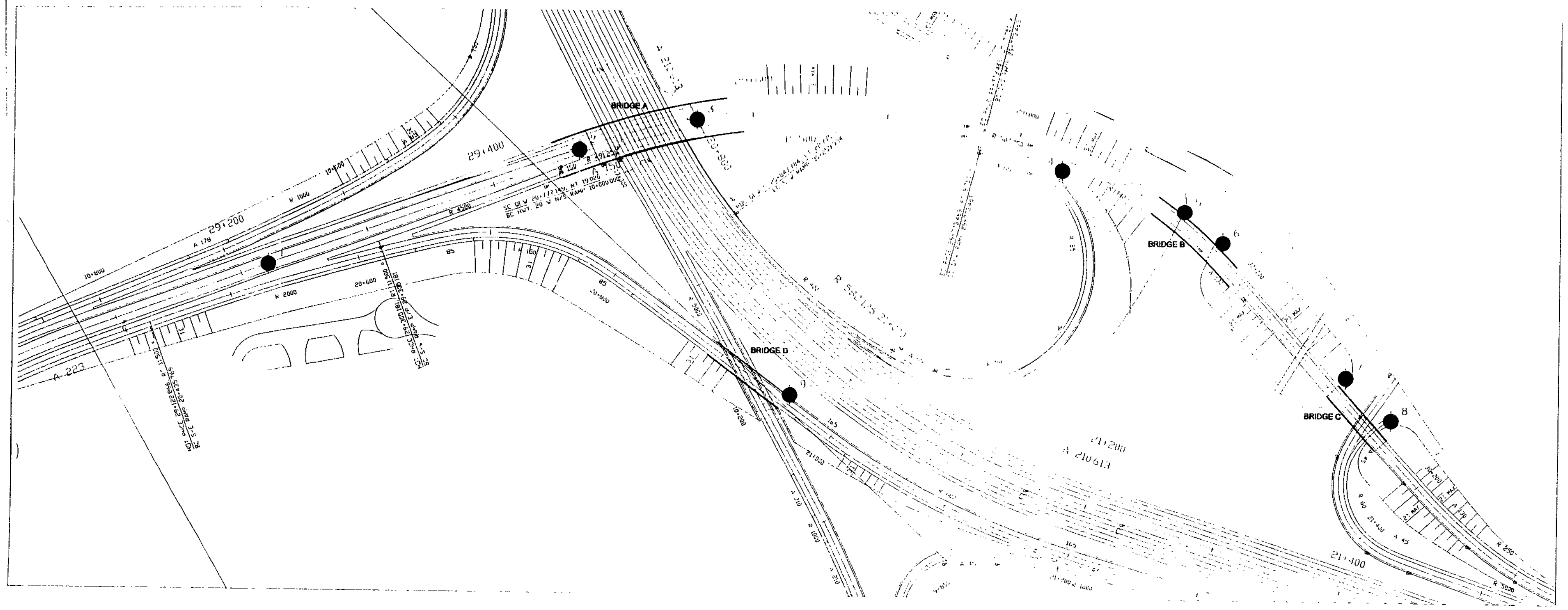
CONT. No.
WP No.

SHEET

QEW / RHCE
INTERCHANGE
BORE HOLE LOCATIONS

Golder Associates

Golder Associates Lt
MISSISSAUGA, ONTARIO, CAN

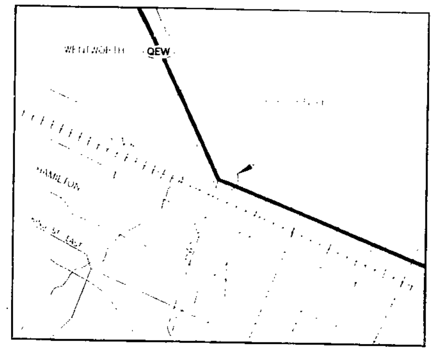


LAN

0 40 80 160 240 320
SCALE 1 : 2000

PROFILE

0 5 10 15 20 30 40m
SCALE IN METRES



KEY PLAN

1 0.5 0 1 2 kilometre
SCALE, km

LEGEND

●	Bore Hole
⦶	Dynamic Cone Penetration Test (Cone)
◕	Bore Hole & Cone
N	Blows/0.3m (Std. Pen. Test, 475 j/blow)
Cone	Blows/0.3m (60° Cone, 475 j/blow)
▼	WL at time of investigation 19[illegible] 05

No.	ELEVATION	LOCATION	
		STATION	OFFSET
1			
2			
3			
4			
5			
6			
7			
8			
9			

NOTES

The boundaries between soil strata have been [illegible] only at Bore Hole locations. Between bore holes the boundaries are assumed from geological evidence.

NOTE : The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Offices, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

NO.	DATE	BY	REVISION

Geocres No.

HWY. QE
PROJECT No. 981 1108 [illegible] 4